



7th Collaboration Meeting of the BM@N Experiment at the NICA Facility



BM@N Software Development Summary of the Software Session

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JINR, Dubna
19-20 April 2021



20 April 2021

BM@N Software Contribution



Peter KLIMAI (19 April 12:05)
Software contribution from MIPT: implementation
of systems and services for BM@N

MIPT (NPM) group (Head: Tagir AUSHEV)



Sergei NEMNYUGIN (19 April 11:40)
Software contribution from SPbU: algorithmic and
code optimization of the BmnRoot framework

SPbU group (Head: Sergei NEMNYUGIN)



JINR LIT (Director: Vladimir KORENKOV)



*Irina FILOZOVA, Igor ALEXANDROV, Evgeniy ALEXANDROV and staff:
Development of Information Systems in frame of the RFBR grant*

JINR LHEP (Spokesperson: Mikhail KAPISHIN)



*Konstantin GERTSENBERGER
Alexander CHEBOTOV*

**BM@N
Software
Contribution**

*(RFBR grant till
begin of 2022
+ in-kind
contribution)*

Software Group Status

BM@N Software Group (2 person):

Konstantin GERTSENBERGER: group leader

Alexander CHEBOTOV: software engineer in JINR since 2018

The Software Group has no department connection with the Department of the BM@N experiment → problems with asking the division for resources for the BM@N Software Group



BM@N Computing and Technical Contribution

JINR LHEP (Computing Leader: Andrey DOLBILOV)



Ivan SLEPOV:

Deployment of the information services for BM@N on the NICA cluster

JINR LIT (Director: Vladimir KORENKOV)



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

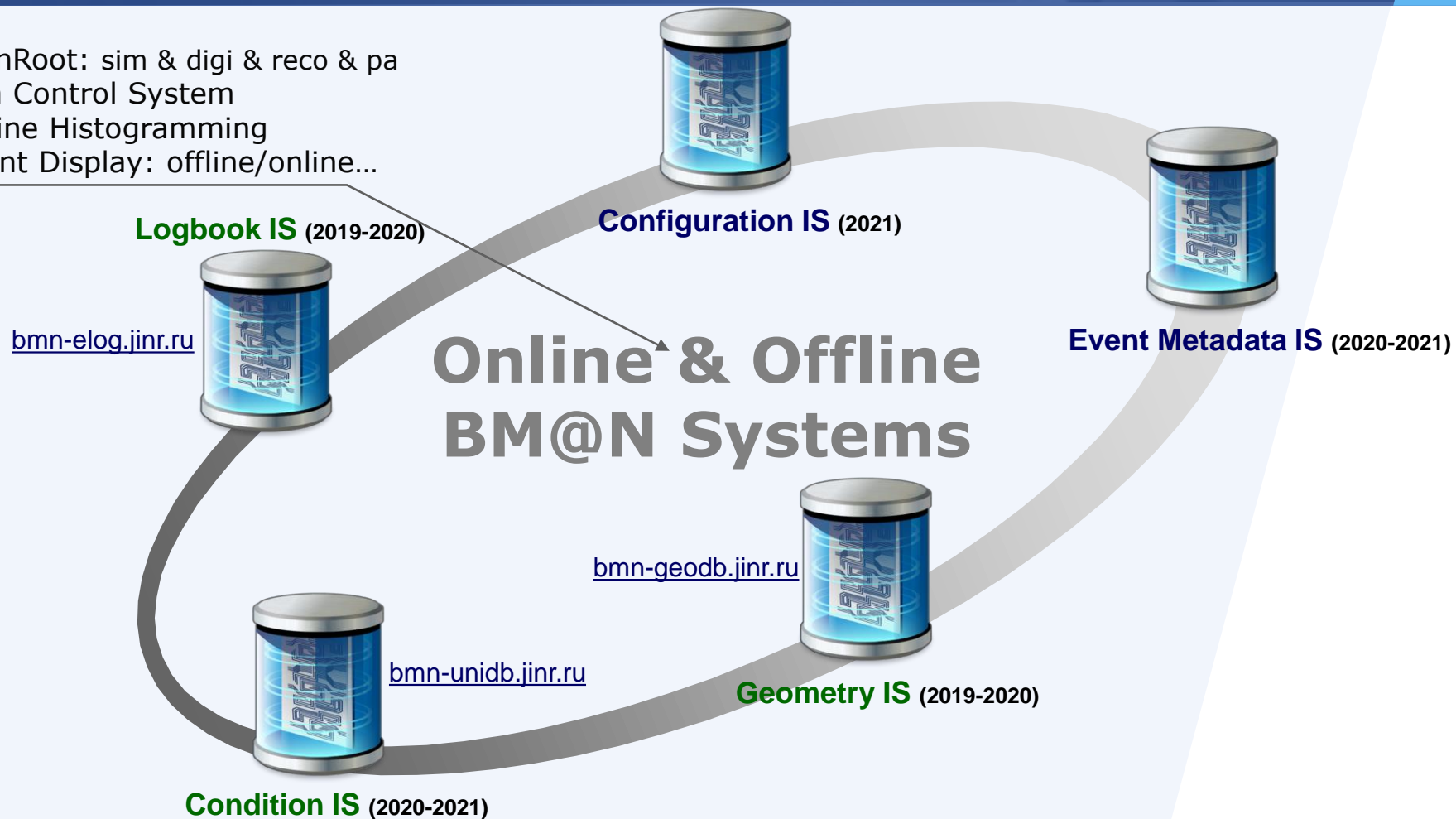
Vladimir TROFIMOV, Daria PRIAKHINA, et. al: Simulation of BM@N data and processing centers

**BM@N
Computing &
Technical
Contribution**
(no financial support,
own motivation)

Information Systems: Databases + Services

Information Systems for online & offline processing

BmnRoot: sim & digi & reco & pa
Run Control System
Online Histogramming
Event Display: offline/online...



RFBR Grant 2019 – 2021: Development of Information Systems for Online and Offline Data Processing for the Experimental Setups of the NICA Complex

Current version of the e-Log platform

Create a new run

Advanced find

Current day records

User Cabinet

Work with dictionaries

Number of records per page

Username

BM@N Electronic Logbook

Fast search

Page number

Logged in as shift

Number of items per page: 10 Logout

Page: 1 of 282

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	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	

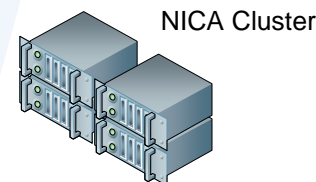
2020 - software team (contact e-mail: gertsen@jinr.ru)

Electronic Logbook Completeness

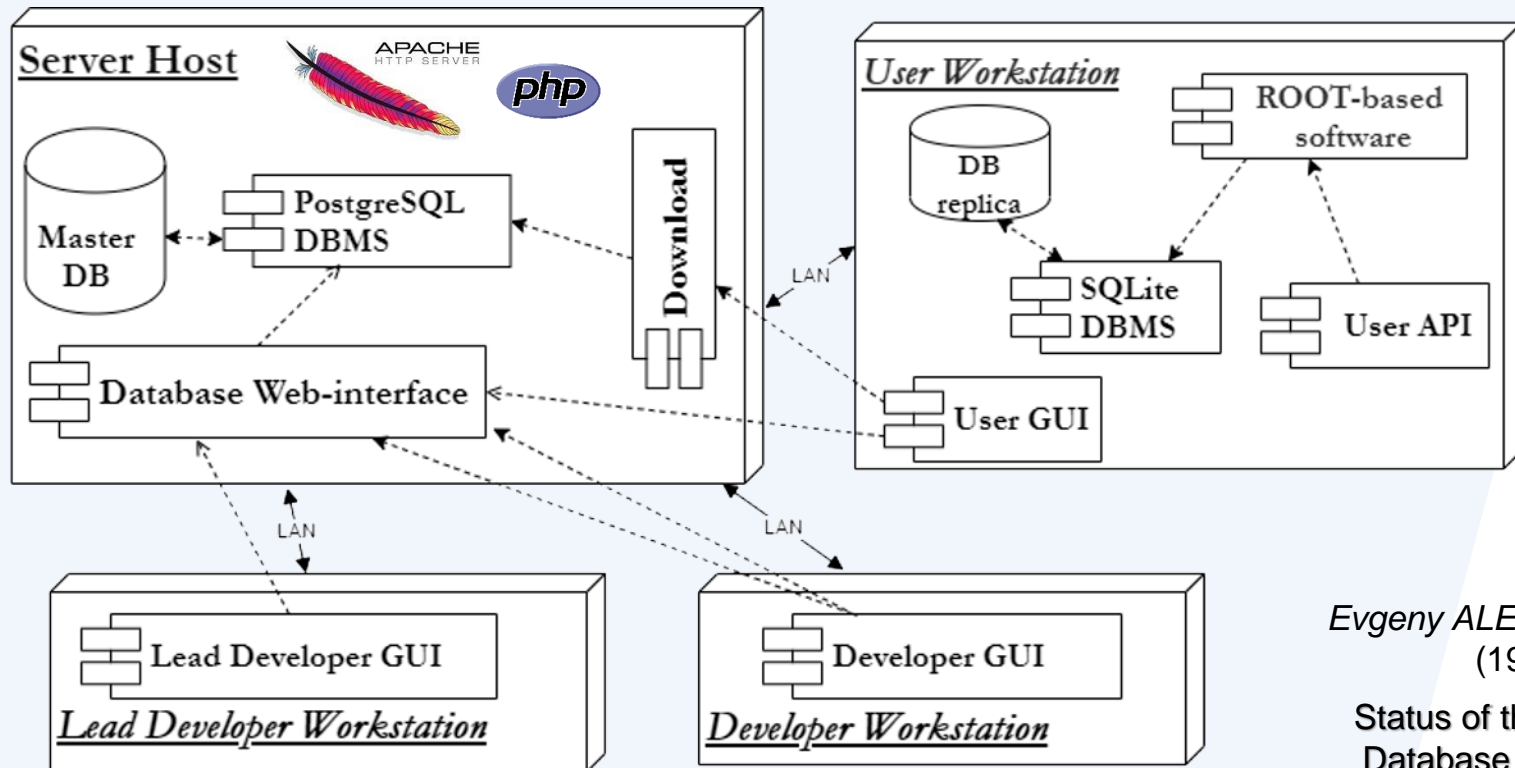
- The Electronic Logbook was employed in the last session of the BM@N experiment, and, at present, it contains records for conducted BM@N runs.
- The Electronic Logbook System has been deployed on the NICA cluster and is ready to use it for the next runs.
- The Common Deployment System can be used to install the Online Logbook System for all the experiments of the NICA project taking into account some specifics of the experiments. db-nica.jinr.ru/mpd_elog/
- The Electronic Logbook System has been implemented (now tests of the deployment system are performed) and are actively used by collaboration members.



BM@N Electronic Logbook
Runs 1 - 7
records ~ 3 000



Geometry Information System Architecture



Evgeny ALEKSANDROV
(19 April 10:00)

Status of the Geometry
Database and steps to
integrate into BM@N

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



PostgreSQL



Status of the Geometry Web Platform



Baryonic Matter
at Nuclotron

Menu

HOME

VIEW GEOMETRY ^

VIEW.SETUPS

VIEW.SETUP MODULES

VIEW.FILES

VIEW.MATERIALS

VIEW.MAGNETIC.FIELDS

EDIT GEOMETRY v

Get in touch

✉ Konstantin Gertsenberger



BM@N Geometry DataBase



bm-n-geodb.jinr.ru

User:: gertsen

[CONFIGURE WEBACCESS](#)

[LOGOUT](#)

Setup Modules

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		Download
				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		Download
				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		Download
				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		Download
				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		Download
				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		Download
				0.000	1.000	0.000	0.000				
				0.000	0.000	1.000	0.000				

BM@N Geometry Database has filled with setup geometries for Run 7 and 6 (all releases + dev)

Graphical User Interface Functions:

View

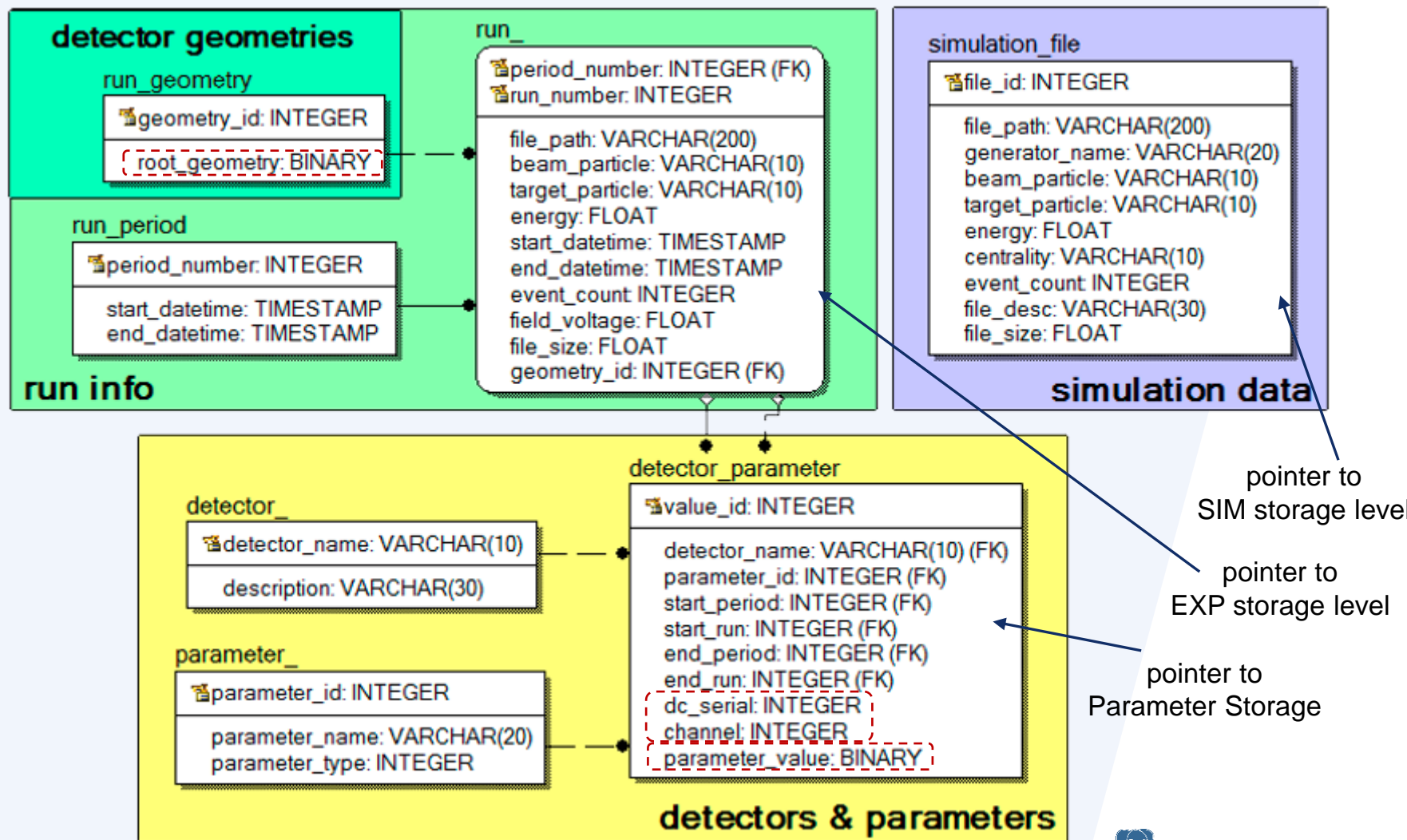
Edit

Download

Geometry Information System Completeness

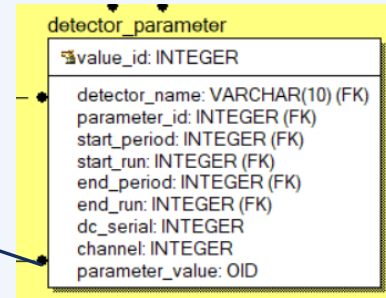
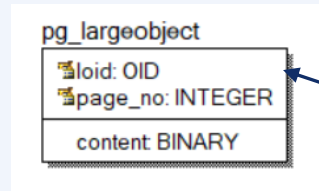
- The developed Geometry Information System provides a central storage of the detector geometries and a set of convenient tools to manage geometry modules and software assemblies of various setup versions in the form of a combination of these modules and auxiliary files containing a description of magnetic field, detector materials and media.
- The geometries of the experiments stored in the database can be further used to process event data of the particle collisions.
- Collaboration members can search and select a required version of the geometry setup to work with.
- The Geometry Information System has filled with setup geometries for the last BM@N Run 7 and 6 and is ready to apply for the BM@N experiment.
- It can be employed in the other NICA experiments using developed unified installation script and customized interfaces.

Unified Database Diagram (before)



BM@N Database: Encountered Problems

1. PostgreSQL 9 (and subsequent) limits access to the *pg_largeobject* table with binary data of the Unified Database



2. Detector parameters were stored as packed structures, it seriously constrained possible parameter types

```
struct IIStructure { int int_1; int int_2; }; __attribute__((packed)) ?
```

3. Separate functions for each parameter type sufficiently increased the size and complexity of the code.
4. 'dc_serial' and 'channel' attributes of the detector parameters (t. 15 571) seriously increased the number of database calls and duplicated all functions to work with, e.g.:

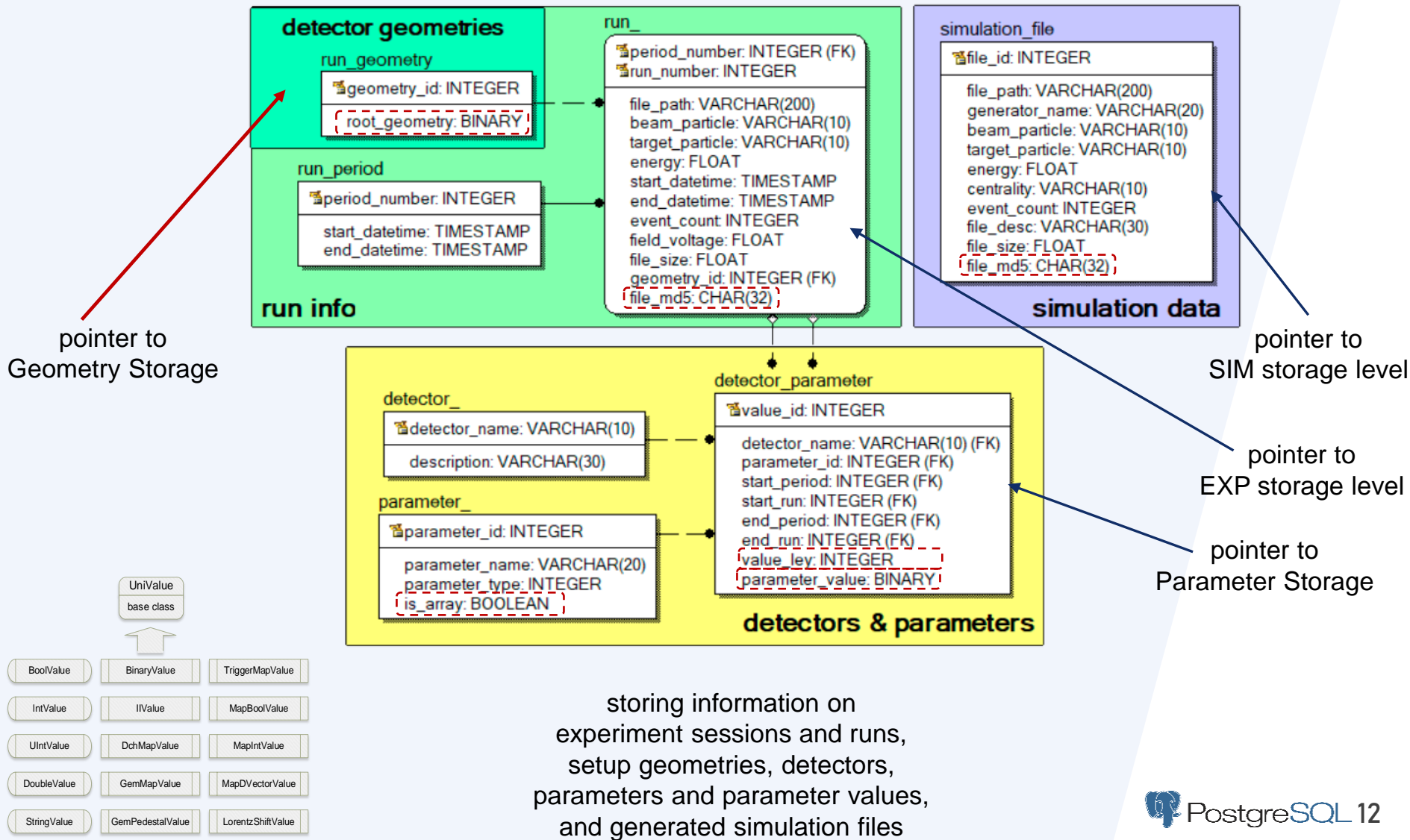
```
CreateDetectorParameter(detector, parameter, start_per, start_run, end_pe, end_run, GemPedestalStructure* value, count)
```

```
CreateDetectorParameter(detector, parameter, start_per, start_run, end_per, end_run, dc_serial, channel, GemPedestalStructure* value...)
```

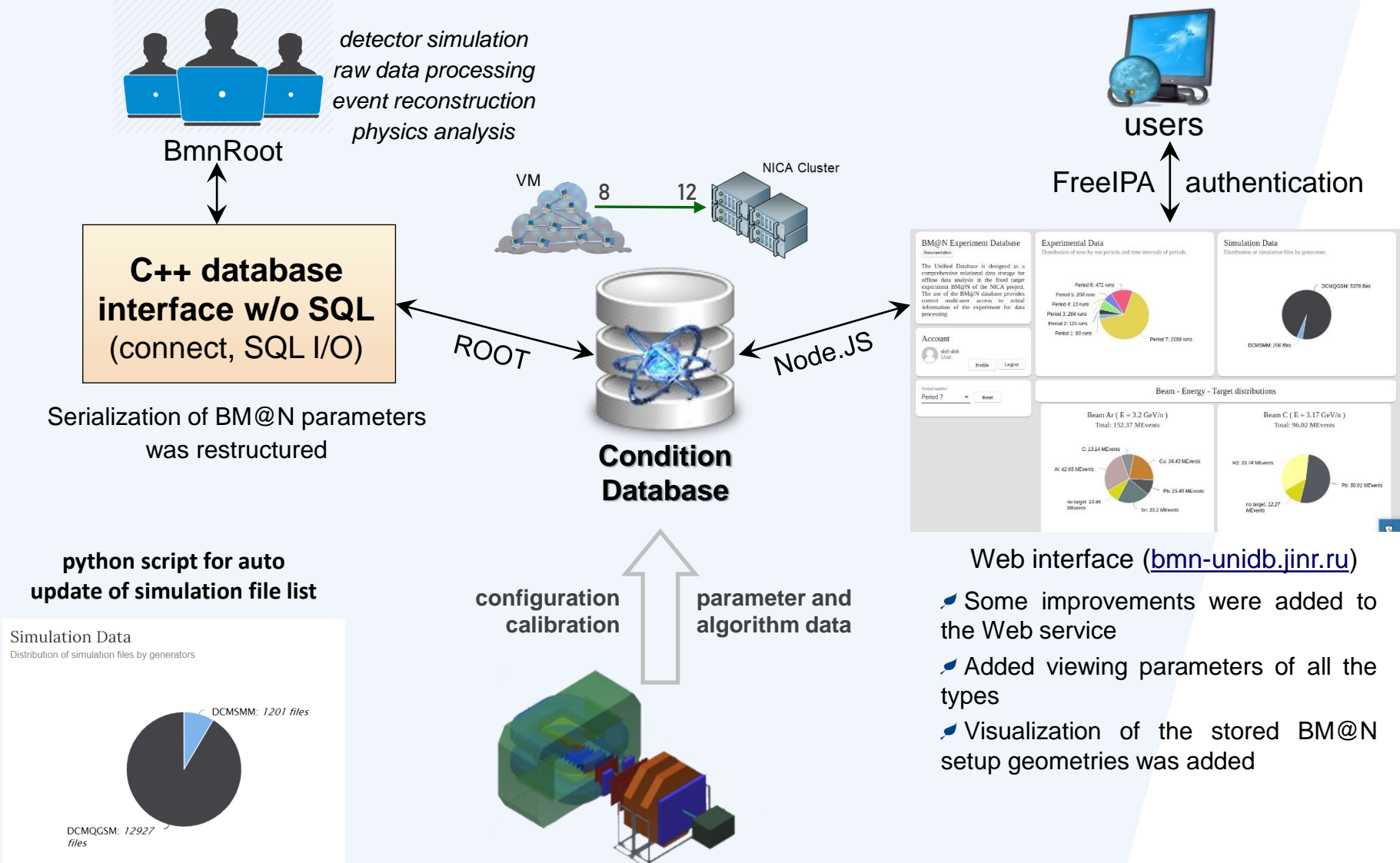
Moving to the New Version of the Database

1. Binary data were moved from *pg_largeobject* table directly to the *parameter_value* (*detector_parameter* table) and *root_geometry* (*run_geometry* table). A new **PostgreSQL 12** instance has been deployed.
2. The following solutions were considered to replace packed structures: ZeroMQ, MessagePack, BOOST, Protobuf, FlatBuffers, ROOT/TStreamer, C++ manual serialization. **C++ manual serialization** was implemented with *UniValue* base class.
3. Separate functions for each parameter type were unified into **GetValue**(vector<UniValue*>& parameter_value) and **GetValue**(UniValue*& parameter_value), and corresponding setters.
4. '*dc_serial*' and '*channel*' attributes of the detector parameters (t. 971) were moved inside the parameter types. Integer '*value_key*' attribute was added to the table.
5. **MD5 hash** was added to the tables with experimental and simulated file paths to ensure integrity of the stored files with BM@N events.

{ Unified → Condition } Database



BM@N Database for offline processing



Tabular View of the BM@N stored data

Run Identifier	Period	Run	Start Date	End Date	Runs	Energy, GeV	Q _{max}	Volume, m ³	Event Count	File Size, GB	Run File Path	Comments
7	5184	2016-04-05 11:26.24	2016-04-05 11:28:31	Run	294	Cu	77.61358	107708	22.627	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5184_020	
7	5185	2016-04-05 12:01.09	2016-04-05 11:30:27	Run	291	Cu	77.61209	112504	23.478	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5185_020	
7	5186	2016-04-05 13:47.50	2016-04-05 13:50:37	Run	294	Cu	77.61406	305449	43.688	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5186_020	
7	5187	2016-04-05 13:20:10	2016-04-05 13:41:14	Run	291	Cu	77.61208	203101	41.030	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5187_020	
7	5179	2016-04-05 09:28:21	2016-04-05 12:12:12	Run	291	Cu	77.62265	20539	42.825	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5179_020	
7	5178	2016-04-05 09:00:01	2016-04-05 09:30:02	Run	294	Cu	77.61313	701554	47.497	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5178_020	
7	5177	2016-04-05 09:20:21	2016-04-05 09:30:31	Run	294	Cu	77.61891	245180	42.940	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5177_020	
7	5176	2016-04-05 09:13:12	2016-04-05 09:25:05	Run	291	Cu	77.61852	101019	31.022	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5176_020	
7	5174	2016-04-05 07:32:47	2016-04-05 08:11:05	Run	294	Cu	77.61659	213131	44.601	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5174_020	
7	5173	2016-04-05 07:01:01	2016-04-05 07:31:10	Run	291	Cu	77.61272	21209	61.900	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5173_020	
7	5170	2016-04-05 06:36:38	2016-04-05 06:54:51	Run	294	Cu	77.61135	201132	42.476	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5170_020	
7	5169	2016-04-05 05:10:11	2016-04-05 05:30:10	Run	294	Cu	77.60973	203884	42.480	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5169_020	
7	5167	2016-04-05 05:12:30	2016-04-05 05:50:30	Run	291	Cu	77.60855	30591	7.360	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5167_020	
7	5166	2016-04-05 05:25:32	2016-04-05 05:39:30	Run	294	Cu	77.60635	63058	11.585	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5166_020	
7	5160	2016-04-05 05:08:41	2016-04-05 05:11:08	Run	294	Cu	77.63672	42024	11.262	0.00346	neoncalab-megapbwt7/2205-0188_RR_NegExperiment_run_5160_020	

BM@N Runs

Simulation Files of the BMGN experiment										Download
Simulation File Selector	Beam	Energy, GeV	Target	Condition	3-view Count	Pd Nt Sum	Simulation File Path			
DCI02GSM	Ar	3.2	Ar	nr	5049	0.221	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_16_12			
DCI02GSM	Ar	3.2	Ar	nr	5053	0.229	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_103_12			
DCI02GSM	Ar	3.2	Ar	nr	5054	0.230	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_103_12			
DCI02GSM	Ar	3.2	Ar	nr	5021	0.220	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_103_12			
DCI02GSM	Ar	3.2	Ar	nr	4999	0.220	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_103_12			
DCI02GSM	Ar	3.2	Ar	nr	5056	0.230	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_104_12			
DCI02GSM	Ar	3.2	Ar	nr	5061	0.229	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_105_12			
DCI02GSM	Ar	3.2	Ar	nr	5041	0.220	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_105_12			
DCI02GSM	Ar	3.2	Ar	nr	5037	0.230	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_107_12			
DCI02GSM	Ar	3.2	Ar	nr	5003	0.230	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_108_12			
DCI02GSM	Ar	3.2	Ar	nr	5020	0.229	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_109_12			
DCI02GSM	Ar	3.2	Ar	nr	5003	0.221	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_111_12			
DCI02GSM	Ar	3.2	Ar	nr	5053	0.230	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_110_12			
DCI02GSM	Ar	3.2	Ar	nr	5073	0.230	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_111_12			
DCI02GSM	Ar	3.2	Ar	nr	5059	0.221	\\ccnlabnmsr\msr\DCMOSS\H\Ar_3.2ArCf_mA\Ar_3.2ArCf_mf_112_12			

Simulation Files

Parameter Values Selector										
Decision Time	Parameter Name	Start period	Start run	End run	End period	Do used	Channel	Parameter value		
DCM1	on	1	12	688	3			True		
TGF1	off	1	12	688	3	23667830	1	1.02852 ± 1.78544		
ICM1	on	1	12	688	2	23667830	2	-0.546814 ± 0.026621 ...		
TGF1	off	1	12	688	3	35667830	1	0.638805 ± 3.11056		
ICM1	on	1	12	688	2	23667830	4	-0.100195 ± 0.0222 ...		
TGF1	off	1	12	688	3	35667830	5	0.73191 ± 0.83107		
ICM1	on	1	12	688	2	23667830	6	0.0022201 ± 0.07068 ...		
TGF1	on	1	12	688	3	35667830	7	-0.1177 ± 0.05077		
TGF1	on	1	12	688	3	23667830	8	0.689176 ± 0.003 ...		
ICM1	on	1	12	688	3	35667830	9	0.311596 ± 0.18159		
TGF1	off	1	12	688	3	23667830	10	0.221516 ± 0.98048 ...		
ICM1	on	1	12	688	3	35667830	11	1.16146 ± 1.24716		
TGF1	off	1	12	688	3	688	12	1.15451 ± 0.0476		
ICM1	on	1	12	688	2	23667830	13	1.01706 ± 0.006068 ...		
TGF1	off	1	12	688	3	35667830	14	-0.066154 ± 0.790348		

Parameter Values

Detector List of the BM@N experiment		Parameter List of the BM@N experiment	
Detector Selector		Parameter Selector	
Detector Name	Description	Parameter Name	Parameter Type
BC1		BC1_global_mapping	trigger mapping
BC2		BC2_global_mapping	trigger mapping
T0		BC_global_mapping	trigger mapping
VETO		DCH_mapping	DCH mapping
ZDC	Zero Degree Calorimeter	QEM_N_ch_XD_sig_1	integer
TOF1	Time-of-Flight near 400cm	QEM_N_ch_XD_sig_2	integer
TOF2	Time-of-Flight near 700cm	QEM_N_ch_XD_misid0	integer
DCH1	first Drift Chamber	QEM_N_ch_XT_sig_1	integer
DCH2	second Drift Chamber	QEM_N_ch_XT_sig_2	integer
RD	Rarefied Detector	QEM_N_ch_XT_misid0	integer
GEM	Gas Electron Multipliers	QEM_N_ch_X_small	integer
magnet	BM@N magnet	QEM_N_ch_Y0_sig_1	integer
BM@N	whole BM@N detector	QEM_N_ch_Y0_sig_2	integer
		QEM_N_ch_Y0_misid0	integer

Detector & Parameters

Visualization of the stored BM@N geometry

Geometry

36_BMN_Krypton/mpd_run_trigCode_5184.data

36_BMN_Krypton/mpd_run_trigCode_5183.data

36_BMN_Krypton/mpd_run_trigCode_5182.data

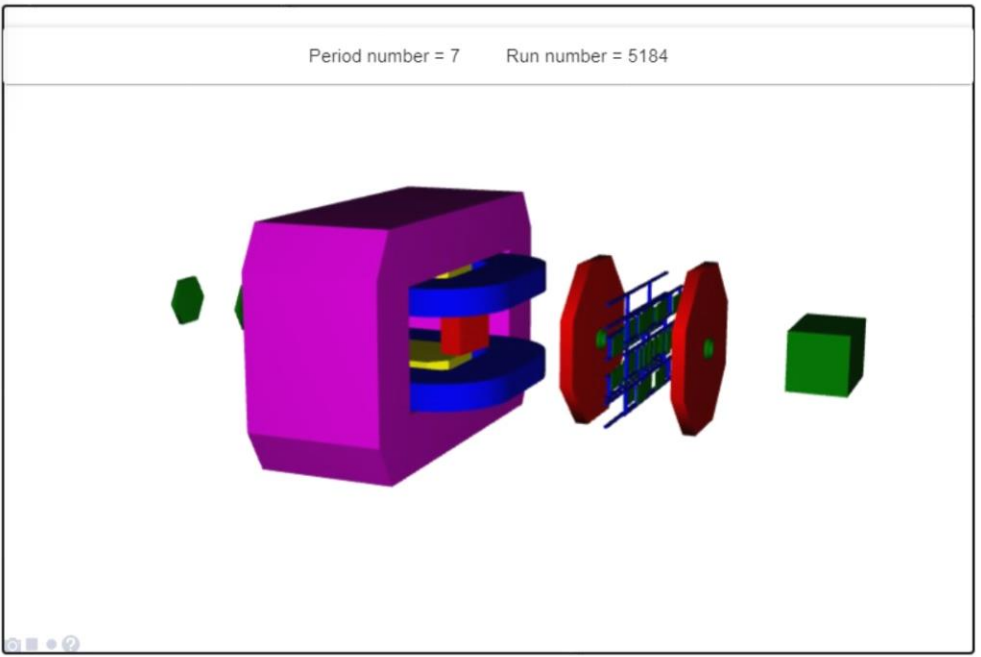
36_BMN_Krypton/mpd_run_trigCode_5180.data

Show

Download

BM@N Experiment Runs

Period number = 7 Run number = 5184

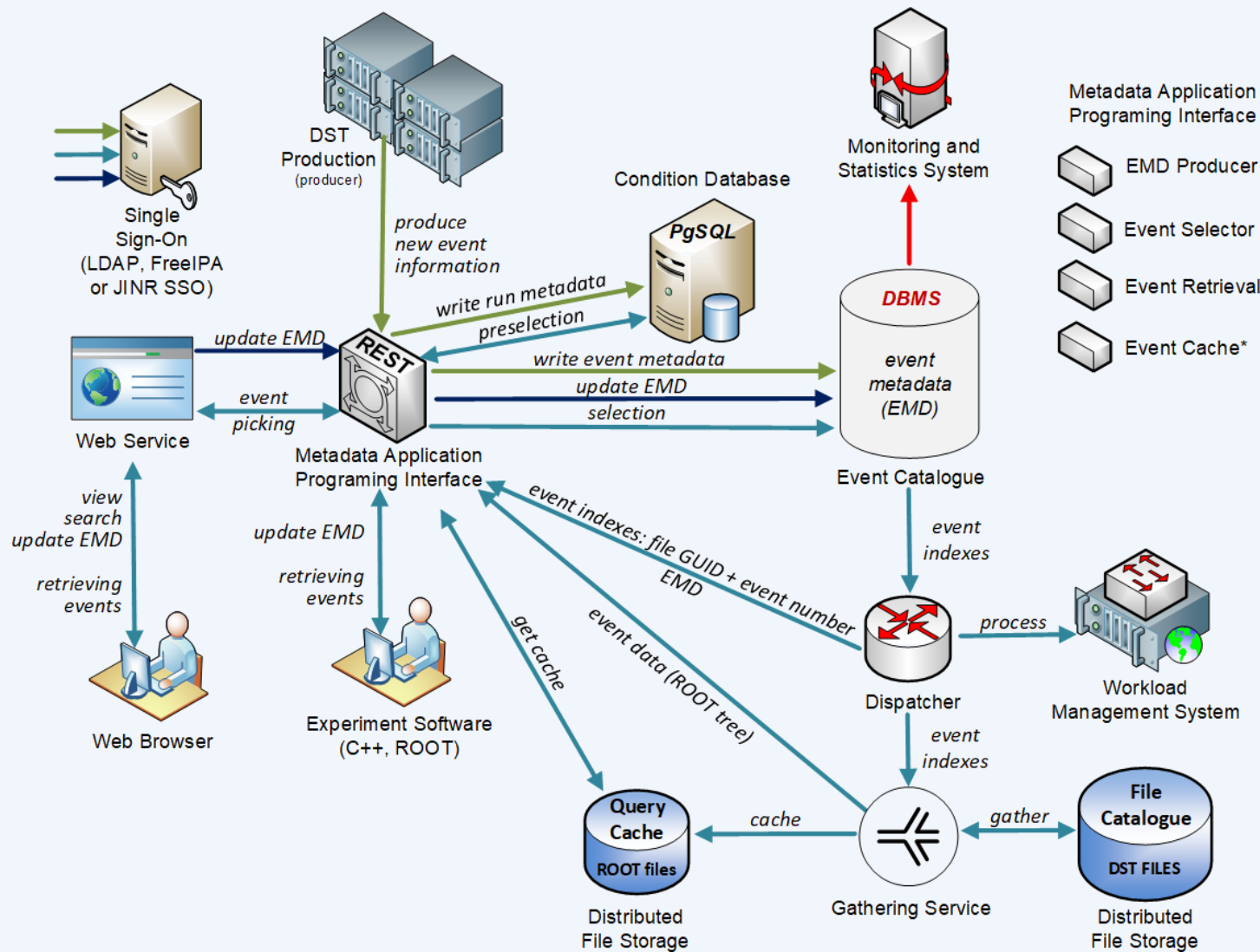


Time	Period	Run	Target	Beam	Beam Energy	Beam Current	Beam Spot Size	Beam Spot Position	Beam Spot Angle	Beam Spot Shape	Beam Spot Color
2018-04-05 06:36:10	Kr	2.94	Cu	77.606753	200884	42.382	/eos/nica/bmn/exp/raw/run7/4720-5186_BMN_Krypton/mpd_run_trig				
2018-04-05 05:58:50	Kr	2.94	Cu	77.609035	36044	7.600	/eos/nica/bmn/exp/raw/run7/4720-5186_BMN_Krypton/mpd_run_trig				

Event Metadata System (EMS)

- **main functions** are description of particle collision events, storing of necessary event metadata, their management and convenient access, and organizing online and offline interfaces to the metadata
- is based on the Event Database called **Event Catalogue**, which contains summary properties of particle collision events and references to their storage location
- allows user to **quickly search** for a set of events required for a particular physics analysis by various criteria and parameters
- is responsible for creating, maintaining and checking the **quality of the catalogue** of physics events

Architecture of the Event Metadata System



Web interface
for viewing and searching for event metadata stored in the Event Catalogue and retrieving events which satisfy given user parameters

Metadata API
for writing new metadata to the Event Catalogue while data processing and requesting events selected by criteria for physics analysis in BmnRoot

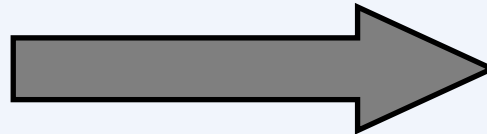
Event Metadata Structure (prototypes)

- period and run number (4+4 bytes)
- **file pointer (GUID) (4 byte)**
- **event number (4 byte)**
- software version (2 bytes)
- event time (4 byte)
- flag to determine whether primary vertex was found (1 byte)
- number of primary tracks (4 byte)
- number of all reconstructed tracks (4 byte)
- track number of positively charged particles from primary vertex (4 byte)
- primary & secondary particles (4+4 bytes)
- number of hits by detectors (4 bytes)
- total input charge in the event (4 byte)
- total output charge in the event (4 byte)

EMS provide the following functions: summary description of collision events and their identifiers, which can be used to select events for a desired analysis goal; recording and storing event metadata in the Event Catalogue; management and a convenient access to the metadata; organization of online and offline interfaces for selecting events of interest

DBMS for Event Catalogue

It is assumed that the number of the events will increase from the current value of hundreds of million BM@N events to billions of events per year (terabytes of event metadata)



high performance

correct multi-access

good scalability

easy configuration

universal design

Alexander YAKOVLEV
(19 April 10:20)

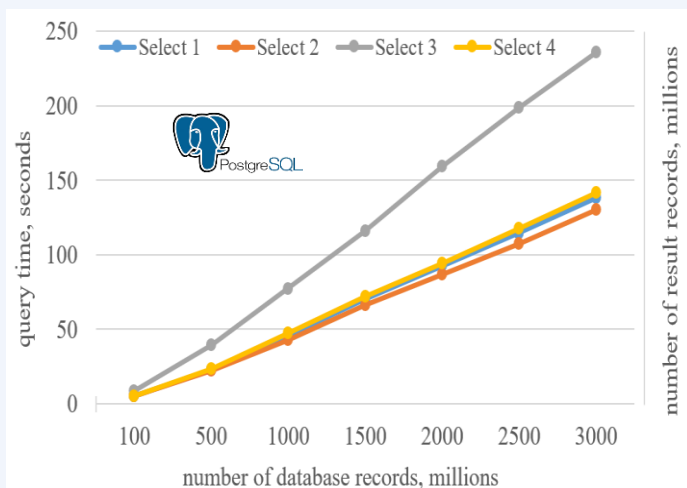
Design of the Event Metadata System for
BM@N and testing the first prototypes

Prototypes of the Event Catalogue (single-node)

Configuration VM:

2 x Intel Xeon E5-2680
DDR4 240 GB 2133 MHz
SSD 400 GB Intel

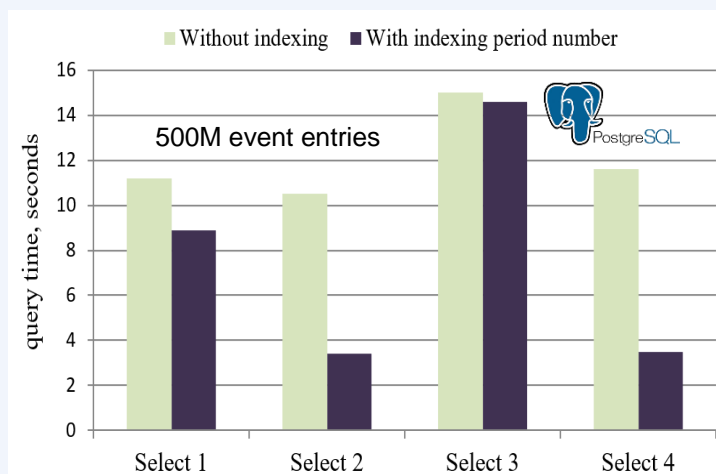
Scientific Linux 7.9
PostgreSQL 12.5
HBase 2.2.3, Hadoop 3.2.1



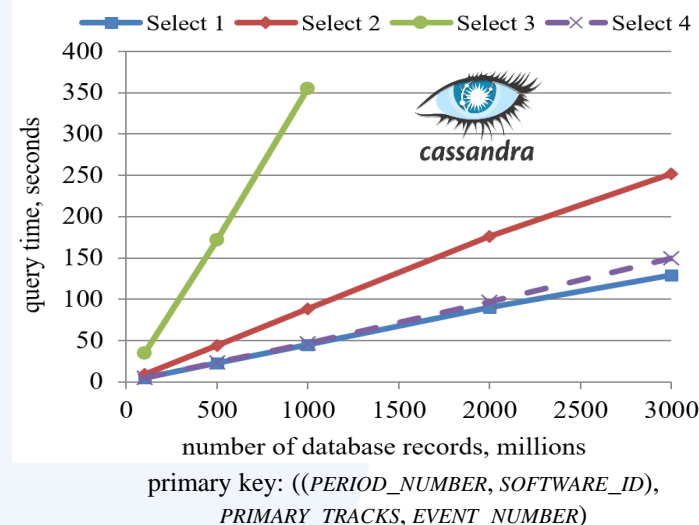
Configuration:

Intel Core i9-10900F
DDR4 64 Gb 3200MHz
SSD 1TB NVMe Samsung

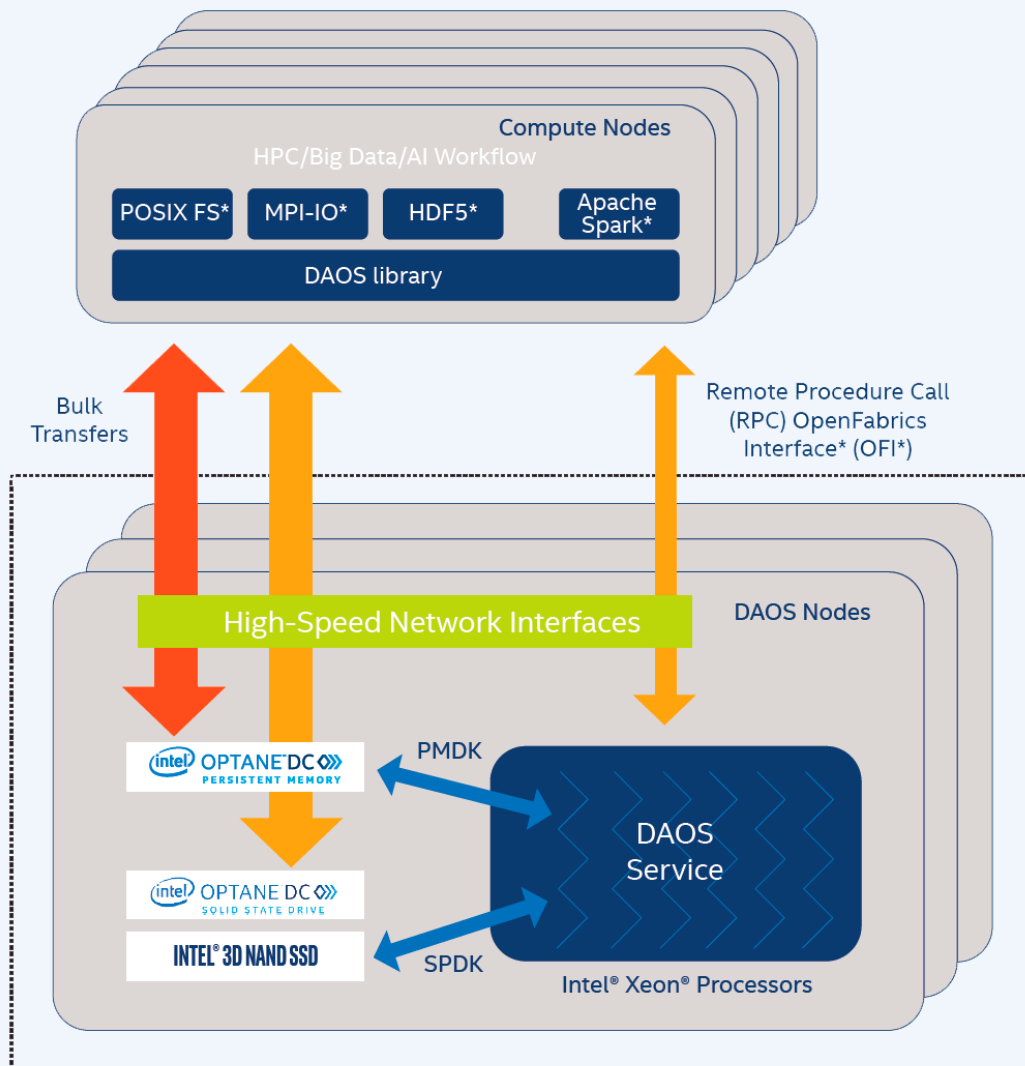
CentOS Linux 8.2
PostgreSQL 12.5
Apache Cassandra 3.11.8



500M	HBase C1	HBase C2	HBase C3
Test 0	56 min	28 min	63 min
Test 1	29 min 55 sec	28 min 02 sec	5 min
Test 2	32 min 4 sec	28 min 47 sec	11 min
Test 3	30 min 20 sec	29 min 52 sec	8 min
Test 4	28 min	not supported by Apache Phoenix	1 min 52 sec
Test 5	29 min	not supported by Apache Phoenix	2 min 12 sec



Intel DAOS with Optane for HPC Storage



8 servers for storage with
2x Intel Optane 512 Gb
RAM 192 Gb

Intel OPA 100 Gbit/s

Mikhail MATVEEV
(19 April 11:00)

Intel DAOS with Optane Technology
for High-Performance Storage

Event Metadata Structure

the first metadata structure was accepted at the software meeting

*write event metadata only
if primary vertex was
found in the event*

BM@N program

- **file pointer (GUID) (4 byte)**
- **event number (4 byte)**
- period and run number (4+4 bytes)
- software version (2 bytes)
- number of all reconstructed tracks (4 byte)

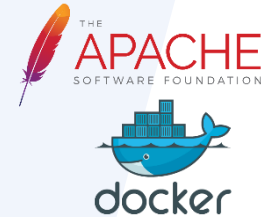
SRC program

- **file pointer (GUID) (4 byte)**
- **event number (4 byte)**
- period and run number (4+4 bytes)
- software version (2 bytes)
- number of all reconstructed tracks (4 byte)
- total input charge in the event (4 byte)
- total output charge in the event (4 byte)

Additional Services

Tango (Slow Control) Viewer

BM@N Slow Control Viewer



Tango Parameter

Dictionary ☐ Custom ☒

Parameter (Alias)

hall sensor

Run Selector

Run ☐ Time ☒

BM@N Period

7

Run Number

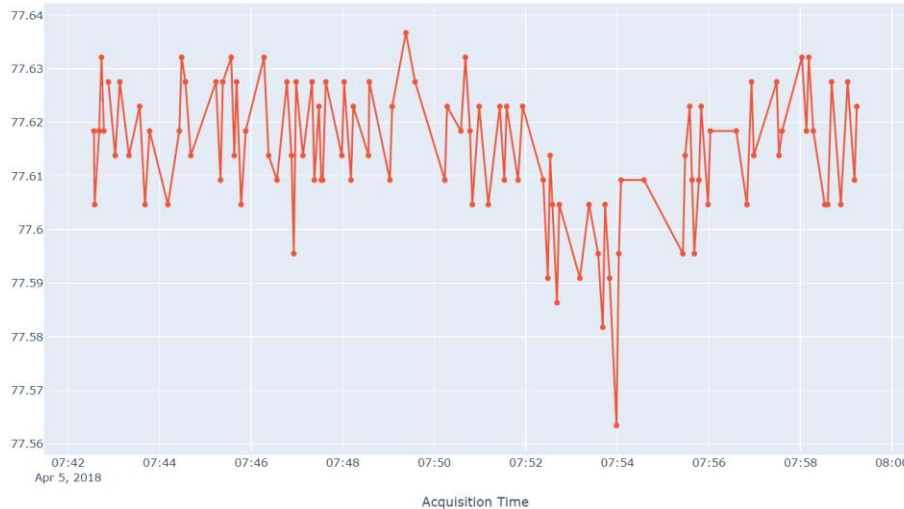
5182

RESET

SHOW

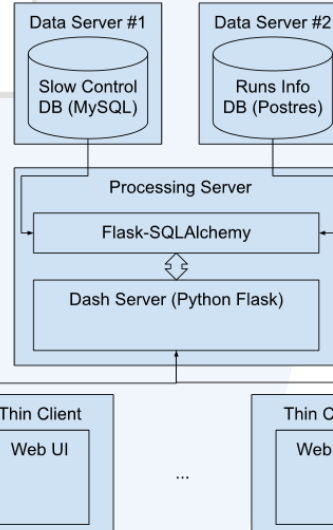
bm-n-tango.jinr.ru

mpd/bmn/adc_bman_beam/ch1



SC data

Run data



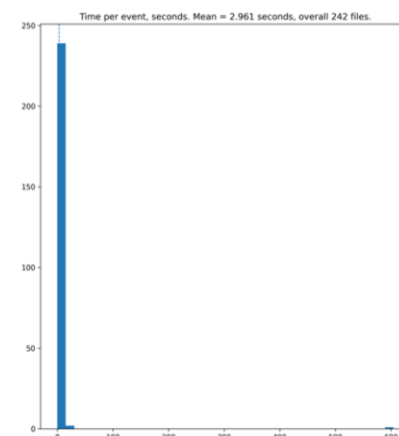
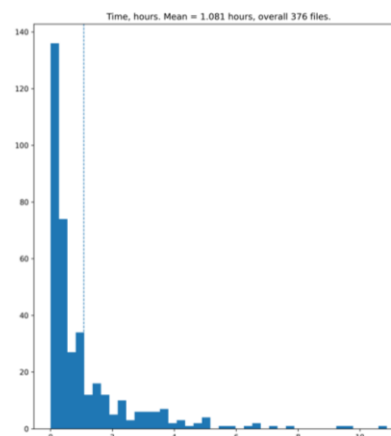
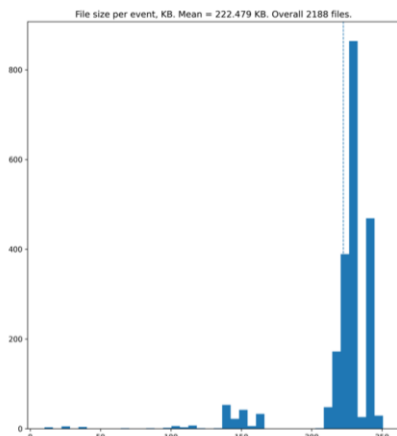
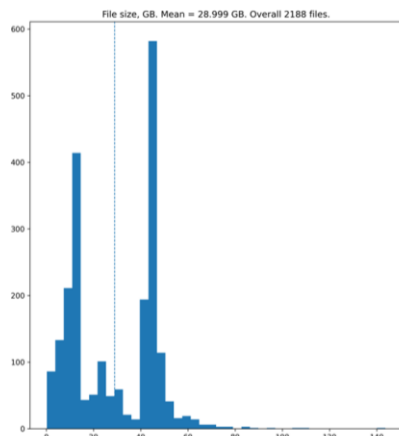
- Web interface for BM@N slow control system
- Shows sensor data graph based on N_{run} or time interval, and parameter name (dictionary or custom)
- If a parameter is 1D array, in this case a multigraph is displayed
- Uses Dash framework and packed in Docker container

Statistics Collection & Reprocessing Service

- Shows histograms and summary data for:
 - File (run) sizes and sizes per event for a given directory with data & **checks integrity of files**: event number being equal to a value in the database
 - Processing time for runs and times per event by parsing job logs & **defines failed jobs** and forms a list of data files for reprocessing
- Implemented on Python (stats.py)
- https://git.jinr.ru/nica/bmnroot/uni_db/services/statistics

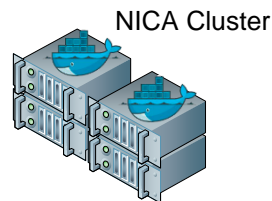
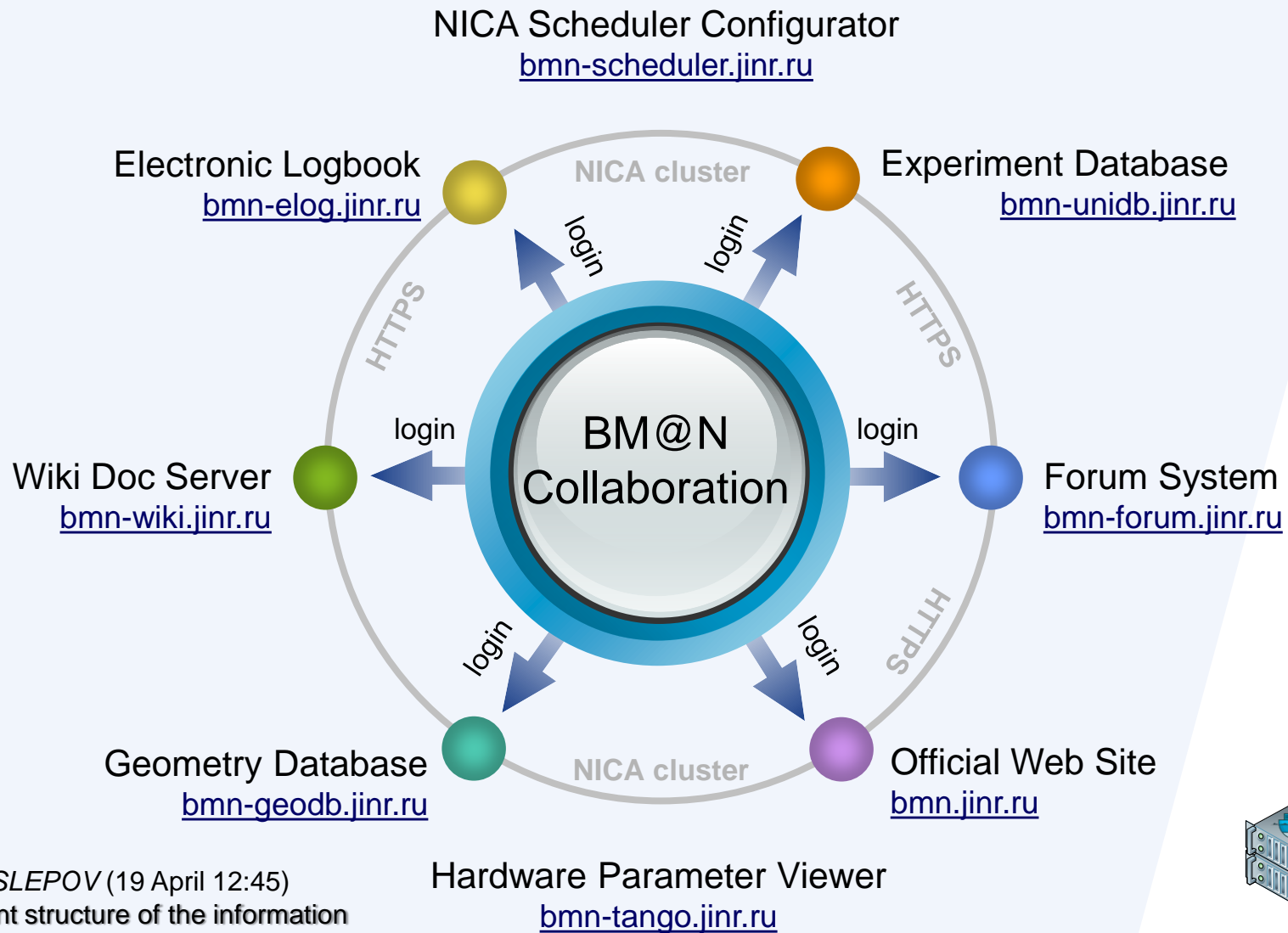
```
# python3 stats.py --size --dir  
/eos/nica/bmn/exp/raw/run7/ --config  
config-size.json --recursive
```

```
# python3 stats.py --time --dir  
/eos/nica/bmn/users/logs/ --config  
config-time.json
```



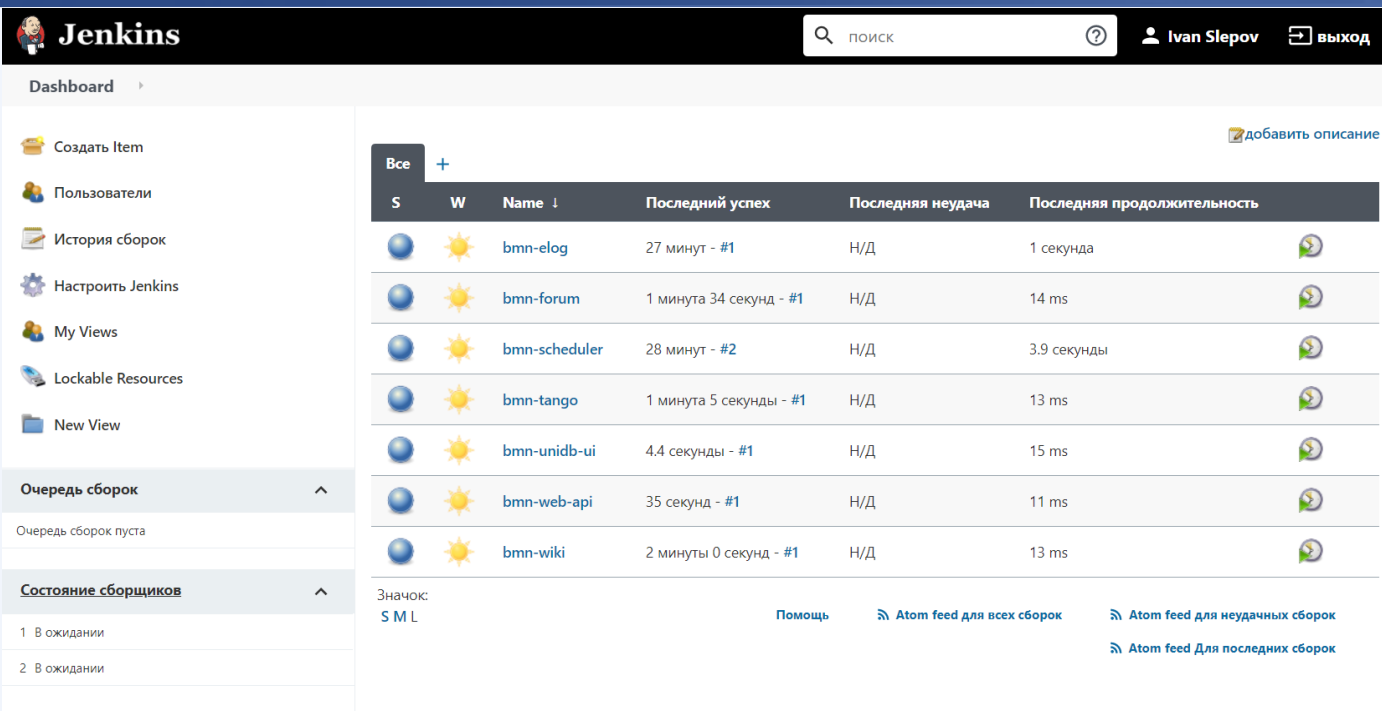
Collaboration Services

Evolution of the BM@N Information Services



Ivan SLEPOV (19 April 12:45)
Deployment structure of the information
services for BM@N on the NICA cluster

Deployment of the BM@N Information Services

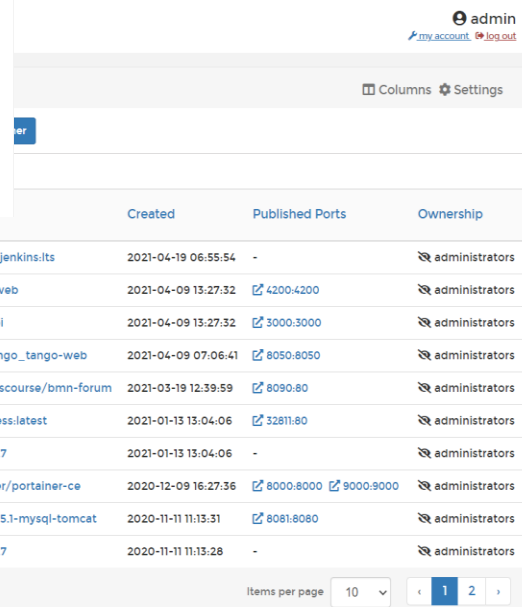


The Jenkins Dashboard shows a list of build jobs. The left sidebar contains navigation links: Создать Item, Пользователи, История сборок, Настроить Jenkins, My Views, Lockable Resources, and New View. The main area displays a table of build jobs with columns for status (S, W), name, last success, last failure, and last duration. Below the table are links for help, Atom feed for all builds, Atom feed for failed builds, and Atom feed for recent builds.

S	W	Name ↓	Последний успех	Последняя неудача	Последняя продолжительность
●	☀	bm-n-elog	27 минут - #1	Н/Д	1 секунда
●	☀	bm-n-forum	1 минута 34 секунд - #1	Н/Д	14 ms
●	☀	bm-n-scheduler	28 минут - #2	Н/Д	3.9 секунды
●	☀	bm-n-tango	1 минута 5 секунд - #1	Н/Д	13 ms
●	☀	bm-n-unidb-ui	4.4 секунды - #1	Н/Д	15 ms
●	☀	bm-n-web-api	35 секунд - #1	Н/Д	11 ms
●	☀	bm-n-wiki	2 минуты 0 секунд - #1	Н/Д	13 ms

Jenkins

Portainer



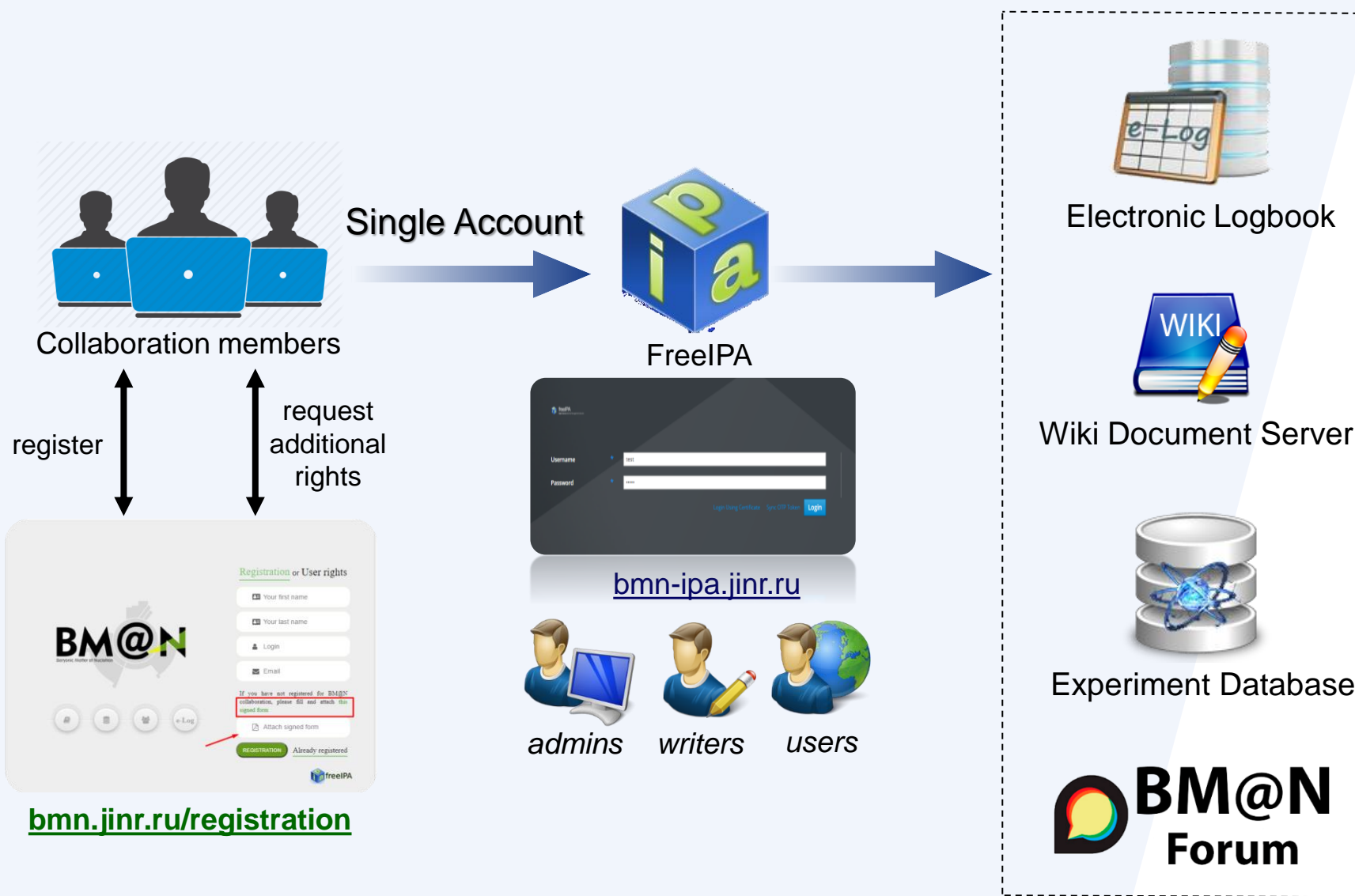
The Portainer interface shows a list of containers. The top bar includes a user profile (admin) and links for my account and log out. Below the bar, there are tabs for Columns and Settings. The main area displays a table of containers with columns for Name, Status, Image, Created, Published Ports, and Ownership.

Name	Status	Image	Created	Published Ports	Ownership
jenkins_jenkins.p9mcg4pejphf9...	running	jenkins/jenkins:its	2021-04-19 06:55:54	-	administrators
unidb_web	running	bm-n-unidb unidb_web	2021-04-09 13:27:32	4200:4200	administrators
web_api	running	bm-n-unidb web_api	2021-04-09 13:27:32	3000:3000	administrators
bm-n-tango_tango-web_1	running	bm-n-tango bm-n-tango_tango-web	2021-04-09 07:06:41	8050:8050	administrators
bm-n-forum	running	- local_discourse/bm-n-forum	2021-03-19 12:39:59	8090:80	administrators
lheptest_wordpress_1	running	lheptest wordpress:latest	2021-01-13 13:04:06	32811:80	administrators
lheptest_db_1	running	lheptest mysql:5.7	2021-01-13 13:04:06	-	administrators
portainer	running	- portainer/portainer-ce	2020-12-09 16:27:36	8000:8000 9000:9000	administrators
xwiki-12.5.1-web	running	xwiki-1251 xwiki:12.5.1-mysql-tomcat	2020-11-11 11:13:31	8081:8080	administrators
xwiki-12.5.1-db	running	xwiki-1251 mysql:5.7	2020-11-11 11:13:28	-	administrators

3 servers on the NICA cluster:

- Web services/sites on NC9
- FreeIPA on NC3
- Databases on NC13

FreeIPA: Single Authentication & Authorization



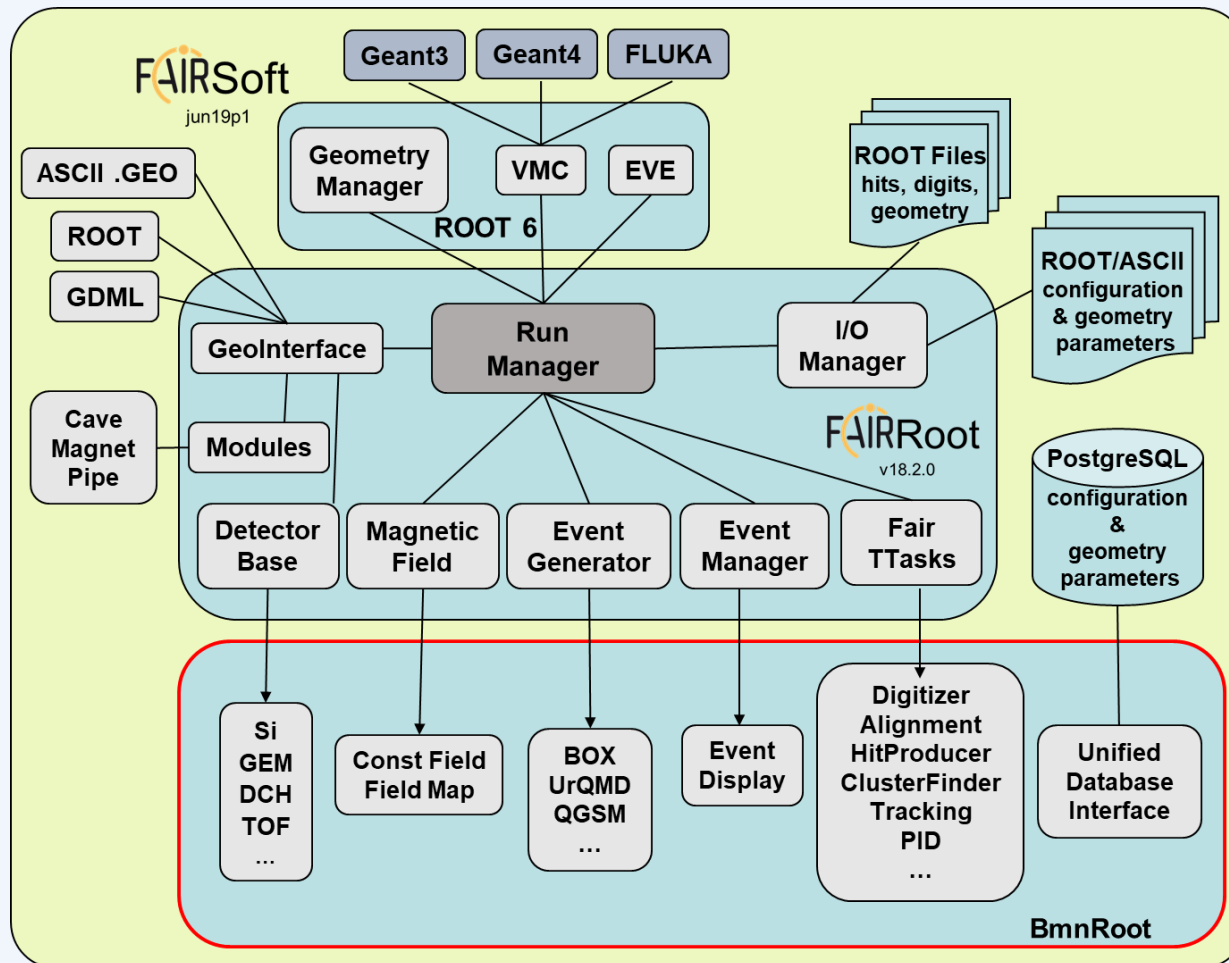
BmnRoot Development

BmnRoot Release preparation: 21.05.0

FAIRSoft
apr21

FAIRRoot
v18.6.2

cannot be updated because of **NCX-cluster** (LIT MICC & HybriLIT are ready)



- Huge efforts have been expended to correct all problems before Release
- The pre-release has to be approved by detector groups
- The pre-release is tested at distributed clusters before Release issue
- Simulation and reconstruction results should be checked very carefully
- *decoder/BmnTof1Raw2Digit* should be corrected before the BmnRoot Release

The mass production of the BM@N digits and reco data for Run 7 is used to check pre-release

Elimination of memory leaks and errors



Sergei NEMNYUGIN
(19 April 11:40)

Software contribution from SPbU: algorithmic and code optimization of the BmnRoot framework

Dynamic analysis with Valgrind 3.15.0



Configuration:

- OS: Ubuntu 20.04.2 LTS x86_64
- compiler GCC 9.3

Reconstruction modules:

run_reco_src.C & run_reco_bmn.C

- Memory leaks have been localized.
- Incorrect access to array elements have been localized
- Memory leaks are consequence of non-release of dynamically allocated memory both explicitly and implicitly.
- Work is in progress

Class with memory leak	Valgrind description of memory leak	Number of function calls with memory leak
BmnInnTrackerAlign.cxx	10,626 (24 direct, 10,602 indirect) bytes in 1 blocks	2
	384 (88 direct, 296 indirect) bytes in 1 blocks	2
	10,818 (24 direct, 10,794 indirect) bytes in 1 blocks	2
	8,000 bytes in 1 blocks are possibly lost	2
UniDbRun.cxx	4 bytes in 1 blocks	2
BmnMwpcHitFinder.cxx	1,008 bytes in 21 blocks	2
	128 bytes in 4 blocks	1
	64 bytes in 2 blocks	1
	32 bytes in 1 blocks	1
BmnFillDstTask.cxx	312 (144 direct, 168 indirect) bytes in 1 blocks	1
	24 bytes in 1 blocks	1
	16 bytes in 1 blocks	1
	8 bytes in 1 blocks	1
BmnFieldMap.cxx	24 bytes in 1 blocks	1
	48 (24 direct, 24 indirect) bytes in 1 blocks	1
BmnMwpcHitFinder.cxx	2,016 bytes in 42 blocks	2

BmnRoot Data Processing

DAQ Storage

raw data in binary format

raw_run.data

RAW binary format

RAW digits format

digitizer

BmnDataToRoot.C

digi_run.root

Geant 3/4, Fluka

simulation

run_sim_bmn.C
run_sim_src.C

bmn_sim.root

SIM format

reconstruction

run_reco_bmn.C
run_reco_src.C

bmn_dst.root

physics
analysis

macro/physics/

DST format

Event Generators

DCM-QGSM, DCM-SMM...

generator.dat

Sergei MERTS
(20 April 11:45)

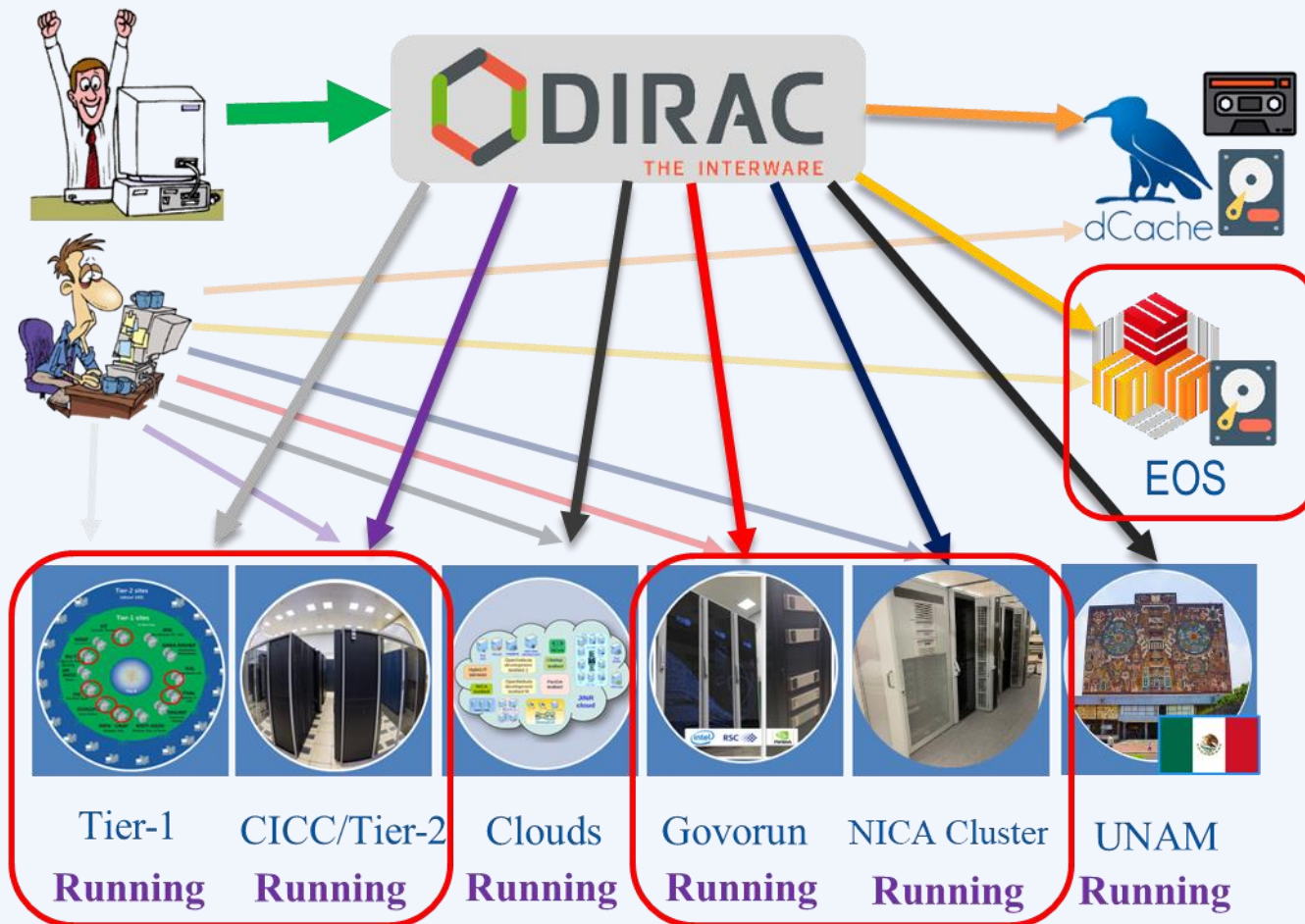
Status of the BM@N simulation
and data reconstruction

Alexander ZINCHENKO
(20 April 10:00)

Summary of the analysis meeting

Distributed Computing

BM@N WorkFlow Services via DIRAC



Igor PELEVANYUK
(19 April 10:40)

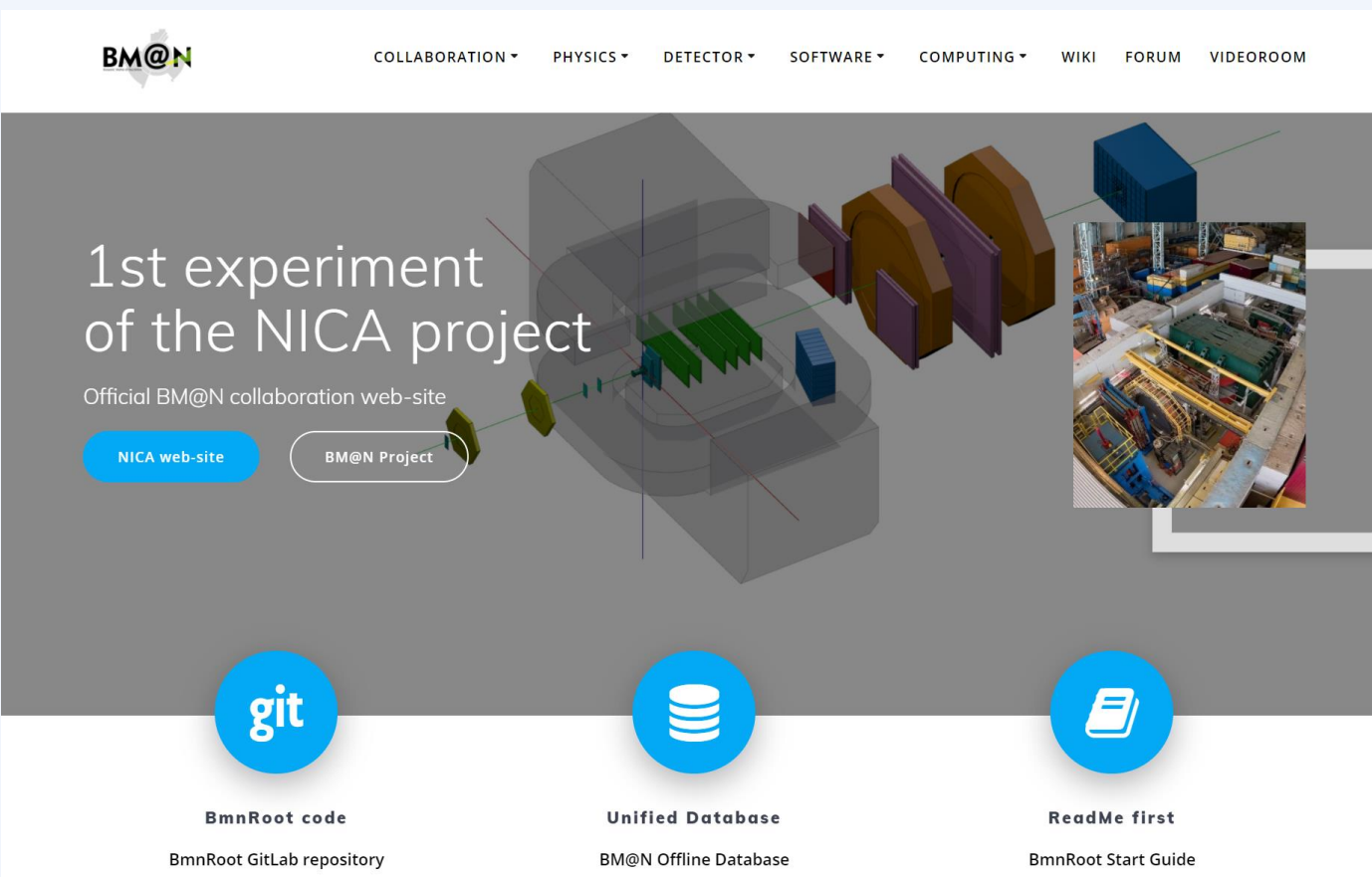
DIRAC workload management system and the very first results for the BM@N experiment

Testing BM@N event processing via DIRAC

	Govorun	NICA cluster	Tier1	Tier2
RawToDigi	Custom – OK CVMFS – OK	-	-	-
DigiToDst	Custom – OK CVMFS – OK	Custom – OK CVMFS – OK	Custom – OK CVMFS – OK	Custom – OK CVMFS – OK
GenToSim	Custom – OK CVMFS – OK	Custom – OK CVMFS – OK	Custom – OK CVMFS – OK	Custom – OK CVMFS – OK
SimToDst	Custom – OK CVMFS – OK	Custom – OK CVMFS – OK	Custom – OK CVMFS – OK	Custom – OK CVMFS – OK

```
dirac-dms-get-file /bmn/digi/run7/1002.root
root -l -q -b run_reco_bmn.C("1002.raw", "out.root",0,0)
dirac-dms-put-file /bmn/dst/run7/1002_dst.root out.root JINR-EOS-BMN
```

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



BM@N

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

1st experiment of the NICA project

Official BM@N collaboration web-site

NICA web-site BM@N Project

git
BmnRoot code
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**
- ✓ **Webex rooms**
- ✓ **BM@N Mail-lists**
- ✓ **etc.**

Conclusions

- ✦ **SPbU Group** joined to the Software Collaboration to make good contribution to the BM@N Software.
- ✦ **The Information Systems** (Geometry and Condition Database, Logbook) and related **services** have sufficiently been improved to simplify data processing by collaboration members. The Event Metadata System and Configuration Database is under development.
- ✦ **RFBR support** with the NICA grant (ending in March, 2021) enables to significantly improve the Information Systems for BM@N data processing.
- ✦ **BmnRoot Release 21.05.0** is scheduled to be issued after approval procedure with the latest BM@N and SRC simulation, reconstruction, analysis and software improvements.
- ✦ The architecture of the BM@N mass data processing is under development. The work with the **DIRAC interware** has started.
- ✦ **The lack of manpower** for BM@N software development is a problem to be solved, but which has not been endorsed.

Thank you for your attention!

More information: bmn.jinr.ru
nica.jinr.ru

Email: gertsen@jinr.ru



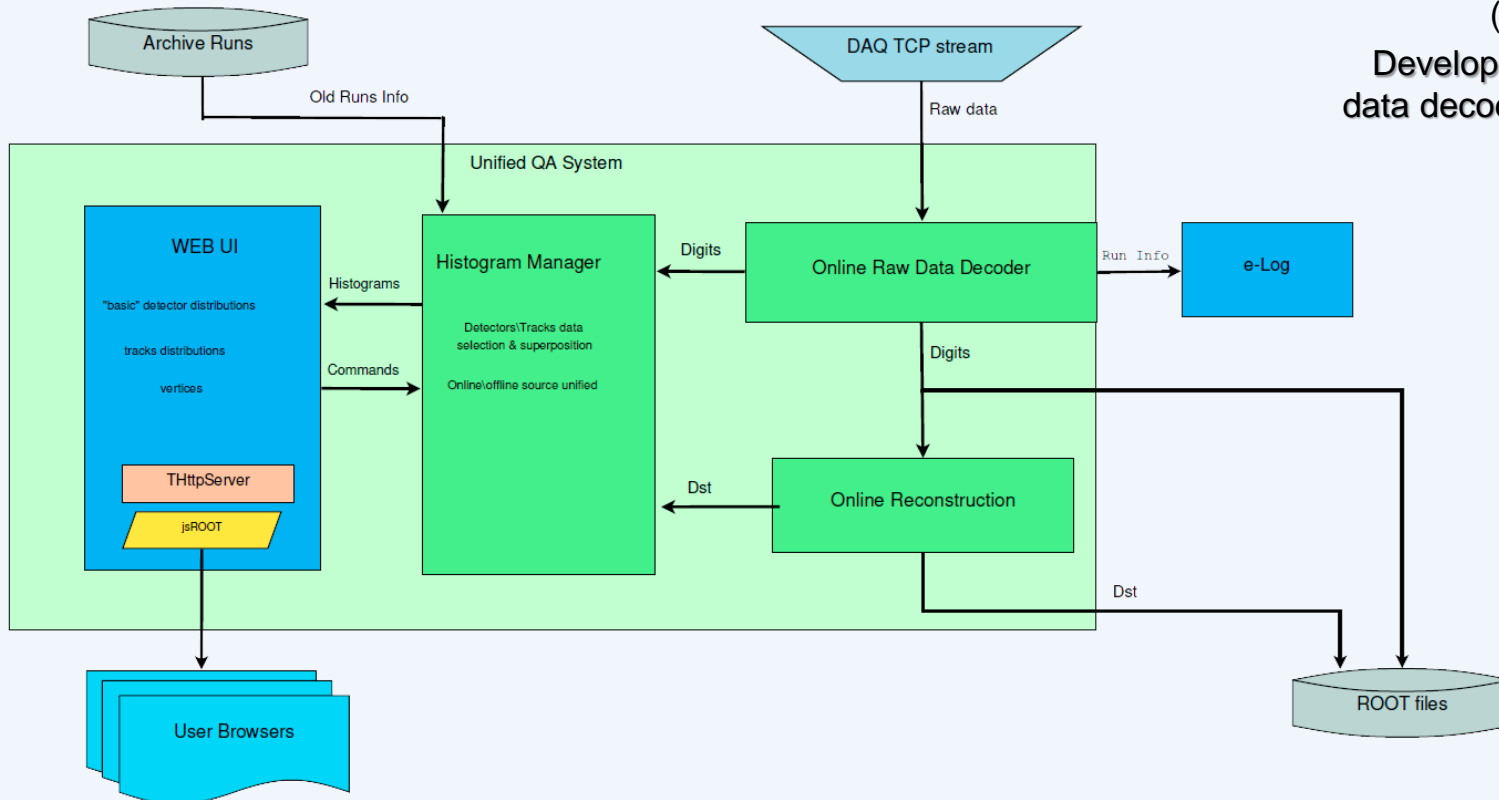
We are open for cooperation!

Backup

Improvement of Online Histogramming System

Ilnur Gabdrakhmanov
(19 April 12:30)

Development of tools for event
data decoding and quality analysis



```
{
  "Name": "GEMS",
  "Title": "GEM Canvas",
  "DivX": "2",
  "DivY": "1",
  "Pads": [
    {
      "Class": "TH2I",
      "Name": "GEM-hits0",
      "Title": "GEM hits",
      "Options": "colz",
      "Dimensions": [
        200,
        0,
        400,
        400,
        -200,
        200
      ]
    }
  ],
  {
    "Class": "TH1F",
    "Name": "GEM0",
    "Title": "Gem Strip",
    "Dimensions": [
      200,
      0,
      400
    ]
  }
}
```

- Make addition of histograms simple and flexible (not require code rebuild)
- Move configuration of online histogramming outside of the code
- Detector groups add histograms as simple configurations in json files