LASER BASED PROFILE AND ENERGY MONITOR DEVELOPMENT FOR H- BEAMS

R. Connolly, S. Bellavia, C. Dawson, C. Degen, W. Meng, D. Raparia, T. Russo and N. Tsoupas
Brookhaven National Lab
Upton, NY, USA
Profile Measurement

Nd:YAG (\(\lambda=1064\text{nm}\))

Transverse Optical System

Mirror angle stepped between linac pulses

Switching mirror

Labview

H- Beam profile

e from H- are guided by magnetic field
SC Potential Measurement

**DC beam**

\[ V(r) = V_s(1 + 2\ln(b/a) - r^2/a^2); \quad r \leq a \]
\[ V(r) = 2V_s \ln(b/r); \quad a < r \leq b \]
\[ V_0 = V_s(1+2\ln(b/a)) \]
\[ V_s = 30 * I/\beta \]

**Bunched Beam**

\[ E_{H^+} = 750,000 \text{ eV} \]
\[ \Delta E_{H^+} = \pm 20,000 \text{ eV} \]
\[ E_e = 408 \text{ eV} \]
\[ \Delta E_e = \pm 10.9 \text{ eV} \]

**Laser**

\[ \Delta E_e = \pm 20,000 \text{ eV} \]
\[ E_e = 408 \text{ eV} \]
\[ \Delta E_e = \pm 10.9 \text{ eV} \]

**Electric Field due to Uniformly Charged Ellipsoid**

\[ E_x = \frac{1}{4\pi\varepsilon_0} \frac{3I\lambda}{c^2} \frac{(1-f)}{a_x(a_x + a_z)a_z} x \]
\[ E_y = \frac{1}{4\pi\varepsilon_0} \frac{3I\lambda}{c^2} \frac{(1-f)}{a_y(a_y + a_z)a_z} y \]
\[ E_z = \frac{1}{4\pi\varepsilon_0} \frac{3I\lambda}{c} \frac{(1-f)}{a_xa_ya_z} z \]

**Potential Distribution in x-z Plane**

<table>
<thead>
<tr>
<th>Current mA</th>
<th>Buncher Off/On</th>
<th>% of DC Component</th>
<th>Bunched Length (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>ON</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>35</td>
<td>ON</td>
<td>30</td>
<td>70</td>
</tr>
</tbody>
</table>

**Electron Energies**

\[ T_e = T_e^0 + \phi \]

**Electron Current VS Bias Voltage**

**Beam Parameters Used in Simulations**

**Electron Current VS Bias Voltage**
Summary

• Transverse Profile
• At low energies ($\Delta E(m_e/m_p) \ll SCP$)
  - Space Charge Potential (SCP)
  - Bunch Length and Bunching Factor
• At high ($\Delta E(m_e/m_p) \gg SCP$)
  - Energy Spread ($\Delta E$)