

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

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BM@N in Nuclotron Runs (2015 – 2023)

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



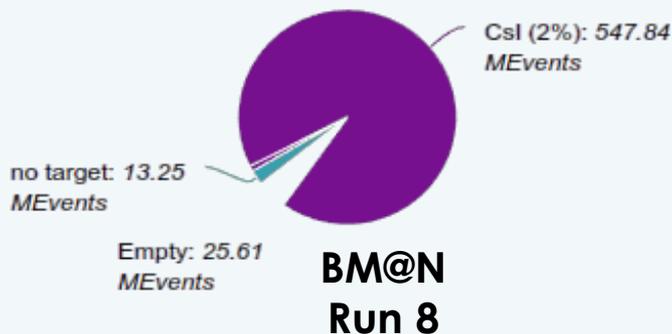
- Beam: **Xe** (3.8, 3.0 AGeV),
previous runs: Kr (2.3, 2.6, 3.0 AGeV), Ar (3.2 AGeV),
C¹² (3.5–4.5 AGeV), d (4, 4.6 AGeV)
- Target: **CsI** or **empty**
previous runs: Pb, Sn, Cu, Al, C₂H₄, C, H₂
- Integrated DAQ, T₀ and Trigger systems
- Detectors: FSD, GEM, CSC, ToF-400, ToF-700,
DCH 1&2, FHCAL, ECal, LAND, profilometers...
- Detect min bias beam-target interactions to
reconstruct hyperons, strange particles, identify
charged particles and nucleus fragments...

Data Production in BM@N Physics Run

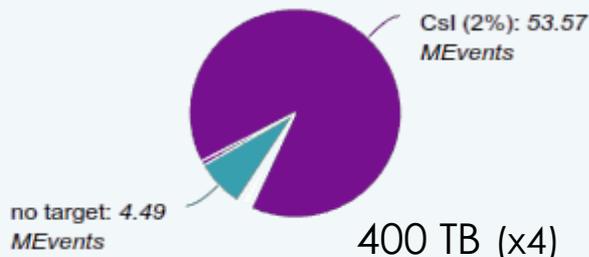
1st Physics BM@N Run

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

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



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



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



BmnRoot Framework

as a central BM@N software package

BmnRoot Framework

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

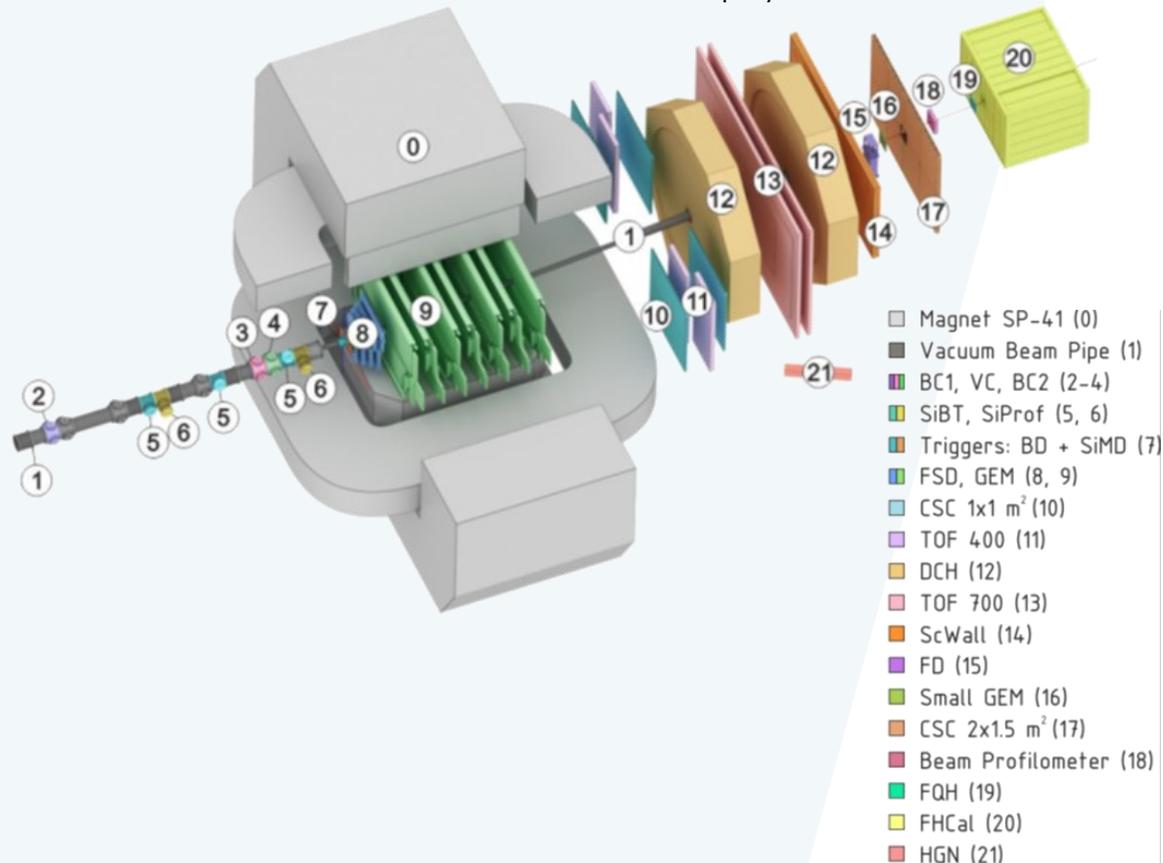
single stack for offline and online (FairMQ)

C++ classes, Linux/MacOS,

based on  ROOT and FairRoot

embedded services on Python

BM@N in the 1st physics Run



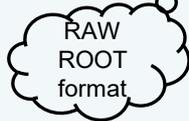
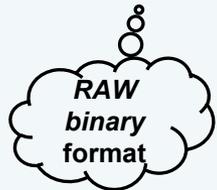
The BmnRoot software is available in GitLab@JINR: <https://git.jinr.ru/nica/bmnroot>

BmnRoot. Event Data Model

DAQ Storage

raw data in a binary format

raw_run.data
≈ 600 KB/event



digit_exp.root
≈ 35 KB/event



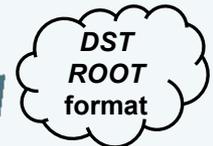
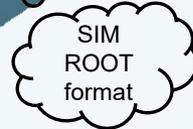
dst_reco.root
≈ 90 KB/event



Geant4, Fluka



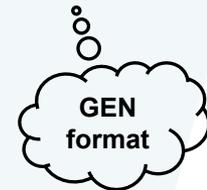
digit_sim.root



Event Generators

(DCM-)SMM, QGSM, UrQMD...

generator.dat
≈ 10 KB/event



RAW → **DIGIT** → **DSTexp** → PhA

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

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

DSTexp: reconstructed data of experimental events



hists
plots
results

GEN → **SIM** → **DSTsim** → PhA

GEN: particle collisions description received by event generators

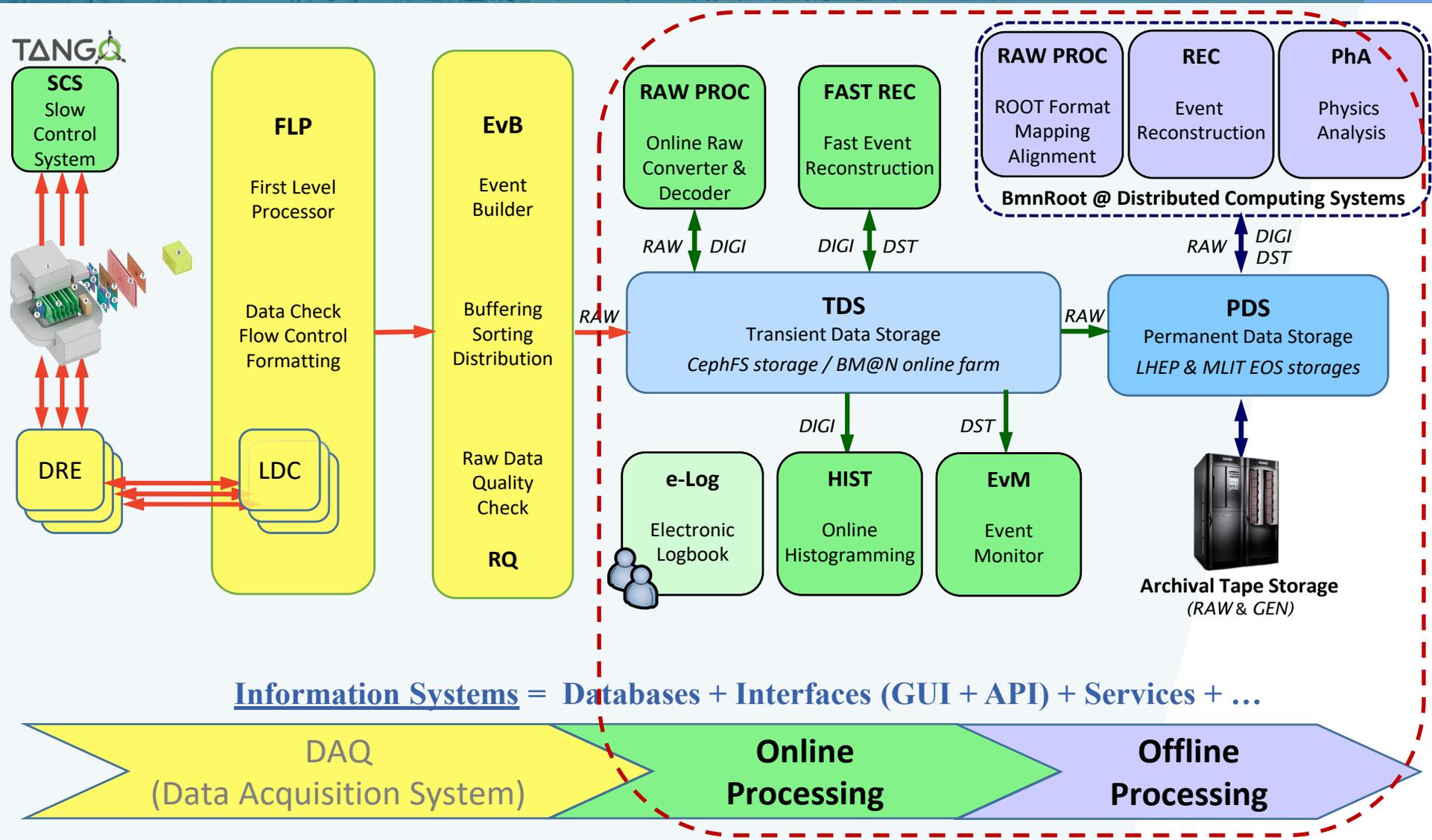
DSTsim: reconstructed data of simulated events



Complex of Software Systems

Distributed Data Processing and Storage

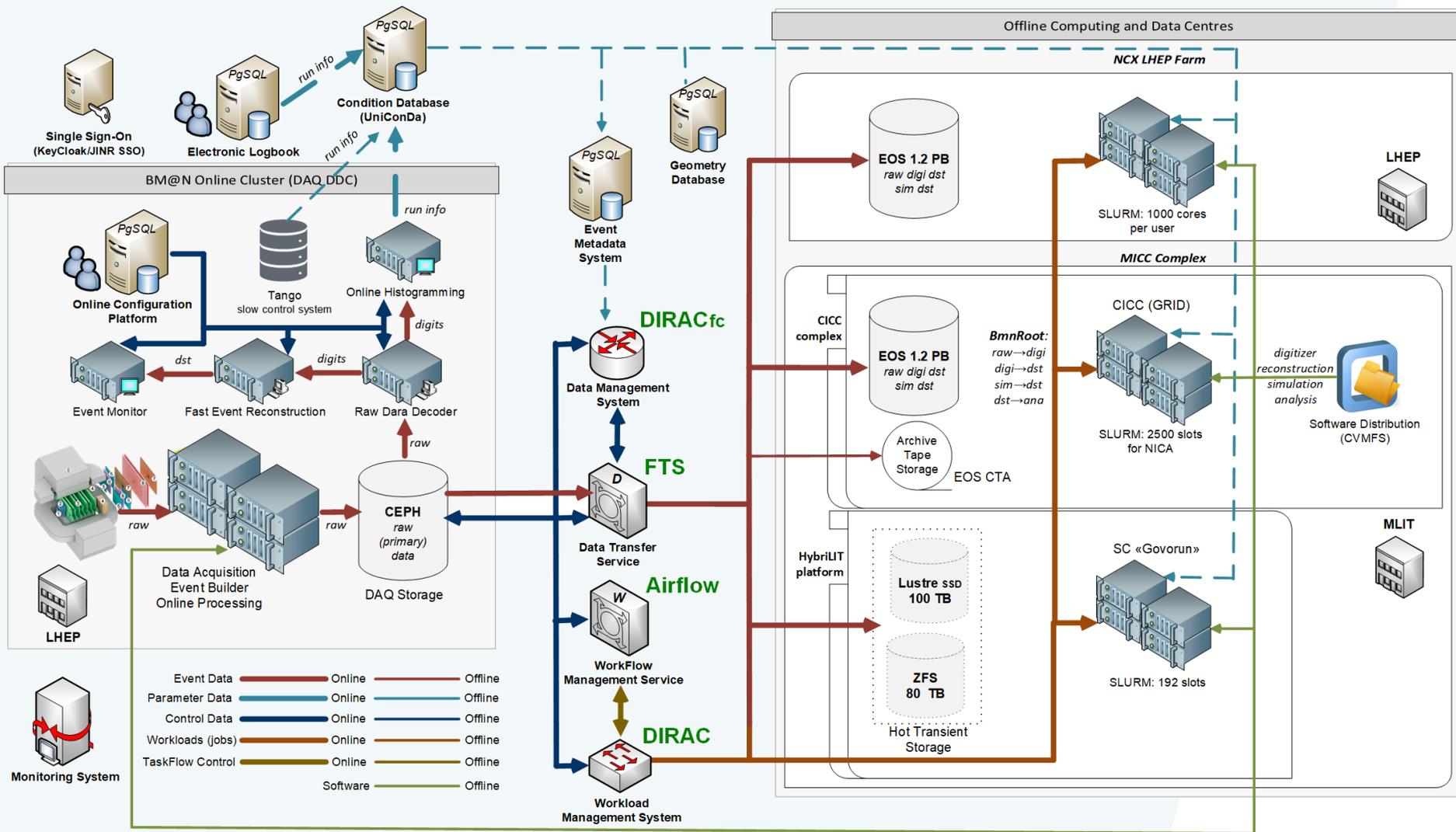
BM@N Data Processing Flow



Components of BM@N distributed complex

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

Developed Architecture of the Software Complex





Workload Management System based on the DIRAC Interware

BM@N Computing Platforms

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



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



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



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



OS: AlmaLinux 9

OS: CentOS / Scientific Linux 7.9

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

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

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

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

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

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

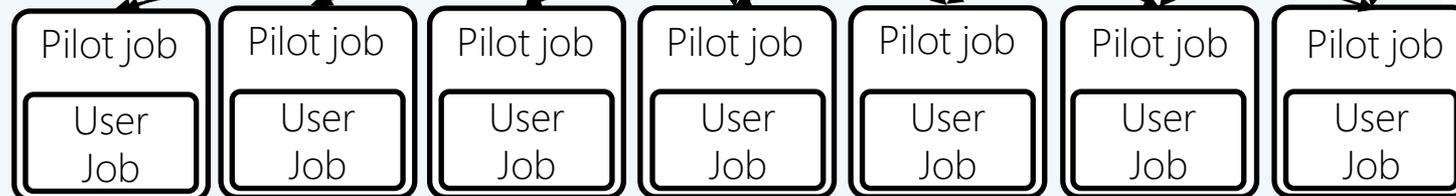
DIRAC Workload Manager for BM@N



Collaboration members

Production Manager: Igor Pelevanyuk

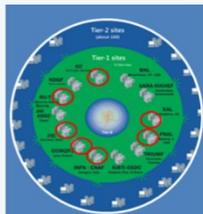
Submit thousand of jobs to DIRAC Job Queue



BM@N
Online Cluster



NICA Cluster



CICC
Tier-1



CICC
Tier-2



Clouds



Govorun



External
Collaborators

BM@N DST Production via DIRAC (Run 8)

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

Quotas (cores):

Tier1: 1500 (for NICA)

Tier2: 1000 (for NICA)

Govorun: 192 (BM@N)

NICA cluster: 1000 (per user)

Duration of a job

Each point is a job with particular duration on a core with particular performance the benchmark

Tier1 old cores

Govorun

Tier1 new cores and NICA cluster

CPU core performance on benchmarks

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

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 \rightarrow 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**

CPU core performance on benchmarks

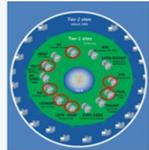
DIRAC jobs on BM@N Computing Resources



BM@N
Online Cluster



NICA Cluster



CICC
Tier-1



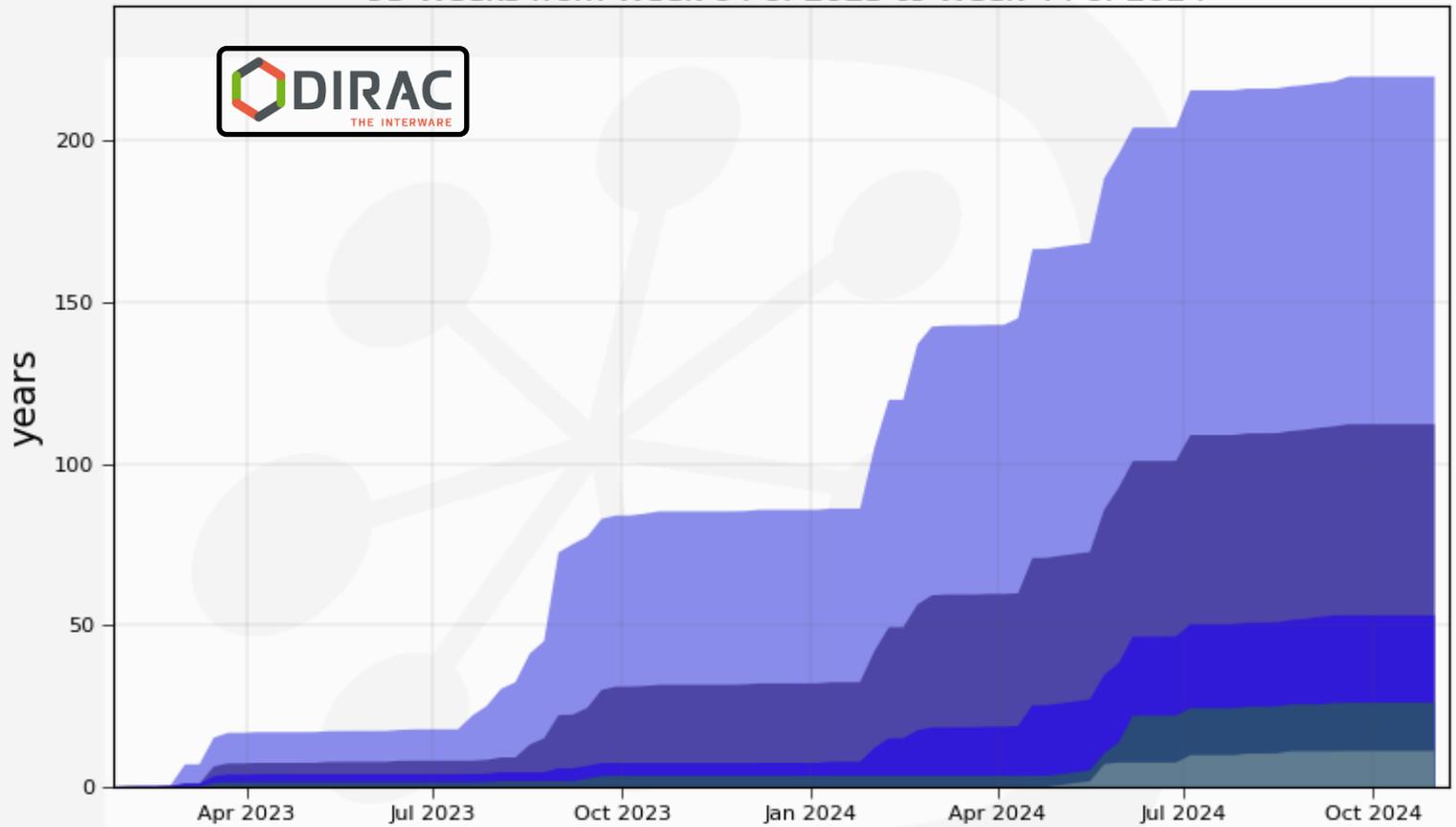
CICC
Tier-2



Govorun

Cumulative wall time by Site

93 Weeks from Week 04 of 2023 to Week 44 of 2024



Max: 220, Min: 0.01, Average: 105, Current: 220

DIRAC.JINR-TIER.ru	107.6	DIRAC.JINR-LHEP.ru	27.0	DIRAC.JINR-LHEP-DDC.ru	11.1
DIRAC.JINR-CREAM.ru	59.1	DIRAC.GOVORUN.ru	14.9		



Software Distribution System using CVMFS and GIT CI|CD

Software Management & Distribution System

NICA / bmnroot / Pipelines / #61482

clang-format files

Passed Konstantin Gertsenberger created pipeline for commit @ad9f7da 21 hours ago, finished 21 hours ago

Related merge request 11294 to merge tango_improving

latest merge request 17 jobs 19 minutes 14 seconds, queued for 1 seconds

Pipeline Needs Jobs 17 Tests 0

Group jobs by Stage Job dependencies

Code Format Checker

Simulation, Raw Data Decoder, Reconstruction Tests

Compilation

check_permissions

check_formatting

build

test_form_digi

test_run_reco

Project information

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

pipeline passed failed macros 356

unformatted files 1983

macros test format test

GIT Pipelines on Merge Requests

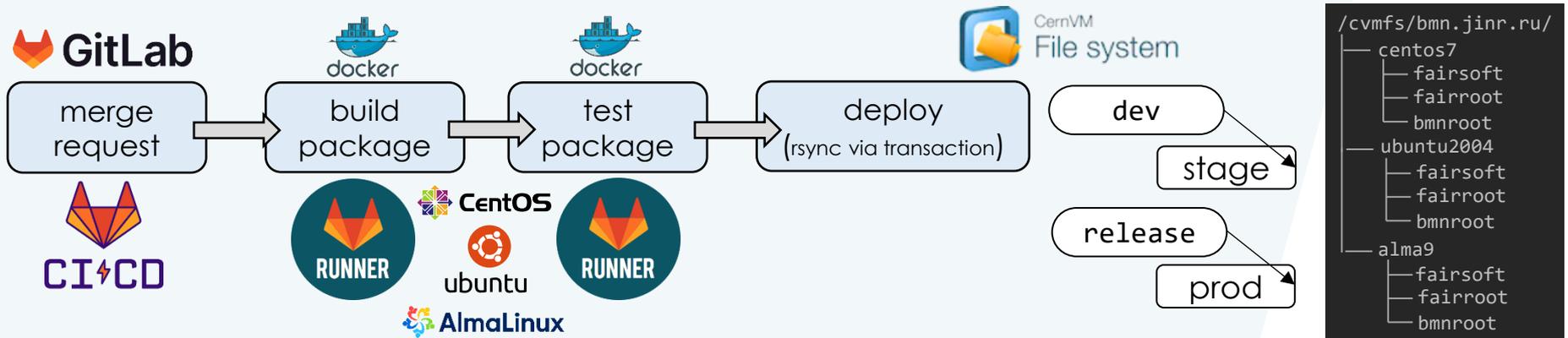
- checking compilation and main macros
 - stable dev & pro branches, all tags
- **deploy BmnRoot to the CVMFS storage**
- **deploy BmnRoot containers to the registry**
- checking Clang code formatting

GIT Night Tests

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

Software Distribution via CernVM File System

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





Data Management System built on the DIRAC File Catalogue

Data Storages for BM@N



for BM@N online (2.8 PB)
build on HDD with SSD buffer



fast on NVMe SSD

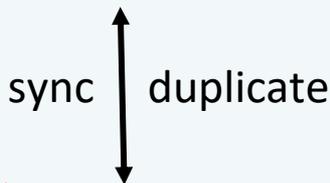


fast on NVMe SSD

NICA cluster



for BM@N offline (1.2 PB)
build on HDD

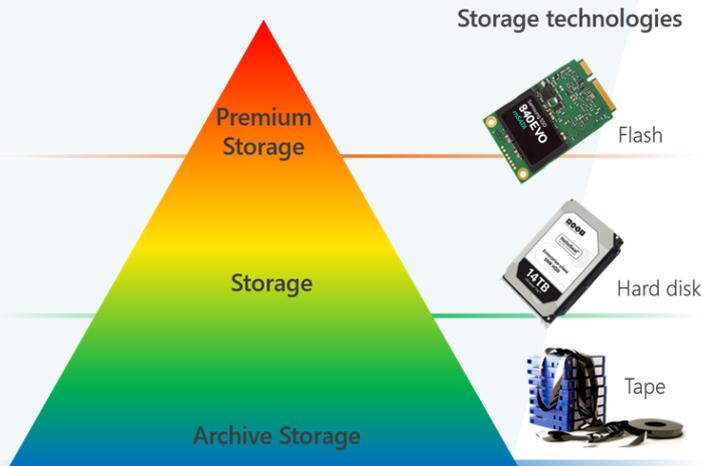


MLIT MICC



for BM@N offline (1.2 PB)
build on HDD

NICA cluster



MLIT MICC

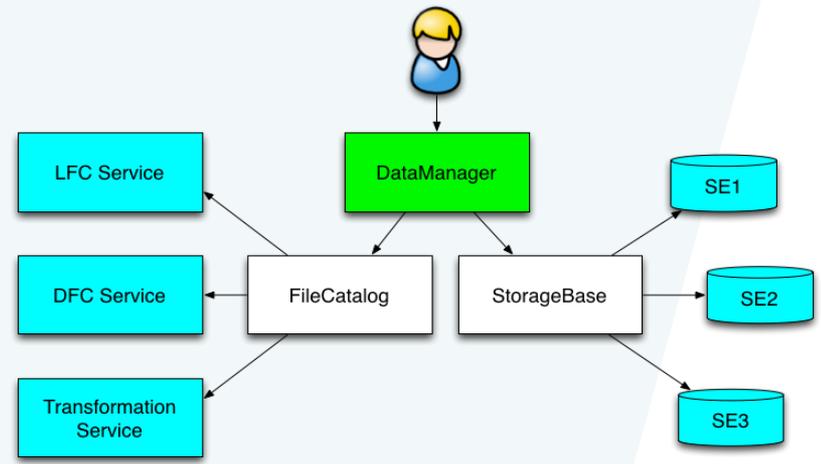


archive tape storage



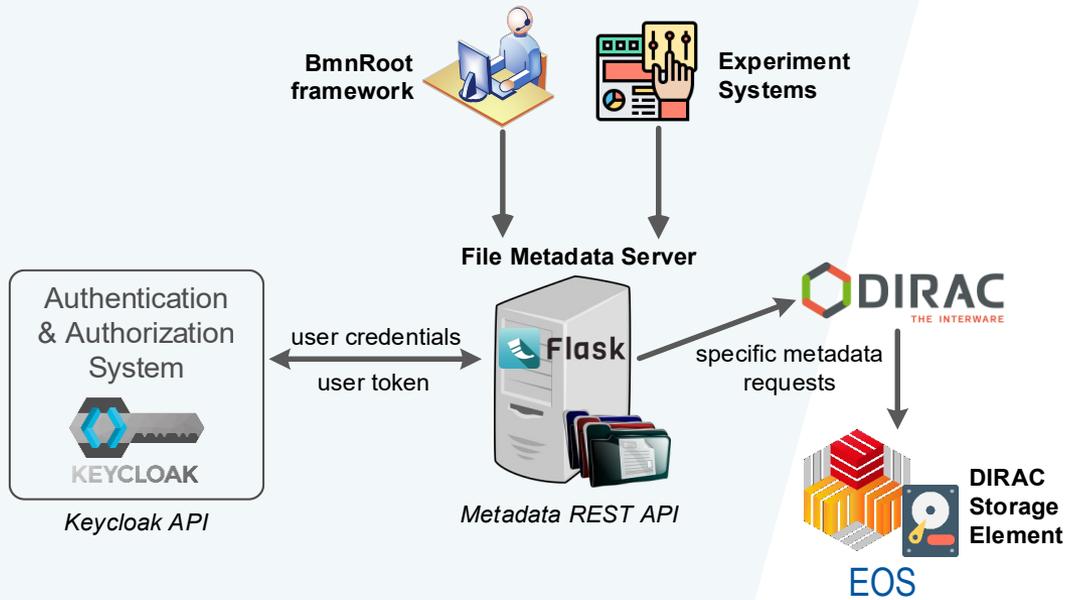
DIRAC File Catalogue for BM@N

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



BM@N DFC Metadata (Run 8):

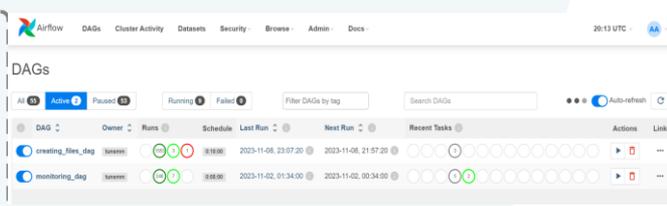
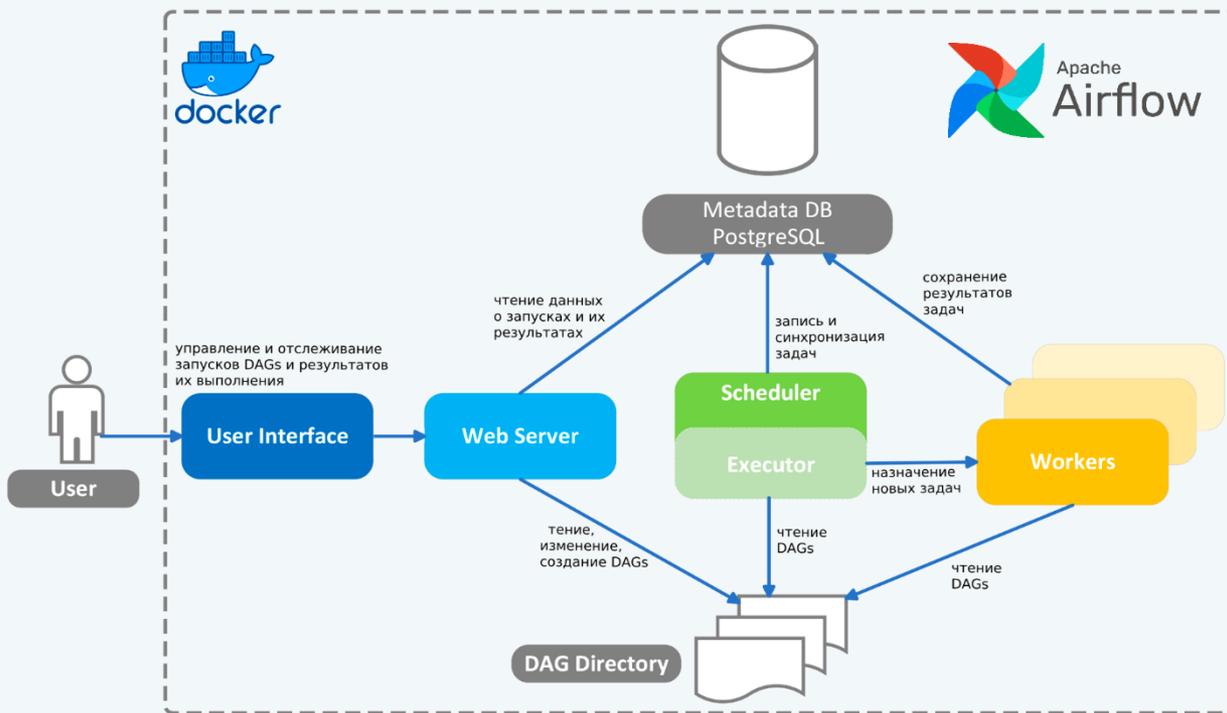
- period and run number
- start and end datetime
- beam and target particles
- run type
- energy
- magnetic field
- start and end event number
- event count
- file size





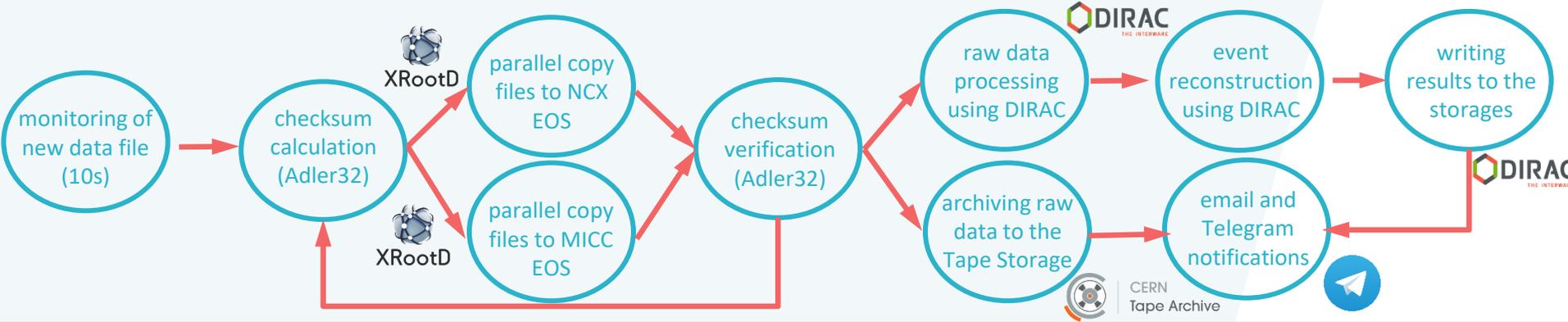
Workflow Management Service implemented through Apache Airflow

BM@N Orchestration with Workflow Manager



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

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





Electronic Logbook Platform

Online Information System

Electronic Logbook (e-Log Platform)

create a new run

advanced search

current day records

user cabinet (event subs)

work with dictionaries

records per page

file attachments

username

page

fast search

BM@N Electronic Logbook

bmn-elog.jinr.ru

Logged in as shift

Home New Find Last day Account Reference Book

Page: 1 of 282



Number of items per page: 10

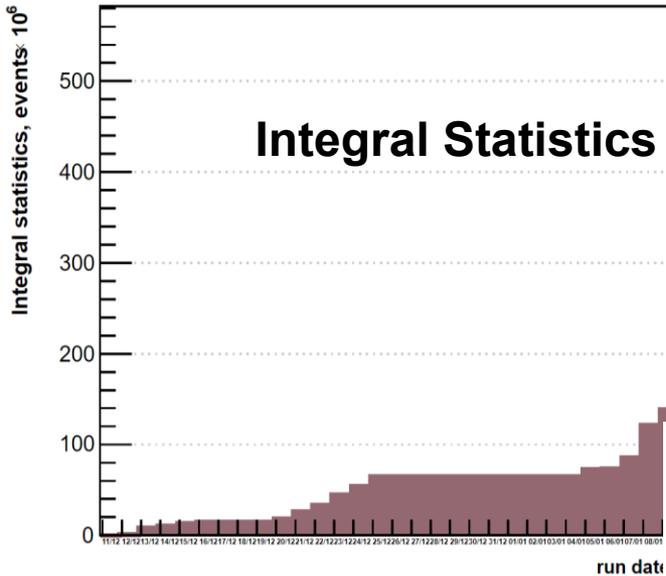
Logout

Date	Shift Leader	Type	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				

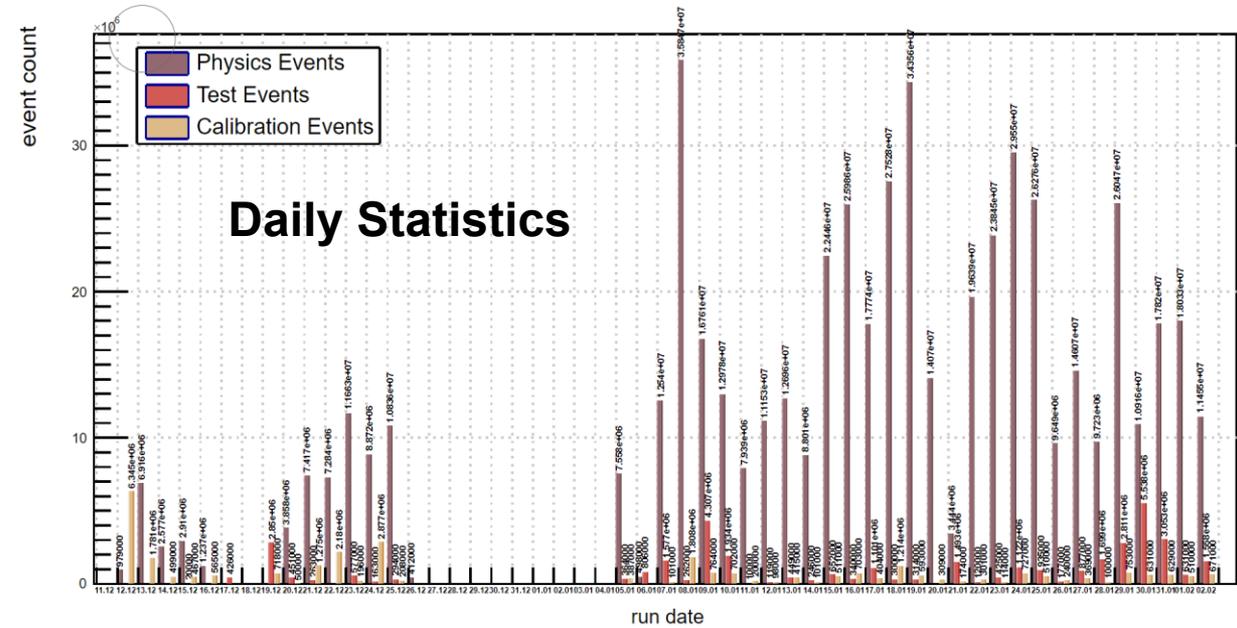


2020 - software team (contact e-mail: gertsen@jinr.ru)

Online Statistics of the e-Log Platform



e-Log event statistics (Run 8): statistics by event type / integral statistics of physics events
The information is current as of February 20 2023 23:59.

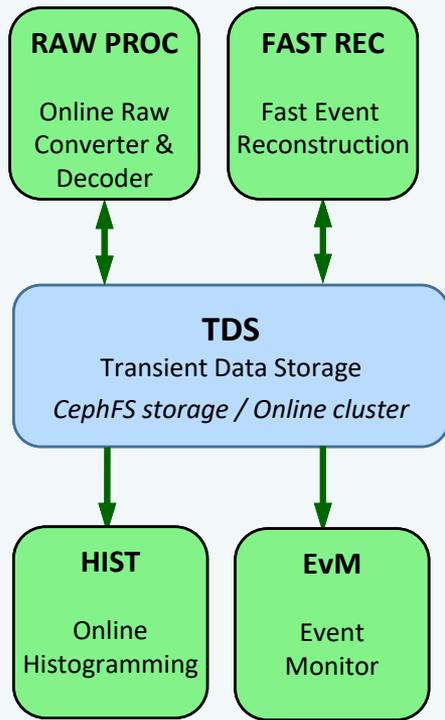




Online Configuration System

Online Data Processing

Online Process Control



Online
Processing

start → monitor → control → restart → stop

COP. Configuration Designer & Monitor

Menu

TASK MONITOR

CONFIGURATION MANAGER

DICTIONARY SET

Get in touch

✉ [Konstantin Gertsenberger](mailto: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				

ADD MODULE TASK

Module Tasks

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

Task Monitor

Select task

Select setup

Select module

Started

Select host

FILTER

RESET

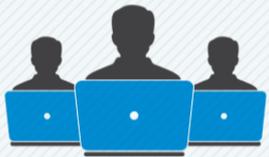
Task Name	Setup:Run	Module	Status	Log	Start Time	End Time	Host
bmn_event_display_imit	BMN:7	OnlineControl	Started		2023-05-05 18:39:16		vps104.jinr.ru
bmn_fast_event_reco_imit	BMN:7	OnlineControl	Started		2023-05-05 18:39:16		vm221-85.jinr.ru
bmn_online_histo_imit	BMN:7	OnlineControl	Started		2023-05-05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

UniConDa in BM@N offline processing



ROOT-based framework

detector simulation
raw data processing
event reconstruction
physics analysis

viewing and managing parameter data



users

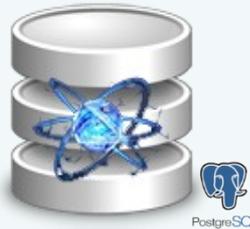
Keycloak authentication authorization

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

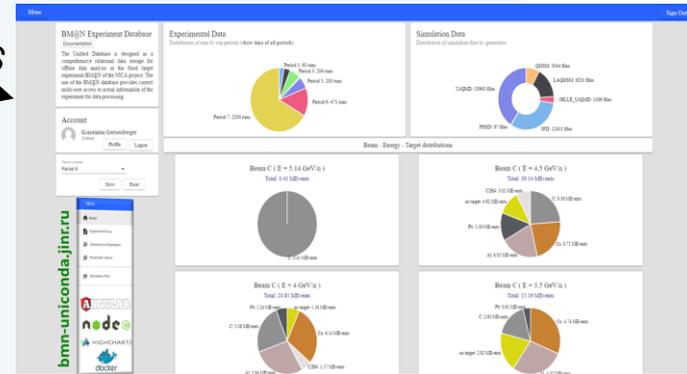
REST API service

http

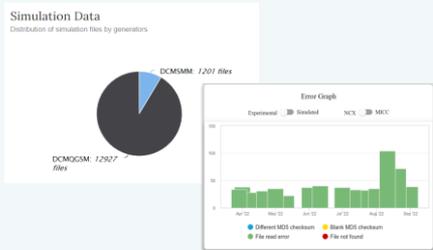
node.JS



Condition Database

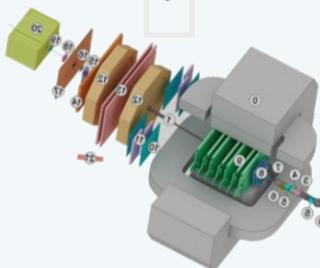


python service for auto updating of metadata on simulation files

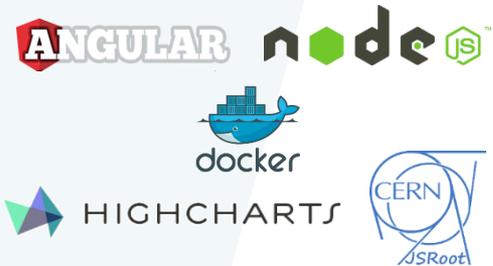


python service for automatic regular checking of file integrity

configuration calibration data parameter algorithm



Web Service



UniConDa. Web Application

The screenshot displays the UniConDa web application interface. At the top, there is a blue navigation bar with a 'Menu' button on the left and a 'Sign Out' button on the right. The main content area is divided into several sections:

- BM@N Experiment Database:** A section with a 'Documentation' link and a paragraph describing the database's purpose for the NICA project.
- Account:** A section showing the user's name 'Konstantin Gertsenberger Administrator' and a 'Logout' button.
- Experimental Data:** A section titled 'Distribution of events by run periods and time intervals of periods.' It features a pie chart with the following data: Period 7: 313 MEvents, Period 6: 76 MEvents, Period 5: 20 MEvents, Period 3: 22 MEvents, Period 2: 10 MEvents, and Period 8: 742 MEvents.
- Simulation Data:** A section titled 'Distribution of events by generators' with a 'DST' button. It features a pie chart with the following data: RQMD: 10 MEvents, DCMSMM: 153 MEvents, UrQMD: 6 MEvents, and DCMQGS: 830 MEvents.
- Beam - Energy - Target distributions:** A section containing two pie charts:
 - Beam Xe (E = 3 GeV/n):** Total: 60.77 MEvents. Data: Csl (2%): 53.88 MEvents, (1%): 0.44 MEvents, target: 4.99 MEvents, Empty: 1.45 MEvents.
 - Beam Xe (E = 3.8 GeV/n):** Total: 639.69 MEvents. Data: Csl (2%): 582.66 MEvents, (1%): 6.11 MEvents, target: 20.76 MEvents, Empty: 28.15 MEvents.

On the left side, there is a vertical navigation menu with a 'Menu' button at the top. The menu items are: Home, Experiment Runs, Detectors & Parameters, Parameter Values, Simulation Files, and a section with logos for ANGULAR, node.js, HIGHCHARTS, and docker. A red arrow points from the text 'File Inspector' to a small icon in the bottom left corner. The URL 'bmn-uniconda.jinr.ru' is written vertically in green text on the left side of the interface.

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

File Inspection Service

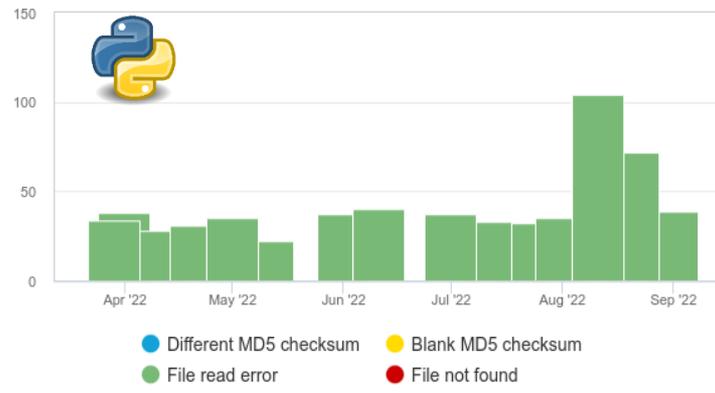
Report Selector

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

Items per page: 5 1 - 5 of 51

Error Graph

Experimental Simulated NCX MICC



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

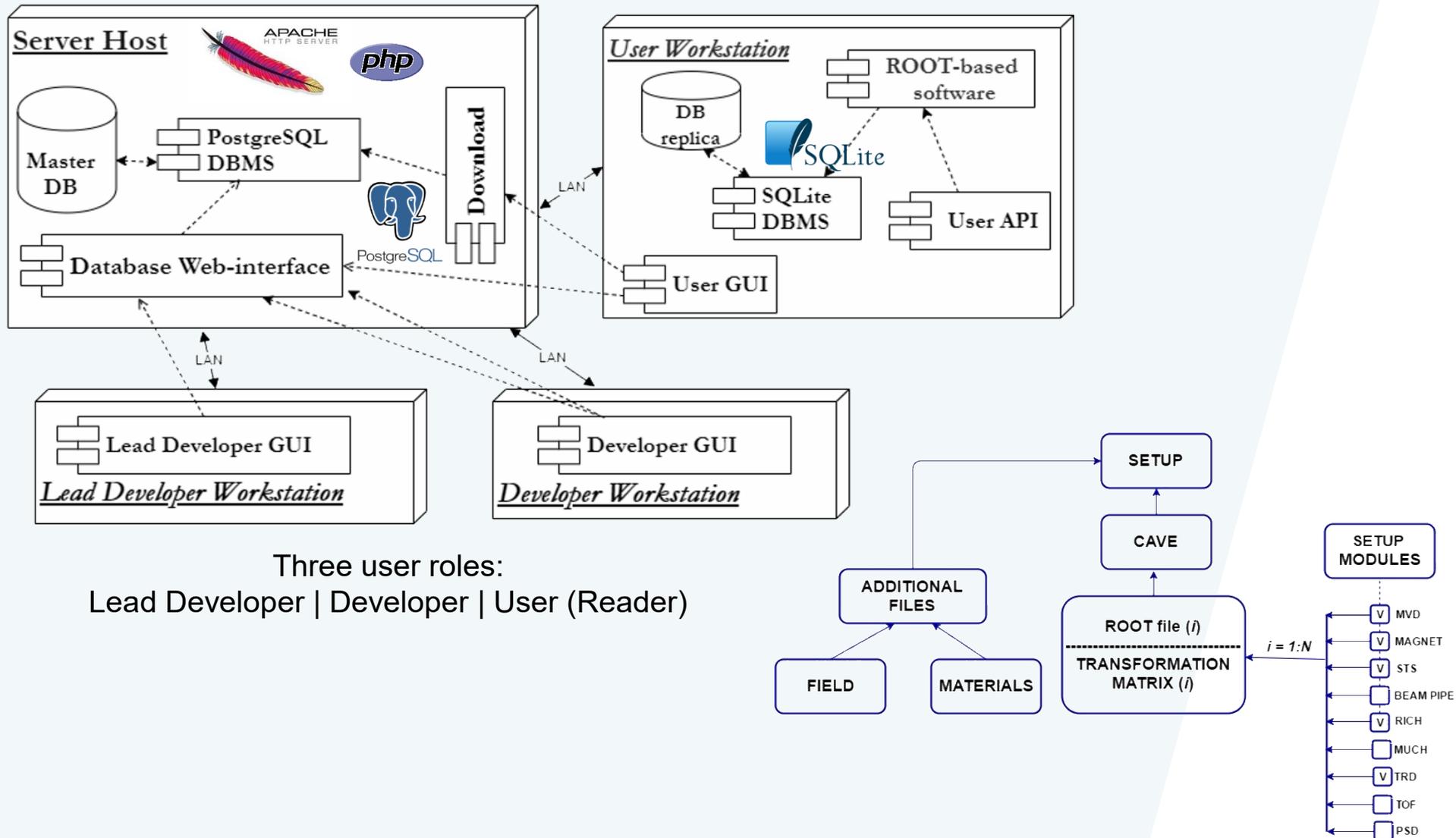
File Inspector





Geometry Database Offline Information System

Geometry Information System. Architecture



Geometry Information System. Web Platform

Menu

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EDIT GEOMETRY

Get in touch

[Konstantin Gertsenberger](mailto:Konstantin.Gertsenberger)

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Setup Modules



➤ Keycloak auth
➤ or DB access

Module	Name (Tag)	Date	File	Transformation	Parent	Author	ParFile	Description	Download
BD	BD_run8_v1	2024-04-27	BD_run8_v1		CAVE	aleksand		BD_run8_v1	
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		CAVE	aleksand		DCH_Run8.root	
FD	FD_run8	2024-04-27	FD_run8		CAVE	aleksand		FD_run8.root	
FHCAL	FHCAL_for_run8_cm_rotationY_1.6deg_v1	2024-05-02	FHCAL_for_run8_cm_rotationY_1.6deg_v1		CAVE	aleksand		FHCAL_for_run8_CBM_20mods_NICA_34mods_54mods_hole_Zpos_977.8cm_Xshift_65.30cm_Yshift_0.8cm_rotationY_1.6deg_v1.root	
HODO	Hodo_for_run8_v1	2024-05-02	Hodo_for_run8_v1		CAVE	aleksand		Hodo_for_run8_with_box_Zpos_970.2cm_Xshift_64.90cm_Yshift_-1.0cm_rotationY_1.6deg_v1.root	
MAGNET	magnet_modified	2024-04-27	magnet_modified		CAVE	aleksand		magnet_modified	
NDET	nDet_VETO_slice_rotY_-27.30	2024-05-02	nDet_VETO_slice_rotY_-27.30	 <div style="border: 1px solid black; padding: 2px; display: inline-block;">1 0 0 0 0 1 0 0 0 0 1 124.5</div>		aleksand		nDet_NEW_NUMBERING_VETO_25mm_5slices_PLA_2mm_Pb_8mm_9slices_Cu_30mm_Sc_25mm_G10_2mm_Air_no_hole_ZdistDET_1_595.617cm_rotY_-27.30deg_rotX_0.0deg.root	
Pipe	section3_Run8	2024-04-27	section3_Run8		CAVE	aleksand		VacuumPipe_section3_Run8.root	
Pipe	section2_Run8	2024-04-27	section2_Run8		CAVE	aleksand		VacuumPipe_section2_Run8.root	

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

User Interface Functions:

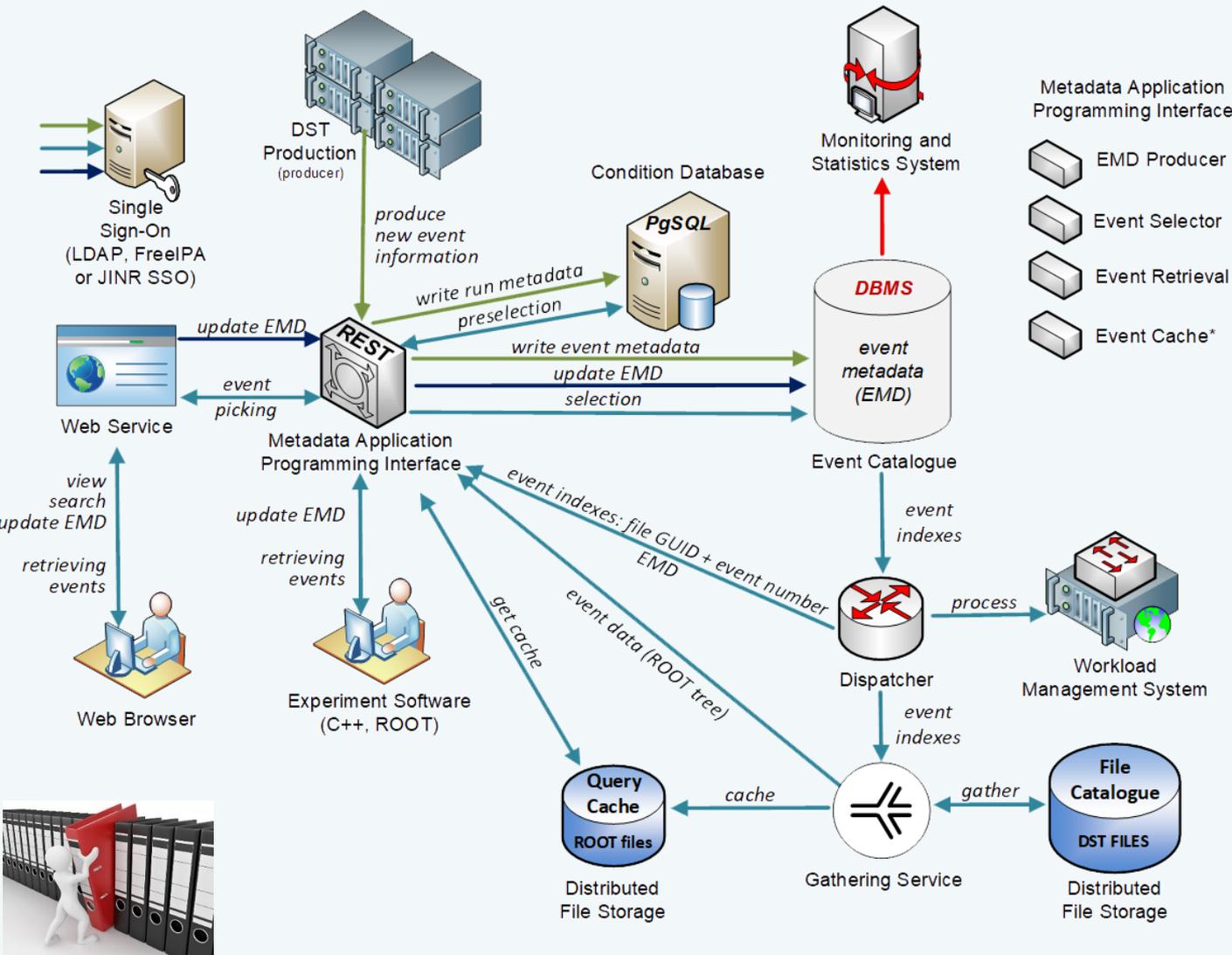
View Add Edit Approve Download



Event Metadata System

Offline Information System

Event Metadata System for BM@N



- Metadata Application Programming Interface
-  EMD Producer
 -  Event Selector
 -  Event Retrieval
 -  Event Cache*

Event Catalogue based on PostgreSQL

Integrated with the Condition Database

REST API and Web UI developed on Kotlin multiplatform

Configurable to support arbitrary metadata

Service for automatic writing new event metadata to the Catalogue

Role-based access control

Monitoring System

Event Catalogue. Web Interface

BM@N Event Metadata System

BM@N Events
SRC Events
Test Events

Condition Database prefilter

base parameters

configured parameters

limits and offset

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

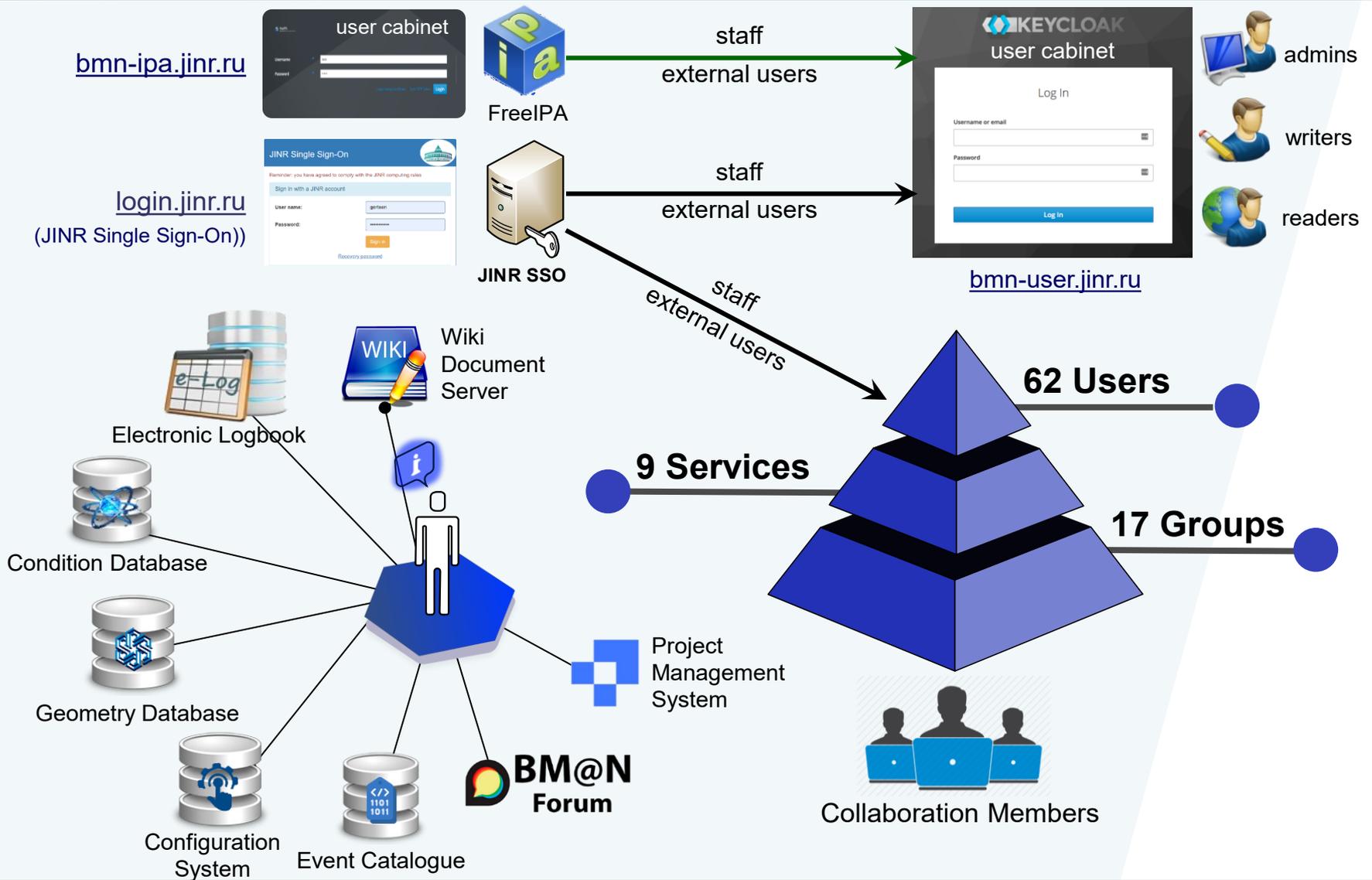
- enables users to browse and quickly search for event metadata stored in the Event Catalogue and retrieve events, which satisfy given parameters
- provides events according to the selected event metadata and run metadata of the Condition Database



Software Infrastructure Service

improving the efficiency and reliability

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

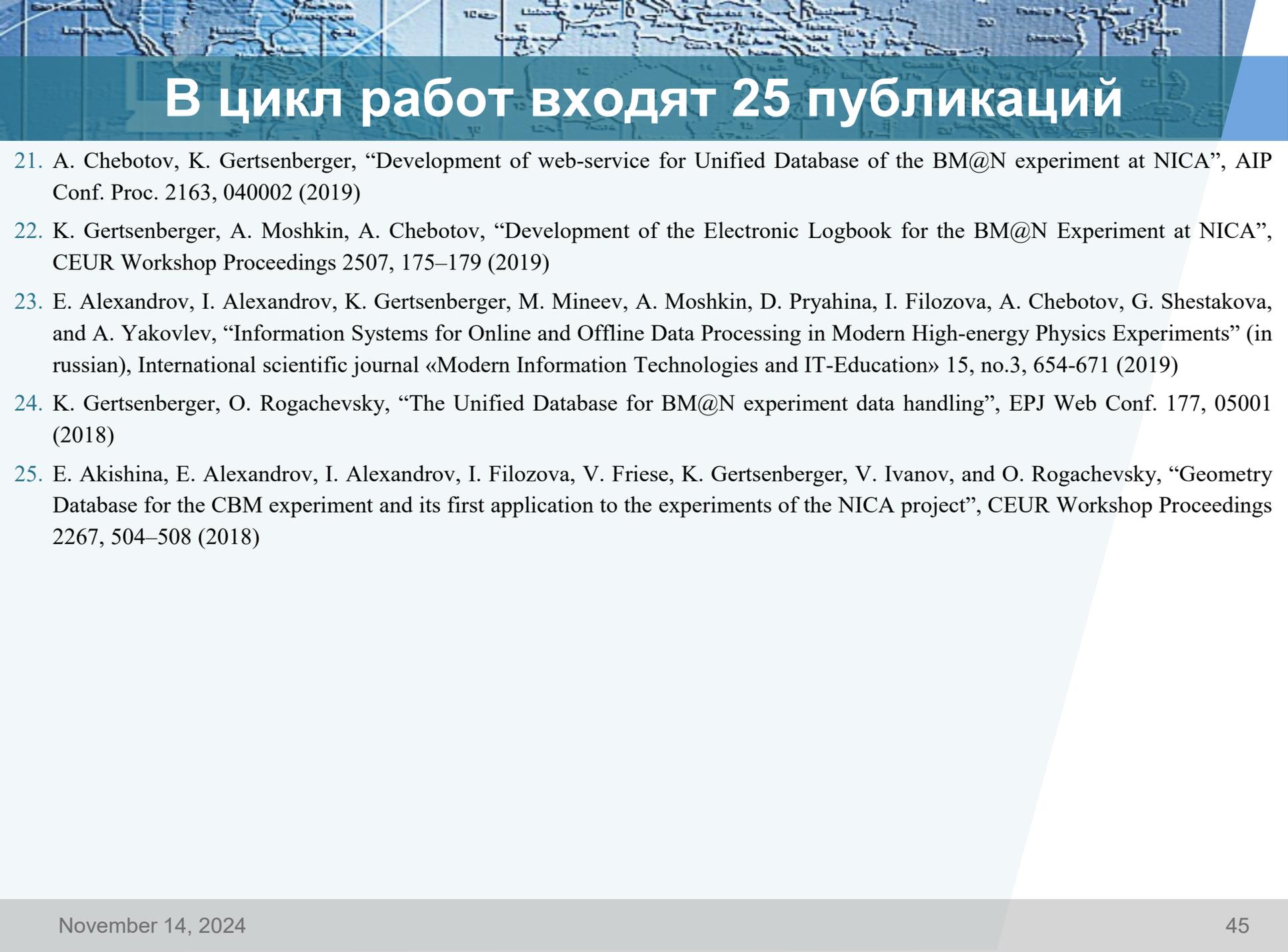


В цикл работ входят 25 публикаций

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2. K. Gertsenberger, I. Pelevanyuk, “*BM@N Run 8 Data Processing on a Distributed Infrastructure with DIRAC*”, Phys. Part. Nucl. Lett. **21**. 778–781 (2024)
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16. E. Akishina, E. Alexandrov, I. Alexandrov, I. Filozova, K. Gertsenberger, and V. Ivanov, “Development of a Geometry Database and Related Services for the NICA experiments”, Phys. Part. Nuclei 52, 842-846 (2021)
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18. K. Gertsenberger, A. Chebotov, P. Klimai, I. Alexandrov, E. Alexandrov, I. Filozova, and A. Moshkin, “Implementation of the Condition Database for the Experiments of the NICA Complex”, CEUR Workshop Proceedings 3041, 128–132 (2021)
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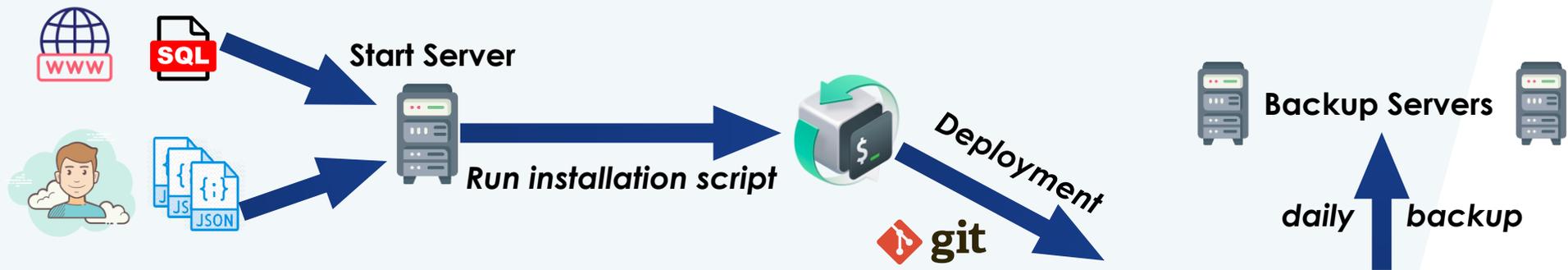
Thank you for your attention!



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

contact email: gertsen@jinr.ru

Common Deployment System (CoDeS)



accounts4db.json
 accounts4extauth.json
 config.json

```

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

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

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

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

rsync
 Crontab
 Tracking updates

```

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

Database Server

Web Server

```

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

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

NICA Accelerator Complex



Nuclotron-based Ion Collider facility

- Beams: from p, d^{\uparrow} to Bi
- Luminosity: 10^{27} (Bi), 10^{32} (p) $cm^{-2}s^{-1}$
- Collision energy: $\sqrt{S_{NNBI}} = 4 - 11$ GeV $E_{lab} = 1 - 5$ AGeV

- Fixed target experiment: **BM@N** (2018)
- 2 interaction points: **MPD** (2025) & **SPD** (2028)
- Official site: nica.jinr.ru, bmn.jinr.ru