



# Radiation levels in IR7

Katerina Tsoulou

Alfredo Ferrari, Vasilis Vlachoudis,  
Mario Santana, Matteo Magistris

RADWG-RADMON Workshop, CERN 01/12/04

---

# Outline

- Motivation
- Geometry and layout
- Results for UJ76/RR73/RR77
- Shielding Studies
- Summary

# Motivation

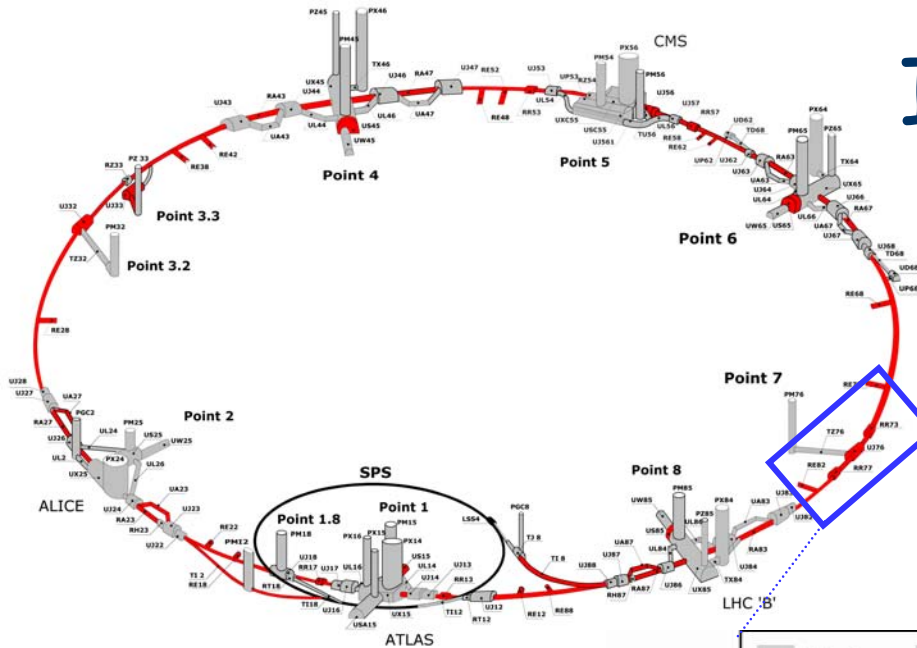
IR7 is the betatron cleaning section

- Energy load on magnets  
(quench - activation - heating - damage)
- Energy/Heat load on collimators
- ...
- Radiation levels on UJ76 and RR73/77

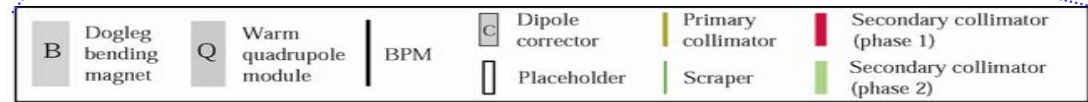
It will be the hottest region in LHC !

Electronics might suffer very high radiation levels...

# IR7 layout

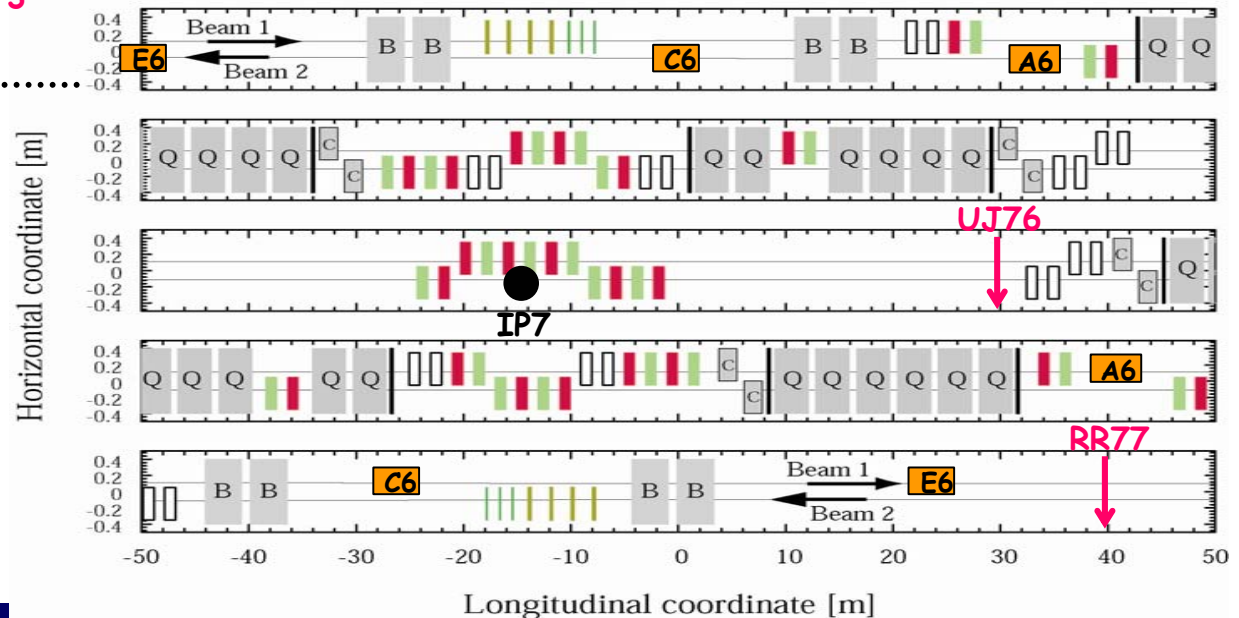


- ✓ LHC lattice and optics files V6.5
- ✓ Primary and Secondary collimators, Scrapers, Absorbers



Normal operation  
 0.2 hours beam lifetime  
 →  $4 \times 10^{11}$  p/s for 10 s

RR73



# Simulation

- ✓ Using the FLUKA Monte Carlo Code
- ✓ Radiation Source: proton losses on collimators
- ✓ For Phase 1 Collimation: Performance and collimator design
- ✓ For latest optics layout (V6.5)

! Aim of current study:

Protection of electronics (UJ76/RR73/RR77)

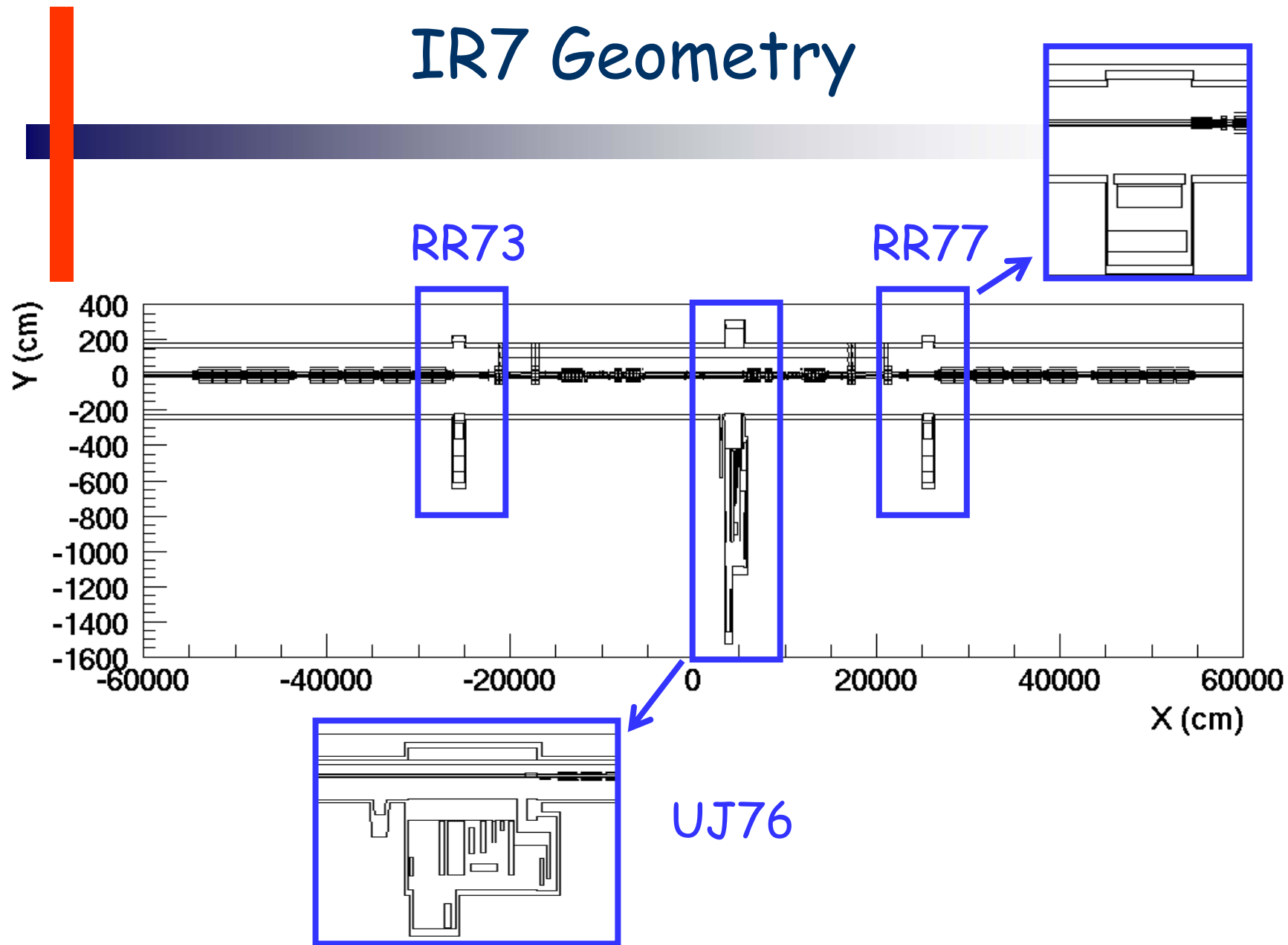
→ Without any absorbers in the layout

→ With 3 absorbers per beam (A6vC6hE6v) → *realistic case!*

Scaling Factor:  $4.1 \times 10^{16}$  protons lost/year

(for 15 hours fill length, at 7 TeV equivalent)

# IR7 Geometry



# Results for NoAbsorber Case

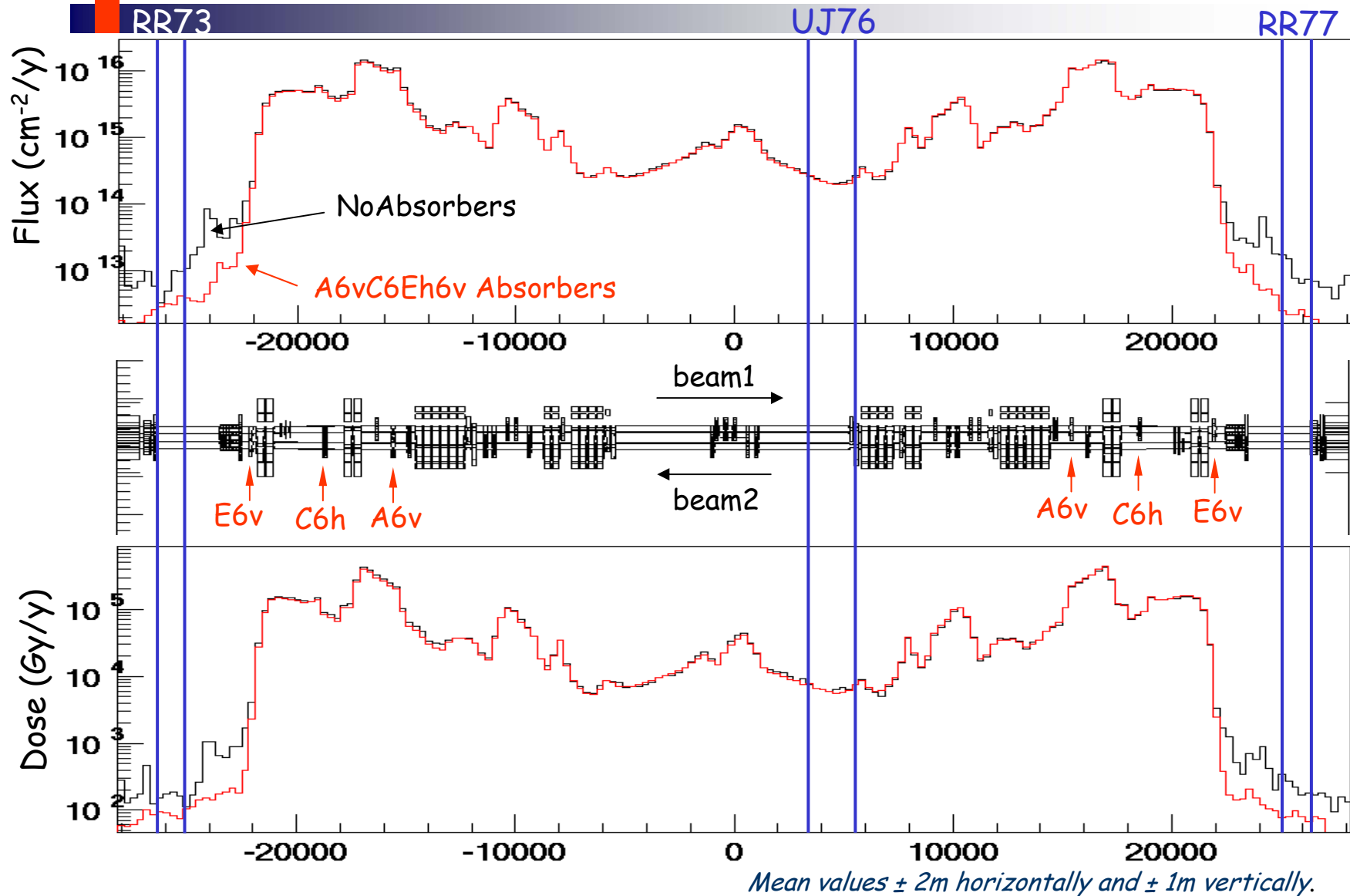
	Dose (Gy/y)	Mean values at both levels (cm <sup>-2</sup> /y)	
		1MeVeq.	Hadrons >20MeV
UJ76	≤ 5	2.0 E+09	9.0 E+08
RR73/77	≤ 50	2.0 E+10	7.0 E+09



In the RRs ~100 times higher levels than those in IR1/5\* !  
Immediate action for shielding is required !  
What about WithAbsorbers ?

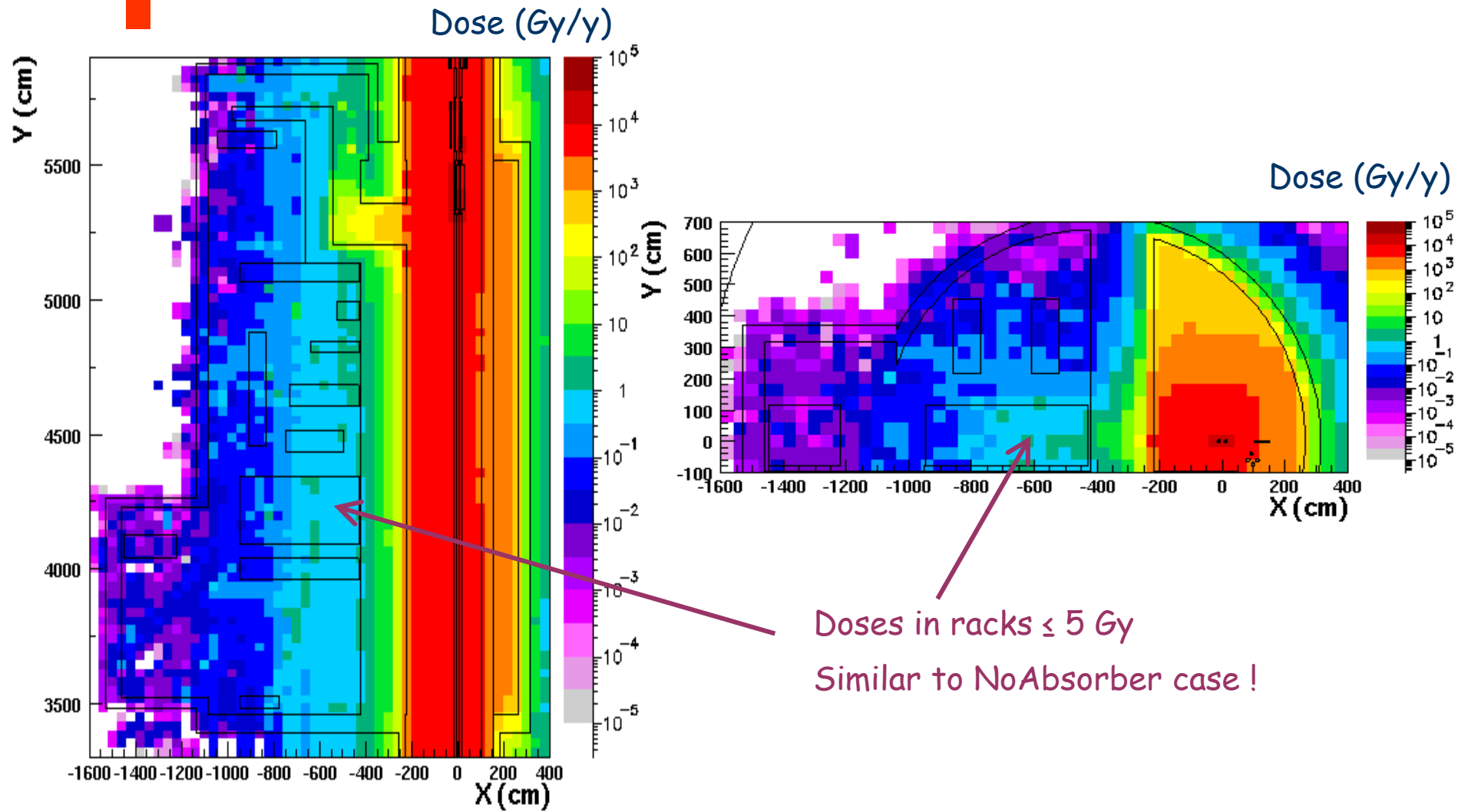
\* [I.Baishev, [http://lhc-radwg.web.cern.ch/lhc-radwg/LHC\\_Radiation\\_Studies/RR\\_IB1404.pdf](http://lhc-radwg.web.cern.ch/lhc-radwg/LHC_Radiation_Studies/RR_IB1404.pdf) (2003)]

# NoAbsorber vs. Absorber (tunnel)



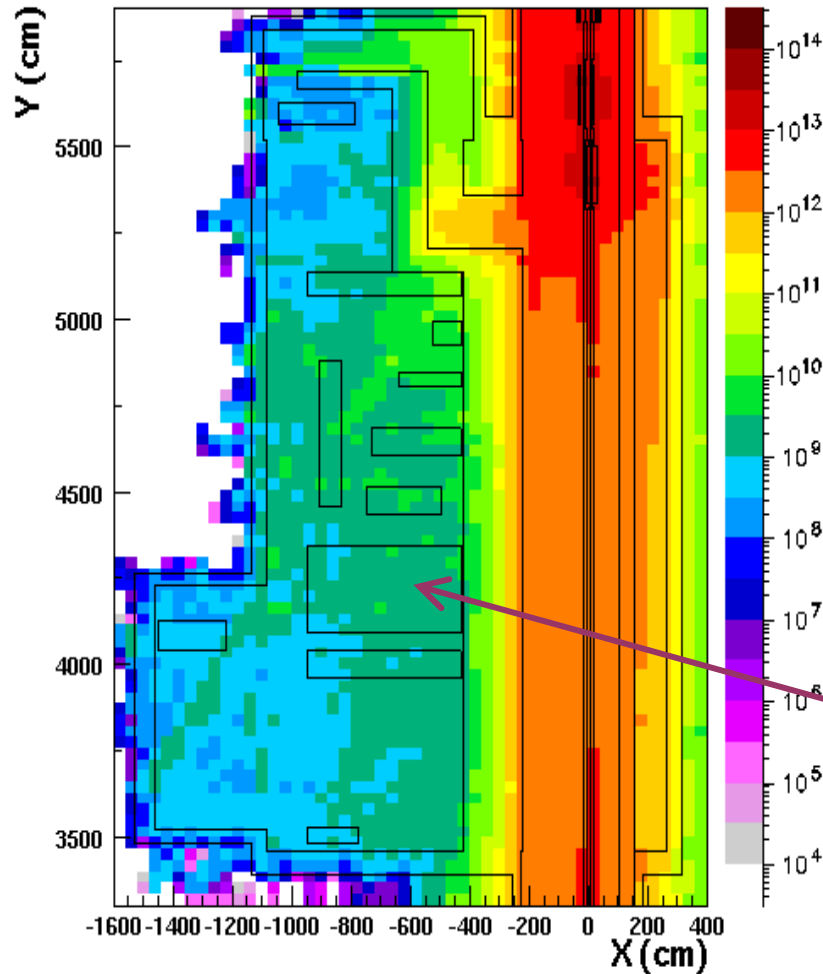


# Three Absorber Case for UJ76

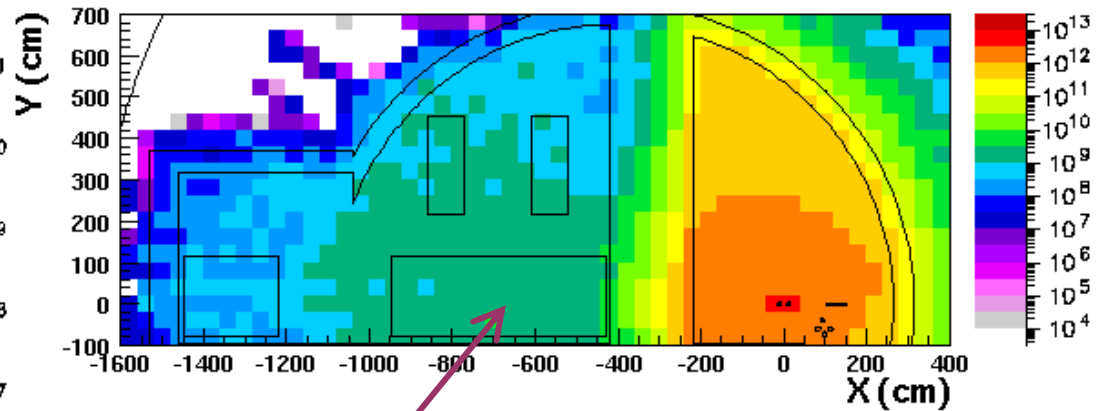


# Three Absorber Case for UJ76

1MeVeq flux (cm<sup>-2</sup>/y)



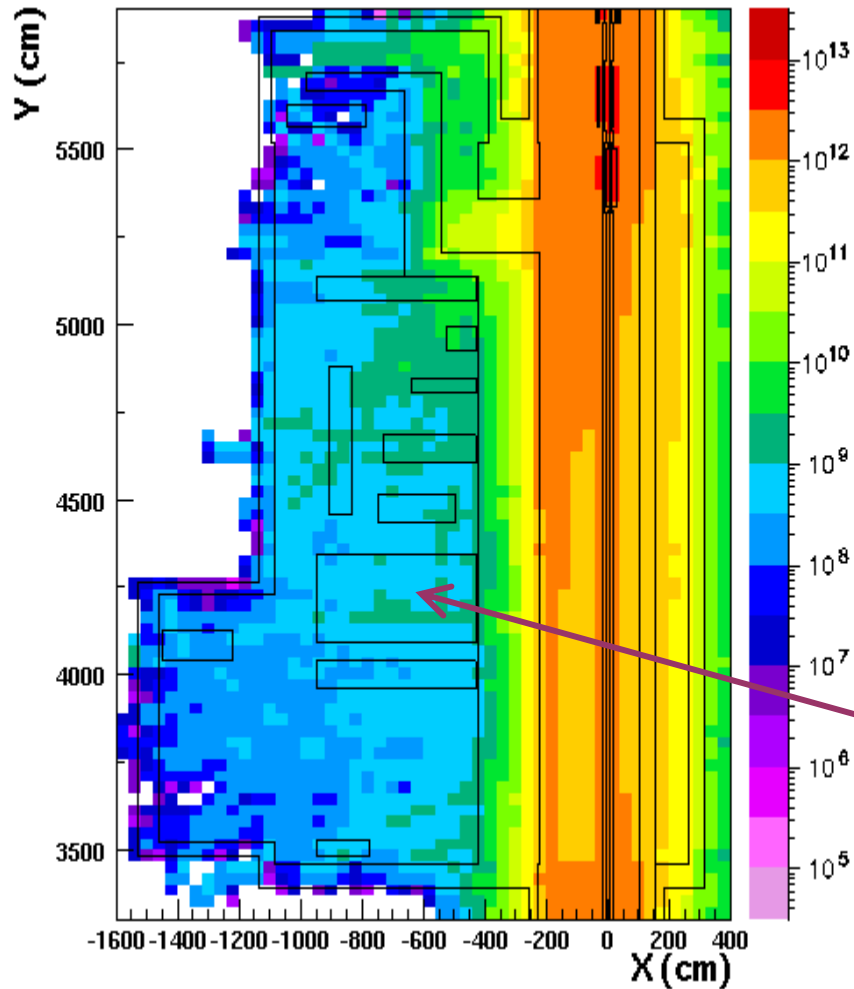
1MeVeq flux (cm<sup>-2</sup>/y)



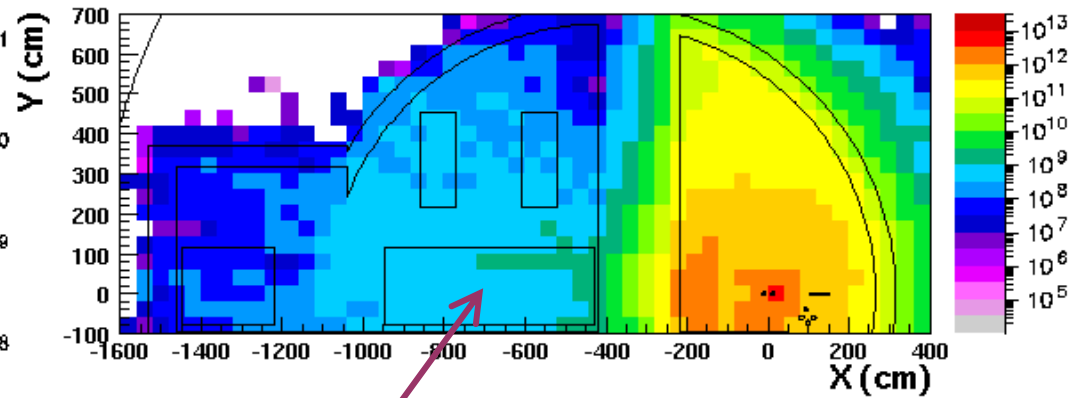
1MeV neutron equivalent  
fluence in racks ~ 10<sup>9</sup> cm<sup>-2</sup>/y  
Similar to NoAbsorber case !

# Three Absorber Case for UJ76

Hadrons > 20MeV flux (cm<sup>-2</sup>/y)



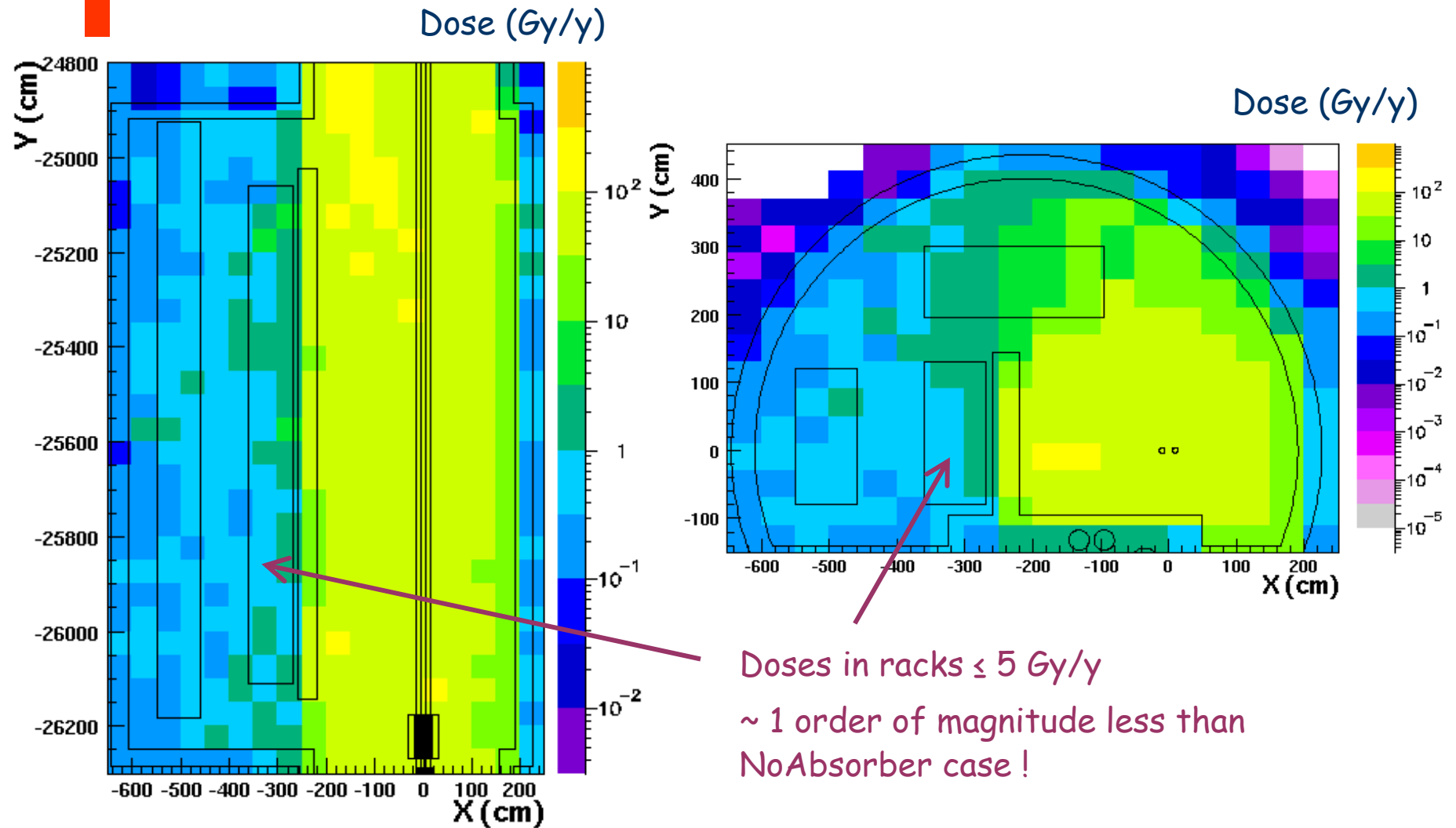
Hadrons > 20MeV flux (cm<sup>-2</sup>/y)



Hadrons > 20 MeV  
in racks  $\sim 5 \times 10^8$  cm<sup>-2</sup>/y  
Similar to NoAbsorber case !

# Three Absorber Case for RR73

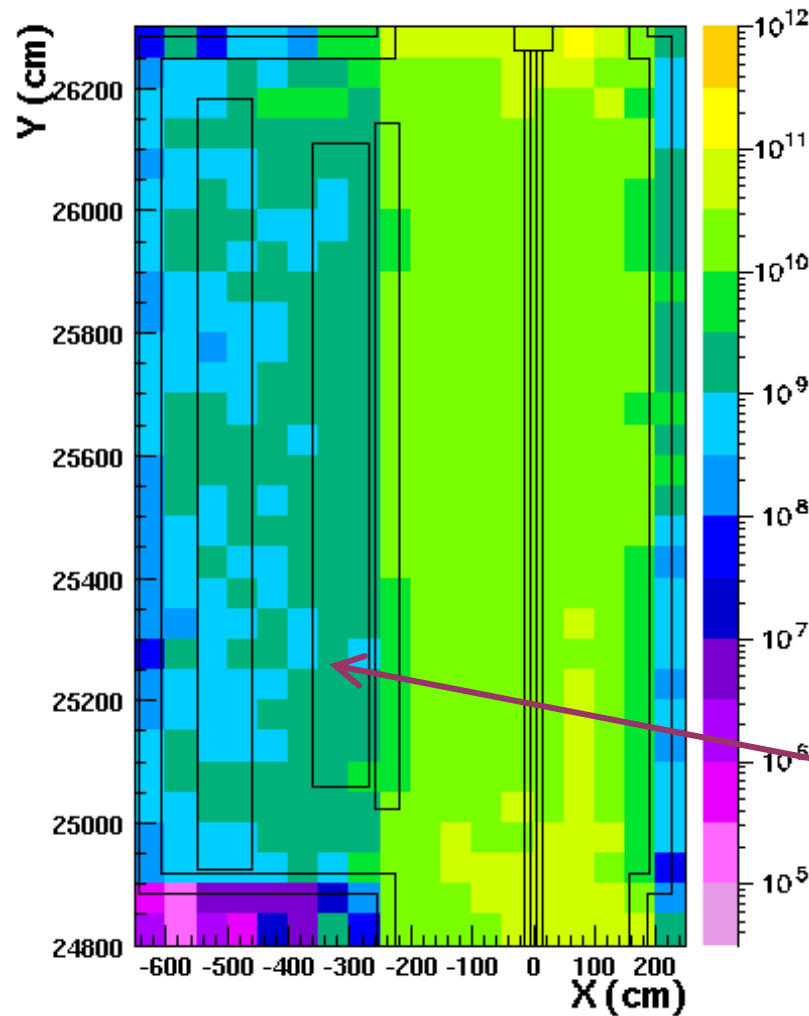
Similar values for RR77



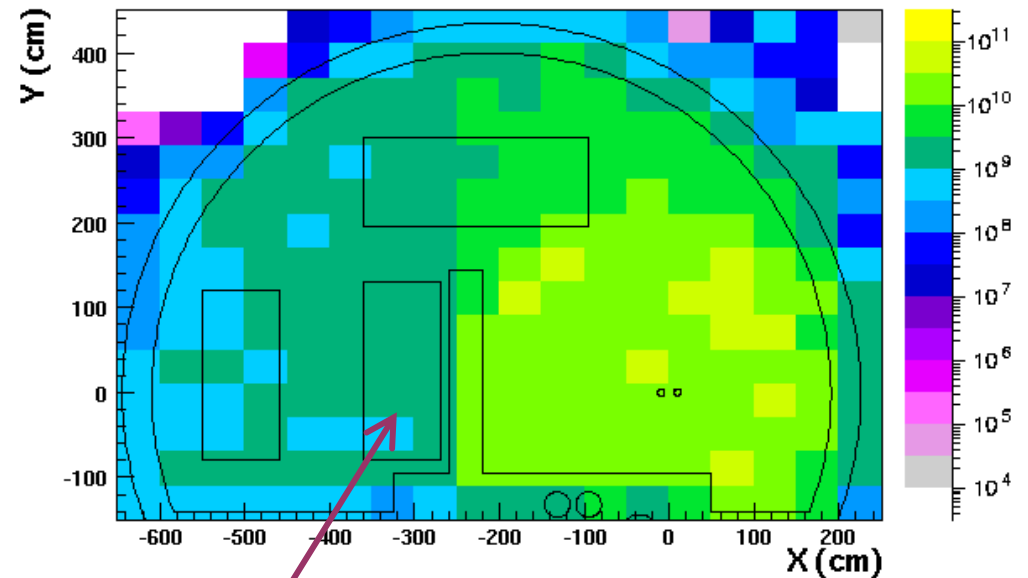
# Three Absorber Case for RR73

Similar values for RR77

1MeVeq flux (cm<sup>-2</sup>/y)



1MeVeq flux (cm<sup>-2</sup>/y)



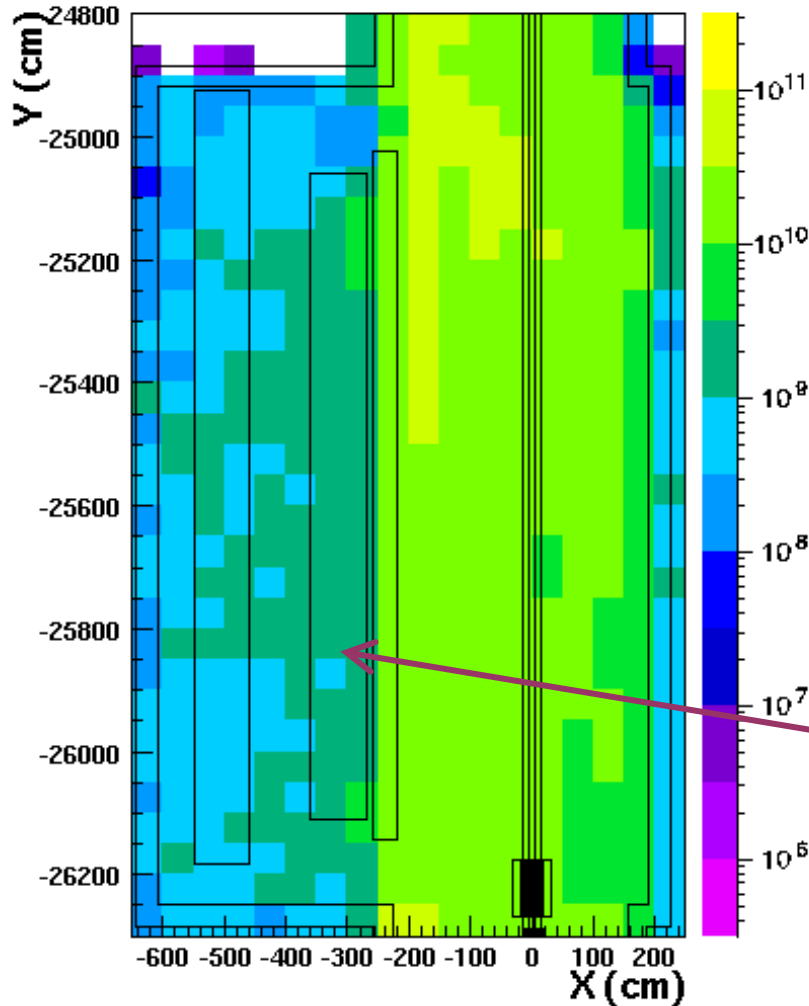
1MeV neutron equivalent flux  
in racks ~ 10<sup>9</sup> cm<sup>-2</sup>/y

~ 1 order of magnitude less than  
NoAbsorber case !

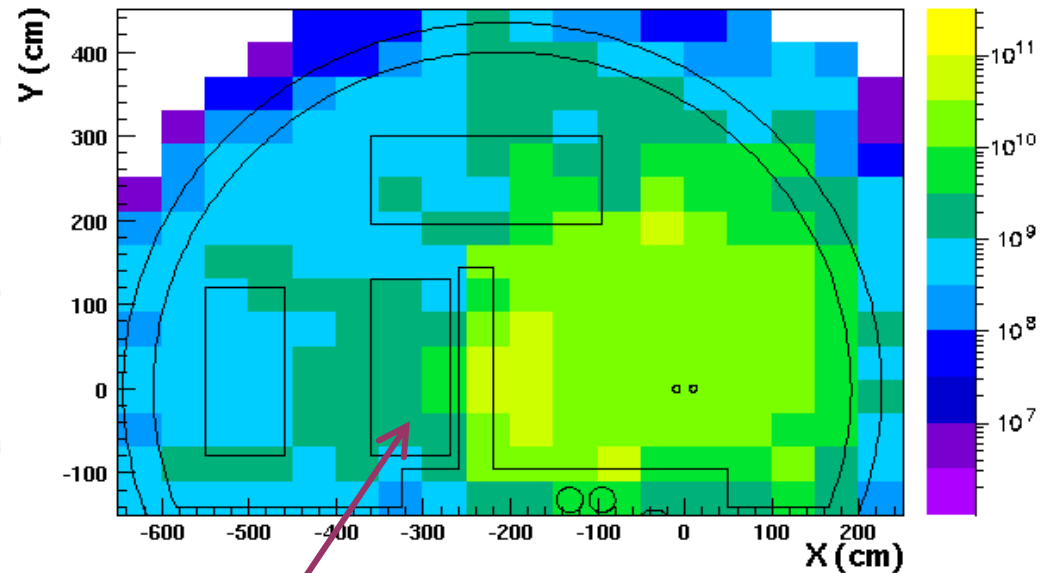
# Three Absorber Case for RR73

Similar values for RR77

Hadrons > 20MeV flux (cm<sup>-2</sup>/y)



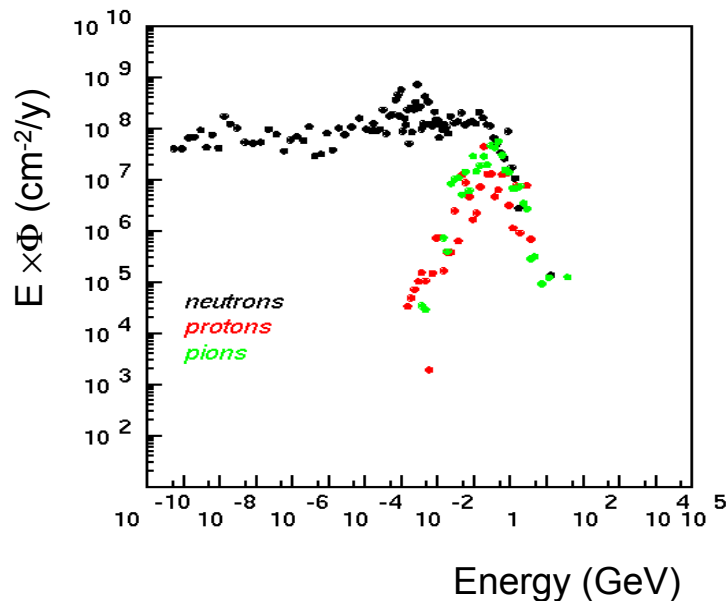
Hadrons > 20MeV flux (cm<sup>-2</sup>/y)



Hadrons > 20 MeV in racks  $\leq 10^9$  cm<sup>-2</sup>/y  
~ 1 order of magnitude less than  
NoAbsorber case !

# RR73/77 - Mean Particle Flux & Particle Spectra

	Dose (Gy/y)	Mean values at both levels (cm <sup>-2</sup> /y)	
		1MeVeq.	Hadrons >20MeV
UJ76	≤ 5	1.0 E+09	5.0 E+08
RR73/77	≤ 5	1.0 E+09	6.0 E+08



~ 1 order of magnitude  
less radiation in RRs  
than in NoAbsorber case

# Is shielding needed?

Safe limits for the RRs:

Dose:  $\sim 0.1$  Gy/year

Hadrons  $>20$ MeV:  $\sim 1 \times 10^8$  cm<sup>-2</sup>/y

*[by T.Wijnands, Collimation WG meeting 19/11/04]*

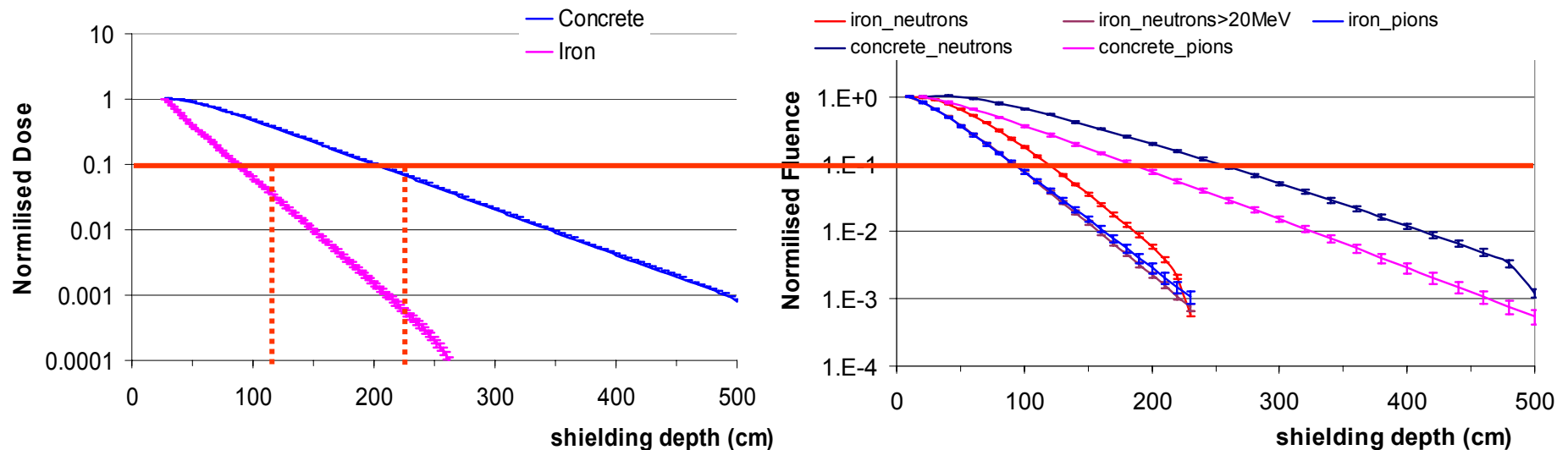
Taking into account a safety factor of (at least) **3**  
we are well above the above limits...

A shielding study is essential to assure the  
functionality of the RR electronics !



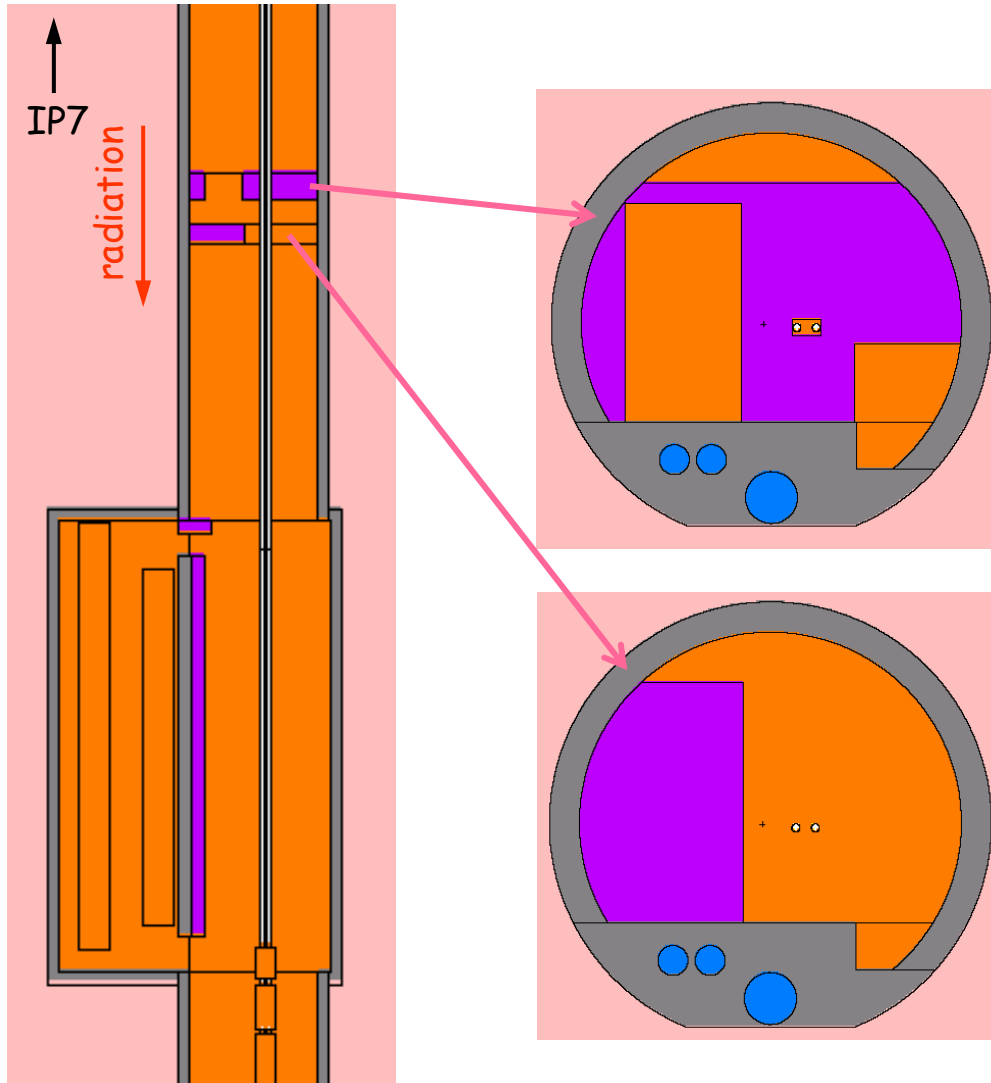
# Shielding study

To estimate the thickness of the shielding needed we scored all the particles coming into the RRs. The attenuation of the those fluences and doses were studied separately on a shielding slab.



for a reduction of ~1 order of magnitude we will need ~1m of iron

# Shielding for the RRs



This shielding scenario is already implemented in the IR7 geometry.

We are now waiting for the results...

# Summary

- IR7 simulation studies for the radiation levels in the UJ76/RR73/RR76 have finished for the ThreeAbsorber (A6vC6hE6v) case.
- The RR dose levels have been found at  $\leq 5$  Gy/y and the hadrons  $>20$ MeV at  $\leq 10^9$  cm<sup>-2</sup>/y (an order of magnitude less than the NoAbsorber case).
- With a safety factor  $\geq 3$  these levels are considered as non-safe.
- The implementation of extra shielding for the RRs is being studied in order to achieve  $\sim 1$  order of magnitude further reduction.