PANalytical

Medipix in X-ray diffraction

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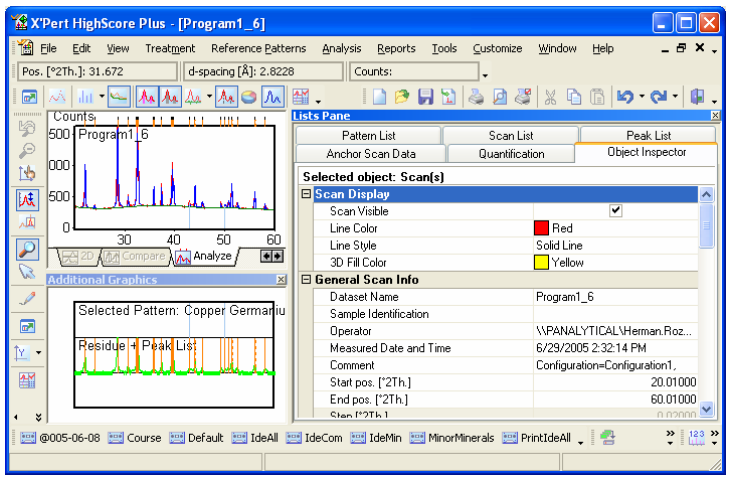
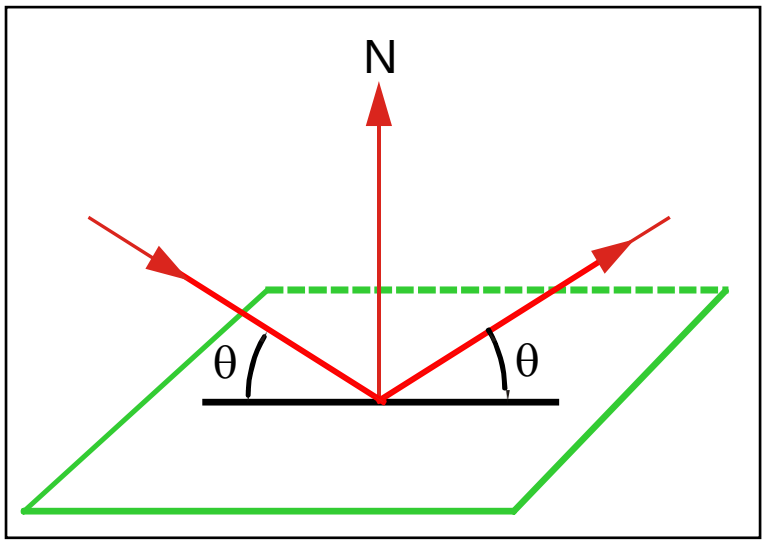
Agenda

- Introduction
- Medipix in X-ray diffraction
- Applications
  - Powder Diffraction
  - Rocking curves
  - Reflectivity
- Future developments
- Conclusion

PANalytical: material analysis with XRD and XRF



Diffraction



N <u>bisects</u> incident and reflected beams

angle of incidence = angle of reflection (symmetrical)

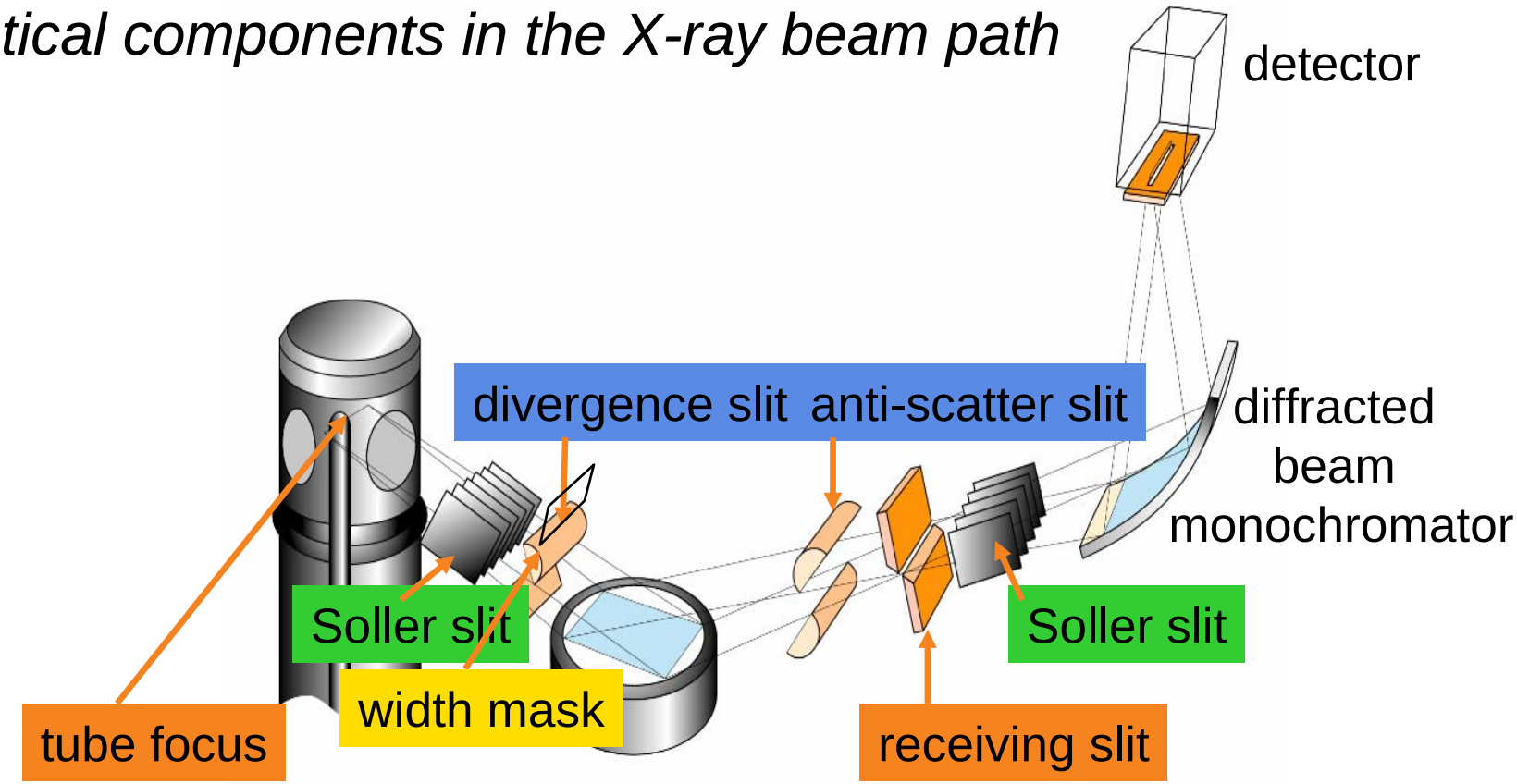
This is called the <u>Bragg Reflection.</u>

$$n\lambda = 2d \sin\theta$$

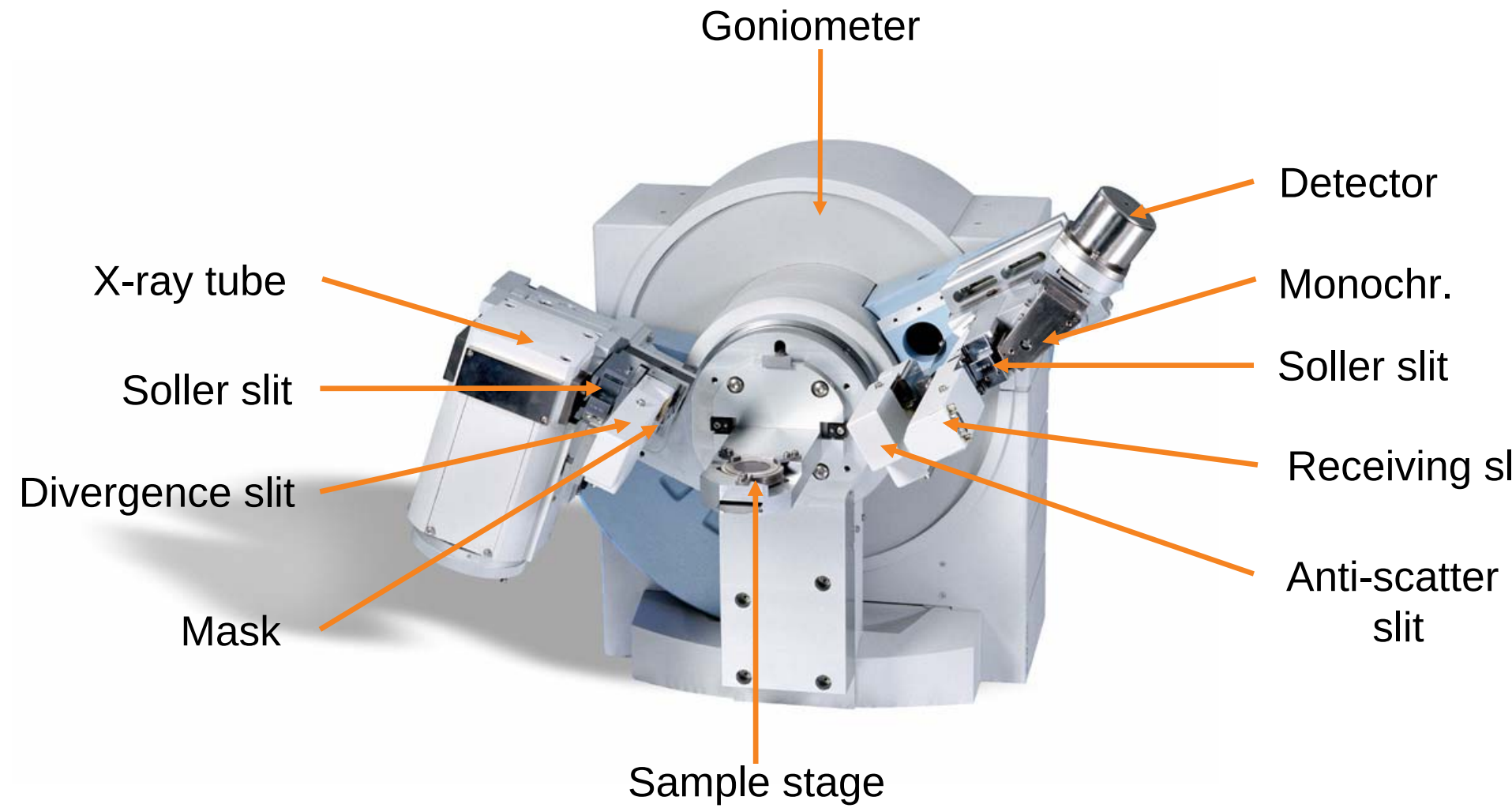
- λ is known (the wavelength of the X-ray beam) (->1.54 Angstrom)
- θ is measured (the reflection angle)
- 'd' is calculated (the spacing between the lattice planes)

Classical powder diffraction

Optical components in the X-ray beam path



Classical powder diffractometer



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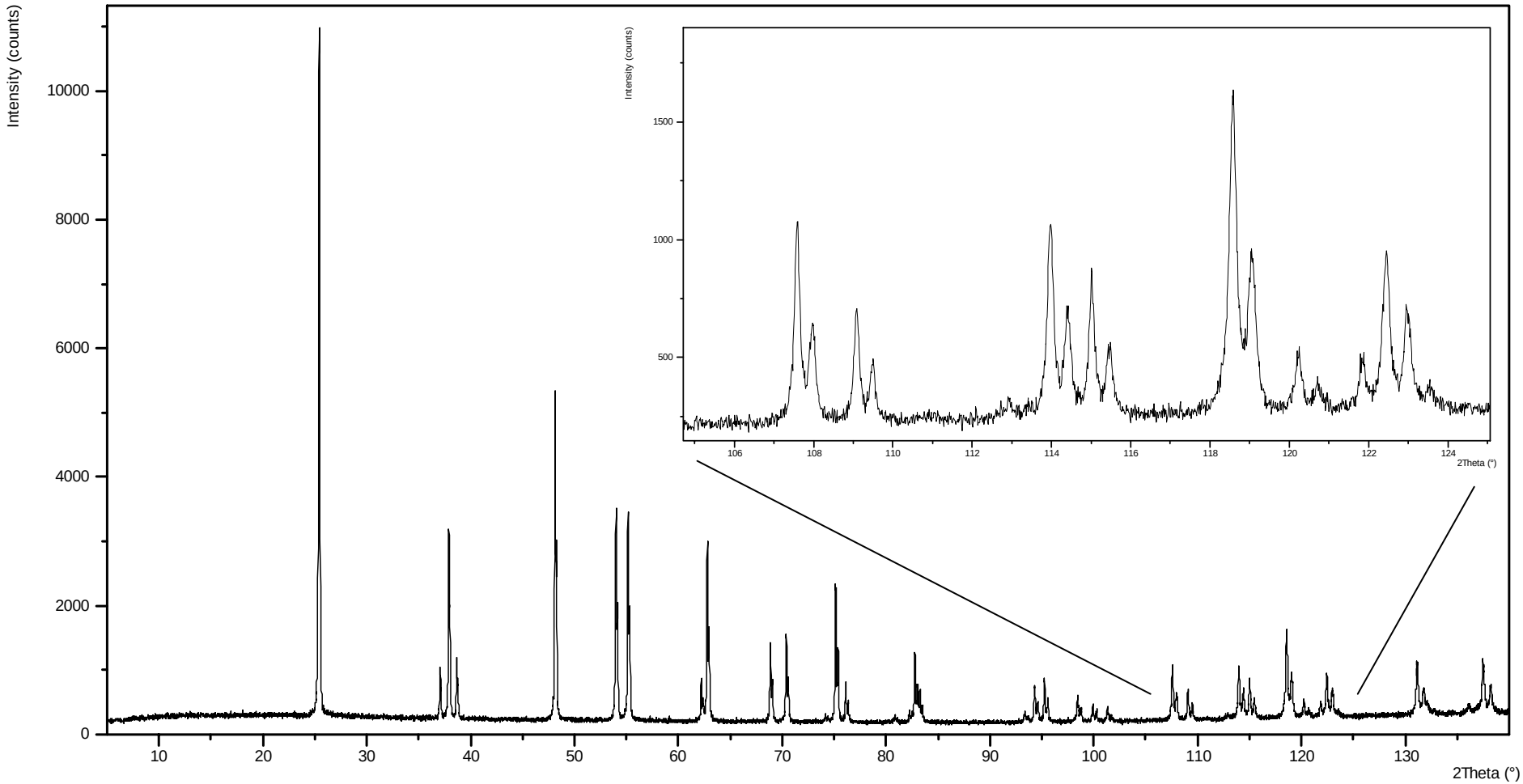
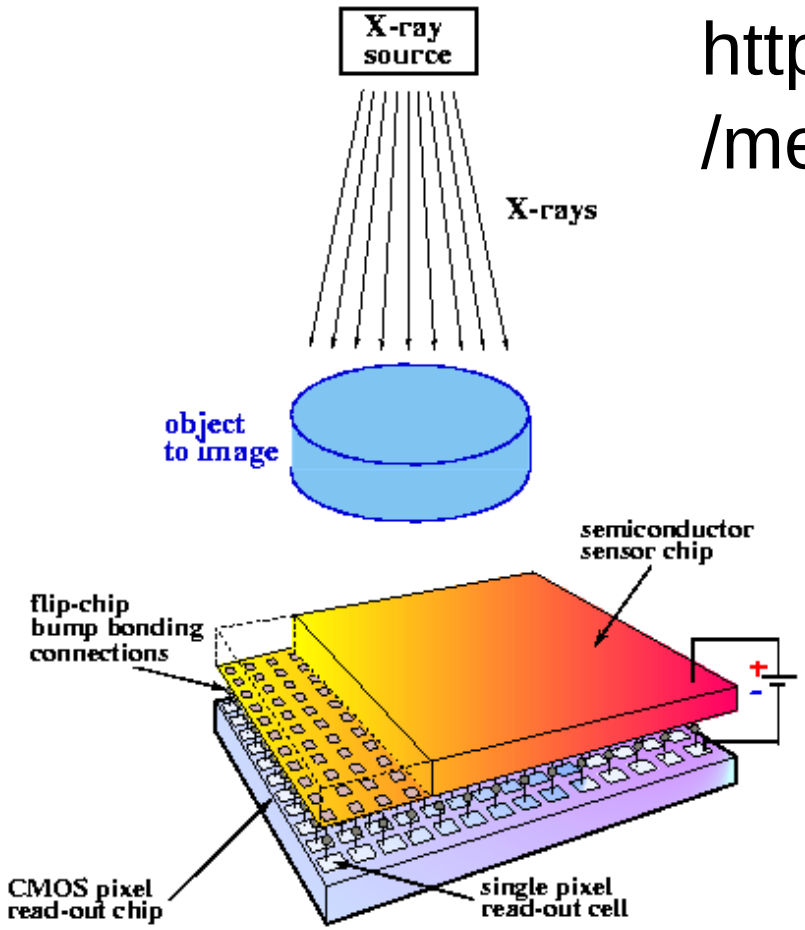
X-ray diffraction:

Typical Measurement: powder diffraction



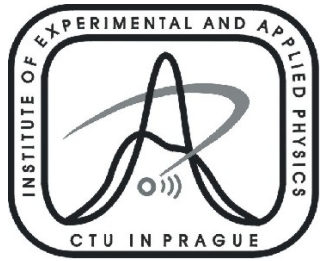
Medipix 2 detector



http://www.cern.ch/medipix

Properties

- 2D, single photon counting chip
- 256x256 pixels
- 55 micron pitch
- “13.5” bit counter (up to 11810 counts/pixel)
- Low and high threshold
- 3-side buttable
- 0.25 micron technology
- Parallel an serial readout



- Univ + INFN Cagliari
- CEA-LIST Saclay
- CERN Genève
- Univ d'Auvergne
- Univ Erlangen
- ESRF Grenoble
- Univ Freiburg
- Univ Glasgow
- IFAE Barcelona
- Mitthoegskolan Sundsvall
- MRC-LMB Cambridge
- Univ + INFN Napoli
- NIKHEF Amsterdam
- Univ + INFN Pisa
- FZU CAS Prague
- IEAP CTU Prague
- SSL Berkeley

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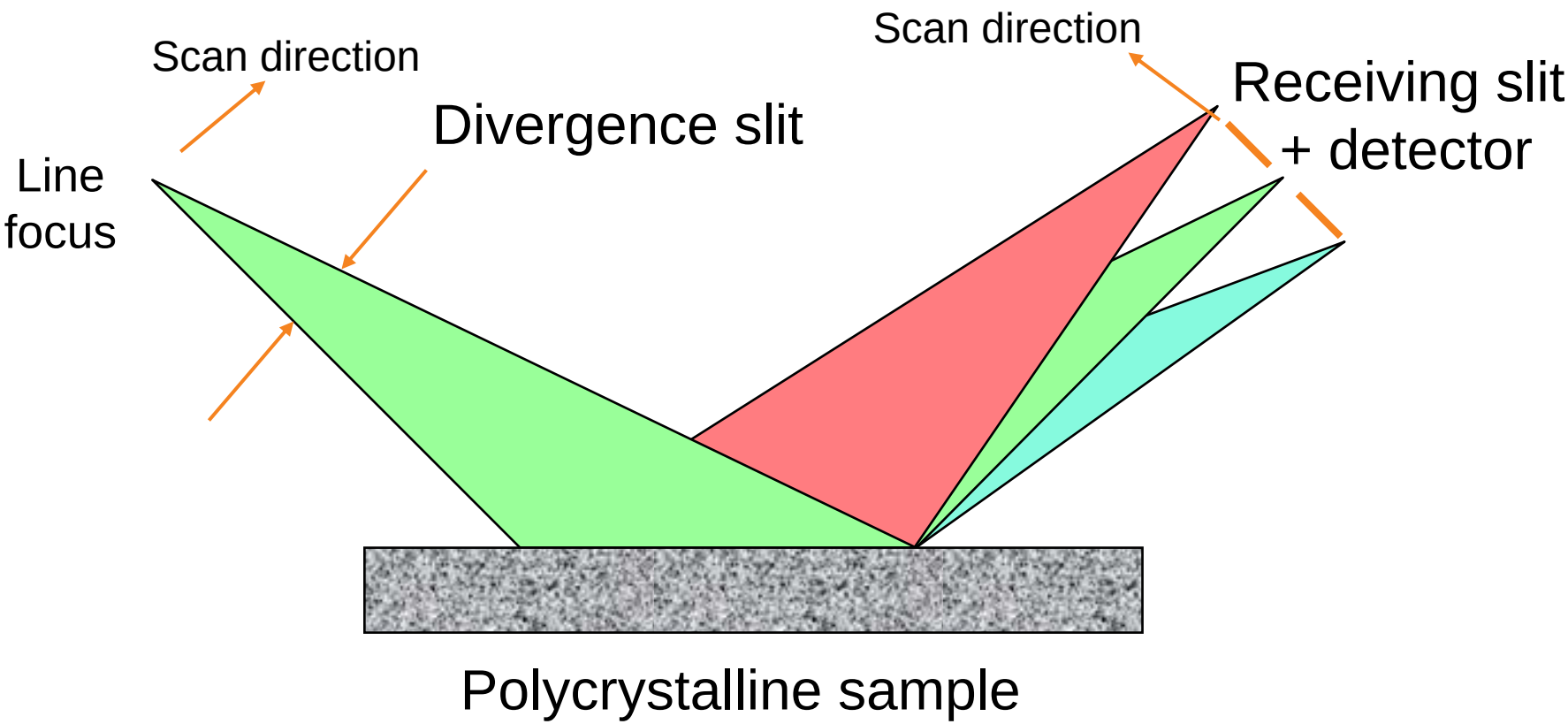
Spokespersons:
Michael CAMPBELL CERN
Jan VISSCHERS NIKHEF

Medipix as a SCANNING 0D/1D detector: why?

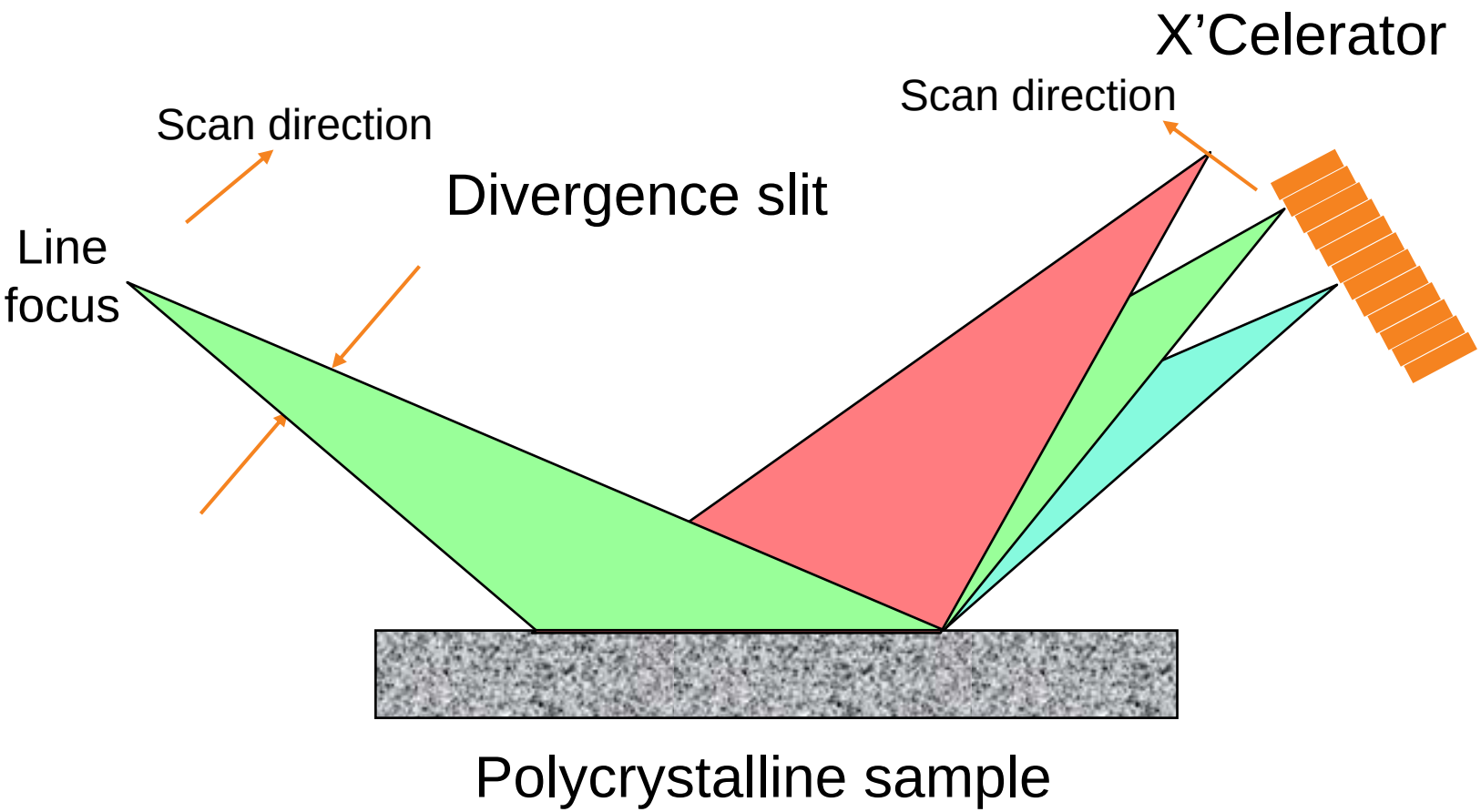
- Many applications require only 1D detector.
- Increase measurement speed by a factor ~150
- Super high dynamic range (leads to fast measurements, no beam attenuator switching needed).
- Small pitch.
- Relatively large active length
- Final goal: choice for 0D, 1D and 2D detection will just be a matter of a software setting.

Increase in measurement speed (1)

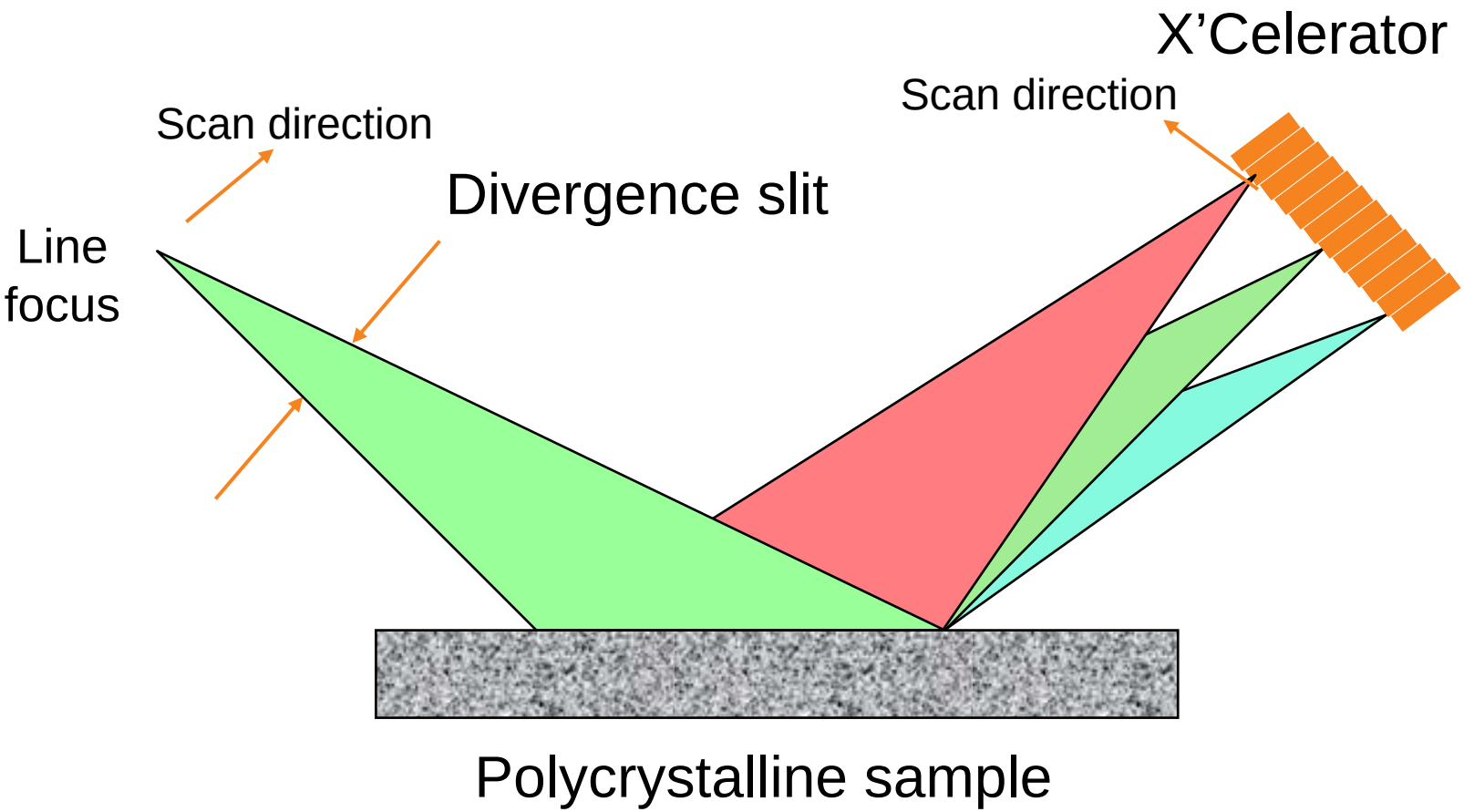
Classical geometry (Bragg-Brentano)



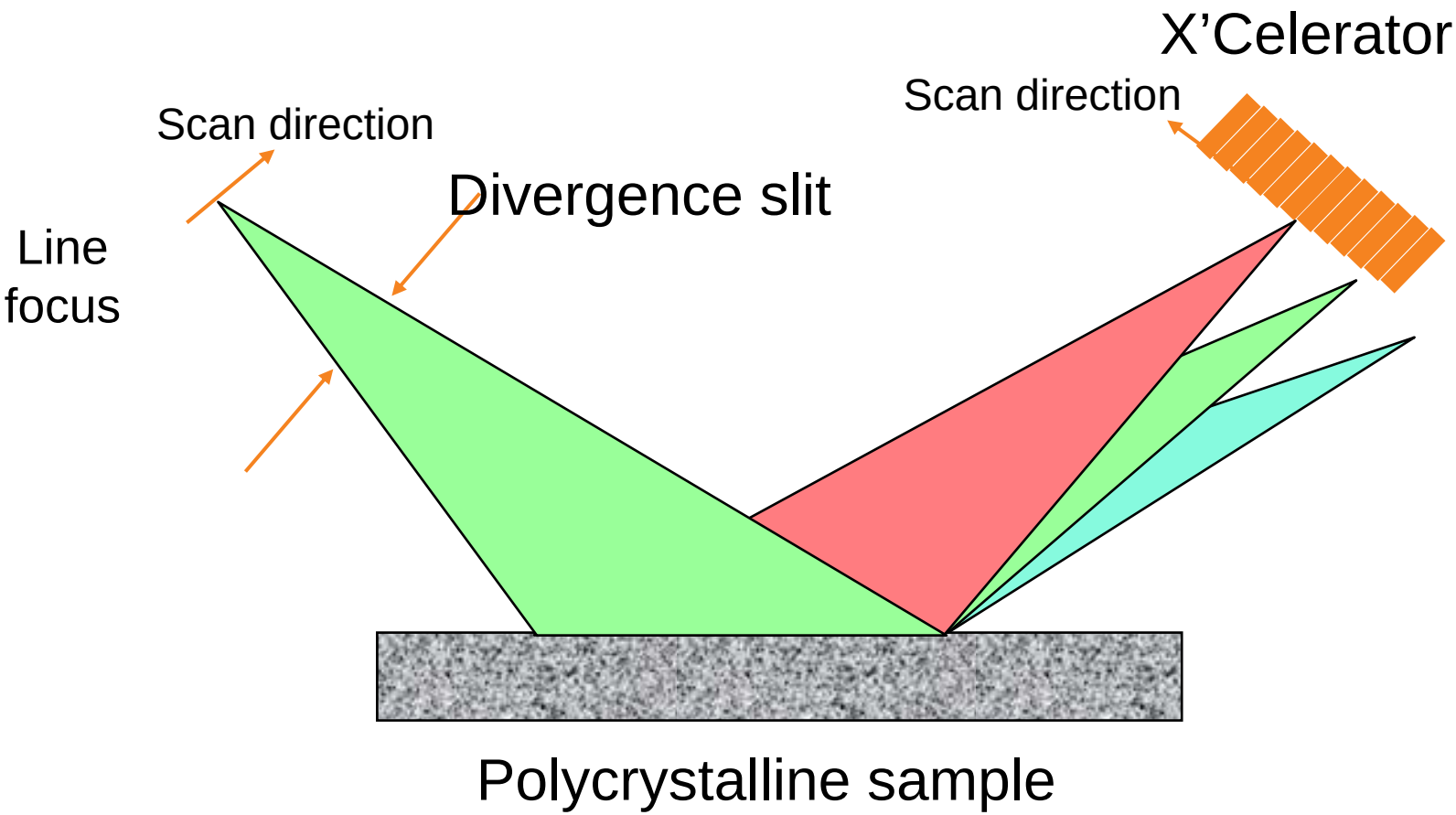
Increase in measurement speed (2)



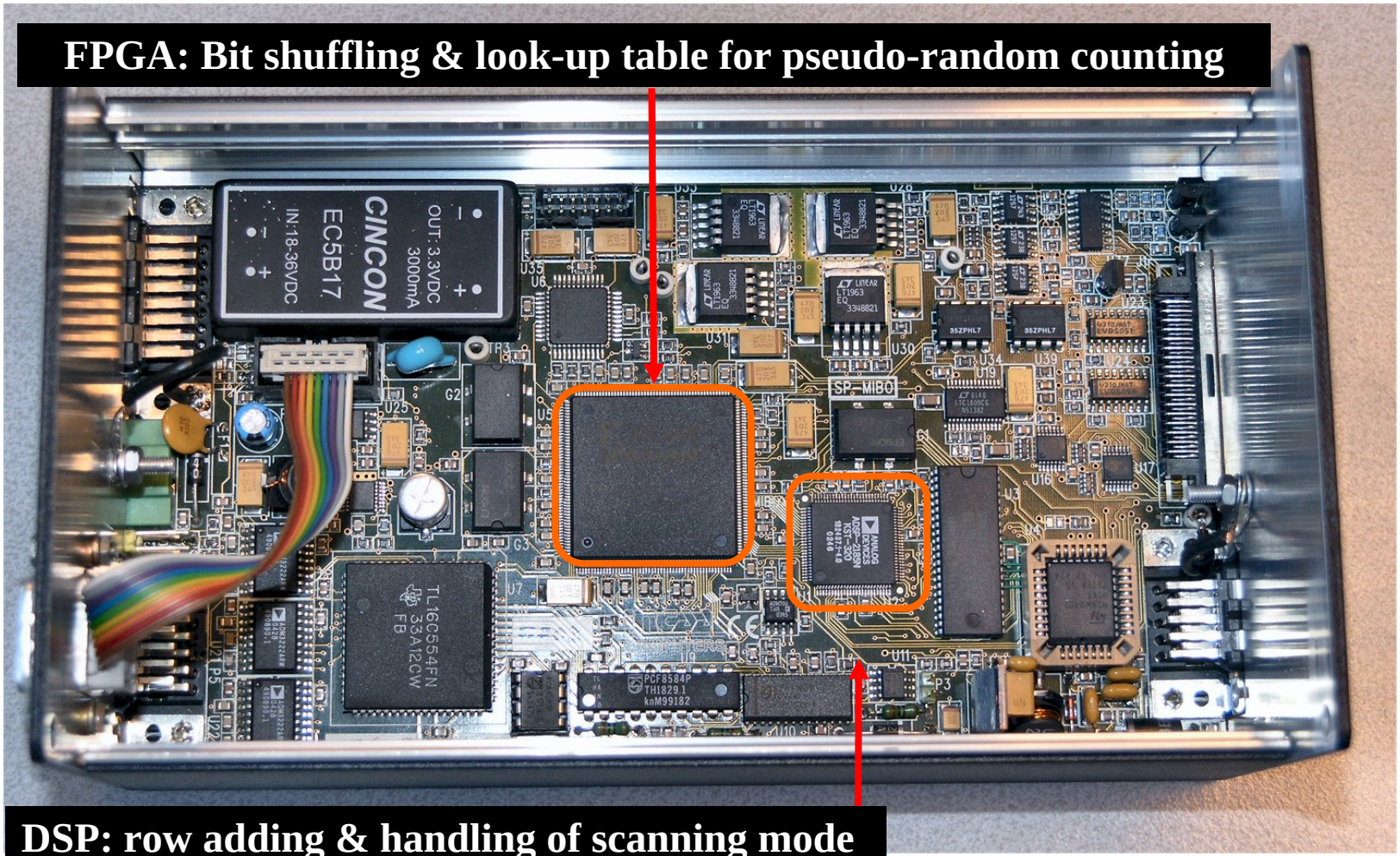
Increase in measurement speed (3)



Increase in measurement speed (4)



Pictures of the MIBO (MedipiX interface board)



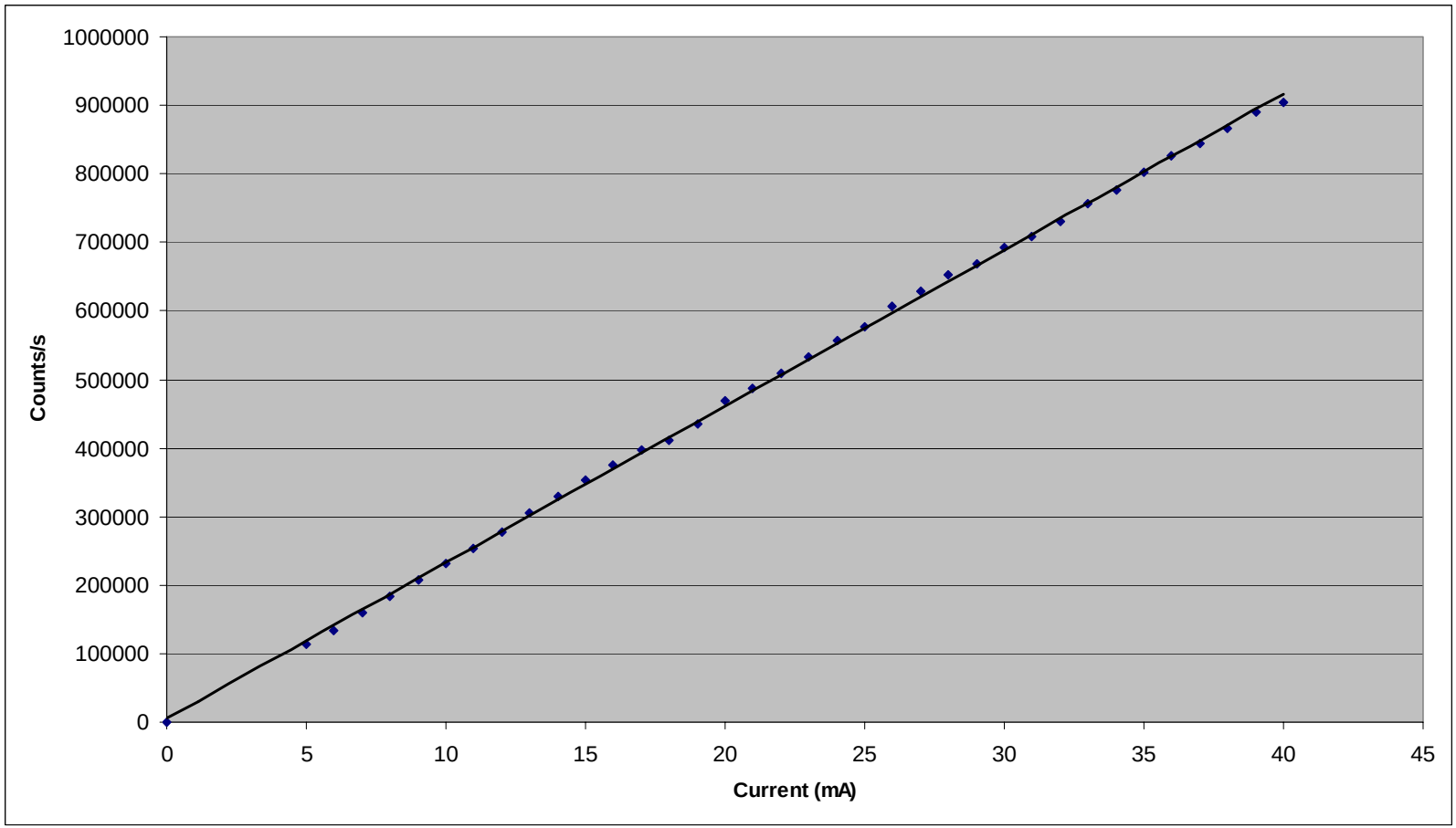
Serial readout

Readout freq.: 160 MHz

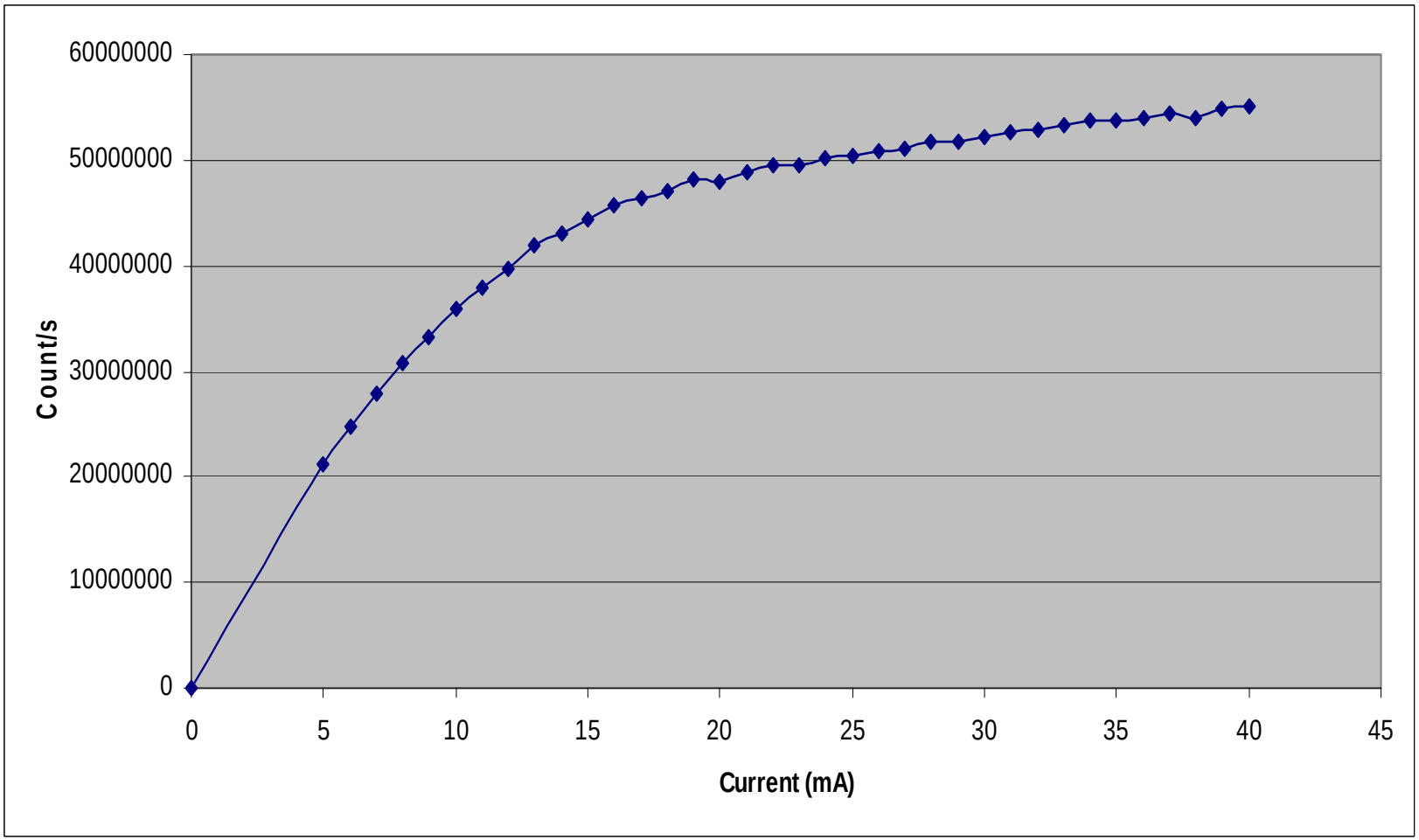
Readout time: 5.7 ms

Medipix 1D: Readout electronics: MIBO (2)

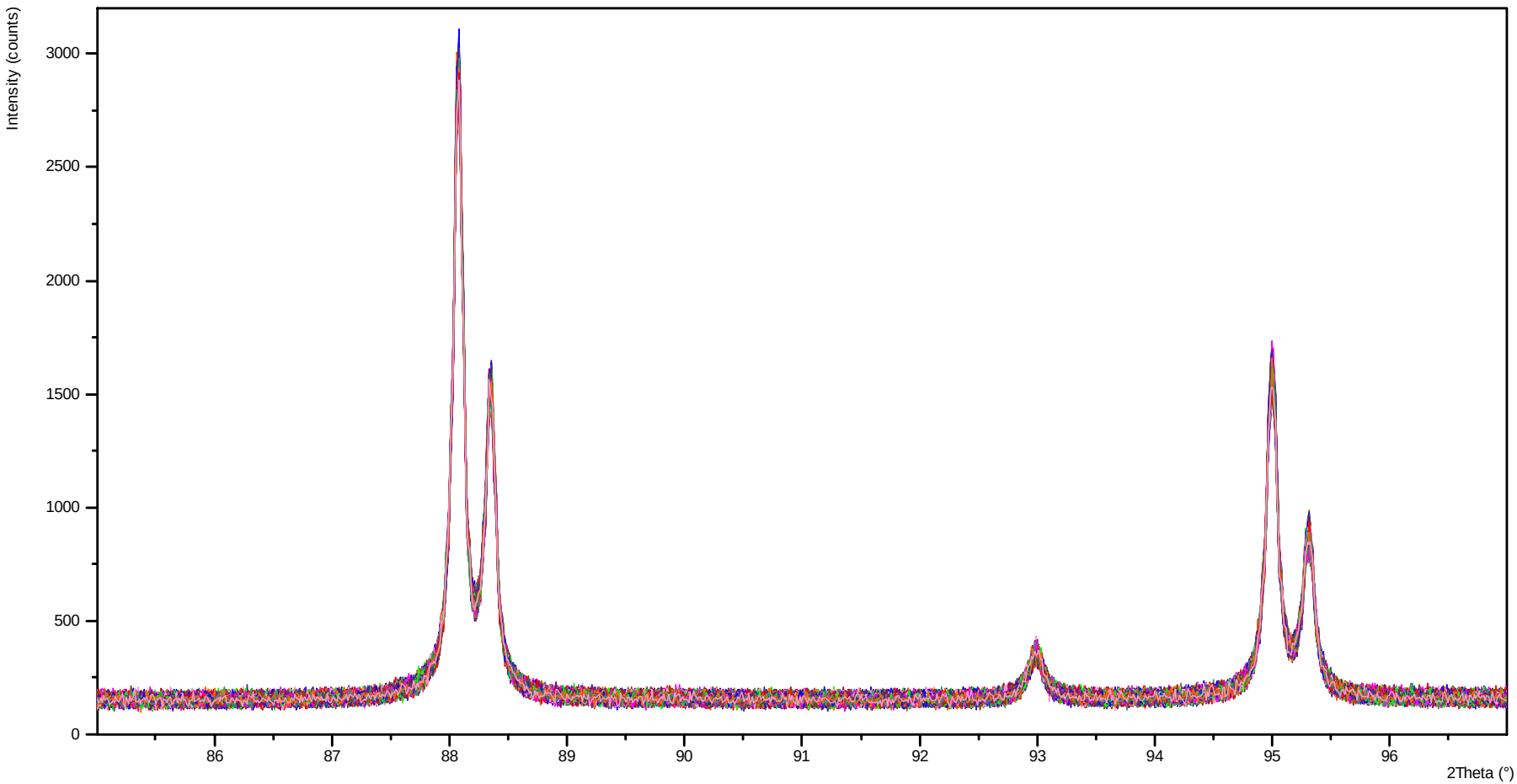
Linearity of pixels (1) (attenuator used)



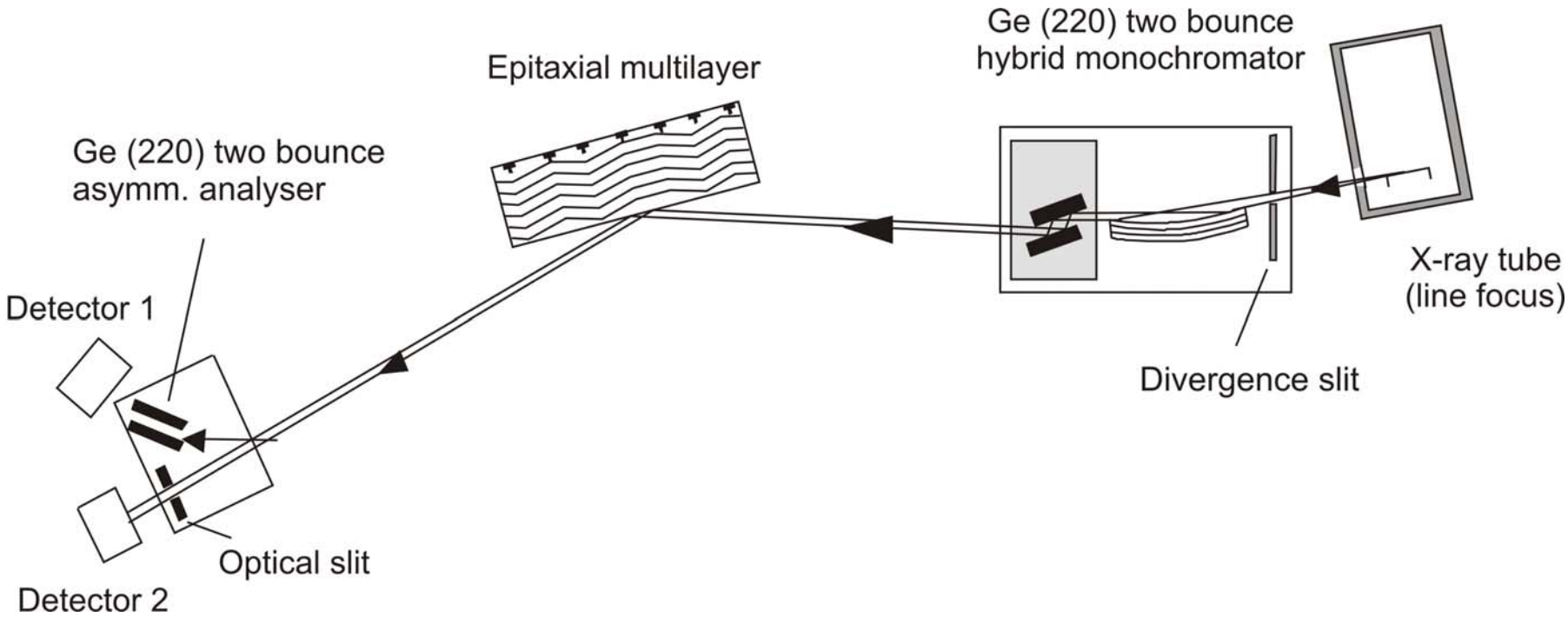
Linearity of pixels (2) (no attenuator used)



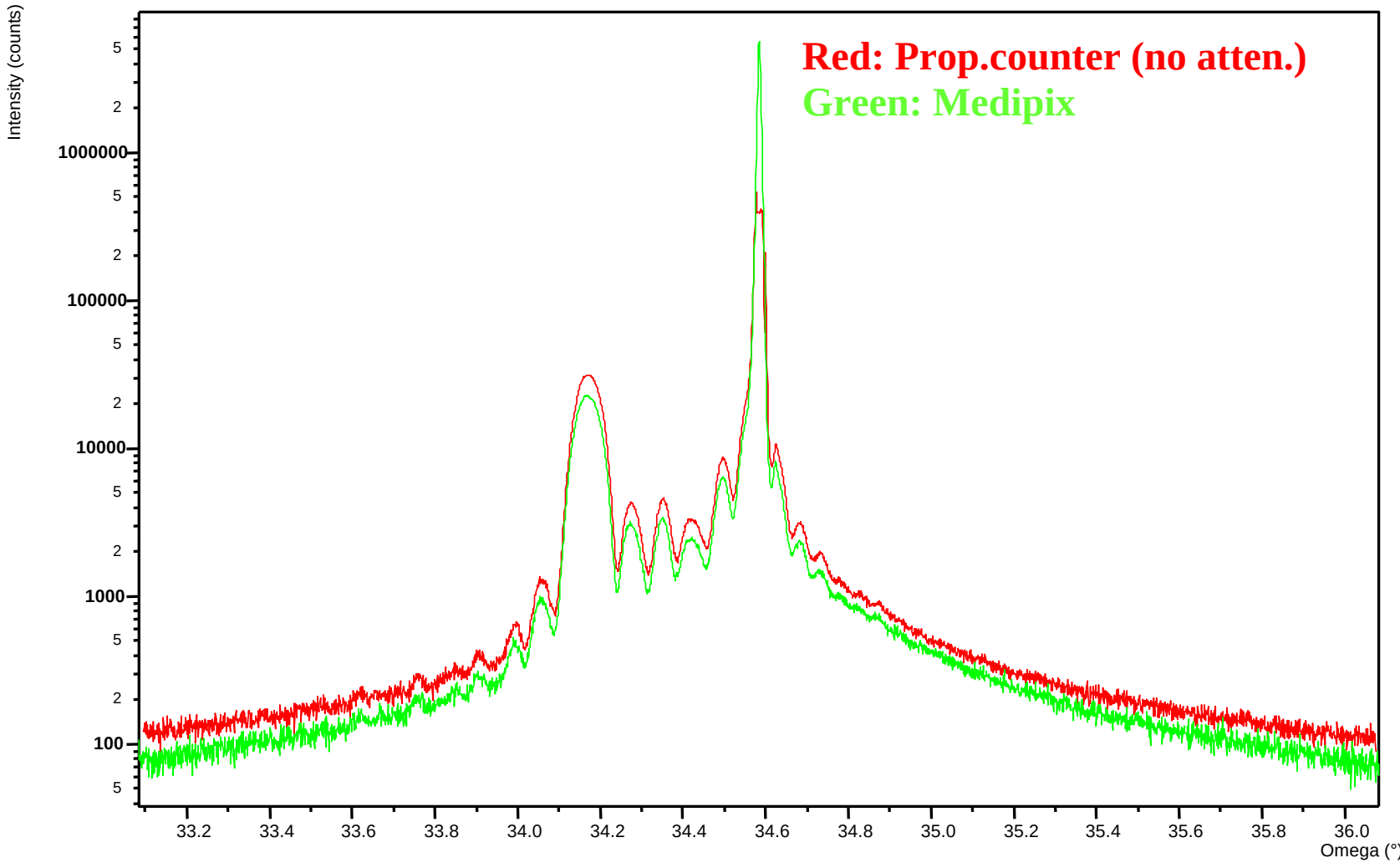
Stability measurements: 1000 scans



Rocking curve

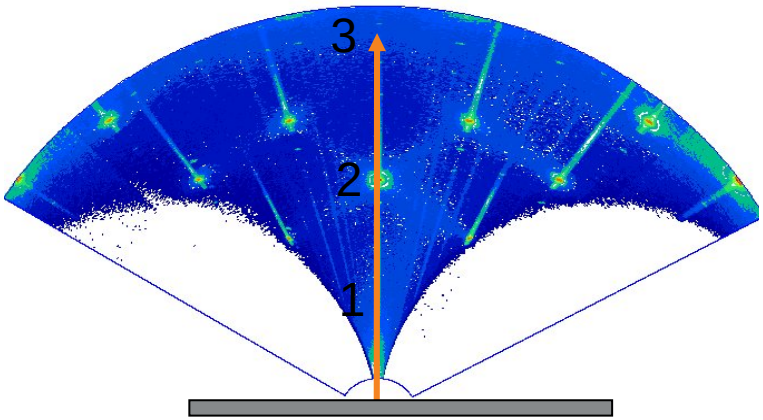


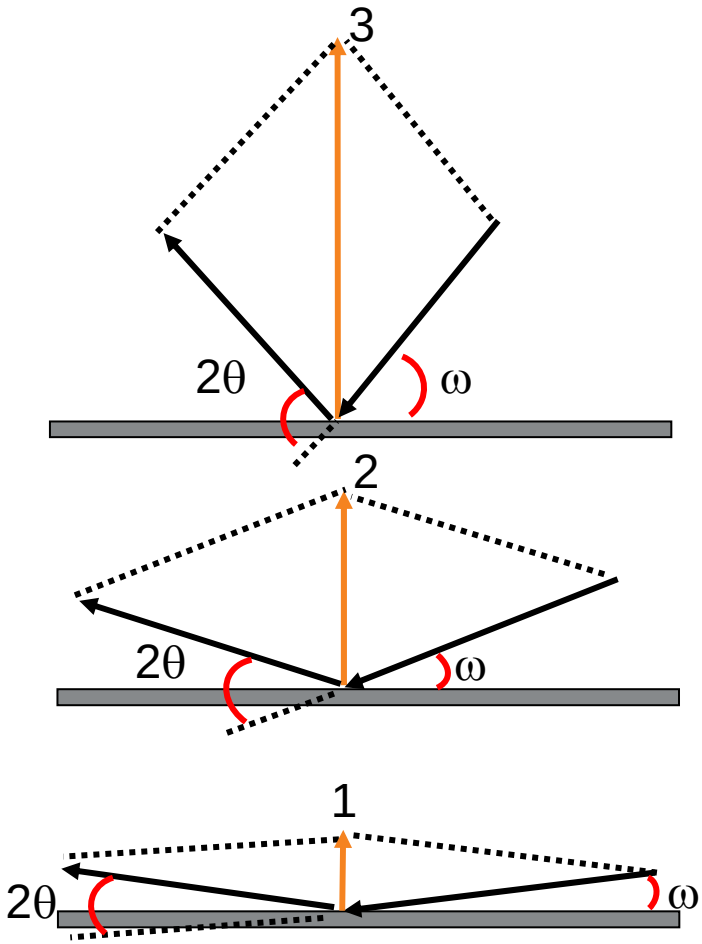
Rocking curve



Visualization of an Omega/2Theta* Scan

Symmetric Omega/2Theta* scan
(no offset)

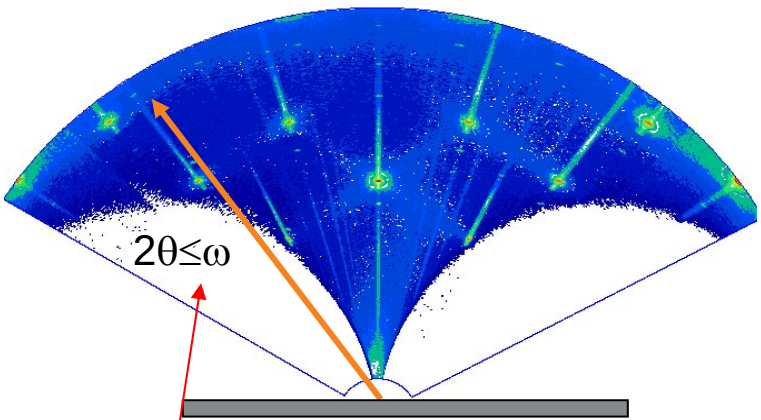




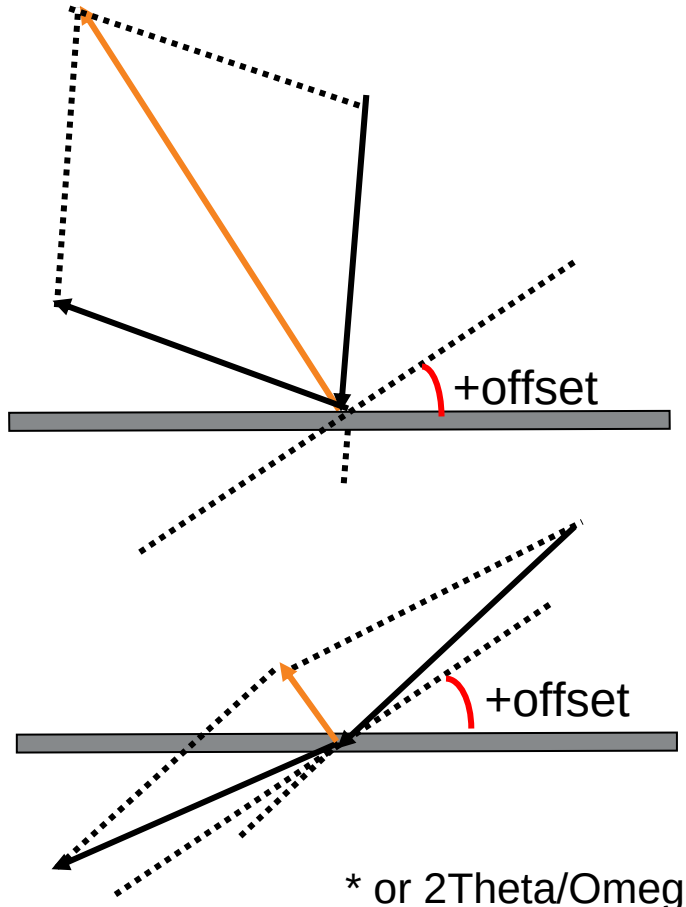
* or 2Theta/Omega

Visualization of an Omega/2Theta* Scan with +Offset

Omega > 2Theta/2



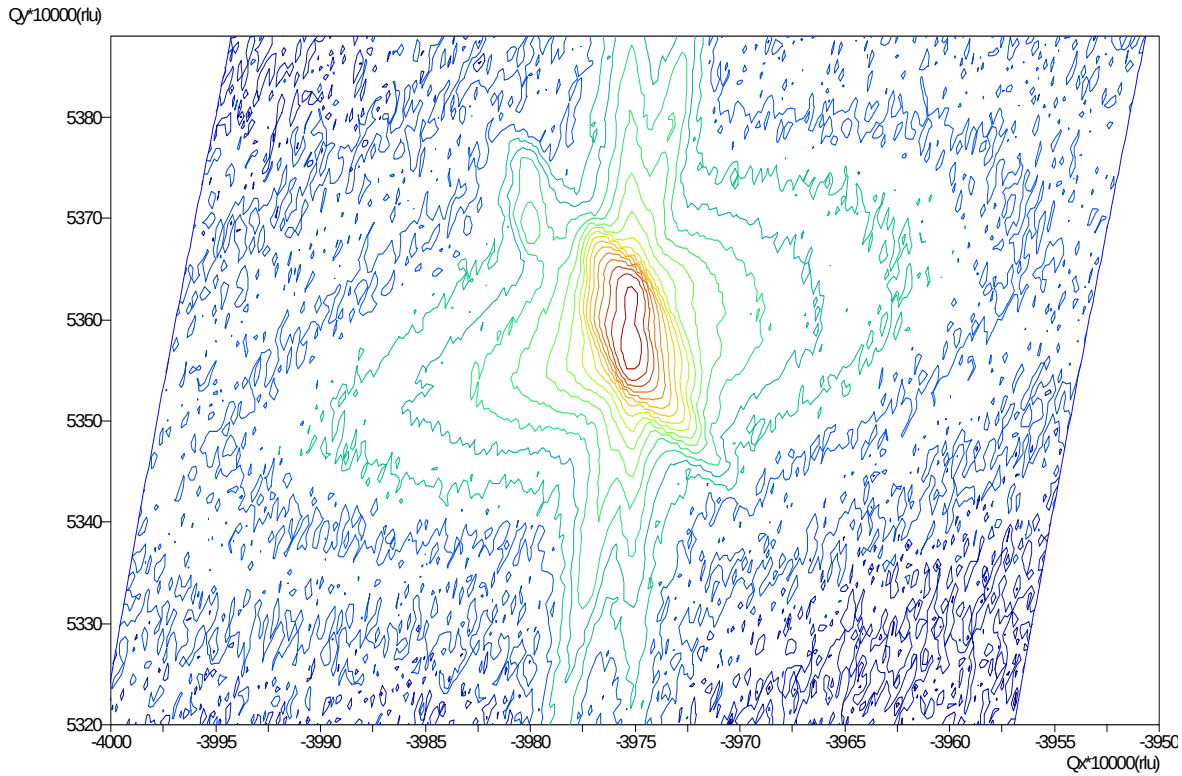
No exit for diffracted beam



* or 2Theta/Omega

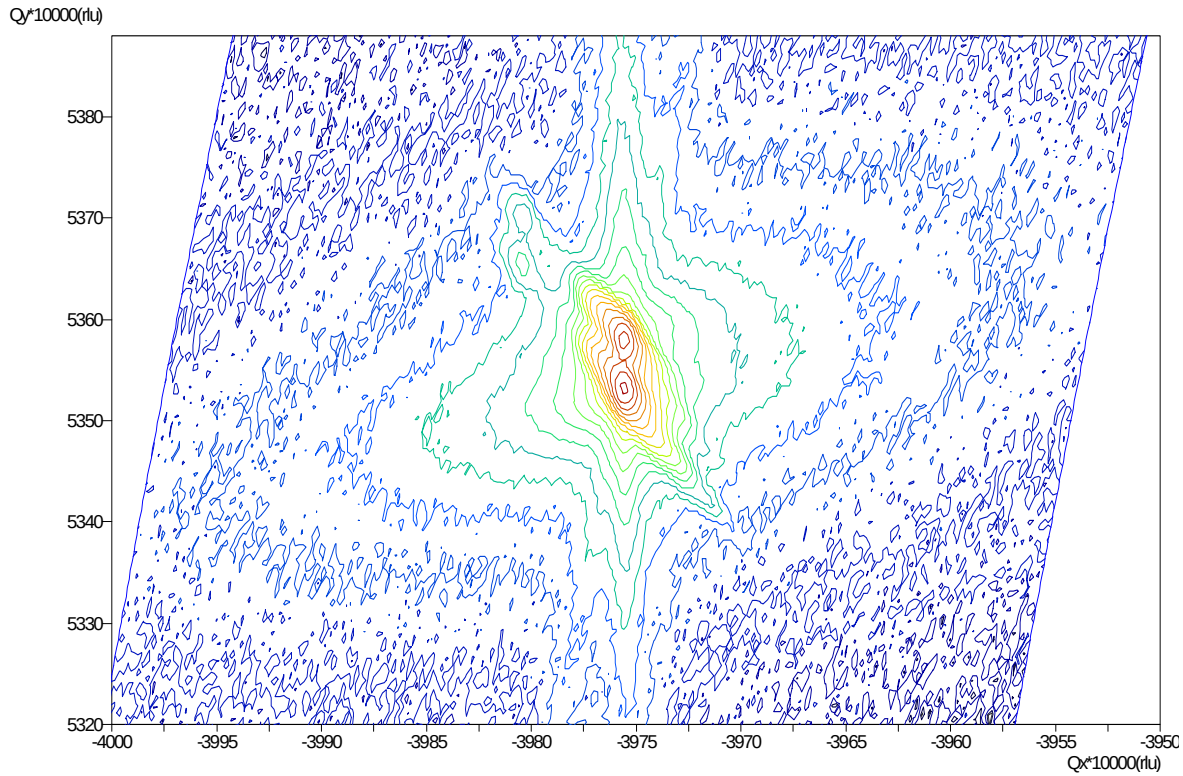
RSM around (224) GaAs

X'Celerator in Static Mode (step size = 0.0125 degree)



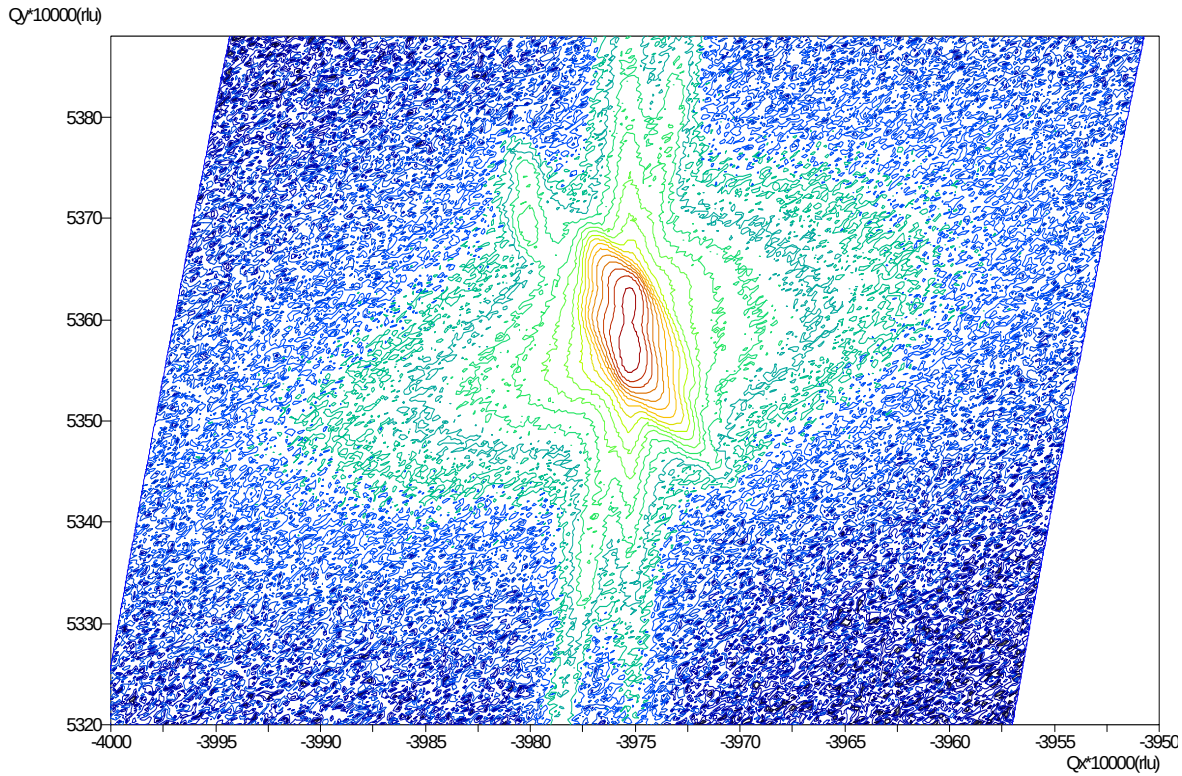
RSM around (224) GaAs

Medipix in Static Mode (step size = 0.0098 degree)



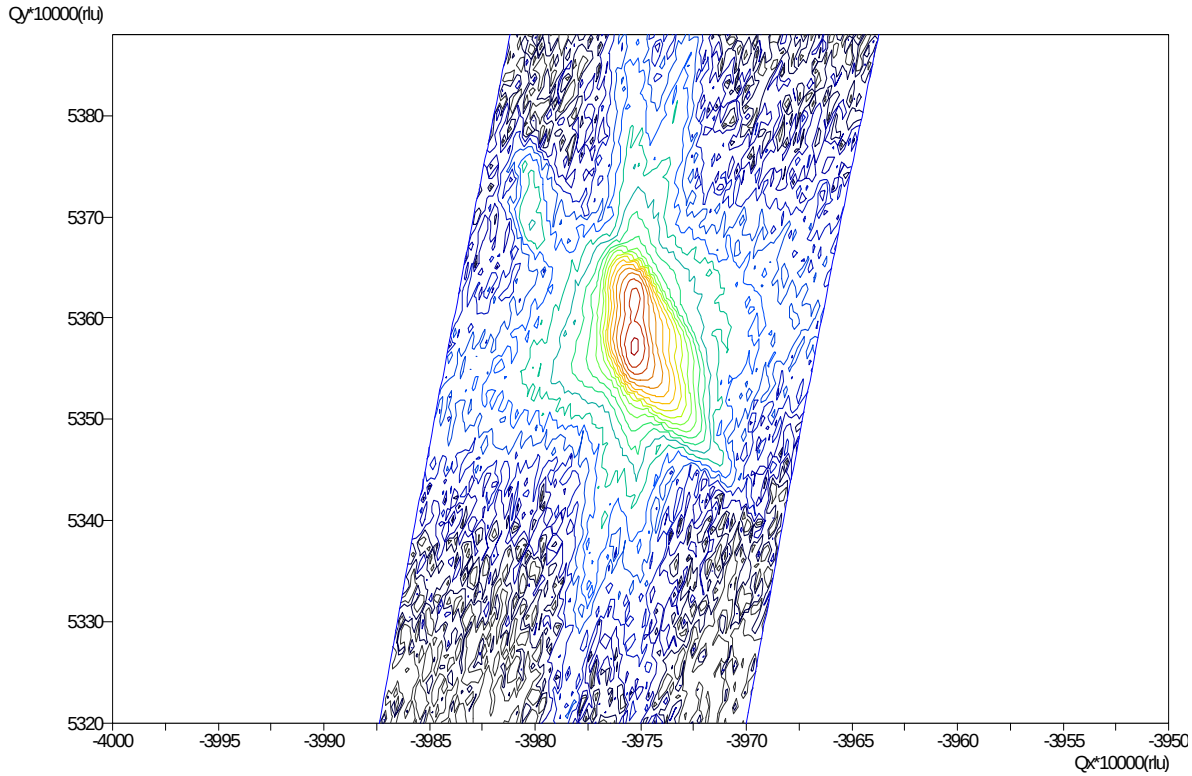
RSM around (224) GaAs

X'Celerator in Scanning Mode (step size = 0.0031 degree)



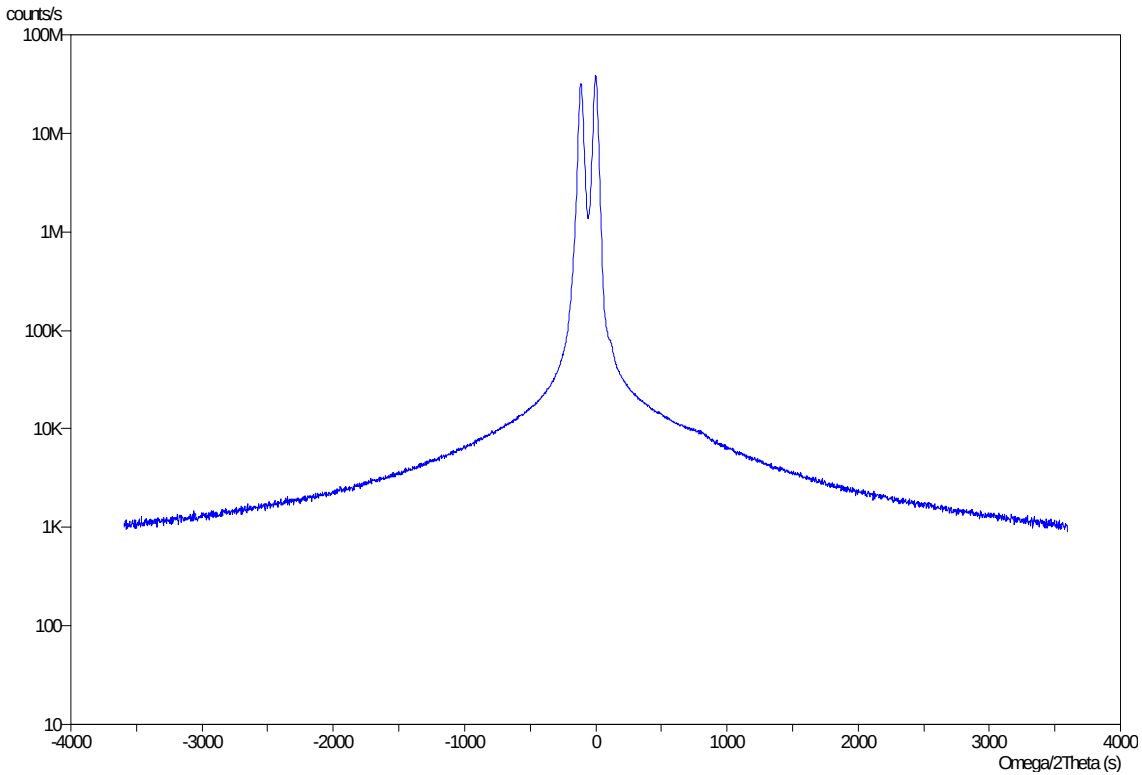
RSM around (224) GaAs

X'Celerator in Static Mode, power of the tube is reduced



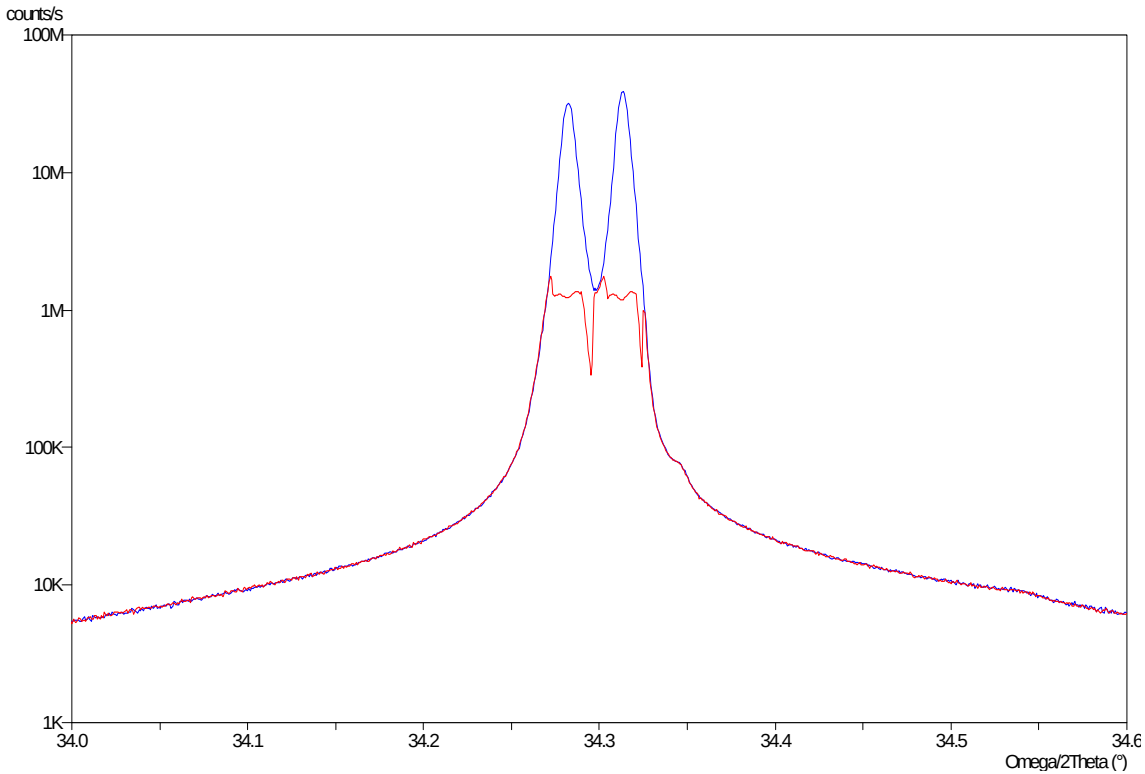
(004) Rocking curves

Proportional Detector with attenuator



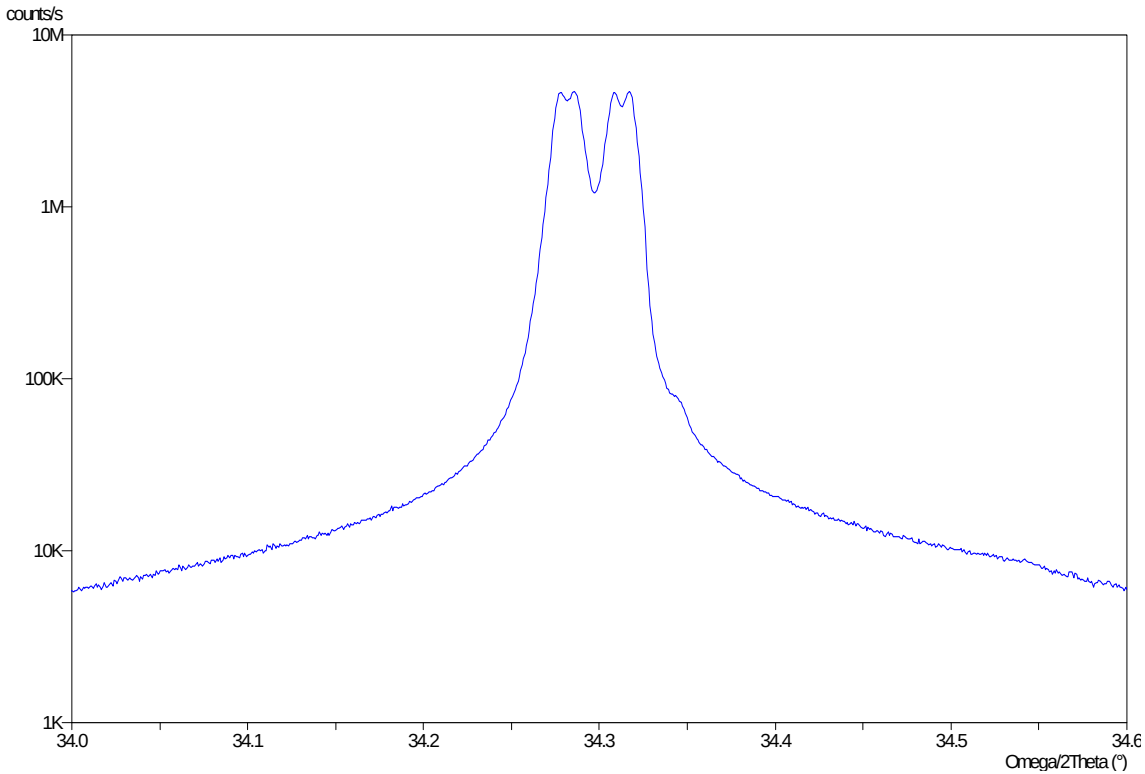
(004) Rocking curves

Proportional Detector with (blue) and without attenuator (red)



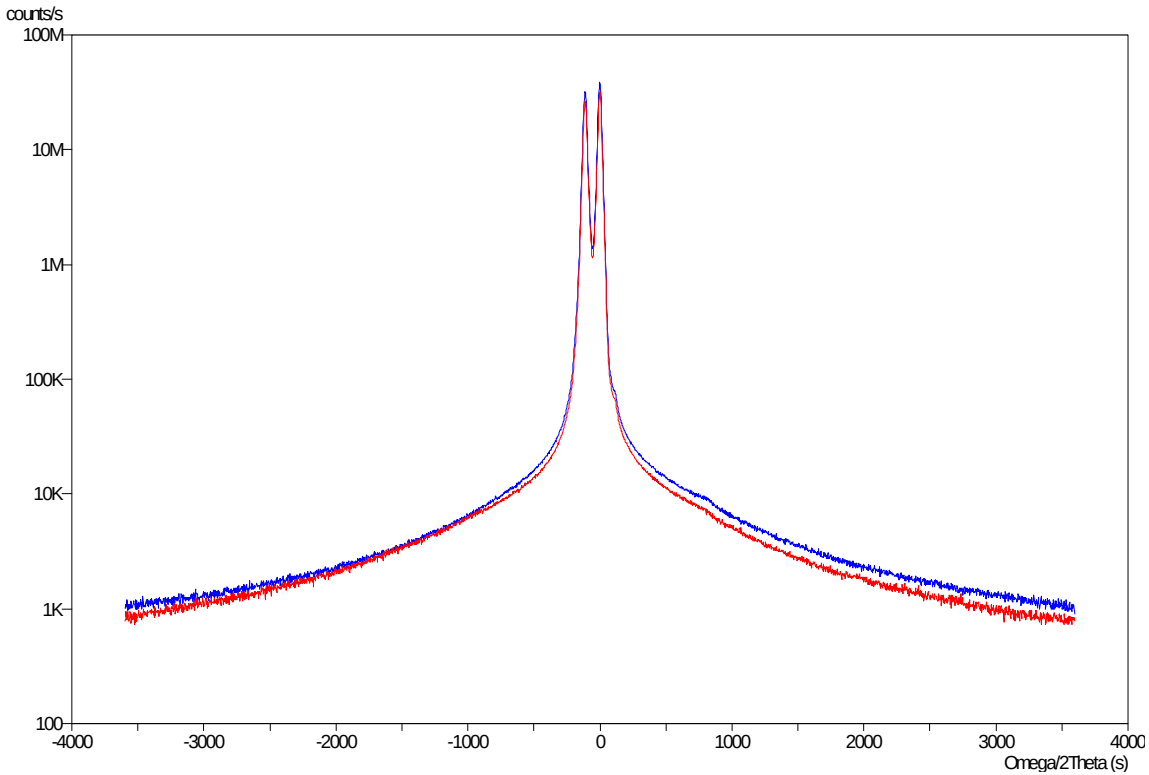
(004) Rocking curves

X'Celerator without attenuator



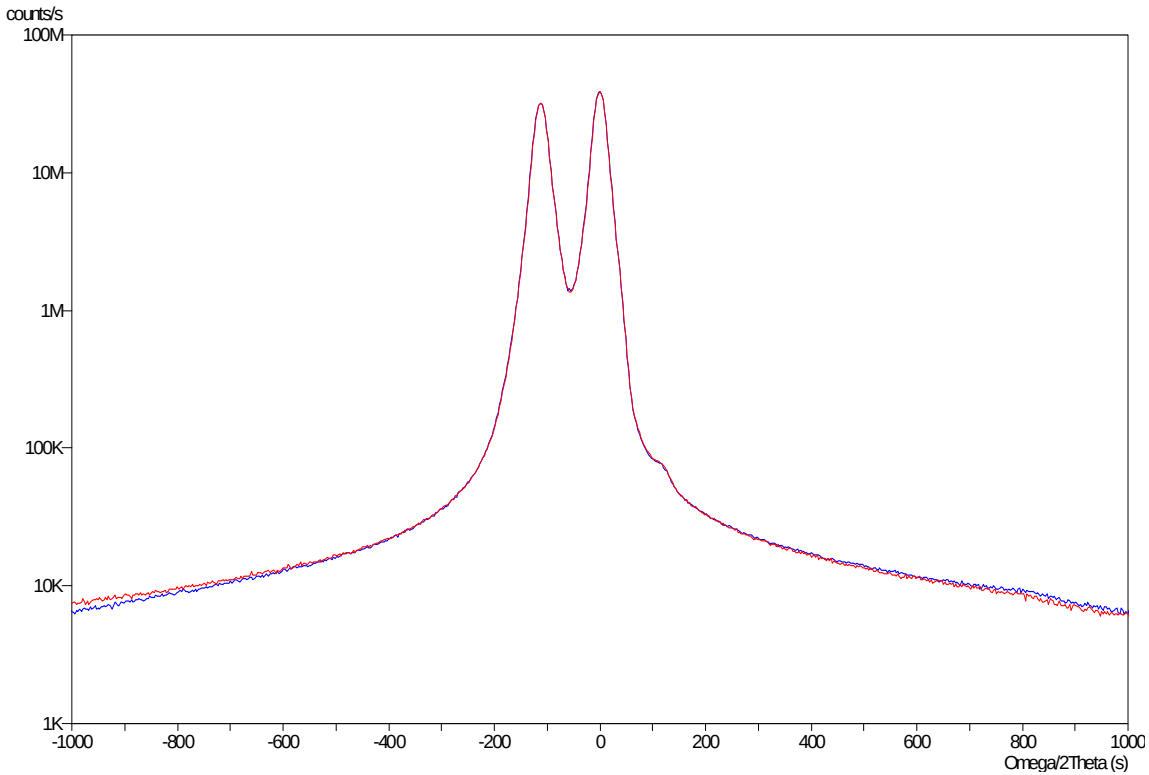
Medipix: (004) Rocking curves

Medipix without attenuator (red) and proportional detector with the attenuator (blue)

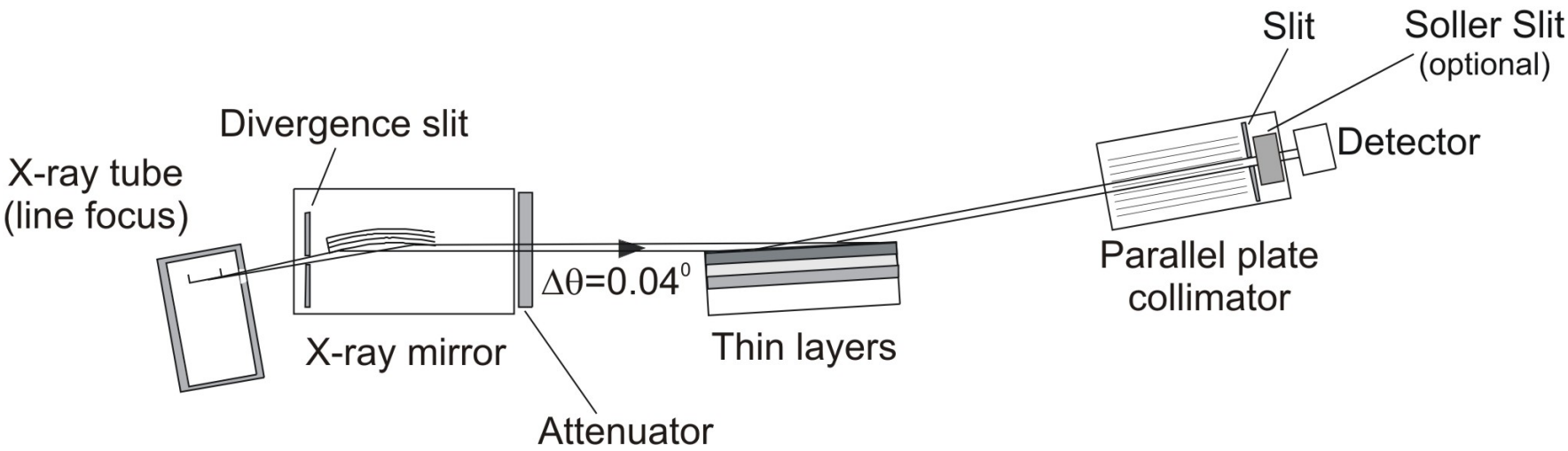


Medipix: (004) Rocking curves

Medipix without attenuator (red) and proportional detector with the attenuator (blue)

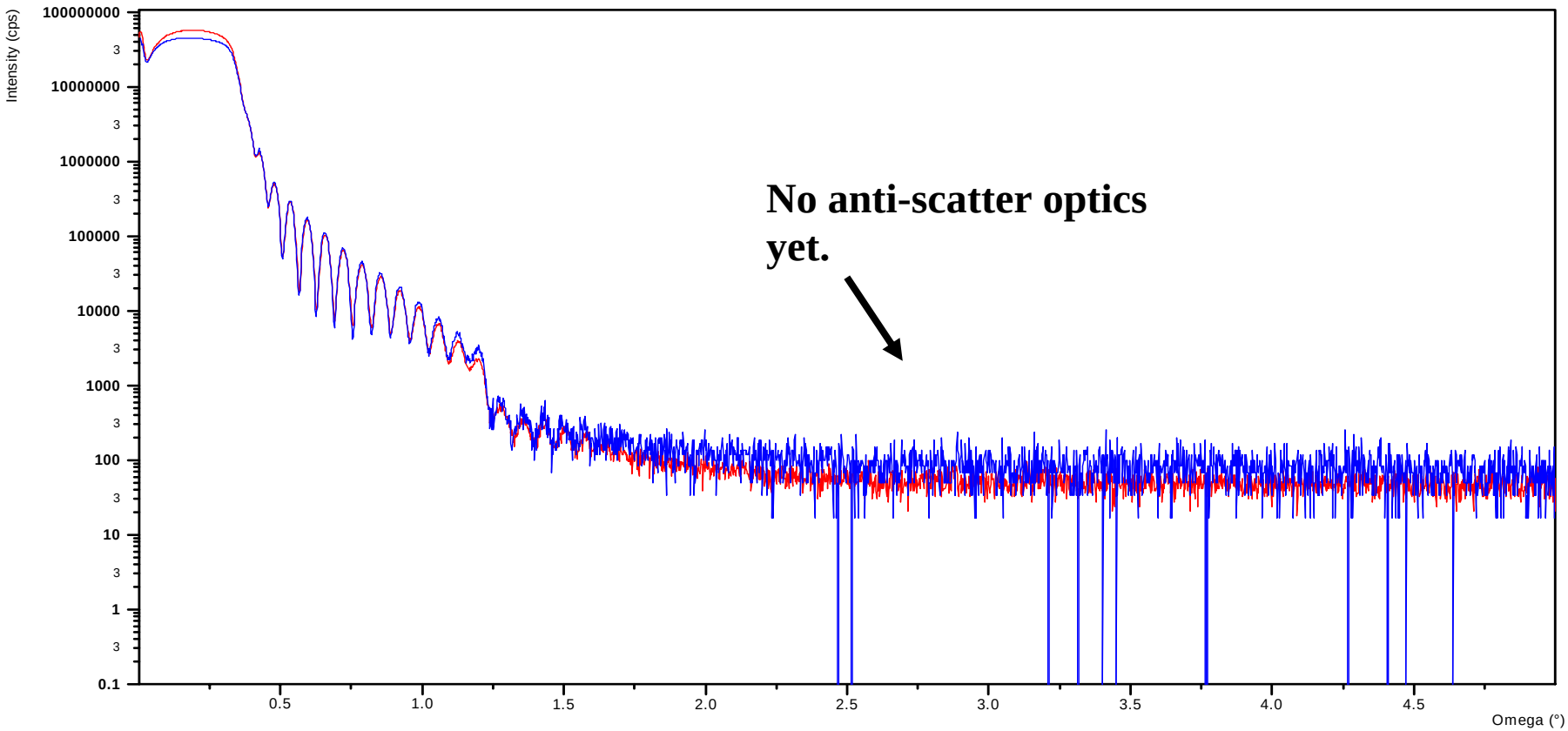


Reflectivity setup



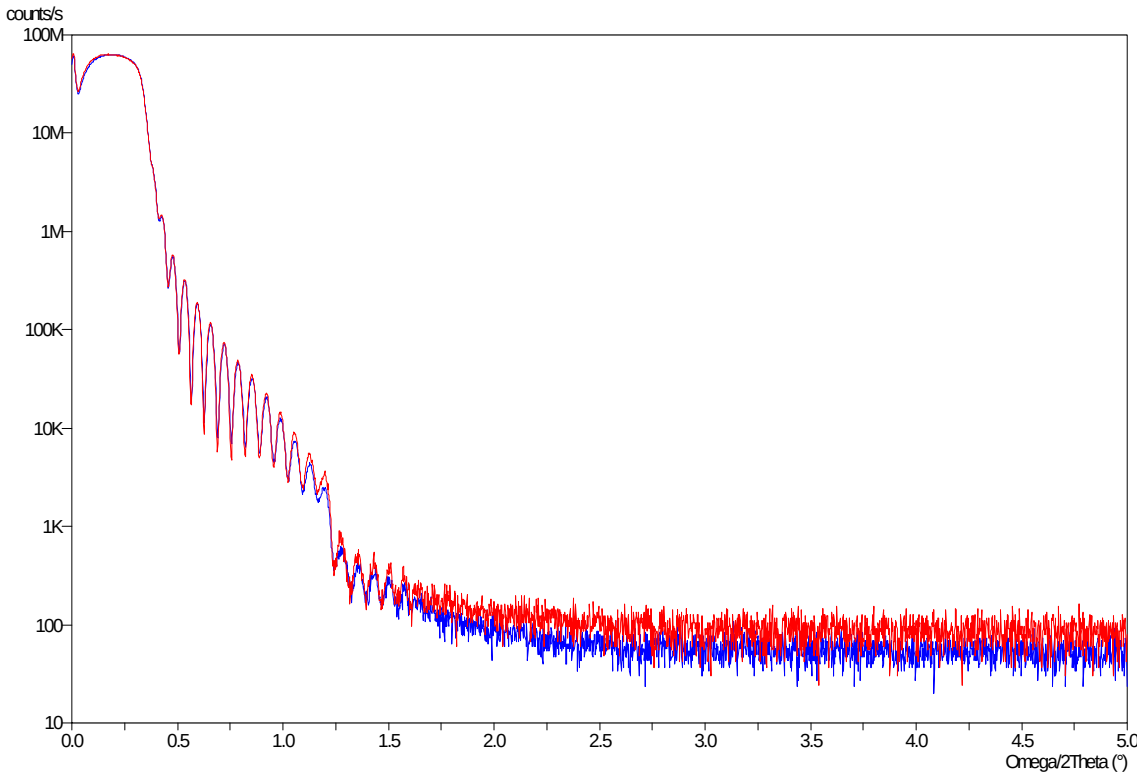
Reflectivity measurement

1 channel of Medipix (red) and proportional detector with the attenuator (blue)



Medipix: Reflectivity

1 channel of Medipix (red) and proportional detector with the attenuator (blue)

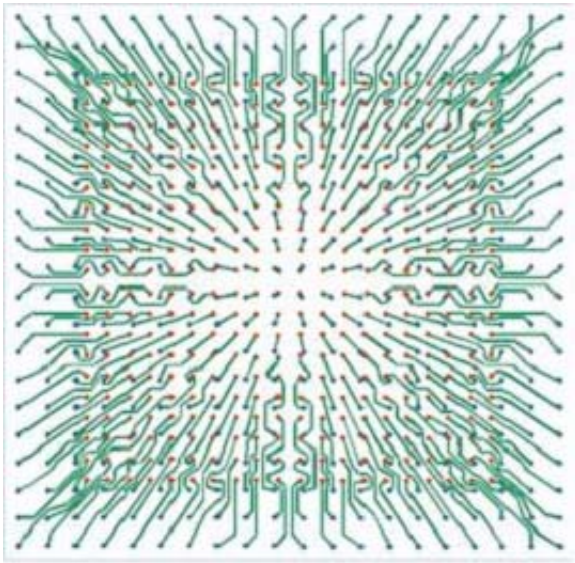


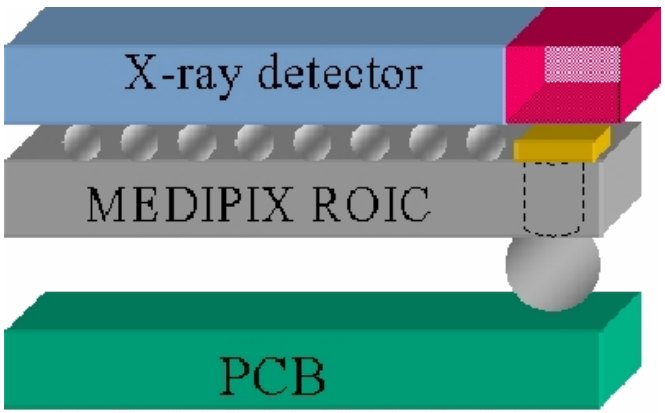
Future:

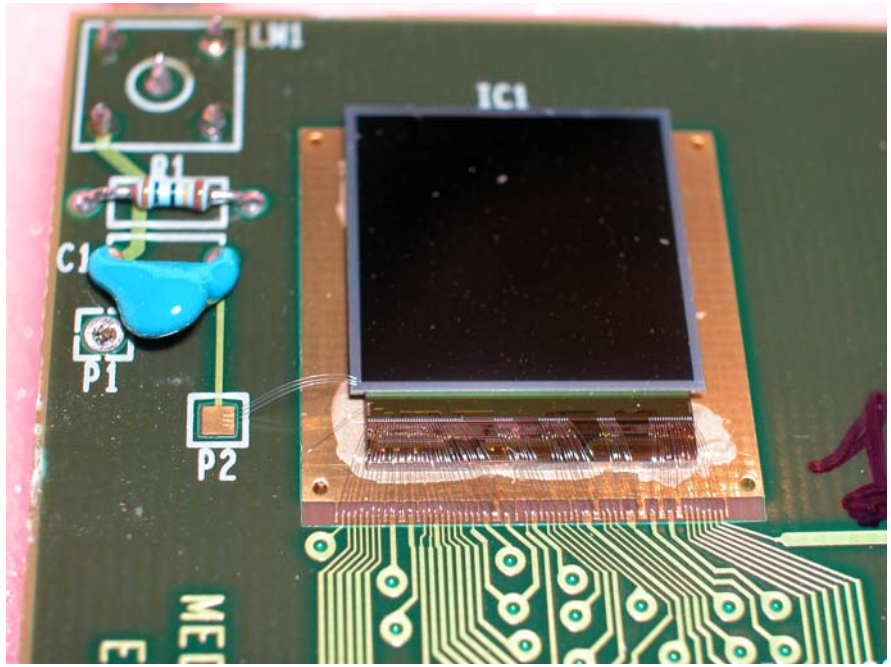
- Move to 2D
- Focus on the quad (2x2 chips)
- No spaces between individual chips
- Minimise spacing between detector units
- Development of high speed readout card will start within a few months

RELAXD

RELAXD (high resolution large area X-ray detector)







Partners: IMEC, CANBERRA, NIKHEF

2.7 MEuro (60% funded)

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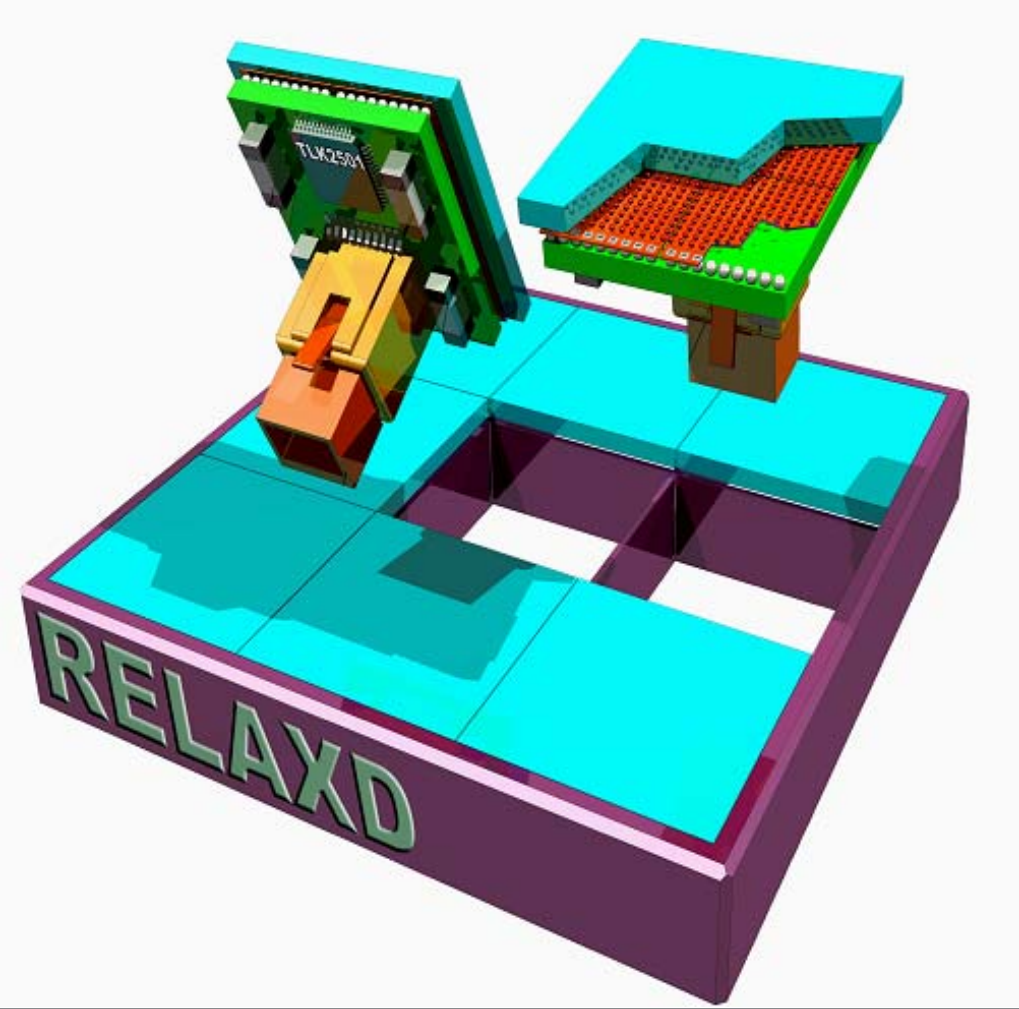
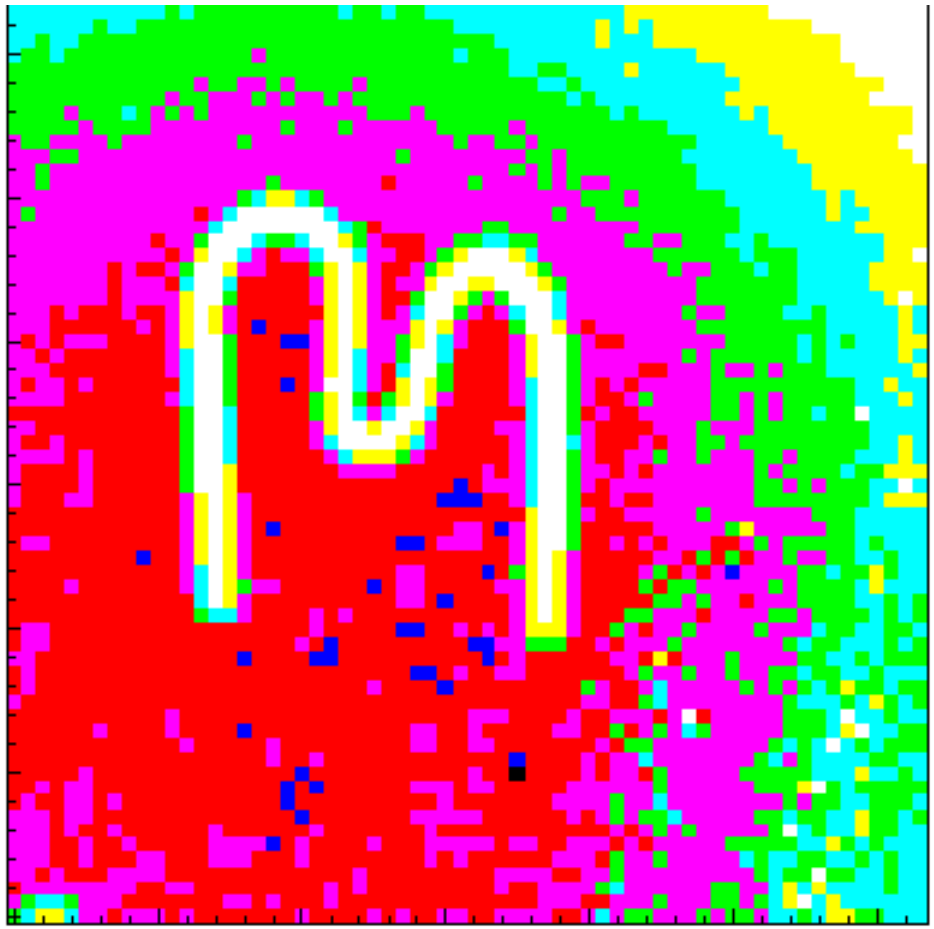
RELAXD



Conclusions:

- Integration of Medipix into diffraction systems is finished
- Testing phase nearly completed
- Medipix2 will give us:
  - Very stable and reliable detector
  - High dynamic range
  - Small pitch
- Will be commercially available soon

Thanks: