Overview of future studies for WP5.1

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For WP5.1

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Introduction

- A lot of work has been done in the past to define the upgrade path for HL-LHC collimation
  - Beam dynamics studies, energy deposition, thermo-mechanical analysis…
- We have now a robust baseline collimation system for HL-LHC, described e.g. in TDR
- Still, studies are needed in the future to
  - follow developments of the baseline,
  - address remaining open points,
  - follow up performance of new hardware in LHC,
  - study alternative and backup scenarios

Main areas for pending and future studies

- Simulation studies of proton collimation in HL-LHC baseline
- Simulation studies of Pb ion collimation in HL-LHC baseline, including crystals
- Simulations of hollow electron lens (operational modes and settings, etc.)
- Experimental studies: planning and follow-up of MDs in Run 3 for HL-LHC collimation
- Improvements of present baseline and alternative scenarios

Simulations of proton collimation

- More open collimators for decreased impedance in new v1.5 baseline
  - IR7 cleaning: potentially need both tracking and FLUKA studies; impact of no TCLDs/11T
  - Failure scenarios: verify protection of aperture and sensitive collimators with latest optics and settings
  - TCDQ settings in new optics
    - To keep hierarchy in β*-levelling, TCDQ should either move or β should be ~constant at TCDQ
    - Collaboration with WP2 and WP14
- TCT materials
  - Updated studies on background to experiments with CuCD and Inermet
  - Detailed robustness studies of CuCD in simulations
- BLM thresholds for new HL-LHC collimators installed in LS2
  - In collaboration with BLM threshold WG

Simulations of Pb ion halo collimation

- Reminder: 11T dipoles not installed in LS2, falling back on backup solution with crystals
- Presently don't have a full simulation model of crystal cleaning with ion beams
  - Goal: have well-benchmarked, integrated tracking simulation with ion-matter and ion-crystal interactions
  - Code development and benchmarking is very high priority
- Need tracking studies and energy deposition studies to assess Pb intensity reach
  - IR7 DS power loads with crystal collimation
  - Do we need crystals on both sides of the beam, or only one (as now)?
  - Power loads and allowed losses on TCTs
  - Ionization energy loss of Pb ions on coated collimators
- Tracking of Pb ion losses in IR3 (halo and collisional losses)
- Potentially study cleaning with future light-ion beams in Run 5
  - Not yet baseline, but strong momentum within experiments
  - New ALICE3 letter of intent under finalization

Pb ion collisional losses

- In close collaboration with WP10
- BFPP losses in Pb-Pb
  - alleviated with new TCLD collimators in IR2 and orbit bumps in IR1/5
  - Request for high luminosity in IR8 – can anything be done? Are we at the limit with present levelling target?
- Load from collisional losses in p-Pb
  - Imposed limit on luminosity in 2016 p-Pb run
  - Need to study if present TCL and TCLD collimators can alleviate these losses
  - What is the limit at LHCb?

Simulation studies for hollow electron lens

- Potentially review requirements on HEL for realistic loss spike scenarios
  - Is 90% depletion enough for all scenarios?
    - For protons, main issues are orbit jitter, flux jumps, crab cavity failures
  - Use with Pb ions for 10 Hz losses?

- Finalize operational scenario for HEL
  - Define pulsing mode (or constant current) and duration that depletes the halo with acceptable (minimum) impact on core
  - Important to include realistic imperfections on electron beam

- Exploratory study of effect on collimation cleaning
  - Can we optimize impact parameters to increase cleaning efficiency?
  - Depends strongly on machine non-linearities – potentially very difficult

Experimental studies in Run 3

- Study new crystals and detailed operational scenarios for Pb ions with crystals
  - First Run 3 crystal tests with protons
  - Consolidation of ramp functions and interlocks for crystals
  - Explore different setting strategies in MDs to maximize cleaning performance in Pb run
- To understand need of 11T dipoles and TCLD
  - Monitor and analyze lifetime and loss rates with LIU beams (protons and Pb ions)
  - Collimation quench test with protons
  - Collimation quench test with Pb ions (using crystals)
- Maximum luminosity tests with Pb ions
  - Understand experimentally the gain from BFPP alleviations (TCLDs + bumps)
  - Study alleviation of collisional losses in p-Pb with existing collimators
- Characterize impedance improvement with new low-impedance collimators
  - In collaboration with WP2
- MDs on tails and halo depletion
  - Tail scans with LIU beams
  - Maybe studies of effect on core from halo depletion, using existing LHC hardware (ADT etc)
- MDs on new optics in IR7 – see next slide

Alternative scenarios, backups

- IR7 optics
  - Could potentially achieve significant gain in both impedance and cleaning through new optics
    - Potentially need tracking and power deposition studies
    - Could be explored both for protons and Pb ions
  - To be tested in MDs

- Asymmetric collimator settings
  - Simulations to find most promising scenarios for protons and Pb ions
  - Assess gain in impedance in MDs
  - Potentially to be combined with new IR7 optics

Conclusions

- We have a solid collimation baseline for HL-LHC, but a number of items remain to be studied

- Rich and interesting future program of WP5 studies
  - Simulations and experimental studies of
    - proton collimation
    - Pb ion collimation
  - Hollow electron lens operation
  - Alternative scenarios and backup

Thanks for the attention