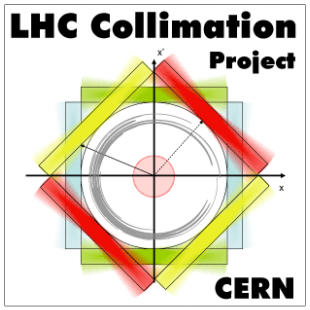

LHC COLLIMATION WORKING GROUP

November 2005

RADIATION LEVELS IN THE UJ33 TUNNEL AND DOSE LOADS TO FIBERS IN THE MOMENTUM CLEANING INSERTION (working version)

Igor A. Kurochkin IHEP, Protvino, Russia

Simulation details

Igor A. Kurochkin

- STRUCT code is used to prepare a map of primary inelastic interactions in the collimator jaws (900000 protons)
- Hadron and electromagnetic cascades development is simulated using the Monte-Carlo code MARS.
- The geometry starts at the end of DS.3L and ends up at the entrance of the DS.3R.
- Active(TCL) and passive absorbers are included in considered model
- An individual cascade starts from the inelastic nuclear interaction of a proton inside one of the collimator jaws.
- MARS prepares a map (9-D) of the cascade products at two positions: at the entrance to UP33 and at the entrance to UJ33.
- Normalization factor is to 10^{16} inelastic proton interactions per year in each Ring

Simulation strategy

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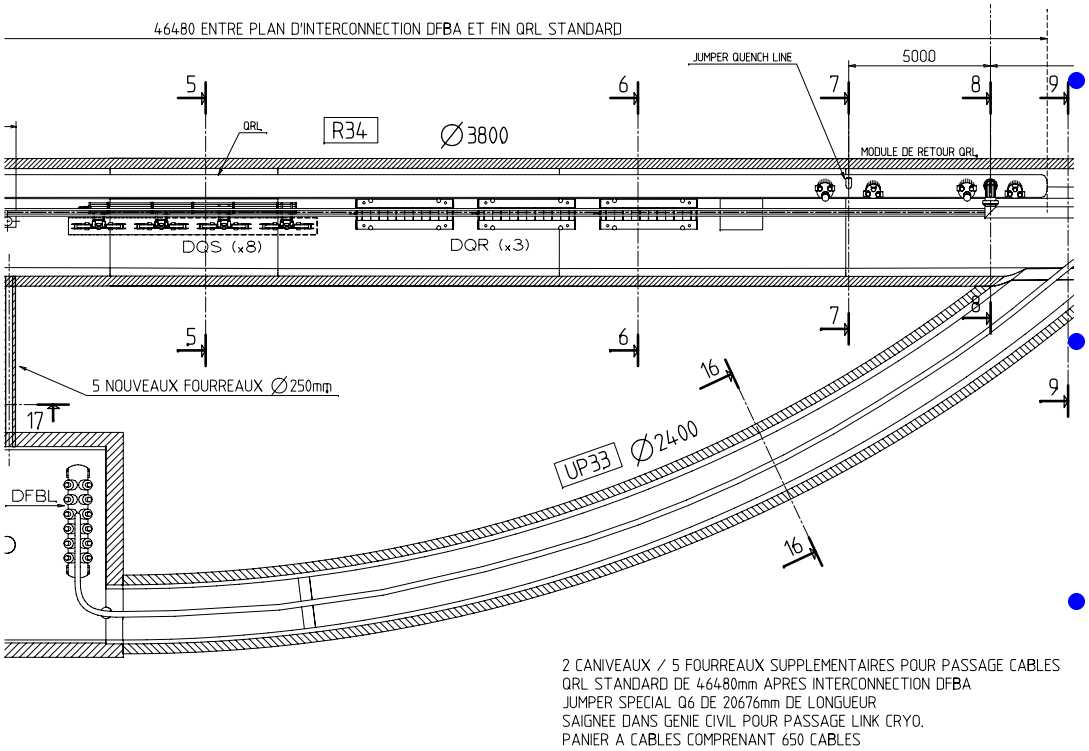
November 2005

Schematic view of the IR3, UP33 and UJ33 tunnels



- Step 1 – proton losses in IR3 (6-D map)
- Step 2 – nuclear electromagnetic cascades in IR3, hadron and low energy particles sources on entrance to UP33 (9-D map)
- Step 3 – nuclear electromagnetic cascades in UP33, hadron and low energy particles sources on entrance to UJ33 (9-D map)
- Step 4 – nuclear electromagnetic cascades in UJ33, energy deposition, hadron and low energy neutron fluence

Simulation strategy

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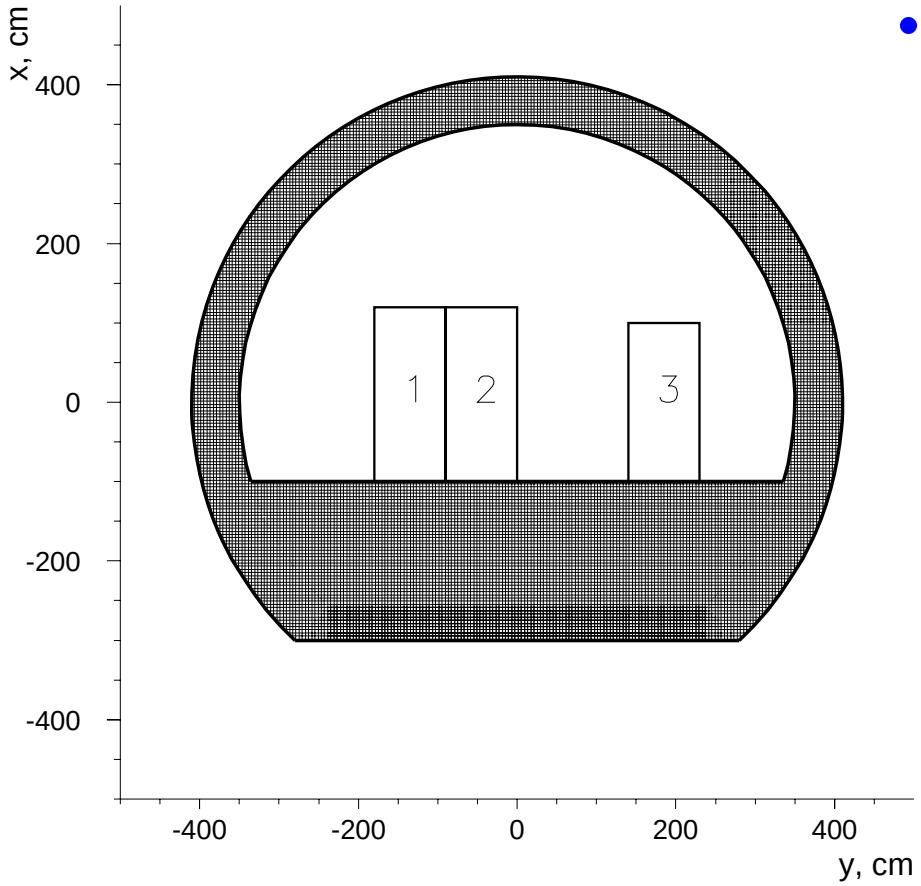
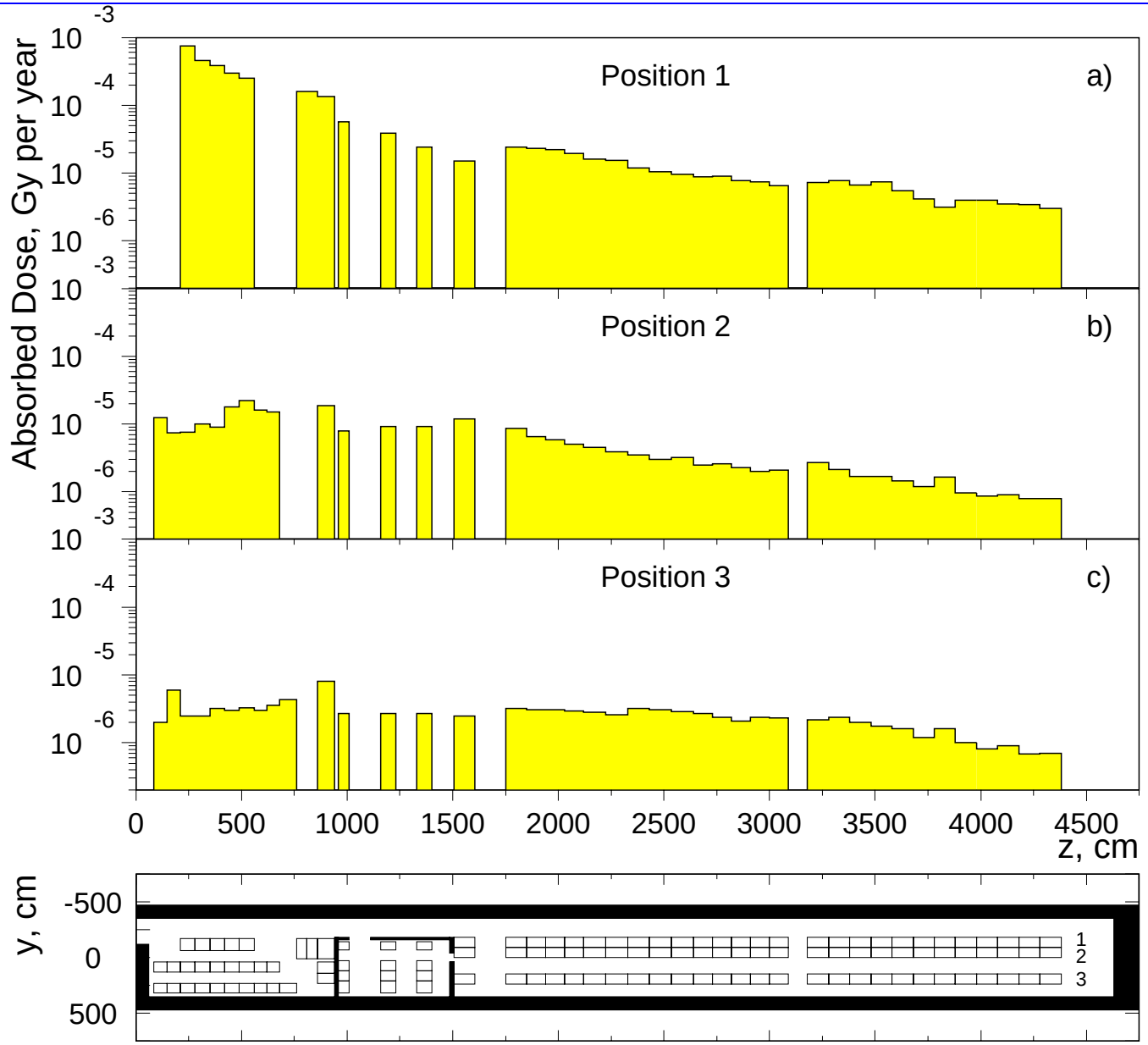
Schematic XY-cut of the UJ33 tunnel with electronic racks locations



- Characteristics of the radiation field in UJ33:
  - D – total absorbed dose in Gy per year
  - Fh – hadron fluence with E$\geq$20 MeV
  - F_{eq1MeV} – “1 MeV neutron equivalent” fluence on base of NIEL approach for silicon

Dose loads to electronics

Igor A. Kurochkin



Hadron fluence

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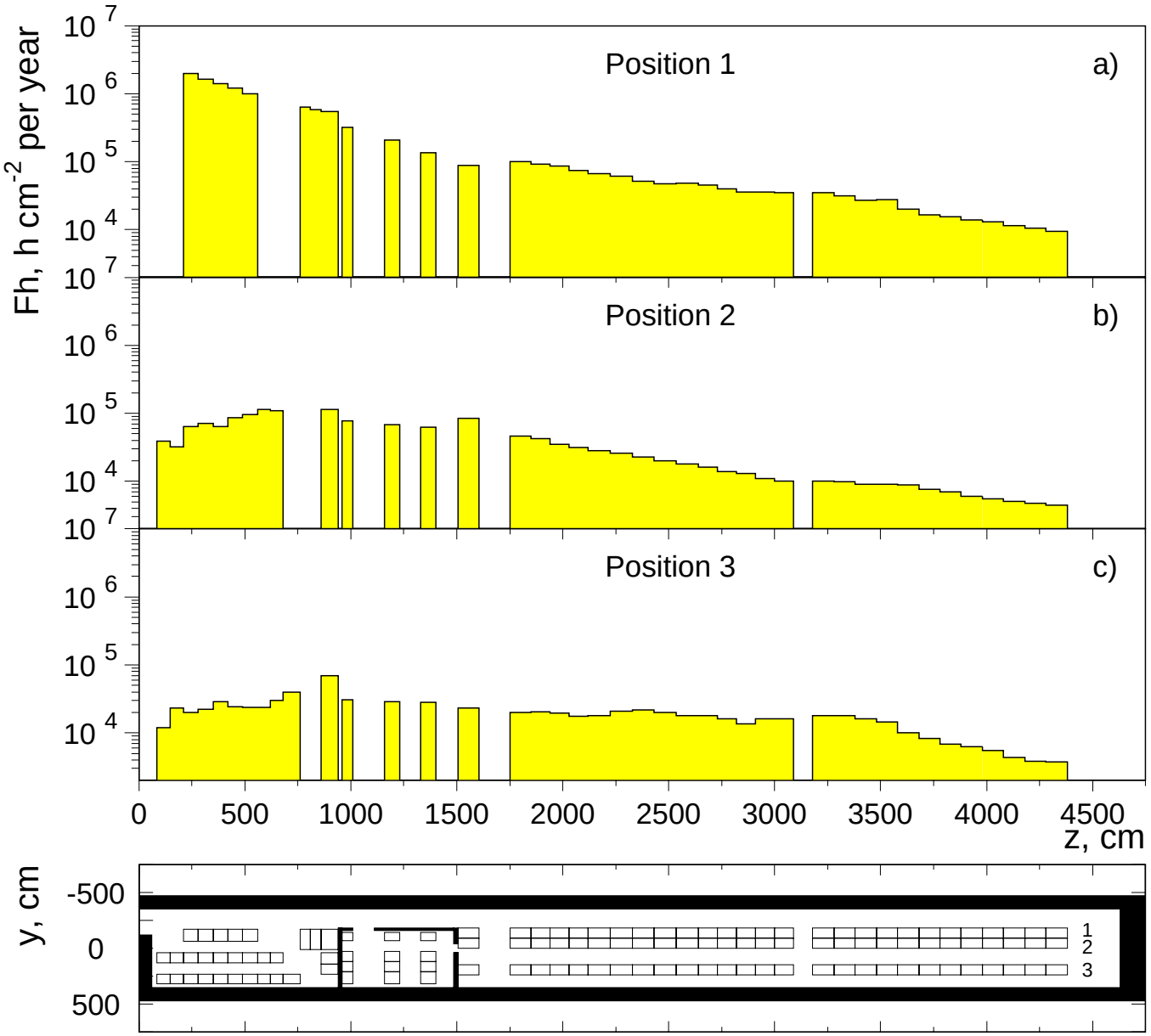
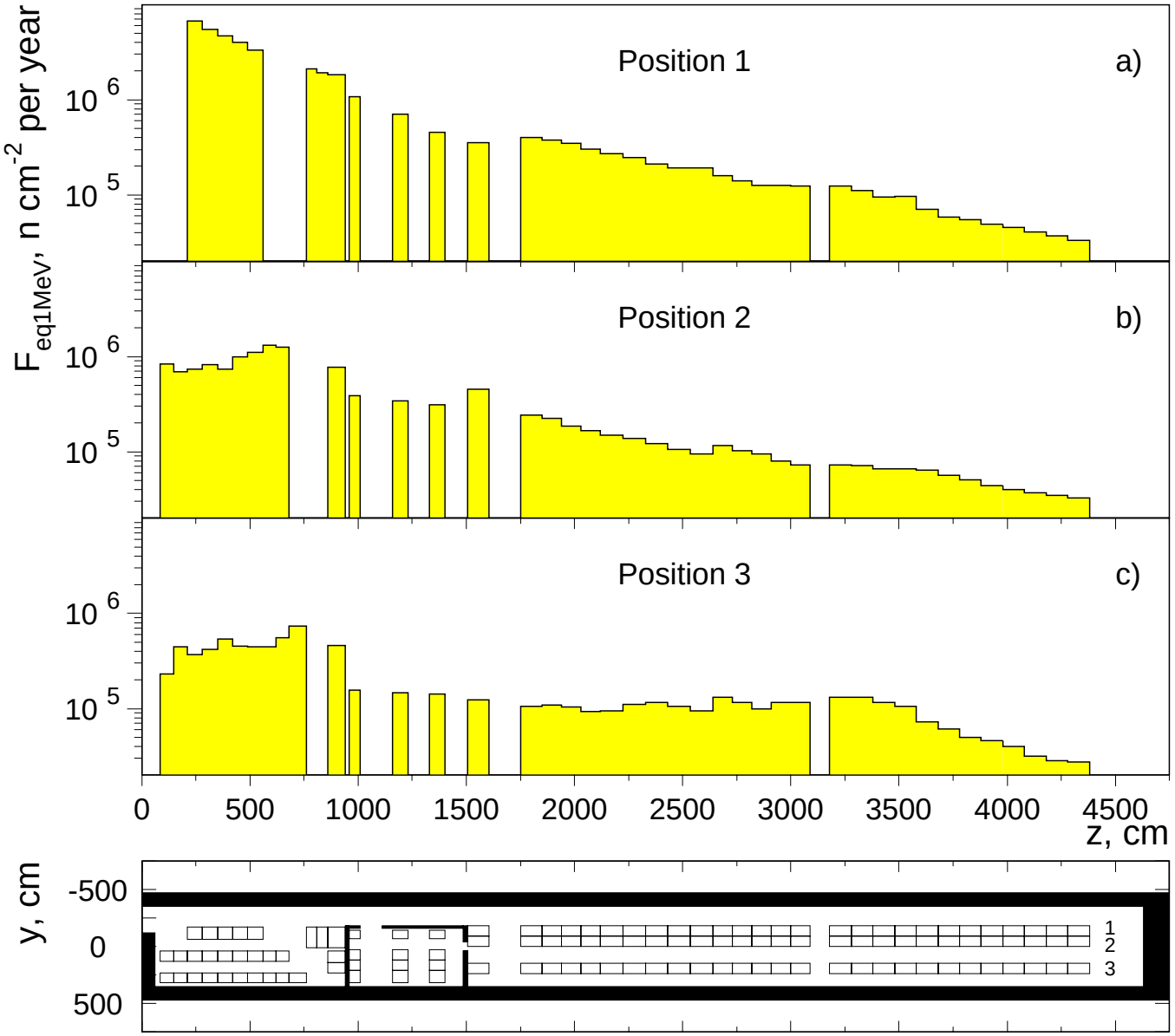
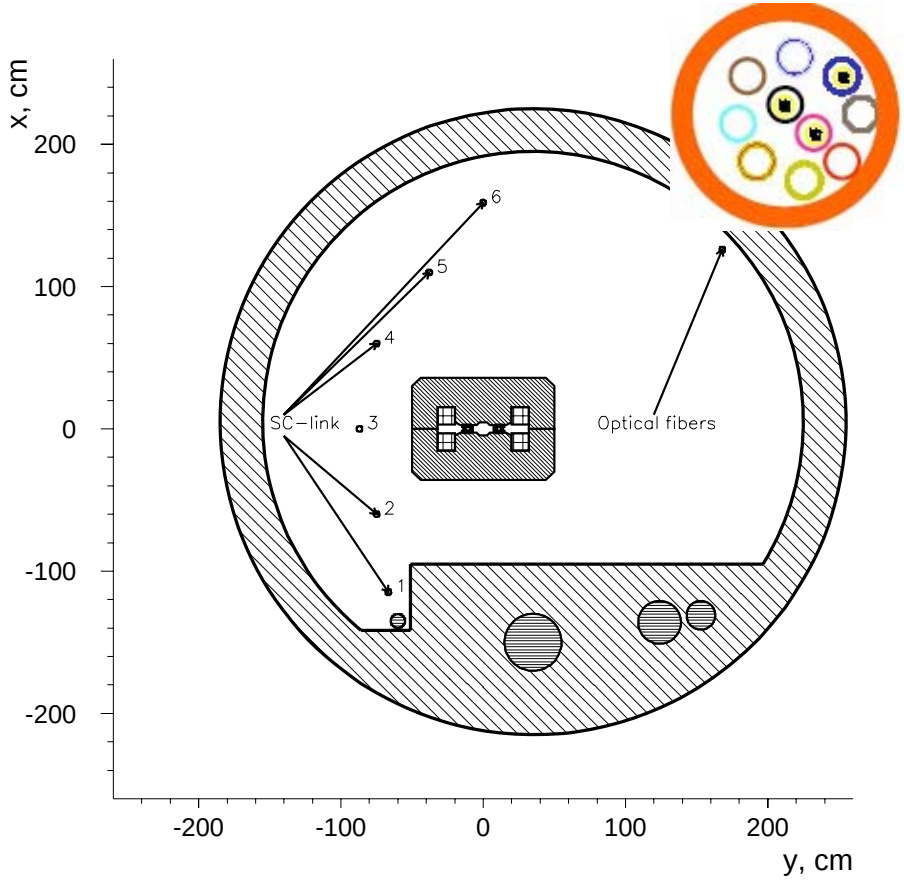


1 MeV neutron equivalent fluence

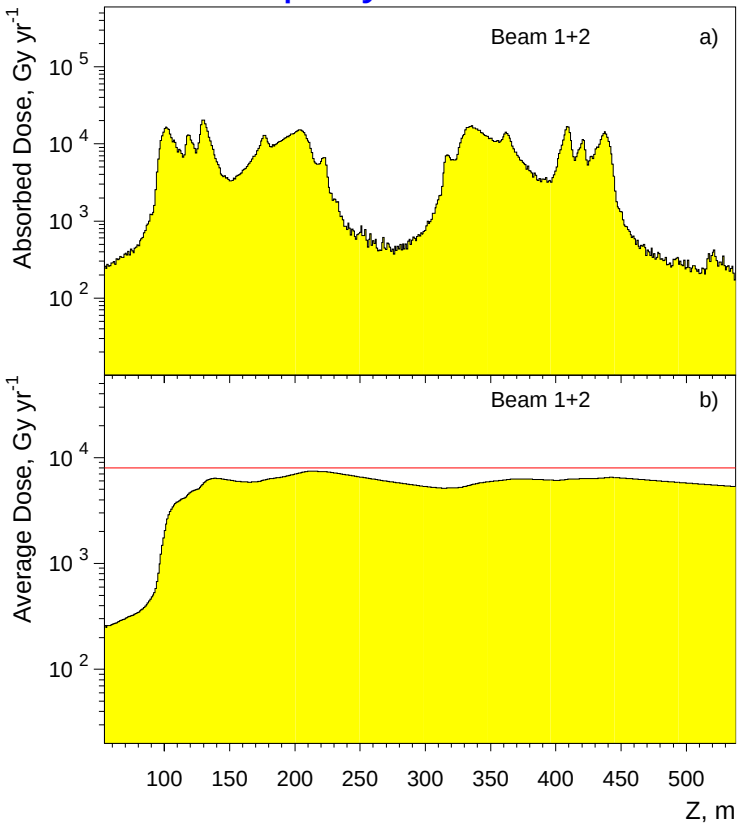


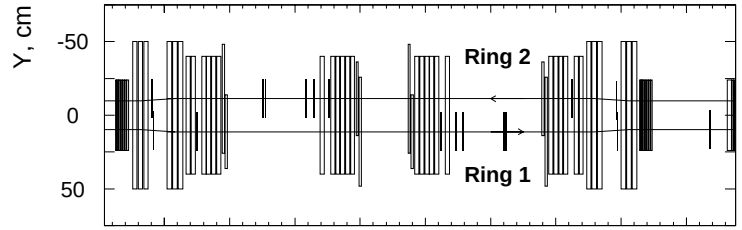
Absorbed dose to fibers

∅ 40 mm duct with 10 x ∅ 7 mm tubes,
10 x 24 = 240 optical fibers



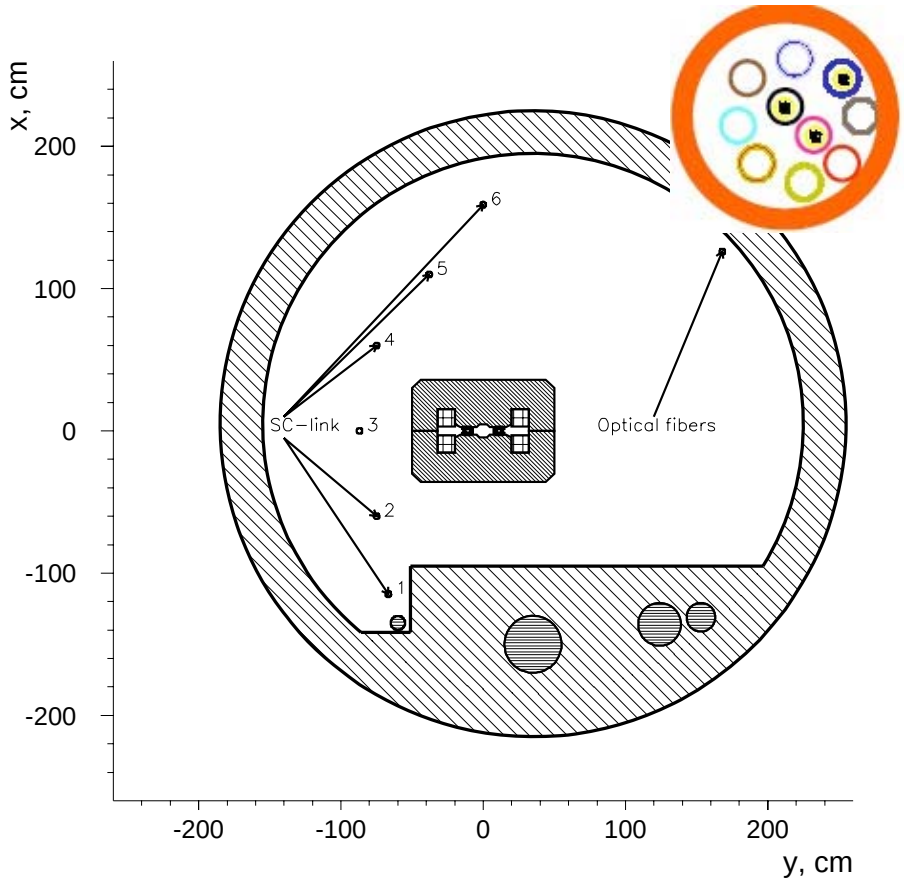
Absorbed dose is normalized to 10^{16} inelastic proton interactions per year



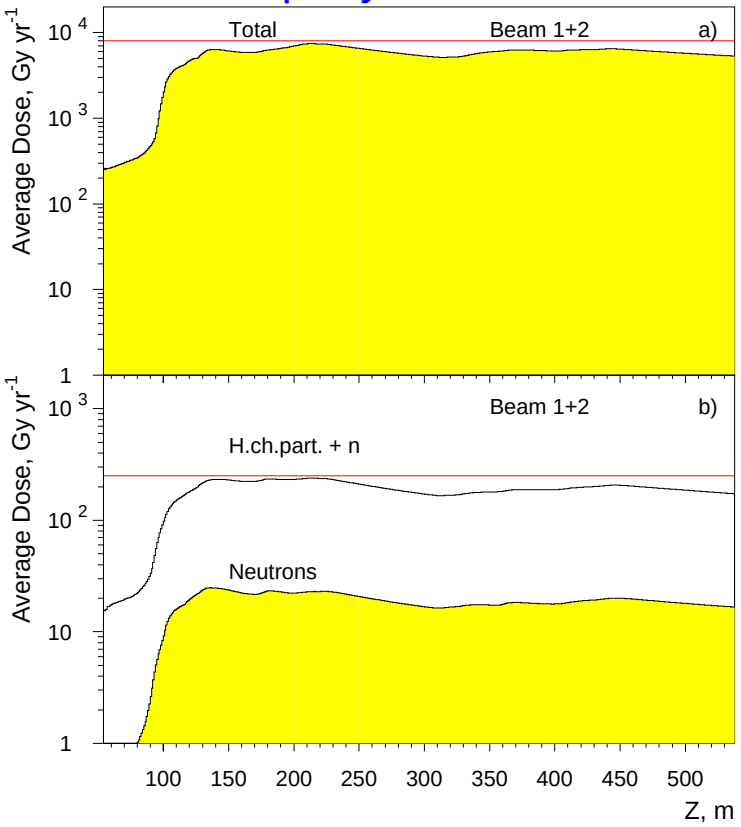


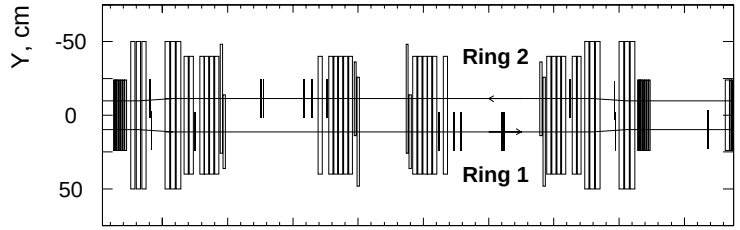
Partial dose to fibers

∅ 40 mm duct with 10 x ∅ 7 mm tubes,
10 x 24 = 240 optical fibers



Absorbed dose is normalized to 10^{16} inelastic proton interactions per year





Estimations of dose in fibers

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Annual total number(per one ring) of protons lost in the IR3 $[M.Lamont]$

- First year – $8.0 \cdot 10^{14}$
- Nominal case – $3.15 \cdot 10^{15}$
- Ultimate case – $5.0 \cdot 10^{15}$

Dose, Gy$\cdot yr^{-1}$	First year	Nominal	Ultimate
Total	640	2500	4000
H.ch.part.+n	24	94	150
only n	2.0	7.9	12.5

Summary

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- Dose loads to electronics do not exceed values of 0.001 Gy per year
- Maximal hadron fluence at the electronic racks reaches $2 \cdot 10^6$ h cm^{-2} per year
- 1 MeV neutron equivalent fluence is in average one order higher than hadron fluence (maximum doesn't exceed $7 \cdot 10^6$ n cm^{-2} per year).
- High level of average dose to fibers along IR3 (about 2.5 KGy and 4 KGy per year for nominal and ultimate cases, respectively)