BM@N Software Progress and Current Issues

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Joint Institute for Nuclear Research

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BM@N Software Contribution

BM@N Software Contribution

Tagir AUSHEV, *Peter KLIMAI, Alexander NOZIK, Olga NEMOVA, Sergey EFIMOV, Igor DUNAEV*
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

Nikolay ERSHOV
Implementation of Fast Track Reconstruction based on NN/ML

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

***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

BM@N Computing & Technical Contribution

***NICA Computing Leader*: Andrey DOLBILOV**

Ilia 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***

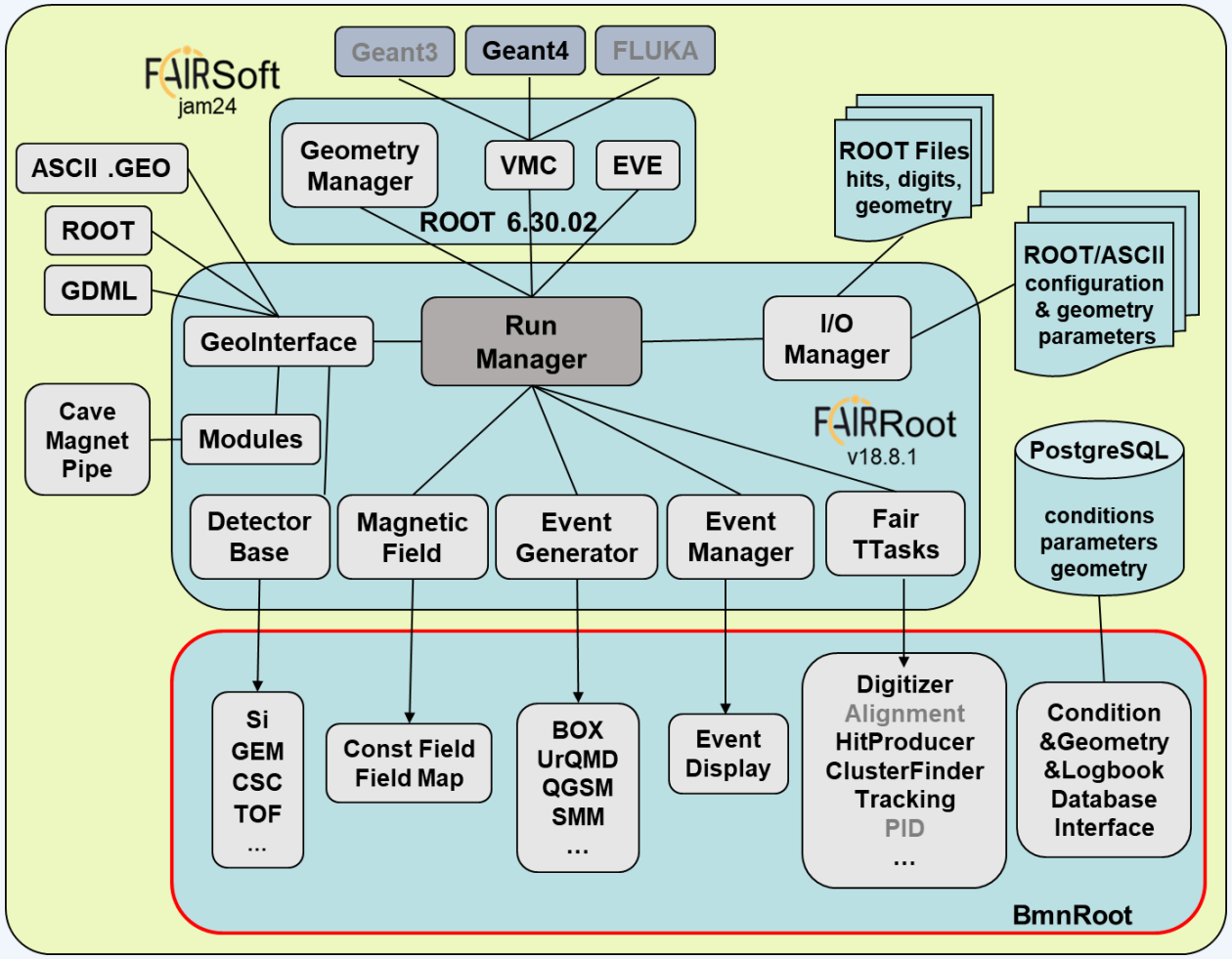
Dmitriy PODGAYNY, Oksana STRELTSOVA
HybriLIT and SC Govorun support

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

BmnRoot. *Production Tags (24.04.0, 24.02.0)*

FairSoft jam24 FairRoot v18.8.1

latest simulation, reconstruction, analysis and software improvements have been integrated for mass production with Run 8 data



- New FairSoft jan24 version with updated packages, enable GSL, patch for ROOT source build dir
- New FairRoot v18.8.1 version with updated base classes
- Old compilation approach is still used in BmnRoot
- New BmnRoot tags for the mass production: 24.04.0 & 24.02.0
- Mass production was performed using DIRAC for 3.8 AGeV data
- SRC macros have been moved from the main directory and pipelines
- Reconstruction does not include Particle IDentification
- New installation script for FairSoft and FairRoot is preferable in case of the stable Internet connection

bmn.jinr.ru/software-installation

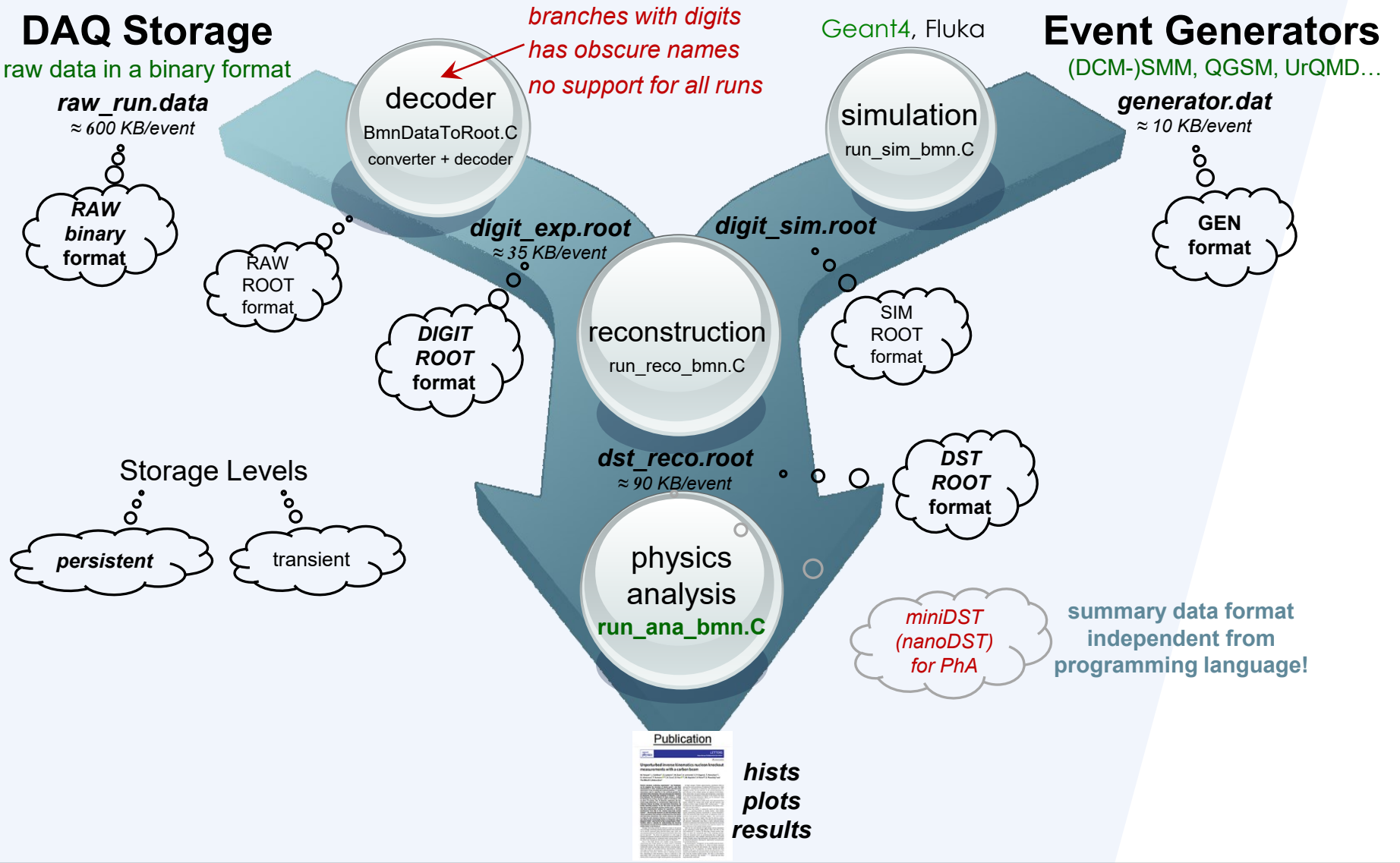
BmnRoot. *Current Issues*

- ✓ 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.
- ✓ 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 parameters

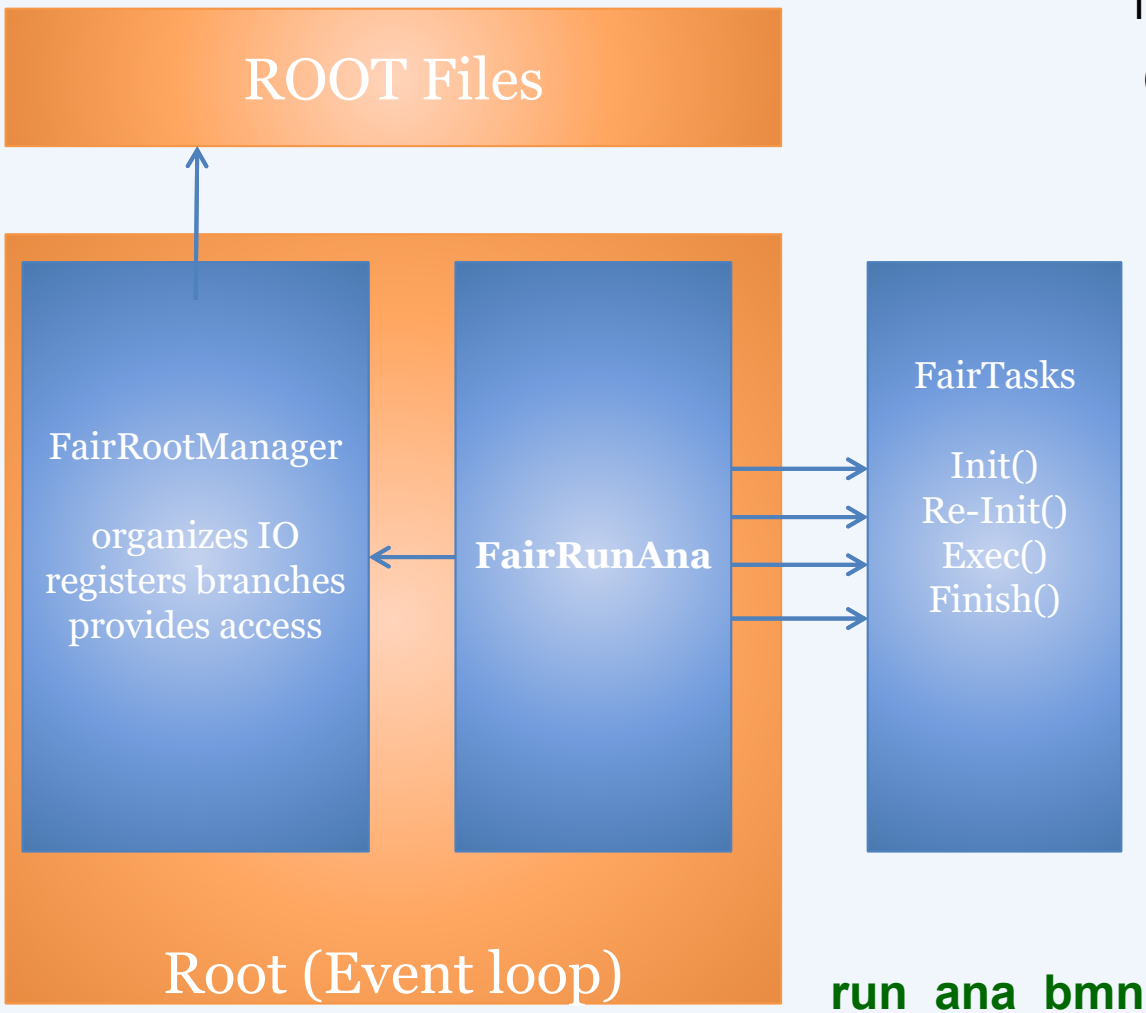
  Simple check of all the macros was integrated to the BM@N pipeline (night checks)
- ✓ Strict separation of short summary output (by default) from debug output for individuals (macro output should be adapted for mass production).

  fVerbose flag (*SetVerbose* function) or FairLoggger::Severity (debug level) must be used
- ✓ A lot of compilation warnings (*after the FairSoft/FairRoot update*) must be corrected.
- ✓ ClassImp() should be removed in the cxx files as obsolete.
- ✓ Raw Data Converter should be fixed to write correct run and raw file metadata. New synchronization of the metadata is needed after.
- ✓ SRC information will be removed from the BM@N databases.

BmnRoot. *Event Data Model*

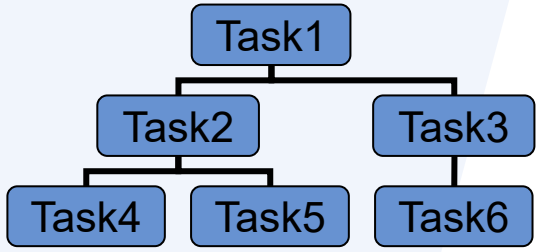


FairRoot. *Reconstruction and Analysis*



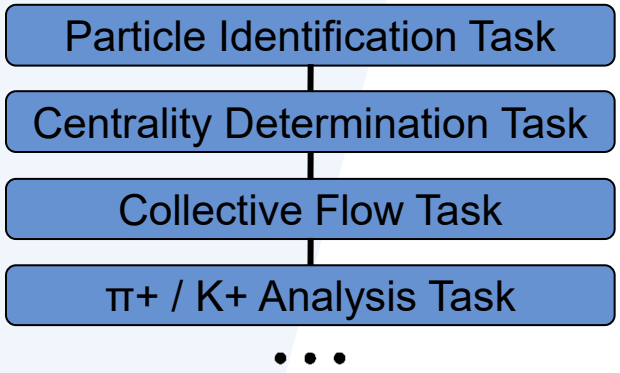
Tasks can be organized into a hierarchy

(FairTask ← base ROOT TTask class)




```
Task1->Add(Task2)
Task1->Add(Task3)
Task2->Add(Task4)
Task2->Add(Task5)
Task3->Add(Task6)
```

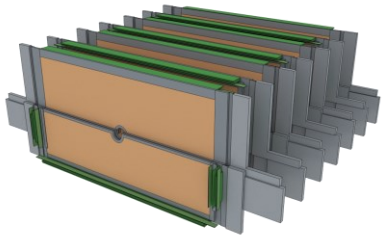
run_ana_bmn.C

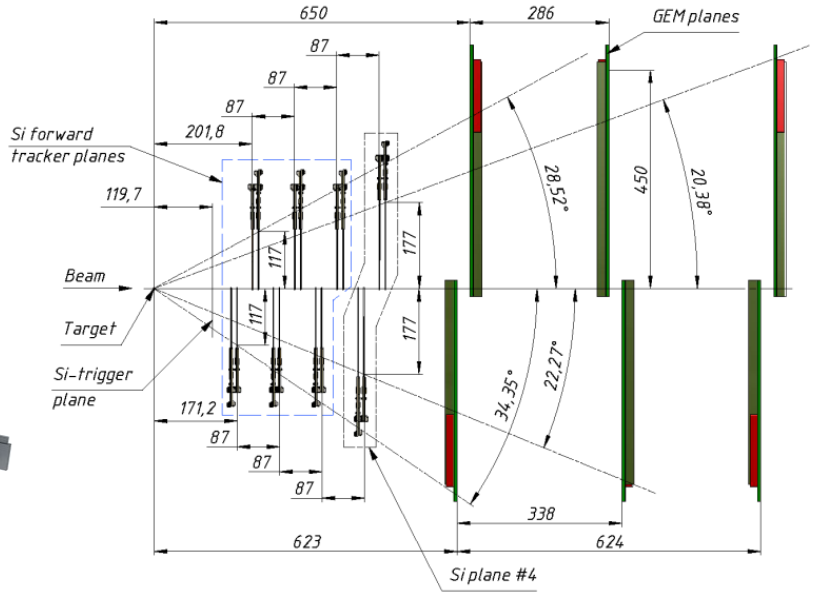


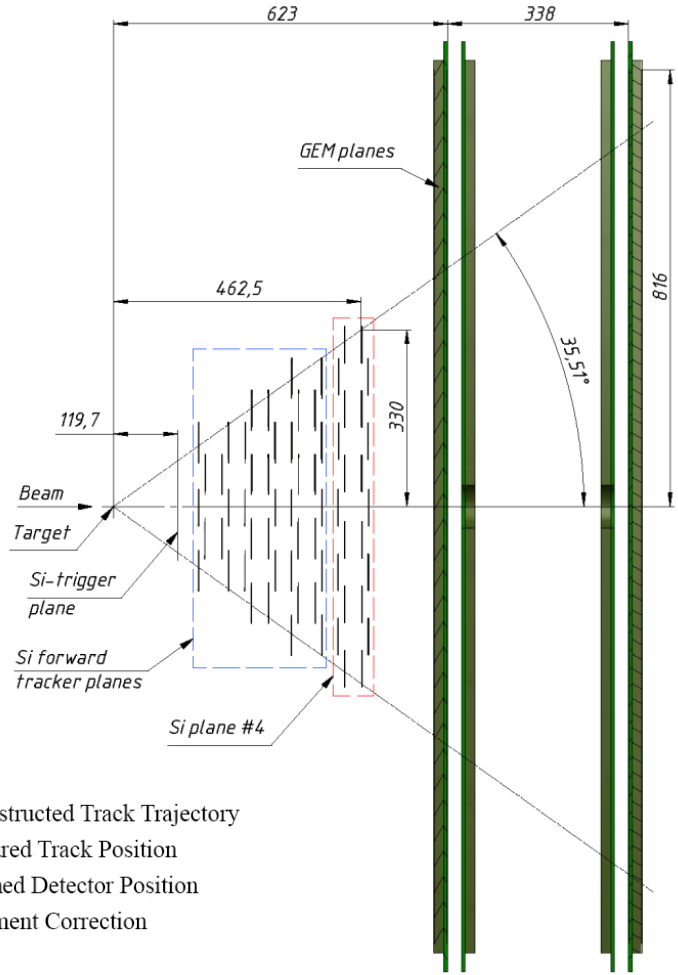
BmnRoot. *Detector Alignment*

Alignment Tools

- IMSL Fortran Library
- Eigen
- Millepede-II





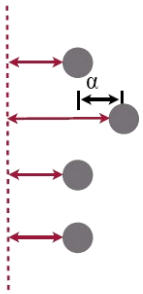


$$\begin{pmatrix} S_2 & 0 & 0 & 0 & 0 \\ 0 & S_2 & 0 & 0 & 0 \\ 0 & 0 & S_2 & 0 & 0 \\ 0 & 0 & 0 & S_2 & 0 \\ 0 & 0 & 0 & 0 & S_2 \end{pmatrix} \begin{pmatrix} S_1 & 0 & 0 & 0 & 0 \\ 0 & S_1 & 0 & 0 & 0 \\ 0 & 0 & S_1 & 0 & 0 \\ 0 & 0 & 0 & S_1 & 0 \\ 0 & 0 & 0 & 0 & S_1 \end{pmatrix} \begin{pmatrix} Z_2 & Z_3 & Z_4 & Z_5 \\ Z_2 & Z_3 & Z_4 & Z_5 \\ Z_2 & Z_3 & Z_4 & Z_5 \\ Z_2 & Z_3 & Z_4 & Z_5 \\ Z_2 & Z_3 & Z_4 & Z_5 \end{pmatrix}$$

$$\begin{pmatrix} S_1 & 0 & 0 & 0 & 0 \\ 0 & S_1 & 0 & 0 & 0 \\ 0 & 0 & S_1 & 0 & 0 \\ 0 & 0 & 0 & S_1 & 0 \\ 0 & 0 & 0 & 0 & S_1 \end{pmatrix} \begin{pmatrix} N_d & 0 & 0 & 0 & 0 \\ 0 & N_d & 0 & 0 & 0 \\ 0 & 0 & N_d & 0 & 0 \\ 0 & 0 & 0 & N_d & 0 \\ 0 & 0 & 0 & 0 & N_d \end{pmatrix} \begin{pmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{pmatrix}$$

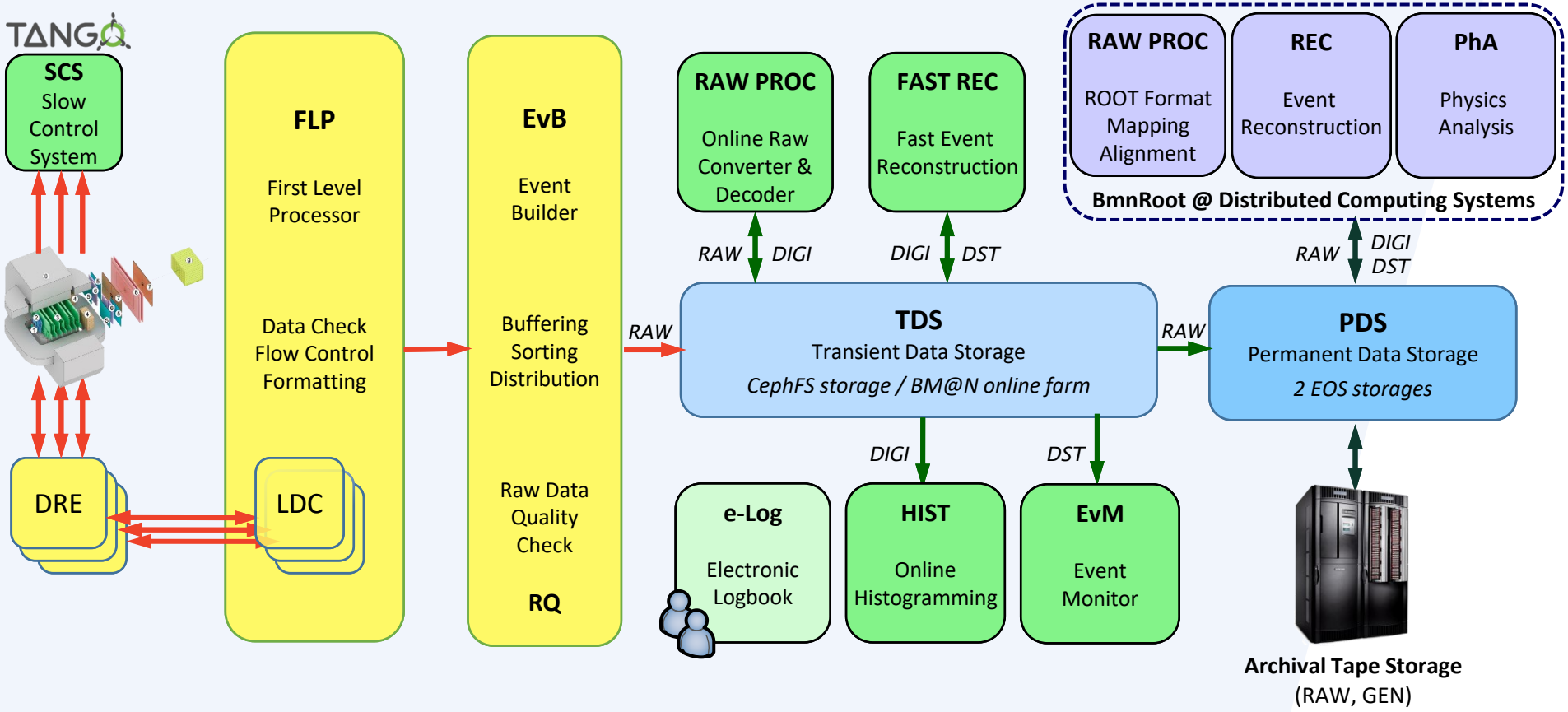
$$\begin{pmatrix} Z_2 & Z_2 & Z_2 & Z_2 & Z_2 \\ Z_3 & Z_3 & Z_3 & Z_3 & Z_3 \\ Z_4 & Z_4 & Z_4 & Z_4 & Z_4 \\ Z_5 & Z_5 & Z_5 & Z_5 & Z_5 \end{pmatrix} \begin{pmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} N_t & 0 & 0 & 0 \\ 0 & N_t & 0 & 0 \\ 0 & 0 & N_t & 0 \\ 0 & 0 & 0 & N_t \end{pmatrix}$$

$$\begin{pmatrix} Ax_1^0 z_2 & Ax_1^0 z_3 & Ax_1^0 z_4 & \dots \\ Ax_2^0 z_2 & Ax_2^0 z_3 & Ax_2^0 z_4 & \dots \\ \dots & \dots & \dots & \dots \end{pmatrix} \begin{pmatrix} Ax_1^0 & Ax_1^0 & Ax_1^0 & \dots \\ Ax_2^0 & Ax_2^0 & Ax_2^0 & \dots \\ \dots & \dots & \dots & \dots \end{pmatrix} \begin{pmatrix} \sum_i Ax_i^0 & 0 & \dots \\ 0 & \sum_i Ax_i^0 & \dots \\ \dots & \dots & \sum_i Ax_i^0 \end{pmatrix}$$



- Reconstructed Track Trajectory
- Measured Track Position
- Assumed Detector Position
- α - Alignment Correction

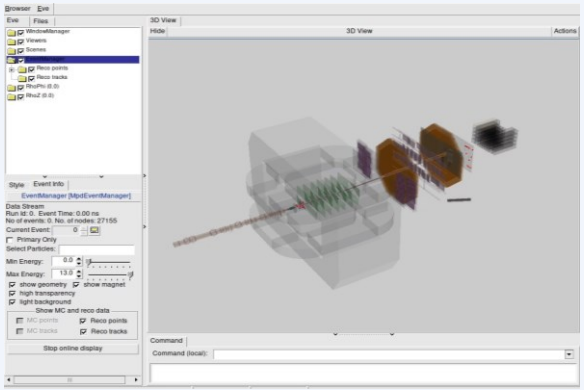
BM@N Data Processing Model



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

Information System = Database + Interfaces (GUI + API) + Services + …

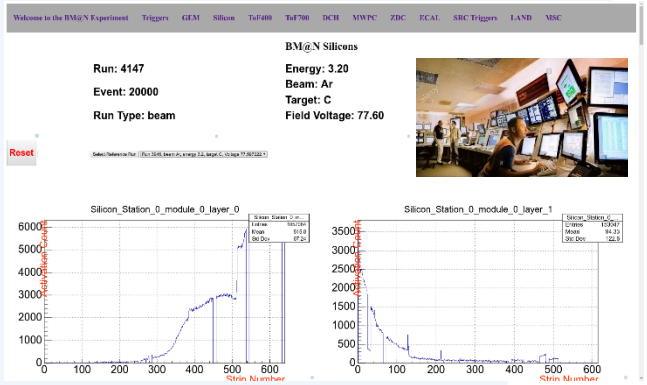
Online Metadata for BM@N Data Processing



DAQ system

EvB

Raw Event Builder



Online Raw

ROOT Format Digit Decoder

EvM

Event Monitor

HIST

Online Histogramming

raw file metadata

period, run

start & end time, event count, file path, file size

incorrect work during Run 8

- no automatic statistics

- wrong metadata for a part of runs and raw files

- as a result, not possible to process some runs

e-Log platform

run metadata

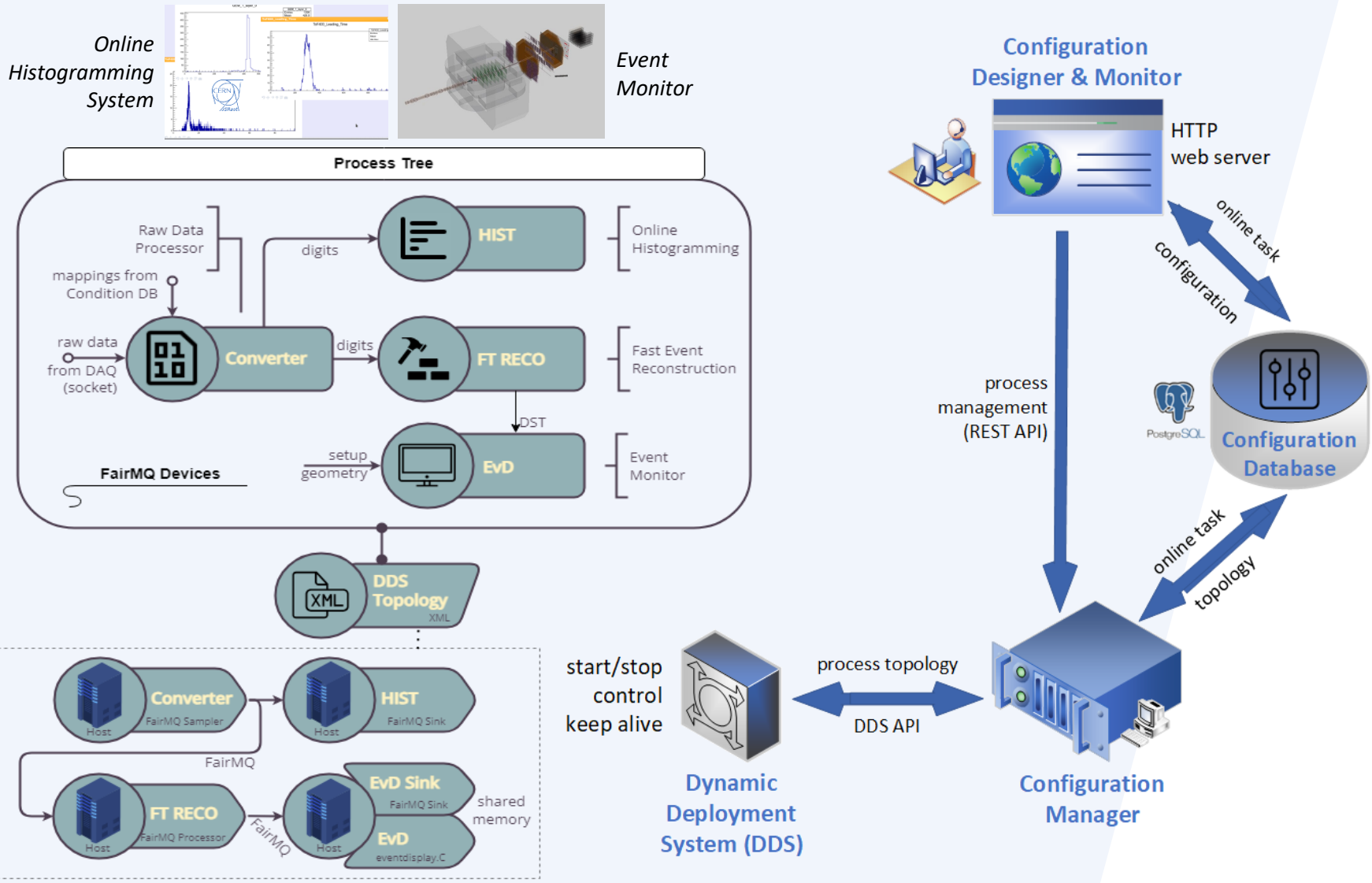
period, run

beam, energy, target, magnetic field

Condition Database

online & offline data processing

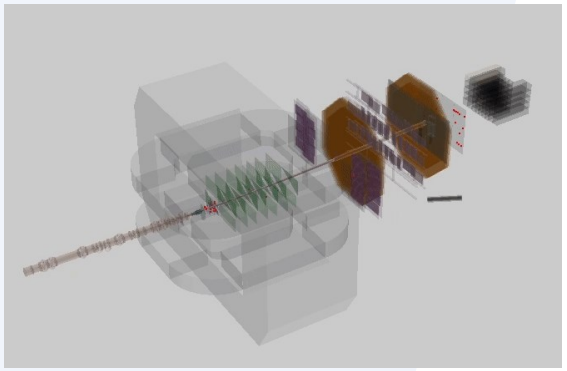
BM@N Online Configuration System (OCS)

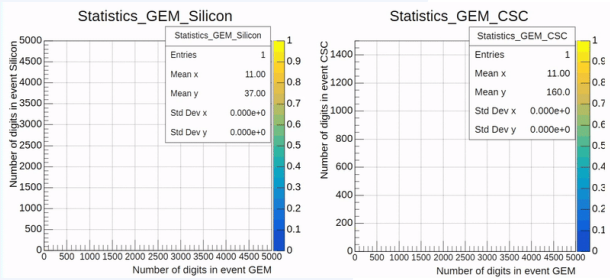


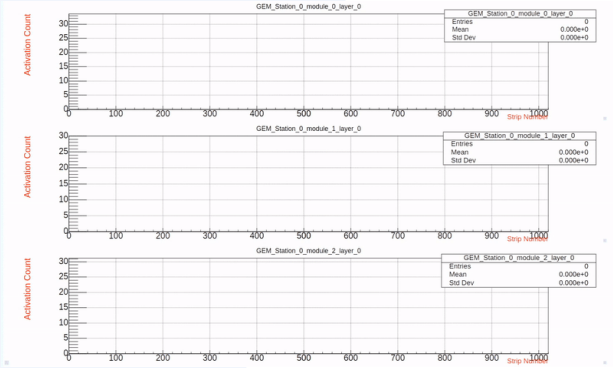
Online Processing System for BM@N

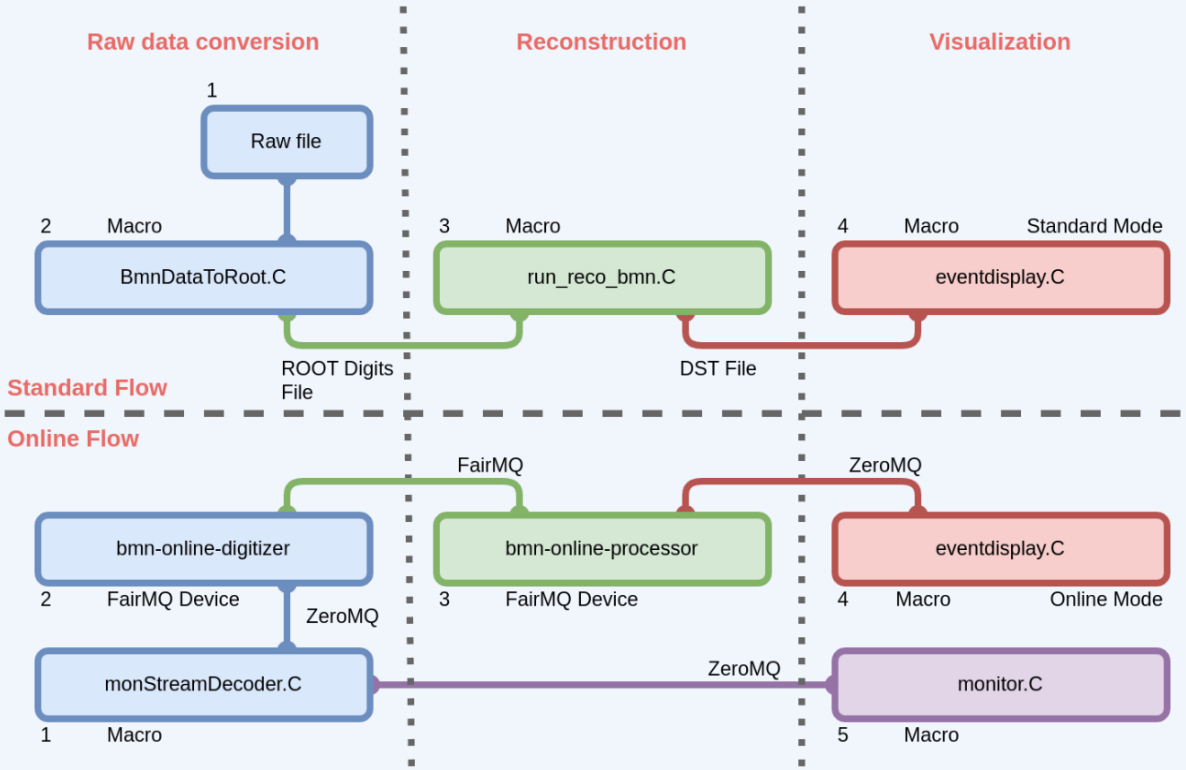
DDS (Dynamic Deployment System) is a set of tools that facilitates the process of system deployment. As a Remote Manipulator System (RMS), it initially provides SSH or SLURM, but also allows you to use other methods.

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.

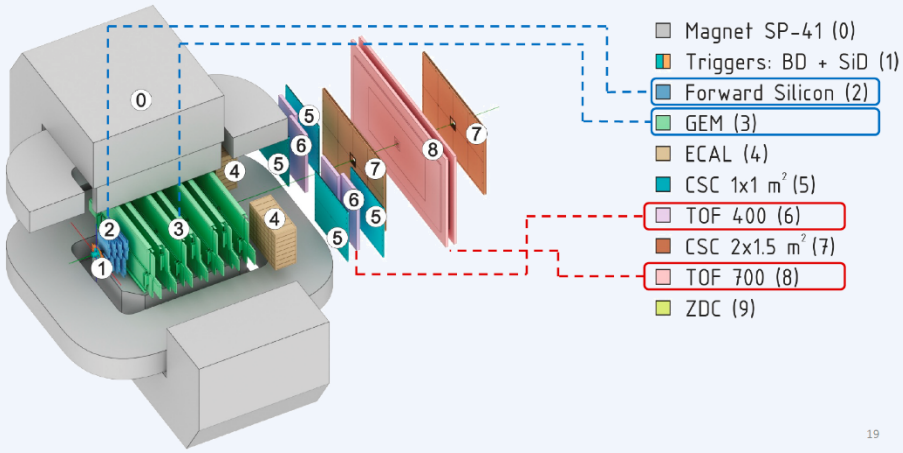


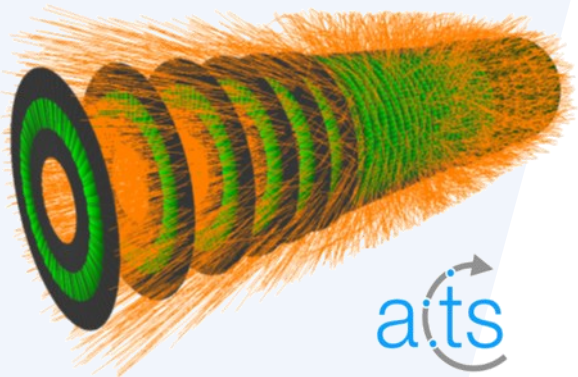




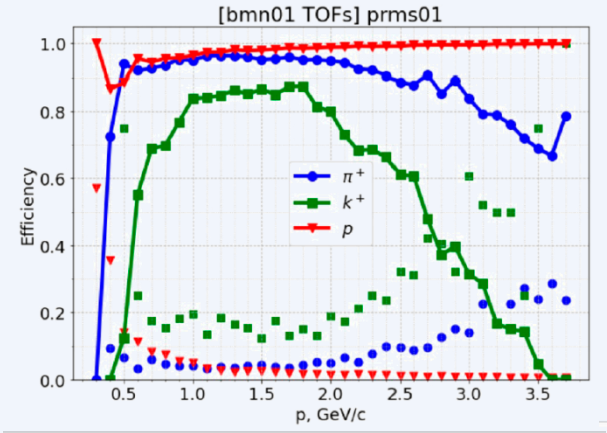


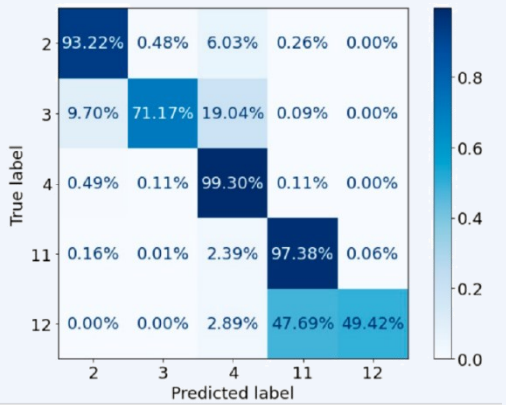
Machine Learning for Reconstruction and PID



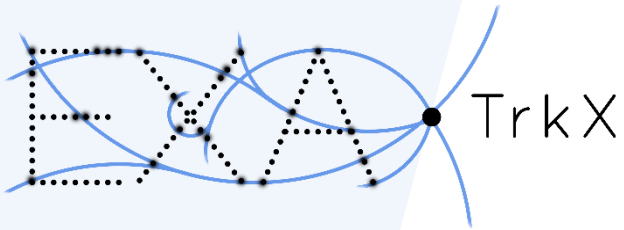


Tracking machine learning challenge
(currently developers from ATLAS, LHCb, FCC-hh)





Alexander AYRIYAN, Vladimir PAPOYAN
Implementation of Particle IDentification based on Machine Learning
(scheduled for 13th Collaboration Meeting)



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

Nikolay ERSHOV
Own implementation of Fast Event Reconstruction based on NN/ML

Geometry Information System

BM@N Geometry DataBase

Menu

HOME

VIEW GEOMETRY

VIEW SETUPS

VIEW SETUP MODULES

VIEW GEOMETRY FILES

VIEW MATERIALS

VIEW MAGNETIC FIELDS

EDIT GEOMETRY

Get in touch

Konstantin Gertsenberger

BM@N Geometry DataBase

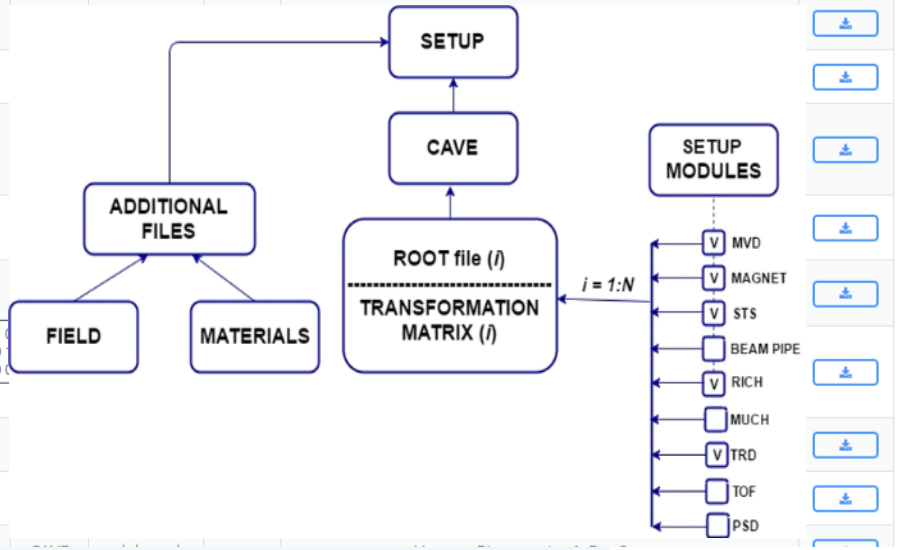
bmn-geometry.jinr.ru

User: aleksand CONFIGURE USER ACCESS LOGOUT

- DB authorization
- or FreeIPA access

Setup Modules

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	
CAVE	cave	2024-03-31	cave		none	administrator		Base cave	
CSC	FullCSC_Run8_detailed	2024-04-27	FullCSC_Run8_detailed		CAVE	aleksand		FullCSC_Run8_detailed.root	
DCH	DCH_Run8	2024-05-02	DCH_Run8						
FD	FD_run8	2024-04-27	FD_run8						
FHCAL	FHCal_for_run8_cm_rotationY_1.6deg_v1	2024-05-02	FHCal_for_run8_cm_rotationY_1.6deg_v1						
HODO	Hodo_for_run8_v1	2024-05-02	Hodo_for_run8_v1						
MAGNET	magnet_modified	2024-04-27	magnet_modified						
NDET	nDet_VETO_slices_rotY_-27.30	2024-05-02	nDet_VETO_slices_rotY_-27.30						
Pipe	section3_Run8	2024-04-27	section3_Run8						
Pipe	section2_Run8	2024-04-27	section2_Run8						

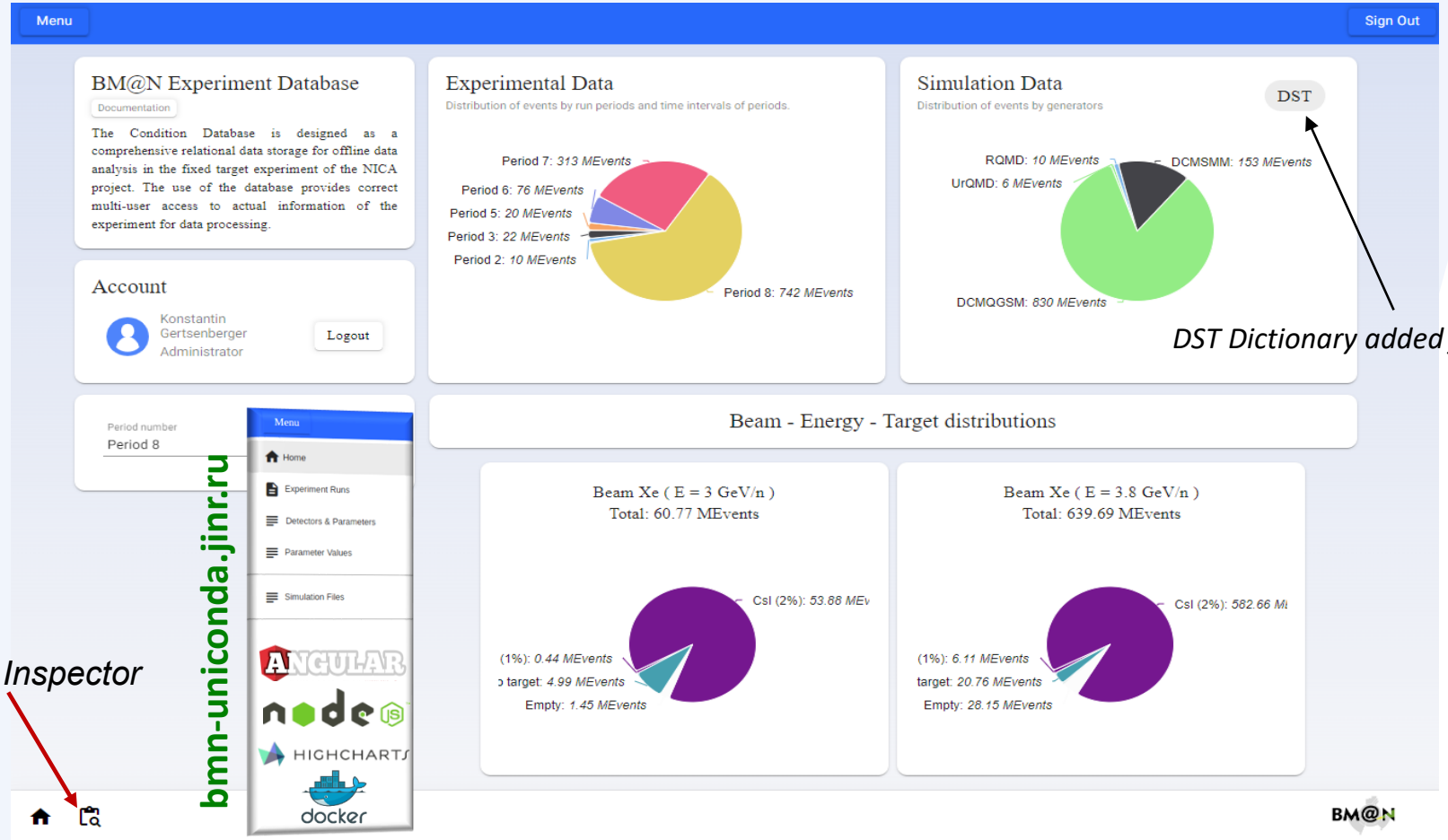


BM@N Geometry Database has filled with the setup geometries for the last Run 8

User Interface Functions:

View Add Edit Approve Download

UniConDa. *BM@N Condition Database*



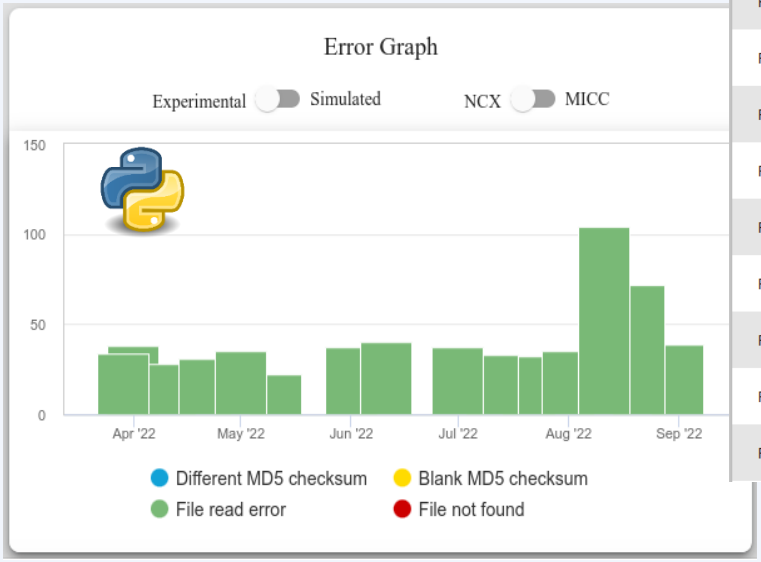
- visualization of summary data in the form of diagrams and charts
- convenient viewing, managing and searching for up-to-date information on the BM@N experiment in tabular view by collaboration members

File Inspection Service. *Web Interface*

Report Selector

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

Items per page: 5 1 – 5 of 51



Error 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

File Inspection Service

Crontab

REST APIs for BM@N Information Systems

login
pass
URL + token

BmnRoot

curl://

\+ login pass URL

OpenAPI specification
Swagger → Documentation

{JSON}

GET
POST
PUT
DELETE

https://bmn-**uniconda**.jinr.ru/uniconda_api/v1/run

case-insensitive

run_number=3950|4000&beam_particle=Ar
energy=3.16|3.18&target_particle=~Lead

HOSTNAME / SERVICE / VERSION / ENTITY?parameter_set

HOSTNAME=https://bmn-[SYSNAME].jinr.ru

SERVICE=[SYSNAME]_api

VERSION=v1 (v2…)

ENTITY=tablename without last '_' (if presents)

parameters are separated by **&**
ranges: min|max → >=min AND <=max
min| → >=min |max → <=max
LIKE a string template: **=~***pattern*

Unified Condition Database, SYSNAME = **uniconda**

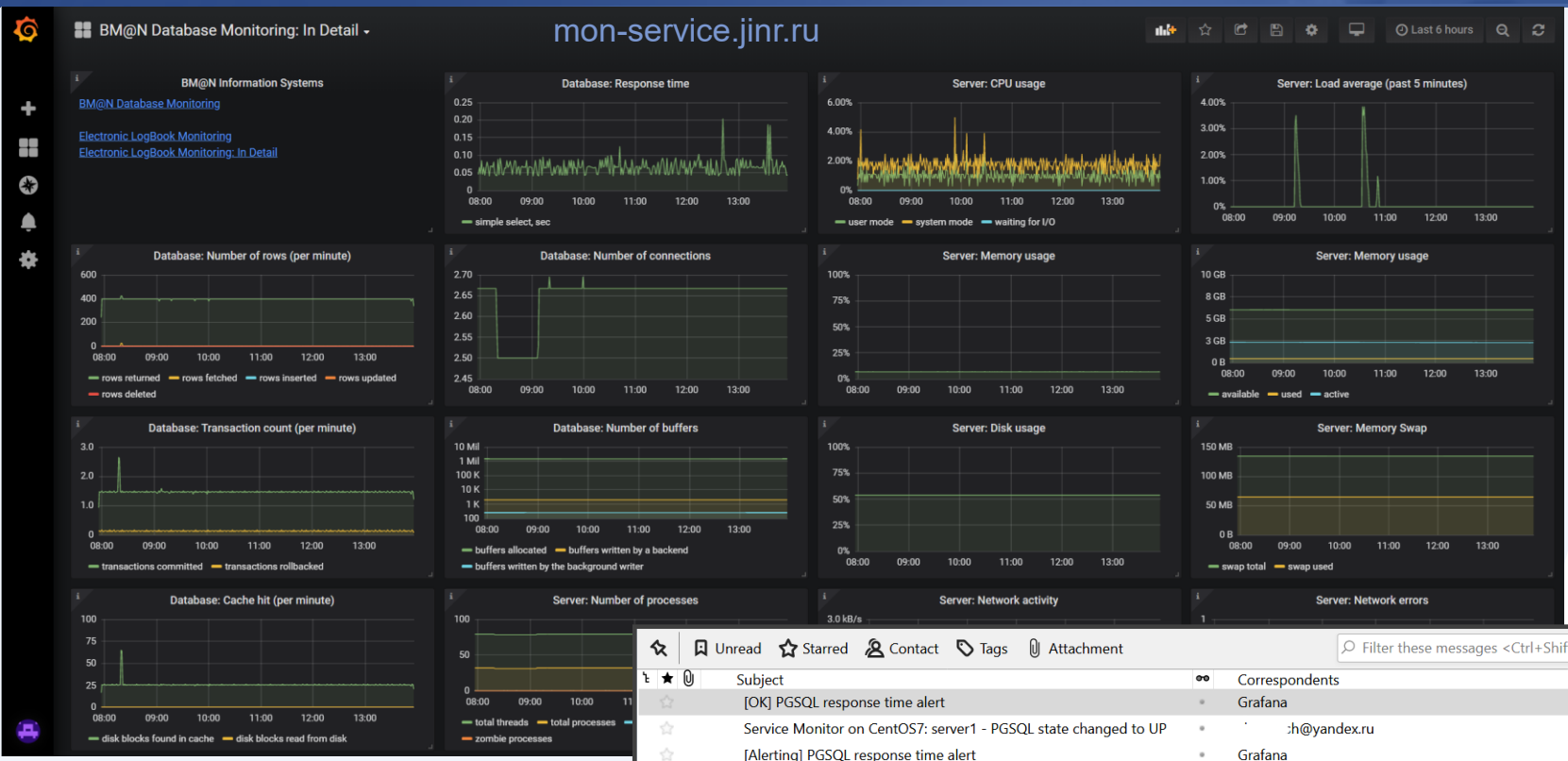
Event Metadata System, SYSNAME = **event**

BM@N File Catalogue, SYSNAME = **file** (prototype)

Geometry Database, SYSNAME = **geo**

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

Monitoring System. *Grafana Visualization*



Telegraf

influxdb

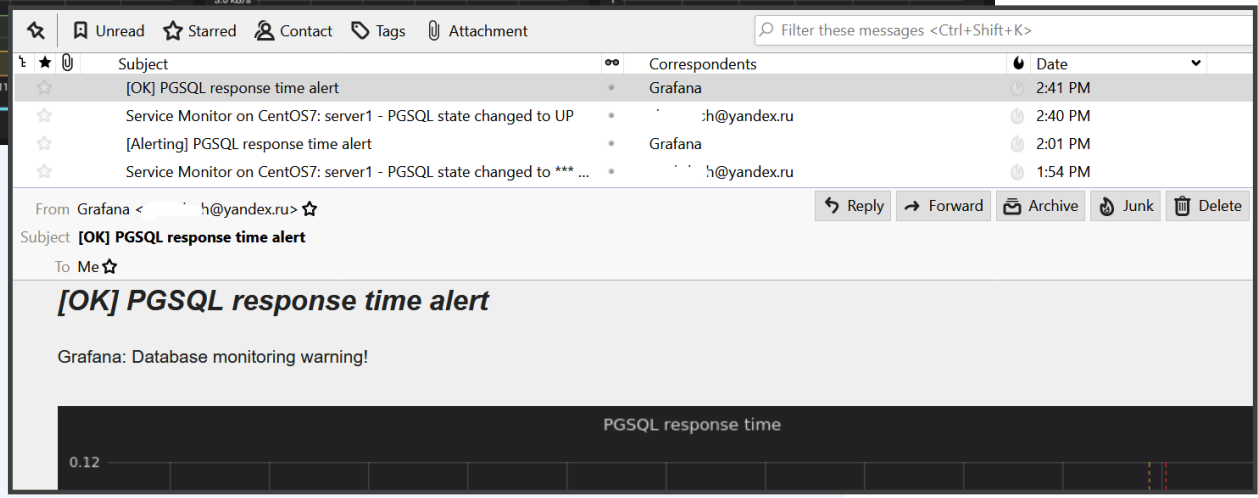
Grafana

- hosts
- databases
- web-sites

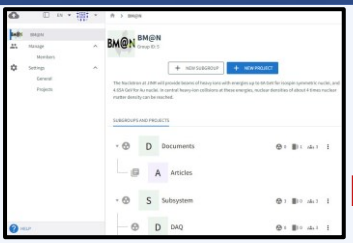
- Condition Database
- Electronic Logbook
- Configuration database
- Integrity Inspector

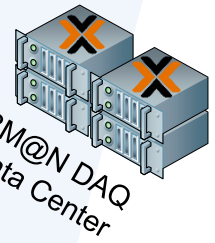
...

Email Alerting



BM@N Software Ecosystem





Official BM@N Web Site
bmn.jinr.ru

Publication Server
bmn-science.jinr.ru
for BM@N scientific activity

Picture Gallery
bmn-gallery.jinr.ru
for officially approved figures (Ilya Romanov)

Wiki Doc Server
bmn-wiki.jinr.ru

Task Management
bmn-task.jinr.ru

NICA-Scheduler
bmn-scheduler.jinr.ru

Tango Viewer
bmn-tango.jinr.ru

Electronic Logbook
bmn-elog.jinr.ru

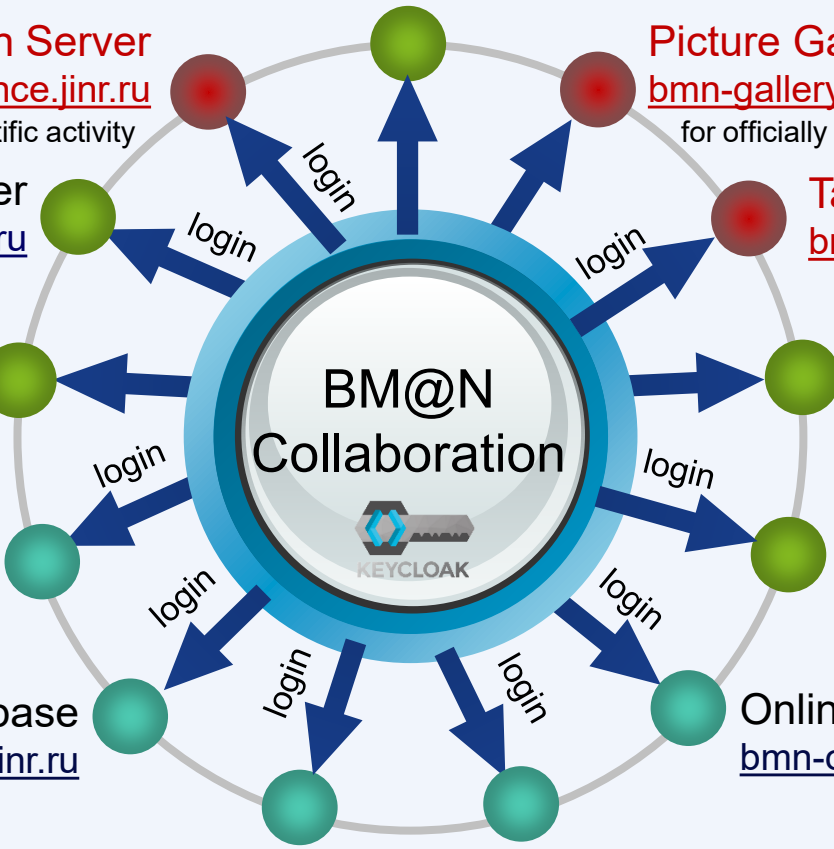
Forum System
bmn-forum.jinr.ru

Condition Database
bmn-uniconda.jinr.ru

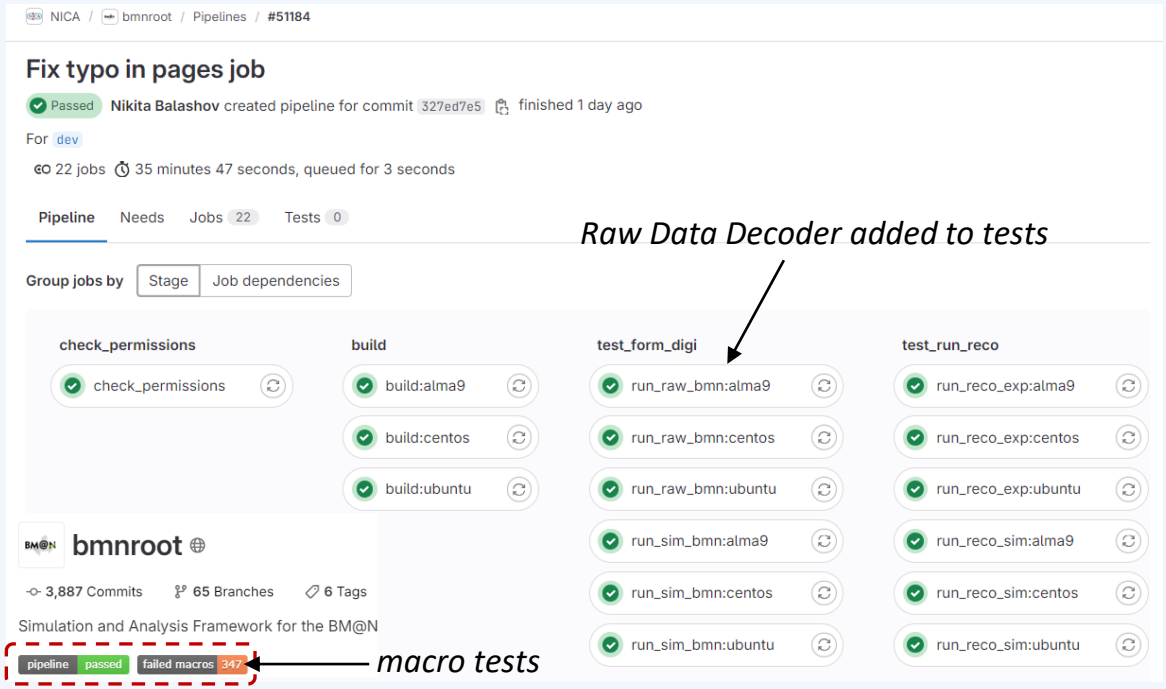
Online Configuration System
bmn-online.jinr.ru

Geometry Database
bmn-geometry.jinr.ru

Event Metadata System
bmn-event.jinr.ru



Software Management & Distribution System



GIT Pipelines on Merge Requests

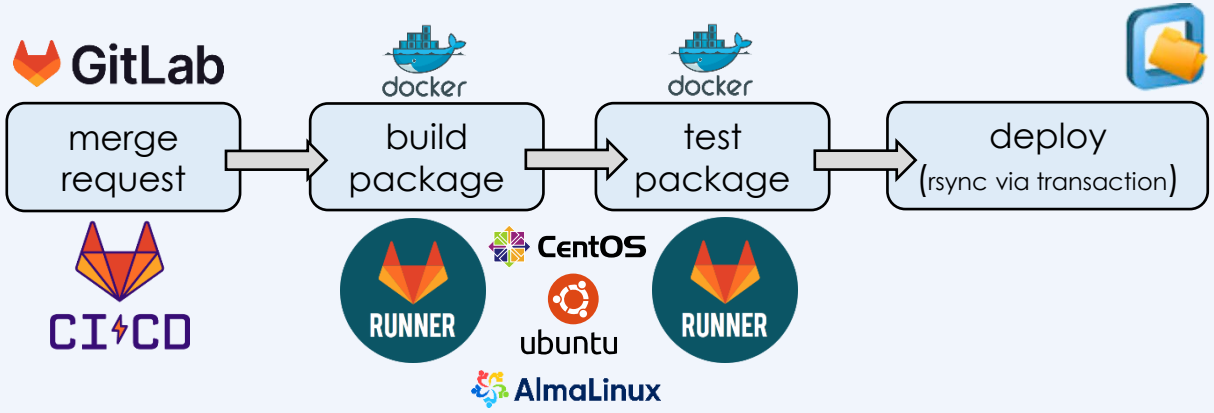
- checking compilation and main macros
  → stable dev and pro branches
- deploy BmnRoot to the CVMFS storage
- deploy BmnRoot containers to the registry
- checking Clang code formatting
  → unified clear programming code

GIT Night Tests

- test all BmnRoot macros
- 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
```

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 (2nd Tab)
- 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

BM@N Computing Platforms

/bmn-daq-computing-center/

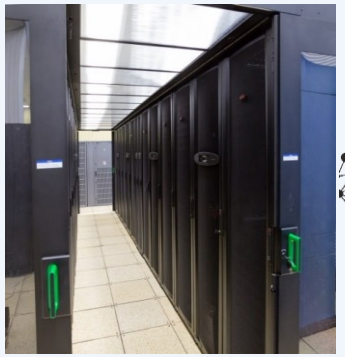
BM@N Online Cluster
ddc.jinr.ru
(LHEP, b.205)

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

Central Software Repository based on ***CVMFS*** for the experiment: /cvmfs/bmn.jinr.ru/

CEPH: 2.8 PB (*replica*)
SLURM: 1500 cores
after the upgrade

EOS: 1.2 PB (*replica*)
NFS: **300 TB** (*for NICA*)
SLURM: 3000 cores
(*for all NICA users*)

EOS: 1.2 PB (*replica*)
EOS CTA: **500 TB**
SLURM: 2500 cores
(*for all NICA users*)

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

M. Kapishin and K. Gertsenberger are members of the new Coordination Council on the NICA Computing

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 CICC

EOS

for BM@N offline (1.2 PB)

build on HDD

NICA cluster

NFS

fast on NVMe SSD

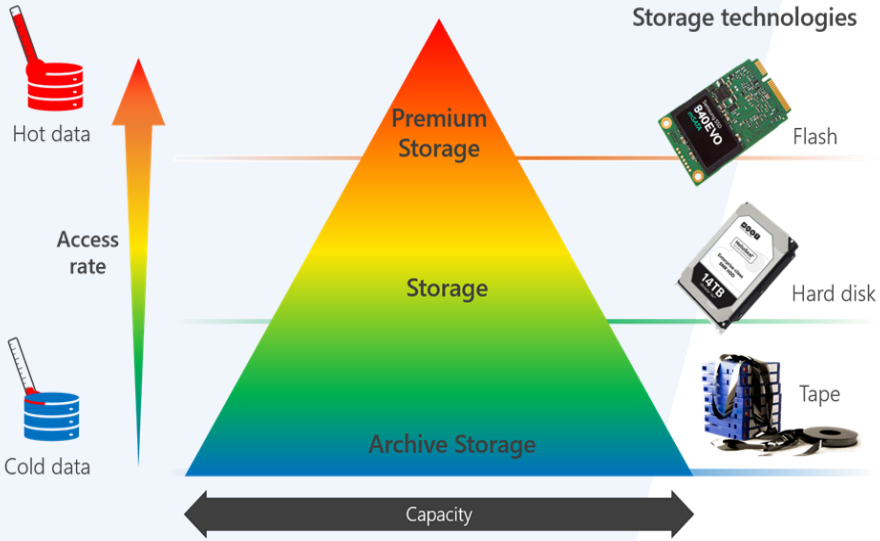
MLIT CICC

nope

HybriLIT

lustre

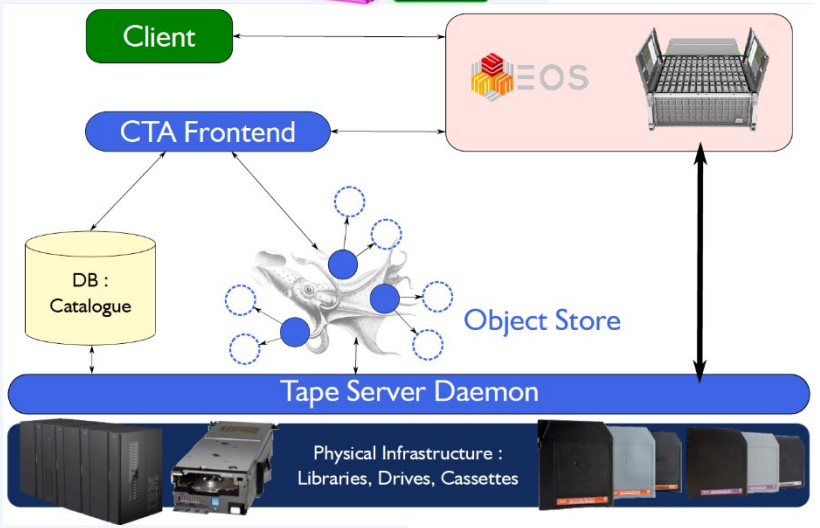
fast on NVMe SSD



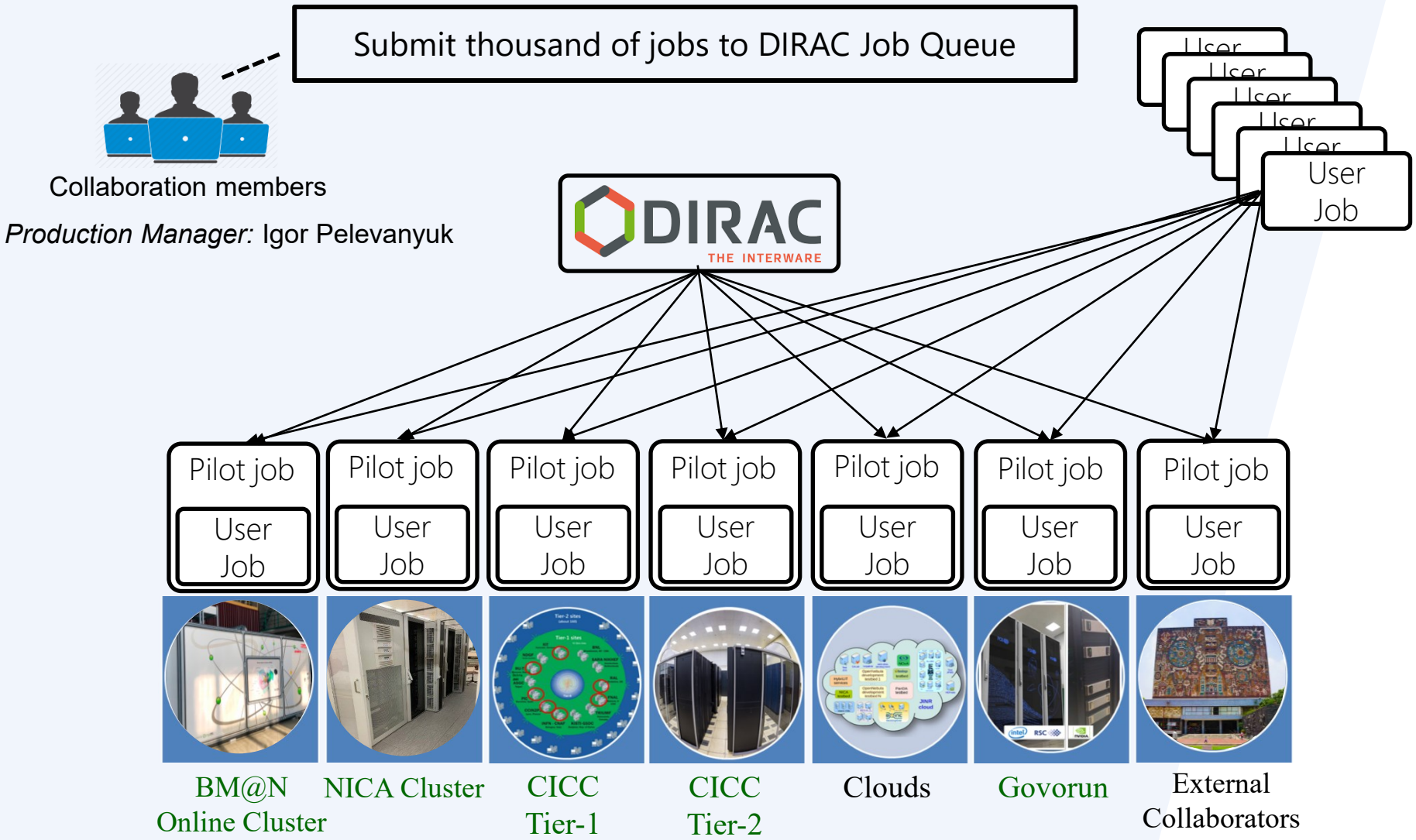
Archive Tape Storage for BM@N

EOS CTA Integration in MLIT

- CTA tape is a new archive solution developed at CERN to replace Castor
- Extends MLIT EOS with tape backend functionality
- Tape “bringonline” exposed via EOS and XRootD protocols
- Gfal2 XRootD plugin
- Can be handled transparently by FTS
- Advantages: long lifespan, cost of use, energy efficiency, security
- Tape robotic systems – a long-term storage for BM@N, stores *raw* and *gen* data, *online raw data backup to tapes*

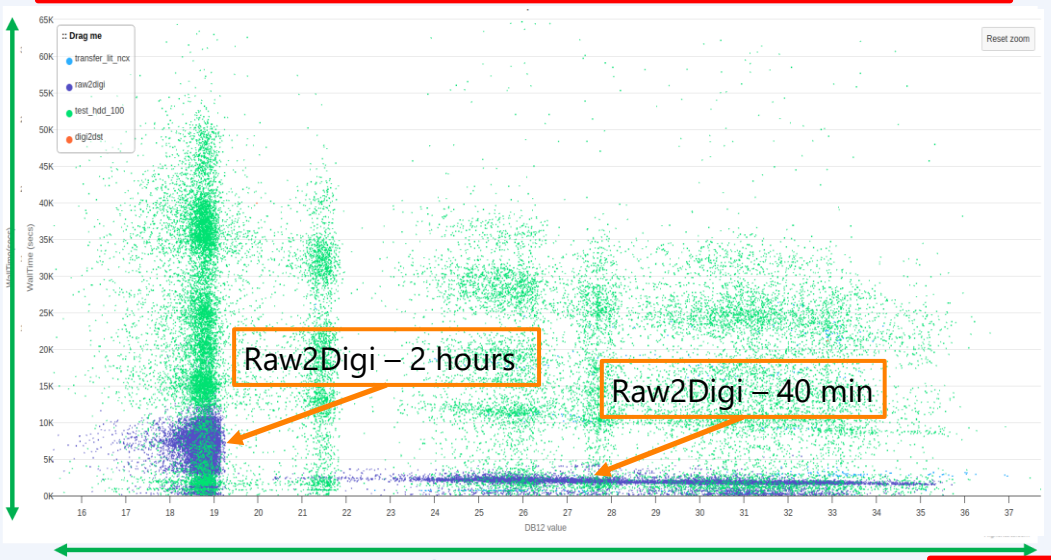


DIRAC Workload Manager for BM@N



BM@N DST Production via DIRAC (Run 8)

Total duration of Raw2Digi campaign ≈ 1.5 days



CPU core performance on benchmarks

Used Resources (cores):

Tier1: 1500 (for NICA)
Tier2: 1000 (for NICA)

NICA cluster: 1000 (per user)

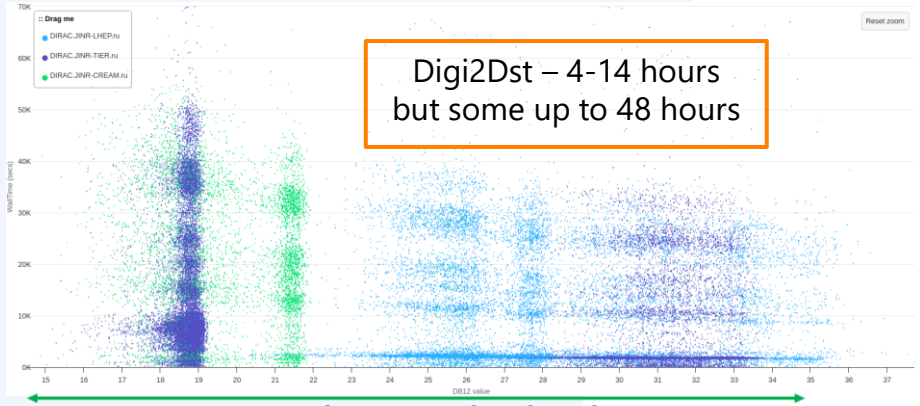
Total files: **30 741** Total raw size: **393 TB**

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**

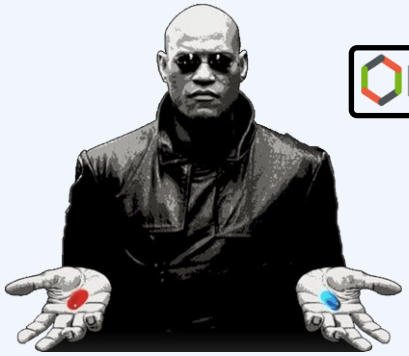
DST production for Run 8 data (3.8 AGeV) took **1 week**



CPU core performance on benchmarks

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 DIRAC 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
- RUCIO 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.



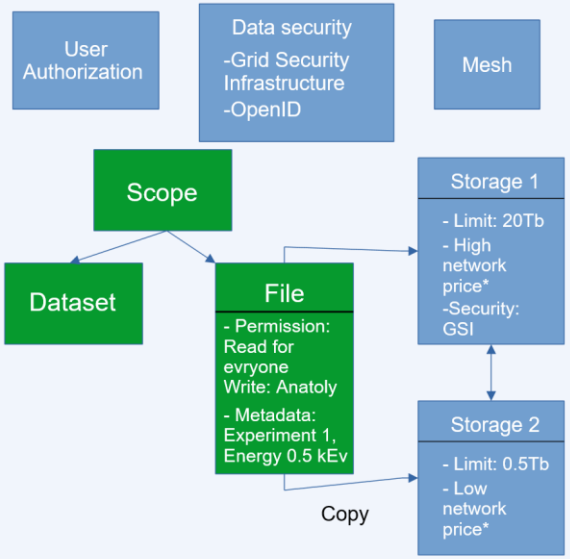
Rucio as a File Catalogue for BM@N

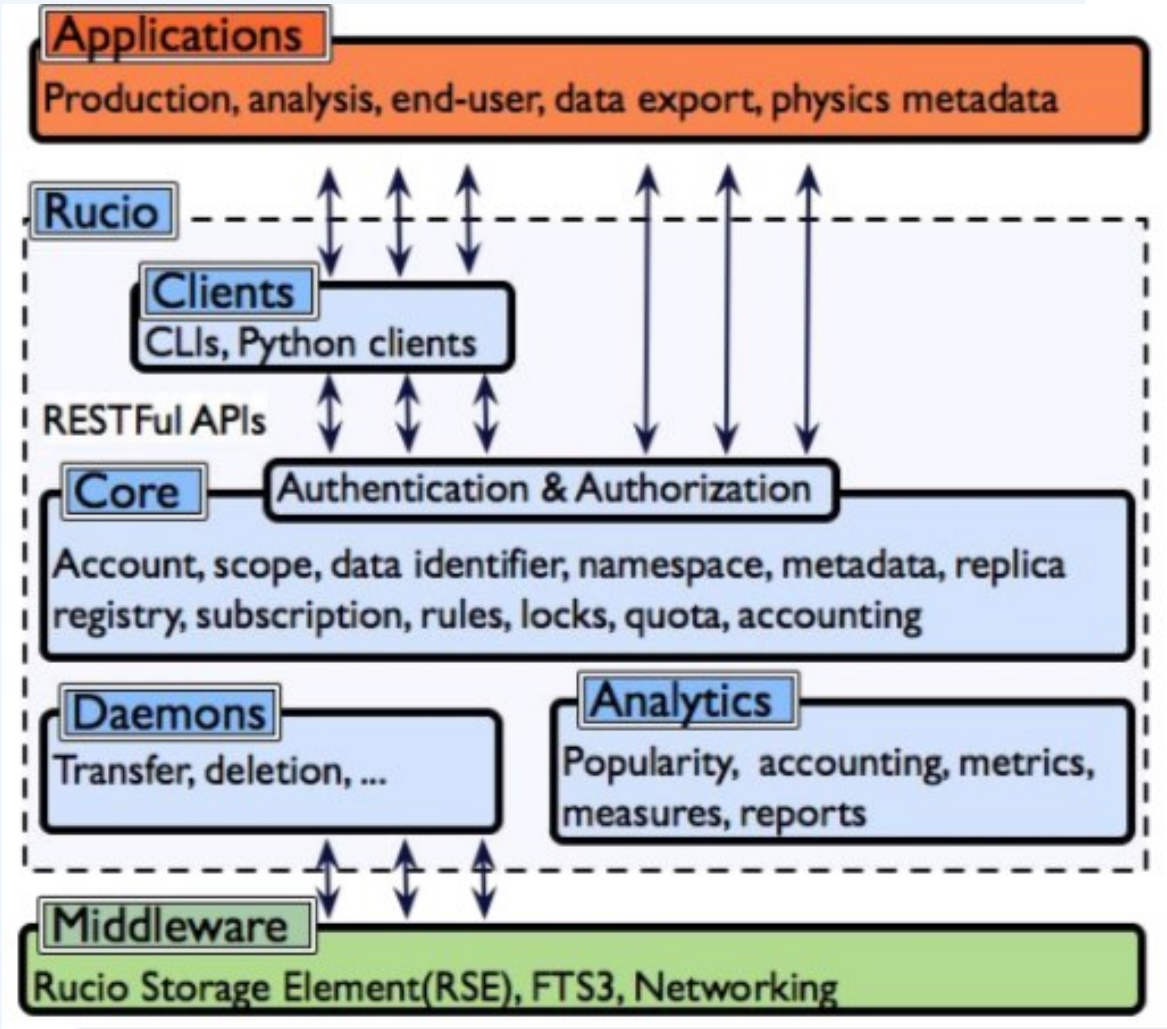
SCIENTIFIC DATA MANAGEMENT
RUCIO

Keeps track of data locations

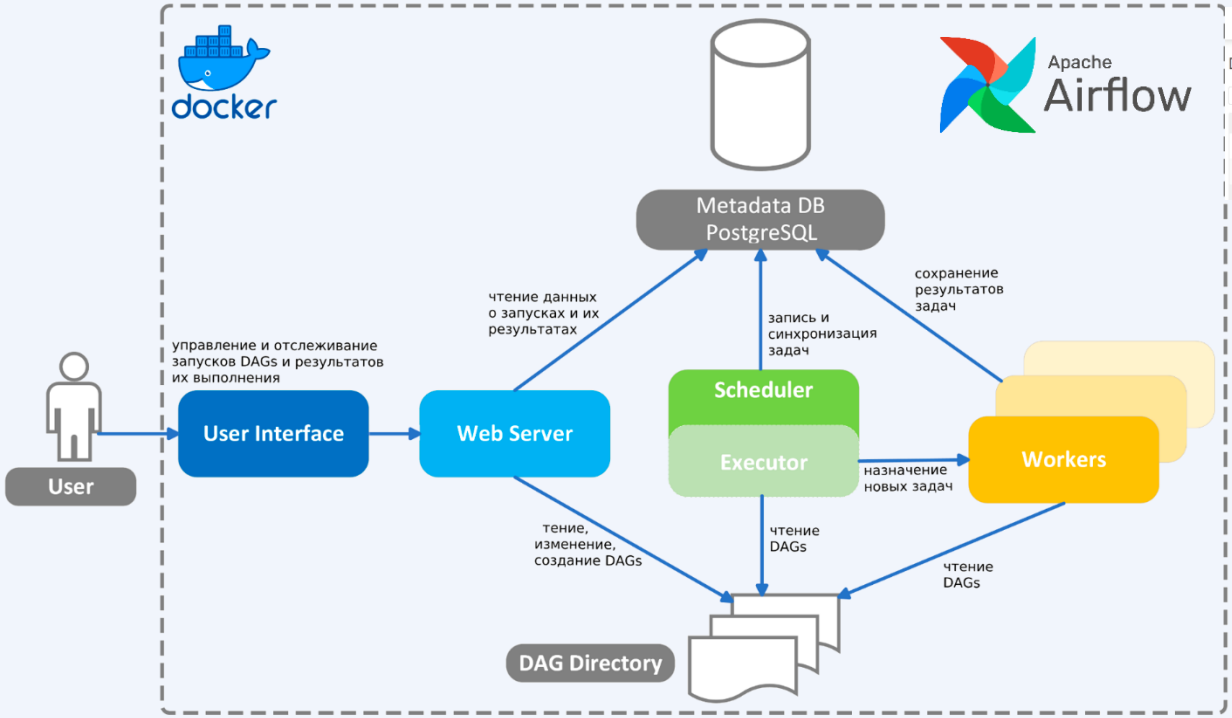
Moves data around as needed

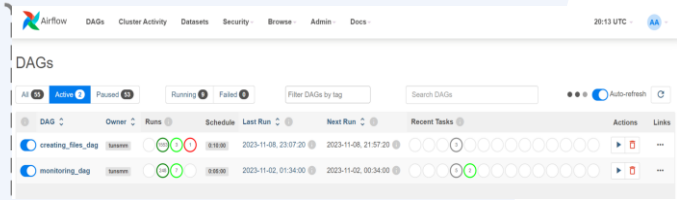
Is used in modern experiments for scientific data management





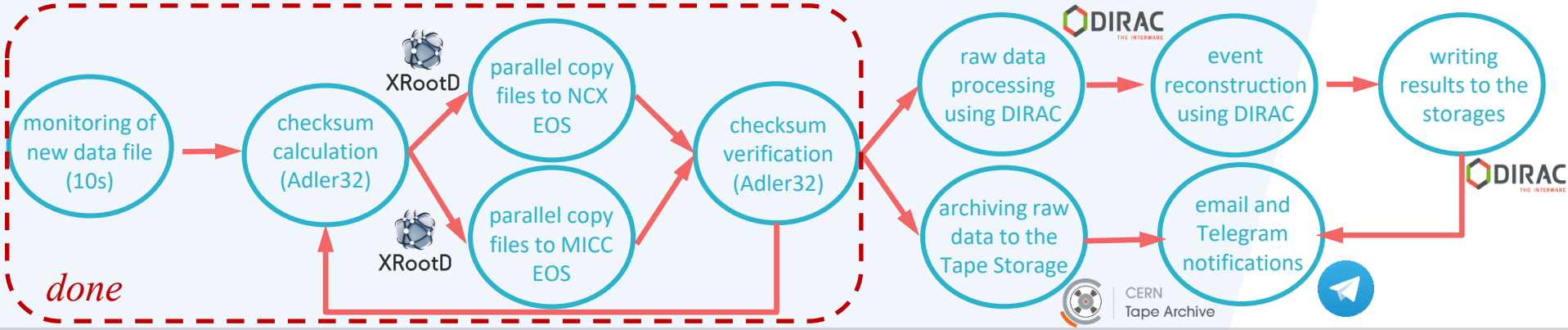
Progress in BM@N Workflow Management





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 possible starting data processing using DIRAC



Concise Roadmap of the BM@N Software

Topic	Development Task	FTE/y
BM@N Computing	BM@N distributed data processing via WMS (DIRAC)	0.25
	BM@N distributed data processing using File Catalogue (DFC & RUCIO)	0.25
	Workflow Service (AirFlow) integration with BM@N systems	0.25
	Dockers for BmnRoot: deployment and distributed processing	0.25
	Benchmarking and testing BM@N clusters to predict failures	0.25
BmnRoot processing	Implementation of the Fast Event Reconstruction based on ML or NN	0.5
	Development of miniDST format	0.25
	Implement Trigger Info format and write to the Condition Database	0.25
	Correcting error messages and memory bugs in BmnRoot	0.25
IS + Services	Data Quality Assurance for online and offline (Jupiter Notebooks?)	0.5
	Modern Web Event Display for online and offline visualization	0.25
	Web system for publication and report activity	0.25
	Institute a Project Management System	0.15
	And many other tasks: documentation (guides); refinement, support and transition to modern solutions (Web ED, NICA-Scheduler, e-Log redesign, NoSQL for Condition DB…); emerging tasks and forgotten tasks	2 – 5

Software Strategy Risks

- Software Fund
  - *no financial fund*
  - *no support of the most external software participants*
- Staff
  - *no full-fledged software group (management's refusals)*
- Computing Resources
  - *not enough guaranteed resources for BM@N for MP: (192 cores on Govorun), 2024→2027: 6 000 cores required*
  - *not enough stable work of the NICA cluster*
  - *no stop announcements from MICC*

Назар аударғаныңызға рақмет!