Dispersion Suppressor Protection

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CERN

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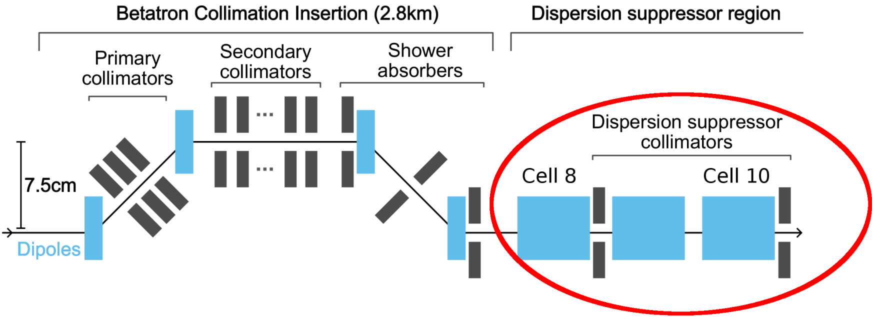
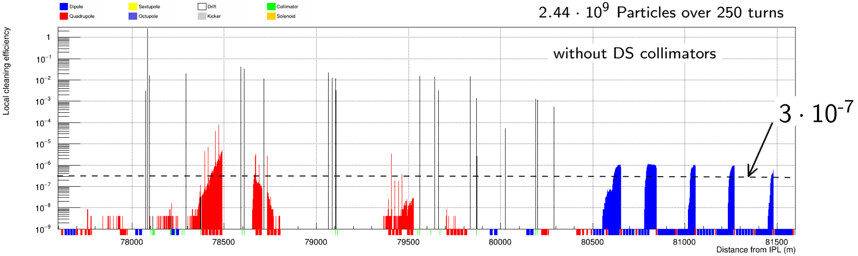
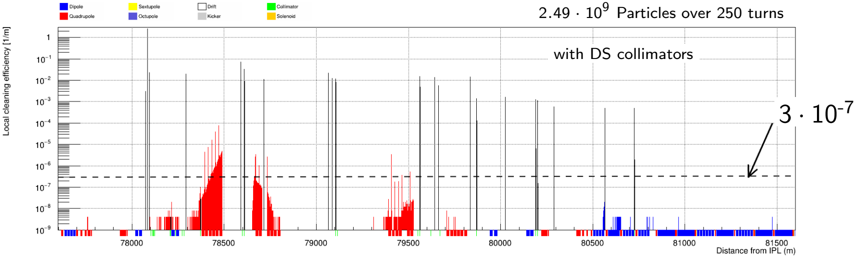
Status at FCC-Week 2017

A. Langner

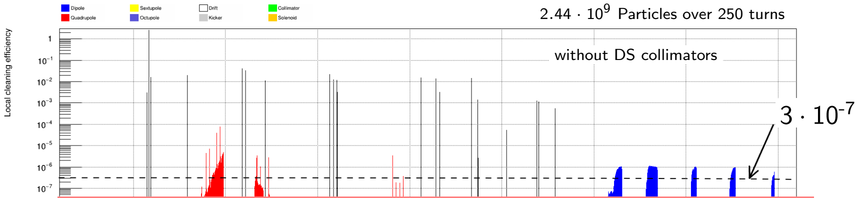


Status at FCC-Week 2017

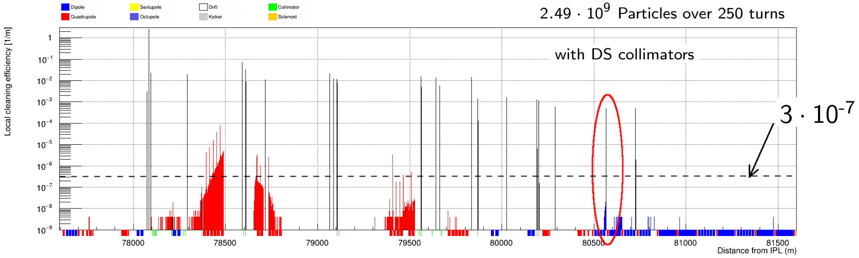




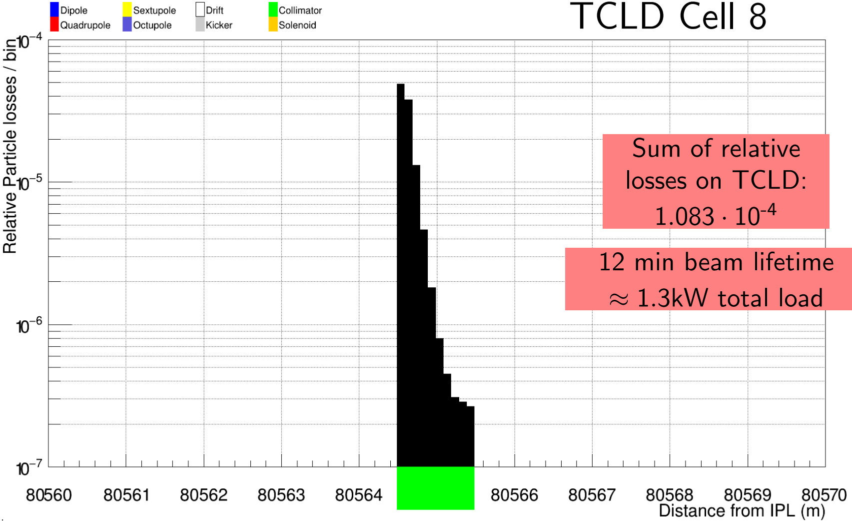
Status at FCC-Week 2017



Similar efficiency in cell 8 and cell 10,
but impact parameters are more challenging in cell 8



TCLD Cell 8



Sum of relative losses on TCLD: $1.083 \cdot 10^{-4}$

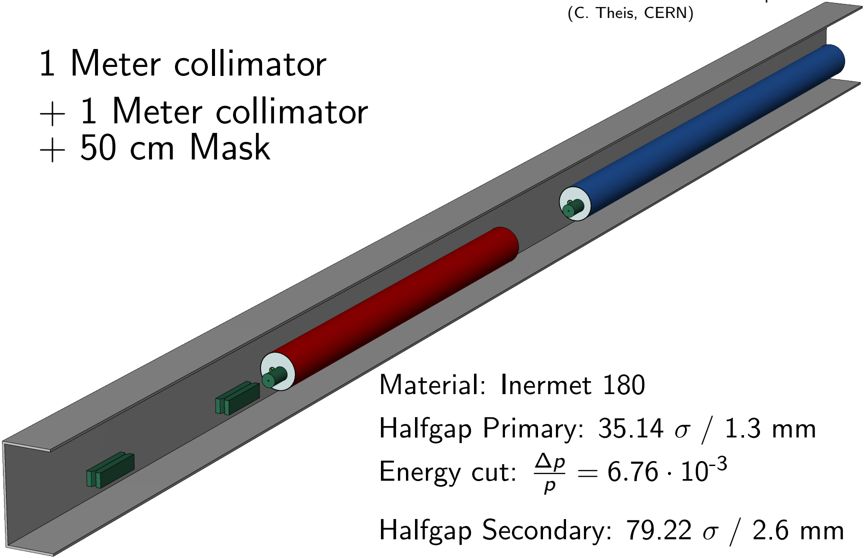
12 min beam lifetime $\approx$ 1.3kW total load

Status at FCC-Week 2017

Visualization done with SimpleGeo (C. Theis, CERN)

1 Meter collimator

+ 1 Meter collimator
+ 50 cm Mask



Material: Inermet 180

Halfgap Primary: 35.14 σ / 1.3 mm

Energy cut: $\frac{\Delta p}{p} = 6.76 \cdot 10^{-3}$

Halfgap Secondary: 79.22 σ / 2.6 mm

FLUKA simulations

- Input distribution is generated from Merlin tracking
  - Every turn the whole bunch is recorded before the collimator.
  - Particles which hit the collimator are selected.
  - This distribution is loaded into FLUKA and particles are randomly selected from it.
- Energy deposition is scored in a meshgrid of bins.
  - Scoring in the coils with 0.5 cm radial, 2° angular and 5 - 10 cm longitudinal binning.

Status at FCC-Week 2017

- Comparisons of simulations and measurements at the LHC showed a factor 2-3 discrepancy.

  (R. Bruce et. al. Phys. Rev. ST Accel. Beams 17, 081004 (2014))

- No imperfections or magnet errors have been taken into account.

Status at FCC-Week 2017

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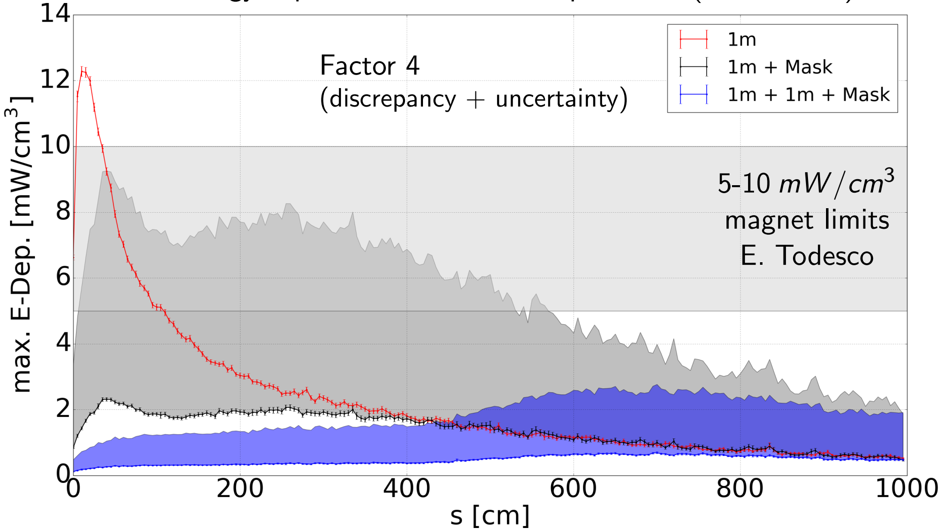
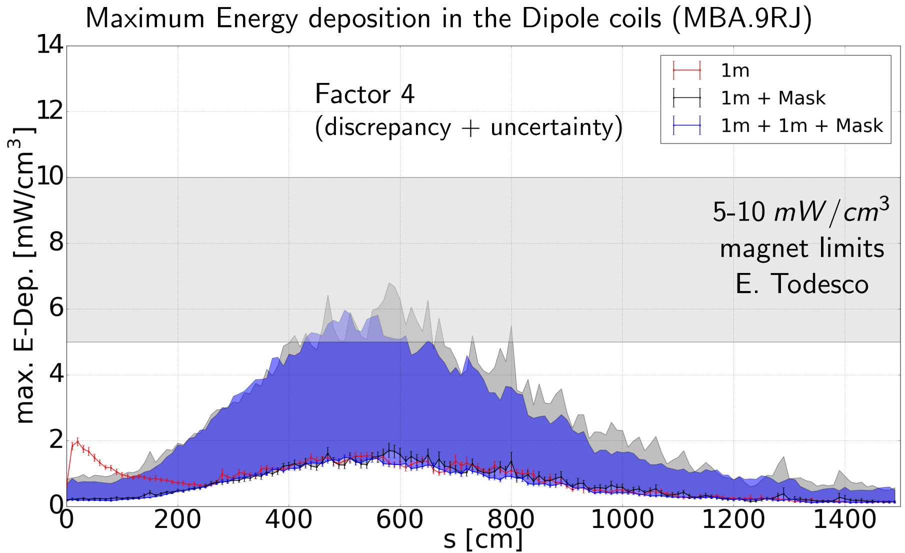
- No imperfections or magnet errors have been taken into account.

- A factor 4 as safety margin was considered.

Maximum Energy deposition in the Quadrupole coils (MQDA.8RJ)




Maximum Energy deposition in the Dipole coils (MBA.9RJ)
Factor 4
(discrepancy + uncertainty)
1m
1m + Mask
1m + 1m + Mask
5-10 mW / cm3
magnet limits
E. Todesco
max. E-Dep. [mW/cm3]
s [cm]
0
2
4
6
8
10
12
14
0
200
400
600
800
1000
1200
1400

- System not completely sufficient to compensate for a factor 4 of safety margin.
- As suggested by R. Bruce, the safety margin might still be to small.

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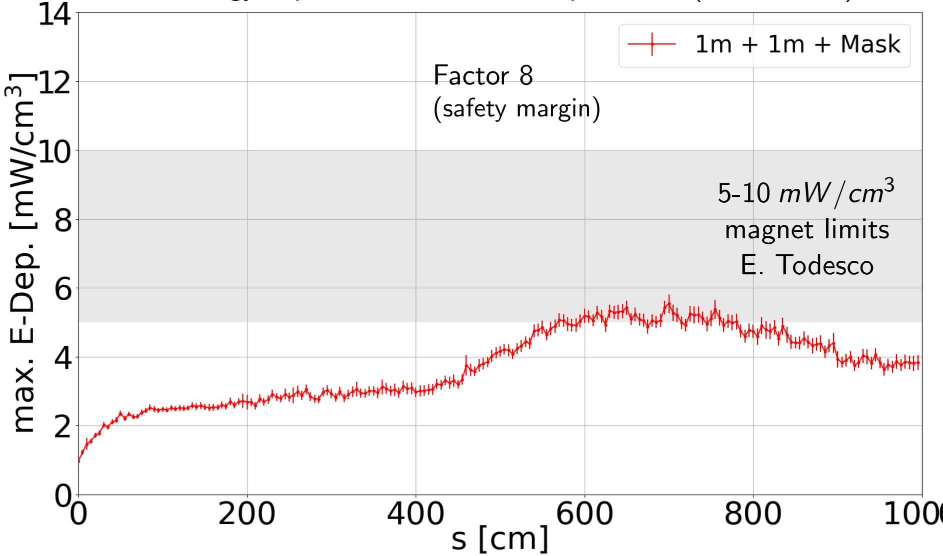
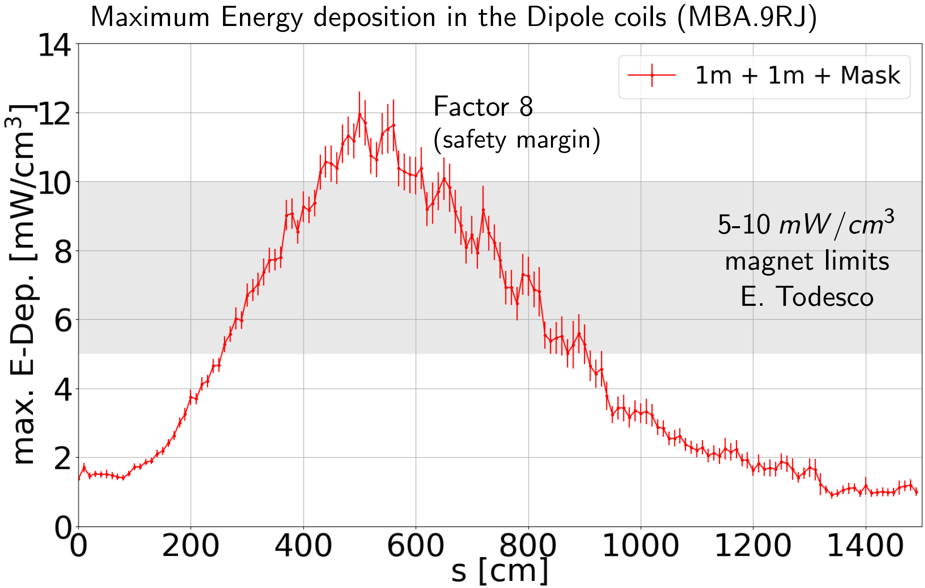
- As suggested by R. Bruce, the safety margin might still be to small.
- Therefore updated simulations have been done for a safety margin of a factor 8 on top of the simulation results.

Energy Deposition, updated safety margin

Maximum Energy deposition in the Quadrupole coils (MQDA.8RJ)



Energy Deposition, updated safety margin



Design update

- Design update to compensate for higher margin without exceeding the available space.

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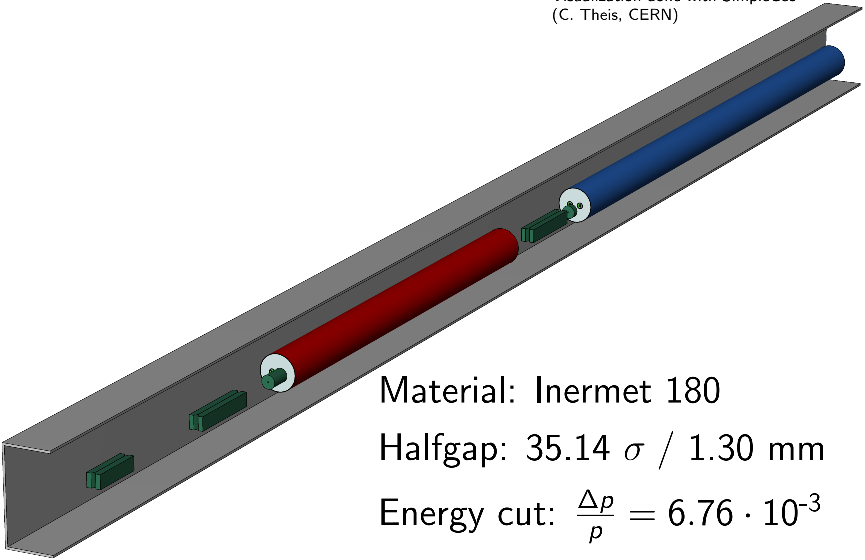
- No changes to the primary TCLD to avoid lattice changes that affect other studies.

Design update

Visualization done with SimpleGeo
(C. Theis, CERN)



Material: Inermet 180

Halfgap: 35.14 σ / 1.30 mm

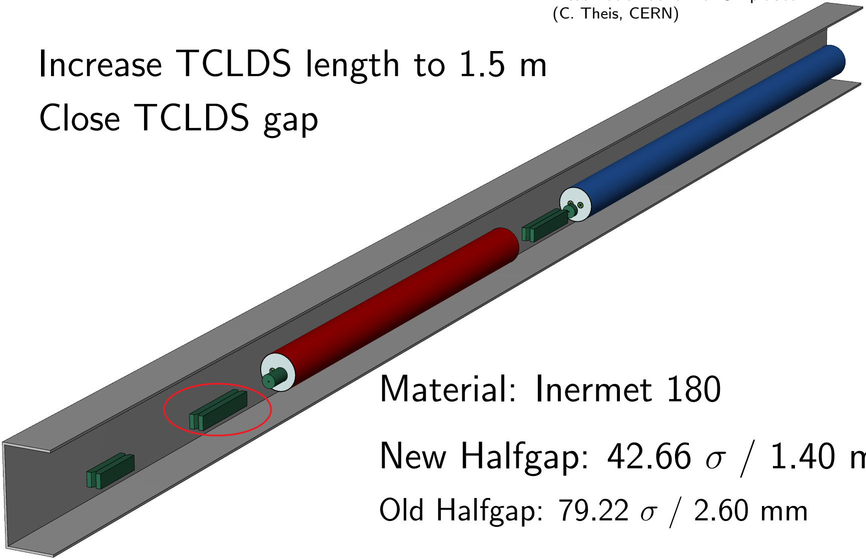
Energy cut: $\frac{\Delta p}{p} = 6.76 \cdot 10^{-3}$

Design update

Visualization done with SimpleGeo (C. Theis, CERN)

Increase TCLDS length to 1.5 m

Close TCLDS gap



Material: Inermet 180

New Halfgap: 42.66 σ / 1.40 mm

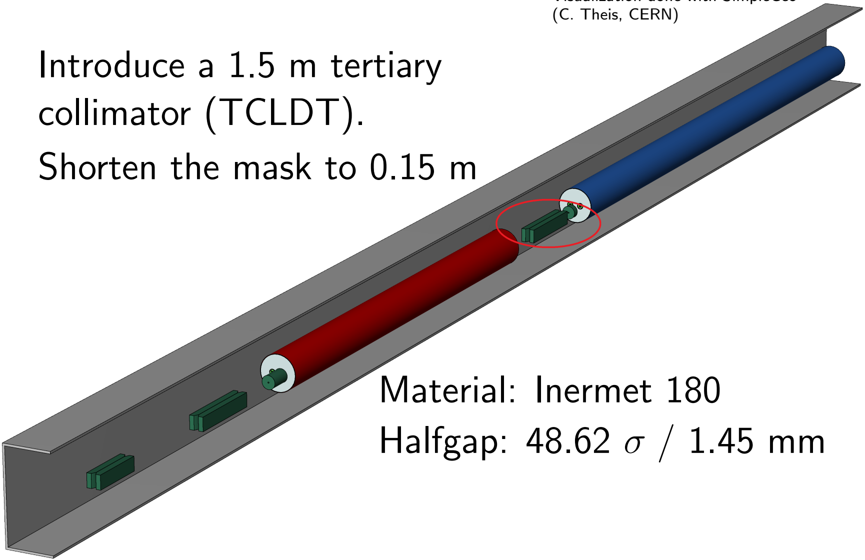
Old Halfgap: 79.22 σ / 2.60 mm

Design update

Visualization done with SimpleGeo (C. Theis, CERN)

Introduce a 1.5 m tertiary collimator (TCLDT).

Shorten the mask to 0.15 m

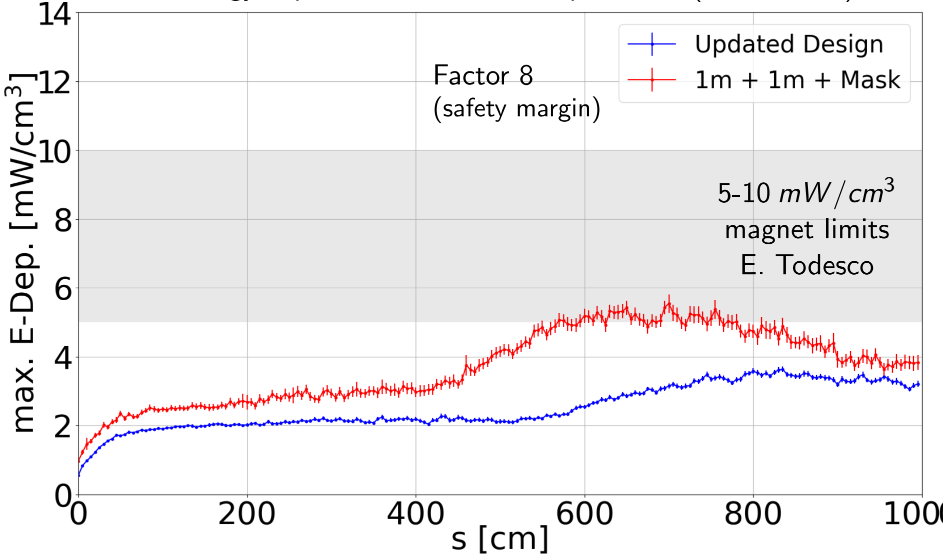


Material: Inermet 180

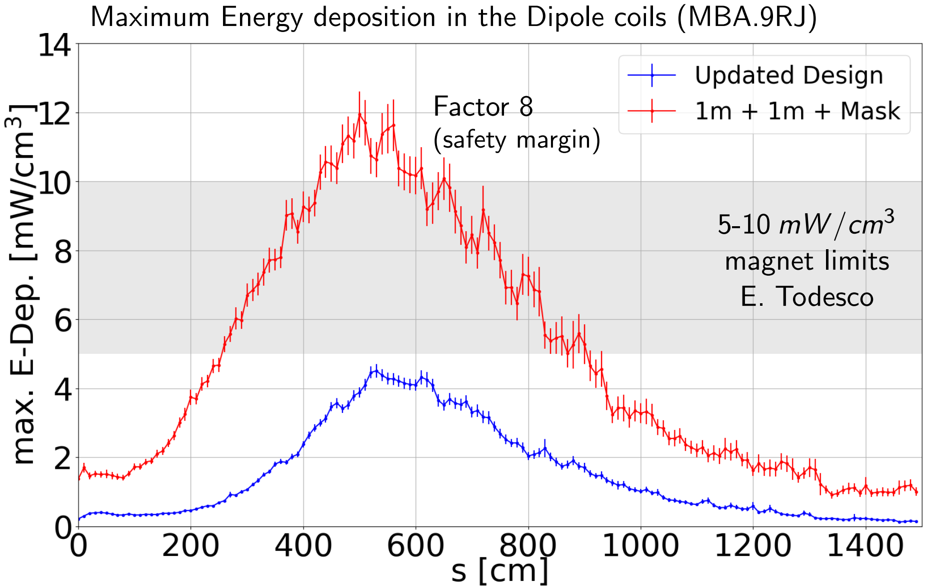
Halfgap: 48.62 σ / 1.45 mm

Energy Deposition with updated design

Maximum Energy deposition in the Quadrupole coils (MQDA.8RJ)



Energy Deposition with updated design



Conclusion

- The updated design increases the safety margin significantly.
  - Energy deposition studies for the most critical case in cell 8 after the Betatron cleaning insertion show that a factor 8 on top of the deposited energy can be handled without reaching the magnet limits.
- The updated design still fits in the current lattice (Version August 2017)
  - The primary TCLD is still the same design, so other studies remain valid.
- An additional collimator was placed after the quadrupole in cell 8 to lower the load on the next bending dipole significantly.

Outlook

- Optimization of DS collimator gaps around the ring
  - Especially considering energy collimation hierarchy
  - DS collimator gaps for the respective operation modes.
  - Energy deposition studies, if impact parameters differ significantly from top energy case.
- Further studies to validate if the current DS collimation system is sufficient for Ion operation as well.

Thank you

Reserve Slides

Energy Deposition around IP

Energy deposition in the Dispersion Suppressors
after IPA from collision debris.