FIRST THOUGHTS ON USE OF SUPERCONDUCTING MAGNETS IN IR7 FOR HE-LHC AND COLLIMATION STUDY WORKFLOW

C. Bahamonde, F. Cerutti, A. Lechner, E. Skordis

in collaboration with the BE-ABP collimation team

FCC collimation design meeting #15 joint with HE-LHC

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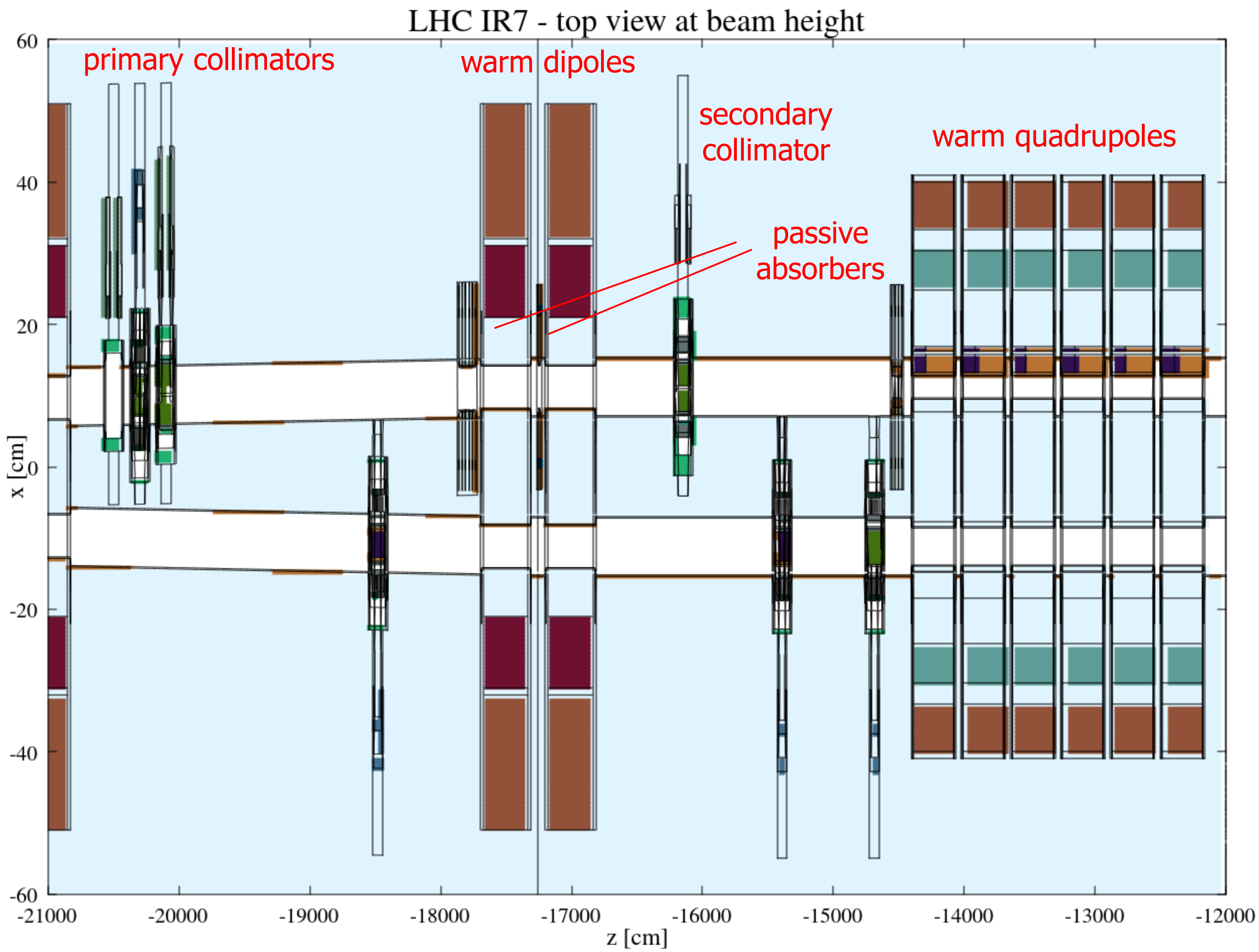
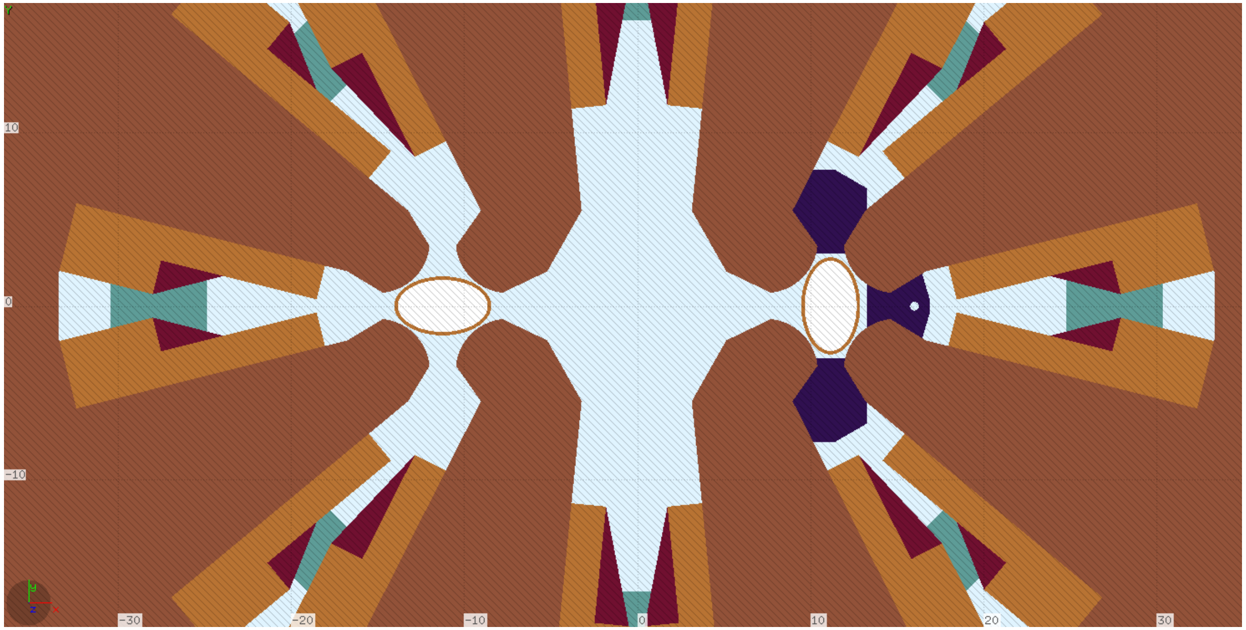
OUTLINE

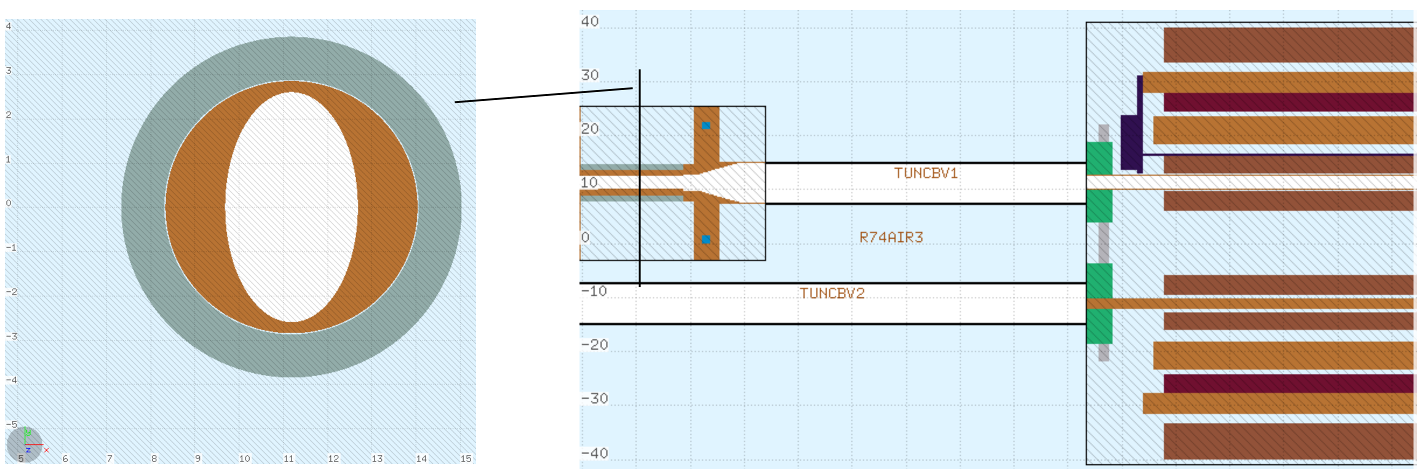
- the betatron cleaning insertion in the LHC: warm magnet exposure
- extrapolation to HE-LHC
- shielding performance
- simulation workflow

LHC IR7 LAYOUT

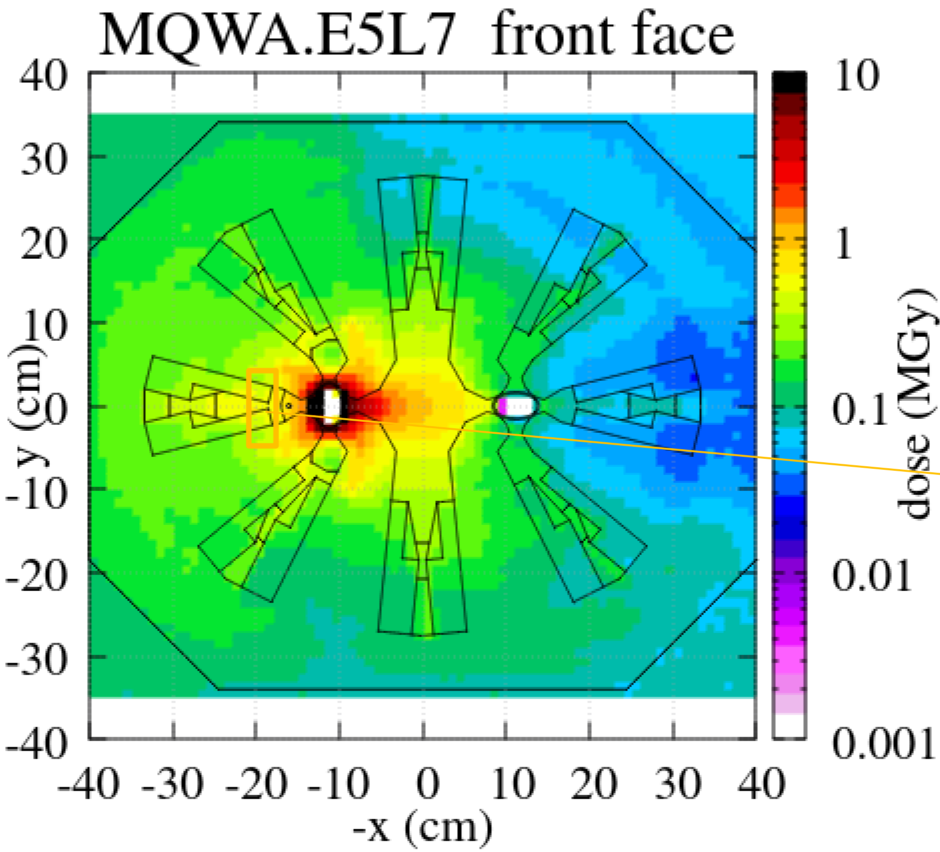


WARM QUADRUPOLES AND COIL PROTECTION

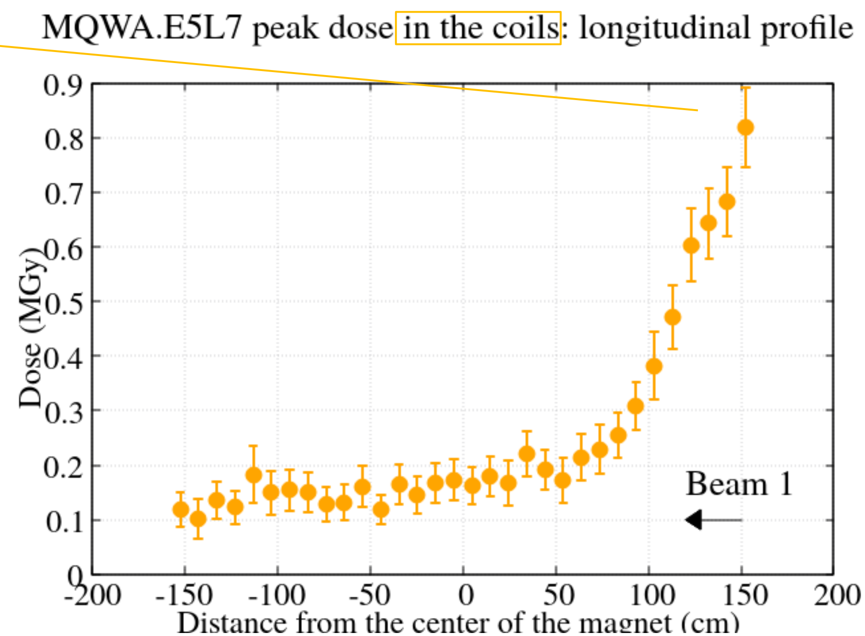




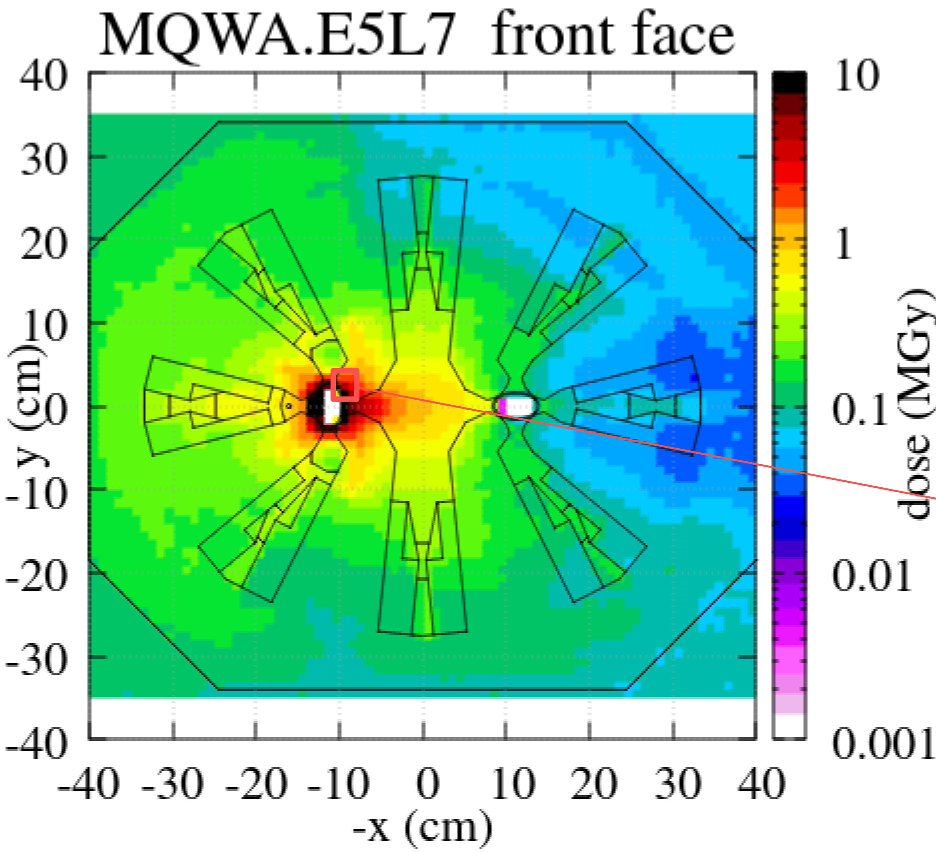
“ANNUAL” DOSE



for 1.15 10^{16} protons
on the IR7 collimators



RADIAL DEPENDENCE



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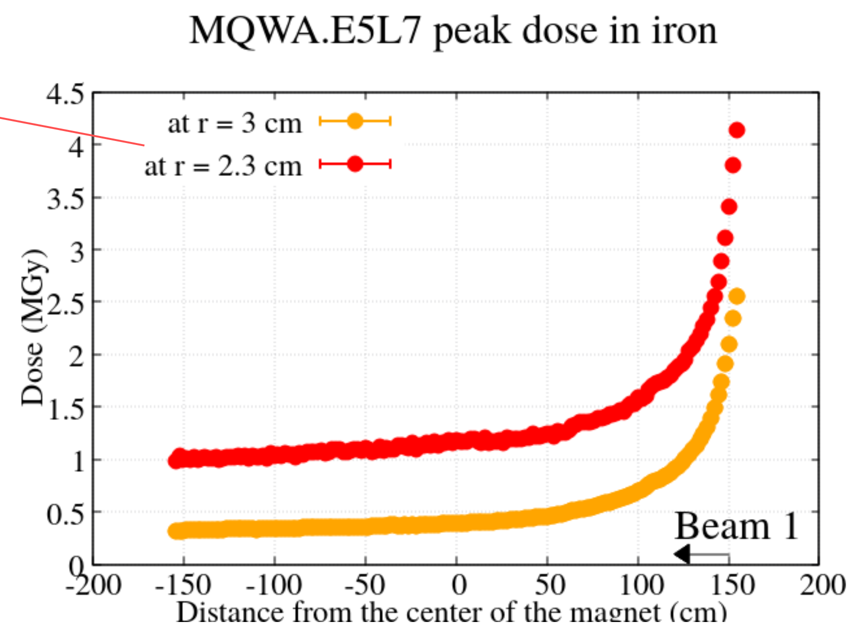


FROM DOSE TO POWER DENSITY

dose [Gy] / (1.15 10^{16} [p/y]) * instantaneous loss rate [p/s] * rho [g/cm^3] = power density [mW/cm^3]

- HE-LHC beam (2800 * 2.3 10^{11} p) lifetime of 12 minutes ➡ 9 10^{11} p/s
- rho = 8 g/cm^3

HE-LHC power density [mW/cm^3] = 620 * (LHC dose [MGy] * 2)

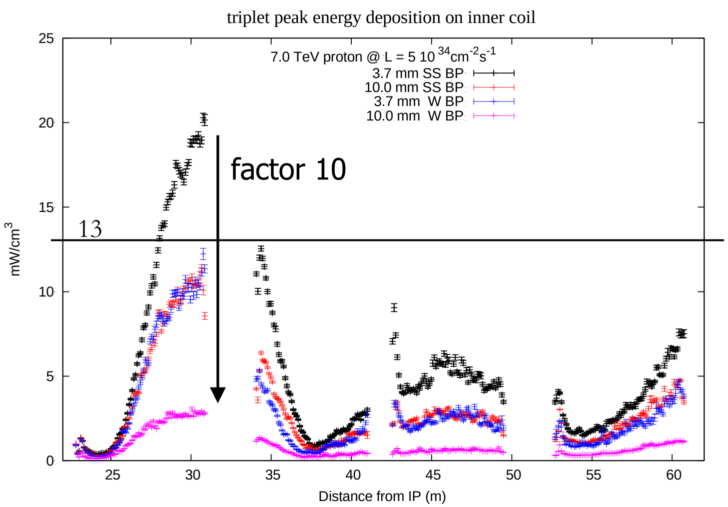
where the factor 2 tentatively reflects the beam energy doubling

One shall expect up to a few (3-5) W/cm^3 at the superconducting coil aperture in the betatron cleaning insertion, i.e. two to three orders of magnitude above the quench limit range

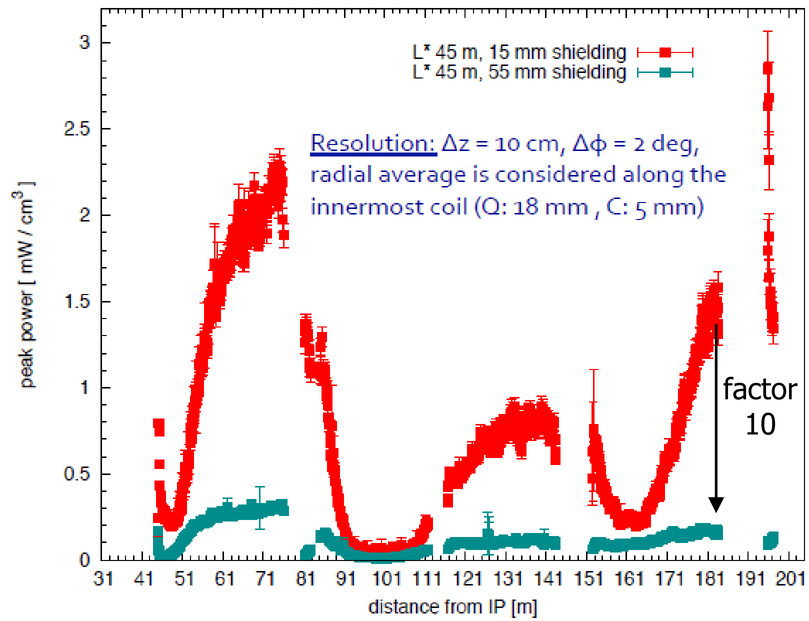
A GLIMPSE OF SHIELDING EFFECTIVENESS

studies for the HL-LHC and FCC-hh triplet protection from the collision debris

from 3.7 mm of stainless steel to 10 mm of tungsten



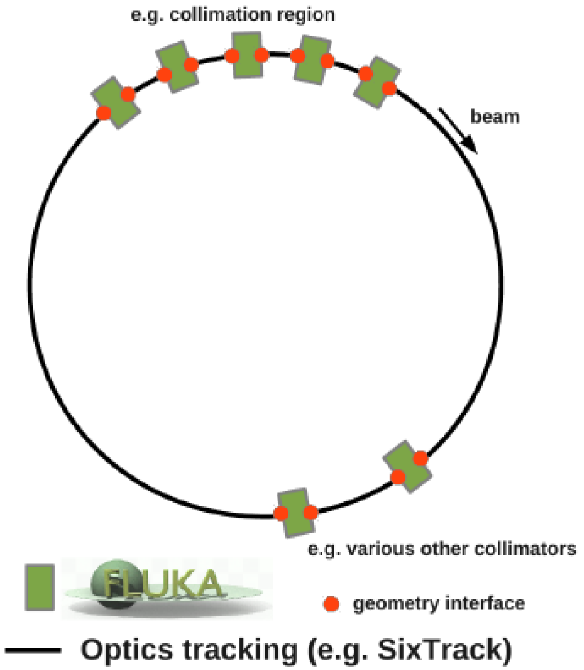
from 15 mm of tungsten to 55 mm of tungsten



SIMULATION WORKFLOW (FIRST STEP)

SixTrack/FLUKA Coupling

- *FLUKA and SIXTRACK run at the same time, talking to each other.*
- *Exchange of particles at run-time, through a network port (dedicated FlukaIO library, TCP/IP)*
- *One or more portions of the accelerator lattice are labelled for transport in FLUKA, the rest is handled by SIXTRACK.*

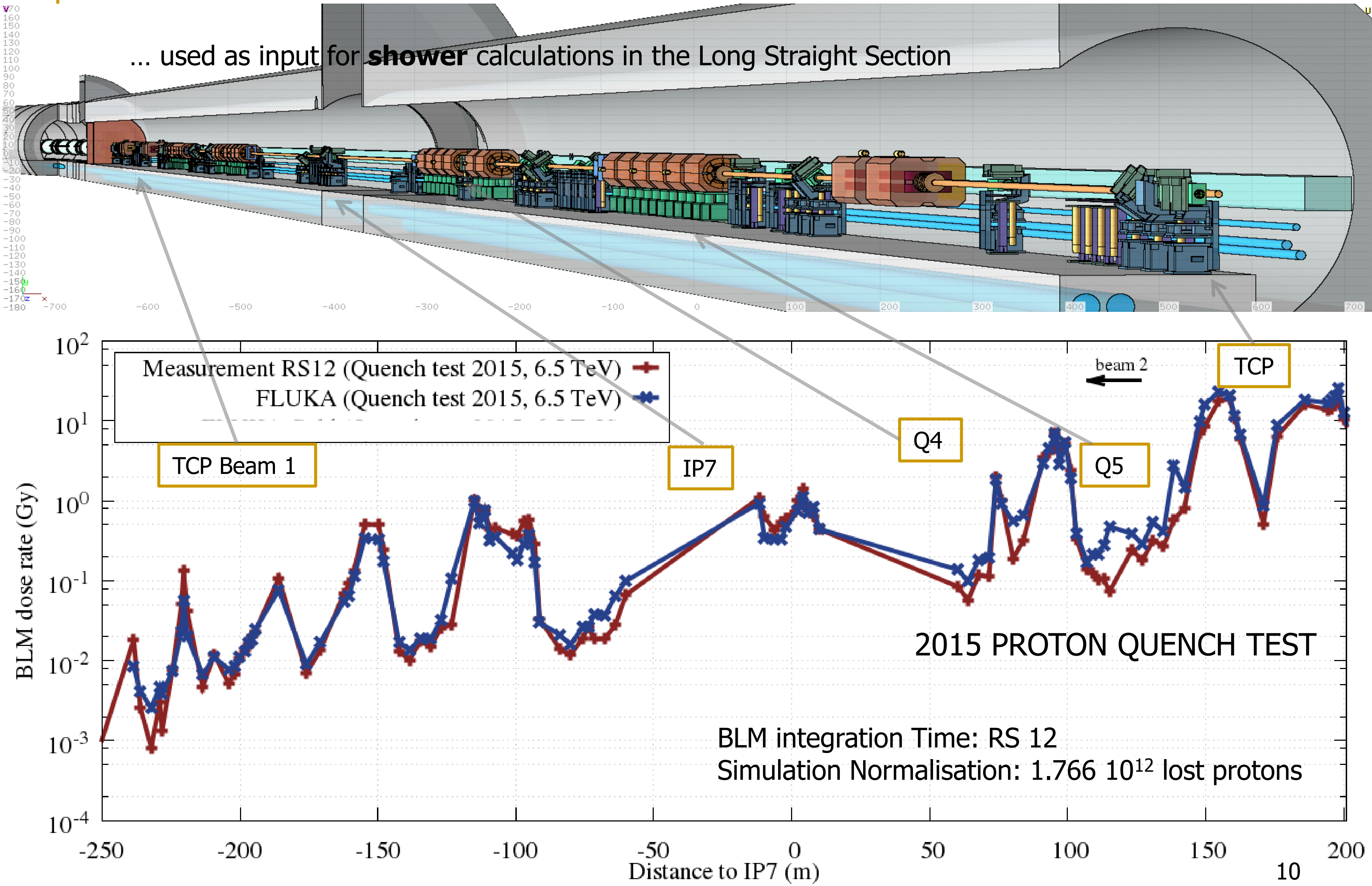


- *Primary particles are transported turn by turn by SIXTRACK throughout the lattice.*
- *When they reach a labelled element, they are transferred to FLUKA for transport in its 3D geometry and for simulating the interaction with accelerator components.*
- *At the end of the FLUKA insert, marked as a geometry interface, particles are sent back to SIXTRACK.*

through beam halo tracking, production of a map of proton impacts on the collimators surface ***(touches)*** …

SIMULATION WORKFLOW (SECOND STEP)

… used as input for **shower** calculations in the Long Straight Section



SUMMARY

- the use of superconducting magnets in the betatron cleaning insertion looks extremely challenging, implying a massive shielding heavily impacting the magnet aperture

- energy deposition studies are going to follow the validated two(three)-step simulation chain

- the close involvement of magnet designers is essential to search for a shielding solution if any (which margins for a normal conducting option?)