Simulations of BeamPipe Heating - Discussion to BLM thresholds

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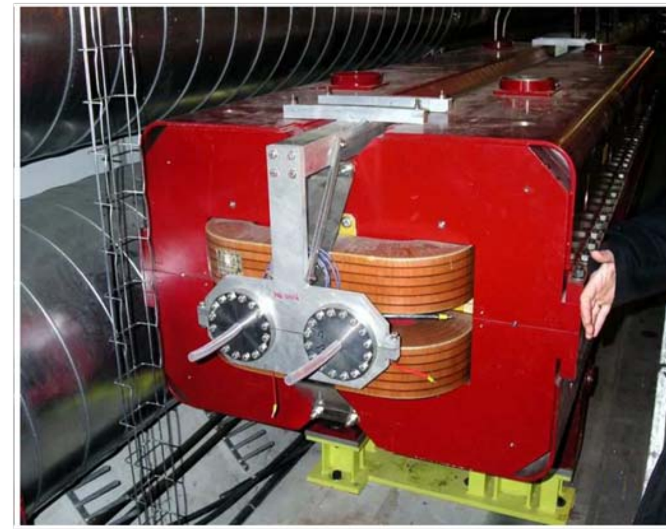
Heating of Beampipe

- Following the proposal of C. Rathjen to define possible locations for temperature sensors along the betatron cleaning insertion
- FLUKA simulation analyzing the peak power densities along the:
  - standard beampipe between elements
  - inside the magnet modules (MBW, MQW,…)
- For normalization considering a peak loss rate of ~4.3×10^{11} protons per second (10s max)
  - Values can be easily scaled, *e.g.*, factor of ~5 for 1h lifetime case
- To get a respective power load per meter one needs to:
  - average along the respective length
  - consider the total deposition inside the pipe (or the respective lateral average value)
- Conclusion for critical locations will not depend on the latter, however distribution will be influenced according to the 'realistic' loss scenario (especially during the first years)

Critical Locations - Simulations

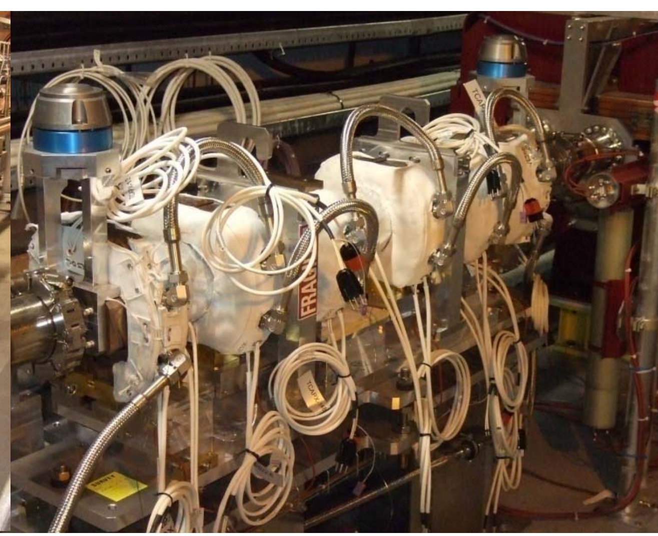
- Including the full IR7 geometry
- FLUKA simulations based on scenario as provided by AB/ABP
  - no imperfections, nominal case
  - changes expected for 'realistic' scenario
- Separate scoring for critical elements

Diploe Magnets

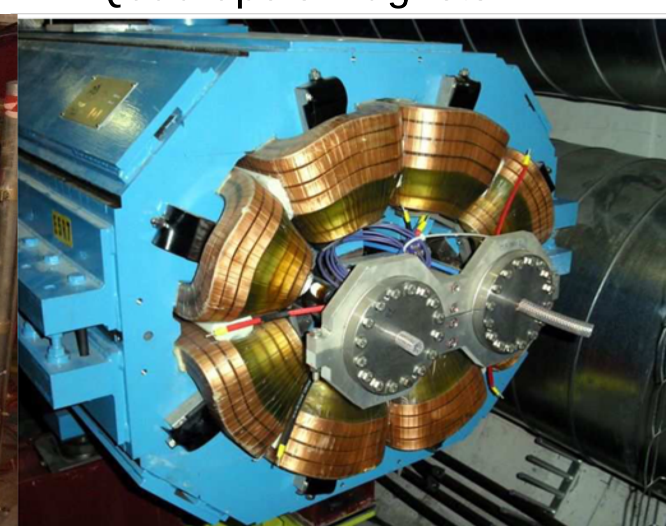


Beampipe and Collimator

Passive Absorber



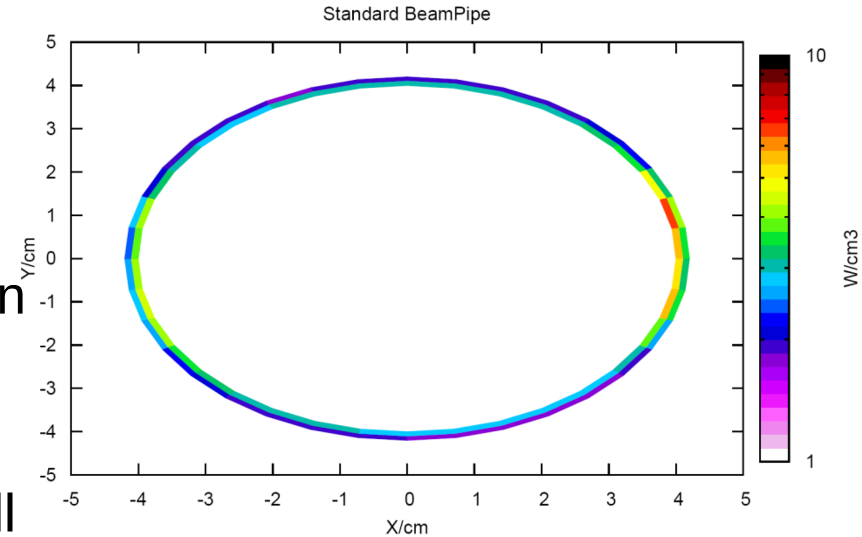
Quadrupole Magnets

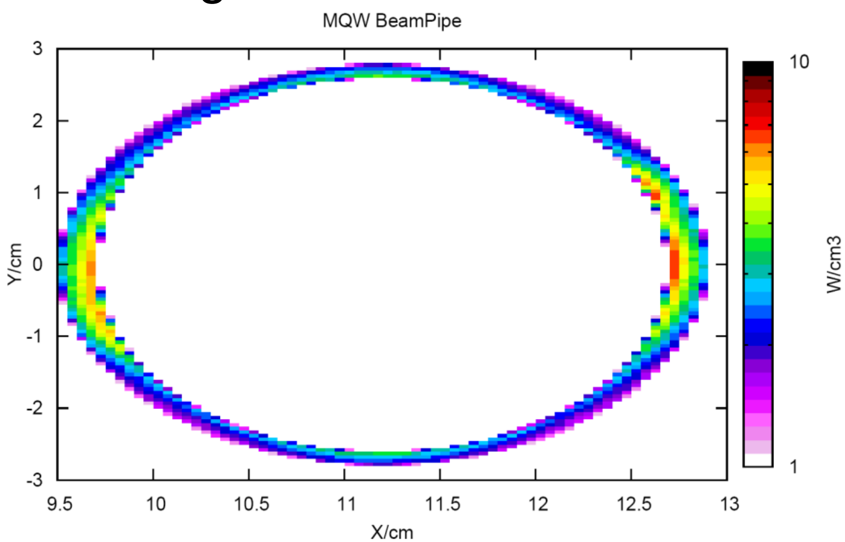


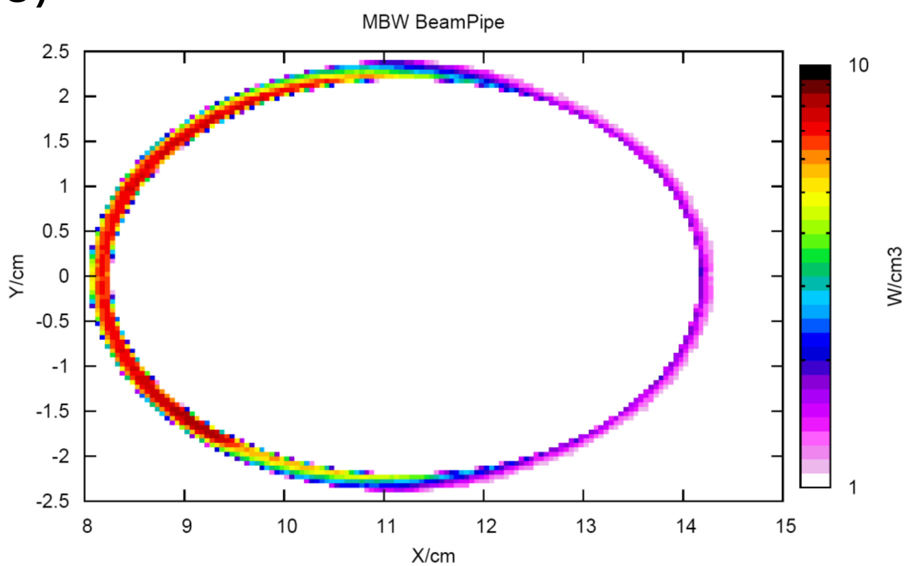
Technicalities

Nominal case
Peak loss rate (10s): 4.3×10^{11}p/s

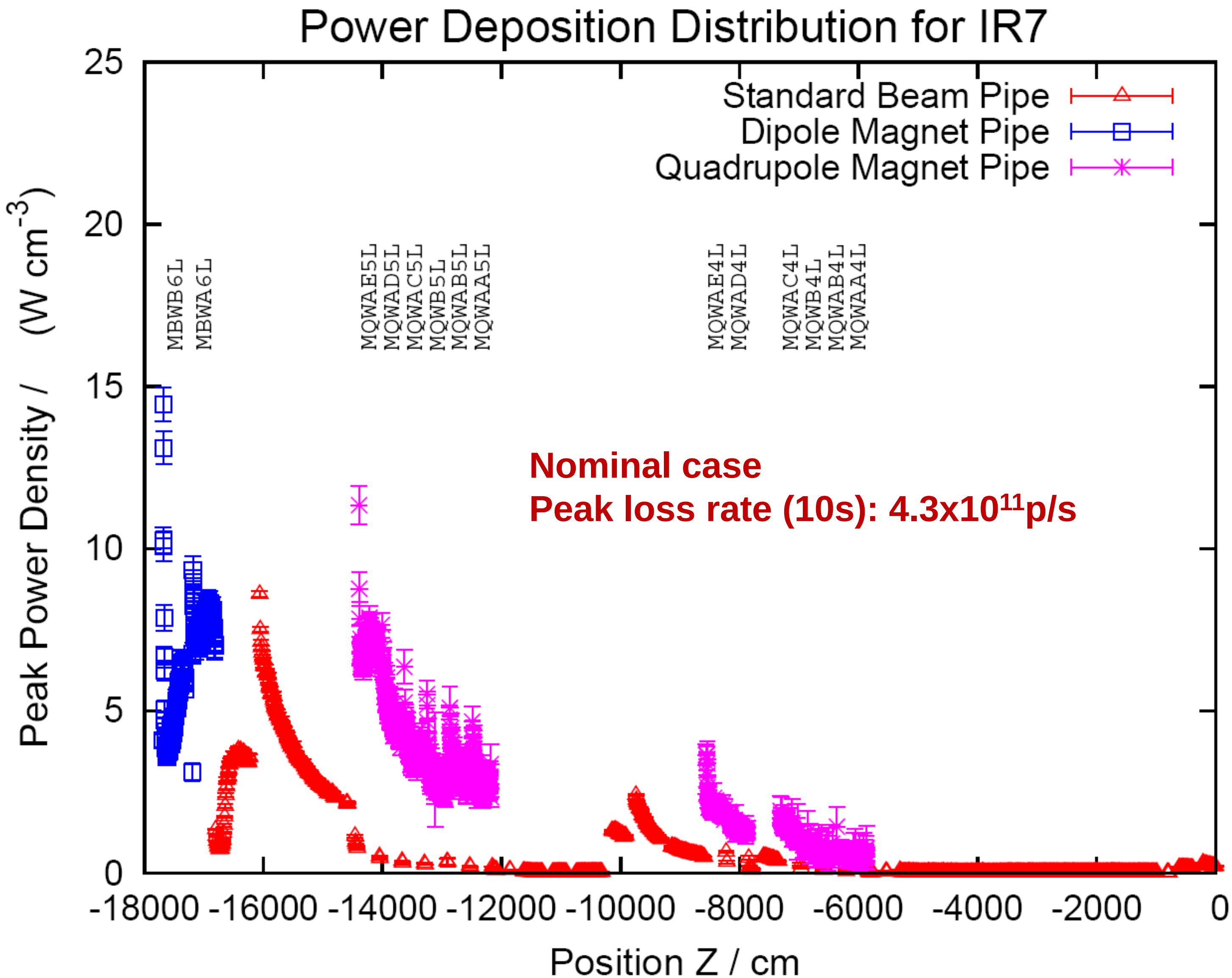
- Special scoring for each type of beam pipe as implemented along the full IR7 FLUKA geometry
- FLUKA calculates peak energy densities (GeV/cm^3), then to be converted into W/cm^3 assuming a given loss rate (in our case the peak rate of 4.3×10^{11}p/s)
- A routine then allows us to extract respective longitudinal maxima (as well as average and total – not shown here)



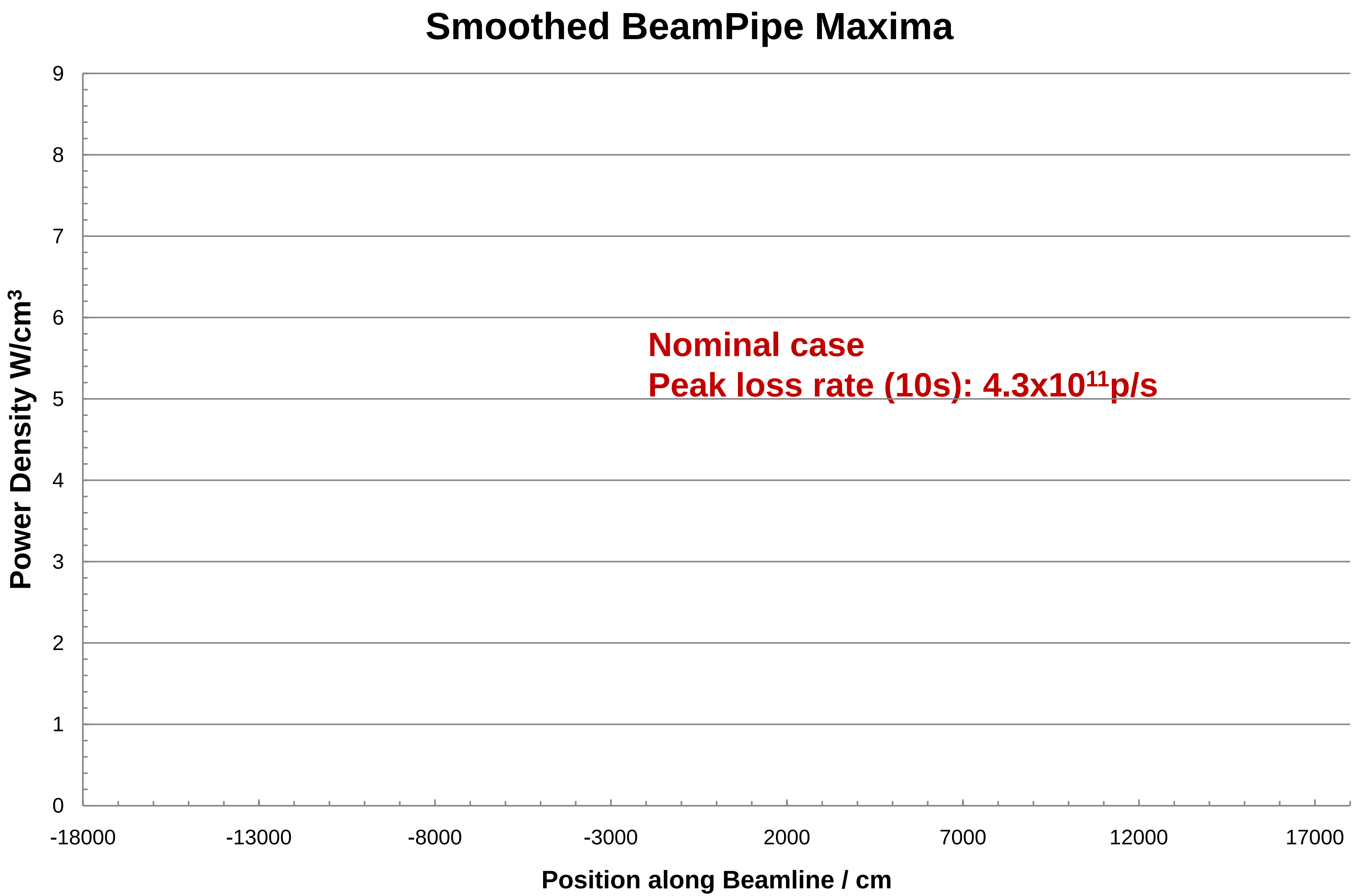




Peak Values along the Beamline



Peak Values but Smoothed over ~1m

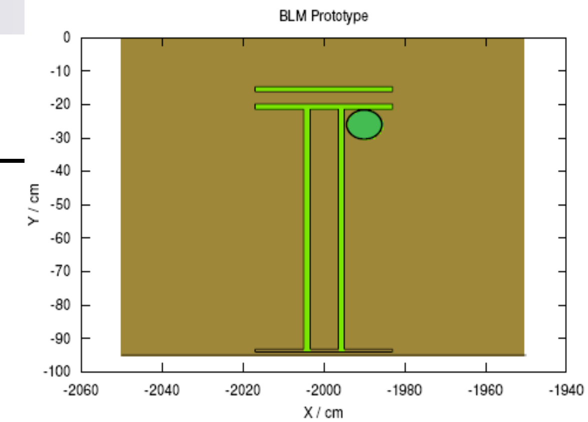


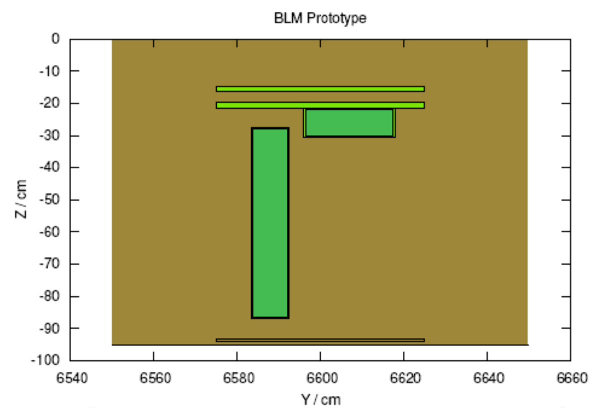
Discussion of the Results

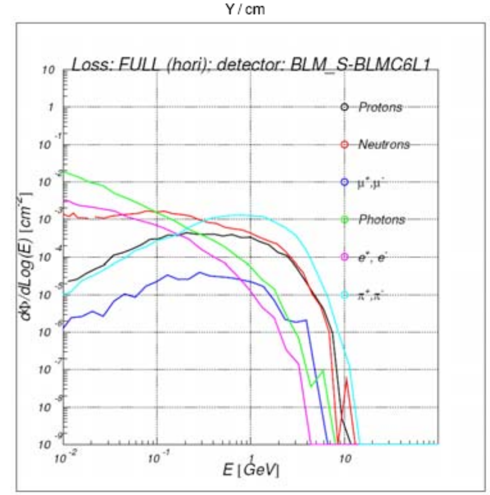
- **Preliminary**: before drawing conclusions the results should be looked at more carefully together with C. Rathjen and R. Assmann
- Peak locations are clearly localized **downstream of highest loss locations**, as well as along magnet modules directly downstream the latter (aperture limitations)
- Peak values are given as W/cm^3, thus to estimate a possible (conservative) power load per meter one has to multiply the results by the expected volume:
  - ~500cm^3/m for the standard beampipe (4.2mm outer radius, 2mm thickness)
- However, the peak values are not fully representative for the power load per unit length, thus one should take the proper lateral average (or total) into account
  - Estimated through the standard beampipe and expected to give a **reduction** (with respect to the stated peak value) in the order of a **factor of three**
- In this case the possible maximum power load would be:
  - For the 10s case: **~1.5kW/m** (4.3×10^{11}p/s)
  - For 1h beamlife time**: ~0.3kW/m** (0.8×10^{11}p/s)

BLM Past Simulations

- Overview of results calculated in the past with FLUKA presented during several past CWG meeting, as well as discussed with AB/BI by M. Santana-Leitner (AB/EET)
  - Calculations were performed for the nominal operational scenario as provided by AB/ABP and for various cases: horizontal, vertical and skew
  - Energy deposition for all BLM (and SEM) locations for all collimator locations
  - Respective *'Response Matrix'* in the requested format
  - Particle energy spectra for the various BLM (and SEM) locations
  - Detailed particle 'dump-file' for selected BLM locations (to be then used for subsequent GEANT simulations?)
  - Corresponding total energy deposition for each collimator jaw
  - Peak energy depositions in the collimator jaws (however not for all possible combinations)
- Currently together with T. Bohlen (AB/BI) we look into further details in order to:
  - Update the real installed locations (and/or perform sensitivity study)
  - Include the BLMs in the DS and ARC (as well as MBWs and MQWs)
  - Cross check the results for peak energy deposition versus BLM signal
  - Compare the results with the SPS test findings







Comments to Threshold Settings Draft

For discussion …

Based on Ralph's draft for the threshold settings we discussed the following:

- definition of 'damage':
  - warm elements: *e.g.*, deformation, melting,..., as well as damage to what: collimator jaw, downstream equipment,…
  - cold section: *e.g.,* risk of quench or damage limit in case of quench,…
- corresponding maximum loss rates (or only absolute signal?)
- related uncertainty in the BLM measurement (*e.g.*, sensitivity on changes of energy spectra, *e.g.*, coming from upstream losses) -> the real threshold will depend on this
- a possible deeper analysis of the BLM response, especially in case of the BLMs in the cold section (how sure are we about the respective calibration as neutron dominant fields might alter the picture)
- ….