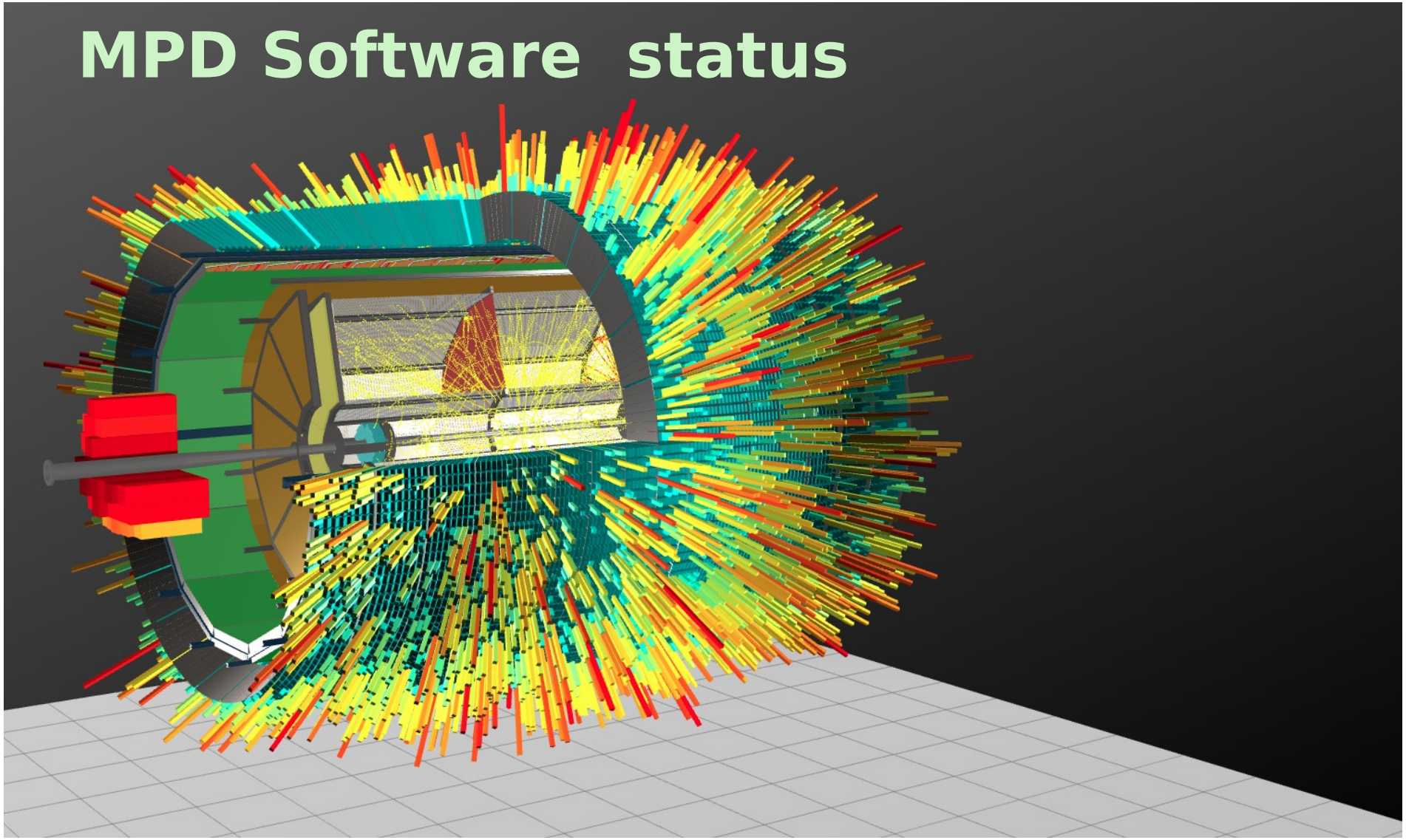
MPD Software status



Rogachevsky Oleg
for MPD collaboration

XII MPD collaboration meeting
5.10.2023
Belgrad

Releases v23.09.2023

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
-

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- 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
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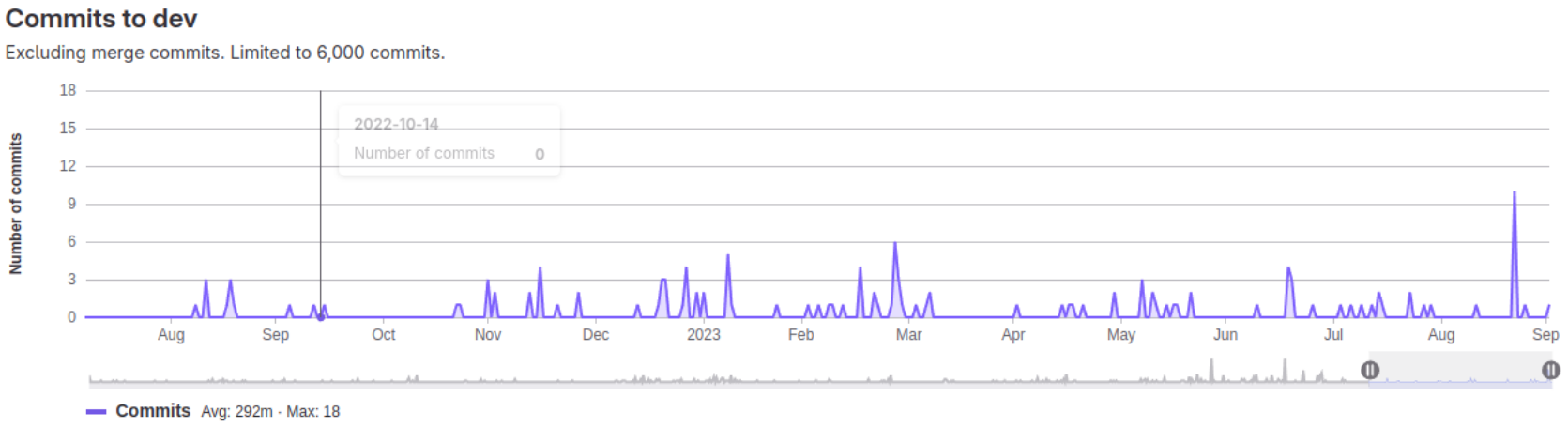
- MpdTpc2dCluster circular build deps fixed #162
- Bad naming workaround #164
- Codeowners bug caused by Gitlab's API change fix #166
- Minuit2 library link fix #158
- GSL include bugfix #138
- Alignment segfault fixed #174
- Macro compilation by ROOT fixed #176

MPD Software status (GIT)



NICA > mpdroot > **Commits**

dev mpdroot Author Search by message

Oct 02, 2023

Added Error, when user is trying to run legacy build. It is no longer...
Jan Busa authored 1 day ago — v23.09.23 — 9d8d1fa8

Sep 25, 2023

Fix MpdKalmanHit fIndex description
Pavel Belecky authored 1 week ago — 168ac392

Sep 22, 2023

QA Engine: (QA_TpcClusterHitFinder) cluster primitive: plotting from mpdroot codebase in jupyter
Slavomir Hnatic authored 3 weeks ago — b41bdffd

QA Engine: (MpdTpcHit) adding local coordinates for QA iface access
Slavomir Hnatic authored 3 weeks ago — f40ab2e2

QA Engine: (QA_TpcClusterHitFinder) method to associate MC tracks with TPC tracks
Slavomir Hnatic authored 3 weeks ago — b48f27b7

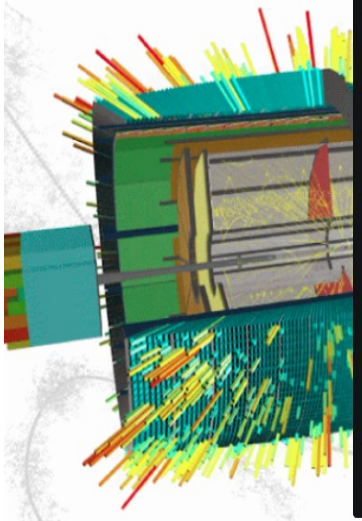
QA Engine: (BaseQA, QA_TpcClusterHitFinder) reading QA primitives from files
Slavomir Hnatic authored 3 weeks ago — afc4a798

Mpdroot deployment

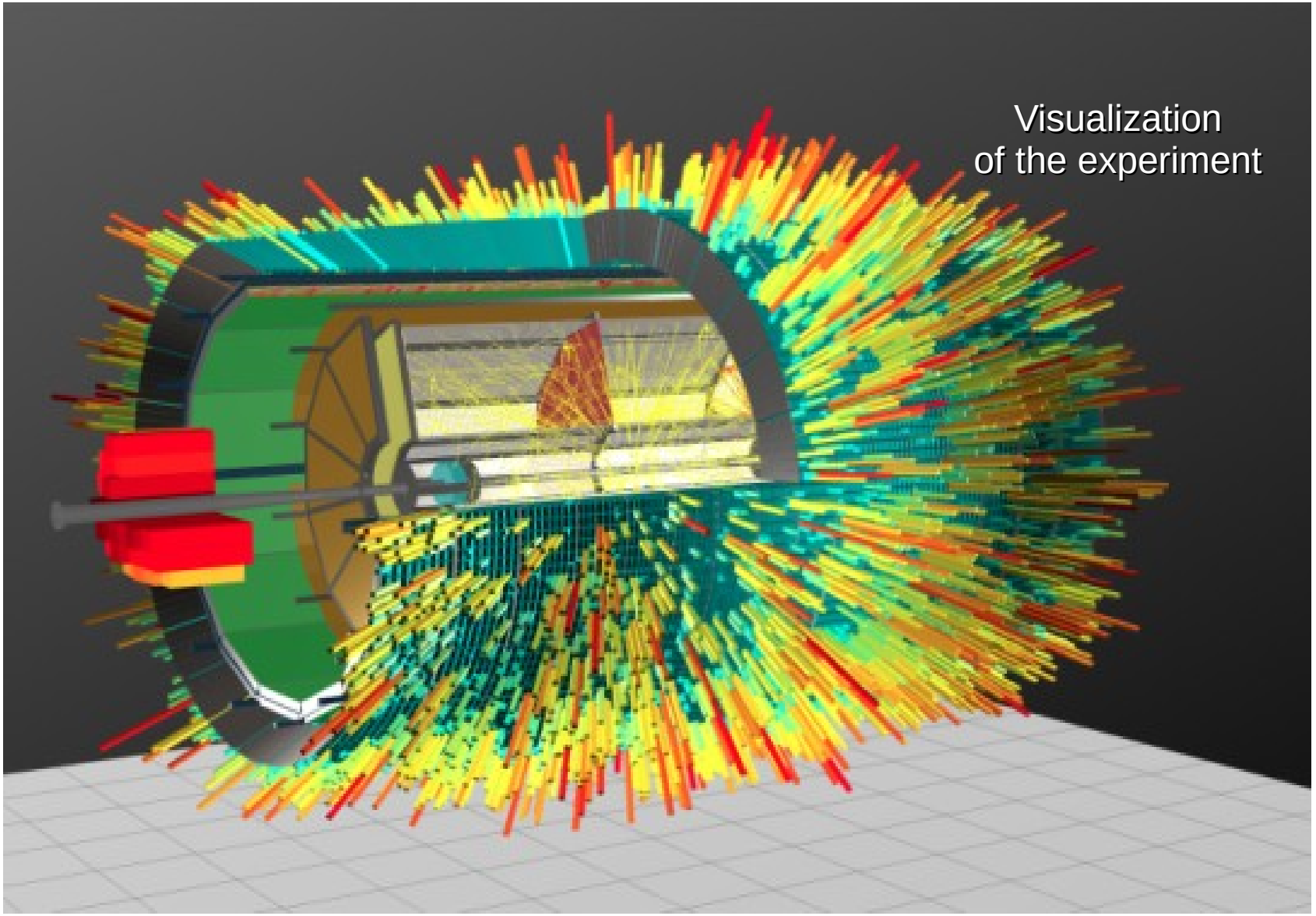
INSTALL CVMFS AND TOOLBOX
(Users and Developers)

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

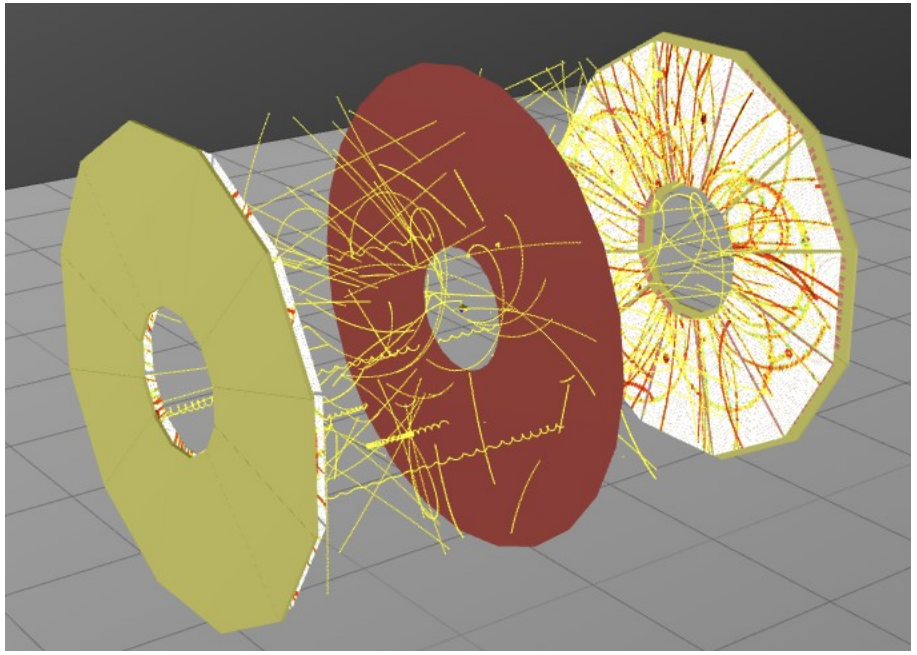
```
[user@fedora ~]$ wget https://git.jinr.ru/nica/nicadist/-/raw/master/scripts/nica-init.sh --no-check-certificate
--2021-12-02 00:00:00--  https://git.jinr.ru/nica/nicadist/-/raw/master/scripts/nica-init.sh
.....
.....
2021-12-02 00:00:02 (87.9 MB/s) - 'nica-init.sh' saved [10794/10794]

[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 ~]$
```

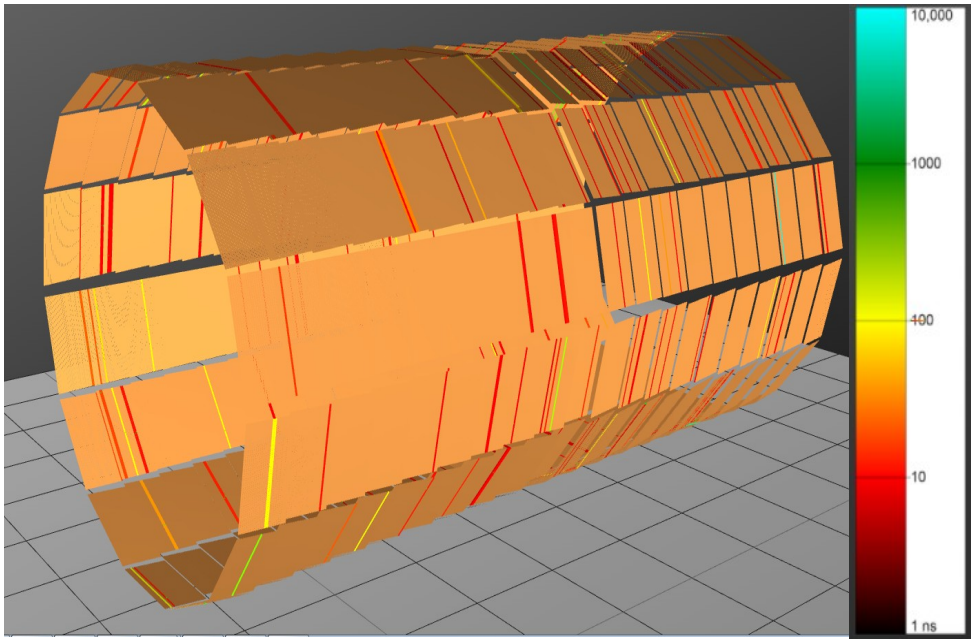


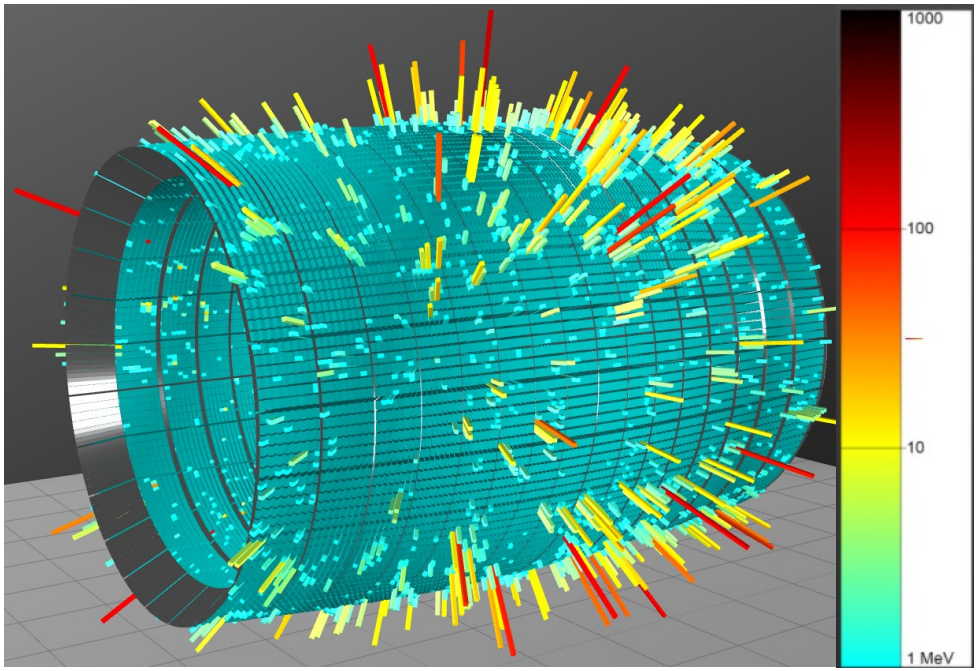
MPD EventDisplay (Victor Krylov's report)

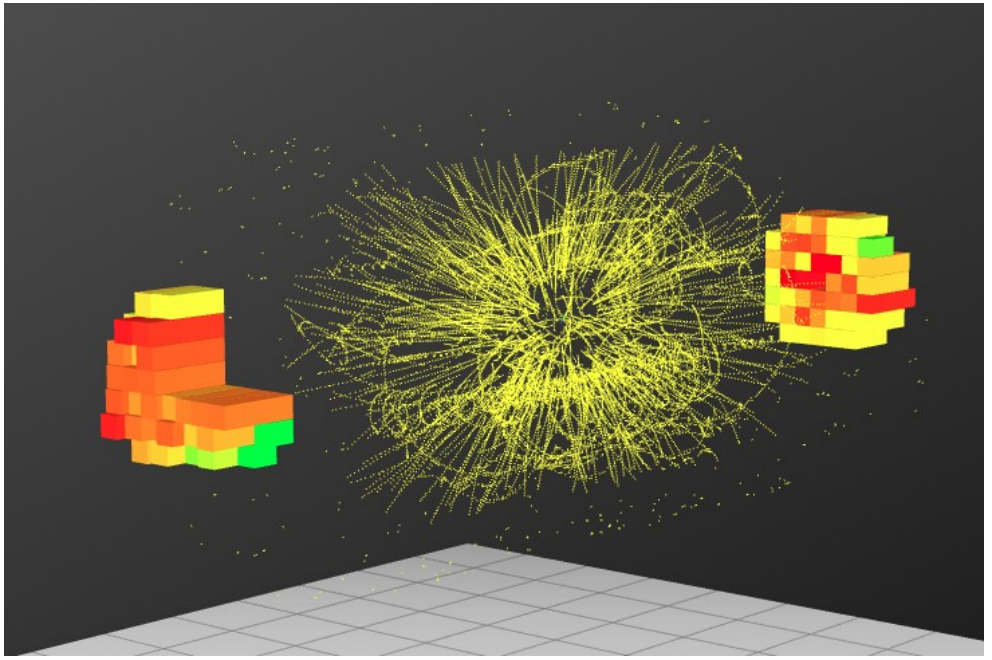


MPD EventDisplay: hits

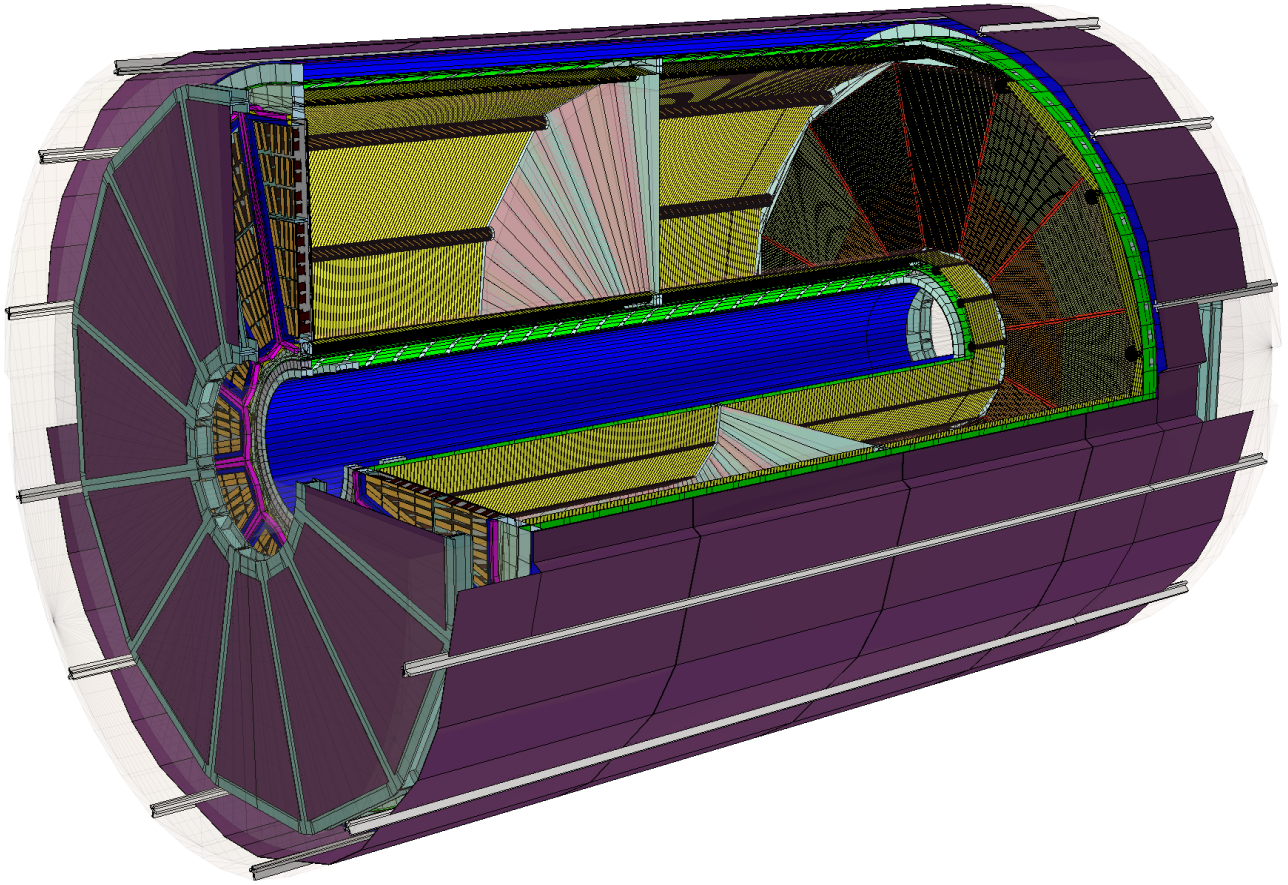




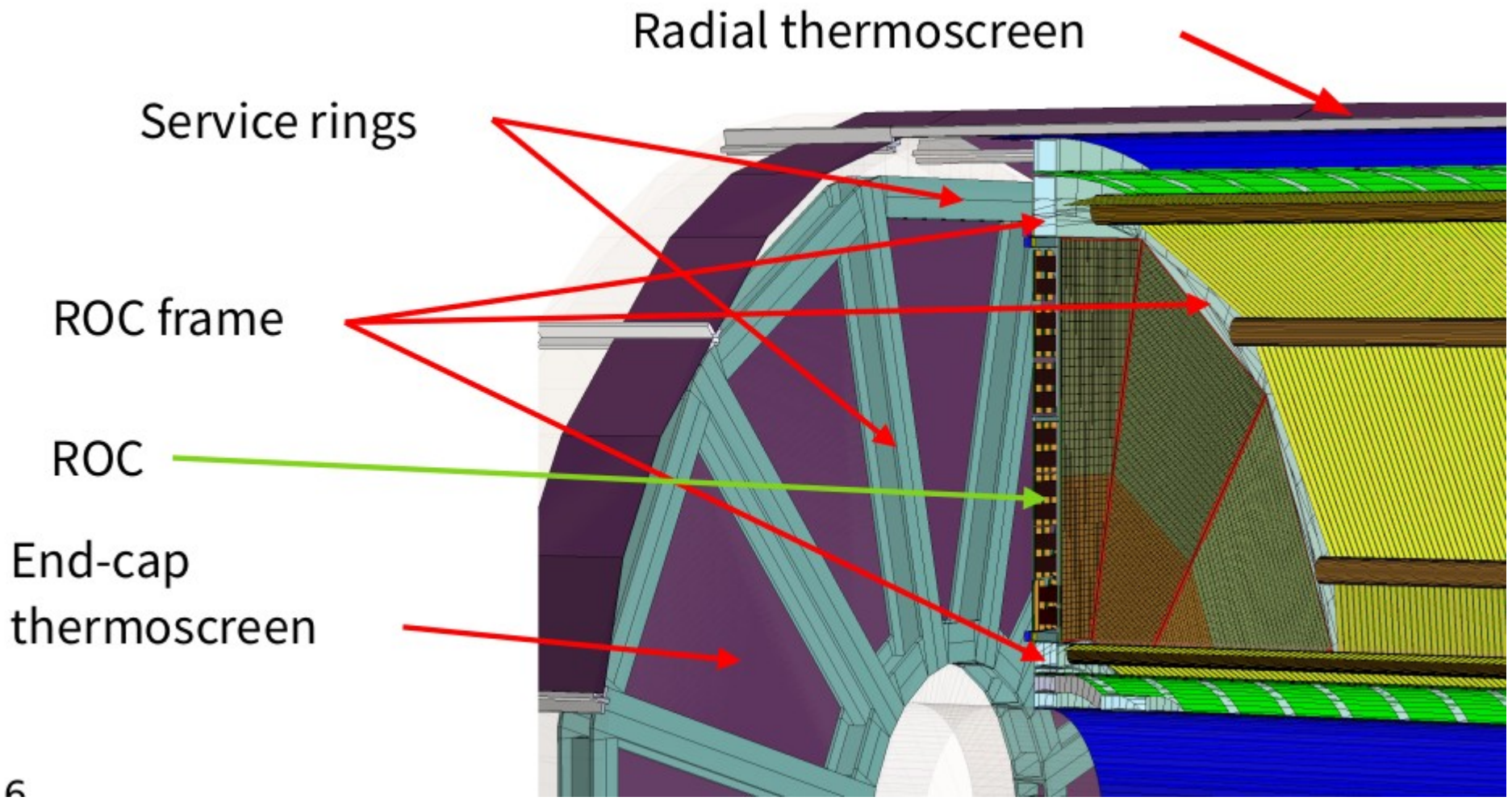




Tracks distortions in barrel and endcap TPC parts



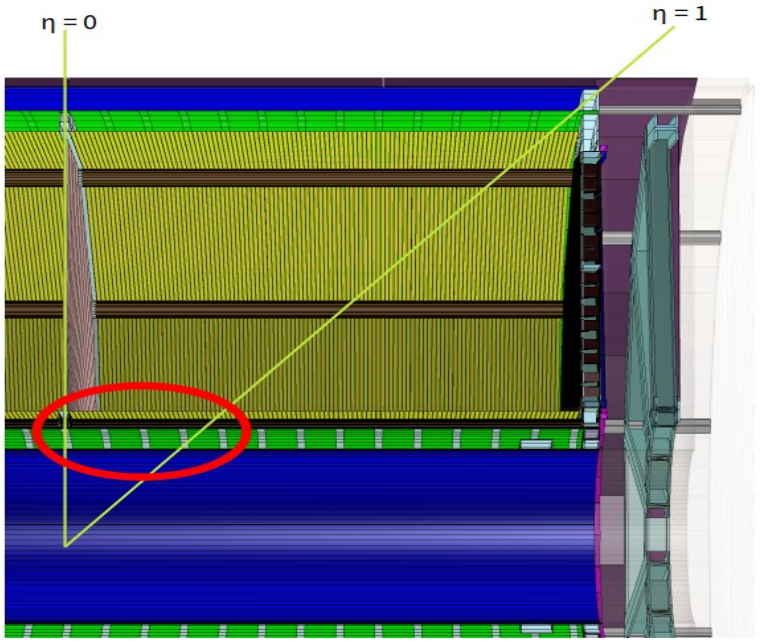
MPD Endcaps structure



Pseudorapidity dependence

P_0 = 900 MeV

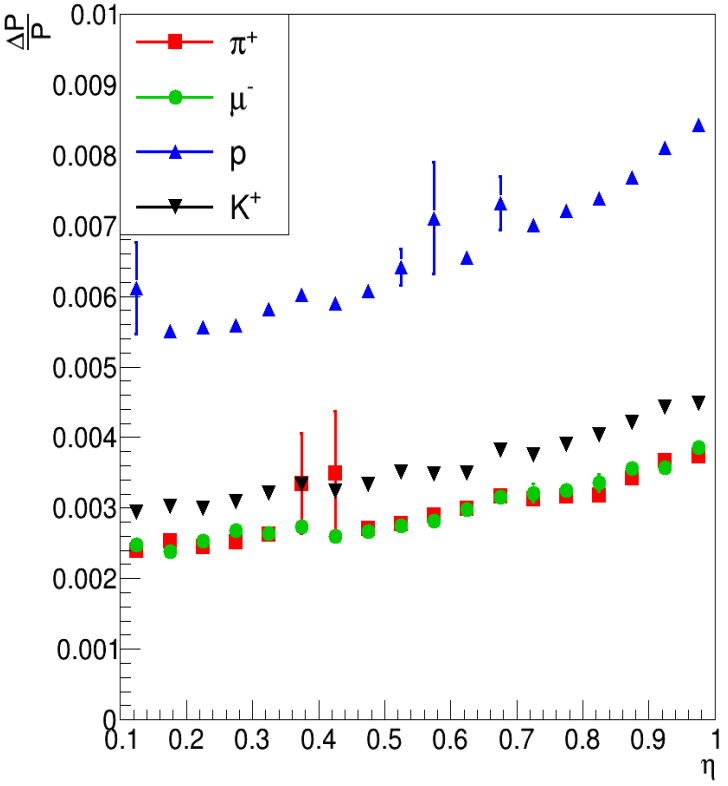
$\eta < 1$



TPC inner wals:
- Kevlar
- Tedlar
- N^2
- Al rings
- Kevlar

Field cage inner pins:
- Polypropylene

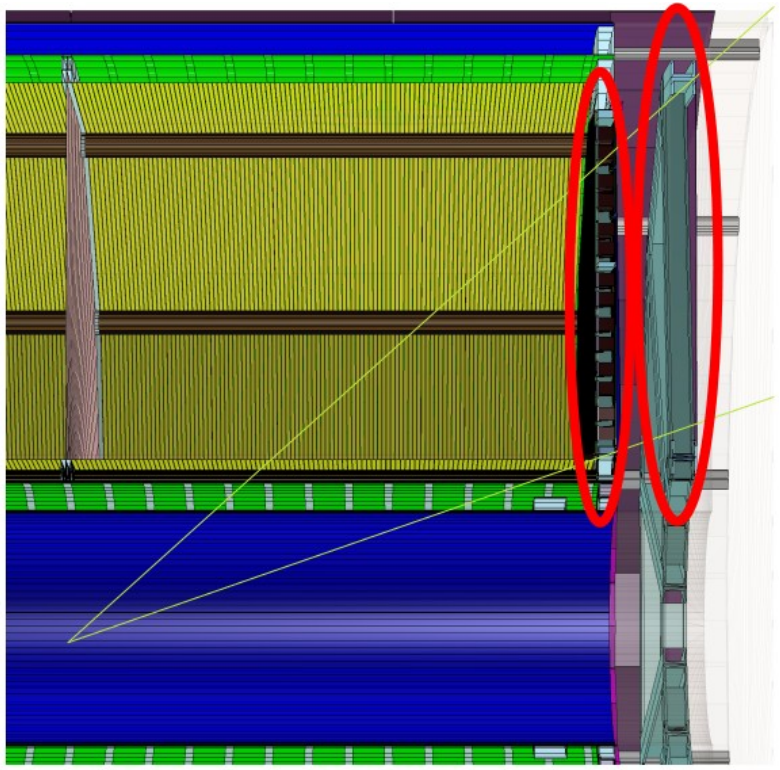
Field cage:
- Mylar film



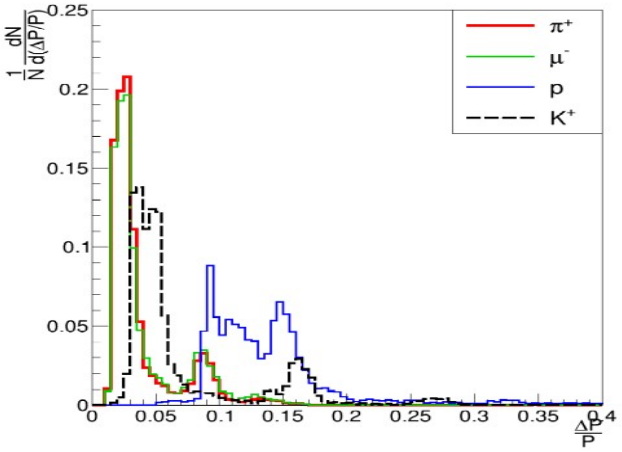
Pseudorapidity dependence

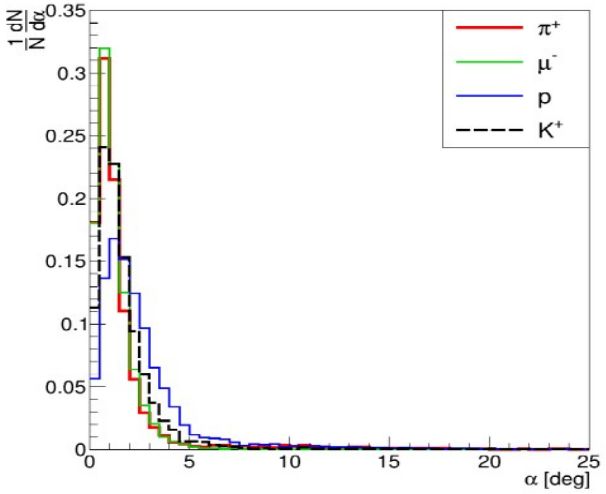
P_0 = 900 MeV

$\eta > 1$



After end-cap flanges

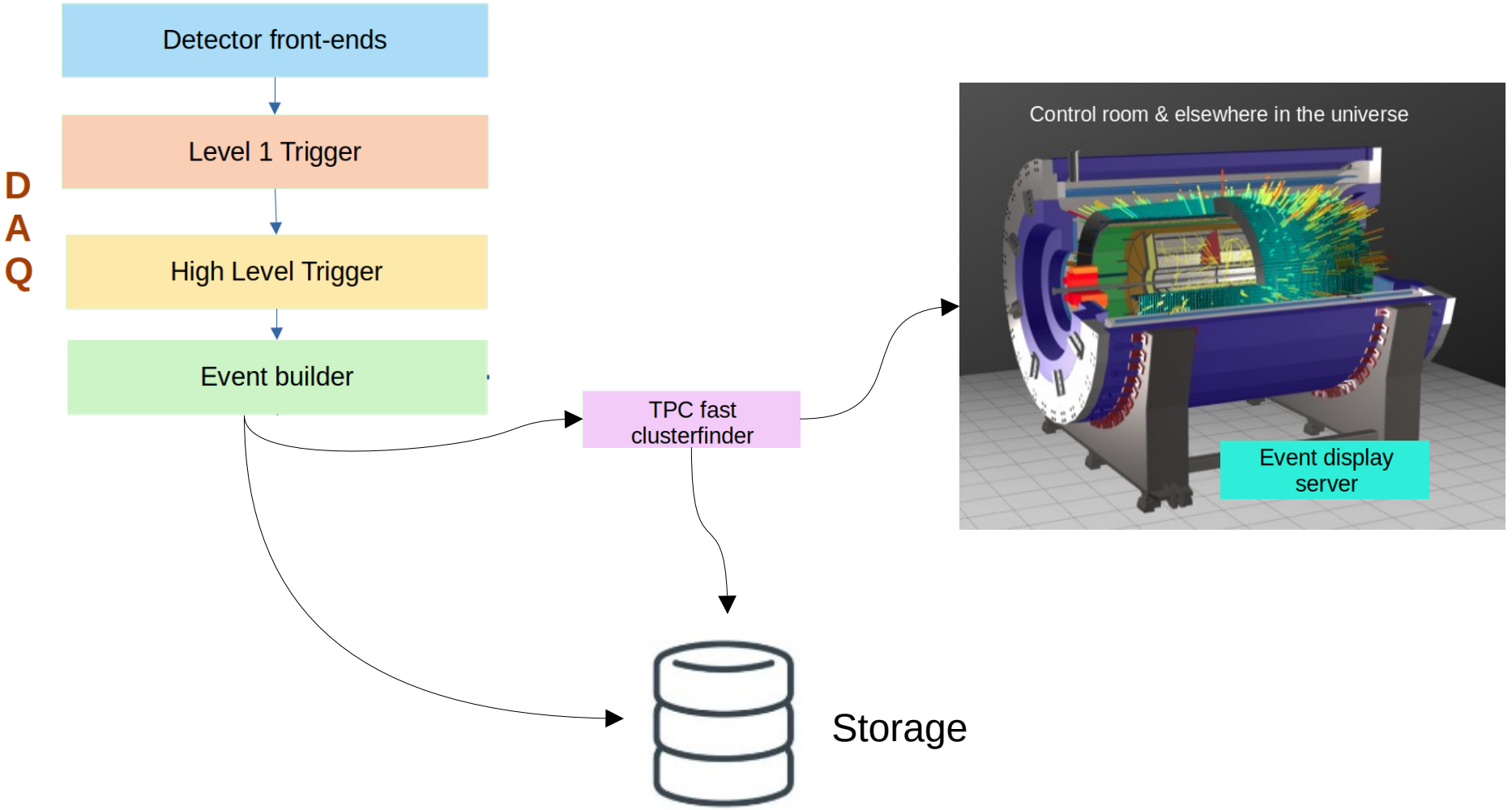




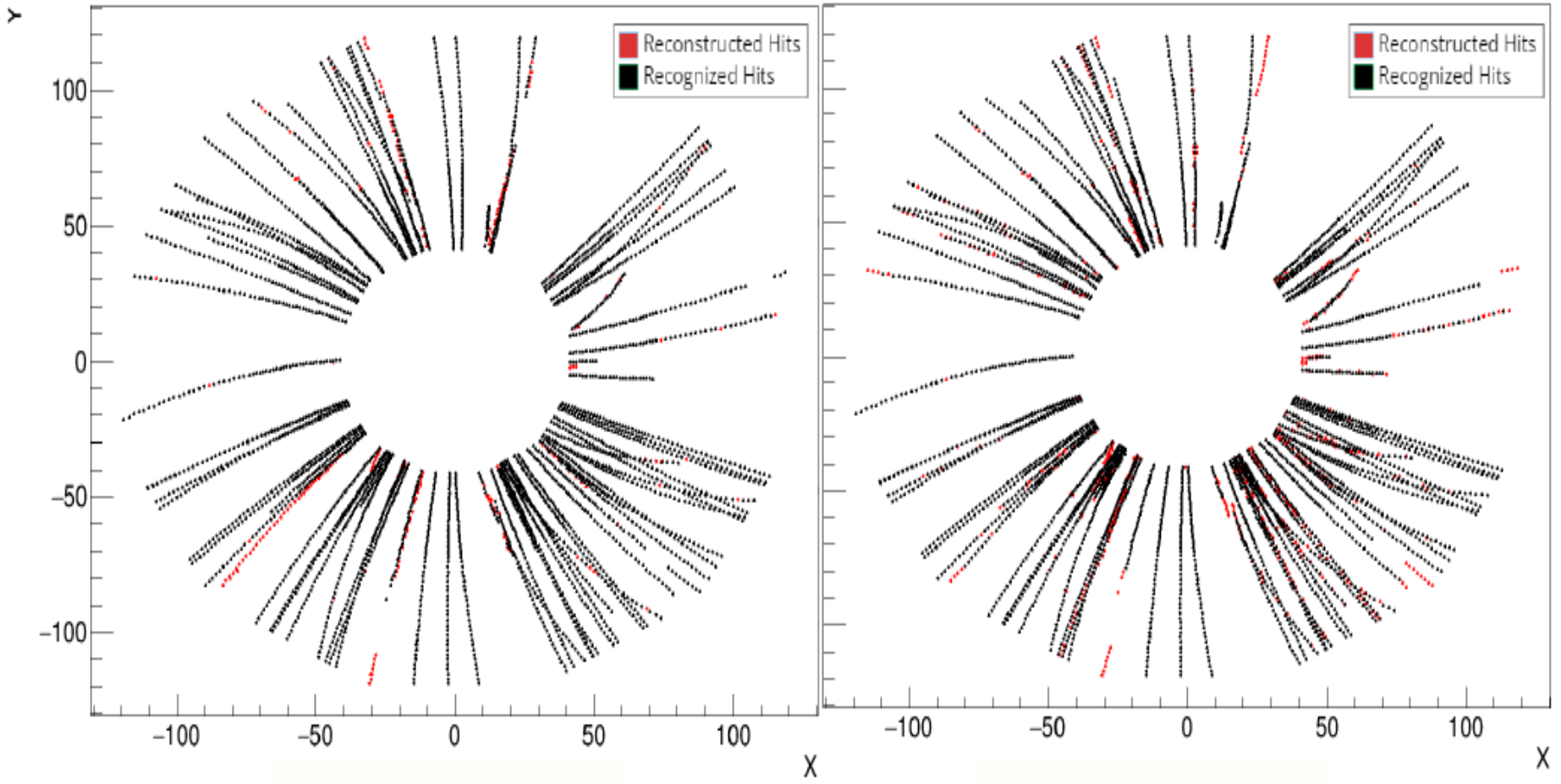
$$\alpha = \langle \vec{p}_{in}, \vec{p}_{out} \rangle$$

MPD TPC clusterfinder

(Alexander Krylov's report)



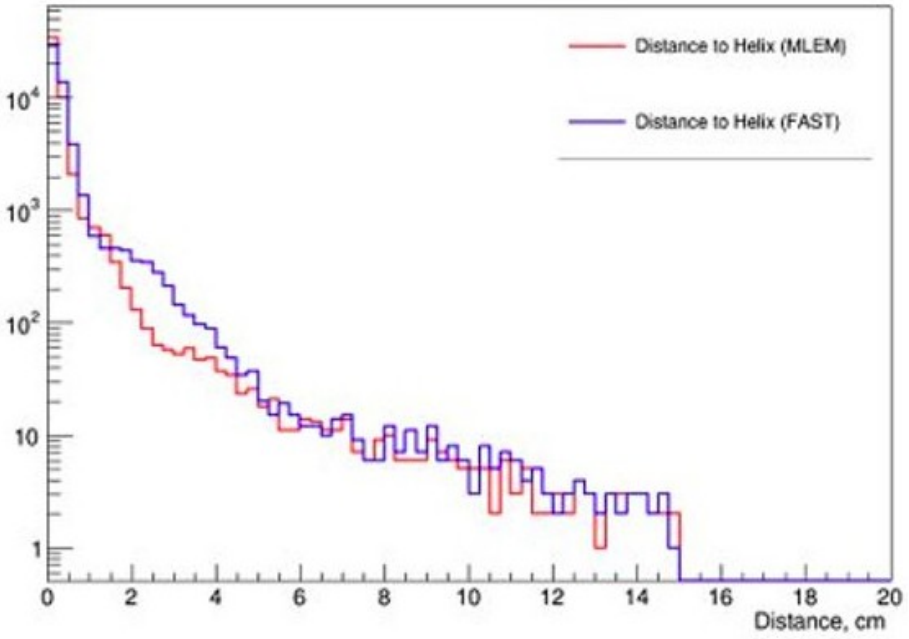
TPC online fast clustering



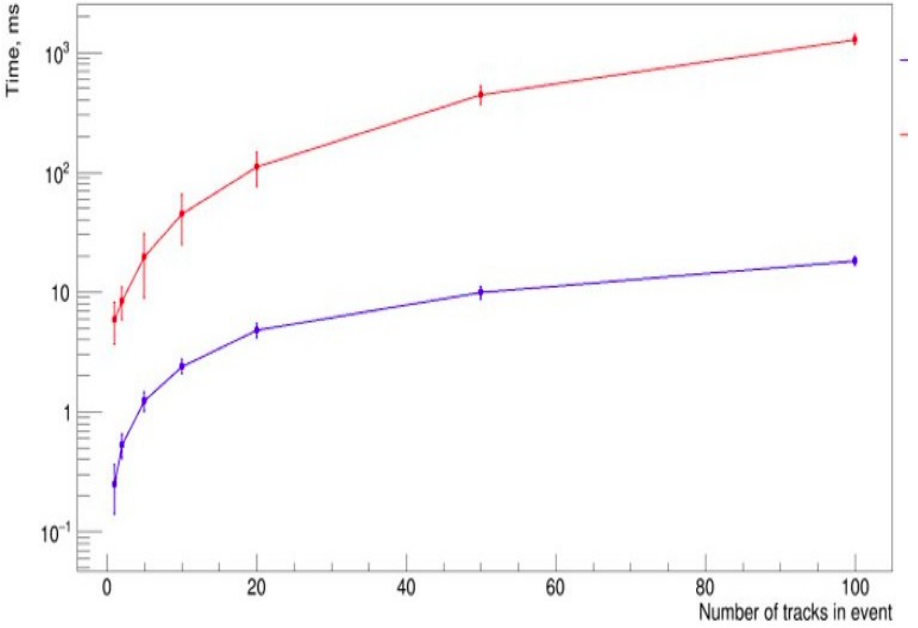
standard clusterfinder

Fast clusterfinder

TPC clustering



standard

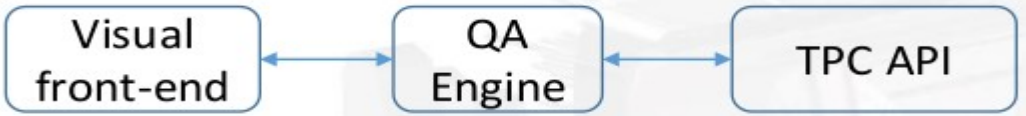


fast

In the future ---> wavelets transform

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

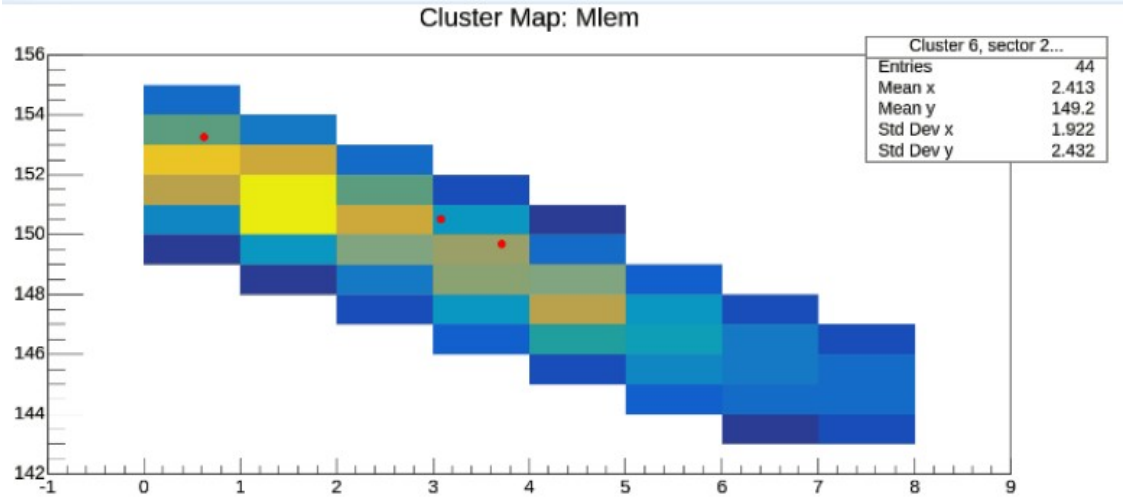
dev / mpdroot / tools / tdd / + History Find file Web IDE Clone

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

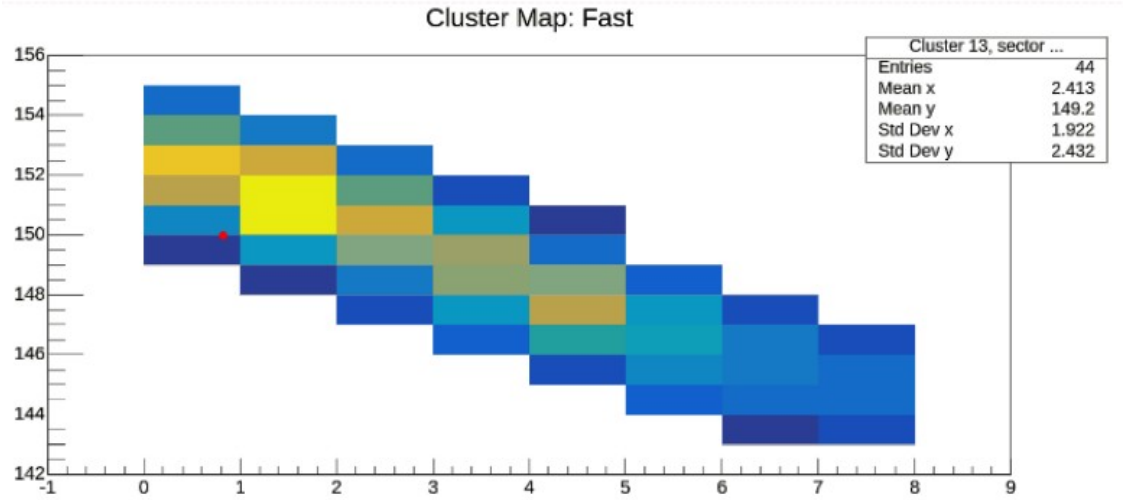
Cluster finders comparison with QA engine

Most illustrative with JSROOT

Standard clusterfinder



Fast clusterfinder

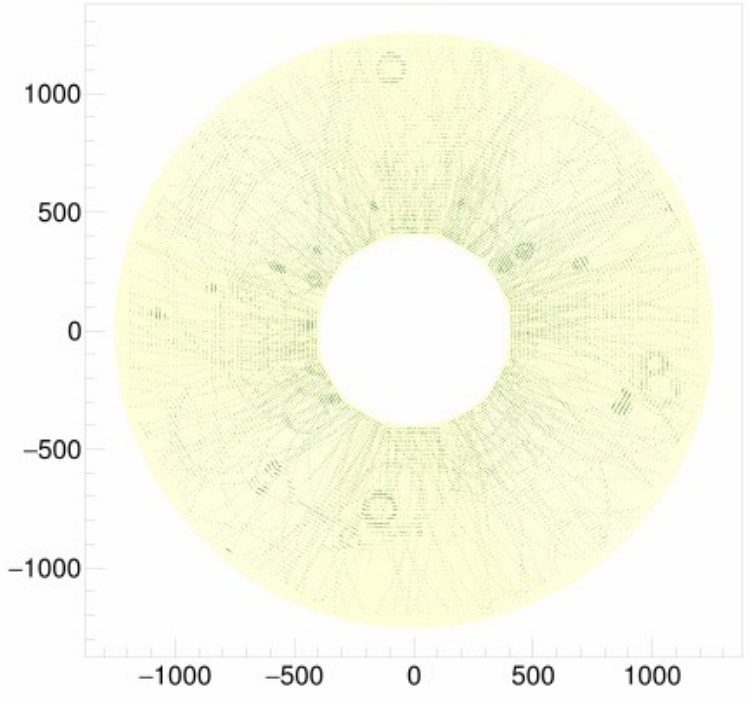


TPC tracking with ACTS

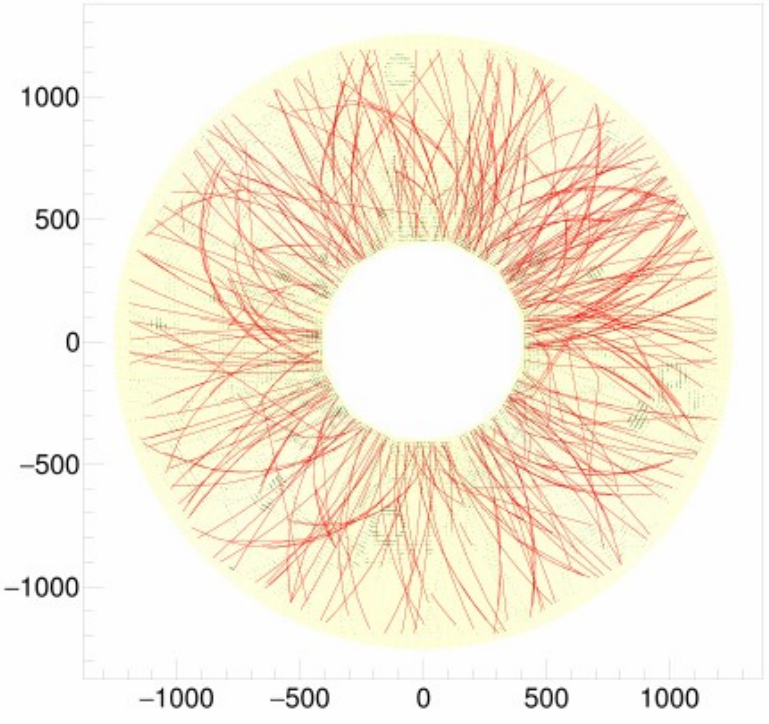
The A Common Tracking Software (Acts) project is an attempt to preserve and evolve the track reconstruction software of the LHC era towards HL-LHC and beyond.

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

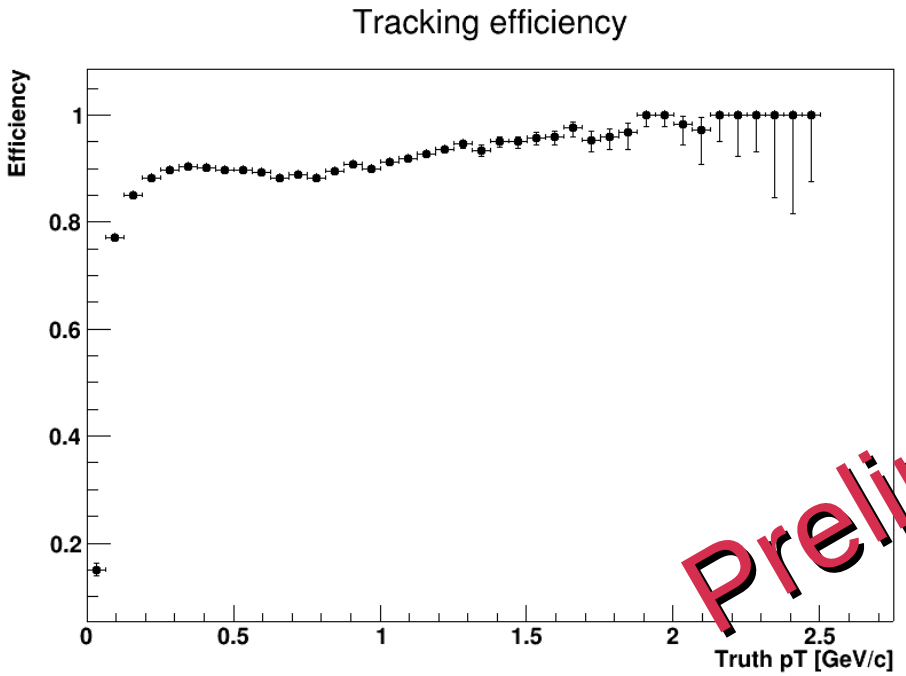
Hits

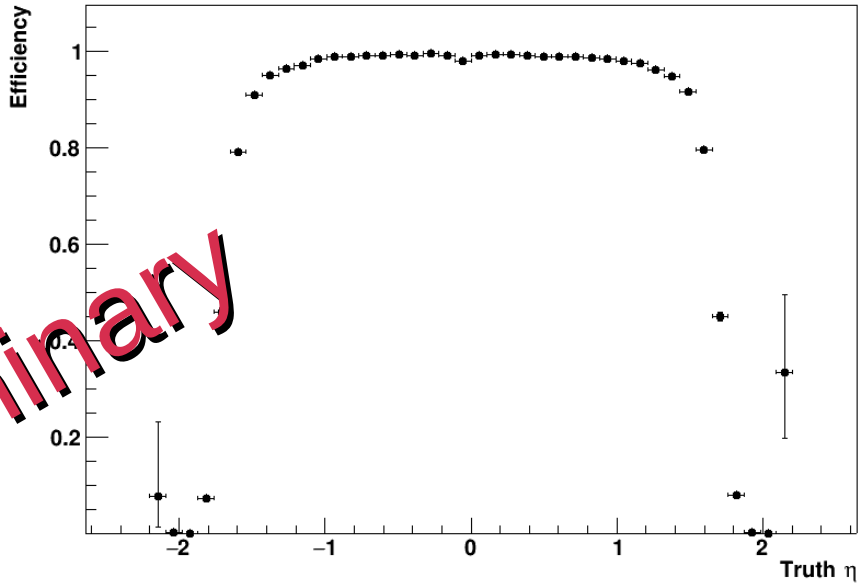


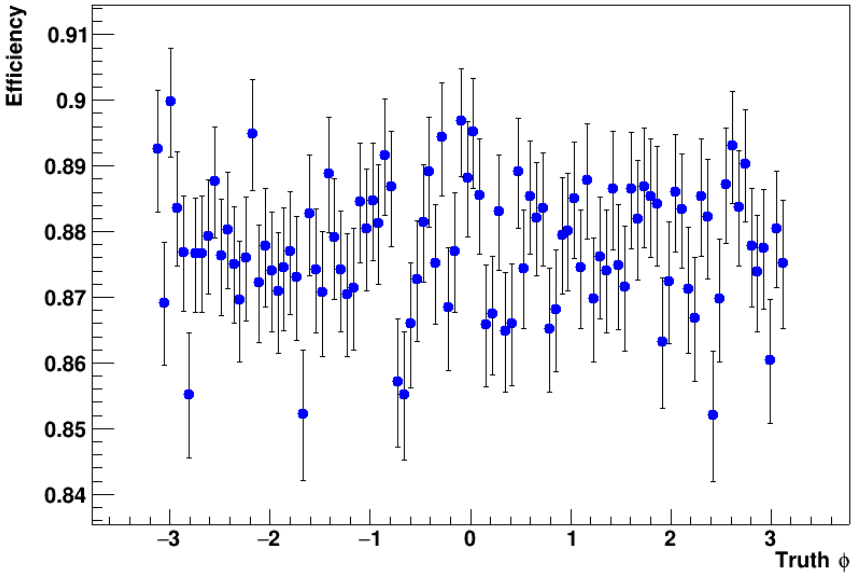
Tracks



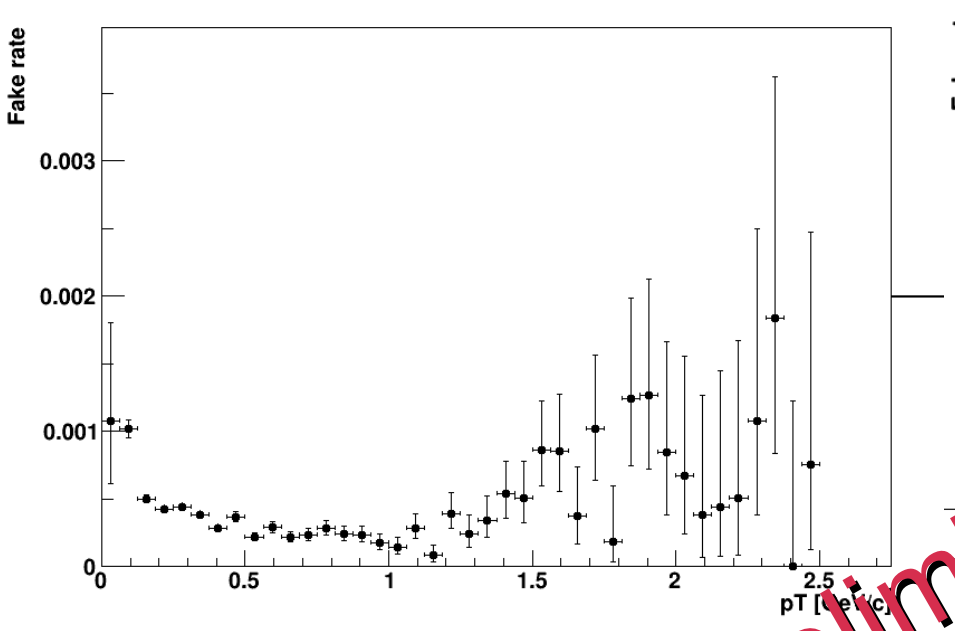
Tracks reconstruction with Acts

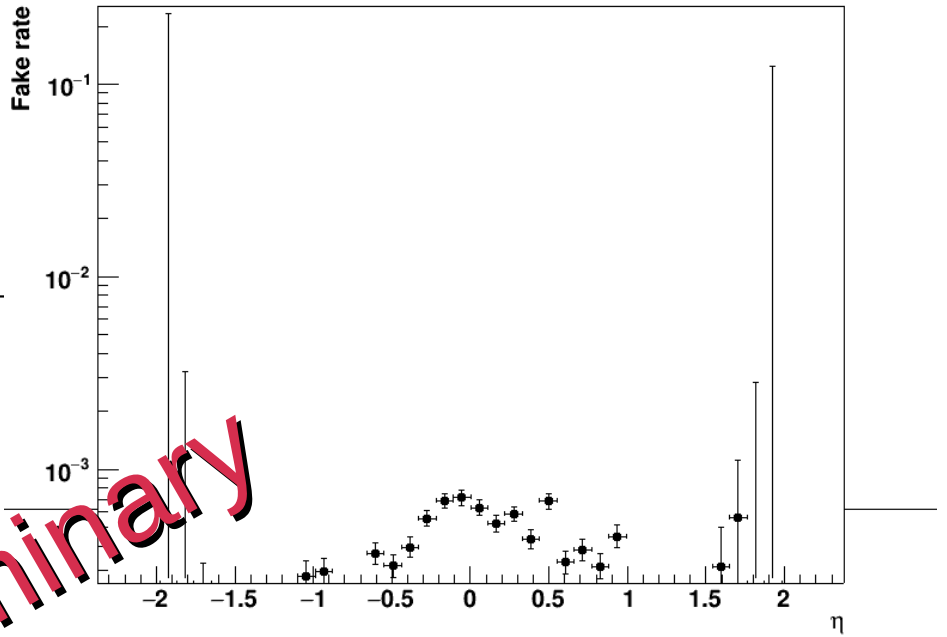


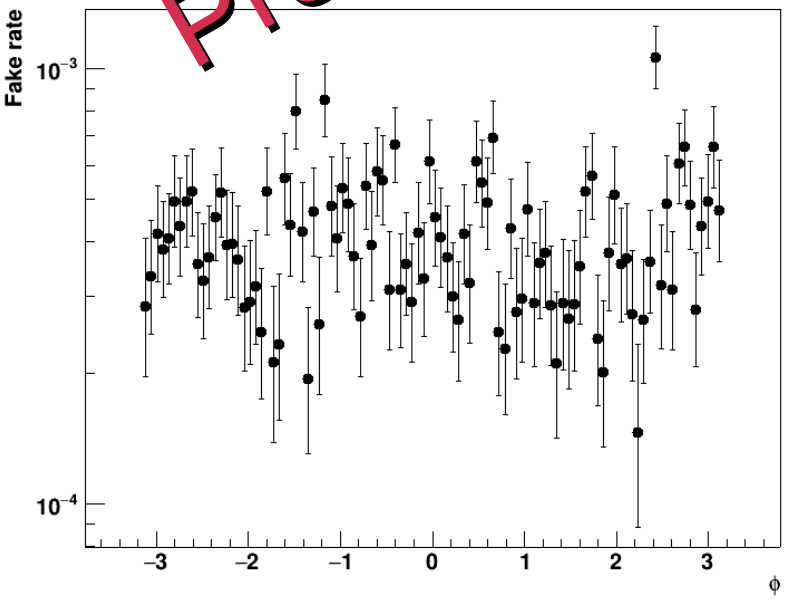




Fake tracks



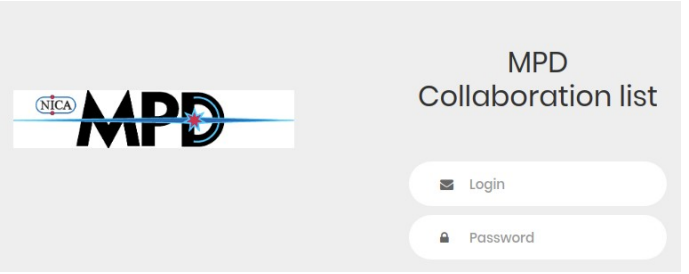


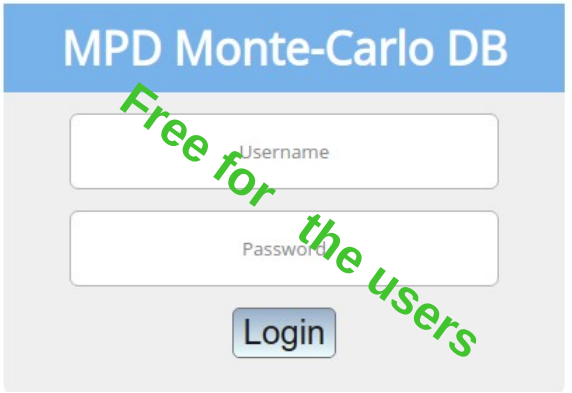


Preliminary

MPD databases

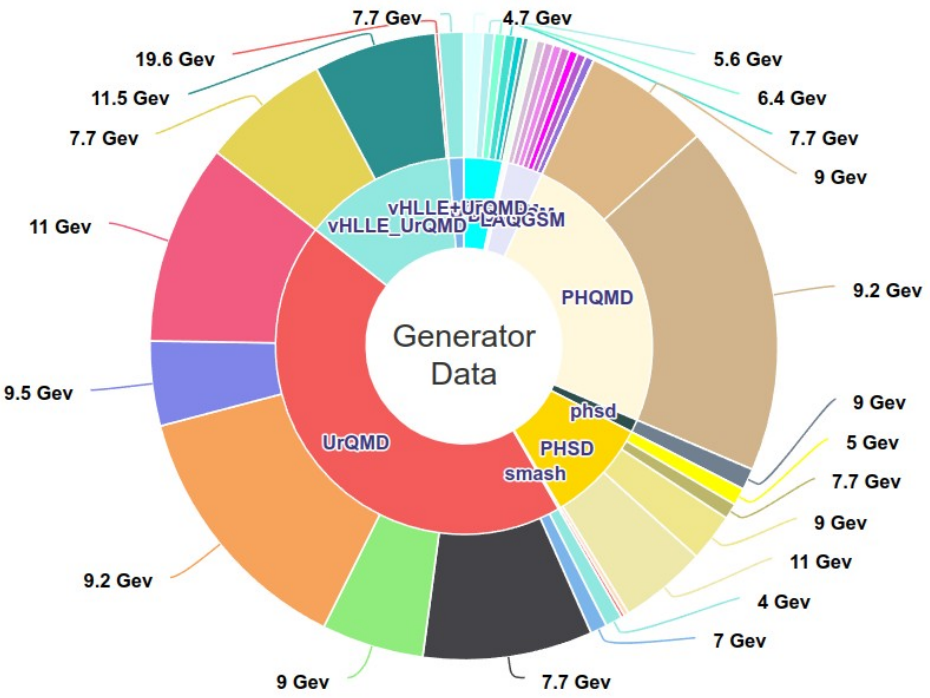
- ✔ List of MPD members & authors
- ✔ MC events mass productions
- ✔ LogBook for Experiment
- ✔ TPC geometry
- ✔ TPC calibration
- ✔ TPC alignment parameters
- ✔ TOF calibration
- ✔ ECAL instrumentation
- ✔ ....



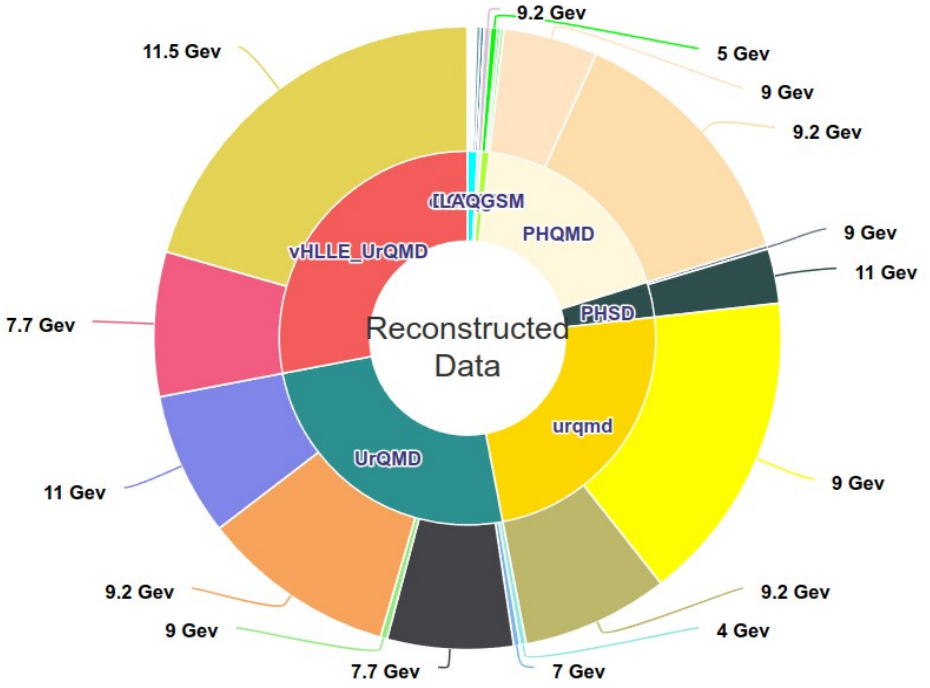


MPD MC data mass production

MC events
> 1300M



Reconstructed events
> 500M



MC Data set for MPD

Generator	PWG	Coll.		# of events()	Reco
UrQMD	PWG4	AuAu	11	15	+
		BiBi	9	10	+
			9.46	10	+
			9.2	95	+
	PWG2	AuAu	11	10	+
	PWG3	AuAu	7.7	10	+
		BiBi	7.7	10	+
			9	15	+
		pp	9	10	+
		BiBi fix target	2.5	12	+
		BiBi fix target	3.0	(12 underway)	+
		BiBi fix target	3.5	(12 underway)	+
	PWG1	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	+
		BiBi	9.2	48	+
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				1293(74 underway)	449(74 underway)

ЛАБОРАТОРИЯ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ имени М.Г. Мещерякова

NICA

hYBRI LIT/JINR

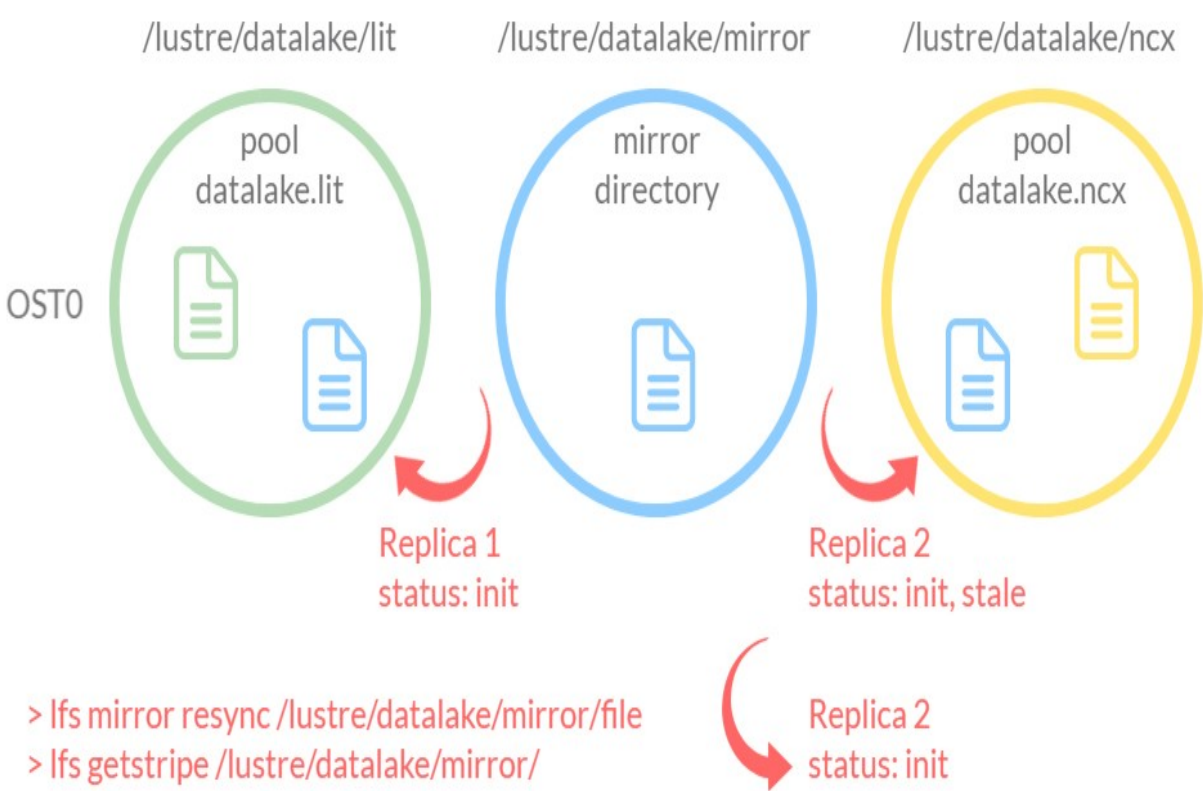
lustre

LHEP ЛФВЭ

Distributed system for processing and data storage for experiments at the Complex NICA

MLIT Team

Belyakov D.V., Dolbilov A.G., Kokorev A.A., Lyubimova M.A., Pelevanuk I.S., Podgainy D.V.



LHEP Team

Moshkin A., Rogachevsky O., Slepov I.

MLIT servers

2x Dell PowerEdge R730xd

2x 160 TB, SAS

Motherboard	PowerEdge R730/R730xd System Board
Processor	2x Intel Xeon E5-2660 v4 @ 2.00 GHz
Memory	8x Micron DDR4 2400 MHz, 16 GB (128 GB)
RAID	Dell PERC H730P
Disk	2x Dell MFC6G (Samsung) SSD SAS, 400 GB (2x 400 GB) 16x HGST UltraStar HE10 SAS, 10TB (160 TB)
Network	Dell 99GTM (Intel X540-T2 2x 10 Gb/s + Intel I350 Dual Port 2x 1 Gb/s)
Power	2x 750W Redundant Power Supply

Data flow rates 100 Gbps

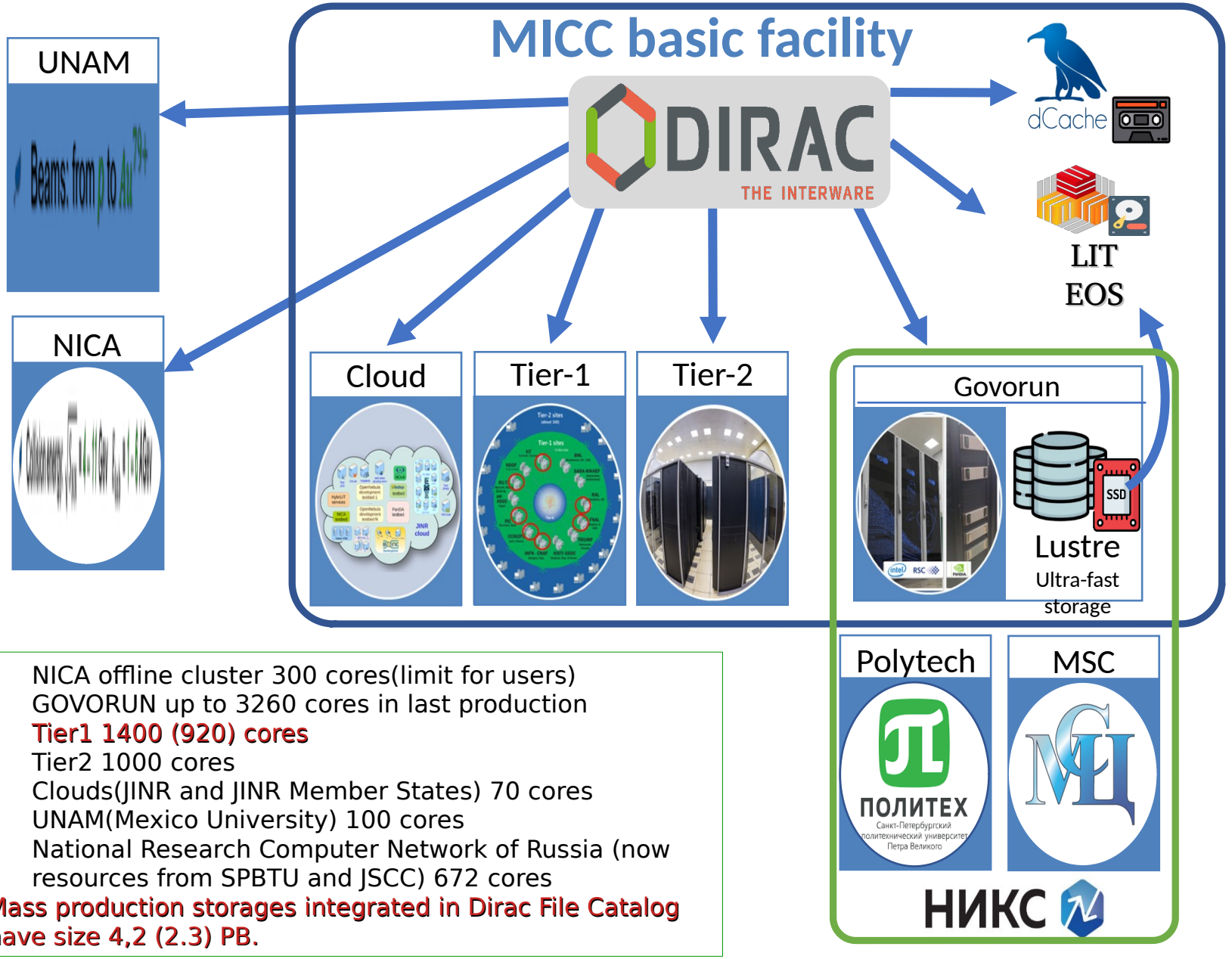
LHEP servers

2x Supermicro SSG 1029P-NEL32R

2x 244.8 TB, NVMe (Rulers)

Motherboard	Supermicro X11DPS-RE
Processor	2x Intel Xeon Gold 6230R @ 2.10 GHz
Memory	12x Samsung DDR4 2993 MHz, 64 GB (768 GB)
Disk	2x Apacer SSD NVME m.2 , 512 GB (2x 512 GB) 16x Intel DC P4510 SSD NVME (Ruler), 15.3TB (244.8 TB)
Network	Intel X550-T Dual Port 2x NVidia (Mellanox MT27800) ConnectX-5 Dual Port 2x 100 Gb/s Ethernet
Power	2x 1600W Redundant Power Supply

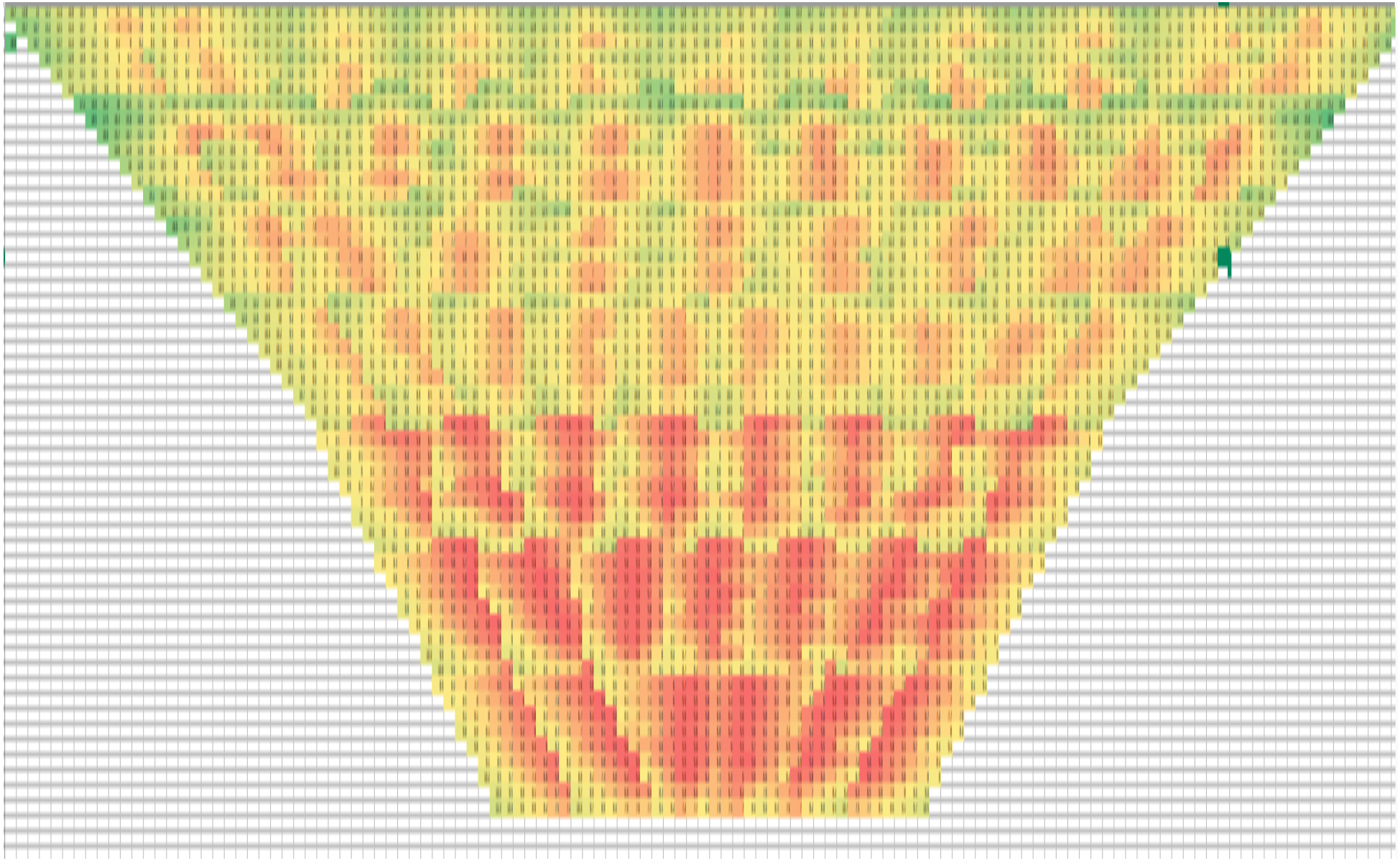
NICA distributed computing



- NICA offline cluster 300 cores(limit for users)
- GOVORUN up to 3260 cores in last production
- Tier1 1400 (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

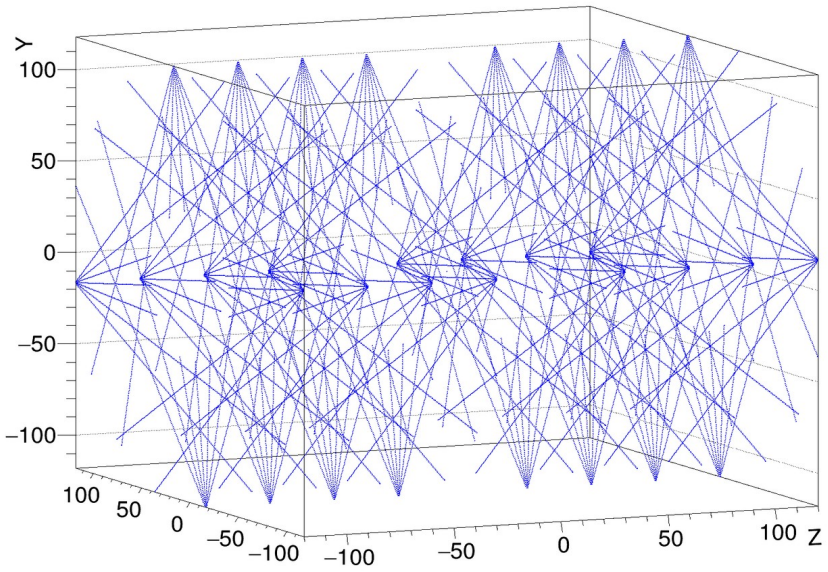
Mass production storages integrated in Dirac File Catalog have size 4,2 (2.3) PB.

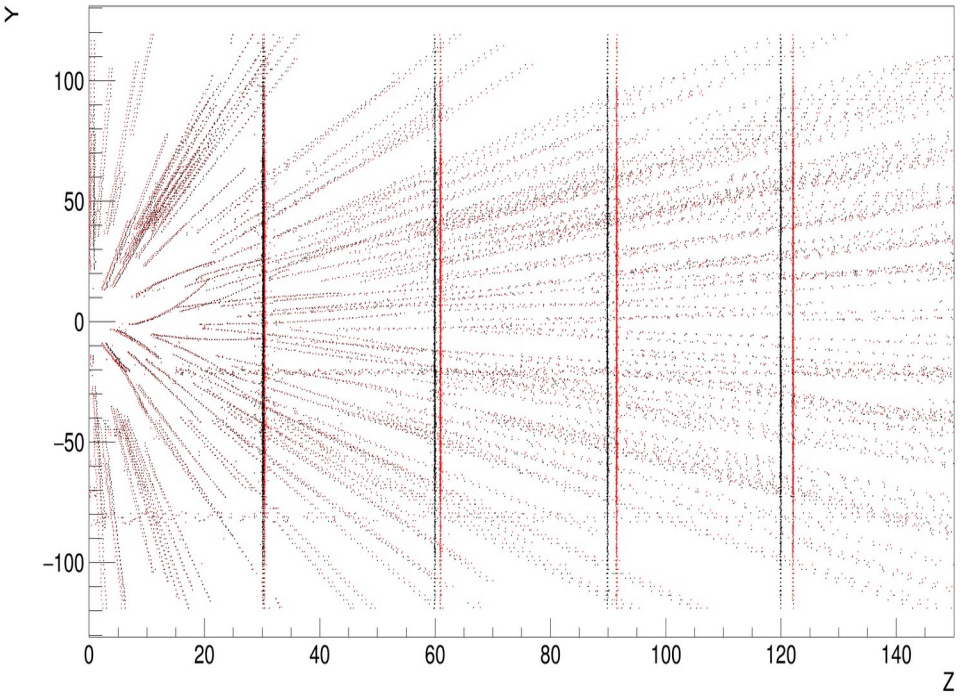
TPC pads capacity DB



Drift time in TPC

Alexander Bychkov's report





Laser system

Two pulsed 130 mJ 5-7 ns Nd:YAG lasers
~1mm diameter
224 laser beams in total

112 "tracks" in each half of the TPC

4 planes of laser beams, 300mm between planes
10 Hz impulses

Example correction

V_{drift} = 5.4 cm/μs $t_{trigger}$ = 545 ns

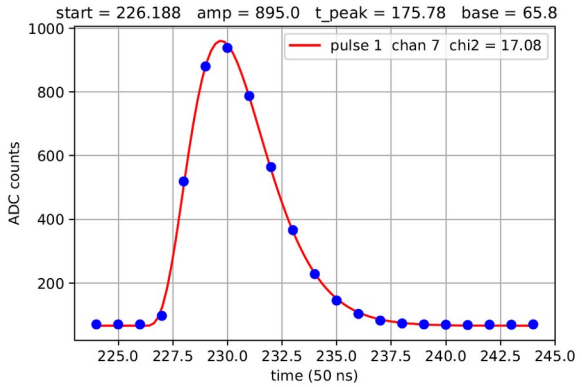
TPC signal formation

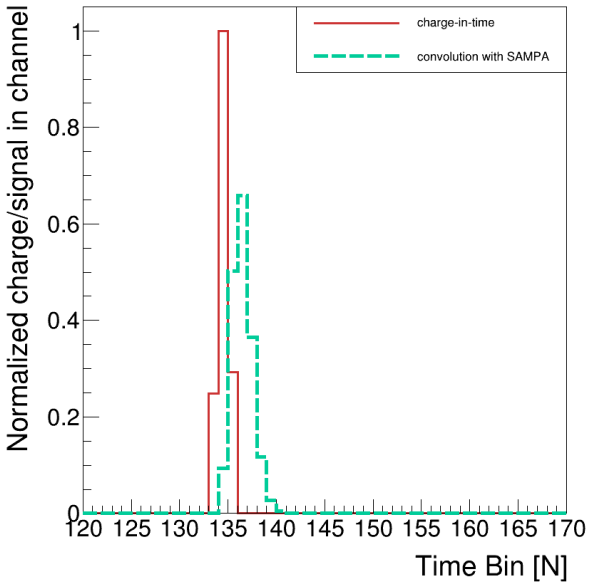
Bychkov' report

- Read-out channel parameters
  - 100 ns – time bucket,
  - 310 time buckets
  - ~95000 read-out channels in total
- **SAMPA** impulse shape function

$$f(x)=\left(\frac{x-t}{\tau}\right)^{N} e^{-N\left(\frac{x-t}{\tau}\right)}+Bl$$

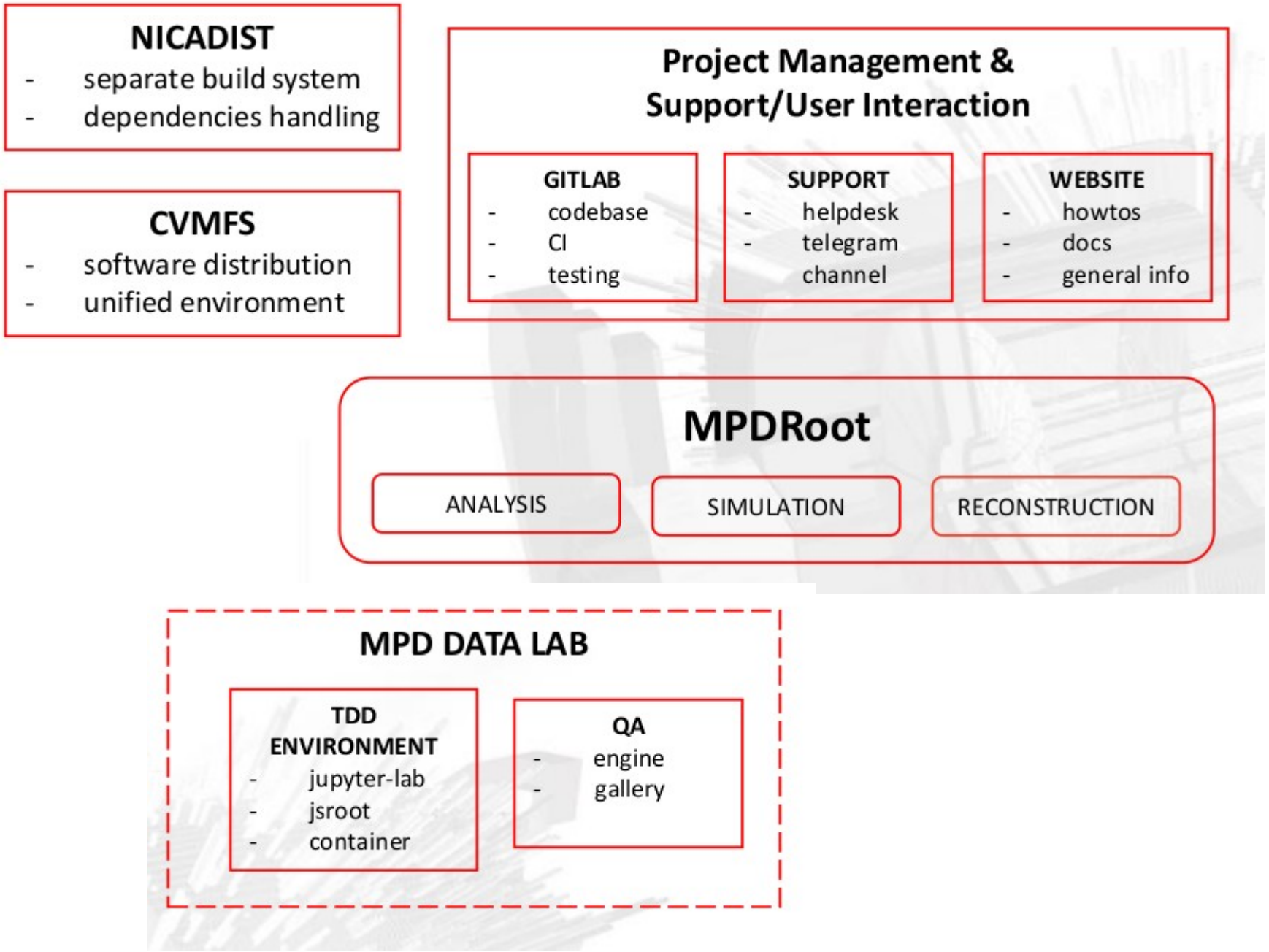
  - N = 4 — shaping order
  - τ = 160 — peaking time (ns)
  - Bl = 0 — baseline
  - t — start time
  - Ae^{-N} = 20 — amplitude (fC per mV)



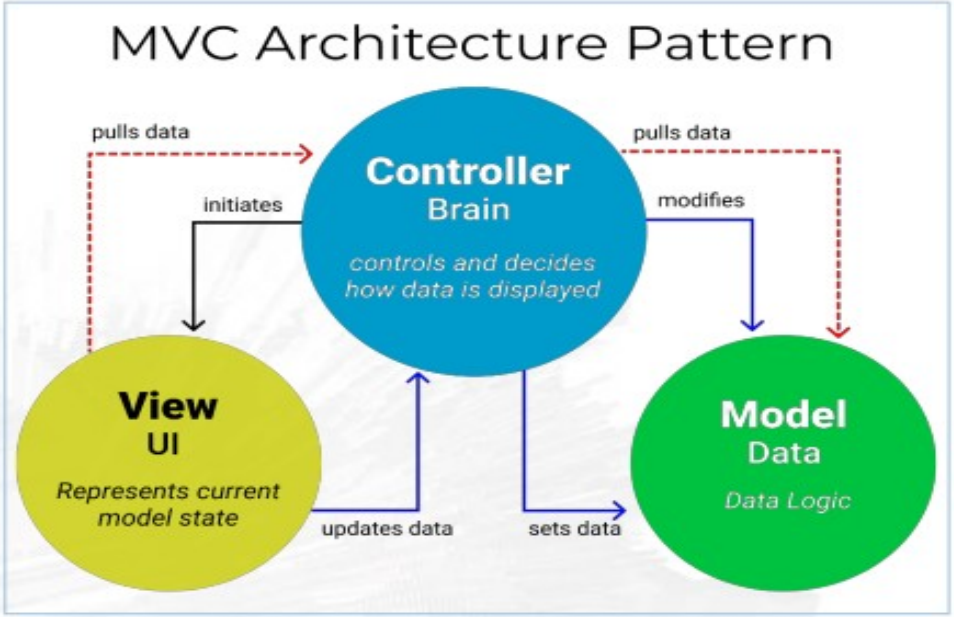


- According **SAMPA Based Streaming Readout Data Acquisition Prototype**

Software supports



QA tasks



QA ENGINE PROPERTIES

pluggable/switchable reconstruction modules
QA modes to choose Diagnostics depth
writing output in terms of MPD primitives into multiple structured root files
for modular diagnostics and postprocessing

RUNRECO.C
(upcoming v23.09.23 release)

Options:
tpcClustering = ETpcClustering::MLEM
= ETpcClustering::FAST
= ETpcClustering::WAVELET (soon)

qaSetting = EQAMode::OFF
= EQAMode::BASIC
= EQAMode::TPCCLUSTERHITFINDER
= EQAMode::TRACKER (soon)

Upcoming:
tracker = ETracking::DEFAULT
= ETracking::ACTS

Output example: BaseQA_Fast.root, QA_TpcClusterHitFinder_Fast.root
Settings: EQAMode::TPCCLUSTERHITFINDER, ETpcClustering::FAST

Test Driven Development

- Jupyter-Lab with JSRoot
- Custom code injection
- Cell structure with reprocess option
- Graphical output customized on demand
- Algo tuning to real experiment data

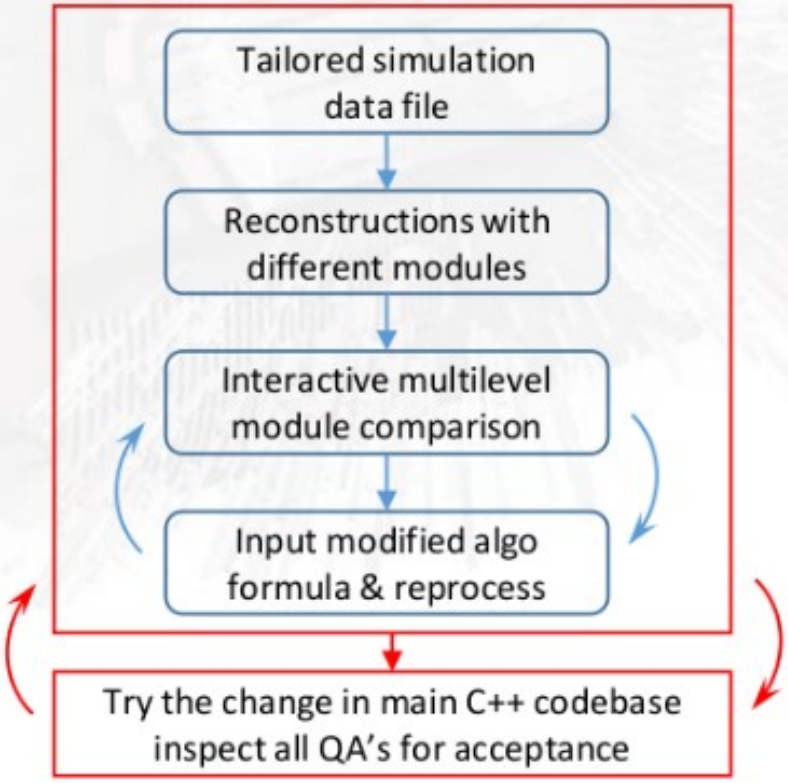
CLUSTERHITFINDER COMPARISON

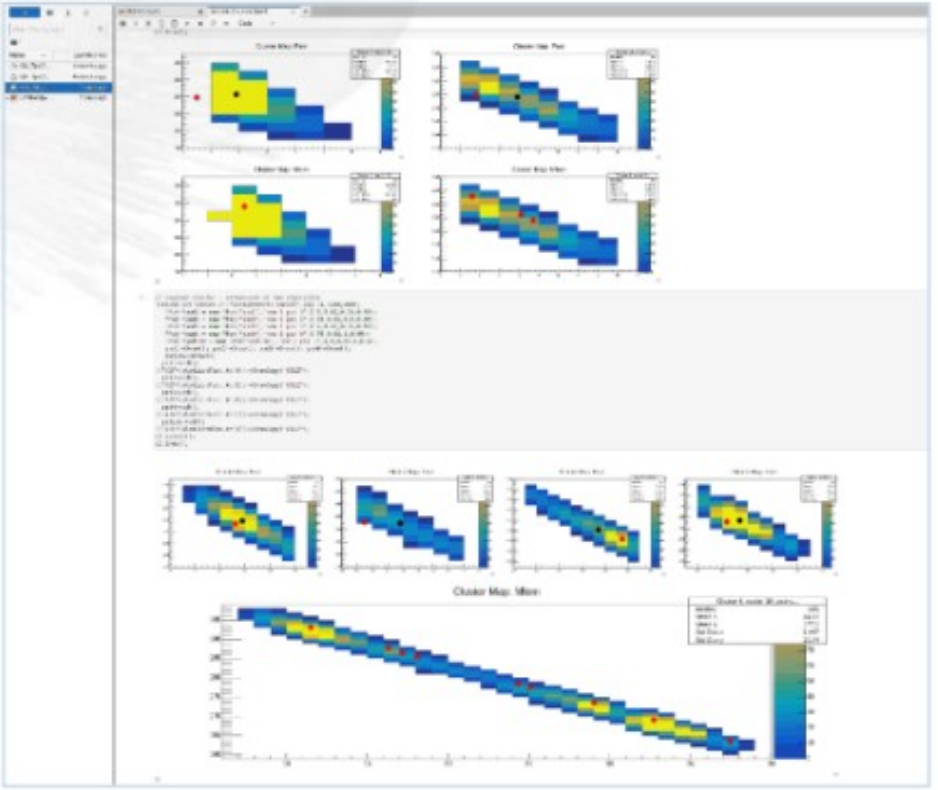
- Mlem
- Fast

ABSTRACTION LEVELS

- Top ……bench……..Reconstruction
- Middle…..component….ClusterHitFinder
- Bottom ……..units……..Clustering, Topology, Hit extraction

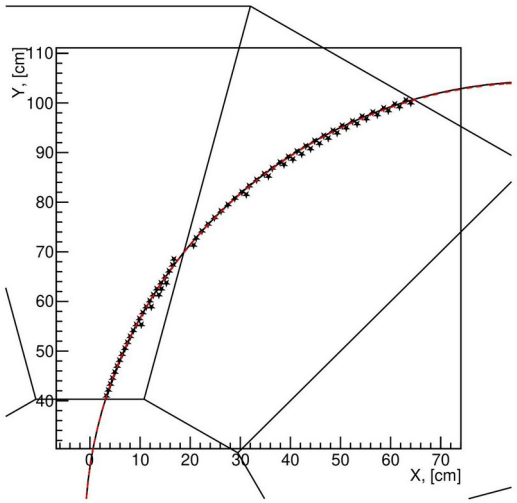
Interactive workflow example

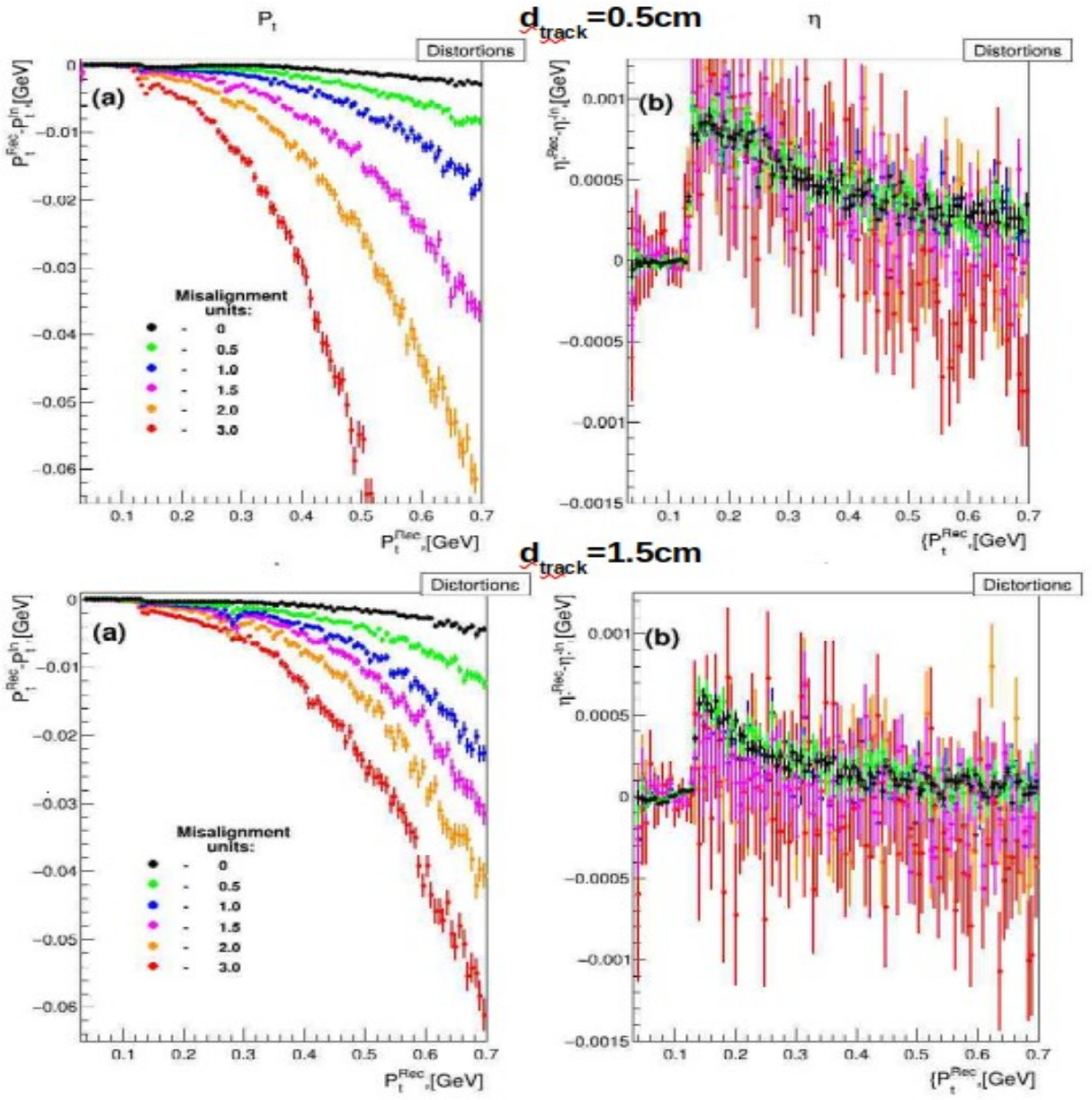




Detectors alignment

Kuzmin V.



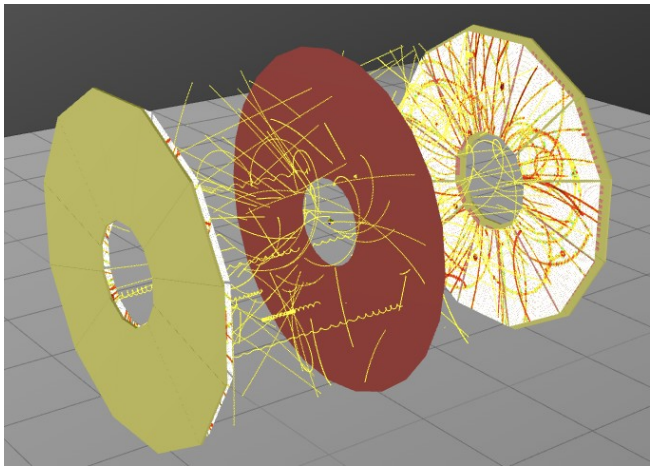


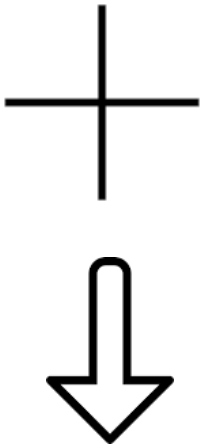
Misalignment "1" means that the average displacement of the sector from its theoretical position on each axis is 0.5 cm, and for the Euler angle this value is 0.5 degrees.

Calculations were carried out for two values of the width of the projection of the track on the surface of the sector: 5 and 15 mm.

TPC control dashboard

TPC eventdisplay





TANGO

A free open source device-oriented controls toolkit for controlling any kind of hardware or software and building SCADA systems...

TPC control system

STAR DAQ monitor

STAR DAQ

Menu
Monitoring
Rate Charts
Current Rates
LED Status
Slow Controls
Current RunLog
Today's ShiftLog
Critical Support
TPC Gating Grid
DAQ Plots
Jeff's Plots
STP Monitor
DET Status
ETOF

Status

NONE
24275001

Auto Update
5 s Now
1

Run Playback
00000000
1 < >

online 3:3

Tonko Ljubicic/BNL

NONE [to RCF] | **24275001** | pedestal_localclock [PEDESTAL]

Stop Forced by Operator

No beam in RHIC
Physics ON (18298m) [No Beam]

Run started	Fri Sep 29 18:43:36 202
Ended	Fri Sep 29 18:46:09 202
Blue	0.9 GeV, 0 ions, Injection Tunin
Yellow	0.9 GeV, 0 ions, Injection Tunin
TCU Clock	0.0

Trigger	DAQ Evts	DAQ Hz	L0 Evts	L0 Hz	Sca Hz	Sca Dead	Built	Xpress	Abt	Err
pedestal	0	0	137904	0	0	0 %	0	0	0	0
ALL	*0*	*0*	*137904*	*0*	*0*	*0 %*	*0*	*0*	*0*	*0*

Det	State	Dead	CPU	Evts	Evts In	Hz	MB/s EVB	Err	MB/s RDO
TOF	DEAD	-1 %	0 %	0	0	0	0.0	0	0
BTOW	DEAD	-1 %	0 %	0	0	0	0.0	0	0
Trigger	DEAD	-1 %	0 %	0	0	0	0.0	0	0
ETOW	DEAD	-1 %	0 %	0	0	0	0.0	0	0
BSMD	DEAD	-1 %	0 %	0	0	0	0.0	0	0
ESMD	DEAD	-1 %	0 %	0	0	0	0.0	0	0
TPX	READY	-1 %	0 %	0	0	0	0.0	0	0
MTD	DEAD	-1 %	0 %	0	0	0	0.0	0	0
GMT	DEAD	-1 %	0 %	0	0	0	0.0	0	0
L4	waiting...	0 %	0 %	-1/536	0	0	0.0	0	0
ETOF	DEAD	-1 %	0 %	0	0	0	0.0	0	0
ITPC	READY	-1 %	0 %	0	0	0	0.0	0	0
FCS	DEAD	-1 %	0 %	0	0	0	0.0	0	0
STGC	DEAD	-1 %	0 %	0	0	0	0.0	0	0
FST	DEAD	-1 %	0 %	0	0	0	0.0	0	0

Evb	State	Built	EvtsIn	Err	Hz	MB/s	Written	Free GB	RCF W+S
evb01	READY	0	0	0	0	0	0 GB	12014 [87%]	0+0
evb02	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb03	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb04	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb05	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb06	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb07	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb08	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb09	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb10	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb11	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb12	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb13	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb14	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb15	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb16	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb17	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb18	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb19	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb20	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb21	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb22	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0
evb23	DEAD	0	0	0	0	0	0 GB	0 [0%]	0+0

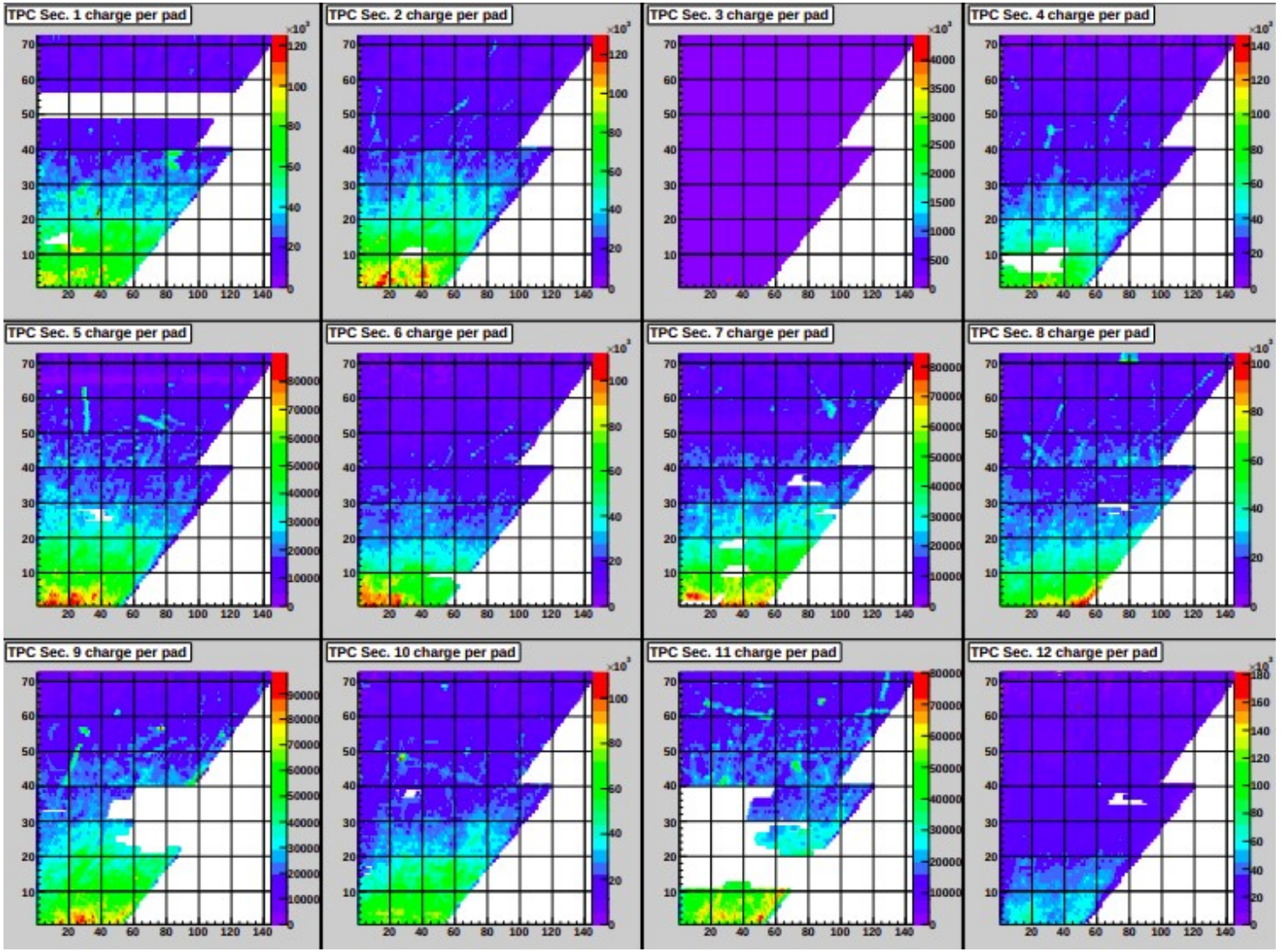
Time	#	Node	Severity	Task	Source#line	Message
09:16:20	1	daqman	OPERATOR	det_sc_daemon_l	det_sc_daemon.C:#280	Powercycling iTPC Sector 4, iRDO 1
12:09:50	1	trgconfi	CRITICAL	trg_group_run_c	trg_rc_node.C:#435	Error configuring STP2 Node - Run 24275001
12:09:20	1	rts02	OPERATOR	rc	RcActions.java:#758	Starting run #24275001. Config file is pedestal_localclock
18:46:09	1	l2ana01	OPERATOR	l2new	rc_handler.c:#1110	L2 : 1 Timeouts for run #24272008 (EQ1 : 1)
18:46:09	1	l2ana01	OPERATOR	l2new	rc_handler.c:#1104	Pedestal calculations complete. Pedestals look ok.
18:46:04	1	l2ana01	CAUTION	l2new	rc_handler.c:#1076	Pedestal calculations. You MUST WAIT until L2 completes
18:46:03	1	daqman	OPERATOR	handler	handler.C:#1766	Got the run stop request for run #24272008
18:43:17	1	rts02	OPERATOR	rc	RcActions.java:#758	Starting run #24272008. Config file is pedestal_localclock
18:42:48	1	l2ana01	OPERATOR	l2new	rc_handler.c:#1110	L2 : 0 Timeouts for run #24272007

TPC dashboard

TPC sectors time buckets

TPC QA histograms

TPC sectors pad planes



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Volunteers Are welcome

Thanks for your attention