CSIC: overview of WP8 work and possible contributions to WP11

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CSIC-IFIC contribution

Reporting from EUCARD WP8 ColMat:

- Task2: Modeling, Materials, Tests for Hadron Beams
  - Subtask1: Halo studies and Beam modeling

1.1. Nature, magnitude and location of beam losses in modern accelerators.
1.2. Dynamics of the beam halo and proper diffusion models.
1.3. Design and optimization of multi-stage collimation systems.
1.4. Simulation of multi-turn collimation processes, including nuclear interactions of halo particles in the collimator materials.

Halo studies and beam modelling

Simulations and beam measurements of beam halo were performed, aimed to improve the performance of the present LHC collimation system and to support its upgrade:

- ✓ Feasibility studies of combined Betatron and Momentum cleaning as a possible solution to mitigate the risks of Single Event Upsets to equipment installed in adjacent and partly not sufficient shielded areas at IP7

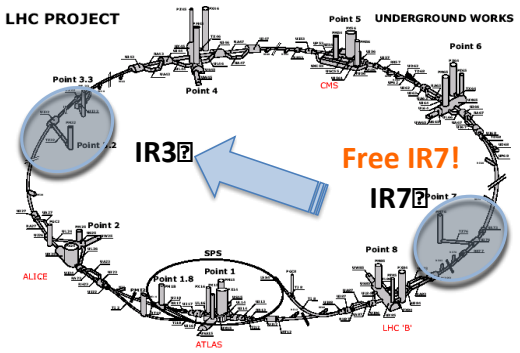
- ✓ Jaw angular misalignment impact studies in case of the most probable failure mode to improve the robustness of the actual LHC collimation system. → **First systematic study**

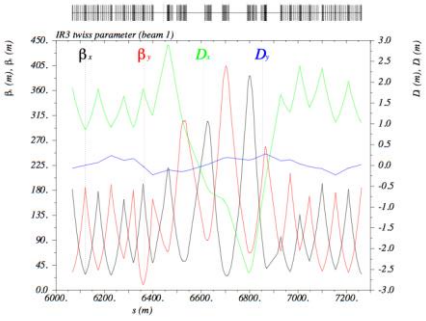
- ✓ Evaluation of new collimation layout solution: Non-linear collimation to improve both operation flexibility and intensity reach

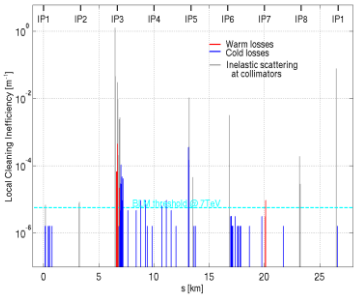
- ✓ Participation in beam experiments at CERN for LHC and SPS (i.e. Crystal collimators (Protons & Ions), collimators set-up, MDs, SC quench test, etc.).

Betatron and Momentum Cleaning in IR3

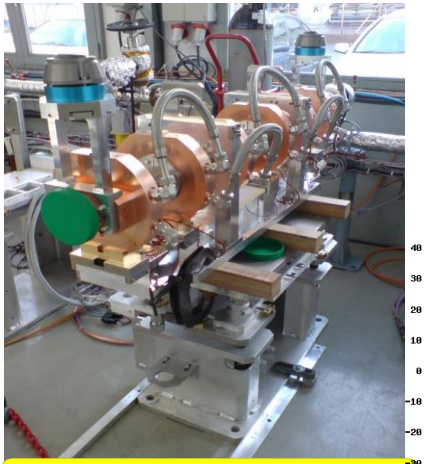
MAD-X + SixTrack + Fluka





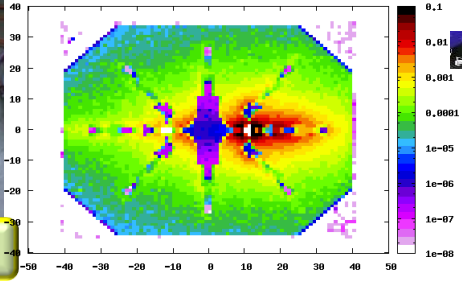


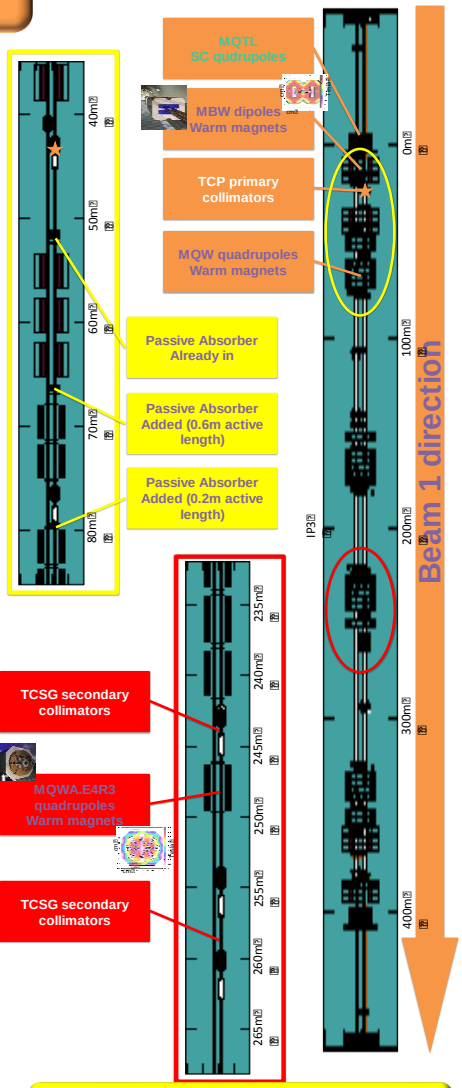
The study was performed adding collimators in the straight section @ Point3, without introducing optics changes. The necessity of adding additional passive absorbers in the line to improve the lifetime of the warm magnets was put in evidence.



Passive Absorber

Energy deposition
[Gev/(cm^3x primary protons]
Inside the quadrupoles
MQWA.E5L3 about 20cm
from the non-IP face.
7TeV Beam energy

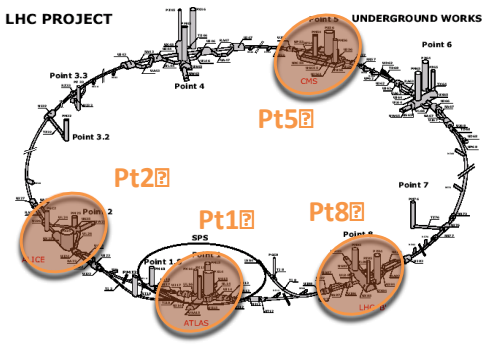




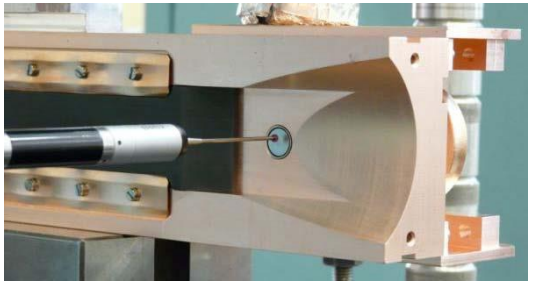
FLUKA IR3 Geometry

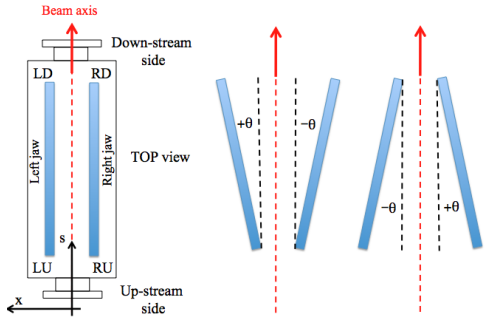
[REF: L.Lari et al. "Evaluation of the Combined Betatron and Momentum Cleaning in Point 3 in terms of Cleaning Efficiency and Energy Deposition for the LHC collimation Upgrade", IPAC11, San Sebastian, Spain.]

Improved robustness studies



By operating with the jaw-beam angle, the consequence of severe incidents on collimator with W jaws could be mitigated.





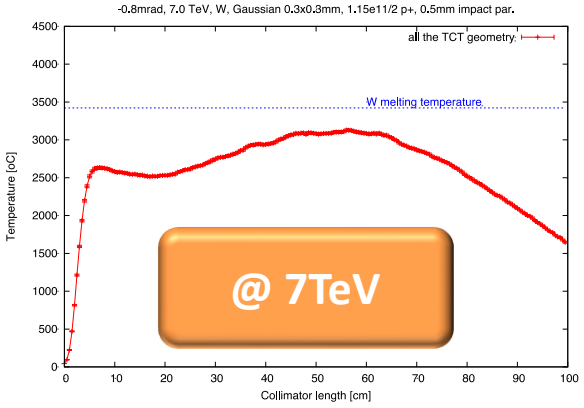
New BPM buttons integrated in the collimator jaws make possible a precise angular alignment of the jaw with respect to beam

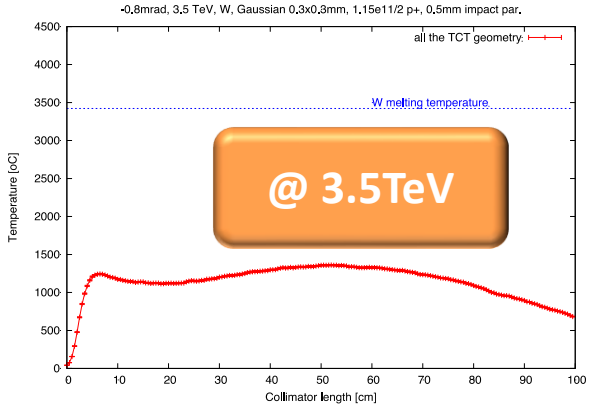
MAD-X +

SixTrack +

Fluka

Preliminary studies show a reduction of the peak temperature profile below the W melting temperature in the most severe incident



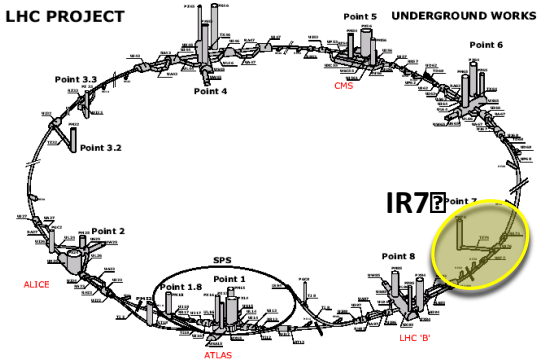


[REF: L.Lari et al. “Accelerator physics study on the effects from an asynchronous beam dump in the LHC experimental region collimators”, IPAC12, New Orleans, USA.]
[REF: L.Lari et al. “Improved robustness of the LHC collimation system by operating with a jaw-beam angle”, IPAC12, New Orleans, USA.]

Evaluation of a new collimation solution in IR7

MAD-X + SixTrack + Fluka

In particular studies of a **LHC non-linear Betatron collimation system at point 7**, allow larger gap for the mechanical jaw, reducing as a consequence the collimator-induced impedance, which may limit the LHC beam Intensity

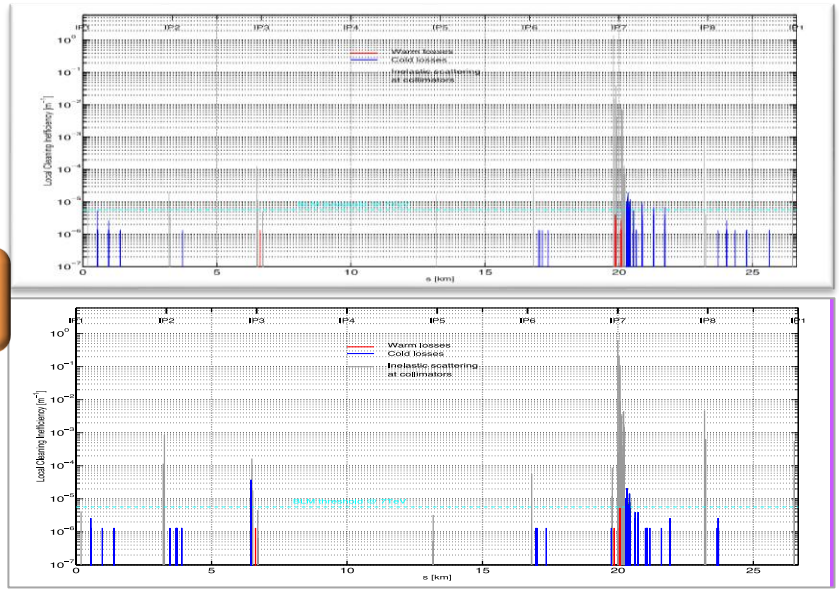


Performance evaluation of the non-linear collimation system **via primary proton loss maps** along the whole LHC ring, considering different collimator layout and aperture in IP7 and **via full particle shower studies** in the IR7 region.

Present LHC collimation system

@ 7TeV

Non-Linear collimation system



[REF: L.Lari et al. "Studies for an alternative LHC nonlinear collimation system", IPAC12, New Orleans, USA.]

Participation in test with beam in LHC and SPS

Some reference

- F.Burkart, R.W.Assmann, R.Bruce, M.Cauchi, D.Deboy, L.Lari, S.Redaelli, A.Rossi, G.Valentino, D.Wollmann Halo Scrapings with Collimators in the LHC IPAC11, San Sebastian, Spain.
- R.W.Assmann, R.Bruce, F.Burkart, M.Cauchi, D.Deboy, L.Lari, S.Redaelli, A.Rossi, G.Valentino, D.Wollmann, Tight collimator settings with beta* = 1.0 m CERN-ATS-Note-2011-079 MD.
- R.W.Assmann, R.Bruce, F.Burkart, M.Cauchi, D.Deboy, L.Lari, S.Redaelli, A.Rossi, G.Valentino, D.Wollmann, Improving LHC Collimator Setup Efficiency at 3.5 TeV CERN-ATS-Note-2011-062 MD.
- R.W.Assmann, R.Bruce, F.Burkart, M.Cauchi, D.Deboy, L.Lari, S.Redaelli, A.Rossi, G.Valentino, D.Wollmann, IR3 combined cleaning test at 3.5 TeV CERN-ATS-Note-2011-061 MD.
- R.W.Assmann, R.Bruce, F.Burkart, M.Cauchi, D.Deboy, L.Lari, S.Redaelli, A.Rossi, G.Valentino, D.Wollmann, Beam distribution measurements in the LHC CERN-ATS-Note-2011-057 MD.
- R.W.Assmann, R.Bruce, F.Burkart, M.Cauchi, D.Deboy, B.Dehning, R.Giachino, E.B.Holzer, L.Lari, A.MacPherson, E.Nebot del Busto, M.Pojer, APriebe, S.Redaelli, A.Rossi, R.Schimdt, M.Sapinski, M.Solfaroli Cammillocci, R. Suykerbuyk, G.Valentino, J.Uythoven, J wenninger, D.Wollmann, M.Zerlauth, Collimator losses in the DS of IR7 and quench test at 3.5 TeV CERN-ATS-Note-2011-042 MD.
- R.W.Assmann, R.Bruce, F.Burkart, M.Cauchi, D.Deboy, L.Lari, E.Metral, N.Mounet, S.Redaelli, A.Rossi, B.Salvant, G.Valentino, D.Wollmann, Summary of MD on nominal collimator setting CERN-ATS-Note-2011-036 MD.

CSIC-IFIC will contribute to

EUCARD2 WP11: Collimator Materials for fast High Density Energy Deposition (COMA-HDED):

- Task11.2: Specification, Beam Halo Dynamics & Safe Operation
  - Specify the new requirements of the collimation system
  - Simulations of cleaning efficiency
  - Definition of accident scenarios
  - Identification of critical loss locations

CSIC-IFIC will also contribute to

HiLumi LHC WP5: IR Collimation

- Task5.2: Simulations of Beam Loss in the Experimental IRs:
  - Beam loss simulations for upgrade scenarios
  - using Sixtrack/Collimation code

- Task5.3: Design of collimation in the Experimental IRs:
  - Beam loss simulations towards the improvement in the experimental IRs
  - Specifications of collimators and absorbers in IRs

Complementary activities