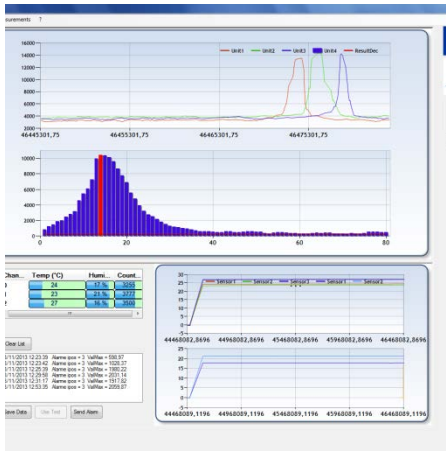
ISOE European Symposium
Bern, 9-11 April 2014

FROM RESEARCH TO INDUSTRY
cea tech

list

NEW MONITORING SYSTEM TO DETECT A RADIOACTIVE MATERIAL IN MOTION

Session 7. #Dosimetry and Monitoring - 2 | Karim Boudergui, Vladimir Kondrasovs, Romain Coulon, Gwenolé Corre, Stéphane Normand



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CONTEXT

STATE OF THE ART

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CONTEXT

WHAT ARE THE DIFFICULTIES TO DETECT A RADIOACTIVE SOURCE IN MOTION ?

- **To have enough count statistic to differentiate the analysis signal from the background noise signal :**
  - Low count rate due to the short time acquisition (speed)
  - Dependency to the background noise (fluctuation)

- **To have an adapted acquisition system**

→ **A real time approach**

CEA List developed a monitoring system to detect radioactive sources in motion based on :

- 2 or more sensor units aligned and separated by the same distance
- Time correlation between each sensor unit

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• Radiation Portal Monitors (RPM) are more and more required.

• RPM are mainly included with one or more large volume plastic scintillation detectors.

• These systems generally use statistical approaches based on threshold set-up with regards to background fluctuations.

RADOS Truck monitor. MIRION

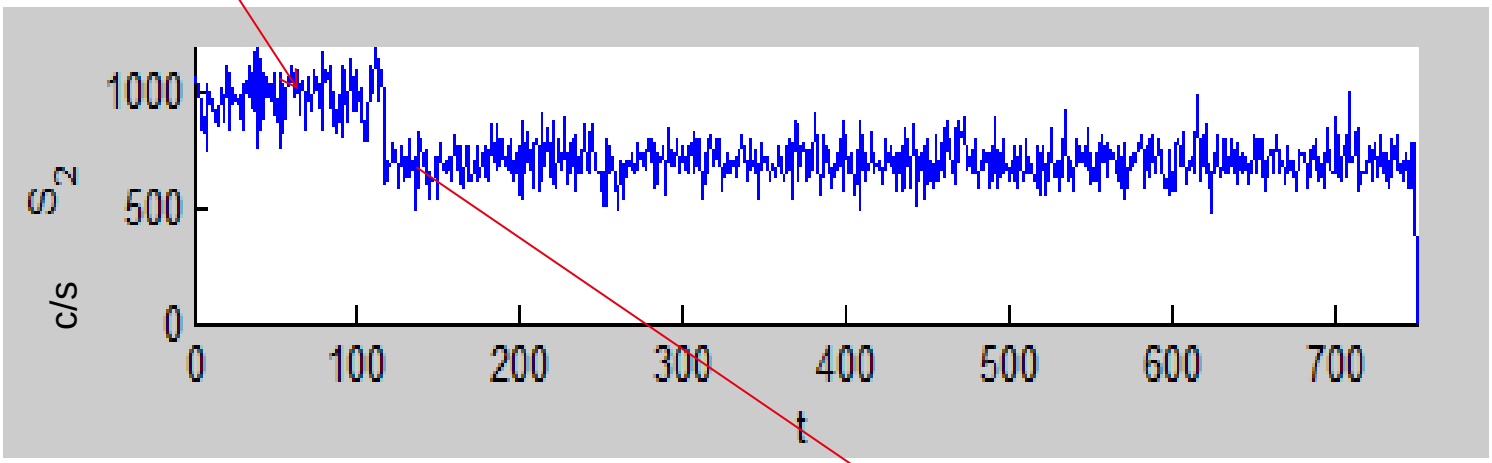
PORTIA - CANBERRA

CRCV. SAPHYMO

STATE OF THE ART

SHIELDING EFFECT

Background baseline

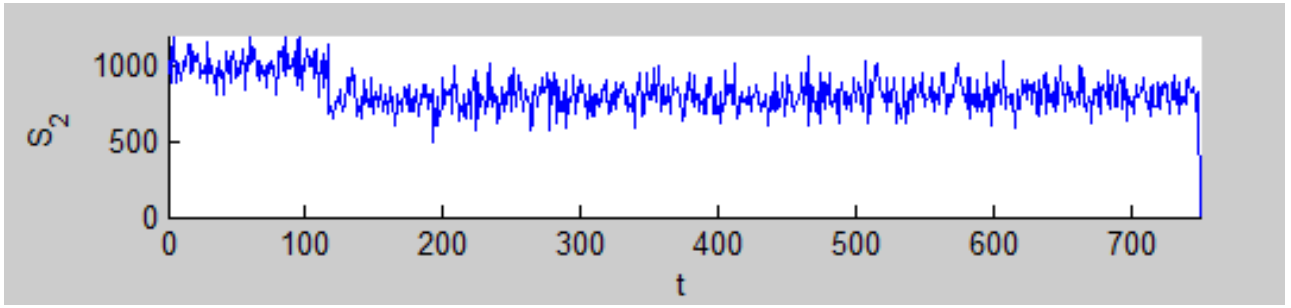


Auto shieilding effect

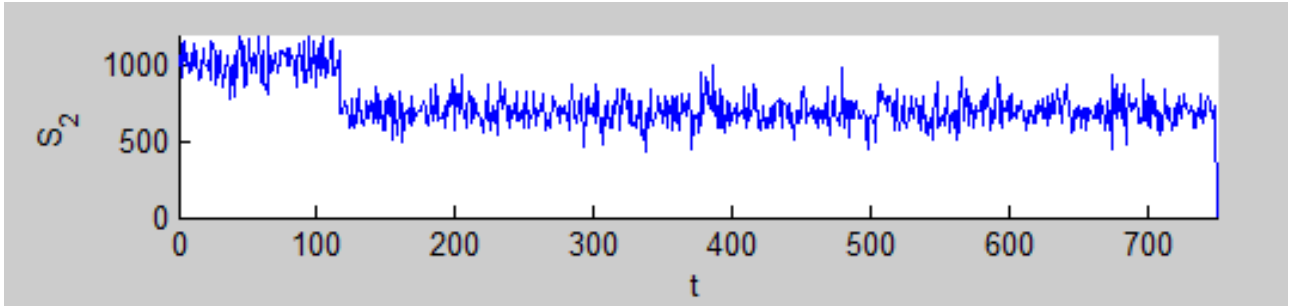
Background noise Simulation with :

- Speed : 15 km/h
- Sampling time 100 ms

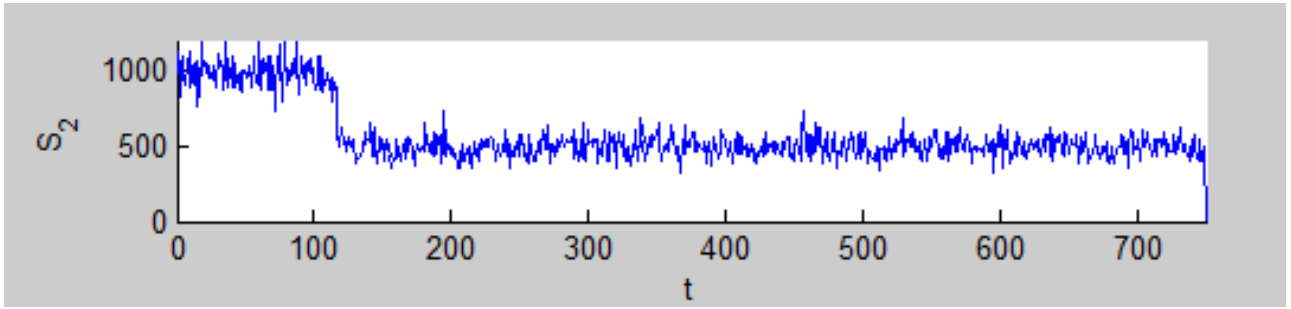
STATE OF THE ART



Shielding factor 0.8



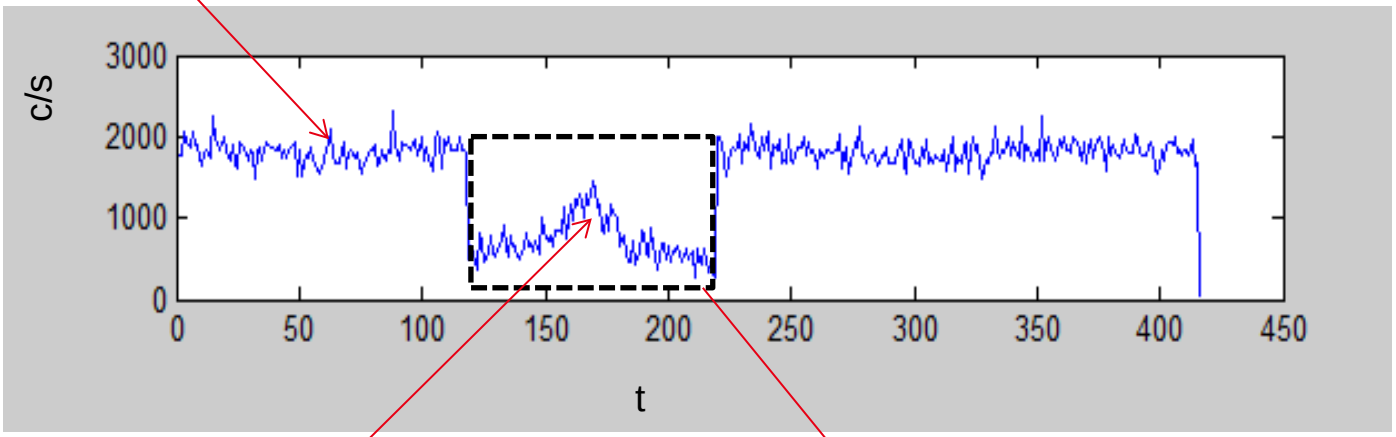
Shielding factor 0.7



Shielding factor 0.5

STATE OF THE ART

Background baseline



Source signal

Auto shieilding effect

CEA LIST developed an approach based on time correlation technics in order to:

- Minimize false alarm number
- Increase detection level
- Achieve no background dependency
- Speed estimation

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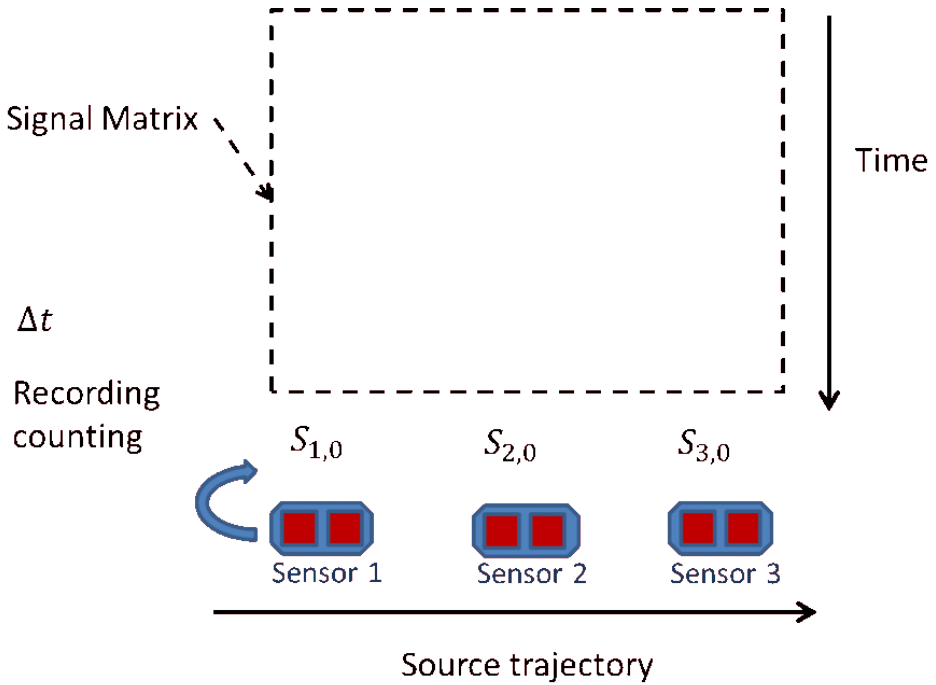
- **3 sensor units aligned** and separated by **constant distance** (eg. 2 m in our case)
- Radioactive source is supposed to move in a **constant direction**.
- Count rates from each sensor is **recorded in a memory.**



$$S_{i,t} = \begin{pmatrix} S_{1,1} & \dots & S_{1,5} & \dots & S_{1,M} \\ S_{2,1} & \dots & S_{2,5} & \dots & S_{2,M} \\ S_{3,1} & \dots & S_{3,5} & \dots & S_{3,M} \end{pmatrix}$$

Time

sensor unit (or channel)

Oldest counting estimate

New counting estimate

METHOD

Delay time

$$V_{1,n} = \frac{1}{M} \times \sum_{i=n-\frac{M}{2}}^{i=n+\frac{M}{2}} S_{1,i} \times S_{2,i+m}$$

$$V_{2,n} = \frac{1}{M} \times \sum_{i=n-\frac{M}{2}}^{i=n+\frac{M}{2}} S_{2,i} \times S_{3,i+m}$$

$$V_{3,n} = \frac{1}{M} \times \sum_{i=n-\frac{M}{2}}^{i=n+\frac{M}{2}} S_{1,i} \times S_{3,i+2m}$$

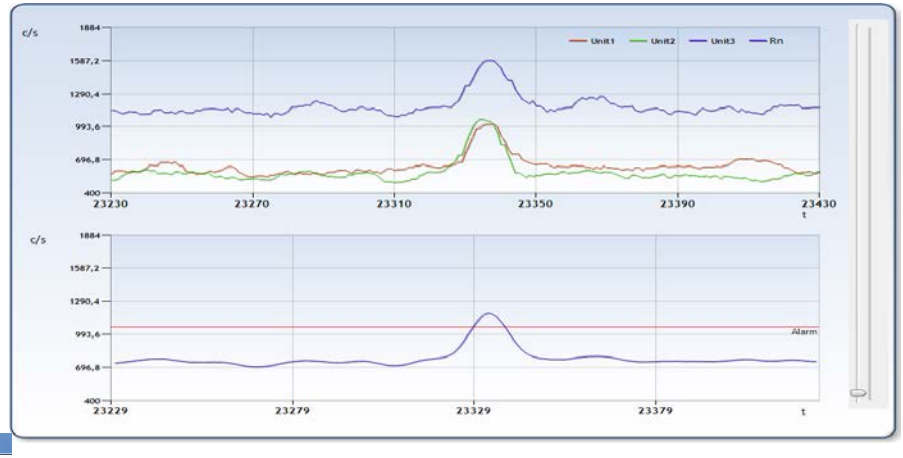
$$R_n = \sqrt{\frac{V_{1,n} + V_{2,n} + V_{3,n}}{3}}$$

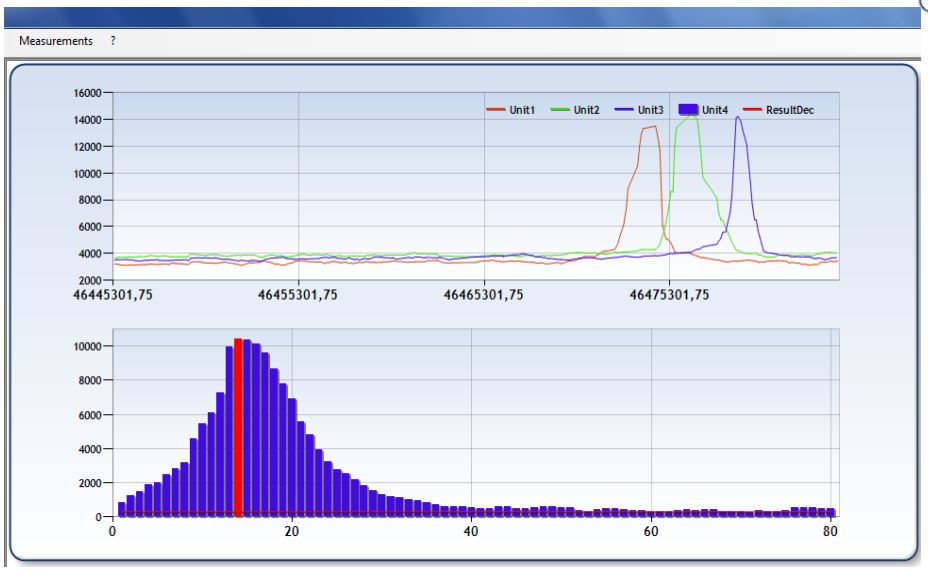
Define time correlation function to increase S/N

HOW TO DETERMINE THE DETECTION LEVEL ?

For each new count rate value :

- Calculation of the correlation function for each delay time





For each delay time :

- Find the maximize of the correlation function.

$$R(v) - \bar{R} > k\sigma(\bar{R})$$

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SYSTEM DESCRIPTION

2 plastic scintillation detectors EJ-200 10x10x100cm

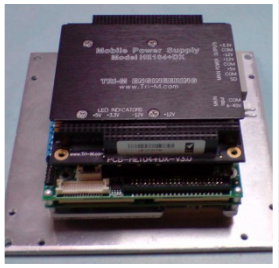
DAQ digitalization by 800MHz ADCs

Detection unit

Command control

Ethernet switch

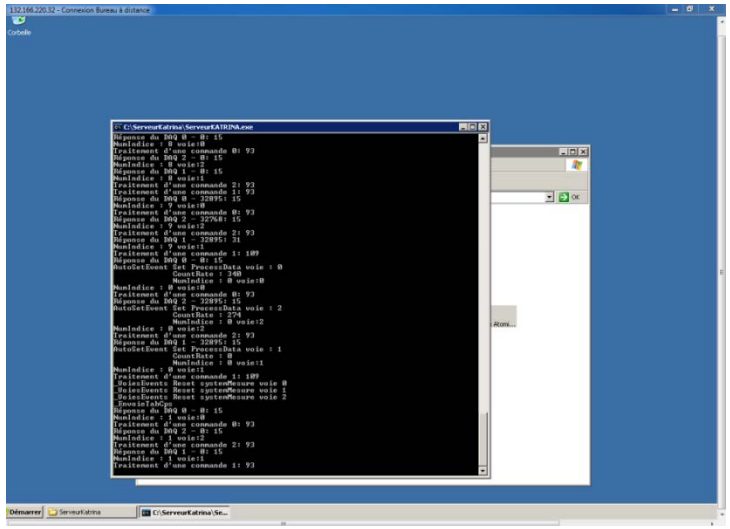
DC-UPS-System



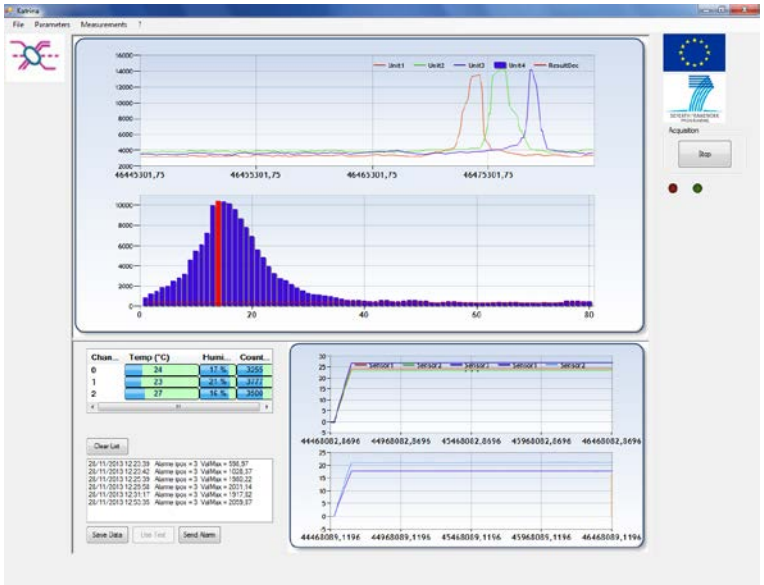
Embedded PC

ANALYSIS SOFTWARE

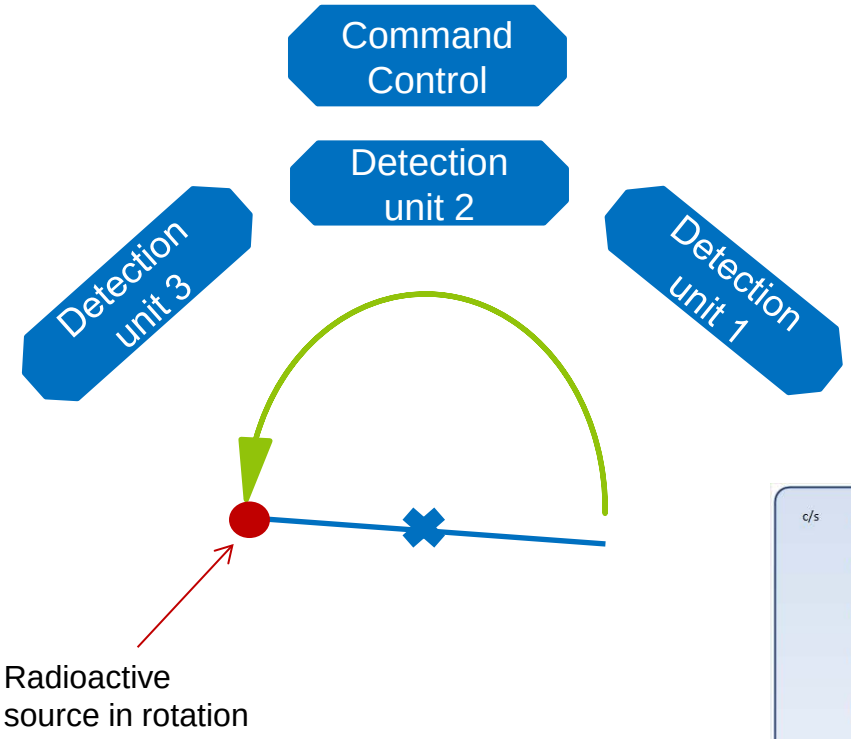
- A client/server model
- Server (Embedded computer) for data collection and analysis
- Sampling period of 100ms



- Client (PC) for visualization
- Display in real time different data series and correlation result.



DETECTION OF RADIOACTIVE SOURCES IN MOTION

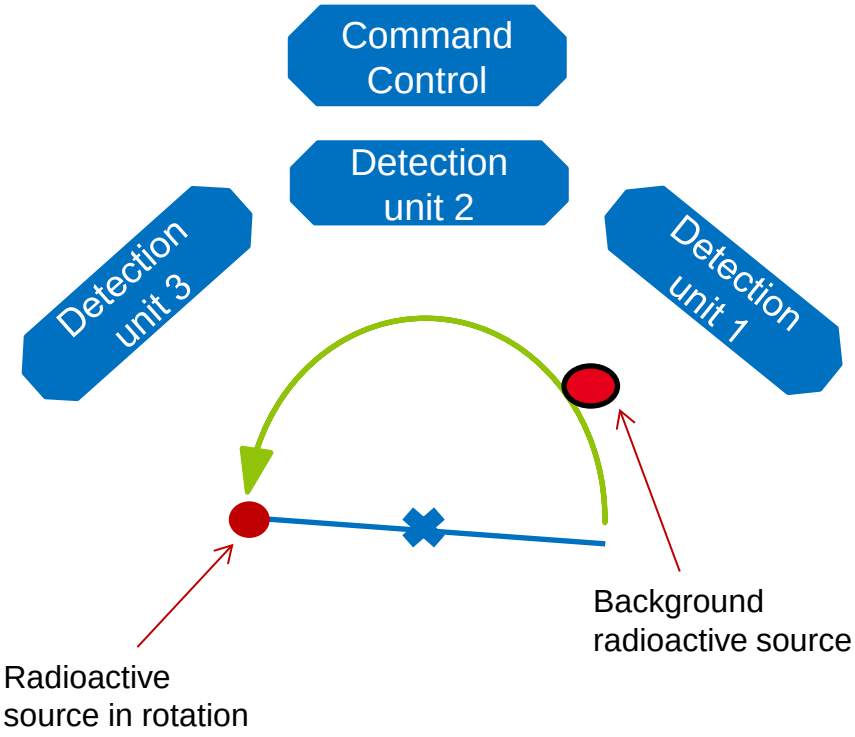


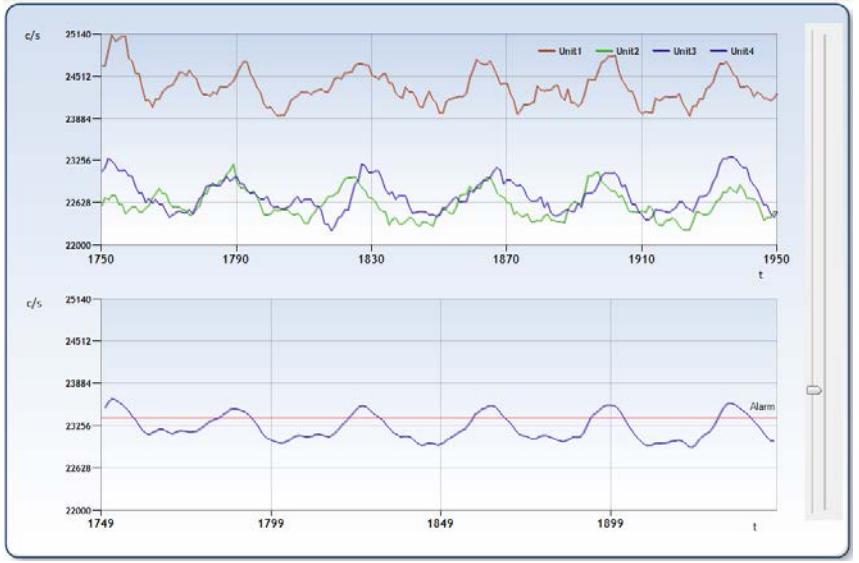
Source in rotation or static: sensor signal is between 240 and 460 c/s

Correlation signal :

- **Between 260 and 340 c/s without source**
- **between 260 and 400 c/s with source in rotation**

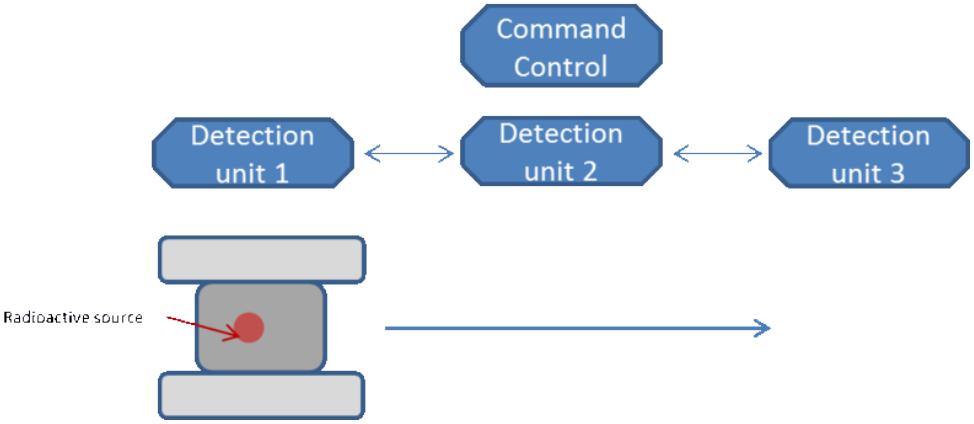
DETECTION OF RADIOACTIVE SOURCES IN MOTION

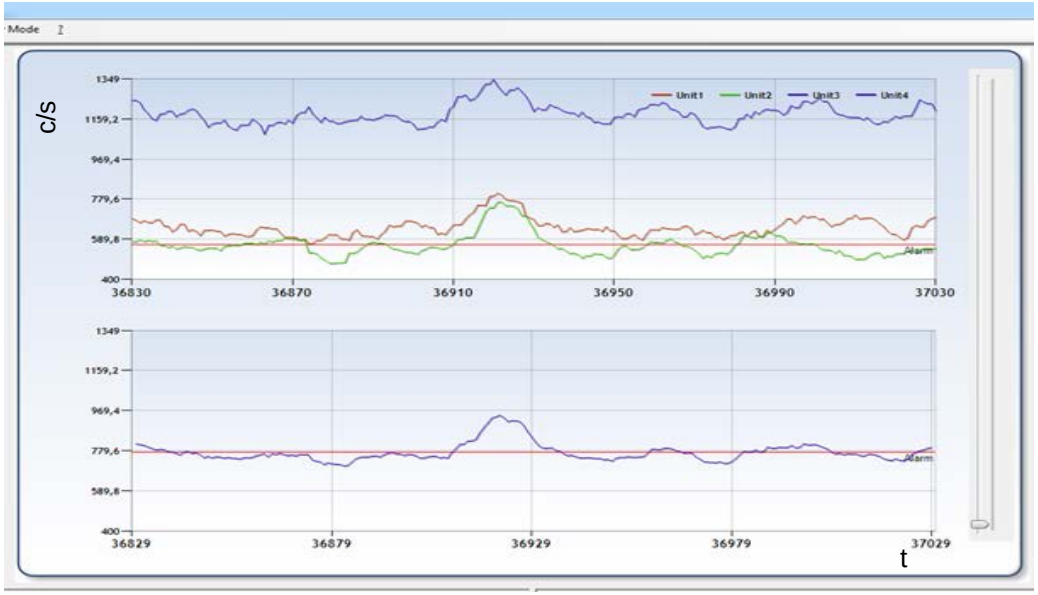




Even with a background noise the time correlation algorithm maintains a good statistic

TEST WITH A LINEAR MOVING SOURCE





SECUR-ED PROJECT

SECUR-ED

SECured URban transportation - European Demonstration

Budget = 40 M€

EC Funding = 25 M€

Apr 2011 - Sep 2014

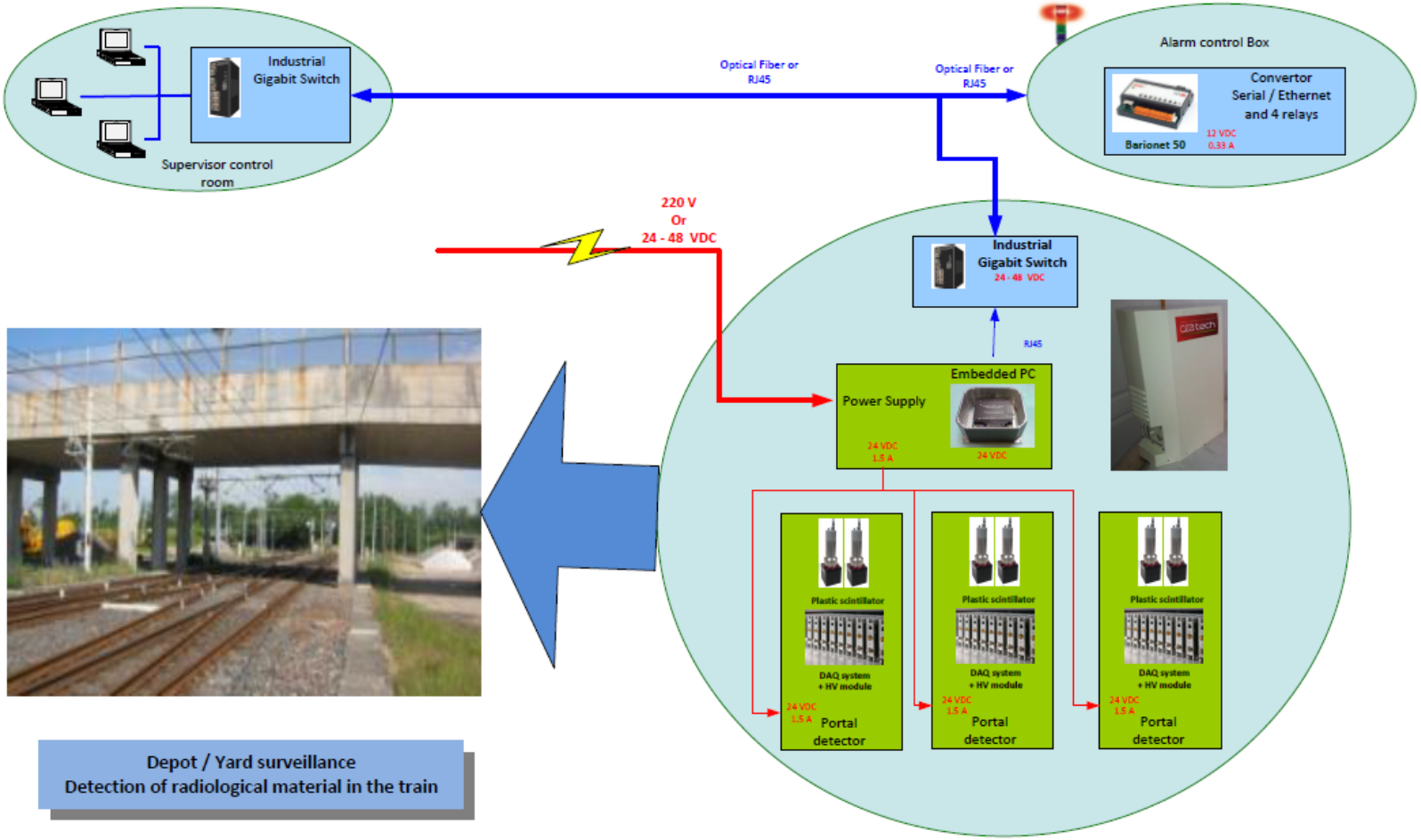
FP7-SEC-2010-1 - Security in Mass transportation

THALES - Project coordinator

Provides public transport operators of large and medium European cities with the means to enhance urban transport security

Enlarges mass transport security market for the European industry

DEMONSTRATION IN MILAN

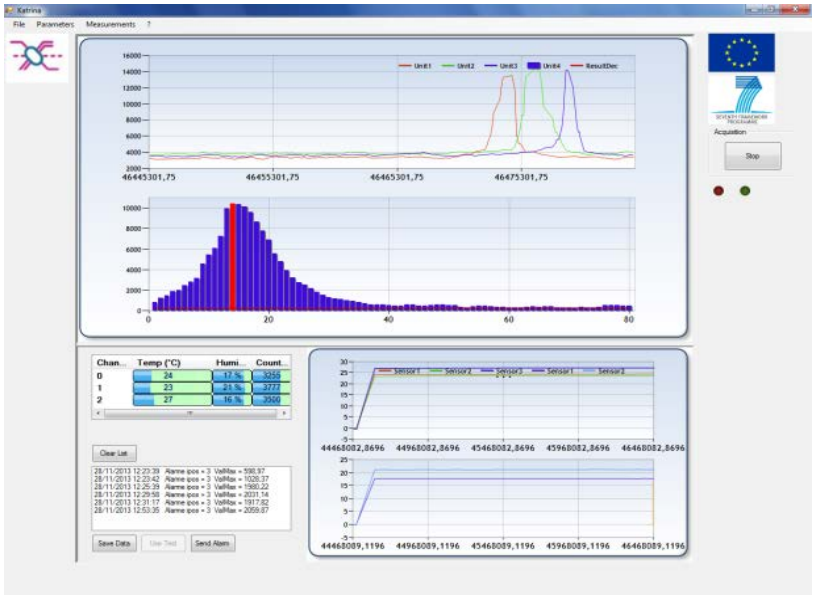


Depot / Yard surveillance
Detection of radiological material in the train

SECUR-ED
SECured URban transportation - European Demonstration

	Secur-ED Project		
	General cable drawing for Portale Monitor and associated equipments in Gorgonzola depot		
	FORMAT A3	N° CODE	N° DESSIN / REV 0
	ECHELLE		FEUILLE

DEMONSTRATION IN MILAN



- Train speed : 25 km/h
- Position of radioactive : 1.5m from sensor units
- Dose rate of the radioactive source : <1µGy/h at 1 meter

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- The false alarm rate decreases with the number of sensor units
- This approach was tested with 2 and 3 sensor units and confirms the gain of detection (and false alarm reduction)
- Preliminary results in our labs and on site confirm the gain of the **time correlation approach**
- **Next study, this approach can be tested with other type of detectors and situation (for example detection of contamination in a pipe with a sensor network)**

THANK YOU FOR YOUR ATTENTION

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