Project Area 13: Secure Societies

Topic 1 Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)

Subtopic 1.1 - *Cyber-physical security of critical infrastructures*
Contact: Felicita Di Giandomenico, ISTI (felicita.digiandomenico@isti.cnr.it)

Development of a generic stochastic modelling framework for resilience-related analysis of Smart Grids

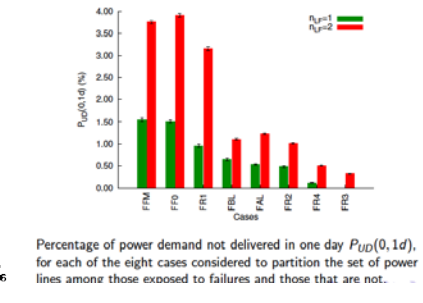- **To quantitatively assess** the impact of failures and attacks on the service provided
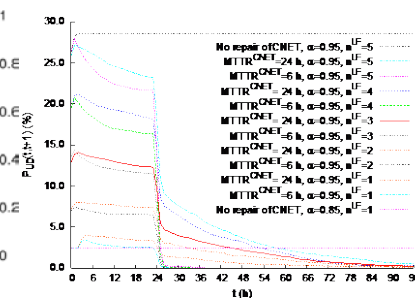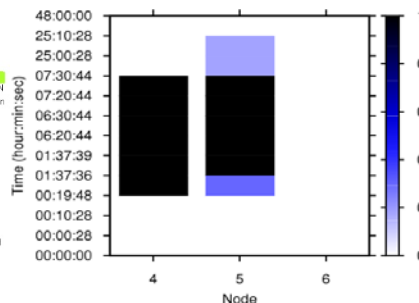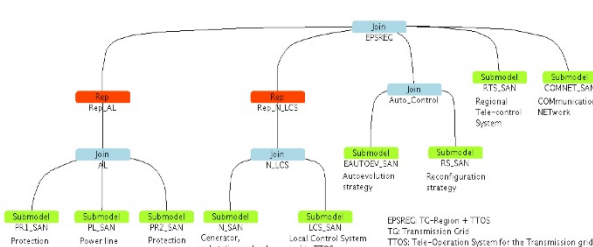 - Addressing variability in power generation (photovoltaic, wind turbines, ..)
  - Accounting for both (smart) cyber control and the grid infrastructure
  - Failure events due to both accidental causes and attacks
  - Interdependencies among system components (grid and cyber)

- **Useful to:**
  - Identification of critical system components (both at grid and control level)
  - Definition of guidelines to improvements
  - Potential extension to other CI (water, gas, …)

- **Emerging research challenges include:**
  - Ability to address large interconnected systems (realistic grid scenarios)
  - Trade-offs optimizations among contrasting system properties (e.g., safety, availability, security)
  - Accounting for evolution of system components behavior/structure

Percentage of power demand not delivered in one day $P_{UD}(0,1d)$, for each of the eight cases considered to partition the set of power lines among those exposed to failures and those that are not.

Project Area 13: Secure Societies

Topic 1 **Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)**

Subtopic 1.1 - *Cyber-physical security of critical infrastructures*
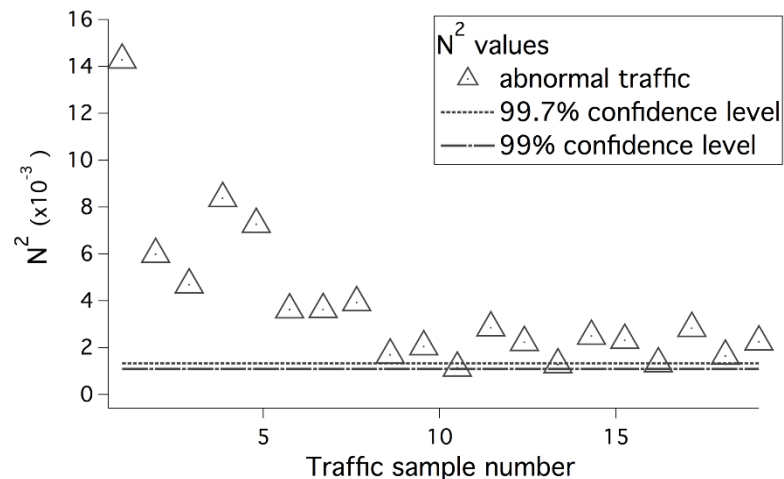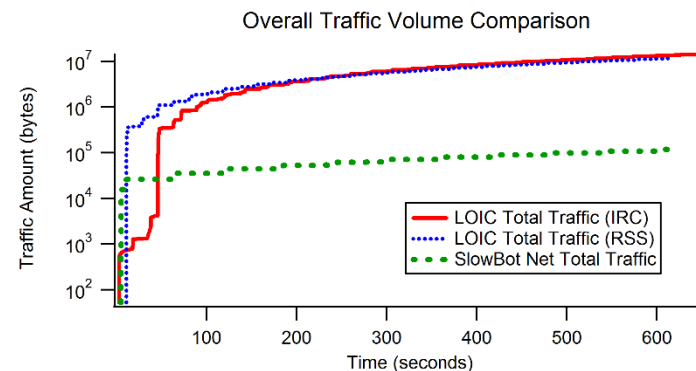Contact: Maurizio Aiello, IEIIT (maurizio.aiello@ieiit.cnr.it)

In order to enhance cyber-physical security of critical infrastructures, the activities of the group are related to the detection of possible vulnerabilities in critical system.
Usually, it is a two step process:
1. Initially, vulnerability assessment and penetration testing activities are performed, using tools able to analyze services and applications exposure to possible exploit
2. Hence, countermeasures are implemented in order to protect the system and prevent malicious users from accessing or exploiting it

The implementation of such topic involves advanced investigation on cyber-attacks against critical infrastructure environments:
- Research activities on innovative and last generation cyber-attacks
- Design and development of detection and mitigation algorithms against advanced and emerging threats

Overall Traffic Volume Comparison

LOIC Total Traffic (IRC)
LOIC Total Traffic (RSS)
SlowBot Net Total Traffic

N^2 values
△ abnormal traffic
········ 99.7% confidence level
─·─ 99% confidence level

Project Area 13: Secure Societies

Topic 1 Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)

Subtopic 1.2 - *Safety of critical infrastructures and built environment*
Contact: Valeria Di Sarli, IRC (valeria.disarli@irc.cnr.it)

Process safety - Loss of control of chemical systems: runaway phenomena; instabilities of chemical processes; industrial toxicology

Combustion safety - Explosion phenomena of gas/vapor, dust and hybrid (dust-gas/vapor) systems; propagation and extinguishment of industrial fires; response of materials to fires; propagation of wildland fires on a landscape

Risk assessment - Methodologies for Na-Tech, domino effect and security; land use planning for industrial sites and forest management; methodologies for the analysis of industrial and natural hazards
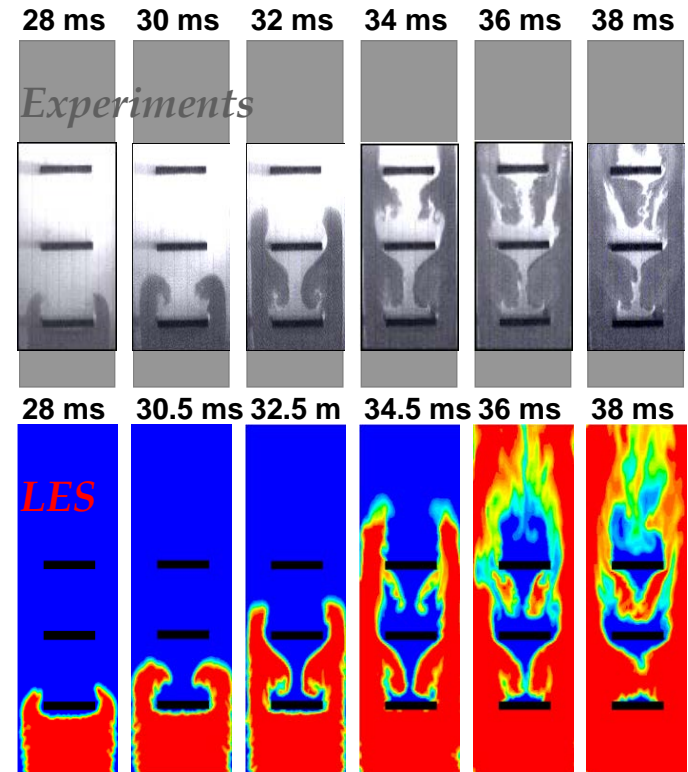
High-Speed Laser-Sheet Flow Visualization (HSLSFV) experiments and Large Eddy Simulation (LES) of flame propagation during an obstacle-aggravated gas explosion

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Topic 1 **Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)**

Subtopic 1.2 - *Safety of critical infrastructures and built environment*
Contact: Davide Calestani, IMEM   (davide.calestani@imem.cnr.it)

Detection and monitoring of leakages or unwanted release of CBRNE substances

remotely controlled and networks of:
- **sensors for gases and volatile substances**
  (metal-oxide nanostructure based sensors)
  - **sensors for liquids**
  (ion-selective conductive polymers)
- **spectroscopic X-ray detectors**
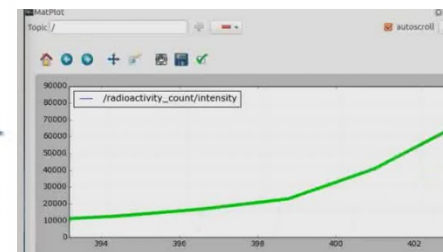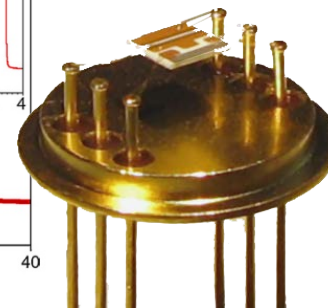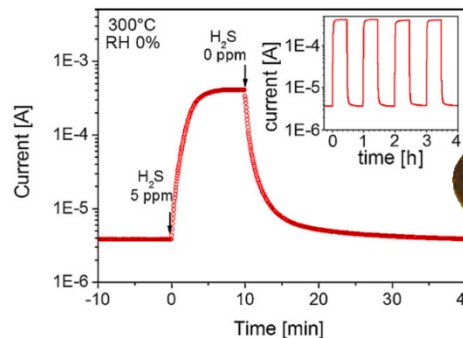 *(CdZnTe bulk crystal based detectors)*

sustainability of the process industry
----
effectiveness of land use planning and civil protection action

R I S K S

C B R N E

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<u>Topic 1</u> Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)

Subtopic 1.2 - *Safety of critical infrastructures and built environment*
Contact: Francesco Soldovieri, IREA (soldovieri.f@irea.cnr.it)

Integrated systems, based on electromagnetic sensing technologies, for a non-invasive long-term monitoring and quick damage assessment of the infrastructures and built environment

The integration of different sensing techniques enables a spatial-temporal monitoring of the structure at different scales, sampling periods, resolutions and depths of investigation.

At IREA-CNR, expertise in Synthetic Aperture Radar (SAR), in-situ radar and optic fiber sensors for diagnostics and monitoring.
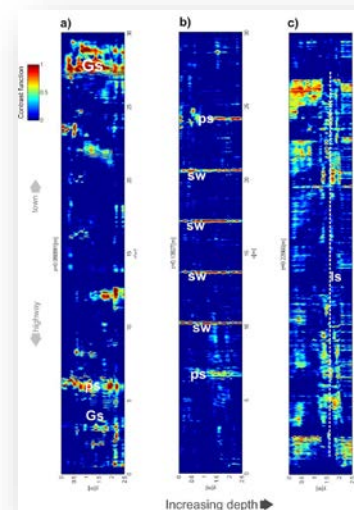
SAR technique allows a "global monitoring" meant as the monitoring not only of the infrastructure itself but even of the surrounding environment. The above monitoring is complementary to the "local monitoring" (i.e., the monitoring of the structure itself) offered by in-situ radar and optic fiber sensors

SAR monitoring of the displacement of a bridge

Optic fiber sensor for strain monitoring


Tomographic radar images of the inside of a structure

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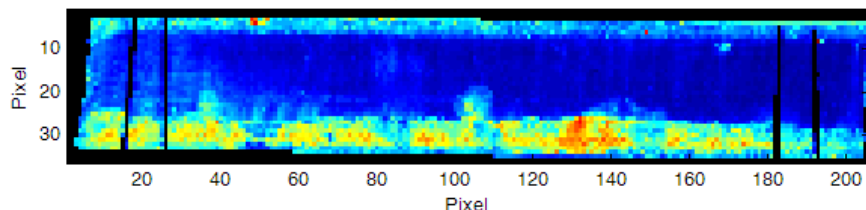**Topic 1** **Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)**

Subtopic 1.2 - *Safety of critical infrastructures and built environment*
Contact: Valentina Raimondi, IFAC   (V.Raimondi@ifac.cnr.it)
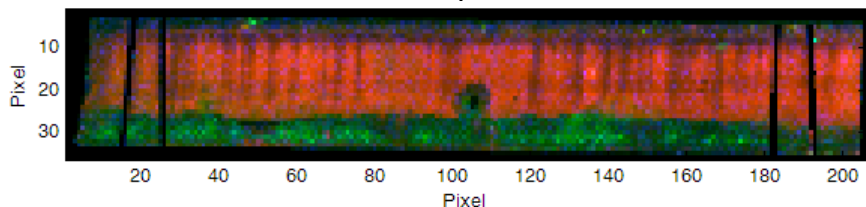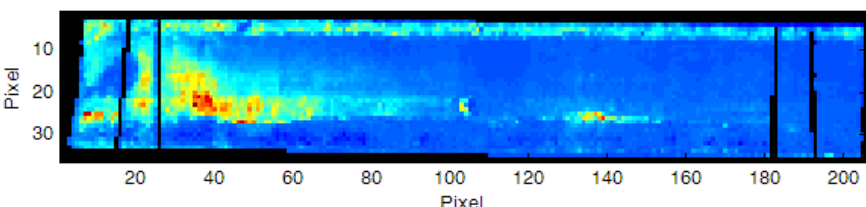
Concrete beam
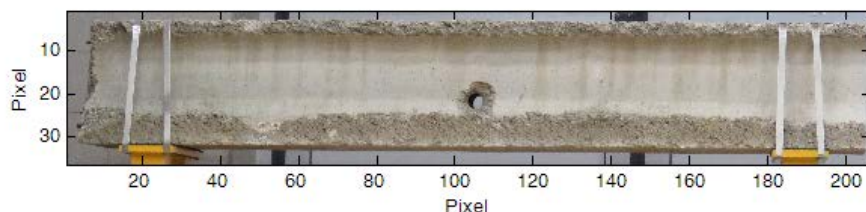
Damaged surfaces

Run-off paths

Microbiological patinas

Hyperspectral fluorescence LIDAR imaging and thermographic analysis as a non invasive diagnostic tool for built environment (e.g. railway bridges)

EXPERTISE
- ❖ **Design and construction of LIDAR systems**
- ❖ **Management of measurement campaigns**
- ❖ **Thermographic analysis for defect detection**
- ❖ **Physico-mathematical modelling of thermal processes.**

IMPACT
- ❖ **Integrated system for the diagnostics of railway bridges (3D laser scanner, fluorescence LIDAR and thermographic analysis)**

In collaboration with:

TE.SI.FER.
Tecnologie e Sistemi Ferroviari

DURAZZANI S.R.L.
TERRITORIO e AMBIENTE

Regione Toscana

FAS
Fondo Aree
Sottoutilizzate
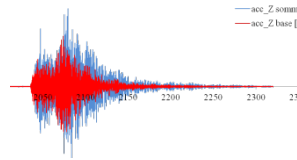2007-2013

REPUBBLICA ITALIANA
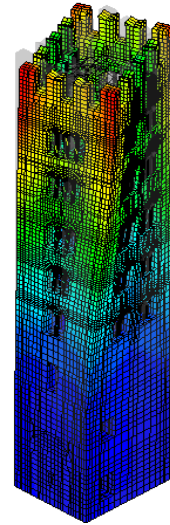
Project Area 13: Secure Societies

Topic 1 **Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)**

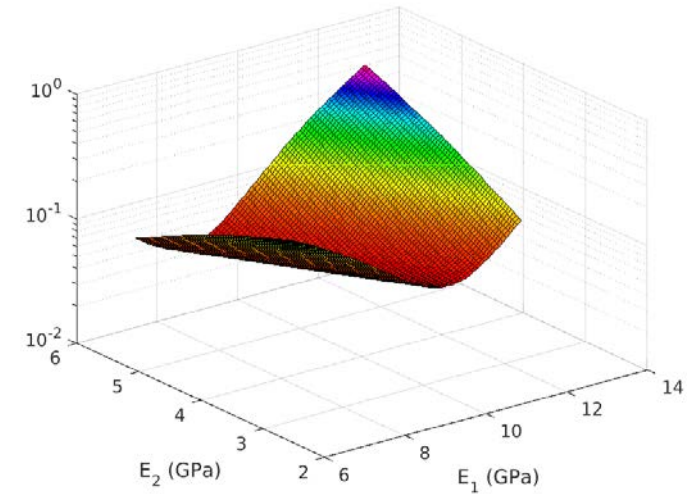**Subtopic 1.2 -** *Safety of critical infrastructures and built environment*
Contact: Felicita di Giandomenico, ISTI (felicita.digiandomenico@isti.cnr.it)
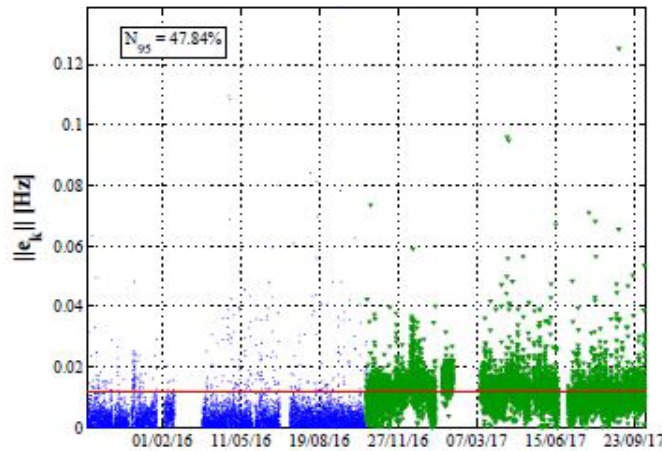

Structural health monitoring

Finite-element modelling

Model updating

Damage detection

NOSA-ITACA is a FE code specifically developed for the structural analysis of age-old masonry buildings and monuments.
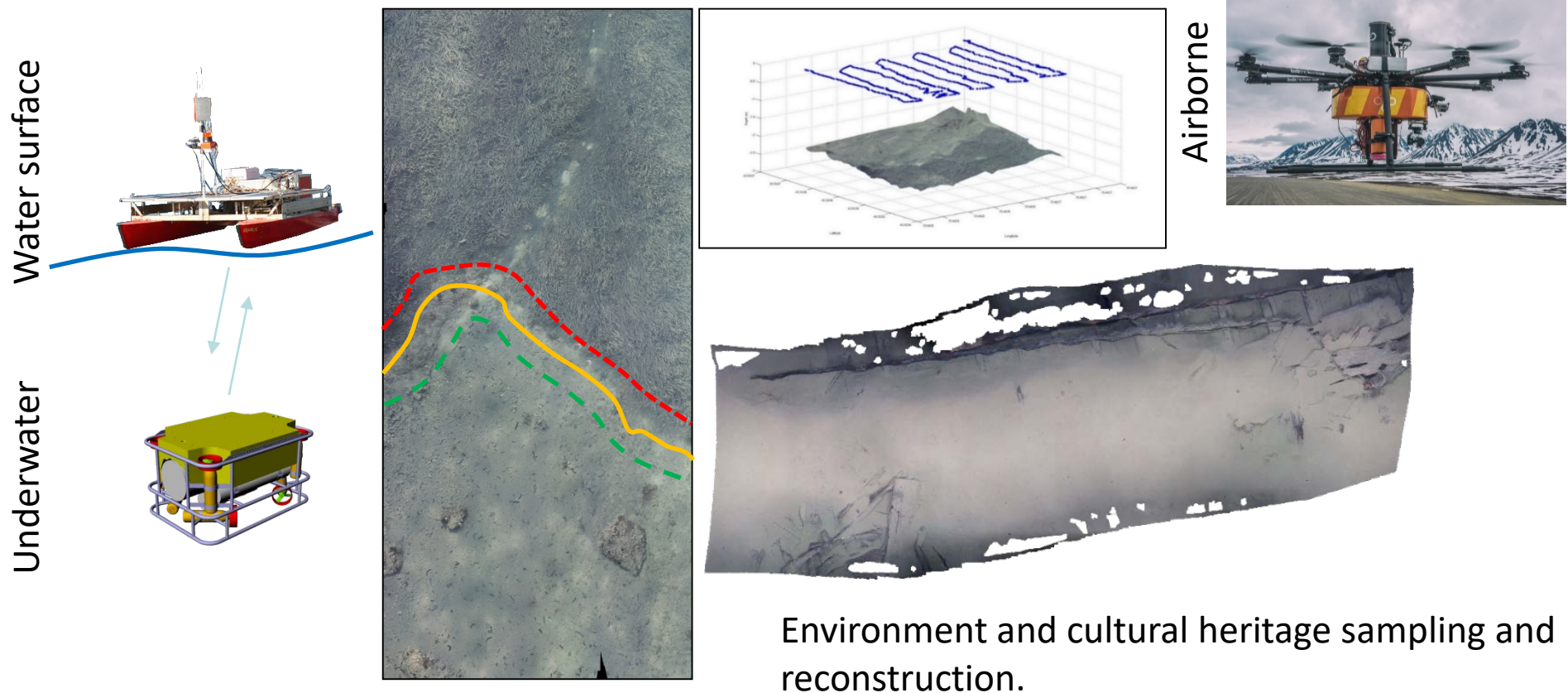It is freely downlodable at:

www.nosaitaca.it

Project Area 13: Secure Societies

Topic 1 Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)

Subtopic 1.2 - *Safety of critical infrastructures and built environment*
Contact: Marco Bibuli, INM (marco.bibuli@cnr.it)

Employment of heterogenous multi-vehicle system for automatic exploration, data gathering, rapid assessment of the environment

Water surface

Underwater

Airborne

Environment and cultural heritage sampling and reconstruction.

Project Area 13: Secure Societies

Topic 1 **Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)**

Subtopic 1.3 - *Improvement of the resilience for Built Environment and Urban Areas*
Contact: Daniele D'Agostino, IMATI (dagostino@ge.imati.cnr.it)

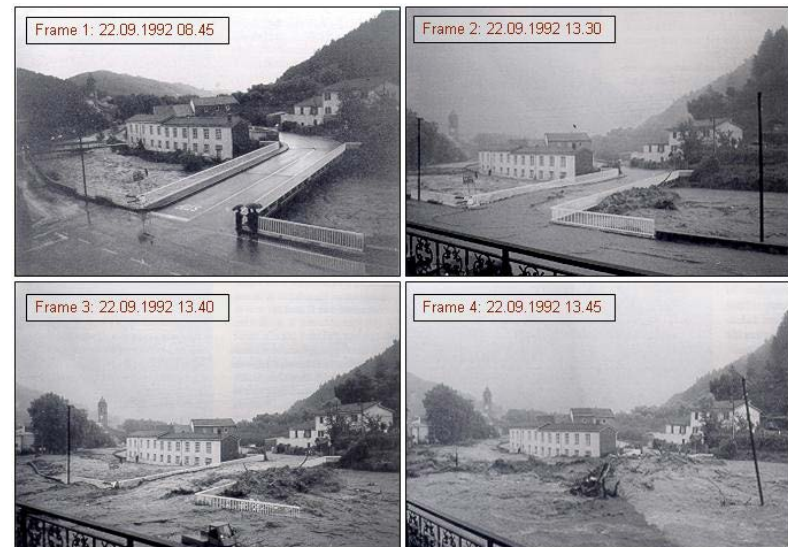**Objective: Improvement of the resilience for built Environment and Urban Areas**

- virtual research environments for the study of high-impact weather events (HIWE)
- modeling of big geospatial data
- environmental monitoring, hazardous event prediction, structural maintenance, quality control

Approach

- seamless integration of hydrometeorological modelling, computing and data services
- adoption of 3D scalar and vector fields to model and simulate the state and evolution of environmental parameters
- point clouds registration and surface analysis techniques for quality evaluation of naval hulls and damage detection of wagons
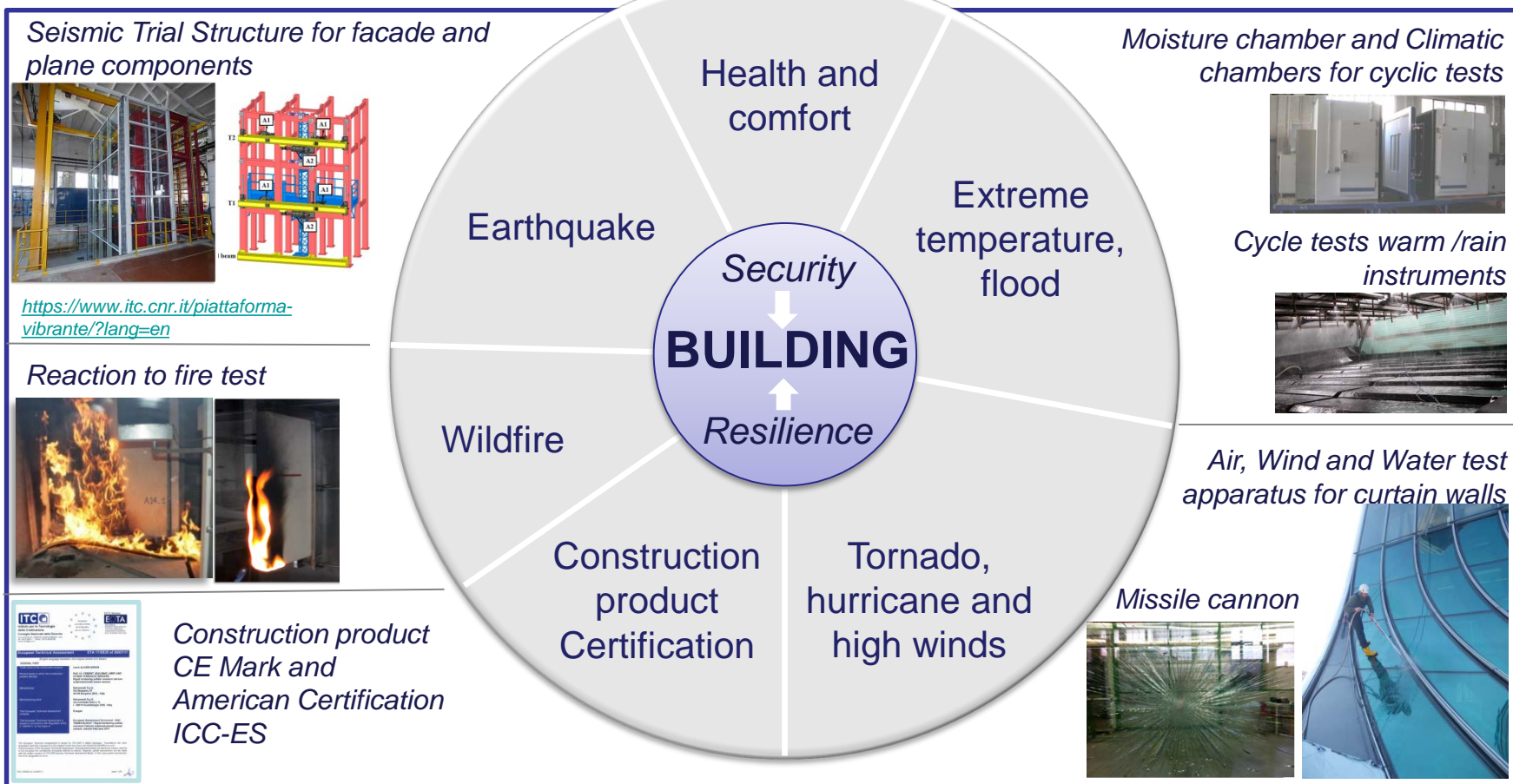
Impact

- Collaboration with Regione Liguria and ARPAL for environmental monitoring
- Members of the CNR leading team of the Competence Centre START4.0 (Sicurezza e Ottimizzazione di Infrastrutture Strategiche) funded by MISE
- Partner of international and national projects

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Topic 1 **Improvement of the Resilience for Critical infrastructures and Built Environment (including Cultural Heritage)**

Subtopic 1.3 - *Improvement of the resilience for Built Environment and Urban Areas*
Contact: Antonio Bonati, ITC (bonati@itc.cnr.it)

Seismic Trial Structure for facade and plane components

https://www.itc.cnr.it/piattaforma-vibrante/?lang=en

Reaction to fire test

Construction product CE Mark and American Certification ICC-ES

Moisture chamber and Climatic chambers for cyclic tests

Cycle tests warm /rain instruments

Air, Wind and Water test apparatus for curtain walls

Missile cannon

Diagram:
- Health and comfort
- Earthquake
- Extreme temperature, flood
- *Security* → **BUILDING** ← *Resilience*
- Wildfire
- Construction product Certification
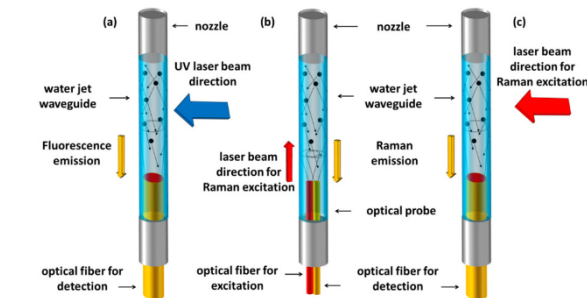- Tornado, hurricane and high winds

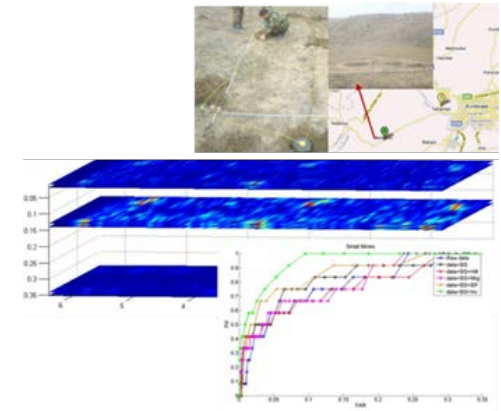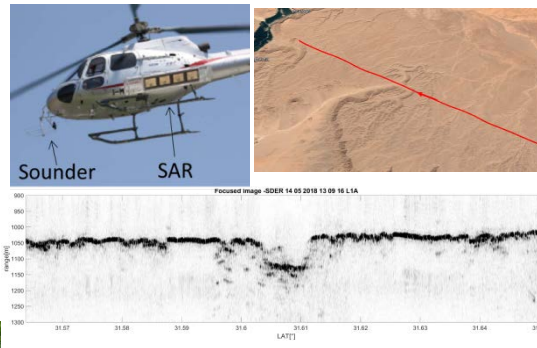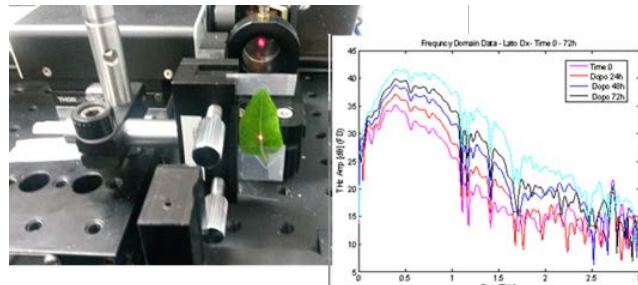# Project Area 13: Secure Societies

Topic 2 Fight against crime and terrorism

Subtopic 2.1 - *Physical threats detection*
Contact: Francesco Soldovieri, IREA (soldovieri.f@irea.cnr.it)
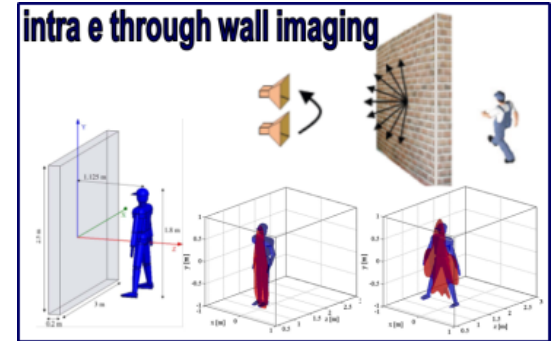
- **High resolution (full 3D) imaging approaches aimed from data gathered by means of down-looking and forward-looking ground penetrating radar systems, even mounted on moving vehicles and airborne platforms**
- **Radar system for drones for surveillance and crisis management**
- **Spectroscopy and imaging strategies for drugs and weapons detection, analysis of biological matter, materials quality controls with THz/mm wave resolution**
- **Sensors for water quality control (f.i.,contaminant detection)**
- **Passive and unconventional radars for people detection, localization and tracking**

intra e through wall imaging

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<u>**Topic 2**</u> **Fight against crime and terrorism**

Subtopic 2.1 - *Physical threats detection*
Contact: Davide Calestani, IMEM (davide.calestani@imem.cnr.it)

Detection and characterization of dangerous substances

► **advanced X-ray scanners** ◄
with improved capability to discriminate target
materials in baggage or goods controls
to identify dangerous or illegal material

systems for the
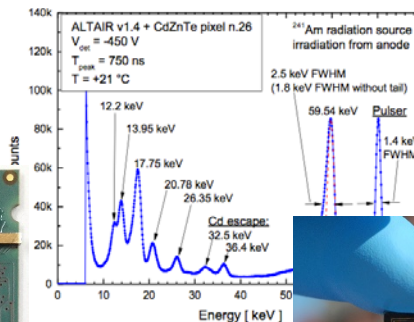► **detection of radioactive material** ◄
in terroristic actions

sensors for
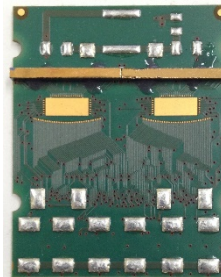► **dangerous and/or explosive substances** ◄
with improved
sensitivity, size, cost and power-consumption
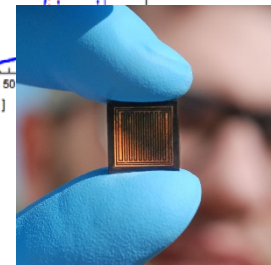(also for networks of stand-alone monitoring units)
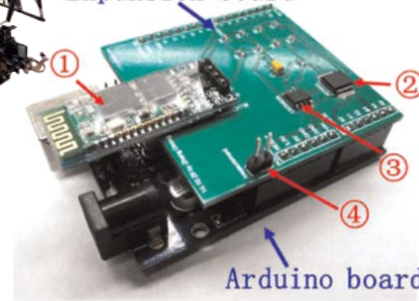

^{241}Am Spectrum Experimental Acquisition

ALTAIR v1.4 + CdZnTe pixel n.26
V_{det} = -450 V
T_{peak} = 750 ns
T = +21 °C

12.2 keV
13.95 keV
17.75 keV
20.78 keV
26.35 keV
Cd escape:
32.5 keV
36.4 keV

^{241}Am radiation source
irradiation from anode

2.5 keV FWHM
(1.8 keV FWHM without tail)

59.54 keV   Pulser
1.4 keV
FWHM

Energy [keV]

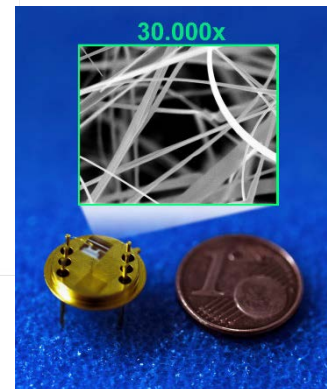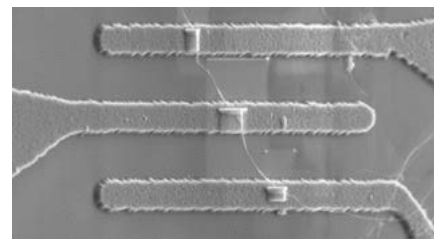CZT spectroscopic
scanner module

CZT radiation
detector

Expansion board
Arduino board

30.000x

oxide nanowire
gas sensor

germanium
nanowire
explosive sensor

Project Area 13: Secure Societies

Subtopic 2.2 - *Crisis management for large events*
Contact: Felicita di Giandomenico, ISTI (felicita.digiandomenico@isti.cnr.it)

- **Key challenges:**
  - Crowded areas and large events need technologies for monitoring and properly reacting to movement of people masses
  - Solutions for the collection and the processing of data, relevant to achieve this goal
  - Large, heterogeneous and decentralized computing architectures, as well as properly defined algorithms are fundamental to enable such processing

- **Approaches:**
  - Definition and development of smart and decentralized solutions matching the structure and the needs of the distributed and heterogeneous computing infrastructure (e.g. IoT devices, Clouds, Edge devices, …)
  - Approaches for the timely processing (filtering, analysis, …) of data collected "in the field"
  - Complex analytics and contextualized visualization of the collected data (trajectories, heatmaps, …)

- **Key Results:**
  - Solutions currently adopted and exploited for the management of people masses in DAS FEST (large music festival ~200 000 participants).

Project Area 13: Secure Societies

Subtopic 2.3 - *Social media analysis as support to crime prevention*
Contact: Maurizio Tesconi, IIT (maurizio.tesconi@iit.cnr.it)

MAIN CONTRIBUTION
- *Scalable algorithms for data ingestion and enrichment from popular social networks.*
- *Hate speech detection on textual contents.*
- *Users interaction analysis for behaviour modeling on social networks.*
- *Image analysis for user's face similarity recognition.*

IMPACT
- *A joint research center between Polizia di Stato and IIT-CNR (named CRAIM) allows technology transfer from Social Media research activities to LEA in order to support crime prevention; technology transfer and advanced consultancy on social media has been provided to Italian Security Information Department.*
- *Hate speech detection research produced scientific publications and annotated datasets.*

CHALLENGES
- *Research on Social Media faces increasing challenges in BigData gathering respecting evolving Data Use Policies and privacy regulations (e.g. GDPR).*
- *Linking of accounts on social networks for the same physical user.*

FUTURE WORK

- *Better integration of existing tools and systems based on social media data, also with regards to traditional systems; provide other scalable and useful analysis tools for crime prevention.*

MAIN EU/IT PROJECTS

- *CRAIM - Polizia di Stato Italiana, 800k€*
- *Sinapsi - Italian Security Information Department, 210k€*
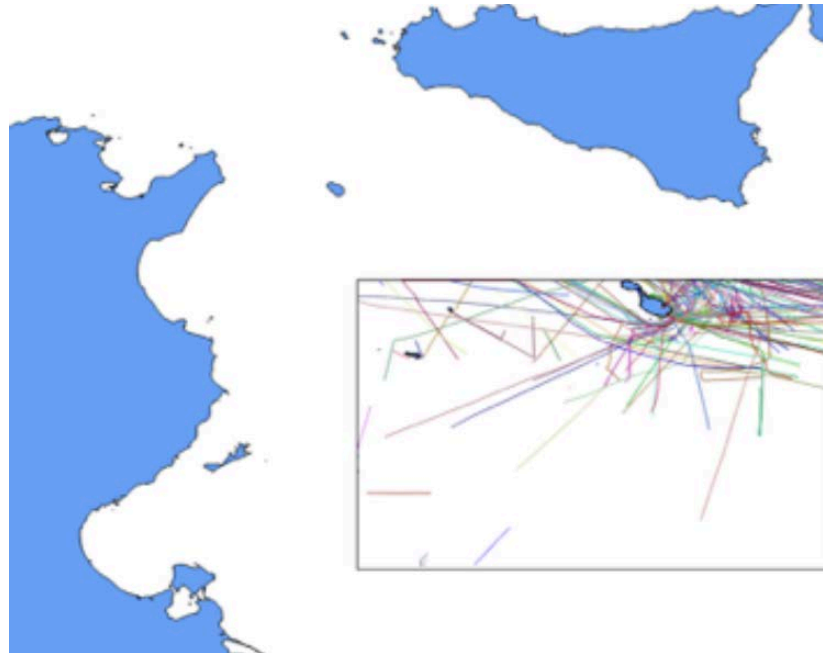
INVOLVED CNR INSTITUTES

- *IIT, ISTI*

Project Area 13: Secure Societies

Topic 3 **Border and maritime security**

Subtopic 3.1 -*Maritime/marine wide area surveillance*
Contact: Felicita di Giandomenico, ISTI (felicita.digiandomenico@isti.cnr.it)

- A maritime surveillance system based on spaceborne SAR and optical image analysis complemented with AIS data – ESA project OSIRIS (A. Marchetti, IIT and E. Salerno, ISTI)

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Subtopic 3.1 - *Maritime/marine wide area surveillance*
Contact: Marco Bibuli, INM (marco.bibuli@cnr.it)

Concept of integrated framework (system of systems) for autonomous and extended marine environmente observation, by means of cooperative fixed stations and mobile agents (both airborne and waterborne).

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Subtopic 3.1 -_Maritime/marine wide area surveillance_
Contact: Valentina Raimondi, IFAC (V.Raimondi@ifac.cnr.it)


Crude oil

Automotive Diesel

Marine Diesel

Oil spills detection and characterization by fluorescence LIDAR (fluorescence spectra and lifetime)

EXPERTISE
❖ Design and construction of LIDAR systems
❖ Laboratory and in-field experiments
❖ Ad-hoc algorithms design and implementation

IMPACT
❖ Research for ultra-compact LIDAR systems for easy installation on small platforms
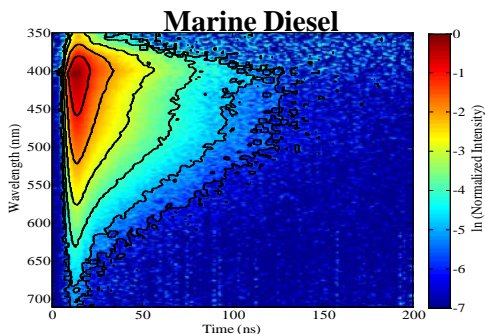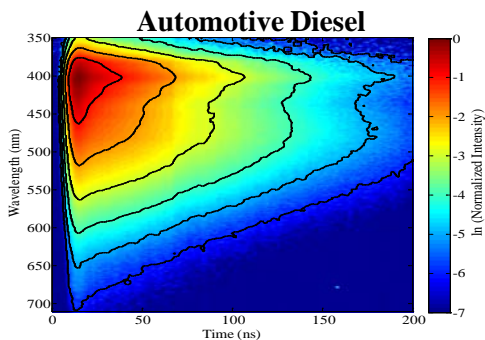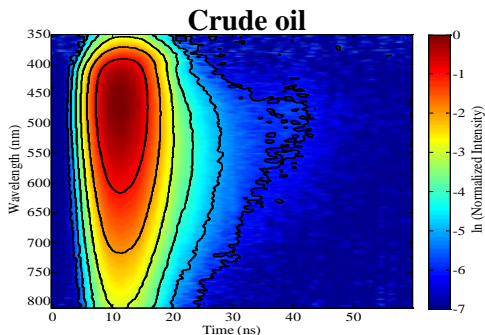
Preliminary study for an UAV-based LIDAR

Name	Spectral range	Measured signal
A	350 - 360 nm	Laser backscattering
B	400 - 410 nm	Water Raman
C	410 – 430 nm	Fluorescence
D	430 – 465 nm	Fluorescence
E	465 – 535 nm	Fluorescence
F	535 – 600 nm	Fluorescence
G	600 – 750 nm	Fluorescence

✓ Instrument concept and main tech specs
✓ Identification of suitable off-the-shelf components
✓ Ad hoc algorithms
✓ Radiometric calculations

In collaboration with:

flyby *applied research solutions*

Topic 3 Border and maritime security

Consiglio Nazionale delle Ricerche
Engineering, ICT and Technologies for
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Subtopic 3.2 -*Security on ships and in port areas*
Contact: Francesco Soldovieri, IREA (soldovieri.f@irea.cnr.it)

- **Radar systems for the remote monitoring of human movements and behavior (vital signs, indications of suspected behavior) and degree of occupancy of indoor environments.**
- **Real-time detection of human movements in indoor scenarios based on ubiquitous Wi-Fi devices (access points, smartphones, etc.)**
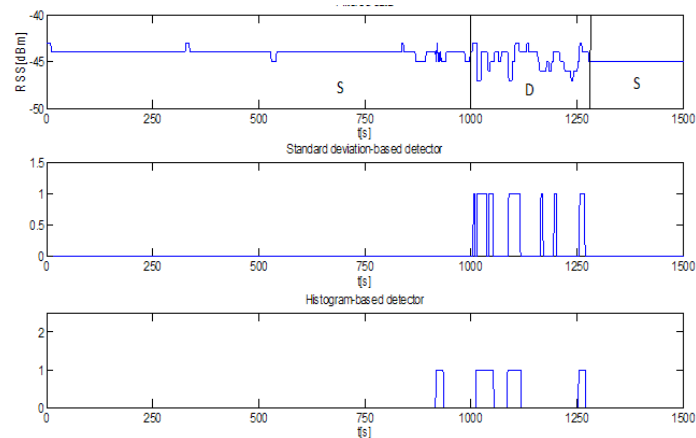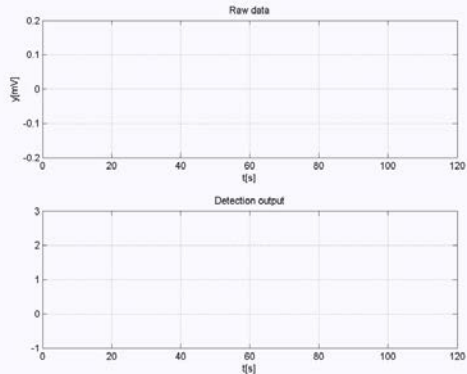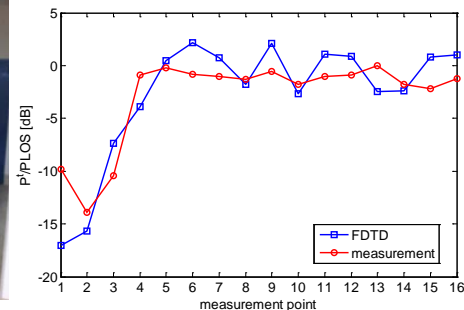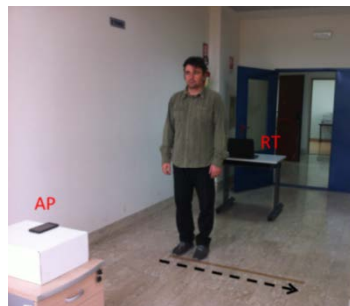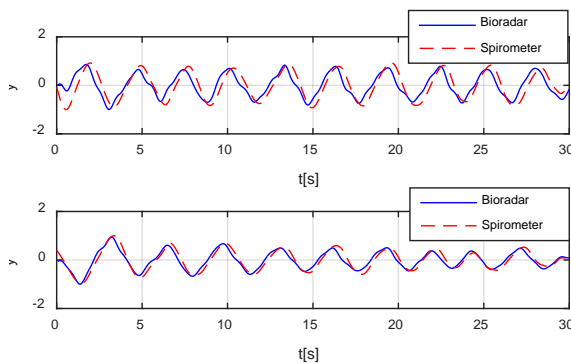
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Energy and Trasportation Department

Subtopic 3.2 - *Security on ships and in port areas*
Contact: Valeria Di Sarli, IRC (valeria.disarli@irc.cnr.it)

> **Safety risk assessment** for the presence of **flammable substances** (which are stored, handled, and transported **on ships and in port areas**)

... **flammable substances may be involved in fires and explosions**

- **Identification of potential events that could initiate an accident sequence**

- **Identification of accidental scenarios for each initiator event**

- **Evaluation of probability of occurrence (by using *logical trees and historical data*) and severity of consequences (by *modeling and simulation*) for each accidental scenario**
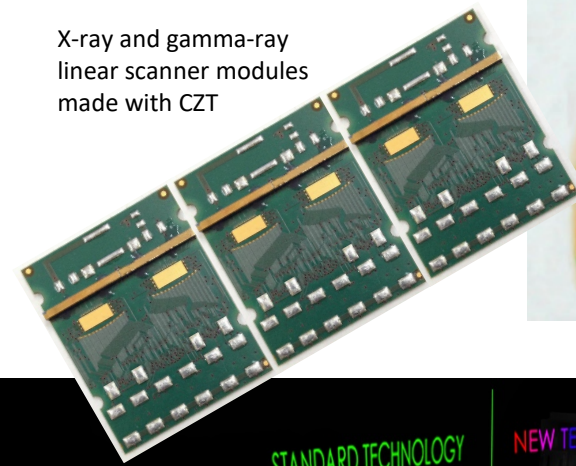
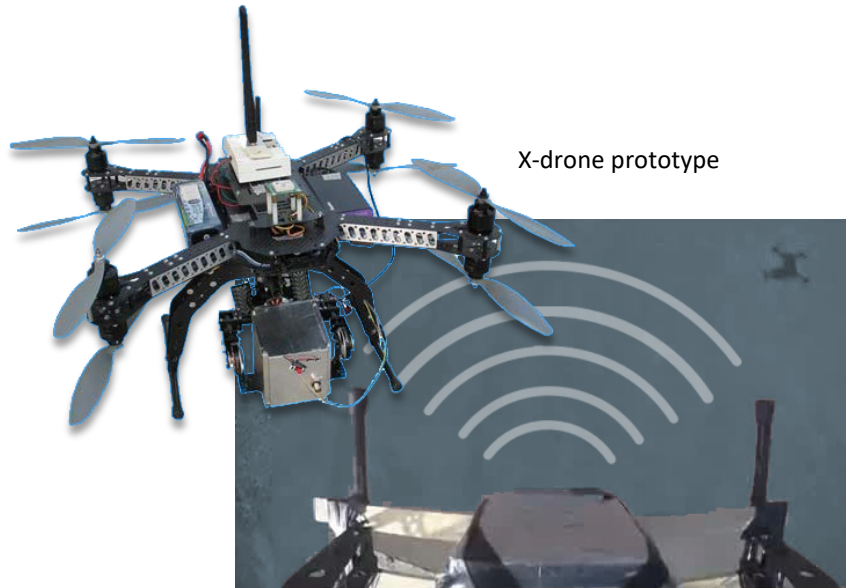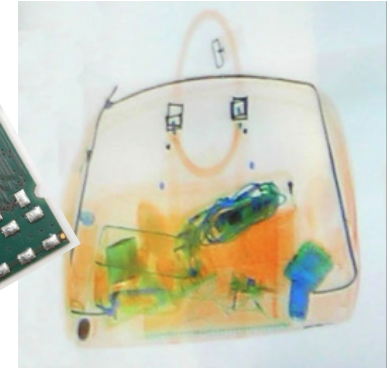## Topic 3 Border and maritime security

Subtopic 3.2 -*Security on ships and in port areas*
Contact: Davide Calestani, IMEM (davide.calestani@imem.cnr.it)

Control of the persons and goods (containers, vehicles, packing) by spectroscopic x-ray and gamma-ray scanners
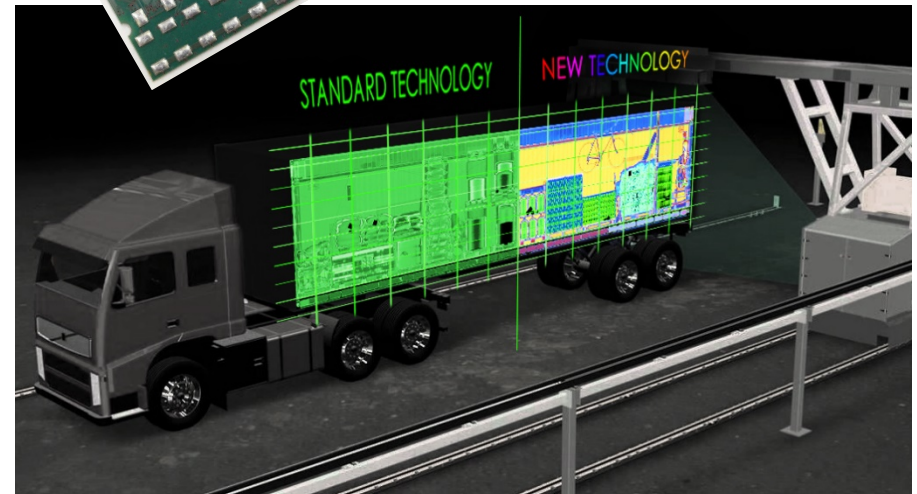
Security of ports based on the integration of sensing technologies from multi-observational platforms

X-ray and gamma-ray linear scanner modules made with CZT

X-drone prototype

Visual concept of spectroscopic color scan imaging

CNR DIITET
Consiglio Nazionale delle Ricerche
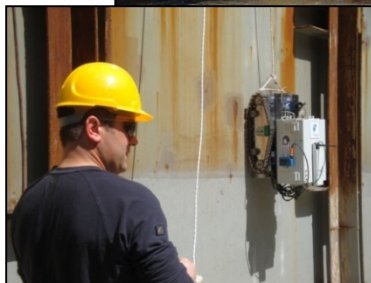Engineering, ICT and Technologies for
Energy and Trasportation Department

Topic 3 **Border and maritime security**

Subtopic 3.2 -*Security on ships and in port areas*
Contact: Marco Bibuli, INM (marco.bibuli@cnr.it)

Extended ship

Widening the operational capability, sensing range and self-maintenance exploiting autonomous tools strictly connected to the ship.

Smart port

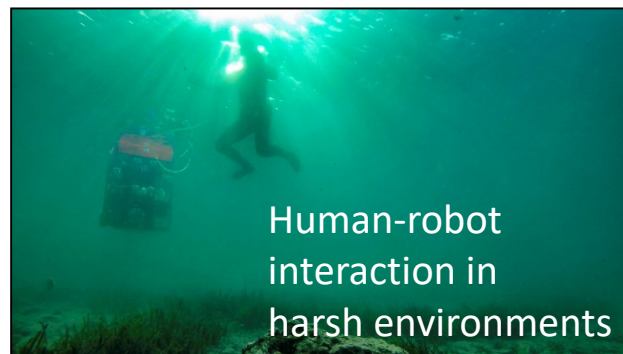Innovative infrastructure capable of efficiently manage ship traffic, goods routing and energy connections.
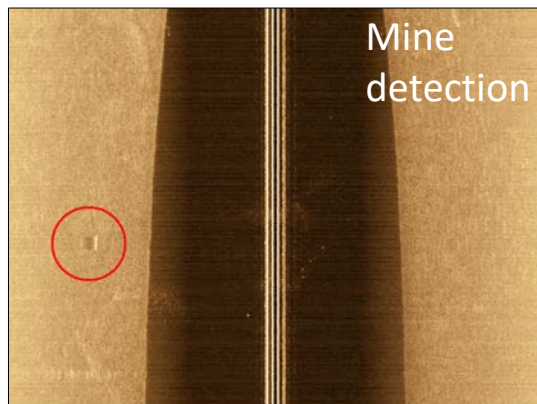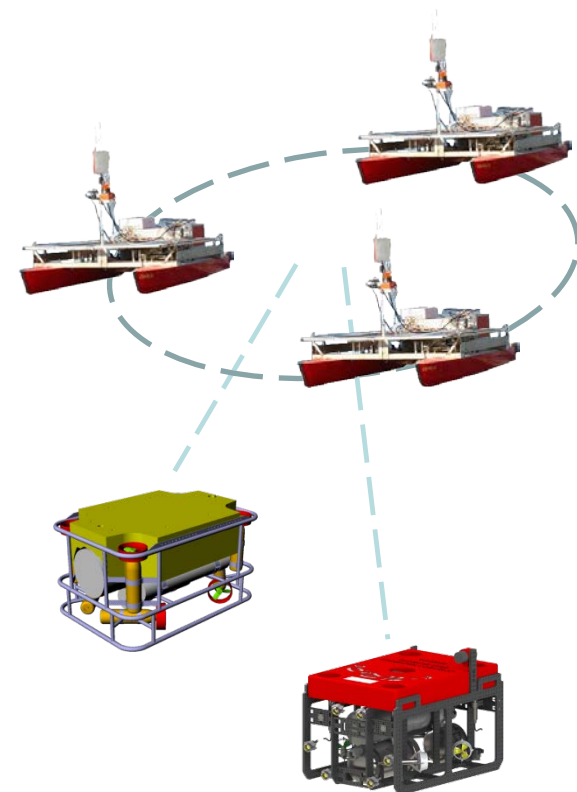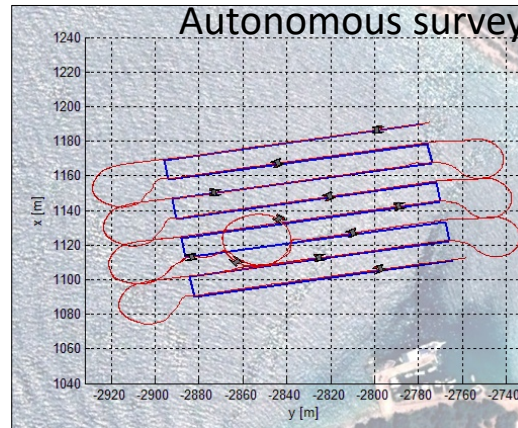
Project Area 13: Secure Societies

Topic 3 Border and maritime security

Subtopic 3.3 -*Robotics and UAV for maritime security*
Contact: Marco Bibuli, INM (marco.bibuli@cnr.it)

Extensive employment of highly autonomous robotic agents capable of simultaneously cooperating to perform specific area observation and possible treat detection.

Underwater manipulation

Autonomous survey

Mine detection

Human-robot interaction in harsh environments

Heterogeneous swarm

Project Area 13: Secure Societies

Subtopic 4.1 - *EMF safety in work environment*
Contact: Daniele Andreuccetti, IFAC (D.Andreuccetti@ifac.cnr.it)

EXPERTISE

❖ **Management of EMF measurement surveys**

❖ **Design of standardized methods of assessment and *ad hoc* instrument set-up**

❖ **Development and use of specialized software for:**

- **EMF data processing procedures**
- **EMF numerical dosimetry**

Measurement of electric and magnetic fields close to an industrial arc welding station

Evaluation of the exposure to the B(t) field experienced when moving in the static field of an MRI scanner

IMPACTS

❖ **Improve EMF exposure assessment techniques**

❖ **Develop new tools and methods for EMF exposure assessments**

❖ **Improve technological techniques to reduce EMF exposure**

Project Area 13: Secure Societies

## Topic 4 Ethical / Societal Dimension and Social Security

Subtopic 4.1 - *EMF safety in work environment*
Contact: Stefania Romeo, IREA (romeo.s@irea.cnr.it)

➢ **Measurement campaigns in living and working environments;**
➢ **Development of numerical tools for the computation of exposure levels in MRI environments**
➢ **Education, training and information activities for workers and security managers through the development of websites, videos and the use of augmented reality communication techniques.**

Sala magnete - 3D
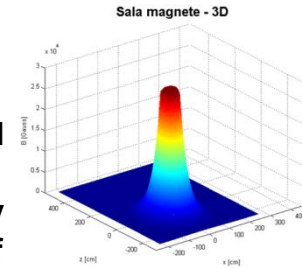
✉ info@mriworkers.eu

M.R.I. WORKERS

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Sicurezza dei lavoratori da esposizioni a campi elettrici, magnetici ed elettromagnetici in MRI

Questo portale è rivolto ai lavoratori, ai responsabili per la sicurezza e a chiunque sia interessato ad aspetti di sicurezza da esposizione a campi elettrici, magnetici ed elettromagnetici in ambienti di Risonanza Magnetica (RM).

Il portale si configura come uno strumento di divulgazione tecnico-scientifica, attraverso il quale ogni utente può avere a disposizione informazioni tecniche, normative vigenti, aggiornamenti sulla letteratura scientifica, indicazioni di buone prassi e comportamenti, con l'obiettivo di promuovere e favorire la cultura della sicurezza in questo particolare ambiente di lavoro.
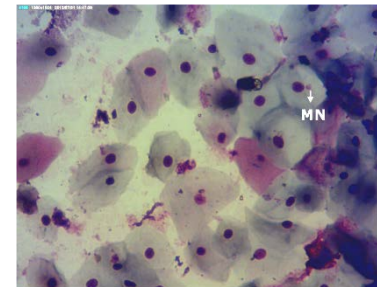
MR Safety

GIDRM Workshop:
Advanced Hardware, Methods and Applications in NMR/MRI
June 7-8 2018, University of L'Aquila, Italy

VIENNA/AT
OCTOBER 18-20, 2018

➢ **Characterization of EMFs sources and exposure scenarios for workers of the maritime sector;**
➢ **Evaluation of genotoxic effects in biological samples of buccal mucosa from exposed workers.**

Subtopic 4.2 – *Privacy Issues in Security Systems*
Contact: Fabio Martinelli, IIT   (Fabio.Martinelli@iit.cnr.it)

The awareness about the respect of the privacy of the people represents one of the main constraint in designing technological solutions. In this context, attention is devoted to the development of privacy aware physical surveillance systems, where the research is focussed on approaches to ease the video control of physical resources (including access to sensitive location) still being able to minimize the data collected/stored and processed.

Indeed, we develop systems that allow on the one hand careful control of the situation using surveillance systems. In addition, these systems also can protect the privacy of the involved people limiting at minimum and depending on the context, the personal identifiable information. The systems work both with biometric aspects as well as for mobility patterns allowing a win-win solutions for security and privacy.

Topic 4 **Ethical / Societal Dimension and Social Security**

Subtopic 4.2 – *Privacy Issues in Security Systems*
Contact: Marco Bibuli, INM (marco.bibuli@cnr.it)

Minimize sensible data collection (with respect to privacy regulation) in urban and sensitive locations.

Extend law and regulation related to the exploitation of technological tools for security goals.