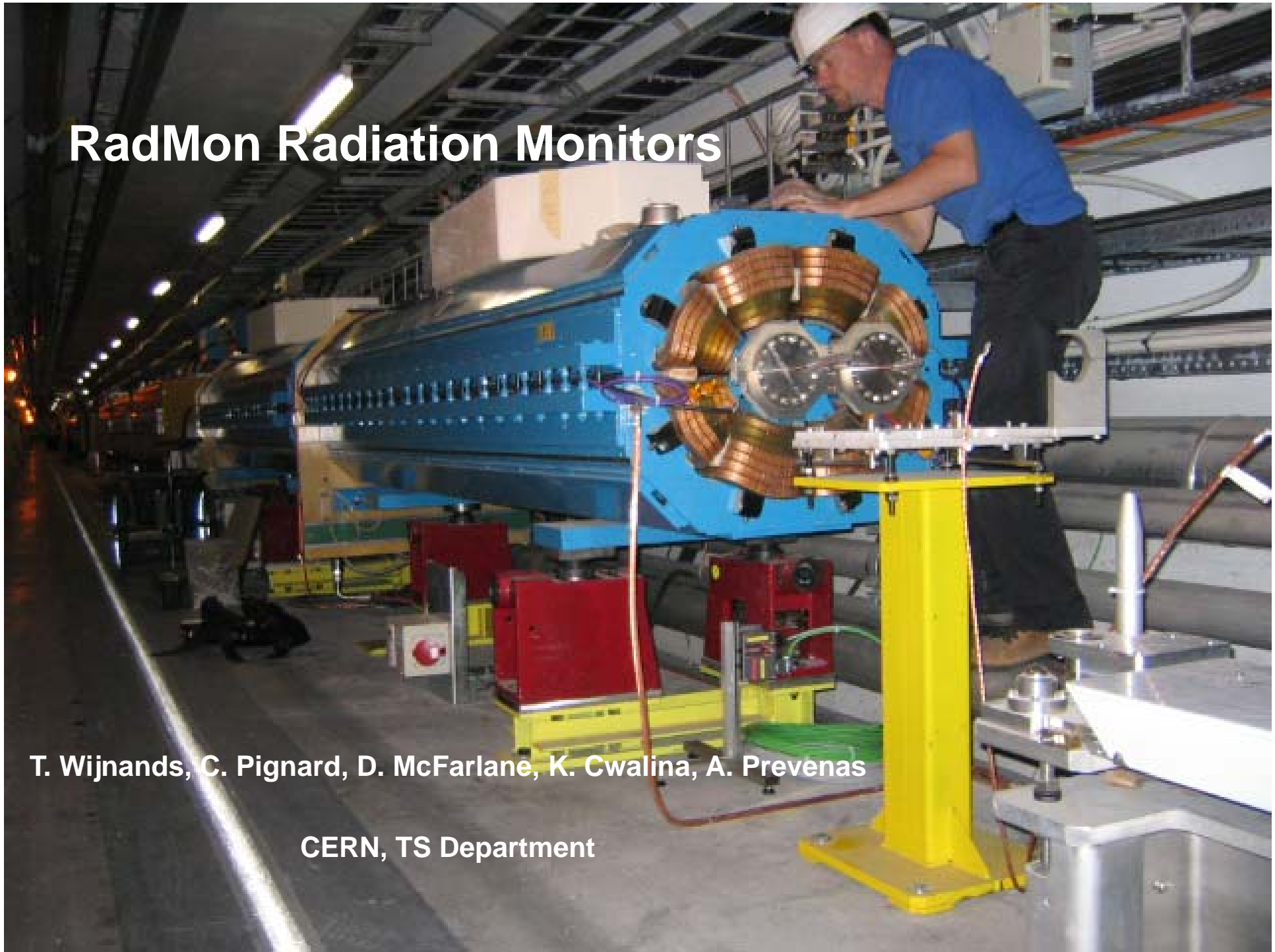


RadMon Radiation Monitors

T. Wijnands, C. Pignard, D. McFarlane, K. Cwalina, A. Prevenas

CERN, TS Department



Radiation Tolerance Assurance

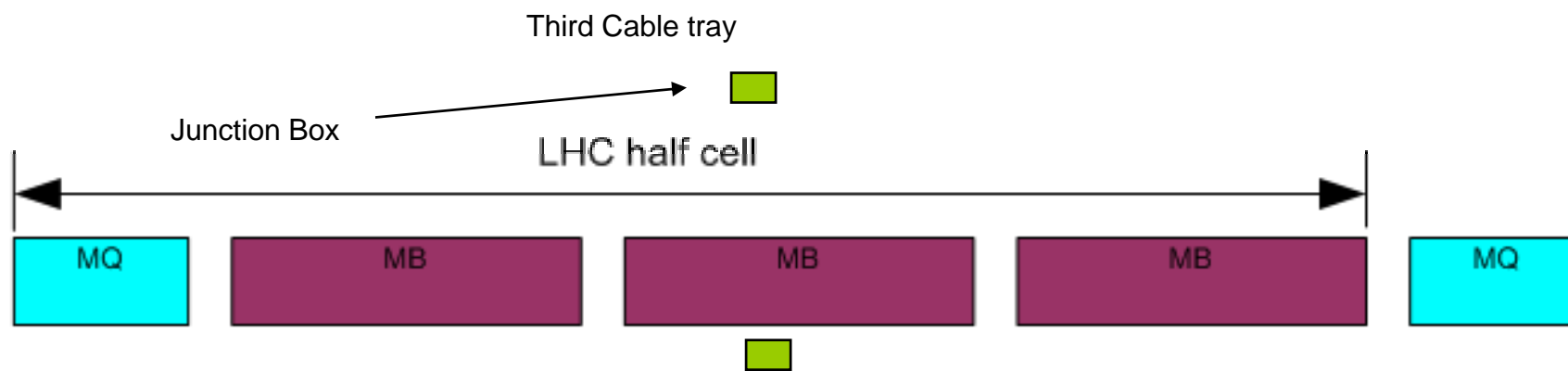
- Baseline LHC : equipment in tunnel
 - Improve S/N ratio
 - Reduce cabling costs
 - Reduce power losses
- To reduce the risks of radiation damage
 - MC simulations
 - Optimized equipment integration
 - Shielding
 - Radiation Tolerant designs
 - **Radiation Monitoring from day 1**

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

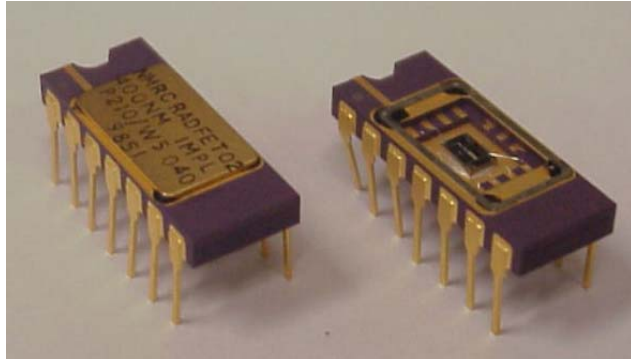
Any location within half cell (max 32 per half cell)



Junction box with signal cabling in ARC



Radiation Sensors



NMRC 300/50 400 nm

Radfet : Total Ionising Dose



TOSHIBA TC554001AF-70L

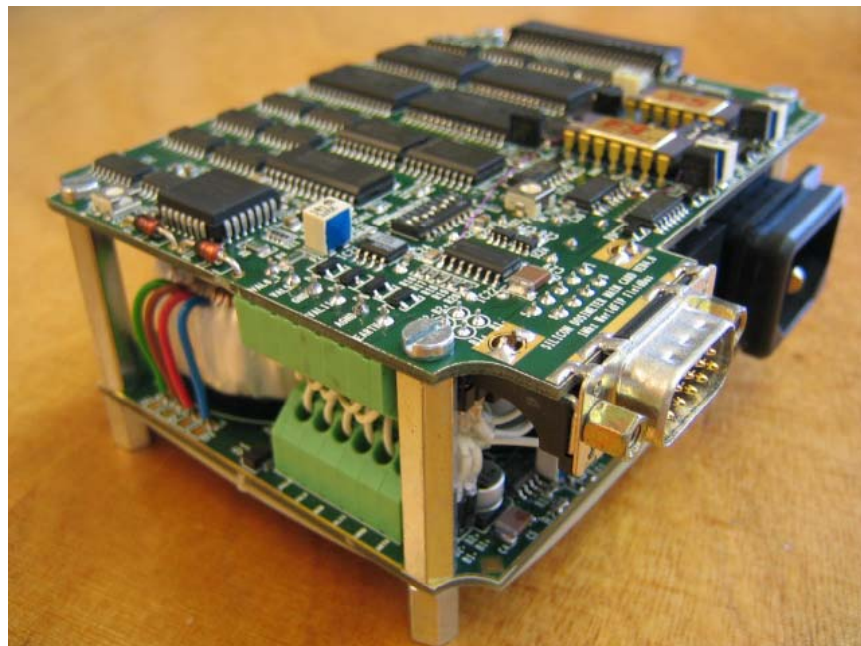
Static RAM $h > 20$ MeV



SIEMENS BPW34

P-I-N diode 1 MeV eq. neutrons

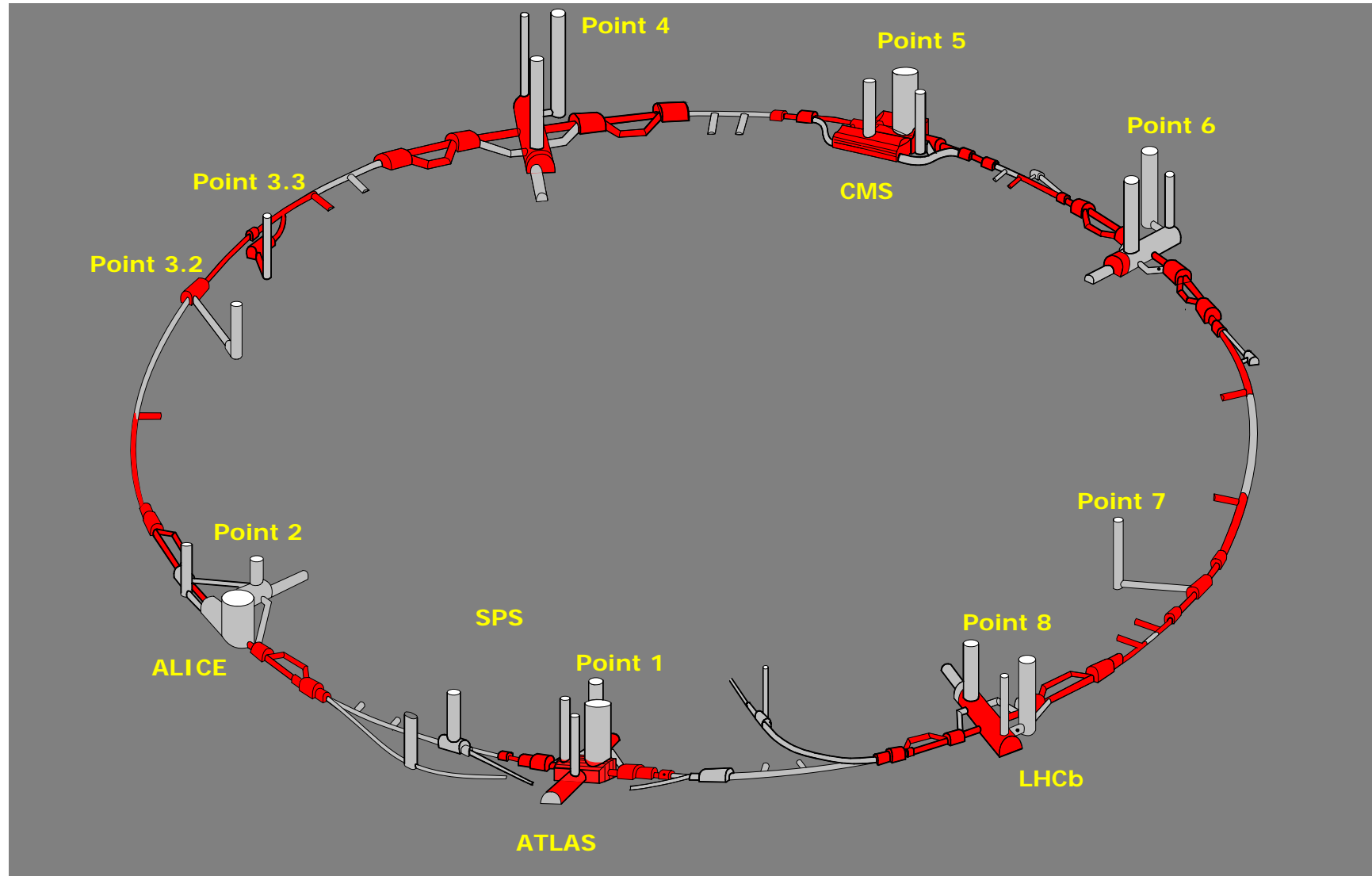
RadMon devices



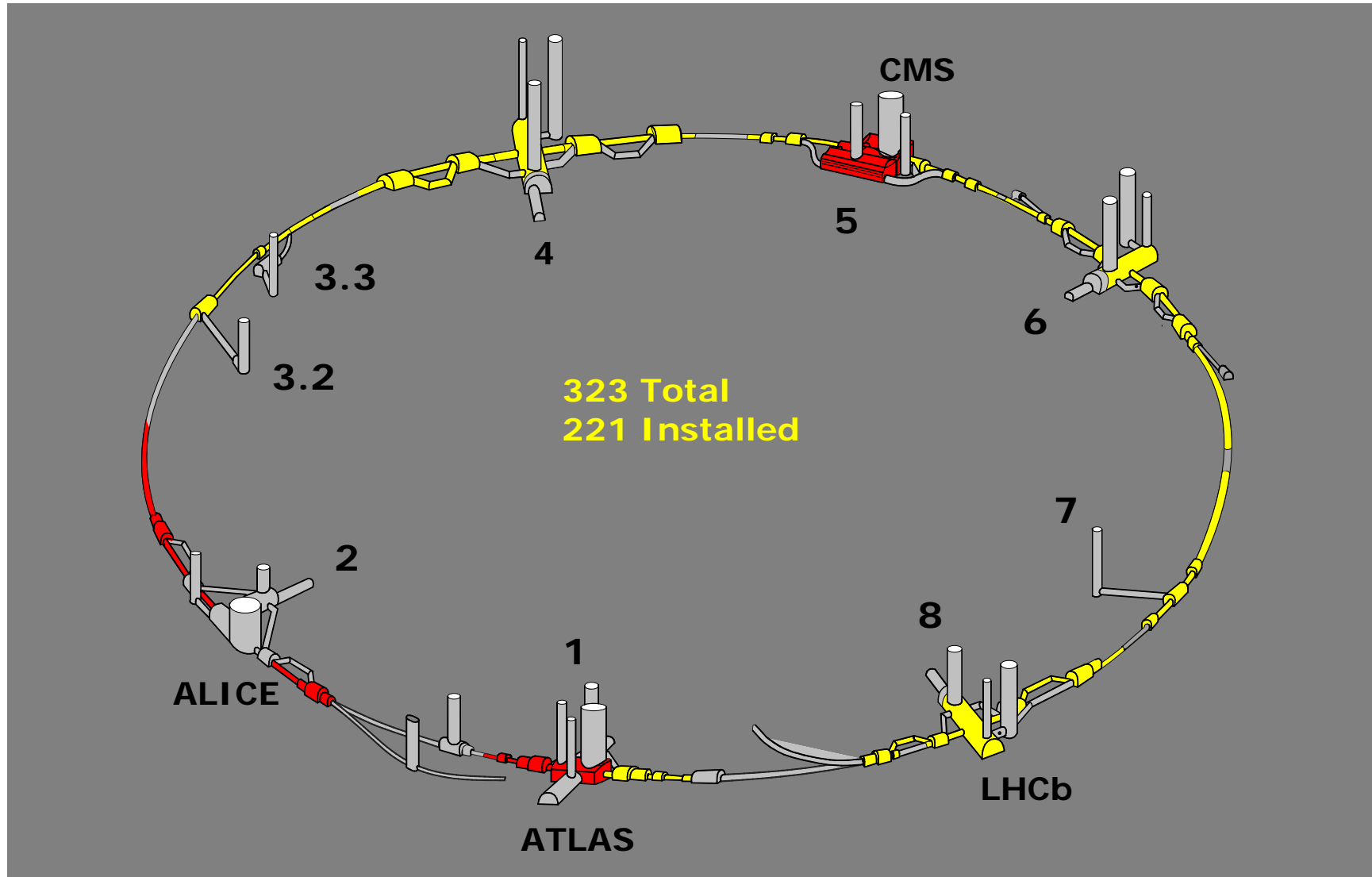
Radiation data

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

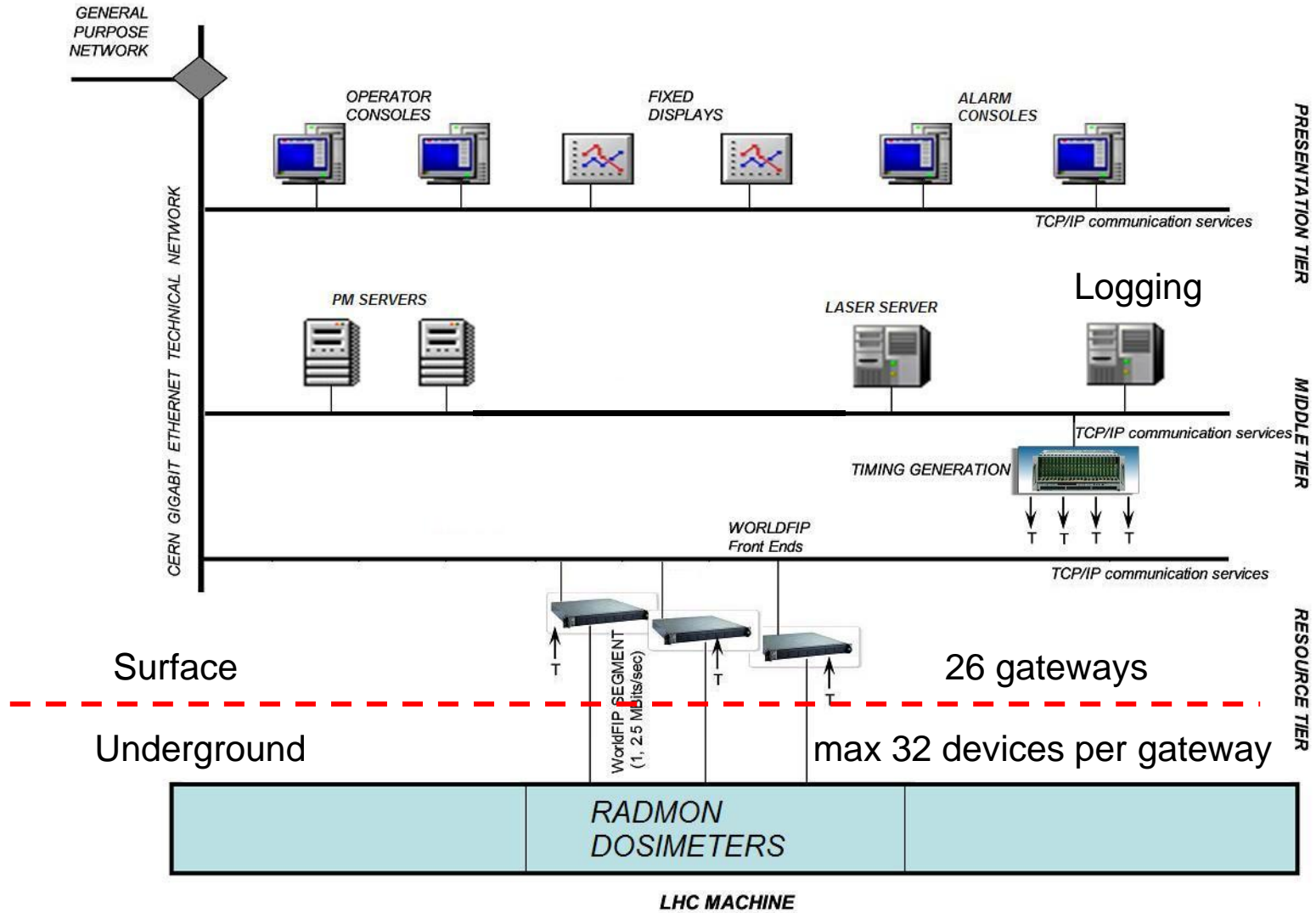


calibration and thermo compensation

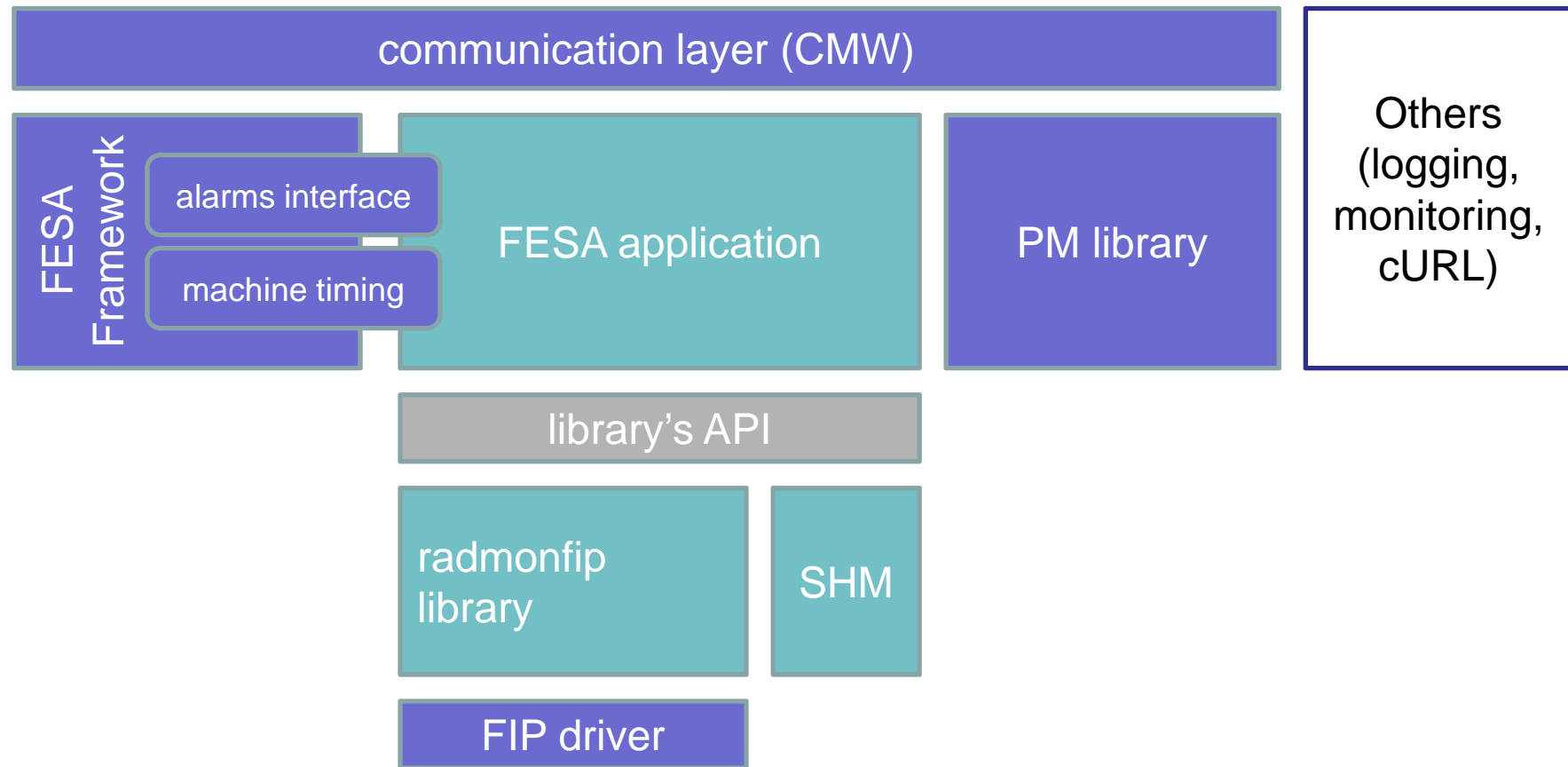


installation in underground areas and tunnel

Network Architecture



Front End Software Architecture

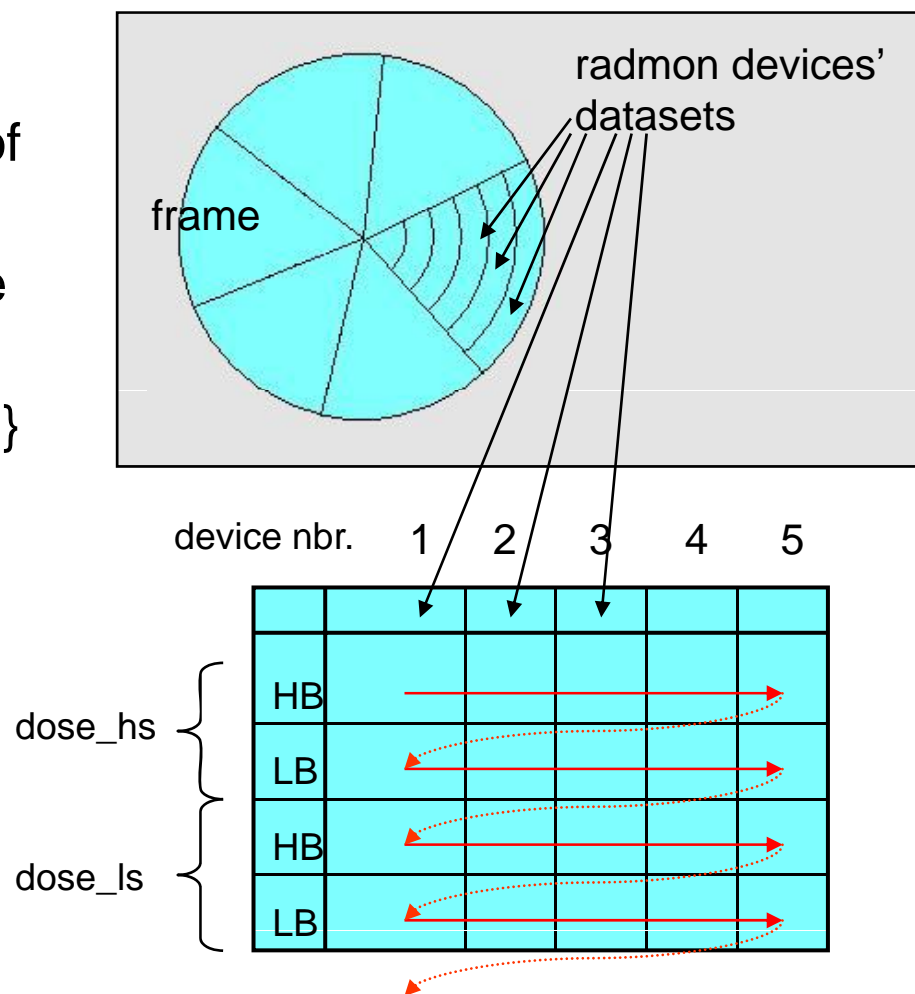


WorldFip Library

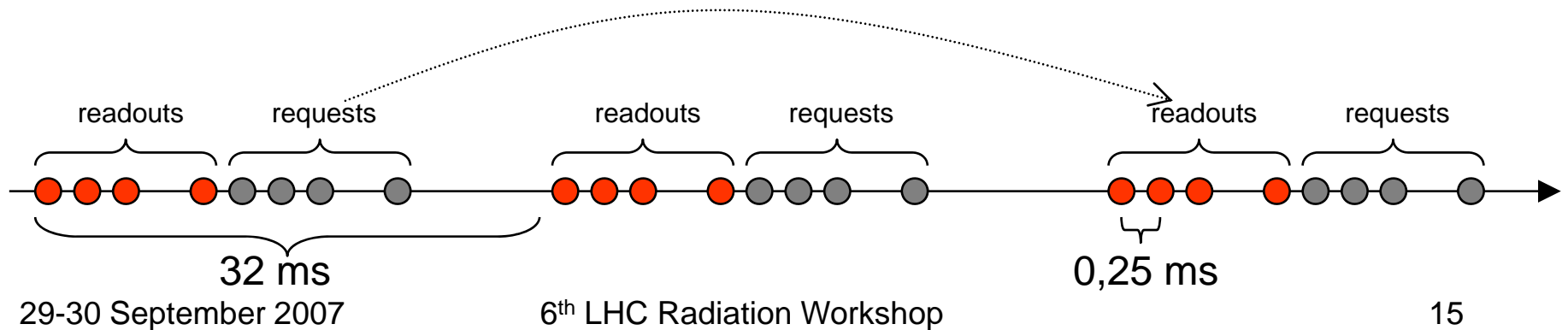
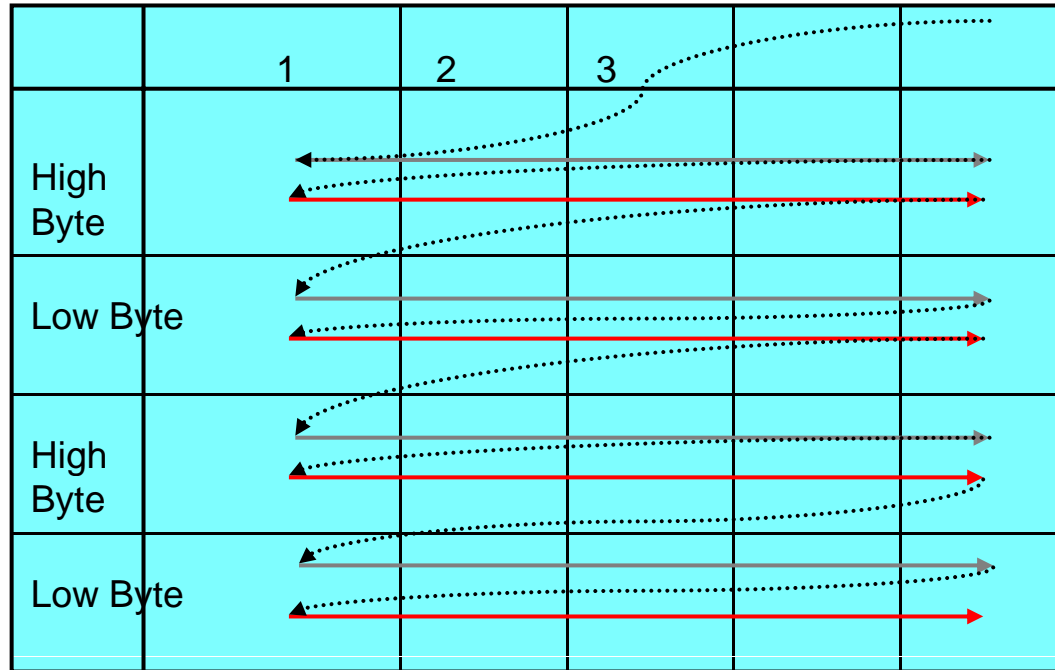
- Library to communicate with radmon devices via WFIP fieldbus
 - initialize devices
 - read/write commands
 - status information
- Reads characteristics of radiation in a device's location
- Provides external applications with [API](#) to
 - configure protocol
 - operate on devices
 - access partially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

Inter process communication

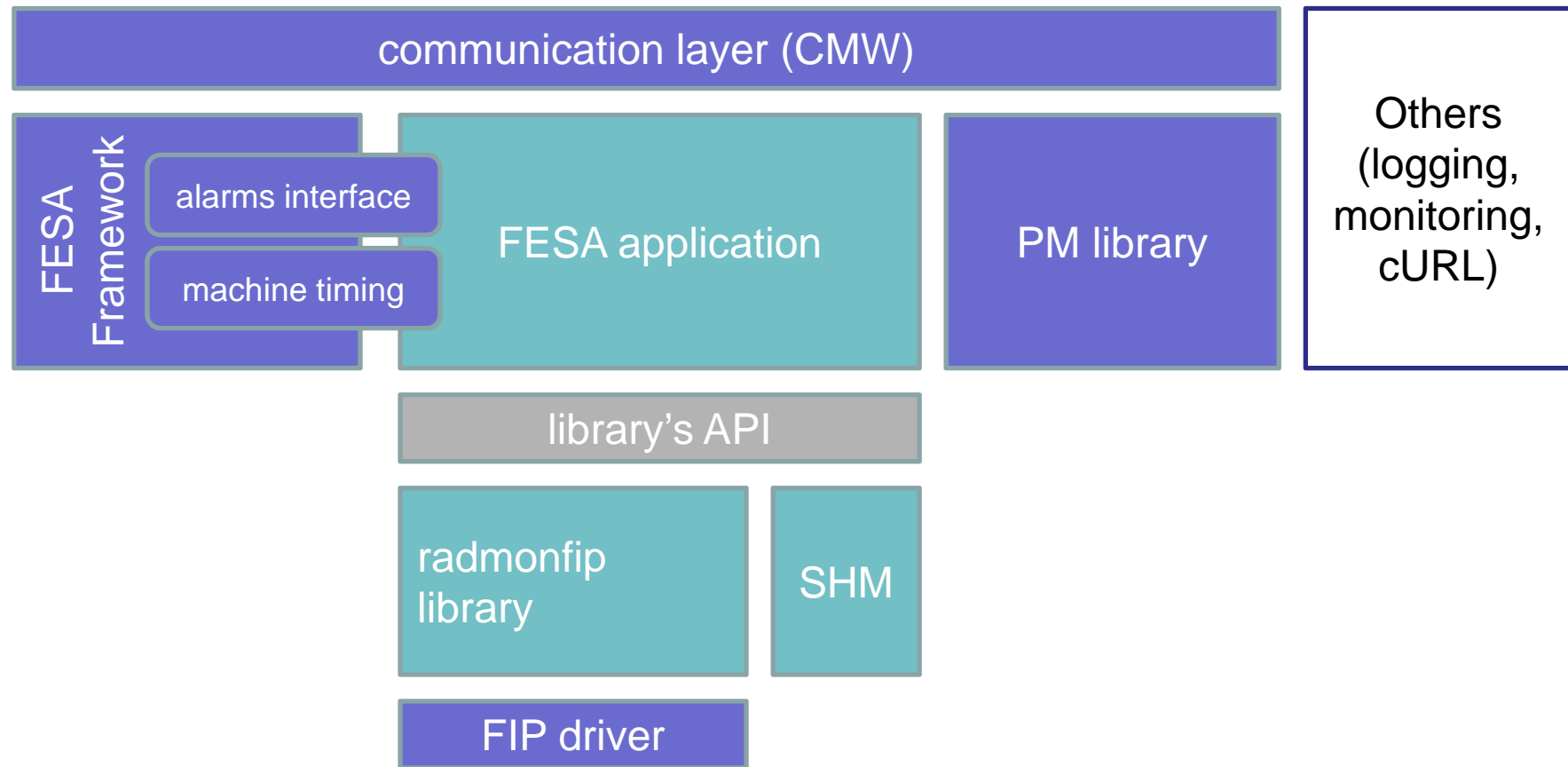
- Measurements stored in a shared memory
- Circular buffer for n frames of data picked up every 1 sec.
- Frame = set of datasets, one dataset for each device
- Dataset = {dose, neutrons,...}



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 services

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)

The screenshot shows the Laser Console interface with the following components:

- Active List Table:**

	Date	Time	System Name	Identifier	Problem Description
◇	14/08	15:45:01	RadMon	SIMA.PCGW21.MGR	Timing: card/li Eit...
◇	03/10	19:36:29	RadMonDev	SIMA.7L1.1LM13S	Either device's con...
◇	08/10	15:09:50	RadMonDev	SIMA.17L8.8LM11S	Either device's con...
◇	15/10	18:44:33	RadMonDev	SIMA.UJ14.1LM02S	Device's temperatur...
◇	N	18:44:34	RadMonDev	SIMA.7L1.1LM13S	Communication with ...
◇	N	18:44:55	RadMonDev	SIMA.17L8.8LM11S	Communication with ...
- Alarm Details Window:**

Alarm Details: RADMONDEV_2:SIMA.UJ14.1LM02S:2000

System Name: RadMonDev
 Identifier: SIMA.UJ14.1LM02S
 Problem Description: Device's temperature has reached level critical for its reliabili...

Static Properties:

Property	Value
Fault Family	RADMONDEV_2
Fault Member	SIMA.UJ14.1LM02S
Fault Code	2000
Priority	2
Action To Take	Call Mr Christian Pignard: phone 7
Responsible Name	KRZYSZTOF KOSTRO
Responsible GSM	4124
Responsible Phone	75437
Responsible Email	Krzysztof.Kostro@cern.ch
Source Name	LHC
Source Description	LHC CMW Alarms
Source Responsible	SIGERUD

Alarm Categories:

Path	Description
CERN.PS.LHC	GM LHC

Empty Properties:

Reason: [Dropdown menu]

Close
- Status Bar:** active: 6 mask: 0 inhibit: 0 Config read-only

Maintenance activated devices

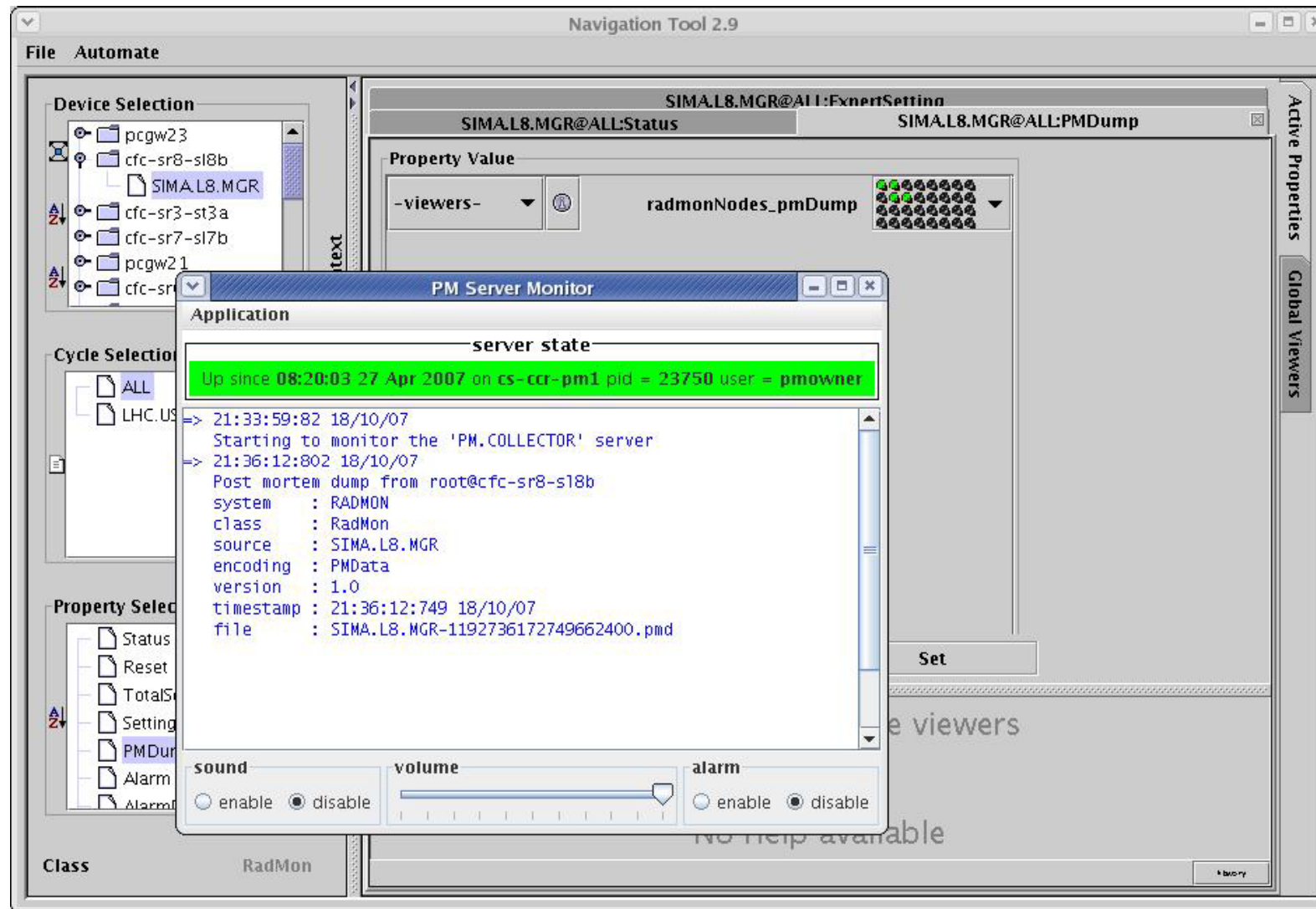


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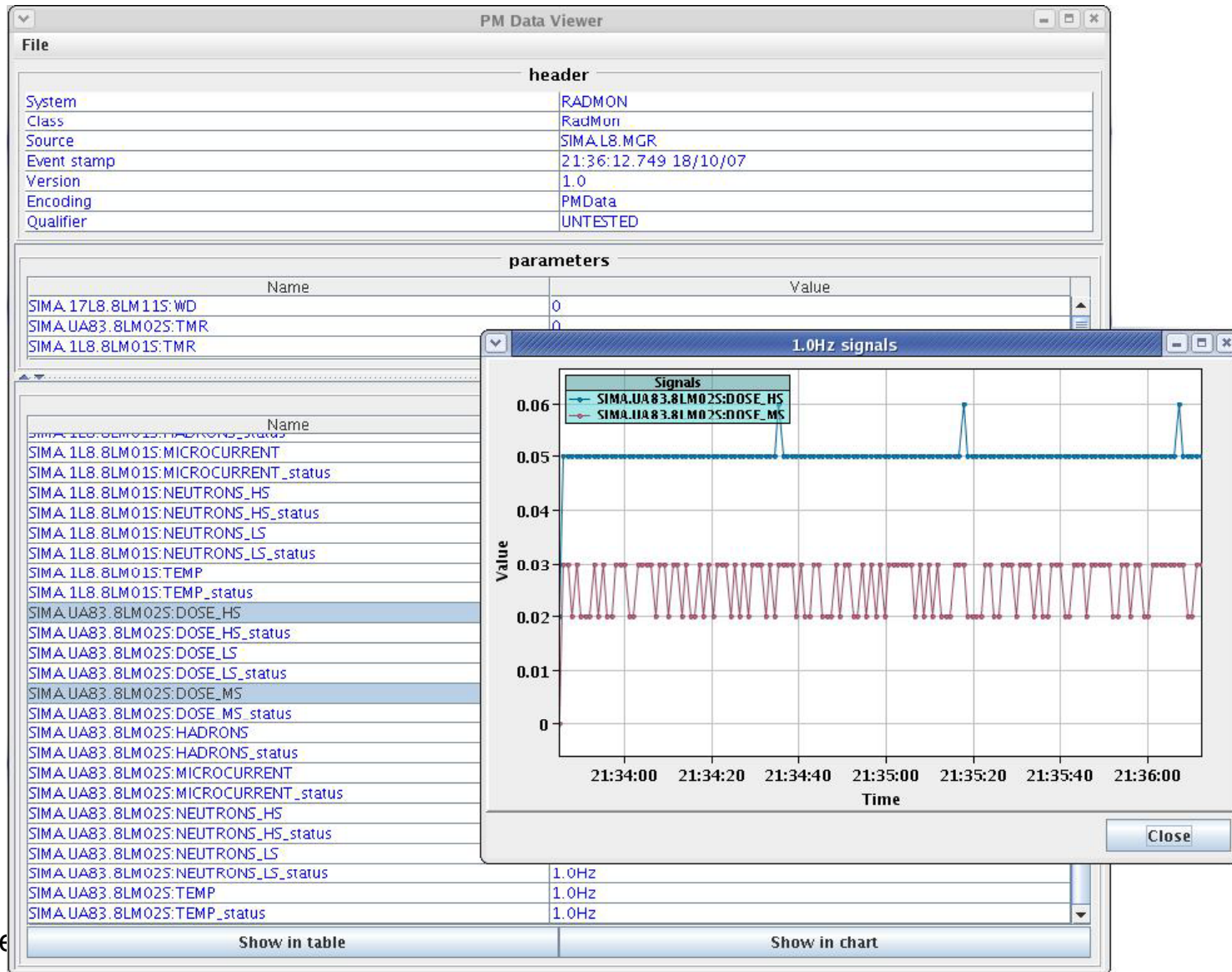
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Post Mortem (screenshots)



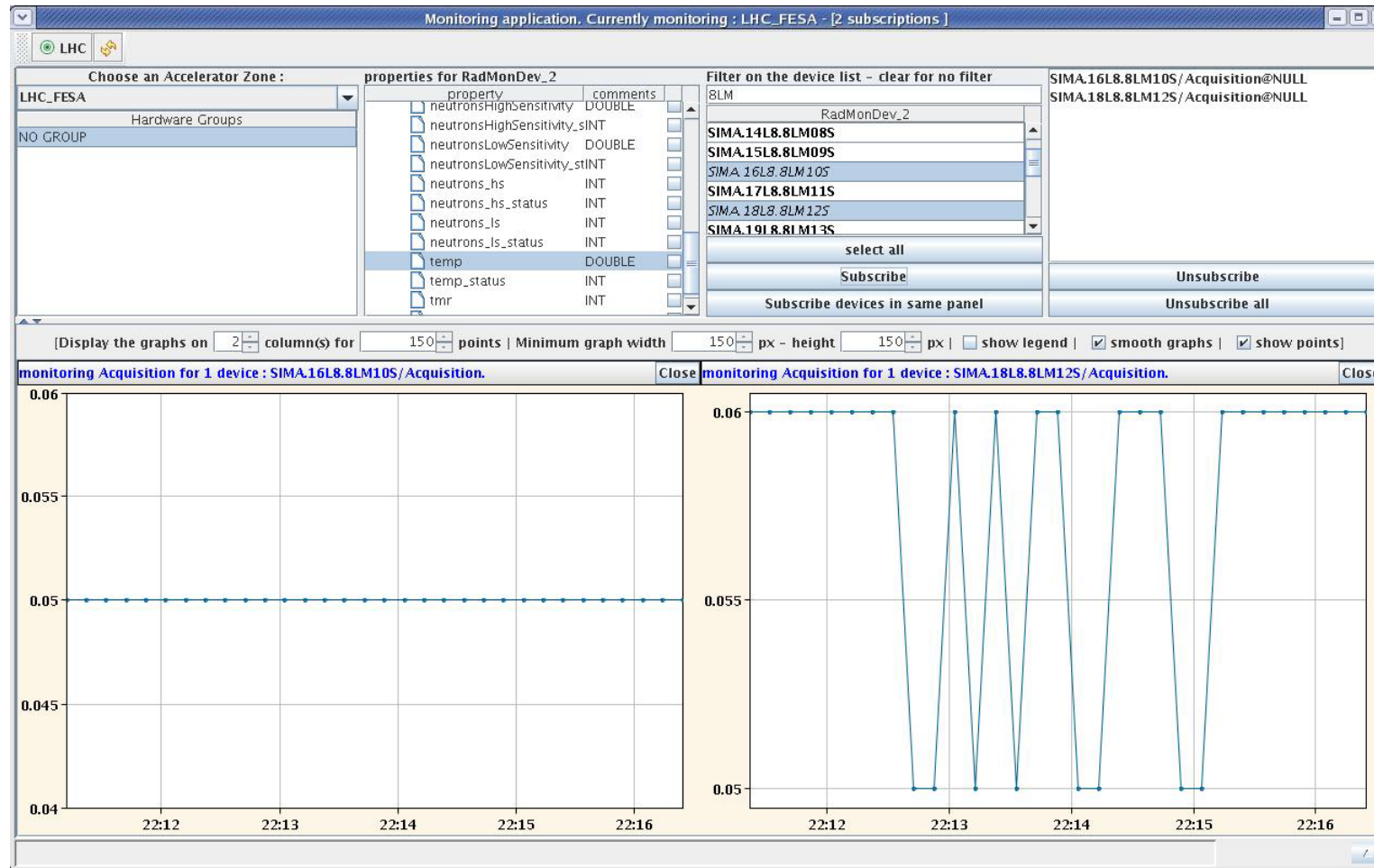
Post Mortem (screenshots)



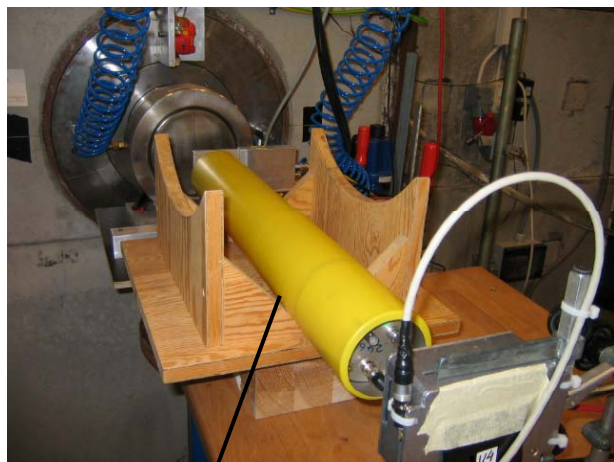
Data logging

- 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

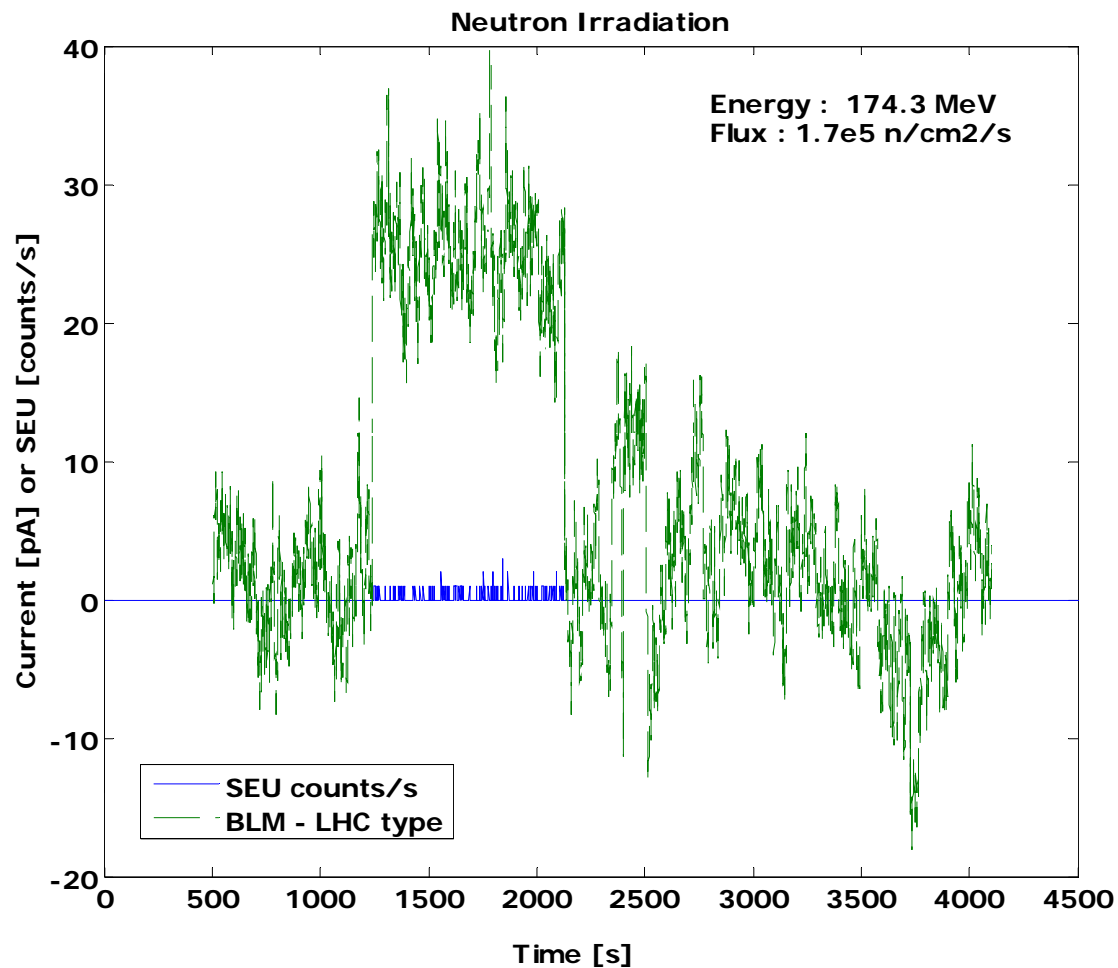


LHC BLM chamber

RADMON

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

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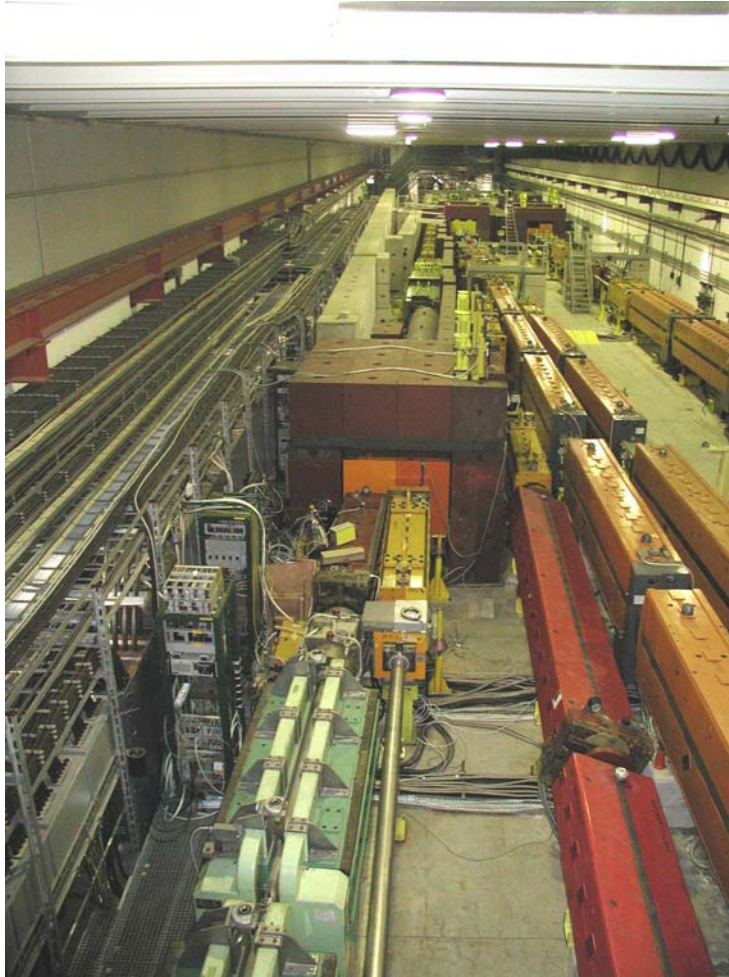


D. Kramer, M. Stockner, C. Pignard, T. Wijnands

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RadMON in SPS North Exp. Area

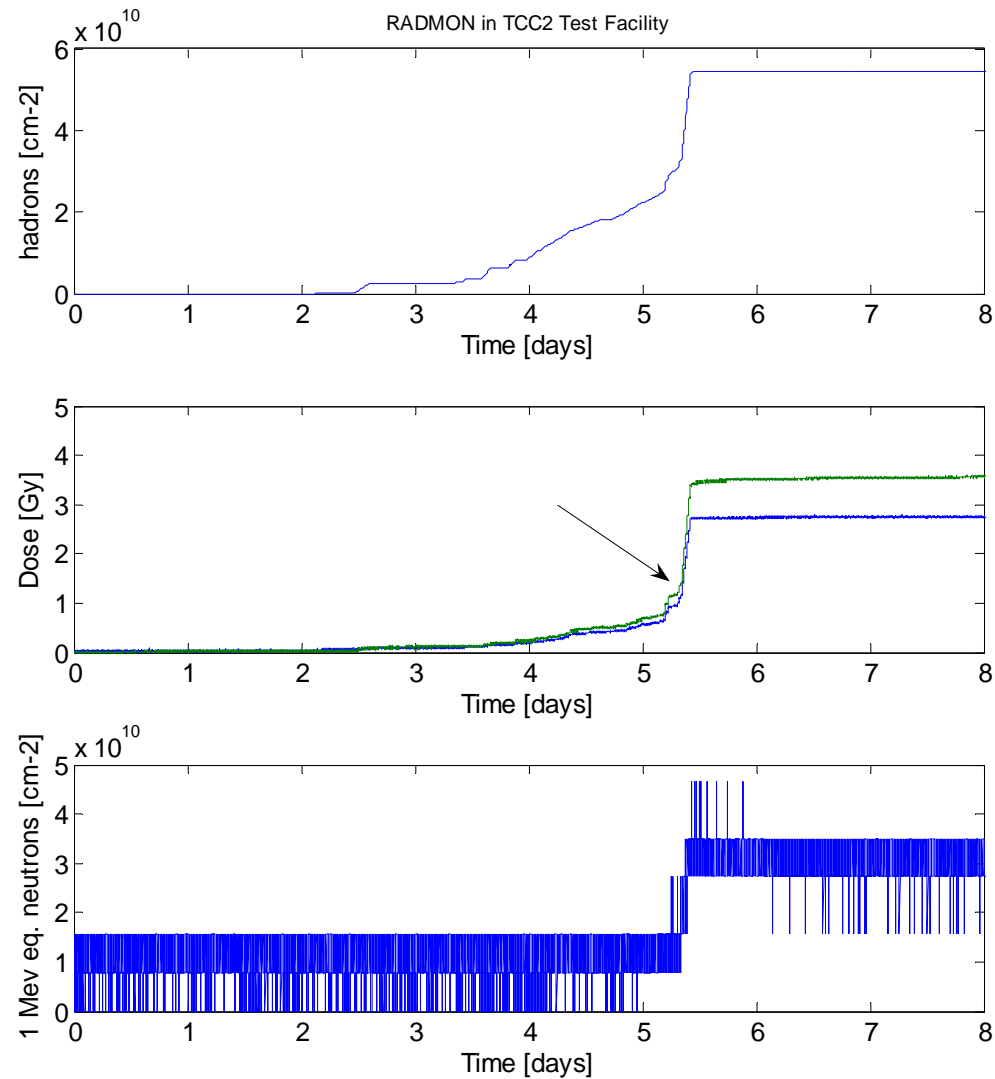


HEP Radiation field similar to LHC
ARCs produced by 450 GeV protons
on a fixed target

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 ...