Summary of LHC Collimation session

Outline

☑ Introduction: HiLumi-WP5
☑ HiLumi-WP5 activities
☑ Other collimation activities
☑ Conclusions
WP5 structure and membership

WP5.1: Coordination & Communication
WP5.2: IR Simulations of Halo Loss
- Assess locations and magnitudes of halo loss in the IR’s for various upgrade scenarios (includes crab cavities, ATS, ...).
- Assess impact of imperfections.

WP5.3: IR Simulations of Energy Deposition
- Assess locations and magnitudes of energy deposition in the IR’s for various upgrade scenarios.
- Assess impact of imperfections.

WP5.4: Design of IR Collimation
- Study required collimation to keep losses at the same level or below before the upgrade.
- Integration of collimators, new layout and optics.
- Feed-forward to simulation WP’s.
Recap. of deliverables

D5.1) Simulation models for beam loss: Set up of simulation models for beam loss halo that correctly describe the halo, the optics and the available LHC aperture after an upgrade. Some of the simulations must allow high statistics of primary beam halo (5-20M protons). (Task 5.2) [month 12]  
DONE

D5.2) Simulation models for energy deposition: Set up energy deposition models that correctly describe the IR1 and IR5 geometries after the upgrade. Define appropriate interfaces to experiments. (Task 5.3) [month 12]  
DONE

D5.3) Beam halo simulations: Simulate and compare beam loss in IR1 and IR5 for various scenarios of halo and upgrade changes. Verify that an upgrade scenario has acceptable beam loss characteristics. For the verified scenarios provide input to energy deposition and other studies (Task 5.2) [month 18]  
DONE

D5.4) Energy deposition simulations: Simulate and compare the local energy deposition for both upgraded IRs. If more than one qualified scenario exists, compare the different scenarios. Generate input to background studies for the experiments. (Task 5.3) [month 24]  
UPCOMING

D5.5) Conceptual design IR collimation: Given the simulated halo loss and energy deposition, work out conceptual designs for upgraded IR collimation systems in IR1 and IR5. (Task 5.4) [month 36]

D5.6) Technical design IR collimation: Study and simulate the conceptual solution of IR collimation for IR1 and IR5. Verify the solution versus various engineering constraints and develop it into a technical design. Iterate if needed. (Task 5.1 using inputs from 5.2, 5.3 and 5.4) [month 42]

D5.7) Design report and functional specification: Provide a design report for the upgraded collimation systems in IR1 and IR5. Provide functional specifications for any additional collimators and absorbers that are required in the upgraded systems (Task 5.1 using inputs from 5.2, 5.3 and 5.4) [month 48]  
(DONE means done formally, but of course ongoing for us)
Collimation review outcome

External review panel:
Mike Seidel (PSI, Chair), Giorgio Apollinari (FNAL), Wolfram Fischer (BNL), Marzio Nessi (ATLAS), Rudiger Schmidt (CERN/ESS), Carsten Omet (GSI).

Main outcome on DS collimation:
Due to the uncertainties on the extrapolations of beam lifetime and quench limits at 7 TeV, “The committee strongly encourages the development and prototyping of one 11 T (5.5 m) dipole magnet, and the cryogenic bypass collimator unit. … Build at least 4 units (1 unit consists of 2 magnets + bypass + collimator) since this would cover 2 possible cases…” Additionally: support for reduced impedance collimators and hollow elens works!

https://indico.cern.ch/event/251588
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support for reduced impedance collimators and hollow lenses works!

The review panel recognized that DS collimation:
- is needed for ions in IR2/1/5, already in LS2 (ALICE upgrade).
- is probably not needed in LS2 but we cannot guarantee that at this stage.
- is certainly beneficial for the HL-LHC era (ATS optics).
- this technology will be clearly useful for the HL-LHC era

Recommendation to work hard to achieve a minimum of 4 by LS2!
WP5 agenda at Daresbury

R. Appleby  WP5: status and plan  
A. Bertarelli  Baseline for cryo-collimators  
A. Lechner  Energy deposition with cryo-collimators in IR2 (ions) and IR7  
R. Kwee  Background studies for different HL-LHC options  
A. Marsili  Simulated cleaning for HL-LHC layouts with errors  
M. Serluca  Comparison Merlin/Sixtrack and first HL-LHC results  
N. Simos  Irradiation tests at BNL for collimator materials  
L. Lari  Collimator failure losses for various HL-LHC configurations  
J. Resta  Update on non-linear collimation schemes  
W. Scandale  Final layout and plans for crystal collimation tests at LHC  
G. Stancari  Progress towards the conceptual design of a hollow electron lens for the LHC  
T. Markiewicz  RC collimator design: prototyping experience and LHC prospect
Simulation workshop tomorrow

BDSIM
A fast tracking library built with C++ and for GEANT4, allowing particle tracking in vacuum, essentially optical tracking, around the LHC lattice alongside secondary showers from G4. Under development by RHUL.

MERLIN
Similar to philosophy to Sixtrack but as a flexible C++ library. Comes with more realistic scattering and parallel operation. Under development by Manchester/Huddersfield in a very modular, easily extendable, way. Tracking is currently 4D.

Various codes for collimation studies - many new simulation challenges

Our ‘standard’ halo tracking tool, with models of collimator scattering. Written in FORTRAN. Essentially 6D symplectic tracking with a K2-inspired non-inelastic scattering model.

FLUKA
Shower code capable of tracking second showers down to low energy, and through magnetic fields. Big library of LHC components in its geometry language.

We will put together the status of available tools and ongoing collimation study challenges.

R. Appleby
S. Redaelli, 3rd HiLumi meeting 14/11/2013
But we need a referee...
Outline

- Introduction: HiLumi-WP5
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- Other collimation activities
- Conclusions
Final layouts for DS collimation

Layouts defined and validate, starting with higher priority points first: IR2-ion (presented at the May review), IR7 (presented here), IR1/5-ion upcoming.
Final layouts for DS collimation

With 11T dipoles

R. Bruce et al.

Preliminary locations, not yet simulated in detail.
Gain factor from local DS collimation

Ions - IR2

Protons - IR7

Gain factor > 25

Need to compare the new results with updated quench limits for the 11 T dipole.
TCLD design and length definition

Agreed on a baseline of 80 cm!

Now: required detailed integration study between 2 11T dipole!

A. Bertarelli
Catching dispersive losses in IR7 with TCLD collimators improve losses around the ring and makes machine less sensitive on errors.
Catching dispersive losses in IR7 with TCLD collimators improve losses around the ring and makes machine less sensitive on errors.
First background studies for HL-LHC

Preliminary results that will be part in our D5.4. Need to be repeated following the layout evolutions.
Merlin / Sixtrack comparison

Collimators Inefficiencies Comparison IR7

M. Serluca
Merlin / Sixtrack comparison

Collimators Inefficiencies Comparison IR7

Very nice results, but some details of comparison still need work. Need to work with high priority on getting 6D simulations! Looking forward to have the new scattering routine available.

M. Serluca
First loss maps for ATS pre-squeeze

M. Serluca
Loads on collimators for fast failures

For Beam1 and Beam2 → Setting and Orbit and Optics errors considered

Feedback on optics design and collimator material choice. Concluded that we can use standard materials for the TCLD collimators.
Other collimation activities

Status of four important collimation activities

- **Irradiation tests at BNL (N. Simos)**
  Crucial for us: MoGr - candidate for next generation of secondary and tertiary collimators - is being tested.
  Nick warned about possible risks of MoGr “delamination” in case of high doses.
  Major hiccup during 2012 irradiation campaign: one sample damaged.
  Irradiation will be completed in 2013 at the beginning of the RHIC run.

- **Crystal collimation studies (W. Scandale)**
  Baseline layout folly defined, clear plan for first beam studies.
  LHC Engineering Change Request out for approval 2 days ago!

- **Hollow electron lens studies (G. Stancari)**
  Very good progress on the conceptual design report, including experimental results.

- **SLAC rotatory collimator (T. Markiewicz)**
  A couple of emblematic photographs.
Hollow e-lens studies and tests

- Hollow cathode
- Heat shields
- Control electrodes

Electron density in straight geometry

Graphs showing vertical and horizontal amplitudes with and without e-lens.
Hollow e-lens studies and tests

Experimental progress on gun characterization for the LHC
Detailed 3D modelling of electron beam
Addressing effects on beam through FMA

Conceptual design report on preparation: now need work together with CERN (BI, MME, Coll) for design report in 2014.

Entering critical phase for manpower: looking for good students!
Status of SLAC rotatory collimator

After that, wind 2nd mandrel, then ............

- Prep with strips & braze coils and inner hub/shafts to mandrels (2 of 2 done)
- Machine assembly round & concentric to axis at diameter to accept Glidecop jaws
- Machine & Cu plate Glidecop jaws
- Prep and braze jaws to mandrels (2nd done 8-Apr-13)
- Machine facets, end features (2nd done 28-May-13)
  
  **Install RF bearing housing**
  **Install shaft support bearings and rotation drives**
  **Test prior to installation in vacuum system**
  **Prep existing vacuum base plate to receive new collimators**
  **Mount, align & test**
  **Decide details of how vacuum cover will be attached to vacuum base plate & machine appropriately**
  **Mate cover & baseplate**
  **Test rotation after welding, pre and post vacuum**
  **Vacuum bakeout Plasma cleaning**
  **Test after Plasma Cleaning**

- Began 3-June-2013
- Began 6-Sept-2013
- Began 16-Oct-2013
Status of SLAC rotatory collimator

Many thanks for the continued effort!

Need to establish a plan for comprehensive testing without and with beam (CERN+US-LARP)
Conclusions

☑ The recent results from HiLumi-WP5 and other collimation related activities were reported.

Recalled the WP5 structure and main activities, and links to other ongoing LHC collimation upgrade works.

☑ Many thanks to the speakers of the parallel and joint sessions!

12 talk in parallel WP5 sessions.
4 related talk in a joint session with WP2/3/4.

☑ Progressing well on the DS collimation studies

Following recommendation of our May, we addressed key layout studies, with priority to points 2 and 7!
Goal: be able to review the situation and take critical decisions in 2015!
Important contributions from CERN partners!

☑ Status of our simulation tools will be discussed tomorrow at a WP5 simulation workshop at Daresbury.

☑ Important progress also on crystal collimation, hollow elens studies and rotatory collimator hardware.
Thank you for your attention