R&D projects liaisons

- *exchange of information between the projects in terms of application scenarios and interoperability of proposed solutions*
- *newsletter/brochure, including a reference to other project*

Links to other initiatives and EU projects

- **CUSTOM project.**

The project will focus on employing multiple techniques, integrating them in a complex system which employs them in a complimentary approach in order to identify an optimum trade-off between opposite requirements: compactness, simplicity, low cost vs. sensitivity low false alarm rate, selectivity. Known techniques, as fluorescence will be improved by mean of novel proteins, as antibodies to extend Probability of Detection (PoD)

- **FORLAB project.**

FORLAB goal is to guide in the investigation of a scene after the blast of an improvised explosive device (IED). The key innovation is the establishment and maintenance of a dynamic, real-time self-adaptable feedback loop between the data collection process at explosion scene and the data repository, with the aim of reducing the number of collected samples, improving the capability to recreate the scenario and fine-tuning the screening process.

- **BONAS project.**

The aim of BONAS is to design, develop and test a novel wireless sensors network for increasing citizen protection and homeland security against terrorist attacks, in particular against the threat posed by IED devices. The sensor network will focus on the detection of traces of precursors used in IED production (particulates, gases and/or waterborne) present in the environment surrounding the vicinity of a 'bomb factory'

DIRAC Consortium

Consortium as a whole

The DIRAC consortium consists of ten partners from six countries (Italy, Germany, Switzerland, Romania, Belgium, and Finland), and includes two Universities (UNIL, UDJG), three public research centres (FRAUNHOFER, CNR IMM, INSTM), one private research centre (CREO), two large enterprises (EADS and SELEX-SI), and two public bodies (NICC and NBI).

Many partners have already cooperated in the past, this leading to an ease in the exchange of information and transfer of know-how.

Partner		Logo	Core expertise	Key tasks in the project
CREO	*Centro Ricerche Elettro Ottiche*	CREO	Electro-optical sensors	**Coordination; Development of the sensor system and of the sensing strategy**
FRAUNHOFER	*Fraunhofer Institute for Physical Measurement Techniques IPM*	Fraunhofer IPM	Methods of analysis based on IRAS, through HF and QCL implementation	**Development of the HF-IRAS module**
CNR IMM	*Centro nazionale Ricerche Istituto per la Microelettronica e Microsistemi*	CNR - IMM Bologna	Silicon micro-machined devices	**Development of the micro-fabricated preconcentration and GC modules**
INSTM	*Consorzio Interuniversitario nazionale per la Scienza e Tecnologia dei Materiali*	INSTM	Supramolecular chemistry and sensors for selective trapping and detection of organic compounds	**Development of the techniques and procedures that allow selective trapping of the ATS**
UDJG	*Universitatea Dunarea de Jos Galati*	UNIVERSITAS GALATIENSIS	Chemiometric methods, particularly applied to the analysis of GC-FTIR spectra of ATS material	**Development of the Expert System**
EADS	*European Aeronautic Defence and Space Company*	EADS	Sensors and sub-assemblies for Defence&Security	**Development of the sampling module and of the SI detector array**
SELEX-ES	*Selex Sistemi Integrati*	Selex ES	Information technologies and systems	**Development of the system software and of the Human-Machine Interface**
UNIL	*Université de Lausanne*	Unil UNIL | Université de Lausanne	Methods of analysis and profiling of illicit drugs and precursors	**Definition of the test plan and benchmarking/lab-validation of the sensorsystem**
NBI	*National Bureau of Investigation*	NBI	Analysis of waste and seized material, in tight cooperation with law enforcement authorities	**Review of target chemicals; support to the definition of sensing procedures**
NICC	*Nationaal Instituut voor Criminalistiek en Criminologie*	NICC INCC	Analysis of waste and seized material, in tight cooperation with law enforcement authorities	**Review of end users' needs and final assessment of system performance; *link* between the consortium and the *group of experts***

Contact: **Sandro Mengali (CREO)**
Website: www.fp7-dirac.eu
e-mail: info@fp7-dirac.eu
Phone: +39 0862 346.1
Mobile: +39 393 9113338
Address: s.s. 17 loc. boschetto
67100 L'Aquila - Italy

Brochure Issue:
01/B
January
2014

DIRAC

rapid screening and identification of illegal **D**rugs by **IR A**bsorption spectroscopy and gas **C**hromatography

This work has been supported by the European Commission under the 7th Framework Programme through the Project SEC-242309

DIRAC

DETECTION AND IDENTIFICATION CAPACITIES:

The DIRAC sensor will be fully functional, from sampling to read-out. In order to better match the operational constraints of real use on the field, and to allow control officers to take rapid and efficient decisions, its output will be in the form of 'levels of attention/alarm', such as:

- Negative Response;
- Positive Response to illicit drugs;
- Positive Response to controlled precursors;
- Response of Similarity to an illicit drug.

FP7 PROJECT "DIRAC"

PROJECT OVERVIEW

The goal of this project is to develop an advanced sensor system, that combines miniaturized Gas Chromatography (GC) as its key chemical separation tool, and Hollow-Fiber-based Infra Red Absorption Spectroscopy (HF-IRAS) as its key analytical tool to recognize and detect illicit drugs, key precursors and potential derivatives. The DIRAC sensor will be developed to be used on the field primarily by customs officers for controls at the EU external frontiers and by law enforcement personnel for intra-Community checks as a rugged and hand-portable unit;

The DIRAC sensor will perform rapid detection of key chemicals,

rejecting interferents with minimal false positive alarm rate;

perform advanced data analyses . DIRAC sensor will also perform advanced data analyses such as similarity evaluation between the chemical structure of the unknown sample with that of controlled/illicit substances

PROJECT OBJECTIVE

The Overall Objective of the project is the development of an advanced sensor for the detection and identification of illicit drugs and key precursors. This sensor is a complex instrument that consists of a number of building blocks, that is logical/physical units with their own processing techniques and procedures.

EXPECTED RESULTS

The main output of the project will be the initial prototype of a sensor capable to provide real support to customs officers in their daily fight against the trafficking and distribution of illicit drugs. The prototype is therefore expected to show:

- Reliability (ability to reject interferents);
- Hand portability;
- Fast response (few minutes)
- Good sensitivity (tens of nano-grams or better);
- Broad chemical spread (sensitivity towards different drugs and precursors);
- Identification capacity, (ability to distinguish one target compound from another at least on a family base).

Major components list

The DIRAC system consists of the following main units, modules and sub-assemblies:

Sampling Unit:

- Vacuum cleaner
- EPS
- On board electronics, enclosure

Sensing Unit

- Preconcentrator/injector/GC
- HF-IRAS module
- SI detector
- On board electronics and enclosure

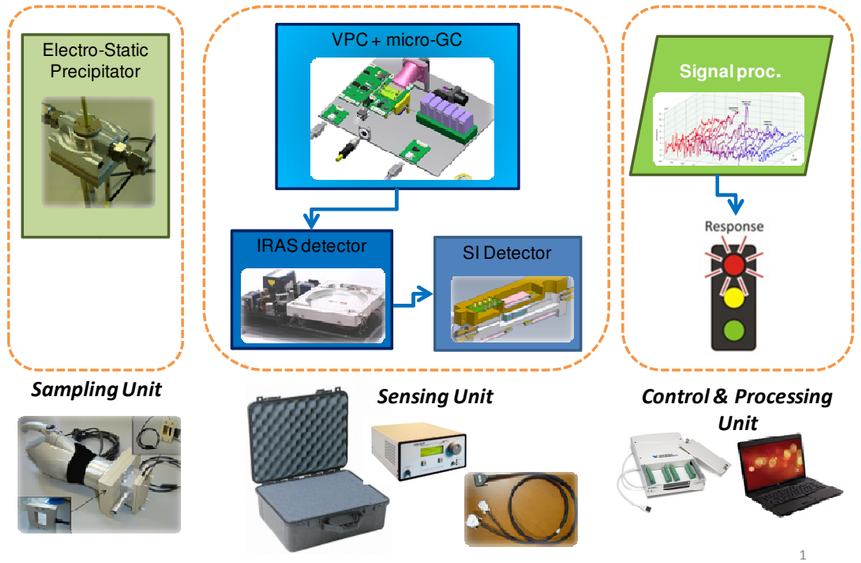
Processing and Control Unit:

- PC (equipped with analysis SW and HMI)
- Onboard electronics and DAQs (optional)

Power module

External interface connectors

DIRAC System Layout



Measurement Concept

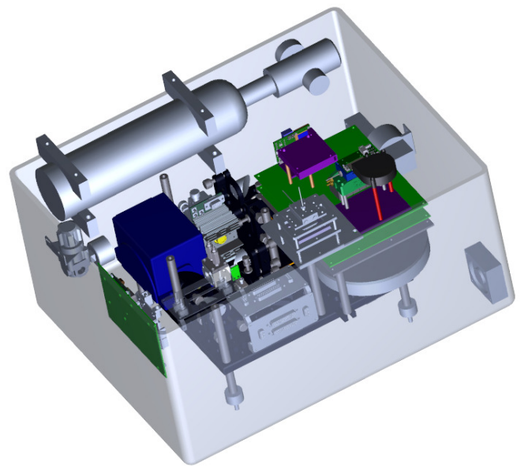
DIRAC combines miniaturized Gas Chromatography (GC) as its key chemical separation tool, and Hollow-Fiber-based Infra Red Absorption Spectroscopy (HF-IRAS) as its key analytical tool to detect and identify amphetamine type stimulant (ATS) illicit drugs and their precursors.

While GC-IRAS is, together with GC-Mass Spectrometry, the most powerful technique for the identification and quantification of amphetamine, so far it has been implemented only as bench-top instrumentation for forensic applications and bulk analysis. In DIRAC, the use of micro-machined GC columns, solid state lasers, and IR hollow fibers, will allow to implement a sensor that features hand-portability and prompt response for field operation, and is capable to perform both bulk and trace analysis.

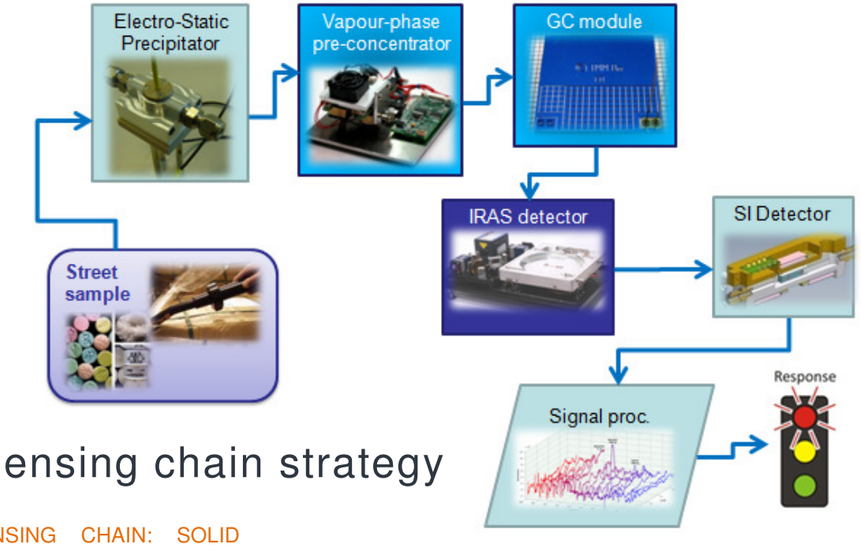
The DIRAC sensor will further feature a) an advanced sampling device, that separates the analyte from larger amounts of materials by electrostatic charging; and, b), an advanced micro-machined pre-concentrator that treats sequentially both volatile ATS substances and non volatile ammonium salts.

Operation modes and outputs

The sensor will implement two alternative operation modes to provide (rapid) detection and (more time consuming) identification. In the detection mode, the output will indicate whether the sample is negative, positive, or non-negative. In the identification mode, the output will indicate the name or the class of non-negative substances present in the sample.



***DIRAC** prototype (3D model)*



Sensing chain strategy

SENSING CHAIN: SOLID PARTICLES

Solid particles are collected in an air flow. Particles with high proton affinity (as free amines) are precipitated out of the air flow by an electrostatic precipitator (EPS), that is by applying an electric field in the presence of a proton shower. The solid sample now available in the EPS is heated up, and vapours are sent to a vapour phase pre-concentrator (VPC). The VPC disposes of very volatile chemicals (such as solvents) and traps less volatile chemicals (particularly aromatic groups, that are present in all the ATS and precursors).

Upon heating, the VPC module releases the analyte to the GC column (for chemical separation), and to the IRAS module (form chemical analysis). Downstream of the IRAS module, the sample is still available to be analyzed by a SI detector.

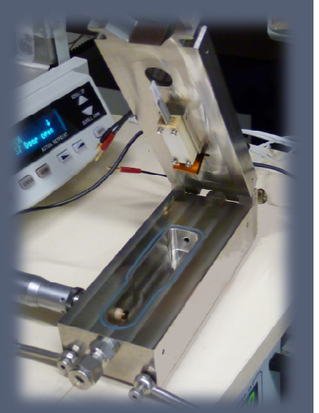
SENSING CHAIN: VAPOURS

In the case of vapours (present in the air, or in the headspace of a tank) there is no need of the EPS: the analyte is directly sucked into the VPC. The rest of the sensing chain (separation and analysis) is the same for particles and vapours. For precursors (pure chemicals) the separation could be bypassed for early detection and identification

Prototype and manufactured components

Identification Unit

SI detector (courtesy of EADS)



SENSING STRATEGY

DIRAC will be capable of treating samples of different chemical and physical nature by means of different sensing chains

SIMPLIFIED SENSING CHAINS

The partners have agreed to consider the implementation of two simplified sensing chains and prototypes that could be delivered and tested in the final DEMO together with the main all-inclusive DIRAC prototype

SIMPLIFIED SENSING CHAINS FOR SALTS

Alumina plate and desorption chamber are coupled directly to SI detector. Detection is fast. Presence of cavitands guarantees selectivity towards amines (and, in particular, methyl amines.

SIMPLIFIED SENSING CHAINS FOR PRECURSORS

This sensing chain bypasses chemical separation and can provide early detection and identification of pure chemical (for example precursors sampled from the headspace of a tank).