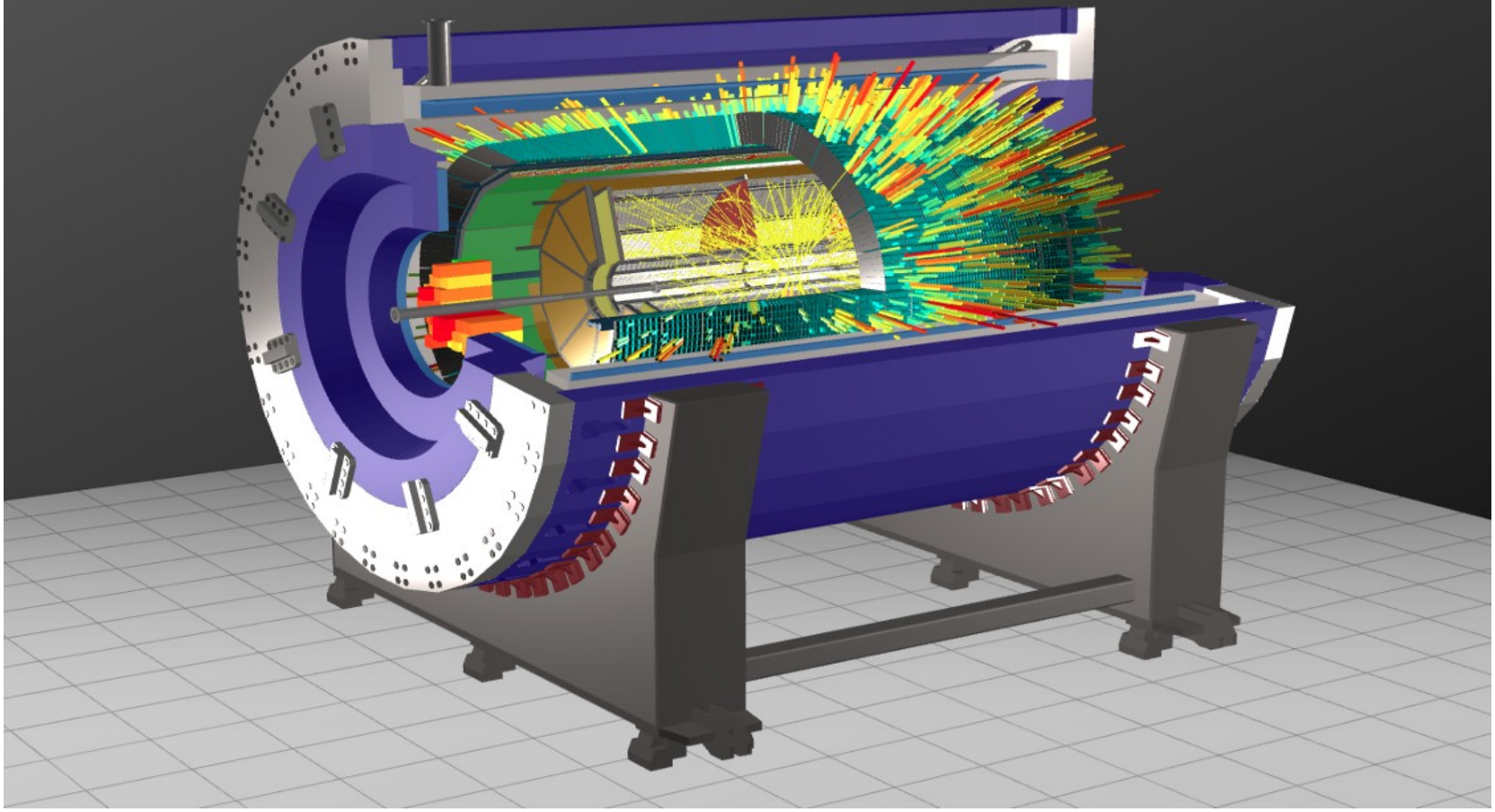
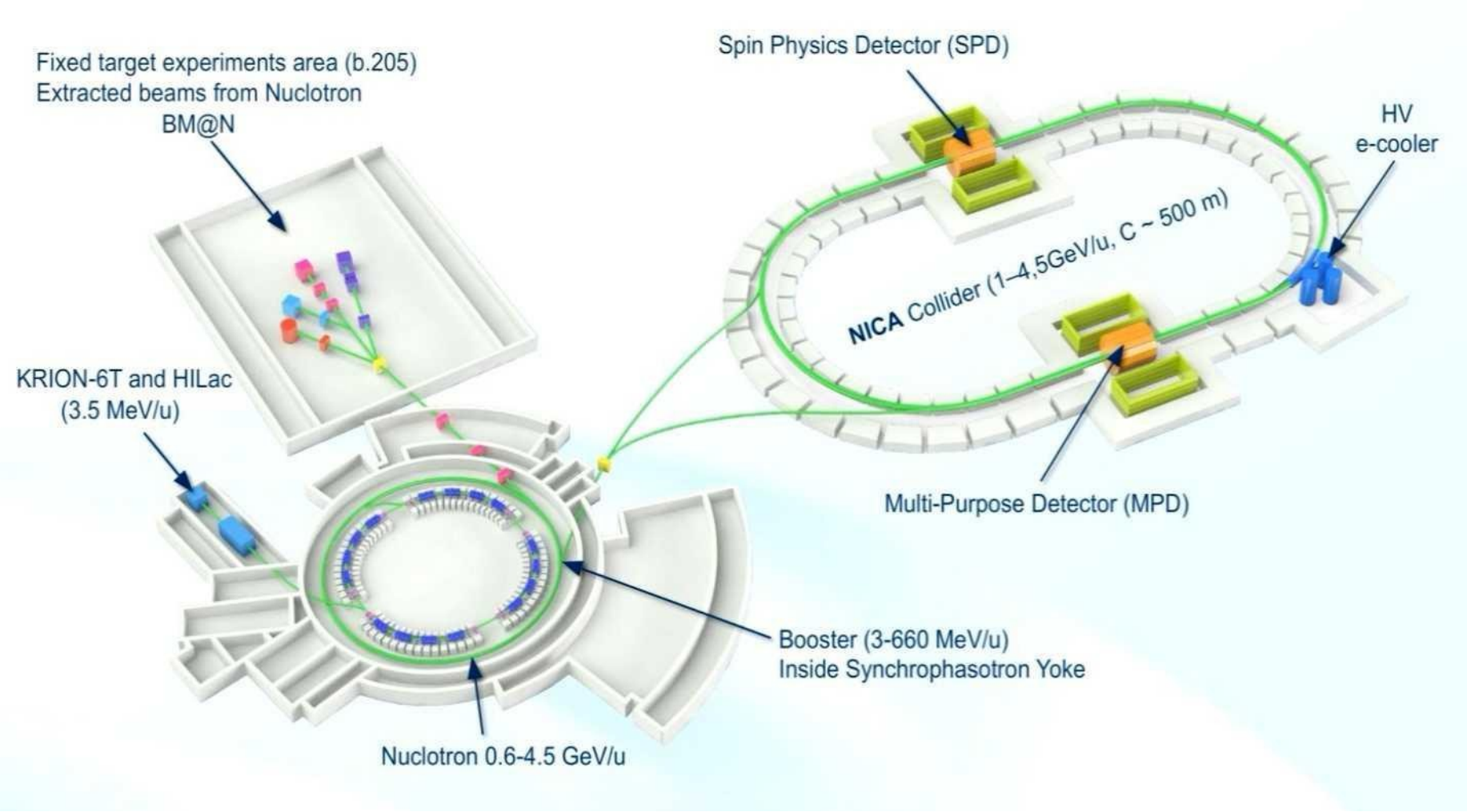
Software development & computing for MPD



Rogachevsky Oleg
for MPD collaboration
rogachevsky@jinr.ru

VIII MPD collaboration meeting
13.10.2021
Dubna

Nuclotron based Ion Collider fAcility



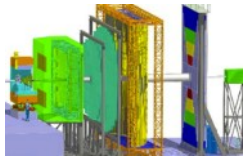
- Beams: from p to Au^{79+}
- Luminosity: $10^{27}\ cm^{-2}s^{-1}$ (Au), 10^{32} (p↑)
- Collision energy: $\sqrt{S_{NN}}$ = *4 – 11 Gev* E_{lab} = *1 – 6 AGev*

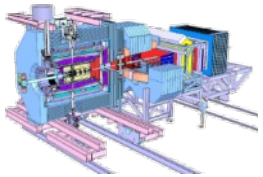
MpdRoot history

Start testing the VMC concept for CBM

2004

First Release of CbmRoot



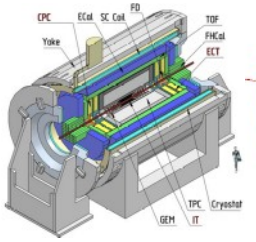


Panda decided to join → oct.

FairRoot: base package for experiments

2006

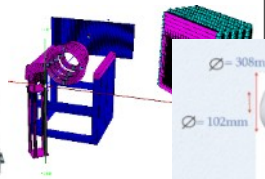
MPD@NICA started with FairRoot

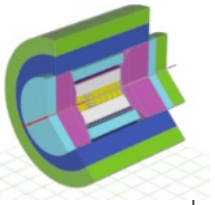


R3B joined

2010

ASYEOS joined

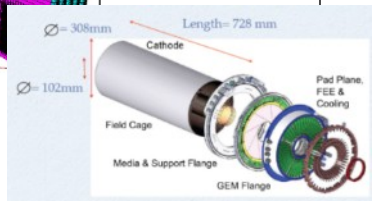


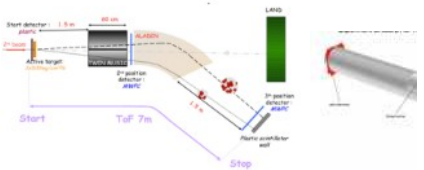


EIC (Electron Ion Collider BNL)

2011

GEM-TPC separated from PANDA branch





SOFIA (Studies On Fission with Aladin)

2012

ENSAR-ROOT

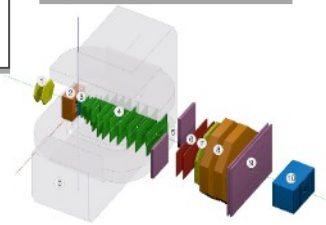
Collection of modules used by structural nuclear physics exp.

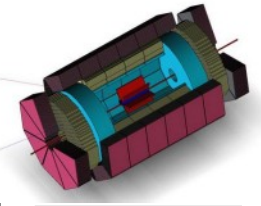
2013

SHIP (Search for Hidden Particles)

2014

BM@N@NICA started with FairRoot



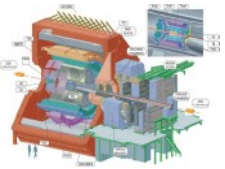


SPD@NICA joined

2015

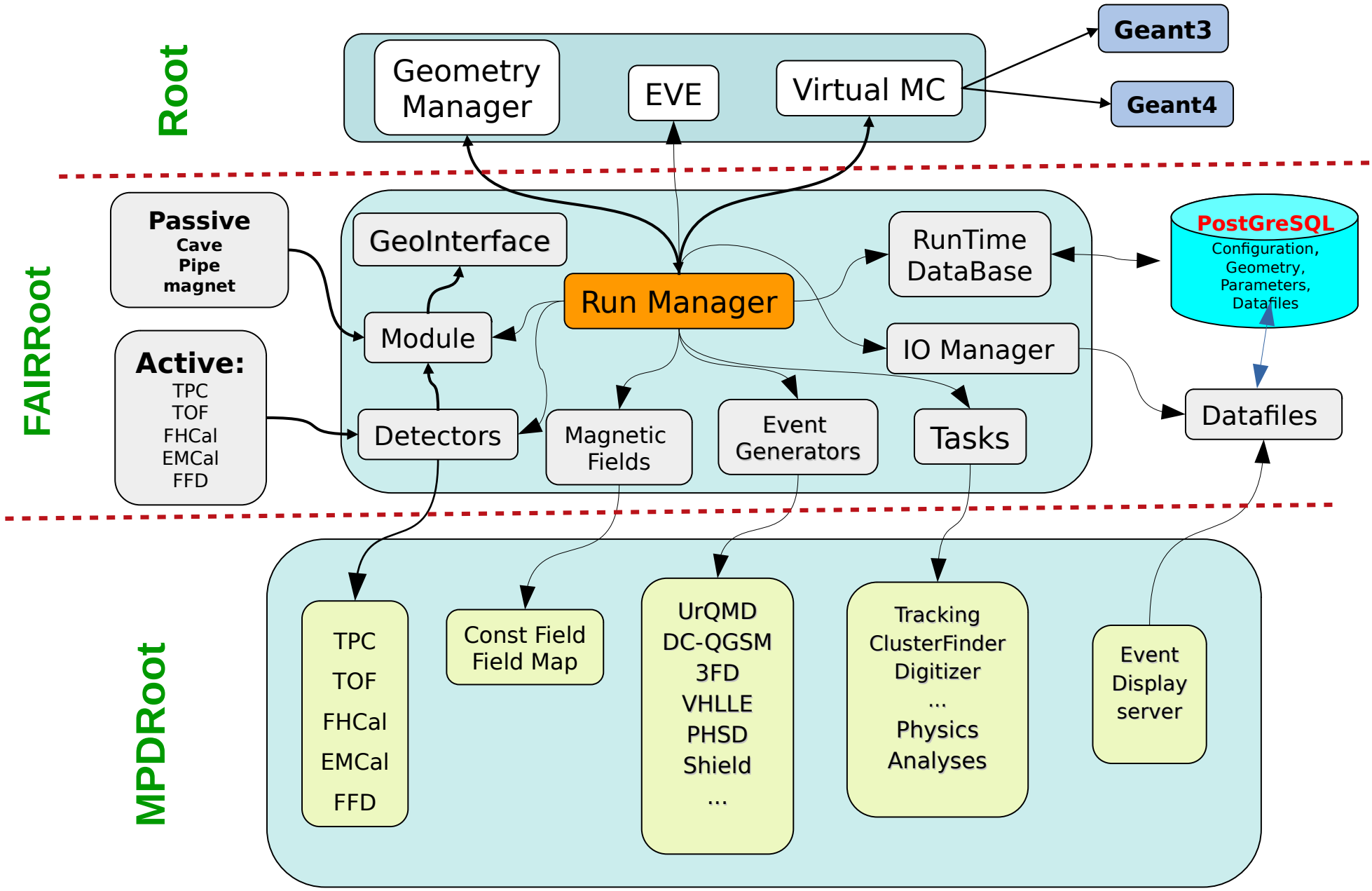
ALICE

FAIR

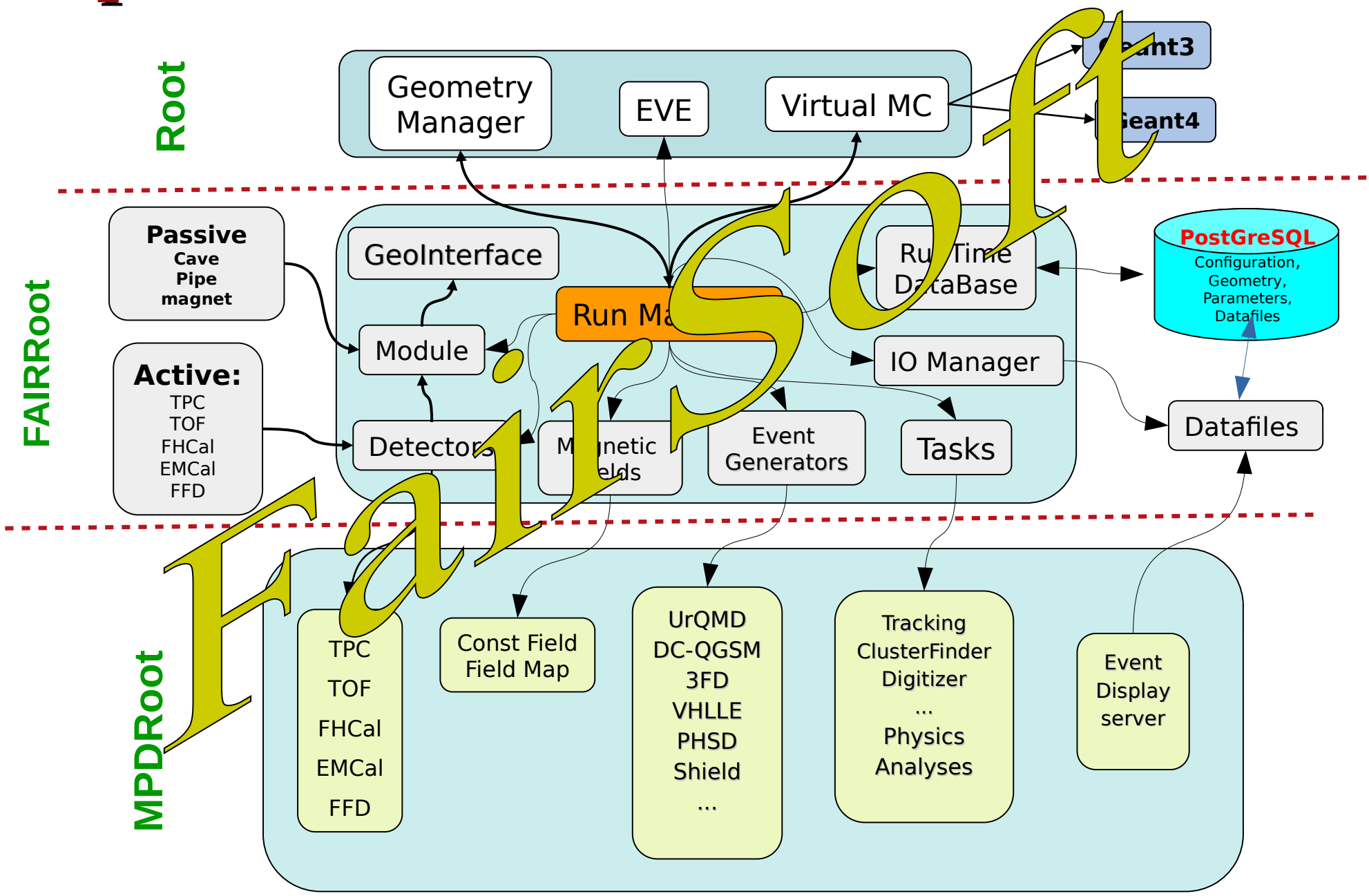


2007 Letter of Intent
2014 Conceptual Design Report
2015 … Detectors TDRs

MpdRoot structure



MpdRoot structure



FairSoft

Latest release apr21

Included packages

Package	Version	URL
boost	1.75.0	https://www.boost.org/
clhep	2.4.4.0	http://proj-clhep.web.cern.ch
dds	3.5.10	http://dds.gsi.de
fairlogger	1.9.2	https://github.com/FairRootGroup/FairLogger
fairmq	1.4.33	https://github.com/FairRootGroup/FairMQ
flatbuffers	1.12.0	https://github.com/google/flatbuffers
fmt	6.1.2	https://github.com/fmtlib/fmt
geant3	3-8_fairsoft	https://github.com/FairRootGroup/geant3
geant4	10.7.1	https://geant4.web.cern.ch
geant4_vmc	5-3	https://github.com/vmc-project/geant4_vmc
hepmc	2.06.11	http://hepmc.web.cern.ch
odc	0.18	https://github.com/FairRootGroup/ODC
pythia6	428-alice1	https://github.com/alisw/pythia6
pythia8	8303	http://home.thep.lu.se/~torbjorn/pythia8
root	6.22.08	https://root.cern
vc	1.4.1	https://github.com/VcDevel/Vc
vgm	4-8	https://github.com/vmc-project/vgm
vmc	1-0-p3	https://github.com/vmc-project/vmc
zeromq	4.3.2	https://github.com/zeromq/libzmq

Boost Libraries: Asio, Atomic, Beast, Bind, Container, Core, DLL, Filesystem, GIL, Intrusive, Interprocess, JSON, LexicalCast, Log, Math, Move, Multiprecision, Nowide, Optional, Outcome, Parameter, PFR, PolyCollection, Predef, PropertyTree, Regex, StackTrace, TypeTraits, Variant2.

The Dynamic Deployment System (DDS) - is a tool-set that automates and significantly simplifies a deployment of user defined processes and their dependencies on any resource management system using a given topology.

FairMQ is designed to help implementing large-scale data processing workflows needed in next-generation Particle Physics experiments. FairMQ is written in C++

FlatBuffers is a cross platform serialization library architected for maximum memory efficiency. It allows you to directly access serialized data without parsing/unpacking it first, while still having great forwards/backwards compatibility

Vc: portable, zero-overhead C++ types for explicitly data-parallel programming

Virtual Geometry Model (VGM) is a geometry conversion tool, actually providing conversion between Geant4 and ROOT TGeo geometry models. Its design allows inclusion of another geometry model by implementing a single sub-module instead of writing bilateral converters for all already supported models.

The Online Device Control project control/communicate with a graph (topology) of FairMQ devices using DDS or PMIx

FairRoot

Latest release 18.6.4

The FairRoot framework

A simulation, reconstruction and analysis framework that is based on the ROOT system. The user can create simulated data and/or perform analysis with the same framework. Geant3 and Geant4 transport engines are supported, however the user code that creates simulated data do not depend on a particular monte carlo engine. The framework delivers base classes which enable the users to construct their detectors and /or analysis tasks in a simple way, it also delivers some general functionality like track visualization. Moreover an interface for reading magnetic field maps is also implemented.

License

FairRoot is distributed under the terms of the GNU Lesser General Public Licence version 3 (LGPLv3).

Release information

Please see : https://github.com/FairRootGroup/FairRoot/releases

Getting started

Please see : http://fairroot.gsi.de/getting_started for details.

Using the Project template

FairRoot deliver meanwhile a project template that can be used as a starting point for anybody who would like to build simulation and reconstruction on FairRoot. The project Template is in the FairRoot/template/project_template directory

The template demonstrate and implement the following:

General structure of the software (cake config files, VMC/Geant configurations, etc ..)

Example detector with sensitive and passive volumes (NewDetector) and data class

Particle Stack for Geant3/4 with filtering infrastructure

Event generators (Pythia6,8) more are available directly from FairRoot

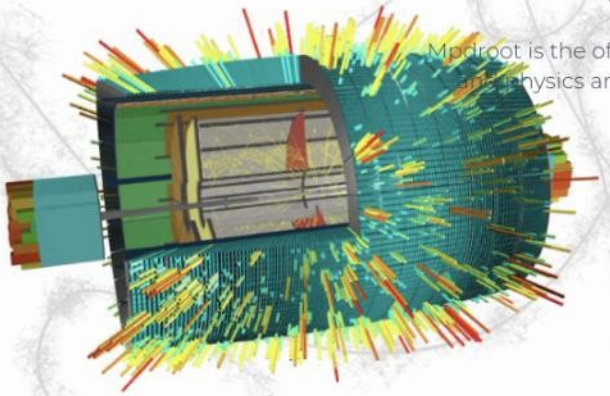
Passive component implementation (Magnet Yoke, Beam Pipe)

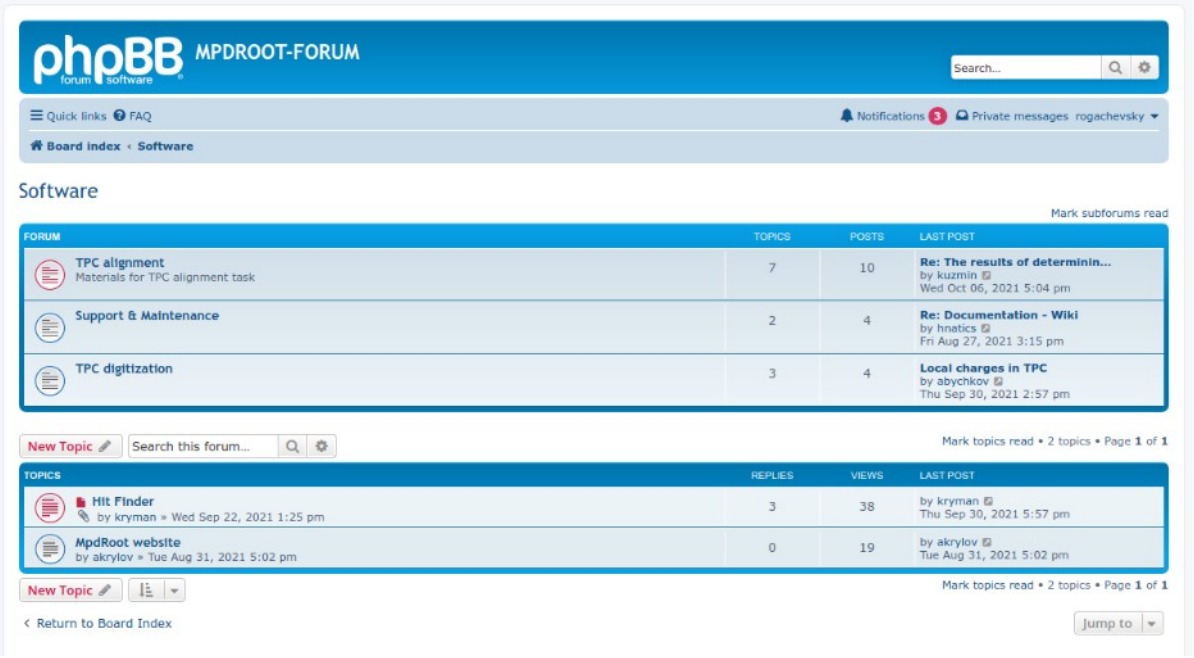
Track visualisation tool (Event display)

A rename script which replace all the generic names to user defined ones

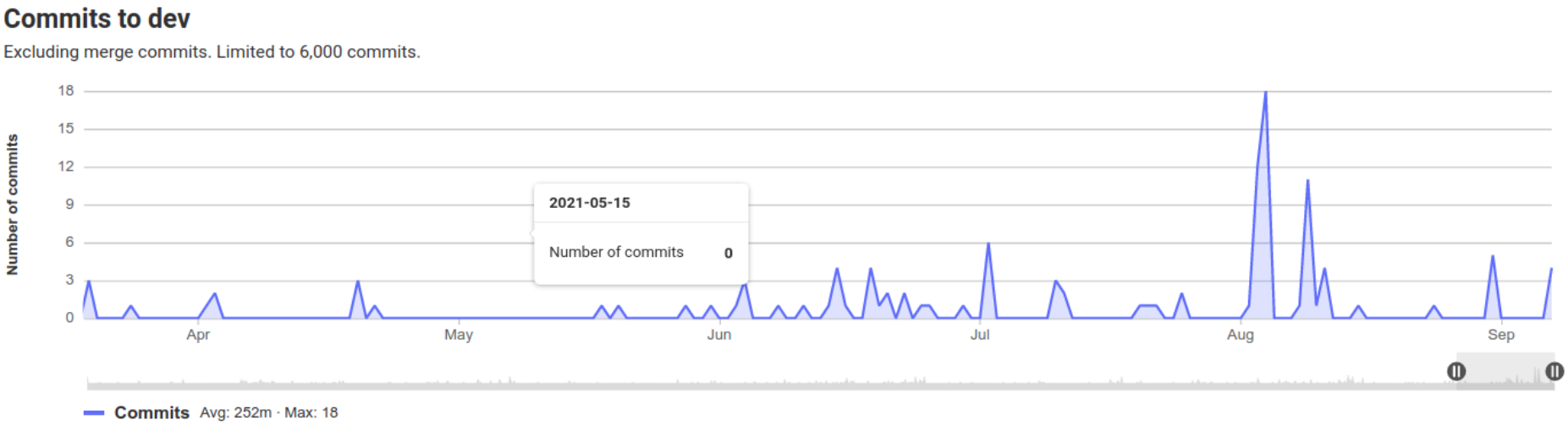
Mpdroot

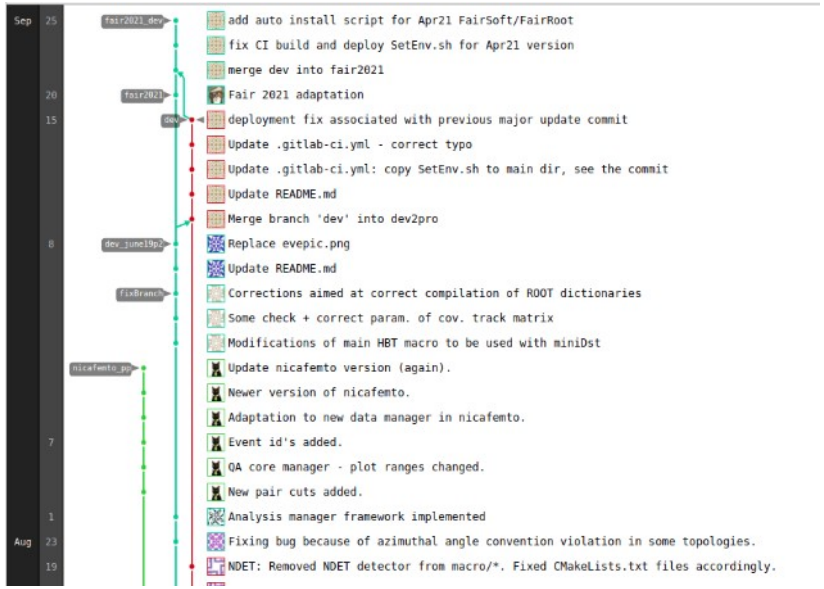
mpdroot.jinr.ru





MPD Software status (GIT)



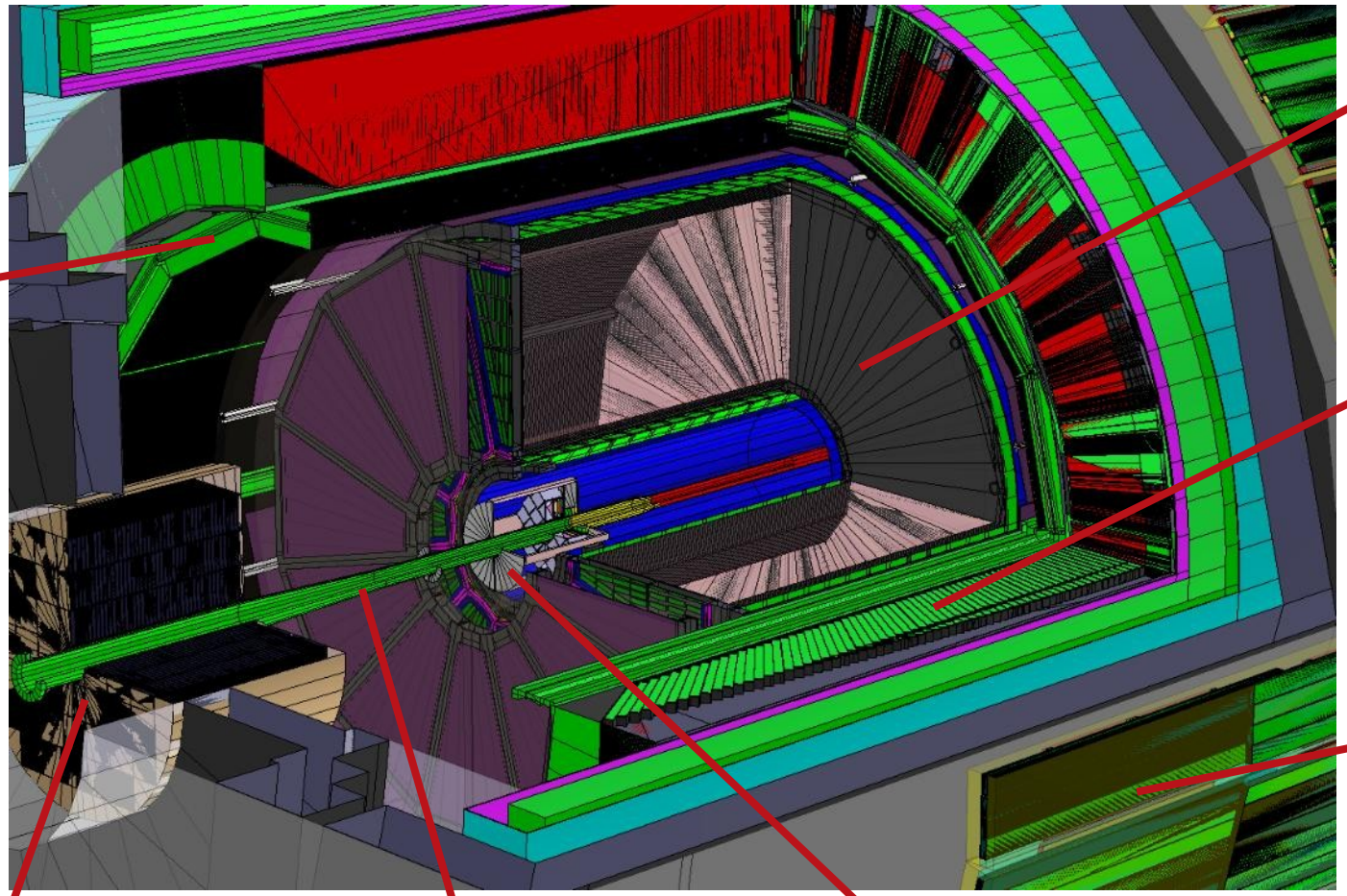


Clean list of developers MpdRoot 52 -> 40

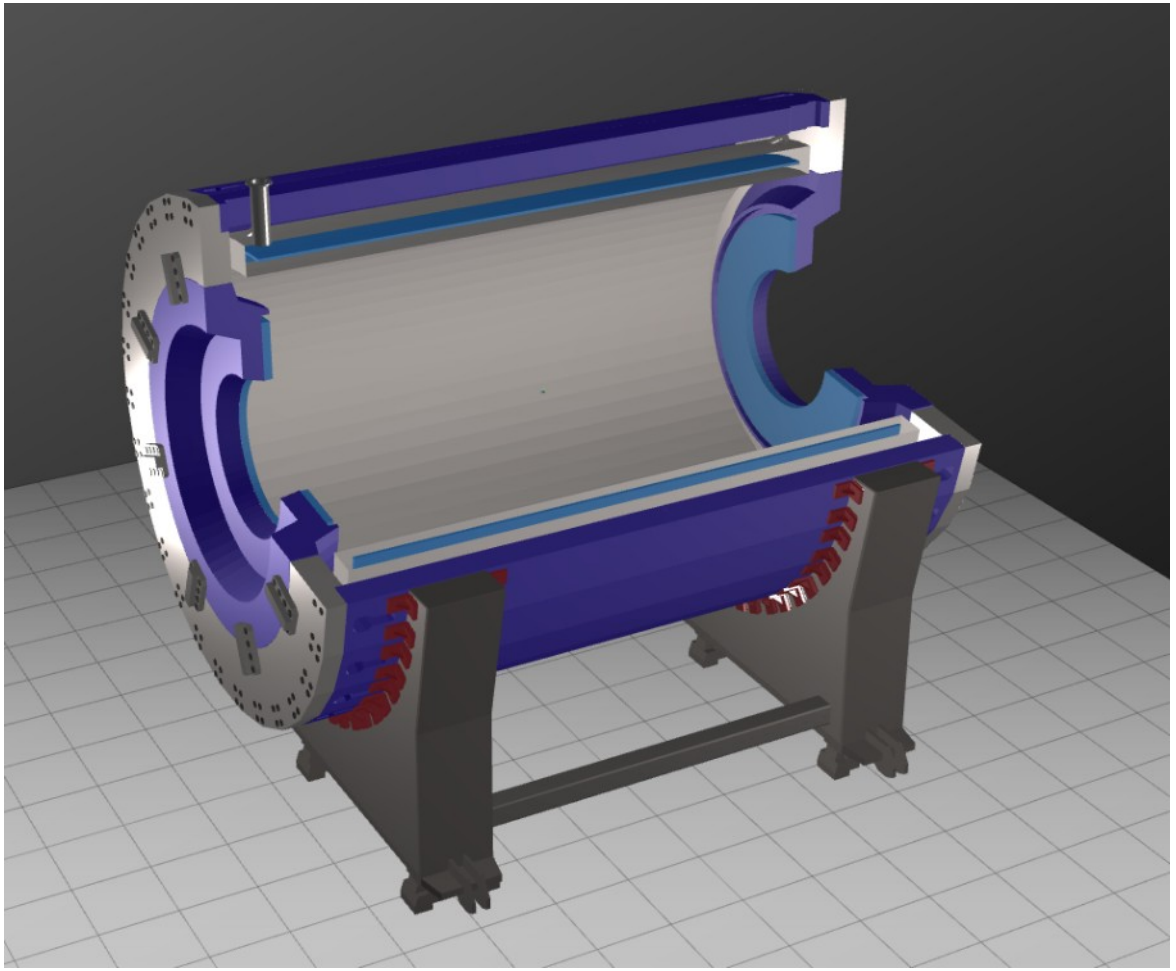
Make list of codeowners.

Codeowners from PWG ?

MPD geometry checked for stage 1



New geometry for magnet

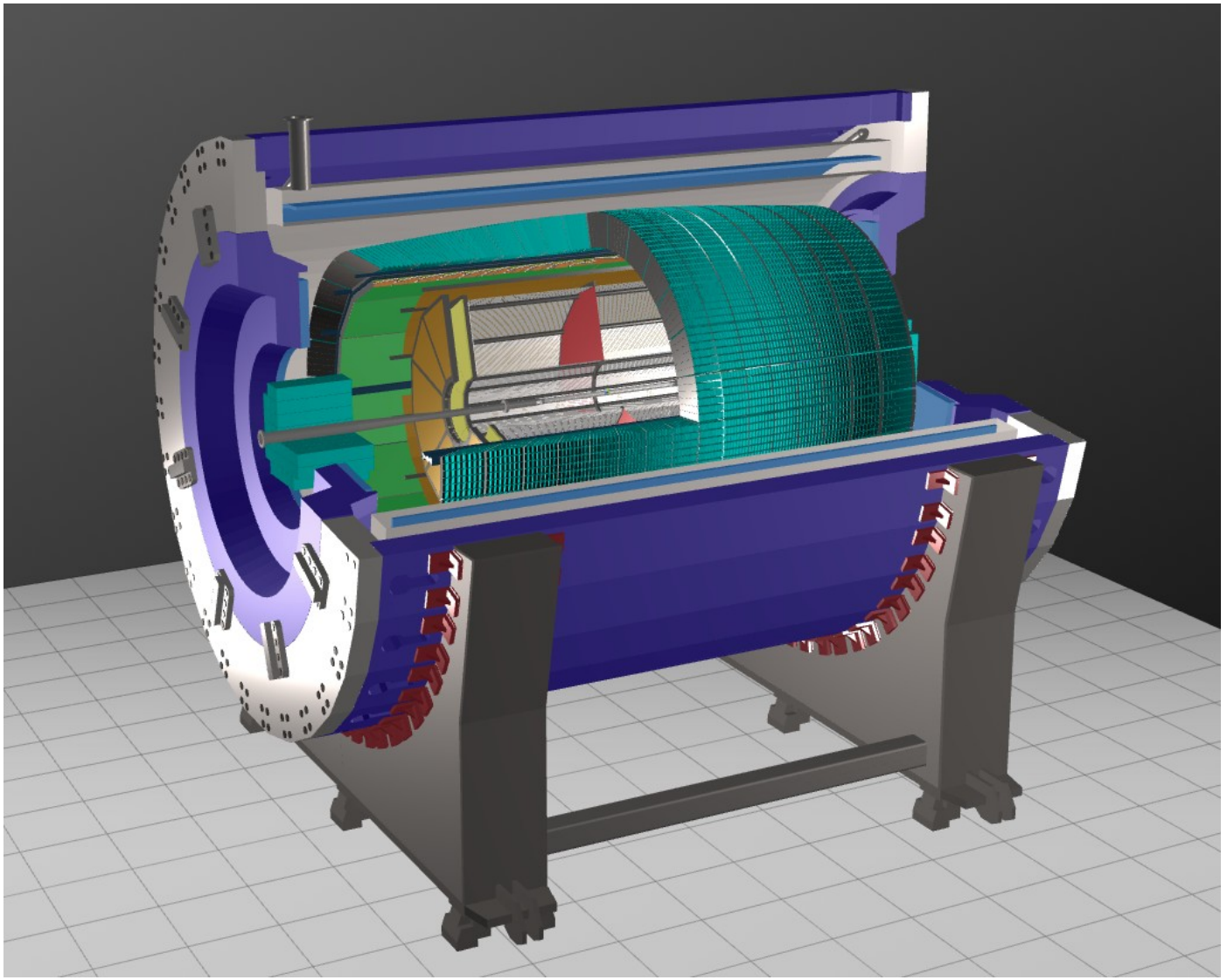


Magnet
with
Cradle

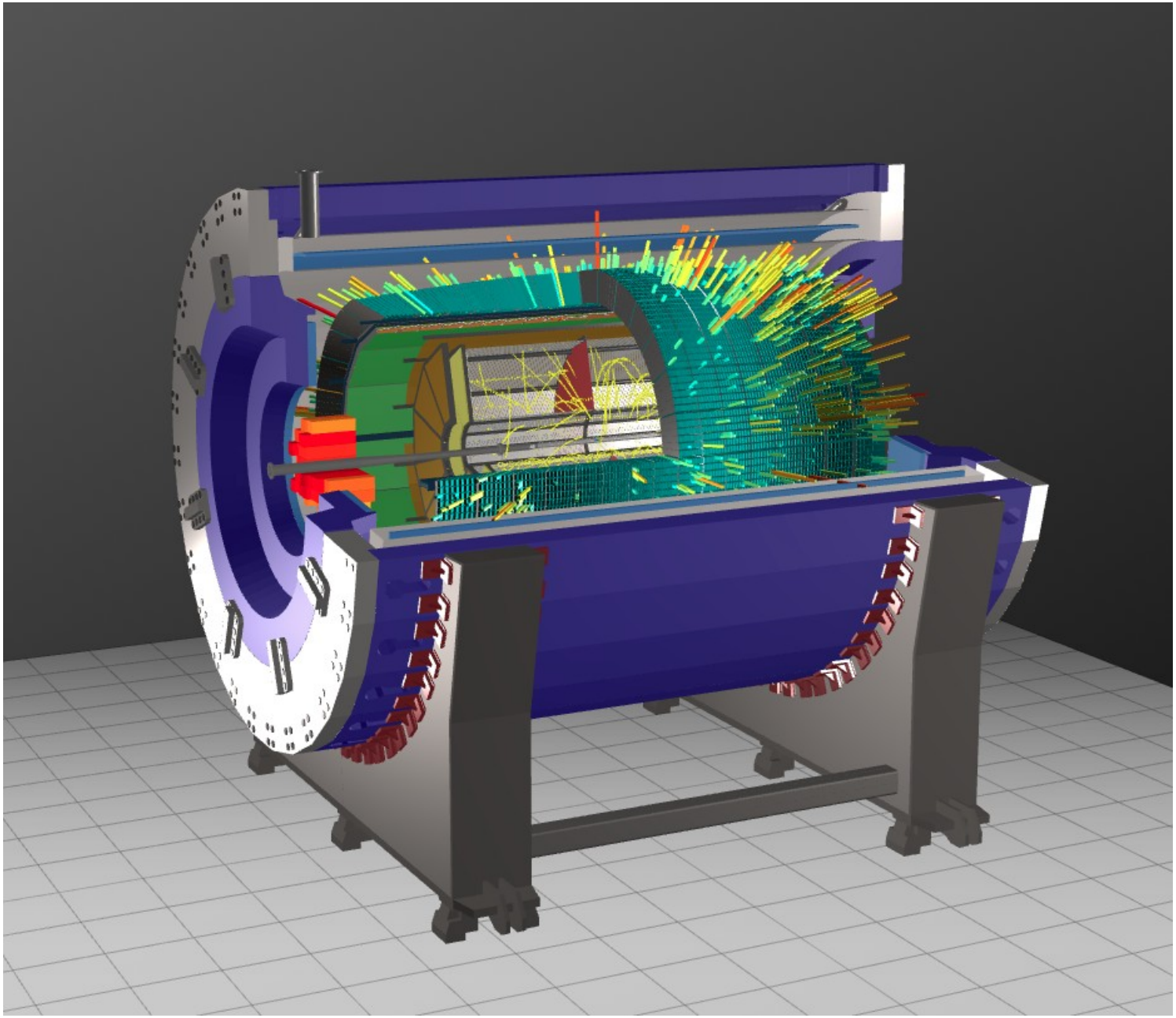
MPD: Event Display geometry

https://mpd-edsrv.jinr.ru/

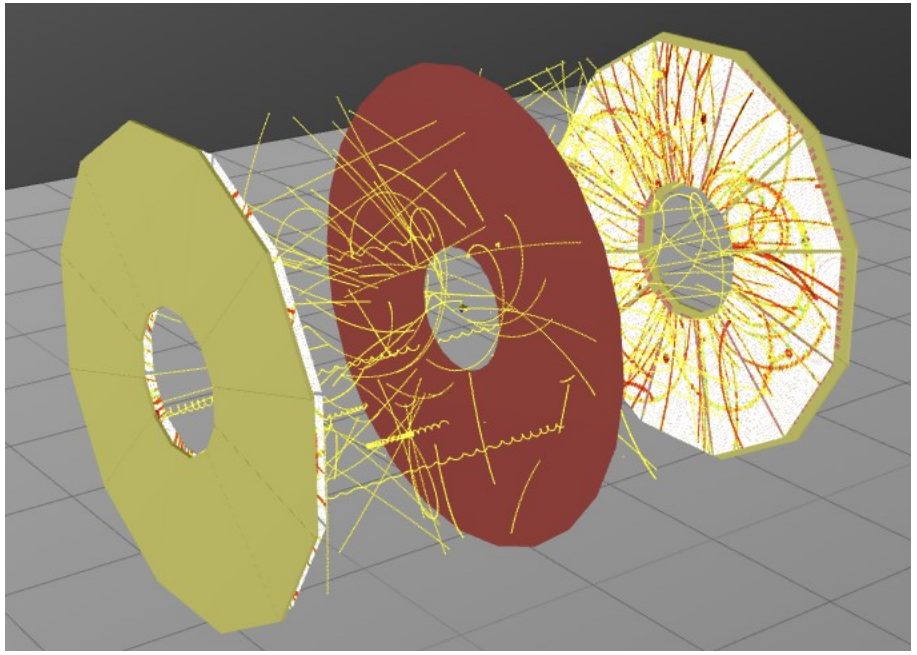
Krylov A. report

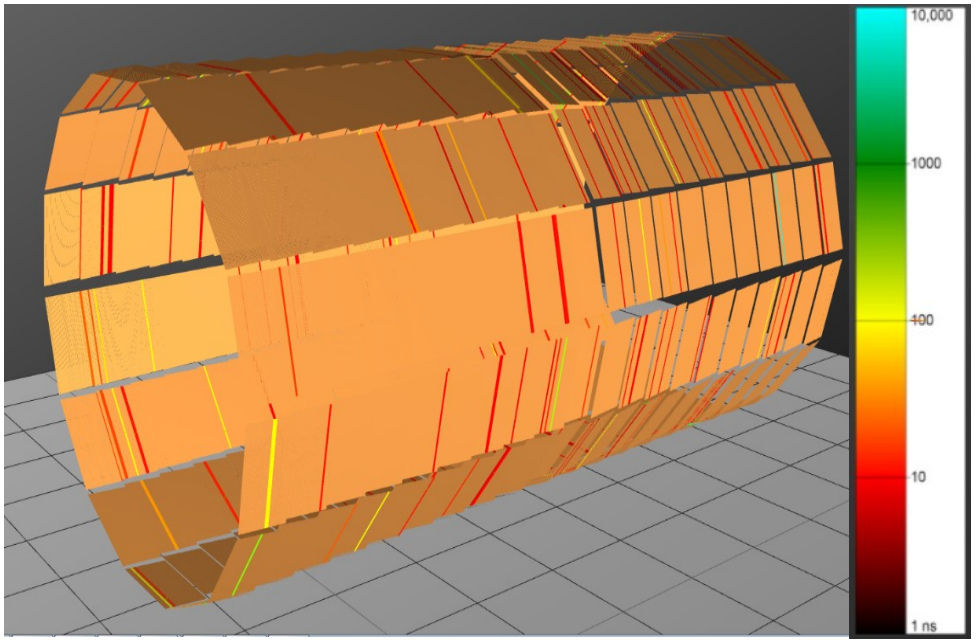


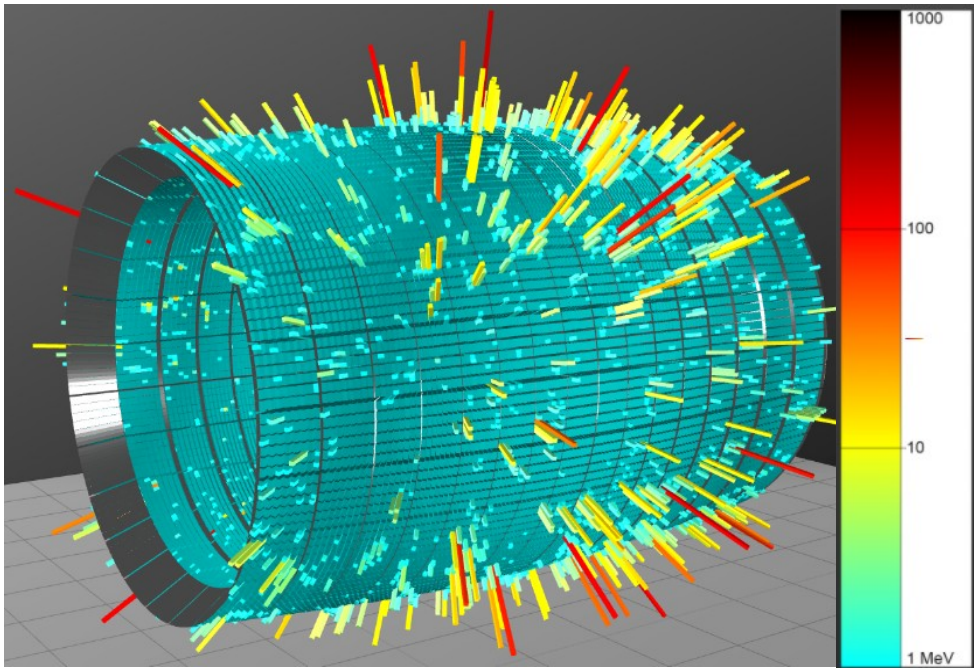
MPD: Event Display Events

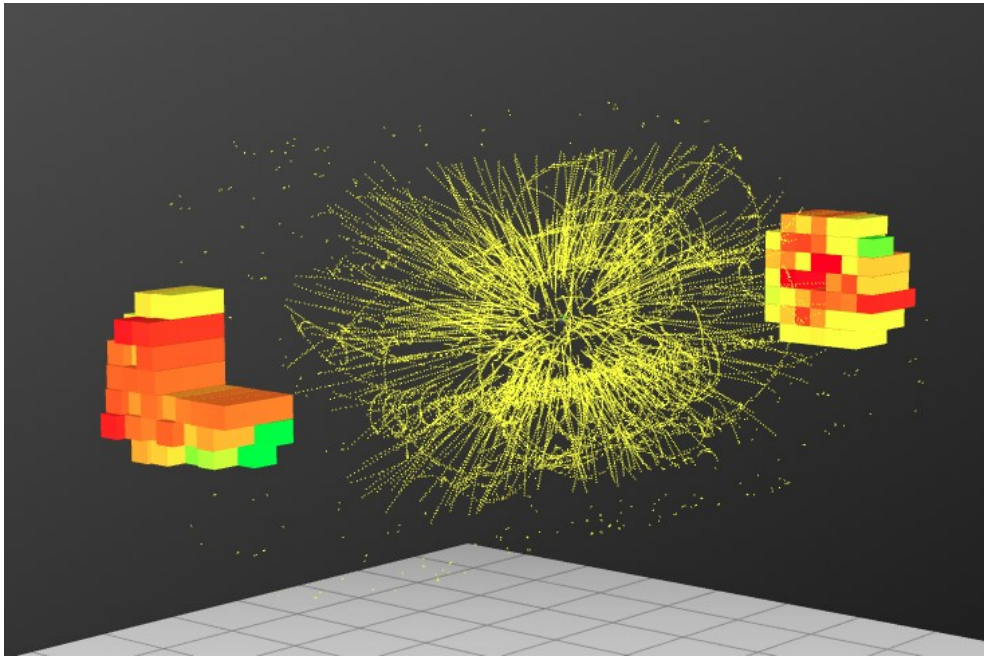


MPD EventDisplay: detectors hits









TPC alignment

Kuzmin V. report

Task: find 144 parameters, which determine the positions of 24 sectors of TPC from the experimental data

Method: If the distance between a single measurement of a track point (hit)

$h_i(p^k)$ (i — number of the track point, k – number of the sector)

and the curve set by the track model

$$\vec{r} = \vec{T}(\vec{q})$$

where q is the vector of track parameters and p_k are 6 global parameters that determine the position of the sector k.
Then we can write the sum:

$$\chi^2 = F(\overline{p}, \overline{q}) = \sum_{events} \sum_{i}^{tracks} \frac{(\overline{r}_i(\overline{p}_k) - T_i(\overline{q}))^2}{\sigma^2}$$

Mass production requests

https://mpdforum.jinr.ru/c/MCProd

MPD

Monte-Carlo productions | Latest | Top | + New Topic

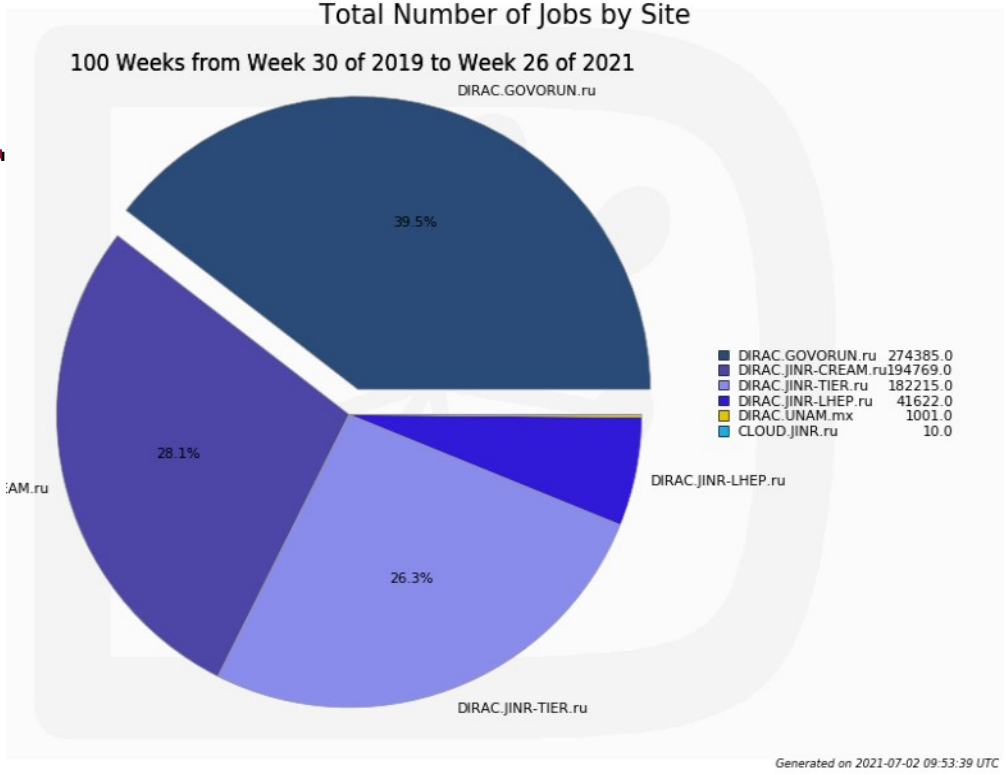
Topic	Replies	Views	Activity
Request 17: PWG3 - PHQMD, flow, 20M min.bias AuAu @ 2.4, 3.0, 4.5 GeV	9	96	11d
Request 16: PWG1 – DCM-SMM, min bias BiBi@9.2 GeV, 1 mln	8	136	Aug 9
Request 15: PWG2, PHQMD, BiBi@9.2, 40M minbias	3	90	Aug 7
Request 14: PWG1 - UrQMD, 1M min. bias BiBi @ 9.2 GeV	3	57	Jun 27
Request13: PWG4 - dielectrons, 15M UrQMD BiBi@9.2	4	111	Jun 12
Mass production storage on NICA cluster	6	102	May 24
Request11: PWG4 - dielectrons, 15M minbias BiBi@9.2, new dE/dx	13	222	Apr 30
Request 12: PWG3 - vHLLE+UrQMD, min. bias, AuAu @ 7.7 GeV	7	143	Apr 12
Request 10: PWG3 - vHLLE+UrQMD, flow, 15M min. bias AuAu @ 11.5 GeV	12	166	Dec '20
Nica cluster problem	1	84	Nov '20
Request 6: PWG1 - SMASH, BiBi @ 9.46 GeV, min. bias, GEANT3	11	299	Oct '20

Computing resources used for MP

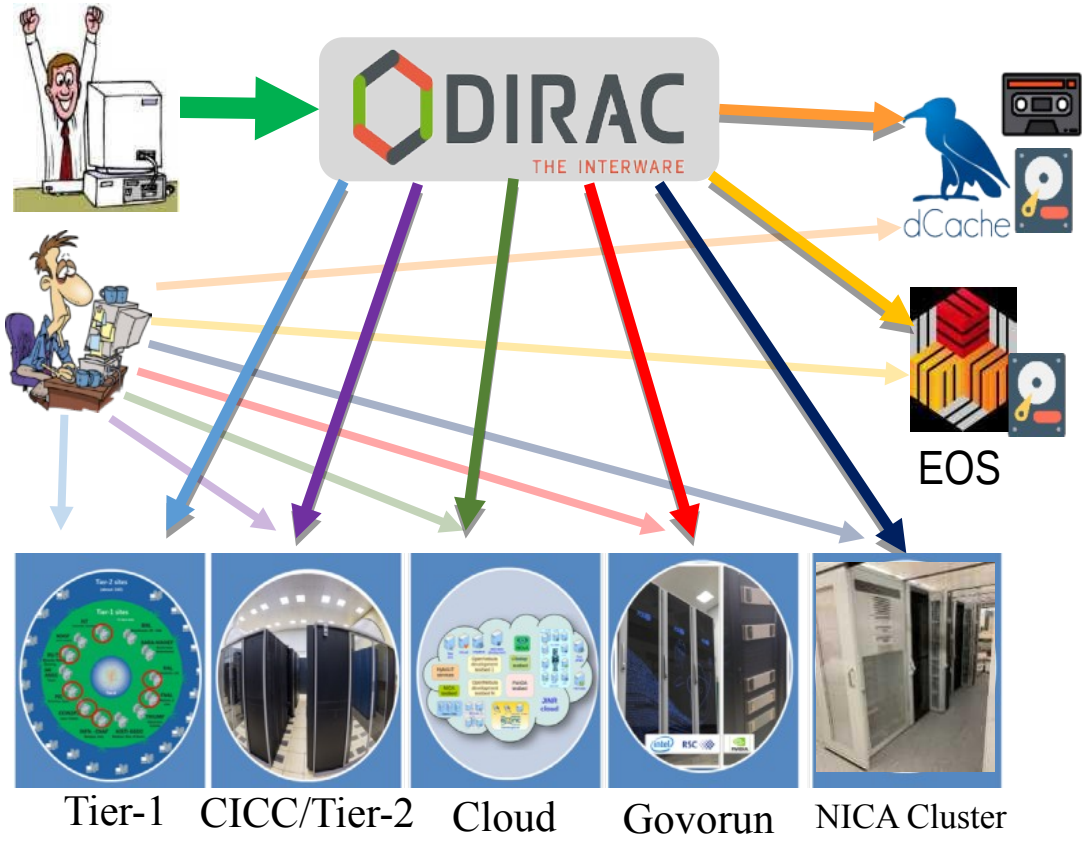
- **NICA offline cluster 250 cores (limit for users)** LHEP
- **GOVORUN 818 cores**
- **Tier1 920 cores**
- **Tier2 1000 cores**
- **Clouds 70 cores**
- **UNAM 100 cores**

LIT

Mexico



JINR computing resources integration for MPD mass production



Igor Pelevanyuk report

The **DIRAC Interware** is a software which provides various interfaces for the integration of distributed heterogeneous computing and storage resources.

Instead of using all JINR storage and computing resources individually, DIRAC allows processing of large amounts of data through unified single system.

Monte-Carlo mass production for MPD were successfully performed on the integrated system of Tier-1, Tier-2, Govorun and NICA cluster via DIRAC. JINR and Member-States cloud resources have been tested and ready to accept jobs.

Mass production summary

2020 – 2021 years

Generator	PWG	Coll.		# of events(M)	Reco
UrQMD	PWG4	AuAu	11	15	+
		BiBi	9	10	+
			9.46	10	+
			9.2	30	+
	PWG2	AuAu	11	10	+
	PWG3	AuAu	7.7	10	+
		BiBi	7.7	10	+
			9	10	+
	PWG1	BiBi	9.2	1	+
DCM-SMM	PWG1	BiBi	9.2	1	+
PHQMD	PWG2	BiBi	8.8	15	+
			9.2	40	+
			2.4/3.0/4.5	10/10/2	-
vHLLE-UrQMD	PWG3	BiBi	11.5	15	+
		AuAu	11.5	15	+
		AuAu	7.7	20	+
Smash	PWG1	BiBi	9.46	10	+
		ArAr	4/7/9/11	20/20/20/20	-
		AuAu	4/7/9/11	20/20/20/20	-
		XeXe	4/7/9/11	20/20/20/20	-
		CC	4/7/9/11	20/20/20/20	-
		pp	4/7/9/11	50/50/50/50	-
Total				744	222

Mass production storages

http://mpdroot.jinr.ru -> SOFTWARE -> DataBases -> MPD DataBase

- **Main storage, integrated in Dirac File Catalog**

  /eos/eos.jinr.ru/nica/mpd/dirac/mpd.nica.jinr/vo/mpd/data/ 1 PB

- **LHEP mirror, will be integrated in Dirac File Catalog**

  /eos/nica/mpd/sim/data/ 300 TB

- **Data produced before 2019**

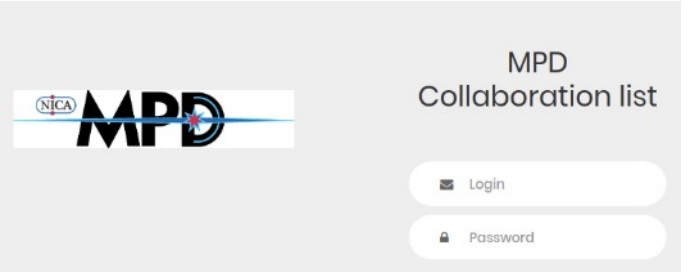
  /zfs/store6.hydra.local/mpddata/data/ 85 TB

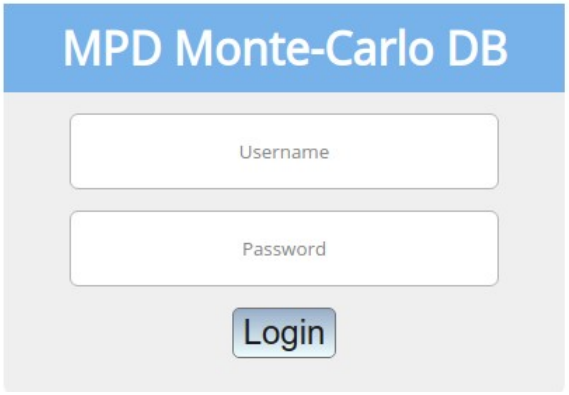
  /eos/hybrilit.jinr.ru/nica/ 100 TB

- **dCache(LIT type robot), tested**

MPD databases

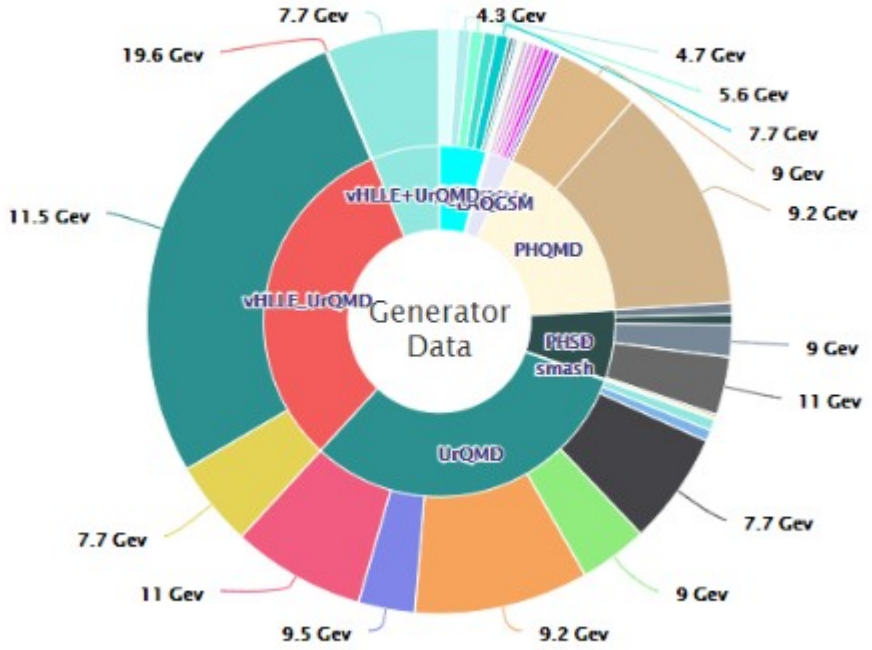
- ✔ List of MPD members & authors
- ✔ MC generator events mass productions
- ✔ ECAL instrumentation
- ✔ TPC instrumentation
- ✔ TOF instrumentation
- ✔ Alignment parameters DB
- ✔ LogBook for Experiment
- ✔ ….

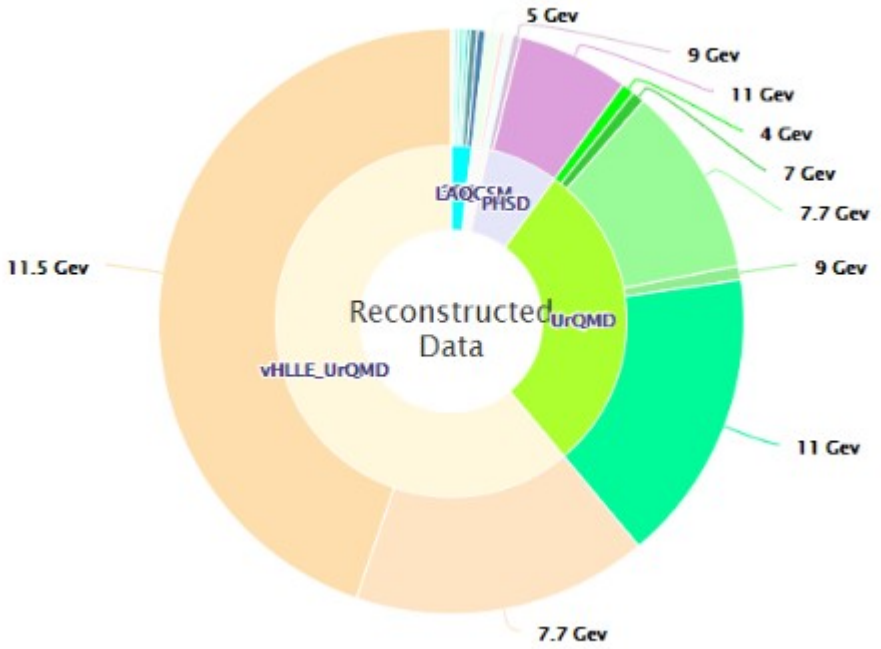




MC events database

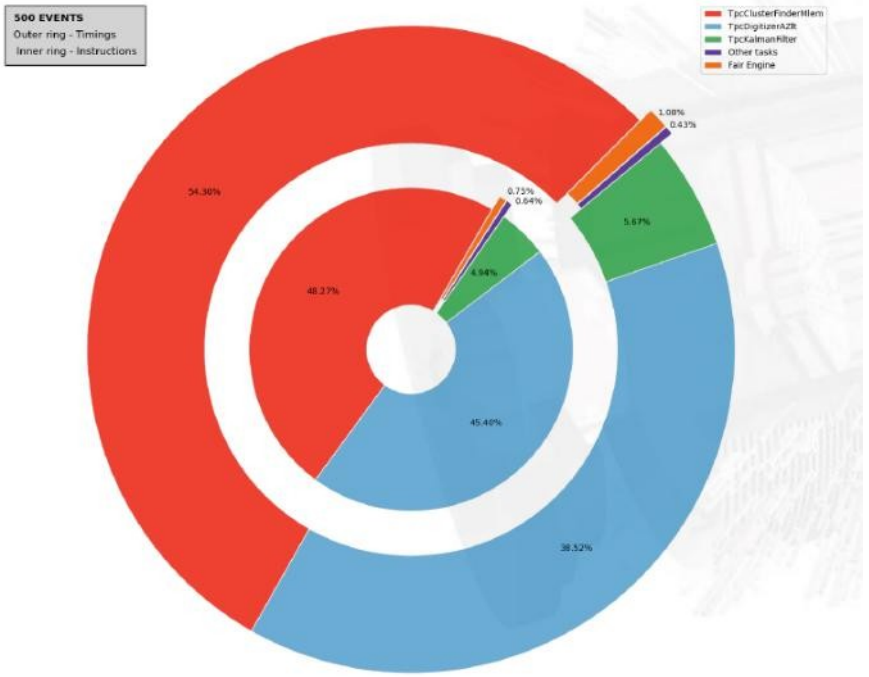
http://mpdroot.jinr.ru -> SOFTWARE -> DataBases -> MPD DataBase

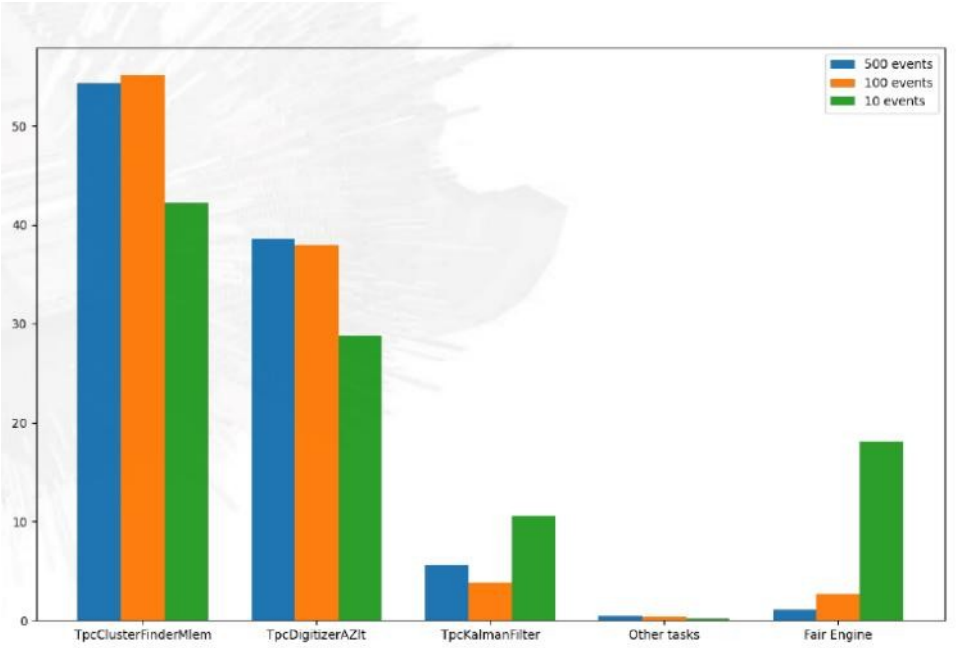




Optimization & improving code quality

Hnatic S. report





GETTING THE SD PROCESS UNDER CONTROL

Code Ownership within GitLab

MPD software development team

Bychkov A.
Fomenko K.
Krylov A.
Moshkin A.
Myktybekov D.
Rogachevsky O.

LIT Participants

Podgainy D.
Zuev M.
Pelevanyuk I.
Belyakov D.
Balashov N.
Kadochnikov I.
Busa Jan Jr.
Hnatic Slavomir

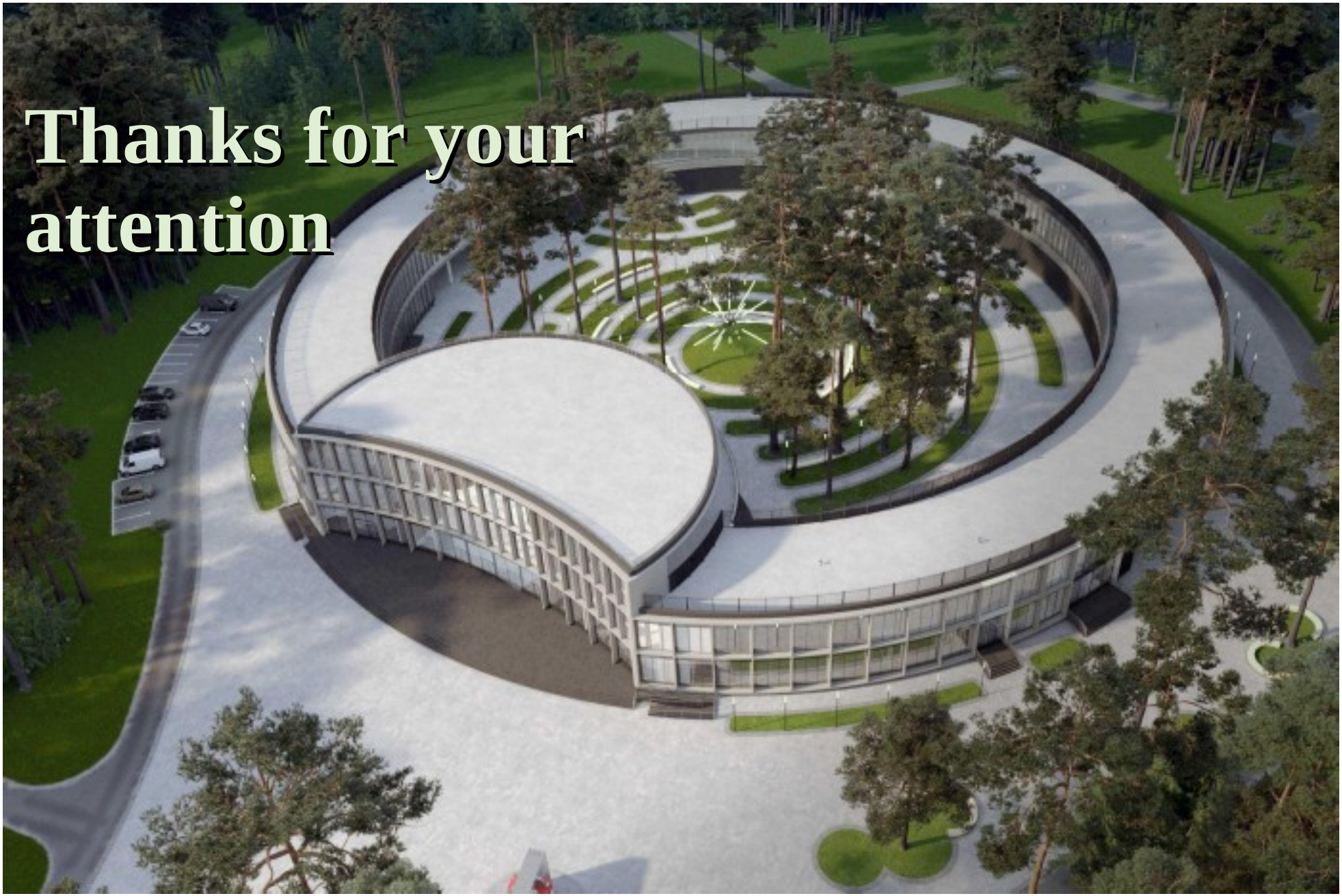
LNP JINR

Krylov V.

Other institutes

Kuzmin V.	MSU
Solomin A.	MSU

The work is supported by RFBR grant №18-02-40102


Thanks for your attention