

From soft to hard X-rays: eICE facility



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Abstract

The project "extended Instrument Calibration Equipment (eICE)", funded by the "Bando per il potenziamento dei Laboratori Spaziali dell'Istituto Nazionale di Astrofisica", is aimed to extend the testing and calibration capability of IAPS laboratories, both in the soft X-rays (0.5 keV - 2 keV), and in the hard X-ray band (20-100 keV - goal 150 keV).

Calibration of X-ray detectors at INAF-IAPS

The "Instrument Calibration Equipment" (ICE) [1] was developed at IAPS to calibrate IXPE Detector Units [2] with polarized and unpolarised X-rays in the 2-8 keV energy band (the facility can operate in the 2-20 keV energy band). It exploits Bragg diffraction at nearly 45° of radiation sources from X-ray tubes onto crystals to produce polarized light. It is equipped also with a gas mixing system to operate gas detectors with gas flowing. Moreover, a facility for calibrating detectors in the 0.5-2 keV energy range in a vacuum chamber (10^{-6} - 10^{-7} mbar) is under development outside the clean room.

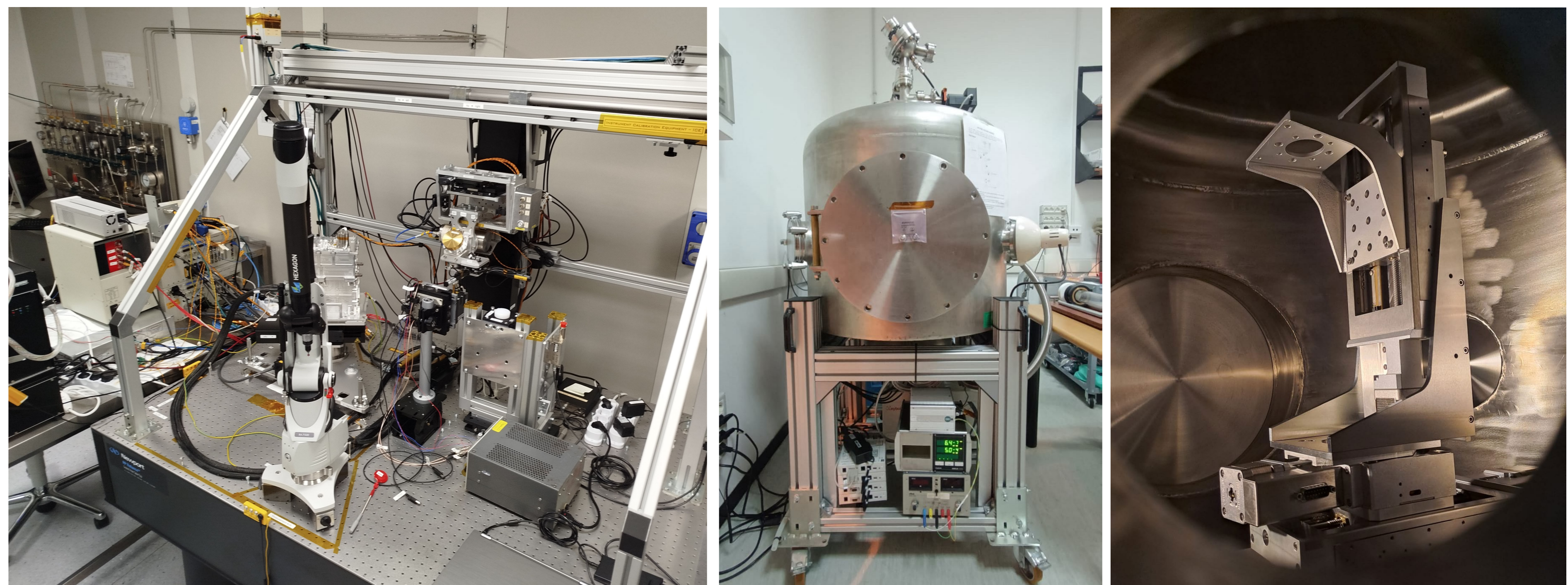


Fig. 1: **Left:** Instrument Calibration Equipment (ICE) in a cleanroom ISO 7 with gas mixing system on the left. **Center:** vacuum chamber for calibration of detector below 2 keV. **Right:** interior of the vacuum chamber with movements for the detectors.

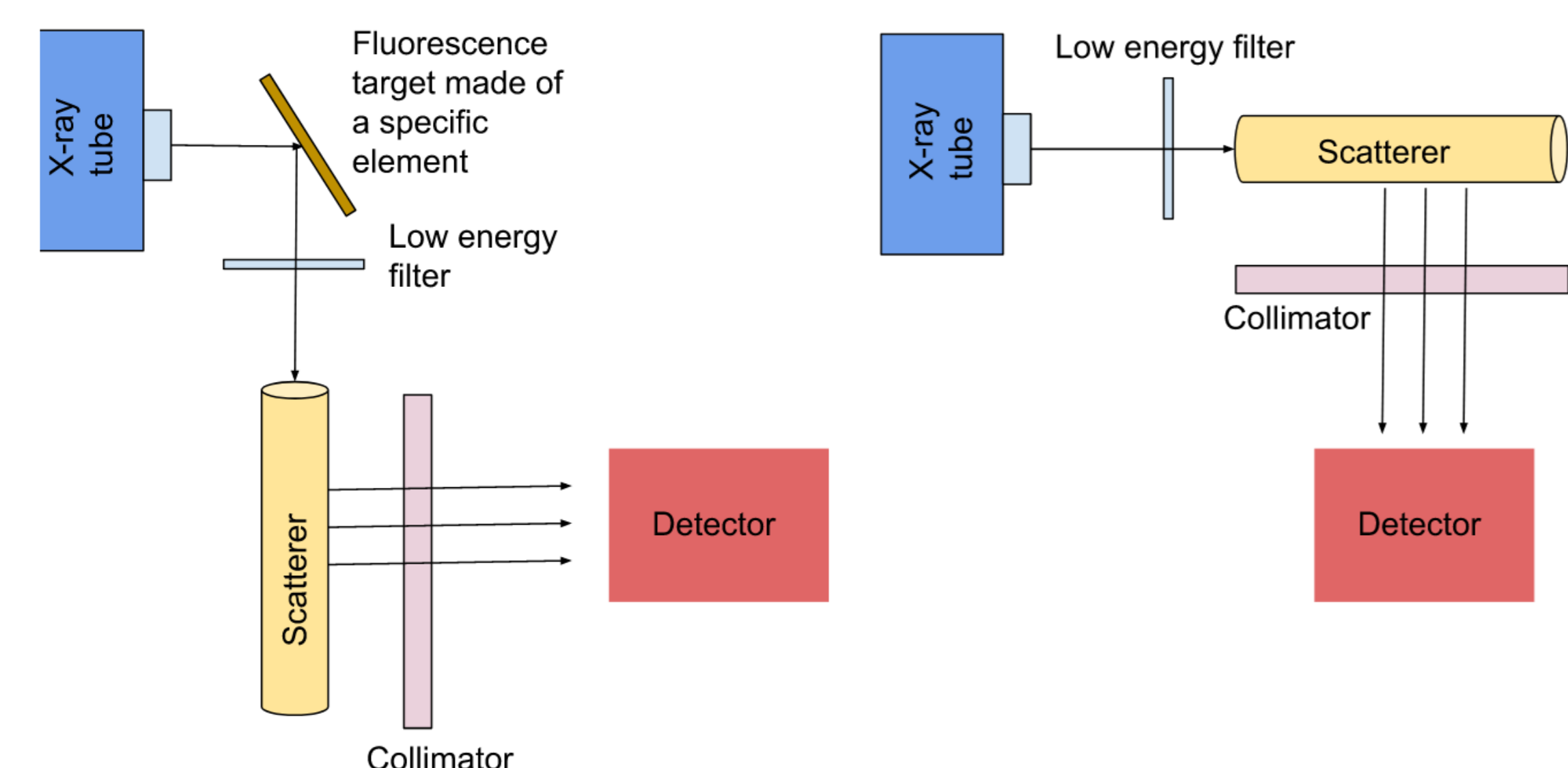


Fig. 2: Possible scattering polarizer set-ups. **Left:** scattering of fluorescence radiation. **Right:** scattering of direct emission from X-ray tube.

Extension from 20 keV - 100 keV (goal 150 keV)

A scattering polarizer [6,7] based on a low atomic number scattering element such as Li encapsulated in Be. A W collimator will allow to extract nearly 90° scattered X-rays to have X-rays polarized at a level >95%. Different energies will be available by illuminating the scatterer directly with an X-ray tube and filtering the low energy part of the spectrum or by extracting fluorescence radiation from different targets such as Gd (~43.9 keV), W (~60.6 keV), Au (~70.3 keV) and Pb (~77.7 keV). Radionuclides such as ¹⁰⁹Cd (22.6 keV), ²⁴¹Am (59.5 keV) and ⁵⁷Co (123.6 keV) are also available to produce unpolarized radiation.

Synergy within INAF

The eICE project is synergistic with the project "CASP Detector Lab" at OACT (PI Giuseppe Romeo, funded by the same INAF call for laboratories). The two projects will allow to characterize SiPMs sensors between 200 to 1000 nm at the OACT CASP laboratory. Then a characterization of the SiPM+scintillator system will be possible at IAPS laboratories (both with polarized and unpolarized radiation), especially for Compton polarimetry in the band 20-150 keV.

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Extension to 0.5 keV- 2 keV

The eICE project will contribute to the completion of the set-up in a 1m³ vacuum chamber that is still under development and mainly contributed by projects PixDD [3], LEM-X [4] and eXTP [5]. An X-ray tube with a revolver will allow to produce X-rays from different targets via Bremsstrahlung. It will be possible to test both detectors compatible with vacuum inside the chamber, but also detectors in an early development stage places just outside the chamber in front of a window with a high transparency to soft X-rays.



Fig. 3: Li scatterer encapsulated in a Be cylinder.

eICE in the INAF framework

INAF-IAPS performs detector characterization and calibration both for spectroscopy and polarimetry. The institute collaborates with a number of national and international institutions. There are many projects that will benefit from the development of a facility for detector characterization both in the 0.5-2keV energy range (BabyIAXO [8], PixDD [3]) and in the 20-150 keV energy range (CUSP [9], HypeX [10,11], SWIPE [12], SpaceltUp! [13]).

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