Very preliminary
H4 Beam-test Summary

August 8 – 27, 2008

for the RD22 collaboration
Satomi Shiraishi

Many many thanks!!

To everyone in RD22

Especially to…

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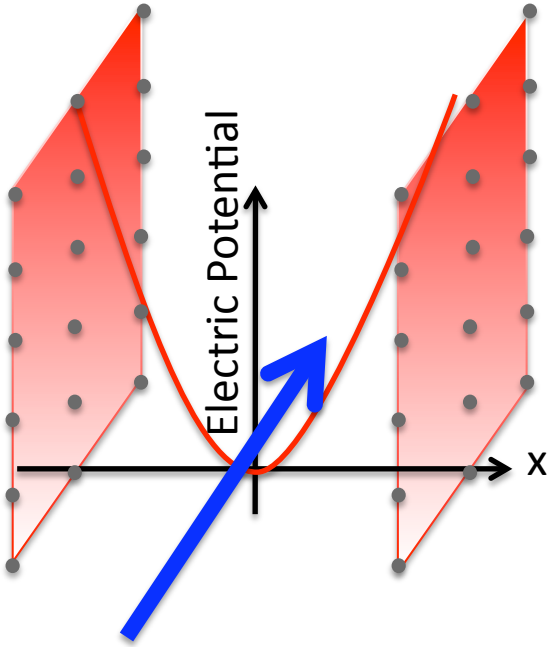
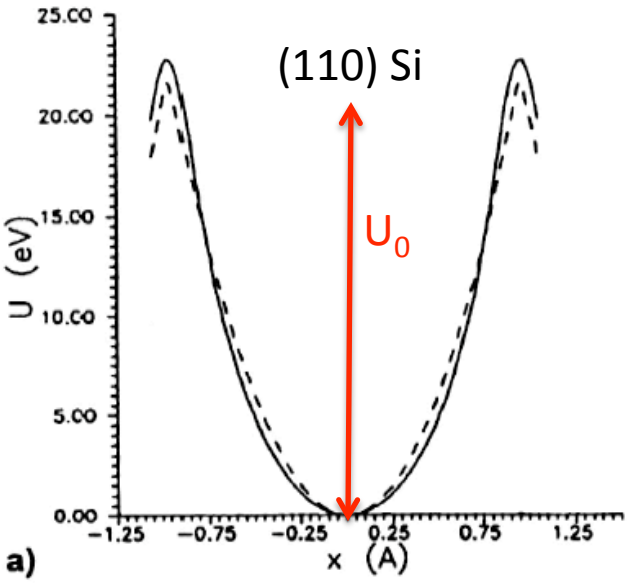
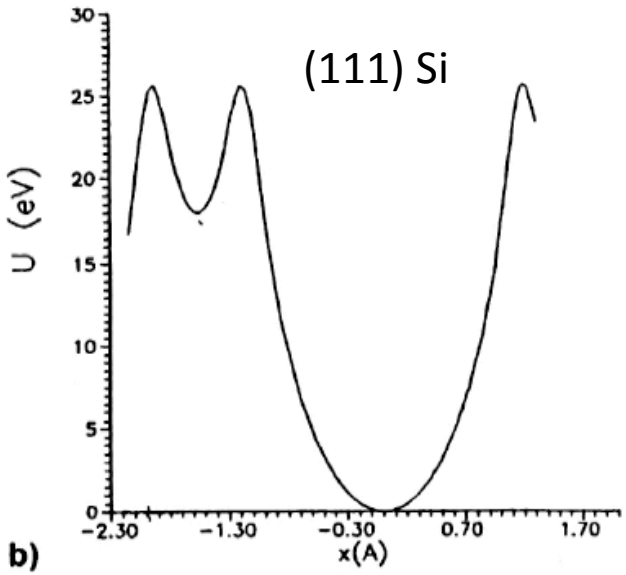
and Enrico Bagli
for the valuable discussions and teachings

Planar Channeling







distance b/w the atomic planes

Deflection angle is the bending angle of the crystal

Channeling acceptance angle: $\theta_c = \sqrt{\frac{2U_0}{pv}}$

Potential well depth

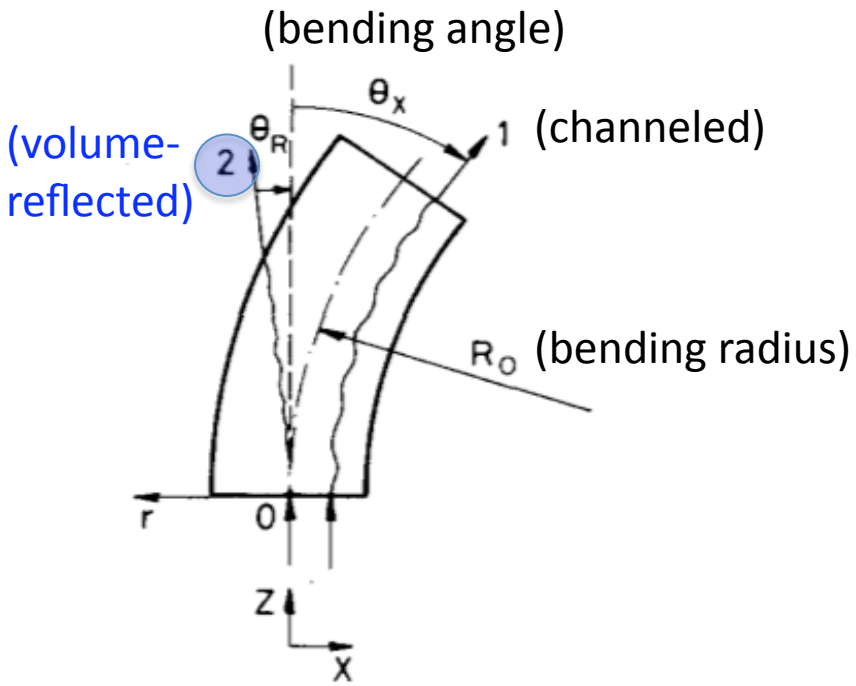
Particle energy

Using (110) Si:

θ_c ~ 18μrad (100 GeV)

θ_c ~ 6μrad (1 TeV)

Volume Reflection

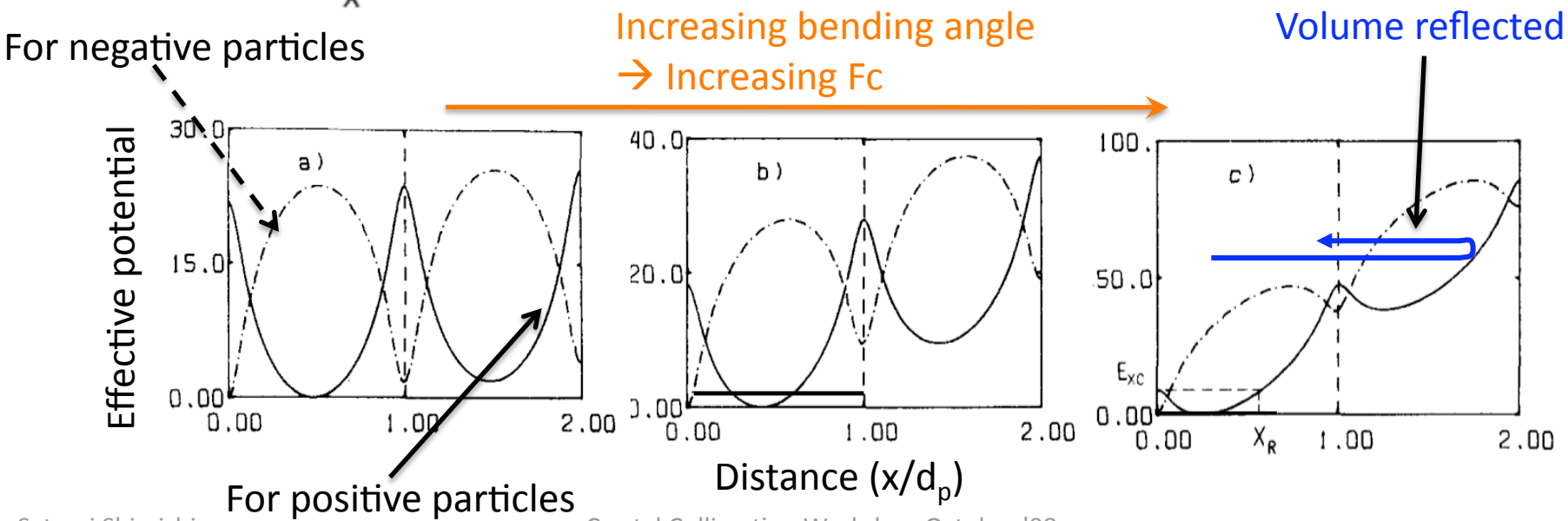


Predicted by A. Taratin & S.A. Vorobiev in 1987

A particle "feels" a centrifugal force when influenced by electric field:

$$F_c \propto 1/R_0$$

$$U_{eff} = U(r) - F_c r$$



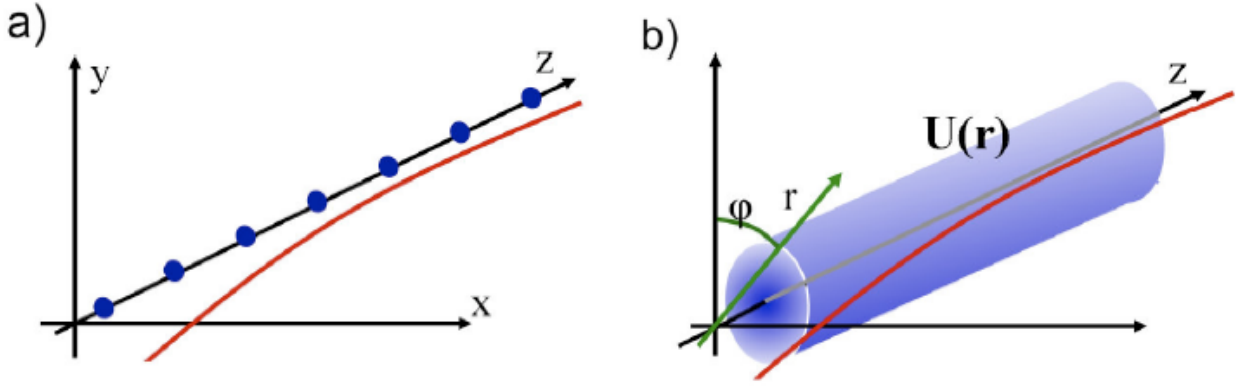
Axial Channeling

Particle moving at small angle with respect to crystal atomic strings

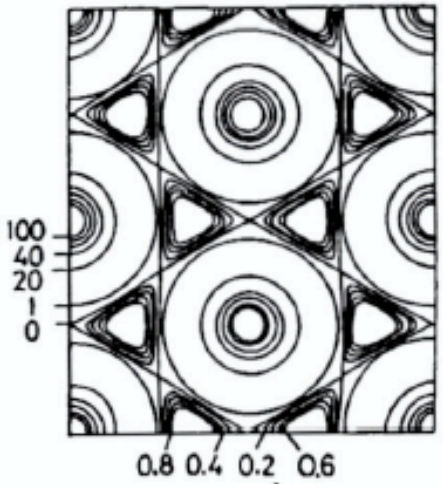
Using (110) Si:

θ_c ~ 48μrad (100 GeV)

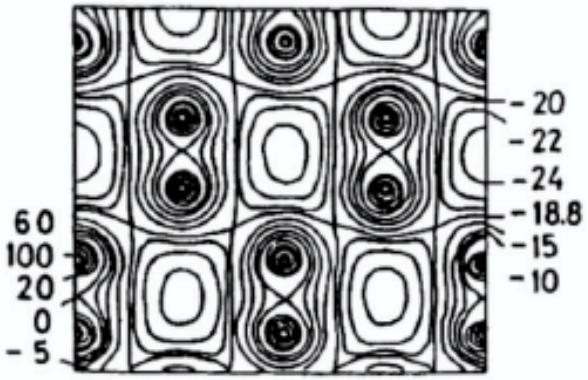
θ_c ~ 15μrad (1 TeV)



Critical angle for axial channeling is greater than that for the planar channeling, but particles are more likely to scatter.
So the axial channeling is still challenging to achieve.



(111) Si

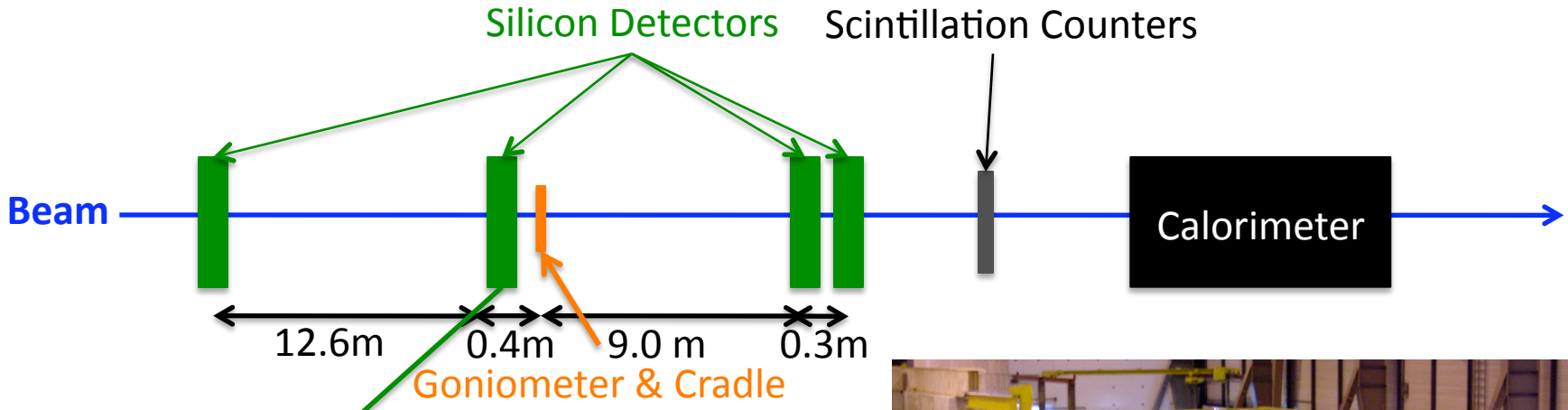


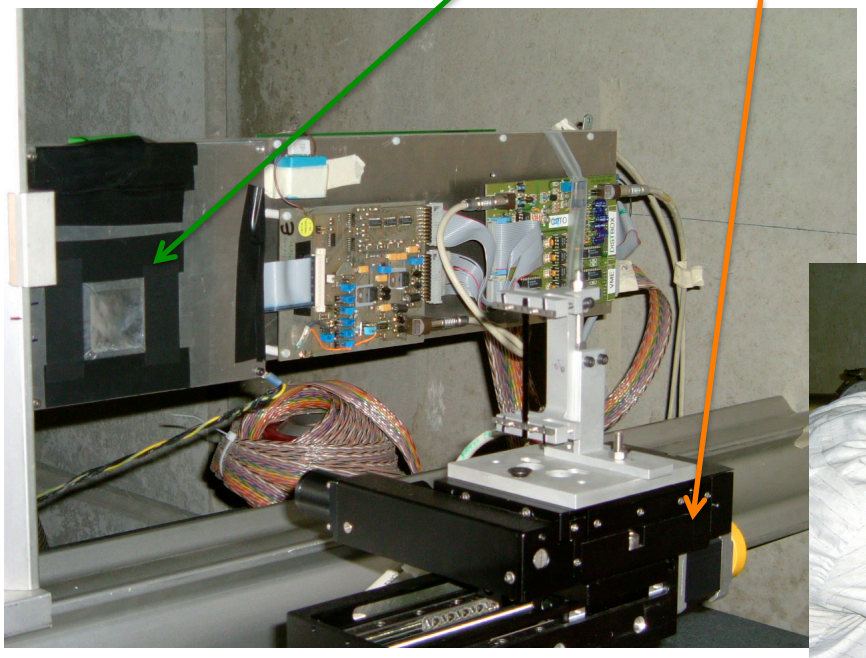
(110) Si

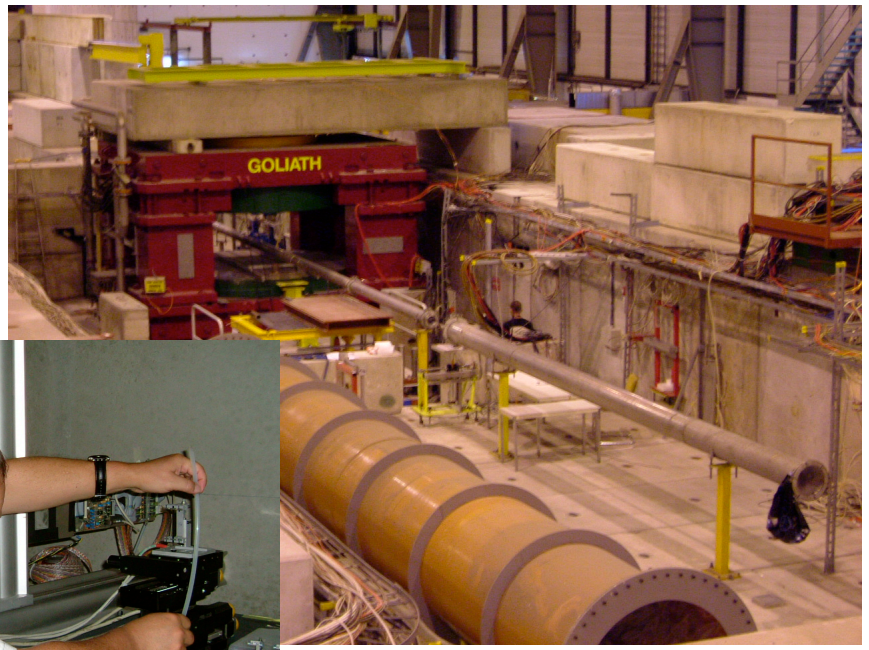
(100) Si

H4 Beam test set-up @ CERN

Experimental set-up by Como group





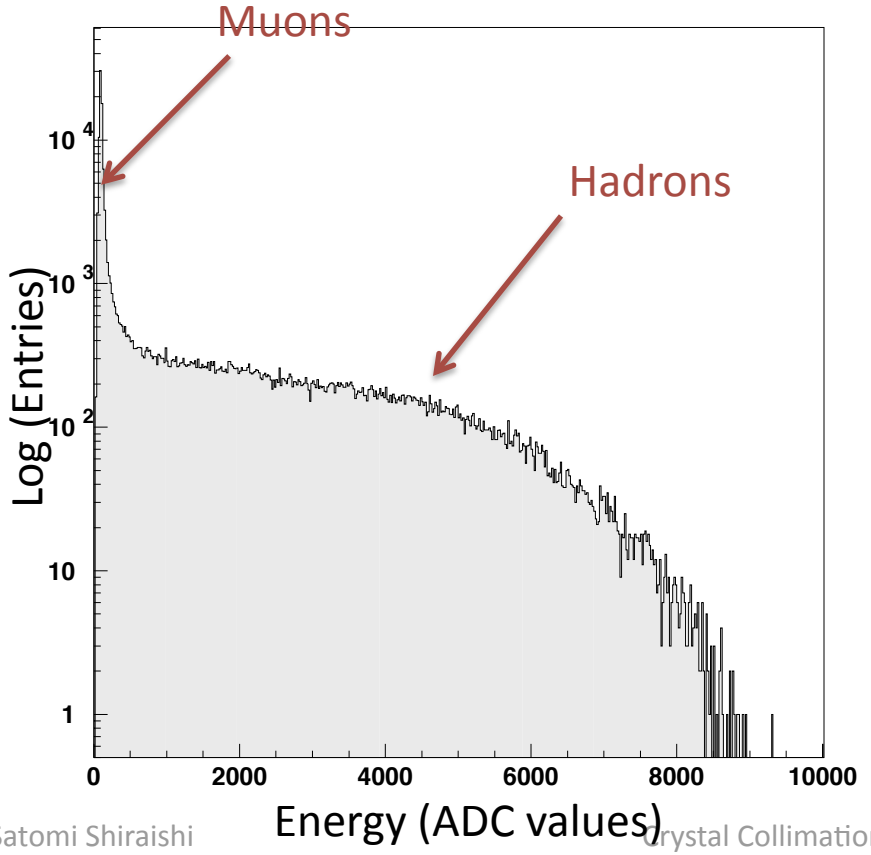


H4 Beam Characteristics

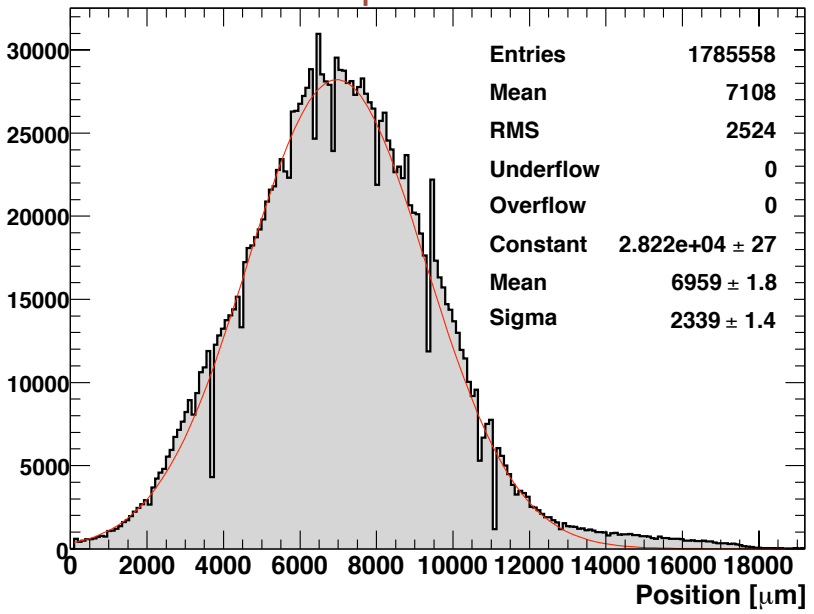
- Roughly 50% μ^- , 50% hadrons (π^-, κ^-)
- 18K events / spill (1 spill / 48 sec)
- Divergence:

  32urad in X and 29urad in Y

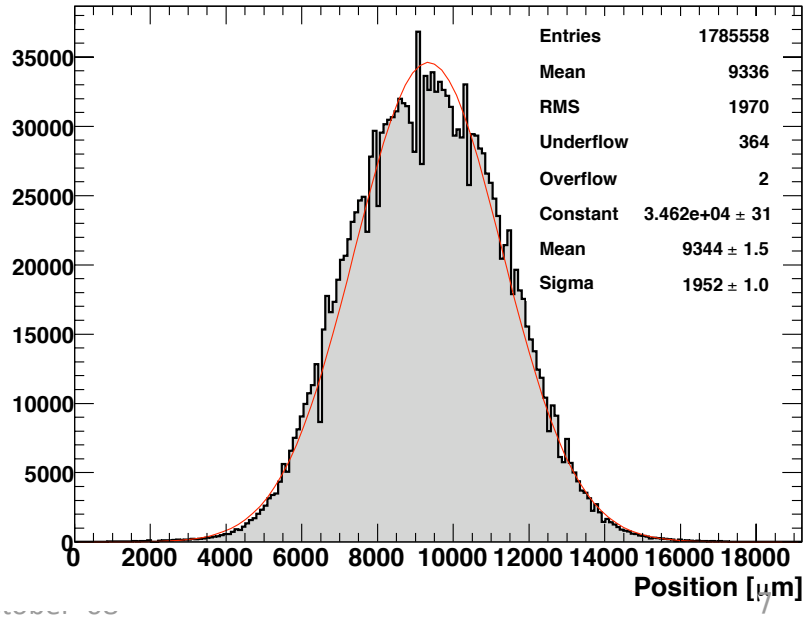
Beam energy ~ 150 GeV



Horizontal beam profile σ ~ 2 -2.5 mm



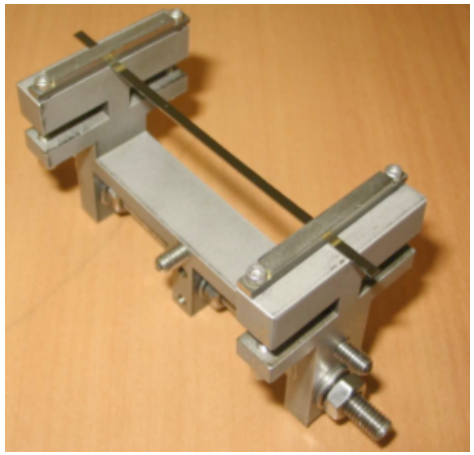
Vertical beam profile σ ~ 2 mm

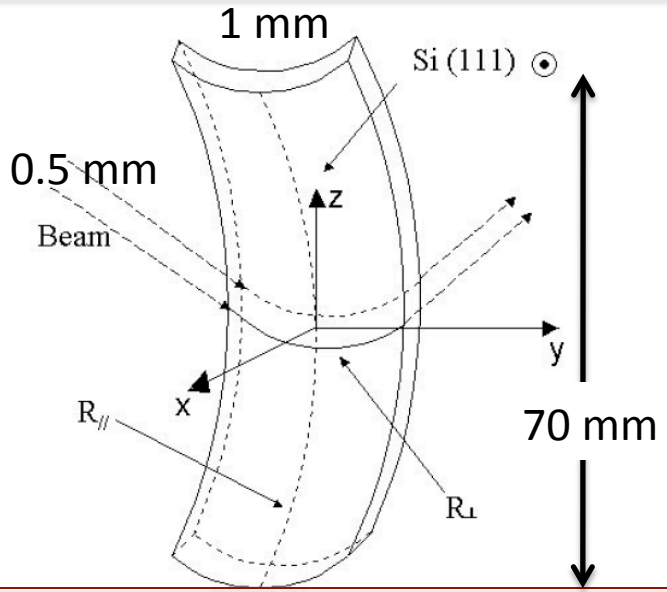


H4 Run Main Results with Negative Particles

- Channeling
  - Quasi-mosaic crystal QM2 (PNPI):
    - Diameter ~2mm, 0.9 mm along the beam
    - Bend angle ~ 60 urad
  - Strip crystal ST10 (INFN):
    - 0.5 x 1 x 70mm^3, 1 mm along the beam
    - Bend angle ~ 40 urad
- Volume reflection
  - Quasi-mosaic crystal QM2 & Strip crystal ST10
- Multiple volume reflection
  - 8-strip crystal (IHEP):
    - 0.9 x 2.2 x 50 mm^3, 2.2 mm along the beam
- Axial channeling
  - Strip crystal ST10

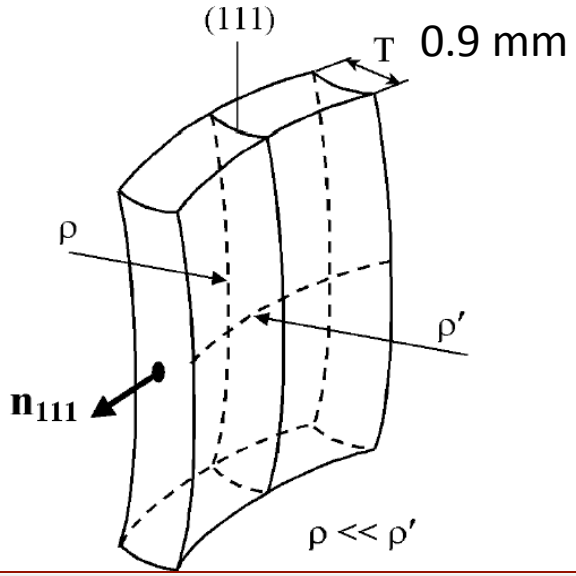
Crystals used in the Experiment





Strip Crystal

Bend angle ~ 40 μrad

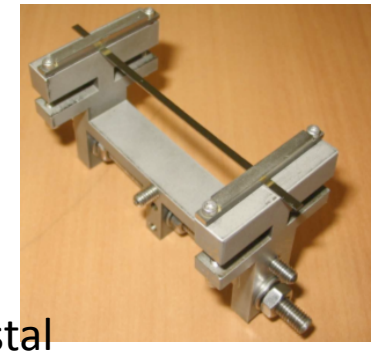


Quasi-Mosaic Crystal

Diameter ~ 2 mm

Bend angle ~ 60 μrad

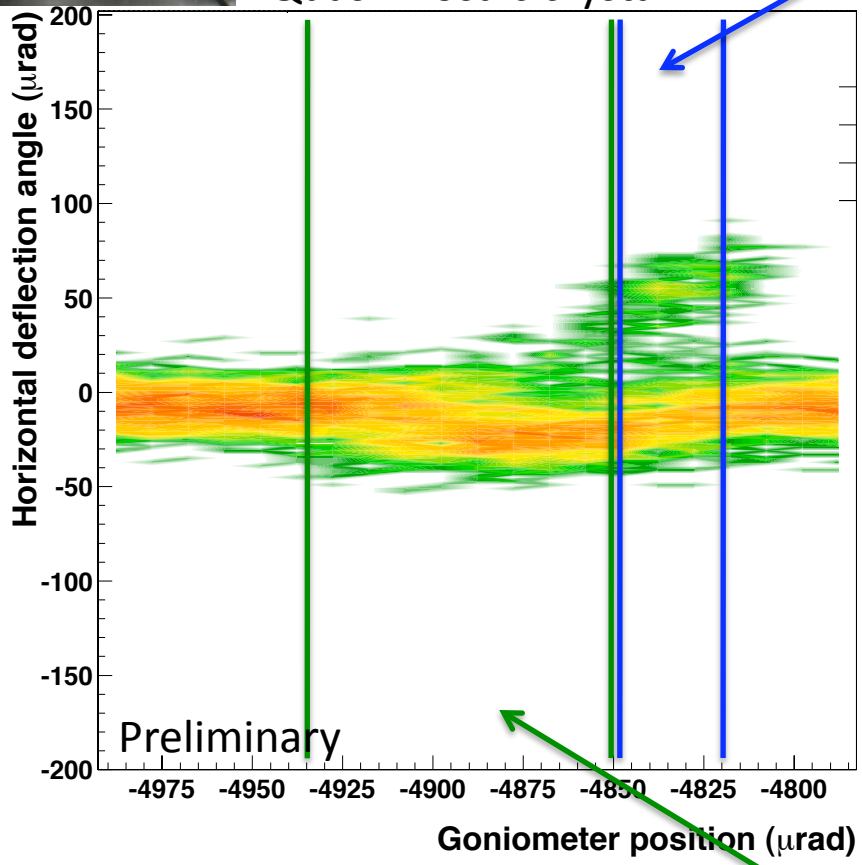
Searching for the optimal crystal position

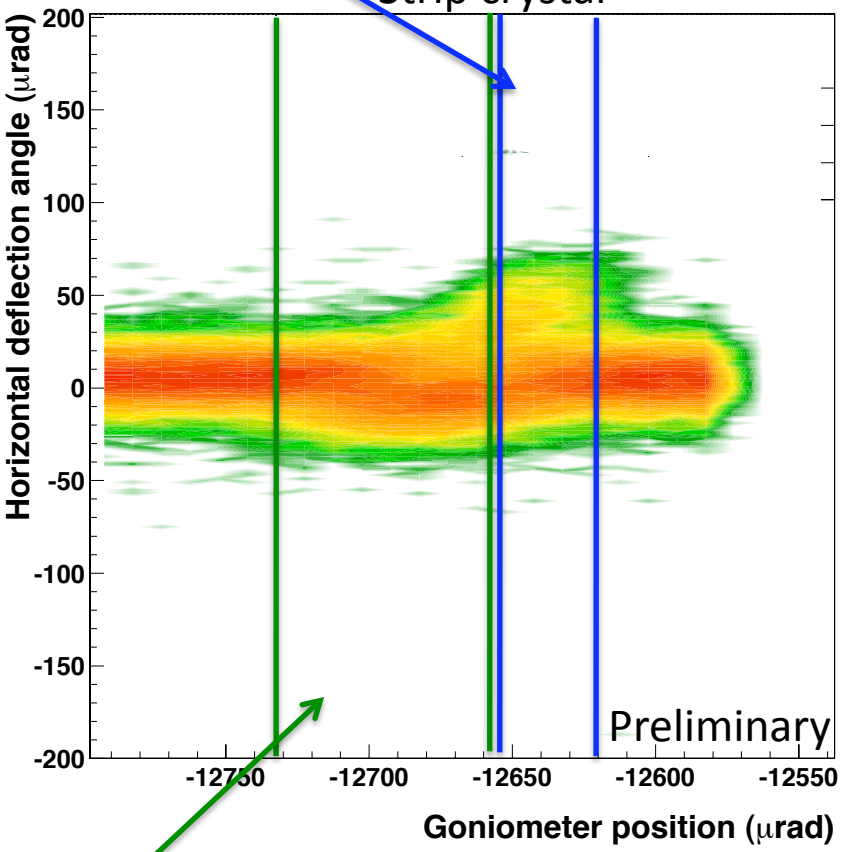


Channeling

Quasi-mosaic crystal

Strip crystal

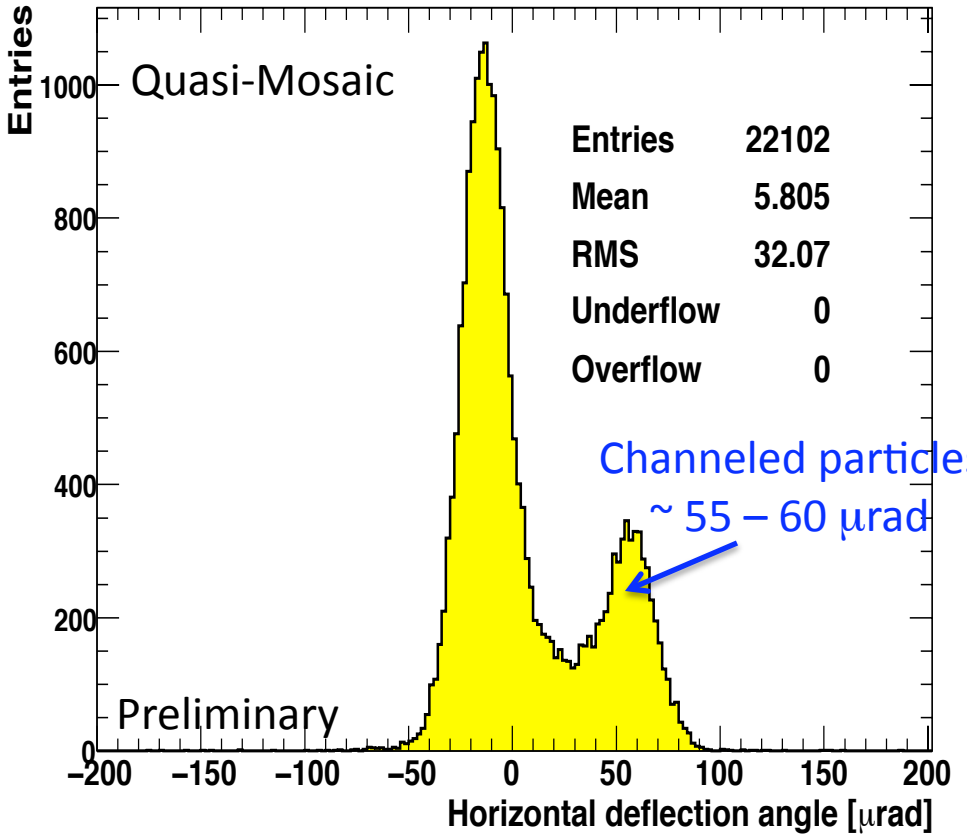


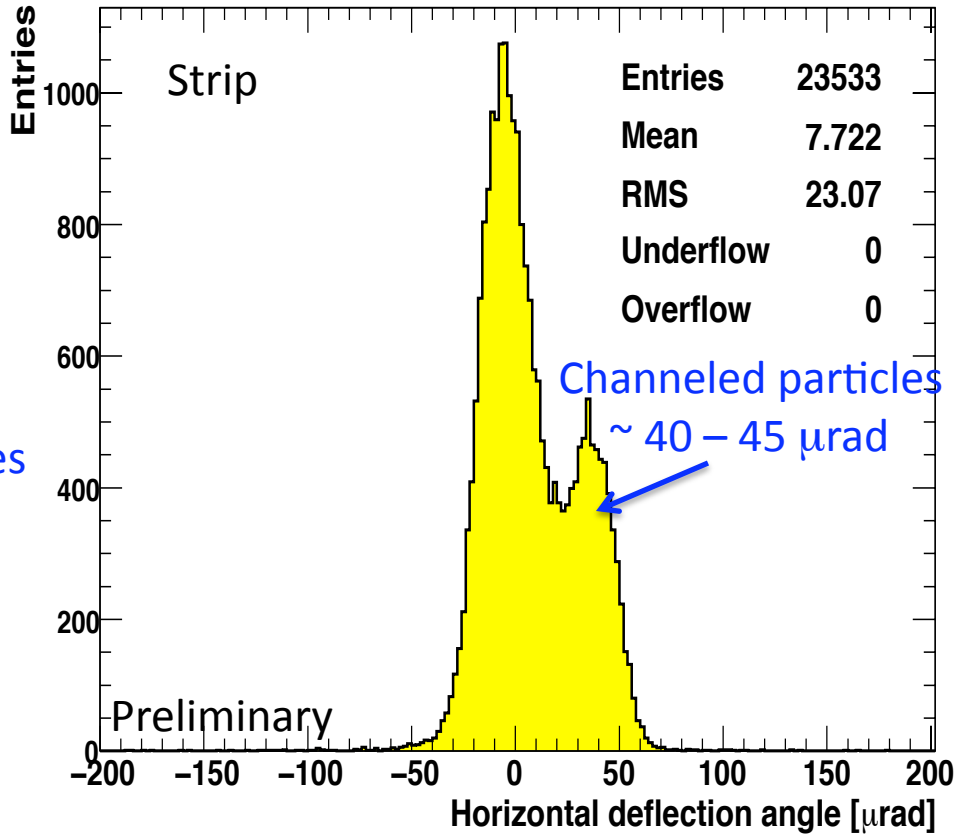


Volume reflection

Planar Channeling

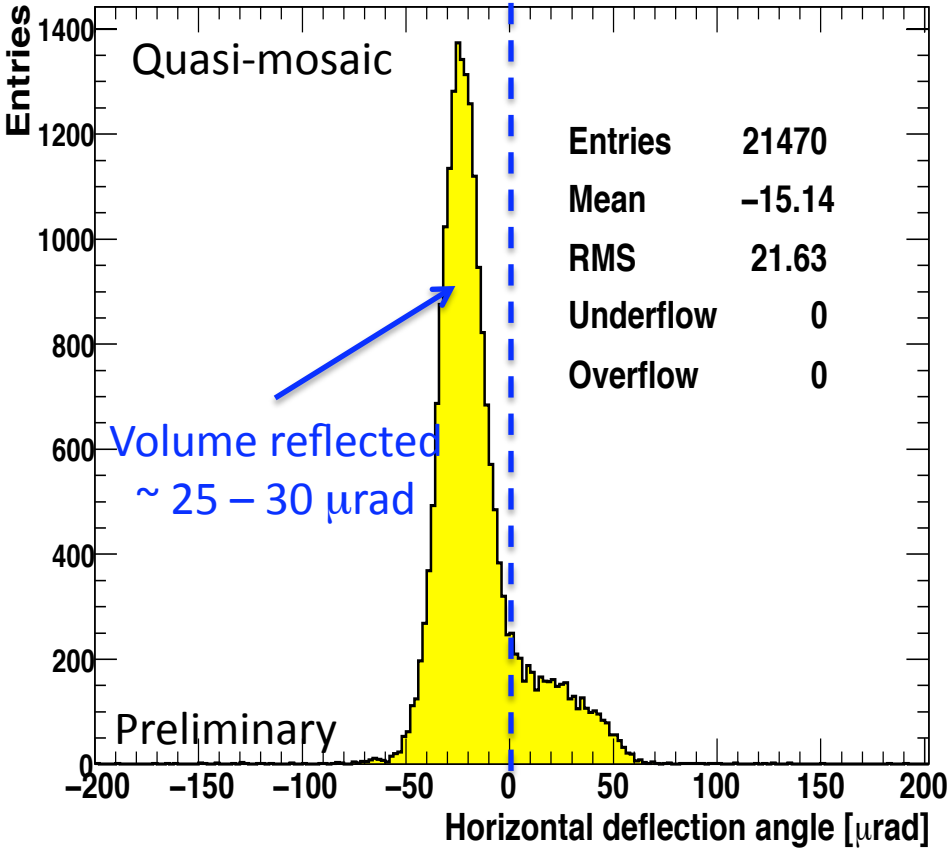
- Quasi-mosaic crystal using {111} plane (PNPI)
- Strip crystal using {110} plane (INFN)

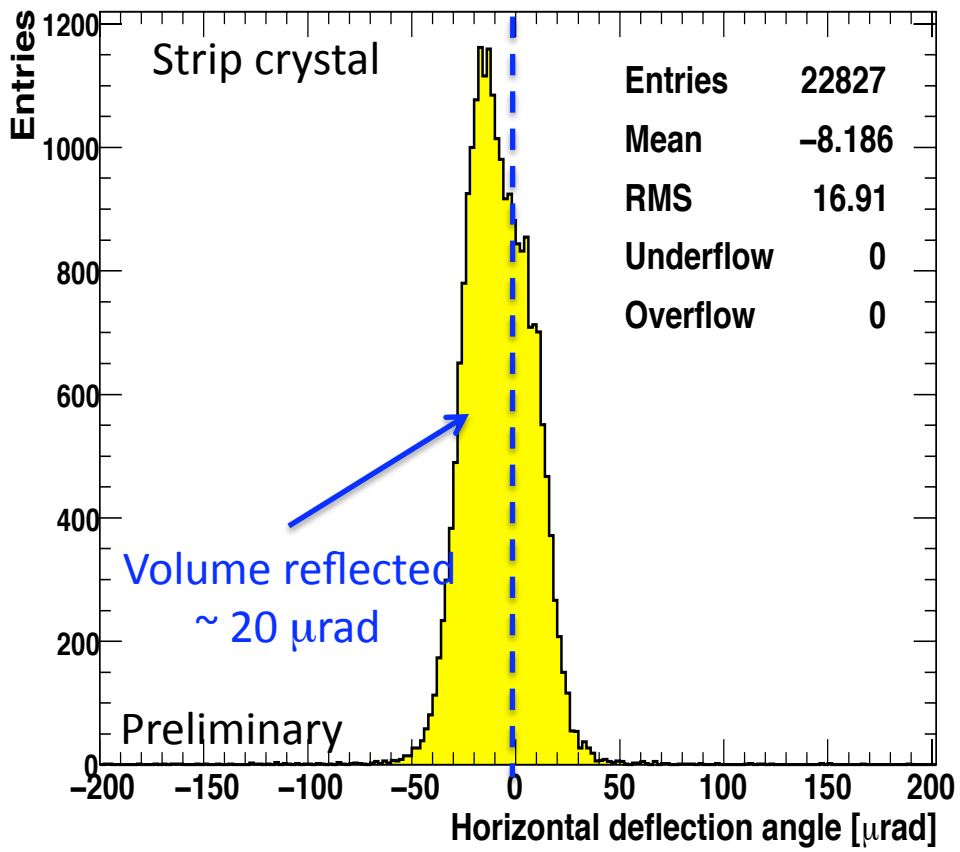




Volume Reflection

- Quasi-mosaic crystal using {111} plane (PNPI)
- Strip crystal using {110} plane (INFN)

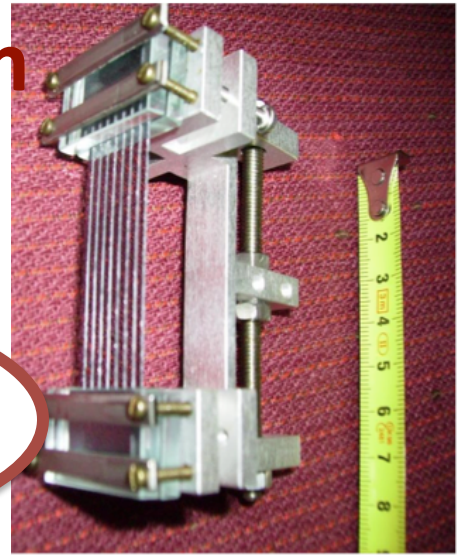




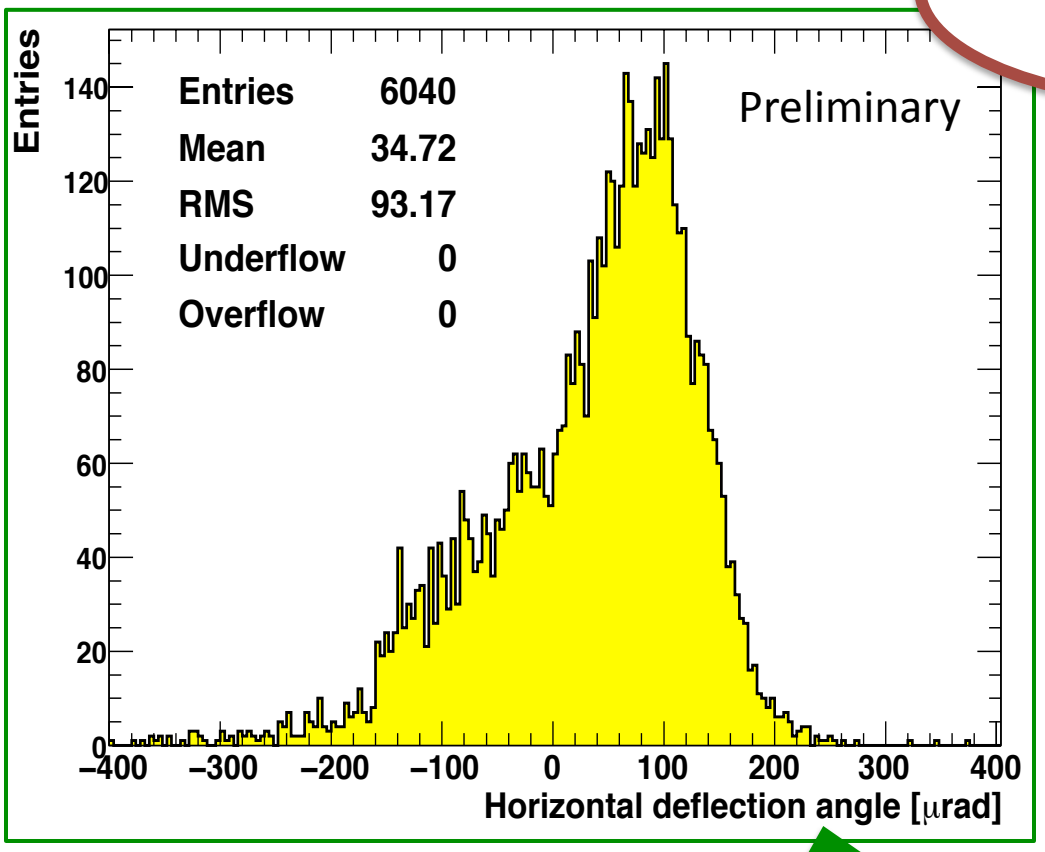
Multiple Volume Reflection

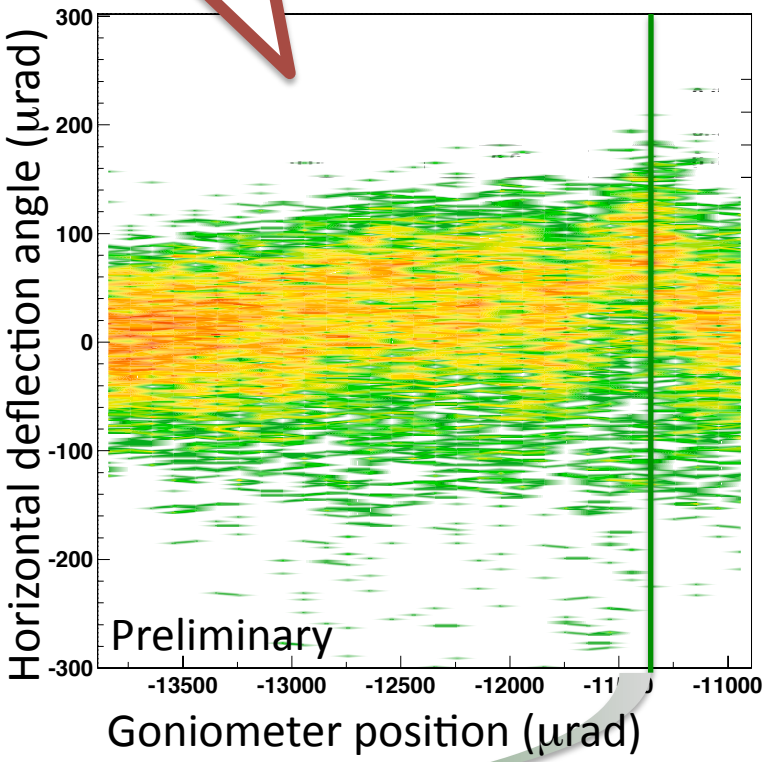
- 8-strip crystal using {110} plane (IHEP)

  Each strip : 0.9 x 2.2 x 50 mm^3, 2.2 mm along the beam



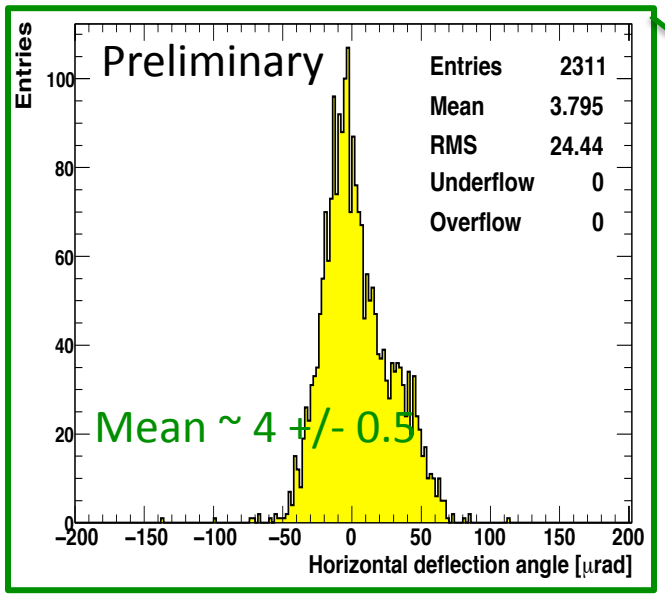
Angular scan to find volume reflection angle

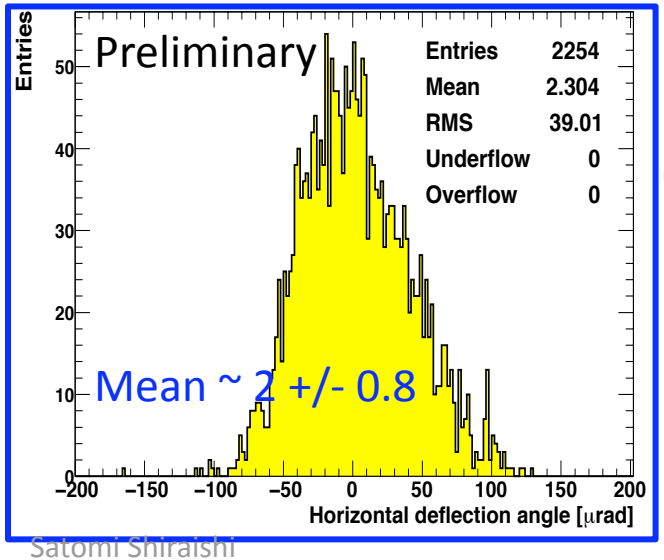


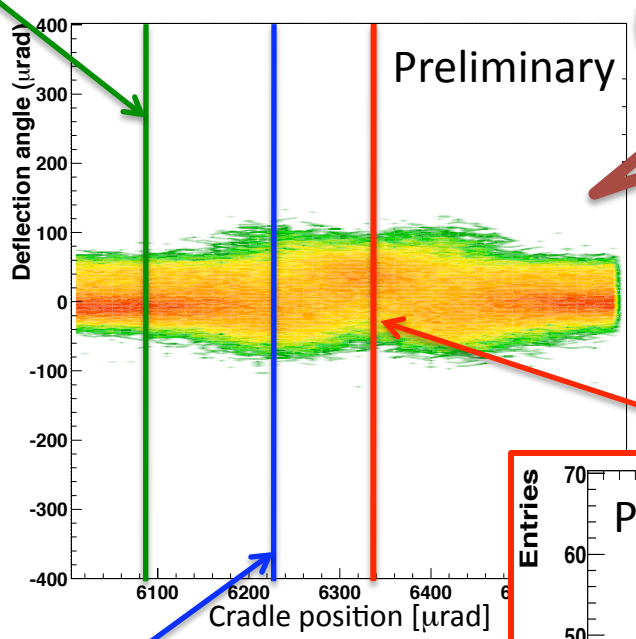


Axial Channeling

- Strip crystal using {111} plane (INFN)

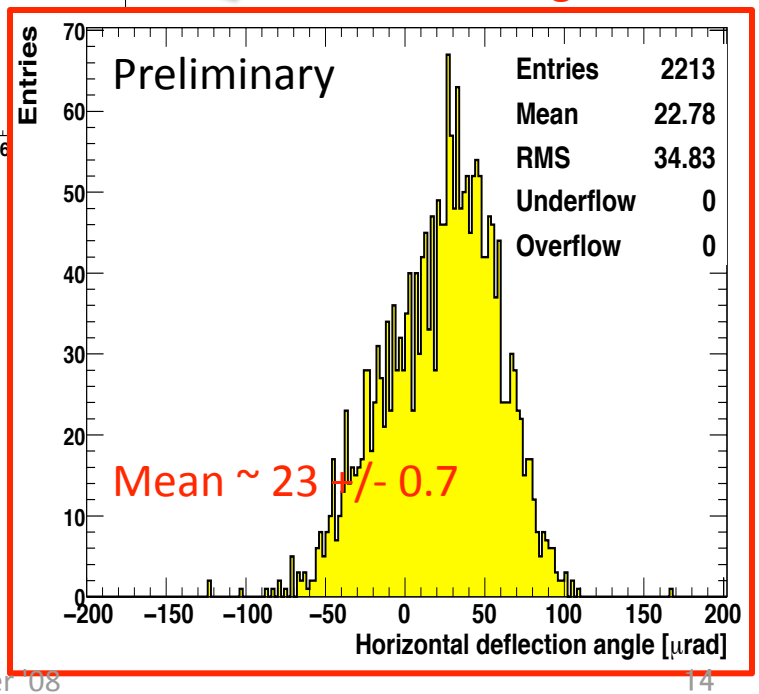






Cradle scan to find axial channeling angle

Axial channeling



Conclusion

- RD22 Successfully completed the H4 run
- Main results are observation of
  - Channeling
  - Volume reflection
  - Axial channeling
  - Multiple volume reflection