Flashy Calibration for the *Athena*/X-IFU X-ray Spectrometer

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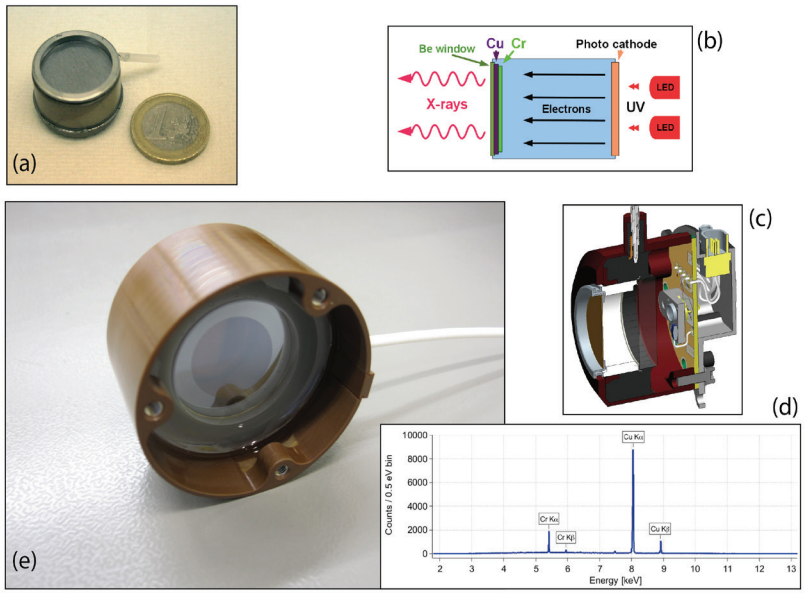

MXS impression: a) size comparison, b) principle of operation, c) crossout, d) MXS X-ray spectrum, e) potted MXS backside, showing the photocathode window. Credits: SRON.

As with every instrument, the X-IFU micro-calorimeter X-ray spectrometer on *Athena* needs proper calibration in order to translate the engineering output values into proper physical units. For each recorded X-ray photon we have to establish its energy to within 2.5 eV (1 eV corresponds to 1.6×10^{-19} Joule) with a systematic uncertainty of < 0.4 eV. To do this, the instrument requires observing X-ray sources with emission lines of known energy to compute the conversion parameters.

A complicating factor is that this conversion changes with time. Depending on the detector state and readout electronics, changes in the energy conversion may occur on time scales of 10 minutes. For this reason, internal X-ray calibration sources within X-IFU are required.

The calibration sources (Modulated X-ray Sources, MXS) on X-IFU will be electrically powered. They consist of LEDs which shine light onto a window containing active material called a photocathode. The light will cause this material to emit electrons, which in turn are accelerated by a high voltage (11300 Volts) to a target of thin metal layers. These high energy electrons will cause fluorescent X-rays from the metal targets, which will show the characteristic lines of the chemical elements present in the targets. Switching the LED's, these sources can be turned on and off on very short time scales (flashes of X-rays), and allow a range of different operation modes, optimized to the needs of the astrophysical observations. The spectral lines will be used for calibration and spread over the main part of the energy range of the instrument. The X-rays will leave this source through a Beryllium window on the opposite side of the photocathode. The sources are small and have sizes comparable to a 1€ coin. Multiple calibration sources will be mounted on a ring with a radius such that they do not block the X-rays coming from the telescope mirror.

The inside of the sources where the electrons are accelerated contains a very high vacuum. The sides of the source cylinder, Beryllium and photocathode windows have therefore to be extremely vacuum tight to allow operation and testing on ground. Of course in the vacuum of space this would not be an issue.

Fine-tuning the intensity and length of the X-ray flashes can prevent two photons hitting a detector pixel simultaneously (energy pile-up), diminish crosstalk between pixels and minimize the dead time induced by the operation of the MXS, along the observation of an astrophysical source. Flashing can also be interrupted to allow quiet periods to eliminate any residual MXS background. All together these flashy X-ray sources are a good choice and promise lots of control over the way the instrument is calibrated. Good quality calibration is vital for the proper interpretation of the X-ray spectra from the observed astronomical targets.