

GAMPIX: a new gamma imaging system for radiological safety and Homeland security purposes

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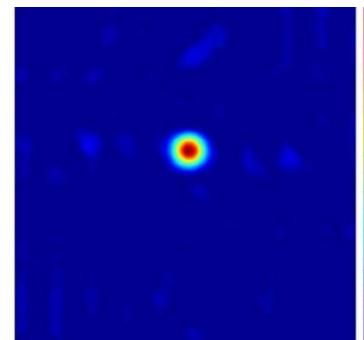
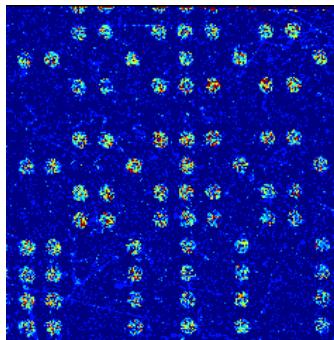
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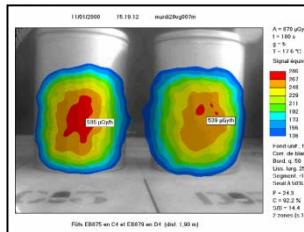
- Context
- The GAMPIX gamma camera: main characteristics
- Experimental performances obtained in laboratory
- Results obtained at CEA DAM Valduc / AREVA LPC Cadarache
- Results obtained in EDF Tricastin Nuclear Power Plant (NPP)
- Results obtained at CEA DAM DIF
- Conclusions and future developments

□ Localization of radioactive hot spots

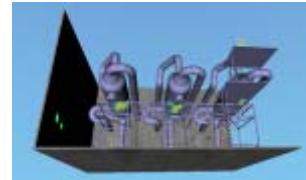


A major issue in several application fields

Dismantling activities



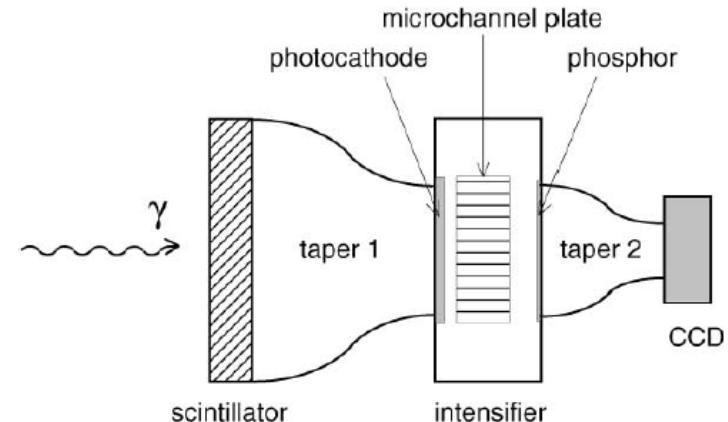
Radiation protection



Homeland Security



Gamma imaging: a powerful technique in the framework of these activities

CARTOGAM: an industrial standard

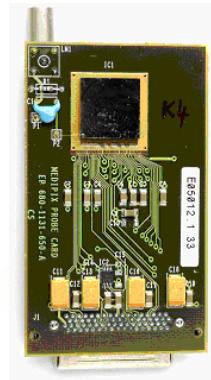
Developed by CEA⁽¹⁾, industrialized by AREVA CANBERRA

Performing but:

- **Sensitivity** has to be improved at low-energy
- **Weight** is too high for a handheld use
- Improve the interface

Coded Mask

Timepix chip

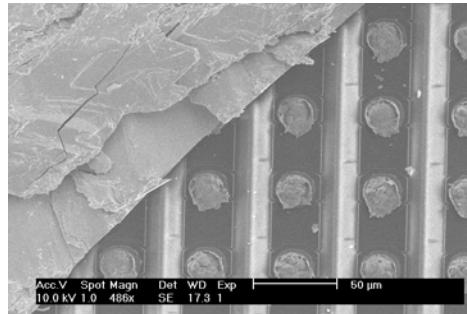


USB interface

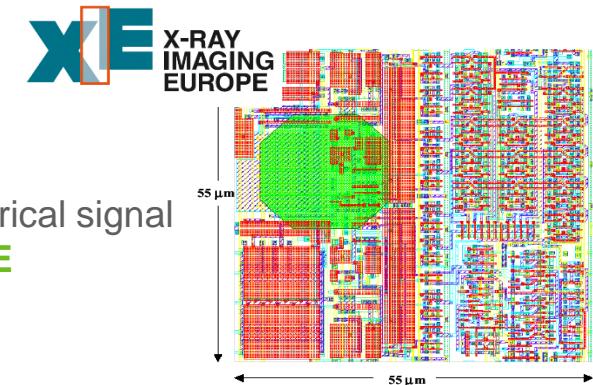


Camera's body

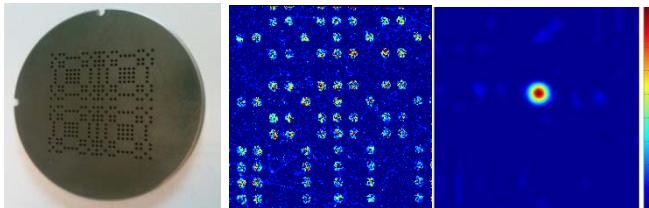
□ Timepix: the GAMPIX's heart



- Matrix of **256 x 256 pixels** (side **55 μm**)
- Hybridization with **CdTe** (thickness **1 mm**)
- **Direct conversion** from gamma-ray to electrical signal
- Developed by **CERN**, commercialized by **XIE**



□ MURA coded mask: a multi-pinhole collimator



- Great improvement of the **sensitivity** in comparison with a pinhole
- Need for a **decoding step**
- **Optimization** of the coded mask (**thickness/rank**) for a dedicated application

□ USB interface: highway to flexibility



Take your laptop and use GAMPIX!

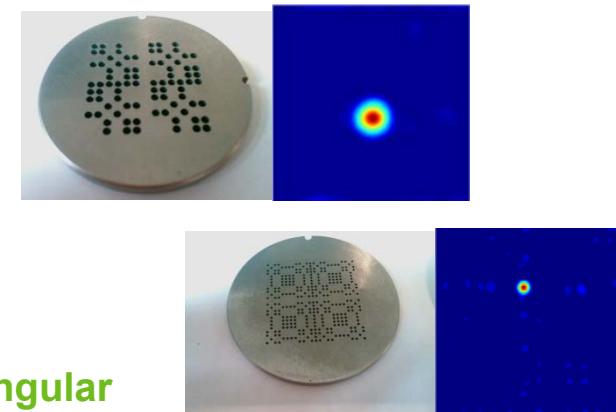
□ Sensitivity: current performances (without background)

Source	Dose rate ($\mu\text{Sv.h}^{-1}$)	Coded Mask Rank 13 – e=2 mm	Coded Mask Rank 7 – e=8 mm
^{241}Am	0.25	~3 s	1 s
^{137}Cs	2.50	300 s	20 s
^{60}Co	3.84	Not detectable	60 s

→ Able to cover a large energy range (from ^{241}Am to ^{60}Co)

□ Angular resolution for a FOV of 30°

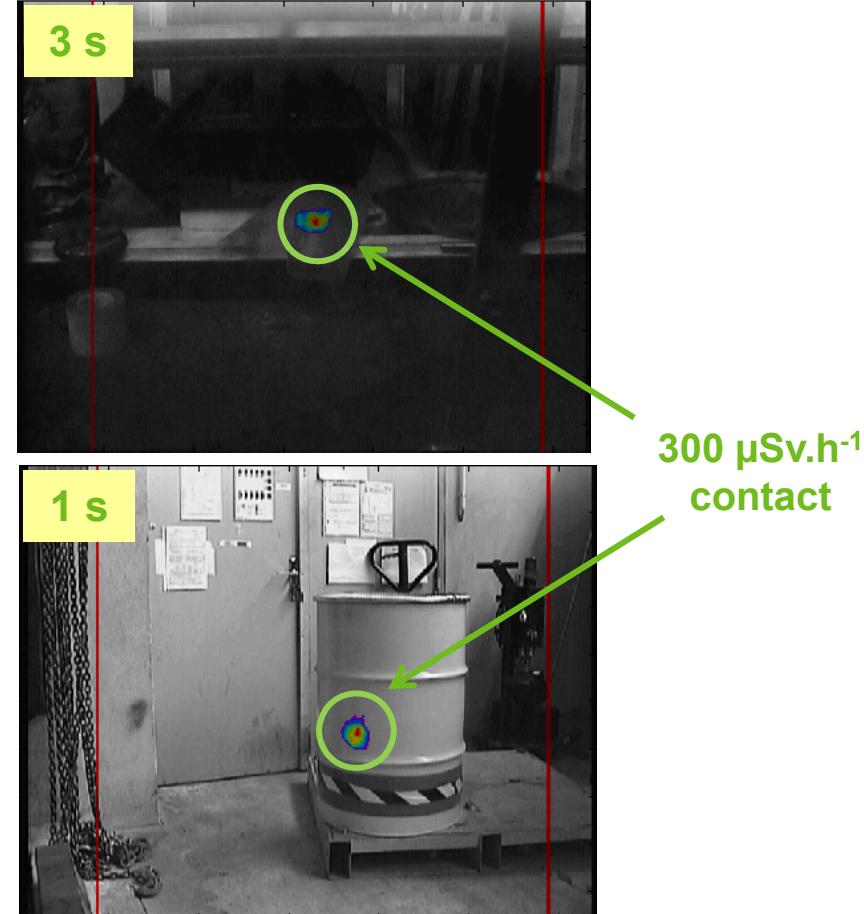
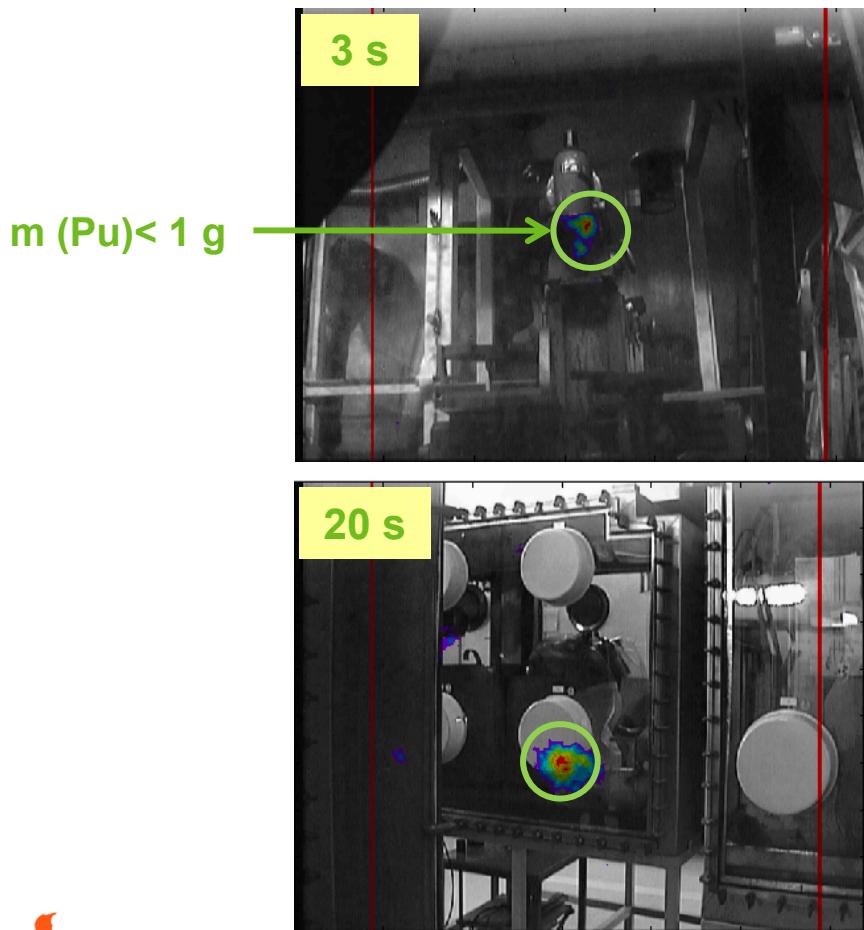
Source	Coded Mask Rank 13	Coded Mask Rank 11	Coded Mask Rank 7
^{241}Am	1.38°	2.12°	3.81°
^{137}Cs	1.35°	2.06°	3.68°
^{60}Co	-	2.57°	3.41°



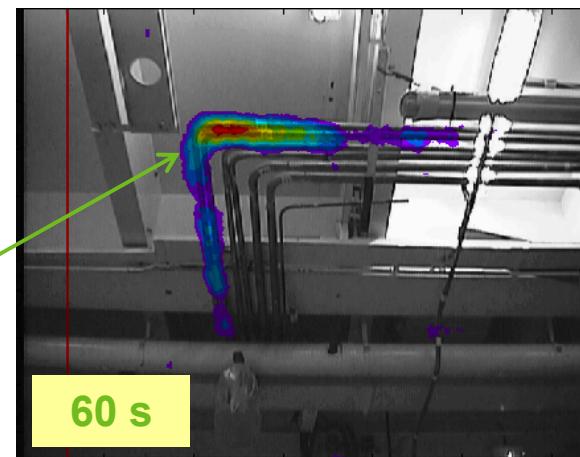
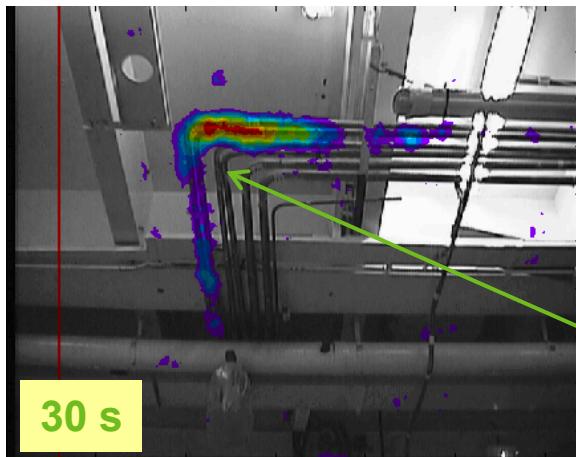
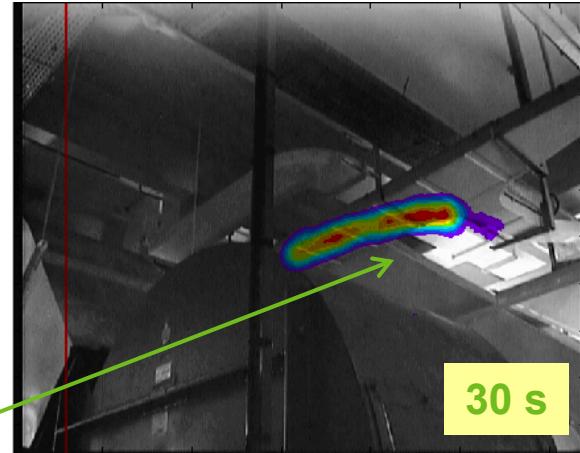
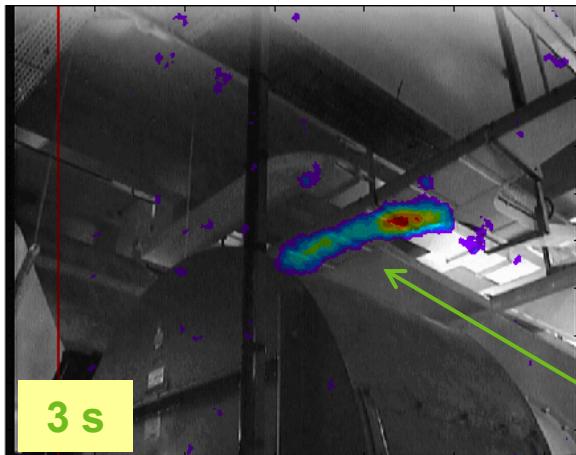
→ The greater the rank of the mask, the better the angular resolution

Results obtained at CEA DAM Valduc

□ Decommissioning purpose



Fast and accurate localization of plutonium hot spots

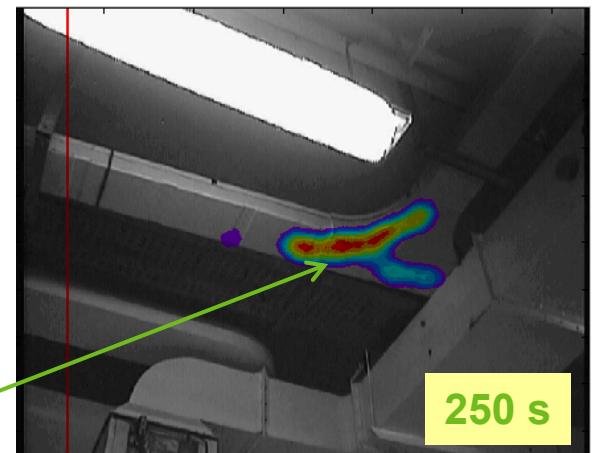
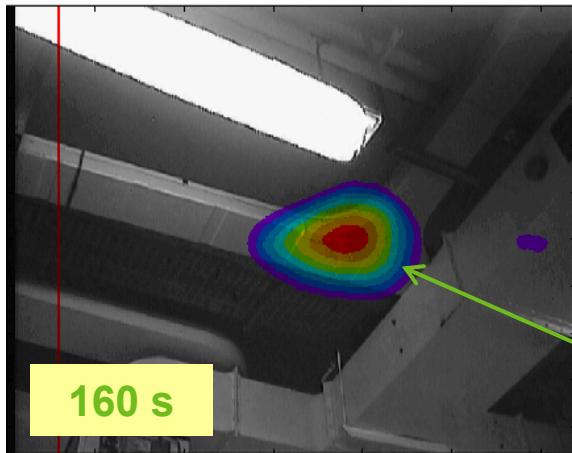
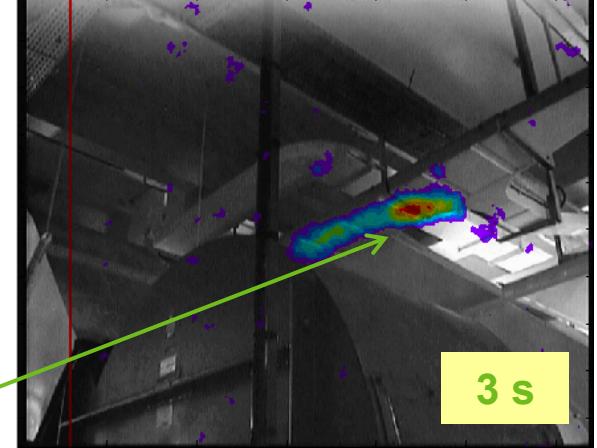
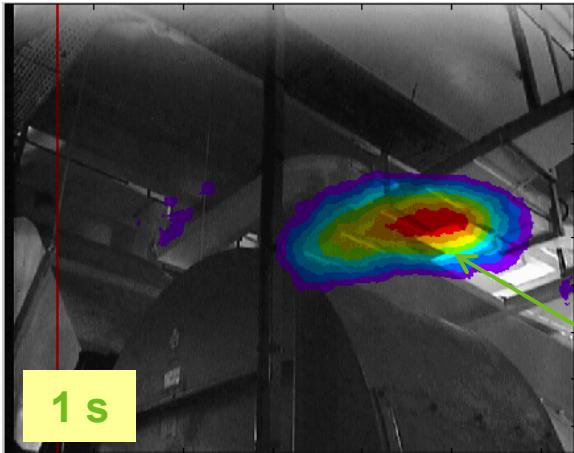
Pipe measurements

6 mSv.h⁻¹
contact

0.4 mSv.h⁻¹
contact

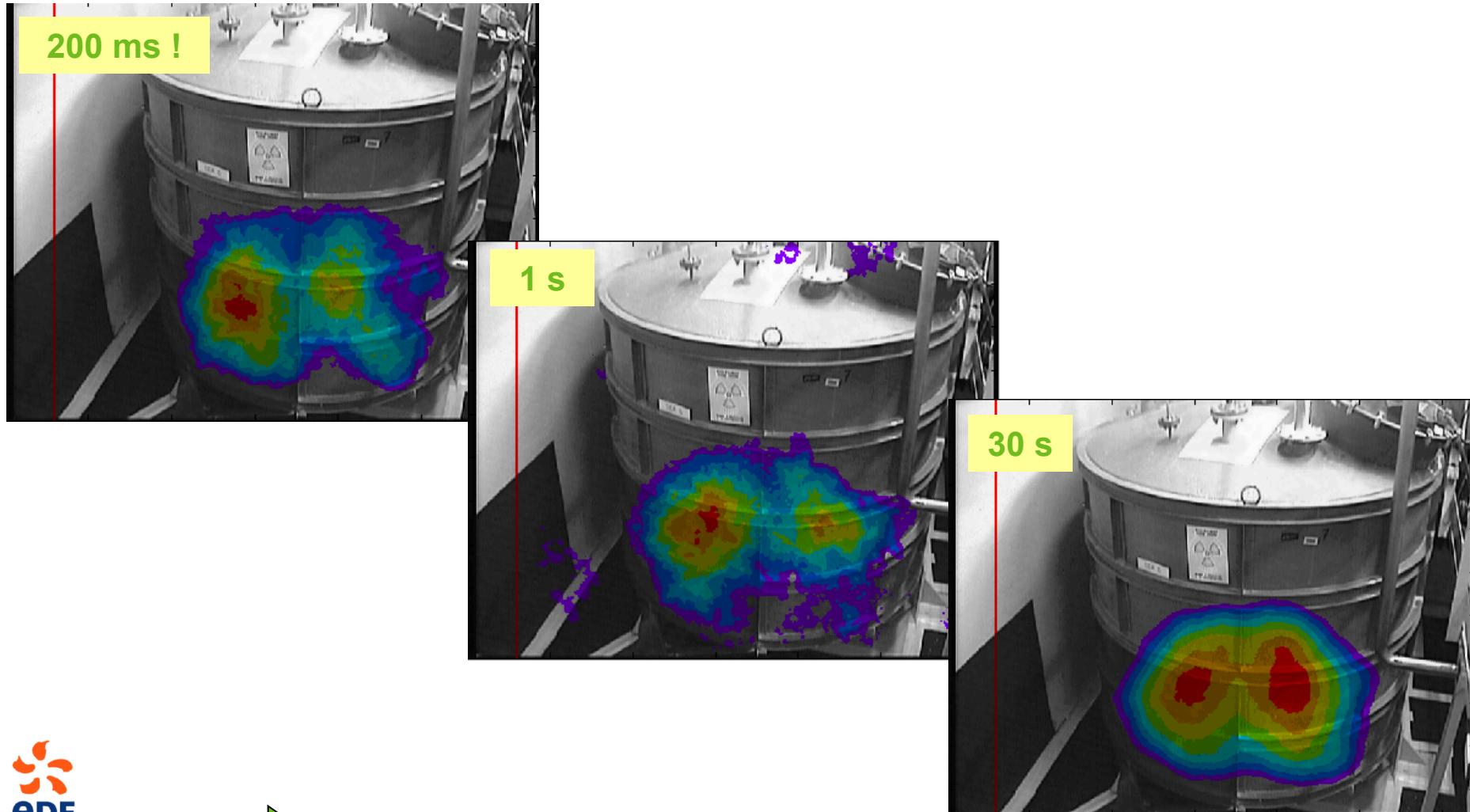


Increase of the **counting time = improvement** of the decoded gamma images

Impact of the rank of the coded mask

6 mSv.h⁻¹
contact

0.35 μ Sv.h⁻¹
contact

Real time gamma imaging measurements

Ability to detect **extended sources**

□ Main characteristics of a measurement in a NPP

- **Detection of ^{60}Co** (« high-energy » gamma-ray emitter)
- **Two measurements campaigns** (January 2011 / May 2011)
- **Constraints** for the deployment of a gamma camera



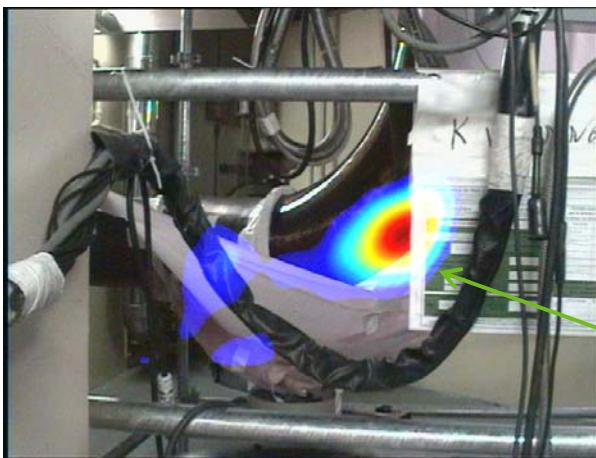
« Pink is beautiful... »

- Deployment of two generations of gamma camera

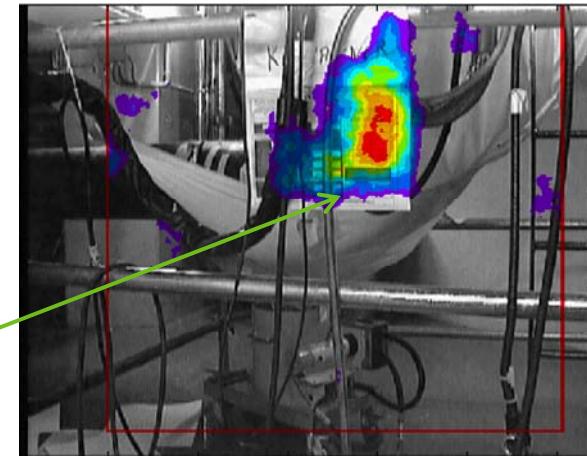
ALADIN



GAMPIX



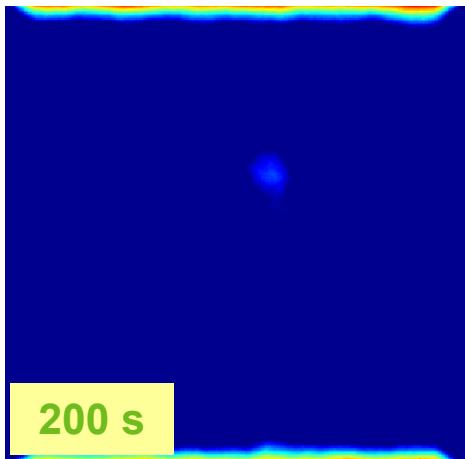
100 $\mu\text{Sv.h}^{-1}$
contact



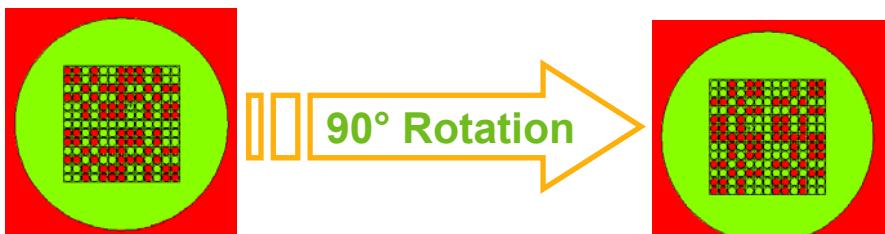
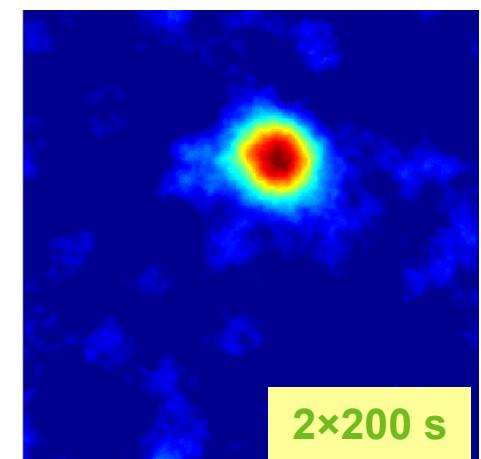
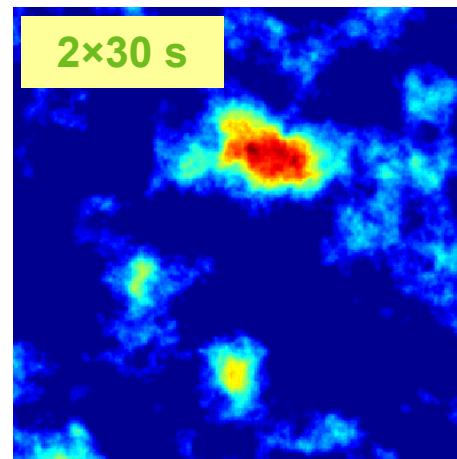
Example of application:
expansion leg of the pressurizer

Benefits of the mask/anti-mask procedure

Without correction



Mask/Anti-mask procedure



Detection of contaminated pipes

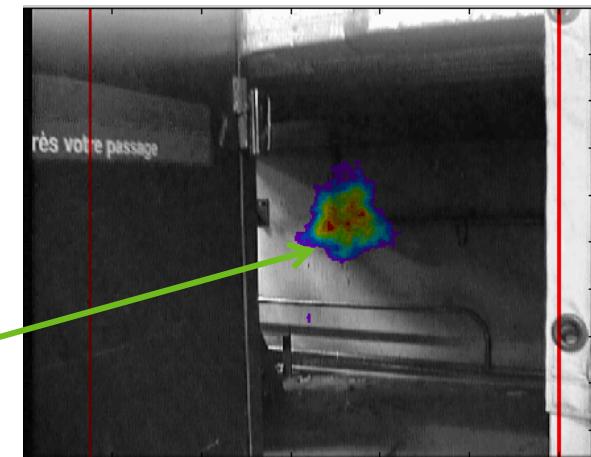
41 mSv.h⁻¹
contact

2×120 s



10 mSv.h⁻¹
contact

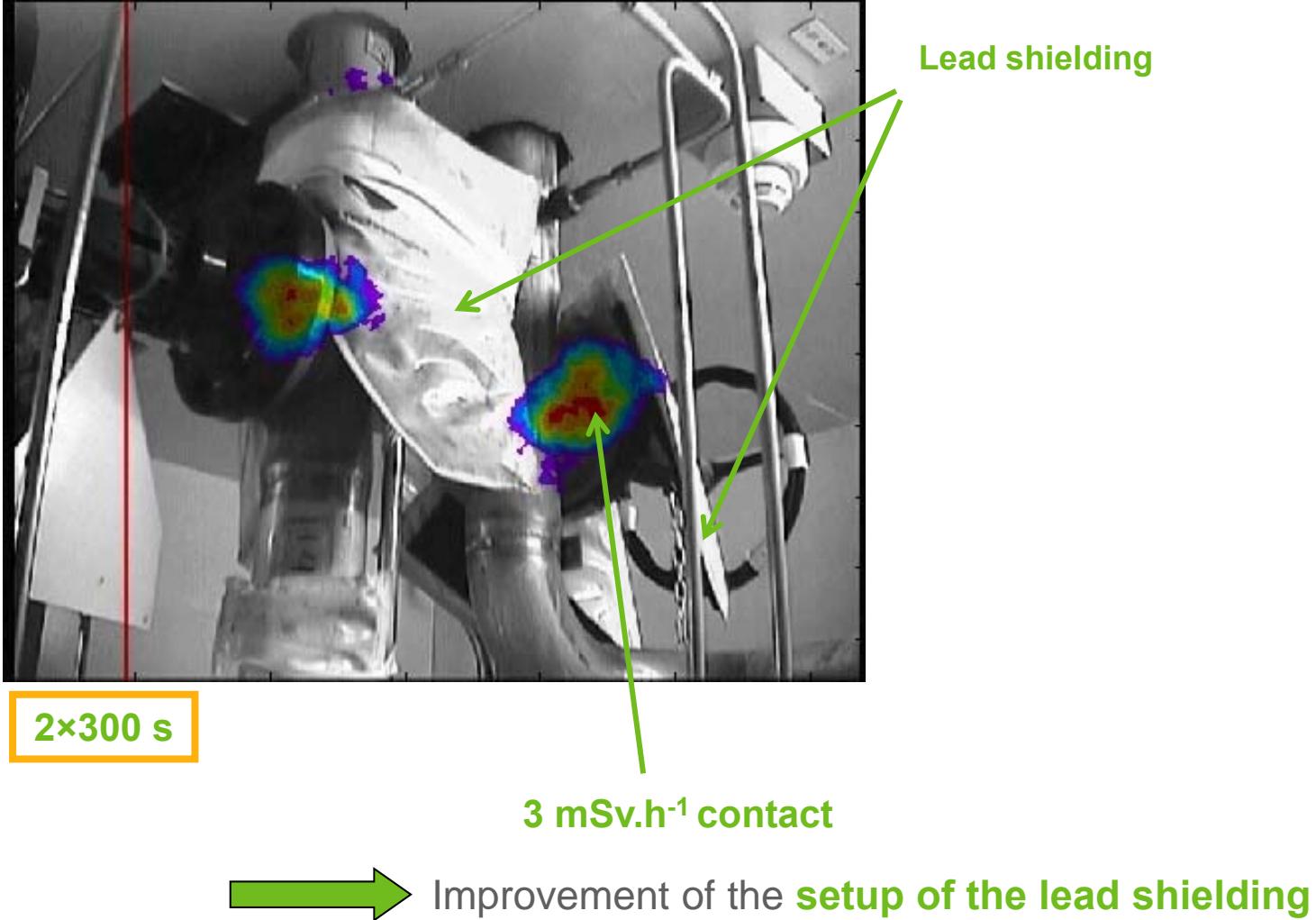
2×300 s



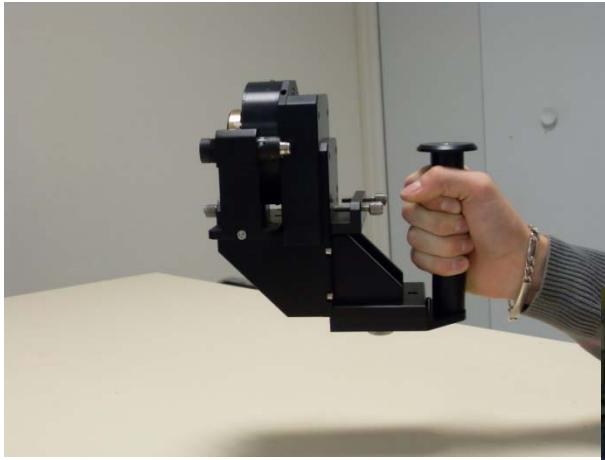
4 mSv.h⁻¹
contact

2×120 s

- Interest for the setup and control of radiobiological protections



- New way of use for a new generation of gamma camera

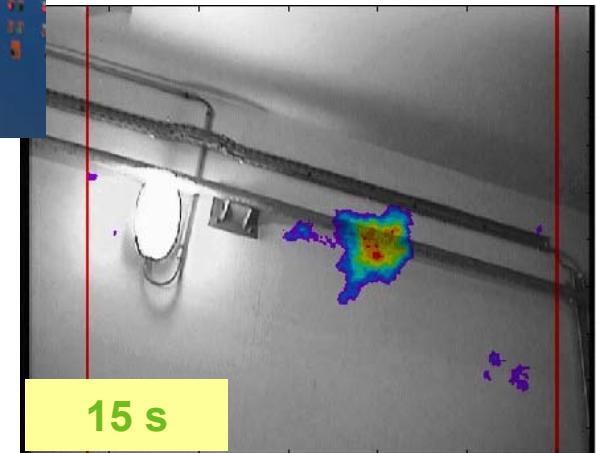


Light...and handheld system!



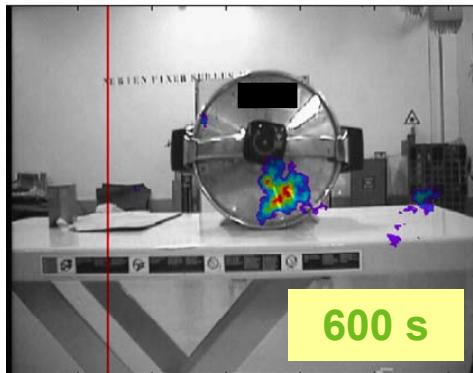
GAMPIX system

Operating people



Main purpose

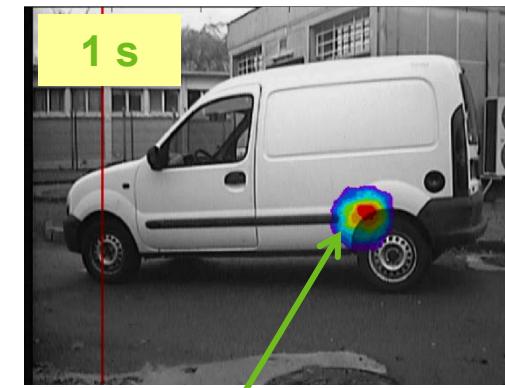
Detection of **illicit nuclear materials** (SNM, radioactive sources ...)

 Potential applications**SNM detection**

Natural uranium, metallic form

Luggage monitoring

^{241}Am , 74 MBq

Vehicle monitoring

^{241}Am , 18 GBq

□ Conclusions

- **GAMPIX:** a new generation of gamma camera based on the **Timepix pixellated chip**
- **Low weight (~ 1 kg), high sensitivity, plug-and-play system**
- Several application fields can be addressed (**radiation protection, D&D, Homeland Security**) using this gamma camera
- **Industrial transfer** currently in progress, industrial system **expected in 2012**

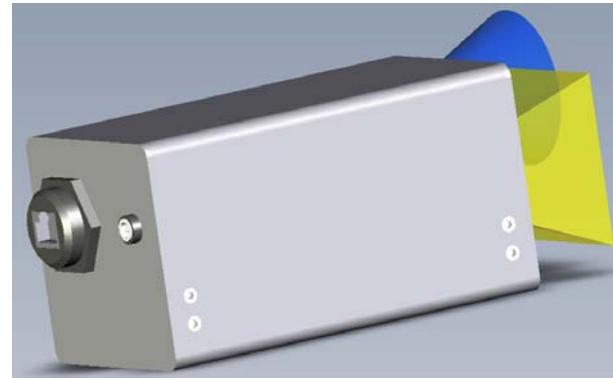
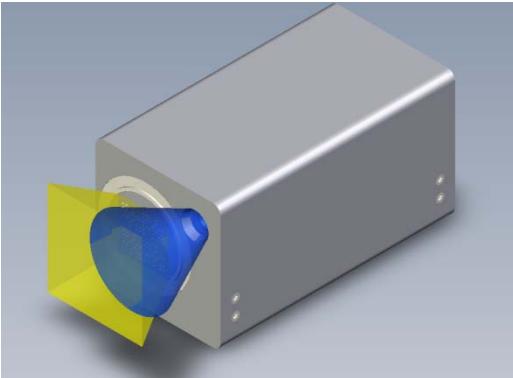


GAMPIX's product manager: **Roger Abou Khalil**
[\[roger.aboukhalil@canberra.com\]](mailto:[roger.aboukhalil@canberra.com])

□ Future developments

- Development of **spectrometric properties** using the Timepix chip (*Time-Over-Threshold mode*)
- Development of **3D abilities**
- Integration of the future **Medipix 3 chip**

□ GAMPIX: an industrial system in 2012



First industrial prototype
available at the beginning of 2012

□ Benefits of the industrial system

- **New design** ($L \times l \times P = 8 \times 8 \text{ cm} \times 15 \text{ cm}$)
- **Automatic mask/anti-mask procedure**
- **Optimized shielding**
- **Simplified connectivity** (only one cable)
- A **single software** for the acquisition and decoding steps

Thanks a lot for your
attention