SAFESIDE

PUBLIC REPORT

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ULCO[1], URCA[2], UGHENT[3], UMONS[4], MULTITEL[5].

Avec le soutien de la Wallonie

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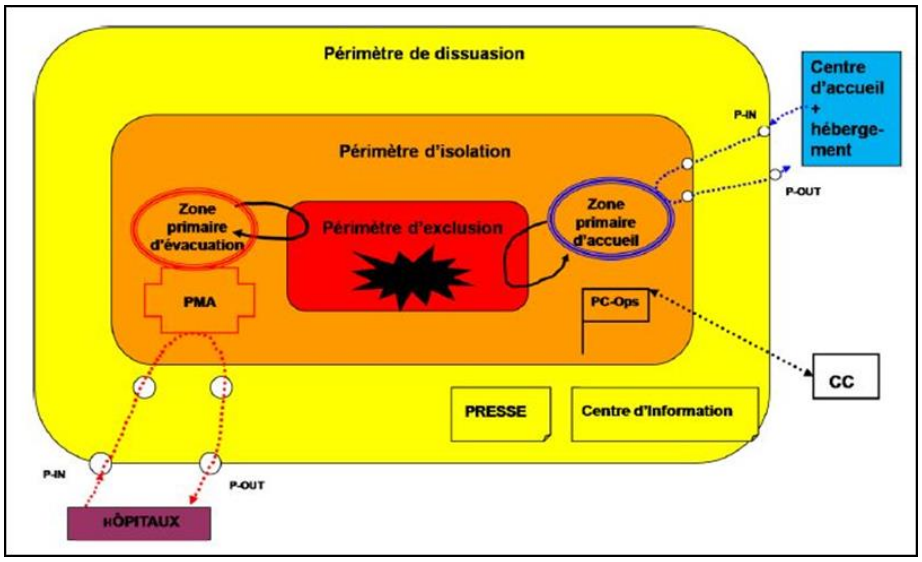
The SAFESIDE project started in january 2017. A dedicated website is available: http://www.safeside-project.eu. The aim of the project SAFESIDE was to develop new spectroscopy tools for on-field measurement. At the beginning of the project we discussed with various actors of the civil security and protection in order to better understand their main needs. We then listed a number of gases of interest and also the type of expected use conditions for the systems to be developed. Among the listed gases we identified a particular interest for Ammoniac, CO, CO_2, HCl, HCN, SO_2 et NO_x. The development of a portable or transportable system that will be able to detect at least five different gases with sufficient accuracy and deployable on field was identified as the most relevant objective. This is then the direction we took for guiding the project developments.



Molecule	ERPG2
HCL	33 ppm
NH3	142 ppm
CO	430 ppm
CO2	27309 ppm
SO2	4 ppm
HCN	*10 ppm*
NO	*10 ppm*
NO2	*10 ppm*

Figure 1 ERPG Limits

Figure 1 shows the different ERPG areas (Emergency Response Planning Guidelines) for the chemical elements targeted in the project. The ERPG-2 levels correspond to the maximum concentrations allowed, below which the risks for exposed persons during 1 hour of having irreversible damages and would avoid these persons of taking adapted protection measures are low.

Different approaches were studied, exploiting the knowledge and know-how available among the different partners :
- The capacity for fabrication on-chip semiconductor diodes and waveguides (UGHENT),
- The know-how in high power fibre lasers and mid-infrared sources (MULTITEL),
- The availability of reference tools and a mobile lab for measurements on field (ULCO),
- The knowledge in spectroscopy and in photo-acoustic sensors (URCA),
- The availability of lab infrastructures for testing different gases and combustions at the “Institut des Risques” (UMONS)

The first lasers were available in 2018 for laboratory experiments. An home-made semiconductor laser was coupled to a multi-pass cell for detection of NH_3 and CO. (ULCO, UGAND).

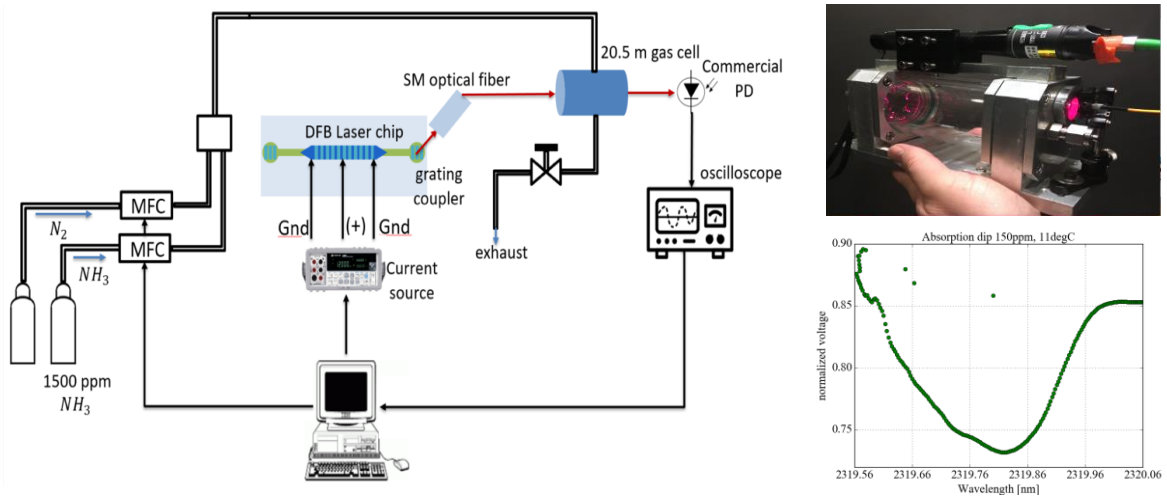


Figure 2 NH_3 mesurements

A reference equipment (GC/MS, partially acquired with SAFESIDE) was tested end of November 2018 with the calorimeter from University of Mons, together with other systems from the mobile laboratory from University of Dunkirk. These analysis were used as first test campaigns to determine absorption regions and kind of species to detect when different materials are brunt.

Figure 3 GC/MS system (Gaz Chromatography / Mass Spectroscopy)

In 2019, the first sources from MULTITEL, emitting in the mid-IR, were tested at URCA with multipass et photo-acoustic cells for measuring different gases: Acetone, Methane, Hydrochloric Acide.

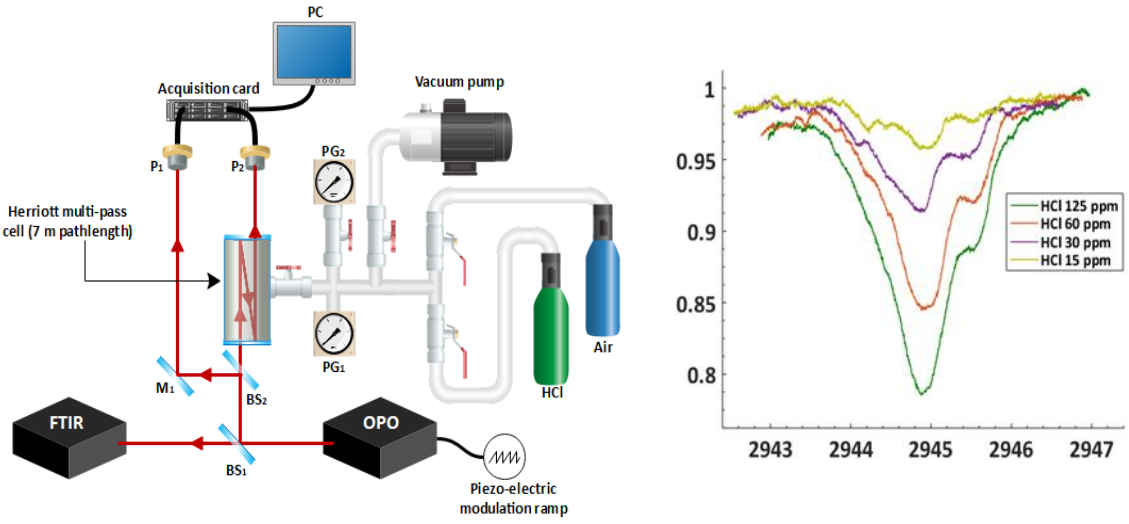


Figure 4 HCL mesurements

In 2020, the laser sources were optimised based on laboratory experiments and prototyped in view of future tests on-field (MULTITEL, UGHENT). The other elements like multi-pass and photo-acoustic cells

were also developed (ULCO, URCA). The first combusting and measurements based on sampling could be carried on (UMONS). Finally, the GC/MS system from ULCO could already be used in different sites.

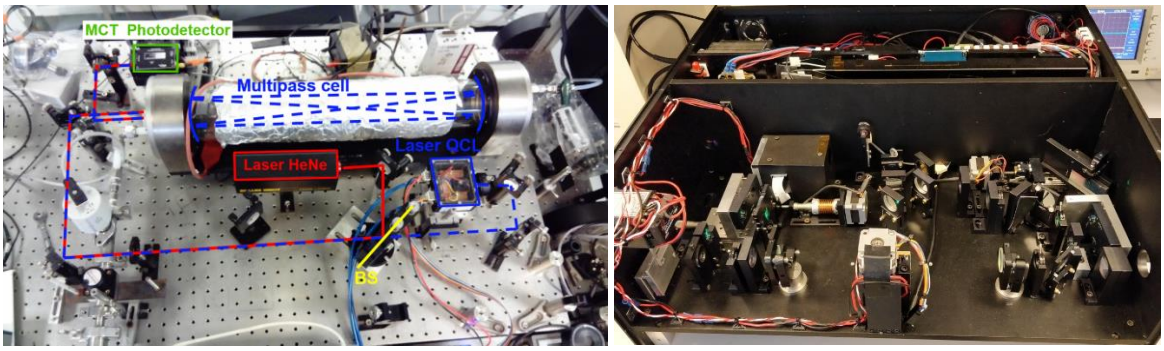


Figure 5 Prototypes (multipass cell, infrared laser)

Different systems were validated on-field in the particular case of CO_2 and Ammoniac (NH_3). The developed systems in the project were confronted with commercial equipment for inter-comparison of results.

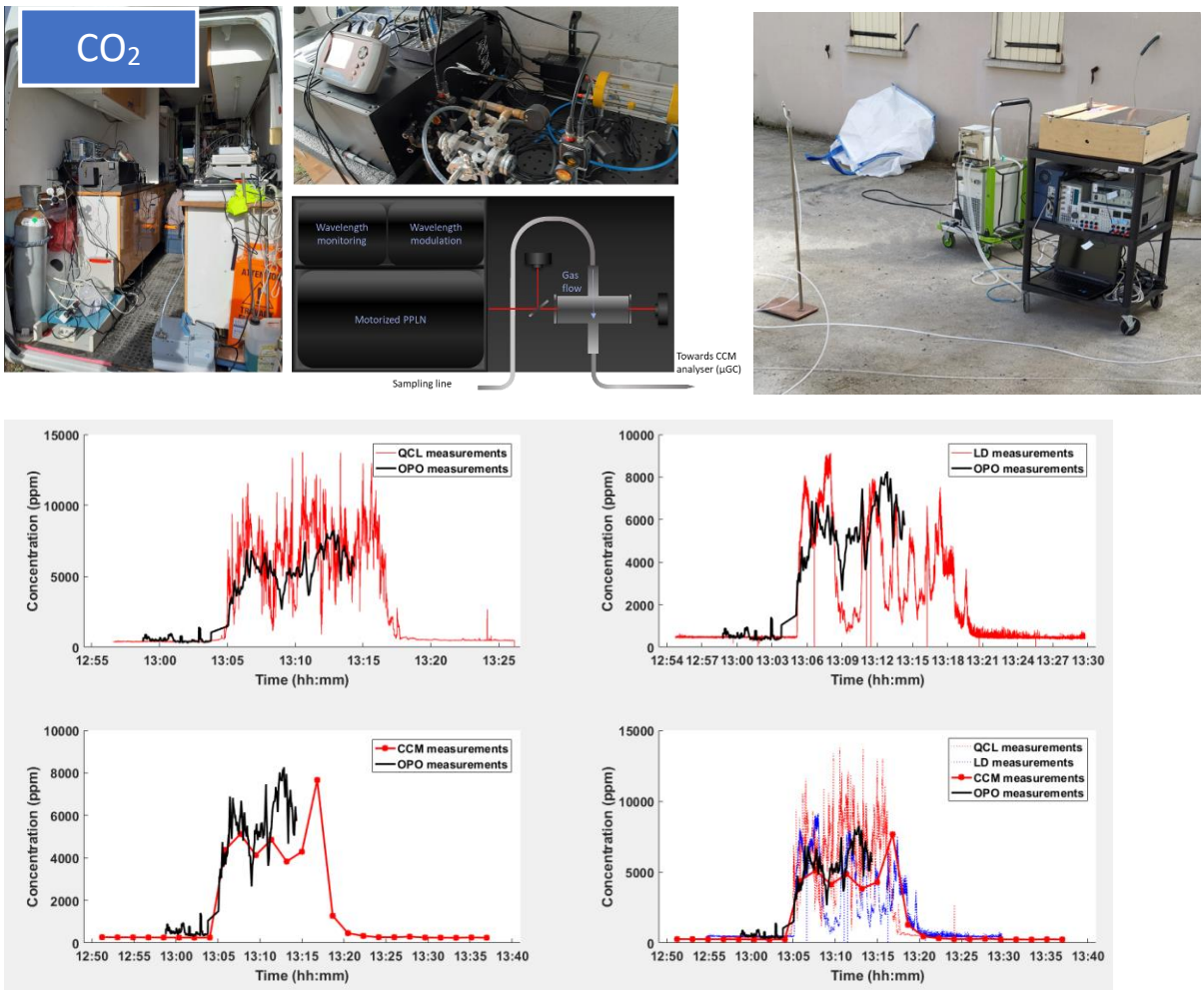


Figure 6 CO_2 measurements

In the previous figure 6 (top left) we can see the system developed at MULTITEL (Tunable Mid-IR laser) Installed into the mobile lab from CCM and coupled to a cell continuously feeded. On top-right we can see a system from URCA based on a diode coupled to a multipass cell. Always on the same picture, we

can see we can see the sampling point (a tube fixed to a vertical mast) that collects the air and gaz to the mobile lab in order to get measurements on different equipment from the same sampling point.

Always on this same figure 6, the four graphics below show the different results between the three equipment: the laser (OPO) the diode (QCL) compared to the reference form the mobile lab (CCM)

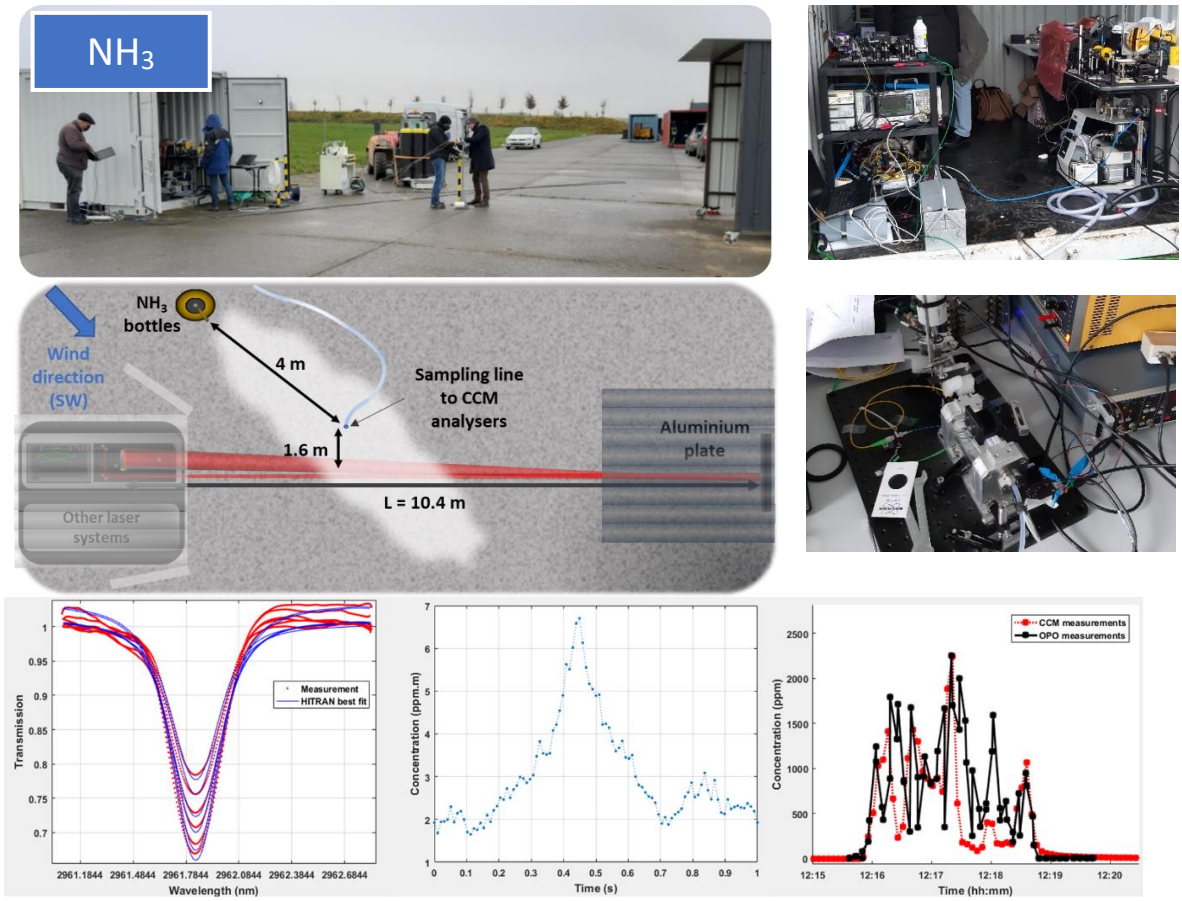


Figure 7 NH_3 measurements

In the previous figure we can see a picture of the three systems installed in a container : OPO laser operating in free-space (reflected in a target), QCL and semiconductor laser diodes, both coupled to a multipass cell (one can be seen in the photography in the middle-right), connected to a sampling line like for the measurements of CO_2. The graphics below show the concentrations of NH_3 measured with the OPO laser in free-space. The last graphic shows the comparison with a reference equipment from the mobile lab (CCM).

These test campaigns permitted to validate our systems in real conditions and by comparison with reference equipment. We validated the ability of our systems to detect various gases in concentration levels comparable with ERPG2 thresholds.

During this project we organized 3 workshops, the first one in GHENT on scientific thematic related with gaz spectroscopy. The second was held at ULCO, wider public and application oriented, in the frame of the national air quality day in France. During this workshop we established connexions between the CCM from ULCO and the SDIS59 services in the optics of expertise and equipment sharing. The final workshop was held online (because of sanitary conditions) and permitted to present all the results of the project, included on-field validation trials, to a large audience.