First ideas for OP MDs in Run 3
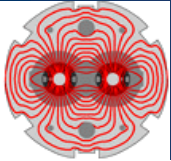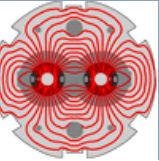
J. Wenninger for the BE-OP-LHC section

❑ The scales and offsets of the BPMs have an impact on aperture, feed-downs of multipolar errors, effective bump amplitudes etc. Although the aim would be to perform as many measurements and corrections as possible during commissioning, some follow up studies may be required.

– Given the interest for operation and many other studies, such MDs should take place as early as possible (2021/22).

❑ MD subjects:

– Improving the knowledge on the BPM scales, in particular in LSS1/2/5/8 with various calibration methods (collaboration with OMC).

  • Ideally done during the recommissioning, if unfinished → MD in 2021 to profit for Run 3.

– Improved measurements of the crossing angles in all IPs.

  • The earlier, the better.

– Improving and speeding up measurements of k-modulation offsets for IPQs and ITs.
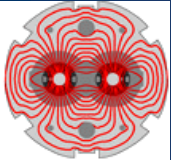
Energy matching
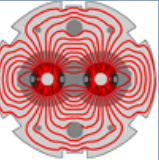
❑ Since we will most likely operate with lower RF voltage in Run 3 and be more sensitive to injection errors (phase & energy), we will have to monitor and most likely also correct the matching regularly. Ideally this is solved in operation, but we may need MD time to try out some ideas (measurements and correction).

❑ MD subject – with RF:

– Energy matching improvements (measurements and correction).

• Recommended to schedule in 2021/22.

Ramp in steps - J. Wenninger
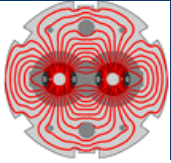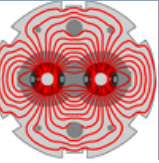
❑ A major renovation of the QFB and OFB is ongoing during LS2. The new FBs must of course be ready to ramp and squeeze beams in 2021, but some of the new functionality may not be ready or finalized for the 2021 recommissioning.

❑ MD subjects:

– Gain functions,

– Eigenvalue configuration functions,

– Tune reference functions and optimization of tunes (eg early part of ramp...),

– Yet another attempt to operate the OFB with MCBX to gain identify issues for HL-LHC.

• Lower priority.

Ramp in steps - J. Wenninger

1/27/2020
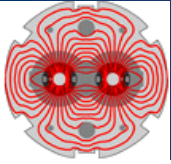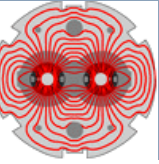
❑ All levelling tools will have to be re-commissioned and optimized after LS2.

❑ Depending on the final schedule and op scenario for 2021, the levelling tools may or may not be part of the commissioning and intensity ramp up.

❑ Optimizations and further development may take place during Run 3.

❑ MD subject:

   – Development and optimization of levelling tools.
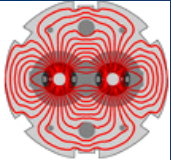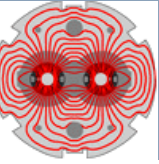
❑ Development of multi-energy ramps to understand the cause of the emittance growth.

– Multiple ramp with varying FT energies are the most straightforward choice (→ not much to develop here, just commissioning) for the emittance study MDs.

❑ MD subject:

– Test of a single ramp with intermediate FT energies **if there is a strong request**.

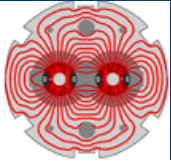• For 2022 or later.

Multiple ramps with varying FT energies

Single ramp with intermediate FT energies
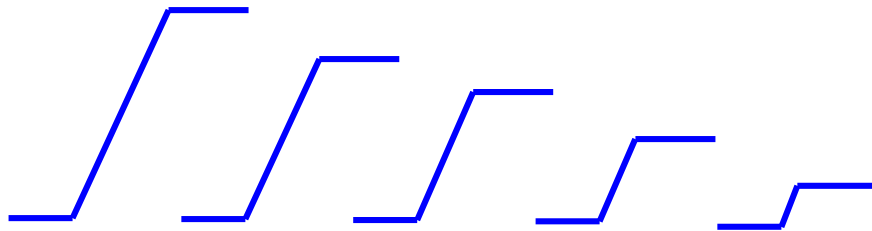
o Straightforward to design,

o No development needed.
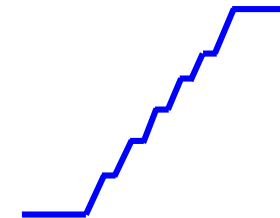
o SW development required,

o Sub-options:

▪ Single or multiple target energies for one cycle.

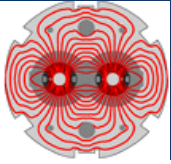**Ramp in steps - J. Wenninger**

1/27/2020

6
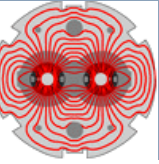
❑ Development of new smooth ramp and squeeze concepts without the fixed matched points (Riccardo ....).

❑ The concepts of such ramps must still be worked out in detail and embedded into controls SW to generate and trim all parameters. To make this work with beam has important consequences on the control system.

❑ MD subject:

– Test of new ramp and squeeze concepts,

• Probably not ready before 2022.
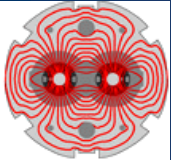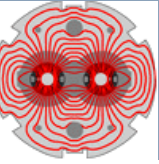
❏ Orbit excursions at top energy in many LSS may be explained by TF errors of the various separation dipole families.

– In LSS1/2/5/8 the perturbations can be steered away with the orbit correctors,

– In LSS4 there are small uncorrectable residuals.

❏ MD subject – already on the Run 2 list:

– Study and correct the TF errors at the source (i.e. with the IPDs).
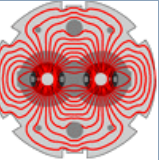
❑ There is an ongoing effort to use ML tools to charactize beam losses, lifetime and loss patterns.

– Continuous loss analysis for anomaly detection (lifetimes, loss patterns),

– Loss map analysis automation,

– ...

❑ At this stage it is however not possible to define a precise topic.

❑ MD subject:

– Application of ML to beam losses.
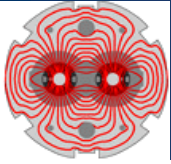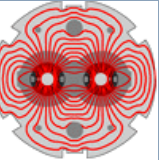
- ❑ Still pending from Run 2 is the injection test at 225 GeV for FCC-hh.
- ❑ I detailled note was written on the requirements, essentially it has to be done at the end of a years before the (E)YETS.
- ❑ It is not clear what the status and priority of that very involved test / MD should be.
  - – Now that it is clear that FCC-hh is for 2050-2060...

Ramp in steps - J. Wenninger

1/27/2020