

Test Infrastructure and Dose Measurements in TCC2

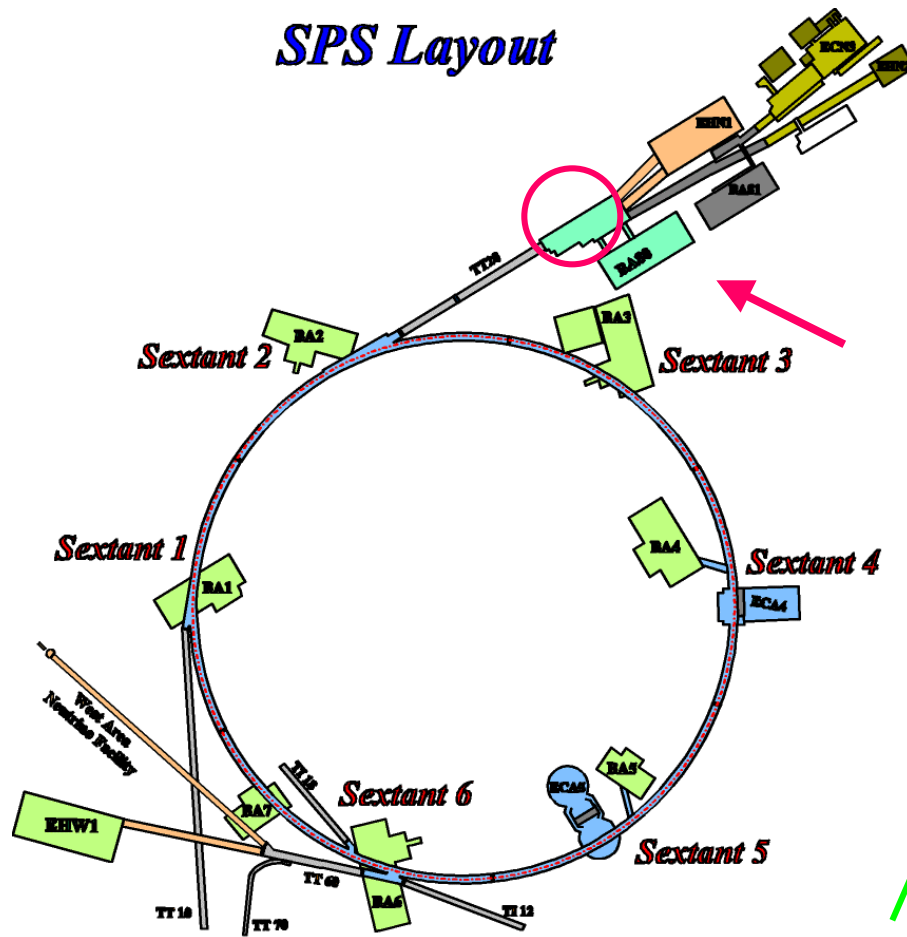
*Christian Pignard, Raymond Rausch
Thijs Wijnands*

RADWG Day 7-12-2001

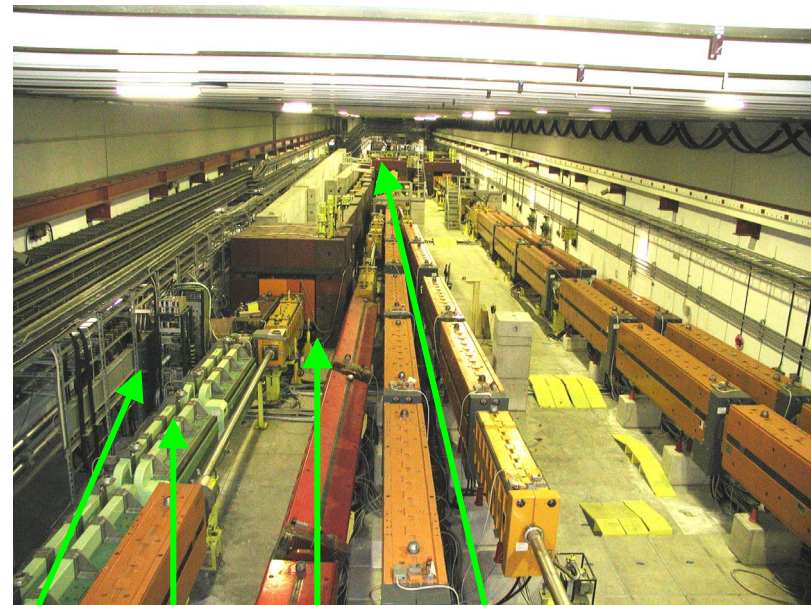
Contents

- TCC2 test area & operation M2 beam line
- TCC2 dose measurements
- Effects of radiation on equipment

BA80-TCC2- North Exp. Area



TCC2 Hall and beam lines



T6 Target

TAX collimator

M2 beam line

Radiation Damage Test Area

Beam Lines

LHC radiation test area next to M2 beam line to COMPASS :

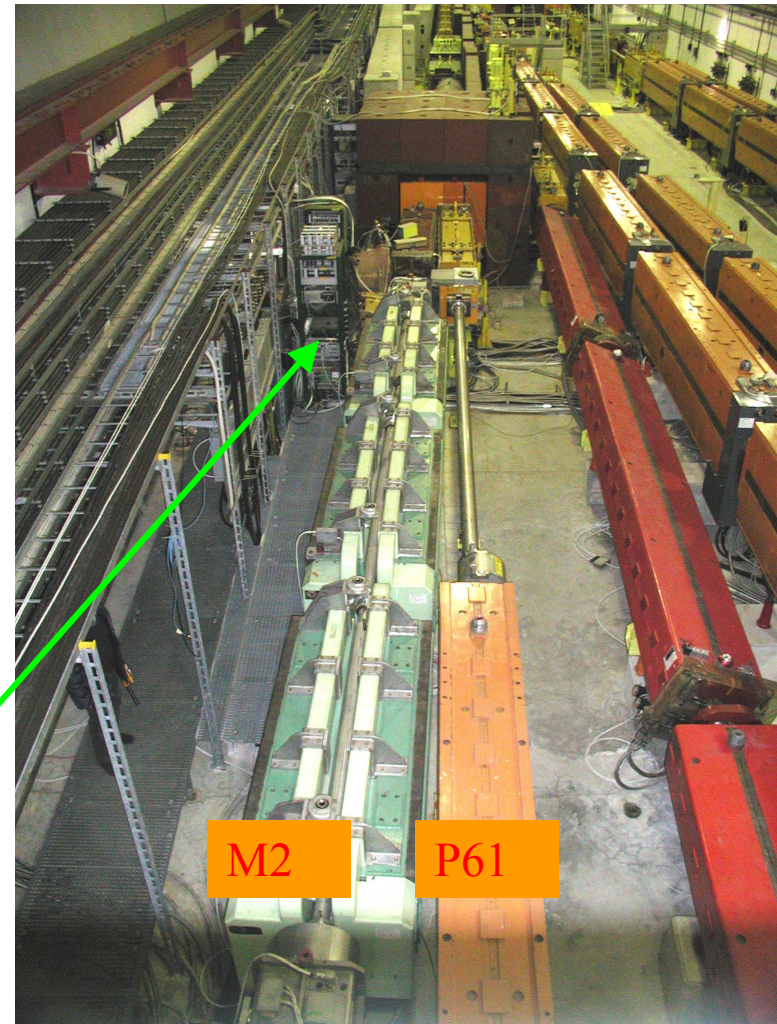
*“COmmon Muon Proton Apparatus
for Structure and Spectroscopy”*

Operation Modes M2 :

- Muon Mode (in 2001, 2002)
- Hadron Mode
- Electron Mode

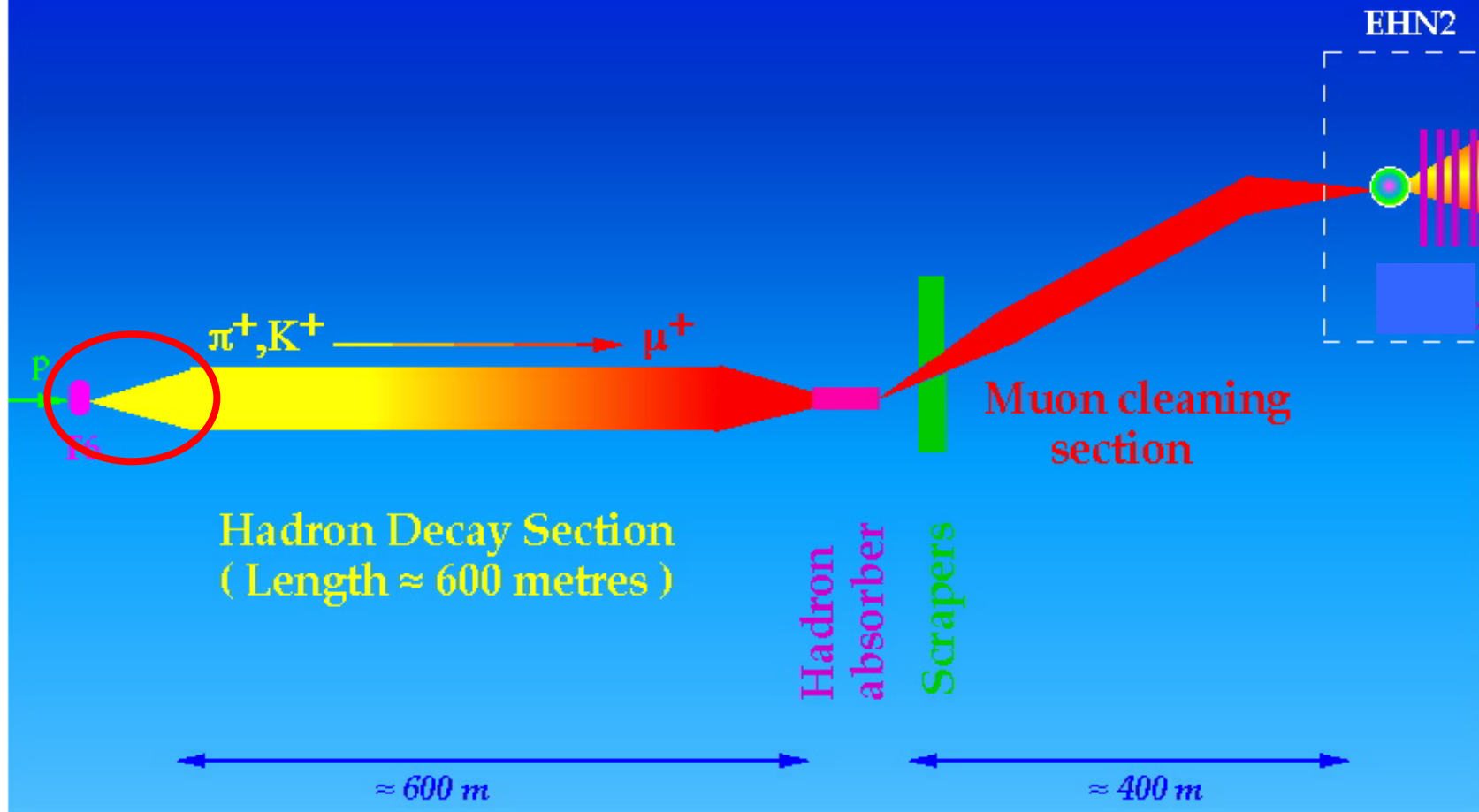
Radiation Damage Test Area

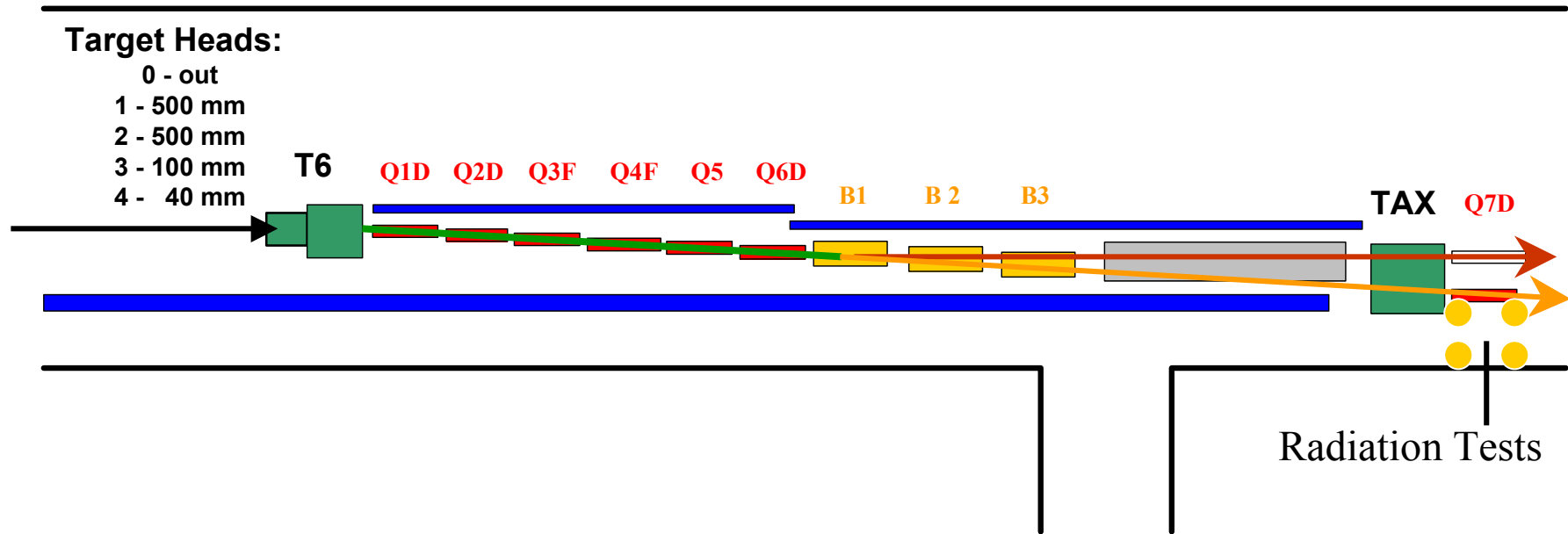
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THE M2 MUON BEAM

Lau Gatignon





Primary SPS beam at 400 GeV (1.2×10^{13} protons/cycle)

Secondary SPS beam (5×10^{12} protons and 5×10^{12} pions, kaons, ...)

P61 beam line

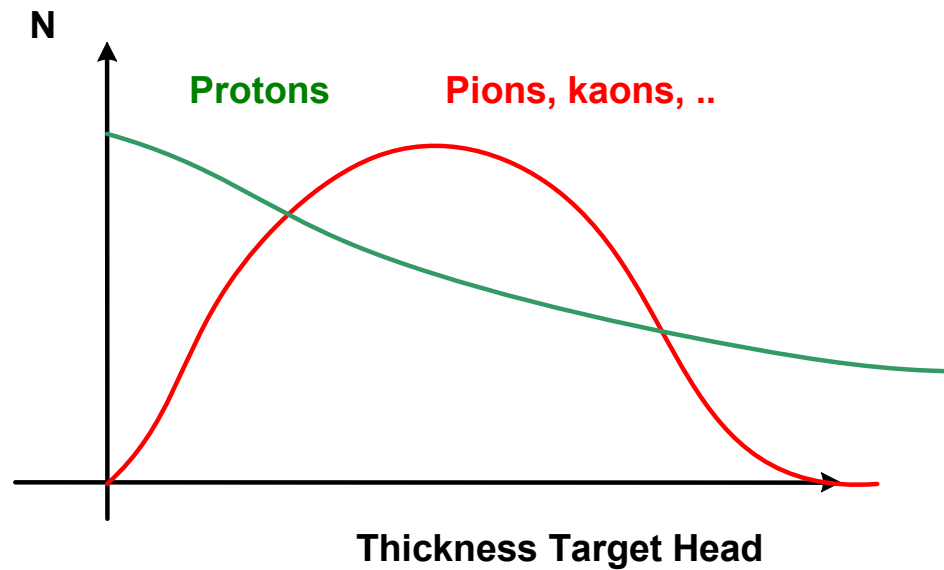
M2 beam line ($2 \cdot 10^8$ muons/cycle from $2 \cdot 10^{10}$ pions)

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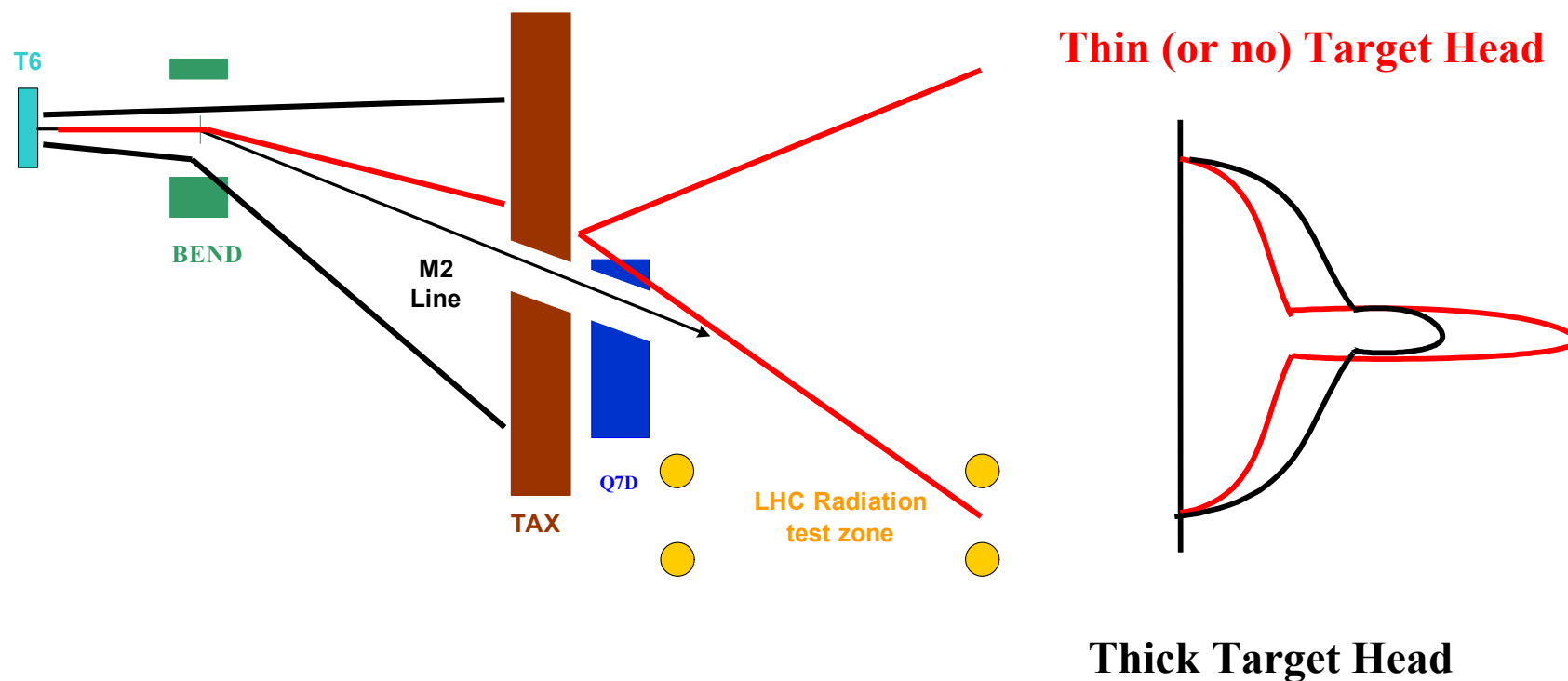
Hadron intensity behind T6

- Intensity primary beam from SPS
- Thickness T6 Target head (0 cm – 50 cm)



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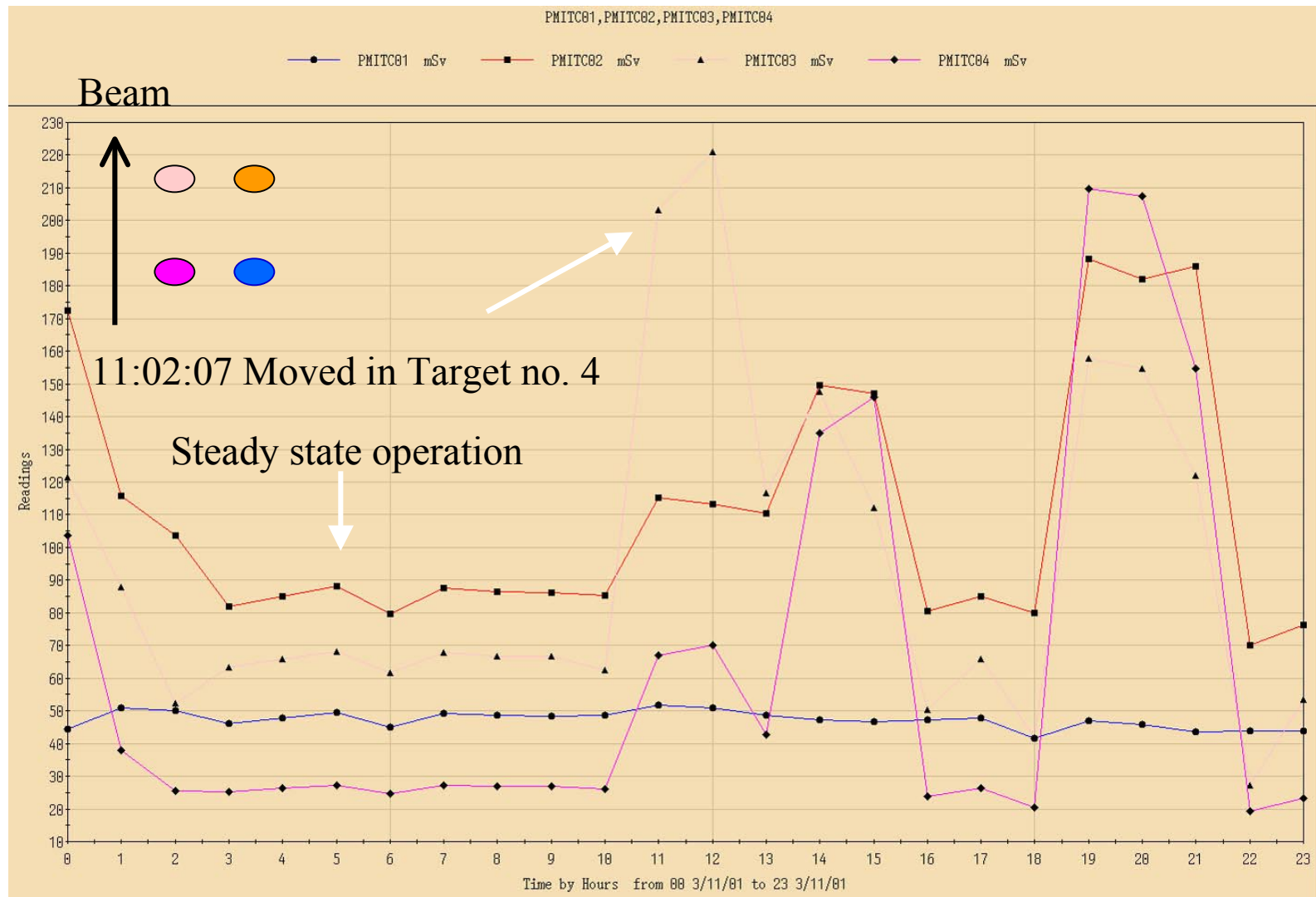
M2 operation scenarios



Schematic plot, drawing not to scale ...

Lau Gatignon

Hourly Dose vs. M2 operation log



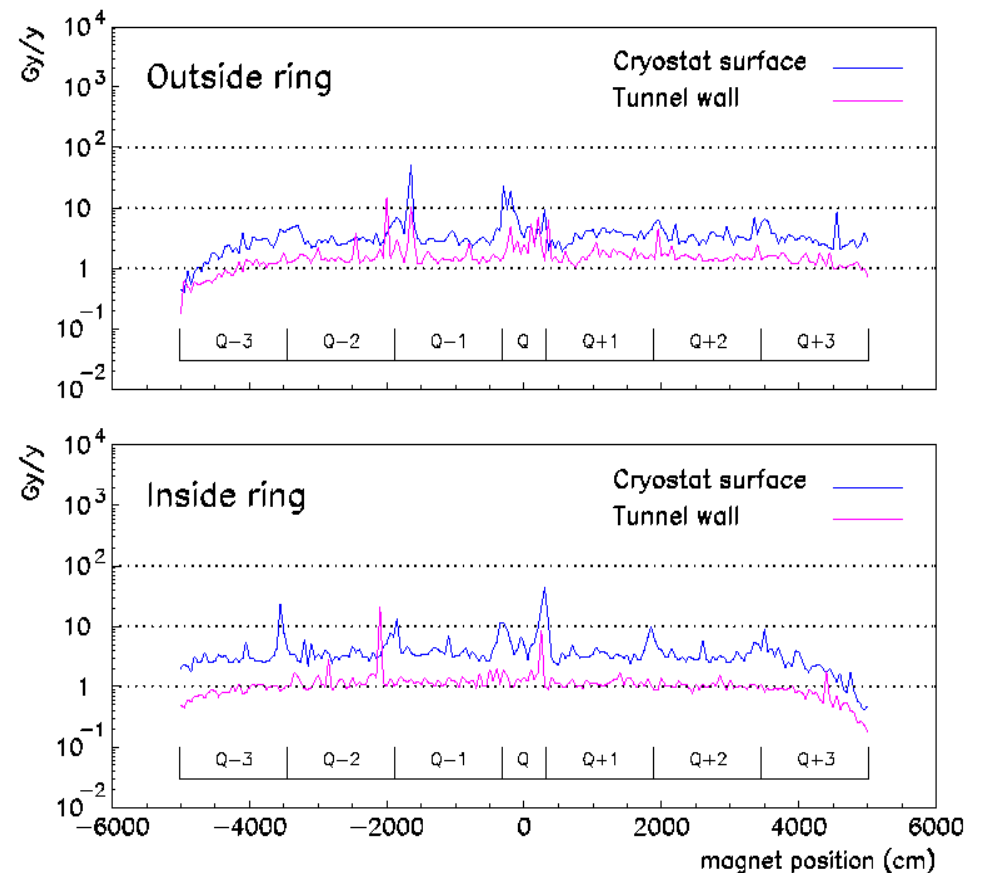
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Radioactivity Units I

- Gray [J/kg]
dose absorbed when energy deposited by the radiation in the material is 1 Joule/kg.

Example : Annual dose LHC arcs

- Alongside inter-magnet gaps < 50 Gy/y.
- < 10 Gy/y entire length of LHC arc cell



Claire Fynbo

Radioactivity Units II

- Sievert [J/kg] dose Gray x Quality Factor
- Quality Factor Q *accounts for Linear Energy Transfer*
-ionisation density ↓ when $v \approx c$
-ionisation density ↑ when $v < 0$

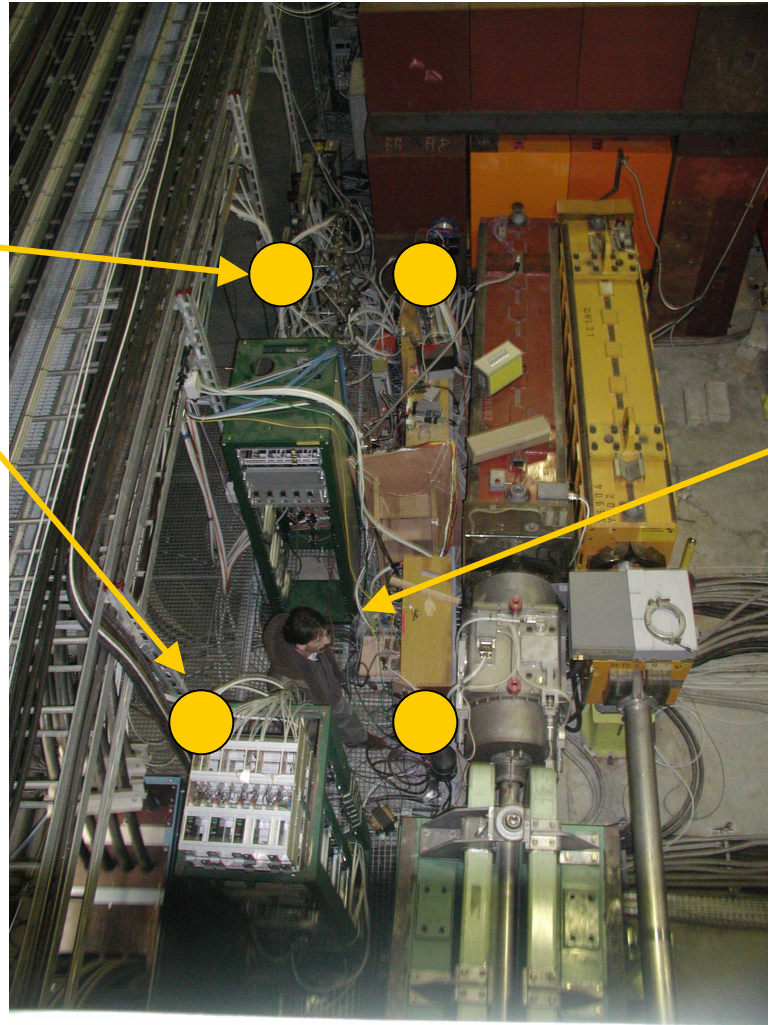
$$\Delta p = F \Delta t$$

Examples for TCC2 :

Protons	> 2 MeV	5
Neutrons	< 10 keV	5
	10 keV – 100 keV	10
	100 keV – 2 MeV	20
	> 20 MeV	5

TCC2 Dosimeters

On line dose
measurements



Christian Pignard

TCC2 Dosimetry - I

Active Dosimeters :

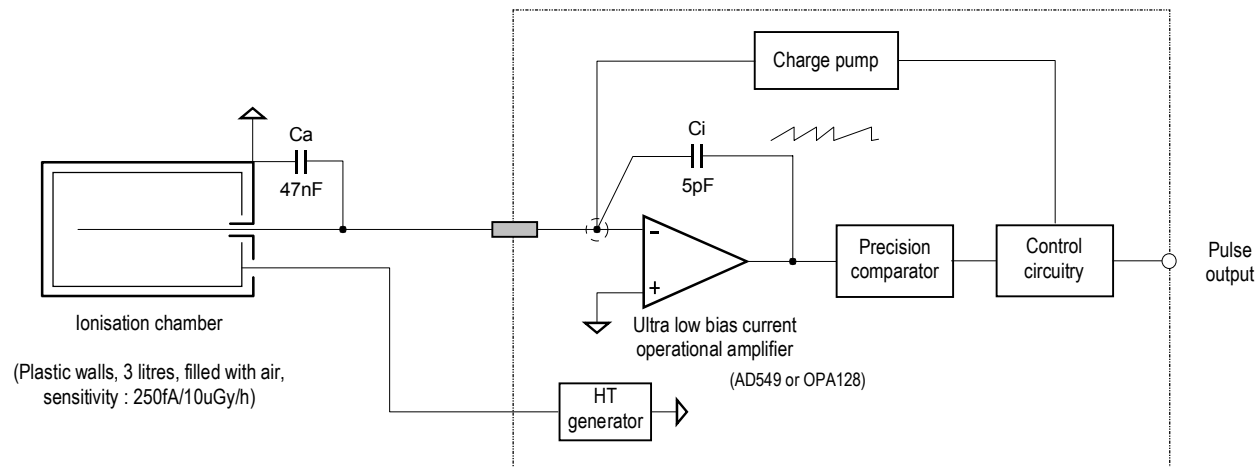
Daniel Perrin

- PMI - Protection Monitoring Induced activity
 - On line measurement
 - Complexity of data acquisition system and a database
 - Designed for protection of personnel
 - Special “setting” for TCC2
 - In TCC2 risk of “saturation”

PMI Ionisation chambers

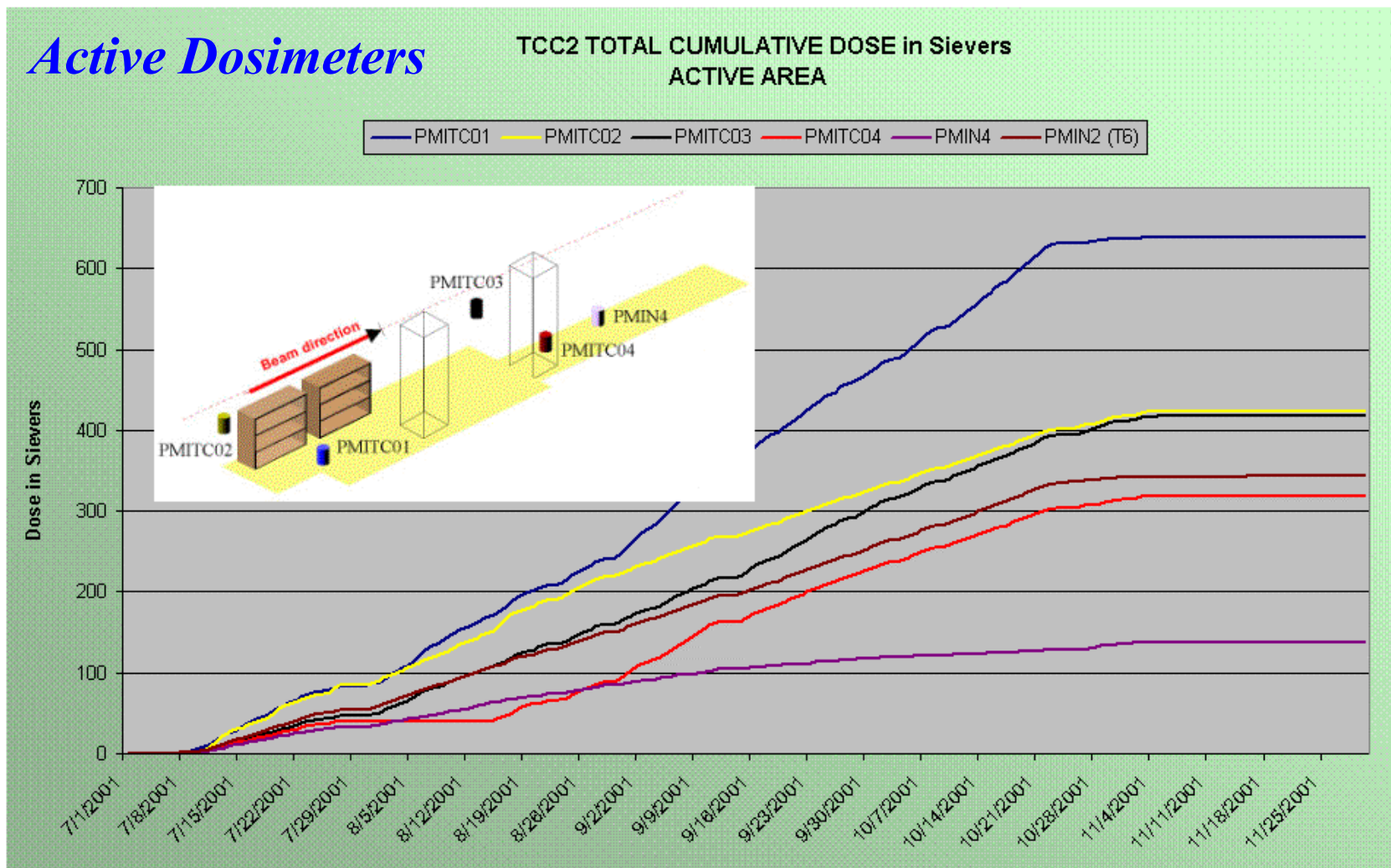
- Air filled plastic container
- Ionising radiation creates electrons
- Electrons are attracted by electrode
- Small current is converted in Sieverts/h

Daniel Perrin



Functional diagram (charge digitizer)

2001 Radiation Campaign



TCC Dosimetry - II

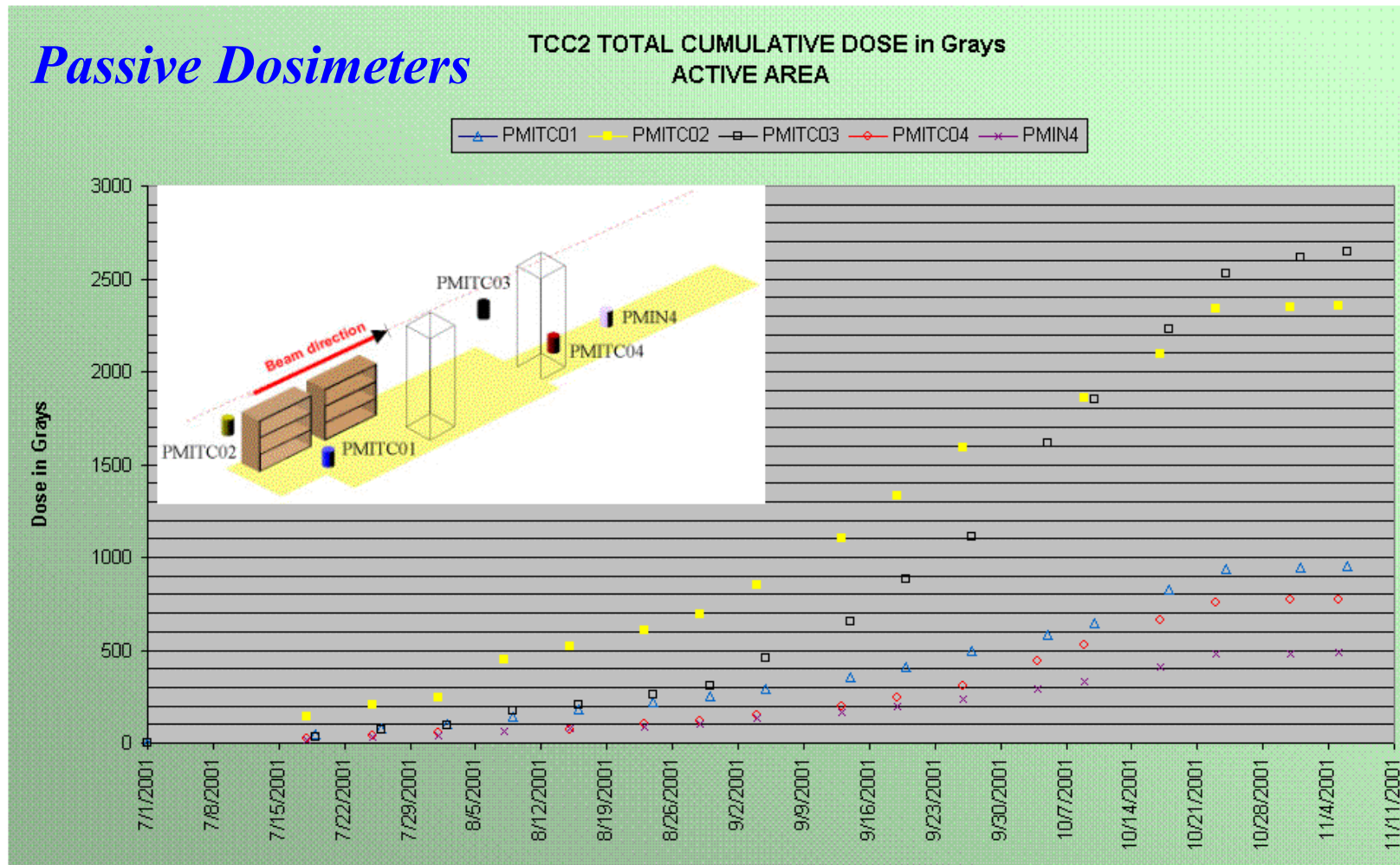
Passive Dosimeters :

- PAD - Polymer-Alanine-Dosimeter
- RPL - Radio Photo Luminescent
- PIN diodes - *p-intrinsic-n* diode

Marc Tavlet

- Compact, simple and cheap
- Integrate the dose over a longer period
- Need to be taken out & processed periodically

2001 Radiation Campaign



On line Radfet and PIN diode

Barbara Camanzi

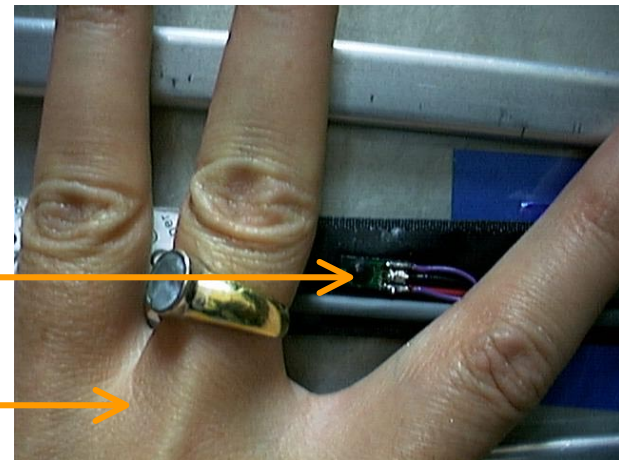
Work done for CMS

On line Dose measurements

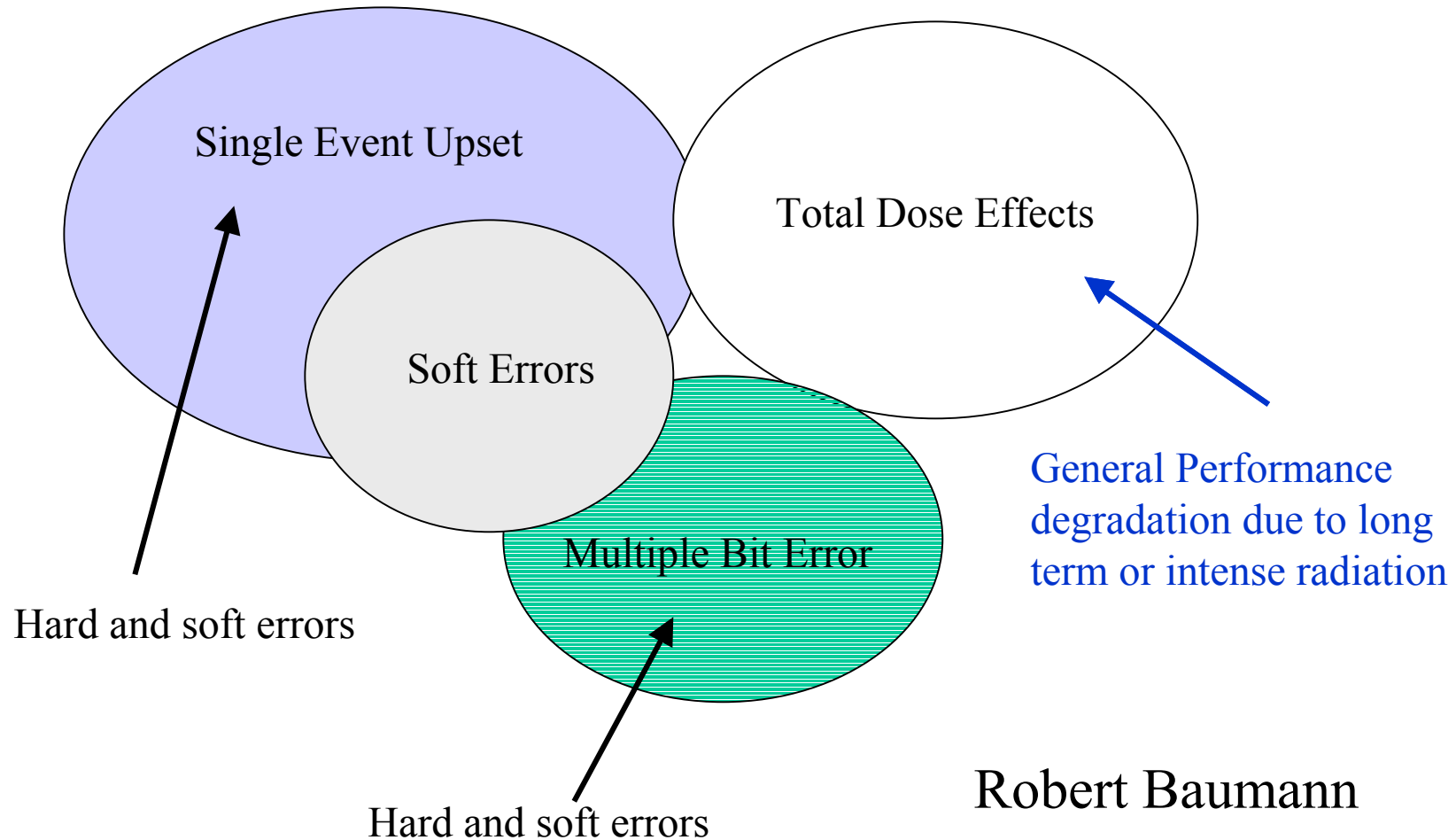
On line Fluence measurements

RadFET

Barbara's hand



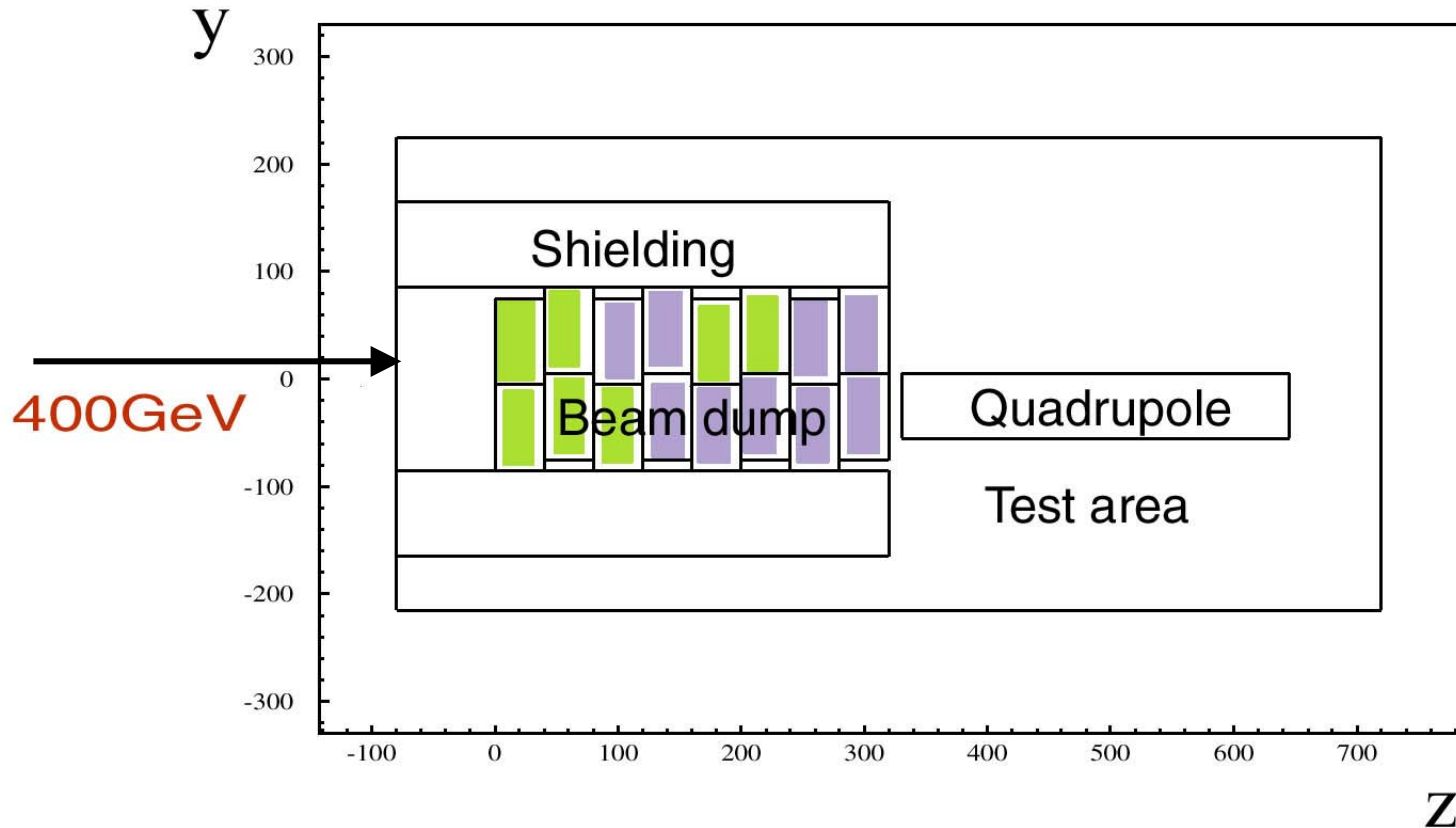
Radiation effects on LHC equipment



Robert Baumann
(Texas Instruments)

Fluka Simulation TCC2

Target Attenuator eXperimental Areas

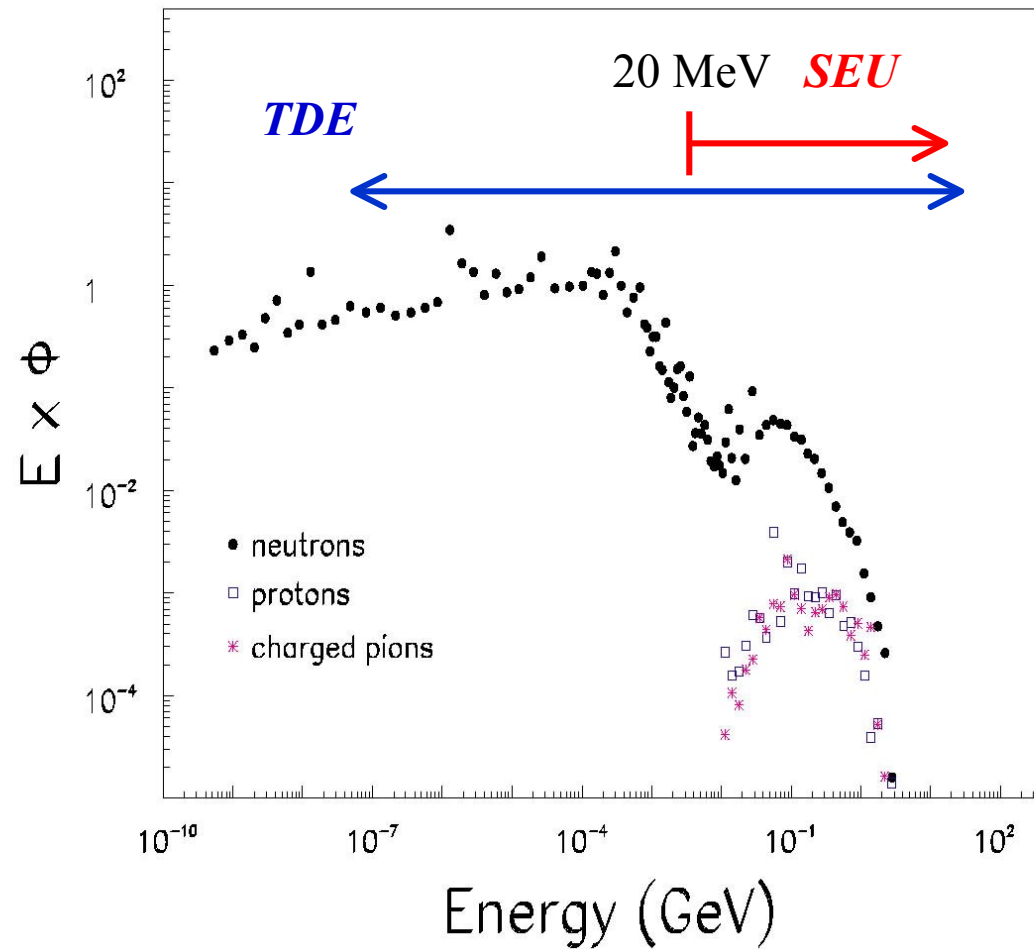


Copper

Iron

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Simulated TCC2 Spectrum

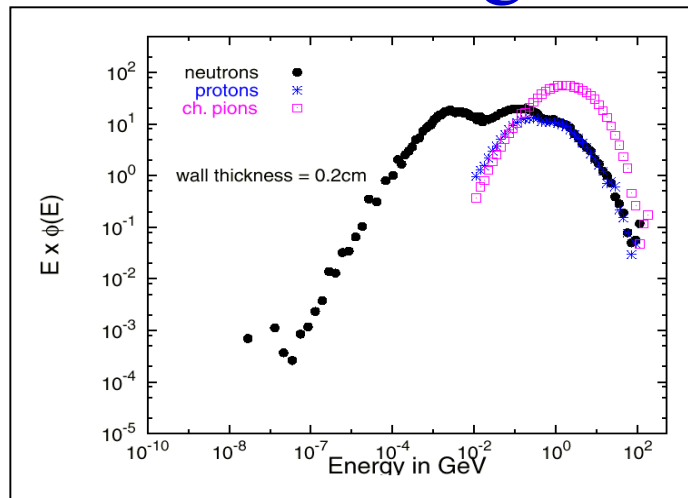


Shielding

Particle Spectra outside shielding are dependent on:

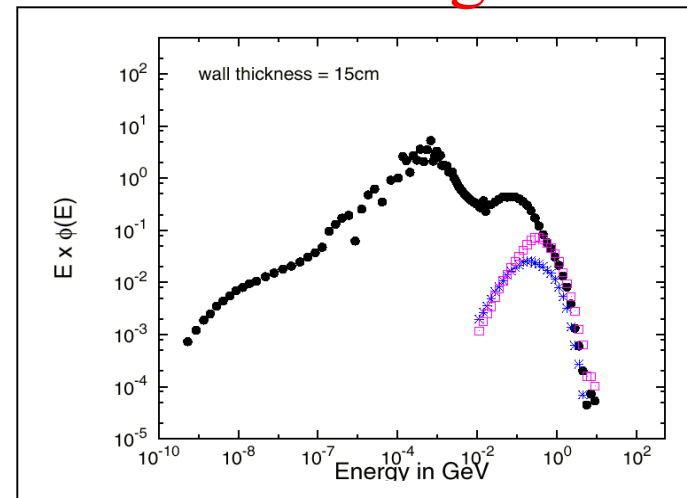
- Type of Shielding material
- Thickness of material

Thin shielding



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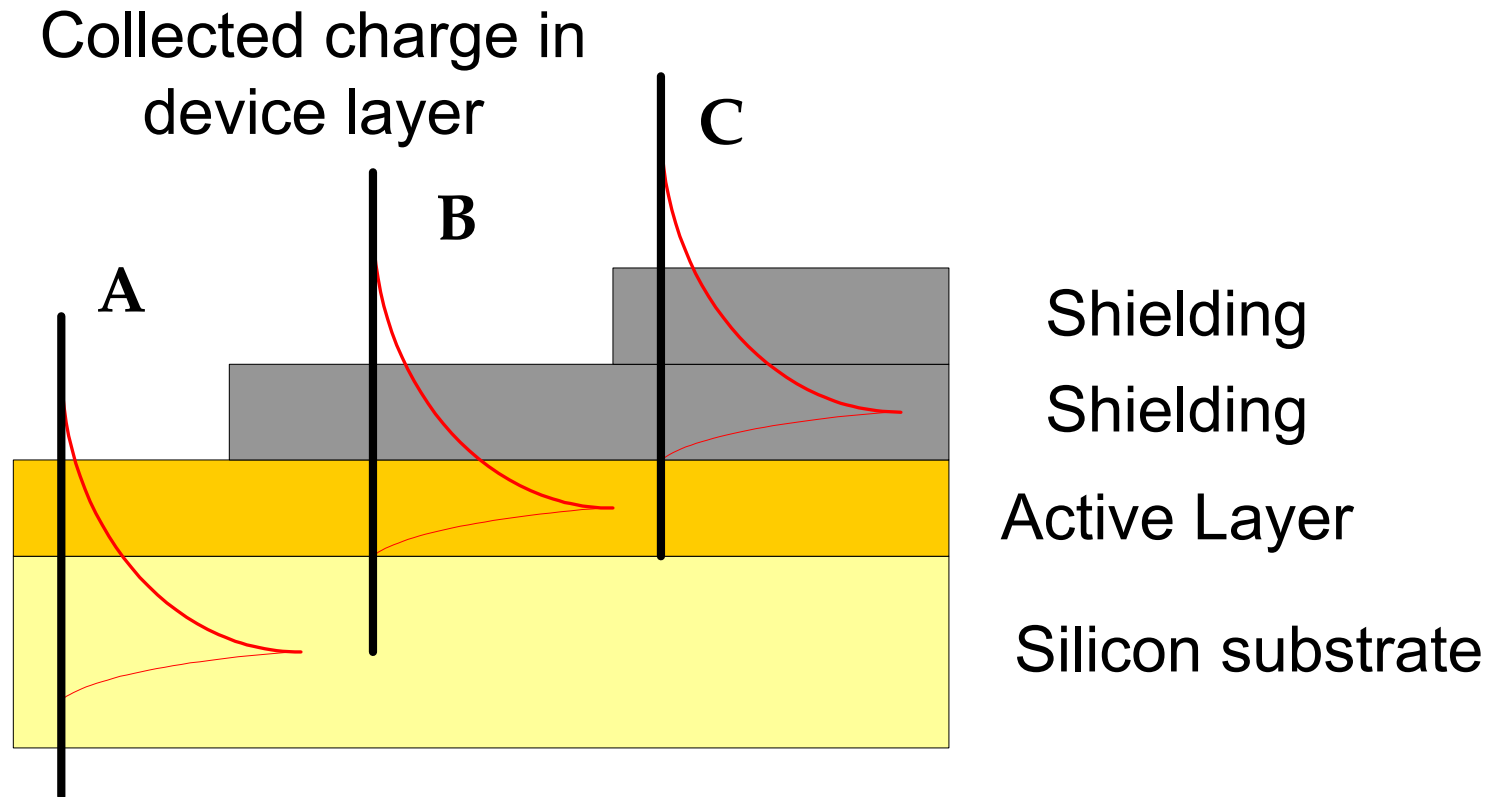
Thick shielding



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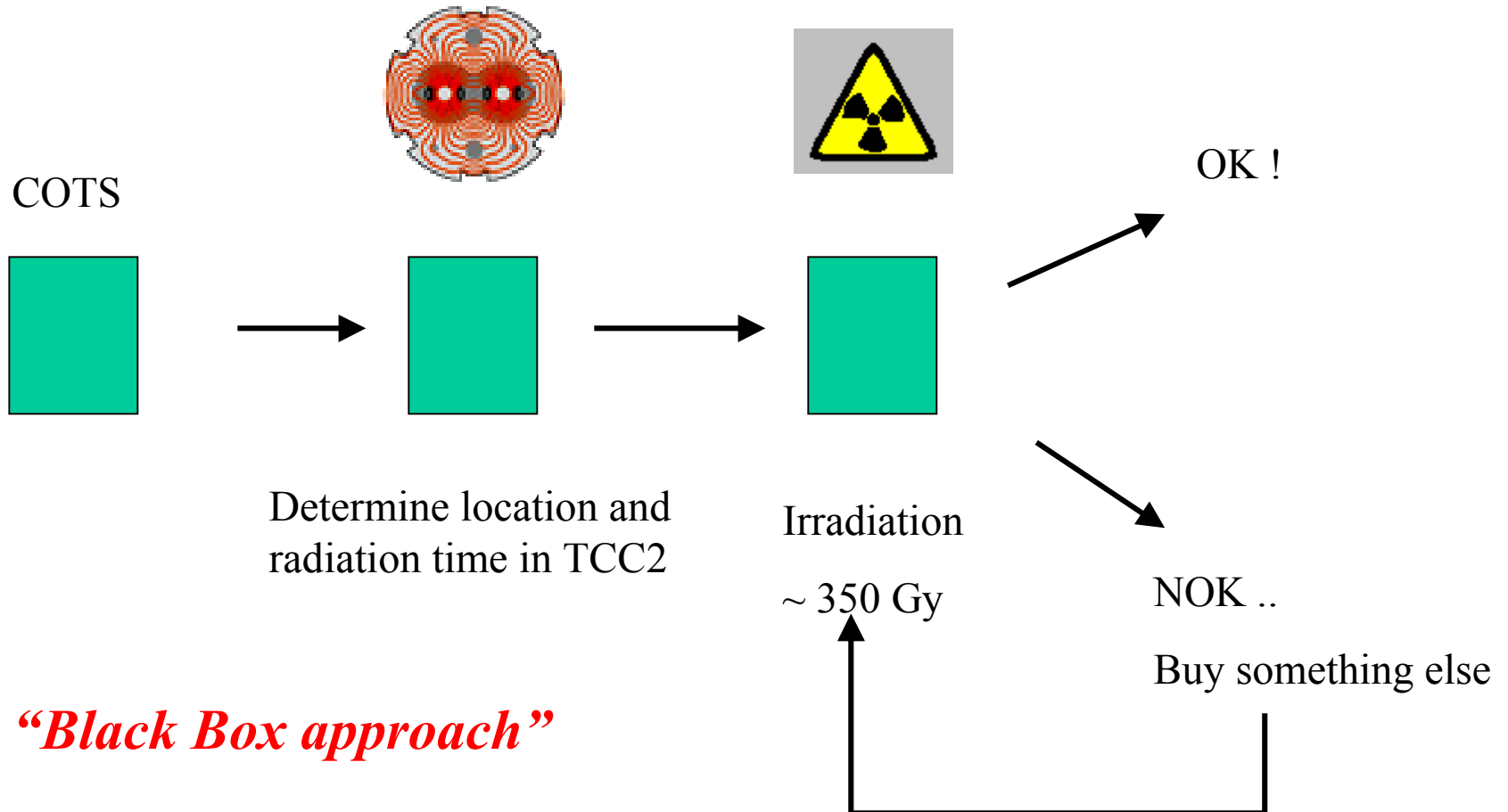
22

Example : Effects in Silicon



Thin *shielding can be worse than* **no** *shielding*

TCC2 rad tests I

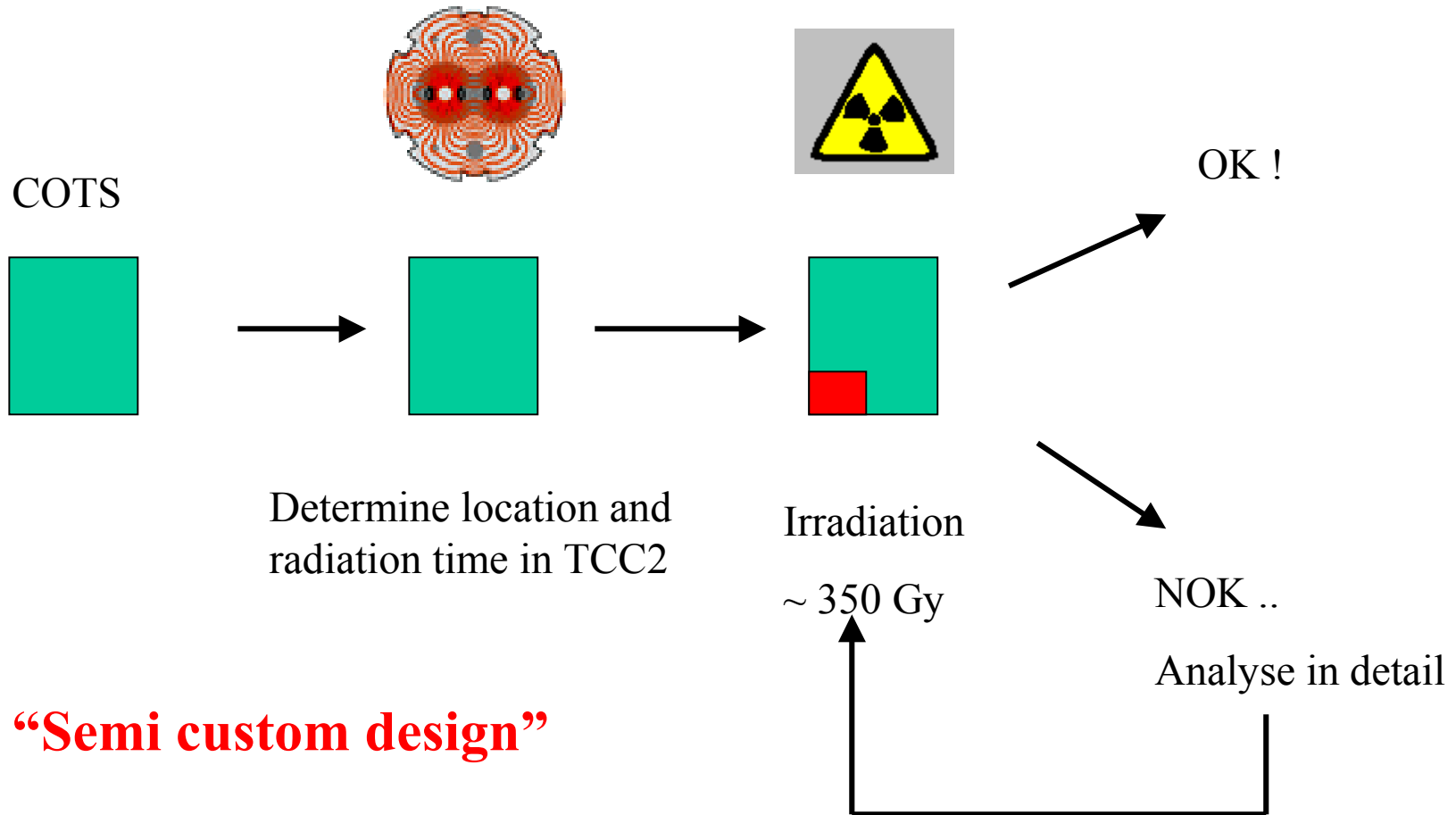


Ex. : Modular Power Supplies



Jean-Denis
Hundzinger

TCC2 rad tests II

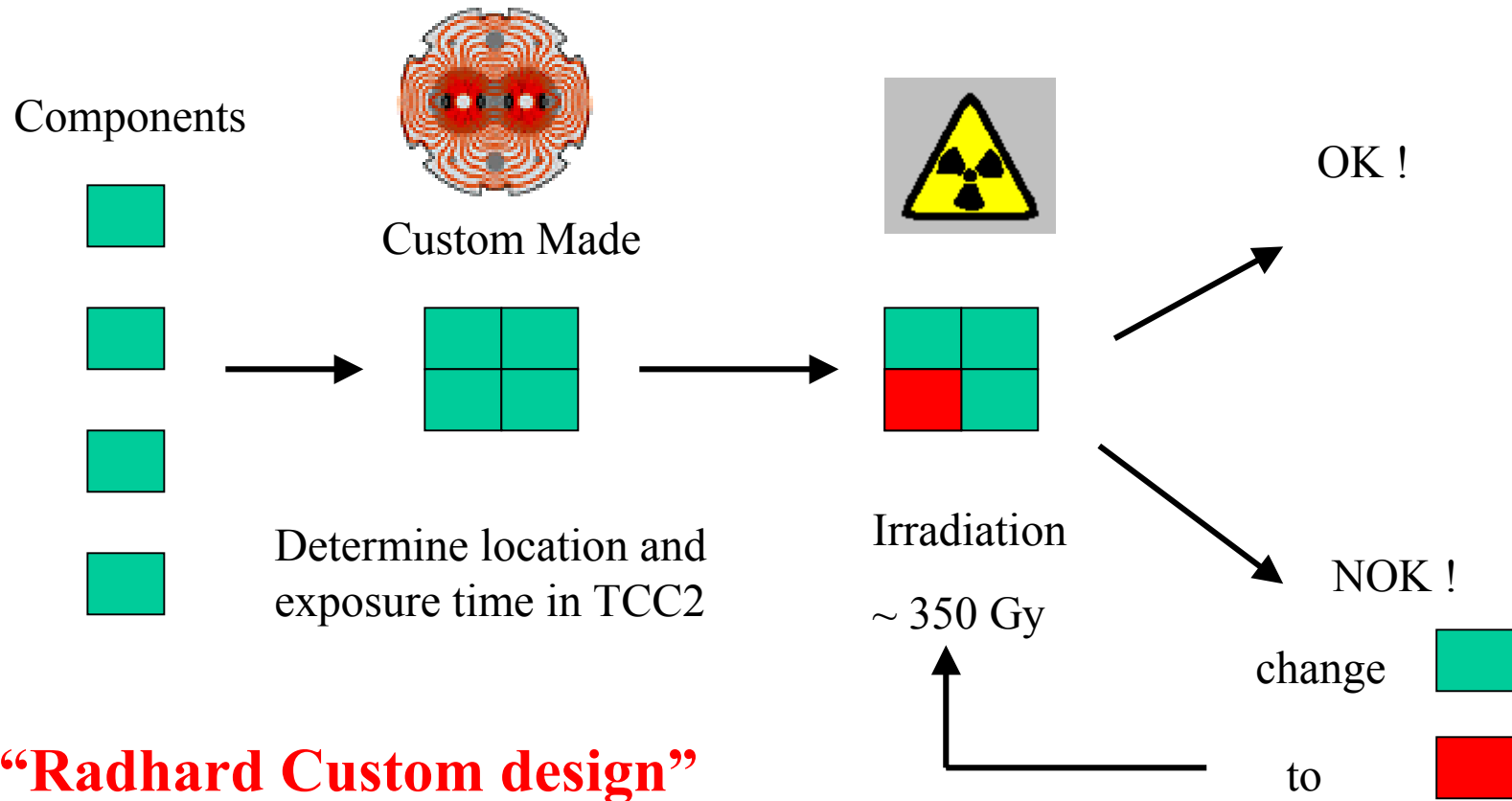


Ex.: power supply quench heaters



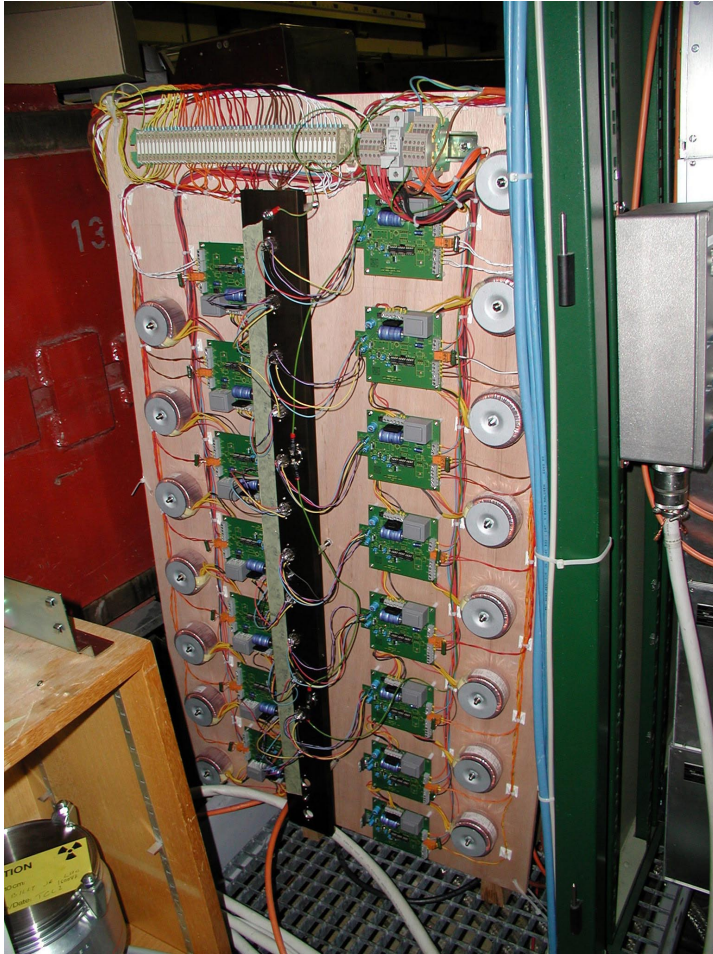
Reiner Denz

TCC2 rad tests III



“Radhard Custom design”

Ex.:LHC cryogenics



Miguel Angel Rodriguez Ruiz

Ensuring Radiation Hardness

- Purchase ALL equipment (and spares) at the same time
- Purchase PART of equipment
 - Stay informed on developments & modifications
 - Test new samples in TCC2 before use
- Use of shielding :
 - Good knowledge of particle spectra in area of interest
 - Test equipment + shielding in TCC2

Conclusions

- Radiation in TCC2 test area is similar to LHC
 - Realistic environment to test LHC tunnel equipment
 - Tests are affected by M2 beam operation
 - Working conditions not optimal (space, access, ...)
- Need better understanding of TCC2 test area
 - Improve on dosimeter measurements
 - Simulations : include optics & simulate entire area behind T6 ?
- Effects of radiation on electronics
 - Field in its own right (training)
 - Number of experts at CERN is growing !