Разработка комплекса программных систем для реализации единой архитектуры распределенной обработки и хранения данных эксперимента BM@N/NICA

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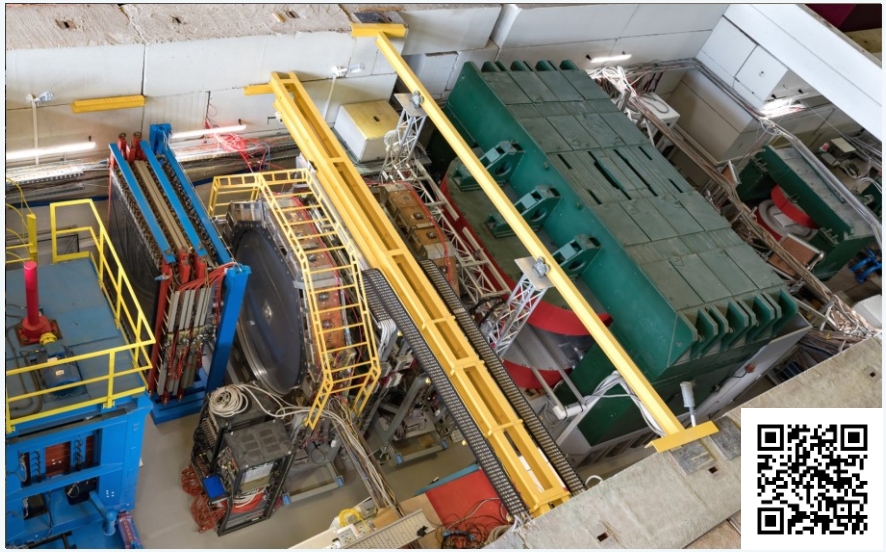
November 14, 2024

BM@N in Nuclotron Runs (2015 – 2023)

❖ **Nuclotron Run 51** (d,C)		*Feb. 22 – Mar. 15,* ***2015***
❖ **Nuclotron Run 52** (d)	***Technical***	*June 29 – June 30,* ***2016***
❖ **Nuclotron Run 53** (d, d↑)	***interaction rate: 5 kHz***	*Dec. 09 – Dec. 23,* ***2016***
❖ **Nuclotron Run 54** (C)	***Technical+SRC Physics***	*Mar. 07 – Mar. 18,* ***2017***
❖ **Nucl. Run 55** (C,Ar,Kr)	***interaction rate: 8 kHz***	*Mar. 03 – Apr. 05,* ***2018***
❖ **Nucl. Run 56: SRC** (C)	***Physics***	*Mar. 07 – Mar. 28,* ***2022***
❖ **Nucl. Run 57: BM@N** (Xe)	***interaction rate: 10 kHz***	*Dec. 12 – Feb. 02,* ***2023***



- Beam: *Xe* (3.8, 3.0 AGeV),
previous runs: *Kr* (2.3, 2.6, 3.0 AGeV), *Ar* (3.2 AGeV), C^{12} (3.5–4.5 AGeV), *d* (4, 4.6 AGeV)
- Target: *CsI* or empty
previous runs: *Pb*, *Sn*, *Cu*, *Al*, C_2H_4, *C*, H_2
- Integrated DAQ, T_0 and Trigger systems
- Detectors: FSD, GEM, CSC, ToF-400, ToF-700, DCH 1&2, FHCal, ECal, LAND, profilometers…
- Detect min bias beam-target interactions to reconstruct hyperons, strange particles, identify charged particles and nucleus fragments…

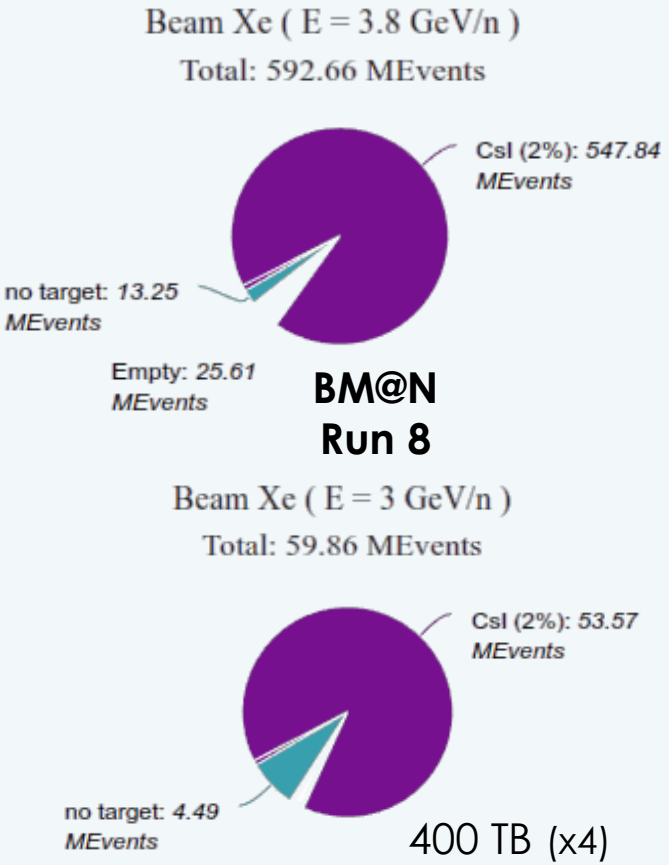
Data Production in BM@N Physics Run

1st 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



Parameter	Value (approx.)
Data acquisition time	**720 hours**
Average run duration	20 minutes
Average run time break	2.5 minutes
Beam intensity (3.8 AGeV)	up to 900k/2.2 Xe^+/sec up to 900k/12 Xe^+/sec
Trigger rate	**8 000/2.2 event/sec**
Average event size	**0,57 МБ**
Data rate	**up to 2 GB/sec**
Raw file size	**15 GB**
Event count per file (total)	25 000
Total event count (+test, calibration, pedestal)	**645 M**
Total (complete) file count	25 800
Total run count	1 920
Total raw data size	**400 TB**
Total replicated raw data	1.6 PB
Avg digit file size	**1.1 GB**
Avg DST file size	**2 GB**

BmnRoot Framework

as a central BM@N software package

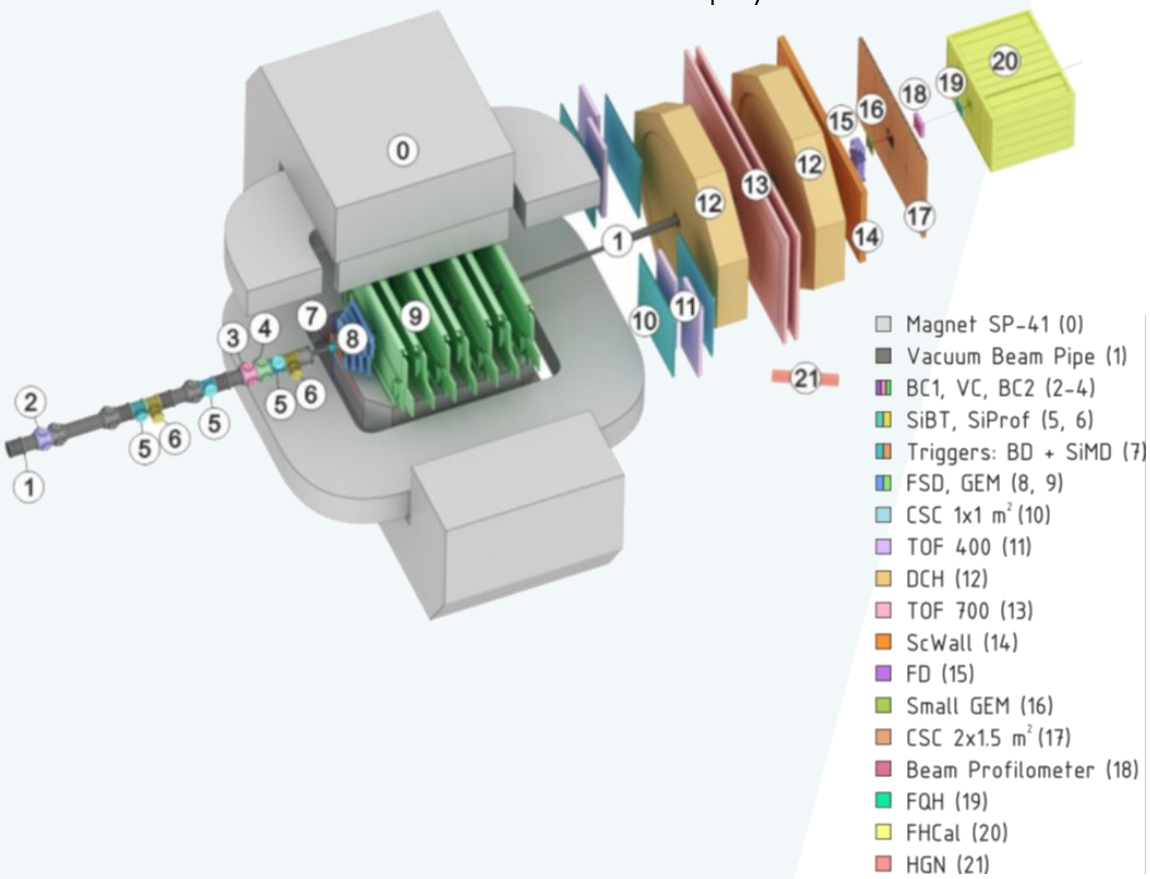
BmnRoot Framework

The BmnRoot framework is developed for realistic event simulation, reconstruction of experimental or simulated data and following physics analysis of ion collisions with a fixed target at the BM@N facility.

single stack for offline and online (FairMQ)

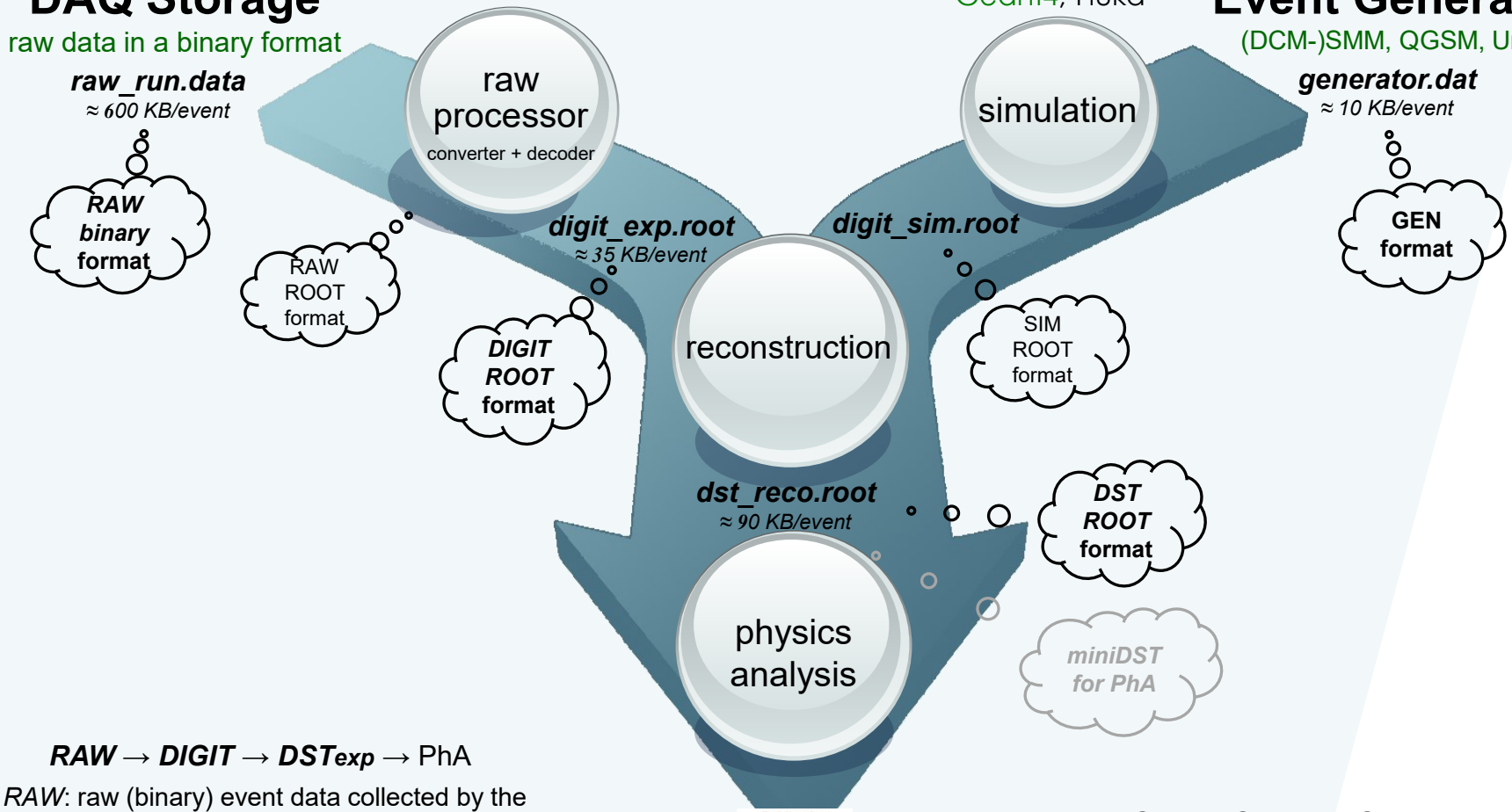
C++ classes, Linux/MacOS, based on ROOT Data Analysis Framework and FairRoot embedded services on Python

BM@N in the 1st physics Run



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

BmnRoot. *Event Data Model*



RAW → ***DIGIT*** → ***DSTexp*** → PhA

RAW: raw (binary) event data collected by the DAQ system after the Event Builder

DIGIT: detector readings (event digits) after the raw data decoder (ROOT macro)

DSTexp: reconstructed data of experimental events

hists
plots
results

GEN → SIM → ***DSTsim*** → PhA

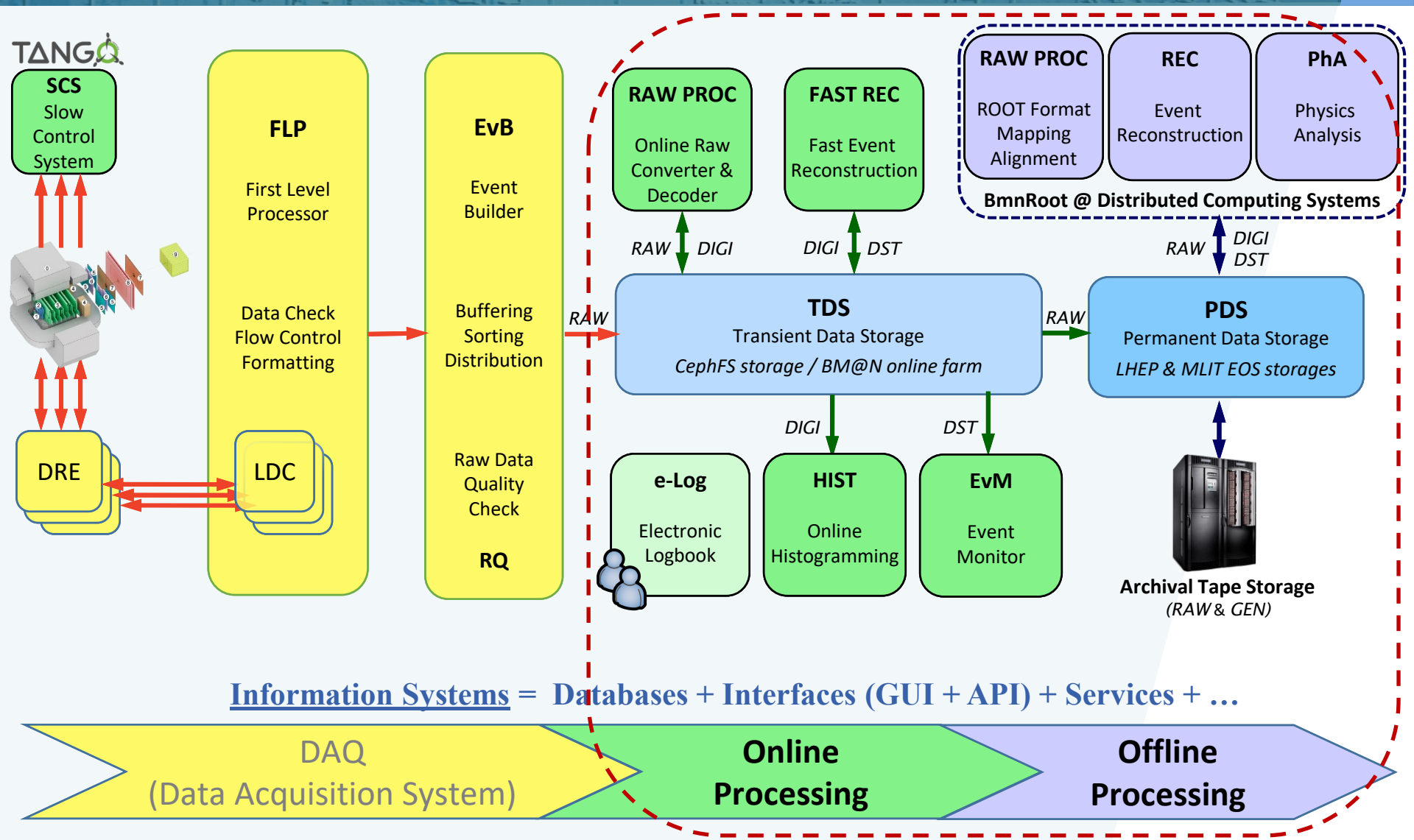
GEN: particle collisions description received by event generators

DSTsim: reconstructed data of simulated events

Complex of Software Systems

Distributed Data Processing and Storage

BM@N Data Processing Flow



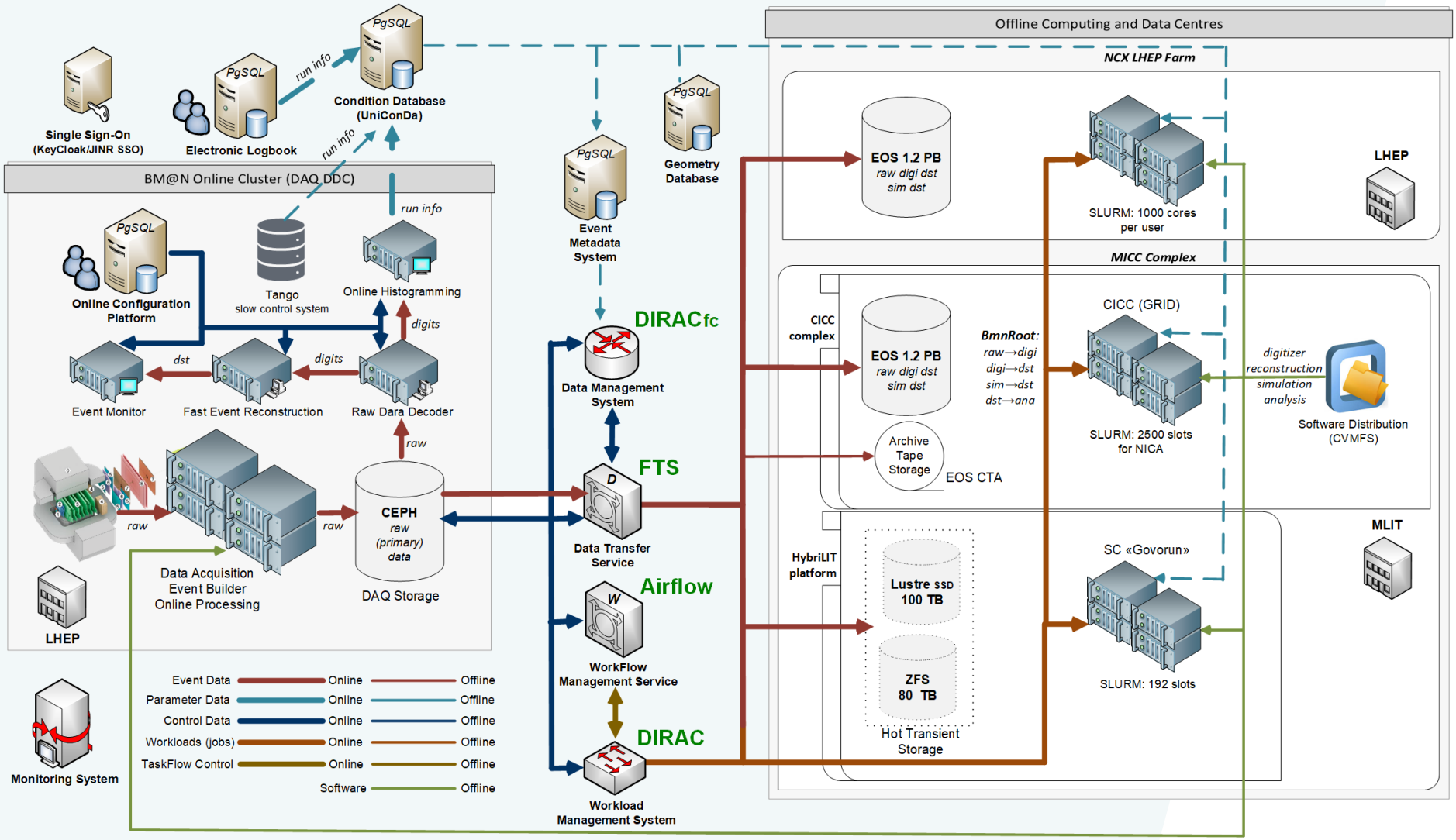
Information Systems = Databases + Interfaces (GUI + API) + Services + …

DAQ (Data Acquisition System) | Online Processing | Offline Processing

Components of BM@N distributed complex

- computing platforms for the BM@N experiment
- software distribution system as a central repository of the experiment software
- data storages on distributed FS for experimental and simulated files
- workload management system for parallel task/job distribution
- file and event catalogues organizing smart namespaces with metadata
- data transfer services enabling the transfer of large amounts of data between users and storages within the federal administration
- workflow management service orchestrating task flows on data processing
- information systems based on databases providing necessary information for offline and online processing
- user interfaces (Web, API, CLI) to manage databases and distributed data processing
- central authentication and authorization system to regulate access rights
- monitoring system to control state of server nodes, databases and interfaces

Developed Architecture of the Software Complex

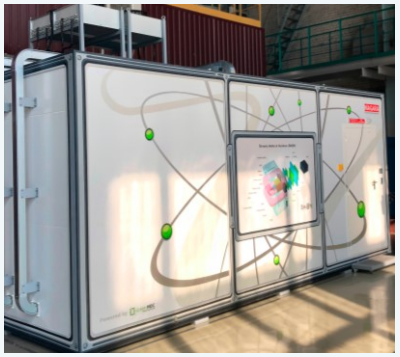


Workload Management System

based on the DIRAC Interware

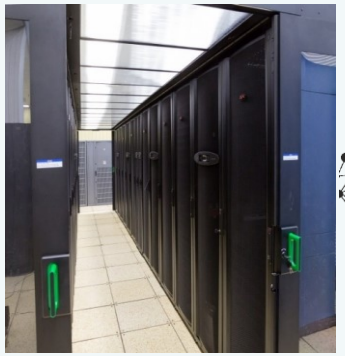
BM@N Computing Platforms

BM@N Online Cluster
ddc.jinr.ru
(LHEP, b.205)



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

GRID Tier1&2 Centres
lxui.jinr.ru (CICC)
(MLIT, b.134)



HybriLIT platform
(«Govorun» SC)
hydra.jinr.ru
(MLIT, b.134)

OS: AlmaLinux 9

OS: CentOS / Scientific Linux 7.9

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

CEPH: 2.8 PB (*replica*)
CEPH (hot): 100 TB_{ssd}
SLURM: ≈**1000** cores

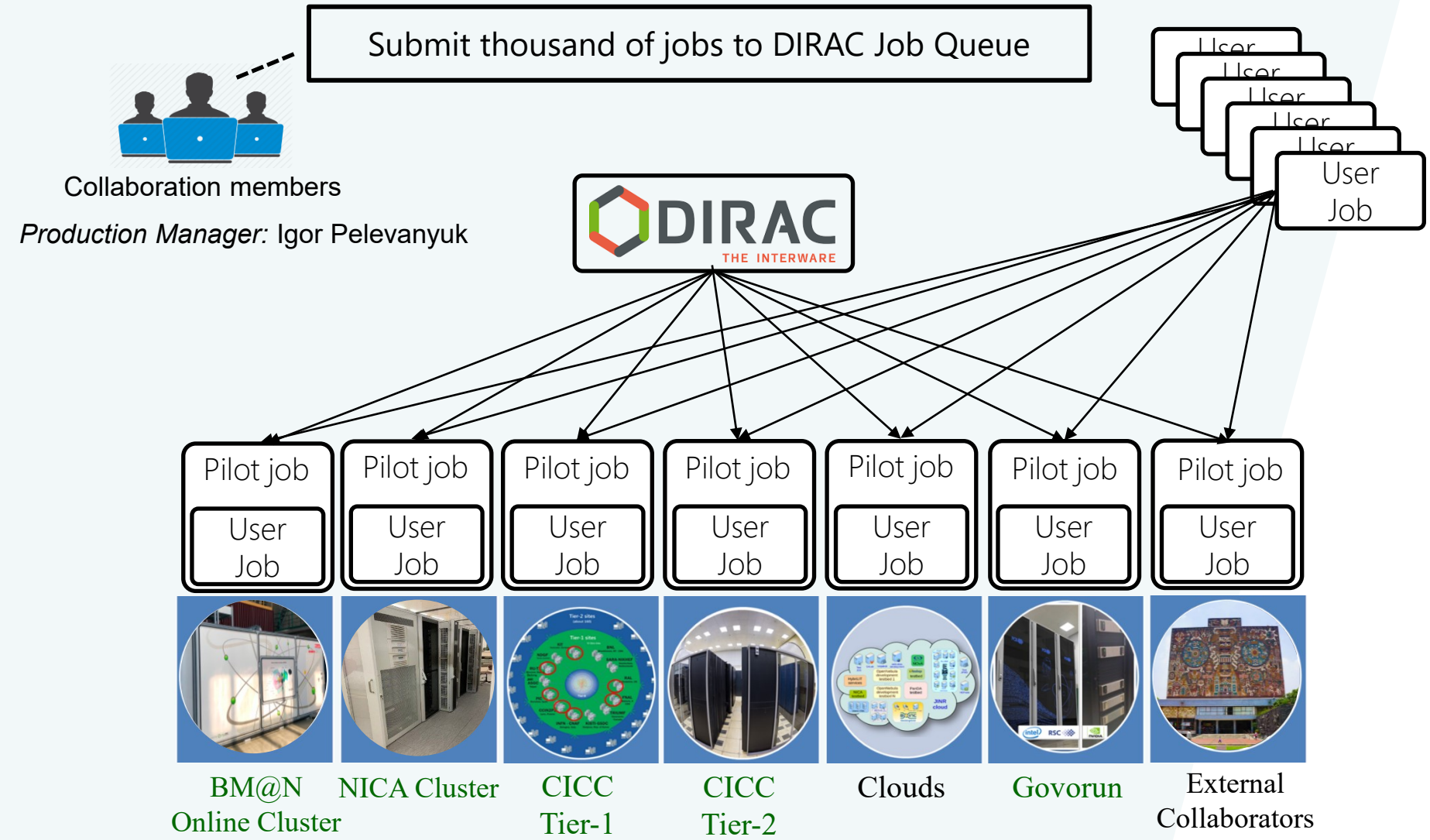
EOS: 1.2 PB (*replica*)
NFS: **300 TB** (*for NICA*)
SLURM: ≈**1800** cores
(*for all NICA users*)

EOS: 1.2 PB (*replica*)
EOS CTA: **500** TB_{tapes}
SLURM: 2500 cores
(*for all NICA users*)

ZFS: 200 TB
Lustre: **300** TB_{ssd} (*for NICA*)
SLURM: *bmn* – **192** cores

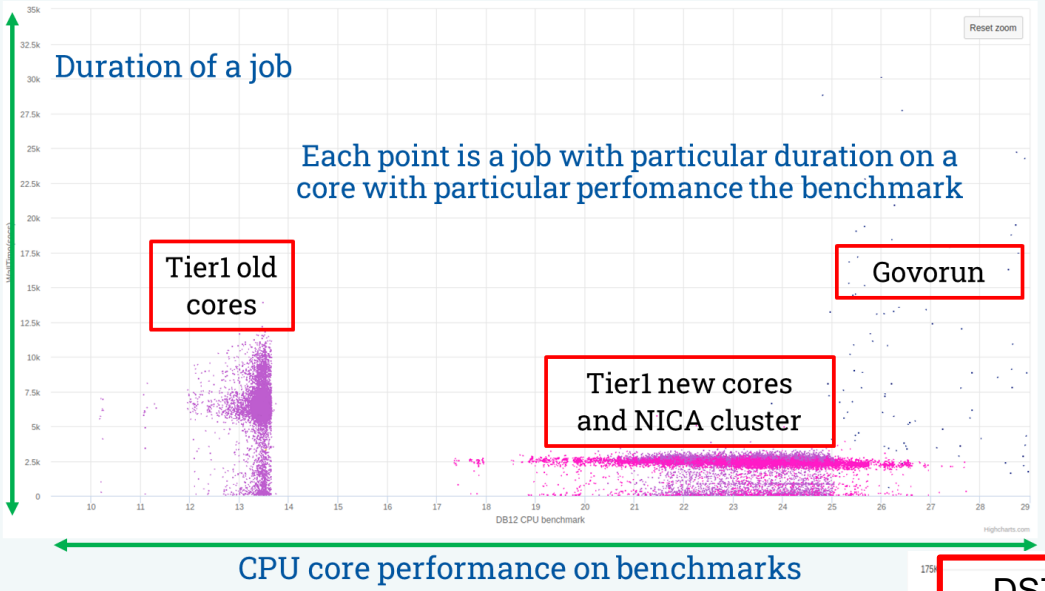
BM@N software has been installed & configured on JINR CVMFS *(/cvmfs/bmn.jinr.ru/)*
Automatic software deployment of the BmnRoot package on CVMFS with GIT CI/CD

DIRAC Workload Manager for BM@N



BM@N DST Production via DIRAC (Run 8)

Total duration of Raw2Digi campaign ≈ 1.5 days (0.2 s/ev)



Quotas (cores):

Tier1: 1500 (for NICA)
Tier2: 1000 (for NICA)
Govorun: 192 (BM@N)

NICA cluster: 1000 (per user)

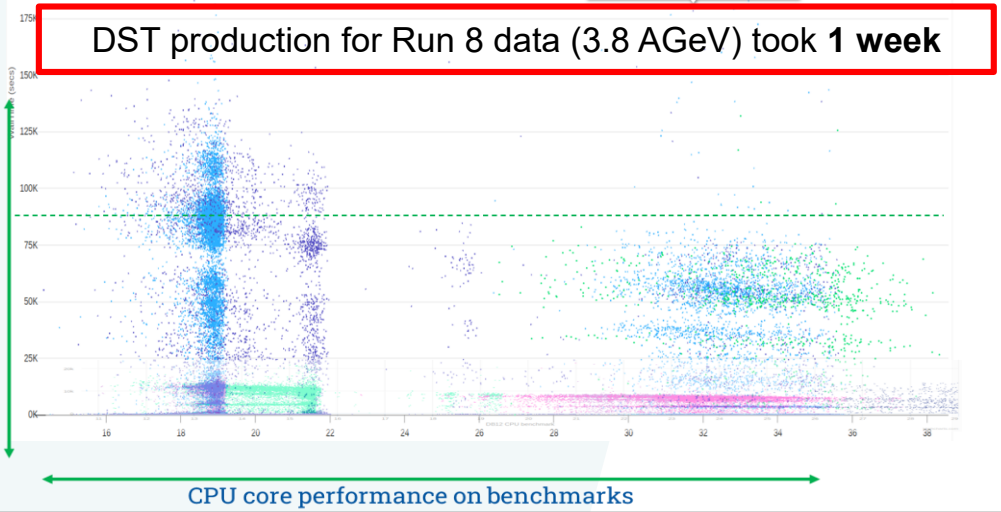
Total files: **30 741** Total raw size: **393 TB**

Average transfer speed (20 streams): **1.92 GB/s**
Total transfer duration: **2d 15h**
Max transfer speed (R+W) EOS@MLIT: **7.5 GB/s**
Achieved Drive → Tape writing speed: **1.25 GB/s**

Total disk usage per job (15 GB): **25 GB**
RAM usage: **2 GB**

Total wall time**: 70 CPU years**

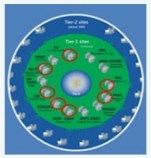
DST production for Run 8 data (3.8 AGeV) took **1 week**



DIRAC jobs on BM@N Computing Resources

BM@N
Online Cluster

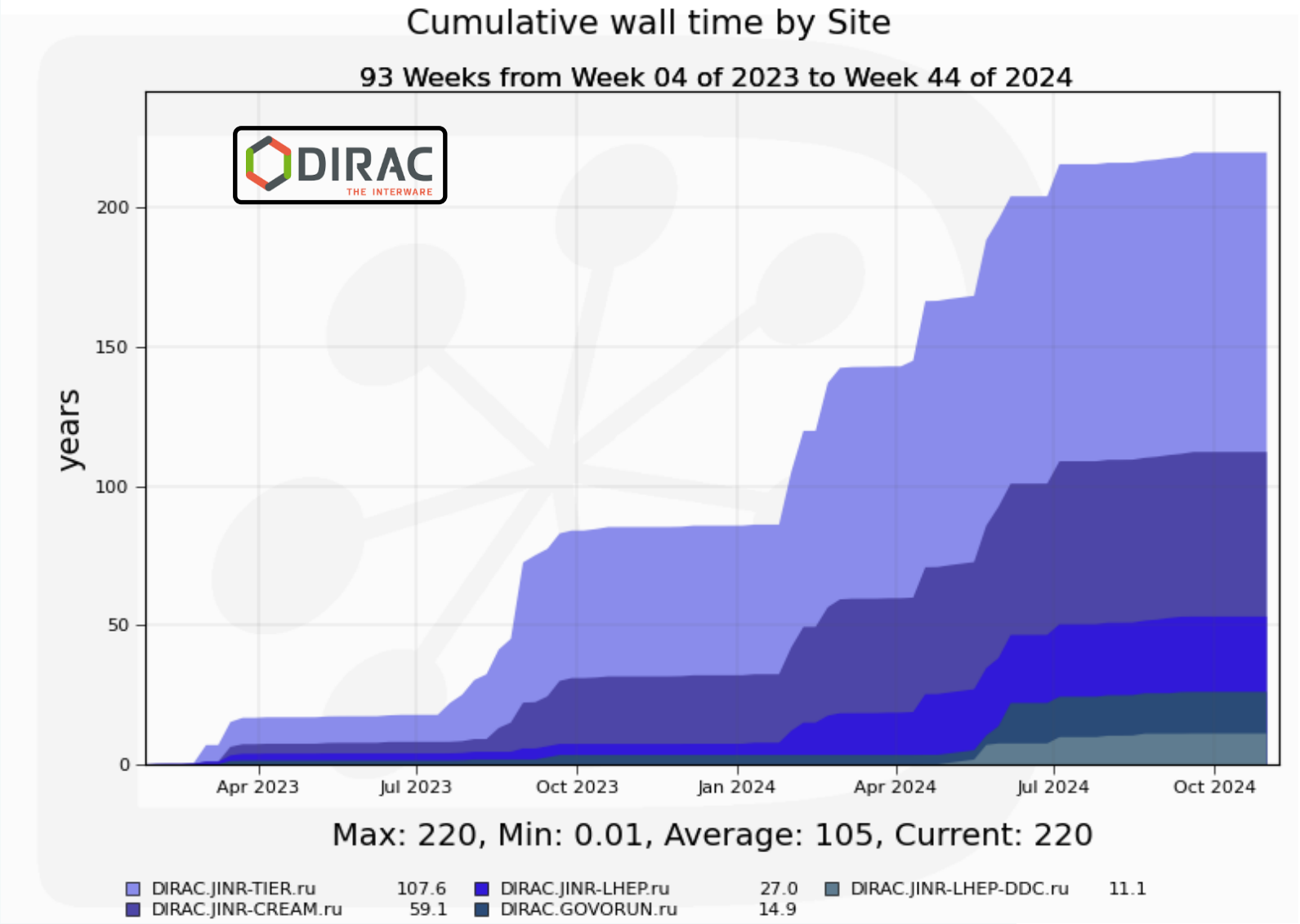
NICA Cluster



CICC
Tier-1

CICC
Tier-2

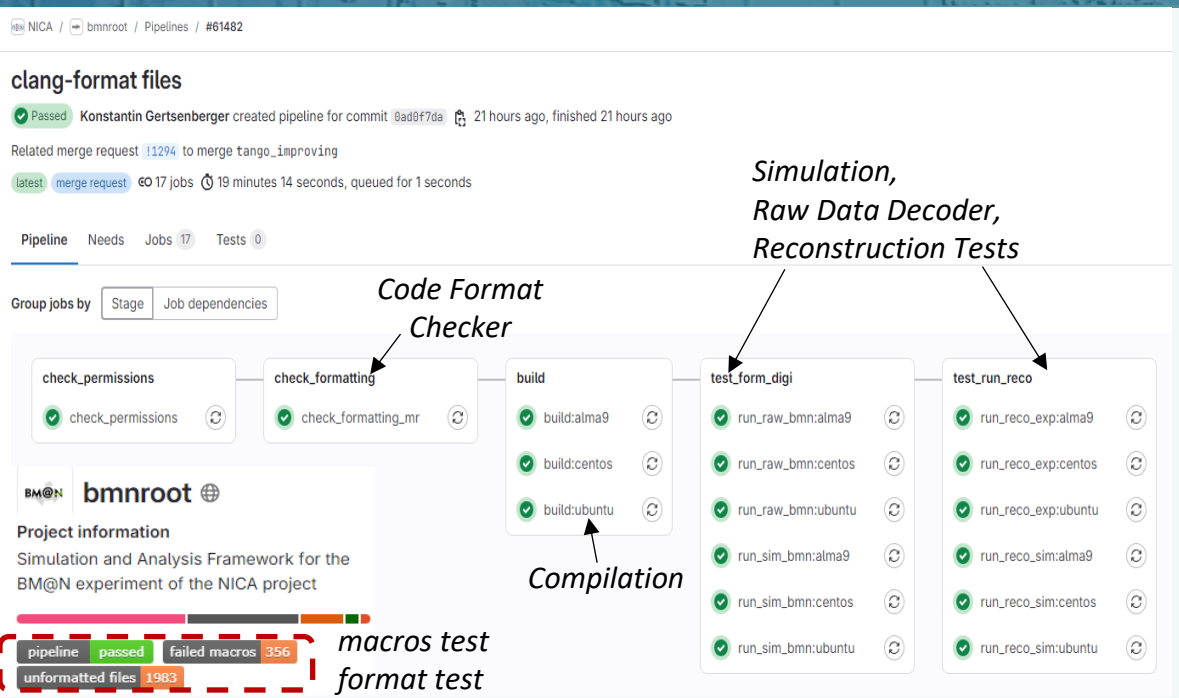
Govorun



Software Distribution System

using CVMFS and GIT CI|CD

Software Management & Distribution System



GIT Pipelines on Merge Requests

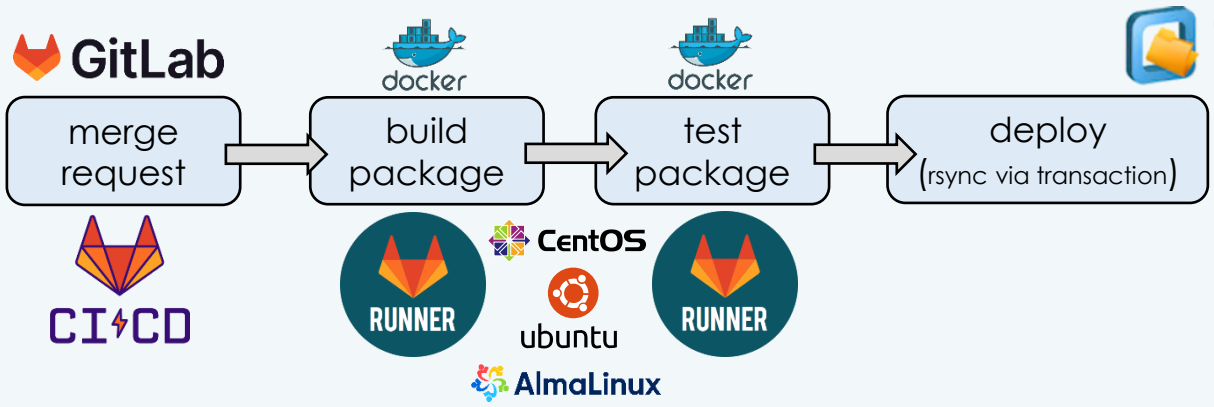
- checking compilation and main macros
  → stable dev & pro branches, all tags
- **deploy BmnRoot to the CVMFS storage**
- **deploy BmnRoot containers to the registry**
- checking Clang code formatting

GIT Night Tests

- test all BmnRoot macros
- test all C++ files for correct code format
- generate Doxygen documentation

Software Distribution via CernVM File System

Read-only network file system with aggressive caching, optimized for software distribution via HTTP in a fast, scalable and reliable way




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

Data Management System

built on the DIRAC File Catalogue

Data Storages for BM@N

ceph

for BM@N online (2.8 PB)

build on HDD with SSD buffer

NICA cluster

EOS

for BM@N offline (1.2 PB)

build on HDD

sync | duplicate

MLIT MICC

EOS

for BM@N offline (1.2 PB)

build on HDD

NICA cluster

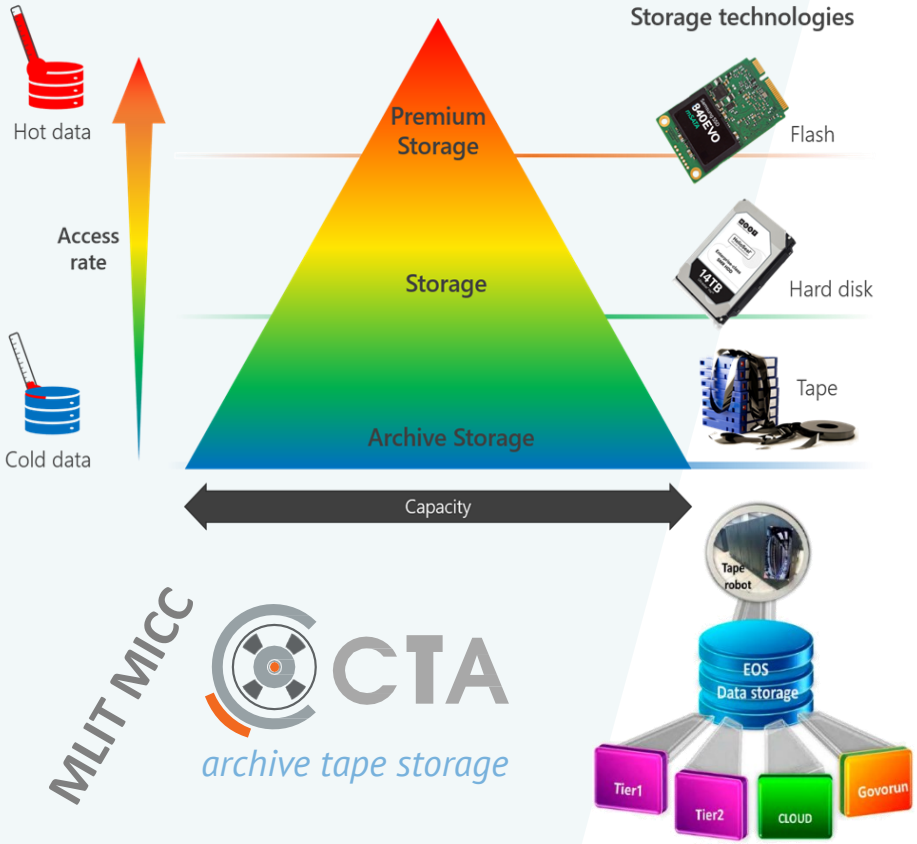
NFS

fast on NVMe SSD

HybriLIT

lustre

fast on NVMe SSD



MLIT MICC

CTA

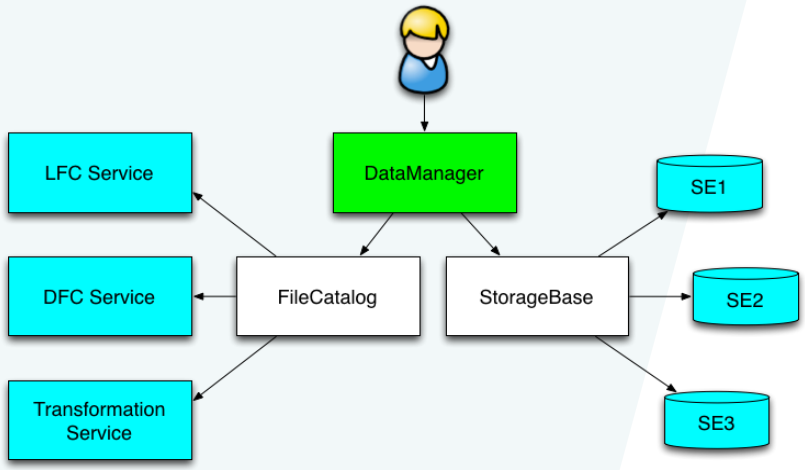
archive tape storage

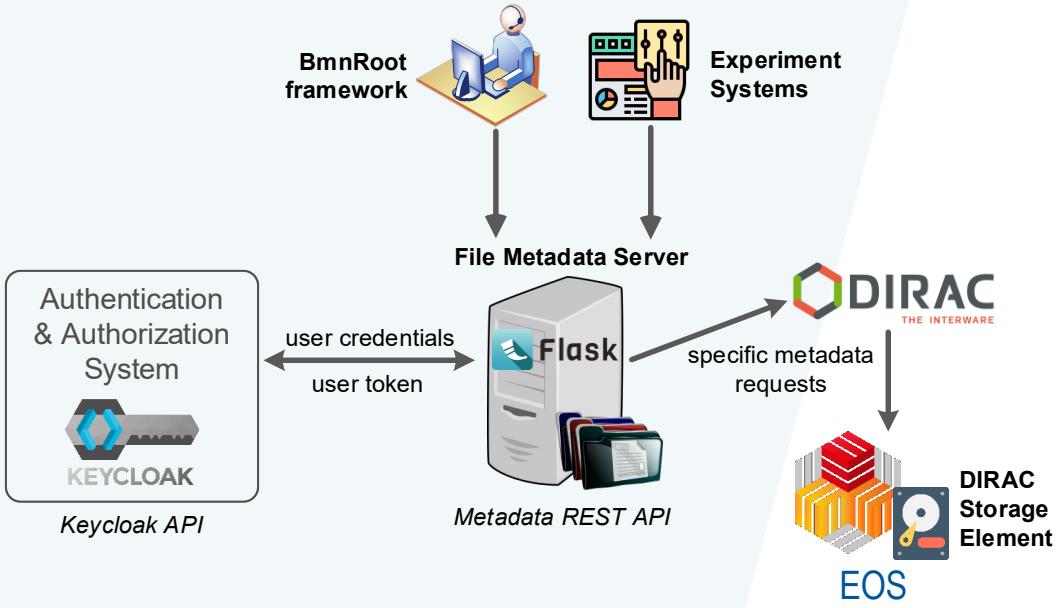
DIRAC File Catalogue for BM@N

- DIRAC File Catalog (DFC) is maintaining a single global logical name space (maps a Logical File Name (LFN) to the Physical File Name (PFN) at distributed computing platforms
- A user sees it as a single catalogue with additional features (replica, policy, caching…)
- DataManager is a single client interface for logical data operations
- DFC also may host Metadata

BM@N DFC Metadata (Run 8):

- **period and run number**
- **start and end datetime**
- **beam and target particles**
- **run type**
- **energy**
- **magnetic field**
- **start and end event number**
- **event count**
- **file size**

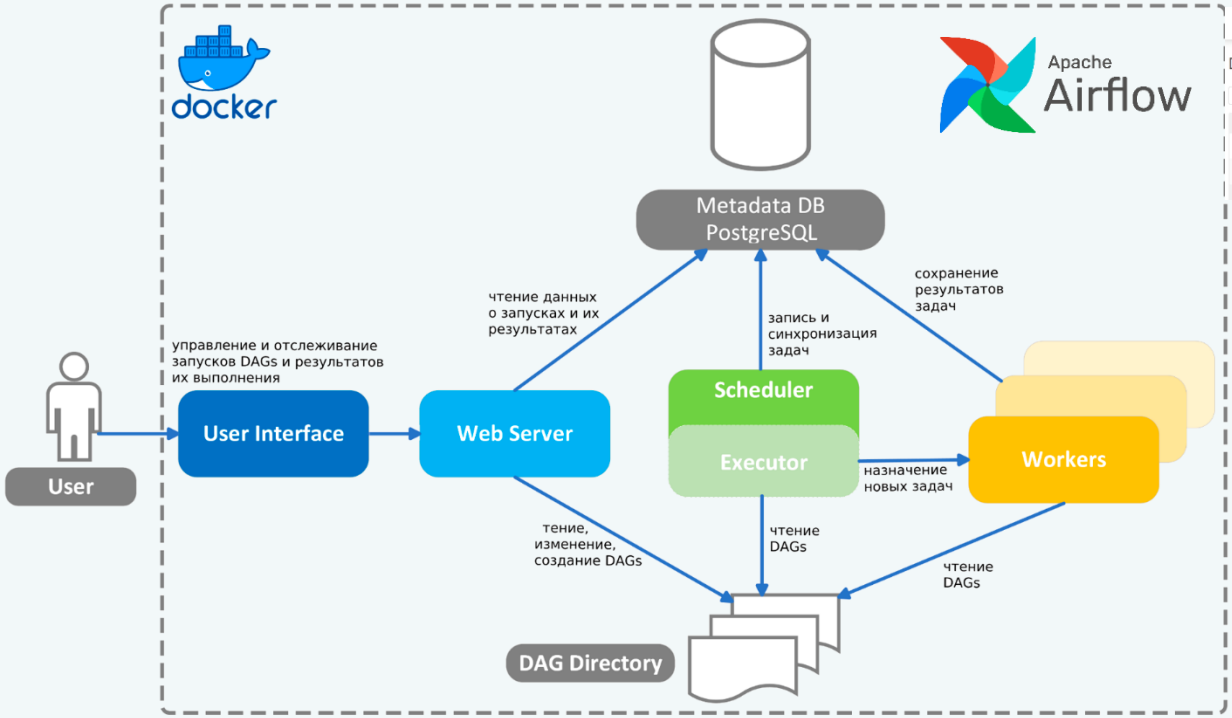


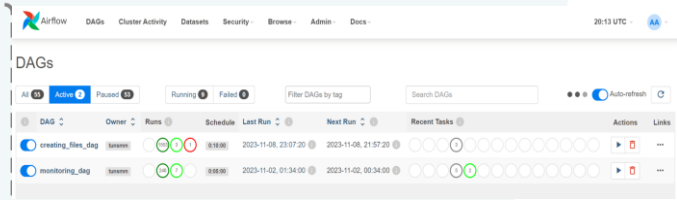


Workflow Management Service

implemented through Apache Airflow

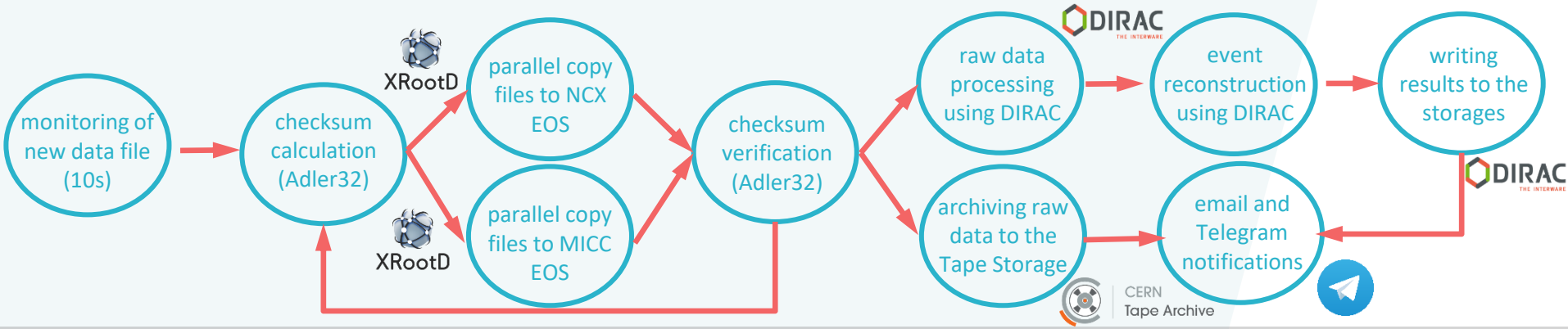
BM@N Orchestration with Workflow Manager





Airflow DAGs can be used for repeating data processing of simulation and experimental events

Airflow DAG for online transferring to the EOS storages, archiving to the Tape Storage and running online data processing using DIRAC



Electronic Logbook Platform

Online Information System

Electronic Logbook (e-Log Platform)

create a new run

advanced search

current day records

user cabinet (event subs)

work with dictionaries

records per page

file attachments

username

page

fast search

BM@N Electronic Logbook

bmn-elog.jinr.ru

Logged in as shift

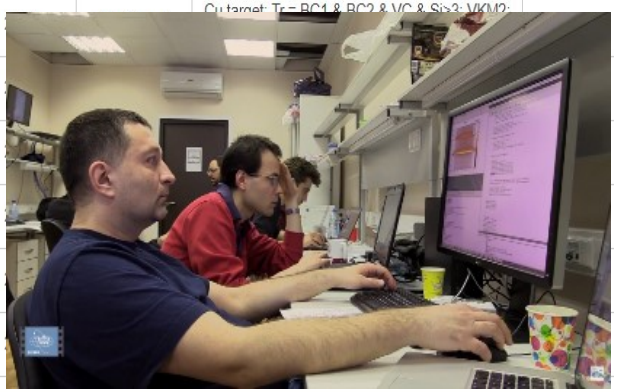
Home New Find Last day Account Reference Book

Page: 1 of 282

Number of items per page: 10

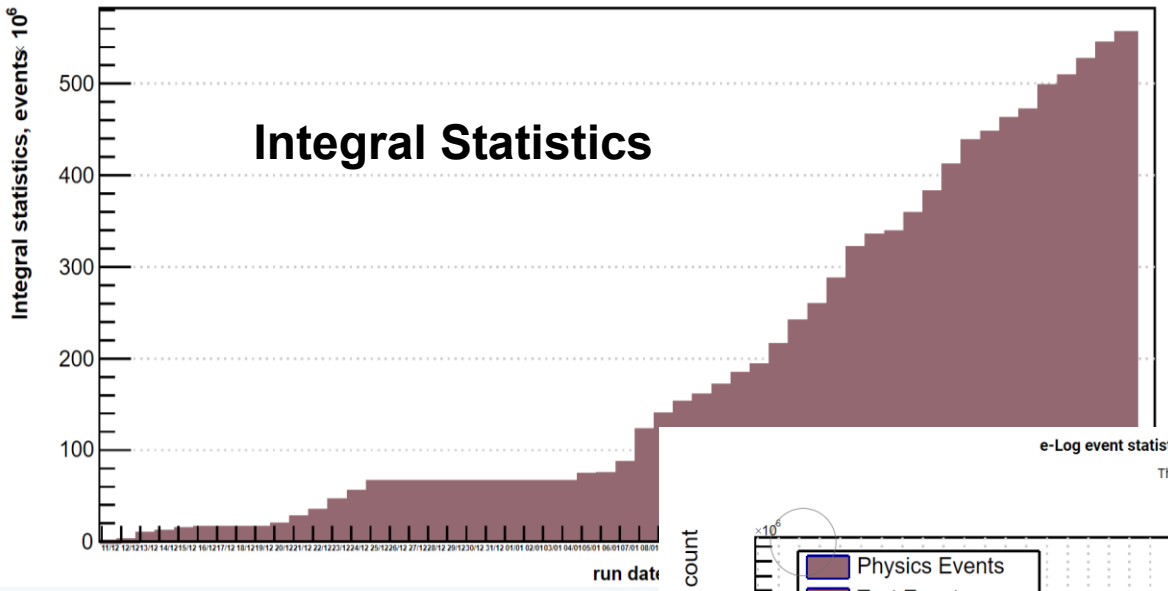
Logout

Date	Shift Leader	Type	№ 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				
2018-04-05 07:25:08	Babkin	New Run	5179 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr				
2018-04-05 06:01:07	Babkin	New Run	5178 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr				
2018-04-05 05:27:39	Babkin	New Run	5177 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr				
2018-04-05 05:27:06	Babkin	New Run	5176 per.7	Beam Trigger + BD>3	All	1250	50	125	Kr				
2018-04-05 04:47:27	Babkin	New Run	5174 per.7	Beam Trigger + BD>3	All	1250	50	125	Kr				



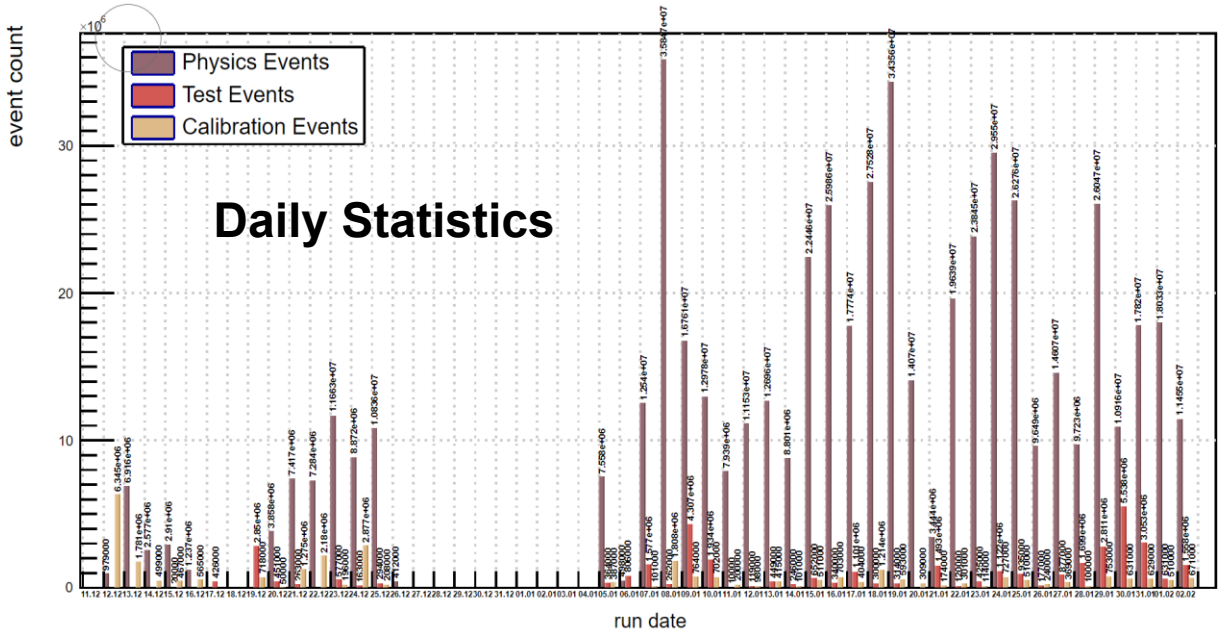
2020 - software team (contact e-mail: gertsen@jinr.ru)

Online Statistics of the e-Log Platform



e-Log event statistics (Run 8): statistics by event type / integral statistics of physics events

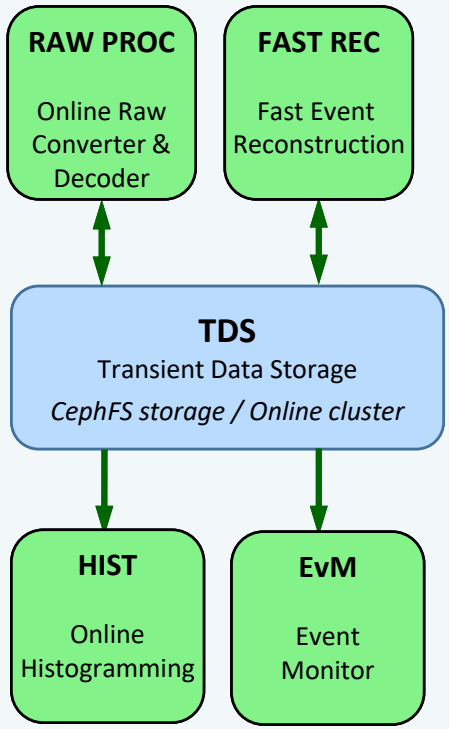
The information is current as of February 20 2023 23:59.



Online Configuration System

Online Data Processing

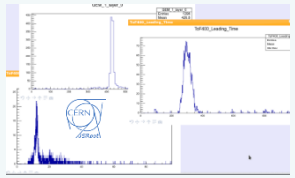
Online Process Control



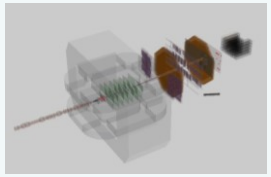
Online Processing

start → monitor → control → restart → stop

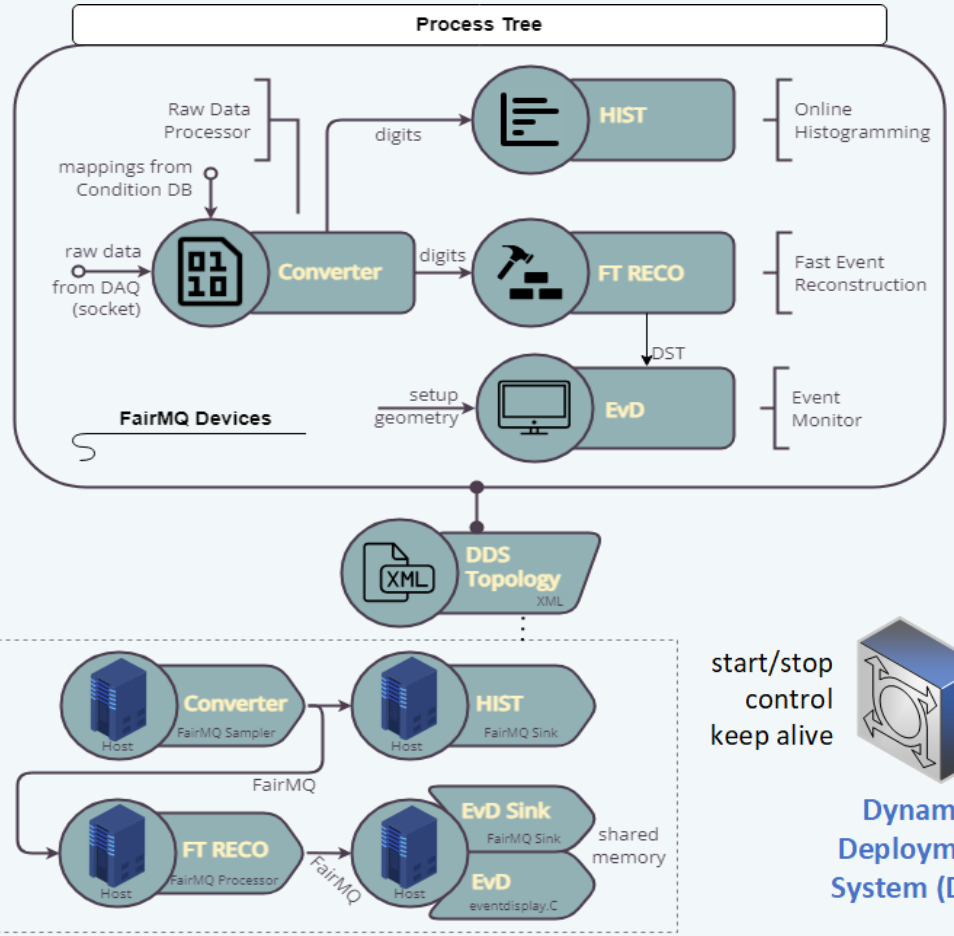
BM@N Configuration Online Platform (COP)

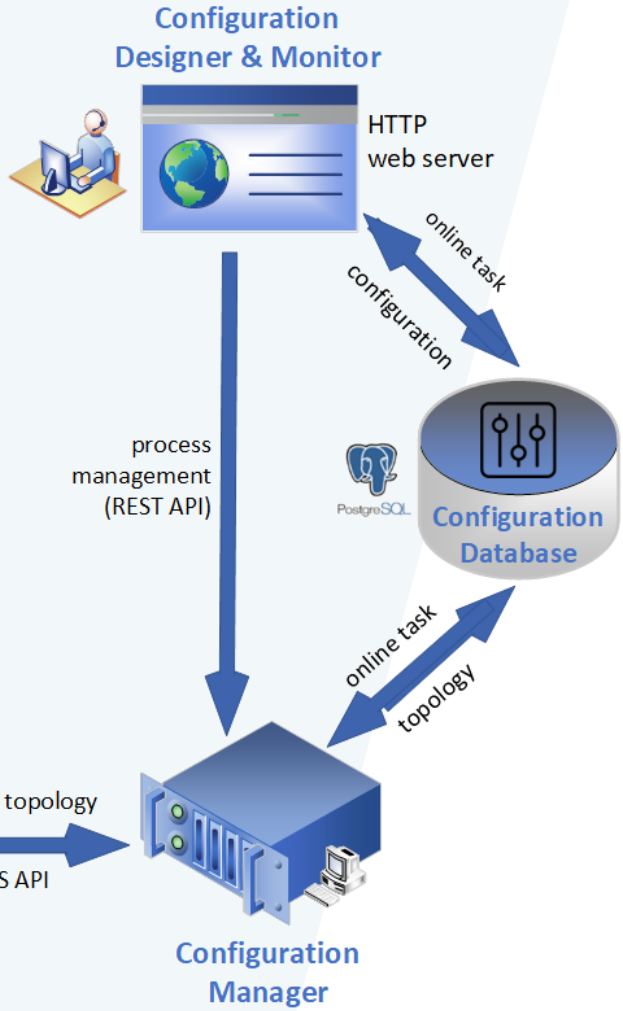


Online Histogramming System

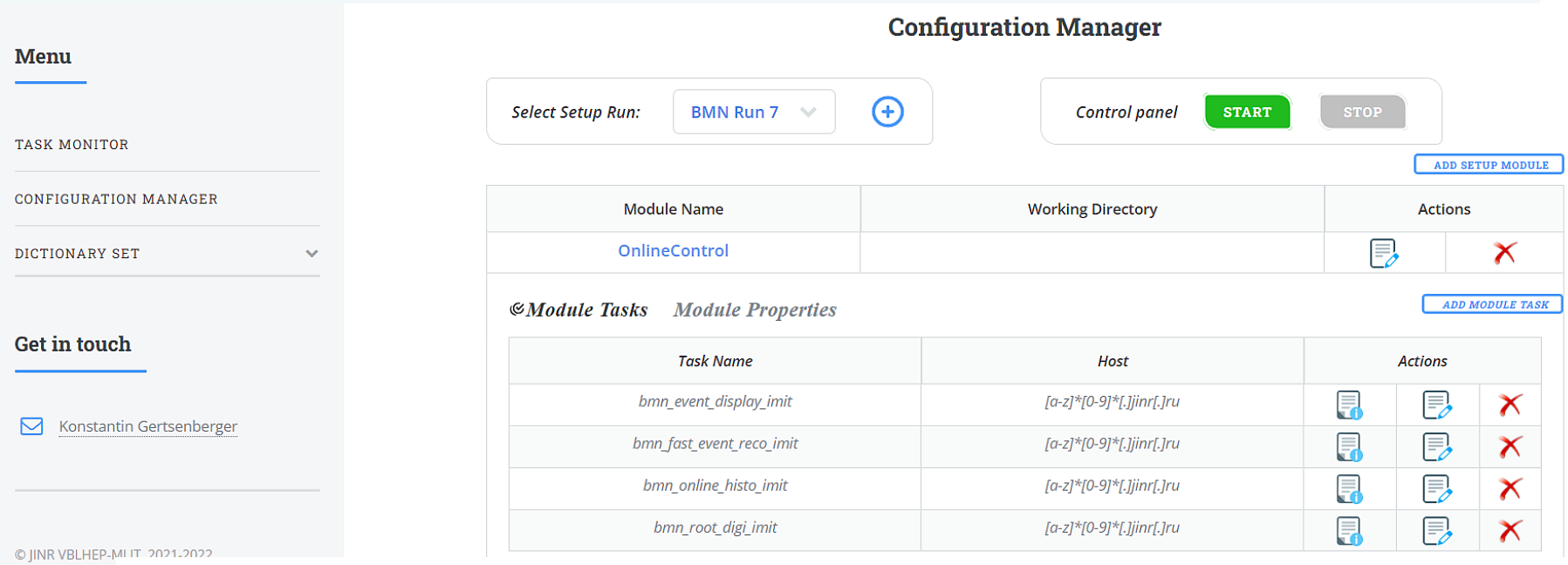


Event Monitor





COP. *Configuration Designer & Monitor*



Condition Database (UniConDa)

Offline Information System

UniConDa in BM@N offline processing

detector simulation
raw data processing
event reconstruction
physics analysis

ROOT-based framework

C++ interface
(connect, I/O, API)

http

REST API service

node.JS

Condition Database

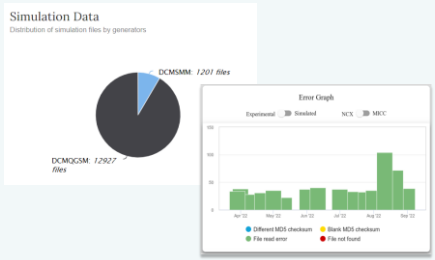
viewing and managing parameter data

users

Keycloak ↕ authentication authorization

Web Service

python service for auto updating of metadata on simulation files

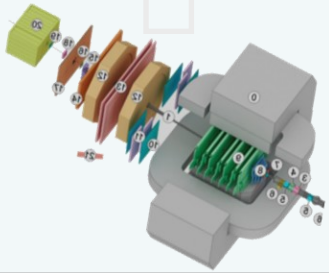


python service for automatic regular checking of file integrity

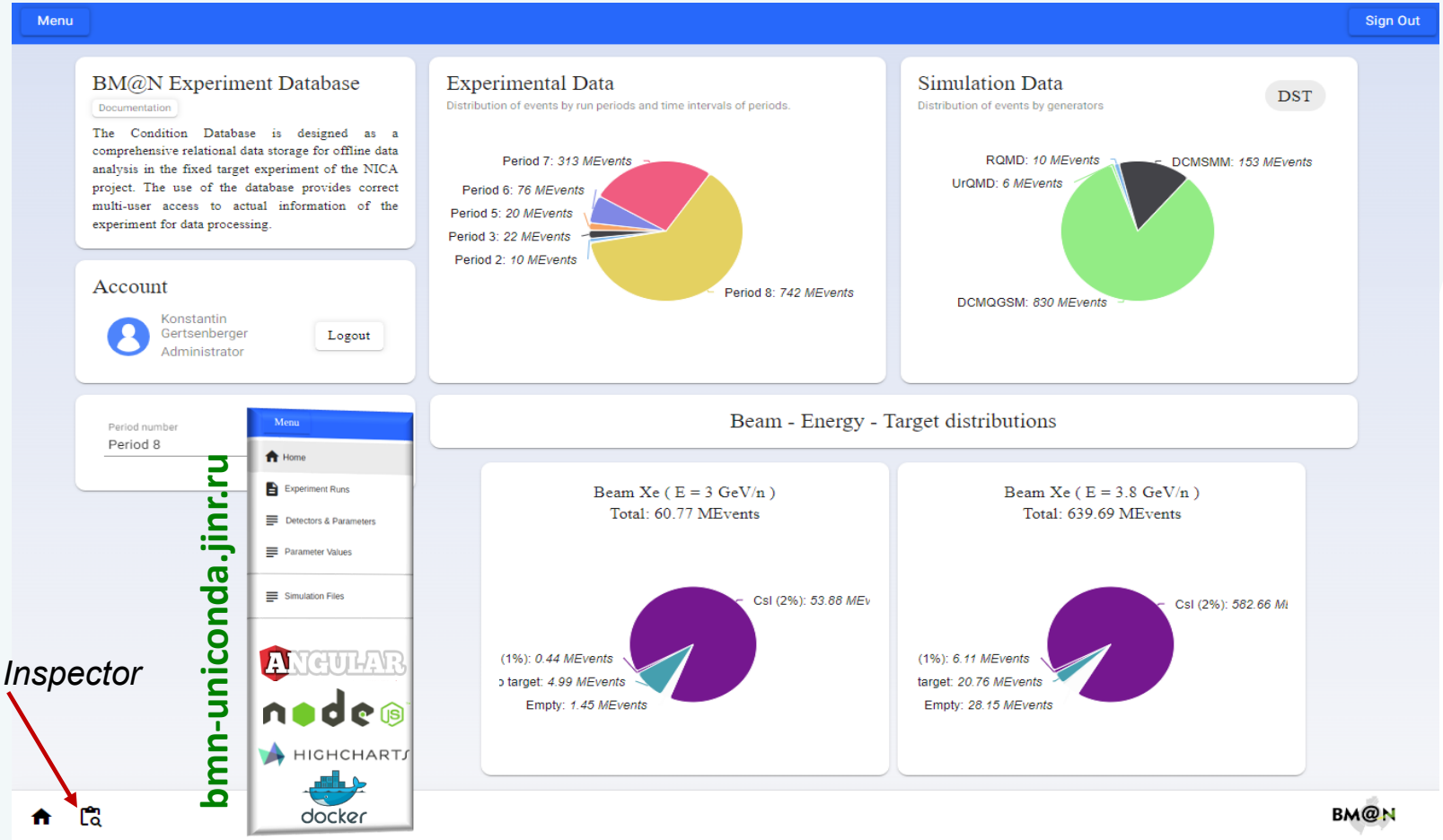
configuration calibration

data

parameter algorithm



UniConDa. *Web Application*



File Inspector

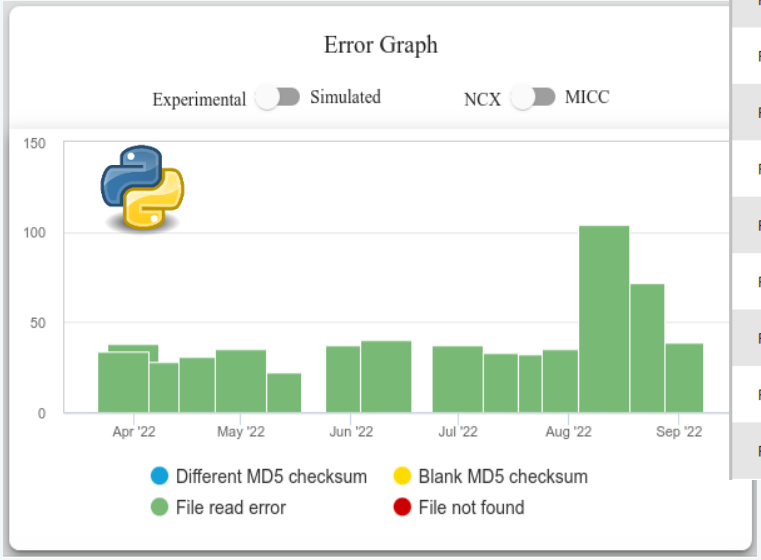
- visualization of summary data in the form of diagrams and charts
- convenient viewing, managing and searching for up-to-date information on the BM@N experiment in tabular view by collaboration members

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



File Inspector

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

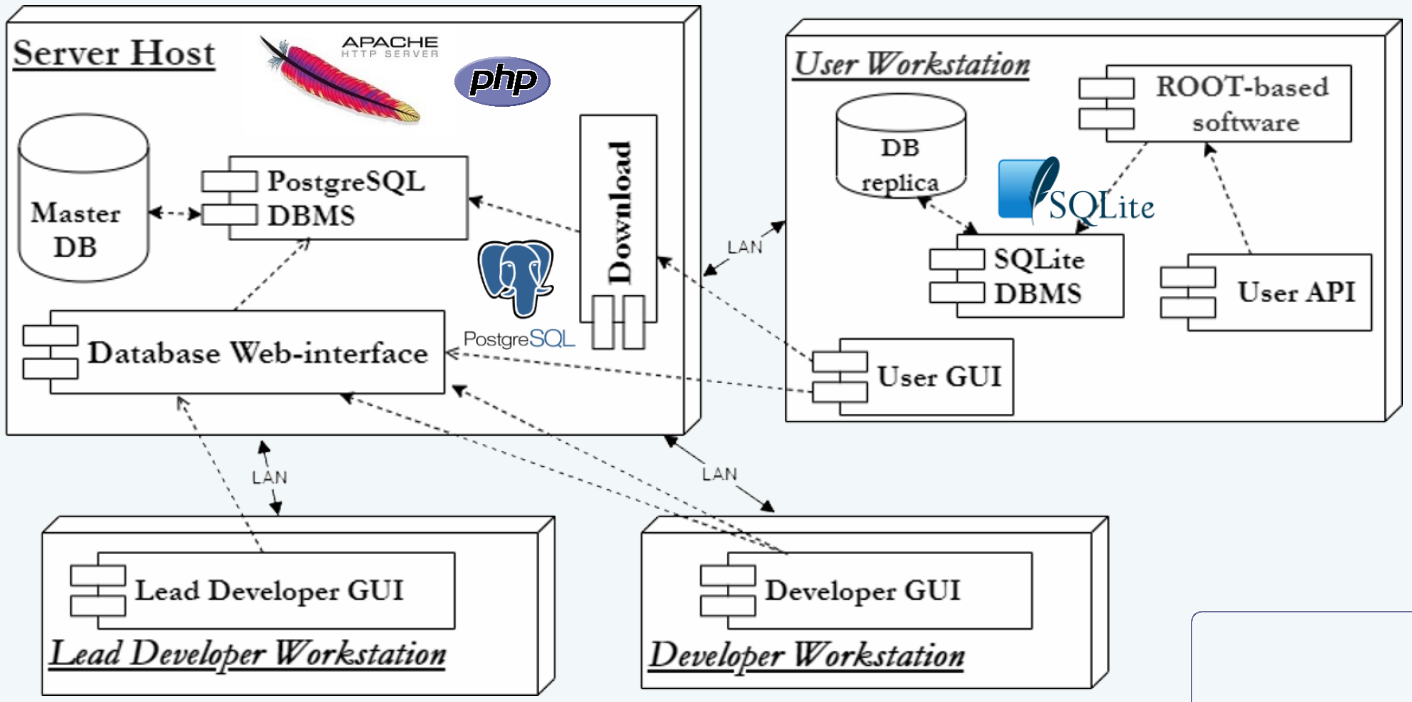
contains information on integrity checks and found errors with details

Crontab

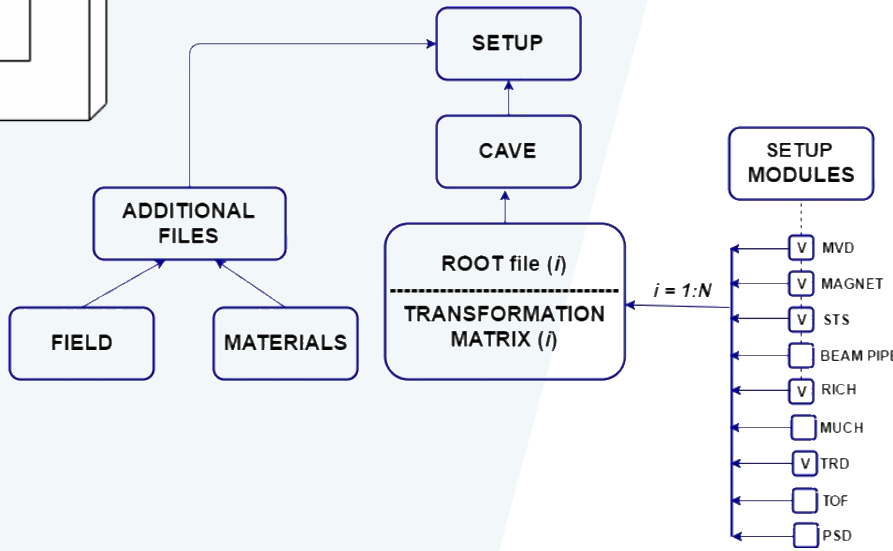
Geometry Database

Offline Information System

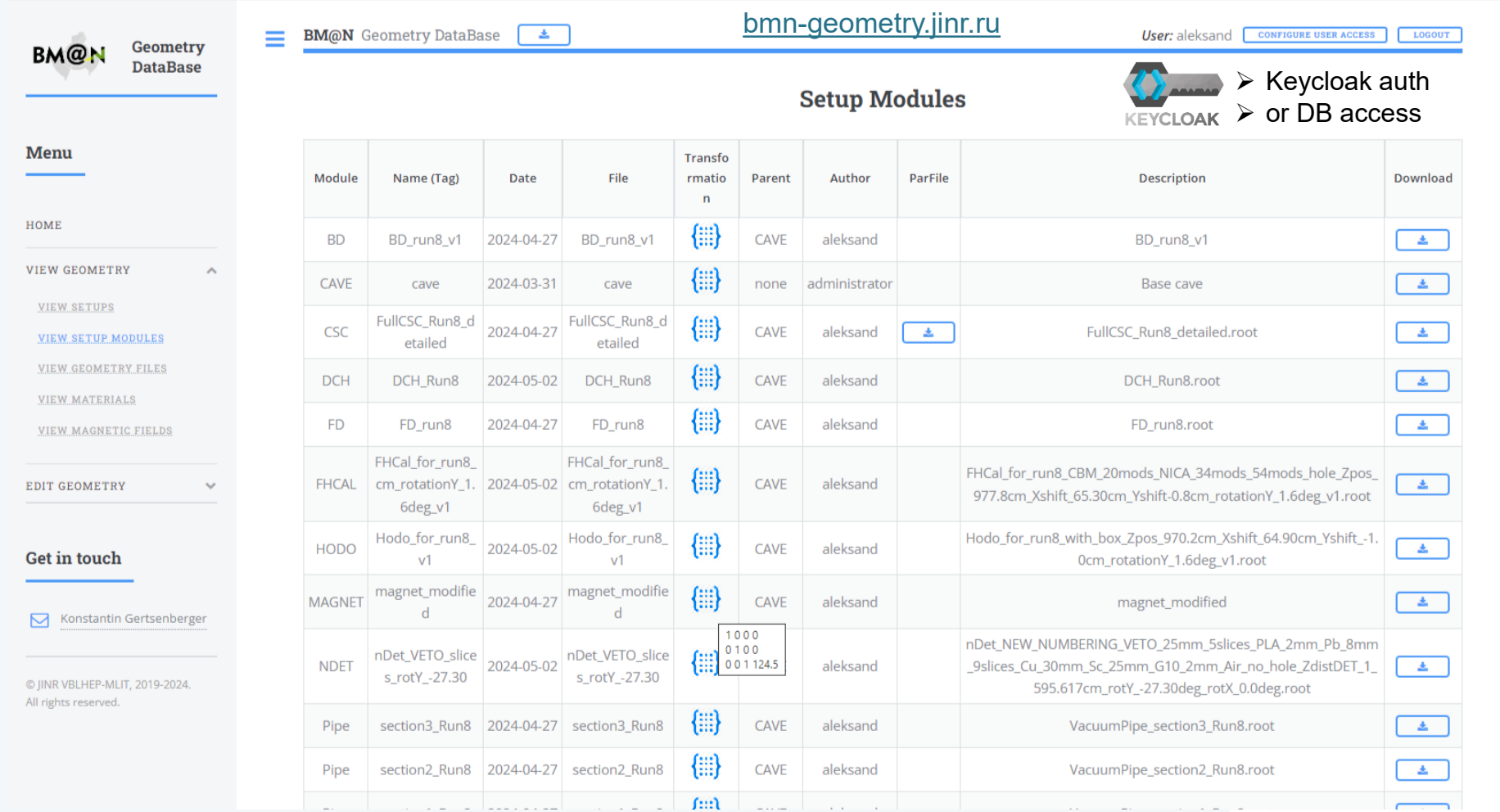
Geometry Information System. *Architecture*



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



Geometry Information System. *Web Platform*



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

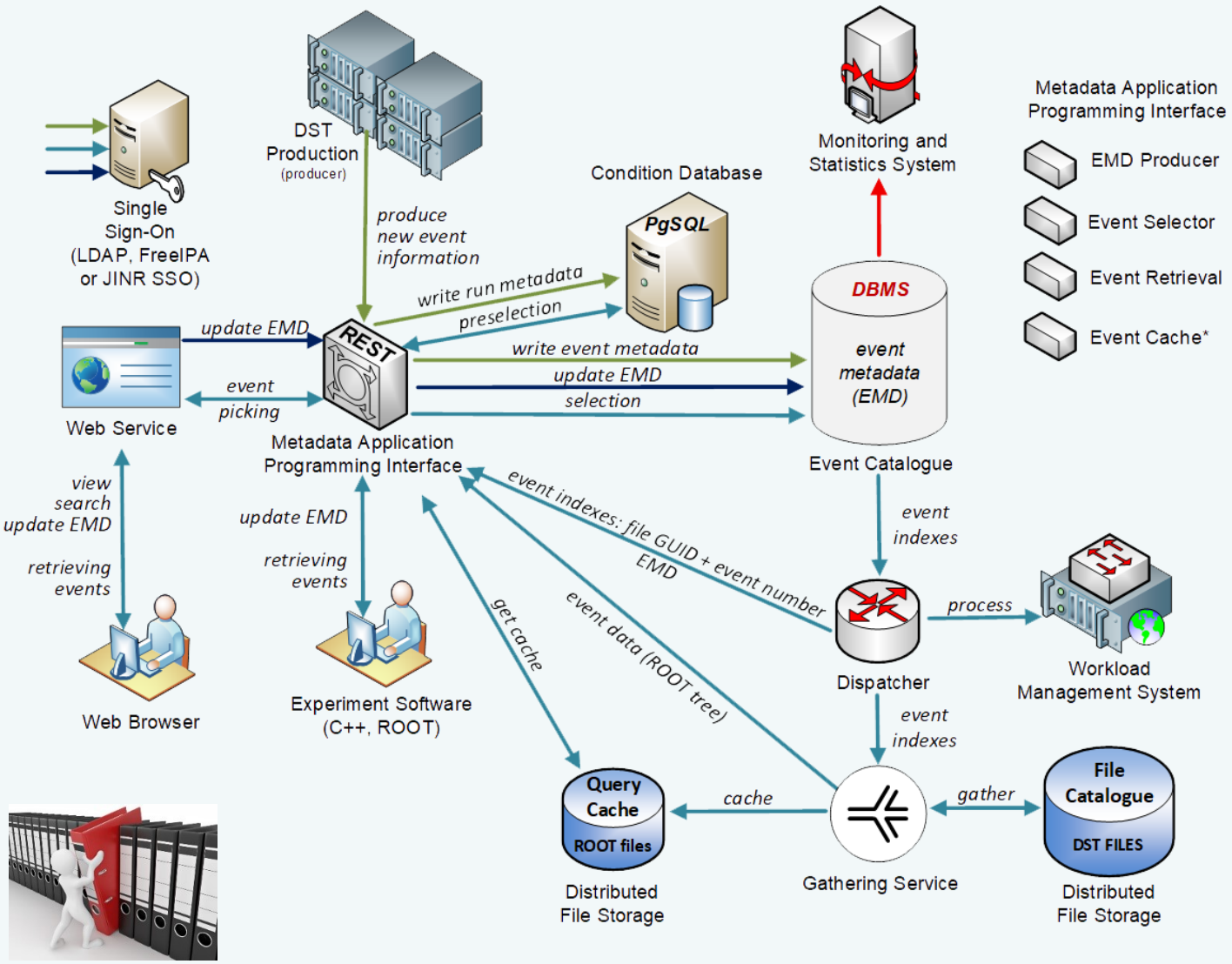
User Interface Functions:

View Add Edit Approve Download

Event Metadata System

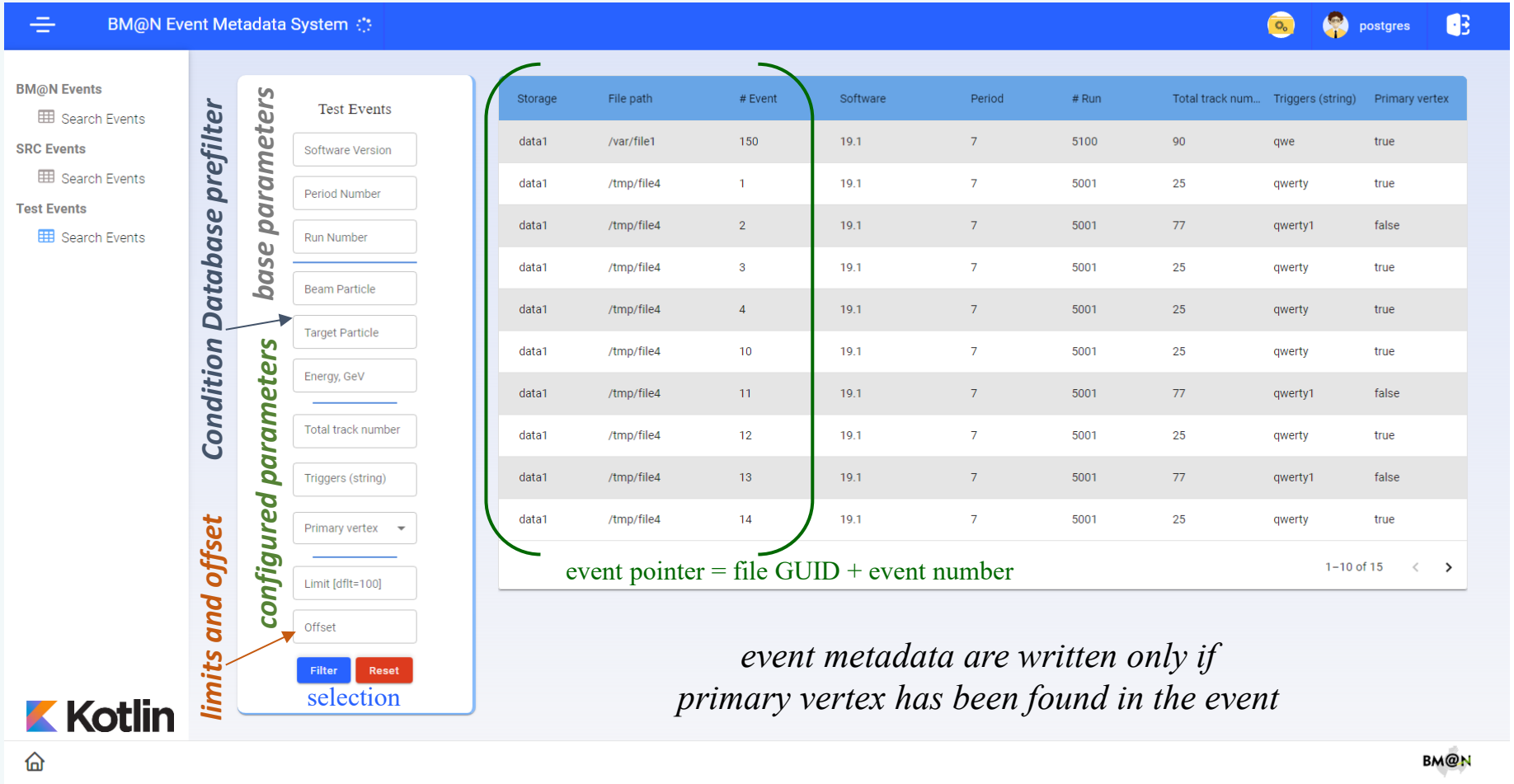
Offline Information System

Event Metadata System for BM@N



- Event Catalogue based on PostgreSQL
- Integrated with the Condition Database
- REST API and Web UI developed on Kotlin multiplatform
- Configurable to support arbitrary metadata
- Service for automatic writing new event metadata to the Catalogue
- Role-based access control
- Monitoring System

Event Catalogue. *Web Interface*



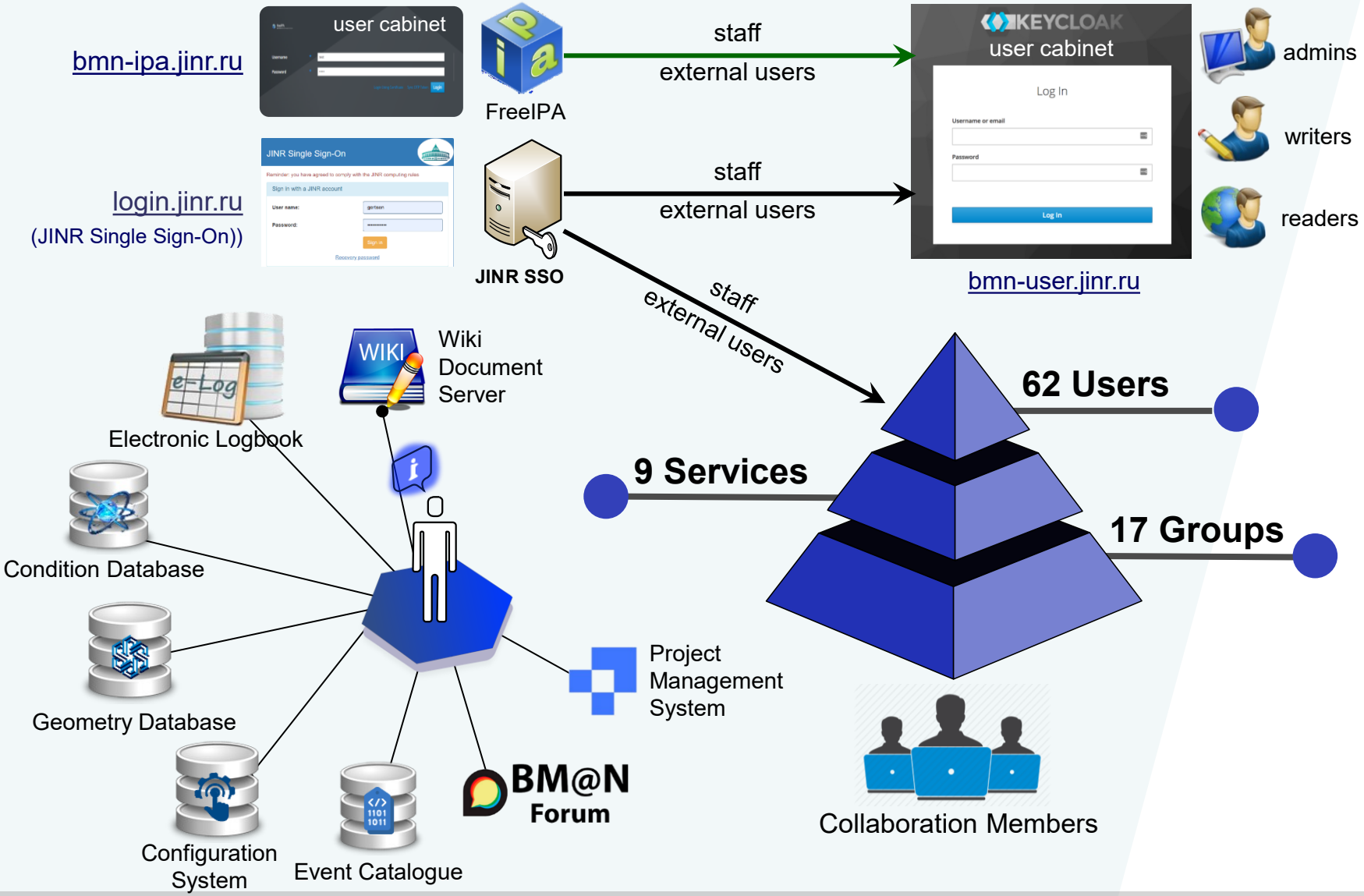
event metadata are written only if primary vertex has been found in the event

- enables users to browse and quickly 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

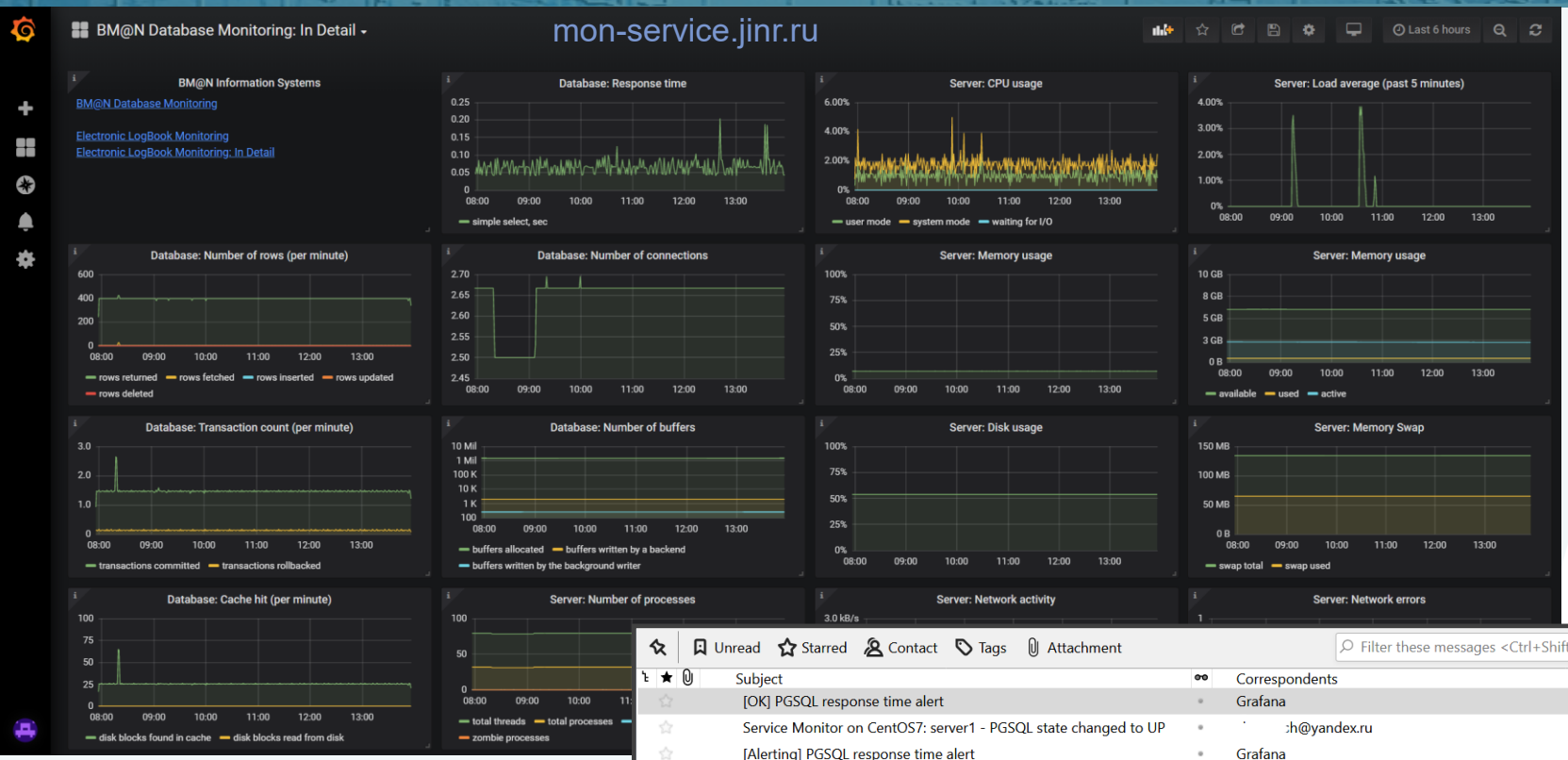
Software Infrastructure Service

improving the efficiency and reliability

Single Sign-On (SSO) System for BM@N



Monitoring System for BM@N software complex



Telegraf

influxdb

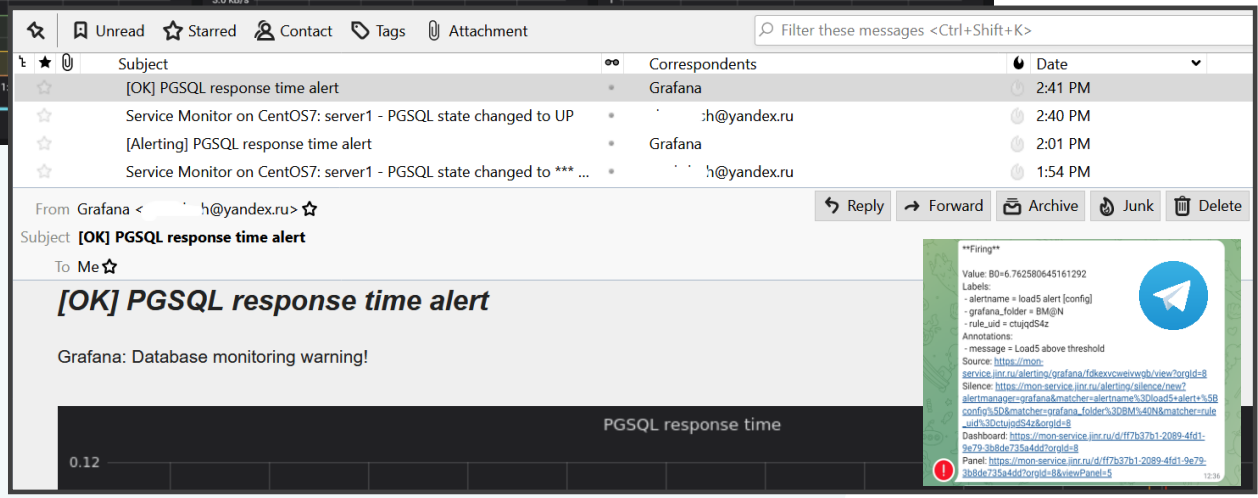
Grafana

- hosts
- databases
- web-sites

- Condition Database
- Electronic Logbook
- Configuration database
- Integrity Inspector

...

Email and Telegram Alerting



В цикл работ входят 25 публикаций

1. K. Gertsenberger, I. Pelevanyuk, P. Klimai, and A. Chebotov, "*Computing Software Architecture for the BM@N Experiment*", Phys. Part. Nuclei **55**, 338–342 (2024)
2. K. Gertsenberger, I. Pelevanyuk, "*BM@N Run 8 Data Processing on a Distributed Infrastructure with DIRAC*", Phys. Part. Nucl. Lett. **21**. 778–781 (2024)
3. N. Balashov, "*JINR Container Distribution Service*", Phys. Part. Nuclei **55**, 482–484 (2024)
4. K. Gertsenberger, P. Klimai, O. Nemova, "*Development of Monitoring Service for BM@N Information Systems*", Phys. Part. Nucl. Lett. **21**, 793–796 (2024)
5. E. Alexandrov, I. Alexandrov, A. Chebotov, K. Gertsenberger, I. Filozova, D. Priakhina, G. Shestakova, and A. Yakovlev, "*Development of the Online Configuration System for the BM@N Experiment* ", Phys. Part. Nuclei **55**, 433–436 (2024)
6. E. Alexandrov, I. Alexandrov, A. Chebotov, A. Degtyarev, I. Filozova, K. Gertsenberger, P. Klimai, and A. Yakovlev, "*Implementation of the Event Metadata System for physics analysis in the NICA experiments*", Journal of Physics: Conference Series **2438**, 012046 (2023)
7. E. Alexandrov, I. Alexandrov, A. Chebotov, K. Gertsenberger, I. Filozova., D. Priakhina, and G. Shestakova, "*Configuration Information System for online processing and data monitoring in the NICA experiments*", Journal of Physics: Conference Series **2438**, 012019 (2023)
8. A. Chebotov, A. Degtyarev, K. Gertsenberger, and P. Klimai, "REST API and Web Interface for the Event Metadata System of the BM@N Experiment", Phys. Part. Nucl. Lett. 20, 1527–1530 (2023)
9. A. Chebotov, K. Gertsenberger, A. Moshkin, and I. Slepov, "Common Deployment Complex for the Information Systems of the BM@N Experiment", Phys. Part. Nucl. Lett. 20, 1269–1271 (2023)
10. K. Gertsenberger, P. Klimai, M. Zelenyi, "Auxiliary Services for the Condition Database of the BM@N Experiment at NICA", Phys. Part. Nucl. Lett. 20, 1217–1219 (2023)

В цикл работ входят 25 публикаций

11. E. Alexandrov, I. Alexandrov, A. Chebotov, K. Gertsenberger, I. Filozova, D. Priakhina, and G. Shestakova, “Status of the Configuration Information System for the NICA experiments “, Phys. Part. Nucl. Lett. 19, 543–546 (2022)
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13. A. Chebotov, K. Gertsenberger, P. Klimai, and A. Moshkin, “Information System Based on the Condition Database for the NICA Experiments, User WEB Application, and Related Services”, Phys. Part. Nucl. Lett. 19, 558–561 (2022)
14. K. Gertsenberger, I. Alexandrov, I. Filozova, E. Alexandrov, A. Moshkin, A. Chebotov, M. Mineev, D. Pryahina, G. Shestakova, A. Yakovlev, A. Nozik, and P. Klimai, “Development of Information Systems for Online and Offline Data Processing in the NICA Experiments”, Phys. Part. Nuclei 52, 801-807 (2021)
15. A. Chebotov, K. Gertsenberger, I. Slepov, and A. Moshkin, “Electronic Logbook platform for NICA experiments”, AIP Conf. Proc. 2377, 040003 (2021)
16. E. Akishina, E. Alexandrov, I. Alexandrov, I. Filozova, K. Gertsenberger, and V. Ivanov, “Development of a Geometry Database and Related Services for the NICA experiments”, Phys. Part. Nuclei 52, 842-846 (2021)
17. E. Alexandrov, I. Alexandrov, A. Degtyarev, K. Gertsenberger, I. Filozova, P. Klimai, A. Nozik, and A. Yakovlev, “Design of the Event Metadata System for the Experiments at NICA”, Phys. Part. Nucl. Lett. 18, 603-616 (2021)
18. K. Gertsenberger, A. Chebotov, P. Klimai, I. Alexandrov, E. Alexandrov, I. Filozova, and A. Moshkin, “Implementation of the Condition Database for the Experiments of the NICA Complex”, CEUR Workshop Proceedings 3041, 128–132 (2021)
19. E. Akishina, E. Alexandrov, I. Alexandrov, I. Filozova, K. Gertsenberger, V. Ivanov, D. Priakhina, and G. Shestakova, “Development of the Geometry Database for the BM@N Experiment of the NICA Project”, EPJ Web Conf. 226, 03001 (2020)
20. K. Gertsenberger, A. Chebotov, I. Alexandrov, I. Filozova., and E. Alexandrov, “Design of the Condition Database for online and offline data processing in experimental setups of the NICA complex” (in russian), Izvestiya SFedU. Engineering Sciences 217, no.7, 172-180 (2020)

В цикл работ входят 25 публикаций

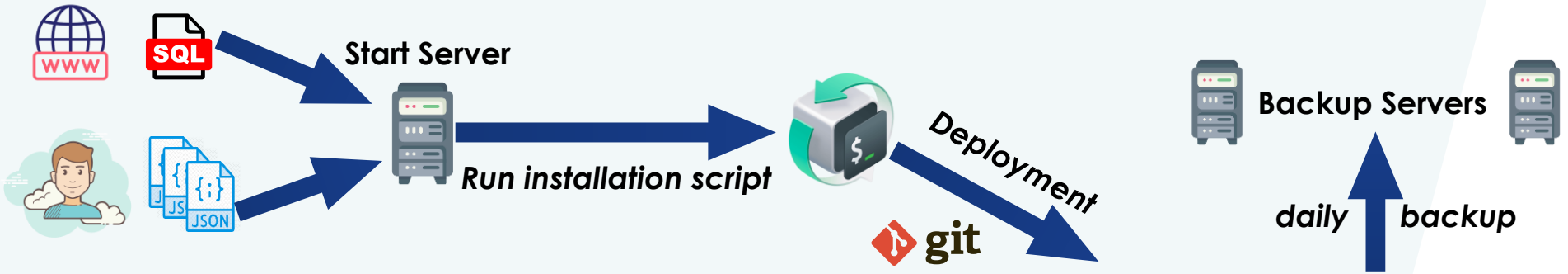
21. A. Chebotov, K. Gertsenberger, “Development of web-service for Unified Database of the BM@N experiment at NICA”, AIP Conf. Proc. 2163, 040002 (2019)
22. K. Gertsenberger, A. Moshkin, A. Chebotov, “Development of the Electronic Logbook for the BM@N Experiment at NICA”, CEUR Workshop Proceedings 2507, 175–179 (2019)
23. E. Alexandrov, I. Alexandrov, K. Gertsenberger, M. Mineev, A. Moshkin, D. Pryahina, I. Filozova, A. Chebotov, G. Shestakova, and A. Yakovlev, “Information Systems for Online and Offline Data Processing in Modern High-energy Physics Experiments” (in russian), International scientific journal «Modern Information Technologies and IT-Education» 15, no.3, 654-671 (2019)
24. K. Gertsenberger, O. Rogachevsky, “The Unified Database for BM@N experiment data handling”, EPJ Web Conf. 177, 05001 (2018)
25. E. Akishina, E. Alexandrov, I. Alexandrov, I. Filozova, V. Friese, K. Gertsenberger, V. Ivanov, and O. Rogachevsky, “Geometry Database for the CBM experiment and its first application to the experiments of the NICA project”, CEUR Workshop Proceedings 2267, 504–508 (2018)

Thank you for your attention!

thanks to the DAQ, CICC, NCX & HybriLIT teams for computing support

contact email: *gertsen@jinr.ru*

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", …
```

rsync

Crontab

Tracking updates

```
~]# 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

docker

Web Server

docker

```
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
```

https://git.jinr.ru/nica_db/codes
https://git.jinr.ru/nica_db/elog_platform
https://git.jinr.ru/nica_db/uniconda_platform
https://git.jinr.ru/nica_db/geo_platform

NICA Accelerator Complex

- Beams: from $p, d^{\uparrow}$ to Bi
- Luminosity: 10^{27} (Bi), 10^{32} (p) $cm^{-2}s^{-1}$
- Collision energy: $\sqrt{S_{NN_{BI}}}$ = *4 – 11 GeV* E_{lab} = *1 – 5 AGeV*
- Fixed target experiment: BM@N (2018)
- 2 interaction points: MPD (2025) & SPD (2028)
- Official site: *nica.jinr.ru, bmn.jinr.ru*