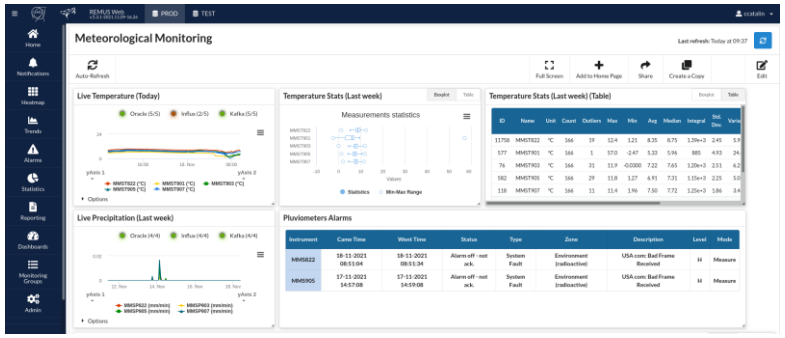
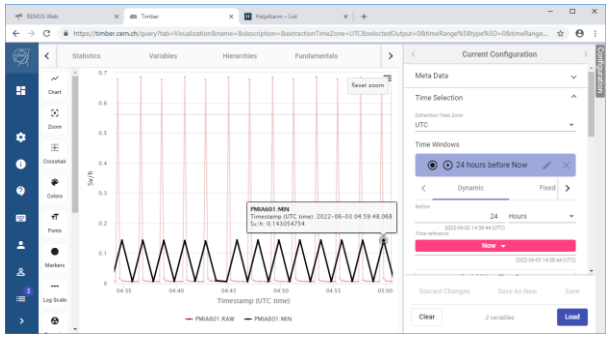
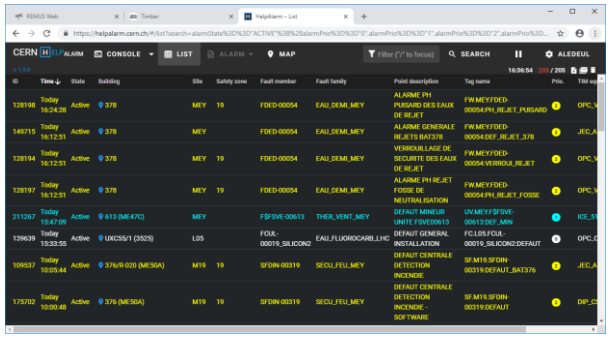

CERN
HSE
Occupational Health & Safety
and Environmental Protection unit

HSE Seminar:
Exploiting data of the Radiological and Environmental Monitoring System



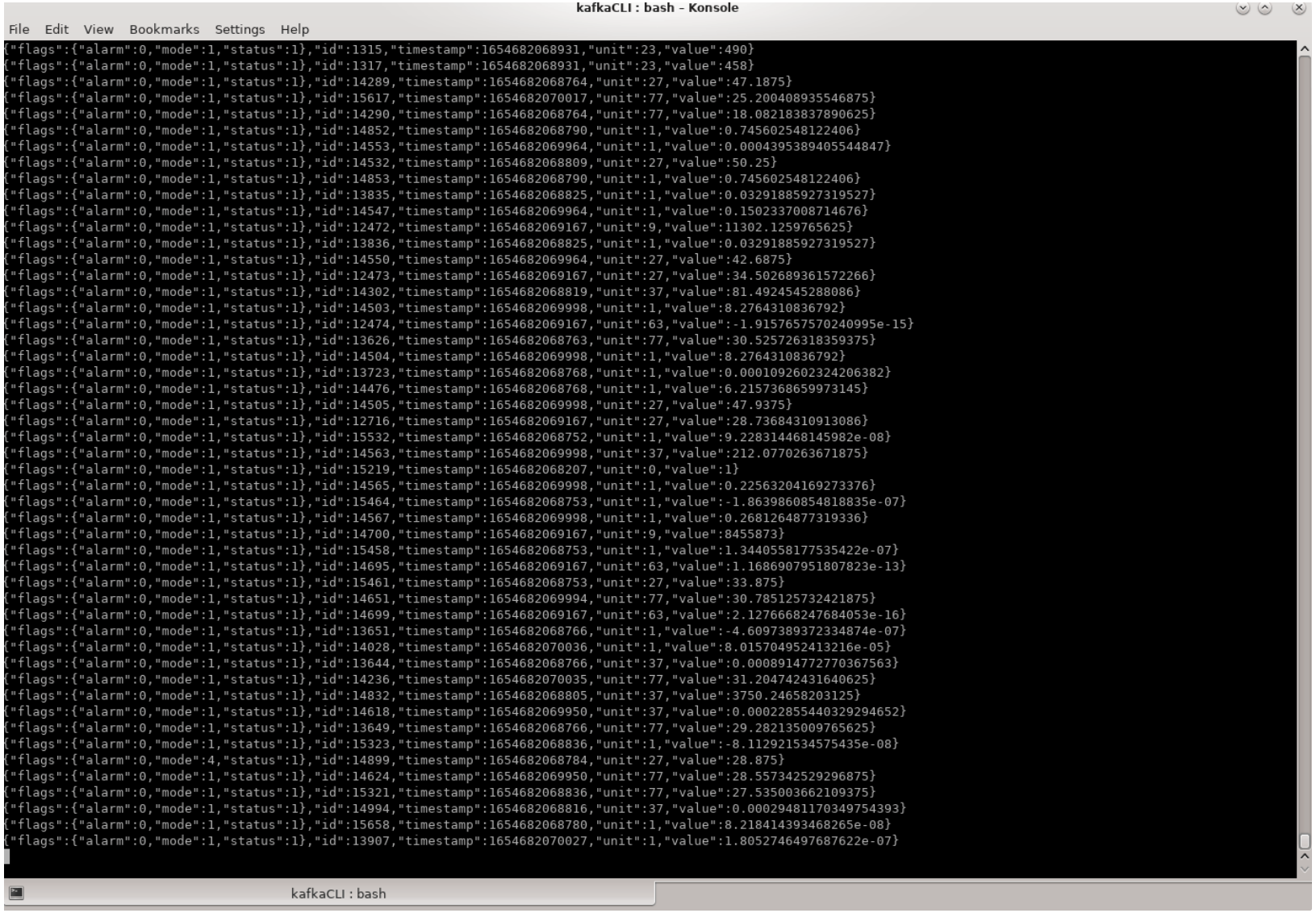




CERN HSE Unit

A. Ledeul, G. De La Cruz, F. Malacrida, M. Widorski, J. Regnard, C. Chiriac, H. Boukabache

Introduction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How to make sense of this ?

Context

From Instrumentation to Operation

OPERATIONAL RADIATION PROTECTION

CONTAMINATION

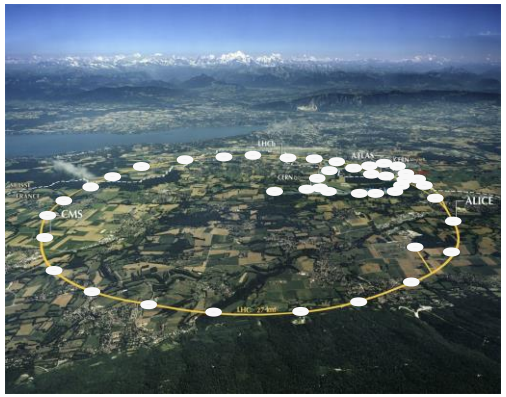
GATE

VENTILATION

WEATHER

AIR

WATER



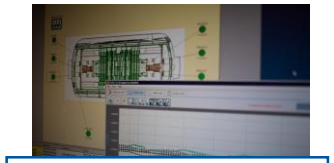
Commands
On, Off, Sample, etc.
Parameters
Thresholds, Units, etc.

300 active users

24/7

800 stations

Measurements
Alarm signals
Faults
Process Statuses

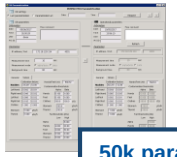


Radiation Protection & Environmental Experts

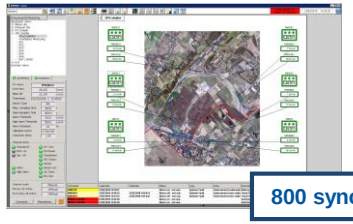
CERN Control Centre

Experiments Control Rooms

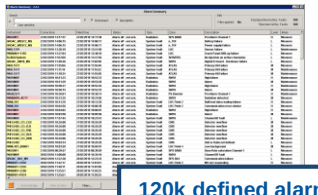
Safety Control Room



50k parameters

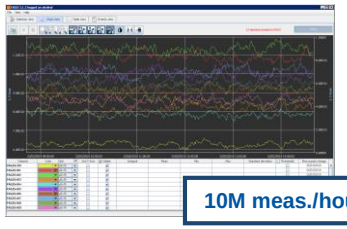


800 synoptic



120k defined alarms

REMUS
Supervision
Control
Data Acquisition



10M meas./hour

ERGO
Data Visualization

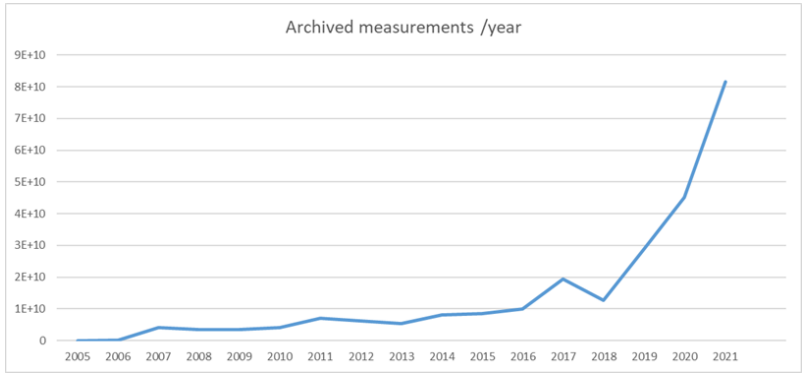
REMS = Radiological and Environmental Monitoring System
REMUS = Radiation and Environment Monitoring Unified Supervision
ERGO = Environment and Radiation Graphic Observer
SCADA = Supervisory Control and Data Acquisition

Problem Statement

From Data to Information

REMUS Data in Numbers

- **1,000,000** online variables
- **50,000** remote parameters
- **90,000,000,000** measurements / year



- Alerts to Control Rooms
- Reports to host state authorities
- Data analysis
- Dashboards
- Aggregated statistics
- Predictive maintenance
- Anomaly detection

REMADS Project (2019-2021)

Integrated in HSE RAMSES Program

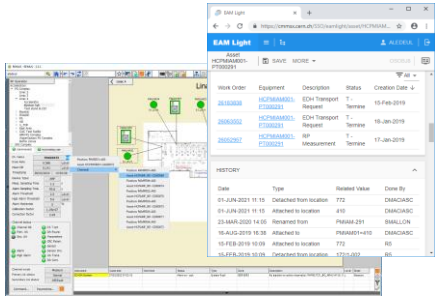
- 6 months discussions with REMS Users
- User Requirement Specification
- Project Proposition

REMUS GPN

Secured GPN LAN/Wifi/4G/LoRaWAN connectivity

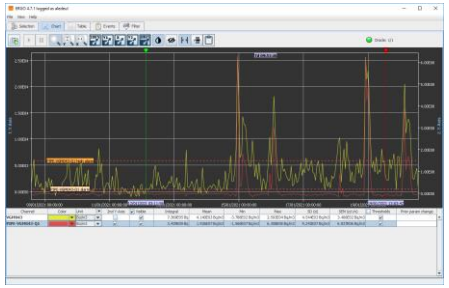
CERN data-stores

Integration with Kafka and Hadoop (NXCALS)



InforEAM Integration

Maintenance Management Information System



ERGO 4.0

Complex transformation operations on Trends

REMUS Web

Data Analysis toolbox

Portable system for on-site intervention

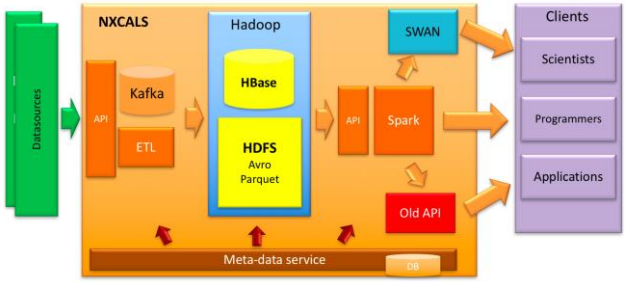
REMADS = REMus Analytics and Data Services
GPN = General Purpose Network
LAN = Local Area Network
LoRaWAN = Long Range Wide Area Network
NXCALS = Next CERN Accelerators Logging Service
EAM = Enterprise Asset Management

Collaboration with other Departments

CERN-wide services used

NXCALS

- Big data technologies
- Centralizes CERN accelerator data
- Managed by **BE**



Source: NXCALS - Architecture and Challenges of the Next CERN Accelerator Logging Service, J. Woźniak and Chris Roderick, 2019

Data

Long Term Storage

Near-Real Time

Apache Kafka®:
open-source distributed streaming platform

kafka

- Data Streaming Platform
- Transmit Real-Time data out of REMUS
- Managed by **IT**

influxdb

- Time Series Database
- Buffer Real Time data
- Managed by **IT**

NXCALS = Next CERN Accelerators Logging Service

Why & How to use the newly available Software Tools ?

Use-cases & Demos

HSE

Dashboards

Speaker: Fabrice Malacrida (HSE-RP)

HSE

REMUS Web

Speaker: Gonzalo De La Cruz (HSE-TS)

HSE

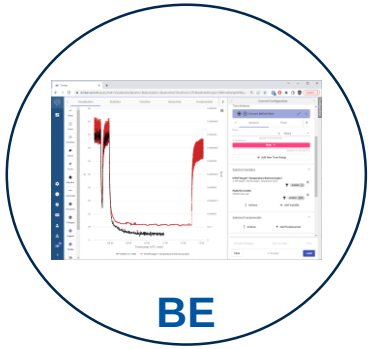
Statistics & Reporting

Speaker: Markus Widorski (HSE-RP)

EN & BE

InforEAM & HelpAlarm

Speaker: Julien Regnard (HSE-ENV)



BE

NXCALS & TIMBER

Speaker: Catalina Chiriac (HSE-TS)

IT & BE

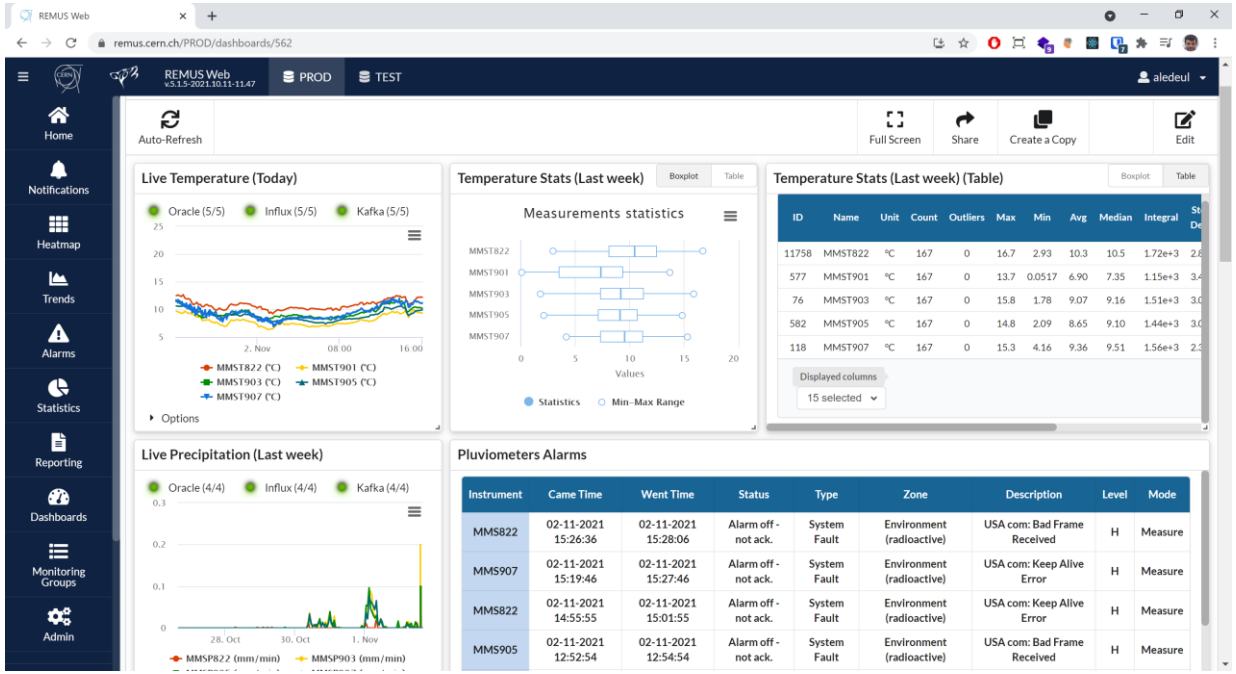
Data Analysis using SWAN

Speaker: Hamza Boukabache (HSE-RP)

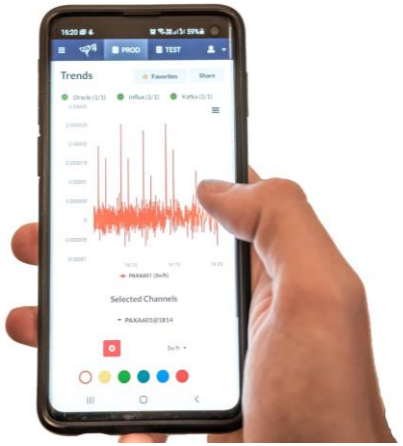
REMUS Web

REMUS Web

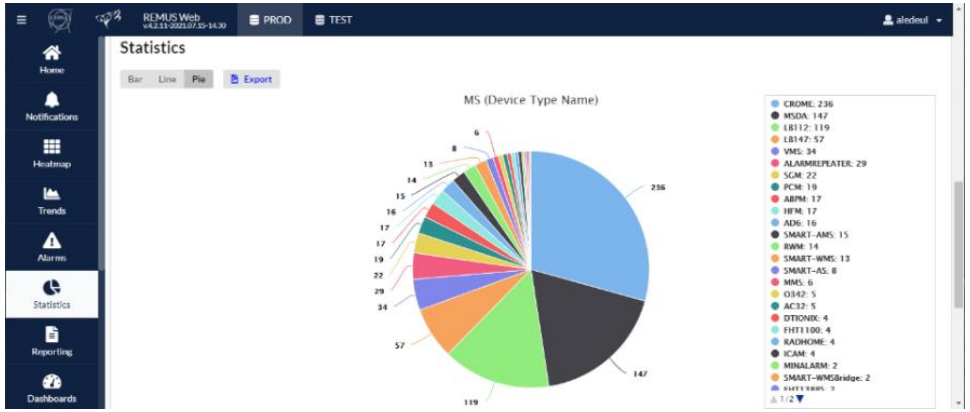
- Dedicated platform for the analysis and exploitation of REMUS data.
- Goals:
  - Facilitate access to REMUS data.
  - Provide data analysis tools for REMUS users.
  - Transform REMUS data into meaningful information.



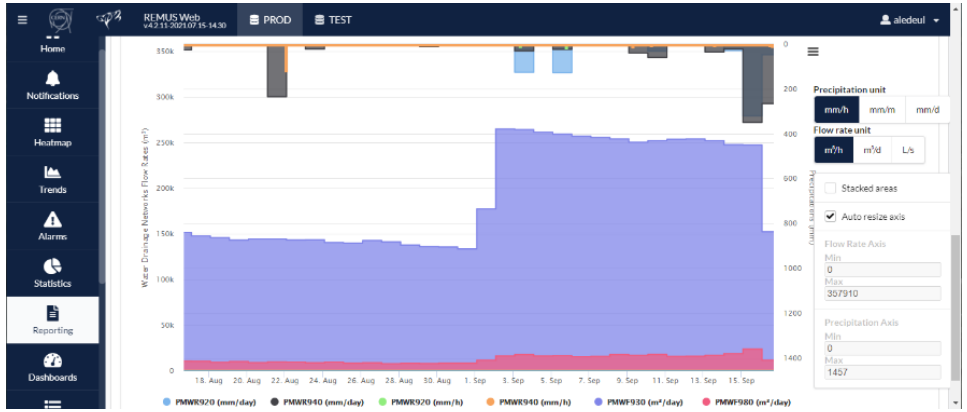
REMUS Web Key Features



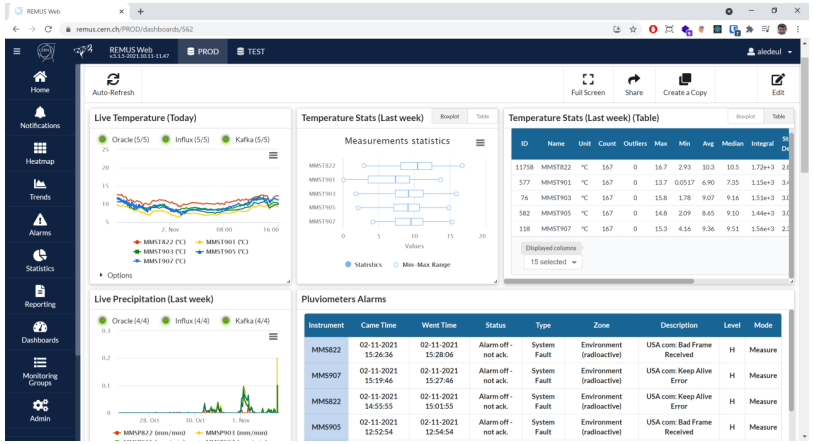
Remote access to REMUS data from any desktop or mobile devices.



Tailor-made data analysis and data extraction tools for Radiation and Environmental protection experts

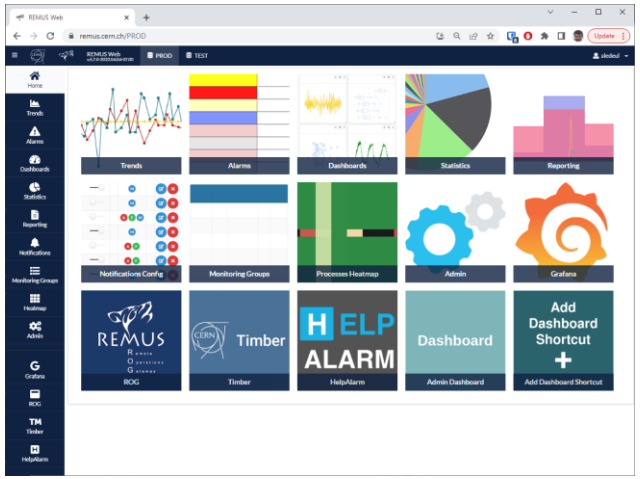


Generation of domain-specific reports for internal analysis and to report to CERN'S host states authorities.



Powerful tool for the creation and visualization of Dashboards.

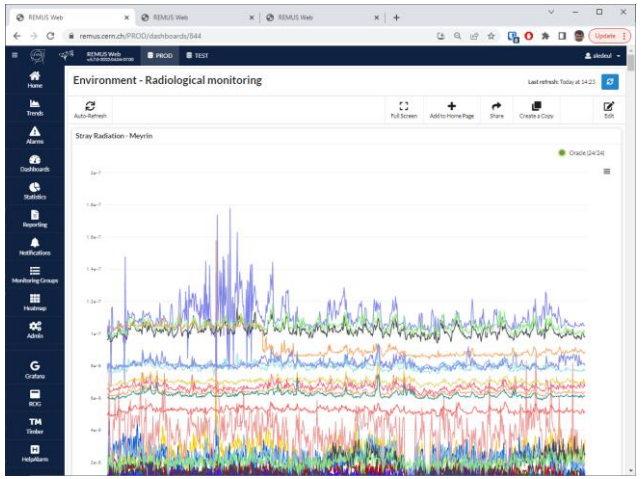
Demo



https://remus.cern.ch

REMUS Web Dashboards

Demo



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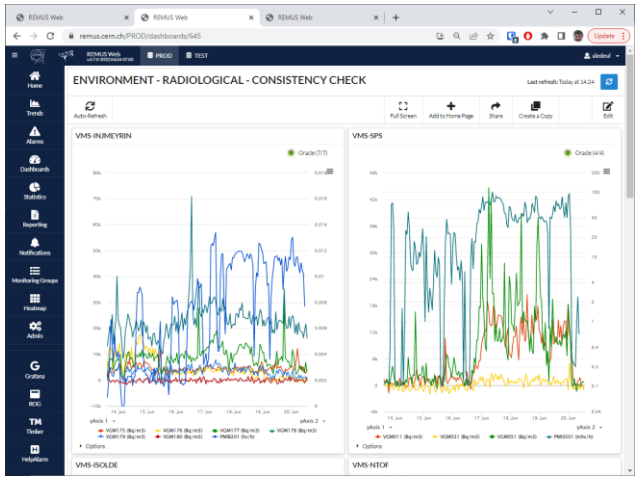

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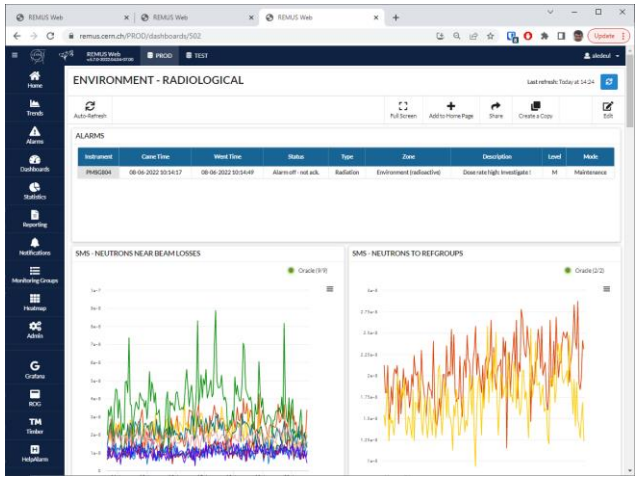

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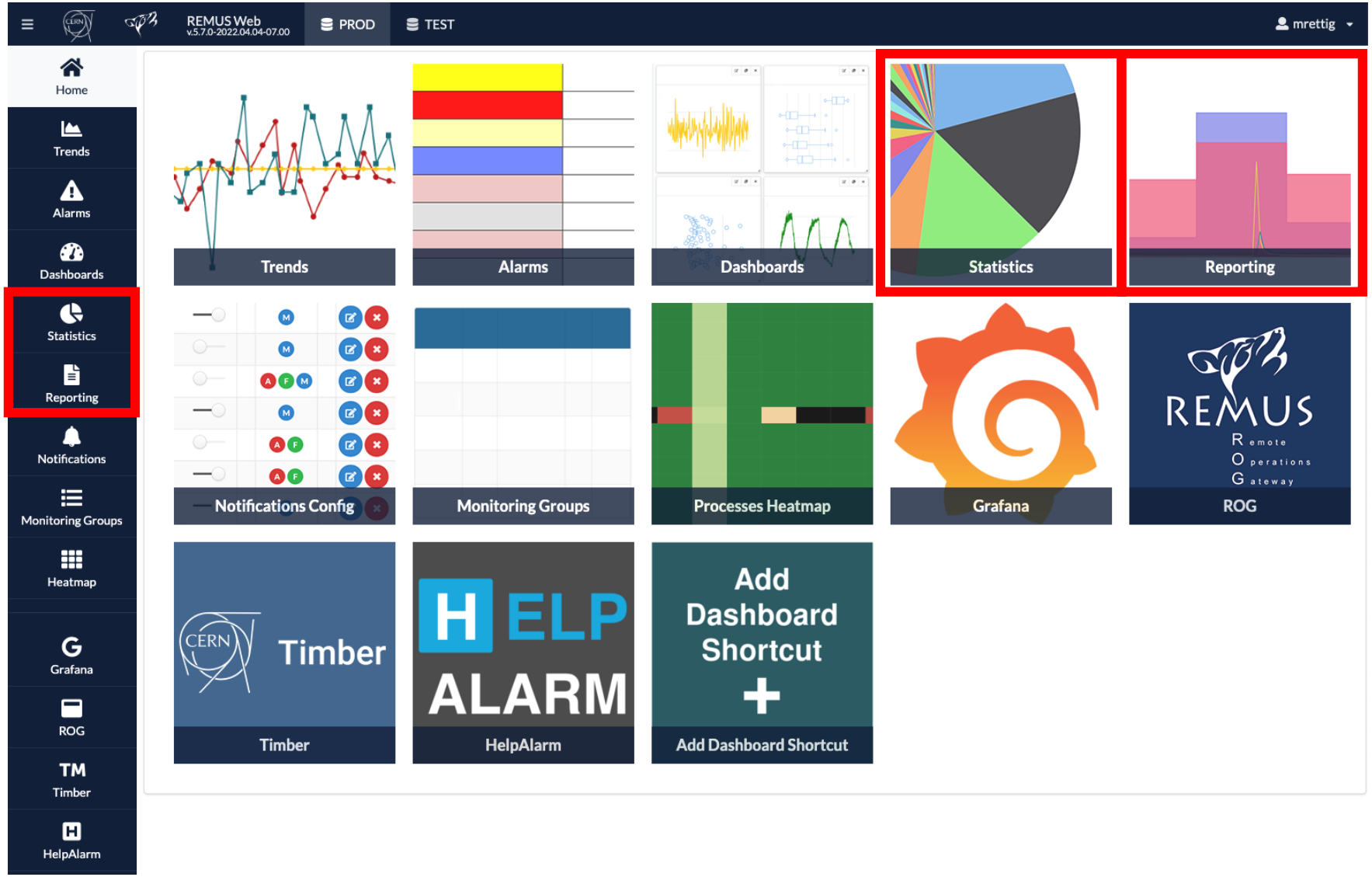
REMUS Web Statistics & Reporting


REMUS Web
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PROD
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Alarms
Dashboards
Statistics
Reporting
Notifications
Monitoring Groups
Heatmap
Grafana
ROG
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HelpAlarm
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Dashboards
Statistics
Reporting
Notifications Config
Monitoring Groups
Processes Heatmap
Grafana
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Operations
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ALARM
HelpAlarm
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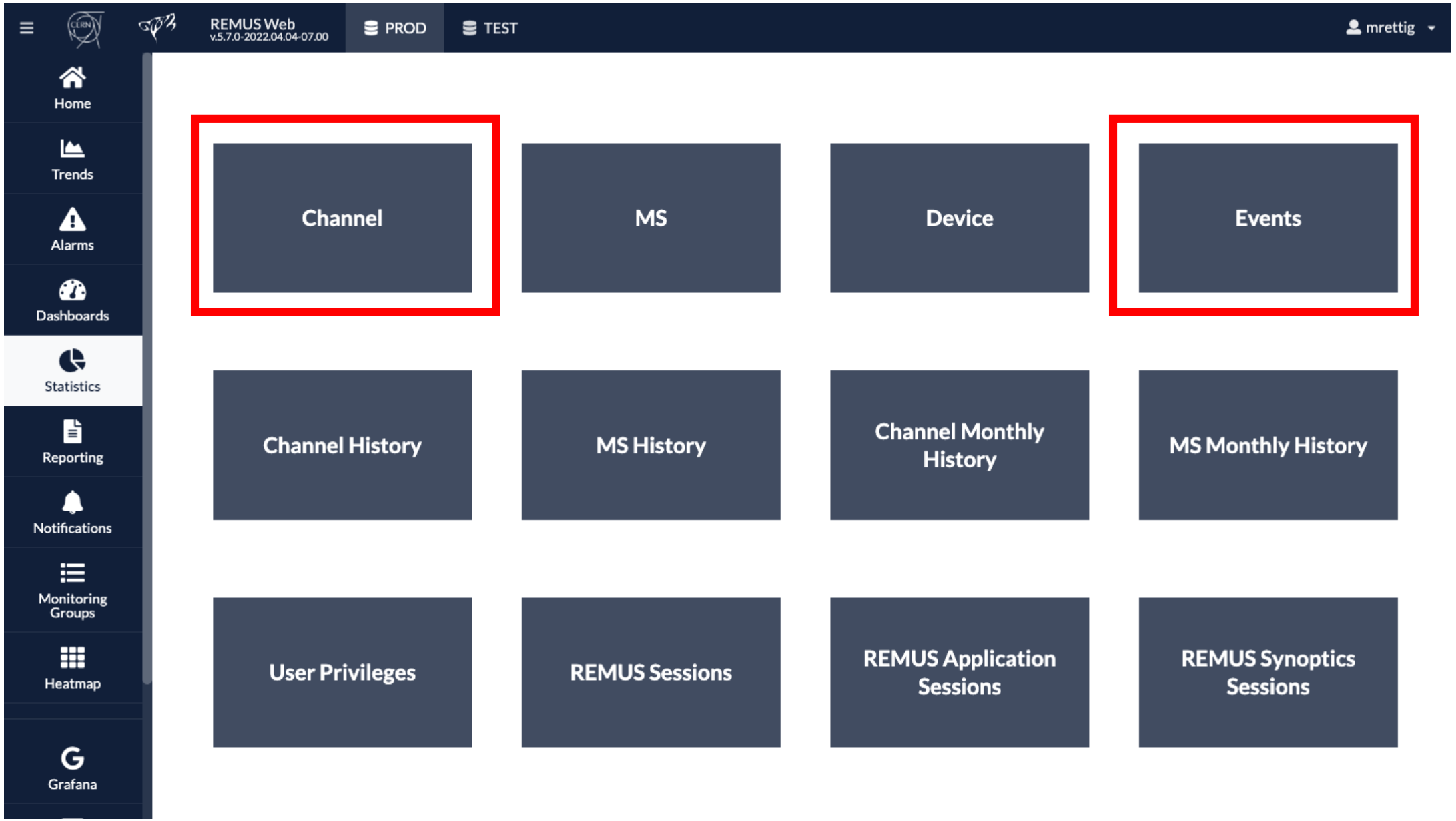
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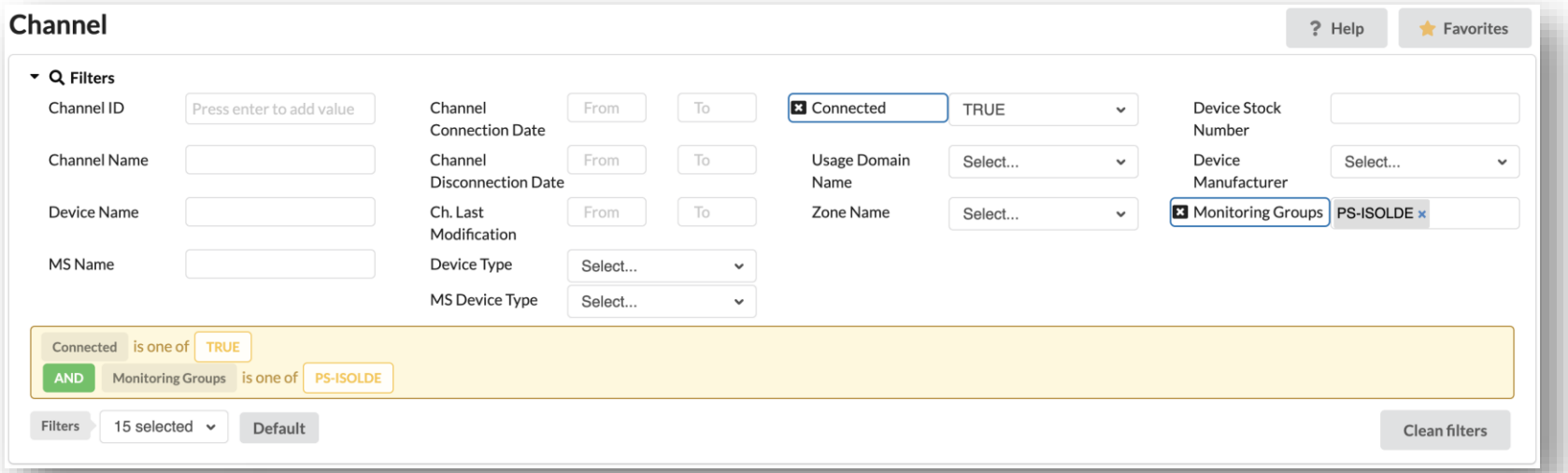
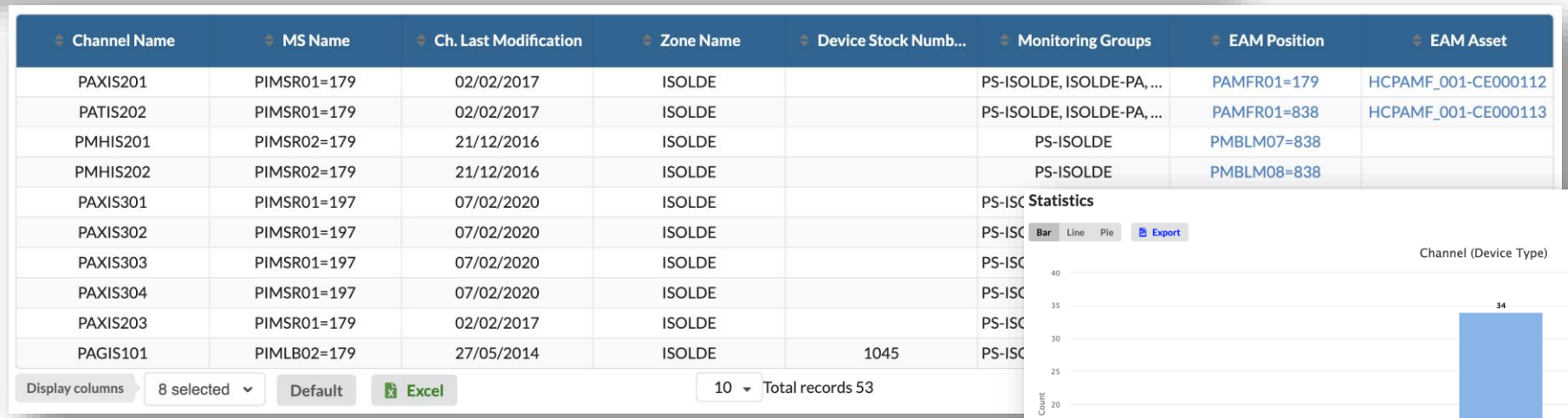
Monitoring Groups
Heatmap
Grafana
Channel
MS
Device
Events
Channel History
MS History
Channel Monthly History
MS Monthly History
User Privileges
REMUS Sessions
REMUS Application Sessions
REMUS Synoptics Sessions

Statistics → Channels / Events

- Retrieve monitor/channel names and types in a specific area
- Access the EAM links to a specific measurement position
- Create statistics on specific types of events (alarms, faults): Listing and aggregating





Channel Name	MS Name	Ch. Last Modification	Zone Name	Device Stock Numb...	Monitoring Groups	EAM Position	EAM Asset
PAXIS201	PIMSR01=179	02/02/2017	ISOLDE		PS-ISOLDE, ISOLDE-PA, ...	PAMFR01=179	HCPAMF_001-CE000112
PATIS202	PIMSR01=179	02/02/2017	ISOLDE		PS-ISOLDE, ISOLDE-PA, ...	PAMFR01=838	HCPAMF_001-CE000113
PMHIS201	PIMSR02=179	21/12/2016	ISOLDE		PS-ISOLDE	PMBLM07=838	
PMHIS202	PIMSR02=179	21/12/2016	ISOLDE		PS-ISOLDE	PMBLM08=838	
PAXIS301	PIMSR01=197	07/02/2020	ISOLDE		PS-ISC		
PAXIS302	PIMSR01=197	07/02/2020	ISOLDE		PS-ISC		
PAXIS303	PIMSR01=197	07/02/2020	ISOLDE		PS-ISC		
PAXIS304	PIMSR01=197	07/02/2020	ISOLDE		PS-ISC		
PAXIS203	PIMSR01=179	02/02/2017	ISOLDE		PS-ISC		
PAGIS101	PIMLB02=179	27/05/2014	ISOLDE	1045	PS-ISC		

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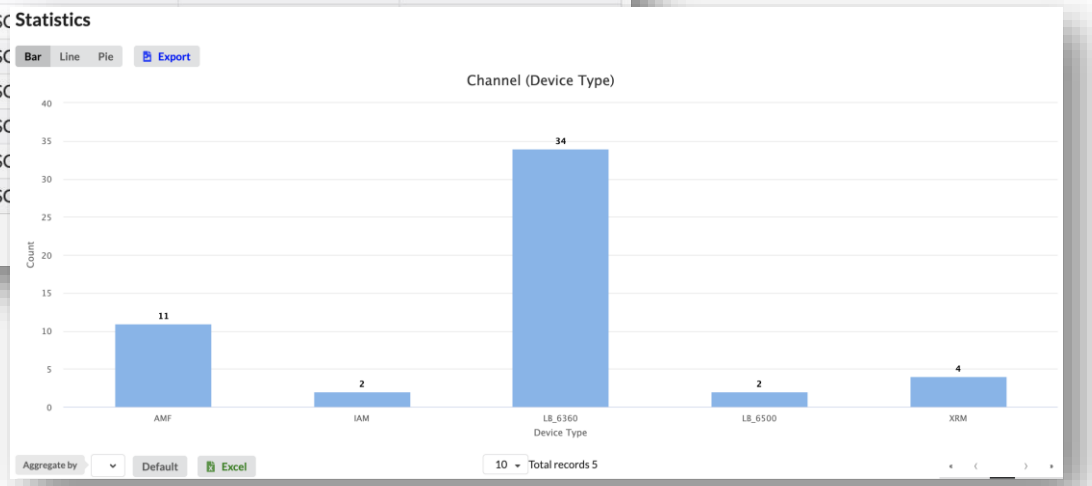


Events

Help | Favorites

Filters

Event type: Select... | Source type: 2 selected | Timestamp: 01-06 To | Message:
Username: | Source name: PAM | Transition: TRUE | Event Work Mode: Select...
Monitoring Groups: | Source ID: Press enter to add value

Source type is one of Channel, MS
AND Source name is PAM
AND Timestamp from We, 01/06/2022 00:00:00
AND Transition is one of TRUE

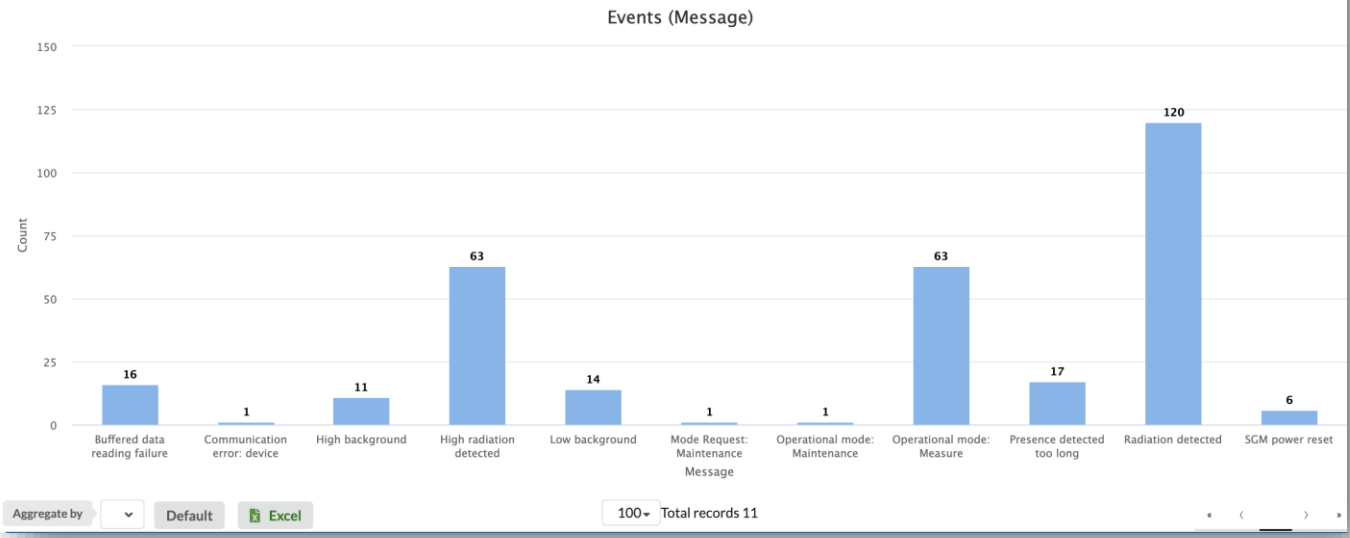
Filters 10

Event type	Username	Monitoring Groups	Source type	Source name	Source ID	Timestamp	Transition	Message	Event Work ...
System Fault	cs-ccr-rems10		MS	PAMA01	151	Th, 09/06/2022 08:...	TRUE	Communication err...	Measure
System Fault	remus_sgm		MS	PAML101	167	We, 01/06/2022 0...	TRUE	SGM power reset	Measure
System Fault	remus_sgm		MS	PAML101	167	We, 01/06/2022 1...	TRUE	SGM power reset	Measure
System Fault	cs-ccr-rems10		MS	PAML101	167	Th, 02/06/2022 11:...	TRUE	Buffered data readi...	Measure
System Fault	cs-ccr-rems10		MS	PAML101	167				
System Fault	cs-ccr-rems10		MS	PAML101	167				
System Fault	cs-ccr-rems10		MS	PAML101	167				
System Fault	cs-ccr-rems10		MS	PAML101	167				
System Fault	remus_sgm		MS	PAML101	167				
System Fault	cs-ccr-rems10		MS	PAML101	167				

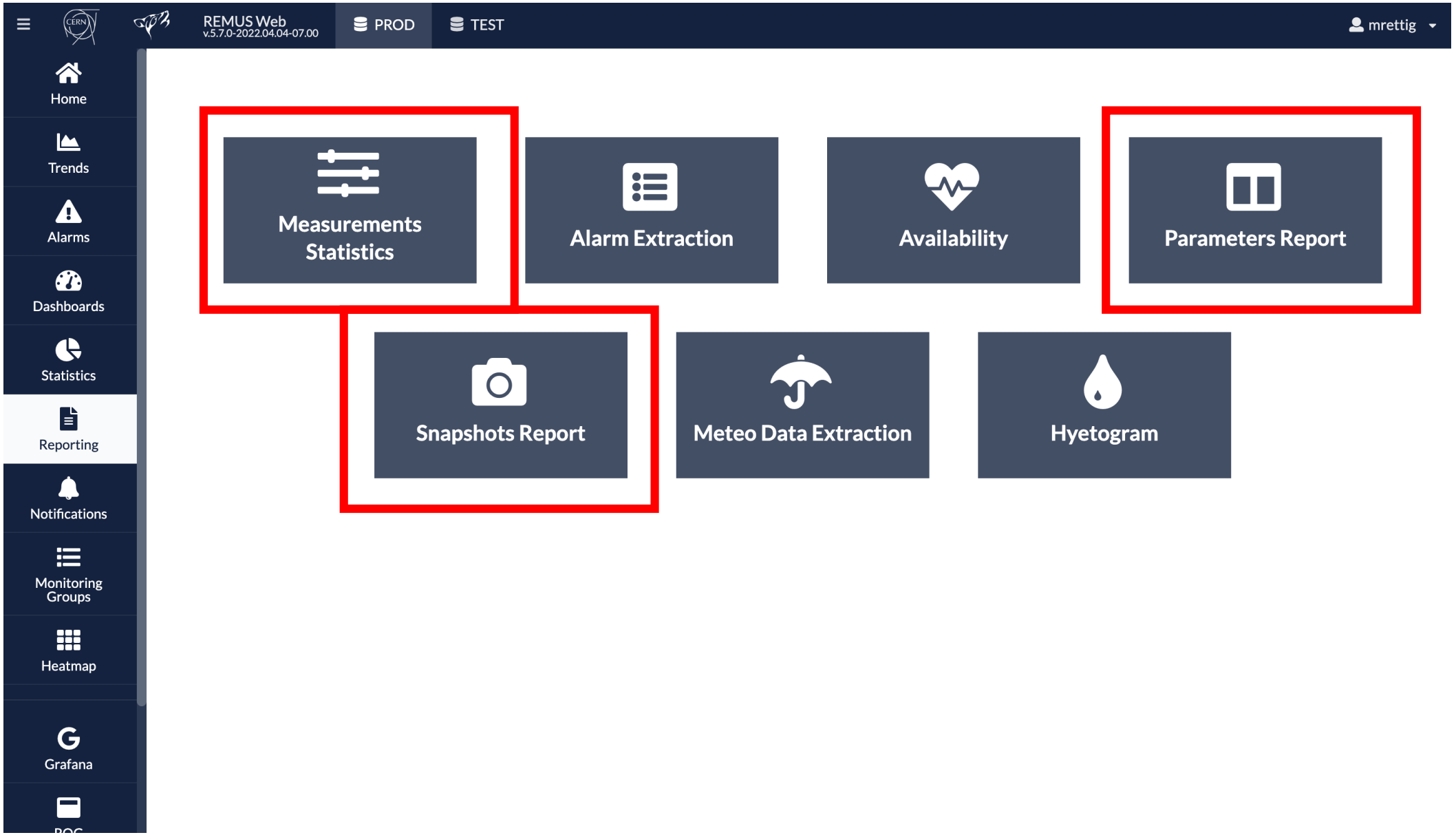
Display columns: 10 selected | Default | Excel | 10 | Total records 313

Statistics

Bar | Line | Pie | Export



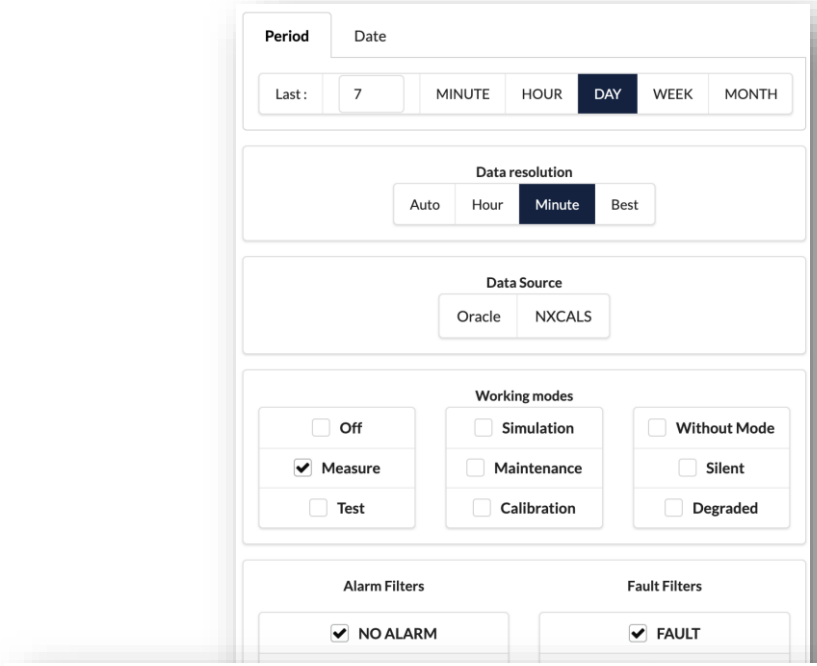
Aggregate by | Default | Excel | 100 | Total records 11


REMUS Web
v.5.7.0-2022.04.04-07.00
PROD
TEST
mrettig
Home
Trends
Alarms
Dashboards
Statistics
Reporting
Notifications
Monitoring Groups
Heatmap
Grafana
Measurements Statistics
Alarm Extraction
Availability
Parameters Report
Snapshots Report
Meteo Data Extraction
Hyetogram

Reporting → Measurement / Parameter / Snapshot

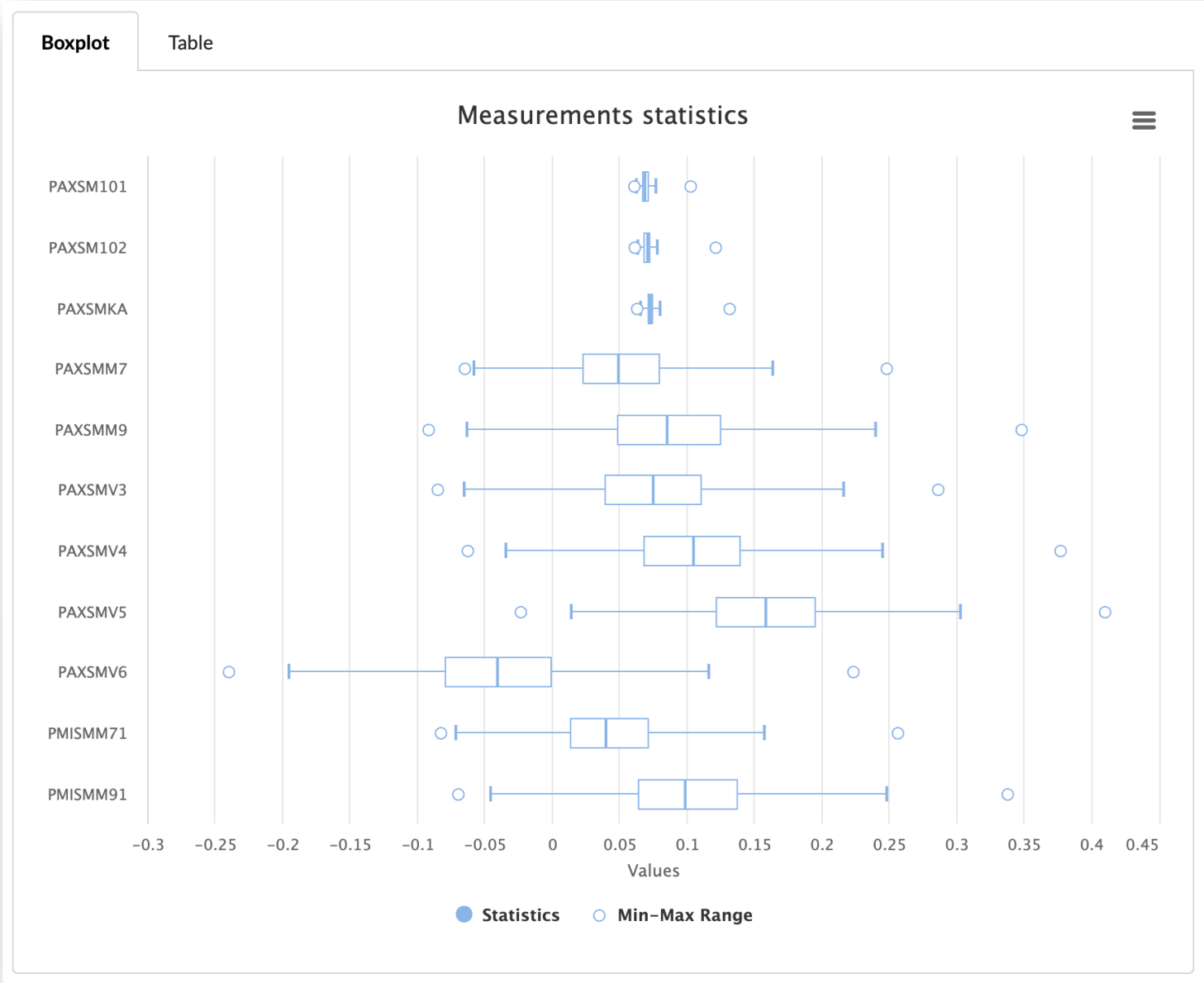
- Get summary statistics of measurements on a group of channels for extended periods
- Check parameters settings of a groups of channels for quick validation or comparison
- Reporting specific for control measurements (HFM, Portal monitors) to generate statistics on number and results of controls

Measurement reporting



ID	Name	Unit	Count	Outliers	Max	Min	Avg	Median	Integral	Std. Dev.	Variance	Q1	Q2	Q3	Q4	IQR
13939	PAXSM101	µSv/h	10078	95000000	0.102	0.0605	0.0687	0.0687	693	0.00267	7.11e-12	0.0669	0.0687	0.0705	0.102	0.00352
13948	PAXSM102	µSv/h	10078	91000000	0.121	0.0609	0.0700	0.0699	706	0.00280	7.81e-12	0.0682	0.0699	0.0718	0.121	0.00364
13957	PAXSMKA	µSv/h	10078	103000000	0.132	0.0626	0.0724	0.0723	729	0.00285	8.12e-12	0.0705	0.0723	0.0741	0.132	0.00363
13849	PAXSMM7	µSv/h	10078	107000000	0.248	-0.0652	0.0522	0.0492	526	0.0417	1.74e-9	0.0223	0.0492	0.0788	0.248	0.0565
13876	PAXSMM9	µSv/h	10078	77000000	0.348	-0.0921	0.0876	0.0849	882	0.0571	3.27e-9	0.0483	0.0849	0.125	0.348	0.0765
13903	PAXSMV3	µSv/h	10077	62000000	0.286	-0.0853	0.0753	0.0740	759	0.0519	2.70e-9	0.0393	0.0740	0.110	0.286	0.0706
13867	PAXSMV4	µSv/h	10079	79000000	0.377	-0.0630	0.104	0.104	1.05e+3	0.0527	2.77e-9	0.0680	0.104	0.139	0.377	0.0708
13912	PAXSMV5	µSv/h	10079	78000000	0.410	-0.0237	0.158	0.158	1.59e+3	0.0551	3.04e-9	0.122	0.158	0.194	0.410	0.0727
13921	PAXSMV6	µSv/h	10078	80000000	0.223	-0.240	-0.0408	-0.0409	-411	0.0591	3.50e-9	-0.0799	-0.0409	-0.00164	0.223	0.0782
13858	PMISMM71	µSv/h	10079	105000000	0.256	-0.0830	0.0431	0.0399	435	0.0435	1.90e-9	0.0127	0.0399	0.0704	0.256	0.0577
13894	PMISMM91	µSv/h	10079	104000000	0.338	-0.0701	0.102	0.0981	1.03e+3	0.0552	3.05e-9	0.0633	0.0981	0.137	0.338	0.0741

Displayed columns
15 selected
Export Statistics



Parameter reporting

MS ID | MS Name | Zone: SPS EHN1, SPS EHN2 | Usage

MS ID	MS Name	Device type	Zone	Usage	Timestamp	ALARM THRESHOLD	ALERT THRESHOLD	AVG TIME FACTOR	MEAS TIME	SPECIAL ALARM THRESHOLD
1627	PATNA8101	CROME	SPS EHN1	Radiation	14-03-2022 08:58:18	0.000100	0.0000500	100	12	0
1628	PATNA8201	CROME	SPS EHN1	Radiation	14-03-2022 08:57:14	0.000100	0.0000500	100	12	0
1647	PATNA852	CROME	SPS EHN2	Radiation	07-02-2022 15:41:39	0	0	100	12	0
1565	PAXNA11201	CROME	SPS EHN1	Radiation	14-03-2022 08:54:14	0.00000600	0.00000300	100	12	0
1605	PAXNA12401	CROME	SPS EHN1	Radiation	14-03-2022 08:55:05	0.0000300	0.0000150	100	12	0
1592	PAXNA12402	CROME	SPS EHN1	Radiation	17-03-2022 14:48:16	0.0000300	0.0000150	100	12	0
1626	PAXNA12601	CROME	SPS EHN1	Radiation	08-06-2022 08:26:41	0.000100	0.0000500	100	12	0
1606	PAXNA12612	CROME	SPS EHN1	Radiation	16-06-2022 11:00:39	0.0000500	0.0000300	100	12	0
1607	PAXNA12801	CROME	SPS EHN1	Radiation	14-03-2022 08:57:35	0.0000300	0.0000150	100	12	0
1608	PAXNA13201	CROME	SPS EHN1	Radiation	14-03-2022 08:58:10	0.0000300	0.0000150	100	12	0
1593	PAXNA13202	CROME	SPS EHN1	Radiation	14-03-2022 08:58:36	0.00000600	0.00000300	100	12	0
1594	PAXNA13203	CROME	SPS EHN1	Radiation	14-03-2022 08:58:58	0.0000300	0.0000150	100	12	0
1609	PAXNA13401	CROME	SPS EHN1	Radiation	17-03-2022 14:26:00	0.0000300	0.0000150	100	12	0
1595	PAXNA13402	CROME	SPS EHN1	Radiation	17-03-2022 14:36:16	0.0000300	0.0000150	100	12	0
1610	PAXNA13601	CROME	SPS EHN1	Radiation	17-03-2022 14:56:02	0.0000300	0.0000150	100	12	0
1611	PAXNA13801	CROME	SPS EHN1	Radiation	14-03-2022 09:00:35	0.0000300	0.0000150	100	12	0

Snapshot reporting

Select Snapshot Type

Select MS

Filters

SOURCE NAME

Advanced search

Reset filters

SOURCES CATALOG

SOURCE TYPE	NAME	ZONE	TYPE	USAGE
MS	METRUM	Portal monitors	FHT1388S	Radiation
MS	PRETRUM	Portal monitors	FHT1388S	Radiation

SOURCE NAME

SOURCE TYPE	NAME	ZONE	TYPE	USAGE
MS	METRUM	Portal monitors	FHT1388S	Radiation
MS	PRETRUM	Portal monitors	FHT1388S	Radiation

Date Selection

Period | Date

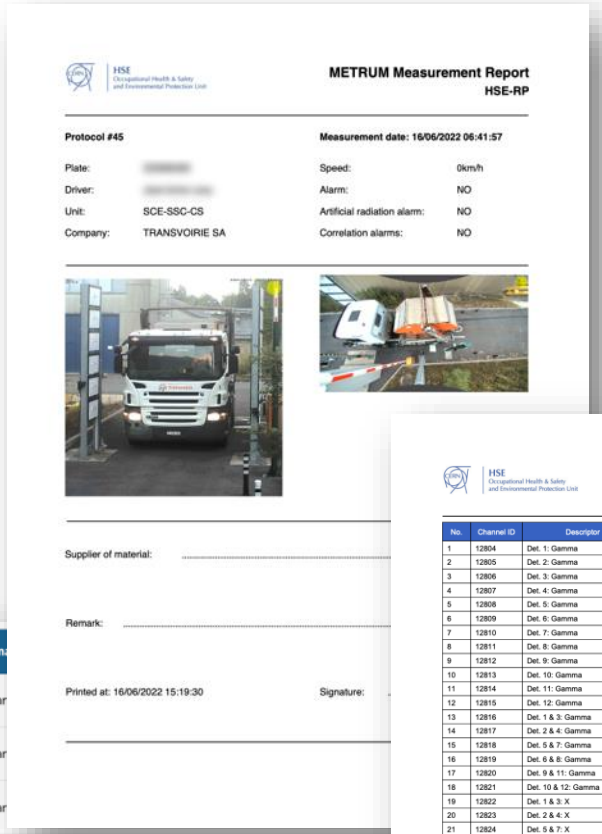
Last : 1 | MINUTE | HOUR | DAY | WEEK | MONTH

Filters

Alarm status in any channel

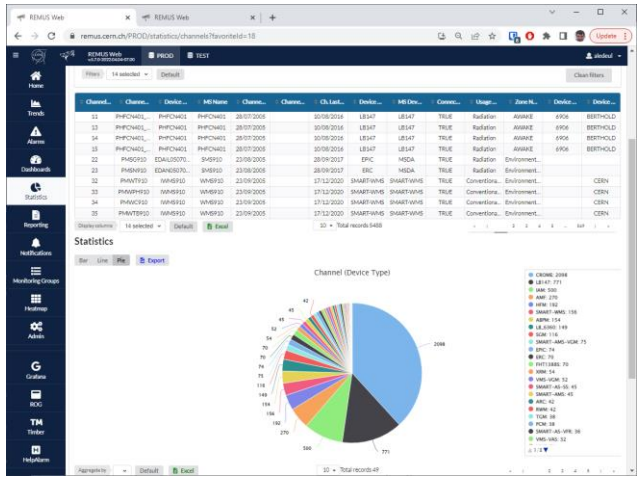
Filters | Select...

PDF Export	CHANNEL_ID	TIMESTAMP	MS_ID	MS_NAME	PROTOCOL	CERN_ID	DRIVER_NAME	PLATE	SPEED	Det. 1: Gamma - Gross	Det. 1: Gamma - BG	Det. 1: Gamma - Net	Det. 1: Gamma
	12873	16-06-2022 12:50:19	1329	PRETRUM	42	746476			0	1403	1353	50	No Alar
	12873	16-06-2022 12:34:29	1329	PRETRUM	41	746476			0	1407	1353	54	No Alar
	12872	16-06-2022 09:17:29	1328	METRUM	47	746476			7	907	875	32	No Alar
	12872	16-06-2022 07:43:35	1328	METRUM	46	676198			3	907	883	24	No Alarm
	12872	16-06-2022 06:41:57	1328	METRUM	45	676198			0	888	882	6	No Alarm
	12873	15-06-2022 14:12:22	1329	PRETRUM	40	676198			0	1502	1407	95	No Alarm
	12873	15-06-2022 13:52:46	1329	PRETRUM	39	746476			0	1478	1420	58	No Alarm
	12873	15-06-2022 13:14:31	1329	PRETRUM	38	0			0	1513	1433	80	No Alarm
	12873	15-06-2022 11:46:23	1329	PRETRUM	37	676198			0	1547	1471	76	No Alarm
	12873	15-06-2022 11:06:19	1329	PRETRUM	36	846343			4	1419	1462	-43	No Alarm

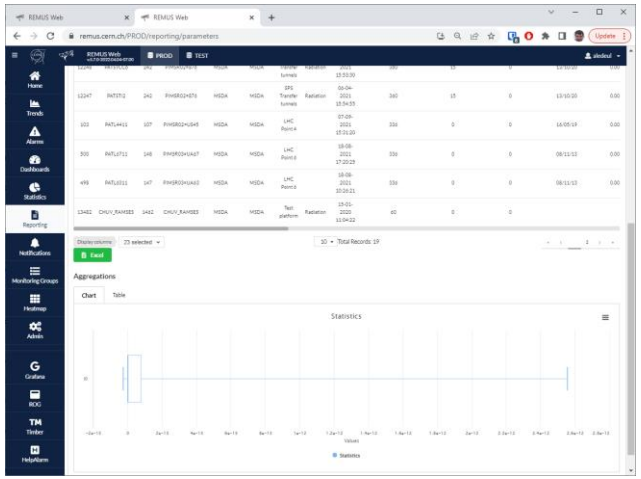


No.	Channel ID	Descriptor	Total Value	Background	Net value	Alarm Threshold	Alarm
1	12804	Det. 1: Gamma	888	882	6	136	NO ALARM
2	12805	Det. 2: Gamma	998	998	0	144	NO ALARM
3	12806	Det. 3: Gamma	813	817	-4	130	NO ALARM
4	12807	Det. 4: Gamma	877	913	-36	138	NO ALARM
5	12808	Det. 5: Gamma	778	805	-27	130	NO ALARM
6	12809	Det. 6: Gamma	873	884	-11	136	NO ALARM
7	12810	Det. 7: Gamma	841	815	26	130	NO ALARM
8	12811	Det. 8: Gamma	889	880	9	135	NO ALARM
9	12812	Det. 9: Gamma	743	796	-53	129	NO ALARM
10	12813	Det. 10: Gamma	885	879	6	135	NO ALARM
11	12814	Det. 11: Gamma	830	840	-10	132	NO ALARM
12	12815	Det. 12: Gamma	834	878	-44	135	NO ALARM
13	12816	Det. 1 & 3: Gamma	1547	1551	-4	177	NO ALARM
14	12817	Det. 2 & 4: Gamma	1863	1898	-35	199	NO ALARM
15	12818	Det. 5 & 7: Gamma	1592	1607	-15	183	NO ALARM
16	12819	Det. 6 & 8: Gamma	1758	1752	6	191	NO ALARM
17	12820	Det. 9 & 11: Gamma	1489	1555	-66	178	NO ALARM
18	12821	Det. 10 & 12: Gamma	1713	1743	-30	191	NO ALARM
19	12822	Det. 1 & 3: X	885	868	17	219	NO ALARM
20	12823	Det. 2 & 4: X	1094	1082	12	235	NO ALARM
21	12824	Det. 5 & 7: X	920	905	15	215	NO ALARM
22	12825	Det. 6 & 8: X	1073	1024	49	230	NO ALARM
23	12826	Det. 9 & 11: X	963	922	41	217	NO ALARM
24	12827	Det. 10 & 12: X	1052	1041	11	229	NO ALARM
25	12828	Det. 1 & 3: NBR Cs	5.59	5.57	1	1.08	NO ALARM
26	12829	Det. 2 & 4: NBR Cs	5.61	5.56	1.01	1.08	NO ALARM
27	12830	Det. 5 & 7: NBR Cs	5.57	5.58	1	1.08	NO ALARM
28	12831	Det. 6 & 8: NBR Cs	5.61	5.57	1.01	1.08	NO ALARM
29	12832	Det. 9 & 11: NBR Cs	5.59	5.57	1	1.08	NO ALARM
30	12833	Det. 10 & 12: NBR Cs	5.63	5.58	1.01	1.08	NO ALARM
31	12834	Det. 1 & 3: NBR Co	3.57	3.55	1.01	1.08	NO ALARM
32	12835	Det. 2 & 4: NBR Co	3.54	3.54	1	1.08	NO ALARM
33	12836	Det. 5 & 7: NBR Co	3.5	3.57	0.98	1.08	NO ALARM
34	12837	Det. 6 & 8: NBR Co	3.62	3.57	1.01	1.08	NO ALARM
35	12838	Det. 9 & 11: NBR Co	3.5	3.56	0.98	1.08	NO ALARM
36	12839	Det. 10 & 12: NBR Co	3.51	3.57	0.98	1.08	NO ALARM
37	12840	Sum (left)	4758	4890	-132	319	NO ALARM
38	12841	Sum (right)	5292	5366	-74	334	NO ALARM
39	12842	All NBR Cs	5.53	5.51	1	1.08	NO ALARM
40	12843	All NBR Co	3.46	3.48	0.99	1.08	NO ALARM

Demo



https://remus.cern.ch/PROD/statistics

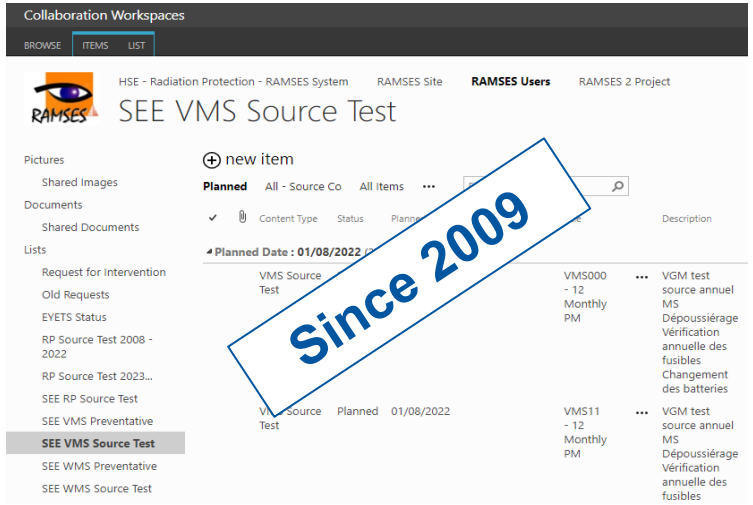


https://remus.cern.ch/PROD/reporting

InforEAM & HelpAlarm

InforEAM & HelpAlarm

- No possibility to aggregate the maintenance activities by MS/Channel
- SharePoint will be obsolete soon
- …



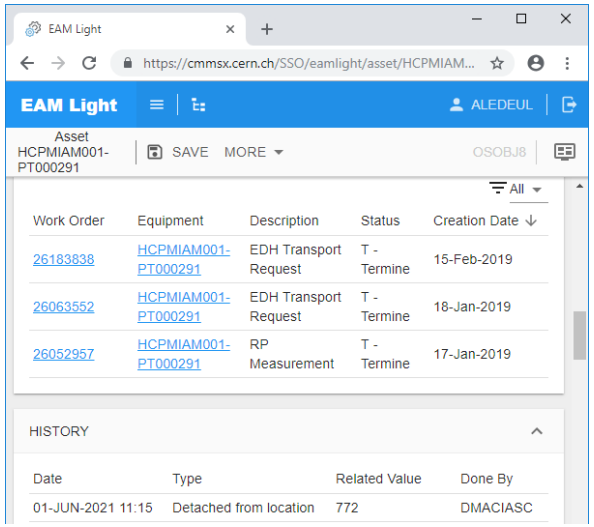
130 Environmental Monitoring Stations

HSE

125 Mi datapoints / year

REMUS

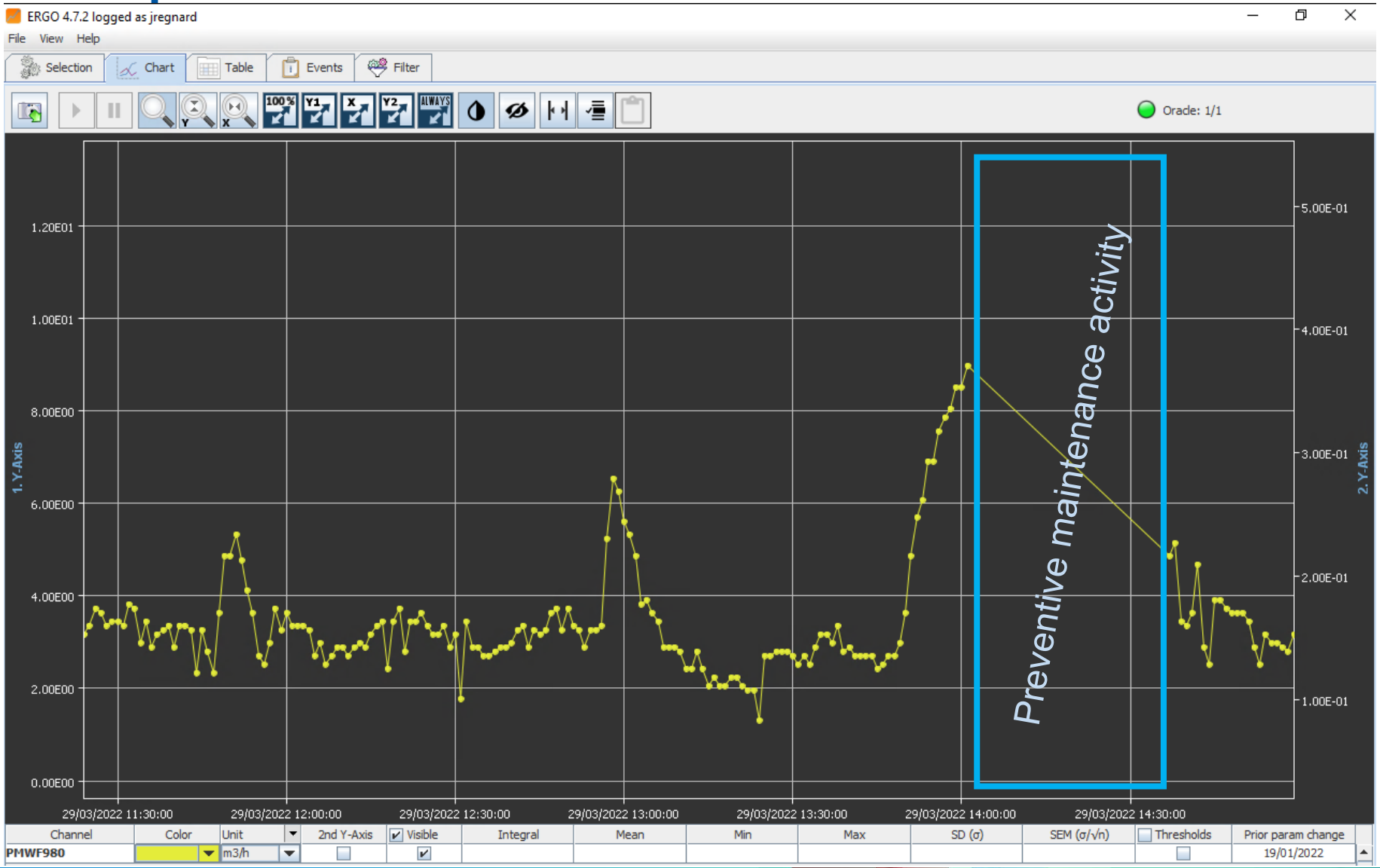
InforEAM



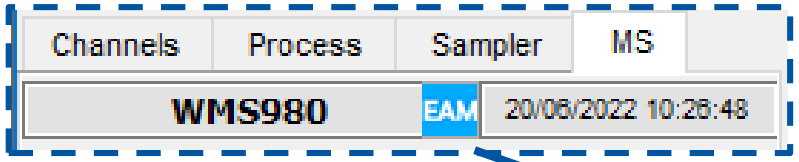
EN

- 2200 pieces of equipment declared
- 750 Preventive maintenance activities / year planned
- Fully operational by October 2022

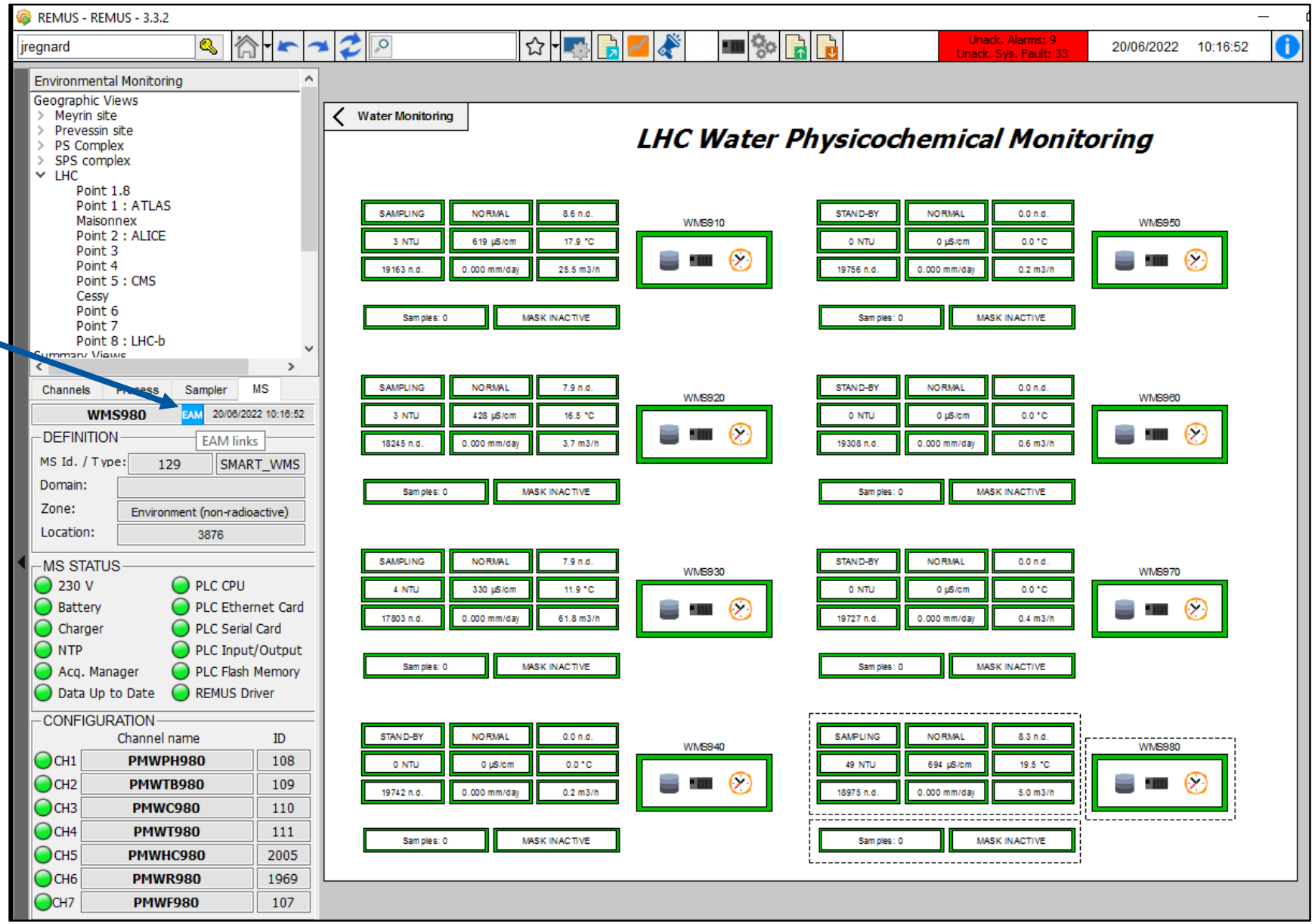
InforEAM & HelpAlarm



InforEAM & HelpAlarm



https://cmmsx.cern.ch/SSO/eamlight/position/PEMWM01=3876



InforEAM & HelpAlarm

160 Environmental Monitoring Stations

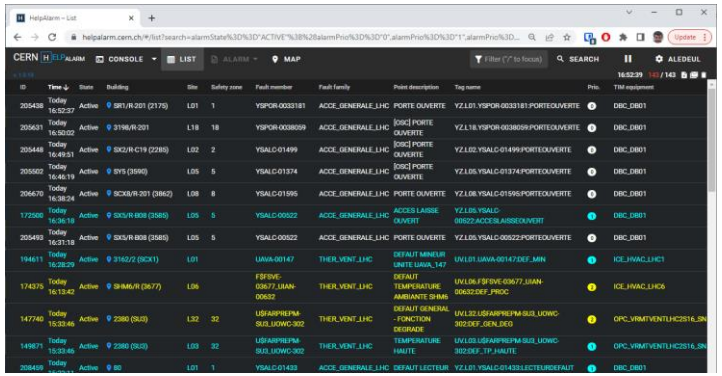
HSE

125 Mi datapoints / year

REMUS

90 alarms requiring immediate intervention

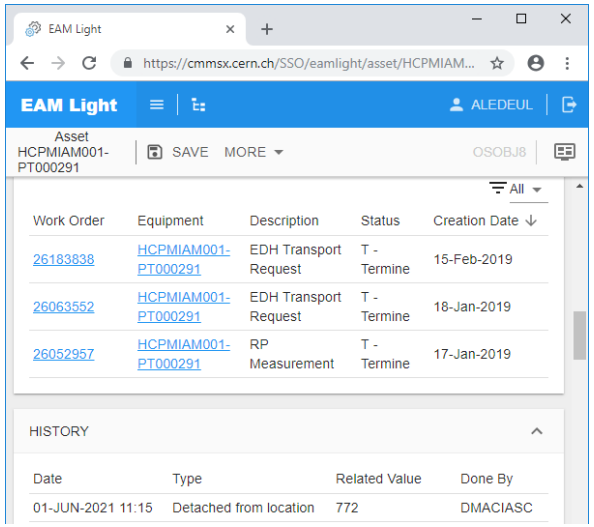
HelpAlarm



BE

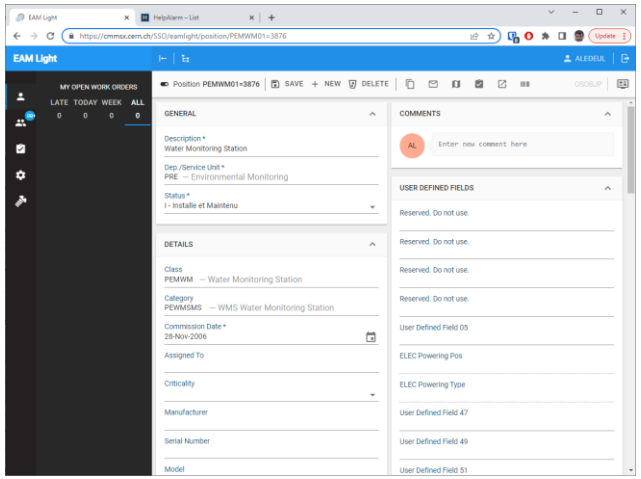
750 Preventive maintenance activities / year

InforEAM

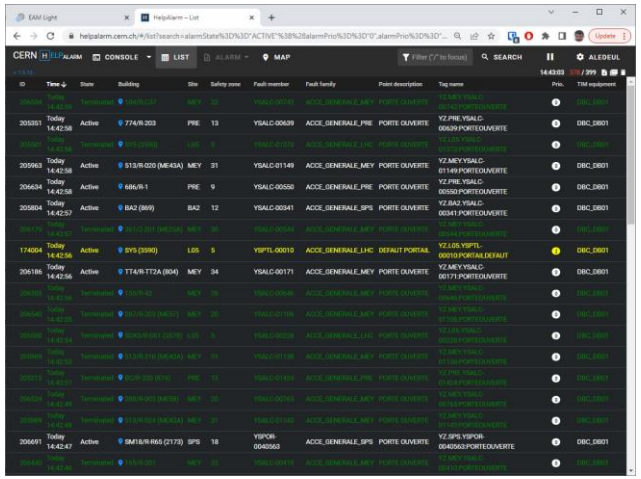


EN

Demo



https://cmmsx.cern.ch/SSO/eamlight



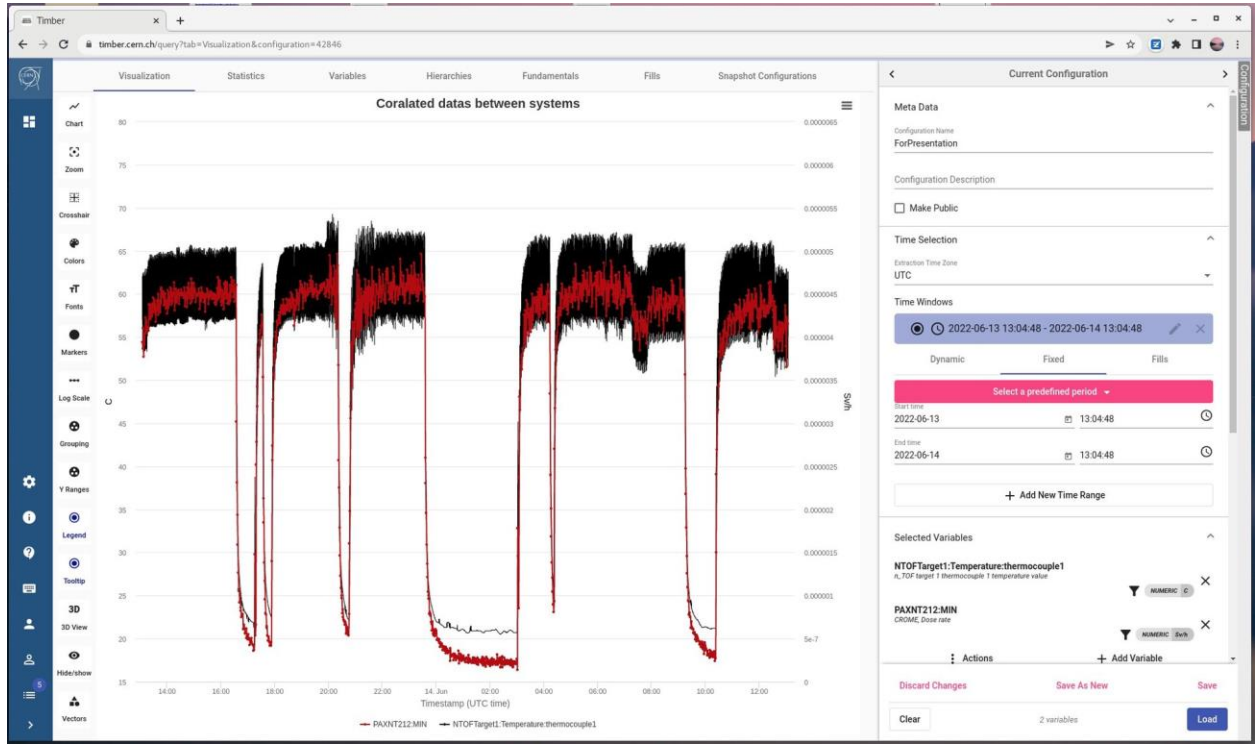
https://helpalarm.cern.ch

REMUS data in NXCALS/TIMBER

Data Sharing to NXCALS

REMUS

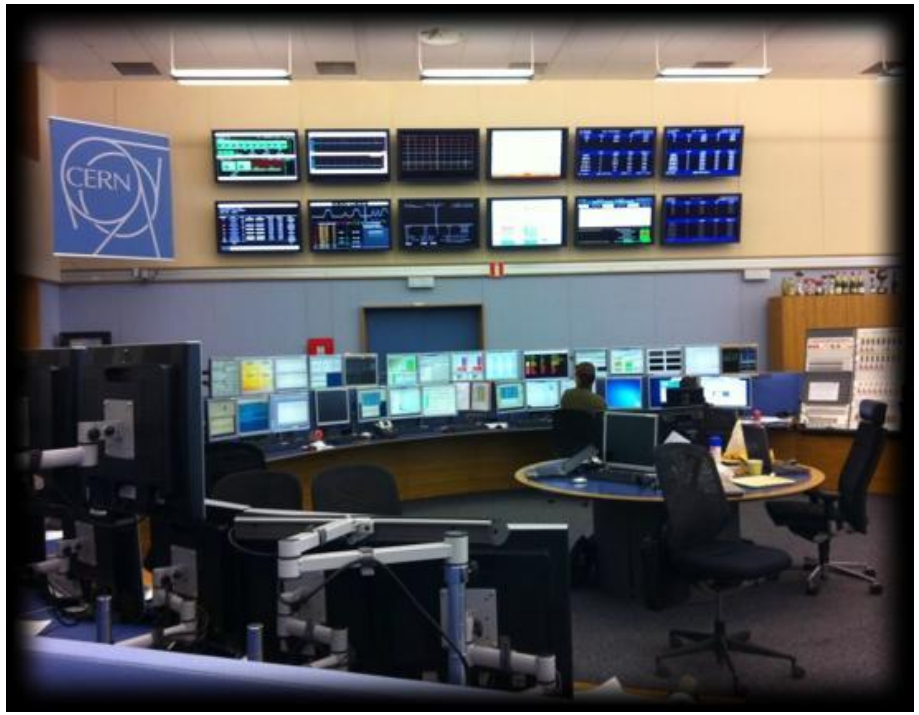
NXCALS



TIMBER Web

HSE-CEN
HSE-RP
BE-OP
EP

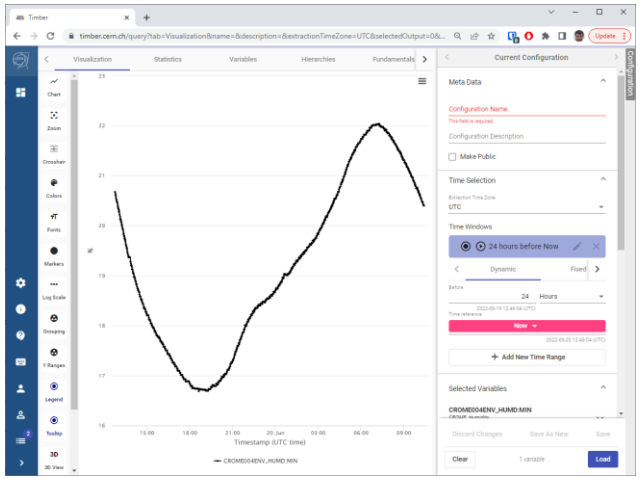
NXCALS System



CERN Control Center

- Shared Big Data storage of all CERN control systems
- Help in beam observation devices and investigate problems with accelerator equipment or unexpected beam behavior.
- Keep data for long period of time and assure good and performant analyses and data extraction by the physicists.

Demo



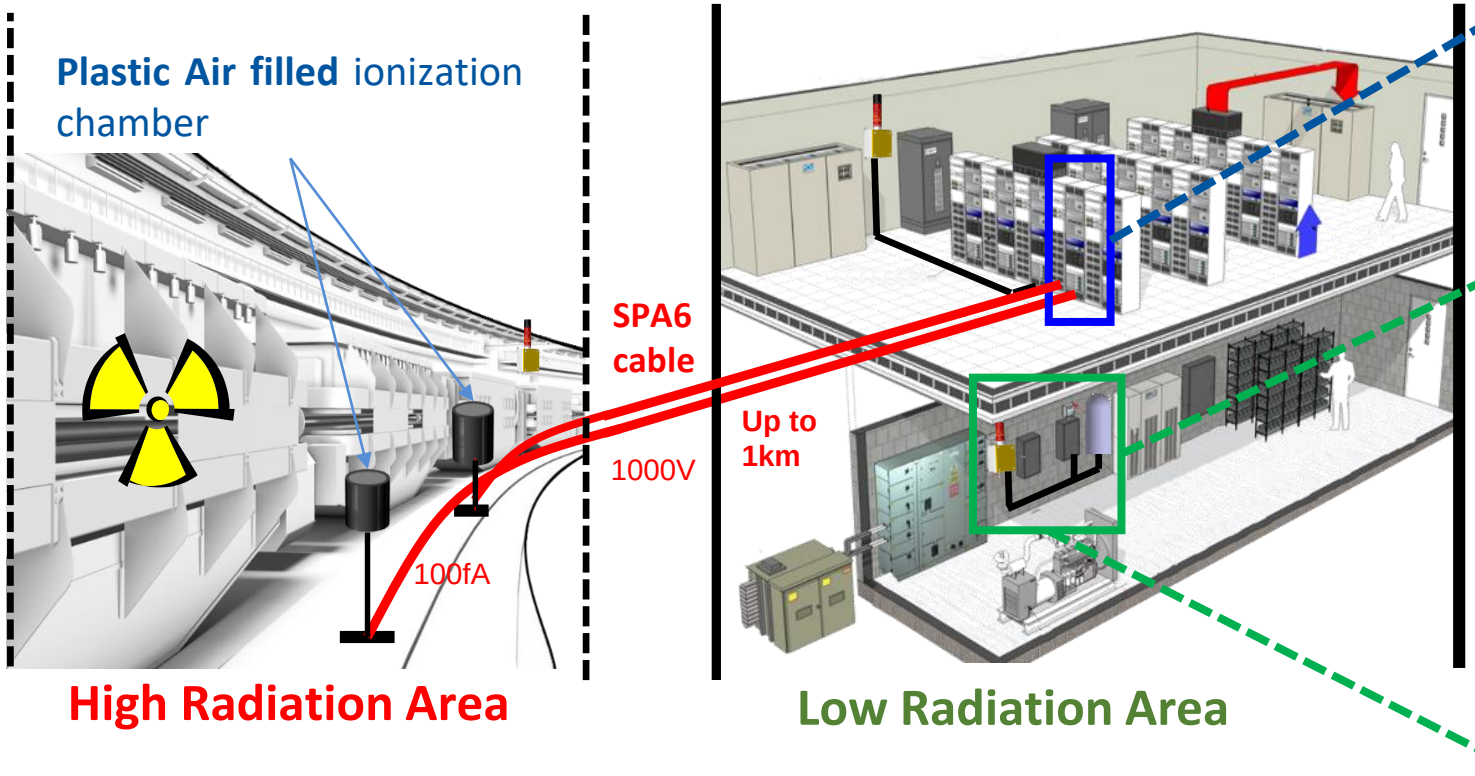
https://timber.cern.ch

Data Analysis using SWAN (NXCALS data)

CERN Radiation Monitoring Electronics (CROME)

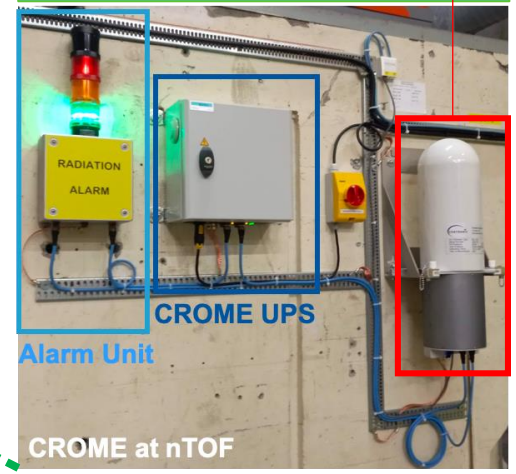
Two configurations :

Conceptual view of CROME at CERN



Radiation Monitoring and processing units

Bulk



Rackable

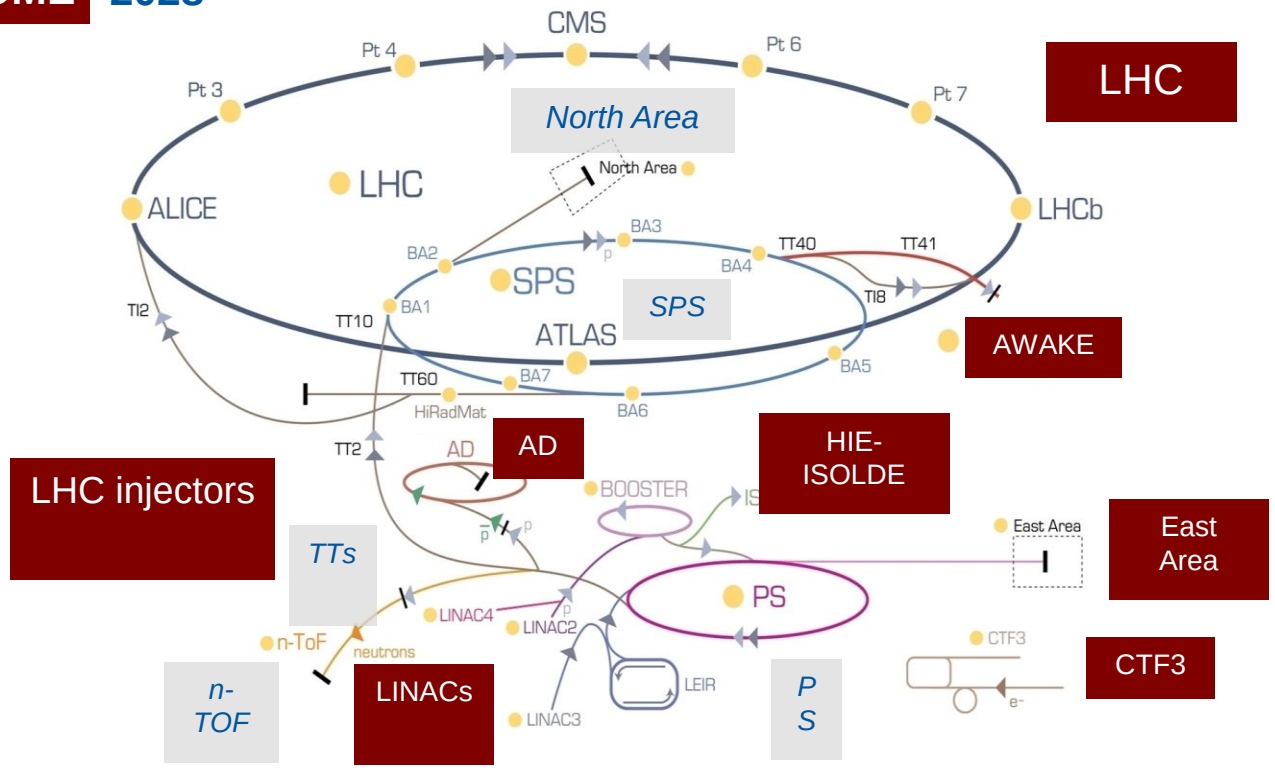
Uninterruptible Power Supply
Includes a battery for continuous operation

CERN - **R**adiation & **E**nvironmental **M**onitoring **S**ystem

650 Radiation Protection and Environmental monitoring devices

CROME **2021**

CROME **2028**

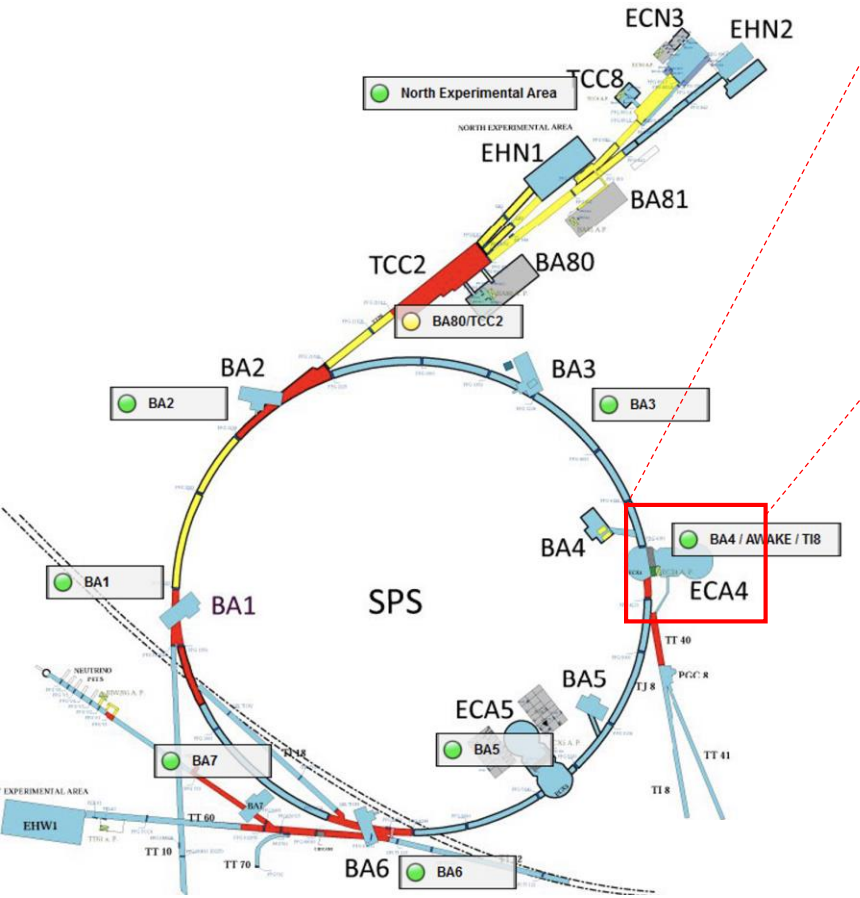


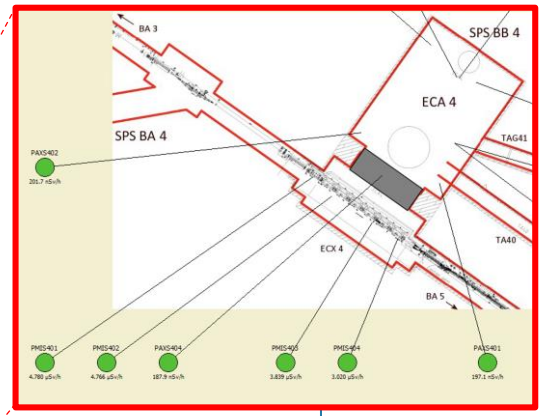
Self production capabilities

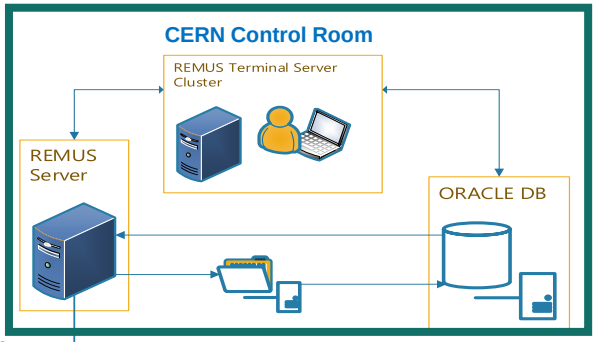
For more info : https://crome.web.cern.ch/node/35

CROME/REMUS Network

ECA4 - SPS







Technical Network

IT Socket

Rack 1

6 Ethernet connections

CROME Rack Chassis
Up to **6 Modules**

- Real Time Measurements
- Events
- Status
- Historical Values

IT Socket

Rack 2

12 Ethernet connections

2 CROME Rack Chassis
Up to **12 Modules**

- Real Time Measurements
- Events
- Status
- Historical Values

IT Socket

Rack3

1 Eth connection

CROME Junction Box
- Status

IT Socket

1 Eth connection

CROME Radiation Monitor

- Real Time Measurements
- Events
- Status
- Historical Values

IT Socket

1 Eth connection

CROME Radiation Monitor

- Real Time Measurements
- Events
- Status
- Historical Values

Data Analysis using SWAN (NXCALS data)

Operational Data

REMUS

- Dose rate
- Integrated doses
- Temperature
- Humidity
- High voltage
- Events
- Statuses

Injection

NXCALS

Wireless CROME rad. det.

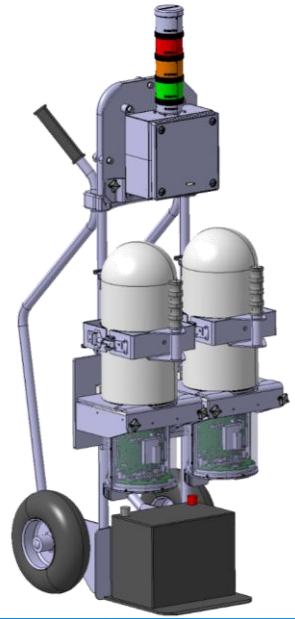
CERN Technical Network

TIM

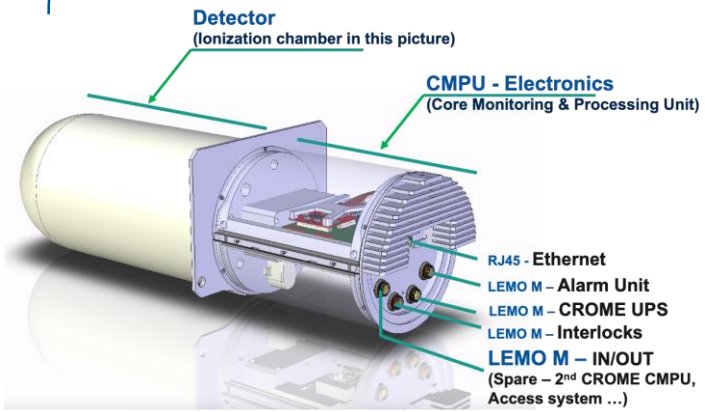
- Internal Voltages
- Internal Temperatures
- SoC internal parameters
- …

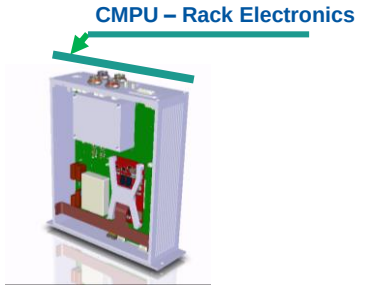
Injection

Non-Operational Data



Wired CROME radiation detectors





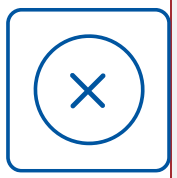
Work Package Overview

Currently: Data sent to NXCALS remains unused

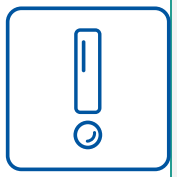
Goal: Use data on NXCALS for Predictive Maintenance

Develop Anomaly Detection process to identify failure precursors

Challenges for Anomaly detection



- No System Failures known
- No data available that represents healthy state of system
- No definition of anomalous behavior

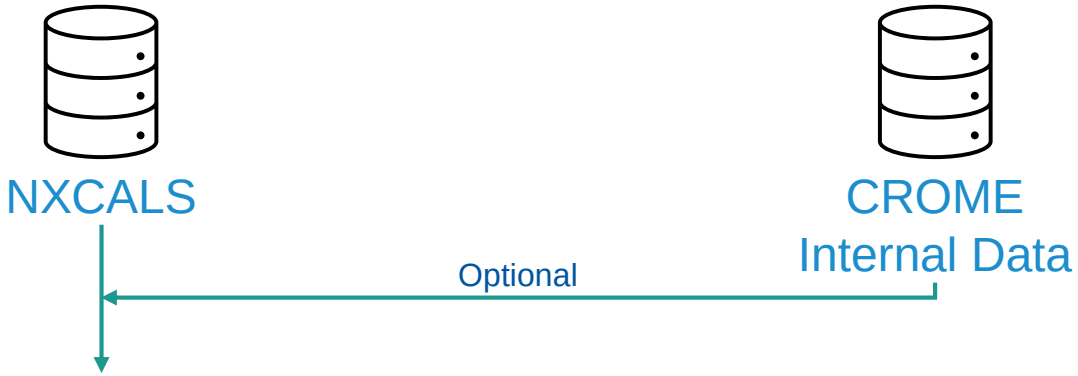


- Anomalies are rare and different
- Focus on noise in signals

Use multi-level wavelet transform (MRA-WT) for noise extraction

Anomaly Detection Process

Being evaluated

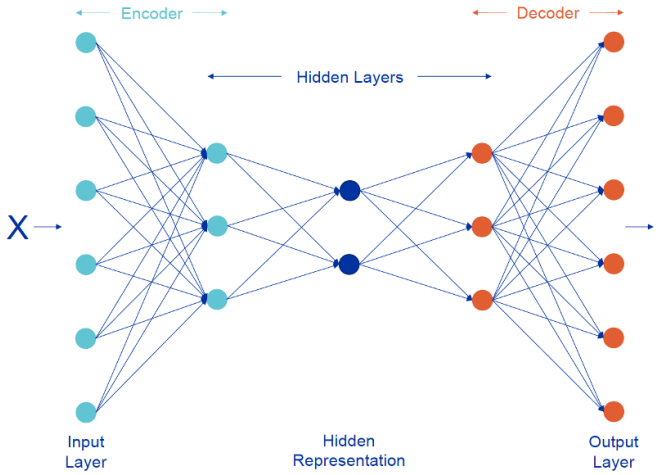


Pre-Processing:

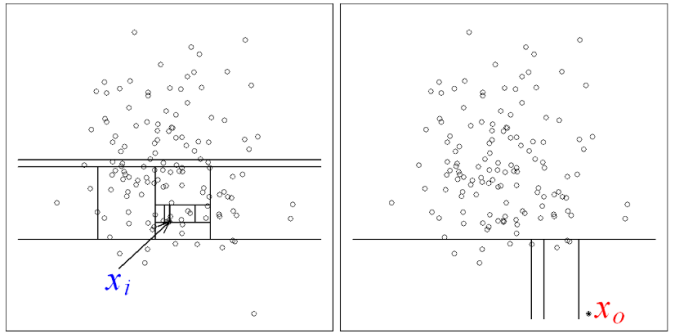
- Feature Engineering: Calculate statistical features (raw and extracted noise signal)
- Handling of Missings
- Scaling

Apply Algorithms:
Isolation Forest, Autoencoder

Schematic of Autoencoder



Isolation of observations

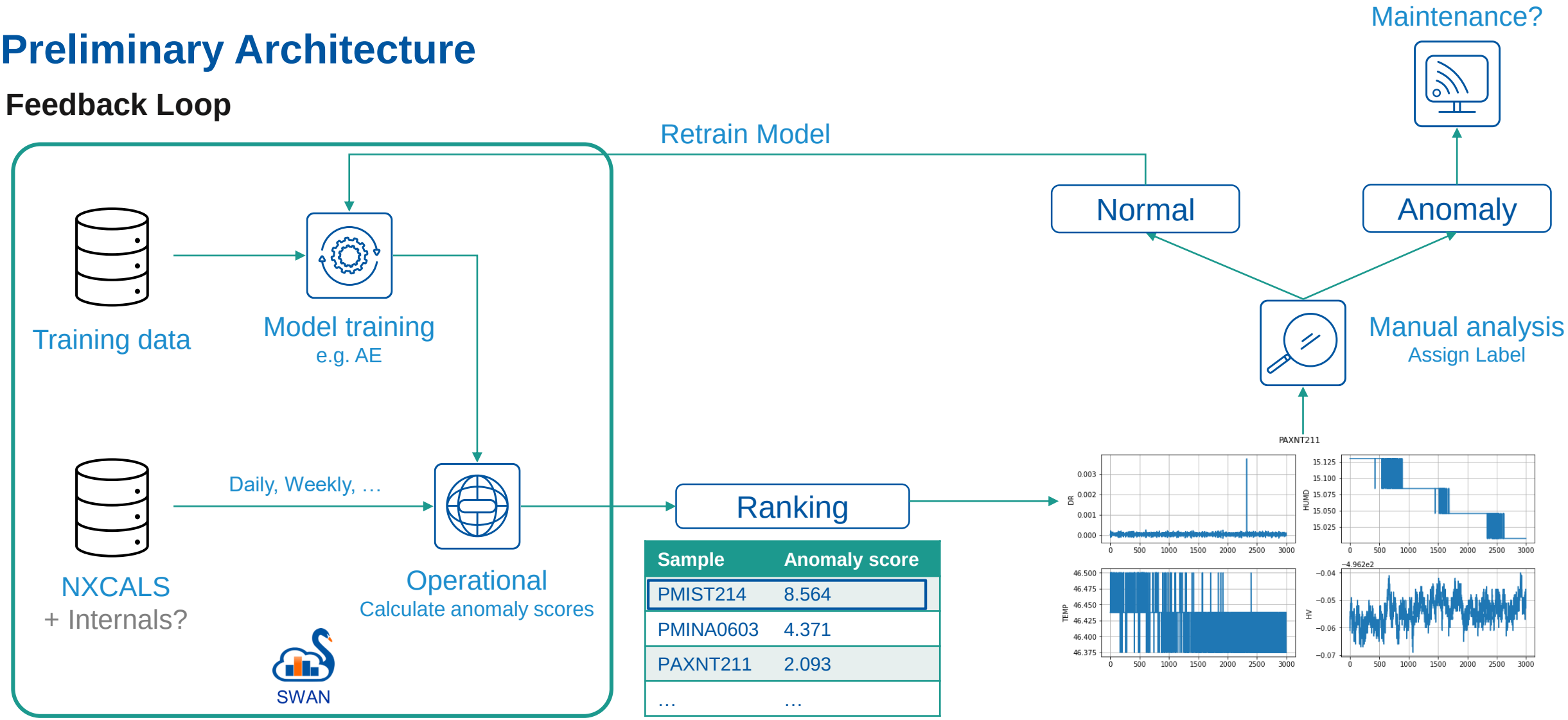


(a) Isolating x_i (b) Isolating x_o

From: F. T. Liu, K. M. Ting and Z. Zhou, "Isolation Forest," 2008 Eighth IEEE International Conference on Data Mining, 2008, pp. 413-422, doi: 10.1109/ICDM.2008.17.

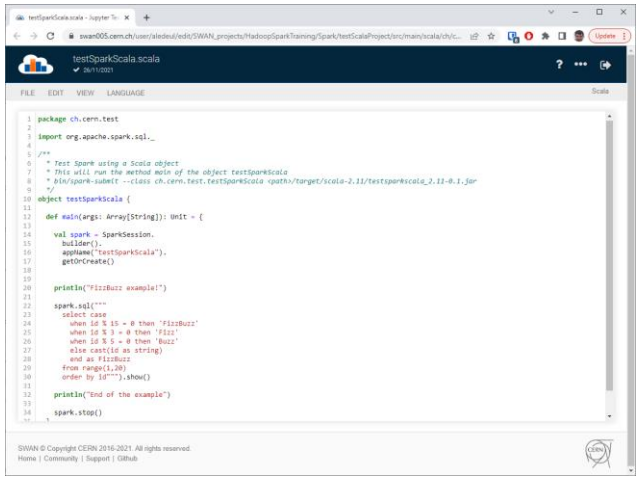
Preliminary Architecture

Feedback Loop



Sample	Anomaly score
PMIST214	8.564
PMINA0603	4.371
PAXNT211	2.093
…	…

Demo



https://swan.cern.ch

Find the tutorial here : https://gitlab.cern.ch/hboukaba/nxcals/

Conclusion

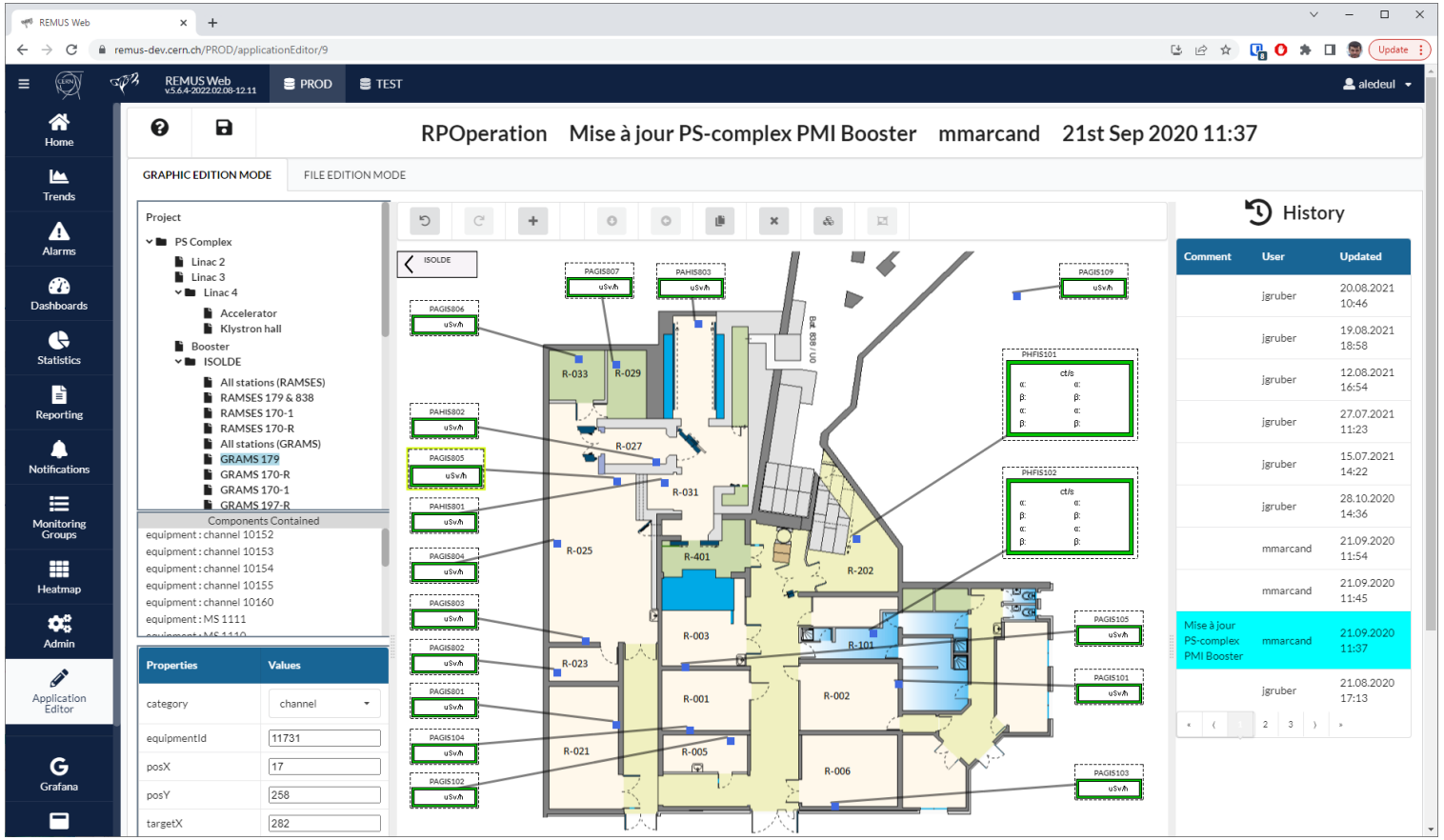
Summary

Evolutions necessary for the operation

- **REMUS Web**
  - REMUS data analysis gateway
- **REMUS Web Dashboards**
  - Share data summary with other
- **REMUS Web Statistics & Reporting**
  - Efficiently generate reports for analysis and reporting
- **InforEAM & HelpAlarm**
  - Interface CERN-wide Maintenance and Alarm systems
- **REMUS data in NXCALS/TIMBER**
  - Long term Data storage at high resolution
  - Allow comparison and correlation with other control systems' data
- **REMUS data in NXCALS/SWAN**
  - Extended big-data analysis capabilities

What’s next? : REMUS Web Application Editor

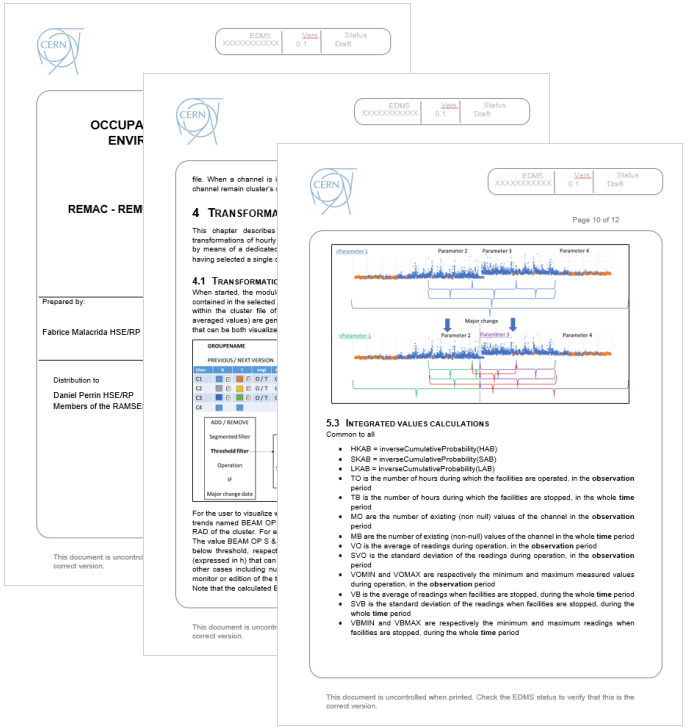
Ease REMUS Application Edition



What’s next? : Net Ambient Doses and Releases Reports

A step further into Knowledge Integration

- Streamline the generation of adjusted Ambient Doses and Releases Reports
  - Increase reliability of data treatment
  - Minimize risk of human error
  - Guaranty repeatability and traceability



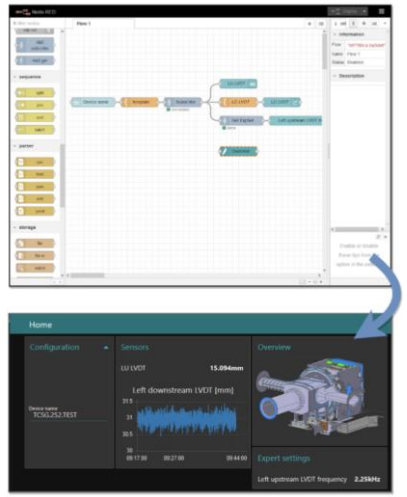
Net Ambient Doses and Releases Reports functional specifications.
Credit: F. Malacrida (HSE-RP)

A glimpse into the future

Other CERN Web Technologies Projects for Control Systems

- Growing trend in Industrial Control Systems at CERN and beyond
- CTTB Working group
  - Web Technologies task Force
- W.R.A.P. (BE-CSS)
  - Cross-system live charts
- Flow Project (EN-SMM/BE-CEM)
  - Live web widgets

WRAP. Credit: BE-CSS



Flow Project. Credit: BE-CEM

CTTB = ATS Common Hardware & Software Technologies Technical Board
WRAP = Web Rapid Application development Platform

Thank you!

Questions

www.cern.ch