STUDY OF RADIATION EMITTED BY LOW ENERGY LEPTONS IN BENT CRYSTALS

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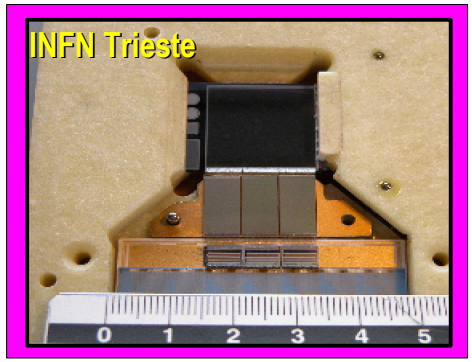
GOALS…

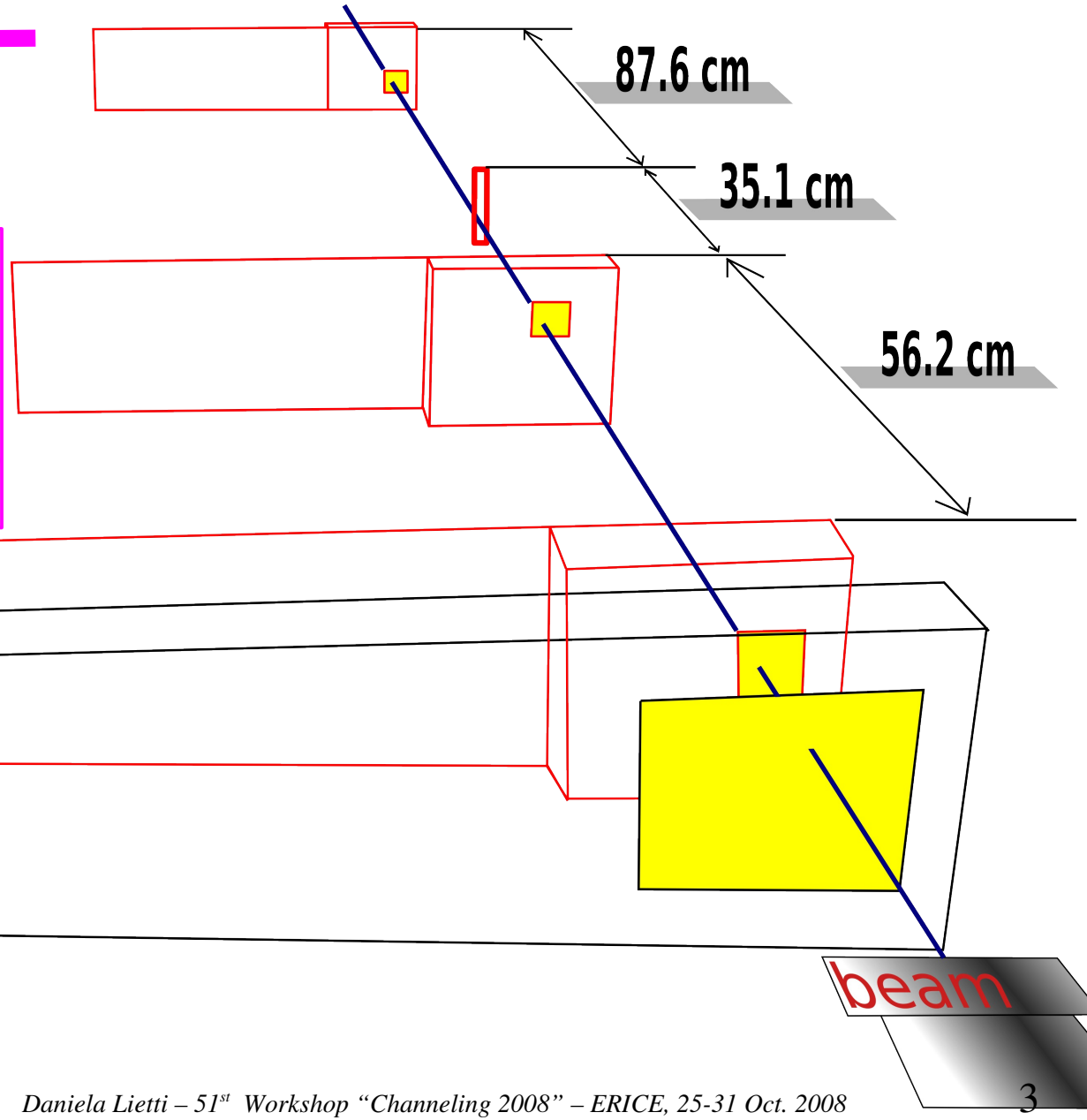
- *Measure channeling and volume reflection effects in a bent strip silicon crystal with positive and negative particles at 13 GeV/c*

- *Evaluate the spectrum of the radiation emitted by e+/e- in the crystal in volume reflection regime*

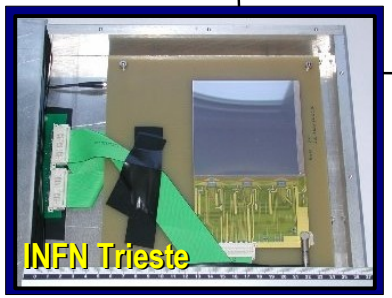
VR setup

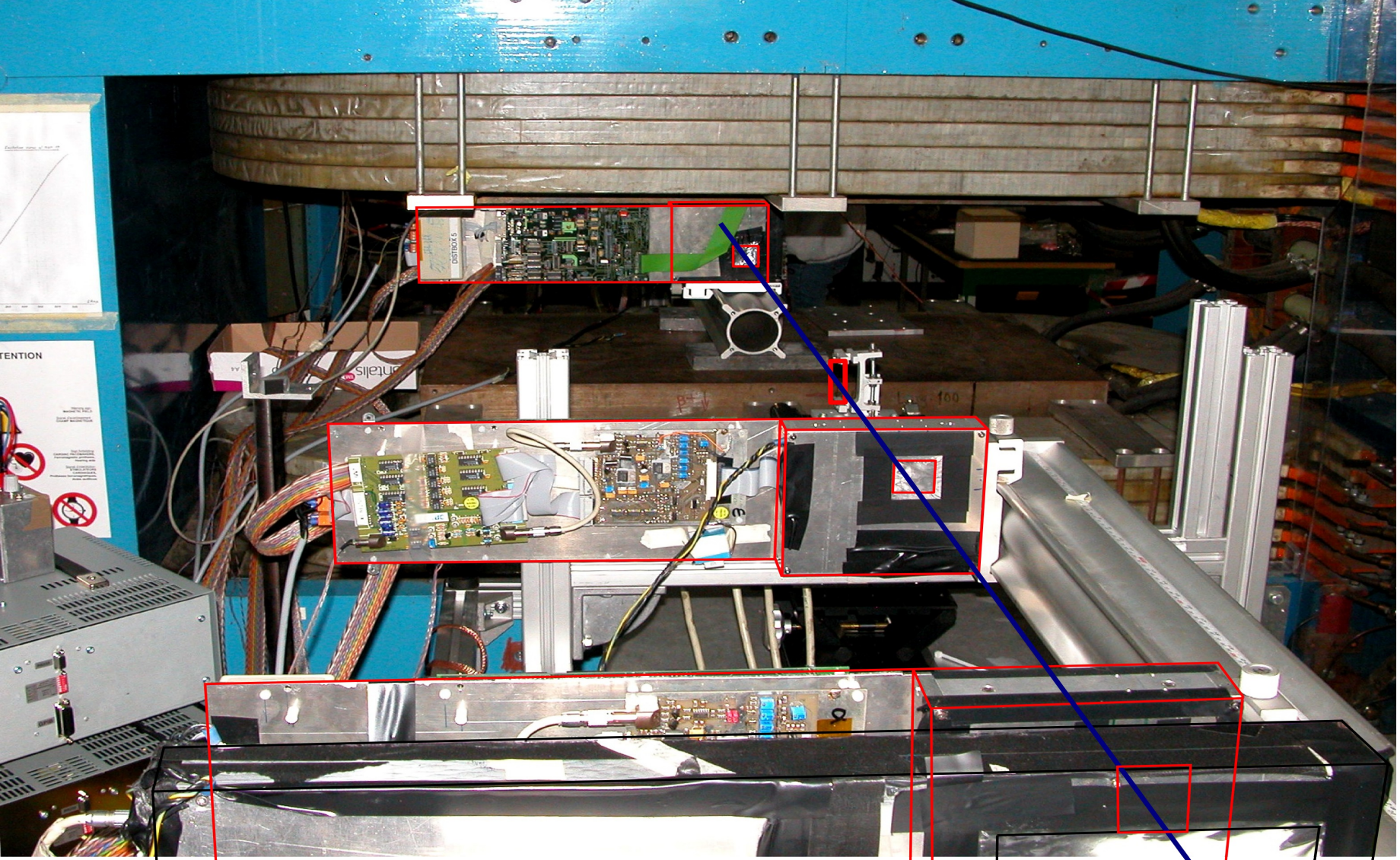


- ✔ double sided silicon microstrip detector
- ✔ dimensions = 1.92 x 1.92 cm^2 sensitive area; 300 mm thickness
- ✔ spatial resolution better than 5 mm
- ✔ readout by 3 VA2 128 channel ASICs
- ✔ reconstruct the incoming angle of the particle with respect to the crystallographic plane and the outgoing one from the crystal (DEFLECTION ANGLE measurement)



- ✔ 2 single sided silicon microstrip detectors
- ✔ dimensions = 9.5 x 9.5 cm^2 sensitive area; 410 mm thickness arranged in x-y way
- ✔ used as TRIGGER





Life is difficult...

- **T9 beam line characteristics:**
  - *beam momentum up to 13 GeV/c*
  - *positive and negative particles (e+/e- , p, π +,π -)*
  - *not ideal divergence (higher wrt the critical angle θ_c):*
    - *xdiv ~ 506 μ rad*
    - *ydiv ~ 505 μ rad*

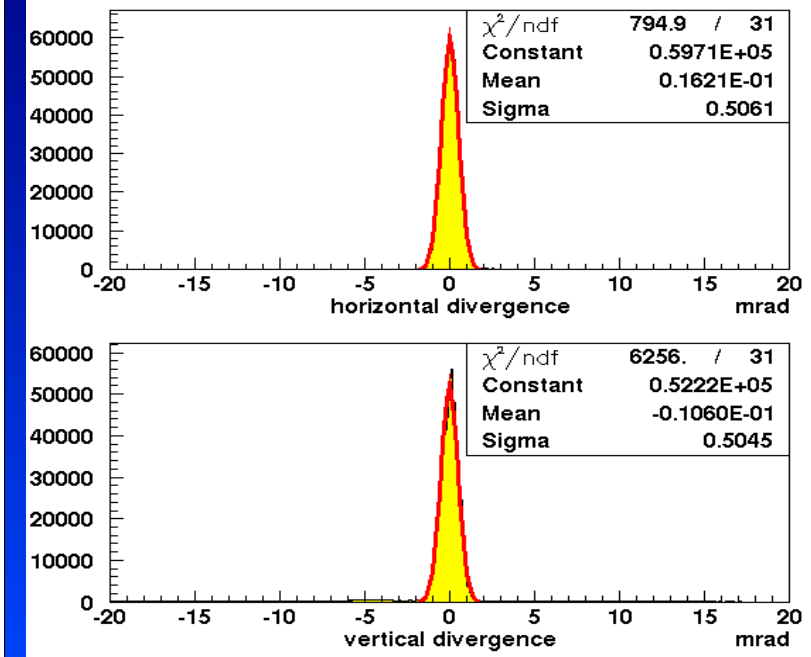
$$\theta_c = \sqrt{\frac{2U(x_c)}{pv}}$$

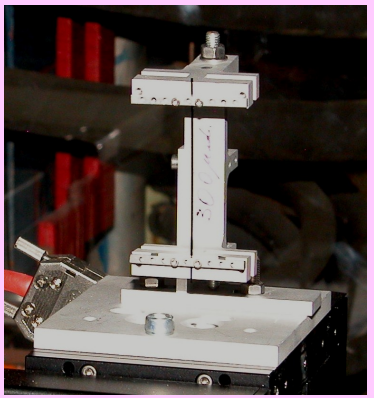
but angular scan is not needed: you can select slices of divergence in the offline analysis

- **multiple scattering is dominant:**
  - *energy scaling with E^{-1}*
  - *θ_{MS} ~ 80 μ rad @ 13 GeV/c*
  - *θ_{VR} ~ 74 μ rad @ 13 GeV/c*

- **the strip crystal used is NOT the ideal one**

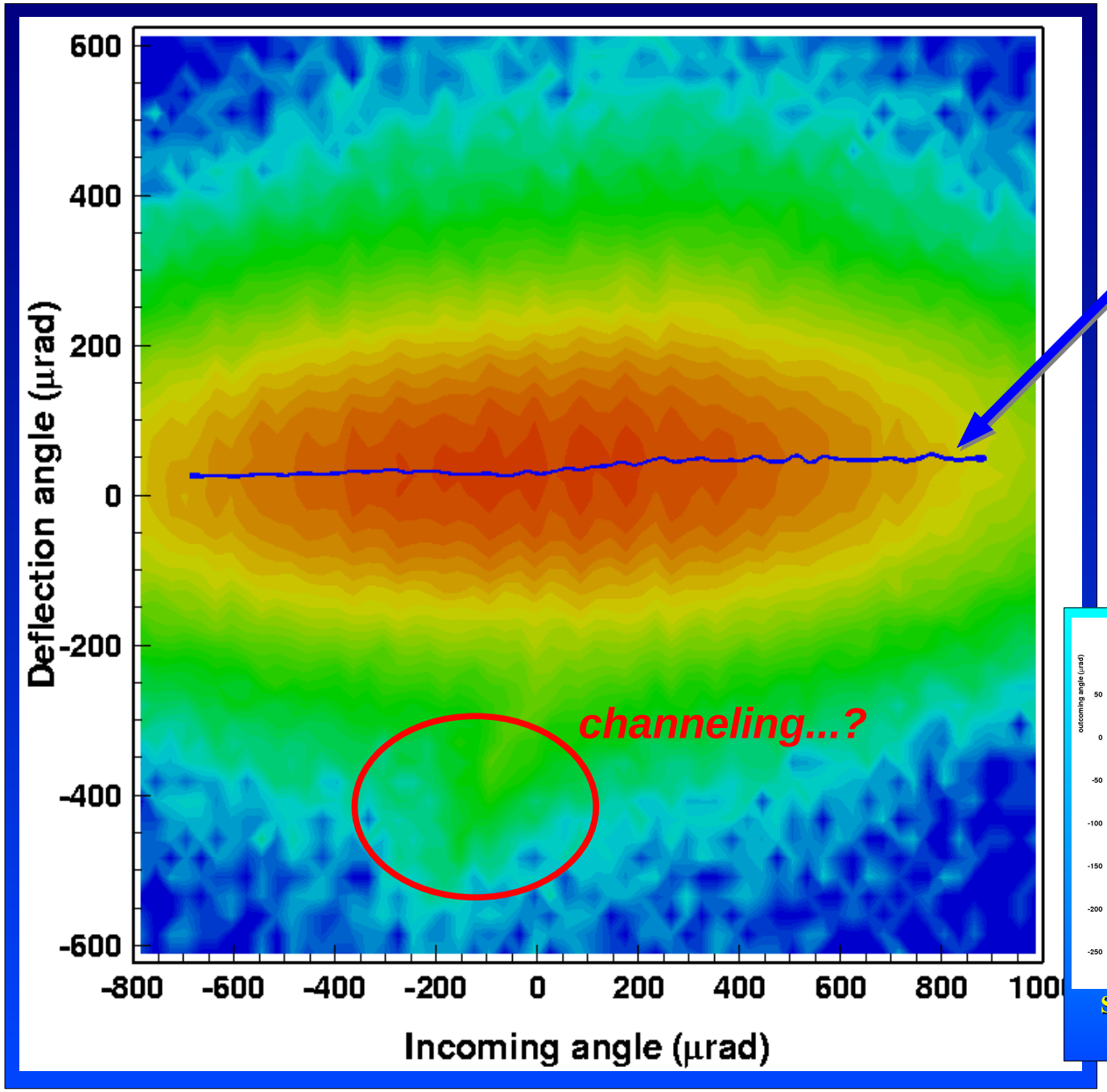
DIVERGENCE



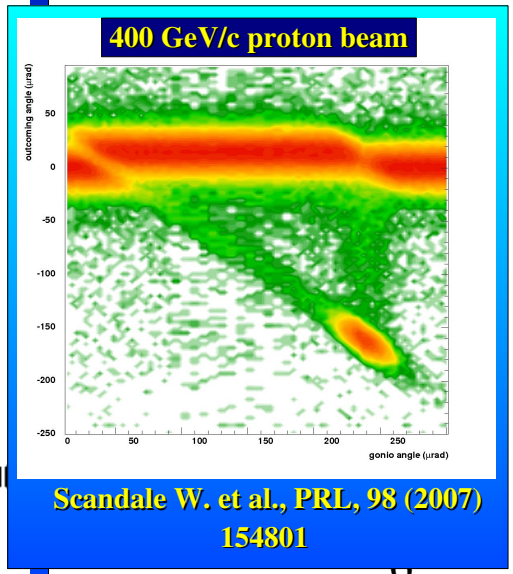


- ✔ *Dimensions: 700 μ m along the beam x 500 μ m x a few cm in height*
- ✔ *300 μ rad bending*
- ✔ *provided by INFN Ferrara, Italy*

We are not able to distinguish different regimes!



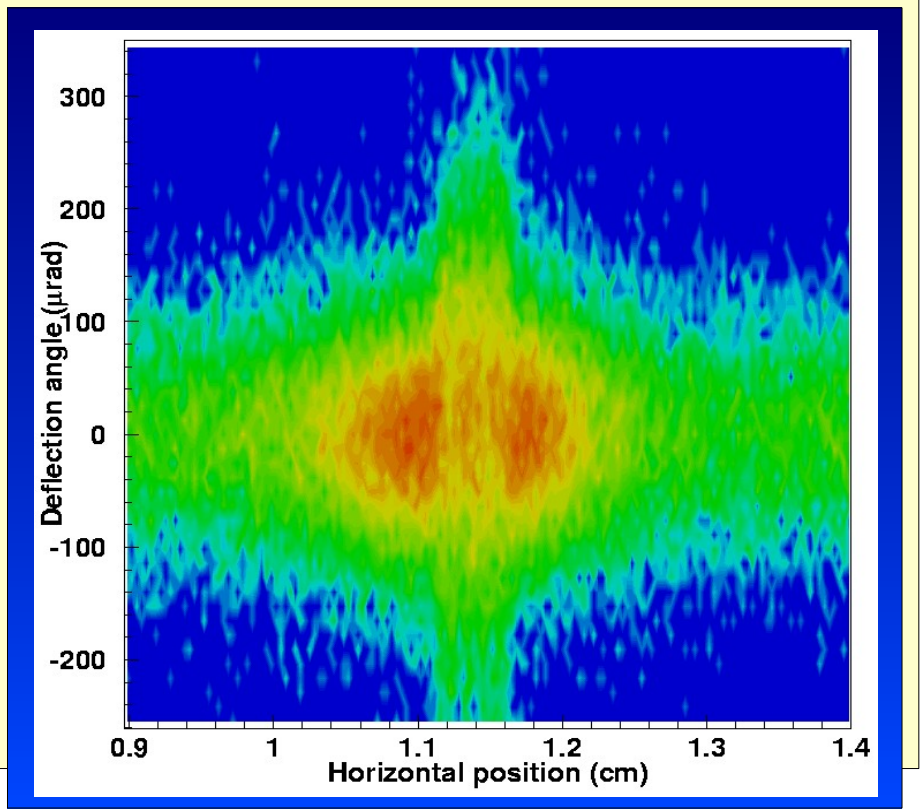
Profile histogram filled with the mean values of the deflection angle distribution

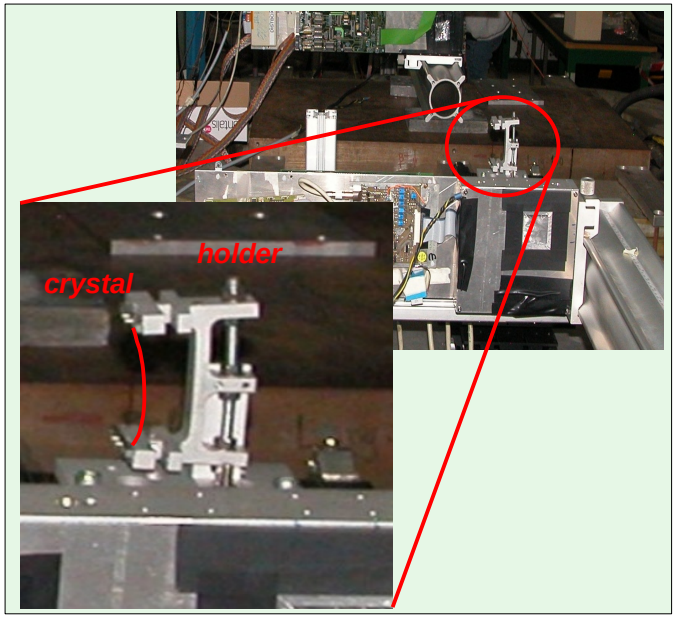


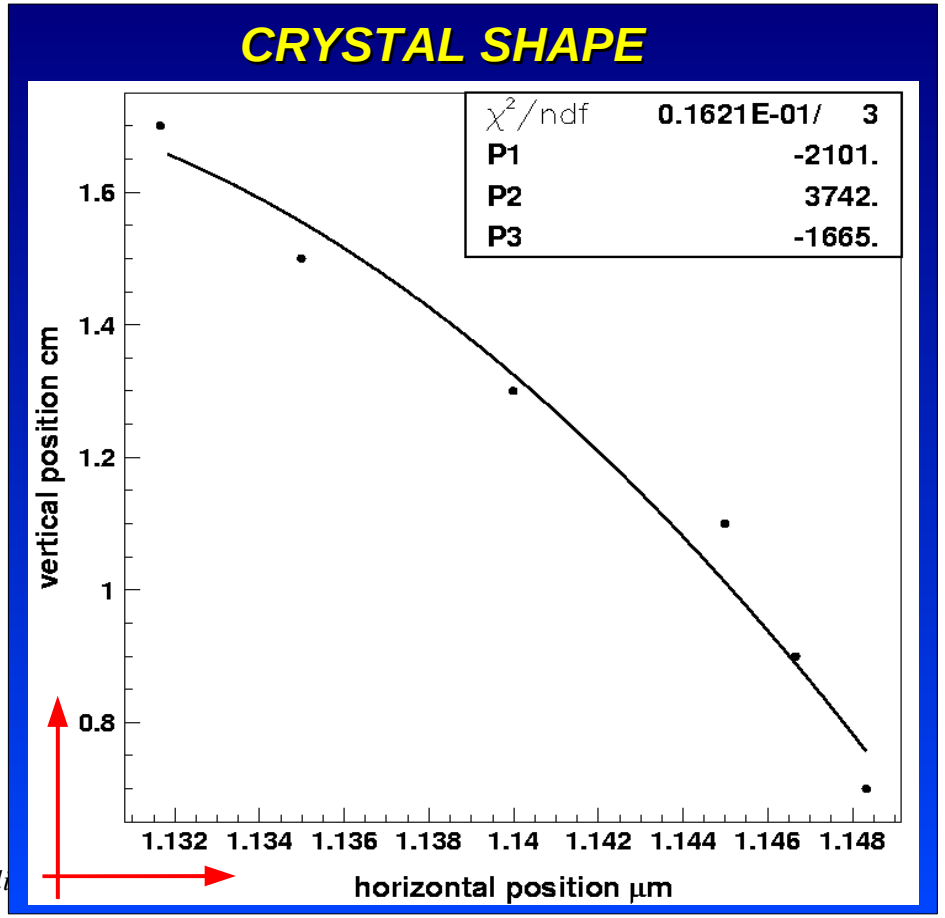
Scandale W. et al., PRL, 98 (2007) 154801

...but..

- ***Selecting ONLY the particles that impinge on the crystal. Our system is able to reconstruct the crystal shape!!***



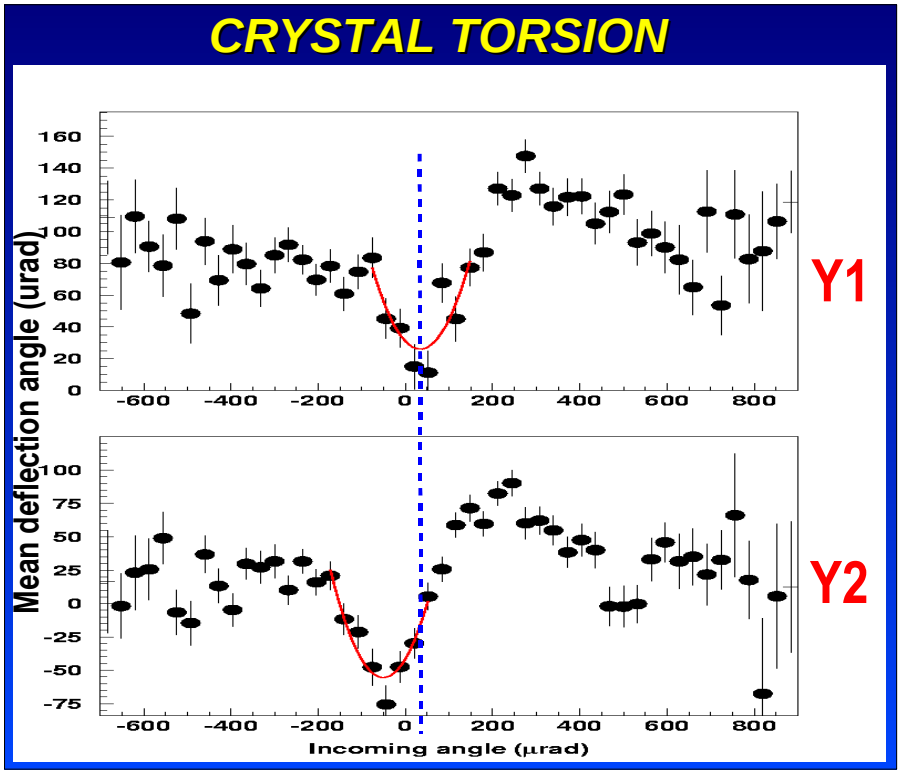


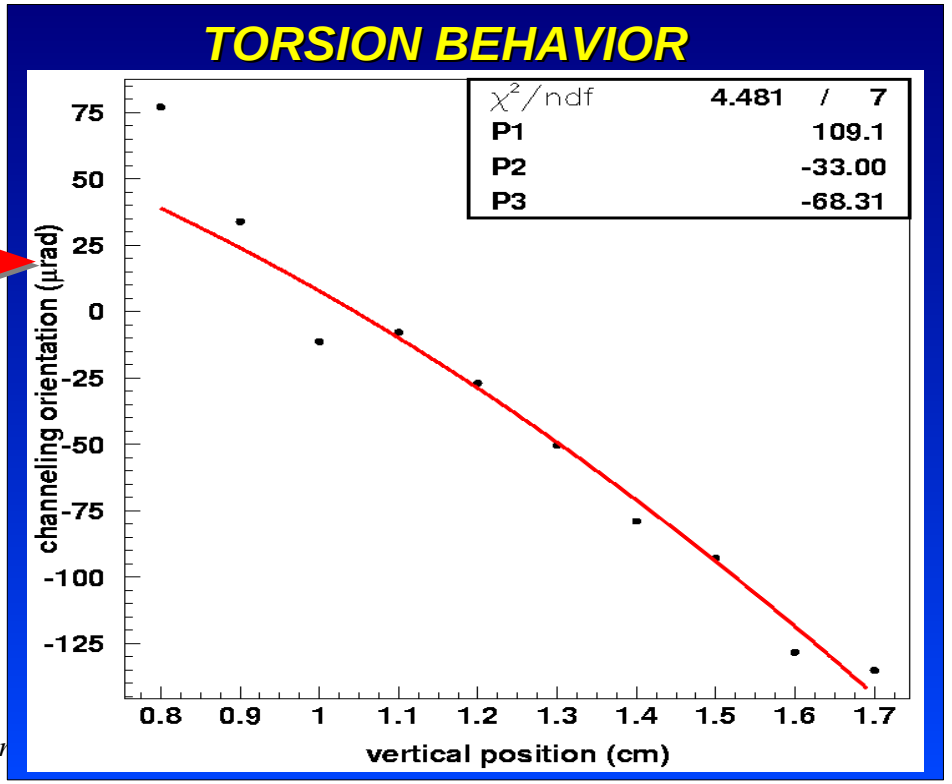


...but..

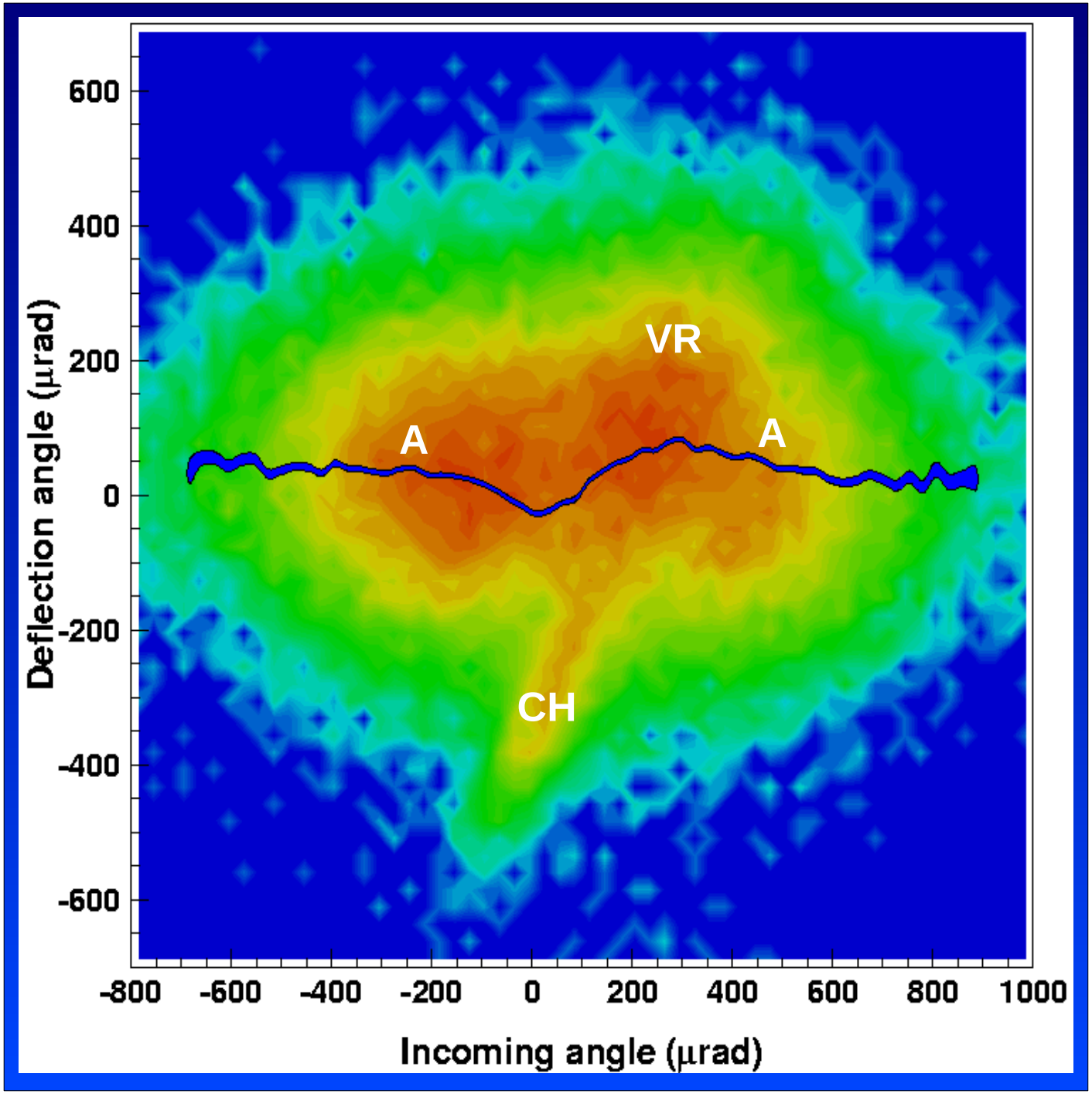
- *Selecting ONLY the particles that impinge on the crystal. Our system is able to reconstruct the crystal shape!!*

- *Considering the TORSIONAL effect of the crystal due to the crystal holder (parallel particles BUT at different vertical position do not behave in the same way)*

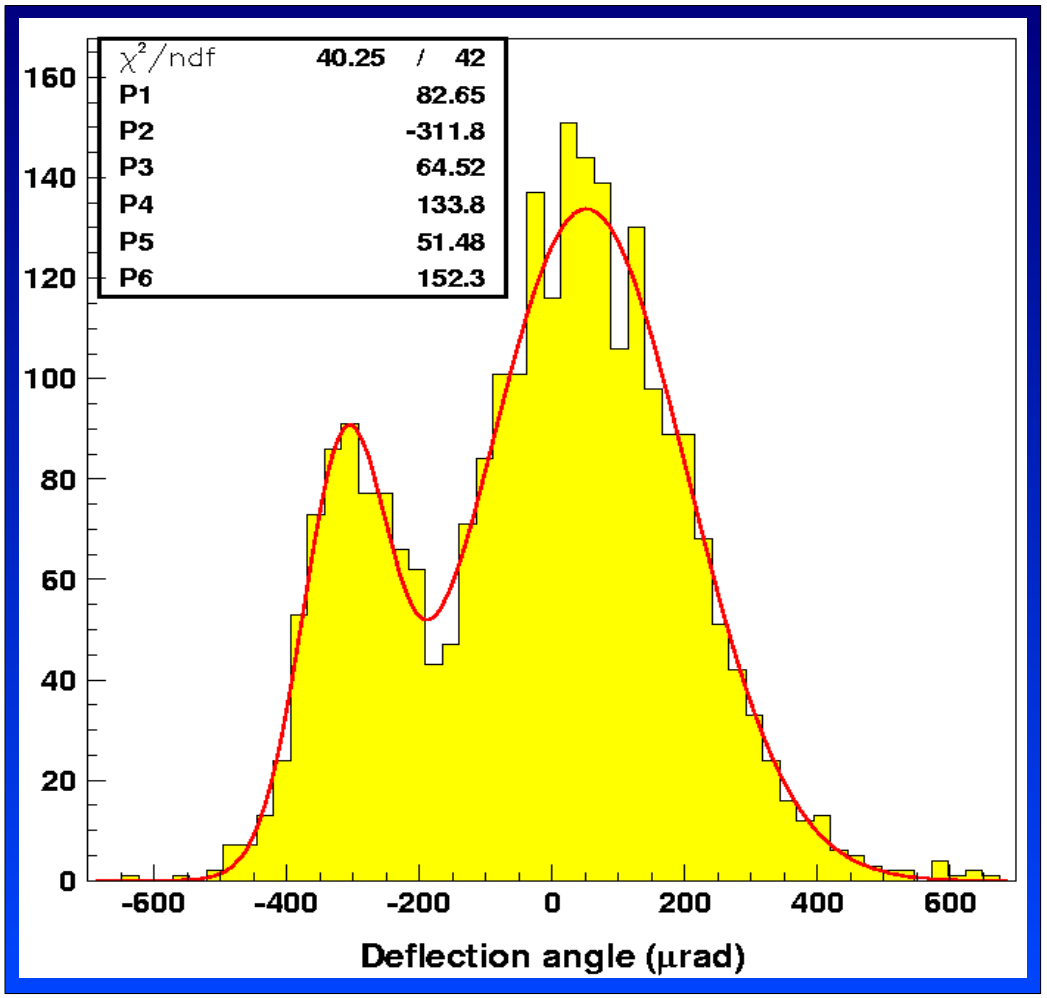




WOW!!!! Positive particles...



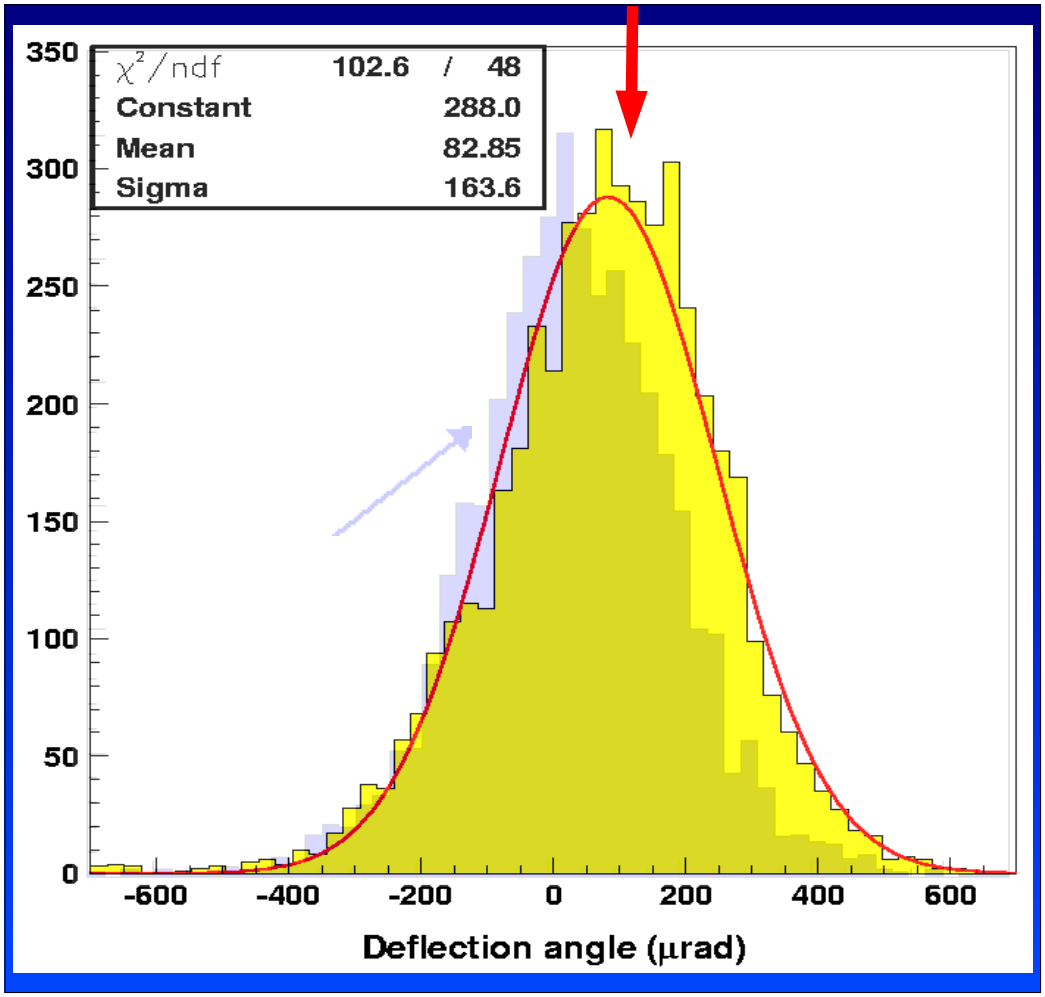
...channeling...



Efficiency ~ 27.0 %
(preliminary)

Deflection angle ~ 310 μ rad

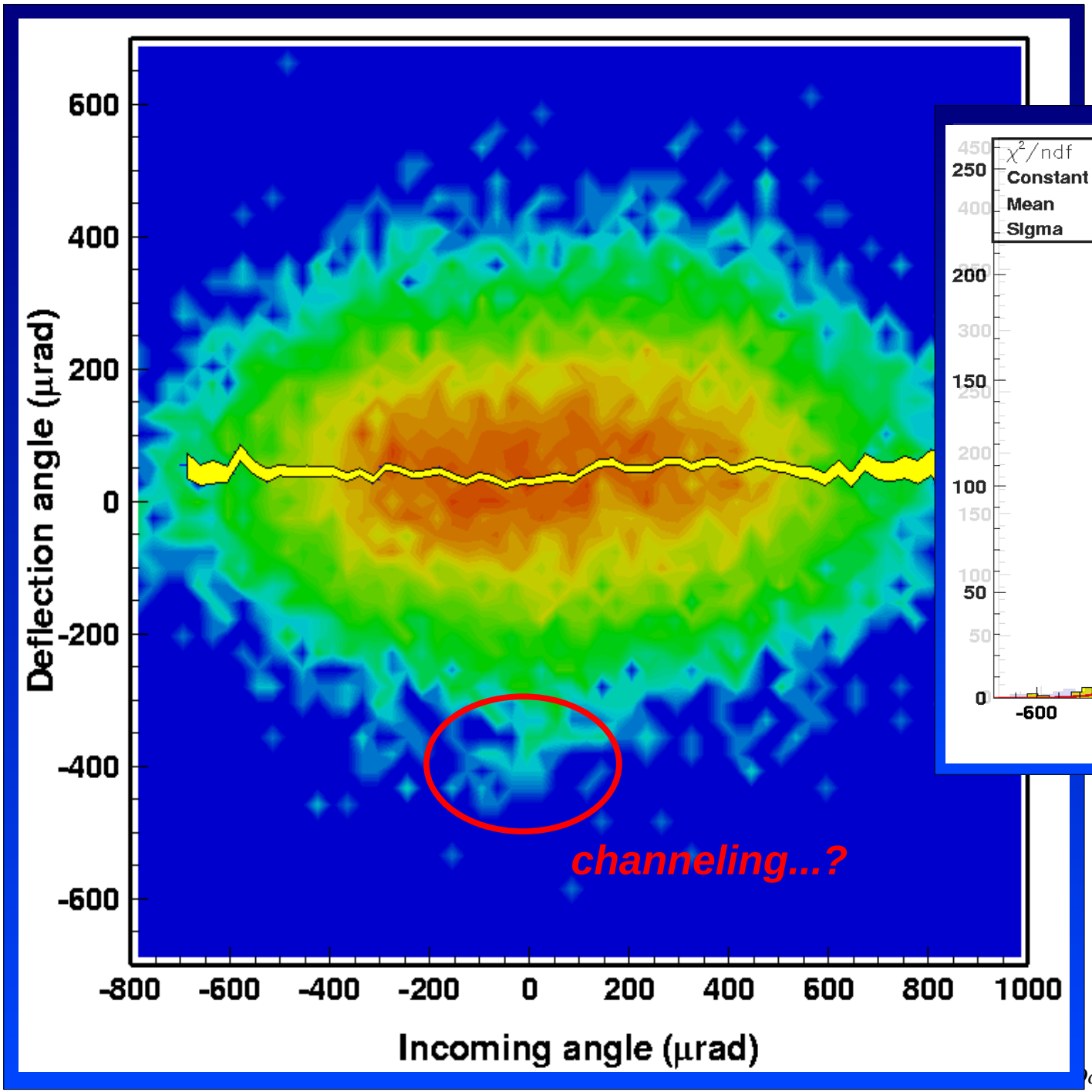
...& volume reflection



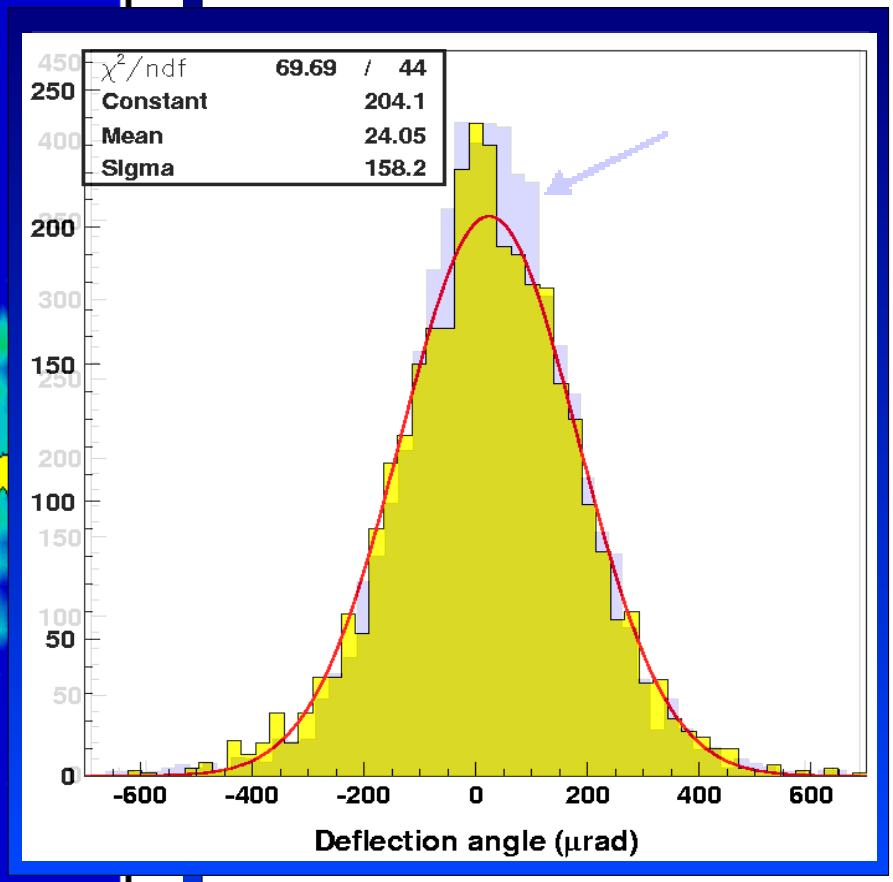
Efficiency ~ 63.8 %
(preliminary)

Deflection angle ~ 82.9 μ rad

Negative particles...



...channeling...

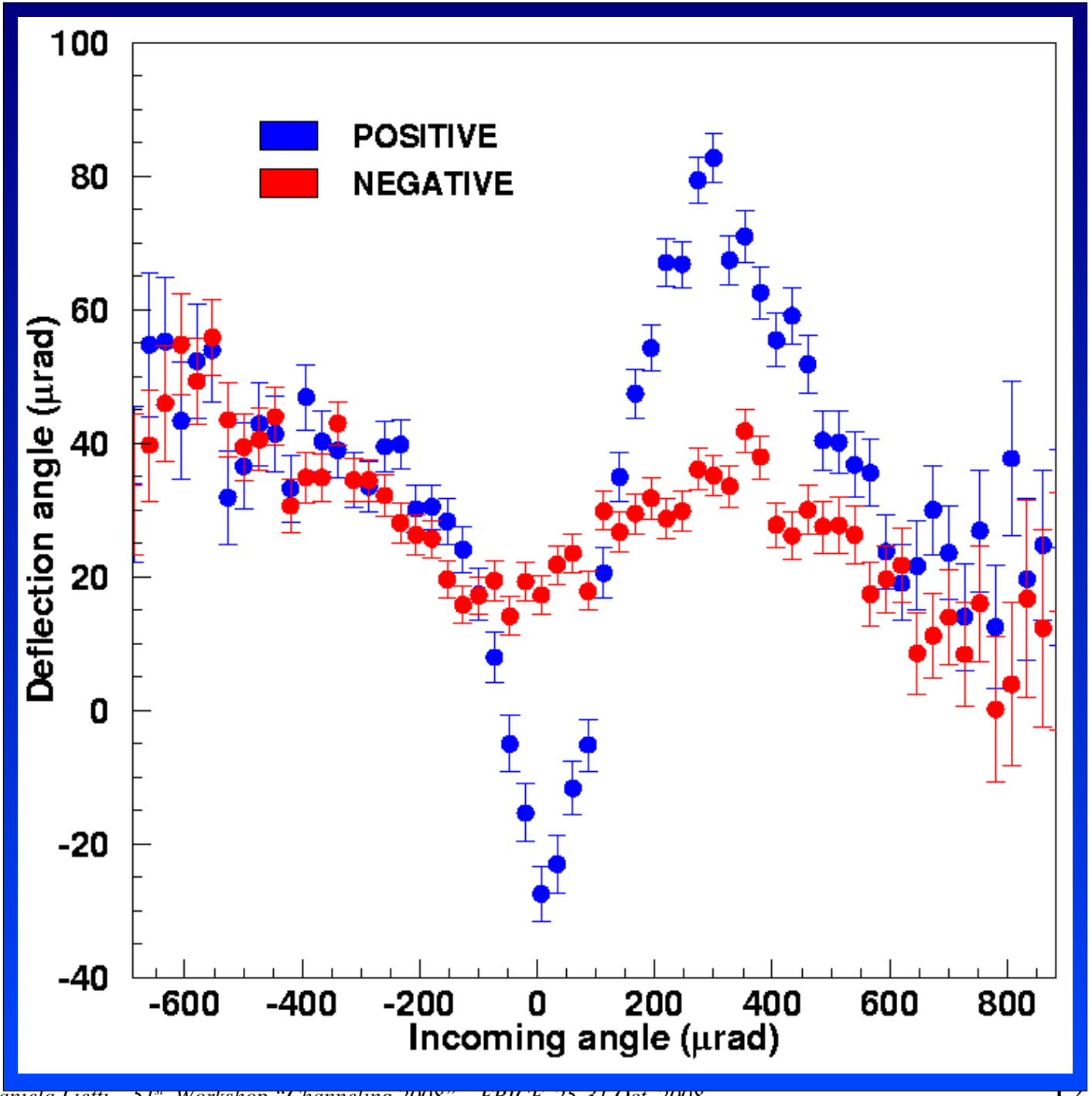


$\sigma_{AMO} \sim 146.4\ \mu$ rad

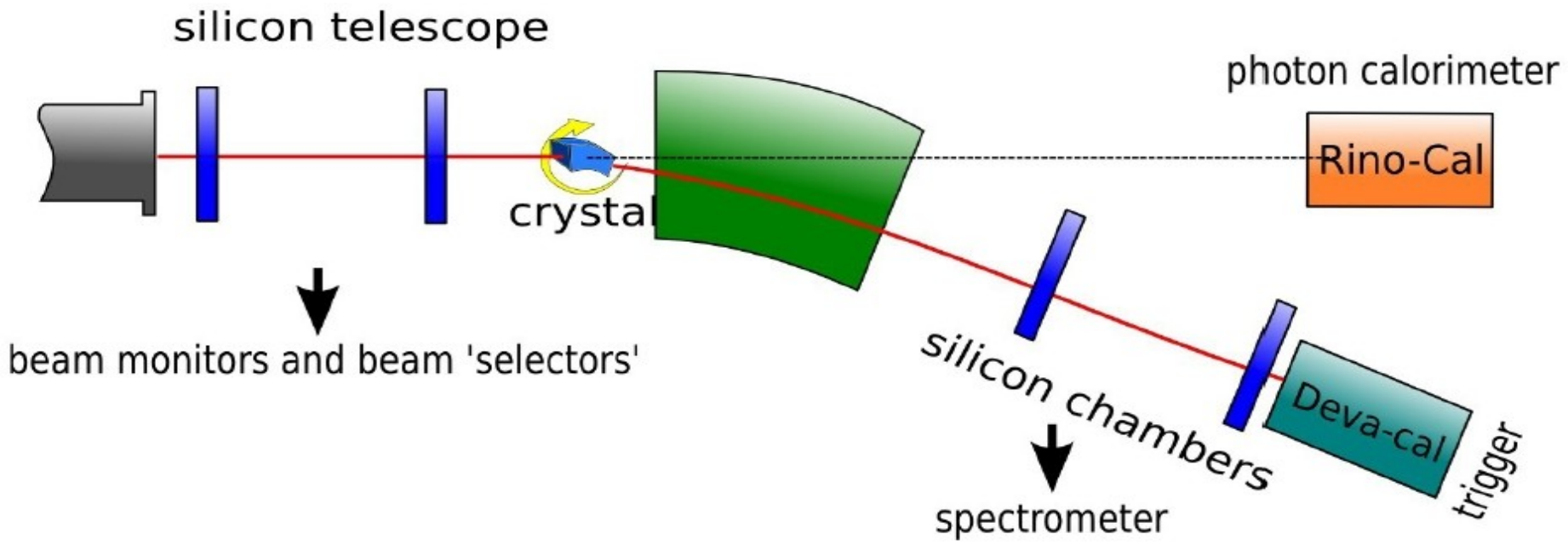
$\sigma_{CH} \sim 158.2\ \mu$ rad

something seems to be there!

...mumble mumble...



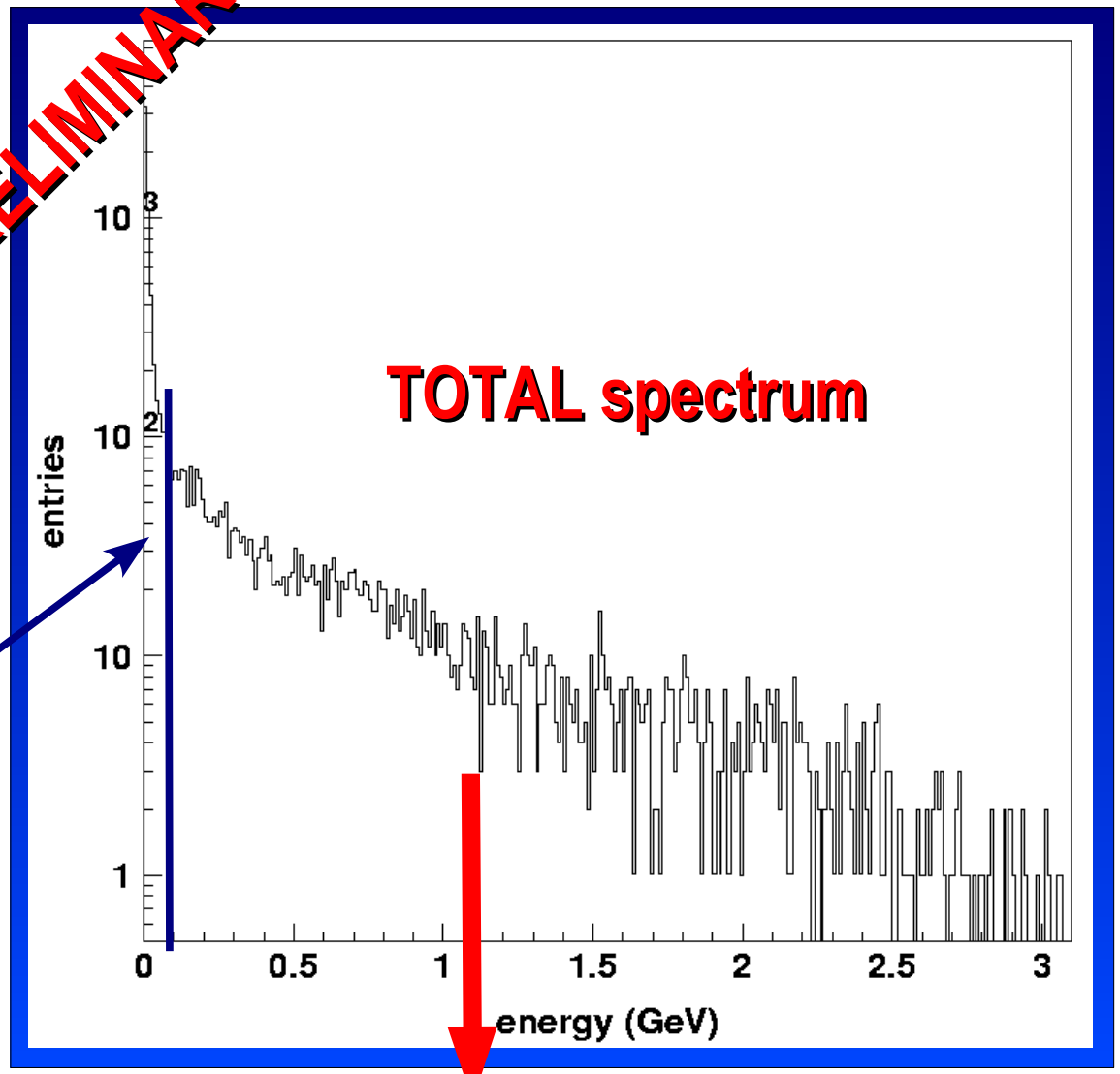
Radiation setup

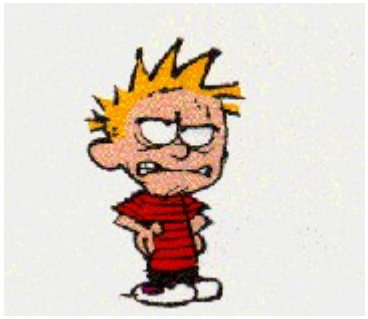


- ***Change the setup introducing the calorimeters and the bending magnet.***
- ***Go down in energy (3GeV/c) and switch on the Cherenkov system to select ONLY light leptons (e+/e-)***
- ***Compute amorphous contribution and compare it with the volume reflection regime one.***

...radiation results

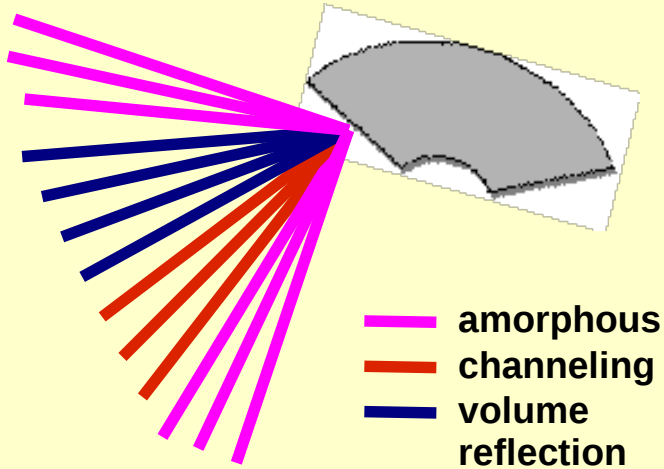
PRELIMINARY





OVER 90 MeV

particles in VR regime that have emitted radiation
~ 95 %



particles in amorphous regime that have emitted radiation
~ 75 %

PRELIMINARY

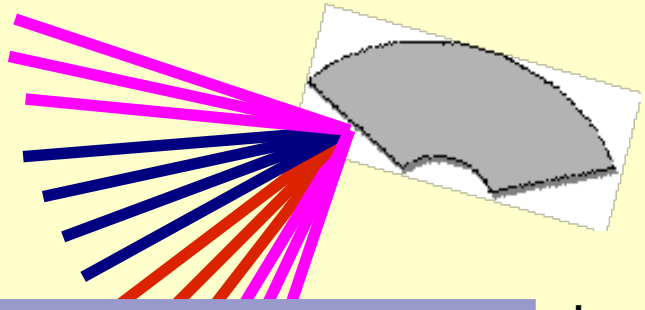
...radiation results

PRELIMINARY

TOTAL spectrum

OVER 90 MeV

particles in VR regime that have emitted radiation ~ 95 %



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- ***PROBLEMS:***
  - ***high background at low energy (0. -> 90. MeV) due to the beam***
  - ***poor statistics***
- ***NEXT:***
  - ***more analysis (evaluate the systematics, background contribution)***

PRELIMINARY

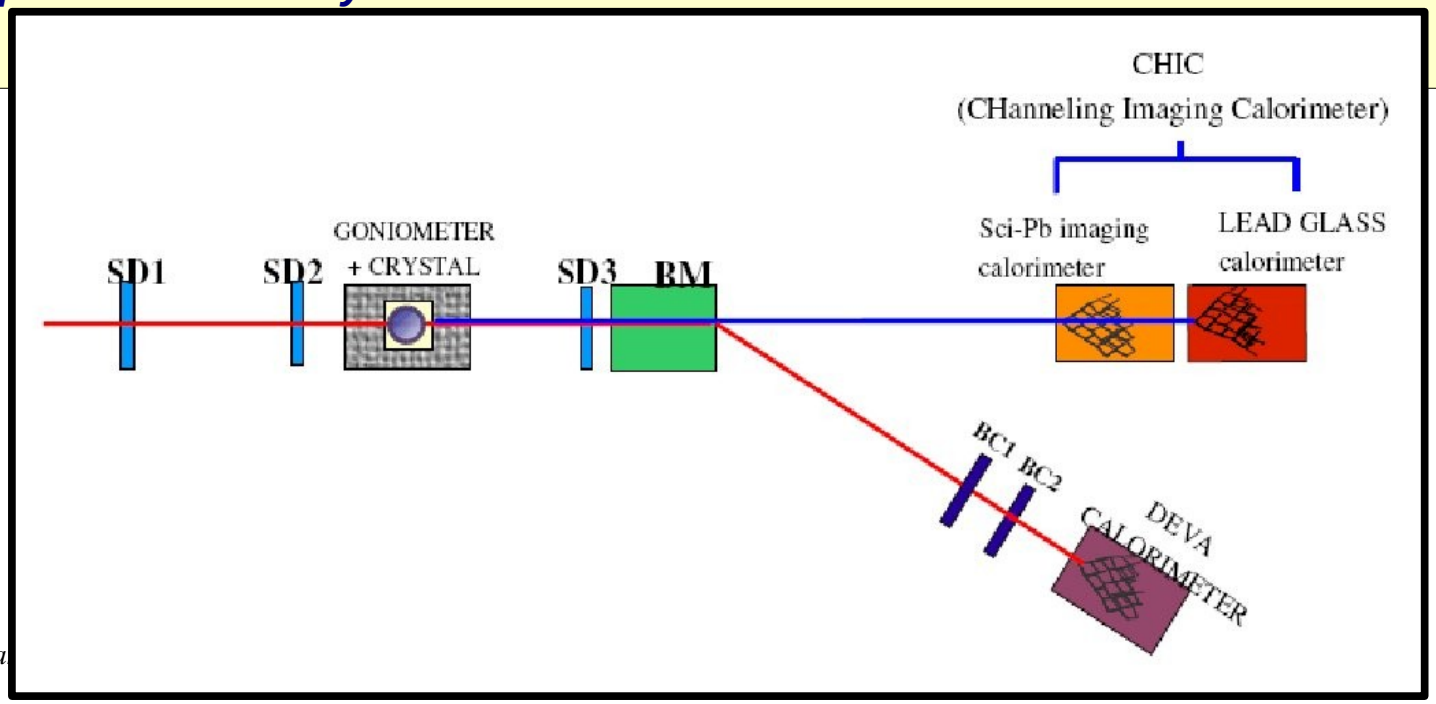
Conclusions & outlooks

➔ *We have measured the volume reflection and channeling effects at 13 GeV/c with an adequate accuracy for positive particles.*

➔ *The negative particles are another story... we know that something is there but we don't understand exactly WHY it seems to be suppressed*

➔ *The radiation at 3 GeV/c was measured but NEEDS more analysis to understand completely how it works at low energy*

➔ *Further beam tests are planned for next year*



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THANK YOU FOR THE ATTENTION !

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