BLMs on Triplets
- preliminary studies

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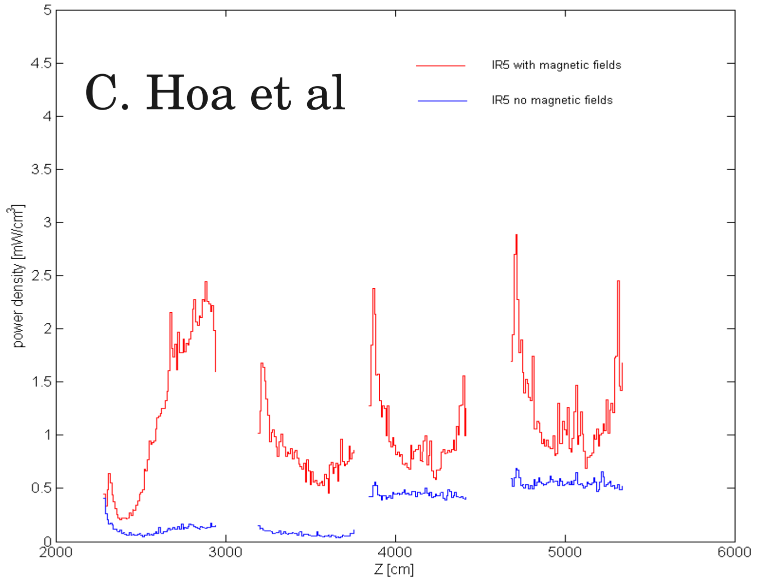
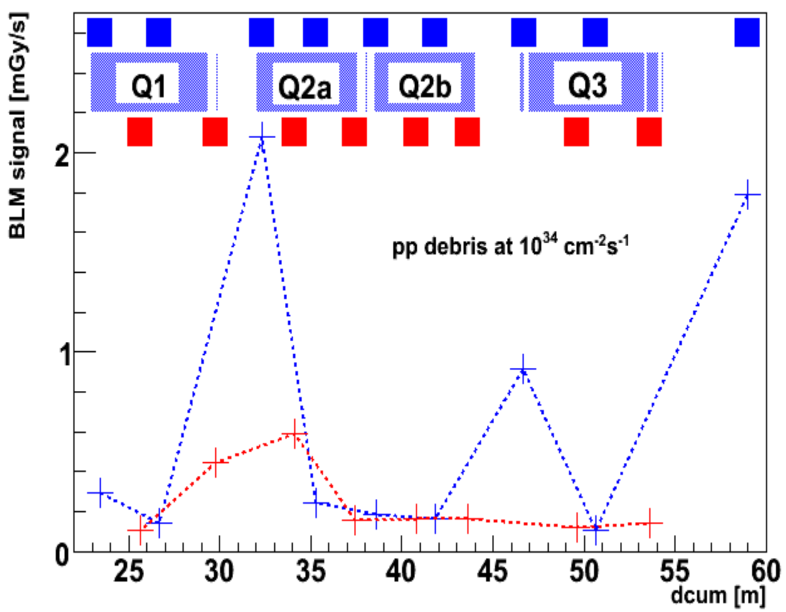
History

- First study (Christine, January 2008) aimed to determine quench protecting thresholds on current Triplets
- It has shown that the BLM signal coming from IR debris is much larger then the signal corresponding to the quench-provoking beam loss, but:
- Geometry development (Elena, Markus, Marco Mauri, Alessio)
- Present model is almost consistent with the one for upgrade studies
- New FLUKA runs started last week therefore only a few results are available

Debris

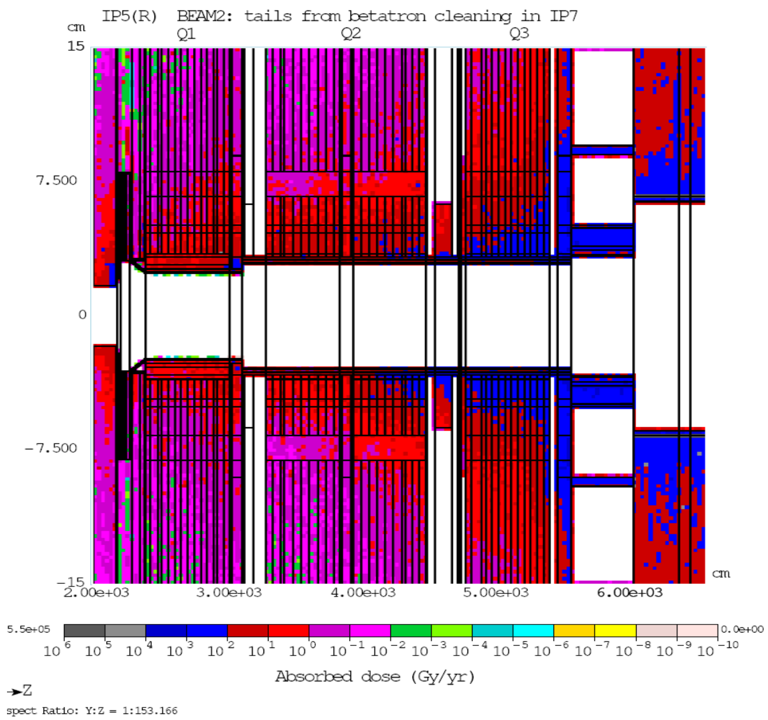




- Debris from DPMJET
- IP1 is similar
- The main contribution to the heat load is indiced by high -energy pions captured by magnetic field and hitting the beam screen (see F. Cerutti et al. presentation at CARE-HHH workshop November 2008)
- Quench level is about 1.2 mJ/cc for transient losses and 12 mW/cc for steady-state losses
- MB threshold for transient losses is about 180 mGy/s (40 µs)

Showers from tertiary collimators

- Nikolai Mokhov studies (LARP Collimation Meeting, CERN, August 23, 2006) : peak power density in Q3 coil of about $6{\cdot}10^{-5}$ mW/g ie. $4.4{\cdot}10^{-4}$ mW/cc
- No data about corresponding signal in BLMs

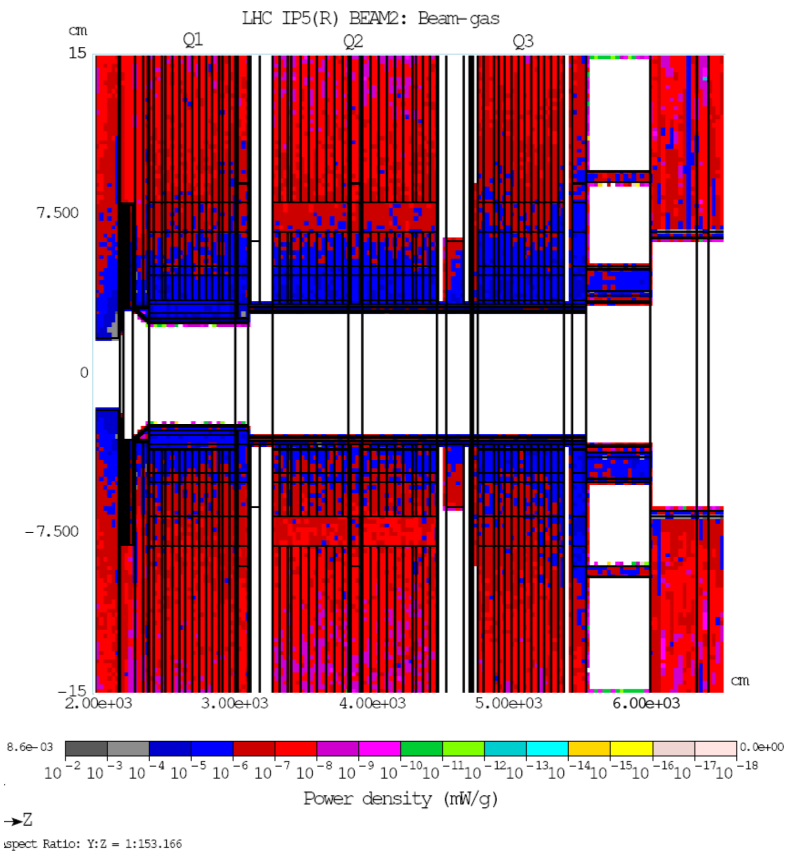


N. Mokhov, 2006

Beam-Gas induced radiation loads

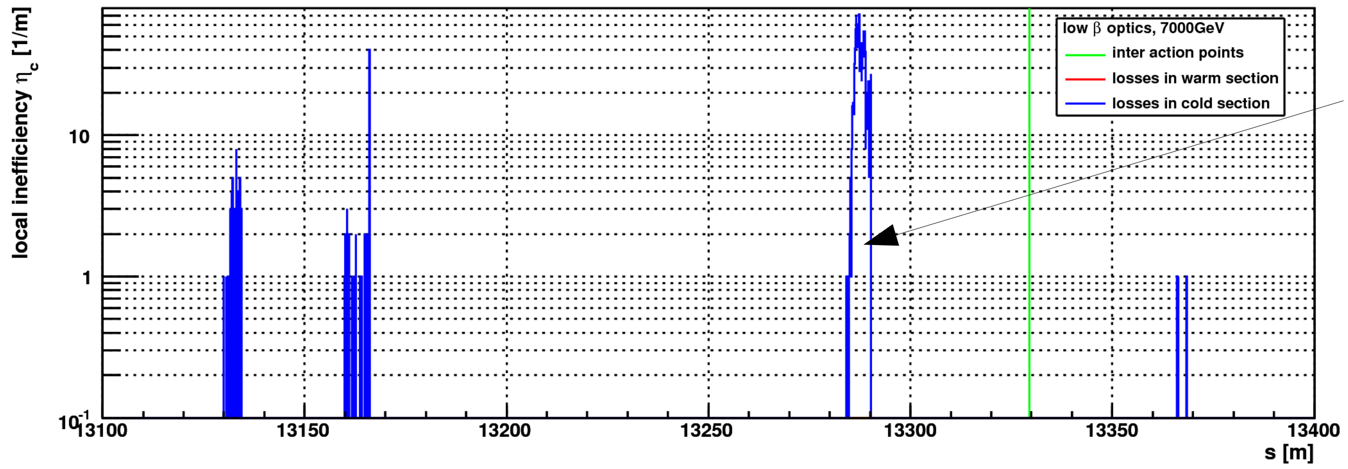
- Peak power density in SC coil: $3 \cdot 10^{-5}$ mW/g ie. $2.2 \cdot 10^{-4}$ mW/cc
- BLM signal unknown

N. Mokhov, 2006



Beam losses

- Triplets are very well protected so standard loss maps show almost no losses
- Exotic (very low probability) scenario:



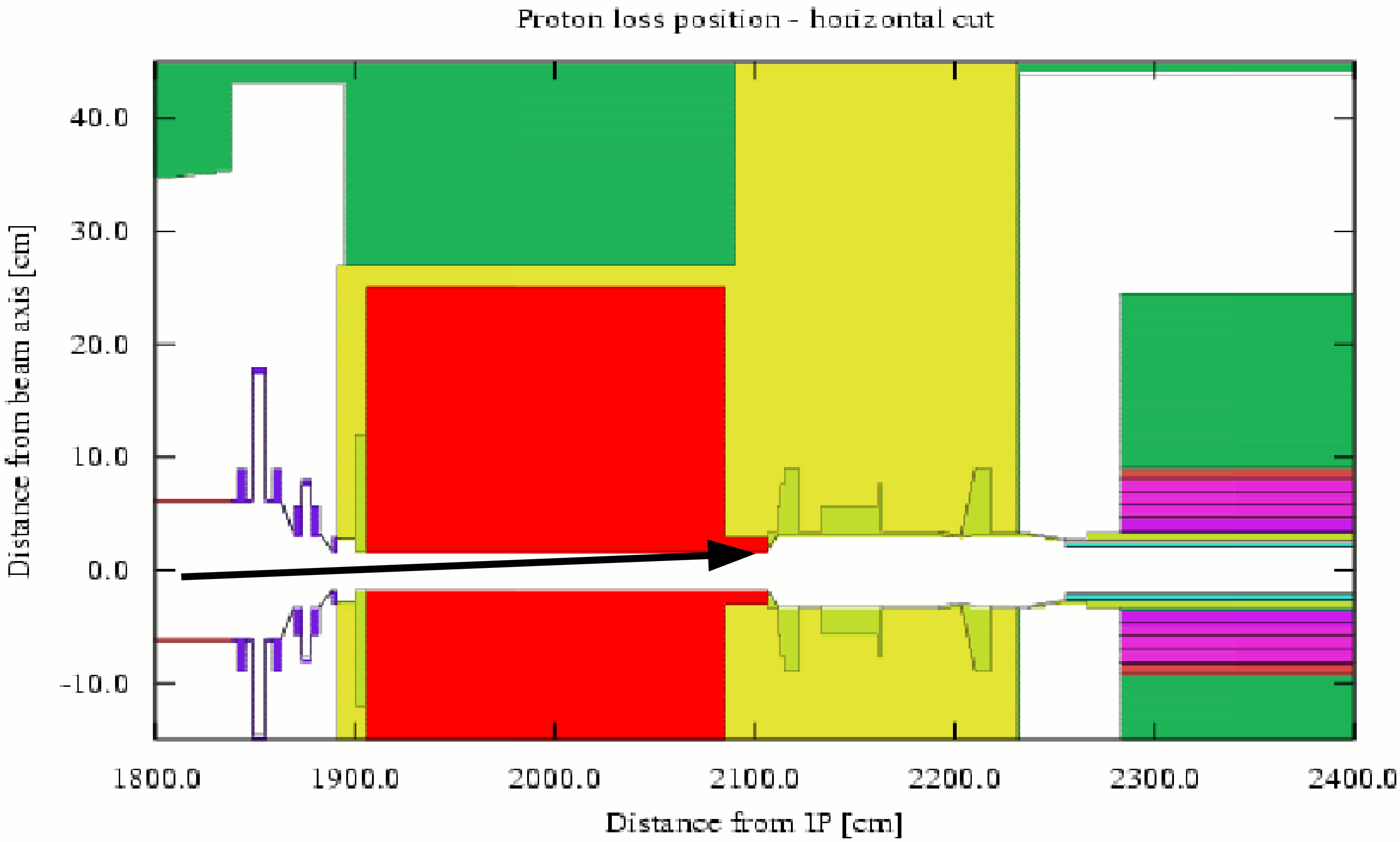
Protons lost between Q2 and Q3

Very unrealistic case from Thomas Weiler: TCP in IR7 at 12σ, TCS at 14σ

- BLMs should protect in all unexpected cases

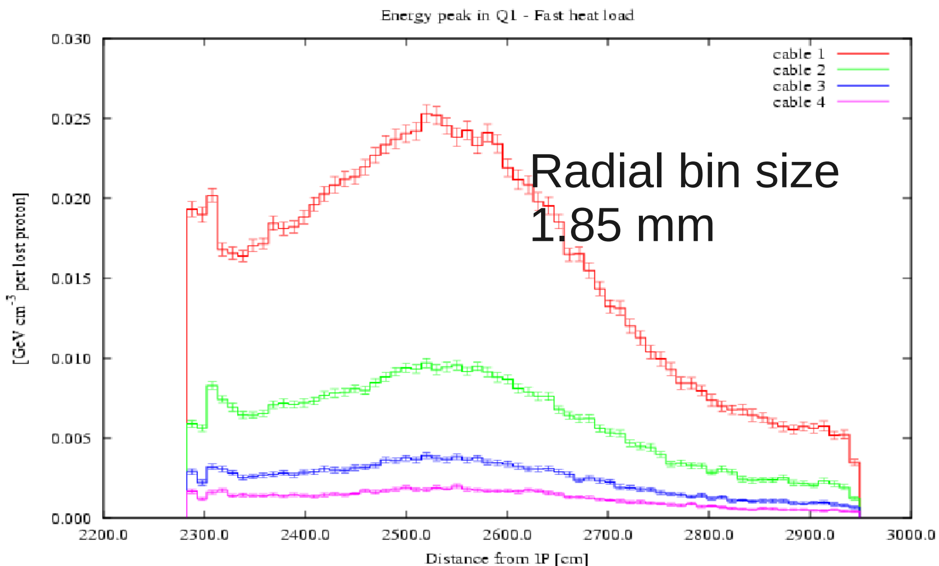
Loss example

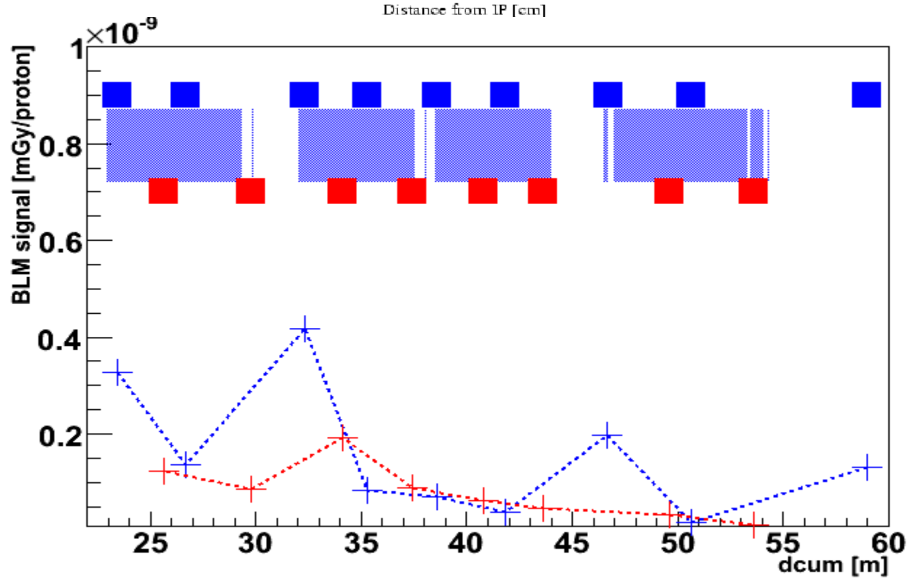
- Horizontal loss in the IP1 on TAS



Loss example (cd)

- Horizontal loss in the IP1 on TAS





- Assuming only debris and direct loss (no TCT shower nor beam-gas)
- For transient loss (the SS heat is evacuated):

  $N_{lossprot} = H_{cable} / E_{loss}^{max}$

  (E_{loss}^{max} is slightly underestimated)
- Take:
  - H_{cable} = 1.2 mJ/cc (is that still true in heavy heat flow conditions?)
  - E_{loss} = 0.025 GeV/cc (in bin of 1.85 mm)

$N_{lossprot} = 3 \cdot 10^8$ threshold (40μs):

10 mGy+10^{-4}mGy

beam loss + debris

Loss example (cd)

- Steady State loss
  - Rate at which protons can be lost:

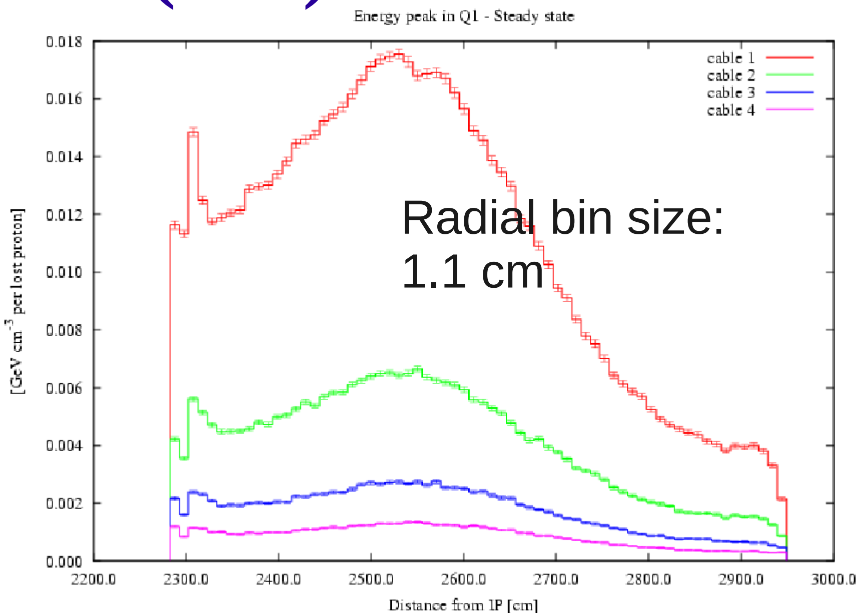
    $R_{lossprot} = (P^{QL}_{cable} - P_{debris}) / E_{loss}^{cable}$

  - Take:

→ P^{QL}_{cable} = 12 mW/cc

→ P_{debris} = 1mW/cc (at the location of the loss maximum)

→ E_{loss}^{cable} = 0.017 GeV/cc (energy density in thermal equilibrium volume)



$R_{lossprot}=4\cdot10^{9}$ protons/s

debris contribution must be below thresholds

threshold (1st monitor): **1.3 mGy/s+0.3 mGy/s**

In case of 3rd external detector: 1.6 mGy/s + 2 mGy/s so we have to set threshold at > 2 mGy/s, which is more then quench level.

Possible solutions

(if we really have the problem
- QPS protects for slow losses)

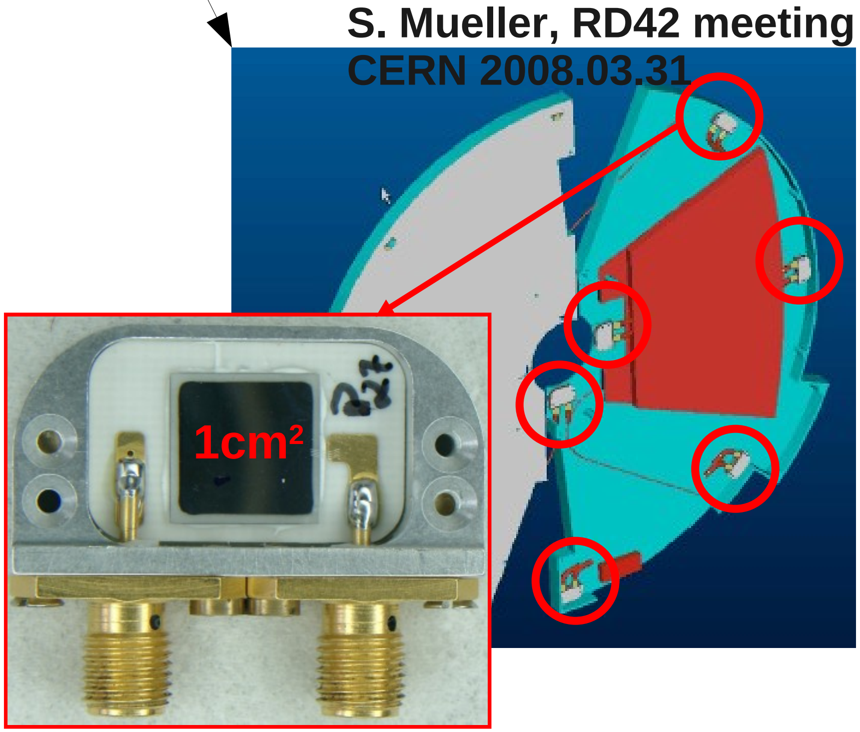
- Shield BLMs – will not work because debris signal come from the Cryostat as well
- Try to optimize BLM configuration
- Combine signal from various detectors
- Use detectors which are spectrum sensitive
- Place detectors closer to the coil

Detectors close to the coil

- In coil vicinity the measured signal is closer to energy deposit in the coil and to shower core
- Detector must be small, radiation hard, reliable and work in cryogenic conditions
- Technologies:
- Scintillating fiber in yoke
- “Liquid-helium” calorimeter – ionisation in gaps
- Diamond detector

Diamond detector

- There are already diamonds operating in ATLAS and CMS (Beam Condition Monitors)
- The same electronics is used
- Compactness
- Small leakage current at room temp.
- Need to investigate behavior in cryogenic conditions

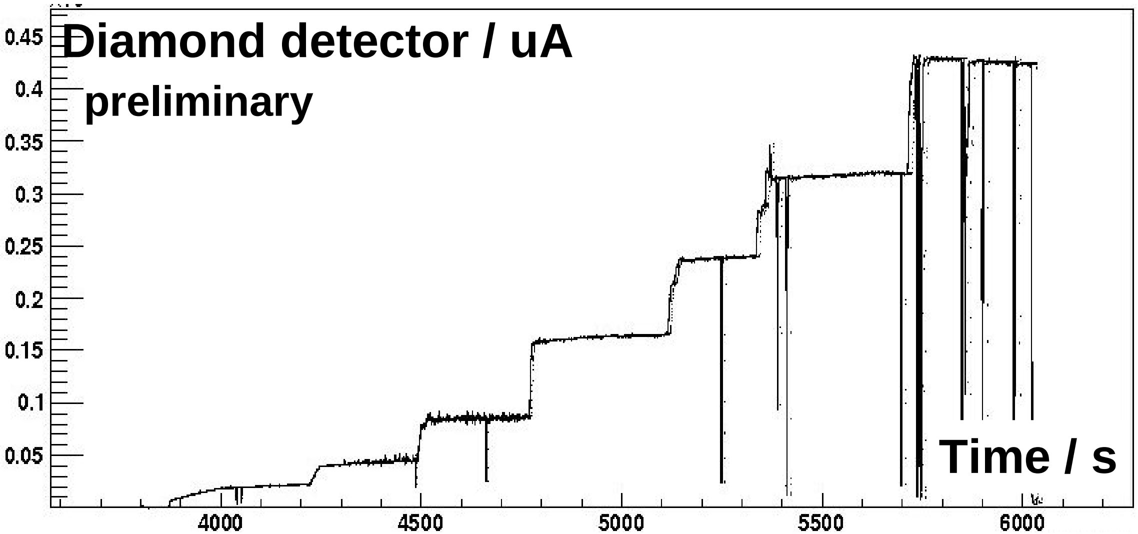


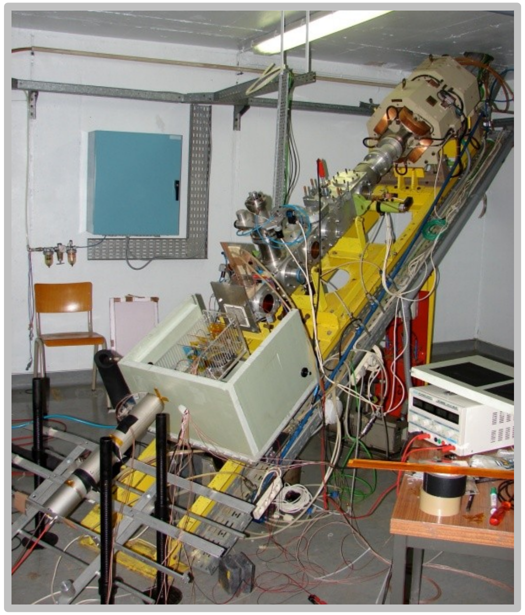
Things to do

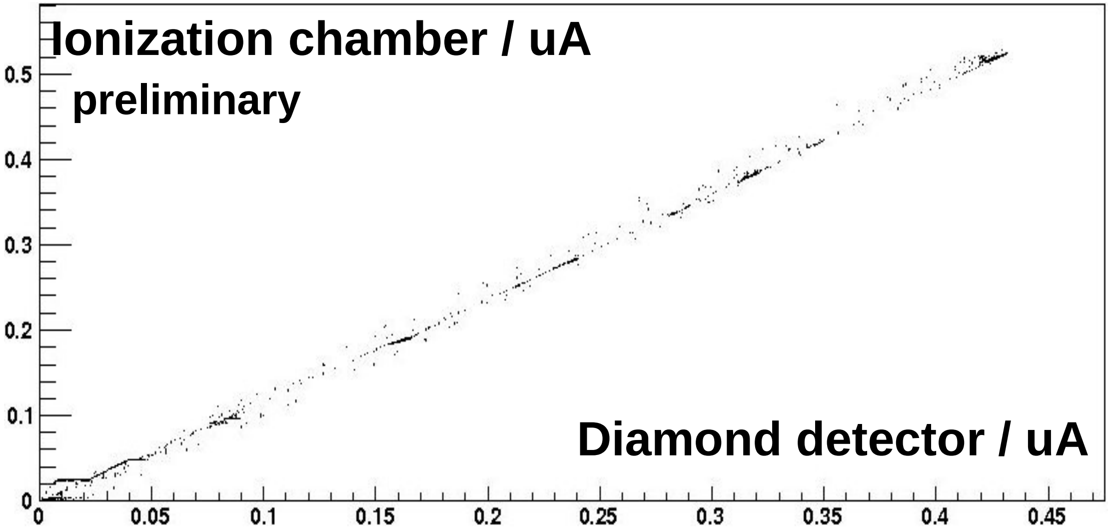
- Perform FLUKA simulations of losses on TCT to estimate BLM signal (need loss maps on TCT from Collimation Group)
- Perform FLUKA simulations for realistic loss locations including failure scenarios (wrong settings of collimators, D1 failure)
- Find optimal BLM locations
- Investigate technologies for BLM in yoke
- Study particle fluxes in various parts of magnet (localization of the new BLM)

Backup slides

Testbeams: Neutrons







21MeV fast neutrons in Louvain la Neuve.

Excellent correlation between ionization chamber and diamond.

Almost identical ionization currents in both detectors for 400 um thick diamond