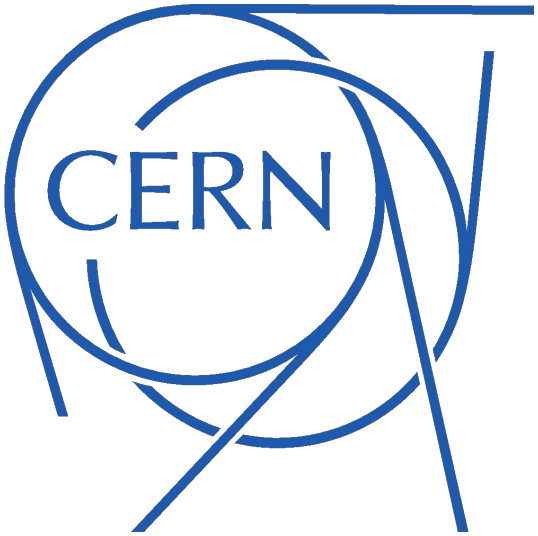

CERN

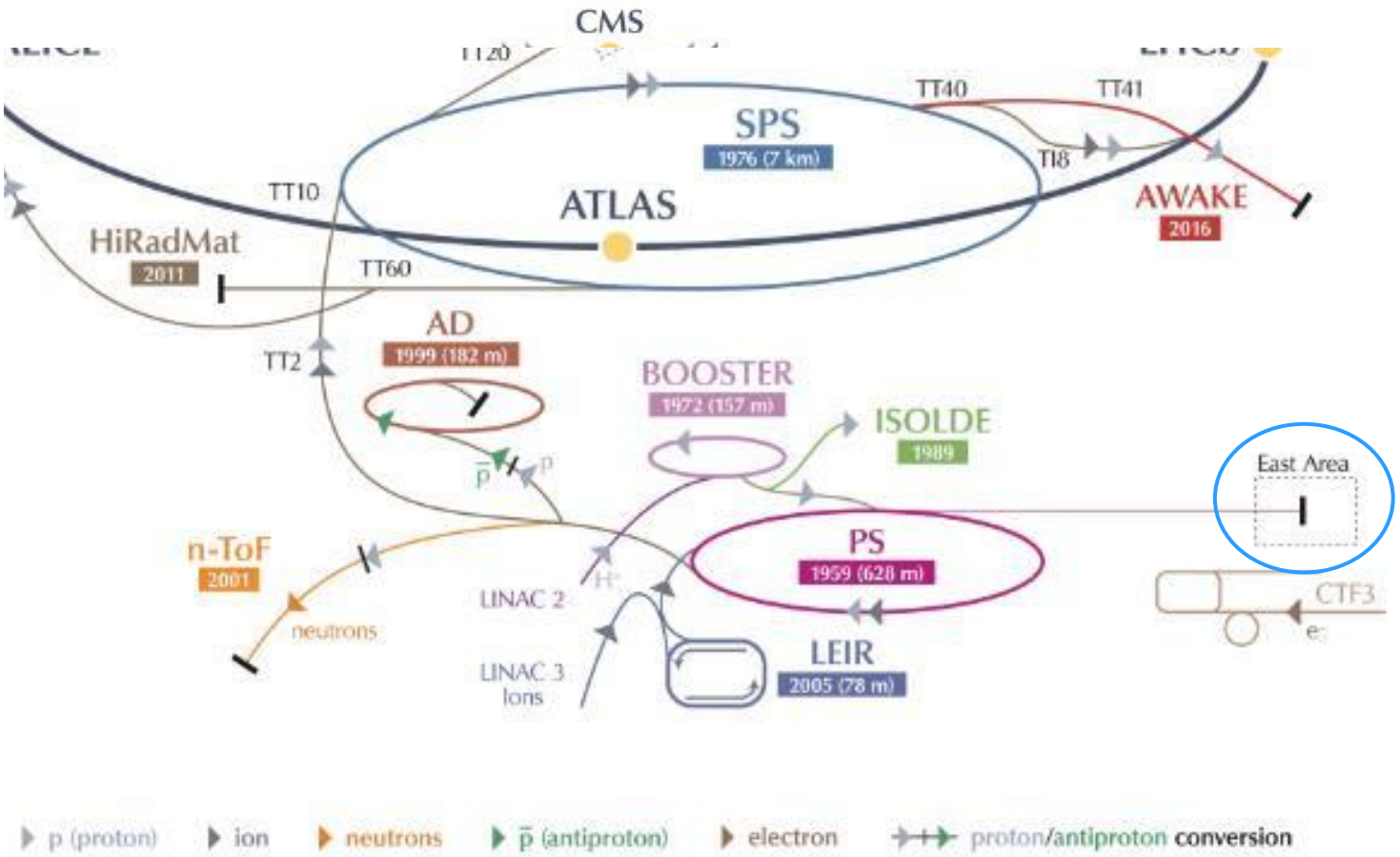
Mixed Radiation Field Characterisation at a New Irradiation Facility at CERN:CHARM

Natanael Mota

Overview

- CERN and the LHC
- CHARM & Mixed Fields
- Radiation Effects
- Radiation Monitoring
- Benchmarking with FLUKA
- Conclusions

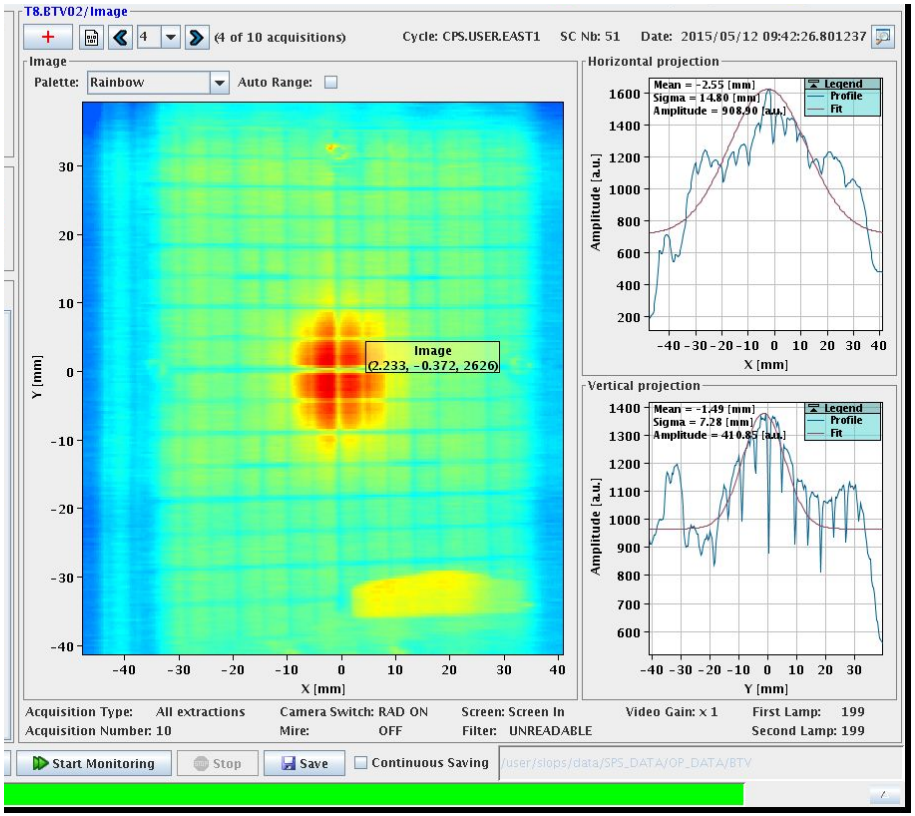
CERN's Accelerator Complex

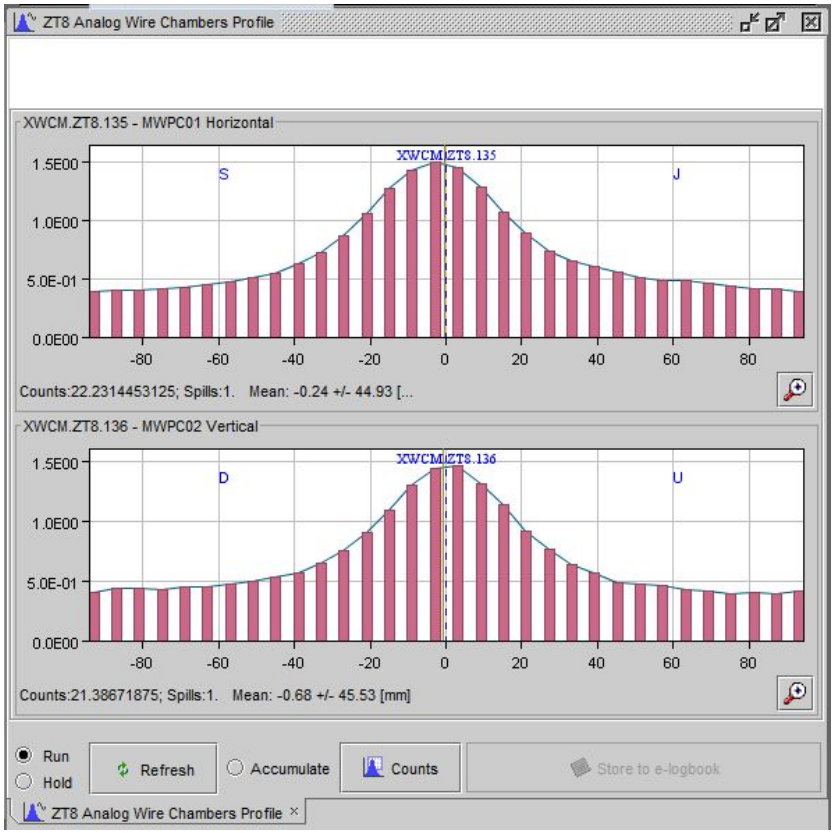


East Area

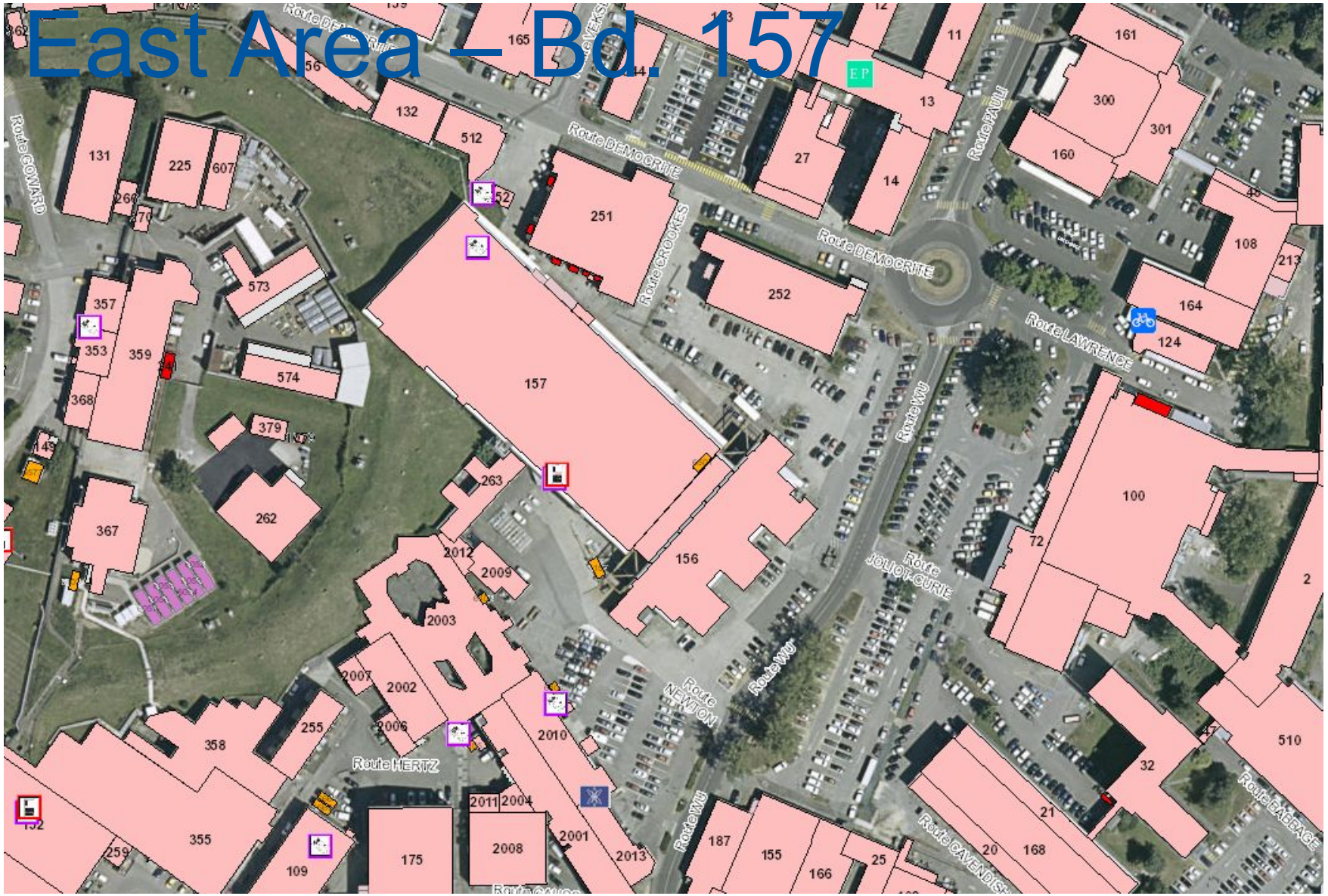
Proton Synchrotron

- 24 GeV/c Proton energy





East Area – Bd. 157

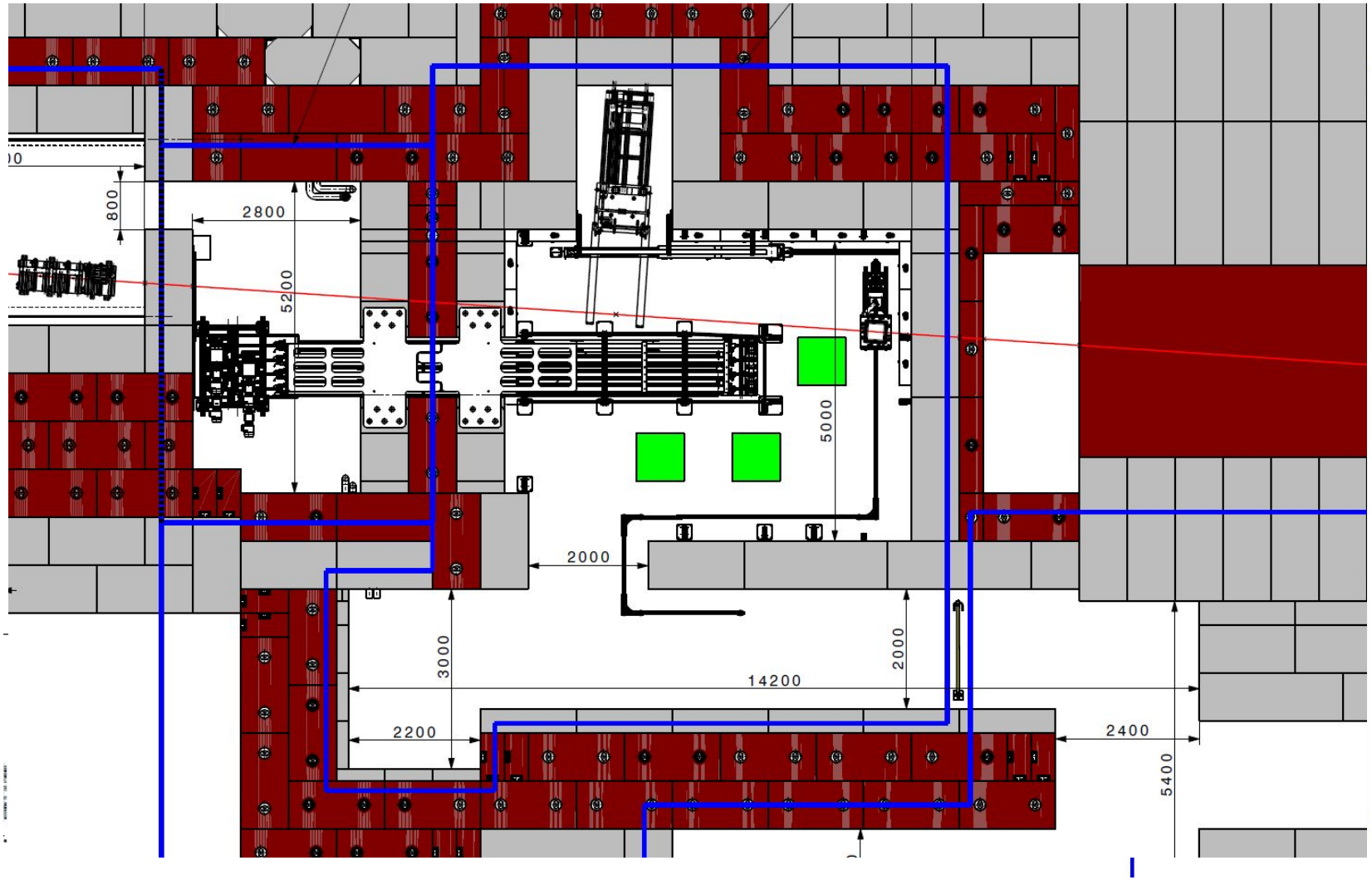


DIRAC → IRRAD + CHARM

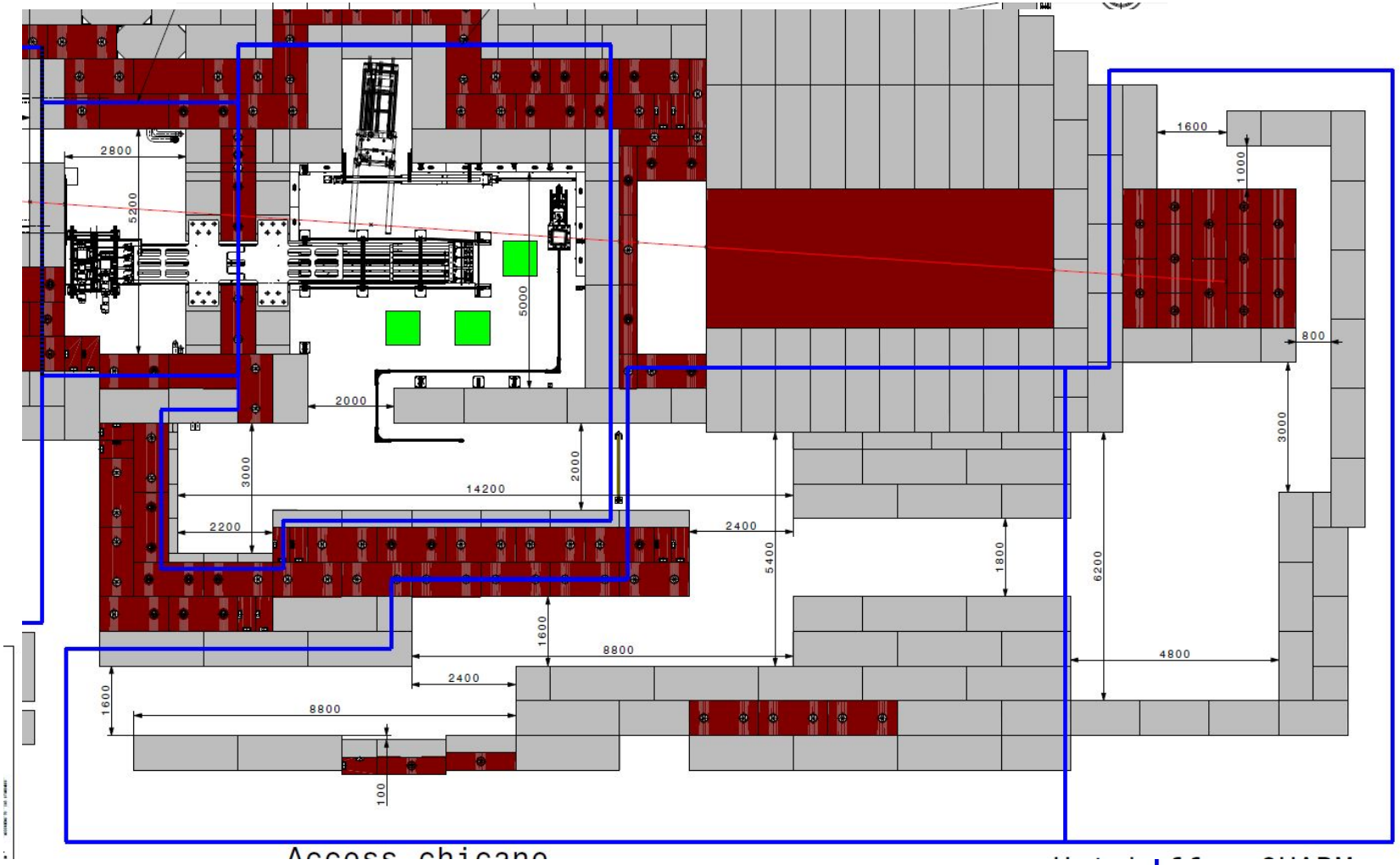
- Dirac previously ran on space now used
  - Aging equipment
    - Increasing failure rates
    - High dose levels

- Long Shutdown 1 – CERN upgrade period
  - IRRAD – Proton Irradiation Facility
  - CHARM – Mixed Field Irradiation Facility
    - Access without stopping protons to other facilities

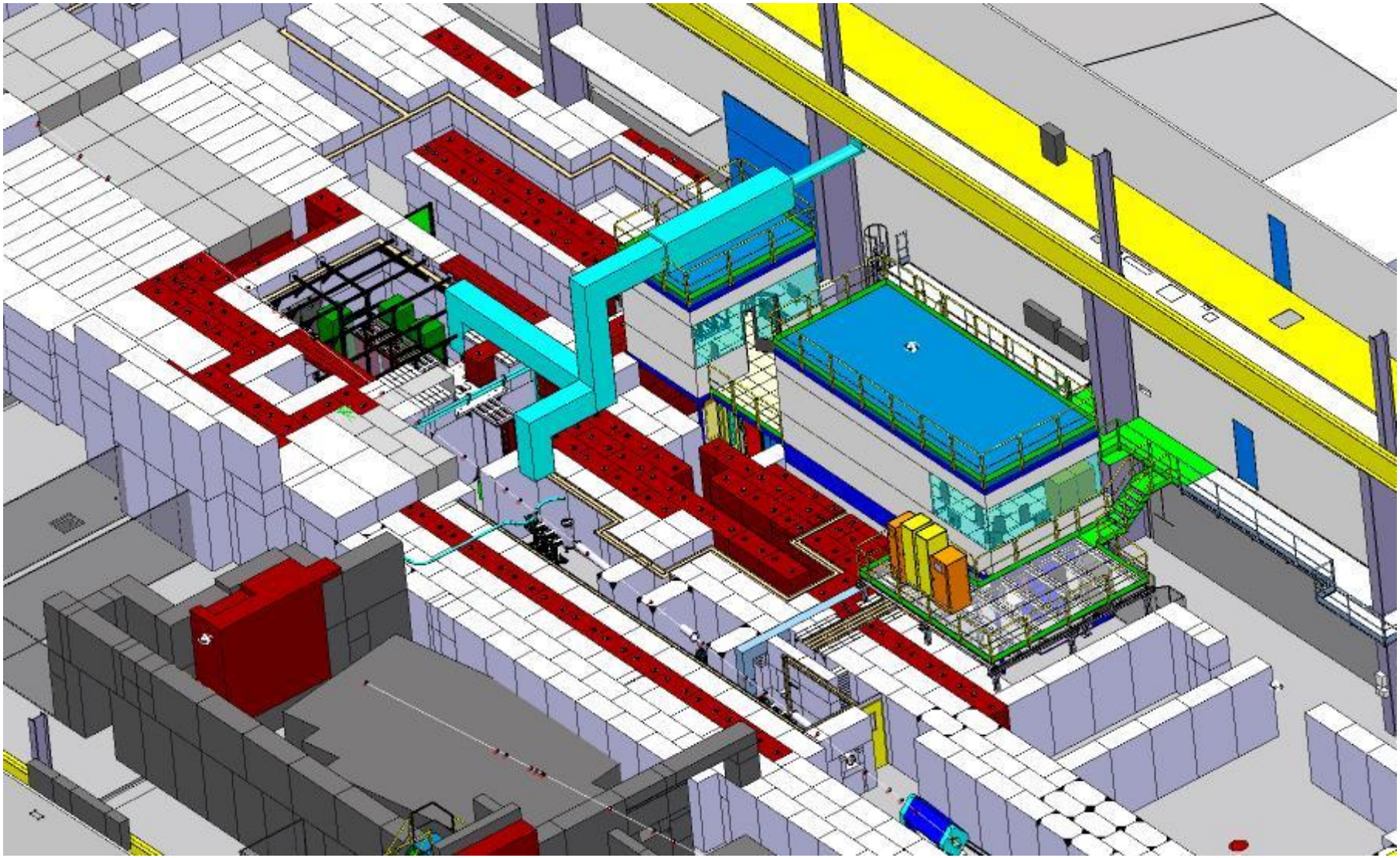
East Area



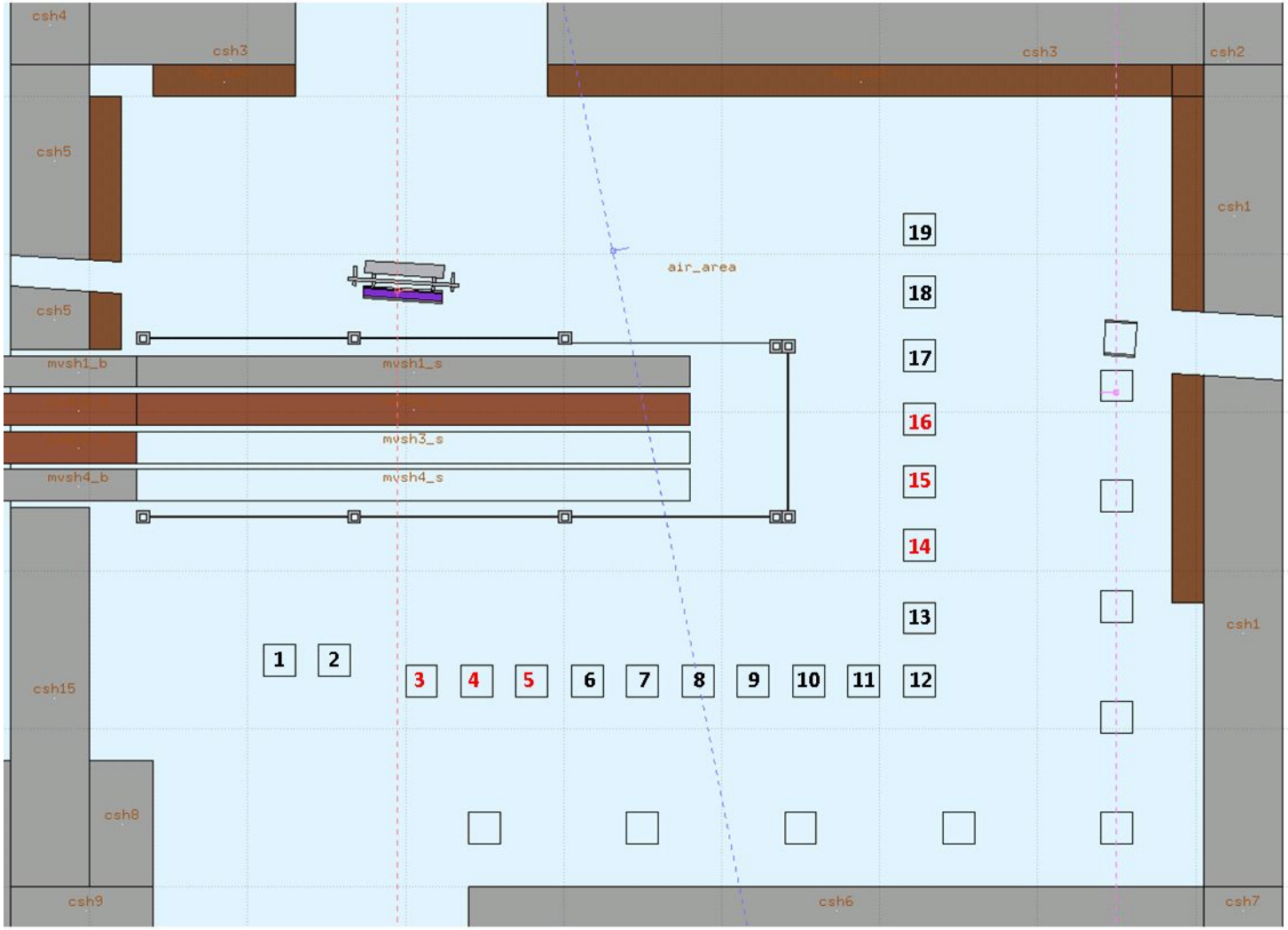
East Area


2800
5200
5000
2000
3000
14200
2200
2000
2400
5400
1800
6200
1600
8800
4800
2400
1600
8800
100
1600
1000
800
3000

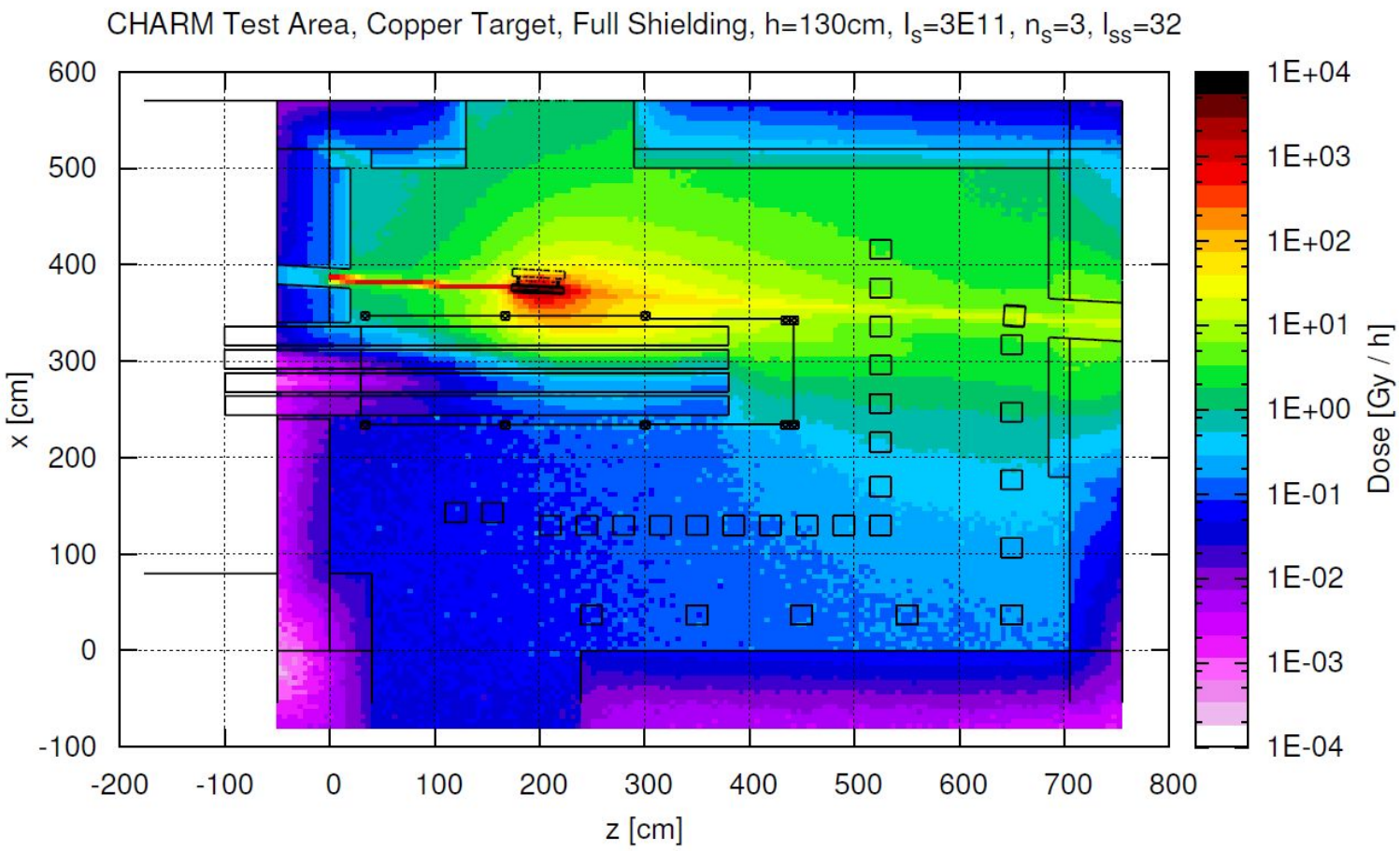
IRRAD+CHARM



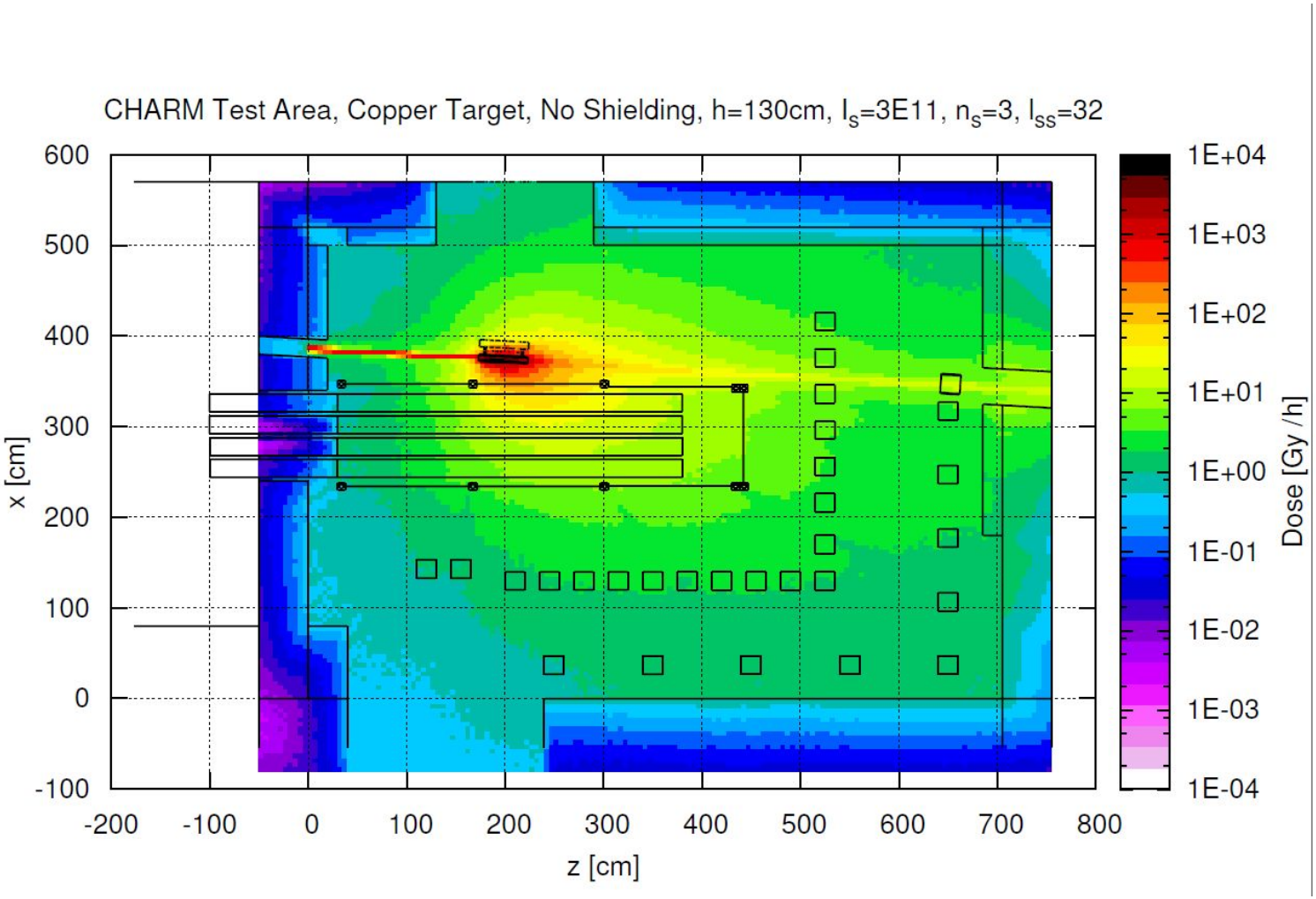
CHARM – Facility layout



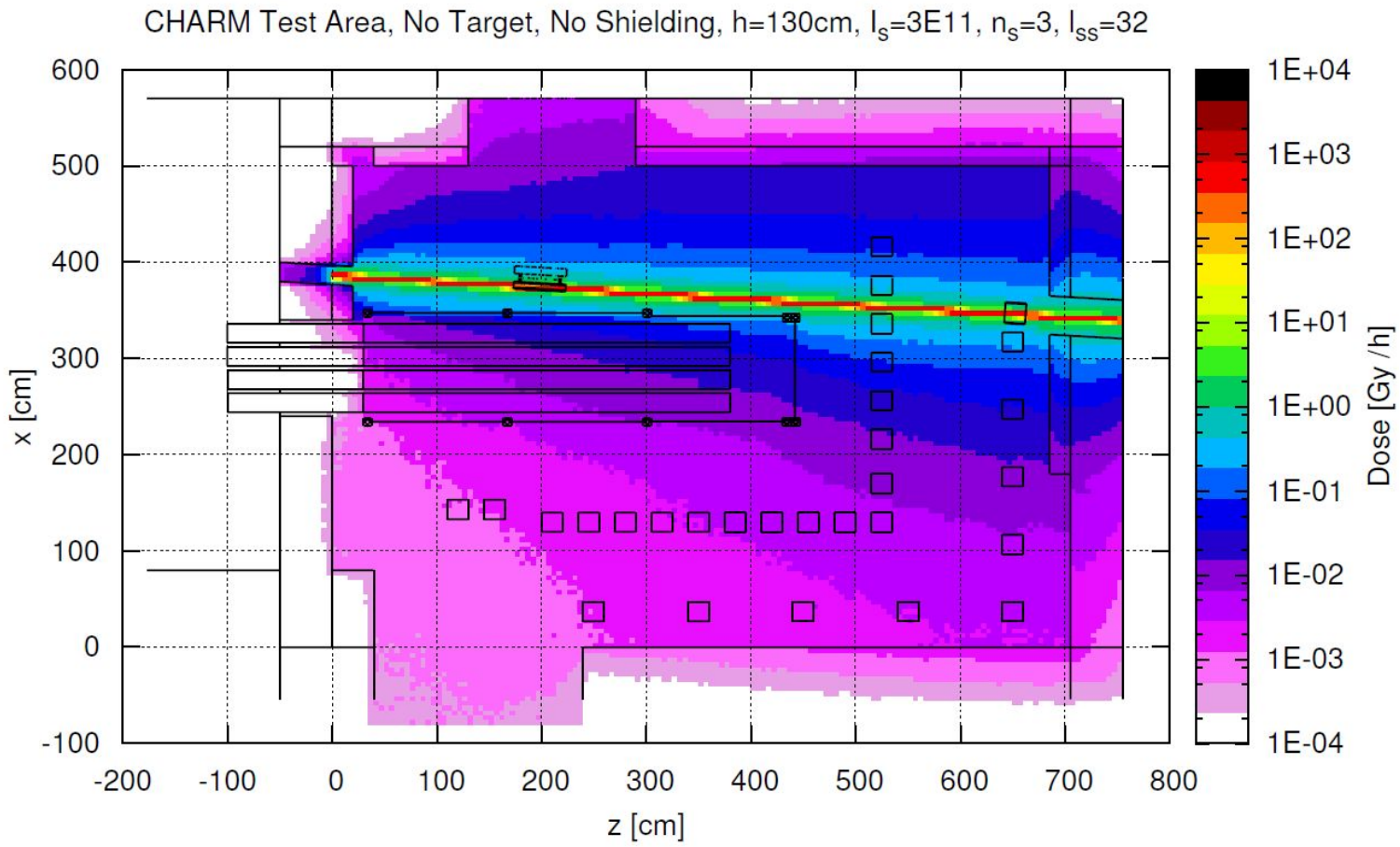
CHARM – Creating Mixed Fields



CHARM – Creating Mixed Fields

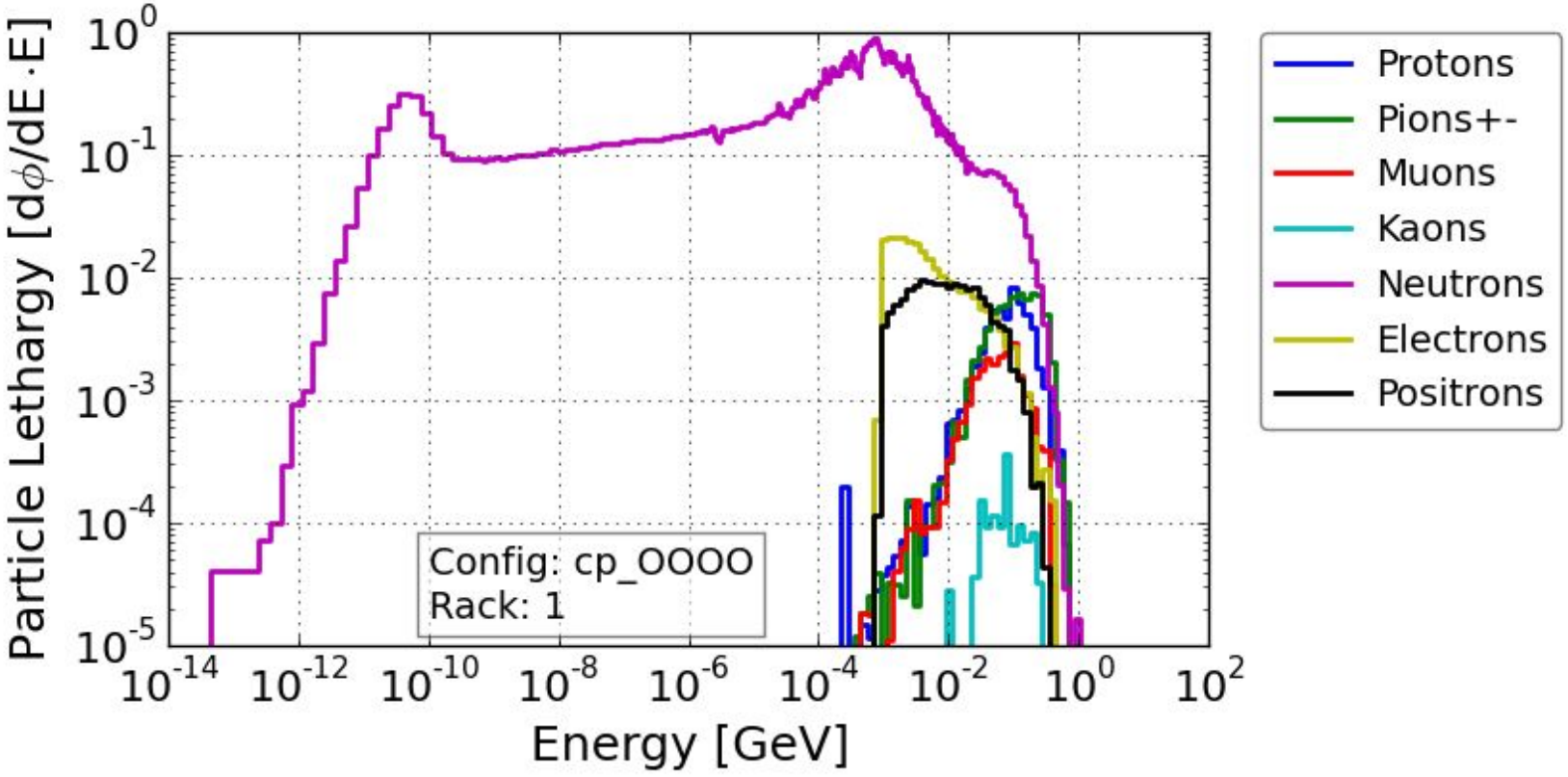


CHARM – Creating Mixed Fields



CHARM – Creating Mixed Fields

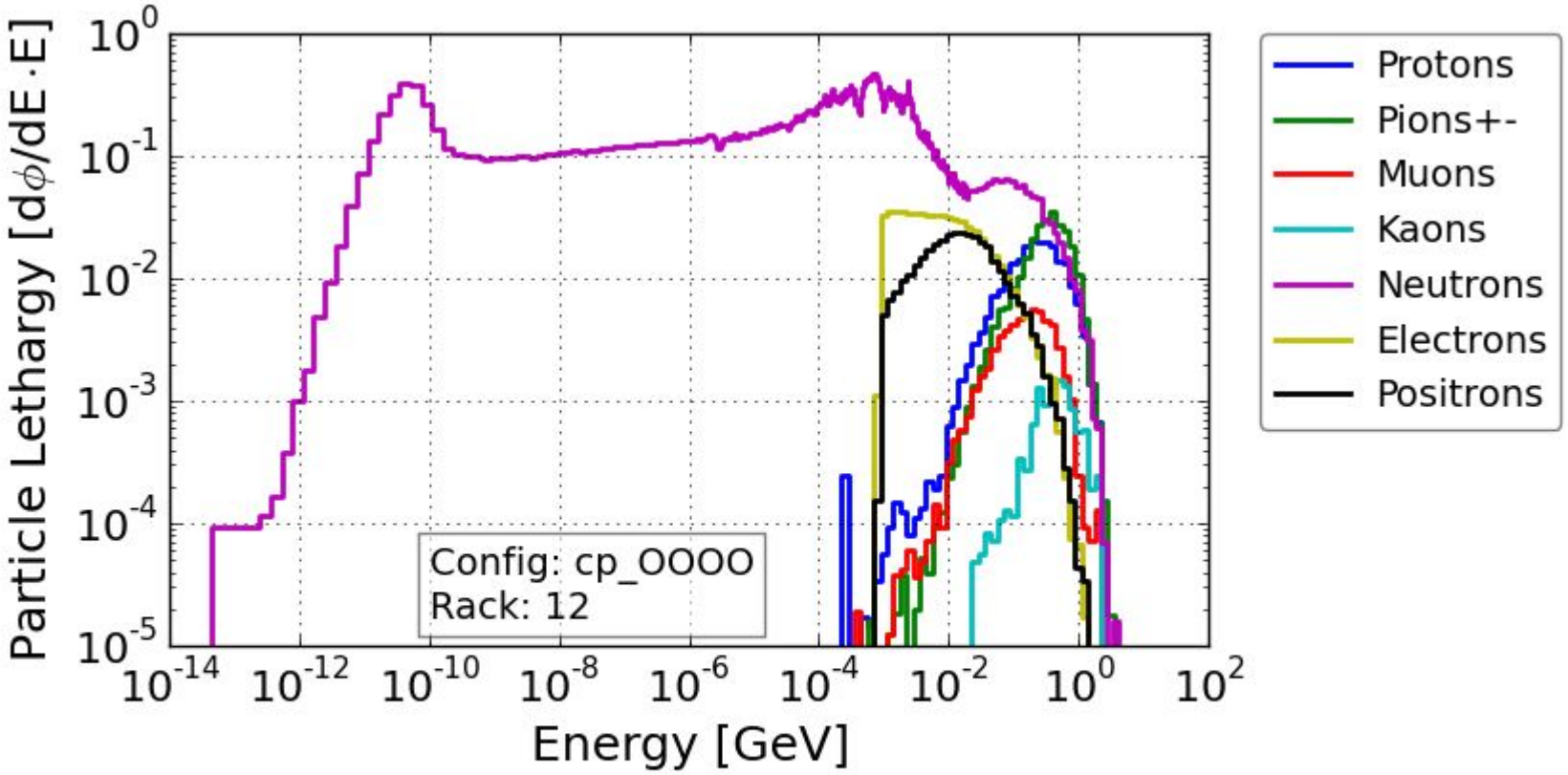
Particle Lethargy – Position 1 Copper No Shielding



Preliminary Data

CHARM – Creating Mixed Fields

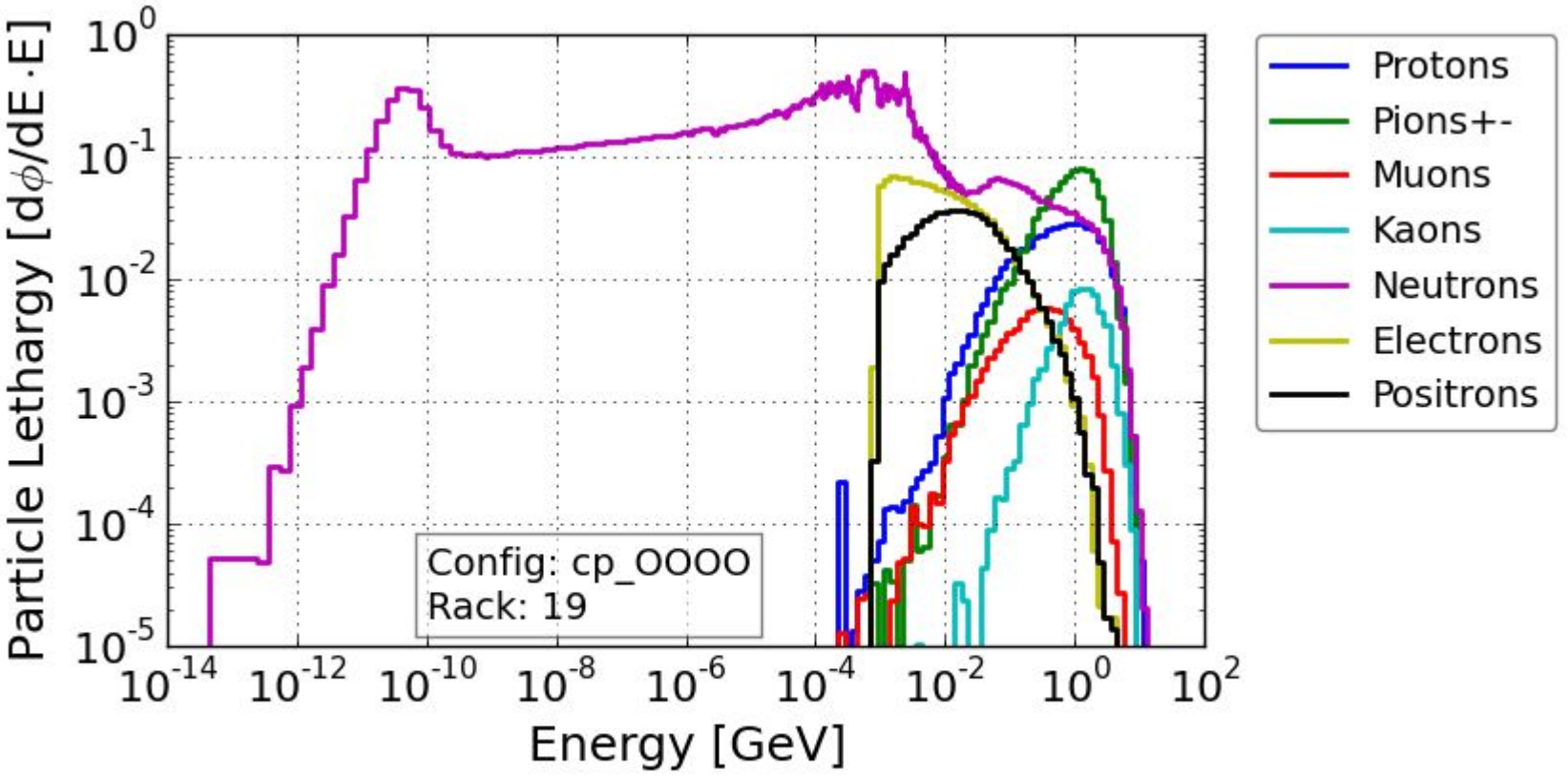
Particle Lethargy – Position 12 Copper No Shielding



Preliminary Data

CHARM – Creating Mixed Fields

Particle Lethargy – Position 19 Copper No Shielding



Preliminary Data

In-Beam Testing Too!

Radiation Effects in and out of the LHC

R2E

- Critical LHC systems exposed to high radiation fields
- Radiation Monitoring
  - Anticipation and failure diagnosis
- Calculations
- Testing
- Device upgrades, relocation and/or shielding
  - CHARM is a very valuable resource for R2E

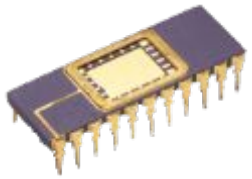
The RadMON


EN/STI Piquet - 78840 - 163720
V412692
EN/STI Piquet - 78840 - 163720
V50031_1
V412692
V60114
V60114
SCHURTER

Radiation Effects

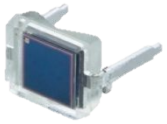
- Ionising
- Non Ionising

  - Total Ionising Dose – RadFET's

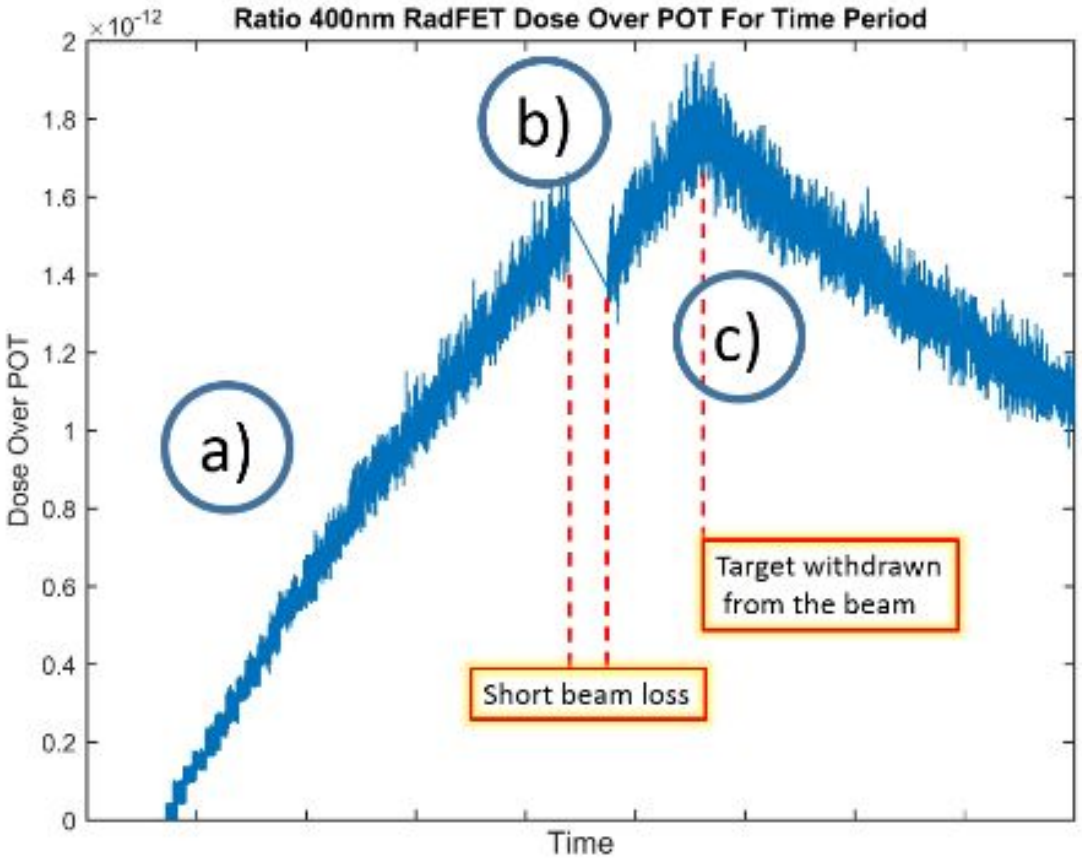


  - Single Event Effects – SRAM
    - "Upsets" that can be reset

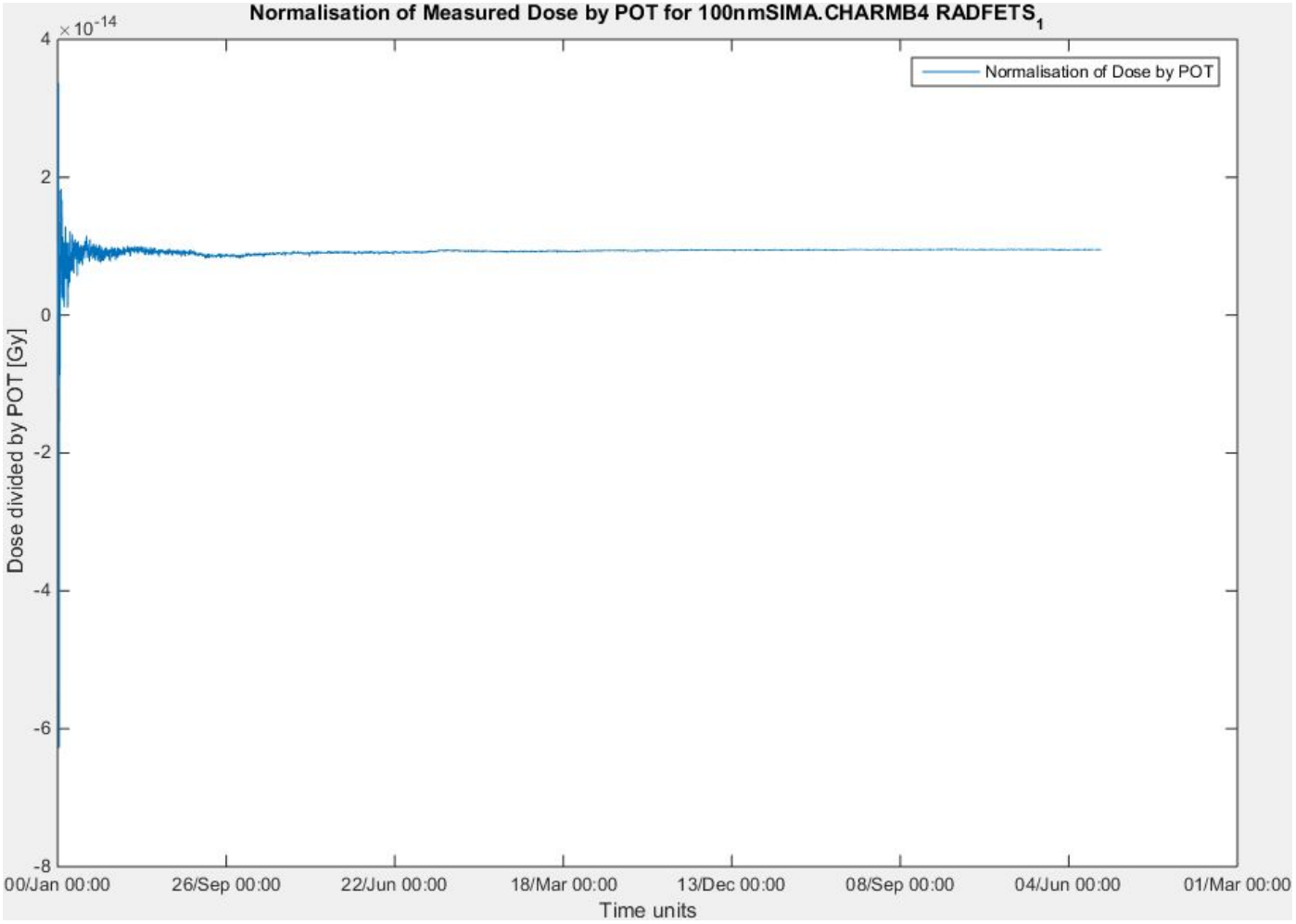
  - Displacement Damage – PIN Diodes



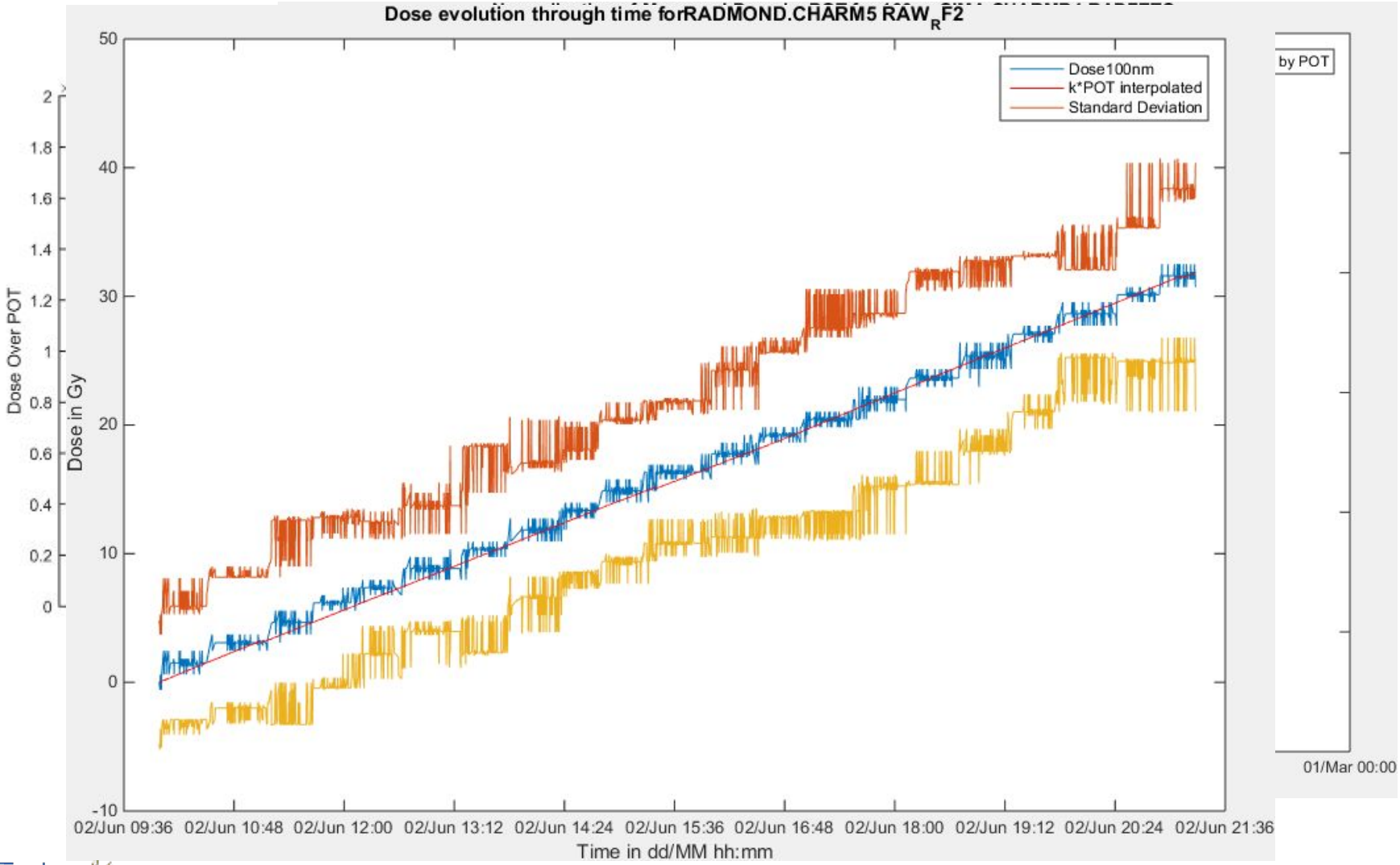
RadFET Behaviour



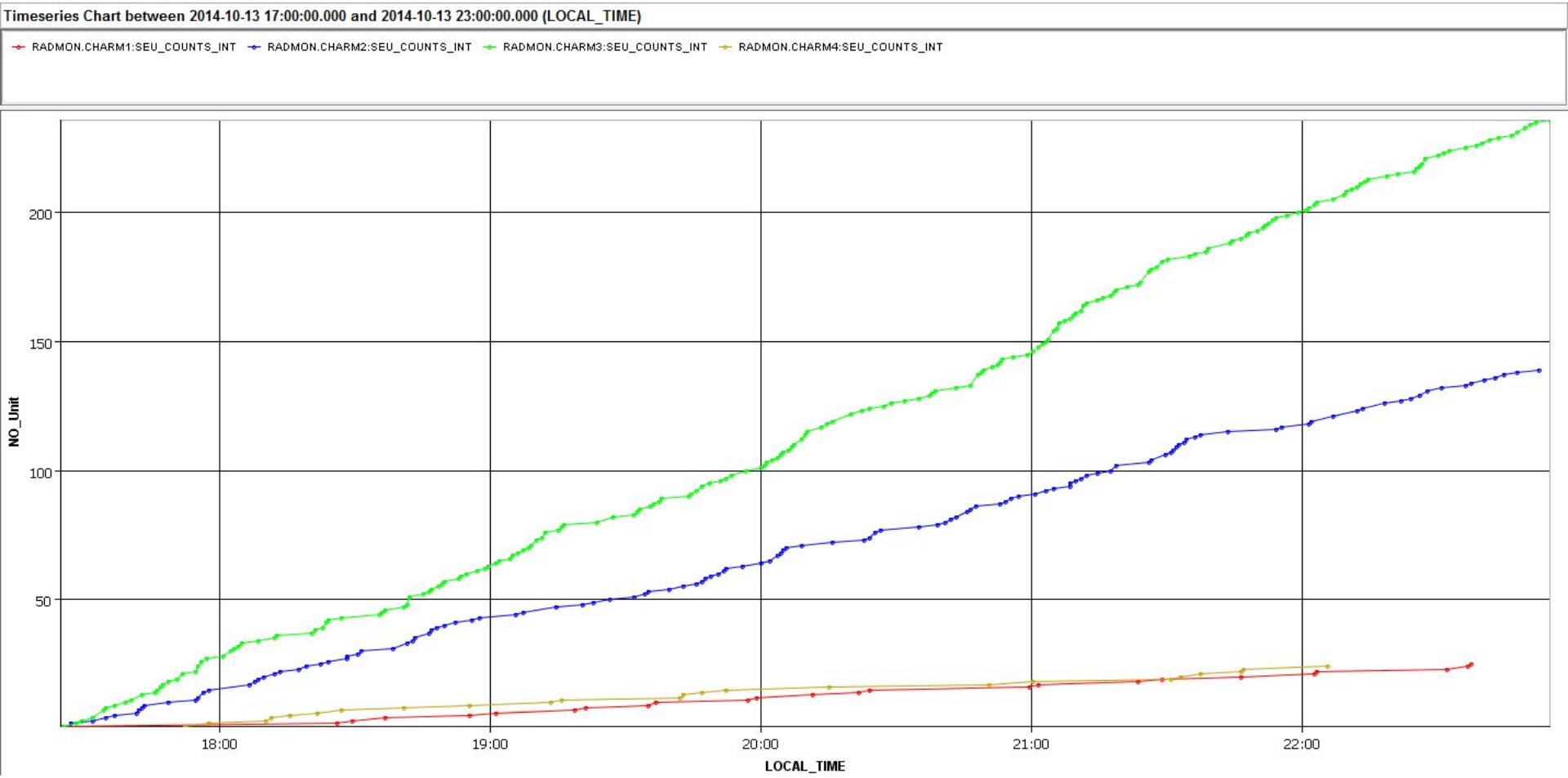
RadFET Behaviour



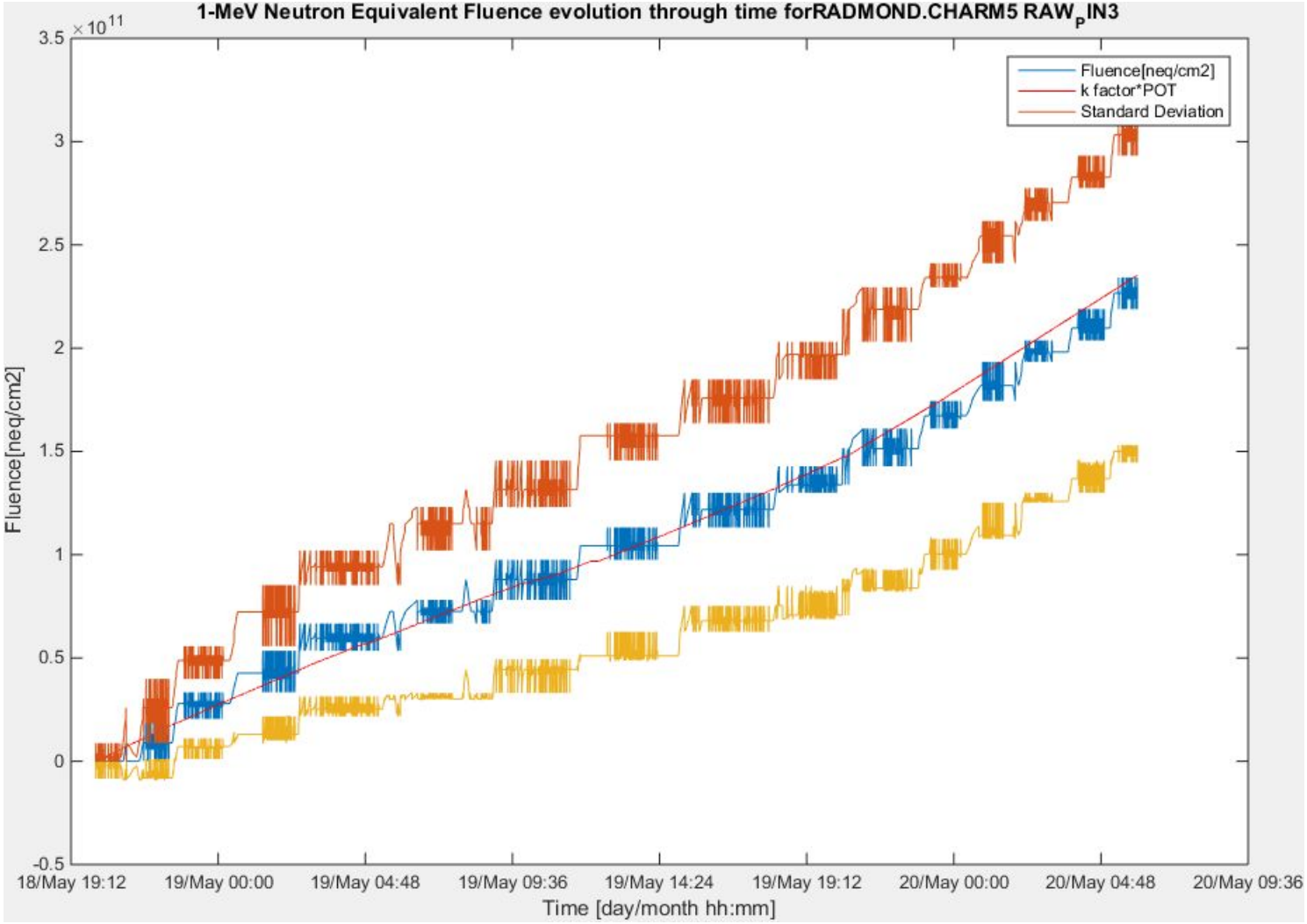
RadFET Behaviour



SEU counts – P17 Vs P18



PIN Diode Behaviour

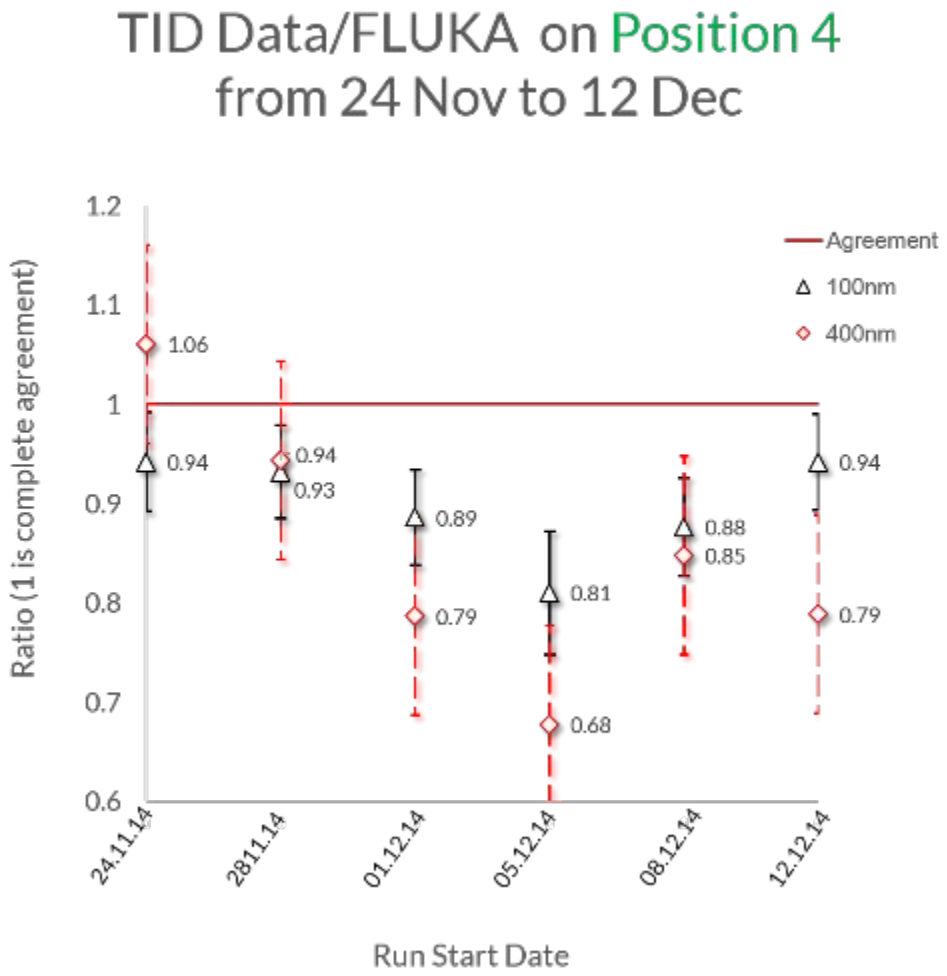


Testing

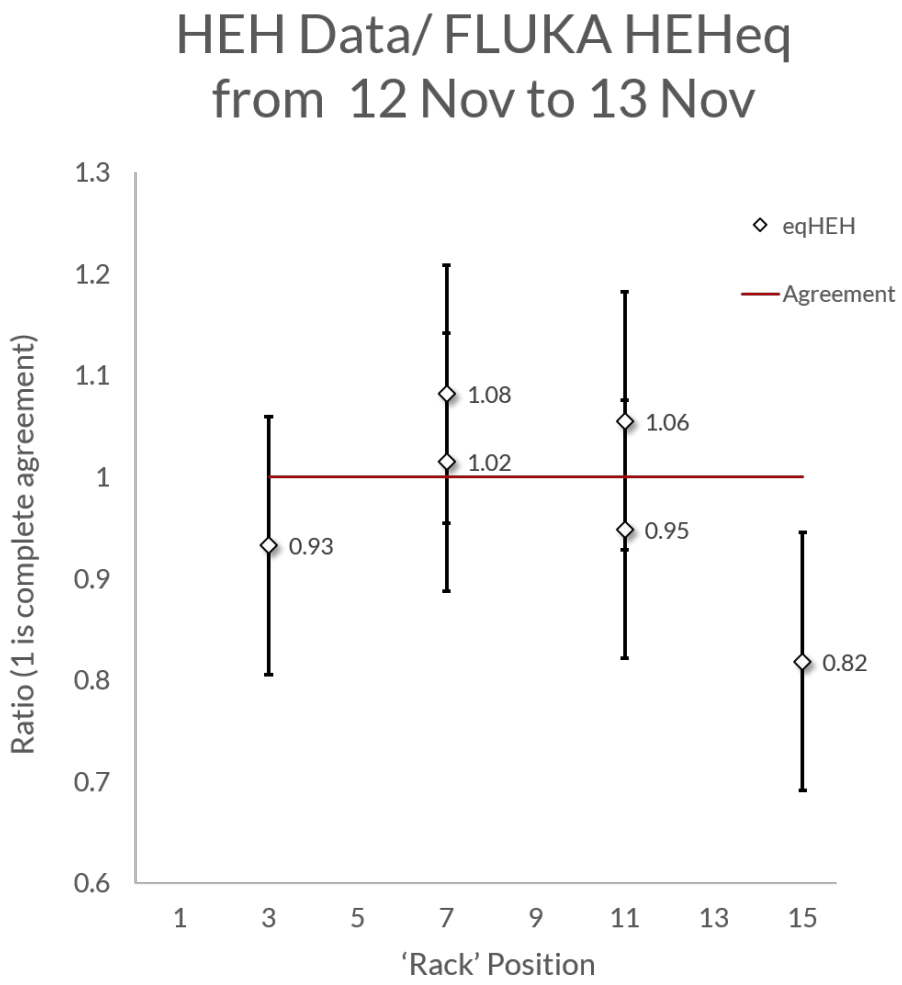
Testing – Runs of 2014

Day	Day	USERS											Target Type	Shielding Config
Tue	11-Nov-2014													
Wed	12-Nov-2014	JDI (P11)											COPPER	OOOO
Thu	13-Nov-2014													
Fri	14-Nov-2014													
Sat	15-Nov-2014													
Sun	16-Nov-2014													
Mon	17-Nov-2014	BUB MEMORY	IT BEACONS	MEMORIES P15										
Tue	18-Nov-2014	RENESAS	On P3 and P15	P15 Then P3										
Wed	19-Nov-2014												COPPER	CIIC
Thu	20-Nov-2014													
Fri	21-Nov-2014			P14										
Sat	22-Nov-2014												ALUMINIUM HOLES	OOOO
Sun	23-Nov-2014													
Mon	24-Nov-2014	CRYO (P15)		P1	CUBESAT P4									OOOO
Tue	25-Nov-2014												COPPER	
Wed	26-Nov-2014													
Thu	27-Nov-2014													
Fri	28-Nov-2014		P3 only	P16				LHCb PCB	CAPA MOS					
Sat	29-Nov-2014							*Tester board on the Montrac*	*Tester board on the Montrac*				COPPER	OOOO
Sun	30-Nov-2014													
Mon	1-Dec-2014	P15	S C radfet only	P7	+CUBESATii (P4)	RMONV6-2 P4	RMONV6-1 P15			TE/EPC TEST.	PELETIER			
Tue	2-Dec-2014									P11	*Tester board on the Montrac*		COPPER	OOOO
Wed	3-Dec-2014													
Thu	4-Dec-2014													
Fri	5-Dec-2014					P3								
Sat	6-Dec-2014												COPPER	OOOO
Sun	7-Dec-2014													
Mon	8-Dec-2014								-1 CAPA MOS					
Tue	9-Dec-2014												COPPER	OOOO
Wed	10-Dec-2014													
Thu	11-Dec-2014													
Fri	12-Dec-2014	P15		P14					-1 CAPA MOS					
Sat	13-Dec-2014													OOOO
Sun	14-Dec-2014												COPPER	
Mon	15-Dec-2014													

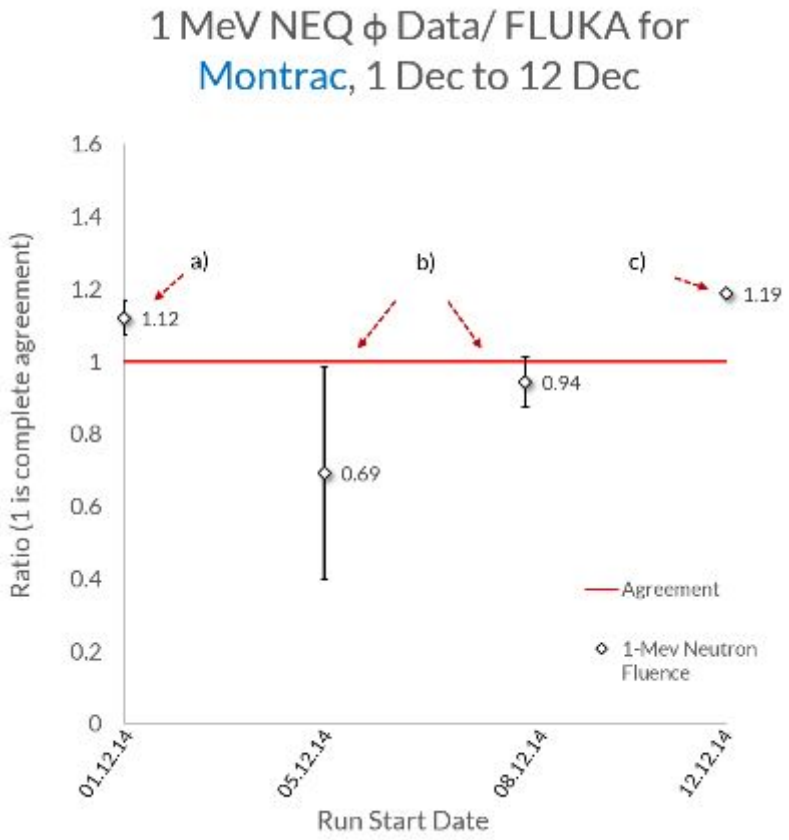
Comparisons



Comparisons



Comparisons



Limitations

- 80 Gy Motherboard limit
- TID measurement counterproductive to HEH measurement
- Simulation approximations
  - Air, not silicon
  - Not all dose is ionising -> remember J/Kg
- Influence of IRRAD on CHARM under study
- 2014 Dominated by copper target

Data summary

- High doses – lots of statistics
- Close agreement with Fluka in 1-MeV NEQ fluence
- Close agreement for HEH data
  - Not so for thermal neutrons – much more measured
  - Difficulty in simulating accurate geometry in FLUKA

Conclusions

- Consistency across positions and time
- Reliability in FLUKA simulations confirmed
- RadMON used to diagnose differences in geometry
- Longitudinal and transversal aspects of particle geometry

- Validation of user experiments!!!

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Thank you!

- Questions?

Aspects