

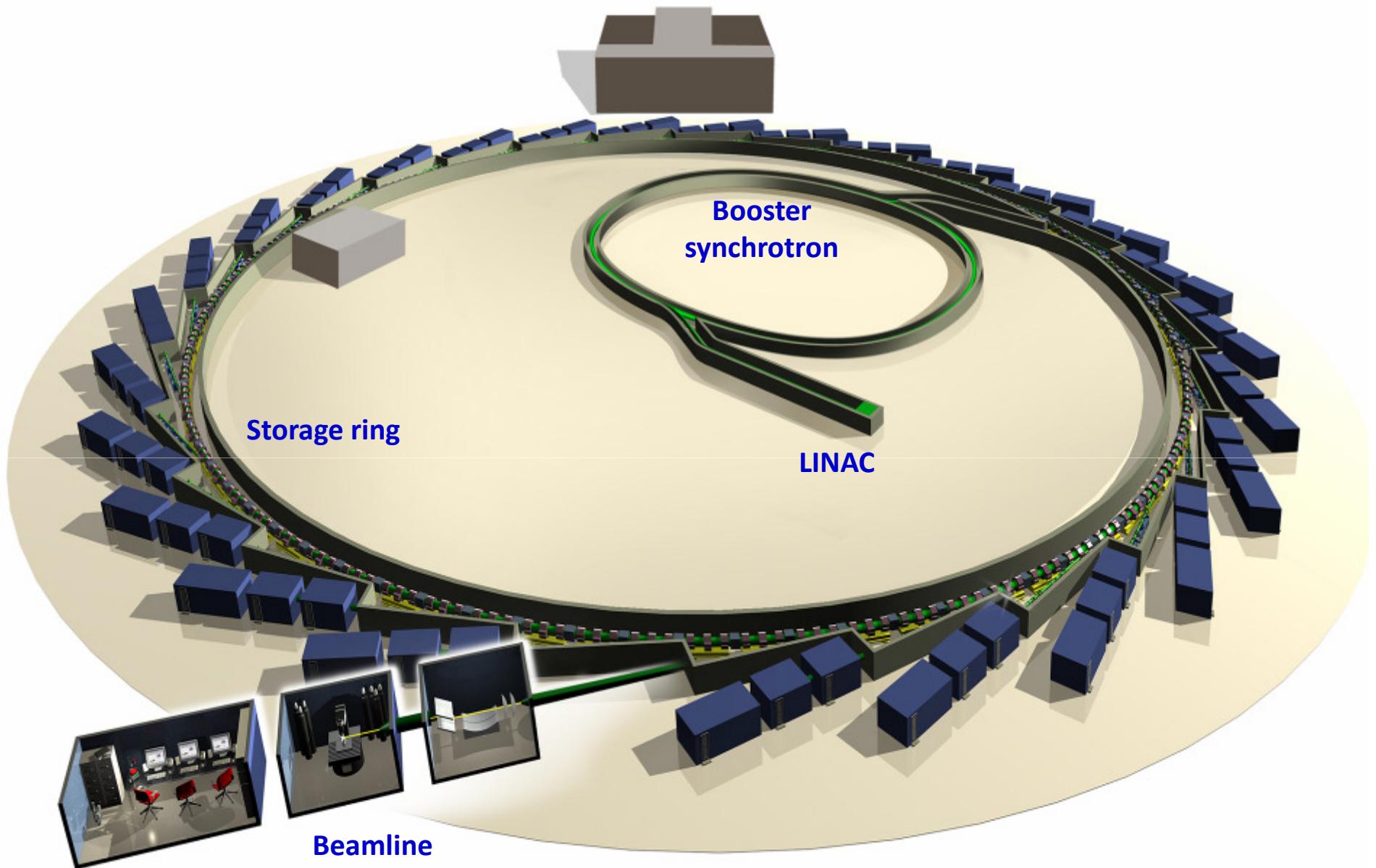
Detectors in Diamond Light Source



A photograph showing a circular array of detector modules at the Diamond Light Source. The modules are arranged in a hexagonal pattern, with a central bright star-like point of light. The background is a deep blue.

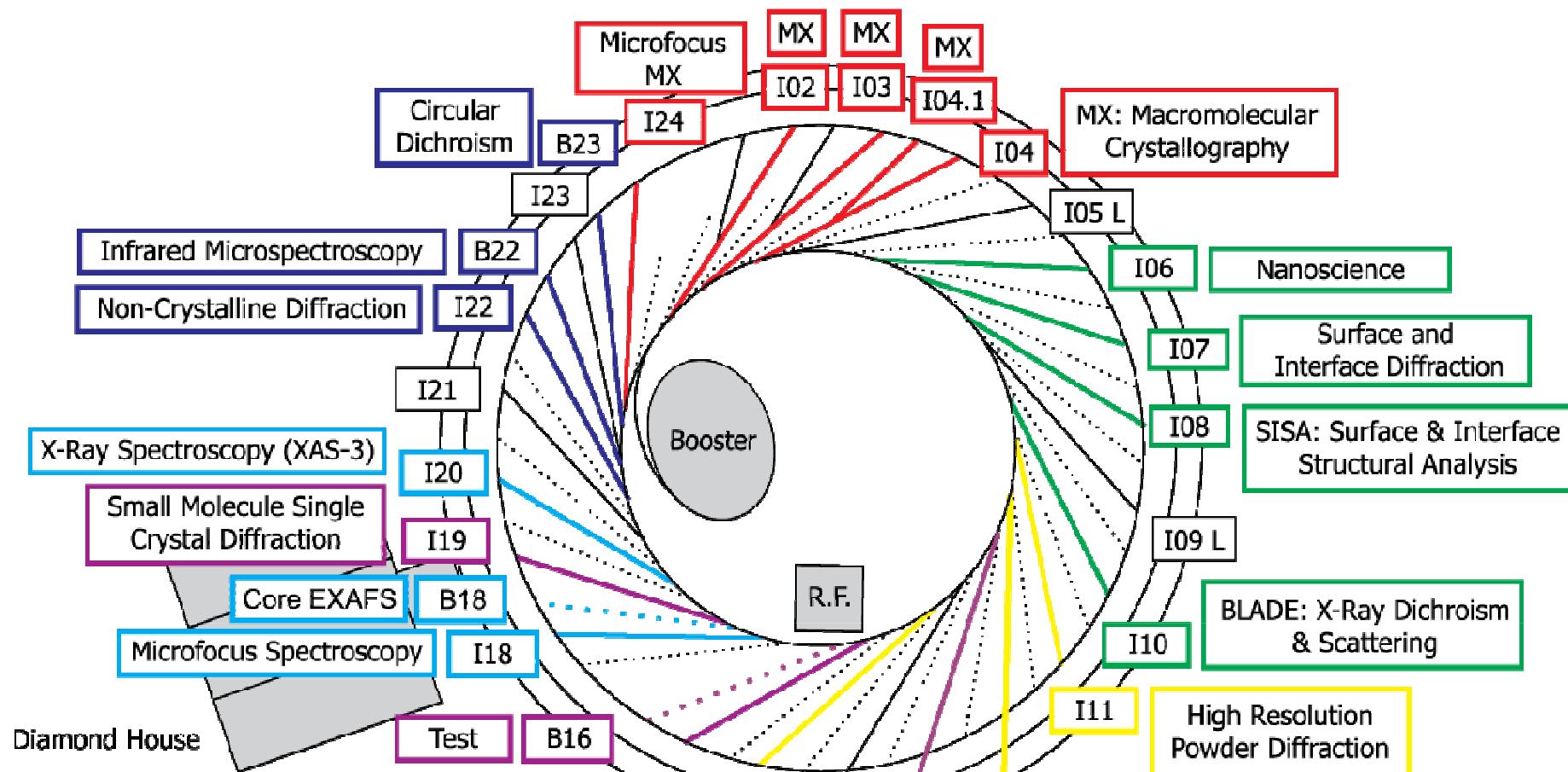
Nicola Tartoni

Head of the detector group at Diamond Light Source









— Macromolecular Crystallography

— Soft Condensed Matter

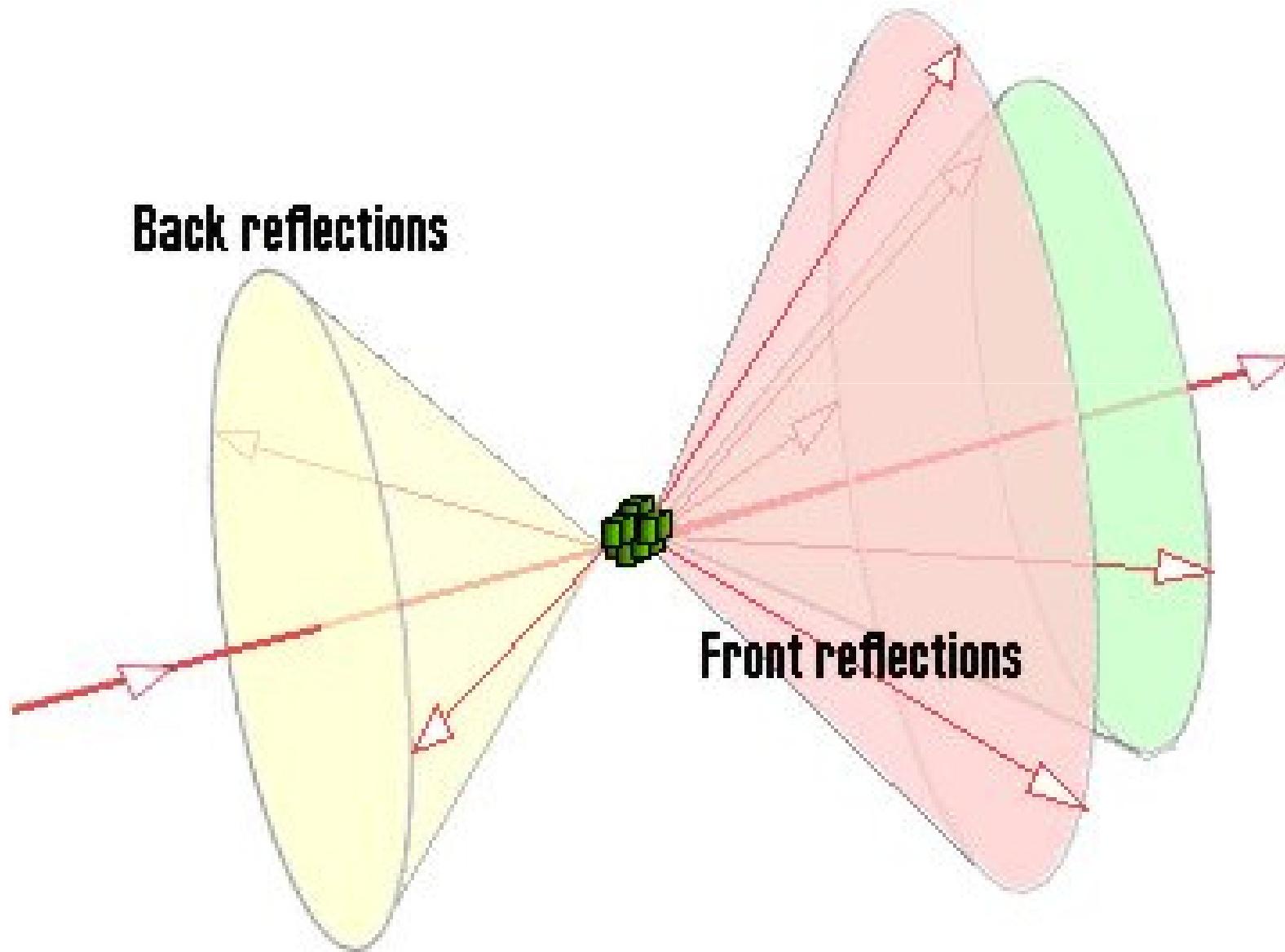
— Spectroscopy

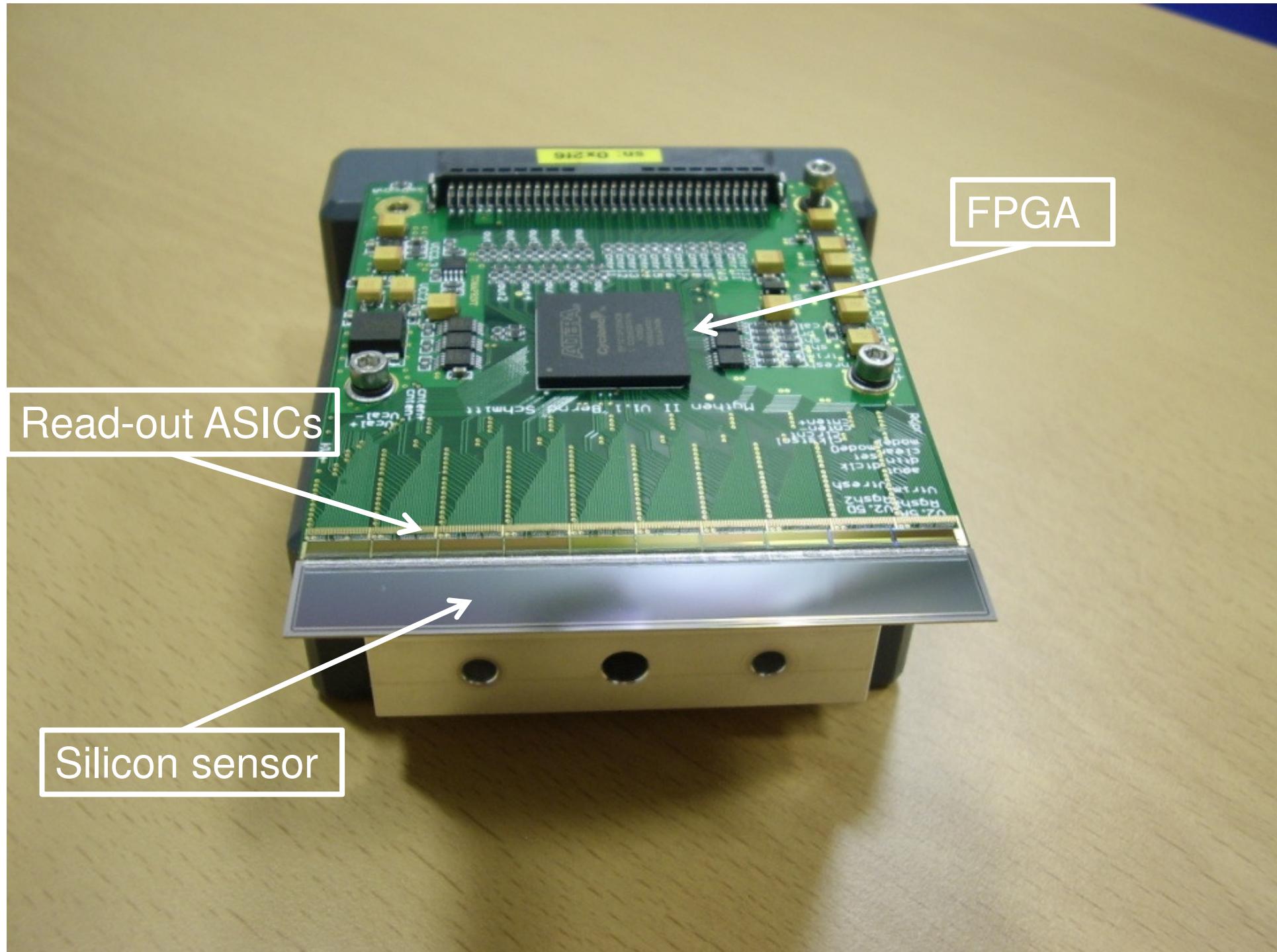
— Engineering and Environmental Science

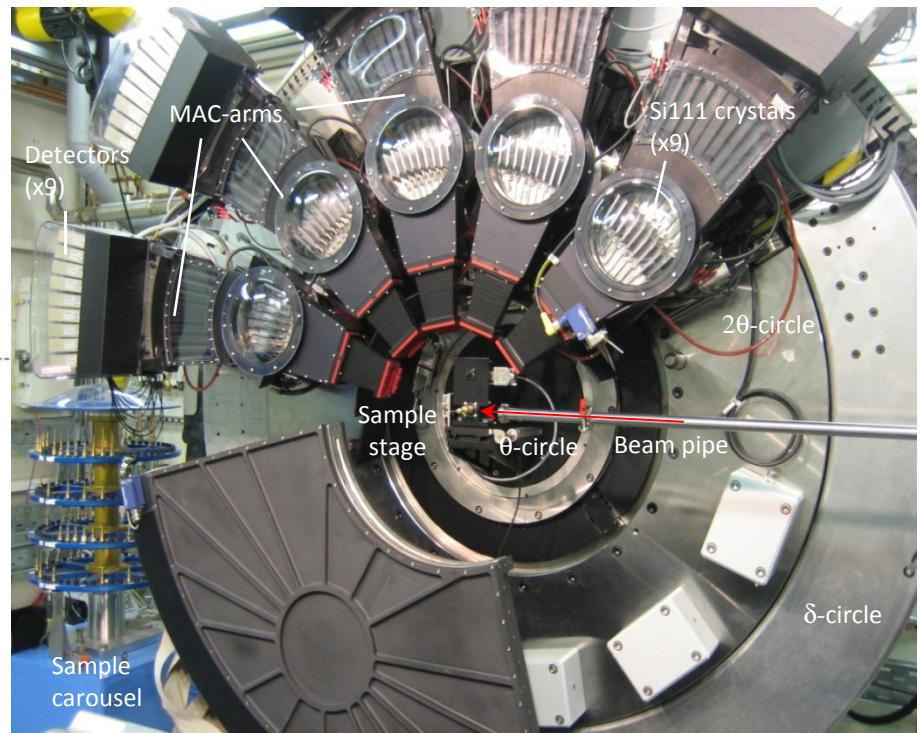
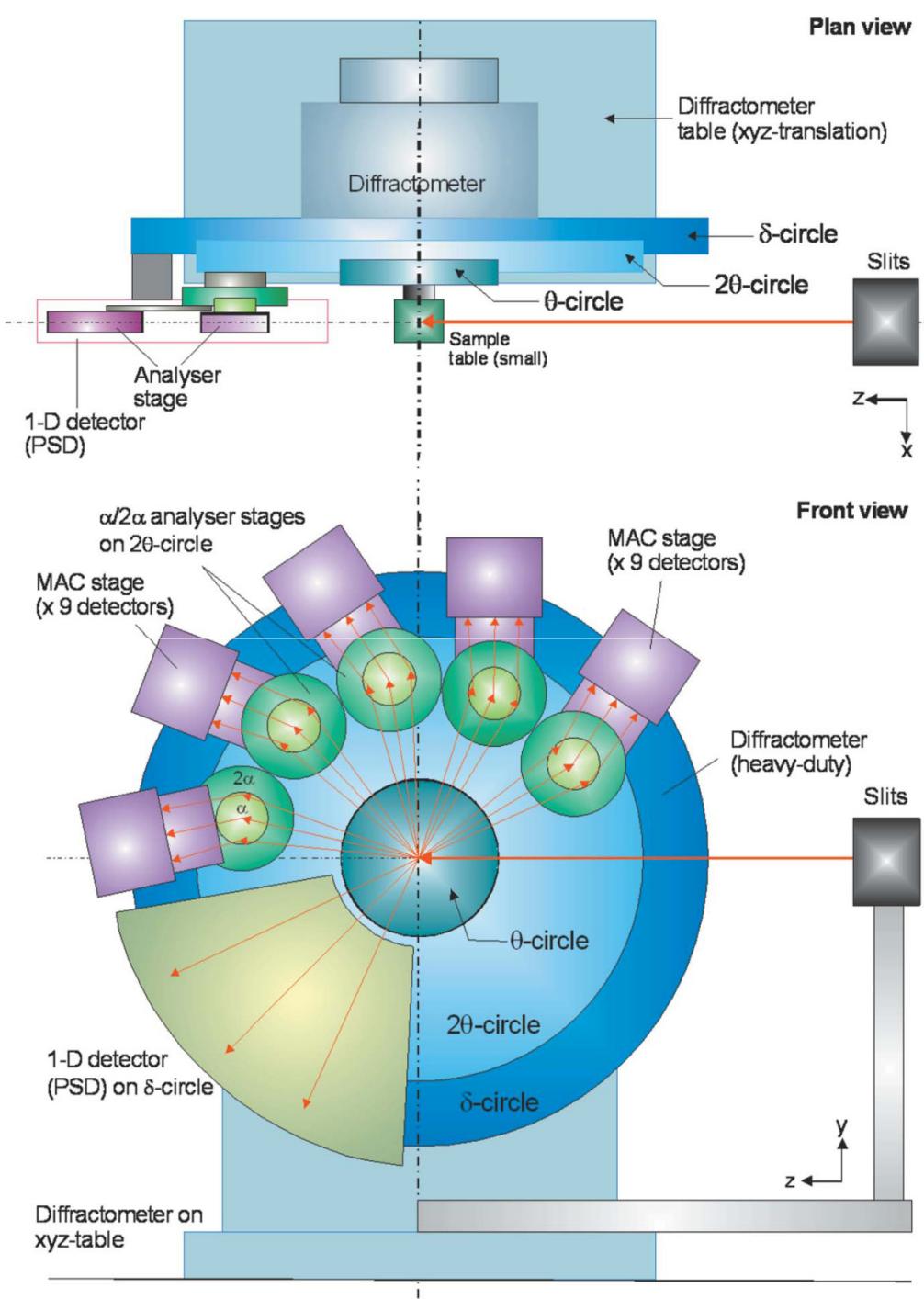
— Materials

— Surfaces and Interfaces

Powder diffraction experiment

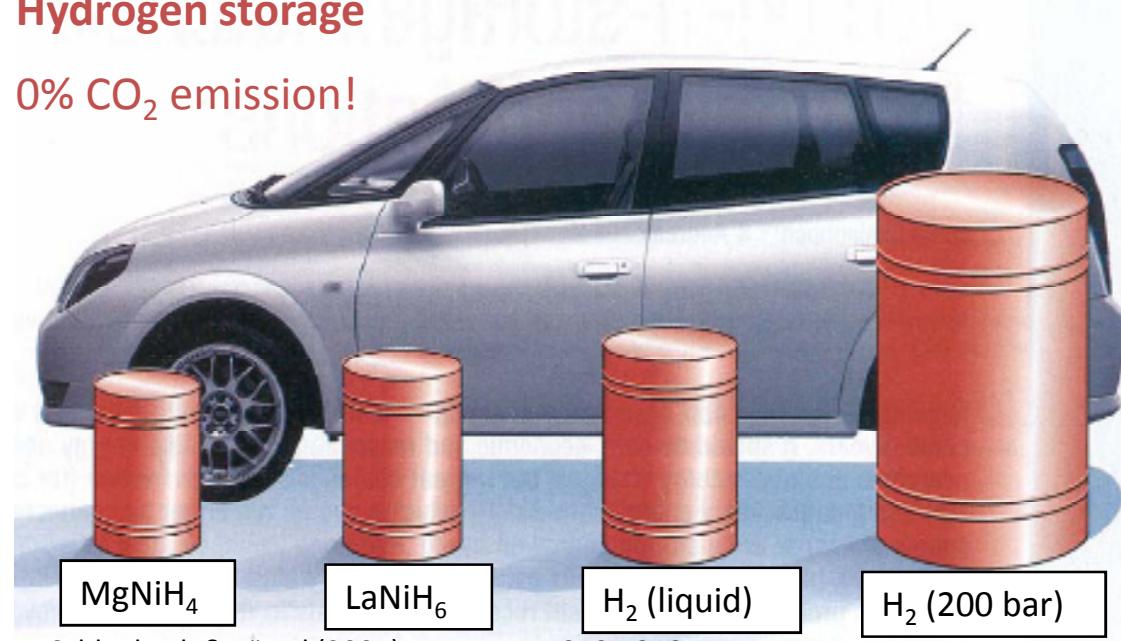




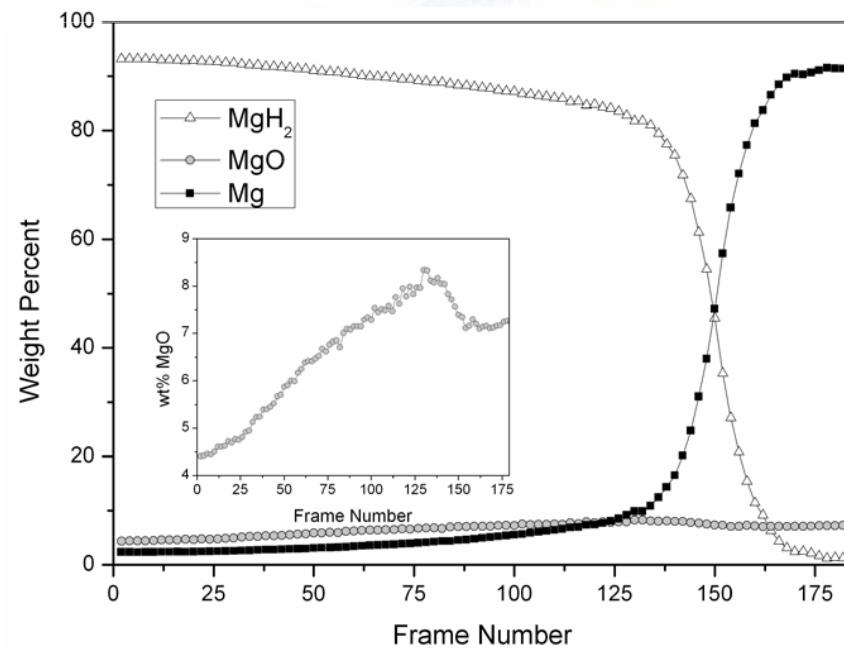


Hydrogen storage

0% CO₂ emission!



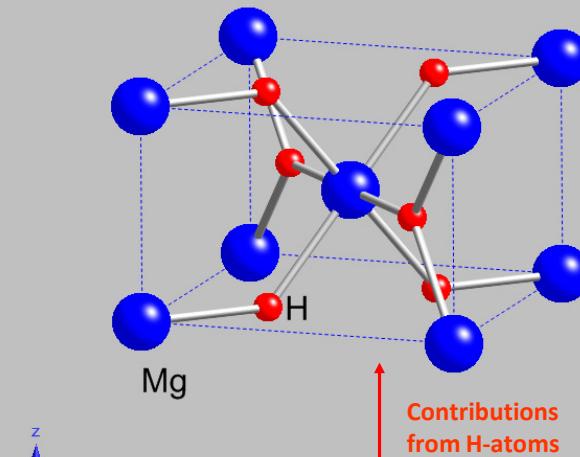
Schlapbach & Züttel (2001) Nature **414** 353 - 358



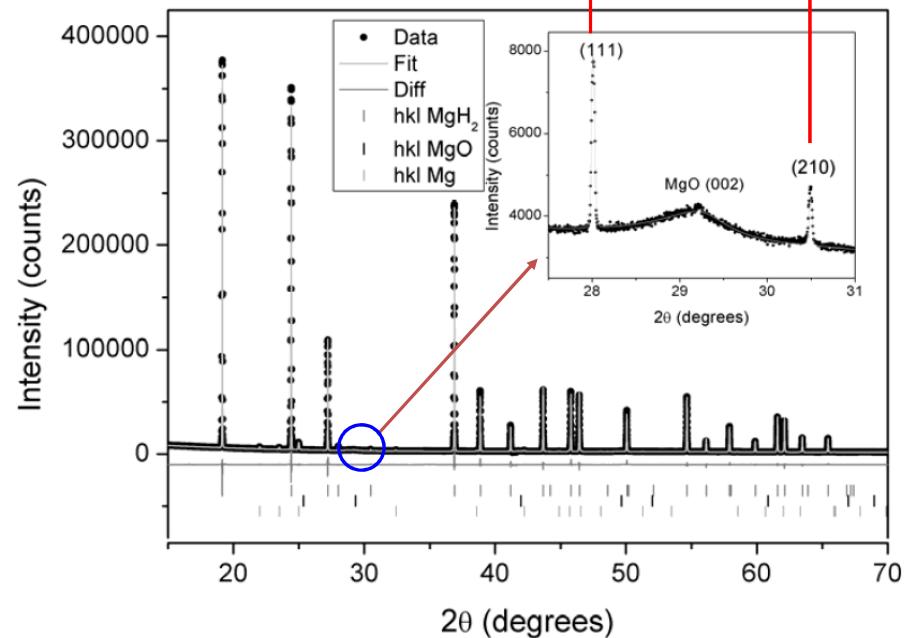
T=460°C, dehydrogenation process ~ 15 min

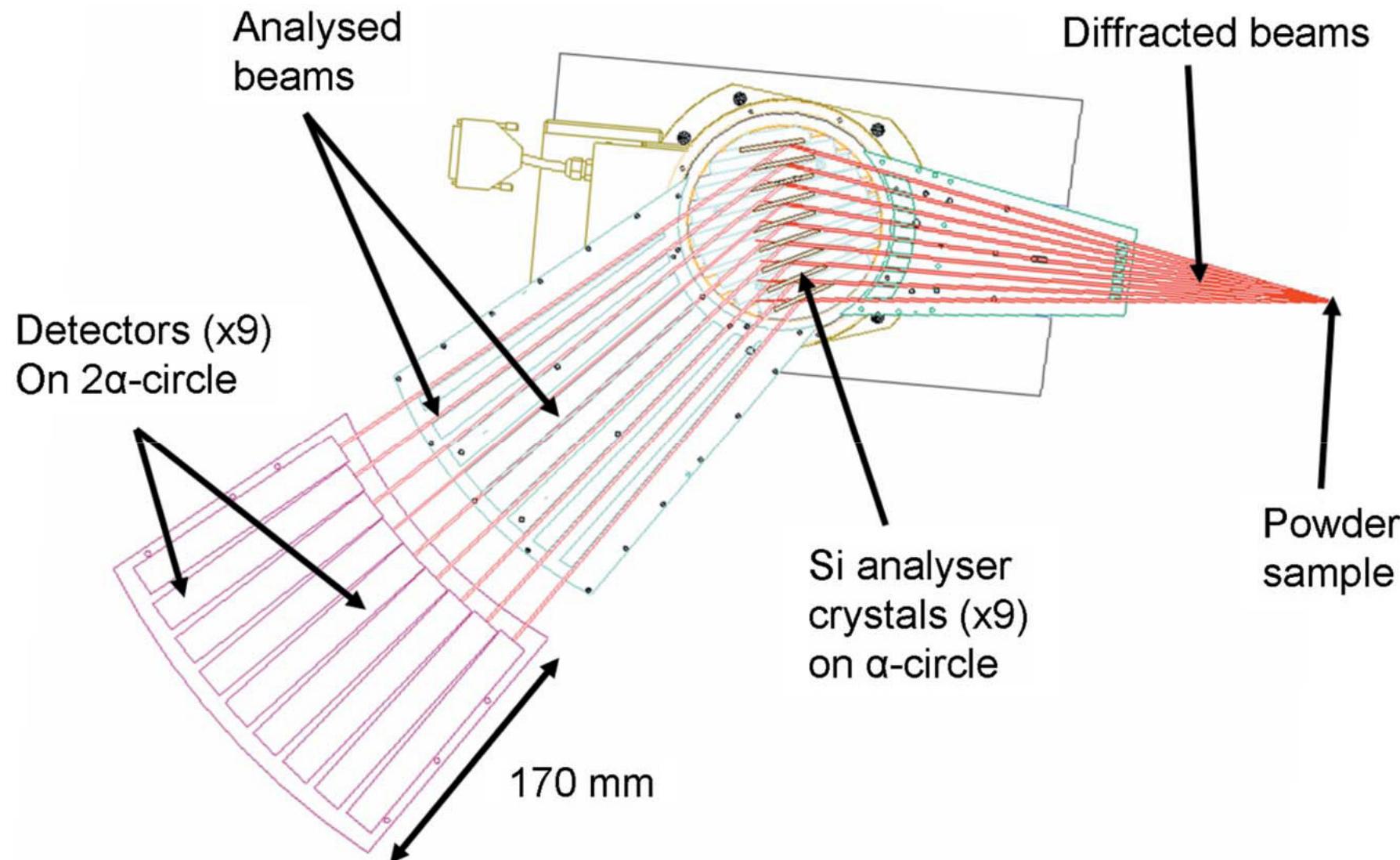
MgH₂ Tetragonal Structure (P42/mnm)

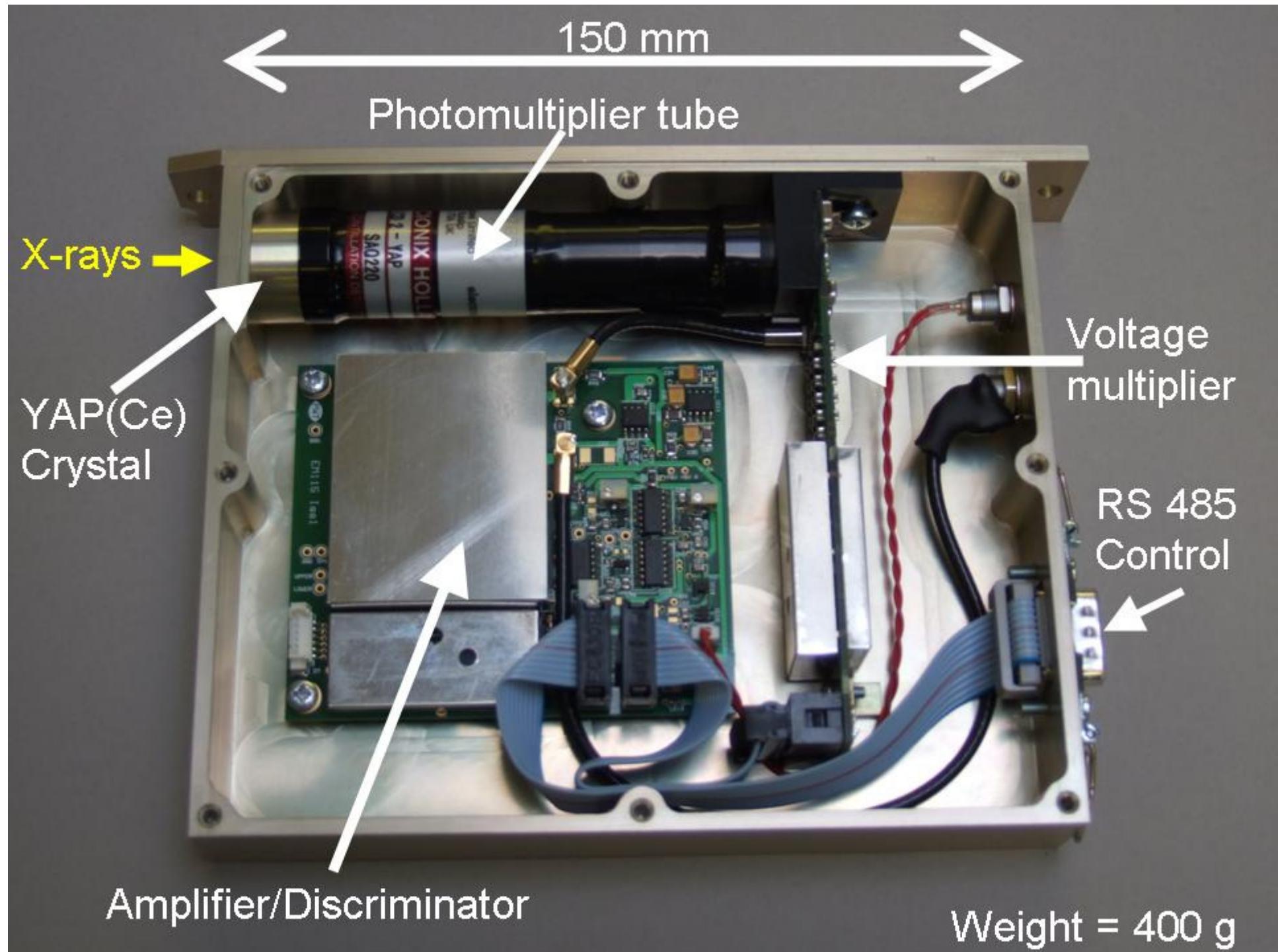
P4₂/mnm, $a = 4.51650 \text{ \AA}$, $c = 3.02081 \text{ \AA}$



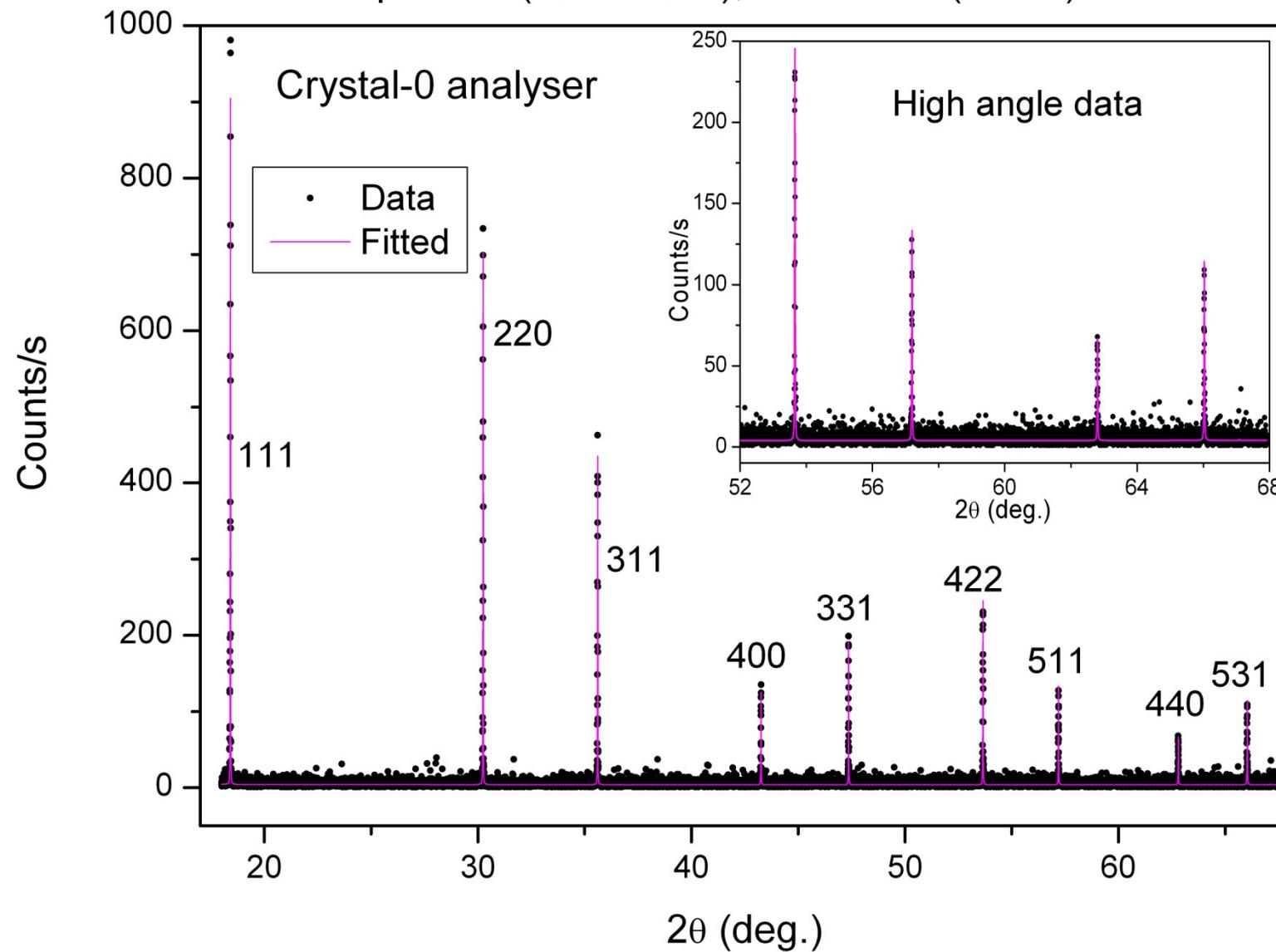
I11 PSD data, 2 s scan

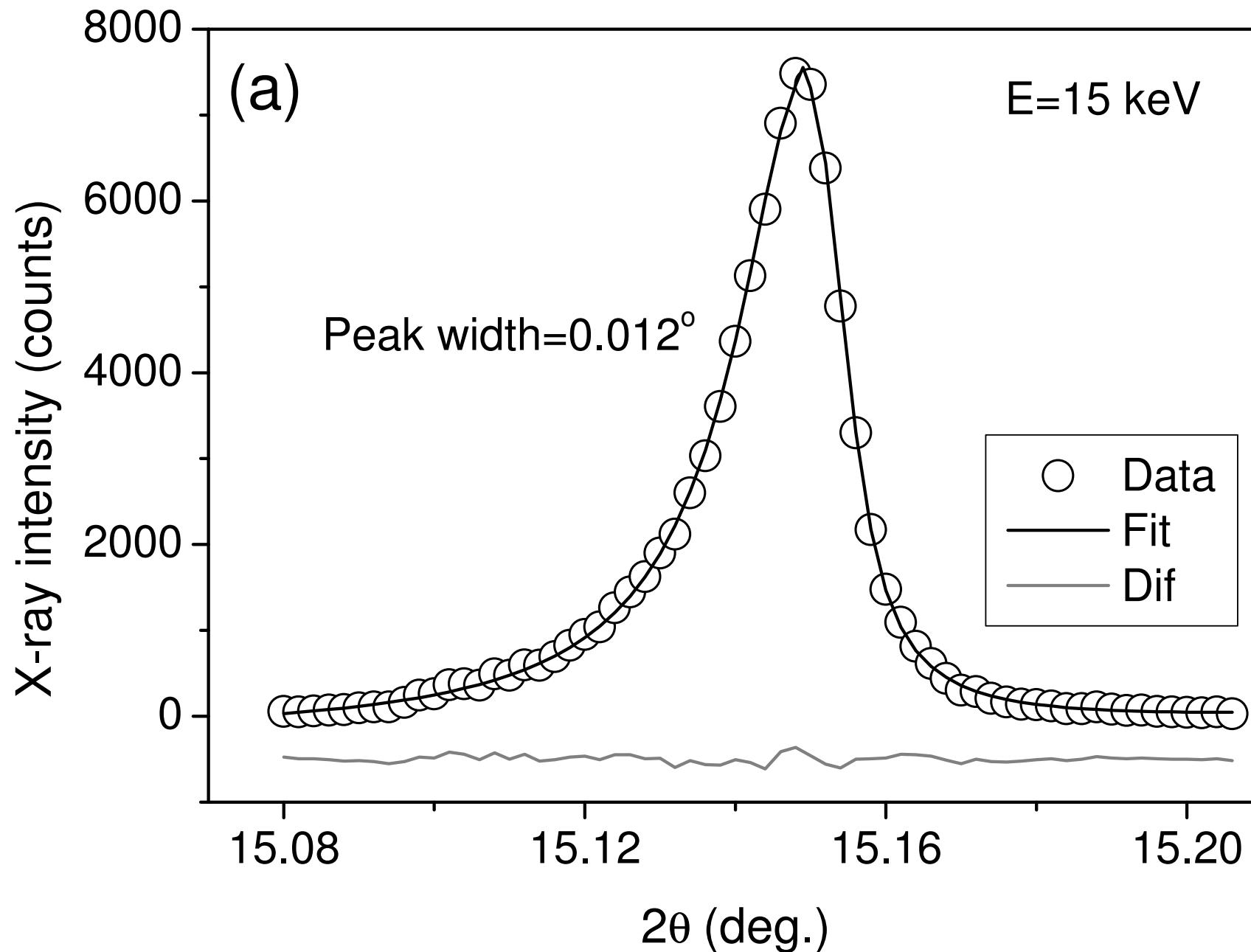


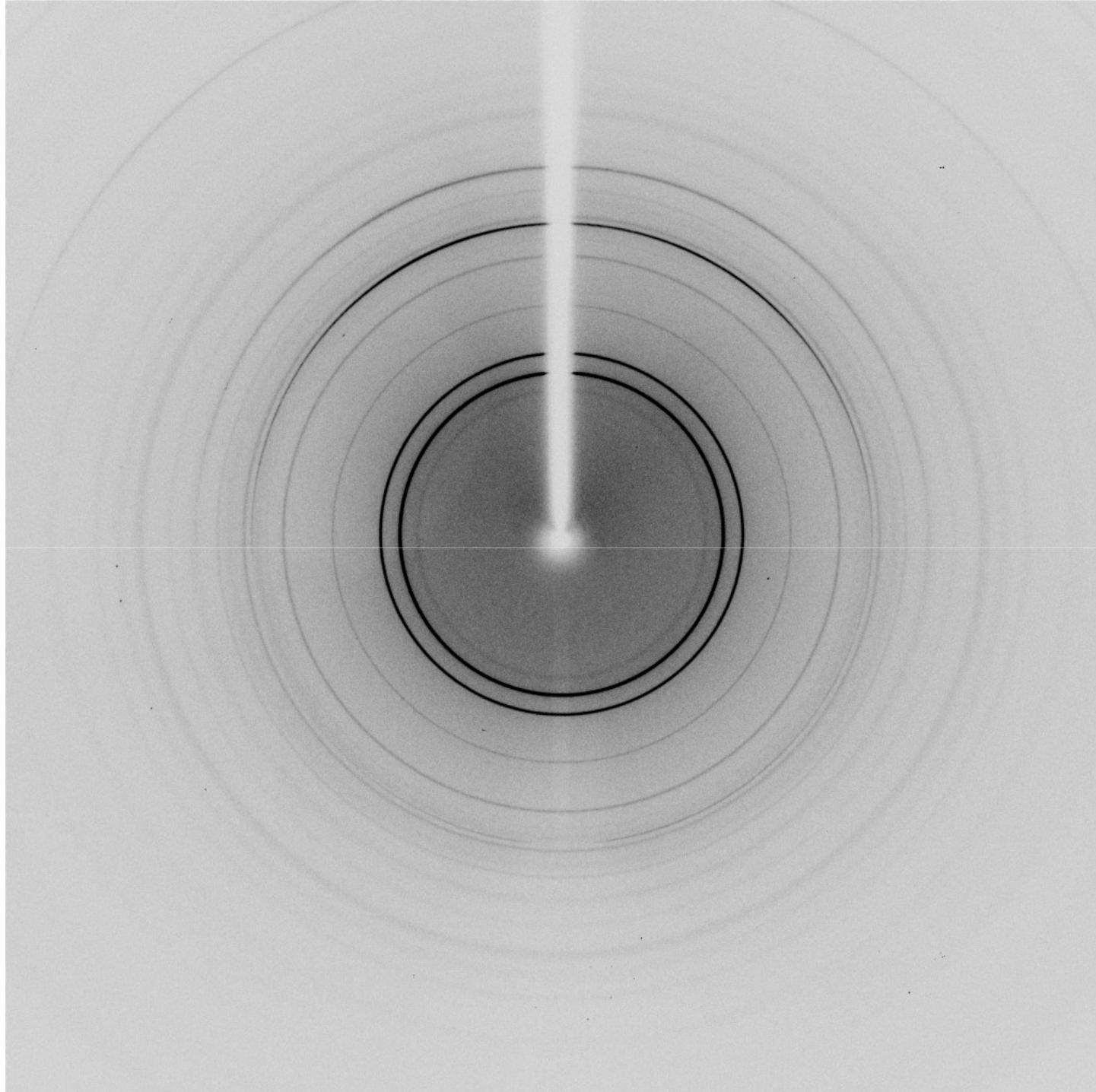


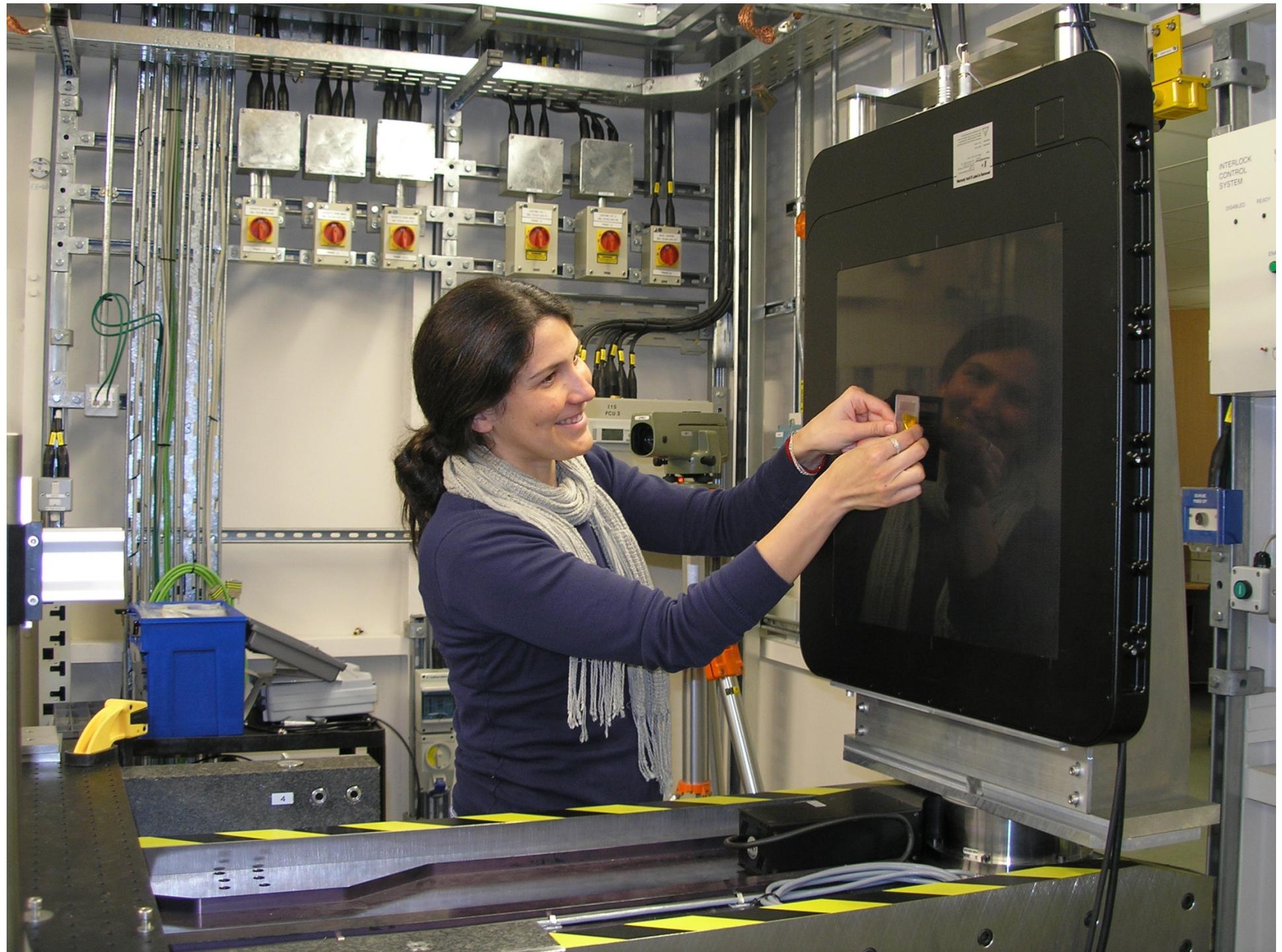


Si powder (NIST 640c), St2.3 data ($\lambda=1$ Å)





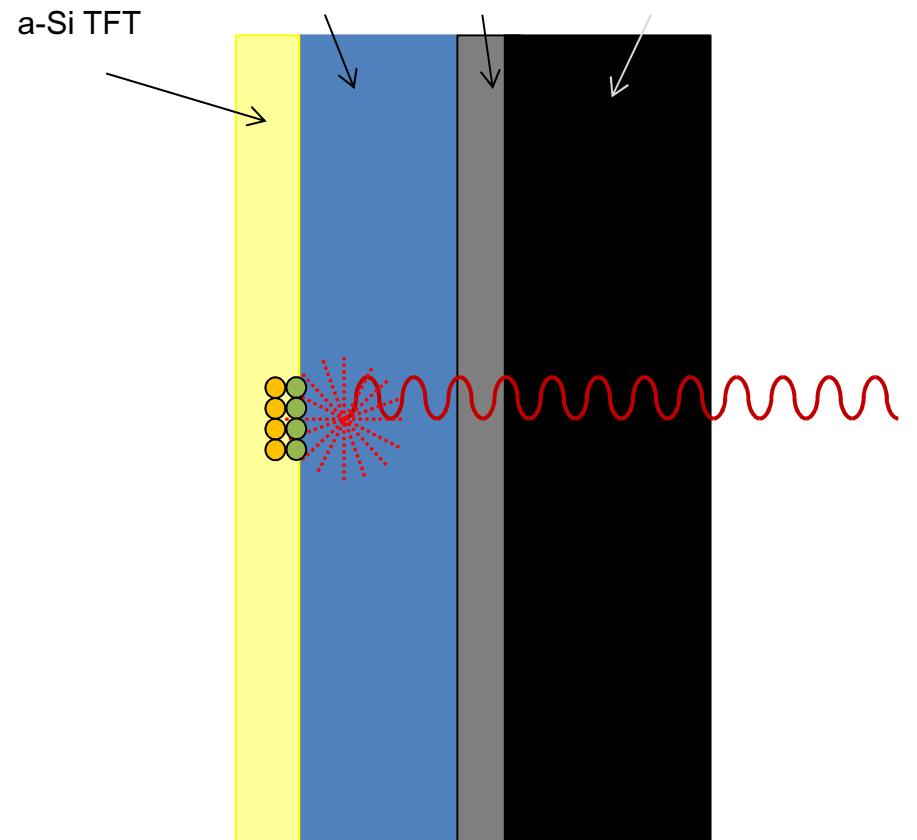




Flat Panel PerkinElmer PE XRD 1621 CN3 EHS

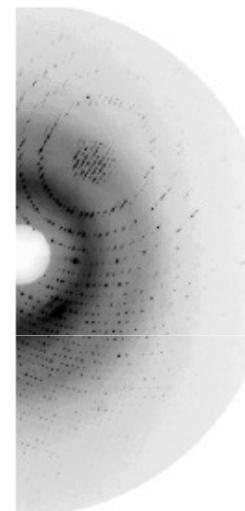
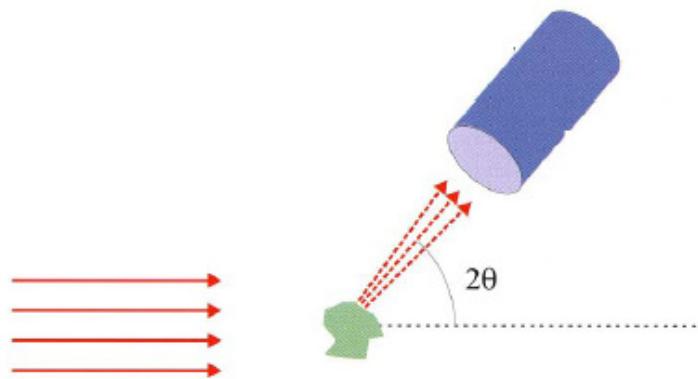
Scintillator type and thickness	CsI (500μm) direct deposition on a-Si
Front window type and thickness	Al metalized (25μm) +Carbon Fiber (825μm)
Pixel size at scintillator	200μm
Number of pixels	2048 x 2048

CsI (500μm) Al (25μm) C (825μm)



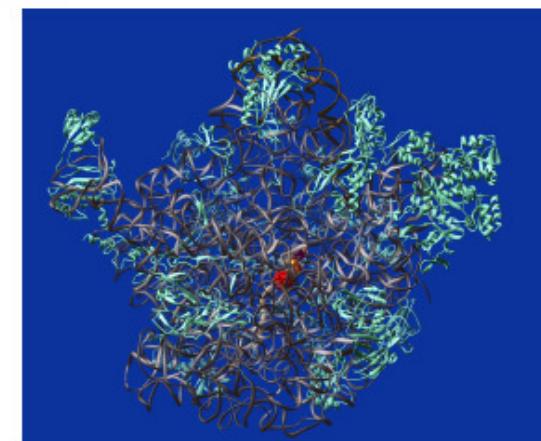
Example of diffraction pattern

Protein structure



Diffraction pattern

Ribosome

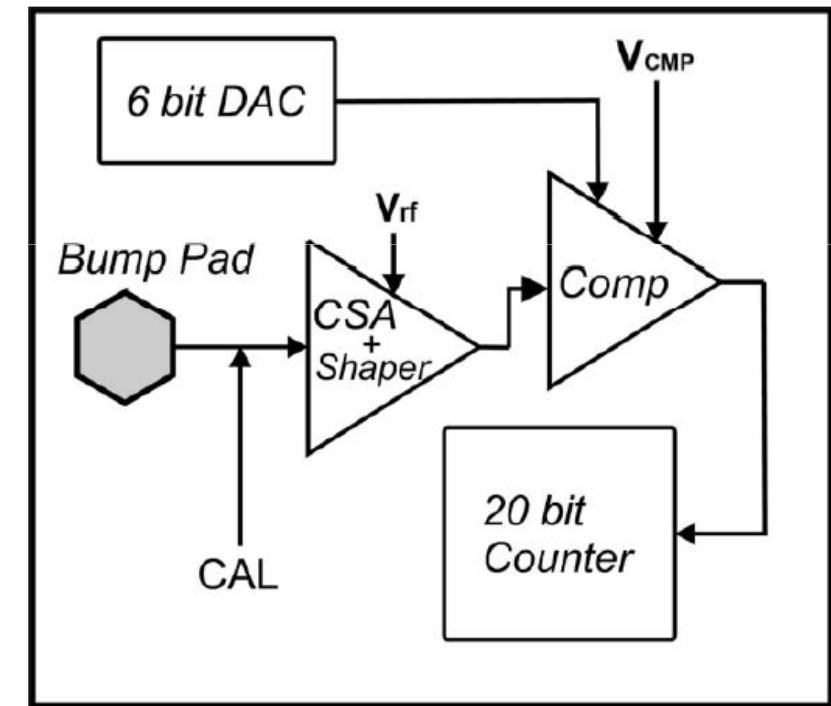
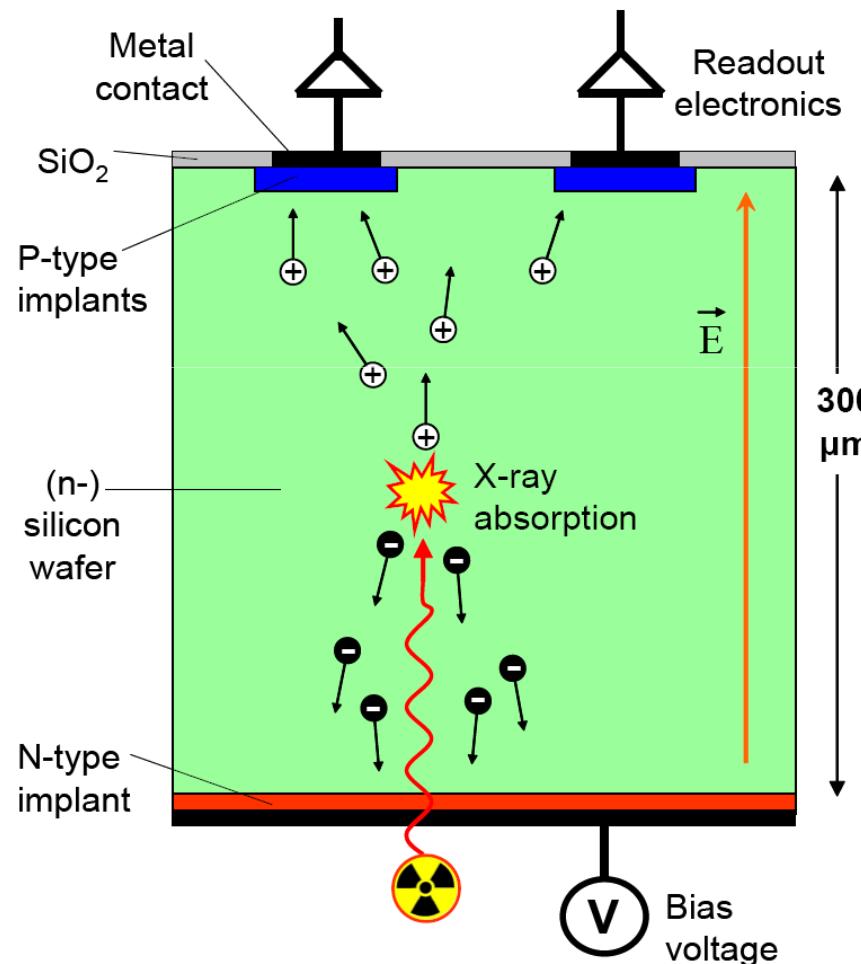


Detector for MX

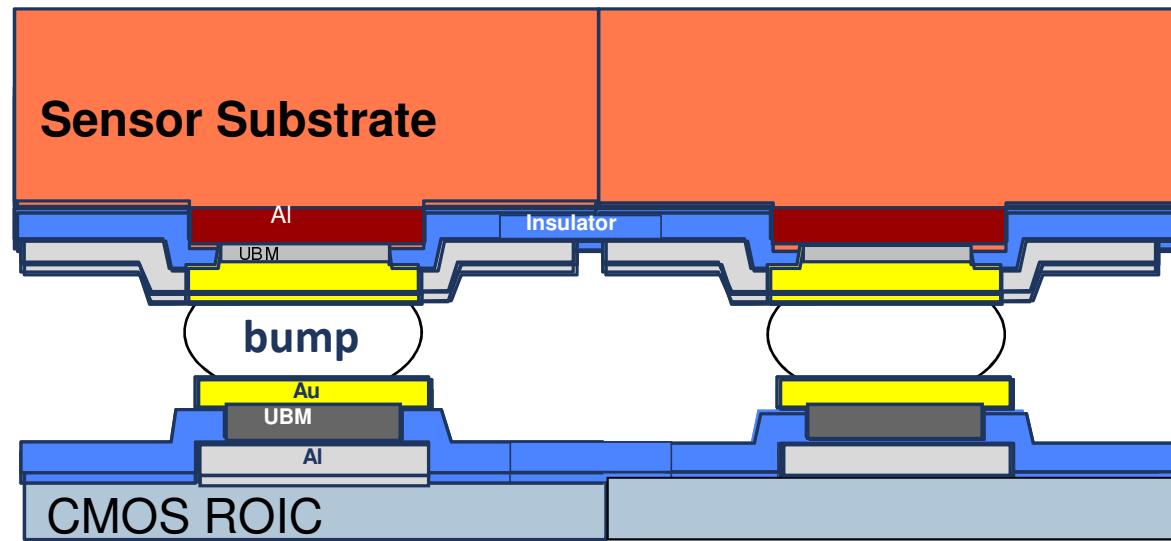
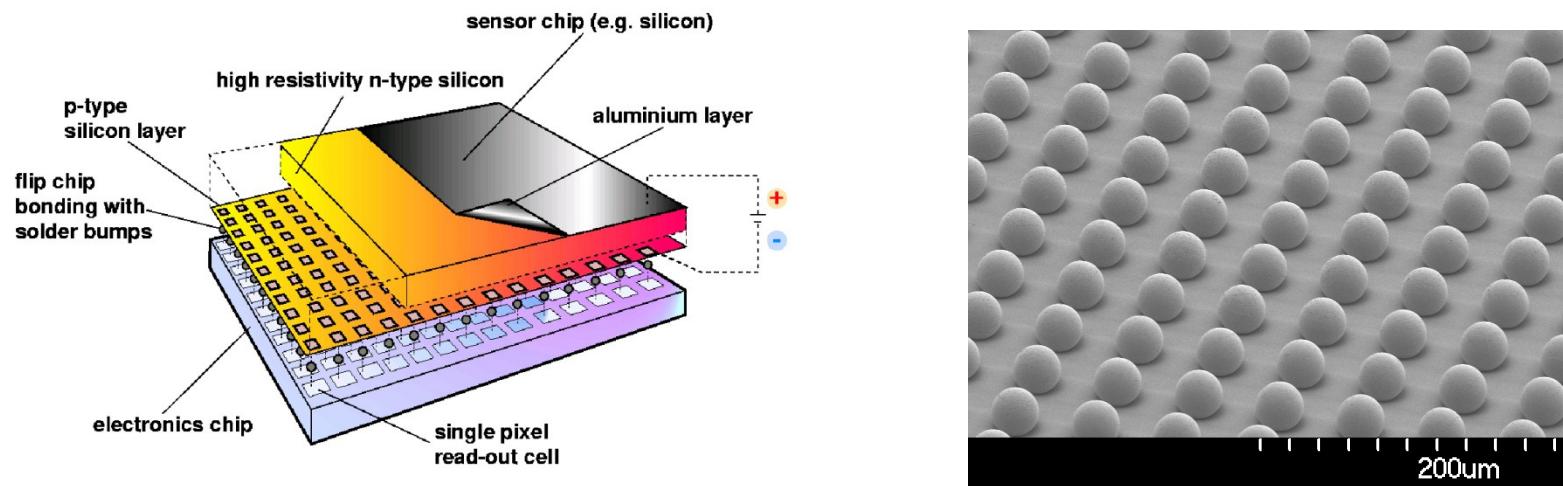


- **Mosaic of 9 CCD sensors**
- **Image size:** 72 MB
- **Binned image size:** ~20 MB
- **Data set per sample:** ~ 300-400 images
- **“Volume” of a data set:** ~ 6-8 GB

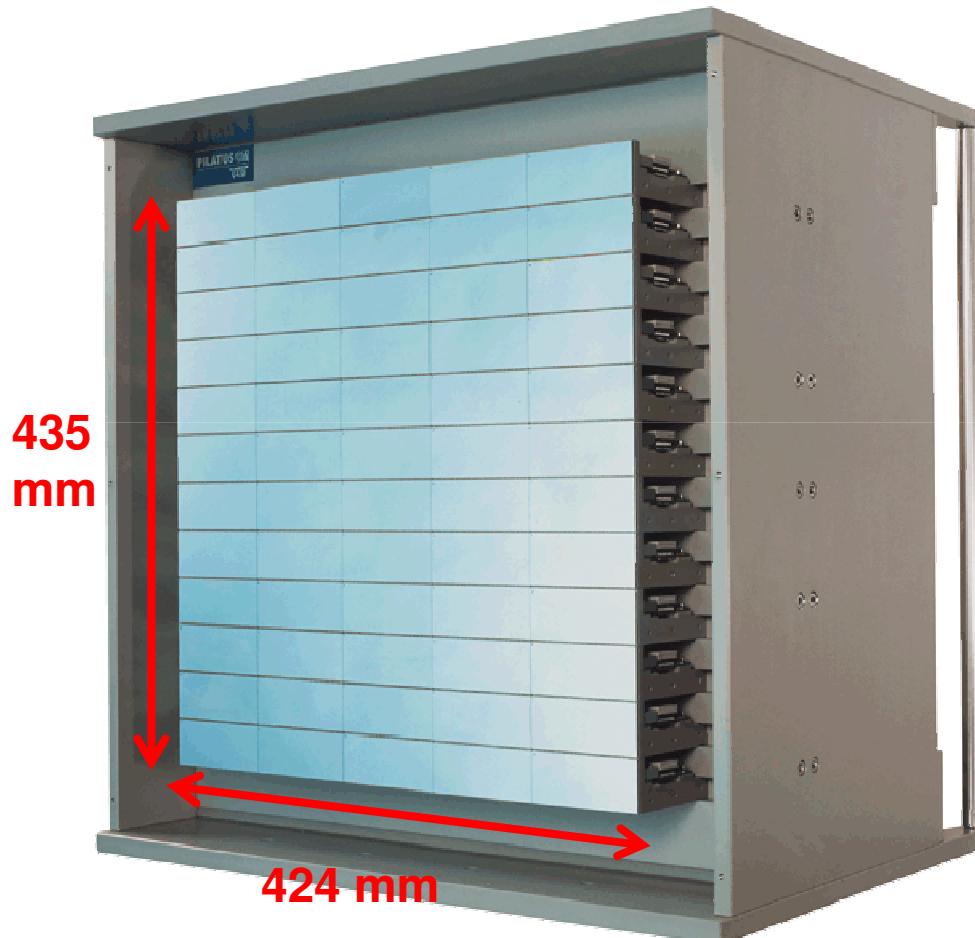
Direct detection and independent pixels



Hybrid technology



Pilatus detector



- Mosaic of 60 modules
- Frame rate: 12 fps
- Image size (Tif 32 bits):
~23 MB
- Compressed image: ~ 6 MB
- Data set: ~ 1800 images
- “Volume” of a data set:
11 GB

Pilatus evolution

- Retriggering scheme
- Improved read-out electronics
- 12 fps -> 100 fps

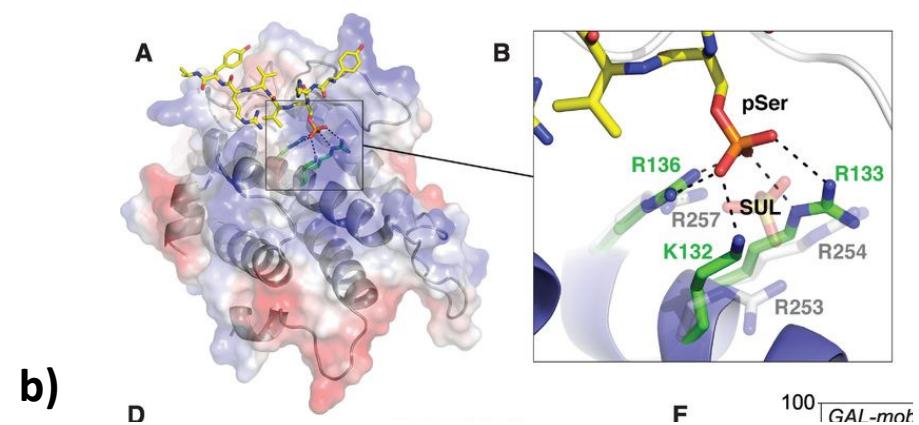
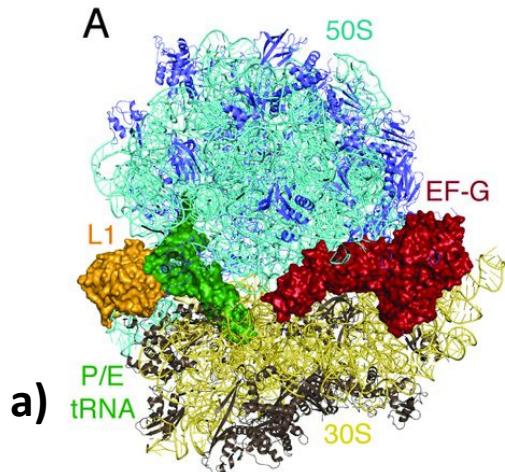
I04 Tuneable Macromolecular Crystallography

a) Two papers on ribosome structures:

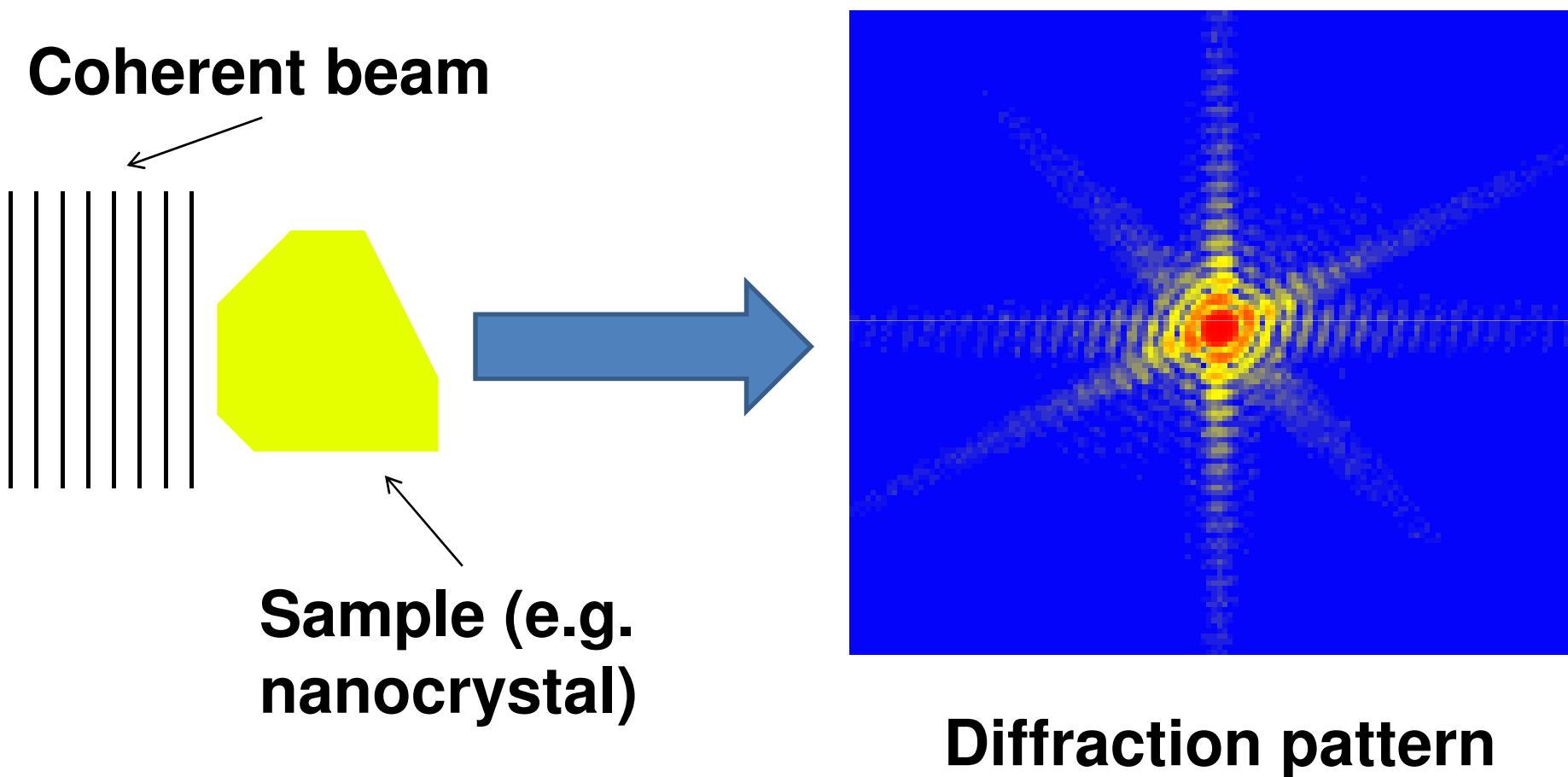
Unusual base pairing during the decoding of a stop codon by the ribosome *Nature* (2013) **500**, 107.

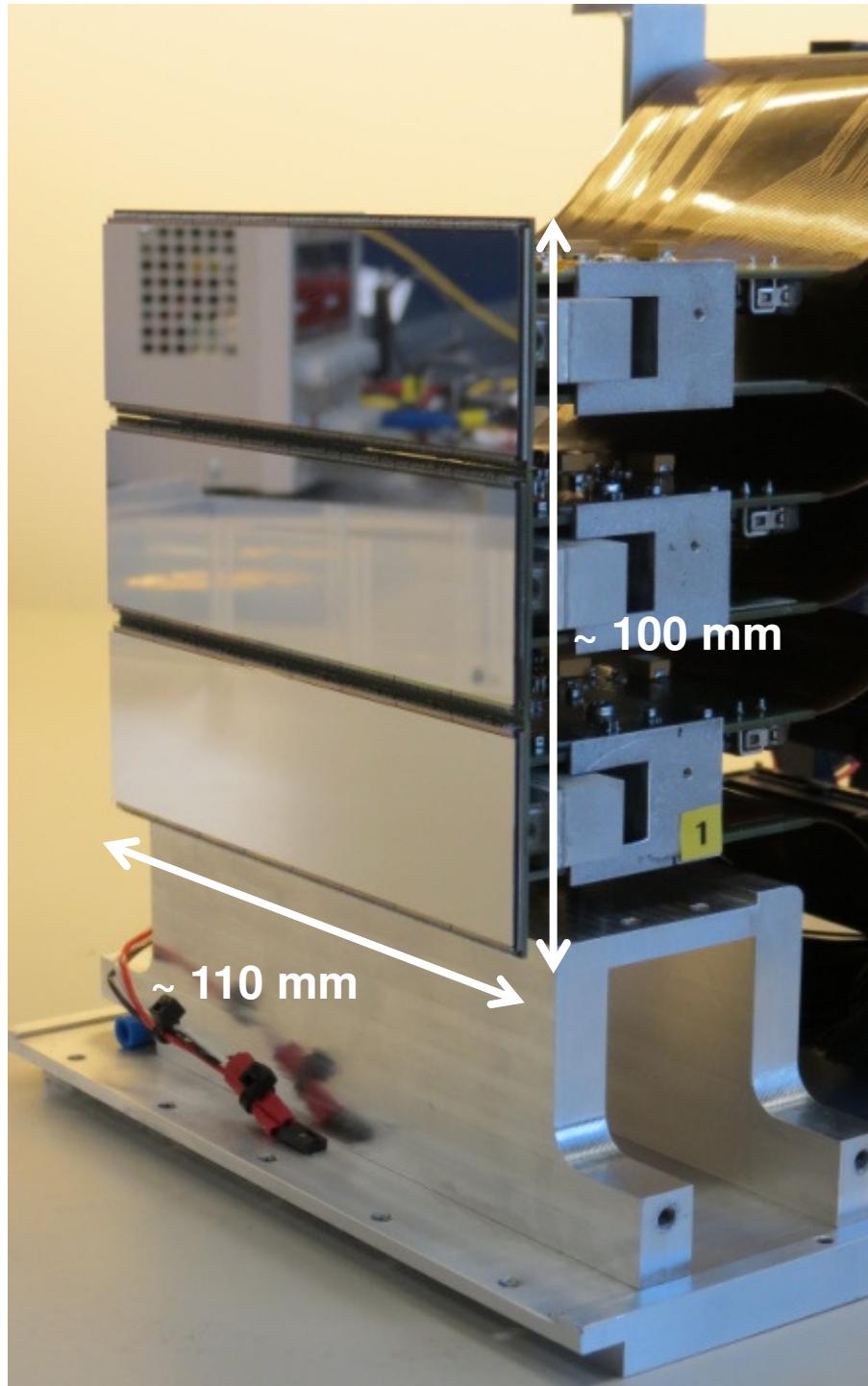
Elongation factor G bound to the ribosome in an intermediate state of translocation *Science* (2013) **340**, 1235490.

b) Activation of the yeast Hippo pathway by phosphorylation-dependent assembly of signalling complexes, *Science* (2013) 340, 871.



I13 - Coherent Diffractive Imaging

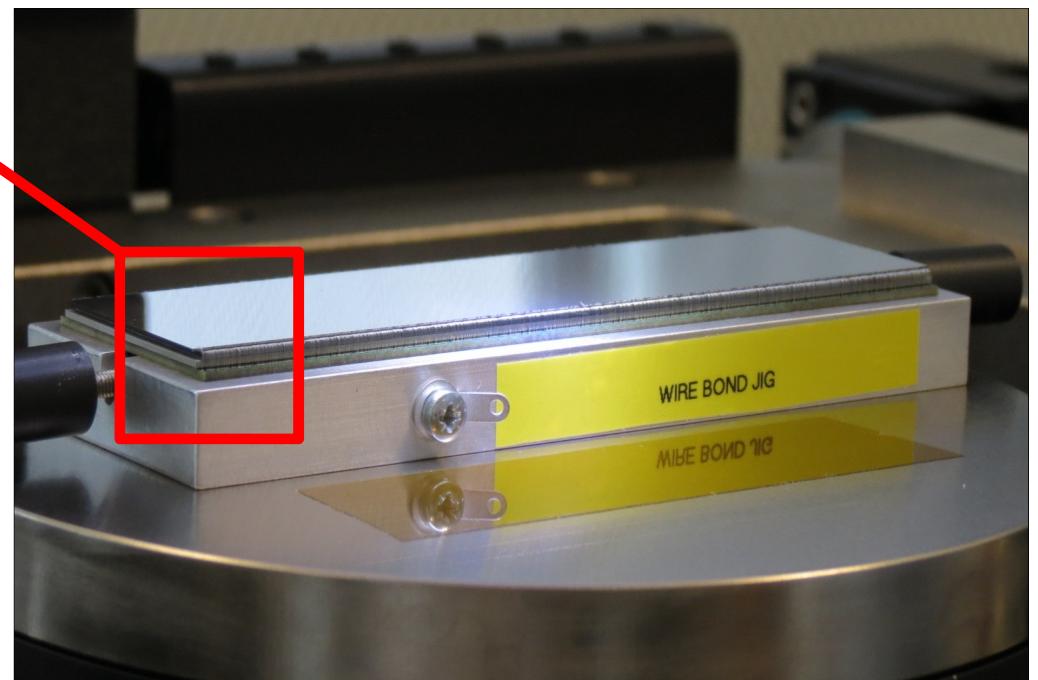
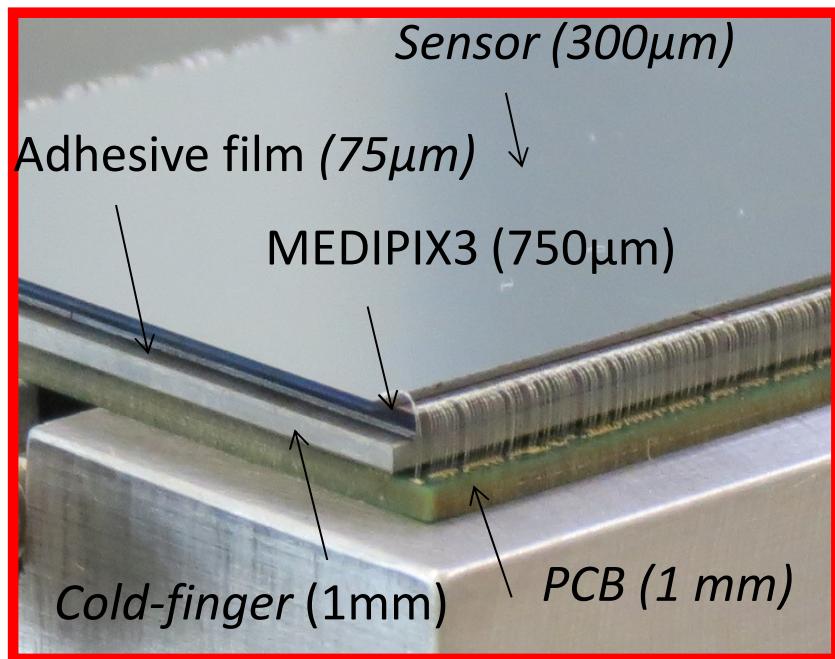




Excalibur

- 48 Medipix3 chips
- Six parallel stream of data
- Cluster of six data acquisition pc
- Parallel writing to remote storage

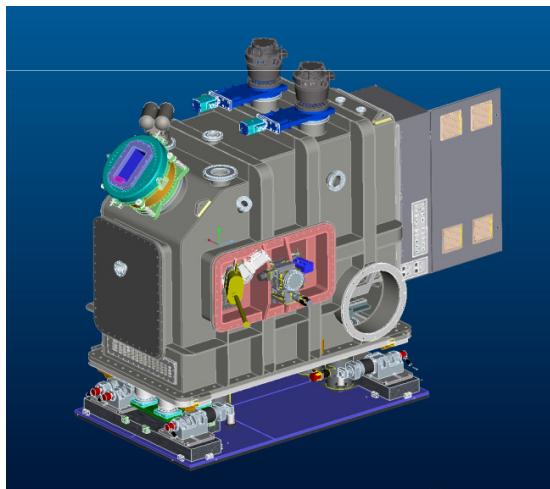
Interconnections



I23 – Long wavelength Macromolecular Crystallography Beamline

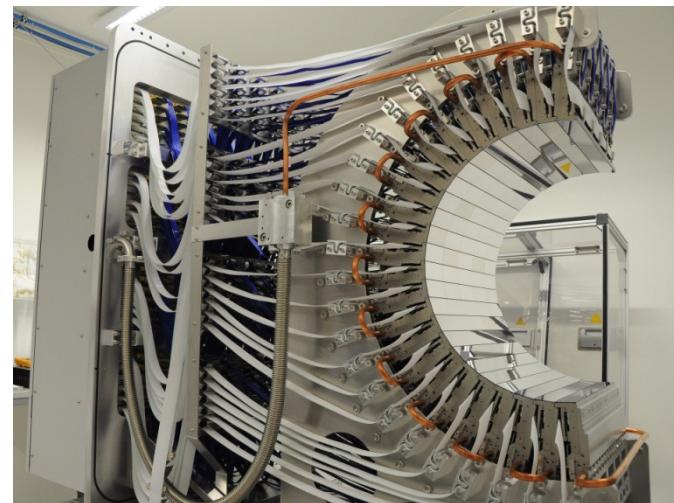
I23 will be the first MX beamline optimized for the long-wavelength region (1.5 – 4 Å).

It will provide a unique tool to fully exploit the potential of experimental phasing from native protein and DNA/RNA crystals.

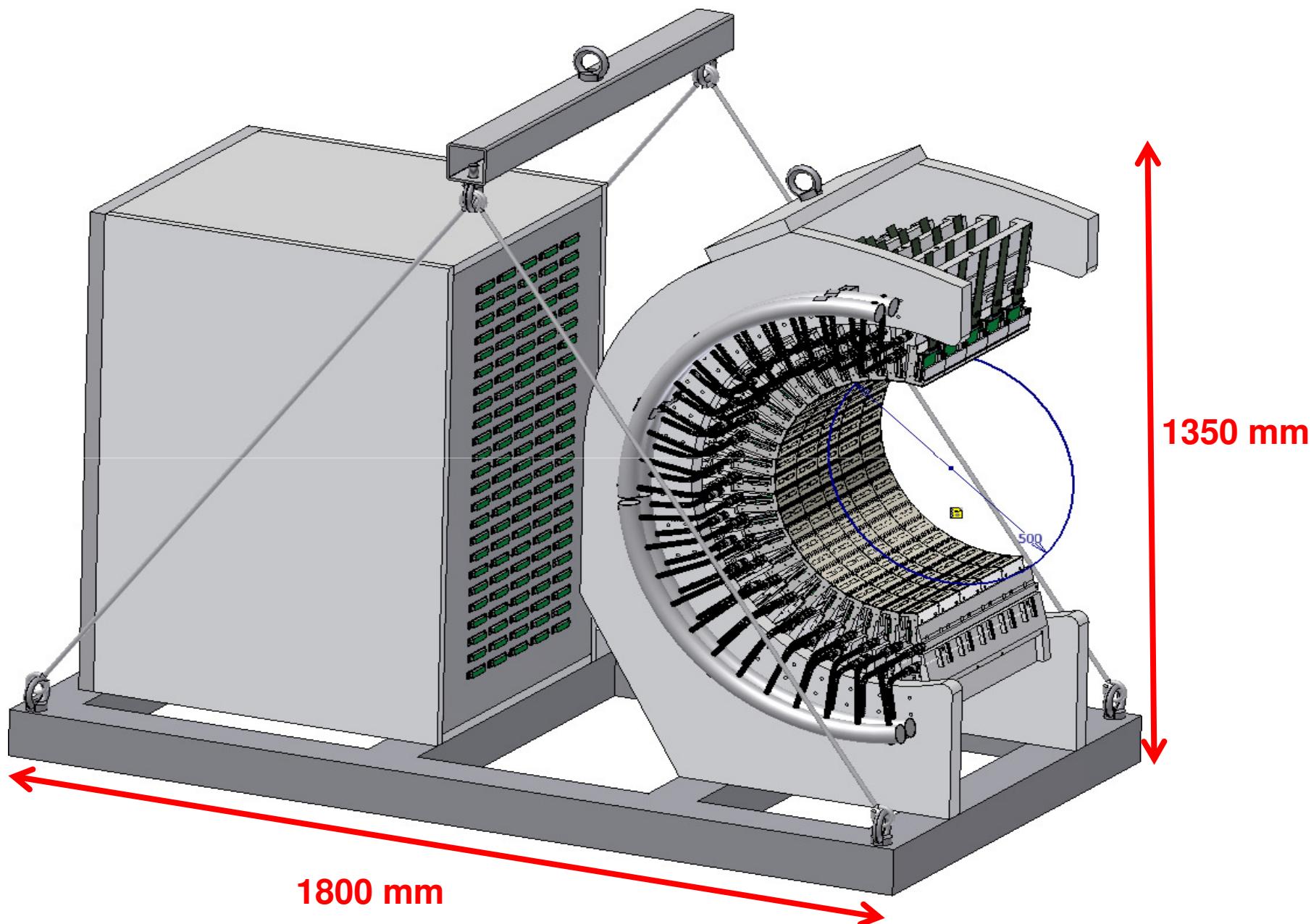


Novel in-vacuum setup for MX

- First User Spring 2014



- P12M detector
- In-vacuum 10^{-7} mbar
- Energy range 3 – 12 keV
- Half cylinder, 250 mm radius

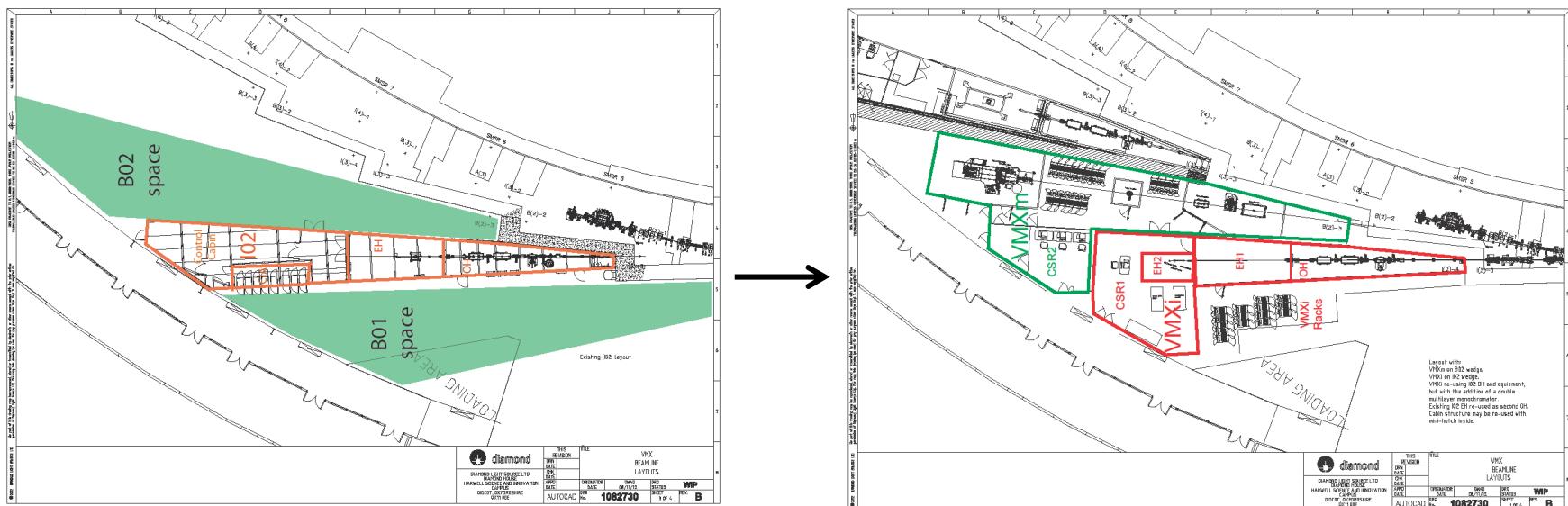




I02 to VMXi

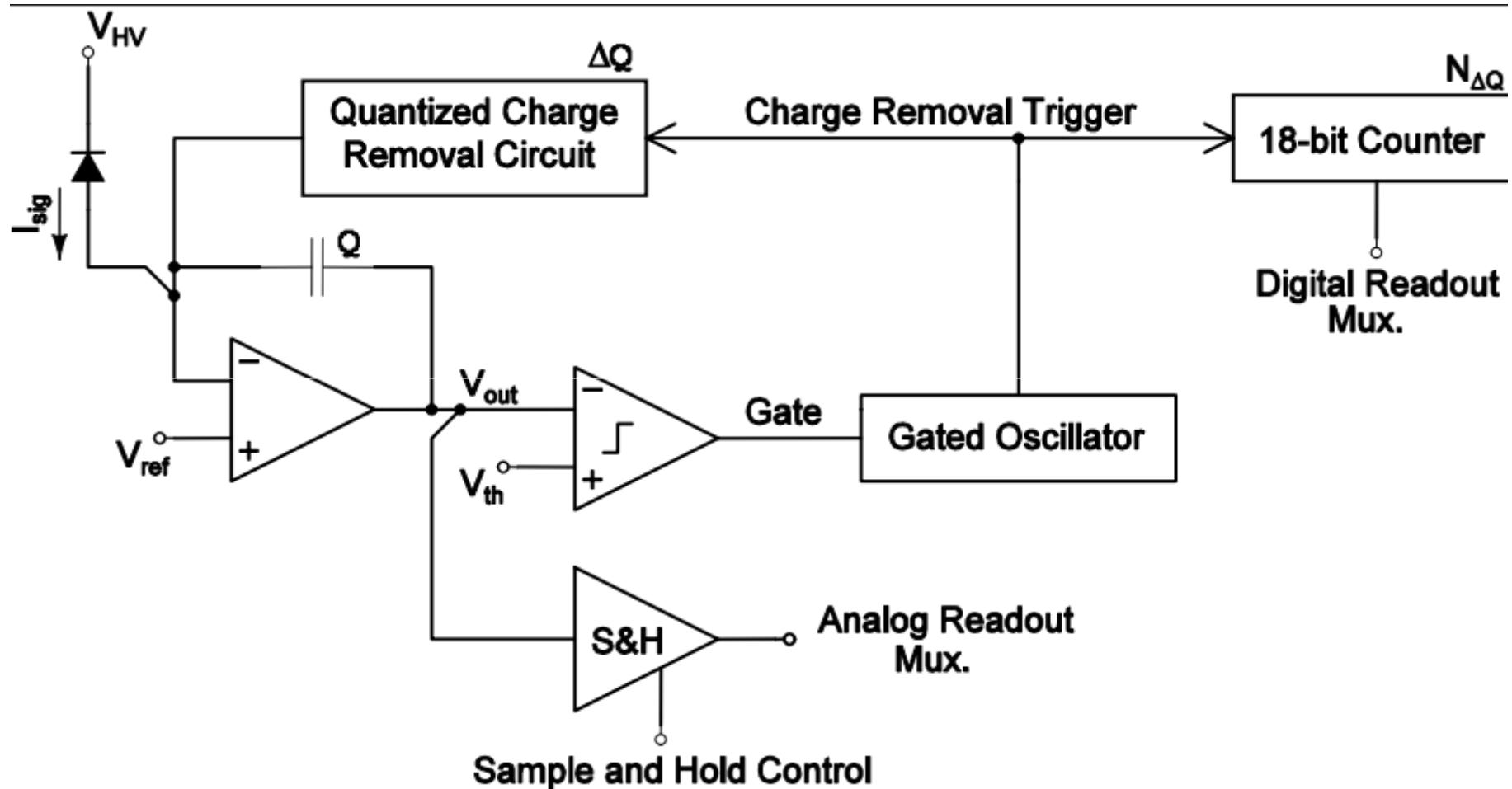
a two stage process

- Preparation stage
 - Modify I02
- Implementation stage
 - Build VMXi

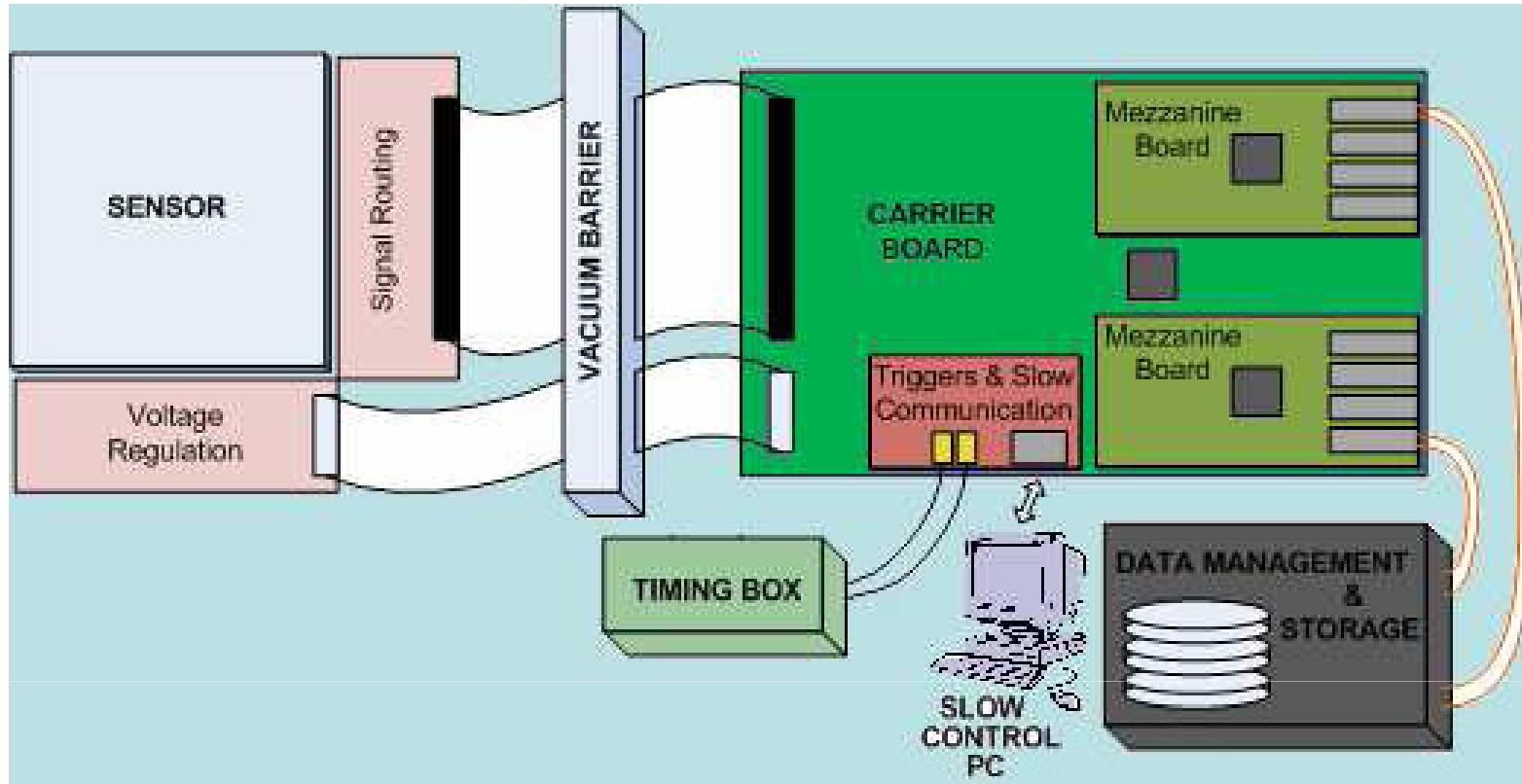


- Up to 1×10^8 12 keV photons/pixel/s
- Integrating detector possible option

Mixed mode pixel

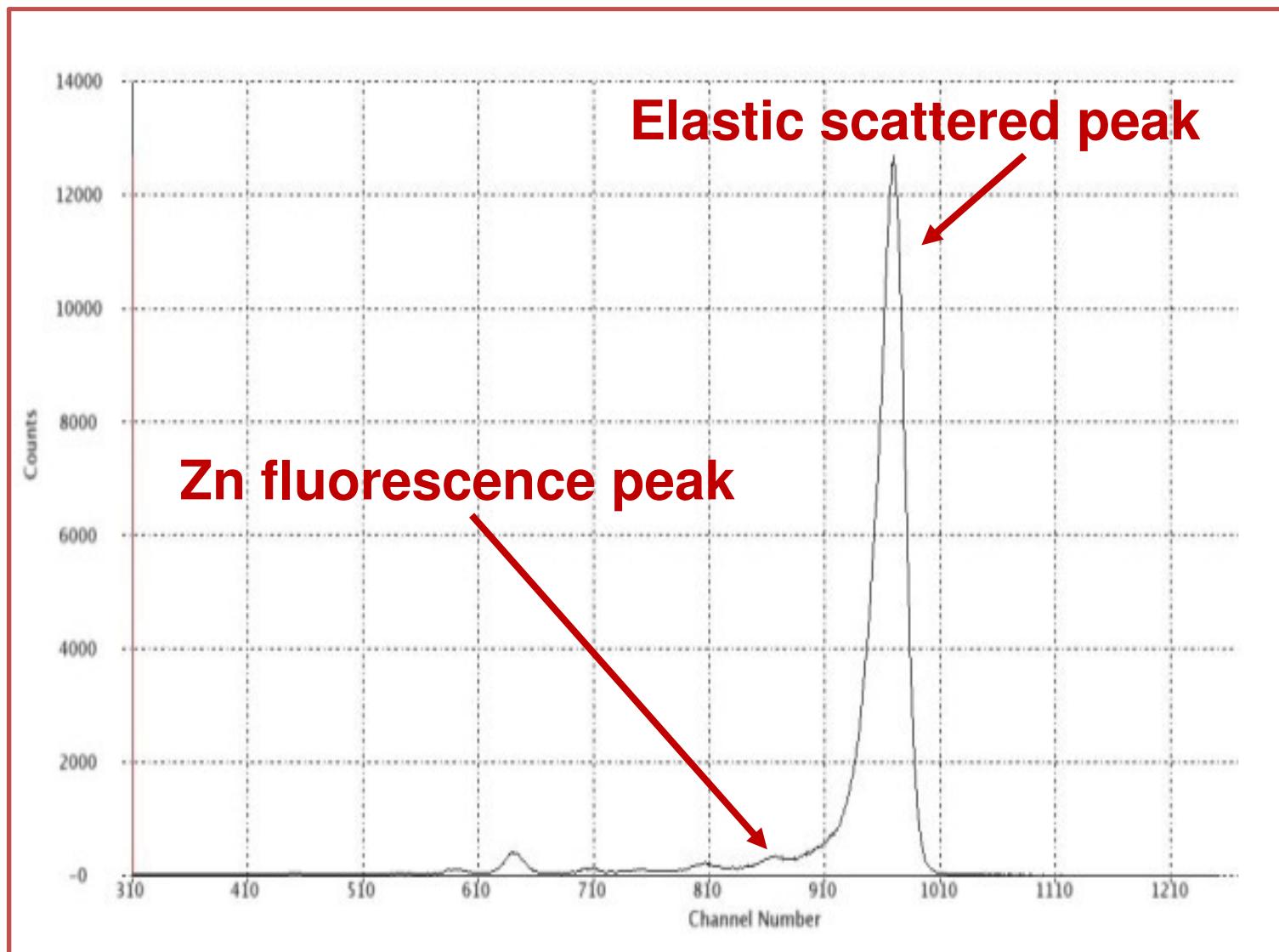


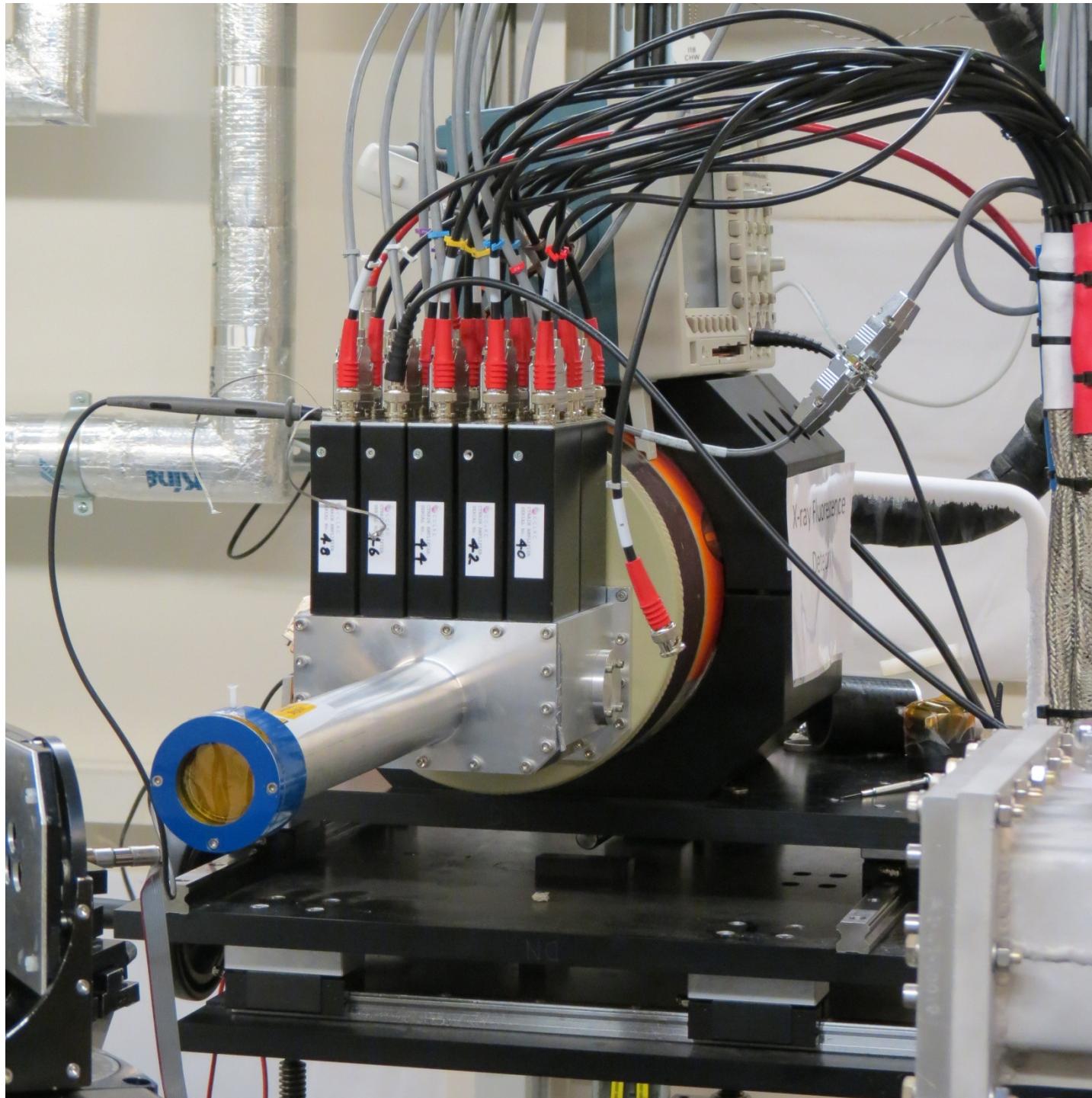


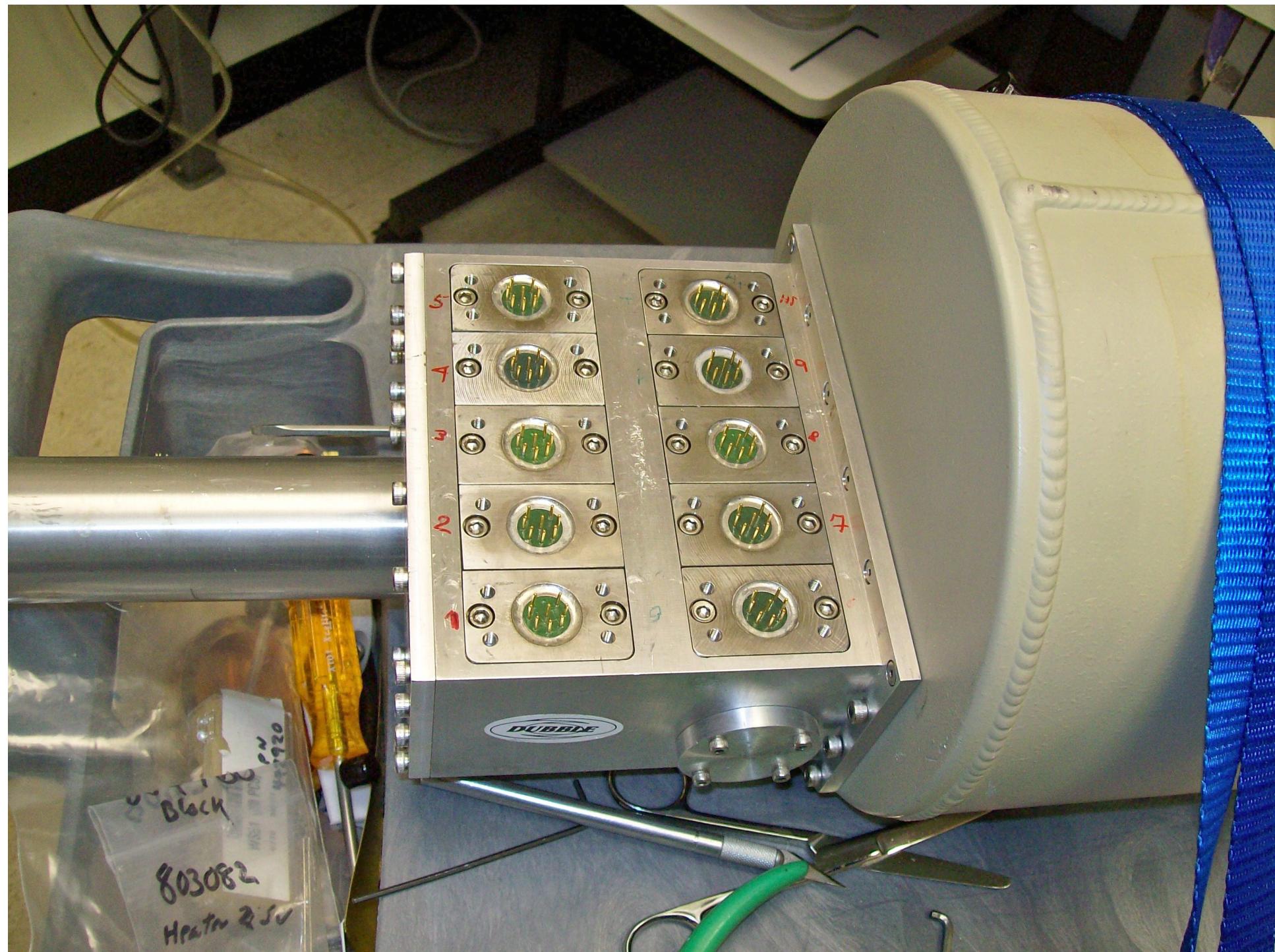


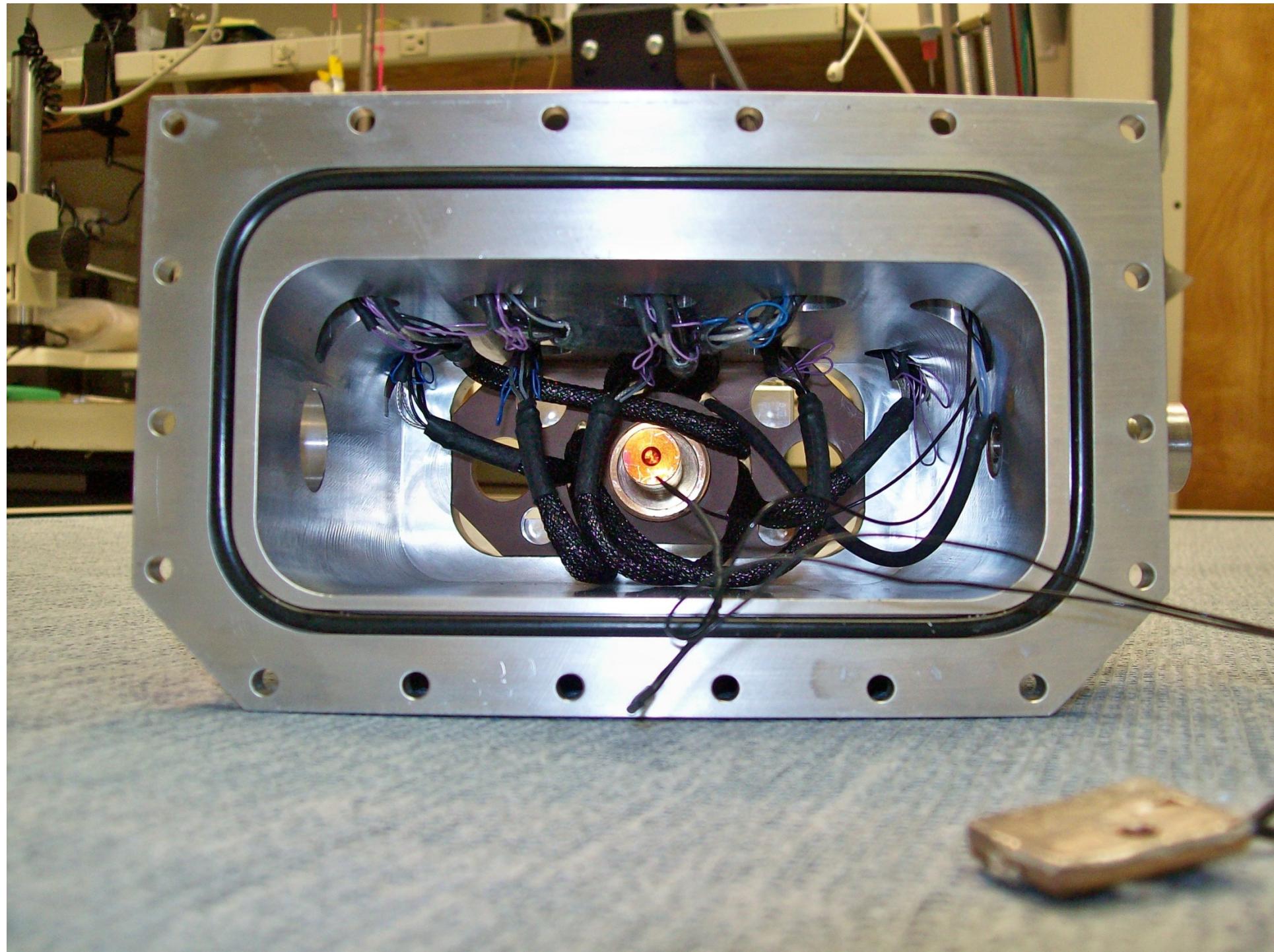
- **Monolithic sensor 10 cm x 10 cm**
- **Maximum frame rate 120 Hz**
- **Pixel size 27 um x 27 um**
- **13.7 million pixels**

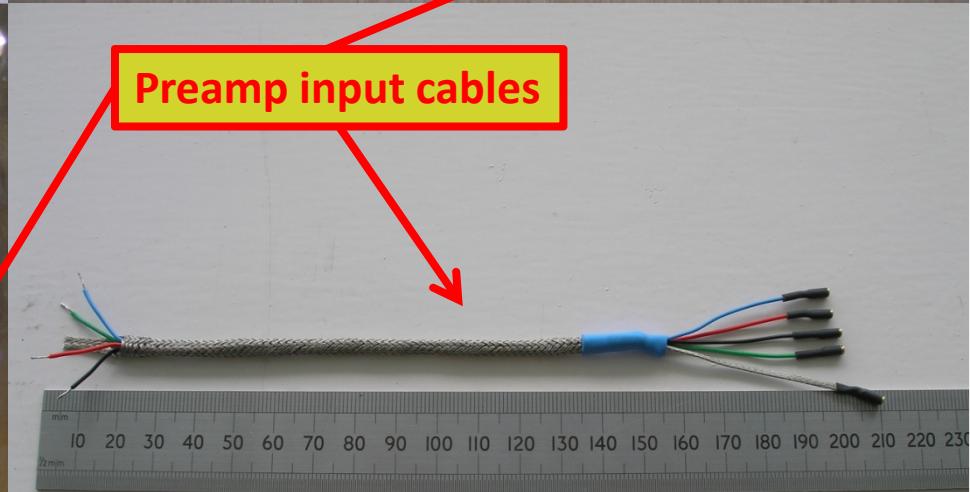
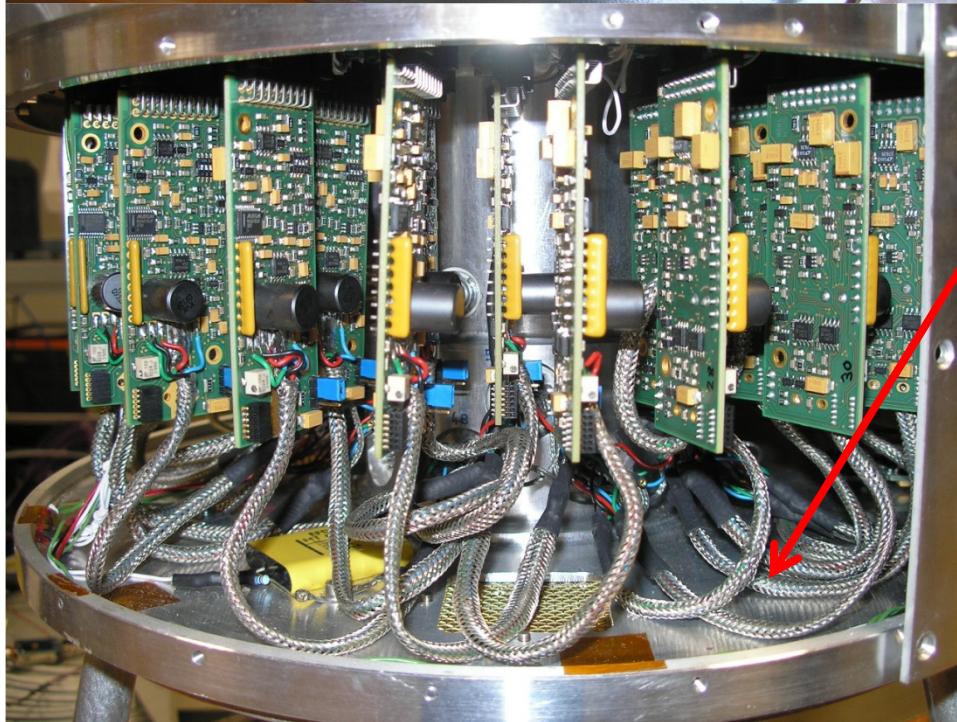
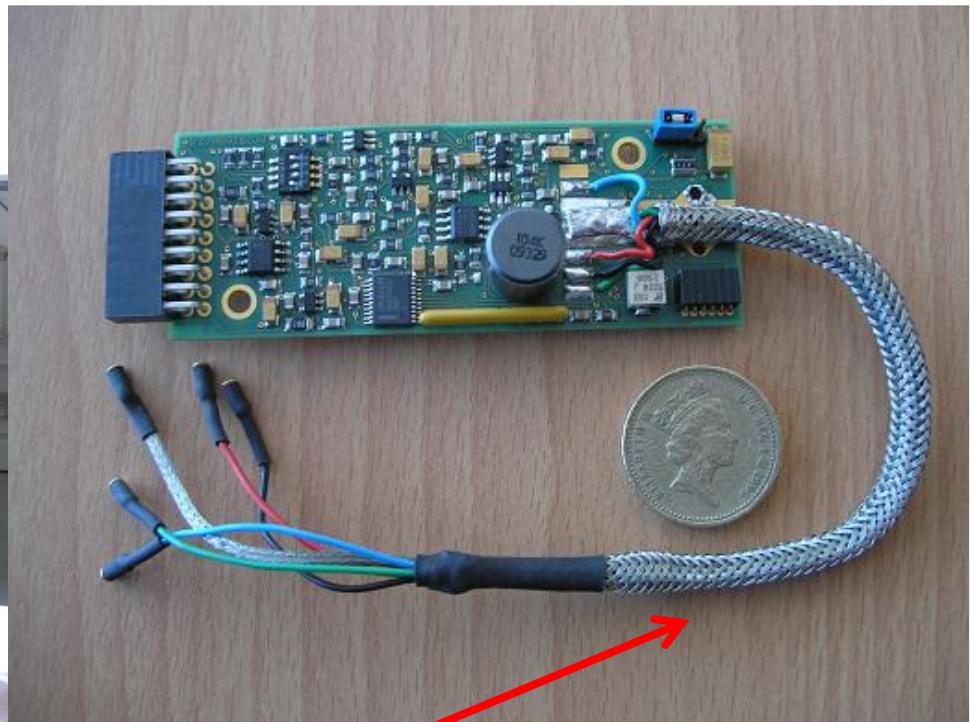
MCA spectrum of the zinc. Solution of $\text{Zn}(\text{CH}_3\text{COO})_2$ in water 1 mmolal concentration



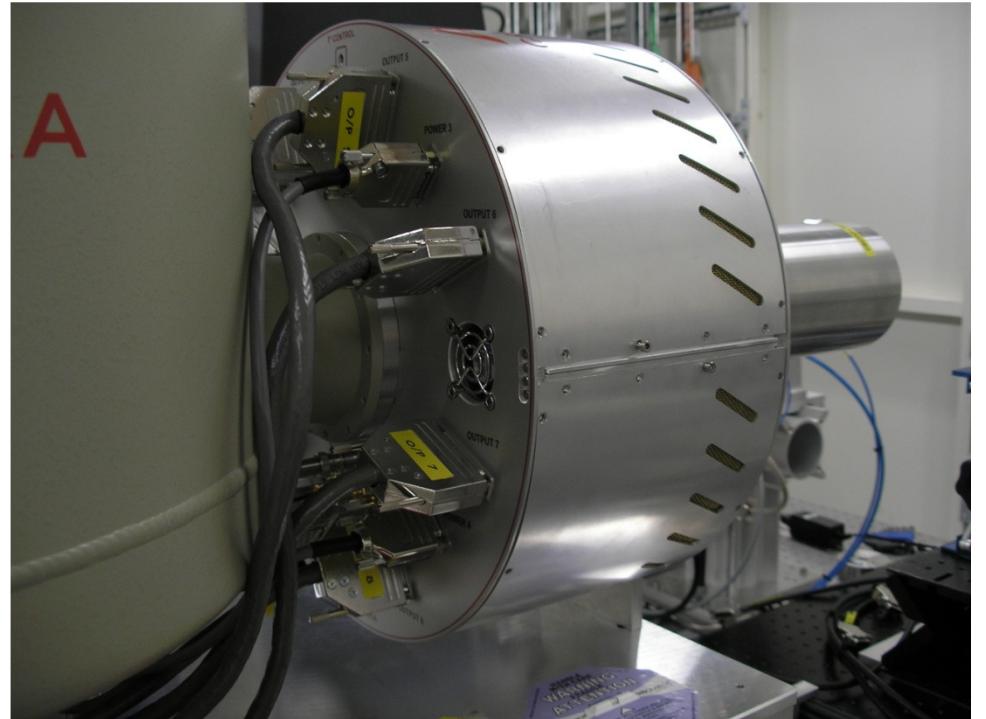




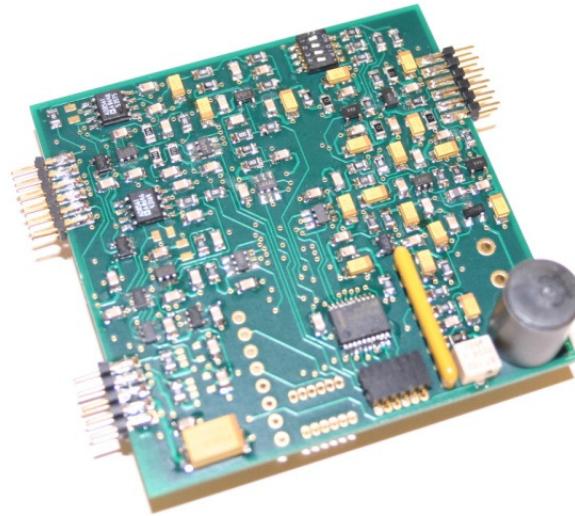




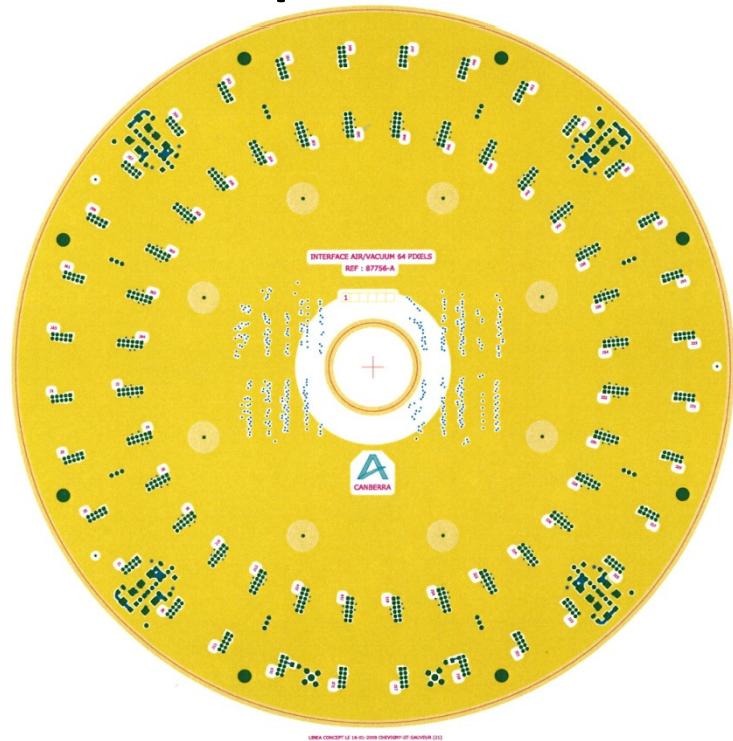
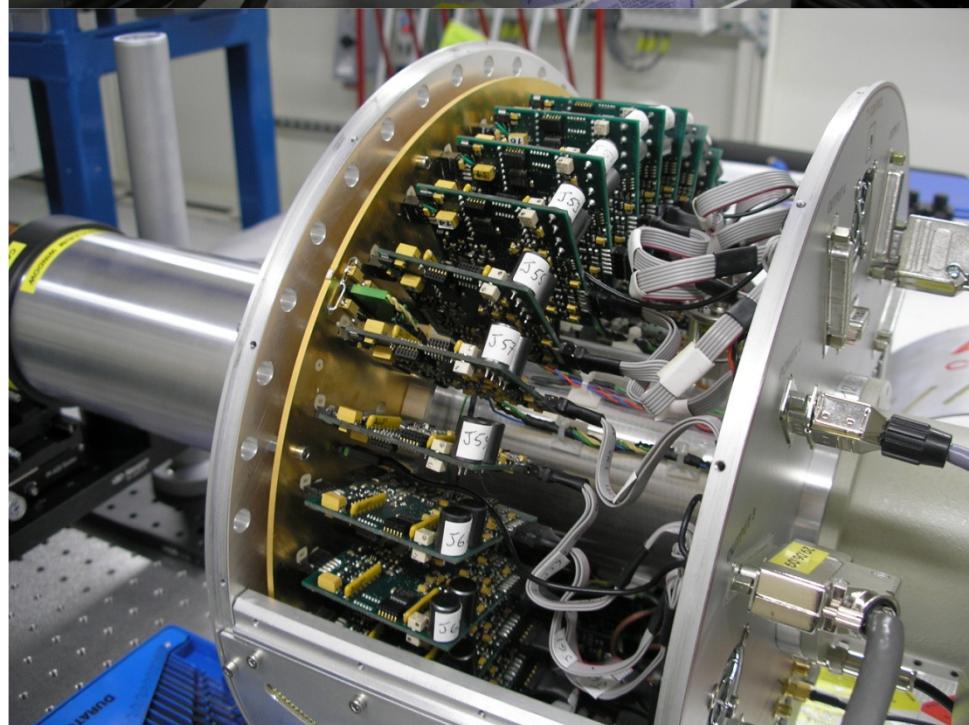


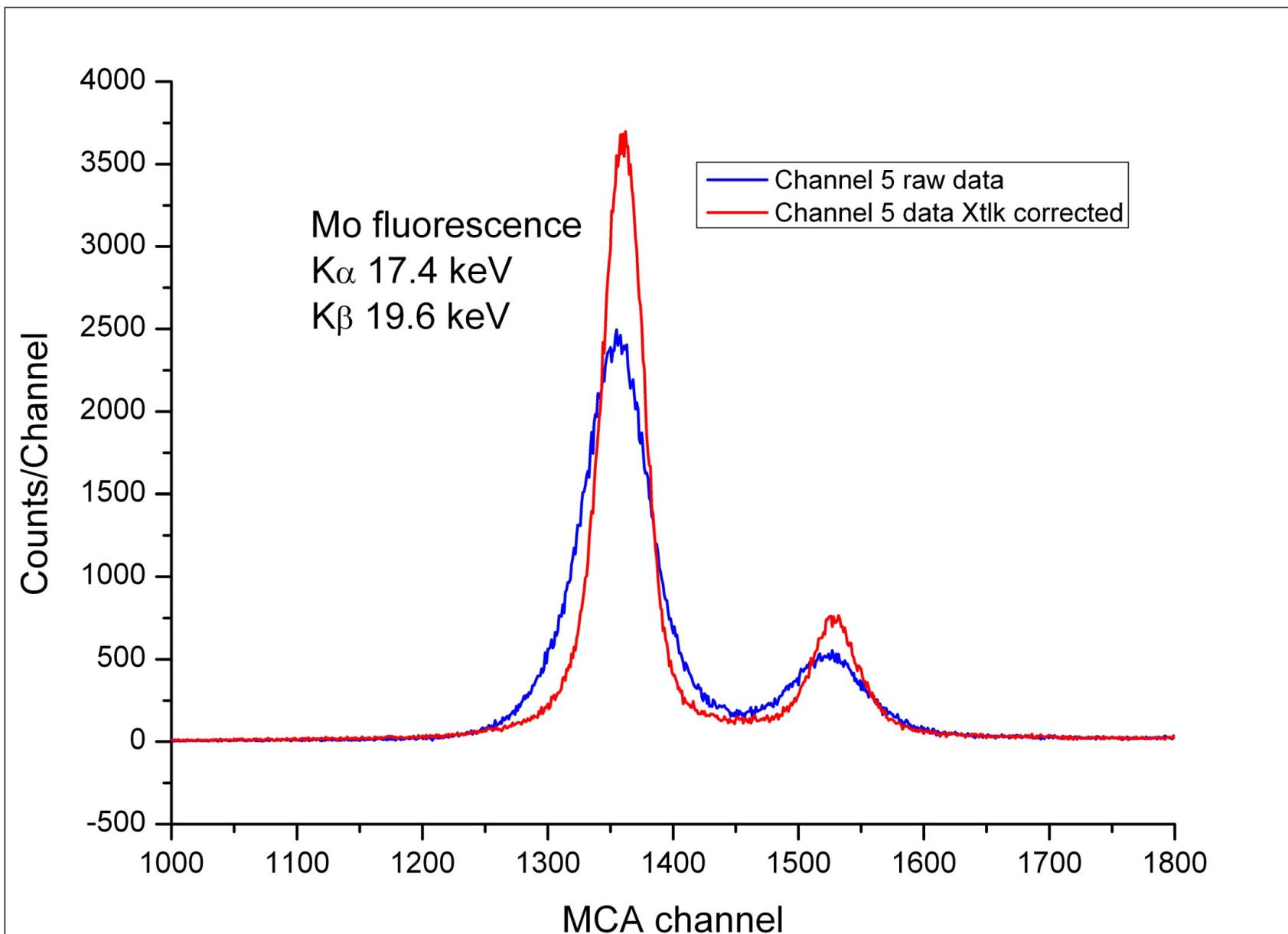


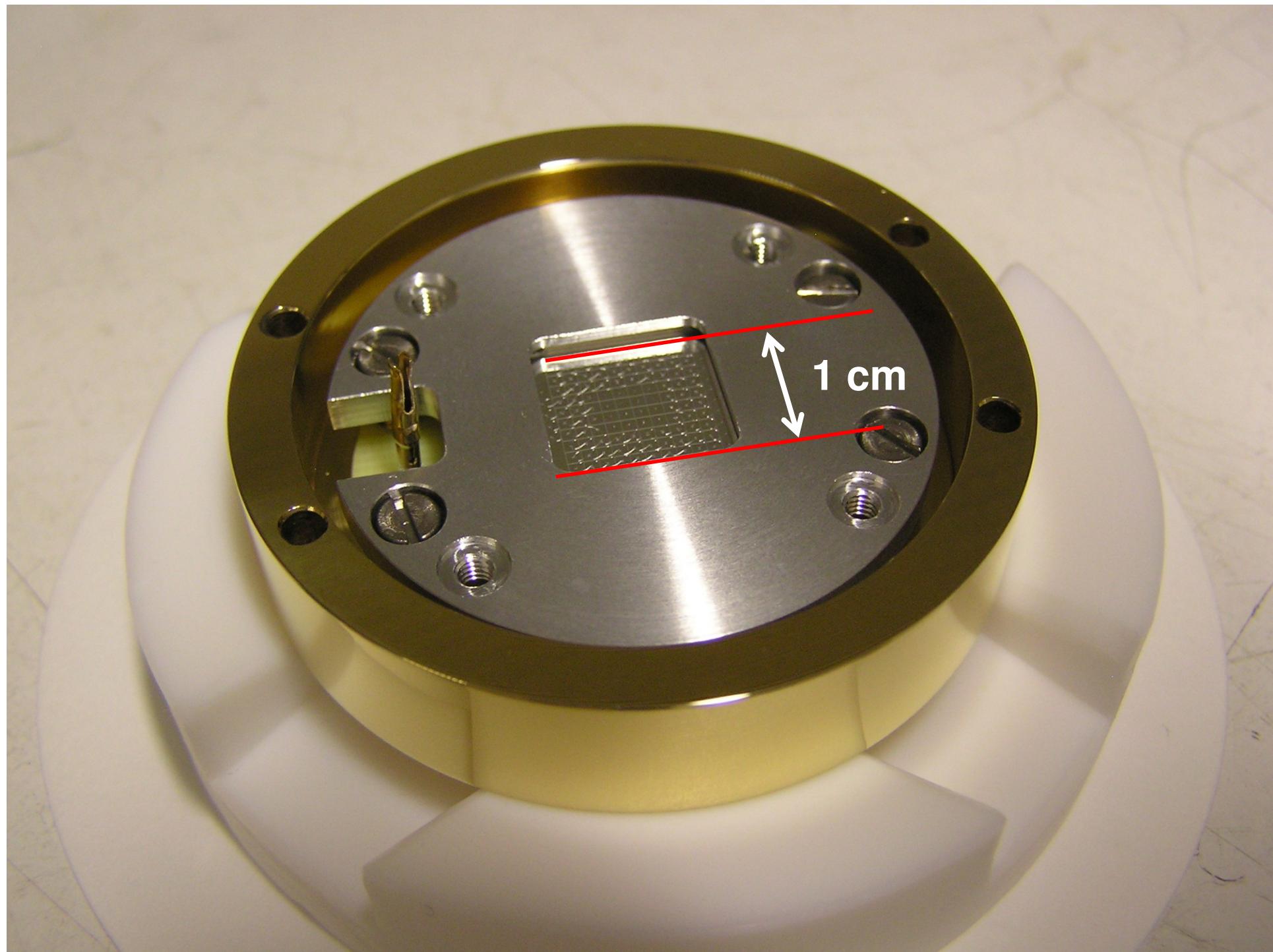
Dual channel preamplifier



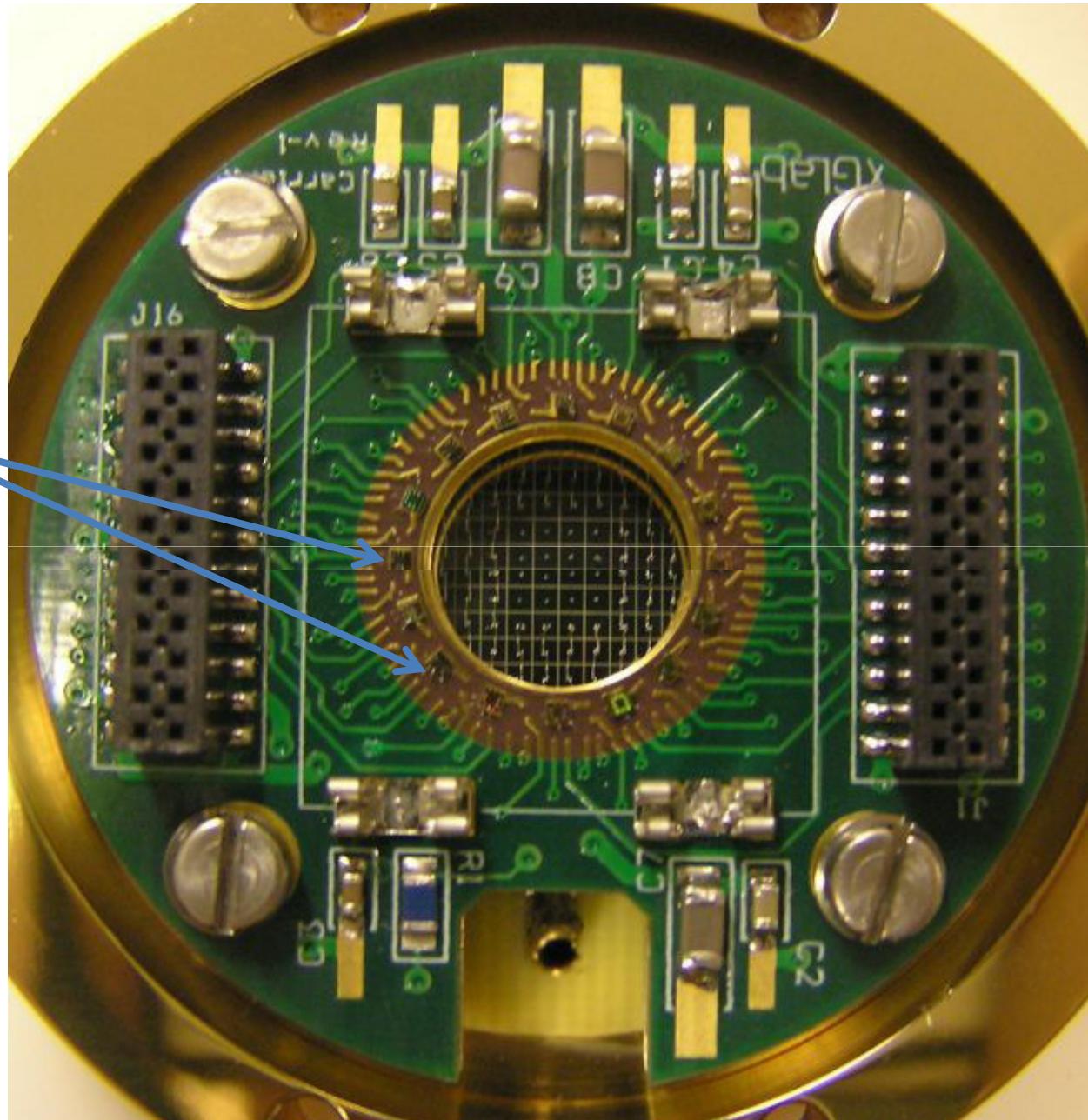
Preamps carrier board

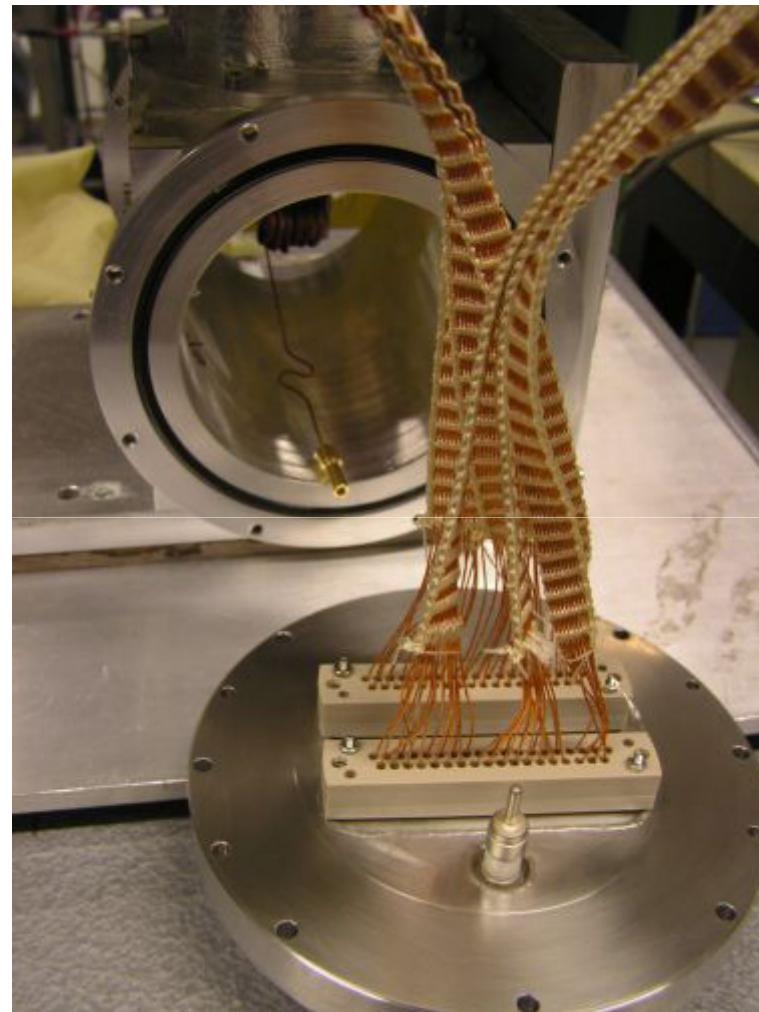
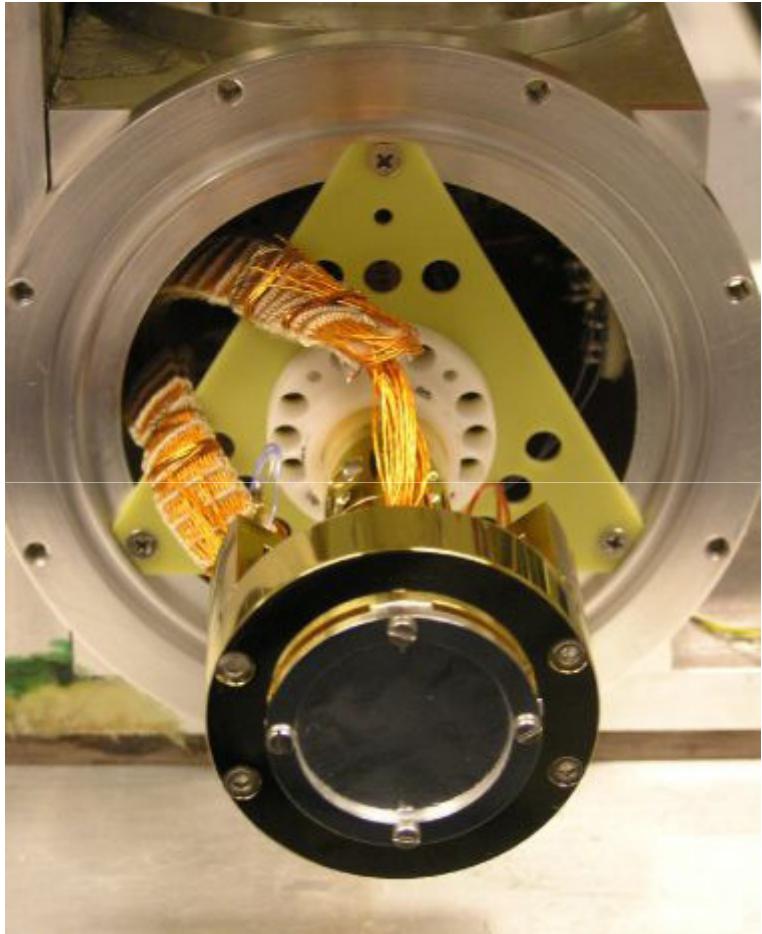






Preamps





Conclusions

- User facility
- Very diverse detectors
- Increase in complexity
- Partnership with industry