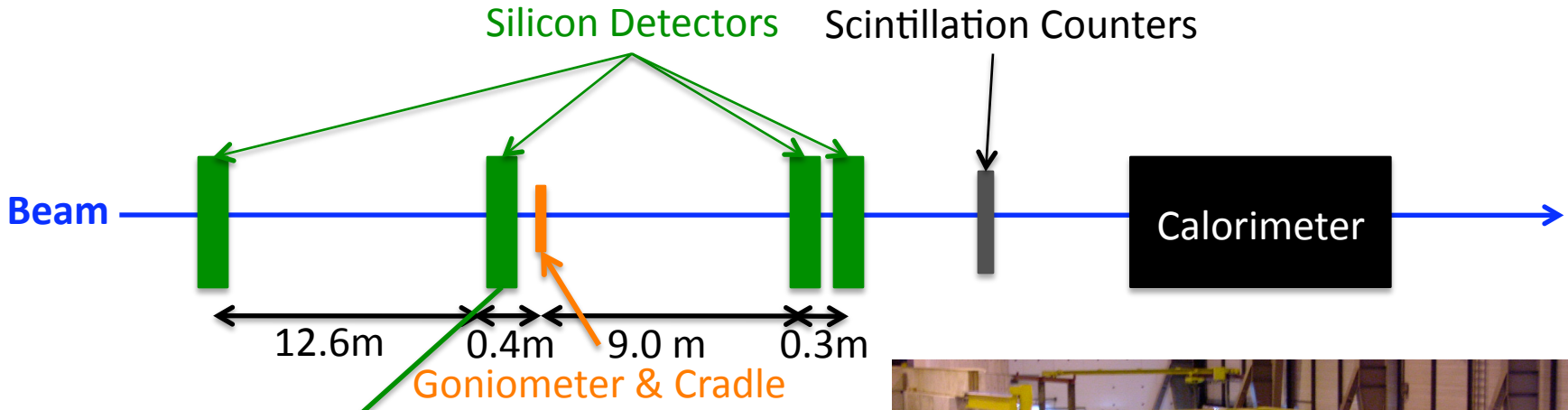
H4 Beam test Results

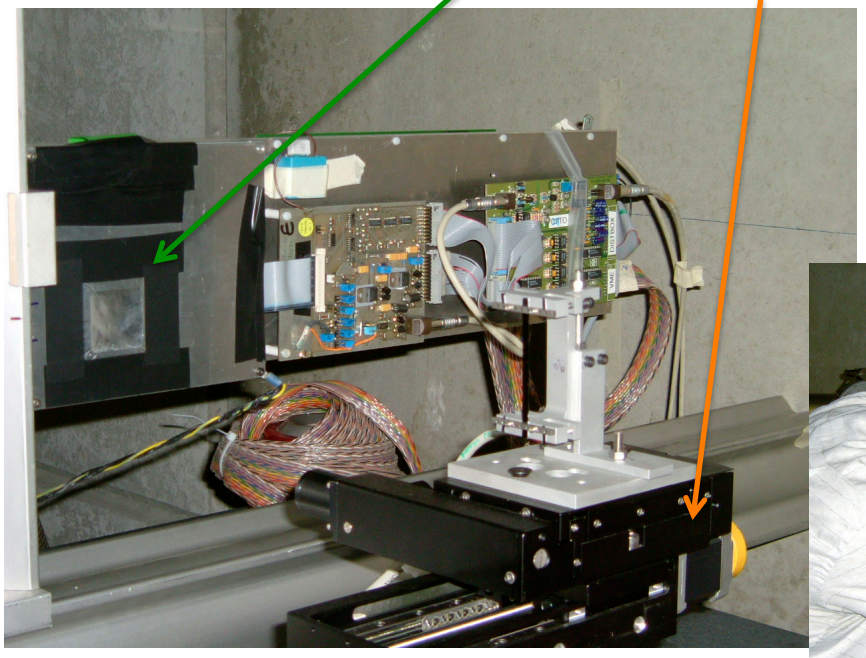
August 8 – 27, 2008

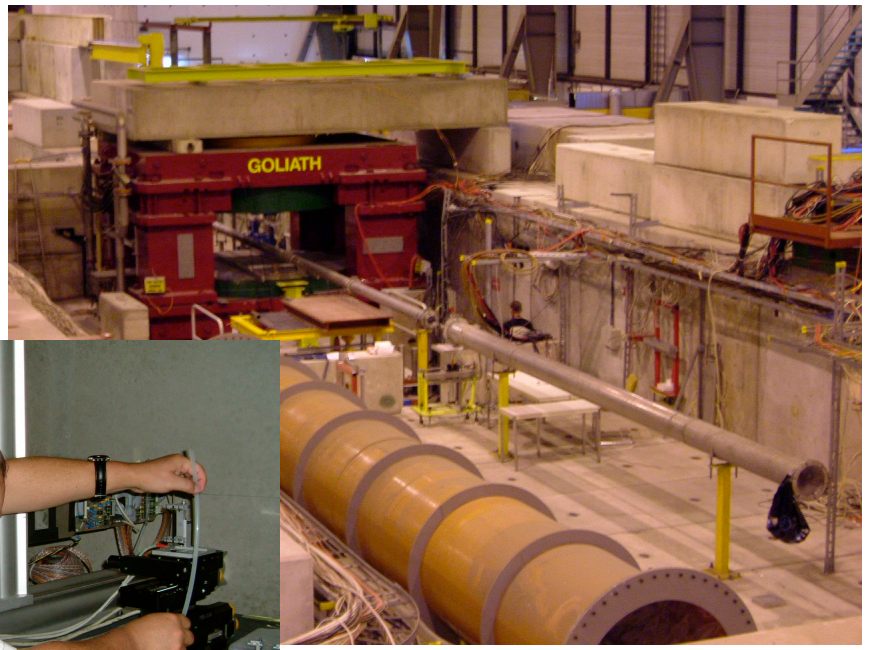
Satomi Shiraishi

H4 Beam test set-up @ CERN

Experimental set-up by Como group





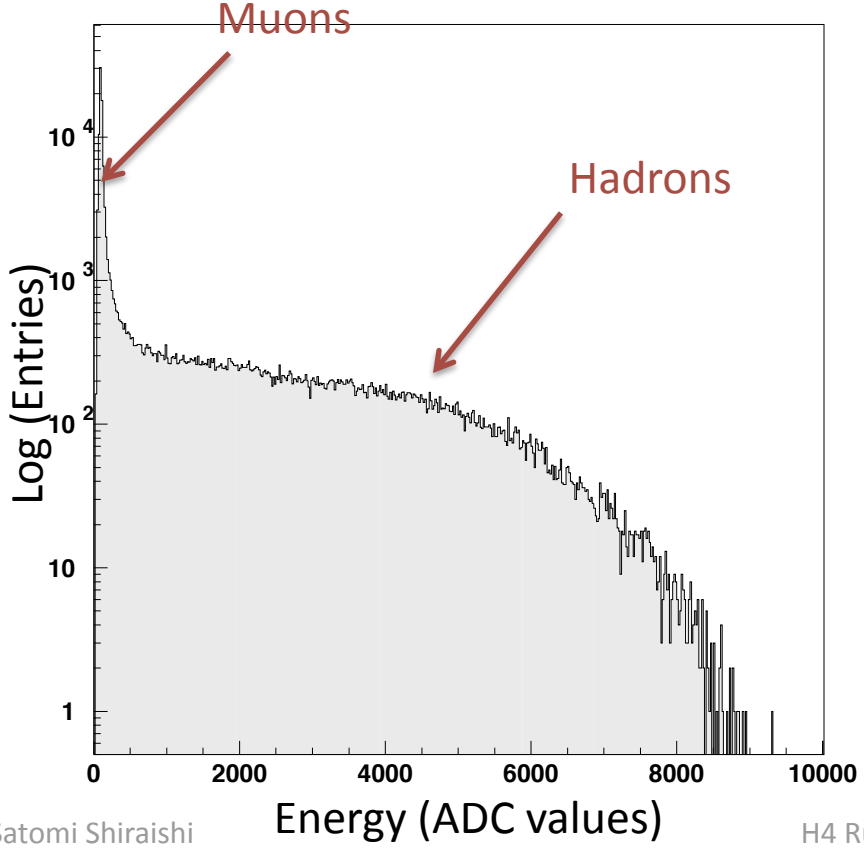


H4 Beam Characteristics

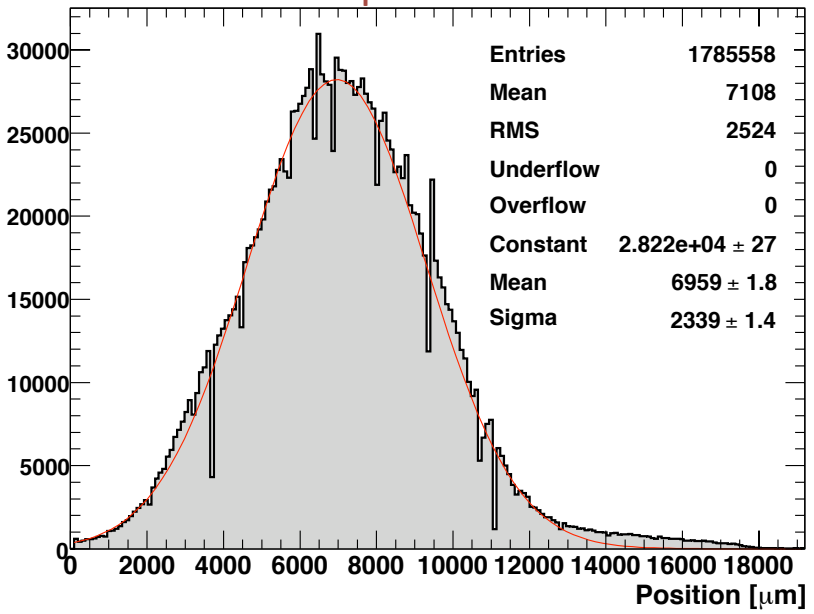
- Roughly 50% μ^- , 50% hadrons (π^-, κ^-)
- 18K events / spill (1 spill / 48 sec)
- Divergence:

  32urad in X and 29urad in Y

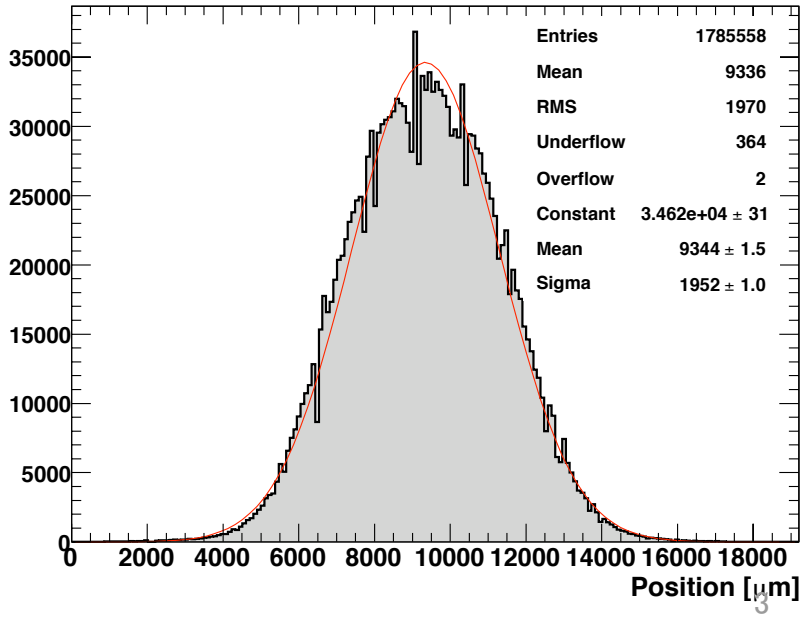
Beam energy ~ 150 GeV



Horizontal beam profile σ ~ 2 -2.5 mm



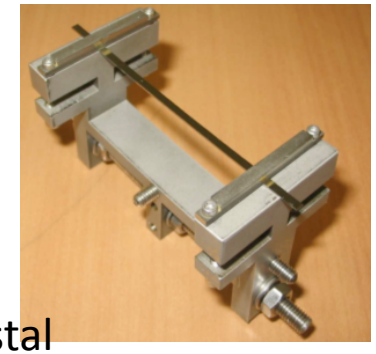
Vertical beam profile σ ~ 2 mm



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

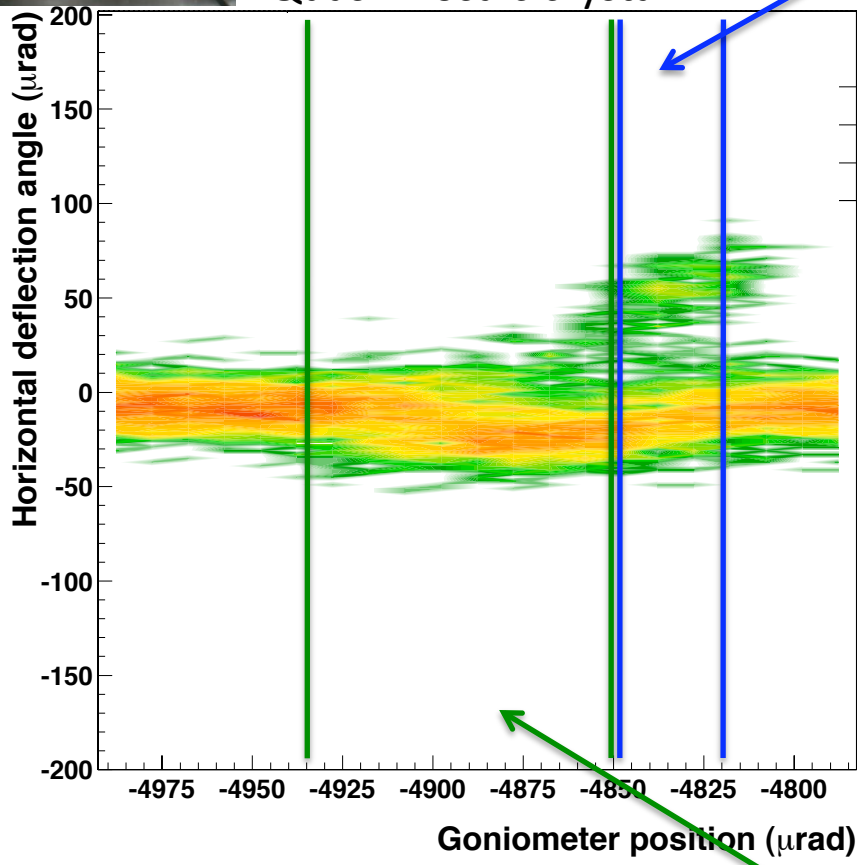
Searching for the optimal crystal position

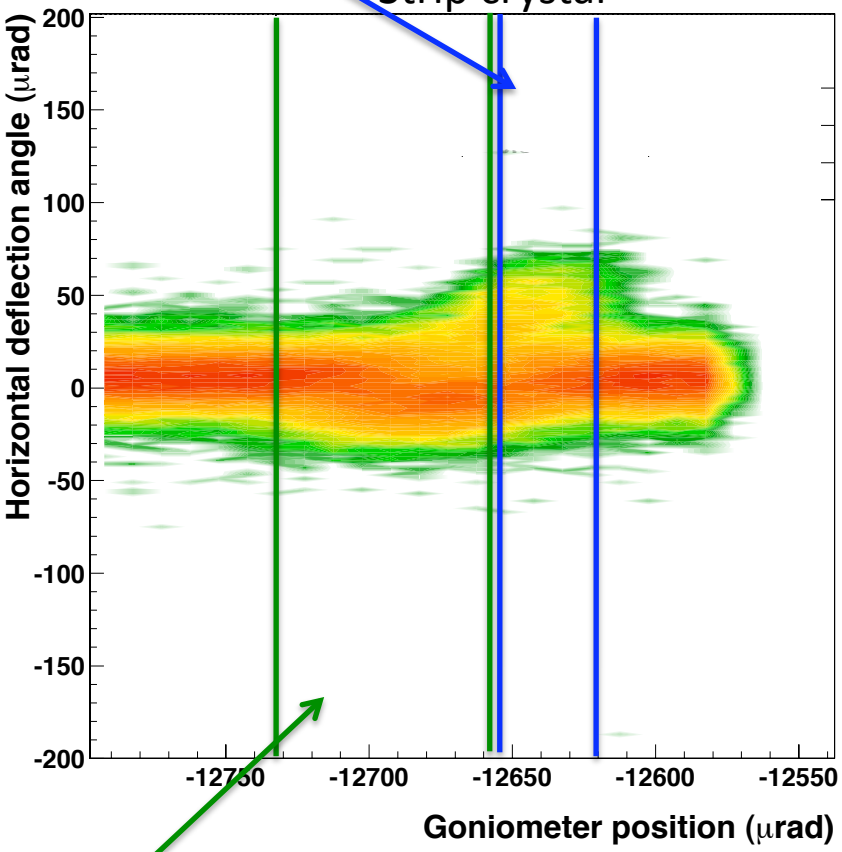


Channeling

Quasi-mosaic crystal

Strip crystal

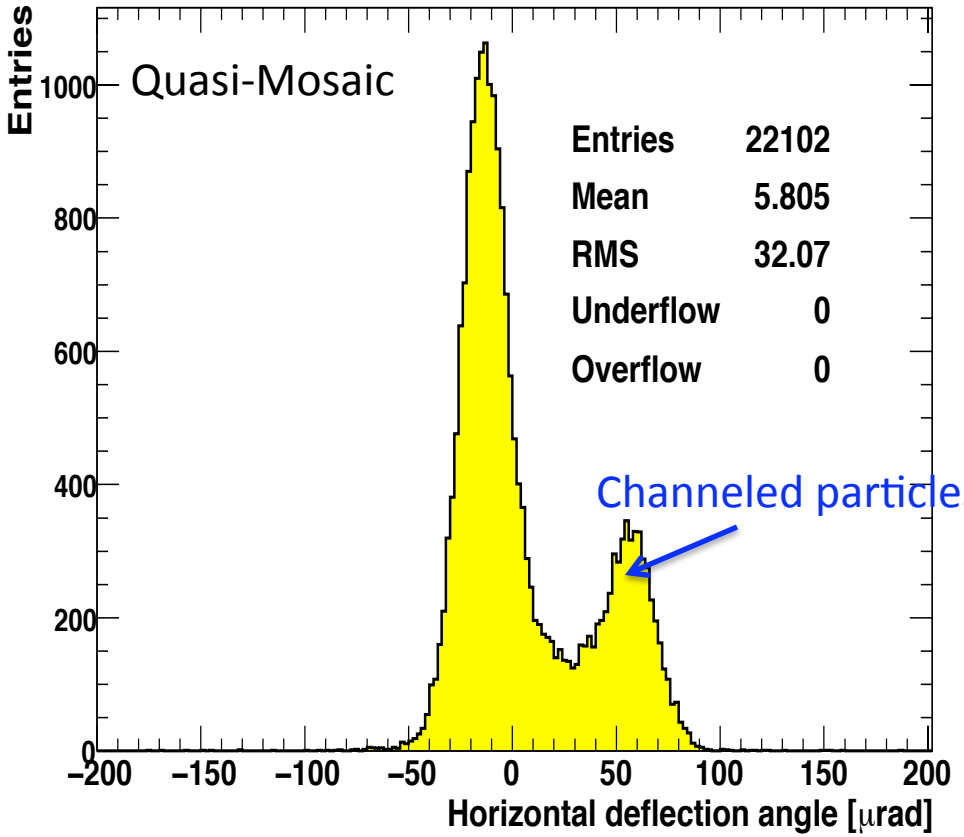


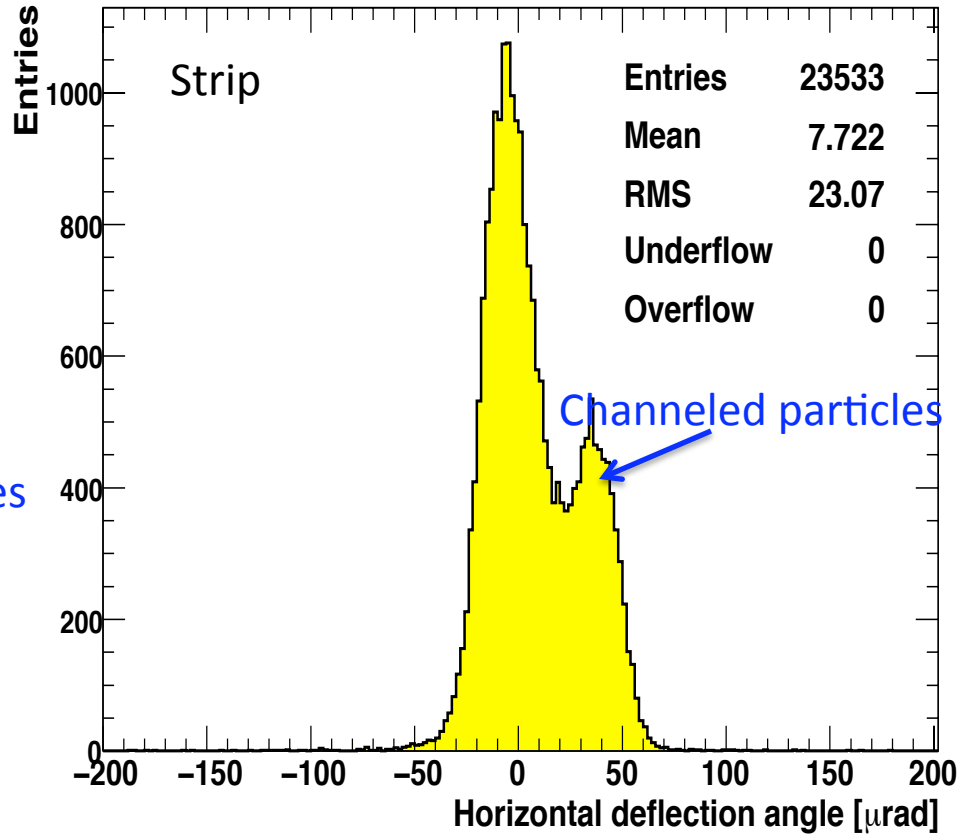


Volume reflection

Planar Channeling

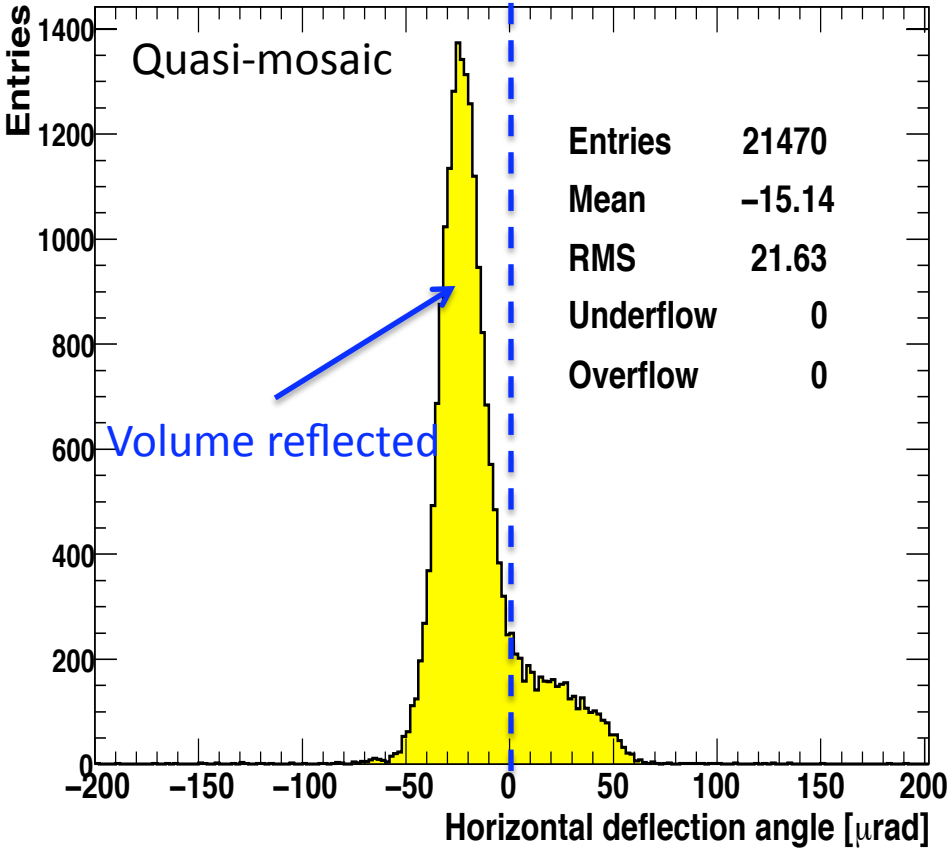
- Quasi-mosaic crystal using {111} plane (PNPI)
- Strip crystal using {110} plane (INFN)

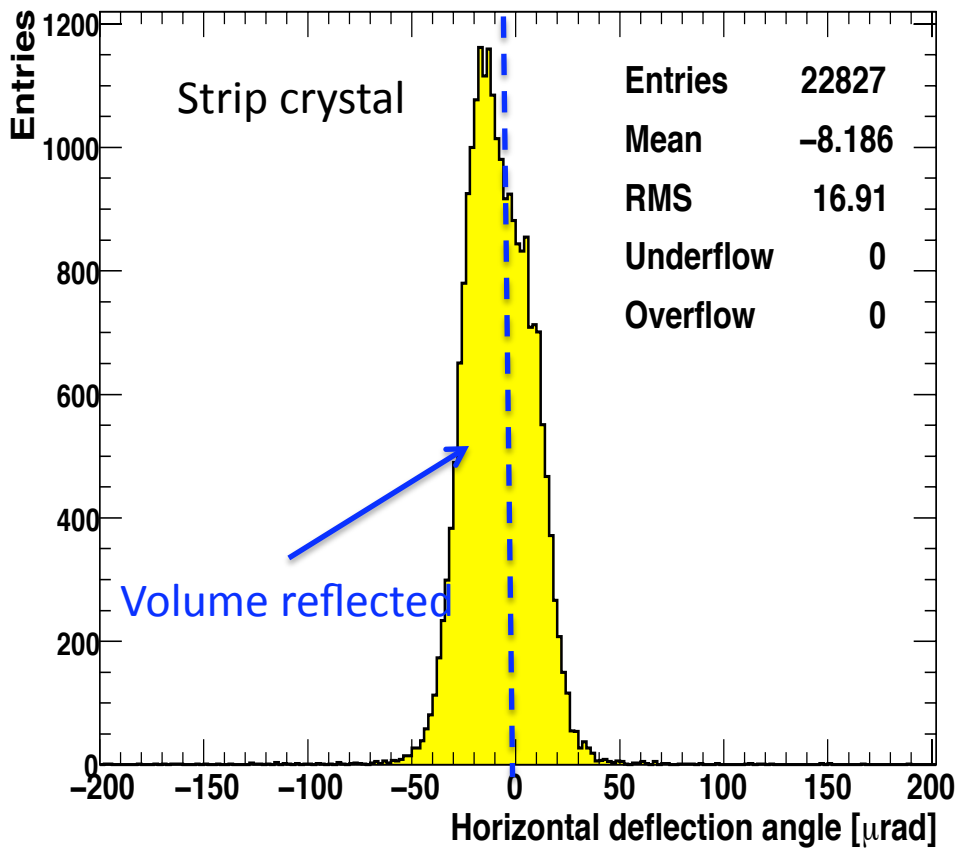




Volume Reflection

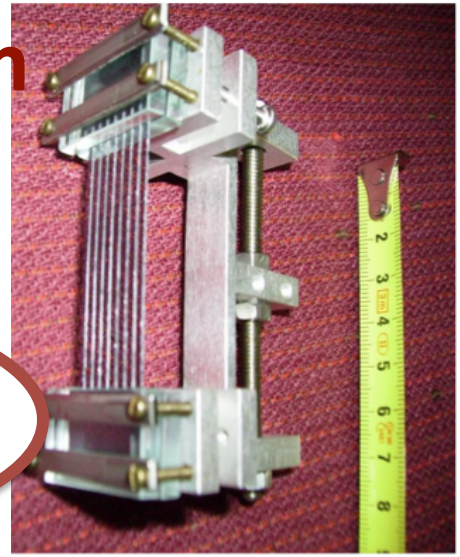
- Quasi-mosaic crystal using {111} plane (PNPI)
- Strip crystal using {110} plane (INFN)



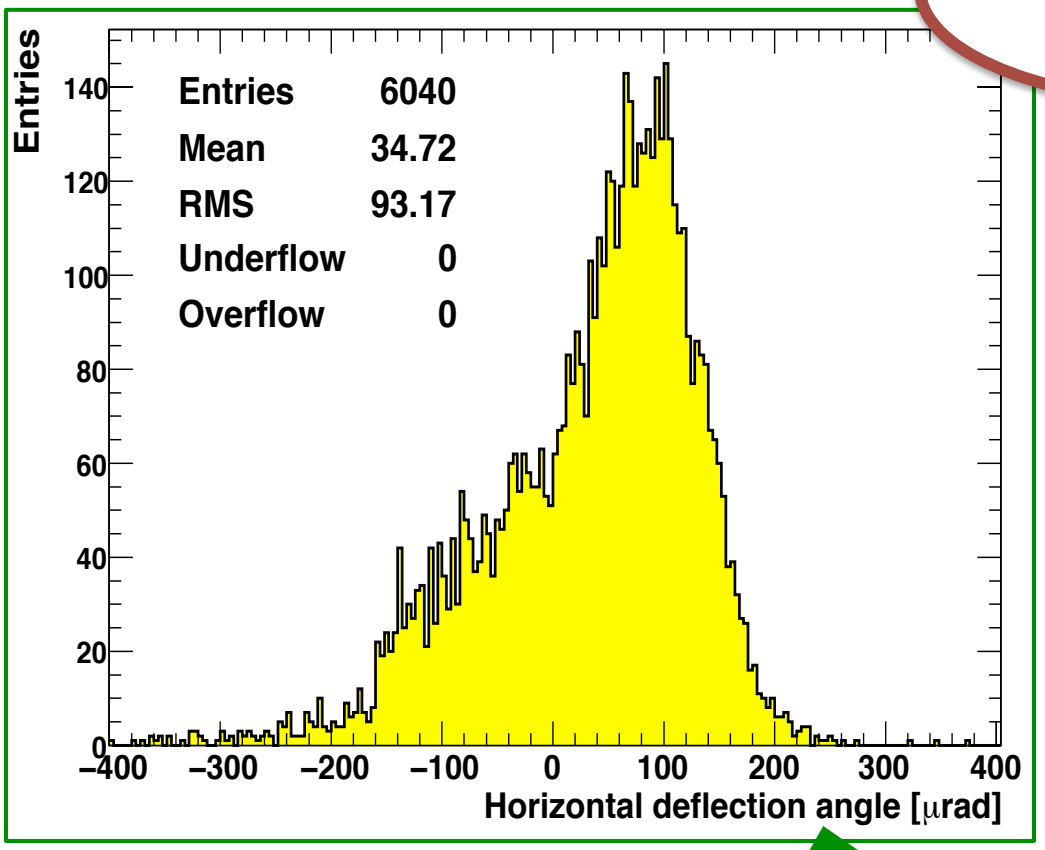


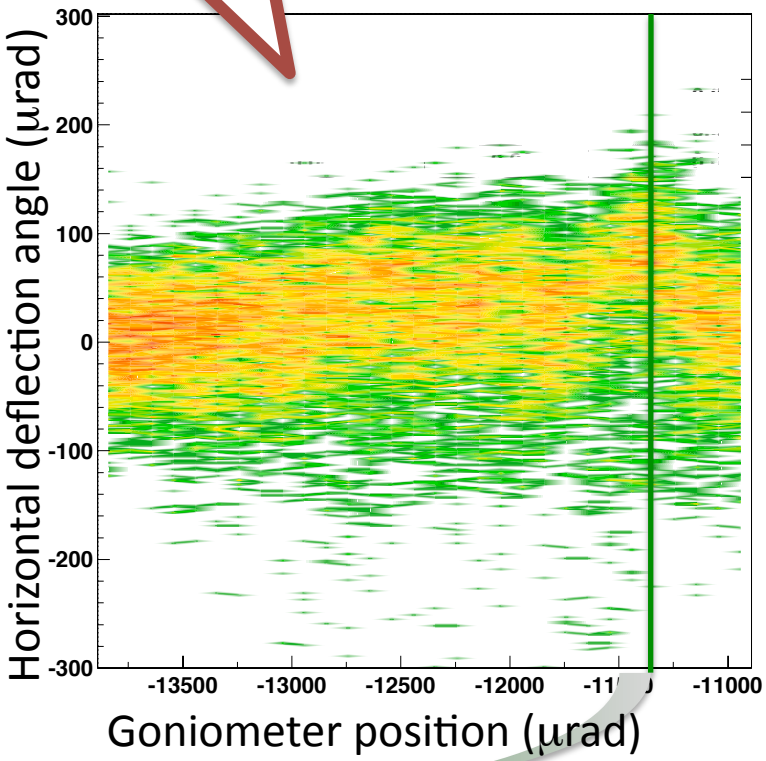
Multiple Volume Reflection

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



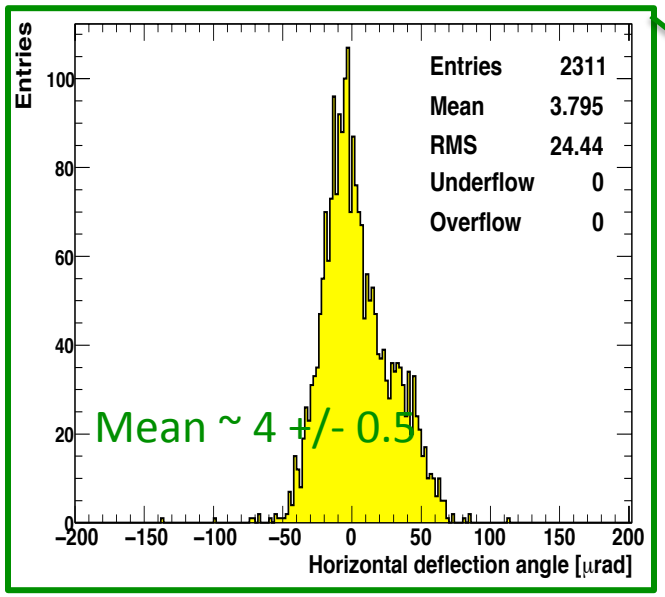
Angular scan to find volume reflection angle

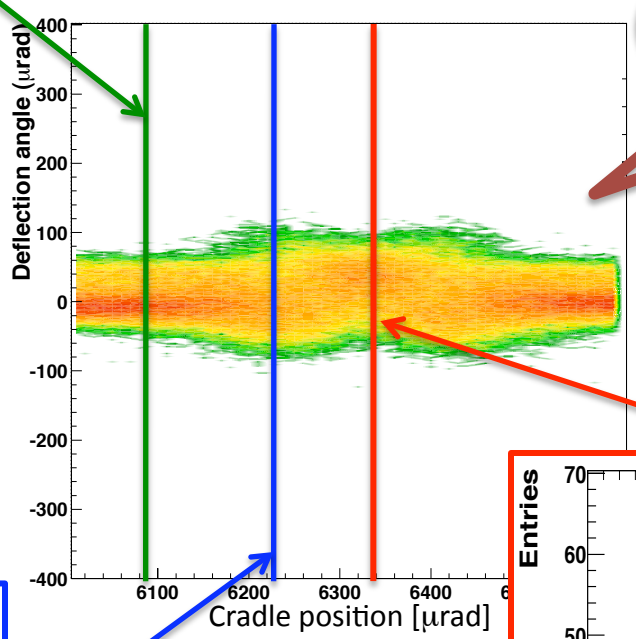




Axial Channeling

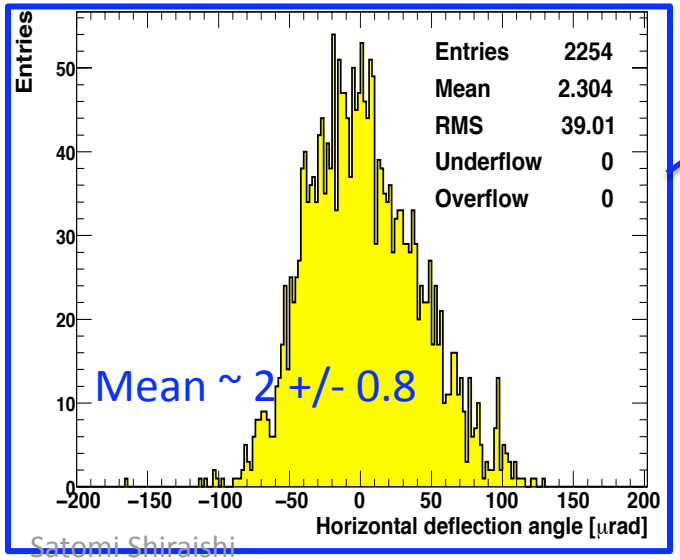
- Strip crystal using {111} plane (INFN)

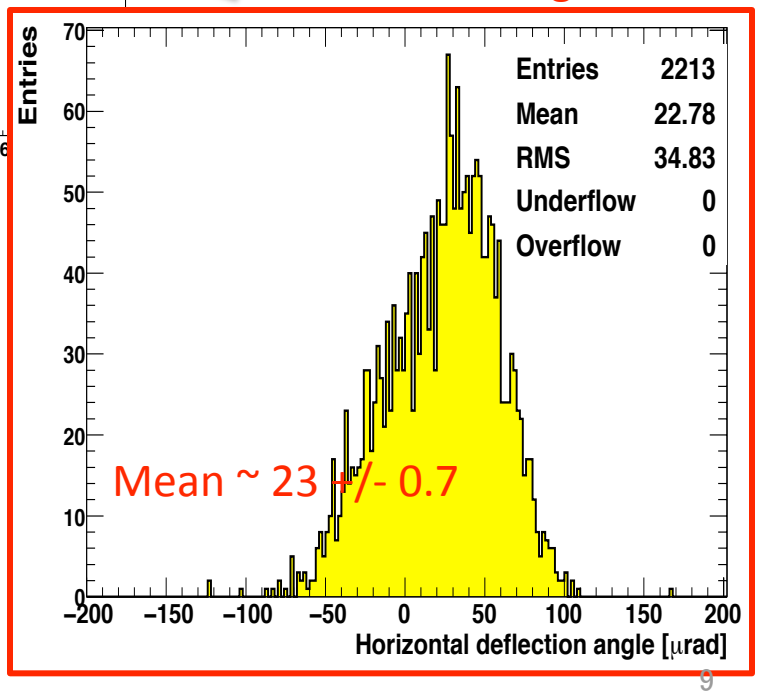




Cradle scan to find axial channeling angle

Axial channeling

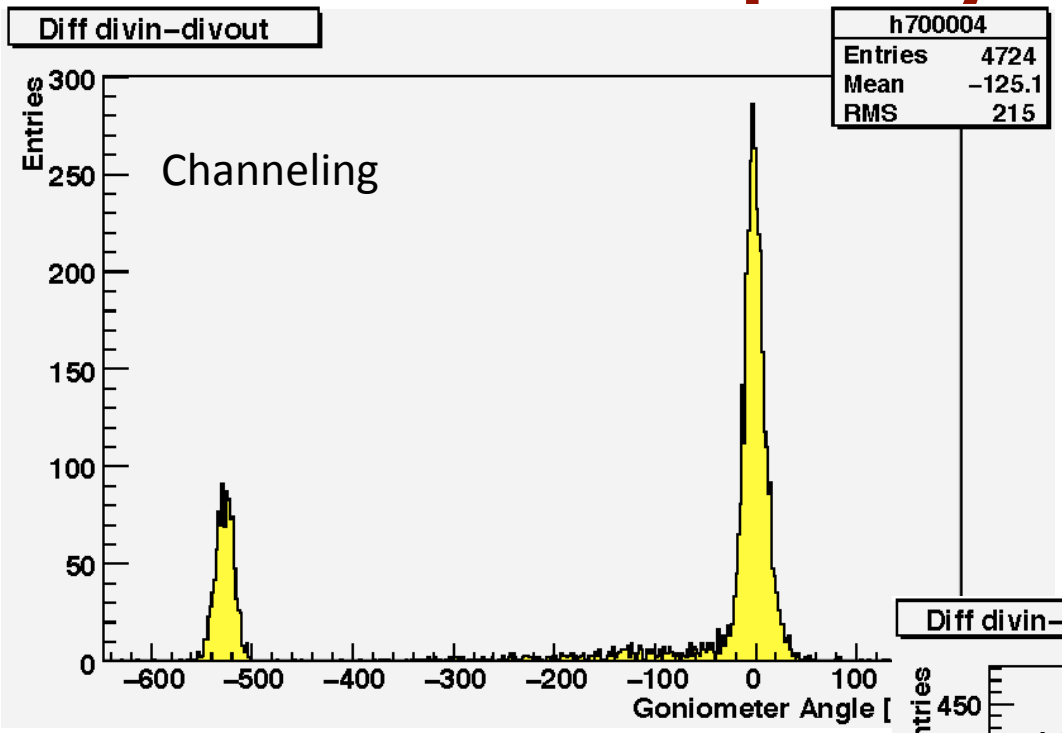


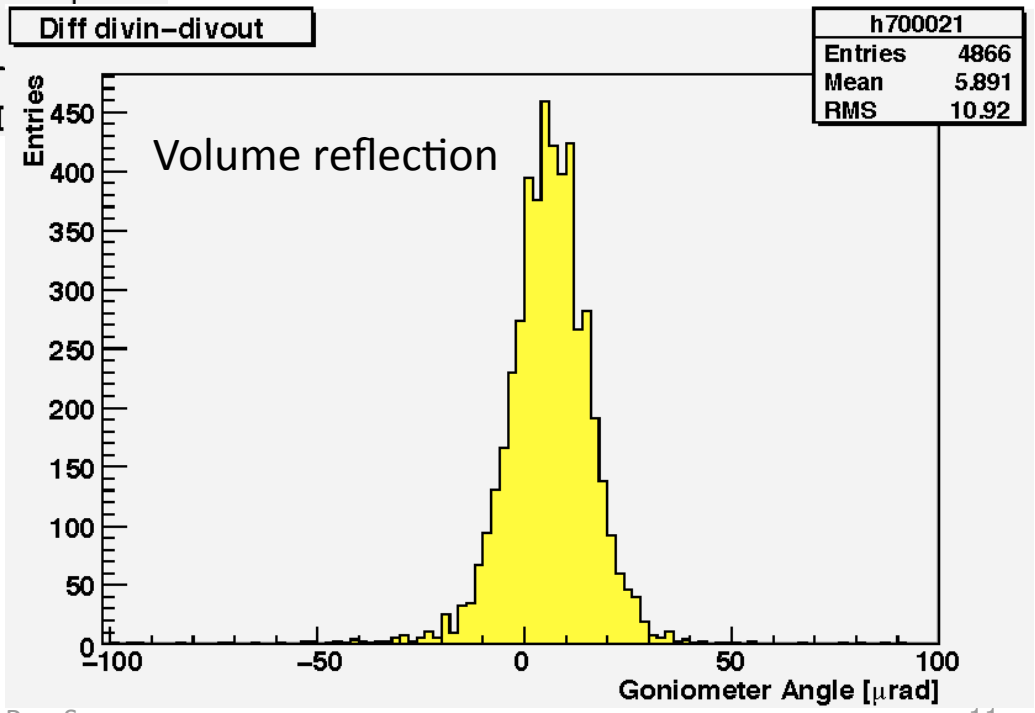


Conclusion

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

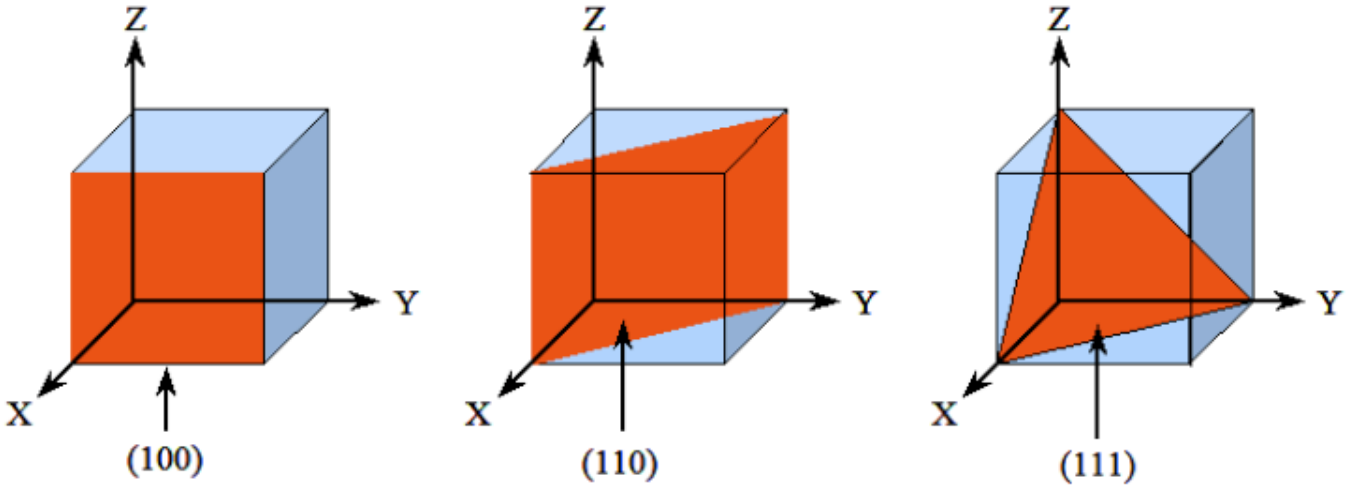
H8: O-shape crystal from PNPI

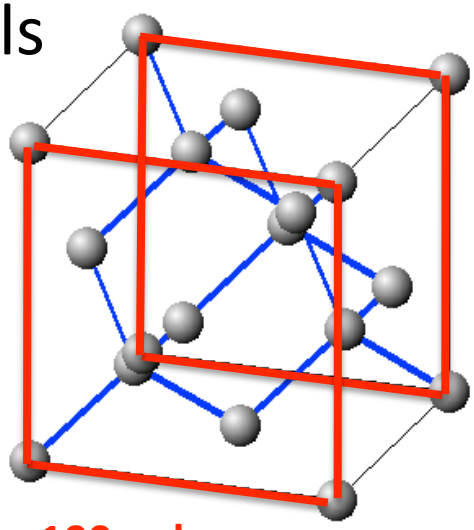




Crystals

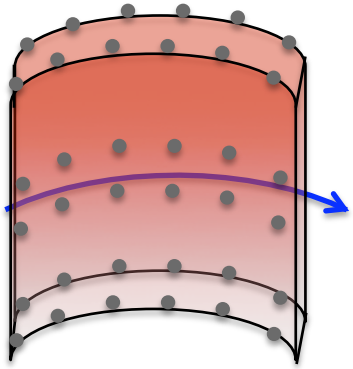
Atoms in the crystal creates electric potentials



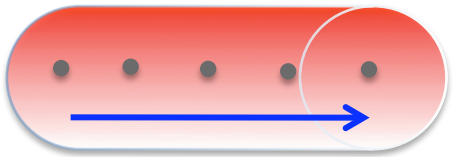


<100> planes

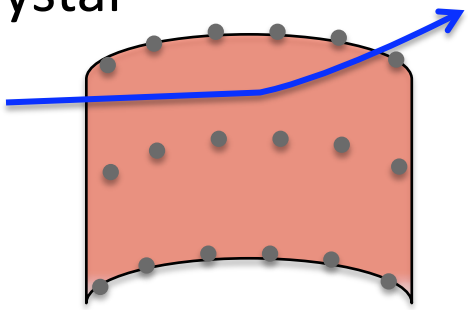
Trajectory of a charged particle is deflected when passing through a bent crystal



Planar Channeling

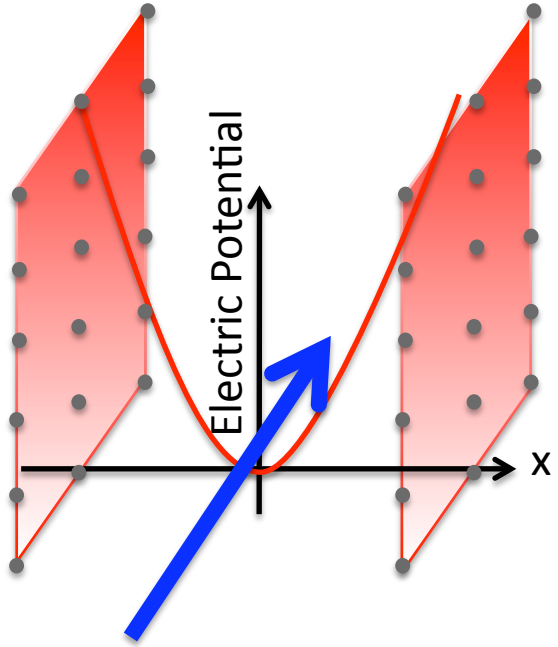


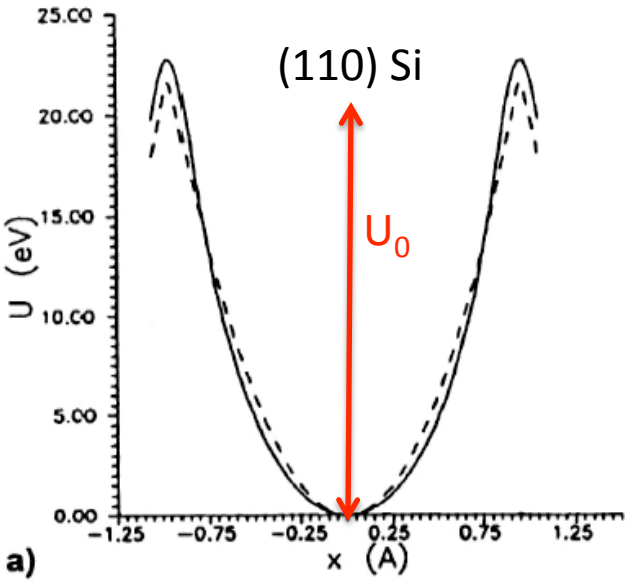
Axial Channeling

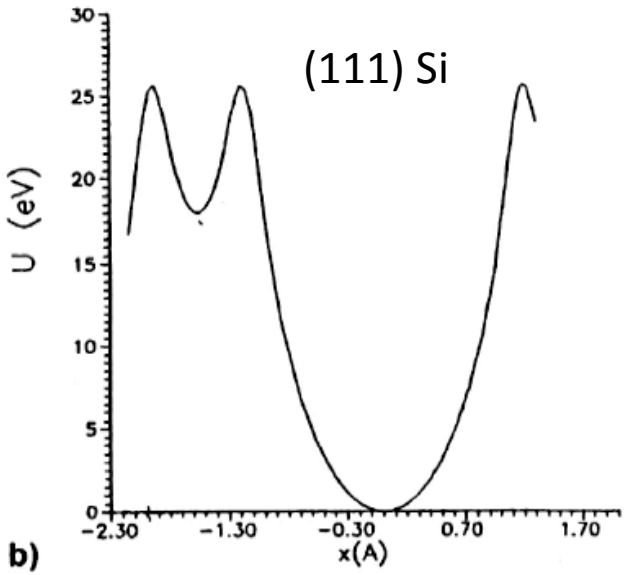


Volume Reflection

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

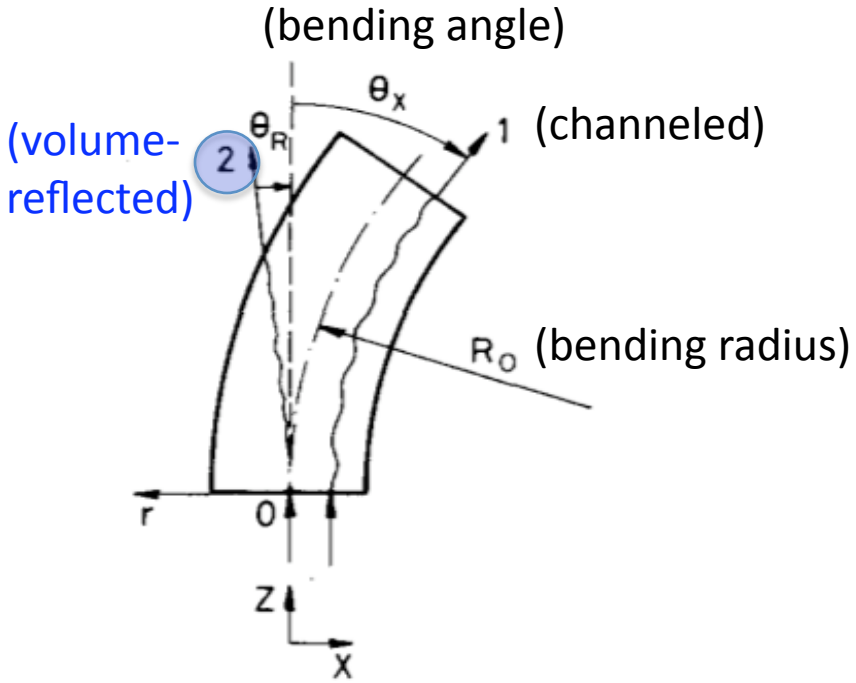
Particle energy

Using (110) Si:

$\theta_c \sim$ 18μrad (100 GeV)

$\theta_c \sim$ 6μrad (1 TeV)

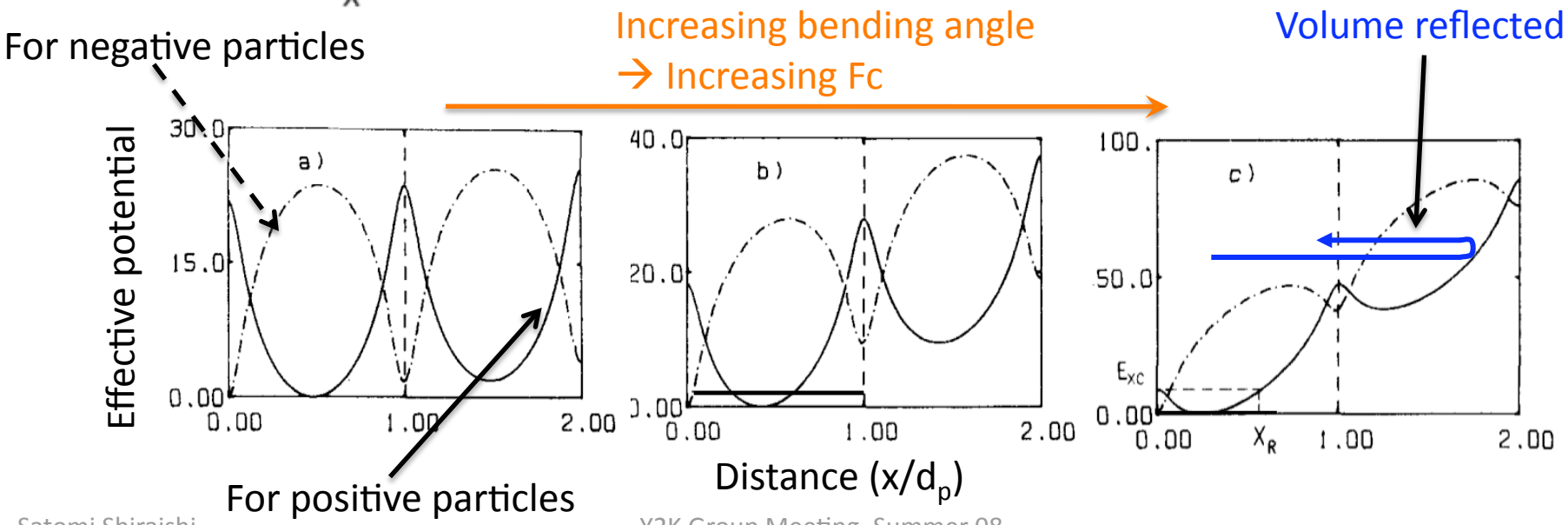
Volume Reflection



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

$$F_c \propto 1/R_0$$

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



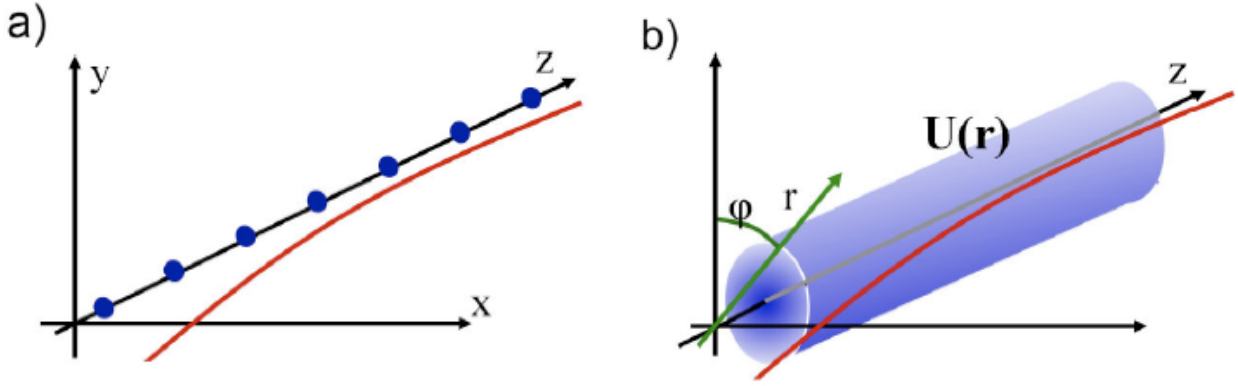
Axial Channeling

Particle moving at small angle with respect to crystal atomic strings

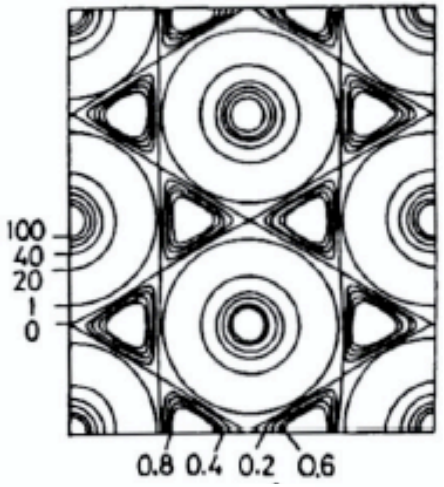
Using (110) Si:

θ_c ~ 48μrad (100 GeV)

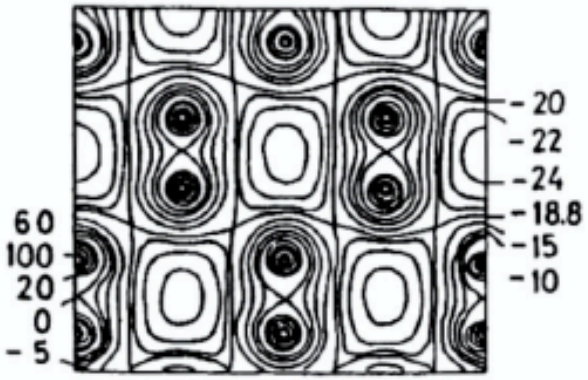
θ_c ~ 15μrad (1 TeV)



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