Energy Deposition from Collision Debris

J.-P. Koutchouk , CERN/AT/MCS

Motivations I

1. Initially primarily for the LHC luminosity upgrade
2. It is THE key issue for the upgrade:
   1. Is it possible to reduce l*? (gain 35% to 90% in L)
   2. Is it possible to install an early separation scheme at a few meters from the IP? (gain ×2 or more in L)
   3. What happens if the quadrupole aperture is largely increased (120 to 130 mm)? (gain 85% to ×3 in L)

   Depending on the answer to these questions, it could become possible to design an upgrade ***with hardly any increase of the beam current.***
3. In CARE05/Arcidosso & US-LARP05/Chicago, no one could answer these questions.

Motivations II

5. The energy deposition is determinant in the design of the early separation dipoles, low-beta quadrupoles and insertion layout: It makes the difference between superconductors, cable structures, insulation, coil cooling strategies, non sc materials used, size of the magnet, radiation lifetime.

   It was thus needed to develop the tools necessary to include the dimension of beam losses into superconducting coils and other materials *directly at the magnet design level*, with possible simplifications that should allow *rapid iterations*.

Team

Team formed in ~April 2006

JPK (ppt) , E. Wildner (pt)
C. Hoa (fellow, ~ft)
G. Sterbini (PhD st., pt for D0), since ~sept.
F. Broggi, INFN Milano, CARE/NED
+
help from the CERN FLUKA team: A. Ferrari, S. Roesler
+
participation to the CERN FLUKA users forum.

+ advicing by N. Mokhov and one visit.

Work Plan I

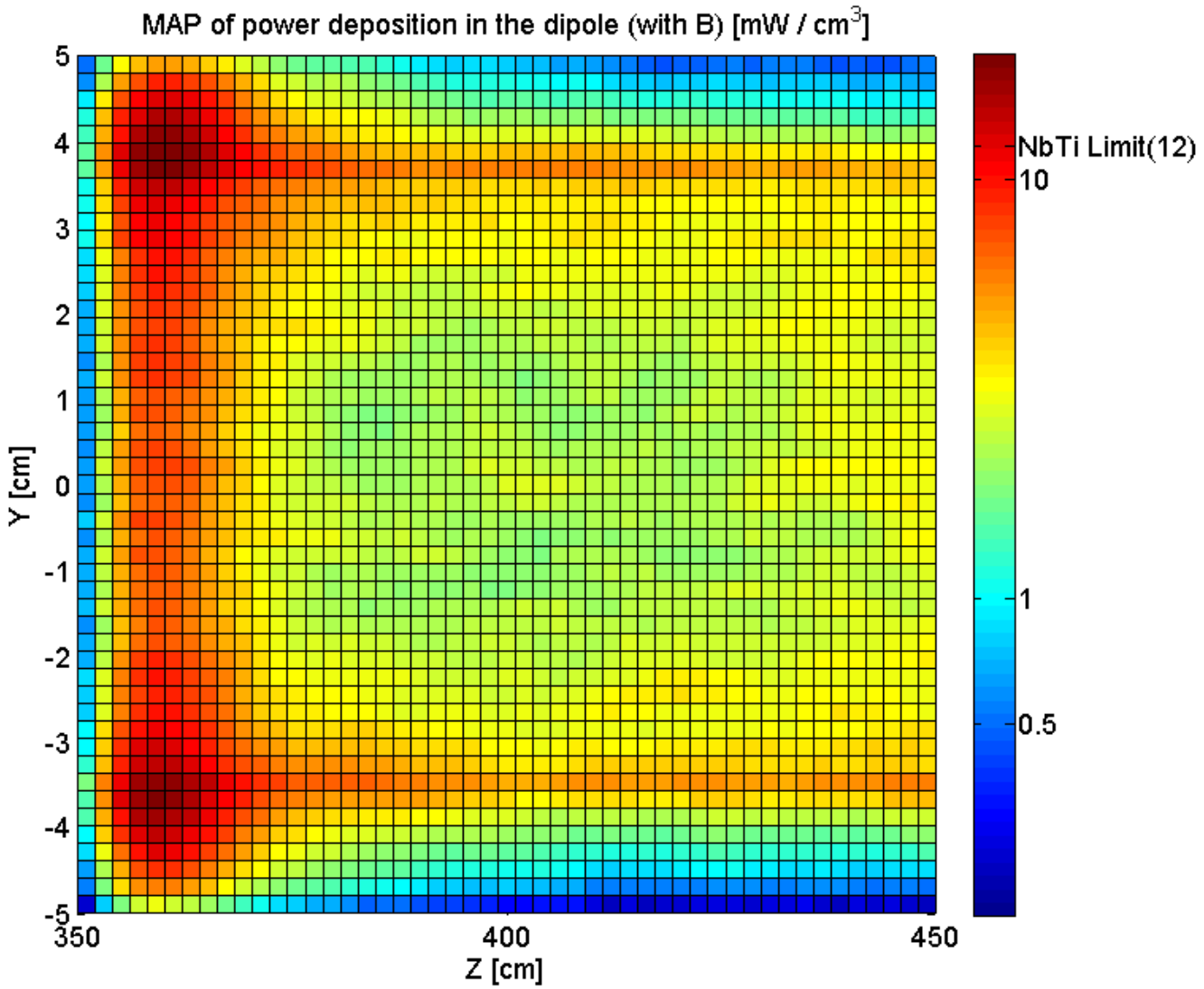
1. **Ultimate goals for Lumi upgrade:**
   - Identify scaling laws for the variation of energy deposition versus l*, quad aperture and other beam, insertion and triplet parameters (Xing angle, beam size/divergence, Gdl,…),
   - Calculate the energy deposition in the early separation scheme and design accordingly,
   - Calculate in detail the energy deposition for solutions for the luminosity upgrade (peak energy deposition, heat load, doses).
2. **Intermediate goals (calibration)**
   - Reproduce the results of N. Mokhov in IR5 for the baseline LHC
   - Carry out the same calculation for IR1.
   - Added value: study the effect of perturbations.

Status I

- So far, bunch-bunch collisions partially implemented in FLUKA (beam size at IP): A. Ferrari.
- Comparison between sources carried out (DTUJET, DPMJET outside and inside FLUKA). The consistency is not yet satisfactory and work is going on.
- The IR1 FLUKA description is gathered in the “old “language except for the exact field map of the ATLAS detector (being collected and transmitted as well to N. Mokhov). Conversion to “SimpleGeo” will be done.
- The baseline IR1 will be evaluated within weeks after i) consistency between sources is established, ii) including the full modelling of the bunch.

Status II

- The variation of energy deposition vs l* was investigated (Valencia) with the first interesting conclusion that, contrary to intuition, the increase of energy deposition between 23m and 13 m remains moderate,
- The energy deposition in a simplified D0 is evaluated but requires a final validation (sources). The azimuthal distribution of the losses seems favorable for shielding.


MAP of power deposition in the dipole (with B) [mW / cm3]
Y [cm]
Z [cm]
5
4
3
2
1
0
-1
-2
-3
-4
-5
350
400
450
NbTi Limit(12)
10
1
0.5

C. Hoa

Conclusions

Preparing and running FLUKA simulations is a lengthy process (CPU-days) and the devil is in the details, but we have a good small team and connections.

The effort, necessarily modest at this stage, starts paying.

It is primarily meant to allow the best selection for the luminosity upgrade solutions and technology.

It could give a new clue at deposition issues in presence of realistic imperfections for the baseline LHC.

Future collaborators are welcome.