



Characterization of Polycrystalline CVD Diamond Detectors with the Munich Heavy Ion Microscope SNAKE

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August 31, 2006

3rd NoRHDia Workshop at GSI

Outline

- ◆ Motivation
- ◆ SNAKE
- ◆ Data
- ◆ Summary

Motivation

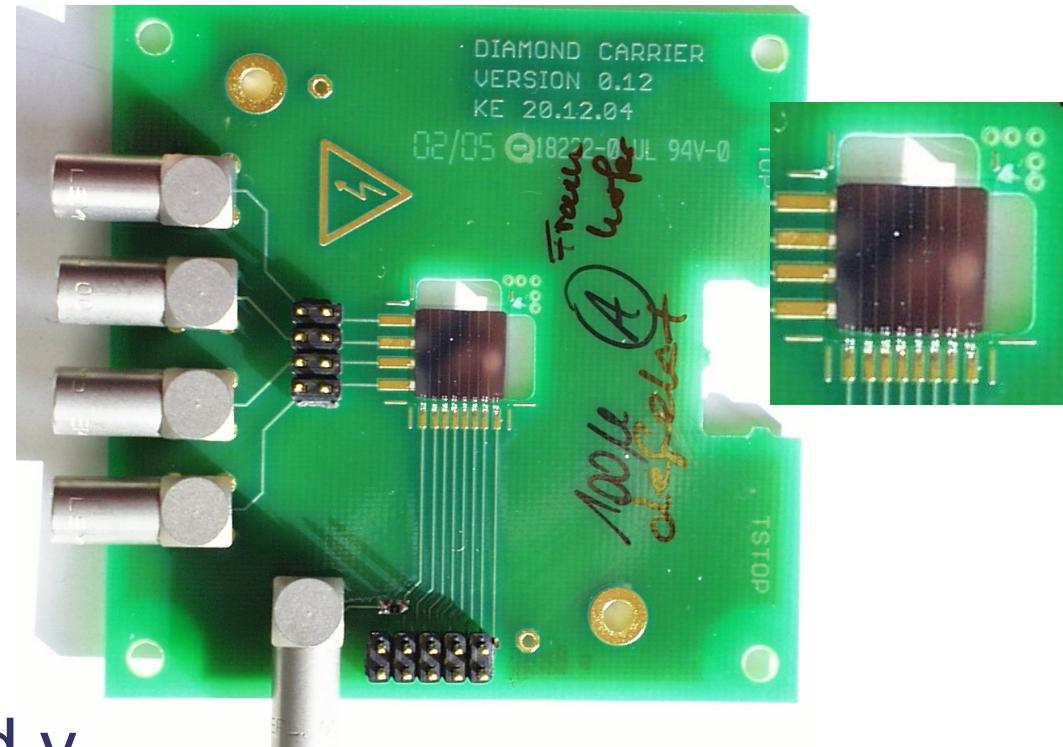
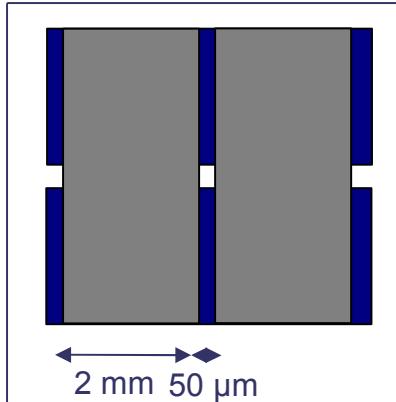
Heavy ion tracking detectors for single particle detection

- ◆ large area ($50 \times 50 \text{ mm}^2$) → polycrystalline CVDD
- ◆ high position resolution → segmentation $\sim 140 \mu\text{m}$
- ◆ high efficiency → edge effects
- ◆ thin material $d < 100 \mu\text{m}$

Suppliers:

- ◆ Elementsix
- ◆ Fraunhofer IAF Freiburg

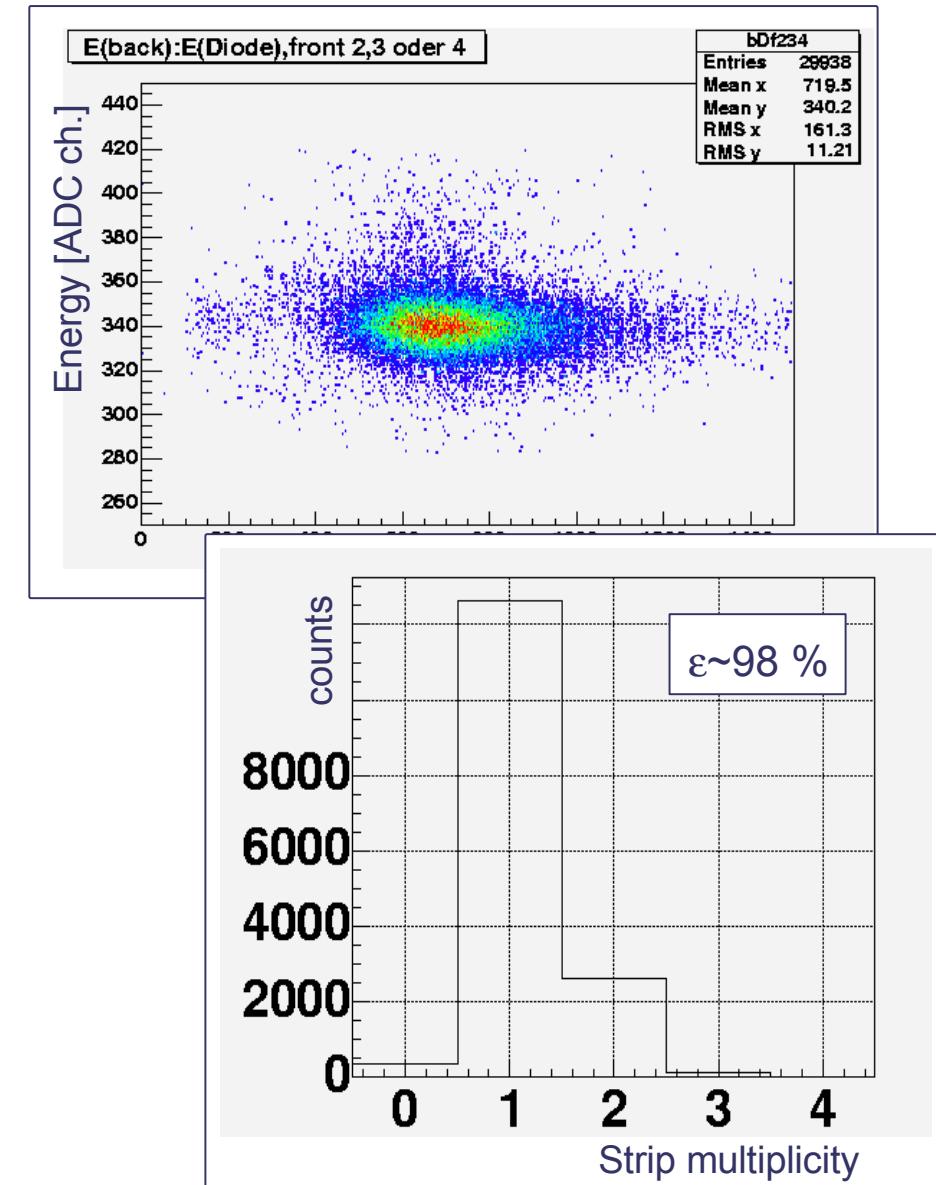
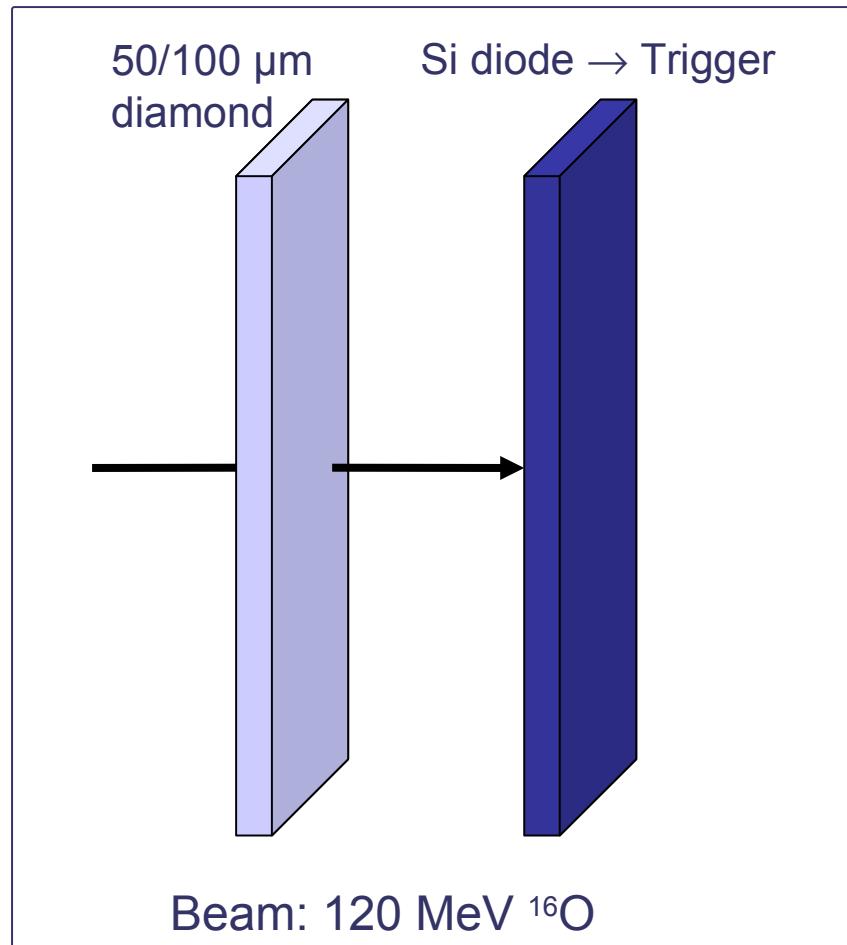
Detector



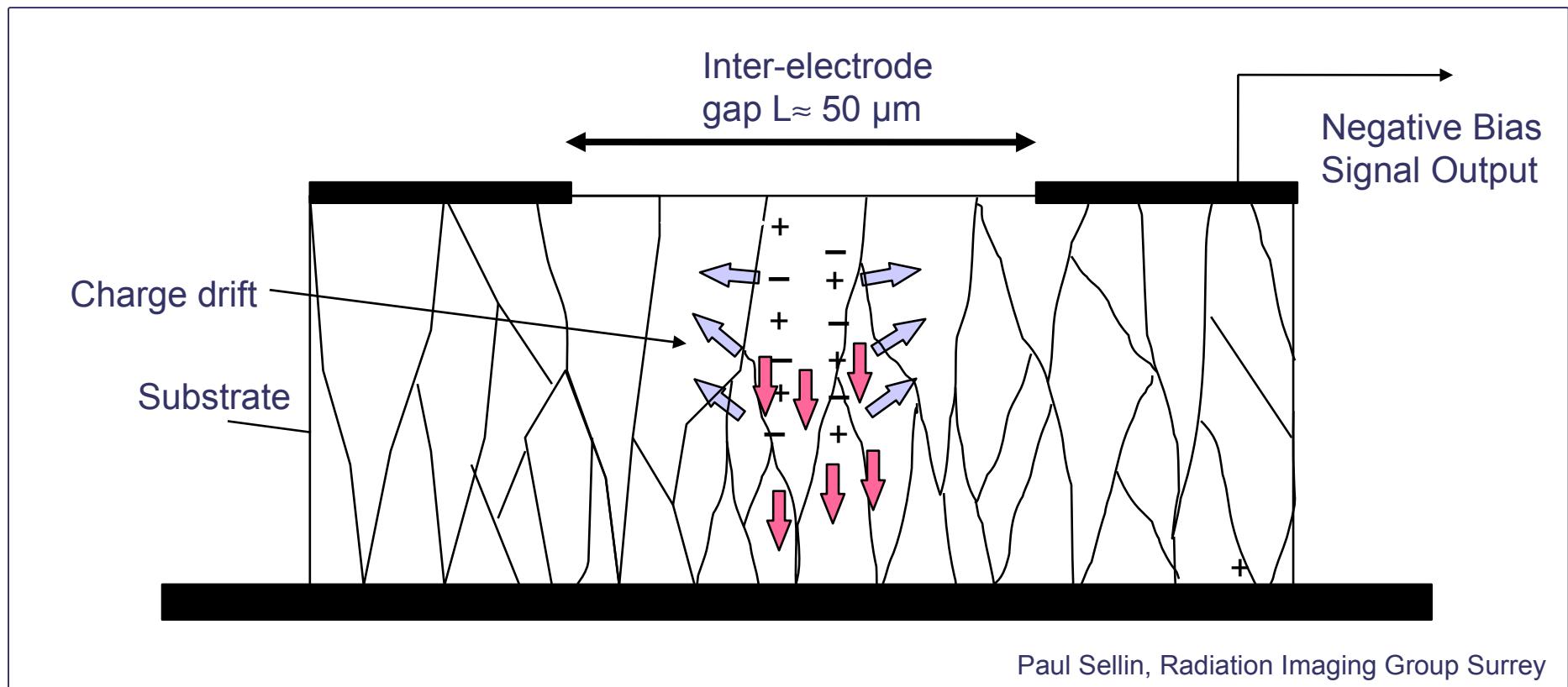
Diamond substrate

- ◆ 10x10 mm²
- ◆ metallization: pure Al
- ◆ segmentation in x and y
 - rough pitch: shadowing technique, 50 μm wire grid
 - fine pitch: lithography, 64 strips per 8 mm
- ◆ mounted on universal board
- ◆ charge integrating readout for every channel

Efficiency



Local CCE



→ grain size

Test procedure

- Test of different diamond substrate materials:
- E6: 120 µm as grown
 - IAF: 50 µm polished

Grain size is dependent on

- ◆ thickness
- ◆ manufacturer
- ◆ production techniques and parameters

→ High resolution scan of strip interface with
SNAKE

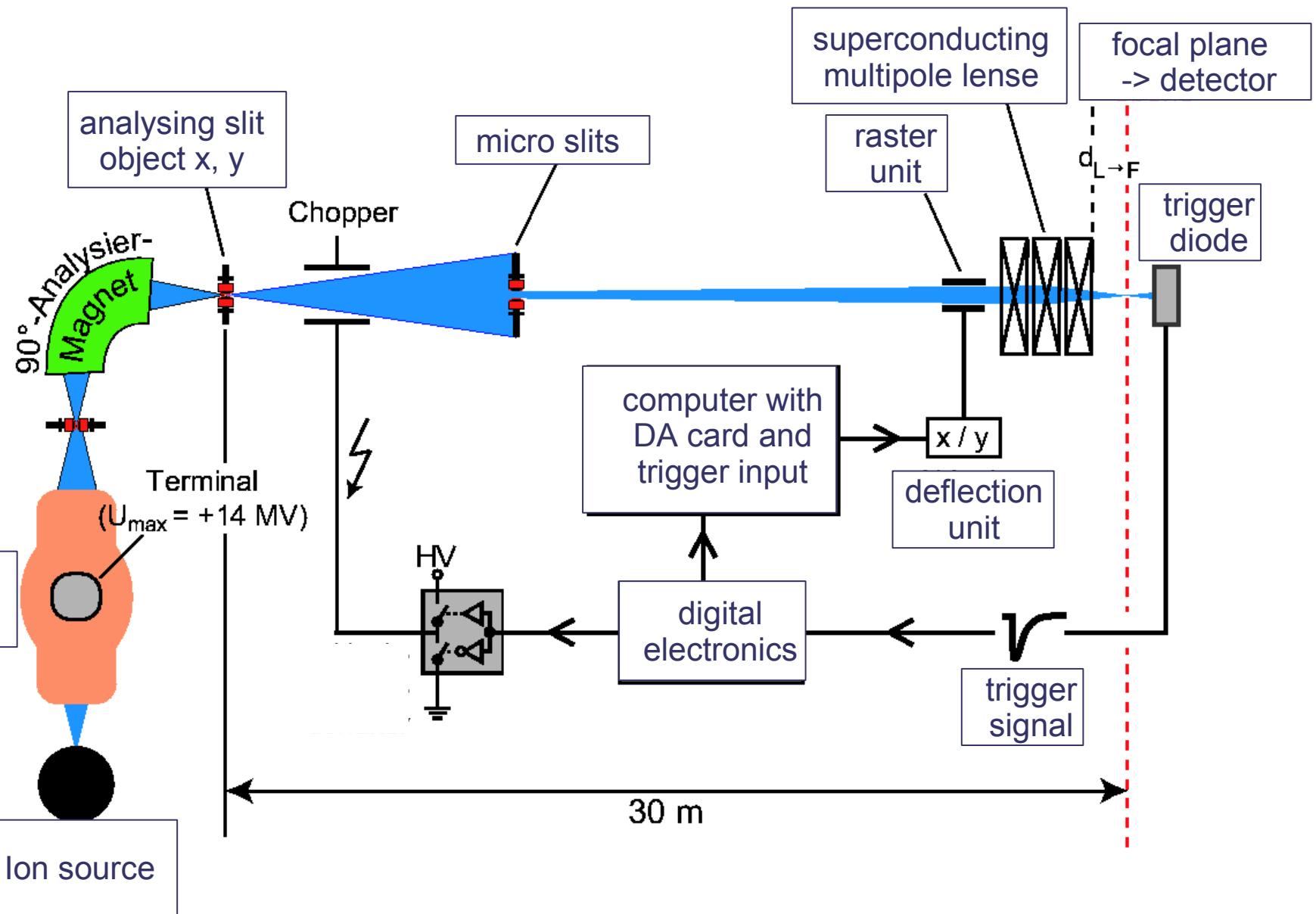


SNAKE

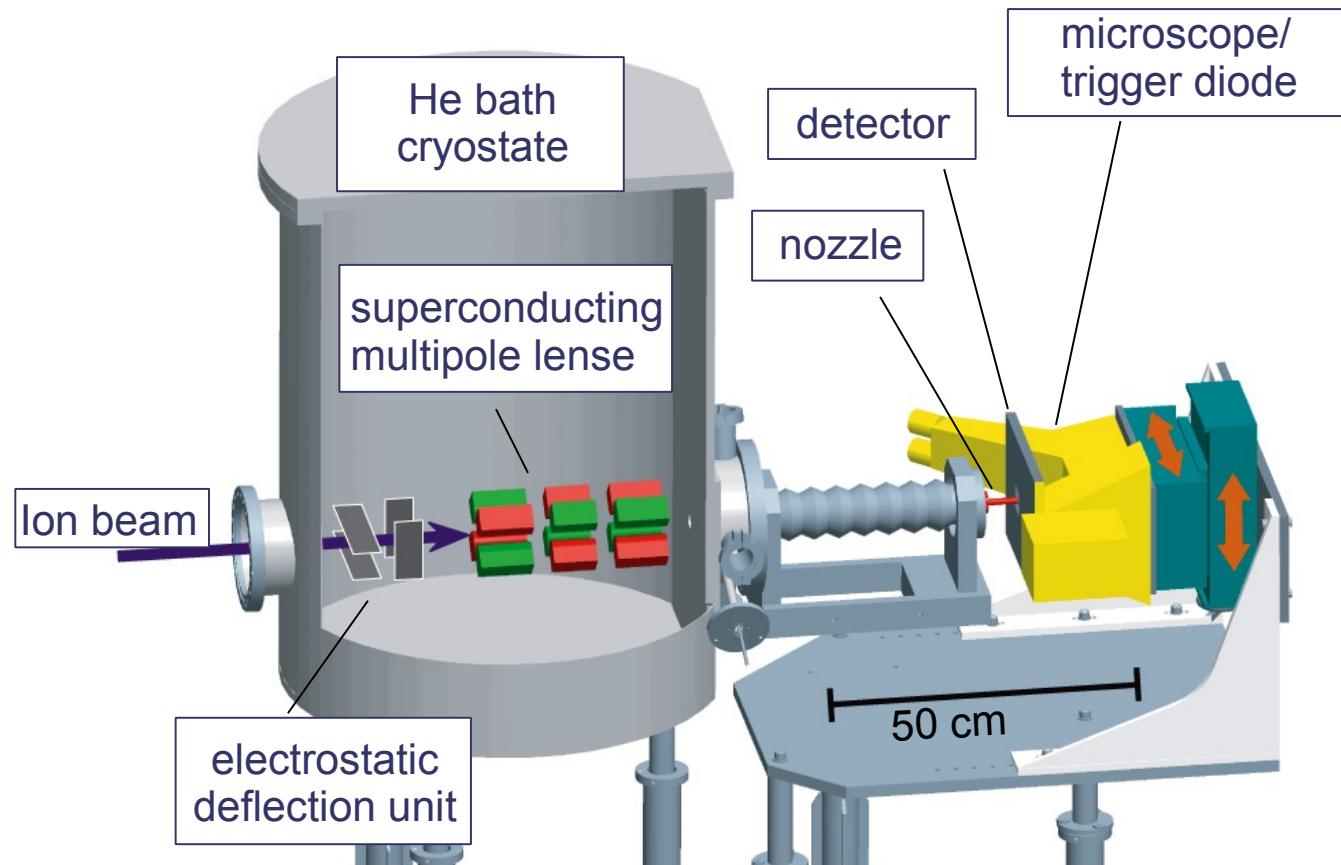
**SNAKE - Superconducting Nanoscope for
Applied nuclear physics (Kernphysikalische)
Experiments**

- ◆ Ion beam with a diameter of about 1 μm
 - 48 MeV Li
- ◆ Scanning point by point
 - 60 x 120 points
 - 128 particles per point
- ◆ Increments
 - rough scan: 10 μm in x-, 5 μm in y-direction
 - fine scan: 3 μm in x-, 2 μm in y-direction
- ◆ Triggersignal from a Si diode

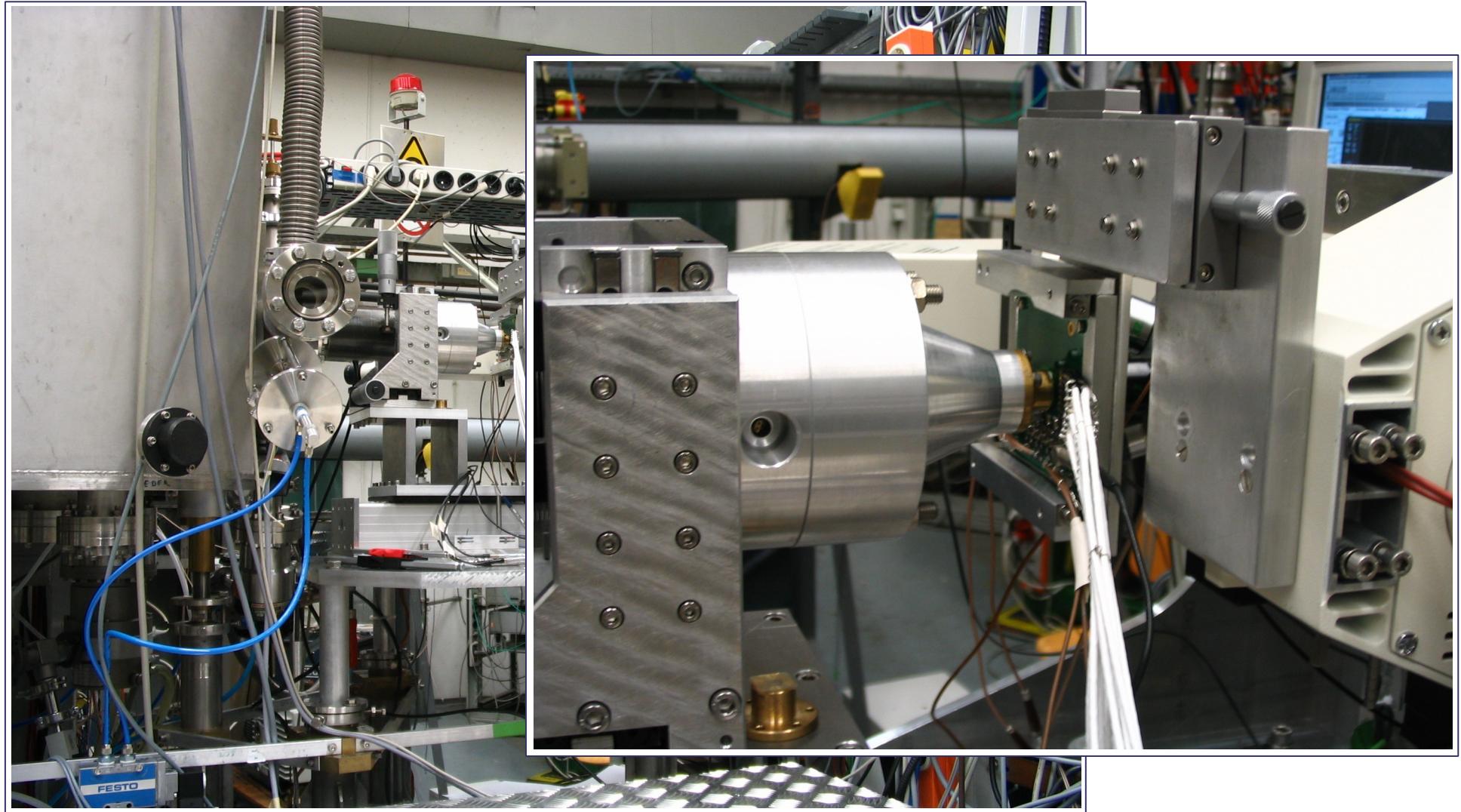
SNAKE - Beam alignment



SNAKE

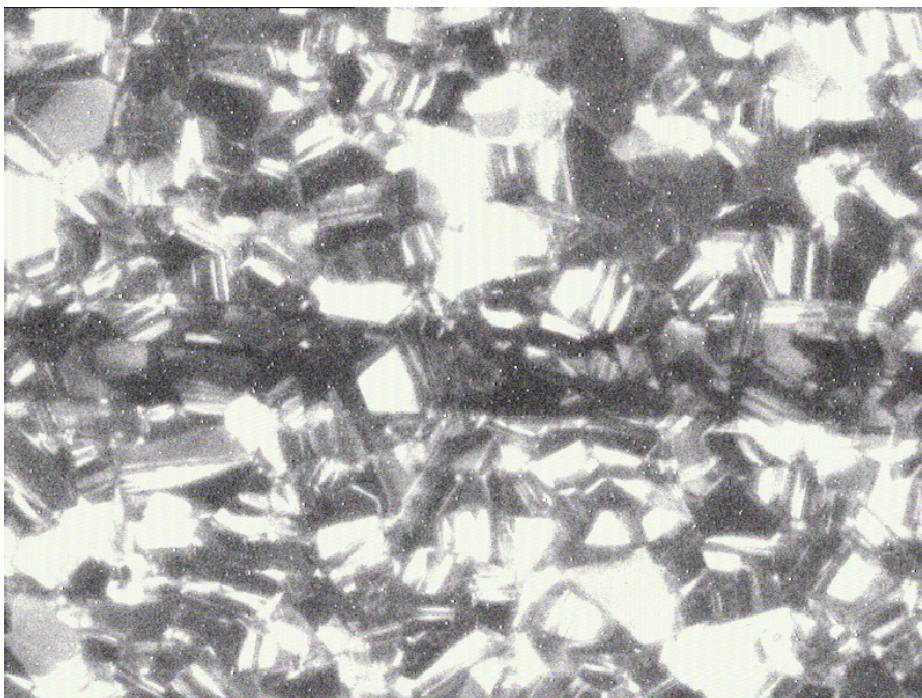


SNAKE



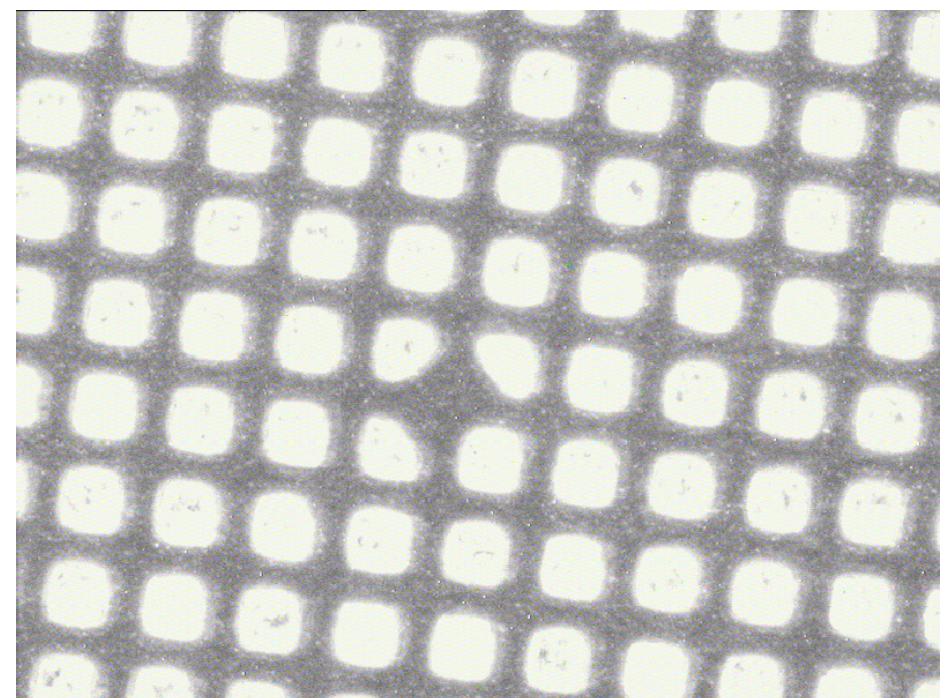
Resolution and calibration

Diamond substrate as grown



↔
50 µm

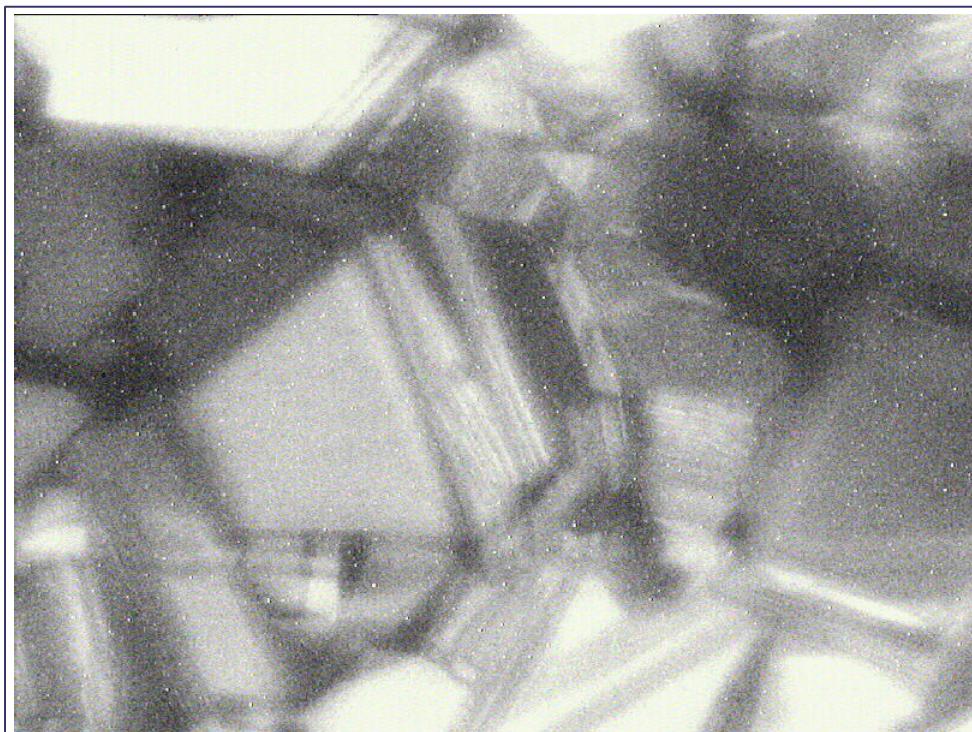
Metal grid



↔
50 µm

Resolution and calibration

Diamond substrate as grown



50 µm

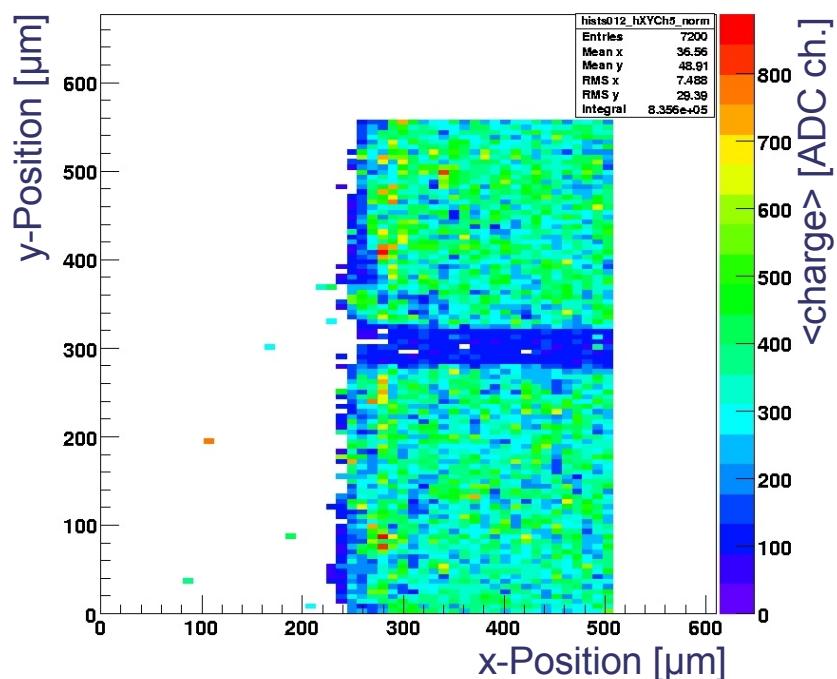
Metal grid



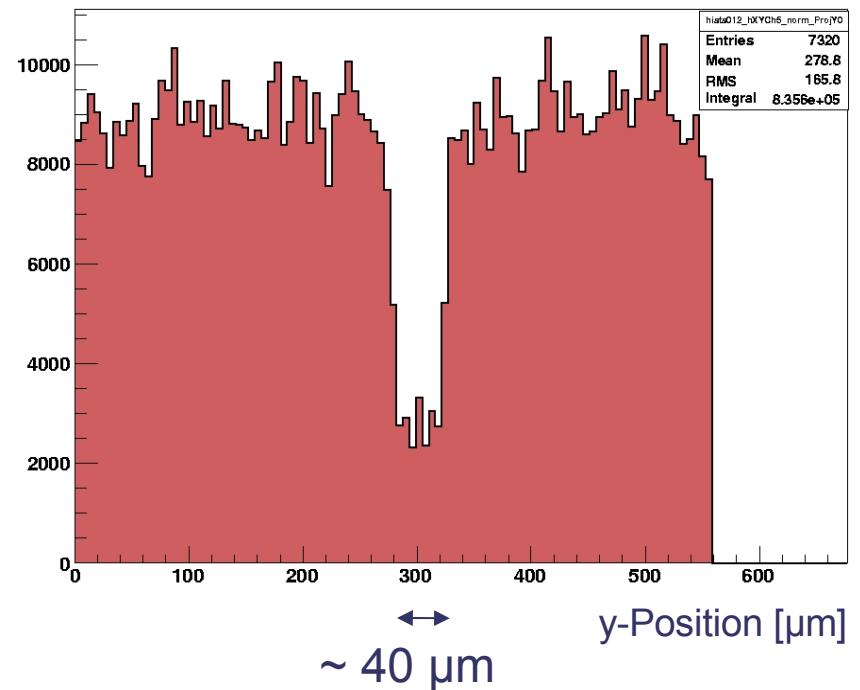
50 µm

Signal map

rough scan: $505 \times 560 \mu\text{m}^2$
 4x4 2mm strips

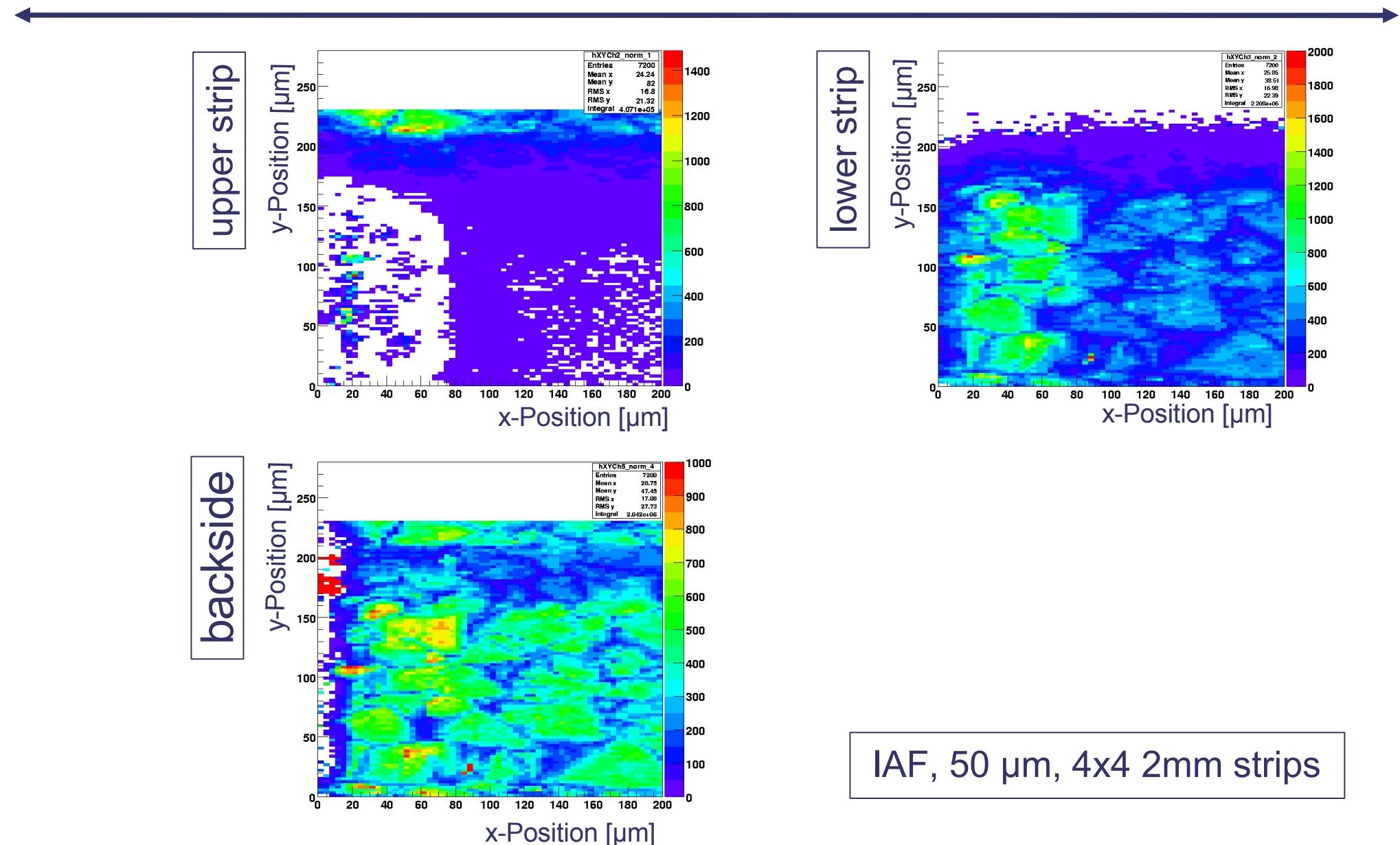


y-Projection

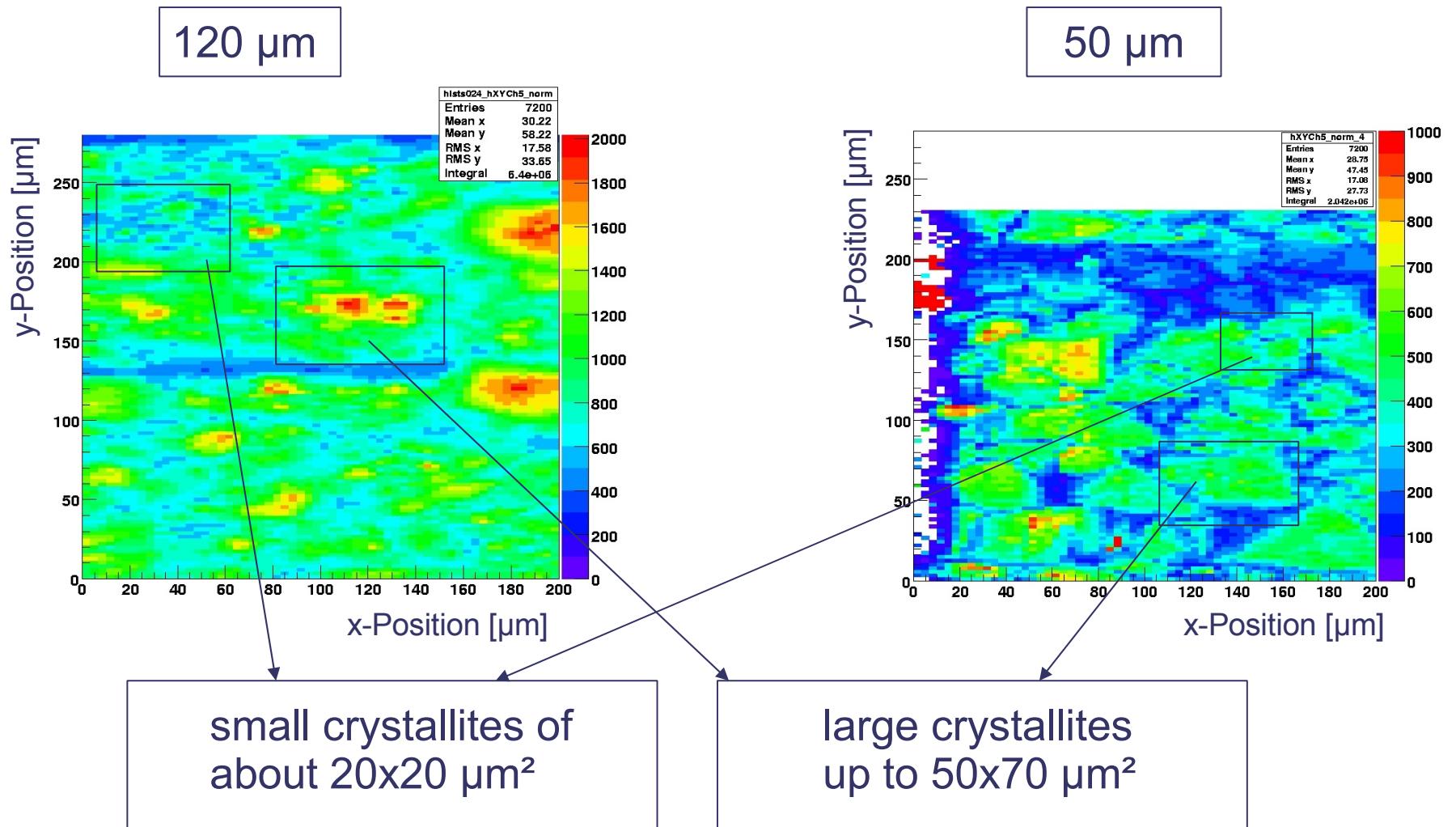


IAF, 50 μm

Fine scan



Crystallite size (fine scan)



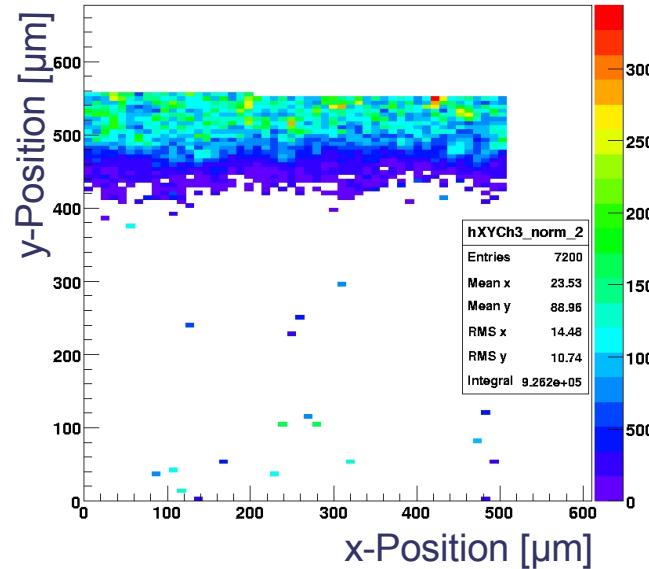
→ no significant difference

High resolution detector

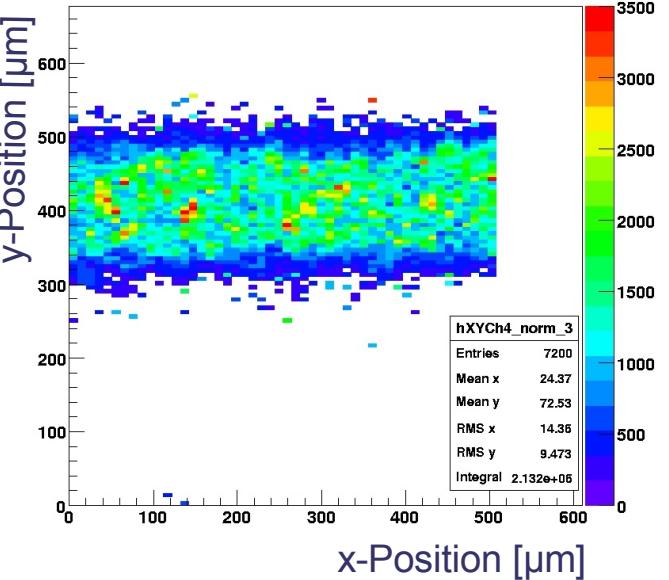


Overview scan

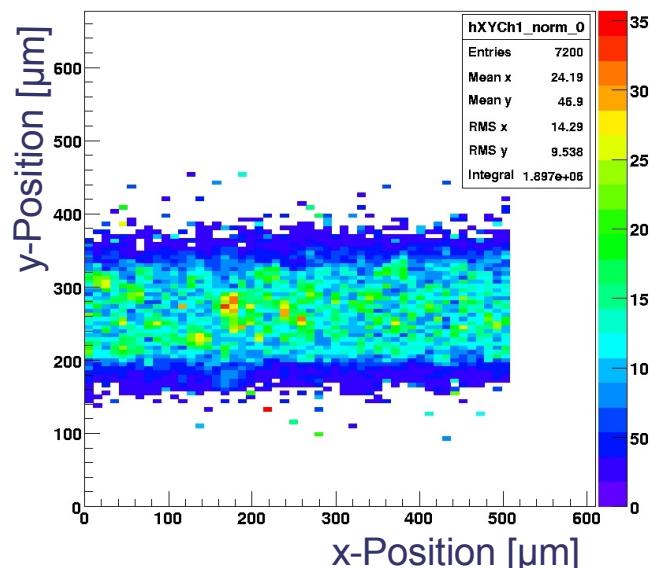
strip 1



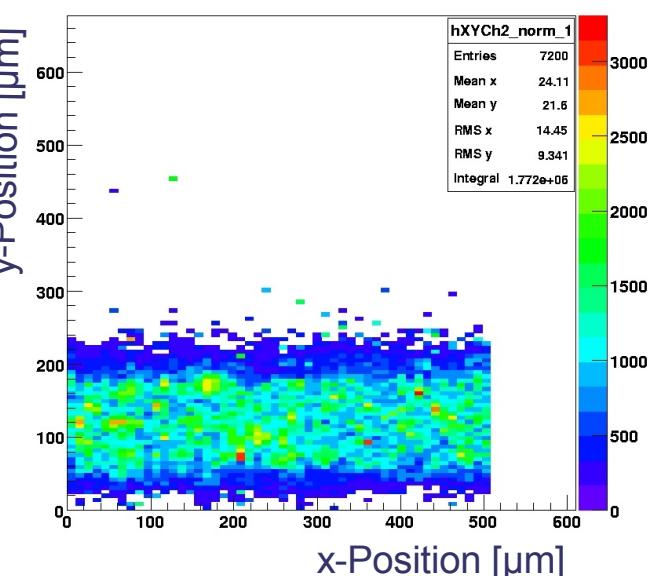
strip 2



strip 3



strip 4



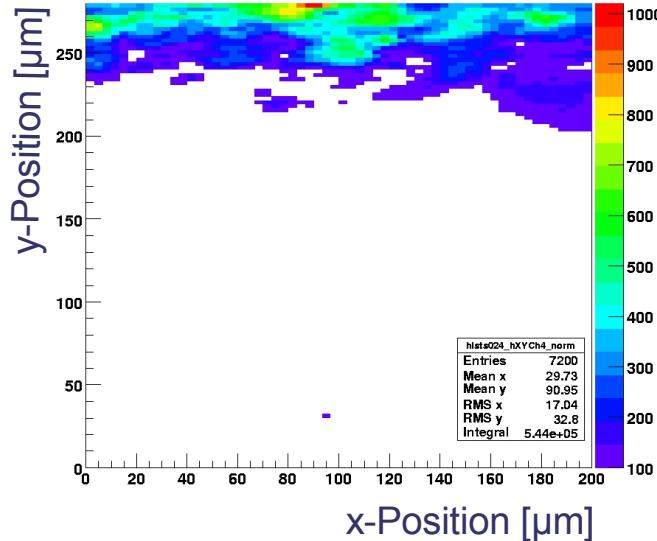
E6, 120 μm,
64x4 strips

High resolution detector

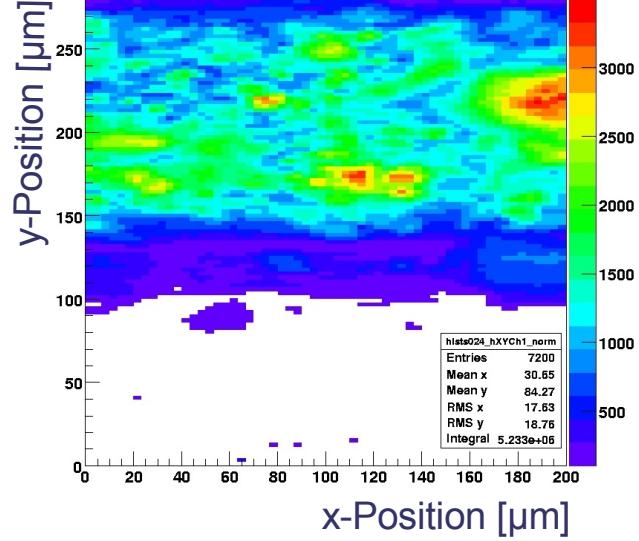


Fine Scan

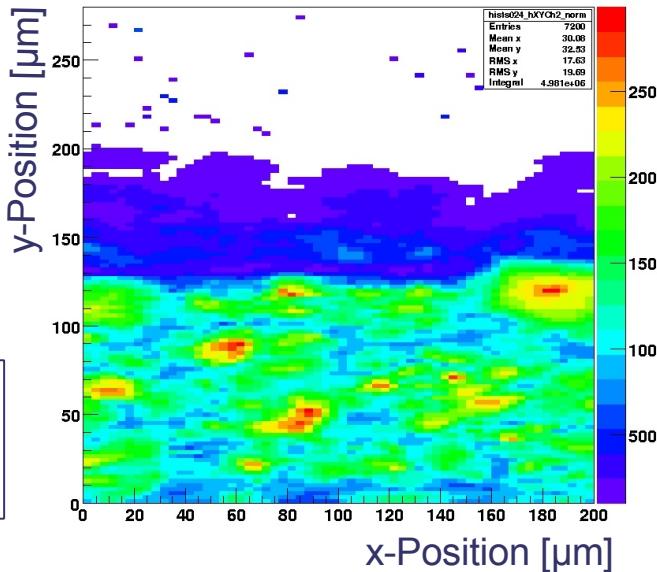
strip 1



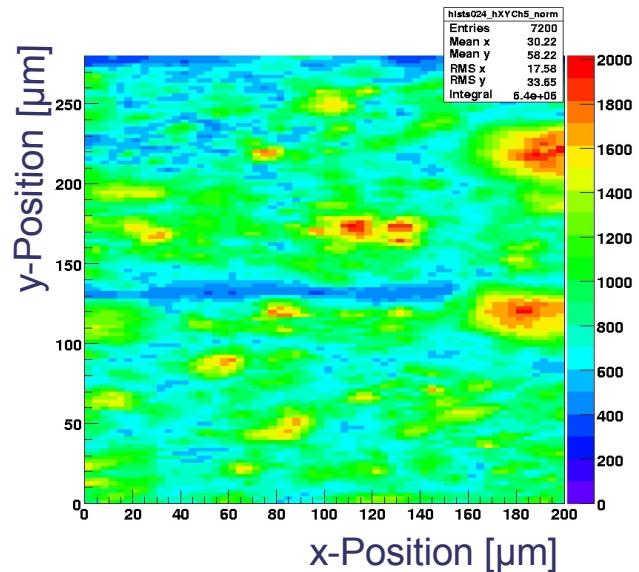
strip 2



strip 3



backside

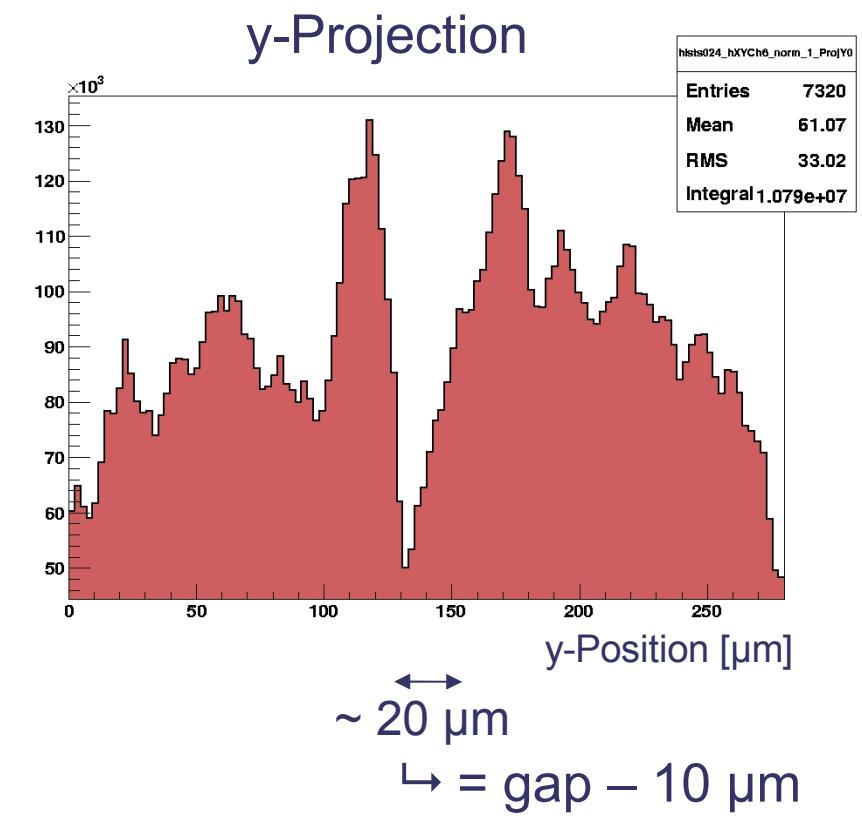
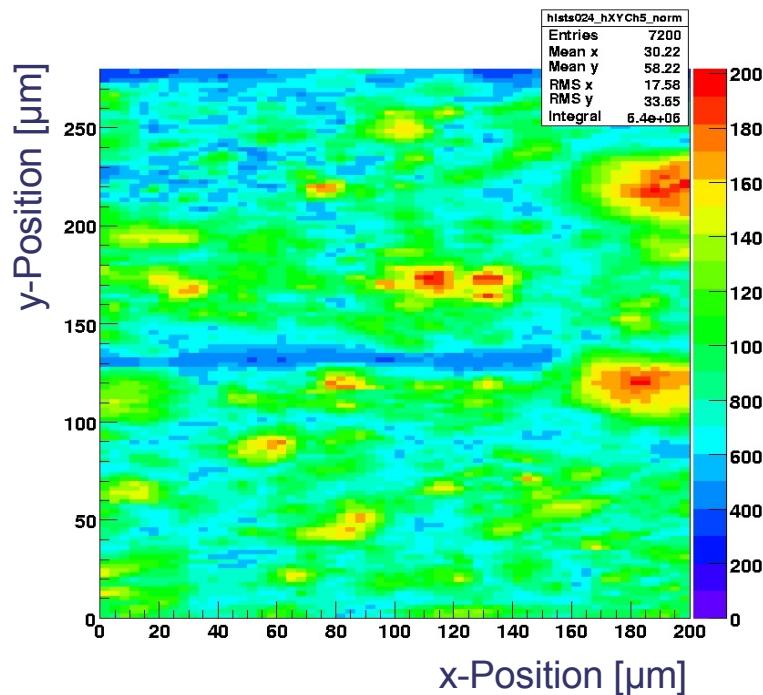


E6, 120 μm,
64x4 strips

Signal map



fine scan: $200 \times 280 \mu\text{m}^2$
 64x4 $110 \mu\text{m} \times 2 \text{ mm}$ strips



E6, 120 μm

Summary

- ◆ The crystalline structure can be seen in CCE.
- ◆ The crystallites are of similar size for both thicknesses but different production techniques.
- ◆ The inefficiency between the strips is
 - about 10 to 20 μm for 30 μm gap
 - about 40 μm for 50 μm gap

The substrates from Elementsix and Fraunhofer Institute are comparable in the measured features.