Topics for LHC…

- Goal: Design the HL-LHC that **best addresses the LHC limitations and optimizes performance**!
- Understand limitations and improvements in the **major areas of concern**:
  - Intensity
  - Aperture
  - Optics
  - Machine Protection
  - Bunch Spacing
  - Beam-beam

Questions for LHC I

- **Intensity limitations:**
  - Heating, impedance, RF fingers, bunch shape (spectral content), …
  - Localized losses (UFO's, injection, transfer lines, …)
  - Cleaning efficiency, BLM thresholds and quench limits
  - Radiation (R2E, magnet lifetime, …) and environm. impact
  - Transverse and longitudinal beam instabilities
  - RF stability (RF feedback loops) and transverse damper limitations

Questions for LHC II

- **Aperture limitations:**
  - Understanding of critical aperture locations (arc, injection regions, triplets) and requirements for future magnets.
  - Feasible margins in orbit, beta beat, collimation, … and requirements for the future.
- **Optics limitations:**
  - beta* reach with different optics (nominal, ATS), including need for correctors
  - Magnet non-linearities and required specifications for future magnets

Questions for LHC III

- **Machine protection limitations:**
  - Assumed and encountered failure scenarios (injection failures, abnormal dumps, collimator movements, fast and slow beam losses). Future requirements.
  - Impacts from measured beam shape (overpopulated tails).
- **Bunch spacing limitations:**
  - Behavior of 25ns beams.
  - E-cloud and scrubbing.
  - Follow-up on special regions (no coating, …)

Questions for LHC IV

- **Beam-beam limitations:**
  - Long-range beam-beam effects for different bunch spacings. Required crossing angles.
  - Luminosity leveling.

“Provocative” Questions

1. Why don’t we cancel many LHC MD’s (non-linear, b-b, ATS, coll, LPA, …) and take physics data instead? In the end, the HEP requirement (physics) decides about LHC upgrade needs!
2. Why don’t we restrict ourselves to only do LHC MD’s with direct operational applications in year 1 after LS1 (25ns, coll., b-b)?
3. Why don’t we focus MD’s only on preparing upgrades and do commissioning tasks (new optics, injection, beam instrumentation, RF, aperture, fingers, …) during commissioning time?
4. Why don’t we spend more time on understanding LHC issues (non-linear, correctors, optics limits, ATS, quench limits, …), such that we can avoid to over-specify the LHC upgrades?
5. Why don’t we spend more time (ATS, long. BD, halo shape, …), proving that a long LS3 can pay off in LHC discovery reach (2 years luminosity lost versus gain in “virtual” luminosity)?

Questions Phrased Differently

1. Do we need to make more collimation MD's (7 TeV design values were reached)?
2. Do we need more beam-beam MD's (operating beyond design and LR beam-beam shown to behave as expected)?
3. Do we need more ATS MD's (principle shown to work well already)?
4. Why do we need to understand non-linearities in the LHC, they do not seem to matter?
5. Why do we need impedance MD's, even as the overall understanding is pretty good (transv. + long.)?
6. Should we spend more time on quench tests (lot's of data exists and it is difficult to quench the LHC magnets at lower energies)?
7. Is it needed to spend more time on injection (nominal beam injection was already achieved and will be set up for 25ns)?
8. …

➔ Discussion useful do define optimum MD program!