

## BM@N Software Development. Summary of the Software Section.

Konstantin Gertsenberger  
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna



# BM@N Collaboration

**11 Countries, 21 Institutions, 234 participants**

spokesperson – **M. Kapishin, JINR**

technical coordinator – **A. Maksimchuk, JINR**

*University of Plovdiv, **Bulgaria**;*

*University of Chinese Academy of Sciences,  
UCAS, **China**;*

*Shanghai Institute of Nuclear and Applied  
Physics, **China**;*

*Tsinghua University, Beijing, **China**;*

*Nuclear Physics Institute CAS, **Czech Republic**;*  
*CEA, Saclay, **France**;*

*Tubingen University, **Germany**;*

*TU Darmstadt & GSI (Consortium), **Germany**;*

*Tel Aviv University, **Israel**;*

*Almaty Institute of Physics & Technology,  
**Kazakhstan**;*

*Institute of Applied Physics, **Moldova**;*

*University of Wroclaw, Wroclaw, **Poland**;*

*Warsaw University of Technology, **Poland**;*

*Institute of Nuclear Research RAS, **Russia**;*



*Institute of Theoretical & Experimental  
Physics, NRC KI, **Russia**;*

***Joint Institute for Nuclear Research;***

***Joint Institute for Nuclear Research,***  
***Laboratory of Information Technologies;***

*NRC Kurchatov Institute, **Russia**;*

*Moscow Engineer and Physics Institute,  
MEPhI, Moscow, **Russia**;*

***Moscow Institute of Physics and Technology,***  
***Moscow, **Russia**;***

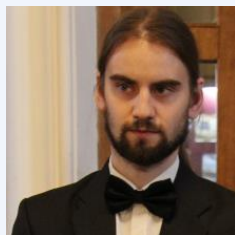
*Skobeltsin Institute of Nuclear Physics, MSU,  
**Russia**;*

*Massachusetts Institute of Technology, **USA**.*

# MIPT contribution to BM@N software



*Head of the MIPT group: Tagir AUSHEV*



Current BM@N Software Activity:

- GUI for the NICA-Scheduler
- Slow Control Data Visualization
- Next Generation Event Display



*Alexander NOZIK (14 October 9:00)*

MIPT contribution in BM@N software systems: visualization and web-services

# JINR LIT participation in BM@N software



***Director, LIT JINR: Vladimir V. KORENKOV***

*Andrey DOLBILOV: Computing Infrastructure for the NICA experiments*

*Nikita BALASHOV: GitLab Services for BmnRoot*

*Irina FILOZOVA, Igor ALEXANDROV, Evgeniy ALEXANDROV:  
Geometry Database for the BM@N experiment*

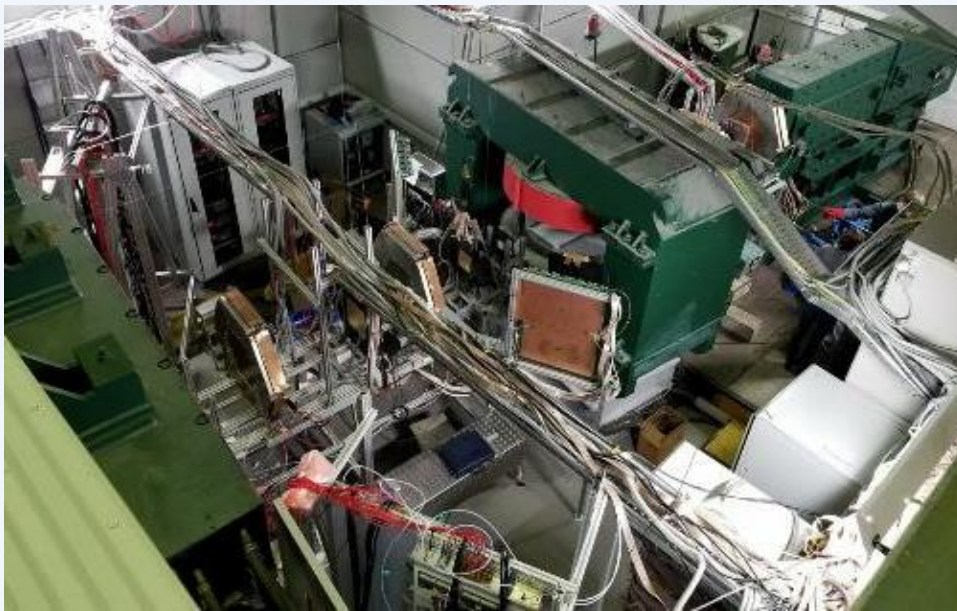
*Dmitriy PODGAYNY (Head of the HybriLIT team), Oksana STRELTSOVA,  
Maksim ZUEV: HybriLIT and SC Govorun support*

*Danila OLEYNIK, Artem PETROSYAN: BM@N WorkFlow implementation*



# BM@N in Nuclotron Runs (2015 – 2018)

❖ Nuclotron Run 51 (d,C)		<i>Feb. 22 – Mar. 15, 2015</i>
❖ Nuclotron Run 52 (d)		<i>June 29 – June 30, 2016</i>
❖ Nuclotron Run 53 (d, d <sup>†</sup> )	<b>Technical</b> <i>interaction rate: 5 KHz</i>	<i>Dec. 9 – Dec. 23, 2016</i>
❖ Nuclotron Run 54 (C)		<i>Mar. 7 – Mar. 18, 2017</i>
❖ Nuclotron Run 55 (C,Ar,Kr)	<b>Technical + Physics</b> <i>interaction rate: 10 KHz</i>	<i>Mar. 3 – Apr. 05, 2018</i>



- Beams: deuteron (4 AGeV),  $C^{12}$  (3.5–4.5 AGeV), Ar (3.2 AGeV), Kr (2.4, 3.0 AGeV)  
Targets: C, Cu, Pb, Al, Sn,  $C_2H_4$ ,  $H_2$  or empty
- Trace beams, measure beam profile and time structure
- Test integrated DAQ,  $T_0$  and Trigger system
- Detectors: MWPC, Si, GEM, ToF-400, DCH-1, DCH-2, ToF-700, ZDC, ECAL, LAND
- Detect min bias beam-target interactions to reconstruct hyperons, identify charged particles and nucleus fragments

# Data Collected in Run 7 (Nucl. Run 55)

## Main BM@N program:

One beam energy available for Ar-beam and three for Kr-beam

Wide set of targets used: (C; Al; Cu; Sn; Pb)

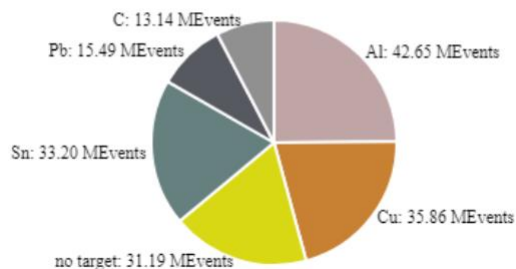
## BM@N SRC program:

One beam energy available for C-beam

More than half of the collected statistics can be used for SRC analysis

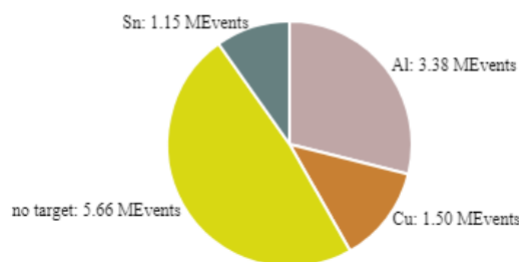
Beam Ar (  $E = 3.2$  GeV/n )

Total: 171.53 MEvents



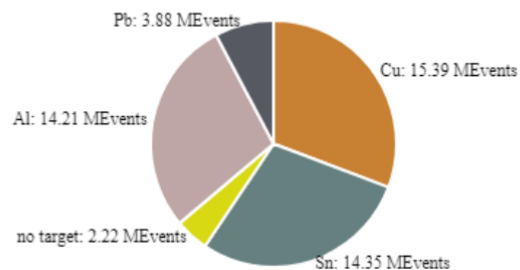
Beam Kr (  $E = 2.3$  GeV/n )

Total: 11.69 MEvents



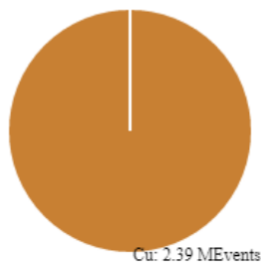
Beam Kr (  $E = 2.6$  GeV/n )

Total: 50.05 MEvents



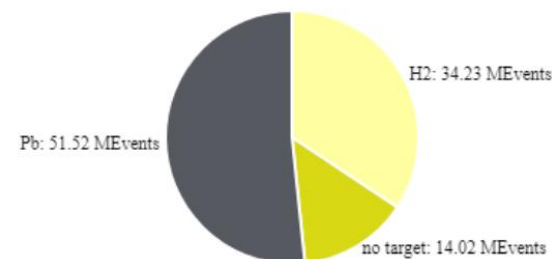
Beam Kr (  $E = 2.94$  GeV/n )

Total: 2.39 MEvents



Beam C (  $E = 3.17$  GeV/n )

Total: 99.77 MEvents



**SRC**

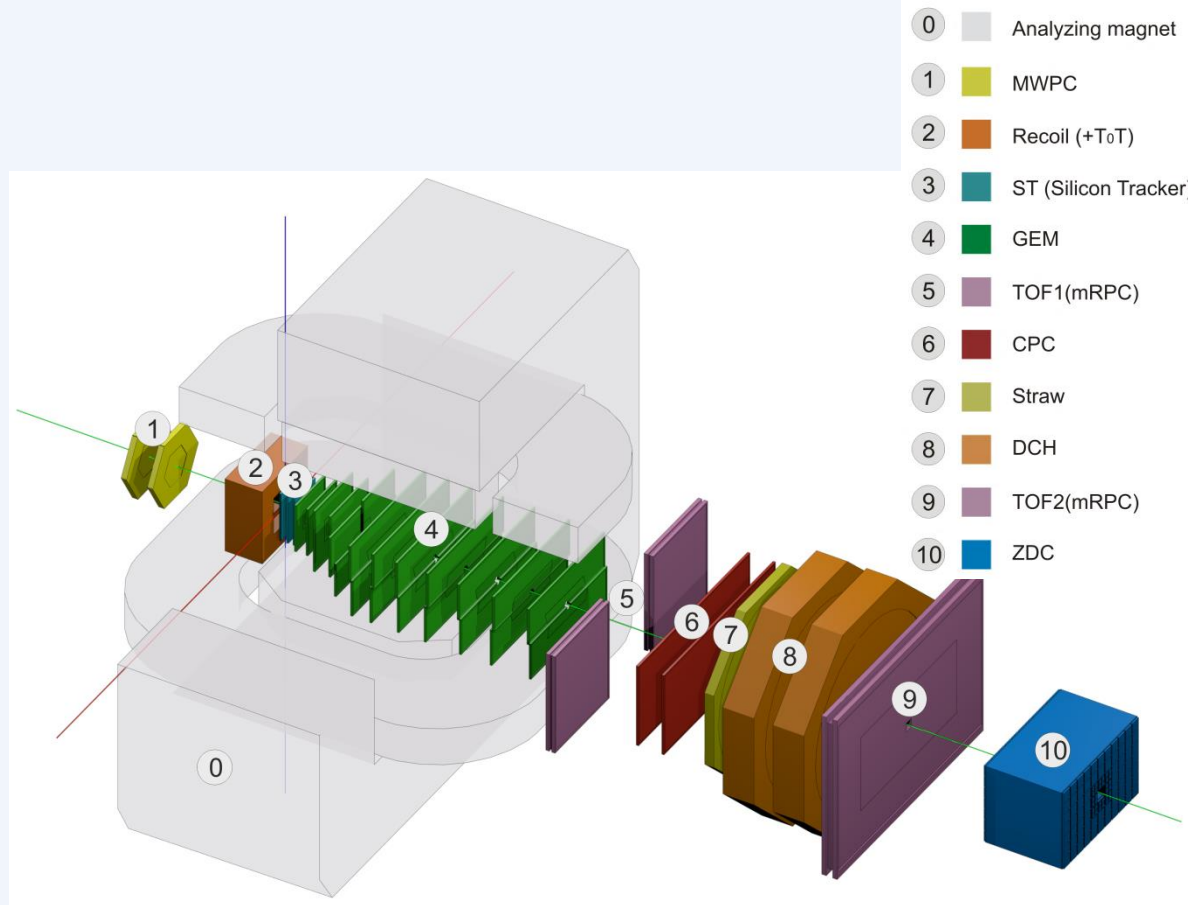
**BM@N**

# **BmnRoot Environment**

# BmnRoot Framework

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

C++ classes, Linux OS support,  
based on ROOT and FairRoot



The Installation Procedure: <http://bmn.jinr.ru/software-installation/>

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



# GitLab services for BM@N software

GitLab interface showing the 'bmnroot' project details. The project is under the 'BM@N' organization and is a 'Simulation and Analysis Framework for the BM@N experiment of the NICA project'. It features 1,922 commits, 22 branches, 1 tag, and 352.9 MB of files. The pipeline status is 'passed'. The interface also displays a list of files and their last commit details.

**advanced opportunity for collective development**

GitLab Pipelines page for the 'bmnroot' project. The page shows a table of pipeline runs with columns for Status, Pipeline, Commit, Stages, and a 'Run Pipeline' button. The table lists several successful pipeline runs with their respective commit hashes and stage results.

Status	Pipeline	Commit	Stages	Run Time
passed	#307 by latest	ψ1-alignment-... → 7bf94510	Correct estimation of t...	00:11:58 about 17 hours ago
passed	#306 by latest	ψ1-alignment-... → f21e1463	Enabled CI tests for all ...	00:21:58 about 17 hours ago
passed	#305 by latest	ψ1-alignment-... → 7bf94510	Correct estimation of t...	00:12:26 about 17 hours ago
passed	#303 by latest	ψ dev → f21e1463	Enabled CI tests for all ...	00:12:39 about 18 hours ago
passed	#301 by latest	ψ dev → 1157e2e4	SILICON: file Silicon_R...	00:13:01 a day ago
failed	#300 by latest	ψ dev → e71f6bca	ToF400 analysis draft	00:12:30 a day ago

Version Control System – Git  
Automated Tests / Automated Deployment – GitLab Runners  
Issue tracker  
Repository branch protection  
Role-based access control to projects

*Nikita BALASHOV (14 October 9:50)*  
**Software development workflow in BM@N: tools and features**

# New Package Versions in BmnRoot Design

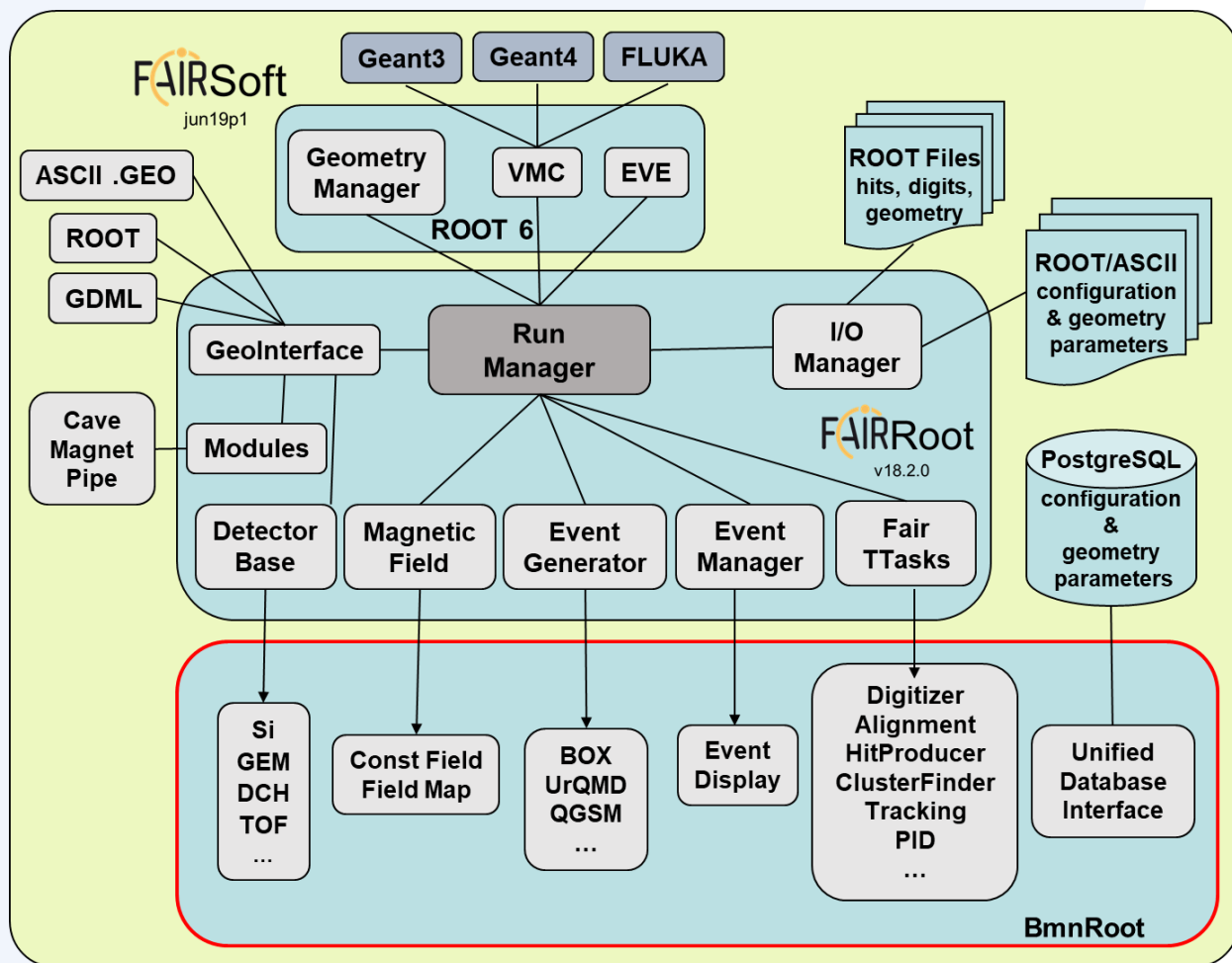


ROOT 6.16

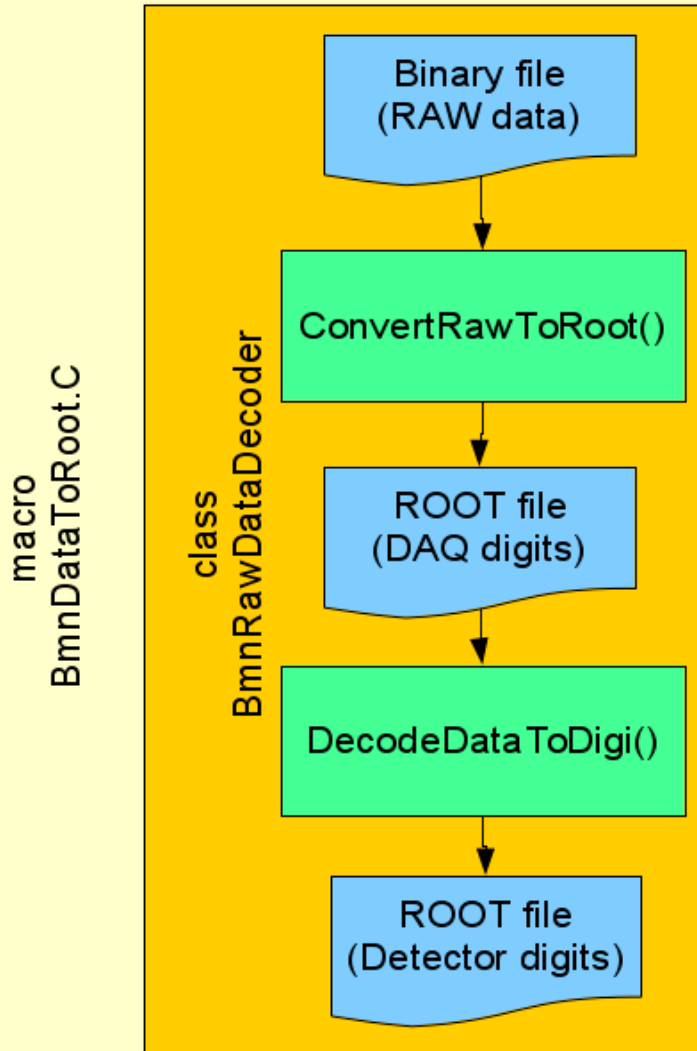
FAIRSoft  
jun19p1

FAIRRoot  
v18.2.0

## BmnRoot



# BmnRoot Release for Run 7 production: 19.10.0

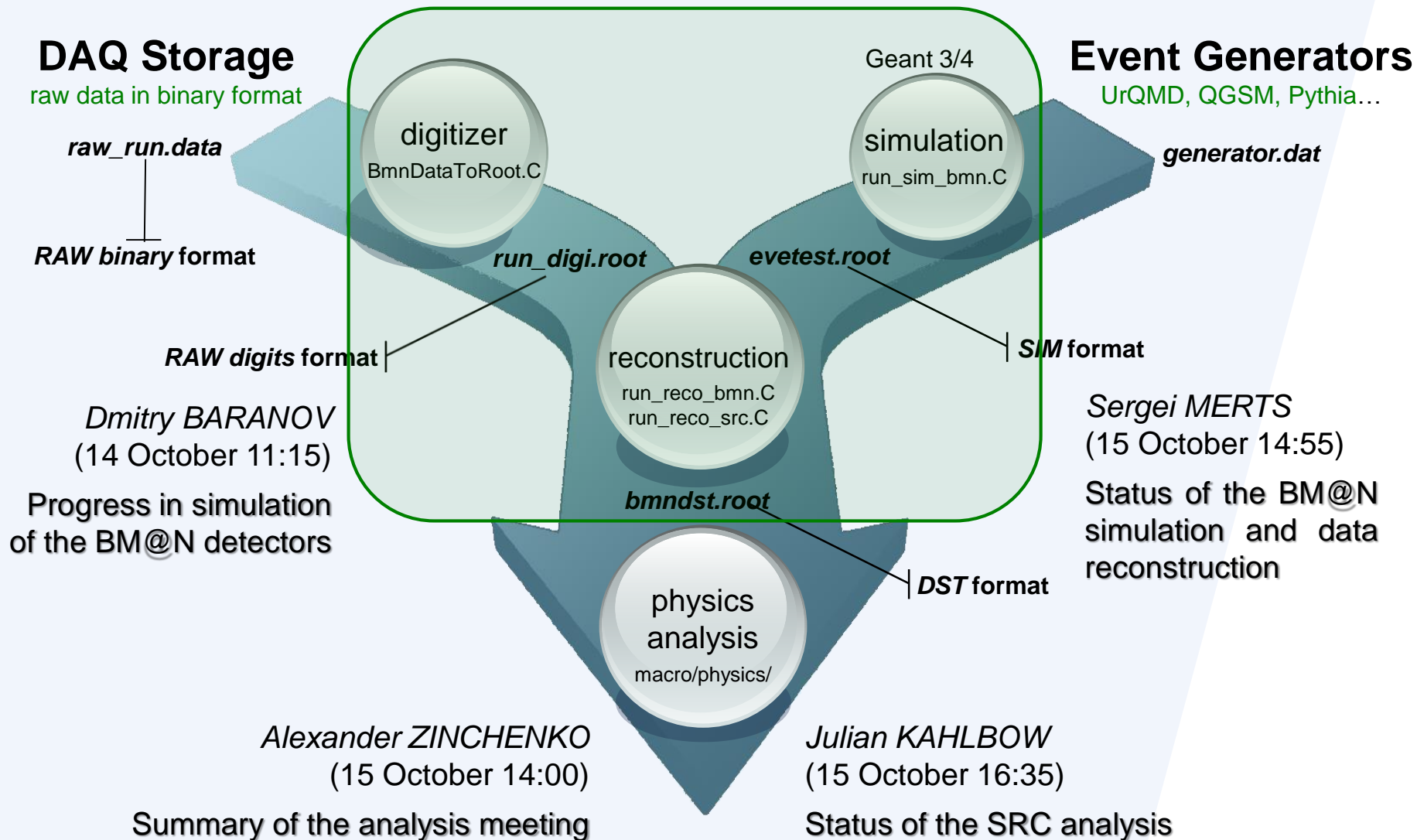


## Raw Data Converter preparations

- separate pieces of raw conversion code for all BM@N detectors have been combined into single Raw Data Converter
- the result tree with detector digits has been renamed and cleaned
- TAI times has been translated to the UTC format
- bugs in raw data conversion, such as wrong mapping, have been corrected
- Run and Event Headers for ROOT files with BM@N digits have been implemented
- Default options do not save RAW-ROOT files
- unification of the silicon and GEMs digits obtaining in two groups was finished a few weeks ago

***Mass production of BM@N detector digits and DST files for Run 7 (& Run 6) has been started at JINR distributed clusters***

# BM@N Event Processing in BmnRoot



# Data Quality Analysis (offline system)

**Current Run: 3387**

**Energy: 3.17**

**Beam: C**

**Target: H2**

**Ref. Run: 1801**

**Energy: 4.50**

**Beam: C**

**Target: Cu**

**Release: 0.0**

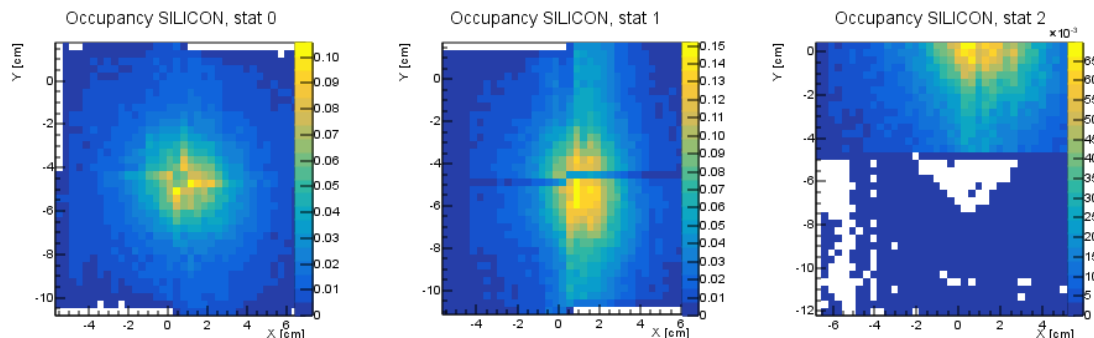
**Period: 7**

**Setup: SRC**

## Occupancy for SILICON in RUN7 SRC

[bmnn-qa.jinr.ru](http://bmnn-qa.jinr.ru)

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



*Pavel BATYUK*  
(14 October 11:55)  
Data Quality Analysis

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



# Distributed Computing

# Current Computing Clusters for NICA

NICA Cluster  
*ncx[101-106].jinr.ru*  
(LHEP, b.215, b.216)



OS: Scientific Linux 7  
Exp. software: Local  
**EOS: 3.3 PB** (replicated)  
GlusterFS: 320 TB (*replicated*)  
**Sun Grid Engine: 3 060**  
(Intel Xeon cores)

MICC Tier1/2 Center  
*lx[pub,mpd-ui].jinr.ru*  
(LIT, b.134)



OS: Scientific Linux 6  
Exp. software: CVMFS  
**EOS: 4 PB**  
**Torque/Maui:**  
Tier2: ~300 IX cores  
Tier1: ~600 IX cores

HybriLIT platform  
*hydra.jinr.ru*  
(LIT, b.134)



OS: CERN CentOS 7  
Exp. software: CVMFS, **Modules**  
**ZFS 200 TB,**  
**UltraFast Storage on Lustre 70 TB<sub>ssd</sub>**  
**SLURM: 2880** (Xeon cores) + **6048** (Xeon  
Phi cores) + **40 GPU** NVidia Tesla V

**All external packages for BmnRoot were installed & configured.**  
**Automatic BmnRoot deployment on CVMFS with GIT CI was implemented.**

# NICA Cluster: from a prototype to the future

OS: Scientific Linux 7

(LHEP, b.215, b.216)



Cluster Administrator:  
Schinov B. G.

## Storage

**EOS: 0.5 PB** distributed FS (*replicated*)  
sim. data: /eos/nica/bmn/sim/[gen,dst]  
exp. data: /eos/nica/bmn/exp/[raw,digi,dst]  
for users: /eos/nica/bmn/users/\$USER

GlusterFS volumes are obsolete

## Software

FairSoft:

/opt/fairsoft/bmn/pro → jun19p1

FairRoot:

/opt/fairroot/bmn/pro → v18.2.0

*SetEnv.sh:*  
need correction!

## Computing

Batch System: **Sun Grid Engine**

Intel Xeon: **3096 log. cores**

## Registration & User Space Quotes

Email to the software coordinator with a detailed user info.

*Currently, about 80 users have been registered*

# MICC Tier1/2 Center: a piece for NICA

OS: Scientific Linux 6

(LIT, b.134)



Cluster Administrator:  
Mitsyn V. V.

## Storage

**EOS: 1 PB** distributed FS

sim. data: /eos/nica/bmn/sim/[gen,dst]

exp. data: /eos/nica/bmn/exp/[raw,digi,dst]

for users: /eos/nica/bmn/users/\$USER

scratch: /scr/u/\$USER

## Software

**CVMFS**: distributed software FS

*scl enable devtoolset-4 python27 bash* *SetEnv.sh: need correction!*

FairSoft: /cvmfs/nica.jinr.ru/sl6/fairsoft/bmn (jun19p1)

FairRoot: /cvmfs/nica.jinr.ru/sl6/fairroot/bmn (v18.2.0)

## Computing

Batch System: **Torque/Maui**

Tier2 queue 'mpd': **~300 log. cores** (Intel Xeon)

Tier1 queue 'mpd@bfsrv': **~600 log. cores** (Intel Xeon)

## Registration

<http://lxs-s03.jinr.ru/cicc/index.php/en/registration-at-cicc/>

# HybriLIT Platform: from education to SC Govorun

OS: CERN CentOS 7

## Storage

**EOS:**

for users: /eos/hybrilit.jinr.ru/user/

scratch: /eos/hybrilit.jinr.ru/scratch, /run/user/\$UID

/eos/eos.jinr.ru → MICC EOS

## Software

**CVMFS:** distributed software FS

`export MODULEPATH="/cvmfs/hybrilit.jinr.ru/sw/slc7_x86-`

`64/modulefiles:/cvmfs/hybrilit.jinr.ru/sw/slc7_x86-64/NICA/modulefiles"`

*module avail – print all modules*

FairSoft & FairRoot: **module add FairRoot/v18.2.0**

## Computing

Batch System: **SLURM**

*module add GVR/v1.0-1* → SuperComputer Govorun

Intel Xeon Gold (queue 'skylake'): **IN PROGRESS**

Intel Xeon Cascadelake (queue 'cascadelake'): **I / P**

Intel Xeon Phi (queue 'knl'): **6048 log. cores**

NVidia Tesla V (queue 'dgx'): **40 GPU cards**

## Registration

[http://hlit.jinr.ru/for\\_users/registration/](http://hlit.jinr.ru/for_users/registration/)

(LIT, b.134)



Maxim ZUEV

(14 October 10:05)

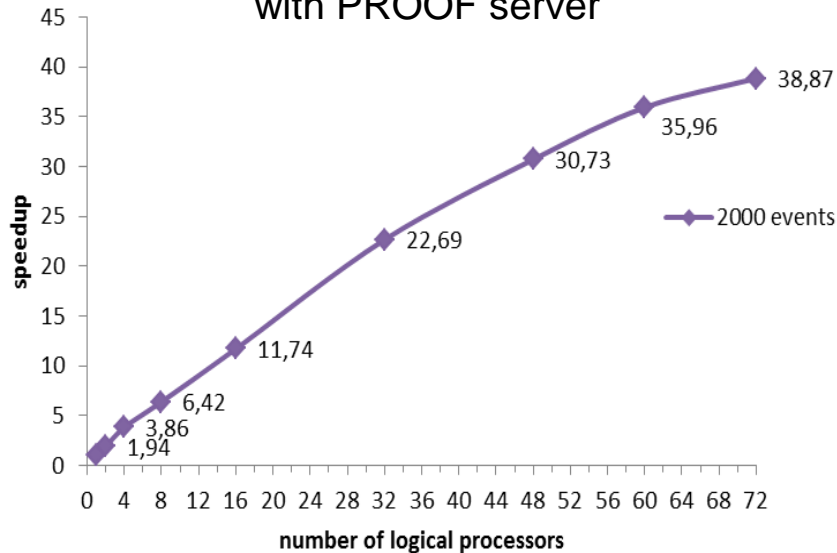
HybriLIT platform and Supercomputer

Govorun as computing platform for BM@N



# Tools for parallel data processing

! event reconstruction  
with PROOF server



**PROOF** (**P**arallel **ROOT** **F**acility) is a part of the ROOT software

Parallel NICA event data processing in ROOT macros on the parallel architectures: user multicore machines, heterogeneous distributed clusters and GRID system

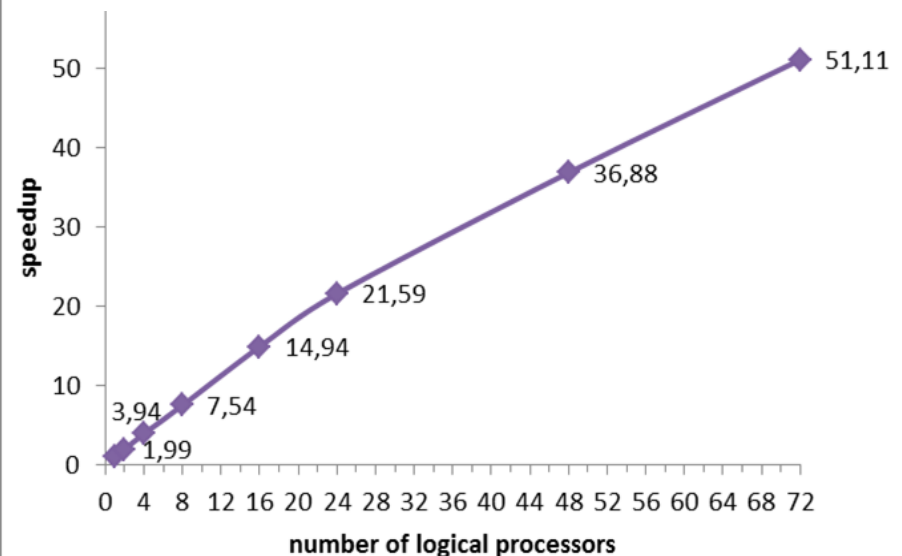
**NICA-Scheduler** for task distribution to parallelize NICA data processing on multicore machines and cluster nodes

**Supports SLURM, SGE and Torque system**

**Can use data of the Unified Database**

Jobs are described and passed as XML file

reconstruction of 72 sim. files  
with MPD-Scheduler



# NICA-Scheduler: from SGE to SLURM

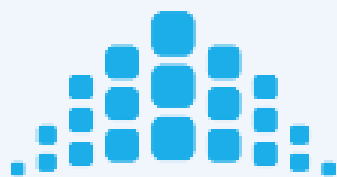
## NICA-Scheduler

\$ mps-scheduler my\_job.xml



*Sun*  
**GRID ENGINE**

**NICA Cluster**



**slurm**

workload manager

**HybriLIT + Govorun**



Torque  
**Adaptive**  
COMPUTING

**LIT MICC Center**

The NICA-Scheduler Guide: <http://bmn.jinr.ru/nica-scheduler/>

# NICA-Scheduler GUI

## NICA Scheduler Configurator

Load config

Выберите файл

Файл ...выбран

Download as XML

### NICA Job Scheme

+ Job

X [Job]: reco\_job

+ Macro

X [Macro]:

+ File

X [File]: \$VMCWORKDIR/macro/mpd/evetest1.root

X [File]: \$VMCWORKDIR/macro/mpd/evetest2.root

X [File]: energy=3,gen=urqmd

### Files To Process

Input type:

Simulation Database

Input Criteria:

energy=3,gen=urqmd

Output File Path:

~/mpdroot/macro/mpd/evetest\_\${counter}.root

Start event:

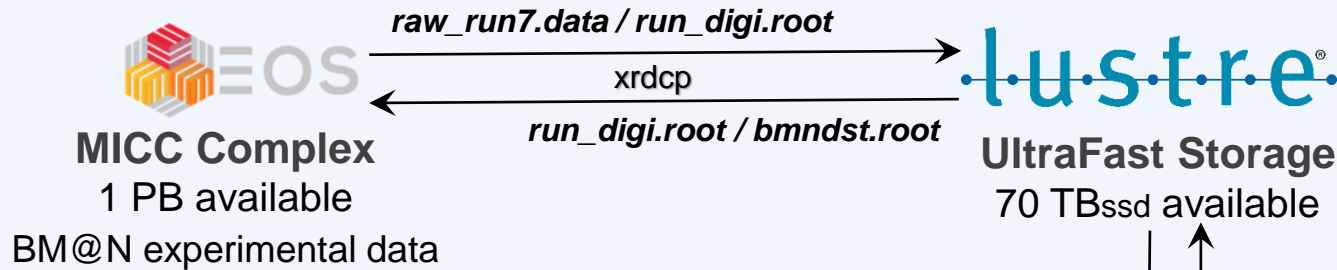
Event count:

Parallel mode:

- Written as a Kotlin Multiplatform application
  - Runs as JavaScript in browser, or in JVM
- Available at [https://git.jinr.ru/nica\\_modules/mpd-scheduler-gui](https://git.jinr.ru/nica_modules/mpd-scheduler-gui)

# BM@N Workflow

# Mass production for BM@N Run 7 (&6)



**Supercomputer  
GOVORUN**

## NICA-Scheduler

\$ mpd-scheduler *raw\_run7.xml*

```
<job name="convert_bmn_raw">
<macro path="/bmnroot/macro/raw/BmnDataToRoot.C">
<file input="/eos/nica/bmn/exp/raw/run7/*">
<put command="xrdcp" path="/lustre/stor/${file_name_with_ext}"/>
<get command="xrdcp" path="/lustre/stor/bmn_run${last_number}_digi.root"
output="/eos/nica/bmn/exp/digi/run7/bmn_run${last_number}_digi.root"/>
</file>
</macro>
<run mode="global" count="100" config="/bmnroot/build/config.sh"
work_dir="/lustre/stor"/>
</job>
```

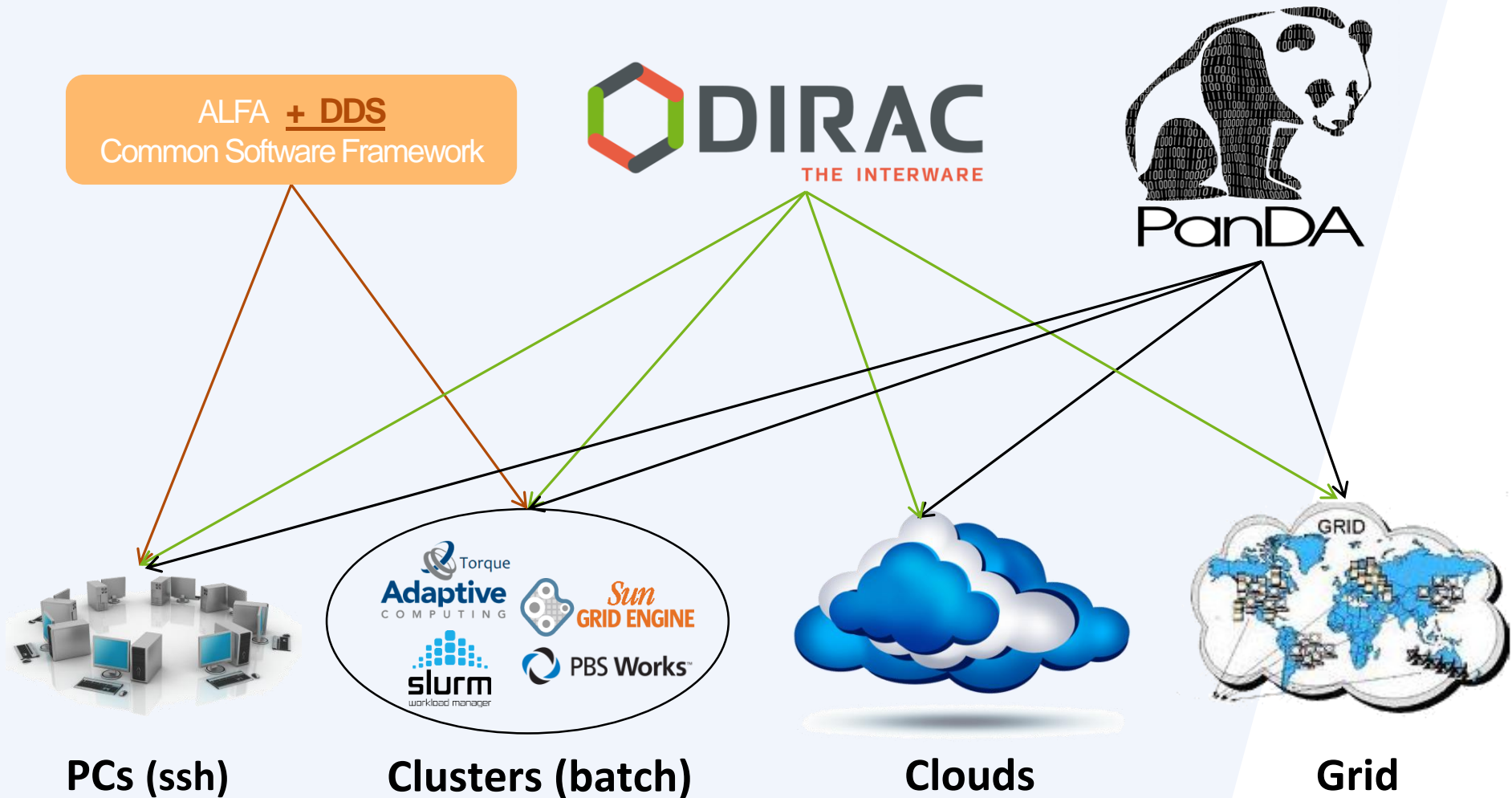


*BmnDataToRoot.C*

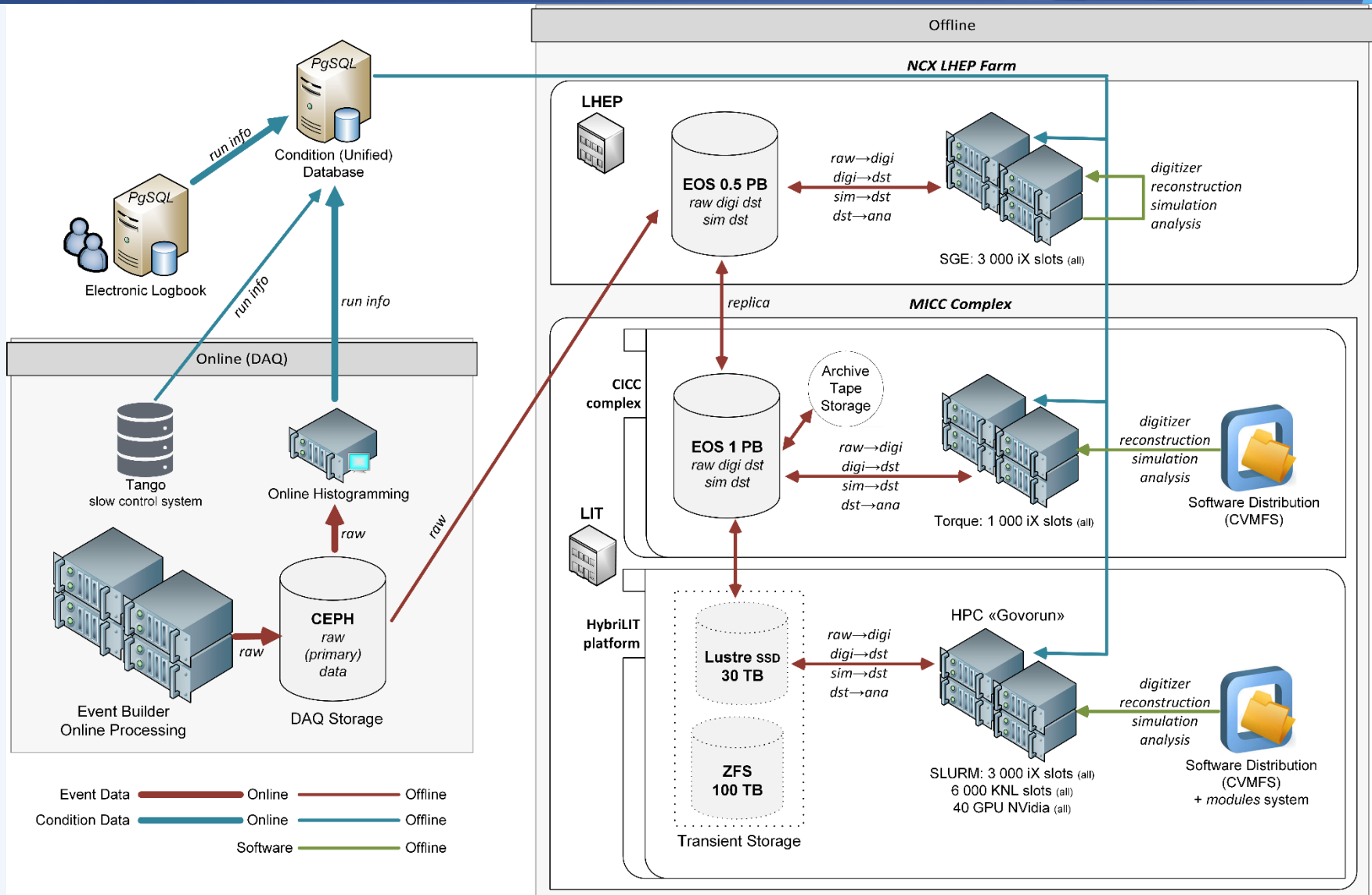
Xeon Gold (queue 'skylake'): 2880 cores  
 Xeon Cascadelake (queue 'bmnl'): 384 cores  
 Xeon Phi (queue 'knl'): 6048 cores



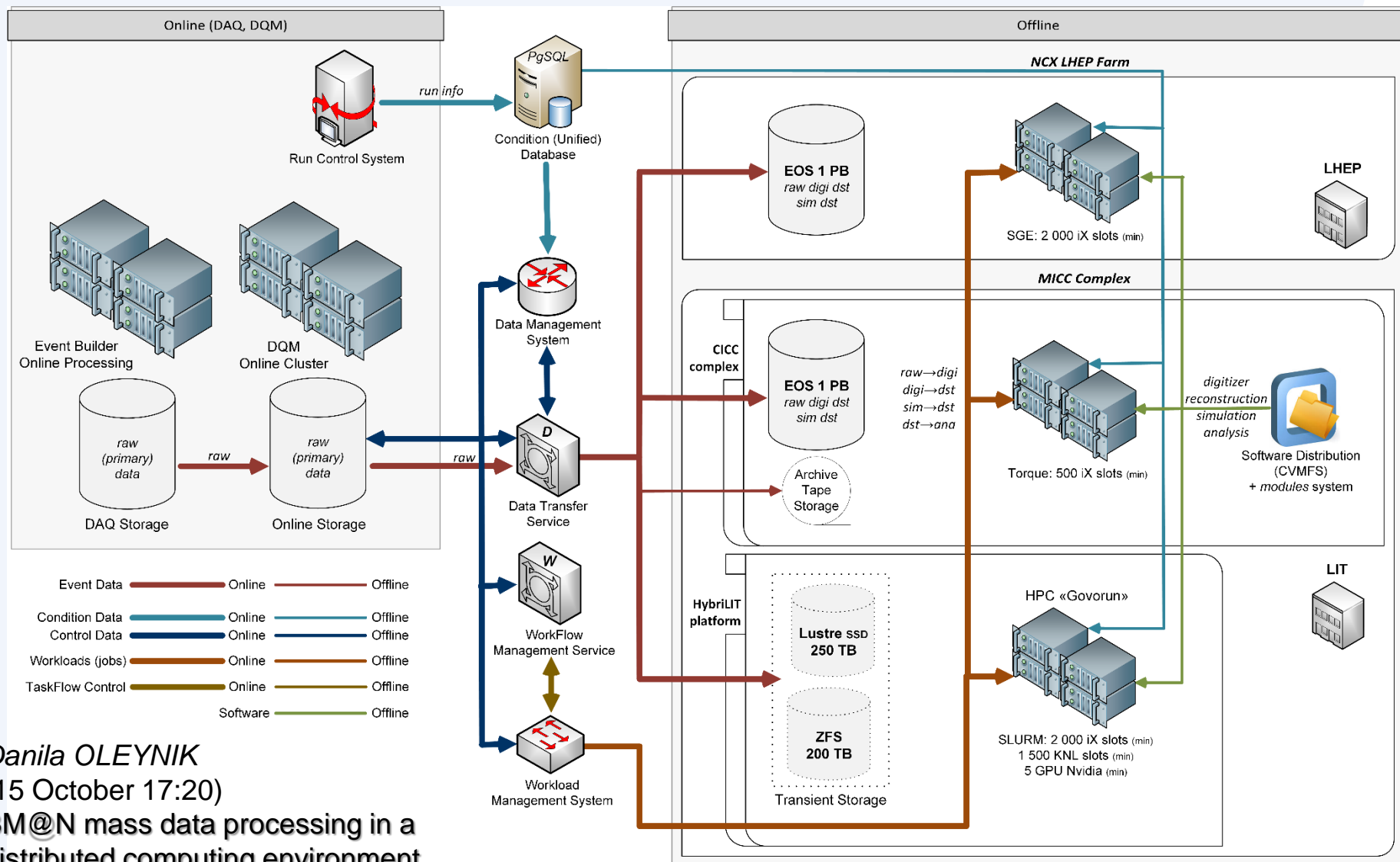
# Workload Manager Selection



# BM@N WorkFlow Status (Run 7)



# BM@N WorkFlow Proposal (Run 8)

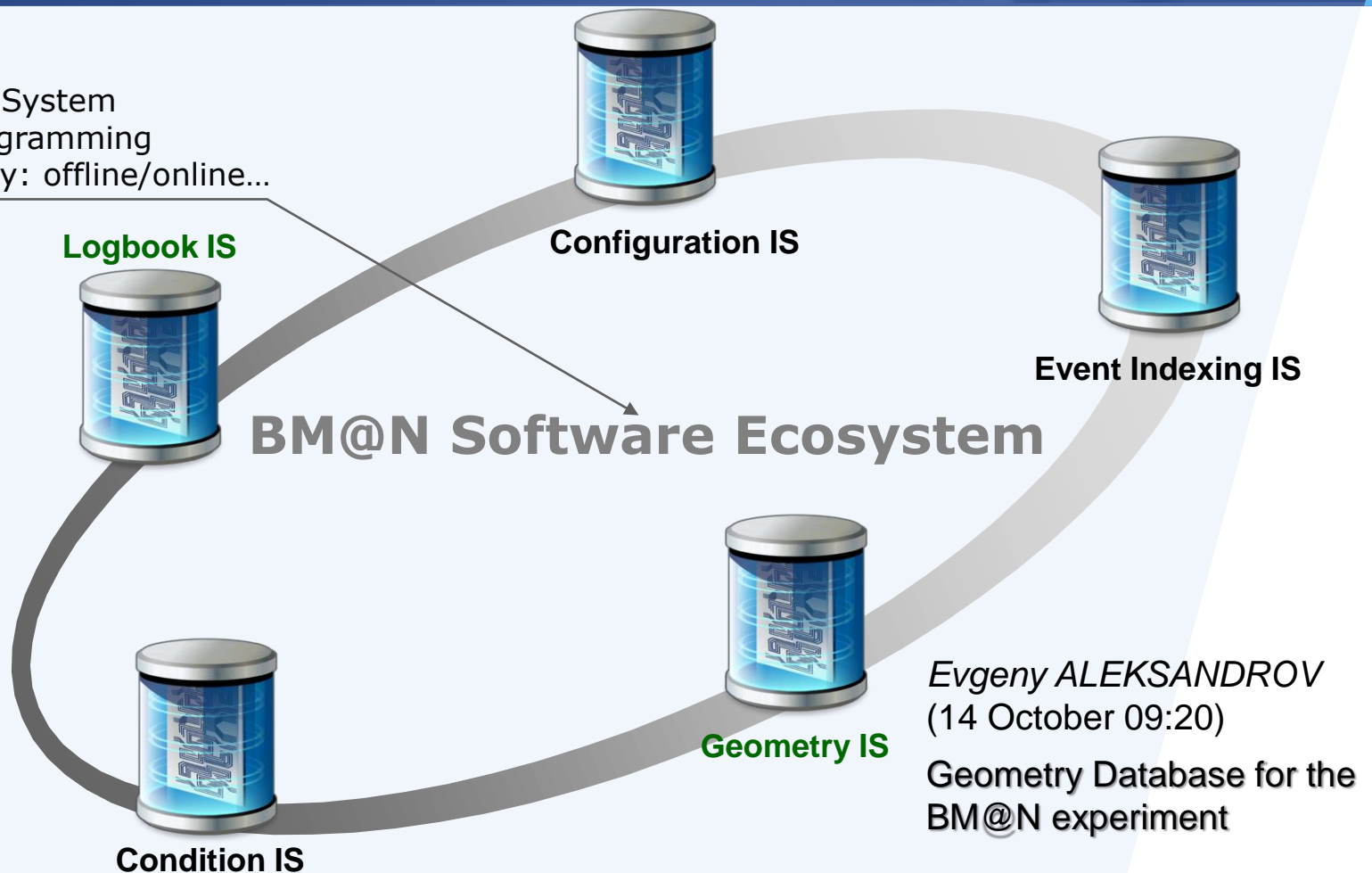


*Danila OLEYNIK*  
(15 October 17:20)  
**BM@N** mass data processing in a  
distributed computing environment

# Information Systems

# Information Systems for online & offline processing

BmnRoot  
Run Control System  
Online Histogramming  
Event Display: offline/online...



Evgeny ALEKSANDROV  
(14 October 09:20)  
Geometry Database for the  
BM@N experiment

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



# Electronic Logbook (e-Log)

- ✦ **e-Log** platform is a collaborative tool which provides shift crews with an interface to store and share information with offline users on various events or problems occurred in the experiment during its operation.
- ✦ The e-Log system uses a developed Logbook Database based on PostgreSQL which ensures correct multi-user access, data consistency, integrity and automatic backup of the stored data.
- ✦ A part of e-Log data is automatically transferred to the Unified Database of the experiment to use in offline analysis.
- ✦ Developed interfaces provide a unified access to required logbook data for various online and offline systems, and convenient viewing, transparent managing and searching for required information by users.

# Web-interface of the Electronic Logbook

BM@N Electronic Logbook

Logged in as admin

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

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Number of items per page: 20 [Logout](#)

Date	Shift Leader	Type	№ 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	<a href="#">Edit</a>
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	<a href="#">Edit</a>
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>3 VKM2: I=125A, SP-57=50A, SP41=1250A; 120 k	<a href="#">Edit</a>
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	<a href="#">Edit</a>
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	<a href="#">Edit</a>
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	<a href="#">Edit</a>
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	<a href="#">Edit</a>
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	<a href="#">Edit</a>
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	<a href="#">Edit</a>
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	<a href="#">Edit</a>
2018-04-05 04:37:43	Babkin	New Run	5173 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; 211 kev	<a href="#">Edit</a>
												Cu target; Tr= BC1 & BC2 & VC &	

2019 - software team (contact e-mail: gertsen@jinr.ru)

**BM@N Runs 1 - 7**  
**# records ~ 3 000**

It contains records of different types for all BM@N conducted Runs  
 Easy search by all parameters

# e-Log interface: modification by shift crew

**BM@N Electronic Logbook**Logged in as admin

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

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

[Add](#) [Cancel](#)

**Attachments:**

Nº	File
Choose file(s) to upload	<a href="#">Выбрать файлы</a> Файл не выбран

## Features:

Authentication: database roles  
(administrator, shift operator, user)

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

Multi-Column Sorting

LastDay View...

A diagram illustrating the relationship between shift operators and users. On the left, a person icon is shown next to the text "shift operators". On the right, a person icon is shown next to the text "users". A double-headed arrow connects the two person icons, indicating a relationship or interaction between shift operators and users.

## Web-interface



## C++ Interface

## C++ Interface

**Online**

## Offline

The screenshot displays the ROOT online server interface. The top navigation bar includes a search icon and a 'ROOT' logo. The main content area shows a histogram titled 'GEN\_1\_taper\_0' with a peak around 100 ns. The histogram is labeled 'Tof400\_Loading\_Time'. The x-axis is labeled 'Tof400\_Loading\_Time' and ranges from 0 to 200 ns. The y-axis is labeled 'Count' and ranges from 0 to 400. The histogram is a blue line plot. The interface includes a sidebar on the left with a file tree showing the directory structure. The right panel displays a table of statistics for the selected dataset.

Variable	Count	Mean	StdDev
Tof400_Loading_Time	400	100	10

```

macro
  BmnDataToRoot.C

class
  BmnRawDataDecoder

    Binary file
    (RAW data)

    ConvertRawToRoot()

    ROOT file
    (DAQ digits)

    DecodeDataToDigit()

    ROOT file
    (Detector digits)
  
```

## BM@N Offline Database

### Event Analysis in BmnRoot

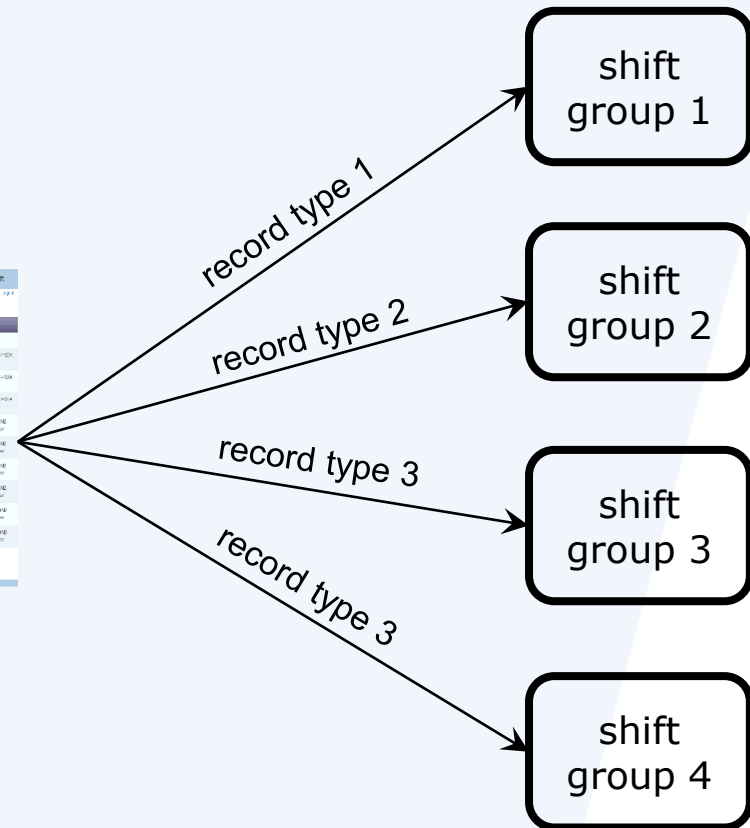
under testing now



different types of events:

“shift started”  
“problem report”  
“configuration”  
“inform all”

...



e-Log FreelPA Authorization and Auto Recovery Services are under development

# Geometry Database for the BM@N experiment

## *Guidelines*

- manage module geometries as ROOT binary objects
- for each module keep: tag, version, transformation matrix, mother module
- manage the pre-defined setups as combinations of module geometries
- manage module version

## *Tasks*

- Store the modules of BM@N
- Load the geometry modules for setup construction
- Construct setup from the stored modules
- Present the BM@N setup
- Support different versions of module



# Web-interface of the Geometry Database



Tag	Date	Status	Author	Description
Setup run6	2018-07-26	Approved	aleksand@jinr.ru	run6 without field

GUI Functions

- View
- Edit
- Download

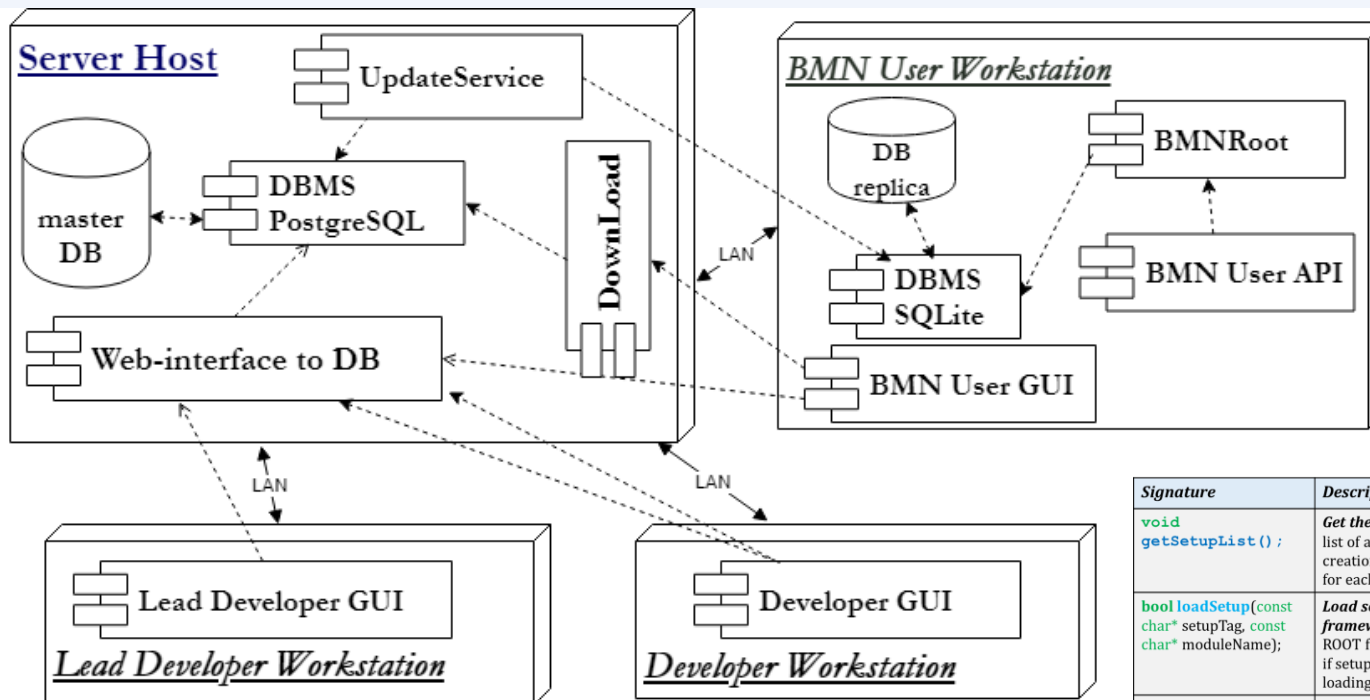
View Setups
View Setup Modules
View Files
View Materials
View Fields
Download GeometryDB

	Tag	Date	Author	Description
PIPE	magnet_modified	2018-07-11		magnet modified
PSD	TOF400_RUN6	2018-07-26		TOF400 RUN6
Material	1	2018-07-03	aleksand@jinr.ru	

## PSD / TOF400\_RUN6

Transformation	Scale	Translation	File Tag
1.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000 1.000	1.000; 1.000; 1.000	0.000; 0.000; 0.000	TOF400_RUN6

# API Interface of the Geometry Database

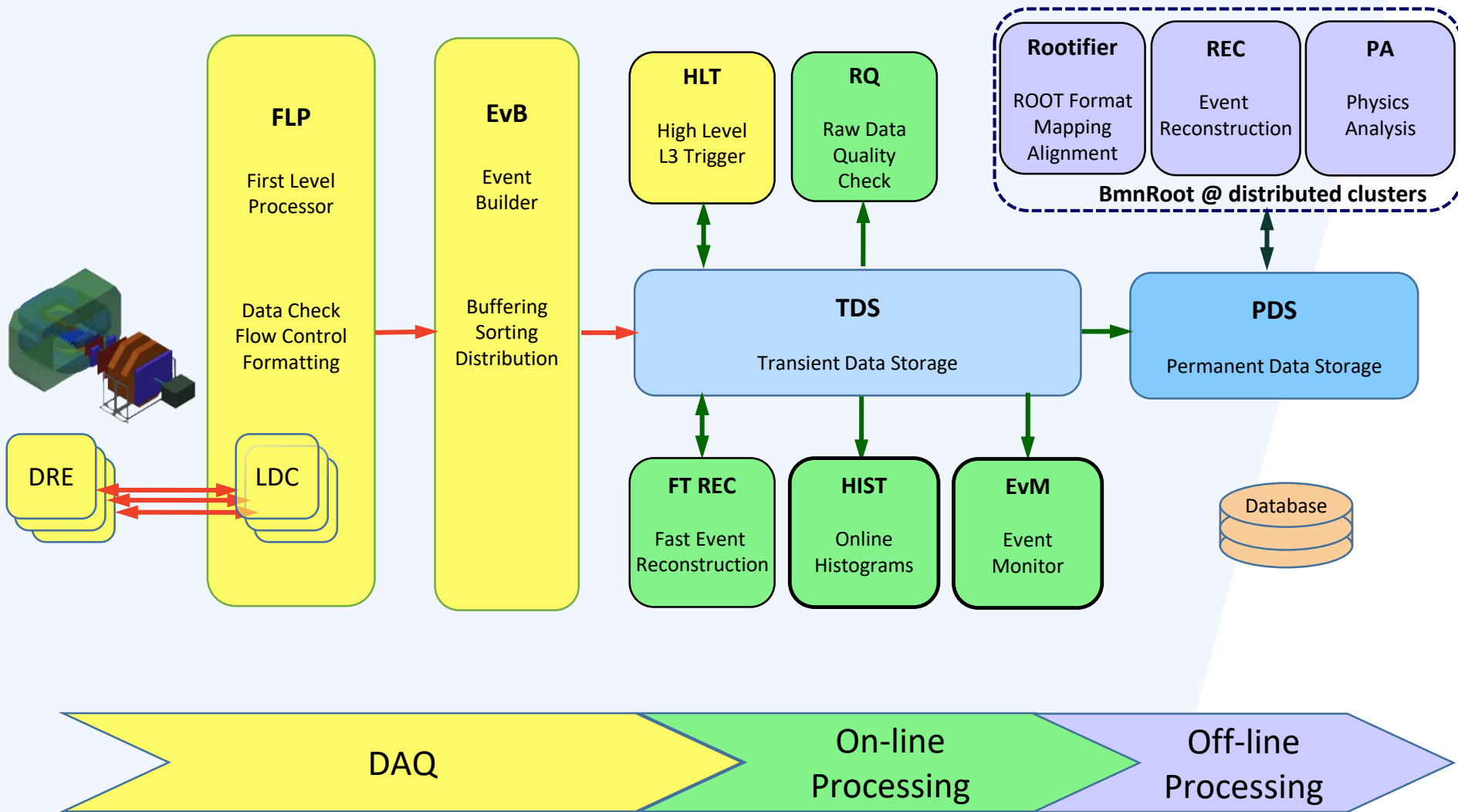


Signature	Description	Call Example	Comment
<code>void getSetupList();</code>	Get the list of available setups. Print the list of available setups including tag, date of creation, author and description parameters for each approved setup.	<code>getSetupList.c();</code>	Return the available setups' list
<code>bool loadSetup(const char* setupTag, const char* moduleName);</code>	Load setup into the BM@N ROOT framework. The Geometry can be used in ROOT framework afterwards. Return FALSE if setup is not loaded, and TRUE if the loading is successful.	<code>bool res = loadSetup("run6", **);</code>	** - all setup modules to be loaded
<code>bool loadSetup(const char* setupTag, int moduleId);</code>	Load setup into BM@N ROOT environment by module Id to load setup into the CBM ROOT framework. The Geometry can be used in ROOT framework afterwards. Return FALSE if setup is not loaded, and TRUE if loading is successful.	<code>bool res = loadSetup("run6",- 1);</code>	
<code>bool loadSetup(const char* setupTag, const char* moduleName, const char* xml);</code>	Load setup into the ROOT environment. Geometry can be used in the ROOT environment after this operation. User can use xml file in order to move any setup module during loading. Return false if setup was not loaded because of errors and true if load is successful.	<code>loadSetup("run6", **,"local.xml")</code>	xml file contains information on the setup modules and their shifts.

## API (Application Programming Interface)

implemented as macros of the ROOT environment

# BM@N Data Processing Pipeline



# Online Histogramming: Web-interface

jsROOT server provides processed data via the Web

Welcome to the BM@N Experiment   Triggers   GEM   Silicon   ToF400   ToF700   DCH   MWPC   ZDC   ECAL   SRC Triggers   LAND   MSC

## BM@N Silicons

Run: 4147

Event: 20000

Run Type: beam

Energy: 3.20

Beam: Ar

Target: C

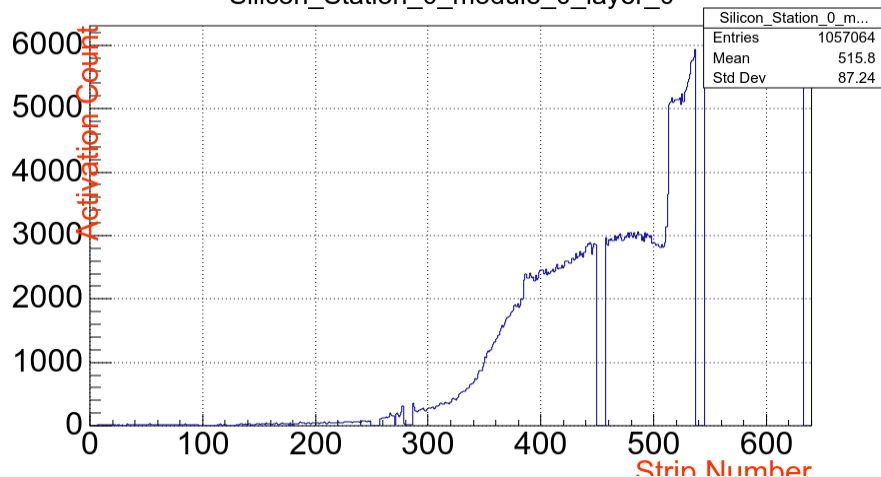
Field Voltage: 77.60

*Ilnur GABDRAKHMANOV*  
(14 October 12:15)

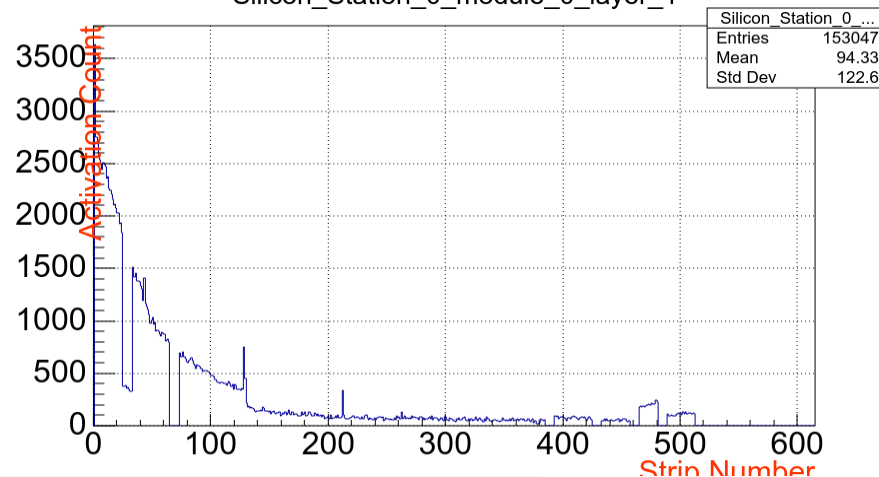
Online Monitoring System for  
BM@N and Raw Data Converter

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

Silicon\_Station\_0\_module\_0\_layer\_0

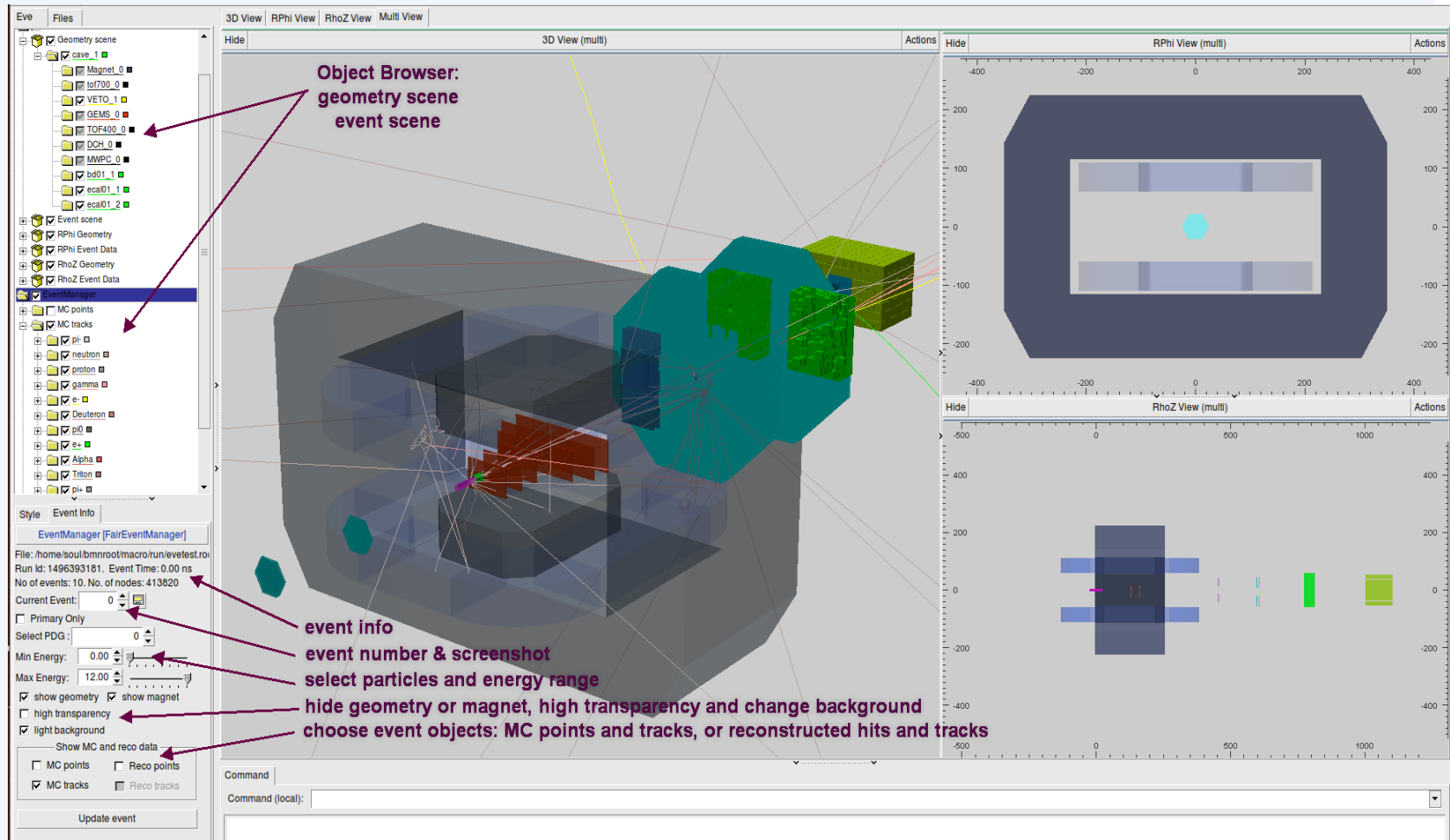


Silicon\_Station\_0\_module\_0\_layer\_1

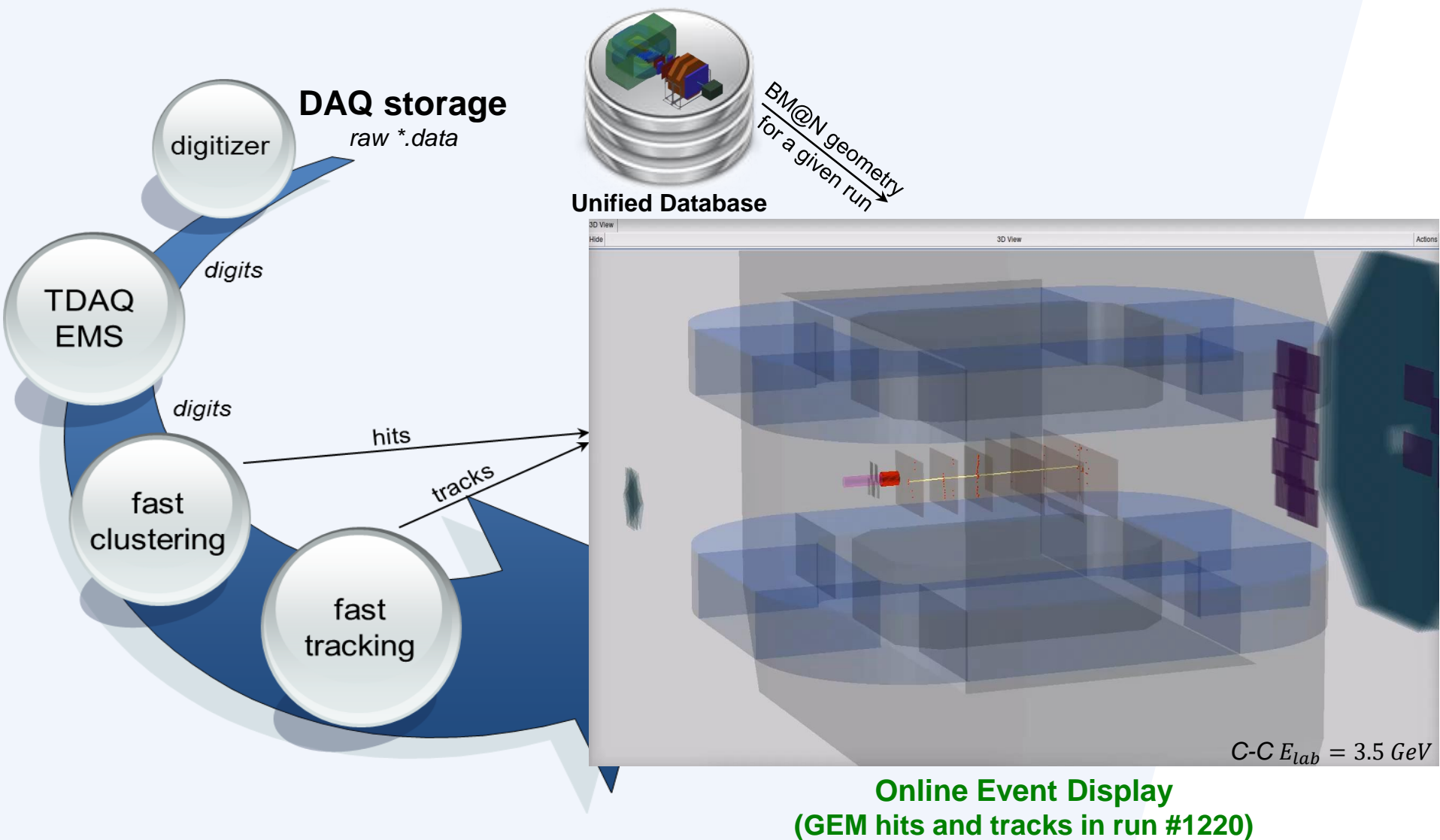


# Event Display for the BM@N experiment

The Event Display can show/hide setup geometry, simulated and reconstructed data: **points**, **hits**, **tracks**, **calorimeter towers**, select event to display, select particles with definite PDG codes, set energy range and many other visualization options.

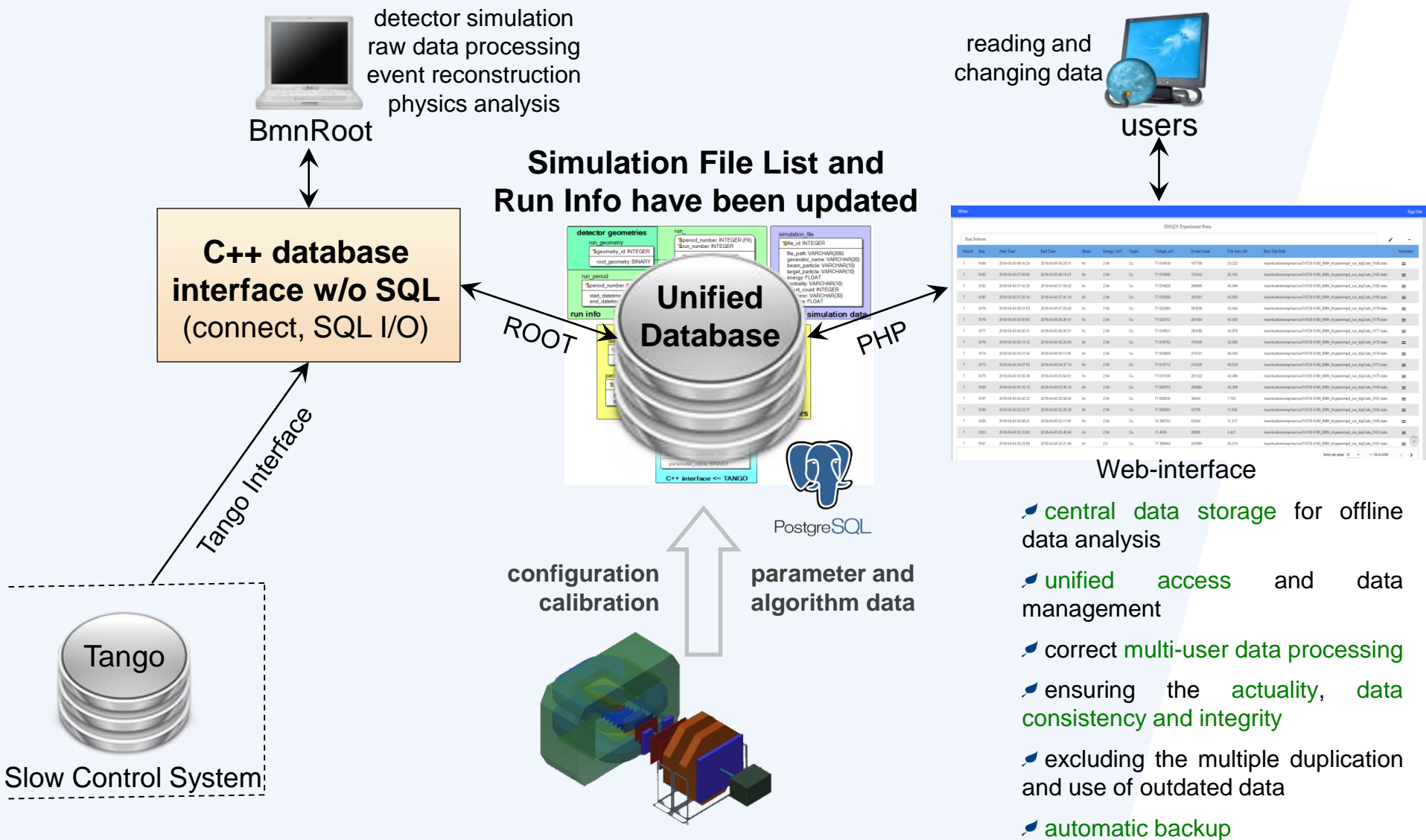


# Online Event Display





# BM@N Central Database for offline processing



# Web-interface of the BM@N database

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

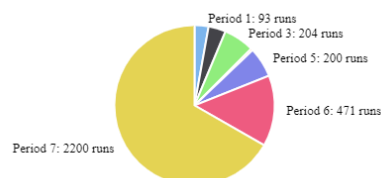
Period 6

Show

Reset

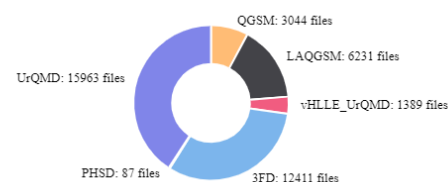
## Experimental Data

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



## Simulation Data

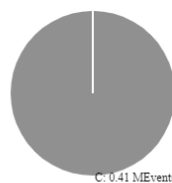
Distribution of simulation files by generators



## Beam - Energy - Target distributions

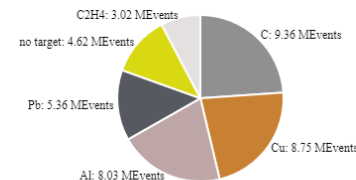
### Beam C ( E = 5.14 GeV/n )

Total: 0.41 MEEvents



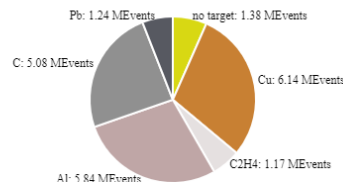
### Beam C ( E = 4.5 GeV/n )

Total: 39.14 MEEvents



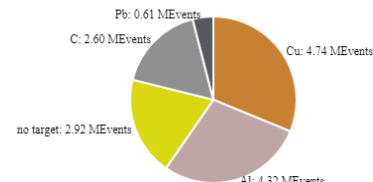
### Beam C ( E = 4 GeV/n )

Total: 20.85 MEEvents



### Beam C ( E = 3.5 GeV/n )

Total: 15.19 MEEvents

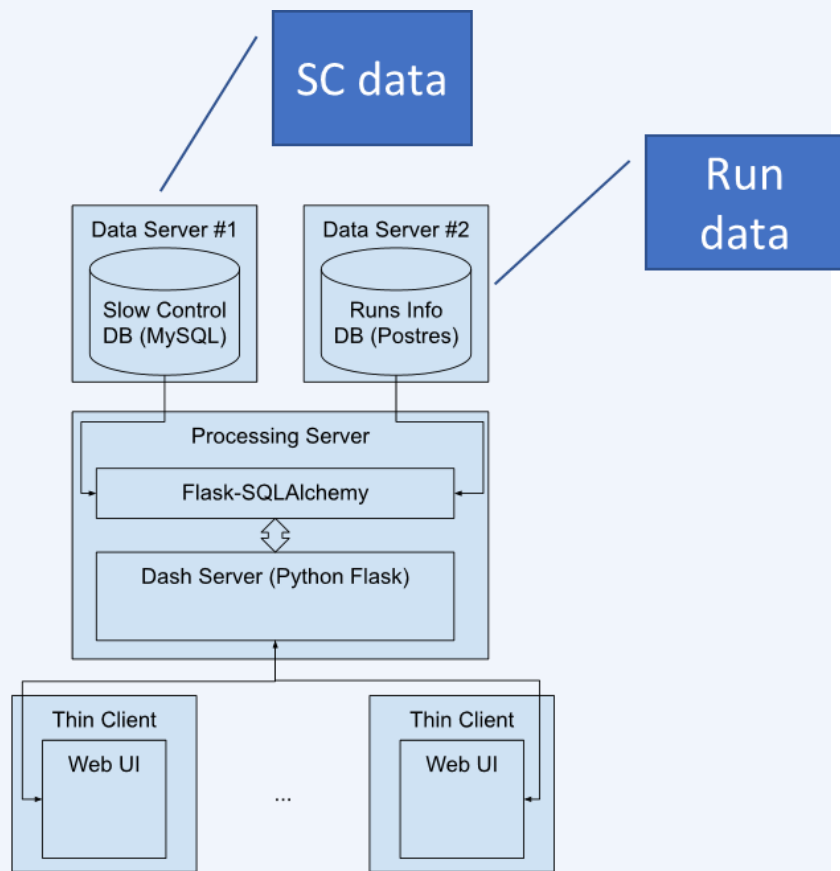


[bmn-web.jinr.ru](http://bmn-web.jinr.ru)

storing information on BM@N experiment sessions and runs, setup geometries, detectors, parameters and parameter values, and generated simulation files

Alexander CHEBOTOV  
(14 October 10:35)  
User web-interface for the  
BM@N offline database

# Tango Slow Control Visualization



BM@N slow controls viewer

## Run selection

7 5158 apply

## Selected run info

Period number: 7

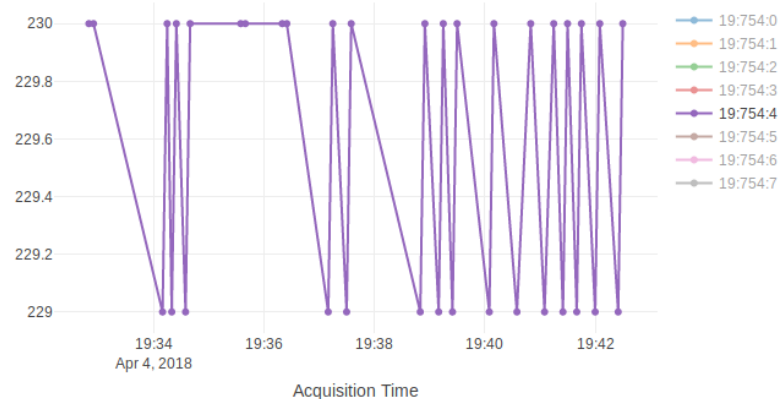
Run number: 5158

Start time: 2018-04-04 19:32:02

End time: 2018-04-04 19:42:36

bmn x daq x ups x outputvoltage x apply

bmn-daq-ups-outputvoltage

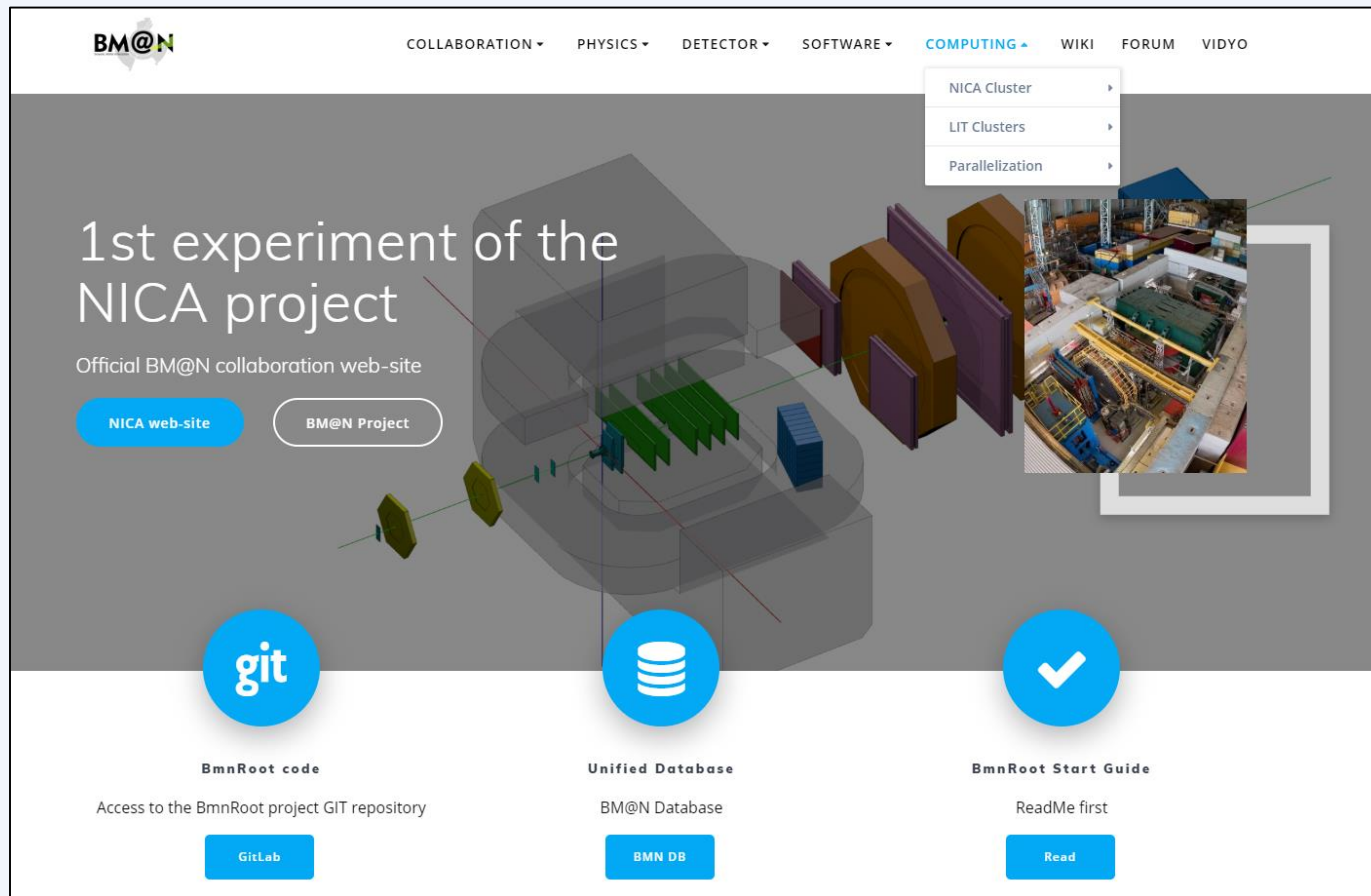


# Collaboration Services

*Ivan SLEPOV*  
(14 October 09:35)

Web-services for the BM@N experiment

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



- ✓ **Information**
- ✓ **Documents**
- ✓ **Software**
- ✓ **Databases**
- ✓ **Computing Section**  
(NICA Cluster, MICC Complex, HybriLIT & Govorun)
- ✓ **Tests dashboard**
- ✓ **Guides**
- ✓ **Forum**
- ✓ **Vidyo**
- ✓ **BM@N Mail-lists**  
(updates, errors...)
- ✓ **etc.**

# BM@N Forum & News system

The screenshot displays the BM@N Forum & News system interface. At the top, the BM@N logo is on the left, the URL <http://se49-48.jinr.ru> is in the center, and search, menu, and user icons are on the right. Below the header, there are tabs for 'all categories', 'Categories' (highlighted in red), and 'Latest'. A '+ New Topic' button is also present. The main content area is a grid of topic cards. Each card has a title, an icon, and a list of links. The cards are: 'Staff' (with a lock icon and links to 'READ ME FIRST: Admin Quick Start Guide', 'Privacy Policy', and 'FAQ/Guidelines'); 'Site Feedback' (with a blue cube icon and links to 'Non-secure connection' and 'Change the server address'); 'Collaboration News' (with a document icon); 'Collaboration Support and Common Questions' (with a blue vertical bar on the left and links to 'Web space for storing work plots, pics, gifs', '[Gitlab] Can not push commits into my own repository', and 'Mail list creation'); 'Software Development and Data Quality Check Group' (with a green vertical bar on the left and links to 'Changes for the first BmnRoot release', 'Data base connection error', and 'Geometry overlaps'); 'Event Reconstruction and Detector Simulation Group' (with a green vertical bar on the left and a link to 'MWPC geometry'); 'Particle Identification Group' (with a green vertical bar on the left); 'ZDC & ECAL Data Analysis and Simulation Group' (with a green vertical bar on the left); 'Hyperon Reconstruction and Simulation Group' (with a green vertical bar on the left); 'SRC Data Analysis and Simulation Group' (with a green vertical bar on the left and links to 'Trigger setup' and 'PID using DCH tracks'); and 'Physics Analysis Issues' (with a blue vertical bar on the left).

**BM@N Forum & News system (built on Discourse) for a quick communication and discussions between collaboration members and groups:**  
various topics for different groups, subscriptions, comments...



# BM@N Document Server

## Main purposes:

- Document Server should contain all reports, meetings, posters, proceedings materials, articles, theses, grants, video materials, TDR, technical documentation for all experiment systems (manuals, graphics, work detector illustrations), etc.
- It allows cataloging hierarchically all the data for quick access to the desired BM@N section
- Document Server provides a quick search by the desired criteria and sections (keywords, authors, themes...)
- Many convenient tools are highly desirable: subscriptions, favourites for sections and documents...
- It also provides an opportunity to analyze the latest achievements on selected BM@N systems and activities of collaboration members

# BM@N XWiki as Document Server



## Menulist

### BM@N Subsystems

Triggers

Detectors

DAQ

### Run Control

Run 7

Run 6

Run 5

Run 4

Run 3

Run 2

Run 1

### SRC @ BM@N

### Documents

Management

BM@N CDR

BM@N TDR

Articles

Internal Notes

Theses

🏠 / Browse Wikis

## Browse Wikis

Last modified by [Ivan Slepov](#) on 2019/10/11 09:17

Results 1 - 1 out of 1 per page of 10

Name	Description	Owner
<a href="#">Home</a>	Main wiki	<a href="#">Ivan Slepov</a>

Results 1 - 1 out of 1

Tags:



### Disadvantages of the current Wiki:

1. Complex structure
2. No explicit hierarchical cataloging
3. No search by specified criteria
4. No personalizing (e.g. baskets)
5. No subscriptions
6. Some unstable conditions

# Summary

- Because of the **absence of the manpower** for the BM@N software development, the search for external software contributors (students, PhD, tenure) will continue in BM@N collaboration and beyond. Many thanks to the current contributors!
- BmnRoot Release 19.10.0** has been issued. The mass production of the BM@N digits and DST files for Run 7 and Run 6 will be completely performed in a couple of weeks.
- The architecture of the **BM@N mass data processing** is under active development, and all related workflow services are under deployment now.
- RFBR support** with the NICA three-year grant (18-02-40125) enables to significantly improve the Information Systems for BM@N online and offline data processing.
- Many **offline and online software systems** have been developed, but a lot of packages and services should be implemented for BM@N data processing. The list of software tasks is containing about 30 problems of different priorities.

# Software Management via GIT Issues

GitLab Projects Groups Activity Milestones Snippets

Search or jump to...

Issues 38

Open

Raw Converter 4

Single Silicon and GEM digits included in the Raw Data Converter  
Raw Converter  
#2 Mar 28

Support all runs in the Raw Data Converter  
Raw Converter  
#4 Aug 30

Modular Structure of the Raw Data Converter  
Raw Converter  
#5 Sep 24

Macro for adding TOF700 slewing and INL corrections to the BM@N Database  
Raw Converter  
#16 May 15

Alignment 1

Global BM@N Alignment  
Alignment  
#6 Jul 24

Simulation 2

CBM STS geometry/classes/simulation to BmnRoot  
Simulation  
#14 May 29

Simulation of new ZDC geometry with CBM modules  
Simulation  
#18 May 29

Reconstruction 8

Tracking selection in the reconstruction macro  
Reconstruction  
#8 Jun 1

DCH in the BmnRoot reconstruction (conducted runs)  
Reconstruction  
#9 Mar 27

DCH in the global tracking  
Reconstruction  
#10 May 22

Matching TOF400 data with global tracks  
Reconstruction  
#11 Aug 7

Matching TOF700 data with global tracks  
Reconstruction  
#13 Sep 4

Add CSC to the BmnRoot reconstruction  
Reconstruction  
#15 Jul 17

Add Fcal to the BmnRoot reconstruction

19 issues have been completed in 2019  
29 issues are still open to be done

https://git.jinr.ru/nica/bmnroot/issues

## GIT Issues:

Milestones → Issue List → Boards with Labels

# Global Development Issues

## **Distributed and High-Performance Computing**

Implementing Distributed Data Flow | Cluster Performance Evaluation  
Parallelization in ROOT (RDataFrame, PROOF) and Geant4 (CUDA)  
Search-profiling-parallelizing: OpenMP, MPI, CUDA/OpenCL...  
MPD-Scheduler evolution  
Workload Manager for Big Data: Panda, DIRAC, ALFA...

## **Visualization**

Event Display as a Web-service: offline & online systems  
Training course for the BM@N event display...

## **Databases and User Interfaces**

Selection of the framework for BM@N File Catalog: RUCIO...  
Converting existing text and table data to the Database view  
Web-monitoring of the Database...

## **Web-services & Online Systems**

Online Monitoring System implementation via DDS system  
Distributed Processing via the Web-service...

## **Simulation and Reconstruction**

New methods for track reconstruction (GenFit...)  
Implementation of fast event reconstruction for online processing  
Global Alignment based on Millepede II...



***Thank you for your attention!***

More information: [bmn.jinr.ru](http://bmn.jinr.ru)  
[nica.jinr.ru](http://nica.jinr.ru)

Forum: <http://se49-48.jinr.ru>

Email: [gertsen@jinr.ru](mailto:gertsen@jinr.ru)

