

# Field Laser Applications in Industry and Research

## FLAIR 2018

Hotel Domus Pacis, S. Maria degli Angeli - Assisi, Italy, 10-14 September 2018

### Organizers

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# Conference Schedule

## SUNDAY

15:00-19:00 Registration

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## MONDAY

09:00 Erik Kerstel and Francesco D'Amato – Opening Remarks  
09:15 Welcome by a delegate of the Municipal Administration of Assisi

## DEVICES

09:30 B. Boulanger – "Crystal parametric nonlinear optics for the generation of mid-infrared coherent light" – Invited Talk

10:30 – 11:00 Coffee Break

11:00 M. Ebrahim-Zadeh – "Optical parametric oscillators spanning the ultraviolet to mid-infrared: Concepts, technology, applications" – Invited talk

12:00 Q. Pan – "A mid-infrared supercontinuum laser-based multi-species trace gas sensor"

12:30 – 14:00 Lunch

14:00 H. Knötig – "Ring interband cascade lasers for trace gas sensing"

14:15 J. Westberg – "Dual-comb spectroscopy using on-chip laser frequency combs"

## PHOTOACOUSTICS

14:30 W. Ren – "Mid-infrared photoacoustic and photothermal trace gas sensors" – Invited talk

15:00 P. Patimisco – "Quartz-enhanced photoacoustic spectroscopy for methane, ethane and propane detection"

15:15 J.P. Waclawek – " $2f$ -wavelength modulation balanced detection cavity assisted photothermal interferometry"

15:30 – 16:00 Tea Break

## INDUSTRIAL SESSION 1

16:00 BOREAL – H. Adam – "Open path laser gas analyzers for quantitative measurement of gas leaks and fugitive emissions"

16:15 NEO MONITORS – P. Geiser – "IROSS – Advanced signal processing for near- and mid-infrared in-situ applications"

16:30 PSI – S.J. Chen – "Quantitative gas imager and leak rate estimator"

16:45 AERIS – J. Scherer – "Field Applications of portable MIRA Pico MIR laser-based gas analyzers: natural Gas, formaldehyde, CO, and N<sub>2</sub>O monitoring"

17:00 – 17:15 Break

17:15 AERODYNE – B. McManus – "Analytical tools for rapid troubleshooting and instrument improvement"

17:30 MGO – M. Godejohann – "MIRa-Guide – waveguide-based mid infrared laser spectroscopy"

17:45 KNESTEL – M. Endras – "New TLAS gas analyzers for process and trace-gas measurement"

18:30 – 20:30 Welcome Party

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## TUESDAY

### 09:00 – 10:30 Exhibition & Poster Session 1

1. M. Siciliani de Cumis, S. Borri, P. Cancio Pastor, I. Lopez Garcia, M. Canino, F. Bonafè, A. Roncaglia and P. De Natale – "A novel MEMS cantilever-based photoacoustic sensor for trace-gas detection"
2. M. Vlk, V. Mittal, G.S. Murugan, J. Jágerská – "Ta<sub>2</sub>O<sub>5</sub> photonic waveguide platform for spectroscopic trace gas detection"
3. J. Wang, T. Tan, Y. Dong, Y. Cao, G. Wang, G. Zhu, K. Liu, W. Chen, D. Weidmann, G. Wysocki, X. Gao – "Near IR laser heterodyne spectroscopy for remote sensing of atmospheric greenhouse gases"
4. M.A. Abbas, J. Mandon, A. Khodabakhsh, S.M. Cristescu and F.J.M. Harren – "Optically referenced two crystal mid-infrared OPO for dual-comb spectroscopy"
5. M. Baer, B. Beck, B. Schmauss – "Linearizing frequency shift of current modulated quantum cascade lasers"
6. K. Eslami Jahromi, Q. Pan, A. Khodabakhsh, S.M. Cristescu, and F.J. M. Harren – "Mid-infrared supercontinuum-based broadband absorption spectroscopy using frequency up-conversion detection"
8. I. Sadiq, T. Mikkonen, T. Tomberg, F. Senna Vieira, J. Karhu, M. Vainio, J. Toivonen, and A. Foltynowicz – "Optical frequency comb photoacoustic spectroscopy"
9. T. Strahl, J. Herbst, E. Maier, S. Rademacher, C. Weber, J.-G. Coutard and J. Wöllenstein – "Performance comparison of photo acoustic and optical detection by a CH<sub>4</sub> laser spectrometer operating at 1.65, 3.3 and 7.8 μm wavelength"
10. R. Vallon, L. Bizet, B. Parvitte, G. Maisons, M. Carras, V. Zeninari – "Detectorless intracavity gas detection with quantum cascade laser"
11. S. Lindner, J. Hayden, M. González Cabrera and B. Lendl – "A new approach to QCL-based mid-infrared refractive index spectroscopy"
12. S.G. Razavipour, J. Gupta – "Pressure-dependent sensitivity of a single-pass methane detection system using a distributed feedback laser at 3270 nm"
13. A. Hangauer, A. Popescu, R. Heinrich, R. Strzoda – "Wavelength modulation spectroscopy with multi-harmonic and ratiometric detection"
14. J. Hayden, J.P. Waclawek, B. Lendl – "Indirect mid-infrared optical-feedback cavity enhanced spectroscopy in a Brewster window cavity"
15. A. Jimenez, M. Hoppe, S. Schmidtman, T. Milde, G. Carpintero and J. Sacher – "Fast tuning MEMS based laser"
16. L. Patrick, J. Westberg, and G. Wysocki – "Faraday rotation integrated cavity output spectroscopy"
17. T. Mikkonen, C. Amiot, A. Aalto, K. Patokoski, G. Genty and J. Toivonen – "Fourier transform photoacoustic spectroscopy with supercontinuum light source"
18. K. Krzempek, G. Dudzik and K. Abramski – "Sub-ppm level detection of CO<sub>2</sub> in an intracavity solid-state laser configuration"
19. A. Wittmann, S. Schlesinger, S. Aiterrami, M. Renggli, M. Habegger, T. Brand, D. Bacher, T. Platz, T. Hessler – "Compact OEM TDLS based gas sensor for portable applications and applications with limited space"

10:30 – 11:00 Coffee Break

### INDUSTRIAL SESSION 2

- 11:00 AIROPTIC – P. Kluczynsky – "Application of tunable laser formaldehyde analyzer for real time process control and emission monitoring in wood panel industry"
- 11:15 IRSWEEP – M. Geiser – "Single-shot microsecond-resolved spectroscopy of the bacteriorhodopsin photocycle with quantum cascade laser frequency combs"
- 11:30 LGR/ABB – D. Baer – "Novel gas analyzers based on off-axis integrated cavity output spectroscopy"
- 11:45 SACHER – J. Sacher – "Quantum cascade laser for TDLAS and QEPAS gas sensor "
- 12:00 NTT-EL – Y. Nishida – "Wavelength scanning lasers for spectroscopy "
- 12:15 HAMAMATSU – A. Naota – "Recent development for quantum cascade lasers and IR-detectors"

12:30 – 14:00 Lunch

### ENVIRONMENTAL 1

- 14:00 H.-W. Hübers – "Gas sensing with THz quantum-cascade lasers" – Invited talk
- 14:30 J. Arkwright – "Fibre Bragg grating sensors – Commercial need meets technical capability" – Invited talk
- 15:00 L. Emmenegger – "Combining dual-wavelength DFB quantum cascade lasers for multi-species trace gas

spectroscopy"

15:15 A. Khodabakhsh – "Time-resolved mid-infrared dual-comb spectroscopy of methane in an electrical discharge"

15:30 – 16:00 Tea break

### INDUSTRIAL SESSION 3

16:00 NANOPLUS – J. Koeth – "Recent technical achievements and corresponding applications"

16:15 ALPES LASERS – O. Landry – "New frontiers of QCLs: frequency comb lasers and extended tuning systems"

16:30 VIGO – Jerzy Łach – "Infrared balanced detection module based on HOT HgCdTe detectors"

16:45 DAYLIGHT SOLUTIONS – S. Crivello – "Advances in ECqL™ tuning parameters and applications in portable MID-IR spectrometers"

17:00 – 17:15 Break

17:15 VERTILAS – C. Neumeyr – "InP long wavelength VCSEL devices, their latest technological progress and deployment in NIR TDLs applications"

17:30 SIEMENS – R. Heinrich – "High resolution quantitative multi-species hydrocarbon gas sensing with a cw EC-QCL"

17:45 REDWAVE LABS – D. Permogorov – "Electronics and Lasers for Spectroscopic Applications"

18:30 – 23:00 Gala Dinner at Castello di Petrata

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## WEDNESDAY

### ENVIRONMENTAL 2

09:00 S. Wofsy – "Airborne measurements of atmospheric gases using laser absorption spectroscopy" – Invited Talk

09:45 B. Stanicki – "A compact QCL absorption spectrometer for mobile, high-precision methane measurements aboard drones"

10:00 M. Ghysels – "Pico-SDLA mid-infrared in-situ spectrometer for lower stratosphere water vapor monitoring"

10:15 S. Zenevich – "Portable near-infrared heterodyne spectroradiometer for greenhouse gas precision measurements"

10:30 – 11:00 Coffee Break

11:00 – 12:30 Exhibition & Poster Session 2

1. G.S. Humphries and M. Lengden – "Azimuthally excited resonators for photoacoustic spectroscopy"
2. D. Bomse, D.M. Bailey, and J.H. Miller – "Precision heterodyne oxygen-calibration spectrometry: development and initial deployment tests"
3. D.M. Bailey and J. H. Miller – "Near-simultaneous measurement of ground level carbon dioxide and methane concentrations with an open-path tunable diode laser sensor at the Bonanza Creek long term ecological research site near Fairbanks, Alaska"
4. H. Tatenguem, A. Sacher, T. Milde, M. Hoppe and J. Sacher – "An FPGA-based QEPAS setup for automatic gas measurement and tracking of quartz resonance frequency"
5. J. Karhu, K. Lehmann, M. Vainio, M. Metsälä and L. Halonen – "Immediate background subtraction in cavity ring-down detection of infrared-infrared double resonance spectroscopy"
6. L. Richard, D. Romanini, K. Jaulin and I. Ventrillard – "Nitric oxide measurements in the ppt range by optical-feedback cavity-enhanced-absorption-spectroscopy"
7. S.P. Seymour, M.R. Johnson – "Measuring correlations of line-of-sight H<sub>2</sub>O vapour and soot through flare plumes"
8. V. Kasyutich, F. Pratesi, R. Kovacich, B. Alizadeh, R. Jenkins, M. Lawson and J. Christian – "In-situ O<sub>2</sub> and CO measurements in combustion processes at gas temperatures from +500 °C up to +1500 °C"
9. O. Aseev, P. Scheidegger, B. Tuzson, S. Blaser, H. Looser, B. Niederhauser and L. Emmenegger – "Using novel, widely electrically tuneable, and conventional DFB-QCLs for the measurement of organic molecules"
10. Y. Dong, J. Wang, G. Yang, X. Tian, J. Chen, G. Zhu, K. Liu, T. Tan, W. Chen, D. Weidmann, G. Wysocki, X. Gao – "Development of a highly sensitive OA-ICOS instrument for in situ measurements of atmospheric CH<sub>4</sub>"

11. K. Chamassi, W. Trzopil, R. Rousseau, A. Vicet and M. Bahriz – "Methane detection based on photoacoustic spectroscopy with a new silicon micro-electromechanical resonator"
12. T. Milde, M. Hoppe, H. Tatenguem, C. Assmann, C.S. Kim, M. Kim, C.D. Merritt, W.W. Bewley, C.L. Canedy, I. Vurgafman, J.R. Meyer, W. Schade and J. Sacher – "Interband cascade laser for methane QEPAS sensor"
13. R. Rousseau, Z. Loghmari, M. Bahriz, K. Chamassi, and A. Vicet – "QEPAS sensors for high sensitivity monitoring. Ethylene and air quality applications"
14. T. Hausmaninger, O. Axner – "Digitalization of NICE-OHMS electronics"
15. M. Mordmueller, W. Schade, and U. Willer – "Non-resonantly driven quartz-enhanced photoacoustic spectroscopy"
16. I. Silander, T. Hausmaninger, M. Zelan and O. Axner – "Gas modulation refractometry (GAMOR) for high-precision pressure assessment"
17. M. Siciliani de Cumis, S. Borri, S. Viciani, F. D'Amato, L. Santamaria Amato, I. Lopez Garcia, G. Santambrogio, A. Savchenkov, D. Eliyahu, A. Matsko, and P. De Natale – "Frequency noise analysis of interband and quantum cascade lasers using crystalline whispering gallery mode resonators"
18. C.C. Teng, H. Zhong, C. Yan, A. Rouso, T. Chen, Y. Ju, and G. Wysocki – "HO<sub>2</sub> radical measurements in a photolysis reactor using line-locked Faraday rotation spectroscopy"
19. N. Hoghooghi, R.K. Cole, and G.B. Rieker – "GHz frequency comb generation using spectral mode filters for rapid dual-comb spectroscopy"

12:30 – 14:00 Lunch

### PRECISION SPECTROSCOPY 1

- 14:00 D. Mazzotti – "The laser way to precise radiocarbon measurements: latest results with SCAR spectroscopy" – Invited Talk
- 14:30 A. Fleischer – "Precision molecular spectroscopy in the near- and mid-infrared: optical cavities, frequency combs, and radiocarbon" – Invited Talk

15:30 – 23:00 Excursion to Assisi and Dinner at Castello di Rosciano

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## THURSDAY

### BIOMEDICAL SESSION

- 09:00 J. Homola – "Optical affinity biosensing with surface plasmons" – Invited talk
- 09:30 M. Metsälä – "Optical techniques for exhaled breath analysis: from single to multi-species detection" – Invited talk
- 10:00 S.M. Cristescu – "Simultaneous detection of HCN and NH<sub>3</sub> from biological samples"
- 10:15 R. Ghorbani – "Extended breath CO analysis – coupling real-time detection to gas exchange modelling"
- 10:30 – 11:00 Coffee Break
- 11:00 J. Kilgus – "Diffraction limited mid-infrared hyperspectral microscopy with a supercontinuum laser"
- 11:15 P. Fjodorow – "Intracavity absorption spectroscopy with a homemade Tm/Ho fiber laser tunable from 1.8 to 2.09 μm"

### METROLOGY OF COMBUSTION AND PLASMAS

- 11:30 M. Aldén – "Combustion diagnostics using laser techniques: from development to industrial applications" – Invited Talk
- 12:15 L. Cocola – "Raman spectroscopy for natural gas analysis"
- 12:30 – 14:00 Lunch
- 14:00 M. Gianella – "Hydroperoxyl measurements in an atmospheric reactor: comparison of cavity ring-down spectroscopy (CRDS) and fluorescence assay by gas expansion (FAGE)"
- 14:15 J. Röpecke – "Spectroscopic investigations of novel metal surface treatment processes based on plasma nitrocarburizing technology: Infrared diagnostics from lead salt and quantum cascade lasers to frequency combs"

14:30 J. Toivonen – "Short-range supercontinuum lidar for temperature profiling"

### ENVIRONMENTAL 3

14:45 S. Brown – "Aircraft measurements of nitrogen oxides and ozone by cavity enhanced spectroscopy" – Invited Talk

15:15 Y. Chen – "Stand-off Detection with Heterodyne Enhanced Chirped Laser Dispersion Spectroscopy"

15:30 R.K. Cole – "Dual Frequency Comb Absorption Spectroscopy of Extreme Pressure and Temperature Environments"

15:45 – 16:15 Tea Break

### 16:15 – 17:45 Exhibition & Poster Session 3

1. B. Bereiter, B. Tuzson, P. Scheidegger, L. Emmenegger, L. Maechler, J. Schmitt and H. Fischer – "High-precision trace gas measurements in air samples from ice cores using a dual-QCL laser absorption spectrometer"
2. H. Abe, K. Hashiguchi, and D. Lisak – "Long-term, real-time measurement of trace moisture using dual-laser cavity ring-down spectroscopy"
3. S. Honda, K. Itabashi, K. Hashiguchi, and H. Abe – "Dew-point hygrometer based on tunable diode laser absorption spectroscopy"
4. Z. Qu, M. Coleman, F. D'Amato, V. Ebert, A. Fateev, G. Guarnizo, T. Kääriäinen, A. Manninen, J. Melendez, S. Persijn, C. Richmond, R. Robinson, V. Ulvila, S. Viciani and O. Werhahn – "EMPIR project IMPRESS2: metrology for air pollutant emission"
5. J. Nwaboh, Z. Qu, O. Werhahn, V. Ebert – "Concepting optical gas standards for HCl concentration measurements in biomethane, clean rooms or industrial stack emissions"
6. A.-L. Moriaux, R. Vallon, B. Parvitte, C. Cilindre, G. Liger-Belair and V. Zeninari – "Tunable diode laser sensor dedicated to monitor gas-phase CO<sub>2</sub> above champagne and sparkling wines"
7. F. Shen, P. Jeseck, Y.-V. Te, T. Tan, X. Gao, E. Fertein, W. Chen – "Quantum cascade laser heterodyne radiometry for ground-based measurement of greenhouse gas in the atmospheric column"
8. C. Lu, F. Senna Vieira, A.C. Johansson, F.M. Schmidt, and A. Foltynowicz – "Near-infrared continuous-filtering Vernier spectroscopy in a flame"
9. A. Upadhyay, D. Wilson, G.S. Humphries, M. Lengden and W. Johnstone – "RAM normalized 1f-WMS technique for the measurement of gas parameters"
10. A.C. Johansson, A. Filipsson, L. Rutkowski, P. Masłowski, and A. Foltynowicz – "CO<sub>2</sub> line parameter retrieval beyond the Voigt profile using comb-based Fourier transform spectroscopy"
11. A. Roy, R. Suddhodhan Chawhan, A.L. Chakraborty – "A 4320 nm quantum cascade laser-based TDLS system for long-term measurement of ambient carbon dioxide levels at Gandhinagar in western India"
12. H. Moser, J.P. Waclawek, A. Genner, C. Gasser, B. Lendl – "A three-channel quantum cascade laser based sulfur species sensor for H<sub>2</sub>S, CH<sub>3</sub>SH and COS in petrochemical process streams"
13. J. Norooz Oliaee, J.A. Gupta, N. Sabourin, P. Lobo, K. Thomson, and G. Smallwood – "UAV-based multi-pass methane sensor using wavelength modulation tunable diode laser absorption spectroscopy"
14. A.S. Makowiecki, J.E. Steinbrenner, J.F. Glusman, N.T. Wimer, J.W. Daily, P.E. Hamlington and G.B. Rieker – "Dual frequency comb spectroscopy for the investigation of ignition behaviour of wildland fire fuels"
15. A. Kannath, J. Chu, N. Macleod, D. Weidmann, B. Hirst and D. Randell – "Multi-beam open-path laser dispersion spectroscopy for the localisation and quantification of methane emission sources"
16. M. Ilke, and M. Lengden – "3D-printed noise cancelling photoacoustic Helmholtz resonator cells"
17. S.V. Malashevich, O.V. Benderov, V.V. Meshcherinov, V.M. Semenov, M.V. Spiridonov, A.V. Rodin – "Ground based mid-infrared (IR) heterodyne spectrometer for the Earth and planetary atmospheres observations"
19. L. Ciaffoni, E. McCormack, H. Mortimer – "A novel static Fourier transform Raman spectrometer for *in vivo* biosensing"

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## FRIDAY

### PRECISION SPECTROSCOPY 2

09:00 I. Gordon – "HITRAN2016: power to the users" – Invited Talk

- 09:30 O. Axner – "Noise-Immune Cavity-Enhanced Optical Heterodyne Molecular Spectroscopy – Means of How to Construct a Low-Drift Shot-Noise Limited System for Doppler Broadened Detection"
- 09:45 J. Fellingner – "Dual-comb generation from a laser cavity via spectral subdivision"
- 10:00 A.C. Johansson – "Broadband calibration-free cavity-enhanced complex refractive index spectroscopy using an optical frequency comb"
- 10:15 L. Rutkowski – "H<sub>2</sub> Transition Lineshape Using Comb Referenced Stimulated Raman Spectroscopy "
- 10:30 E. Fasci – "Comb-calibrated spectroscopy of weakly absorbing molecules in the near-infrared"
- 10:45 – 11:15 Coffee Break

#### 11:15 – 12:45 Exhibition & Poster Session 4

1. G. Kidd – "Control algorithms for managing the shape of the reference laser intensity and absorbance functions using the discrete cosine transform in direct absorption spectroscopy"
2. L. Rutkowski, A. Foltynowicz, F.M. Schmidt, A.C. Johansson, A. Khodabakhsh, A.A. Kyuberis, N.F. Zobov, O.L. Polyansky, S.N. Yurchenko, and J. Tennyson – "An experimental water line list at 1950 K in the 1.5-1.6  $\mu\text{m}$  region"
3. Y. Lu, P. Kang, T.-J. Lin, Y. Wang – "QCL-based ammonia slip sensor in thermal power plant deNO<sub>x</sub> process"
4. K.M. Manfred, M. Gianella, G.A.D. Ritchie, and D.G. Fraser – "Chiral selectivity by mineral surfaces investigated with a near-infrared cavity-enhanced polarimeter"
5. J. Bremner, T. Kissinger, J. Hodgkinson, R.P. Tatam – "Range resolved interferometric multiplexing of optical fibre coupled gas cells"
6. W. Nie, Z.Y. Xu, R.F. Kan, J. Ruan, L. Yao, Y.B. He, B. Wang – "Dew point temperature measurement based on Tunable Diode Laser Absorption Spectroscopy"
7. C. Dyroff, B. McManus, M. Agnese, D. Nelson, and M. Zahniser – "A miniaturized high precision laser spectrometer platform"
8. B. Baumgartner, J. Hayden, A. Schwaighofer, and B. Lendl – "Ordered mesoporous silica films for mid-IR evanescent field spectroscopic sensing of organic contaminants in water"
9. N. Yokota, H. Nagata, S. Sakaida, K. Tanaka, M. Konno, and K. Tonokura – "Detection of hydrogen peroxide using a mid-infrared quantum cascade laser with wavelength modulation spectroscopy"
10. M. Nikodem, D. Stachowiak, and P. Jaworski – "Near-infrared laser absorption spectroscopy – application to multi-gas sensing in animal housing"
11. A.C. Johansson, J. Westberg, G. Wysocki, and A. Foltynowicz – "Optical frequency comb Faraday rotation spectroscopy"
12. E. Slivinskiy and M. Vainio – "Minimization of atmospheric scattering losses in free-space laser links"
13. H. Waechter, M. Brühwiler, S. Troller, and U. Schnell – "Handheld and wearable optical sensors for medical applications"
14. M.B. Frish, N.F. Aubut, S. Yang, R.W. Talbot, L.M. Golston, M.A. Zondlo, P.D. Wehnert, and J. Rutherford – "Monitoring fugitive methane emissions utilizing advanced small unmanned aerial sensor technology"
15. F. Nadeem, A. Khodabakhsh, J. Mandon, S.M. Cristescu and F.J.M. Harren – "Compact resonant cavity with high throughput for OA-ICOS"
16. M. Graf, B. Tuzson, B. Stanicki, and L. Emmenegger – "Optically stable circular multipass cell for compact and lightweight absorption spectrometers"
17. G. Rieker, S. Coburn, C. Alden, R. Wright, N. Hoghooghi, R. Cole, P. Schroeder, N. Malarich, A. Makowiecki, A. Rybchuk, G. Wendland, M. Cich, B. Drouin, and I. Coddington – "The expanding reach of fielded dual frequency comb spectrometers: from kilometer-scale measurements of oil & gas fields to model development for exoplanet spectroscopy"

12:45 Francesco D'Amato and Erik Kerstel – Closing remarks