



Школа по информационным
технологиям ОИЯИ



Информационные системы и сервисы сопровождения эксперимента BM@N

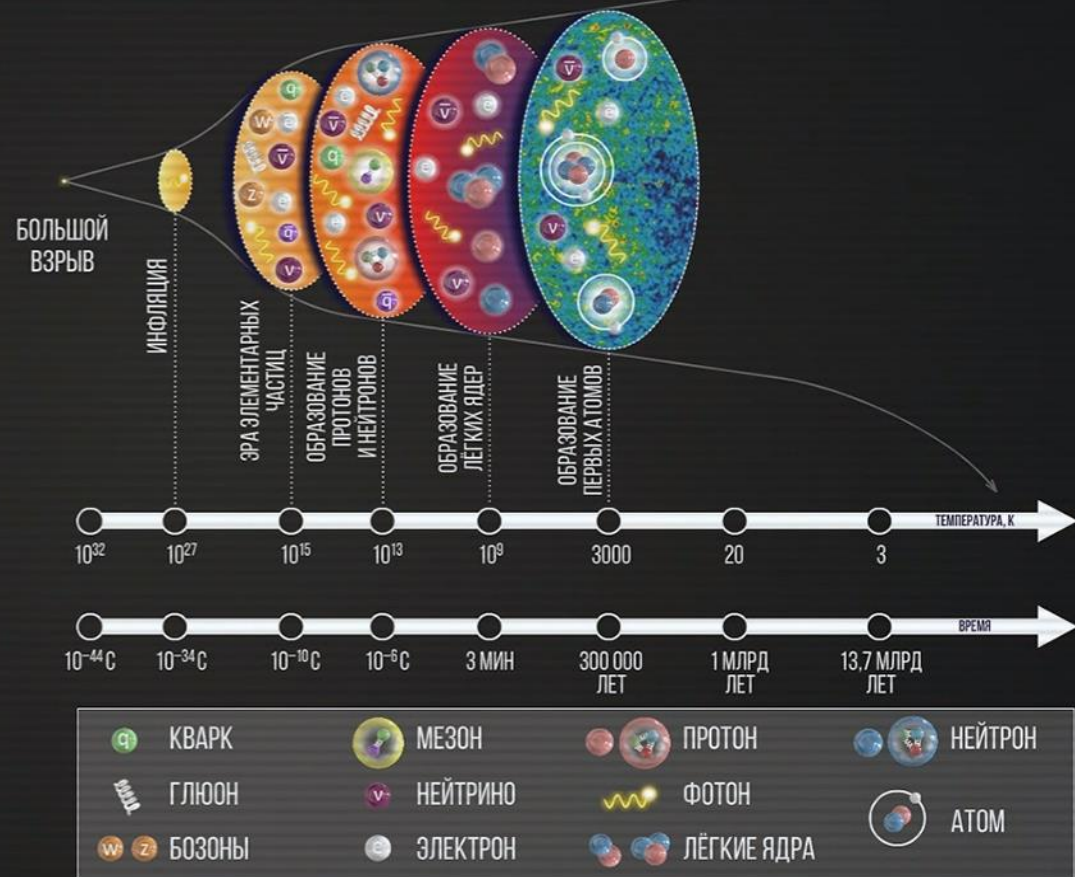
Константин Викторович Герценбергер
координатор программной части эксперимента BM@N
ЛФВЭ, Объединенный институт ядерных исследований



15 November 2022

BM@N Experiment at NICA

NICA – Вселенная в лаборатории



Nuclotron-based Ion Collider fAcility



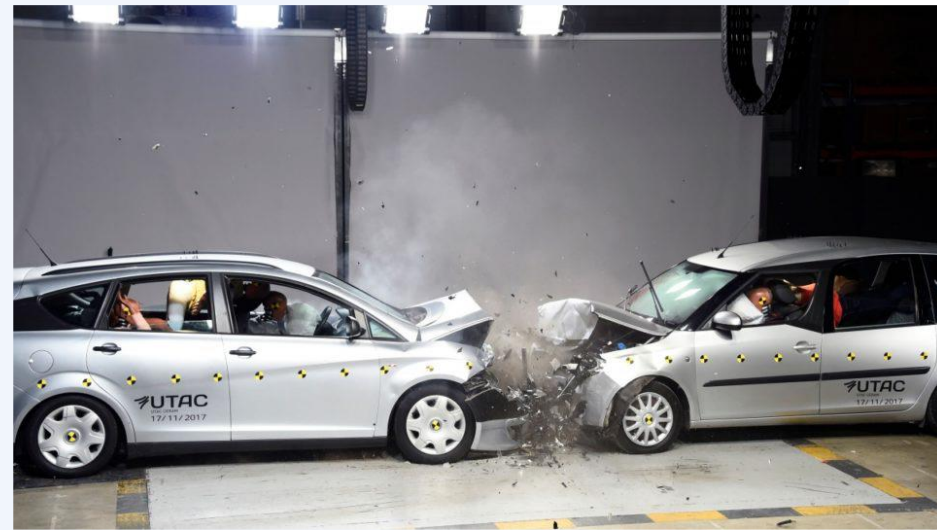
- Beams: from p, d^{\uparrow} to Au^{79+}
- Luminosity: 10^{27} (Au^{79+}), 10^{32} (p) $cm^{-2}s^{-1}$
- Collision energy: $\sqrt{S_{NN_{AU}}} = 4 - 11$ Gev $E_{lab} = 1 - 6$ AGeV

- Fixed target experiment: **BM@N** (2018)
- 2 interaction points: **MPD** (2023) & **SPD** (2027)
- Official site: nica.jinr.ru

Experimental Modes



fixed target



collider

advantages

- *rate is limited just by detector capability*
- *easy upgradable*
-

- ***coverage of max. phase space***
- *minimum biased acceptance*
- *free of target parasitic effects*
-

disadvantages:

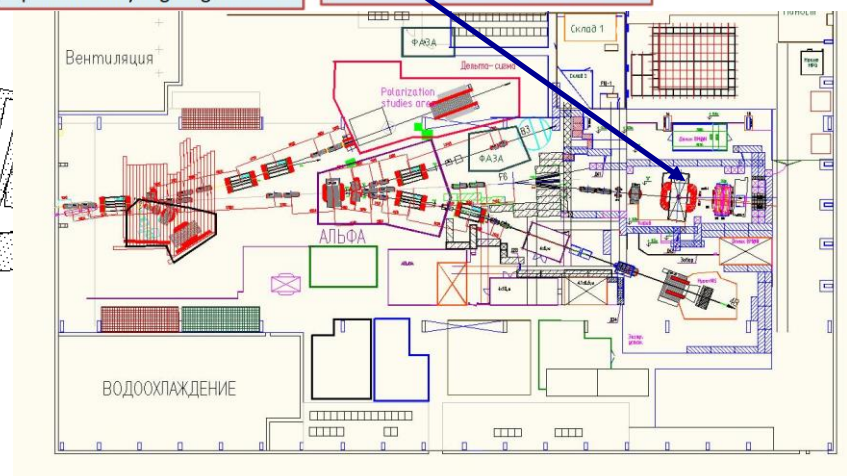
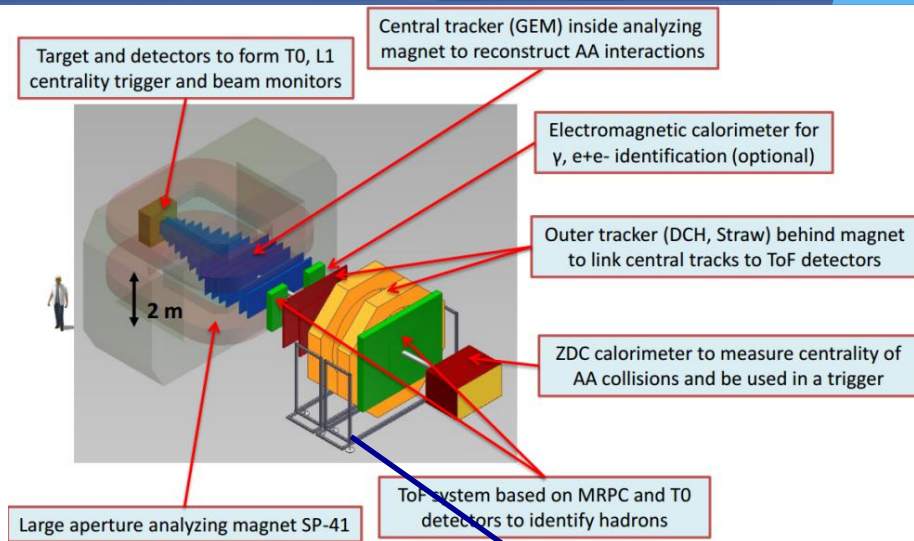
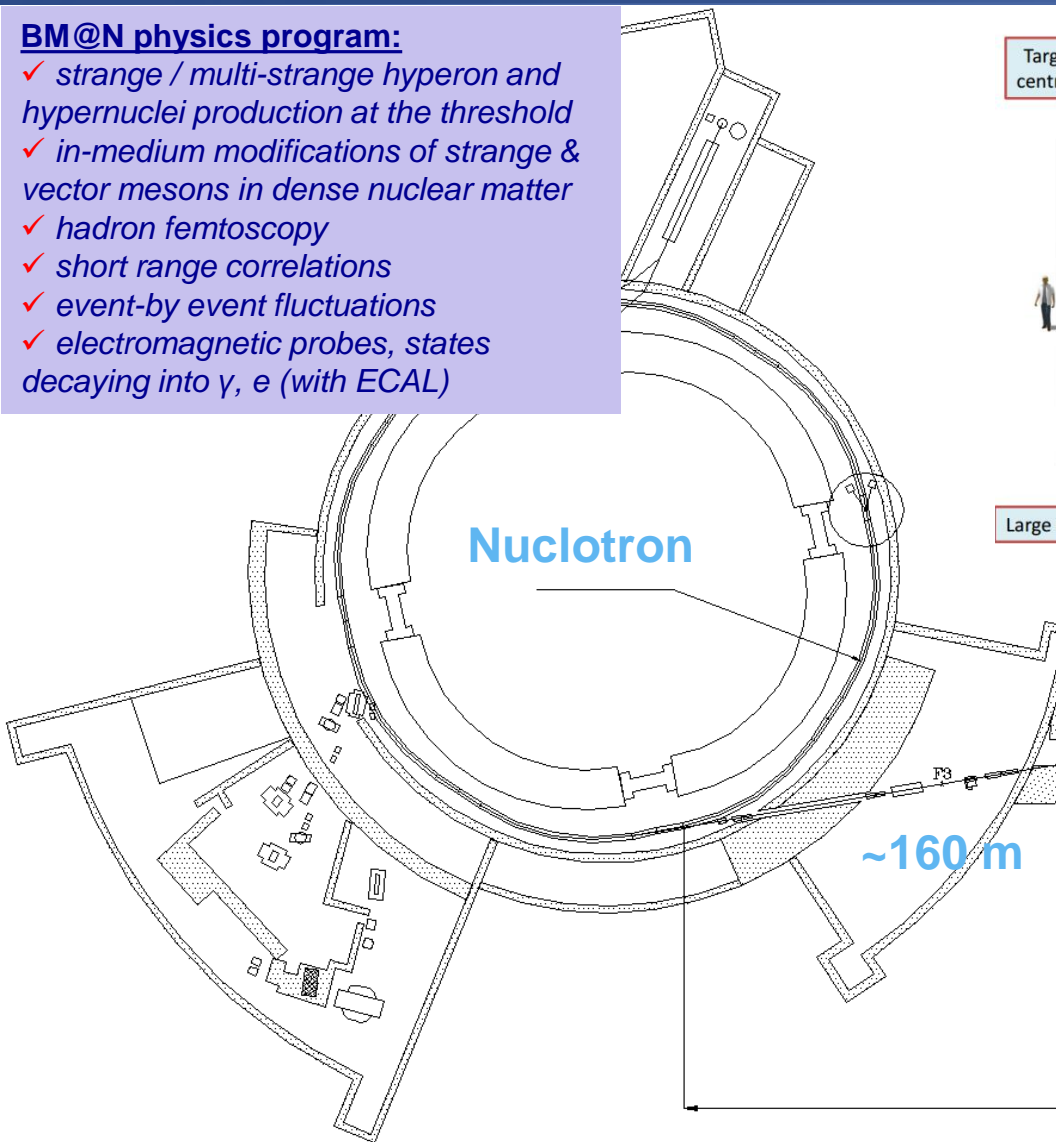
- *a limited phase space*
- *momentum dependent corrections*
- *target influenced corrections*

- *rate is limited by luminosity*
- *limited combinations "beam"/"target"*
-

Baryonic Matter @ Nuclotron

BM@N physics program:

- ✓ strange / multi-strange hyperon and hypernuclei production at the threshold
- ✓ in-medium modifications of strange & vector mesons in dense nuclear matter
- ✓ hadron femtoscopy
- ✓ short range correlations
- ✓ event-by event fluctuations
- ✓ electromagnetic probes, states decaying into γ , e (with ECAL)



BM@N Collaboration

9 Countries, 17 Institutions, 227 participants

spokesperson – *M. Kapishin, JINR*

technical coordinator – *S. Piyadin, JINR*



BM@N in Nuclotron Runs (2015 – 2022)

- ❖ Nuclotron Run 51 (d,C)
- ❖ Nuclotron Run 52 (d)
- ❖ Nuclotron Run 53 (d, d[↑])
- ❖ Nuclotron Run 54 (C)
- ❖ Nucl. Run 55 (C,Ar,Kr)
- ❖ Nucl. Run 56: SRC (C)
- ❖ Nucl. Run 57: BM@N (Xe)

Technical

interaction rate: 5 KHz

Technical+SRC Physics

interaction rate: 10 KHz

Physics

interaction rate: 10 KHz

Feb. 22 – Mar. 15, 2015

June 29 – June 30, 2016

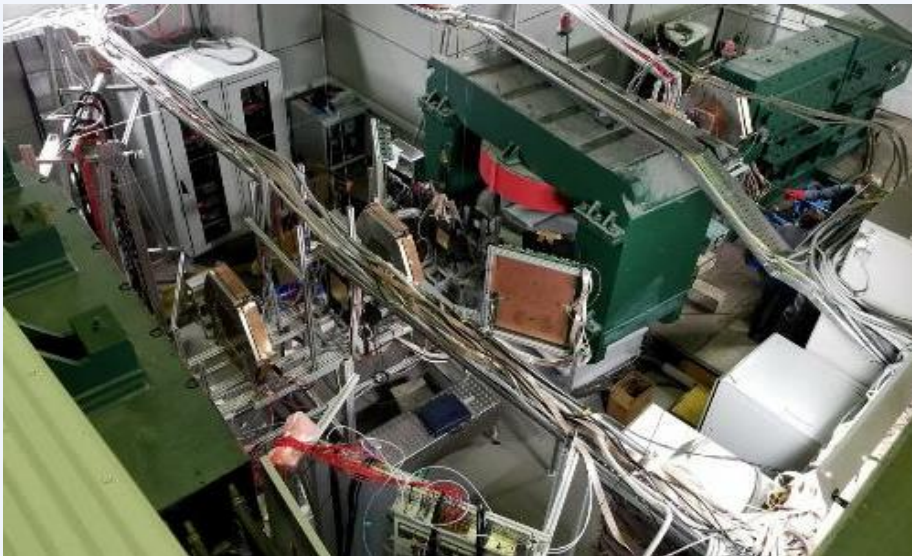
Dec. 09 – Dec. 23, 2016

Mar. 07 – Mar. 18, 2017

Mar. 03 – Apr. 05, 2018

Mar. 07 – Mar. 28, 2022

upcoming weeks



- Beams: deuteron (4 AGeV), C¹² (3.5–4.5 AGeV), Ar (3.2 AGeV), Kr (2.4, 3.0 AGeV)
Targets: C, Cu, Pb, Al, Sn, C₂H₄, H₂ or empty
- Trace beams, measure beam profile and time structure
- Test integrated DAQ, T₀ and Trigger system
- Detectors: MWPC, Si, GEM, ToF-400, DCH-1, DCH-2, ToF-700, ZDC, ECAL, LAND
- Detect min bias beam-target interactions to reconstruct hyperons, identify charged particles and nucleus fragments

Data Collected in Run 7 (Nucl. Run 55)

Main BM@N program:

One beam energy available for Ar-beam and three for Kr-beam

Wide set of targets used: (C; Al; Cu; Sn; Pb)

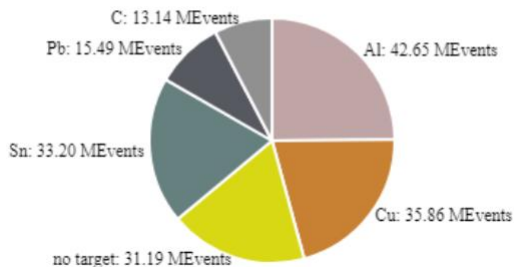
BM@N SRC program:

One beam energy available for C-beam

More than half of the collected statistics can be used for SRC analysis

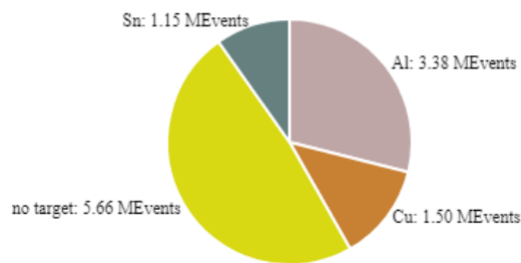
Beam Ar (E = 3.2 GeV/n)

Total: 171.53 MEvents



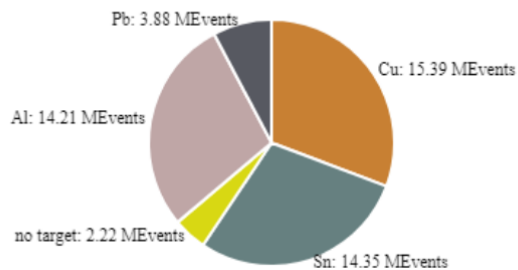
Beam Kr (E = 2.3 GeV/n)

Total: 11.69 MEvents



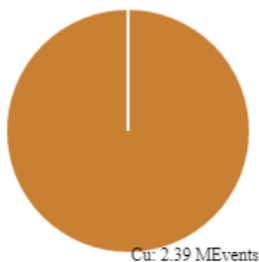
Beam Kr (E = 2.6 GeV/n)

Total: 50.05 MEvents



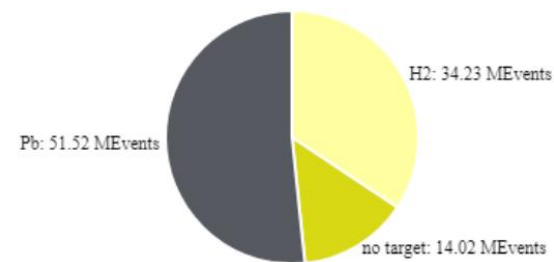
Beam Kr (E = 2.94 GeV/n)

Total: 2.39 MEvents



Beam C (E = 3.17 GeV/n)

Total: 99.77 MEvents

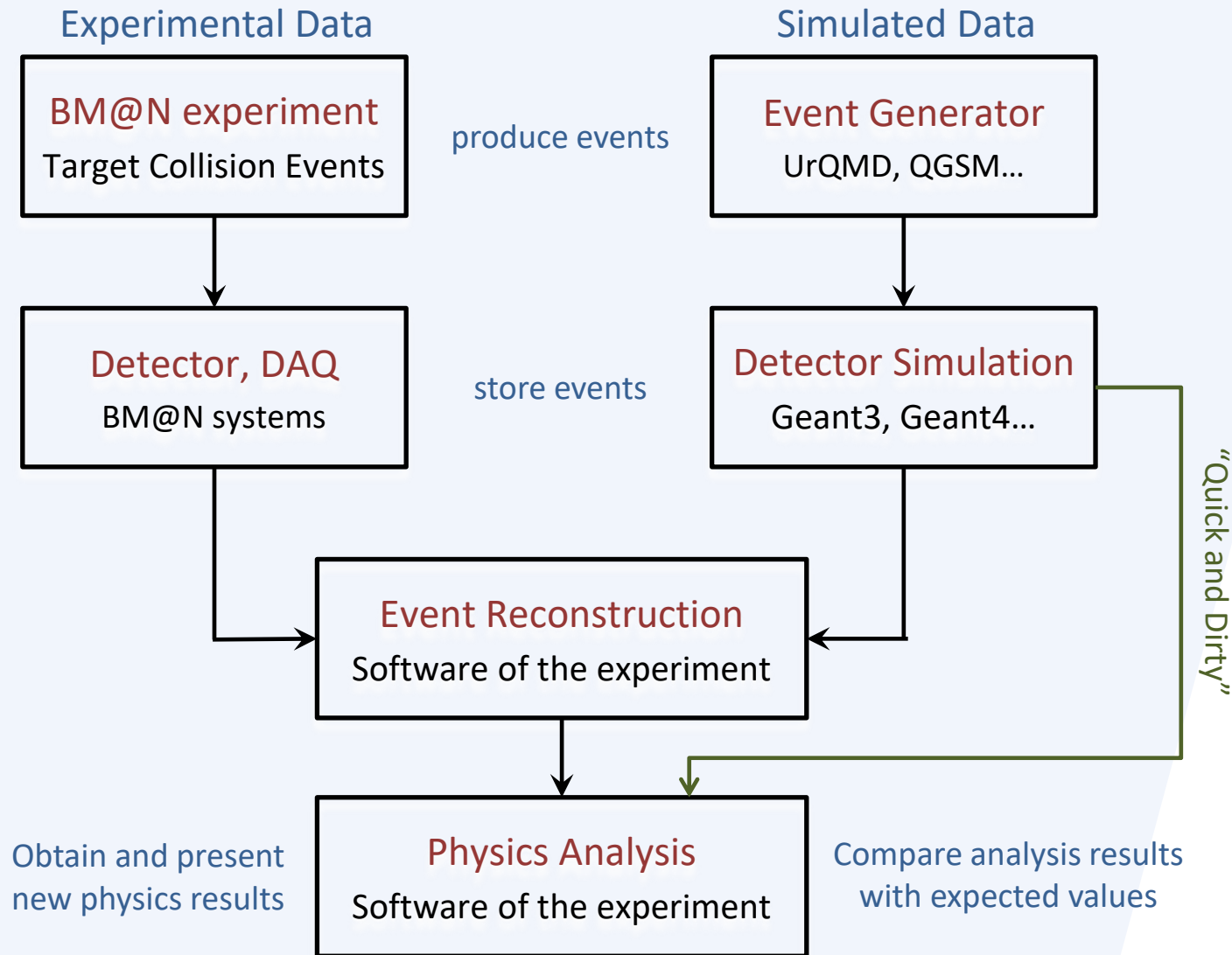


SRC

BM@N

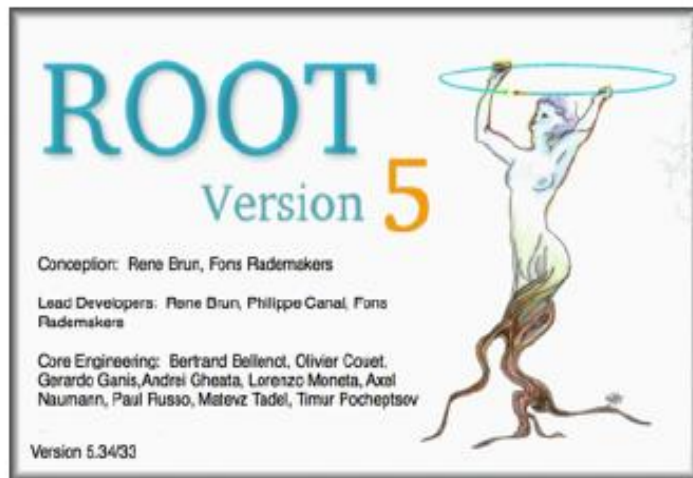
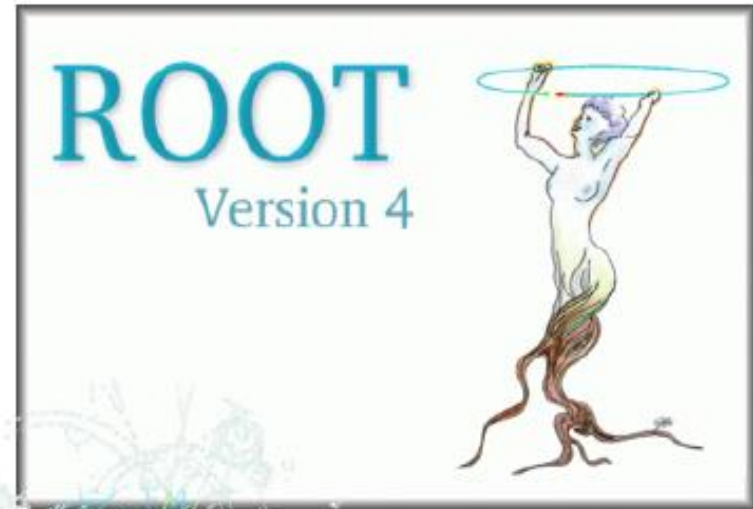
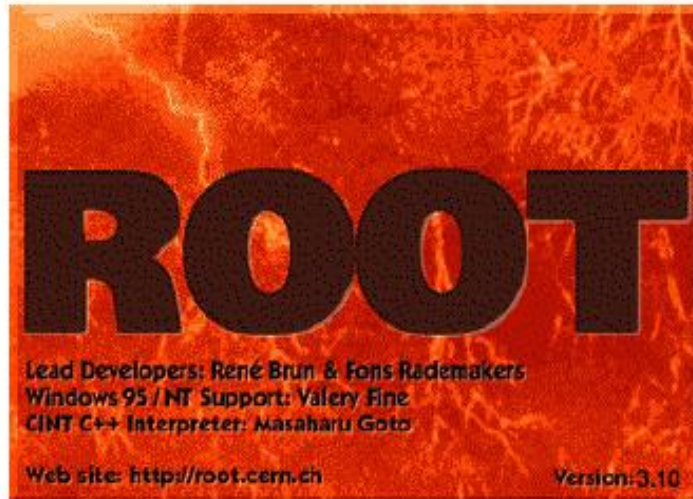
Physics Software

Common scheme of the BM@N experiment



27 years of CERN ROOT evolution

<https://root.cern.ch>



FairRoot Framework

The FairRoot package is an object-oriented simulation, reconstruction and data analysis framework based on ROOT. It includes core services for detector simulation and data analysis for HEP experiments. The framework delivers base classes which enable the users to easily construct experimental setup in a fast and convenient way. By using the Virtual Monte Carlo concept it is possible to perform the simulations using either Geant3 or Geant4 without changing the user code or the geometry description.



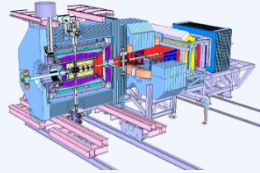
The basic idea of FairRoot is to provide a unified package with generic mechanisms to deal with most commonly used tasks in HEP. FairRoot allow physicists to:

- X Allows physicists to concentrate on detector performance details, avoiding purely software engineering issues like storage, retrieval, code organization etc.
- X Do not submerge into low-level details, use pre-built and well-tested code for common tasks.
- X Focus on physics deliverables while reusing pre-built and well-tested software components for common tasks.

FairRoot Universe



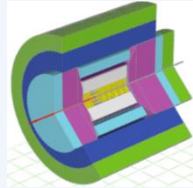
Start testing the VMC concept for CBM



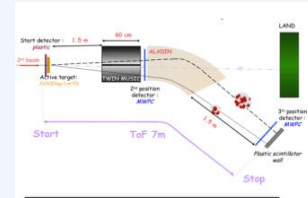
Panda decided to join → oct.
FairRoot: base package for experiments



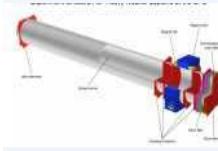
R3B joined



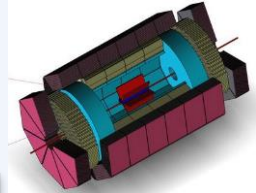
EIC (Electron Ion Collider BNL)



SOFIA (Studies On Fission with Aladin)



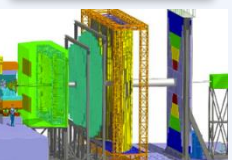
SHIP (Search for Hidden Particles)



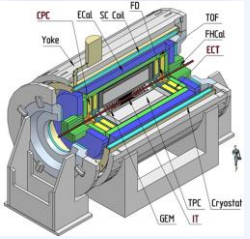
SPD@NICA joined



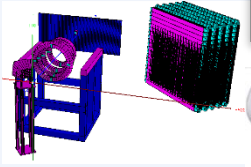
First Release of CbmRoot



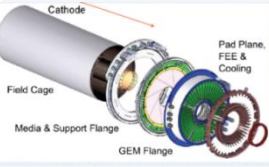
MPD@NICA started with FairRoot



ASYEOS joined

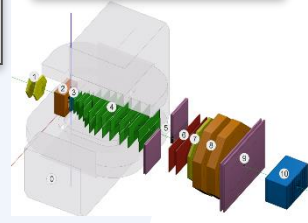


GEM-TPC separated from PANDA branch

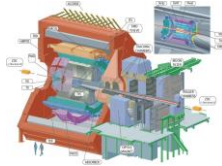


ENSAR-ROOT Collection of modules used by structural nuclear physics exp.

BM@N@NICA started with FairRoot



ALICE
FAIR

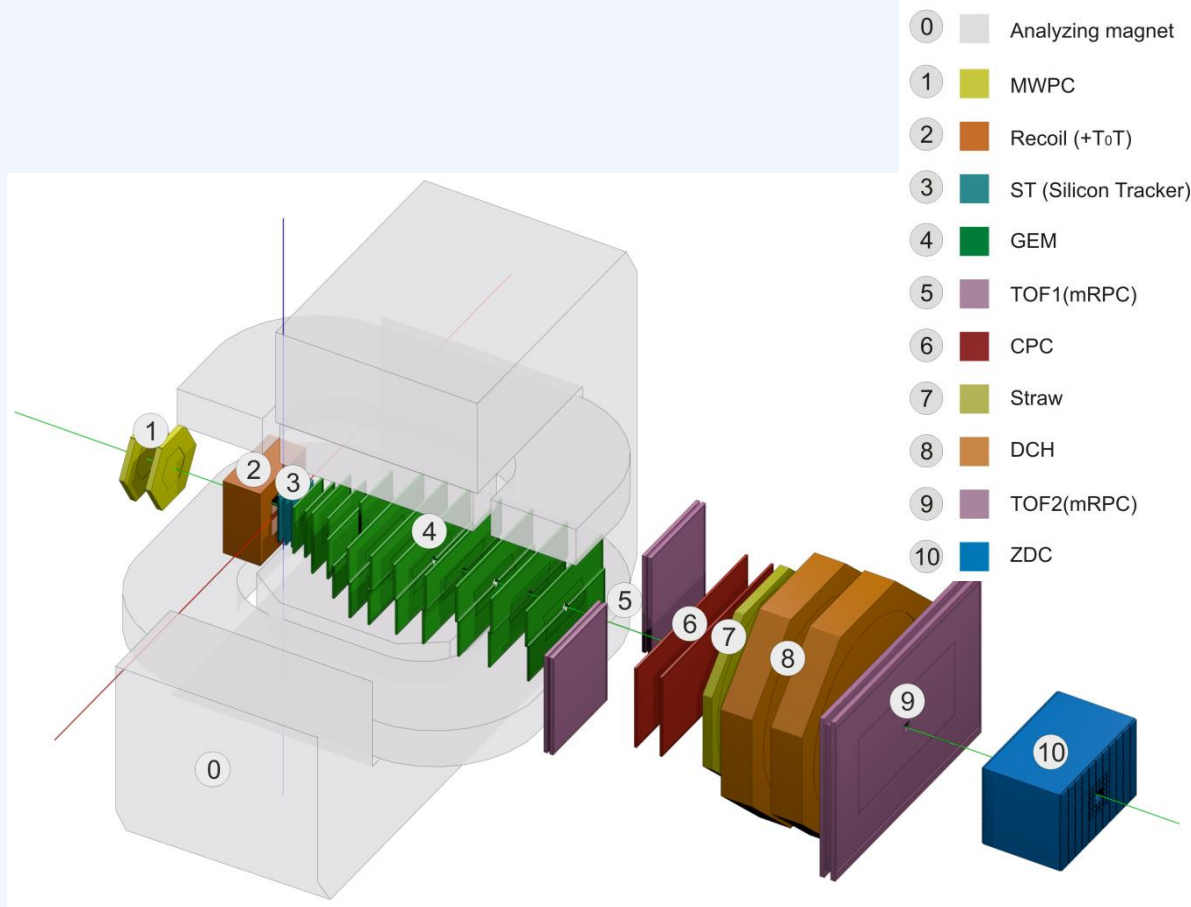


BmnRoot Framework

BmnRoot Framework

The software **BmnRoot** is developed for event simulation, reconstruction of experimental or simulated data and following physics analysis of collisions of elementary particles and ions with a fixed target at the BM@N facility.

C++ classes, Linux OS support, based on ROOT and FairRoot



The BmnRoot software is available in GitLab@JINR: <https://git.jinr.ru/nica/bmnroot>

GitLab services for BM@N software

The screenshot shows the GitLab interface for the 'bmnroot' project. The top navigation bar includes 'Projects', 'Groups', 'Activity', 'Milestones', and 'Snippets'. The project details section shows 'bmnroot' with 'Project ID: 25', '6' stars, and '4' forks. It lists 'GNU GPLv2' license, '1,922 Commits', '22 Branches', '1 Tag', and '352.9 MB Files'. A pipeline status bar is visible, and a recent commit by 'Konstantin Gertsenberger' is shown. The left sidebar contains navigation options like 'Project', 'Repository', 'Issues', 'Merge Requests', 'CI / CD', 'Operations', 'Wiki', and 'Settings'. A table lists project folders and their last commit details.

Name	Last commit	Last update
KF	update L1CAFinder for run7. Tested at the hydra with Fa...	1 month ago
QA	BmnSSDHitProduced removed from CellAutoTracking a...	
alignment	corrections for right compilation	
bd	new FairSoft release; FairRoot was separated from BmnR...	
bmndata	corrections for new Event Header; almost all tasks copie...	
bmnfield	first version of the L1 tracking in the official reconstructi...	
cat	update L1CAFinder for run7. Tested at the hydra with Fa...	
cmake	first version of the L1 tracking in the official reconstructi...	
config	decoder; tree name changed and now is stored in the bu...	

advanced opportunity for collective development

The screenshot shows the 'Pipelines' page for the 'bmnroot' project. It displays a table of pipeline runs with columns for Status, Pipeline, Commit, Stages, and Time. The table shows several successful runs (passed) and one failed run (failed).

Status	Pipeline	Commit	Stages	Time
passed	#307 by latest	1-alignment-... -> 7bf94510	Correct estimation of t...	00:11:58 about 17 hours ago
passed	#306 by latest	1-alignment-... -> f21e1463	Enabled CI tests for all ...	00:21:58 about 17 hours ago
passed	#305 by latest	1-alignment-... -> 7bf94510	Correct estimation of t...	00:12:26 about 17 hours ago
passed	#303 by latest	dev -> f21e1463	Enabled CI tests for all ...	00:12:39 about 18 hours ago
passed	#301 by latest	dev -> 1157e2e4	SILICON: file Silicon_R...	00:13:01 a day ago
failed	#300 by latest	dev -> e71f6bca	ToF400 analysis draft	00:12:30 a day ago

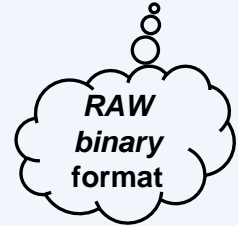
Version Control System – Git
Repository branch protection
Role-based access control to projects
Issue Tracker (as a Project Management System)
Automated Tests & Deployment – GitLab Runners

Event Data Processing in BmnRoot

DAQ Storage

raw data in binary format

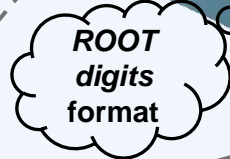
raw_run.data



Unified
Condition
Database



digi_run.root



bmn_dst.root

Geant 3/4, Fluka

simulation

run_sim_bmn.C

bmn_sim.root



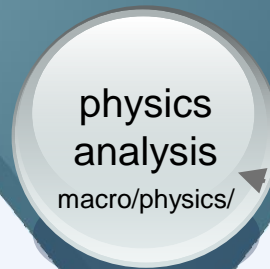
Event Generators

DCM-QGSM, DCM-SMM, UrQMD...

generator.dat



Geometry
Database

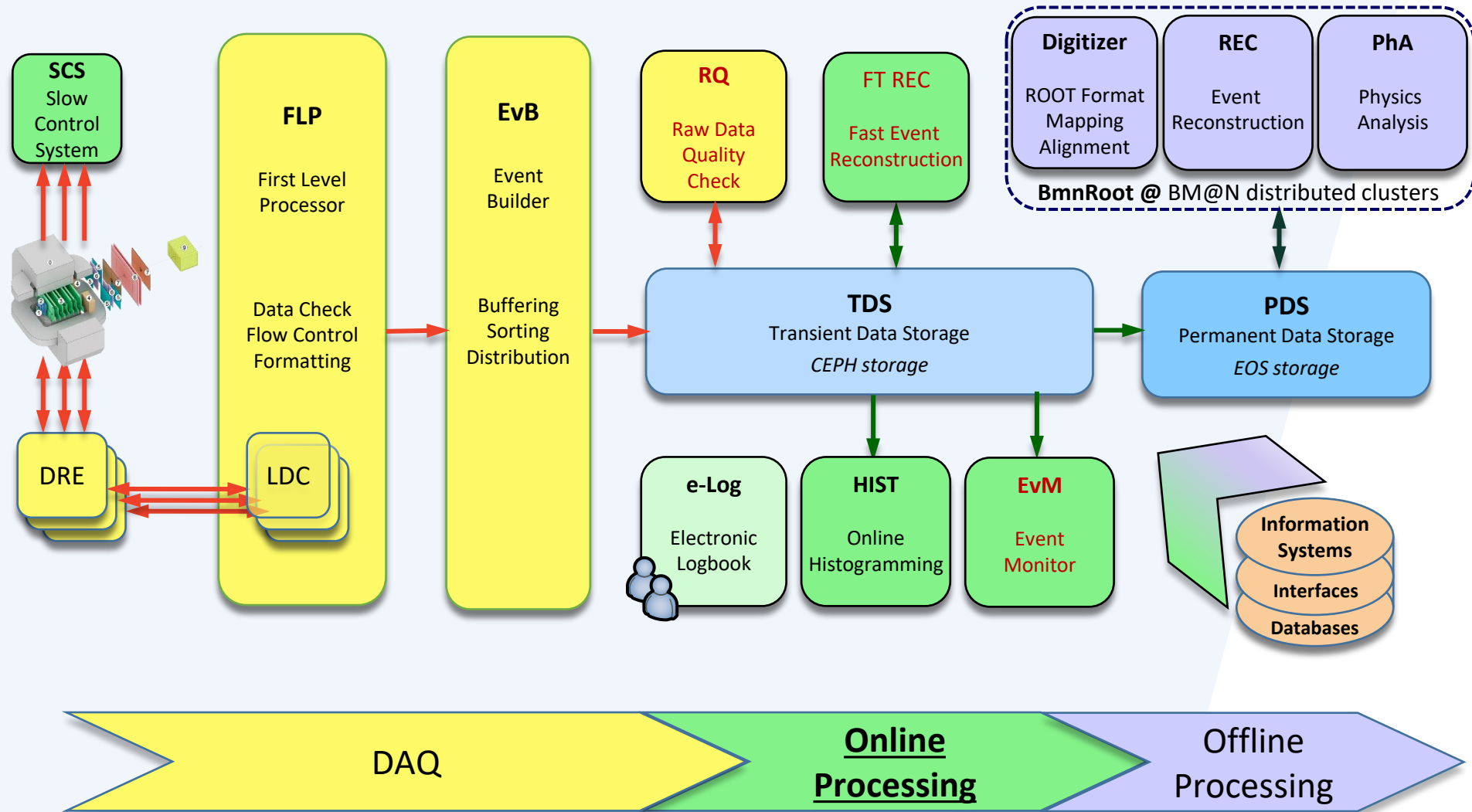


Event
Catalogue

Information Systems

Database + Interfaces + Services + ...

BM@N Data Processing Flow



Online Information System

Electronic Logbook

Online Electronic Logbook (e-Log)

- The **e-Log** platform is a collaborative tool which provides shift crews with an interface to store and share information with offline users on various events or problems occurred in the experiment during its operation
- It uses the developed **Logbook Database** on PostgreSQL which ensures correct multi-user access, data consistency, integrity and automatic backup of the stored data
- Implemented **interfaces** provide a unified access to required logbook data for various online and offline systems, and convenient viewing, transparent managing and searching for required information by users
- A part of the logbook data is automatically transferred to the **Condition Database** of the experiment to use in offline analysis

User Web Interface of the e-Log Platform

BM@N Electronic Logbook

bmn-elog.jinr.ru

Logged in as shift

[Home](#) [New](#) [Find](#) [Last day](#) [Account](#) [Reference Book](#)

Page: 1 of 282

Number of items per page: 10 [Logout](#)

Date	Shift Leader	Type	N _e Run	Trigger	DAQ Status	SP-41, A	SP-57, A	VKM2, A	Beam	Energy, GeV	Target	Comment	Attachment
2018-04-05 11:47:06	Rumyantsev	Inform All	5185 per.7	Special Trigger	All	0	0	0	Kr	2.94	Cu (2 mm)	End of the RUN7	
2018-04-05 11:09:20	Rumyantsev	New Run	5184 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3 VKM2: I=125A, SP-57=50A, SP41=1250A; 100 k	
2018-04-05 08:12:35	Rumyantsev	New Run	5183 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>2 VKM2: I=125A, SP-57=50A, SP41=1250A; 120 k	
2018-04-05 07:46:35	Babkin	New Run	5182 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3 VKM2: I=125A, SP-57=50A, SP41=1250A; 208 kev	
2018-04-05 07:41:29	Babkin	New Run	5180 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 201 kev	
2018-04-05 07:25:08	Babkin	New Run	5179 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 201 kev	
2018-04-05 06:01:07	Babkin	New Run	5178 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 201 kev	
2018-04-05 05:27:39	Babkin	New Run	5177 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 204 kev	
2018-04-05 05:27:06	Babkin	New Run	5176 per.7	Beam Trigger + BD>3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & BD>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 150 kev	
2018-04-05 04:47:27	Babkin	New Run	5174 per.7	Beam Trigger + BD>3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & BD>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 213 kev	

2020 - software team (contact e-mail: gertsen@jinr.ru)

Common FreeIPA Authentication: Administrator, Editor, Reader roles



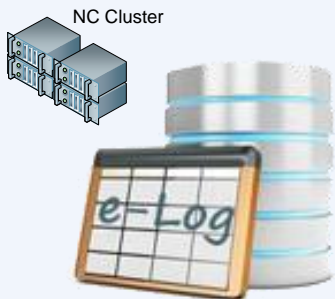
File Attachments (text description, photo)
Email Subscription to selected event types

Multi-Column Sorting
Logbook Monitoring

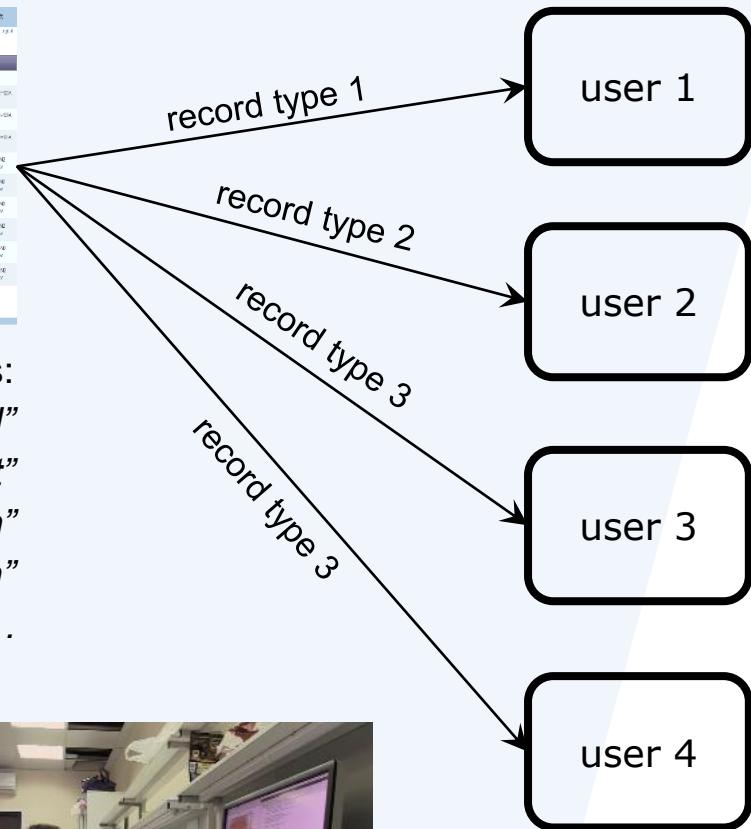
User Cabinet
Easy Searching

e-Log Platform. Notification Service

e-mail notifications



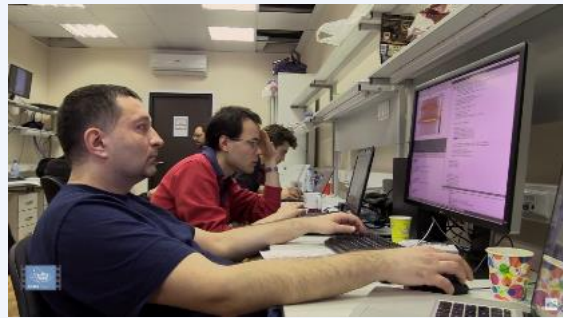
Inv.	Module	Tip	St/In	Type	Mod Name	SP/CP	SP/CS	VM/E	Row	Temp/Cel	Temp	Comment
2108080100	Control	Normal	010000	Open/Close	00	0	1	1	1	23.0	69.2°F	Open/Close
2108080100	Control	Normal	010000	Start/Stop	00	0	0	0	1	23.0	69.2°F	Open/Close
2108080100	Control	Normal	010000	New/Repair	00	0	0	0	1	23.0	69.2°F	Open/Close
2108080100	Control	Normal	010000	Start/Stop	00	0	0	0	1	23.0	69.2°F	Open/Close
2108080100	Control	Normal	010000	New/Repair	00	0	0	0	1	23.0	69.2°F	Open/Close
2108080100	Control	Normal	010000	Start/Stop	00	0	0	0	1	23.0	69.2°F	Open/Close
2108080100	Control	Normal	010000	New/Repair	00	0	0	0	1	23.0	69.2°F	Open/Close
2108080100	Control	Normal	010000	Start/Stop	00	0	0	0	1	23.0	69.2°F	Open/Close



different types of events:
 “shift started”
 “problem report”
 “configuration”
 “new run”
 ...

User Cabinet

Event	Subscription
New record of the 'Configuration' type.	<input type="checkbox"/>
New record of the 'Inform All' type.	<input type="checkbox"/>
New record of the 'New Run' type.	<input type="checkbox"/>
New record of the 'Other' type.	<input type="checkbox"/>
New record of the 'Problem Fixed' type.	<input type="checkbox"/>
New record of the 'Problem report' type.	<input type="checkbox"/>
New record of the 'Routine' type.	<input type="checkbox"/>
New record of the 'Shift started' type.	<input type="checkbox"/>
New record of the 'Shift summary' type.	<input type="checkbox"/>
New record of the 'Software Installation' type.	<input type="checkbox"/>



C++ API → REST API (in progress)

Autogenerated class wrappers for the logbook objects allow to access and manage the data in the BmnRoot framework

ElogRecord – records written by a shift crew during the experiment runs which describe operating modes of various systems and detectors and different types of events

ElogType – record types: ‘Shift started’, ‘Problem report’, ‘Configuration’, ‘New Run’, etc.

ElogPerson – a list of the experiment staff

ElogTrigger – dictionary of all possible trigger types

ElogBeam – dictionary of all possible beam particles

ElogTarget – dictionary of all possible targets

ElogAttachment – files attached to a record for detailed description of the run

ElogConnection – serves to open and close connections to the databases including e-Log

ElogSearchCondition – forms criteria for selection of necessary records

The main functions of the e-Log interface:

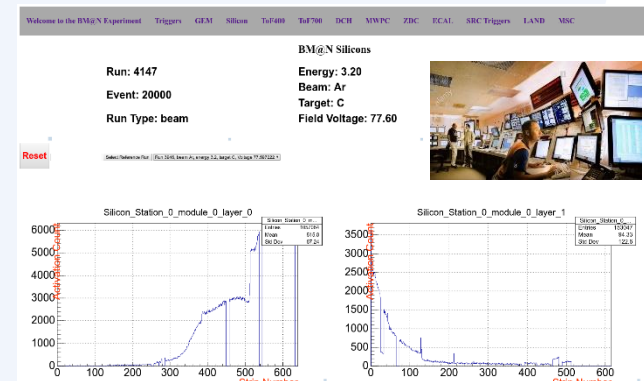
for data objects (static): *Create*, *Delete*, *Get*, ***Search***, *PrintAll*.

for attributes (non-static): *Getters* and *Setters* functions, *Print*.

Online metadata → BM@N Condition Database



DAQ
system



new run
*period, run
start & end time,
event count, file
path, file size*



offline data processing



new run
*period, run
beam, energy, target,
magnetic field*

Online/Offline System Event Data Quality Assurance

Online Histogramming. *Web application*

jsROOT (Javascript ROOT) server provides processed histograms via the Web

Welcome to the BM@N Experiment Triggers GEM Silicon ToF400 ToF700 DCH MWPC ZDC ECAL SRC Triggers LAND MSC

BM@N Silcons

Run: 4147

Event: 20000

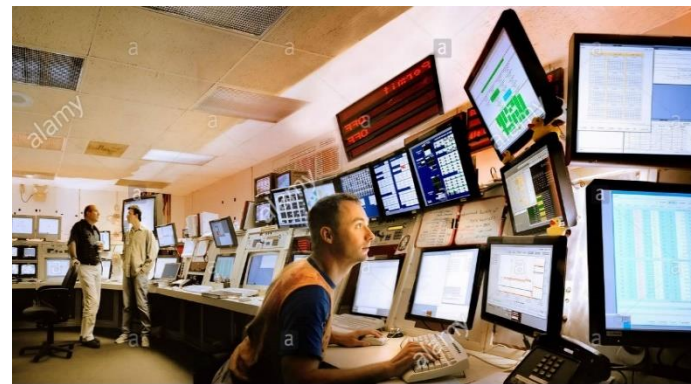
Run Type: beam

Energy: 3.20

Beam: Ar

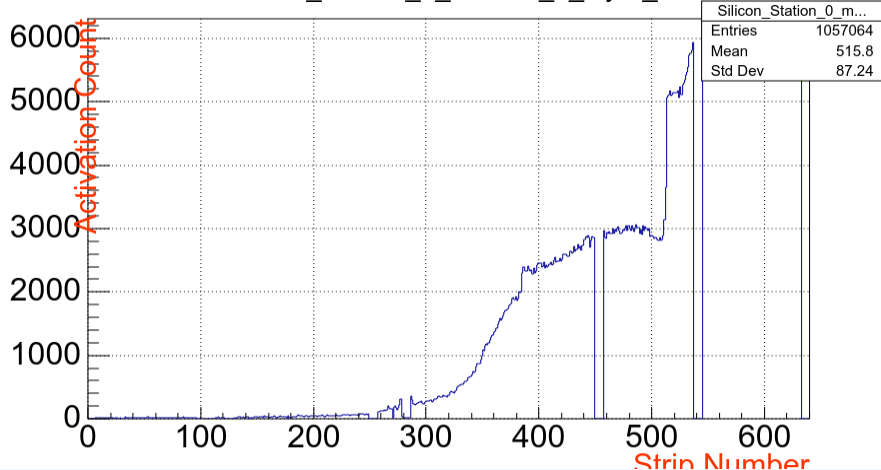
Target: C

Field Voltage: 77.60

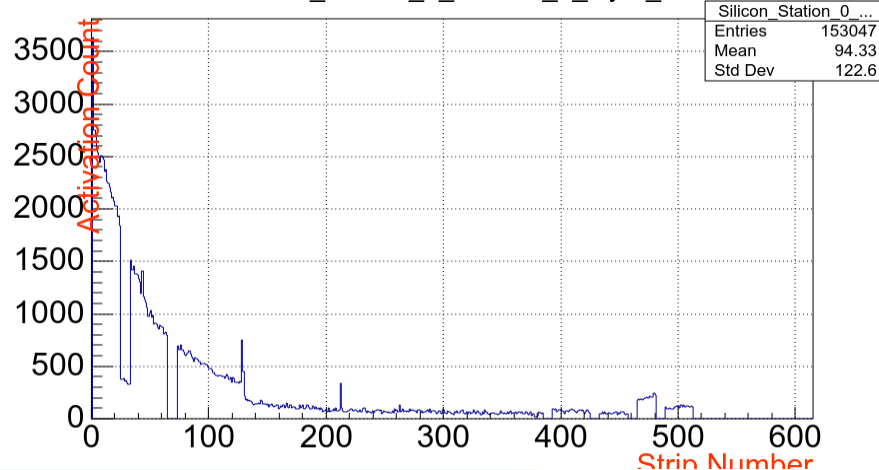


Reset Select Reference Run Run 3946, beam Ar, energy 3.2, target C, Voltage 77.597222 ▼

Silicon_Station_0_module_0_layer_0



Silicon_Station_0_module_0_layer_1

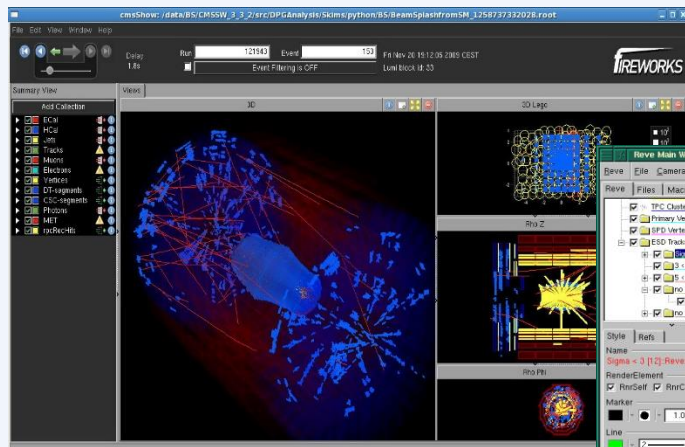


Online/Offline System

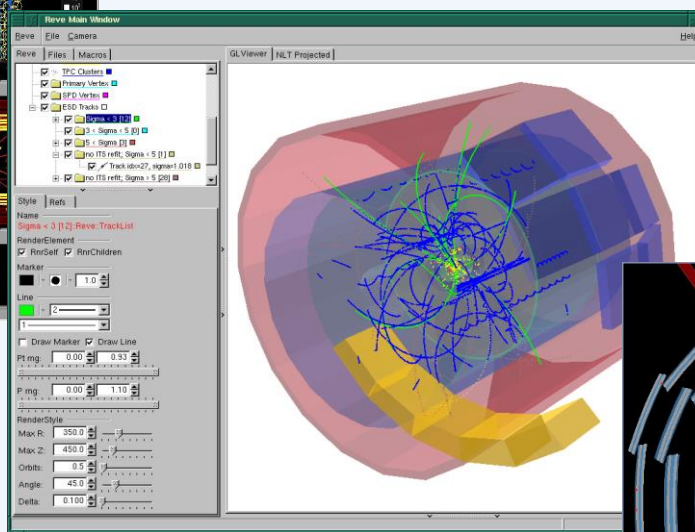
Event Monitor / Event Display

Event Display in modern experiments

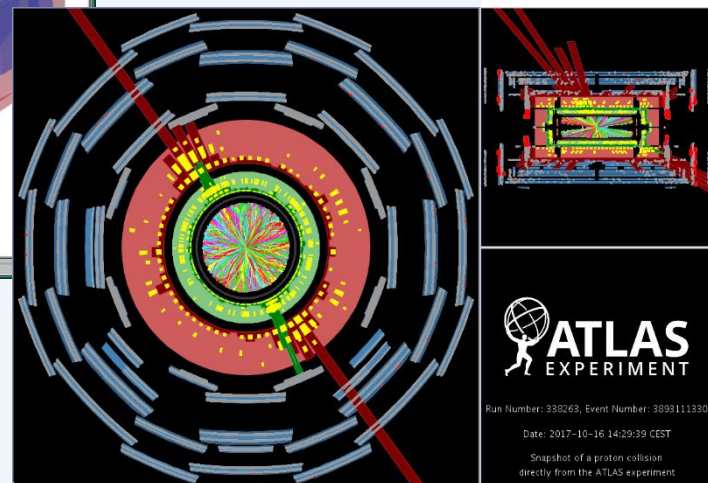
CMS (Fireworks)



ALICE (AliEVE)



ATLAS (Atlantis)



Purposes of Event Display

design / offline stage = **Offline Event Display**:

- ❖ model and algorithm **checking** and debugging for developers
- ❖ data reconstruction and analysis visualization for a better **understanding** of the detector and event structure
- ❖ **demonstration** and presentation of works

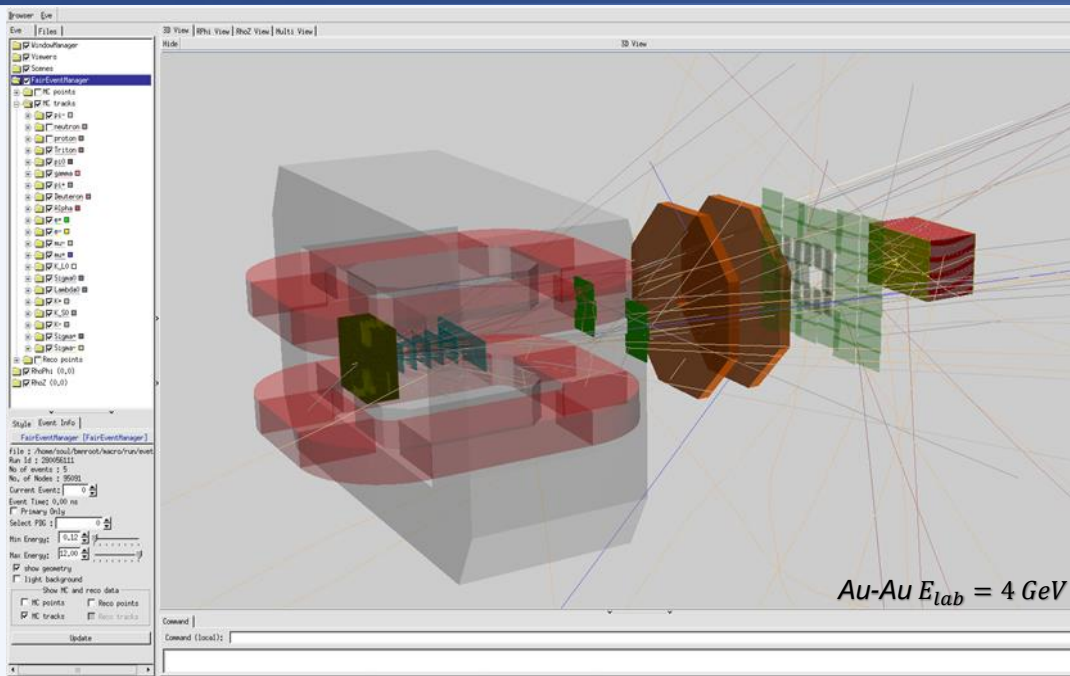
run / online stage = **Online Event Monitor**:

- ❖ visual online presentation of selective events during the experiment run as a **monitoring system**
- ❖ **visual control** and debugging of current events

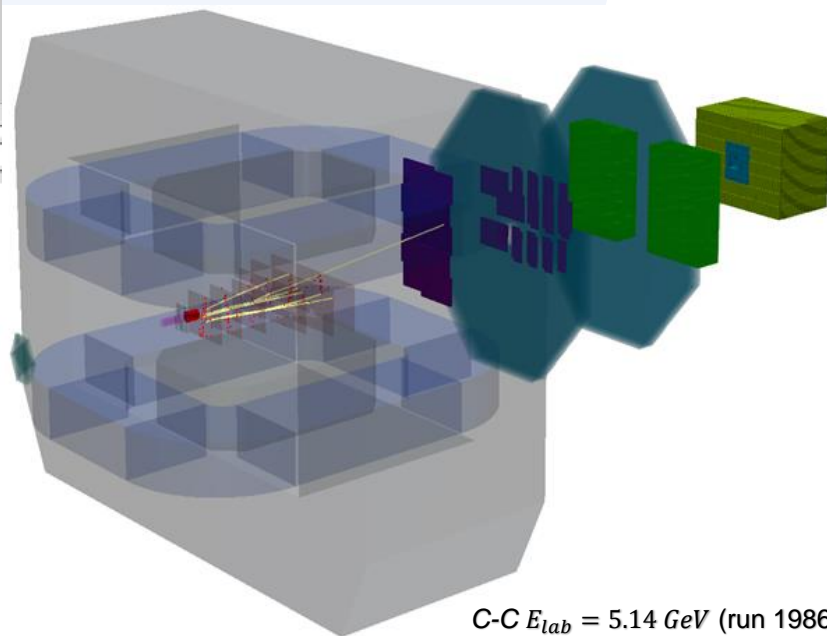
Event Display for the BM@N experiment

based on the **ROOT EVE** package
graphically presents the events by
means of ROOT GUI and OpenGL

Event Display for **reconstructed** data:
hits, tracks, calorimeter towers



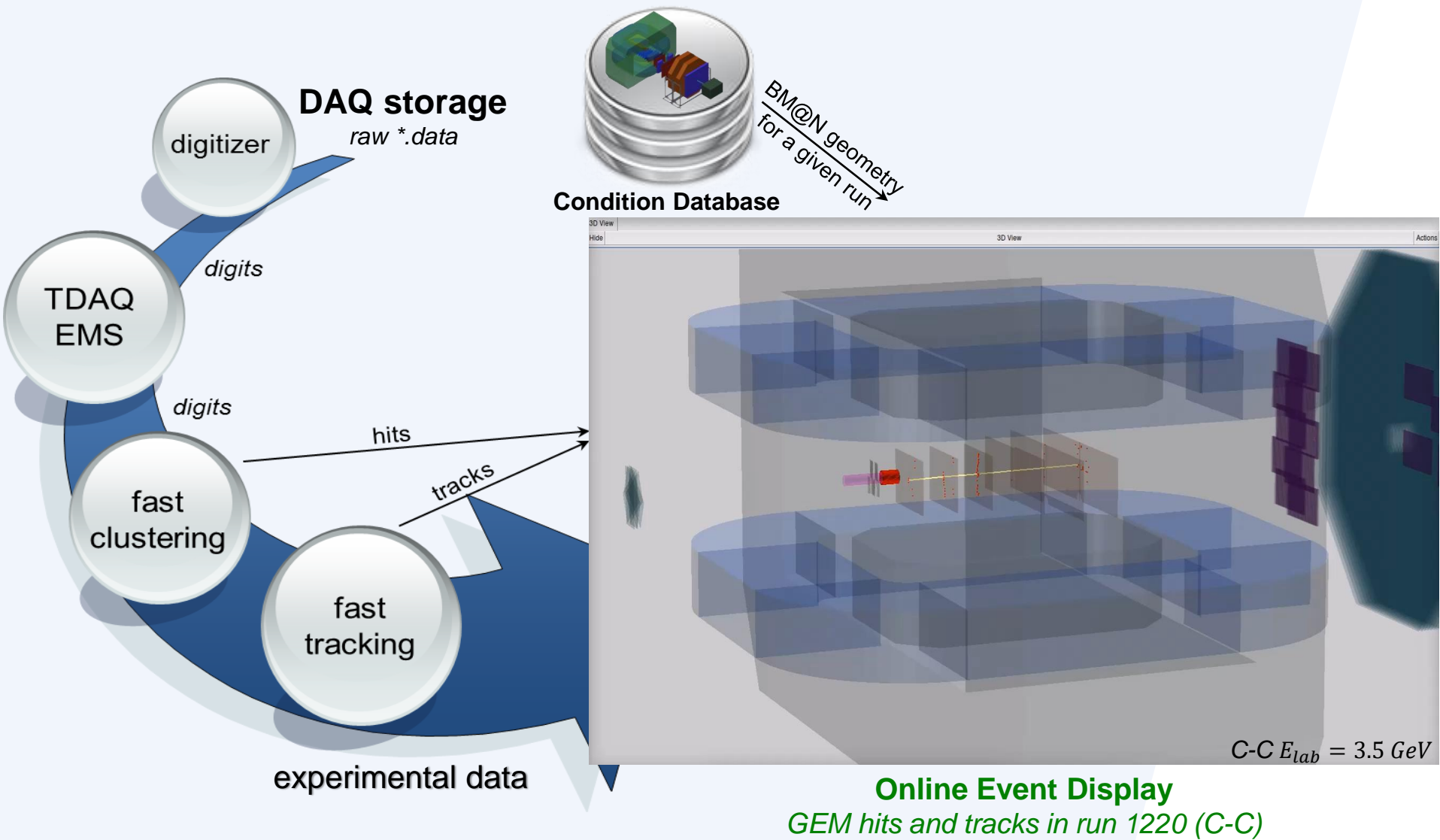
Event Display for **simulated** event data:
MC points, tracks, calorimeter towers



`bmnroot/macro/eventdisplay/eventdisplay.C`

C-C $E_{lab} = 5.14$ GeV (run 1986)

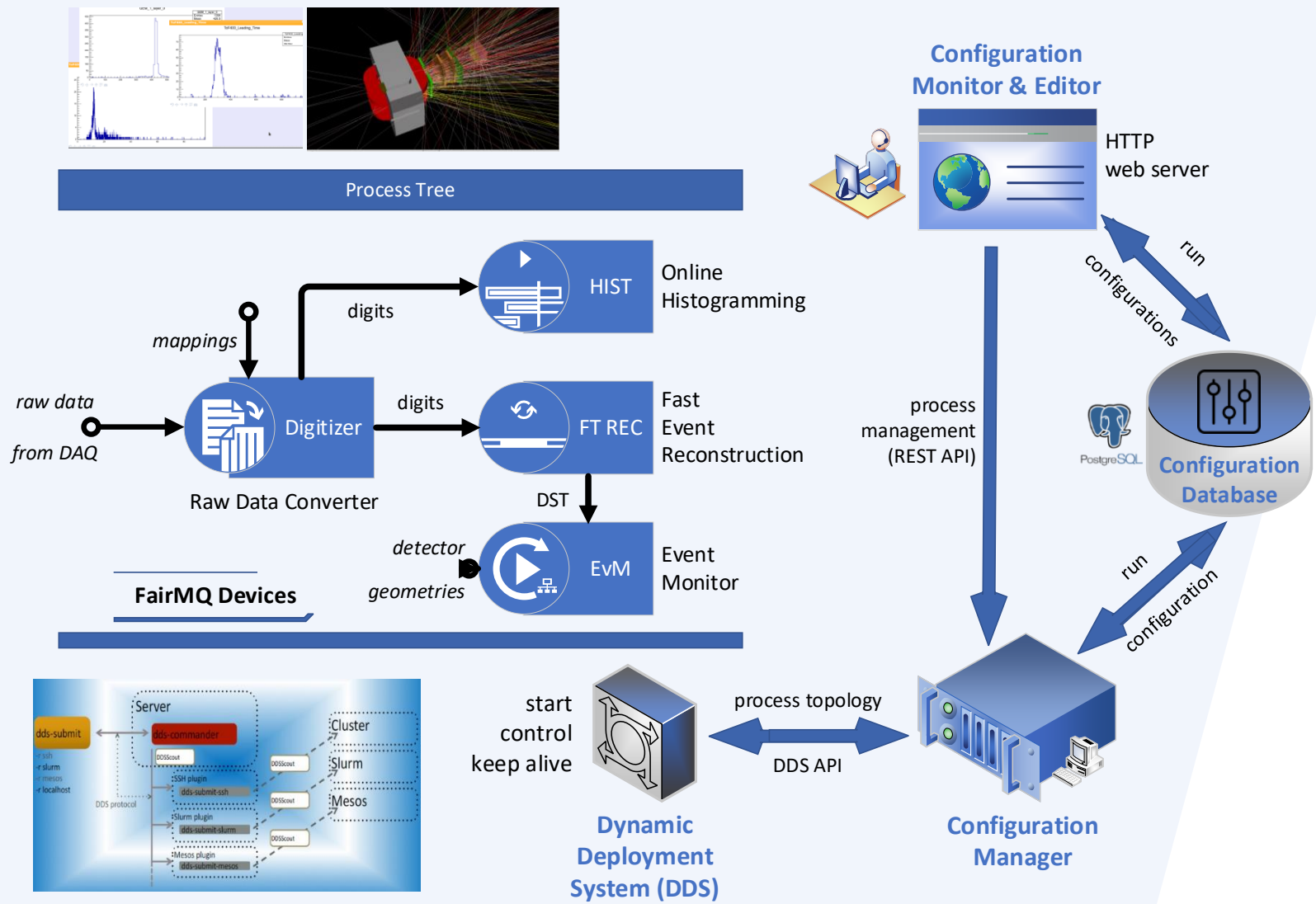
Event Monitor in BM@N Runs



Online Information System

Online Configuration System

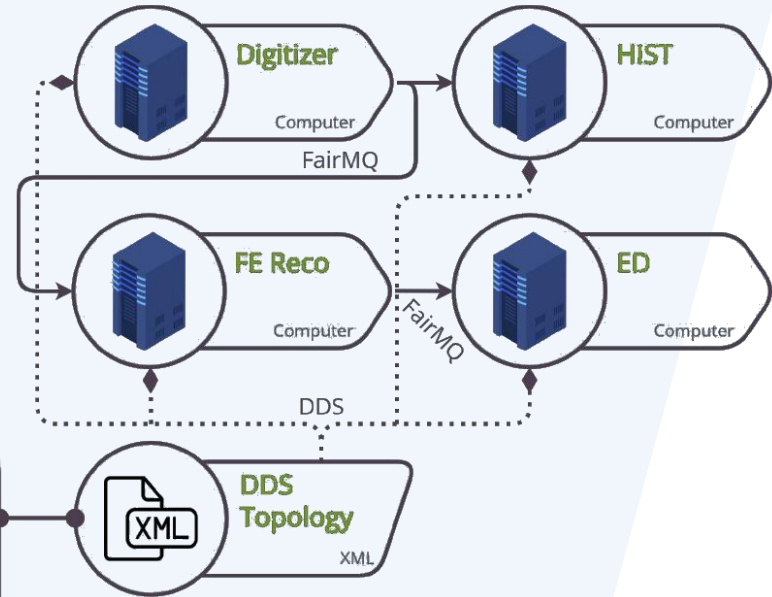
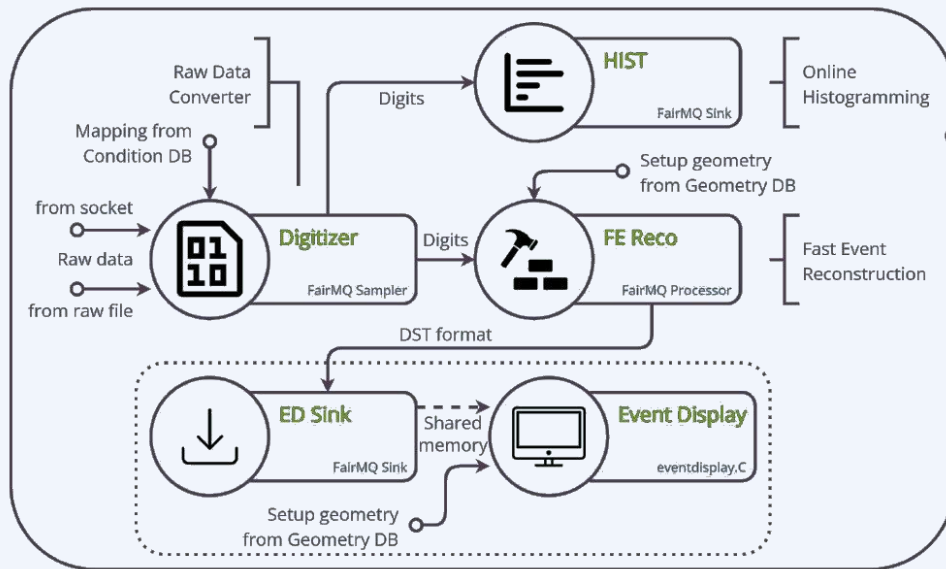
BM@N Online Configuration System



Online Processing System for BM@N

DDS (Dynamic Deployment System) is a set of tools that facilitates the process of system deployment. As a Remote Manipulator System (RMS), it initially provides SSH or SLURM, but also allows you to use other methods.

FairMQ is a messaging library focused on building modular systems for data processing in high energy physics experiments. It represents an abstraction over various messaging technologies such as ZeroMQ, Nanomsg, etc.




The purpose of the online data processing system is selective data processing (digitization of events and fast reconstruction) and monitoring of the data of the ongoing experiment.

OCS Web Interface. *Task monitor*

Menu

ACTIVATED TASKS

CONFIGURATION DESIGNER

DICTIONARIES 

[HOSTS](#)


[OS](#)

[TASK TYPES](#)

[MODULE NAMES](#)

[SETUP NAMES](#)

Get in touch

 [Konstantin Gertsenberger](mailto:Konstantin.Gertsenberger)

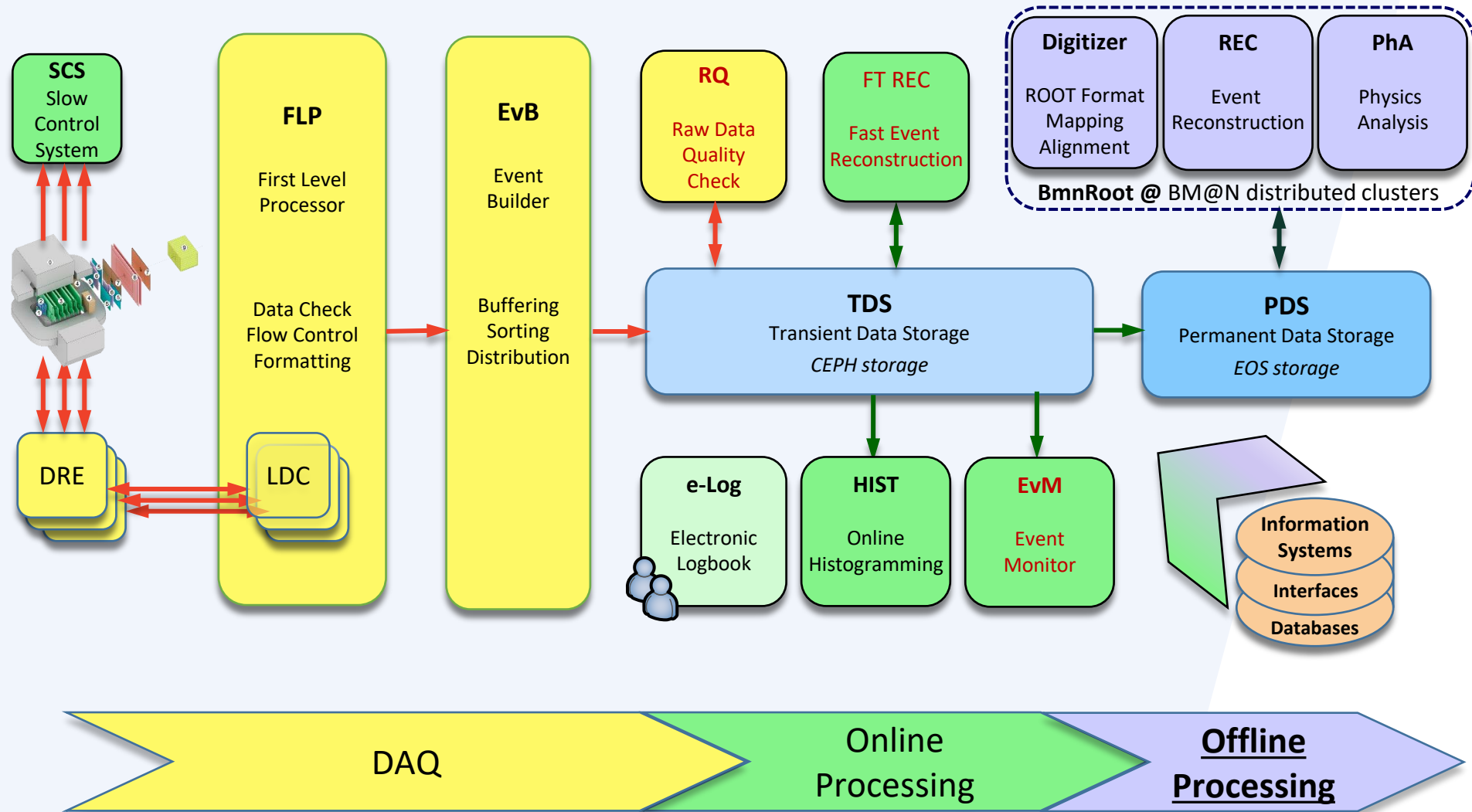
List of activated tasks

Task: Computer: Module: Setup: Status:

For more task information, click on the task name.

Name	Computer	Module		Start Time	Stop Time	Status
fast_event_reco_imitator	localhost	OnlineControl	test	2021-10-19 15:18:35	2021-10-19 15:19:14	Crashed
event_display_imitator	localhost	OnlineControl	test	2021-10-19 15:17:55	2021-10-19 15:18:26	Stopped
root_digi_imitator	localhost	OnlineControl	test	2021-10-19 15:19:24		Running
<i>Parameters: --time 10 -ts 10 -mfn bmn_root_digi_imit_message;</i> <i>PathExe: tutorials/tutorial1/bmn_root_digi_imit;</i> <i>Task Type: exe;</i> <i>OS: centos;</i> <i>Version: 1;</i> <i>Instances: 1;</i> <i>Restart_On_Crash: \;</i> <i>Start_On_Boot: \;</i> <i>Property: Name- DigiMessProperty; Value- write;</i>						
online_histogram_imitator	localhost	OnlineControl	test	2021-10-19 15:19:52		Running

BM@N Data Processing Flow



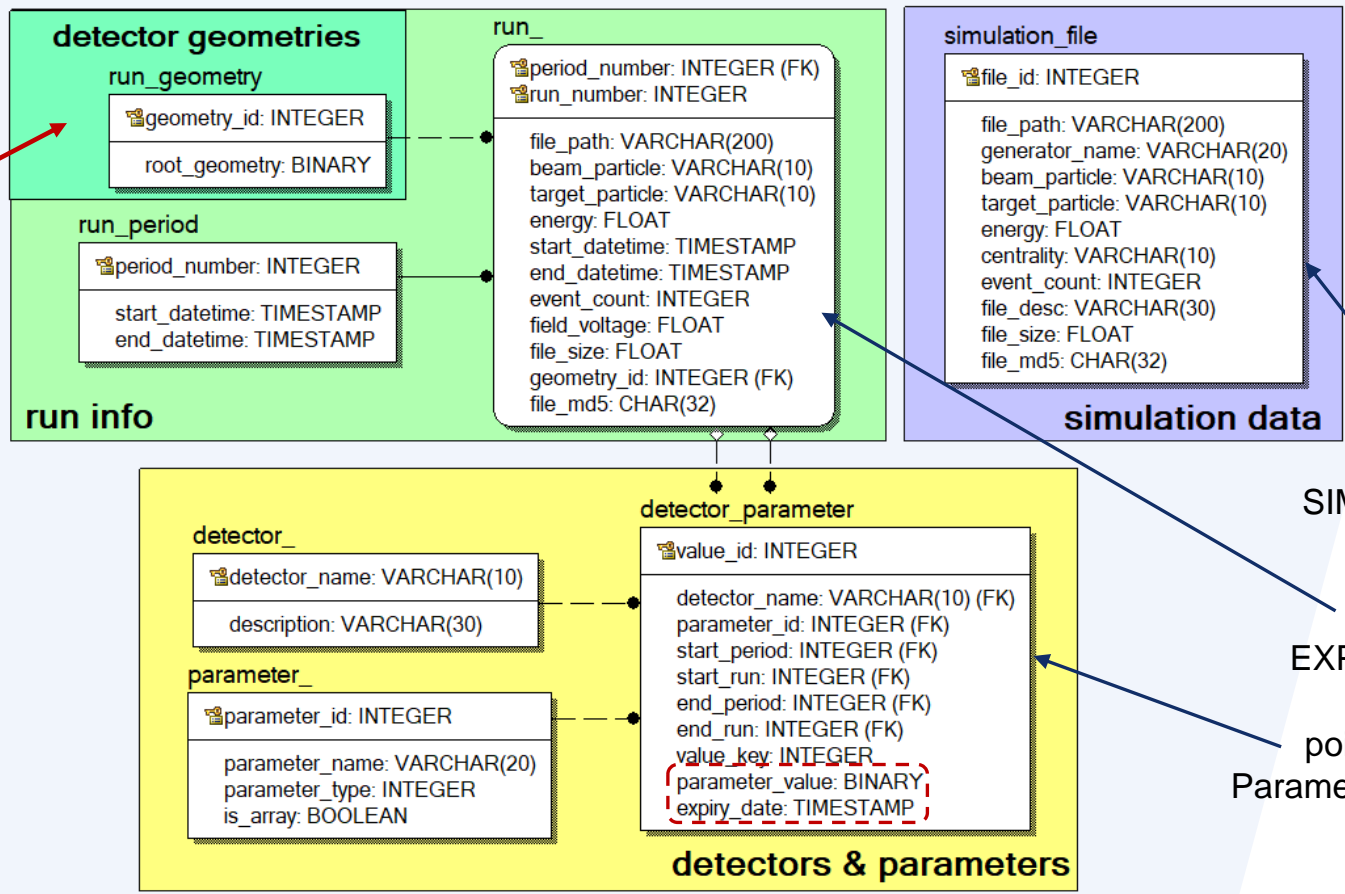
Offline Information System

Unified Condition Database (UniConDa)

Purposes of the Unified Database

- **central data storage** for offline data analysis (and may be online tasks) in the experiments of the NICA project
- **unified access** and data management for all collaboration members
- correct **multi-user data processing**
- ensuring the **actuality of the information** being accessed (sessions and run parameters, technical and calibration data, etc.), **data consistency and integrity**
- excluding the multiple duplication and use of outdated data
- **automatic backup** of the stored data

Unified Condition Database Structure



storing information on experiment sessions and runs, setup geometries, detectors, parameters and parameter values, and generated simulation files

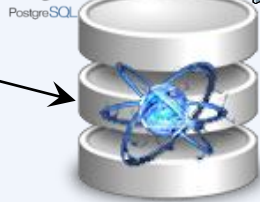
UniConDa in BM@N offline processing



BmnRoot framework

detector simulation
raw data processing
event reconstruction
physics analysis

C++ interface
→ **REST API**
(connect, I/O, API)



Condition Database

ROOT

Node.JS

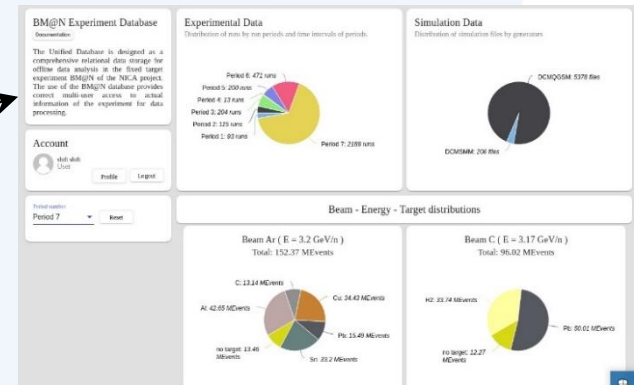


reading and changing data

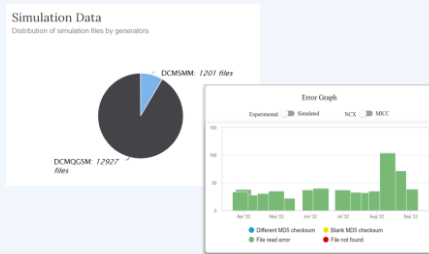


users

FreeIPA authentication



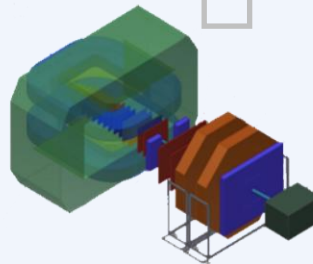
service python script for auto updating simulation file list



service python script for checking integrity of the raw data files

configuration calibration

parameter and algorithm data



Web Service



Web service for the Condition Database

Menu

Sign Out

BM@N Experiment Database

Documentation

The Unified Database is designed as a comprehensive relational data storage for offline data analysis in the fixed target experiment BM@N of the NICA project. The use of the BM@N database provides correct multi-user access to actual information of the experiment for data processing.

Account



Konstantin Gertsenberger
Admin

Profile

Logout

Period number

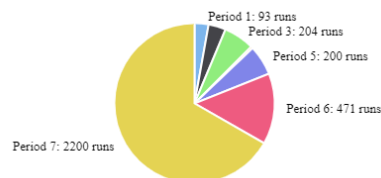
Period 6

Show

Reset

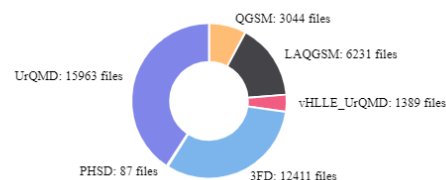
Experimental Data

Distribution of runs by run periods (show time of all periods)



Simulation Data

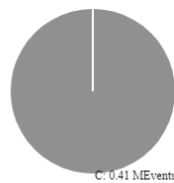
Distribution of simulation files by generators



Beam - Energy - Target distributions

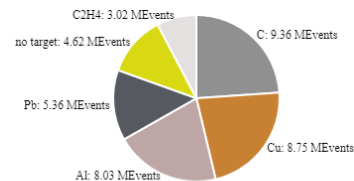
Beam C (E = 5.14 GeV/n)

Total: 0.41 MEvents



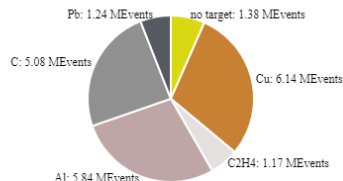
Beam C (E = 4.5 GeV/n)

Total: 39.14 MEvents



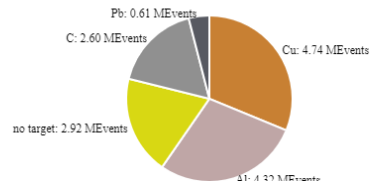
Beam C (E = 4 GeV/n)

Total: 20.85 MEvents



Beam C (E = 3.5 GeV/n)

Total: 15.19 MEvents



bmn-unidb.jinr.ru

- visualization of summary data in the form of diagrams and charts
- convenient viewing, managing and searching for up-to-date information on the BM@N experiment in tabular view by collaboration members

Tabular View of the Condition Database

Run Selector	ProcId	Run	Start Time	End Time	Beam	Beam Opt	Start	Stop	Beam Cost	File Size, GB	Run File Path	Overview
7	5184	2016-04-05 11:30:24	2016-04-05 11:39:31	Rz	294	Cu	17.616008	107708	22.677	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1184.data	
7	5185	2016-04-05 13:56:30	2016-04-05 13:56:27	Rz	291	Cu	17.616008	121014	25.538	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1185.data	
7	5187	2016-04-05 13:42:30	2016-04-05 13:50:23	Rz	294	Cu	17.616006	309468	43.880	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1187.data	
7	5190	2016-04-05 13:20:10	2016-04-05 13:41:14	Rz	294	Cu	17.616008	201031	42.638	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1190.data	
7	5179	2016-04-05 09:20:30	2016-04-05 10:21:12	Rz	294	Cu	17.622485	201029	42.625	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1179.data	
7	5183	2016-04-05 09:05:35	2016-04-05 09:30:31	Rz	294	Cu	17.616119	301054	47.453	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1183.data	
7	5177	2016-04-05 09:20:31	2016-04-05 09:00:22	Rz	294	Cu	17.616011	204786	42.900	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1177.data	
7	5178	2016-04-05 09:13:12	2016-04-05 08:25:49	Rz	294	Cu	17.616782	181019	31.822	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1178.data	
7	5174	2016-04-05 07:37:47	2016-04-05 08:11:05	Rz	294	Cu	17.616689	710131	44.951	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1174.data	
7	5173	2016-04-05 07:37:30	2016-04-05 07:37:11	Rz	291	Cu	17.617212	211029	61.600	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1173.data	
7	5170	2016-04-05 08:38:38	2016-04-05 08:54:31	Rz	294	Cu	17.613163	301132	42.478	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1170.data	
7	5190	2016-04-05 09:20:31	2016-04-05 09:30:10	Rz	294	Cu	17.606703	203884	42.380	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1190.data	
7	5187	2016-04-05 09:42:30	2016-04-05 09:55:30	Rz	294	Cu	17.616005	303911	7.060	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1187.data	
7	5186	2016-04-05 09:35:37	2016-04-05 09:35:35	Rz	294	Cu	17.616005	60709	11.385	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1186.data	
7	5190	2016-04-05 09:00:41	2016-04-05 09:11:05	Rz	294	Cu	14.396762	64832	11.262	10000	vsocadbm@epjgwpa071220-6180_BM@N_Kognomel_run_1190.data	

Experiment Runs

Detector Name	Parameter Name	Run period	Start run	End run	Run period	Default	Channel	Parameter value
DCH1	off	1	12	688	3			True
TOP1	off	1	12	688	3	23657930	1	1.02852 1.78584
TOP1	off	1	12	688	3	23657930	2	-0.06316 0.022627 ...
TOP1	off	1	12	688	3	23657930	5	0.63805 1.31165
TOP1	off	1	12	688	3	23657930	4	-8.105195 1.86232 ...
TOP1	off	1	12	688	3	23657930	8	0.79191 1.89107
TOP1	off	1	12	688	3	23657930	6	0.022291 1.07066 ...
TOP1	off	1	12	688	3	23657930	7	-4.1177 1.85877
TOP1	off	1	12	688	3	23657930	9	0.88879 1.52003 ...
TOP1	off	1	12	688	3	23657930	9	0.311956 1.35169
TOP1	off	1	12	688	3	23657930	10	0.221916 1.59048 ...
TOP1	off	1	12	688	3	23657930	11	1.10140 1.24716
TOP1	off	1	12	688	3	23657930	12	1.19151 1.80875
TOP1	off	1	12	688	3	23657930	13	1.07190 0.00006 ...
TOP1	off	1	12	688	3	23657930	14	-0.089154 0.790548

Parameter Values

Simulation File Selector	Detector Name	Beam	Energy, GeV	Target	Channel	Beam Cost	File Size, GB	Simulation File Path	Overview
DCHQ28M	Ar	32	Ar	nb	8046	0.231	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8053	0.229	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8034	0.730	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8031	0.230	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8069	0.230	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8035	0.230	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8061	0.229	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8041	0.230	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8007	0.230	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8001	0.730	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8023	0.229	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8003	0.231	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8073	0.229	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8075	0.230	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	
DCHQ28M	Ar	32	Ar	nb	8038	0.231	10000	vsocadbm@epjgwpa071220-6180_BM@N_mAAAr_32GeV_11812	

Simulation Files

Detector Name	Description
BC1	
BC2	
T0	
VETO	
ZDC	Zero Degree Calorimeter
TOP1	Time-of-Flight near 400cm
TOP2	Time-of-Flight near 700cm
DCH1	First Drift Chamber
DCH2	second Drift Chamber
BD	Barrel Detector
GM1	Gas Electron Multiplier
magnet	DV@N magnet
BM@N	whole BM@N detector

Detector & Parameters

Condition Database. *File Inspection Service*

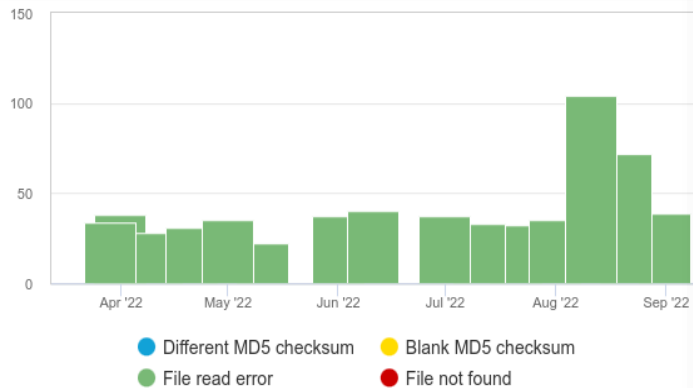
Report Selector

Type name	Storage name	Check date	Complete date	File count	Errors
exp_data	NCX	2022-09-01 03:00	2022-09-05 04:00	3635	39
exp_data	NCX	2022-08-21 03:00	2022-08-25 05:11	3635	72
exp_data	NCX	2022-08-11 03:00	2022-08-14 22:05	3635	104
sim_data	NCX	2022-08-05 03:00	2022-08-05 08:08	23964	8
exp_data	NCX	2022-08-01 03:00	2022-08-05 12:15	3635	35

Items per page: 5 1 - 5 of 51

Error Graph

Experimental Simulated NCX MICC



Error name	File Path	Error Details
File read error	/eos/nica/bmn/exp/raw/run7/2213-3588_SRC_Carbon/mpd_run_trigCode_3567.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/3590-4707_BMN_Argon/mpd_run_trigCode_3799.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/3590-4707_BMN_Argon/mpd_run_trigCode_4260.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/3590-4707_BMN_Argon/mpd_run_trigCode_3735.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/3590-4707_BMN_Argon/mpd_run_trigCode_4500.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/3590-4707_BMN_Argon/mpd_run_trigCode_4633.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/3590-4707_BMN_Argon/mpd_run_trigCode_4662.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/3590-4707_BMN_Argon/mpd_run_trigCode_4689.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/4720-5186_BMN_Krypton/mpd_run_trigCode_5088.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/2213-3588_SRC_Carbon/mpd_run_trigCode_3455.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/4720-5186_BMN_Krypton/mpd_run_trigCode_5150.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/2213-3588_SRC_Carbon/mpd_run_trigCode_3303.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/2213-3588_SRC_Carbon/mpd_run_trigCode_2240.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/2213-3588_SRC_Carbon/mpd_run_trigCode_2687.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/3590-4707_BMN_Argon/mpd_run_trigCode_4327.data	[Errno 5] Input/output error
File read error	/eos/nica/bmn/exp/raw/run7/3590-4707_BMN_Argon/mpd_run_trigCode_4125.data	[Errno 5] Input/output error

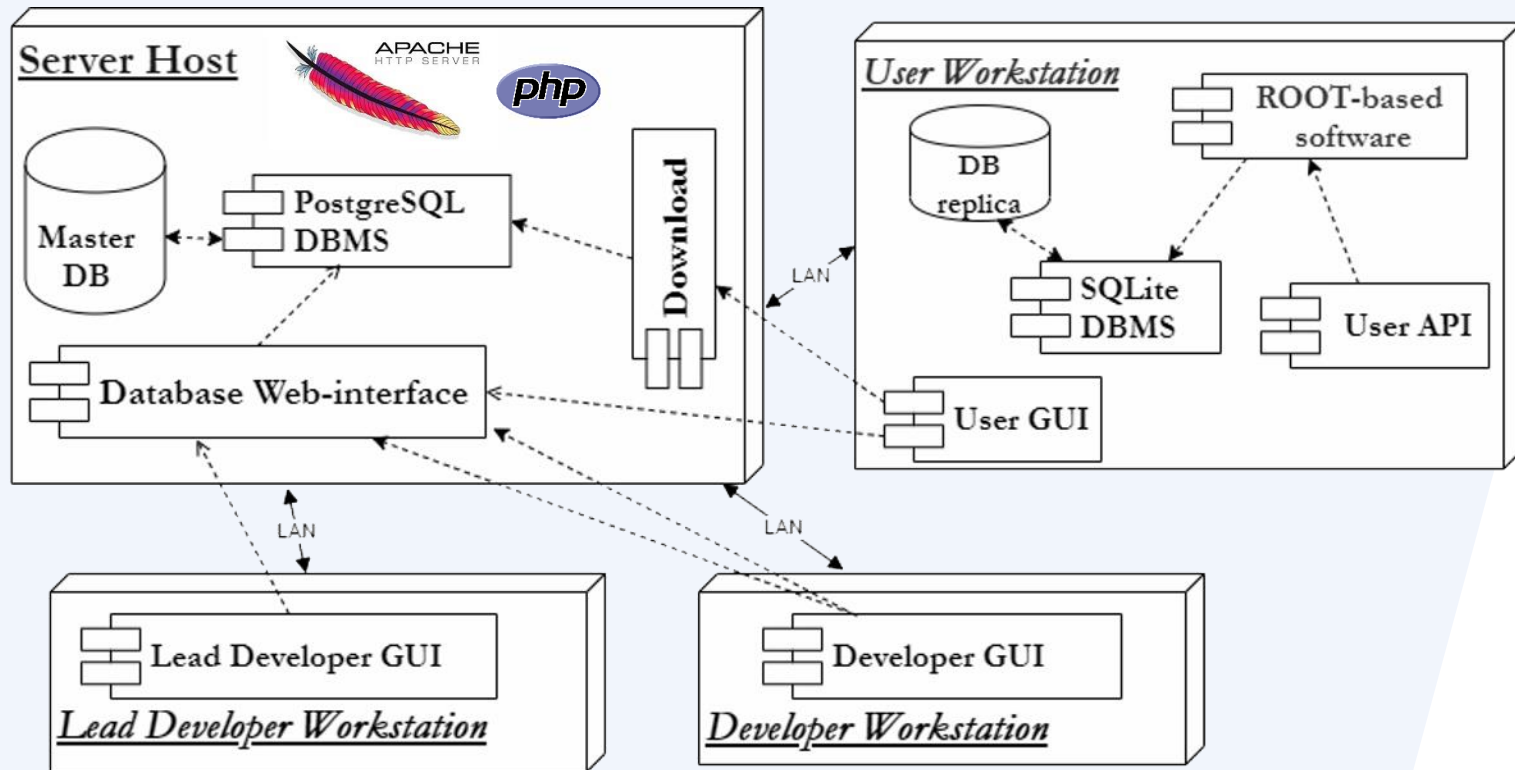
File Inspection Service

Offline Information System Geometry Database

Geometry Information System

- is based on the **Geometry Database** to work with detector geometries of the NICA experiments and intended for storing and managing information on the geometry models of the detectors
- stores and manages geometry modules as **ROOT binary objects**
- each **setup module** stores a tag, version, transformation matrix, link to the parent module
- constructs and manages full setups as a **combination** of geometry setup modules, magnetic field and materials
- manages **versions** of the modules and setups
- provide users with **viewing** all components and setups
- provide detector geometries for **online** (e.g. monitoring the current events) and **offline** (e.g. event reconstruction and analysis) systems

Geometry Information System Architecture



Three user roles:
Lead Developer | Developer | User (Reader)



Status of the Geometry Web Platform



Baryonic Matter
at Nuclotron

Menu

HOME

VIEW GEOMETRY ^

VIEW.SETUPS

VIEW.SETUP.MODULES

VIEW.FILES

VIEW.MATERIALS

VIEW.MAGNETIC.FIELDS

EDIT GEOMETRY v

Get in touch

✉ [Konstantin Gertsenberger](mailto:Konstantin.Gertsenberger)



BM@N Geometry DataBase



bmn-geodb.jinr.ru

User:: gertsen

[CONFIGURE WEBACCESS](#)

[LOGOUT](#)

Setup Modules

- simple authorization
- or FreelPA access



Module	Name (Tag)	Date	File	Transformation				Description	Author	ParFile	Download
BD	bd_v1_0	2018-07-26	v1	1.000	0.000	0.000	0.000	bd_v1_0	aleksand		
				0.000	1.000	0.000	0.000				
				0.000	0.000	1.000	0.000				
BD	geom_BD_det_v2	2020-04-19	geom_BD_det_v2	1.000	0.000	0.000	0.000	geom_BD_det_v2	aleksand		
				0.000	1.000	0.000	0.000				
				0.000	0.000	1.000	0.000				
BD	bd_v1_run6	2019-12-24	bd_v1_run6	1.000	0.000	0.000	0.000	bd_v1_run6.geo	aleksand		
				0.000	1.000	0.000	0.000				
				0.000	0.000	1.000	0.000				
CSC	CSC_RunSpring2018	2020-04-19	CSC_RunSpring2018	1.000	0.000	0.000	0.000	CSC_RunSpring2018	aleksand		
				0.000	1.000	0.000	0.000				
				0.000	0.000	1.000	0.000				
DCH	DCH_RunWinter2016	2018-07-26	DCH_RunWinter2016	1.000	0.000	0.000	0.000	DCH_RunWinter2016	aleksand		
				0.000	1.000	0.000	0.000				
				0.000	0.000	1.000	0.000				
DCH	DCH_RunSpring2018	2019-12-24	DCH_RunSpring2018	1.000	0.000	0.000	0.000	DCH_RunSpring2018.ro	aleksand		
				0.000	1.000	0.000	0.000				
				0.000	0.000	1.000	0.000				

BM@N Geometry Database has filled with the setup geometries for Run 7 and 6 (all releases + dev)

Graphical User Interface Functions:

View

Edit

Download

Offline Information System

Event Metadata System

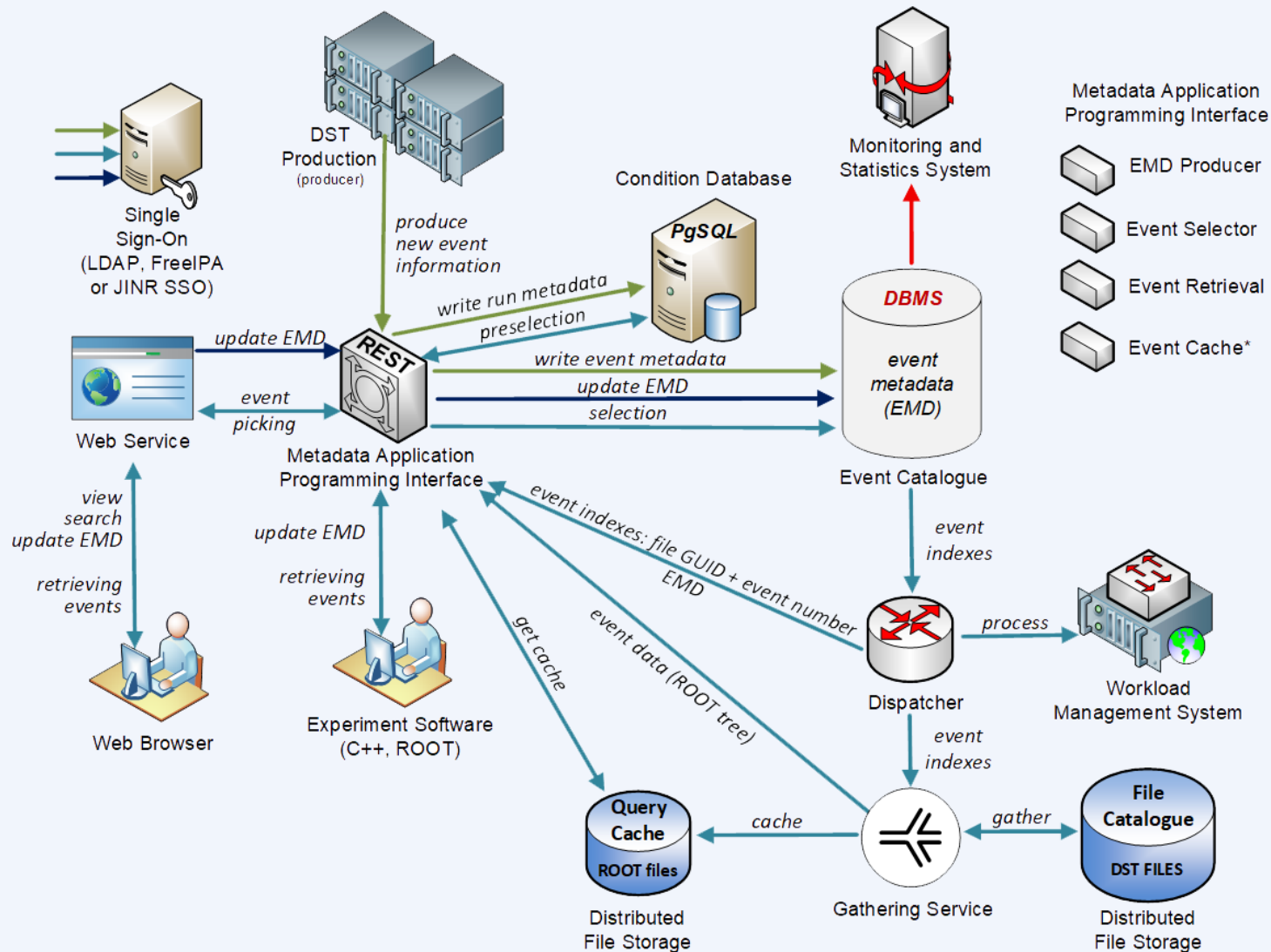
Event Metadata System (EMS)

- **main functions** are summary description of particle collision events and their identifiers to select events for a desired analysis goal; recording and storing necessary event metadata, their management and convenient access; organization of online and offline interfaces for selecting events of interest
- is based on the Event Database called **Event Catalogue**, which contains summary properties of particle collision events and references to their storage location
- allows user to **quickly search** for a set of events required for a particular physics analysis by various criteria and parameters
- is responsible for creating, maintaining and checking the **quality of the catalogue** of the physics events and for providing statistics

Event Metadata System Requirements

- ✦ Performance
 - There are not too many requests per seconds, but heavy ones
- ✦ Scalability
 - BM@N has recorded about 0.5B experimental events
 - Billions of events per year are expected for the NICA experiments
- ✦ Availability and fail safety
- ✦ Role-based access control (LDAP or database)
 - Event Consumer, EMD Writer, EMD Administrator
- ✦ Integration with other experiment systems
 - Run metadata are stored in the Condition Database
 - FairRoot-based frameworks (BmnRoot, MPDRoot, SPDroot).

Architecture of the Event Metadata System



Web interface
for viewing and searching for event metadata stored in the Event Catalogue and retrieving events which satisfy given user parameters

Metadata API
for writing new metadata to the Event Catalogue while data processing and requesting events selected by criteria for physics analysis in BmnRoot

Event Metadata Structure

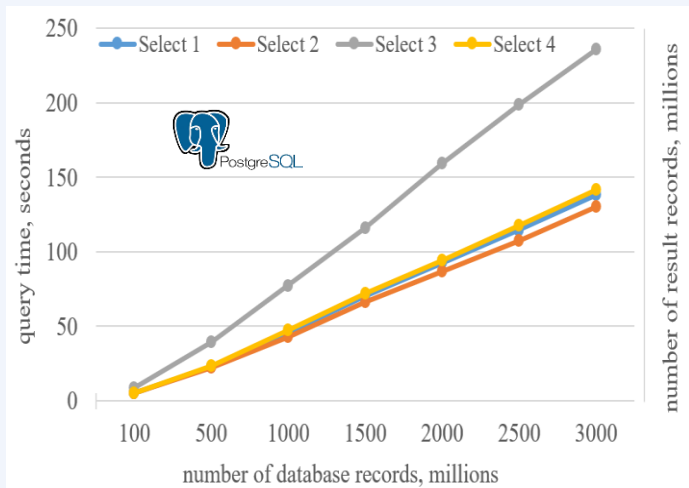
- period and run number (4+4 bytes)
- **file pointer (GUID) (4 byte)**
- **event number (4 byte)**
- software version (2 bytes)
- event time (4 byte)
- flag to determine whether primary vertex was found (1 byte)
- number of primary tracks (4 byte)
- number of all reconstructed tracks (4 byte)
- track number of positively charged particles from primary vertex (4 byte)
- primary & secondary particles (4+4 bytes)
- number of hits by detectors (4 bytes)
- total input charge in the event (4 byte)
- total output charge in the event (4 byte)

EMS provide the following functions: summary description of collision events and their identifiers, which can be used to select events for a desired analysis goal; recording and storing event metadata in the Event Catalogue; management and a convenient access to the metadata; organization of online and offline interfaces for selecting events of interest

Prototypes of the Event Catalogue

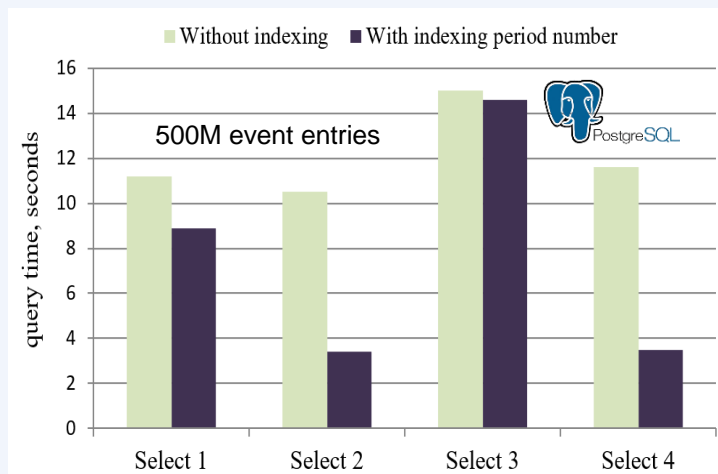
Configuration VM:
 2 x Intel Xeon E5-2680
 DDR4 240 GB 2133 MHz
 SSD 400 GB Intel

Scientific Linux 7.9
 PostgreSQL 12.5
 HBase 2.2.3, Hadoop 3.2.1

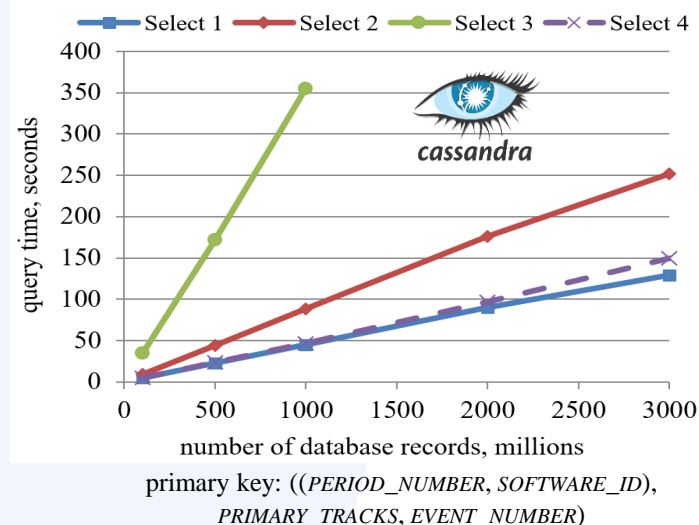


Configuration:
 Intel Core i9-10900F
 DDR4 64 Gb 3200MHz
 SSD 1TB NVMe Samsung

CentOS Linux 8.2
 PostgreSQL 12.5
 Apache Cassandra 3.11.8

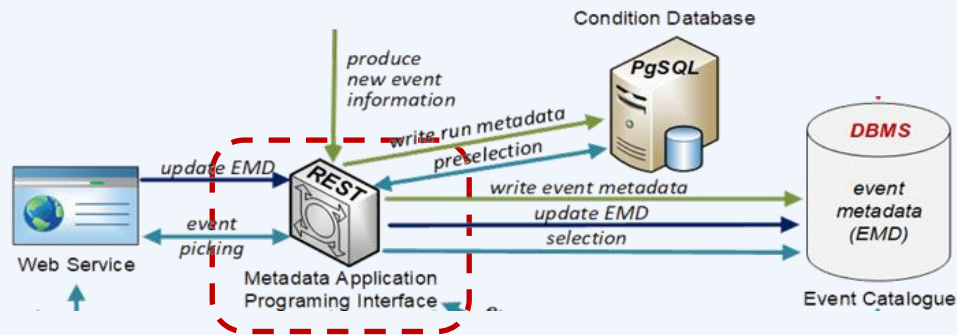


500M	HBase C1	HBase C2	HBase C3
Test 0	56 min	28 min	63 min
Test 1	29 min 55 sec	28 min 02 sec	5 min
Test 2	32 min 4 sec	28 min 47 sec	11 min
Test 3	30 min 20 sec	29 min 52 sec	8 min
Test 4	28 min	not supported by Apache Phoenix	1 min 52 sec
Test 5	29 min	not supported by Apache Phoenix	2 min 12 sec



primary key: ((PERIOD_NUMBER, SOFTWARE_ID), PRIMARY_TRACKS, EVENT_NUMBER)

REST API for the Event Metadata System



Event JSON scheme

```
{
  "reference": {
    "storage_name": "data1",
    "file_path": "/tmp/file1",
    "event_number": 1
  },
  "software_version": "19.1",
  "period_number": 7,
  "run_number": 5000,
  "parameters": {
    "track_number": 20
  }
}
```

- Provides HTTP-based API using JSON formatting: *POST* command to create event metadata in the event catalogue, *GET* request to obtain event records by criteria, *DELETE* to delete event metadata
- Ensures writing new metadata to the Event Catalogue while data processing and requesting events by other experiment systems for chosen criteria, e.g. for physics analysis in the ROOT-based frameworks
- FreeIPA/LDAP protocol is supported for authentication (admin, writer and consumer roles)
- Uses the same selection criteria as the web service including range support

`GET /emd?period_number=7&run_number=5000+&software_version=20.08.0&track_number=10-15`

`GET /eventFileRef[?parameters]`

`GET /eventFile[?parameters]`

`GET /count[?parameter1=value1[¶meter2=value2[...]]]`

User Web Interface of the Event Metadata System

BM@N Event Metadata System

BM@N Events
 Search Events

SRC Events
 Search Events

Test Events
 Search Events

Condition DB prefilter

base parameters

configured parameters

limits and offset

selection

Storage	File path	# Event	Software	Period	# Run	Total track num...	Triggers (string)	Primary vertex
data1	/var/file1	150	19.1	7	5100	90	qwe	true
data1	/tmp/file4	1	19.1	7	5001	25	qwerty	true
data1	/tmp/file4	2	19.1	7	5001	77	qwerty1	false
data1	/tmp/file4	3	19.1	7	5001	25	qwerty	true
data1	/tmp/file4	4	19.1	7	5001	25	qwerty	true
data1	/tmp/file4	10	19.1	7	5001	25	qwerty	true
data1	/tmp/file4	11	19.1	7	5001	77	qwerty1	false
data1	/tmp/file4	12	19.1	7	5001	25	qwerty	true
data1	/tmp/file4	13	19.1	7	5001	77	qwerty1	false
data1	/tmp/file4	14	19.1	7	5001	25	qwerty	true

event pointers

1-10 of 15

event metadata are written only if primary vertex has been found in the event



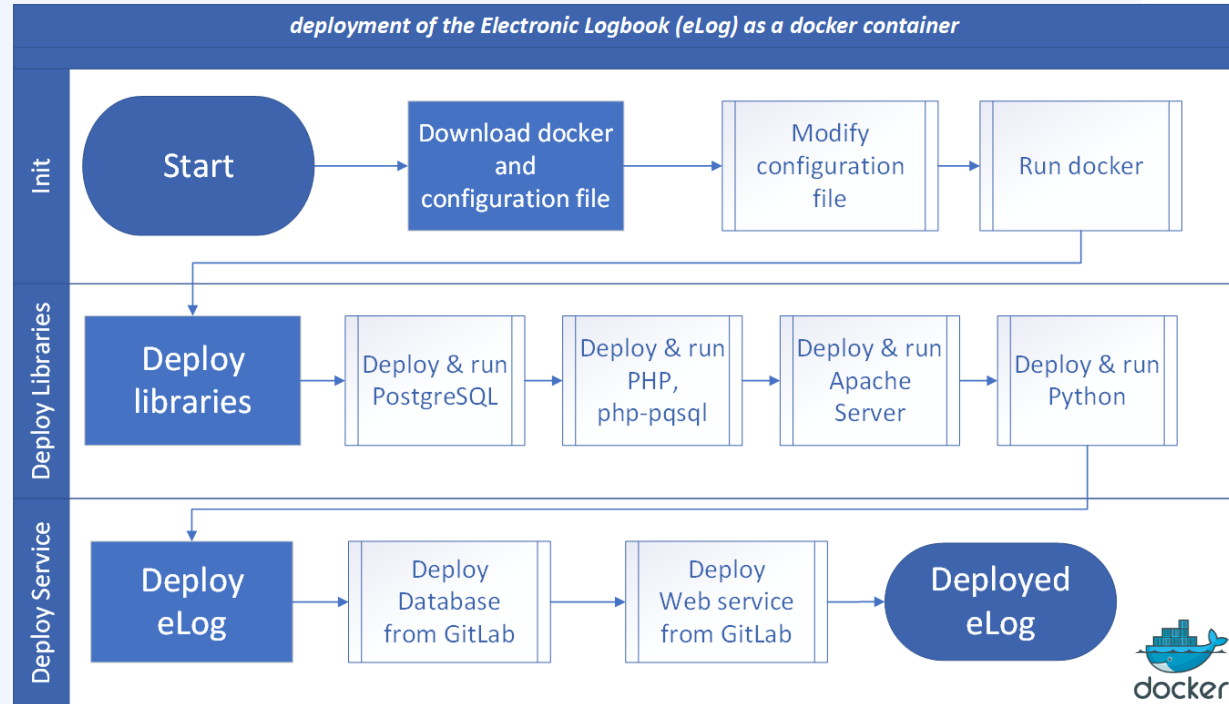
- enables users to browse and search for event metadata stored in the Event Catalogue and retrieve events, which satisfy given parameters
- provides events according to the selected event metadata and run metadata of the Condition Database

Information and Collaboration Services

Common Deployment System

Configuration File

```
{ "remoteHost" : "db_host.jinr.ru", // e-Log database host
  "remoteUser" : "remote_user",   // remote host user
  "dbname" : "elog_db",           // e-Log database name
  "dbPort" : "5432",              // e-Log database port
  "dbAuth" : true,                // authorization type
  // custom (additional, specific to experiment) column names
  "colName": { "sp_41" : "SP-41, A",
               "sp_57" : "SP-57, A",
               "vkm2" : "VKM2, A"},
  "colDef" : [
    {"column" : "sp_41 int null"},
    {"column" : "sp_57 int null"},
    {"column" : "vkm2 int null"}],
  "expName" : "BM@N",             // experiment name
  "expLogo" : "logo.png",        // experiment logo image
  "expUrl" : "https://bmn.jinr.ru", // URL to official experiment site
  "notifySend" : true,           // activate notification system
  ....
```



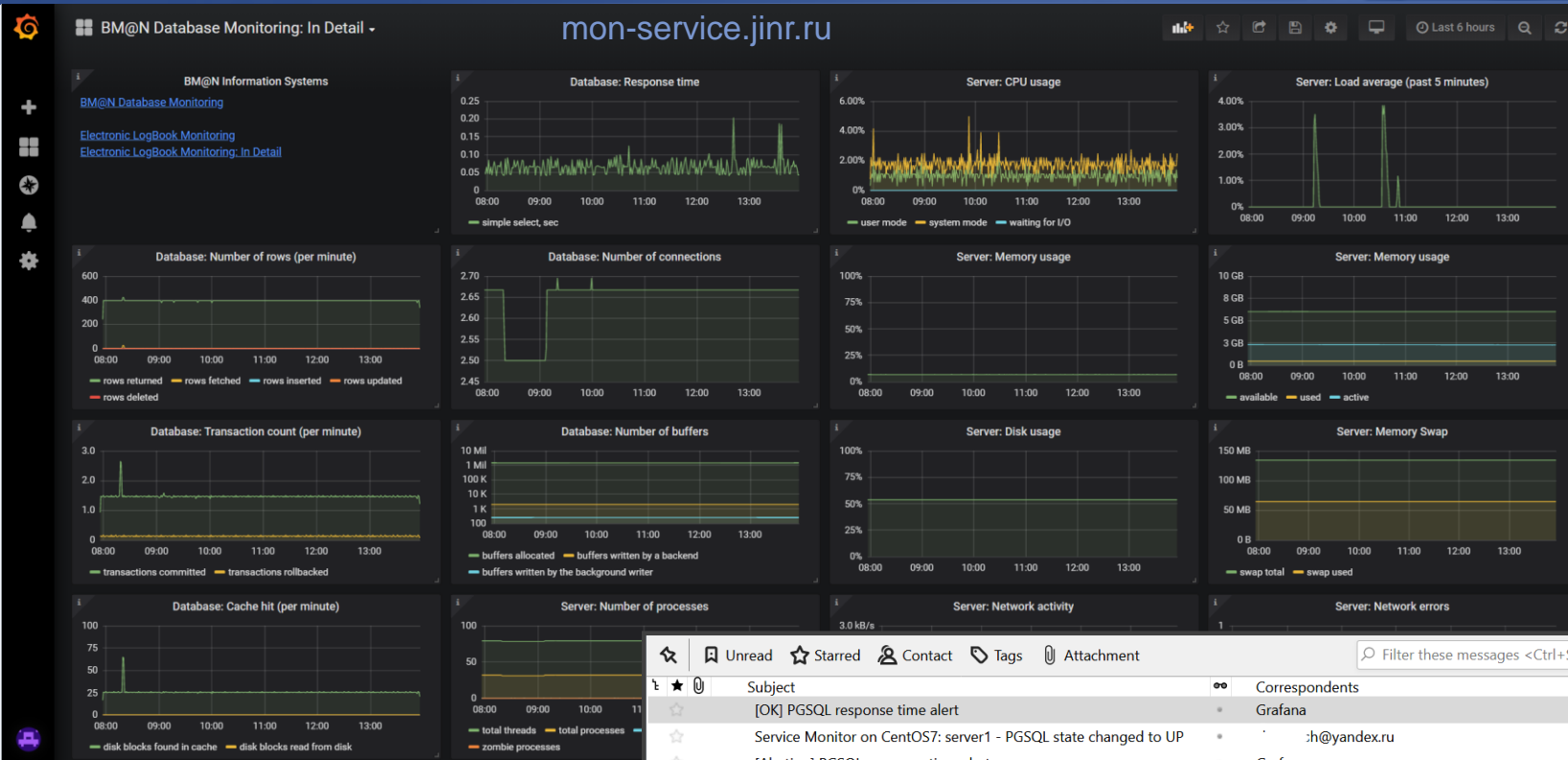
Deployment Scheme

The Common Deployment System is based on Docker containers and shell scripts

It allows to install the Electronic Logbook System for all the experiments of the NICA project taking into account some specifics of the experiments

Monitoring Information Systems

Grafana View



- Unified Database + detailed
- Electronic Logbook + detailed
- BM@N Web sites

Email Notifications

Unread Starred Contact Tags Attachment Filter these messages <Ctrl+Shift+K>

Subject	Correspondents	Date
[OK] PGSQL response time alert	Grafana	2:41 PM
Service Monitor on CentOS7: server1 - PGSQL state changed to UP	h@yandex.ru	2:40 PM
[Alerting] PGSQL response time alert	Grafana	2:01 PM
Service Monitor on CentOS7: server1 - PGSQL state changed to *** ...	h@yandex.ru	1:54 PM

From Grafana <h@yandex.ru> ☆
Subject [OK] PGSQL response time alert
To Me ☆

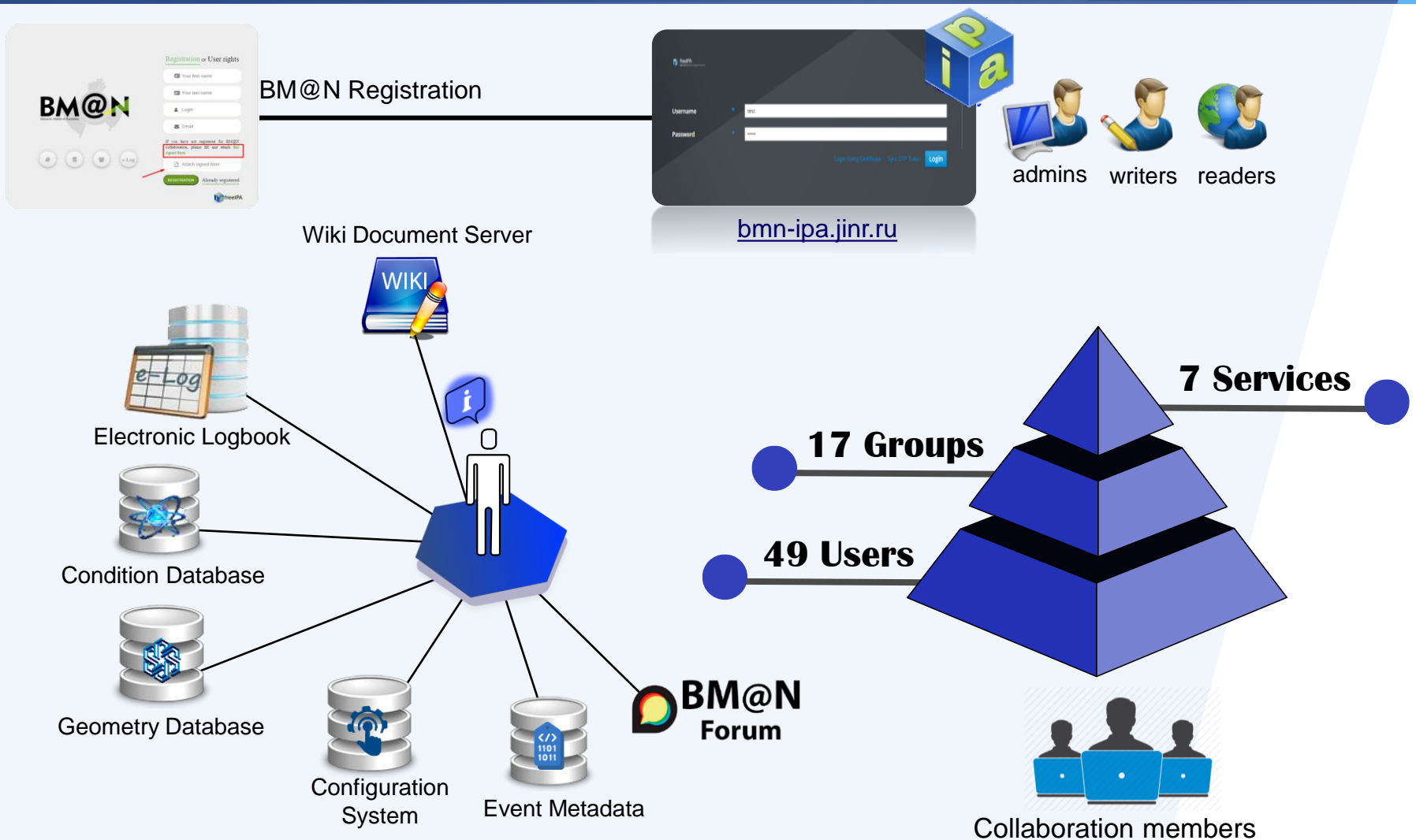
[OK] PGSQL response time alert

Grafana: Database monitoring warning!

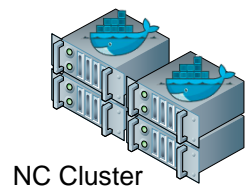
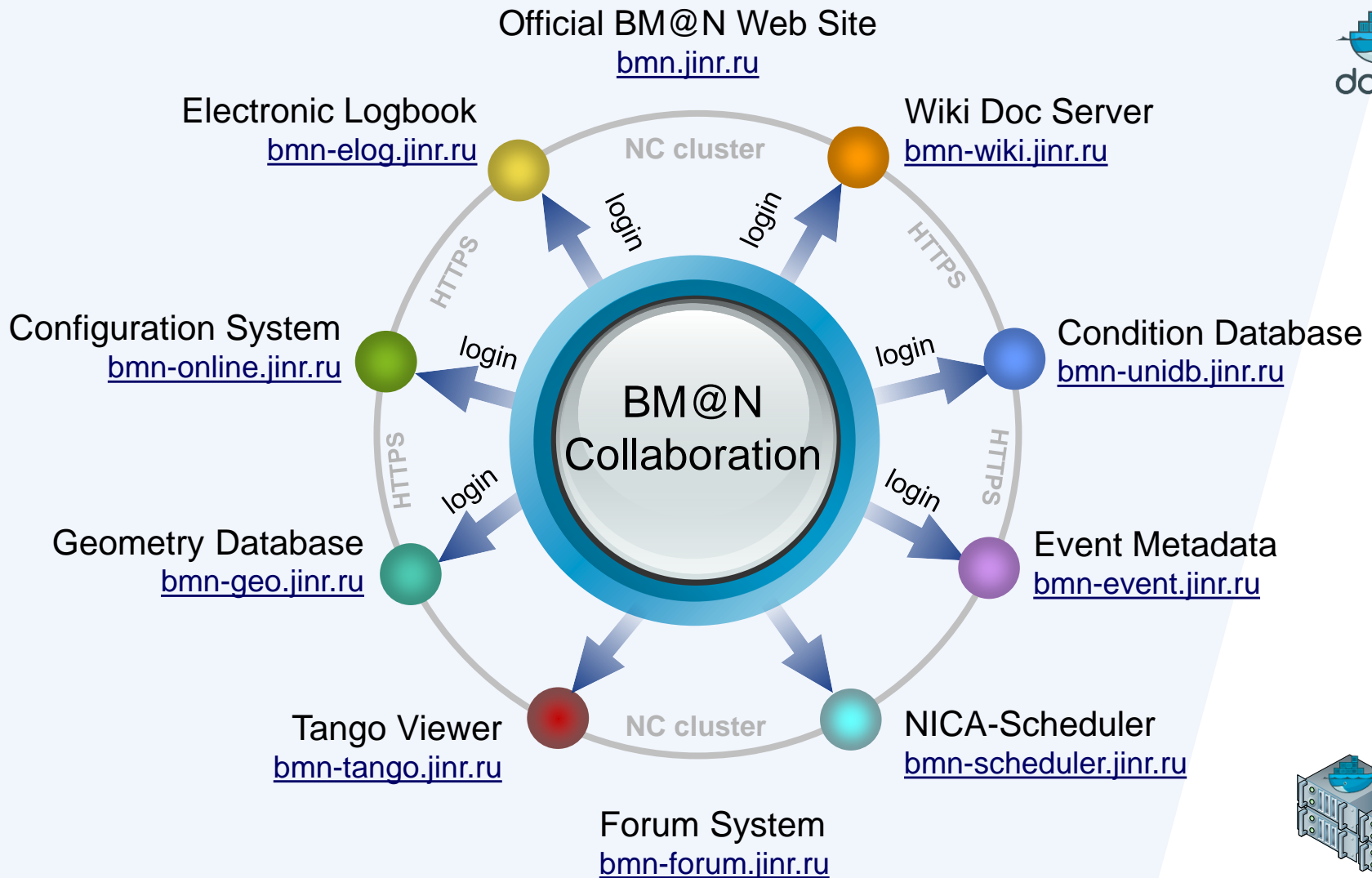
PGSQL response time

0.12

FreeIPA: Single Authentication & Authorization



Evolution of the BM@N Services



Distributed Processing and Computing Clusters

Status of Computing Clusters for BM@N

NICA Cluster
ncx[101-106].jinr.ru
(LHEP, b.216)



OS: CentOS 7.7
Exp. software: **CVMFS**
EOS: 1 PB (replicated)
GlusterFS: 116 (replicated)
SGE: 500 slots/user

MICC Tier1/2 Centre
lxui.jinr.ru
(LIT, b.134)



OS: Scientific Linux 7.9
Exp. software: **CVMFS**
EOS: 1 PB (replicated)
SLURM: *cicc* – 400 slots/user

HybriLIT platform (HPC Govorun)
hydra.jinr.ru
(LIT, b.134)

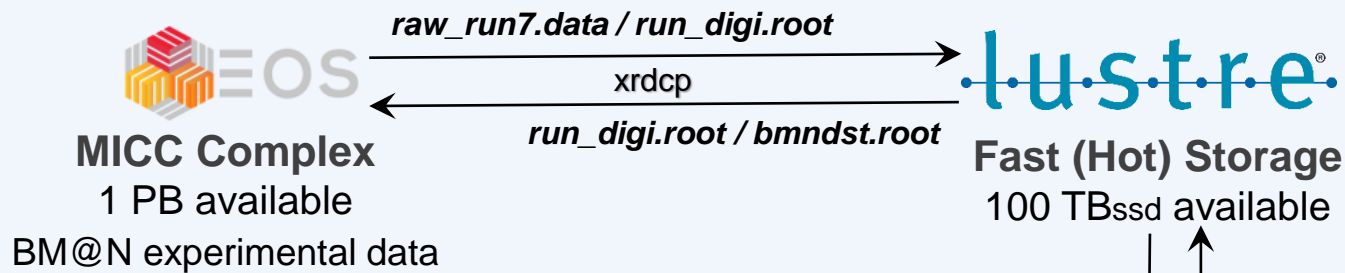


OS: Scientific Linux 7.9
Exp. software: **CVMFS, Modules**
ZFS: 280 TB,
Fast Storage on Lustre 100 TB_{ssd}
SLURM: *bmh* – 192 slots



All external packages for BmnRoot have been installed & configured in JINR CVMFS
Automatic software deployment of the BmnRoot on CVMFS with GIT CI

Mass production for BM@N Runs



Supercomputer
GOVORUN

NICA-Scheduler
\$ nica-scheduler
bmn_raw_run7_govorun.xml

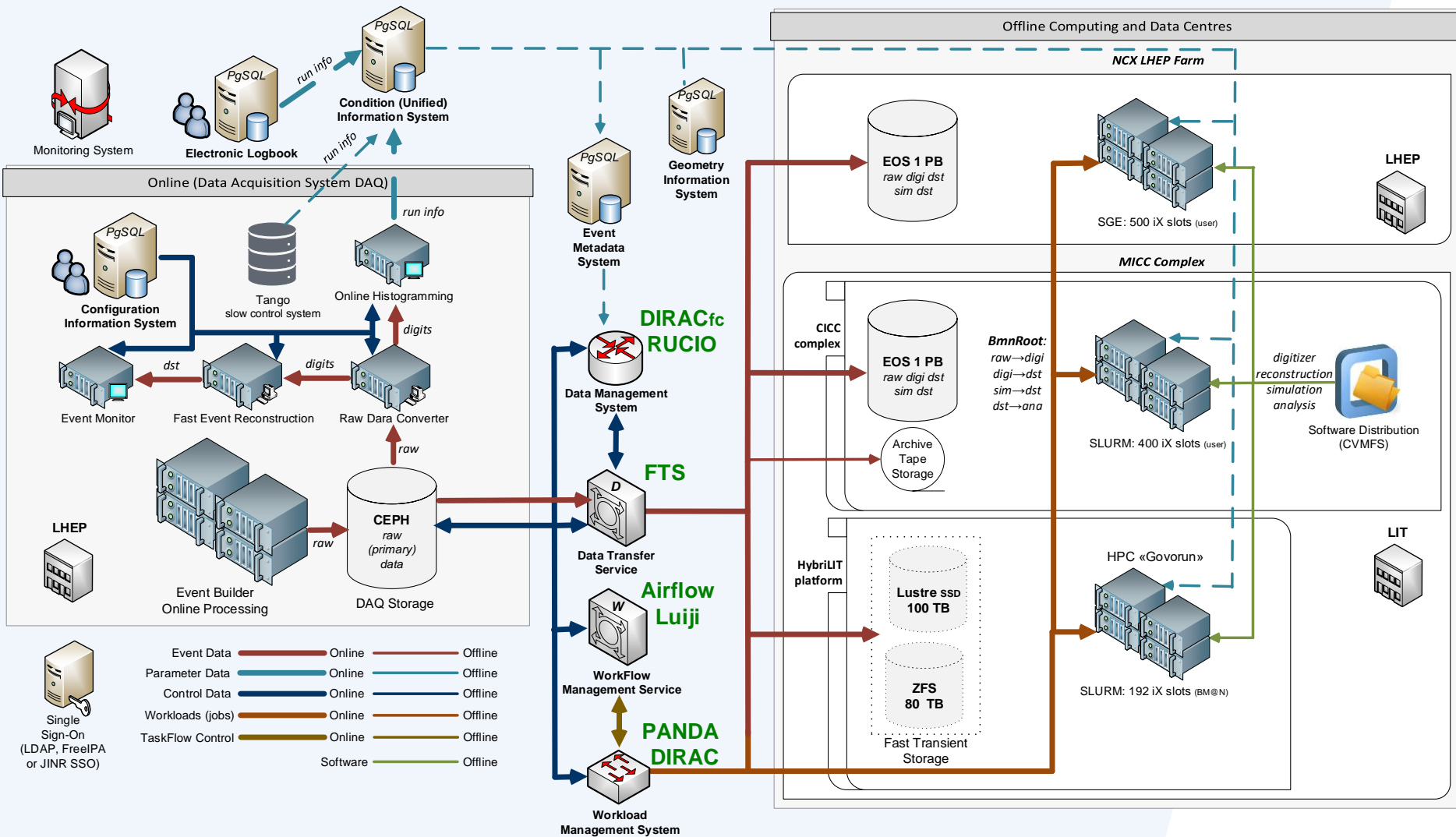
```
<job name="convert_bmn_raw">
<macro path=~ / bmnroot / macro / raw / BmnDataToRoot.C">
<file input="/eos/nica/bmn/exp/raw/run7/*">
<put command="xrdcp" path="/lustre/stor/${file_name_with_ext}"/>
<get command="xrdcp" path="/lustre/stor/bmn_run${last_number}_digi.root"
output="/eos/nica/bmn/exp/digi/run7/bmn_run${last_number}_digi.root"/>
</file>
</macro>
<run mode="global" count="200" config=~ / bmnroot / build / config.sh"
work_dir="/lustre/stor"/>
</job>
```



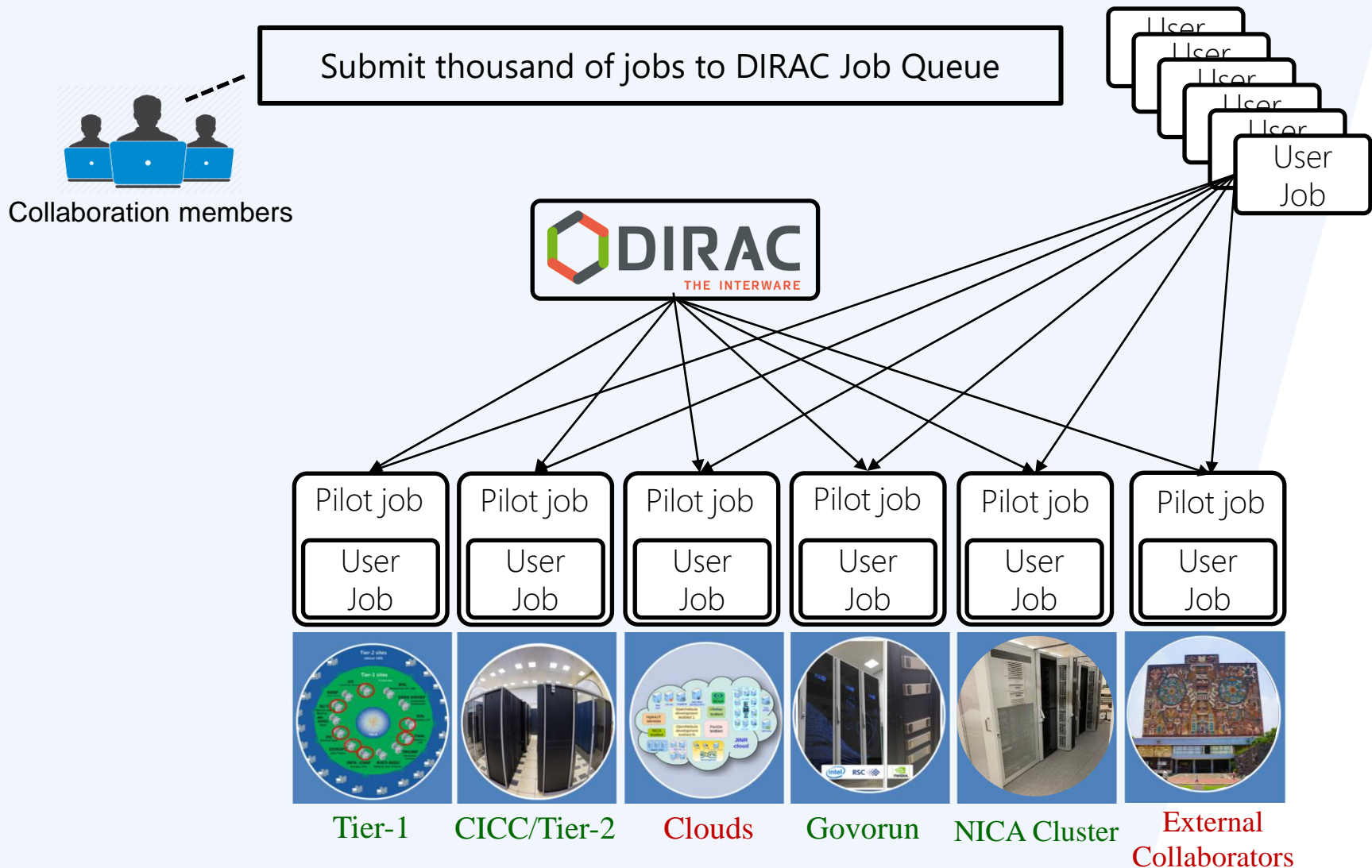
Intel Xeon Platinum (queue 'bmn'): 192 cores



BM@N Software – Computing Architecture



BM@N WorkFlow Services via DIRAC



BM@N event processing via DIRAC

Tier-1 CICC/Tier-2 Clouds Govorun NICA Cluster

	Tier-1	CICC/Tier-2	Clouds	Govorun	NICA Cluster
RawToDigit	Red	Red	Only with CVMFS	Green	Red
DigitToDst	Green	Green	Only with CVMFS	Green	Green
GenToSim	Green	Green	Only with CVMFS	Green	Green
SimToDst	Green	Green	Only with CVMFS	Green	Green

Total number of jobs: 18,900

Total wall time: 29 years Average duration: 13 hours

Quotas (cores):

Tier1: 920 (for NICA)

Tier2: 1000 (for NICA)

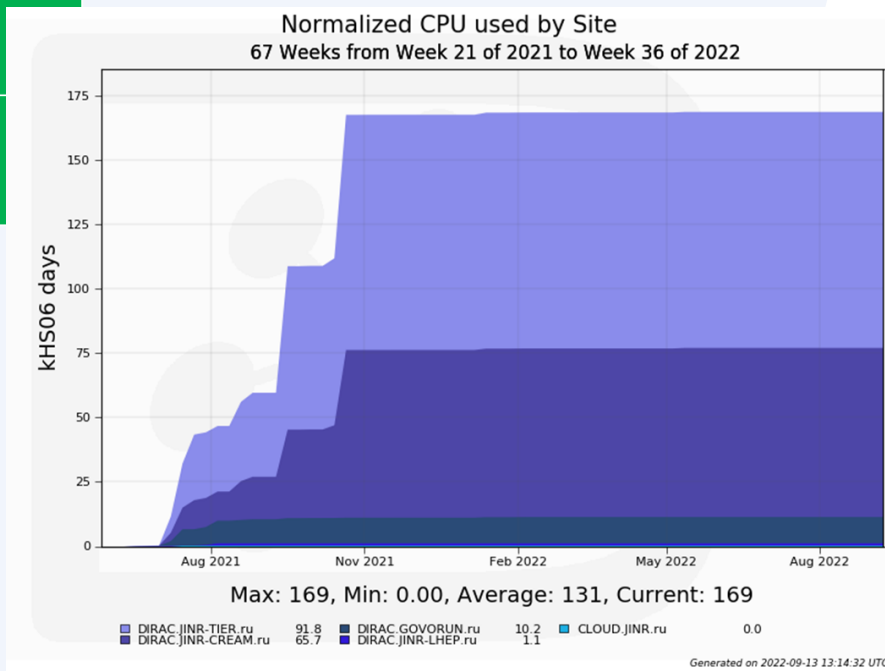
Govorun: 192 (BM@N)

NICA cluster: 250 (for NICA)

JINR Cloud: 90 (for JINR)

Members-states clouds: ~500 (for JINR)

number of running jobs exceeded 1600



Official BM@N Web-site: *bmn.jinr.ru*

BM@N COLLABORATION ▾ PHYSICS ▾ DETECTOR ▾ SOFTWARE ▾ COMPUTING ▾ WIKI FORUM VIDEOROOM

1st experiment of the NICA project

Official BM@N collaboration web-site

NICA web-site BM@N Project

git
BmnRoot code
BmnRoot GitLab repository

Unified Database
BM@N Offline Database

ReadMe first
BmnRoot Start Guide

- ✓ **Collaboration**
- ✓ **Information**
- ✓ **Documents**
- ✓ **Software**
- ✓ **Databases**
- ✓ **Computing Section (NICA Cluster, MICC Complex, HybriLIT & Govorun)**
- ✓ **Guides, Manuals**
- ✓ **Wiki**
- ✓ **Forum**
- ✓ **Webex rooms**
- ✓ **BM@N Mail-lists**
- ✓ **etc.**

Global Development Issues

Distributed and High-Performance Computing

Workload Manager and File Catalogue for Big Data: DIRAC, PanDA, RUCIO...
Using Docker technologies to organize and support data processing
Implementing Distributed Data Flow | Computing Performance Evaluation
Search-profiling-parallelizing: OpenMP, MPI, CUDA/OpenCL, RDataFrame...
NICA-Scheduler evolution

Visualization

Event Display as a Web-service: Offline & Online systems
Training course for the BM@N event display

Databases, User Interfaces and Services

Developing components of the Event Metadata System
Implementing new database features on C++ and ROOT 6, REST API
Database migration from SQL → NoSQL

Web-services & Online Systems

Implementation of Online and Offline Monitoring Systems
Distributed Processing via the Web-service...

Simulation and Reconstruction

Development of a miniDST format and data generation
Implementation of fast event reconstruction for online processing
Optimization of the BmnRoot framework...

Задачи квалификационных работ (часть)

- Разработка системы распределенного запуска и управления задачами эксперимента по высокоинтенсивной обработке данных при помощи платформы DIRAC (python).
- Внедрение Каталога файлов со смоделированными и экспериментальными данными эксперимента для реализации высокоинтенсивной обработки (RUCIO/DIRAC Catalogue)
- Разработка сервиса автоматизации распределенной обработки данных эксперимента VM@N (Apache Airflow, python).
- Использование докер-контейнерных технологий для организации и поддержки обработки данных эксперимента VM@N (Dockers, python).
- Разработка веб-сервиса визуализации событий столкновения частиц эксперимента (React, TypeScript, CERN ROOT || Phoenix Event Display).
- Разработка специализированного формата miniDST в эксперименте (C++, ROOT)
- Разработка и внедрение информационных систем на базах данных, сопутствующих интерфейсов (React, REST API) и сервисов. Перевод на NoSQL параметрической части.
- Развитие основного фреймворка VmnRoot, устранение проблем (C++, ROOT).
- Создание и внедрение полной методики оценки производительности существующих вычислительных платформ для эксперимента VM@N.

Thank you for your attention!

You are welcome to take an active part in the building of the great project in Dubna!

More information: bmn.jinr.ru
nica.jinr.ru

Email: gertsen@jinr.ru



We are open for young people!