

# A Calibrated X-Ray Irradiation Platform

## COLLABORATION

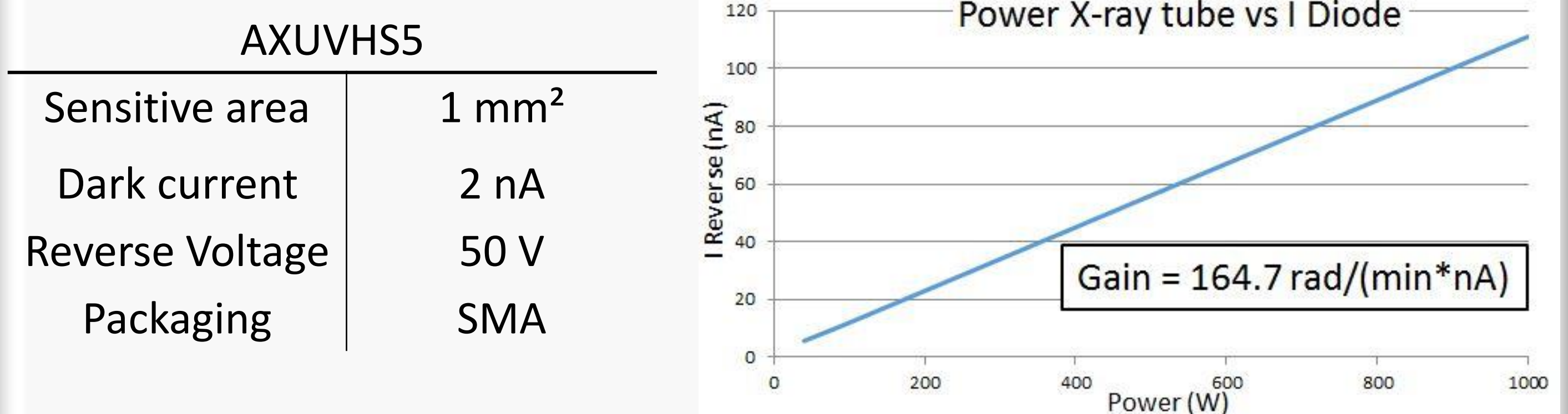
An X-Ray irradiation system is developed jointly between the CPPM and the REER<sup>(\*)</sup> department of the IM2NP. These two institutes lead some common studies about characterization and reliability of advanced CMOS technologies.

This platform, located at Marseille, is used for applications requiring a very high radiation tolerance level, such as particles physics experiences where the environment can be particularly radioactive.

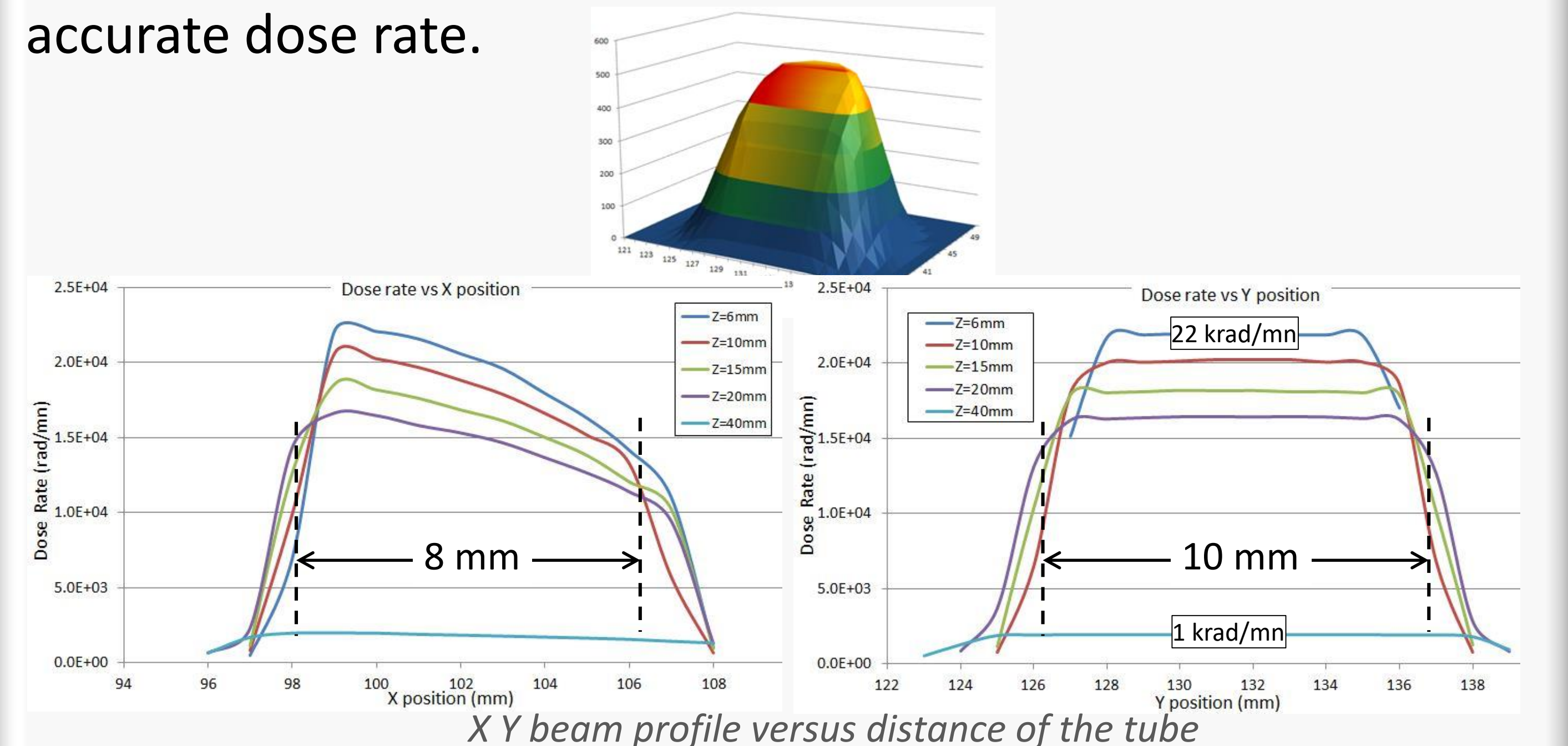
(\*): Radiation Effects and Electrical Reliability

## CALIBRATION

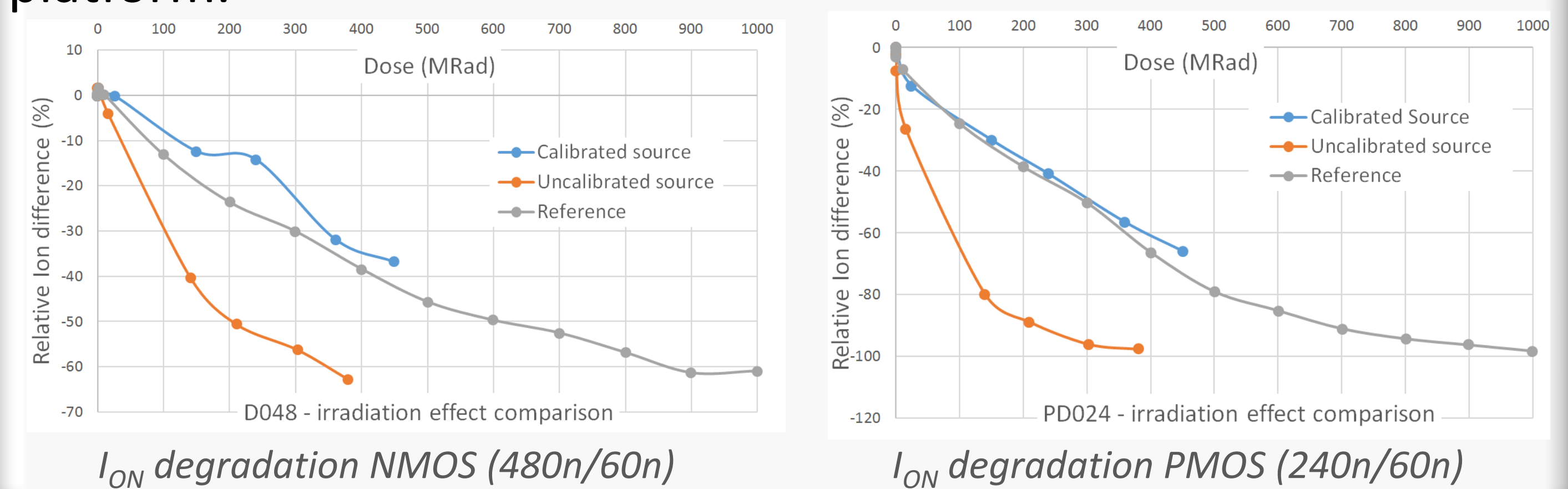
The X-ray source has been calibrated with an AXUVHS5 PIN diode, thanks to the CERN-EP/ESE group which has a pre-calibrated facility. Main properties of this device are a negligible dead region on its sensitive area and a very thin radiation-hard passivation layer (3-7nm). The quantum efficiency of AXUV diodes can be predicted close to the theoretical expression  $E_{ph}/3.6$ , where  $E_{ph}$  is the photon energy (eV), and for a large range of wavelength including X photons. The gain of our samples has been extracted as show in the following picture.



Following this characterization, a beam profile has been extracted for different Z values in order to determinate an accurate dose rate.

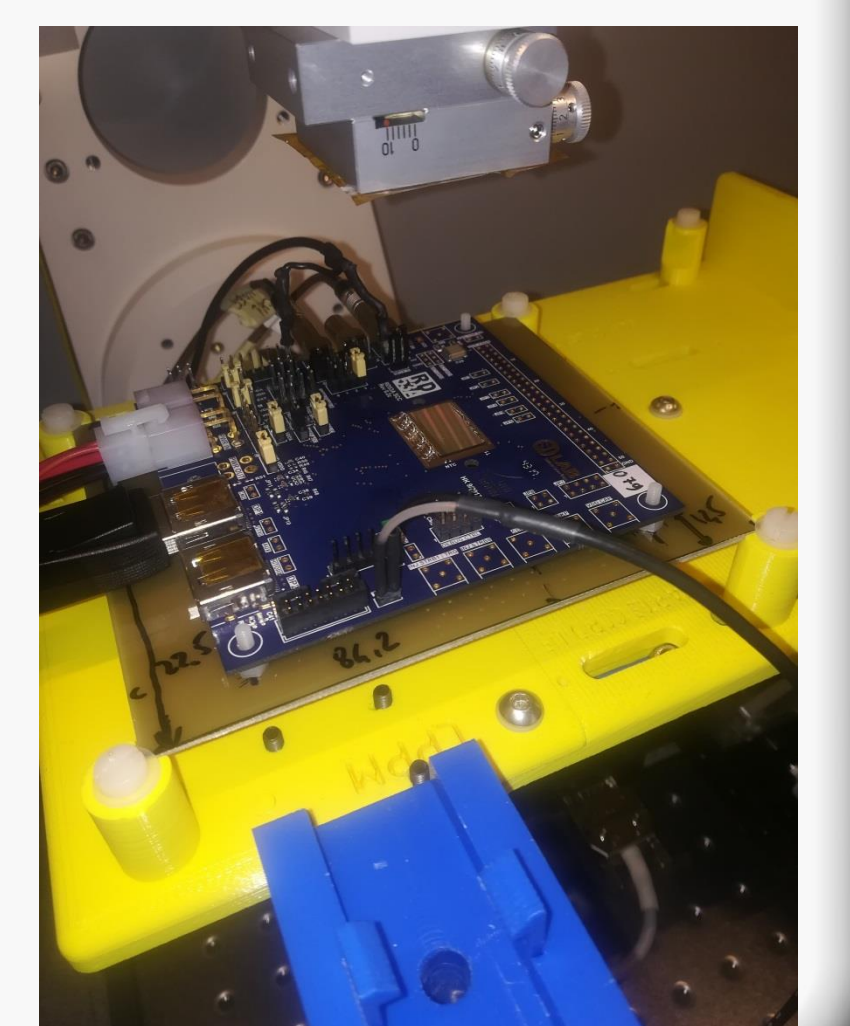


To be sure about the value of the measured dose rate, a 65 nm chip transistors has been irradiated (dose rate@1 Mrad/hour). This chip is considered as a reference and has been irradiated previously with a calibrated X-Ray source at CERN. Results we obtained show a similar behavior with the reference chip and validate all calibration steps we did on this new irradiation platform.



## ONGOING...

Actually, a new irradiation campaign is ongoing to characterize a RD53A chip. This chip will be implemented in the inner tracker for the upgrade of ATLAS experience at CERN in 2024. Two main irradiation campaigns are foreseen, first @ high dose rate (1 Mrad/hour), the second @ very low dose rate (<100 krad/hour).

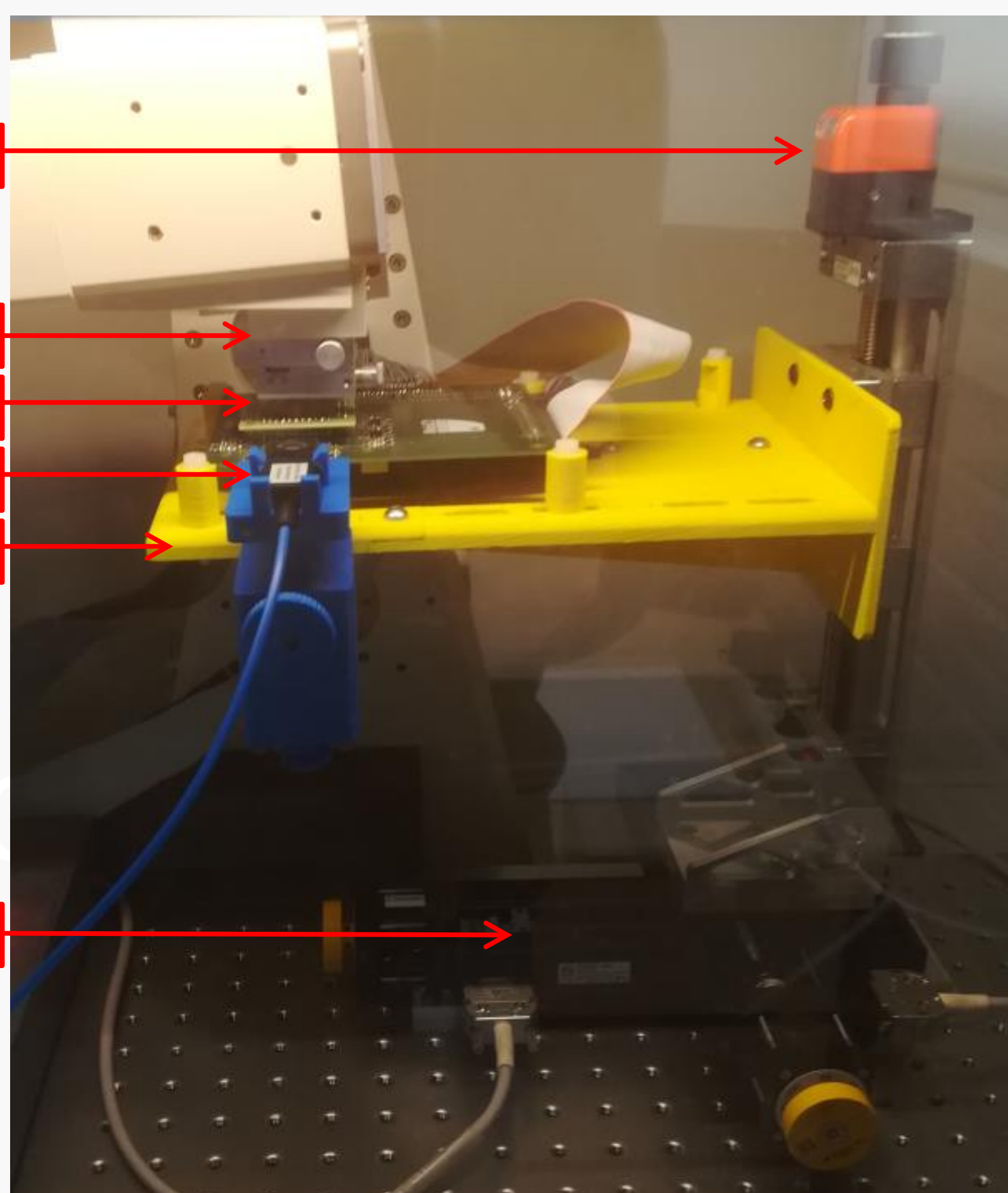


## IRRADIATION SYSTEM

The irradiation system is composed of an X-ray machine (Thermofisher (ex Inel) : Model XRG3D), and a table with crossed movements (Physik Instrument Model VT-80). The Z movement is manual in order to approach the sample to the tube with an accurate distance less than  $\pm 1$ mm. A printed 3D support is mounted to this mechanical part for the electronic boards integration. All measurements are done at room temperature. Studies are ongoing in order to irradiate samples at negative temperature values.

Main characteristics :

X ray generator	
Target material	Tungsten (peak@10 keV)
Dose rate	up to 1 Mrad(SiO <sub>2</sub> )/hour
Supply voltage	20 kV max.
Tube current	20 mA max.
Al filter <sup>(*)</sup>	120 $\mu$ m
Linear stage	
Travel range	150 mm
Velocity	20 mm/s max.
Repeatability	$\pm 10 \mu$ m



Irradiation test set-up

(\*) : Al filter of 120  $\mu$ m is inserted to ensure a uniform dose rate in the DUT that has to be exposed bare (no package).