

**Pictures for the Final publishable summary report, section Main S&T results and foreground.**

**Pictures from WP5 section:**

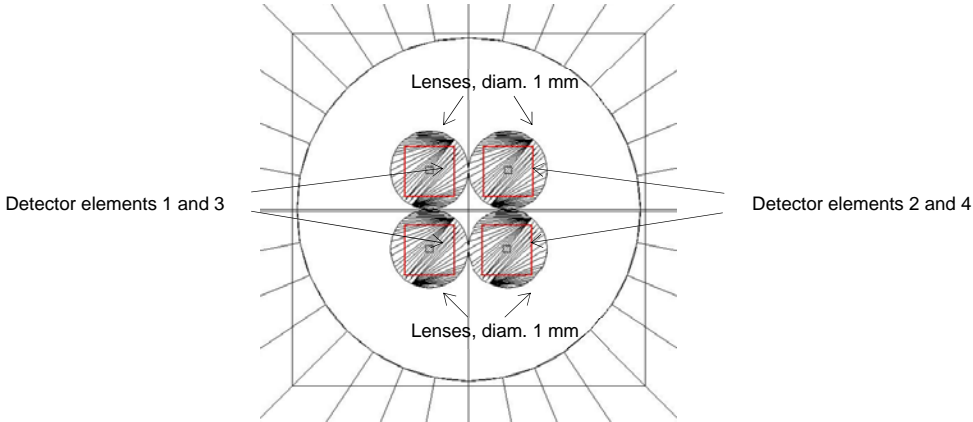


Figure 1. ZEMAX model of four single element detectors with separated immersion lenses.

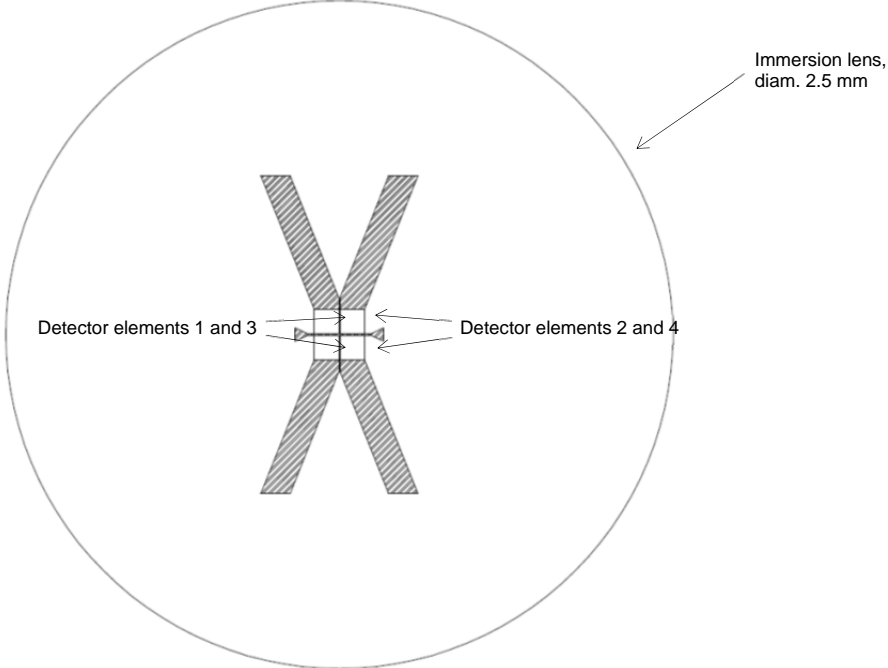


Figure 2. Four single element detectors with one immersion lens (bottom view).

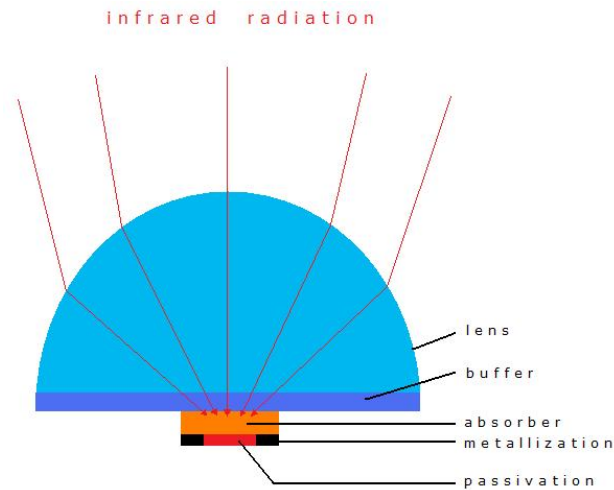


Figure 3. Concept of an infrared photodetector (photoconductor) as a heterostructure chip integrating optical, detection and electronic functions.

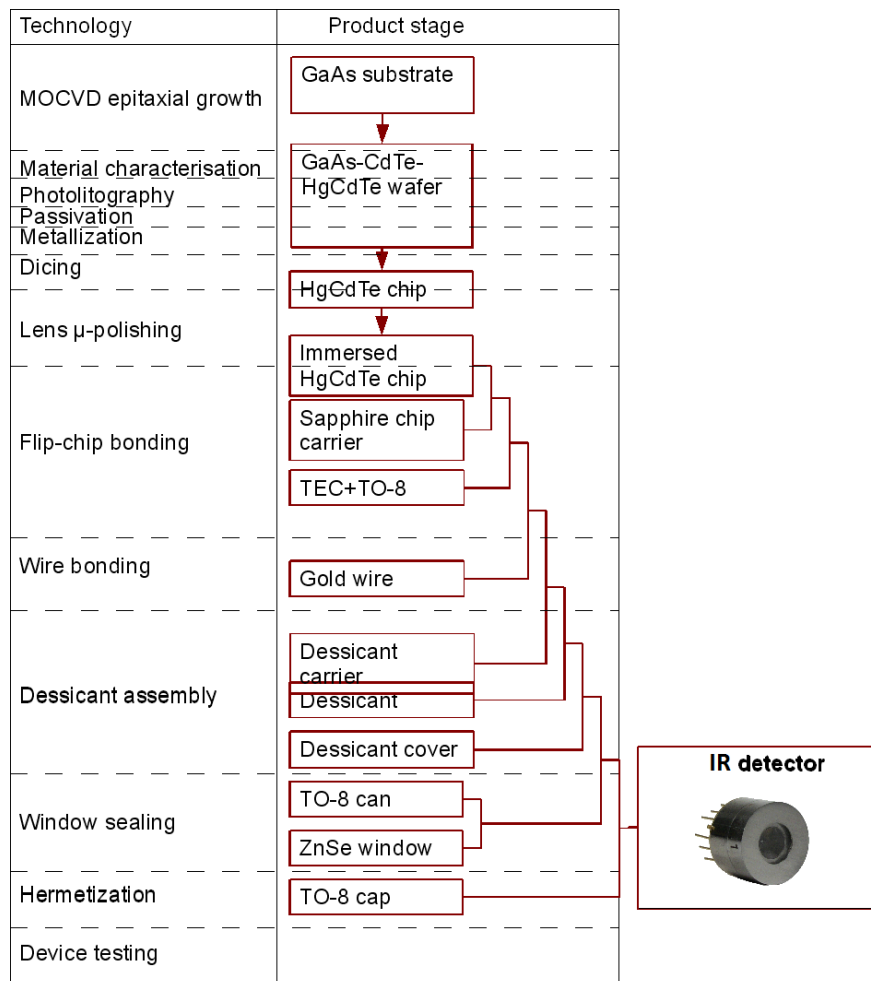


Figure 4. Manufacturing process flow.

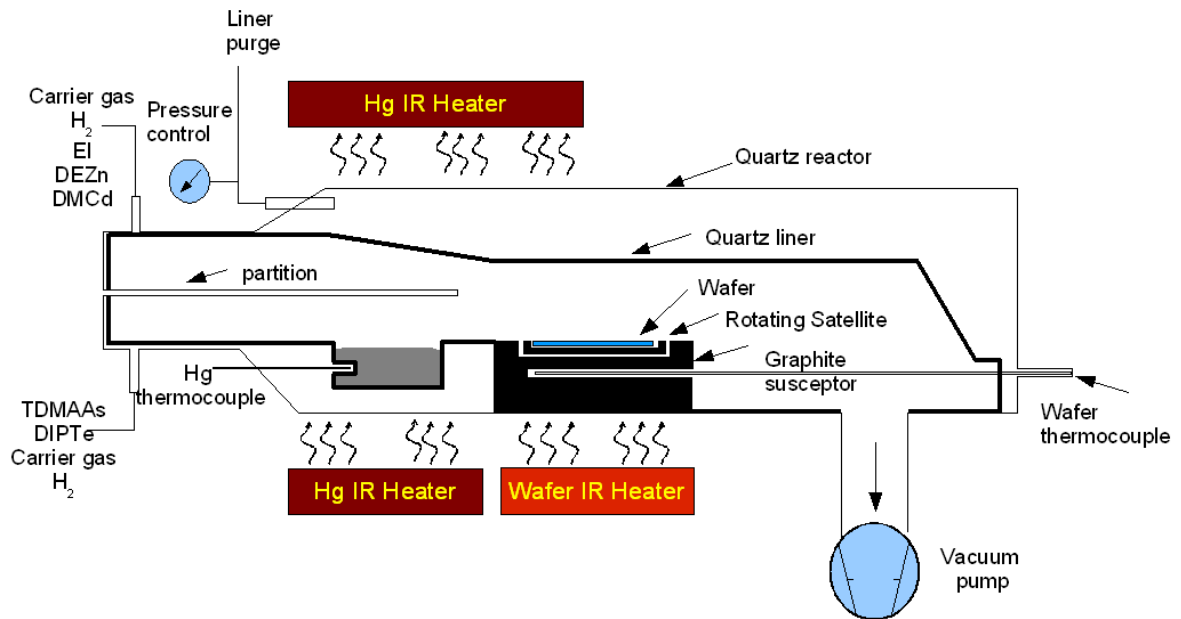


Figure 5. Horizontal reactor cell with internal mercury source.

Detector type	PCQI 4x(1x1 mm)				PCQ 4x(1x1 mm)
	2TE	2TE	3TE	4TE	3TE
Detector Temperature, K	283	230	210	195	210
$I_n$ , pA/sqrt(Hz)	39	29	24	21	24
Fall time, ns	3.8	3.5	2.9	2.9	2.9
BW, MHz	92	100	121	121	121
Transimpedance min, k $\Omega$	3				
Transimpedance max, k $\Omega$	12				
Output impedance, $\Omega$	50				
Supply, V	+/- (6V - 7.5V)				
Dimensions, mm	Front: 50 x 50, Depth: 40				
Rv (4 $\mu$ m), V/W	450-1800	510-2040	750-3000	1110-4440	135-540
Rv (8 $\mu$ m), V/W	630-2520	840-3360	1275-5100	2520-10080	150-600
Rv (11 $\mu$ m), V/W	360-1440	750-3000	1050-4200	1860-7440	120-480
Rv (11.5 $\mu$ m), V/W	-	-	1020-4080	-	-
D*(4 $\mu$ m), Gjones	0.38	0.59	1.05	1.81	0.18
D*(8 $\mu$ m), Gjones	0.54	0.97	1.77	4.00	0.21
D*(11 $\mu$ m), Gjones	0.31	0.86	1.46	2.95	0.17
D*(11.5 $\mu$ m), Gjones	-	-	1.38	-	-

Standard TEC parameters	2TE	3TE	4TE
Detector Temperature, K	230	210	195
Vmax, V	1.3	3.6	7.6
I <sub>max</sub> , A	1.2	0.45	0.4

Figure 6. Detection module parameters

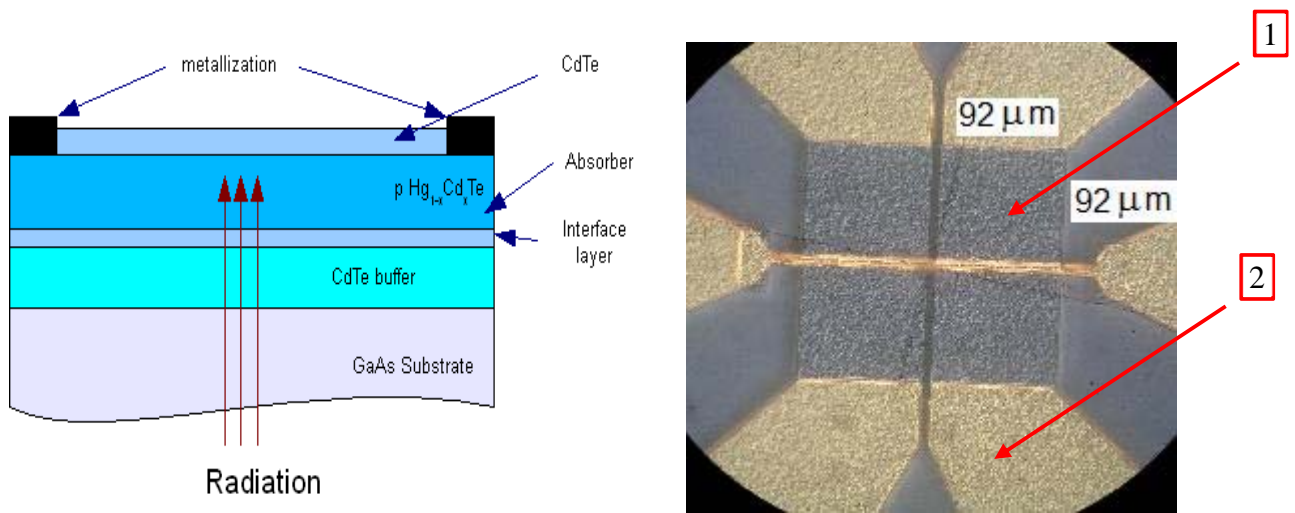


Figure 7. Photoconductor structure (a) and bottom view of quadrant photodetector (b): 1- active element, 2 – Au contact.

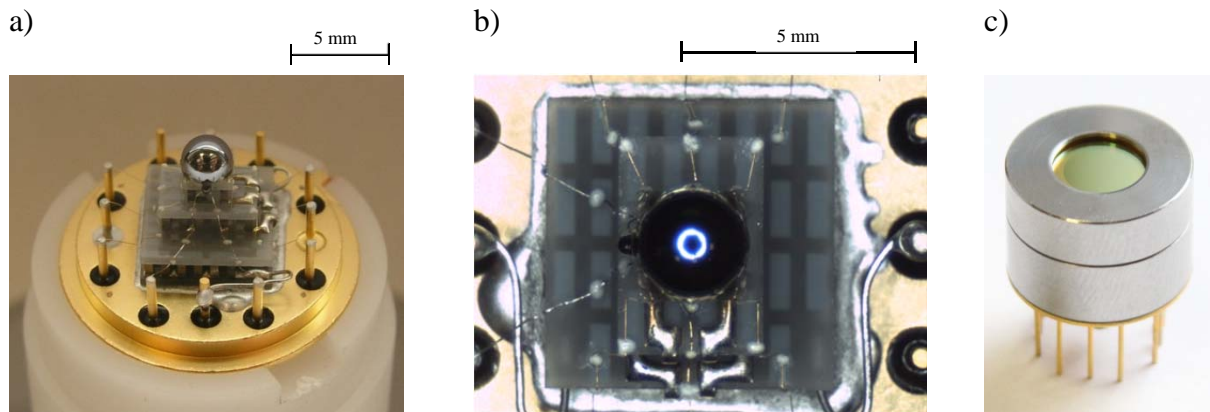


Figure 8. Side view (a) and top view (b) of Emphasis detector (photoconductor) and three stage Peltier cooler mounted on TO-8 header. Picture (c) shows hermetically sealed Emphasis detector.



Figure 9. Front and rear view of Emphasis detection module design and its final version.

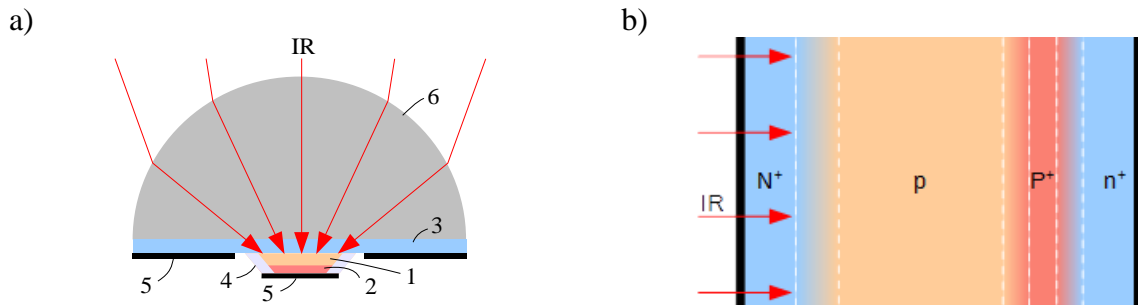


Figure 10. Schematic cross-sections of the device: a - the device integrated with an immersion microlens, b - heterostructure. References: 1 – p-type absorber of IR, 2 – P+ – anode, 3 – N+ – cathode, 4 – passivation, 5 – contact pads, 6 – GaAs immersion microlens.

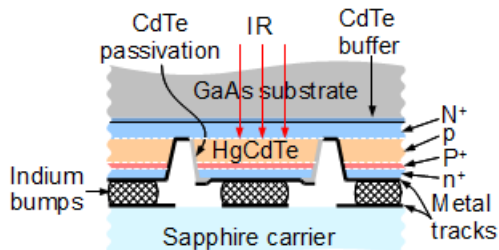


Figure 11. Cross-section of mesa photodiode after bump bonding.

a)



b)

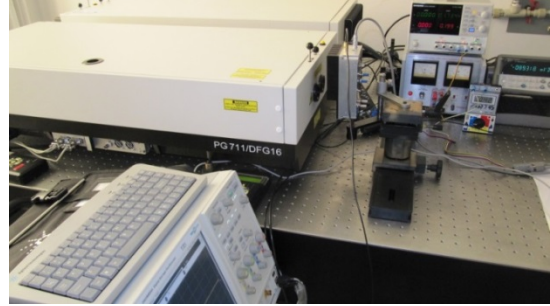


Figure 12. Time response measurement sets with quantum cascade laser (a) and optical parametric oscillator (b).

a)



b)



Figure 13. Emphasis detection module (a) and TEC controller (b).

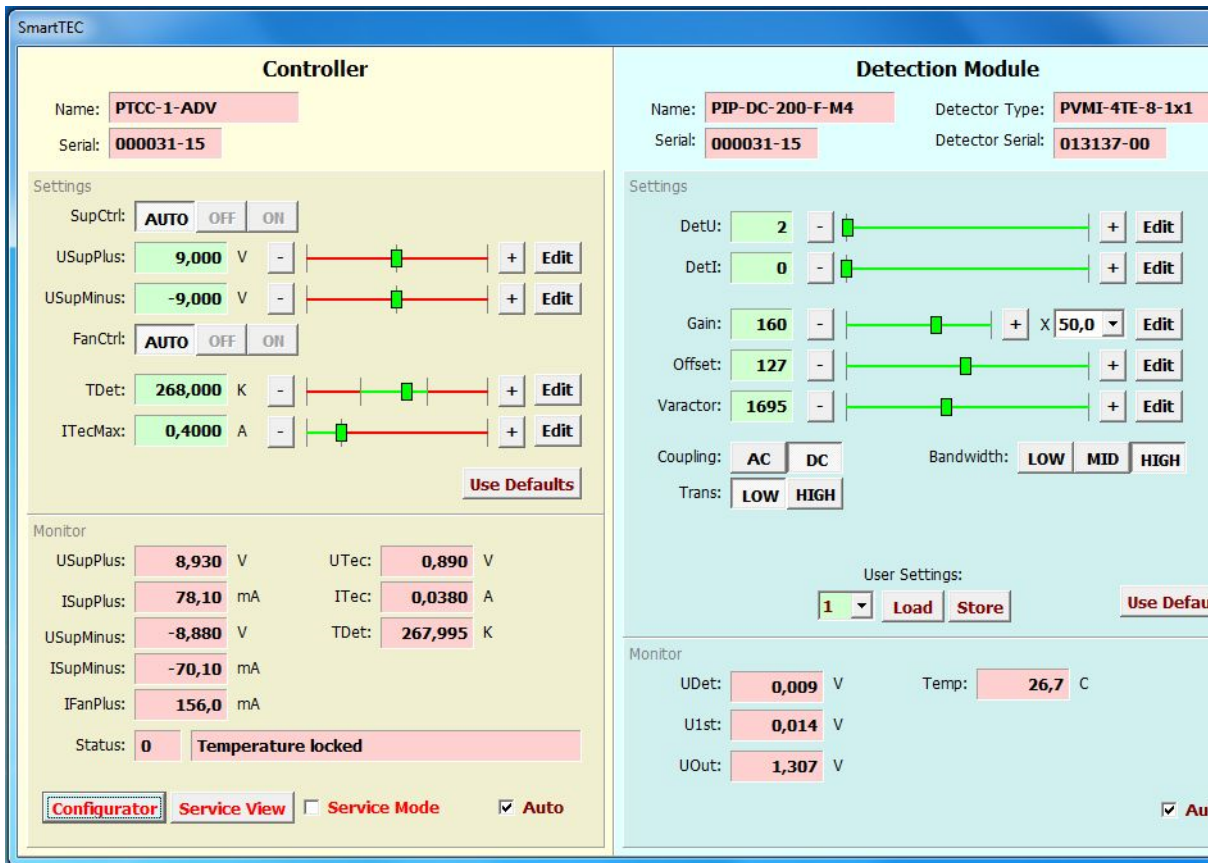
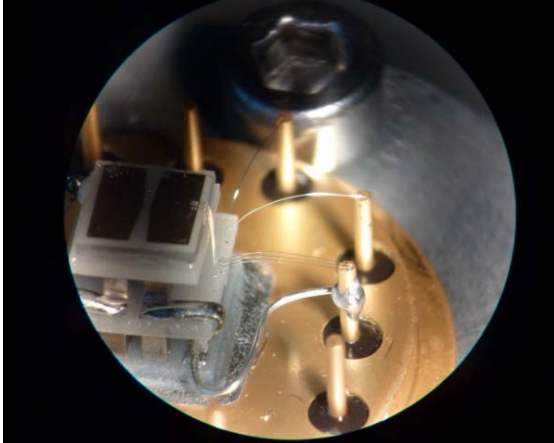


Figure 14. PC software for controlling the parameters of the SMART detection module.



Figure 15. Semi-automatic wire bonder.

a)



b)

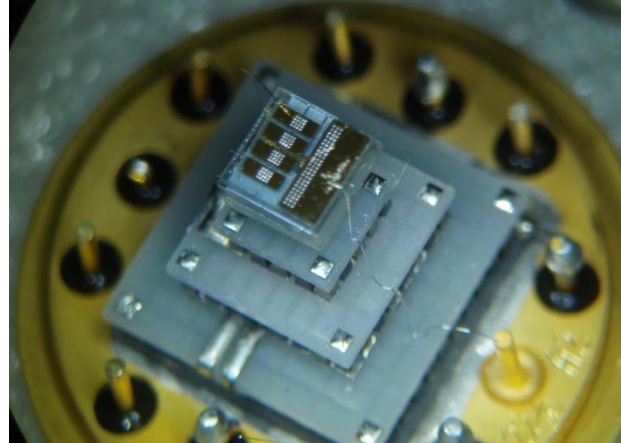


Figure 16. Aluminium wire bonded to Au pad, particular TE stages and TO8 pin. Picture (a) presents two stage TE cooler and (b) four stage TE cooler.

**Pictures from WP6 section:**

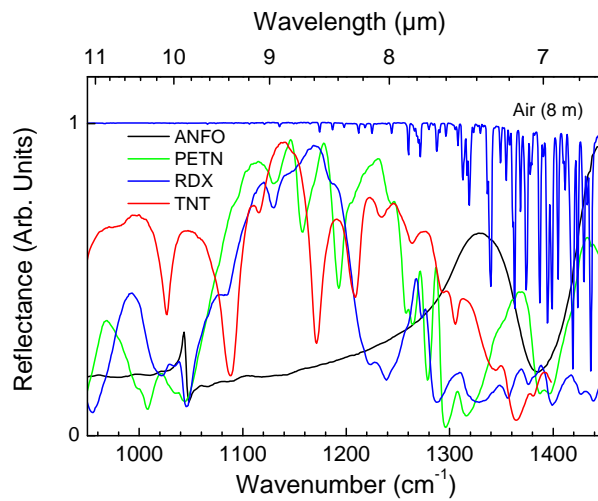


Figure 17. Typical backscattering spectra of various explosives



Figure 18. Left: closed EC-QCL module Right: view into interior of EC-QCL module showing the optical grating that is used as wavelength selective element and is mounted on a rotation stage.





Figure 19. The backscattering spectroscopy system developed within the EMPHASIS project.



Figure 20. Wavelength range extension by addition of a second laser illumination source covering the range between  $1000\text{ cm}^{-1}$  and  $1100\text{ cm}^{-1}$ . The two beams were overlaid using a dichroitic mirror at  $1100\text{ cm}^{-1}$

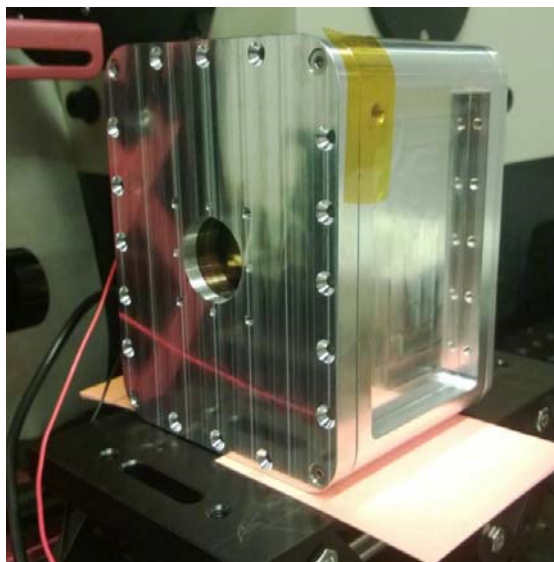


Figure 21. VTT developed an electronically tuneable filter working in the UV-range.

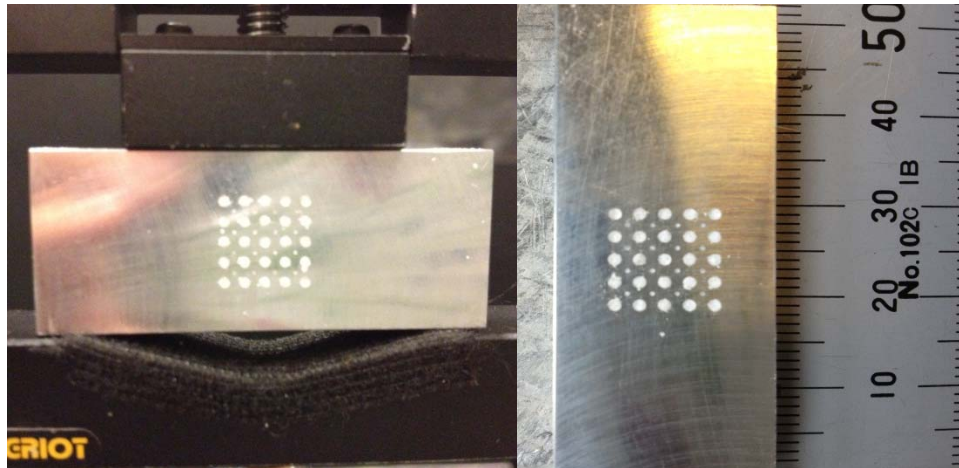


Figure 22. Test plate consisting of 41 drilled holes with two different diameters, the larger ones 1 mm and the smaller ones 0.3 mm. The holes are filled with mortared ammonium nitrate. Larger holes contained approximately 500  $\mu\text{g}$  while the smaller contained  $<50 \mu\text{g}$ .

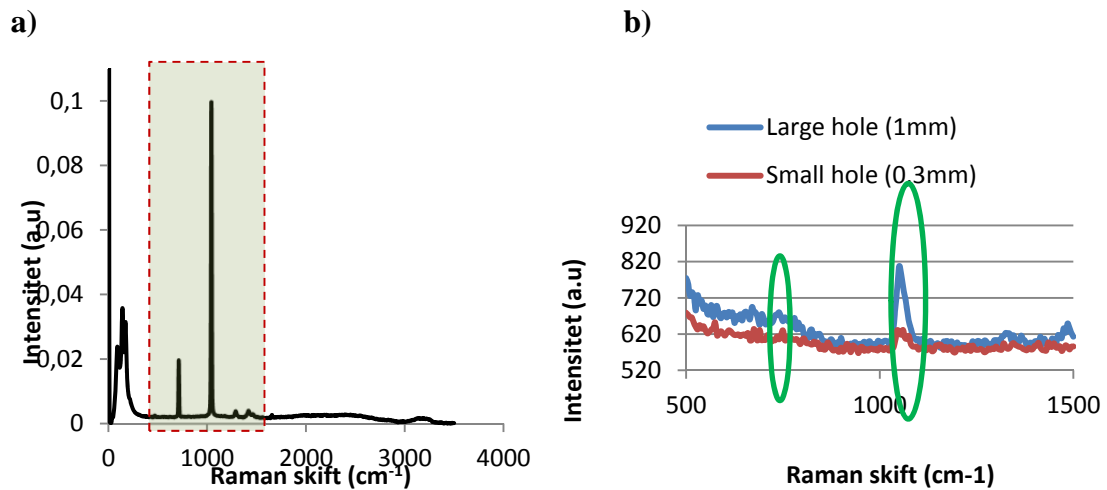


Figure 23. a) Ammonium nitrate reference spectrum acquired with Bruker IFS Raman spectrometer with a 1064 nm laser. The reference spectrum reveals that ammonium nitrate has two distinct peaks, one at 715  $\text{cm}^{-1}$  and the other one at 1043  $\text{cm}^{-1}$ . The interesting spectral span for our analyses is 500 -1500  $\text{cm}^{-1}$ . b) Spectra extracted from the hyperspectral image cube from a large hole (blue) and a small hole (red). It is possible to detect (stand-off) ammonium nitrate in both large and small holes.

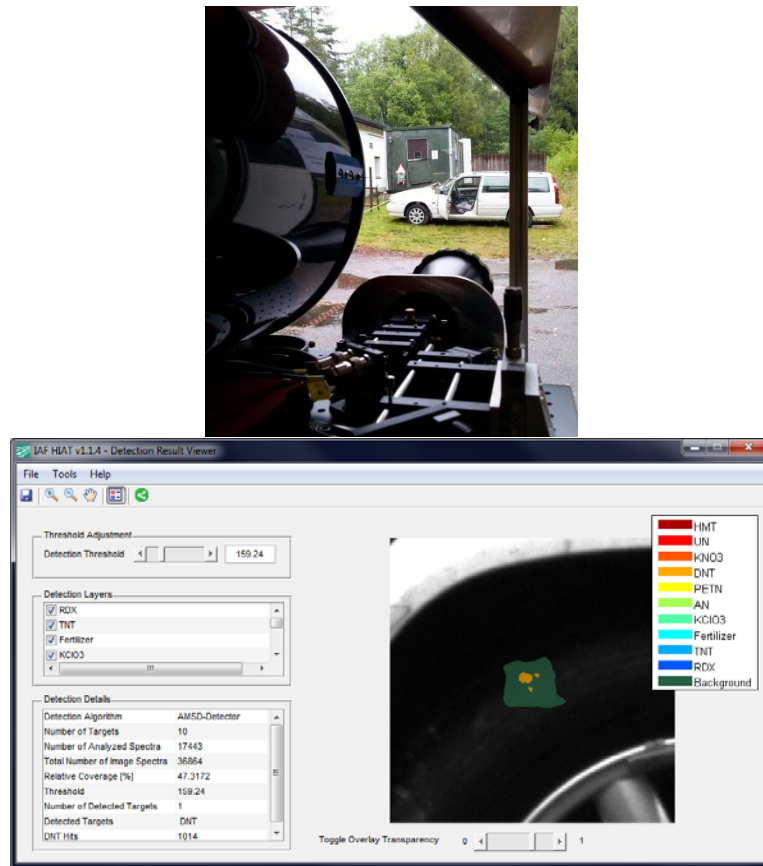


Figure 24. Left: sensor setup. The target substances were deployed on parts of a parked car at a distance of about 15m. Right: detection result. The system detected the DNT contamination (precursor of TNT) placed on the tire. No false alarms for competing substances were generated.

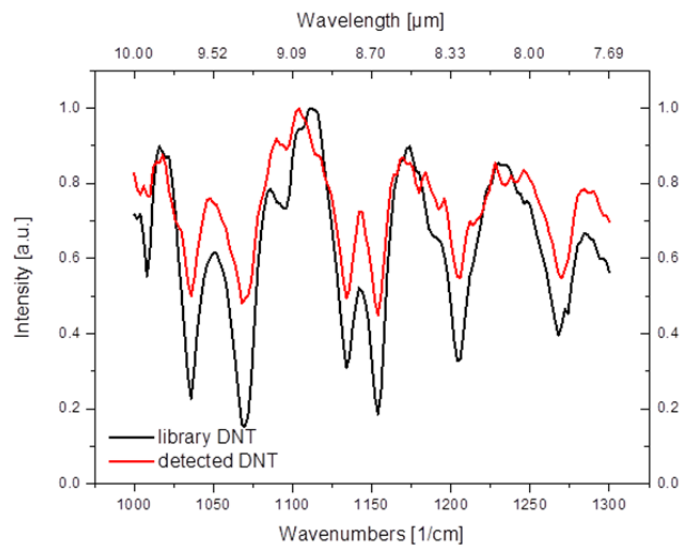


Figure 25. Red line: Spectrum of DNT. The black line is the DNT spectrum from our library of target materials. Excellent match is observed.

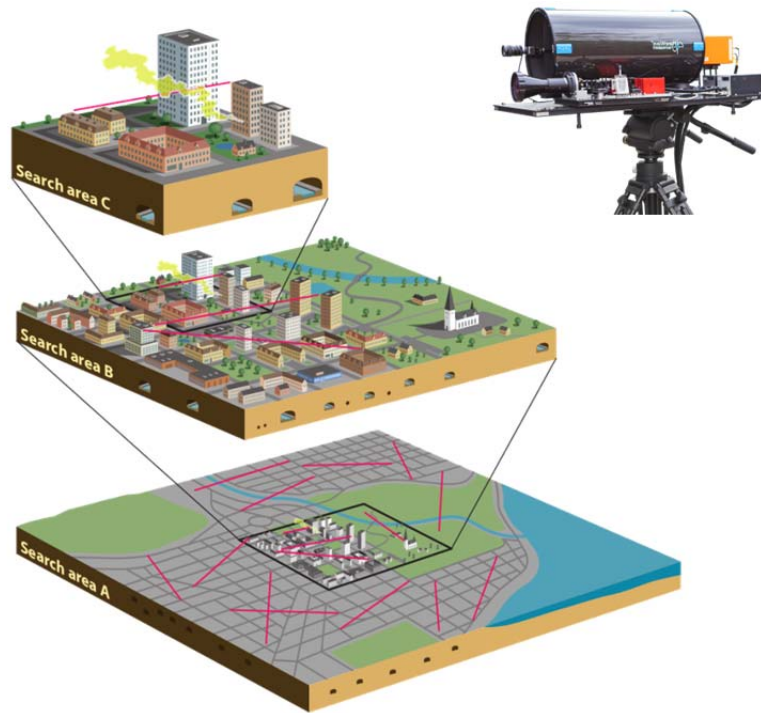


Figure 26. The mobile IR imaging spectroscopy sensor was realized to be operational in search area c of the EMPHASIS sensor network.

#### Pictures for WP7 section



Figure 27. One of the transceivers tested



Figure 28. Field-trial with GSM based equipment

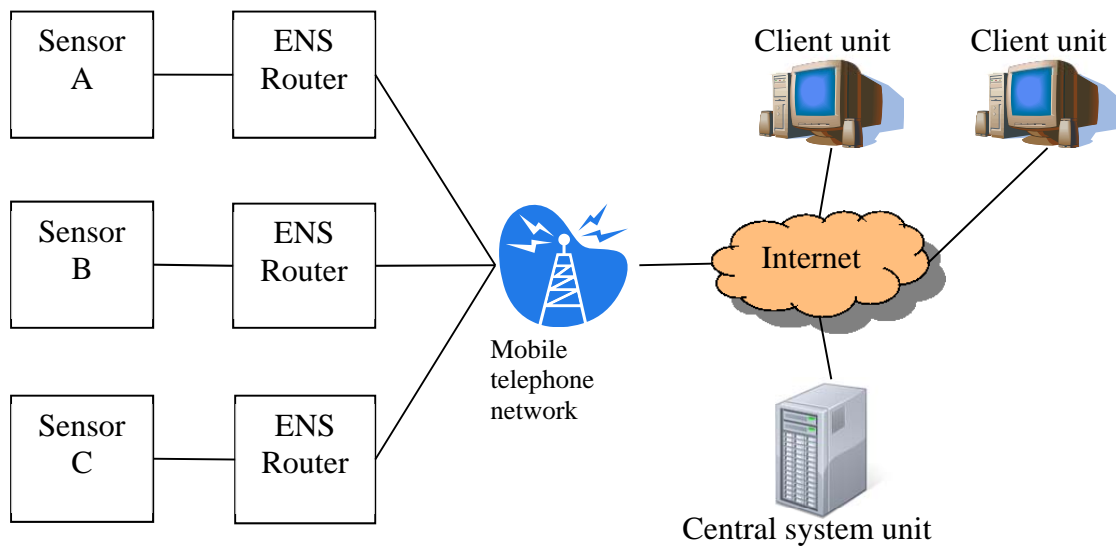


Figure 29. Emphasis Network System overview



Figure 30. Router hardware

**Pictures for WP8 section**

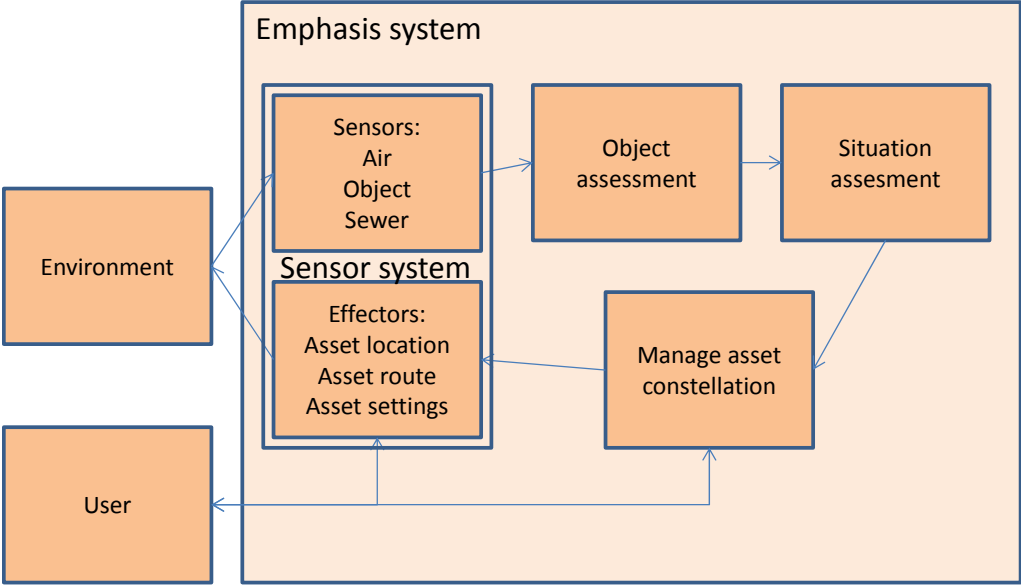


Figure 31. System architecture.

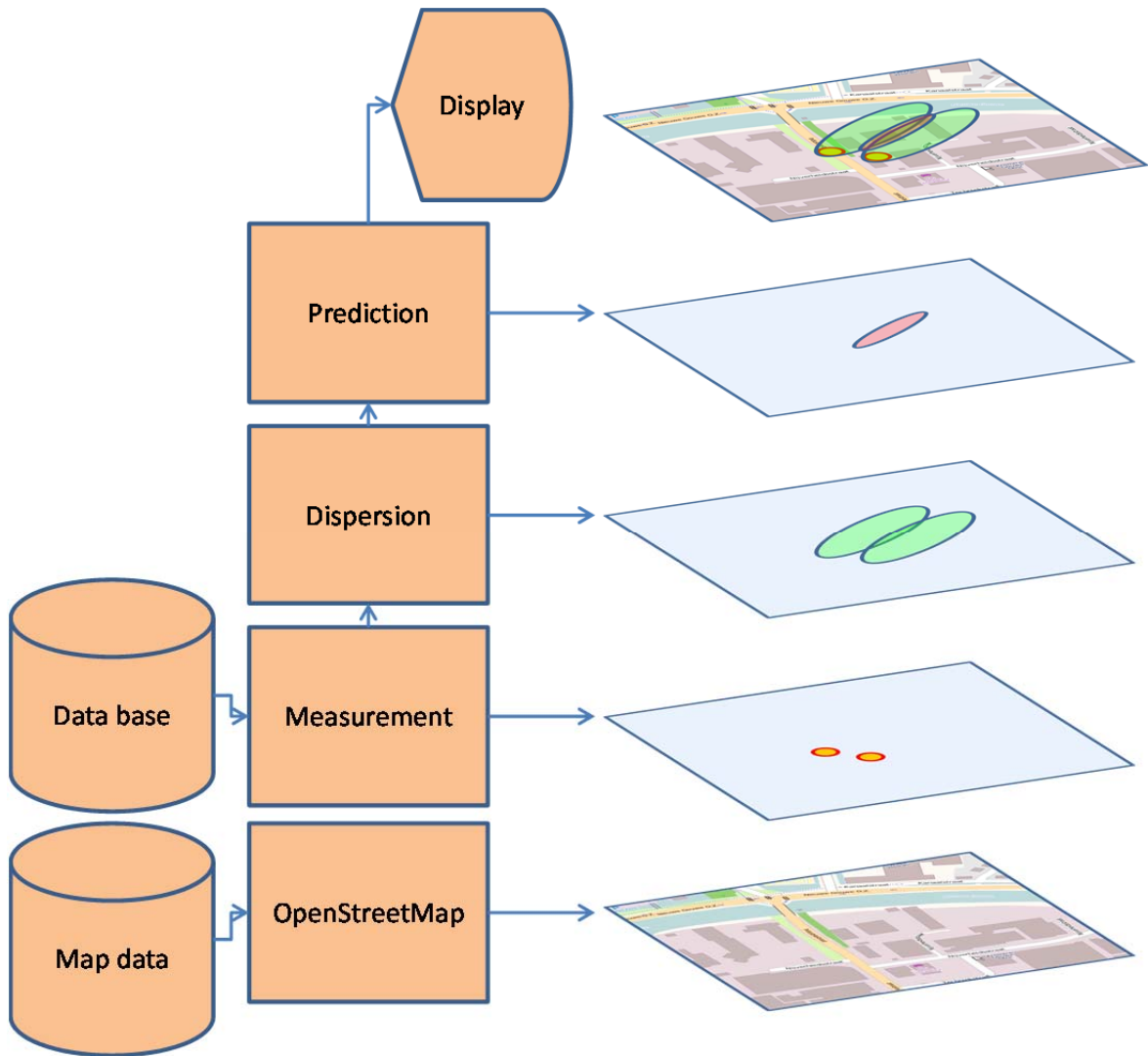


Figure 32. Emphasis Central System implementation.

**Pictures for WP10 section**



Figure 33. Photos from preparation work and the experimental validation event.





Figure 34. The RERS setup and the cabin outside of the laboratory.

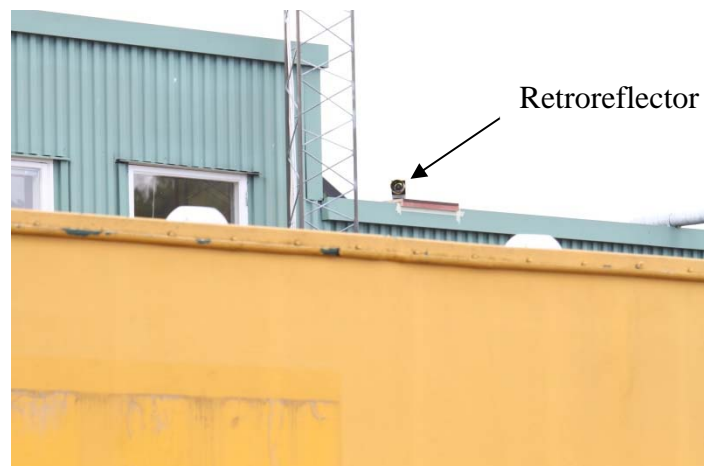


Figure 35. An open path system deployed during the EMPHASIS demonstration for IR detection.



Figure 36. EMPHASIS sewer sensor; Concept and deployment in sewer.

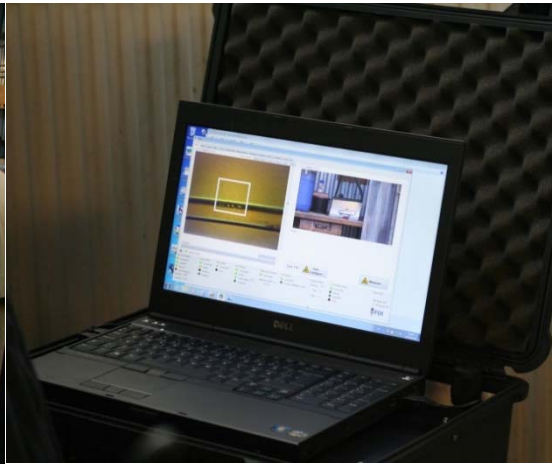


Figure 37. The imaging Raman setup during the demonstration.

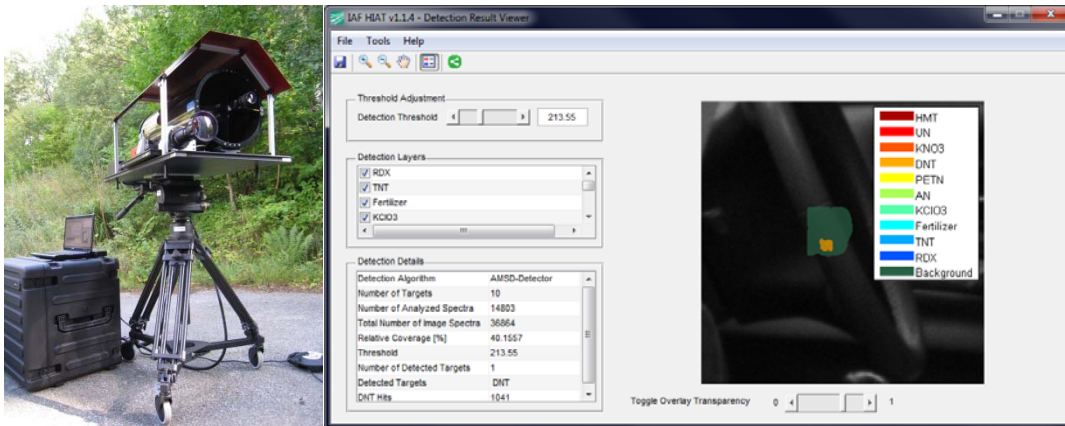


Figure 38. Left: sensor setup. The target substances were deployed on parts of a parked car at a distance of about 15m. Right: detection result. The system detected the DNT contamination (precursor of TNT) placed on the steering wheel. No false alarms for competing substances were generated.



Figure 39. The BONAS Sensor Network and C2 Centre (right side) integrated and shared in the common Centre of Control with the EMPHASIS project (left side).

### Emphasis central system

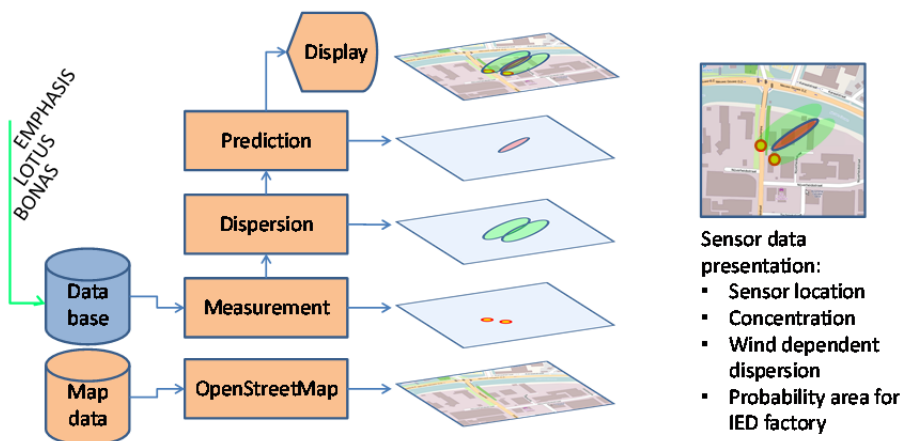
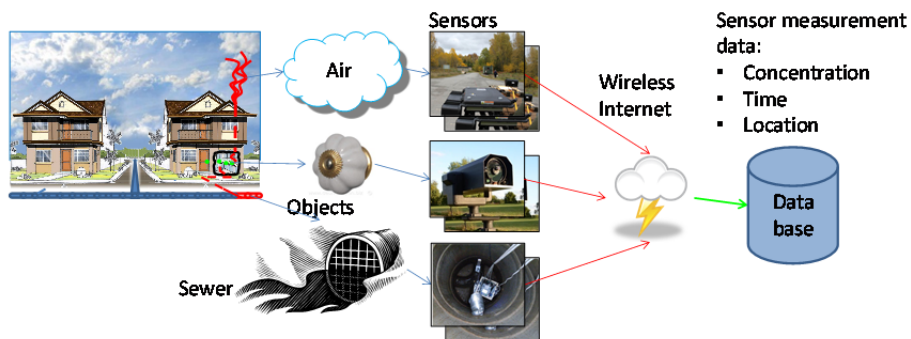


Figure 40. EMPHASIS Central System Architecture



Figure 41. Photos from the demonstration including some of BONAS and EMPHASIS sensors.

Project website, project logo and all partner logos.

<http://www.emphasis-fp7.eu>

EMPHASIS 



**TNO**



**Fraunhofer**

ICT



**Fraunhofer**

IAF



**SAFRAN**

Morpho



EMPHASIS is a collaboration between:  
FOI | TNO | Fraunhofer ICT | Fraunhofer IAF | Cascade Technologies |  
MORPHO | Institut National de Police Scientifique | VIGO

