RAdiation Monitoring System for the Environment and Safety (RAMSES)

The RAMSES Team

Presented by
L. SCIBILE (TS/CSE) and D. PERRIN (SC/RP)
The RAMSES will provide LHC, and finally CERN, with an integrated radiation monitoring system for the Environment and Safety covering acquisition, transmission, logging and display for the LHC machine, LHC experiments and experimental areas.

SC will exploit this system to assess radiation risks and to control the release of radioactivity. The system will also be incorporated into the accelerator and experiment control rooms.

The mandate of the project team covers the system specification, prototyping, tendering, installation and integration of radiation monitors and industrial control equipment for safety systems. The Contractors are ASSYSTEM and SAPHYMO.

History:
- Project Launched October 2001
- 1st RAMSES workshop November 2001
- IT3091 Market Survey July 2002
- 2nd RAMSES workshop December 2002
- Contract B1214 signed January 2004
The RAMSES project is a multi-departmental project between SC and TS

TS has the responsibility of the realization of the system with resources provided by the two departments

The Project Engineers of the team are:
- Daniel Perrin (SC/RP)
- Doris Forkel-Wirth (SC/RP) -> replaced by Markus Widorski (SC/RP)
- Pavol Vojtyla (SC/IE)
- Gustavo Segura (SC/IE)
- Ali Day (TS/CSE -> now SC/RP) and Claude Jouve (SC/RP)
**RAMSES description:**

**Major Functions**

- **Monitoring radiation variables (real-time)**
  - Measurement of dose rates during LHC operation around the accelerator, in experimental areas and their annexes, on the surface and in the environment (prompt radiation)
  - Measurement of radioactivity in released gases and fluids (radioactive nuclides)
  - Measurement of induced activity during LHC stop/shutdown
  - Generation of local radiation alarms and transmission of remote alarms

- **Generation of interlocks**

- **Monitoring of conventional parameters**
  - Measurement of physical and chemical parameters in the released water (pH, temperature, conductivity, turbidity)
  - Generation of remote alarms in case of deviation from normal range

- **Monitoring non-ionising radiation fields**
  - e.g. electromagnetic fields

- **Long term data storage**
  - Measured values
  - Events (radiation alarms, technical alarms, system faults, etc)
  - System configuration
RAMSES description: Major Requirements & Constraints

- Distributed Radiation Monitoring network
- Integrated software infrastructure (control rooms and networks)
- Flexible and modular design for easy configuration
- Industrial components
  - State-of-the-art radiation monitors and monitoring stations.
- Operational 24/24 hours a day, 365/365 days per year
- International standard in radiation protection
- Valid for the replacement of the current radiation monitoring system
**RAMSES**

Radiation Monitoring Stations

- Monitors and alarm panels on a field-bus for
  - Dose rate measurements
  - Alarms (evacuation)
  - Interlocks

- TCP/IP network connection for
  - Transfer of measurements and alarms
  - Remote configuration

- **Autonomous** stations for safety reasons
  - Radiation measurements off-line
  - Stores temporary measured values
  - Generates radiation alarm
  - Generates Interlocks

- Certified equipment (Hardware&Software)
Fully redundant server
Centralises data coming from the stations
Stores the data in the database (measured values, alarms, configurations)
Surveys the correct operation of the RAMSES (technical alarms)
Acts as server for the different HCI of the system
Integrates RAMSES in the CERN control infrastructure and control rooms
Sends radiation alarms to the LHC control room (LASER)
Sends technical alarms to the CCC (LASER)
Provides displays for radiation monitoring in the LHC control room
Provides displays for monitoring conventional parameters in water releases
Shares measured values with external system (DIP)

Offers a secure WEB interface to display radiation measurements
IHM animations

Push button to go to detailed plan

Push the button to open summary page

Push the button to open LHC point summary
Push to get the details about the object.

Push the button to open other pages of the same LHC point.
 Radiation Monitoring system
 Scope of the system

- ~350 radiation detectors for the monitoring of radiation variables (real-time)
- ~50 detectors for the environment for the monitoring of conventional parameters
- ~90 Monitoring stations
- 2 redundant servers for the data acquisition, data display and storage
- 6 dedicated consoles for the radiation protection remote supervisions
- 4 dedicated consoles for the configuration and calibration of radiation equipment
### Radiation Monitoring system

#### Scope of the system in numbers

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RAMSES physical implementation
RAMSES
Factory Acceptance Tests

- 100% of the equipment factory tested.
- All main reserves solved.
RAMSES
Site installation

- 90% of the equipment installed and being interconnected.
- Final site acceptance and hardware commissioning in preparation.
## Status of implementation

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* Cable Only  |  To be done  |  To be verified  |  Done  |  Not applicable  

* Indicates cable only, **To be done**, ***To be verified***, ****Done****, *****Not applicable*****.
RAMSES @ ALICE
## Status of implementation

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* Cable Only      | To be done | To be verified | Done | Not applicable |
RAMSES @ CMS

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PMS2962 (ERC)
PSA565 (EAS)

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PMV9586 (VCM)
PMV9587 (VCM)
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PMV9589 (VCM)

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PSA569 (EAS)

MSPA95 (LRD)

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PMIL5531
PMIL5522

PMIL5511

PMIL5501
(entrée UP555)

PMIL5502
(dessous)

PMIL5513
(entrée UPX56)

SURFAX

CMS UXC56 vue perspective
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* Cables Only  
** To be done  
--- To be verified  
### Done  
### Not applicable

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**Notes:**
- **US5:** Equipment and cabling details.
- **CMS Experiment Cavern UX/C05:** Details as per the CMS experiment.
- Colors indicate status: Red for To be done, Yellow for To be verified, Green for Done, and Gray for Not applicable.

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**Legend:**
- **ARC:** ARC equipment
- **LRD:** LRD cabling
- **PCM:** PCM equipment
- **HFM:** HFM equipment
## Status of implementation

<table>
<thead>
<tr>
<th>Equipment installed</th>
<th>Cabling</th>
<th>Power supply</th>
<th>TCP/IP</th>
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<tr>
<td><strong>Surface Site</strong></td>
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<td>01</td>
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<td><strong>Service zone for UX85</strong></td>
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<td>3531</td>
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</tbody>
</table>

* Cable Only  | To be done  | To be verified  | Done  | Not applicable
## Installation planning

<table>
<thead>
<tr>
<th>Task Name</th>
<th>ATLAS</th>
<th>ALICE</th>
<th>CMS</th>
<th>LHCb</th>
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<tbody>
<tr>
<td><strong>Service areas</strong></td>
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<tr>
<td>Installation</td>
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<td>Commissioning</td>
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<tr>
<td>Installation</td>
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</tr>
<tr>
<td>Commissioning</td>
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</tbody>
</table>

### ATLAS

- **2007**
  - January: Installation
  - March: Commissioning

### ALICE

- **2007**
  - April: Commissioning

### CMS

- **2007**
  - May: Commissioning

### LHCb

- **2007**
  - June: Commissioning
Conclusions

- Large number of monitoring stations -> many little details to be looked at!

- Final interconnections coming a bit late -> this will imply a compressed schedule for the hardware commissioning: Big challenge of this year

- For the experiments,
  - all the sensors in the baseline have been integrated.
  - Few sensors need still to be installed after the completion of the works in the experimental areas.
Thank you for your attention!

Acknowledgements to the project team

Daniel Perrin
Doris Forkel-Wirth
Pavol Vojtyla
Gustavo Segura
Ali Day
Markus Widorski
Claude Jouve
Michel Pangallo
Jean Claude Gaborit
Dietlinde Wittekind
Stray radiation monitoring station:
- Gamma and muons monitor [EPIC];
- Neutrons monitor [ERC];

Ventilation monitoring station (Emissions):
- Gas monitor [VGM];
- Aerosol sampler [VAS];

Water monitoring station (Effluents):
- Release water monitor [RWM];
- Release water sampler [RWS];
Meteorological data:
(wind speed, wind direction, atmospheric stability class):
- Ultrasound anemometer [USA];

Samples from the environment:
- Environmental aerosol sampler [EAS];

Conventional parameters in released water:
- pH;
- Temperature
- Conductivity
- Turbidity
- Flow rate
 Radiation Monitors

For the Environment

Stray radiation Monitoring

Ventilation Monitoring

Water Monitoring station

EPIC

ERC

VGM - VAS

Wind Monitoring

USA

RWM - RWS

EPIC ERC
Radiation Monitors

For radiation protection

◆ **LHC experimental areas:**
  - Area REM-counter monitor [ARC];
  - Area Gamma dose rate monitor [AGM];
  - Area Mixed field radiation monitor [AMF];
  - Induced activity monitor [IAM];

◆ **Specialised monitors:**
  - Hand & Foot monitor [HFM];
  - Tools & material controller [PCM];
  - Site Gate monitor [SGM];

◆ **Other equipment:**
  - Radiation Monitoring Station [MS];
  - Alarm radiation display [PAD];
Measure the ambient dose equivalent and ambient dose equivalent rate caused by neutrons;

- Applicable standard: IEC 61005;
  - (Energy range: 0.025 eV to 14.8 MeV)
- Thermo Eberline SWENDI 2 FHT762;
- Performances:
  - Measuring range: 10 nSv/h to 100 mSv/h,
  - Energy range: 0.025 eV to 5 GeV,
  - Measuring time: from 0.1 s and its multiples.
Measure the ambient dose equivalent and ambient dose equivalent rate caused by photons or minimal ionising particles (e.g. muons);

- Applicable standard: IEC 60532;
  (Energy range: 50 keV to 7 MeV)
- Centronic IG5 – A20 (20 atm. Argon);
- Performances:
  - Measuring range: 10 nSv/h – 50 mSv/h,
  - Energy range: 50 keV à 10 MeV,
  - Linearity (over measuring range): ± 10% (réf. 662 keV),
  - Measuring time: from 0.1 s and its multiples.
- Extensive Monte-Carlo simulations (FLUKA code) and experimental results (at CERF*).

Reference C. Theis et al.

* CERN-EU high-energy reference field
Measure the ambient dose equivalent and ambient dose equivalent rate in mixed radiation fields consisting in high-energy charged particles (protons, pions, muons, electrons, positrons) and neutrons and photons;

Applicable standard: IEC 60532;

(Energy range: 50 keV to 7 MeV)

Centronic IG5 – H20 (20 atm. Hydrogen-filled);

Performances:
- Measuring range: 30 nGy/h to 100 mGy/h,
- Energy range: 65 keV to 10 MeV,
- Linearity (over measuring range): ± 10% (réf. 662 keV),
- Measuring time: from 0.1 s and its multiples.

Extensive Monte-Carlo simulations (FLUKA code) and experimental results (at CERF*) in order to extend the application field to mixed high energy fields.

Reference C. Theis et al.

* CERN-EU high-energy reference field
Radiation Monitors

For radiation protection

IAM
INDUCED ACTIVITY MONITOR

- Measure the ambient dose equivalent and ambient dose equivalent rate in photon fields (beam off);
- Applicable standard : none;
- Manufacturer PTW Freiburg;
- Plastic ionisation chamber (1 atm. Air-filled);
- Performances :
  - Measuring range : 5 μSv/h to 500 mSv/h,
  - Energy range : 50 keV to 7 MeV,
  - Measuring time : from 1 s and its multiples.

Reference H. Vincke et al.
Radiation Monitors

For radiation protection

So called Alarm Unit, provides indication to personnel of potential radiation hazard:
- Generates visual radiation alarms
- Generates audible radiation alarms
- Indicates good working conditions of the monitoring system

- Green fixed light = NORMAL situation
  (radiation levels low, monitoring system operational)

- ORANGE flashing light + SOUND
  WARNING → Limited stay

- RED flashing light + SOUND
  ALARM → Evacuation of the area

LRD
LOCAL RADIATION ALARM DISPLAY
Radiation Monitors

For radiation protection

MST
MONITORING STATION

- **Autonomous stations (battery backup)**
  - Radiation measurements off-line
  - Stores temporary measured values
  - Generates local/remote radiation alarms
  - Generates Interlocks

- **Monitors and alarm units on a field-bus for**
  - Dose rate measurements
  - Alarms (evacuation) Interlocks

- **TCP/IP network connection for**
  - Transfer of measurements and alarms
  - Remote configuration
PCM
TOOLS and MATERIAL CONTROLLER

- Used to give an indication on the radioactivity of a possibly activated component before this item leaves the controlled area;
- Applicable standard: under investigation;
- Manufacturer: Genitron – Saphymo – Novelec;
- Performances:
  - Measuring range: 10 nSv/h to 250 µSv/h,
  - Energy range: 50 keV to 2.7 MeV (eq. $^{137}$Cs)
HFM
HAND & FOOT MONITOR

- Foreseen to check for potential beta or gamma contamination of persons involved in activity like the maintenance of the inner part of the experimental detectors or of very specific accelerator components;
- Applicable standard: IEC 61098;
- Manufacturer: Saphymo;
- Performances:
  - $\alpha$, $\beta$, $\gamma$ detection,
  - Detection efficiency:
    - $^{90}\text{Sr}$: > 20 %
    - $^{60}\text{Co}$: > 12 %