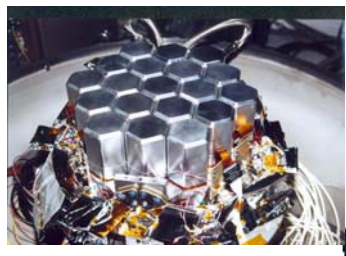
SPI Gamma-Ray Spectrometer on INTEGRAL

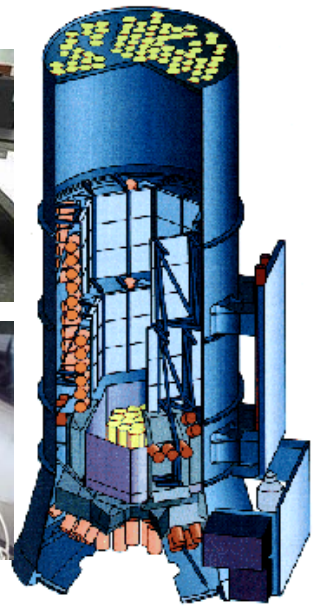
Since Oct 2002, a high-resolution gamma-ray spectrometer operates in space, aboard the ESA INTEGRAL observatory. Satellite and instrument performaces are excellent, so that the planned 2-year mission has been extended up to Dec 2008.

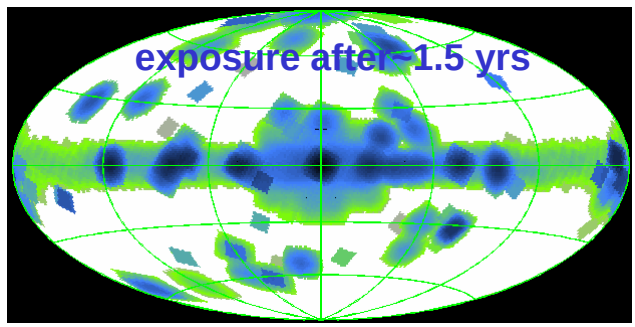
INTEGRAL's main two instruments are coded-mask telescopes, an imager IBIS and a spectrometer SPI. One of the main science goals of ESA's INTEGRAL mission is to provide a new window into spectroscopy with gamma-ray lines, yet with imaging capability.

Previous experiments did not have the energy resolution to measure line broadenings, which are typically in the 0.1 to 50 keV range. Solid state detectors based on high-purity Ge can provide the needed resolution. Therefore the SPI instrument on INTEGRAL features a 19-element Ge camera with a total area of 500 cm^2, and uses a coded mask made from tungsten to allow imaging and signal-from-background discrimination. Stirling cryocoolers maintain the Ge operational temperature at ~90K. Limited by instrumental-background lines, narrow-line sources down to fluxes of 2 10^{-5} ph $cm^{-2}s^{-1}$ can be studied.

With its coded-mask and a field-of-view of ~16x16º, diffuse emission and sources can be studied in its energy range of 15-8000 keV, and a timing resolution of 52µs also allows the study of pulsars and accreting source phenomerna.







The spectrometer performance is excellent, although two detector elements have stopped functioning, within the first two mission years. Spectral resolution degrades during the mission, due to cosmic-ray bombardement of the Ge detectors, damaging the charge collection properties within the crystal. Every ~6 months, after ~20% degradation of resolution, "annealings" are conducted, where the Ge camera is heated to 105ºC for ~2 days. This re-establishes the spectral resolution to typical values of 3 keV @ 1800 keV, adequate for measuring kinematics of radioactive isotopes through Doppler shifts, for isotopes such as ^{44}Ti, ^{26}Al, ^{60}Fe, ^{56}Ni.

References:

- Vedrenne G., J.P. Roques, V. Schönfelder, et al., A&A 411, L63 (2003)
- Roques J.-P., Schanne S., von Kienlin A., et al., A&A 411, L93 (2003)
- Winkler C., Courvoisier T. J.-L., Di Cocco G., et al., A&A 411, L1 (2003)

see several other posters on science results

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