On the feasibility of using an extracted polarized antiproton beam of the HESR with a solid polarized target

(continue)

Presenters Yu. A. Plis, A.V. Smirnov

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Urban model of beam energy loss

\[ \Delta E = n_1 I_1 + n_2 I_2 + \sum_{i=1}^{n_3} \frac{I}{1 - g \xi_i} \]

\[ g = \frac{E_{\text{max}}}{E_{\text{max}} + I} \]

- \( n_1, n_2 \) – number of excitation events to different atomic energy levels
- \( n_3 \) – number of ionization events
- \( \xi \) – uniform random number

WASA@COSY experiment
(momentum on time – no barriers)
Burrier buckets reflect particles and keep inside barriers while momentum spread less than barrier height.

Example of moving barrier buckets
Burrier buckets compensate the effect of beam energy loss

\[ \frac{\Delta P}{P} \]

no barriers:
fast negative energy loss

barrier buckets
momentum spread growths due to scattering process which is much slower than energy loss
Simulation of particle interaction with pellets using BEATCOOL code

http://betacool.jinr.ru

For each particle

Find number of interaction events:
1) Integration over betatron oscillation
2) Integration over pellet flux
3) Number of turns per integration step

A few interactions of each particle per integration step (about 0.1 - 1 sec) with realistic interaction models (Urban + plural scattering)
# Designed parameters for PANDA (high-luminosity mode)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Momentum, GeV/c</td>
<td>9</td>
</tr>
<tr>
<td>RMS momentum spread</td>
<td>$1 \cdot 10^{-4}$</td>
</tr>
<tr>
<td>Transverse emittance (RMS normalized)</td>
<td>0.4</td>
</tr>
<tr>
<td>Average luminosity, cm^{-2} s^{-1}</td>
<td>$2 \cdot 10^{32}$</td>
</tr>
<tr>
<td>Detector limit, cm^{-2} s^{-1}</td>
<td>$3 \cdot 10^{32}$</td>
</tr>
<tr>
<td>Effective target density, cm^{-2}</td>
<td>$4 \cdot 10^{15}$</td>
</tr>
<tr>
<td>Pellet velocity, m/s</td>
<td>60</td>
</tr>
<tr>
<td>Pellet flux radius, mm</td>
<td>1.25</td>
</tr>
<tr>
<td>Pellet size (diameter), µm</td>
<td>28</td>
</tr>
<tr>
<td>Distance between pellets, mm</td>
<td>5</td>
</tr>
</tbody>
</table>
Effective luminosity simulation for different variants of detector limit

Microstructure of luminosity on time

Average luminosity

Detector limit

Detector can not count more than limit

Full overload of detector

Luminosity on time
Conclusion

• BETACOOL simulations show that the pellet size should be much less than 28 μm which was accepted by PANDA community

• Algorithms in BETACOOL code were especially elaborated for PANDA experiment and can be effectively used for the optimization of the beam extraction with the scattering on the different types of internal targets