

# Giorgio's Contributions to High-Energy Astronomy in Europe



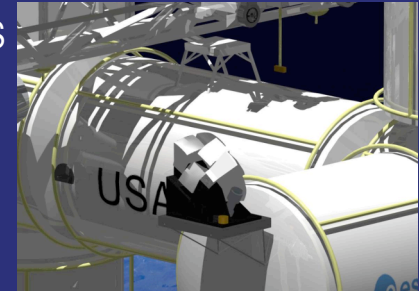
A.N. Parmar,  
ESA Dept of Science  
Operations, ESAC

- My collaborations with Giorgio have mainly been in 3 areas:
  - Science with the ISS: Lobster, EUSO, Rosita and (early) XEUS
  - Integral - ESA's flagship  $\gamma$ -ray observatory
  - XEUS – the next generation X-ray observatory, now a global mission, IXO

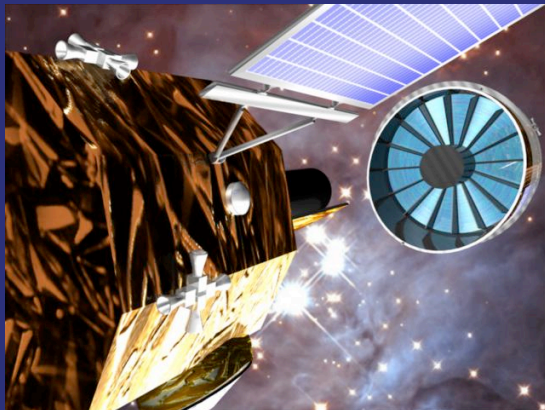
INTEGRAL



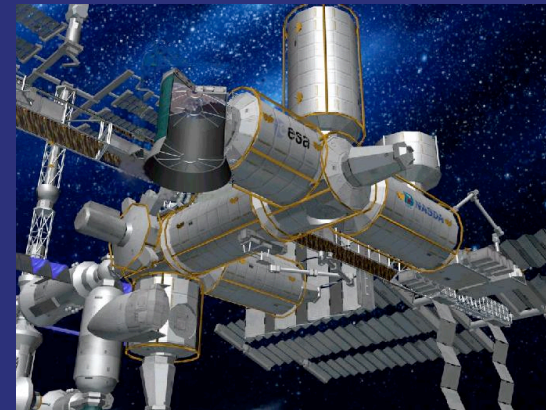
Lobster-ISS



XEUS



EUSO



Rosita



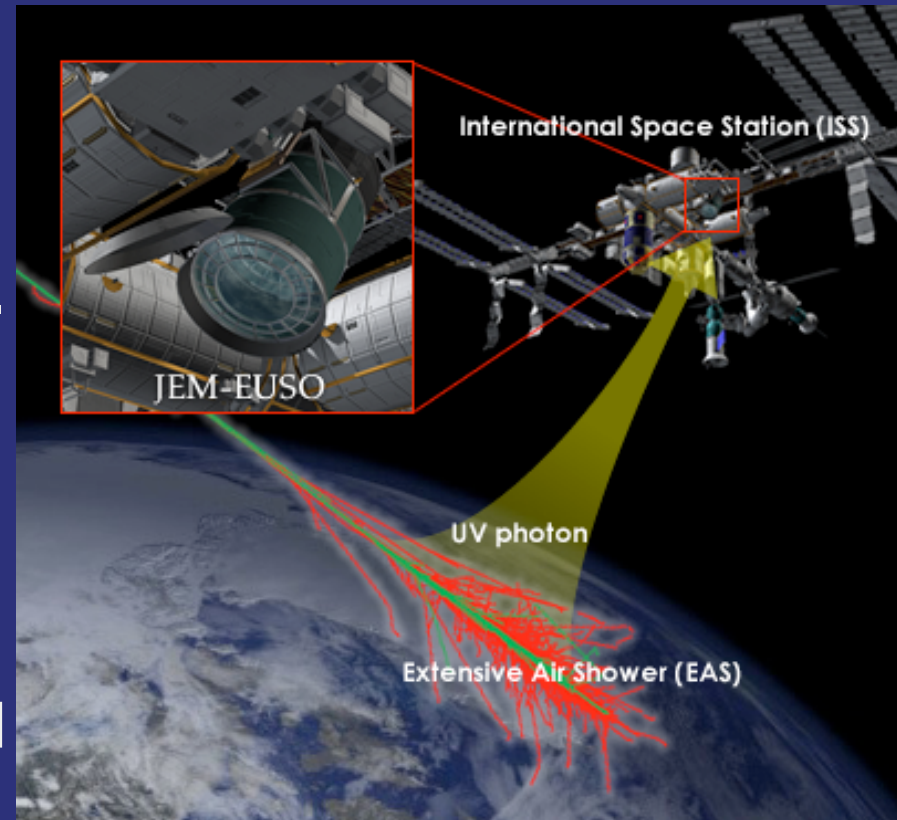




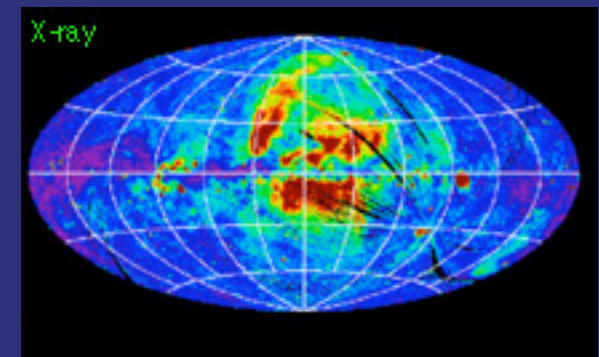
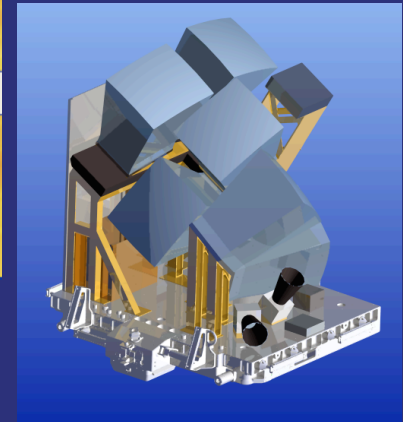
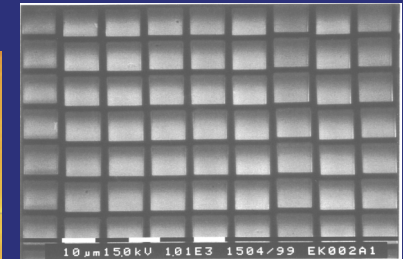
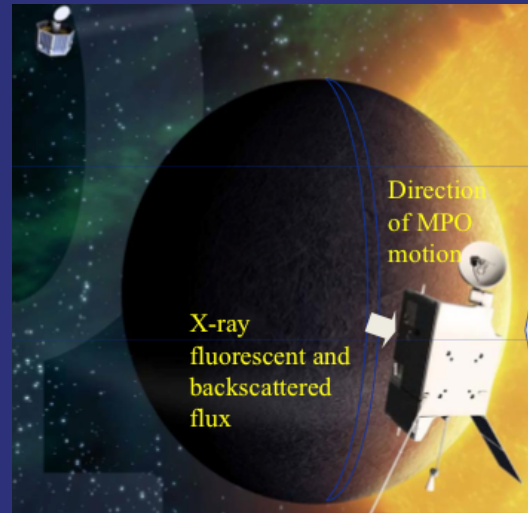
- In the late 1990s there really a feeling of optimism from some of us in the astronomical community that we could help the ISS become a powerful tool for astronomy.
- Like any good space agency, ESA established numerous committees to look into, and advise on, the prospects for science from the ISS.
- Giorgio served on ESA's Astronomy Working Group, Science Programme Committee, Space Station User Panel, Integral Science Working Team and the XEUS Science Advisory Group.
- There were 3 potential high-energy astronomical payloads studied...



- EUSO was designed to study the highest energy cosmic rays using the Earth's atmosphere as a giant detector.
- EUSO was not selected for a Phase-B study by the ESA Science Advisory Structure.
- However, good ideas do not simply disappear and a modified form of EUSO is being studied by JAXA and partners for attachment to the recently launched Japanese Kibo module

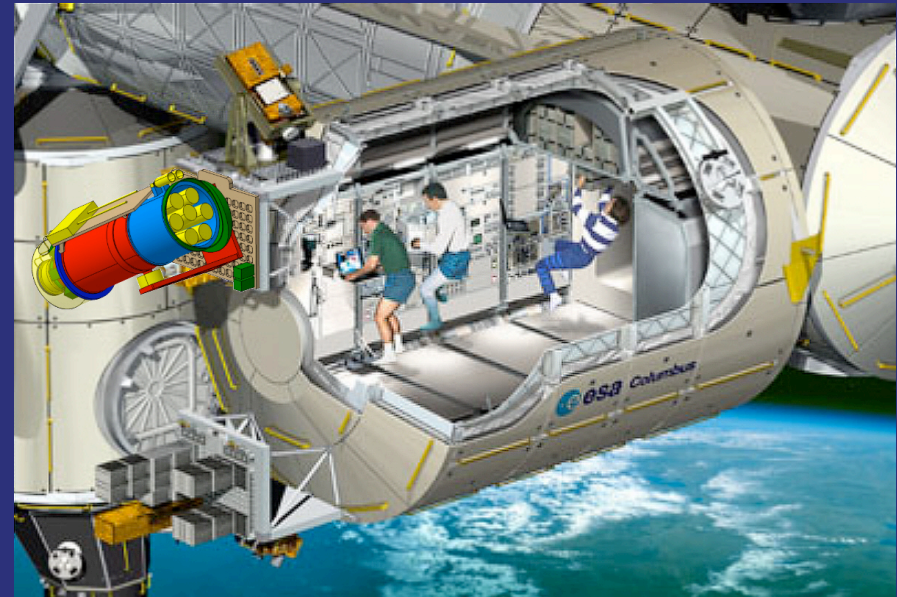


- The Lobster all-sky monitor would have provided unprecedented sensitivity of the X-ray sky due to its true imaging capability provided by the novel micro-pore optics.
- Whilst Lobster may not fly, at least for the foreseeable future, the micro-pore optics provides a light-weight, moderate spatial resolution imaging system for the MIXS-T instrument. This will study the surface composition of Mercury using X-ray fluorescence.





- Rosita, the first medium-energy X-ray imaging sky survey may not have been a suitable external payload for the ISS, but..



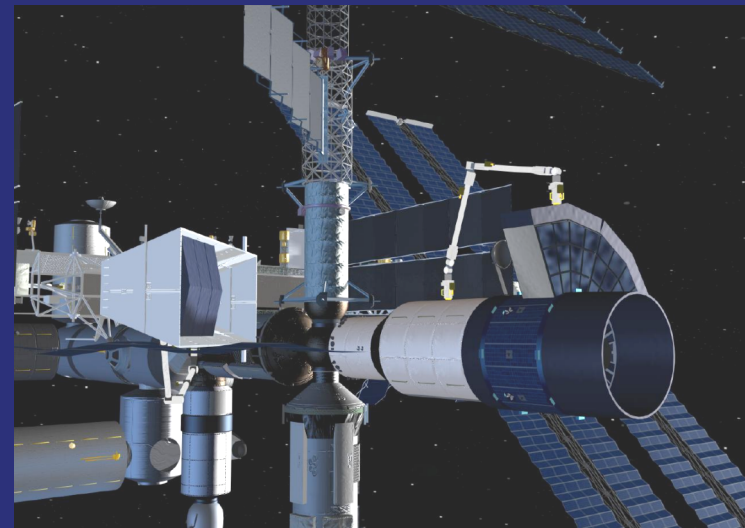
- As e-Rosita it is now a fully approved payload on the Russian SRG mission scheduled for launch in 2012.
- Will provide X-ray surveys with unprecedented sensitivities and be a pathfinder for future X-ray observatories

# XEUS to XEUS and then IXO

- Original XEUS concept was a 6 m<sup>2</sup> optic which was enlarged to 30 m<sup>2</sup> by robotic assembly at the ISS. Horizon 2000+
- Two free flying spacecraft separated by 50 m focal length in LEO
- Required Ariane V, Proton and STS launches and the ISS.....



5 m<sup>2</sup> optic at  
L2





# XEUS – The Very Beginning

Next Generation of  
X-ray Observatories,  
Leicester University, UK  
July 10 - 12 1996



**Martin Turner, U of Leicester, UK**

**Monique Arnaud, CEA Saclay, F**

**Xavier Barcons, CSIC-UC, Santander, E**

**Johan Bleeker, SRON, NL**

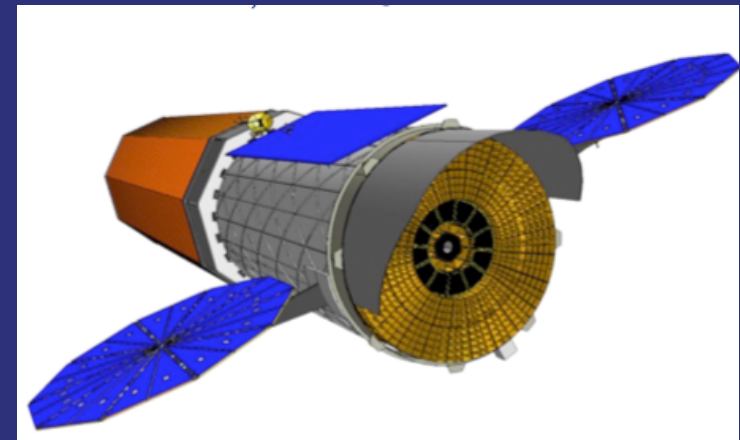
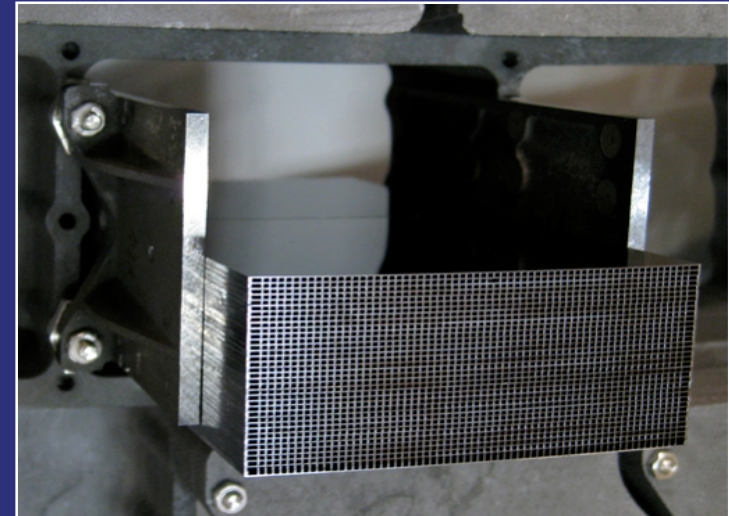
**Gunther Hasinger, AIP, Potsdam, D**

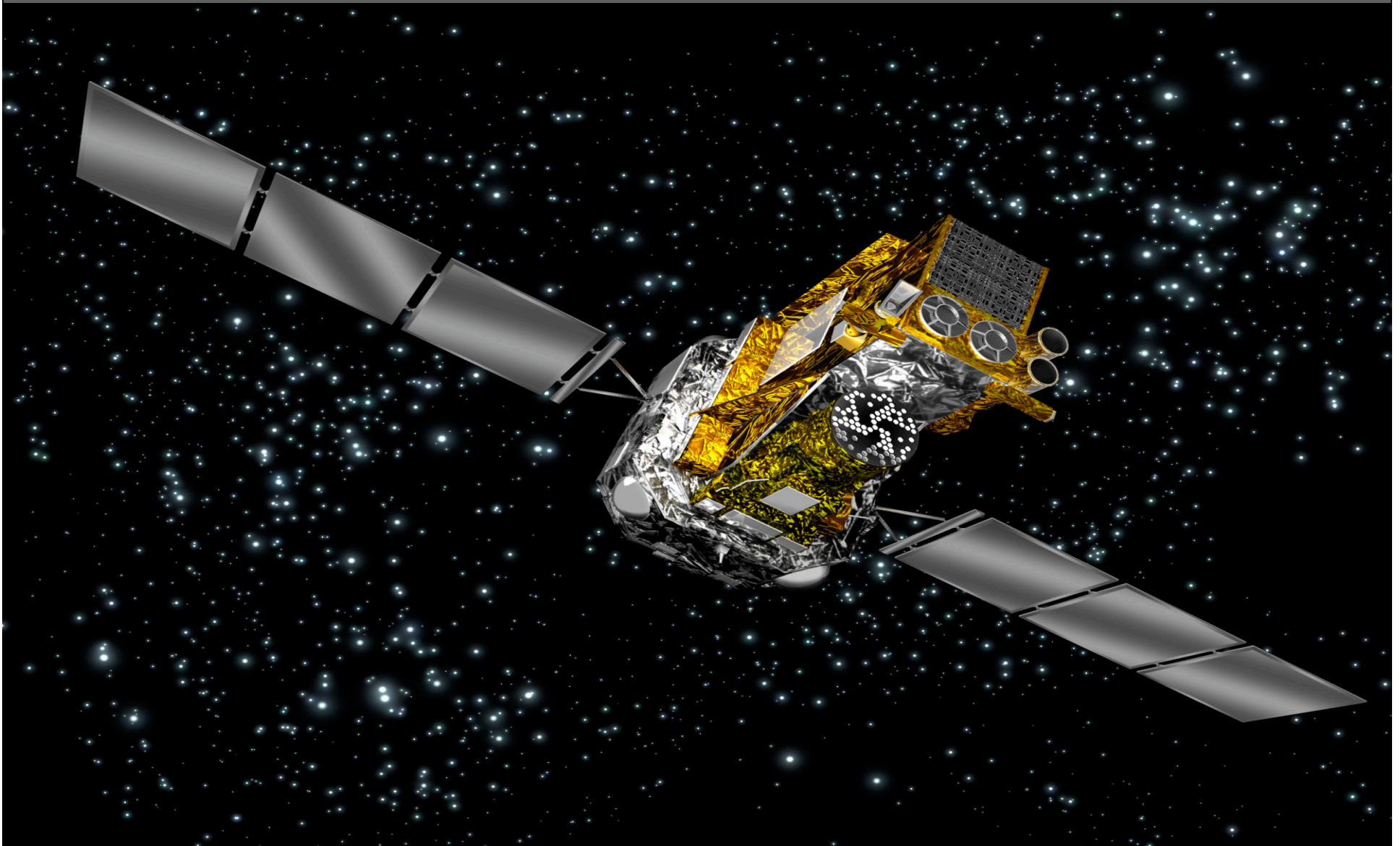
**Hajime Inoue, ISAS, J**

**Giorgio Palumbo, U of Bologna, I**

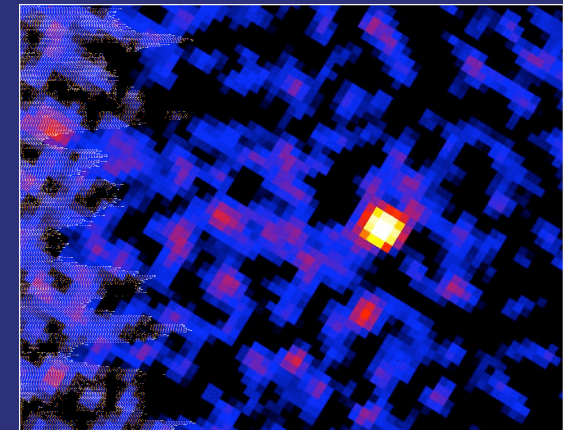
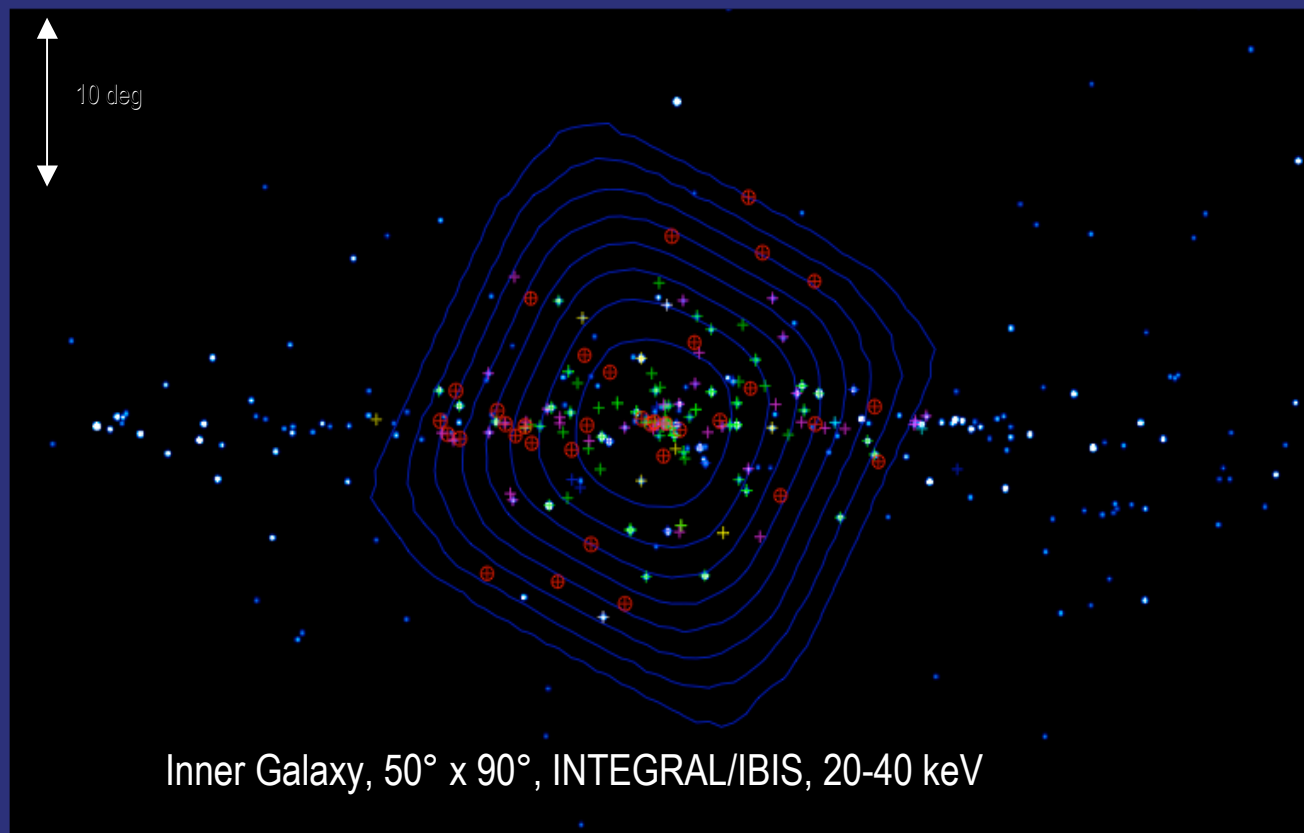


- Steering Committee guided XEUS through its formative years. Their work ended when XEUS was selected as one of three Large mission concepts for CV assessment studies.
- In July 2008, XEUS and NASA's Con-X were merged to form IXO – the International X-ray Observatory.
- IXO is the next generation high-energy observatory, 10 – 100 times more capable than existing missions.
- A global collaboration between ESA, JAXA, NASA and the European national agencies which could be launched in 2021.
- Support from XEUS Steering Committee enabled modest investments in high precision pore optics technology. HPO is now at 10" HPD per module (5" requirement).





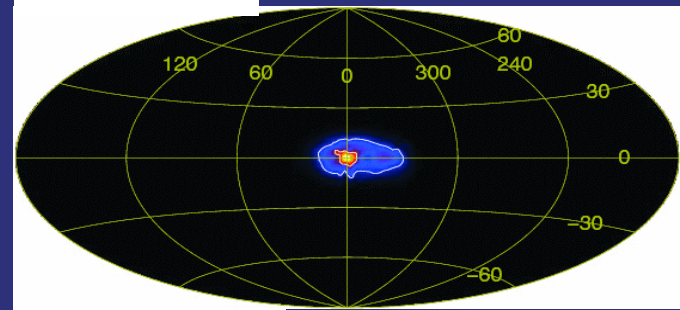
- INTEGRAL's key feature is probably the large FOVs of its instruments – allows many sources to be studied in a single exposure





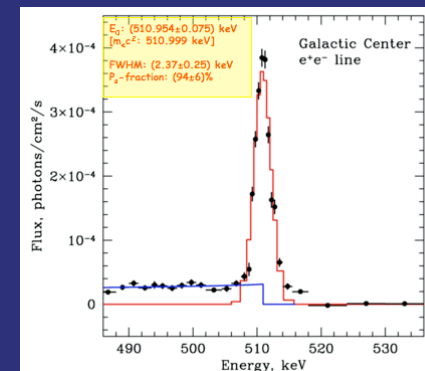
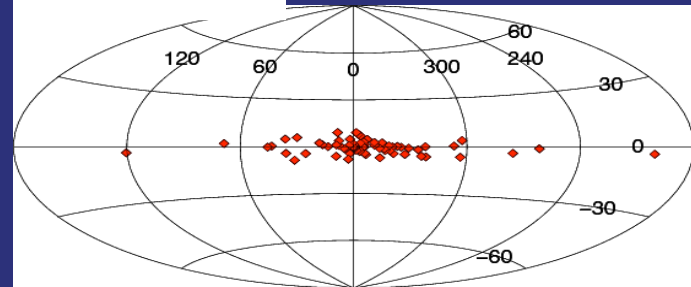
- INTEGRAL has many science highlights so far: discovery of a new class of obscured HMXB and a local faint GRB population, insights into the outburst mechanisms of super-giant fast X-ray transients and so on.
- INTEGRAL's spectrometer, SPI, has accurately measured the spatial distribution of the 511 keV line emission from the inner regions of the galaxy.
- Distribution only similar to that of hard ( $>20$  keV) LMXB systems. However new (old) insights into the transportation of  $e^+$  from their production site, reduces (or eliminates) the need for more exotic explanations for their production involving e.g., dark matter
- INTEGRAL is tremendously productive. Over 1050 (460 refereed) papers so far, and rising!

511 keV



Weidenspointner et al., Nature (2008)

Hard LMXB





As an INTEGRAL Mission Scientist, Giorgio has been a member of the Science Working Team since 1994.

Here: the ISWT during their 20th meeting (16-17 January 2001, ESTEC)



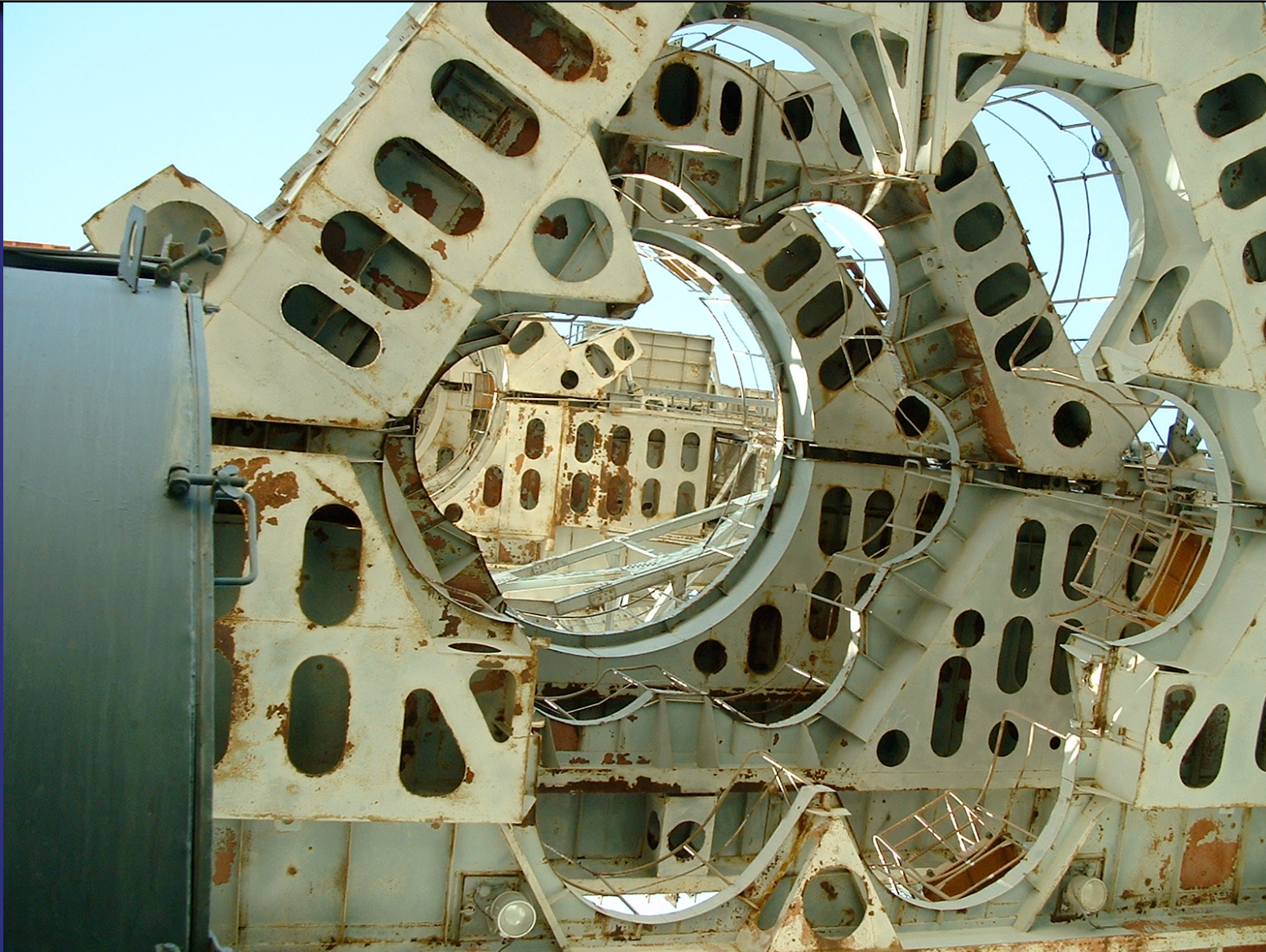


The ISWT inspect the  
INTEGRAL spacecraft...  
(26 March 2002, ESTEC).



















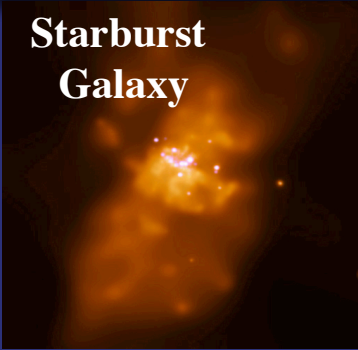




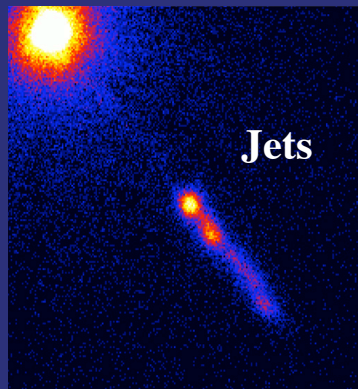




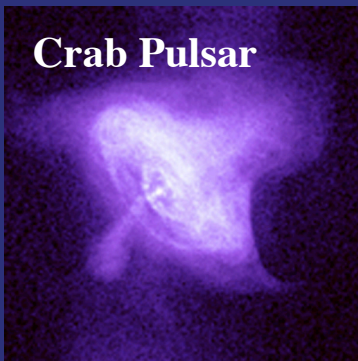
**Starburst  
Galaxy**



- At the end of the day its not about the technology, its about the science you can do with it.
- With his close links to his students and his understanding of what is, and what is not, important scientifically, this was always something that Giorgio kept in mind when guiding ESA in its workings.
- Although we were not wholly successful with the ISS exploitation, the fact that all the instruments supported live on in different forms is a testament to the strength of the underlying science and technology cases.



**Jets**

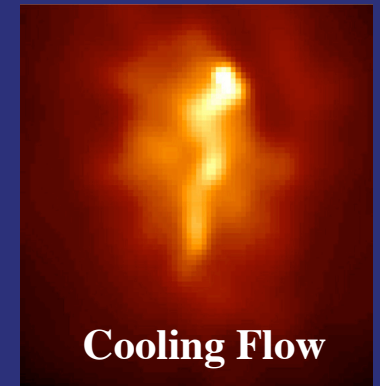


**Crab Pulsar**

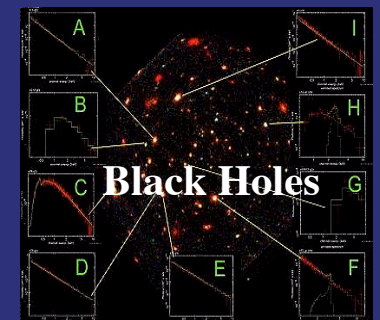
- No one can deny the success of INTEGRAL, nor the difficult challenges we face in order to make IXO a reality. I hope that the work of the XEUS Steering Committee will be recognised in keeping the support (and technology funding) for a large X-ray mission alive in Europe.



**Cas A Supernova**



**Cooling Flow**



**Black Holes**