ColUSM #150

4 March 2022

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New PPS Studies since EoI

Next project step: TDRs (first volume due for this summer)

Present main activities:

1. Design studies for new Roman Pot vessels and detectors:
   • detector dimensions from predicted hit maps (vertical crossing with 2 possible polarities)
   • segmentation for tracking and timing detectors (from occupancy)
   • remote-controlled shifting of detectors inside the pot to distribute peaked irradiation
     Not the topic of this meeting

2. Update of performance studies
   • Optics 1.3 (EoI) → 1.5
     Noticed changes less in the optics, but in the layout (aperture!)

     • Chamonix 2022: new running scenario:
       - lumi levelling trajectory during fill has changed
       - TCT collimator settings have changed
       → acceptances to be recalculated for new ($\alpha/2$, $\beta^*$) points and new XRP distances

Here: some comments and questions on (2), triggered by a recent email exchange.
**New HL-LHC Running Scenario**

**Basis:**
- R. Tomas @ Chamonix 2022
- Draft note: “HL-LHC Run 4 proton operational scenario” (25 Jan. 2022)

**Recalculation of performance: no drastic change relative to EoI!**

<table>
<thead>
<tr>
<th>Year</th>
<th>ppb $[10^{11}]$</th>
<th>Virtual lumi. $[10^{34}\text{cm}^{-2}\text{s}^{-1}]$</th>
<th>Days in physics</th>
<th>$\theta$ [\mu rad]</th>
<th>$\beta_{\text{start}}$ [cm]</th>
<th>$\beta_{\text{end}}$ [cm]</th>
<th>CC</th>
<th>Max. PU</th>
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<tbody>
<tr>
<td>2029</td>
<td>1.8</td>
<td>4.4</td>
<td>90</td>
<td>380</td>
<td>70</td>
<td>30</td>
<td>exp 116</td>
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<tr>
<td>2030</td>
<td>2.2</td>
<td>9.7</td>
<td>120</td>
<td>500</td>
<td>100</td>
<td>30</td>
<td>on 132</td>
<td></td>
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<tr>
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<td>2.2</td>
<td>11.3</td>
<td>160</td>
<td>500</td>
<td>100</td>
<td>25</td>
<td>on 132</td>
<td></td>
</tr>
<tr>
<td>2032</td>
<td>2.2</td>
<td>13.5</td>
<td>160</td>
<td>500</td>
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<td>20</td>
<td>on 132</td>
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<td></td>
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<td>13.5</td>
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<td>on 132</td>
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<tr>
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<td>16.9</td>
<td>170</td>
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<td>15</td>
<td>on 132</td>
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<tr>
<td>2036</td>
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<td>200</td>
<td>500</td>
<td>100</td>
<td>15</td>
<td>on 200</td>
<td></td>
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</tbody>
</table>

**Old TCT settings:**
$$d_{\text{TCT}} = 12.9 \sigma(\beta^* = 15\text{cm}) = 16.1 \text{ mm}$$
(constant position during the fill)

**New TCT settings:**
$$d_{\text{TCT}} = 13.2 \sigma(\beta^* = 20\text{cm}) = 14.3 \text{ mm}$$
(constant position during the fill)

TCL settings stayed unchanged in absolute distance.

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Fast phase to ~55 cm
• Are numerical data available for this graph?
• There seems to be a fast phase from 1 m to ~55 cm. Is there anything “magic” about this transition point of 55 cm? Normal squeeze to telescope?
• How does the trajectory look like in the first year? Start at 70 cm → transition to slow phase also at 55 cm?

We studied:
\( \beta^* = 15, 20 \text{ cm} \) (“round” optics directory)
\( \beta^* = 50, 64, 85, 100 \text{ cm} \) (“ramp” optics directory)
\( \rightarrow \) confirmed that from 15 to 50 cm the transport matrix is constant, but not from 50 to 100 cm

Knowledge of transport functions at all \( \beta^* \) is crucial. Constant functions are advantageous but not mandatory if reliable parametrisation is available.
Variation of Transport Functions

Forward physics notation:

\[ v_x = T_{11} \quad L_x = T_{12} \]
\[ v_y = T_{33} \quad L_y = T_{34} \]

Seeing non-monotonic evolution was bad news.
Any simple rules, or do we need all magnet currents to predict this?
We have optics reconstruction knowledge in the group, but only for \( \beta^* \) points where calibration data are available \( \rightarrow \) interpolation would be useful.
Some Answers to Your Questions

- Preference for smaller or larger crossing-angle?
- Preference for smaller or larger dispersion?

**Vertical crossing-angle \( \propto \) vertical dispersion:**
Argument from detector coverage:

Detectors will be designed to cover up to (+ or -) 250 \( \mu \)rad (polarity change assumed only in YETS)
\( \Rightarrow \) smaller \( \alpha/2 \) and \( D_y \) are ok,
larger ones not (protons out of acceptance)

**Horizontal dispersion:**
Larger \( D_x \) always welcome (gives acceptance for small masses), but not a formal request.
For Info: XRP Distance vs. $\beta^*$

Optics V. 1.5

Note: 2 TCTs at HL-LHC (incoming beam): TCT-4 (cell 4) and TCT-6 (cell 6), respect hierarchy to the most stringent one (here TCT-4).

In general: XRP-to-beam distances greater (i.e. less aggressive) than in Runs 2 – 3, except for XRP-234!