

# Publicaties 2021

## RESEARCH:

### CHEMIE

- **Metrologie voor geoxideerd kwik (MercOx)**
  - Iris de Krom, "Traceable calibration methods for oxidised mercury", Envirotech-online 2019.
  - I. de Krom, W. Bavius, R. Ziel, E. Efremov, D. van Meer, P. van Otterloo, I. van Andel, D. van Osselen, M. Heemskerk, A.M.H. van der Veen, M.A. Dexter, W.T. Corns, H. Ent, Primary mercury gas standard for the calibration of mercury measurements, Measurement, 169 (2021), 108351, Dio: 10.1016/j.measurement.2020.108351 <https://doi.org/10.1016/j.measurement.2020.108351>.
  - I. de Krom, W. Bavius, R. Ziel, E.A. McGhee, R.J.C. Brown, I. Zivkovic, J. Gacnik, V. Fajon, J. Kotnik, M. Horvat, H. Ent, Comparability of calibration strategies for measuring mercury concentrations in gas emission sources and the atmosphere, Atmospheric Measurement Techniques, 14 (2021), 2317, Dio: 10.5194/amt-14-2317-2021 <https://doi.org/10.5194/amt-14-2317-2021>.
  - GAS Analysis 2019, The Hague, the Netherlands, 18-20 June 2019:
    - Lezing: Iris de Krom "Comparable measurement results for mercury concentrations in gas emission sources and the atmosphere".
    - Posterpresentatie: Ruben Ziel "VSL's novel primary mercury vapour generator versus the Dumarey equation".
  - ICMGP 2019, Krakow, Poland, 8 – 13 September 2019:
    - Lezing: Iris de Krom "Comparable measurement results for mercury concentrations in gas emission sources and the atmosphere".
    - Posterpresentatie Iris de Krom: "VSL's novel primary mercury vapour generator versus the Dumarey equation".
- **Metrologie voor klimaatrelevante VOCs (MetClimVOC)**
  - Atmospheric trace gases: "VOCs, impact climate change", blog november 2020, geschreven voor de projectwebsite (<http://www.metclimvoc.eu/blog.html>).
  - In maart 2021 is een virtuele training voor project stakeholders gehouden met ongeveer 100 deelnemers. VSL heeft het deel "Mengselbereiding van VOC in cilinders met gravimetrische methode" gegeven.
  - In oktober 2021 is een virtuele project stakeholder workshop gehouden met meer dan 50 deelnemers, tijdens welke VSL zijn resultaten heeft gepresenteerd "Mengselbereiding en onzekerheid van VOC in cilinders met gravimetrische methode".
- **Metrologie voor isotooanalyses (Stellar)**
  - Braden-Behrens, J., Meuzelaar, H., Mohn, J., Nwaboh, J. A., Persijn, S., Rolle, F., ... & Ebert, V. (2021, July). Optical isotope ratio spectroscopy—complementing isotope ratio mass spectrometry. In Optics and Photonics for Sensing the Environment (pp. EW5D-2). Optical Society of America.
- **Metrologie voor AMC monitoring II (MetAMC II)**
  - Online workshop georganiseerd op het gebied van reactieve gassen en tevens een presentatie verzorgd (april 2021): <http://empir.npl.co.uk/metamcii/workshop-on-generation-handling-of-reactive-gases/>
  - Een Youtube filmpje opgenomen (<https://www.youtube.com/watch?v=49L3d4g3CME>) over de 'Good practice guide on the handling and use of static HCl materials'
  - LinkedIn-bijdrage geplaatst over de ontwikkelde HCl-standaarden.

- **European Metrology Network Energy Gases (EnergyGases)**

- VSL heeft twee lezingen over het EMN en het belang van metrologie in energiegassen gegeven: key-note tijdens de Internationale Conferentie van Metrologie (CIM 2021) en key-note tijdens de online partner event "European Gas and Energy Research and Innovation Days" georganiseerd door ERIG (tijdens de Duitse GAS/WAT 2021 bijeenkomst).

ELEKTRICITEIT

- **Energiemanagement van elektrische spoorwegsysteem (MyRails)**

- Helko E. van den Brom, Ronald van Leeuwen, Ralph Hornecker, "Characterization of DC current sensors with AC distortion for railway applications", *IEEE Trans. Instrum. Meas.*, Vol. 68, pp. 2084-2090, June 2019, DOI 10.1109/TIM.2019.2898014.
- Ronald van Leeuwen, Helko van den Brom, Gert Rietveld, Ernest Houtzager and Dennis Hoogenboom, "Measuring the Voltage Dependence of Current Transformers", accepted for publication in CPEM Conf. Dig., Denver, Colorado, 2020.
- Helko van den Brom and Ronald van Leeuwen, "Calibrating Sensors to Measure Braking Chopper Currents in DC Traction Units", accepted for publication in CPEM Conf. Dig., Denver, Colorado, 2020.
- Helko van den Brom, Domenico Giordano, Danielle Gallo, Andreas Wank, Yljon Seferi, "Accurate Measurement of Energy Dissipated in Braking Rheostats in DC Railway Systems", geaccepteerd voor publicatie in CPEM Conf. Dig., Denver, Colorado, 2020.
- Domenico Giordano, Davide Signorino, Daniele Gallo, Helko E. van den Brom, and Martin Sira, "Methodology for the accurate measurement of the power dissipated by braking rheostats", *Sensors*, Vol. 20, art.no. 6935, 2020.
- Helko E. van den Brom, Ronald van Leeuwen, Gert Rietveld, and Ernest Houtzager, "Voltage Dependence of the Reference System in Medium- and High-Voltage Current Transformer Calibrations", *IEEE Trans. Instrum. Meas.*, vol. 70, pp. 1-8, 2021, Art no. 1502908.

- **Elektromagnetische interferentie bij statische elektriciteitsmeters (MeterEMI)**

- Fani Barakou, Paul Wright, Helko van den Brom, Gertjan Kok, and Gert Rietveld, "Detection Methods for Current Signals Causing Errors in Static Electricity Meters", EMC Europe 2019, Barcelona, Spain, DOI 10.1109/EMCEurope.2019.8872120.
- Helko van den Brom, Zander Marais, Dennis Hoogenboom, Ronald van Leeuwen, and Gert Rietveld, "A Testbed for Static Electricity Meter Testing with Conducted EMI", EMC Europe 2019, Barcelona, Spain, DOI 10.1109/EMCEurope.2019.8872130.
- Zander Marais, Helko van den Brom, Gert Rietveld, Ronald van Leeuwen, Dennis Hoogenboom, and Johan Rens, "Sensitivity of static energy meter reading errors to changes in non-sinusoidal load conditions", EMC Europe 2019, Barcelona, Spain, DOI 10.1109/EMCEurope.2019.8872006.
- Ronald van Leeuwen, Helko van den Brom, Dennis Hoogenboom, Gertjan Kok, Gert Rietveld, "Current waveforms of household appliances for advanced meter testing", AMPS 2019, Aachen, Germany, DOI 10.1109/AMPS.2019.8897771.
- H.E. van den Brom, G. Rietveld, D. Hoogenboom, R. van Leeuwen, Z. Marais, G.J.P. Kok, S. Sharma and M.G.A. van Veghel, "Towards improved standardization of electricity meter testing", CPEM Conf. Dig., Denver, Colorado, 2020.
- Z. Marais, H. E. van den Brom, G. Kok and M. G. A. van Veghel, "Reduction of Static Electricity Meter Errors by Broadband Compensation of Voltage and Current Channel Differences", *IEEE Transactions on Instrumentation and Measurement*, vol. 70, pp. 1-11, 2021, Art no. 1501511, DOI 10.1109/TIM.2020.3039631.
- Z. Marais, H. E. van den Brom, G. Kok and M. G. A. van Veghel, "Reduction of Static Electricity Meter Errors by Broadband Compensation of Voltage and Current Channel Differences", *IEEE Transactions on Instrumentation and Measurement*, vol. 70, pp. 1-11, 2021, Art no. 1501511, DOI 10.1109/TIM.2020.3039631.

- Helko E. van den Brom, Ronald van Leeuwen, Zander Marais, Bas ten Have, Tom Hartman, Marco A. Azpúrua, Marc Pous, Gertjan J.P. Kok, Marijn G.A. van Veghel, Iliia Kolevatov, Helge Malmbekk, Ferran Silva, and Frank Leferink, “EMC Testing of Electricity Meters Using Real World and Artificial Current Waveforms”, submitted to *IEEE Trans. EMC*
  - Stefano Lodetti, Deborah Ritzmann, Peter Davis, Paul Wright, Helko van den Brom, Zander Marais, Bas ten Have, “Wavelet-based Representation of Test Waveforms for Static Electricity Meters”, submitted to *IEEE Trans. Instrum. Meas*
  - Paul Wright and Helko van den Brom, “Electromagnetic Interference on Static Electricity Meters”, invited presentative tijdens interne meeting van IEC TC13 WG11, Februari 2021.
  - Paul Wright and Helko van den Brom, “Electromagnetic Interference on Static Electricity Meters”, invited presentative tijdens interne meeting van Welmec WG11 Maart /2021.
  - Gert Rietveld en Helko van den Brom, “Electromagnetic Interference on Static Electricity Meters”, invited webinar voor EMC-ESD vereniging, Maart 2021.
  - Helko van den Brom, “Electromagnetic Interference on Static Electricity Meters”, invited presentatie voor FHI Platform Energie, April 2021.
  - Ronald van Leeuwen, Zander Marais, Dennis Hoogenboom, Helko van den Brom, Marijn van Veghel, Gert Rietveld, “A Testbed for Static Electricity Meter Testing”, presentatie tijdens de MeterEMI final workshop, April 2021.
  - Zander Marais, Helko van den Brom, Dennis Hoogenboom, Ronald van Leeuwen, Gertjan Kok, Marijn van Veghel, “A benchmark meter for settling customer complaints”, presentatie tijdens de MeterEMI final workshop, April 2021.
  - Helko van den Brom, Ronald van Leeuwen, Zander Marais, Gertjan Kok, Marijn van Veghel, “Results from testing a sample of European static meter types”, presentatie tijdens MeterEMI final workshop, April 2021.
  - Gert Rietveld en Helko van den Brom, “Impact van power electronics op statische elektriciteitsmeters”, keynote presentatie op FHI Power Electronics event, Juni 2021.
- **Verliesmetingen voor vermogenstransformatoren en reactoren (TrafoLoss)**
- Gu Ye, Wei Zhao, and Gert Rietveld, “Verification of a capacitive high voltage divider with 6  $\mu$ rad uncertainty up to 100 kV”, *IEEE Transactions on Instrumentation and Measurement*, vol. **70** (2021). DOI: [10.1109/TIM.2021.3056647](https://doi.org/10.1109/TIM.2021.3056647).
  - Gert Rietveld, “TrafoLoss progress overview: Loss Measurements on Power Transformers and Reactors”, presentatie op de EURAMET Power & Energy experts meeting, mei 2021.
  - Gu Ye, W. Zhao and G. Rietveld, “Verification of a Capacitive Voltage Divider with 6- $\mu$ rad Uncertainty Up to 100 kV”, poster presentatie op de 2021 I2MTC conferentie, mei 2021.
  - Gert Rietveld, “TrafoLoss project results: Loss Measurements on Power Transformers and Reactors”, presentatie op de Future Grid II final stakeholder workshop, juni 2021.
  - Gert Rietveld, “Understanding JRP impact: stakeholder engagement in the TrafoLoss project”, presentatie op de EURAMET Impact workshop, juni 2021.
  - Gert Rietveld, “Introduction to the TrafoLoss R&D project”, presentatie op de final stakeholder workshop van het TrafoLoss project, juni 2021.
  - Gu Ye, Gert Rietveld, “Harmonic analysis of non-sinusoidal waveforms during no-load loss measurement of power transformers”, presentatie op de final stakeholder workshop van het TrafoLoss project, juni 2021.
  - Gert Rietveld, “Calibration guidance for power transformer and reactor LMS”, presentatie op de final stakeholder workshop van het TrafoLoss project, juni 2021.
  - Ernest Houtzager, Gert Rietveld en Gu Ye, “New VSL high-end reference setup for transformer LMS system calibration”, presentatie op de final stakeholder workshop van het TrafoLoss project, juni 2021.

- Gert Rietveld, “TrafoLoss project outputs, stakeholder uptake and outlook”, presentatie op de final stakeholder workshop van het TrafoLoss project, juni 2021.
- Gert Rietveld, “Metrology for energy efficiency: traceability of power transformer loss measurements”, presentatie op de APMP Energy Efficiency Focus Group workshop on “Measurements for sustainable energy”, november 2021.
- Gert Rietveld, “Power Transformer Loss Measurements: voltage channels, NLL harmonics, uncertainty analysis”, presentatie op de 68e CENELEC TC14 meeting, december 2021.
- **Metrologie voor digitale onderstations (FutureGrid II)**
  - E. Houtzager, T. Lehtonen, G. Rietveld, Z. Marais, “Metrology-grade Precision ADC for Power and Energy Applications”, accepted for publication in the proceedings of the 2020 Conference Precision Electromagnetic Measurements (CPEM2020), Denver, 2020.
- **Herleidbaarheid voor hoogfrequente metingen aan planaire componenten (TEMPT)**
  - K. Haddadi, E. Okada, K. Daffé, F. Mubarak, D. Théron, G. Dambrine, "Multiport Vector Network Analyzer Configured in RF Interferometric Mode for Reference Impedance Renormalization," IEEE MTT-S International Microwave Symposium, Boston, MA, pp. 1-3, 2019.
  - F. Mubarak, C.D. Martino, R. Toskovic, G. Rietveld, and M. Spirito, “Automated Contacting of On-Wafer Devices for RF Testing”, in Proc. of conference on precision electromagnetic measurements, 2020, Canada.
  - F. Mubarak, C.D. Martino, R. Toskovic, G. Rietveld, and M. Spirito, “Automated Contacting of On-Wafer Devices for RF Testing”, in Proc. of Conference on Precision Electromagnetic Measurements, 2020, Canada.
  - Faisal Mubarak, “Measurement Software for Advanced VNA Calibration and Covariance based Uncertainty Evaluation”, FHI RF technology event 2020, 1-3 December 2020.
  - Raffaele Romano, Faisal Mubarak, Marco Spirito, Luca Galatro, “The HF-VNA, an Interferometric Approach for the Accurate Measurement of Extreme Impedances”, mondelinge presentatie op IMS2019, Boston, Verenigde Staten.
  - F. Mubarak, “High Frequency Measurement Facilities”, Philips Research, Philips, 2019-01-22, Eindhoven.
  - F. Mubarak, “Measurement Applications of RF Interferometer-based VNAs”, EURAMET TC-EM SC-RF&MW Experts Meeting, 10 april 2019, INTA, Spanje.
  - F. Mubarak, “Enhancing measurement resolution of vector network analyzers with RF-interferometers”, Keysight Metrology Workshop, 11 april 2019, INTA, Spanje.
  - F. Mubarak, “Design and applications of interferometer-based Vector Network Analyzers”, ME-Colloquium Delft University of Technology, 2019-09-26, Delft.
  - F. Mubarak, “Ultra low-noise broadband impedance measurements”, Quantum Opportunities Workshop, Delft University of Technology, 2019-11-2, Delft.
- **Meettransformatoren voor power quality metingen (IT4PQ)**
  - G. Crotti, H.E. van den Brom, E. Mohns, R. Tinarelli, M. Luiso, R. Styblikova, M Agazar, H. Cayci, P. Mazza, J. Meyer, M. Almutairi, “Measurement Methods and Procedures for Assessing Accuracy of Instrument Transformers for Power Quality Measurements”, geaccepteerd voor publicatie in CPEM Conf. Dig., Denver, Colorado, 2020.
  - Gabriella Crotti, Jan Meyer, Helko Van den Brom, Enrico Mohns, Yeying Chen, Roberto Tinarelli, Mario Luiso, “Assessment of Instrument Transformer Accuracy for Power Quality Measurements in Distribution Grids: Recent Activities and First Results from 19NRM05 IT4PQ Project”, CIRED Conf., Genève, 2021.
  - Gabriella Crotti, Palma S. Letizia, Giovanni D’Avanzo, Mario Luiso, Carmine Landi, Fabio Muñoz, Helko van den Brom, “Instrument Transformers for Power Quality Measurements: a Review of Literature and Standards”, AMPS workshop, Aken, 2021.

- **Metrologie voor DC-netten (DC Grids)**
  - Helko van den Brom, Zander Marais, and Ronald van Leeuwen, “Testing of DC Electricity Meters with Broadband Conducted Electromagnetic Disturbances”, submitted to International Conference on Harmonics and Quality of Power (ICHQP), Naples, May 2022.
- **Ondersteuning voor een Europees Metrologie Netwerk op het gebied van Slimme Elektriciteitsnetwerken (SEG-Net)**
  - Gert Rietveld, Harald Haughlin, “EMN on Smart Electricity Grids - update to EURAMET TC-TF”, presentatie op de EURAMET TC-TF contact persons meeting, maart 2021.
  - Emma Woolliams, Arul Murugan, Gert Rietveld, “European Metrology Networks”, keynote presentatie tijdens het Science debate van de IPQ-EURAMET workshop “the role of measurement science in delivering the EU’s Green Deal”, mei 2021.
  - Gert Rietveld, “Connecting renewables to the electricity grid – measurements supporting the Energy Transition”, keynote presentatie op de 2021 NSERC CREATE TOP-SET workshop, Ottawa, Canada, juli 2021.
  - Gert Rietveld, “EMN on Smart Electricity Grids - update to EURAMET TC-EM”, presentatie op de EURAMET TC-EM contact persons meeting, oktober 2021.

#### IONISERENDE STRALING

- **Radiotherapie in combinatie met hyperthermie (RaChy)**
  - G. Durando, P. Miloro, V. Wilkens, B. Karaboce, J. de Pooter, G. van Rhoon, G. ter Haar, B. Caccia, A. Spinelli, A. Denkova, R. Dijkema, RaChy-Radiotherapy Coupled with Hyperthermia-18HLT06 EURAMET EMPIR Project, 2019 IEEE International Symposium on Medical Measurements and Applications, [10.1109/MeMeA.2019.8802202](https://doi.org/10.1109/MeMeA.2019.8802202).
  - Jacco de Pooter, Evaluation of the synergistic biological effects from combined radiotherapy hyperthermia experiments, 2<sup>nd</sup> RaChy Stakeholder workshop, November 2021, Berlijn.

#### LENGTE

- **Metrologie voor extracellulaire deeltjes (MetVes II)**
  - M. Kuiper, A. van de Nes, R. Nieuwland, Z. Varga, E. van der Pol, Reliable measurements of extracellular vesicles by clinical flow cytometry, American Journal of Reproductive Immunology, 2020, e13350, <https://doi.org/10.1111/aji.13350>.
  - Martine Kuiper, Richard Koops, Rienk Nieuwland, Edwin van der Pol, Method to traceably determine the refractive index by measuring the angle of minimum deviation, <https://doi.org/10.1088/1681-7575/ac8991>.
  - Poster presentatie: BIGSS 2020 (Biophotonics and Imaging Graduate Summer School 2020) <https://www.youtube.com/watch?v=J7pyZpDc9hA&t=32s>.
  - Er is een korte online presentatie van het project gepubliceerd als “VSL talk” in het kader van Wereldmetrologiedag op 20 mei 2020.
- **Metrologie voor nanowire energy harvesting devices (NanoWires)**
  - Richard Koops, Characterization of Nanowires systems, DSPE-lunchlezing, 4 oktober 2021.
- **Metrologie voor de fabriek van de toekomst (Met4FoF)**
  - Eichstädt, S.; Gruber, M.; Vedurmudi, A.P.; Seeger, B.; Bruns, T.; Kok, G. *Toward Smart Traceability for Digital Sensors and the Industrial Internet of Things*. Sensors 2021, 21, 2019. <https://doi.org/10.3390/s21062019>.
  - Gertjan Kok, *Metrological redundancy in distributed measurements*, presentation at international MSMM 2021 workshop (on-line).
  - Gertjan Kok, *Noise and Form Deviations in Virtual Instruments; Some Virtual Instruments at VSL*, presentation at VirtMet 2021: Workshop on digital twins and virtual measurement devices.
  - Gertjan Kok e.a., Euramet workshop on Metrology for Digital Transformation, session on Machine learning and artificial intelligence, joint presentation *Mathematical modelling and*

*algorithms for the factory of the future Met4FoF* and panel member in 'Meet the experts session', 23 September 2021.

- Gertjan Kok, *Quantifizierung von Redundanz in Sensorsystemen und die Beziehung zur Messunsicherheit*, presentation at 10. VDI-Fachtagung Messunsicherheit praxisgerecht bestimmen – Prüfprozesse in der industriellen Praxis 2021, Erfurt / online.
- Gertjan Kok, *Quantifizierung von Redundanz in Sensorsystemen und die Beziehung zur Messunsicherheit*, submitted to Technisches Messen, 2022.

## OPTICA

### - **Metrologie voor aardobservatie en klimaat (METEOC3)**

- S. van den Berg, P. Dekker, G. Otter, M. Pelica Páscoa and N. Dijkhuizen, 'Calibration of a cube-sat spectroradiometer with a narrow-band widely tunable radiance source', Appl. Opt., Feb. 2021, doi: 10.1364/AO.417467. <https://doi.org/10.1364/AO.417467>.
- Paul Dekker en Steven van den Berg "SI-traceable tunable radiance source for spectroradiometer calibration", presentatie tijdens Workshop on Innovative Technologies for Space Optics, ESA ESTEC, Noordwijk, November 2019.
- Steven van den Berg, Paul Dekker, Gerard Otter, Marcela Pelica Páscoa and Niels Dijkhuizen, "CubeSat spectroradiometer calibration with a laser-based tunable radiance source", presentatie tijdens de NEWRAD 2021 online conferentie georganiseerd door NIST.
- Steven van den Berg, Paul Dekker, Tessel van der Laan, Gerard Otter, Niels Dijkhuizen, Bilgehan Gür, Sanneke Brinkers "Traceable radiance source for spectroradiometer calibration", poster ICSO2018.
- Steven van den Berg, Paul Dekker, Marcela Pelica Páscoa, Gerard Otter and Niels Dijkhuizen, "Calibration of a CubeSat spectroradiometer with a narrowband tunable radiance source", poster ICSO2020.

### - **Metrologie voor 'Temporal Light Modulation' (MetTLM)**

- OP27 Facility for calibration of photometers for temporal light modulation, Dekker, P.R., van Bloois, A.L. DOI 10.25039/x48.2021.OP27, publicatie en presentatie op de OP27-conferentie. De publicatie is geselecteerd voor een speciale editie van *Lighting Research and Technology* en zal daarin onder peer-review gepubliceerd worden.

## TIJD & FREQUENTIE

### - **Nieuwe tijdssignalen voor (sub-)ps tijdsintervalmetingen (TiFOON)**

- Yan Xie, Erik Dierikx, Marijn van Veghel, "A new SDR-based TX-RX structure for accurate time and frequency transfer over optical fibers", presentatie aangeleverd voor EFTF 2022.

### - **Optische netwerkverbindingen voor TF-disseminatie**

- Presentatie tijdens de EURAMET TC-TF vergadering op 24 maart 2021, "Progress with optical fiber links at VSL".
- Jeroen C. J. Koelemeij, Han Dun, Cherif E. V. Diouf, Erik F. Dierikx, Gerard J. M. Janssen & Christian C. J. M. Tiberius, "A hybrid optical-wireless network for robust decimetre-level positioning in urban environments", submitted for publication in Nature

### - **Nauwkeurige tijddisseminatie voor de industrie**

- Xie, Yan; Dierikx, Erik; van Veghel, Marijn (2021): *Design of "Universal Module" Based Time and Frequency System using White Rabbit Technology*, TechRxiv. Preprint: <https://doi.org/10.36227/techrxiv.17122154.v1>

## VOLUMETRIE

### - **Debietmetingen voor hernieuwbare gassen en gasmengsels in het gasnet (NewGasMet)**

- MacDonald, M., *Flow metering of renewable gases*, EMPIR-project presentatie tijdens de European Energy Gases workshop, "Exploring current and future scenarios within energy gas industries that may create new measurement challenges", National Physical Laboratory, Teddington, UK, 22 Januari 2020; [European energy gases workshop Registration, Wed 22 Jan 2020 at 09:00 | Eventbrite](#).

- Brun, C., “Flow metering of renewable gases (biogas, biomethane, hydrogen or syngas)”, 20<sup>th</sup> international metrology congress 2021.
- Op 4 november 2020 en op 26 mei 2021: communicatie over project in standaardisatie-commissie 310066 “Debiet- en hoeveelheidsmeting”.
- Deelname aan CEN/TC237 meetings met bijdragen ter herziening standaarden met name in de WG5 Task Group “Non-conventional gases” in april, mei en juli 2021.
- NEWGASMET stakeholder meeting, kennisverspreiding, o.a., duurzaamheidstestresultaten van huishoudelijke gasmeters), 9 maart 2022.
- NEWGASMET presentaties in de EURAMET TC Flow, in november 2020, september 2021 en mei 2022.
- NEWGASMET training session bijdrage door M. Workamp, European metrology network (EMN), 29 september 2022.
- *Flow metering of renewable gases (biogas, biomethane, hydrogen or syngas)*, 20<sup>th</sup> international metrology congress 2021, [Link](#).
- Online paper (niet peer-reviewed) “Effect of hydrogen admixture on the accuracy of a rotary flow meter” (<https://www.vsl.nl/sites/default/files/rtf/Report%20accuracy%20test%20rotary%20meter.pdf>).
- Dissemination van *Recommendations report - MID compliance for rotary displacement gas meters (EN 12480) when measuring renewable gases* aan de CEN/TC237 WG2 voorzitter, 11 januari 2022.
- Dissemination van *Recommendations report - MID compliance for turbine gas meters (EN12261) when measuring renewable gases* aan de CEN/TC237 WG3 voorzitter, maart 2022.
- NewGasMet report - *Report on the Effect of the renewable gases on the uncertainty budgets of gas meters* (newgasmeter.eu website – [Link](#)).
- NewGasMet report – *Report on gas tightness testing of domestic gas meters and compact conversion devices (EVCD) for hydrogen applications* (newgasmeter.eu website – [Link](#)).
- Deliverable D4 - *Report on recommendations for the traceable calibration (type testing) and verification procedures for rotary displacement, turbine, diaphragm, domestic ultrasonic, thermal mass flow gas flow meters which measure renewable gases, in compliance with the requirements of the 2014/32/EU Measuring Instruments Directive and recommendations reports on (I) test gases, flow rate, pressure range, and meter sizes, (II) the effects of renewable gases on the uncertainty budgets of gas meters* (newgasmeter.eu website - [Link](#)).
- Deliverable D5 - *Report on (I) the durability of the materials, electrical insulation and internal components of domestic gas meters after exposure to renewable gases, (II) the effects that renewable gas flow has on the durability of gas meters and how this effects their accuracy, and (III) recommendations for improving current calibration and verification facilities* (newgasmeter.eu website – [Link](#)).
- Deliverable D6 - *Report on the inter-comparison of 2 flow calibration standards with N<sub>2</sub>, H<sub>2</sub> and CH<sub>4</sub> including the test protocol, validated calibration methods and uncertainty budgets* (newgasmeter website – [Link](#)).
- Deliverable D7 - *Report on the type testing procedures for domestic and commercial gas meters with hydrogen and one other test gas (air, nitrogen, methane or natural gas)* (newgasmeter.eu website – [Link](#)).
- Online EMPIR-project news features (<https://newgasmeter.eu/news>):
  - “Expert group formation”, 10 December 2019.

- “Durability test protocol Newgasmeter”, 10 Maart 2020.
- “2nd newsletter Newgasmeter”, 6 November 2020.
- “NEWGASMETER expert group defines test gases for potential adoption into the CEN/TC 237 Gas meters scope”, 16 Maart 2021.
- “Training session”, 24 augustus 2022.
- “Final Project Meeting”, 25 oktober 2022.
- **Metrologie voor Portable Emission Measurement Systems (MetroPEMS)**
  - Tweetal presentaties gedurende de “MetroPEMS stakeholder workshop” op 15 december 2020:
    - Algemeen: “MetroPEMS calibration capabilities at VSL”.
    - M.b.t. WP3 “EFM: Robust, reliable, and application-oriented exhaust flow meter calibration”.
  - 24<sup>th</sup> ETH Conference on Combustion Generated Nanoparticles “*MetroPEMS: Metrology for portable emission measurement systems. Project goals and preliminary finding*”, [https://www.nanoparticles.ch/2021\\_ETH-NPC-24.html](https://www.nanoparticles.ch/2021_ETH-NPC-24.html)
- **Ontwikkeling van de nieuwe waterstofstandaard “HyQs”**
  - Website: VSL lanceert eerste mobiele kalibratiefaciliteit voor waterstof in Nederland: <https://www.vsl.nl/over-vsl/actueel/vsl-lanceert-eerste-mobiele-kalibratiefaciliteit-voor-waterstof-nederland>.
- **Metrologie voor hoge-druk gas en vloeibare waterstofflows (MetHyInfra)**
  - H.-B. Böckler et al., *Metrology infrastructure for high-pressure gas and liquified hydrogen flows*, 20<sup>th</sup> international metrology congress 2021, [Link](#).
- **Ontwikkeling van de nieuwe waterstofstandaard “HyQs”**
  - Website: VSL lanceert eerste mobiele kalibratiefaciliteit voor waterstof in Nederland: <https://www.vsl.nl/over-vsl/actueel/vsl-lanceert-eerste-mobiele-kalibratiefaciliteit-voor-waterstof-nederland>.

## TECHNOLOGIEOVERSCHRIJDEND

- **Voorbeelden van evaluatie van meetonzekerheid (EMUE)**
  - Van der Veen A.M.H., Meuzelaar H., Causevic M., Cox M.G., “Modelling of the dynamic gravimetric preparation of calibration gas mixtures using permeation for trace gas analysis”, in: F Pavese, A B Forbes, N F Zhang, A G Chunovkina (Eds.): *Advanced Mathematical and Computational Tools in Metrology and Testing XII*, Series on Advances in Mathematics for Applied Sciences, Vol. 90, pp. 429-440.
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