

First thoughts on LHC Heavy-Ion MDs in 2016

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The species and energy for the 2016 run are not yet decided so this list, including time estimates, is tentative (but MDs will be later in the year in any case).

When

- In 2016, as previous years, there is no time designated for MD during the heavy-ion run but we may take a little physics time for very high priority studies that cannot be done at other times.
- Some MDs could be done during the regular MD periods because Pb beams could be available from end July (shown in blue).
- Some MDs could ***and should*** be done during the regular MD periods to allow analysis and preparation before the physics run (shown in red).

Possible MD topics for Pb-Pb

- BFPP studies
 - If analysis of 2015 result shows need for more data
 - Another quench test
 - Detailed effects of BFPP mitigation bumps, understanding aperture in the BFPP impact locations
 - Only feasible in a Pb-Pb run

Possible MD topics for Pb-Pb OR p-Pb

- **Asymmetric TCP settings, varied TCT settings (1 shift?)**
 - Already partly demonstrated, P. Hermes further tracking studies
 - Few Pb bunches in physics optics
 - Reduce collimation losses at IR2 TCT, other locations
 - Also relevant for p-Pb. Needs to be tested, then incorporated in run setup, best done in MD time before the run
- **Emittance and intensity evolution (2 shifts???)**
 - Few Pb bunches at flat top (also injection?), might be done with non-colliding bunches during physics (?)
 - Study strong radiation damping, IBS, debunching, etc without collisions to further test the luminosity model
- **Crystal collimation (1 shift)**
 - Pb beam at flat top (easily done in regular MD period?)
 - Finish study from 2015

Possible MD topics for p-Pb

- **Absolute energy calibration of LHC (< 2 shifts)**
 - Only absolute measurement of LHC energy
 - Both p-Pb AND Pb-p needed to control systematic errors
 - Not needed if we do p-Pb AND Pb-p physics at 6.5 Z TeV
 - Ramp two beams to 6.5 Z TeV, no cogging procedure
 - Revolution frequency difference on central orbit (as before at 4 Z TeV)
- **p-Pb moving beam-beam encounter studies at injection (1.5 shifts)**
 - (lost MD time in 2012) find when protons limit Pb intensity
 - Coupled to BI MD on stripline BPMs
 - losses, emittance growth
- **Unequal beam sizes in collision (1.5 shift)**
 - Source of losses in p-Pb in 2013
 - Few bunches in collision conditions
 - Might be done with p-p (adapted intensity), blow up one beam ?

BACKUP SLIDES

Reminder of p-Pb in 2013

- LHCC 13/3/2013 <http://indico.cern.ch/event/239117/session/1/contribution/14>
- Almost unprecedented mode of collider operation:
$$E = 4 Z \text{ TeV} \Rightarrow \sqrt{s_{\text{NN}}} = 5.02 \text{ TeV}$$
 - Injection and ramp with unequal revolution frequencies, resynch and cogging at flat-top
 - Complex filling scheme: p and Pb had to match up, led to 200/225 ns alternating bunch spacing, 338 bunches/beam
 - Off-momentum squeeze $\Rightarrow \beta^*=0.8 \text{ m}$ from aperture limit around ALICE (took same for ATLAS/CMS)
 - ALICE levelling briefly at $L \approx 1 \times 10^{29} \text{ cm}^{-2}\text{s}^{-1}$
 - Proton bunch intensity equivalent to $1/\beta^*$ (but limited by BPMs), integrated luminosity of a fill \sim proportional to Pb intensity.
 - Lowest $\beta^*=2 \text{ m}$ ever for LHCb
 - Beam reversal *and* solenoid polarity reversal
 - Catch-up fills to equalise final integrated luminosity for ALICE
 - p-p reference done in extra time, after final whistle of Run 1

ALICE: 31.94 nb^{-1} ATLAS: 31.2 nb^{-1} CMS: 31.69 nb^{-1} LHCb: 2.12 nb^{-1}