



DE LA RECHERCHE À L'INDUSTRIE

DEVELOPMENT AND OPERATIONS OF THE ULTRA-COMPACT EMBEDDABLE GAMMA CAMERA NANOPIX

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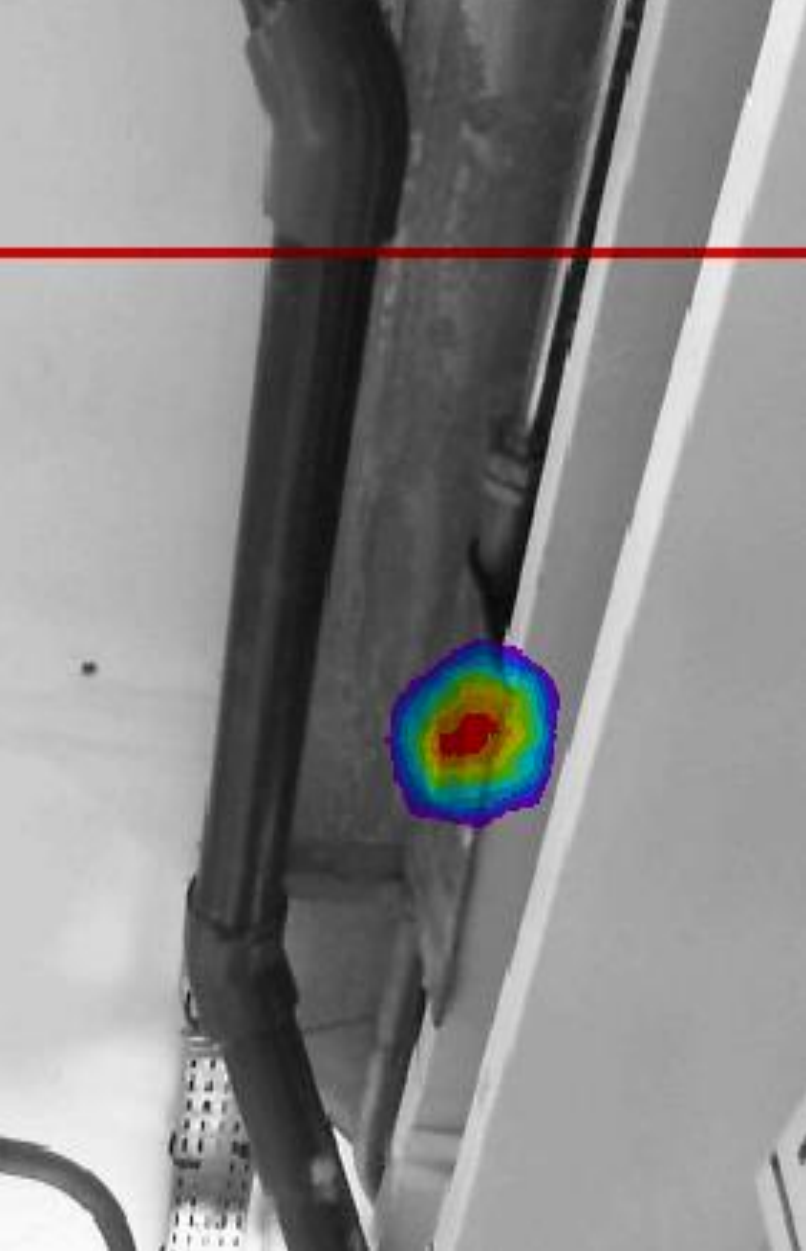
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01

VISUALIZE RADIOACTIVITY

*GAMMA IMAGING, A TECHNIQUE OF
GREAT INTEREST FOR RADIATION
PROTECTION AND D&D*



**Dismantling &
decommissioning**



**Nuclear waste
management**



Accidental situations



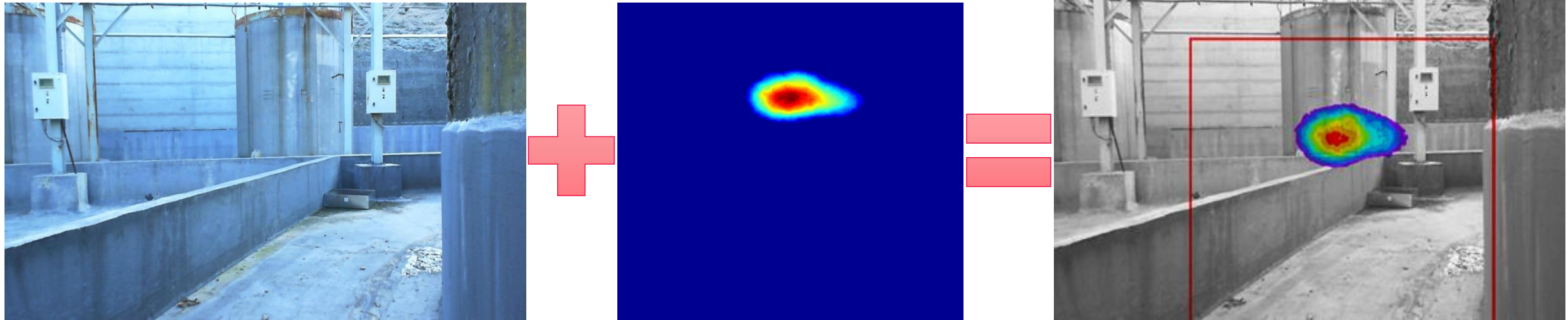
**Operational Radiation
Protection**



Homeland Security



Border monitoring



- **Superimposition** of a **gamma** image on a **visible** image
- **Remote visualization** of hot spots
- Information on **intensity / dose rate**



02

FROM GAMPIX TO NANOPIX

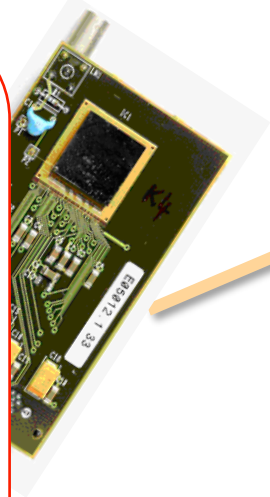
*DEVELOPING A SMART &
ULTRA-COMPACT IMAGER*

Timepix Detector

256 x 256 pixels

55 μm pitch1.4 x 1.4 cm^2 active zone

1 mm thick CdTe sensor



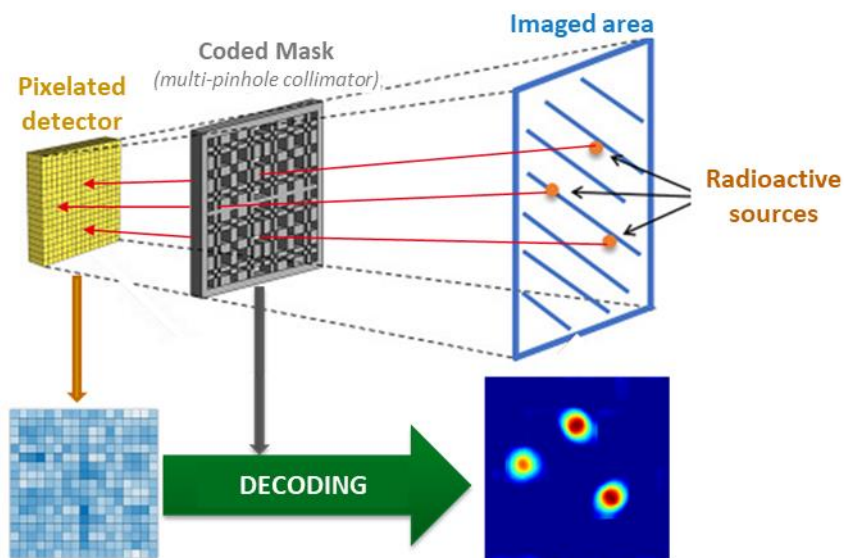
USB Interface

MIRION
TECHNOLOGIES

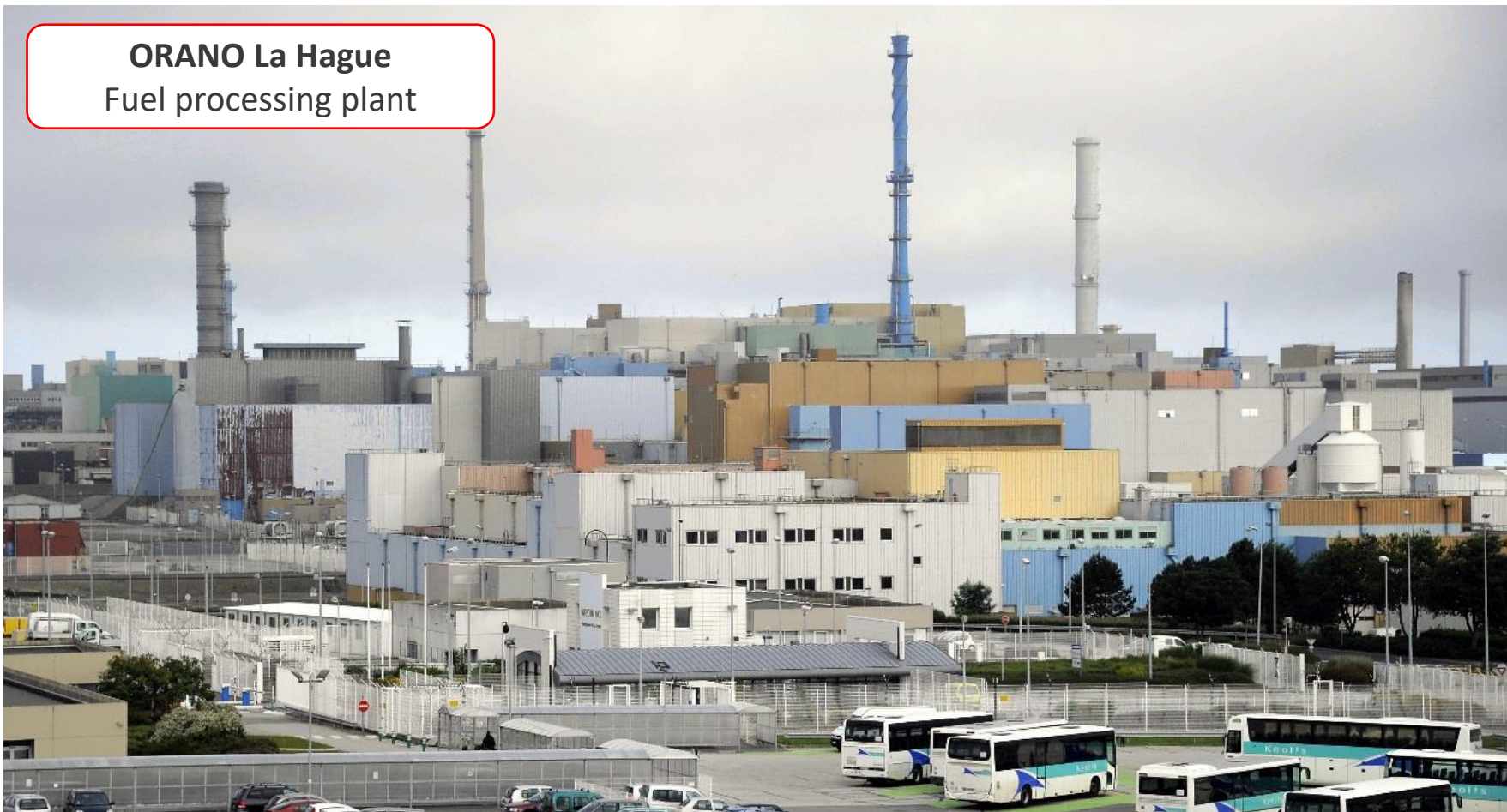
Coded Mask



Multi-pinhole collimator

Improved sensitivity /
Improved angular
resolution

ORANO La Hague
Fuel processing plant



Hot cells for fuel rods
(re)processing

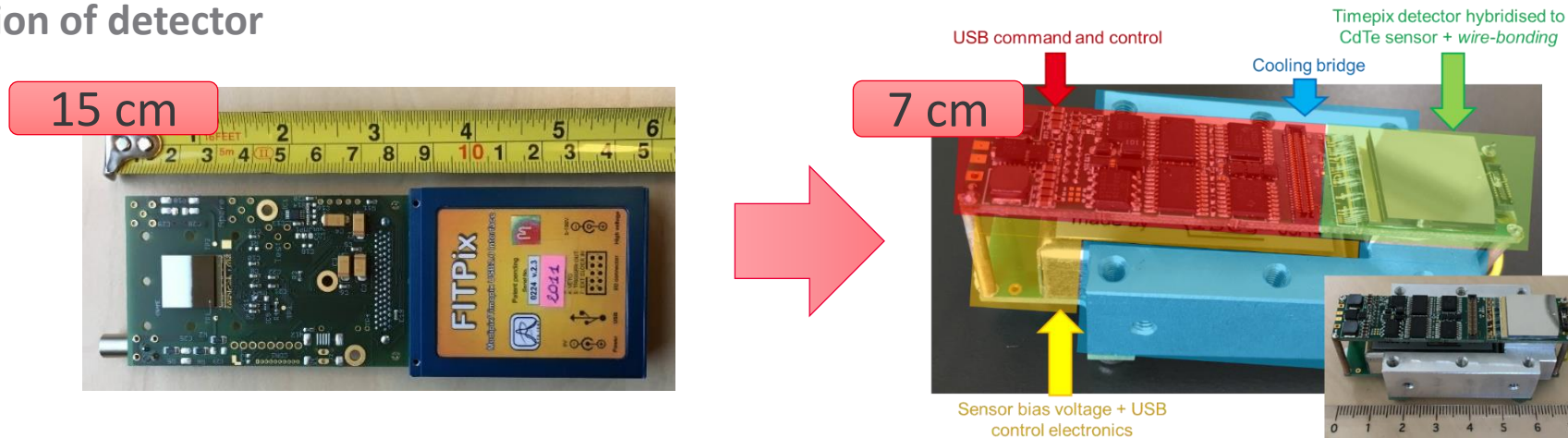


**ϕ 8 cm holes for
instrumentation**

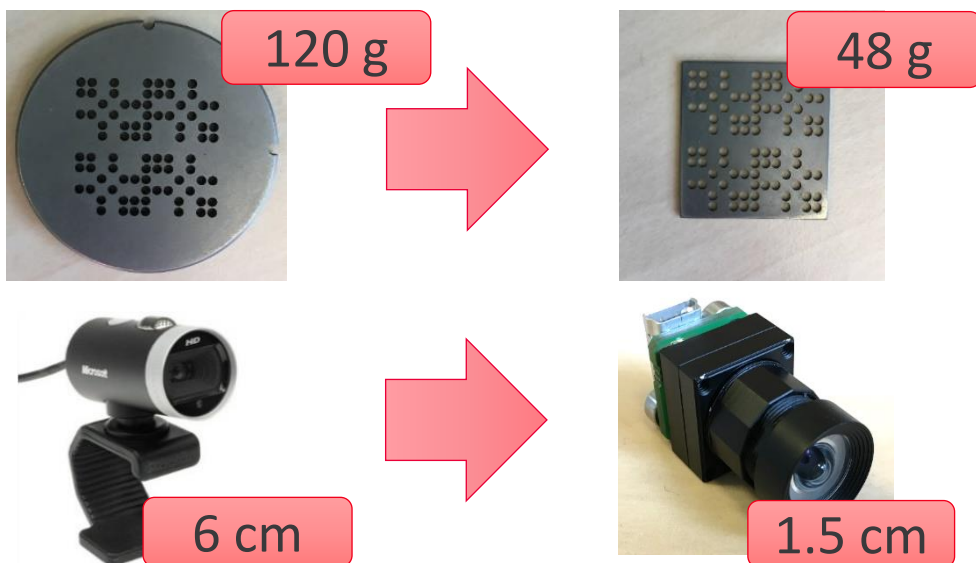


**Needs for the development of a
miniaturized gamma camera**

- Miniaturization of detector



- Miniaturization of other building blocks



NANOPIX Innovation Award

*World Nuclear Exhibition
Paris - 2018*



NanoPix
The smallest and lightest
gamma camera in the world

INTERFACING AND SUPERVISION

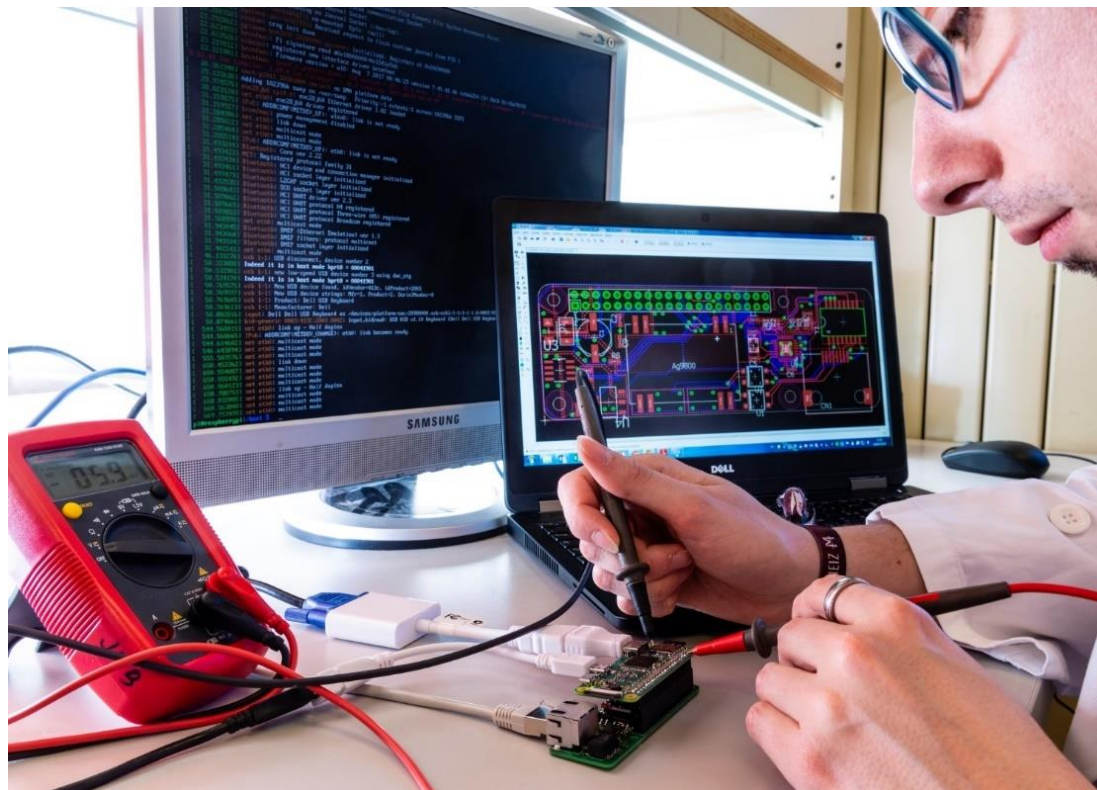


*Integration of onboard
intelligence*

CONNEXION AND POWER SUPPLY



*Improvement of
connexion (PoE)*

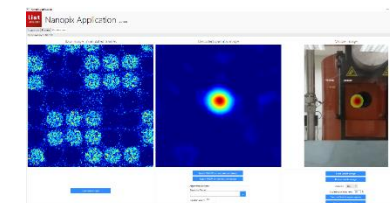


AUTOMATION



*Integration of
nanomotor for remote
control*

ACQUISITION AND TREATMENT



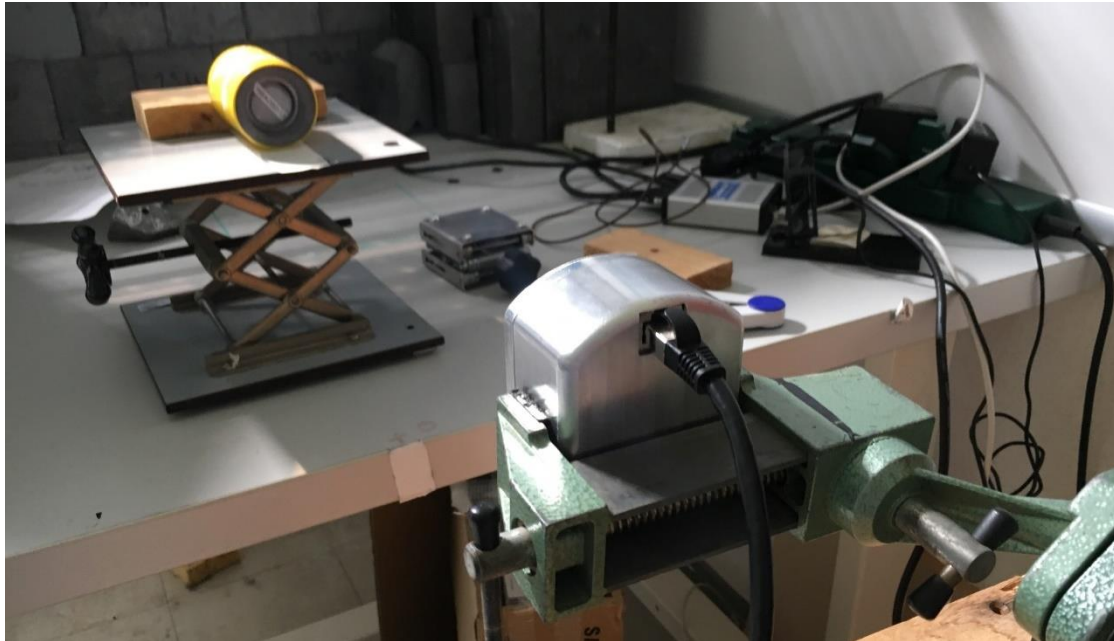
*Improvement of
software for embedded
application*

SMART-NANOPIX

**INNOVATION CONCENTRATED IN A
COMPACT GAMMA IMAGER**

***100 x 70 x 55 mm³
450 g***





Angular Resolution: **from 1.5 to 6°**

Field of View: **50°**

Dose rate range: **25 nGy.h⁻¹ to > 50 Gy.h⁻¹ (irradiator limit)**

Energy range: **8 keV to 1.5 MeV**

RN	Activity	Sensitivity @ 1 m
²⁴¹ Am	74 MBq	< 1s
¹³⁷ Cs	33 MBq	60 s
⁶⁰ Co	4,6 MBq	1200 s

Background rejection: **Yes**

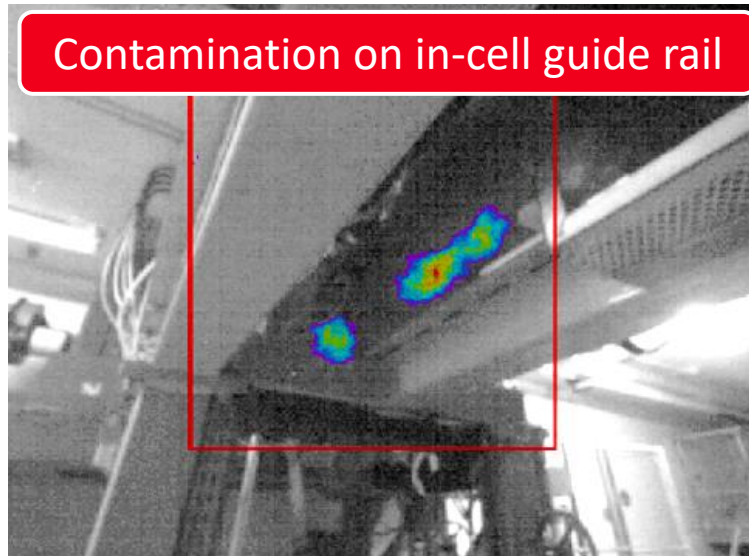
Spectroscopy capability: **Yes**

Dose Rate info possible: **Yes**

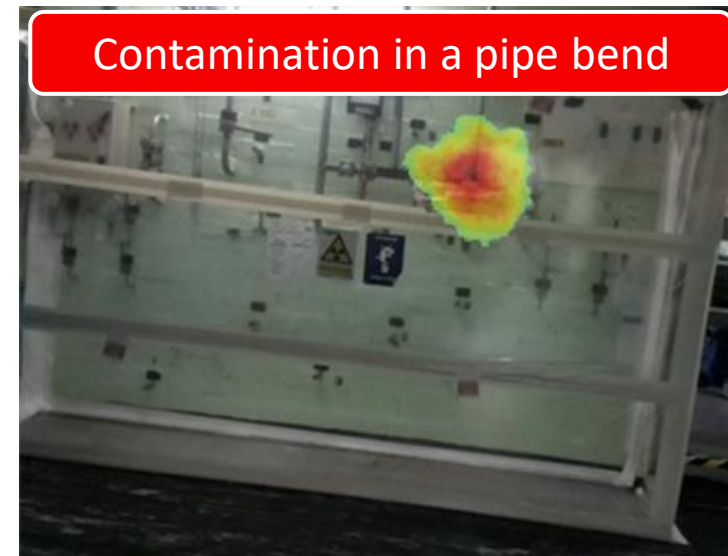
Remote hot spot location after fuel decladding operation



Contamination on in-cell guide rail



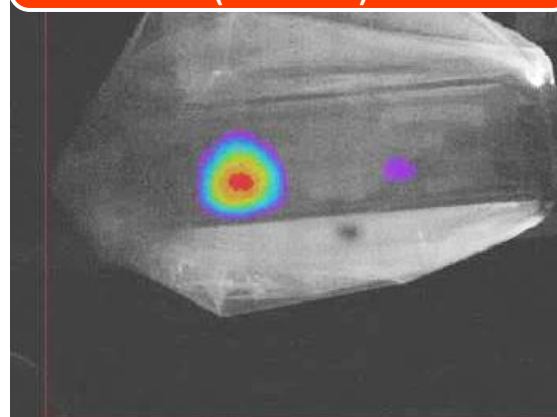
Contamination in a pipe bend



Liquid effluent contamination under glove box



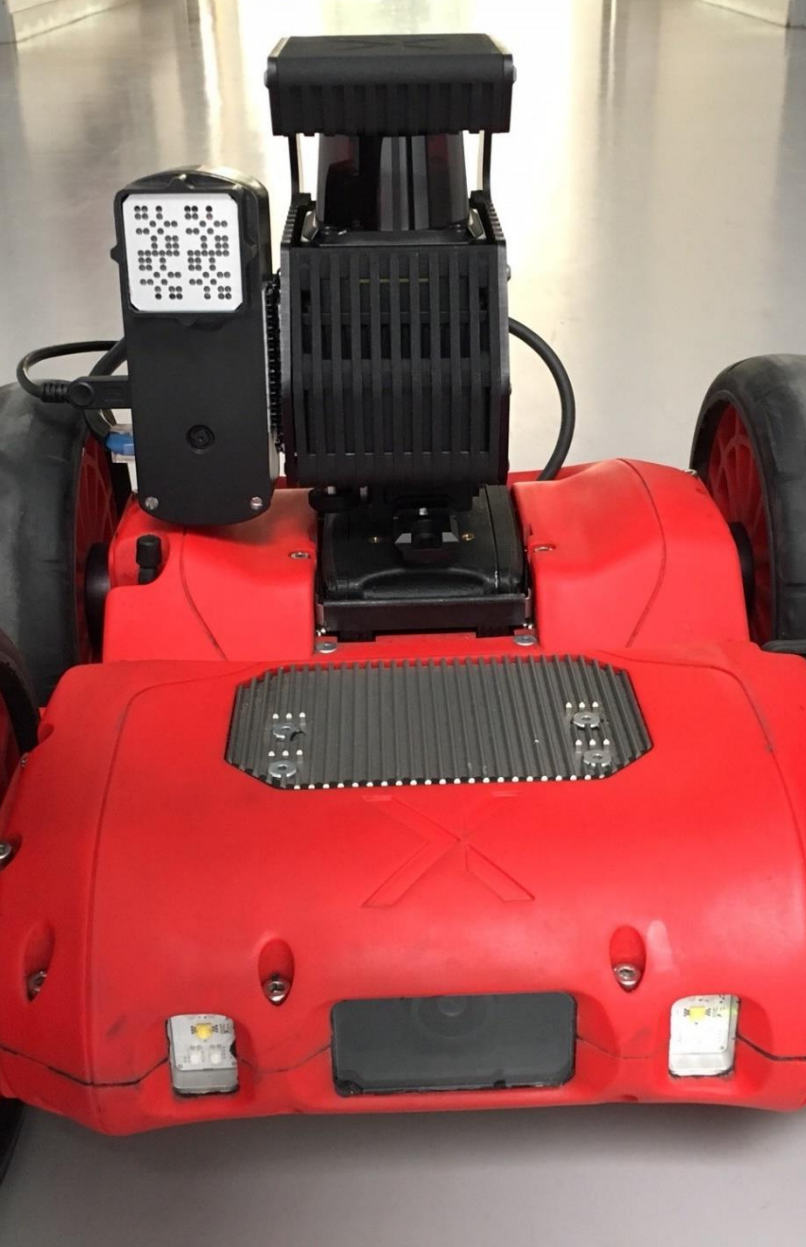
Contaminated filter (ratio $\frac{1}{4}$)



Contaminated part in a waste package



© Pictures are courtesy of **ORANO La Hague**



03

ROBOTIC VECTOR EMBEDMENT

*REDUCE OPERATORS EXPOSURE
WITH UNMANNED VEHICLES*

Embedment of Nanopix imager on **UGV / UAV for remote unmanned inspection** in the frame of H2020 TERRIFFIC Project



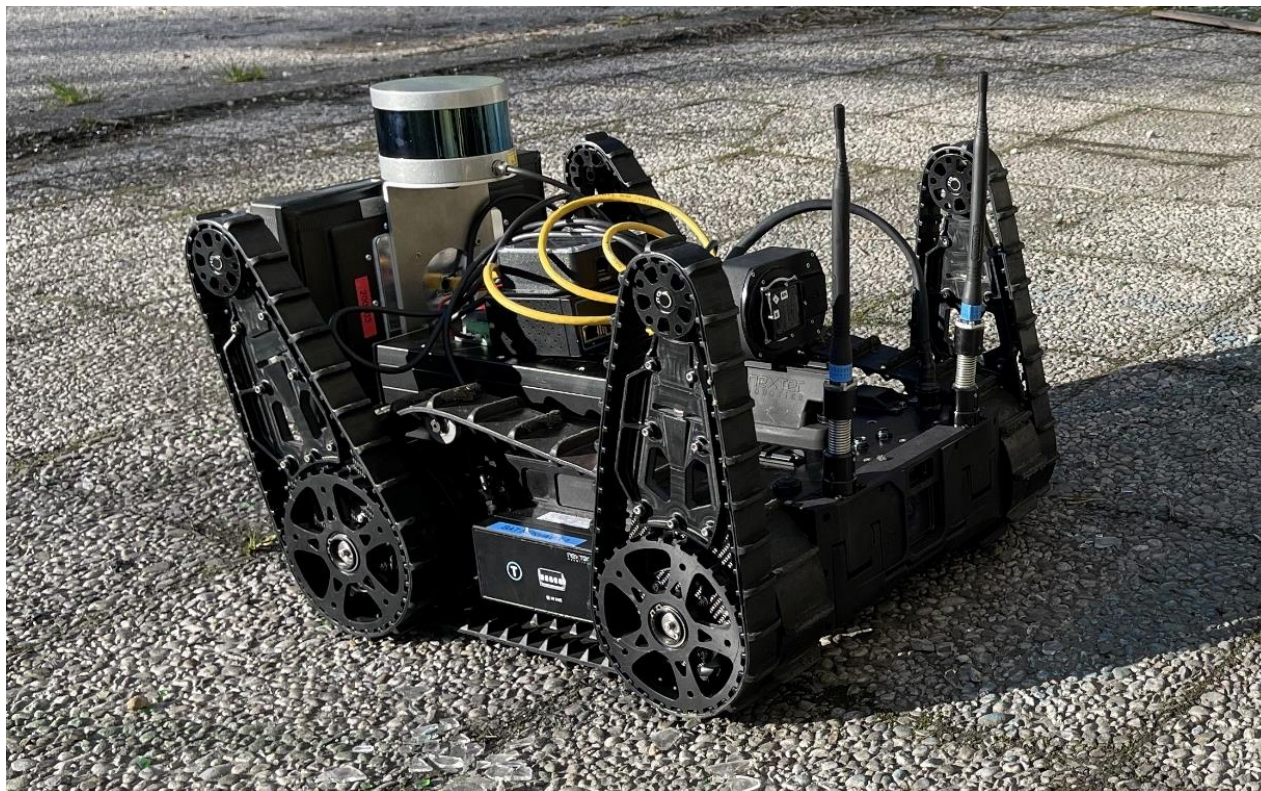
nexter
ROBOTICS

list
cea tech



aeraccess[®]
airborne engineering research

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 786729 (TERRIFFIC)



Results acquired during TERRIFFIC trials with French Firefighters in Chambéry (March 2021)

Location of a **300 MBq Cs-137 Source @5m in 20 seconds**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 786729 (TERRIFFIC)



Results acquired during TERRIFFIC trials
with Slovak and Czech Firefighters in
Bratislava (September 2021)



**Ir-192 (50.68 GBq) from 50m
in 6 min**



**Ir-192 & Se-75 in 90
sec, from 50m and
90 m**



**Se-75 (79.15 GBq) from 60m
in 2 min**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 786729 (TERRIFFIC)



Thank you for your attention

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