HESR Electron Cooler

COOL05

Eagle Ridge, Galena, IL USA

September 18-23, 2005

D. Reistad, TSL
The Future International Facility at GSI: Beams of Ions and Antiprotons
HESR

HESR ‘flagship’ beam parameters

<table>
<thead>
<tr>
<th>Mode</th>
<th>pbar Energy</th>
<th>L [cm(^{-2}) s(^{-1})]</th>
<th>(\Delta p/p)</th>
<th>(\varepsilon) [mm mrad]</th>
</tr>
</thead>
<tbody>
<tr>
<td>High luminosity</td>
<td>8 GeV</td>
<td>2\times10(^{32})</td>
<td>10(^{-4})</td>
<td>1</td>
</tr>
<tr>
<td>High resolution</td>
<td>8 GeV</td>
<td>2\times10(^{31})</td>
<td>10(^{-5})</td>
<td>1</td>
</tr>
</tbody>
</table>

Number of antiprotons for an internal target area density of 4\times10\(^{15}\) cm\(^{-2}\):

- HL mode: 10\(^{11}\) (0.8-14.1 GeV)
- HR mode: 10\(^{10}\) (3-8 GeV)

HESR ring/lattice parameters

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<table>
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<tbody>
<tr>
<td>(C) [m]</td>
<td>570</td>
</tr>
<tr>
<td>(&lt;D_x&gt;) [m]</td>
<td>3.5</td>
</tr>
<tr>
<td>(&lt;\beta_x&gt;) [m]</td>
<td>7.5</td>
</tr>
<tr>
<td>(\gamma_t)</td>
<td>i8</td>
</tr>
</tbody>
</table>
• Hydrogen pellet target
• 2 cm diameter beam pipe!
WASA Pellet Target

- access and availability restricted
- development of the PTS!
Pellet Generation Principle

- **H₂**
- nozzle
- droplet formation
- capillary
- vacuum injection
At WASA:

width of pellet stream: 2 mm
vertical separation of pellets: 3 mm
PANDA needs a 2-3 mm big beam with \(10^{10} - 10^{11}\) antiprotons with momentum spread \(10^{-5} - 10^{-4}\), and without any halo.

This can not be achieved with electron cooling alone.

We need also very good beam scraper system and/or stochastic halo-cleaning system.
$3 \text{ GeV}$,
$68.3\%$ of anti-protons
$I_e = 1 \text{ A}$
$r_0 = 5 \text{ mm}$
$l_C = 30 \text{ m}$
$B = 0.2 \text{ T}$
$kT = 1 \text{ eV}$
$\theta = 10^{-5}$ radians
$\beta_C^* = 50 \text{ m}$
$\beta_T^* = 2.5 \text{ m}$
$N_{p\text{bar}} = 10^{10}$

\[ \sqrt{\varepsilon \beta_T^*} \approx \sqrt{0.1 \times 10^{-6} \text{ m} \times 2.5 \text{ m}} = 0.5 \text{ mm} \]
3 GeV, 68.3 % of anti-protons
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8 GeV, 68.3 % of anti-protons

$I_e = 1 \text{ A}$

$r_0 = 5 \text{ mm}$

$l_C = 30 \text{ m}$

$B = 0.2 \text{ T}$

$kT = 1 \text{ eV}$

$\theta = 10^{-5}$ radians

$\beta^*_C = 100 \text{ m}$

$\beta^*_T = 10 \text{ m}$

$N_{\text{pbar}} = 10^{10}$
Prior Art:

FNAL RECYCLER 4.3 MeV electron cooling system

First e-cooling demonstration - 07/15/05

Pbar beam: 63.5e10
Barrier-bucket bunched.
Bunch length 1.7-us
Tr. emittance (95%,n) kept at 4-pi n
Electron beam current: 200 mA
Traces are 15 min apart

Sergei Nagaitsev (Fermilab)

CONGRATULATIONS!!!
The Budker Institute in Novosibirsk (BINP) has performed a detailed study. They propose a 30 m long electron-cooling section with a 0.5 T longitudinal magnetic field with straightness $10^{-5}$ radians (rms). They propose to produce the high voltage (up to 8 MV) with an H⁻ cyclotron, which charges the high-voltage terminal.

Prior Art, continued:
We are looking at alternatives, especially to use more conventional means to achieve the high voltage van de Graaff accelerators ("Pelletrons") as in Fermilab...
drift section is shown too short
... or (cascade generators, so called (“Dynamitrons”))
Advantages of Pelletron:
- experience at FNAL
- possibilities for copying from FNAL (getting help from FNAL?)
- proven UHV performance
- no need for extensive R&D

Advantages of Dynamitron
- low impedance on electrodes (150 MΩ vs 10 GΩ)
- proven performance with 10^-5 voltage stability and ripple
- fast regulation of voltage without corona spikes
- horizontal layout (no need for tower)
We will continue study of both alternatives, but hope to make a choice shortly.

Updated Technical Report must be ready 15 December.
We would very much like to again establish collaboration with BINP, also with JINR, FNAL, BNL...