Andra Call for Projects
with the support of the
Investments for the Future Programme

CAMRAD

High-performance radiation-hardened imaging system for in-situ characterisation of nuclear waste

Project supported by Andra under the "Investments for the Future Programme" ("Investissements d'Avenir") - Selected under the Andra Call for Projects "Optimization of post-dismantling radioactive waste management", organized in cooperation with the French National Research Agency (ANR).

Duration: 48 months

Project launch: 05/2016

Total project cost: €5 million

Sum covered under the Investments for the Future Programme: €1.9 million

Type of financial support: Subsidy with ROI guarantees for the State

Locations: Toulouse (31), Saint-Etienne (42), Bruyères-le-châtel (91), La Défense (92), Saclay (91)

Coordinator: ISAE-SUPAERO (French Higher Institute of Aeronautics and Space)

Partners:

- ISAE-SUPAERO
- Hubert Curien Laboratory, UMR CNRS 5516, University of Lyon, University of Saint-Etienne
- CEA, Department of Military Applications (DAM)
- Areva
- Optsys
- IRSN

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BACKGROUND

The visual inspection of conditioned or unconditioned radioactive waste is a significant safety issue for all waste management processes from production site characterisation to disposal. The constraints of this type of inspection include obtaining optimal image quality, unaffected by the radiological environment on decommissioning sites and radioactive waste management sites. Ionising radiation has a number of harmful consequences on camera components. In particular, it prevents electronics from functioning properly and can modify the optical characteristics of materials.

The cumulated dose of ionising radiation that a camera can bear before loss of visual inspection directly affects the frequency of required maintenance and replacement operations (with a direct impact on cost and human risk). The most resilient solutions currently available are monochrome tube cameras which are bulky and fragile. The nuclear industry is therefore looking for radiation-resistant (hardened) imaging systems that are more versatile, compact and effective, using CMOS imaging technologies. These chip-based cameras are used in all modern smartphones and digital cameras, and present the advantage of getting all the electronics onto a single circuit just a few square centimetres in size, while offering the best performance on the market.

OBJECTIVES

The industrial research project, CAMRAD, seeks to develop and test, under real conditions, a high-performance (colour camera, high sensitivity and high resolution) imaging system that is resistant to ionising radiation (over 1 MGy) for characterising nuclear waste and general use in the nuclear industry.

PROJECT SEQUENCE

The CAMRAD project will be carried out over four years and is split into two phases:

- an operational phase where several radiation-hardening options for the various camera sub-systems (lenses, CMOS sensor, flash system) are studied and tested to identify the most promising solutions;
- a radiation-hardened camera prototype development phase which will lead to an imaging system that can be directly rolled out under real conditions.

▶ Example of an assembled camera illustrating the CAMRAD project objective.

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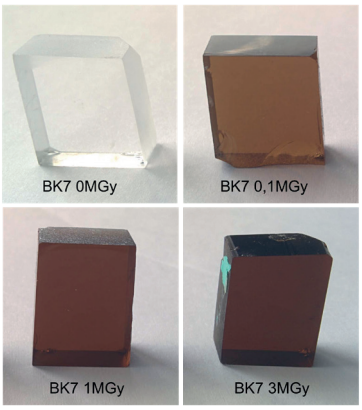
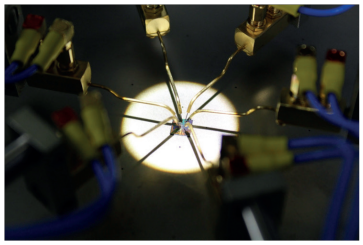
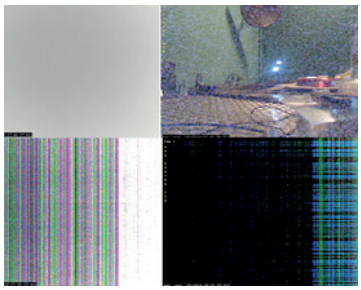


▶ Blackening of lenses under the effect of radiation (0 MGy =no radiation).



▶ Prototype of a CMOS "chip-based camera" during an electrical test.



▶ Alteration of a non-hardened camera image under the effect of radiation

EXPECTED RESULTS

Innovation

Unlike conventional products based on "off-the-shelf" components, CAMRAD intends to optimise design and develop new, more radiation-resistant, technological building blocks for each camera sub-system. That way, all hardening-related constraints will be taken into account across all of this new camera's development stages.

CAMRAD is looking to develop a camera with a much greater resistance to ionising radiation than existing products (cumulative dose of 1-10 MGy) with performance levels not generally found on this market (colour image, high resolution, compact design, etc.).

Economic impact for radioactive waste management and other nuclear applications

The prototype developed under CAMRAD will improve conditions for the inspection and monitoring (with high quality images) of radioactive waste and nuclear facilities, in areas that are currently inaccessible, and significantly reduce the frequency of replacement of these imaging systems due to their greater radiation resistance. All of these advances will have a direct positive impact on costs and on the safety and security of personnel in these facilities

Optsys, a company specialised in the manufacture of reinforced cameras (mechanical and thermal resistance) for military applications, is responsible for the industrial integration of developments under the CAMRAD project. This project therefore has the potential for diversification for business applications.

Scientific impact

The behaviour of electronic, optical and optoelectronic technologies under the dose levels addressed by CAMRAD remains unknown. This project seeks to move the industry forward by identifying the damage mechanisms for these camera components and proposing changes to improve resistance to ionising radiation. These advances could prove useful for the development of any radiation-resistant electronic system.

APPLICATION AND COMMERCIALISATION

The radiation-hardened camera prototype will be able to meet requirements for observation in intense radioactive environments, such as:

- the inspection and monitoring of nuclear plants (particularly areas that are too radioactive to use existing cameras or rely on human intervention), disposal of radioactive waste and development of radiation-resistant emergency response robots;
- the maintenance and instrumentation of nuclear physics facilities (particle accelerators) and experimental reactors;
- some space exploration missions (e.g. future missions to Europa, Jupiter's moon).