

IHEP CRYSTALS

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Fabrication technologies of IHEP crystals.

Applications of IHEP crystals

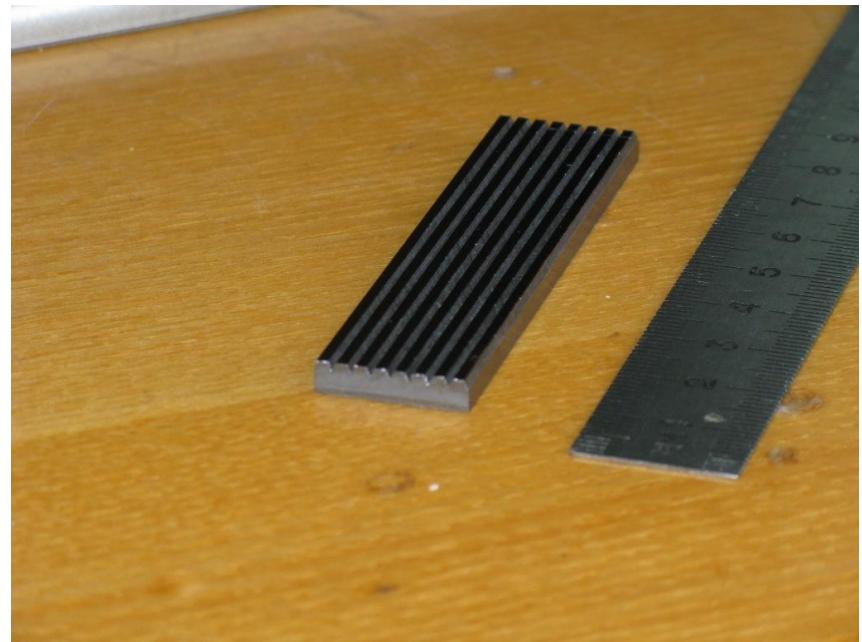
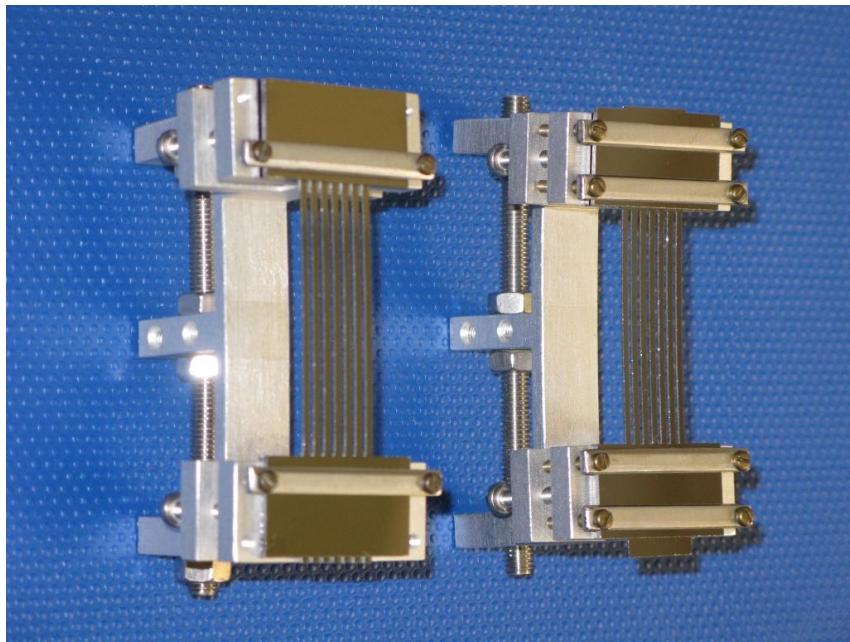
Optimization of crystal parameters for beam extraction from
IHEP accelerator.

Our recommendation for extraction of 120 GeV proton beam
from SPS.

IHEP technologies for production of multi-crystals.

UA9 meeting, CERN, Geneve,
2010

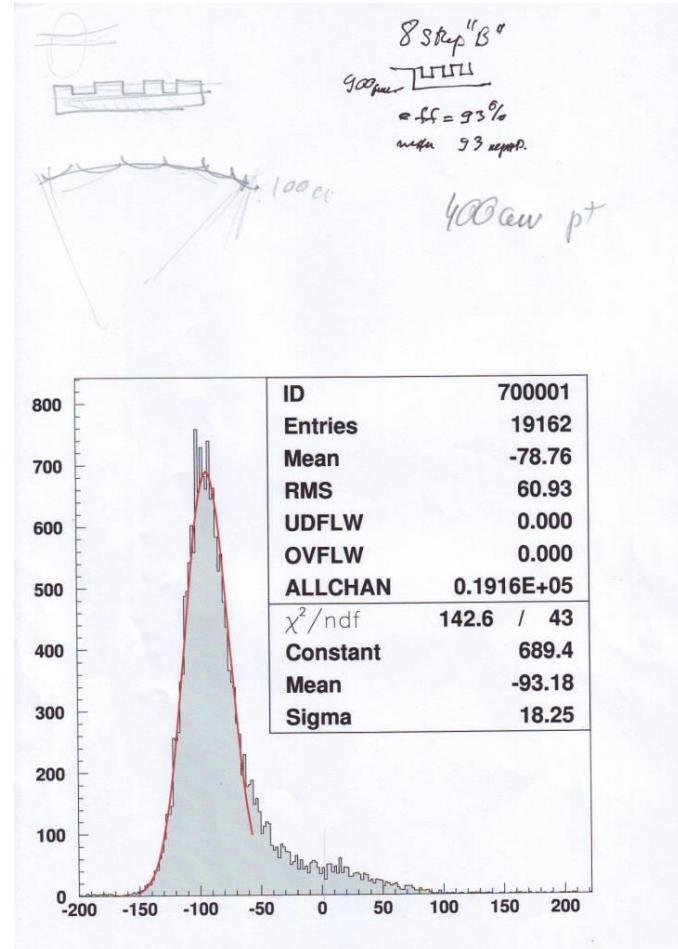
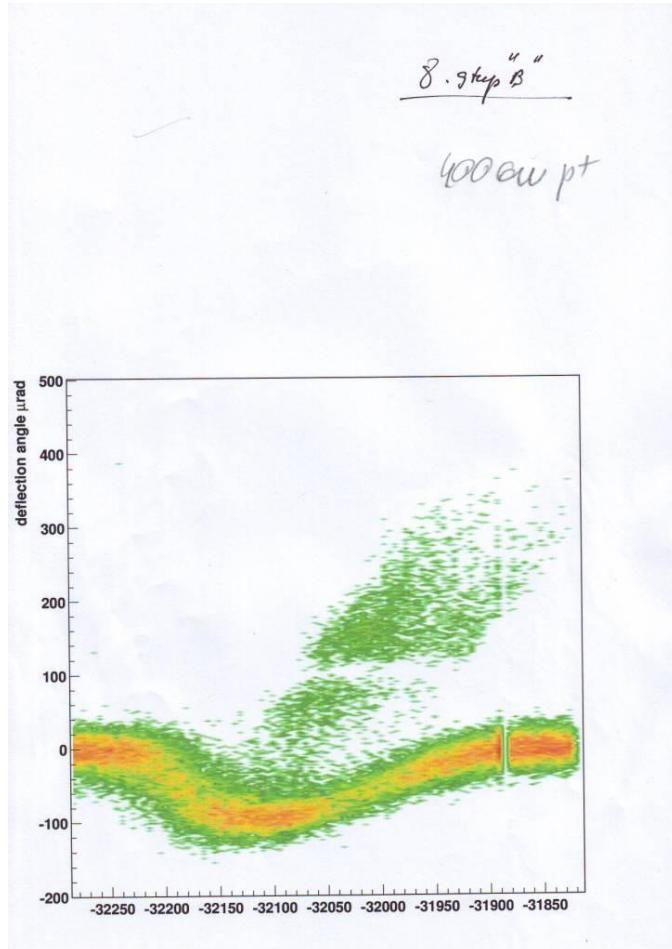
A-B-C technologies



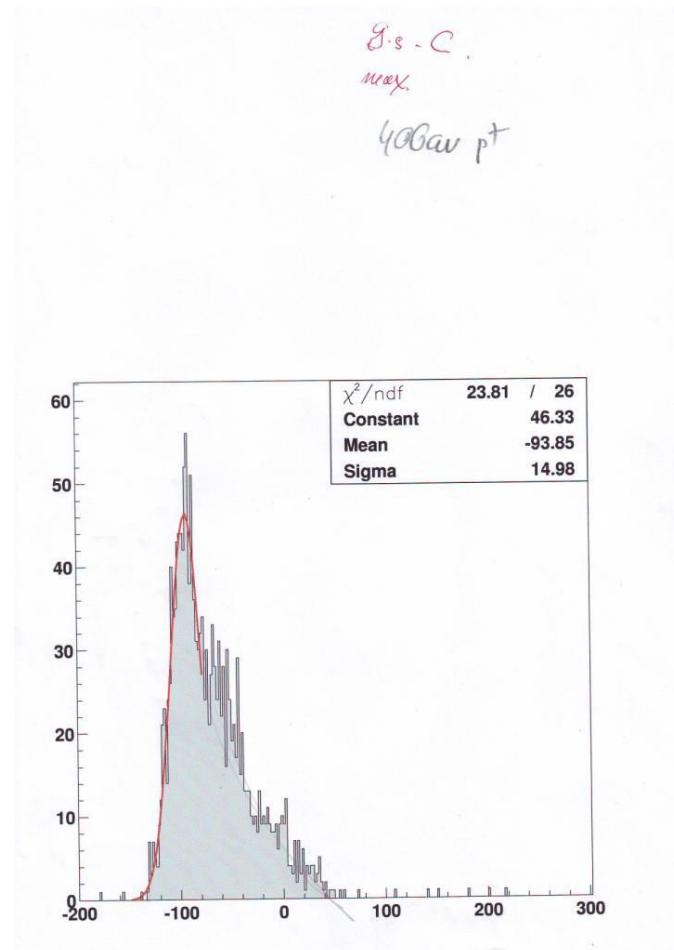
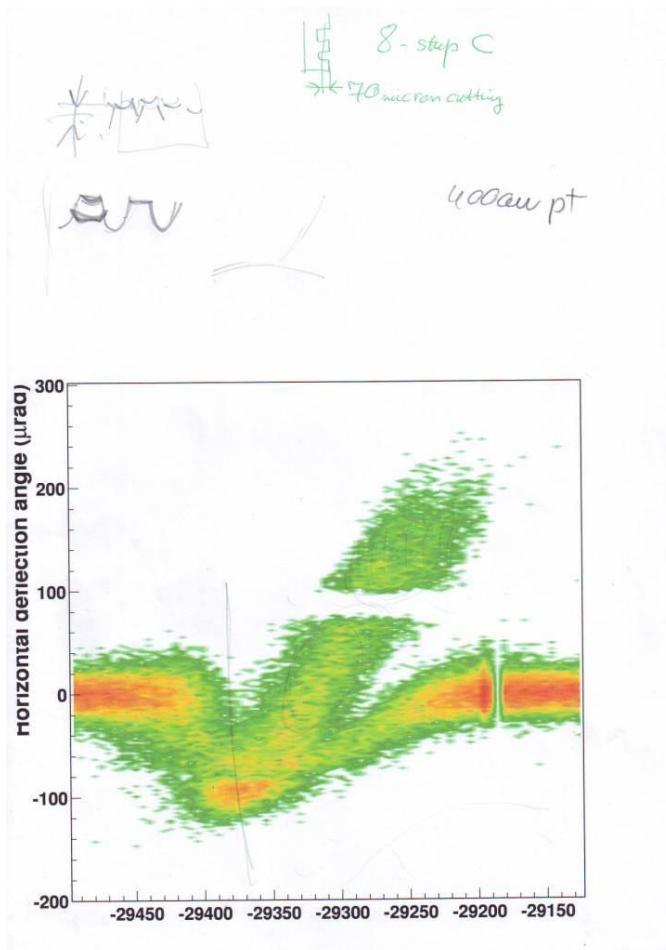
A- production of bending due to anticlastic effect, C- bending effect due to Mechanical trenches, B – combined effect

GA9 meeting, CERN, Geneve,
2010

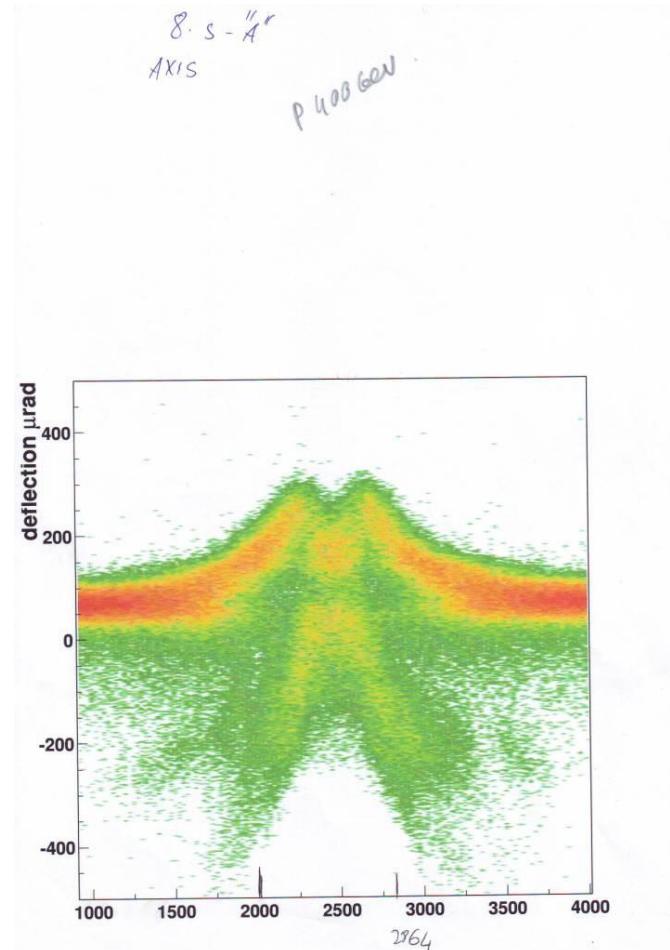
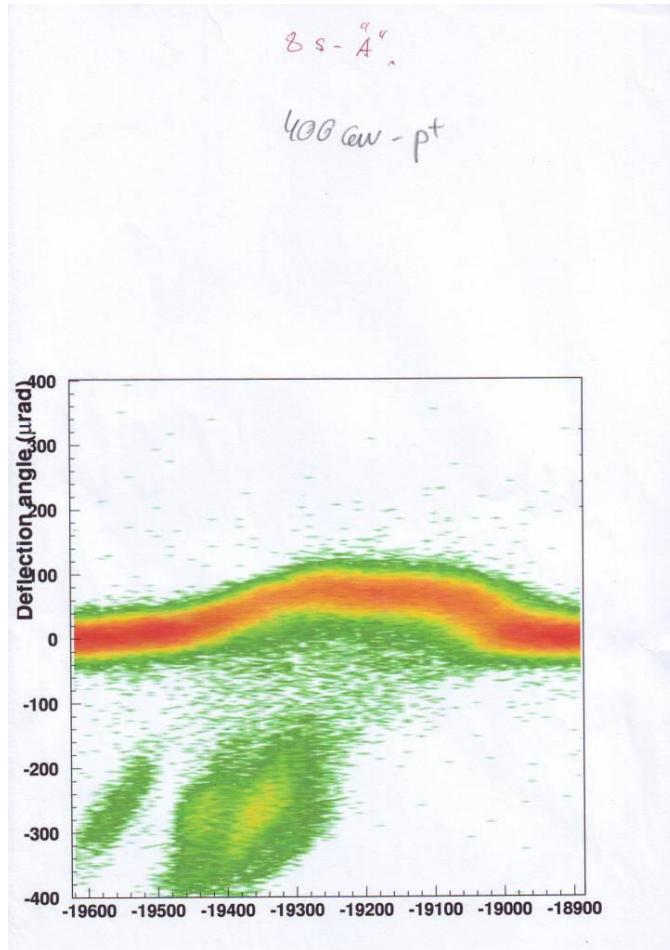
Testing of B-technology, 400 GeV/C protons



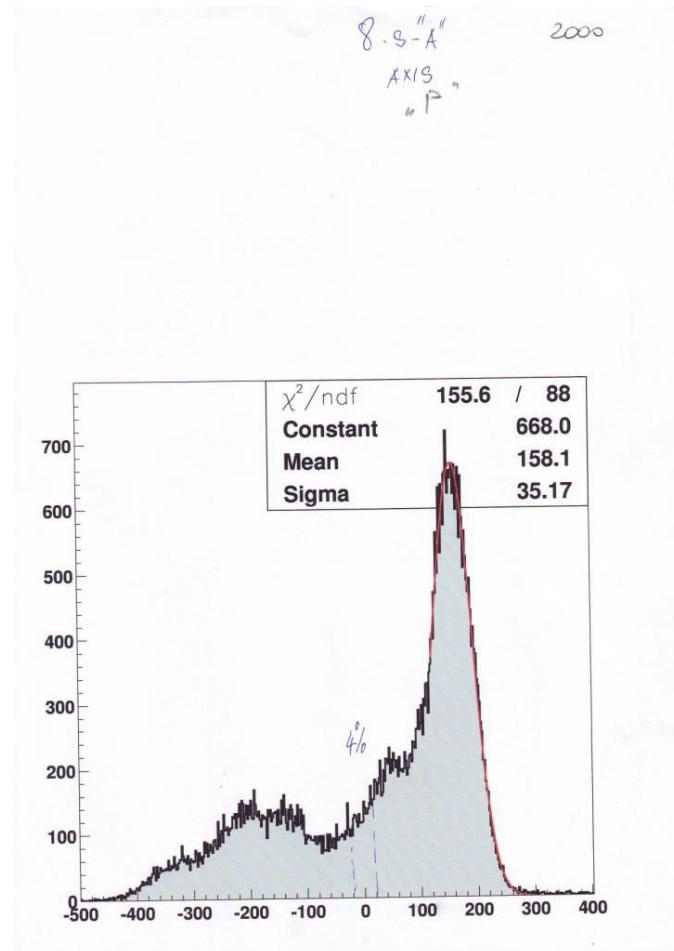
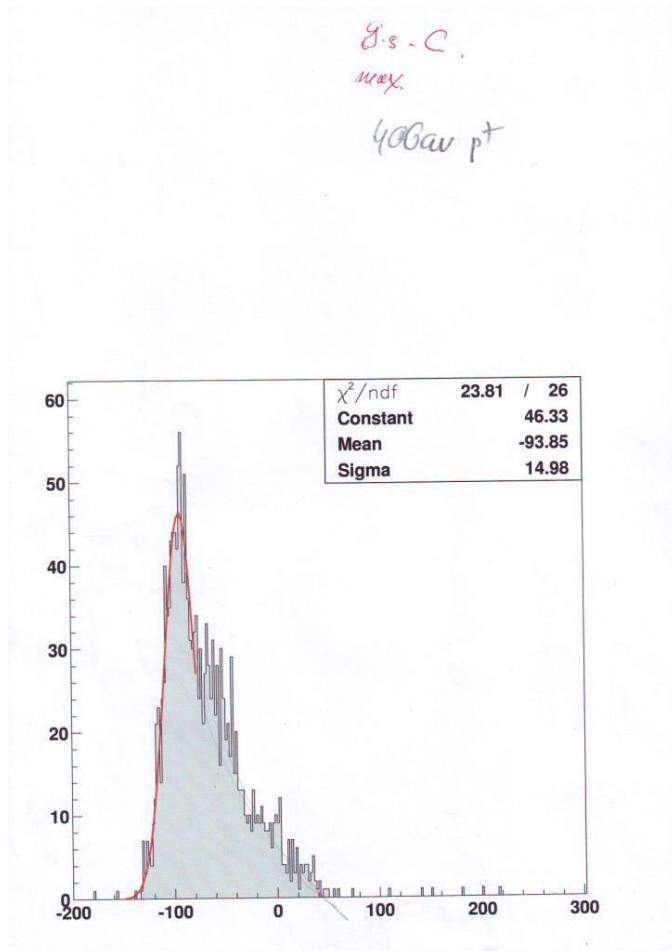
C-tecnology, 400 GeV/C protons



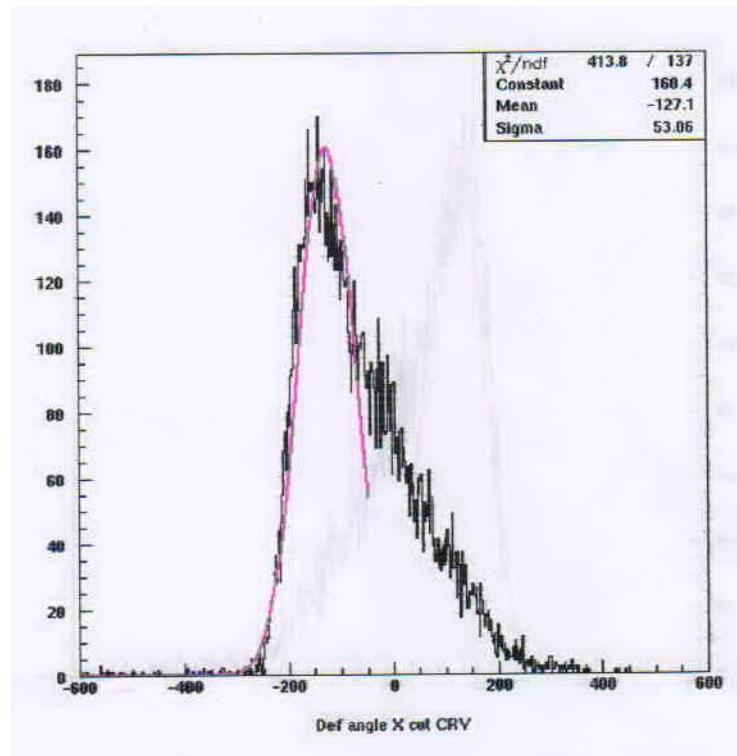
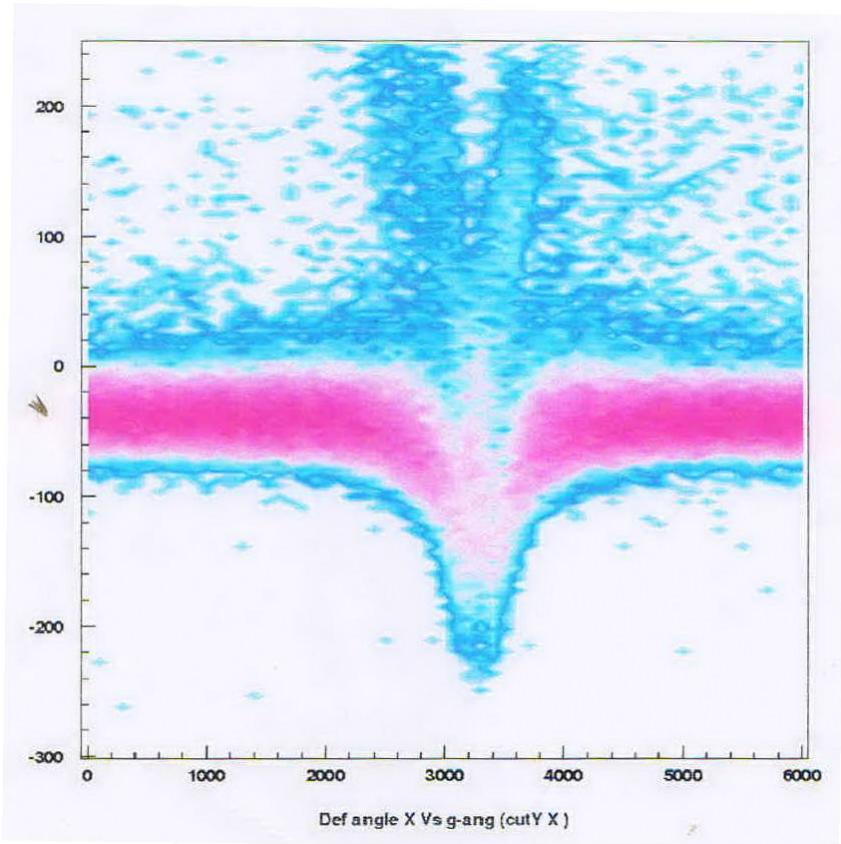
Enhancement of bending due to axial effect (7 strip data)



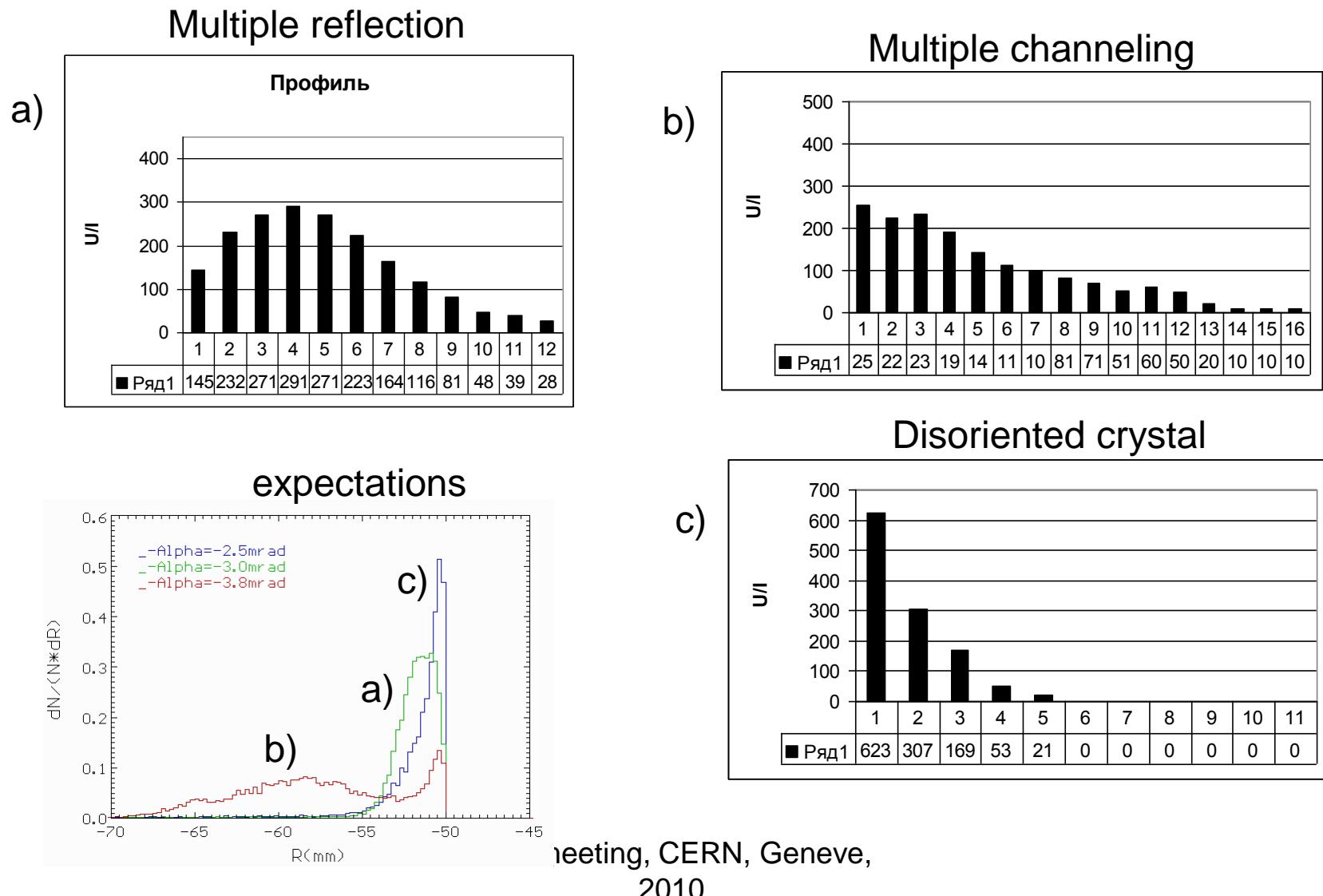
projections



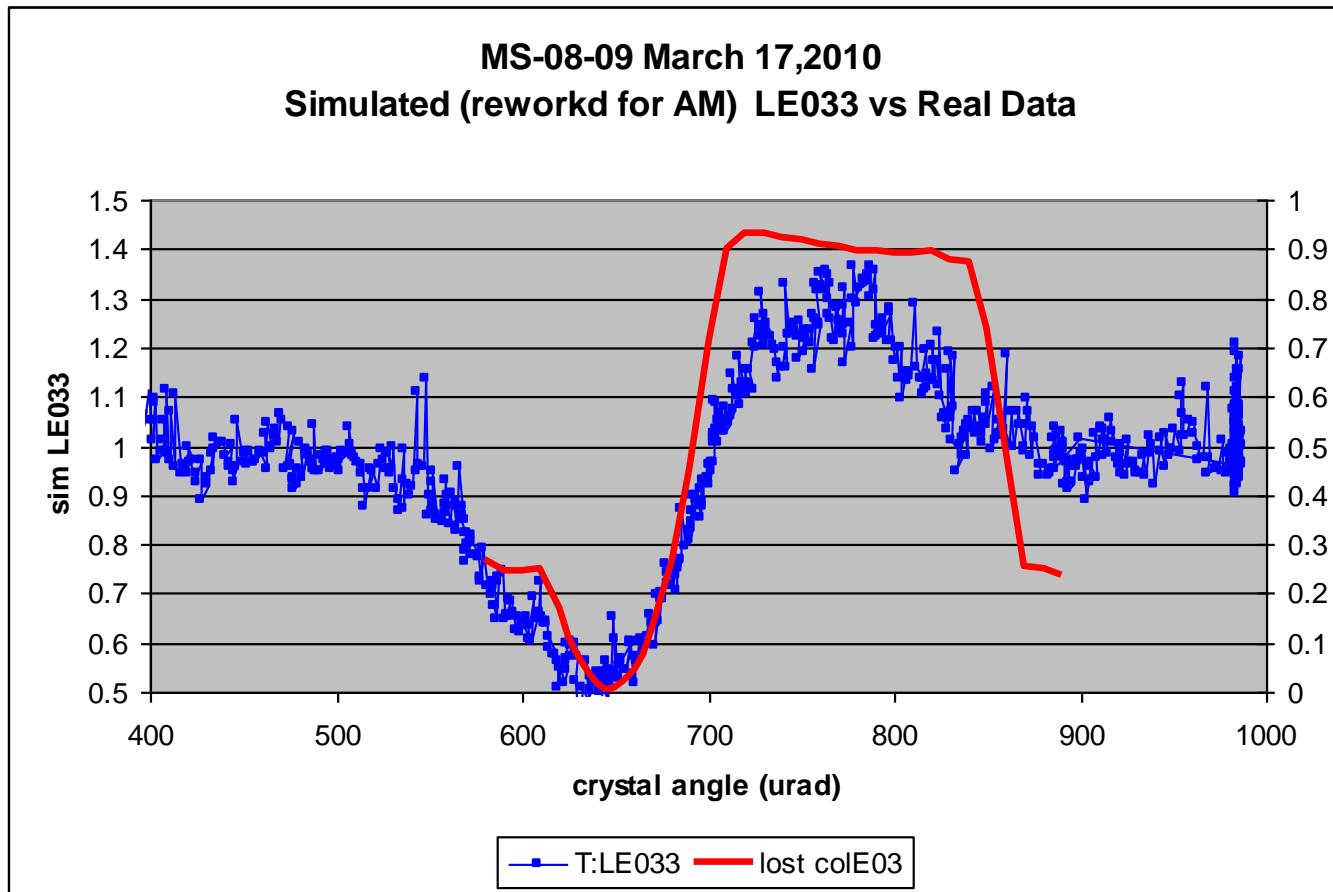
Testing of 4 strip



Application of multistrip (A) in U-70. Measured beam profiles at absorber entry, run april-2008.



Application of multistrip (B) in the Tevatron (slide from V.Shiltsev report in IPAC 10).

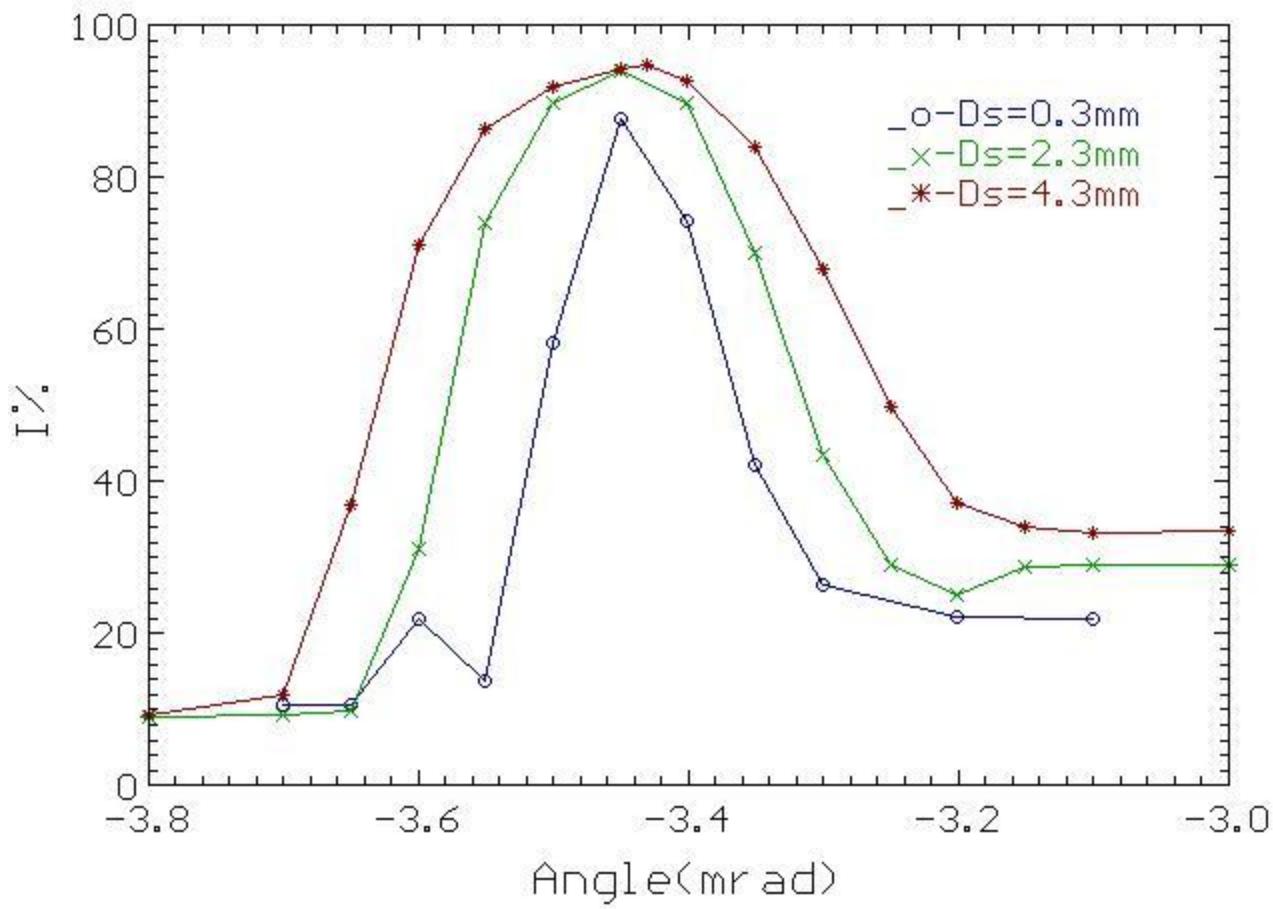


Last measurements of extraction efficiency for IHEP accelerator give approximately 90 % for this parameter at proton energy equal to 50 GeV. The single strip silicon crystal of planar (111) orientation was used for this aim. Its thickness was 1 mm, and bending angle was ≈ 1 mrad.

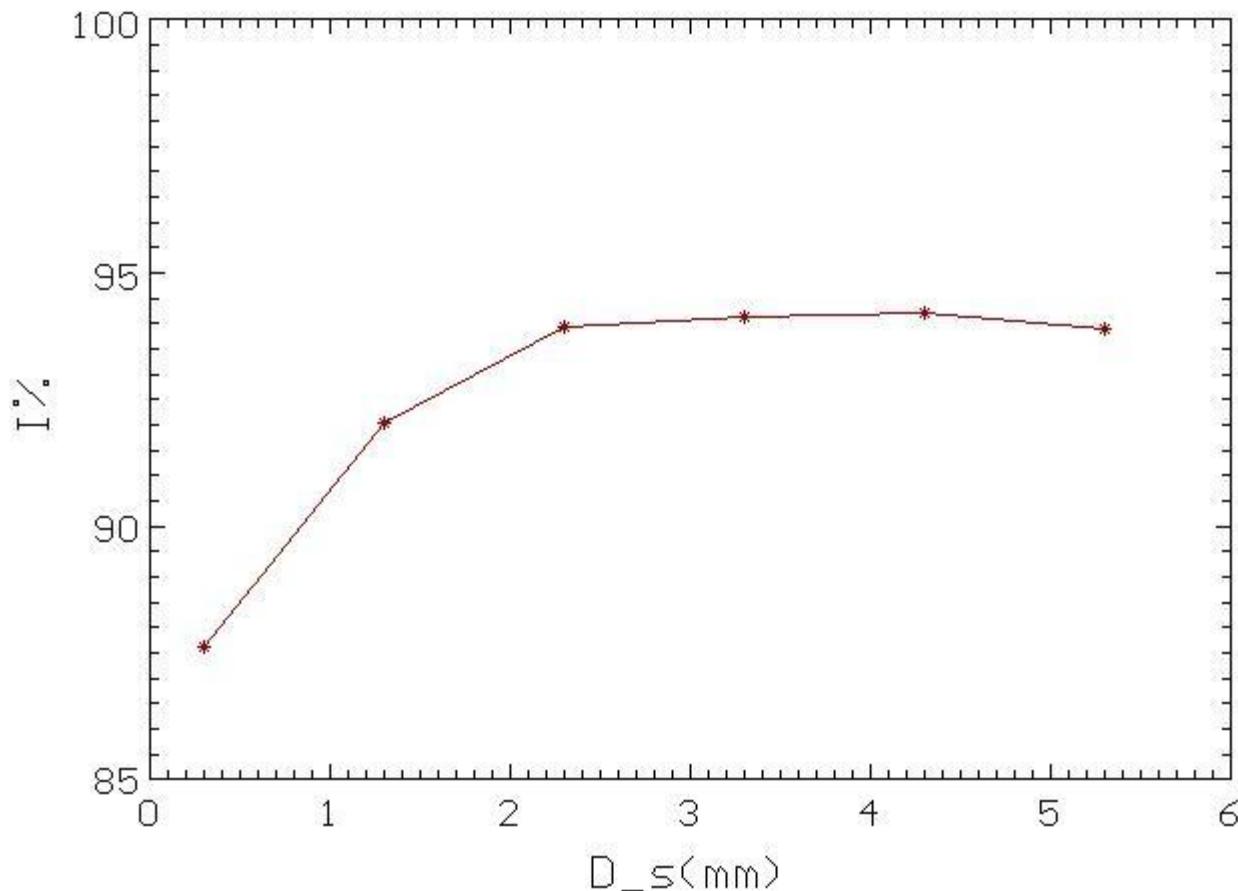
The simulations of extraction were performed for conditions of IHEP accelerator by Monte Carlo method (I. Yazynin).

Performed optimization gives the following result

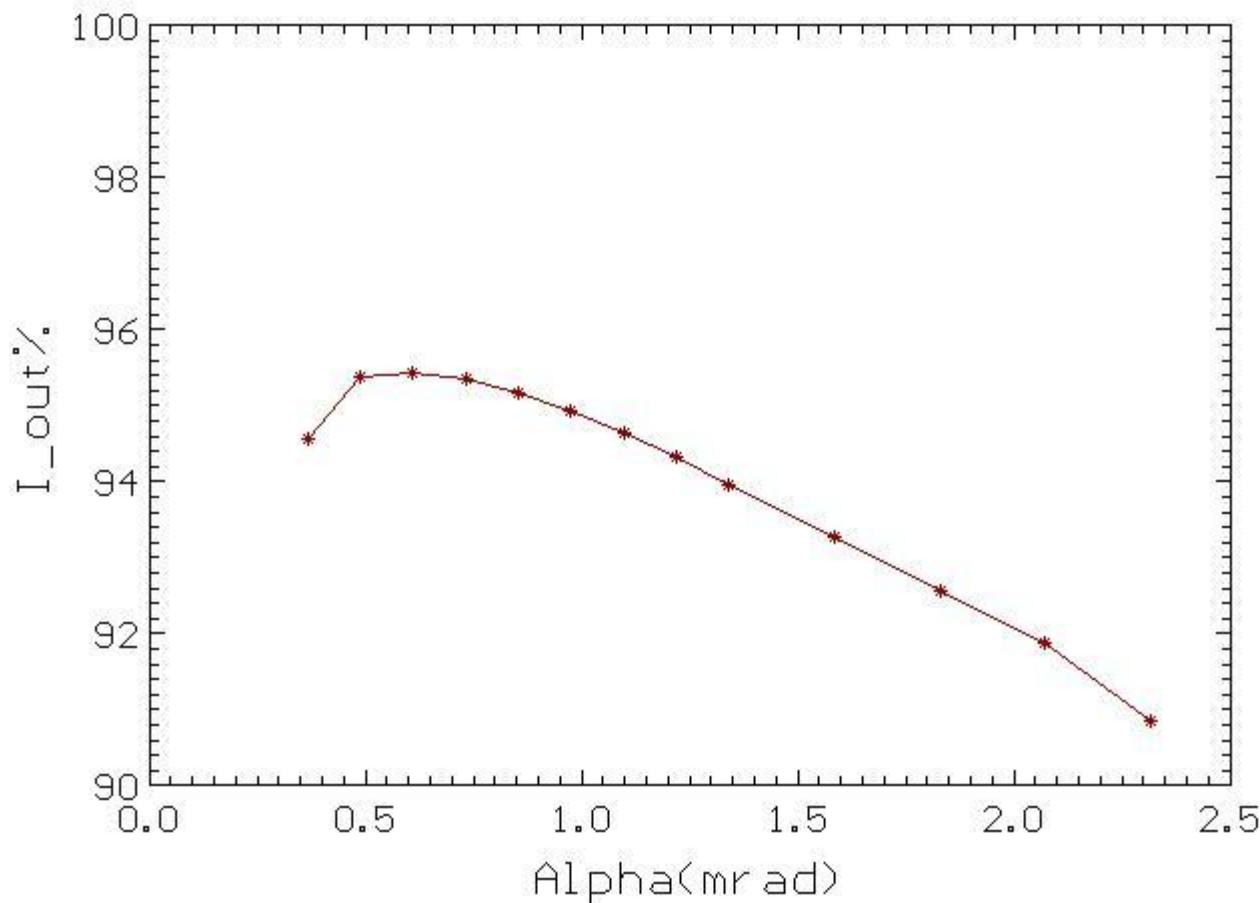
For (111) planar orientation the optimal crystal should be 0.7-0.8 mm of a length with the bending radius equal to 0.6-0.7 meters (about 7-8 critical radii). In this case the optimal calculated efficiency of extraction is equal to $\approx 95\%$.



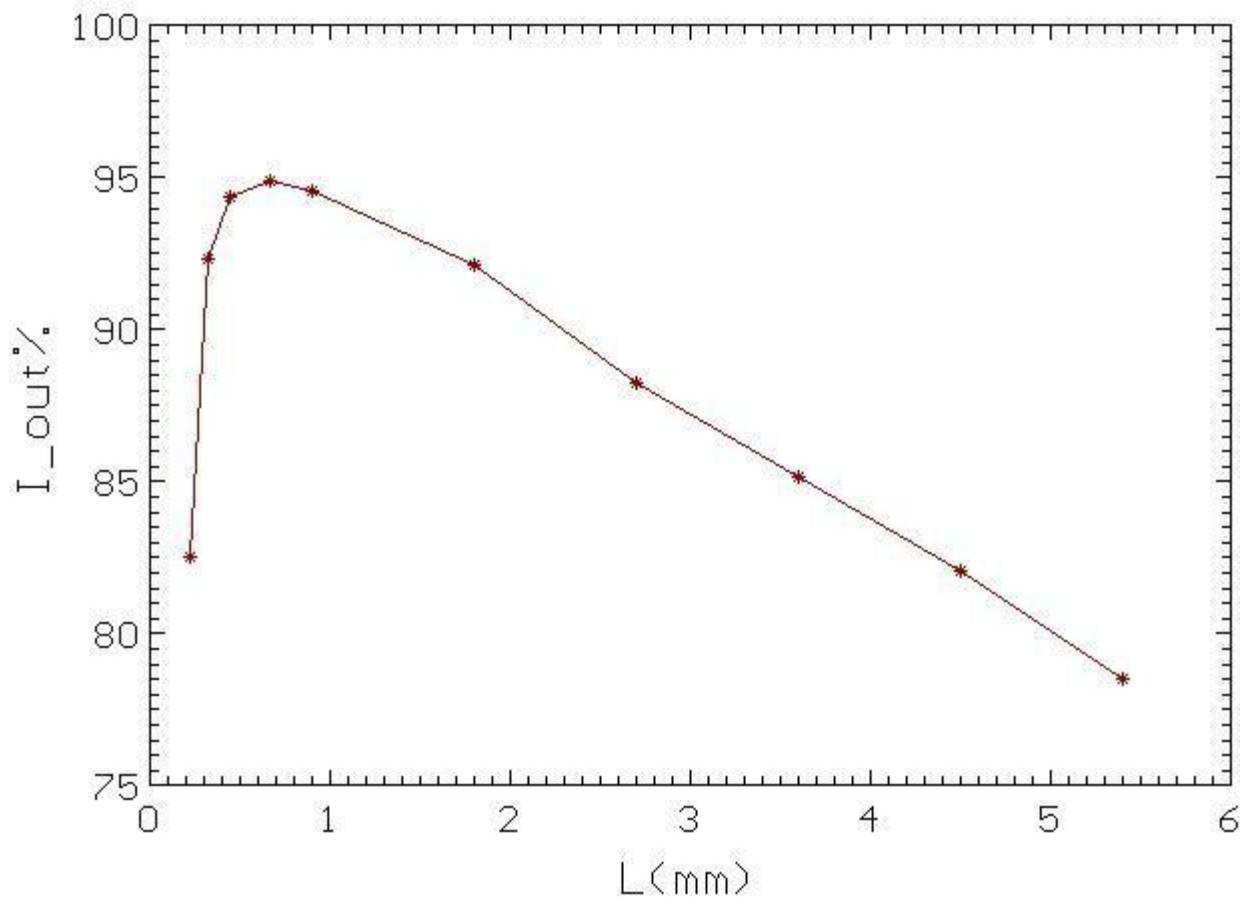
Orientation curves of extraction efficiency with some offsets.



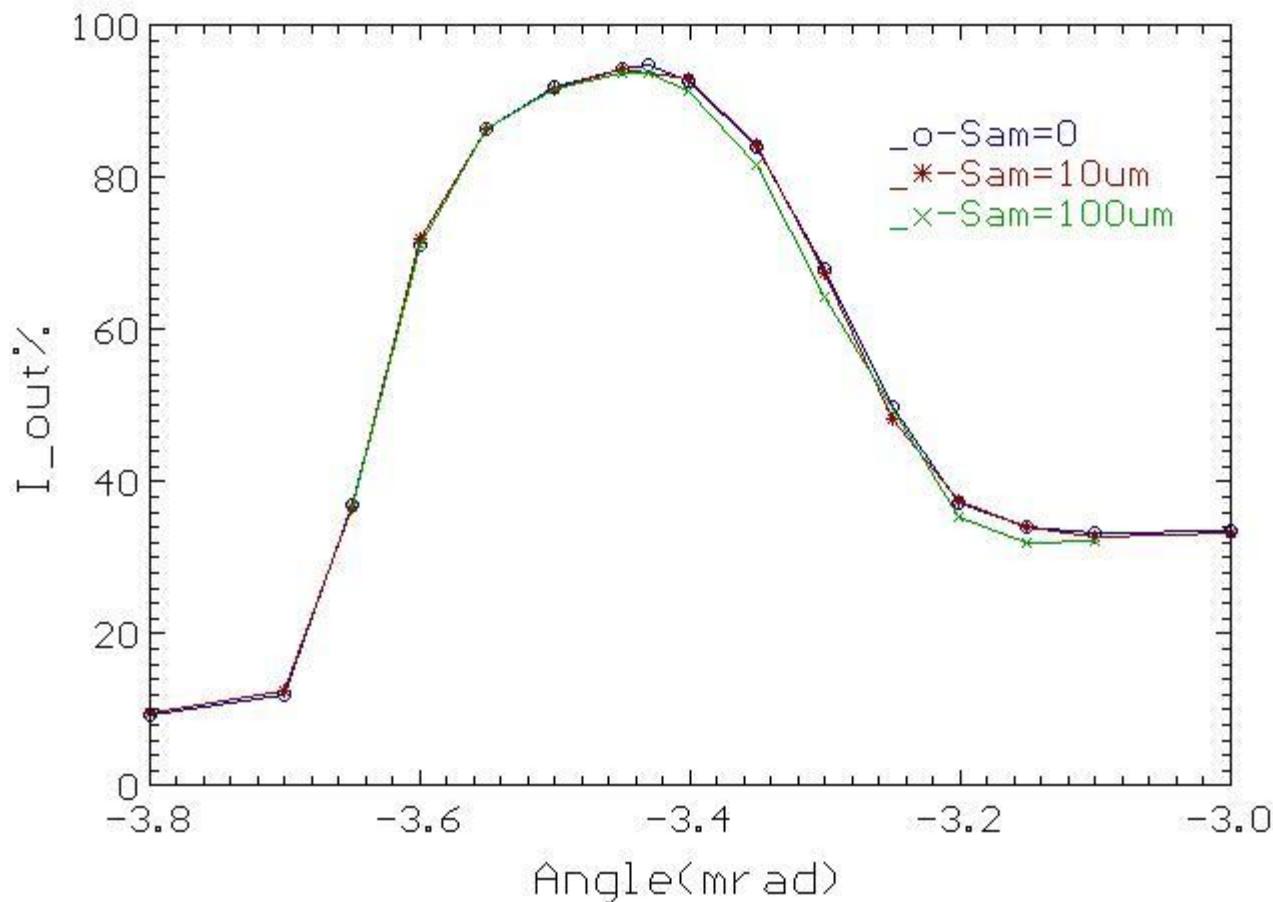
Extraction efficiency versus offset.



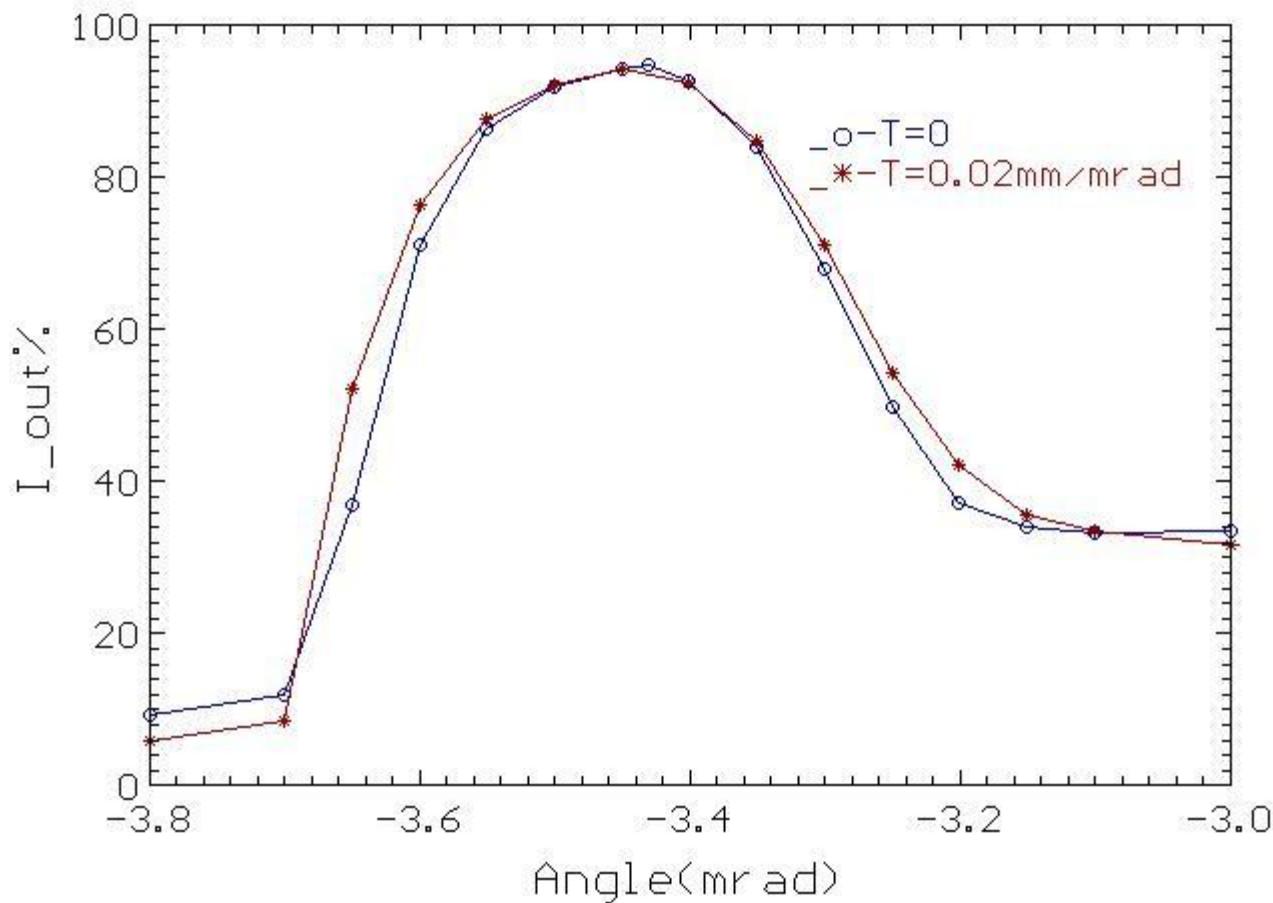
**Extraction efficiency versus bend angle of crystal with constant curve
radius R = 0.82 m.**



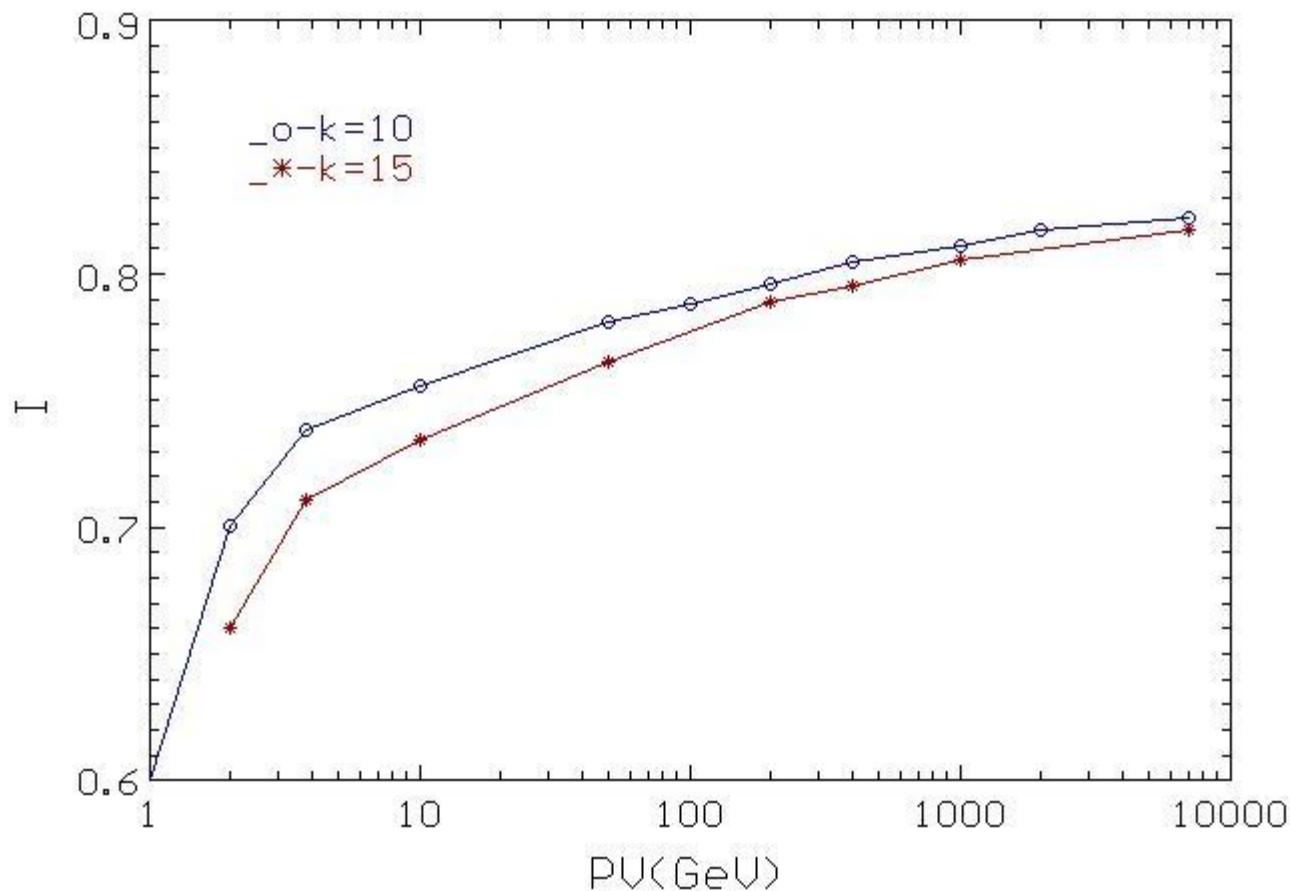
Extraction efficiency versus length of crystal with constant bend angle 1.1 mrad.



Dependence of extraction efficiency from thickness of amorphous layer of crystal.



Dependence of extraction efficiency from torsion parameter.



The intensity of channeling fraction versus momentum of proton in single passage. For characteristic emittance 4 mm mrad and beta function of 100 m .

Analytical consideration of the volume capture.

This consideration one can find in the paper

Yu.A. Chesnokov, V.A. Maisheev and I.A. Yazynin. ArXiv:0808.1486

For the probability of volume capture we got the following simple equation:

$$\varepsilon_1 \approx \frac{1.39 A U_0^{\frac{1}{4}} J_p}{2^{\frac{7}{4}} \sqrt{\pi} E_0^{\frac{1}{4}} \mathcal{E}_{max} d^{\frac{1}{2}} X_0^{\frac{1}{2}}} \left(\frac{R}{R_c} - \frac{R_1}{R_c} \right), \quad (1)$$

where U_0 and \mathcal{E}_{max} are the potential barrier and maximal value of planar electric field,

E_0 is the energy of proton beam,

$A \approx 11$ MeV,

R abd R_c are the bending radius and its critical value,

$R_1/R_c \approx 0.7$,

d is the interplanar distance,

J is the constant value for specific planes of a single crystal ($J = 1.49$ for the (110) plane of silicon).

X_0 is the radiation length of single crystal.

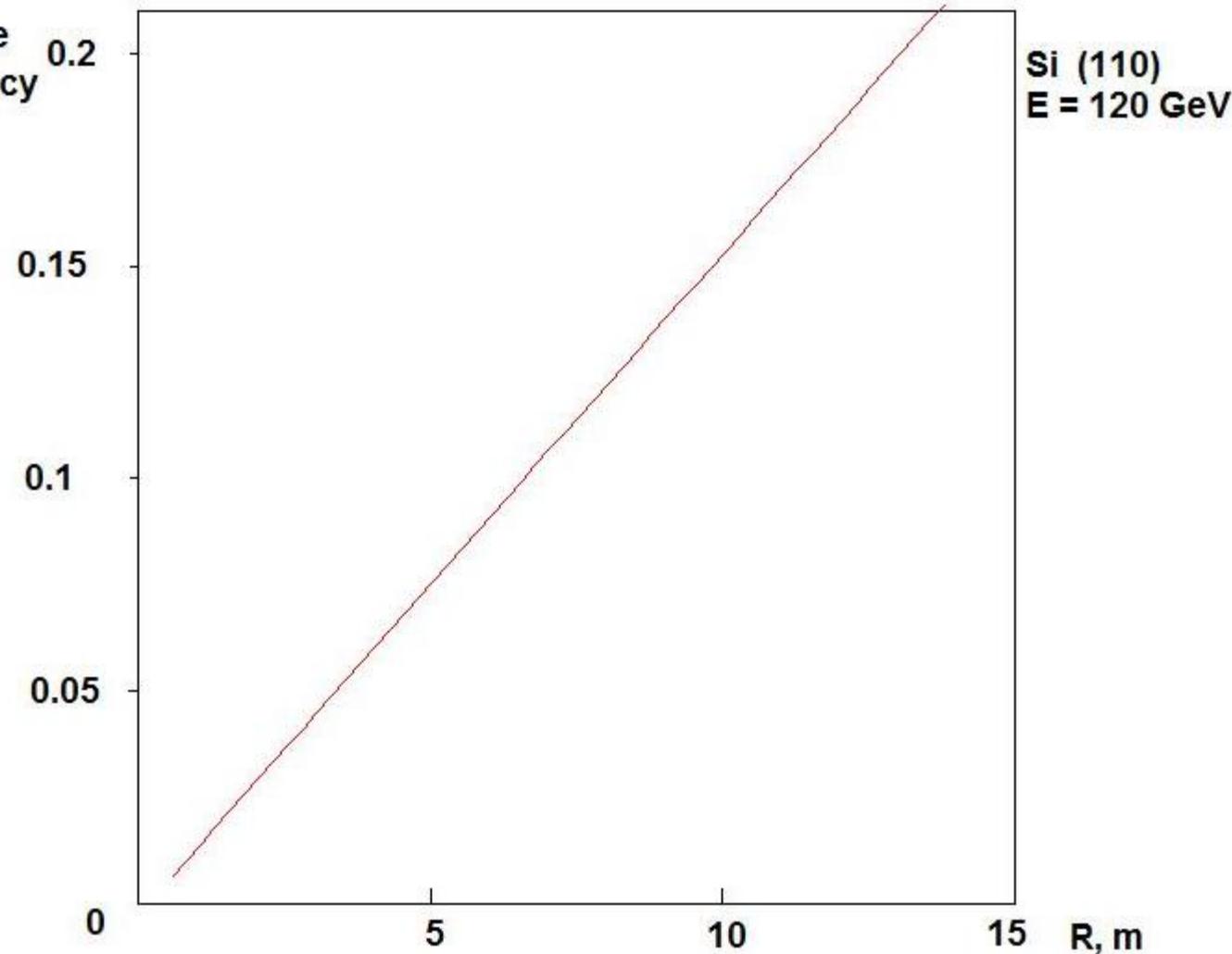
Eq.(1) is valid for bending radii $1.5R_c < R < 30 - 50R_c$

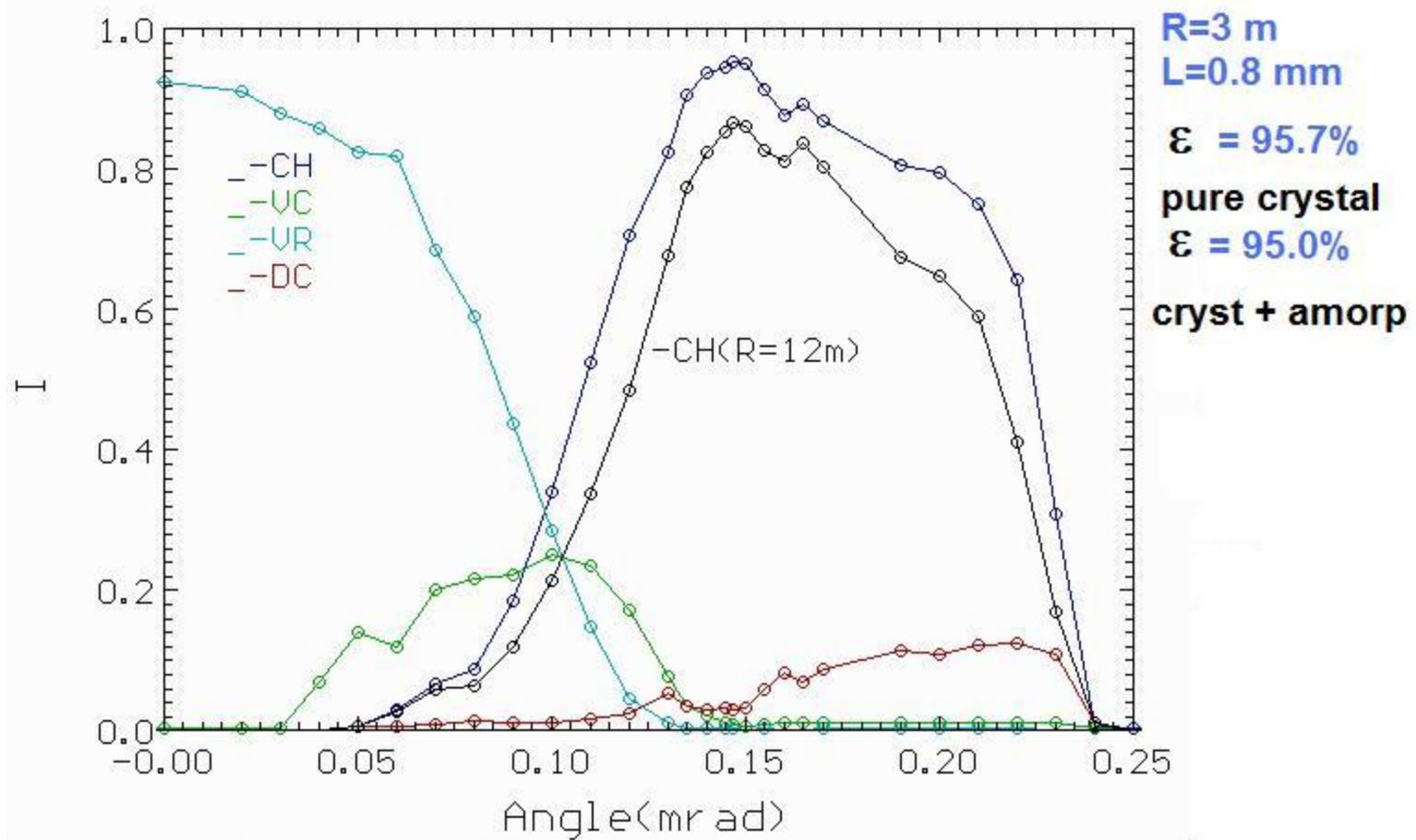
For silicon (110) plane Eq.(1) reads

$$\bar{\varepsilon}_1 \approx \frac{0.01}{E_0^{1/4}} \left(\frac{R}{R_c} - \frac{R_1}{R_c} \right) \approx \frac{0.01}{E_0^{1/4}} \frac{R}{R_C} = \frac{6R}{E_0^{5/4}} \quad (2)$$

where E_0 and R are measured in GeV and meters.

Capture
efficiency





Optimal crystal for SPS (120 GeV) $R=3\text{m}$ $L=0.8 \text{ mm}$ b. angle= 270 urad

Conclusions

The fabrication technologies of IHEP crystals and their different applications were considered.

The problems of optimization of extraction for IHEP accelerator were discussed.

The recommendations for obtaining optimal crystal parameters for extraction from SPS were done.

Thickness ~ 0.8 mm R ~ 3 m (bend angle ~ 270 μ rad)

Thank you for your attention