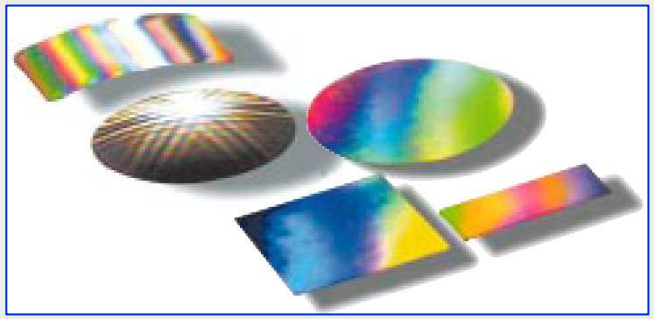
Square Pore Optics



PHOTONIS

Industrial and Scientific Detectors ISD

Square Pore Optics

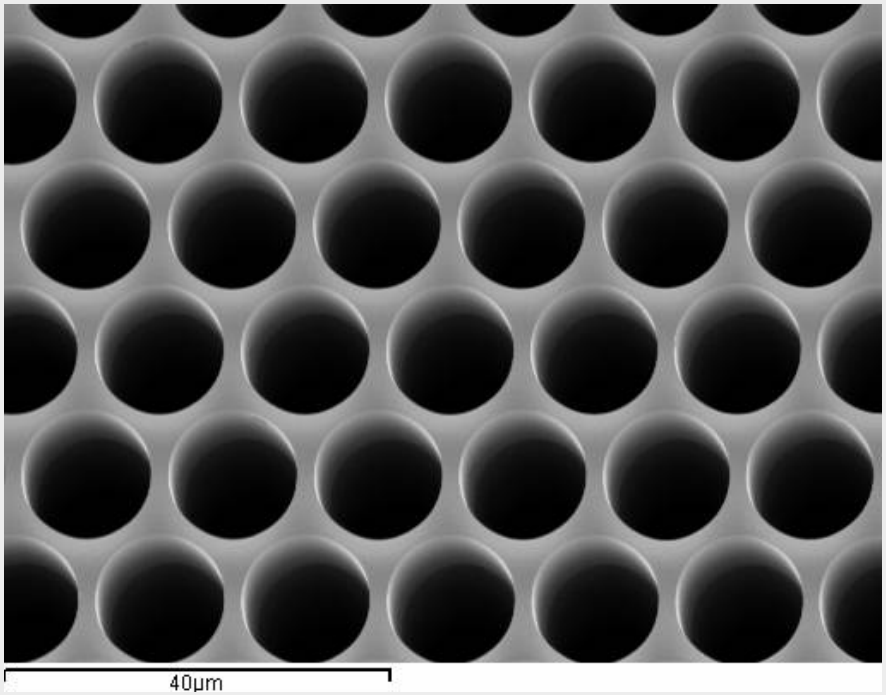
- Introduction
- Production
- Applications
  - Space: X-ray focussing
  - Laboratory
- Competitors
- Gogogo …

PHOTONIS

Square Pore Optics

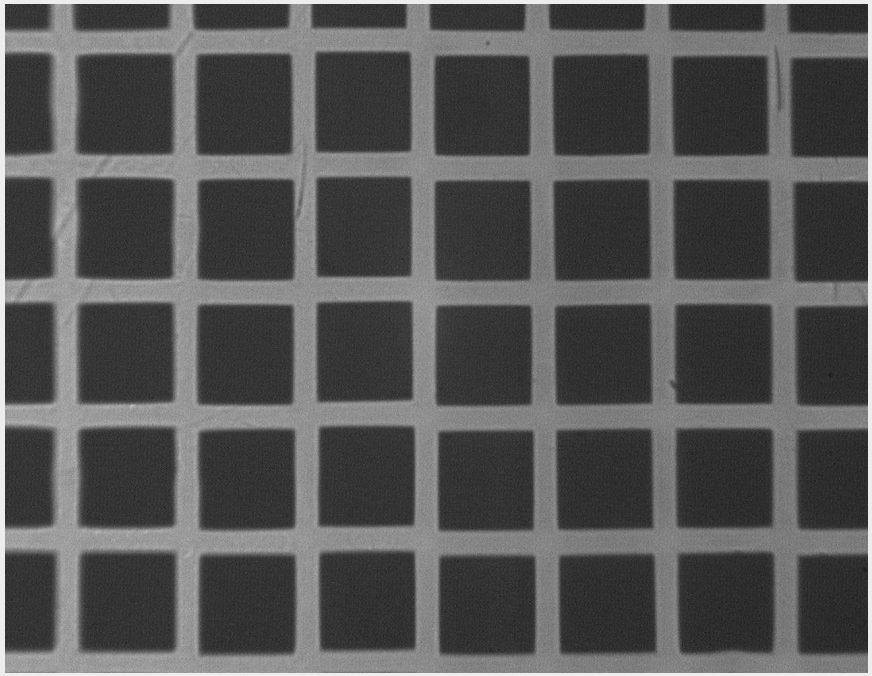
MPO = Micro Pore Optics (historical name but confusing)

MCP



SEM-picture

MPO (20 µm Square Pores)



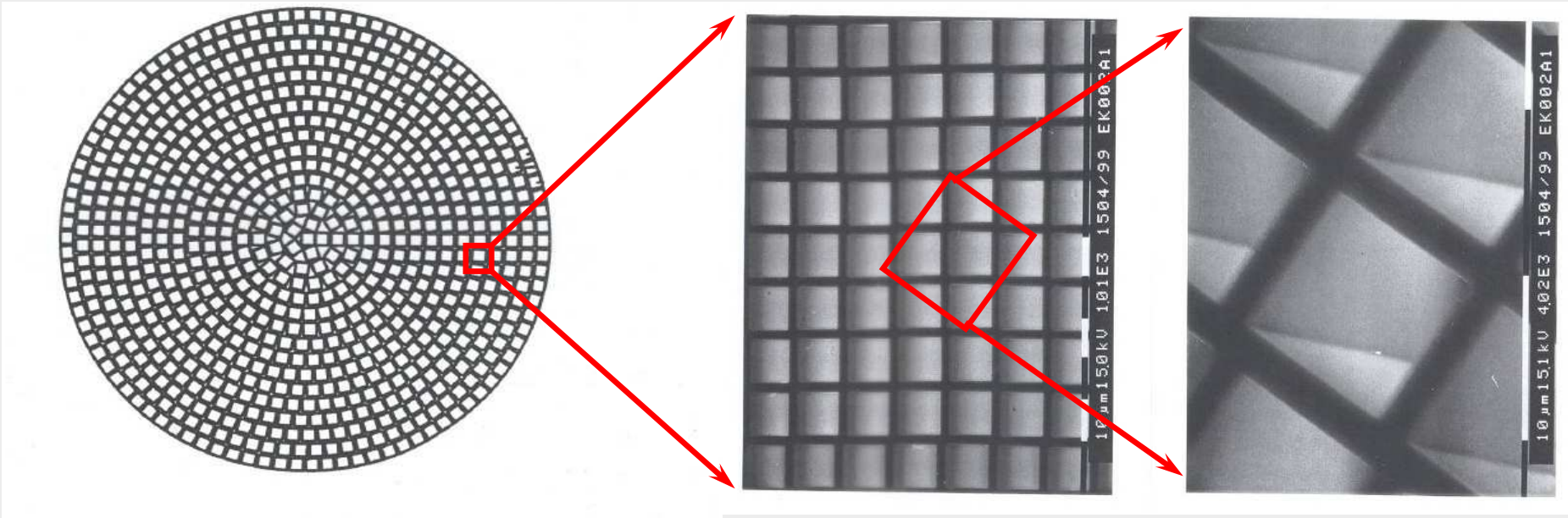
Optical microscope picture (old)

PHOTONIS

Square Pore Micro OptiX

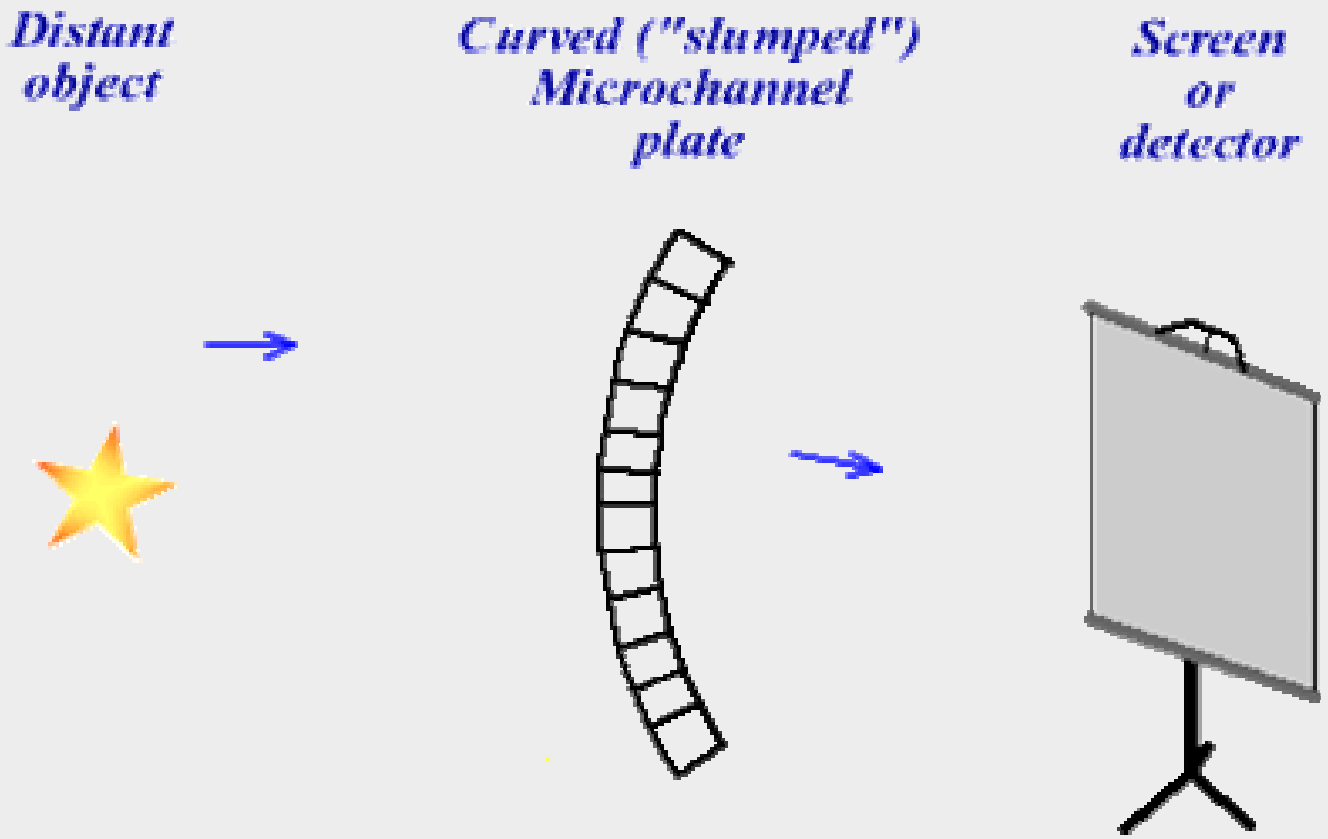
New technology development by PHOTONIS
(€ supported by European Space Agency)

Square Pore Micro Channel Plates



PHOTONIS

µ Pore OptiX : MuPOX

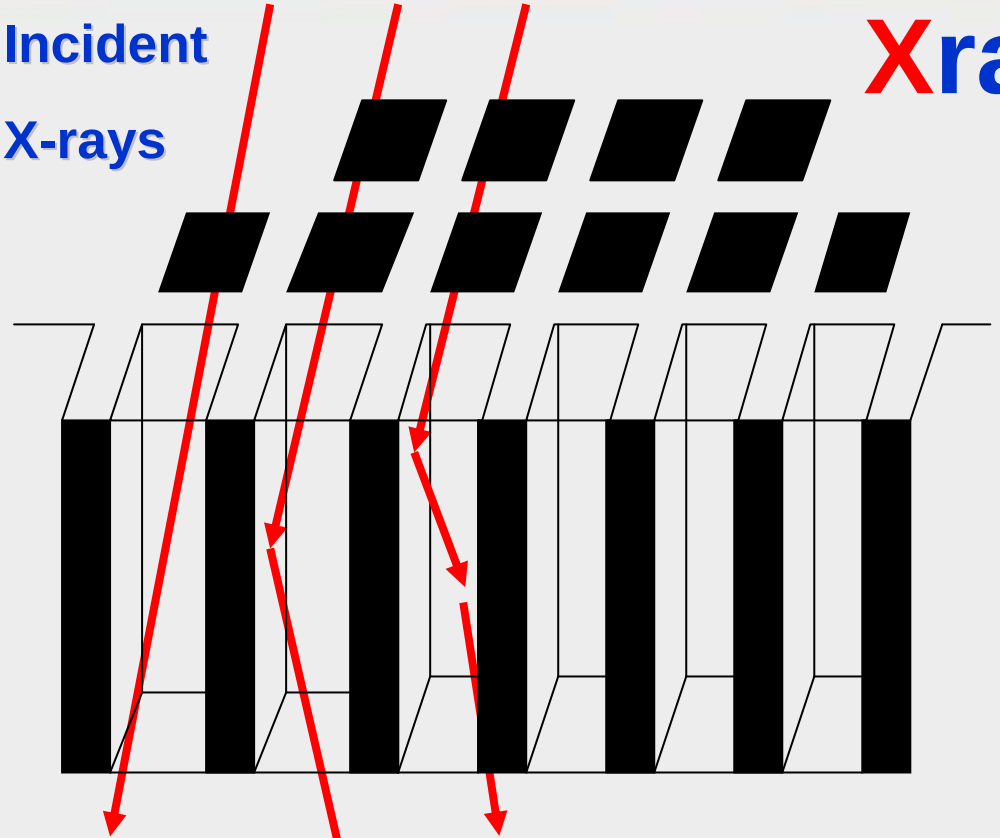


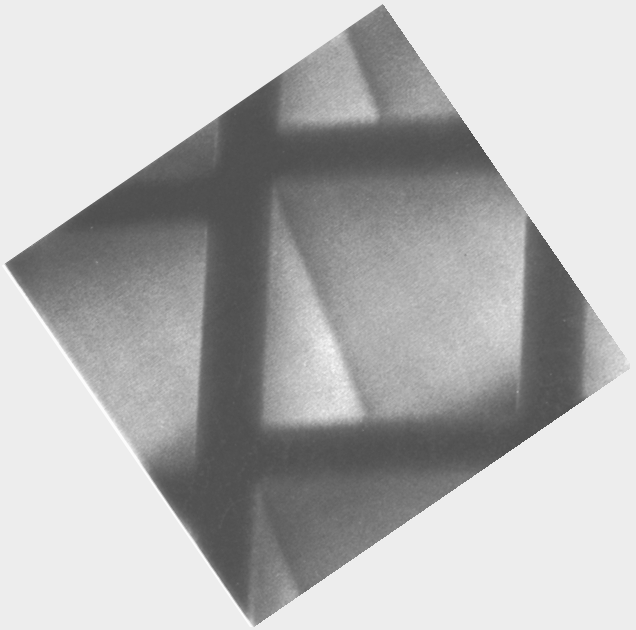
PHOTONIS

Operation of an MCP *X-ray Lens*

Incident X-rays

XrayFLECTOR ! ?





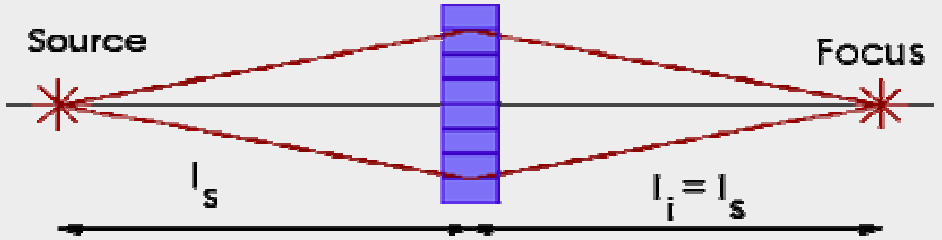
PHOTONIS

Micro Pore OptiX : MPOX

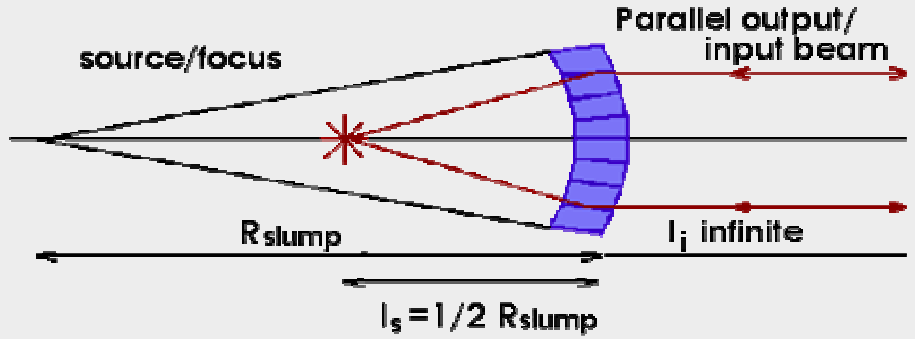
Focussing / Imaging

FLAT:

$I_{image} = I_{source}$



SLUMPED:

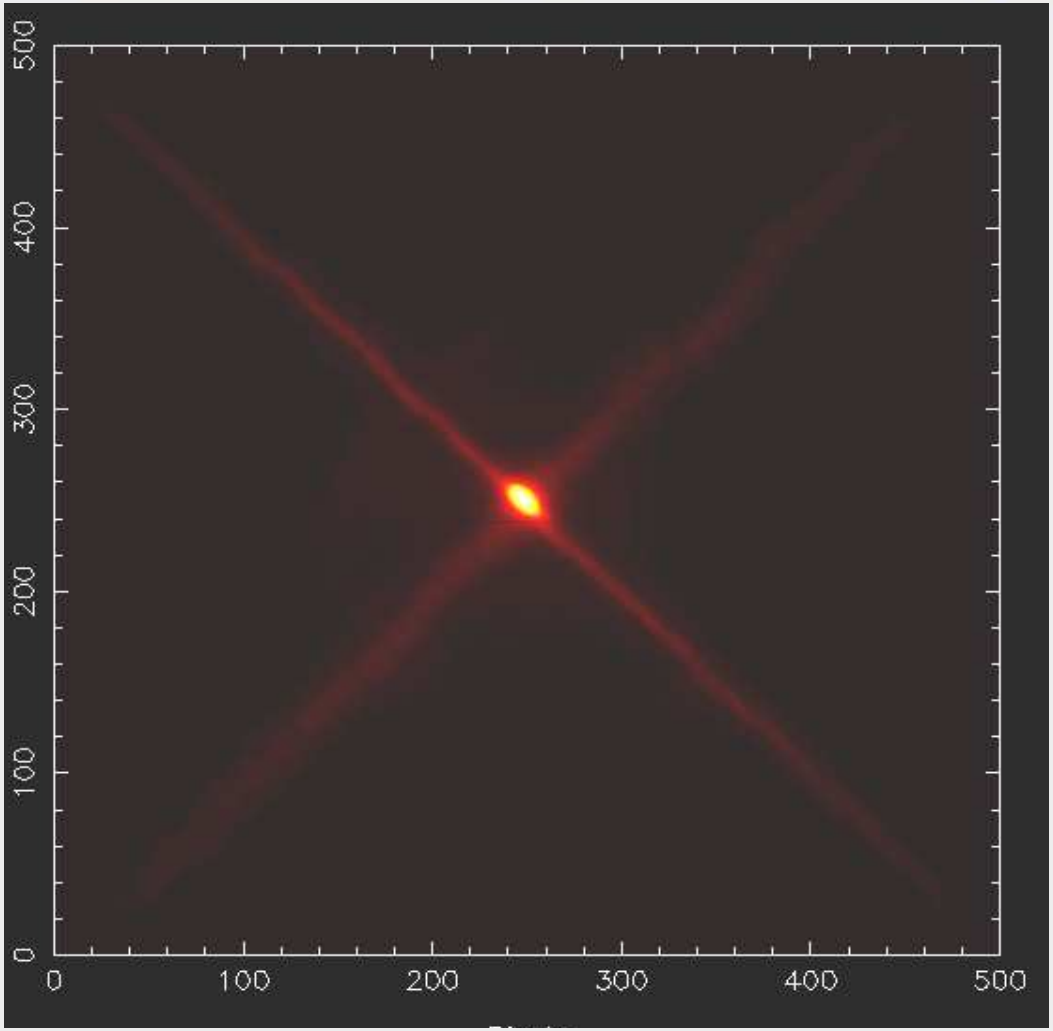


Make parallel output-beam: $I_{source} = ½\ R_{slump}$

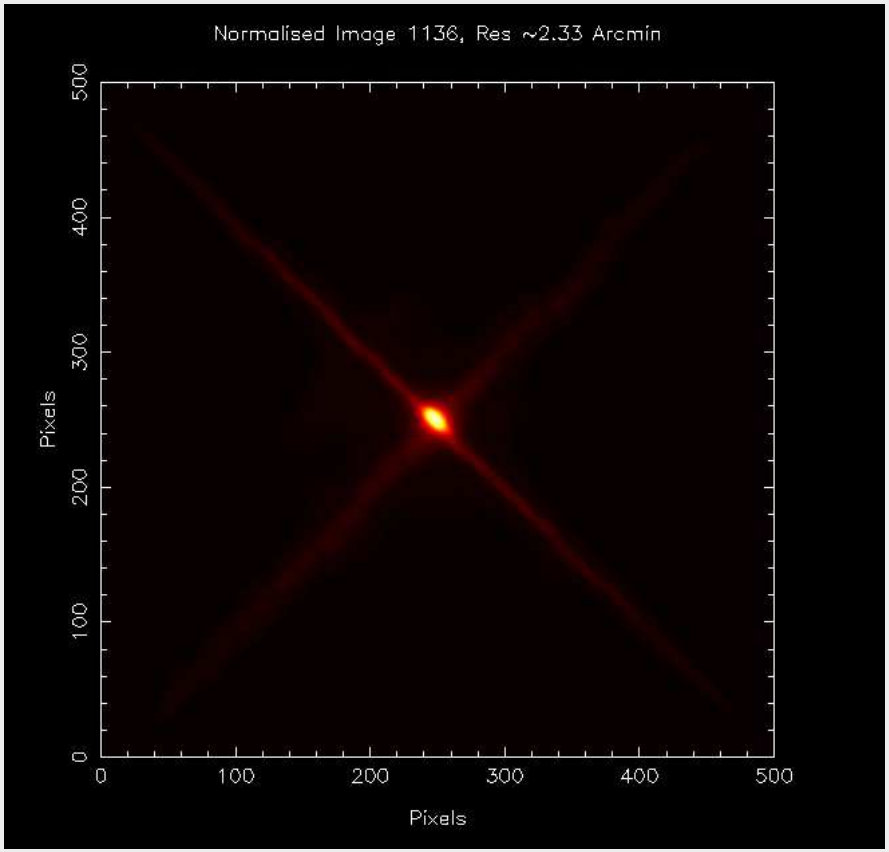
Focus (quasi)-parallel beam into a spot: $I_{spot} = ½\ R_{slump}$

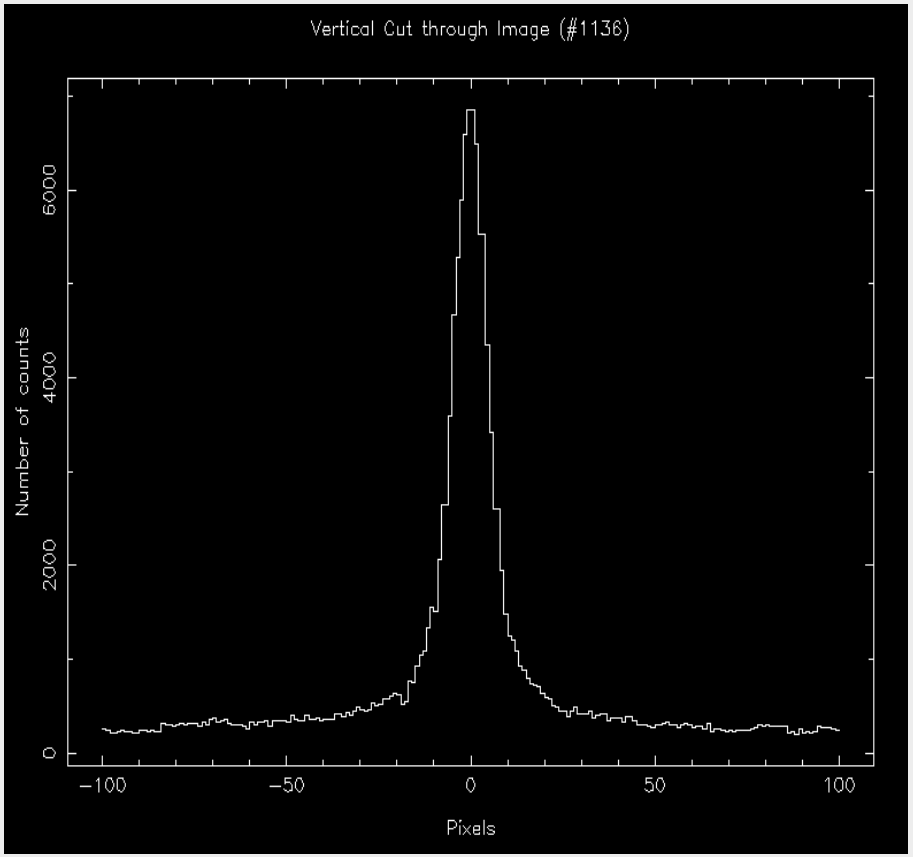
PHOTONIS

MCP X-ray image quality



PHOTONIS


Normalised Image 1136, Res ~2.33 Arcmin
Pixels
0
100
200
300
400
500
Pixels


Vertical Cut through Image (#1136)
Number of counts
0
2000
4000
6000
−100
−50
0
50
100
Pixels

PHOTONIS

Square Pore µ-OptiX

focusing X-rays by reflection off the inside surfaces of square channels

Imagine channel plates as collection of millions of little “micro-mirrors” :

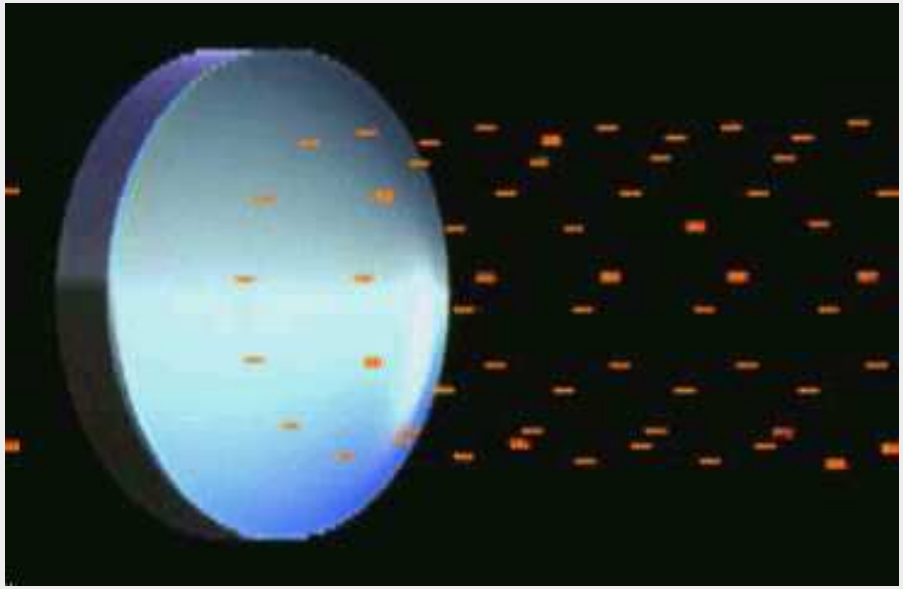
- **compact**
- **low mass**
- **relatively cheap**

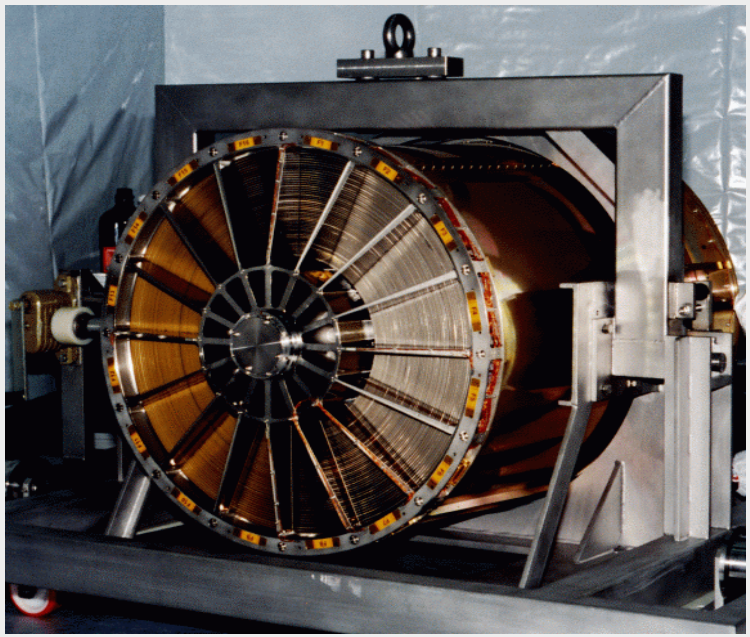
PHOTONIS Square Pore OptiX: SPOX?

The old technology:

Concentric gold plated cylinders

focus / reflect X-rays onto a detector





Mirrors for XMM Space project

PHOTONIS

Micro Pore Optics / MPO

NEW vs OLD TECHNOLOGY

	XMM	SPO
WEIGHT	350 kg	29 g
DIAMETER	700 mm	60 mm
Platform	910 Kg/m^2	10 Kg/m^2

PHOTONIS

The production process

Square-Pore-Square-Pack

(Square MF stacking)

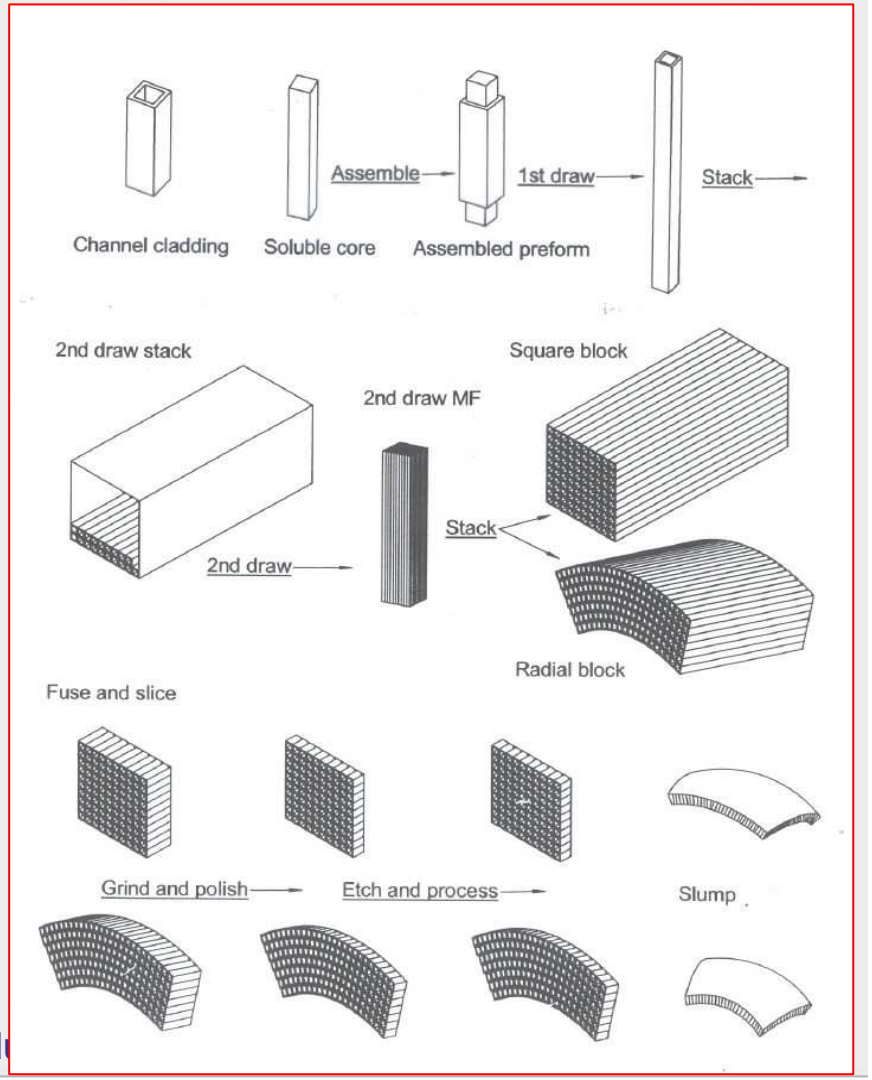
Or

Square-Pore-Radial-Pack

(Radial MF stacking)

More difficult to make (>€) but

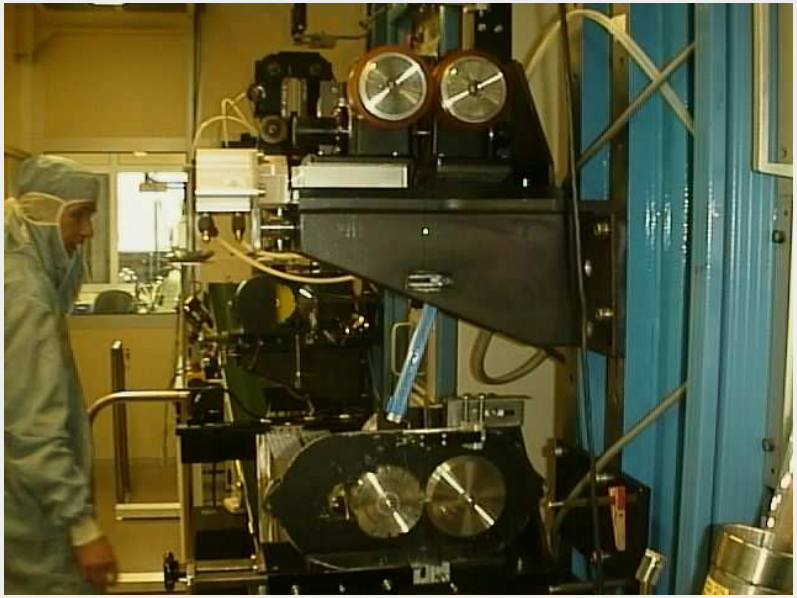
better optical (focal) properties



PHOTONIS

THE DRAWING PROCESS

drawing tower
automatic fibre
or
multifibre “kickers”



Automatic fibre and multi-fibre monitor

PHOTONIS

THE STACKING PROCESS

Square stacking of square multifibres

(square-pore square-pack)

Stacking with video and software for quality control

PHOTONIS

Micro Mirror Optics

At high photon energies i.e. very short λ, scattering from surface roughness is an important source of loss

Currently we make channel roughness ~5 nm rms

ETCHING CORE TECHNOLOGY

➔ need small angles of incidence (< 2º)

➔ allow the rays to strike (graze) the surface

➔ the channels have to be long

NEED HIGH L/D RATIO i.e. the larger L/D the better

(also allowing X-rayFLECTION with higher energies …)

PHOTONIS

µ Mirror OptiX

The resolution will be mainly due to:

- **The geometrical quality of the OptiXs**
- **The roughness of the channel's inner surface**

Main parameters

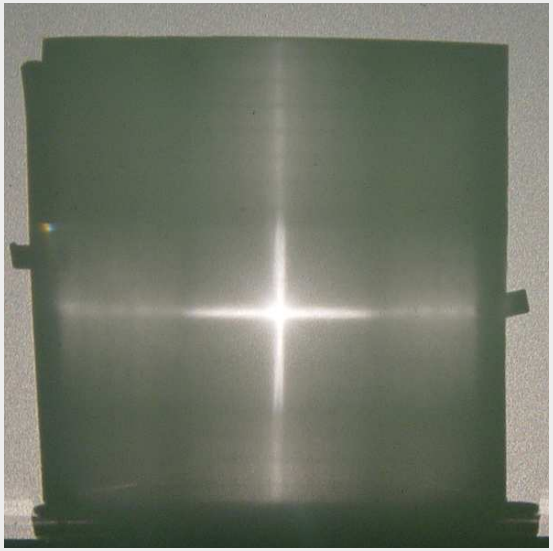
- **Size of the holes (pore size, length, L/D)**
- **Geometry of the channels (fibers, multi-fibers)**
- **Stacking, channel's alignment**
- **Material reflectivity (special glass)**
- **Inner surface roughness**

PHOTONIS

Square Pore µ-OptiX

Applications

- Scientific / Space applications
- Laboratory applications
- X-ray lithography



(image from visible light)

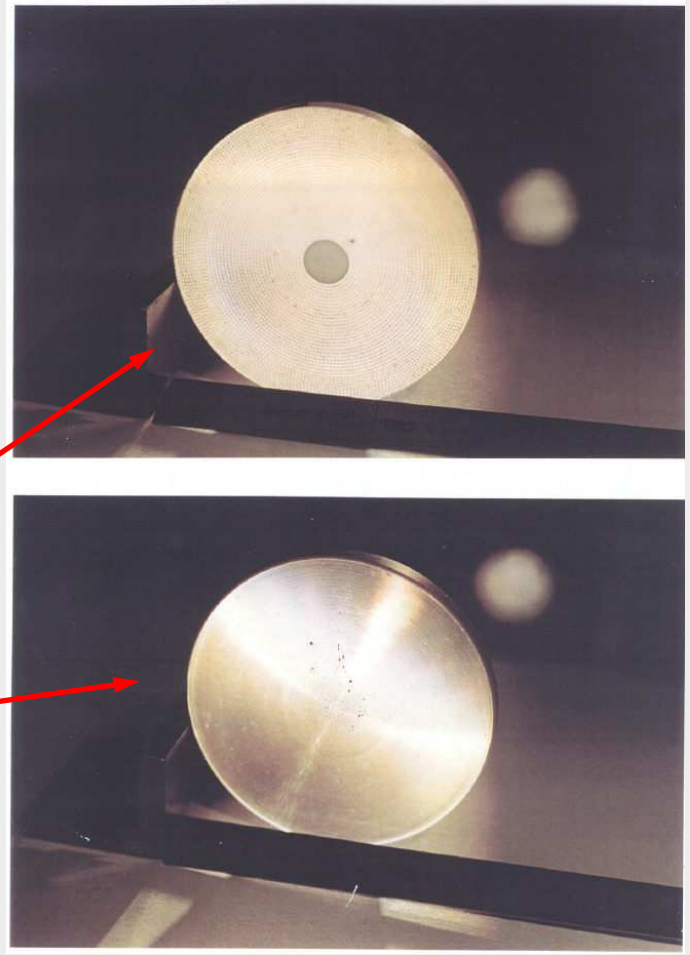
Square Pore µ-OptiX

SCIENTIFIC APPLICATIONS:

SPACE

- X-ray domain

- Deep UV (XUV / EUV)

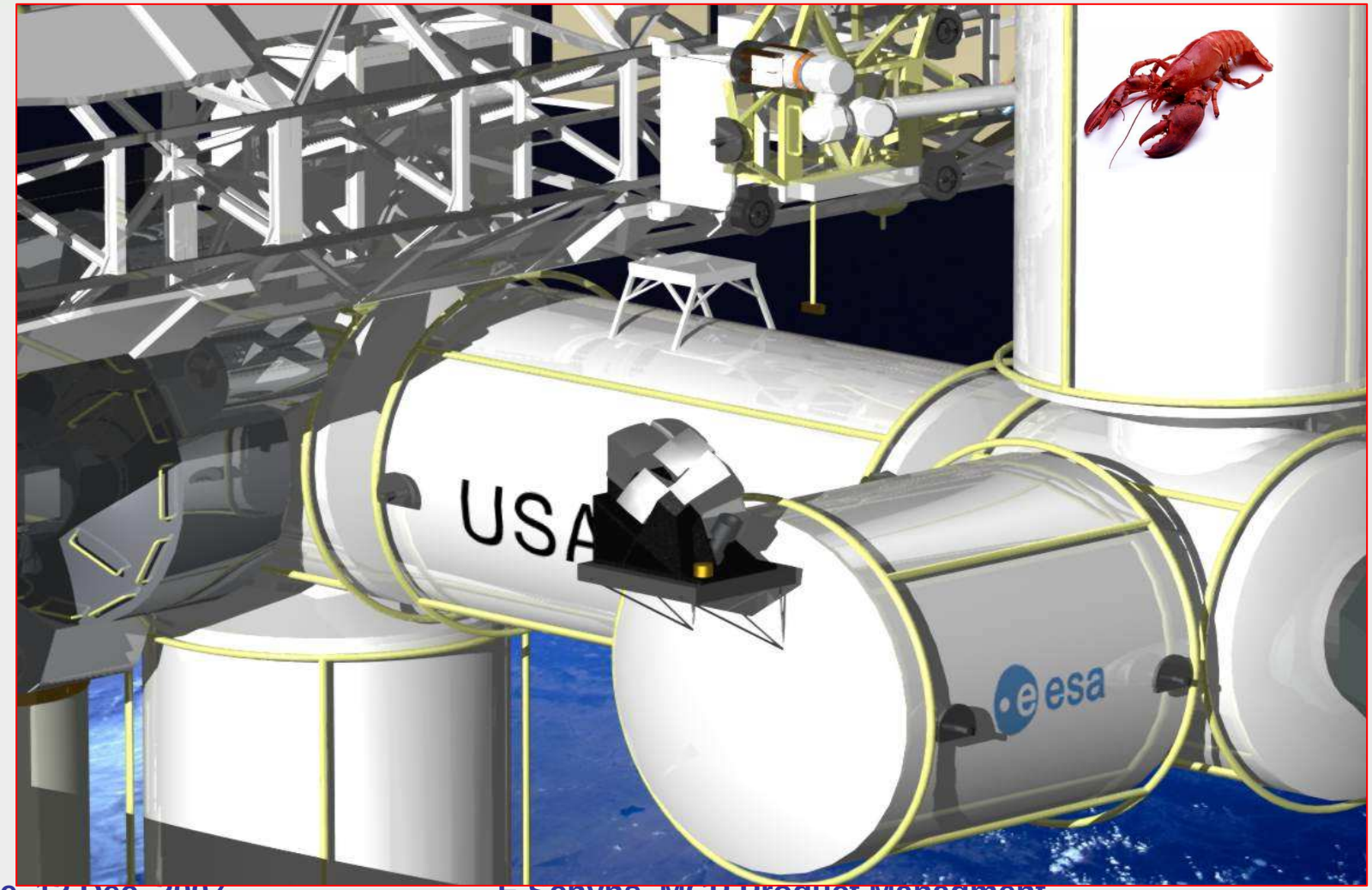


OptiX made by PHOTONIS

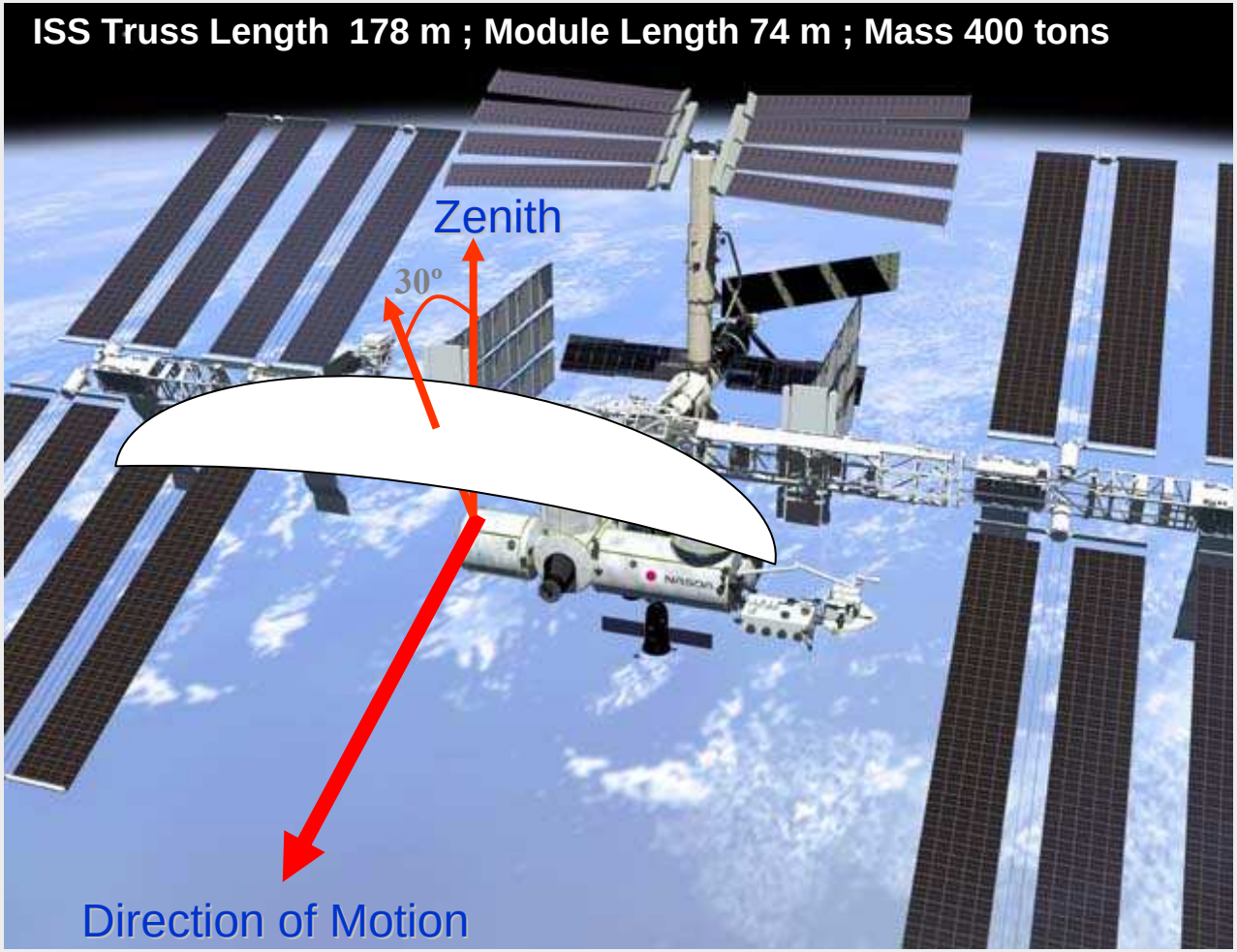
(ESA / ESTEC contract)

PHOTONIS

Lobster – mission in X-ray Astronomy

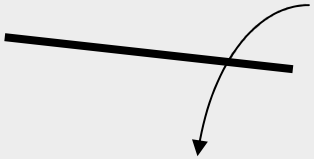


The ISS as a platform for All Sky Monitoring



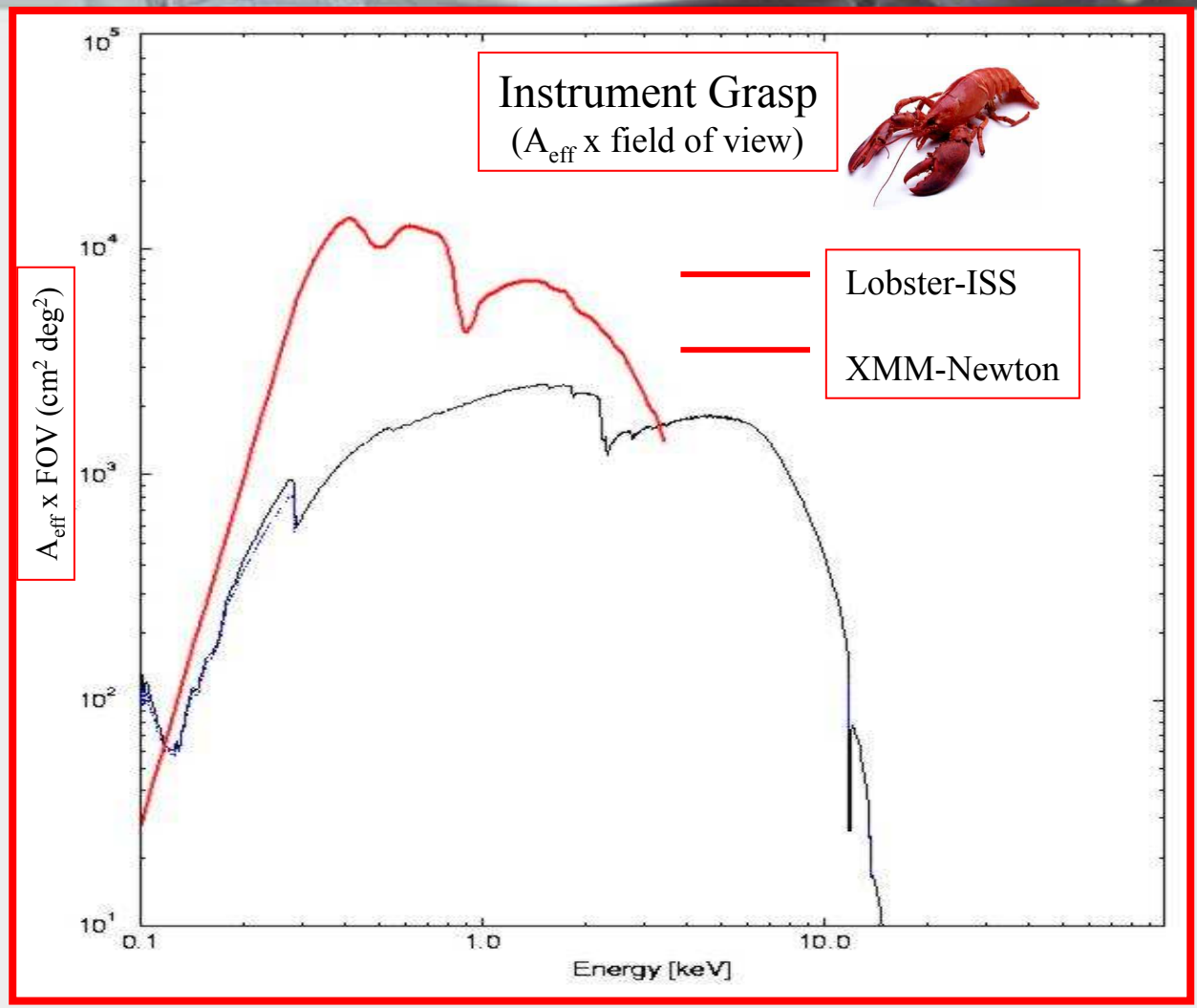
Tilt: 30° forward of zenith
Total field: 162°x 22.5°

Field sweeps sky every 90 minute orbit.



Rotation Axis

Lobster and XMM-Newton : The impact of novel, low-mass technology



Mission Bepi-Colombo (ESA) Launch in 2011?

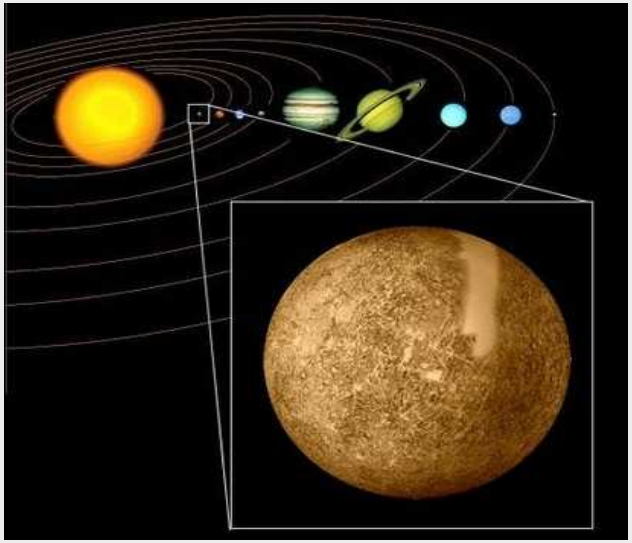
TARGET: Analyses of Mercury surface (X-ray spectroscopy)

*** Why close to the sun ?**

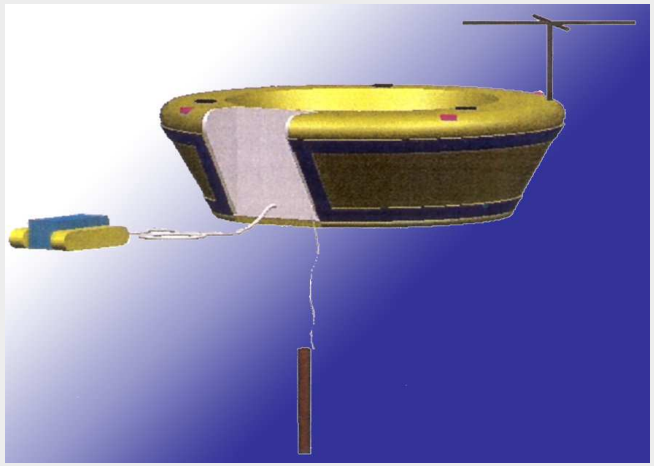
*** Why core is big (80% of the mass) ?**

*** Why Mercury has a magnetic field ?**

*** Ice on the pole of Mercury ?**

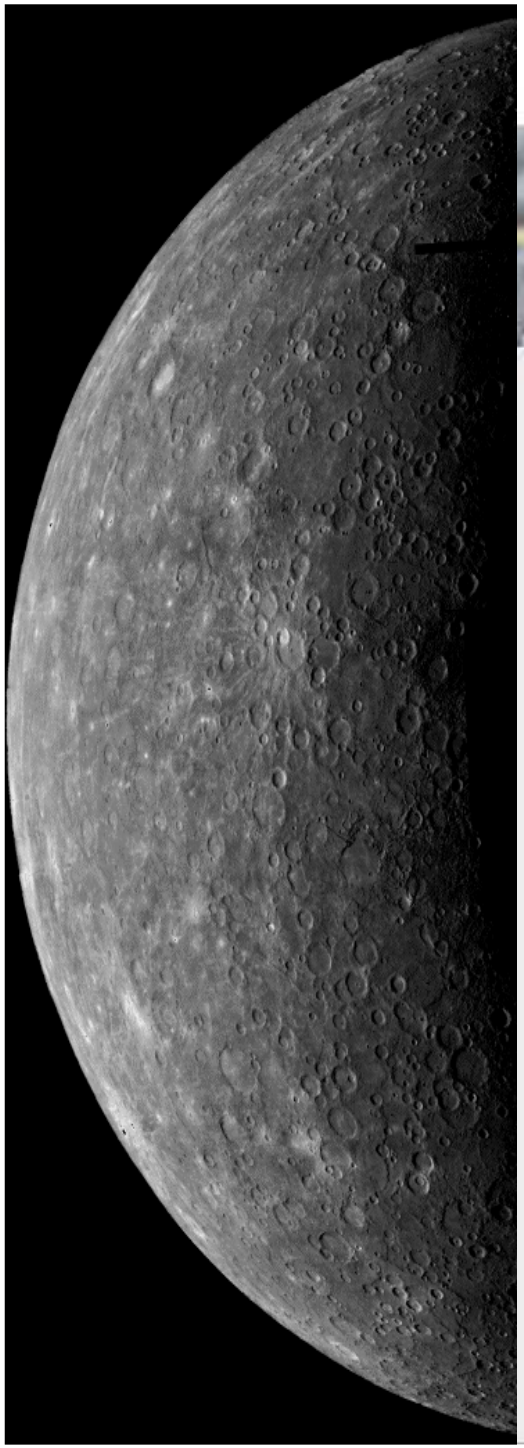


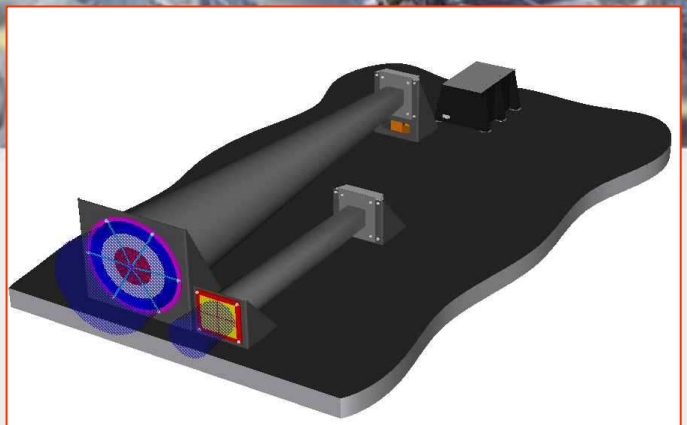
Mercury



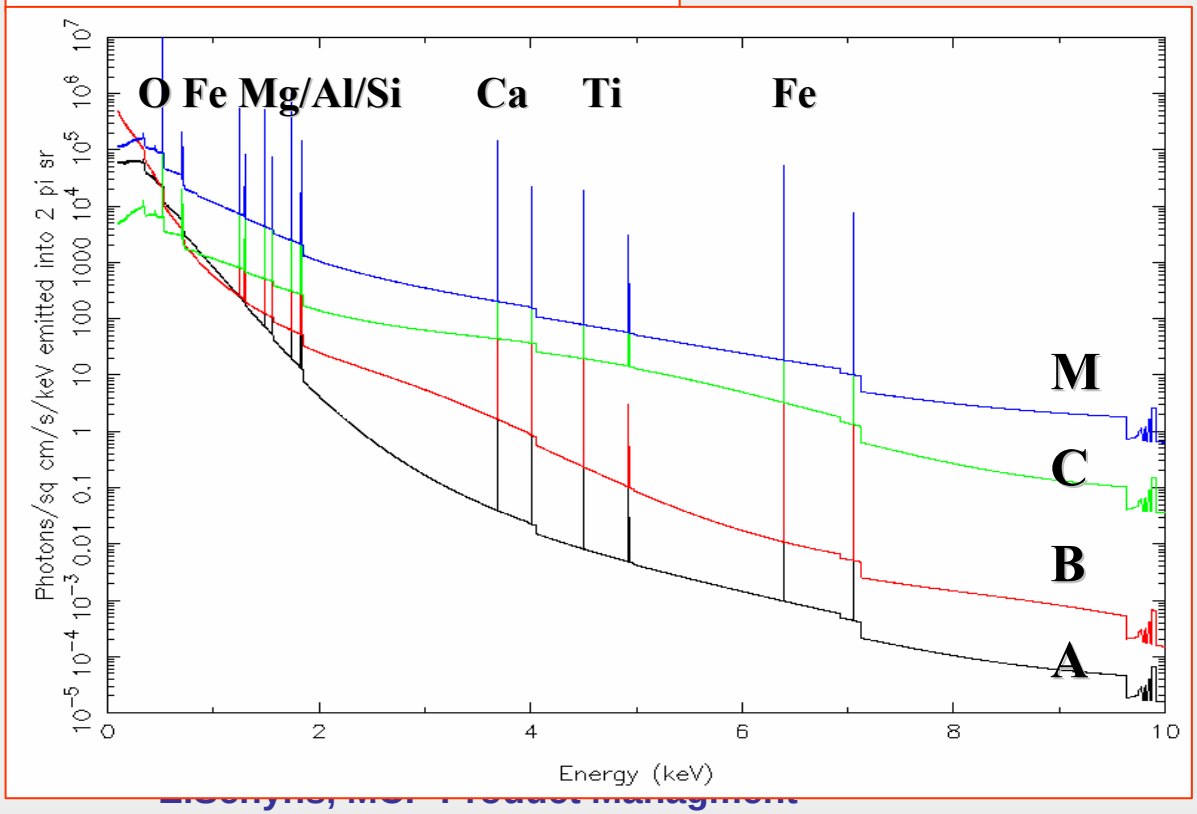
On it's way to Mercury, passes by the Moon & Jupiter: switch on?

Square Pore µ-OptiX





2 instruments
- MIXS-T
- MIXS-C

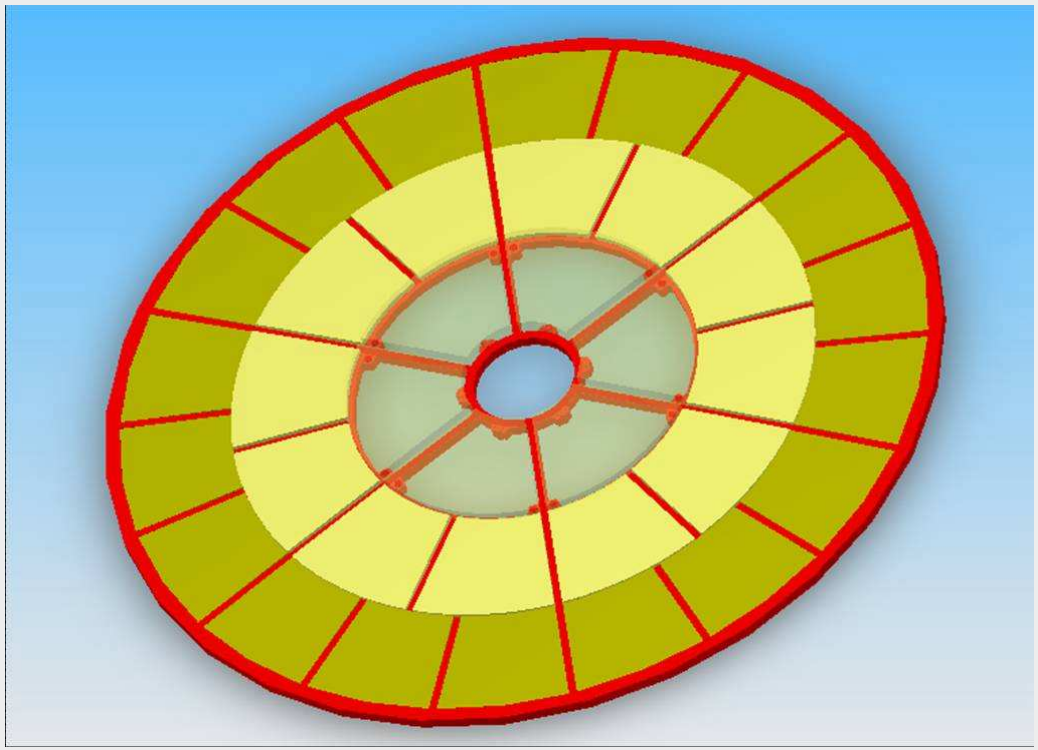


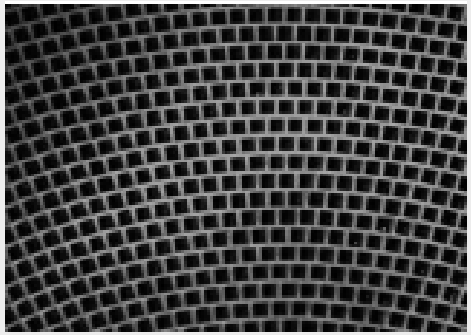
PHOTONIS

Detailed MIXS-T optic design

Input to Breadboard development project

ESA / Photonis / cosine-Research collaboration



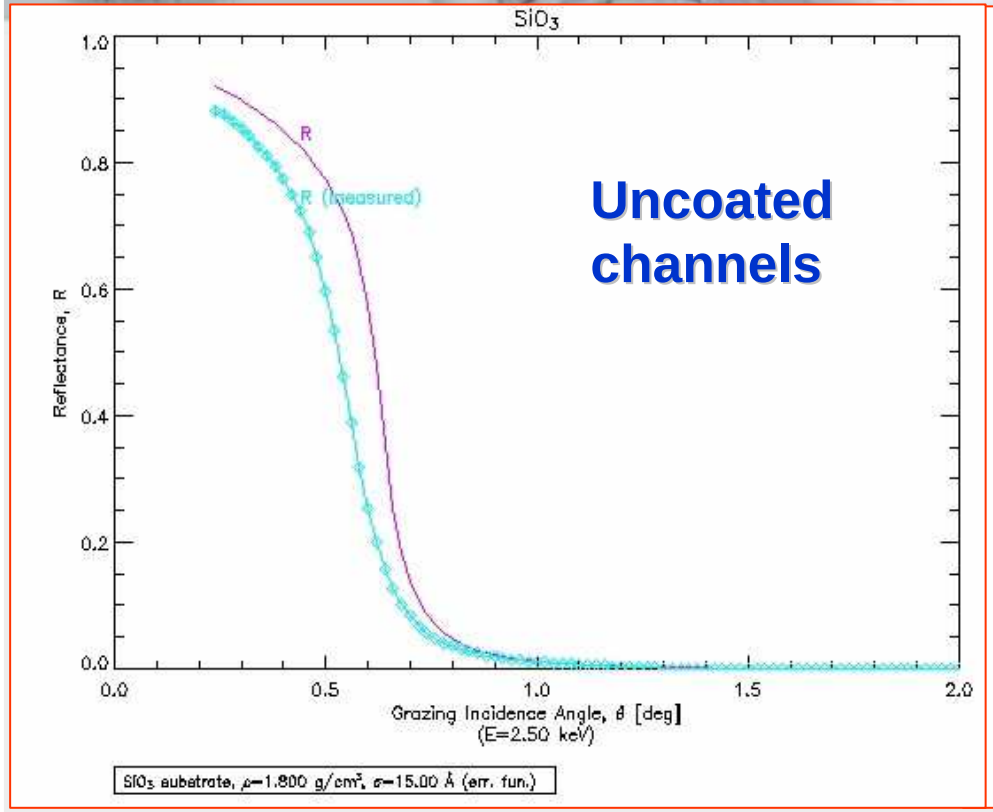


6 sectors of
1-2-3 doublets

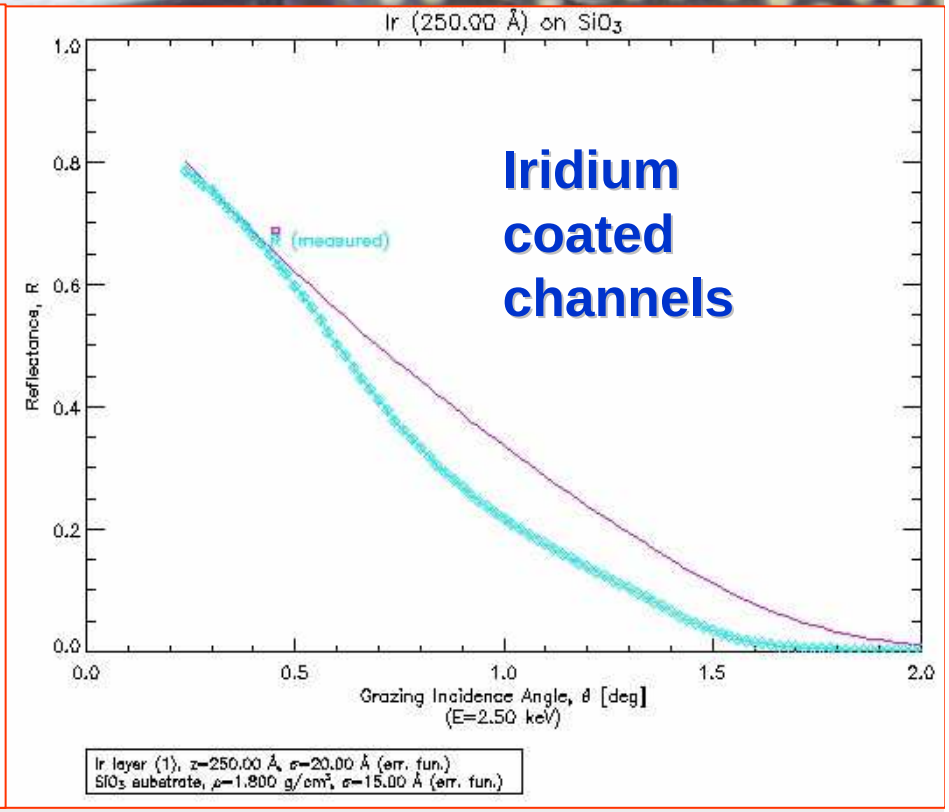
R_{slump} 1 = 4 m

R_{slump} 2 = 1.3 m

PHOTONIS



Uncoated channels



Iridium coated channels

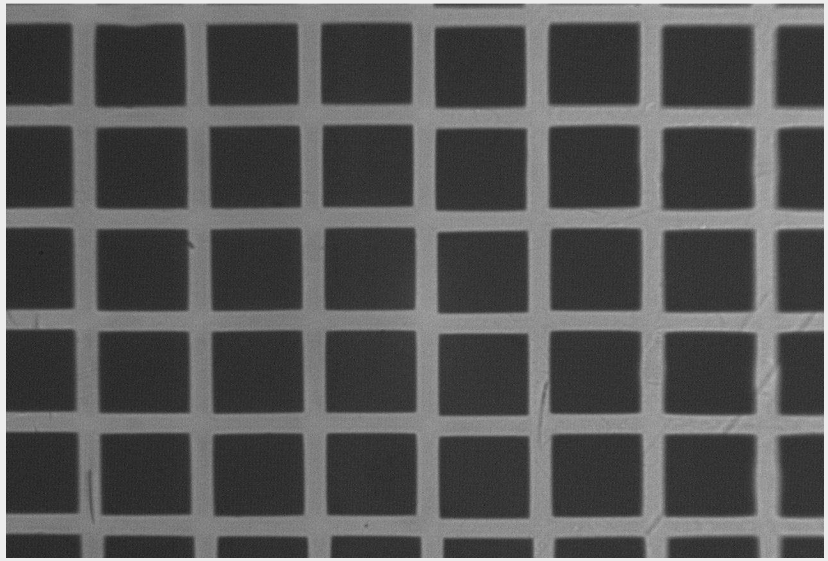
Demonstration of enhanced X-ray reflectivity at 2.5 keV for Iridium-coated MCP

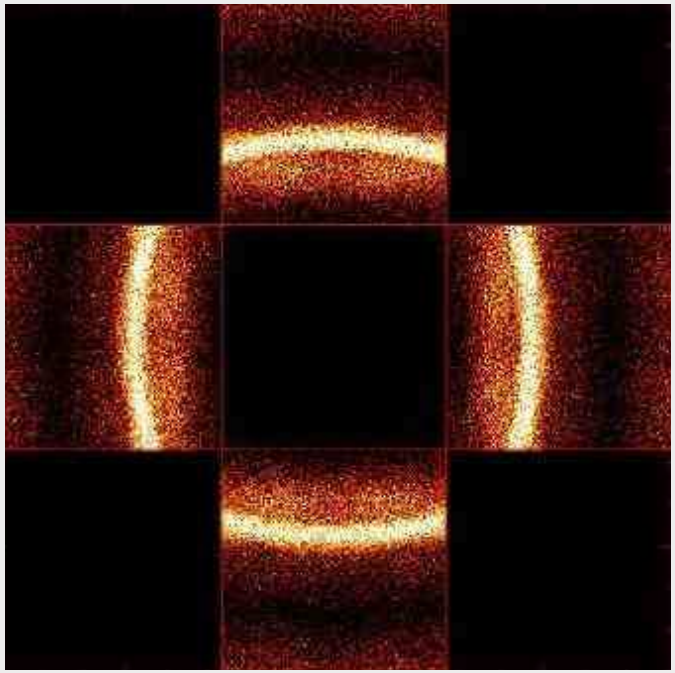
Other coatings possible: Au, Ni

(difficult to get metal all the way in the channels)

Mission Auroral Imager (ESA)

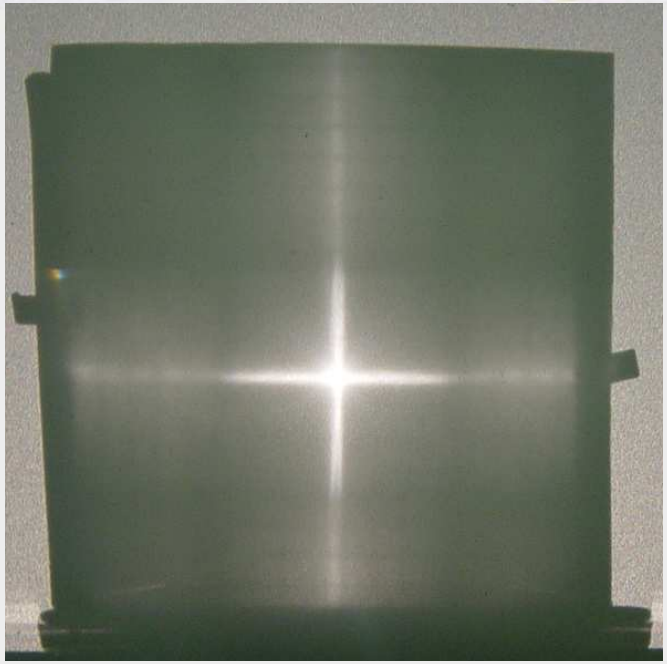
- Idea from University of Leicester to measure the interactions between particle flux and earth magnetic field at the poles.
- Same optics as Lobster programme.
- TELESCOP X with 5 modules





Applications

In the laboratory



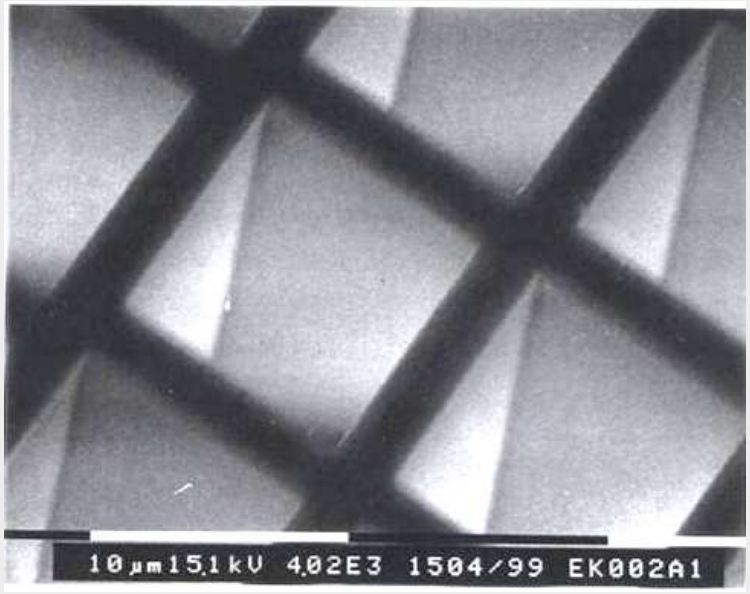
- Material test and quality control
- X-ray lithography
- XUV lithography
- Medical imaging (decreased dose) !

Applications e.g. X-ray lithography

- The resolution of features on a chip is limited by diffraction from the mask “blurring” the image.
- Diffraction is inversely proportional to λ,
- Soft X-rays λ ~ 1 nm : no problem
- OptiX turns a diverting X-ray beam from a point-like source into a parallel beam and focuses down to a tiny point

PHOTONIS is the sole provider, i.e.

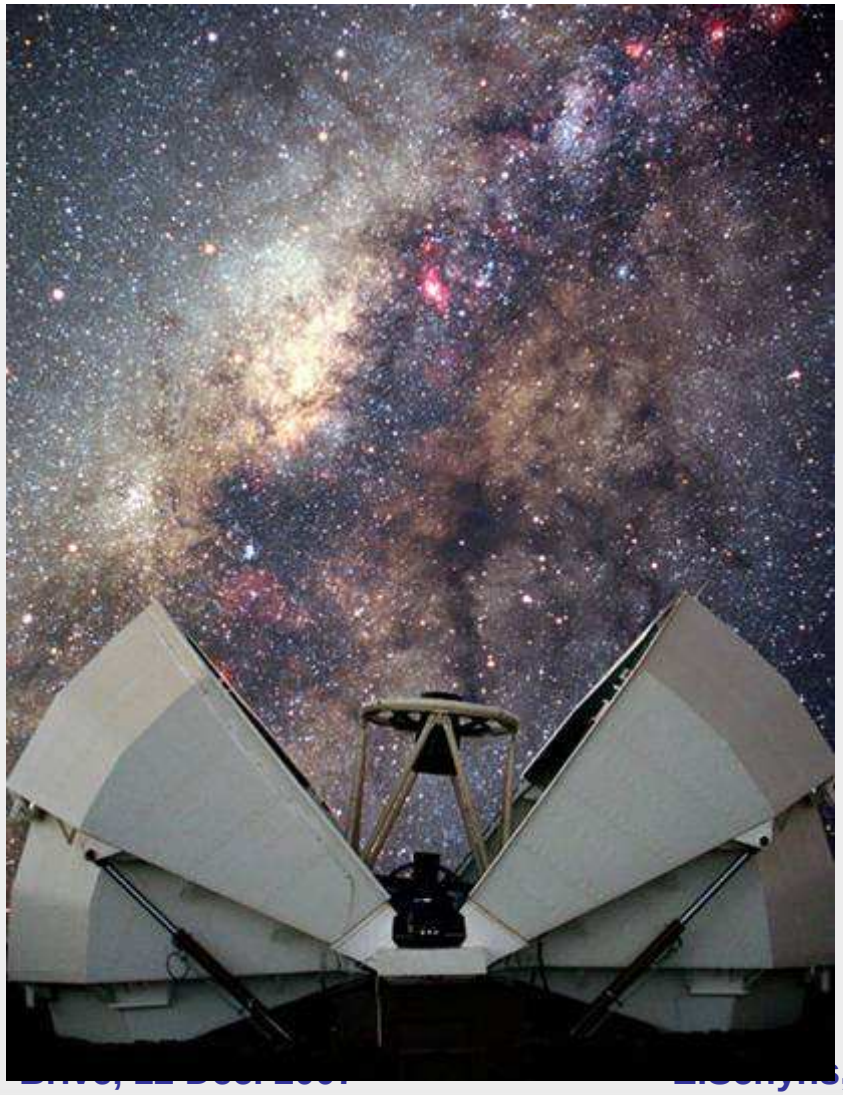
- can produce large quantities
- special glass composition

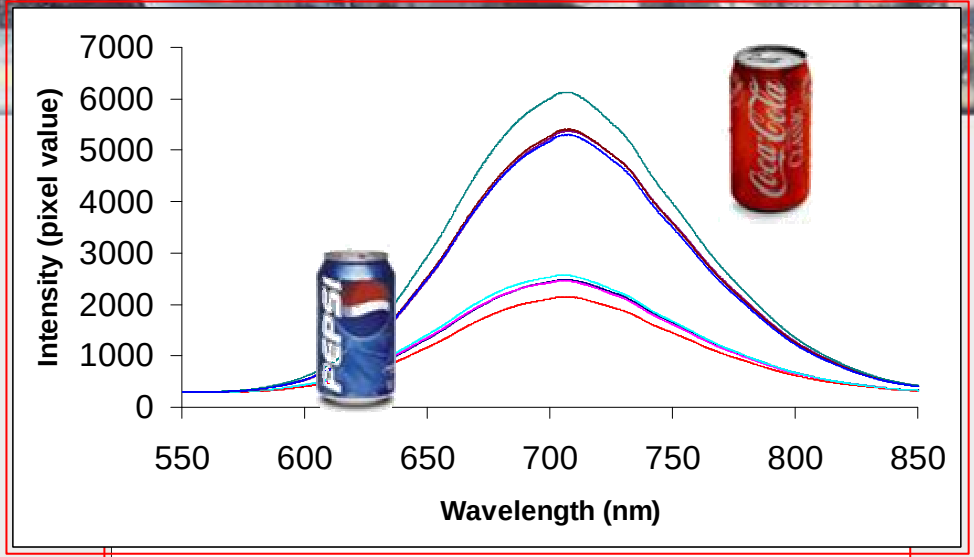


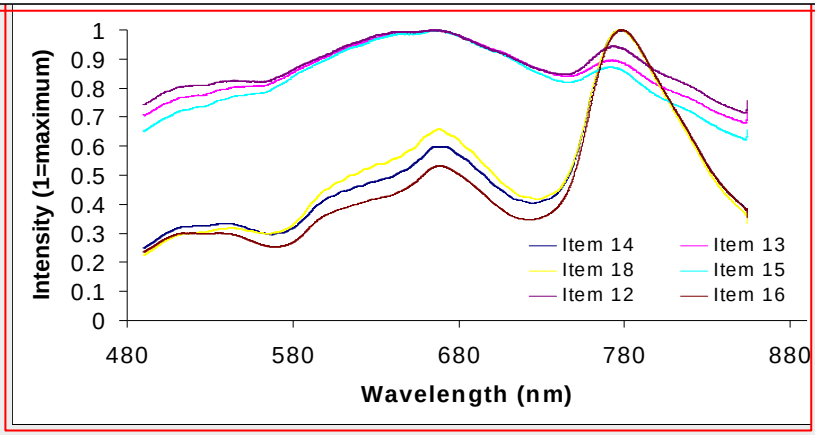
PHOTONIS

Note: the is not Square Pore Optics!

Other examples of applications coming from (outer) space:





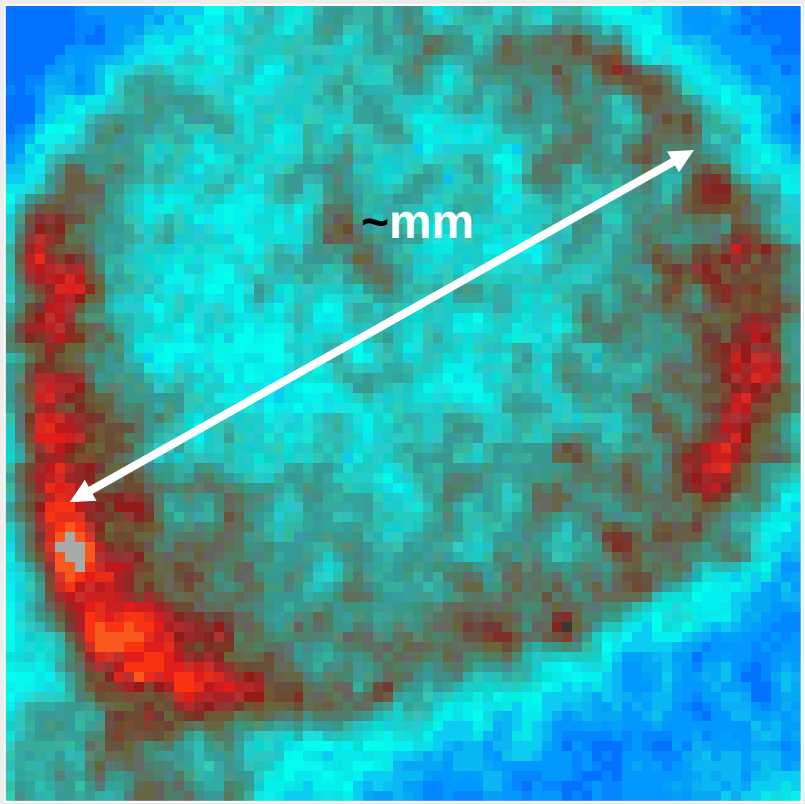


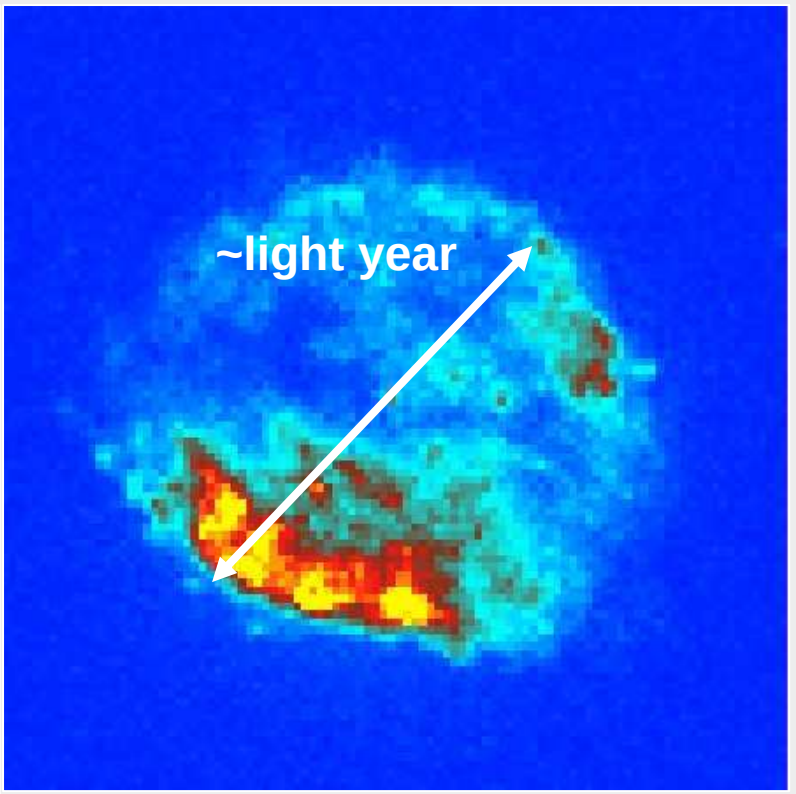
Faulkes Spectrograph **–**
measures the precise colours of objects (originally stars) to a high level of precision

PHOTONIS

Applications: From Astronomy to Biology

Goals - large area, high resolution, high efficiency, low background





BIOIMAGING UNIT