RadMon Radiation Monitors

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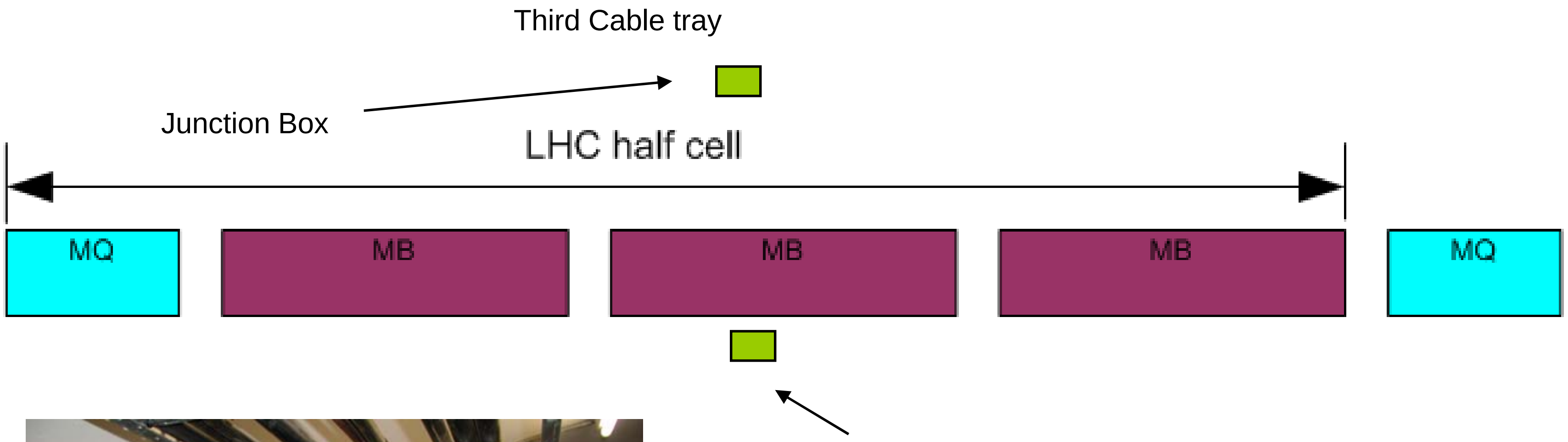
Radiation Tolerance Assurance

- Baseline LHC : equipment in tunnel
  - Improve S/N ratio
  - Reduce cabling costs
  - Reduce power losses
- To reduce the risks of radiation damage
  - MC simulations
  - Optimized equipment integration
  - Shielding
  - Radiation Tolerant designs
  - **Radiation Monitoring from day 1**

RadMon Radiation Monitors

- 350 RadMon devices in LHC tunnel, underground areas, caverns
  - online digital data readout over Real Time WorldFIP Fieldbus
  - thermo compensated measurements
  - radiation tolerance design : 200 Gy (integrated) to 20 kGy (remote sensing)
  - synchronized with machine/experiments timing/Post Mortem

Monitors in a LHC Half Cell



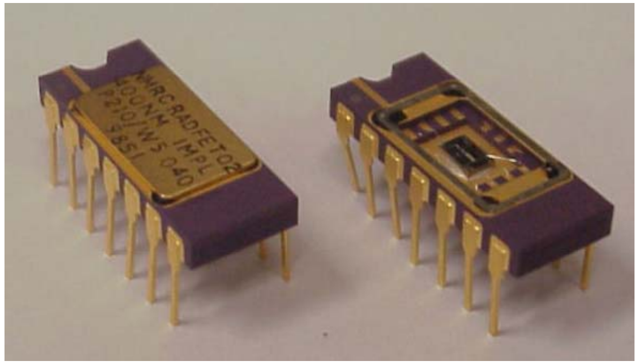
Radiation Monitor

Can be placed at max 25 meters from junction box

Any location within half cell (max 32 per half cell)

Junction box with signal cabling in ARC

Radiation Sensors



NMRC 300/50 400 nm

Radfet : Total Ionising Dose

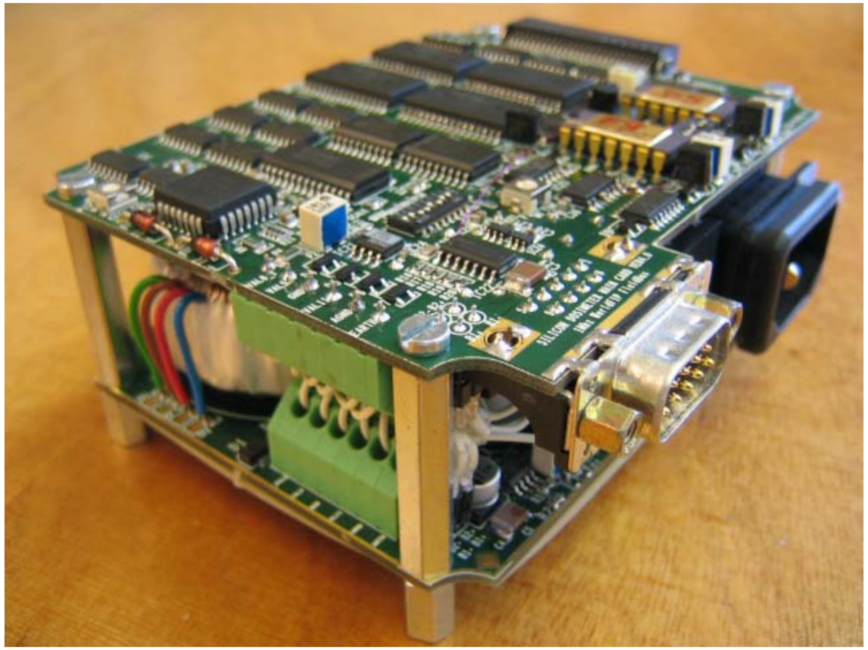
TOSHIBA TC554001AF-70L

Static RAM h > 20 MeV

SIEMENS BPW34

P-I-N diode 1 MeV eq. neutrons

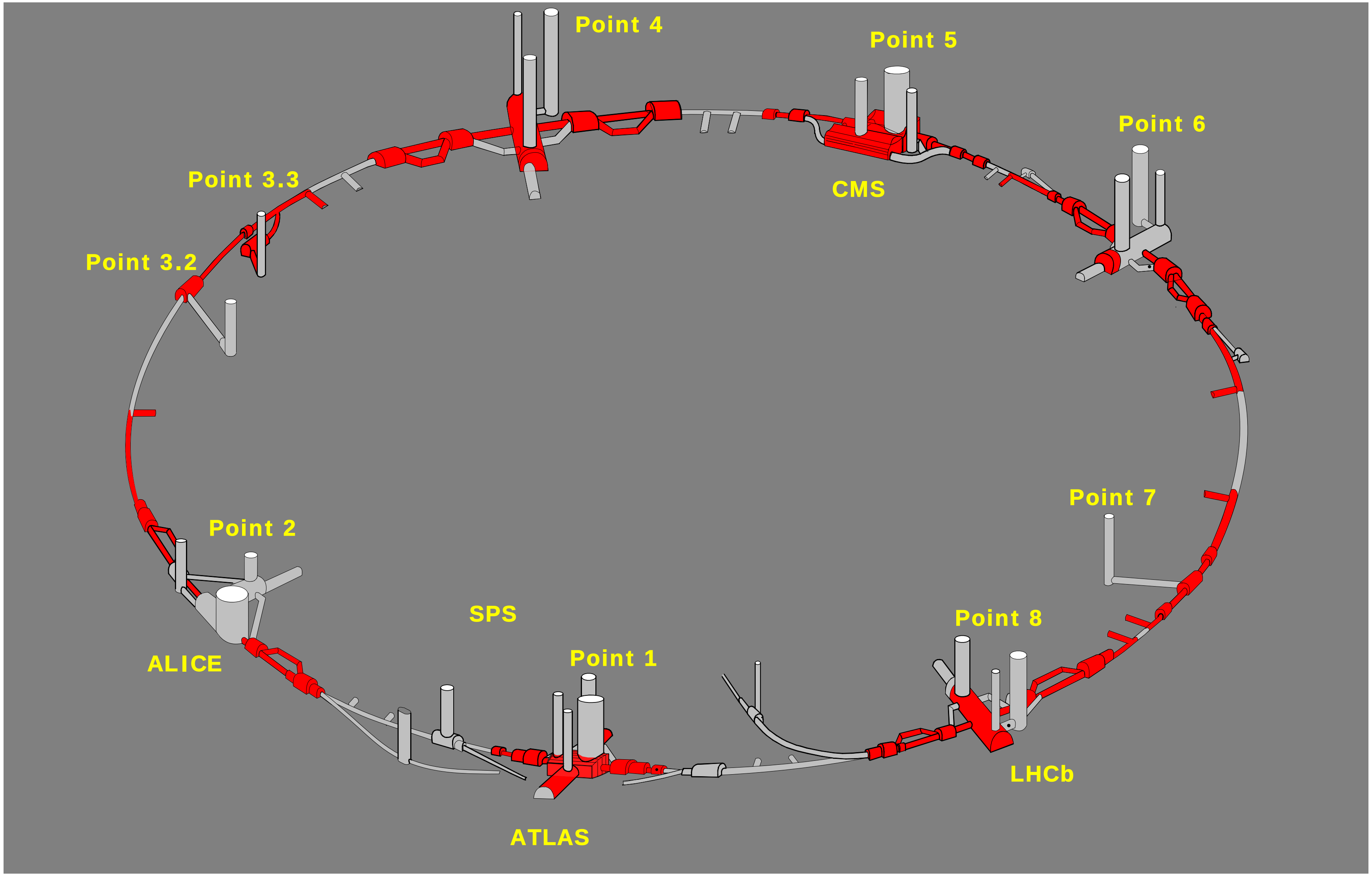
RadMon devices



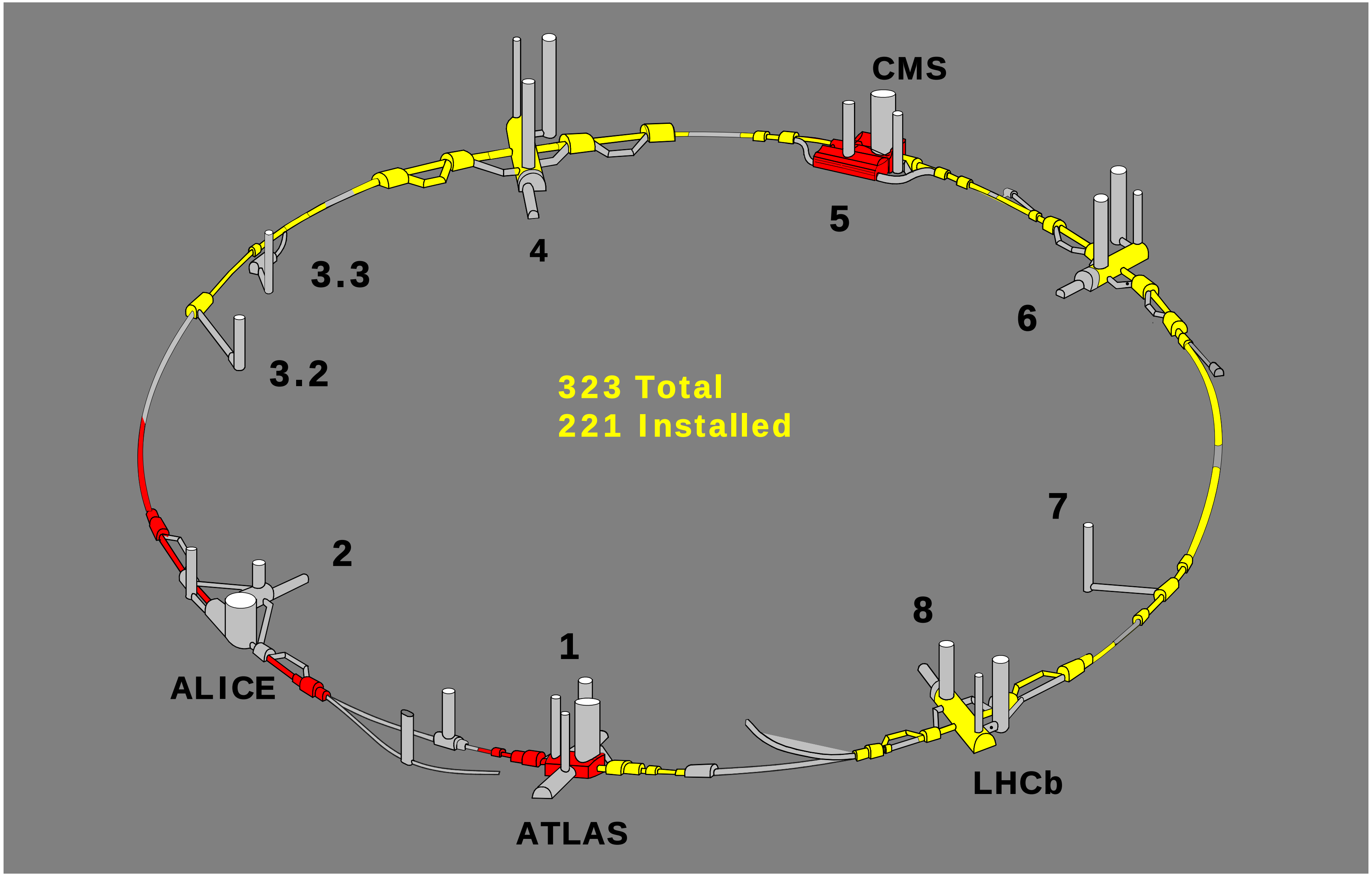
Radiation data

Name	Unit	Resolution	Aquisition	Maximum
Dose HS	[Gy]	0.01	1Hz	21
Dose MS	[Gy]	0.04	1Hz	130
Dose LS	[Gy]	1.0	1Hz	3000
Hadrons	[cm^{-2}]	$1x10^{6}$	1Hz	$1x10^{11}$
Neutrons HS	[cm^{-2}]	$1x10^{10}$	1Hz	> $5x10^{12}$
Neutrons LS	[cm^{-2}]	$3x10^{10}$	1Hz	> $5x10^{12}$
Temperature	°C	1.7	1Hz	-
Current	mA	2.44	1Hz	-

LHC areas covered



LHC installation progress



From production to LHC installation

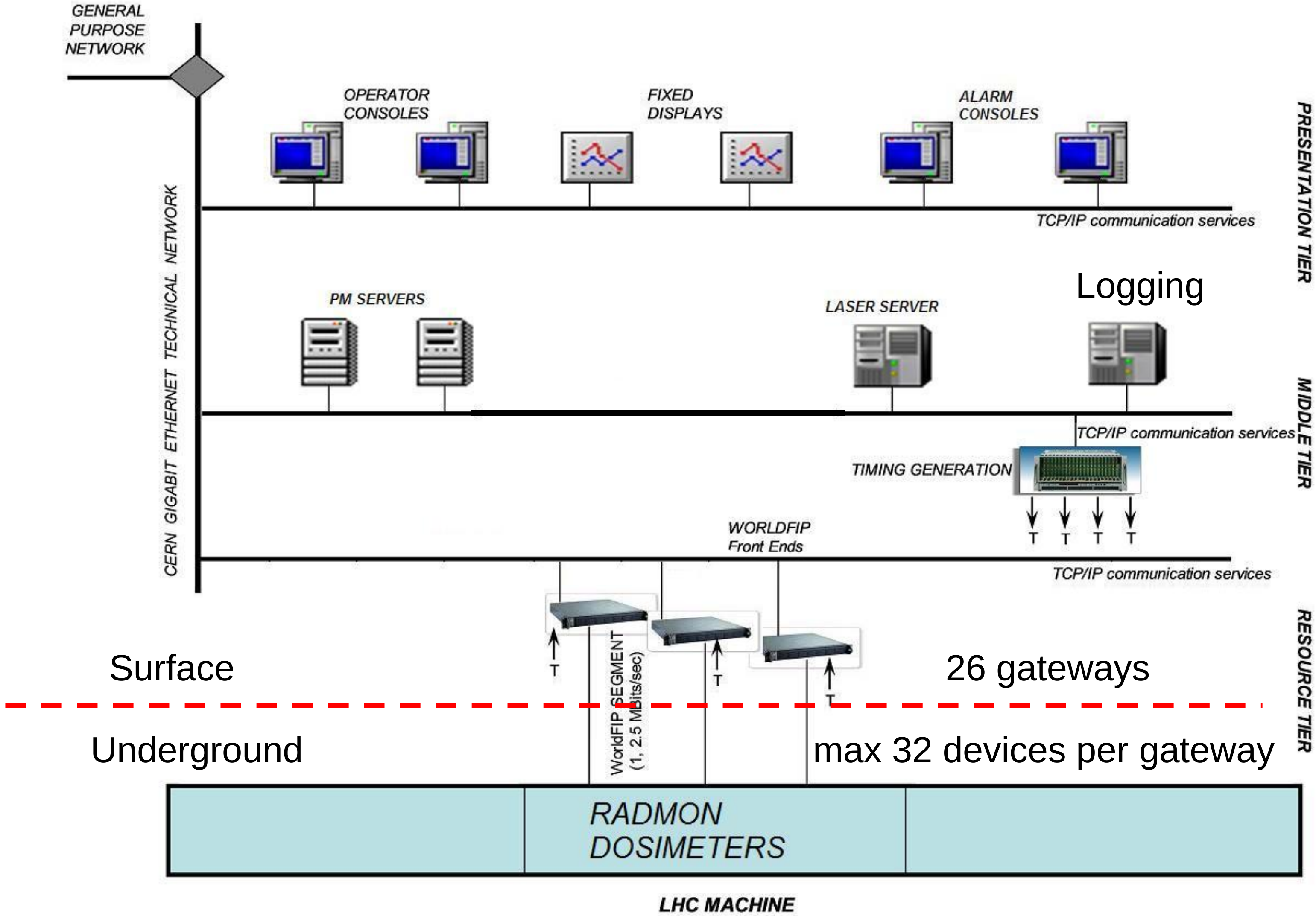
production at ARVELEC

arrival at CERN series production

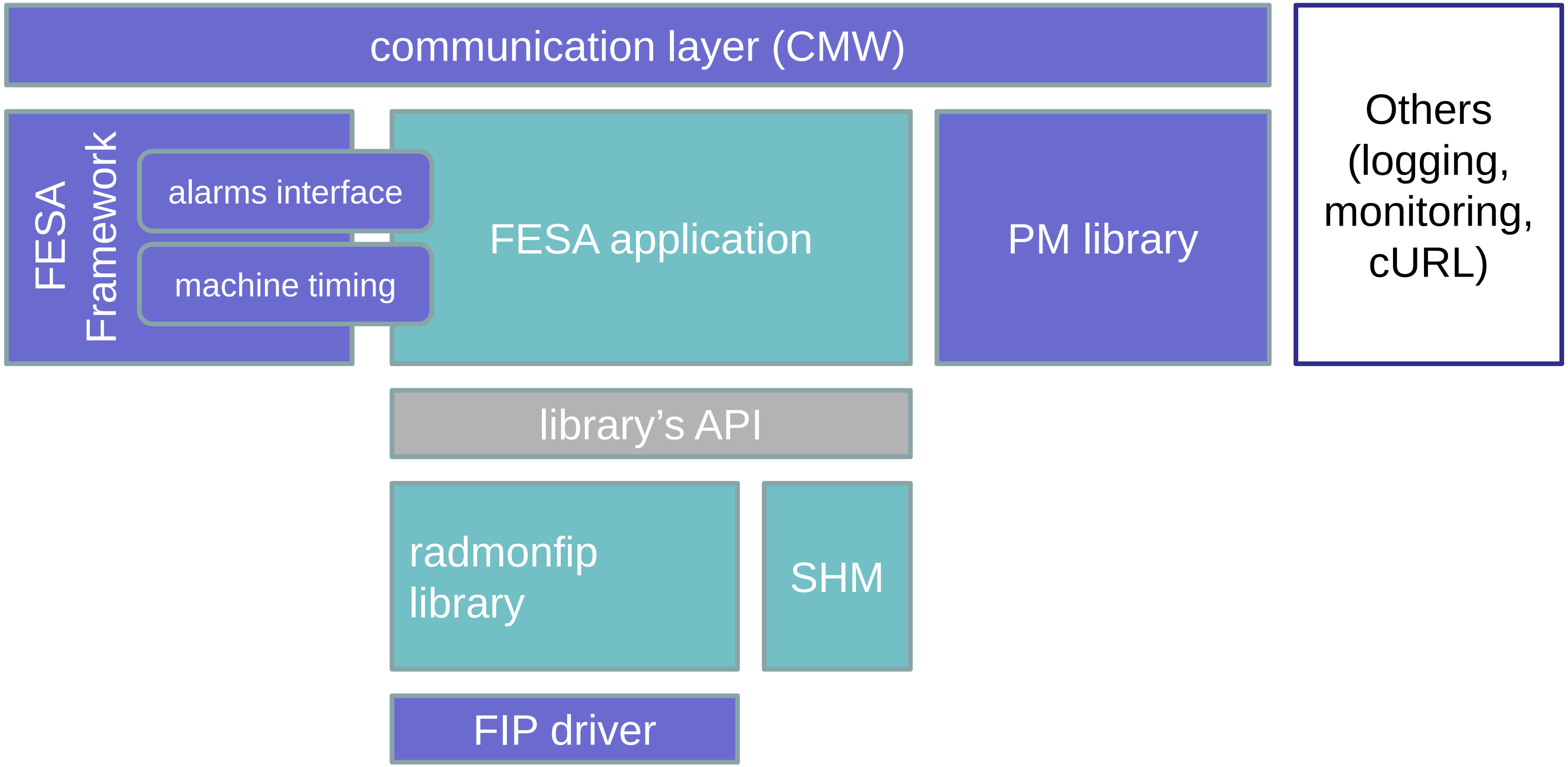
calibration and thermo compensation

installation in underground areas and tunnel

Network Architecture



Front End Software Architecture

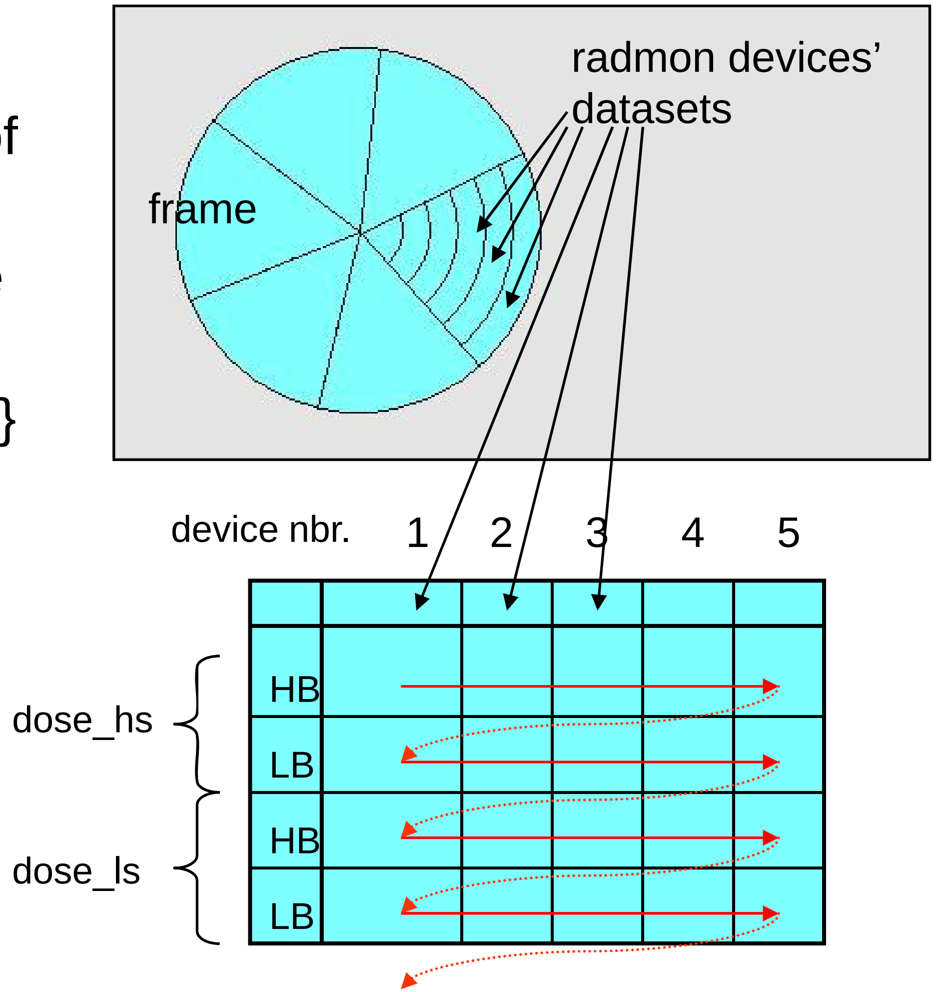


WorldFip Library

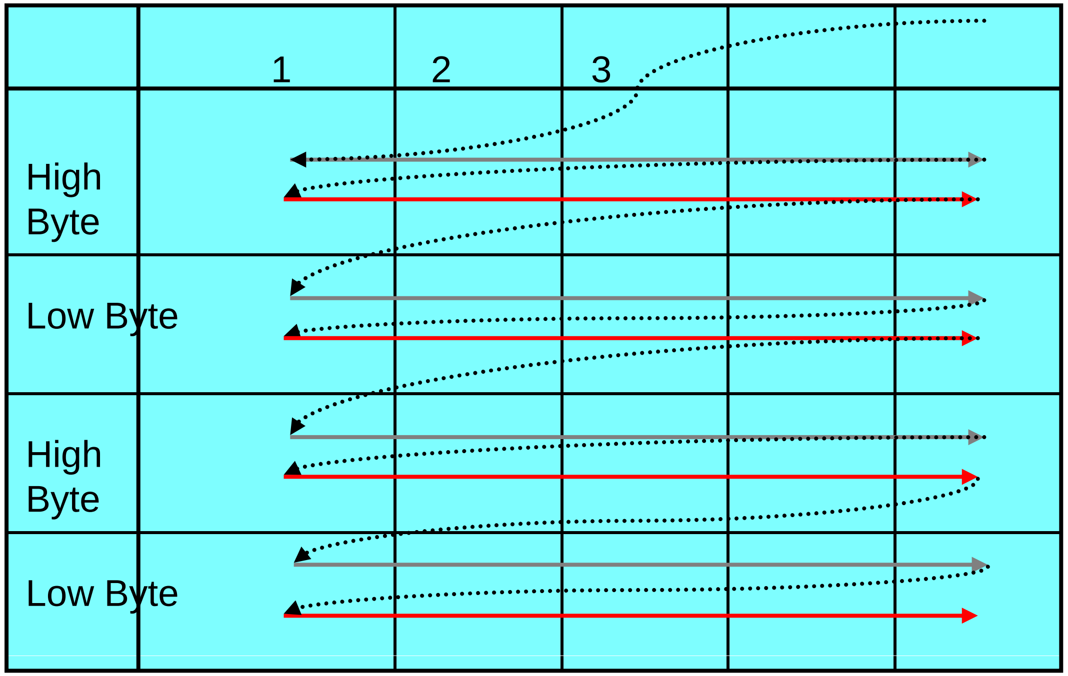
- Library to communicate with radmon devices via WFIP fieldbus
  - initialize devices
  - read/write commands
  - status information
- Reads characteristics of radiation in a device's location
- Provides external applications with API to
  - configure protocol
  - operate on devices
  - access partially interpreted data
- Provides direct access to device via toolset
  - to check raw data

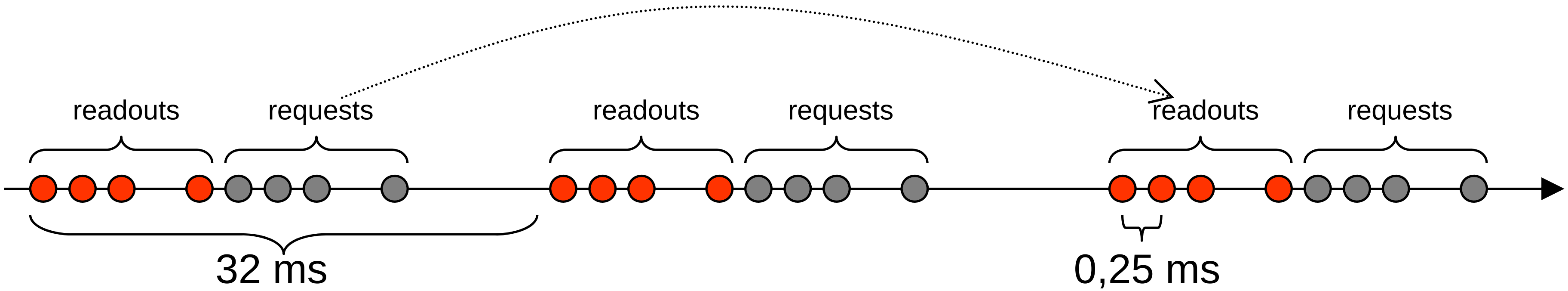
Inter process communication

- Measurements stored in a shared memory
- Circular buffer for n frames of data picked up every 1 sec.
- Frame = set of datasets, one dataset for each device
- Dataset = {dose, neutrons,...}

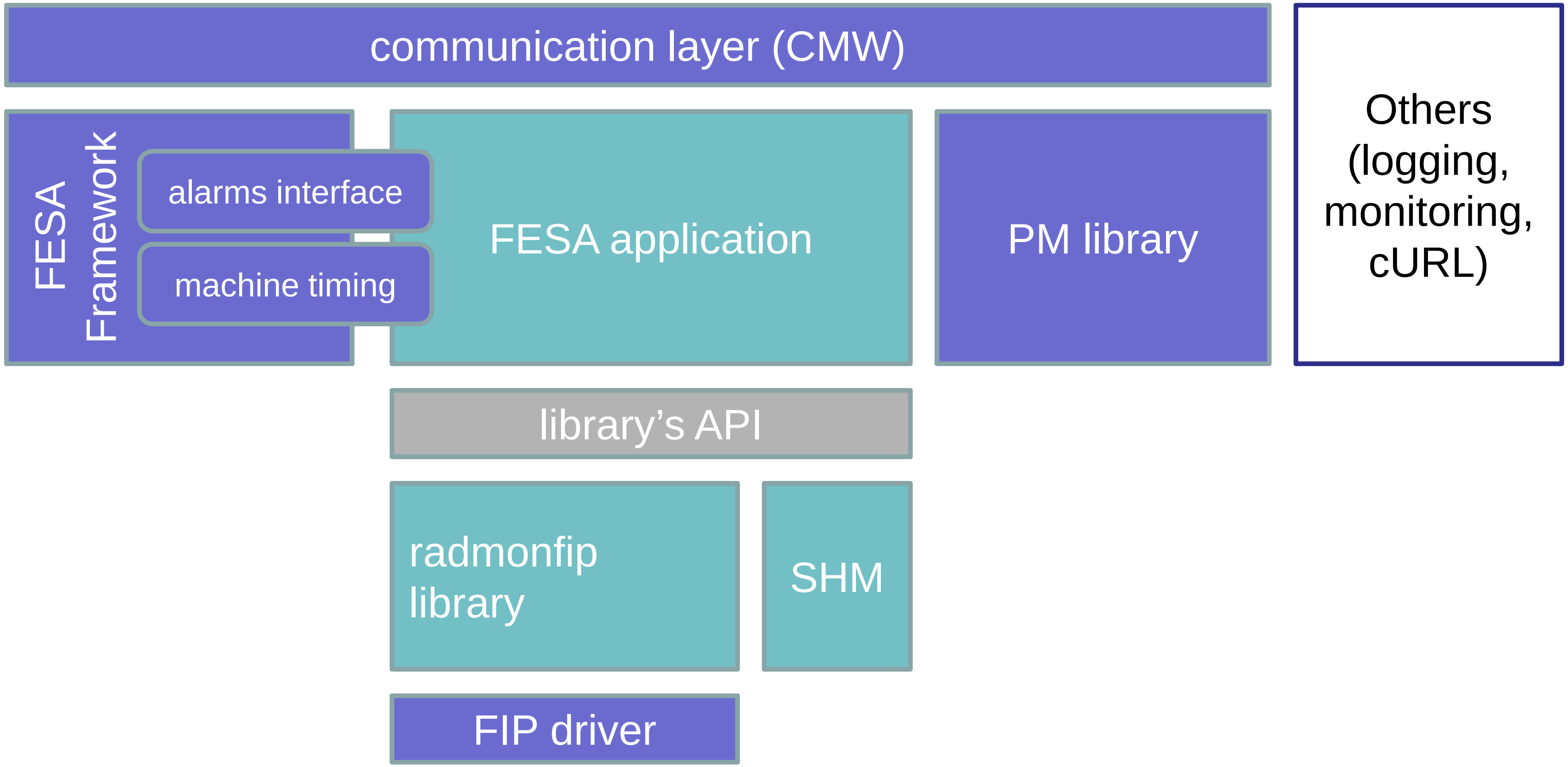


Data macrocycles





Front End Software Architecture



FESA :Front End Software Architecture

- FESA : framework for front-end software development
  - design, implementation, instantiation, deployment and maintenance
  - follows AB/CO group standards
  - 300-400 projects defined, possibly in many versions
  - reliable and thoroughly tested
  - publicly available FESA project (both design and sources)
- Incorporates :
  - CERN technical computing infrastructure
  - CERN serivces

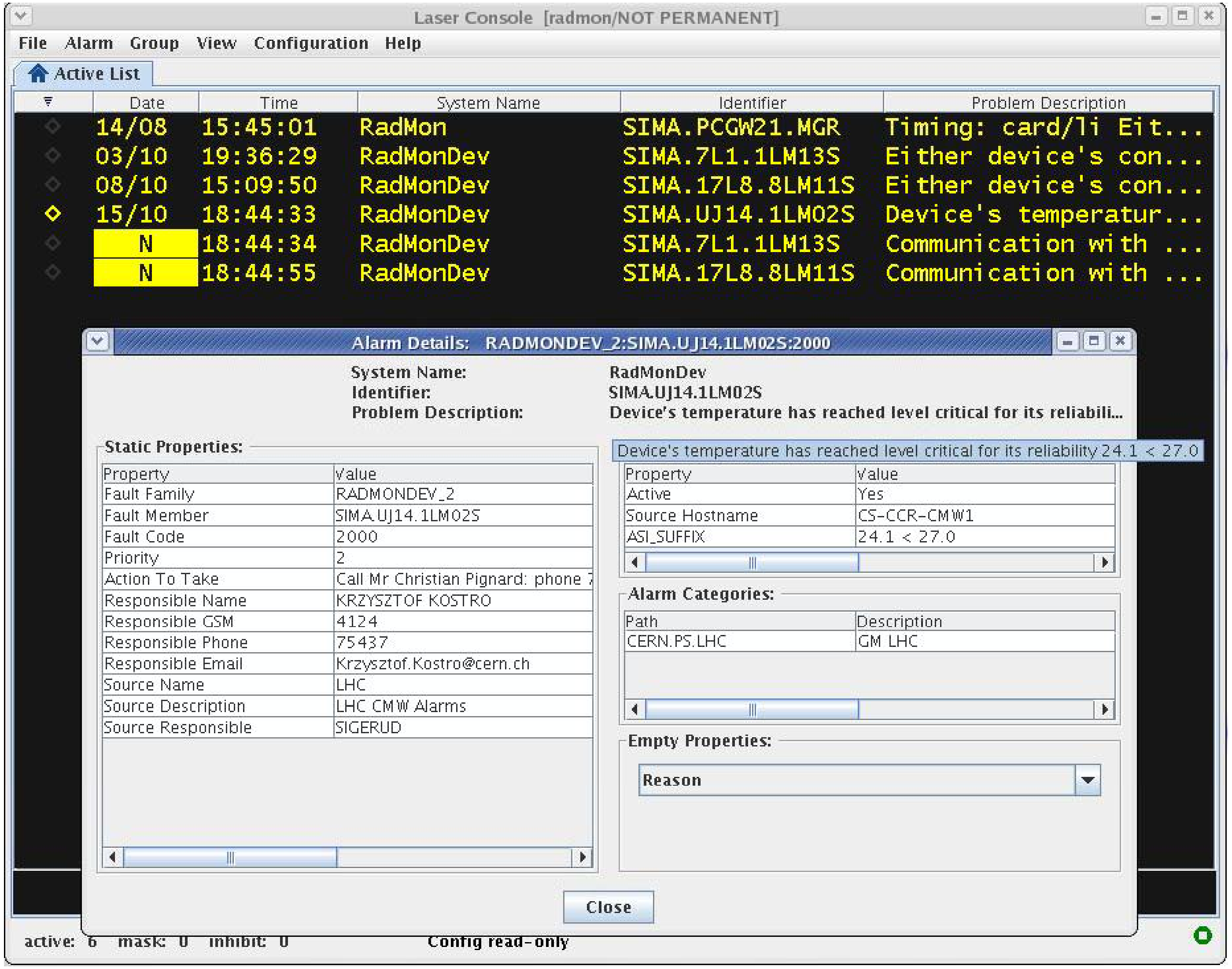
FESA application : services incorporated

- Complete radmonFIP library
- Acces to radmon CALIBRATION files
- LASER alarm system
  - maintenance and operation
- Machine timing
  - source of time and distributed events
  - LHC cycle
  - LHC state transitions
- Allows to operate on FESA properties
  - high-level interface for user
  - low-level universality of the CMW for software
  - giving us universal displays and logging system for free
- *Post Mortem functionality*

Equipment Alarms

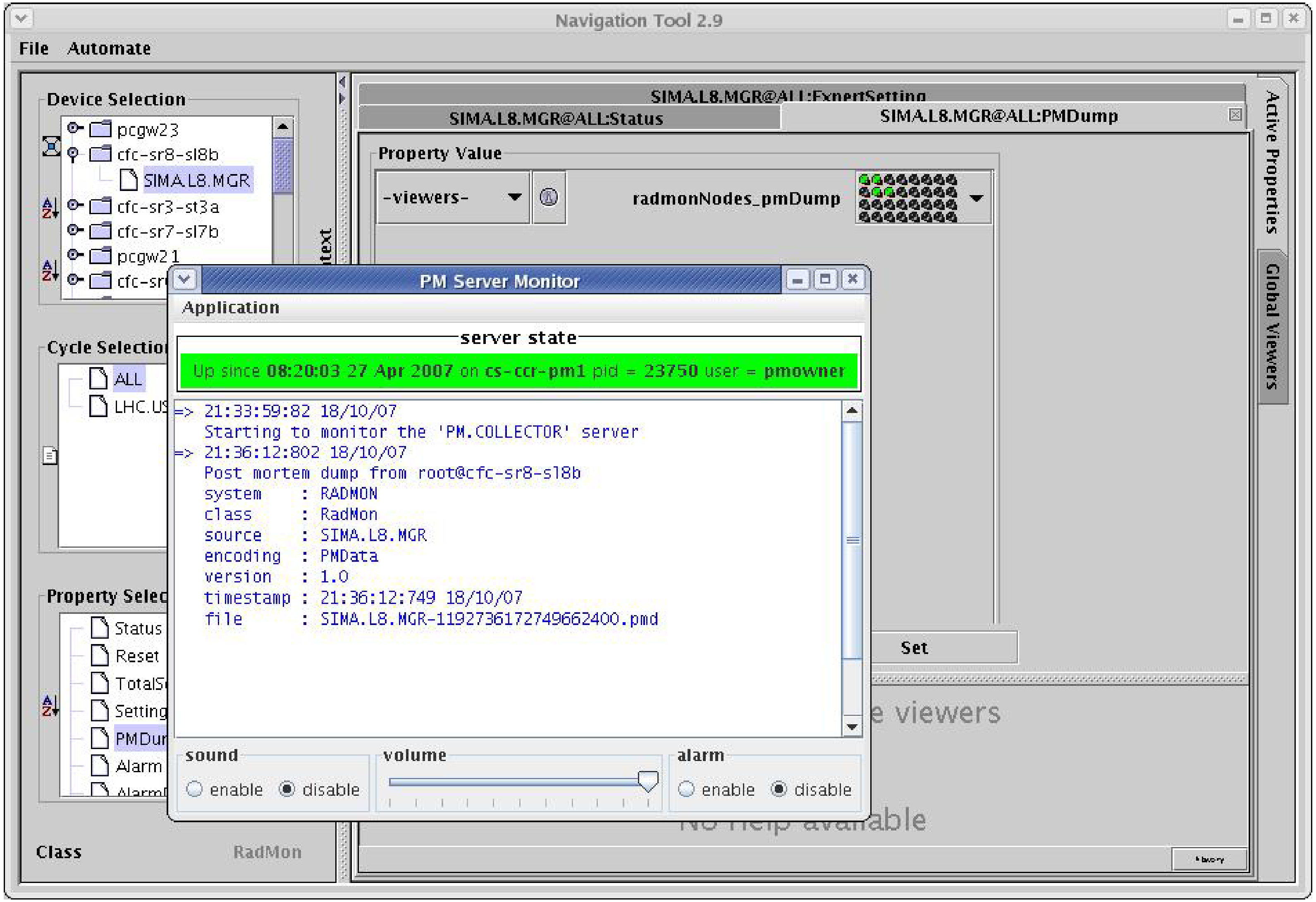
- application constantly performs validity check (1 Hz)
  - check global state (timing card state)
  - check particular dosimeter's state
    - Temperature
    - Current consumption (aging)
    - Watch Dogs
    - Errors in FIP communication
- alarms are delivered to the LASER system …
- … and visualised via the LASER Console

ALARM console (screenshot)

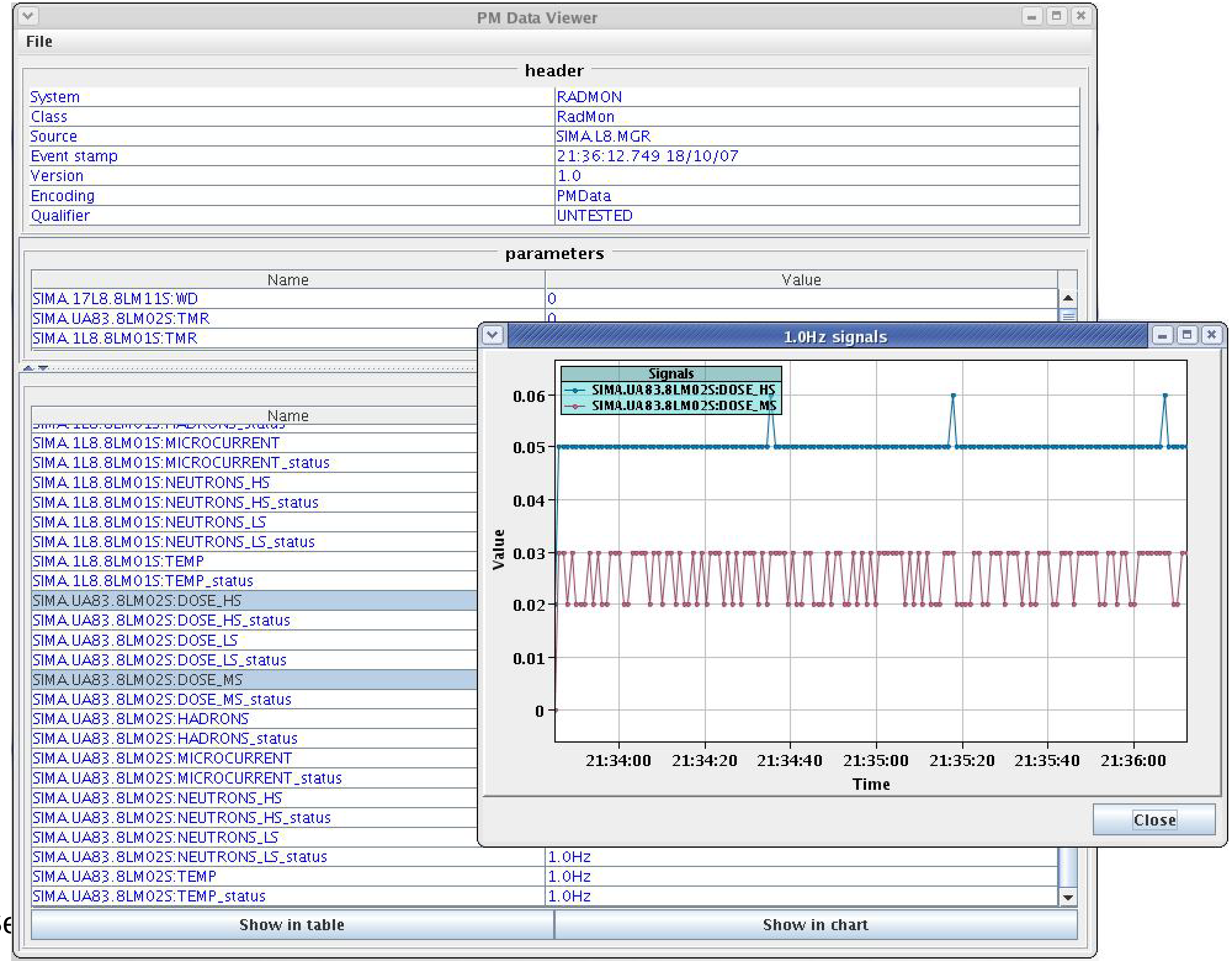


Maintenance activated devices

Post Mortem (screenshots)



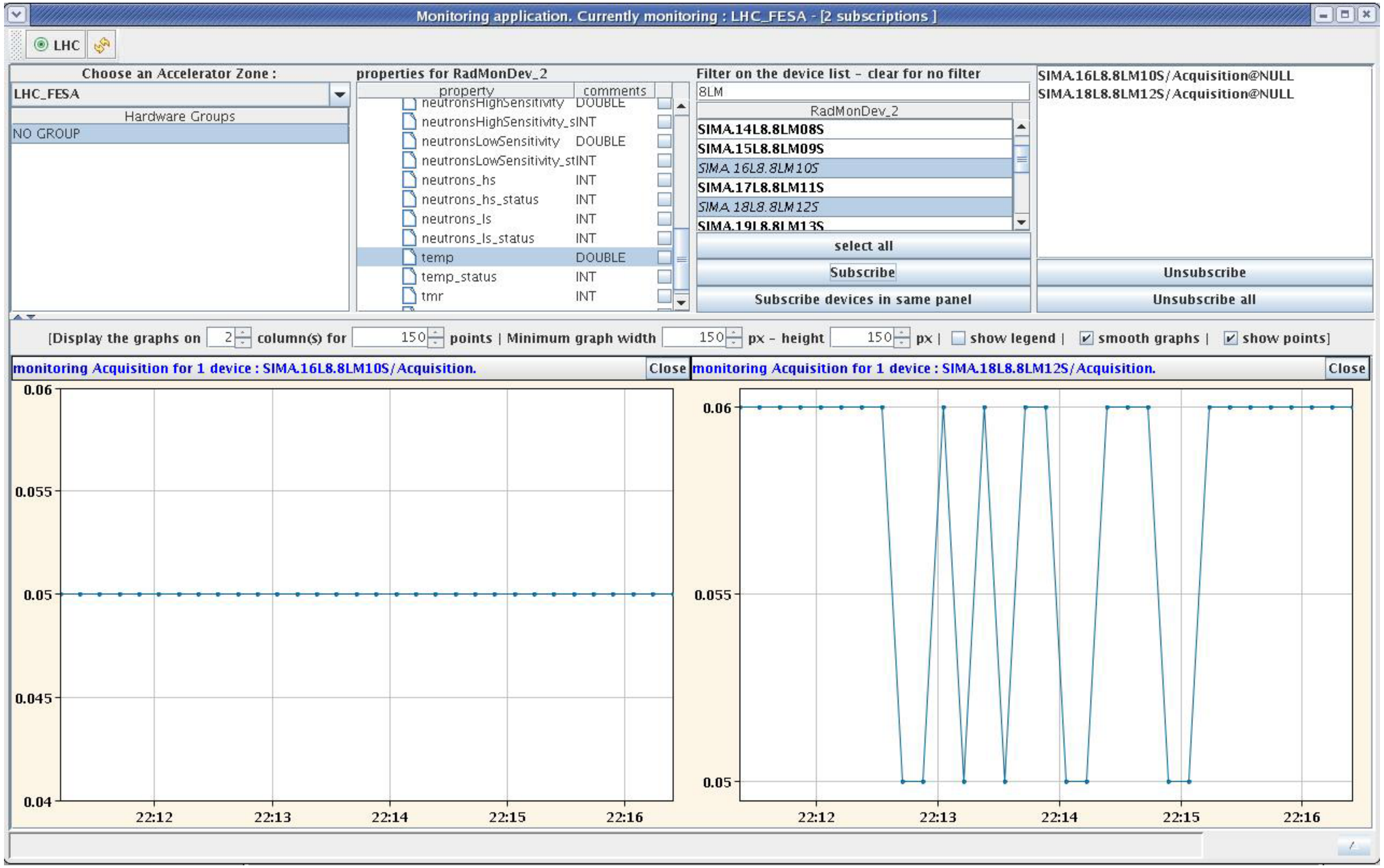
Post Mortem (screenshots)



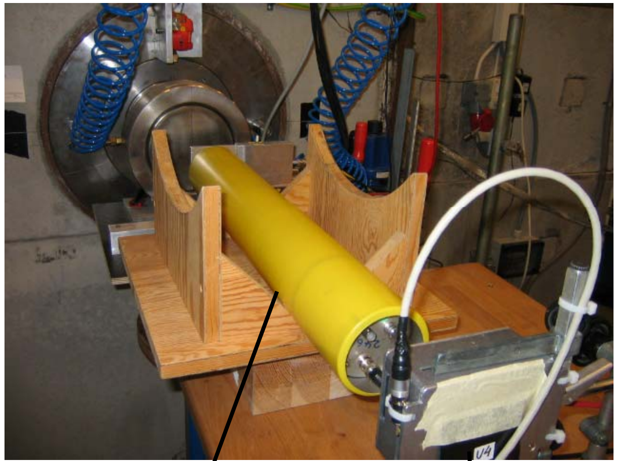
Data logging

- Stored in two separate databases :
  - Measurement DB
    - short-term storage
    - overwrite data after 7 days
    - all device data stored
    - high time resolution (1 Hz)
  - Logging DB
    - permanent storage
    - selected data only
    - low time resolution (0.1 Hz)
- Logging process operating on a dedicated machine
- All data can be retrieved with :
  - web interfaces: TIMBER and METER
  - Java API

EquipMonitor (by LSA, screenshot)

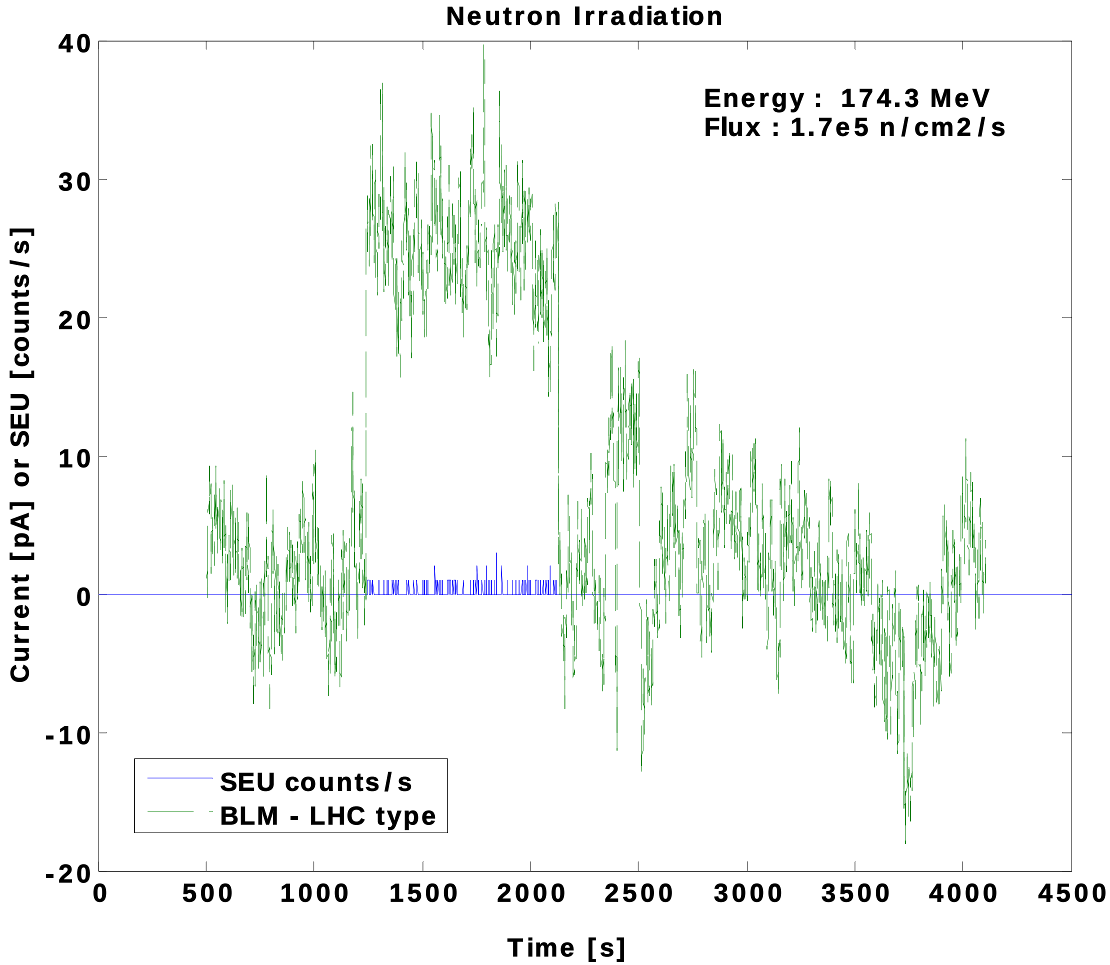


TSL :174 MeV Neutron Irradiation



LHC BLM chamber

RADMON



Q : would such a signal be
of interest to the CCC ?

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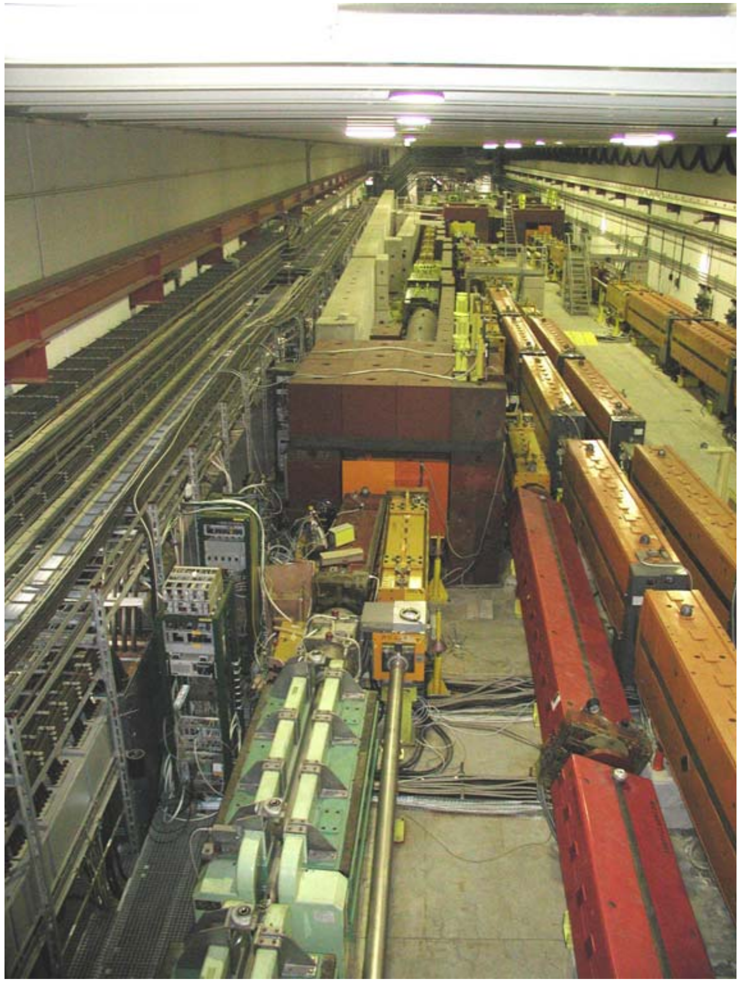
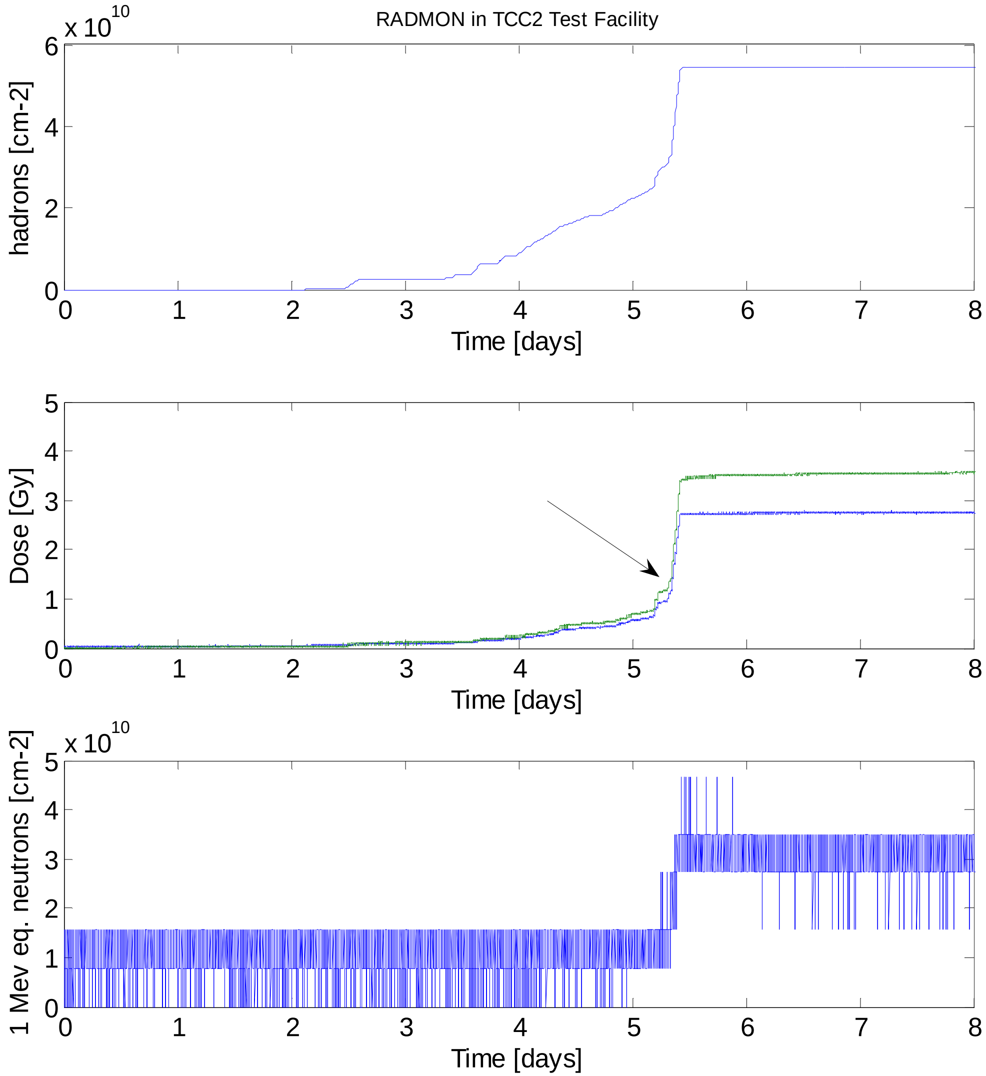
RadMON in SPS North Exp. Area



HEP Radiation field similar to LHC ARCs produced by 450 GeV protons on a fixed target

Example : magnet strength incorrect

Bending Magnet M2 beam line wrong



Q : do we need a control room alarm in this case ?

Points for Discussion

- Single fixed display for instantaneous data during fill ?
  - hadron flux (RadMon)
  - dose rate (BLM, RAMSES)
  - Mips (BCM)
- Single fixed display for integrated data during fill ?
  - dose, fluence, luminosity
  - beam currents
- A single expert program (ROOT) for all ?
- Radiation database ?
  - store all radiation data from last second before dump
  - store critical machine data – stored energy, bunch intensity …