

# Athena inter-calibration working group



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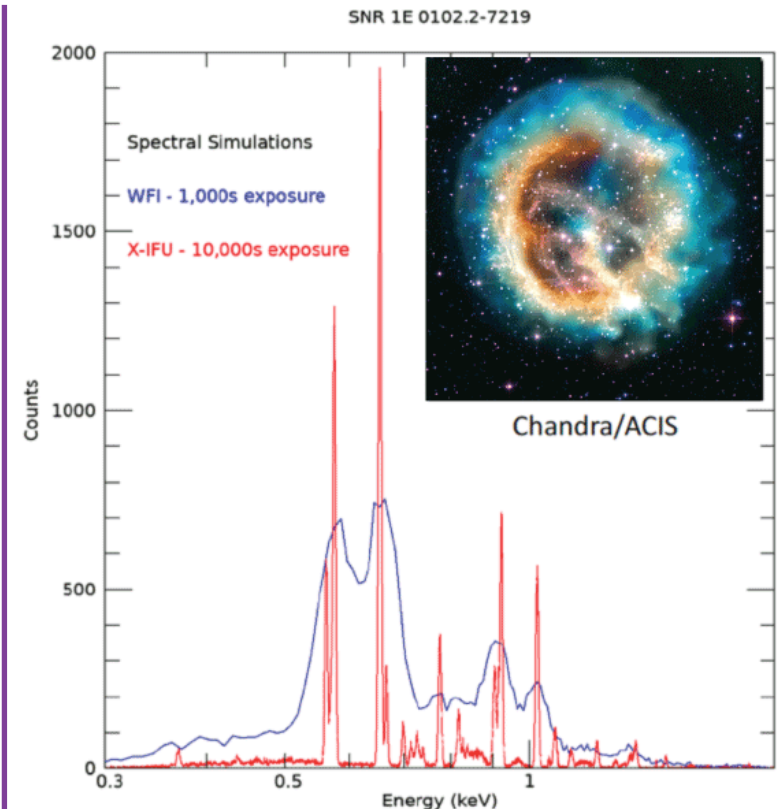
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The general purpose of calibration is essentially twofold: 1) to inform the mathematical model of an instrument used in calculating the instrument response used in science data analysis and 2) to quantify the uncertainty of our knowledge of the true instrument response compared with the model. The *Athena* telescope (mirror system plus instruments) essentially measures three things: 1) a signal proportional to the number of electrons or to the heat deposited by a photon (or charged particle) within a pixel of the detector, 2) the detector coordinates of the pixel the event occurred in and 3) the time of the event. The response of the instrument is essentially a set of probability functions which provide a prediction of the distribution of recorded signals for an ensemble of events with a given input energy and the distribution of detector positions for an ensemble of events with a given input direction relative to the telescope. Only the recorded time of the event has a one to one correspondence with the physical attribute of the input event, i.e. the arrival time. Calibration data is acquired from test campaigns on the ground in dedicated facilities and in-orbit from X-ray source signals which have known characteristics, e.g. emission lines at known energies.

In *Athena*, the responsibility for the ground calibration resides with ESA for the mirror system and the **X-IFU** and **WFI** instrument teams for the focal plane. The concept of inter-calibration is to have an advisory group (taken largely from ESA and instrument team members) that ensures that, taken as whole, the *Athena* calibration plan for all elements is sufficient to meet the science requirements of the mission and forms a coherent strategy.

The philosophy behind inter-calibration goes beyond the needs of a single mission. *Athena* is part of a long development of X-ray astronomy missions with overlapping capabilities. As instruments have become more capable in collecting power the uncertainty in interpretation of scientific results has tended to become ever more dominated by our knowledge error of the instrument responses (i.e. calibration) in each mission. Inter-calibration, or cross-calibration, is also the process by which different missions compare results and attempt to form a consensus view of the X-ray sky given that formally they can disagree when considering only the statistical component (due to photon noise) of the uncertainty of a given measurement.

The International Consortium for High Energy Calibration (**IACHEC**) is an advisory group formed from calibration experts from many X-ray and Gamma-ray current and future missions (e.g. Chandra, XMM-Newton, Suzaku, Swift, INTEGRAL, NuSTAR, XRISM and *Athena*) which explores various methods for studying the cross-calibration between missions and defining standardized analyses of reference sources (see Figure) which current, and future missions such as *Athena*, can use as an in-orbit calibration reference.



The SNR 1E 0102.2-7219 is used as a calibration standard in X-ray astronomy. The IACHEC spectral model of the whole remnant has been used to simulate Athena WFI and X-IFU spectra. The insert plot shows the Chandra/ACIS image of the SNR color-coded by energy.