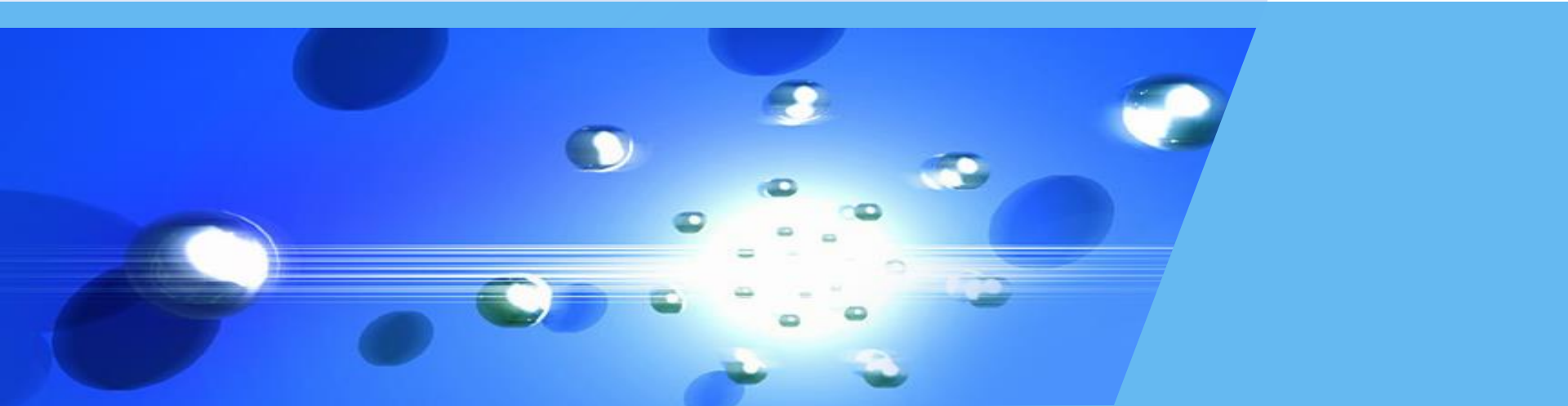




10th Collaboration Meeting of the BM@N Experiment at the NICA Facility



BM@N Software Status, Current Issues and Further Plans

Konstantin Gertsenberger

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



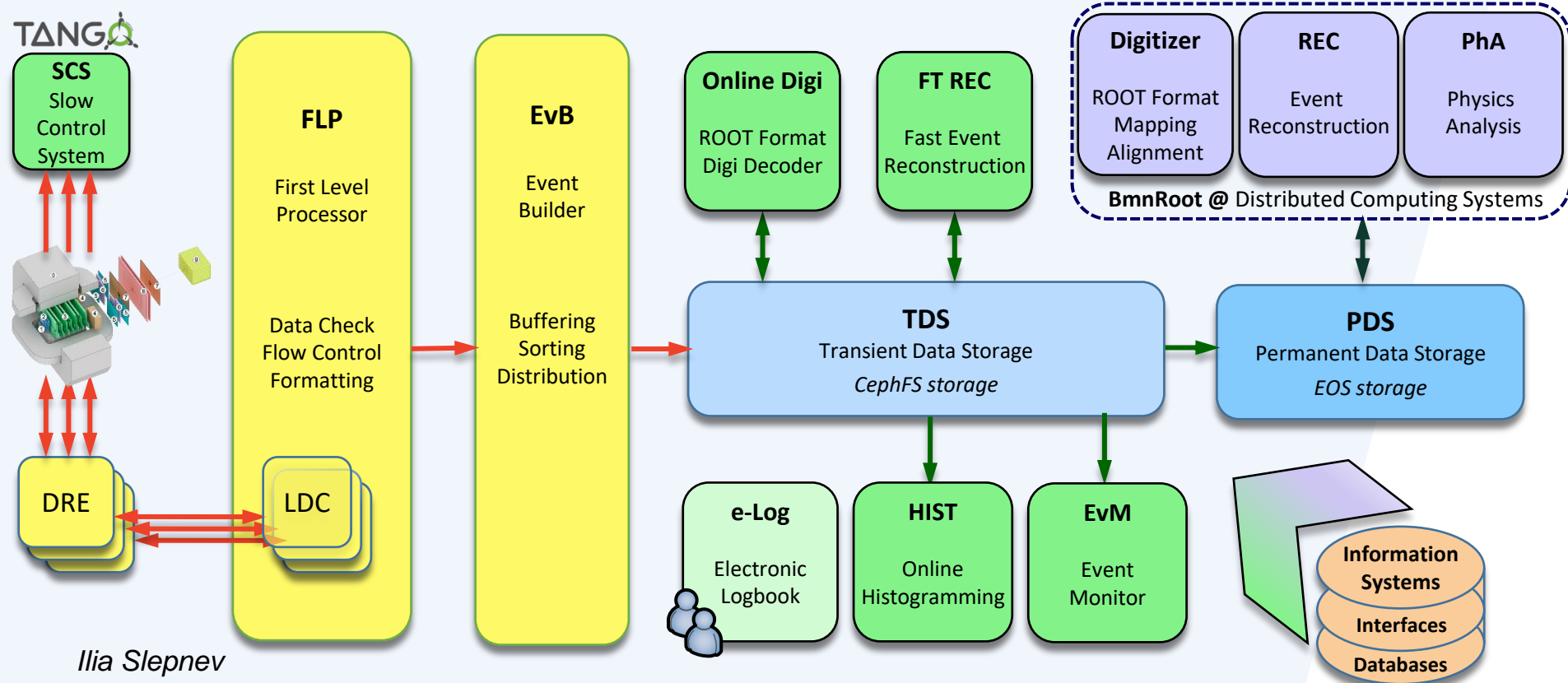
15-19 May 2023



St Petersburg
University

May 19, 2023

BM@N Data Processing Flow



Iliia Slepnev
(18 May 09:30)

BM@N DAQ & Online Computing



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

Online Information System

Electronic Logbook

Improvements of the e-Log Platform

The screenshot shows the BM@N Electronic Logbook interface. Callouts point to the following features:

- Create a new run**: Points to the 'New' button in the navigation bar.
- Advanced search**: Points to the 'Find' button.
- Current day records**: Points to the 'Last day' button.
- User Cabinet**: Points to the 'Account' button.
- Work with dictionaries**: Points to the 'Reference Book' button.
- Number of records per page**: Points to the 'Number of items per page' dropdown menu.
- Username**: Points to the 'Logged in as shift' text.
- Fast search**: Points to the search input field.
- Page number**: Points to the 'Page: 1 of 282' indicator.
- New Run Checks**: Points to the 'Type' column header in the table.
- New Run Types**: Points to the 'No Run' column header in the table.

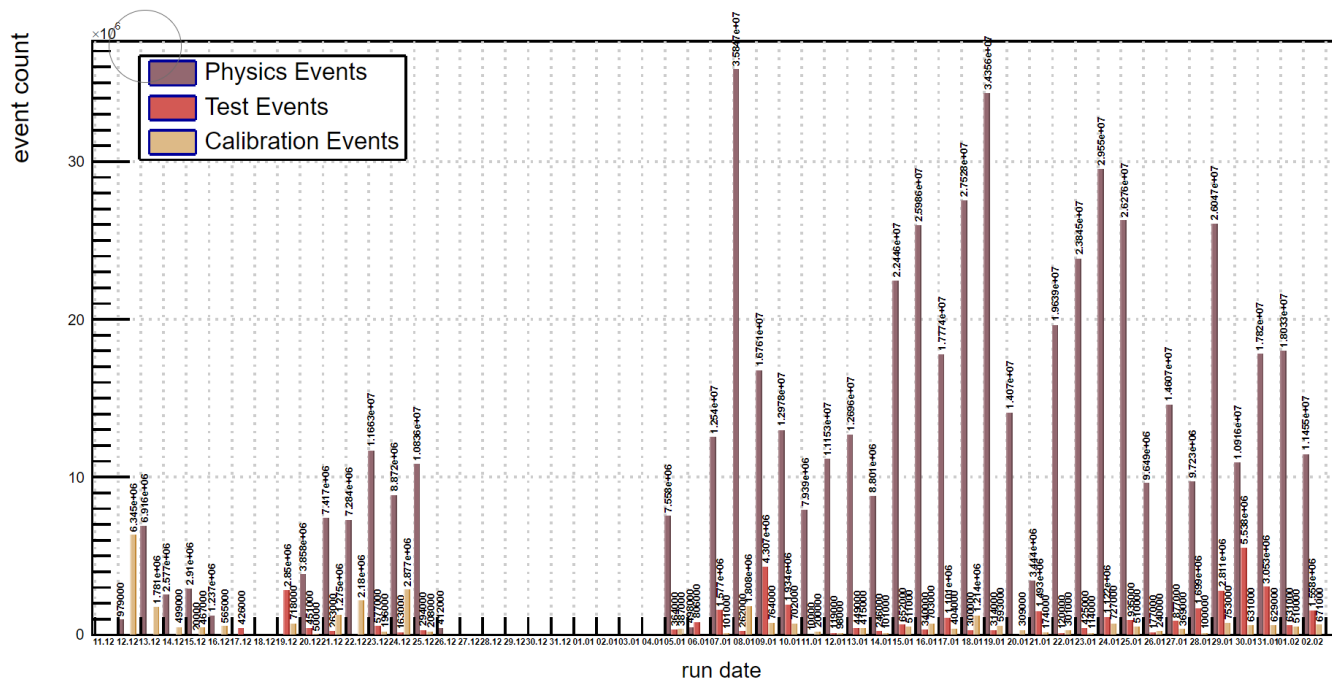
Date	Shift Leader	Type	No Run	Trigger	DAQ Status	SP-41, A	SP-57, A	VKM2, A	Beam	Energy, GeV	Target	Comment	Attachment
2018-04-05 11:47:06	Rumyantsev	Inform All	5185 per.7	Special Trigger	All	0	0	0	Kr	2.94	Cu (2 mm)	End of the RUN7	
2018-04-05 11:01:20	Rumyantsev	New Run	5184 per.7	Beam Trigger + Si >3	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 08:42:35	Rumyantsev	New Run	5183 per.7	Beam Trigger + Si >2	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 07:41:29	Babkin	New Run	5180 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 201 kev	
2018-04-05 07:25:08	Babkin	New Run	5179 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 201 kev	
2018-04-05 06:01:07	Babkin	New Run	5178 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 201 kev	
2018-04-05 05:27:39	Babkin	New Run	5177 per.7	Beam Trigger + Si >3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & Si>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 204 kev	
2018-04-05 05:27:06	Babkin	New Run	5176 per.7	Beam Trigger + BD>3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & BD>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 150 kev	
2018-04-05 04:47:27	Babkin	New Run	5174 per.7	Beam Trigger + BD>3	All	1250	50	125	Kr	2.94	Cu (2 mm)	Cu target; Tr.= BC1 & BC2 & VC & BD>3; VKM2: I=125A, SP-57=50A, SP41=1250A; 213 kev	

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

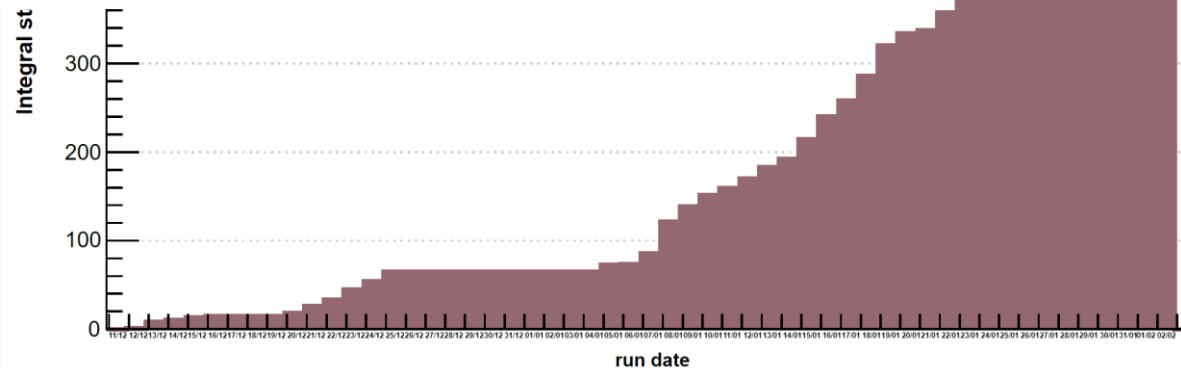
Manual Statistics of the e-Log Platform

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.



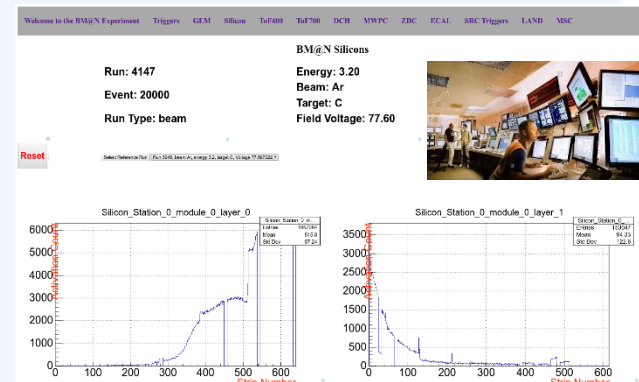
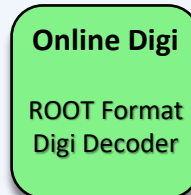
run date



Run Metadata → BM@N Condition Database



DAQ system



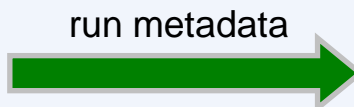
run and raw file metadata

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



Condition Database

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 raw data



run metadata
period, run beam, energy, target, magnetic field

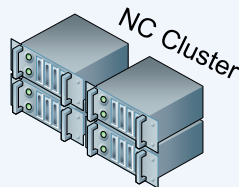


offline data processing



e-Log Platform. *Summary*

- The Electronic Logbook deployed on NC-cluster was successfully employed in BM@N Run 8, and, at present, it contains records for conducted BM@N runs from 5 to 8.
- New types of BM@N runs, such as Test, Calibration and Physics ones were added on request.
- Manual run statistics were added, but there must be automation.
- A lot of checks were missing, which have been added by A. Chebotov.
- Run metadata from the e-Log Platform was successfully transferred, but improving of the Raw Data Converter is required.
- The re-design of the e-Log platform is desirable.

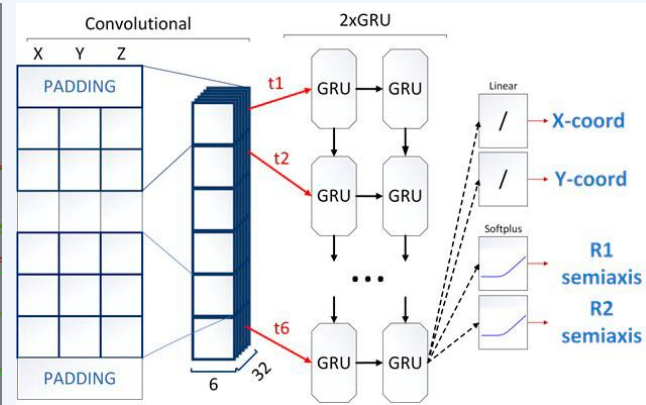
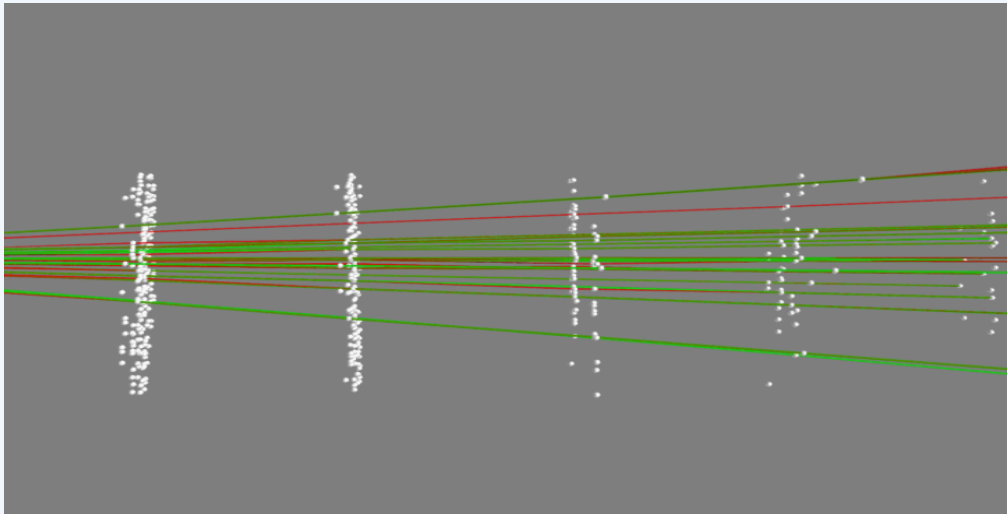


BM@N Electronic Logbook
Runs 5 - 8
records ~ 5 200

Online Software System

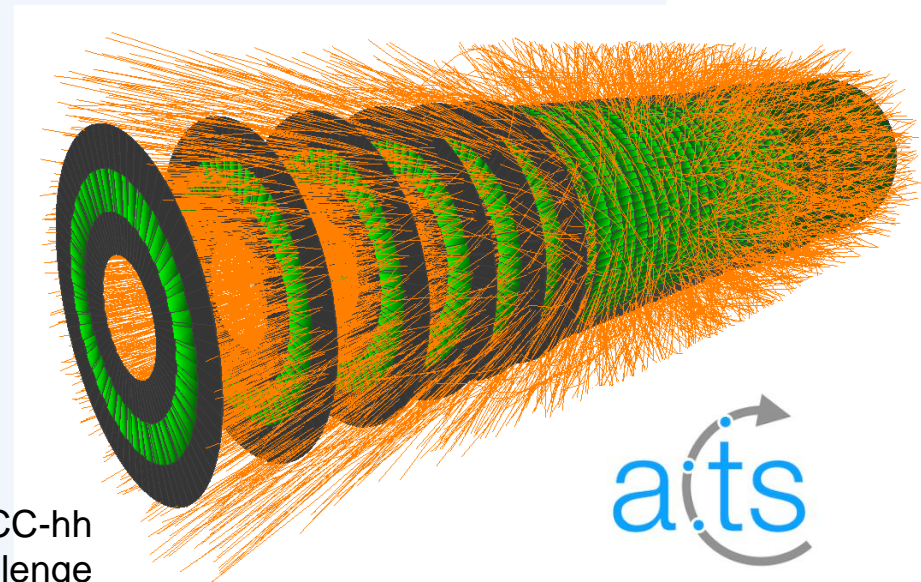
Fast Event Reconstruction

Fast Event Reconstruction Approach



TrackNET model

G. Ososkov, P. Goncharov, A. Tsytrinov
Deep learning for BM@N tracking

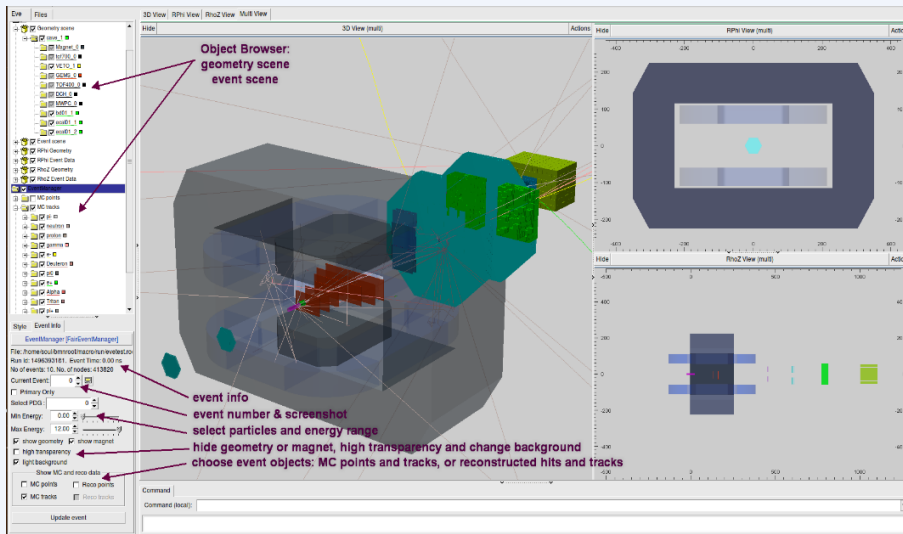


Currently developers from ATLAS, LHCb, FCC-hh
supporting: FCC-hh, Tracking machine learning challenge

Online/Offline System

Event Monitor / Event Display

Event Display for the BM@N experiment



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

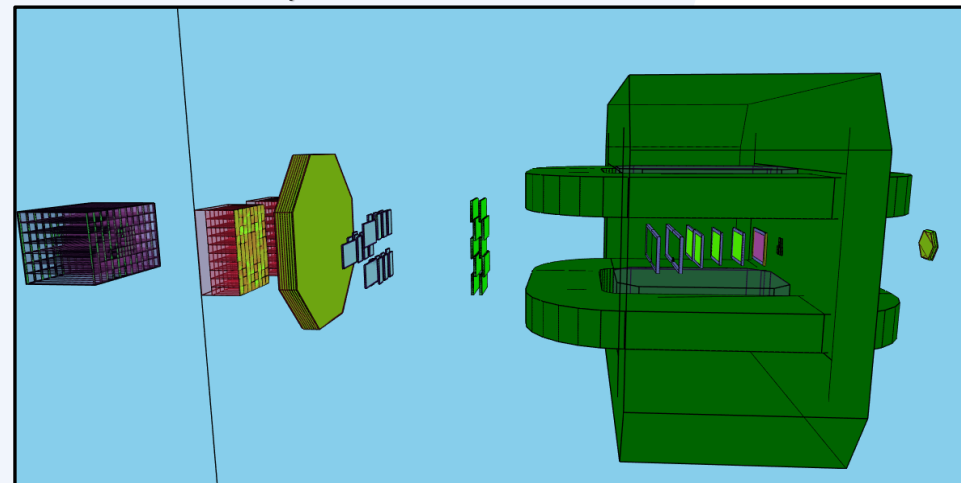
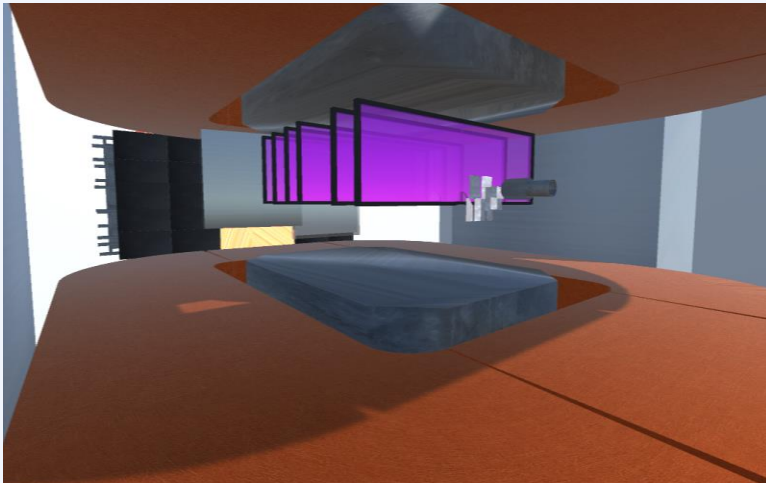
Event Display for **simulated** data
MC points, tracks, calorimeter towers

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

Alexander Nozik (18 May 12:45)

Development of Next-Gen Event Visualization Platform

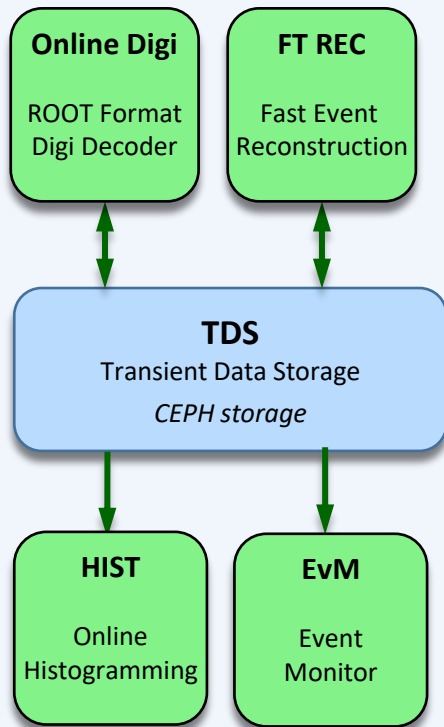
Anastasiia Iusupova



Online Information System

Online Configuration System

Online Process Control



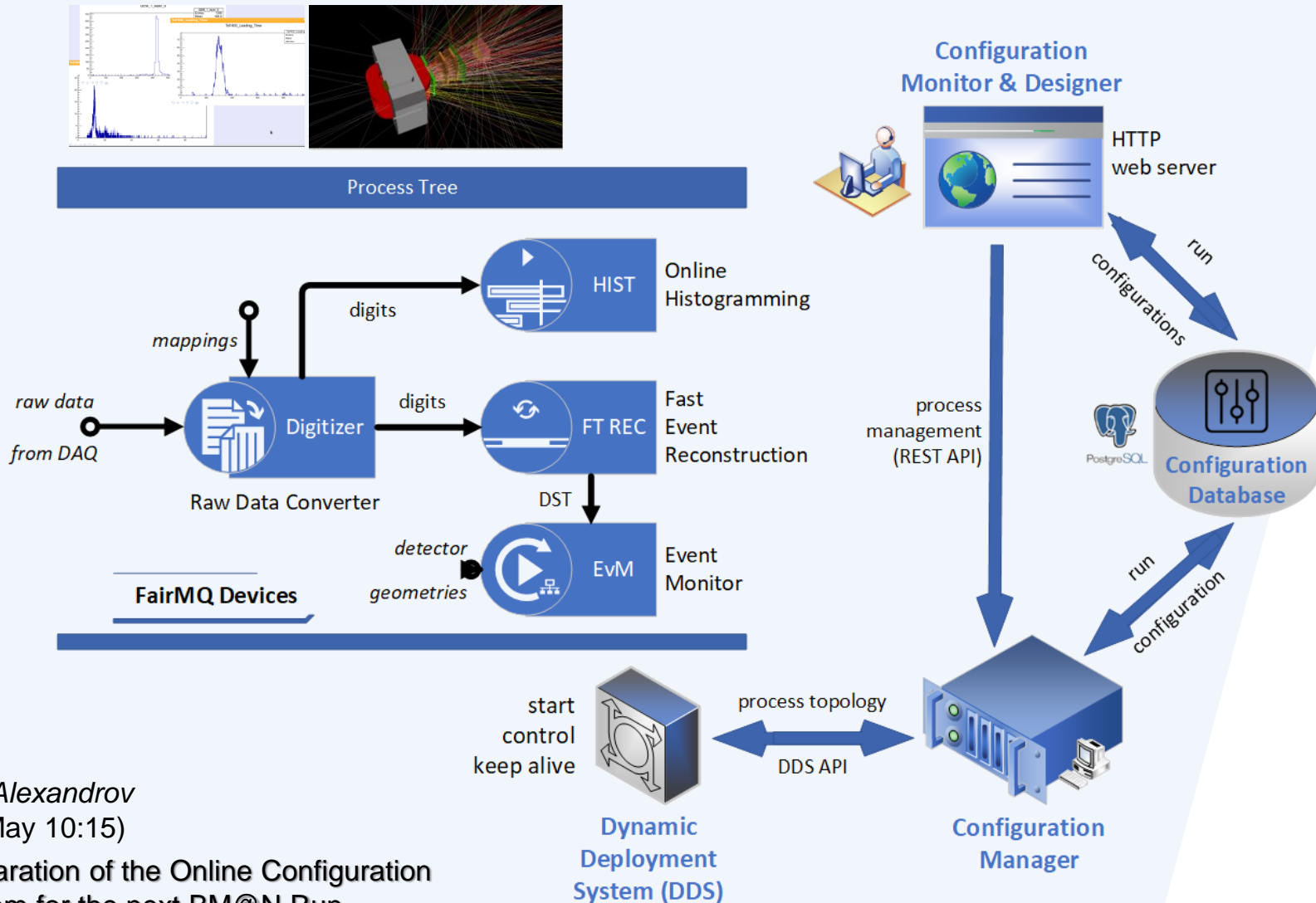
start → monitor → control → restart → stop

Ilnur Gabdrakhmanov

(18 May 09:55)

Status of the Raw Data Decoder and Online Histogramming, their results for Run 8

Online Configuration System (OCS)



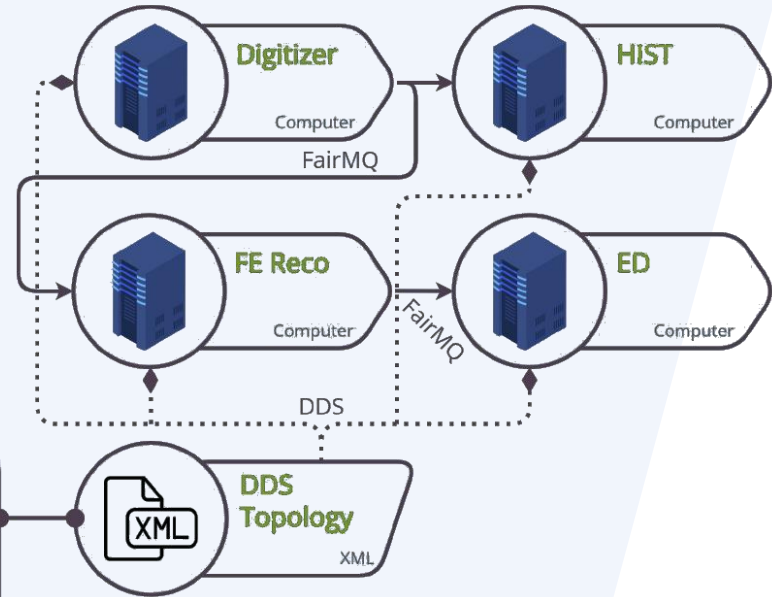
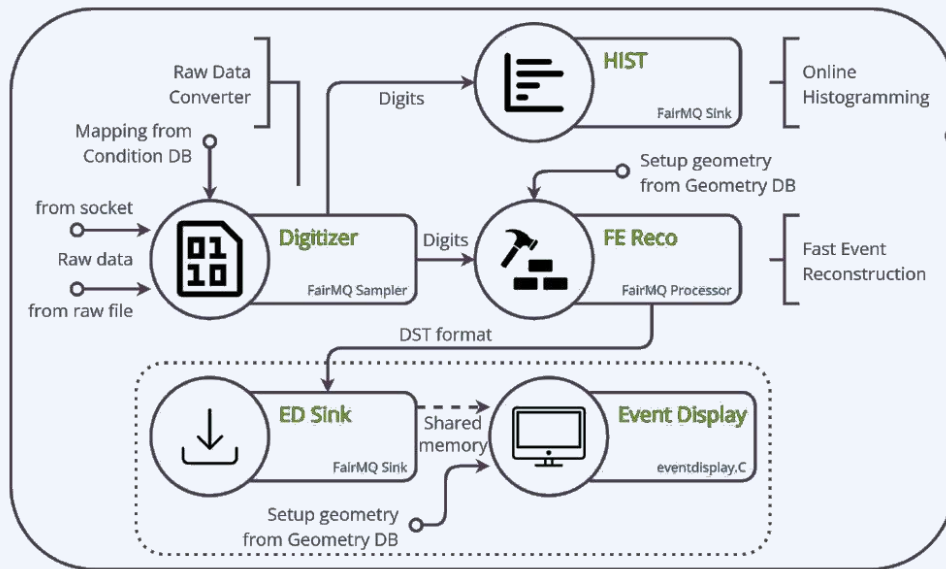
Igor Alexandrov
(18 May 10:15)

Preparation of the Online Configuration System for the next BM@N Run

Online Processing System for BM@N

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

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



The purpose of BM@N online processing system is data processing (digitization of events and fast reconstruction) and their monitoring in the ongoing experiment.

Ilya Romanov
(18 May 10:35)

Status of the Online Processing System for the BM@N experiment

OCS. Web interface

Menu

TASK MONITOR

CONFIGURATION MANAGER

SESSION LOGS

DICTIONARY SET

Get in touch

[✉ Konstantin Gertsent](#)

Configuration Manager

Select Setup Run: **BMN Run 7** [+](#)

Control panel [UPDATE](#) [STOP](#)

[ADD SETUP MODULE](#)

Module Name	Parent Name	Actions
OnlineControl		📄 ✖

Task Monitor

Select task [v](#)

Select setup [v](#)

Select module [v](#)

Started [v](#)

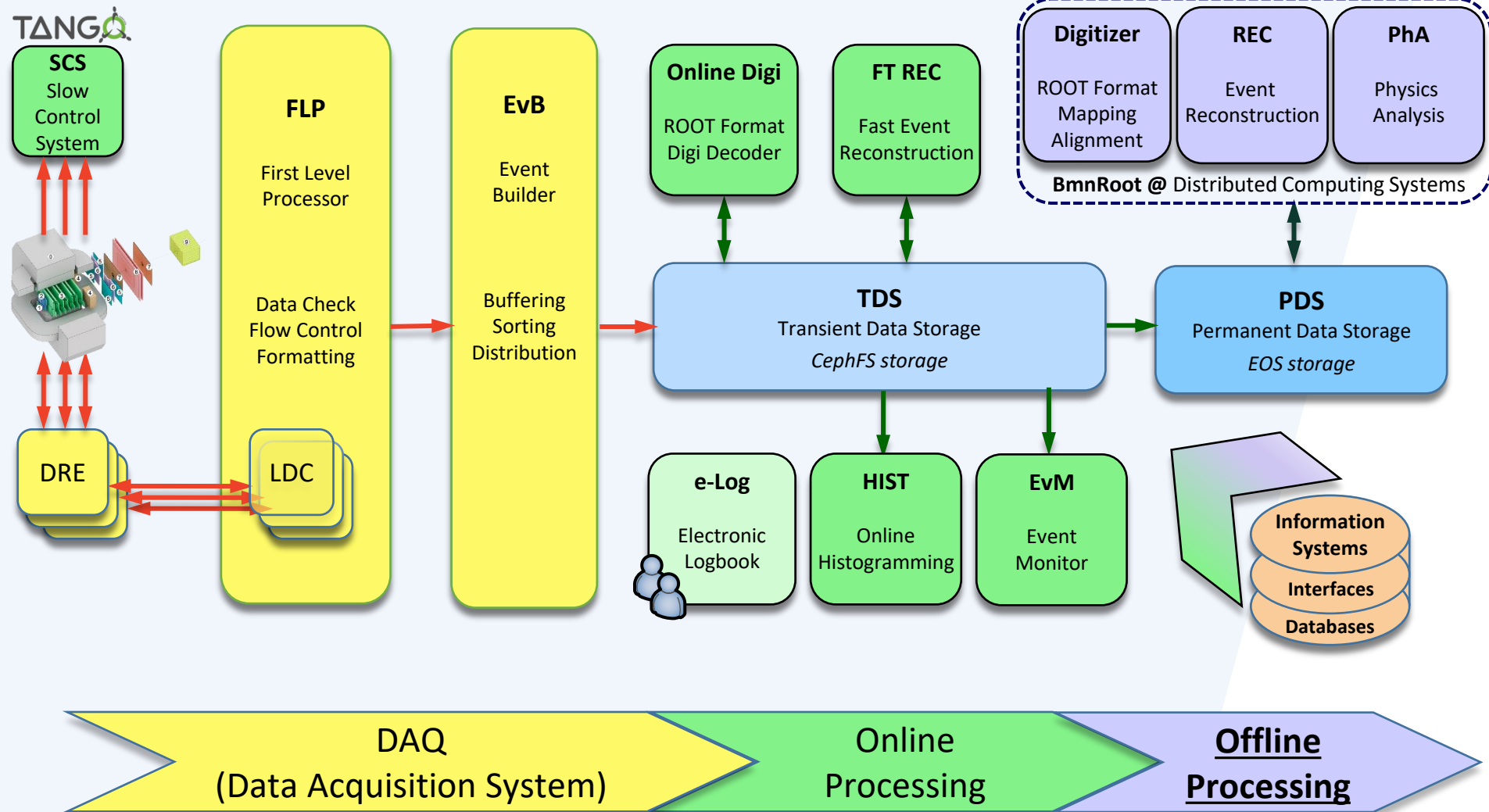
Select host [v](#)

[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

BM@N Data Processing Flow



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

Offline Software System

BmnRoot Framework

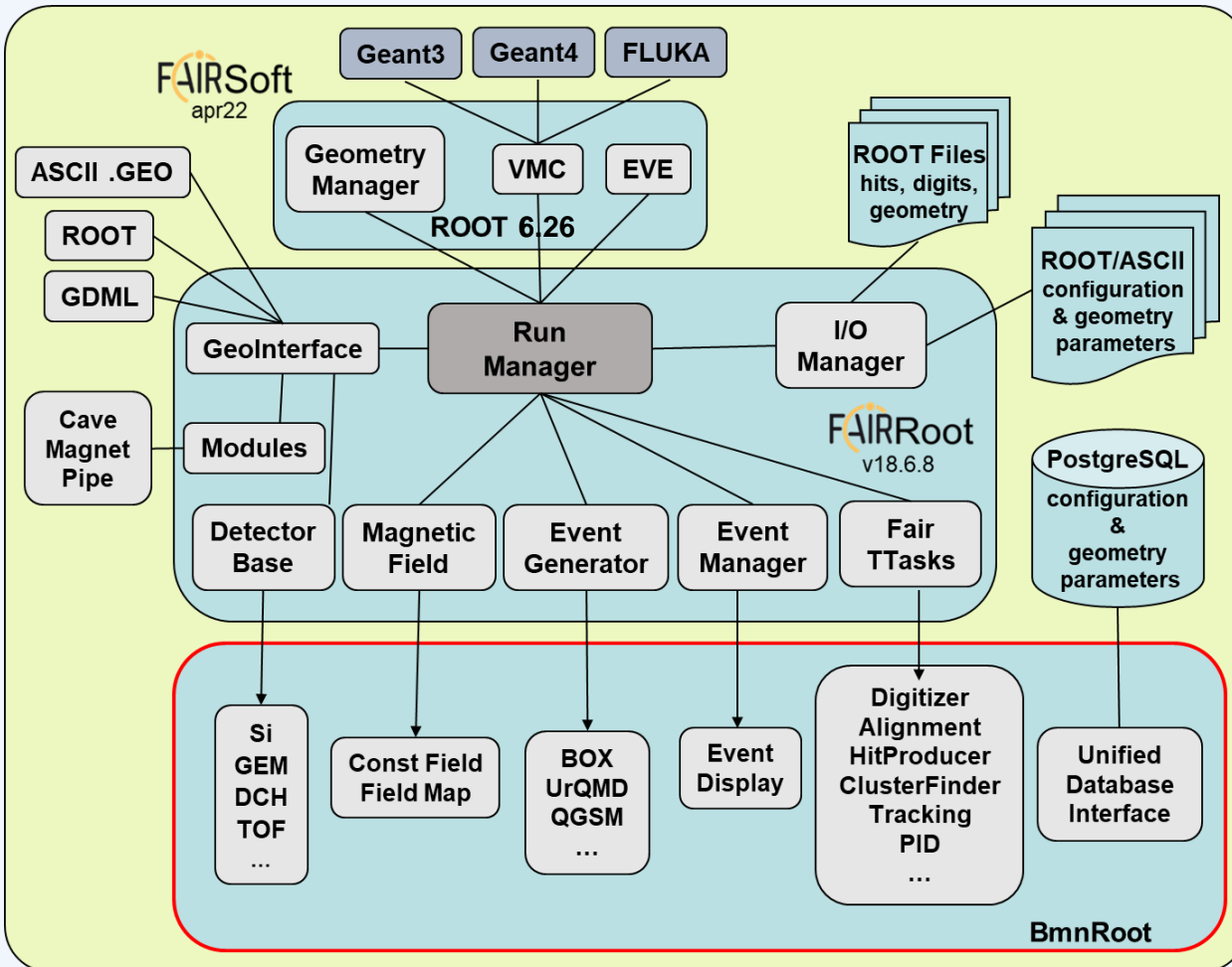
Sergei Nemnyugin
(18 May 10:50)

Status of the BmnRoot Optimization

BmnRoot. Release Issue (23.06.0)

FAIRSoft apr22
FAIRRoot v18.6.8

latest simulation, reconstruction, analysis and software improvements to be employed for mass production with Run 8 data



- Three versions of the tracking: *CellAuto* for Run 7, *L1Tracking* for Run 8 in online, *VF* for Run 8 in offline (default).
- Event simulation with Geant4 is used by default.
- New geometry, field map and BM@N simulation, converter and reconstruction tasks for Run 8.
- New approaches for online processing and Tango SCS has been implemented.
- Mass production is currently being performed via DIRAC before the release.
- All improvements and new features will be described at the release tag.

BmnRoot. *Release Preparation*

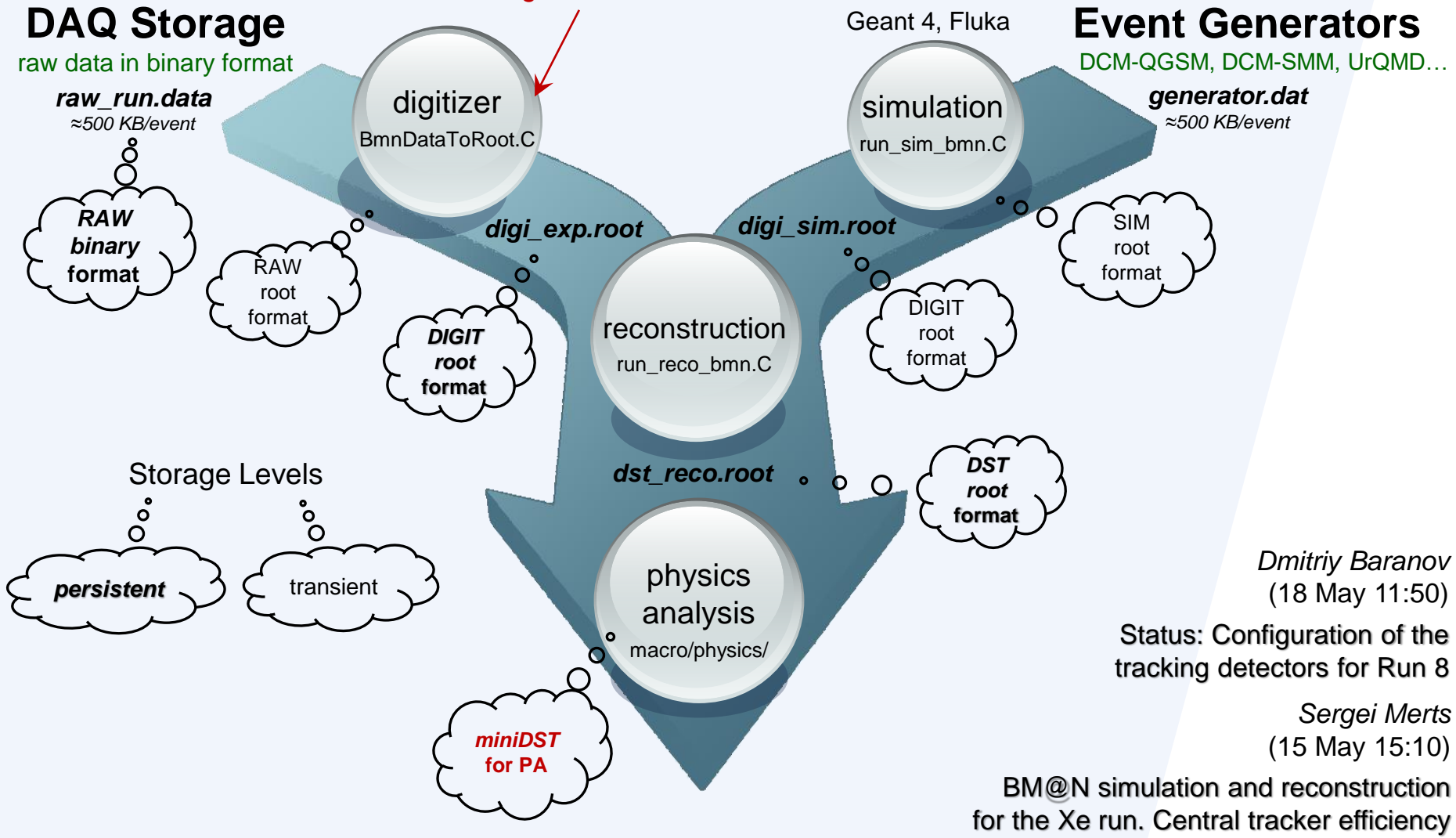
- ✓ Correct the current BM@N geometry employed in Run 8 to pass overlap test.
- ✓ All macros, which are used for more than 1 collaboration member, must contain common logic and parameters without local input parameters, user paths, hardcoded global parameters:
 - No default input parameters for a concrete user (but for production)
 - No own local paths and local parameters
 - No inner logic for own local machine

Macros in the CVMFS repository are not writable for mass production

- ✓ 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) must be used
Is progress in percents a good idea?
- ✓ Compilation warnings should be corrected.
- ✓ Raw Data Converter should be fixed to write correct run and raw file metadata.
- ✓ Move SRC information from the databases and SRC macros from the main directory.

BmnRoot. Event Data Model

branches with digits has not been renamed



Dmitriy Baranov
(18 May 11:50)

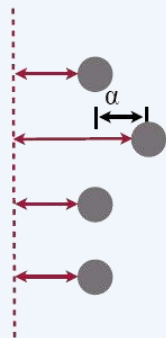
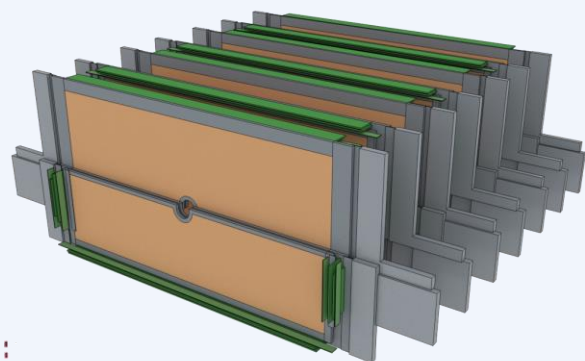
Status: Configuration of the tracking detectors for Run 8

Sergei Merts
(15 May 15:10)

BM@N simulation and reconstruction for the Xe run. Central tracker efficiency

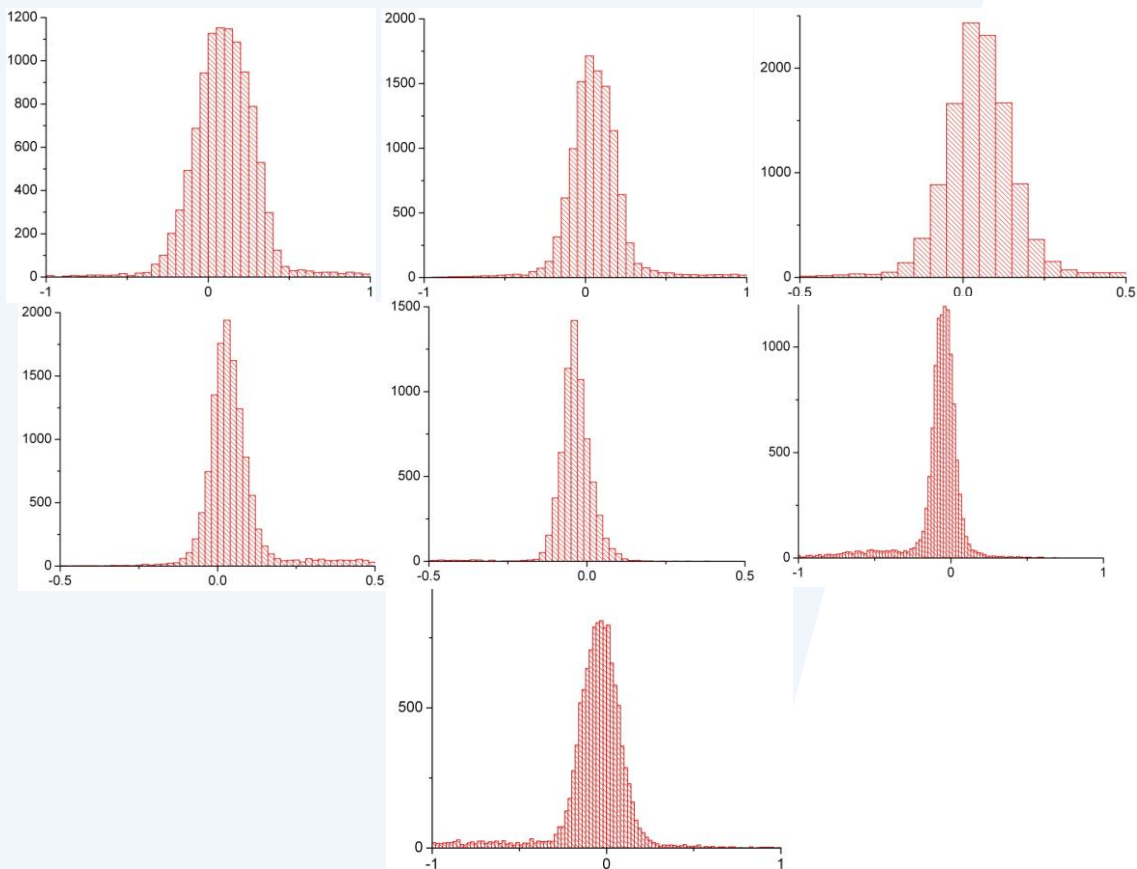
BmnRoot. *Detector Alignment*

The alignment of the GEM detectors has been performed with a C++ template library, *Eigen*
Events for alignment: run 7651, Magnetic Field **OFF**, Target (Csl) **ON**



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

GEM mod2



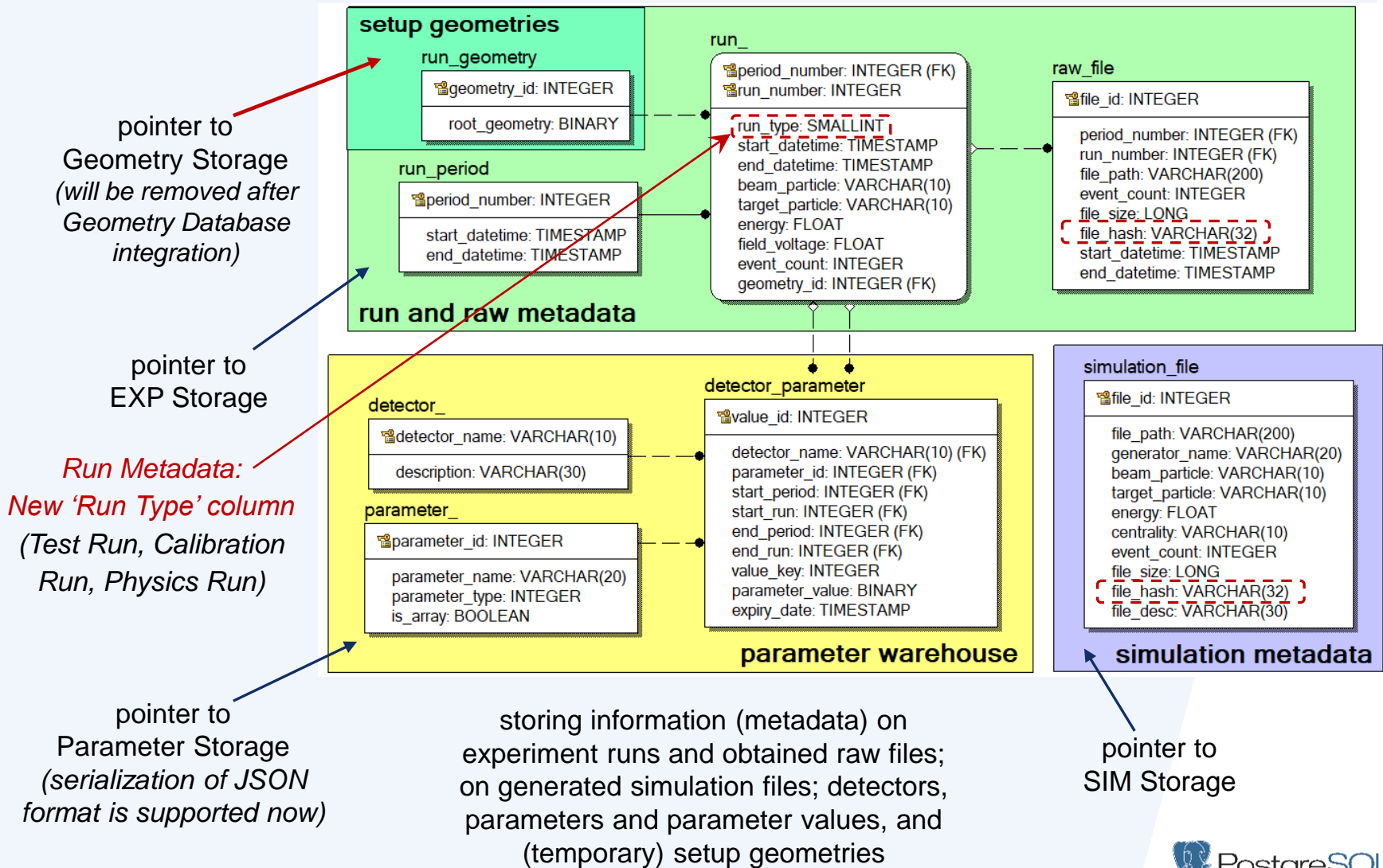
Zarif Sharipov
(18 May 11:30)

Geometry alignment of BM@N GEM detectors

Offline Information System

Unified Condition Database (UniConDa)

Unified Condition Database. Architecture



UniConDa in Offline Processing



ROOT-based framework

detector simulation
raw data processing
event reconstruction
physics analysis

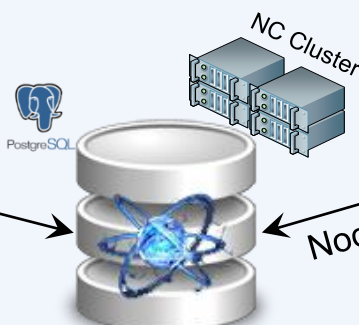


reading and changing data

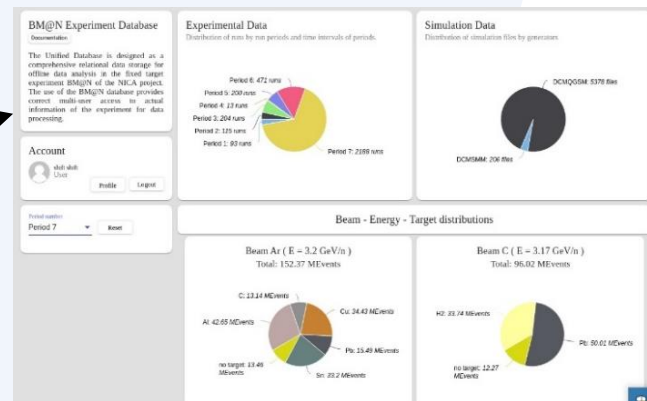
users

FreelIPA authentication

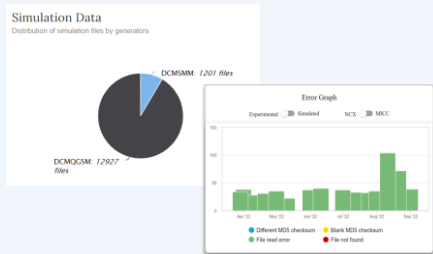
C++ interface
→ **REST API**
(connect, I/O, API)



Unified Condition Database



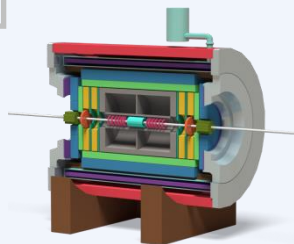
python script for automatic updating metadata on sim files



python script for automatic checking file integrity

configuration calibration

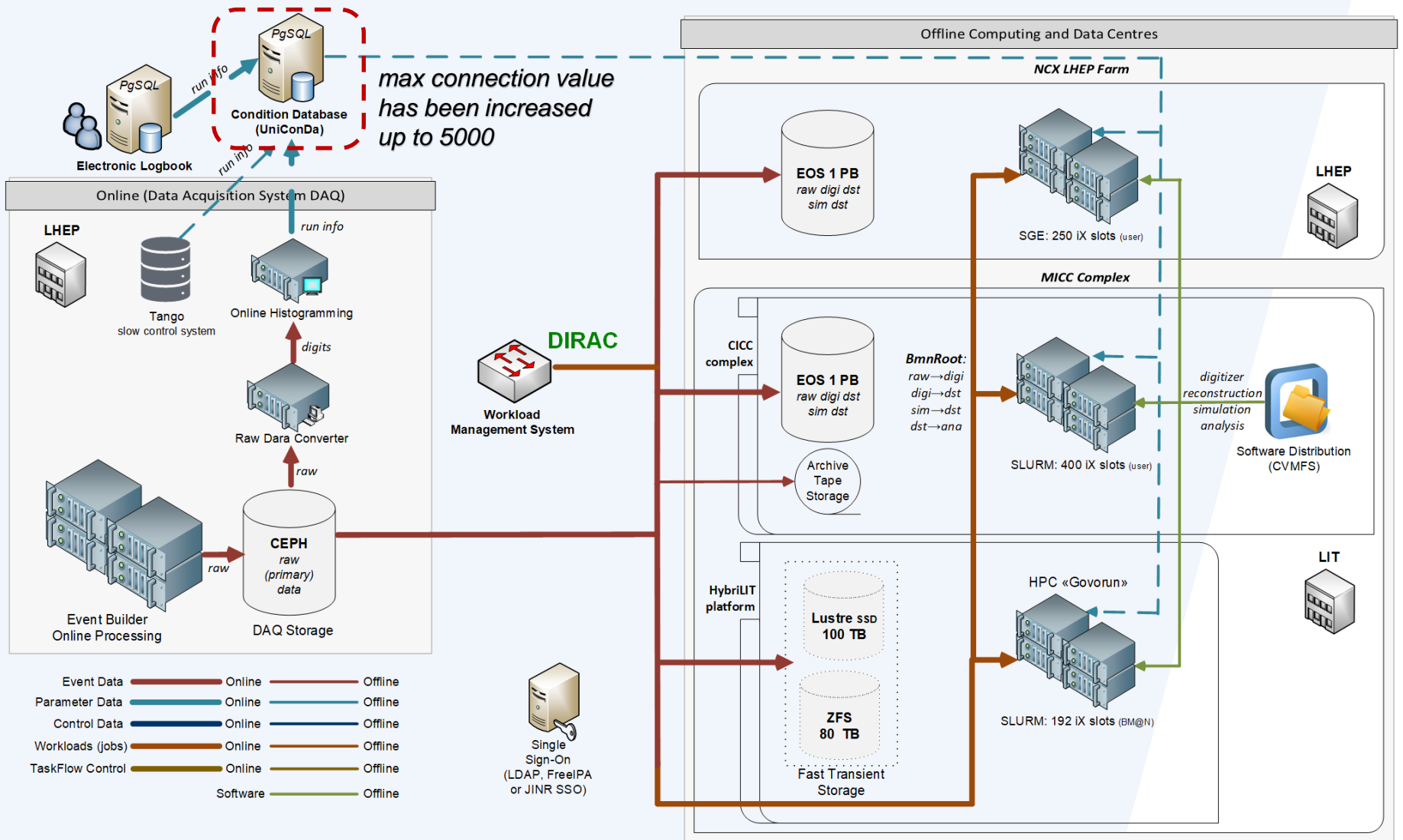
parameter and algorithm data



Web Service



UniConDa in Distributed Computing



UniConDa. Web Application (home page)

Menu

Sign Out

BM@N Experiment Database

Documentation

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

Account



Konstantin Gertsenberger
Admin

Profile

Logout

Period number

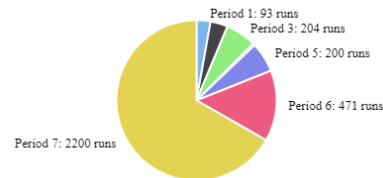
Period 6

Show

Reset

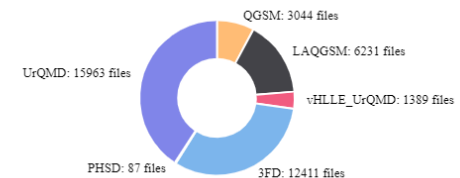
Experimental Data

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



Simulation Data

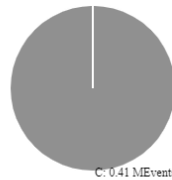
Distribution of simulation files by generators



Beam - Energy - Target distributions

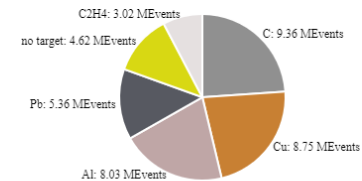
Beam C (E = 5.14 GeV/n)

Total: 0.41 MEvents



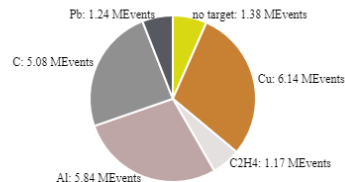
Beam C (E = 4.5 GeV/n)

Total: 39.14 MEvents



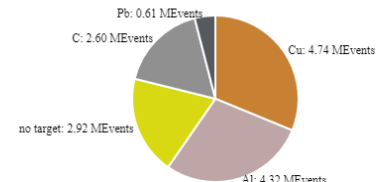
Beam C (E = 4 GeV/n)

Total: 20.85 MEvents



Beam C (E = 3.5 GeV/n)

Total: 15.19 MEvents



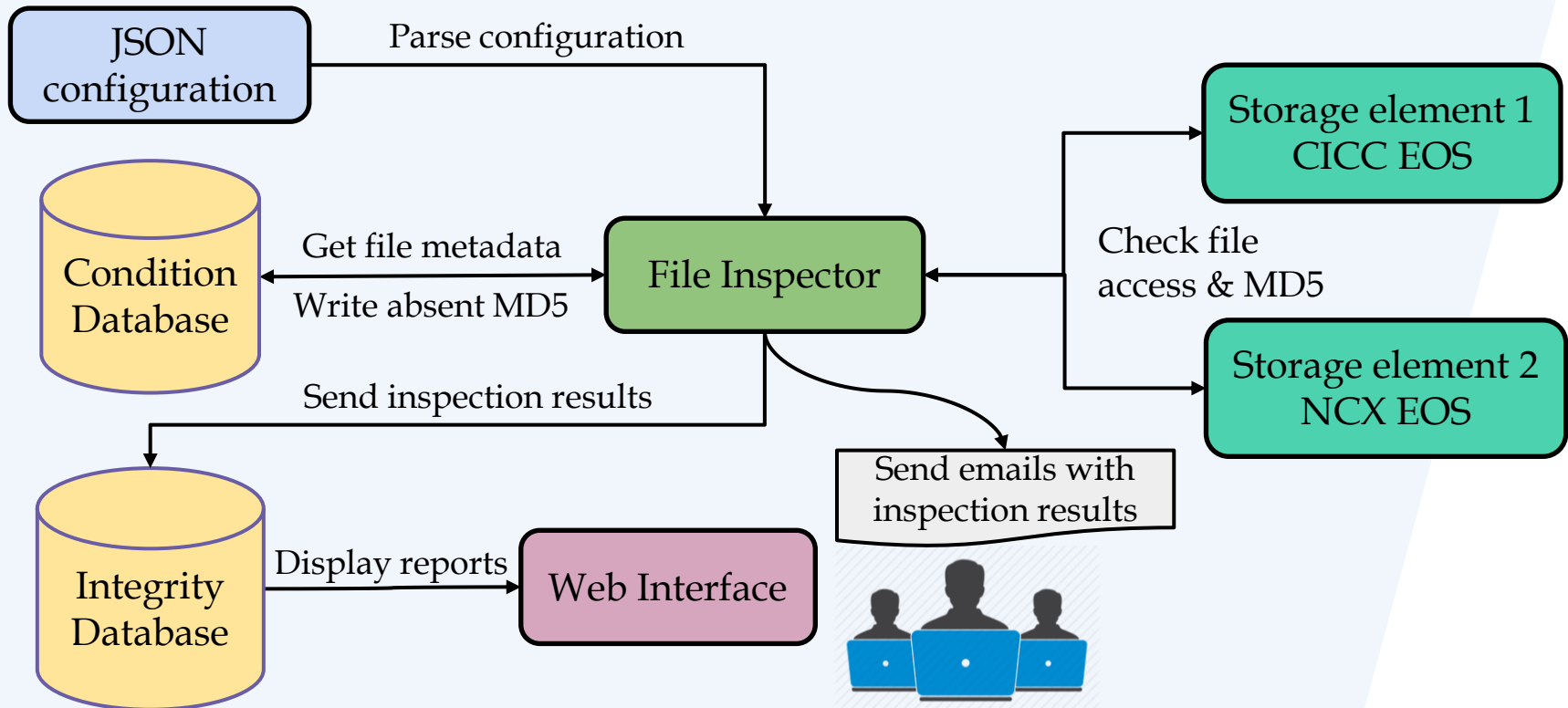
statistics in event number,
not in run and file count

improvements in colouring
proposed by Semen

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. Overview



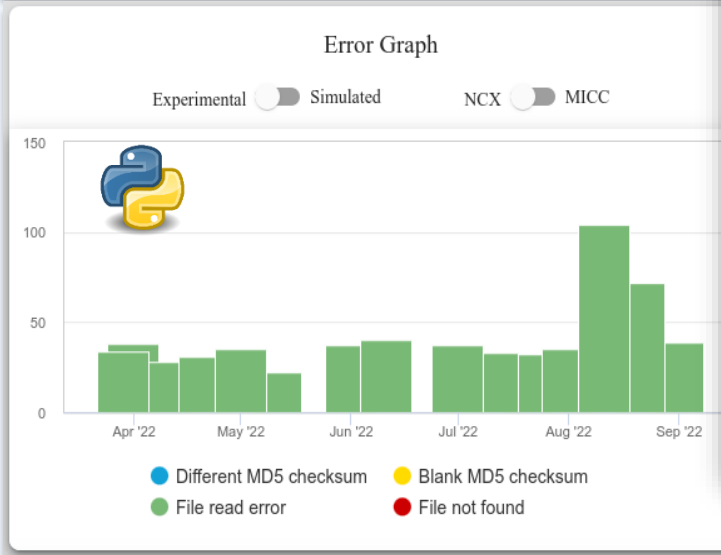
Number of files tested is equal to number of files described in the Condition Database
Currently, obtained raw and simulated files are tested for the access and MD5-hash

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

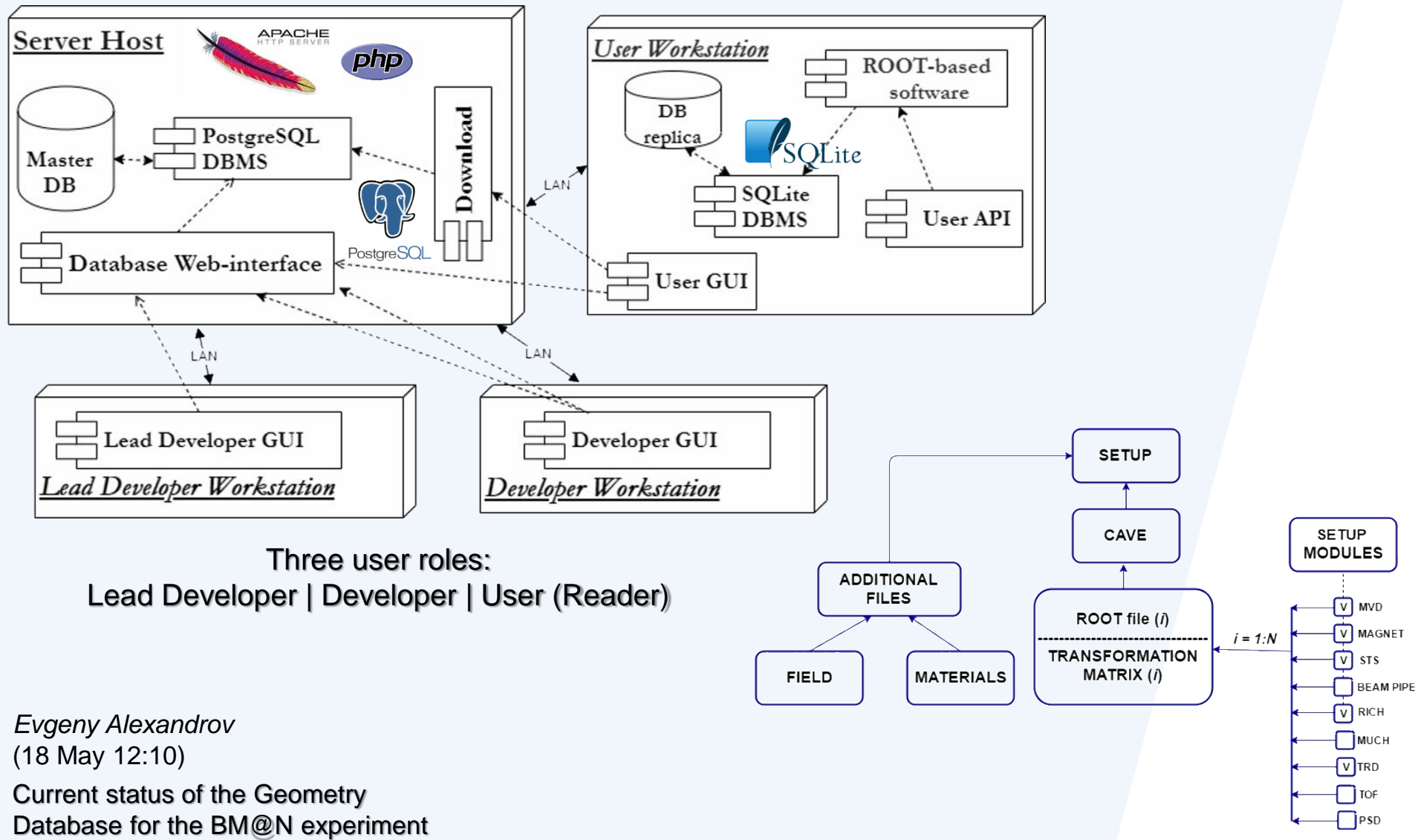
File Inspection Service



Offline Information System

Geometry Database

Geometry Information System. Architecture



Evgeny Alexandrov
(18 May 12:10)

Current status of the Geometry
Database for the BM@N experiment

Geometry Information System. *Web Platform*

Menu

HOME

VIEW GEOMETRY ^

[VIEW.SETUPS](#)

[VIEW.SETUP.MODULES](#)


[VIEW.FILES](#)

[VIEW.MATERIALS](#)

[VIEW.MAGNETIC.FIELDS](#)

EDIT GEOMETRY v







Get in touch

 [Konstantin Gertsenberger](mailto:Konstantin.Gertsenberger)

Setup Modules

- simple authorization
- or FreelPA access



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

BM@N Geometry Database has filled with the setup geometries for last Runs (all releases + dev)

Graphical User Interface Functions:

View

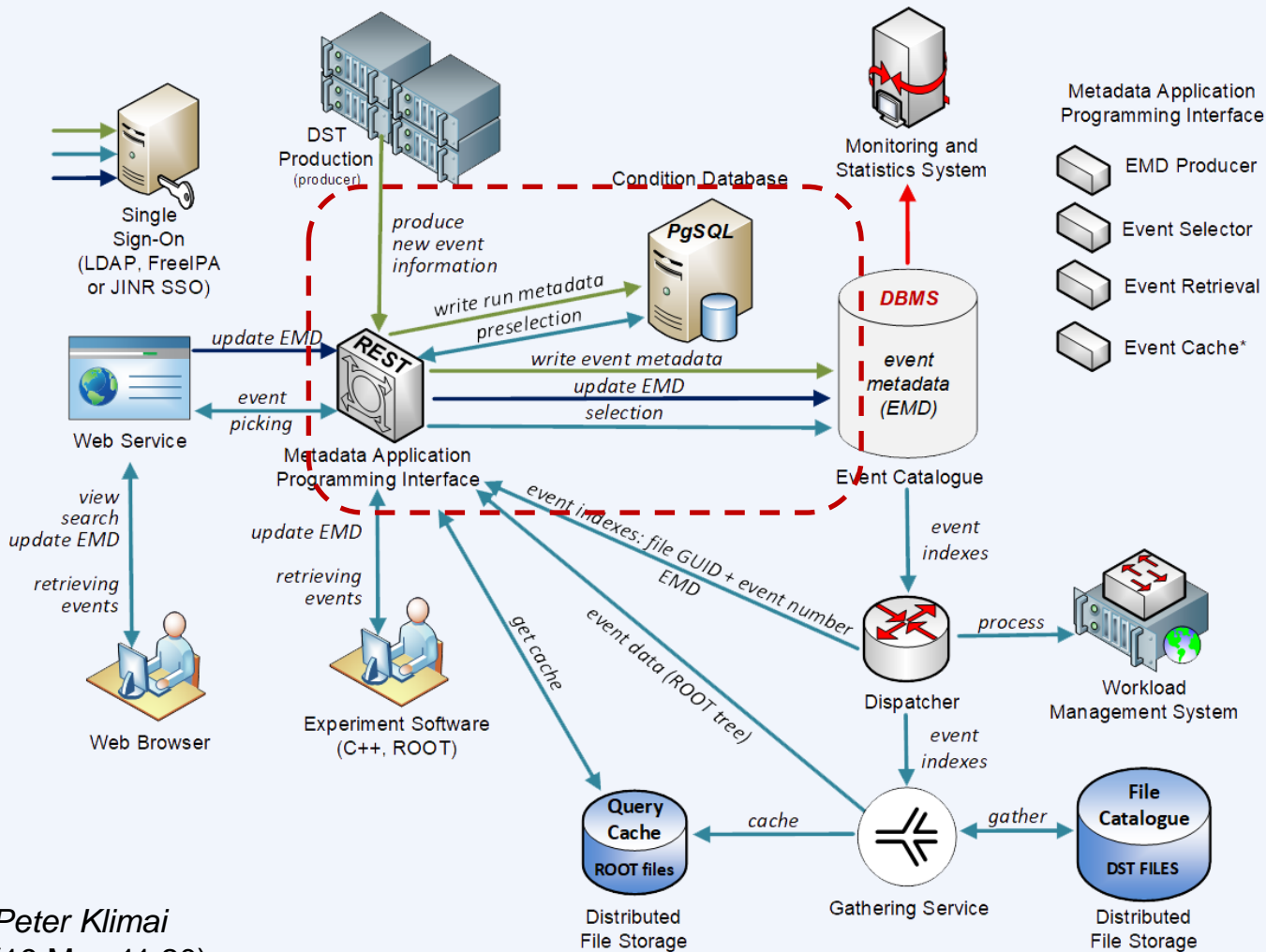
Edit

Download

Offline Information System

Event Metadata System

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

Peter Klimai
(19 May 11:20)

Software contribution from MIPT: Development of Event Metadata System and Monitoring & High-Availability Service

Event Metadata System. Web Interface

BM@N Event Metadata System

BM@N Events
 Search Events

SRC Events
 Search Events

Test Events
 Search Events

Condition DB prefilter

base parameters

limits and offset

configured parameters

selection

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

event pointer = file GUID + event number

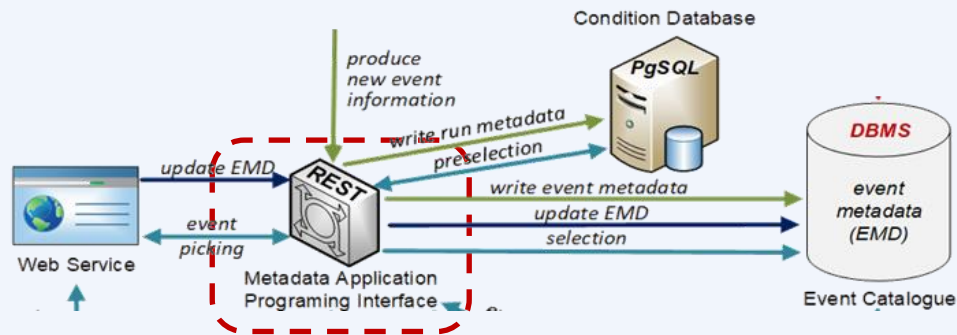
1-10 of 15

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



- enables users to browse and 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

Event Metadata System. *REST API service*



Event JSON scheme

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

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

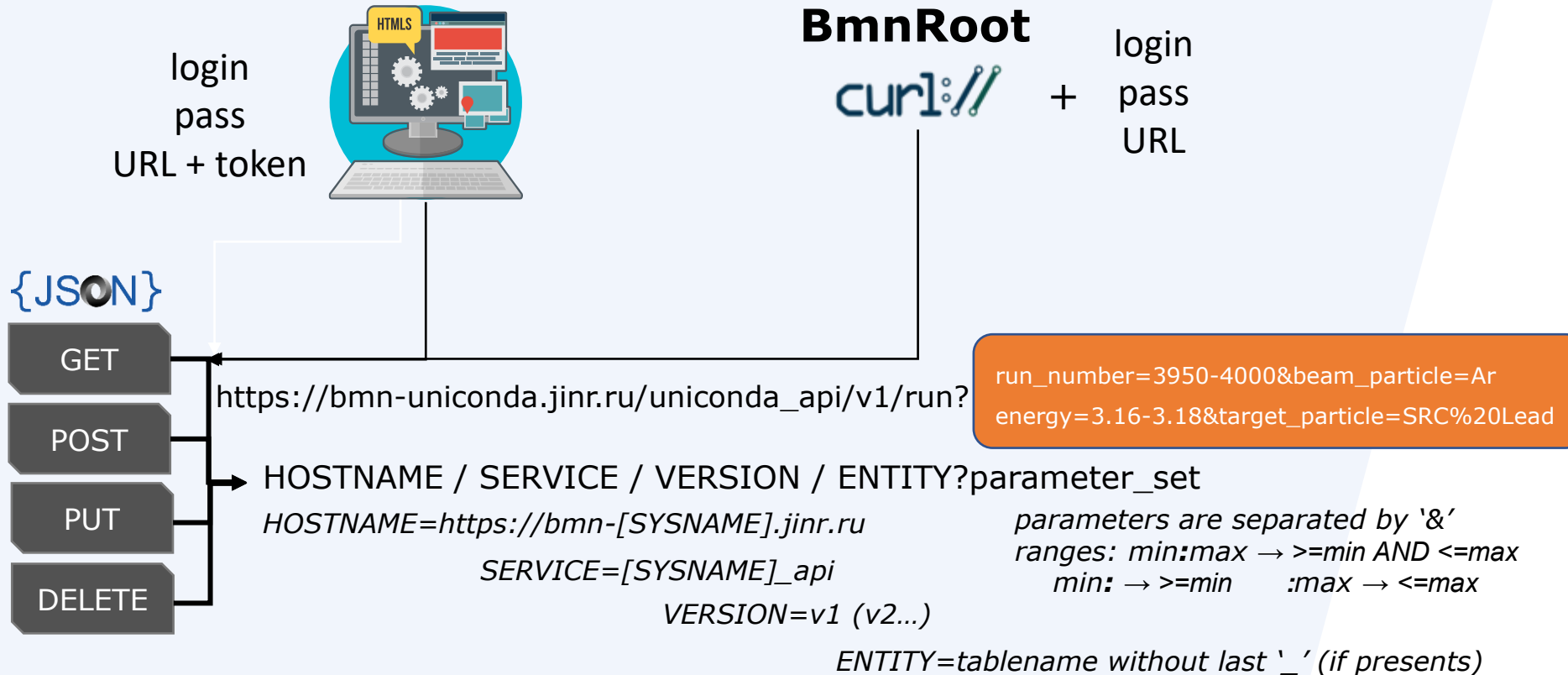
```
GET /emd?period_number=7&run_number=5000:&software_version=20.08.0&track_number=10:15
```

```
GET /eventFileRef[?parameters]
```

```
GET /eventFile[?parameters]
```

```
GET /count[?parameter1=value1[&parameter2=value2[...]]]
```

REST API for BM@N Information Systems

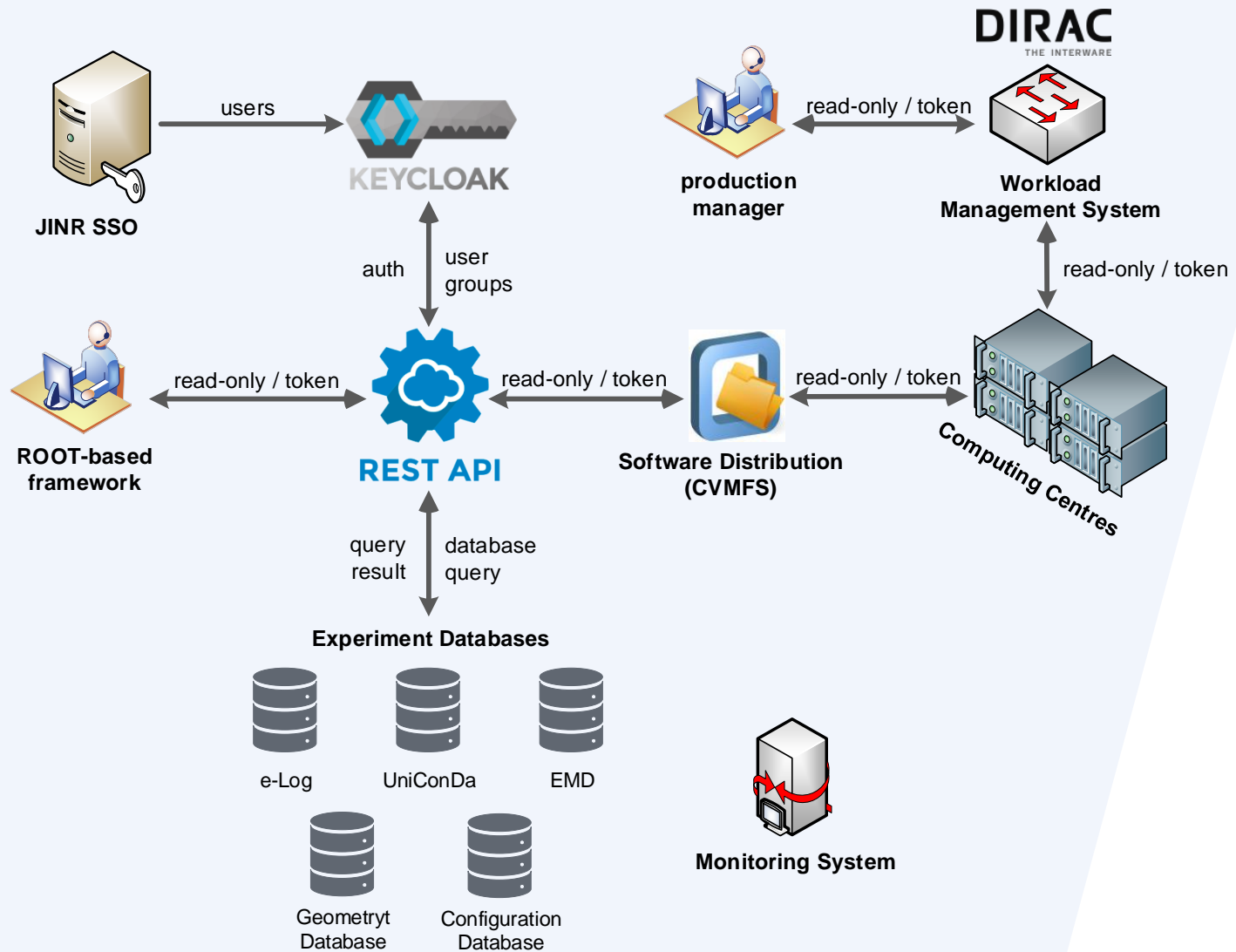


For the Unified Condition Database, SYSNAME = uniconda

For the Event Metadata System, SYSNAME = event https://bmn-event.jinr.ru/event_api/v1/event?...
 /eventFile?...
 /eventFileRef?...

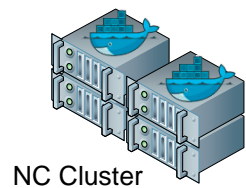
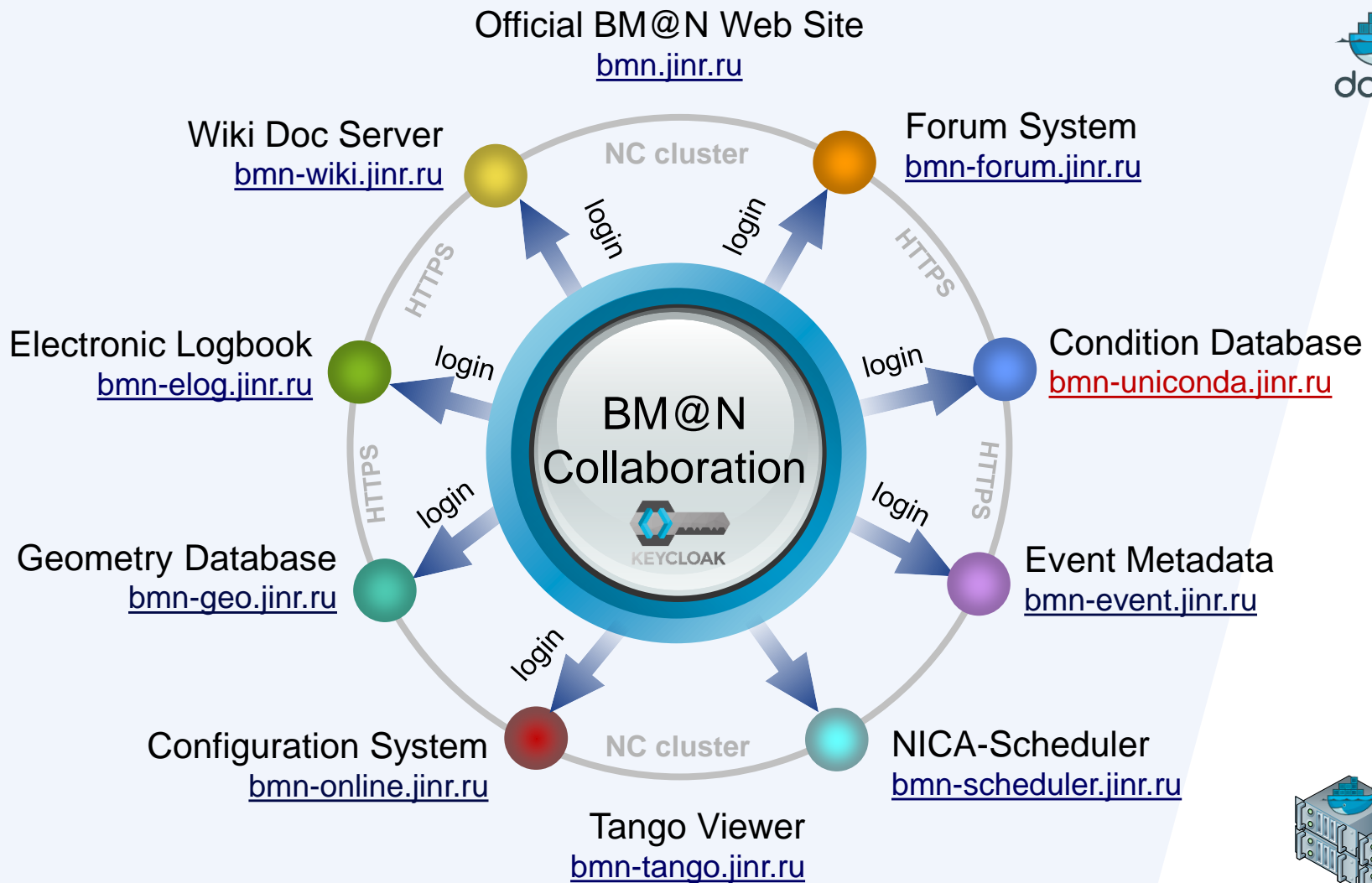
OpenAPI specification  Swagger → Documentation

REST API for BM@N Information Systems

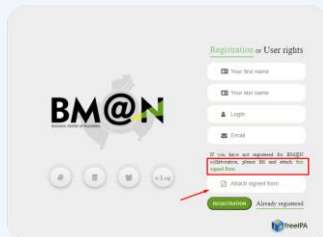


Information and Collaboration Services

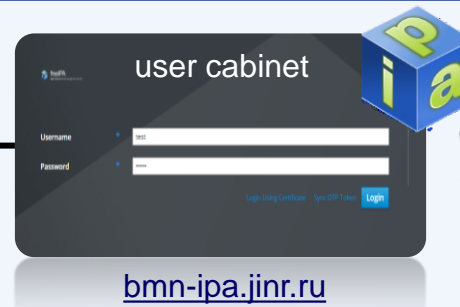
Evolution of the BM@N Services



FreeIPA. Single Authentication & Authorization

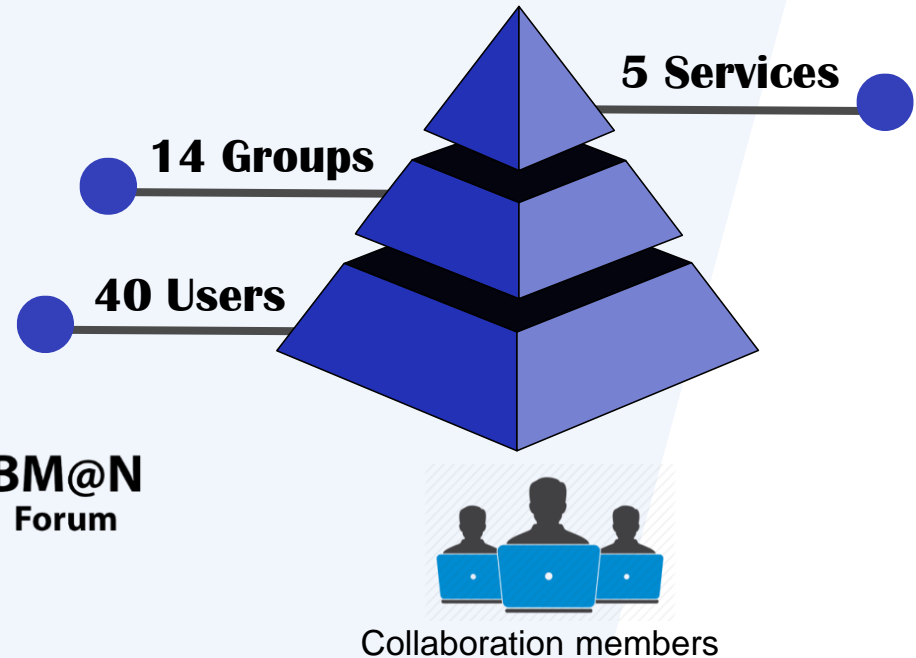
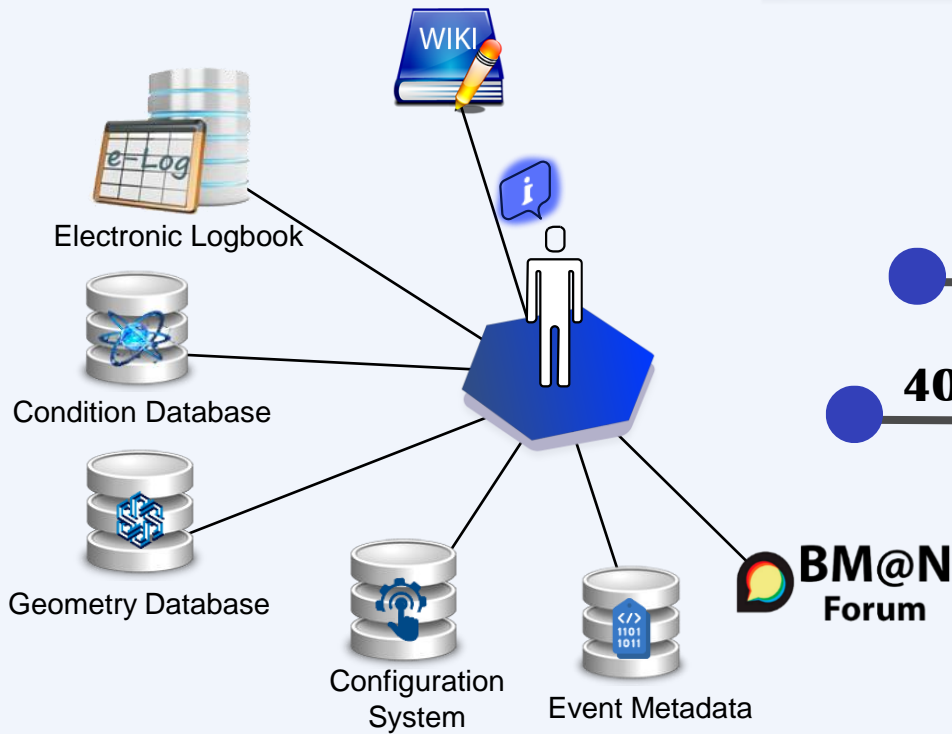


bmn.jinr.ru/registration
BM@N Registration on *bmn.jinr.ru*



Wiki Document Server

bmn-ipa.jinr.ru



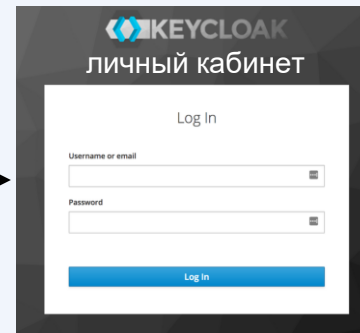
*Database Roles are also supported

Migration to JINR SSO

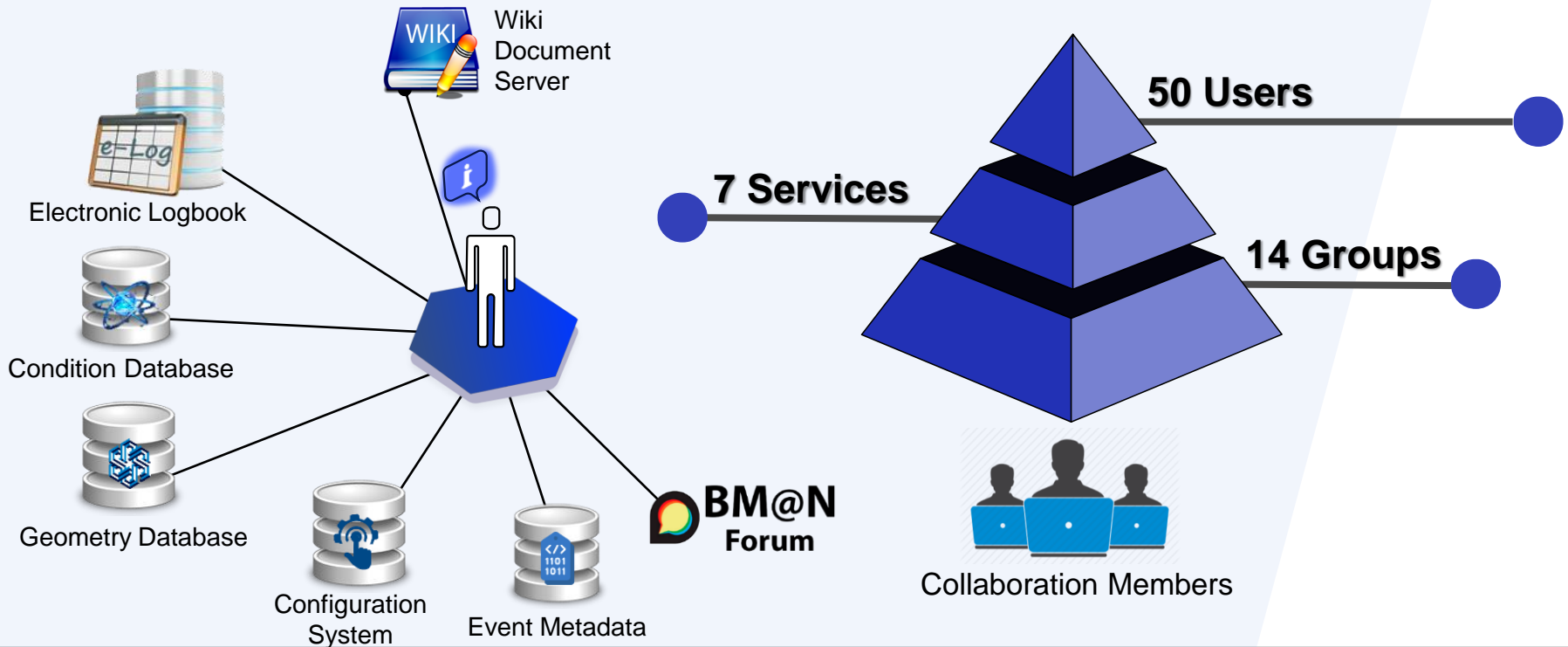


JINR SSO

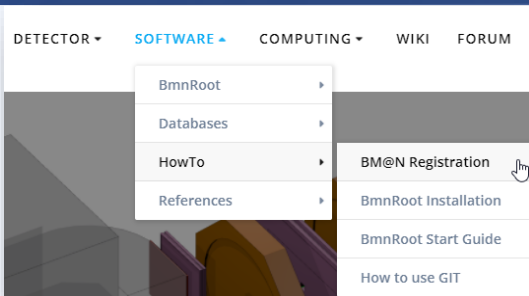
staff
external users



bmn-user.jinr.ru



BM@N User Registration Form



bmn.jinr.ru/registration

Registration or User rights

REGISTRATION | Already registered



If you have not registered for BM@N collaboration, please fill and attach [this signed form](#)

BM@N REGISTRATION FORM

Please complete all sections and send the signed form to the BM@N official person

<input type="checkbox"/> new JINR user <input type="checkbox"/> new external user <input type="checkbox"/> change of status		JINR department
Family name		JINR office
First name (s)		JINR phone number
Second name (<i>if exists</i>)		JINR email
Date of Birth (<i>Day.Month.Year</i>):		<i>if not JINR employee</i>
Contact email		Home Institute name
Contact phone number		Home Institute work phone
Preferred login		Home Institute work email
Contract period (or association with BM@N) (Day.Month.Year): from to		
Average presence at JINR: %		
Status: <input type="checkbox"/> Prof. <input type="checkbox"/> PhD <input type="checkbox"/> Scientist/Specialist <input type="checkbox"/> PhD student <input type="checkbox"/> Summer Student <input type="checkbox"/> Student		
Nature of activity: <input type="checkbox"/> Scientific <input type="checkbox"/> Engineering <input type="checkbox"/> Technical <input type="checkbox"/> Administrative <input type="checkbox"/> Other:		
Team Leader:		
Work area at BM@N (briefly)		
Participation in other experiments		
<p>I understand and certify that, for the entire duration of my association with BM@N:</p> <ul style="list-style-type: none"> All BM@N users are expected to participate in Collaboration activities, scientific and technical, in a collegial manner respecting the cultural and ethnic diversity within the Collaboration. All BM@N users are expected to abide by the BM@N Bylaws and other adopted policies. They are also expected to abide by the JINR rules and procedures while present at the host premises. The scientific results obtained in course of the experiment shall be published only with the consent of all authors. The paper to be published and report to be presented shall be cleared by a Convener of the corresponding Working Group before submission. BM@N computing facilities, services and software are intended for the attainment of the experiment's aims. Their use must come within the professional duties of the user and work on the BM@N experiment. The use of the computing facilities and software must cause no material or moral damage to the experiment or any computing facilities, nor disrupt their operation. BM@N computing facilities must be used in conformity with their rules of use. The rules for the NICA (NCX) cluster, HybriLIT platform with Govorun and JINR CICC are listed on the official web sites, currently at https://webncx.jinr.ru/start, http://hybriLit.jinr.ru/en/for_users and http://lxs-s03.jinr.ru/cicc/index.php/en/home/. I am aware of the prohibition on divulging given passwords, the use of unlicensed software, the inadmissibility of attempts of unauthorized access to the services, computer and network resources of the BM@N experiment. Although the Collaboration endeavours to maintain and protect its computing facilities and software, it cannot 		

The required fields are filled in and the request is sent by e-mail to the software coordinator
 It is impossible to register yourself on the resources only via sending this request
 You must specify the mail, select resources and specify the necessary rights

Distributed Processing and Computing Clusters

Data Collected in BM@N Run 8 (comparing with Run 7)

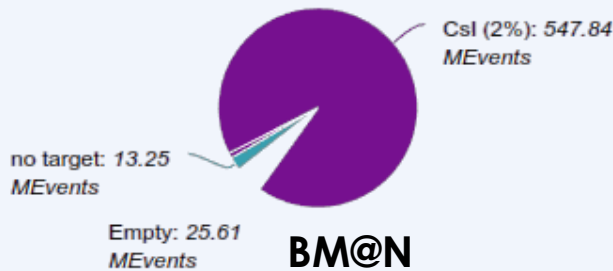
1st Physics BM@N Run

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

Technical BM@N Run 7

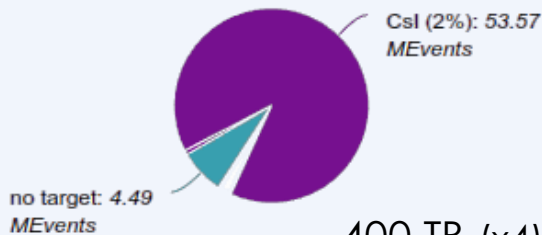
One beam energy available for Ar-beam and
 three for Kr-beam
 Wide set of targets used: (C, Al, Cu, Sn, Pb)

Beam Xe (E = 3.8 GeV/n)
 Total: 592.66 MEvents



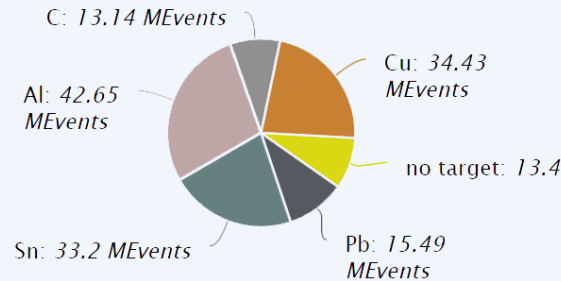
**BM@N
 Run 8**

Beam Xe (E = 3 GeV/n)
 Total: 59.86 MEvents

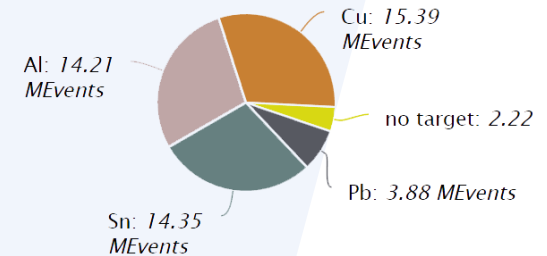


400 TB (x4)

Beam Ar (E = 3.2 GeV/n)
 Total: 152.37 MEvents

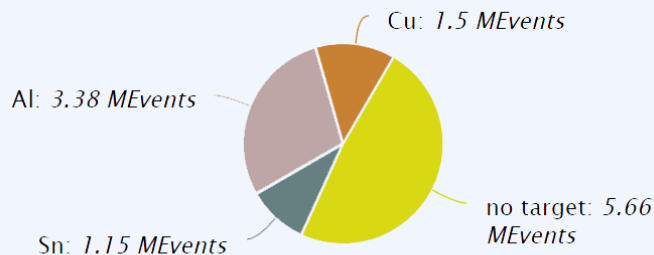


Beam Kr (E = 2.6 GeV/n)
 Total: 50.05 MEvents

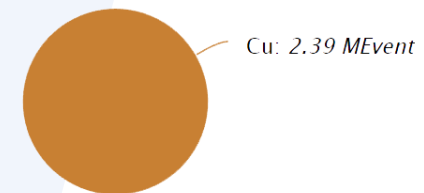


**BM@N
 Run 7**

Beam Kr (E = 2.3 GeV/n)
 Total: 11.69 MEvents



Beam Kr (E = 2.94 GeV/n)
 Total: 2.39 MEvents



62 TB (x4)

Status of Computing Clusters for BM@N

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



OS: CentOS 7
Exp. software: **CVMFS**
EOS: 1 PB (replicated)
GlusterFS: 116 (replicated)
SGE: 500 slots/user

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



OS: Scientific Linux 7
Exp. software: **CVMFS**
EOS: 1 PB (replicated)
SLURM: *cicc* – 400 slots/user

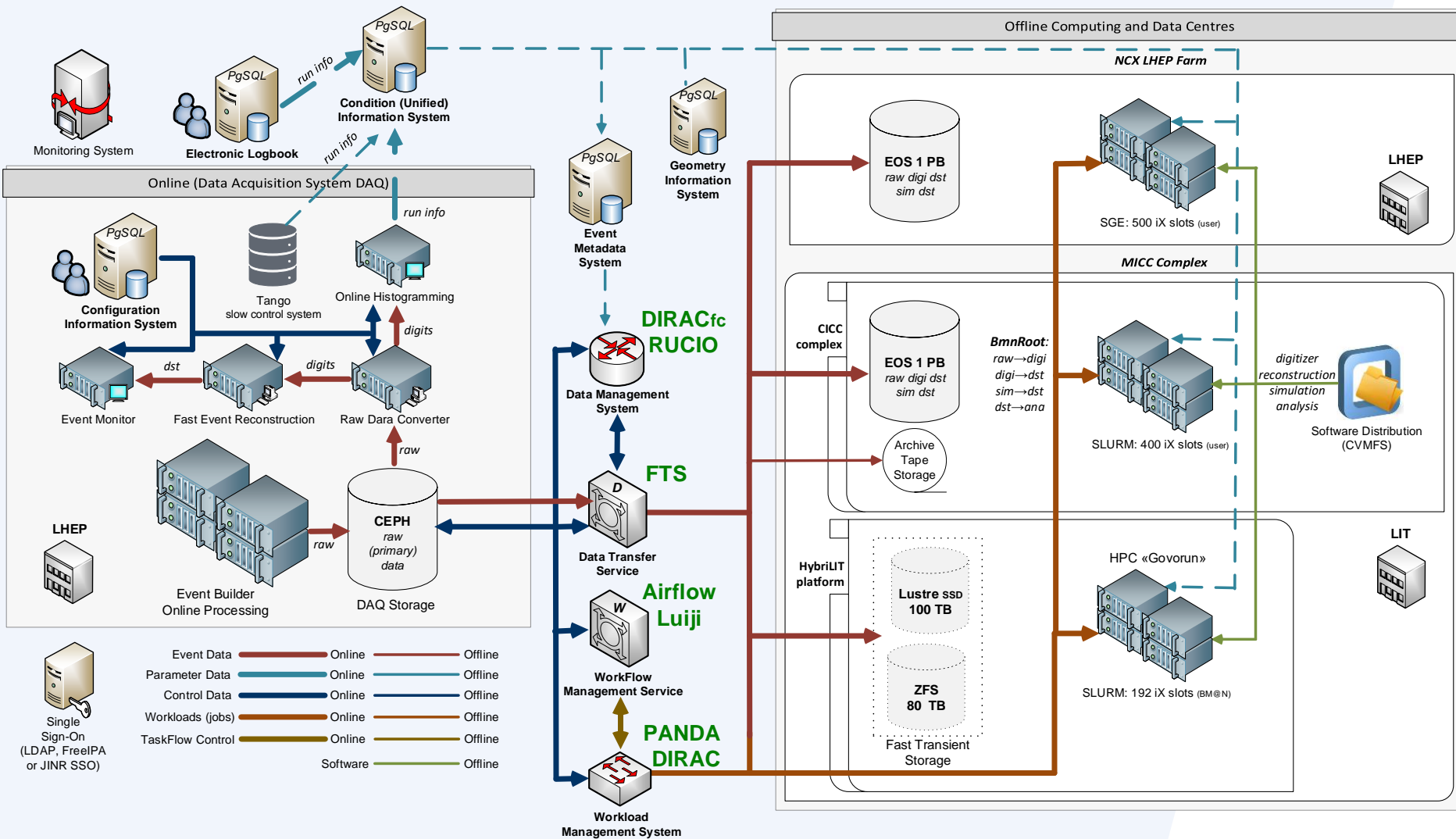
HybriLIT platform (HPC Govorun)
hydra.jinr.ru
(MLIT, b.134)



OS: Scientific Linux 7
Exp. software: **CVMFS**, **Modules**
ZFS: 280 TB,
Fast Storage on Lustre 100 TB_{SSD}
SLURM: *bmn* – 192 slots for BM@N

FairSoft/FairRoot have been installed & configured in JINR CVMFS
Automatic software deployment of the BmnRoot on CVMFS with GIT CI

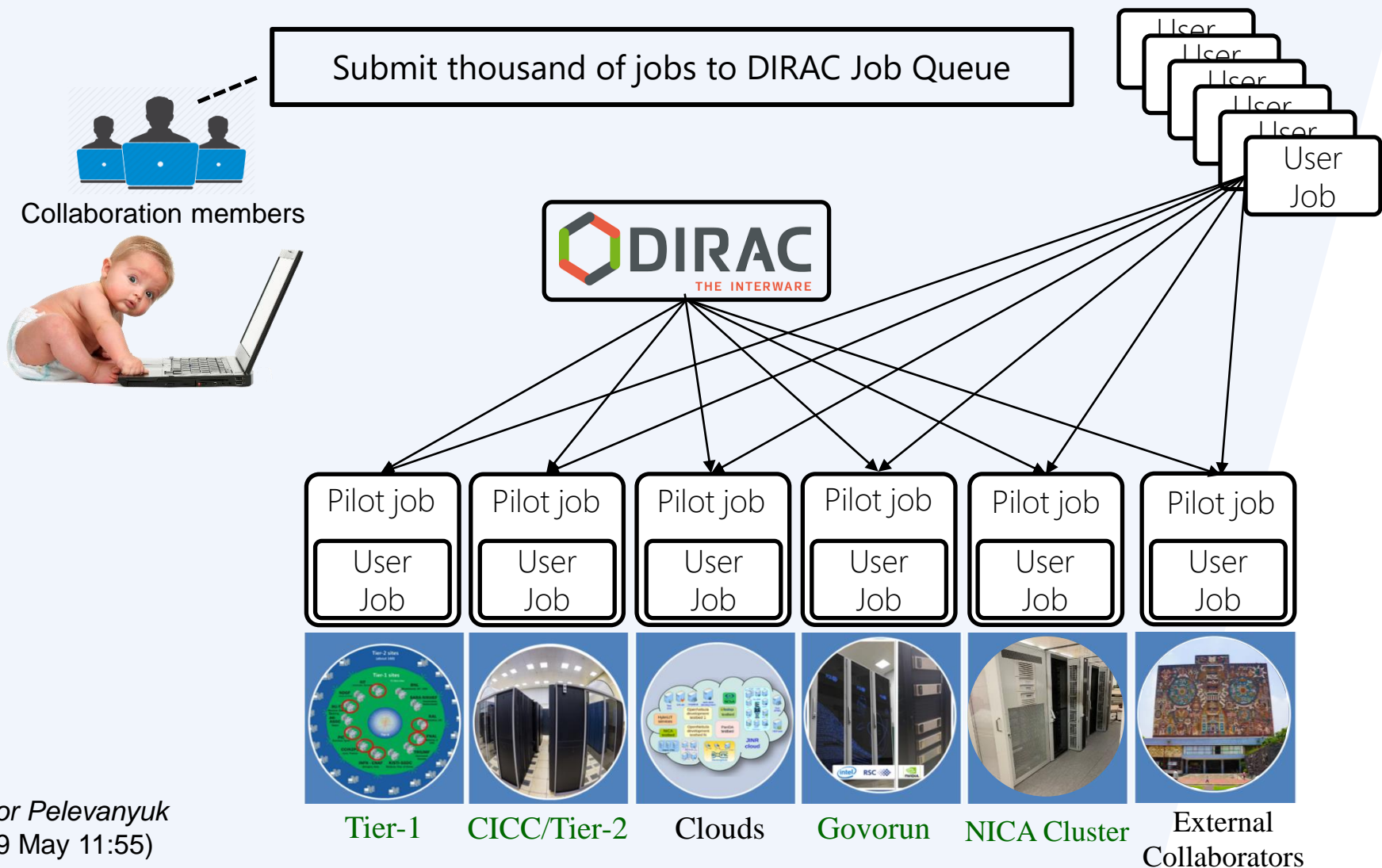
BM@N Software – Computing Design



BM@N Distributed Processing

DIRAC Interware

DIRAC Workload Manager for BM@N

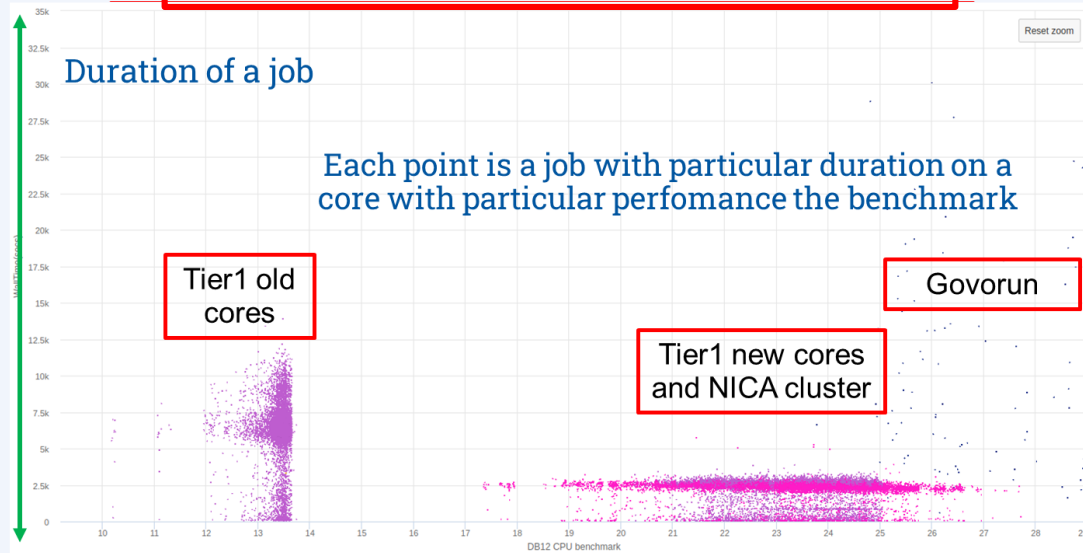


Igor Pelevanyuk
(19 May 11:55)

BM@N Mass Data Production on distributed infrastructure for Run 8 using DIRAC

BM@N Mass Production via DIRAC (Run 8)

Total duration of Raw2Digi campaign – 18 hours



CPU core performance on benchmarks

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

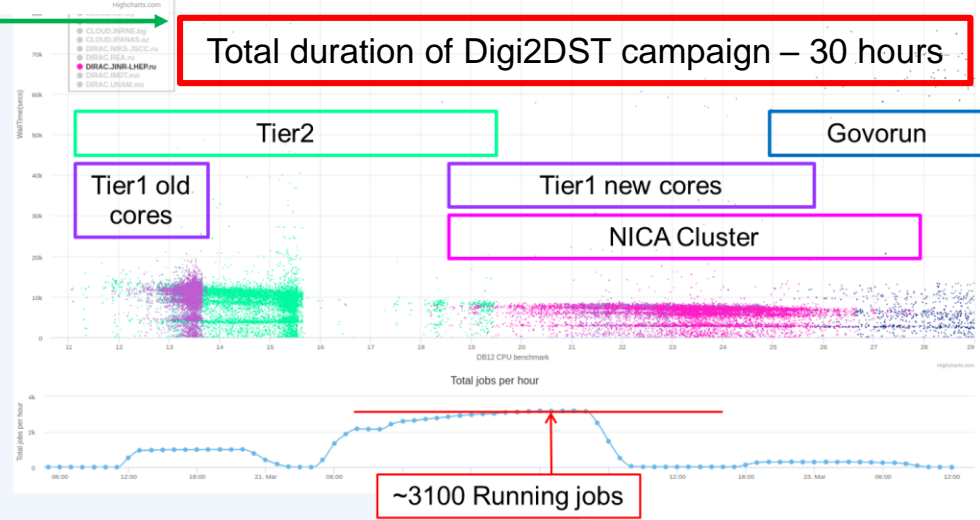
NICA cluster: 500 (per user)
 NICA cluster: max 100 slots (**big files**)

Total files: **31 306** Total raw size: **436 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**

Disk usage: tmp file: **8 GB** result file: **800 MB**
Total disk usage per job (15 GB): 25 GB
 RAM usage: **2 GB**

Total wall time: **14 years**

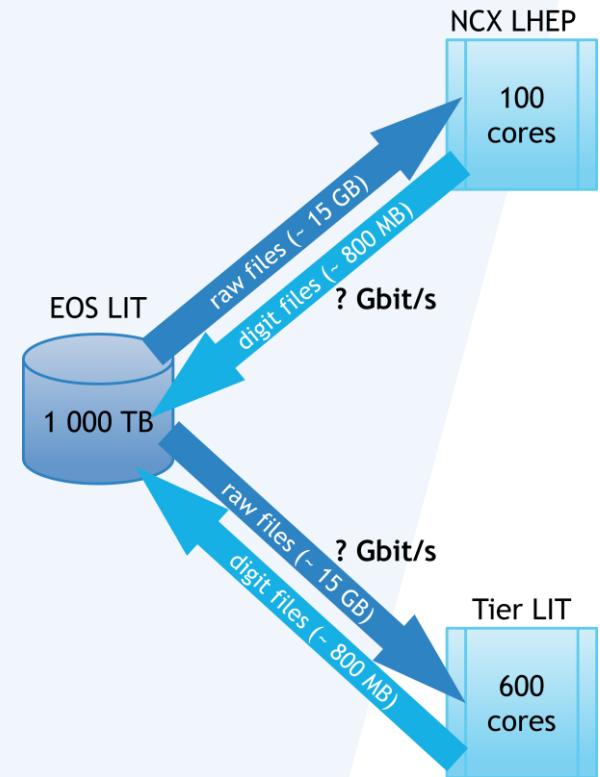
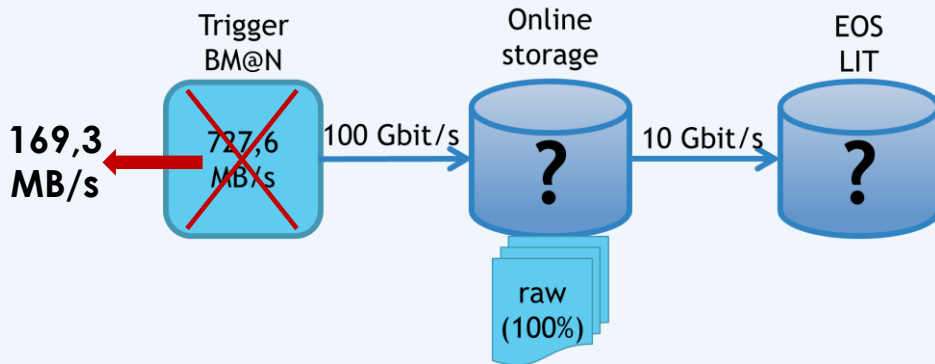
Total duration of Digi2DST campaign – 30 hours



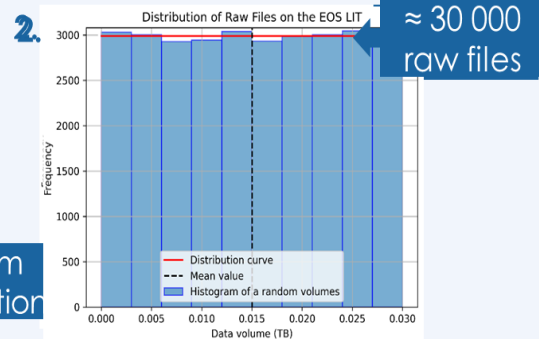
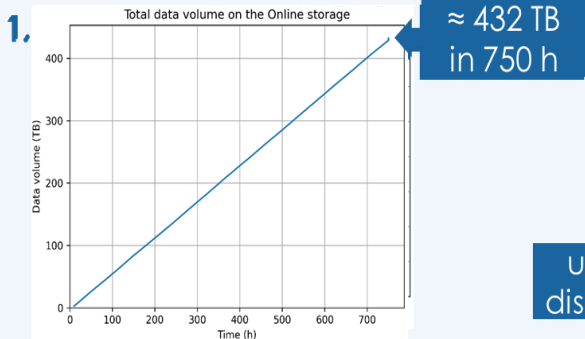
Modelling System. *BM@N* Data Storing

DATA ACQUISITION AND STORAGE

RUNNING AND EXECUTING JOBS



Results



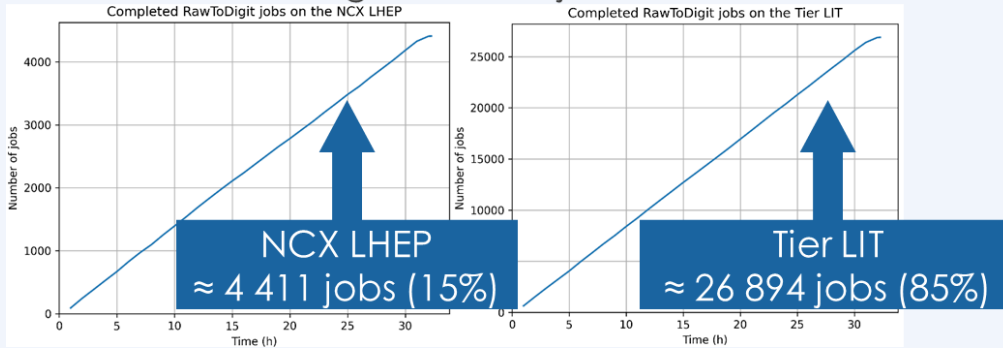
- Duration ≈ 750 h
- 1 raw file ≈ 15 GB
- 1 digit file ≈ 800 MB
- 1 job time ≈ 2 500 s

Daria PRYAHINA
(19 May 12:15)

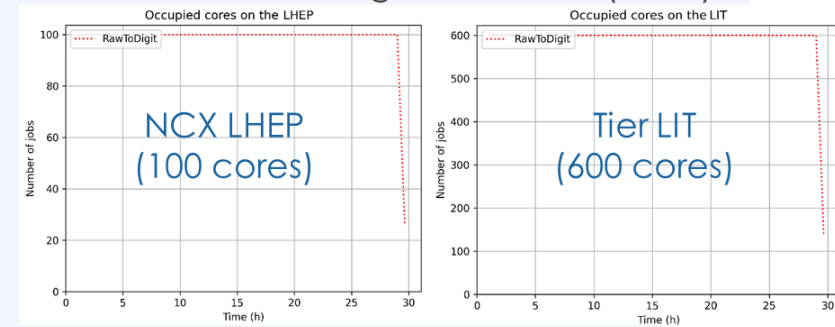
Verification of the Modelling Program for *BM@N*
Computing Infrastructure based on Run 8 mass production

Modelling System. *BM@N* Data Processing

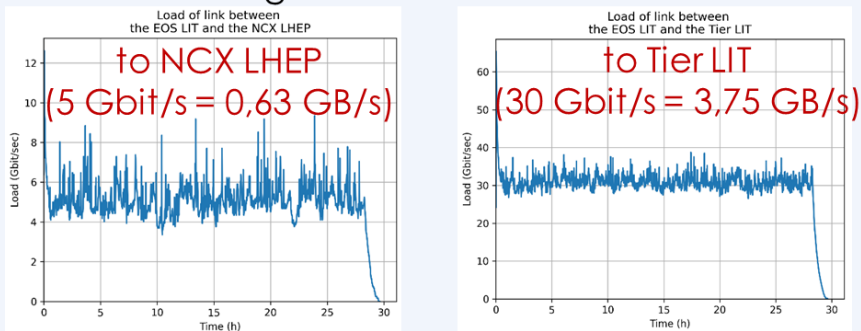
1. Processing time of all jobs \approx 33 h



2. Uniform using of resources (100%)



3. Average load of communication links



Tier LIT: 600 \rightarrow 1500 cores

1. Processing time of all jobs \approx 15 h
3. Average load of communication links:
 - to NCX LHEP (5 Gbit/s = 0,63 GB/s)
 - to Tier LIT (75 Gbit/s = 9,37 GB/s)

- the software modelling complex has been upgraded and verified
- Based on the simulation results, we can predict critical points that may appear during future experiment runs and data processing

BM@N Software Contribution

Peter KLIMAI, Alexander NOZIK, Mikhail ZELENYI, Igor DUNAEV, et alia
Event Metadata System (Web, REST AP...), Auxiliary services for the Condition Database, Monitoring & High-Availability Service

MIPT group (Head: Tagir AUSHEV)



Sergei NEMNYUGIN, Anastasia IUSUPOVA
Development of an Interactive Virtual Reality application for BM@N Visualization

SPbU group (Head: Sergei NEMNYUGIN)



JINR LIT (Director: Vladimir KORENKOV)



Igor ALEXANDROV, Evgeniy ALEXANDROV, Irina FILOZOVA, et alia
Development of the Geometry Database and Online Configuration Systems
Zafar TUKHLIEV, Zarif SHARIPOV. Automation of BM@N Alignment

JINR LHEP (Spokesperson: Mikhail KAPISHIN)



BM@N Software "Group" (2.5 FTE)

Konstantin GERTSENBERGER
Alexander CHEBOTOV, Ilya ROMANOV

BM@N
Software
Contribution

BM@N Computing and Technical Contribution

Iliia SLEPNEV (LHEP Deputy Director for Computing):

BM@N DAQ & online farm support

Ivan SLEPOV:

Support of the BM@N Information Systems and Services on the NC-cluster

JINR LHEP (Computing Leader: Andrey DOLBILOV)

JINR MLIT (Director: Sergei SHMATOV)



Nikita BALASHOV: CVMFS Deployment, GitLab Services, Docker Containers

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

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

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

**BM@N
Computing &
Technical
Contribution**

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 (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 (Jupyter Notebooks?)	0.5
	Modern Web Event Display for online and offline visualization	0.25
	Web system for publication and report activity	0.25
	Web Gallery for officially approved figures	0.25
	Institute a Project Management System	0.15
	And many other tasks: refinement and support, forgotten tasks, emerging tasks, transition to modern solutions (Web ED, e-Log redesign, NoSQL for Condition DB...)	1 – 5

Software Group Status

BM@N Software Group (2.5 FTE):

Konstantin GERTSENBERGER: software coordinator

20% coordination – 20% support – 60% code **mb:** 50% coordination – 20% support – 30% code

Development and support of the BmnRoot framework, Information Systems, Databases. BM@N services, distributed computing (&NICA-Scheduler), writing documentation, tutorials...

Alexander CHEBOTOV: software engineer in JINR since 2018

Improving web interface for the Condition Database, REST API interfaces to the Information Systems, Common Deployment System for the Information Systems, Auxiliary Services (File & Cluster Inspectors)...

Ilya ROMANOV: research assistant in JINR since 2018

Online Processing System using FairMQ & DDS, Event Display, JINR SSO Integration

The BM@N Software Group must be increased from 2.5 to 6 FTE at least to support stable work of the BM@N software

Software Strategy Risks

Software Fund

no fund, own motivation of the most software participants (neither carrot nor stick)

Staff

no full-fledged software group (management's refusals)

Computing Resources

not enough guaranteed resources for BM@N (192 cores on SC Govorun), 2024-2030: 5950 cores not enough servers (LHEP-MLIT) for BM@N software systems and services

Conclusions

- A lot of efforts have been invested to make progress in development of the systems for **BM@N online data processing**, such as Configuration Information System and process management system via FairMQ and DDS packages. Fast Event Reconstruction is in demand.
- Many **software systems** of the complex are on the final stage of the implementation and deployment to reduce the time of obtaining physics results. The Electronic Logbook and Condition Database with related services are actively improved and employed by the collaboration members. The Geometry Database, Event Metadata and Configuration Systems are on the last stage of the completion. Migration to **JINR SSO** is in progress.
- **BmnRoot Release 23.06.0** should be issued with the latest BM@N simulation, reconstruction, analysis and software improvements to be employed for mass data processing in Run 8. Some corrections for digitizer and reconstruction must be made.
- The distributed software-computing architecture of the BM@N data processing has been designed. The mass production via the **DIRAC** workload manager has been tested.
- The lack of the **software fund, regular staff** and **computing resources** poses serious risks for the further BM@N data processing and analysis, and decisions need to be made before the experiment is totally wrapped up in the issues.

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

BM@N

COLLABORATION ▾ PHYSICS ▾ DETECTOR ▾ SOFTWARE ▾ COMPUTING ▾ WIKI FORUM GALLERY ▾

1st experiment
of the NICA project

Official BM@N collaboration web-site

NICA web-site

BM@N Project

git

BmnRoot framework

BmnRoot GitLab repository



Unified Database

BM@N Offline Database



ReadMe first

BmnRoot Start Guide

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

Mailing Lists at the official BM@N Web-site














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Mailing Lists

Below is a listing of all BM@N public mailing lists. If you are having trouble using the lists, subscribing or unsubscribing, please contact [the leader of the group](#)

- BMN_Coll_list@maillist.jinr.ru - BM@N Collaboration Members
- bmngroups@maillist.jinr.ru - BM@N Group Leaders
- berds@maillist.jinr.ru - Event Reconstruction & Detector Simulation Group
- bmidentification@maillist.jinr.ru - Particle Identification & Analysis Group
- analysis_PAWG@maillist.jinr.ru - Hyperon Simulation & Analysis Group
- bmsoftware@maillist.jinr.ru - BM@N Software Group
- bmshift@maillist.jinr.ru - BM@N Shift Team
- bmndaq@maillist.jinr.ru - BM@N DAQ Group
- bmroot@maillist.jinr.ru - BmnRoot Developer Team

<p>Detector Board</p> <p>Convener</p>  <p>Semen Pyadin (semenpyadin@yandex.ru)</p> <p>MailList: Undefined Detector Board Meetings</p>	<p>Data Analysis Direction</p> <p>Convener</p>  <p>Mikhail Kapahin (kapahin@jinr.ru)</p> <p>MailList: Undefined Data Analysis Meetings</p>	
<p>DAQ TWG</p> <p>Convener</p>  <p>Ilya Slepnev (islepnev@jinr.ru)</p> <p>MailList: bmndaq@maillist.jinr.ru DAQ Wiki Section</p>	<p>Software Development TWG</p> <p>Software Coordinator</p>  <p>Konstantin Gertzenberger (gertsen@jinr.ru)</p> <p>MailList: bmsoftware@maillist.jinr.ru Software Group Meetings</p>	<p>Event Reconstruction & Detector Simulation TWG</p> <p>Convener</p>  <p>Sergey Merts (sergey.merts@gmail.com)</p> <p>MailList: berds@maillist.jinr.ru Simulation & Reconstruction Meetings</p>
<p>Hyperon Reconstruction, Simulation & Analysis PAWG</p> <p>Convener</p>  <p>Alexander Zinchenko</p>	<p>Particle Identification & Analysis TWG/PAWG</p> <p>Conveners</p>   <p>Mikhail Rumyantsev Vasily Plotnikov</p>	<p>ZDC Centrality & ECAL Data Analysis TWG</p> <p>Conveners</p>    <p>Sergey Morozov Sergei Afanasiev Alexey Stavinsky</p>

Thank you for your attention!

ГОВОРИ КАК ПЕТЕРБУРЖЕЦ!



ПОРЕБРИКЪ



ЛАРЕКЪ



ПУХТО



РЕЗИНКЪЯ



ПЫШКЪЯ



ВИАДУКЪ

ГОВОРИ КАК ПЕТЕРБУРЖЕЦ!



ГРЕЧА



БАДЛОН



БУЛКА



ШАВЕРМА



ПАРАДНАЯ



КУРА

BACKUP

Current Post-Run Procedure [1]

- ✓ Define real first and last run numbers to replace virtual ones: 6587 → 8427 (6309+). Execute changing run_period time interval and parameter ranges.

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

- ✓ Write the current setup geometry of the Run to the Condition Database.

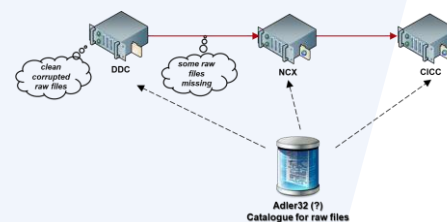
```
root bmnroot/database/examples/uni_db/geometry/write_actual_geometry_to_db.C
```

- ✓ Find and move corrupted raw files to a trash directory. Match checksums (a new DB with Adler32 sums) and copy missed raw files from the online farm → NCX → CICC.

```
python3 bmnroot/services/checks/filter_raw_data.py
```

```
python3 bmnroot/services/checks/catalog_raw_data.py
```

```
python3 bmnroot/services/checks/transfer_raw_data.py
```



- ✓ Run mass production of digit files for obtained raw files via DIRAC with writing run and file metadata to the Condition Database (≈70 hours). dev → release

```
python3 dirac4bmn/RawToDigi/submit_jobs.py
```



Current Post-Run Procedure [2]

- ✓ Update run metadata in the Condition Database:

- a) Correct raw file paths.

- b) Write absent run metadata from e-Log to UniConDa, such as beam, target, energy, field_voltage.

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

- ✓ Match event count and time in the records of the Condition Database comparing run and raw file metadata. Encountered errors: starting not from 1, more than 1 event between raw files, the sums of the event count of the raw files differ from the event count of the corresponding runs, the times of the first and last raw files differ from the start and end time of the runs. ~300 errors have been found.

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

- ✓ Rewrite average magnetic field stored in Tango to the Condition Database and check possible issues, such as Tango <> e-Log and UniConDa <> e-Log.

```
root bmnroot/database/tango/examples/show_avg_field.C
```

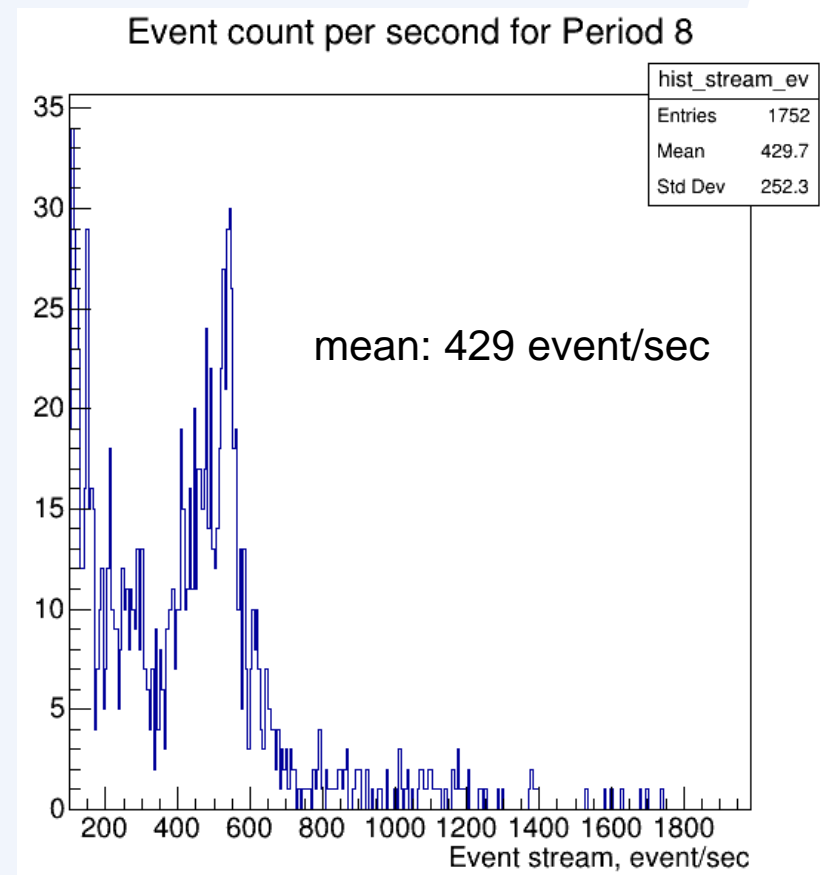
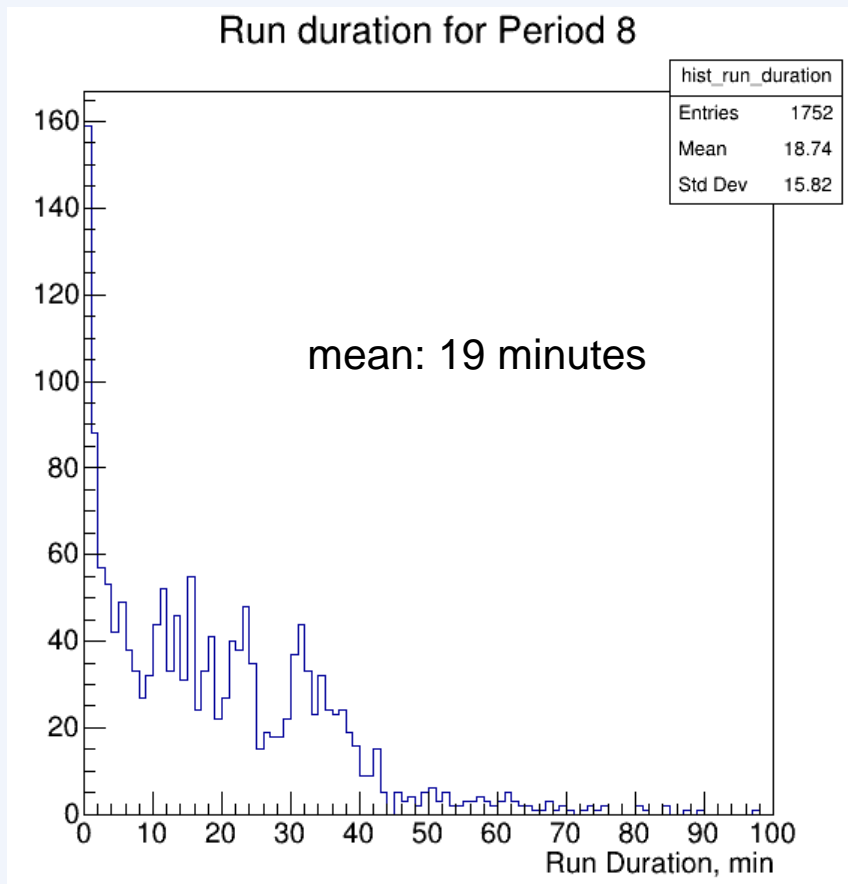
- ✓ Run mass production of DST files via DIRAC for obtained digit files.

```
python3 dirac4bmn/DigiToDst/submit_jobs.py
```


Preliminary Post-Run Statistics [1]

- ✓ Get statistics data for runs, raw and digit files to check the correctness of the metadata and tune BM@N computing model.

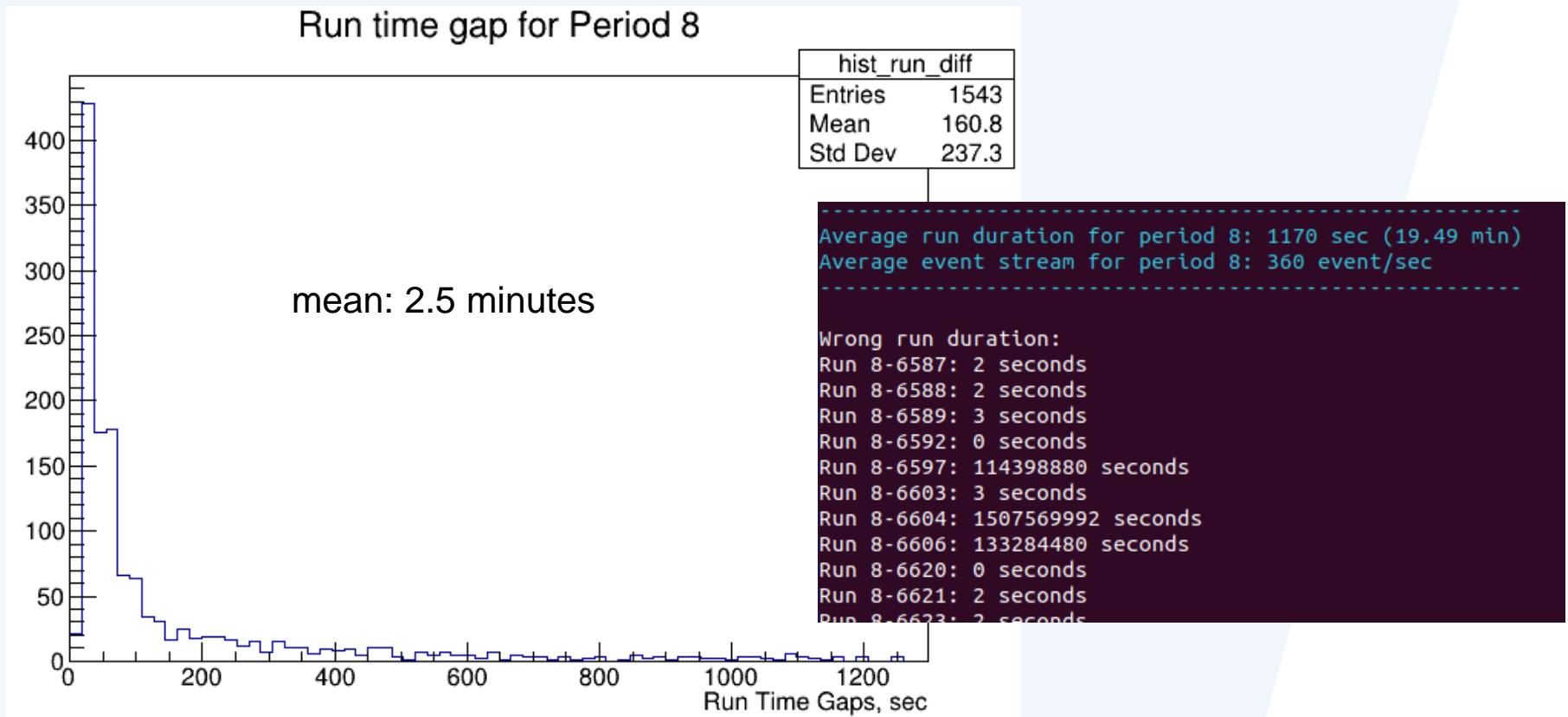
`root bmnroot/database/uni_db/examples/run/show_run_stats.C`



Preliminary Post-Run Statistics [2]

- ✓ Get statistics data for **runs**, raw and digit files to check the correctness of the metadata and tune BM@N computing model.

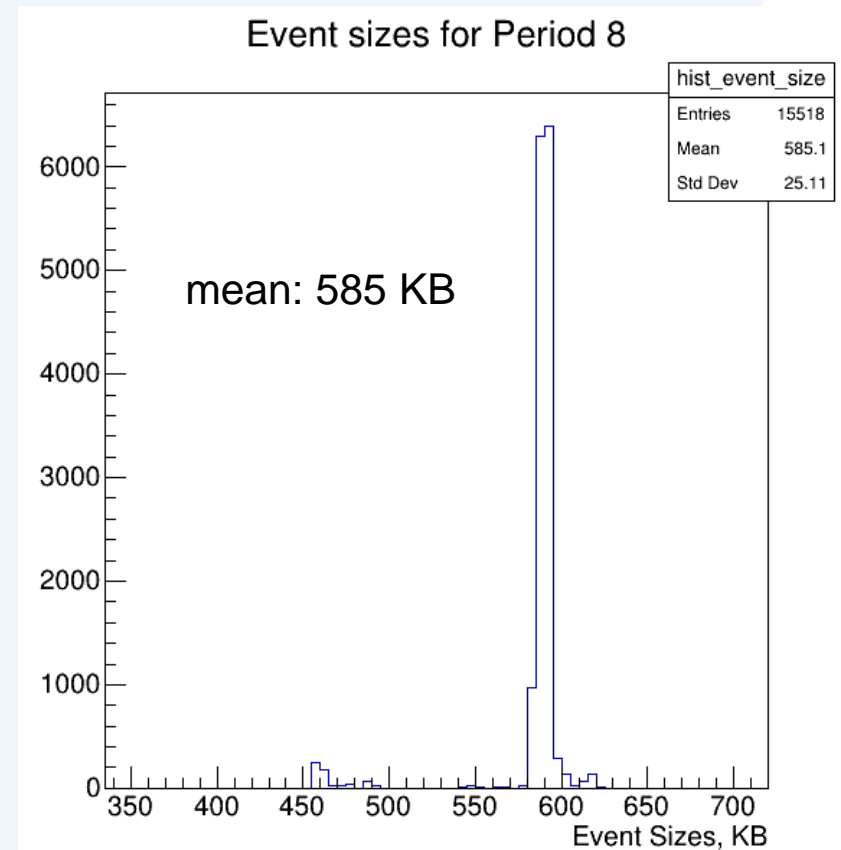
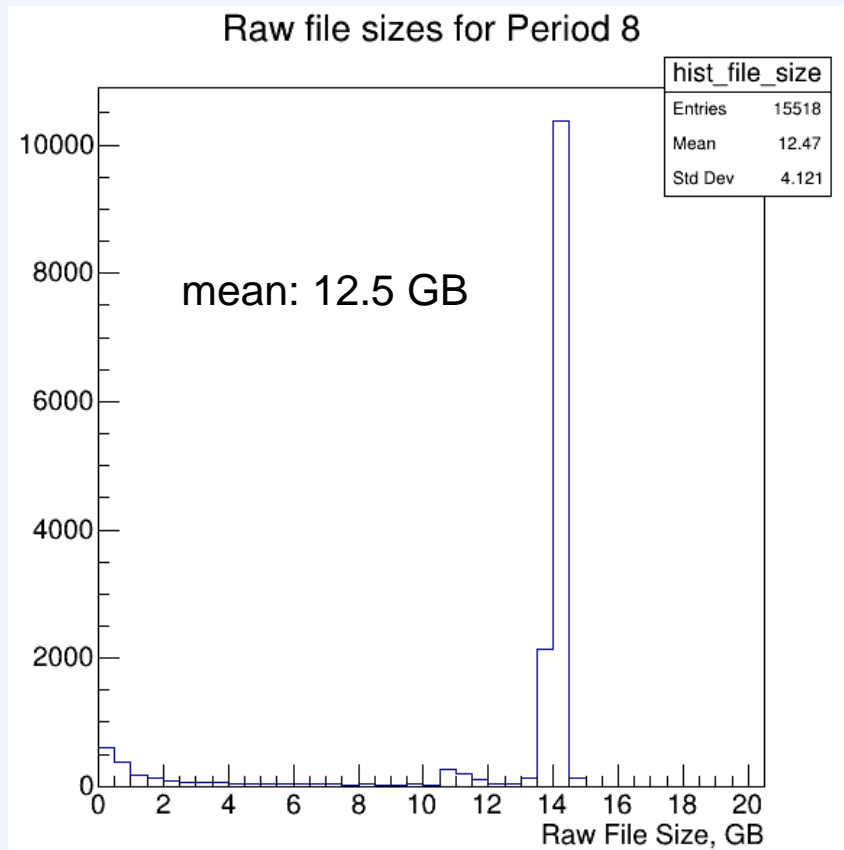
`root bmnroot/database/uni_db/examples/run/show_run_stats.C`



Preliminary Post-Run Statistics [3]

- ✓ Get statistics data for runs, **raw** and digit files to check the correctness of the metadata and tune BM@N computing model.

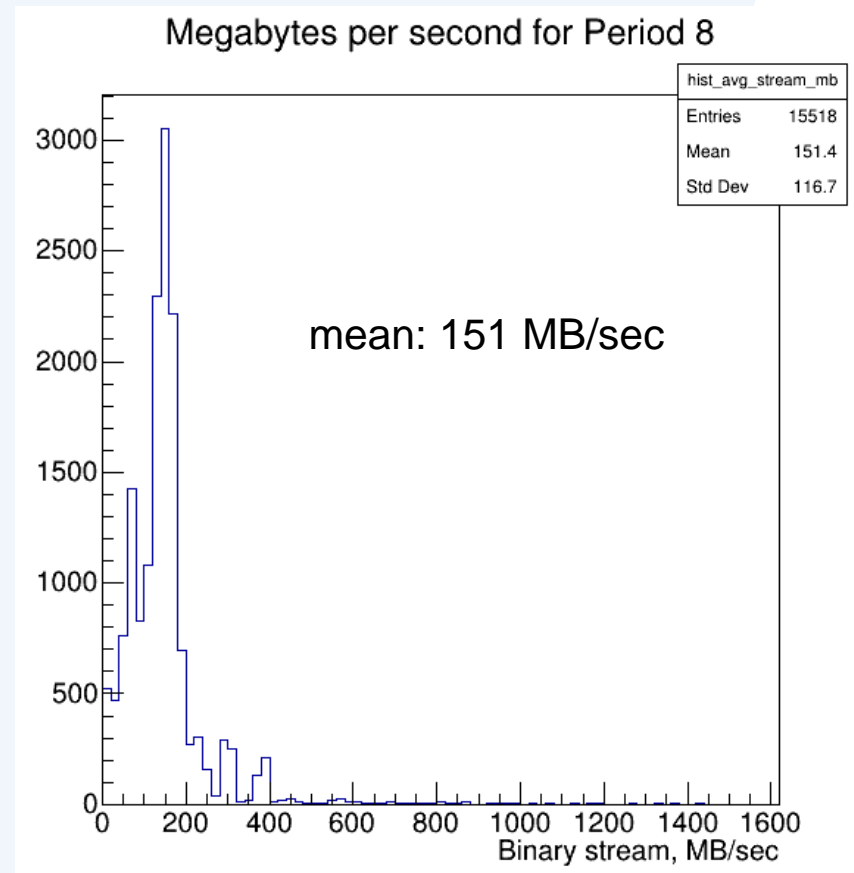
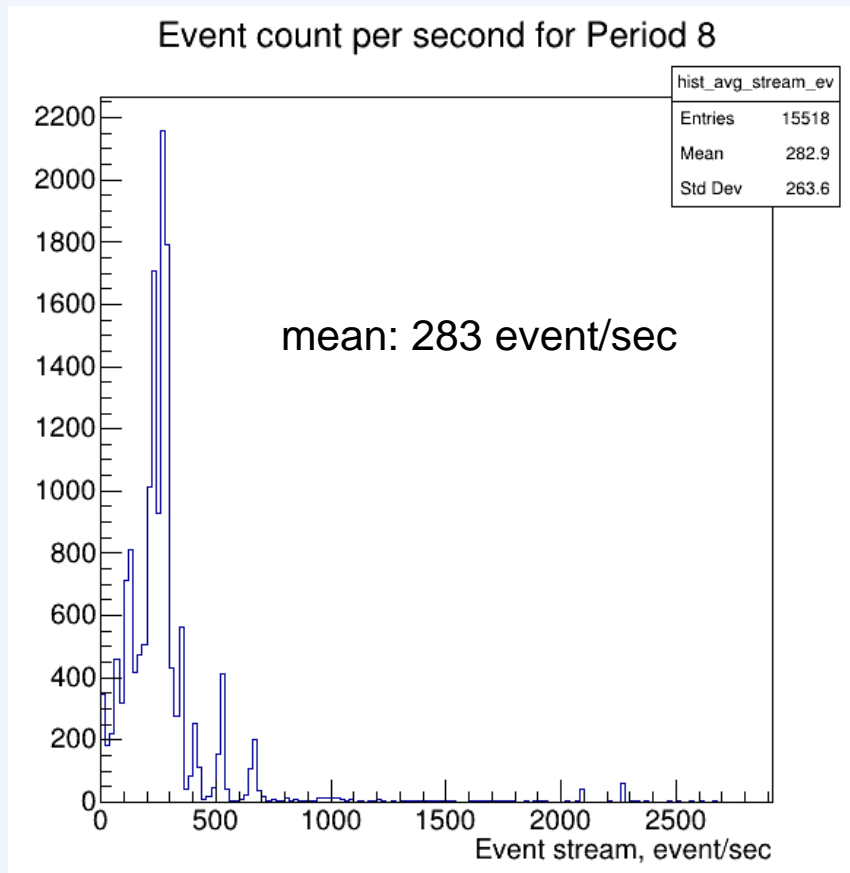
`root bmnroot/database/uni_db/examples/raw/show_raw_stats.C`



Preliminary Post-Run Statistics [4]

- ✓ Get statistics data for runs, **raw** and digit files to check the correctness of the metadata and tune BM@N computing model.

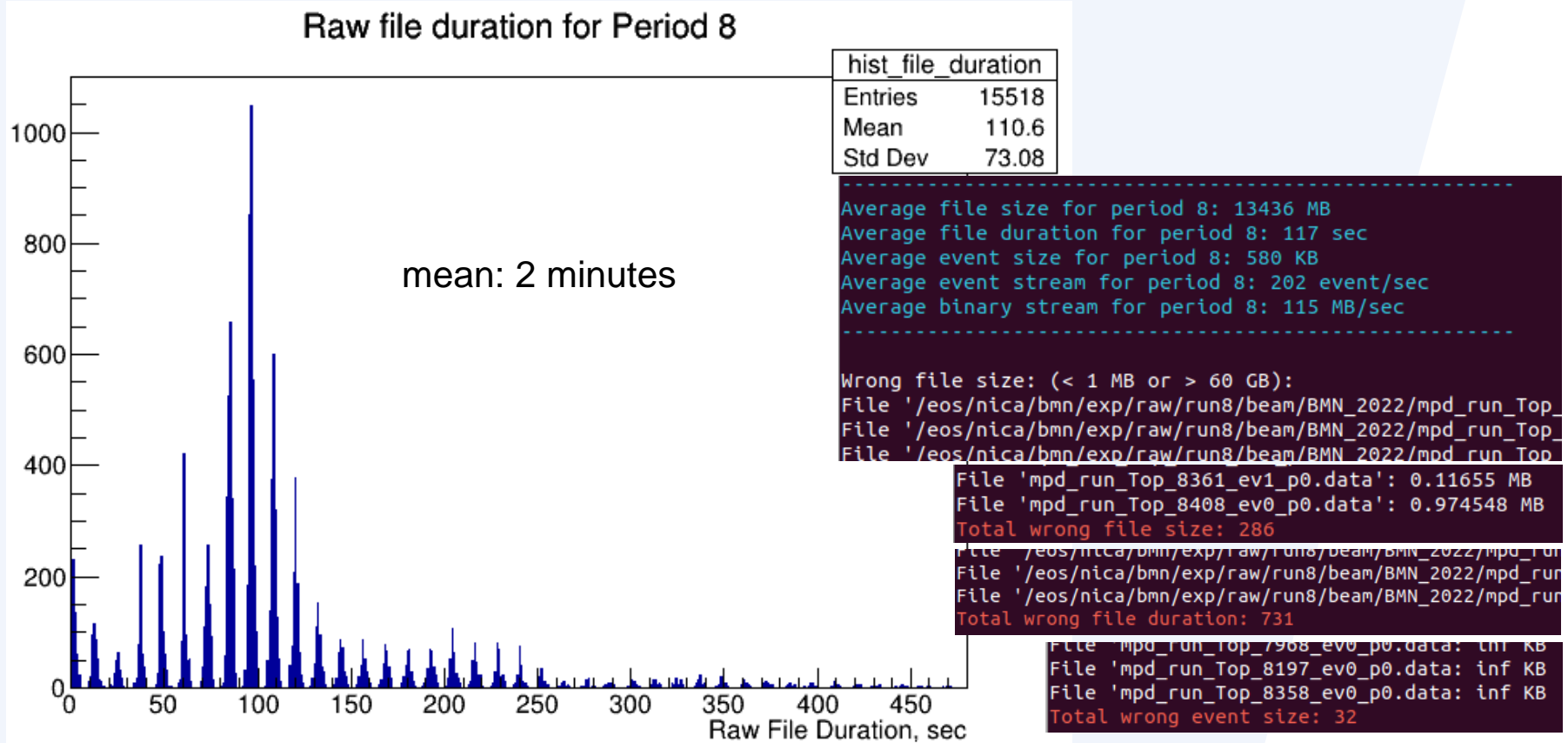
`root bmnroot/database/uni_db/examples/raw/show_raw_stats.C`



Preliminary Post-Run Statistics [5]

- ✓ Get statistics data for runs, raw and digit files to check the correctness of the metadata and tune BM@N computing model.

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



Preliminary Post-Run Statistics [6]

- ✓ Get statistics data for runs, raw and **digit** files to check the correctness of the metadata and tune BM@N computing model.

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

