



# 13<sup>th</sup> Collaboration Meeting of the BM@N Experiment at the NICA Facility



## BM@N Software Summary

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Joint Institute for Nuclear Research



8–10 October 2024



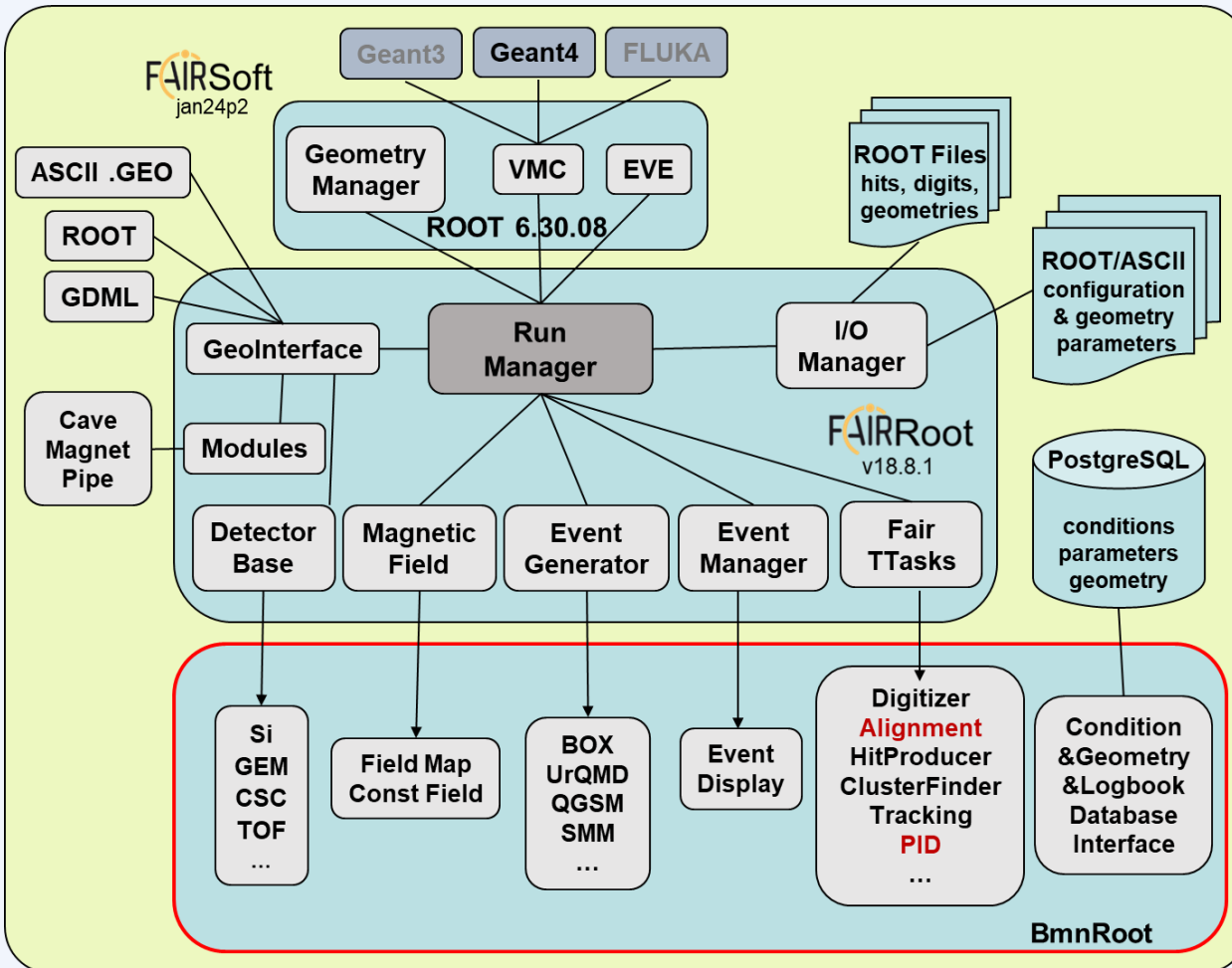
October 10, 2024

# BmnRoot. Production Tag 24.09.0

FAIRSoft  
jan24p2

FAIRRoot  
v18.8.1

- FairSoft jan24p2 is used now (with ROOT 6.32.08) instead of jan24 version
- FairRoot v19.0.0 is available but requires **new compilation** approach in BmnRoot



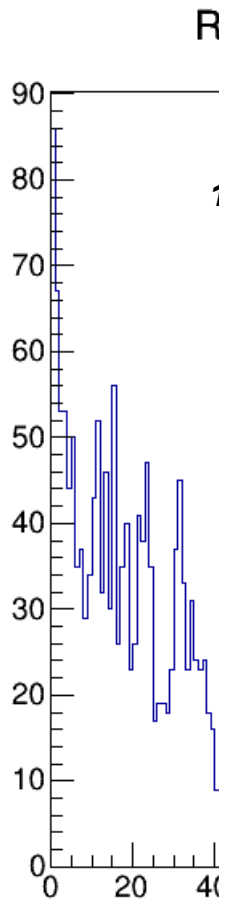
- Issue with the current FairSoft, FairRoot directory (.../bmn/) was corrected on the clusters
- The previous BmnRoot tag 24.04.0 has a serious bug in simulation (**with DCH**)
- New BmnRoot tag 24.09.0 has been created and is being tested with 10M data production
- *MCInfo* branch is a part of the DST<sub>sim</sub> format for using main MC data in physics analyses
- Most detector geometries were updated including the GEM geometry that crashes BM@N simulation
- VSP (Vertex Silicon Plane) was added for the next run

# BmnRoot. Spring Issues

- ✓ The current BM@N geometry is not passing standard ROOT tests (e.g. there are a lot of overlaps) and breaking both the simulation and reconstruction macro → **several overlaps**
- ✓ BmnRoot macros must contain common logic and parameters without local input parameters, user paths, hardcoded global parameters:
  - No default input parameters for a concrete user (but for production)
  - No inner logic for own local machine
  - No own local paths and local parametersSimple check of all the macros was integrated to the BM@N pipeline (night checks)
- ✓ Strict separation of short summary output (by default) from debug output for individuals (macro output should be adapted for mass production) → **solved**, **but new debug messages** *FairLogger::Severity* (debug level) or *fVerbose* flag (*SetVerbose* function) must be used
- ✓ A lot of compilation warnings (*after the update*) must be corrected → **solved**, **almost all**
- ✓ *ClassImp()* should be removed in the *cxx* files as obsolete → **solved**, **but new lines (TOF700)**
- ✓ SRC information will be removed from the BM@N databases → **not done yet**
- ✓ Raw Data Decoder should be fixed to write correct run and raw file metadata. New synchronization of the metadata is needed after → **metadata reprocessed and synced (e-Log)**

# Reprocessed Run Statistics

*root bmnroot/database/uni\_db/examples/run/show\_run\_stats.C*



Run time gap for Period 8

hist_run_diff	
Entries	1391
Mean	178.3
Std Dev	300.7

od 8

hist_stream_ev	
Entries	1558
Mean	457.8
Std Dev	289.4

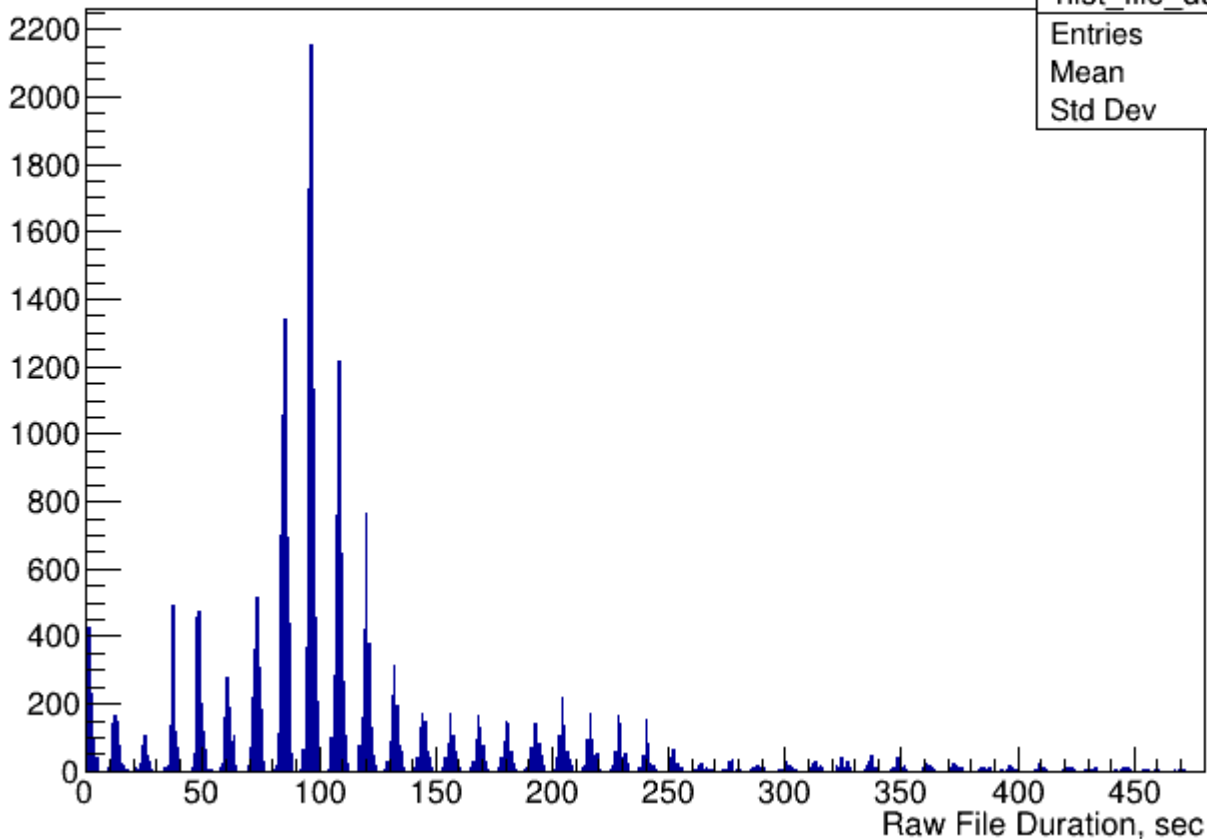
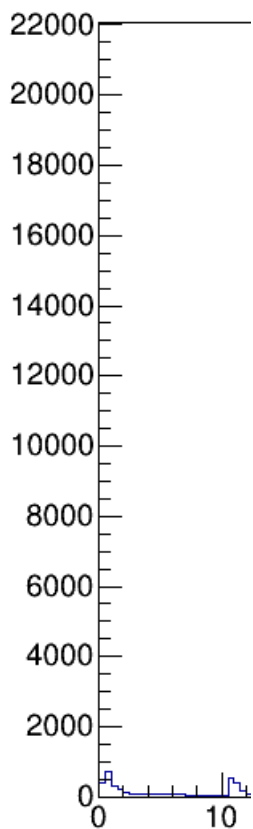
100 3000  
event/sec

# Reprocessed Raw Statistics

`root bmnroot/database/uni_db/examples/raw/show_raw_stats.C`

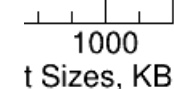
F

Raw file duration for Period 8



hist_file_duration	
Entries	30435
Mean	114.4
Std Dev	73.4

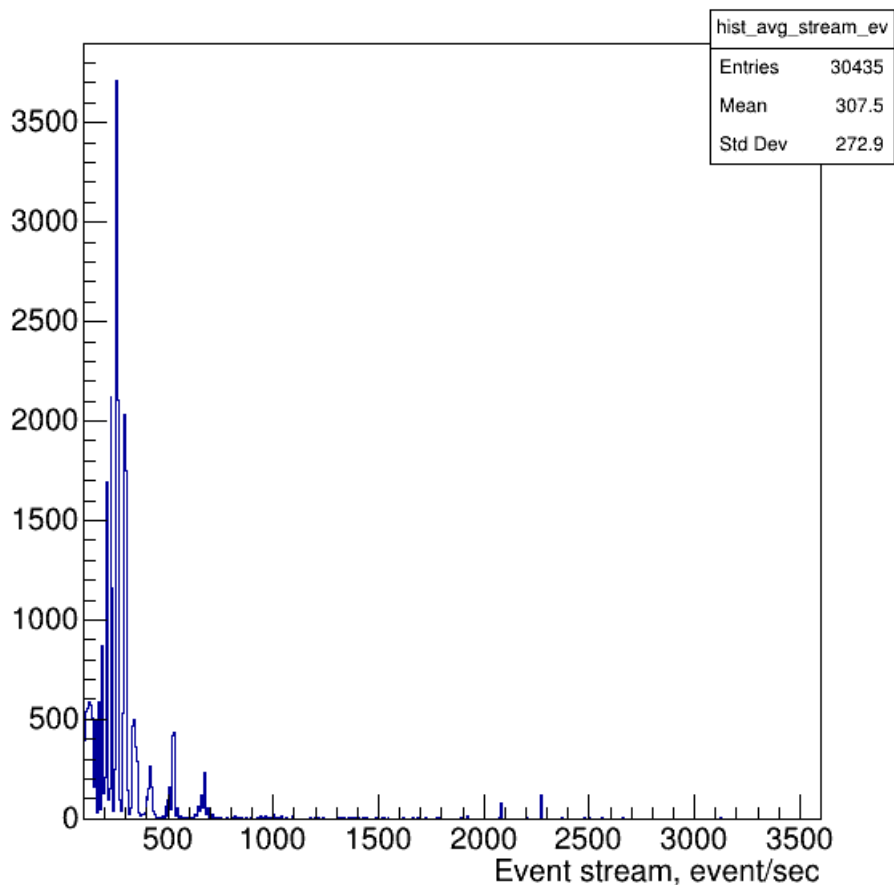
hist_event_size	
Entries	30435
Mean	578.6
Std Dev	64.99



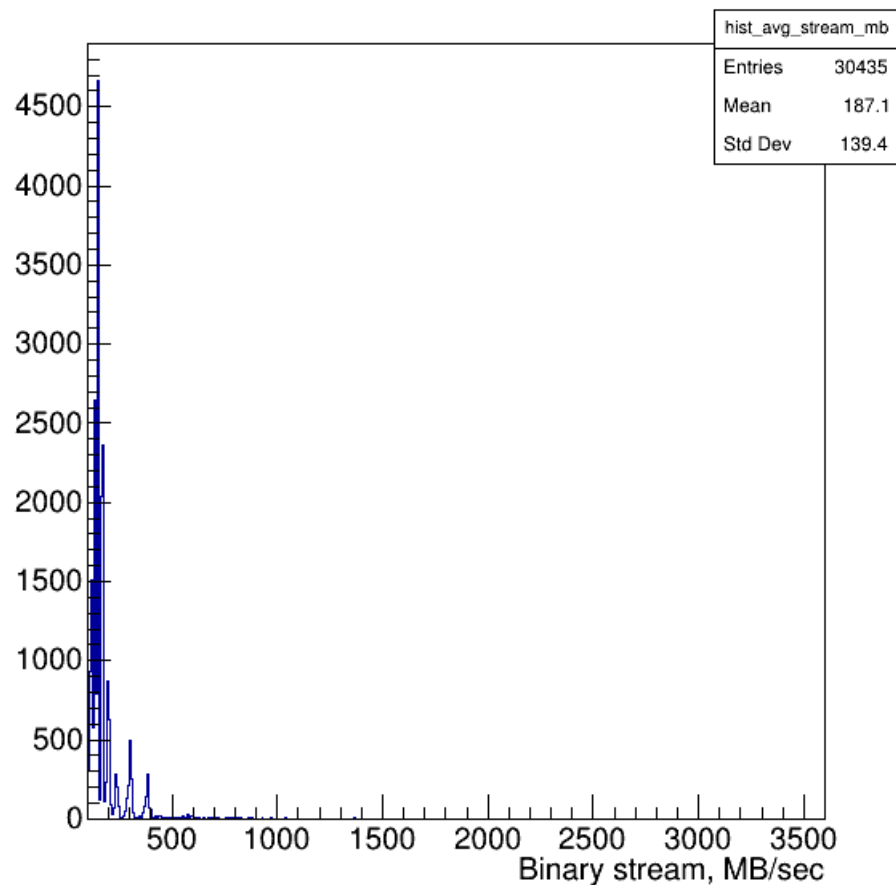
# Reprocessed Raw Statistics

*root bmnroot/database/uni\_db/examples/raw/show\_raw\_stats.C*

Event count per second for Period 8



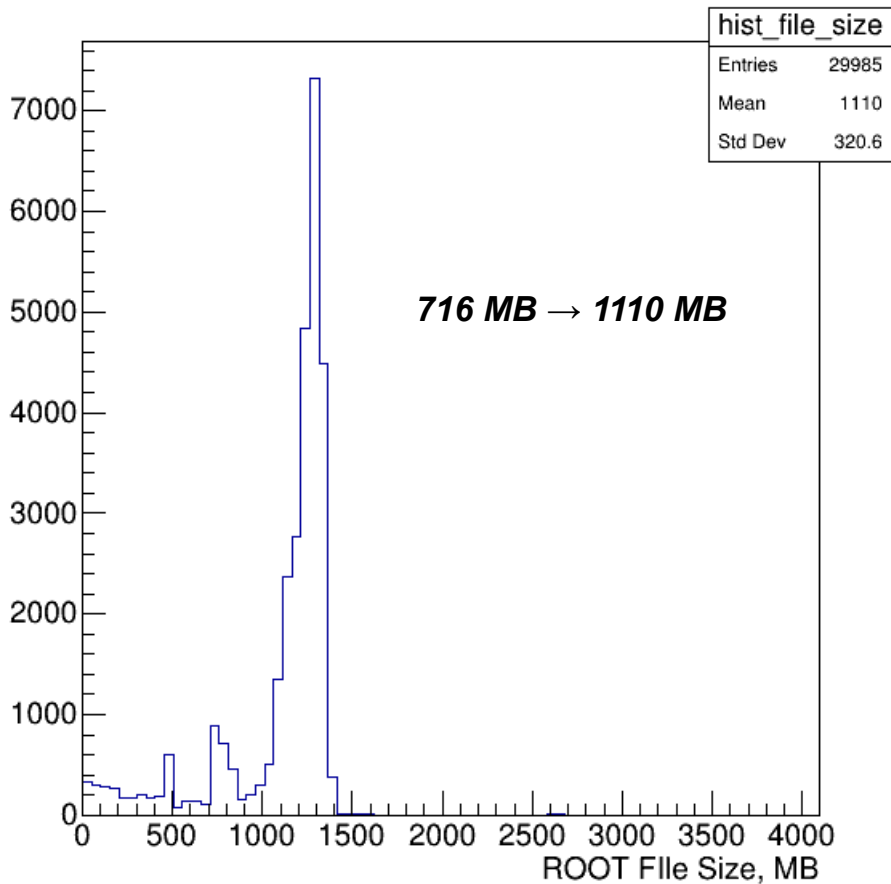
Megabytes per second for Period 8



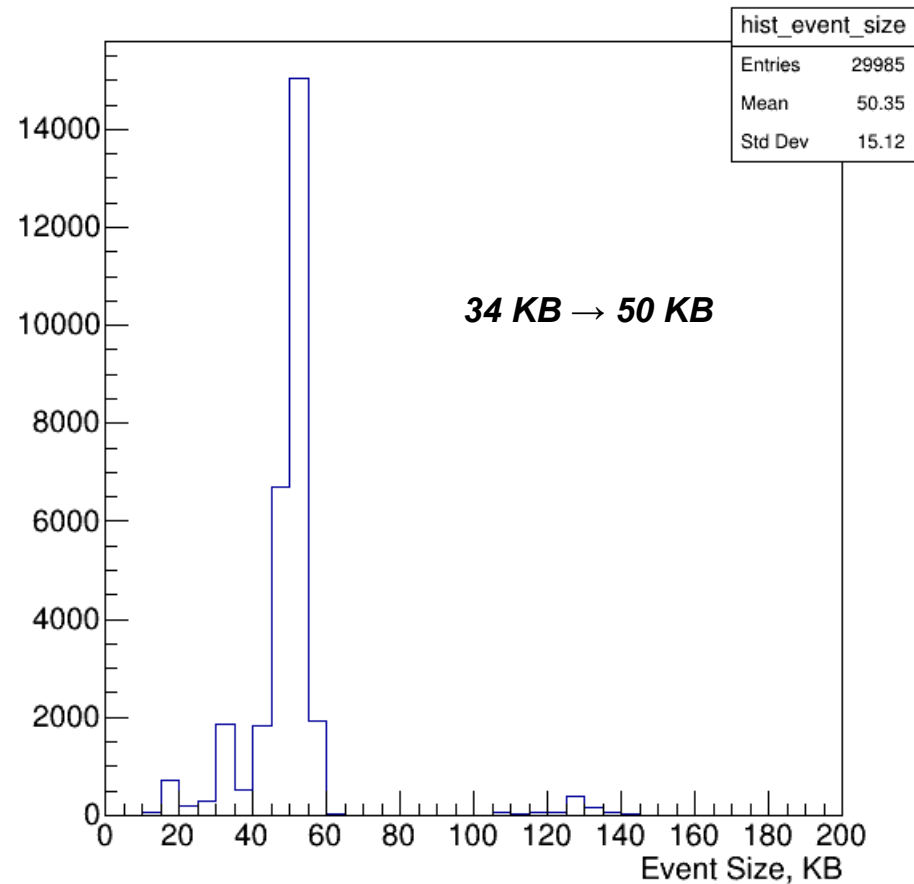
# Reprocessed DIGIT Statistics (24.04.0)

`root bmnroot/database/uni_db/examples/root/show_root_stats.C`

### DIGIT file size



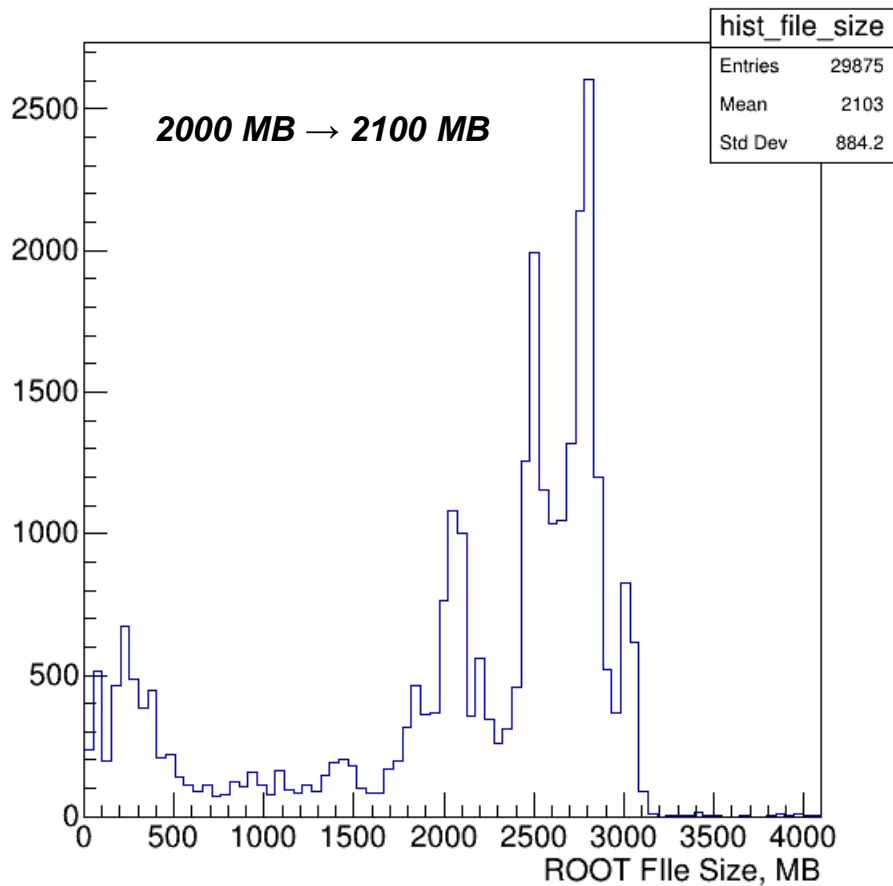
### DIGIT event size



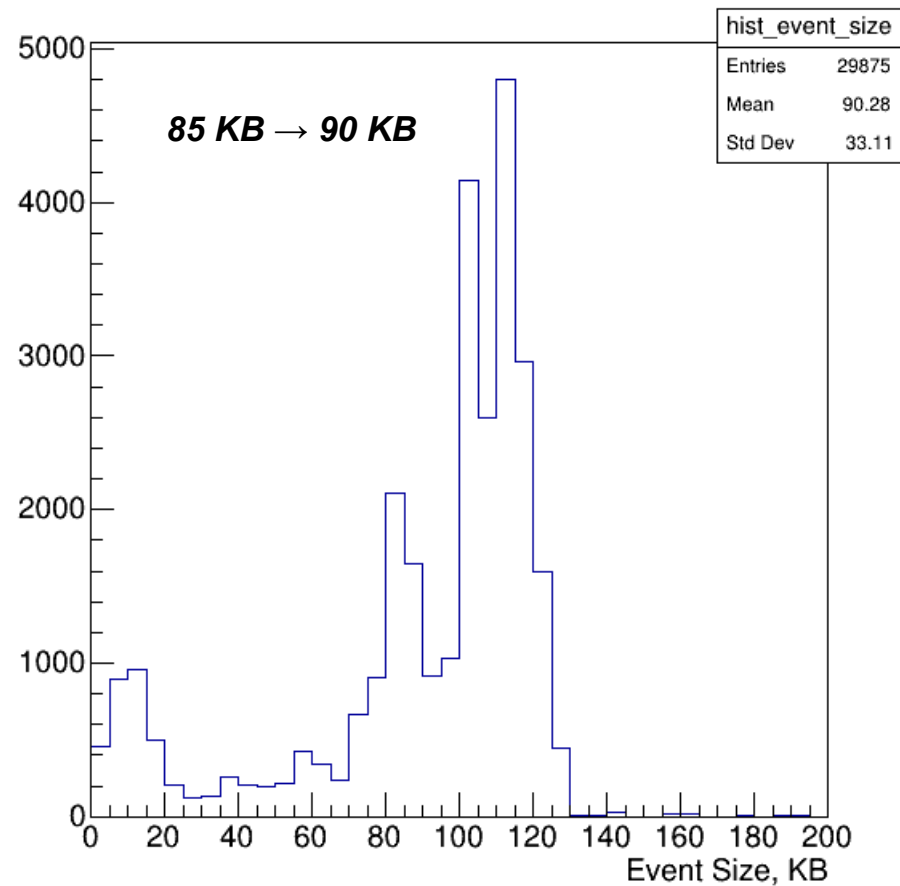
# Reprocessed DST Statistics (24.04.0)

`root bmnroot/database/uni_db/examples/root/show_root_stats.C`

### DST file size



### DST event size



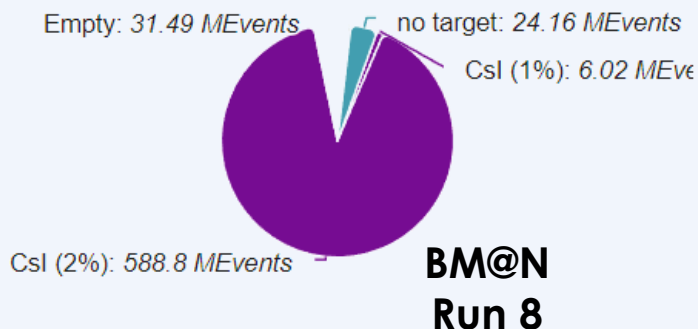


# Data Production in BM@N Physics Run

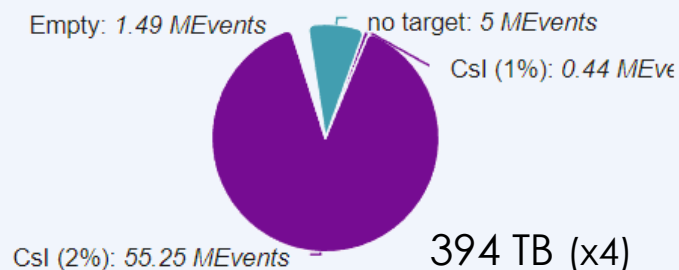
## 1<sup>st</sup> Physics BM@N Run

Two beam energy available for Xe-beam  
CsI target is used as more similar to Xe  
More than 600M events were collected

Beam Xe ( E = 3.8 GeV/n )  
Total: 652.48 MEvents



Beam Xe ( E = 3 GeV/n )  
Total: 62.19 MEvents

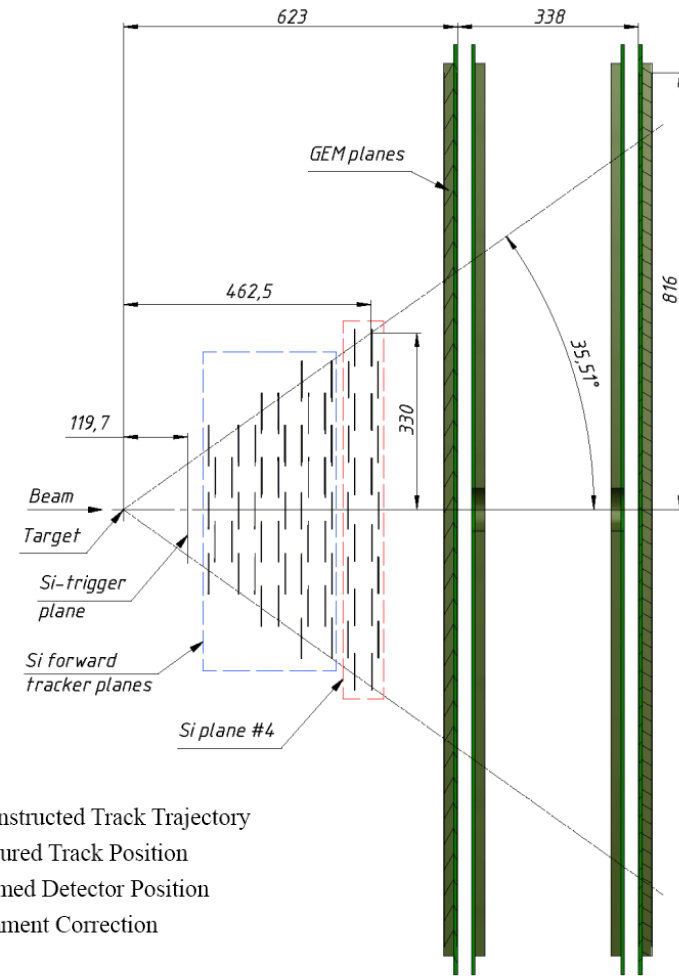
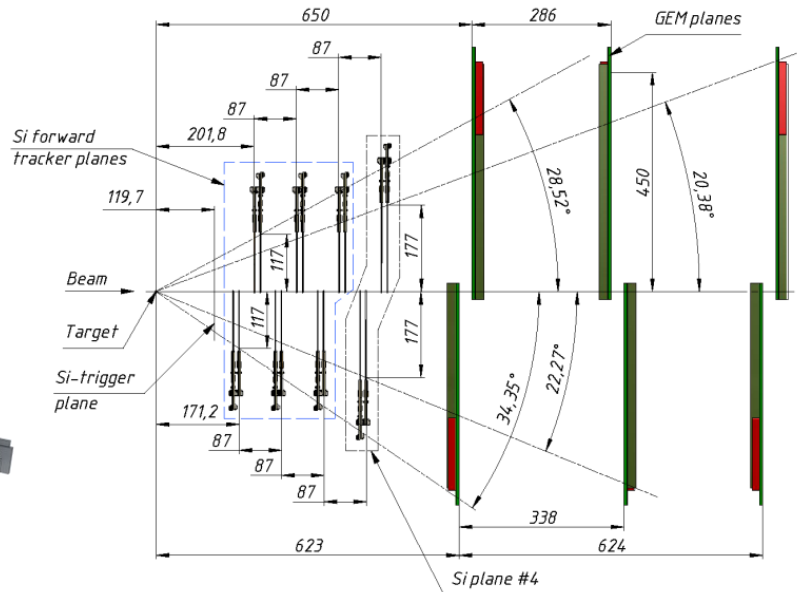
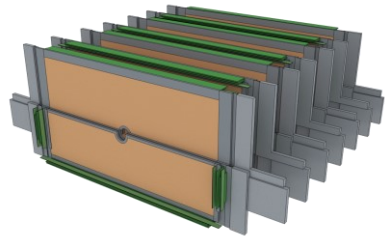


Parameter	Value (approx.)
<b>Data acquisition time</b>	<b>720 hours</b>
Average run duration	20 minutes
Average run time break	3 minutes
Beam intensity (3.8 AGeV)	up to 900k/2.2 Xe <sup>+</sup> /sec up to 900k/12 Xe <sup>+</sup> /sec
<b>Trigger rate</b>	<b>8 000/2.2 event/sec</b>
<b>Average event size</b>	<b>0,57 MB</b>
<b>Data rate</b>	<b>up to 3 GB/sec</b>
<b>Raw file size</b>	<b>15 GB (avg.13)</b>
Event count per file (with pedestals?)	25 000
<b>Total event count (+test, calibration, physics)</b>	<b>710 M</b>
Total file count (with tails)	30 753
Total run count	1 706
<b>Total raw data size</b>	<b>394 TB</b>
Total replicated raw data	1.6 PB
<b>Avg digit file size</b>	<b>1 100 MB</b>
<b>Avg DST file size</b>	<b>2 100 MB</b>

# BmnRoot. *Detector Alignment*

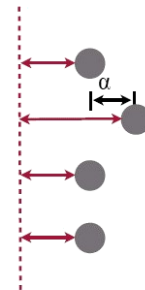
## Alignment Tools

- IMSL Fortran Library
- Eigen
- Millepede-II



$S_2$	0	0	0	0	$S_1$	0	0	0	0	$Z_2$	$Z_3$	$Z_4$	$Z_5$
0	$S_2$	0	0	0	0	$S_1$	0	0	0	$Z_2$	$Z_3$	$Z_4$	$Z_5$
0	0	$S_2$	0	0	0	0	$S_1$	0	0	$Z_2$	$Z_3$	$Z_4$	$Z_5$
0	0	0	$S_2$	0	0	0	0	$S_1$	0	$Z_2$	$Z_3$	$Z_4$	$Z_5$
0	0	0	0	$S_2$	0	0	0	0	$S_1$	$Z_2$	$Z_3$	$Z_4$	$Z_5$
$S_1$	0	0	0	0	$N_d$	0	0	0	0	1	1	1	1
0	$S_1$	0	0	0	0	$N_d$	0	0	0	1	1	1	1
0	0	$S_1$	0	0	0	0	$N_d$	0	0	1	1	1	1
0	0	0	$S_1$	0	0	0	0	$N_d$	0	1	1	1	1
0	0	0	0	$S_1$	0	0	0	0	$N_d$	1	1	1	1
$Z_2$	$Z_2$	$Z_2$	$Z_2$	$Z_2$	1	1	1	1	1	$N_t$	0	0	0
$Z_3$	$Z_3$	$Z_3$	$Z_3$	$Z_3$	1	1	1	1	1	0	$N_t$	0	0
$Z_4$	$Z_4$	$Z_4$	$Z_4$	$Z_4$	1	1	1	1	1	0	0	$N_t$	0
$Z_5$	$Z_5$	$Z_5$	$Z_5$	$Z_5$	1	1	1	1	1	0	0	0	$N_t$

$Ax_1^0 z_2$	$Ax_1^0 z_3$	$Ax_1^0 z_4$	...
$Ax_2^0 z_2$	$Ax_2^0 z_3$	$Ax_2^0 z_4$	...
...	...	...	...
$Ax_1^0$	$Ax_1^0$	$Ax_1^0$	...
$Ax_2^0$	$Ax_2^0$	$Ax_2^0$	...
...	...	...	...
$\sum_i Ax_i^0$	0	...	...
0	$\sum_i Ax_i^0$	...	...
...	...	$\sum_i Ax_i^0$	...



- - - Reconstructed Track Trajectory
- - - Measured Track Position
- Assumed Detector Position
- $\alpha$  - Alignment Correction

# Software Management & Distribution System

## GIT Pipelines on Merge Requests

- checking compilation and main macros
  - stable dev & pro branches, all tags
- deploy BmnRoot to the CVMFS storage
- deploy BmnRoot containers to the registry
- checking Clang code formatting

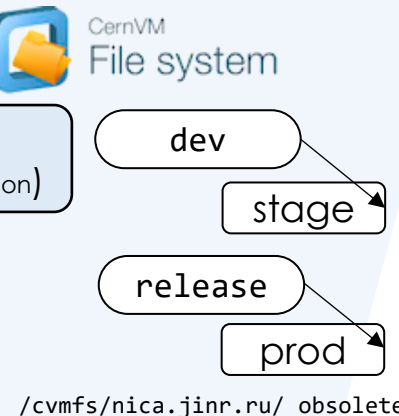
## GIT Night Tests

- test all BmnRoot macros
- test all C++ files for correct code format
- generate Doxygen documentation  
(<http://nica.pages.jinr.ru/bmnroot>)

## Software Distribution via CernVM File System

```

/cvmfs/bmn.jinr.ru/
├── centos7
│   ├── fairsoft
│   ├── fairroot
│   └── bmnroot
├── ubuntu2004
│   ├── fairsoft
│   ├── fairroot
│   └── bmnroot
└── alma9
    ├── fairsoft
    ├── fairroot
    └── bmnroot
    
```



NICA / bmnroot / Pipelines / #61482

**clang-format files**

Passed Konstantin Gertsenberger created pipeline for commit @ad8f7da 21 hours ago, finished 21 hours ago

Related merge request 11294 to merge tango\_improving

latest merge request 6017 jobs 19 minutes 14 seconds, queued for 1 seconds

Pipeline Needs Jobs 17 Tests 0

*Format Checker added to tests*

Group jobs by Stage Job dependencies

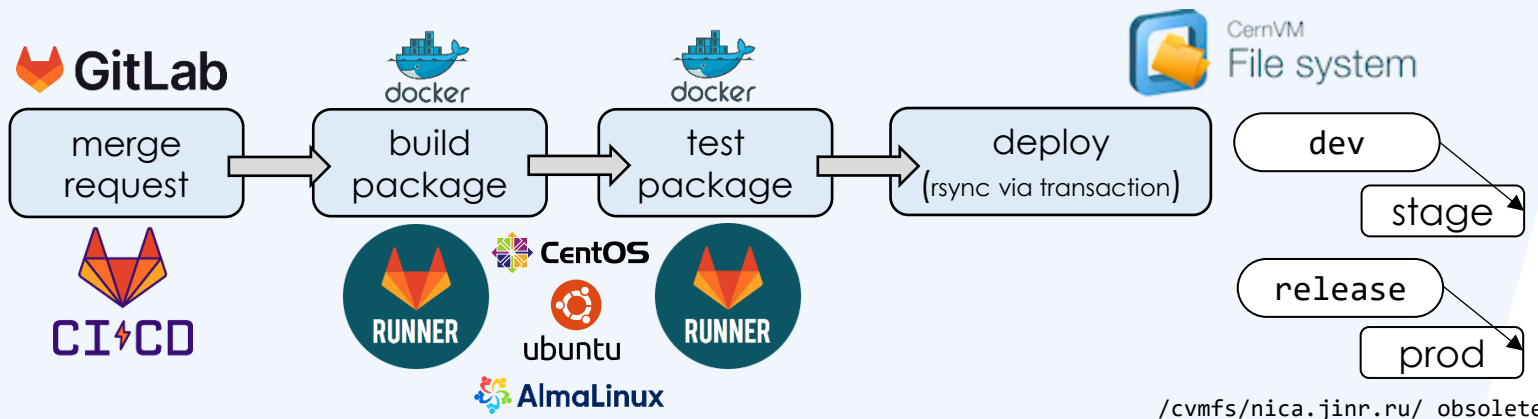
check_permissions check_permissions	check_formatting check_formatting_mr	build build:alma9 build:centos build:ubuntu	test_form_digi run_raw_bmn:alma9 run_raw_bmn:centos run_raw_bmn:ubuntu run_sim_bmn:alma9 run_sim_bmn:centos run_sim_bmn:ubuntu	test_run_reco run_reco_exp:alma9 run_reco_exp:centos run_reco_exp:ubuntu run_reco_sim:alma9 run_reco_sim:centos run_reco_sim:ubuntu
--	---	--	--	---

Project information

Simulation and Analysis Framework for the BM@N experiment of the NICA project

pipeline passed failed macros 356 unformatted files 1983

*macros test format test*



# Code Style (Format) Checker

## clang-format files

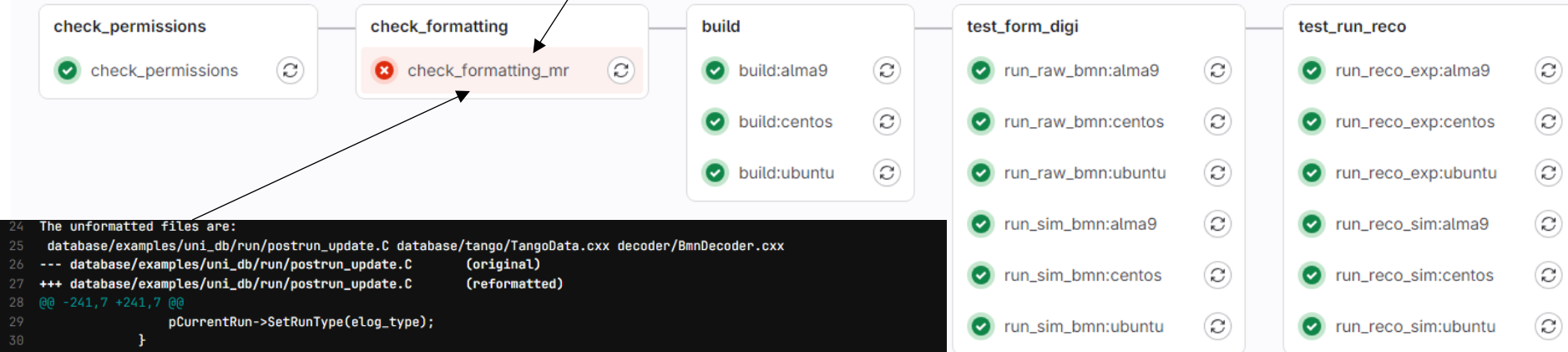
✖ Failed Konstantin Gertsenberger created pipeline for commit d77e16c3

Related merge request 11294 to merge tango\_improving

merge request @ 17 jobs ⌚ 30 minutes 8 seconds, queued for 1 seconds

Pipeline Needs Jobs 17 Failed Jobs 1 Tests 0

Group jobs by Stage Job dependencies



Code Checker added Unformatted label 1 day ago

Code Checker @project\_25\_bot\_7b91abf2d5f15e4b78377bd261dd93b8 · 1 day ago

Developer

Dear @gertsen, you have submitted unformatted files. To format them, please run the following command in your bmnrow directory:

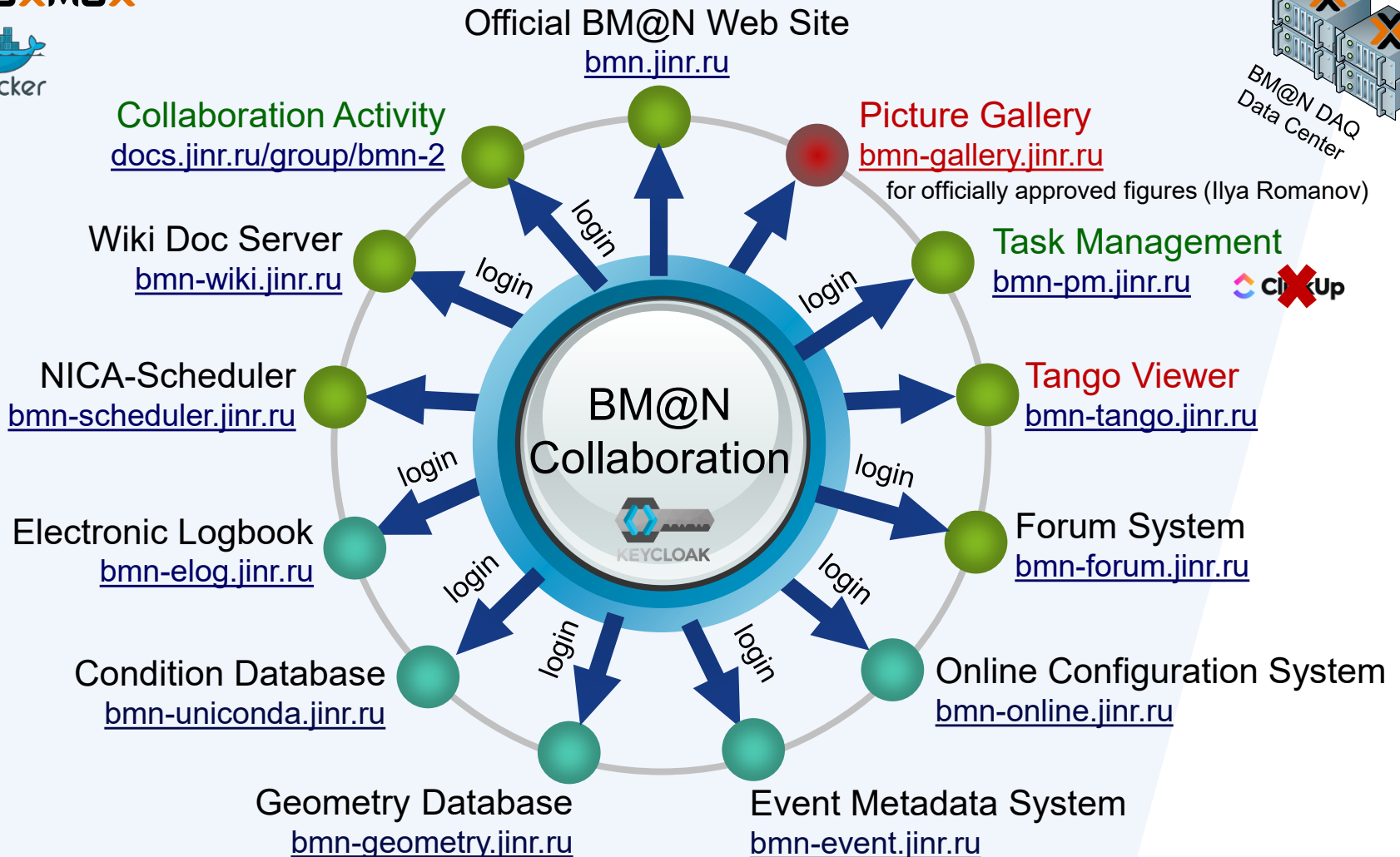
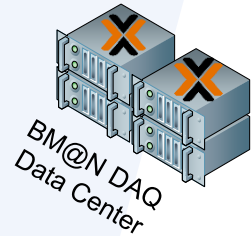
```
clang-format -i database/examples/uni_db/run/postrun_update.C database/tango/TangoData.cxx database/tango/TangoData.h database/tango/examples/show_avg_field.C database/tango/examples/tango_gem_trip.C database/tango/examples/tango_gem_u.C decoder/BmnConverter.cxx decoder/BmnDecoder.cxx decoder/BmnRawDataDecoder.cxx
```

You can check the required changes in the [job log](#) or the full [clang-format log](#).

```
24 The unformatted files are:
25 database/examples/uni_db/run/postrun_update.C database/tango/TangoData.cxx decoder/BmnDecoder.cxx
26 --- database/examples/uni_db/run/postrun_update.C (original)
27 +++ database/examples/uni_db/run/postrun_update.C (reformatted)
28 @@ -241,7 +241,7 @@
29     pCurrentRun->SetRunType(eLog_type);
30 }
31 } // if ((run_beam == "") || (run_target == nullptr) || (run_energy == nullptr) || (run_field == nullptr))
32 - } // for (int i = 0; i < run_count; i++)
33 + } // for (int i = 0; i < run_count; i++)
34
35 return 0;
36 }
37 --- database/tango/TangoData.cxx (original)
38 +++ database/tango/TangoData.cxx (reformatted)
39 @@ -810,7 +810,7 @@
40 }
41 }
42 } // for (int j = 0; j < pParameter->bool_parameter_value.size(); j++)
43 - } // for (int i = 0; i < arrTangoData->GetEntriesFast(); i++)
44 + } // for (int i = 0; i < arrTangoData->GetEntriesFast(); i++)
45
```

12<sup>th</sup> Collaboration Meeting  
Nikita Balashov (May 16, 10:25 AT)  
Automated BM@N Software Distribution and  
Testing: Current Status

# BM@N Software Ecosystem



# Presentation and Report (DocsDB) Server

The screenshot displays the DocsDB Reports interface. The top navigation bar shows the user is logged in as 'EN' and is viewing the 'Reports' section for 'BM@N'. The sidebar menu includes options for Reports, Manage, Topics, Keywords, Document Types, and Settings. The main content area shows a list of reports with columns for #, Title, Authors, and Last Update. A detailed view of a report is shown on the left, including basic information (Year: 2022, Document Title: Studies of dense baryonic matter with the BM@N experiment at the Nuclotron) and authors (Sergei Merts, Speaker). The bottom right corner features a blue box with the text: '12th Collaboration Meeting Ivan Sokolov (May 16, 10:40 AT) Storage Service for Scientific Documentation'.

**Reports**  
Project ID: 36  
+ NEW DOCUMENT

Reports of the BM@N collaboration at the scientific events

Hide Column Filter

Search

# Keywords Document Type Topics Description Abstract Authors Created at Last Update Template

#	Title	Authors	Last Update
90-v0	Studies of dense baryonic matter with the BM@N experiment at the Nuclotron	Sergei Merts	about 2 months ago
	iduals study in MonteCarlo simulation for Run 6 at the BM@N experiment	Ksenia Alishina	about 2 months ago
	d target BM@N experiment for studies of heavy nucleus interactions at NICA	P. Batyuk	about 2 months ago
	f the GEM tracking system at the BM@N experiment	Andrei Galavanov	about 2 months ago
	f the GEM/CSC tracking system of the BM@N experiment	Elena Kulish	about 2 months ago
	льная трековая система эксперимента BM@N	Андрей Галаванов	about 2 months ago
	BM@N: reconstruction of tracks upstream and downstream the target using PC and Silicon detector systems	Vasilisa Lenivenko	about 2 months ago
	vertex reconstruction in the BM@N experiment	N. Kakhanovskaya et al.	about 2 months ago
	a-driven readout system for the wide aperture Silicon Tracking System of I@N experiment	Dmitrii Dementev	about 2 months ago
	rd readout electronics for BM@N STS	Mikhail Shitenkov et al.	about 2 months ago

Records per page: 10 1-10 of 48

**Editors**  
Chebotov Aleksandr  
chebotov@jinr.ru

**Basic information**

**Year:**  
2022

**Document Title:**  
Studies of dense baryonic matter with the BM@N experiment at the Nuclotron

**Authors:**  
Sergei Merts  
merts@jinr.ru  
Speaker

**Conference information**

**Conference name:**  
NUCLEUS-2022

**Link to conference:**  
CS-NUCLEUS-2022

12<sup>th</sup> Collaboration Meeting  
Ivan Sokolov (May 16, 10:40 AT)  
Storage Service for Scientific Documentation

# Project Management System for BM@N Software

S Software G

All Issues

New Issue

Home Notifications

Workspace

All Issues

Projects

Active Cycles

Analytics

Settings

My projects

RECO-1 Implementation of Particle  
RECO-2 Global BM@N Alignment  
RECO-3 Remove tmp files while  
RECO-4 Disable LOG(INFO) from  
RECO-5 Remove all\_XXX.par fro

Home Notifications

Workspace

All Issues

Projects

Active Cycles

Analytics

Settings

My projects

BmnRoot Framework

Computing

Event Reconstruction

Community

Issues	State	Priority	Assignees	Labels	Start date	Due date
BMNRO-2 Correcting error and warning messages while simul...	Todo	Medium	Assignees		May 22, 2021	Mar 31, 2025
BMNRO-1 Correcting memory leaks in BmnRoot simulation and...	In Progress	High	Assignees		Jun 30, 2022	Nov 30, 2024
COMPU-2 Study and check DIRAC scripts	Done	Medium	isjironn		Jun 30, 2023	Feb 29, 2024
COMPU-1 Implementation of BM@N File Catalogue on DIRACf...	In Progress	Medium	isjironn		Jan 20, 2022	Dec 31, 2024

Analytics

Scope and Demand Custom Analytics

Total open tasks: 8

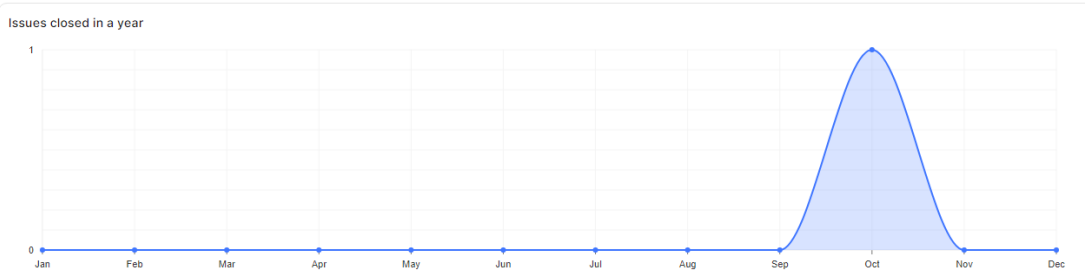
- Started: 4 (44%)
- Unstarted: 4 (44%)

Pending issues: 1 (Unassigned: 7)

Most issues created: 9 (gertson)

Most issues closed: 1 (isjironn)

Issues closed in a year





- ❖ Self-Hosted
- ❖ Advanced Interface
- ❖ Progress Tracking

# TANGO (Slow Control System) Viewer

BM@N Slow Control Viewer

Tango Parameter

Dictionary  Custom

Domain: bmn

Family: daq

Member: ups

Name: batterytemperature

Run Selector

Run  Time

Start Time: 02.04.2018 16:30:56

End Time: 02.04.2018 18:00:44

RESET SHOW

[bmn-tango.jinr.ru](http://bmn-tango.jinr.ru) bmn/daq/ups/batterytemperature

Old Tango Viewer by the team

Updated version of Tango slow control database uses PostgreSQL

Convenient REST API service has been developed (supports gRPC)



REST API request example

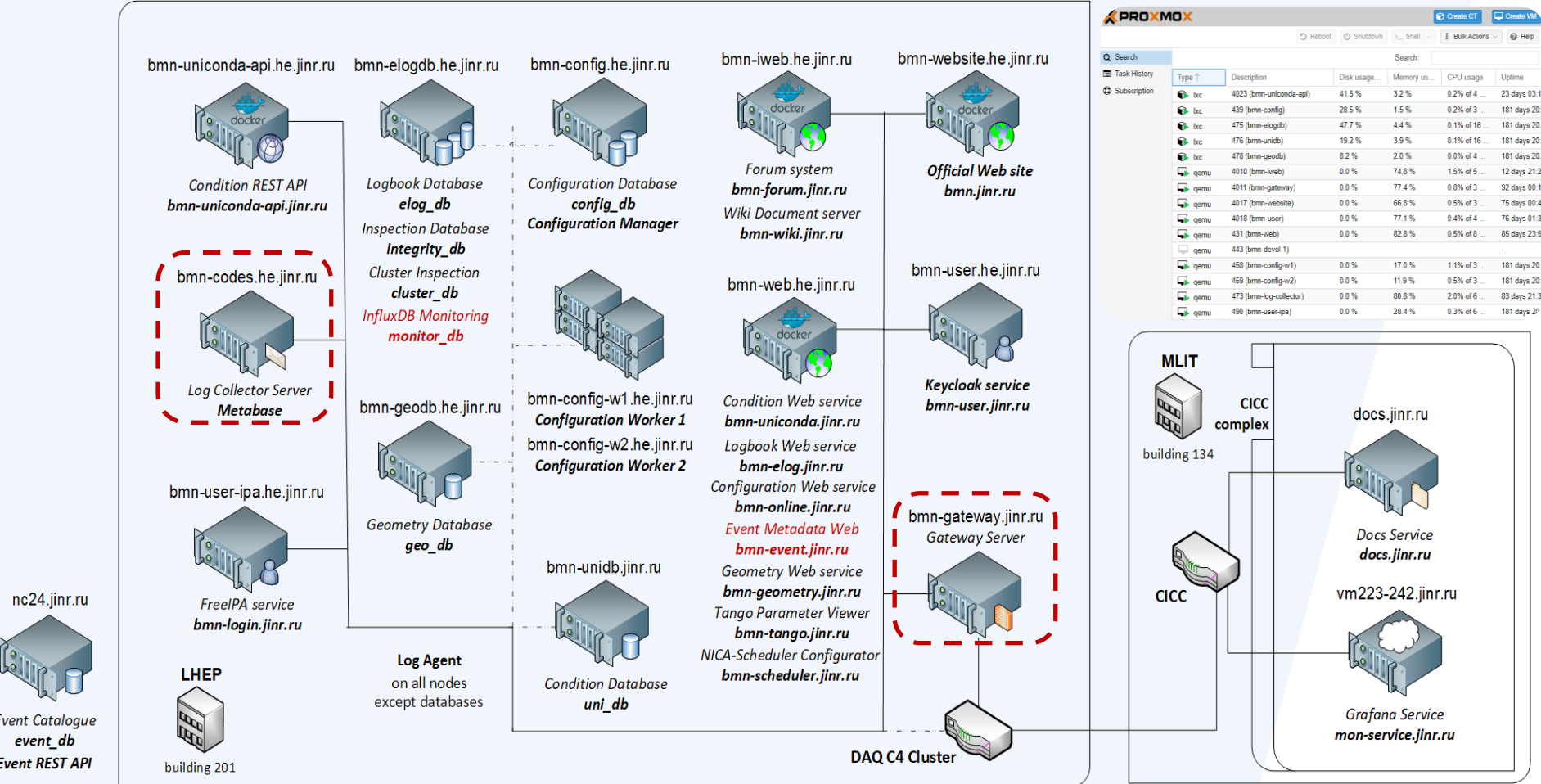
```
https://<host>:7000/tango-api/v1/parameter?system_name=bmn&parameter_name=temperature&member_name=pir230e_1&start_time=2021-11-26&end_time=2021-11-27
```

- Web-based Viewer for SCS hardware parameters
- Shows sensor data graph based on run number or time interval, and parameter name (dictionary or custom set)
- If a parameter is 1D array, in this case a multigraph is displayed
- Uses Dash framework and packed in Docker container



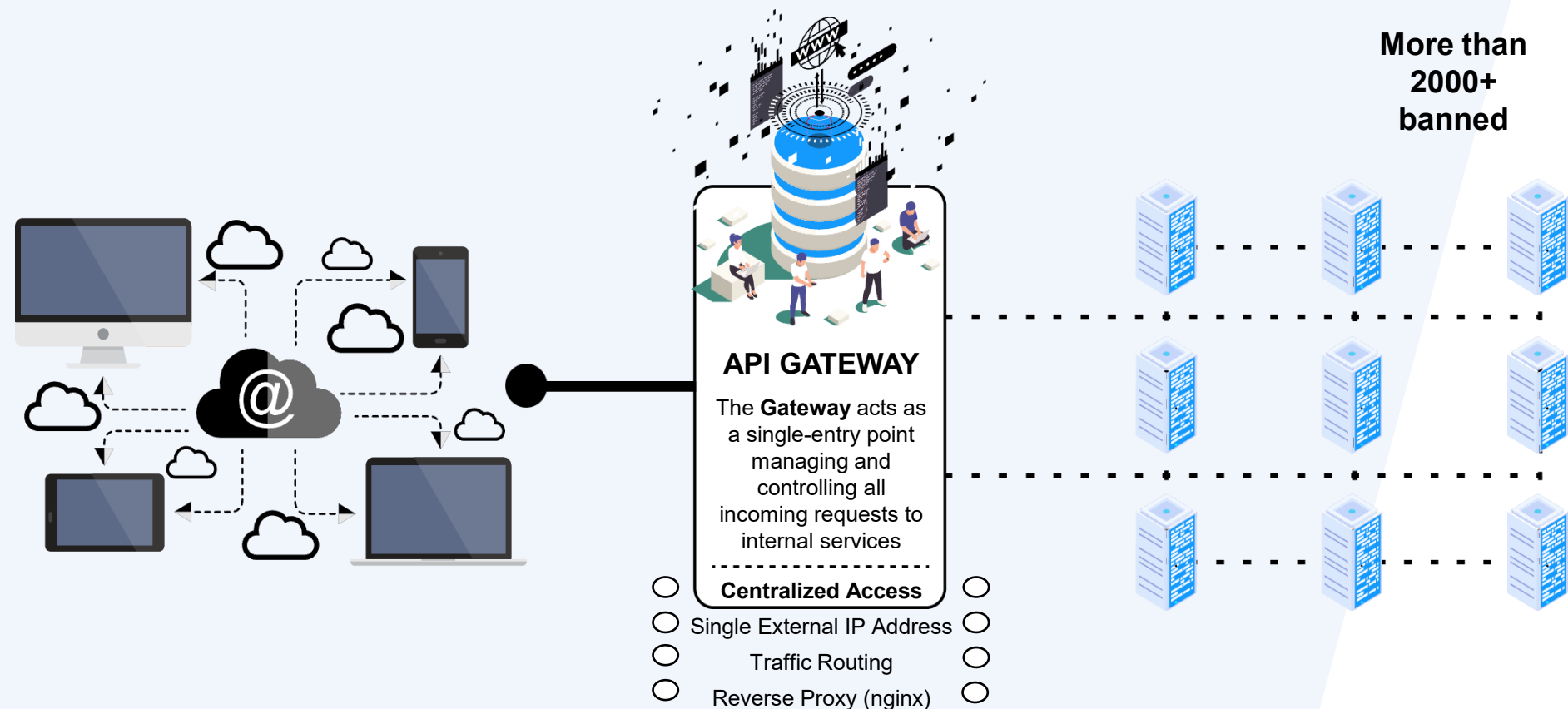


# BM@N Services. Migration to BM@N Online Farm



DAQ C4 Cluster (*administrators: Ilya Slepnev and DAQ team*) uses Proxmox, virtualization and resource management platform that allows one to create VMs and containers using virtualization technologies such as KVM for VMs and LXC (Linux Containers) for containers.

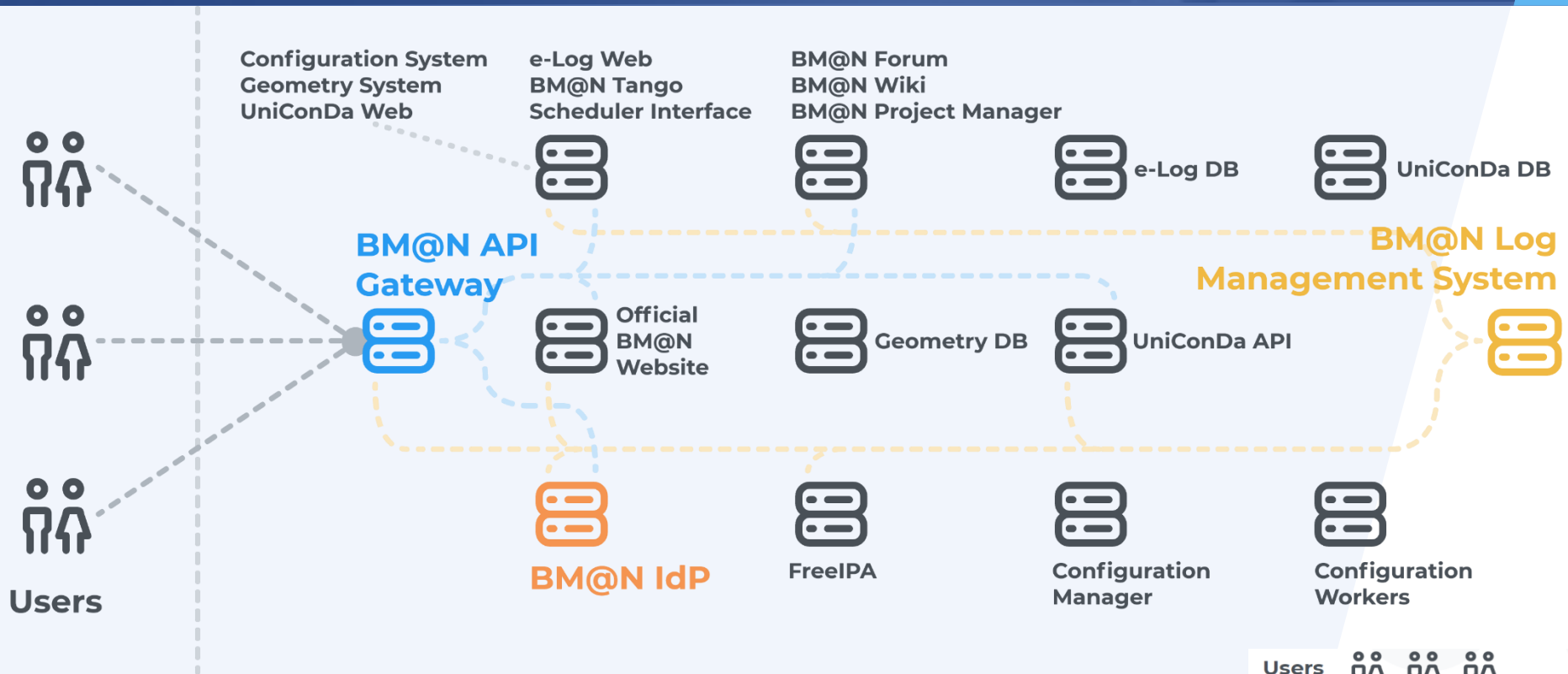
# BM@N Gateway as a new security protection



- Enhanced Security
- Traffic Protection and Filtering
- Simplified Traffic Management
- Centralized Logging and Monitoring

- ❖ IPTABLES: Traffic filtering at the Linux kernel level
- ❖ Fail2Ban: Automated IP blocking on suspicious activity

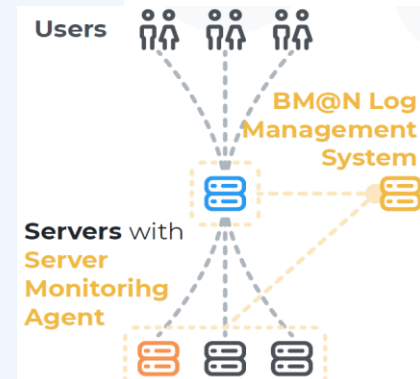
# BM@N Log Management System



The utilization of the [BM@N API Gateway](#) as a single-entry point enables the collection of access logs for all systems in a single location.

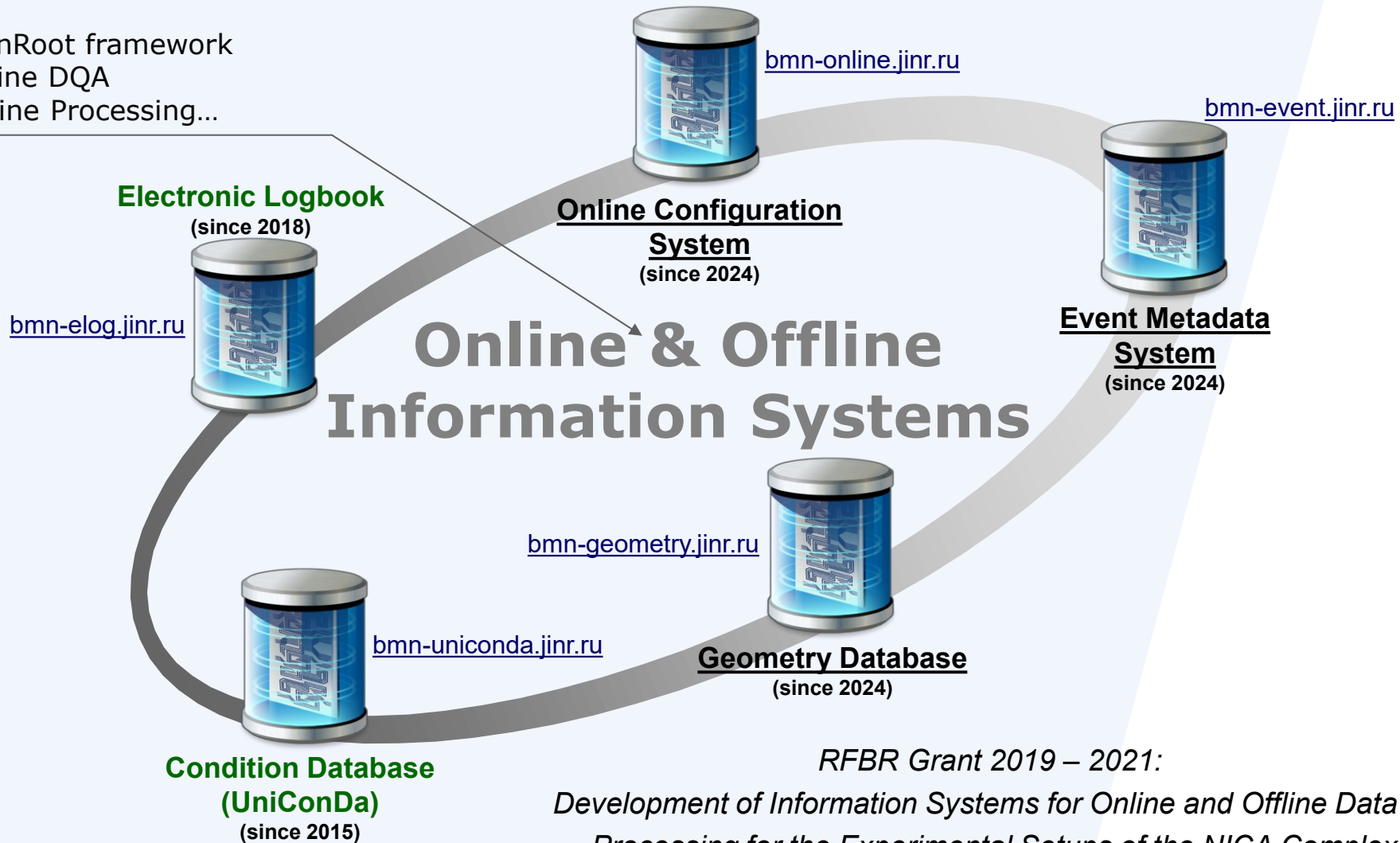
The [Server Monitoring Agent](#) has been developed to monitor the operation of the BM@N servers and collects data from the auth.log file

The [Log Management System](#) helps to quickly identify and fix security issues, making the BM@N infrastructure more resilient.

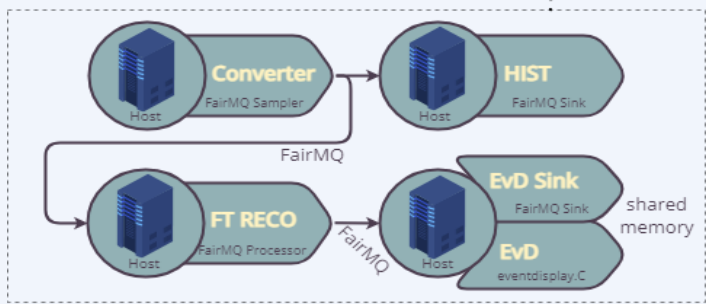
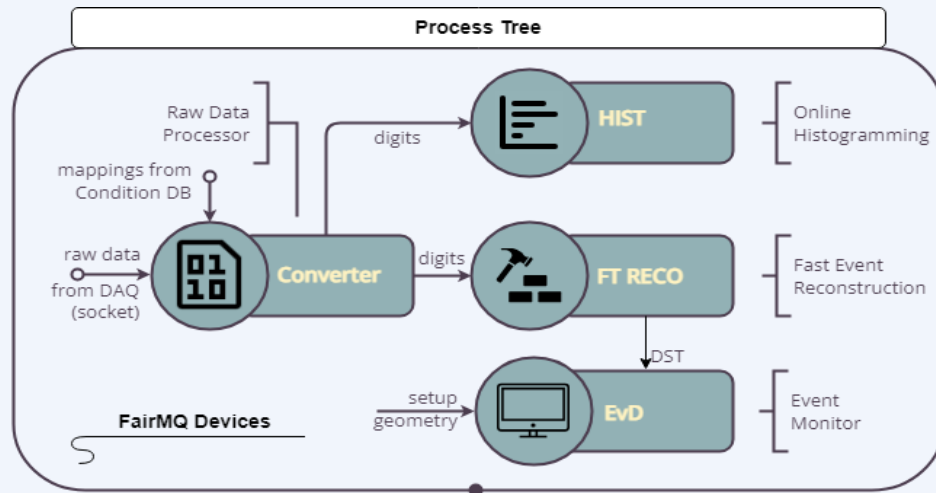
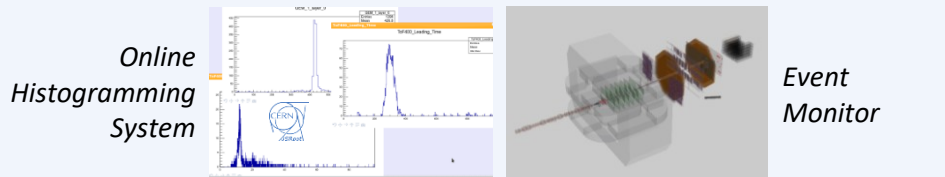


# Complex of BM@N Information Systems

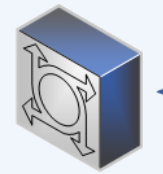
BmnRoot framework  
Online DQA  
Offline Processing...



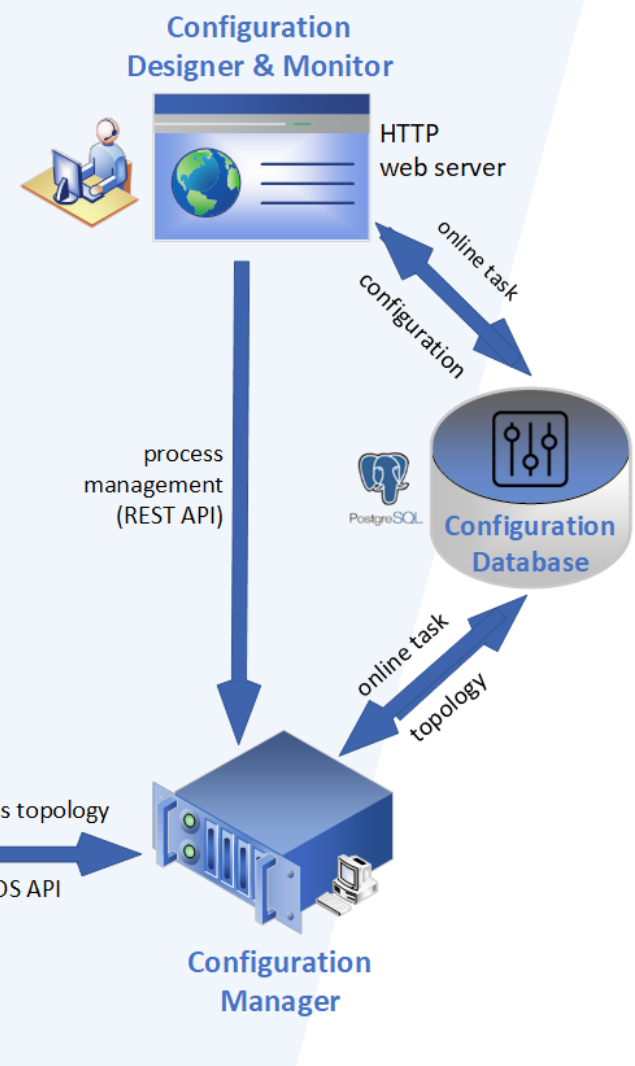
# BM@N Online Configuration Platform



start/stop control  
keep alive



process topology  
DDS API



# Geometry Database

## Menu

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[VIEW GEOMETRY FILES](#)

[VIEW MATERIALS](#)

[VIEW MAGNETIC FIELDS](#)

EDIT GEOMETRY

## Get in touch

[✉ Konstantin Gertsenberger](#)

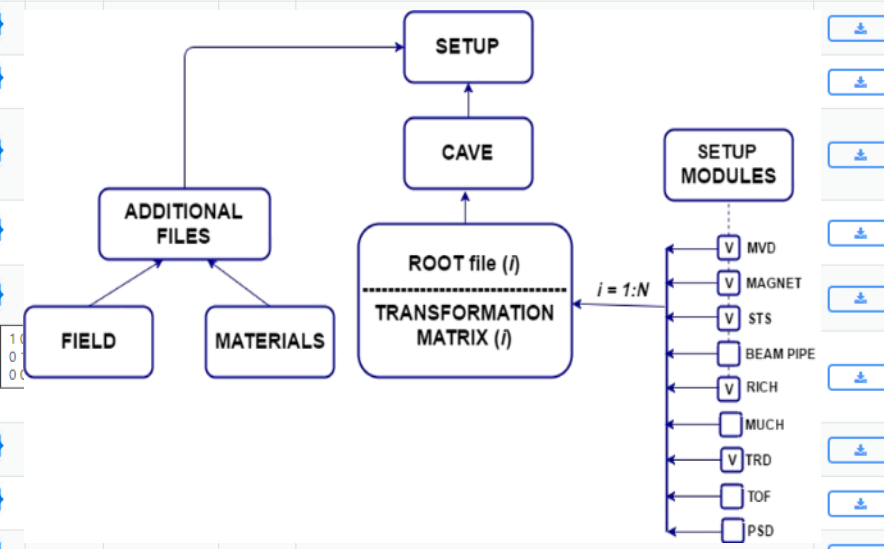
© JINR VBLHEP-MLIT, 2019-2024.  
All rights reserved.

## Setup Modules



- DB authorization
- or FreeIPA access

Module	Name (Tag)	Date	File	Transformation	Parent	Author	ParFile	Description	Download
BD	BD_run8_v1	2024-04-27	BD_run8_v1		CAVE	aleksand		BD_run8_v1	<a href="#">Download</a>
CAVE	cave	2024-03-31	cave		none	administrator		Base cave	<a href="#">Download</a>
CSC	FullCSC_Run8_detailed	2024-04-27	FullCSC_Run8_detailed		CAVE	aleksand	<a href="#">Download</a>	FullCSC_Run8_detailed.root	<a href="#">Download</a>
DCH	DCH_Run8	2024-05-02	DCH_Run8						<a href="#">Download</a>
FD	FD_run8	2024-04-27	FD_run8						<a href="#">Download</a>
FHCAL	FHCal_for_run8_cm_rotationY_1.6deg_v1	2024-05-02	FHCal_for_run8_cm_rotationY_1.6deg_v1						<a href="#">Download</a>
HODO	Hodo_for_run8_v1	2024-05-02	Hodo_for_run8_v1						<a href="#">Download</a>
MAGNET	magnet_modified	2024-04-27	magnet_modified						<a href="#">Download</a>
NDET	nDet_VETO_slice_rotY_-27.30	2024-05-02	nDet_VETO_slice_rotY_-27.30						<a href="#">Download</a>
Pipe	section3_Run8	2024-04-27	section3_Run8						<a href="#">Download</a>
Pipe	section2_Run8	2024-04-27	section2_Run8						<a href="#">Download</a>



BM@N Geometry Database has filled with the setup geometries for the last Run 8

User Interface Functions:

View Add Edit Approve Download

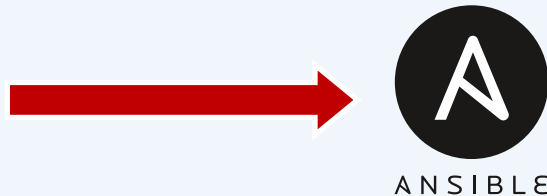
# Automated Deployment for Information Systems

## Why automated deployment?

- Manual deployment of a distributed system is slow and error-prone
- Automation increases speed and predictability
- Avoids issue of “forgotten step” in documentation
- Information Systems may be deployed by other NICA experiments

## Main components of solution

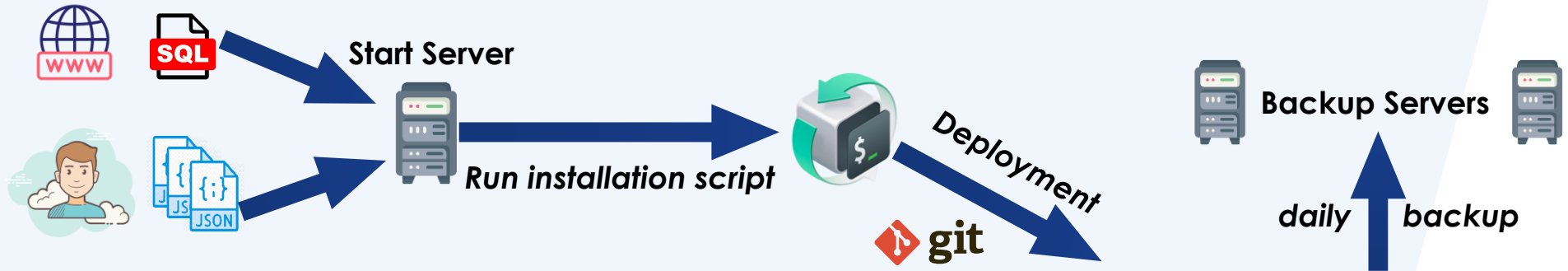
- Dockers
- Python script



## Inputs

- User Configuration of Information System as JSON → YAML template
- Account configuration for the Information System as JSON file

# Common Deployment System (CoDeS)



accounts4db.json  
accounts4extauth.json  
config.json

```
"dbHost" : "db_host.jinr.ru",
"dbName" : "elog_db",
"dbPort" : 5432,
"dbBackup" :
"remote_user@backup_server.jinr.ru",

"authExt" : false,
"authHost" : ""...

"expName" : "NICA",
"expLogo" : "login/images/nica.png",
"expUrl" : "https://nica.jinr.ru",

"notifySend" : true,
"contactEmail" : "person@jinr.ru", ...
```



```

-]# docker ps -a
IMAGE          COMMAND          CREATED        STATUS        PORTS          NAMES
postgres:12.4 "docker-entrypoint.s..." 2 hours ago    Up 2 hours    0.0.0.0:5432->5432/tcp, :::5432->5432/tcp    elog_db
    
```

**Database Server**

```

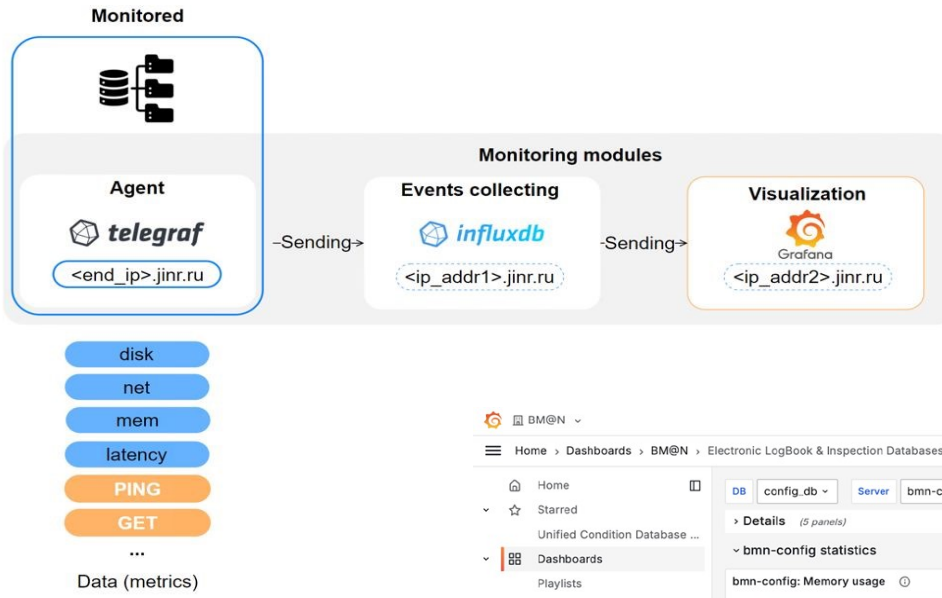
eLog_platform# docker ps -a
IMAGE          COMMAND          CREATED        STATUS        PORTS          NAMES
nginx          "/docker-entrypoint..." About an hour ago    Up About an hour    0.0.0.0:80->80/tcp, :::80->80/tcp    eLog_web
web_php        "/entry-elog-php.sh ..." About an hour ago    Up About an hour    9000/tcp          eLog_php
    
```

**Web Server**

[https://git.jinr.ru/nica\\_db/codes](https://git.jinr.ru/nica_db/codes)  
[https://git.jinr.ru/nica\\_db/elog\\_platform](https://git.jinr.ru/nica_db/elog_platform)  
[https://git.jinr.ru/nica\\_db/uniconda\\_platform](https://git.jinr.ru/nica_db/uniconda_platform)  
[https://git.jinr.ru/nica\\_db/geo\\_platform](https://git.jinr.ru/nica_db/geo_platform)

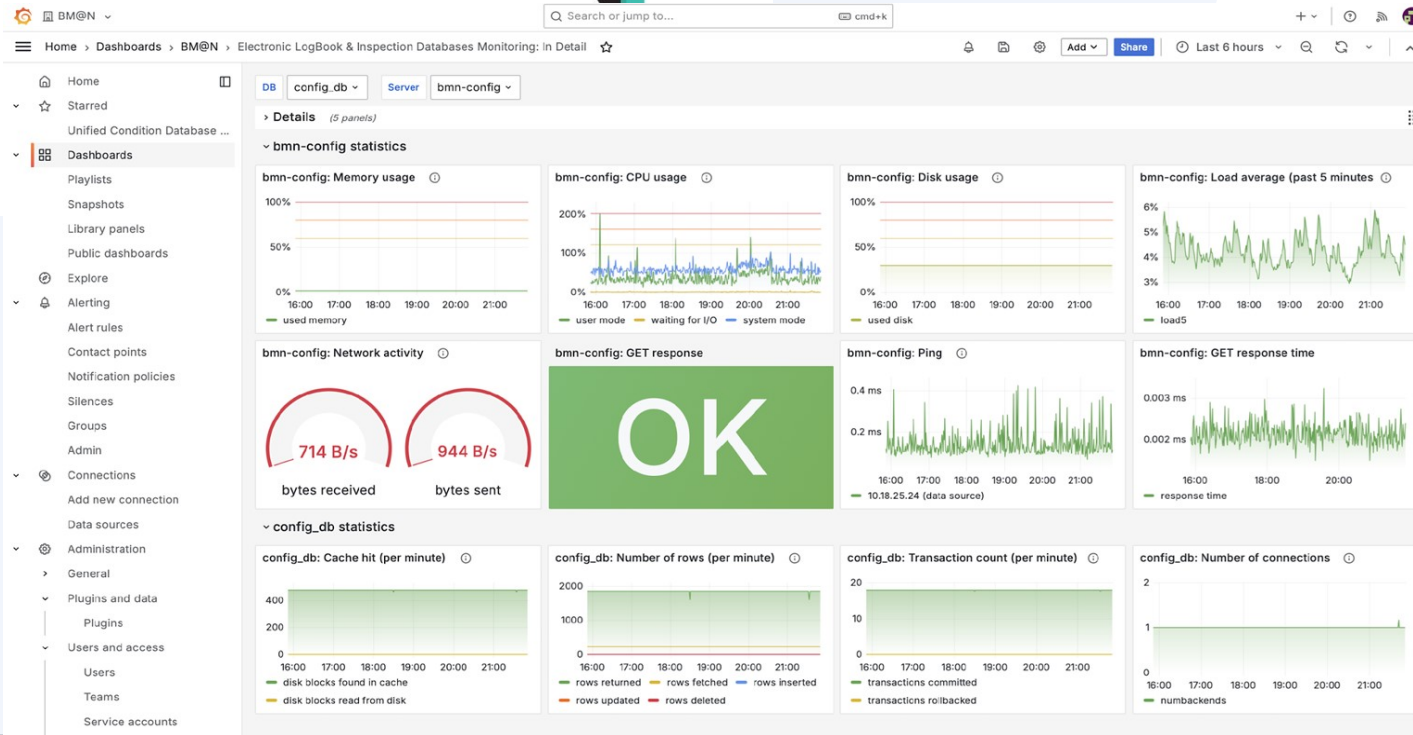


# BM@N Monitoring System



- Ping servers, HTTP request and SQL latency to check current status
- Monitor server parameters, such as *Disk*, *CPU*, *Memory*, etc.
- Response time stored in InfluxDB
- Use Grafana for visualization and failure alerting

- Module architecture
- Configurable via JSON file
- Deploying with **Ansible playbooks**
- Email and **Telegram** notifications



# BM@N Computing Platforms

[/bmn-daq-computing-center/](#)

**BM@N Online Cluster**

[ddc.jinr.ru](#)

(LHEP, b.205)



[bmn.jinr.ru/nica-cluster/](#)

**NICA Cluster**

[ncx\[101-106\].jinr.ru](#)

(LHEP, b.216)



[bmn.jinr.ru/micc-complex/](#)

**GRID Tier1&2 Centres**

[lxui.jinr.ru](#) (CICC)

(MLIT, b.134)



[bmn.jinr.ru/hybrilit-govorun/](#)

**HybriLIT platform**

(«Govorun» SC)

[hydra.jinr.ru](#)

(MLIT, b.134)



OS: AlmaLinux 9

OS: CentOS / Scientific Linux 7.9 (EOL on June 30, 2024)

Central Software Repository based on **CVMFS** for the experiment

**CEPH: 2.8 PB** (*replica*)

**CEPH** (hot): 100 TB<sub>ssd</sub>

**SLURM: ≈1000** cores

**EOS: 1.2 PB** (*replica*)

**NFS: 300 TB** (*for NICA*)

**SLURM: 1800** cores  
(*for all NICA users*)

**EOS: 1.2 PB** (*replica*)

**EOS CTA: 500 TB**<sub>tapes</sub>

**SLURM: 2500** cores  
(*for all NICA users*)

**ZFS: 200 TB**

**Lustre: 300 TB**<sub>ssd</sub> (*for NICA*)

**SLURM: bmn – 192** cores

**BM@N software has been deployed on JINR CVMFS for Centos 7 and AlmaLinux 9  
AlmaLinux 9 does not require cluster configuration script (but different versions of GCC)**

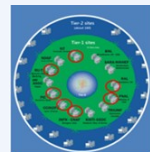
# DIRAC jobs on BM@N Computing Resources



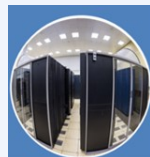
BM@N  
Online Cluster



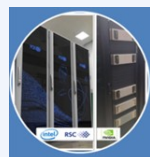
NICA Cluster



CICC  
Tier-1



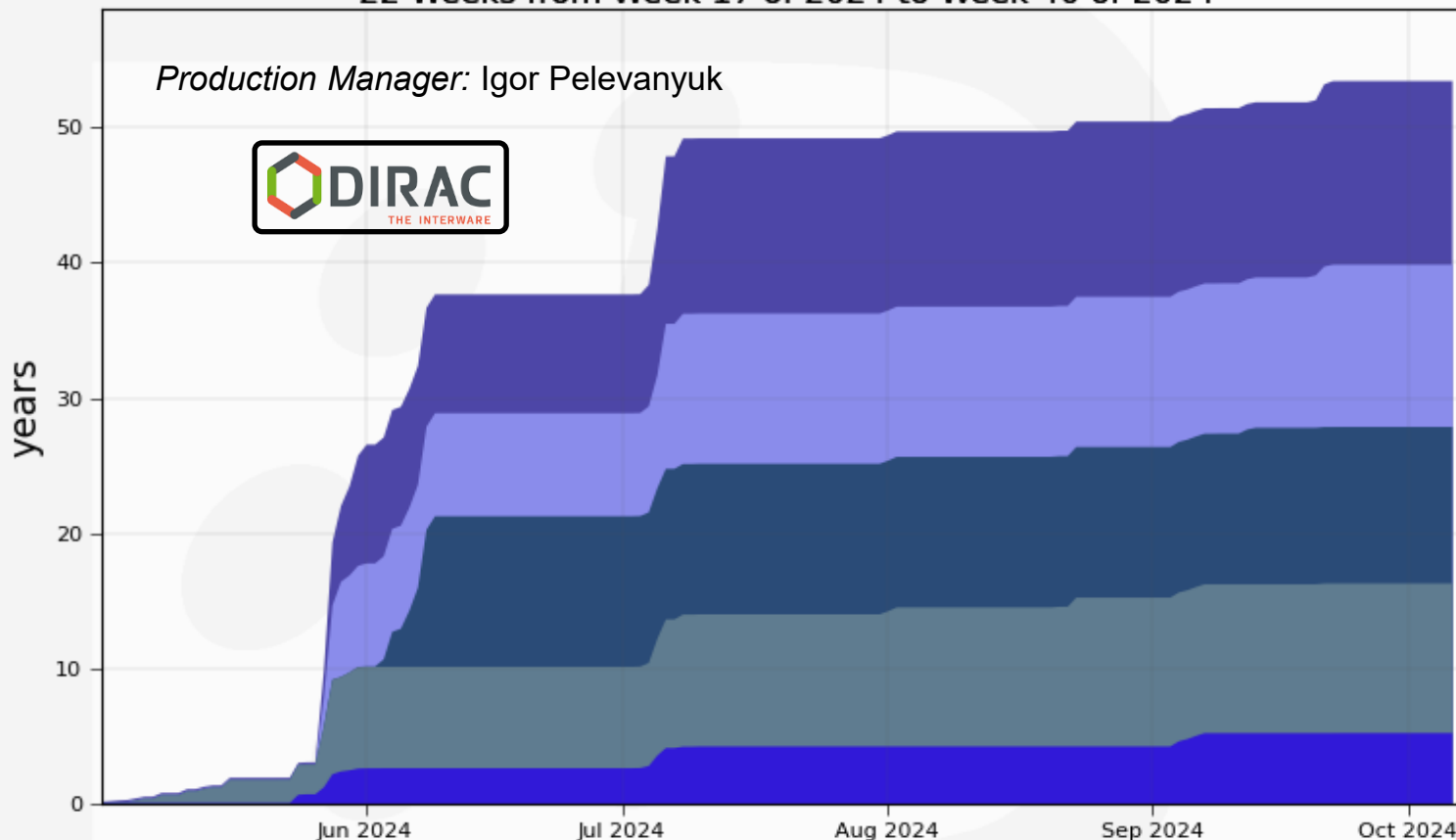
CICC  
Tier-2



Govorun

## Cumulative wall time by Site

22 Weeks from Week 17 of 2024 to Week 40 of 2024



Max: 53.4, Min: 0.14, Average: 38.4, Current: 53.4

DIRAC.JINR-CREAM.ru	13.6	DIRAC.GOVORUN.ru	11.6	DIRAC.JINR-LHEP.ru	5.2
DIRAC.JINR-TIER.ru	12.0	DIRAC.JINR-LHEP-DDC.ru	11.1		

Generated on 2024-10-07 17:11:20 UTC

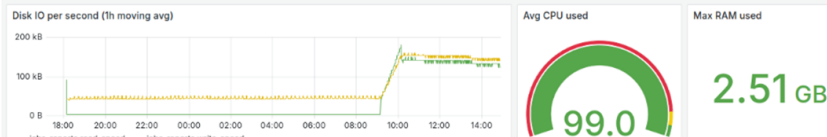
# Production Reports via DIRAC

Avg execution time: 22 hours  
GenToSim: 16 hours  
SimToDst: 6 hours  
Max RAM: ~ 2.6 GB  
Disk usage: ~ 6 GB  
CPU Usage: ~ 99%  
CPU time per event: 16 s

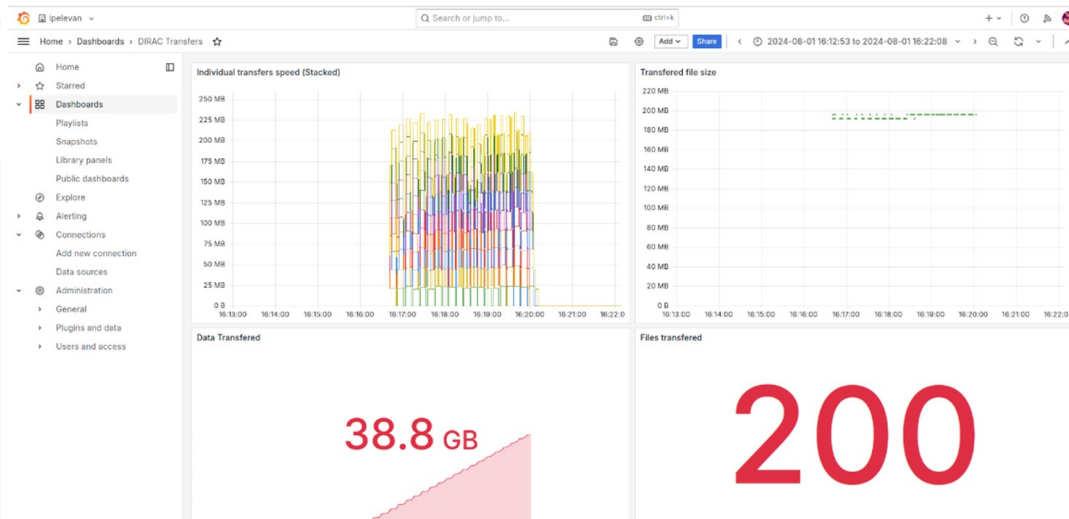


*profile of processed and transferred data*

Events: 1M  
Total output files: 200  
Total size: 39 GB  
Size per file: 195 MB  
Size per event: 39 KB



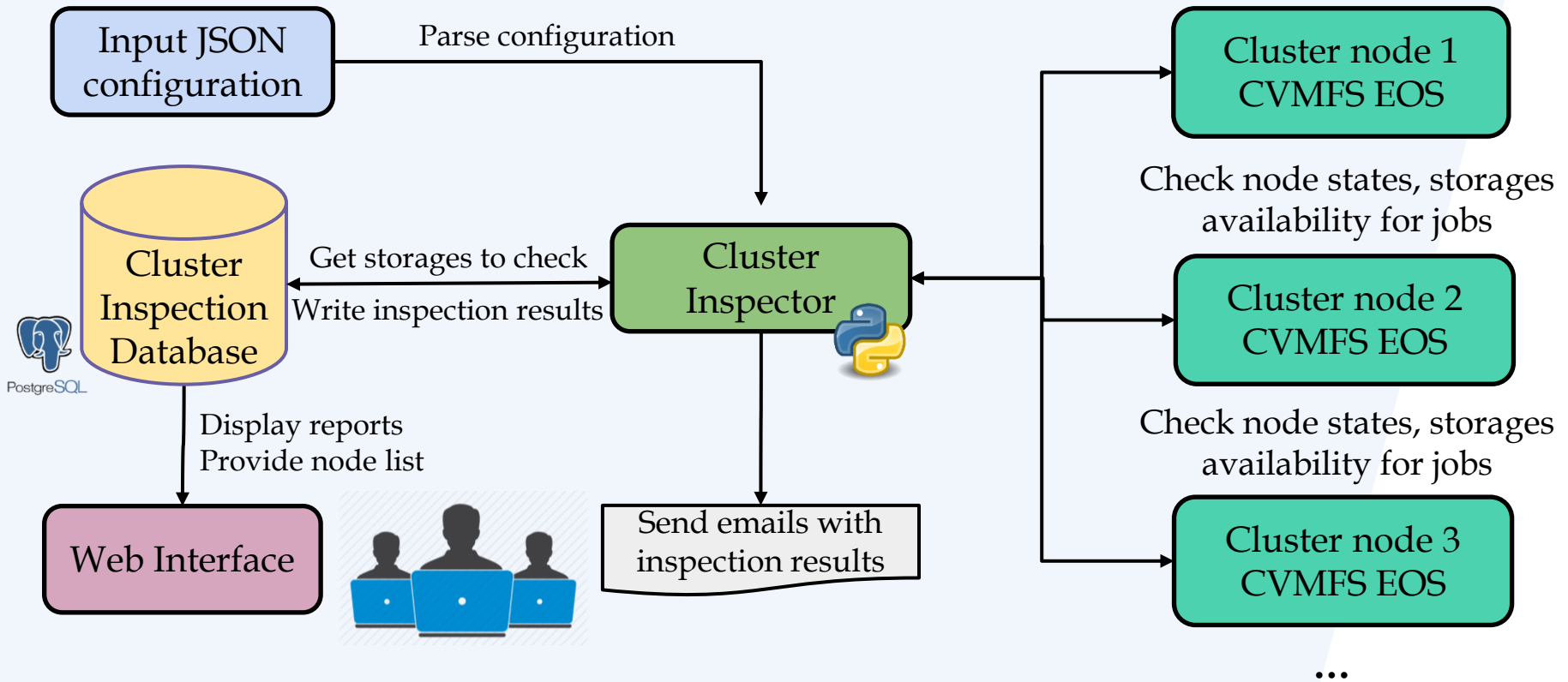
*utilization profile of processed jobs*



# Cluster Inspection Service. *Motivation*

- ✦ Not enough reliability of the NICA cluster including regular failure of its computing and storage elements
- ✦ The need to constantly have an up-to-date list of non-failed nodes with available data storages to run data processing via the batch system
- ✦ To store and visualize the history of the NICA cluster health
- ✦ As a result, a tool for tracking and analyzing the status of necessary cluster elements is required, which provides users with a list of successfully tested nodes

# Cluster Inspector (Task Crawler). Overview

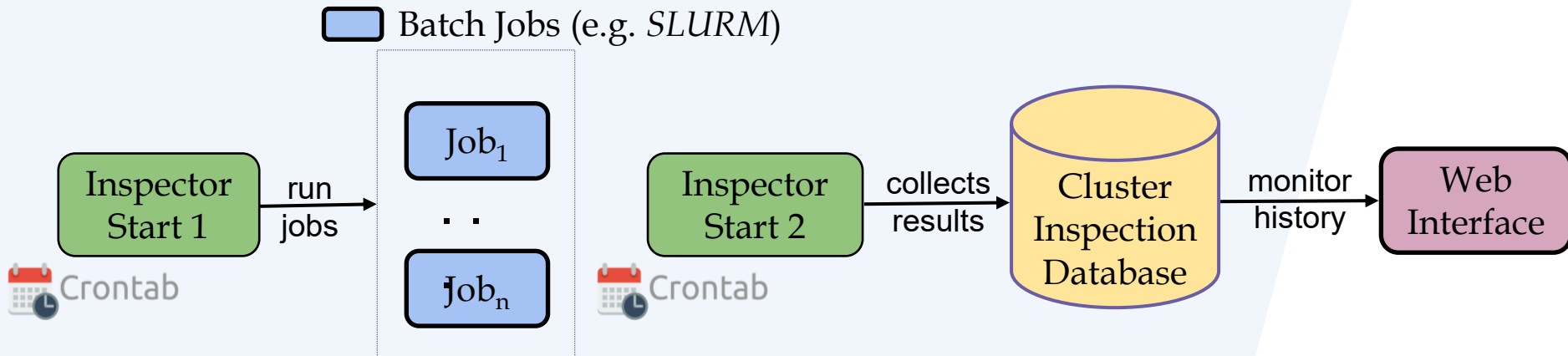


Input JSON configuration contains only the cluster name, its batch system type and email information to send the reports

# Cluster Inspector. *Execution on the NICA cluster*

Periodically launches inspection jobs to a batch system of the specified cluster

- A list of nodes of the cluster is defined automatically via the batch system commands
- It checks states of the cluster nodes (*ping* & batch system commands), possibility to start jobs on the nodes (waiting one day) and access to specified (in DB) storage elements
- In 24 hours, the Cluster Inspector collects and analyzes the results, identifies failed nodes, writes the results to the database and send a summary report to specified emails
- The results are displayed on the deployed Web interface



# Cluster Inspector. Web Interface

## Cluster Inspection

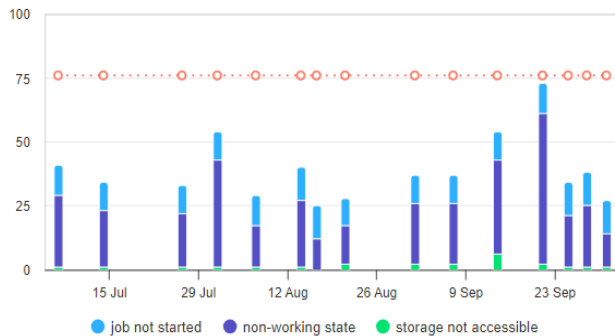
save a list of fully checked cluster nodes to clipboard or text file

Save the last successful hostlist to  or

Cluster name	Check date	Complete date	All nodes	Faulty nodes
NCX	2024-10-01	2024-10-02	76	27
NCX	2024-09-28	2024-09-29	76	38

Items per page:  1 - 2 of 92 < >

Error Statistics



Error Node	Error name	Error Details
ncx112	non-working state	State: down*
ncx115	non-working state	State: unk*
ncx121	non-working state	State: inval
ncx144	non-working state	State: drng
ncx157	non-working state	State: drng
ncx171	non-working state	State: unk*
ncx181	non-working state	State: unk*
ncx188	non-working state	State: drain
ncx214	non-working state	State: down*
ncx216	non-working state	State: unk*
ncx223	non-working state	State: drain
ncx225	non-working state	State: down*
ncx227	non-working state	State: unk*
ncx111	job not started	State: comp
ncx114	job not started	State: comp

contains history of all the conducted NICA cluster checks with statistics on different types of found errors and detailed information on each inspection

[https://bmn.jinr.ru/cluster\\_inspector/](https://bmn.jinr.ru/cluster_inspector/)





# BM@N Software Contribution



**Tagir AUSHEV**, Peter KLIMAI, Alexander NOZIK, PhD student, 1 x graduated, 3 x students (6y)  
**Event Metadata System, Event Display, Monitoring Service, Services for BM@N Databases...**



**Sergei NEMNYUGIN**, Anatoly ALEXANDROV, Rinat NIZAMOV, Anastasiya IUSUPOVA  
**RUCIO File Catalogue, Docker Containers for BmnRoot, BM@N Event Visualization**



**Arkadiy TARANENKO**, Peter PARFENOV, Anton TRUTSE  
**Software corrections of the BmnRoot framework**

## BM@N Software Contribution

**Director: S. V. SHMATOV. Scientific Leader: V. V. KORENKOV**

Igor ALEXANDROV, Evgeniy ALEXANDROV, Irina FILOZOVA, et alia  
**Development of the Geometry Database and Online Configuration Systems**

Zarif SHARIPOV, Zafar TUKHLIEV. **Automation of BM@N Alignment**

Alexander AYRIYAN, Vladimir PAPOYAN

**Implementation of BM@N Particle IDentification based on ML**



**Spokesperson: Mikhail KAPISHIN**

**BM@N Software "Group" (3 FTE)**

Konstantin GERTSENBERGER

Alexander CHEBOTOV, Ilya ROMANOV

# BM@N Computing and Technical Contribution

**NICA Computing Leader: Andrey DOLBILOV**

*Ilya SLEPNEV (LHEP Deputy Director for Computing)*

**BM@N DAQ & online farm support**

*Ivan SLEPOV*

**NICA Cluster support**



*Igor ZIRONKIN*

**BM@N distributed data processing with DIRAC File Catalogue**



**Director: S. V. SHMATOV. Scientific Leader: V. V. KORENKOV**

*Nikita BALASHOV: CVMFS Deployment, GitLab Services, Docker Containers*

*Igor PELEVANYUK: DIRAC workload management system and BM@N mass production*

*Dmitriy PODGAYNY, Oksana STRELTSOVA  
HybriLIT and SC Govorun support*

*Daria PRIAKHINA, Vladimir TROFIMOV  
Modelling System for BM@N computing infrastructure*



**BM@N  
Computing &  
Technical  
Contribution**

# Software Strategy Risks

## Software Fund

- *no financial fund*
- *no support of the external software participants*

## Staff

- *no full-fledged software group*  
*(permission to hire 3rd employee)*

## Computing Resources

- *not enough guaranteed resources for BM@N (only 192 cores on Govorun, online cluster)*  
*2024→2027: 6 000 cores required*
- *not stable work of the NICA cluster*
- *unrealizable procedure of obtaining VPN for new external participants*

