

---

# LHC MACHINE CONDITIONS

*Francesco Cerutti & Marta Sabaté Gilarte §*



*§ and University of Sevilla*

Forward Spectrometer meeting

vidyo

Apr 16<sup>th</sup>, 2020

---

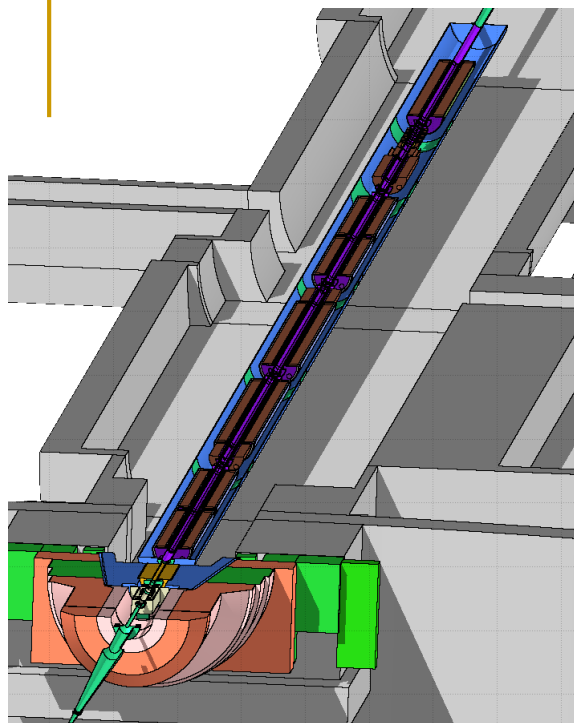
# OUTLINE

- The HL layout, as modeled in FLUKA
- **Proton-proton collision debris** figures and benchmarked impact
- Radiation levels across the Long Straight Section
- The TAXN region and its particle field
- The D1 side and the effect of a magnetized iron toroid

# HL IR5

7 TeV proton beams

250 urad half crossing angle in the vertical plane



↑  
Triplet – D1

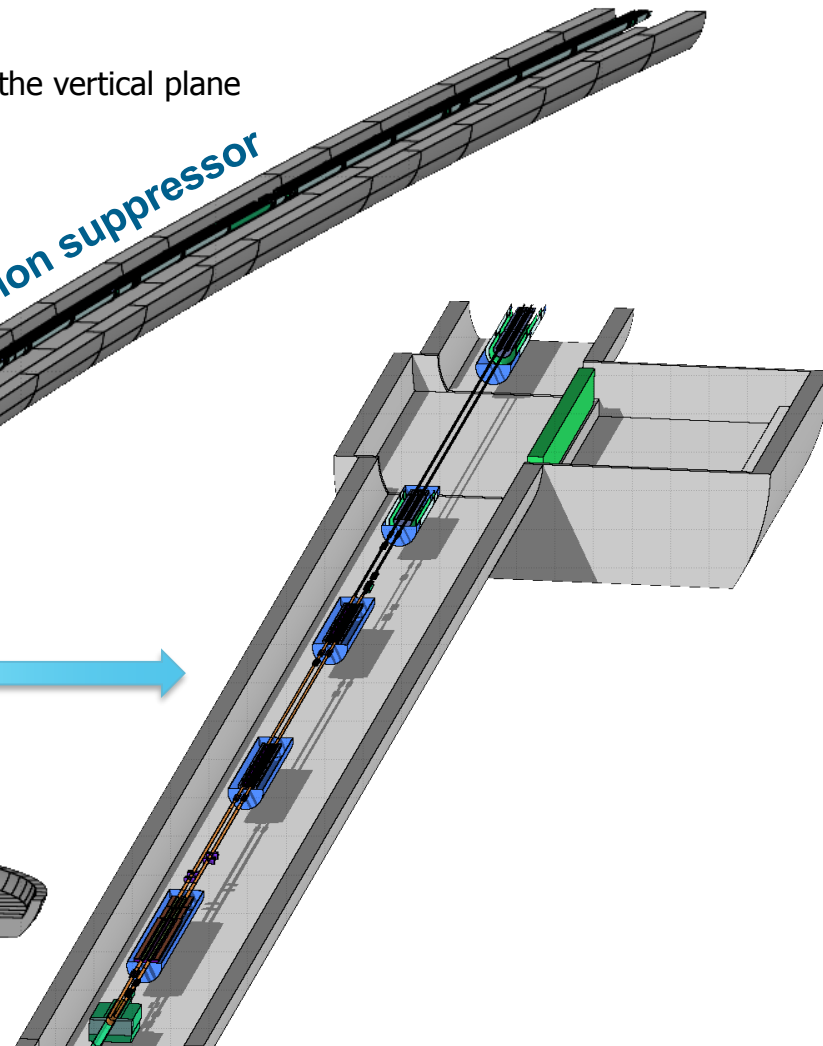
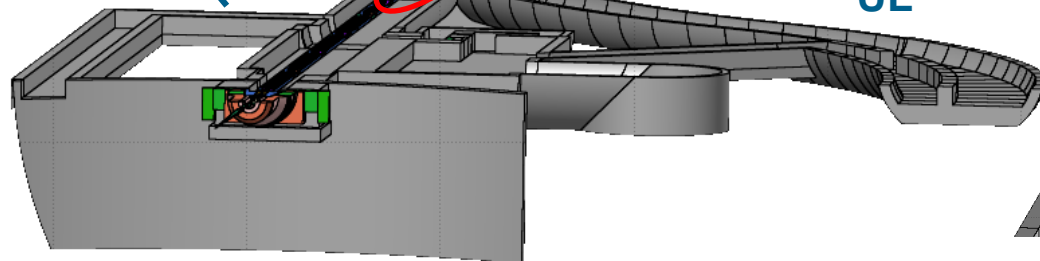
Matching section

Dispersion suppressor

RR

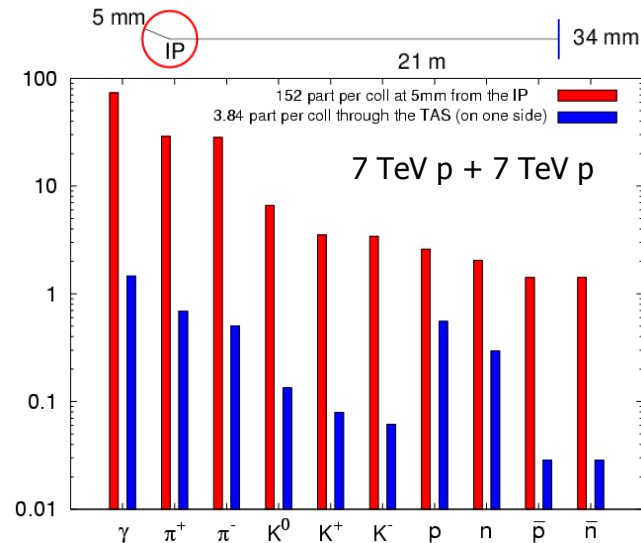
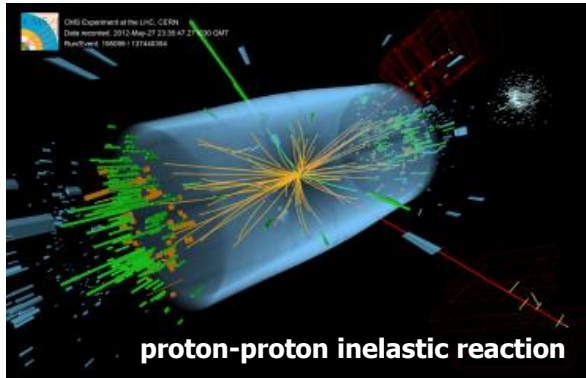
UJ

UL



Experimental cavern

# THE COLLISION DEBRIS



by DPMJET (in FLUKA)  
A. Fedynitch, PhD Thesis,  
[cds.cern.ch/record/2231593](https://cds.cern.ch/record/2231593)

@  $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ , i.e.  $8.5 \cdot 10^8 \text{ s}^{-1}$  inelastic collision rate

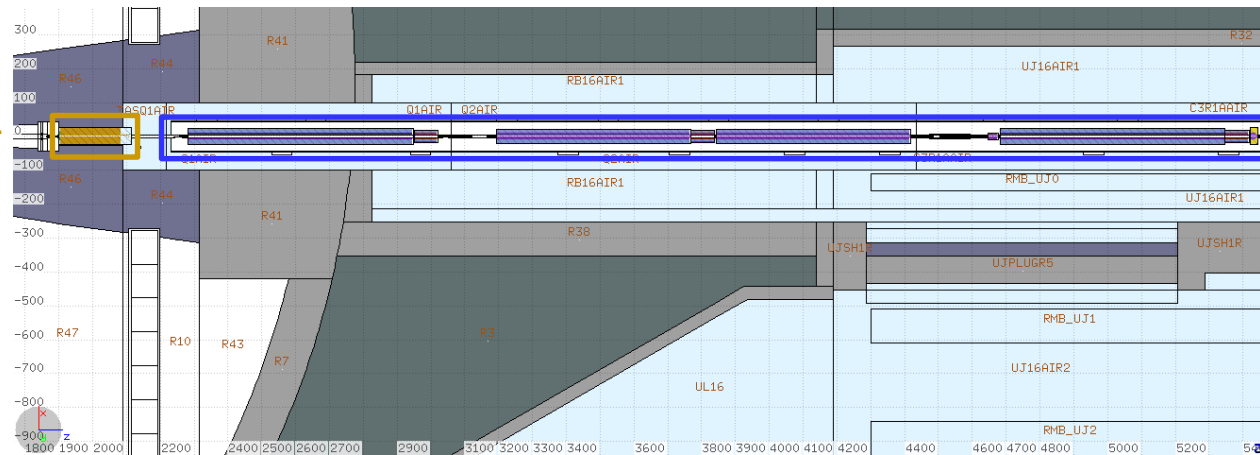
950 W towards each (L&R) side

150 W absorbed in the TAS absorber

650 W going through the TAS

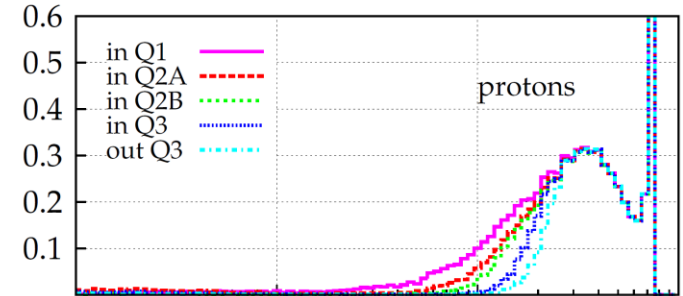
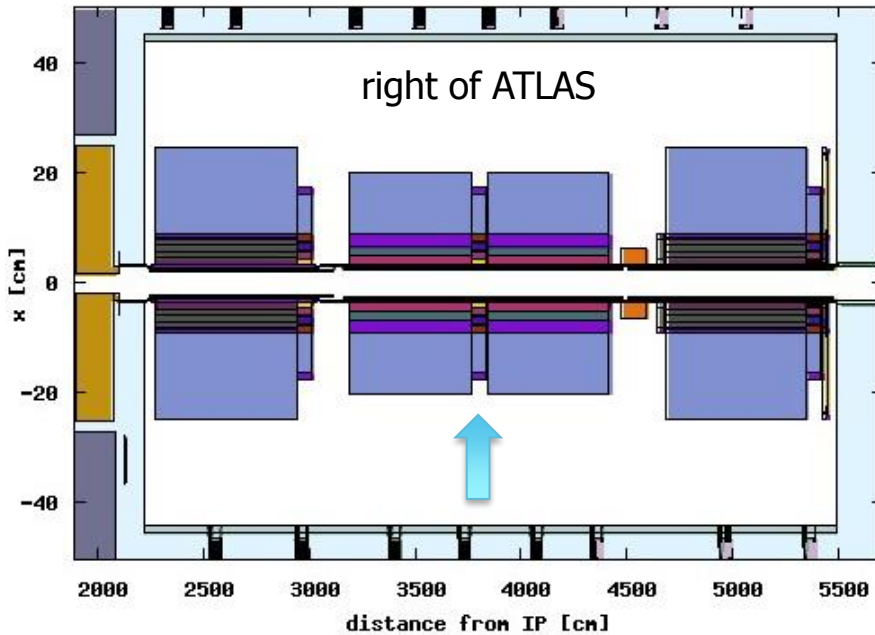
of which

150 W absorbed in the triplet cold magnets

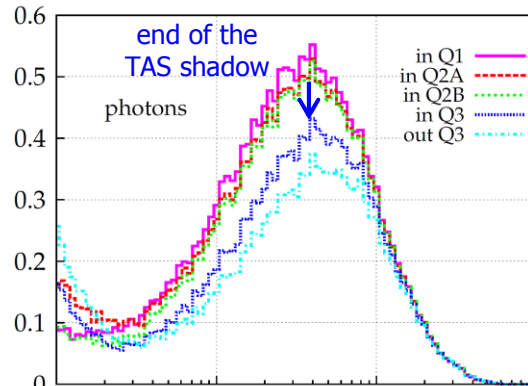
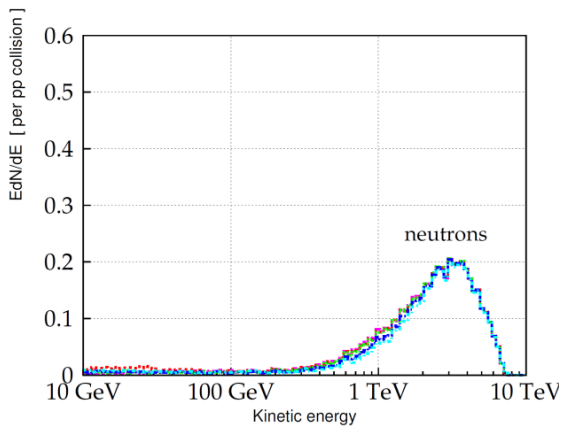
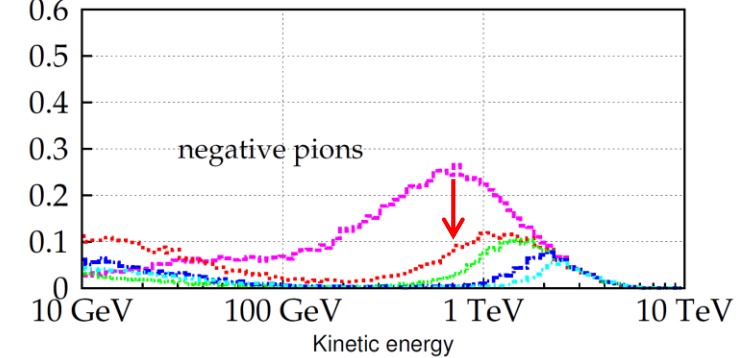
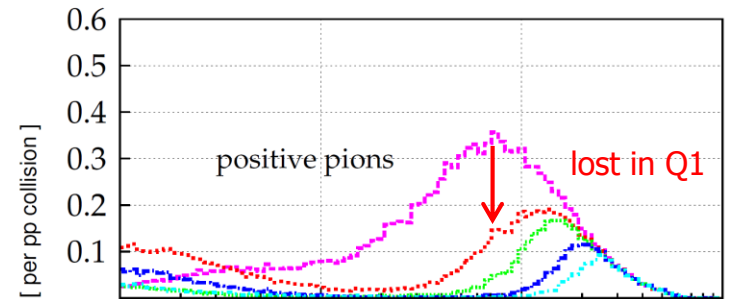


with 6.5 TeV beams (80mb) ~125 W (magnet end uncertainties) prediction at  $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$   
vs 115-135 W measurements (TE-CRG-OP) in the triplet cold mass

# DEBRIS CAPTURE IN THE TRIPLET

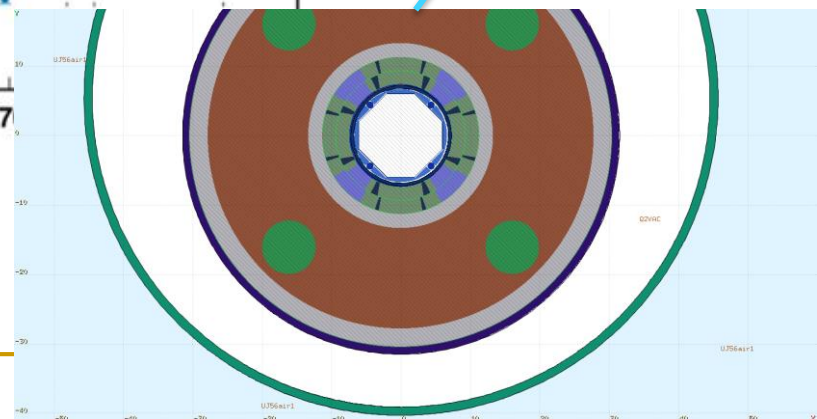
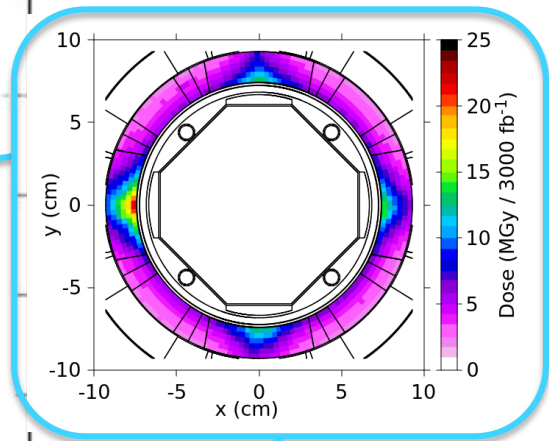
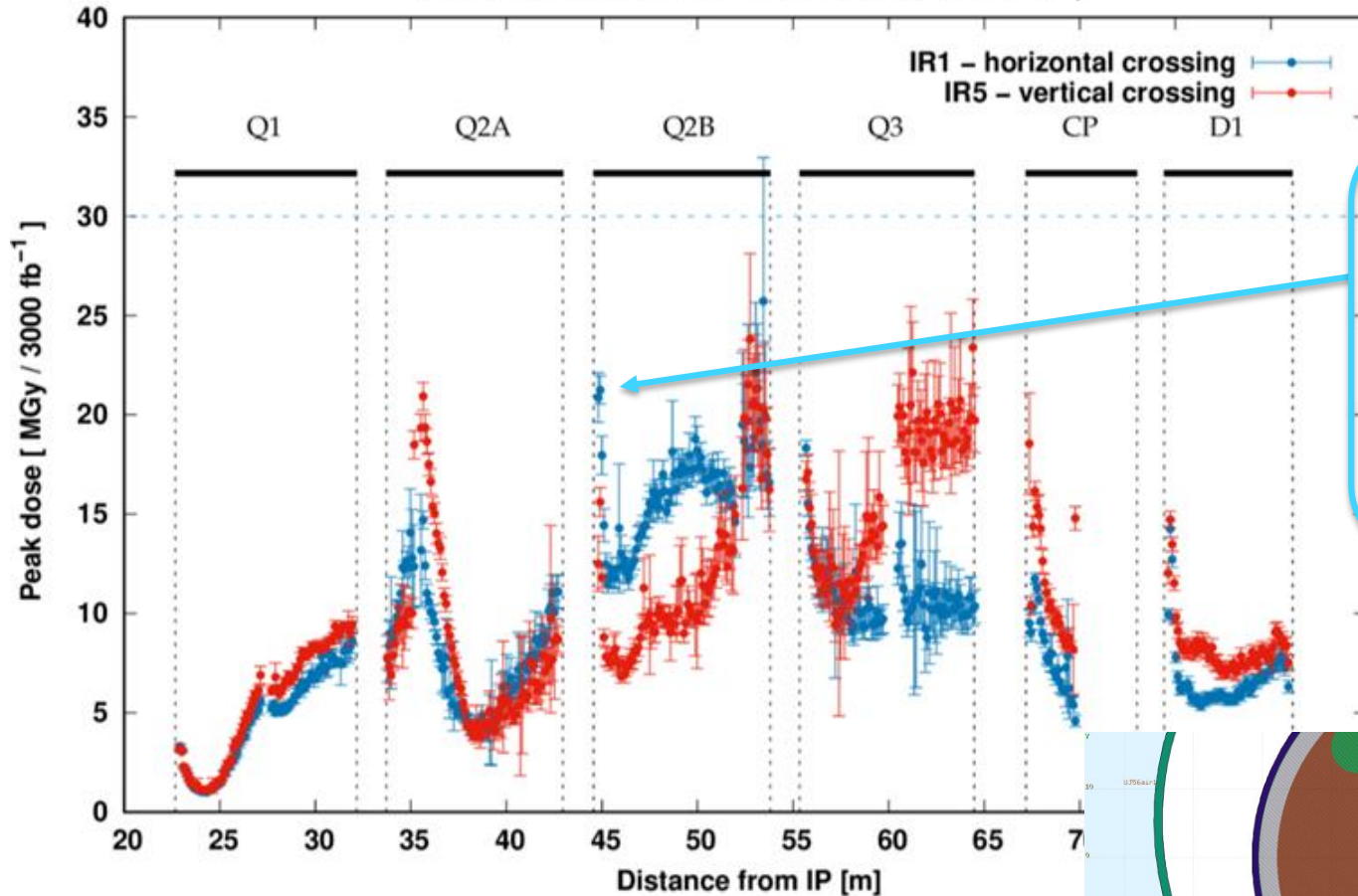


high energy spectra are depopulated by *charge particle* (especially *pion*) interception in the successive quadrupoles due to magnetic field bending



# MAGNET LIFETIME

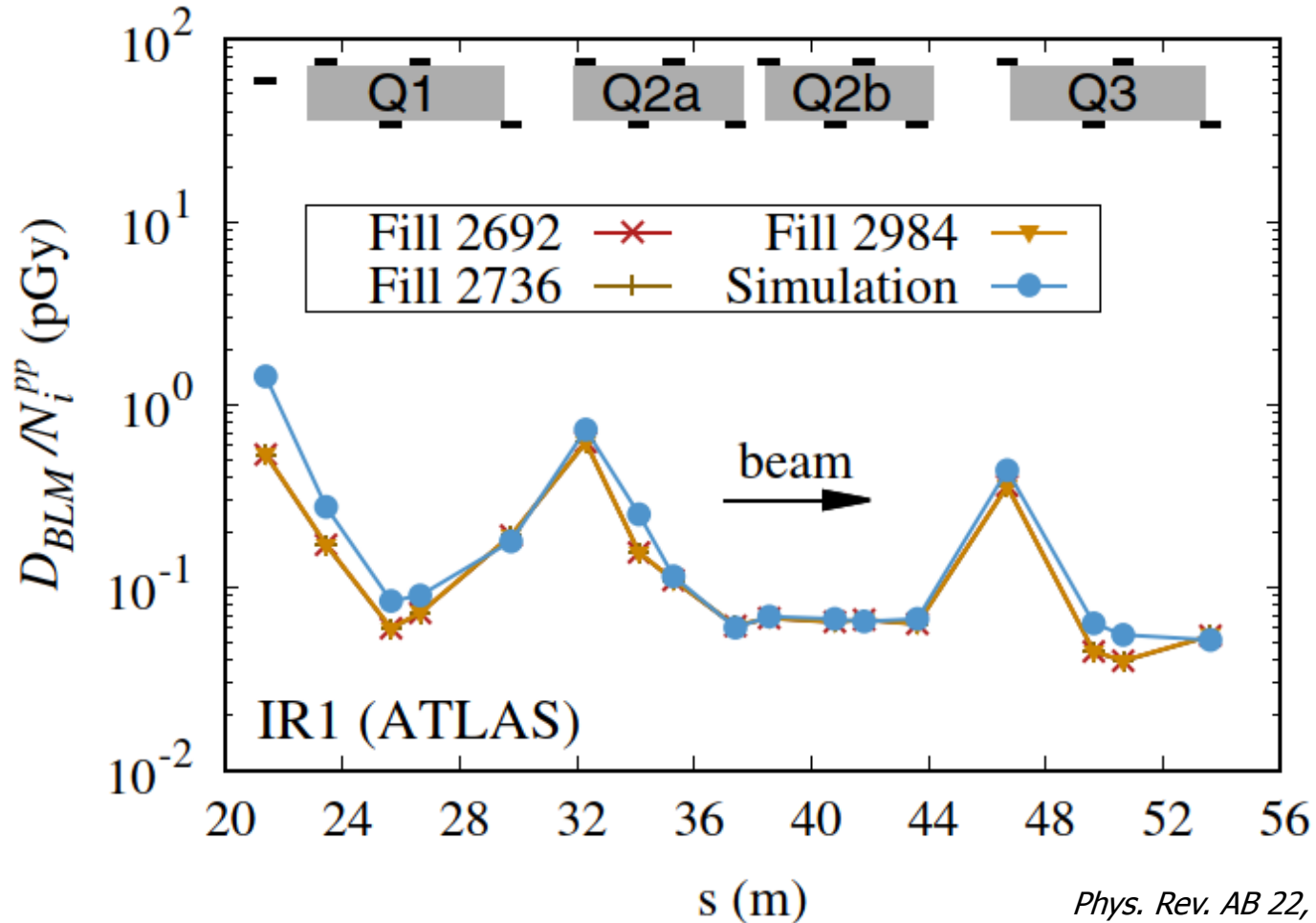
Peak dose profile in the inner coils ( $L_{int} = 3000 \text{ fb}^{-1}$ )



different behavior reflecting the crossing plane variation for the same magnetic configuration of the triplet (FDF in the horizontal plane for positively charged particles coming from the IP)

# TRIPLET: BLM BENCHMARKING

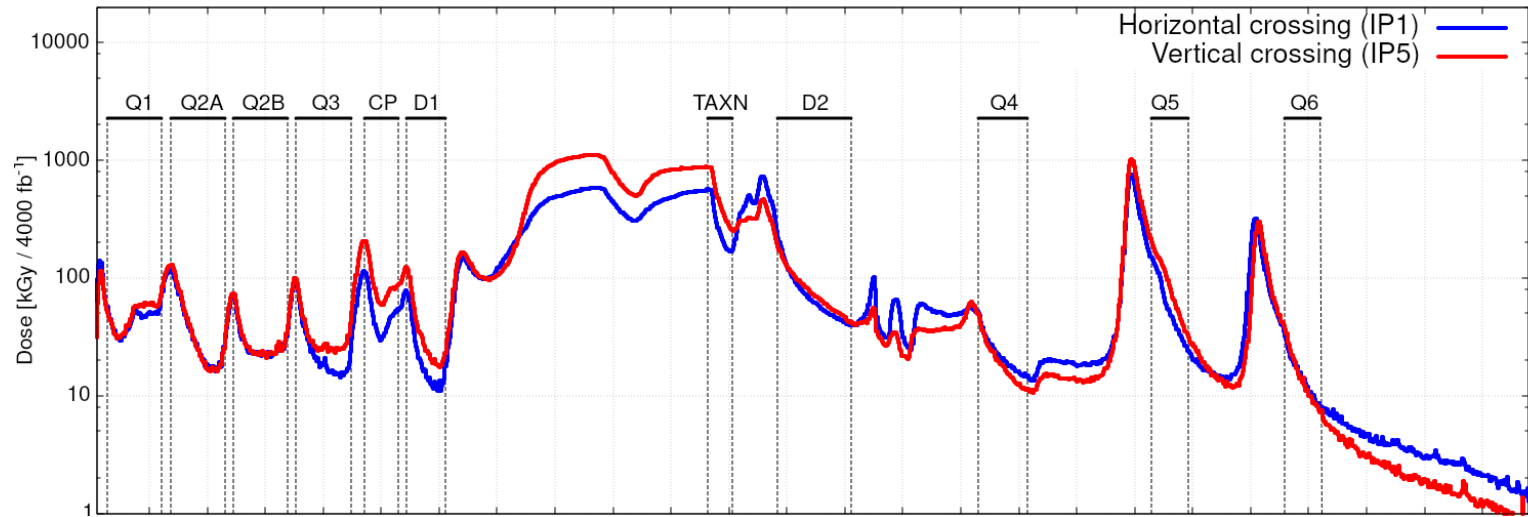
2012  
4 TeV beams



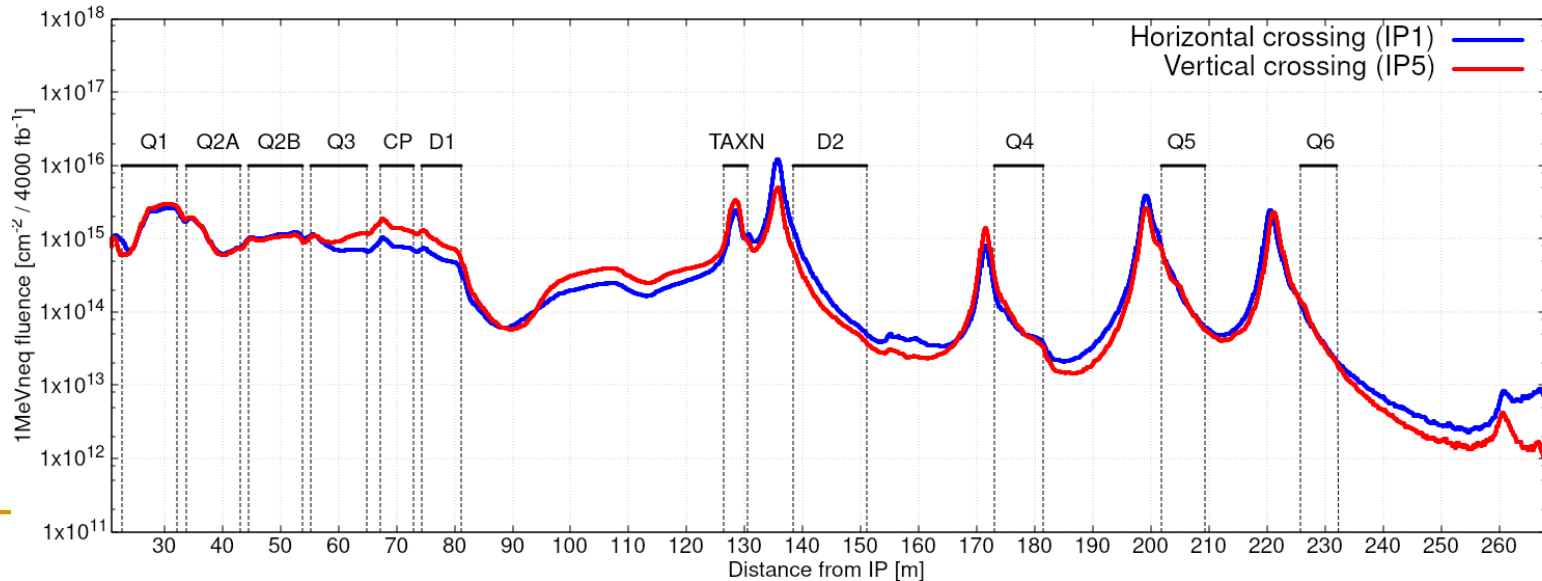
*Phys. Rev. AB 22, 071003 (2019)*

# LSS RADIATION LEVEL PROFILES [I]

Total HL-LHC dose 80cm below the beam in the LSS of IP1 and IP5



Total HL-LHC 1MeVneq fluence 80cm below the beam in the LSS of IP1 and IP5



2020 April 16<sup>th</sup>

F. Cerutti

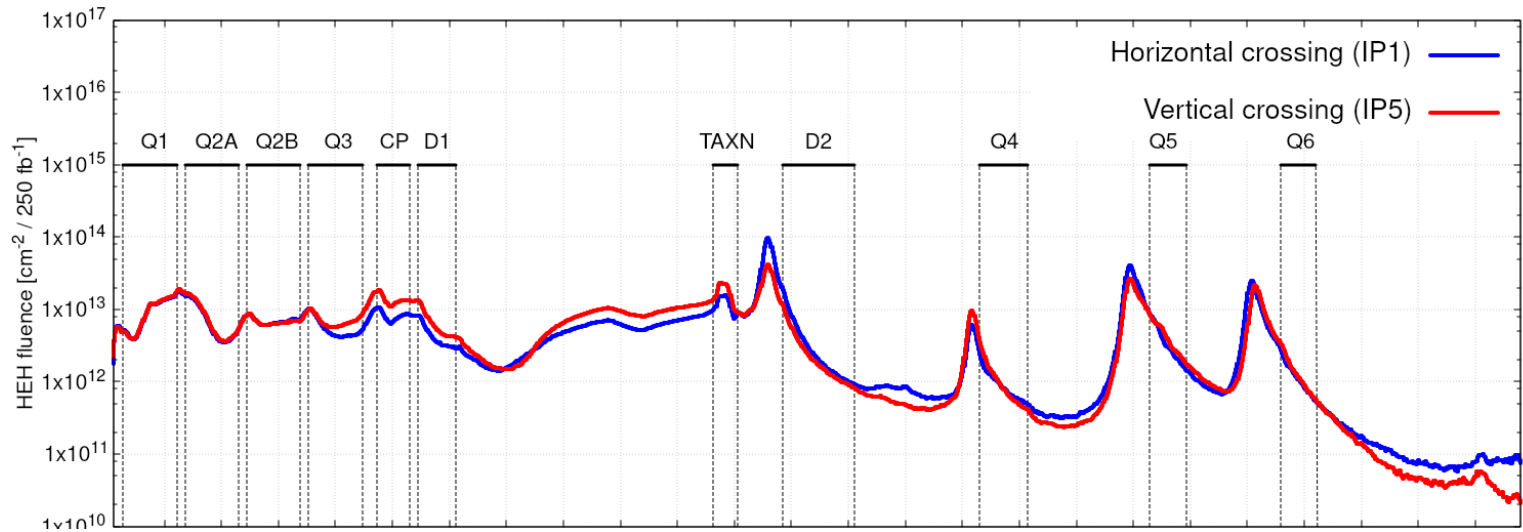
FS meeting

G. Lerner

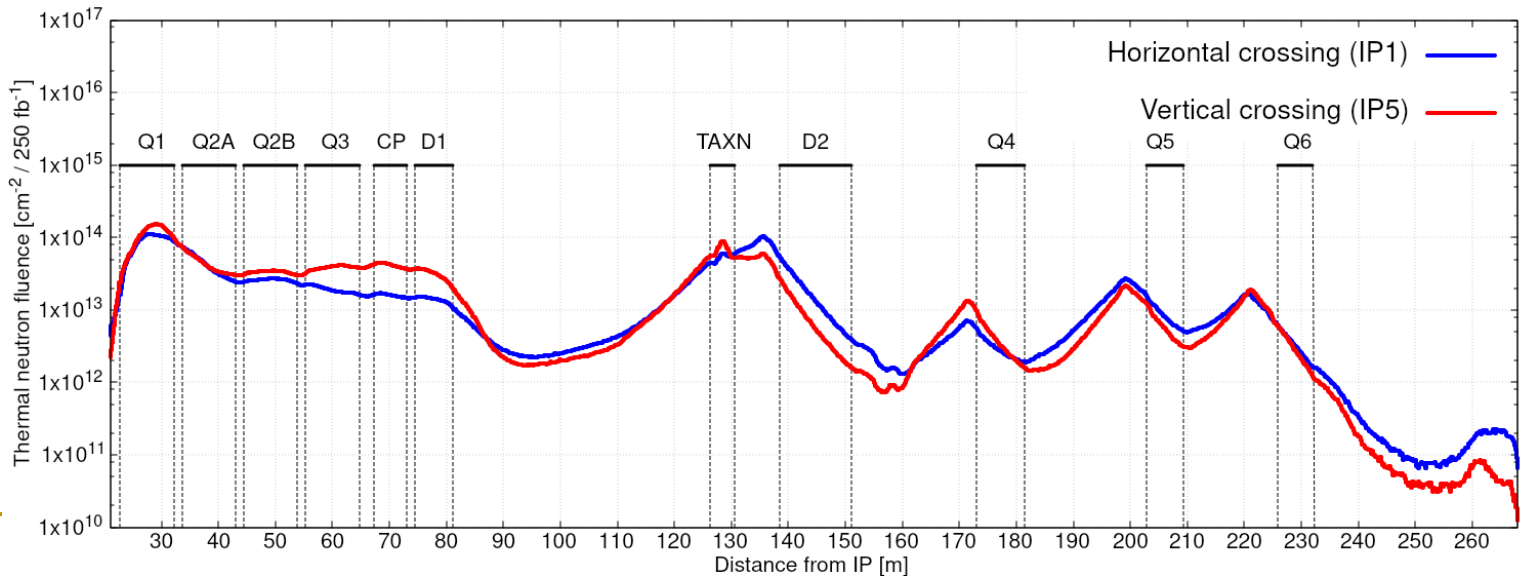


# LSS RADIATION LEVEL PROFILES [II]

Annual HL-LHC HEH fluence 80cm below the beam in the LSS of IP1 and IP5



Annual HL-LHC thermal neutron fluence 80cm below the beam in the LSS of IP1 and IP5



2020 April 16<sup>th</sup>

F. Cerutti

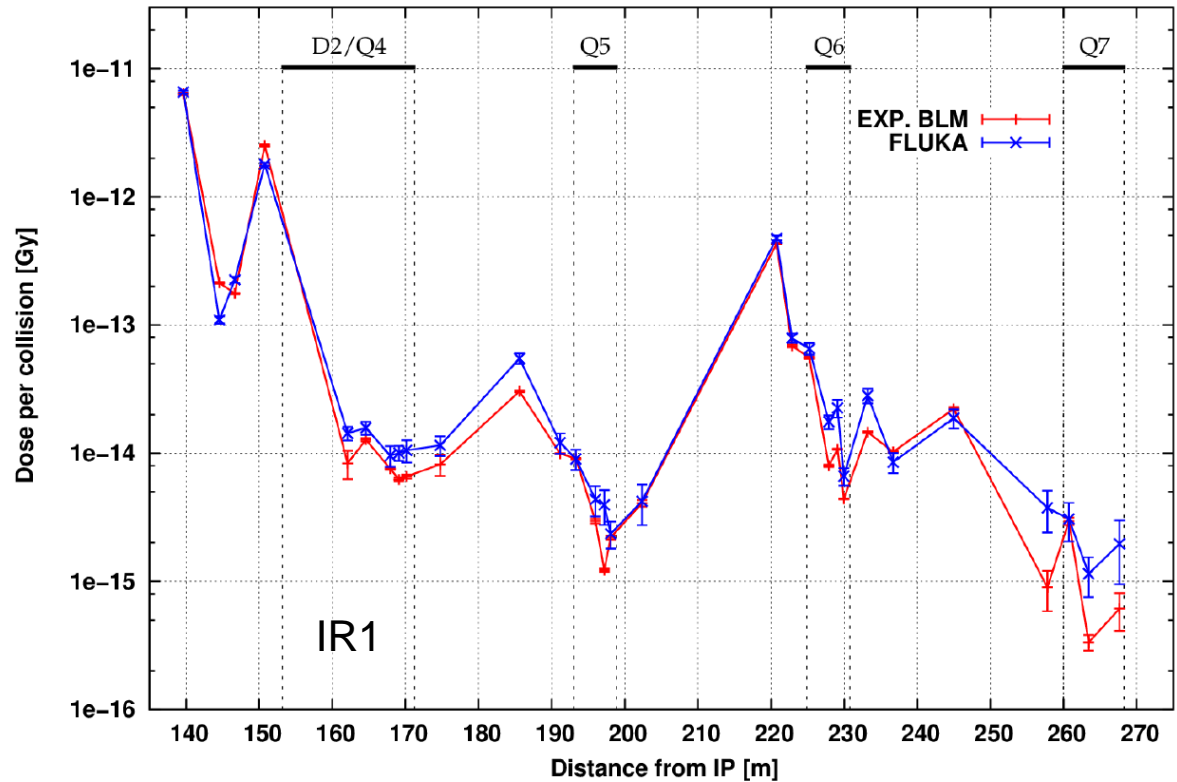
FS meeting

G. Lerner

# MATCHING SECTION: BLM BENCHMARKING

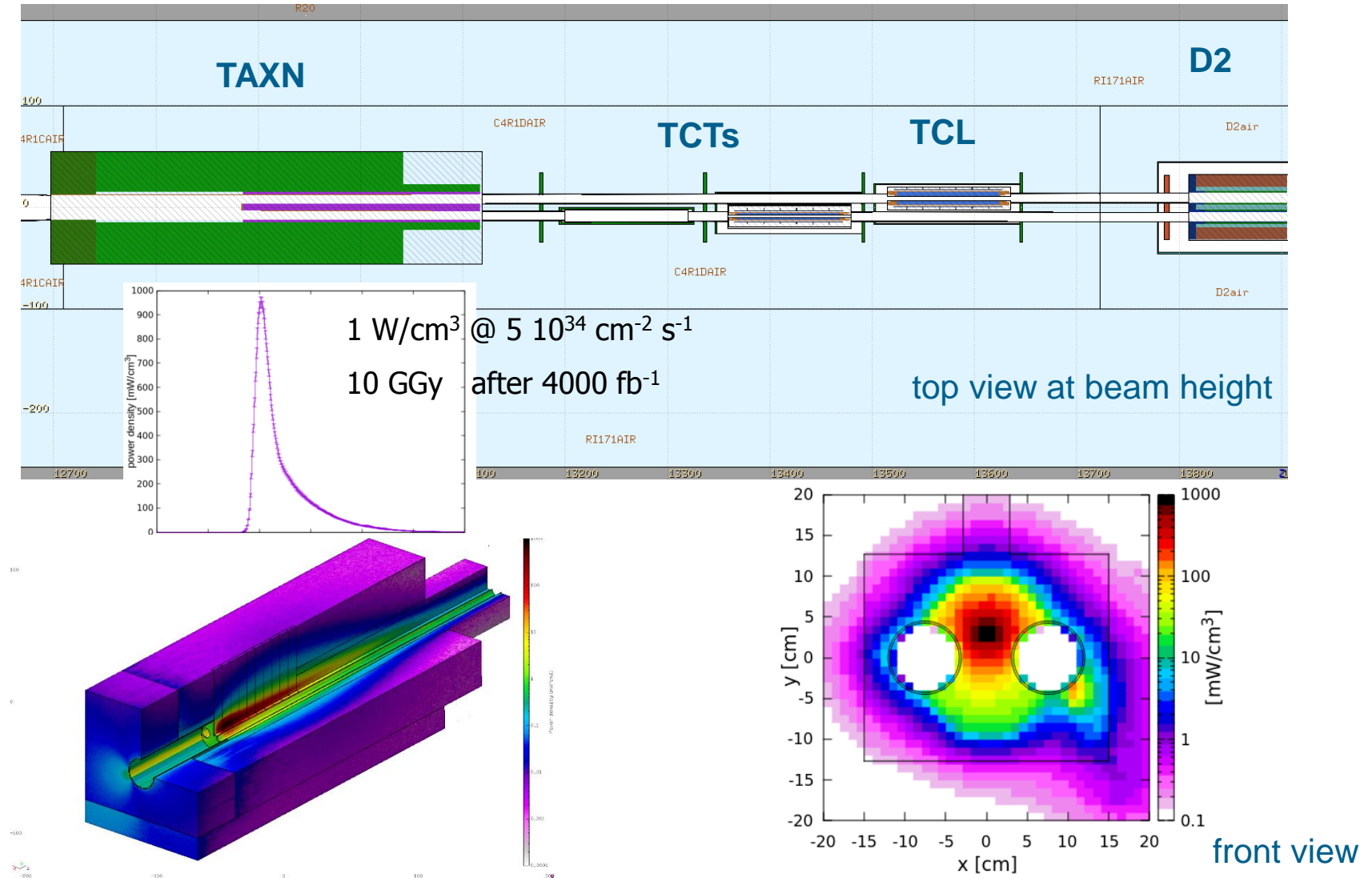
6.5 TeV beams

- Fill #4919 (May 2016) Experimental BLM data vs. FLUKA – TCL6 closed



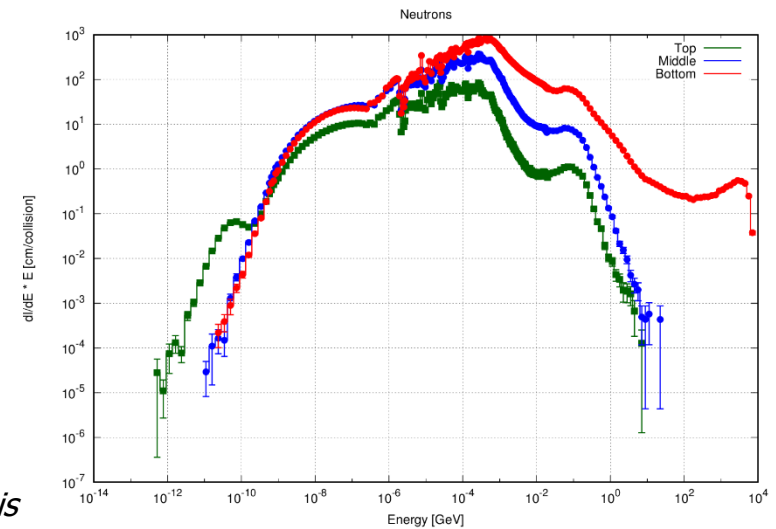
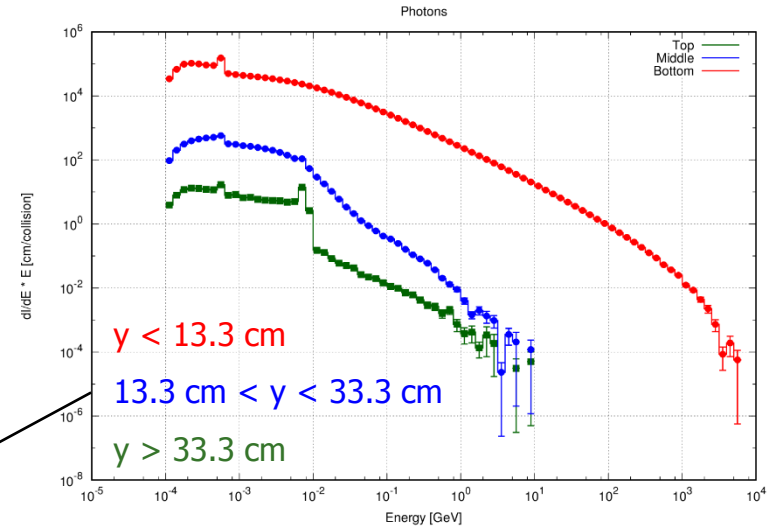
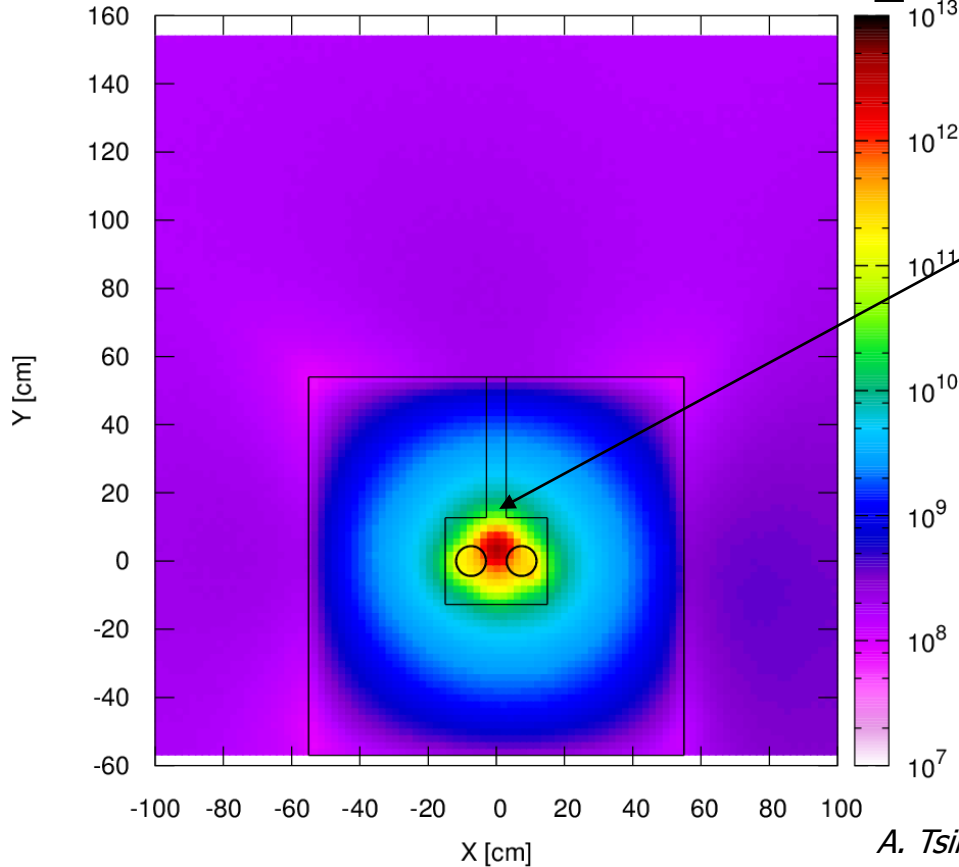
A. Tsinganis

# BEAM SEPARATION REGION



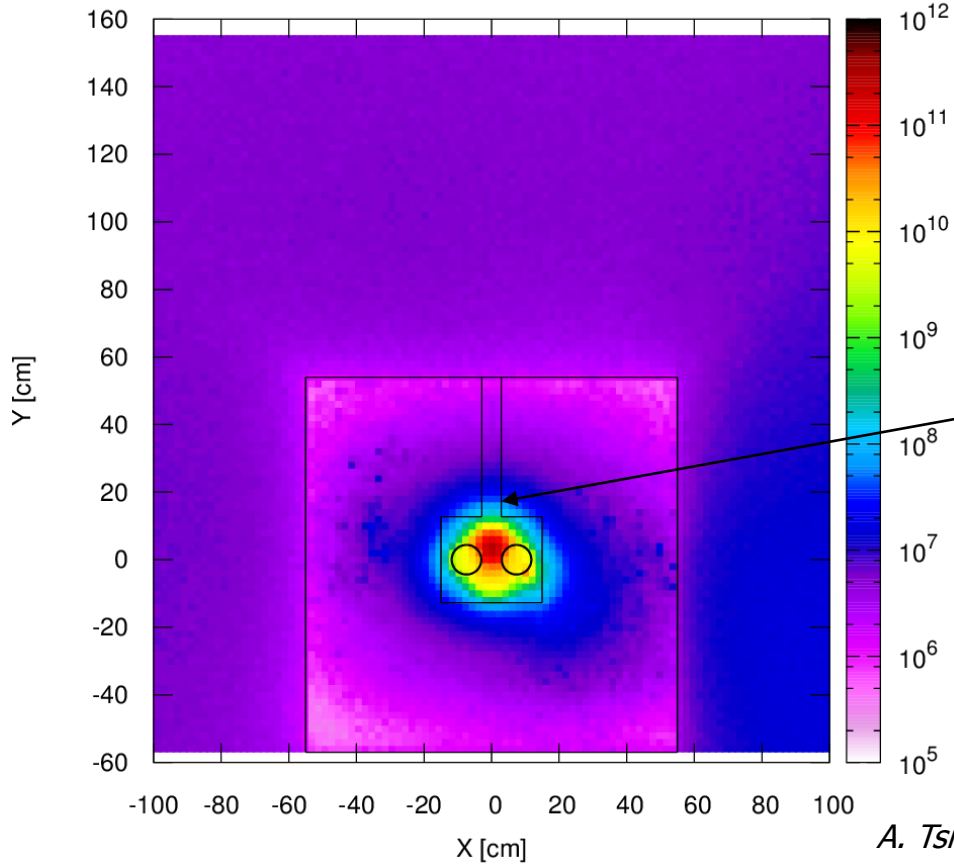
# NEUTRAL PARTICLE FLUENCE RATE/SPECTRA IN THE TAXN

Neutral particle fluence rate at peak ( $5.0 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ )

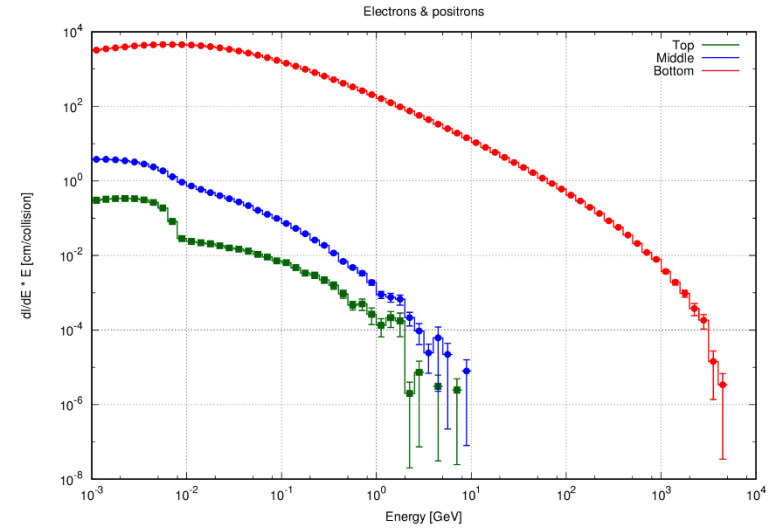


# CHARGED PARTICLE FLUENCE RATE/SPECTRA IN THE TAXN

Charged particle fluence rate at peak ( $5.0 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ )



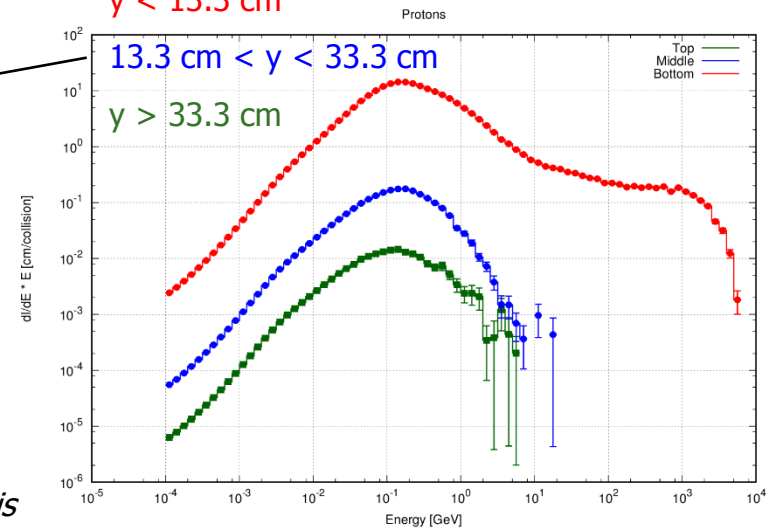
A. Tsinganis



$y < 13.3 \text{ cm}$

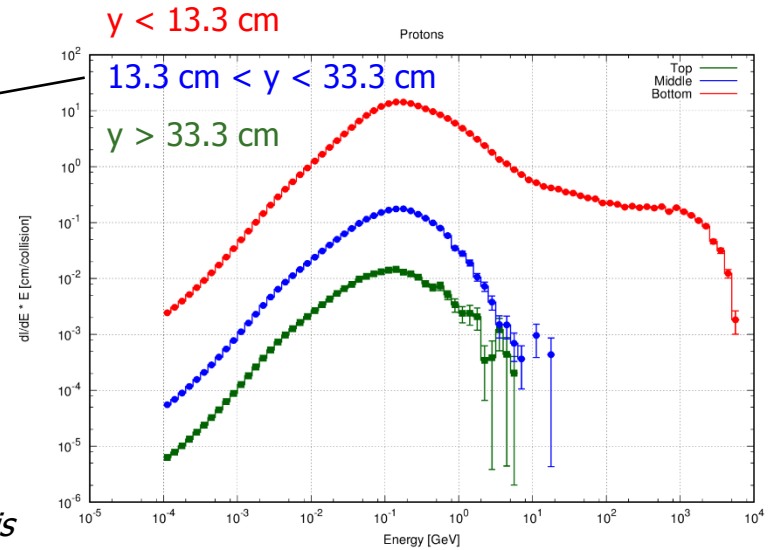
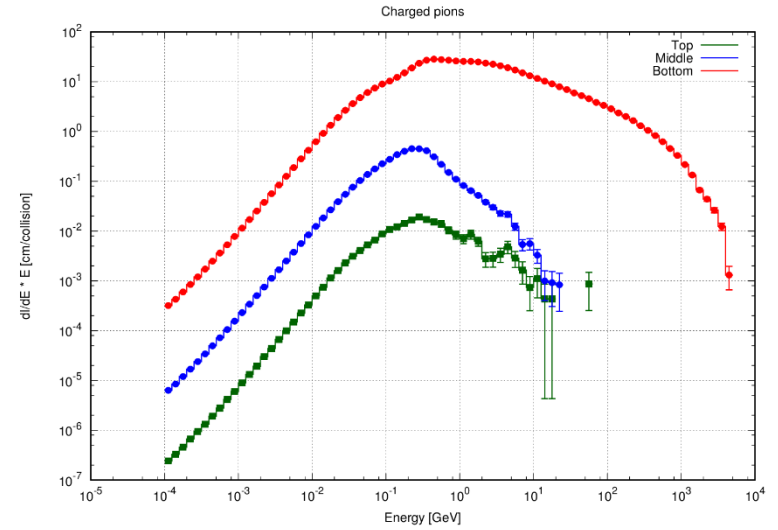
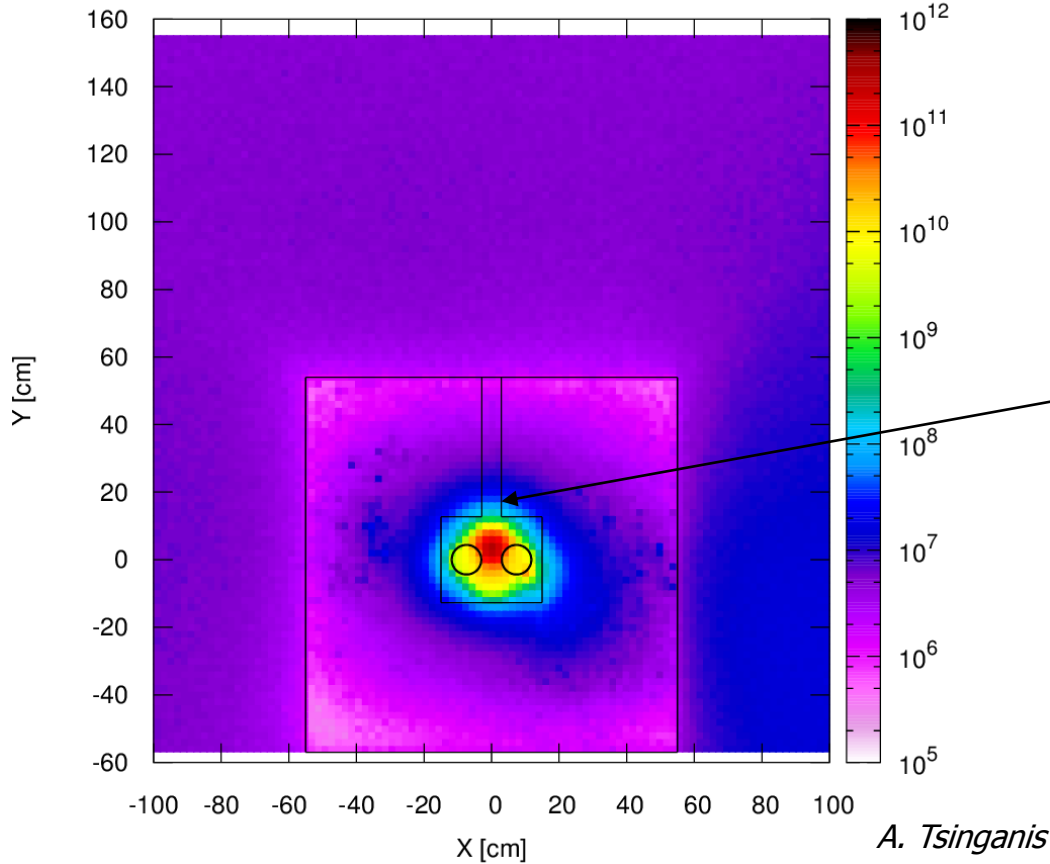
$13.3 \text{ cm} < y < 33.3 \text{ cm}$

$y > 33.3 \text{ cm}$

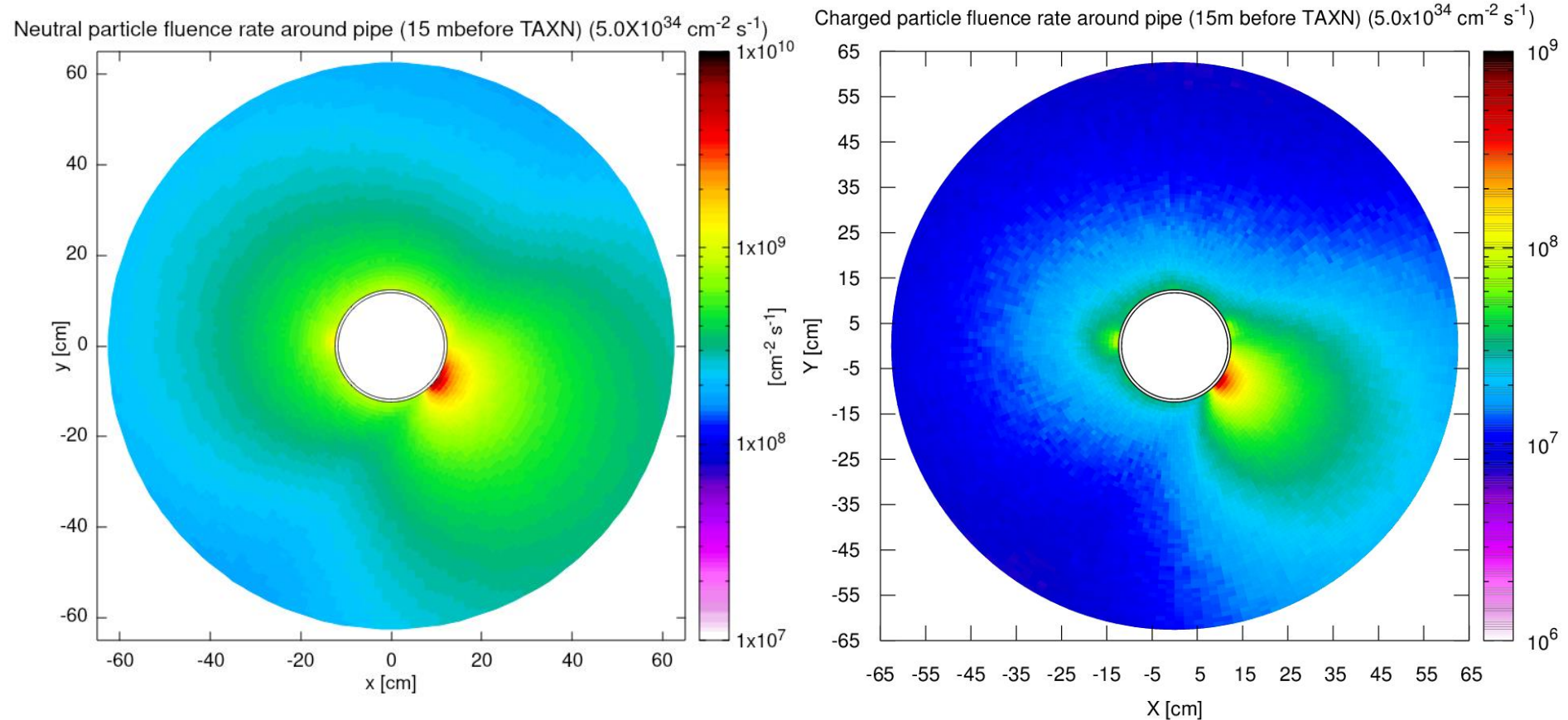


# CHARGED PARTICLE FLUENCE RATE/SPECTRA IN THE TAXN

Charged particle fluence rate at peak ( $5.0 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ )

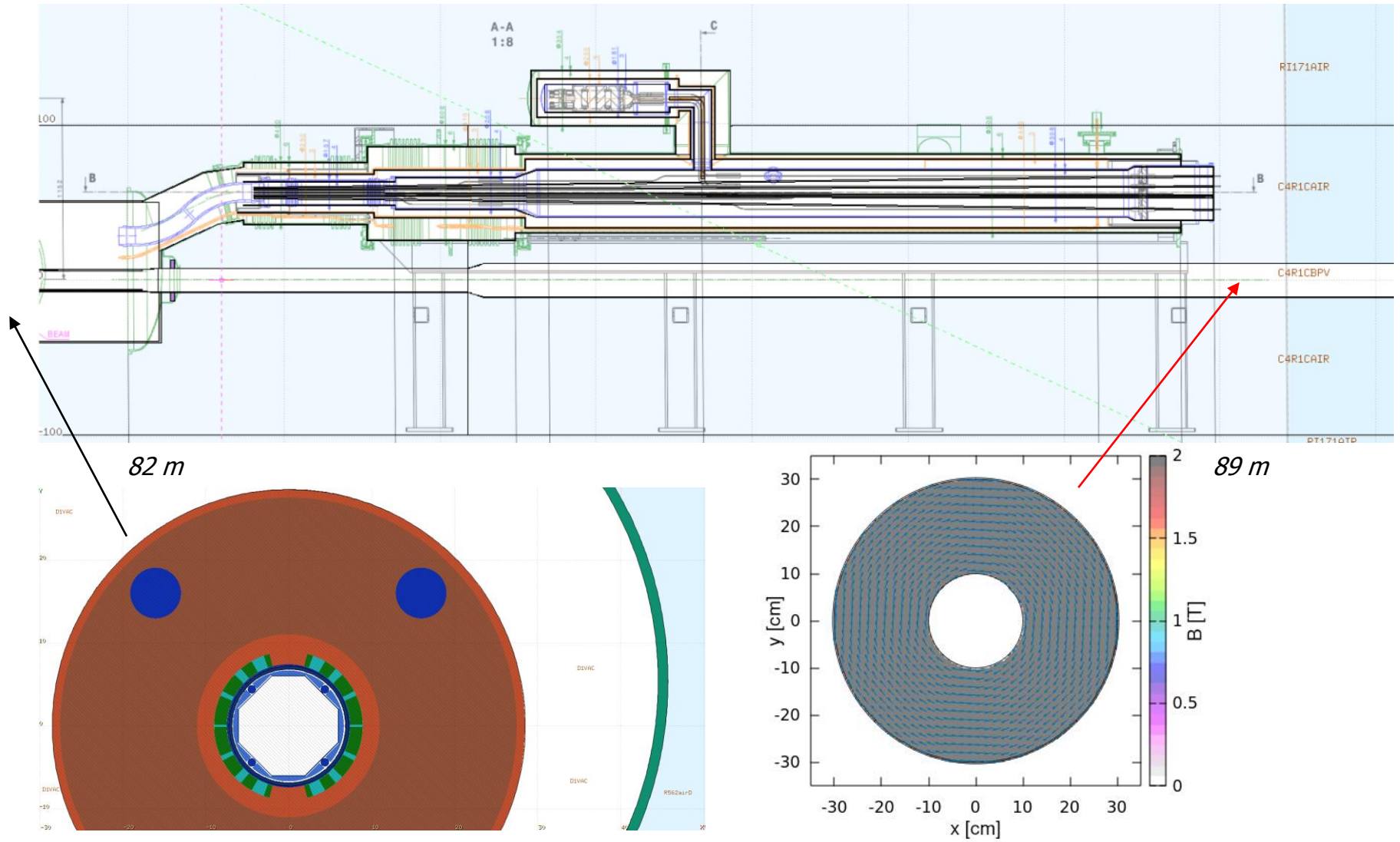


# 15 m UPSTREAM i.e. 110 m FROM IP5



*A. Tsinganis*

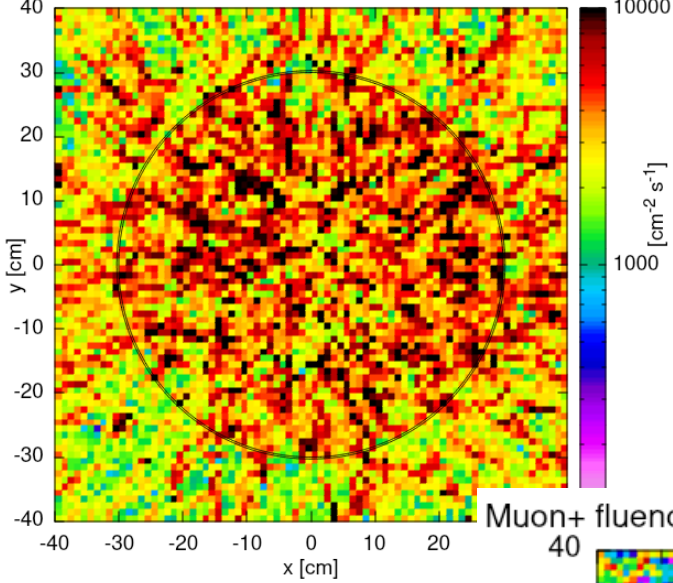
# COLD DIODE AND DFX



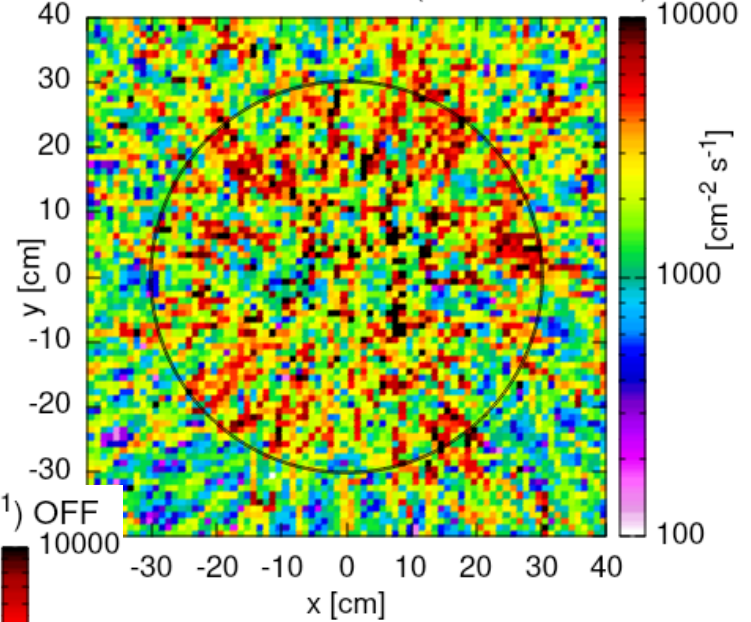


# MUON FLUENCE RATE

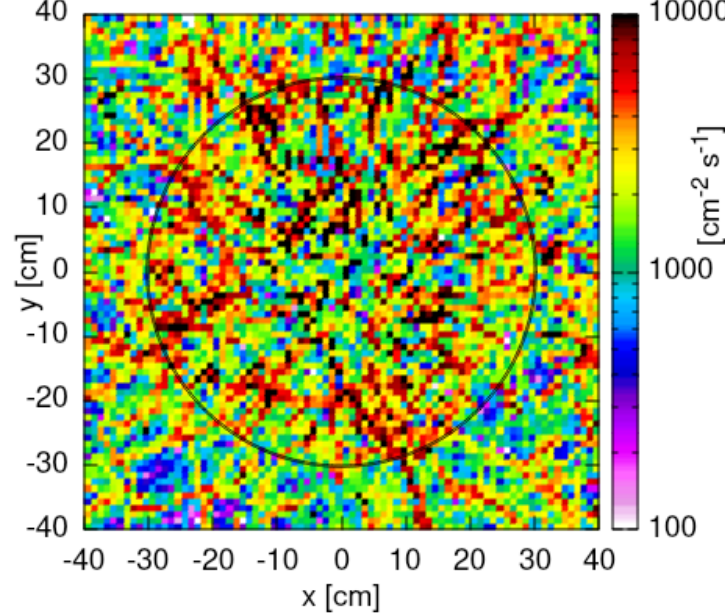
Muon+ fluence rate at 115 m ( $5 \cdot 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ )



Muon+ fluence rate at 115 m ( $5 \cdot 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ ) ON



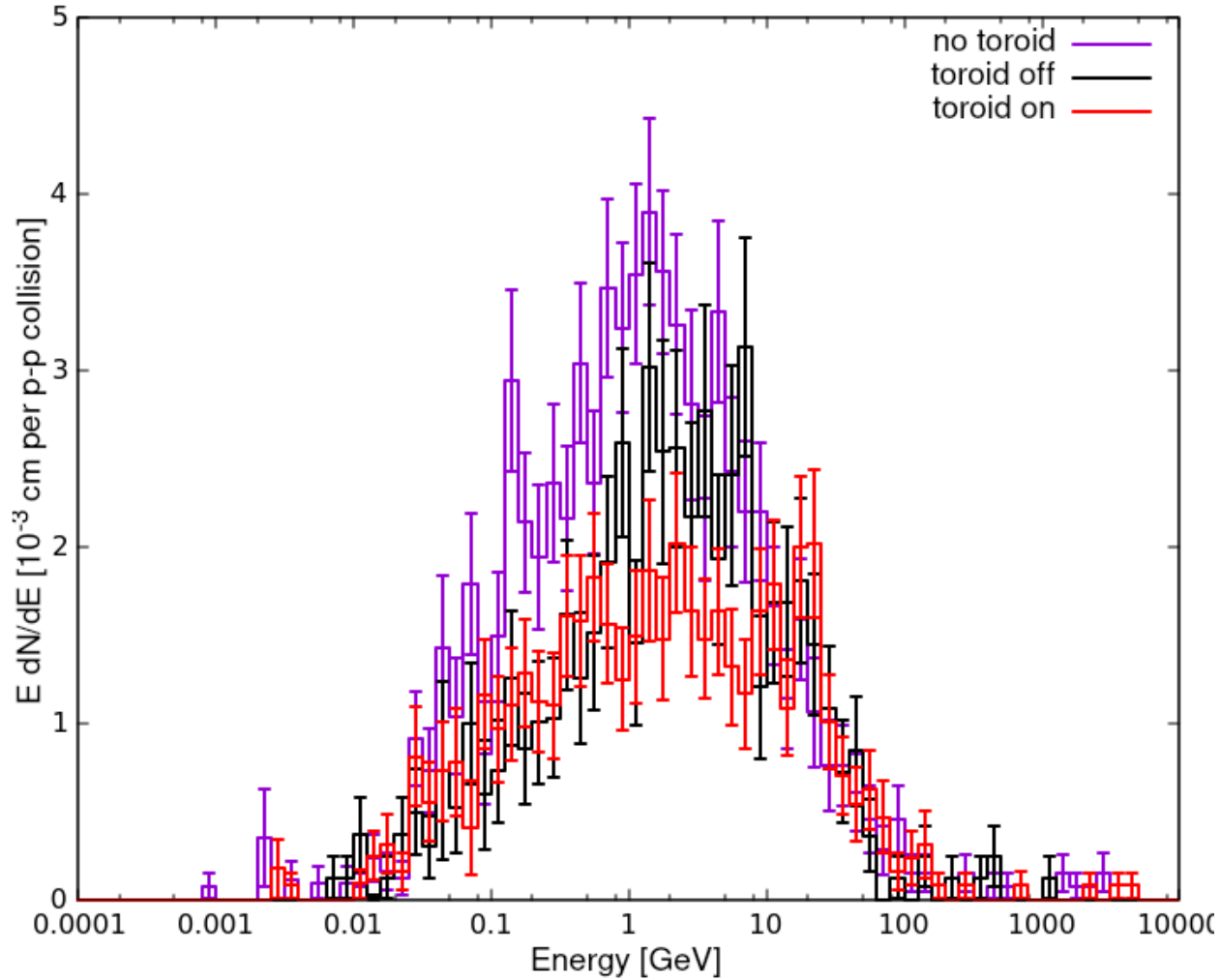
Muon+ fluence rate at 115 m ( $5 \cdot 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ ) OFF



# MUON SPECTRUM

positive muons

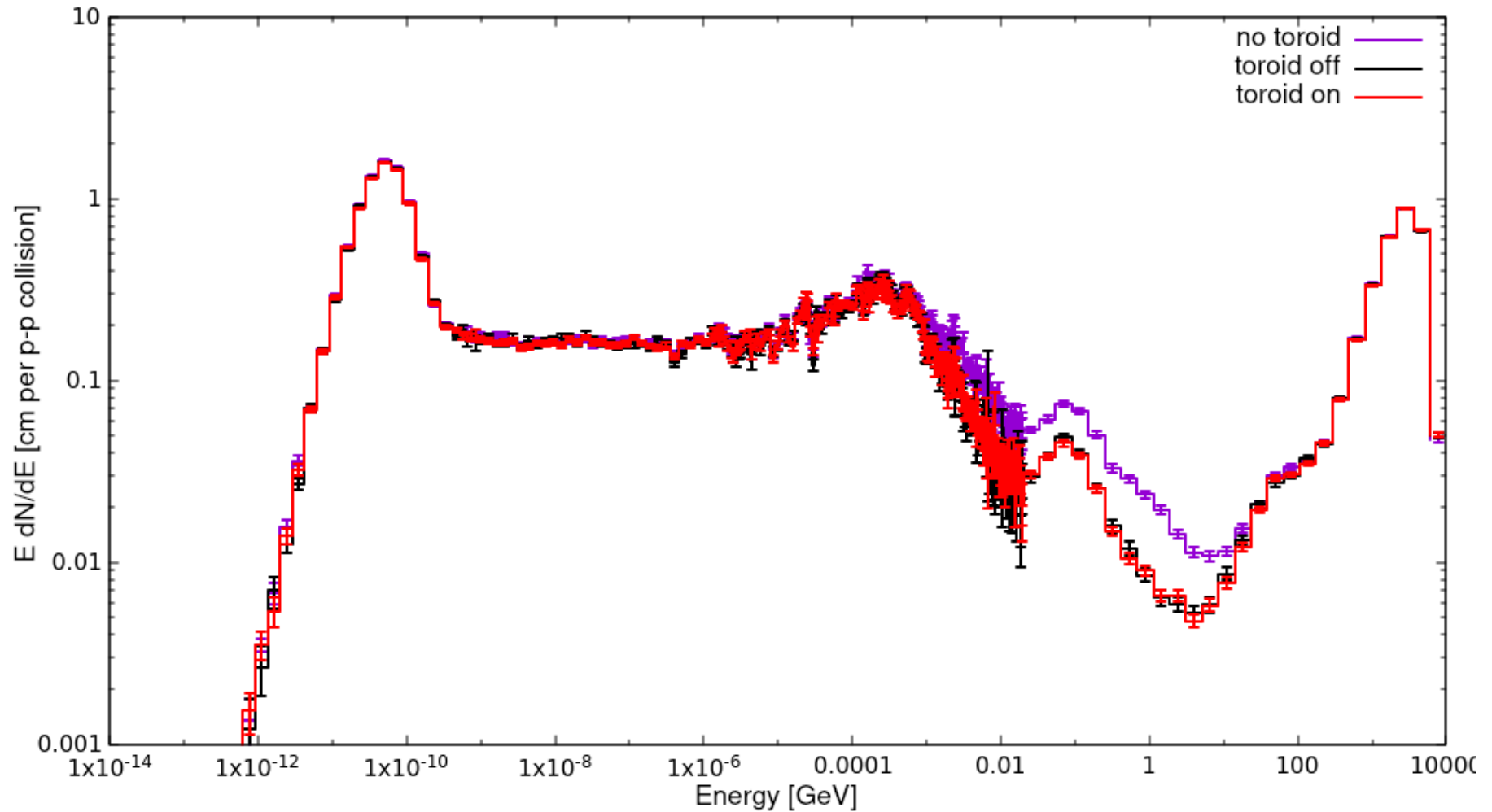
inside 30 cm radius



# NEUTRON SPECTRUM

inside 30 cm radius

neutrons



---

MORE  
IN MARTA'S TALK  
TOMORROW