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Publication title	*Remote Sensing of Diesel and Petrol NOx Emissions during a Decade*
Publication type	Presentation
Introduction & Background	Traffic is a main source for air pollution especially regarding NOx / NO2. So we, as the responsible cantonal institution for air quality, wanted to monitor the promised improvements (e. g. by the emission factors written down in HBEFA) in this field. By the late nineties we started to measure real-driving emissions from cars and light duty vehicles (LDV). We report on long-term remote sensing measurements of passenger car and light duty vehicle emissions at one site close to Zurich/Switzerland. The time series of annual measurements at the same site between 2000 and 2016, the same season, and virtually the same instrument is unique, probably worldwide.
Methodology	Vehicle remote sensing (RS) is a non-intrusive technique to determine the concentration of certain pollutants in situ. The attenuation of light in its exhaust plume is measured when a vehicle crosses the beam. The stronger the attenuation in a specific wavelength, the higher is the concentration of a particular absorbent. The concentration difference relative to the measured background concentration is ascribed to the vehicle that has just passed. The instrument is regularly calibrated against a puff of gas of known concentrations. Instantaneous speed and acceleration of the vehicle are measured slightly upstream of the emission measurement. This is matched to the recorded concentrations and used as information about the engine load leading to the emissions. The technique has been developed in the late 1980's and has been further developed until today. (1) For the latest measurements in 2016 we were using a new generation of RS system, which is able to measure not only NO but also NO2. (1) Chen & Borken-Kleefeld Atm. Env. 2014, 88, 157-164
Results & Conclusions	We analyze the development of unit exhaust emissions from model years 1990 until 2016, covering all six Euro emission limit stages in force. NOx emissions from both diesel cars and light duty vehicles have not decreased in real-driving over almost two decades although emission limits have been progressively tightened. This behavior is explained mostly by a significant discrepancy between engine conditions during real-driving and the homologation test procedure. This discrepancy is not important for the other pollutants or for gasoline cars or light duty vehicles, for which the emission control equipment is found working over a wide range of engine conditions. Latest results show an improvement of the NOx emissions towards the newest generation of diesel passenger cars (stage Euro 6). The development regarding NOx emissions of the newest generation of LDV has to be watched closely. By measuring also NO2 we are now able to compare the calculated NOx emissions (depending on NO2 shares from HBEFA) with the measured NOx emissions.
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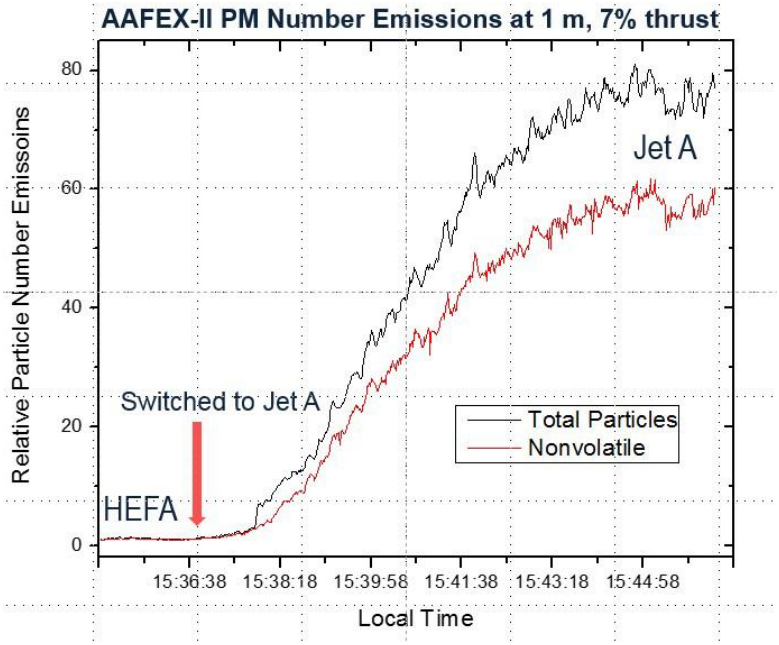
Publication title	*Effects of Fuel Composition on Aircraft Particle Emissions: Results from NASA Ground and Airborne Experiments*
Publication type	Presentation
Introduction & Background	To accelerate the development and introduction of alternative fuels, various U.S. federal agencies are conducting research to improve feedstock production, fuel conversion, processing facility scale-up and fuel certification. The U.S. National Aeronautics and Space Agency's role in this collaboration is to assess the performance and environmental impacts of candidate fuels. To fulfill this obligation, NASA has conducted field experiments to examine fuel effects on gas turbine engine gas and particle emissions during ground and cruise altitude operations. This talk will focus on utrafine/fine particle emissions and how they are effected by changes in fuel aromatic and sulfur content.
Methodology	NASA has performed a number of studies using its DC-8 with CFM56-2C engines to burn pure and blended alternative fuels for emission and performance testing. The Alternative Aviation Fuel Experiments (AAFEX-1 and -2) were conducted in 2009 and 2011 to evaluate Fischer-Tropsch (FT) and Hydrotreated Esters and Fatty Acids (HEFA) fuels, respectively. The Alternative Fuel Effects on Contrails and Cruise Emissions (ACCESS-1 and -2) flight series were conducted in 2013 and 2014 to measure DC-8 emissions when burning standard Jet A and blended HEFA fuel in both ground and airborne operations. AAFEX-2 and ACCESS-2 included tests to determine the effects of fuel sulfur on aerosol nucleation within aging engine exhaust plumes. All experiments included extensive measurements of volatile and nonvolatile (nvPM) particle number and mass concentrations along with size distribution, solubility and composition. Data were obtained during >60 hrs of ground tests and on more than 10 flights of 2 to 3 hours in duration.
Results & Conclusions	Ground tests indicate that burning pure alternative fuels reduce CFM56 nvPM number and mass emissions by 60 to 95%, depending on fuel and engine type. Reductions are generally greatest at idle and decrease with increasing thrust. Fuels with the highest hydrogen to carbon ratio typically produce the greatest nvPM reduction benefit, likely because they have higher cetane numbers and thus burn more quickly. Fuels blended with 50% standard jet fuel decrease nvPM emissions in both ground and flight operations, with reductions ranging from 30 to 70%, depending on thrust setting. Burning alternative fuels also decreases nvPM size, which leads to slighty larger reductions in nvPM mass than number emissions. Fuel sulfur concentration plays a significant role in regulating total engine PM number emissions, particularly in cool conditions. These particles form rapidly within exhaust plumes and can exceed nvPM concentrations by 1 to 2 orders of magnitude; number densities typically decease with thrust as condensation onto the surface of the increasing concentrations of nvPM competes more favorably with nucleation. Because the plumes rapidly mix with background air, the observed nucleation and "soot" modes remain externally mixed for at least several minutes downwind. Moreover, fuels with low average molecular weight, high H:C ratios, and low S content generate the lowest PM emissions.

Caption Figure 1:



DC-8 CFM56-2C engine PM number emissions after fuel is switched from 100% tallow-based HEFA to standard Jet A and the mixture residing in the fuel manifold slowly change between the two..

Author CV:

Dr. Bruce Anderson is a senior research scientist at NASA Langley Research Center in Hampton Virginia. He leads the Langley Aerosol Research Group, which conducts in situ measurements to obtain data for validating/improving remote sensor retrieval algorithms and assessing human impacts on atmospheric composition. Dr. Anderson also leads NASA efforts to characterize aircraft emissions and evaluate the effects that alternative fuels have on particle emissions and contrail formation.

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Publication title	*PN Measurements above & below 23nm*
Publication type	Presentation
Introduction & Background	The introduction of Real-world Driving Emissions (RDE) regulations and, specifically, inclusion of Particle Number (PN) for direct-injection gasoline (GDI) vehicles as of 1 September 2017, has accelerated the development of Gasoline Particulate Filters (GPF), though there are none yet in series production on mass-market vehicles. As part of a project investigating fuel and drive cycle impacts on emissions from a GDI in standard build and with a retrofit GPF, particle number measurements were made using lab-based systems and a Particle Number Portable Emissions Measurement System (PN-PEMS). Both >23nm particles and >7nm non-volatile particles were measured.
Methodology	Particle numbers >23nm were measured according to current European regulations, while >7nm particles were measured simultaneously from the same Constant Volume Sampler (CVS) dilution system. The wider size range was determined using a 7nm d50 particle counter downstream of a Catalytic Stripper (CS). A simple model, based upon manufacturer particle penetration

	and a typical GDI particle size distribution, was used to generate a correction factor for the post-CS data. Measurements were made from standard chassis dyno cycles: NEDC and WLTC, and from RDE routes reproduced on the chassis dynamometer. These chassis dynamometer RDE tests were modified to investigate the impact of going to the RDE boundary conditions for driving dynamics and ambient temperature. NEDC and WLTC drive cycles were undertaken at moderate and extreme low temperatures. All tests were undertaken both with and without GPF to determine ranges in emissions levels, filtration efficiencies and study any differences in the impact of the GPF on 23nm particles.
Results & Conclusions	From a variety of emissions cycles, including testing at high loads and low temperatures, with the retrofitted GPF, a Conformity Factor (CF) of 1 was observed for regulatory PN. Engine-out <23nm particle emissions were increased by both low temperatures and high loads, in some cases substantially, but CF=1 (at 6x1011#/km) was still observed for all conditions tested once the GPF was fitted. The data shows that the GPF effectively captures <23nm particles. In this project the retrofitted GPF appears to support compliance with PN limits over both chassis dyno cycles and demanding RDE. Initial indications are that filtration efficiencies for the GPF are increased for particles <23nm while control of particles, and compliance with CF=1 down to 10nm, or below, appears possible with the same GPF.
Author CV:	Jon Andersson is Manager of Aftertreatment and Chemical Analyses at the Shoreham Technical Centre of Ricardo UK, Ltd. with responsibility for unregulated, future emissions and PEMS research programmes conducted for governments, OEMs, Tier Ones and the oil industry. He acted as the "Golden Engineer" in the Particle Measurement Programme helping to lead the development of the measurement approach for European particle number legislation. In 2006 he was awarded the Arch T. Colwell Merit Award by SAE, and in 2013 the SAE Interregs Award, both for work on particulates and particles.

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Publication title	*Nucleation-Particle Formation in Modern Diesel Vehicle Exhaust via Acid-Base Reactions*
Publication type	Presentation
Introduction & Background	Modern Diesel Vehicle Exhaust contains numerous trace gas species, including also strongly acidic molecules (like H2SO4, HNO3, HCl) and strongly basic molecules (like NH3). These may undergo acid-base reactions, leading to molecules with strong ion-bonds, like (NH4)2SO4, NH4NO3, and NH4Cl, which may combine with each other, leading to stable salt-nucleation-particles.
Methodology	We have made a search, in modern Diesel engine exhaust, for trace gas molecules possessing large gas-phase acidities (GA) and large proton affinities (PA). The search was focused on super-acids with GA larger than GA(H2SO4) and super-bases with PA larger than PA(NH3). It was conducted in the exhaust of a modern heavy duty diesel vehicle engine, fitted with different exhaust-after-treatment systems. The analytical technique employed was a special form of chemical ionization ion trap mass spectrometry (negative and positive ions), originally developed at MPIK-Heidelberg.
Results & Conclusions	Numerous trace gas species possessing large-GAs and large-PAs have been detected. These include sulfuric acid and certain super-acids as well as ammonia and super-bases. Our findings have interesting implications for nucleation-particle formation in modern Diesel vehicle exhaust. Implications will be discussed in the light of accompanying model simulations.
Author CV:	The research group “Atmospheric Ions and Trace gases” at MPIK (Max-Planck-Institut für Kernphysik at Heidelberg is headed by Prof. Frank Arnold; Atmospheric measurements which covered altitudes between ground-level and 350 km mostly focused on the troposphere and stratosphere. These measurements yielded numerous pioneering discoveries for which Prof. Arnold was awarded the “Deutscher Umweltpreis” and the “Max Planck Forschungspreis für Physik” and some of his PhD students received awards for their PhD thesis (Otto Hahn Medals and Humboldt award for young scientists). Prof. Arnold is teaching environmental and atmospheric physics at the university of Heidelberg. He has published more than 210 peer reviewed papers on atmospheric research including 22 in NATURE and SCIENCE.

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Publication title	*Diesel, Petrol or Electricity for Future Road Traffic*
Publication type	Presentation
Introduction & Background	Mobility is a key requirement for humanity. This can be seen not least in the sales figures of the automobile industry, the expansion of the road network and the ever-increasing traffic density, especially in our cities. The internal combustion engine has been used as a central powertrain unit for various reasons. Despite continuous improvements in consumption and emissions, this technology is now justified. On closer examination, however, the complexity of the overall situation must be respected. For the assessment of powertrain technologies, all processes of the generation, the storage and the conversion of energy are to be assessed. In addition, the maturity of components and processes must be considered. Today's discussion is largely based on the hope that technical problems will be solved. The automobile industry is often criticized by the preventive because the social memory has not forgiven certain discussions about the introduction of new technologies. For the introduction of, for example, the 3-way catalytic converter or the diesel particulate filter, the public has realized that the automobile industry is implementing technology when pressure is exerted. This is what she now thinks in the introduction of electric mobility. In doing so, it misunderstands that certain solutions only appear tangible. And it misunderstands that it is actually the total resource consumption of mankind that is the central problem. The key invention in the internal combustion engine is not piston, injection system or turbocharger, the most important invention is the fuel. Hydrocarbons are a good way of storing energy. The use of energy conversion in the form of combustion is not always the wrong way. Since the early days of mankind, the flame has done us much good, it gave us light and heat, helped us in the preparation of food and protection from the evil lion. To evaluate the future of our powertrain technologies, it is important to conduct the discussion comprehensively and holistically. The long-term future is unpredictable. In the medium term, hybrid technologies are likely to become increasingly popular because they combine the advantages of different systems.
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Publication title	*Cross Evaluating the Effects of a Cerium-Based Diesel Fuel Additive on Exhaust Toxicity with in vitro Air-Liquid Interface Cell Exposure Systems of Different Flow Patterns*
Publication type	Poster
Introduction & Background	Inhalation of particles from diesel exhaust has been shown to lead to pulmonary morbidity (Oberdörster et al., 2005), cardiovascular disease (Geiser et al., 2010) and lung cancer (Oeder et al., 2015). Metal oxide fuel additives for oxidizing soot particles trapped on the diesel particulate filters have been explored as sources of additional oxidation for the soot particles and gases, reducing emissions within diesel exhaust; however, unclear evidence exists regarding their influence on exhaust toxicity (Steiner et al., 2015, Snow et al, 2014). Inhaled aerosols are generally tested in suspension or at the air-liquid interface (ALI). In suspension, particles are added directly to liquid over cells and allowed to settle. ALI exposure conditions are considered more physiologically relevant, as the cells are grown on a membrane, allowing one side to equilibrate to air and then exposed to aerosols while the other side receives nutrients. Various in vitro systems have been developed to facilitate exposure at the ALI; however, these systems operate with various flow patterns, each mimicking different methods of deposition within the respiratory tract. Systems using parallel flow, over the cells, provide less stress on the cells compared to a perpendicular flow, directly onto the cells. While the effects of diesel exhaust have been studied in vitro, the effects have not been extensively studied at the ALI, nor with metal oxide additives.
Methodology	The objective of the current work is to investigate how the addition of a commercial, cerium-based additive in low-sulfur diesel fuel affects the exhaust cytotoxicity and oxidative activity, using two ALI cell exposure systems of different flow patterns: the newly designed Portable In Vitro Exposure Cassette (PIVEC) (Secondo and Lewinski, in preparation) and the Multiculture Exposure Chamber (MEC) (Asimakopoulou et al., 2011, 2013). In this respect, a series of cellular and acellular exposure experiments is performed using a diluted exhaust stream from a single cylinder, four-stroke, air cooled and direct injection diesel engine. Exposure particulate emissions are sustained at 106 #/cm3, while particulate size distribution and concentrations are measured by a Scanning Mobility Particle Sizer. All exposure experiments are performed for 3 hours. For dosimetry determination, acellular experiments using glass-fiber filters and blank cell culture inserts within the PIVEC are performed as well as Transmission Electron Microscopy. Exposure experiments with low-sulfur commercial diesel without additive are also performed as reference, while control cell cultures are exposed to filtered air. The alveolar adenocarcinomic cancer line, A549, is used to evaluate cytotoxicity and oxidative activity.
Results & Conclusions	Cellular cytotoxicity results show decrease in viability with the addition of the cerium-based additive. Experimental results support initial hypotheses regarding cell exposure system design, i.e. the actual amount of particulates deposited on the cell layer is dependent upon flow conditions. Since, the

	MEC's principle of operation relies on the stagnation point and thus operates under parallel flow, while the PIVEC uses perpendicular flow, variations in cytotoxicity are expected. Less cell death is observed in the MEC in comparison with the PIVEC due to less stress on the cells.
Author CV:	Ms. Penelope Baltzopoulou is Chemical Engineer (Dipl. ChE - Aristotle University of Thessaloniki, 2001) and holds an MSc on Environmental Physics (Aristotle University of Thessaloniki, 2004). She is experienced in particulate emissions measurements, aerosol characterization, environmental data analysis and air pollution assessments. She has participated in several research projects related to emission measurements and assessment of exhaust aftertreatment technologies, as well as assessment of the health effects of nanoparticle exposure (also member of the finalist research group of the 2nd "Greece Innovates!" competition (2013) with the "System for preliminary in-vitro health impact assessment of size-selected nanoparticles"). She is the author and co-author of 4 publications in peer-reviewed journals and of more than 20 publications/participations in conferences. She is a member of the Aerosol and Particle Technology Laboratory (APTL) / Centre for Research and Technology – Hellas (CERTH) for 8 years (2002-2005, 2011-now) and member of the Hellenic Association of Aerosol Research (HAAR). She was responsible for the environmental studies department in DRAXIS ENVIRONMENTAL S.A. (2005-2011).

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Publication title	*Combustion and Emissions Investigations Using OME and Stoichiometric Operation in a Compression Ignition Engine*
Publication type	Presentation
Introduction & Background	Oxygenated fuels are well known for their emission reduction potential in internal combustion engines. In particular Poly(oxymethylene) dimethyl ether (POMDME, OME) reducing soot at the exhaust of internal combustion engines due to their lack of chemical C-C bonds. In addition, due to their potential production in large scale from renewable feedstocks, these fuels have received great attention in the last years. Consequently, detailed analysis on their combustion and emissions formation process provides a valuable contribution for optimum use of alternative green fuels for low emission engines.
Methodology	In the present study, OME with the following molecular structure CH3-O-(CH2-O)n-CH3 with n = 3,4 and 5 has been used for investigations in a single cylinder heavy duty research engine. The chemical structure of OME allows extremely high EGR ratios without the presence of soot in the exhaust. The operating strategy of this study includes a comparison of OME with a standard diesel as well as operation with very high EGR ratios and stoichiometric global equivalence ratio. For the experiments, the nozzle holes of the engine fuel injector have been modified to compensate for the reduced lower heating value of OME. The engine is equipped with cylinder pressure sensors to obtain the combustion characteristics. In addition, the exhaust particles are counted with a differential mobility sizer, partially analyzed using transmission electron microscopy (TEM) and the exhaust gas is analyzed for CO, CO2, O2, NOx, HC and CH4 emissions.
Results & Conclusions	The operation with OME in comparison to Diesel shows a remarkably higher diffusion combustion rate. Even though, the injection duration is longer, the late phase combustion is faster using OME in comparison with Diesel operation. Both effects are attributed to the oxygen content in the fuel. The operation with OME allows a sweep in EGR rate, substituting the charge air with recirculated exhaust gas until globally stoichiometric conditions are achieved. Without EGR, particles numbers above 23 nm are in the range of the background noise. With higher EGR rates, agglomerated particles are detected until the increasing EGR rate reduces the in-cylinder temperature to the point where soot formation is inhibited altogether. NOx emissions decrease monotonically with increasing EGR rate. The unburned hydrocarbons (HC) show an average methane (CH4) content of 50% throughout the measurements. The investigation of an exhaust sample in the TEM shows only particles with a metal core (possibly from lube oil), surrounded by a soot layer. Apparently, the metal particles drive the nucleation process and determine the particle number emissions. The operation of a Diesel engine, fueled with OME with only minor modifications, allows a stoichiometric operation with mixing controlled combustion. This setup would enable the exhaust gas aftertreatment to be performed by a three-way-catalyst, without limitations of engine knock present in a premixed engine with high compression ratio. However, carbon monoxide (CO) emissions close to stoichiometric operation are very high.
Author CV:	Christophe Barro graduated in mechanical engineering in 2008 at the ETH Zurich, from where he received his PhD in 2012. He is still at the ETH as

lecturer and currently leads one of the experimental groups at the aerothermochemistry and combustion systems laboratory. In 2016 he co-founded the ETH spin of company Vir2sense, developing virtual combustion and emission sensors for optimum diesel engine and aftertreatment operation. His research focus is in the fields of ultra-fast emission and combustion modelling, emission measurement and optical diagnostics of diesel engines and their derivatives.

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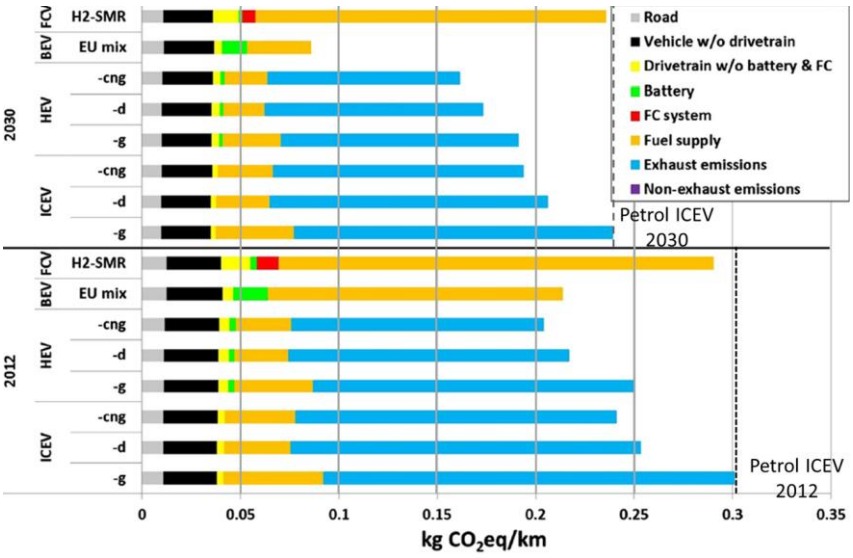
Publication title	*The environmental performance of current and future passenger vehicles: Life cycle assessment based on a novel scenario analysis framework*
Publication type	Presentation
Introduction & Background	Current passenger vehicles are predominantly fueled by crude-oil based fuels and therefore a substantial source of CO2 emissions. In addition, these vehicles are important sources of air pollutants such as nitrogen oxides (NOx), sulfur dioxide (SO2) and particulate matter (PM), which are increasingly contributing to human health impacts, especially in urban areas. Several advanced vehicle and fuel technologies - e.g. battery electric vehicles (BEV) and fuel cell vehicles (FCV) - are currently being developed in order to reduce the environmental impacts of road passenger transport and the dependency on fossil resources. However, the potential advantages of these new technologies from the environmental perspective need to be demonstrated taking into account the complete life cycle of the vehicles including their manufacturing, operation, and end-of-life, as well as the fuel supply. For this purpose, a comprehensive Life Cycle Assessment (LCA) of a wide range of current and future passenger vehicle technologies and their energy supply chains has been carried out and is presented.
Methodology	Life Cycle Assessment includes compiling inventories of the environmentally relevant flows (i.e. emissions, natural resources, material and energy, waste) related to all processes involved in the production, use, and end-of-life of a product and based on these, quantifying the associated cumulative life-cycle burdens. The results are supposed to answer the question ‘‘What are (will be) the environmental burdens associated with traveling one kilometer with a certain vehicle today (and in 2030) and where do they come from?’’. The functional unit used for the comparative evaluation is ‘‘one kilometer (km) driven’’. The assessment is based on generic, mid-sized European passenger vehicles (‘‘VW Passat class’’). These are modeled with different fuels and drivetrains and their operation is simulated for “real-life” operation. Modeling and simulation are both carried out in a consistent framework which is mandatory for a comparative assessment.
Results & Conclusions	BEV and FCV cause substantially less life-cycle greenhouse gas (GHG) emissions than conventional fossil-fueled ICEV, if – and only if – they use electricity and hydrogen, respectively, produced from non-fossil energy resources. They can in the best case reduce the carbon footprint of current and near-future passenger vehicles by almost 80%. However, using fossil energy carries for electricity and hydrogen production can even lead to an increase in GHG emissions. Therefore, it is currently counterproductive to promote BEV in areas with high shares of coal power in the electricity mix as well as FCV as long as NG SMR is the main source of hydrogen. Concerning the other environmental burdens analyzed, BEV and FCV provide less benefit. While BEV charged with ‘‘clean electricity’’ cause at least slightly lower burdens than fossil fueled ICEV, FCV tend to generate higher burdens independent of the hydrogen generation pathway. This more ambiguous performance of BEV and FCV is mainly a consequence of emissions along the fuel supply chains and vehicle (component) manufacturing: often, resource extraction and processing as well as combustion of fossil fuels in the production chains generate

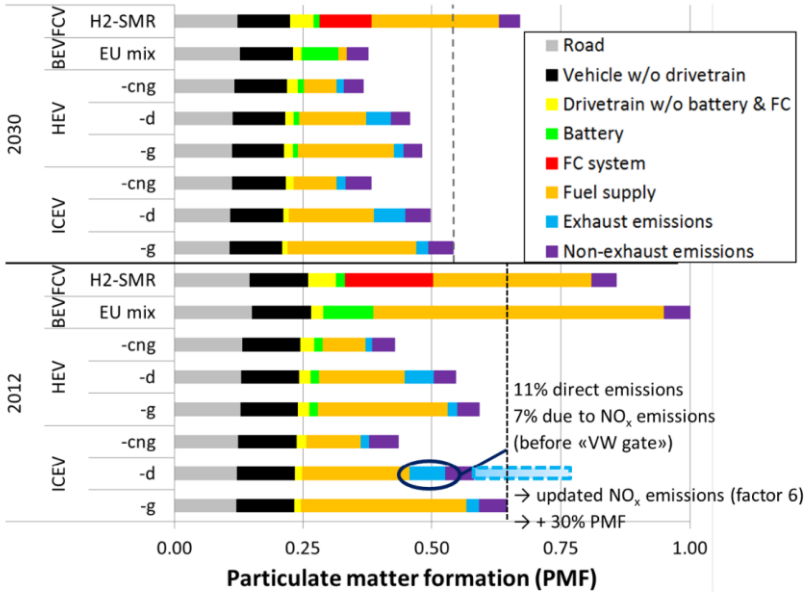
comparatively high burdens.

Caption Figure 1:



Life-cycle GHG emissions of selected mid-size passenger vehicles with different drivetrains and fuels. ICEV: internal combustion engine vehicle; HEV: hybrid electric vehicle; BEV: battery electric vehicle; FCV: fuel cell vehicle; SMR: steam methane reforming; cng: compressed natural gas; d: diesel; g: gasoline.

Caption Figure 2:



Particulate matter formation (PMF) LCA results of selected mid-size passenger vehicles with different drivetrains and fuels (scaled to max=1). ICEV: internal combustion engine vehicle; HEV: hybrid electric vehicle; BEV: battery electric vehicle; FCV: fuel cell vehicle; SMR: steam methane reforming; cng: compressed natural gas; d: diesel; g: gasoline.

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Christian Bauer is researcher at the Paul Scherrer Institute in Villigen, Switzerland. He is working in the Laboratory for Energy Systems Analysis. His research focuses on Life Cycle Assessment as well as sustainability assessment of current and future energy and mobility technologies. He is member of the expert group and the board of the LCA database ecoinvent.

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Publication title	*Traffic-related UFP and Cardiovascular Health: Findings from a community-based study in Boston, MA*
Publication type	Presentation
Introduction & Background	Health effects of airborne, transportation-related ultrafine particles (UFP) are of increasing interest. In contrast to fine particulate matter, less is known about the health consequences of exposure to UFP.
Methodology	We measured particle number concentration (PNC, representing UFP; >4 nm) by mobile monitoring on 34-46 days/year in each of three urban neighborhoods with both near-highway and background areas. We developed regression models of PNC that included wind speed and direction, temperature, highway traffic volume, and distance from the highway edge as predictors. We also recruited participants in each study area (N=703) and collected survey and blood samples on a subset (hsCRP, IL-6, TNFRII and fibrinogen; N=450) and blood pressure from them. Models estimated PNC at residences for every hour for a year at 20 meter resolution. Outdoor residential PNC were adjusted for air conditioning and for participant time-activity to assign individualized time-activity annual average PNC (TAA-PNC). Multivariable regression modeling was used to assess associations of TAA-PNC with blood biomarkers and complete covariate data (N=408), cardiovascular disease outcomes (N=703), and blood pressure (N=409). We also assessed short term associations of blood biomarkers with central-site PNC for a subset (N=142). Blood samples from 59 non-smoking participants were selected based on high (mean 24,000 particles/cm3) and low (mean 16,000 particles/cm3) TAA-PNC exposures and analyzed using high-resolution mass spectrometry to quantify levels of 79 central metabolic intermediates, followed by a metabolome-wide association study (MWAS) for untargeted identification of discriminatory metabolic features.
Results & Conclusions	TAA-PNC was positively, but not significantly, associated with a 14.0% (95% CI: −4.6%, 36.2%) positive difference in hsCRP, an 8.9% (95% CI: −0.4%, 10.9%) positive difference in IL-6, and a 5.1% (95% CI:−0.4%, 10.9%) positive difference in TNFRII. For the non-Hispanic white subpopulation the associations were larger and significant, while they were smaller and not significant for the Asian subpopulation. Structural equation modeling confirmed associations between inflammation and TAA-PNC exposure. There was a non-significant positive association of TAA-PNC with stroke and ischemic heart diseases (S/IHD), no evidence of an association with hypertension, and a non-significant negative association with diabetes. A subset analysis controlling for BMI produced slightly stronger associations for S/IHD (OR=1.61, 95% CI: 0.88, 2.92) and hypertension (OR=1.28, 95% CI: 0.81, 2.02), and no association with diabetes (OR=1.09, 95% CI=0.61, 1.96). We found that TAA-PNC was not significantly associated with any of the blood pressure values; however, as with blood biomarkers, there were significant associations in the non-Hispanic white subpopulation. Estimated short term effects with central site PNC generally increased with longer averaging times (highest at 28 days) for IL-6, hsCRP, and fibrinogen. Comparison of quantified metabolites identified five differentially-expressed metabolites consistent with increased oxidative stress and endothelial dysfunction. MWAS identified metabolites related to lipid peroxidation,

endogenous inhibitors of nitric oxide, and environmental chemicals arising from exhaust emissions. Network correlation analysis showed 38 metabolic pathways were associated with UFP exposure, including those related to inflammation, oxidative stress, endothelial function and mitochondrial bioenergetics. Our findings are consistent with cardiovascular effects of UFP of traffic origin.

Caption Figure 1:

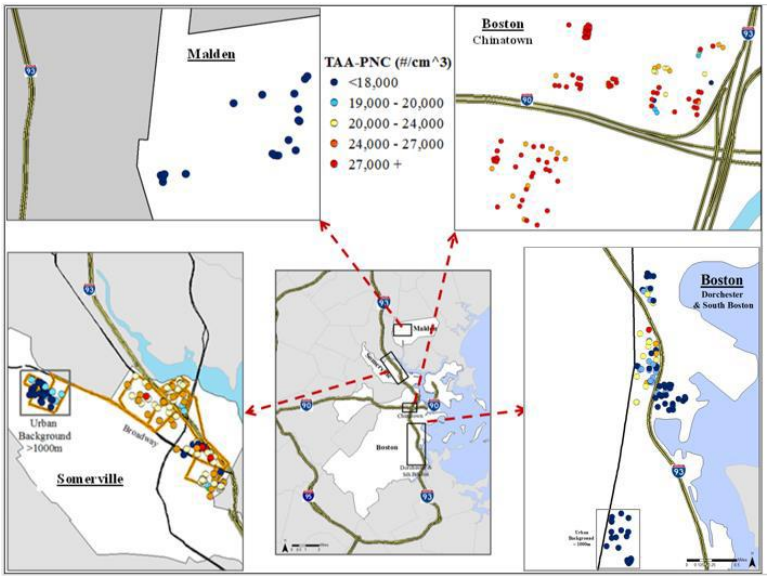

Figure 1: Time-activity adjusted annual average particle number concentration (TAA-PNC) by study area.

Caption Figure 2:

Image not found or type unknown

Figure 2. GAM plot of hsCRP with TAA-PNC exposure.

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Publication title	*Wall-flow Type DPF System to Replace Existing Wet Element Filter Systems Used in Typical LHDs in Underground Coal Operations*
Publication type	Presentation
Introduction & Background	The need to protect workers from diesel particulate matter (DPM) has lead the Australian underground coal mining industry to install disposable filter systems on their vehicles. While the disposable filters are efficient at removing significant DPM, the following major issues have arisen: • High cost of operations. Disposable filters need to be changed at least once per shift, and additionally incur environmental costs for disposal and management. • Improper installation, damaged seals and lack of installing a new filter when the old filter is removed means that workers are still being exposed to excessive amounts of DPM. ACARP, the Australian Coal Association Research Program, funded the studies into the suitability of conventional on-road heavy duty diesel wall-flow filter systems to be adapted for use in underground coal operations. In addition to regulatory constraints including maximum limits on system surface and tailpipe temperatures, the relatively light duty of the machines in operations looked set to make it challenging for wall-flow filter systems to satisfactorily regenerate.
Methodology	The bulk of the ACARP system development program uses Orbital's state-of-the-art heavy duty engine testing facility to replicate LHD onsite operations using its transient dynamometer capability so as to not interrupt site operations. This also minimises safety risk as early prototypes could present an explosion risk if tested at site given the gaseous nature of underground coal operations. Another important consideration is test repeatability. Use of a test facility ensures that factors such as changes in the mine operation do not impact the test results. The development of both customised steady-state and transient engine test cycles for LHD type vehicles was based on measured and analysed data gathered from onsite testing and data collection. This type of data acquisition and analysis is understood to have been an Australian coal industry first. The developed engine test cycles are expected to have applicability beyond this current project, assisting the industry to quantify not just emissions but in optimising other operational aspects, such as fuel use and operator training. The process adopted whereby the core activities were undertaken off-line from the operational mining environment, but still retaining engagement with industry through frequent onsite testing and re-testing, has allowed for a complex program to be executed in a safe and very fast timeframe;
Results & Conclusions	The ACARP project successfully demonstrated both comparable significant DPM emissions reduction and satisfactory system robustness on a proof-of-concept (PoC) wall-flow DPF system for implementation on a Load Haul Dump (LHD) vehicle typical of that used by the Australian underground coal industry. It was noted in testing that the technology increased modal NO2 formation, but was compliant over typical operational duty cycles. One of the key benefits with the use of a wall-flow DPF system is its tamper-proof design mitigating the risk of operating unfiltered diesel plant in poorly ventilated

	areas. Elimination of the need for continual replacement of disposable filters provides significant operational savings estimated to be up to 80% of the incumbent technology. ACARP project C25073 was scoped to fund only the proof-of-concept phase of the wall-flow DPF development program. Industrialisation of the project system was beyond the scope of the project budget and is deferred to the next stage. The system looks to have potential as both an OEM and retrofitable solution.
Author CV:	Nick has over twenty years of powertrain engineering experience. He has managed research and development programs in high technology, low emissions fuel systems as well as advanced application-engineering programs for customers around the globe. Nick's project exposure has been diverse. He's guided the Australian government on fuels policy, helped OEMs meet the latest emissions norms on both petrol and diesel products, worked with catalyst technology leaders to develop state-of-the-art aftertreatment systems and partnered with CSIRO on health effects of engine emissions. He has also published several technical papers and holds patents in fuel injection and vapour handling systems.

Czerwinski Jan

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Publication title	*Nanoparticle Emissions of GDI Car with Increased Lube Oil Consumption, Potentials of GPF*
Publication type	Presentation
Introduction & Background	The particle number (PN) emissions are increasingly considered in the progressing exhaust gas legislation for on- and off- road vehicles. The invisible nanoparticles penetrate like a gas into the living organisms and cause several health hazards. The present paper shows how the PN- and gaseous emissions of a modern GDI *) vehicle change, when there is an in-creased lube oil consumption. What are the potentials of a gasoline particle filter to reduce the emissions?
Methodology	The lube oil consumption was simulated by mixing 2% vol. lube oil into the fuel. A non-coated GPF was mounted at tailpipe, so only the filtration effects were indicated. The tests were performed at transient (WLTC) and at stationary (SSC) operating conditions.
Results & Conclusions	It has been shown that the increased lube oil consumption significantly increases the PN-emissions and the applied high quality GPF eliminates these emissions very efficiently.
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Publication title	*Assessment of Particle Pollution from Jetliners: From Smoke Visibility to Nanoparticle Counting*
Publication type	Presentation
Introduction & Background	Aviation is a substantial and a fast growing emissions source. Besides greenhouse gases, aircraft engines emit black carbon (BC), a climate forcer and air pollutant. Aviation BC emissions have been regulated and estimated through exhaust smoke visibility (smoke number). Their impacts are poorly understood because emission inventories lack representative data. The air quality and climate impacts of aviation can be soon better assessed through the nonvolatile PM (nvPM) emissions standard for commercial jet engines, the first new aviation emissions standard in 40 years. Here, we use standardized nvPM measurement data and a detailed engine performance model to estimate BC mass and number emissions from a single aisle airliner modeled on the Next-Generation Boeing 737 (almost 1/3 of all 100+ seater airliners in service) over entire flight missions. We then use our flight mission estimates to answer the question whether modern-day air travel produces more BC per passenger and kilometer than cars and buses.
Methodology	The emission tests were done on two in-service well run-in engines in the engine test cell of SR Technics at Zurich airport, Switzerland using an nvPM measurement system compliant with the future nvPM standard. The nvPM mass and number concentrations were corrected for losses due to diffusion and thermophoresis. The loss-corrected concentrations were converted to emission indices (EIs). We estimated the effects of fuel composition variability on the EIs using an empirical model developed for the engine tested (Brem et al., ES&T, 2015). The emissions measured were corrected to flight conditions by correcting for the effects of combustor inlet pressure and air-fuel ratio on soot formation. To determine the engine performance parameters at any flight condition, we developed a detailed engine performance model calibrated to sea level performance data (Durdina et al., ES&T, 2017).
Results & Conclusions	Compared to previous estimates, we found up to a factor of 4 less BC mass emitted from the standardized landing and take-off cycle and up to a factor of 40 less during taxiing. However, the taxi phase accounted for up to 30% of the total BC number emissions. Depending on the fuel composition and flight distance, the mass and number-based emission indices (/kg fuel burned) were 6.2 – 14.7 mg and 2.8×1e14 – 8.7×1e14, respectively. For the representative cruise conditions with nominal fuel, the determined mission EIm is up to 85% lower than previous estimates for the global fleet (Stettler et al., ES&T, 2013). The BC mass emissions per passenger-km were similar to gasoline vehicles, but the number-based emissions were relatively higher, comparable to old diesel vehicles (Figure 1). This study provides representative data for models and will lead to more accurate assessments of environmental impacts of aviation.
Caption Figure 1:	Comparison of the BC mass (a) and number (b) emissions per passenger-km. Vehicle emissions data were taken from Giechaskiel et al., AS&T, 2012 and Hallquist et al., ACP, 2013 and normalized per two car passengers and 30 bus passengers.
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2012 – 2016 PhD in Environmental Engineering, ETH Zurich
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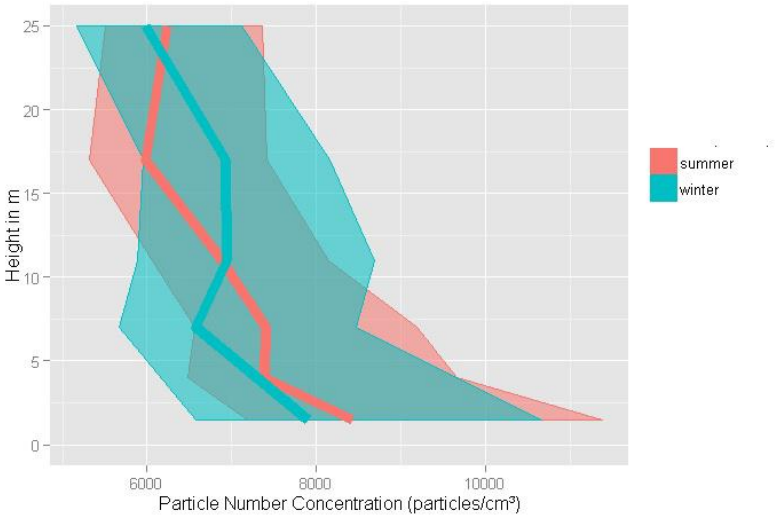
Publication title	*Characterizing Real-time Vertical Air Pollution Gradients in an Urban Environment*
Publication type	Presentation
Introduction & Background	Air pollution monitoring and modelling studies commonly only consider proximity to sources in the horizontal plane while differences in air pollution exposure in the vertical dimension; eg, depending on the floor of residence, are rarely characterized. We aimed to understand how the real-time vertical gradients for three different air pollutants depend on traffic intensity, street configuration and seasonality.
Methodology	Measurement sites were selected along 11 streets in Basel, Switzerland on two quiet (50-100 vehicles/30min), four medium-traffic (100-250 vehicles/30min) and five busy streets (over 300 vehicles/30min), with different street configurations. We measured Particle Number Concentration, PM2.5 and black carbon using real-time instruments at up to six different heights above ground (1.5, 4, 7, 11, 17 and 25 meters) simultaneously, during the winter and summer seasons of 2016. Baskets containing the instruments were hung from a bucket truck, which remained at each sampling site for 30 minutes during off-peak hours.
Results & Conclusions	Wintertime PNC concentrations were typically 19% lower at 7m than at 1.5m, and 50% lower at 25m than at 1.5m. The decrease in concentration was consistently larger for busy streets than for medium-traffic streets and for quiet streets (e.g. for a height difference 1.5m and 7m: 29%, 22% and 14%, respectively). We found no significant vertical gradient for PM2.5, even between 1.5m and 25m. PM2.5 is known to be a secondary aerosol showing less spatial variability. For BC, we found no substantial differences between the heights of 1.5m and 7m, whereas we saw a median reduction of 25% in BC concentration with increasing height from 1.5m to 25m. The absence of a BC gradient between 1.5m and 7m may be due to a major source of BC: the tailpipes of diesel trucks, which are commonly higher than the tailpipes of cars. If we measure and model air pollutants only at ground level, we may substantially overestimate exposure at higher floors, especially for pollutants whose levels decrease sharply within close proximity of the source, such as PNC.

Caption Figure 1:

Respirable carbon fiber fragments (after a composite fire).

Caption Figure 2:



Decrease of particle number concentration with increasing height above the ground on a busy street in Basel

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Marloes Eeftens CV
AREAS OF ACADEMIC INTEREST
• Environmental epidemiology focussed on the health effects of air pollution and electromagnetic fields
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FUNDING AWARDED
CHF 23,500 Principal Investigator, Foster Identity through Collaborations - Call for SSPH+ Workshops or Projects 2016, SSPH+, Switzerland
CHF 79,950 Forschungsfonds 2015 - Förderung excellenter Nachwuchsforschender (Research fund for excellent Young Researchers), University of Basel, Switzerland
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Publication title	*Formation of Respirable Carbon Fiber Fragments in Carbon Composite Fires*
Publication type	Presentation
Introduction & Background	Recently, elevated concentrations of respirable fiber dust according to the Definition by the World Health Organization were detected during handling of combusted carbon composite material after a fire [1, 2], requiring personal protective equipment, especially for rescue personnel and police [3]. The handling of fire residues has a major influence on the release of critical fiber dust, because mechanical load promotes the breaking of degraded fibers and the release of their fragments. This work defines critical conditions of fires, when the formation of respirable carbon fibers is to be expected. Therefore, laboratory experiments are performed to principally characterize the degradation mechanism of carbon fibers at elevated temperatures. Approaches to improve combustion properties of carbon composites are presented an the risk of potential health hazards are assessed.
Methodology	Reaction-to-fire characteristics such as heat release, mass loss, etc. were analysed with a cone calorimeter (Fire Testing Technology Ltd., England) according to ISO 5660. Specimens (100 x 100 mm2) were irradiated at heat fluxes between 25 and 80 kW/m2 corresponding to developing and fully developed fires. A large scale fire test using 20 kg of composite material was performed with 40l kerosene and evolved fiber fragments were collected on gold coated filters. Thermogravimetric analyses (TGA) were carried out with a thermo balance Iris 209 F1 (Netzsch) starting at room temperature and heated to 900°C in various concentrations of air and nitrogen (50 ml/min) with a heating rate of typically 10°C/min. A JEOL JSM-6480 LV scanning electron microscope was used for the determination of fiber diameters and calculation of concentrations of respirable fibers.
Results & Conclusions	Significant degradation of typical carbon fibers occurs beyond a threshold temperature of ca. 600°C during a fire. High external heat load and prolonged duration of a fire lead to decreasing fiber diameters. Critical fiber diameters below 3µm are reached earlier for thin fibers compared to thicker fibers. The type of carbon fiber (intermediate modulus, high tenacity etc.) does not play a major role concerning its degradation velocity. Principles for effective protection of carbon fibers during a fire are identified. Flame retardants forming for example glassy layers thermally stable beyond 600°C are proposed. Considering various conditions of a fire and the possible exposition against respirable carbon fibers, a potential health hazard is assessed. Carbon fiber reinforced plastic material still remains an important leight weight material in future applications However, further research is necessary to improve the material and to increase the awareness of certain risks.
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Publication title	*Blue Technology not green enough: Nitrogen Chemistry of Current On-road DeNOx-Technologies*
Publication type	Presentation
Introduction & Background	The integration of particle filters in diesel passenger cars (PCs) started already in 2000. DPFs are now widely used and considered as best available technology. Nevertheless, most DPFs, often used in combination with diesel oxidation catalysts (DOCs), increase NO2 emissions. On-road measurements in Zürich indicate that NOx emissions of diesel PCs and light duty vehicles (LDVs) have increased about 2 fold from 1990 to 2005 and are only slowly decreasing since then still exceeding levels of pre-1990 vehicles [1]. In other words, on-road NOx emissions of diesel PCs and LDVs are 10 times higher than those of gasoline vehicles. Diesel vehicles are major contributors to the urban NO2 pollution with frequent exceedances of the air quality standard of 40 µg/m3 in many European cities. To start the focus event, advantages and problems of current deNOx-technologies will be discussed and risks and challenges of future developments will be addressed.
Methodology	Time-resolve chemical ionization mass spectrometry (CI-MS, V&T 500, Absam, Austria) and Fourier transform infrared spectroscopy (FT-IR, Sesam, AVL) were applied to study emissions of reactive nitrogen compounds (RNC) of gasoline vehicles, equipped with three-way catalysts and NOx-traps. The vehicles were operated on chassis dynamometers under steady and transient driving. In addition, a medium-duty diesel engine (3.0 L, 100 kW) equipped with an urea-based SCR catalyst with and without DPF operated on a test bench was studied with respect on RNC emissions.
Results & Conclusions	The NOx-trap vehicle released RNCs in variable composition. NO and NO2 were frequently found throughout the test. NO2 proportions varied from 6-38%. Ammonia was mainly released under transient driving conditions and when extra fuel was injected to regenerate the NOx-trap. These fuel injections immediately changed the chemical composition of the exhaust. They induced a quick release of adsorbed compounds and the secondary formation of pollutants such as NH3, N2O and HNCO. NO conversion in the NOx-trap was low (0-26%). NO2 conversion was slightly higher (14-42%). The fuel penalty was substantial (5-12%). For comparison, RNC emissions of TWC gasoline vehicles and a medium-duty diesel engine with urea-based SCR technology will also be discussed [2,3]. NO conversion efficiencies above 95% were achieved at most conditions. However, ammonia formation in the TWC and slip from the SCR catalyst are relevant too. We conclude that the performance of the three most important deNOx-technologies currently applied on roads vary substantially with respect to efficiencies and secondary emissions of NO2, NH3, HNCO and N2O. NO conversion is highest for TWCs, followed by SCR catalysts, which are active at high engine loads, but inactive e.g. at urban driving. NO conversion of the tested NOx-trap is poor not exceeding 30%. Overall we conclude that the Diesel deNOx-technologies used so far did not lower NO and NO2 emissions to levels prescribed by legislation. This is

supported by two decades of on-road measurements at Zürich [1].

[1] Chen et al. Atm. Env. 2014, 88,157-164.
[2] Heeb et al. Atm. Env. 2006, 40, 5986-5997.
[3] Heeb et al. ES&T. 2012, 46, 13317-13325.

Author CV:

Norbert Heeb studied chemistry at the ETH Zürich with a focus on organic and analytical chemistry. In 1991, he earned his PhD at the ETH Zürich in Prof. Steven Benner's group at the Institute of Organic Chemistry, where he developed novel DNA-based biocatalysts. During his post-doctoral studies at the University of California in Davis, he investigated DNA-protein recognition mechanisms of artificial peptides. In 1993, he joined the Laboratory of Organic Chemistry at Empa. His current research activities are in the field of applied catalysis. With different mass spectrometry techniques, he is studying chemical transformations in current and future catalytic converter technologies such as particle filters, deNOx-technologies and combined filter-deNOx-system. For his research on particle filter chemistry he was awarded with the Sandmeyer Prize of the Swiss Chemical Society in 2009.

Hosseini Vahid

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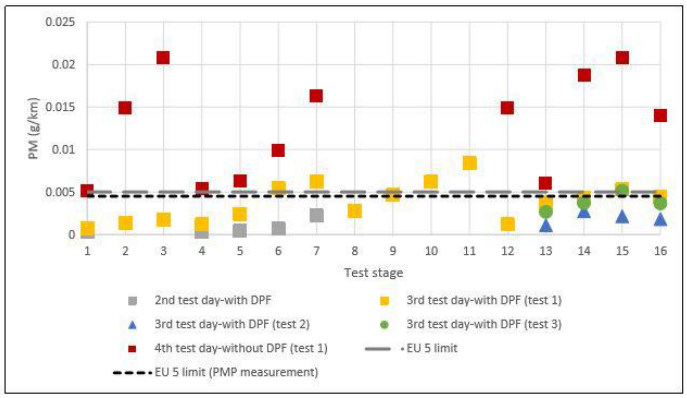
Publication title	*New-fit Sulfur Tolerant DPF Solution to Meet Iran's New Emission Legislation*
Publication type	Presentation
Introduction & Background	The new Iranian emission legislation for diesel vehicles became effective for city and intercity vehicles since September 2016 and March 2017 respectively in which mandatory use of wall-flow closed DPF is enforced while keeping all pollutant emission levels at minimum of Euro IV This however imposed a challenge for diesel vehicle companies as diesel's sulfur content varies drastically nationwide from below 50 ppm in mega cities up to 7000 ppm in other areas. Hence, use of CRT systems is impossible at the moment and a customized solution is needed. A novel combined OEM solution was developed based on a commercial vehicle which incorporates DOC, DPF, EGR, and active regeneration by fuel early/late fuel injection strategies. The system works on the basis of passive DPF regeneration using NO2 produced by DOC. Secondary and tertiary regeneration steps were added to the system to increase the reliability of the system under worst case operating scenarios with low exhaust temperature and high diesel sulfur content. If the passive regeneration is not successful, a combination of early post injection, temporary EGR deactivation, and idle speed increase is used to increase exhaust temperature. Further regeneration can also be triggered manually by the driver if needed. An experimental campaign was conducted to evaluate the effectiveness of the developed solution to remove diesel particles while monitoring durability of the system under real-world operating conditions.
Methodology	The study is based on experimental tests and contain three different parts, emission measurement, field tests and ATS system modification.
Results & Conclusions	Using PEMS device, DPF performance was measured and a decrease of average PM from 0.0128 g/km to 0.003 g/km was observed. PN measurement under idle conditions demonstrated more than 95% removal of solid nano-particles from the exhaust Durability tests were done under Iran real- world operational conditions. Two sample trucks equipped with offline dataloggers were tested for the duration of 4 months in 3 different routes with more than 50,000 km real-world driving mileages as 1st round of field test. Each route represented different climate, humidity, altitude and topography conditions in Iran. The results showed that no manual regeneration was required during the road test despite of different diesel fuel qualities used during the tests. Instantaneous automatic regeneration was done almost each 600 km of driving. A worst case operating condition scenario was applied to one truck which resulted in DPF blockage only after few driving mileages. PCV clogging caused lubricating oil ash accumulation in the filter. Detailed visual inspection of the ATS revealed no mechanical deterioration. A standard cleaning procedure was used to revitalize the system. Besides DPF cleaning, desulfurization of DOC increased NO to NO2 conversion after removing sulfate material from the catalyst. The result of study showed acceptable effectiveness and durability of the proposed new-fit solution for the Iranian market which resulted in licensing of

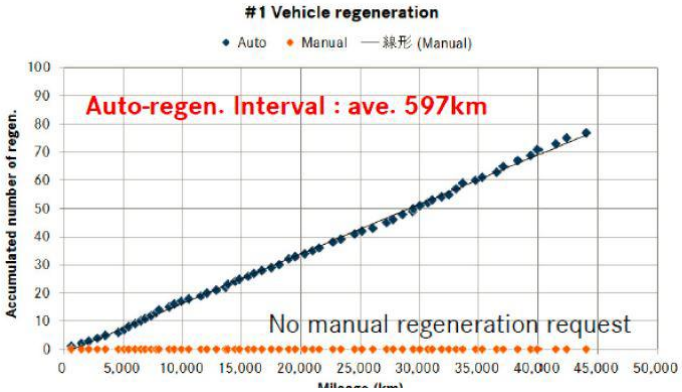
the first truck models in the nation in compliance with new legislation.

Caption Figure 1:



PM emissions during the PEMS test, with and without DPF

Caption Figure 2:



Regeneration regime of vehicle No.1 during the field test

Author CV:

Prof. Vahid Hosseini has joined the department of mechanical engineering at Sharif University of Technology in 2010. Since then, he has been active as a researcher in urban air pollution and particulate matters with the focus on UFPs and diesel particles. He is also the head of Tehran air quality control Company which is responsible for air quality monitoring of the capital of Iran. Prof. Hosseini is leading several projects including Tehran emission inventory, real-world driving emission measurement of Iranian mobiles sources using PEMS, development of photochemical air pollution dispersion models, passive sampling campaign for the city of Tehran in collaboration with Swiss ETH, source apportionment of PM2.5 for Tehran in collaboration with University of Wisconsin- Madison, and feasibility study of using BAT closed filters under local conditions for public transit buses. Prior to this has was a research associate at National Research Council Canada. He obtained his PhD in combustion from University of Alberta, Edmonton, Canada in 2008.

Mahdi Doozandegan graduated as M.Sc in mechanical engineering from Sharif University of Technology in 2016. His M.Sc project title was “Investigation of DPF-CRT performance in relation with diesel fuel sulfur content”. He is a member of FCE research center of Sharif university of technology since 2014. He has joined ASA company (2014) and currently is head of technical and engineering department. ASA is official VERT Tehran office and currently he is directly responsible for VERT actions in Iran.

Aidin Akbarzadeh has graduated as M.Sc. in mechanical engineering from University of Tabriz with expertise major in vehicle powertrain systems; he has B.Sc. of mechanical engineering from Iran University of Science and Technology (IUST) in fluid mechanics. He was engineering manager of Mammut Diesel Co. (2013-2015) which is exclusive distributor of Scania trucks in Iran; His carrier in Mammut diesel was when a sulfur tolerant DPF system for

Iran was developed by Scania. He is currently Engineering Director in Mayan Intr. & Mfg. Co. which is exclusive distributor of Mitsubishi Fuso (a member of Daimler Group) commercial products in Iran and is project manager for field tests and all technical assessments related to development of a sulfur tolerant DPF system for Mitsubishi Fuso trucks in Iran.

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Publication title	*Effects of traffic related abatement policies on Swiss air quality trends*
Publication type	Presentation
Introduction & Background	During the past two decades, a number of policy initiatives have been implemented in Switzerland to reduce air pollution from road traffic. Of particular importance is the introduction of the Euro emission standards in 1995, leading to stepwise tightening of the emission limits and consequently the reduction of exhaust emissions from new vehicles. Several political actions provide financial incentives for the use of low-emission vehicles: Examples are the dependence of the federal heavy transport vehicle charge (LSVA) on the emission level of the vehicle (since 2001) and incentives for public transport companies for operating low-emission busses (since 2008).
Methodology	The available atmospheric measurements allow the calculation of the long-term trends of atmospheric concentrations and roadside increments of air pollutants. The trends of air pollutants such as nitrogen oxides (NOx), black carbon (BC) and particle number concentrations (PNC) in Switzerland have been calculated and are discussed in relation to the implemented policies for the abatement of air pollution from traffic.
Results & Conclusions	The observed strong downward trend of BC and the clear downward trends for NOx and PNC proof that road traffic emissions have in Switzerland been markedly reduced. However, the achieved improvement in atmospheric NOx concentrations has likely been limited by the known gaps between the EURO emission limits and the real world emissions of diesel vehicles.
Author CV:	1993 – 1997 PhD at Laboratory for Solid State Physics, ETH Zurich. 1997 – 2000 PostDoc at Empa, Swiss Federal Laboratories for Materials Science and Technology 2000 – 2002 Private sector. Since 2002 Senior Scientist at Empa, Swiss Federal Laboratories for Materials Science and Technology, Duebendorf. Responsible for operation of the Swiss National Air Pollution Monitoring Network (NABEL). Research in the field of air quality.

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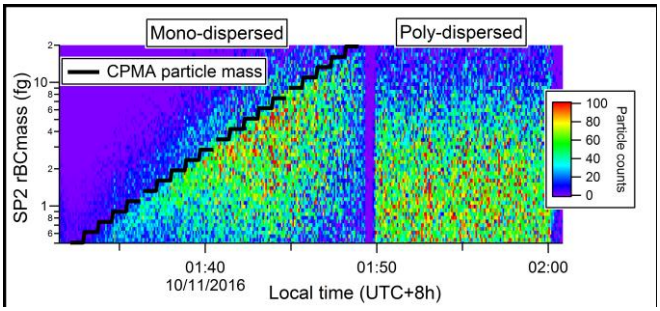
Publication title	*A New Method to Obtain the Black Carbon Mixing State of Biomass and Combustion Aerosols*
Publication type	Presentation
Introduction & Background	Black carbon particles (BC) significantly contribute to warming effects in the atmosphere, altering weather systems, and also pose significant health risks. These impacts are especially efficient at regional hotspots with high emissions of pollutants, such as in fast-developing megacities. These urban environments have the most population exposure, and improving the understanding of the sources and the processing of pollutants in these environments is critical in guiding policy making. Here we present the results of BC characterization in Beijing during the winter of 2016 (10th Nov-10th Dec), as part of a large joint UK-China field experiment. During this experiment, we successfully gathered 4 weeks of continuous measurements, including several severe pollution events in Beijing.
Methodology	The mixing state of BC, which is how BC is associated with non-BC material (its coating) within a particle, is crucial to determine its lifetime in the atmosphere and also its optical properties. However precisely quantifying the BC mixing state has posed a challenge, in part due to complex particle morphology. We have applied morphology-independent measurements of BC mixing state on a single-particle basis throughout this experiment: mono-dispersed particle mass (MP) is selected using a Centrifugal Particle Mass Analyser (CPMA, Cambustion Ltd) and a single particle soot photometer (SP2, DMT inc.) was used downstream of the CPMA to measure the refractory BC mass (MrBC). The full scan of CPMA masses (21 mass bins covering most of MP) are performed every half hour, following polydispersed particles measured without running CPMA.
Results & Conclusions	Figure 1 shows the preliminary results for one full scan. For monodispersed particles, there is significant faction of particles with MrBC lower than MP, and the difference between MP and MrBC defines the coating mass. Higher MrBC than MP is due to a multiply-charged particles passing through the CPMA. This set up will give the full picture of rBC and coating distributions, allowing a comprehensive examination of BC mixing state at each particle mass. By combining this system with measurements from an Aerodyne Soot Particle Aerosol Mass Spectrometer (SP-AMS), this information can also be linked to the BC sources and atmospheric processing within the city. These results will provide important information to understand the source distribution, emissions, lifetime, and optical properties of BC under complex environments in Beijing.

Caption Figure 1:



The example of one scan showing the CPMA-selected mono-dispersed and the following poly-dispersed rBC mass distributions.

Author CV:

Martin graduated with an MPhys degree (Master of Physics) from the University of Manchester Institute of Science and Technology (UMIST, in Manchester, UK. His Master's research project was on the study of thunderstorm electrification – a field of research pioneered in the 1970s at the Centre of Atmospheric Science at UMIST (now University of Manchester). Martin became more interested in atmospheric microphysical processes, and started a Ph.D in Atmospheric Physics, culminating in a thesis entitled "The characterisation of the interaction between atmospheric aerosol and water vapour". His researched presented extensive field measurements of cloud condensation nuclei (CCN) and aerosol hygroscopicity from different environments around the world. Further, Martin developed a novel error model to propagate instrumental uncertainties through to commonly used data products used in large-scale atmospheric models. Martin illustrated that a popular single hygroscopicity framework was not able to reconcile the measurements within their errors for the different environments. Thus, caution should be employed when using single parameter frameworks within large scale models. Martin presented this work at both the European Geophysical Union (EGU) and its American counterpart (AGU). During the writing up stage of his thesis, Martin applied for (and was successful in obtaining) a Japan Society for the Promotion of Science (JSPS) Short-Term Award Fellowship to further conduct atmospheric research in Japan. It was during his time in Tokyo that Martin moved from cloud physics research to black carbon research, installing black carbon monitoring equipment in 7 sites around the world, from the Arctic to the Tropics. Data from these studies are to be presented at the AGU Fall Meeting 2016 in San Francisco. Following the JSPS Fellowship, Martin continued to research in Japan as a postdoctoral researcher for 3 years before moving back to the UK for an R&D Aerosol Scientist position at an SME, Cambustion Ltd., based in Cambridge. Cambustion was founded in 1987 by a research group at Cambridge University Engineering Department, to produce a fast response Flame Ionisation Detector (FID) for hydrocarbon measurement. Cambustion now produce a suite of gas and aerosol fast response analysers, in addition to performing a range consultancy work. Martin's role at Cambustion principally involves the research and development of new aerosol instrumentation, in addition to attending conferences and meetings around the world.

Jarvis Ian

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Coauthors	Ian Mudway, Volker Arlt, David Phillips

Publication title	*Genotoxic and Inflammatory Responses of Human Bronchial Epithelial Cells to Diesel and Biodiesel Exhaust*
Publication type	Poster
Introduction & Background	Outdoor air pollution and diesel engine exhaust have been classified as carcinogenic to humans (Group 1) by the International Agency for Research on Cancer. The primary route of human exposure is through inhalation of such chemicals after they become adsorbed onto particulate matter (PM), and exposure has been linked to the development of lung cancer and other respiratory diseases, though the mechanisms involved in disease pathogenesis remain unclear. One of the most important aspects of studying human toxicity in an in vitro system is selecting appropriate models that are able to predict toxicity in vivo. The aim of this study was to optimise in vitro lung epithelial models using standard reference diesel exhaust material that can then be applied to the testing of diesel and biodiesel material. This model optimisation will allow for validation of the cell systems and the results will then be compared with those from human chamber studies for various combustion-generated aerosols.
Methodology	Model optimisation: Human primary airway epithelial cells (hAEC) and immortalised bronchial epithelial cells (BEAS-2B) were exposed to 0 – 20 µg/ml NIST diesel exhaust standard (SRM 2975) suspended in cell medium for up to 48 hours. Cells were harvested for analysis of cytotoxicity by AlamarBlue assay and DNA damage by alkaline comet assay. Activation of the immune-inflammatory cascade was assessed by real-time qRT-PCR analysis of mRNA levels of CSF2 (macrophage-stimulating factor), IL8 (induction of immune cell chemotaxis), TNF (apoptosis stimulation) and TSLP (maturation of T-cells). Diesel and biodiesel samples: RME100 diesel, low-sulphur standard diesel and on-site blended RME30 biodiesel (30% by volume blend of RME100 and low-sulphur diesel) were generated as part of an ongoing collaboration with Umeå University. Exhaust was generated using a Volvo diesel engine (Volvo TD40 GJE, 4.0 L, 4 cylinders) running under variable load, according to the urban part of the European Transient Cycle, to mimic urban driving conditions. Exhaust was impinged directly into water to avoid filter extraction artefacts.
Results & Conclusions	At the concentrations of SRM 2975 tested there was no detectable cytotoxicity. Concentrations of 10 and 20 µg/ml of SRM 2975 induced a significant increase in DNA damage in hAEC cells after 24 hours as assessed by comet assay, though this was not seen after 48 hours. No significant increase in DNA damage was observed in BEAS-2B cells. Levels of CSF2 mRNA were significantly increased in both hAEC (up to 4-fold) and BEAS-2B cells (up to 6-fold), and levels of TSLP mRNA were increased but only significantly in hAEC cells (up to 3-fold). No change in IL8 and TNF mRNA levels was observed in either cells. Taken together we have shown that the primary airway epithelial cells present a sensitive model for studying the in vitro response of cells to standard reference diesel exhaust. Work is ongoing to study the effects of contemporary diesel and biodiesel samples using the same established markers to allow for comparison with human exposure studies.
Author CV:	Professional Experience

Research Associate
King's College London, London, UK
Jan 2015 – to date

Investigating genotoxic and inflammatory mechanisms that contribute to respiratory disease pathogenesis in humans after exposure to airborne particulate matter and platinum-containing anti-cancer drugs.

Postdoctoral Researcher
Karolinska Institutet, Stockholm, Sweden
Oct 2011 – Dec 2014

Investigated mechanisms involved in DNA damage and repair in response to airborne particulate matter and ultraviolet radiation.

Education

Ph.D. in Oncology, Newcastle University, Newcastle upon Tyne, UK
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Jensen Thomas Nørregaard

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Publication title	*Characterization of Particle Emissions from Candles*
Publication type	Presentation
Introduction & Background	All sorts of candles are being used in widely different situations and locations all over the world. New types of candles see the light of day every year, such as candles made of beeswax, mixes of traditional candle waxes and paraffin, vegetable waxes, animal fat based waxes etc The growing awareness regarding particle emissions from various sources is increasing, demanding additional information and knowledge. In a study, particle emissions in 56 Danish homes were measured, and it was found, that in the homes where candles were used, candles were responsible for approx. 60% of the residential integrated exposure (Bekö et al, Environ. Sci. Technol. 47, 2013).This has resulted in an increasing demand for measurements on particle emissions from various candle types, such as square candles, tealight candles, candlestick candles and oil lamps. In the present work, particle emission from 32 different candles were measured as true duplicates, which means that measurements were carried out on 64 candles.
Methodology	Measurements were carried out in a climate room with temperature, air change and humidity control. Particle emissions have been measured using an SMPS (Scanning Mobility Particle Sizer), model 3080 from TSI, and CPC (Condensation Particle Counter), model 3776. The particles have been counted and size distributed in the size interval from 4.3 nm to 167 nm. Older equipment for particle sizing in the nano-range is often been limited down to 10-20 nm, giving an enormous bias in the results, as the main part of the particles emitted from candles are in the 5 nm to 25 nm range in size. Additionally, sampling on filter was performed for subsequent chemical analysis of emitted particles for content of lead and nickel. Sooting behaviour has been measured according to the well-established standard EN15426.
Results & Conclusions	In average, the particle emission from paraffin and wax was approximately 9 million particles/cm3, whereas the emission from stearin was about 19 million particles/cm3. Lead and nickel was identified in a few of the waxes and lead was identified in 26 out of the 32 different candles. This work is continued in a new and larger project where new candle types will be developed with the purpose of reducing particle emissions. It is expected that preliminary results from this project can be presented. The project is co-financed by the Danish EPA.
Author CV:	2015 – present Consultant, Danish Technological Institute, Aarhus, Denmark. Areas of interest are: Characterization of airborne particles, emission reducing technologies, online measurement technologies, and advanced spectroscopy for chemical identification 2010 – 2015 PhD nanoscience, Aarhus University, Denmark >2006 – 2012 M.Sc. nanoscience, Aarhus University, Denmark

Jokiniemi Jorma

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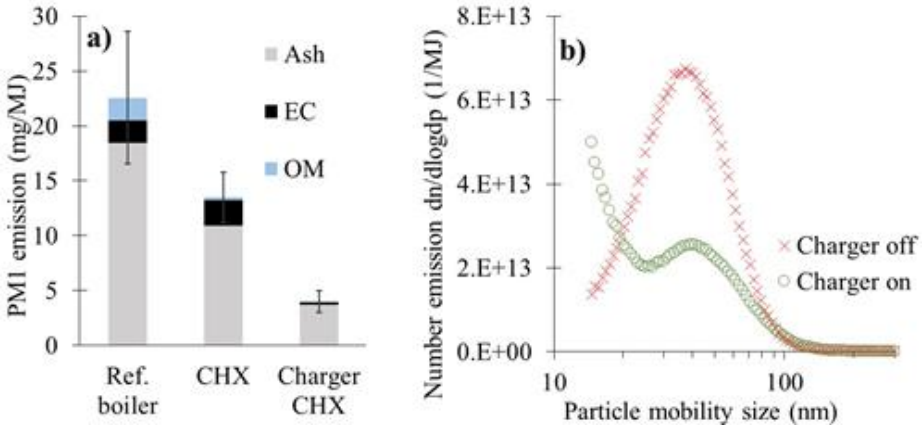
Coauthors	Heikki Suhonen, Julija Grigonyte, Ari Laitinen, Miika Kortelainen, Jarkko Tissari, Petri Tiitta, Olli Sippula

Publication title	*Novel Electrical Charging Condensing Heat Exchanger for Efficient Particle Emission Reduction and Heat Recovery in Small Boilers*
Publication type	Presentation
Introduction & Background	There is an urgent need to develop cost-effective particle emission reduction technologies for small scale biofuel-fired boilers in order to reduce adverse health and environmental effects of fine particulate matter and to comply the small and medium scale boilers with the forthcoming European emission limits (MCP and Ecodesign directives). We have recently demonstrated the utilisation of two novel approaches for cost-effective separation of fine particle emission from combustion gases. First, a condensing heat exchanger (CHX) system was developed, in which the thermophoretic and diffusiophoretic particle precipitation was optimized, leading to approximately 50% fine PM reduction in a small biomass boiler (Grigonyte et al., 2014). It is especially beneficial for boilers operating with moist fuels, such as forest residues or pyrolysis oil. Second, a shielded corona charger was recently demonstrated, as an inexpensive system for electrical precipitation of particles from pellet boiler flue gases (Laitinen et al. 2016). In the present work, we have combined both of these technologies and demonstrate a CHX system, in which particle charging is carried out upstream of the heat exchanger and the charged particles are collected in the heat exchanger surfaces, and finally removed with the flowing condense film, formed at the heat exchanger tube surface.
Methodology	The pilot heat exchanger system was installed in the grate combustion reactor fired with wood chips (30% moisture content) with an output of 9 kW. The shielded corona charging electrode was installed upstream the condensing heat exchanger, at about 600 oC gas temperature. The formed condensate was collected and taken for chemical analyses. Particle emissions were measured online from diluted flue gas sample using a scanning mobility particle sizer (SMPS, TSI), Electrical low pressure impactor (ELPI, Dekati) and Tapered element oscillating microbalance (TEOM). Offline samples were collected on filters for gravimetric and thermal-optical carbon analyses as well as for imaging with electron microscopy. Gas-phase composition was measured both upstream and downstream the CHX using the FTIR multicomponent analyser. In addition, reference experiments with a conventional firetube boiler heat exchanger with the same combustion settings were carried out.
Results & Conclusions	In the CHX the flue gas temperature decreased on average to 43 oC in the CHX and roughly 60% of the flue gas water vapour condensed, resulting in a thermal efficiency of 105%, based on the conventional efficiency calculation method. The mean fine particle mass (PM1) emission level was 23 mg/MJ with the reference heat exchanger, while the emissions were 13 mg/MJ and 4 mg/MJ for CHX and corona charger assisted CHX, respectively. Thus, the usage of CHX only resulted in 40% decrease in PM1 emissions. Particle charging upstream the CHX increased the particle mass reduction efficient to 82% and particle number emissions reduction efficiency to 42%. In summary, the electrical charging condensing heat exchanger was confirmed to have a high reduction efficiency for fine particles with simultaneous high thermal efficiency under conditions representing automatic biofuel boilers. The benefits of the system are that it replaces the conventional heat

exchanger in boilers, making it a compact and inexpensive solution, when compared to additional flue gas cleaning devices installed after the boiler.

Caption Figure 1:



Fine particle (PM1) emissions and their chemical composition with different heat exchanger setups (a) and particle number emission size distributions with and without the usage of charger in the condensing heat exchanger setup (b)

Author CV:

Prof. Jorma Jokiniemi (M) is the director of the Fine Particle and Aerosol Technology Laboratory (FINE) at UEF Department of Environmental and Biological Sciences. He has 172 peer reviewed journal publications (h-index 29), 8 national and 4 international patents. He has supervised 18 Ph.D. theses (6 on-going) and given over 20 international invited talks. The research topics of Jorma Jokiniemi cover fine and nanoparticle particle measurements, nanoparticle/nanomaterial synthesis, combustion, emissions and modelling aerosol dynamics.

	Kadijk Gerrit
Affiliation	TNO, The Netherlands
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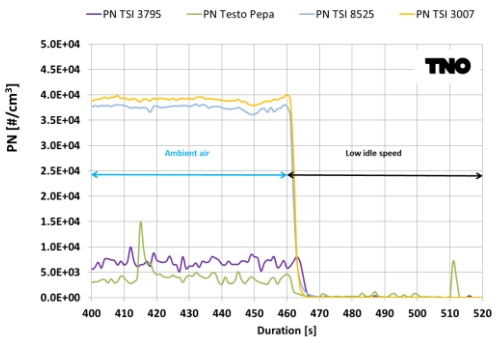
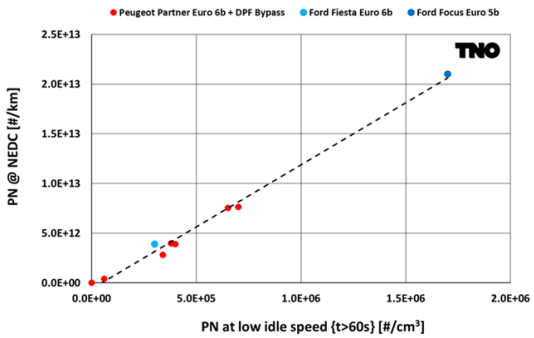
Coauthors	Mitch Elstgeest;Norbert Ligterink;Peter van der Mark

Publication title	*Investigation into a Periodic Technical Inspection (PTI) test method to check for presence and proper functioning of Diesel Particulate Filters in light-duty diesel vehicles*
Publication type	Presentation
Introduction & Background	Wall flow diesel particulate filters (DPFs) are a very effective means to reduce emissions of soot particles in the exhaust gases of diesel cars. European Euro 5 and Euro 6 standards have meant that DPFs are now being applied to all new diesel vehicles. However, in 2014, research conducted by TNO and RDW shows that for approximately 5 to 7 % of diesel passenger cars with a DPF, the particulate filter was removed or defect. It is known that possible losses in filtration efficiency or removal of DPF's significantly affect real-world PM emissions. Another concern of Periodic Technical Inspection (PTI) DPF investigations is the quality of the smoke emission test and the relation with real world PM&PN emissions.
Methodology	In this research study the current free acceleration PTI smoke emission test procedure is assessed and alternative PTI test procedures are investigated. Several Euro 3,4,5 & 6 diesel vehicles (with cracked DPFs) were tested in PTI conditions and on a chassis dynamometer.
Results & Conclusions	The current free acceleration smoke emission tests is not suitable for assessment of a DPF in the PTI. A lack of sensitivity, the poor definition of the test procedure and the very weak relationship with PM and PN emissions are the most important reasons. A PN emission test at low idle speed with a hot DPF is suitable for PTI purposes. This PN emission correlates well with the PN emission in an NEDC test on the chassis dynamometer, the correlation with PM is less good. Current mobile PN-testers are accurate but too expensive for most PTI workshops. New specifications for a lower cost PTI-PN-tester has been drafted. After standardization of this new PTI-PN-tester it can be built and validated by equipment manufacturers and legislators may implement the new test in regulations.
Images	
Caption Figure 1:	 PN emissions measured with four different mobile PN-testers of ambient air and at low idle speed of a Peugeot 308 diesel Euro 6b with DPF @ 104,755 km.

Caption Figure 2:



PN emissions at low idle speed and NEDC tests of 3 different diesel vehicles with (cracked) DPF or variable bypass.

Author CV:

Gerrit Kadijk is a researcher-consultant of TNO. He received his Bachelor degree in Mechanical Engineering at the Institute Higher Professional Education, Faculty of Technology in Rotterdam. From 1988 to 2007 he was working as a test engineer of internal combustion engines and vehicles in research, development engineering, testing and type approval projects. His current research field is on-road vehicle emission testing and development of new test procedures. His recent achievement is the development of a new particulate number test at low idle speed for Diesel Particulate Filters in the Periodic Technical Inspection.

Kelesidis Georgios A.

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Coauthors	Eirini Goudeli; Sotiris E. Pratsinis
Publication title	*Mobility Size and Effective Density of Soot Nanoparticles*
Publication type	Presentation
Introduction & Background	Soot impact on health strongly depends on its effective density and mobility size (Rissler et al., 2012). As nascent soot nanoparticles evolve to their mature well-developed fractal-like structures by agglomeration and surface growth, their effective density decreases up to an order of magnitude lower than bulk soot (Rissler et al., 2013; Yon et al., 2015). The mobility size estimation of such evolving fractal-like aggregates is not trivial, as it depends on their structure as well as the number and size of their constituent primary particles. A scaling law describing the mobility size of agglomerates consisting of monodisperse primary particles in point contact (Sorensen, 2011) overestimates the mobility diameter of mature soot aggregates from diffusion flames for a given number of primary particles (Rissler et al., 2013). Rissler et al. (2013) attributed this difference to the primary particle polydispersity and chemical bonding induced by surface growth (aggregation), neglected in the above scaling law (Sorensen, 2011). Typically population balance models for soot formation estimate the mobility diameter assuming it is equal to the gyration diameter (Yapp et al., 2015).
Methodology	Here, the Discrete Element Model of nascent soot agglomeration and surface growth by acetylene pyrolysis (Kelesidis et al., 2017) is extended to investigate the dynamics of mature soot formation at longer residence times and different flow regimes than nascent soot in the absence of soot oxidation.
Results & Conclusions	The evolution of soot mean gyration, mobility and primary particle diameters as function of the mean number of primary particles per aggregate are elucidated. The common assumption that the mobility is equal to the gyration diameter leads to 40% underestimation of the nascent soot mobility size and 30% overestimation of the mature soot aggregate mobility diameter. Relationships for the soot mobility size and effective density are derived by following the evolution from nascent to mature soot morphology and compared to the correlation of Sorensen (2011) and mass-mobility measurements in quenched diffusion flames (Rissler et al., 2013; Yon et al., 2015). The scaling law for agglomeration in the absence of surface growth (Sorensen, 2011) overestimates the measured mature soot aggregate mobility size by 37 % and underestimates its effective density by 44 %. Accounting, however, for the primary particle polydispersity and chemical bonding or aggregation induced by surface growth reduces the deviation from the mass-mobility measurements down to 7 and 11 % for the mobility size and the effective density, respectively.
Author CV:	Georgios A. Kelesidis is a PhD student at the Particle Technology Laboratory of Prof. S.E. Pratsinis at ETH Zürich. He has obtained his Diploma in Chemical Engineering from University of Patras, Greece in 2013. He then accomplished the Master of Science in Process Engineering from ETH Zürich, Switzerland in 2015.

Keller Alejandro

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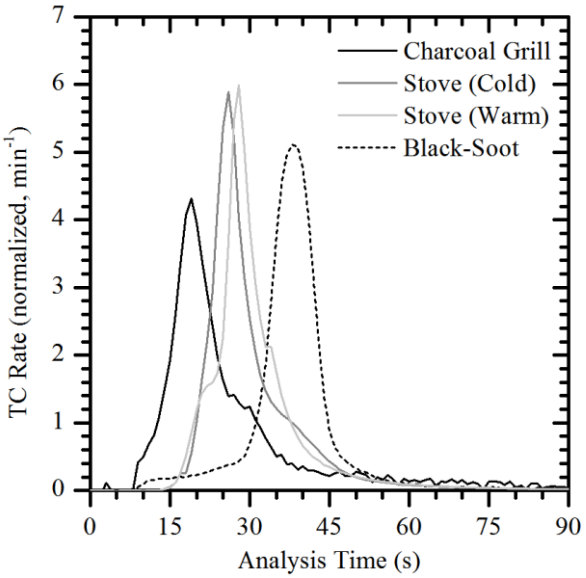
Coauthors	Heinz Burtscher

Publication title	*FATCAT: New Characterization Method for Particulate Emissions from Wood Burning Appliances*
Publication type	Presentation
Introduction & Background	Biomass burning is a major contributor to environmental particulate matter pollution that should be contemplated by emission control legislation. However, existing standards are based on total particulate matter (PM) without differentiation by chemical composition or particle size. This is not ideal since neither combustion efficiency nor toxic potential are well reflected by this approach. Legislation also neglects the potential for the formation of secondary organic aerosol (SOA), which is one of the most important atmospheric pollutants in Europe (Denier van der Gon, 2015).
Methodology	We propose an alternative metric that incorporates recent scientific results and is compatible with type-approval testing as well as field measurements (Keller and Burtscher, 2017). In short, we produce SOA by aging emissions in the micro smog chamber (MSC, Keller and Burtscher, 2012) and quantify the emissions using particle-bound total carbon (TC) analysis. For this purpose, we developed the FAst Thermal CArbon Totalizator (FATCAT). This device collects a PM sample on a filter and heats it within 50 seconds to 800°C under an oxidizing atmosphere. Further oxidation of carbonaceous material is achieved by a catalyst located downstream of the heating unit. Total carbon detection is done by means of a CO2 measurement. Fast heating allows an analysis time under 2 minutes.
Results & Conclusions	Figure 1 shows sample analysis curves for a charcoal grill, cold and warm starts of a log-wood batch-operated stove, and a black soot sample from a propane flame CAST generator (Jing Ltd, Switzerland). The total carbon emissions for these measurements are TC = 3, 62, and 33 mg/m3 STP at 13% O2 for the grill, stove cold, and stove warm respectively. Peaks appearing to the left of the graph correspond to more volatile material whereas the CAST signal, consisting almost exclusively of refractory black carbon, appears latter in time when the filter temperature is closer to the final temperature of 800°C We will present emission data from a variety of wood-burning devices, including automatic as well as batch operated installation. Emission factors, calculated from our TC measurements, will be compared against standard gravimetric measurements and thermal-optical analysis data. Our TC data comprises measurements performed on raw as well as aged emissions in order show how SOA increases the emission factor. We will show that the combination of aging and TC analysis is a feasible and practical alternative for characterization of wood-burning appliances

Caption Figure 1:



Total carbon analysis cycle performed for raw emissions (i.e. not aged in the MSC) for two different biomass burning appliances and a black-soot sample. The curves show the time-resolved total carbon rate normalized to an area of one. Time zero marks the start of the 50 seconds filter heating.

Author CV:

Alejandro Keller studied physics engineering at the Iberoamericana University in Mexico City. He joined the group of Prof. Hans-Christoph Siegmann at the ETH Zurich, where he worked in the field of aerosol science, and was awarded with a doctoral degree in 2001. Alejandro works as a research scientist at the Institute for Aerosol and Sensor Technology of the University of Applied Sciences and Arts Northwestern Switzerland.

Khalek Imad A.

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Publication title	*Particle Number and Ash Emissions from a Heavy Duty Natural Gas and Diesel w/DPF Engines*
Publication type	Presentation
Introduction & Background	Solid particle number emission regulations such as those enacted by the European Union under Euro 6/VI are key regulations in this century that have resulted in cleaner engines on the road particularly relative to diesel & GDI engine particle emissions. Further refinement of the regulation with an extension down to 10 nm in diameter should ensure a wider coverage of engine technologies that emit particles across the entire spectrum below and above 23 nm, which is the current particle size cut-off limit. Solid particles below 23 nm can be harmful and cannot be ignored. The JRC of the EU is currently examining a test procedure that may include particles down to 10 nm.
Methodology	In this work, solid particle number emissions above and below 23 nm were investigated for a state-of-the-art stoichiometric heavy-duty natural gas engine with a three-way-catalyst and a diesel heavy-duty diesel engine with DFP. Furthermore, real time ash particle number emissions were measured using SwRI real time ash measurement instrument (RT-ASH). Both engines met the potential future CARB ultra low NOX emissions of 0.02 g/hp-hr, a 90% reduction from current emissions level in the USA. The engines were tested in an engine test cell under cold- and hot-start transient engine operation including FTP, WHTC and RMC. While both engines met comfortably the PM mass emissions, solid particle number emissions and ash emissions were significant for the natural gas engine. The emissions of solid particles from the natural gas was a factor of 5 to 10 higher than that of a diesel engine with DPF. Under WHTC testing, the natural gas engine showed more particles below 23 nm, compared to particles larger than 23 nm.
Results & Conclusions	In this presentation, we will report more details about this work and the results. This work may highlight some issues related to natural gas particle emissions. The particle work to be presented was funded by MECA on engine platforms that were tested at SwRI with funding from the California Air Resources Board (CARB) under the ultra low NOX project.
Author CV:	Dr. Khalek is a Senior Program Manager at Southwest Research Institute in the Department of Engine and Emissions R&D, Particle Science & Technology. He has more than 20 years of experience in the subject of particle emissions from combustion sources. He has led major emissions research projects for industry and government. His interest is in particle emissions research from various combustion sources and particle sensors. He has a B.S. in Aerospace Engineering and Mechanics, and M.S. and a Ph.D. in Mechanical from the University of Minnesota.

Khan M. Yusuf

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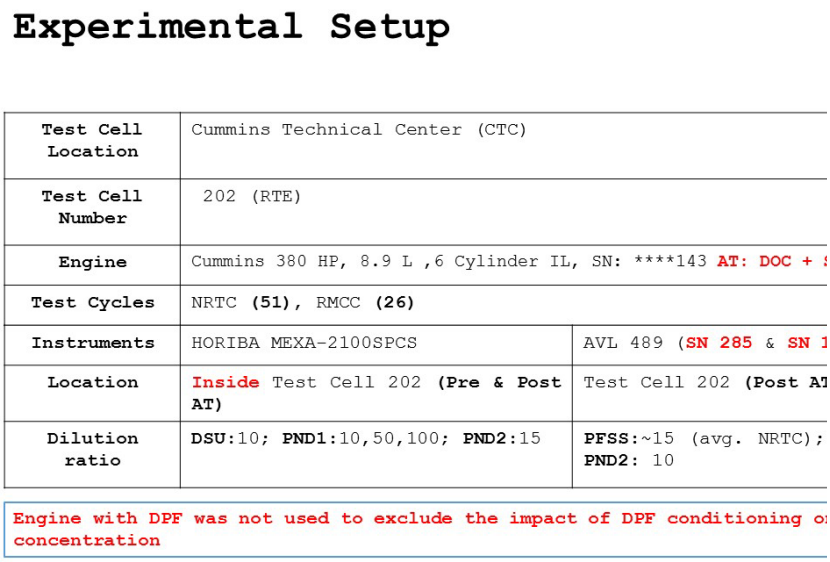
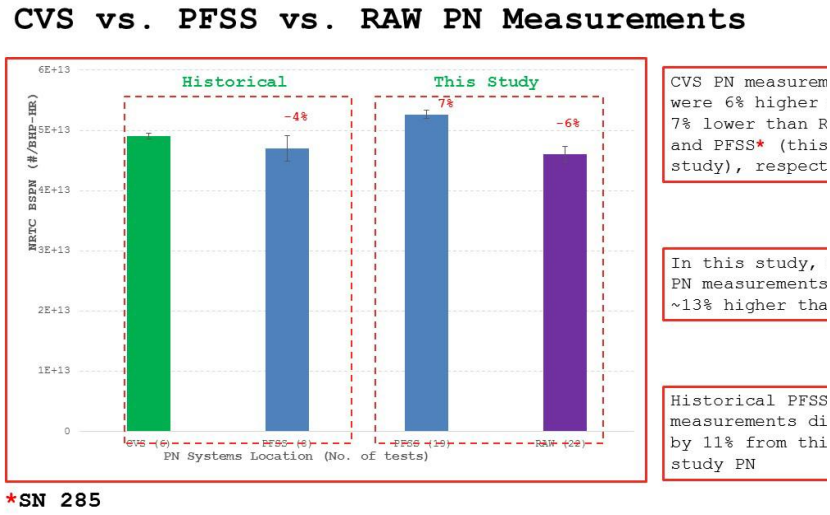
Publication title	*Comparison of Full Flow Dilution, Partial Flow Dilution, and Raw Exhaust Particle Number Measurements*
Publication type	Presentation
Introduction & Background	Currently, both Euro VI and Stage V regulations for on-highway and Off-road heavy duty engines allow PN measurements from full flow and partial flow dilution systems. Previous studies have shown up to 15% difference between full flow and partial flow PN measurements. Given that, engine manufacturers always target brake-specific PN values at least 50% lower than the standards in order to allow for the PN measurement uncertainty due to measurement procedure. In this study, the performance of current particle number measurement protocol was evaluated when sample is extracted directly from the raw exhaust.
Methodology	This study was done in two phases. In the first phase, a Cummins 8.9 L, 380 HP engine with just DOC and SCR was used. The engine was not equipped with DPF to avoid the impact of conditioning on PN measurements as repeatability and reproducibility of the measuring instruments were also evaluated. The raw PN measurements were made right after the AT system using the HORIBA MEXA-2100 Solid Particle Counting System (SPCS). The PN from the partial flow system was measured using AVL 489 Particle Counter (APC). The measured data was compared with the historical data from the same engine when ran in the test cell with full dilution system. In the second phase, a Cummins XXX engine with DPF will be used. The SPCS will be placed inside the test cell and will measure PN right after DPF whereas APC will measure PN from the full flow dilution tunnel.
Results & Conclusions	The first phase of testing showed that the percent difference between the PN measured by APC at partial flow and SPCS at raw location were 5-15%. The comparison of Full flow dilution, Partial flow dilution, and raw PN measurements were within 15% of each other. Also, the repeatability of SPCS were between 0.4-3.2%. Also, no impact on PN measurements were found when dilution ratios were changed from 2200 to 24000.

Caption Figure 1:



Experimental Set Up

Caption Figure 2:



CVS vs. PFSS vs. RAW PN Measurements

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EDUCATION
Ph.D in Chemical & Environmental Engineering GPA: 3.78/4.0O March 2013
University of California, Riverside
Dissertation: Strategies and Technologies for Improving Air Quality around Ports
B.Tech. in Chemical Engineering GPA: 74/100 June 2008
Institute of Engineering and Technology, Lucknow, UP, India

EXPERIENCE
Technical Specialist, Emissions Development, R&T, Cummins Inc. (2016 – present)
Senior Engineer, Emissions Development, R&T, Cummins Inc. (2013 –

present)
• Owner of the emissions analysis program which is globally used at Cummins for the post-processing of measured emissions data required for the development and engine certifications for various regulatory agencies around the world.
• Developed formulas for dual-fuel engine applications. These formulas were accepted by Emissions Measurement Testing Committee of Engine's Manufacturer Association. These formulas got incorporated in the Code of Federal Regulations (CFR), Title 40 Protection of Environment Part 1065. Also, emission analysis program was updated to post-process data from dual-fuel engines.
• Contributed to the new greenhouse gas regulations: 40 CFR Part 1036, Control of Emissions from New and In-use Heavy-Duty Highway Engines. Developed detailed derivations for calculating the mass of the diesel fuel consumed by the engine equipped with a Selective Catalyst Reduction consuming urea for reducing nitrogen oxides emissions.
• Developed methodology to improve chemical convergence for natural gas engine emission testing in raw transient test cells. Implementation of this method via emissions analysis program saves significant money on re-testing and labor required for emissions testing.
• Emissions test cells at Cummins Technical Center were made capable for measuring Particle Number according to UNECE regulations. Developed Repeatability and Reproducibility for particle number measurement instruments, required for the development of the on-road heavy duty engines complying with European regulations.
• Provide training to Test Operations/engineers on post-processing program, data retrieval programs, AVL Particle Counter, Micro soot sensor, Partial flow sampling system at Cummins international test sites in India and China.
• Member of technical team for hiring Laboratory Operations Manager and Coaches. Represent Cummins for recruiting students at University of California, Riverside
Graduate Student Researcher, University of California, Riverside (2008 – 2013)
• Evaluated greenhouse gas and criteria pollutants benefits from reducing ocean-going vessel speed for California Air Resources Board. Article was cited by the LA times and various marine journals. The Port of Santa Barbara in California took initiative based on this study.
• Performed rigorous validation testing for the PM-PEMS measurement allowance program sponsored by US EPA, CARB and EMA. The measurement allowance for PM-PEMS determined in this study is used in current regulation, 40 CFR Part 1065 Subpart J Field Testing and Portable Emission Measurement Systems.
• Comparison of International Maritime method and PEMS for ships in-use gaseous emission measurements. Based on this study US EPA will allow ships to show emissions compliance using gaseous PEMS.
• Performed and reported emission benefits of using algal based biofuel versus ultra-low sulfur diesel fuel in D2 marine engine for Maritime Administration (USDOT/MARAD) and US Navy. Report was cited by various marine journals.
• Part of the team which evaluated emission benefits from the world's first hybrid tugboat. This study was funded by CARB and was cited by various marine journals.
• Evaluated benefits of hybrid retrofit system for a tugboat Based on this study, US EPA approved hybrid retrofit system for reducing emissions.
• Conducted first study to evaluate emissions benefits from Tier 1 diesel engine and by switching to lower sulfur fuel in the newly formed regulated zone around USA for ocean-going vessels.
• Evaluated emission benefits from repowering the marine vessel for AEP River Operations.

PUBLICATIONS AND PRESENTATIONS

• 7 first author and 4 Co-author peer-reviewed journal articles on emission control strategies and technologies for on-road and off-road (marine) diesel engines (9 published and 2 under preparation).
• Publication cited by authors from over 24 Countries.
• Reviewer for Atmospheric Environment & SAE International Journal.
• Presented findings at 12 international conferences.

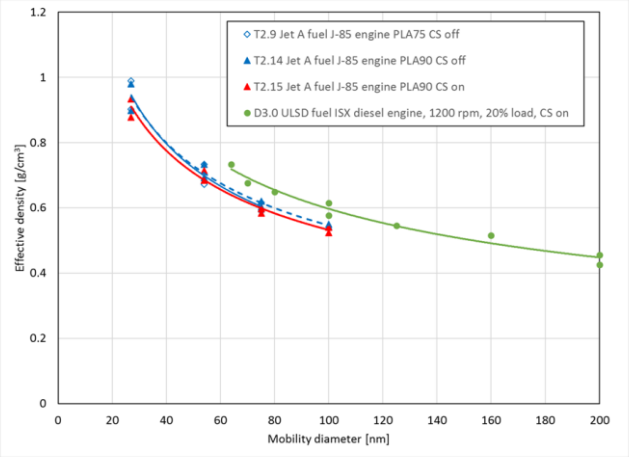
AWARDS & OTHER SKILLS

• Active member of Engine Manufacturer Association's Emissions Measurement Testing Committee
• Started scholarship for graduate students at University of California, Riverside
• Distinguished Dean's Fellowship and William R. Pierson/Ford Graduate Fellowship
• Recipient of Travel Award for American Association for Aerosol Research 2011 Annual Conference
• Recipient of Scholarship to cover 2011 METRANS International Urban Freight Conference
• Graduate Aptitude Test in Engineering: All India Rank-400 (Top 4%) in Chemical Engineering, 2008
• Member of Society of Automotive Engineers (SAE) International

	Kittelson David
Affiliation	University Minnesota
Email	kitte001@umn.edu
Coauthors	Jeffrey Stevens, USEPA: Robert Giannelli, USEPA

Publication title	*Diesel and Gas Turbine Nanoparticle Density Distribution Measurements*
Publication type	Presentation
Introduction & Background	The effective density of combustion generated aggregates are known to be a function of mobility diameter. This new work reports density measurements for a variety of combustion sources: an old and a new technology diesel engine, a gas turbine auxiliary power unit, and a J-85 turbojet engine (used to power for example, Learjets). These results are of interest not only for improving our fundamental understanding of nanoparticle formation by combustion, but also for two more practical reasons. First, fast response particle sizing instruments like the TSI EEPS and the Cambustion DMS 500 measure particle number as a function of electrical mobility diameter. If particle effective density is known as a function of mobility diameter, mass based size distribution can be calculated from EEPS or DMS 500 data - allowing fast response mass emission measurements. Second, new methodology for measuring emissions of solid particle number and mass from aircraft turbojet engines is being developed by the SAE E-31 committee. Sampling from the exhaust of large jet engines requires the use of long sampling lines that introduce large, size dependent particle losses. These losses can be calculated quite accurately using existing models if the particle size distribution is known. Unfortunately, regulators and engine makers do not wish to measure size, only mass and number. The E-31 committee has developed a line loss model that allows losses to be estimated from mass and number measurement using the following assumptions: the exhaust size distribution is unimodal and lognormal, the geometric standard deviation is known, and effective particle density is known. Thus we need to improve our understanding of the effective density of jet engine exhaust particles.
Methodology	Diesel engine tests were run using standard ULSD and Hydrogenation-Derived Renewable Diesel (HDRD) and the gas turbine tests were done using blends Jet-A and HDRD. Engine exhaust was sampled a two stage ejector dilutor system. Tests were made with and without a catalytic stripper designed to remove semi-volatile particles. Many instruments were used to characterize the particles but the focus of the work reported here was on particle size and effective density. Particle size was measured using a pair of TSI SMPS's and a TSI EEPS. Particle density was measured TSI differential analyzer (DMA) to select particles by mobility size and a Cambustion Centrifugal Particle Mass Analyzer (CPMA) to measure particle mass.
Results & Conclusions	Effective densities were measured in the size range from 15 to 200 nm electrical mobility diameter, smaller for turbine, larger for diesel, to encompass the size range where most of the mass is found for each engine type. Figure 1 shows some typical measurements. In general, effective density decreased with size, typically ranging from about 1 down to 0.4 g/cm3. When the catalytic stripper was used to remove semi-volatile particles, densities were usually lower. When the J-85 was tested with Jet A/HDRD blends particle emissions were lower, particles smaller and densities lower.

Caption Figure 1:



Effective densities of J-85 turbojet and Cummins ISX diesel engine exhaust particles. PLA75 and PLA90 denote medium high and high thrust settings on the J-85. CS denotes catalytic stripper used to remove semi-volatile particles

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Professor Kittelson has worked for more than 40 years on improving performance and reducing emissions from engines. Current research interests include sampling and characterization of ultrafine and nanoparticles from engines, development of new methods for measuring solid particles, measurement of vehicle emissions using mobile platforms, measurement of performance and emissions of engines operating in advanced low temperature combustion modes, use of hydrogen rich gases to modify combustion in engines, development of advanced engine exhaust aftertreatment systems, reducing fuel use and greenhouse emissions from transportation, production and use of biofuels including biodiesel, butanol, DME, Fischer-Tropsch liquids, ethanol, and biocrudes, and development of fast response sensors for engine control. He is a Fellow of the Society of Automotive Engineers.

	Køcks Morten
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Coauthors	Thomas N. Jensen, Jesper N. Holm, Jacob B. Jeppesen

Publication title	*Shipboard Characterization of a Combined Particle Filter and NOx-reducing Technology: Influence on Particle Number Concentration, Particle Size Distribution and Gas Emissions*
Publication type	Presentation
Introduction & Background	Particle and gas emissions from diesel engines have profound impact on human health and as result; emissions from marine engines are under scrutiny. Although regulations on NOX emissions from ships have been implemented and sulphur content in marine fuel is limited to 0.1% in emission control areas (ECAs), and globally limited to 0.5% in 2020, emissions from ship traffic is still a much-debated subject. Particle emissions are today unregulated but expected to be regulated in the future. Thus, different mitigation strategies are being exploited including implementation of emission-reducing technologies such as particle filters, SCR catalysts and scrubbers. In this study, emission data from a Danish inland ferry with a retrofitted, integrated particle filter and SCR (Selective Catalytic Reduction) system (Dinex F-SCR) is presented. All measurements were carried out on-board the ferry connecting the island of Ærø with Funen. The ferry has two main engines (MaK M20C, 1020 kW 4-stroke diesel engine) both of them running on marine diesel, in which the sulphur content is limited to 0.1%.
Methodology	The emission was characterized at 4 points of engine load: Idle, 50%, 85% and 100% MCR (maximum continuous rating), and measured according to the ISO 8178 steady state method. Nanoparticle size distribution and number concentration was measured using a scanning mobility particle sizer (SMPS) (TSI) in connection with a rotating disc dilutor (Testo) and further connected with a catalytic stripper (Catalytic Instruments) for measuring the solid particle fraction. Gas emissions were measured using standard laboratory gas analyzer equipment as well as a Thermo Scientific Antaris IGS FTIR analyzer.
Results & Conclusions	Particle number concentration was in average reduced by more than 90 % by the filter – similar findings as compared to the previously installed filter without catalytic coating. The mean particle size was largest with the ferry operating in idle in the harbour during load and unload, and between 50 nm and 200 nm during all four engine loads tested. A NOx-reduction of at least 40% was measured when the system was put into operation. However, the efficiency of the filter dropped significantly during the day, probably due to soot contamination of the filter catalyst material. This shows that the efficiency might be even higher early in the morning during the first crossing. A solution for this problem could be more frequent regeneration. In conclusion, the installed particle filter in average reduced the particle emission with minimum 90% by number, measured in real-time during operation. The expected reduction was 99 % and the difference is very likely due to leaky bypass valves in the exhaust gas system. The NOx reduction was about 40% and the actual NOx level measured after the filter was below the IMO TIER II regulation for ships and comparable to the EURO III norm for on-road heavy-duty diesel engines. Following this work, a larger Danish project, also co-financed by the Danish

	EPA, has just been initiated (2017-2020) where three different particle/NOx-reducing technologies will be tested on three different ship engines.
Author CV:	2009 – present Senior Specialist, Danish Technological Institute, Aarhus, Denmark. Areas of interest: Characterization of airborne particles, emission reducing technologies, online measurement technologies, and advanced spectroscopy for chemical characterization 2003 – 2008 M.Sc. physics, Aarhus University, Denmark Publications: 10 peer reviewed papers Presentations : +10 conference posters and speaker at +5 scientific conferences/workshops.

Konstandopoulos Athanasios

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Coauthors	Margaritis Kostoglou; Anastasios Melas

Publication title	*On the Soot Particle Size Distribution Evolution During Oxidative Fragmentation*
Publication type	Presentation
Introduction & Background	There is recent evidence that adverse health effects associated with soot particles are affected not only by total soot mass concentration but also by number concentration. This means that processes that govern the soot particles number concentration evolution in vehicles exhaust aftertreatment must be taken into account. One of these processes is the so-called oxidative fragmentation i.e. the fragmentation due to the loss of connectivity between soot primary particles resulting by the oxidation of the necks between them. A generalized population balance description based only on particle size is not relevant since particle structure is important to the underlying phenomena so its special treatment is necessary.
Methodology	Particle structure and oxidative fragmentation is modeled in a hierarchical fashion motivated by our observations of experimental particle size distributions evolution and from electron microscopy images: Initially soot particles are considered to be aggregates of monomers described by a size distribution, with a size metric taken to be the number of monomers (i.e. primary soot particles) per aggregate. The monomers follow their own size distribution taken to be independent from the size of the aggregate in which they are located. The monomers are connected with solid bonds (quantified by an effective contact diameter that characterizes the bond strength). The bond strength is also assumed to be statistically distributed. Each primary particle (monomer) contains inside it a number of nuclei (described by another size distribution) which are spatially distributed inside the primary particle which can be assumed to have a spherical shape. The problem formulation is completed introducing the degree of ramification (cross linking) of the soot aggregate which can extend from a linear chain to an isotropic fractal structure.
Results & Conclusions	We demonstrate that the above hierarchical model can be cast in terms of a generalized soot aggregate population balance linking the corresponding probability density functions of each element (nuclei, primary particles, bonds, aggregates). Instead of imposing classical mean field fragmentation laws on the aggregate population, our approach treats fragmentation as a dynamic result of the system evolution, through the formulation of a novel shrinking operation (expressed through a temperature dependent oxidation rate) to the hierarchical aggregate structure. Several indicative results for different initial aggregate structures are presented and discussed, in order to describe the generation of oxidative fragmentation derived nanoparticles the majority of which has size less than the current legislation limit of 23 nm for particle number count emission limits.
Author CV:	Athanasios G. Konstandopoulos (PhD, MPhil, MScChE, Yale University; MScME Michigan Tech; Dipl. MEng. Aristotle University of Thessaloniki), Chairman of the Board of CERTH and Professor of Chemical Engineering, Aristotle University, is a specialist in nanoparticles, combustion aerosols and structured reactors for energy, environmental and biotech applications. He has coordinated and managed numerous research projects, funded by the European Commission and leading international industries. He is the recipient

of the 2006 European Descartes Prize and the 2010 European Research Council Advanced Grant, a Fellow of the Society of Automotive Engineers, author of numerous widely cited papers and member of the Board of Governors of the European Commission's Joint Research Center.

	Künzli Nino
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Coauthors	

Publication title	Ultrafine particles and Health: reviewing the evidence in the current policy context
Publication type	Presentation
Introduction & Background	Although health effects of ultrafine particles (UFP) are well established experimentally, its independent role and health relevance in the current mixture of ambient air pollution is less well understood but a relevant factor for the promotion of independent air quality standards.
Methodology	To understand the specific role of UFPs in ambient air, solid epidemiological evidence plays a dominant role.
Results & Conclusions	This presentation will summarize the current state of epidemiological studies on health effects of UFP's. Its independent role will be particularly addressed and put in context of open questions and the link of evidence with possibly policies.
Author CV:	Prof. Nino Künzli, MD, PhD, is the Deputy Director of the Swiss Tropical and Public Health Institute in Basel and the Dean of the Swiss School of Public Health – a foundation of eight Swiss Universities established 2005. As Professor of Social and Preventive Medicine of the University Basel he is responsible for the public health teaching in the Uni Basel medical school. His research focuses since >25 years and in > 350 publications on the health effects of ambient air pollution including the assessment of peoples' exposure and the related public health impact. He is a member of several large-scale national and international health studies, including the Swiss SAPALDIA. He regularly serves as policy advisor in international boards. He is a member of the international Guideline Development Group advising WHO in the ongoing up-date of the WHO Air Quality Guidelines – the scientific basis for air quality policy making around the world. Since 2012, Künzli is the President of the Swiss Federal Commission for Air Hygiene (FCAH) – the extra-parliamentary advisory board of the Swiss Government on air quality issues.

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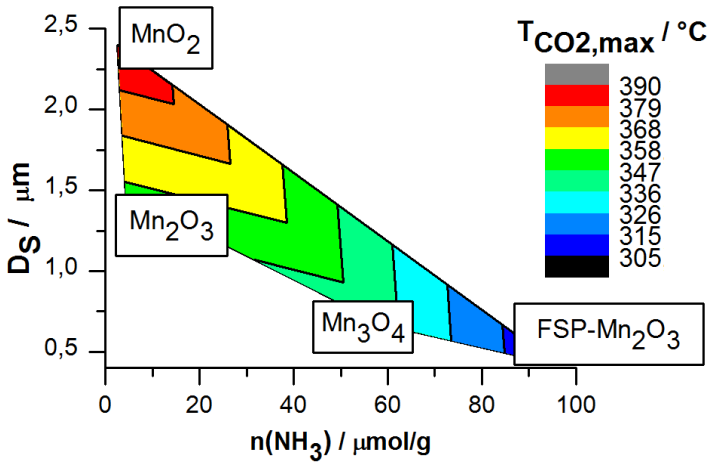
Coauthors	Christian Singer

Publication title	*Soot Oxidation on Manganese Oxide Catalysts in Gasoline Exhaust*
Publication type	Presentation
Introduction & Background	Gasoline engines with direct fuel injection (GDI) reveal high efficiency associated with reduced CO2 emission. However, due to tightening of emission limits the output of soot even from GDI engines comes more and more under pressure. Thus, gasoline particulate filters (GPF) with passive regeneration are considered. Thus, present paper addresses the development of MnOx catalysts for oxidation of soot by O2 in GPF systems. Manganese oxides were reported to be active for oxidation of hydrocarbons and soot in excess of oxygen [1].
Methodology	A series of bare MnOx samples was evaluated towards soot oxidation in gasoline model exhaust. Catalysts were characterized by XRD, BET, SEM, HTPR and NH3-TPD. Catalytic tests were performed by temperature programmed oxidation (TPO) using tightly contacted mixtures of catalysts with model soot (Printex U). Additionally, the best catalyst was investigated with propene and propene/ethanol carbon black mimicking (biogenic) gasoline soot. For mechanistic investigations, isotopic TPO studies with 18O2 were also made.
Results & Conclusions	Results and discussion The TPO tests demonstrated Mn2O3 prepared by flame spray pyrolysis (FSP) as the best catalyst providing soot combustion already at 250°C. This sample is one of the most efficient soot oxidation catalysts reported so far. The correlation of physical-chemical characteristics with catalytic activity showed that the number of surface oxygen vacancies and particle size determine the performance of the catalyst (Fig 1). Isotopic TPO of FSP-Mn2O3/soot suggested transfer of oxygen from surface and bulk of catalyst to soot by physical contact points. Oxygen vacancies produced were assumed to be refilled by gas-phase O2. Additionally, in situ Raman spectroscopy evidenced simultaneous oxidation of graphitic and amorphous carbon moieties. The tests of FSP-Mn2O3 catalyst with propene and propene/ethanol soot (Fig 2) showed that catalytic activity is not clearly affected by physical-chemical properties of the soot, e.g. the number of oxygen compounds present on soot surface. Conclusion Manganese oxide catalysts reveal outstanding efficiency in soot oxidation under gasoline exhaust conditions. Systematic physical-chemical characterization of a series of MnOx samples shows that the number of surface oxygen vacancies and particle size determine the catalytic performance of the catalysts by affecting the supply of oxygen. Isotopic studies evidence oxygen transport from the surface and bulk of the catalyst to the soot by physical contact points, while oxygen vacancies are refilled by gas phase oxygen. Furthermore, biogenic fuel components such as ethanol hardly affect the catalytic soot oxidation as referred to Printex U model soot. Finally, FSP-Mn2O3 represents one of the best soot oxidation catalysts and represents a promising candidate for the application in gasoline particulate filter systems. Literature

[1] S. Waglöhner, M. Nitzer-Noski, S. Kureti, Chem. Eng. J. 2015, 259, 492-504.

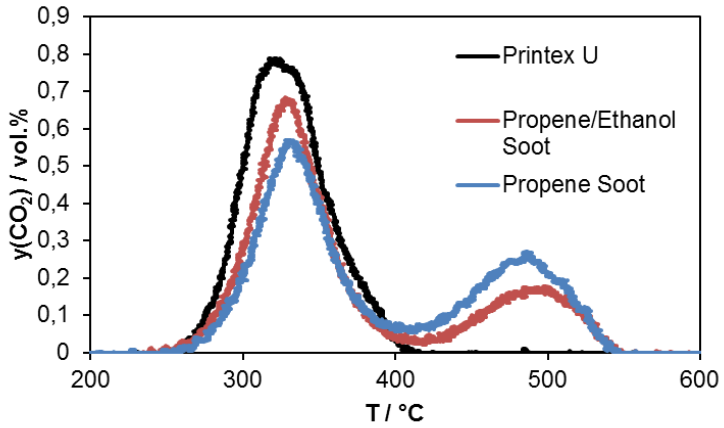
Acknowledgment
Financial support by Fachagentur Nachwachsende Rohstoffe (FNR) under the project BiOtto is thankfully acknowledged.

Caption Figure 1:



Correlation of TCO2,max, n(NH3) ascribing the number of oxygen vacancies and particle size (DS) of the MnOx catalysts.

Caption Figure 2:



TPO study of tight contact mixtures of FSP-Mn2O3 with Printex U, ethanol and propene/ethanol soot under gasoline conditions: y(O2)=1 %, y(H2O)=2 %, N2 balance.

Author CV:

Prof. Kureti studied Chemistry in Karlsruhe. After Ph.D. and habilitation in Technical Chemistry at Karlsruhe (with Prof. Bockhorn), two research stays at ETH Zurich (Prof. Baiker) and guest lectureship for Chemical Reaction Engineering at University of Leipzig he moved to University of Freiberg in 2010, where he holds the chair of Reaction Engineering. The research of Prof. Kureti mainly focuses on catalytic pollution control and synthesis gas chemistry.

	Lawrence Alfred
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Coauthors	

Publication title	*Indoor Air Quality Assessment and Health Impact with Respect to Household Conditions in Urban and Rural Lucknow Houses*
Publication type	Presentation
Introduction & Background	Natural sources as well as human activities, population growth, urbanization and economic development have contributed towards increasing air pollution in developing countries. The changes in the outdoor environment considerably affect the indoor environment. In developing countries indoor air pollution (IAP) is designated as one of the four most critical global environmental problems. A great deal of research has been done on IAP in urban areas, whereas lesser attention has been paid to rural scenario. Indoor air pollution from solid fuels, caused 3.5 million deaths and 4.5% global daily-adjusted life year (DALY) in 2010, in the same year solid fuel use was found to be responsible for 16% of Particulate Matter pollution. The study was conducted to assess indoor air quality in urban and rural Lucknow homes from November 2014 to October 2015.
Methodology	Five urban and five rural houses were selected for monitoring. Urban sites were subdivided in three microenvironments- 1- Densely populated 2-well planned and 3- Roadside on the basis of population distribution, traffic rush and architectural pattern of the houses. Rural areas selected for the study were Arjunpur, Malihabad, Gaura, Kakori and Bijnour. A questionnaire based survey of urban and rural homes was also done. NO2 & SO2, CO2, CO NH3 and H2S were measured indoor through 24hrs continuous monitoring by a portable YES-205 multigas monitor. NO2 & SO2 were also measured and compared by the impinger method (spectrophotometer method) using handy samplers (Ecotech, India). PM10 and PM2.5 were measured using APM-550 Fine particulate Sampler (Envirotech). Inhalation/deposition fluxes for average concentrations of particulate matter were calculated as at both rural and urban sites. AQI calculations were also done using a previously described method.
Results & Conclusions	Particulate concentration was higher than WHO limit and highest in winter season at both urban and rural sites having values 280±19 and 315±24 µg/m3for PM10 and 85±18 and 110±65 µg/m3 for PM2.5. Particularly higher concentrations were obtained when cooking was in progress. Owing to use of solid fuel like wood/ coal/ cow dung as shown by fill day variability data (Figure 1) Mean concentration of gaseous pollutants were within the threshold limits. SO2 and NO2 in urban houses can be attributed to heavy diesel generators due to scanty electricity supply in summer season. In rural households high particulate concentrations in winter season were due to inadequate heating measures and improper ventilation. Presence of NH3 in rural environment during rainy season was attributed to animal excreta. Mortality rate was highest (35.1%) in densely populated microenvironment during winter season and minimum in well planned in rainy season (4.3%). In rural households highest mortality rate (35.0%) was predicted in winter season. Eye irritation (55%) was prominent in summer season especially in urban respondents due to exposure of SO2 and NO2. Skin irritation (34.2%) commonly occurred in rainy season due to increased level of H2S and NH3. In winter season common symptoms were cataract (66.9%), headache (52.5%), and shortness of breath (48.5%). Indoor activities like cigarette smoking, crude fuel burning and outdoor activities like garbage burning had a significant effect on sudden elevation of pollutants indoor. AQI calculated with respect to particulate concentration was

very poor in rural homes hence making the exposed population highly susceptible for respiratory diseases. In urban environment AQI was poorest in densely populated and roadside colonies.
Conclusion- PM10 and PM2.5 were found to be higher in rural indoor environment as compared to urban environment as shown by yearly data. Crude fuel usage, poor sanitary conditions, improper ventilation were major offenders in rural areas whereas vehicular exhaust and outdoor surroundings were major cause of concern in urban environment. Educational status had a significant influence on living standards. Outdoor activities had a prominent role. Due to lack of awareness the rural population was found to be more susceptible to bear consequence of poor IAQ.

Caption Figure 1:

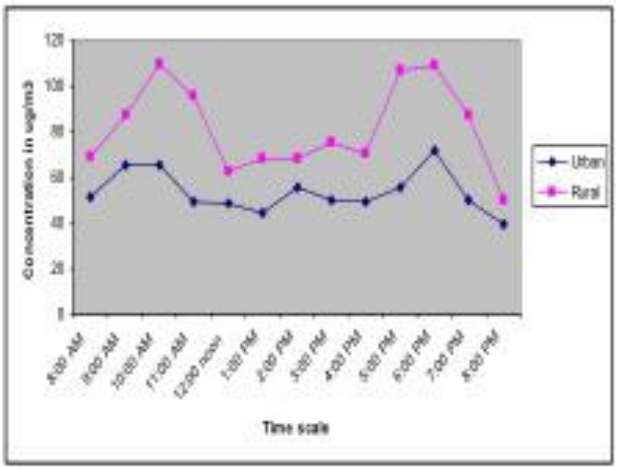

Fig. 1 (a) Full day variation pattern of PM in urban and rural households (a) PM10

Caption Figure 2:

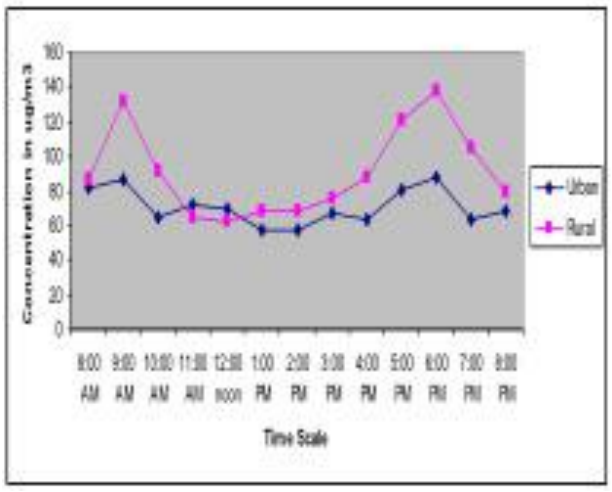

Fig. 1 (b) Full day variation pattern of PM in urban and rural households (b)PM2.5

Author CV:

Dr. Alfred Lawrence is young researcher with sixteen years' experience in the field of air pollution assessment and health impact studies. He has done his Ph. D. from St. John's College, Agra. During his doctoral study he visited University of Manchester and Oxford University, as visiting scholar. For his Post Doctoral research which he pursued from Purdue University, West Lafayette, USA, he worked on the project titled "National Air Emission Monitoring Study", Department of Agronomy" and worked as data manager for the years 2006-2009. After joining Isabella Thoburn college, Lucknow in the year 2010 as Assistant Professor in Department of Chemistry he has expanded the research division of the college and has been serving as the coordinator of the of Research & Networking Cell since his joining. He has also completed

one major project under the young scientist scheme funded by CST, U.P. and one minor research project funded by U.G.C. India, respectively. His expertise lies in the field of Indoor Air pollution assessment and its gruesome effects on human health. He has received many fellowships throughout the world for presenting his work. He has been involved in organizing two national conferences (Combating Air Pollution) and has also organized one international conference on “Women in Higher Education: Responding to the Challenges of Change and Innovation in a Global Environment”. He has more than 25 research publications in reputed International & National journals. Dr. Lawrence is a member of many National and International Scientific Societies and has also reviewed many international journals. Currently he is interested in modelling predictions of local but wider range pollution and looking for collaborations with international researchers in the field and wants to expand the air pollution research network.

Migliorini Francesca

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Coauthors	Silvana De Iuliis, Roberto Dondè, Giorgio Zizak

Publication title	*Can Black Carbon be defined by the Absorption Properties of Laser-heated Combustion Generated Nanoparticles?*
Publication type	Presentation
Introduction & Background	Laser heating of carbonaceous nanoparticles during laser-induced incandescence measurements has been proved to significantly affect the particles internal structure and to promote the formation of new particles as a result of a vaporization effect. Recently, the possibility of a permanent or reversible change in the optical properties of laser heated carbonaceous nanoparticles has been also considered, but this issue is far from being solved. The aim of the present work is to further investigate the variation of carbonaceous nanoparticles optical properties resulting from pulsed laser heating and to explore the possibility of using this phenomenon as a more unique definition of black carbon.
Methodology	The spectral behavior of carbonaceous nanoparticles absorption properties during laser irradiation has been explored by performing wavelength-resolved extinction measurements on laser-heated cold carbonaceous nanoparticles. Continuous measurements of the extinction coefficient are carried out from 400 to 680 nm by using a laser spark as light source. The variation of the extinction coefficient is explored without laser irradiation and simultaneously to the 4-ns prompt incandescence signal. Measurements are performed at different laser density energy. Cold carbonaceous nanoparticles are produced by Nitrogen-quenched ethylene and methane diffusion flames, providing carbonaceous nanoparticles of different nature.
Results & Conclusions	The results show a significant variation of the extinction coefficient of the laser-heated carbonaceous nanoparticles compared to the extinction coefficient of the non-heated ones. Such effect is particularly relevant below 550 nm and raises increasing the density energy of the laser. Moreover, it has been observed that carbonaceous nanoparticles heated by a laser pulse of 350 mJ/cm2, or higher, shows the same spectral dependence of the absorption properties, independently from the nature of the soot particles. Therefore, a working definition of black carbon could be: “any carbonaceous nanoparticles heated by a high laser energy density”.
Author CV:	Education Ph.D. in Industrial Chemistry and Chemical Engineering “Cum Laude”, Politecnico di Milano, Italy, 2009 Master degree in Industrial Chemistry, Università degli Studi di Milano, Italy, 2004 Reasearch and visiting positions - Researcher at the Institute of Condensed Matter Chemistry and Technologies for Energy (CNR-ICMATE), Milano, Italy, 2011- present. - Research Associate at the National Research Council Canada, Ottawa, Canada, 03/2009-03/2011 - Researcher on grant at the Institute for Energetics and Interphases (CNR-IENI), Milano, Italy, 2004-2009 - Scientific guest, Deutsches Zentrum fur Luft-und Raumhart (DLR),

Stuttgart (Germany), 01/2010-03/2010
Research interest

Dr. Migliorini is an active researcher in the development and application of optical/spectral diagnostics in reactive systems, with a particular interest in measuring and characterizing particulate matter. In the last years the research activity has been focused mainly on the development of the Laser-induced Incandescence (LII) technique, which has been proved to be a powerful tool for carbonaceous nanoparticle concentration and size measurements in combustion, particles synthesis and in environmental application. Recently, she is been directly involved in the designed and developed of a portable high sensitivity instrument based on two-color LII technique for the detection of carbonaceous particles in the environment Moreover, the laser-induced breakdown spectroscopy (LIBS) technique is also implemented as analytical tool for the elemental analysis of aerosols Other expertise concern the implementation of nanoparticle sampling procedures and TEM/STEM analysis

Muñoz Maria

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Coauthors	Heeb, Norbert; Comte, Pierre; Czerwinski, Jan; Haag, Regula; Zeyer, Kerstin; Mohn, Joachim;

Publication title	*Are GDI Vehicle Exhausts Genotoxic like Non-treated Diesel Exhausts?*
Publication type	Presentation
Introduction & Background	Gasoline Direct Injection (GDI) vehicles are quickly replacing traditional port fuel injection vehicles. GDI vehicles are expected to account for 1/3 of the EU fleet (53 MIO vehicles) by 2020. However, several sources reported high emissions of particles exceeding the Euro 6 diesel limit of 6x1011 particles/km. The question appears whether GDI exhausts are as genotoxic as untreated diesel exhausts. It is known that certain PAHs can induce genotoxic responses in cells causing mutations, which may lead to cancer. The WHO classified several PAHs as carcinogenic, like benzo(a)pyrene, a group 1 carcinogen. Filters will be required to reduce particles, as now it is for diesel vehicles. But filters may also support the formation of new pollutants. Therefore, it is urgent to assess benefits and risks of GDI technology.
Methodology	In this study, complete exhaust samples, including solid, condensed and gaseous fractions, have been collected from 7 different GDI vehicles (V1-V7, Euro 3 to Euro 6b) and a diesel vehicle with DPF at the chassis dynamometer of the UASB. The vehicles were driven following the WLTC under hot (WLTC-H) and cold start conditions (WLTC-C). Diluted exhausts were sampled from a CVS tunnel. In addition, 2 non-coated and 2 coated particle filters have also been tested with the reference vehicle (Volvo). In the laboratory, samples were processed following extraction and cleanup procedures and analyzed by HRGC-HRMS to determine PAH, alkyl-PAH and nitro-PAH concentrations.
Results & Conclusions	Figure 1 illustrates the toxic equivalent concentrations (ng TEQ/Nm3) for all GDI vehicles tested, the mean GDI value and the diesel vehicle emissions with DPF. In general, it can be seen that all GDI vehicles release genotoxic PAHs above the level of the diesel vehicle with DPF (the Euro 3 vehicle, the oldest one, is up to 60 times higher, 140 times higher in ng/Nm3 units).Whereas, vehicle 6 and 7 (both Euro 6) show the lowest emissions possible because they are Euro 6b and therefore should comply with more restrictive emission limits. PAH emissions seem to depend on GDI engine technology. Vehicle 1 was tested with two filters from brand A and two from brand B. In figure 1 (left) toxic equivalent concentrations of the 7 genotoxic PAHs (ng TEQ/Nm3) are shown for the reference vehicle without and with filters. Overall, PAH emissions are lowered with the use of filters when, for example, WLTC-H emissions are compared (3 to 7 times lower). However, emissions under the WLTC-H with filter 4 increase around 2.5 times. The black line shows the level of the diesel with DPF emissions in the WLTC-H. It can be seen that emissions for the reference vehicle with filters are always above this value. Therefore, higher emissions are released from this GDI vehicle tested with different filters than the Diesel vehicle with DPF. From figure 1, it can also be deduced that the difference between coated and non-coated filters is small. Taking into account these results, it is evident that GDI vehicles should be equipped with filters in order to reduce their emissions to levels of a diesel with DPF. Moreover, a certification procedure similar to that applied for DPF

approval should also be performed for GPFs to comply with specific quality parameters.

Caption Figure 1:

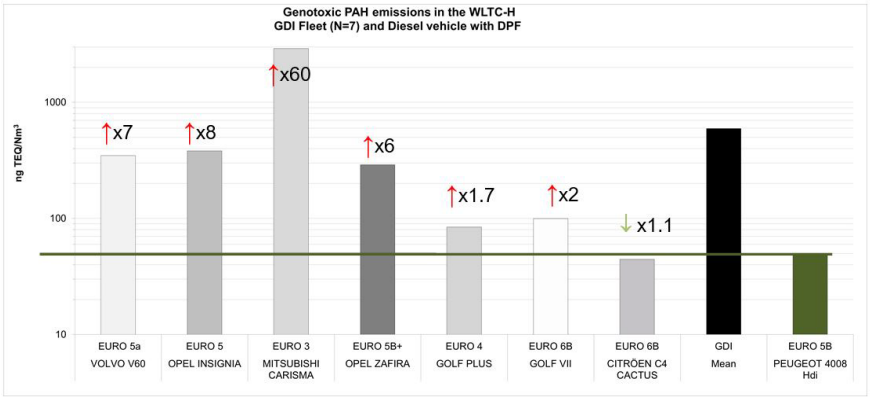

Figure 1. Toxic equivalent concentrations in ng TEQ/Nm3 of the sum of the 7 genotoxic PAHs in the WLTC-H (Benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene and dibenzo(ah)anthracene) in log scale for all the GDI vehicle tested, the diesel vehicle and the mean GDI value. The green line indicates the emission value of the diesel vehicle. X-increase indicated with a red arrow and related to the diesel vehicle, likewise, green arrow indicates a decrease related to the diesel vehicle.

Caption Figure 2:

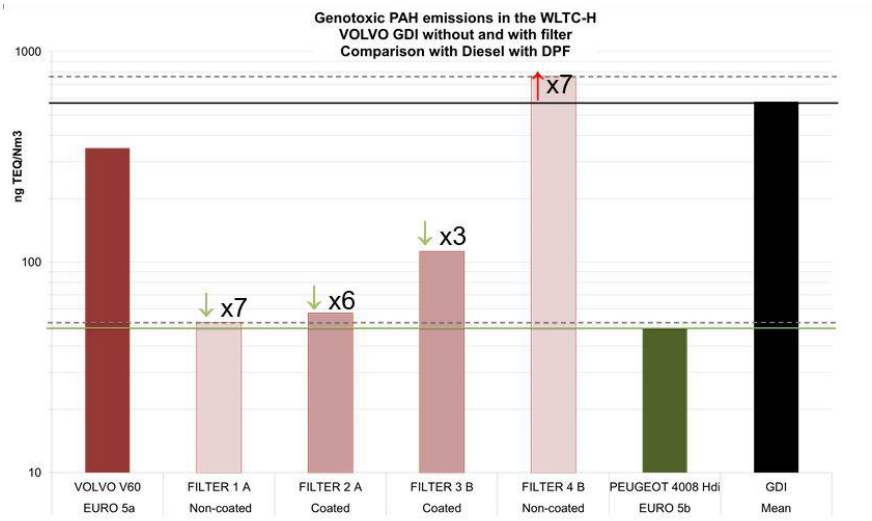

Figure 2. Toxic equivalent concentrations in ng TEQ/Nm3 of the sum of the 7 genotoxic PAHs in the WLTC-H (Benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene and dibenzo(ah)anthracene) in log scale for the reference vehicle (Volvo V60) without filter and same vehicle with the 4 tested filters (F1, A-non-coated; F2, A-coated; F3, B-coated and F4, B-non-coated). Emissions for the diesel vehicle (green bar) and the GDI mean value (black bar) are also shown. Dark line indicates de mean GDI value whereas the dashed lines show the minimum and the maximum emission values obtained. The green line indicates the emission value of the diesel vehicle. X-increase indicated with a red arrow and related to the vehicle without filter, likewise, green arrow indicates a decrease related to the same vehicle.

Author CV:

Maria Muñoz is a postdoctoral researcher at the Laboratory for Advanced Analytical Technologies at Empa, Dübendorf since September 2014. She is currently working in a project on GDI vehicle emissions and jet engine emissions. She gained her Ph.D. in 2013 at the University of Alicante, Spain. She developed her research based on the analysis of

organohalogen compounds emitted in different waste treatment processes. During her more than 7 years of research experience she has published more than 12 papers in relevant journals and contributed with several oral and poster communication in several national and international conferences

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Publication title	*Total Particle Number Concentration and Particle Size Distribution of Nanoparticles from Real-scale Pulverized Solid Fuel Combustion*
Publication type	Presentation
Introduction & Background	Energy production is affected by actions made for reducing CO2 emissions from fossil fuels. Energy production can not depend on fossil fuels. At the transition time period, combustion processes are needed for energy production. During the transition time, the fossil fuels can be substituted partly or fully with biomass (The European Industrial Bioenergy Initiative, version 24 Jan. 2014, p. 3). Depending on the biomass adopted to energy production the combustion technology must be chosen correctly to maintain boiler operation and avoid corrosion and fouling problems (The European Commission, Technology assessment, COM(2013), 253 final, 2 May 2013 pp. 23,25) . All of the changes can affect the emissions of a power plant.
Methodology	Emissions of a coal- or coal - 10.5% industrial quality pellet-fired power plant (726 MWth) were characterized in three different locations of the flue-gas duct system by on-line instruments after dilution. First sampling point was the superheater area of the boiler, the second sample was taken from the power plant stack after electrostatic precipitator with and without desulphurization plant and fabric filters, and the third sample was taken with a helicopter from the atmosphere. ELPIs (Dekati Inc.) and SMPSs (TSI Inc.) were used in first two locations, whereas EEPS (TSI Inc.) and CPC3776 (TSI Inc.) were applied in the atmospheric measurements. The measurements made from the helicopter allowed studying the atmospheric dilution of the flue-gas plume particle number concentration.
Results & Conclusions	10.5% of industrial quality pellets mixed with coal affects the particle formation by decreasing the amount of nanoparticles (25 nm in mean diameter) and increasing the amount of larger particles (120 nm in mean diameter) (Mylläri et al. Comb and Flame, 176, pp. 554-566, 2017). Combustion of 10.5 % of industrial pellet decreases total particle number concentration after electrostatic precipitators compared to 100 % coal combustion (Mylläri et al. in prep., 2017). Fabric filters and desulphurization plant lower the SO2, dust and total particle number emissions even more after electrostatic precipitators and thus the flue-gas cleaning technologies have high impact on power plant emissions (Mylläri et al. Atmos. Chem. & Phys., 16, pp. 7458-7496, 2016). The nano- and fine particle emissions are rather low after the flue-gas cleaning technologies, however, the particle number concentration increases when the flue gas ages in the atmosphere (Mylläri et al. Atmos. Chem. & Phys., 16, pp. 7458-7496, 2016). In this study, the flue gas was in the atmosphere 400-800 seconds, during which the new particle formation started in the flue-gas plume.
Author CV:	I am a Ph. D. student focusing on energy production emissions. I have four publications in international journals: Environmental Science & Technology, Atmospheric Chemistry and Physics, Combustion and Flame.

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Coauthors	Herbert Juch; Sabine Reimann; Martin Gauster; Gottfried Dohr; Barbara Obermayer-Pietsch; Dominic Gröger; Rainer Haag
Publication title	*Nanotoxicology of Human Placenta: Evaluation of Suitable Model for Environmental Toxicity*
Publication type	Presentation
Introduction & Background	There is a growing concern that air pollution could cause potential harmful effects on pregnancy outcomes. Epidemiological and research data provide the evidence that in utero exposure to particular matter (PM) during pregnancy might increase the risk of low birth weight as well as evolves certain molecular changes in growing fetus. Due to interspecies differences in placenta structure, data obtained on rodents could not be easily extrapolated on humans; therefore there is a growing need of advanced model to study molecular mechanisms of PM toxicity in human placenta.
Methodology	Biodegradable dendritic polygycerol particles (dPG- NPs) 5nm in diameter, with different surface-charge, at concentrations of 1µM and 10nM, were chosen for analysis. First trimester human placental explants, BeWo choriocarcinoma cells and isolated primary trophoblast cells from human term placenta were exposed to fluorescence labelled dPG- NPs for 6 and 24 hours. Accumulation of dPGs as visualised by fluorescence microscopy, LDH and hCG release were measured to assess the dPG-NP impact on cells integrity and endocrine function.
Results & Conclusions	A dose- and charge-dependent accumulation of dPG-NPs was observed at the early placental barrier and in placental cells; positive charge facilitated the NP-crossing the placental barrier. No sign of plasma membrane damage could be detected. At the same time we observed a significant reduction of ß-hCG secretion in placental explants, but not in trophoblast cells, especially at low dPG-NP concentrations. Thus NP´s surface-charge substantially influences their biodistribution at the maternal- foetal interface. The first trimester placental explant model, containing natural placental barrier, in contrast to cell line and primary cells, revealed potentially hazardous influences of dPG-NPs on placental hormone production. Therefore placental explants model could be considered to be of biological relevance for studying environmental toxicity of human placenta.
Author CV:	Employment: January 2012-present: University Assistant, Institute of Histology, Cell Biology and Embryology, Medical University of Graz, Austria February 2009- February 2012: postdoctoral fellow, Institute of Biochemistry and Molecular Medicine, University of Bern, Switzerland November 2007- October 2008: postdoctoral fellow, Institute of Cell Biology, Histology and Embryology, Medical University of Graz, Austria December 2006 - October 2007: Research assistant of Research center for Obstetrics, Gynecology and Perinatology named after acad. Kulakov, Moscow, Russia December 2003-September 2006: PhD Fellowship in Biochemistry Department of Faculty of Medicine Lomonosov Moscow State University, Moscow, Russia

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Publication title	*Cross-Intersection Profiles of Ultrafine Particles in Different Built Environments: Implications for Pedestrian Exposure and Bus Transit Stops*
Publication type	Presentation
Introduction & Background	There is growing recognition that exposure to roadway pollution is associated with increases in a wide range of adverse health outcomes, especially for sensitive groups. We explore the impacts of the built environment form and urban planning decisions on exposures of pedestrians and transit users to roadway pollution.
Methodology	We investigate the characteristics of cross-intersection concentration profiles of ultrafine particles (UFP) with 5 m spatial resolution, using 1,744 profiles covering 90 m before and after each intersection center. Cross-intersection UFP profiles were measured with a mobile monitoring platform from 10 signalized intersections at six urban sites with distinct built environments for both morning and afternoon. Measurements were made within 1.5 m of the sidewalk and approximately at breathing height (1.5m above ground level) to approximate sidewalk exposures. Built environments include a tall street canyon, a site with a solid wall of buildings on one side and low buildings and open space on the other, several sites with variously configured isolated tall buildings, and a site with 1-storey development.
Results & Conclusions	UFP profiles were strongly influenced by high emissions from accelerating vehicles, and showed elevated concentration peaks within 30 m of intersection centers followed by sharp decreases in concentrations with distance. The UFP peak concentrations were located near the intersections, and averaged about 90% higher than the minima along the blocks. The area near the intersection was accompanied with more frequent and larger transient concentration spikes. Thus, people staying longer at the intersection have an increased chance of being exposed to short-term highly elevated concentrations. The minima before the intersection (the ‘near side’) were somewhat lower than after the intersection (the ‘far side’), However as siting transit stops after intersections is preferred for smooth traffic flow, we focus on the location of the ‘far side’ minimum. Simple time-duration exposure calculations combined with breathing rates suggest moving a bus stop farther from the intersection reduces transit-users’ exposure levels to the total UFP by up to about 60% for the sites studied here.

Caption Figure 1:

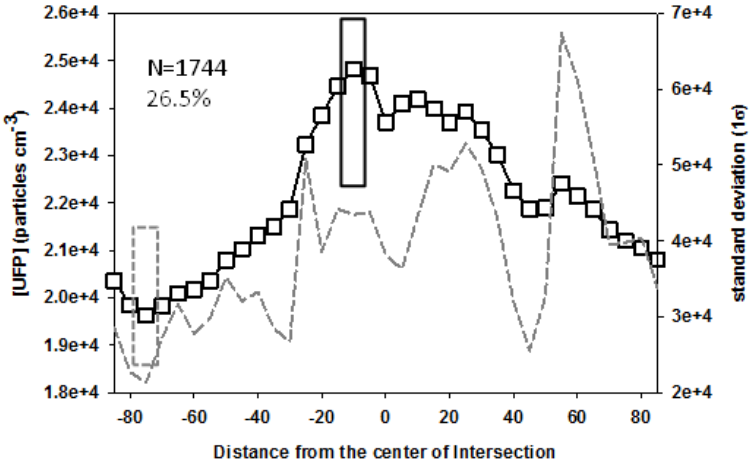

Figure 1. The mean [UFP] profiles across the intersection for all sites and all directions (1744 total profiles); average UFP concentration: solid line, standard deviation: broken line. The black rectangle indicates the peak and the grey rectangle indicates the base location. Because so many profiles are averaged and their peak location varies somewhat, this figure underestimates the enhancement at the intersection.

Author CV:

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PROFESSIONAL HISTORY

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Assistant & Associate Professor of Atmospheric Chemistry 1994-2005
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Advanced Study Program Post-Doctoral Fellow, National Center for Atmospheric Research, Boulder, CO 10/1991-2/1994

EDUCATION

Ph.D., Environmental Engineering Science, June 1991, California Institute of Technology. Course Concentration in Chemistry and Chemical Engineering. Thesis: "Contributions of Biogenic and Anthropogenic Hydrocarbons to Photochemical Smog Formation." Advisor: Professor John H. Seinfeld.
M.S., Environmental Engineering Science, June 1987, California Institute of Technology.
M.S., Plant Biology, August 1986, University of Illinois, Urbana-Champaign.
B.A., Chemistry, December 1983, University of Colorado at Boulder.

HONORS AND AWARDS

2014 Environmentalist of the Year Award (with others), Faith2green and Councilman Koretz, Los Angeles
2011, 2002, 1999 Gordon Conference Invited Lectures
2011 Invited article, Journal of Physical Chemistry
2001 Guest Professor, University of Innsbruck, Austria
1999 University of California Regents Faculty Fellowship
1999 Invited feature article, Journal of Physical Chemistry
1999 - Who's Who in American Women in Science & others
1996 NSF CAREER Award
1995 Award for Excellence in Teaching and Education, UCLA Dept. of Atmospheric Sciences.
1991-1993 National Center for Atmospheric Research Advanced Study Program Post-Doctoral Fellowship.
RECENT SCIENTIFIC SERVICE

Expert Panelist, Comision de Nacional de Investigacion Cientifica y Technologica –CONYCIT
(Chilean National Science Foundation) 2015
American Association of Aerosol Research Development Committee 2013-2016
Publications Committee 2009-2012
Chair 2010-2012
Research Screening Committee Appointee, California Air Resources Board 2008-
(lifetime appointment)
Expert, Whitney v. Hyatt Legionella Case, Silicon Valley Law 2014
Science Advisory Board member, EPA Clean Air Research Center, Georgia Tech 2011-2016
72. 27th Southern California Photochemistry and Kinetics Conference, Universtiy of California at San Diego, CA May 12, 2017.
71. Parks, Obesity, Air Pollution and Health, Panelist, California Endowment April, 2017.
70. "Effectiveness of Soundwall-Vegetation Combination Barriers as Near-Roadway Pollutant Mitigation Strategies." Coordinating Research Council Mobile Source Air Toxics Workshop, Sacramento, Feb. 15, 2017.
69. "The wind, the traffic and the buildings: the role of the built environment in determining air pollution exposures" 20th Combustion Nanoparticles Conference, ETH Zurich June 15, 2016.
68. "Particle Dynamics in the Road-toAmbient in the Stable Early Morning Atmosphere" Cambridge Particle Conference, Cambridge, UK June 12, 2016.
67. University of Cambridge, Cambridge UK 2-16 "The Tangled World of Reactive Oxygen Species: the Search for the Bad Actors in Ambient Particles" Feb. 2016.
66. University of Birmingham, Birmingham UK "Roadway Pollution in Complex Urban Environments: Spatial Distributions, Built Environment Characteristics and Dynamics of Ultrafine Particles" Feb. 2016.
65. University of Surrey Guildford, UK "The wind, the traffic and the buildings: the role of the built environment in determining air pollution exposures" Dec. 2015.
64. Breathe California Sacramento Symposium on near roadway mitigation strategies Sacramento Apr., 2015.

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Publication title	*Gas Phase Composition and Secondary Organic Aerosol Formation from Gasoline Direct Injection Vehicles Investigated in Batch and Flow Reactors*
Publication type	Presentation
Introduction & Background	Vehicular pollution is a significant source of air pollution in many urban areas. Historically, diesel-fueled vehicles have been recognized as a significant source of primary fine particular matter (PM), containing a significant fraction of black carbon (BC). Accordingly, the use of older-generation diesel vehicles is often restricted in cities and modern diesel vehicles are subject to stringent primary PM limits, which are met with both, oxidation catalysts and diesel particulate filters (DPFs). In contrast, gasoline fueled vehicles and especially gasoline direct injection (GDI) systems have been recognized only recently as significant source of primary PM, especially BC. In light of more stringent legislations, automobile manufacturers have recently considered equipping modern gasoline light-duty vehicles with gasoline particulate filters (GPFs) to reduce primary PM emissions. Although GPFs are likely to be similarly effective to DPFs in reducing primary emissions, recent research indicates that the dominant fraction of the total PM from modern GDIs is secondary, originating from gaseous precursors that are transformed in the atmosphere to form secondary organic aerosol (SOA). Those precursors are unlikely to be removed by GPF systems. Laboratory results are, however, missing. SOA formation of GDI vehicles (w/o GPFs) has been studied previously in atmospheric simulation chambers (SC). However, the SOA-forming precursors could not be unambiguously identified, in parts due to limitations of the applied techniques to study the non-methane organic compounds (NMOC) emitted, as well as the batch-style SC experiments, which limit the number of experiments practically.
Methodology	Here, we investigate primary and secondary emissions from modern GDI vehicles, of which one is additionally equipped with a prototype GPF. Vehicles were tested on a chassis dynamometer during a modern regulatory driving cycle (WLTC) and the older low-load NEDC, under cold- and hot-started engine conditions. SOA formation was investigated through batch-style aging of collected emissions in the PSI mobile SC, and the potential aerosol mass (PAM) oxidation flow reactor (OFR). Further, time-resolved analysis of aged emissions during a driving cycle using the OFR was performed. Relevant SOA precursors were characterized by proton transfer reaction time-of-flight mass spectrometry (PTR). The SOA mass and its bulk chemical composition were characterized by aerosol mass spectrometry (AMS). An aethalometer was used to determine equivalent BC (eBC) concentrations.
Results & Conclusions	GPF installation was found to greatly decrease primary PM through the near complete removal of eBC, but to have a complex and volatility-dependent effect on the minor primary organic aerosol (POA) fraction, and no detectable effect on NMOC emissions or SOA production (Fig.1). In all tests, overall NMOC and primary and secondary PM emissions were dominated by the engine cold start, i.e. before thermal activation of the catalytic after-treatment system (Fig.1-2). SOA formation in SC and OFR compared well in terms of SOA yields and bulk compositional properties such as O:C and H:C ratios. Effective SOA yield analysis shows that SOA production is predominantly explained by a small number of aromatic hydrocarbons (ArHC), based on a comparison with single substance SOA yields of toluene, o-xylene and 1,2,4-trimethylbenzene tested in our OFR.

This work was supported by the CCEM Project GasOMeP.

Caption Figure 1:

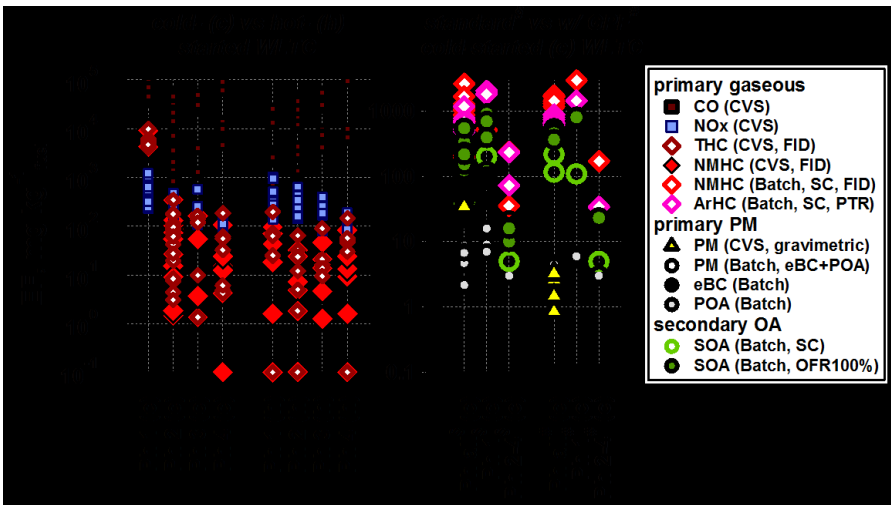

Fig.1. Emission factors (EF) of primary and secondary pollu-tants from constant volume sampler (CVS) and batch sampling (SC) from Phase 1 to 4 of a cold- and hot-started WLTC test. Total hydrocarbons (THC) and non-methane hydrocarbons (NMHC) were measured by flame ionization detection (FID). OFR100% denotes OFR operation at 100% UV power. Other abbreviations are explained in the text.

Caption Figure 2:

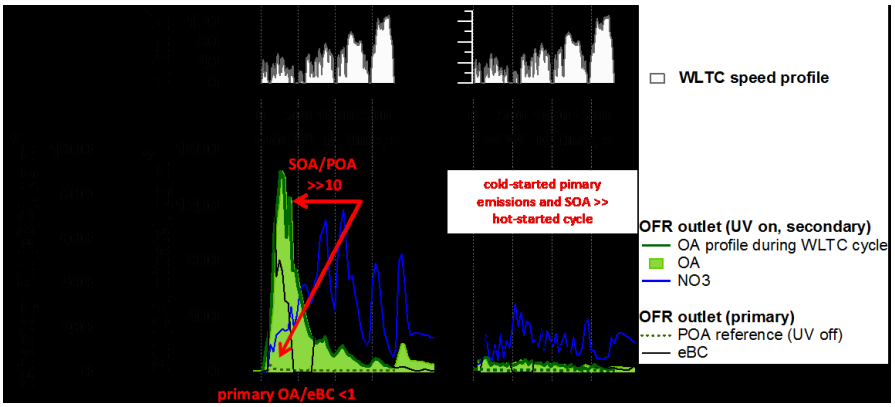

Fig.2. Time-resolved primary and secondary PM (SOA and nitrate (NO3)) emissions profile.

Author CV:

2005 – 2012 BSc. and MSc. in Environmental Chemistry (University of Graz, AT and Utrecht University, NL) and MSc. in Energy and Environmental Engineering (University of Applied Sciences Burgenland, AT), 2013-2017 PhD Research at Paul Scherrer Institute (CH) in the Laboratory of Atmospheric Chemistry – Gasphase and Aerosol Chemistry Group.

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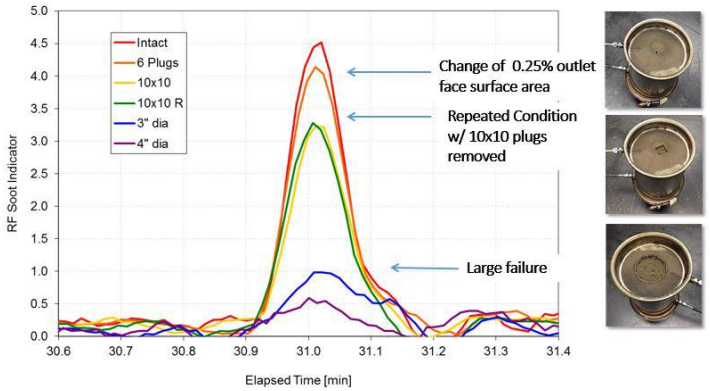
Publication title	*In-Use Particulate Filter State of Health Monitoring: Prognostics and Diagnostics Using Radio Frequency Sensing*
Publication type	Presentation
Introduction & Background	The increasing use of diesel and gasoline particulate filters requires advanced on-board diagnostics (OBD) to prevent and detect filter failures and malfunctions. Early detection of upstream (engine-out) malfunctions is paramount to preventing irreversible damage to downstream aftertreatment system components. Such early detection (prognostics) can mitigate the failure of the particulate filter resulting in the escape of emissions exceeding permissible limits and extend the component life. Current approaches using downstream soot sensors provide only reactive diagnostics to detect a failure after it has already occurred. However, despite best efforts at early detection and filter failure prevention, the OBD system must also be able to detect filter failures when they occur.
Methodology	In this study, radio frequency (RF) sensors were used to directly monitor the particulate filter state of health for both gasoline particulate filter (GPF) and diesel particulate filter (DPF) applications. The testing included controlled engine dynamometer evaluations on diesel and gasoline engines, which characterized soot slip from various filter failure modes. Additional testing included a four-year on-road fleet study with heavy-duty DPF-equipped vehicles operated on New York City drive cycles.
Results & Conclusions	The results show a high sensitivity of the RF measurements to detect conditions resulting in soot leakage from the particulate filter, as well as potential for direct detection of structural failures including internal cracks and melted regions within the filter media itself. Furthermore, the measurements demonstrate, for the first time, the capability to employ a direct and continuous monitor of particulate filter state of health, providing early warning of potential failure modes before they occur, as well as the detection of a reduction in trapping efficiency, should the filter be compromised.

Caption Figure 1:

RF sensor control units and antennas for monitoring particulate filter state of health.

Caption Figure 2:



Reduction in RF derivative signal response as a result of increased soot slip (reduced trapping efficiency) of a damaged particulate filter.

Author CV:

Dr. Alexander Sappok is Director of RF Sensors for CTS Corporation's Boston Innovation Office. Previously, Dr. Sappok served as President of FST, an MIT spin-out company developing advanced sensors for engine emissions control systems, acquired by CTS Corporation in 2015.

Prior to CTS and FST, Dr. Sappok's research career at the Massachusetts Institute of Technology Sloan Automotive Laboratory spanned a range of topics including fuel efficiency, emissions reduction, and diesel emissions aftertreatment systems. He is a past recipient of the SAE Arch T. Colwell Merit Award, SAE Lloyd. L. Withrow Distinguished Speaker Award, and the SAE John Johnson Award for Diesel Research, as well as an R&D 100 Award.

Dr. Sappok holds a B.S. in Mechanical Engineering from Kansas State University, and S.M. and Ph.D. degrees in Mechanical Engineering from MIT, where he also held the Cummins-MIT Fellowship.

Schripp Tobias

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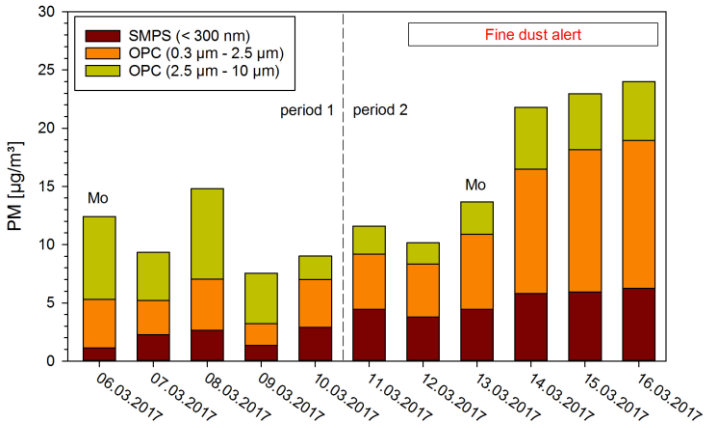
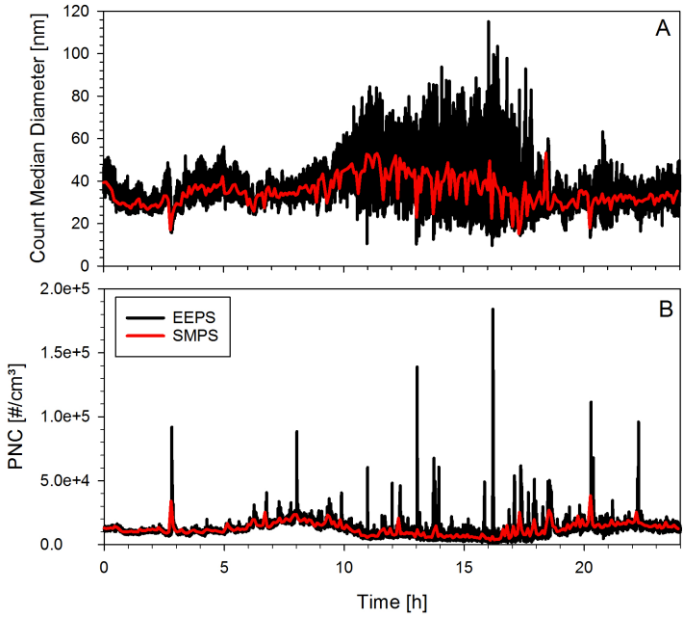
Publication title	*Ambient Ultra-fine Particle Concentration Monitoring During a "Fine dust alert" Event in Stuttgart Focusing on High Size and Time Resolution*
Publication type	Presentation
Introduction & Background	Due to a special geographical situation, the city of Stuttgart, Germany is affected by elevated particle concentrations under meteorological conditions that hinder a sufficient air exchange. Since the European limit value of 50 µg/m³ (PM10) is exceeded more than 35 days per year under these conditions, the city launched a series of actions to reduce emission sources during unfavorable weather conditions. One action is the "fine dust alert" that provides public information on upcoming increases in particle concentrations and recommendation on reduction strategies (e.g. ban of wood oven use, use of public transport, etc.). More drastic measures are announced for 2018 to reduce the concentration of particles and nitrogen oxides, including the ban of non-Euro-6 diesel vehicles. However, present monitoring focusses on PM2.5 and PM10 using gravimetric techniques assisted by continuously recording light scattering spectrometers. This paper aimed at the precise characterization of particles during a "fine dust alert" in the range < 300 nm using two techniques that either focus on high time resolution or high size resolution.
Methodology	A measuring station was set up near to the Kernerplatz in Stuttgart containing a TSI Engine Exhaust Particle Sizer (5.6 nm – 560 nm, Δt = 1 s), a TSI Scanning Mobility Particle Sizer (7 nm – 300 nm, Δt = 300 s) and a TSI Optical Particle Sizer (0.3 µm – 10 µm, Δt = 30 s). Weather conditions (wind speed, direction, etc.) were continuously recorded. Ambient air sampling was performed at a height of 10 m through a stainless-steel probe. Monitoring was performed from the 06.3.2017 to the 16.03.2017.
Results & Conclusions	The measuring period featured two phases of different wind speeds. During the 06.03. – 10.03.17 (period 1), the wind speed was 0.08 ± 0.22 m/s while during 11.03. – 16.03.17 (period 2) the wind speed was lower with 0.02 ± 0.08 m/s. This trend mirrors in the airborne particulate matter (Figure 1) which increases from approx. 11 µg/m³ to 24 µg/m³. The predominant increase in PM happens in the size range between 0.3 µm and 2.5 µm. Since the count median diameter (combined data of SMPS and OPC) is 40 ± 9 nm (period 1) and 55 ± 10 nm (period 2), the majority of the particle number (99.2%) is optically not detectable (d < 300 nm). The characterization of the ultra-fine particle fraction is, however, an important aspect for the exposure assessment against airborne particle since they are not deposited in the upper respiratory pathways. Overall, the slow-measuring SMPS is not able to detect several emission events observed by the EEPS but the mean particle number concentration provides a sufficiently precise data set for further exposure assessment (Figure 2). Furthermore, the fact that the measured concentrations at Kernerplatz are approx. half the concentration observed by the spot measuring station in 0.5 km distance at Neckartor (which reported exceeding of the limit value) illustrates that these elevated concentrations represent a local phenomenon.

Caption Figure 1:



Particulate matter for the two measuring periods in dependence of the size of the measured particles.

Caption Figure 2:



Development of the count median diameter (A) and the particle number concentration (B) on the 15.03.2017 (“fine dust alert”) using high (EEPS) and low (SMPS) time resolution.

Author CV:

Dr. Tobias Schripp holds a PhD in chemistry from the Technical University Braunschweig, Germany. He performed his PhD work at the Fraunhofer Wilhelm-Klauditz-Institute (WKI) in cooperation with the Institute for Physical Chemistry of the TU Braunschweig and the Department of Civil and Environmental Engineering at the VirginaTech, Blacksburg VA. From 2009 to 2016 he served as scientific research officer at the Fraunhofer WKI in the department “Material Analysis and Indoor Chemistry”. Since 2016 he works for the German Aerospace Center in the Institute of Combustion Technology, Stuttgart in the department of “Chemical Analytics”.

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Publication title	*Comparison of Aircraft Emissions from Los Angeles International Airport to Urban Vehicle Traffic Emissions and its impact on air quality in Los Angeles*
Publication type	Presentation
Introduction & Background	Among various combustion sources of particulate matter (PM) in urban areas, accurate assessment of airport-related emissions and how they compare to other predominant PM sources such as traffic emissions is essential in understanding the impact of airports on air quality and human health. This study investigates the overall impact of aircraft emissions from the Los Angeles International Airport (LAX) and its facilities in comparison to vehicular emissions from freeways, within the impact zone of the airport, an area of roughly 100 km2 downwind of the LAX, on air quality on a local scale. Moreover, there is growing literature supporting the hypothesis that one of the important pathways underlying adverse health effects associated with PM exposure is the oxidative stress that derives from the interaction of PM with cells. Elevated reactive oxygen species (ROS) levels can alter the redox status of the cell and consequently trigger a series of acute and chronic responses such as pulmonary inflammation and mitochondrial damage. Differences in the chemical and physical properties of combustion generated particles can potentially lead to differences in their oxidative potential.
Methodology	To this end, air monitoring measurements of particle number (PN), black carbon (BC) and PM2.5 mass concentrations were performed in the vicinity of the Los Angeles International Airport (LAX) (roughly 150 m downwind of the LAX's south runways) as well as on-road measurements of the aforementioned pollutants using a mobile platform on three major freeways near the airport (i.e., I-110, I-105, and I-405) during May-July 2016. We also investigated the oxidative potential (OP) of ambient ultrafine particles (PM0.25,
Results & Conclusions	PN concentration was, on average, 4.1±1.2 times greater at the LAX site than on the studied freeways. Particles measured at LAX had an average diameter of about 20 nm, while on-road freeway measurements on I-110, I-105, and I-405 indicated an average particle diameter of >40 nm, a particle size range that is more typical of vehicle traffic and not aircraft emissions in urban areas. Particle number emission factors for takeoffs and landings were comparable, with average values of 8.69 ×(10)^15 particles/kg fuel and 8.16 ×(10)^15 particles/kg fuel, respectively, and indicated a nearly 4-fold statistically significant reduction in PN emission factors for takeoffs during the past decade. The results also indicated that the LAX's daily contributions to PN, BC, and PM2.5 emissions were approximately 11, 2.5, and 1.4 times greater than those from the three surrounding freeways. These results underscore the significant role of the LAX airport as a major source of pollution within its zone of impact comparing to freeway emissions. Furthermore, the chemical composition and toxicological properties of samples collected at the LAX airport and those in the vicinity of a freeway are compared and discussed.

Caption Figure 1:

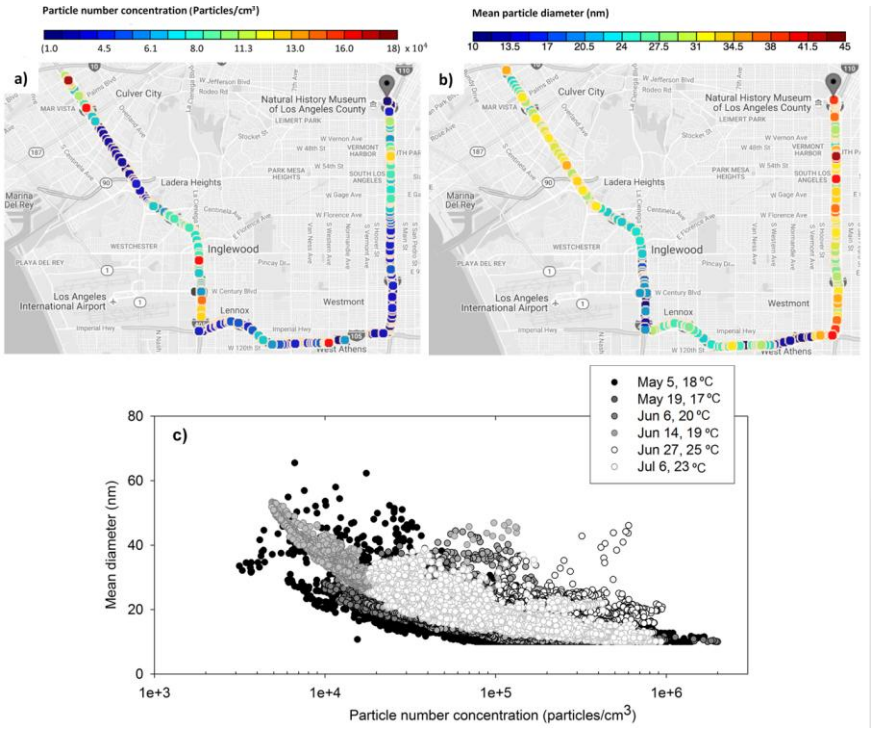

Figure 1 (a-c). Spatial pattern of a) particle number concentration (particles/cm3) and b) mean particle diameter (nm) measured inside of freeways on June 6, 2016 between 12:00-3:00 PM. c) Mean particle diameter versus particle number concentration during the sampling at the Los Angeles International Airport (LAX) with the average ambient temperature (ºC) during the sampling period obtained from the Air Quality Management District (AQMD) monitoring station at LAX. The data shown here are raw data.

Caption Figure 2:

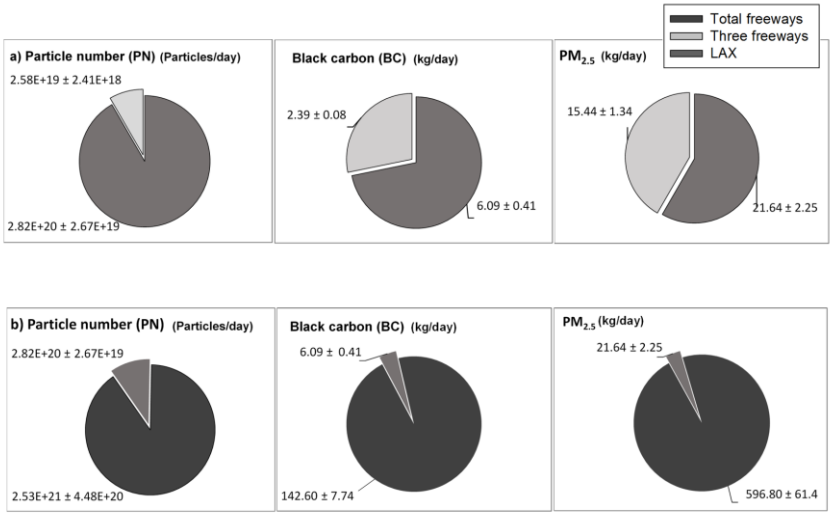

Figure 2 (a-b). Pie charts of the contribution of Los Angeles International Airport (LAX) to particle number (PN), black carbon (BC) and PM2.5 daily emissions versus a) the segments of the three adjacent freeways (i.e. I-110, I-105 and I-405) and b) total freeways in the Los Angeles County.

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Presenting author biography:
Dr. Constantinos Sioutas, Sc.D., is the first holder of the Fred Champion Professorship in Civil and Environmental Engineering at the University of Southern California (USC). His research has focused on investigations of the underlying mechanisms that produce the health effects associated with exposure to airborne ultrafine particulate pollutants generated by a variety of sources. He has developed many state-of-the-art technologies used by many academic institutions and national laboratories for aerosol sampling and

characterization. He has authored over 300 peer-reviewed journal publications, and holds 13 U.S. patents in the development of instrumentation for aerosol measurement and emissions control. His work has been cited in more than 15,000 scientific publications. He is the recipient of the American Association for Aerosol Research (AAAR) David Sinclair award in 2014 (AAAR's highest distinction), the Hagen Smit award of Atmospheric Environment for seminal publications, the 2010 Scientific and Technological Achievement Award by the U.S. Environmental Protection Agency, and a Fulbright fellow.

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Publication title	*Oxidized Ultrafine Particles Induce the Activation of the Inflammasome in Human Peripheral Blood Mononuclear Cells Obtained from Chronic Obstructive Pulmonary Disease Patients.*
Publication type	Presentation
Introduction & Background	Inflammation is central to the development of chronic obstructive pulmonary disease (COPD), which is caused by inhalation of noxious particles or gas. Emerging genetic and pharmacological evidence suggest that IL-1-like cytokines are highly detected in the sputum and broncho-alveolar lavage (BAL) of COPD patients, implying the involvement of the multiprotein complex inflammasome.
Methodology	In order to understand the role of this complex in COPD, we isolated PBMCs from healthy volunteers (smoker and non-smoker) and COPD patients. To mimic environmental pollution, PBMCs were treated with ultrafine particulate matter produced from different combustion sources. We used a premixed flames fed with two different fuel mixtures, namely pure ethylene and a mixture of ethylene (C2H4) and dimethylfuran (DMF) (this latter mimic the combustion of biofuels), in different operating conditions, ranging from blue flames, typically encountered in domestic burners and in gasoline engines, to yellow flames, typically found in diesel engines and industrial burners. Finally we collected samples in a urban area (one day of sampling) and used them as representative of the real environmental pollution by particles. It is well known that depending on the operating conditions of the combustion process, different particles can be formed. We isolated three main classes of particles by changing both the operating conditions and the sampling procedure: 1. Sub-100 nm soot particles obtained from C2H4 or C2H4/DMF as fuel mixture, 2. 20-40nm, typical of single primary soot particles, obtained from C2H4 or C2H4/DMF, and 3. 100-500nm soot particles typical of agglomerates, obtained from C2H4
Results & Conclusions	We found that, differently from what already published, PBMCs from COPD patients were less susceptible to C2H4-derived soot primary particles in terms of IL-1a, IL-1b and IL-18 release. This effect was also observed for the production of mitochondrial-derived reactive oxygen species, which were lower from PBMCs obtained from COPD patients than smokers, who presented higher levels of mtROS, associated to lower OGG1, involved in oxidative stress repair, compared to healthy PBMCs. In sharp contrast, COPD-derived PBMCs treated with C2H4ox, C2H4oxDMF, and sub-10nm particles identified as NOC-E and NOC-ED, according to the combustion process, released much higher levels of IL-18, implying that the dimension and the oxidized nature of the particles can lead to the activation of the inflammasome. Moreover, these latter particles induced higher levels of IL-33 from COPD-derived PBMCs, however, these levels were still lower than healthy PBMCs. To note, it was interesting that IL-33 release in COPD patients was not caspase-1/8 dependent. In conclusion, our data imply that oxidized UFPs induce the activation of the inflammasome in COPD patients compared to healthy subjects, shedding new light into the biology of this complex in COPD patients.

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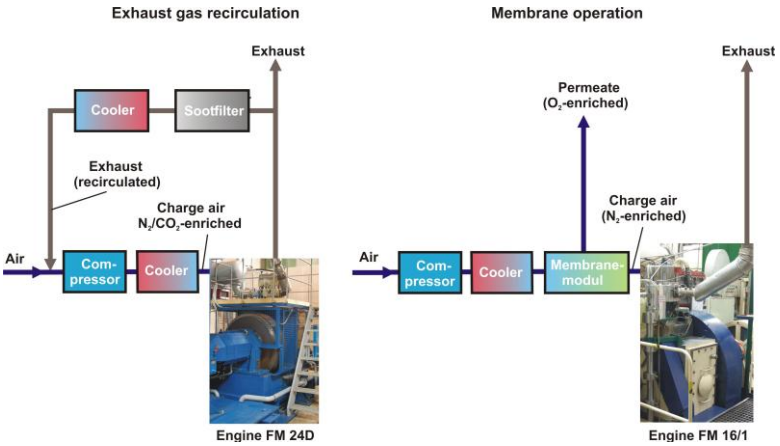
Publication title	*The green marine engine – A dream or reality?*
Publication type	Presentation
Introduction & Background	Investigations about the influence of international shipping on the atmosphere and the climate show that this implicates 42 to 72 percent in the air pollution in terms of nitrogen oxide, particulate and sulfur dioxide emissions. In this context the International Maritime Organization (IMO) adopted measures in 2000 to gradually reduce the nitrogen oxide emission and to limit the sulfur content of fuels. Especially the reduction of nitrogen oxide in certain Emission Control Areas (ECAs) of about 80% by 2016 in accordance to the IMO Tier III was an enormous challenge for ship engine manufacturers. Hence, innovative technologies are being searched for and developed to meet these legal requirements.
Methodology	The WTZ Roßlau has been carrying out wide range investigations on reduction of nitrogen oxide and particulate emissions inside marine diesel engines. Maintaining a high degree of efficiency during this process was one of the biggest challenges. The used single-cylinder research diesel engine could be operated with a conventional pump-line-nozzle (PLN) or a modern Common-Rail-Injection system. Effects of the injection strategy, nozzle configuration, compression ratio, Miller-cycle, fuel-water-emulsion, charge air inerting and dual-fuel operation were methodically investigated. Moreover Computational Fluid Dynamics (CFD) simulations for the influence of the piston bowl geometry on pollutant emissions were carried out. With the use of measuring technologies the exhaust components, such as nitrogen oxide, carbon monoxide, unburnt hydrocarbons, particulate matter and the Filter Smoke Number (FSN) were recorded.
Results & Conclusions	With the adjustment of the start of injection, the injection nozzle configuration and the turbo charger setup it was relatively easy to reach the IMO Tier I requirement and with the introduction of the Miller-cycle in combination with an increase in compression ratio and charge air pressure the IMO Tier II legal requirements could be achieved. A method to undercut the IMO Tier III limit is to decrease the oxygen concentration in the charge air. This was successfully implemented at WTZ Roßlau through exhaust gas recirculation and air separating membranes. The increase in FSN and fuel consumption could be prevented for engines with Common-Rail-Injection system by increasing the injection pressure up to 2000 bar and optimizing the start of injection, post-injection, injection nozzle configuration and piston bowl geometry. A combination of lowered oxygen concentration in the charge air and the use of fuel-water-emulsion are measures to undercut the IMO Tier III limit with an excellent smoke behavior in engines with a PLN injection system. Compared to diesel engines, the nitrogen oxide emission of dual-fuel engines is lower due to the reduced temperature of the mainly premixed combustion. Accordingly, the IMO Tier III limit can be achieved in these engines by optimizing the start of injection, the air-fuel-ratio and the pilot fuel quantity. By the use of exhaust gas recirculation in combination with sulfurous and ash containing heavy fuel oils the sooting and corrosion of coolers and other components is to this day an unsolved problem. Hence, engine manufacturers currently prefer dual-fuel operation and exhaust gas treatment through Selective Catalytic Reduction (SCR). An alternative is the use of air separating membranes, which is currently being further researched at the

WTZ Roßlau. Concluding, it can be stated that the IMO Tier III limit can be undercut in actual ship operation.

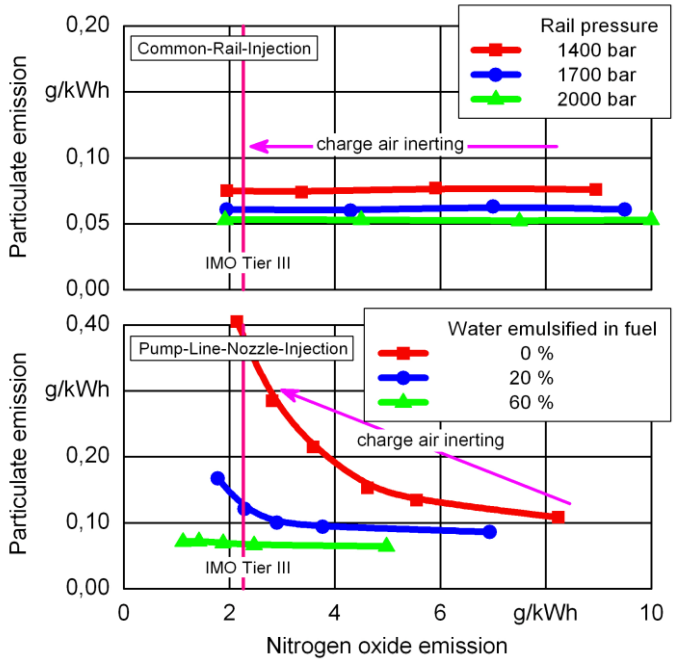
Images

Caption Figure 1:



Arrangement of the experimental equipment

Caption Figure 2:



Measures for the reduction of nitrogen oxide and particulate emissions

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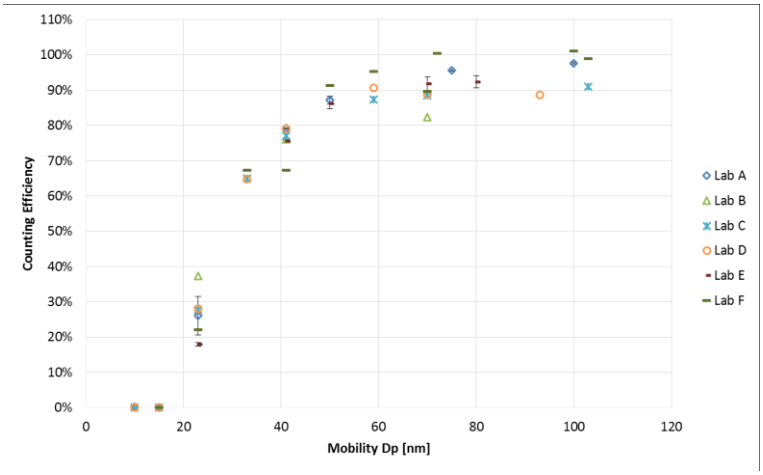
Publication title	*Inter-laboratory Comparison of Calibration Aerosols for Engine Exhaust Condensation Particle Counters*
Publication type	Presentation
Introduction & Background	Pollution with Particulate Matter is an ongoing challenge in many metropolitan areas of the EU. Therefore a lowered emission limit for Particle Number (PN) of 6*10^11/km was introduced in the EURO 5/6 legislation, which is now being amended by the adoption of Real Driving Emissions (RDE). This legislation calls for reliable measurement instruments, high reproducibility and accuracy. Instrument manufacturers are implementing calibration procedures for their stationary PMP (Particle Measurement Program)-compliant particle counting systems and PEMS (portable emission measurement system). Due to the nature of particles and as traceability is a significant challenge for particle number measurements, high measurement uncertainties are observed in the field. A variety of calibration materials, among them Emery Oil, Natrium Chloride, propane-flame and spark-discharge soot are currently used to calibrate PN counting systems. The design of PN-PEMS (e.g. built-in volatile particle remover) inhibits the usage of emery oil, which is most common in the automotive industry. To improve measurement uncertainty, the calibration procedure should be specified more precisely and calibration material of PEMS and stationary systems should be harmonized.
Methodology	In order to investigate possible calibration materials, an inter-laboratory comparison investigation was carried out by the JRC in cooperation with BMW Group and the German National Metrological Institute (NMI) Physikalisch Technische Bundesanstalt (PTB). A propane flame soot generator (CAST-type) as well as three Condensation Particle Counters (CPC) were circulated among the 7 participating labs, including an NMI, instrument manufacturers, vehicle manufacturers and calibration services. These labs conducted a standardized calibration of the circulated devices with their established setups and reference devices. Both in-house and circulated aerosol generators were used in the calibration. The first author participated at all locations as an observer. Investigated calibration aerosols include propane flame soot (circulated and in-house generators), spark discharge graphite, silver nano-particles as well as emery oil
Results & Conclusions	The inter-laboratory comparison gives an overview of the uncertainty of a CPC calibration carried out by different professional laboratories. Furthermore calibration material-specific influences on the overall measured efficiency and the uncertainty of the measurements could be observed. The calibration with a soot-like material yielded a lower counting efficiency curve for a PMP-compliant CPC than a calibration with emery oil. The investigation shows that soot-like aerosol (CAST or spark-discharge) is a promising candidate for the harmonization of the calibration materials for automotive PN measurements. It may prove suitable for calibration of the CPC, the particle losses in the dilution system and VPR (PCRF) and also for PN-PEMS that are calibrated as a whole system in near future.

Nano-silver particles which are proposed as a primary standard produced counting efficiencies similar to soot-like calibration materials.

Caption Figure 1:



PMP CPC calibration curve with circulated CAST, all laboratories

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Master’s thesis at Bosch Mahle Turbo Systems:
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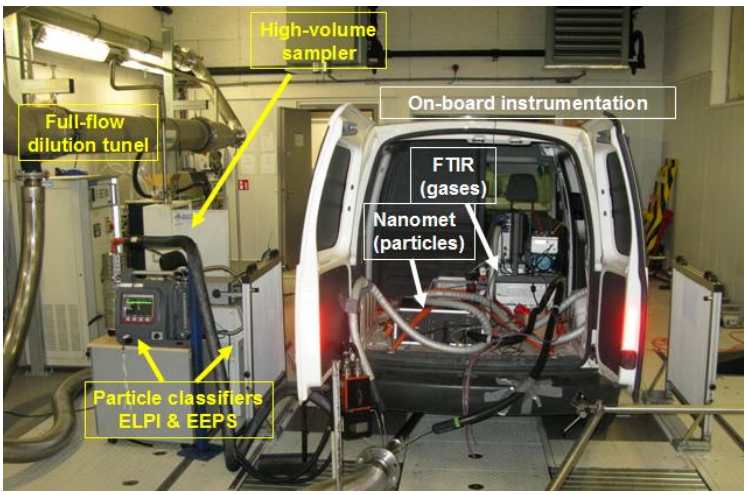
Publication title	*On-road Measurement of Emissions of Reactive Nitrogen Compounds and Greenhouse Gases from Euro 6 Diesel and Natural Gas Vans Using an On-board FTIR*
Publication type	Presentation
Introduction & Background	To address the disparity between “laboratory” and “real-world” emissions, portable emissions monitoring systems (PEMS) were introduced. In addition to the regulatory “PEMS” and “real driving emissions” (RDE), we also need “non-regulatory” on-board instrumentation and tests (and how should they be called?), and assessment of additional pollutants, such as nitrogen monoxide, dioxide and ammonia (reactive nitrogen compounds), and nitrous oxide (potent greenhouse gas), resulting from aftertreatment devices. The focus of this study is an application of an on-board Fourier Transform Infra-Red (FTIR) spectrometer as the primary instrument to assess exhaust emissions of gaseous pollutants of interest from Euro 6 light-duty (< 3.5 tons) vehicles to address the lack of data in this important category. Also, while non-motorized, electric and public transport can transport passengers in cities and rail can transport people and goods over long distance, light utility vehicles are likely to be useful in our cities
Methodology	Two automobiles and six vans, half powered by diesel fuel, half by natural gas, have been tested on chassis dynamometer using multiple driving cycles and on the road. An industrial FTIR analyzer was used to measure all gaseous pollutants and a NanoMet3 analyzer was used to measure the number concentrations of non-volatile particles. The FTIR with a five-meter optical path length cell running at 130 C, ZnSe optics, liquid nitrogen cooled HgCdTe detector was packaged with accessories into a compact frame. Exhaust flow was inferred from engine control unit data. In the laboratory, the measurements also included traditional instrumentation including two particle classifiers.
Results & Conclusions	On all vehicles with diesel engines, the emissions of nitrogen oxides (NOx) were relatively high, with a high share of nitrogen dioxide. On some vehicles, NOx were also high during a warm-start type approval cycle (NEDC), suggesting that the disparity between the real world and type approval limits is to be addressed. One van from a rental fleet had excessive emissions of particles, suggesting that the technical condition of the general fleet should be continuously assessed. The emissions of ammonia were negligible; but there was not much real effort to reduce NOx either. The global warming potential of nitrous oxide was equivalent to several g/km CO2, suggesting that it should be included in an assessment of greenhouse gas emissions. Natural gas powered vehicles, all using port fuel injection spark ignition engines with electronic controls and three-way catalysts, produced relatively low emissions, with nitrogen monoxide and ammonia emissions both on the order of several tens of mg/km, methane emissions corresponding to less than 1 g/km CO2, and negligible emissions of nitrous oxide, formaldehyde and acetaldehyde. The number of non-volatile particles varied greatly but was generally low except for the defective diesel vehicle. The on-board FTIR has proven to be a useful instrument capable of covering, except for total hydrocarbons, essentially all gases of interest. The

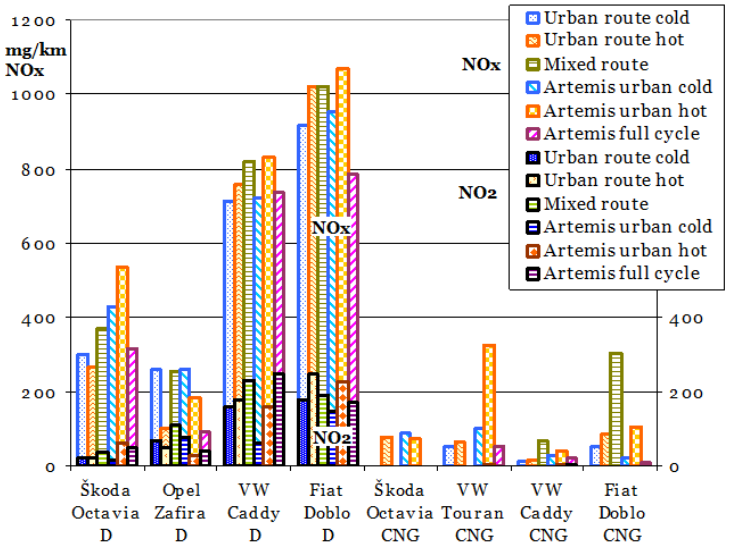
optimization of the on-board system for simplicity of installation and operation has allowed, within the given budget of time and resources, to test a relatively large number of vehicles, covering vehicle-to-vehicle variance.

Caption Figure 1:



On-board measurement system: FTIR, NanoMet3, and other instrumentation)

Caption Figure 2:



Summary results of NOx and NO2 (darker color) emissions on chassis dynamometer (Artemis cycle) and on the road for diesel and compressed natural gas (CNG) vehicles

Author CV:

Michal Vojtisek-Lom has designed and built one of the first portable emissions monitoring systems (PEMS) twenty years ago. It was used to assess real driving emissions from a fleet of natural gas buses at the University of Pittsburgh, where he obtained a M.S. degree in Energy Resources. He is currently a resident alchemist and Associate Professor at the Center of Sustainable Mobility at the Czech Technical University in Prague, and Associate Professor of Mechanical Engineering at the Technical University of Liberec, where he also obtained Ph.D. in Mechanical Engineering. Michal's primary interest are combustion of alternative fuels, real-world emissions, and evaluation of the effects of new fuels and technologies on emissions, environment, and human health.

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Publication title	*Real World Particle Number Reduction Evaluation under Shenzhen DPF Retrofit Program in China*
Publication type	Presentation
Introduction & Background	Emissions from diesel vehicle and machinery have become the main source of particulate matter in Shenzhen. In order to further improve the air quality, the Shenzhen Municipal Government issued the “Special action plan for Shenzhen PM2.5 pollution prevention and control ", entrusted vehicle emission control center(VECC) of Chinese Research Academy of Environmental Sciences(CRAES) to conduct technical evaluation for DPF retrofit and DPF installation specification development, thus laying a firm foundation for large-scale diesel engine retrofit in Shenzhen.
Methodology	"Diesel Particulate Filter Demonstration Project" in Shenzhen selected 200 diesel vehicles and 40 non-road mobile machineries for DPF installation and testing. By using engine bench test, low speed condition cycle and NRMM typical steady-state condition, we evaluated the DPF emission reduction performance for particulate number(PN), particulatemater(PM), and ohter regulated pollutants(HC,CO,NOx,NO2)and ungragulated pollutants(Toluene,Ethyl benzene,Xylene,Formaldehyde,Acetaldehyde,etc.).finally selected DPF products from 5 manufactures. In addition, the emission reduction reliability of various DPF products installed on the vehicles and machineries was investigated by means of non-scheduled PN test with parallelly installed two sets of Nanomet before and afer the DPF. At the same time, romote monitoring was utilized to check the DPF's performance and durability.
Results & Conclusions	The operating conditions of the vehicle / machine are very significant for the selection of DPF regeneration type. Particle Number is an important indicator of DPF performance. DPF performance supervision is crucial to ensure the DPF's maintenance.
Author CV:	WANG Yanjun, Researcher of Chinese Research Academy of Environmental Sciences(in Beijing), head of pollutant reduction technologies evaluation department of VECC. Field in combustion mechanism and pollutants control for internal combustion engine over 19yrs.

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Publication title	*Effect of Fuel Properties on Particulate Emissions from Euro4, 5 and 6 Passenger Cars*
Publication type	Presentation
Introduction & Background	Certain diesel fuel properties including Polycyclic Aromatic Hydrocarbons (PAH), density and Cetane Number (CN) are considered to be environmental parameters according to the European Fuels Quality Directive (FQD, 2009/EC/30) and previous regulations. Consequently these properties are limited in the EN 590 specification based on findings from the European Programme on Emissions, Fuels and Engine Technologies (EPEFE) which was carried out in the 1990's on diesel vehicles meeting Euro 2 emissions standards. Fuel Fatty Acid Methyl Ester (FAME) content is another important fuel parameter given its potential to help meet Renewable Energy Directive (RED) targets and its effects on emissions. No significant work has been conducted since the EPEFE study to investigate whether relaxing these limits would give rise to performance or emissions debits or benefits in more modern vehicles.
Methodology	Concawe has commissioned a test programme to evaluate the impact of these specific diesel properties on emissions and fuel consumption in Euro 4, Euro 5 and Euro 6 light-duty diesel vehicle technologies. The tests were conducted using two driving cycles, the New European Driving Cycle (NEDC) and a hot start Worldwide harmonised Light duty Test Cycle (WLTC), as well as at a steady state condition specifically to study effects on particle size distribution. This paper focuses on the effects of the fuel parameters, test cycle and vehicle on particulates through particulate mass (PM), number (PN), size distribution and composition measurements.
Results & Conclusions	Increasing density from 820 to 855kg/m3 and CN from 46 to 54 fuels tended to produce higher PM and PN and particles of larger mean diameter in the non-DPF Euro 4 car but fewer particles in the Euro 5 and 6 vehicles in some cases. Increasing PAH from 2 to 7.5% also tended to produce higher PM and PN in the Euro 4 car but only higher PN in the Euro 5 NEDC tests. In general the Euro 5 and Euro 6 vehicles appeared insensitive to changes in PAH. Increasing FAME from 0 to 9.5% tended to produce lower PM and PN and smaller mean diameter particles in the Euro 4 car whereas the only statistically significant effect in the other cars was higher PN in the Euro 6 NEDC tests with the higher FAME level.
Author CV:	Rod Williams is a Chartered Mechanical Engineer working as Manager of Diesel Joint Development Activities in Shell Global Solutions' Diesel Innovation group and is based in the UK. Rod has a background of roles in fuel development and industry liaison for Shell and is currently Chair of Concawe STF/25 - the Concawe group concerned with diesel fuel and emissions. Rod has been previously published with SAE, ImechE, TRA and TAE.

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Publication title	*Effect of Soot Size on Particle Filtration and Soot Cake Formation in Diesel Particulate Filter*
Publication type	Presentation
Introduction & Background	In order to realize further improvement of fuel economy and reduction of tailpipe emissions, Japanese automakers have established a joint research organization, the Research Association of Automotive Internal Combustion Engines (AICE) in 2014 [1]. The goal of AICE is to utilize the research achievement and to accelerate the development activities of each automaker. Our group in Nagoya University has joined AICE as one of research players since 2015. In the presentation, we will explain our research activities, together with the brief introduction of AICE. So far, diesel particulate filters (DPFs) have been widely used to collect diesel particulates in the exhaust after-treatment. The mechanism for its particle trap is simple: when the exhaust gas passes through the walls (the filter's sidewalls), which separate cells at inlet and outlet sides of the filter, the soot is deposited within the filter wall. However, as the soot is continuously collected, the exhaust pressure (filter backpressure) increases. Consequently, the fuel consumption rate is unexpectedly worsened with the reduction of the engine output. To conduct the filter regeneration process efficiently, we need to predict the filter backpressure more precisely. Then, we have developed a numerical model of soot filtration and oxidation based on the lattice Boltzmann method [2-5].
Methodology	In this study, we simulated the flow and soot deposition in SiC-DPF. The structure of the filter substrate was obtained by an X-ray CT technique. Mainly, we focused on the effect of soot aggregation size on the filtration process and the pressure drop.
Results & Conclusions	Figure 1(a) shows the numerical domain. The filter substrate obtained by the X-ray CT was inserted at the center. The thickness of the filter wall is 300 micrometer. The inlet and outlet regions were attached to set the inflow and outflow boundary conditions. The inlet velocity was 1 cm/s. The flow velocity was largely accelerated inside the filter wall when the exhaust gas passed through pores in the wall. There were many flow paths inside the filter, and the complex flow pattern was observed. Figure 1(b) shows the soot deposition region at t = 15, 30, 60 s. The soot size was 100 nm. As more soot was deposited, the filter backpressure was increased. Once all pores in the filter wall surface were plugged, the surface filtration was observed. Next, the soot size was changed. Figure 2(a) shows the mass of soot deposited in DPF. The soot size was 75, 100, 125, 150 nm. When the soot size was smaller, more soot was trapped. Figure 2(b) shows the pressure drop. The time-variation of pressure drop was quite similar. That is, the abrupt increase was due to the depth filtration. After that, the linear increase was observed in the case of the surface filtration. It was found that, as the soot size was decreased, the pressure drop was higher. When the smaller soot was deposited, the soot cake permeability increases but the soot density decreases. On the other hand, the soot cake formed on the filter wall surface was thicker. Hence, the larger pressure drop caused by the smaller soot was due to the fact that the smaller soot was easily trapped by the Brownian motion.(

Caption Figure 1:

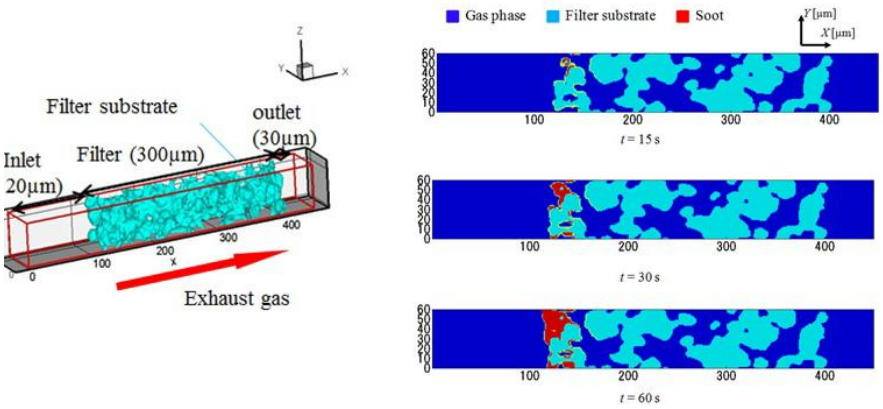

Fig. 1 (a) Numerical domain with SiC substrate (left), (b) Soot deposition region at t = 15, 30, 60 s (right)

Caption Figure 2:

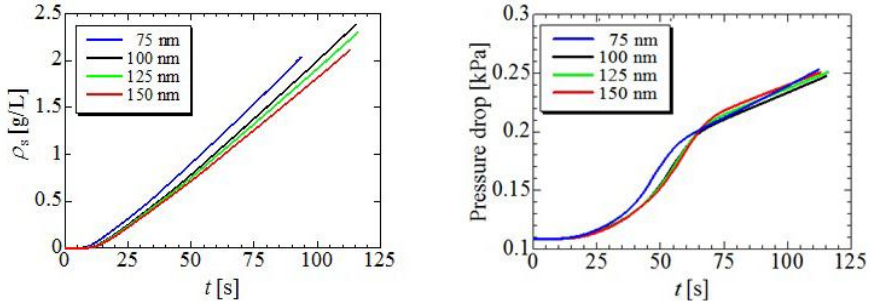

Fig. 2 (a) Mass of soot deposited in DPF (left), (b) Pressure drop across the filter wall (right)

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Publication title	*Biological effects of emissions from ship diesel, gasoline car-engines and wood combustion: Multi-omics characterization of aerosol-exposed lung cells and chemical profiles of the emissions.*
Publication type	Presentation
Introduction & Background	Ambient air pollution and particulate matter cause severe health effects in the popula-tion and combustion emissions are considered to be particularly harmful. In this con-text ship engine- and bio mass combustion-emissions are important sources of air pollution.
Methodology	In the framework of the HCIE-project we exposed human lung cells to fresh, diluted exhaust fumes from a ship engine running on heavy fuel oil (HFO) or cleaner diesel fuel (DF) as well as to wood combustion emissions (log wood and pellet burner). Fur-thermore car exhaust emissions were investigated. A field deployable air-liquid inter-face cell-exposure system in a mobile S2-biological laboratory (HICE mobilab) was used. The biological effects were toxicologically and molecular-biologically character-ized (multi-omics study: comprehensive transcriptiomic, proteomic and metabolomic analysis). Advanced chemical and physical analysis of the exhaust aerosols was per-formed and correlated with the obtained biological results.
Results & Conclusions	Lung cell responses include inflammation and apoptosis. Surprisingly, DF ship emis-sions, which contain much less toxicants, induce a significantly stronger acute regula-tion of essential cellular pathways (e.g., mitochondrial function, intracellular transport in A549, Oeder et al., PloSone 2015) and a higher cytotoxicity (RAW macrophages, Scapariu et al., PloSone 2016) than HFO-emissions. Wood combustion emissions from different compliances induce lower acute biological impact in the exposed cells than DF- and HFO-ship emissions at similar exposure doses. By combining aerosol chemical and biological information, relevant compounds and factors for the observed biological effects are identified. In addition to acute effects, also long-term effects, in-duced e.g. by analysis of carcinogenic compounds are discussed.
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