

ESA Space Science MNT Perspectives

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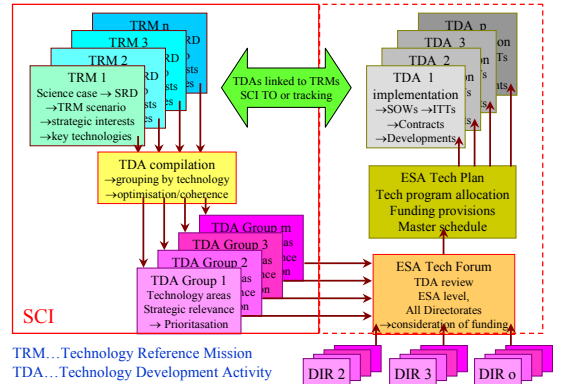
Science Payload Drivers and MNT

- Planetary exploration:
 - large distances and many in-situ and remote sensing instruments
 - use of MNT to drastically reduce the size of in-situ instruments
 - new, MNT based sensors
 - novel designs to improve the remote sensing instruments, e.g. MNT optics
 - micro- and nano-sats and probes
- Astrophysics missions:
 - large collecting areas with few, but complex instruments
 - novel lightweight optics required (active control, ... and MNT)
 - improved instrumentation (improvements include MNT)
- Fundamental Physics:
 - e.g. gravitational wave detection: formation of satellites
 - new science, new instruments, use of MNT important

Venus Aerobot TRM, Micro-probes

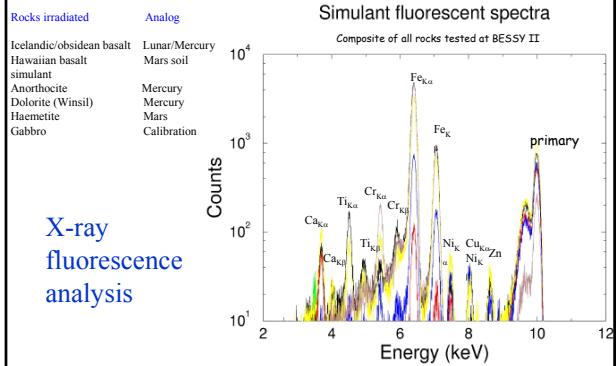
- Float altitude (~ 55 km)
- VEP communicates with orbiter
- Generates power via solar collectors on skin of balloon
- Performs particulate analysis of cloud constituents at rest altitude
- Drops swarm of active ballast probes to stay at float altitude

TRMs and TDAs

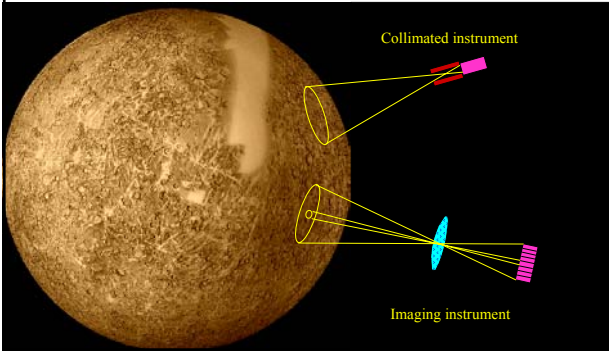


Three examples

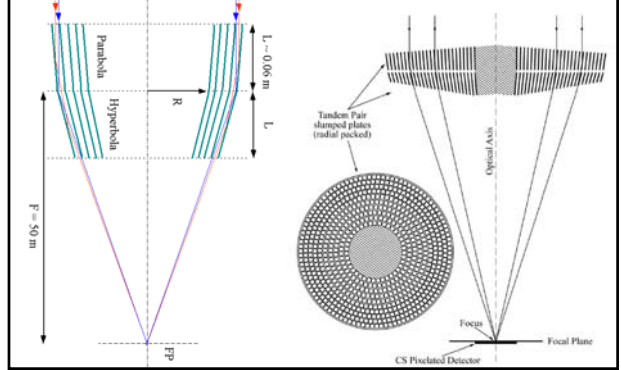
1. Planetary Optics for remote XFA sensing
2. Micro machined IR rejection filters for photon detectors
3. Lightweight large area X-ray optics for astrophysics



Collimating and imaging



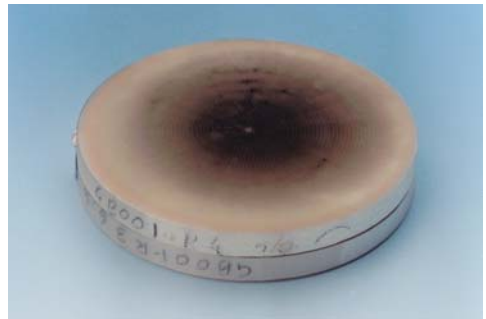
MCP X-ray Optics System



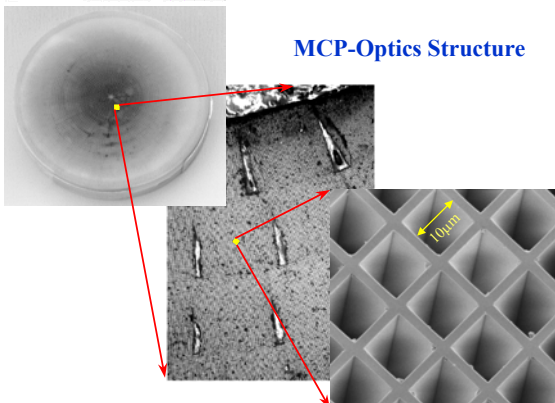
Production of MCP-based X-ray Optics



Prototype Wolter-I MCP X-Ray Optics (60 mm Ø)

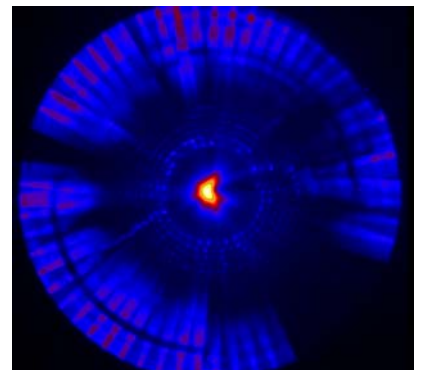


MCP-Optics Structure



Radially packed MCP X-ray Optics (single, flat element)

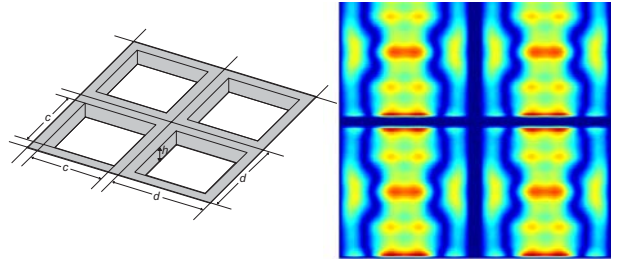
$E=10\text{keV}$
 $\varnothing_{\text{MCP}}=40\text{mm}$
 Scale: $0.8''/\text{pxl}$
 $\text{HEW}=33''$
 $\text{FWHM}=20''$



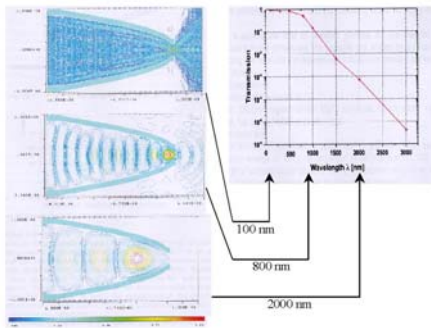
NIR Grid Filters

- Transmission of UV & soft X-rays
- Blocking IR and visible photons
- Inductive grids, nano-machined
- Free-standing or on substrates
- Essential for cryogenic detectors
- Theoretical modelling
- Prototype production
- Characterization

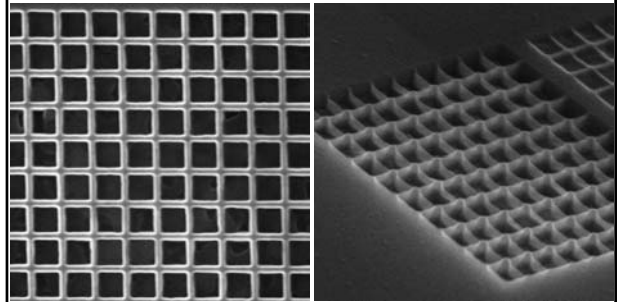
Theoretical modelling



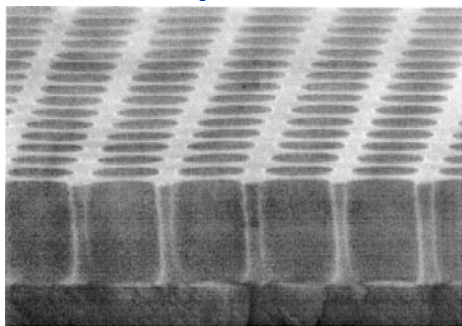
Calculated transmission characteristics of a parabolic microstructure



Gold grids produced by FIB



WSi₂ filter sample



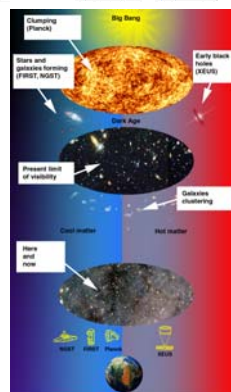
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300 nm

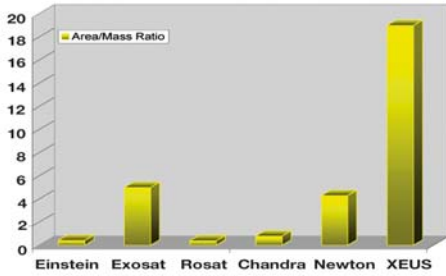
Human hair diameter: 10x width of this VG

XEUS X-ray Evolving Universe Spectroscopy Mission

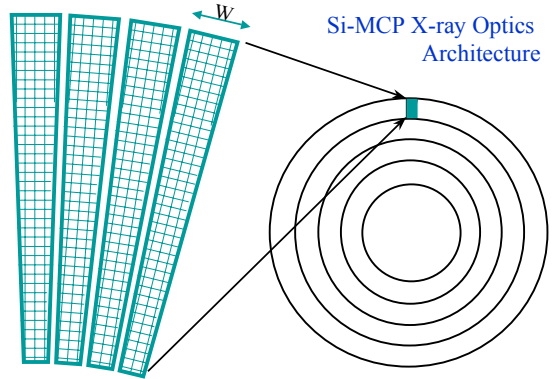
- Potential follow on to ESA's cornerstone X-ray spectroscopy mission (XMM-Newton).
- Under study as envisaged by the [Horizons 2000 Survey Committee](#). Recommended analyzing XEUS as a potential utilization of the International Space Station (ISS) for high-energy astrophysics applications.
- XEUS will be a long-term X-ray observatory providing a telescope aperture equivalent to the [largest ground-based telescopes](#).



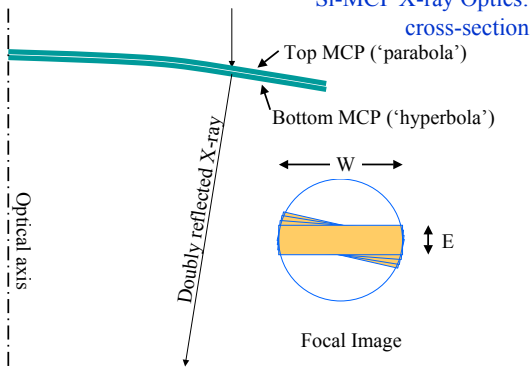
Mirror Area to Mass Ratio – a Figure of Merit



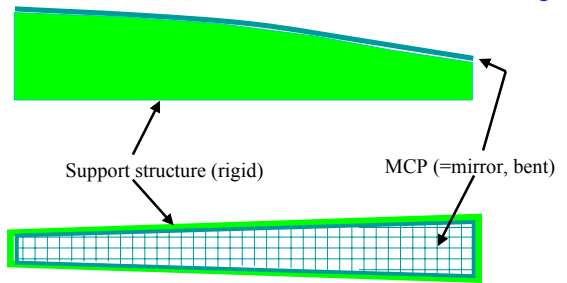
Si-MCP X-ray Optics Architecture



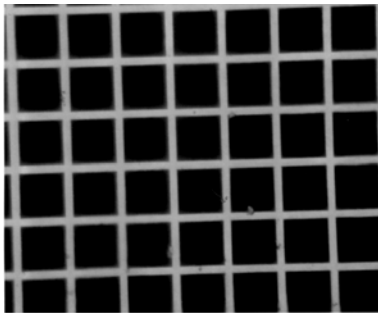
Si-MCP X-ray Optics: cross-section



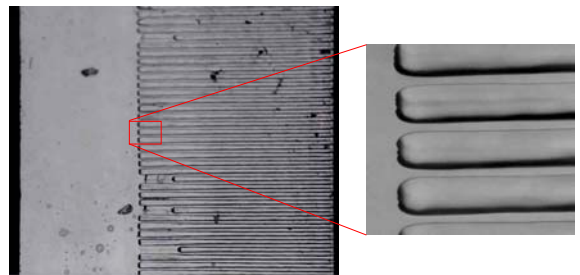
Si-MCP X-ray Optics : Mounting



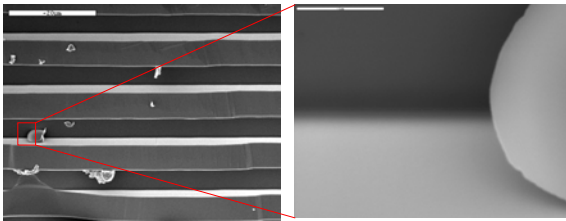
Silicon-based MCP X-ray Optics



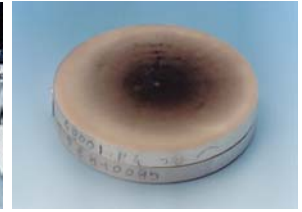
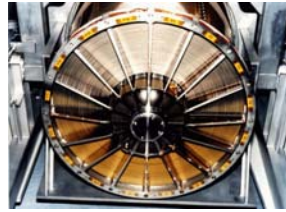
SEM of Si-MCP Cross section



Si-MCP Surface Roughness (SEM) (smooth)



X-ray optics Mass



XMM optics:
~ 350 kg for 700mm diameter,
~910kg/m²

MCP optics (glass or Si):
~ 29g for 60mm diameter,
~10kg/m²

XMM-size: 4 kg