MERIT beam optics

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MERIT Elements – Layout

QDE.430s (de-focusing) quads
3 elements in series

QFO.415s (focusing) quads
3 elements in series
Survey data after the MERIT run – 18.12.2007

Upstream face: -72.3 cm
Beam optics

- Fit parameters: QFO, QDO strengths and locations (within limits)

<table>
<thead>
<tr>
<th>Element</th>
<th>S_line</th>
<th>Beta_x</th>
<th>Alfa_x</th>
<th>Delta_x</th>
<th>Beta_y</th>
<th>Alfa_y</th>
<th>Delta_y</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTV.454</td>
<td>365.1484</td>
<td>8.7535</td>
<td>2.1732</td>
<td>1.5415</td>
<td>7.5513</td>
<td>1.2242</td>
<td>-0.0419</td>
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<tr>
<td>MTV.484</td>
<td>366.8514</td>
<td>3.2477</td>
<td>1.0598</td>
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<td>4.3414</td>
<td>0.6607</td>
<td>0.0294</td>
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<td>HG-WUP</td>
<td>370.3394</td>
<td>3.8082</td>
<td>-1.2205</td>
<td>1.7834</td>
<td>3.7581</td>
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<td>HG-TARG</td>
<td>371.0624</td>
<td>5.9148</td>
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<td>1.8171</td>
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<td>0.2058</td>
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<td>1.9397</td>
<td>10.7838</td>
<td>-1.6025</td>
<td>0.3160</td>
</tr>
</tbody>
</table>
Beam envelope (1-sigma) - $\varepsilon=0.25$ (mm.mrad), $Dp=0.1\%$

- Without dispersion term
  - $\sigma(x) = 2.2\text{mm}$, $\sigma(y) = 0.86\text{ mm}$,

- With dispersion term
  - 164 J/gr@30TP
Beam optics – summary

- Optics solution found within the overall constrains

- Lack of survey before the data-taken introduced an error to the beam focus position
  - Beam waist advanced by ~1m upstream of solenoid

- Beam spot estimate depends on emittance measurement
  - We did not insist of having systematic measurement of the beam emittance during the run
  - Only five measurements done
Beam Emittance measurement – 14 GeV/c

- Friday 26.10@15:55
- Beam intensity: h16, 1E13
Beam Emittance measurement – 14 GeV/c

- Friday 26.10@17:37
- Beam intensity: 2.5E11/bunch
- 2 extracted bunches,
Beam Emittance measurement – 14 GeV/c

- **Friday 26.10@18:24**
- **Beam intensity:**
  - 1.3E12/bunch
  - 2 extracted bunches,
Beam Emittance measurement – 24 GeV/c

- Friday 02.11@14:55PM
- Beam intensity: 2.5E11/bunch
- 16 bunches
Beam Emittance measurement – 24 GeV/c

- Friday 02.11@16:02PM
- Beam intensity:
  - 16 bunches,
  - 6E12 protons
Emittance measurement

- Use the data to extrapolate at higher intensities

<table>
<thead>
<tr>
<th>Intensity [e13]</th>
<th>Pbeam [GeV]</th>
<th>Eh(2s) [mm.mrad]</th>
<th>Ev(2s) [mm.mrad]</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>MERIT-run</td>
<td>1.0090</td>
<td>1.02</td>
<td>15.33</td>
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</table>

Transverse emittance (2s) in TT2

- MERIT-Eh
- MERIT-Ev

Linear (MERIT-Eh): $y = 11.23x + 1.5998$, $R^2 = 0.6783$
Linear (MERIT-Ev): $y = 6.0664x + 5.6415$, $R^2 = 0.6321$
Estimated beam spot and density

- Use the extrapolated emittances to estimate the beam spot and energy density at target

- Example: 24 GeV, 30 TP

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<th>Alfa_y</th>
<th>Delta_y [m]</th>
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24 GeV

$\Delta p = 1.1 \, [0.1\%]$

$E_{\text{h}_x(2s)} @ 30\, \text{TP} = 1.3678 \, [\text{pl. mm.mrad}]$  
$E_{\text{h}_y(2s)} @ 30\, \text{TP} = 0.9242 \, [\text{pl. mm.mrad}]$

Beam density (1s) = 122.37 [j/gr for 30TP]