BLM quench threshold estimates on the MB magnet (Steady State case)

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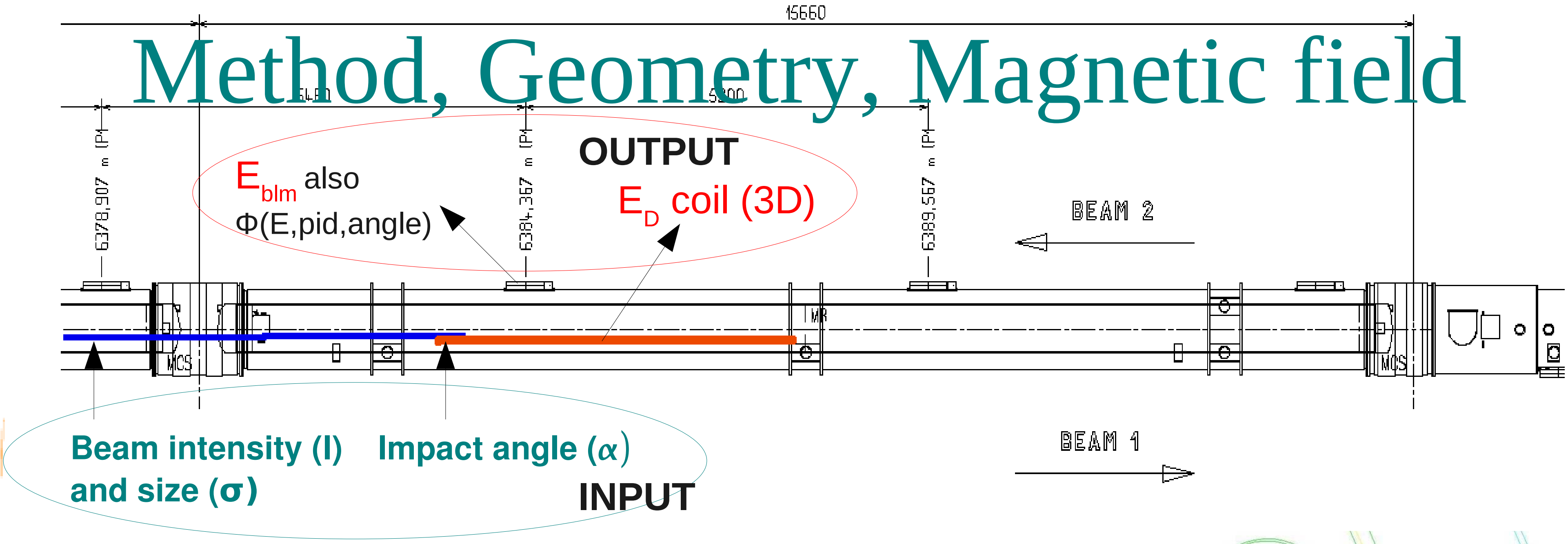
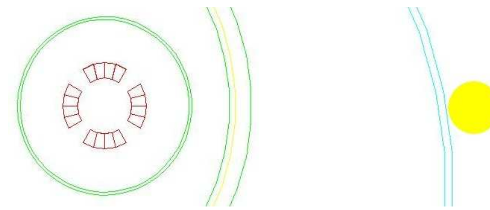
Outline

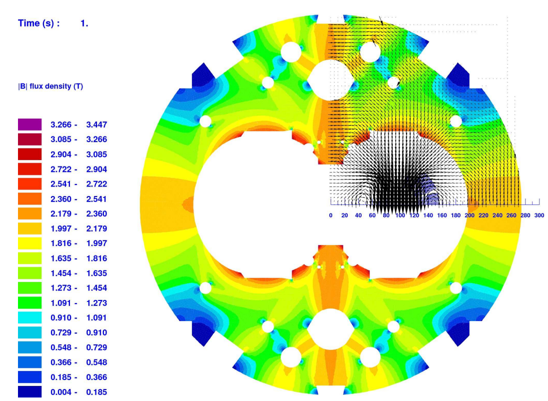
- Simulation procedure, geometry and magnetic field
- Results for transient losses
- Experience from real quenches
- Longer and Steady State losses
- Network model -> Dariusz
- Conclusions

Method, Geometry, Magnetic field



- Geant 4.9.0p01 with BERTini cascade parametrization and low energy neutrons (HP).
- BLM as a long tube along the cryostat – registering particles entering the tube
- Magnetic field from ROXIE
- Losses on beam screen inside the coil length
- Response functions (from M. Stockner) used to evaluate the signal in the BLM



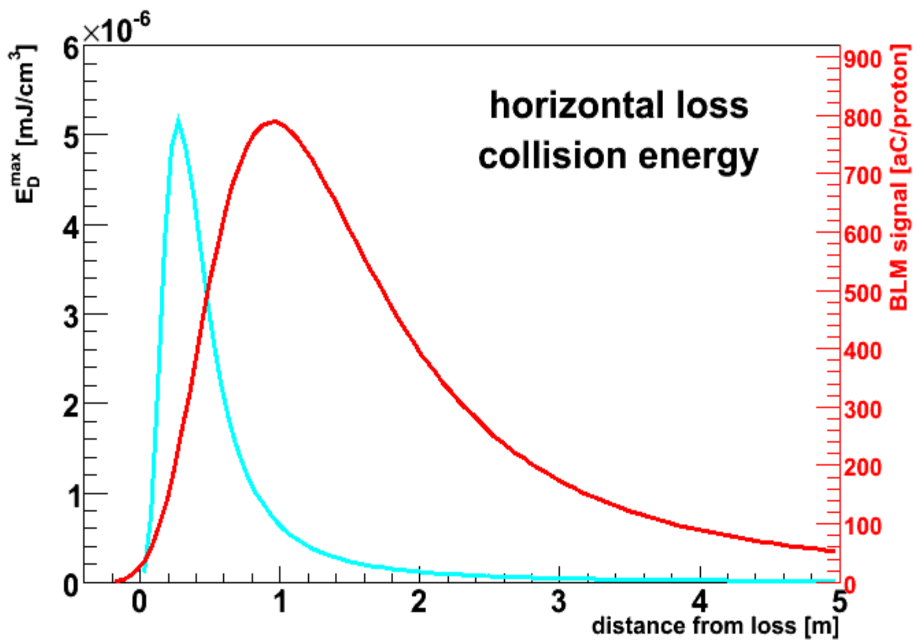


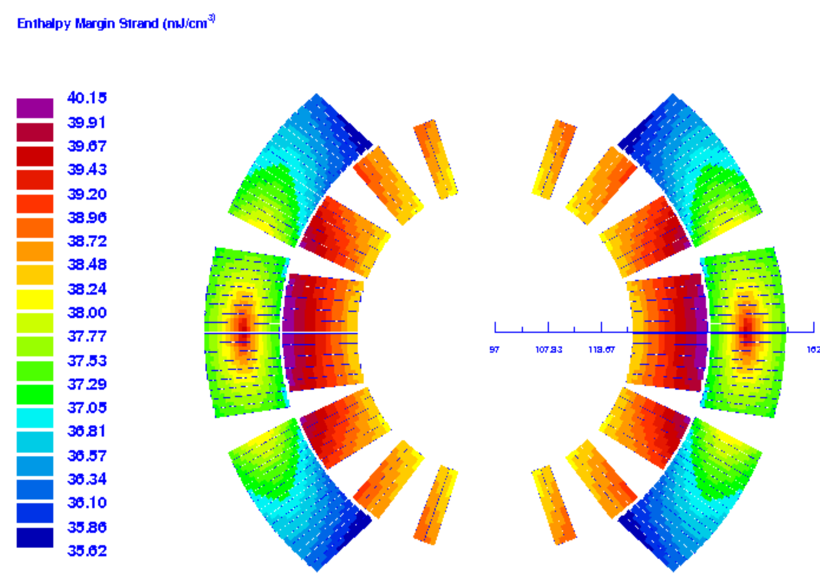
Quench-protecting threshold for transient losses

$$D\ [Gy] = (C\text{->}Gy)\ Q_{BLM}\ H_{strand}\ /\ E_D^{max}$$

- **Two inputs from this analysis: E_D^{max} and Q_{BLM}**
- **E_d^{max} - shower core – good agreement with FLUKA**
- **H_{strand} from ROXIE (N.Schwerg) or EDMS 750204 (D.Bocian)**

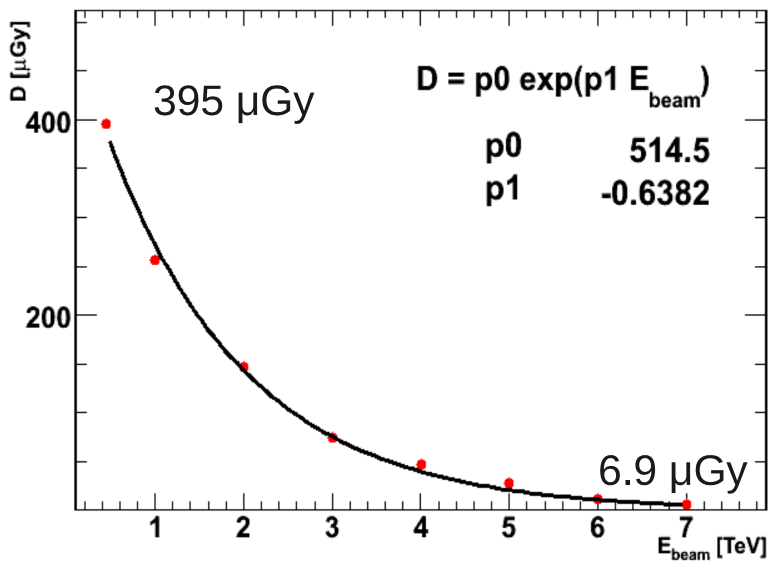
more conservative

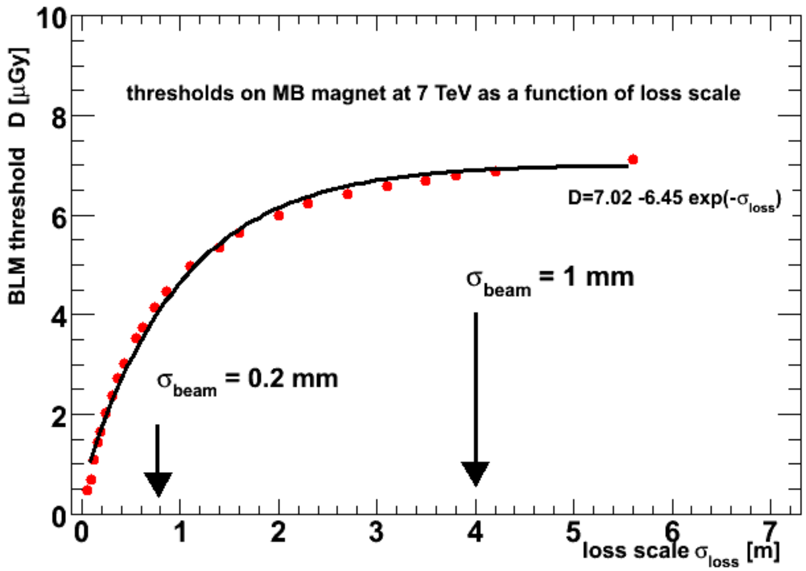




Quench-protecting threshold for transient losses

- In function of beam energy and loss size

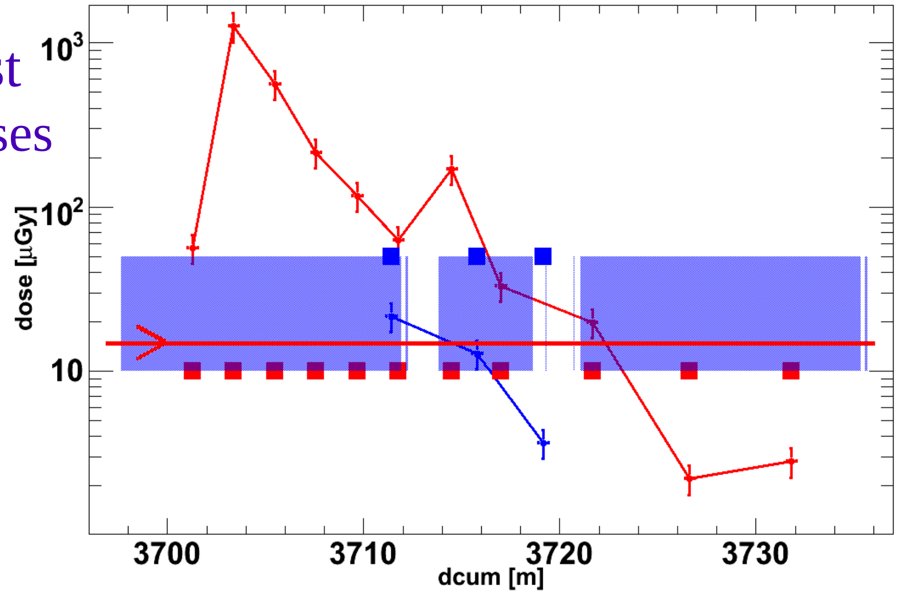




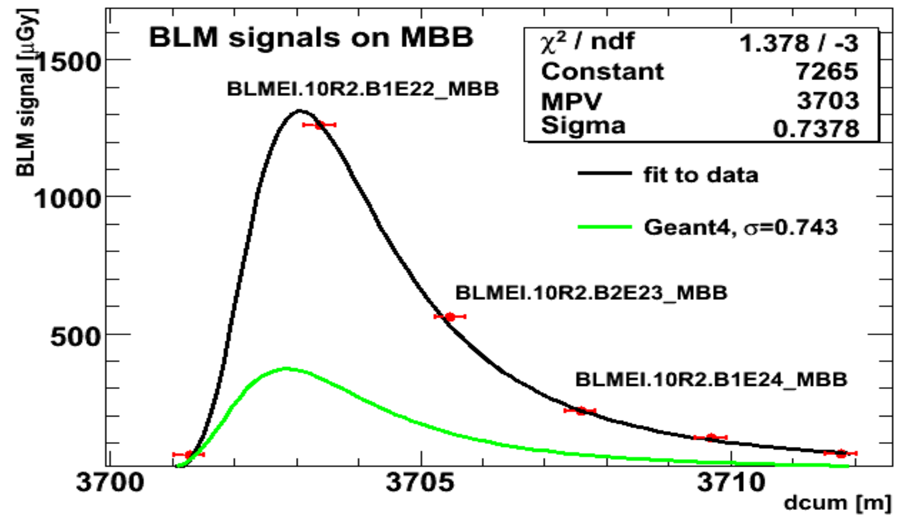
- In case of localized losses (aperture limit, obstacle in the beam pipe) the energy concentration in the coil raises fast and threshold becomes lower even if BLM is placed in the shower maximum

Experience from real quenches

- 2 beam-induced quenches in August and September 2008: MB in both cases
- Bunch intensity: 2-4·10^9 protons
- Angle 250-750 μrad
- beam σ < 1mm

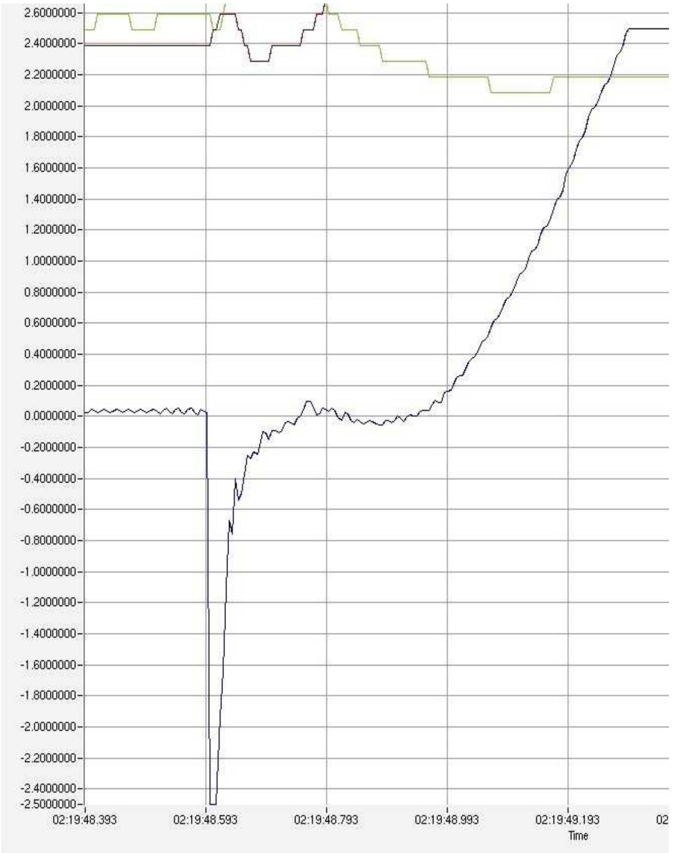


Simulation gives signal 3 times smaller then measured
Possible reason: lack of tunnel walls which thermalize neutrons (M. Brugger observation)
Or wrong description of cascade tail by Geant4



Thresholds could be set to 3x of the calculated ones

Remarques



- Both quenches were self-healing, so at the limit, nevertheless the QPS signal has been 2-3 times over threshold -> is there any conclusion about the QPS threshold? Should BLMs protect from QPS premature trigger?

- The maximum energy deposition in the coil is simulated to be about 13-16 mJ/cc, ie. 35-50% of the predicted one.

- Energy deposition in case of vertical loss is about 4-8 times smaller then in case of horizontal loss

- BLM signal almost the same for vertical/horizontal loss therefore the threshold lower for horizontal losses (~factor 3 or more)

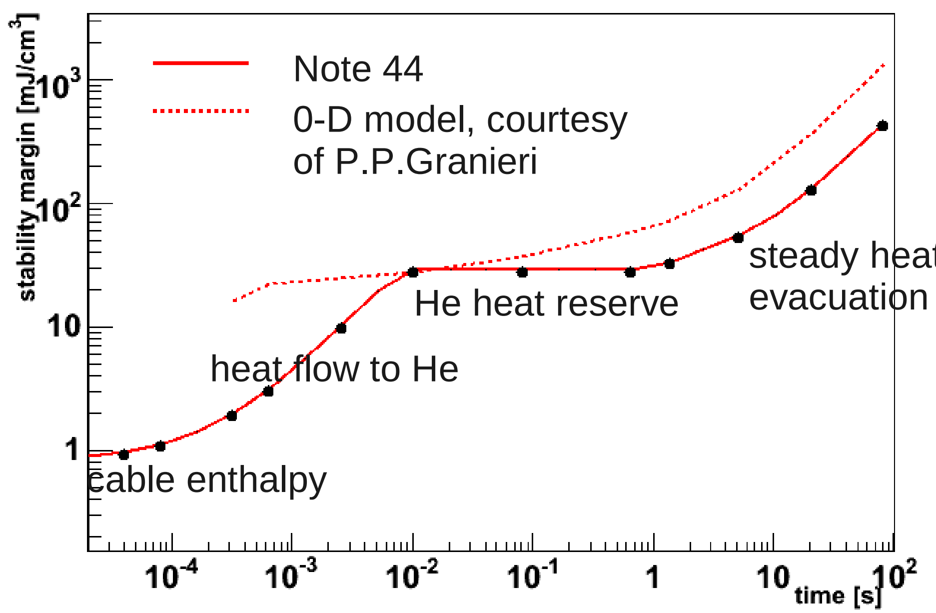
- Increase of the impact angle (250 -> 750 μrad) leads to threshold decrease by 20% (injection, vertical loss) mostly because more punctual loss

Longer losses

- Threshold table for every monitor contains: 12(signal integration times)x32(E_{beam}) = 384 values

(heat transfer model) (Geant4/FLUKA)

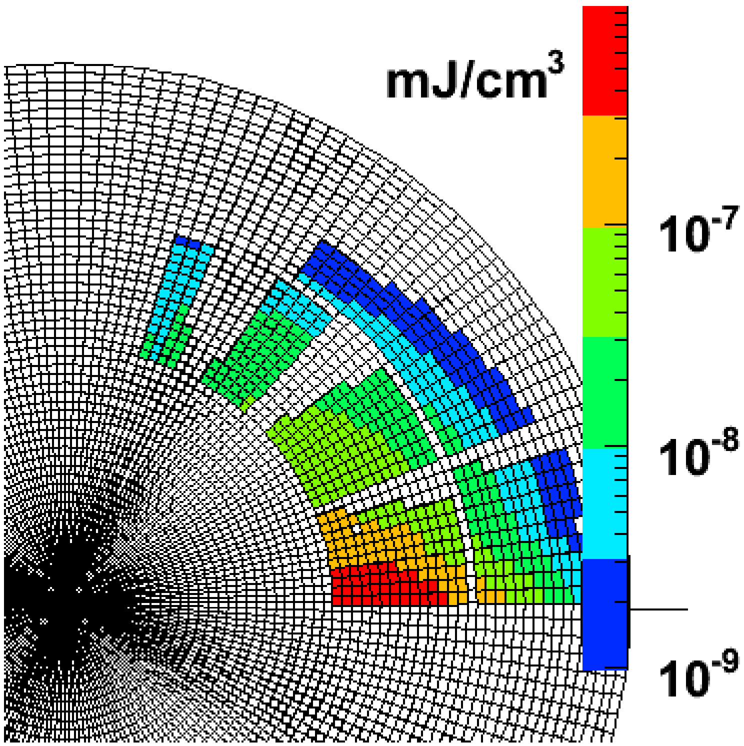
- We have models confirmed by measurements adequate to transient and steady state losses



- SS losses: taking E_D in thermal equilibrium volume (cable cross section times transposition pitch) and cable stability margin for long perturbations

Input to Network Model

- Energy deposits in strands, wedges and cold bore
- In total 1616 numbers
- A distributed loss of beam
  E_{beam}=7 TeV and
  σ_{beam} = 0.5 mm
  (peak large: σ_{loss} = 2 m)



Conclusions

- Quench-protecting threshold for Steady State loss on MB magnet is around 100 μGy/s for 7 TeV beam
- For transient losses the threshold is about 21 μGy at 7 TeV and 1200 μGy at 450 GeV (TESTED and corrected)
- Safety factor 3 is used
- Simulations suggest that magnets quenched for enthalpy limit below the theoretical one
- Additional quenches in horizontal plane would help to validate the model and understand energy depositions in coil
- Simulation improvement is investigated