SCINTILLA
A European project for the development of new detector technologies in the nuclear security field

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HeRe 2013

Outline

1. Homeland security
2. Radiations
3. The SCINTILLA project and its approach
4. The first SCINTILLA benchmark and its results
5. The integration of a full portal device
6. Summary and future plans

Homeland security






Goods, vehicles and people transported around countries are inspected to detect and identify radioactive and strategic nuclear materials

Important for world-wide citizens security

Increasing request for special devices to detect and identify radiation

- Different environments
- Several detector sizes
- Different radiation sensitivities
- Innovative, versatile, robust and simple systems to use

There is **NOT** a single solution for all problems

3

Radiations

Photons

- ***NORM*** (naturally occurring radioactive materials): ^{201}Tl, ^{40}K, ^{226}Ra
- ***Medicals***: ^{67}Ga, ^{131}I, ^{192}Ir, ^{99}Tc-m
- ***Others***: ^{60}Co, ^{137}Cs, ^{241}Am

1. Wide energy range
2. Reduce the false alarm rate

Devices with specific characteristics

Spectrometric properties

Neutrons

- ***Strategic nuclear materials***: WGPu, HEU
  - Most of the n detectors based on ^{3}He technology
  - Since early 2000 increase of ^{3}He request and production reduction drove the prize increase
  - New projections (GOA-11-753) redefined needs and urgencies

Necessity to have an ^{3}He technology replacement

The SCINTILLA project

SCINTILLA is a European project within the 7th Framework Program (2007/2013)

International consortium of **9 groups**:

- 5 research groups: *CEA, EK, Fraunhofer INT institute, INFN and JRC*
- 4 companies: *Ansaldo Nucleare, Arttic, Saphymo and Symetrica*

SCINTILLA aim

Improving sensors for first responders

New techniques for spectroscopy detectors

Neutron detection techniques alternative to ^{3}He

The SCINTILLA scope

6 technologies:

- 4 scintillator-based technologies
- 2 semiconductor technologies

- 3 neutron detectors
- 2 gamma spectrometric detectors

- 1 CZT gamma camera
- 1 Mini-CZT device for prompt intervention

- Toolbox of devices for masked and shielded radioactive source and nuclear materials detection
- Categorization and identification of radioisotopes
- Radiation Portal Monitors (RPM) for neutron detection with **Helium-3** free materials

The SCINTILLA scope

Usage cases

UC1: RPM for containers

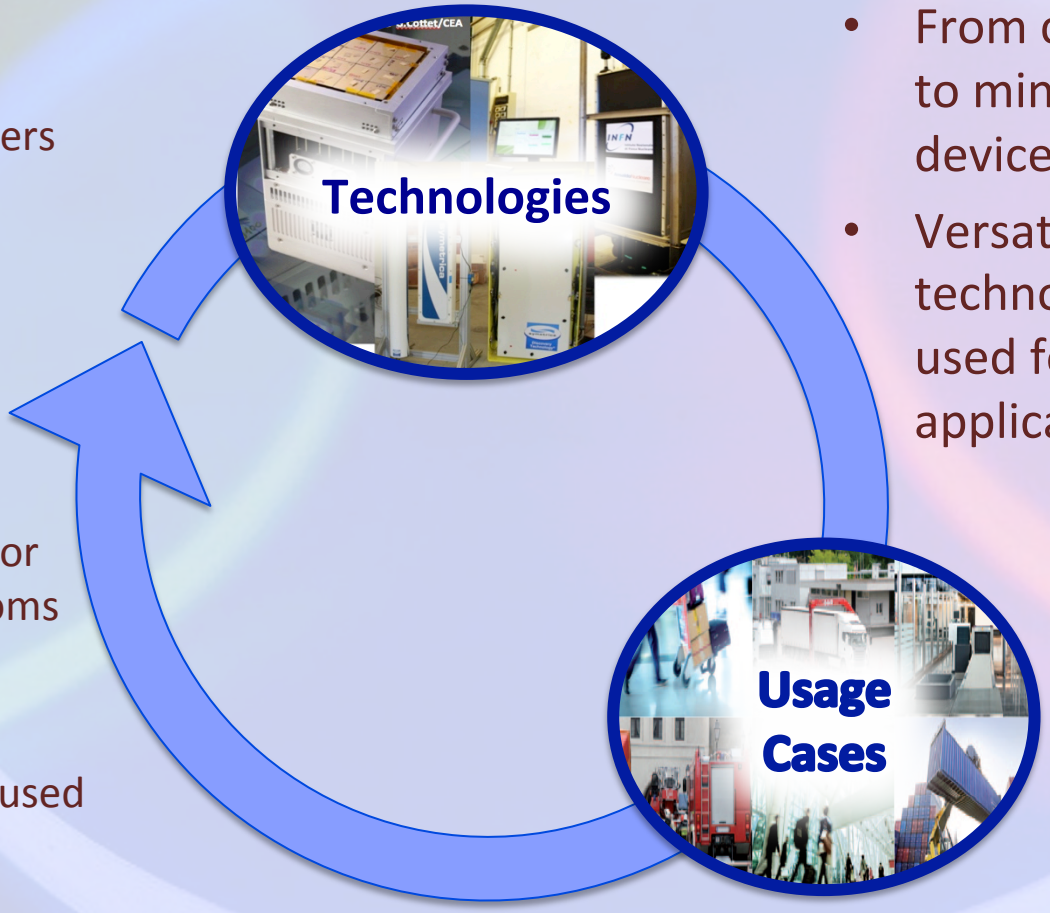
UC2: RPM for vehicles control

UC3: RPM for luggage control

UC4: RPM for people

UC5: portable device for usage by police & customs in airports

UC6: communicating miniature device to be used fro prompt response



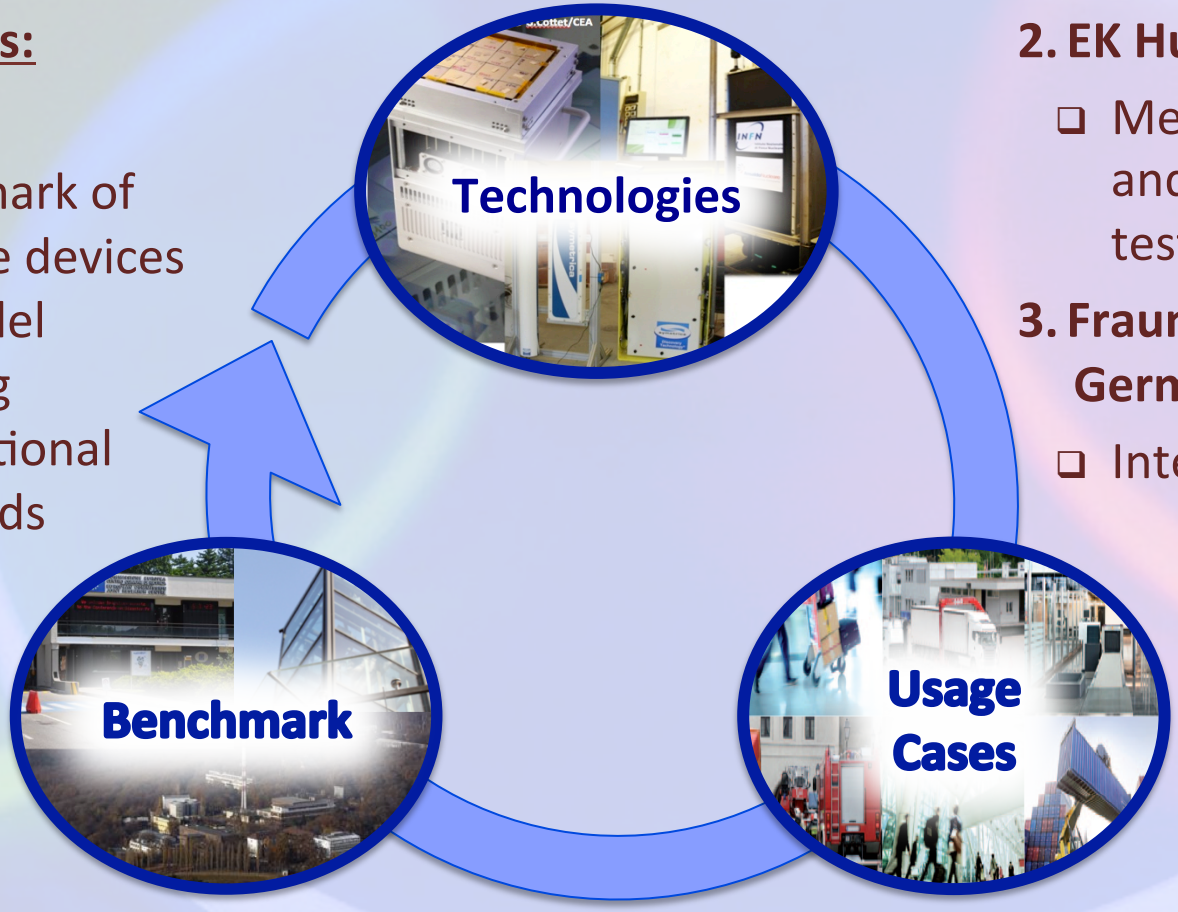
- From container scan to miniaturized devices
- Versatility of the technologies to be used for different applications

Detector prototypes, realized with different technologies, cover several usage cases satisfying requirements of the broad international market

The SCINTILLA scope

3 Laboratories:

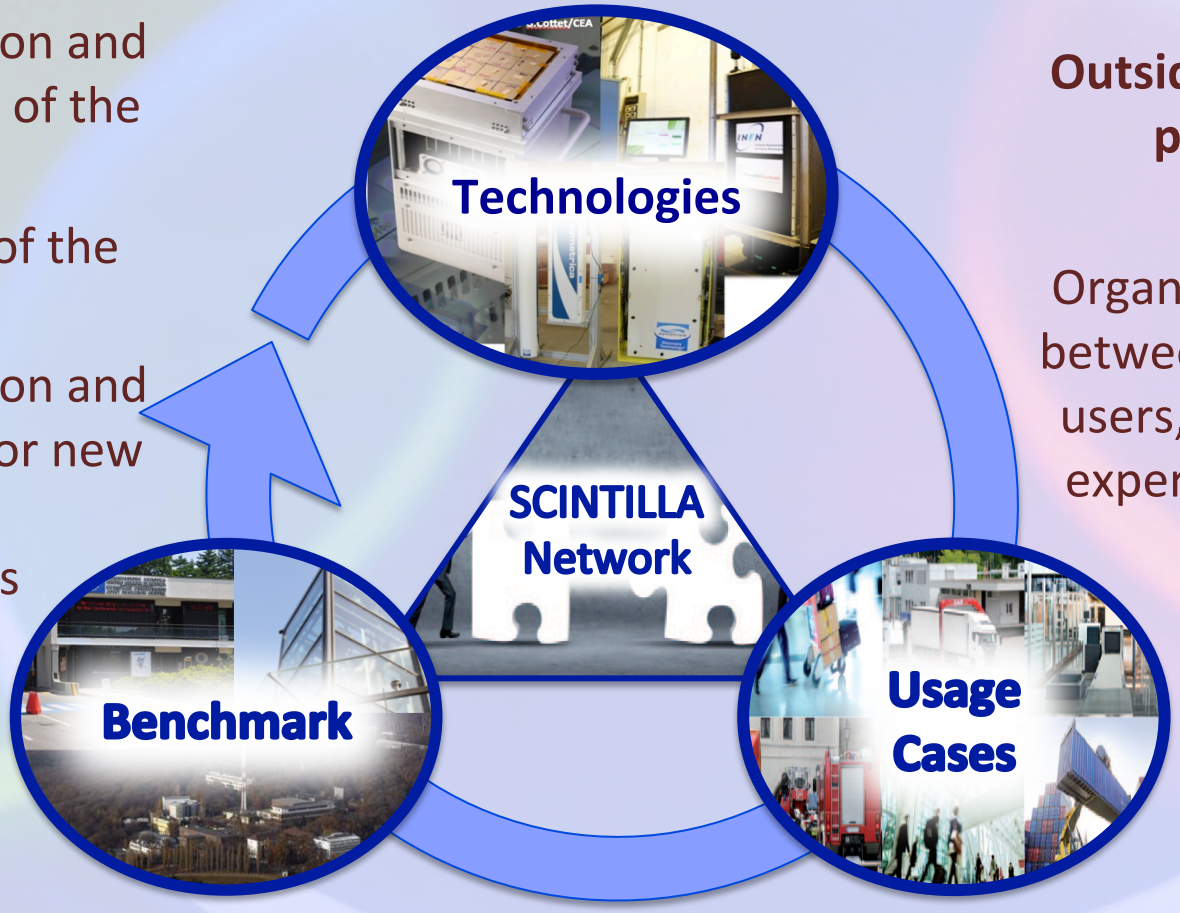
1. **JRC Italy**
   - Benchmark of multiple devices in parallel meeting international standards
2. **EK Hungary**
   - Measurements and spectrometric tests with sources
3. **Fraunhofer INT Germany**
   - Integration tests



All detector prototypes are annually benchmarked to verify status and radiometric performances

The SCINTILLA scope

- Optimization and refocusing of the project
- Evolution of the market
- Optimization and proposal for new evaluation procedures



Outside and inside partners!

Organize a synergy between worldwide users, developers, experts and users

www.scintilla-project.eu

The benchmark facility

SCINTILLA technologies benchmarked in the laboratory of the European Joint Research Centre (JRC) at Ispra

1st benchmark held in February 2013

The ITRAP+10 facility:

- Equipped with sources satisfying international standard requirements
- Reference procedures according to the international standards

The SCINTILLA detectors @ benchmark

All 7 RPM* detector prototypes of the SCINTILLA project were tested

***RPM**: Radiation Portal Monitor. Passive and non destructive detector device. It is used for neutron and gamma separation and give a first fast gamma identification. It is usually made of 2 pillars were the object to be scanned is passing through for inspection.

All detectors were single pillar objects

Spectrometric devices:

- NaI(Tl) gamma spectrometer (Symetrica)
- 2 PVT spectrometers of different sizes (Symetrica)

Neutron and gamma detectors

- Gd-lined plastic scintillator (INFN/Ansaldo)
- LiZnS neutron detector (Symetrica)
- 2 Plastic scintillators with PSD (SAPHYMO and CEA)

The benchmark test procedures

Dynamic tests following international standards

- Cart equipped with source
  - 8 km/h for containers and vehicles control
  - 1.2 km/h for luggage and people control
- Distance from source for 1 pillar prototype
  - 2 m for containers and vehicles control
  - 1 m for luggage and people control
- Source tests
  - Alarm tests
  - Masked & Shielded source tests

Static test with radioactive sources

Gammas: ^{241}Am, ^{57}Co, ^{133}Ba, ^{137}Cs, ^{60}Co, ^{232}Th, ^{226}Ra, HEU, WGPu, ^{67}Ga, ^{131}I, ^{192}Ir, ^{99}Tc-m, ^{201}Tl, ^{40}K (spectroscopic studies)

Neutrons: ^{252}Cf source with emission of 20'000 n/s

The benchmark results

Neutron detection systems

Not moderated neutron source test:

- All detector prototypes satisfied the not moderated neutron source identification, giving 100% of alarms meeting standards

Moderated neutron source test:

- One detector reached 100% of the alarms.
- The others triggered alarms above 70% of the cases. They showed alarms with time delays or reduced efficiency, compatible with single pillar detectors.

Masked neutron source test:

- No false neutron alarms by exposing detectors to gamma dose of 20µSv/h on detector surface (^{137}Cs)
- 2 detectors resolved 100% of passages. One detector applied a software modification to better cope the high count rate.
- 2 detectors showed sensitivity to high rates.

The benchmark results

Gamma spectroscopic systems

PVT based detectors

Categorization of the sources as *NORM* or *NOT NORM*

Tests with not defined standard procedures

Crystal based detector

Good identification for most of the sources

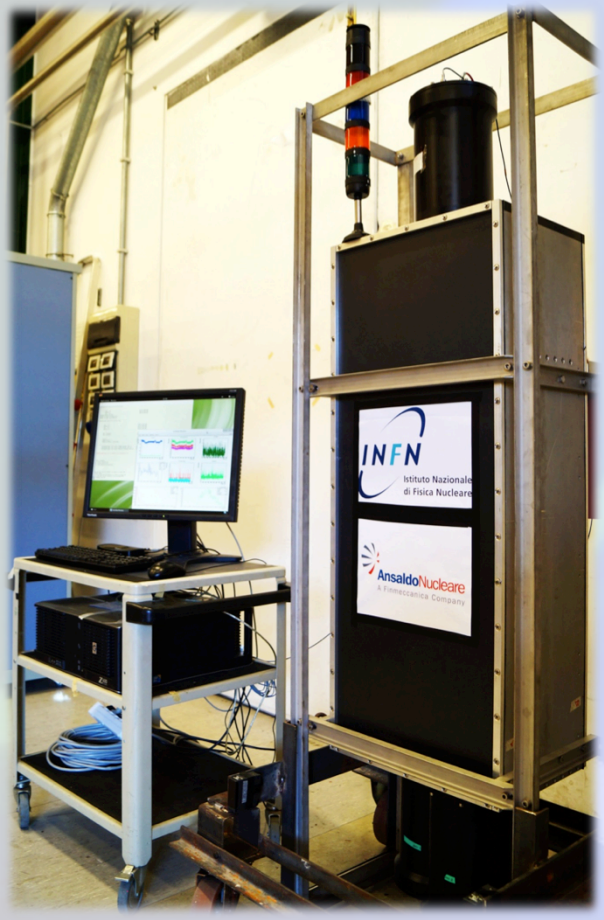
Some limitations with complex masking scenarios

Extremely encouraging results confirming the quality of the technologies

Detector improvements, required to enhance performance, are under implementation in the new prototypes

The ANN-INFN detector

The **ANN-INFN** is a Gadolinium lined plastic scintillator detector



- Neutron and gamma radiation detection and discrimination
- ^{3}He-free material
- Modular and versatile detector made of robust components (*patent pending*)
- PMT-based readout
- Fast commercial signal digitizer (VME) in pipeline configuration
- Real-time event selection & neutron/gamma software discrimination (*patent pending*)
- GUI interface
- Master & slave communication systems
- Standard outputs: ANSI/IEC data format, annunciators, occupy sensors, RS485 communication protocol

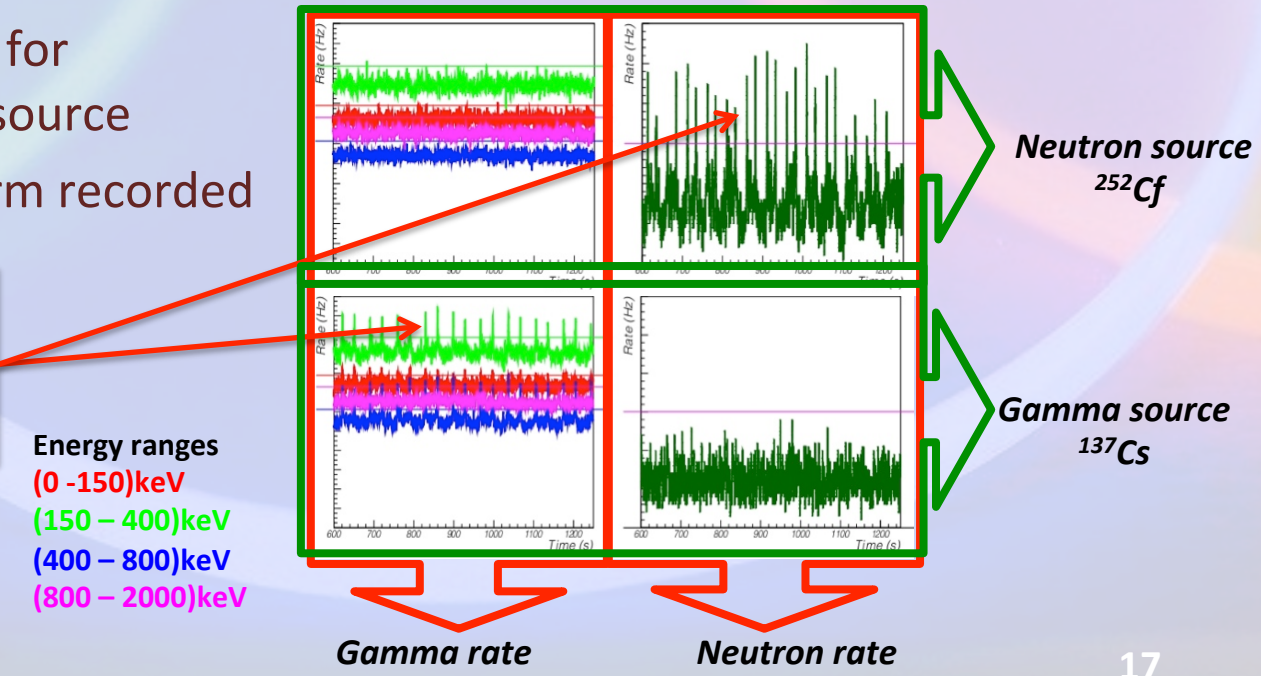
The ANN-INFN benchmark considerations

The ANN-INFN detector shows a very positive behaviour to benchmark tests:

Dynamic tests:

- 100% detection alarm efficiency for high and medium gamma sources
- 100% detection alarm efficiency for pure neutron sources
- 100% detection alarm efficiency for pure gamma masked neutron source with increased energy thresholds
- 70% detection alarm for moderated neutron source
- No false neutron alarm recorded

Each peak corresponds to passages of the source in front of the detector



RPM Integration

SCINTILLA project planned the integration of a full portal system

A full RPM is a system of devices managed by an intelligent master system:

- Neutron and gamma separation
- Gamma spectroscopy
- Alarms and occupy sensors
- Data analysis and data storage

Partnership between SCINTILLA developers

The ANN-INFN group is collaborating with SAPHYMO company

The INFN-ANN has the capability to work as a slave detector

First integration step: last June, communication protocol and data transfer were successfully tested

Summary and future plans

- The FP7 SCINTILLA European project completed the first half of the project
- The first-generation of RPM detectors were tested during first benchmark with very promising results
- The integration of a full RPM prototype is ongoing
- The development of the second phase detectors is under implementation to be ready for the second benchmark
- The next benchmark will be next January for a 2 week campaign
- The 2nd and the 3rd benchmark campaigns and the next public workshop are planned and open to selected external partners

The research leading to these results has received funding from European Community's Seventh Framework Program (FP7/2007-2013) under grant agreement n°285204