

HL-LHC WP5 energy deposition studies - where we are and what needs to be done

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input:

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Introduction

- Following the tradition of last year's meeting, this presentation is an informal summary of **WP5-related FLUKA simulation studies** which
 - a) have been completed in the last 1-2 years
 - b) still are to be completed in the coming months/year
- I already apologize in advance for not introducing all the topics in detail
- I will cover following sources:
 - 1) Collision debris in IR1/5
 - 2) Accidental beam impact on TCTs in IR1/5 (ABD, crab failure)
 - 3) Halo impact on the TCTs in IR1/5
 - 4) Beam-gas collisions in IR1/5 and the adjacent dispersion suppressors
 - 5) Ion losses in the dispersion suppressors next to IR1/5 and IR2
 - 6) Halo cleaning in IR7, leakage to the adjacent dispersion suppressors

Contents

- 1 ATLAS and CMS insertions (IR1/5) and adjacent dispersion suppressors
- 2 Dispersion suppressors next to the ALICE insertion (IR2)
- 3 Betatron cleaning insertion (IR7) and adjacent dispersion suppressors

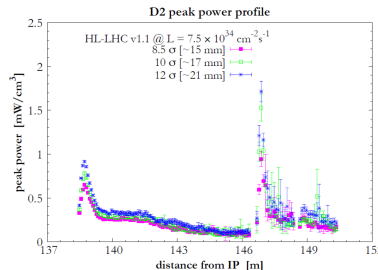
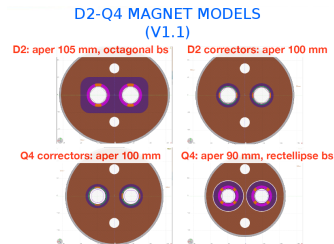
IR1/5: pp collision debris (WP10)

Completed studies:

- Power deposition and dose simulations for matching section magnets based on layout version V1.1
 - Discussed at the 4th Annual HiLumi Meeting/Tsukuba and more recently in a WP3 Meeting (21/08/15)

Planned (short-to-mid term):

- Matching section magnets: updated power deposition and dose studies for layout V1.2 (diff. TAN, corr. and Q4 aperture)
- Power deposition studies for dispersion suppressor magnets once we have a more final IR layout



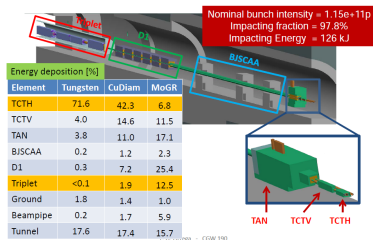
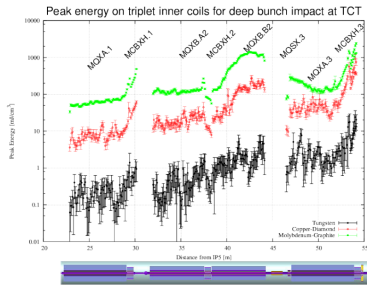
IR1/5: accidental beam impact on TCTs

Completed studies:

- Studies of accidental beam impact on TCTs due to an asynchronous beam dump have been carried out for the present IR layout (**energy deposition in triplet** for different TCT materials)
 - results discussed in the **Collimation WG Meeting #190** (D1 follow-up needed)
- Energy deposition studies as input for TCT damage limit calculations
 - Maps provided to **MME**
- First studies of **particle fluence to experiments** due to crab phase shift (HL layout with TCT5)

Planned (mid term):

- Repeat asynch. beam dump studies for HL layout with TCT4+5 (**energy deposition in superconducting coils (MS, D1, triplet), particle fluence to experiments**)
- Potentially the same magnet protection studies for (realistic) crab failures



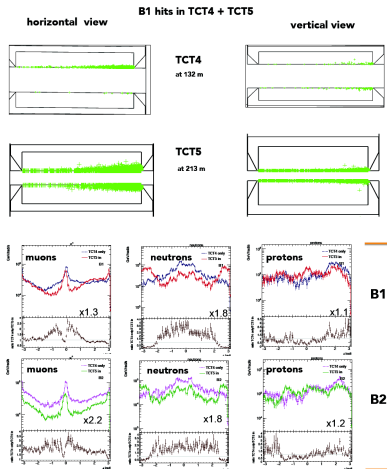
IR1/5: halo impact on TCTs

Completed studies:

- Particle fluence to experiments due to halo impact on TCTs for different TCT layouts (TCT4 only, TCT4+5)
 - results have been presented at the 3rd Annual HiLumi Meeting/Daresbury, IPAC14, IPAC15, recent follow-up in the LBS Meeting #66
 - data has been provided to experiments (<http://bbgen.web.cern.ch/bbgen/hl-lhc/index.html>), were used for background simulations

Potential future studies (long term):

- Repeat simulations of particle fluences to experiments once IR layout has been finalized



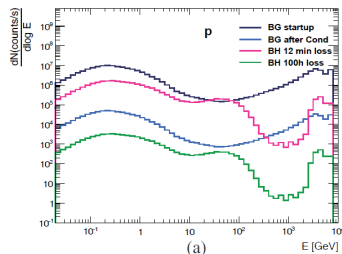
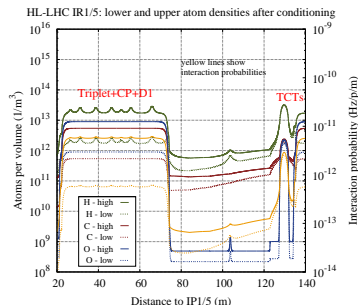
IR1/5: beam-gas collisions

Completed studies:

- **Particle fluence to experiments** due to beam-gas collisions up to the D1 (based on preliminary gas profile provided by vacuum team, assuming a conditioned and a non-conditioned machine)
 - results have been discussed at the **3rd Annual HiLumi Meeting/Daresbury**
 - were used by experiments for background simulations

Potential future studies (long term):

- **Gas-induced background** up to arc (muon background) once a final IR layout is available
 - *evidently requires updated gas profile, which extends further than D1*



DS next to IR1/5: BFPP ions

Completed studies:

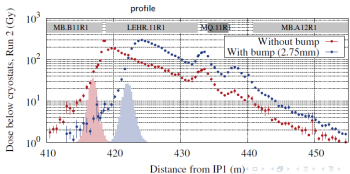
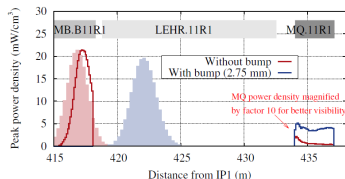
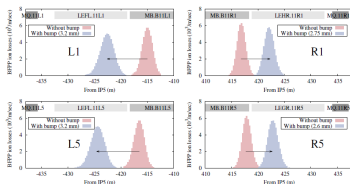
- Shower simulations for BFPP losses in the connection cryostat (peak power density in coils and bus-bars, dynamic heat load to cold mass, dose to electronics, BLM signatures)
 - results have been discussed in the CoIUSM #51 and #62, LMC #233 and BLMTWG Meeting #19 and #23
 - 2015 BLM thresholds based on FLUKA studies
 - Can learn more from the 2015 ion run (quench levels, R2E, cryo)

Future studies (mid term):

- Potentially, a validation against BLM and RadFet measurements for the 2015 ion run

Run 2 optics (assuming $\beta^* = 80\text{ cm}$):

T. Mertens



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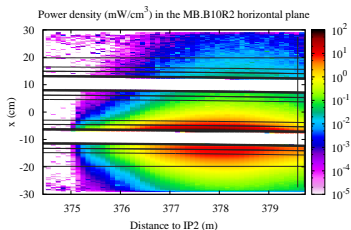
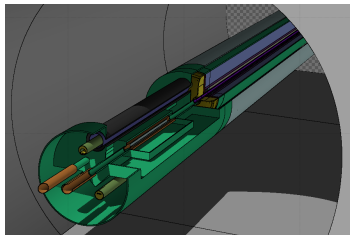
DS next to IR2: BFPP ions

Completed studies:

- Shower simulations for BFPP impacts on DS collimators embedded between 11T magnets (peak power density in coils, dynamic heat load to magnets)
 - results have been discussed at the 2013 Coll Review, at the 3rd Annual HiLumi Meeting/Daresbury and in the ColUSM
- Shower simulations for BFPP losses spread out in cell 12 (peak power density in coils, dynamic heat load to magnets)
 - results not yet presented

Ongoing/future studies (short term):

- Dose to quench diode of 11T magnets + dose to electronics (almost completed)
- Power deposition studies for DS collimator in connection cryostat (losses shifted by bump)
- Shower simulations for the BFPP quench test at 6.5 TeV (peak power in coils, BLM signals)



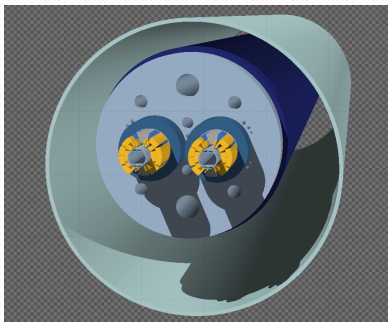
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IR7: halo cleaning for proton (and ion) operation

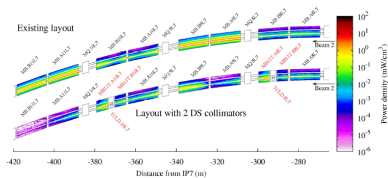
Completed studies:

- Proton collimation leakage: **power deposition** simulations for 1 or 2 DS collimators (embedded between 11T magnets)
 - results have been presented at the **3rd Annual HiLumi Meeting/Daresbury, IPAC14**, follow-up discussion at the **ColUSM #51**
- Power deposition** and **BLM signals** in the DS with a crystal as primary deflector (MD prep)
 - results have been presented at the **ColUSM #44**



Future studies (short-to-mid term):

- Showers simulations for proton (and ion) collimation quench tests at 6.5 TeV (**peak power in coils, BLM validation**)
- BLM pattern** for regular ion cleaning
- Total power load** to new secondary collimators (**new materials**)



IR7 collimators: accidental impact and long-term damage

Previous studies:

- **Energy deposition simulations** in support of HRMT-23 (different secondary collimator jaws, beam sizes, impact parameters)
 - Results provided to MME
- First, preliminary **DPA calculations for primary collimators in IR7**
 - Discussed in **EuCard WP11 meeting** at GSI 2014
- First **DPA calculations for GSI irradiation campaigns** (carbon ions)

Ongoing/future studies (short-to-mid term):

- Few more HRMT-23 simulations+more realistic injection failures (flat beam spot)
- More detailed investigation of **DPA in primary and secondary collimators in IR7** (considering also new coll. materials)
- Extension of **GSI DPA simulations** to other ion species/material samples

