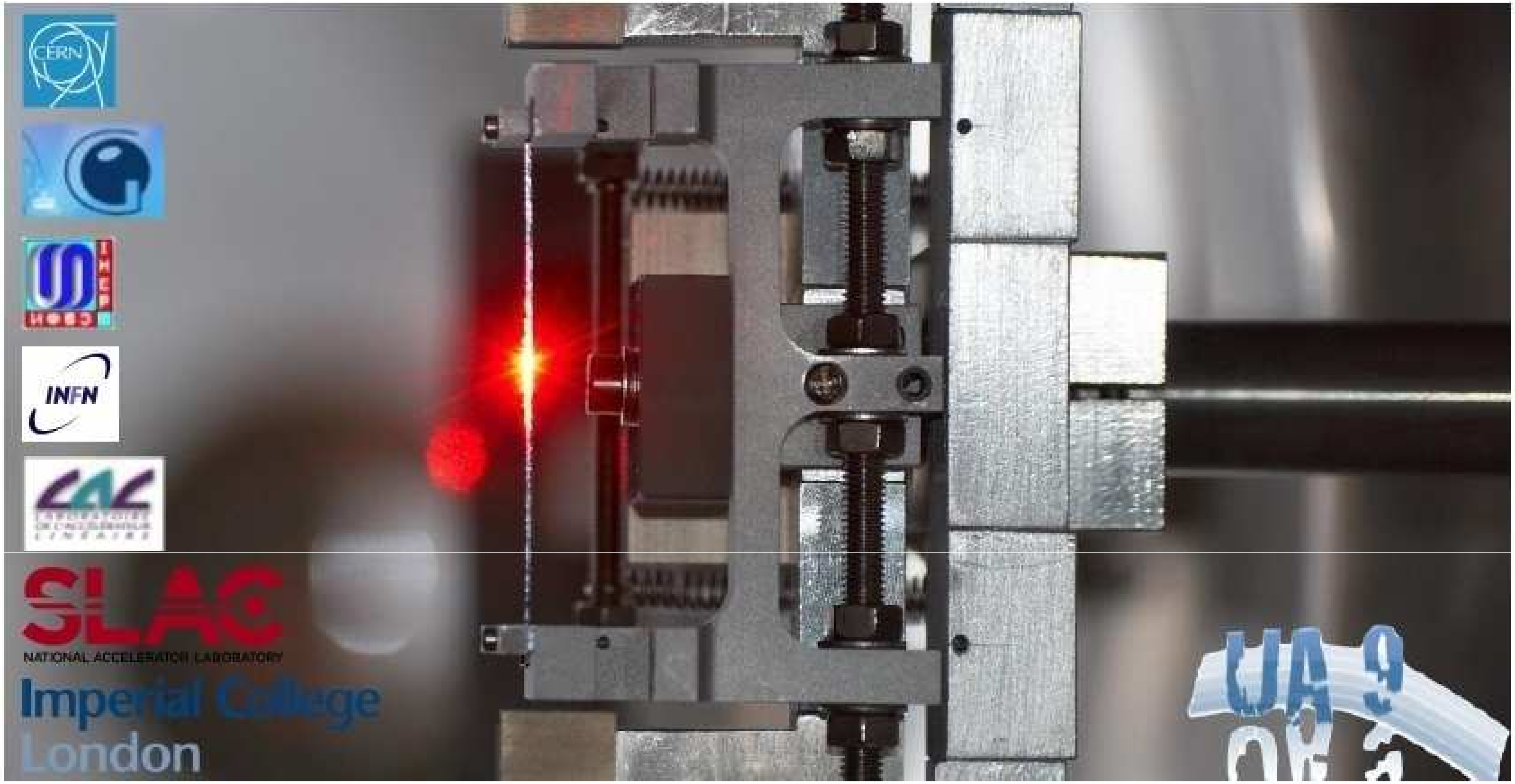
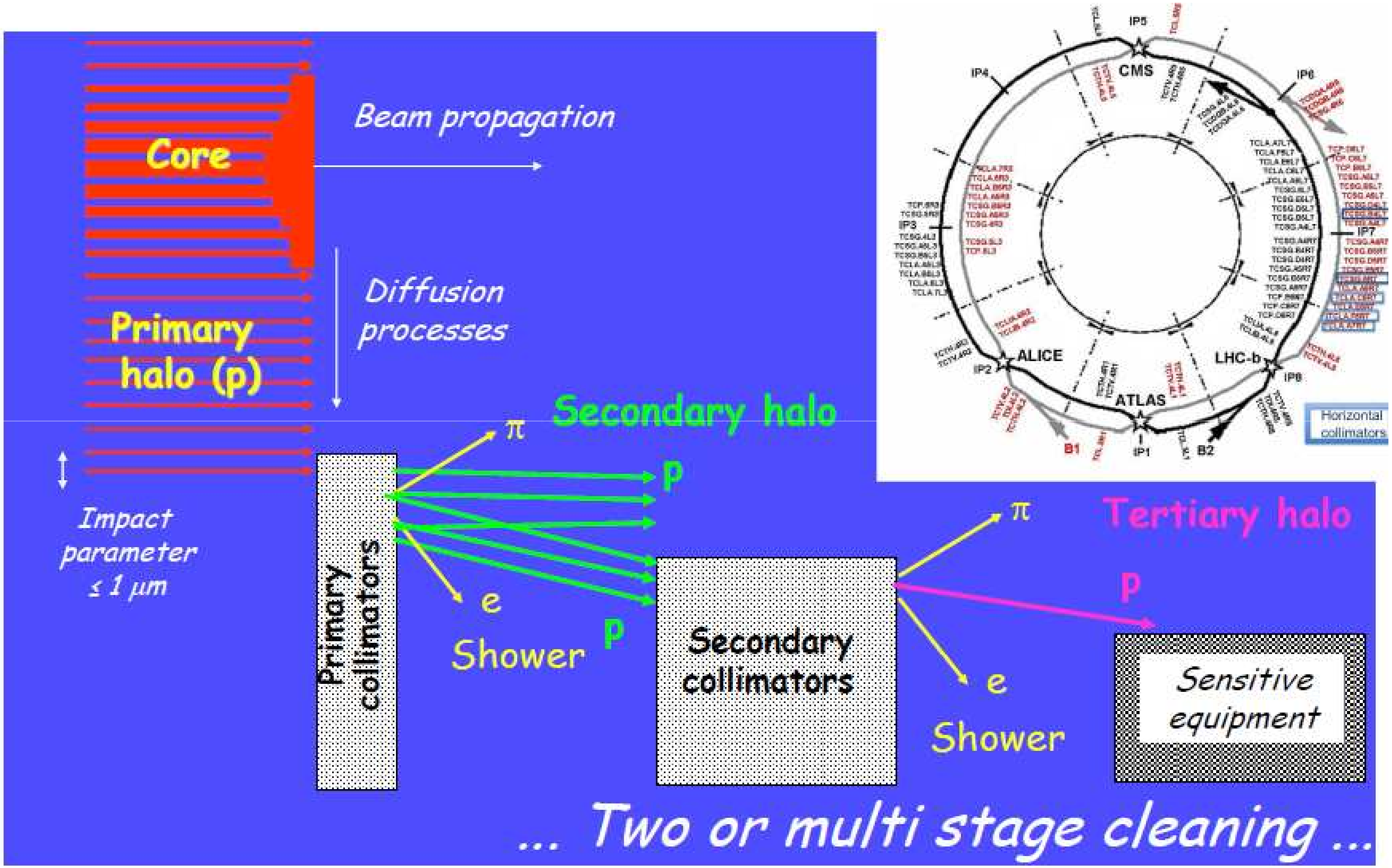


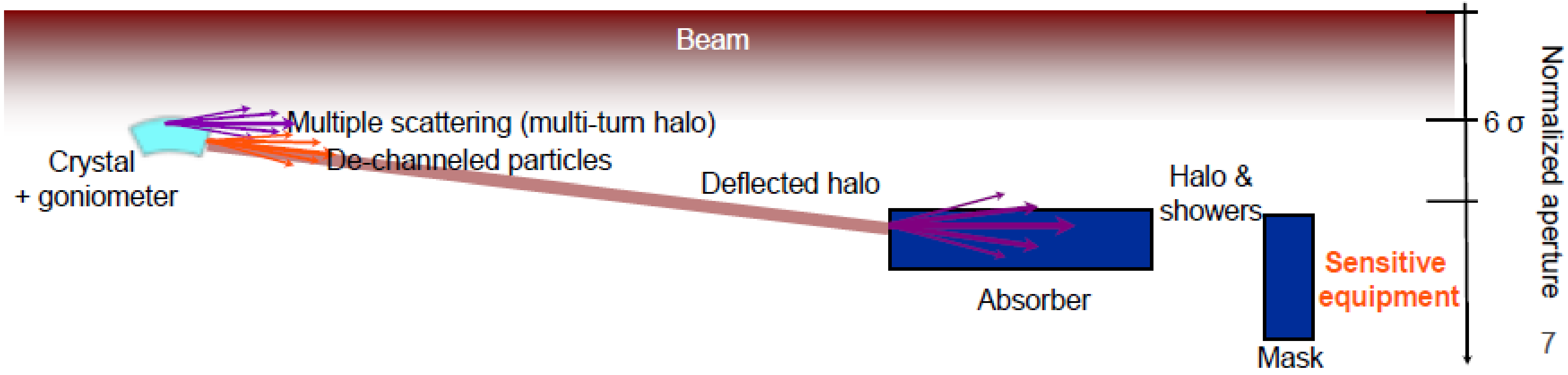

# Эксперимент UA9 в CERN

**Ю.М.Иванов**

# Principle of beam collimation

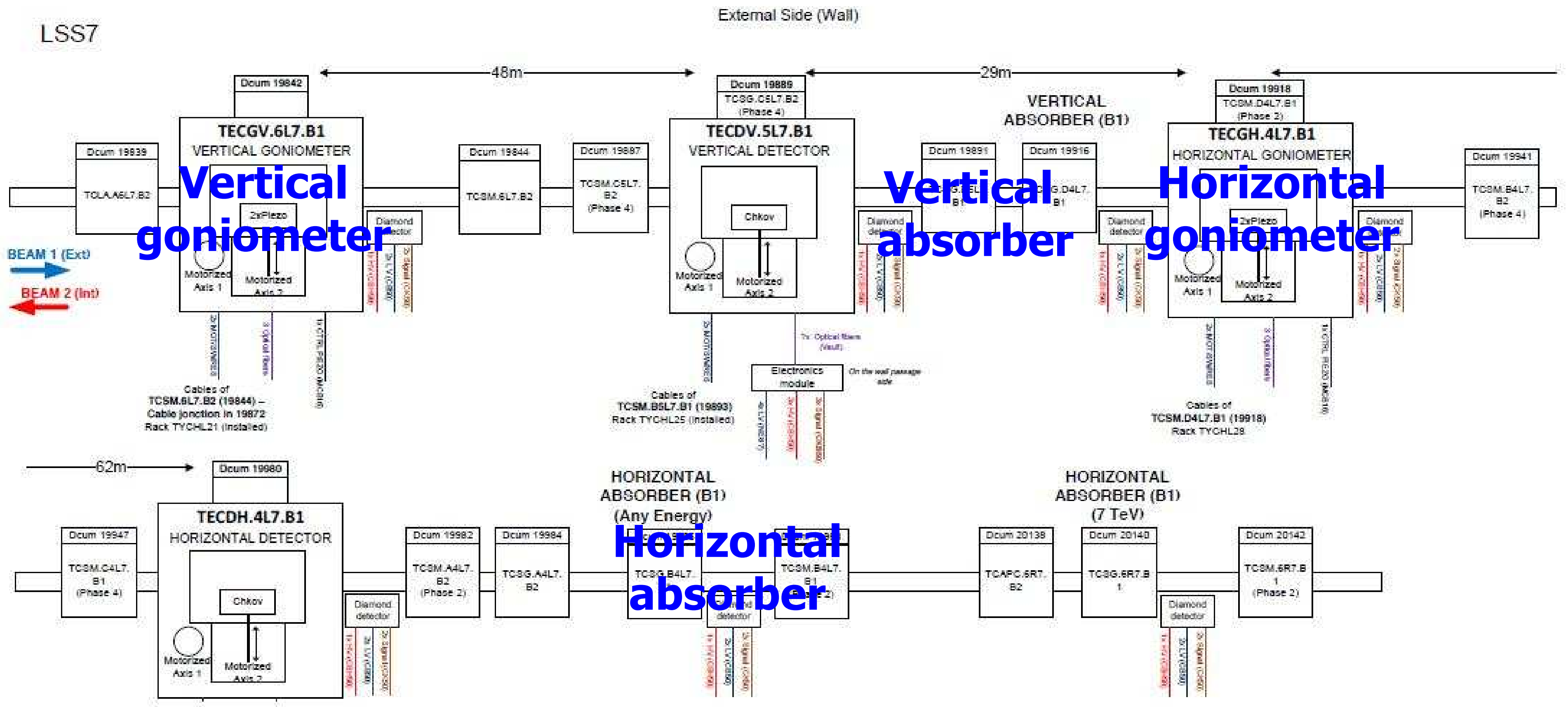


# UA9: investigate bent crystals as primary collimators in hadron colliders

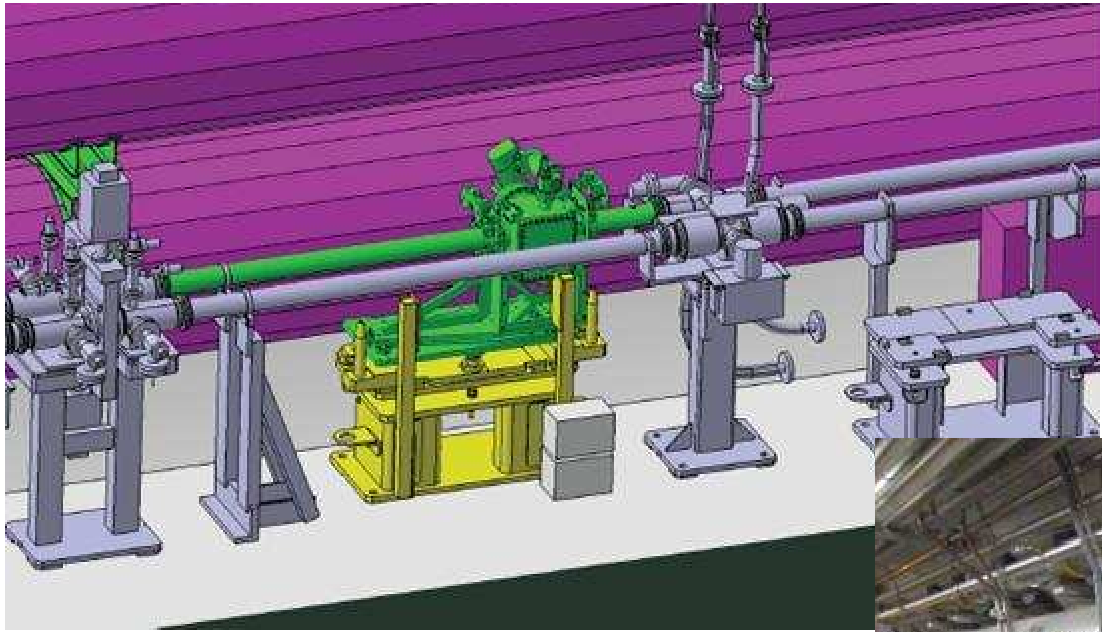


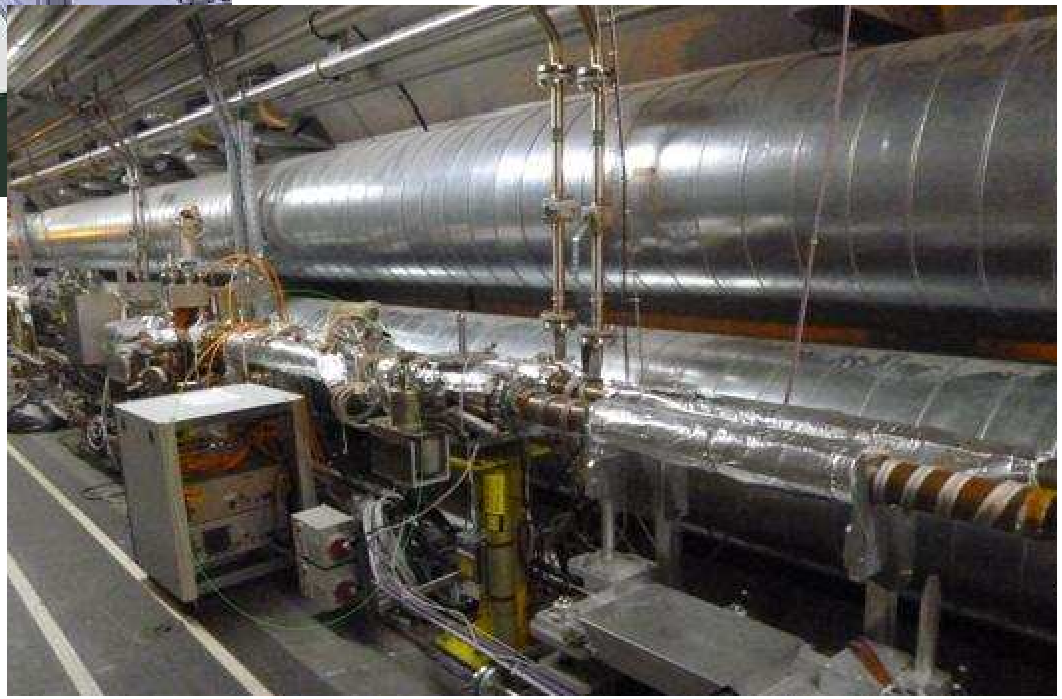

- **Bent crystal instead of amorphous primary scatterer**
- **Particles are subjected to channeling**
  - **reduced loss rate close to the crystal**
  - **reduced probability of diffracted events**
  - **localization of losses in a single absorber**

# Layout of crystal collimation experiment in LHC ring

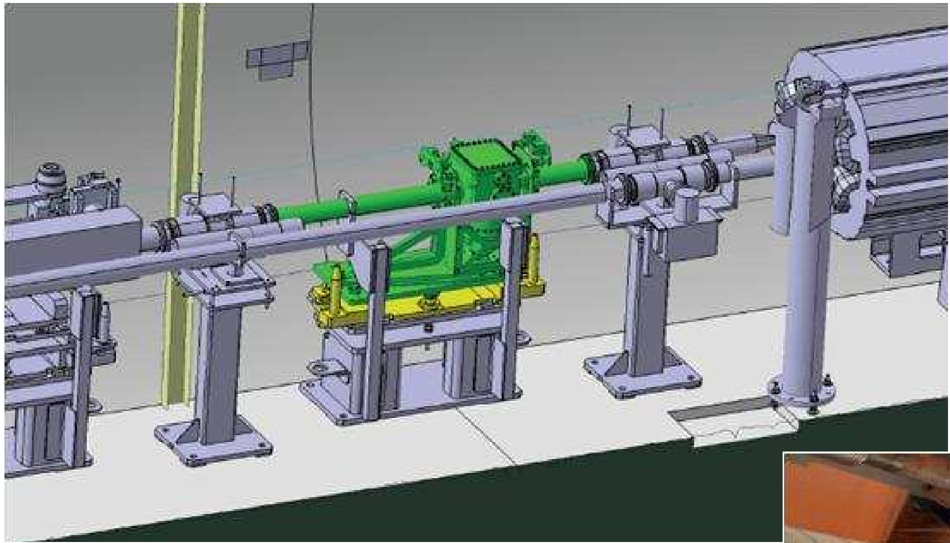


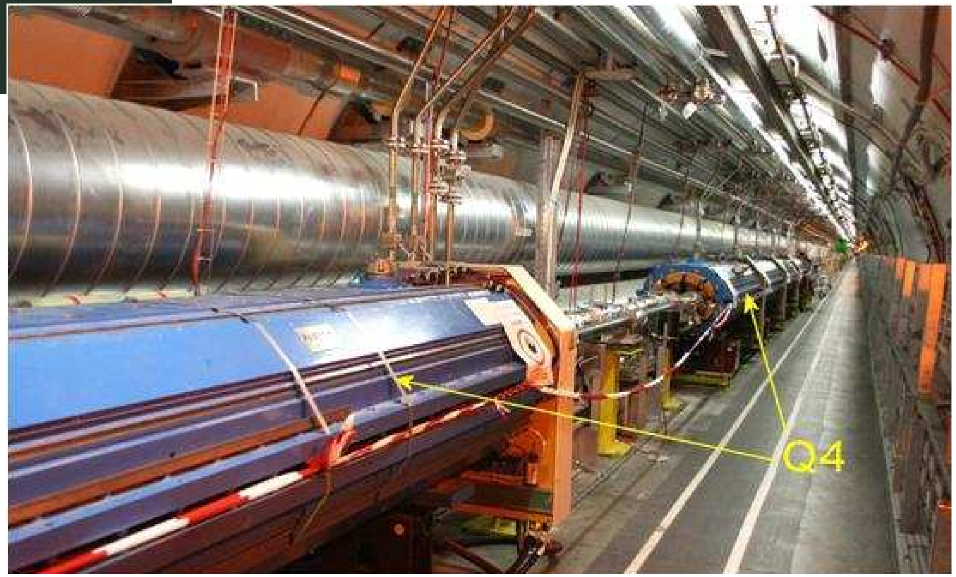
# Layout of vertical goniometer in LHC ring



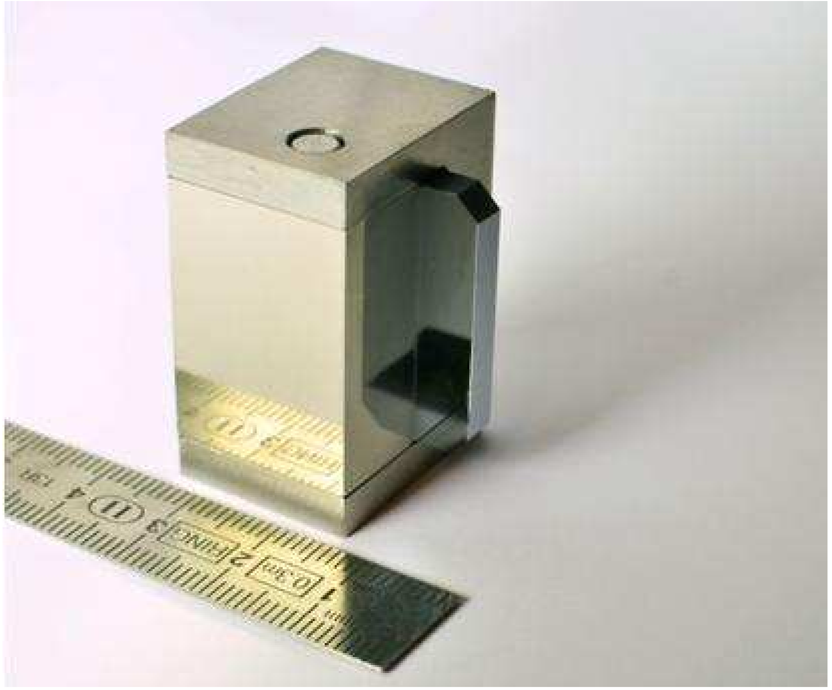


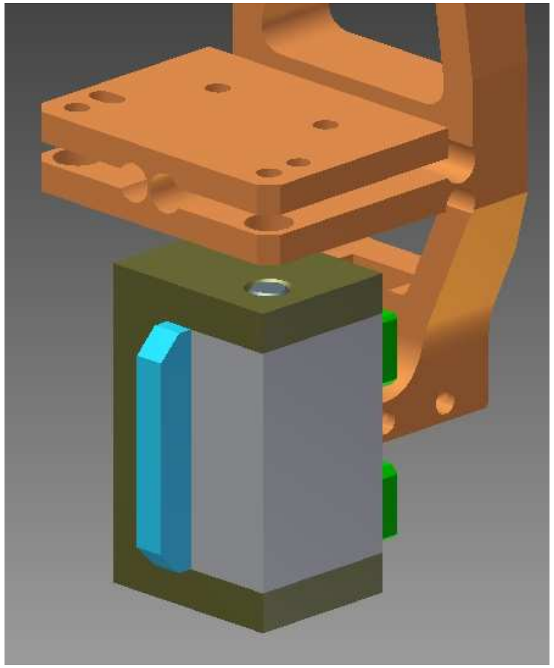
# Layout of horizontal goniometer in LHC ring





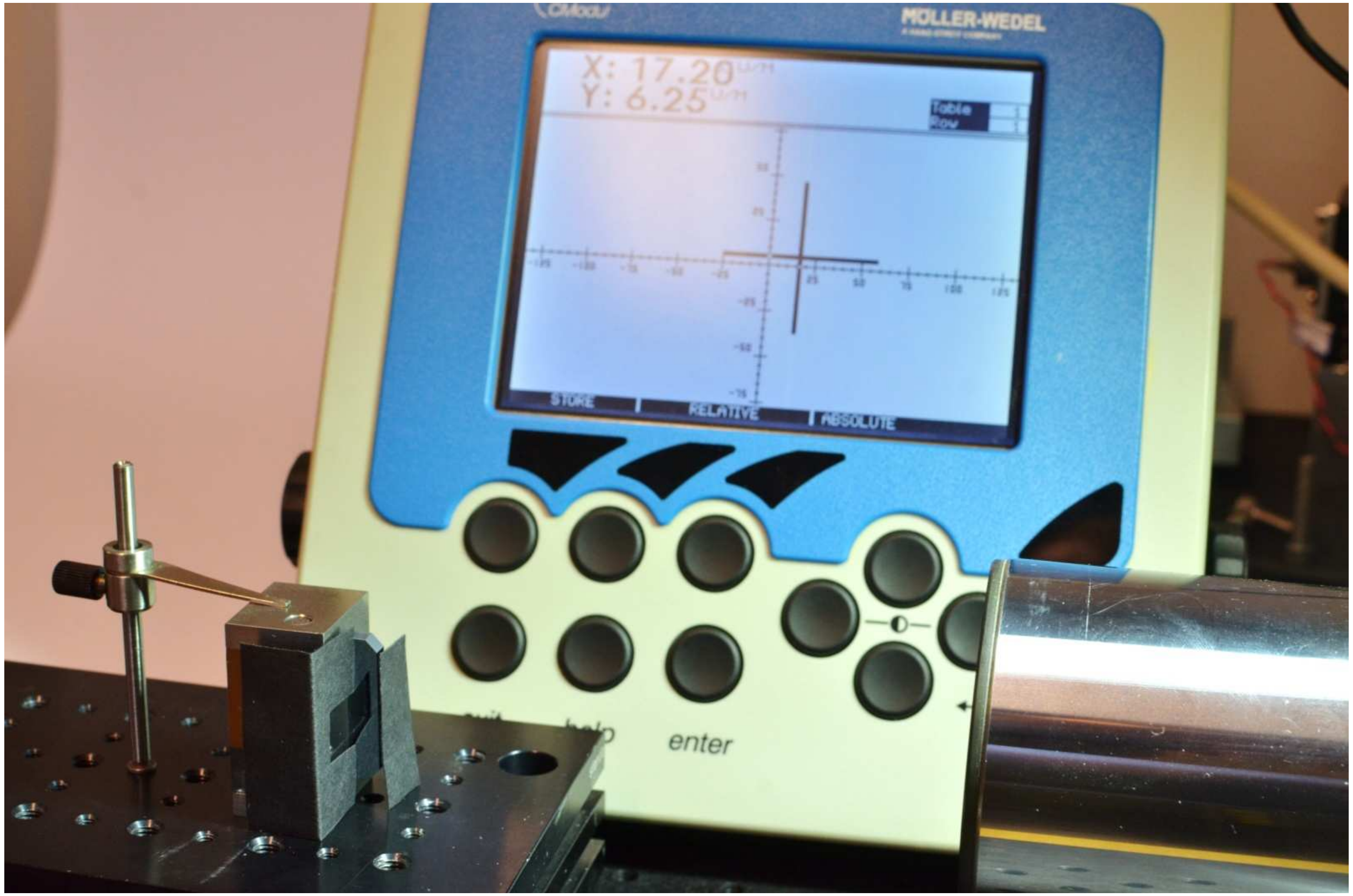
# Crystal deflectors for LHC produced at PNPI



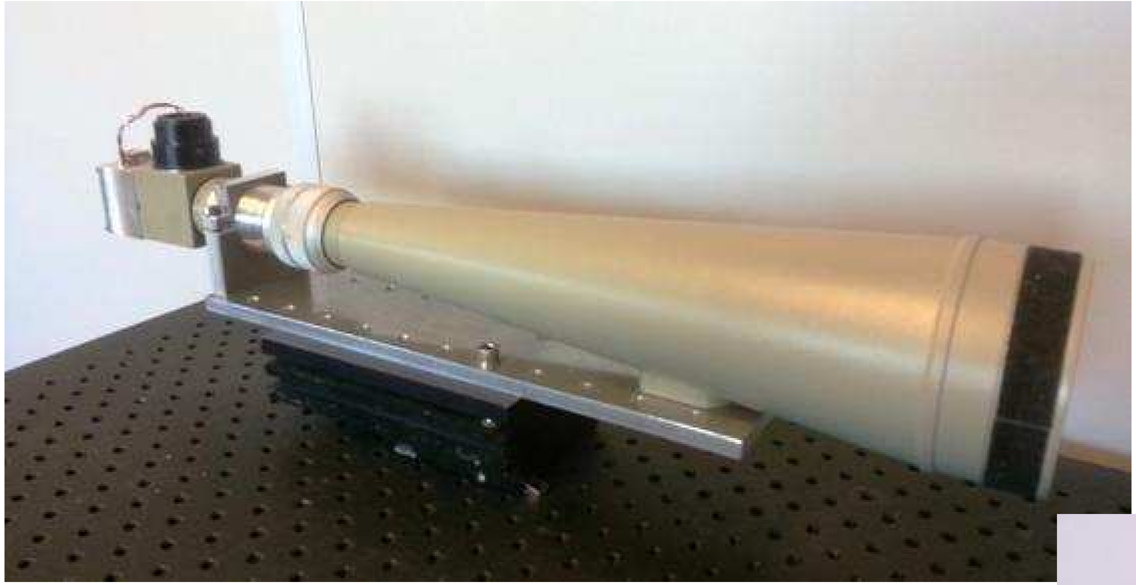


# Heating test of bent crystals at CERN

# Check of crystal bending at CERN



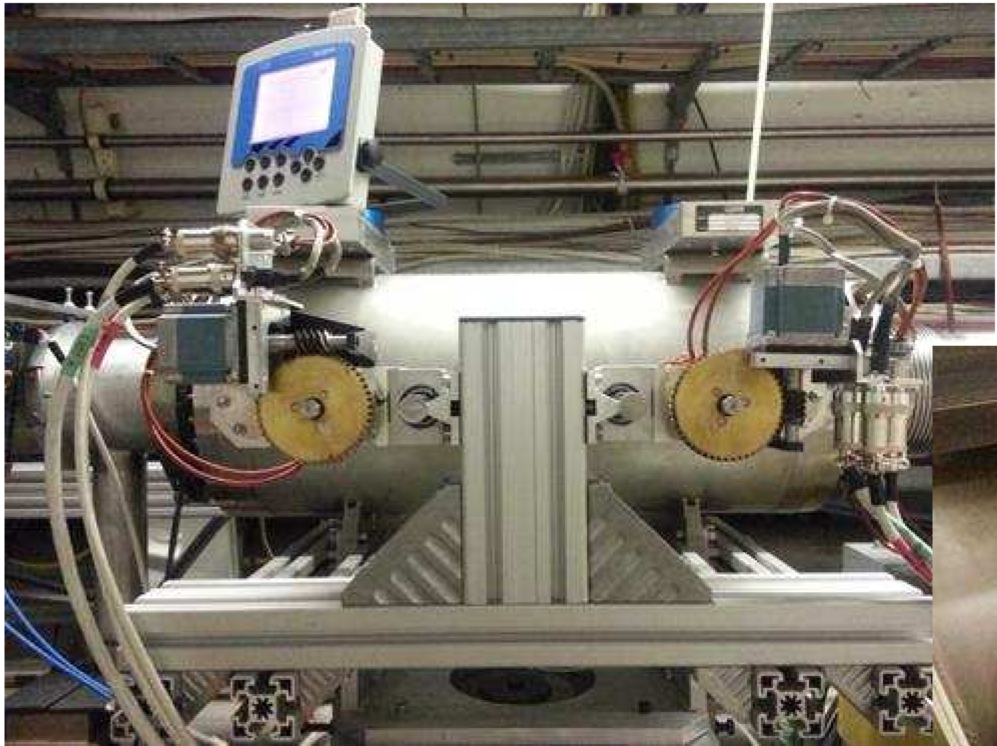
# Development of instrumentation to control crystal bending and positioning

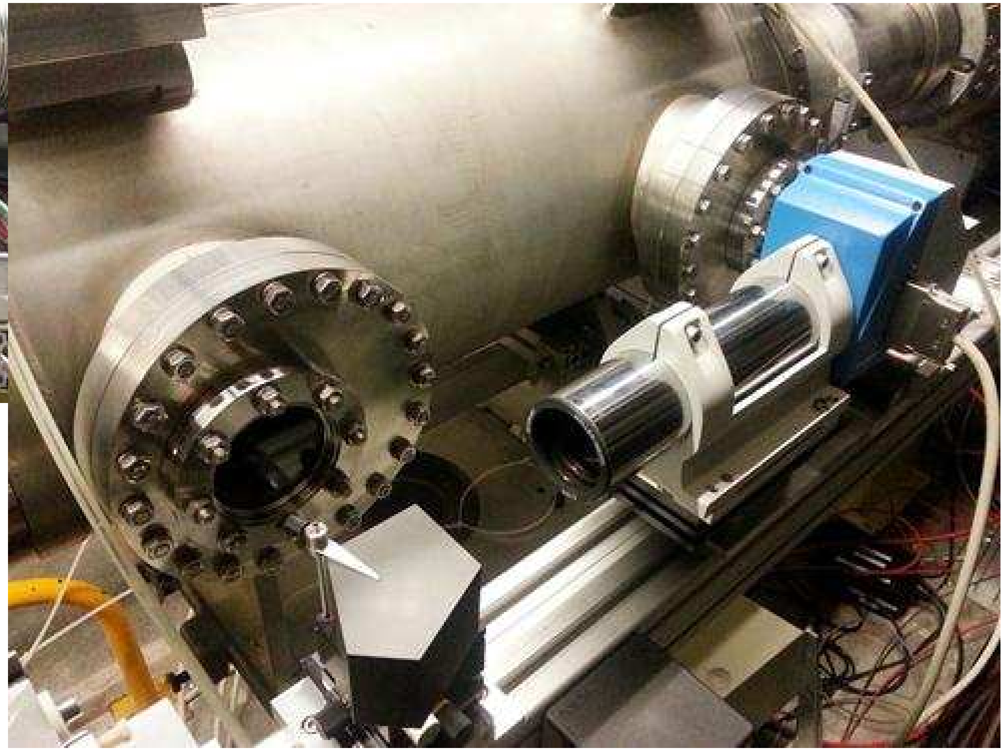


**Optical autocollimator with improved sensitivity**

**Laser autocollimator**

# SPS goniometers and alignment system





# Plans for 2014

- Installation of experimental setup with crystals in LHC by the end of March, 2014
- Upgrade and commissioning of experimental setup in SPS by the end of June
- 2-3 MD runs in SPS ring in July-December, 2014
- one week run in H8 to check twins of LHC crystals

# Publications in 2013

- **W.Scandale et al., Optimization of the crystal assisted collimation of the SPS beam, Physics Letters B726(2013)182–186**
- **W.Scandale et al., Measurement of the dechanneling length for high-energy negative pions, Physics Letters B 719 (2013) 70–73**

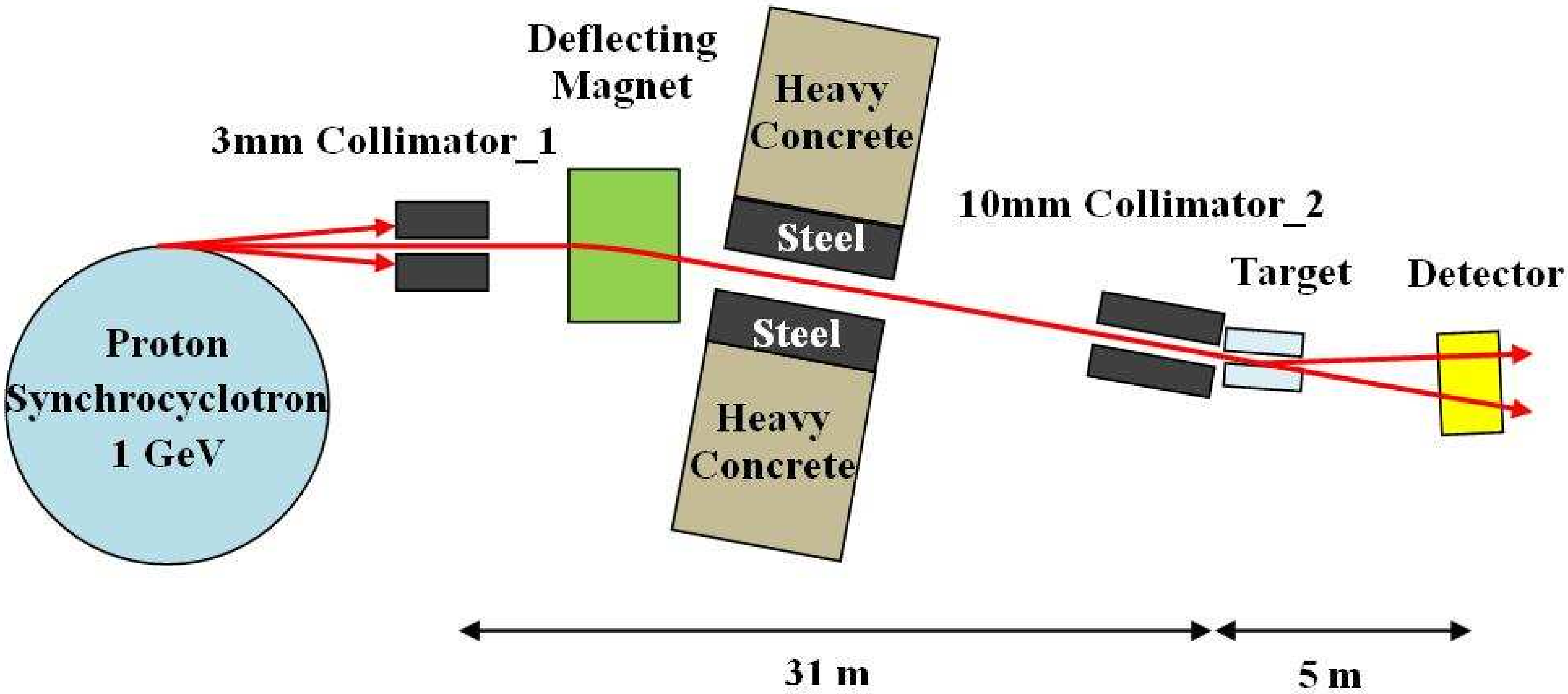
# Study of surface reflection of high energy protons from solids

- The H8-RD22 and UA9 made possible to start an experiment on beam crystal collimation at LHC (LUA9 Project).

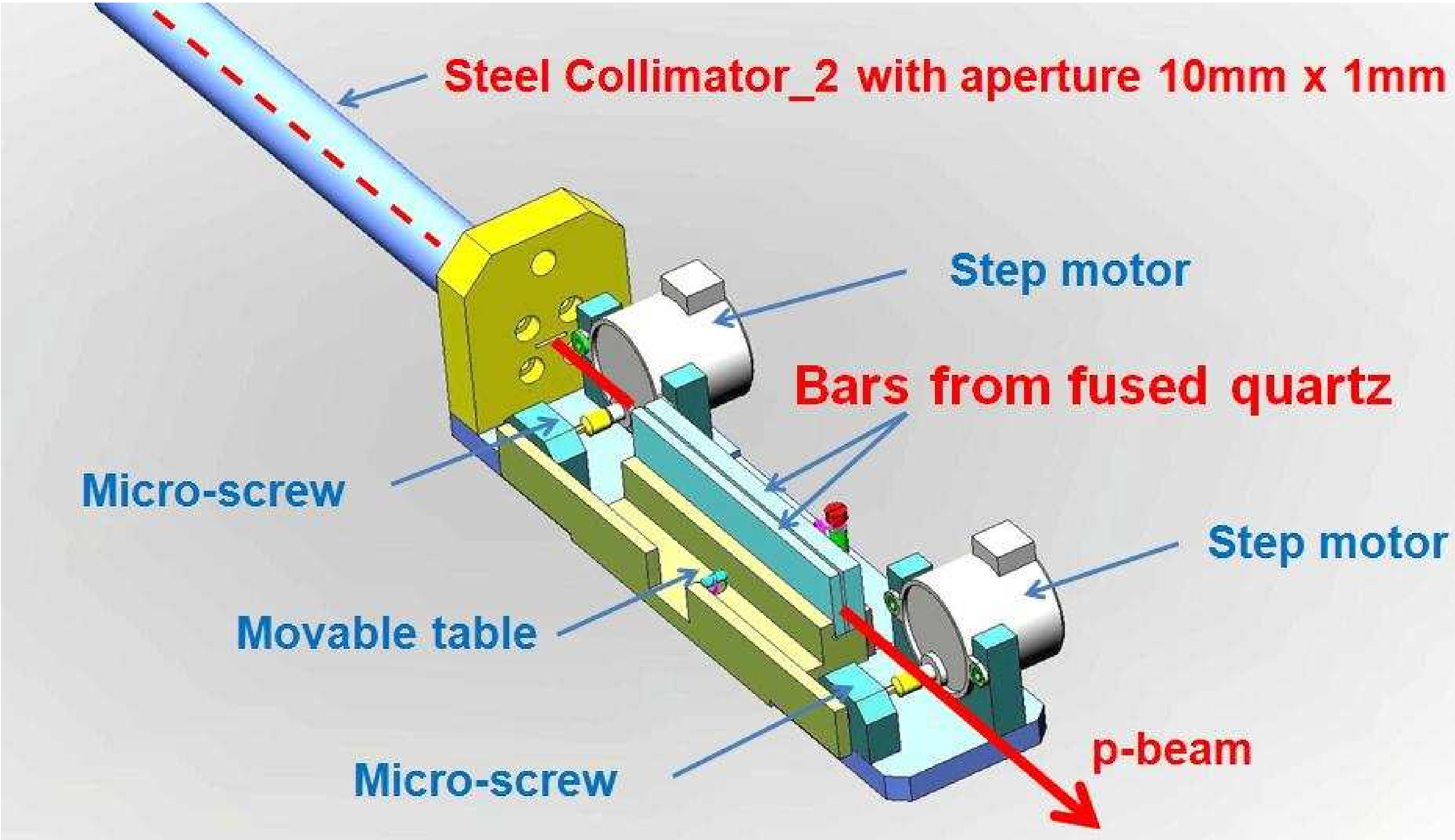
- In the collider, the circulating high energy particle beam spreads very slowly to the targets restricting the aperture of beam pipe (collimator, crystal etc.), so the first interaction of halo particle with the target takes place in the surface layer.

- The present study was done to clarify this interaction.

# Experimental layout at PNPI



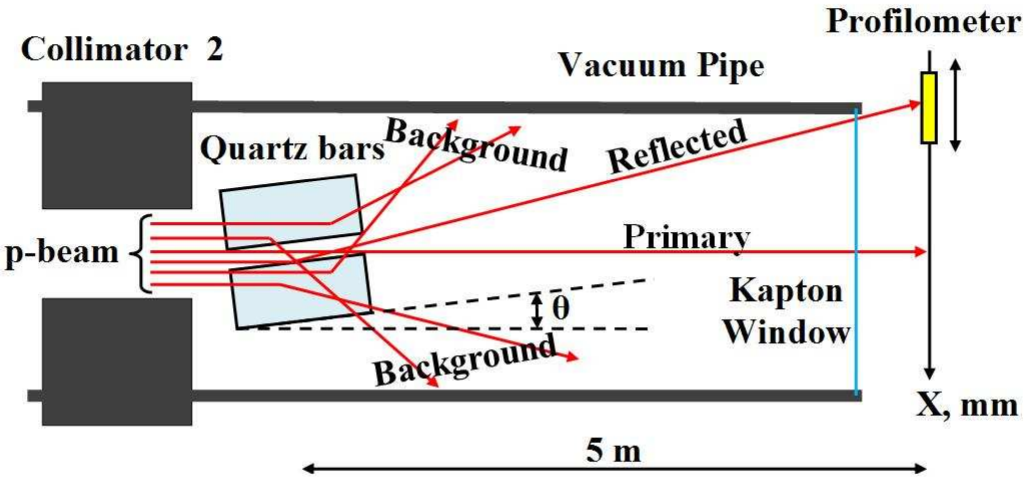
# Linear-rotary motion stage with samples

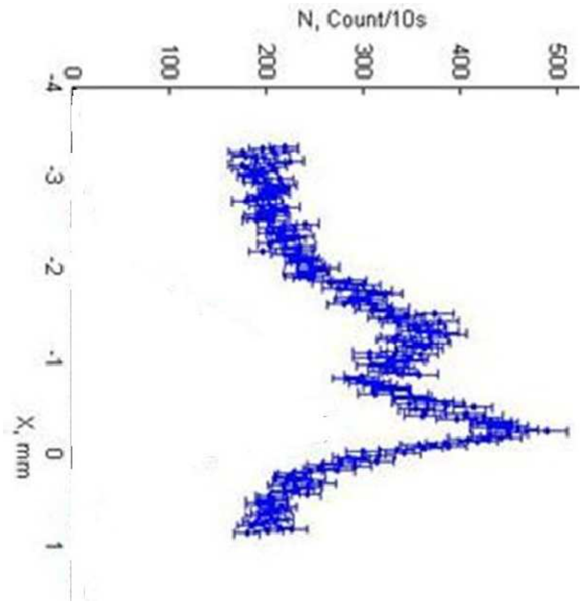


# Experimental details

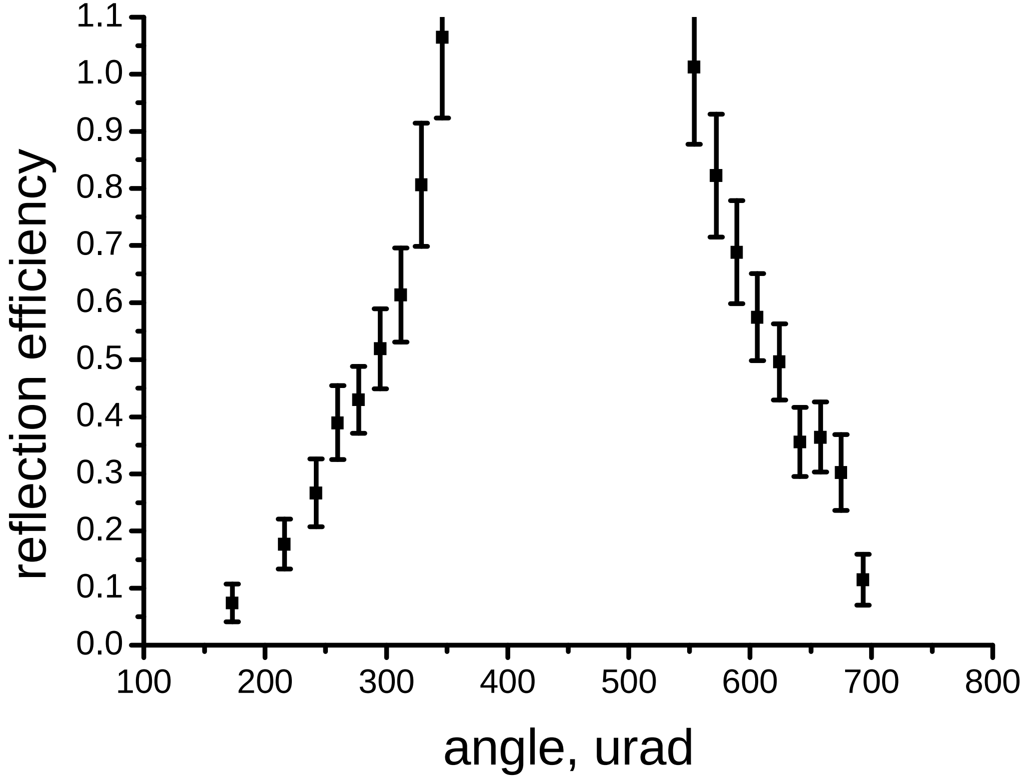
| | |
|---|---|
| **Beam divergence:** | **30 – 100 μrad** |
| **Aperture of collimator:** | **1mm x 4mm** |
| **Material of plates:** | **fused quartz** |
| **Sizes of plates:** | **8mm x 20mm x 100mm** |
| **Flatness of plates:** | **~ 0.1 μm** |
| **Width of gap between plates:** | **~ 15 μm** |
| **Angular range:** | **± 300 microradians** |
| **Sensitive area of beam scanner:** | **85μm x 850 μm** |

# Typical beam profile with two peaks



# Reflection efficiency in dependence on target angle

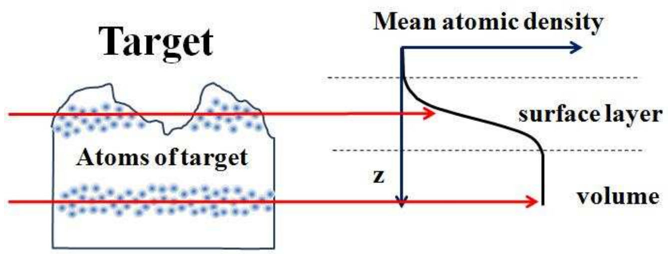


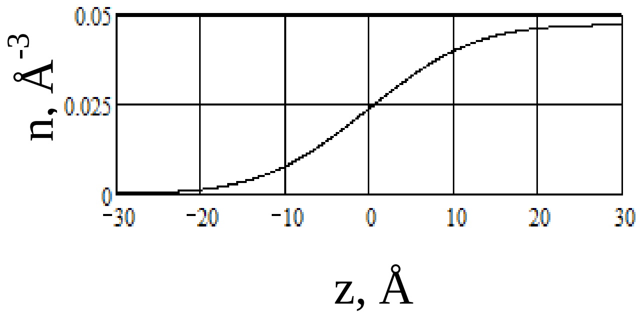
# Result for surface reflection of 1 GeV protons from quartz plate

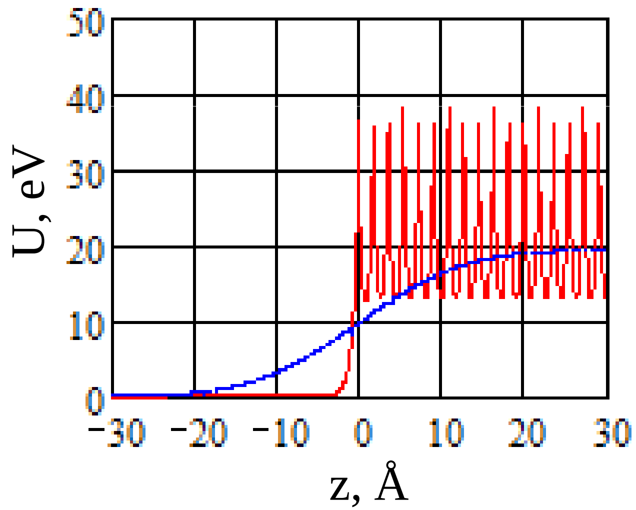
**For probability of surface reflection ~0.7 , the mean deflection angle of reflected protons is ~ 260 μrad**

**It is comparable with the volume reflection case!**

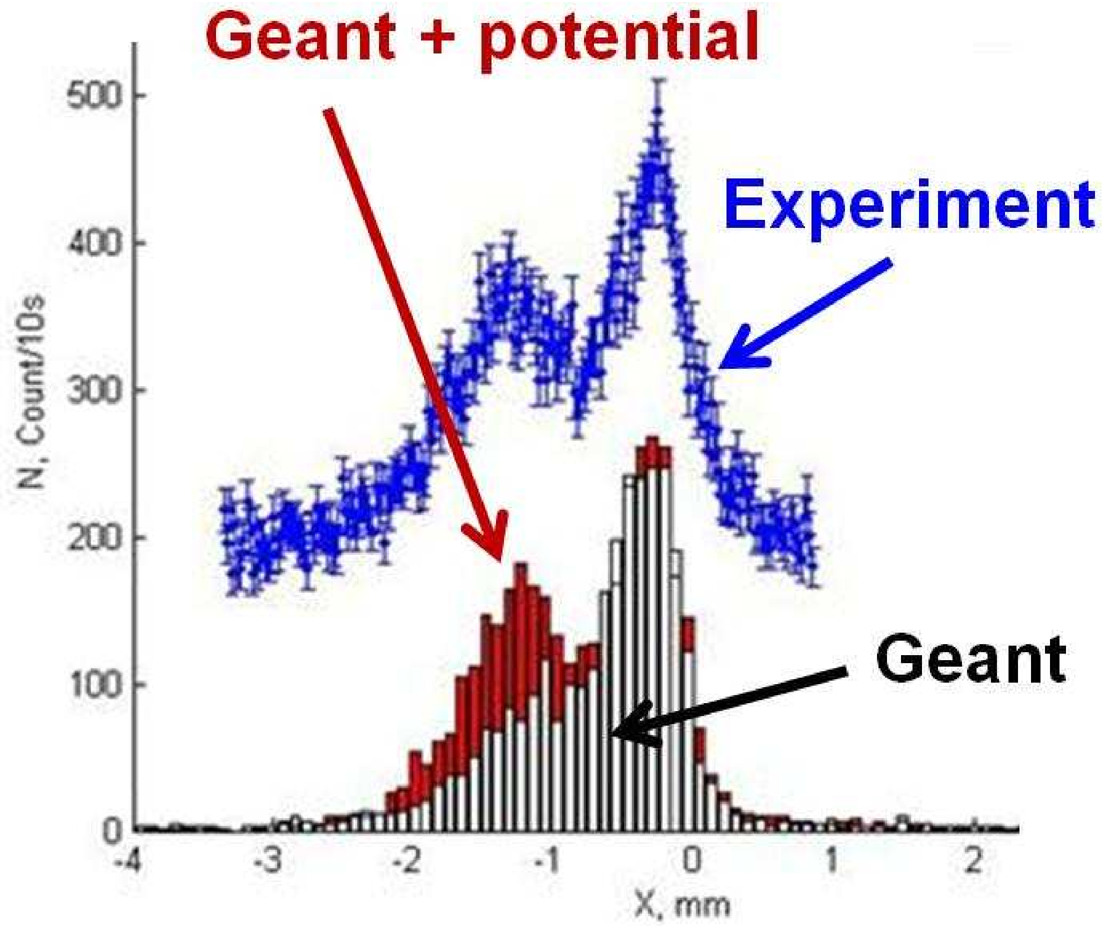
# The model to describe rough suffface and comparison with ideal crystal



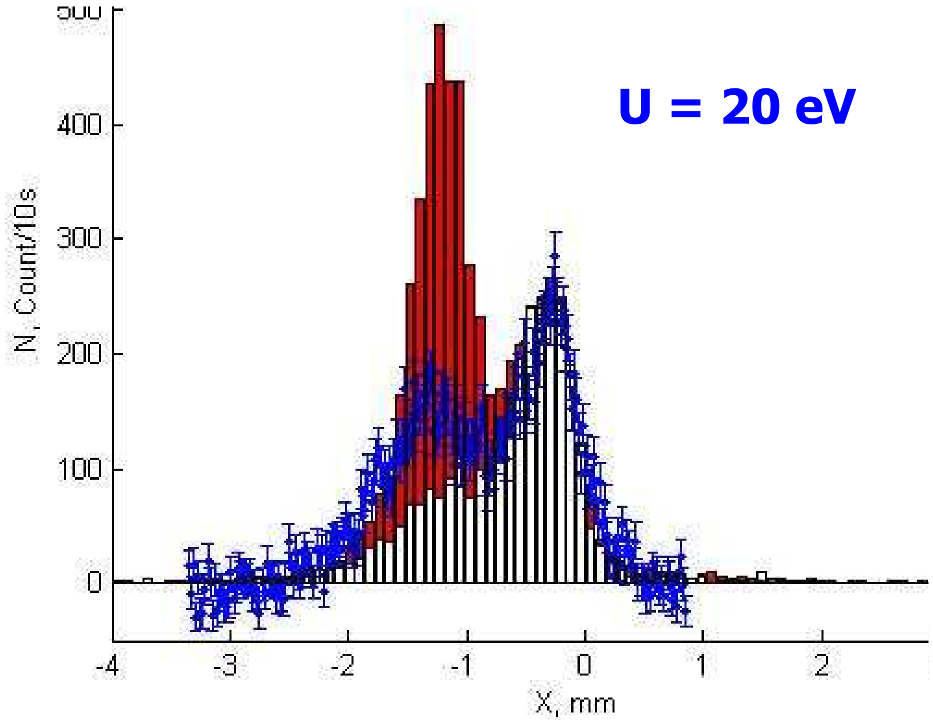



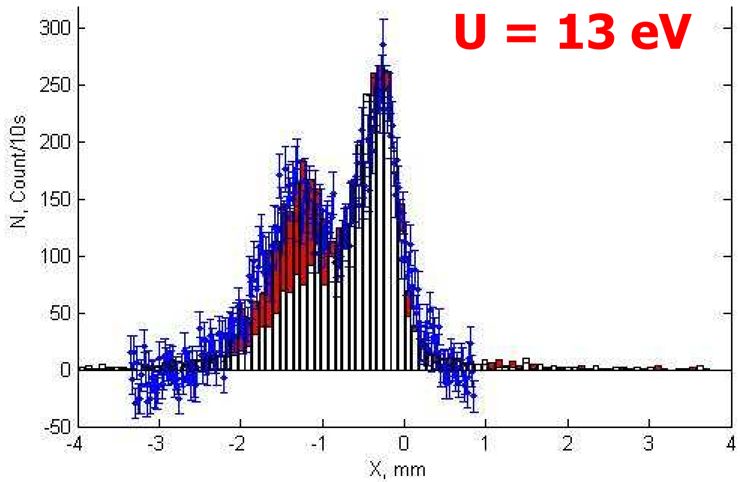



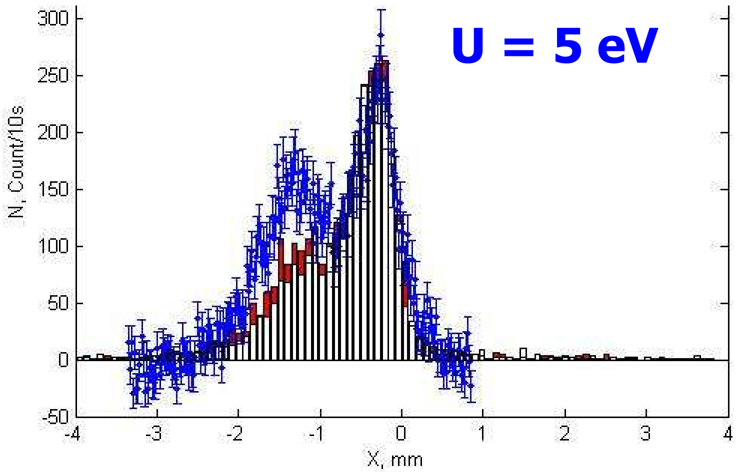
# Collimation with small gaps



# Geant calculations with different values of effective potential




**Estimation of effective potential**

# U ≈ 13 eV

# Conclusions

- **We have found that solid surface with roughness which is much more than atomic distance well reflects high energy protons.**

- **This reflection can be described with the model of continuous  potential.**

- **The origin of the potential barrier is the density gradient across the solid boundary.**

- **The value of the potential barrier is comparable with the value of internal potential of solids.**