Collimation chapter in FCC-hh conceptual design report

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Scope

- Initial discussion in FCC coll. meeting on 12/3/2018
  - Draft outline presented
- This talk: brief update on where we are now
- Timescale: Aim at a full draft as soon as possible
- Overleaf document started – read link is https://www.overleaf.com/read/jbqtqwxgrvdg
  - For people contributing to the writeup: Ask me for edit link

Outline of collimation chapter

1. Introduction: roles of collimation, loss specification ← Done
2. Baseline collimation concept and settings ← Done
3. Machine aperture ← Almost done
4. Betatron collimation performance: tracking and protection of cold magnets
5. Energy deposition in warm betatron section ← Under preparation
6. Collimator robustness ← Done
7. Off-momentum collimation performance ← To be done
8. IR collimation ← To be done
9. Passive protection during failures ← Under preparation
10. Advanced concepts and key R&D ← To be done
11. (FCC collimation with heavy ions) ← Goes in ion chapter
12. Conclusions and outlook ← To be done

Outstanding items

- Following slides: draft content outlines from March talk
- Highlighting the *studies* that were outstanding in March and their status now

4. Betatron collimation performance

- Betatron loss maps at injection and top energy
  - Compare with criterion on cleaning inefficiency for 12 minute lifetime
  - Study to be shown today
- Influence of removed skew primary: what happens to skew losses?
  - Study to be shown today
- Influence of imperfections
  - Study done and added in CDR
- Recap work done on power deposition in cold section: check that we don't quench
  - To be discussed: Need iteration with latest design?
- Losses in experimental Irs, other loss spikes around the ring if applicable

5. Energy deposition in warm betatron section

- Assumptions on element design and layout, FLUKA model
- Energy deposition in warm section based on tracking from previous section
  - Overview of where the power goes
  - Discuss critical elements and what can be done.
    - Iterations with shorter TCP, thicker TCSG, no skew TCP
  - Any outstanding point? (Collimator robustness in next section)
- Outstanding work – to be discussed:
  - Systematic summary of remaining elements with high loads. Any worries? Warm magnets, passive absorbers, tunnel wall, beam pipe,
  - another iteration with final collimation system design?
  - Comparison of 50 TeV energy deposition between FLUKA and MARS?
  - Quench limit study in one selected magnet – rough estimate of quench limit in p/m/s at different beam energies → ongoing

6. Collimator robustness

- Thermo-mechanical studies of most loaded collimators during design loss scenario
  - Done: TCSG with thicker jaws
  - Look also at the TCPs? -- > Done
  - Another iteration with final system design?
- Statement on severity of consequences

7. Off-momentum collimation performance

- Tracking studies for design loss scenario (start of ramp). Compare to quench limit at injection
  - To be done
- Possibly tracking studies of off-momentum cleaning at top energy
  - To be done
- Optics and design alternatives
- Energy deposition studies?

8. Passive protection during failures

- Asynchronous beam dump: tracking studies to see losses on collimators and aperture around the ring
  - Focus on top energy
  - Summary of most loaded elements – any risk of damage?
  - How many extraction kickers can be tolerated to fail, in view of protection of collimators and aperture?
  - Extraction concept discussed in previous chapter, so no need to repeat
  - Work done, need only to be written up. Possibly re-iterate with new extraction design
- Local effects at extraction and design of extraction system in other chapter
- Injection failure – in other chapter?

9. IR collimation

- Possible issues, with experience from LHC and HL-LHC design in mind.
- Collimator layout in experimental IRs.
  - To be fixed in present layout: TCT should be further away than TAN from the IP → Done
- Losses in experimental Irs during different loss scenarios
- Energy deposition studies for DS collimators?

11. FCC collimation with heavy ions

- Reminder of challenges of heavy-ion collimation compared to proton collimation
- We need the beam parameters for ions – should this section be a part of the ion chapter instead, after that has been presented?
- Cleaning simulations for the design betatron loss scenario, comparison of inefficiency with proton results and estimated quench limit
  - Work presented today
- Energy deposition study in DS?
- This section might go into the heavy-ion chapter
  - Need probably beam paramters etc. before discussing collimation

Conclusions

- Most important parts are covered
- Still a few outstanding studies
  - Possibly iteration of energy deposition + robustness with final design. Could also come after CDR
  - Momentum cleaning – further studies needed
  - Quench limit study with FLUKA → work ongoing
- We should also agree on author list for collimation chapter (for later)