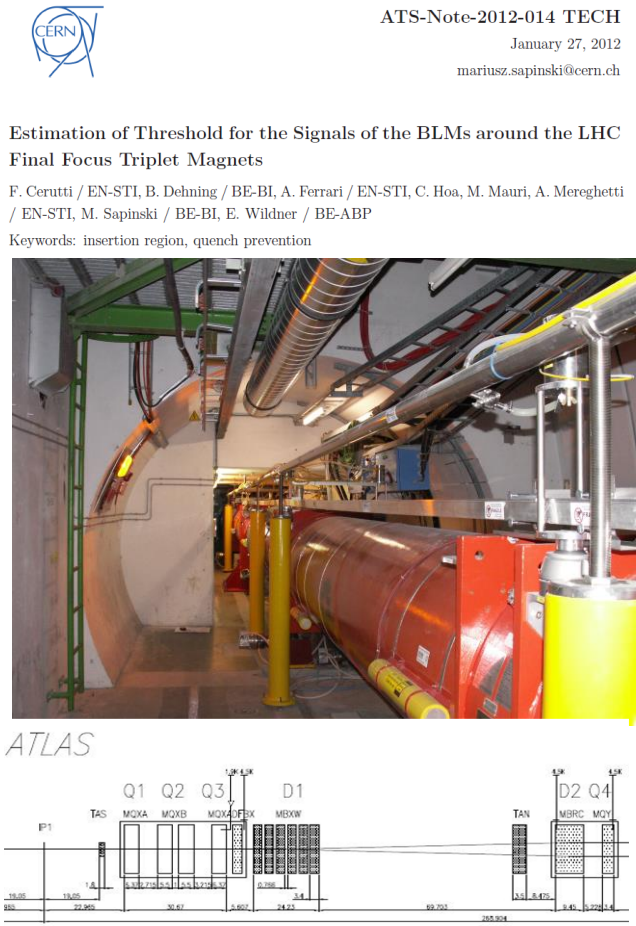

CERN

Results on the 2009 Loss and Debris Simulations for Cryo-BLMs

A. Mereghetti, on behalf of the Fluka Team
M. Sapinski, on behalf of the BLM Team

Introduction

- In **2009**, numerical simulations (mainly Fluka) were carried out with the aim of proposing refined BLM thresholds at the inner triplet (IT);
- The challenge: to set thresholds capable of identifying the onset of abnormal losses on top of the usual debris signal and trigger a beam dump before quench;
- Two scenarios were mainly investigated for 7 TeV beams, Nominal LHC:
  - Collision debris:
    - Regular source term of heat load on IT SC cables, proportional to instantaneous luminosity;
    - Baseline signals of BLMs at the IT: “constant” (i.e. slowly varying) term once collisions are established;
  - Abnormal, localised losses:
    - (unlikely) direct beam impact on IT beam screen;
    - the IT is effectively protected by TCT collimators; nevertheless, the (accidental) case of wrong collimator settings has been evaluated;
- two different time scales were considered:
  - Fast (transient) losses, i.e. <100μs – heat has no time to leak to superfluid He;
  - Steady-state losses, i.e. >100μs – the cryogenic system is effective in removing the generated heat.

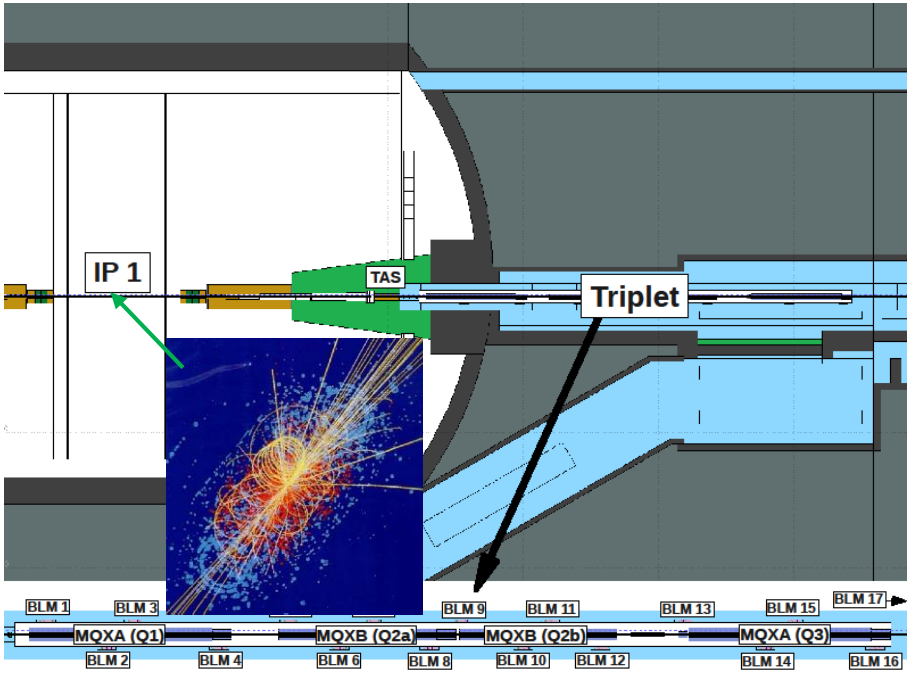


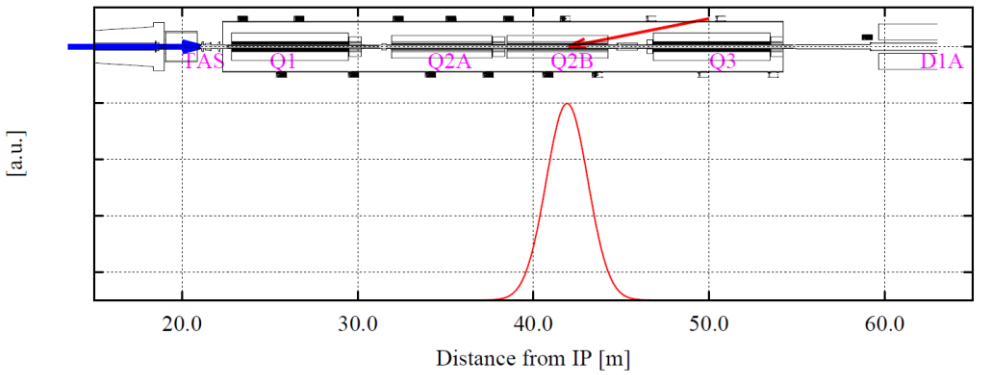
Introduction (II)

- Debris:
  - $L_0=10^{34}$ cm^{-2} s^{-1};
  - 80mb pp-inelastic @14 TeV cms;
- Q2B loss scenario:
  - The IT is exposed to halo protons , as a consequence of open TCTs or wrong TCP and TCSG settings; the Q2B is hit;
  - Predicted with SixTrack by C.Bracco and T.Weiler;

- It was soon realized that:
  - **Fast losses**: the number of protons lost before quenching the magnet induce a signal in the IT BLMs that stands out clearly from the one induced by debris;
  - **Steady state losses**: this is not the case, and a single value for all the IT BLMs cannot be easily set;

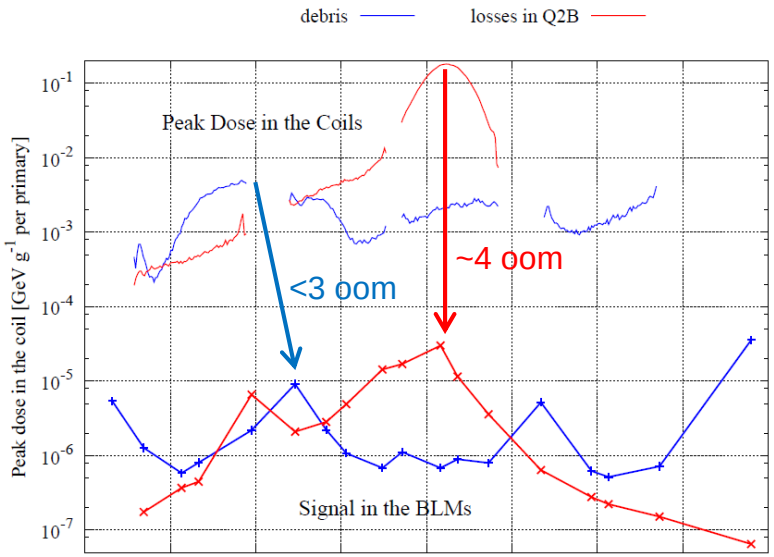
- In the following, only a recap of results is presented – for more infos/details/references, see ATS-Note-2012-014 TECH;





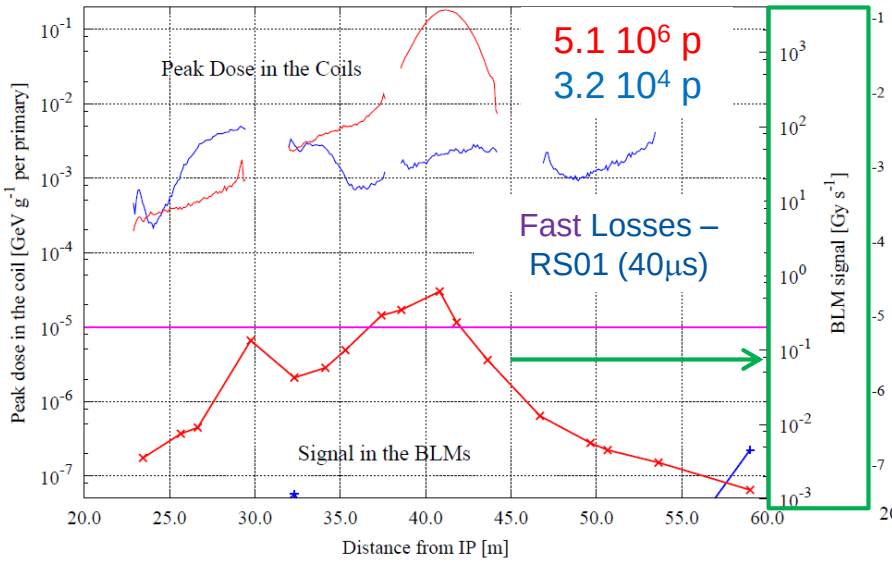
Results

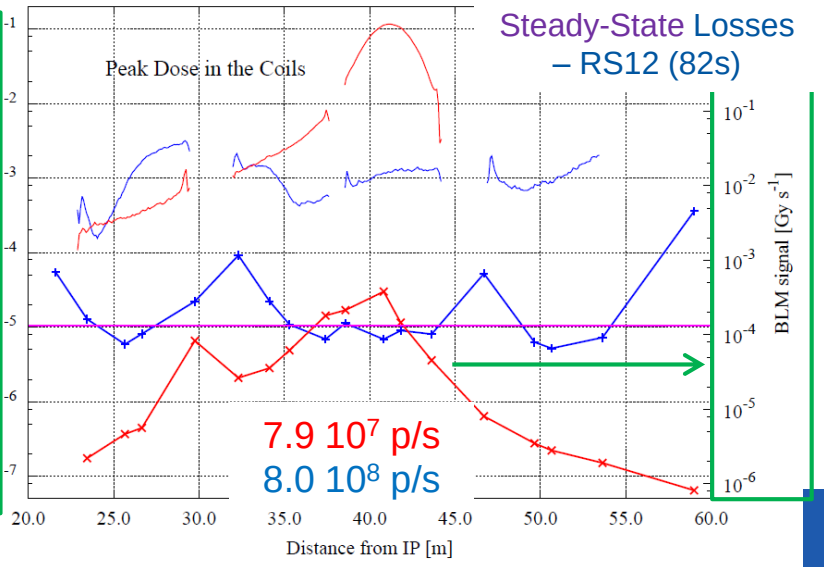
Per Primary Event



- Pattern of BLM signals qualitatively reproduces the one of peak endep:
  - Debris: peak in coil located at edges of magnets → interconnects allow for more secondary particles to reach BLMs → 3 oom;
  - Q2B: peak in coil at the centre of magnet → self-shielded effect by cold mass → 4oom;
- Normalization:
  - Q2B: proton losses allowed by the quench limits, i.e. 1.2 mJ/cm^3 and 12 mW/cm^3;
  - Debris: collisions taking place in 40μs or rate of collisions;
- A unique BLM threshold value for all IT BLMs does not allow to dump at the onset of a slow loss!

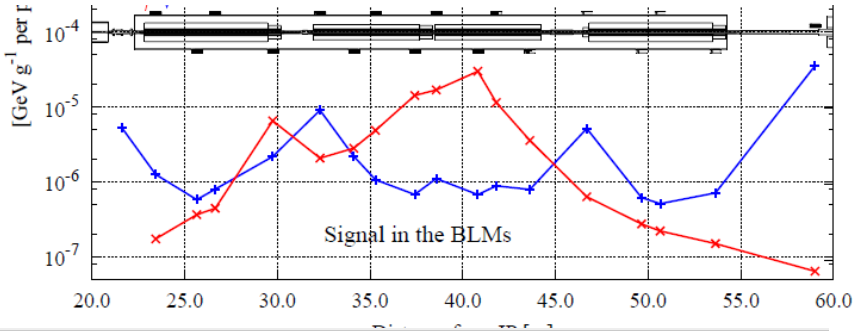
Integrated in relevant RS

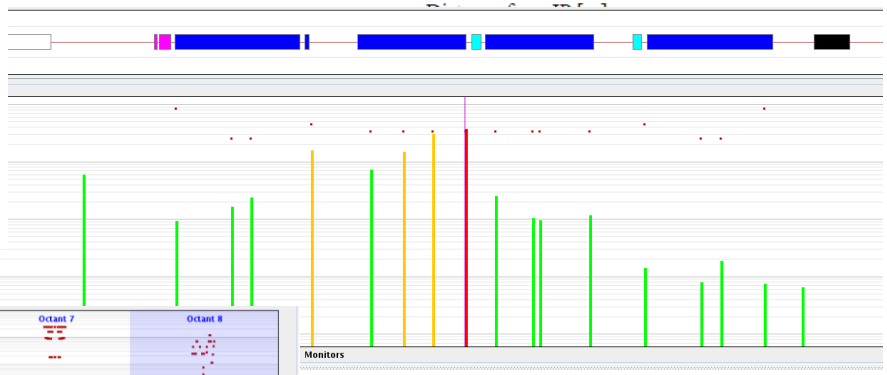


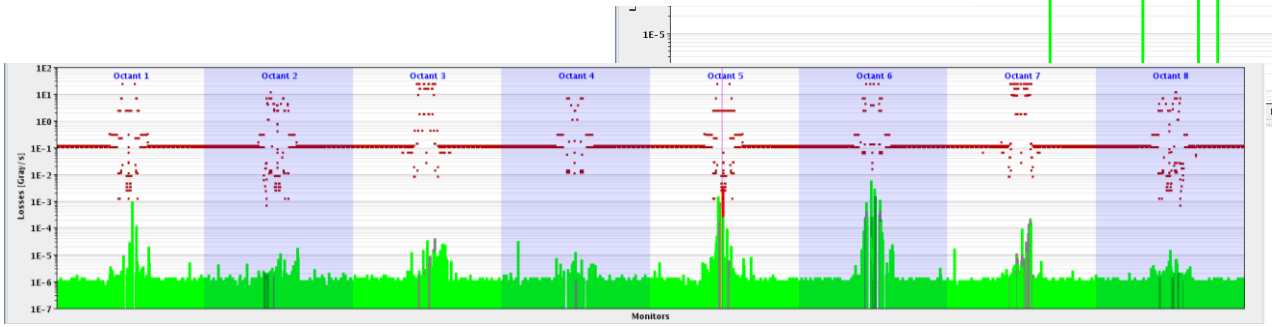


Remarks

- BLM pattern of Q2B scenario was actually measured in 2015, during the initial commissioning of RunII:
  - 27th May 2015, 02:11 AM, optics measurements at end of squeeze;
  - Beams dumped by RS06 (10ms) of BLMQI.02L5.B2E22_MQXB (IP5 Q2);
  - Measurements carried out kicking B2 (V) with the AC-dipole, with a frequency close to the tune;
  - Analysis presented by V. Chertvertkova, MPP 19th June 2015 (slides);





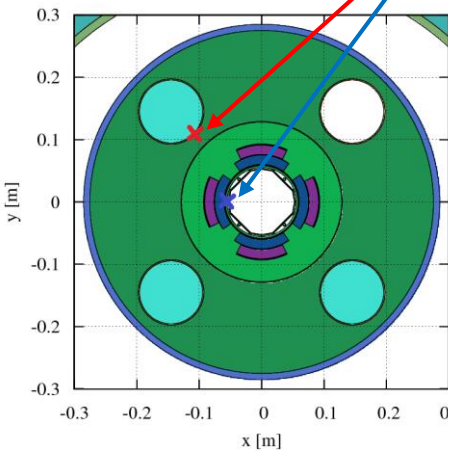


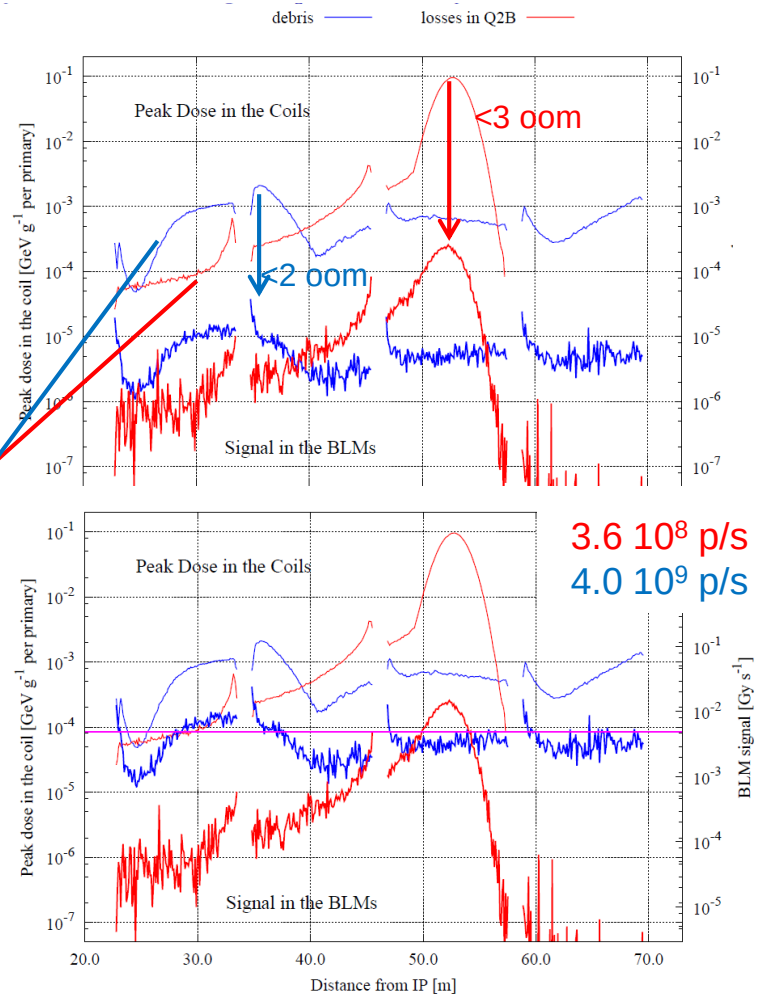
- Possible lines of development (not in aut/aut):
  - "topological thresholds": the beam dump is triggered when the BLM pattern is distorted;
  - BLMs closer to the coils: cryoBLMs reflect more accurately endep in coils;

LHC Upgrade Phase 1 - Results

- LHC Upgrade Phase 1: former LHC upgrade project (now HL-LHC);
- Design parameters relevant to this topic (2009):
  - L_0=5 10^{34} cm^{-2} s^{-1}, i.e. x5 wrt Nominal LHC;
  - SC: Nb_3Sn → quench limit: 35 mW/cm^3, x3 wrt NbTi;
  - Overall worse conditions for detection, mainly due to normalization factors;
- In this context, first estimations of cryo BLM signals in the same scenarios;

Getting closer to SC cables would allow to see the loss by the BLM even with conditions of detection worse than for Nominal LHC, even though loss signals do not stand out against debris pedal for the overall length of the IT (need for topological thresholds);





Conclusions

- Numerical simulations were run (2009) to optimize thresholds of BLMs at the IT for Nominal LHC;
- The challenge: to identify the onset of abnormal losses (Q2B case) over the baseline signals given by debris;
- Simulation results showed that:
  - Fast losses: the signature from the abnormal loss is clear and a threshold value, unique for all the IT BLMs, can be identified;
  - Steady-state losses: the signature from the abnormal loss is recognizable, but it does not fully stand out against the debris signal; hence, a single value of BLM threshold cannot be assigned to all IT BLMs;
- Possible solutions:
  - Topological thresholds;
  - Cryo BLMs;
- Results for LHC Phase I upgrade:
  - General worsening of conditions for recognizing onset of abnormal losses;
  - Pattern of cryoBLMs would reflect endep profile in SC coils more faithfully than BLMs out of cryostat;