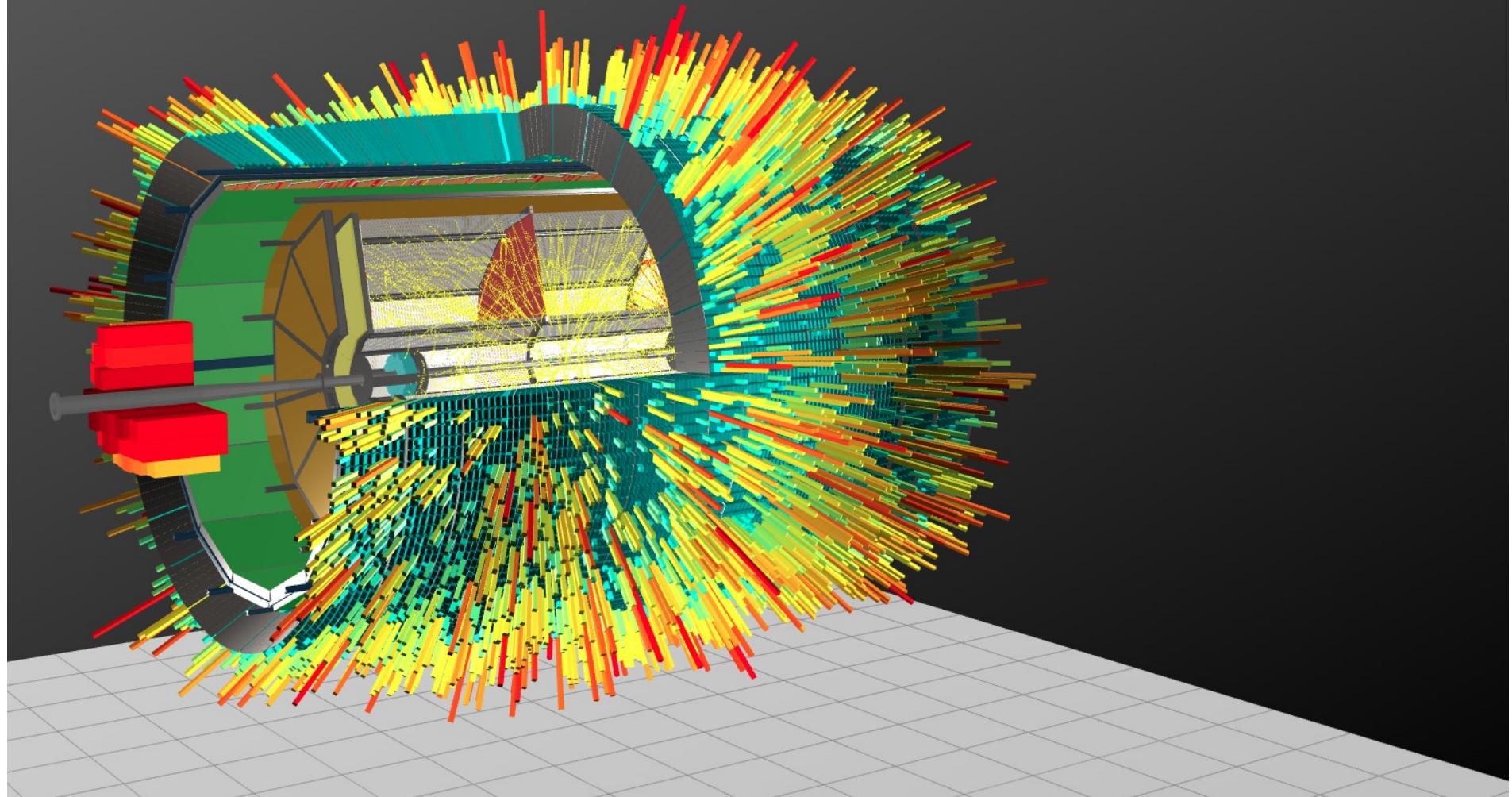


MPD Software status



Rogachevsky Oleg
for MPD collaboration

XI MPD collaboration meeting
19.04.2023
Dubna

News in software design

All details in the reports of:

Slavomir Hnatic

Design by Contract & Acceptance Test Driven Development
in MPDRoot

Alexander Krylov

Visualization of MC & DST tracks with MPD event display

Ivonne Maldonado

Implementation of MiniBeBe detector in the MPD setup

Alexander Bychkov

Particle parameter changing due to TPC construction and
materials

Pavel Belecky

Track reconstruction with Acts for MPDRoot

Releases v23.03.2023

<https://git.jinr.ru/nica/mpdroot/-/releases/v23.03.23>

Installation <https://mpdroot.jinr.ru/running-mpdroot-on-local-machine-using-cvmfs/>

FOR USERS

- Physics Analysis centrality update #172 !434
- Physics Analysis update train functional !433
- Physics Analysis evPlane wagon alpha !437
- Physics Analysis manager update !435 !436
- MpdMcDstGenerator bugfix !440
- Fedora 38 support added & Ubuntu 18.04 LTS
- support discontinued [nicadist!48](#)
- Macros debugging howto #171
- Latest GEANT4 v11.1.1 nicadist@9d69bd9b
- Emacs recipe for nicadist [nicadist!47](#)
-

FOR Developers

- TPC API (alpha) #165
- QA Engine (alpha) !426
- Libraries encapsulation: libtpcDigitizer.so, libtpcGeometry.so, libtpcClusterHitFinder.so #161, #160, #159
- Mlem and Fast TPC clusterhitfinders ported to common interface #86
- TPC clusters unified design #115
- Fast TPC Clusterhitfinder implementation of getting clusters information #170
- Fast TPC ClusterHitFinder implementation of getting MC information !414, !419
- Fast TPC ClusterHitFinder - correct storing of digits !439
- Alignment code port to dev (alpha): #157
- get/set DriftTime for TpcHit #175
- Drift velocity db initial version !423
- directory for multi-detector tasks #168
- MpdTpcDigitizerAZ, MpdTpcClusterFinderAZ moved to legacy #163
- Bmd detector removal from build #156
- Mcord detector removal from build #154
- googletest removal nicadist!49
- MpdTpc2dCluster circular build deps fixed #162
- Bad naming workaround #164
- Codeowners bug caused by Gitlab's API change fix #166
- Minuit2 library link fix #158
- GSL include bugfix #138
- Alignment segfault fixed #174
- Macro compilation by ROOT fixed #176

MPD Software status (GIT)

Commits to dev

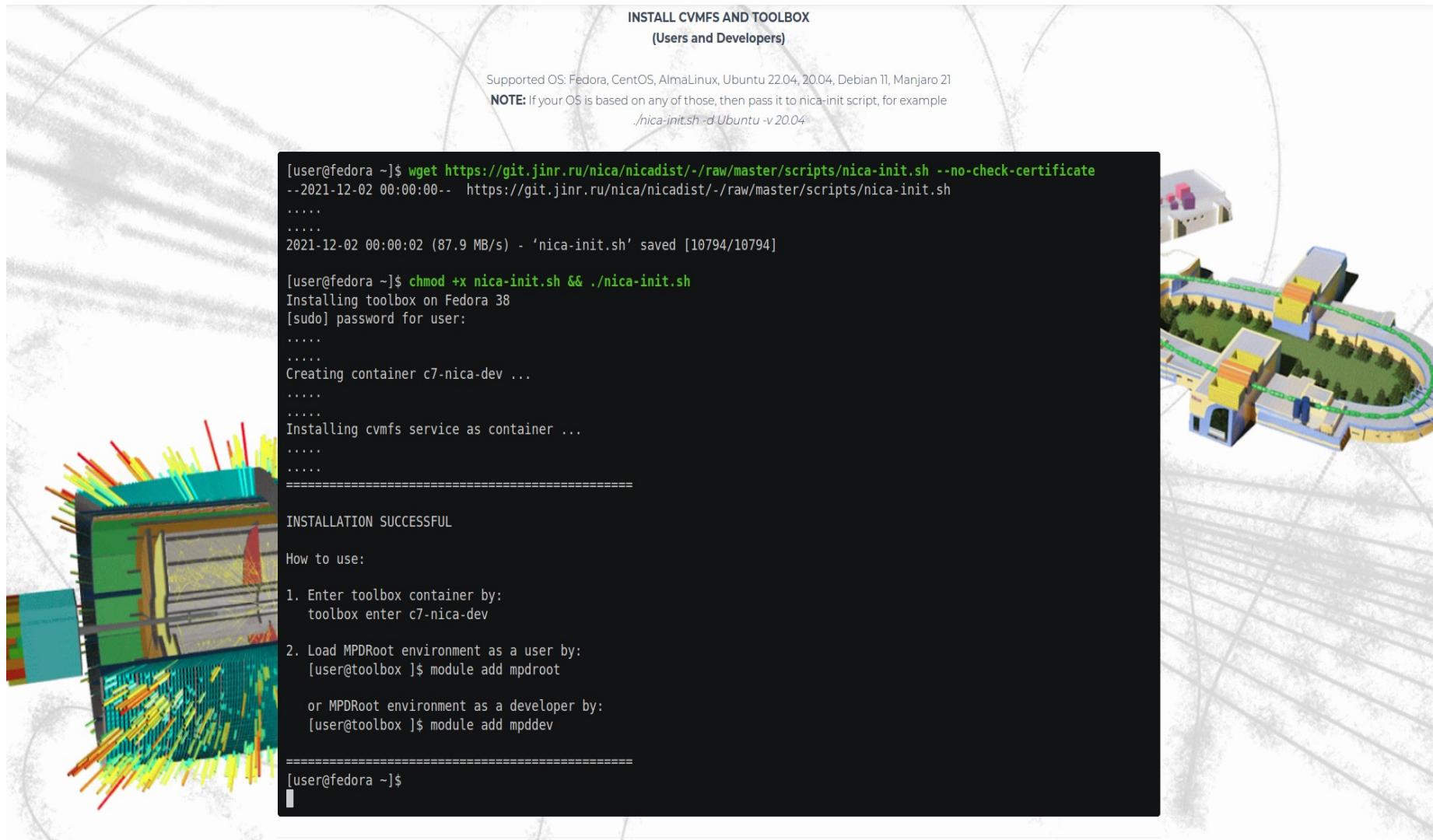
Excluding merge commits. Limited to 6,000 commits.



— Commits Avg: 292m · Max: 18

Author	Search by message	Actions
dev	mpdroot	
07 Apr, 2023 2 commits		
 Small fix in evPlane wagon: optimized histograms for Q-vectors from FHCAL ParfenovPeter authored 1 week ago	3c83250f	 
 Small fixes to evPlane wagon: mirror weighting of Q-vectors from FHCAL, add... ParfenovPeter authored 1 week ago	69072dc0	 
06 Apr, 2023 1 commit		
 Analysis - centrality update pt4 (Victor Riabov's request) Slavomir Hnatic authored 1 week ago	0bfd9fe1	 
03 Apr, 2023 1 commit		
 Fix MpdMcDstGenerator bug, add Pdg getter to MpdGenTrack Slavomir Hnatic authored 2 weeks ago	4d1682a3	 
30 Mar, 2023 1 commit		
 TpcClusterFinderFast interface port: correct storing of digits in clusters Slavomir Hnatic authored 2 weeks ago	175b9f46	 
29 Mar, 2023 3 commits		
 Small addition in README ParfenovPeter authored 2 weeks ago	bd92187c	 
 Added brief README for evPlane wagon ParfenovPeter authored 2 weeks ago	dcf548bb	 

MPDroot deployment



INSTALL CVMFS AND TOOLBOX
(Users and Developers)

Supported OS: Fedora, CentOS, AlmaLinux, Ubuntu 22.04, 20.04, Debian 11, Manjaro 21

NOTE: If your OS is based on any of those, then pass it to nica-init script, for example
`./nica-init.sh -d Ubuntu -v 20.04`

```
[user@fedora ~]$ wget https://git.jinr.ru/nica/nicadist/-/raw/master/scripts/nica-init.sh --no-check-certificate
--2021-12-02 00:00:00--  https://git.jinr.ru/nica/nicadist/-/raw/master/scripts/nica-init.sh
.....
.....
2021-12-02 00:00:02 (87.9 MB/s) - 'nica-init.sh' saved [10794/10794]

[user@fedora ~]$ chmod +x nica-init.sh && ./nica-init.sh
Installing toolbox on Fedora 38
[sudo] password for user:
.....
.....
Creating container c7-nica-dev ...
.....
.....
Installing cvmfs service as container ...
.....
.....
=====
INSTALLATION SUCCESSFUL

How to use:

1. Enter toolbox container by:
   toolbox enter c7-nica-dev

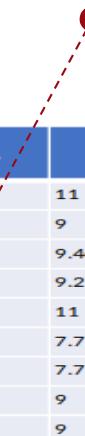
2. Load MPDRoot environment as a user by:
   [user@toolbox ]$ module add mpdroot

   or MPDRoot environment as a developer by:
   [user@toolbox ]$ module add mpddev

=====
[user@fedora ~]$
```

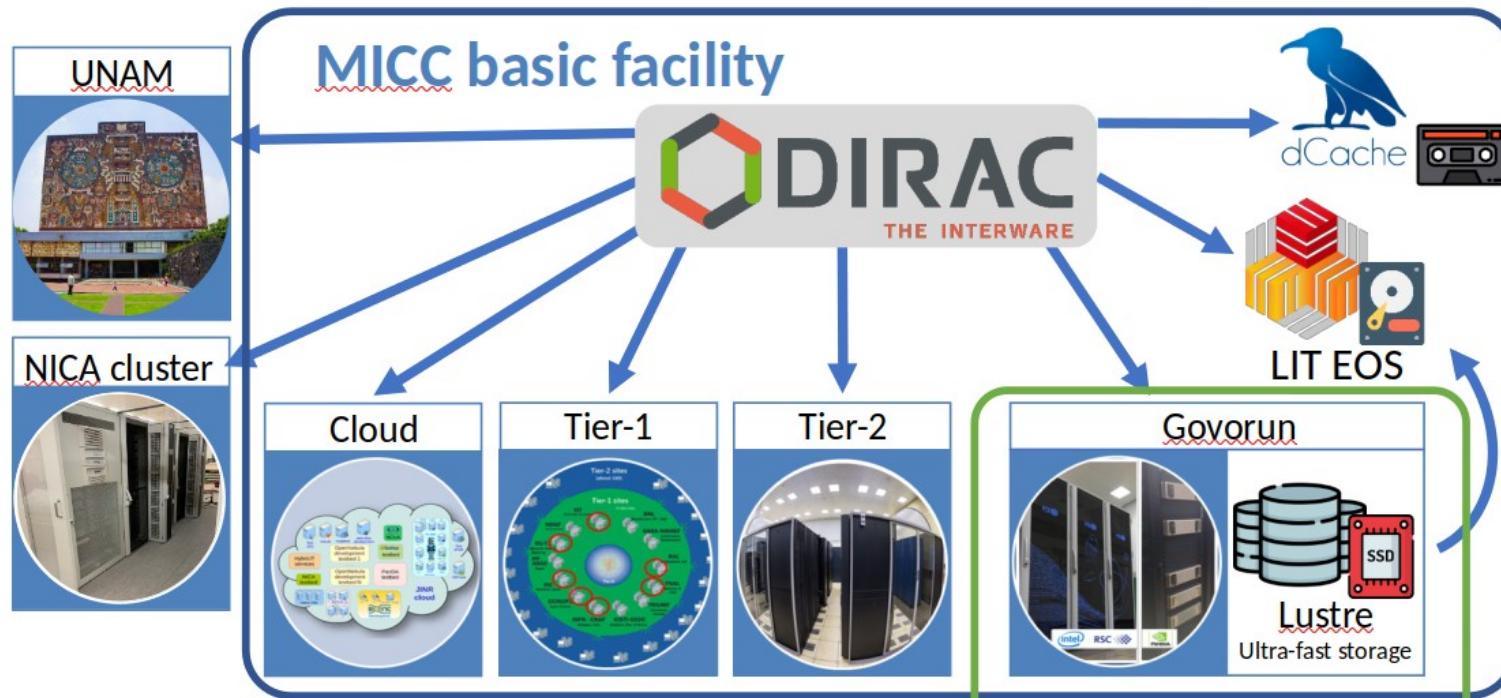
Mass production

Last Request 31: Femtoscopy-purpose, 50 M UrQMD BiBi@9.2 with freeze-out




Generator	PWG	Coll.		# of events() 10 ⁶	Reco
UrQMD	PWG4	AuAu	11	15	+
		BiBi	9	10	+
			9.46	10	+
			9.2	95	+
		AuAu	11	10	+
	PWG3	AuAu	7.7	10	+
		BiBi	7.7	10	+
			9	15	+
		pp	9	10	+
		BiBi	9.2	11(50 underway)	+
DCM-SMM	PWG1	BiBi	9.2	1	+
PHQMD	PWG2	BiBi	8.8	15	+
			9.2	61	+
			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	20/20/20/22	-
		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	-
JAM	PWG3	AuAu	3/3.3/3.5/3.8/4.0/4.2/4.5/5	40/40/40/40/40/40/40/40	
DCM-QGSM-SMM	PWG3	AuAu	4/9.2	5/5	+
		AgAg	4/9.2	5/5	+
		BiBi	4/9.2	5/6	+
PHSD		BiBi	9/9.2	25	+
Total				1233(50 underway)	389(50 underway)

Computing resources

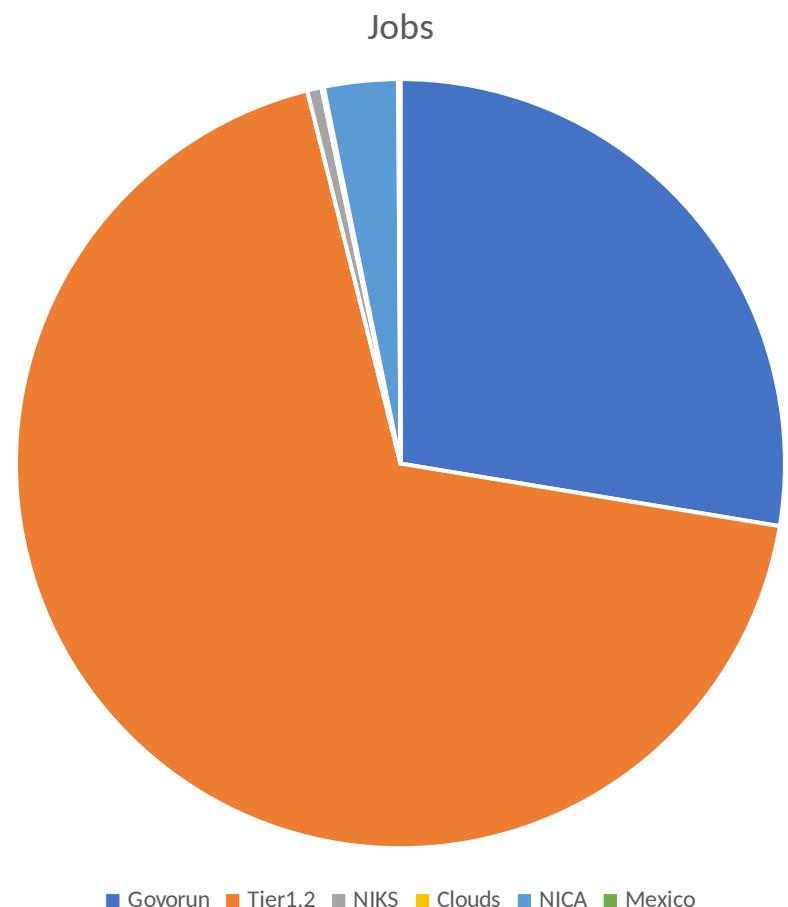
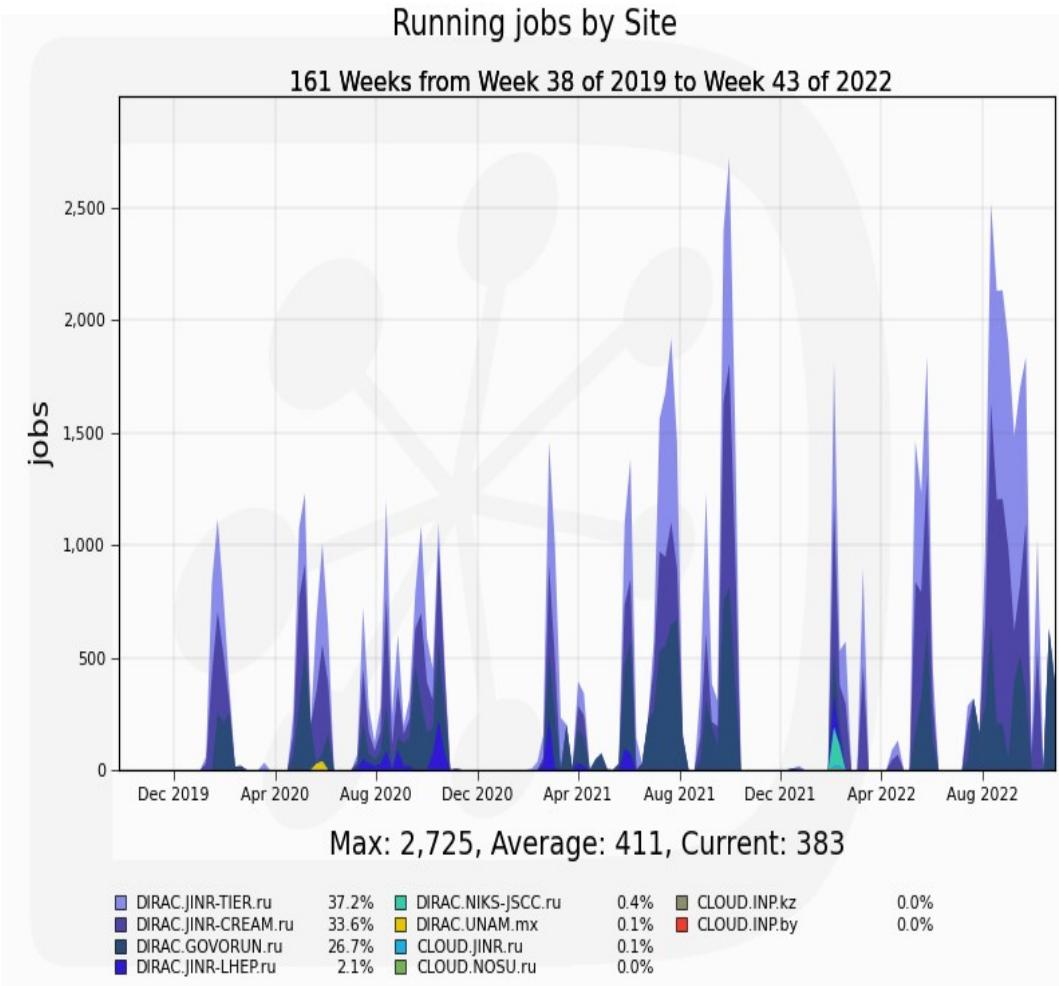


- NICA offline cluster 300 cores(limit for users)
- GOVORUN up to 3260 cores in last production
- Tier1 920 cores
- Tier2 1000 cores
- Clouds(JINR and JINR Member States) 70 cores
- UNAM(Mexico University) 100 cores
- National Research Computer Network of Russia (now resources from SPBTU and JSCC) 672 cores - New resource

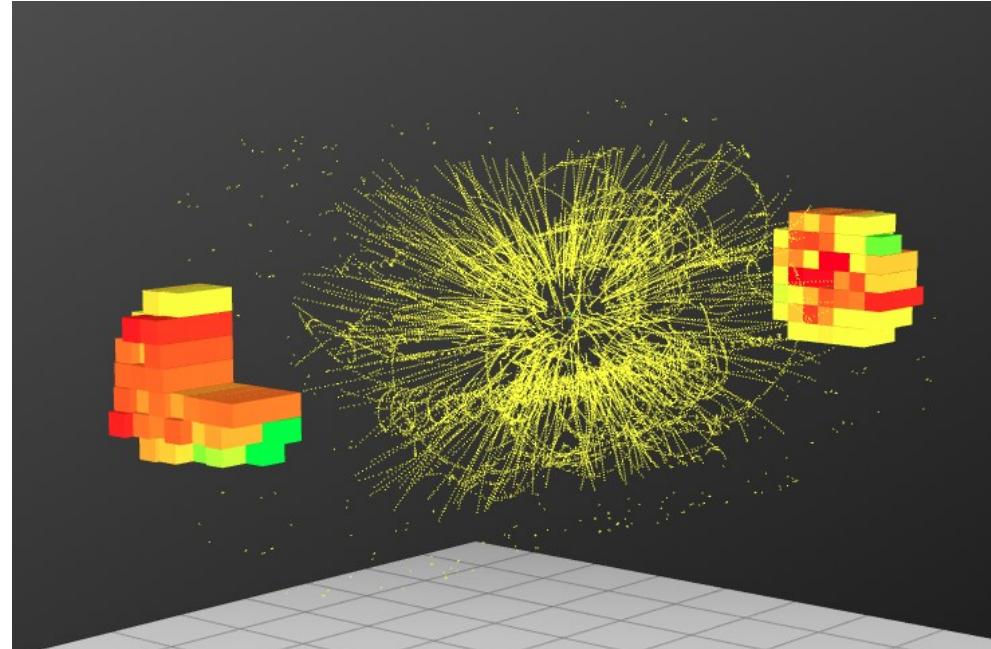
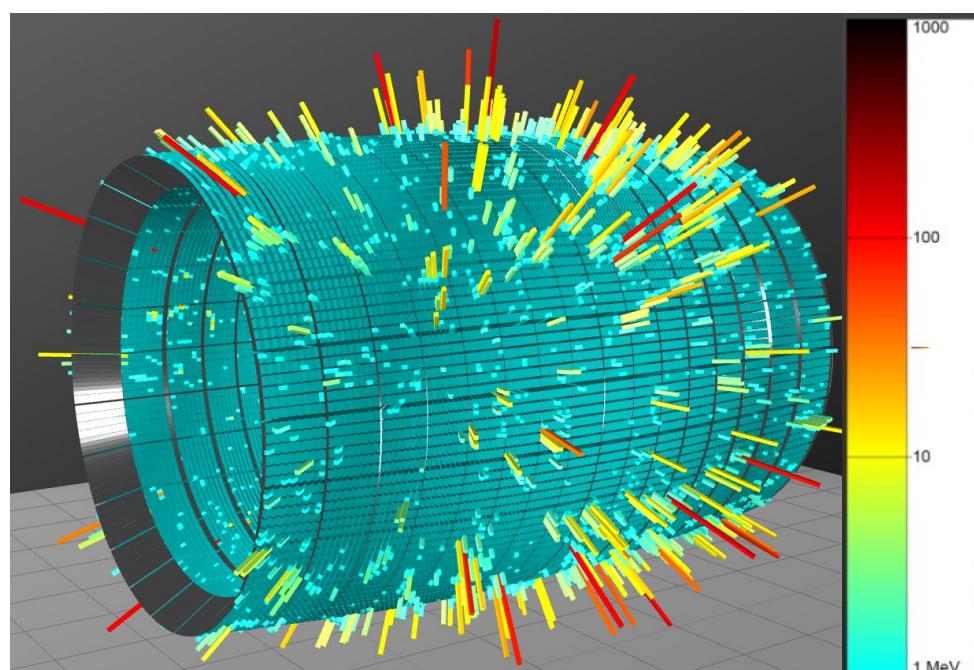
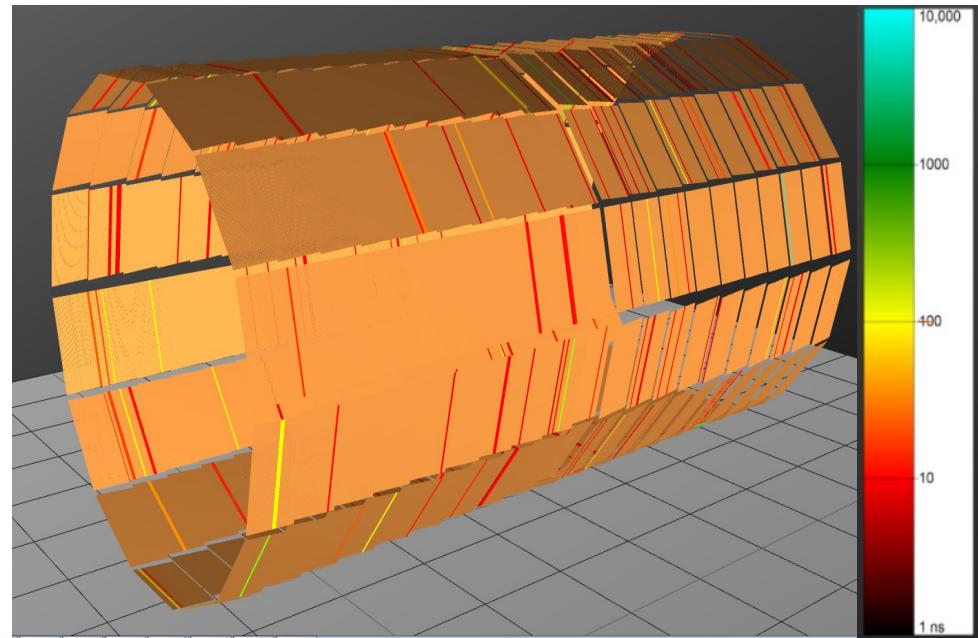
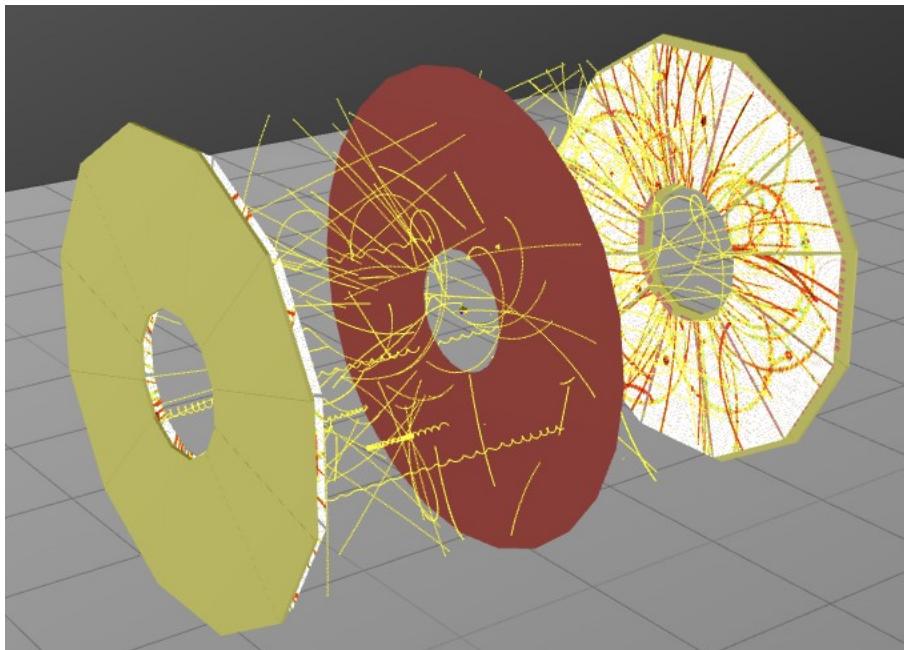
Mass production storages integrated in Dirac File Catalog have size 2,3 PB.



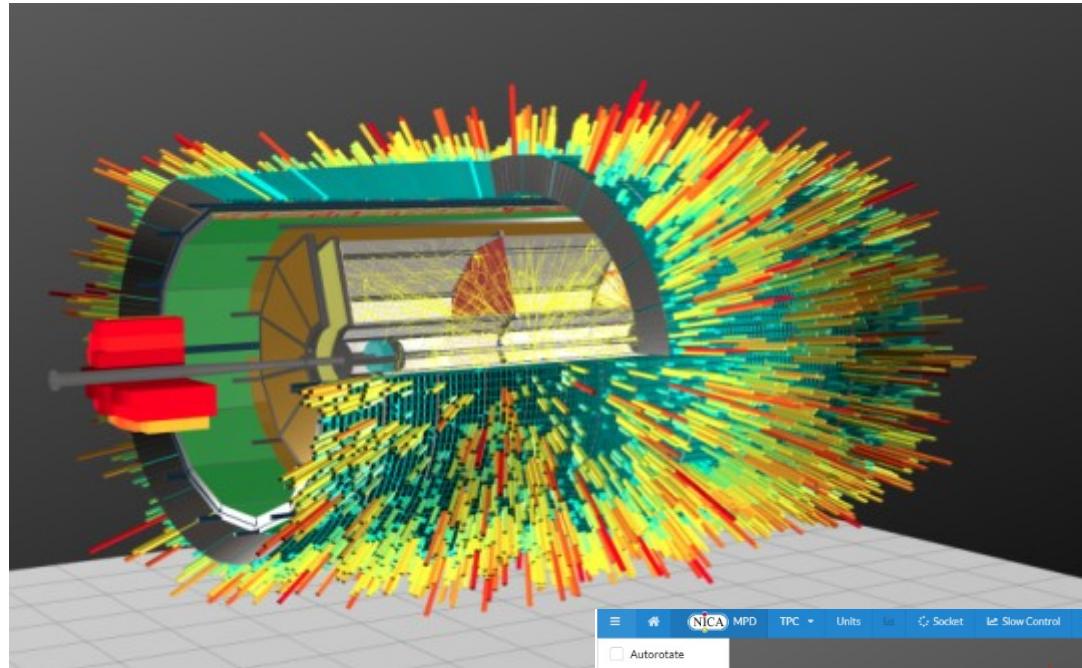
MPD mass production 2019-2023 summary



MPD EventDisplay: hits

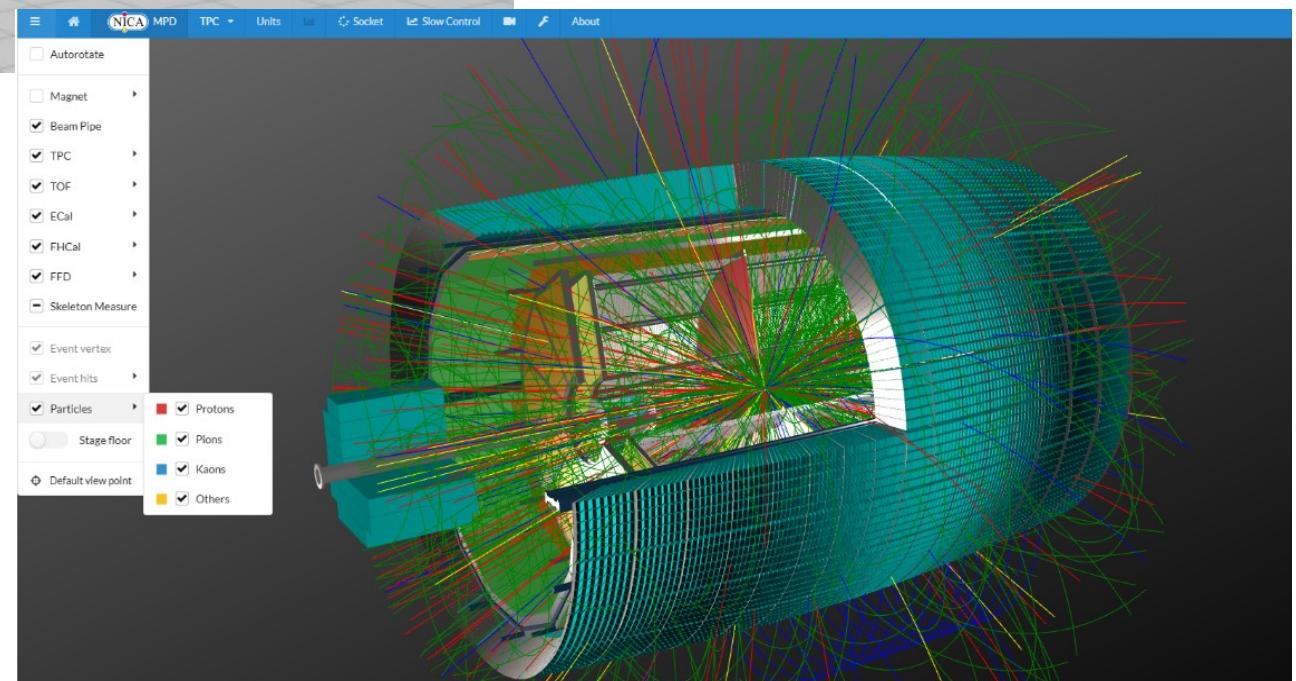


MPD EventDisplay: dst events

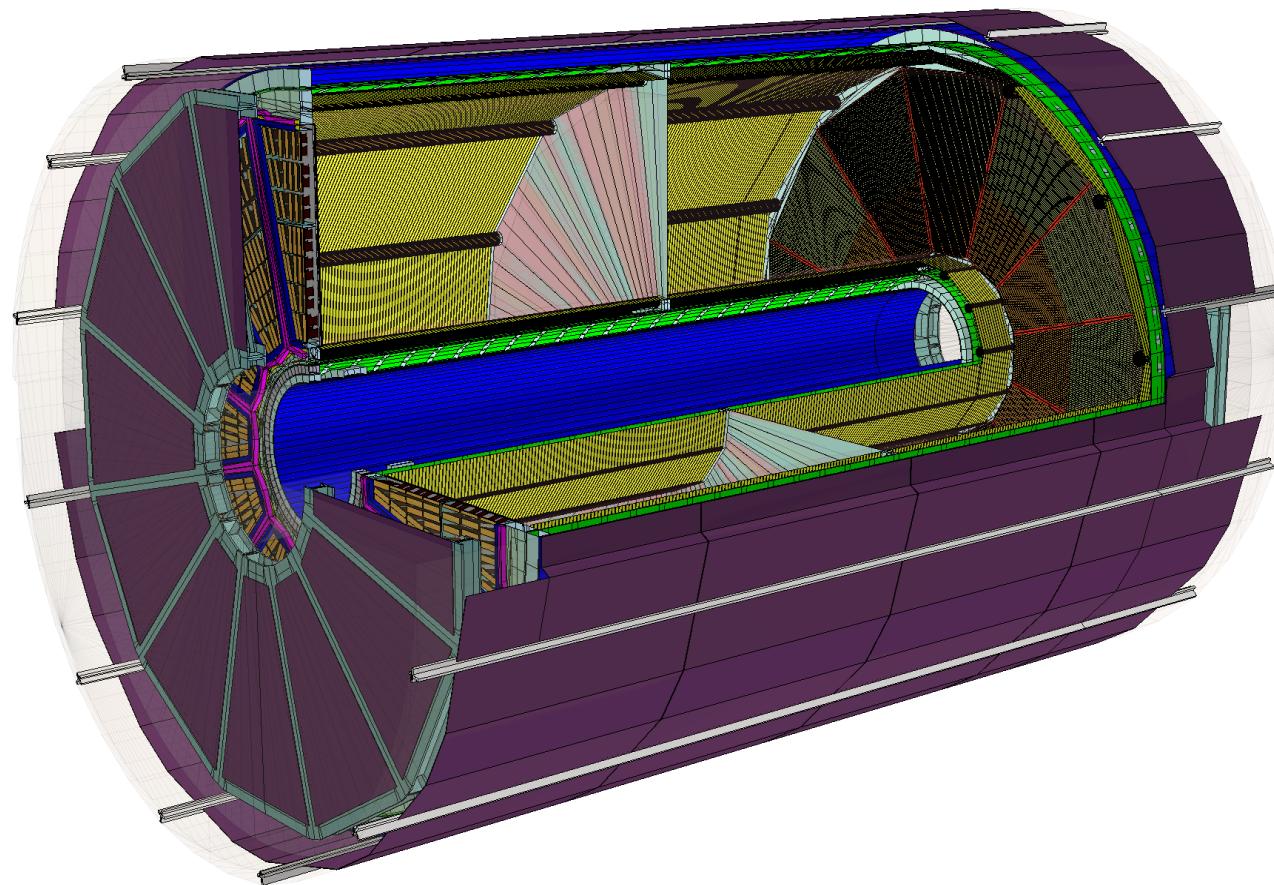


Visualization
of the experiment

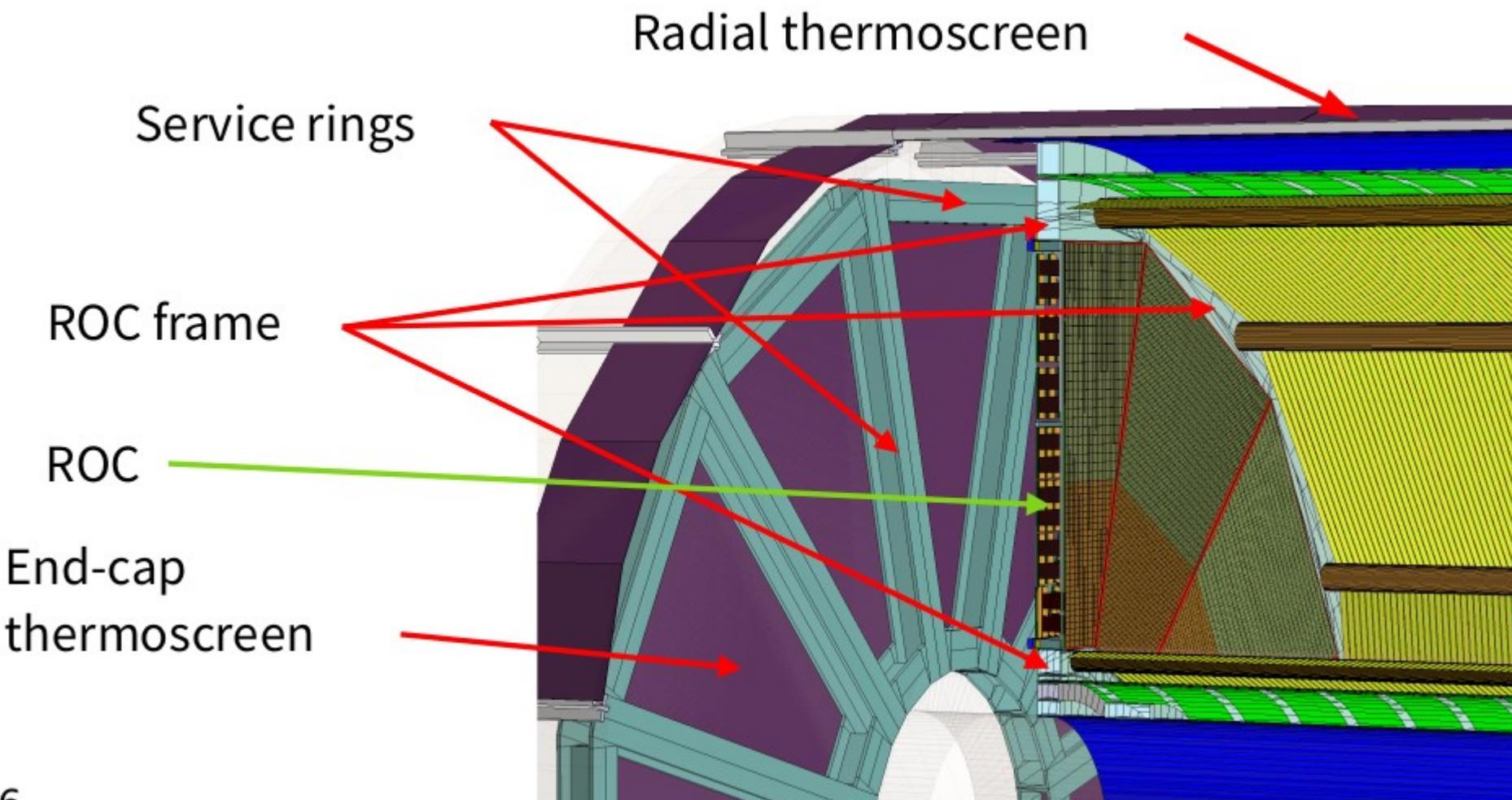
Visualization
of the event physics



Tracks distortions in barrel and endcap TPC parts

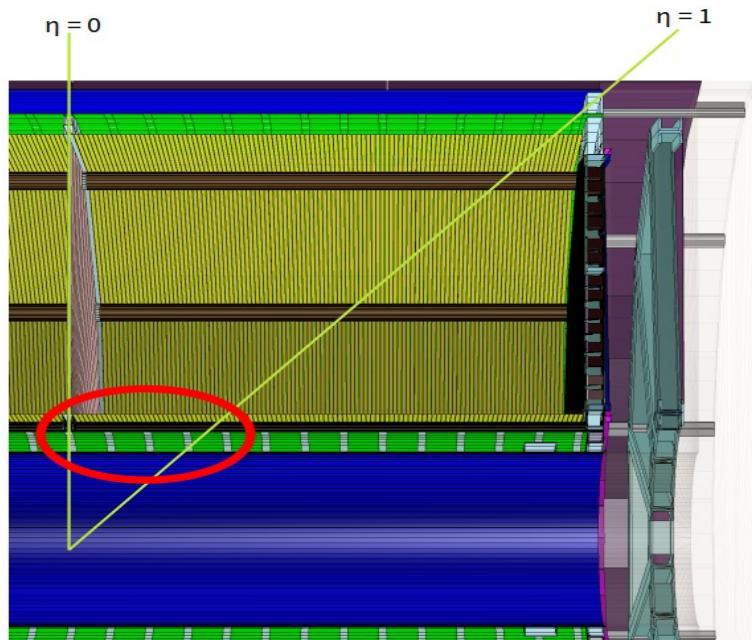


MPD Endcaps structure



Pseudorapidity dependence

$\eta < 1$



$P_0 = 900 \text{ MeV}$

TPC inner walls:

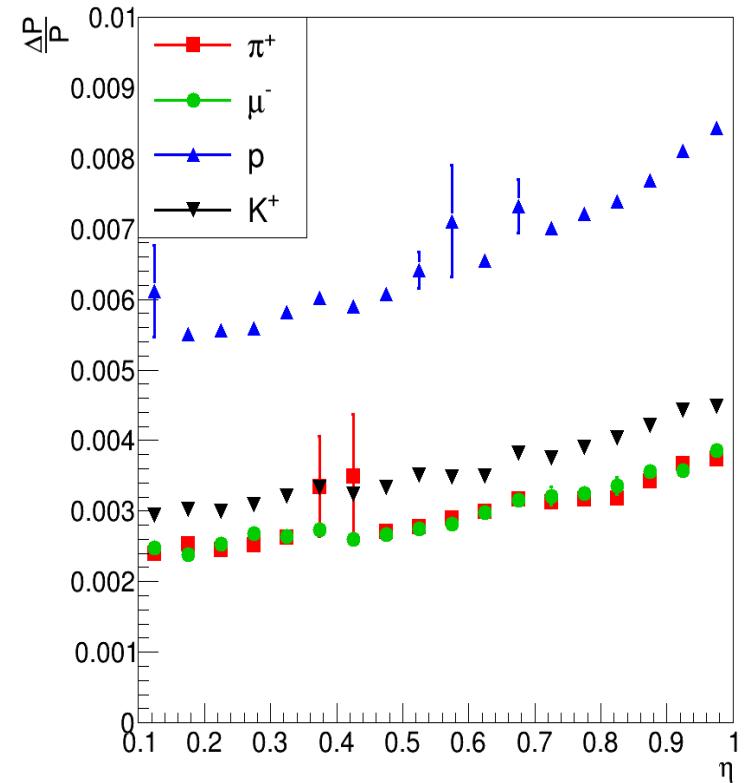
- Kevlar
- Tedlar
- N²
- Al rings
- Kevlar

Field cage inner pins:

- Polypropylene

Field cage:

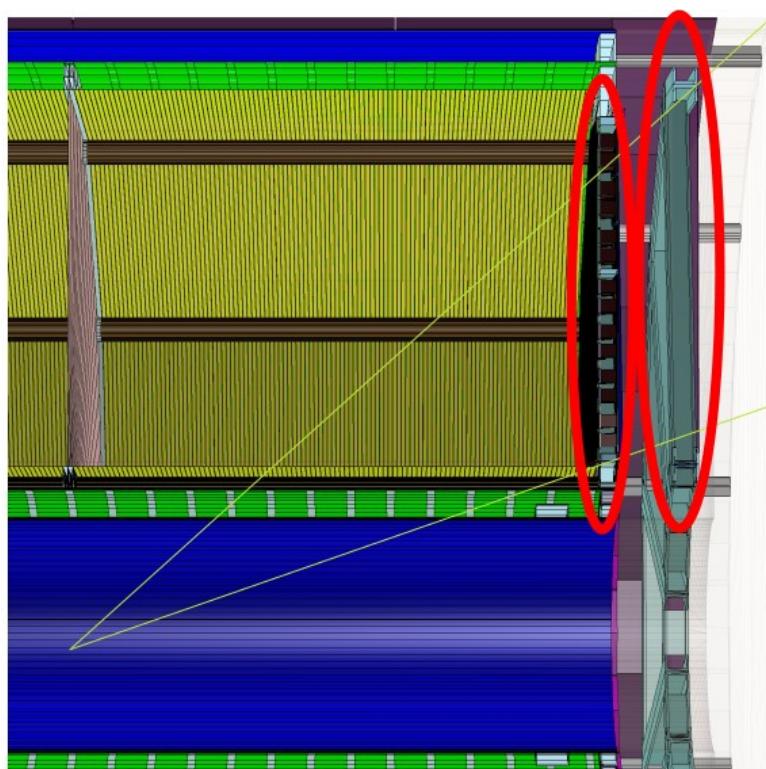
- Mylar film



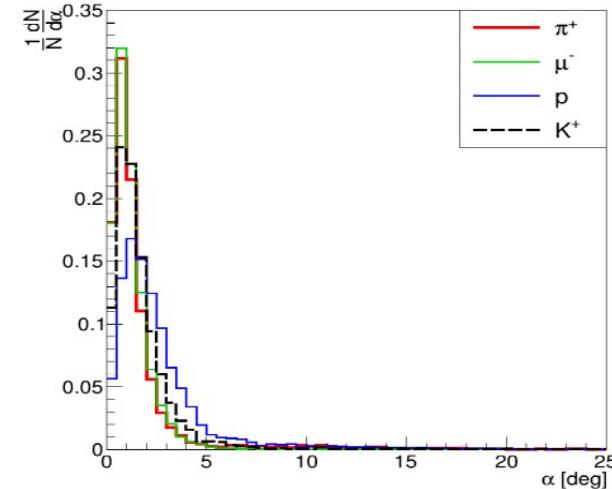
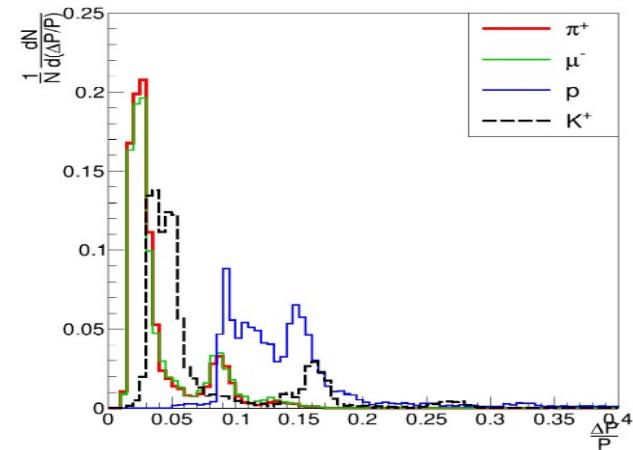
Pseudorapidity dependence

$P_0 = 900 \text{ MeV}$

$\eta > 1$

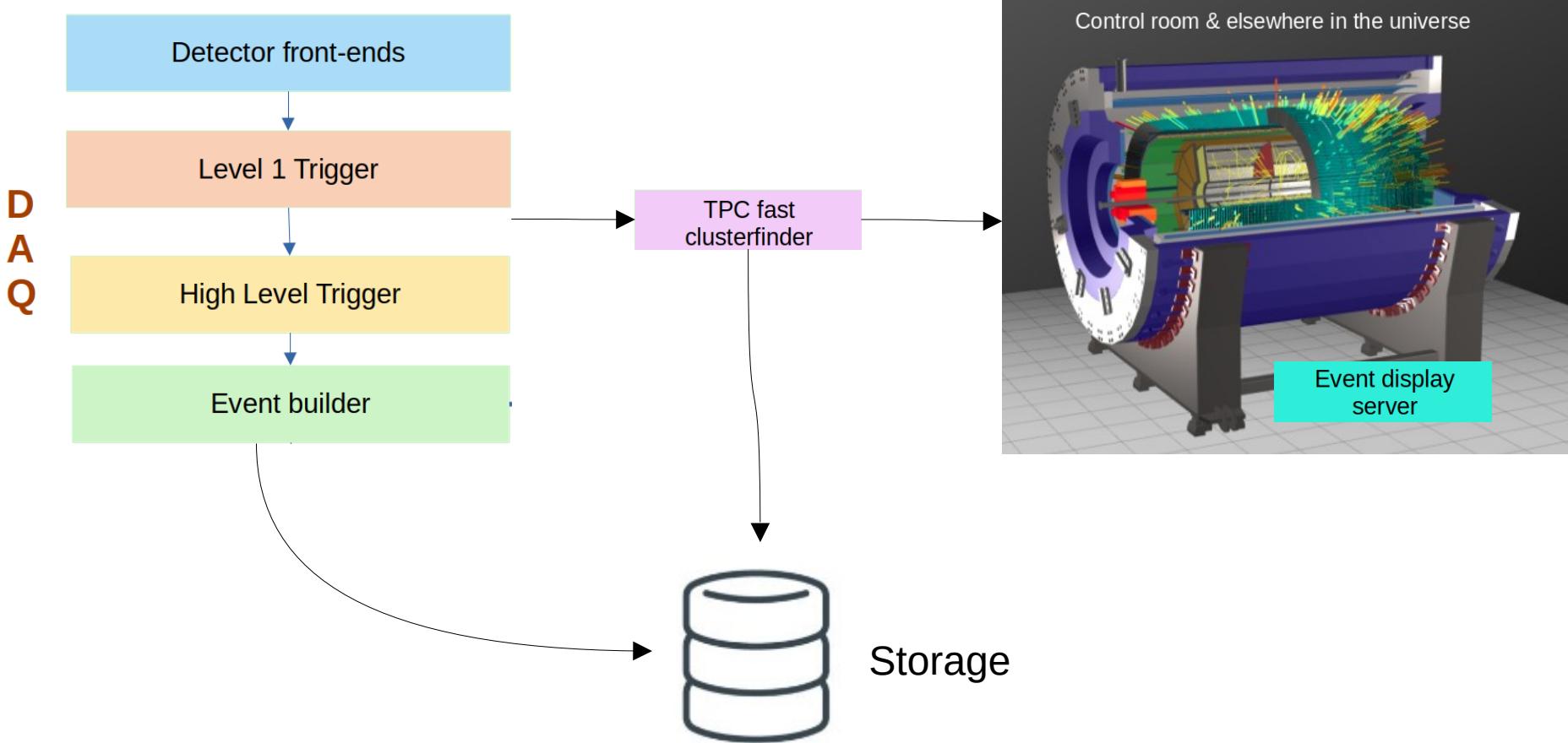


After end-cap flanges



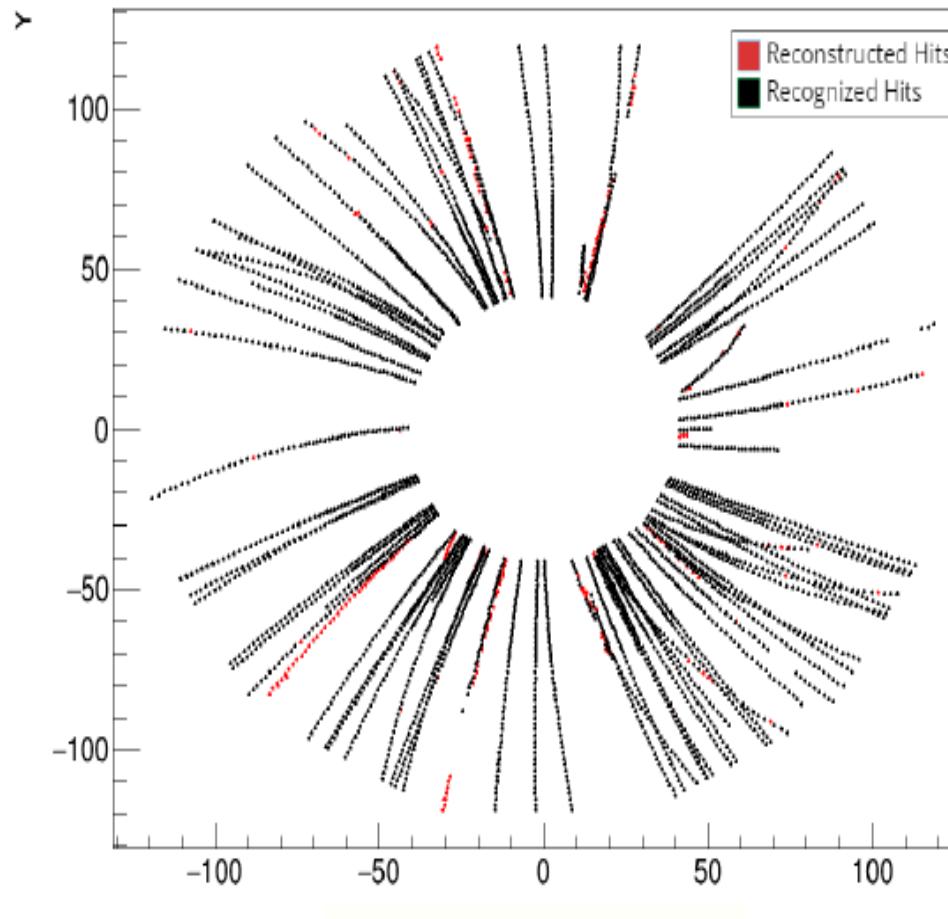
$$\alpha = \langle \vec{p}_{in}, \vec{p}_{out} \rangle$$

MPD TPC clusterfinder

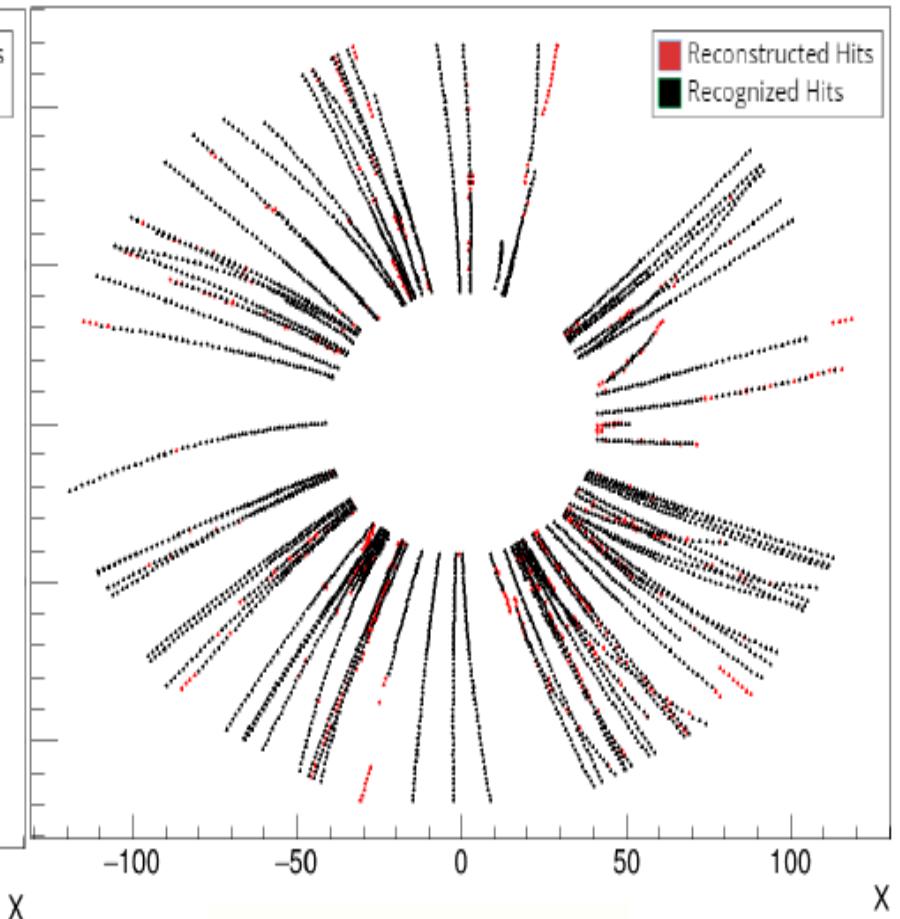


TPC online fast clustering

Krylov V.



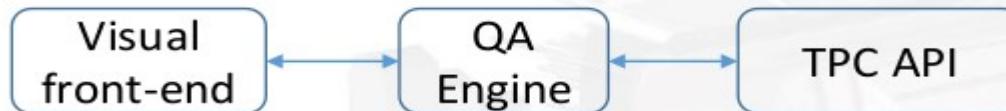
MLEM cluster finder



Fast cluster finder

Quality Assurance engine

Architecture



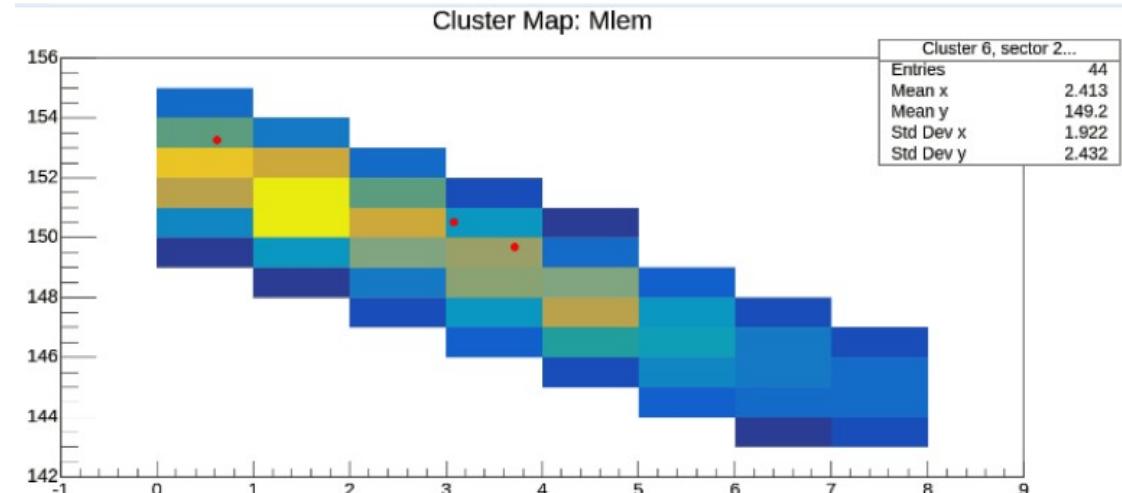
- QA Engine is a separated entity on its own
- interacts through API with reconstruction/simulation backend and generates output for visual front-end
- work of testers and algorithm developers is separated

Name	Last commit	Last update
..		
QA	QA Engine: directory placeholders, build, initial Abstract Base Class	1 month ago
scripts	QA Engine: directory placeholders, build, initial Abstract Base Class	1 month ago
CMakeLists.txt	QA Engine: directory placeholders, build, initial Abstract Base Class	1 month ago

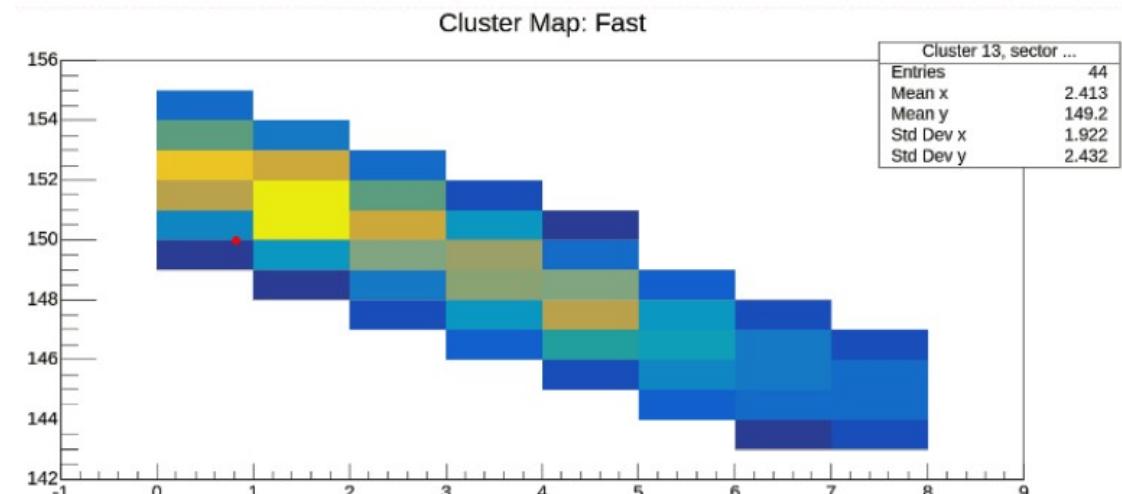
Cluster finders comparison with QA engine

Most illustrative with JSROOT

Mmem clusterfinder



Fast clusterfinder

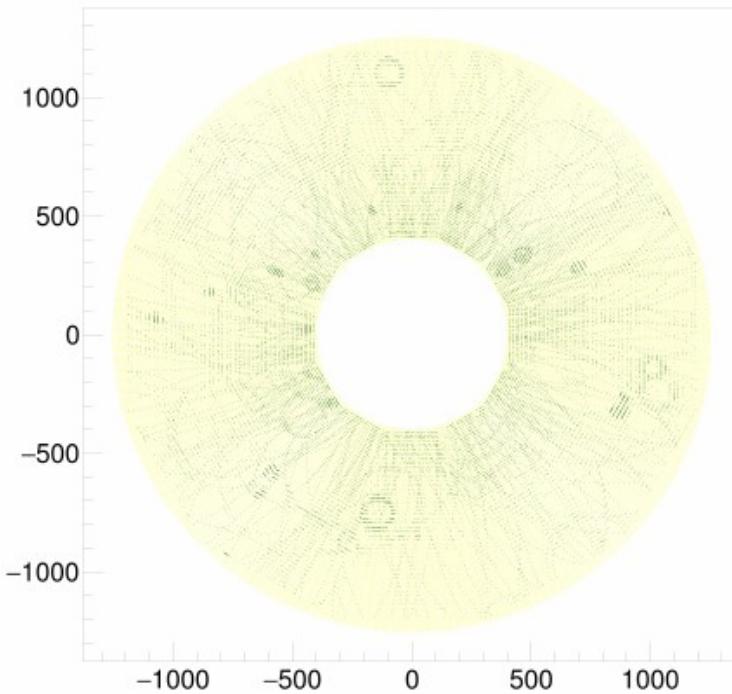


TPC tracking with ACTS



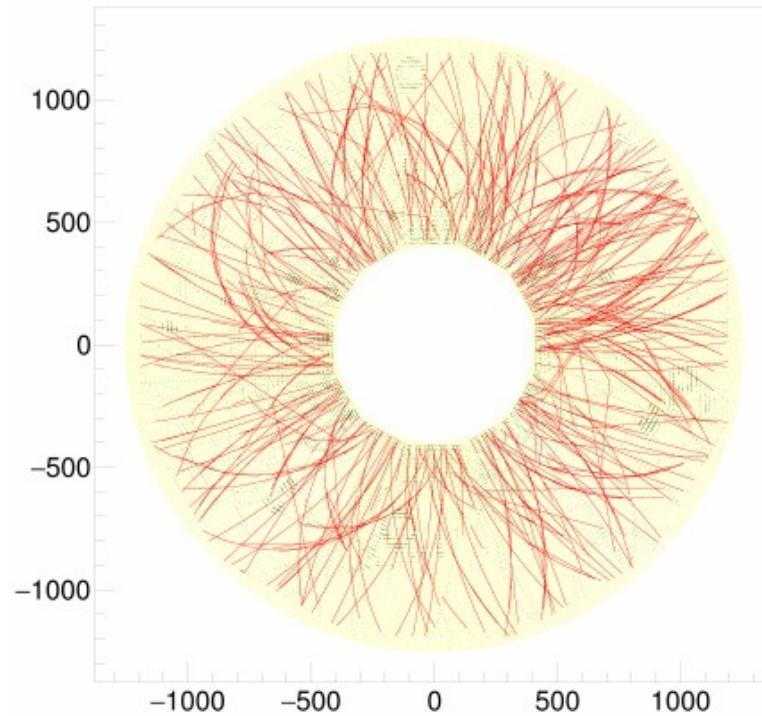
The A Common Tracking Software (Acts) project is an attempt to preserve and evolve the track reconstruction software of the LHC era towards HL-LHC and beyond.

Hits



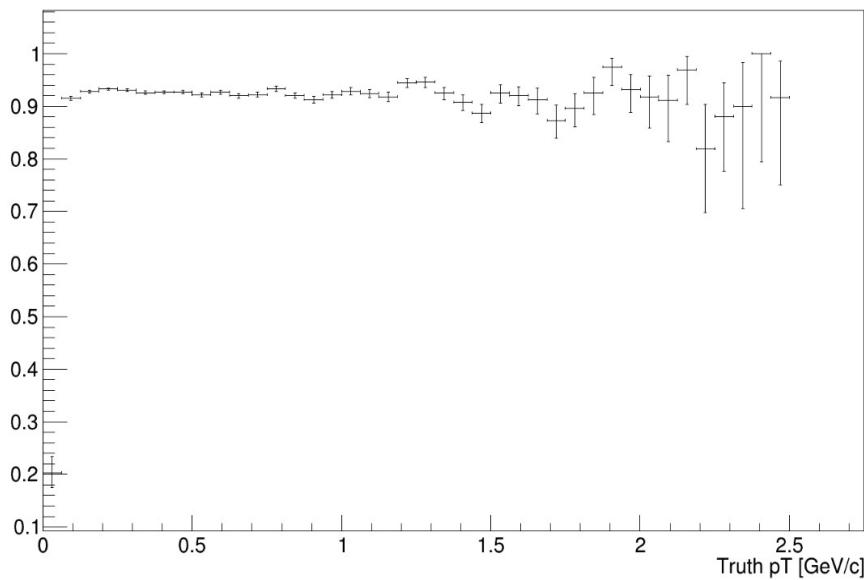
UrQMD AuAu
 $\sqrt{s} = 9 \text{ GeV}$

Tracks

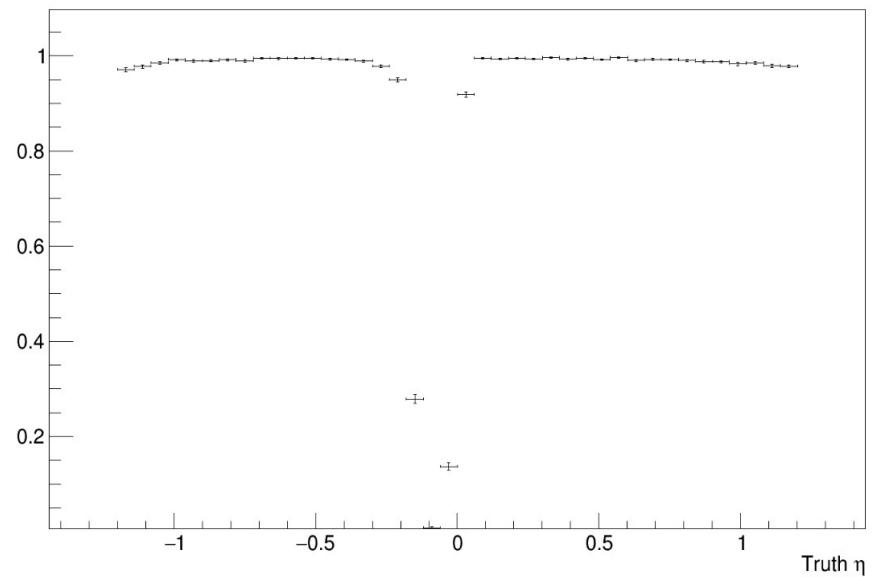


ACTS tracking efficiency

P_T dependence



η dependence

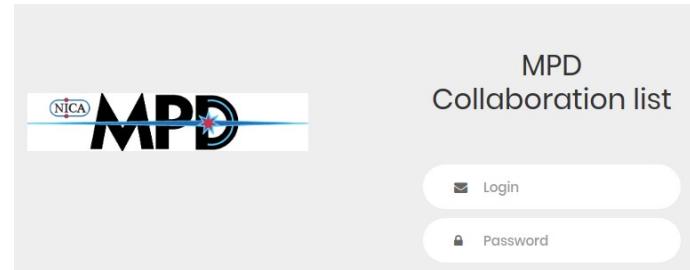


MPD databases

- ✓ List of MPD members & authors
- ✓ MC events mass productions
- ✓ LogBook for Experiment
- ✓ TPC geometry
- ✓ TPC calibration
- ✓ TPC alignment parameters
- ✓ TOF calibration
- ✓ ECAL instrumentation
- ✓

MPD geometry alignments DB

Home TPC alignments TOF alignments



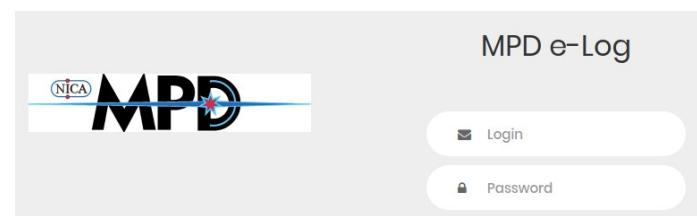
MPD Monte-Carlo DB

Free for the users

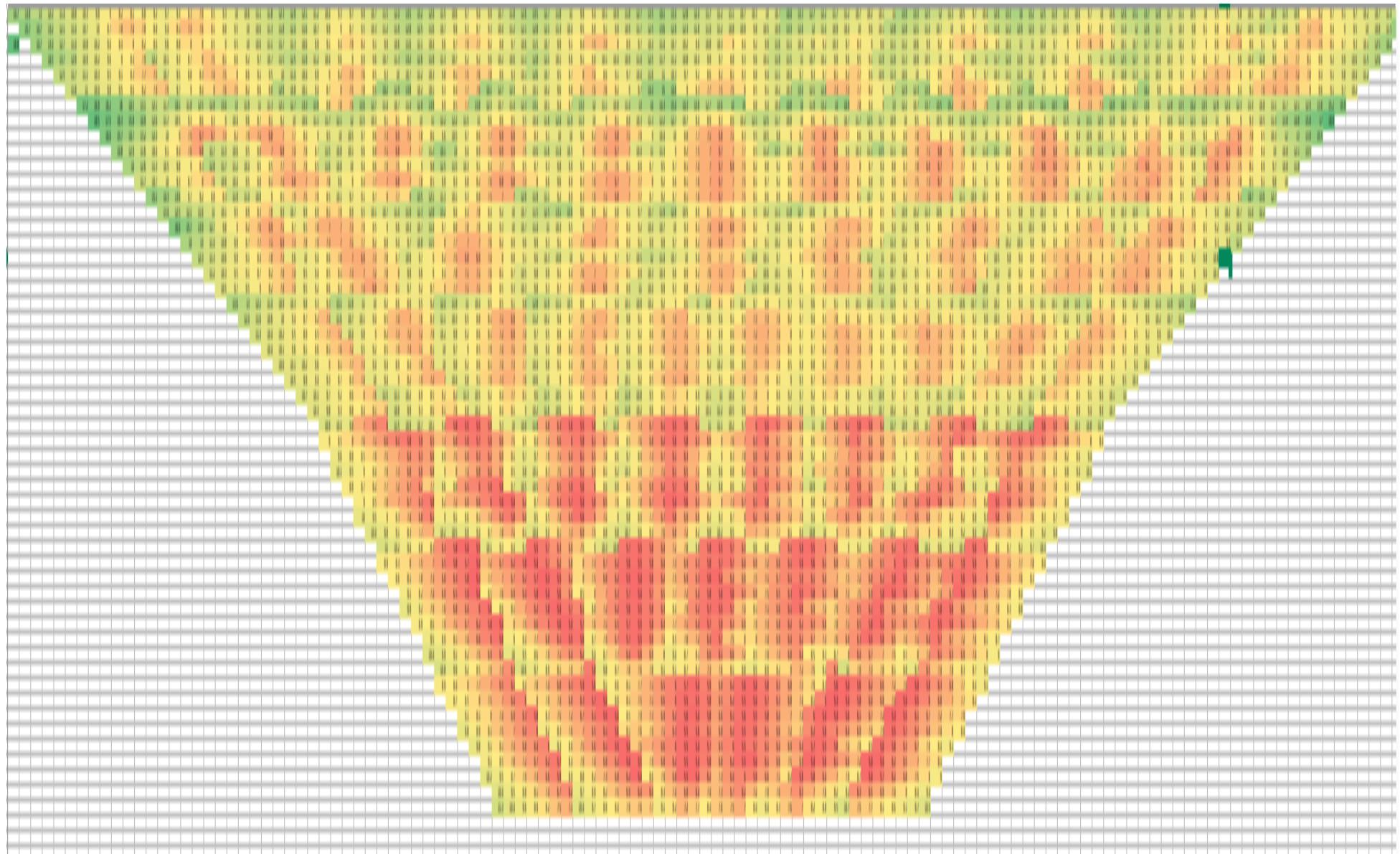
Username

Password

Login



TPC pads capacity DB

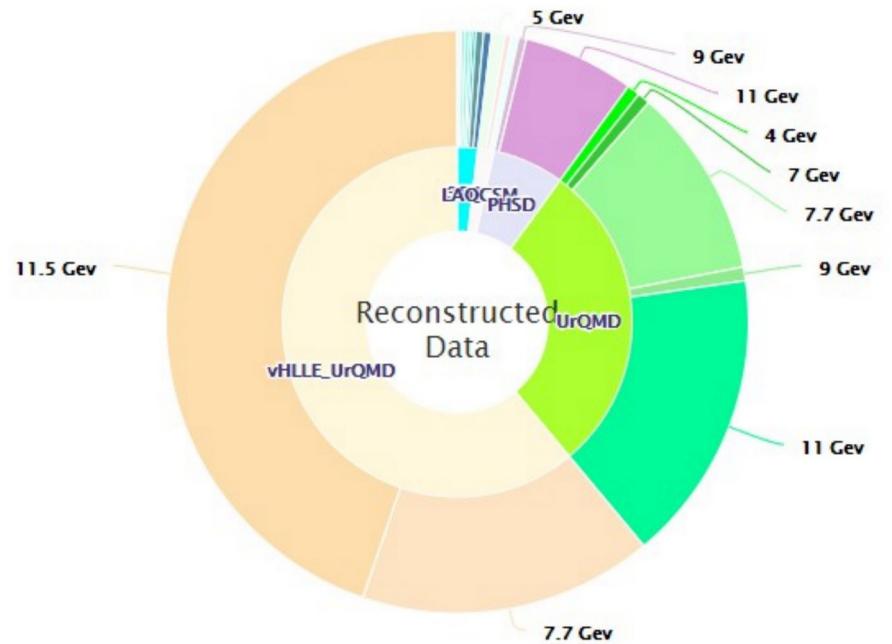
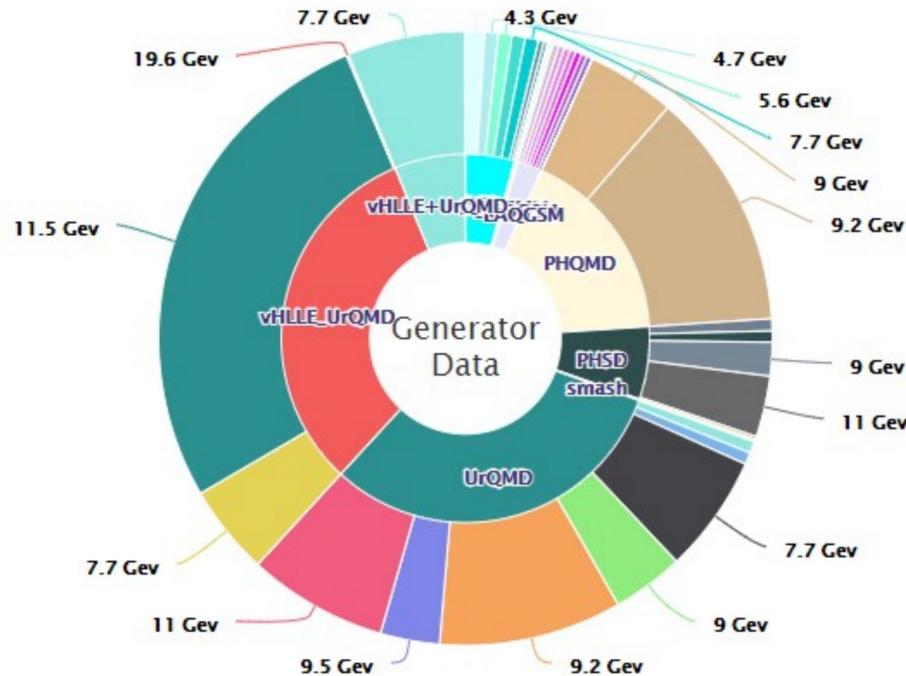


MPD mass production database



<http://db-nica.jinr.ru/mpdmc/stat.php>

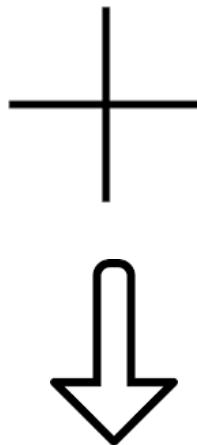
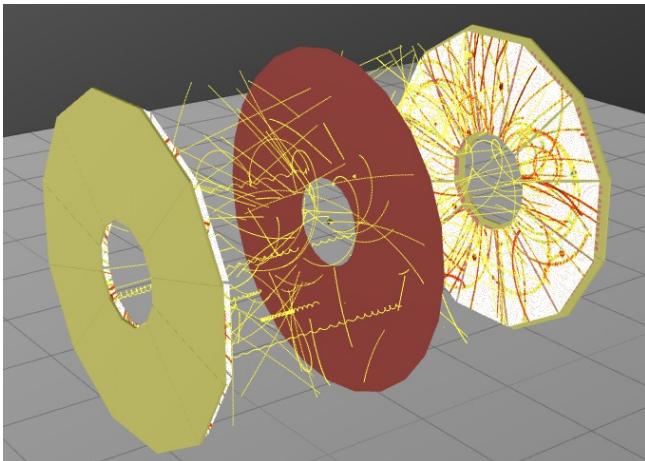
31 mass production requests were done



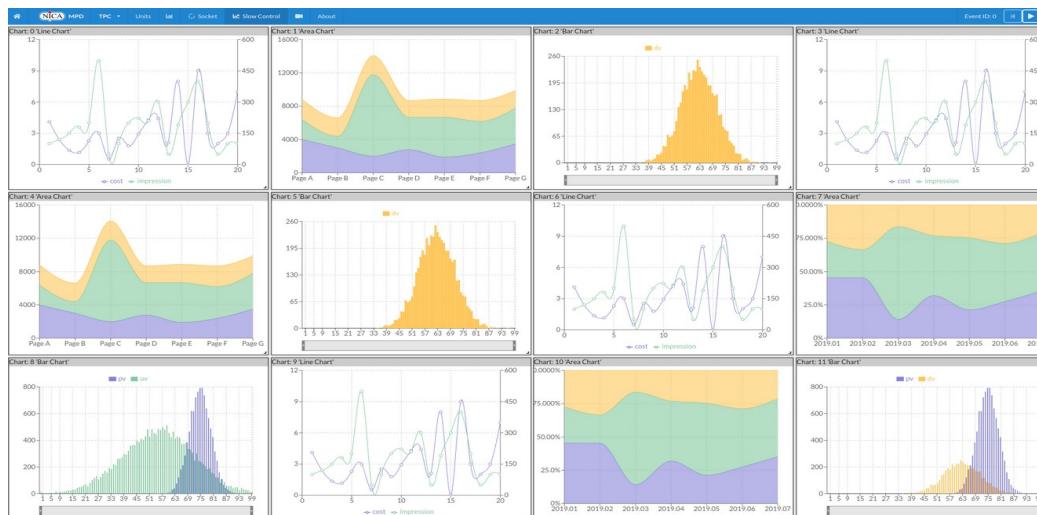
All production data stored in Dirac File Catalog

TPC control dashboard

TPC eventdisplay

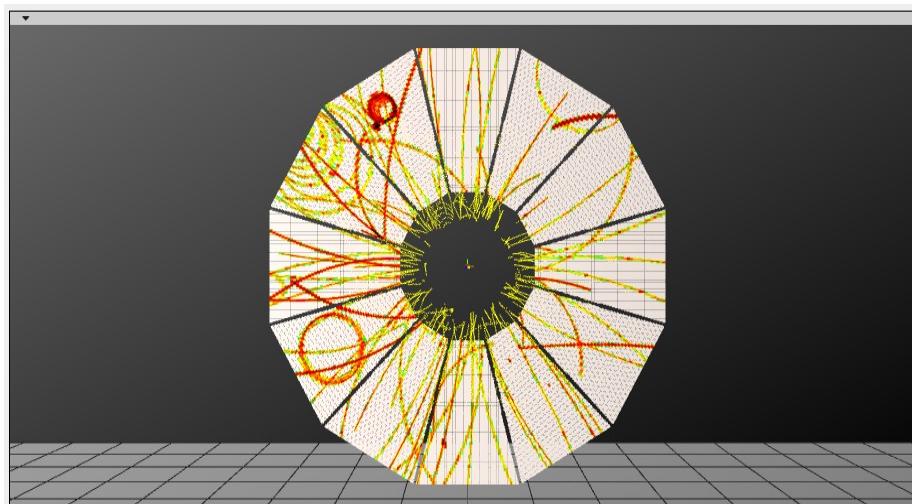


TPC control system

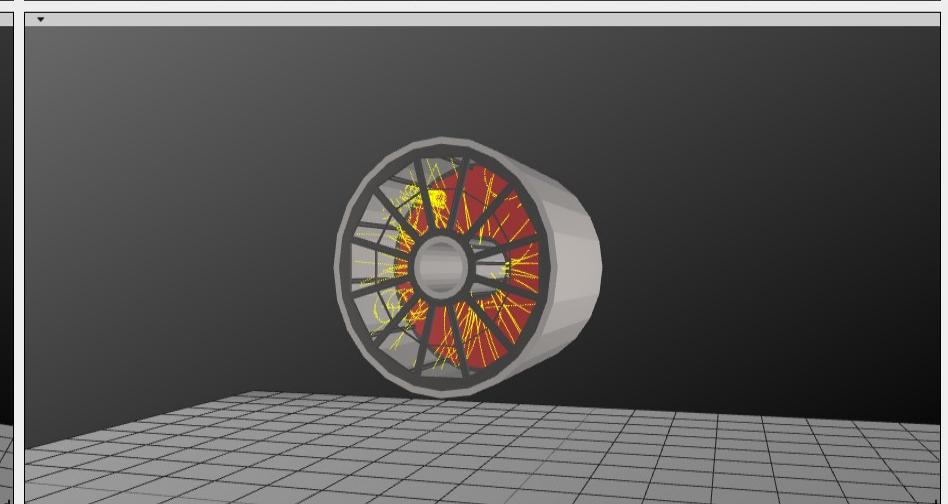
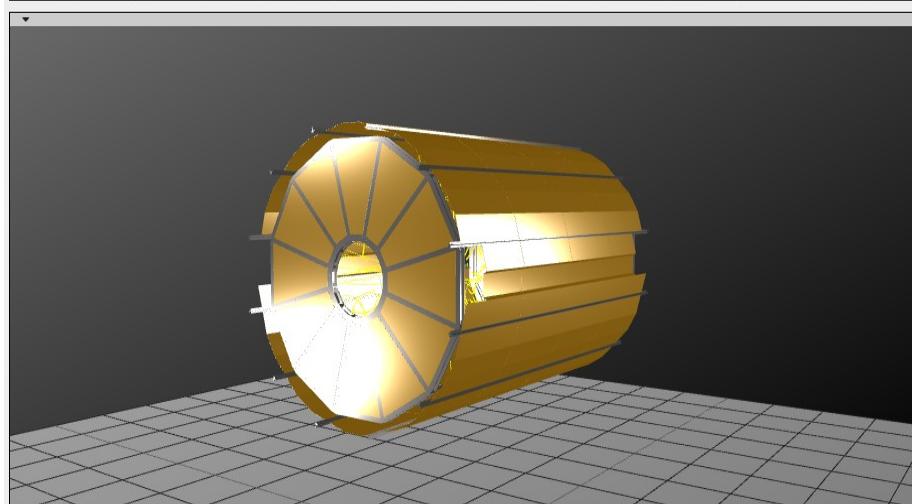
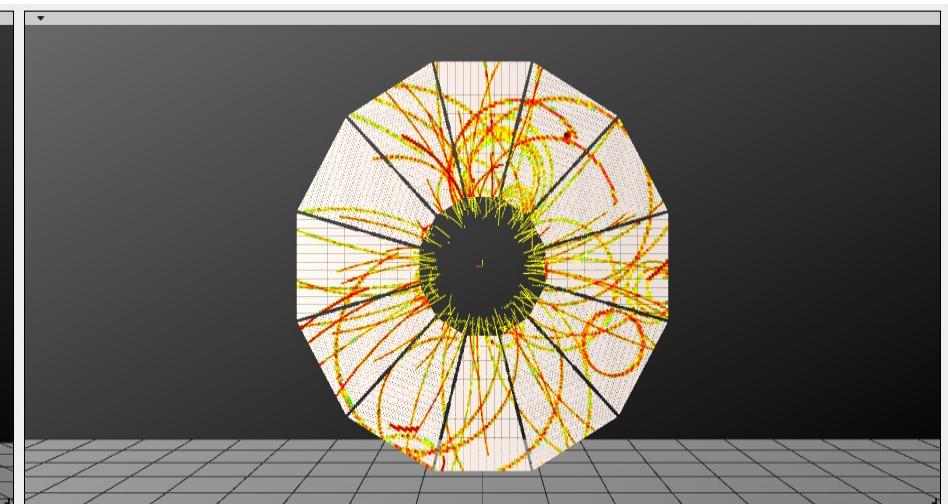


TPC online pad planes

West



East



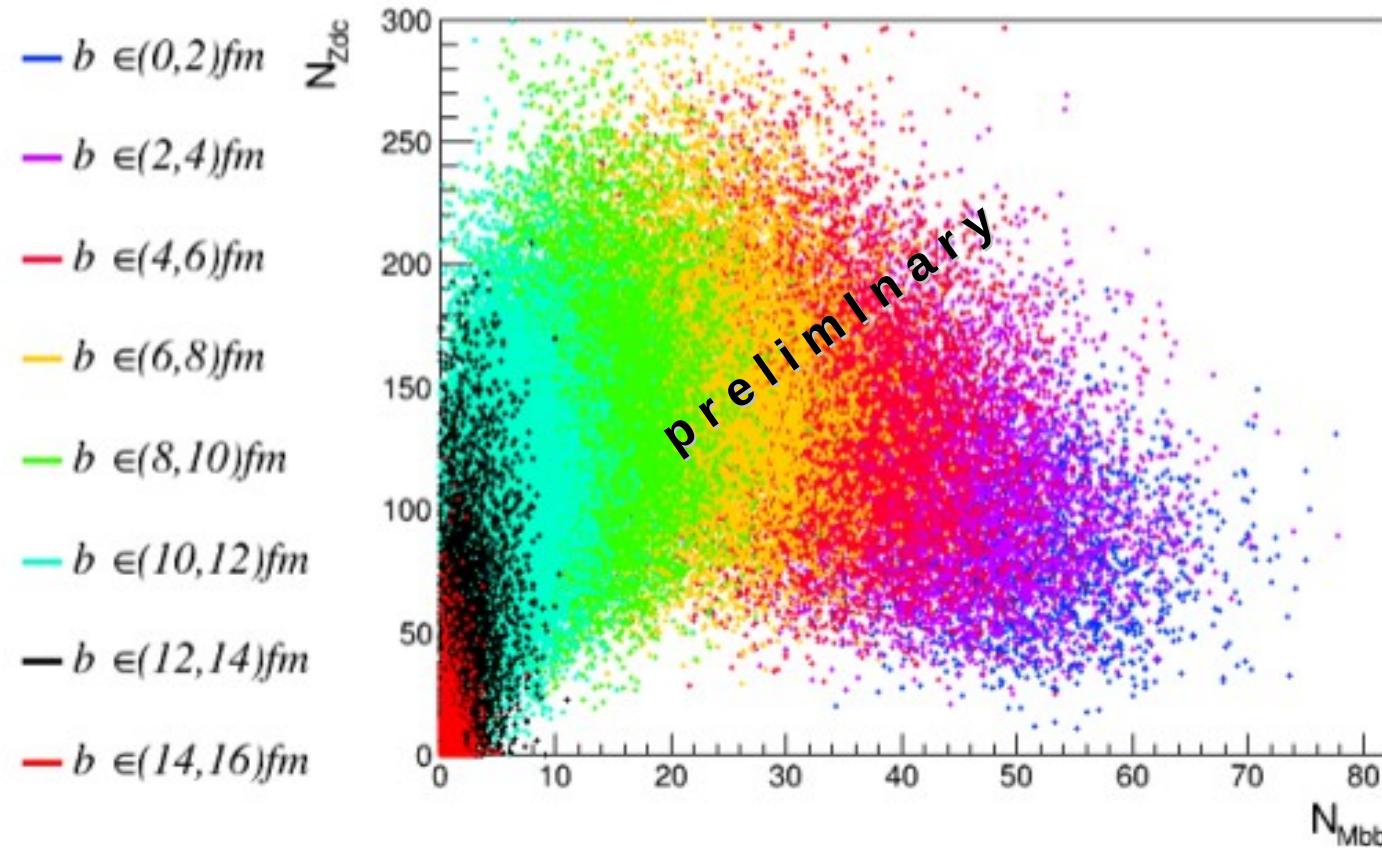
TPC dashboard

TPC sectors time buckets



FHCal vs MiniBeBe

DCM-QGSM-SMM - BiBi $\sqrt{s_{NN}} = 4 \text{ GeV}$

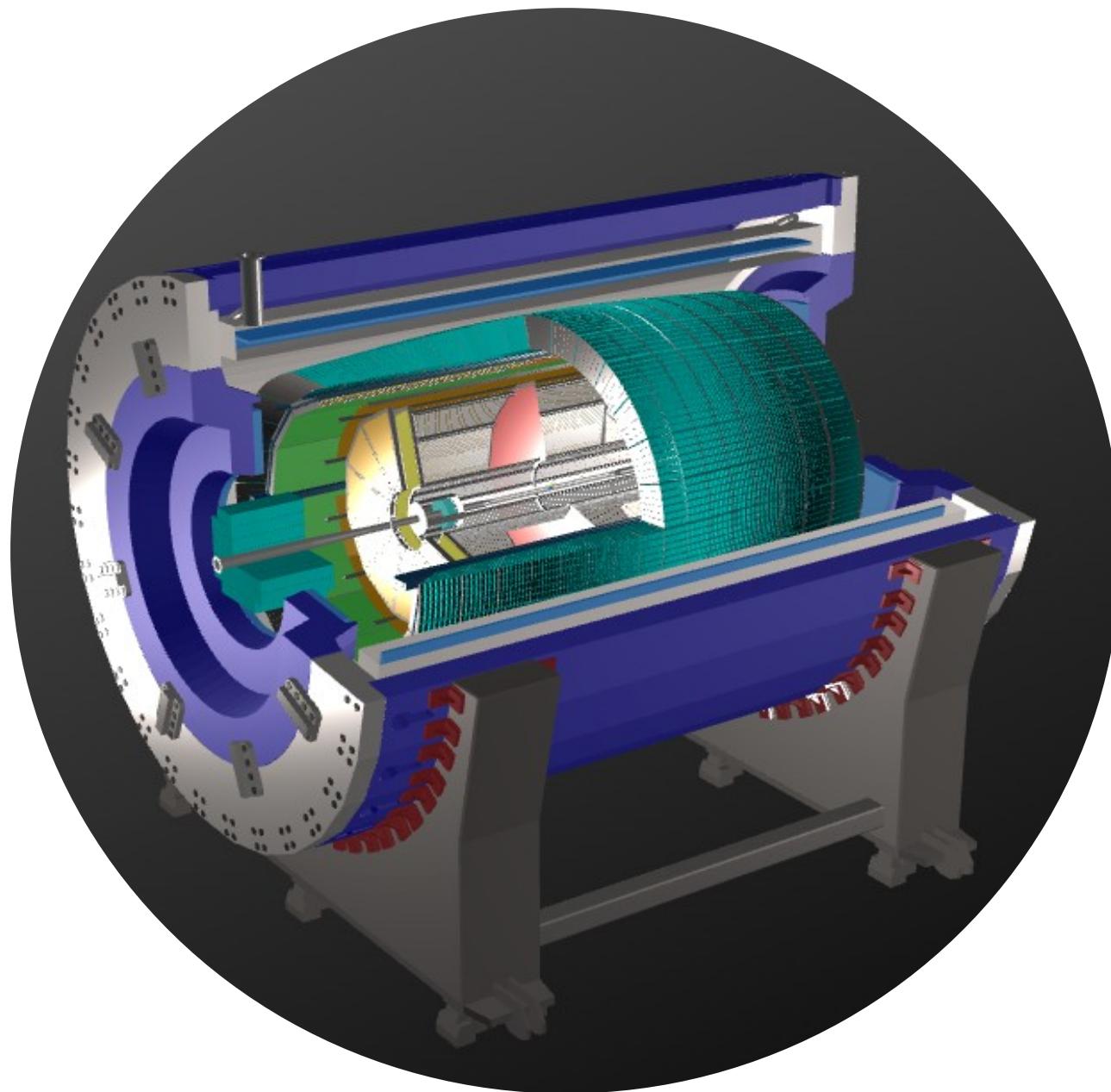


MPD software development team

LHEP	LIT	OTHER
Bychkov A. Krylov A. Moshkin A. Rogachevsky O.	Alexandrov E. Alexandrov I. Balashov N. Belyakov D. Busa J. Hnatic S. Pelevanyuk I. Podgainy D. Zuev M.	Kuzmin V. Krylov V.

**Volunteers
Are
welcome**

Thanks for your attention



HEP physics & computing

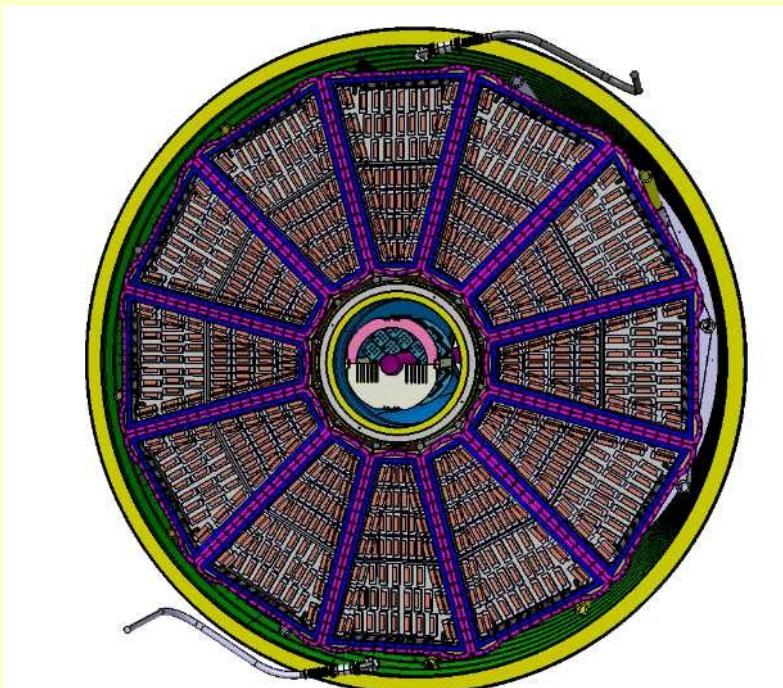
The further we go,
The further you go

SW tasks for TPC commissioning

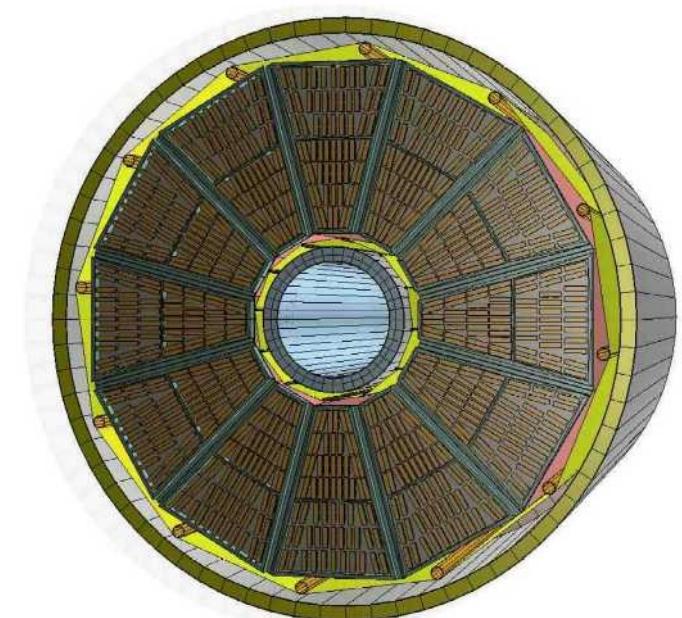
- Noise distribution within TPC
- ExB effect study $\Delta r\varphi$ (B_z)
- Momentum resolution $\Delta p_T(p_T)$
- Drift length dependence σ_y (L_{drift})
- Alignment
- Field of charge distribution in TPC
- ...

Geant TPC geometry

- Drawing



- Geant geometry



35 000 nodes

Geant TPC Electronics Simulation



Each board:

2+1 mm Copper

3,5 mm Textolite

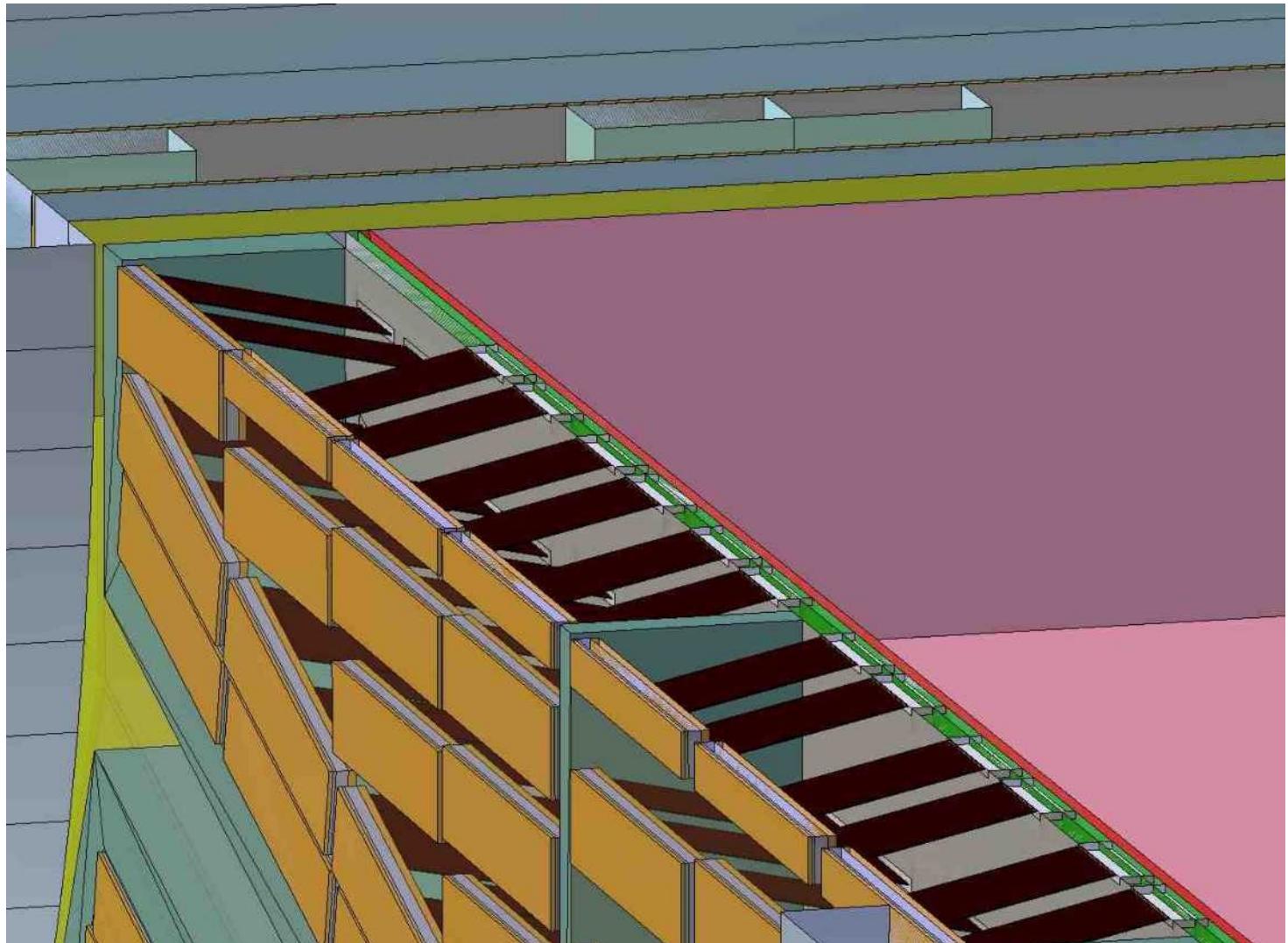
Flat cable:

0,1+0,1 mm
Polypropylene
Insulation

0,15 mm
Copper wire

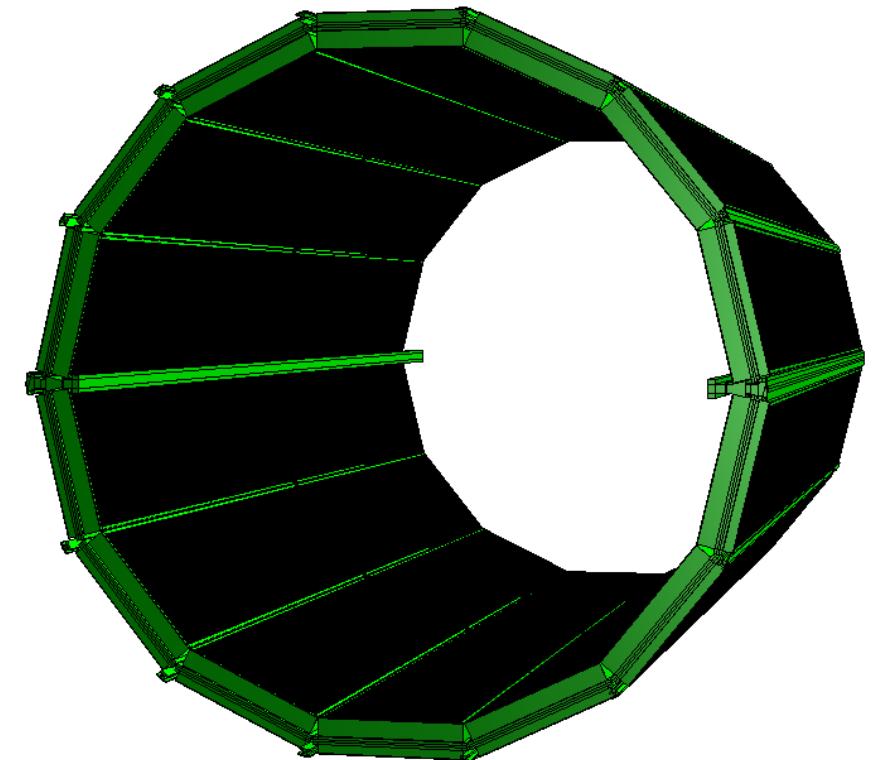
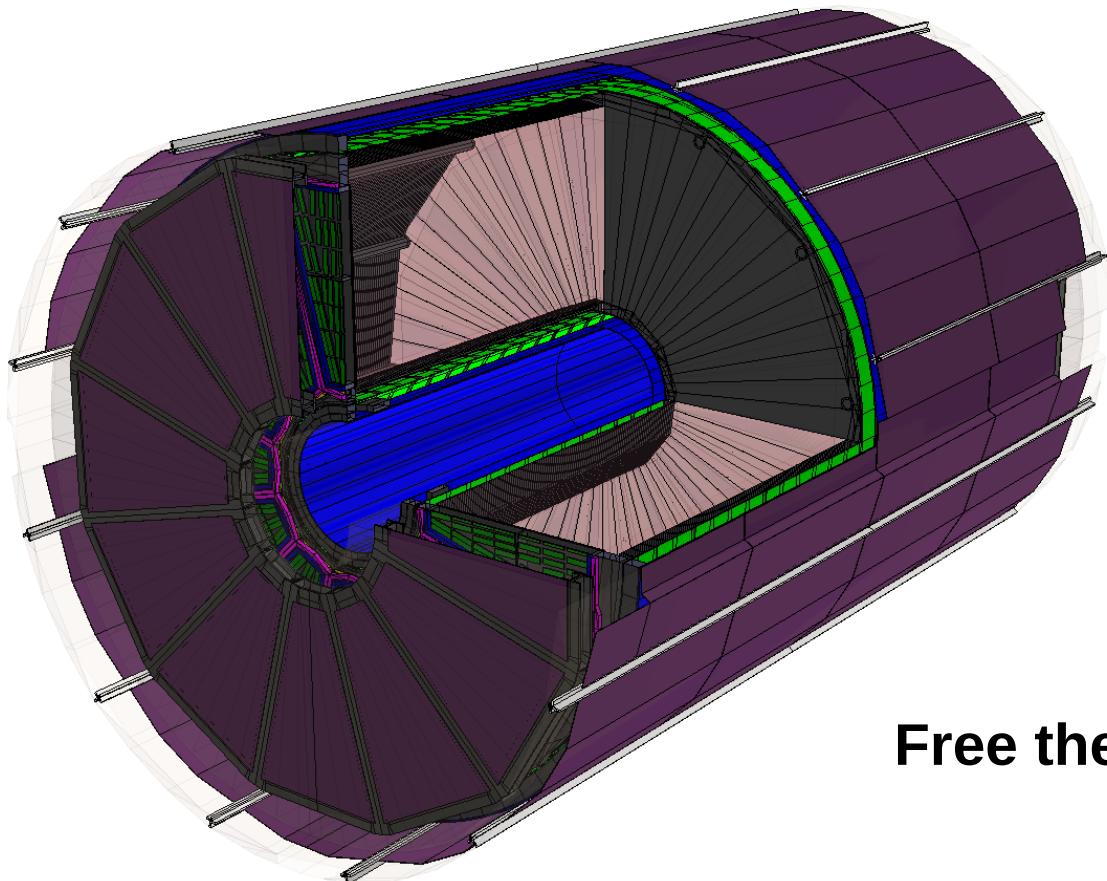
Connector to
Pads plane:

Plastic + Air gap



MPD geometry update

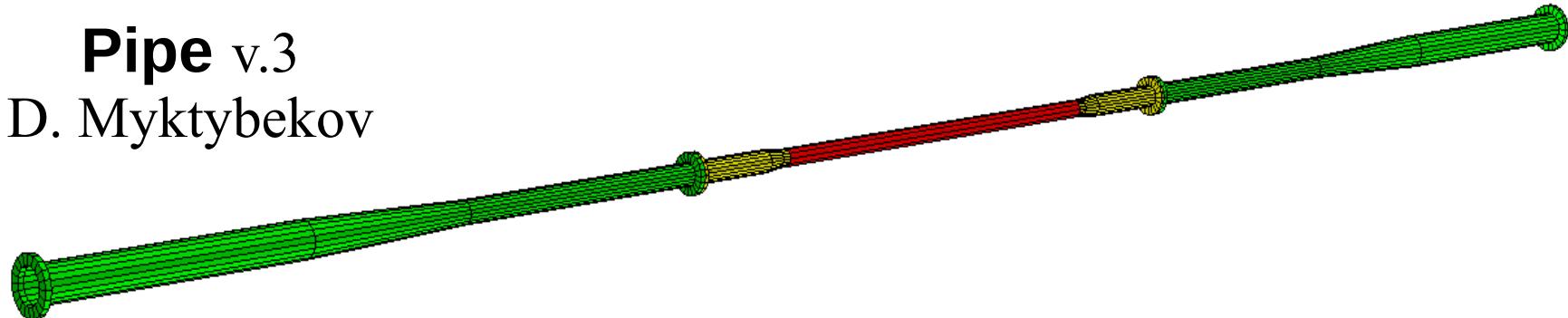
Update geometry TOF v.8_3
S. Lobastov



Free the space for supported rails
TPC v.9
A. Bychkov

MPD geometry update

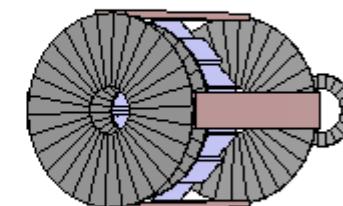
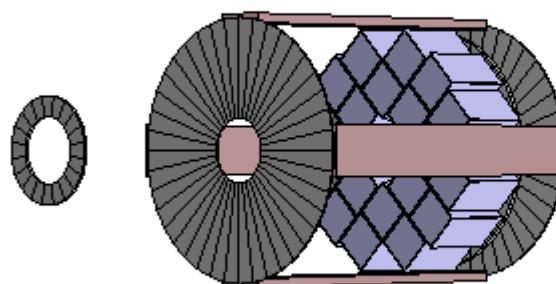
Pipe v.3
D. Myktybekov



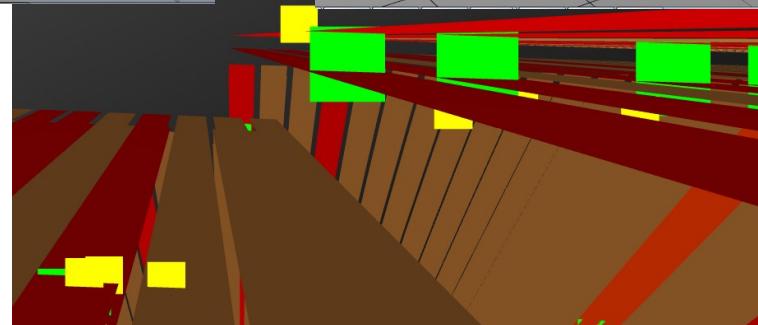
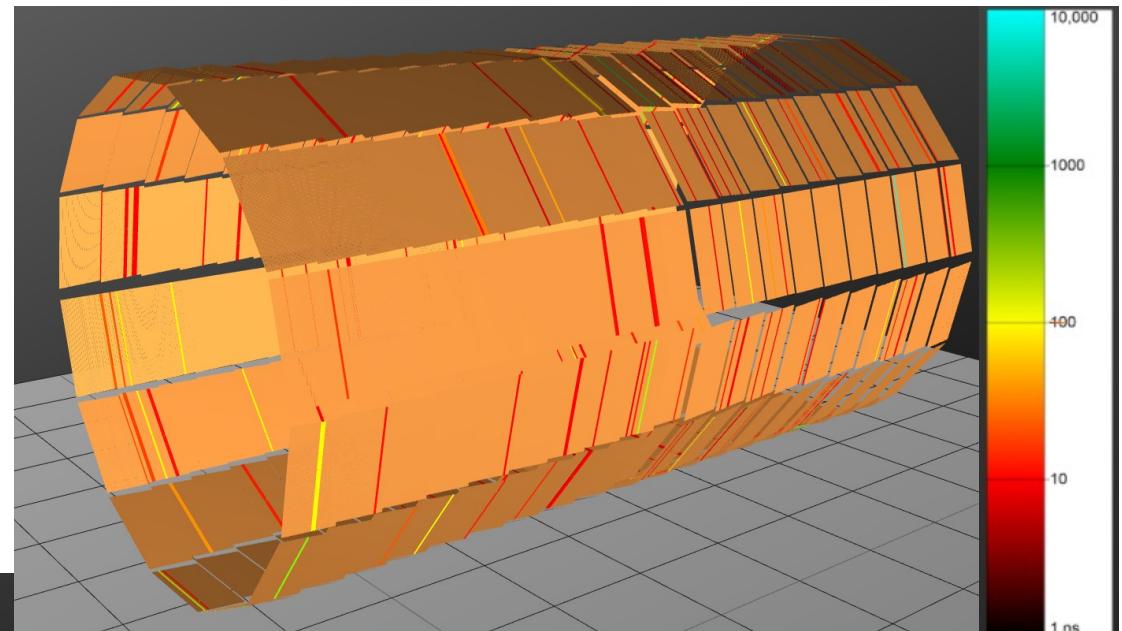
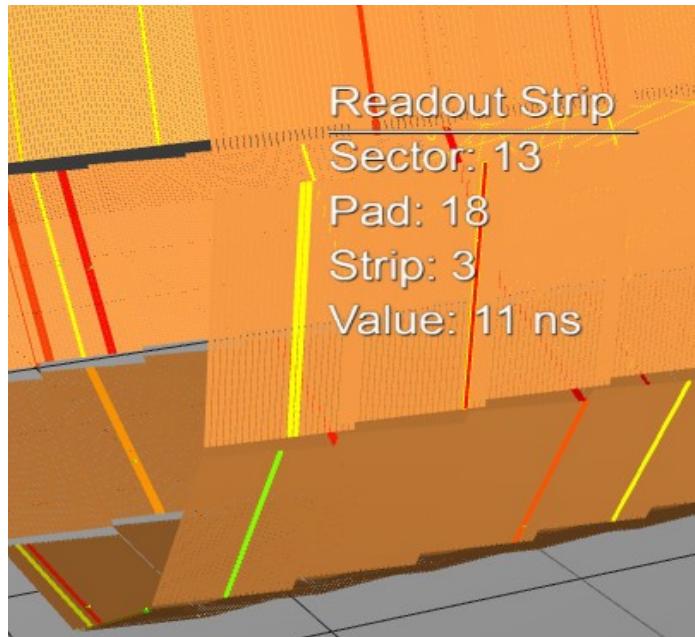
FFD v.3
N. Lashmanov

First version of FFD hit
producer

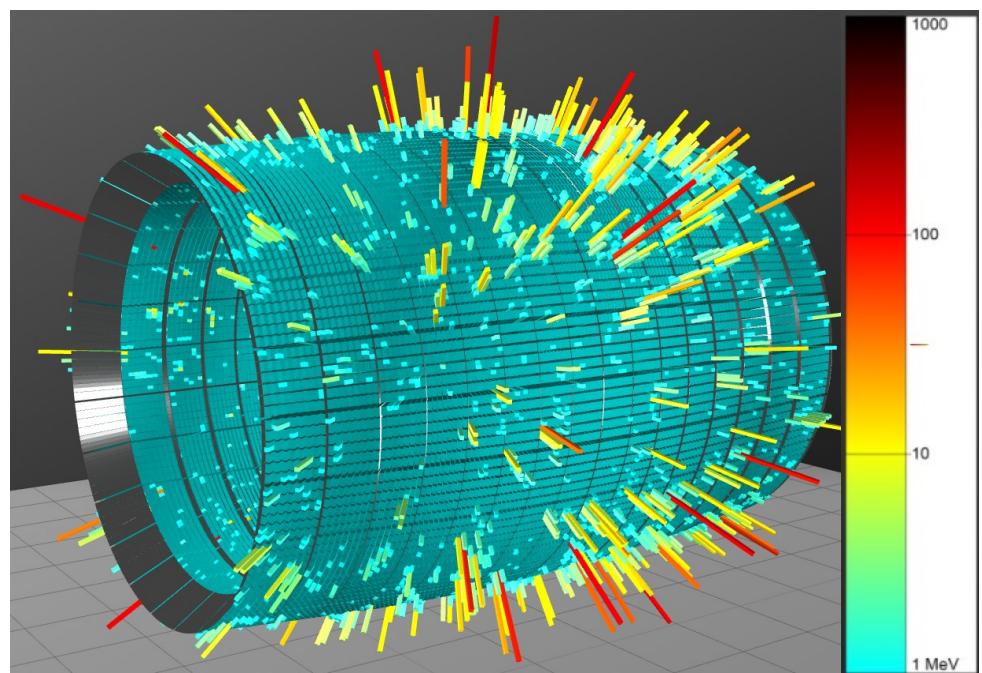
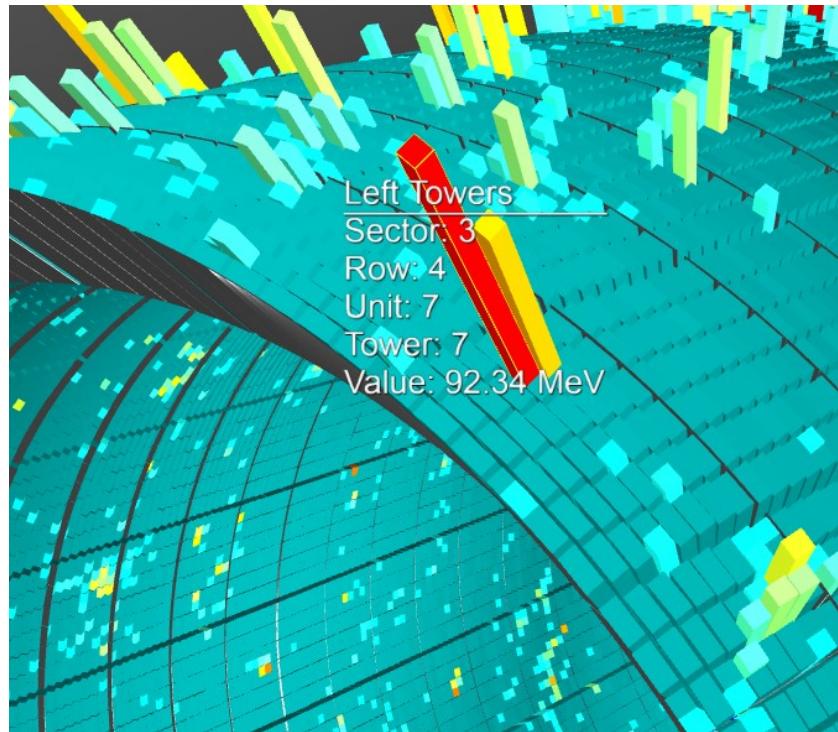
S.Lobastov



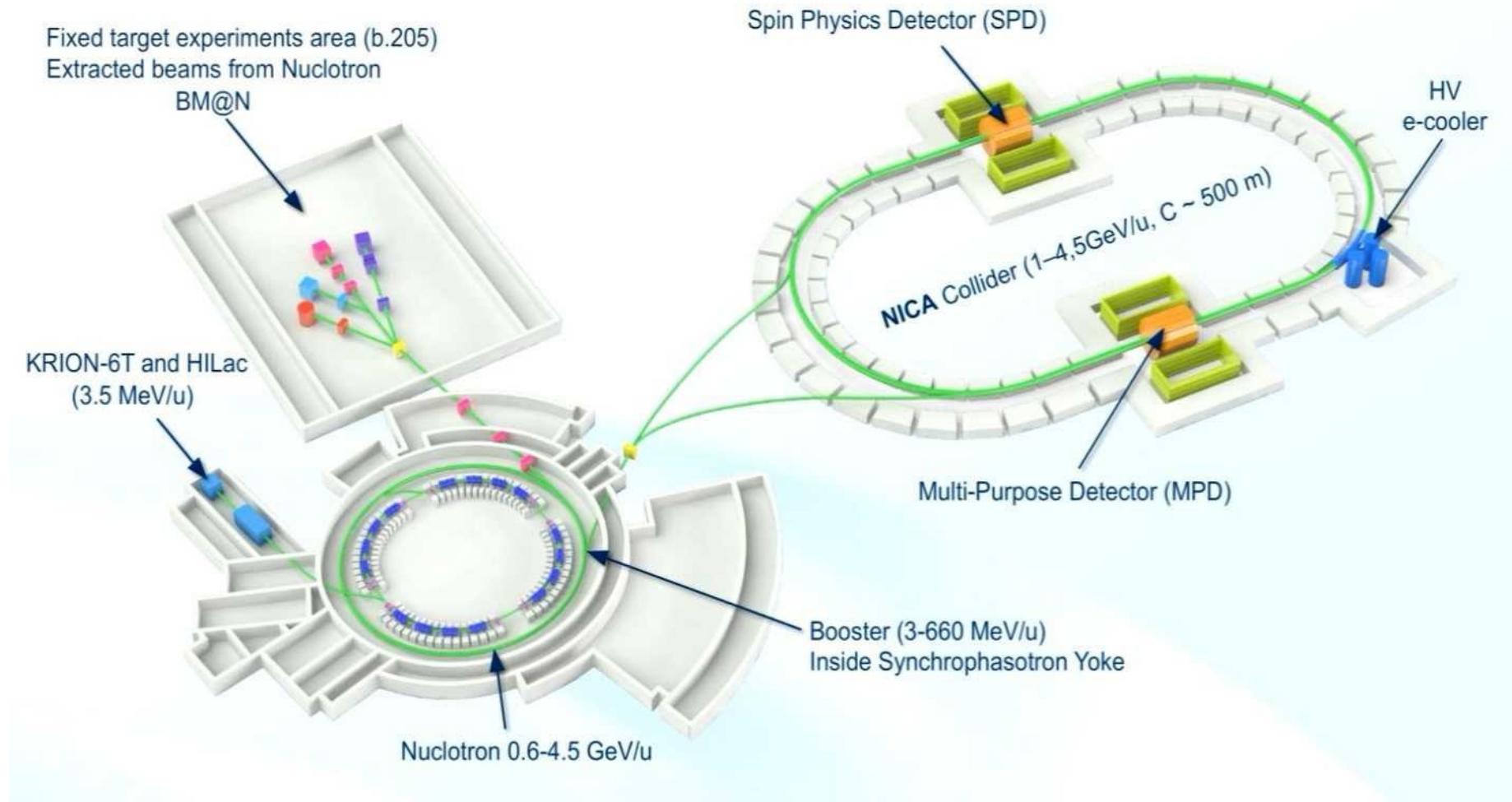
MPD EventDisplay: TOF



MPD EventDisplay: ECAL

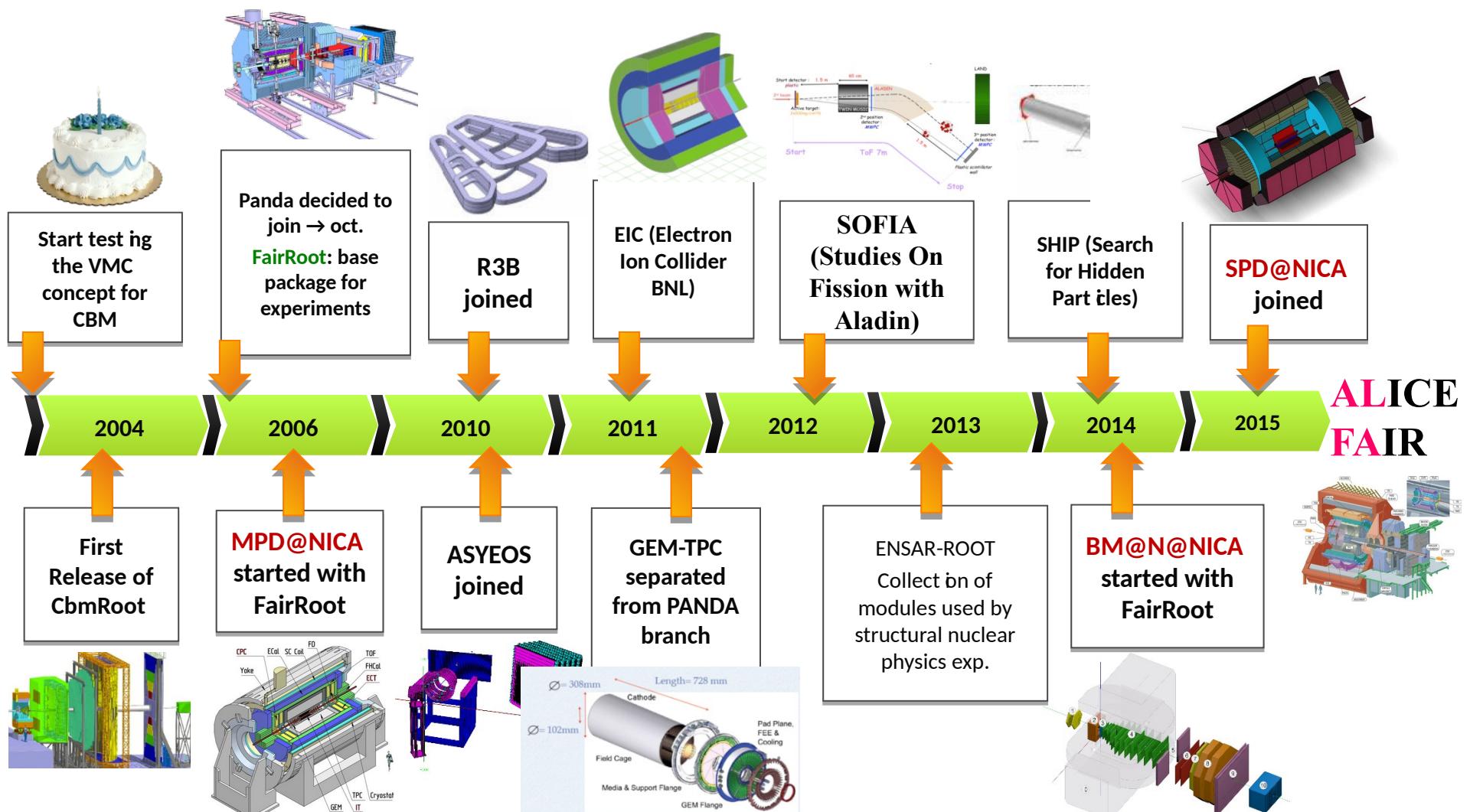


Nuclotron based Ion Collider fAcility



- ↗ Beams: from p to Au^{79+}
- ↗ Luminosity: $10^{27} \text{ cm}^{-2}\text{s}^{-1}$ (Au), 10^{32} ($p\uparrow$)
- ↗ Collision energy: $\sqrt{s_{NN}} = 4 - 11 \text{ GeV}$ $E_{lab} = 1 - 6 \text{ AGeV}$

MpdRoot history



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

MPD geometry checked for stage 1

NICA MPD

