FINALIZATION OF THE DESIGN OF THE SLIT FOR THE EMITTANCE METER

B.Cheymol, F.Roncarolo
A.Dallocchio, D. Steyaert
G.Bellodi, Carlo Rossi

3MeVTCC meeting, 5 May 2010
The design assumes to use a unique slit for the 3 commissioning stages
- slit thickness such that all particles apart from beamlet to be sampled need to be absorbed --> minimum slit thickness
- must stand all operational beam parameters --> maximum deposited energy
- must provide enough resolution accuracy coping with
  ▪ signal/noise ratio at profile monitor
  ▪ space charge
  ▪ scattering / stripping of H- travelling through the slit gap
- all fitting in the available space
LINAC4 VS SNS

In addition to comparison table presented in a previous meeting, we looked more in detail @:
• SNS 7.5 MeV
• Linac4 3 MeV

<table>
<thead>
<tr>
<th></th>
<th>Energy [MeV]</th>
<th>Intensity [mA]</th>
<th>pulse length [µs]</th>
<th>sigma_x [mm]</th>
<th>sigma_y [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNS</td>
<td>7.5</td>
<td>36</td>
<td>50</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>LINAC4</td>
<td>3</td>
<td>65</td>
<td>100</td>
<td>3.6</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Number of particles per pulse
SNS: 1.119.10^{13}
LINAC4: 4.04.10^{13}

Transverse particle density
SNS: 3.975.10^{13} particles.cm^{-2}
LINAC4: 11.52.10^{13} particles.cm^{-2}

Longitudinal energy deposition density

<table>
<thead>
<tr>
<th></th>
<th>energy [MeV]</th>
<th>depth [µm]</th>
<th>width [µm]</th>
<th>peak [MeV.cm^{2}.g^{-1}]</th>
</tr>
</thead>
<tbody>
<tr>
<td>L4/SNS</td>
<td>4</td>
<td>~ 1.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

L4/SNS = ~ 3
L4/SNS = ~ 4
ENERGY DEPOSITION STUDIES

- FLUKA simulations to assess
  - energy deposition in appropriately defined 3D mesh
  - temperature profiles analytically calculated from energy deposition

- Figure of merit: maximum temperature at beam core transverse position and Bragg’s peak depth

- From the beginning a slit perpendicular to beam direction looked not acceptable. Problem is during a single shot --> independent of external cooling

- We started investigating designs with slit blades inclined w.r.t. beam reference trajectory
  - energy deposition diluted in a larger volume

- After investigating several material options: graphite results to be the more suitable
FLUKA RESULTS
FLUKA and analytical temperature calculations results

Energy deposition vs Z

- even smaller angles could be envisage but
  - 15deg --> 10deg doesn’t makes a big
difference in terms of energy deposition
peak and requires a larger longitudinal
space for the slit

For calculating max temperature:
- Single pulse
- Only black body radiation as cooling process

Maximum temperature at Bragg’s peak

<table>
<thead>
<tr>
<th></th>
<th>SRIM</th>
<th>FLUKA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Angle $\alpha$ [deg]</strong></td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td><strong>RFQ</strong></td>
<td>1359</td>
<td>1342</td>
</tr>
<tr>
<td><strong>MEBT</strong></td>
<td>2673</td>
<td>2613</td>
</tr>
<tr>
<td><strong>DTL1 (bench at tank exit)</strong></td>
<td>4669</td>
<td>4954</td>
</tr>
<tr>
<td><strong>DTL1 (bench at 1 m from tank exit)</strong></td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

15 degrees looks acceptable for all commissioning stages

F.Roncarolo, 3MeVTCC meeting, 5 May 2010
BI is writing an EDMS document to be checked and approved by L4 management, that will serve as reference for the design completion by TE-MME.

Next:
- review the document
- give a draft version to MME
- discuss details (mechanics, positioning accuracy, alignment etc...)
- circulate document for approval

**FUNCTIONAL SPECIFICATIONS**

**Tolerances**

**Geometric constraints**
A. Dallocchio & Co

- Ansys simulations starting from BI FLUKA studies
- account for cooling effects other than black body radiation
- study and dimension external cooling
- estimate thermo-mechanical stresses

Preliminary:

confirmation that 15deg looks ok
CONCLUSIONS

‣ energy deposition studies completed

‣ we all agreed (with Carlo and Giulia too) on
  ▪ slit orientation
  ▪ slit gap longitudinal position (w.r.t. to grid and w.r.t. test bench start)
  ▪ slit gap values

‣ EN-MME is finishing
  ▪ FE thermo-mechanical simulations to confirm: graphite slit with 15deg w.r.t. beam trajectory is suitable for all commissioning stages
  ▪ details of mechanical design (cooling, slit gap tuning, graphite thickness, etc...)
  ▪ validation of full integration into L4 tunnel including movement mechanisms

‣ BI and MME need to finalize motorization dimensioning and choice