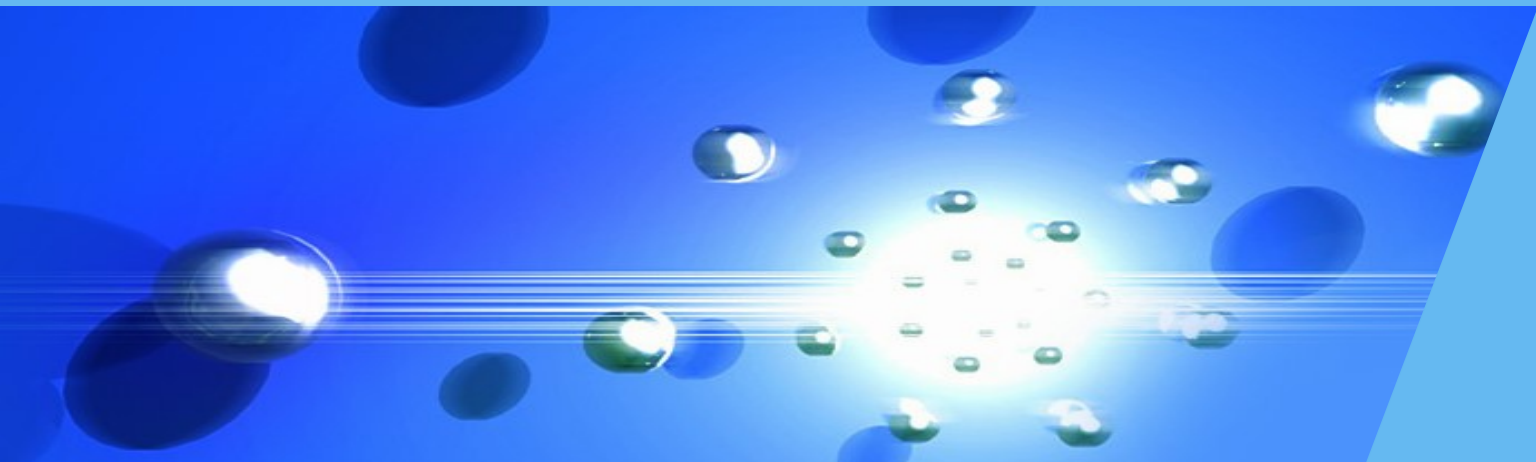




11th Collaboration Meeting of the BM@N Experiment at the NICA Facility



BM@N Software Roadmap *When is it time to pick some fruits?*

Konstantin Gertsenberger

V. Veksler and A. Baldin Laboratory of High Energy Physics
Joint Institute for Nuclear Research



28-30 November 2023



November 30, 2023

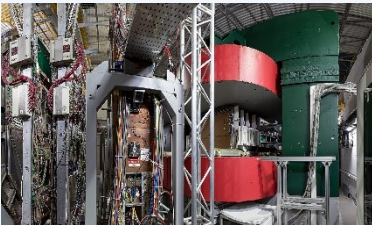
Reports on Software Status (*since May 19, 10th CM*)



*Distributed Computing and Grid Technologies
in Science and Education*

(July 4, 2023)

BM@N Computing Software Architecture and its use
for the mass production



Analysis & Software Meeting of the BM@N Experiment

(September 13, 2023)

BM@N Software Progress and Issues while Data Processing



Осенняя Школа по информационным технологиям ОИЯИ

(October 19, 2023)

Программные системы обработки данных эксперимента
BM@N на комплексе NICA



11th Collaboration Meeting of the BM@N experiment

(November 30, 2023)

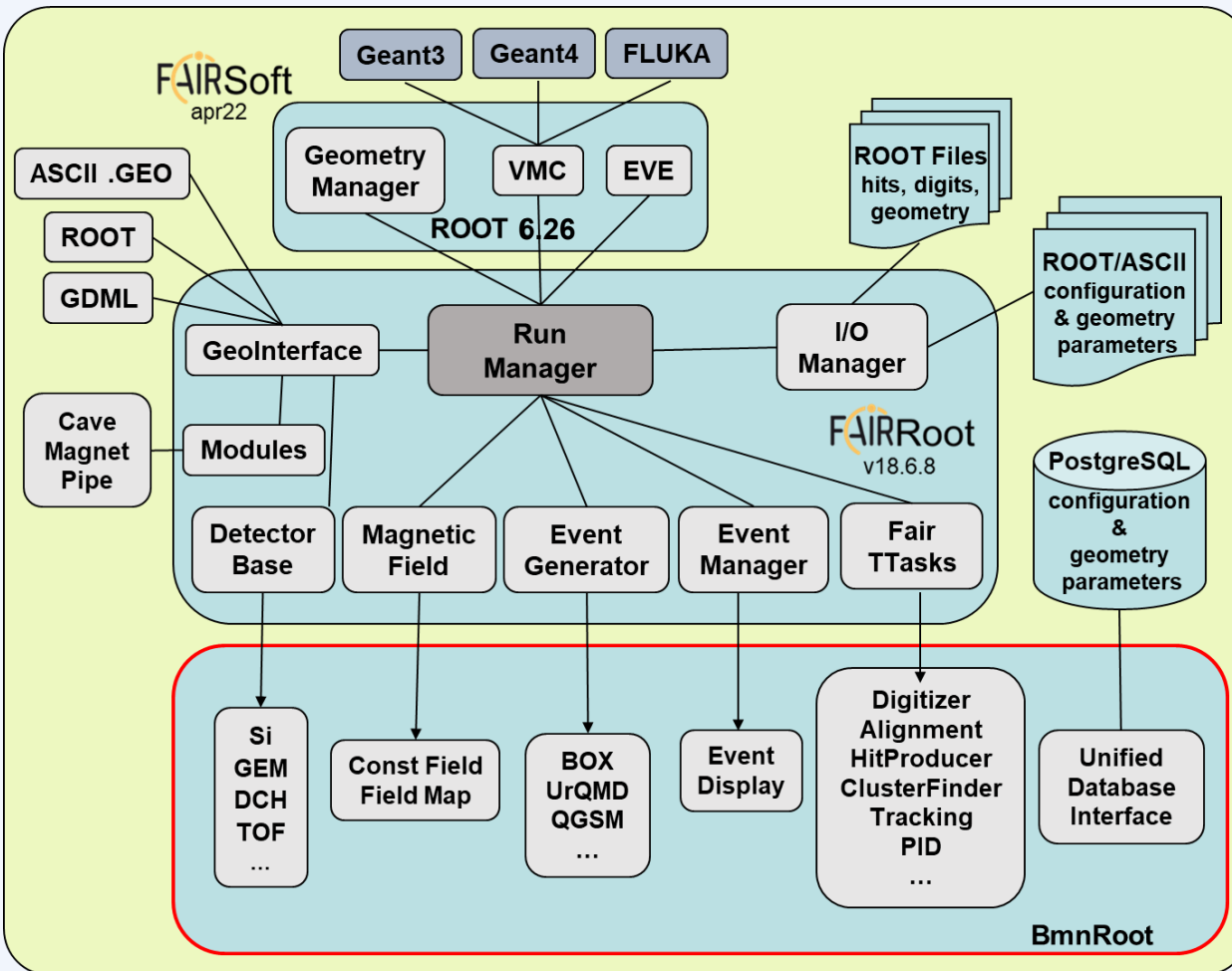
BM@N Software Roadmap

BmnRoot Framework as a central software system

BmnRoot. Architecture

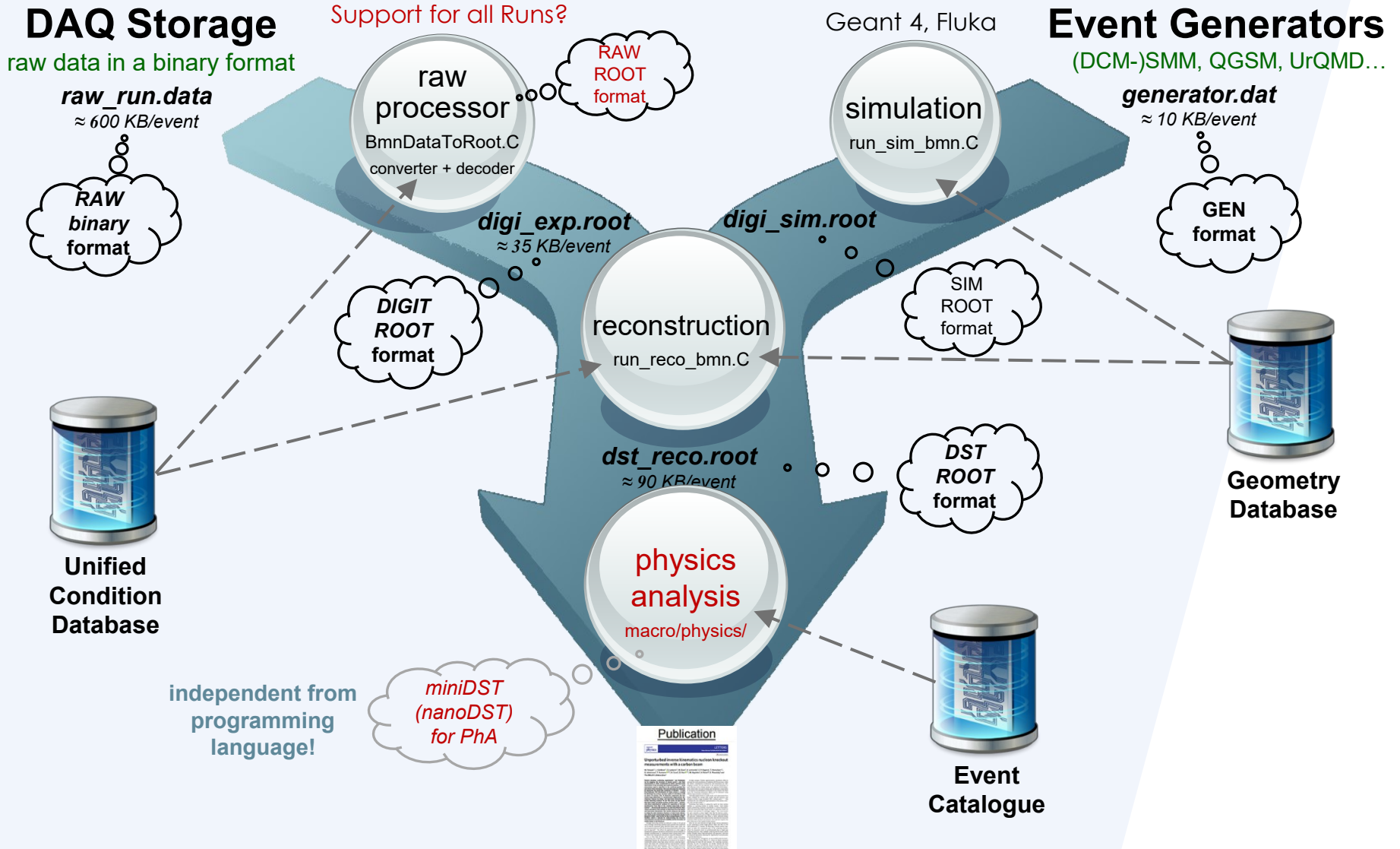
FAIRSoft apr22
FAIRRoot v18.6.8

BmnRoot Release with latest simulation, reconstruction, analysis and software improvements is required to perform full official mass production with Run 8 data



- Use **FairSoft** external packages **ROOT 6**, **XRootD**, **Pythia**, **HepMC**, **VGM**, **MillePede**, **Geant4**, **GSL**, **Boost**, **DDS...** (the last release – nov22)
- Use **FairRoot** as a set of base classes and modules of needed by the **BM@N** experiment
- Clean **BM@N** software systems from the **SRC** data
- BmnRoot** supports **AlmaLinux 9** now (follows the use of **CentOS 7**)
- Particle propagation** by **Geant4** (**VMC** interface)
- Three versions of the tracking: **CellAuto** for Run 7, **CBM L1** for Run 8 in online, **VectorFinder** for Run 8 in offline
- New installation script for **FairSoft** and **FairRoot** is preferable
bmn.jinr.ru/software-installation

BmnRoot. Event Data Model



BmnRoot. Simulation & Reconstruction Status

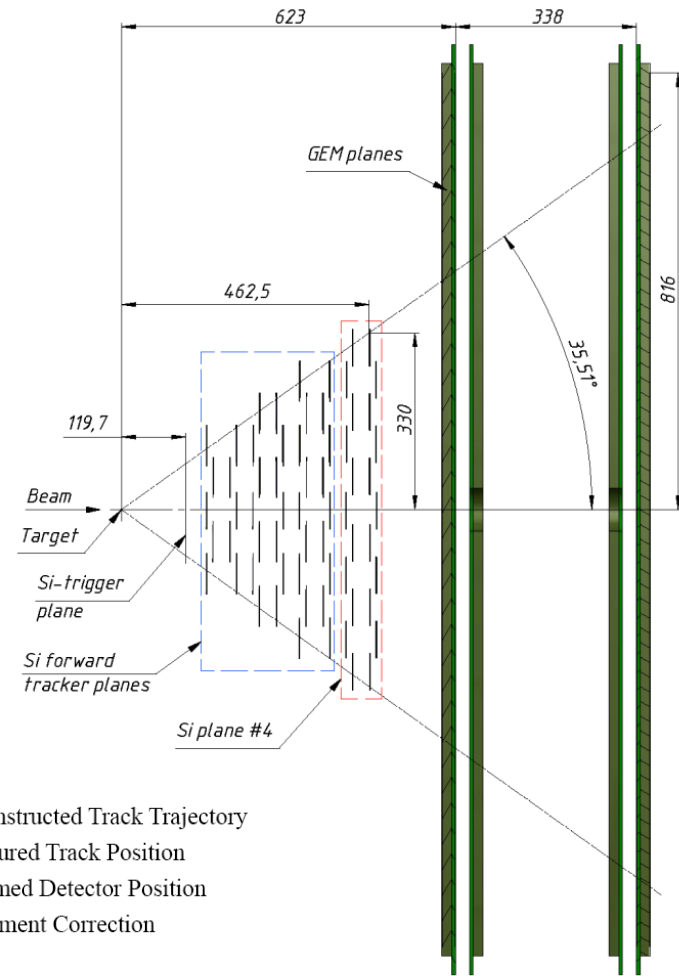
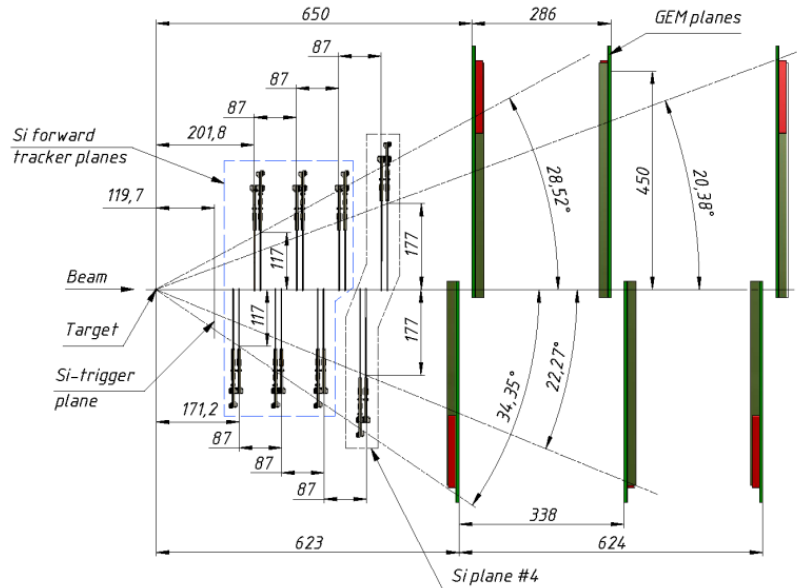
Simulation Completeness	Detector	Geometry	MC classes	Digitizer	RECO	Comments	Reconstruction Completeness (exp. data)
	Beampipe	✓	—	—	—		
	Target	✓	—	—	—		
	SiMD	✓	✓	✓	—		
	BD	✓	✓	✓	—		
	FD	✓	✓	✗	—		
	FSD	✓	✓	✓	✓		
	GEM	✓	✓	✓	✓		
	SiBT	✓	✓	✓	✓		
	CSC	✓	✓	✓	✓		
	LCSC	✓	✓	✓	✓		
	DCH	✓	✓	✓	✓		
	TOF-400	✓	✓	—	✓		
TOF-700	✓	✓	—	✓			
HGN	✓	✓	✓	✓			
FHCal	✓	✓	✓	✓			
FQH	✓	✓	✓	✓			
ScWall	✓	✓	✓	✓			

Detector	Digi	Local reco (hits/tracks)	Global tracks	Comment
SiMD	✓	—	—	
BD	✓	—	—	
FD	✓	—	—	
FSD	✓	✓	✓	
GEM	✓	✓	✓	
SiBT	✓	✓	—	Need to be added in Vertex Finder
CSC	✓	✓	✗	Alignment needed
LCSC	✓	✓	✗	Alignment needed
DCH	✓	✓✗	✗	Problems with multiplicity
TOF-400	✓	✓	✗	Alignment and proton peak calibration needed
TOF-700	✓	✓	✗	Alignment and proton peak calibration needed
HGN	✓	✓	—	
FHCal	✓	✓	—	
FQH	✓	✓	—	
ScWall	✓	✓	—	

BmnRoot. *Detector Alignment*

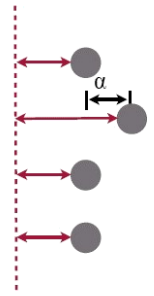
Alignment Tools

- IMSL Fortran Library
- Eigen
- Millepede-II



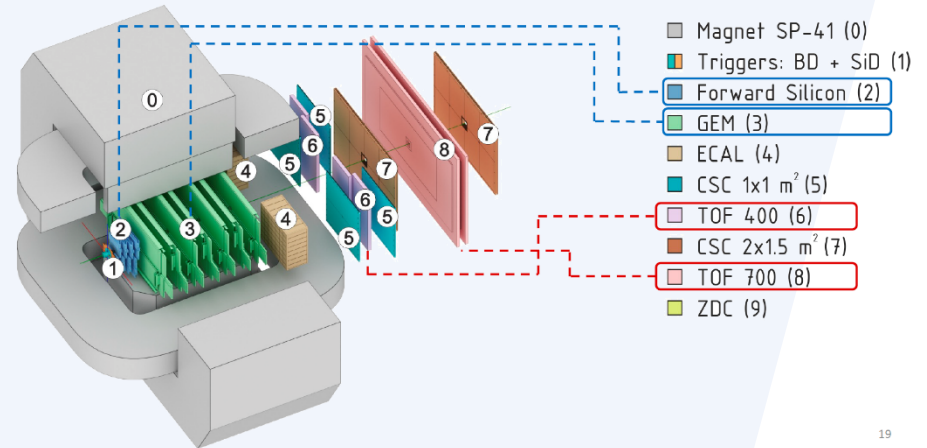
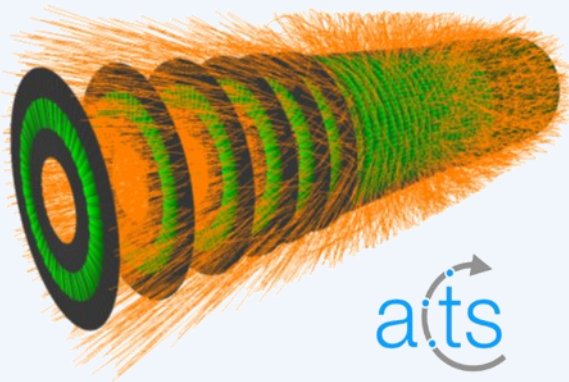
S_2	0	0	0	0	S_1	0	0	0	0	Z_2	Z_3	Z_4	Z_5
0	S_2	0	0	0	0	S_1	0	0	0	Z_2	Z_3	Z_4	Z_5
0	0	S_2	0	0	0	0	S_1	0	0	Z_2	Z_3	Z_4	Z_5
0	0	0	S_2	0	0	0	0	S_1	0	Z_2	Z_3	Z_4	Z_5
0	0	0	0	S_2	0	0	0	0	S_1	Z_2	Z_3	Z_4	Z_5
S_1	0	0	0	0	N_d	0	0	0	0	1	1	1	1
0	S_1	0	0	0	0	N_d	0	0	0	1	1	1	1
0	0	S_1	0	0	0	0	N_d	0	0	1	1	1	1
0	0	0	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	$\sum_i Ax_i^0$
...	...	$\sum_i Ax_i^0$...

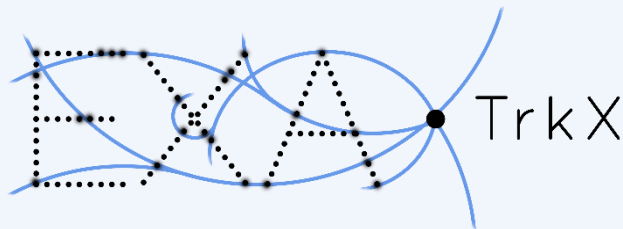


- - - Reconstructed Track Trajectory
- $\leftarrow\rightarrow$ Measured Track Position
- \bullet Assumed Detector Position
- α Alignment Correction

Machine Learning for Reconstruction and PID

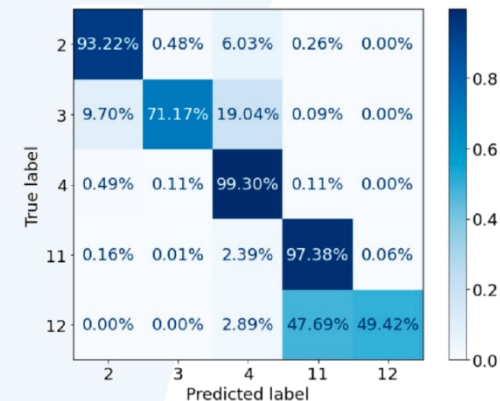
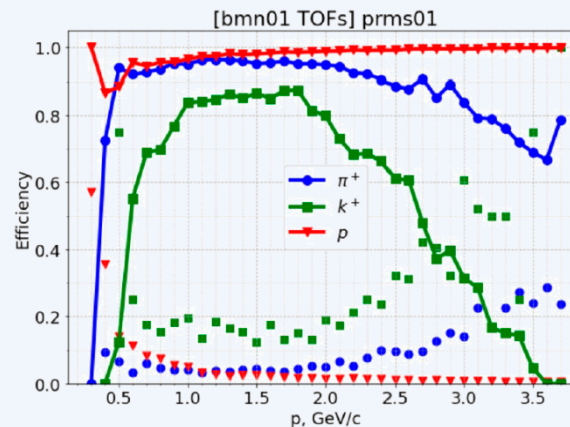


Tracking machine learning challenge
(developers from ATLAS, LHCb, FCC-hh)



HEP advanced tracking algorithms
at the exascale
(Caltech, FNAL, Princeton, SLAC...)

Nikolay ERSHOV
Own implementation of Fast Event
Reconstruction based on NN/ML
(scheduled for 12th Collaboration Meeting)



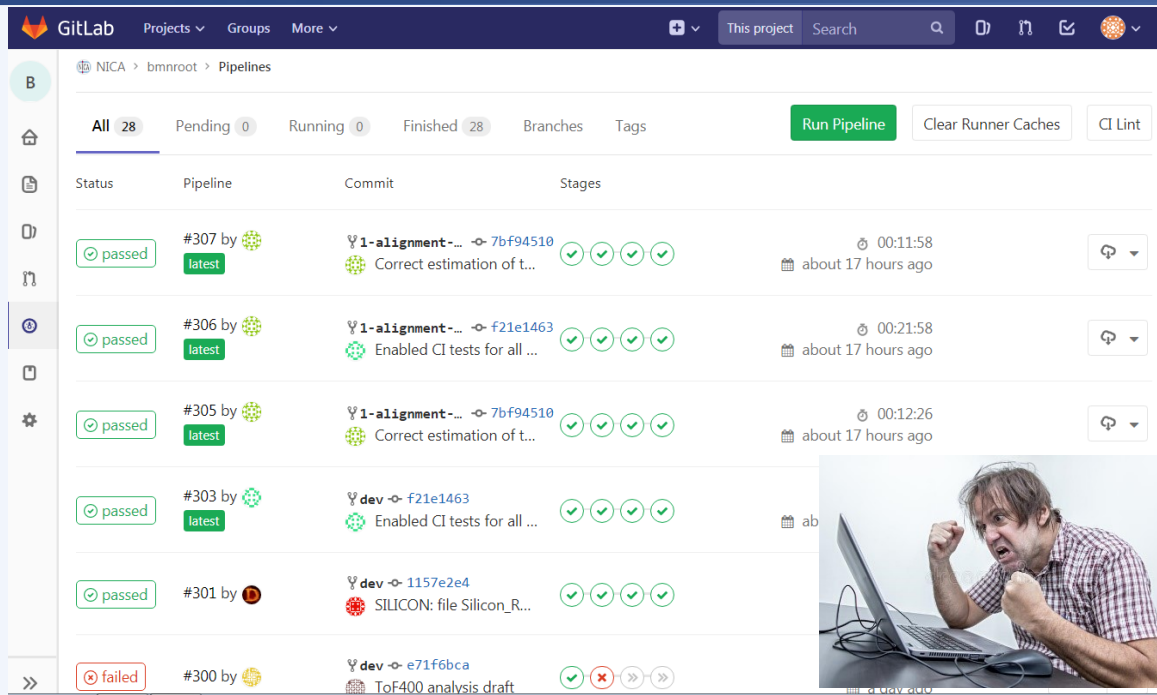
Alexander AYRIYAN, Vladimir PAPOYAN
Implementation of Particle IDentification
based on Machine Learning
(scheduled for 12th Collaboration Meeting)

Docker/Apptainer Containers for BmnRoot

- User Docker Containers with BmnRoot software
 - base image = OS + FairSoft + FairRoot
 - users do not need to install software – just run the BmnRoot container
 - hosting computer can potentially run any operating system
 - great for short-period students and fast analysis
 - BmnRoot (& its dockers) is automatically built and published with GitLab CI
- Apptainers for using BmnRoot Containers
 - 2 containers (on AlmaLinux 9 & Ubuntu 22.04) with full local installation
 - 2 containers with CernVM-FS client to the central JINR CVMFS repository
 - The Installation Procedure: <https://bmn.jinr.ru/software-installation>
- Dockers for testing BmnRoot before MR in GitLab CI
 - simplify CI-infrastructure using BmnRoot Pipelines
 - quickly add any OS environments to CI pipelines (CentOS 7 / Ubuntu 20.04)
- Jupyter Notebook for simple physics analysis



Automatic BmnRoot (& its dockers) Deployment

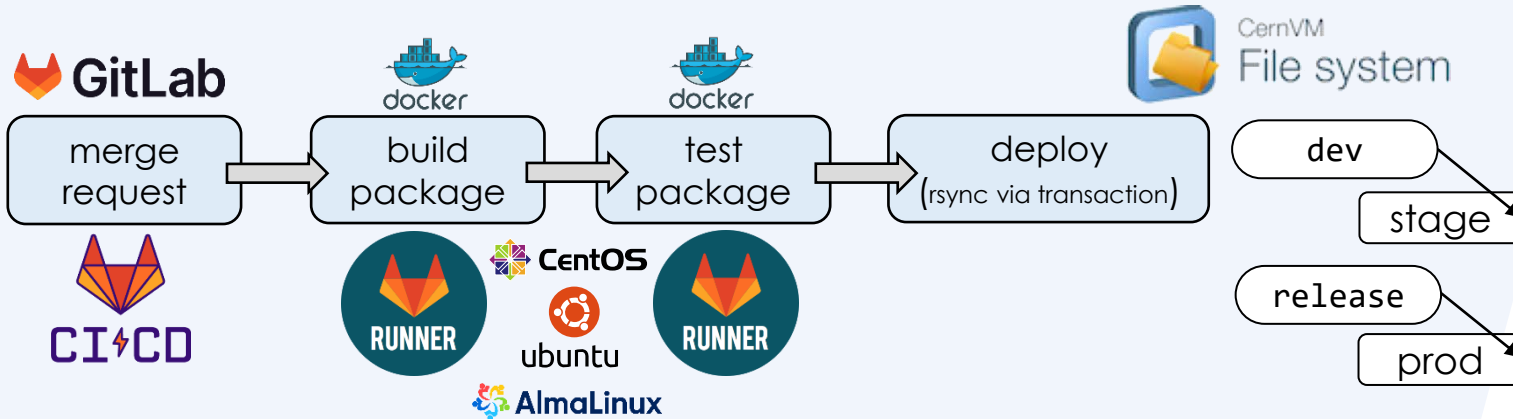


GIT CI Tests on merge requests
checking compilation and main macros
→ stable *dev* and *pro* branches

In case of compilation failure or macro errors
e-mail is sent to the software developers

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



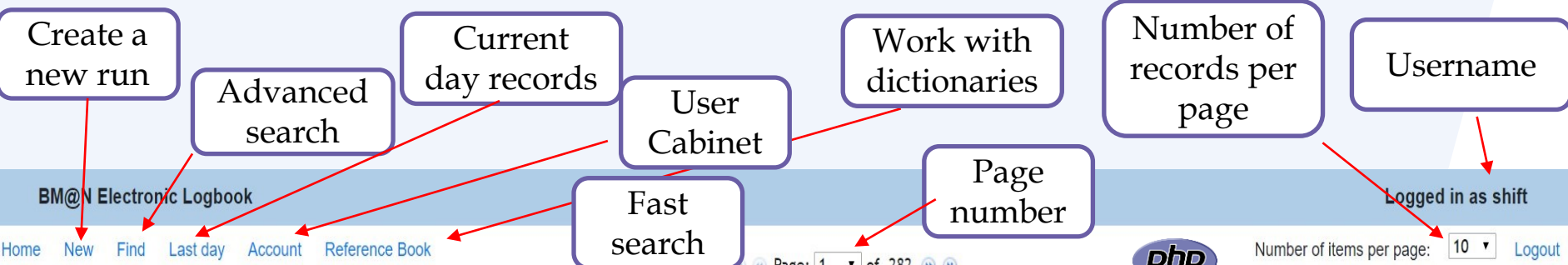
```

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

Electronic Logbook Platform

Online Information System

e-Log Platform. *User Web Interface*



BM@N Electronic Logbook

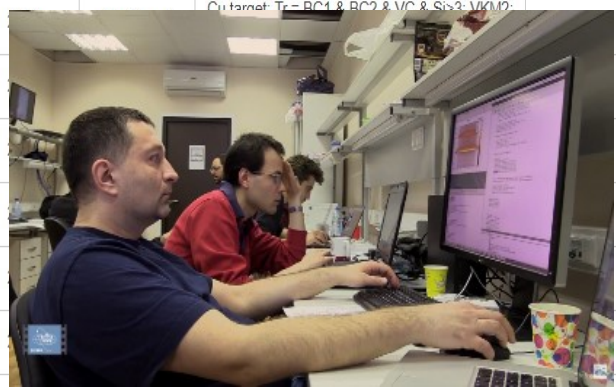
Home [New](#) [Find](#) [Last day](#) [Account](#) [Reference Book](#)

Page: 1 of 282

Number of items per page: 10 Logout

Logged in as shift

Date	Shift Leader	Type	No 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			Cu target; Tr.= BC1 & BC2 & VC & Si>3 VKM2:	
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)

e-Log Platform. *Shift Crew Records*

BM@N Electronic Logbook

Logged in as admin

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

[Logout](#)

Shift Leader	<input type="text" value="Rumyantsev"/>	<input type="button" value="Add New >>"/>
Type	<input type="text" value="Inform All"/>	<input type="button" value="Add New >>"/>
Period	<input type="text" value="7"/>	
№ Run	<input type="text" value="5186"/>	
Trigger	<input type="text" value="Special Trigger"/>	<input type="button" value="Add New >>"/>
DAQ Status	<input type="text" value="All"/>	
SP-41, A	<input type="text" value="0"/>	
SP-57, A	<input type="text" value="0"/>	
VKM2, A	<input type="text" value="0"/>	
Beam	<input type="text" value="Kr"/>	<input type="button" value="Add New >>"/>
Energy, GeV	<input type="text" value="2.94"/>	
Target	<input type="text" value="Cu"/>	<input type="button" value="Add New >>"/>
Target Width, mm	<input type="text" value="2"/>	
Comment	<input type="text"/>	

Attachments:

№	File
Choose file(s) to upload	
<input type="button" value="Выбрать файлы"/> Файл не выбран	

Features:

Access rights: database roles (administrator, shift operator, user) → **Keycloak, JINR SSO**

Multi-Column Sorting

Data Filtration

Easy Searching

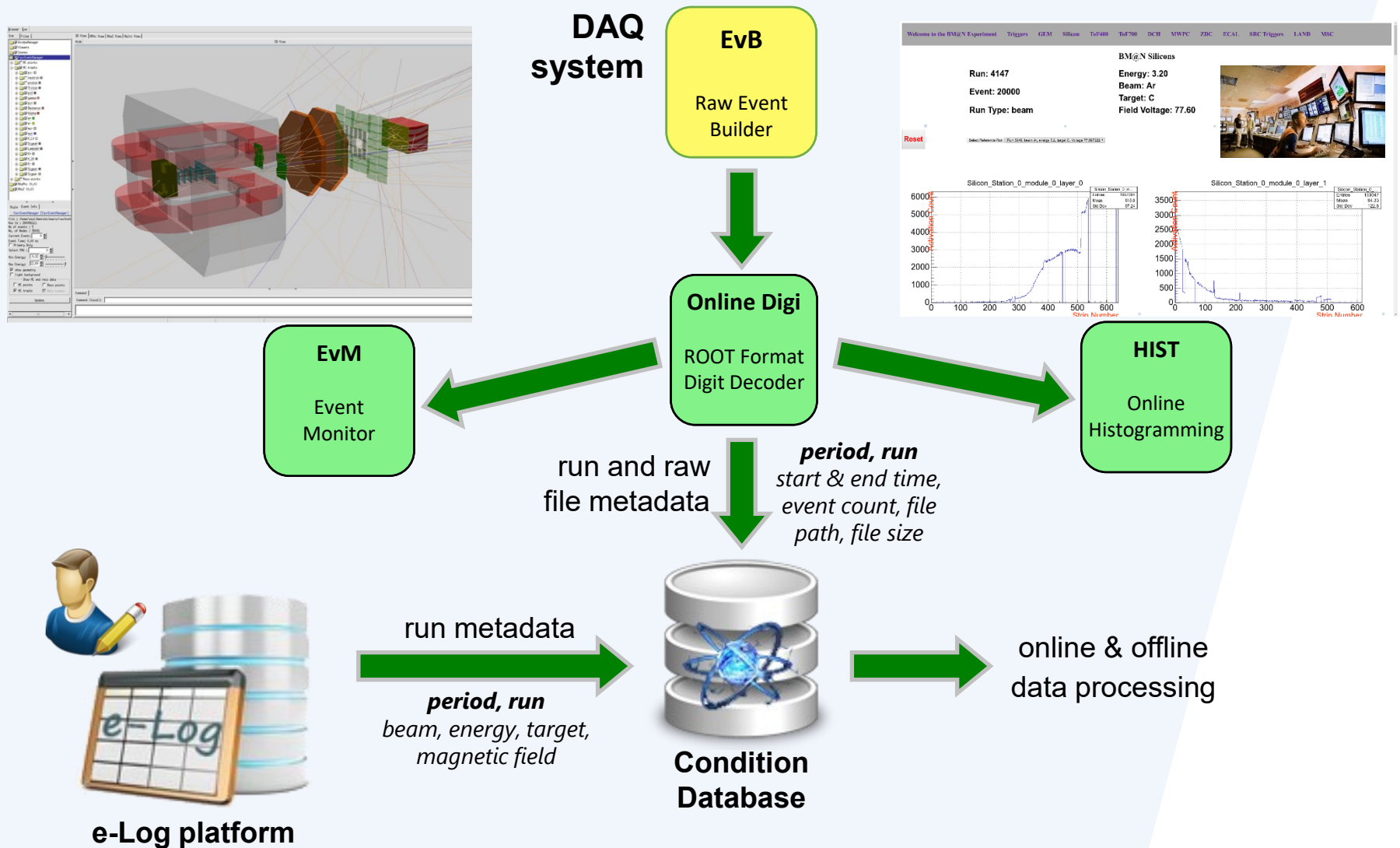
File Attachments (text description, photos, e.g. detector mapping)

Email Notification: Subscription to selected events/records of a certain type → **+Telegram**

User Cabinet

Logbook Monitoring...

Online Metadata for BM@N Data Processing



Data Quality Assurance Online/Offline Software System



She says she's from Quality Control. We've failed the furniture inspection.

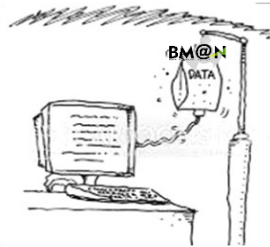
Online Histogramming System

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

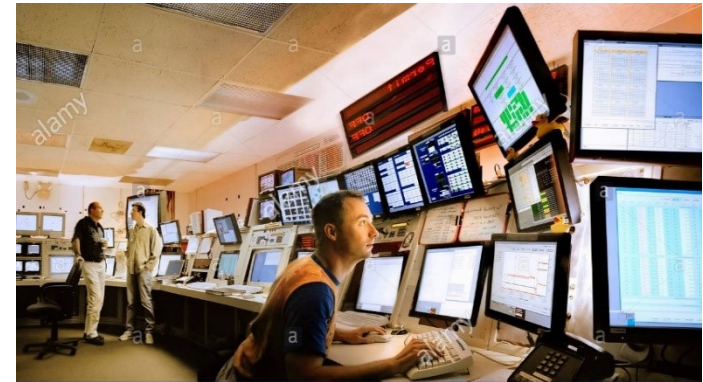


Run: 4147
Event: 20000
Run Type: beam



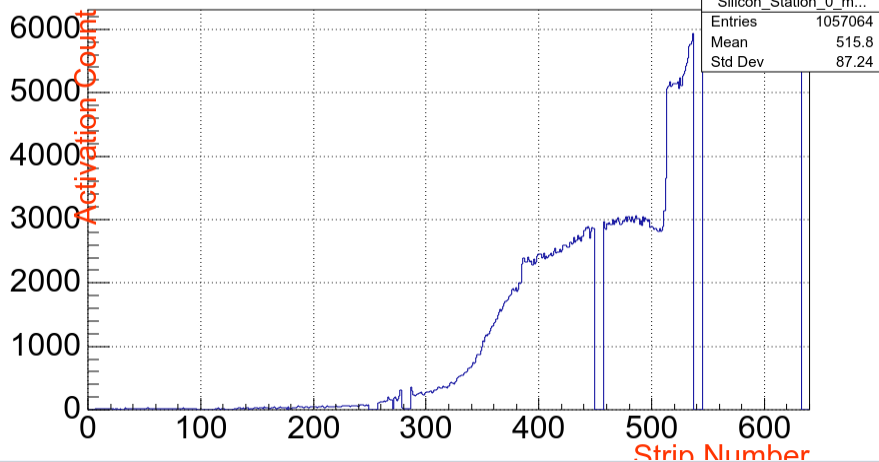
BM@N Silicons

Energy: 3.20
Beam: Ar
Target: C
Field Voltage: 77.60

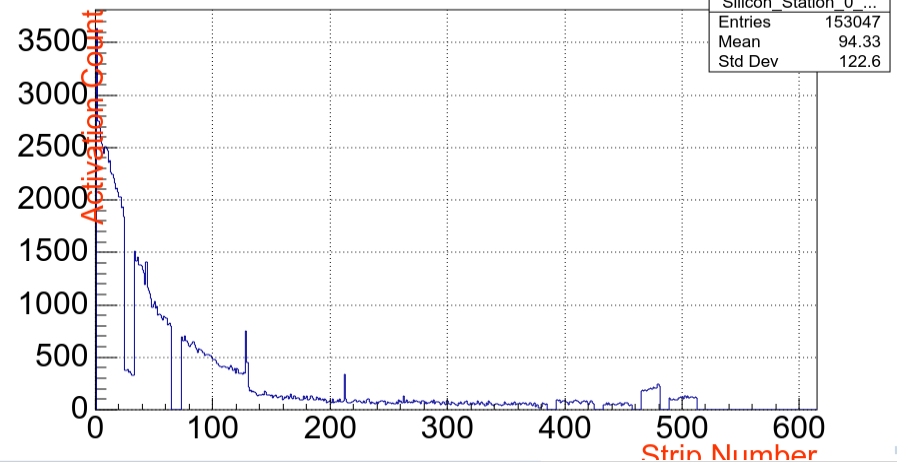


Reset Select Reference Run Run 3946, beam Ar, energy 3.2, target C, Voltage 77.597222 ▼

Silicon_Station_0_module_0_layer_0



Silicon_Station_0_module_0_layer_1



Offline Data Quality Assurance

Current Run: 3387

Energy: 3.17

Beam: C

Target: H2

Ref. Run: 1801

Energy: 4.50

Beam: C

Target: Cu

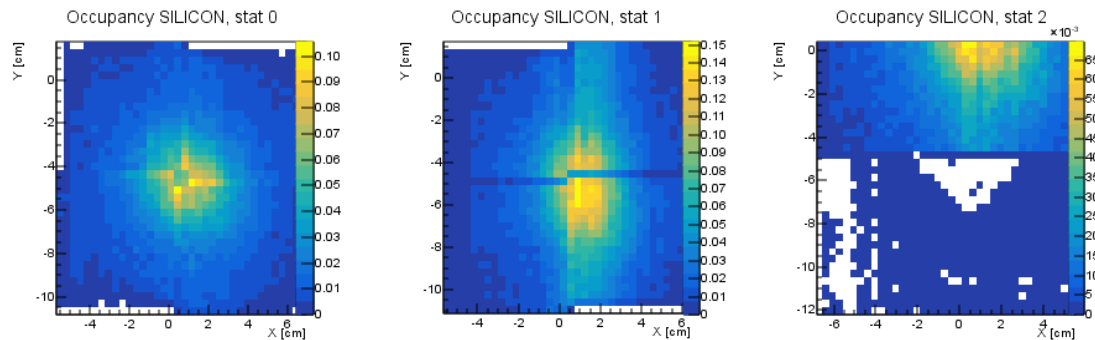
Release: 0.0

Period: 7

Setup: SRC

Occupancy for SILICON in RUN7 SRC

Select Release:	Select Period:	Select Setup:	Select Current Run:	Select Reference Run:
0.0 ▾	7 ▾	SRC ▾	Run 3387, beam C, energy 3.17, target H2, Voltage 108 ▾	- ▾



bmn-qa.jinr.ru



1. To represent basic distributions for obtained experimental data for all detectors (trigger counters, GEMs, SILICONS, DCH ...), and define whether one relies on a run is being analyzed or not
2. To check hit finders and tracking by basic hit and track distributions (occupancy, reconstructed track parameters, results on matching and PID...)
3. To monitor data that would require a precise monitoring

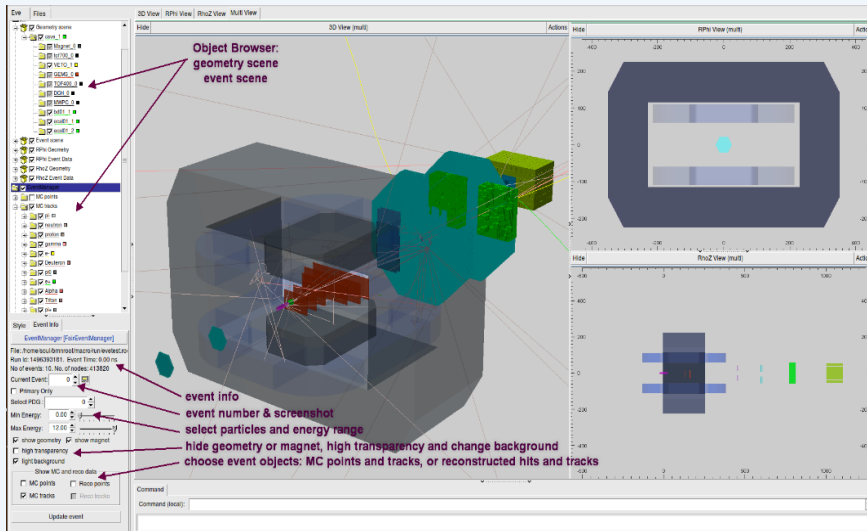
Data Quality Assurance (DQA) system for BM@N

- Single DQA system for the BM@N experiment should be developed to provide control histograms in the same way in 3 modes:
 - for online histogramming and reconstruction (online data monitoring)
 - for qualitative assessment of new BmnRoot versions (after MRs)
 - for manual run to check user versions of the software
- A client-server architecture should ensure a graphical representation of control histograms on a central Web service (for example, *JupyterLab*), which receives the displayed data distributions from the experiment software of the BM@N experiment (BmnRoot)
- The DQA system should provide the ability to easily add new types of control histograms in a user-friendly format (suitable for physicists and detector team, who are not developers), for instance, using *JSON* description

Event Display (Monitor) Offline/Online Software System

Development of new Event Display solutions

Old Solution

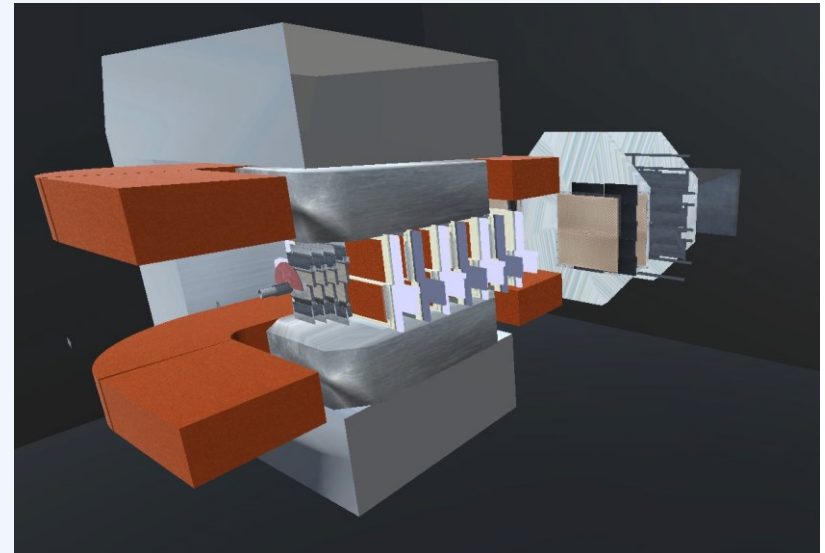
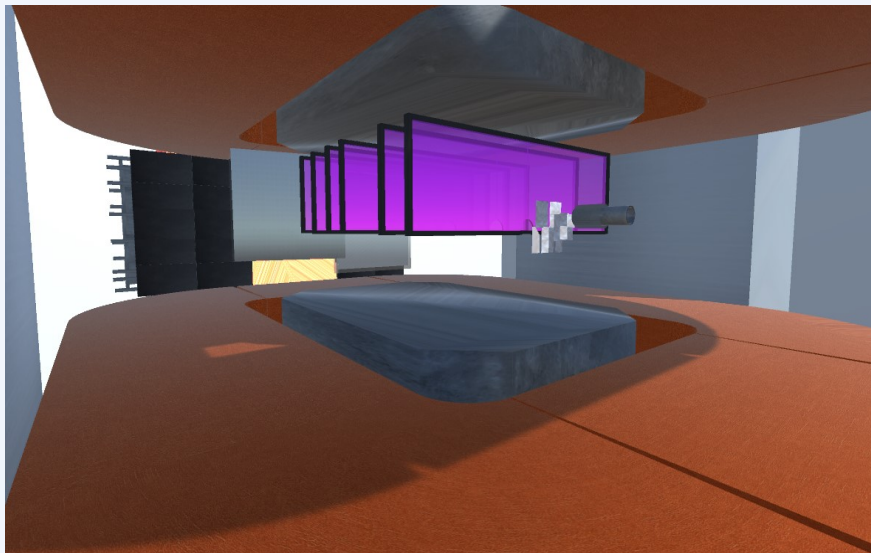


based on the **ROOT EVE** package
can show/hide setup geometry, select an event to display, select particles with definite PDG codes, set energy range and many other visualization options

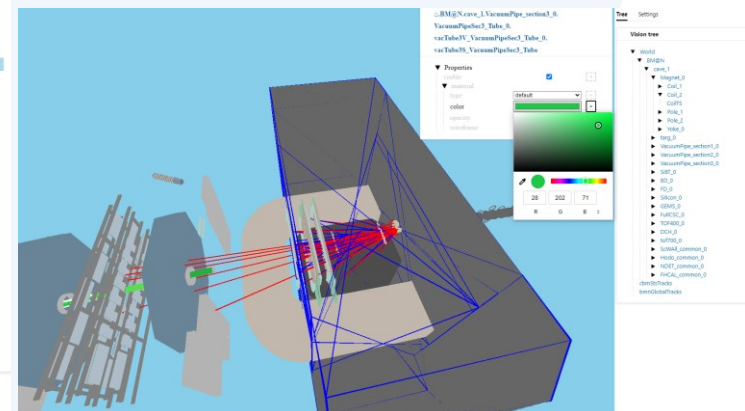
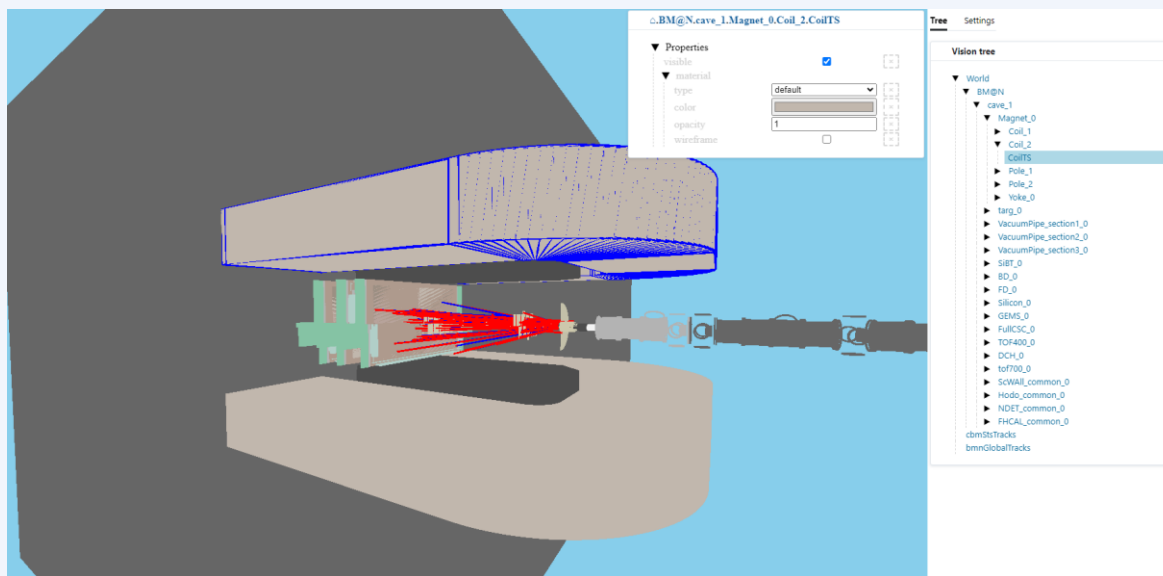
Event Display for **simulated** data
MC points, tracks, calorimeter towers

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

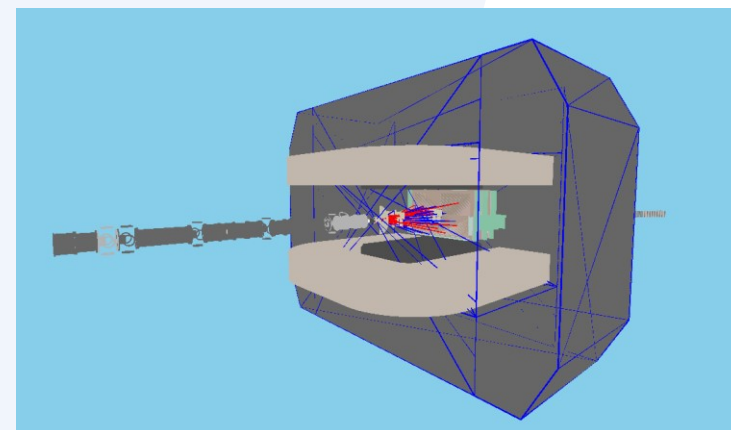
New Solution from SPBU team



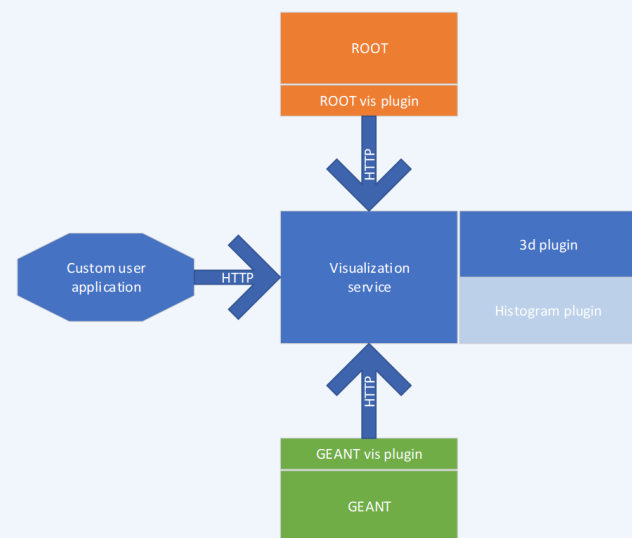
Event Display on the VisionForge platform



VisionForge Project



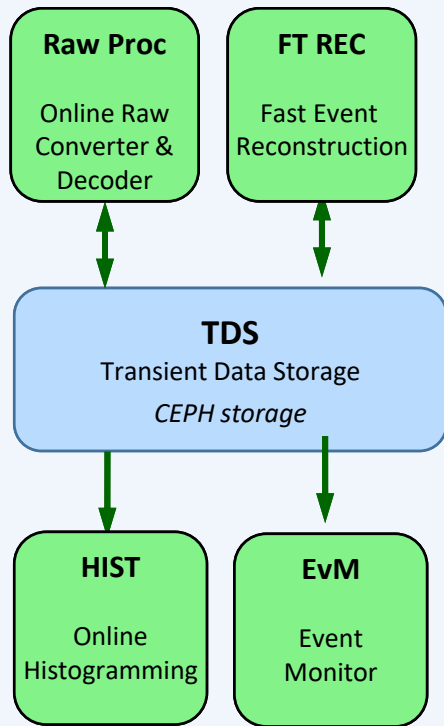
- Visualization runs as a stand-alone service
- It communicates with other services via HTTP
- The service itself uses plugin system to include new visualization types
- Adapters are made to convert ROOT/GEANT/whatever format into visualization tree



Online Configuration System

Online Information System

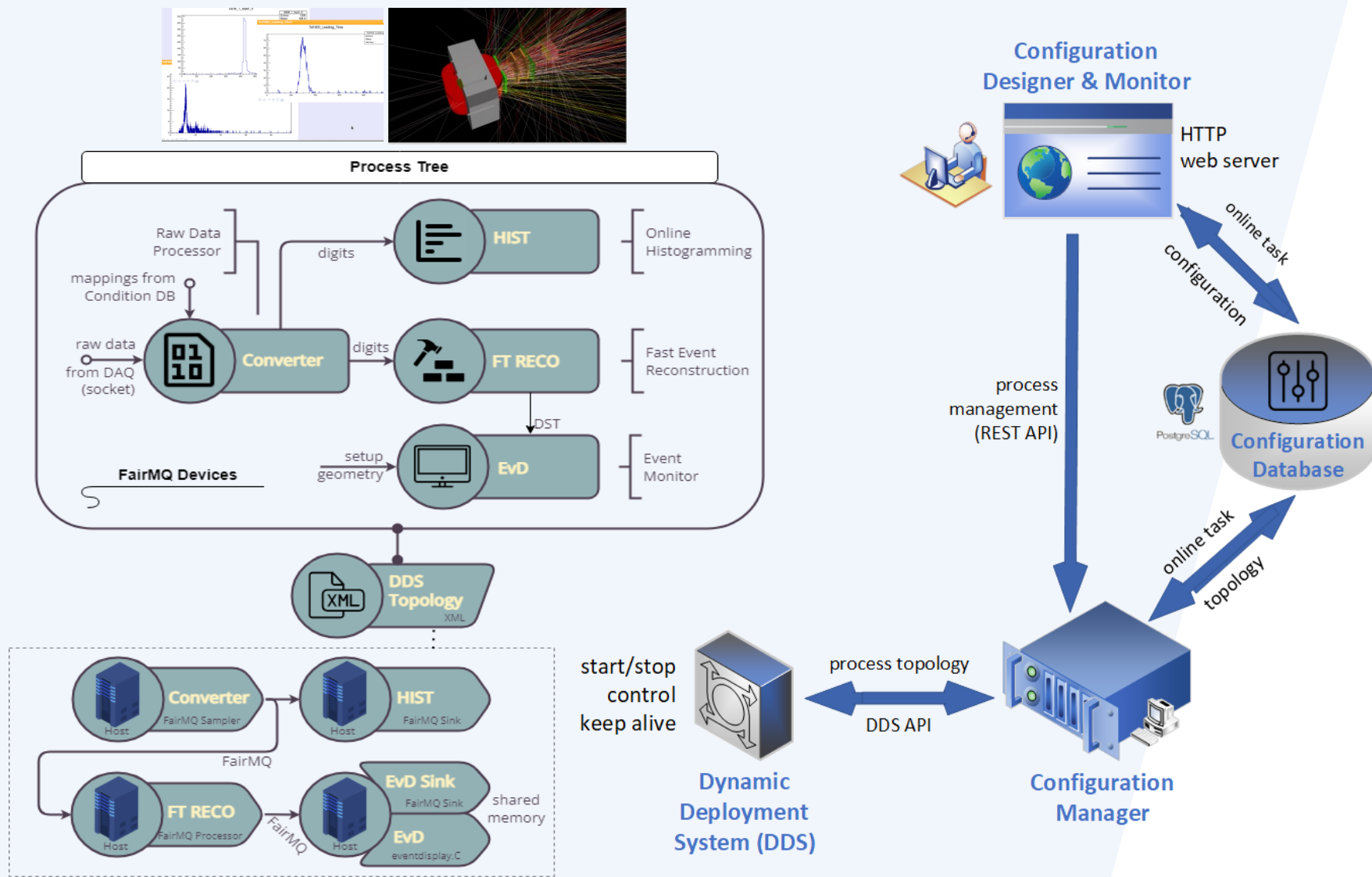
Online Process Control



Online
Processing

start → monitor → control → restart → stop

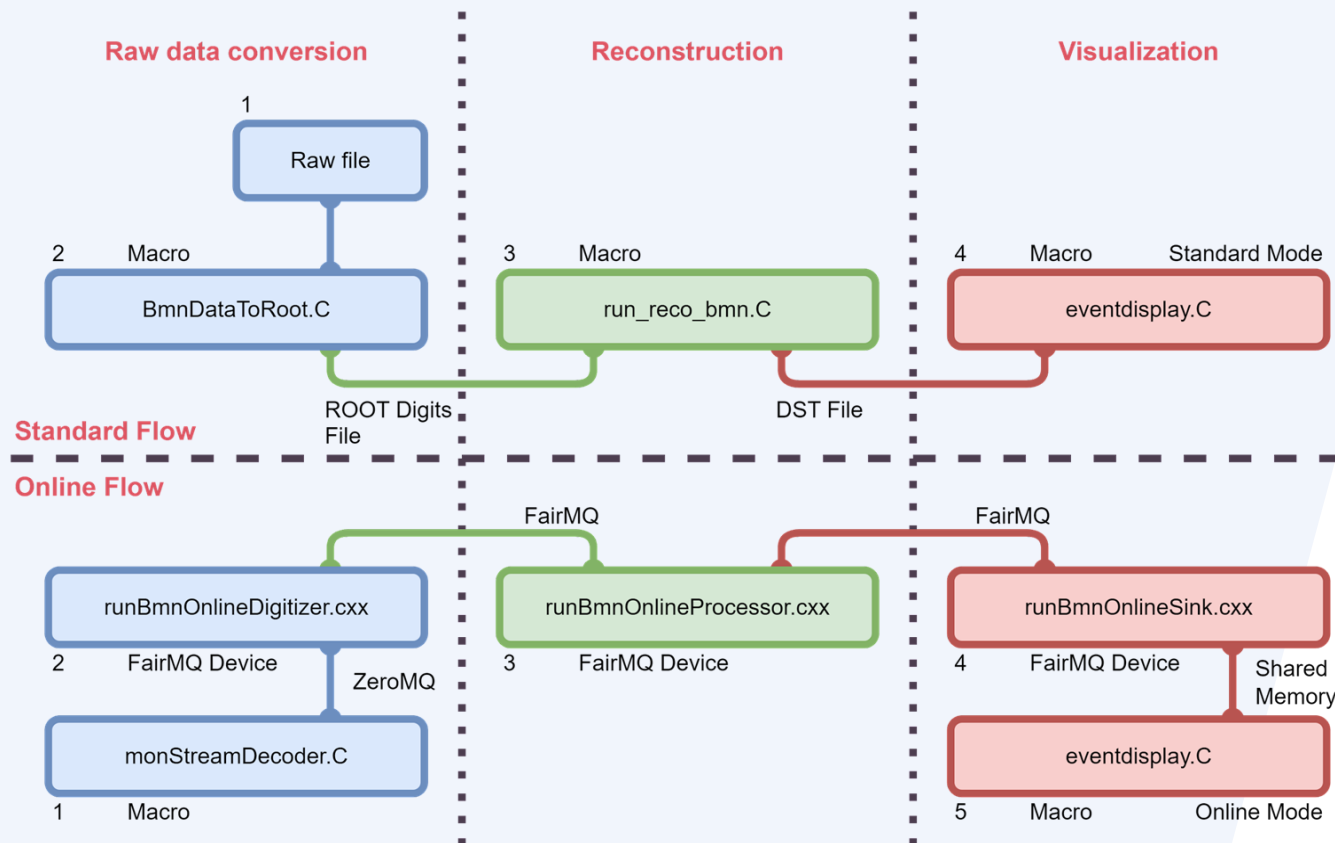
BM@N Online Configuration System (OCS)



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.



OCS. Configuration Designer & Monitor

Menu

TASK MONITOR

CONFIGURATION MANAGER

DICTIONARY SET

Get in touch

✉ [Konstantin Gertsenberger](#)

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Supported by

Configuration Manager

Select Setup Run:

BMN Run 7



Control panel

START

STOP

ADD SETUP MODULE

Module Name	Working Directory	Actions		
OnlineControl				

Module Tasks Module Properties

ADD MODULE TASK

Task Name	Host	Actions		
bmn_event_display_imit	[a-z]*[0-9]*[.]jinr[.]ru			
bmn_fast_event_reco_imit	[a-z]*[0-9]*[.]jinr[.]ru			
bmn_online_histo_imit	[a-z]*[0-9]*[.]jinr[.]ru			
bmn_root_digi_imit	[a-z]*[0-9]*[.]jinr[.]ru			

Task Monitor

Select task

Select setup

Select module

Started

Select host

FILTER

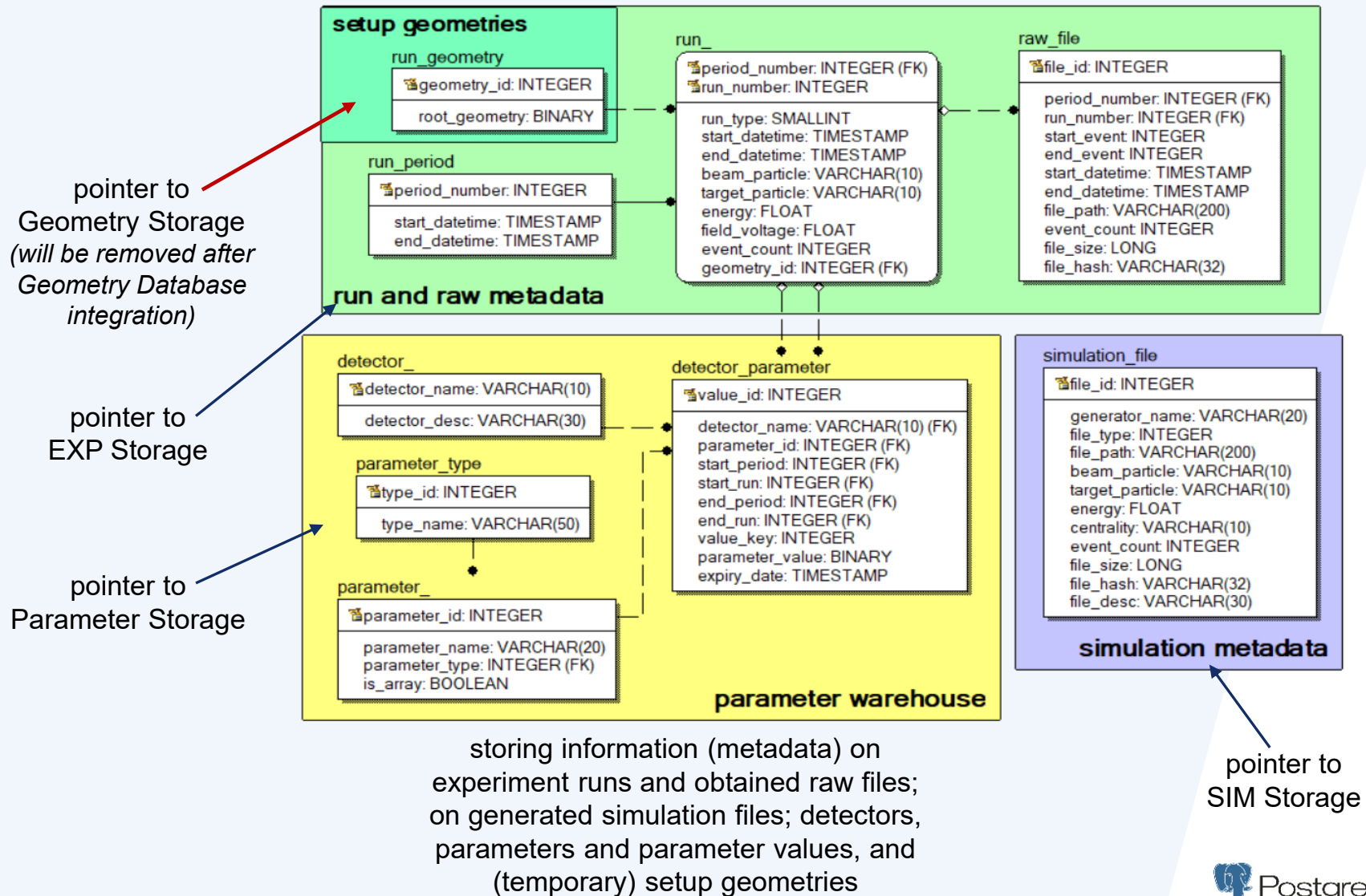
RESET

Task Name	Setup:Run	Module	Status	Log	Start Time	End Time	Host
bmn_event_display_imit	BMN:7	OnlineControl	Started		2023-05-05 18:39:16		vps104.jinr.ru
bmn_fast_event_reco_imit	BMN:7	OnlineControl	Started		2023-05-05 18:39:16		vm221-85.jinr.ru
bmn_online_histo_imit	BMN:7	OnlineControl	Started		2023-05-05 18:39:16		vps104.jinr.ru
bmn_root_digi_imit	BMN:7	OnlineControl	Started		2023-05-05 18:39:16		vps104.jinr.ru

Condition Database (UniConDa)

Offline Information System

Unified Condition Database (*UniConDa*)



UniConDa. Web Application (home page)

Menu

Sign In

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

Account
Unauthorized user
Guest [Sign In](#)

Period number
Period 8 [Reset](#)

Experimental Data
Distribution of events by run periods and time intervals of periods.

Period	MEEvents
Period 8	742
Period 7	313
Period 6	76
Period 5	20
Period 3	22
Period 2	10

Simulation Data
Distribution of events by generators

Generator	MEEvents
DCMQGSM	830
DCMSMM	153
UrQMD	6

Beam - Energy - Target distributions

Beam C (E = 3.6 GeV/n)
Total: 0.79 MEEvents

Target	MEEvents
no target	0.79

Beam Xe (E = 3 GeV/n)
Total: 60.77 MEEvents

Target	MEEvents
Csl (2%)	53.88
no target	4.99

Beam Xe (E = 3.8 GeV/n)
Total: 638.98 MEEvents

Menu

- Home
- Experiment Runs
- Detectors & Parameters
- Parameter Values
- Simulation Files

ANGULAR
node.js
HIGHCHARTS
docker

File Inspector

bm-n-uniconda.jinr.ru

BM@N

- 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

NoSQL Solution for BM@N Condition Database



Open for research work of a student



Geometry Database Offline Information System

Geometry Information System

Menu

HOME

VIEW GEOMETRY

VIEW.SETUPS

VIEW.SETUP.MODULES

VIEW.FILES

VIEW.MATERIALS

VIEW.MAGNETIC.FIELDS

EDIT GEOMETRY

Get in touch

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



PostgreSQL

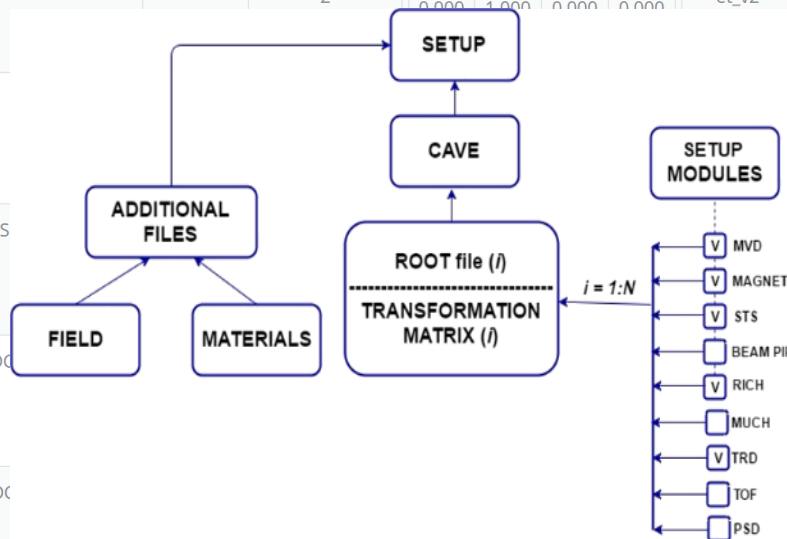


Setup Modules

- db authorization
- or FreeIPA 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 0.000 1.000 0.000 0.000 0.000 0.000 1.000 0.000	bd_v1_0	aleksand		Download
BD	geom_BD_det_v2	2020-04-19	geom_BD_det_v2	1.000 0.000 0.000 0.000 0.000 1.000 0.000 0.000	geom_BD_det_v2	aleksand		Download
BD						ileksand		Download
CSC	CS					ileksand		Download
DCH	DC					ileksand		Download
DCH	DC					ileksand		Download



Three user roles

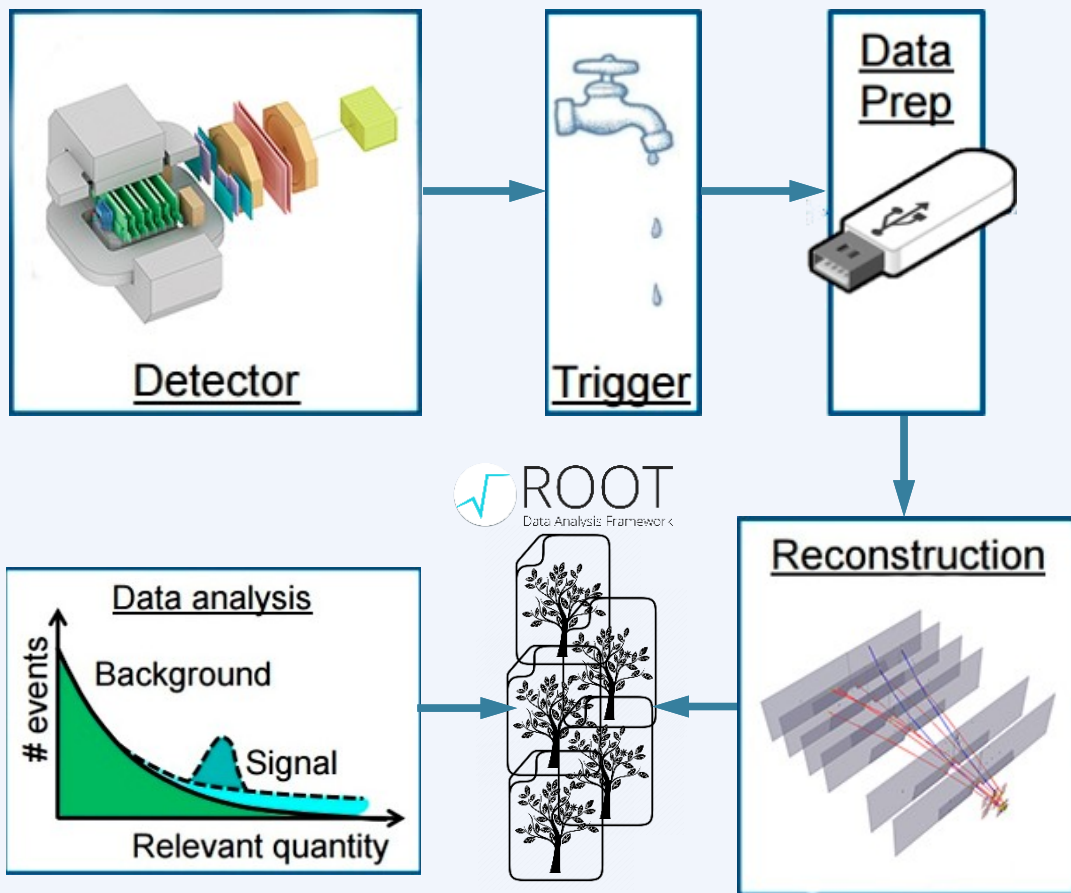
Lead Developer | Developer | User (Reader) View Add Edit Approve Download

User Interface Functions:

Event Metadata System

Offline Information System

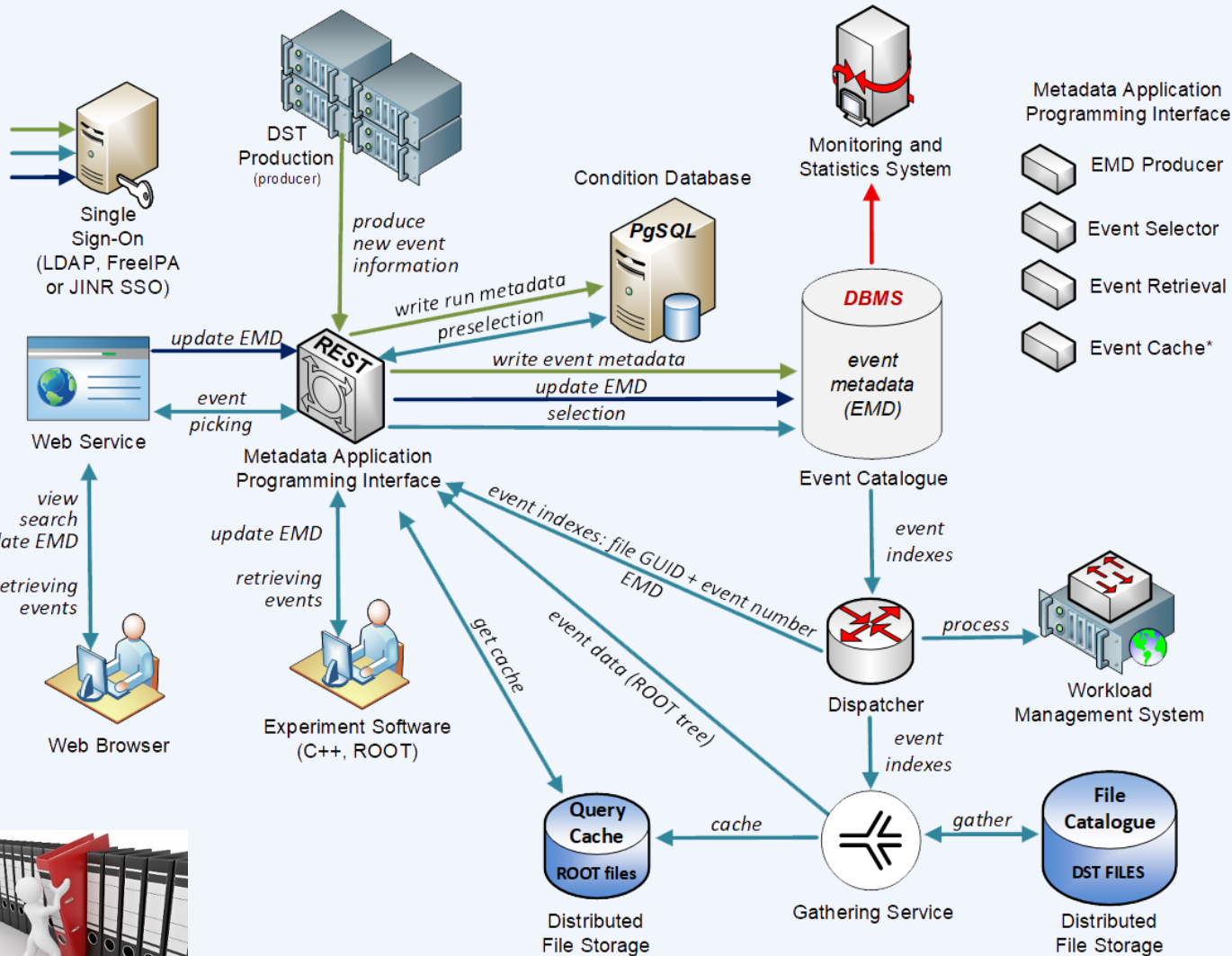
Event Metadata for Physics Analysis



Run 8 (12.12.2022 – 02.02.2023)
24 000 files, 23 000 events per file

- Event Selection for PhA:
 - beam particle
 - target particle
 - beam energy
 - trigger type
 - number of primary (all) tracks
 - number of +/- charged particles
 - types of reconstructed particles
 - number of hits by detectors
 - total input/output charge
 - software version...
- Index all (selected) events
- Event Catalogue Quality
- Event Catalogue Statistics

Event Metadata System. *Architecture*



Event Catalogue is based on PostgreSQL

Integrated with the Condition Database

REST API and Web UI developed on Kotlin multiplatform

Configurable to support any metadata

ROOT macro to write new event metadata to the Catalogue

Role-based access control

Monitoring

Event Metadata System. *Web Interface*

BM@N Event Metadata System

BM@N Events
 Search Events
 SRC Events
 Search Events
 Test Events
 Search Events

Condition Database prefiler

base parameters

Test Events

Software Version

Period Number

Run Number

Beam Particle

Target Particle

Energy, GeV

Total track number

Triggers (string)

Primary vertex

Limit [dff=100]

Offset

Filter Reset

limits and offset

configured parameters

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 pointer = file GUID + event number

1-10 of 15

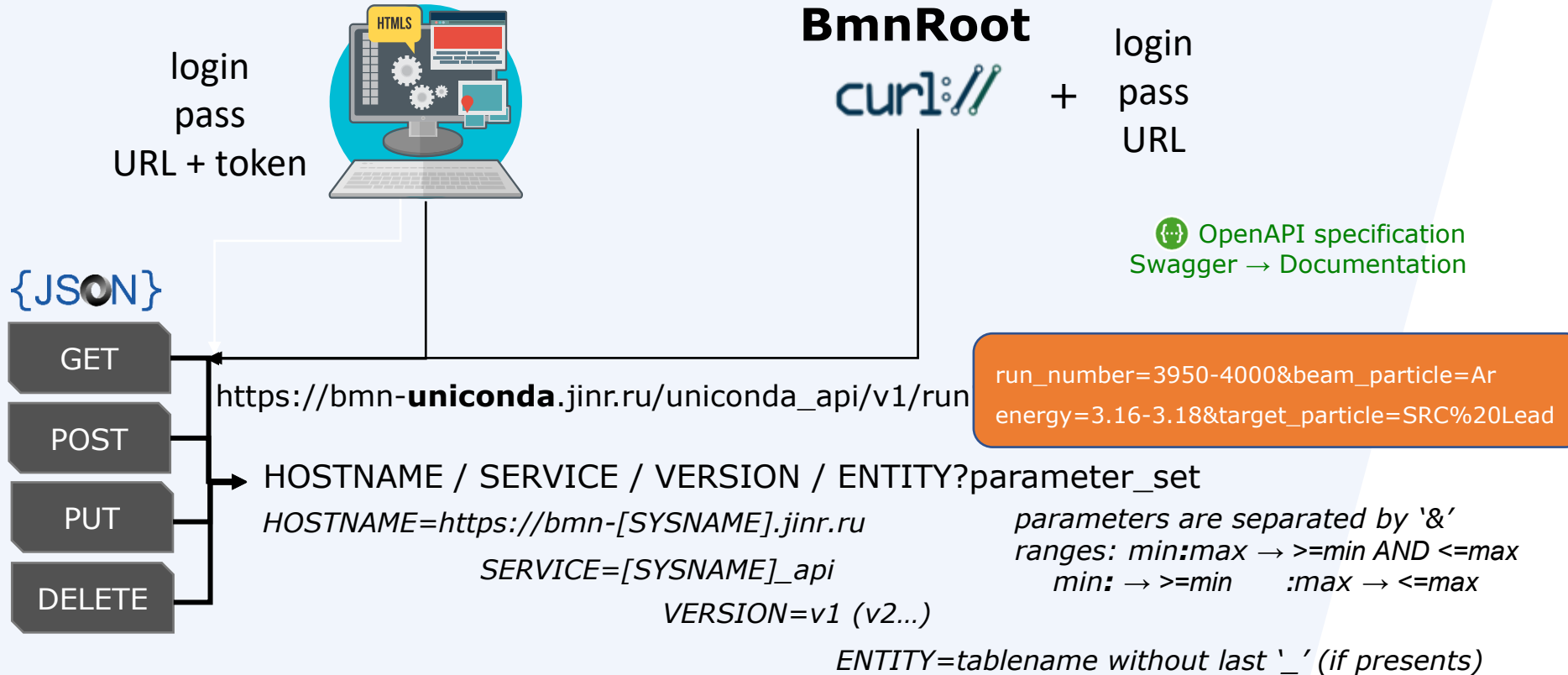
event metadata are written only if primary vertex has been found in the event



- 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

Information and Collaboration Services

REST APIs for BM@N Information Systems



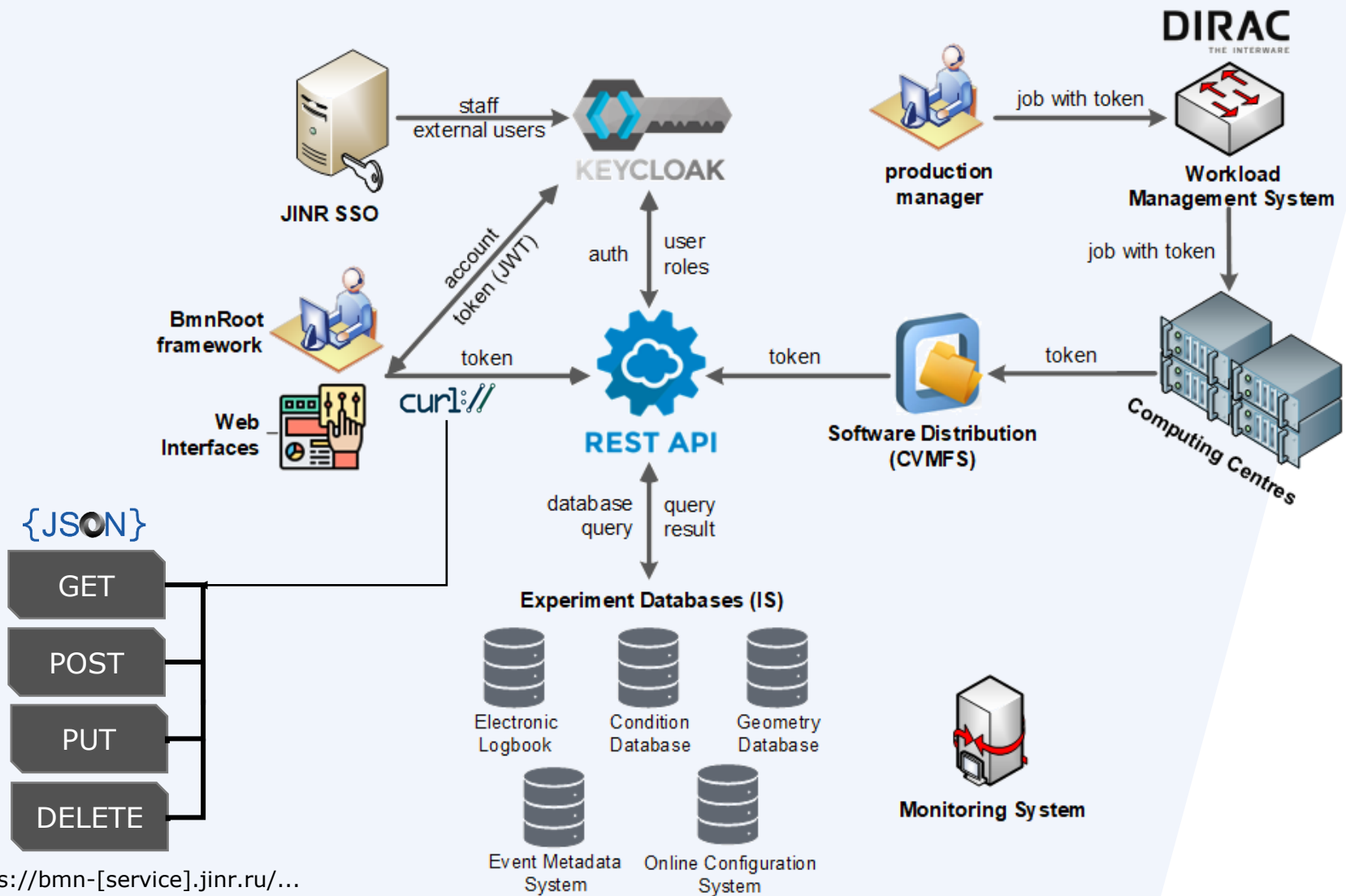
Unified Condition Database, SYSNAME = **uniconda**

Event Metadata System, SYSNAME = **event**

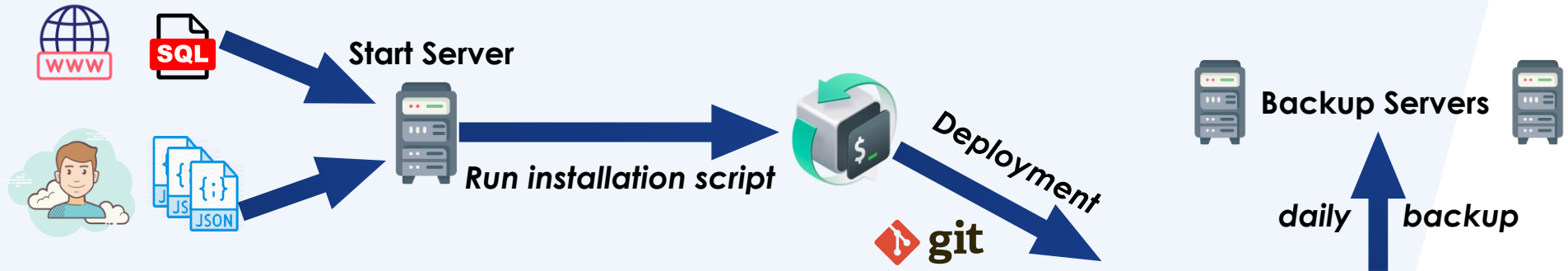
Geometry Database, SYSNAME = **geo**

https://bmn-event.jinr.ru/event_api/v1/event?...
 /eventFile?...
 /eventFileRef?...

Architecture of REST API requests to BM@N ISs



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-entrypoi... 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-entrypoi... 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/elog_platform
https://git.jinr.ru/nica_db/uniconda_platform
https://git.jinr.ru/nica_db/geo_platform

Monitoring System for BM@N software complex



- hosts
- databases
- web-sites

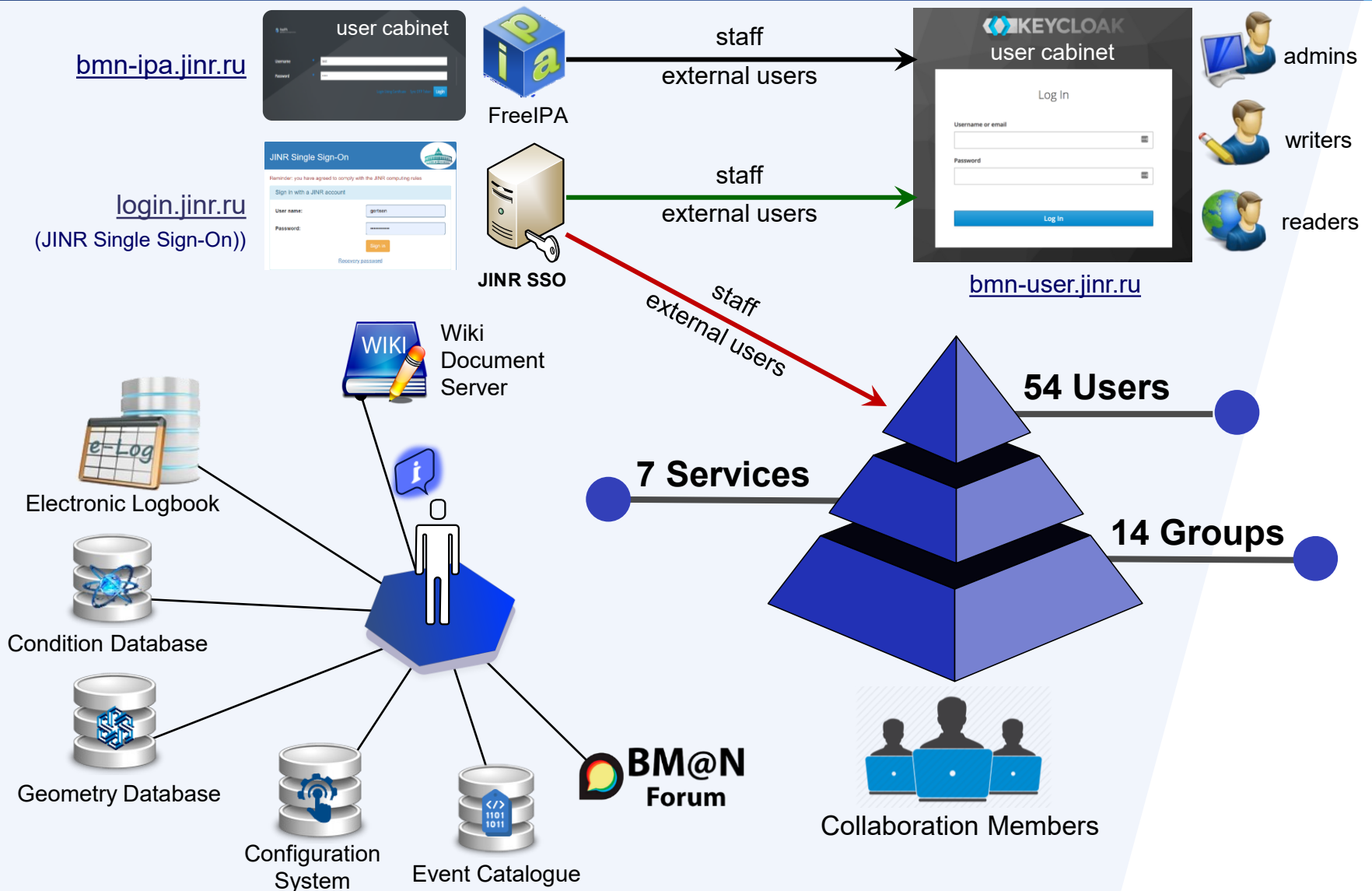
- **Condition Database**
simple or detailed visualization
- **Electronic Logbook**
simple or detailed visualization

...

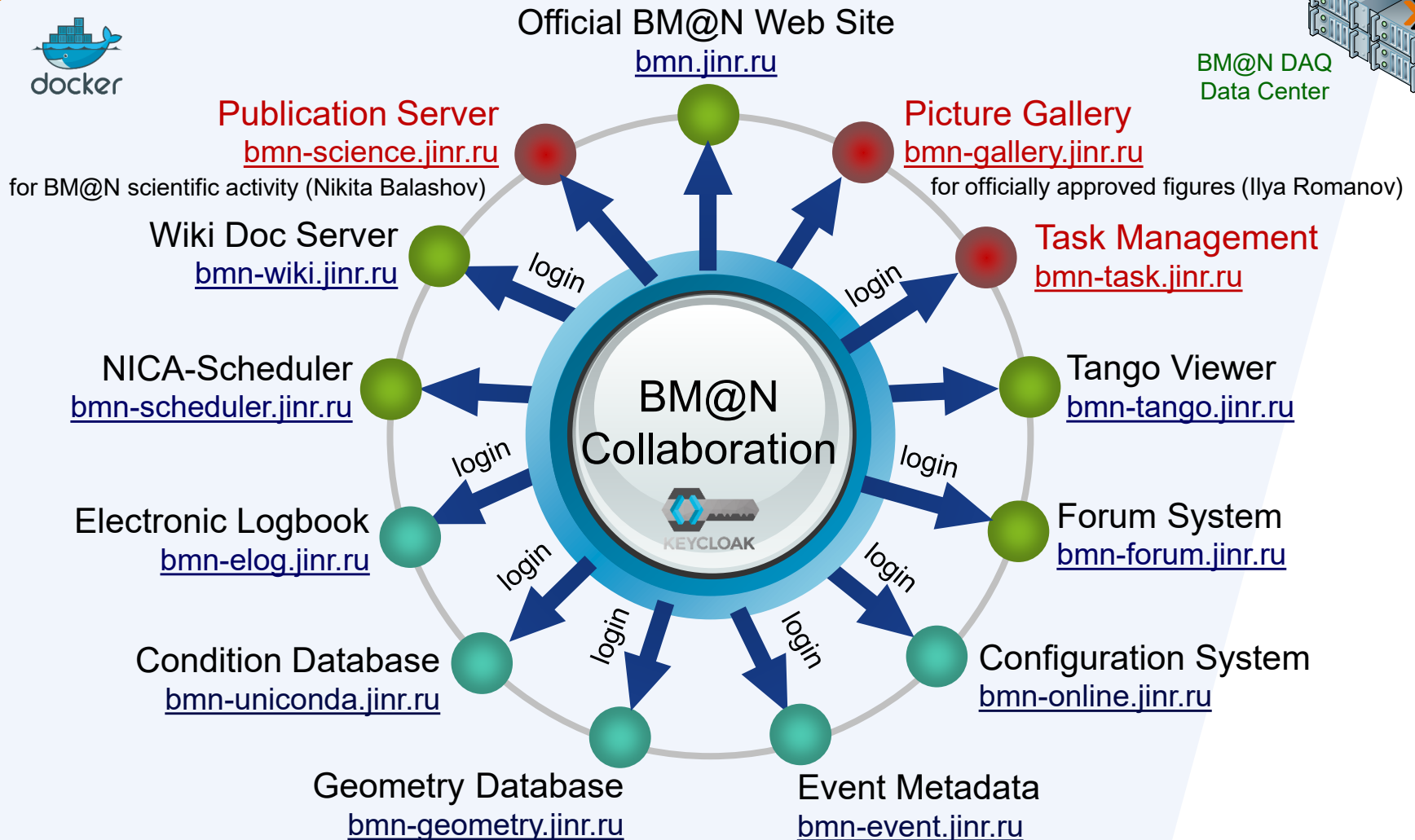
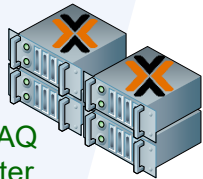
Email Alerting

The email interface shows a list of messages with columns for 'Subject', 'Correspondents', and 'Date'. The selected message has the subject '[OK] PGSQL response time alert' and is from 'Grafana' to 'h@yandex.ru'. The email body contains the text: 'From Grafana <h@yandex.ru>', 'Subject [OK] PGSQL response time alert', 'To Me', and '[OK] PGSQL response time alert'. Below this, it says 'Grafana: Database monitoring warning!'. A small image of a boy with a shocked expression is overlaid on the bottom right of the email content.

Migration FreeIPA → Keycloak → JINR SSO

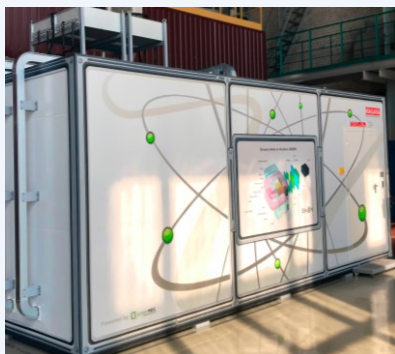


Evolution of the BM@N Services



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



OS: CentOS / Scientific Linux 7.9

Central Software Repository based on CVMFS for the experiment

CEPH: 2 PB (*replicated*)

SLURM: 1000 cores
after future upgrade

EOS: 1 PB (*replica*)

*new number of resources
in Ivan Slepov's report*

EOS: 1 PB (*replica*)

EOS CTA: 100 TB for NICA

SLURM: 1250 cores

ZFS: 200 TB

Lustre (hot): **300 TB_{ssd}**

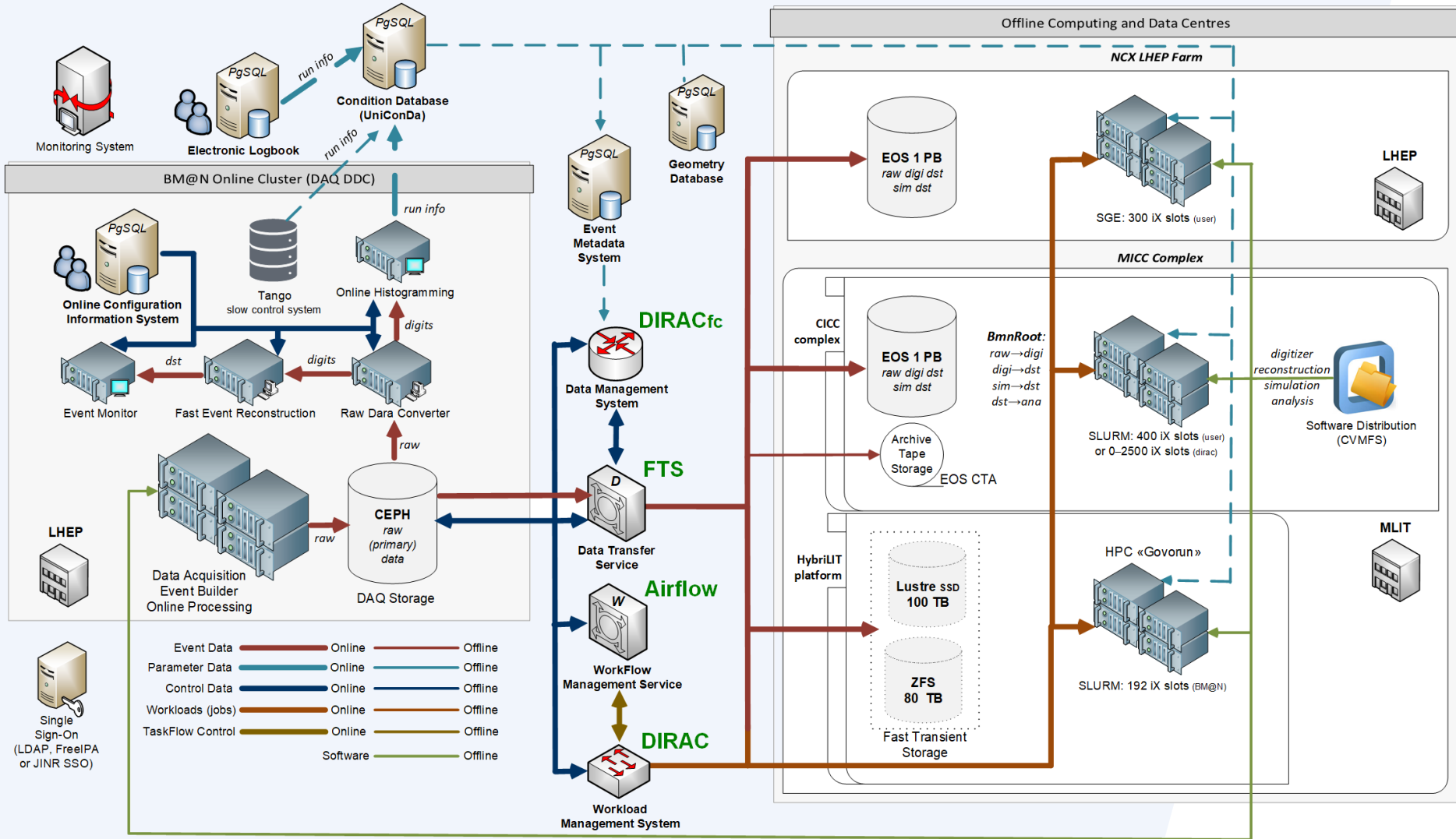
SLURM: bmn – 192 cores

Is there enough free space on the storages for data of the next BM@N Run?

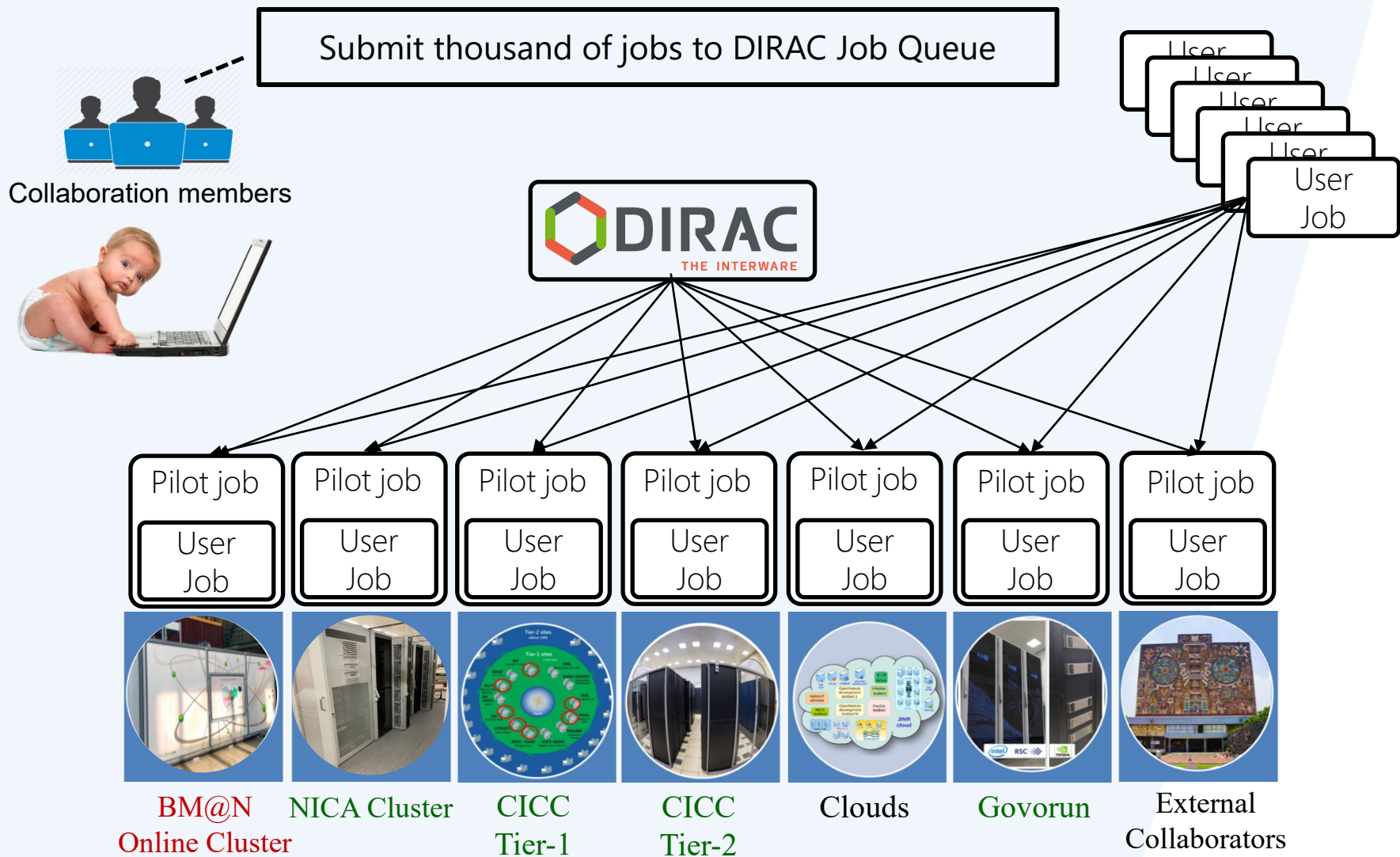
BM@N software have been installed & configured on CVMFS (moving to bmn.jinr.ru)

Automatic software deployment of the BmnRoot package on CVMFS with GIT CI



BM@N Computing Software Architecture



DIRAC Workload Manager for BM@N

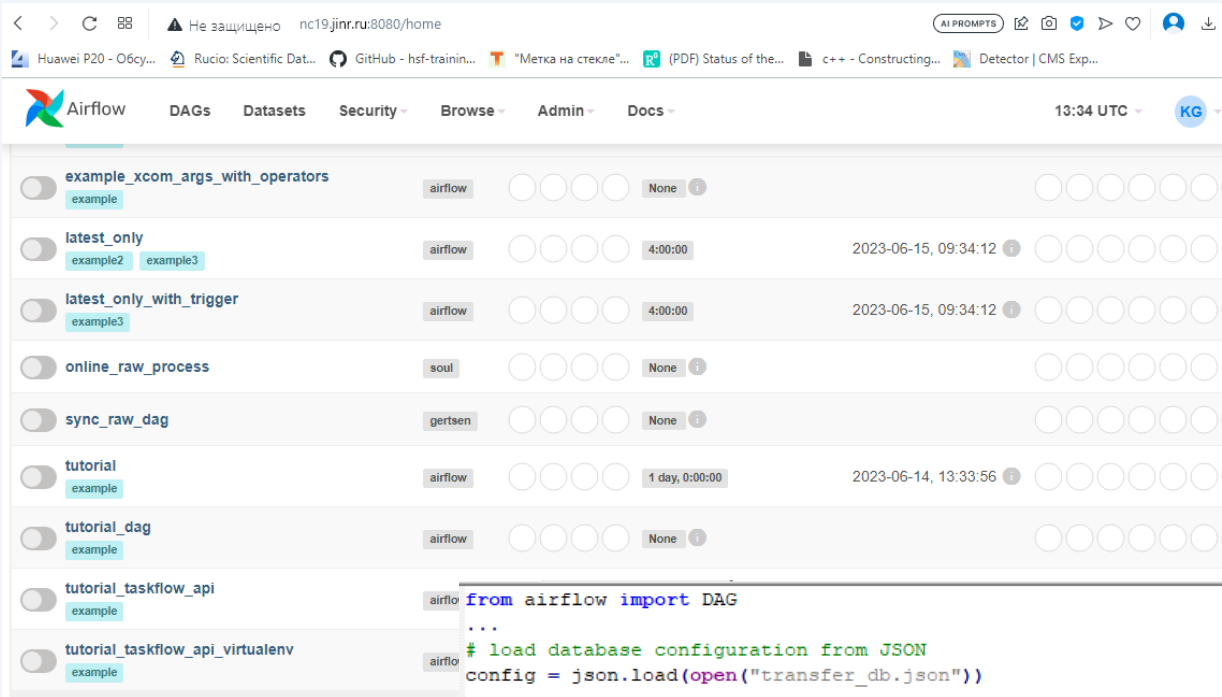


File Catalogue Choice for BM@N

- File Catalogues map a Logical File Name (LFN) to the Physical File Name (PFN) at distributed computing platforms
- The native  File Catalog (DFC) combines both replica and metadata functionality. In the DFC metadata can be associated with any directory, and subdirectories inherit the metadata of their parents
-  is a Distributed Data Management System initially developed for the ATLAS experiment in 2014 providing file and dataset catalogue and transfers between sites and staging capabilities, policy engines, caching, bad file identification and recovery, and many other features.



BM@N Workflow Management



Airflow **deployed** on the NC-farm

Used in BM@N Run 8 to **transfer raw data** emerging on the NICA-cluster to the LIT EOS storage and **to check the integrity** of the source and destination files

To be employed for **managing online** (for emerging raw data files) **and offline data production** via DIRAC



*MC simulation pipeline
event filtering digitizing
reconstruction analysis*

...

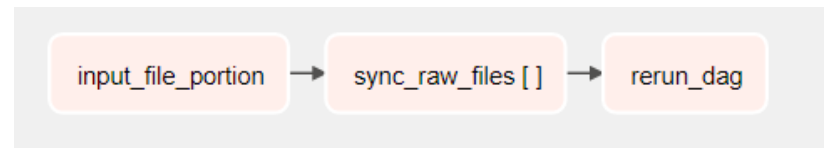
```
from airflow import DAG
...
# load database configuration from JSON
config = json.load(open("transfer_db.json"))
...
]with DAG('sync_raw_dag', description='This DAG is for copying new raw data files from an inpput directory to LIT EOS',
         default_args=default_args, schedule_interval=None, catchup=False, max_active_runs=1) as dag:

    @task
    def input_file_portion():
        ...
        return process_list

    @task(max_active_tis_per_dag=8)
    def sync_raw_files(input_file_path):
        ...

    trigger = TriggerDagRunOperator(task_id='rerun_dag',
                                    trigger_dag_id="sync_raw_dag")

    sync_raw_files.expand(input_file_path=input_file_portion()) >> trigger
```



Modelling System. *BM@N* Data Processing

Experimental data

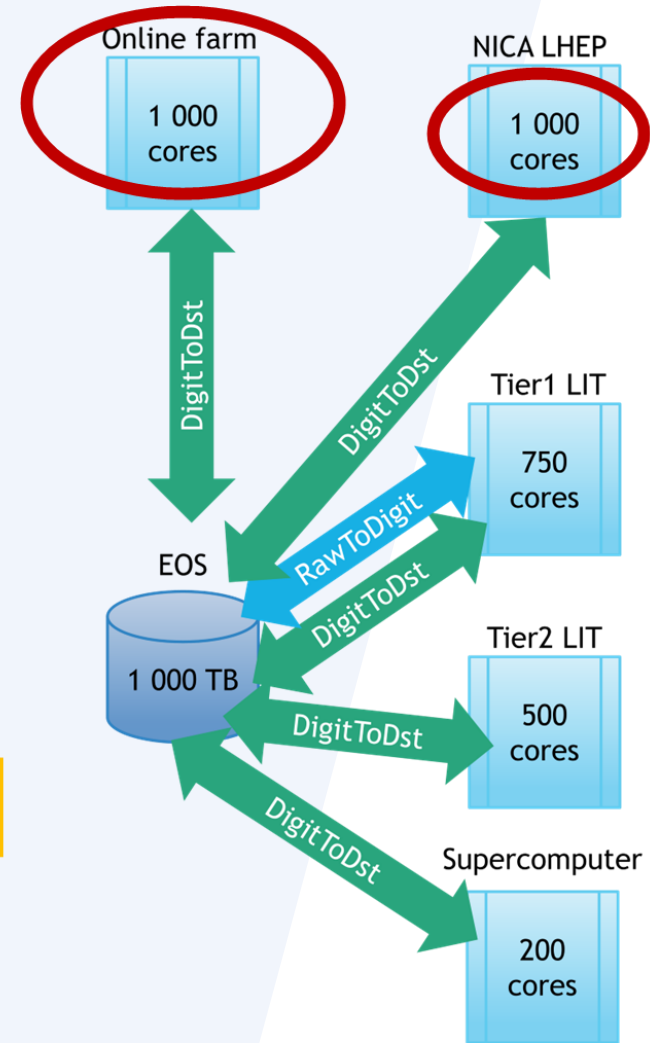
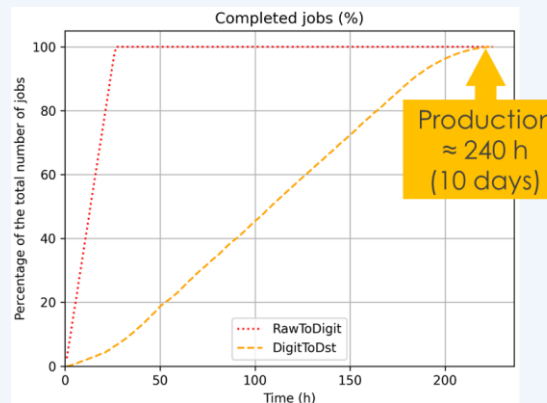
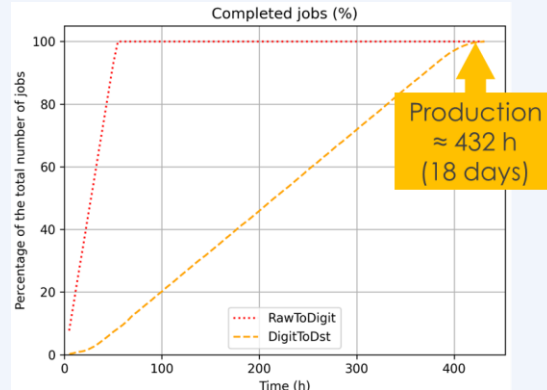
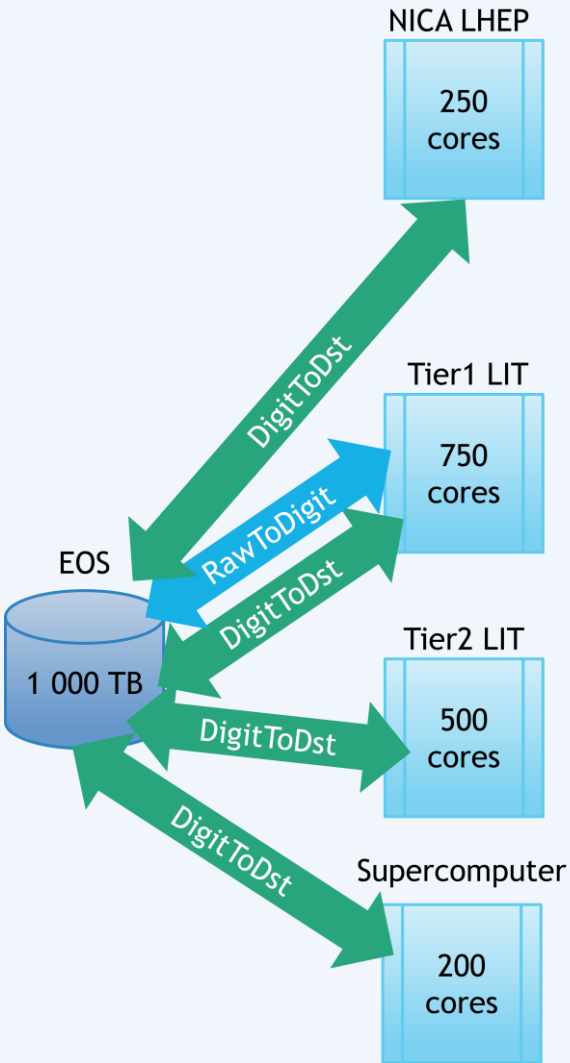
645×10^6 events

(25 800 raw files)

1 raw file = 15 GB (25 000 events)

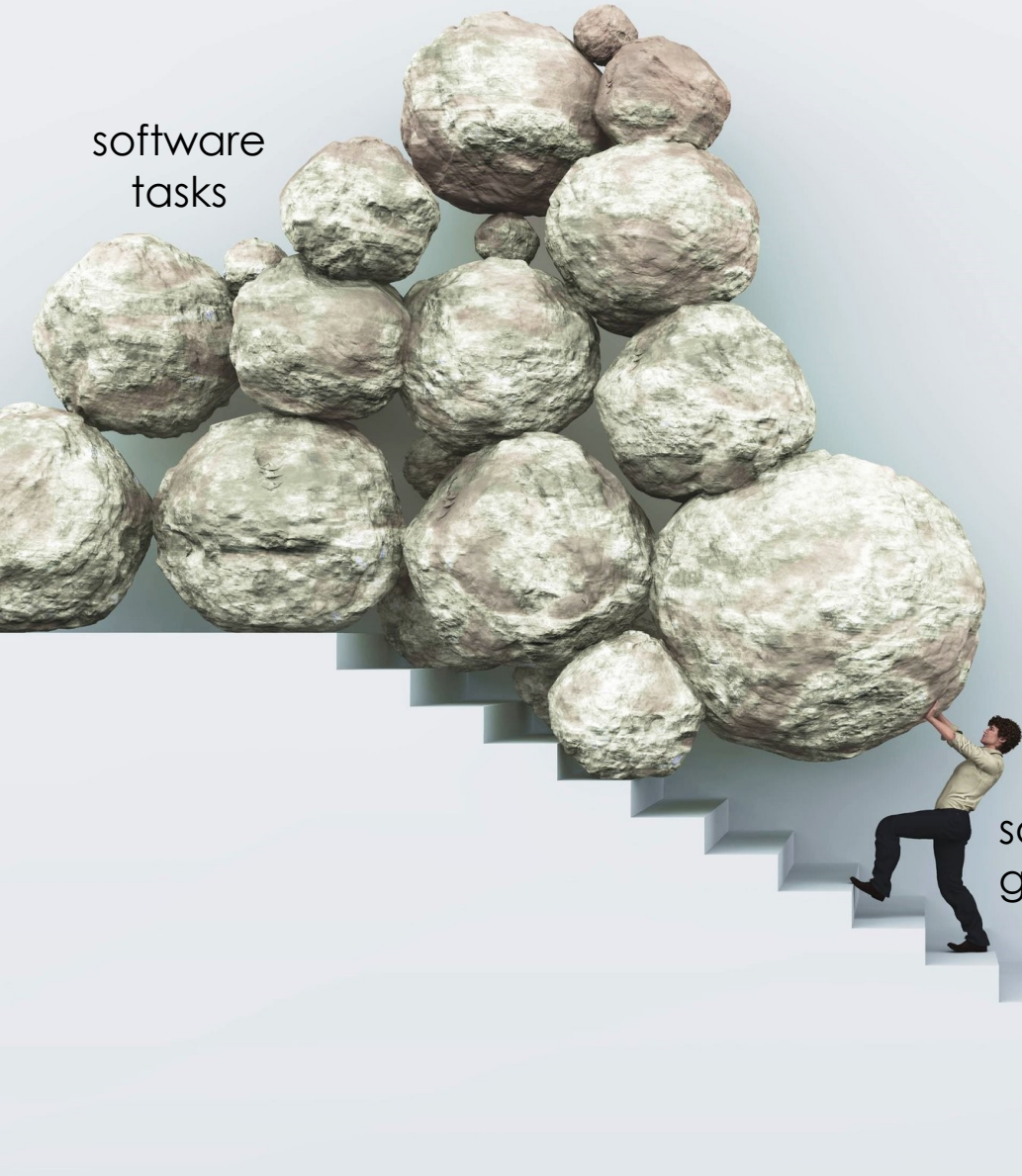
1 digit file \approx 870 MB

1 dst file \approx 2 000 MB



Thank you for your attention!

software
tasks



software
group