MD Wishes
from the Experiments

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LHC MD Day
Introduction

- Had first discussion on possible experimental requests on Monday last week
  - Likely not a full wish list presented today
- Most requests related to achieving precision luminosity measurements
  - Partly as follow-up from LHC Lumi Days 2019 workshop
- Not all requests are necessarily meant to happen during regular MD periods
  - Some might be more natural to do during VdM run period
  - Others during/at end of regular Physics fills
- Not covering setup of VdM beams etc.
  - Prerequisite for VdM scans themselves and MD studies related to these
  - Expect this to be mostly done during beam recommissioning
  - Critical that high-quality VdM beams be produced by injector chain and propagated to the LHC
Luminosity Uncertainty

- Luminosity uncertainty dominant for some precision cross-section measurements in ATLAS and CMS
- Strong effort over last years to get luminosity uncertainty down to 2-2.5%
- Long-term aim is to approach 1% uncertainty
  - Requires reducing individual uncertainties to <<1%
  - Have to be sure no uncertainty is missing or underestimated
- Request to recheck beam-current instrumentation
  - Reproducibility and precision
  - During beam-commissioning or needs MD?

### ATLAS luminosity uncertainties

<table>
<thead>
<tr>
<th>Data sample</th>
<th>2015+16</th>
<th>2017</th>
<th>2018</th>
<th>Comb.</th>
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<tbody>
<tr>
<td>Integrated luminosity (fb⁻¹)</td>
<td>36.2</td>
<td>44.3</td>
<td>58.5</td>
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<tr>
<td>Total uncertainty (fb⁻¹)</td>
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<td>1.0</td>
<td>1.2</td>
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<tr>
<td>Uncertainty contributions (%)</td>
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<td>DCCT calibration†</td>
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<td>FBCT bunch-by-bunch fractions</td>
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<td>Ghost-charge correction*</td>
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<tr>
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<td>Scan curve fit model†</td>
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<td>Background subtraction</td>
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<td>Beam position jitter†</td>
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<td>Non-factorization effects*</td>
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<td>Bunch-by-bunch ( \sigma_{\text{vib}} ) consistency</td>
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<td>Subtotal for absolute vdM calibration</td>
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<td>Afterglow and beam-halo subtraction*</td>
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<td>Total uncertainty (%)</td>
<td>2.1</td>
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<td>1.7</td>
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</table>
**Study Beam-Beam Effects in VdM**

- Beam-beam effect changes orbit and dynamic beta when beams are separated in VdM scan
  - Affects position and rate estimates
  - Corrected for in VdM analysis (1-1.8% effect) and an uncertainty is added (0.2-0.6% in CMS)

- Questions on the modeling uncertainties
  - Would like to measure actual effect
  - Present vdM optics ($\beta^* \sim L^*$) makes it difficult to measure $\beta^*$ precisely at some IPs
    - Reoptimize VdM $\beta^*$?
    - Under discussion among experiments
Study Beam-Beam Effects in VdM

- Goal is to cross-check the beam-beam modeling in the VdM scan setup
- Since effect normally is %-level, need to increase the effect to allow measurement
- Two proposals from ATLAS and CMS:
  - 1) Different $\beta^*$ at IP2/8 to maximize the effects at IP1/5
  - 2) High brightness, i.e. $I_b>1.2e11$ ppb and $\epsilon<2\mu m$
  - Both make use of VdM optics ($\beta^*=19m$), individual bunches, head-on collisions etc.
- Quantitative comparison of measurements with beam-beam simulations requires the precise knowledge of $\beta^*$ at all 4 IPs and of the phase advances from one IP to the next
  - These measurements would be an integral part of setting up a new VdM configuration with different $\beta^*$
  - They should be carried out even if the present $\beta^*$ is kept
- Ideally should happen early in Run 3
  - Possibly during first VdM scan period?
Emittance Scan MDs

- CMS is relying strongly on emittance scans to monitor the long-term stability of their luminometers.
- See some not understood jumps across luminometers, i.e. likely not detector effects.
  - Calculated emittances also do not match measurements from the machine.
- Propose several studies to improve understanding:
  - Varying $\beta^*$
  - Crossing angle precision (how well is angle known?)
  - Longitudinal profile
    - Needs full beam profiles, not just sigma
Luminometers Check

- CMS would like to check the performance of their luminometers, specifically hadronic forward one (HF), to very high pile-up
  - Would like to measure up to pile-up of ~200
  - Expect this need to be with a regular length train
Collimator Settings for Roman Pots

- The maximum mass reach of both PPS (CMS) and AFP (ATLAS) depends on the opening of TCL4 and TCL5.
- In Run 2 had TCL4 $\sigma$ and TCL5 $\sigma$.
- Configuration in Run 3 under discussion in collimation WG.
  - Experiments desire largest possible opening.
- Might be useful to have study of losses as a function of TCL4 position with TCL5 open.
  - Risk of quench in study?
  - To use it to optimize configuration for most of physics running would have to happen early (i.e. 2021).