Cryogenic BLMs

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TE-TM meeting September 4th 2012

Outline

- Why do we need Cryogenic BLMs?
- What has been done so far?
- Ongoing irradiation tests
- What do we want to do during LS1?
- What next?

FLUKA Simulations for Assessing Thresholds of BLMs Around the LHC Triplet Magnets

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October 18^{th}, 2011

Partly in: CERN-ATS-Note-2012-014 TECH

FLUKA Simulations

Aim

Relate the energy deposited in the superconducting coil of the *inner triplet* to the signal read by BLMs all around: **assessment of the signal thresholds**.

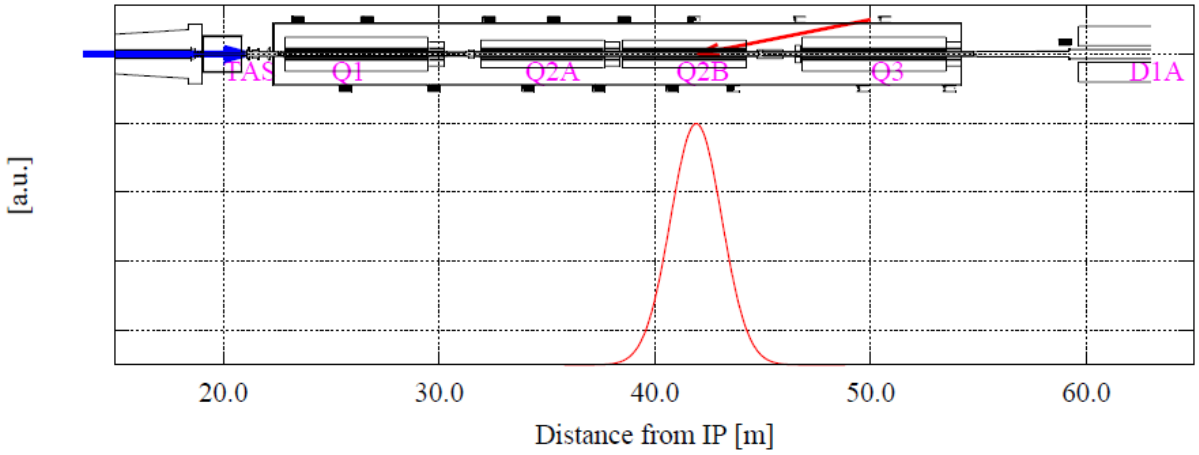
FLUKA simulations of the *Inner Triplet* presently installed on the right side of Point 1 of LHC (ATLAS). Considered scenarios:

pp-collision debris

- $L_0 = \mathbf{10^{34}\ cm^{-2}\ s^{-1}}$ [1];
- **80 mb** as pp inelastic cross section at 14 GeV centre-of-mass energy;

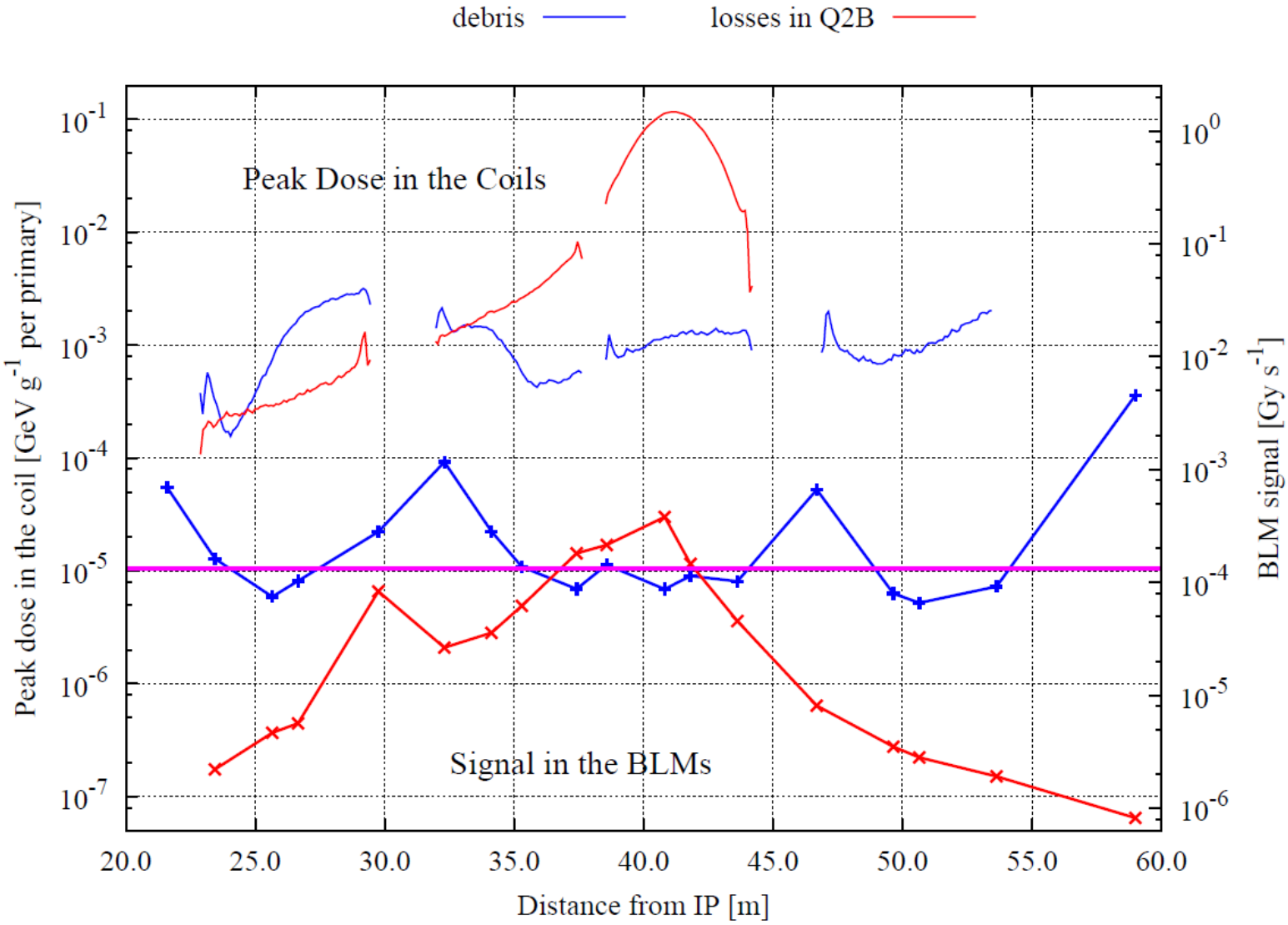
direct losses in Q2B (MQXB.2BR1)

7.0 TeV protons on Q2B magnet, due to wrong settings of collimators;



For other scenarios: EDMS doc in preparation.

Steady-State Losses: **Final** Signals



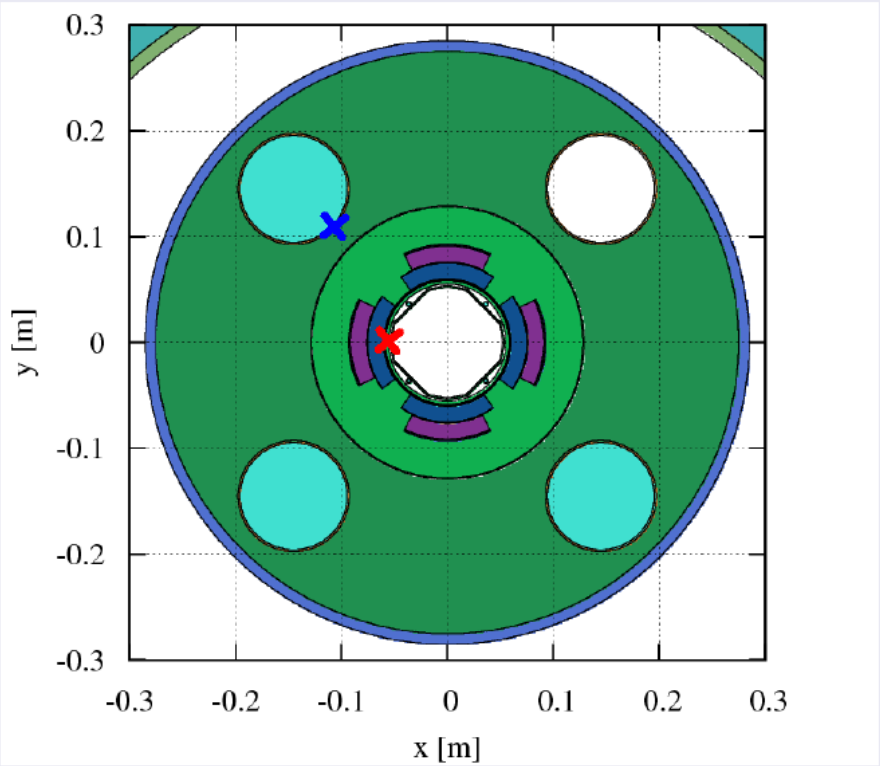
After normalisation...

...the signal due to the loss can't be distinguished from the one due to the debris!

New Positions of BLMs

The Closer to the Coils, the Better

- higher intensity of the signal;
- signal better follows the longitudinal pattern of the peak in the coil;



FLUKA geometry: LHC Phase I Upgrade

more prone to host the new BLMs, with no important change in the physics behind.

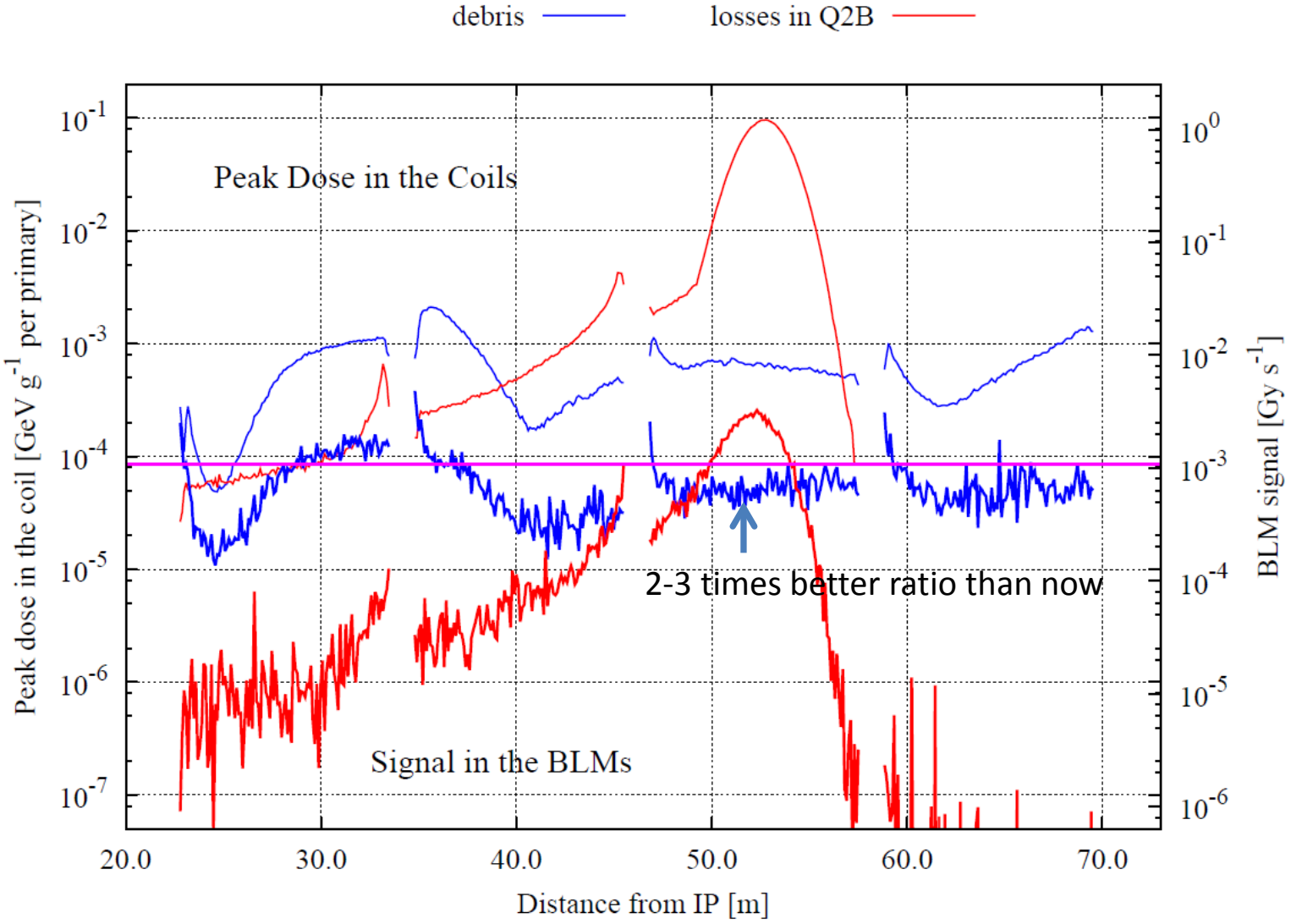
Four Holes

- one for the heat exchanger;
- the others for not breaking the quadrupole symmetry. Good location for the new BLMs.

FLUKA Estimation

No design or location of the new BLMs (at that moment): estimation of the signal via the dose inside the yoke (blue cross).

Steady-State Losses: **Final** Signals

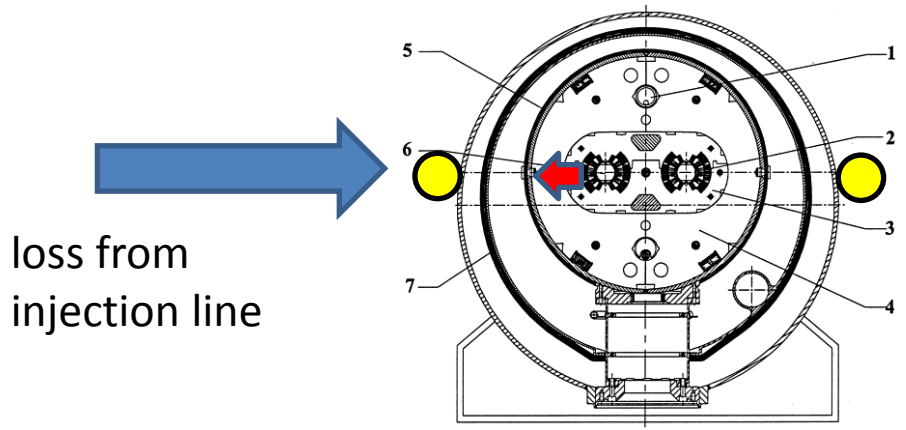


After normalisation...

...the signal due to the loss can be distinguished from the one due to the debris.

Other examples

- <u>injection losses</u>:

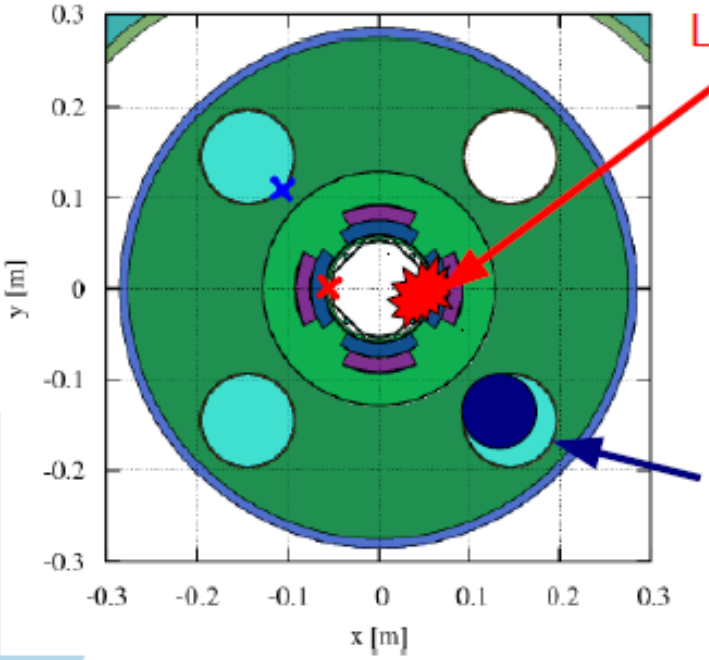


- <u>collimation losses</u>:

  showers from distant collimators might give quite large signal in BLMs on the magnets and small energy deposit in the coil.

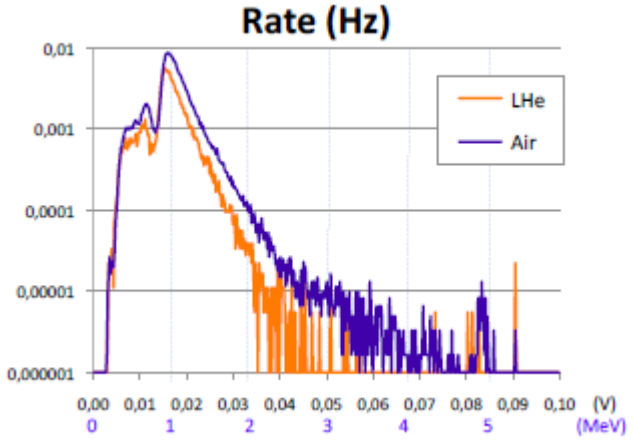
Cryogenic BLM as solution

- Future BLMs placed closer to:
  - where losses happen and
  - the element needing protection (so inside cold mass of the magnet, 1.9 K)
- Measured dose then better corresponds to dose inside the coil



Summary of motivations

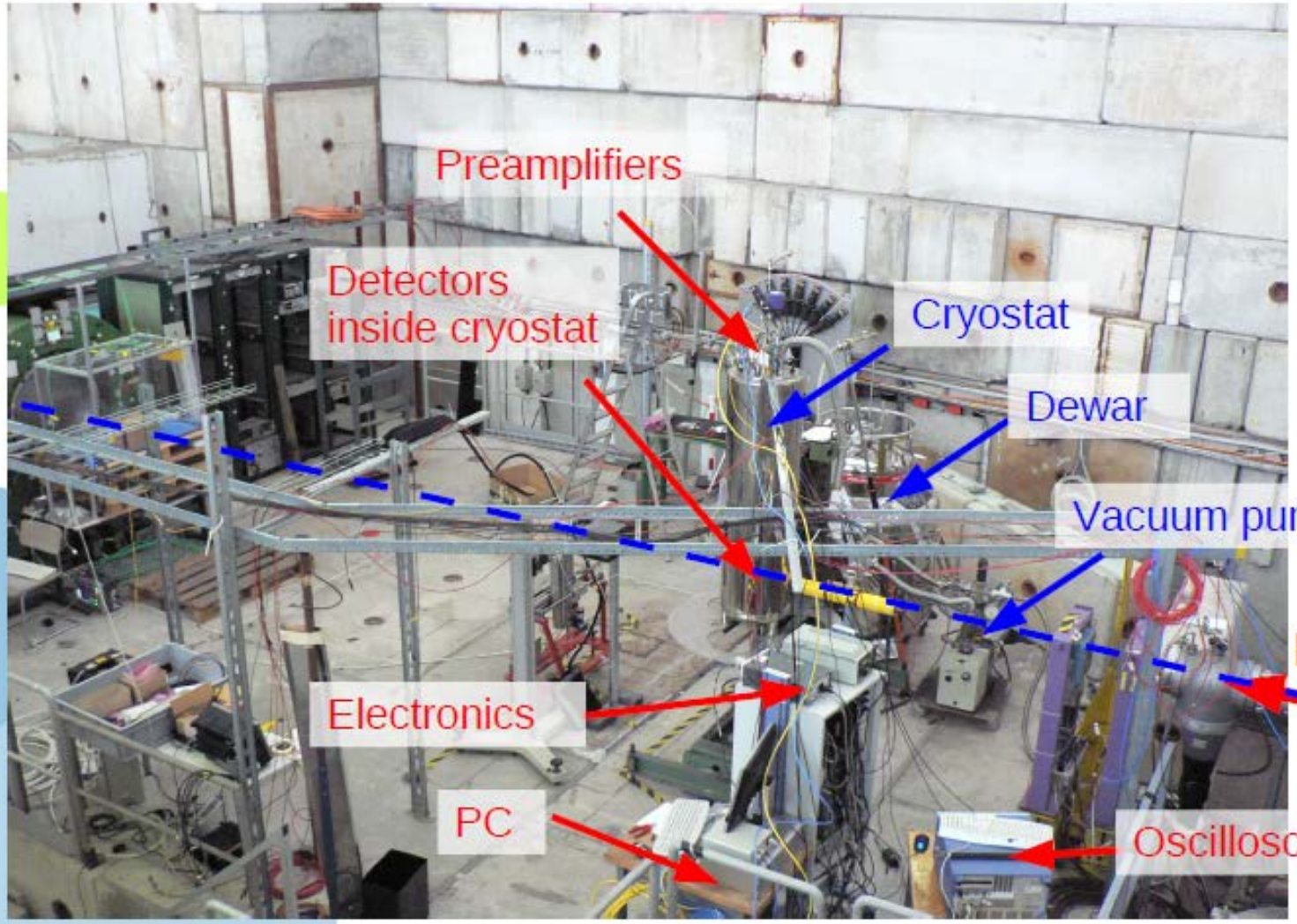
- If we want to protect superconducting element it is better to measure beam loss close to it.
- It will probably allow to work closer to the quench limit.
- It makes us less dependent on loss scenario.
- LIPAC, ESS, NLC – all investigate for cryogenic loss monitors – they are interested in this study.

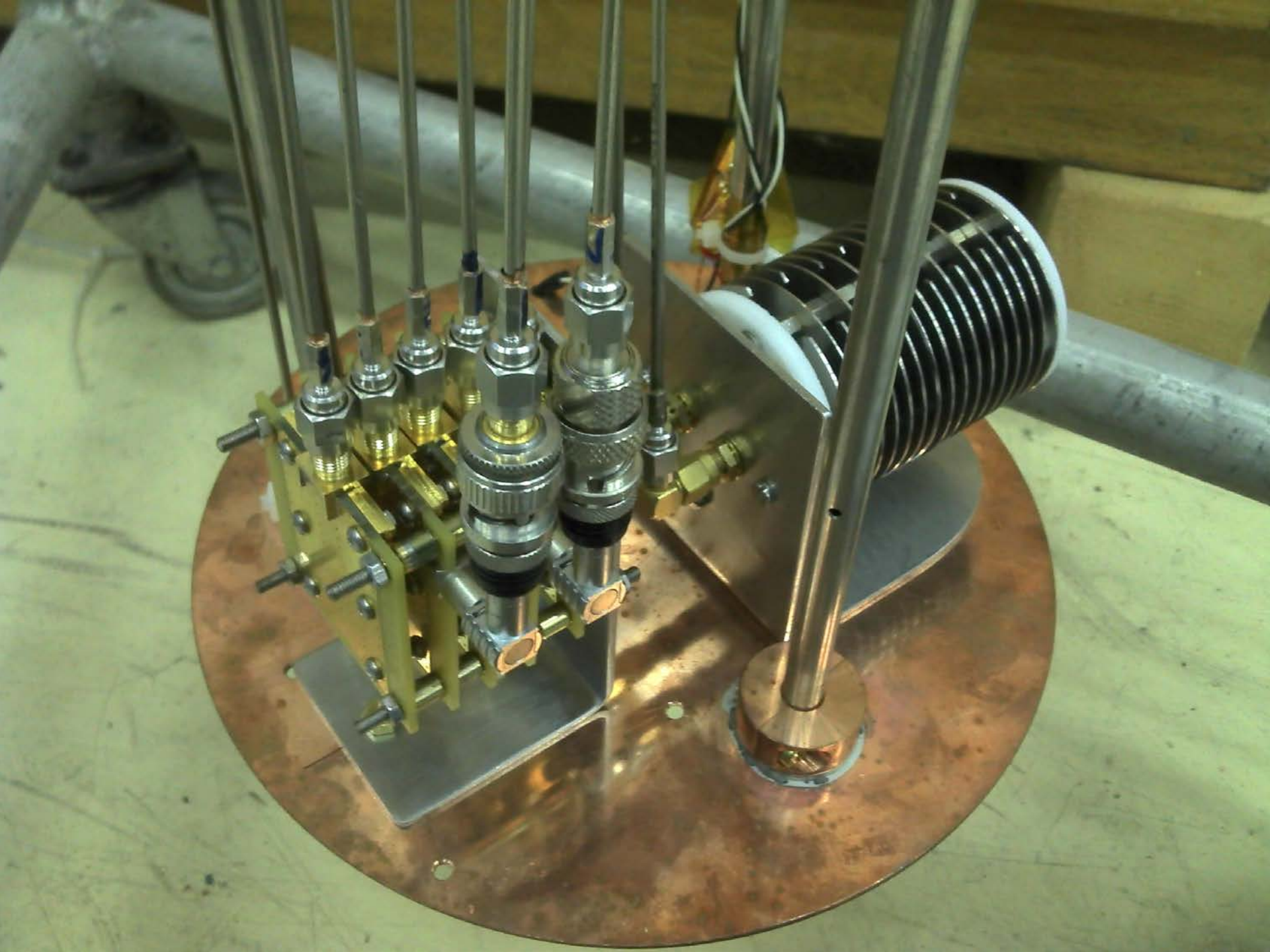


Done

- Investigation of possible technologies: Silicon, Diamond, LHe ionisation chamber
- CryogenicBLM workshop:
  http://indico.cern.ch/event/CryoBLM2011
- Extensive study of diamond, silicon and Liquid Helium Ionization Chamber detectors on beam tests (Christoph Kurfuerst, presentation at IPAC12, CERN-ATS-2012-094)
- Diamond (in room temperature) are already used in LHC for loss monitoring (experience!)

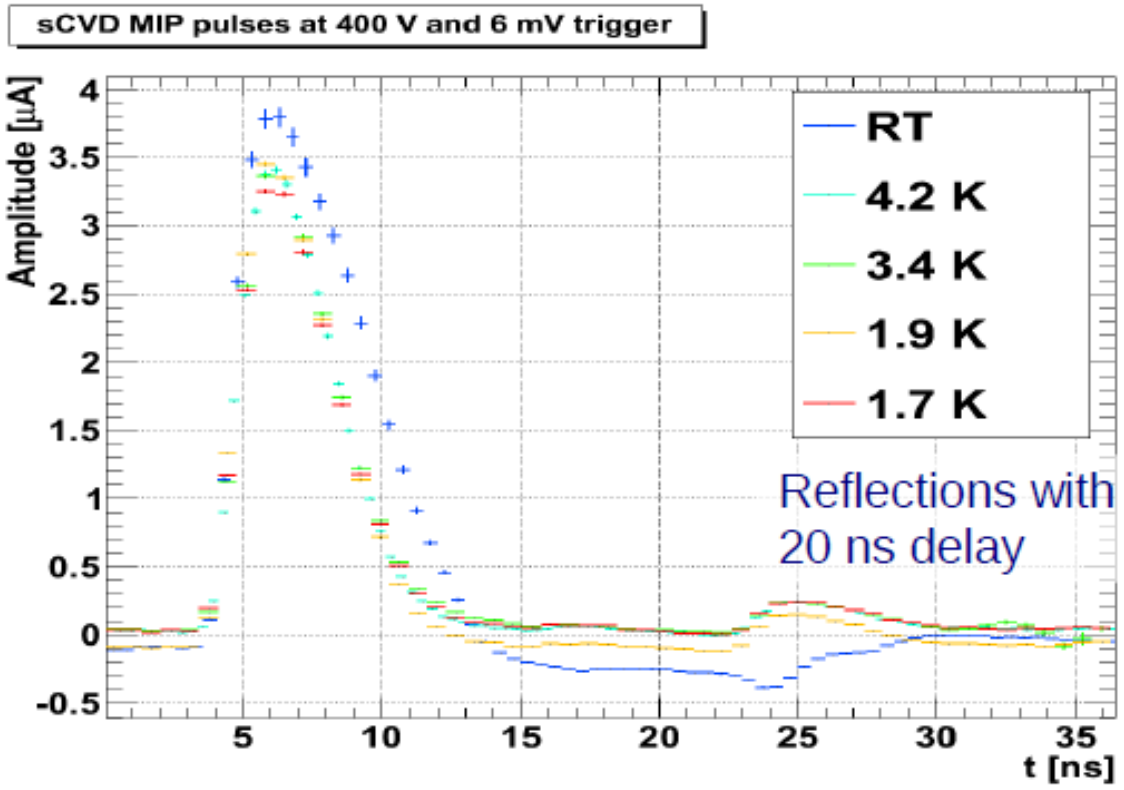
CERN PS Beam test area





Diamond results
Single particle (response averaged from ~5000 pulses)

Example of results



Drift time change of about 28%

Ch.Kurfuerst

Ongoing

- 1 MGy irradiation test in IR7 in room temperature – ongoing

- Irradiation test in cryogenic conditions – November
- (special Cryostat and Cryogenic line – a challenge)

Specifications for CryoBLM

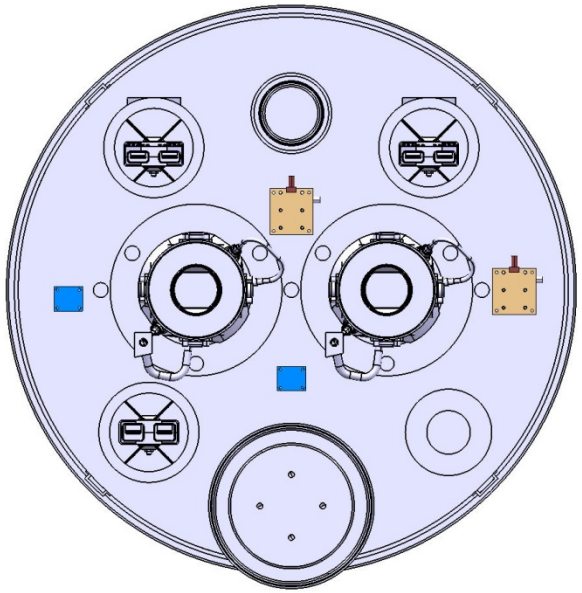
- Present conditions:
  - low temperature of **1.9 K** (superfluid Helium)
  - radiation of about **1 MGy** in 10 years
  - magnetic field of **2 T**
  - pressure of 1.1 bar, withstanding a fast pressure rise up to about 20 bar
- Linearity between **0.1 and 10 mGy/s**
- Detector response **faster than 1 ms**
- **Stability, reliability and availability:** after installation no access possible

This is why we need to install detectors on cold masses during LS1

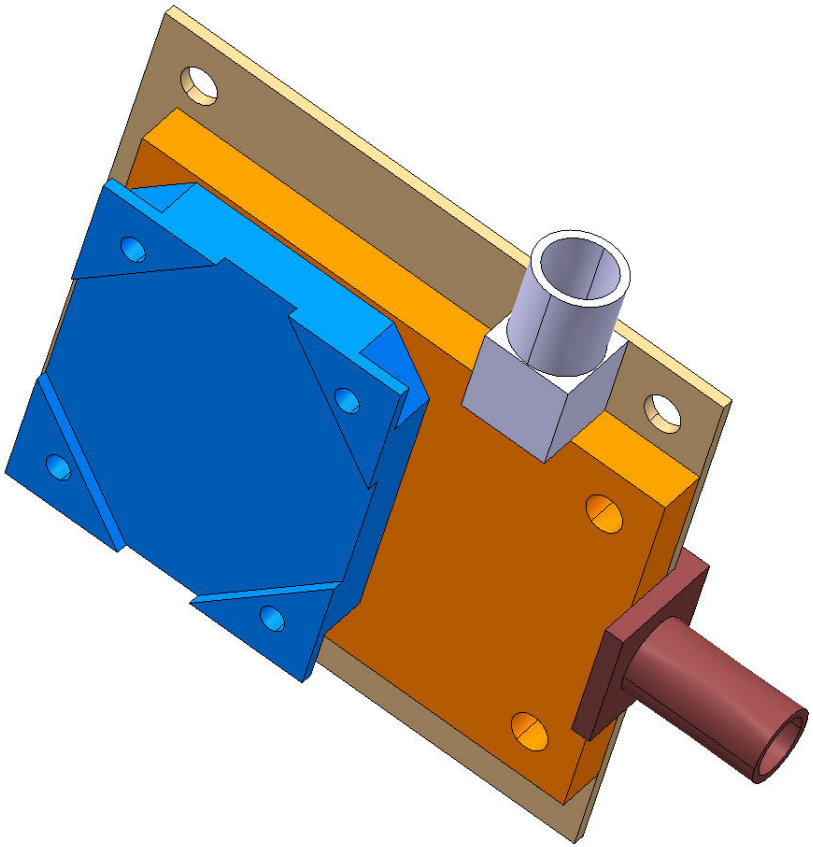
Discussion with J-P Tock, V. Parma and T. Renaglia on June 28th

Proposal

- Install diamond and silicon detectors on the outside of the cold masses
- Front face of Q7R3 – a very good place to install – losses, interesting physics and the magnet to be replaced
- Another location on MBs in Dispersion Suppressor (easily accessible for installation - left of IR3?)
- Drawings by Thierry Renaglia
- Exact proposal to be finalized



Detector holders



by Thierry Renaglia

Plan

- Prepare 6-10 detectors
- Test them with a source
- Perform at least one cryogenic cycle
- Install, connect to BLM electronics
- Prepare data acquisition (standard monitoring but maybe also expert one – scopes – to be seen – DS 3L)
- Observe long-term behavior between LS1 and LS2
- During LS2 – installation inside magnets – open question
- LS3 – new triplets

Main people involved

- BI side: Bernd Dehning, Christoph Kurfuerst
- Marie-Curie fellow starting in October (3 years)
- Jean-Phillipe Tock, Vittorio Parma
- Thierry Renaglia

- Vladimir Eremin (Si expert)
- Chris Fabjan (LHe IC)
- Erich Griesmayer (Diamond)
- Francesco Cerutti (FLUKA)
- Thomas Eisel (Cryogenic)

Conclusions

- Lot of tests already done.
- Installation of tested detectors on cold masses of LHC magnets during LS1 is a next step of CryoBLM project.
- Lot of experience with diamond detectors already collected.
- Relatively easy installation (use existing feedthroughs ?).
- It will have no drawback on machine.
- Holders are being prepared with design office.
- Q7R3 installation and DS could give already interesting results concerning the topology of losses.