Input of the experiments for 2018

LPC

C.Schwick, J.Boyd
With help and input from a lot of colleagues
From the machine and the experiments
• Draft Schedule 2018
• Experiment requests / wishes
  – pp run
  – special runs
  – Pb Pb run
# Draft Schedule 2018 v0.7

## January

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- **Week 1:** Commis Maintenance
- **Week 2:** Technical stop (YETS)
- **Week 3:** 
- **Week 4:** 
- **Week 5:** DSO test
- **Week 6:**

## March

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- **Week 9:** LHC to OP
- **Week 10:** Start powering tests
- **Week 11:** LHC, T12, T18 closed
- **Week 12:** T12 & T18 Beam tests
- **Week 13:** Experiments valves open

## April

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- **Week 14:** Start Beam Commissioning

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- **Week 21:** Easter
- **Week 22:** Whitsun
- **Week 23:** VOM run
- **Week 24:** April
- **Week 25:** May
- **Week 26:** June

## Color Key

- **Special physics runs (indicative - schedule to be established):**
- **Machine development:**
- **Scrubbing (indicative - dates to be established):**
- **Pb - Pb Ion physics run:**
- **Pb Ion Setting up:**
- **LINAC 3 Pb oven re-fill:**
- **Technical Stop:**
- **Powering tests:**
- **Machine check out:**
- **Recomissioning with beam:**
- **Interleaved commissioning & intensity ramp up:**
- **Proton physics run:**

**Note:** Dates and activities are illustrative and subject to change.
## Draft Schedule 2018 v0.7

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### Legend
- Special physics runs (indicative - schedule to be established)
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- Recommisionning with beam
- Interleaved commissioning & intensity ramp up
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12/12/17

LPC for Evian 2017
Remarks on the schedule

- The **start date for the commissioning** activities depend on the outcome of the CMS pixel detector investigations which should be available in January (Chamonix).

- It is under discussion if the **Technical Stops can be shortened**

- The **special run period** is to be understood as a **place holder**. Length and position of this period are still under discussion. The number of special runs which will be requested might be one or two (see below)

- In Chamonix the final decision on the need for **Week 49** “Powering Tests, Magnet tests” will be taken. If not needed the period from MD4 to the end of the Ion run will be shifted one week later to insert one more week of pp physics.
pp running

Preferences of Experiments
Preferences of experiments

- Preferred pp scheme
  - 25ns BCMS: preferred over 8b4e and “standard” (288b)
    - Promises highest integrated luminosity at moderate pileup
    - Decent amount of collisions in LHCb
    - Filling scheme candidate for 200ns batch spacing and 800ns injection spacing:
      25ns_2556b_2544_2215_2332_144bpi_20inj

- Regular Insertion of AFP and CTPPS pots
- Continue to use full de-tuning
  - No problems observed in experiments.
pp run: Pile-Up

- Pile-up distribution at start of Stable Beams
  - The width of the pile-up distribution in a fill is related to the trigger efficiency:
    - Bunch crossing with the highest pileup define the necessary trigger thresholds.
    - The width of the pile-up distributions in 2017 was acceptable for experiments and should stay similar in 2018.

Fill 6323

CMS
Mean 57.1
RMS: 5.8

ATLAS
Mean: 54.7
RMS: 4.6
pp run: Pile-Up

- Maximal Pile-up density
  - No problems encountered in 2017.
  - In 2018 maximal pile-up density expected to be similar to 2017 due to leveling at similar pile-up and similar crossing angles at IPs.
  - For LHCb the pile-up density with their dipole polarity “DOWN” needs to be controlled by bunch length leveling (bunch length needs to stay above 0.9ns)
pp run: Forward Physics

• Acceptance of CTPPS and AFP
  
  – It is expected that the acceptance for CTPPS and AFP remains similar to that of 2017. ($\beta^*$ leveling discussed below)

• Calibration data
  
  – CTPPS will need to take calibration data for three different crossing angles between which they can interpolate:
    • Minimal crossing angle
    • Middle crossing angle
    • Maximal crossing angle

  – This is needed since the crossing angle modifications change the dispersion at the pots.
pp run: Low Pile-up

- Low pile-up data samples are valuable for physics
  - Main motivations of large low μ sample: Reduce systematic errors in W-mass measurements
    - High pile-up data: $p_t$ distribution of $W$ cannot be measured directly ($E_{\text{miss}}$ of neutrino in high pileup environment not measurable)
      → need to extrapolate from $Z$ data → systematic errors
    - Low pile-up: $E_{\text{miss}}$ of neutrino can be measured → more precise $W - p_t$ distribution
      - $μ \sim 2-3$
  - Forward physics (e.g. QCD at low mass)
  - Heavy Ion physics (“ridge” – physics)
    - $μ \sim O(0.01) – O(1)$
pp run: Low Pile-up

- In 2018 ATLAS/CMS will continue to ask for separation of beams
  - During intensity ramp-ups
  - Possibly one or both experiments ask for dedicated fills
    - Seems an efficient way to take this data in long fills if both experiments request the data
    - Long fills are appreciated by leveled experiments (LHCb / ALICE)
  - In 2017 no stability issues were encountered when leveling ATLAS and CMS simultaneously
    - This was done (with lower than nominal) intensity at the end of 2017
pp run: High Pile-up

- CMS request (and ATLAS supports) a high pileup physics fill early in the year
  - Physics fill possibly during ramp-up
    - without leveling
    - with highest possible bunch-intensities
  - Allows to study detector or trigger related effects at high pileup
  - Serves to prepare for scenarios which could arise later in the year
pp run: Lumi Measurements

- **VdM scan requested by ATLAS CMS ALICE (LHCb will participate)**
  - ATLAS and CMS request a scan early in the year
  - ATLAS prefers a quiet period after an MD or TS. CMS no preference pronounced yet.
  - Both experiments might request a second scan if problems in the first scan arise.
  - With crossing angle at injection to allow for some flexibility in filling scheme
    - Avoid long-range encounters at injection
  - ALICE requests crossing angle change to insert ZDC (as in 2017)

- **ATLAS requests a calibration transfer directly after the VdM scan**
  - Fill with brightest possible INDIVs after the VDM scan as fill 6336 in 2017 using scheme `Multi_525ns_140b_140_104_24_8bpi_19inj`
    - Allows to investigate effects sub-system dependent effects (Tracker / Tile Calo) when transferring the VdM calibration to physics conditions
    - Requires high statistics for Tile Calorimeter
    - Take ~2h data at $\mu \sim 0.5$ as during VdM scan and some other separations (shorter periods)

- **Both experiments request a $\mu$-scan with trains**
  - Study pileup dependent response of various luminometers in one single fill over a wide range
  - Fill with highest possible number of trains and 1 or 2 INDIVs
  - ATLAS requests this fill directly after the calibration transfer fill

- **ATLAS & CMS intend to perform emittance scans during physics fills**
  - Help to control stability of luminometers and measure their performance at different pile-up conditions in physics.
    - ATLAS emittance scans new in 2018: frequency and timing to be determined by ATLAS

- **CMS requests fill with INDIV pairs of different emittances**
  - Validate emittance scan linearity in one single fill with constant conditions
  - This could be done in a BSRT calibration fill
(Anti-) Leveling

- **Pile-up / Lumi leveling**
  - ATLAS and CMS have not yet defined the maximal luminosity / pile-up combinations they would like to be leveled at. Might want to level at different levels in 2018.
  - It is expected that these values will be similar to the values in 2017. For the 25ns BCMS scheme this means:
    \[
    \mu_{\text{max}} \sim 60 \\
    L_{\text{max}} \sim 2.15 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}
    \]

- **Crossing angle anti-leveling**
  - No problems in 2017
  - Appreciated gains in integrated luminosity
  - Experiments are ready for continuous leveling (i.e. many small steps) (at fixed $\beta^*$)

- **Bunch length leveling**
  - As in 2017 LHCb requires bunch length leveling with dipole polarity “DOWN” to keep the pileup density low.
    - Bunch length > 0.9ns
Remarks on $\beta^*$ leveling

- **Scenario considered so far**
  - A few (4) discrete steps of $\beta^*$ at the start of the fill
    - A. Without change of crossing angle
    - B. With simultaneous change of crossing angle (to optimise DA)
  - Afterwards crossing angle anti-leveling (as in 2017)

- **Consequences for experiments**
  - Disadvantages for Forward Physics experiments (CTPPS / AFP)
    - Need calibration data for three $\beta^*$ step in CTPPS
    - Complication of data analysis (separated data sets for different $\beta^*$ values)
    - In case B the relevant optical function for particles propagating from the IP to the pots change: difficult interpretation of the data.
    - Not clear today if pots need to be moved when changing the $\beta^*$ in order to obtain good acceptance for physics
  - Advantages
    - None

- **Statement**
  - **Separation leveling is the preferred leveling method**
  - If absolutely necessary to commission $\beta^*$ leveling this year experiments will not oppose.

- **Alternative scenarios**
  - Scenarios where $\beta^*$ is leveled later to lower values than could be used at the start of the fill (e.g. 25cm) have advantages:
    - gain in integrated luminosity
    - Flexibility of separation leveling at the start of the fill
    - In case of problems can be omitted.
Other topics

• Non-overlapping 12b trains
  – Used by experiments (ATLAS) for background studies
  – Need to be non-overlapping
  – Policy as in 2017
    • Keep then non-overlapping as long as this does not cost
      • a significant amount of collisions in any experiment
  – Question (MPP): Could the 12b be shortened to some extent if this preserves the non-overlapping?

• LHCb continues SMOG fixed target programme
  – Important input to VdM scans of all experiments (ghost charge, beam imaging)
  – Fixed target physics programme
  – Inject various gas species in target zone (VELO)
  – Transparent for operations
  – Pb-Ne collisions will be recorded during HI run

• Luminosity goals
  – LHCb would like to have a Luminosity goal defined
    • Discussions in LHCC / research board
  – LPC agrees with the concept
    • The goal should be defined by the machine experts
    • The goal should be achievable under reasonably good running conditions (as it was defined for ATLAS/CMS integrated lumis in the past)
Special runs
β* ~ 90m at high lumi

- Requested by TOTEM & CMS
  - Physics interest:
    - Glueball searches
    - Low missing mass searches
  - Limited to 1 week including setup time

- Machine parameters under discussion with experts
  - Hope to reach pile-up ~ O(1)
    - Can be digested by TOTEM due to new timing detectors
  - TOTEM needs to define the minimal β* necessary for this run in order to reach their physics goals
    - Hope to reach 13/pb in 5 days data taking (assume 2 days setup)

- Scheduling constraints
  - After the timing detectors have been successfully commissioned.

- ATLAS / ALFA will participate in this run
  - ATLAS/ALFA needs to work out a request for a configuration at their IP
Possible request: low E high $\beta^*$ run

- Interest of this run confirmed by LHCC
  - Physics goal:
    - Elastic cross-section in interference region nuclear - coulomb
      - Interference region characterised by rho parameter: Imaginary part / real part of scattering amplitude

- Interest for this run: TOTEM & ATLAS/ALFA
  - 2018 might be the last year for ALFA

- Status of request
  - Successes:
    - Optics found which is acceptable for physics
    - Possible to inject into physics optics (fast turn-around)
  - Problems:
    - So far too high background observed.
  - Request depend on analysis of data taken in a series of tests during 2017.
  - Some optimism/ideas by experts to find a working configuration

- Possibly conflicting interest to be resolved
  - Beam energy
    - ATLAS/ALFA would like to go to 2 TeV if 900GeV turns out to be difficult to achieve. TOTEM strongly prefers 900 GeV.
    - ATLAS/ALFA prefers the run to be scheduled early and before the 90m run whereas TOTEM prefer the other way round
  - Discussions ongoing and hope to converge in these points. Guidance from LHCC expected.

13/12/17
LPC for Evian 2017
Heavy Ion run
Heavy Ion Pb – Pb run

- Experiments converged on Energy: 6.37 ZTeV

- Preparation
  - Installation of ZDC in CMS and ATLAS
  - Installation of CASTOR (CMS) still under discussion

- “Ambitious” expectations of experiments
  - ALICE: 1 nb\(^{-1}\) delivered
    - Assuming that a configuration can be found in which they are running always leveled
    - Default leveling to 1.0\times10^{27}\text{cm}^{-2}\text{s}^{-1}
    - Tests ongoing if readout rate can be increased so that they can be leveled to 1.3\times10^{27}\text{cm}^{-2}\text{s}^{-1}:
      results expected after having taken some pp data.
  - ATLAS & CMS:
    - As much luminosity as possible
    - No data taking limitations
  - LHCb: more colliding bunches and stronger squeeze than in 2015
    - Hoping for 60-70 colliding bunches
    - Squeeze to 1.5m

- VdM scans requested by ALICE/ATLAS/CMS,
  - Details to be discussed

- ATLAS requests AFP pots to be inserted
  - Details to be discussed. Alignment and loss maps necessary
Heavy Ion Pb – Pb run

• Configuration being worked out by HI machine experts:
  
  – Try to optimise parameter in ALICE to maximise the leveling time
    • Evaluate if $\beta^*$ can be lowered in IP2

• Some sharing of the luminosity will need to be implemented
  
  – Probably some guidance from LHCC / CERN management needed to decide on this.
Summary

- Clear wishes for pp – run
  - 25ns BCMS
  - Some “standard extras”

- Special run
  - Requests to be finalised: probably 2 runs will be requested
    - 90m like run at high luminosity
    - Probably low E high ß* run will be requested
  - Total time, schedule and configuration to be defined (soon)
  - First tests should be started early in the year

- Heavy Ion run
  - “Challenging” expectations
Proton Electron Collisions

- **LHCb**
  - No interest in Stable Beams, but will take data if it happens
  - Do not expect to be able to do anything new wrt HERA

- **CMS**
  - Not requesting stable beams
  - Will take data if it happens to do some distributions
  - Do not expect to be able to do anything new wrt HERA

- **ATLAS**
  - No interest in Stable Beams

- **ALICE**
  - Interest in stable beams under evaluation.
## Schedule comparison

<table>
<thead>
<tr>
<th></th>
<th>2018</th>
<th>(2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25ns pp days</td>
<td>138</td>
<td>127</td>
</tr>
<tr>
<td>Special runs (incl. 1 VdM)</td>
<td>9 (tbc) (placeholder)</td>
<td>18 (incl pp ref.run and low μ days)</td>
</tr>
<tr>
<td>Pb Pb run</td>
<td>24</td>
<td>-</td>
</tr>
<tr>
<td>MD</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>TS &amp; recovery</td>
<td>18</td>
<td>12</td>
</tr>
</tbody>
</table>
# Low E high $\beta^*$ schedule

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 days</td>
<td>Setup of high $\beta^*$, collimation, etc</td>
</tr>
<tr>
<td>1.5 days</td>
<td>High $\beta^*$ data taking</td>
</tr>
<tr>
<td>0.5 days</td>
<td>11m $\beta^*$ data taking with RPs at 3sigma</td>
</tr>
<tr>
<td>0.5 days</td>
<td>VdM scan at 900 GeV</td>
</tr>
</tbody>
</table>
• **Scan ranges**
  
  – VdM
  
  – Emittance scan