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 cm² 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 cm² sensitive area; 410 mm thickness arranged in x-y way
- Used as TRIGGER
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 $\theta_C$):
  \[ \theta_C = \sqrt{\frac{2U(x_c)}{pv}} \]
  $x_{\text{div}} \approx 506 \mu \text{rad}$
  $y_{\text{div}} \approx 505 \mu \text{rad}$
  but angular scan is not needed: you can select slices of divergence in the offline analysis

multiple scattering is dominant:
- energy scaling with $E^{-1}$
  - $\theta_{\text{MS}} \approx 80 \mu \text{rad} @ 13 \text{ GeV/c}$
  - $\theta_{\text{VR}} \approx 74 \mu \text{rad} @ 13 \text{ GeV/c}$

the strip crystal used is NOT the ideal one

Dimensions: 700 $\mu$ m along the beam $\times$ 500 $\mu$ m $\times$ a few cm in height
- 300 $\mu$ 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

channeling...?
Selecting ONLY the particles that impinge on the crystal. Our system is able to reconstruct the crystal shape!!
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)

Daniela Lietti – 51st Workshop “Channeling”
WOW!!!! Positive particles...

...channeling...

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<table>
<thead>
<tr>
<th>$\chi^2/\text{ndf}$</th>
<th>40.25 / 42</th>
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<tbody>
<tr>
<td>P1</td>
<td>82.65</td>
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<tr>
<td>P2</td>
<td>-311.8</td>
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<tr>
<td>P3</td>
<td>64.52</td>
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<tr>
<td>P4</td>
<td>133.8</td>
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<td>P5</td>
<td>51.48</td>
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<td>P6</td>
<td>152.3</td>
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Efficiency ~ 27.0 % (preliminary)
Deflection angle ~ 310 $\mu$ rad

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<table>
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<th>$\chi^2/\text{ndf}$</th>
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<tbody>
<tr>
<td>Constant</td>
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<tr>
<td>Mean</td>
<td>82.85</td>
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<tr>
<td>Sigma</td>
<td>163.6</td>
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Efficiency ~ 63.8 % (preliminary)
Deflection angle ~ 82.9 $\mu$ rad

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...& volume reflection
Negative particles...

channeling...?

\[ \sigma_{AMO} \sim 146.4 \, \mu \text{rad} \]
\[ \sigma_{CH} \sim 158.2 \, \mu \text{rad} \]

something seems to be there!
...mumble mumble...
➢ 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

OVER 90 MeV
particles in VR regime that have emitted radiation
~ 95 %

particles in amorphous regime that have emitted radiation
~ 75 %

TOTAL spectrum

Background
VR contribution
Amorphous contribution

NOT considered in the analysis
PROBLEMS:
- high background at low energy (0. -> 90. MeV) due to the beam
- poor statistics

NEXT:
- more analysis (evaluate the systematics, background contribution)
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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