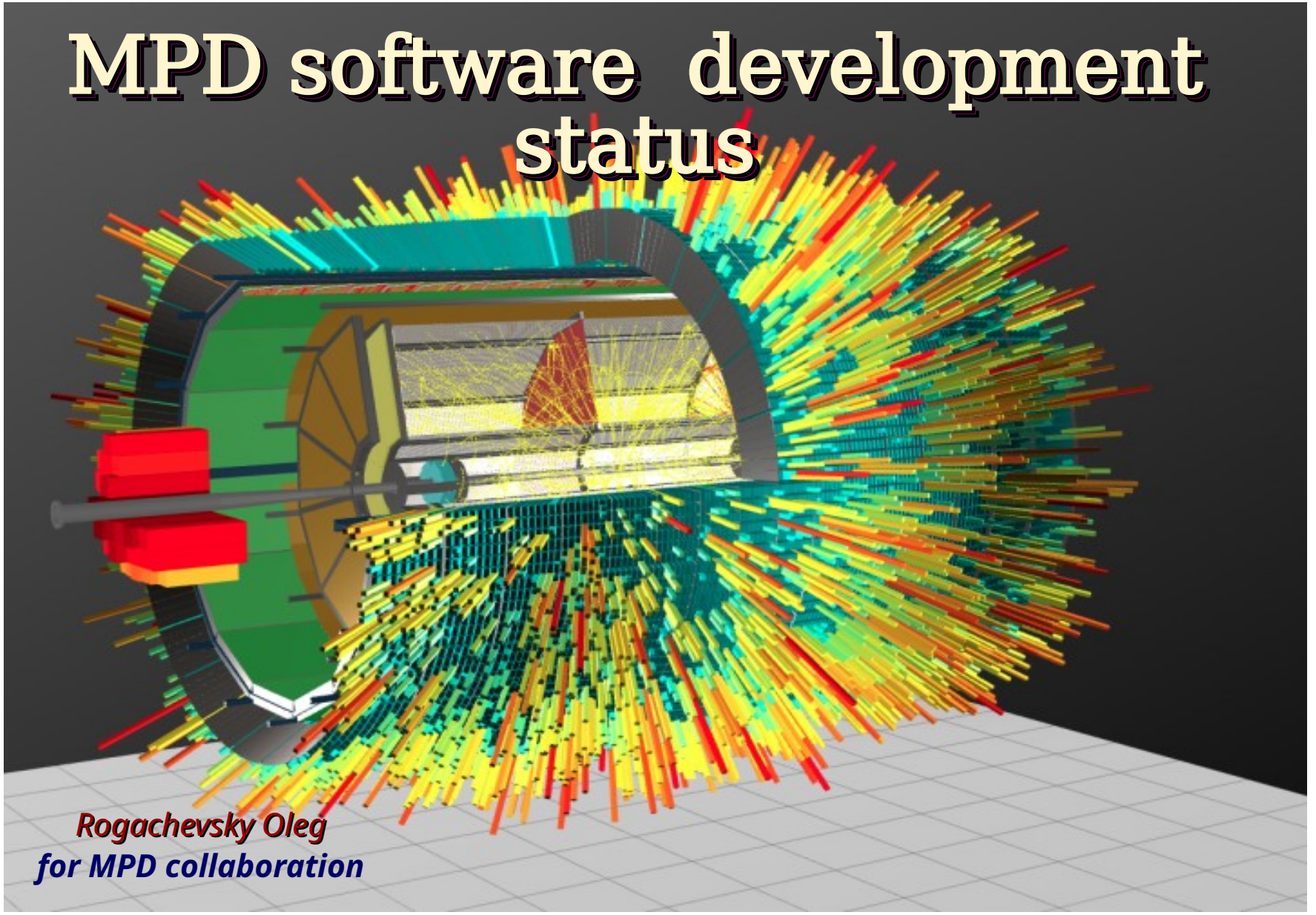
MPD software development status



Rogachevsky Oleg
for MPD collaboration

Current tasks in the mpdroot development

Software reports:

Slavomir Hnatic
A Common Tracking Software (ACTS) Implementation in MPDRoot

Alexander Krylov
QA histograms for MPD TPC monitoring

Ivonne Maldonado
Progress on MiniBeBe detector for the MPD

Ilya Kozmin
Ambiguity Resolution in TPC track reconstruction

Alexander Bychkov
Data flow simulation for MPD

Updates in release v24.09.24

Hnatic S., Busa J.

MOST IMPORTANT CHANGES

New features

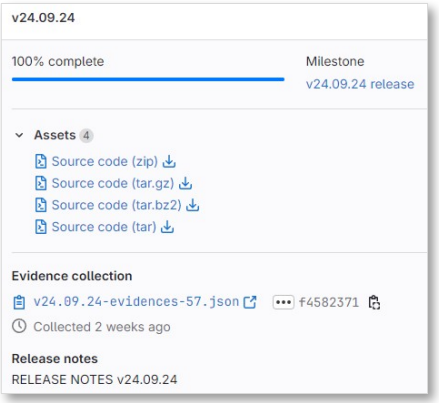
- Analysis updates (physicists)
- LUSI detector
- Global QA histograms
- ACTS vertexing
- ACTS v36 port

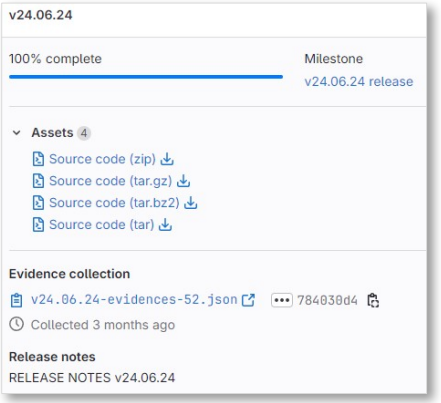
Latest dependencies

- ROOT …… 6.32.06
- GCC ……13.2.0
- Boost ……1.83.0
- FairRoot …. 18.6.10
- GEANT4 …. 11.2.1
- Python …… 3.12.4
- GSL ……2.8
- Fedora 40, Ubuntu 24.04 LTS

DETAILED INFO in RELEASE NOTES

git.jinr.ru/nica/mpdroot/-/releases





Important fixes

- GEANT4 working with ACTS
- Nonzero Z vertex working with ACTS

MPDroot deployment

Running MPDRoot locally using CVMFS

Questions? Click here

INSTALL CVMFS AND TOOLBOX
(Users and Developers)

Supported OS: Fedora, CentOS, AlmaLinux, Ubuntu 22.04, 20.04, Debian 11, 12, 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 -N 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 39
[sudo] password for user:
.....
.....
Creating container a9-nica-dev ...
.....
.....
Installing cvmfs service as container ...
.....
.....
================================================

INSTALLATION SUCCESSFUL

How to use:

1. Enter toolbox container by:
   toolbox enter a9-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 ~]$
```

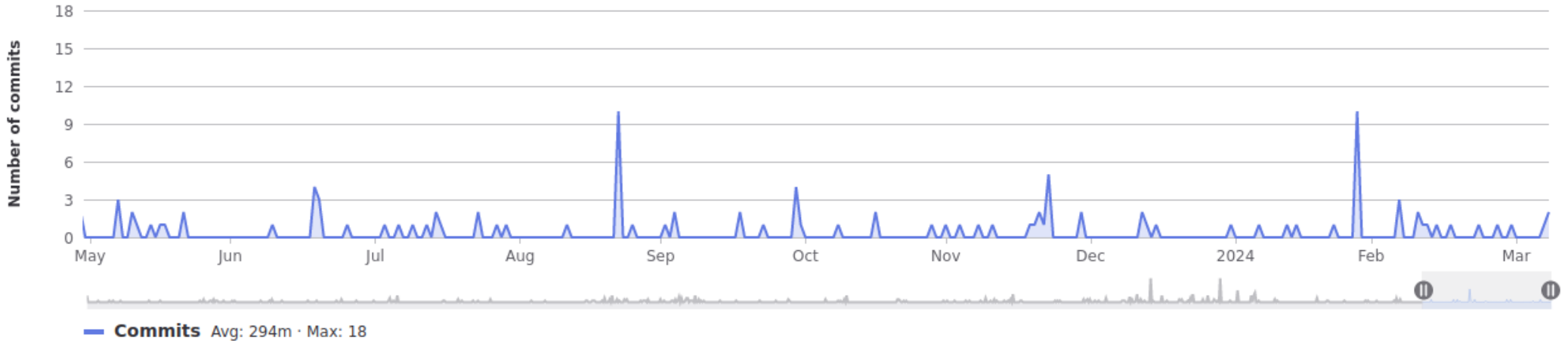
USERS

NOTE: If you are using CentOS 7 instead of "toolbox enter a9-nica-dev" command, type:
"source /cvmfs/nica.jinr.ru/sw/os/login.sh"

MPD GIT software repository

Commits to dev

Excluding merge commits. Limited to 6,000 commits.



Apr 08, 2024

Fix clang-format in CI pipeline
Slavomir Hnatic authored 2 weeks ago — `da92eadf`

Fixes of MPDROOT towards ROOT 6.30.06 and Pythia 8.3.11
Jan Busa authored 2 weeks ago and Slavomir Hnatic committed 2 weeks ago — `5d4739ee`

Apr 07, 2024

Acts Tracker: remove clutter
Slavomir Hnatic authored 2 weeks ago — `42cfcebc`

Mar 31, 2024

Analysis update: KK, PK, PiK, PiLambda, PiPi (Victor Riabov's request)
Slavomir Hnatic authored 3 weeks ago — `b0de6b05`

Mar 28, 2024

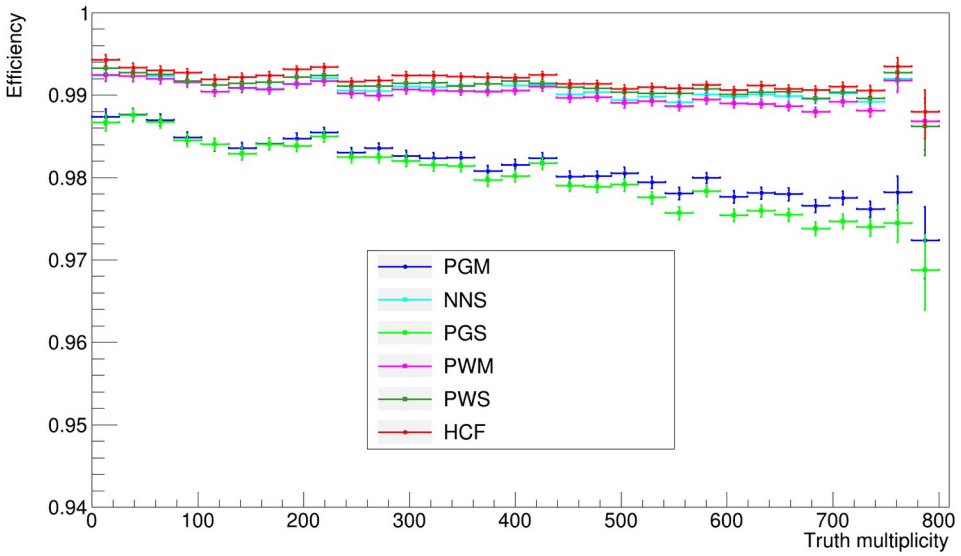
Added evFlowEP wagon
Пётр Парфёнов authored 3 weeks ago — `4f9e1d4b`

Mar 24, 2024

Fix for MCStack for GEANT4.
Alexander Zinchenko authored 4 weeks ago — `9f84583f`

TPC tracking with ACTS

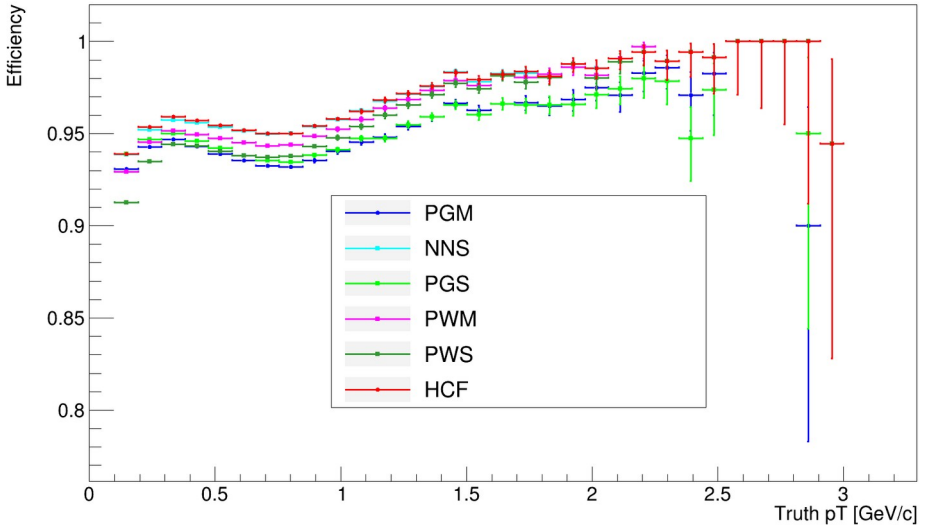
Kozmin Ilia & REU group

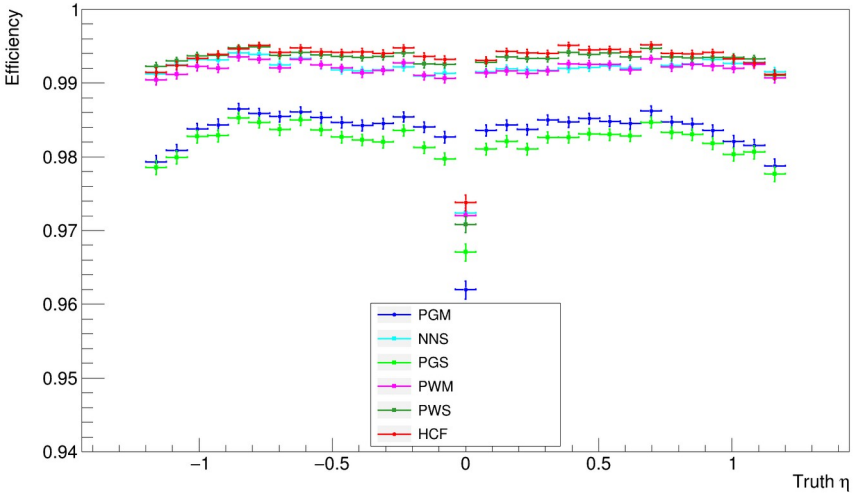


UrQMD v 3.4
AuAu @ $\sqrt{s} = 7.7$ GeV

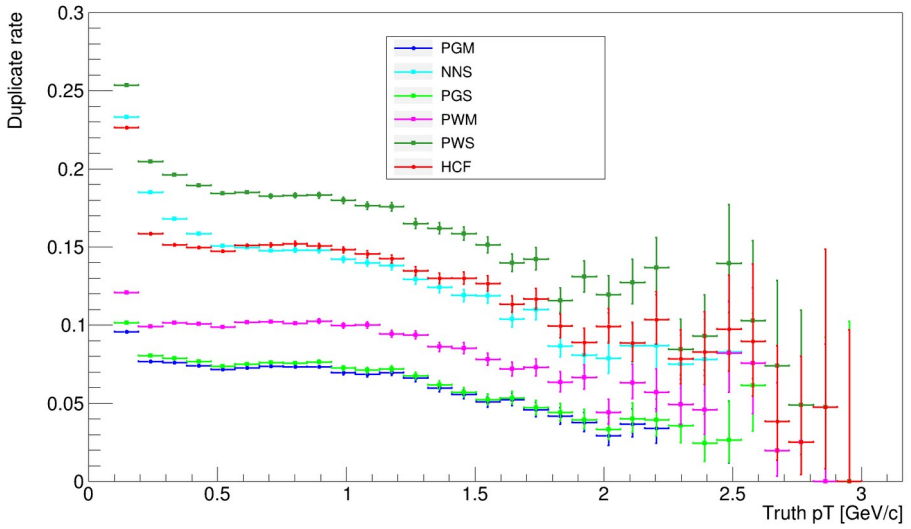
1. Hit-coverage-based track filtering (HCF)
2. Pairwise track matching and selection (PWS)
3. Pairwise track matching and merging (PWM)
4. Track proximity graph selection (PGS)
5. Track proximity graph merging (PGM)
6. Neural network-based selection (NNS)

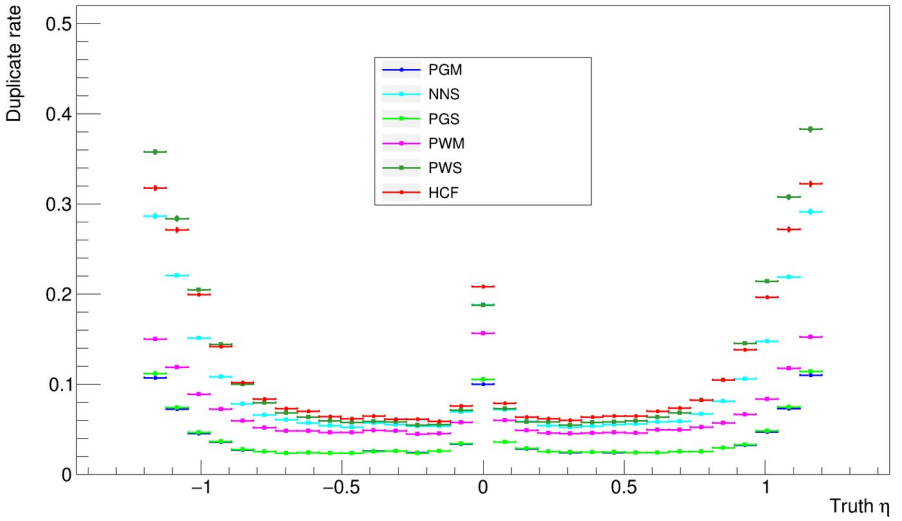
Efficiency with ambiquity resolution





Dublicate rate with ambiquity resolution



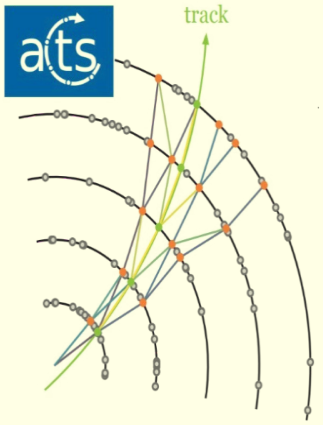


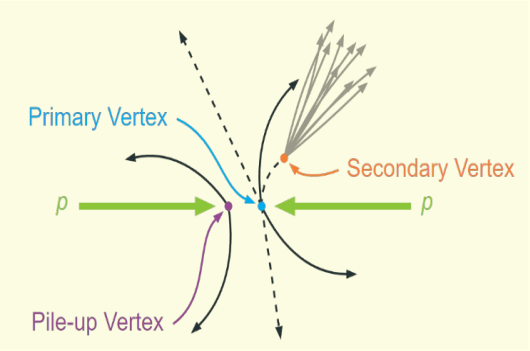
MPD vertexing with ACTS

Slavomir Hnatic

TRACKING PIPELINE

- Virtual geometry
- Input Hits
- Projection
- Seeding
- Input KF parameters
- Track finding
- Selector
- Vertexing (primary)
- TOF Matching





VERTEXING

- Seed finding
- Vertex finding
- Vertex fitting

Algorithms

AMVF: finding-through-fitting

Iterative: fitting-after-finding

ACTS v36.0.0 (July 2024) → v37.0.0 (October 2024)

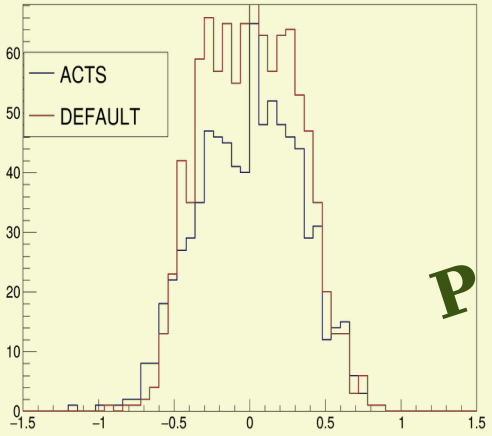
Vertex

Slavomir
Hnatic

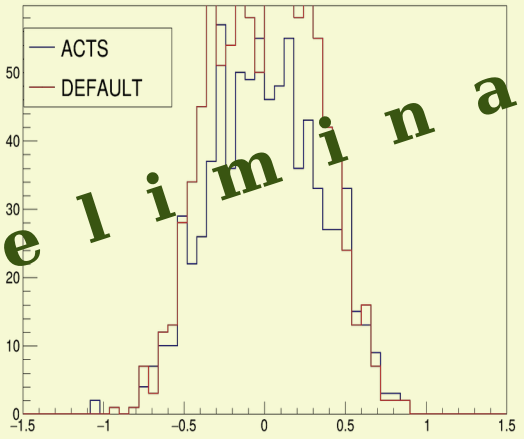
AMVF vs DEFAULT PRIMARY VERTEX FINDER

1000 events, BOX generator

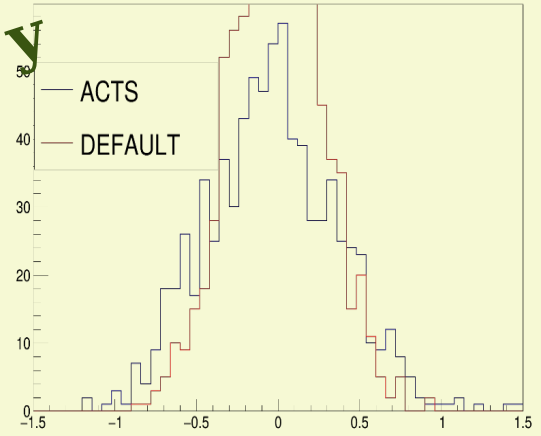
- $|d_0| < 2$mm, apart from that no tuning
- fine-tuning to be done by somebody later
- In some events seed not assigned (solvable)



X-X



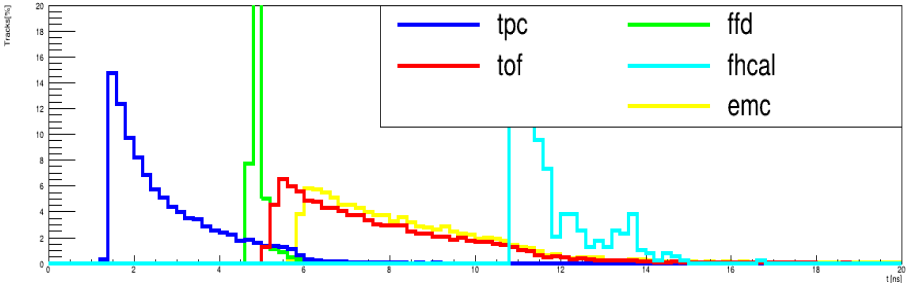
Y-Y



Z-Z

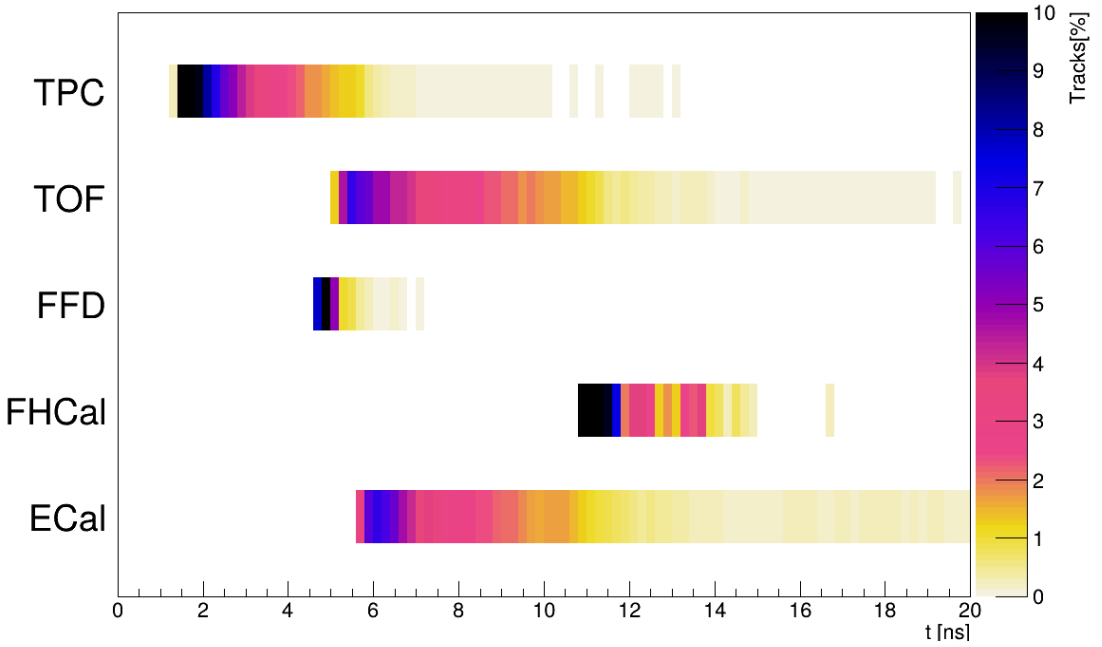
Trigger latency for data taking for MPD detectors

Alexander
Bychkov



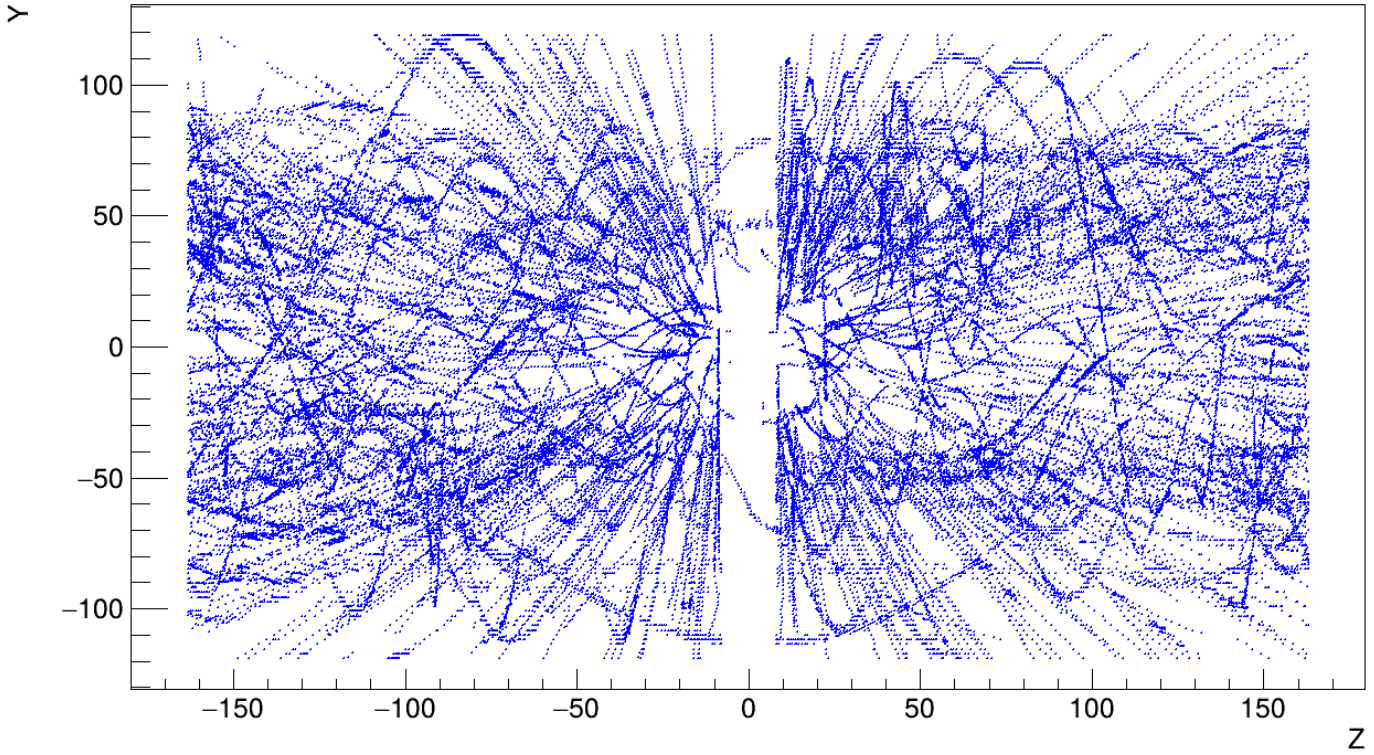
Collision point (0, 0, 0)

- 100 events from PHSD generator
- Reaching time for
  - Primary particles
  - π^0 gammas



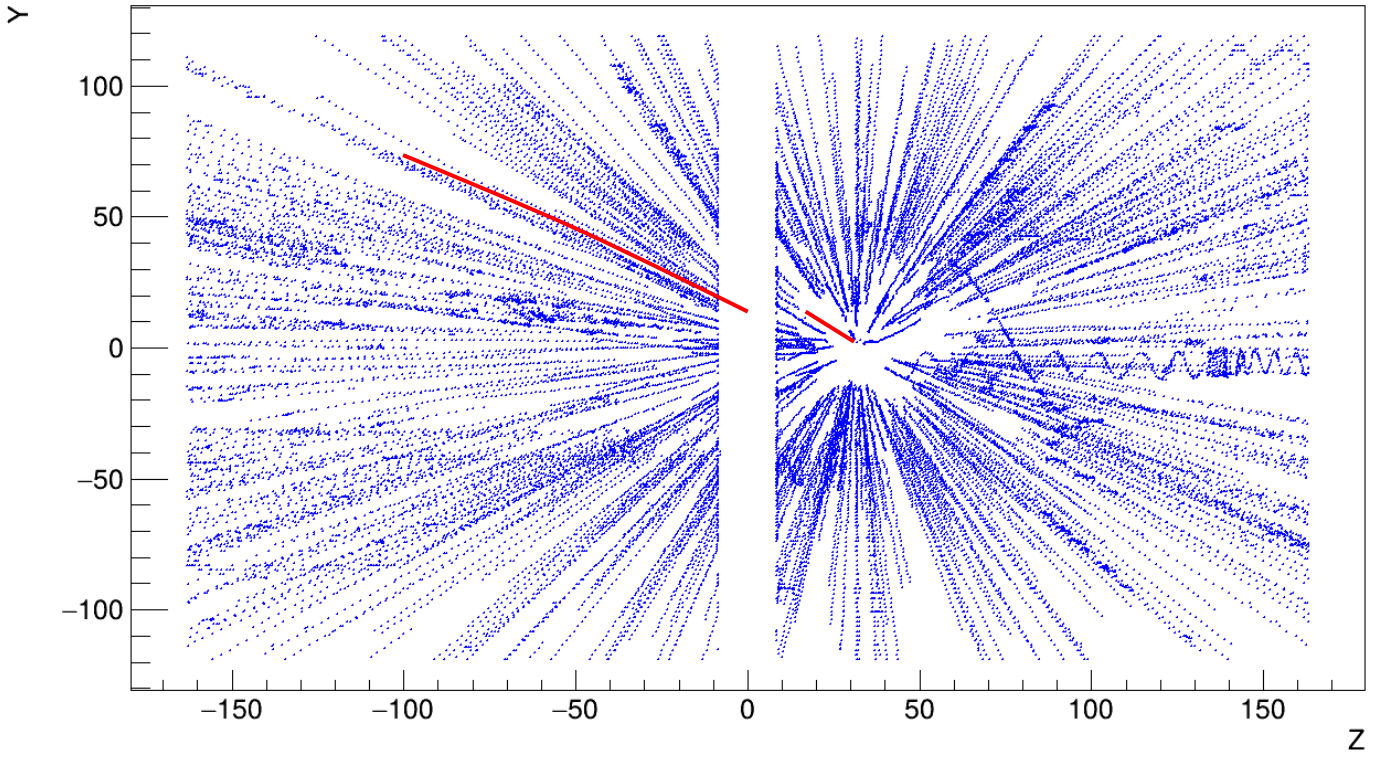
TPC data taking

- Collision point at (0, 0, 0)
- PHSD

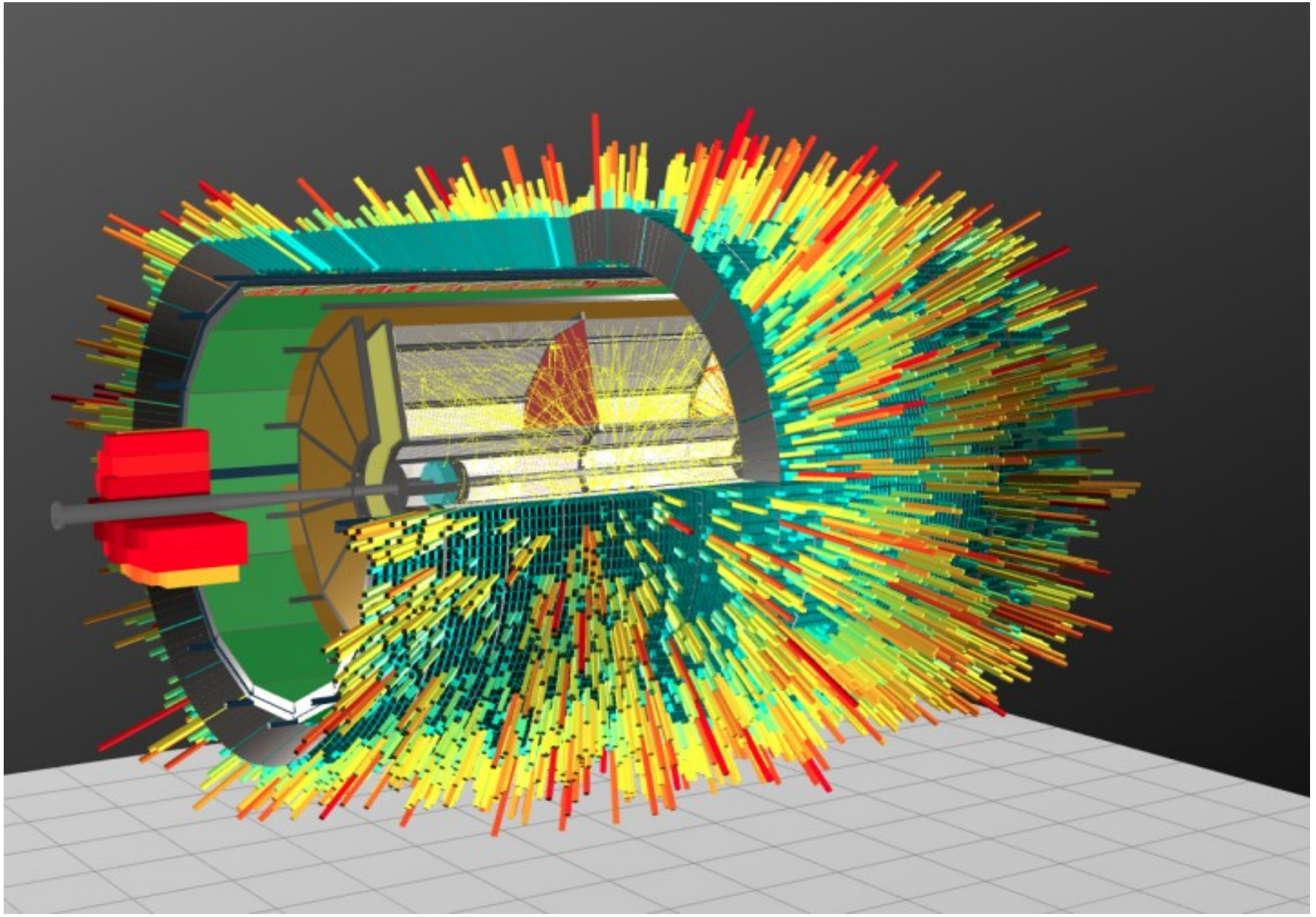


TPC data (shifted vertex)

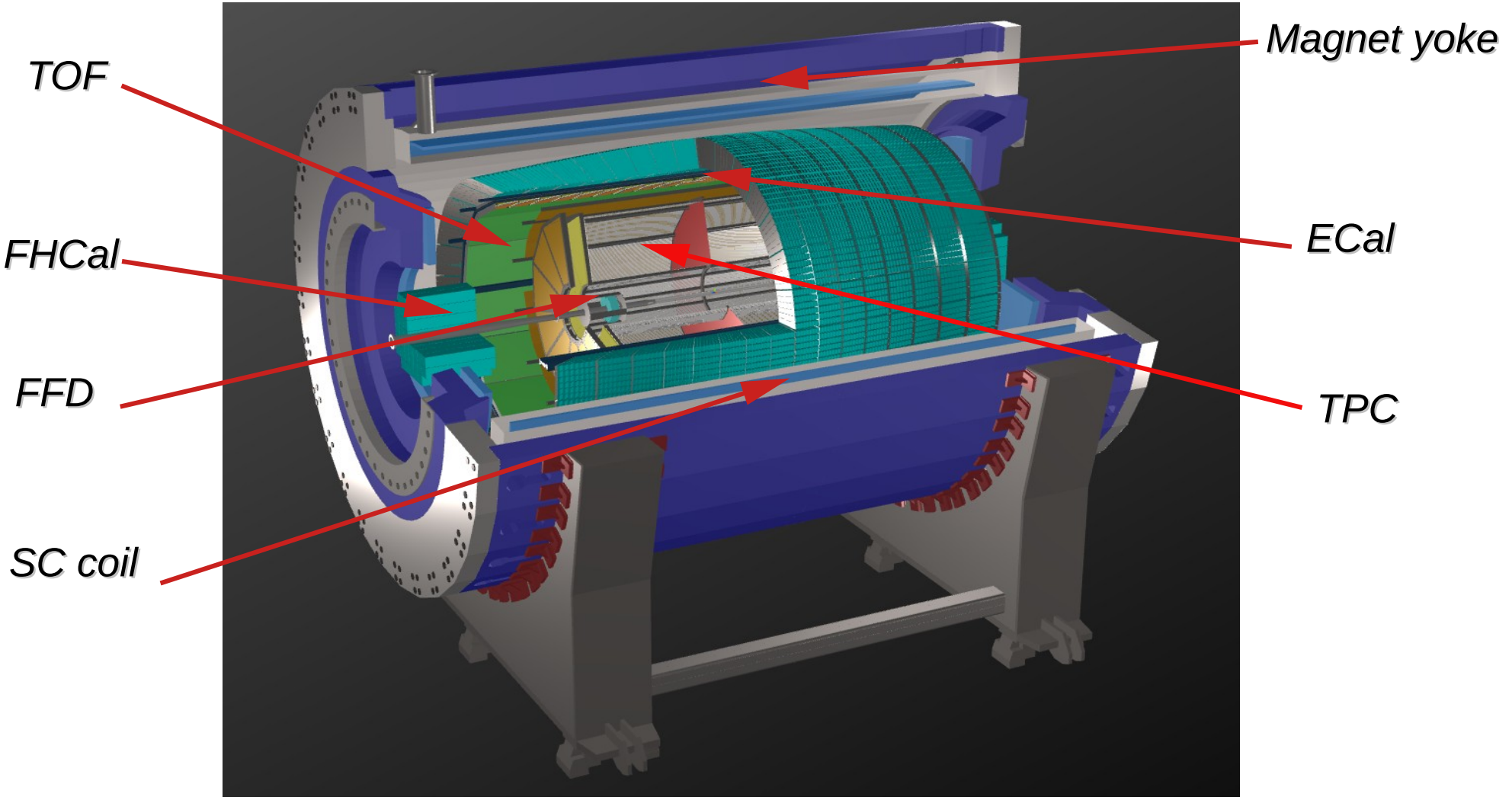
- Collision point at (0, 0, 24 cm)
- BOX muons



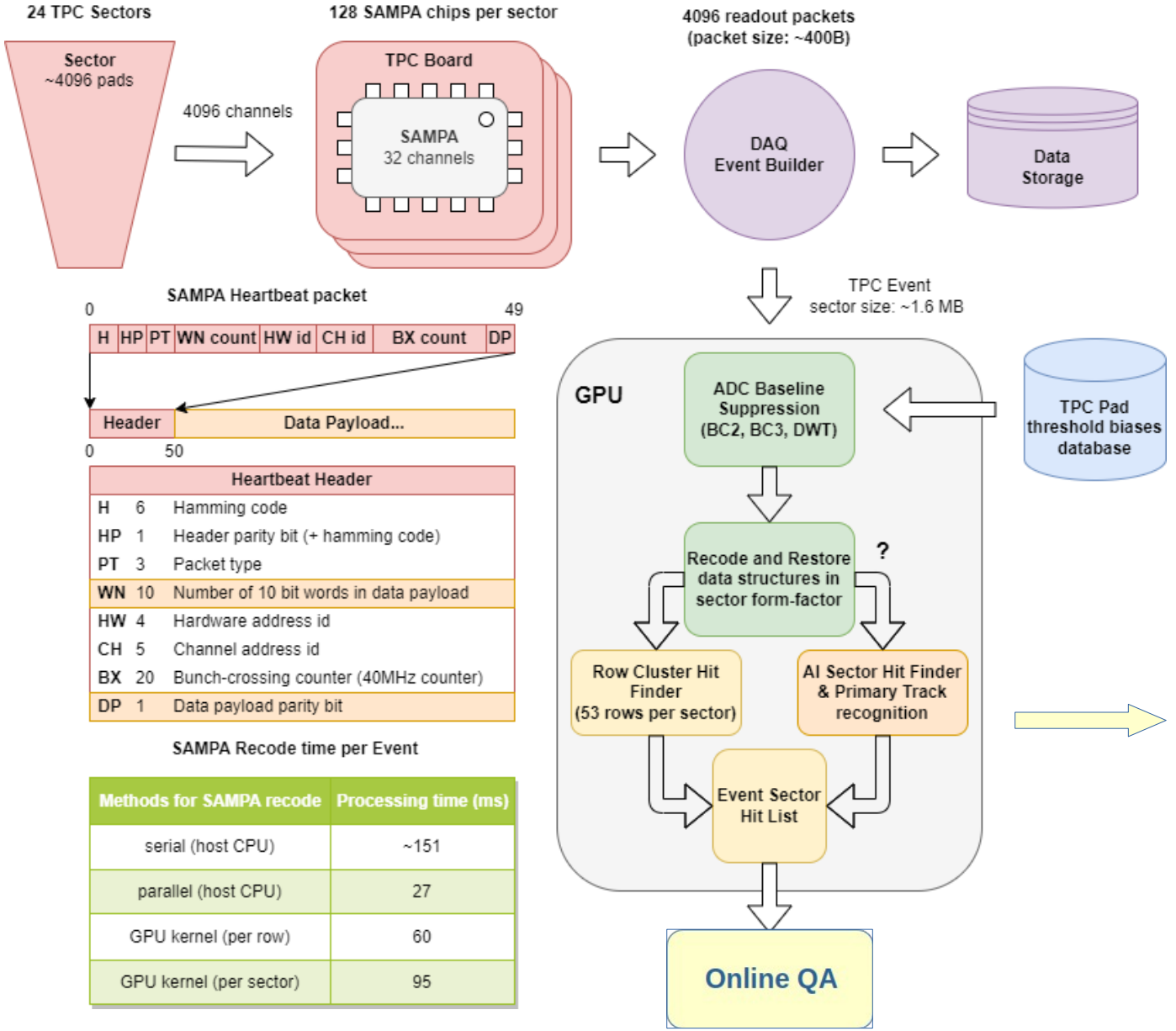
MPD eventdisplay (A.Krylov)



Update geometry for eventdisplay
(dev. version)



TPC data for online tasks

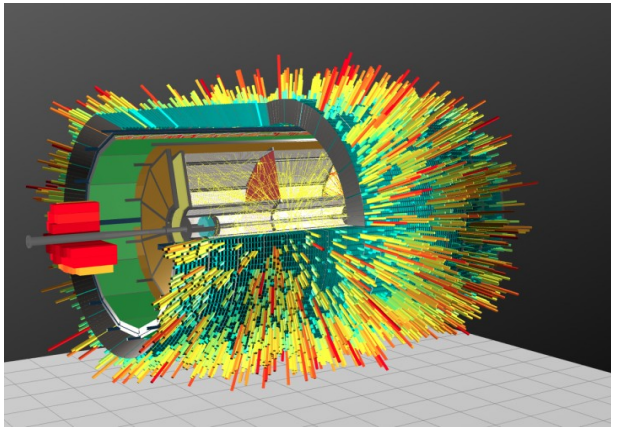


SAMPA Heartbeat packet

Heartbeat Header		
H	6	Hamming code
HP	1	Header parity bit (+ hamming code)
PT	3	Packet type
WN	10	Number of 10 bit words in data payload
HW	4	Hardware address id
CH	5	Channel address id
BX	20	Bunch-crossing counter (40MHz counter)
DP	1	Data payload parity bit

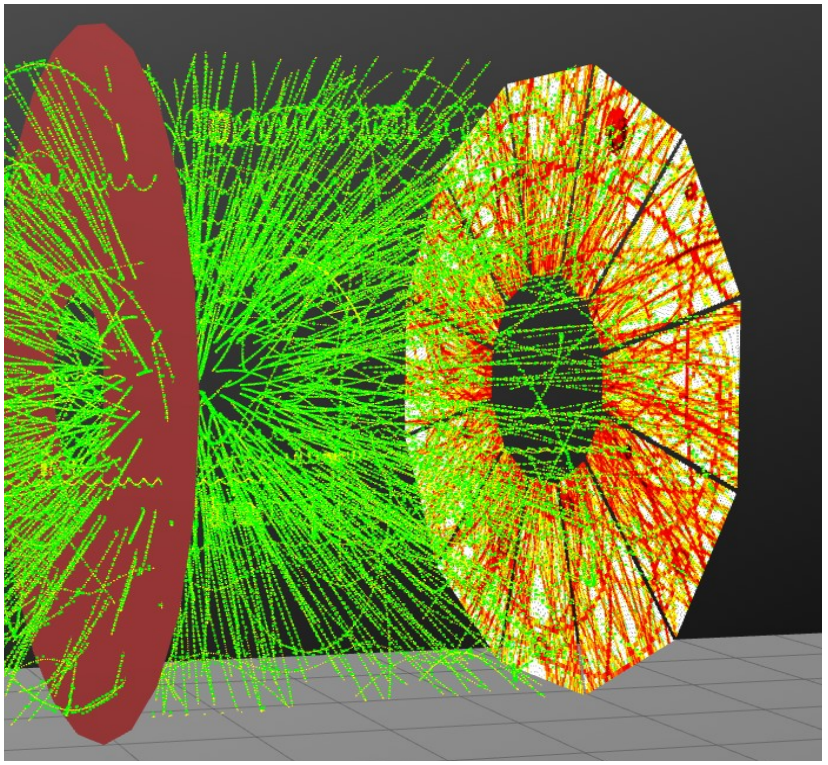
SAMPA Recode time per Event

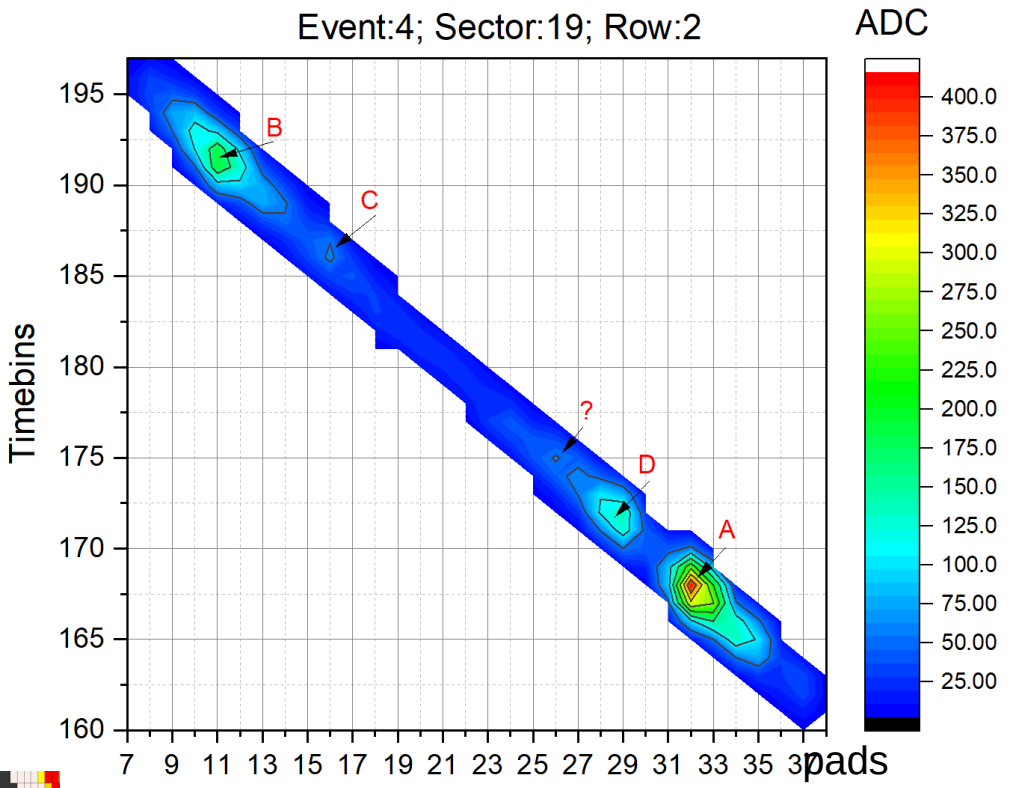
Methods for SAMPA recode	Processing time (ms)
serial (host CPU)	~151
parallel (host CPU)	27
GPU kernel (per row)	60
GPU kernel (per sector)	95

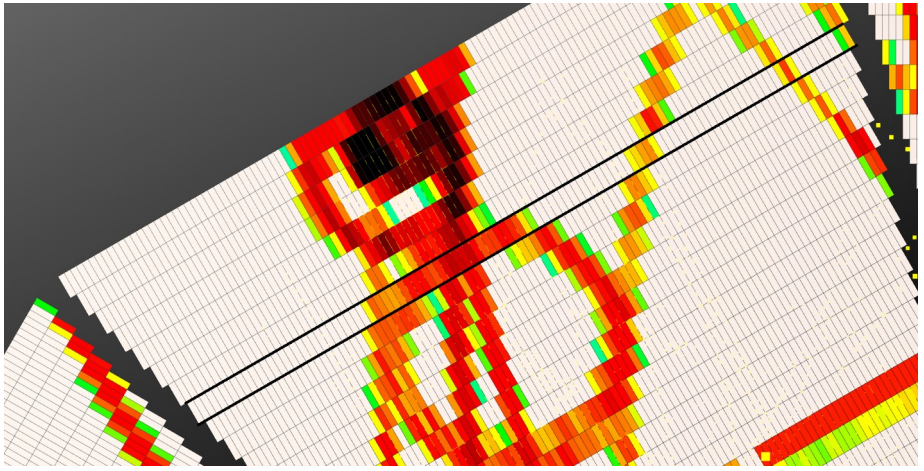


Online TPC clustering

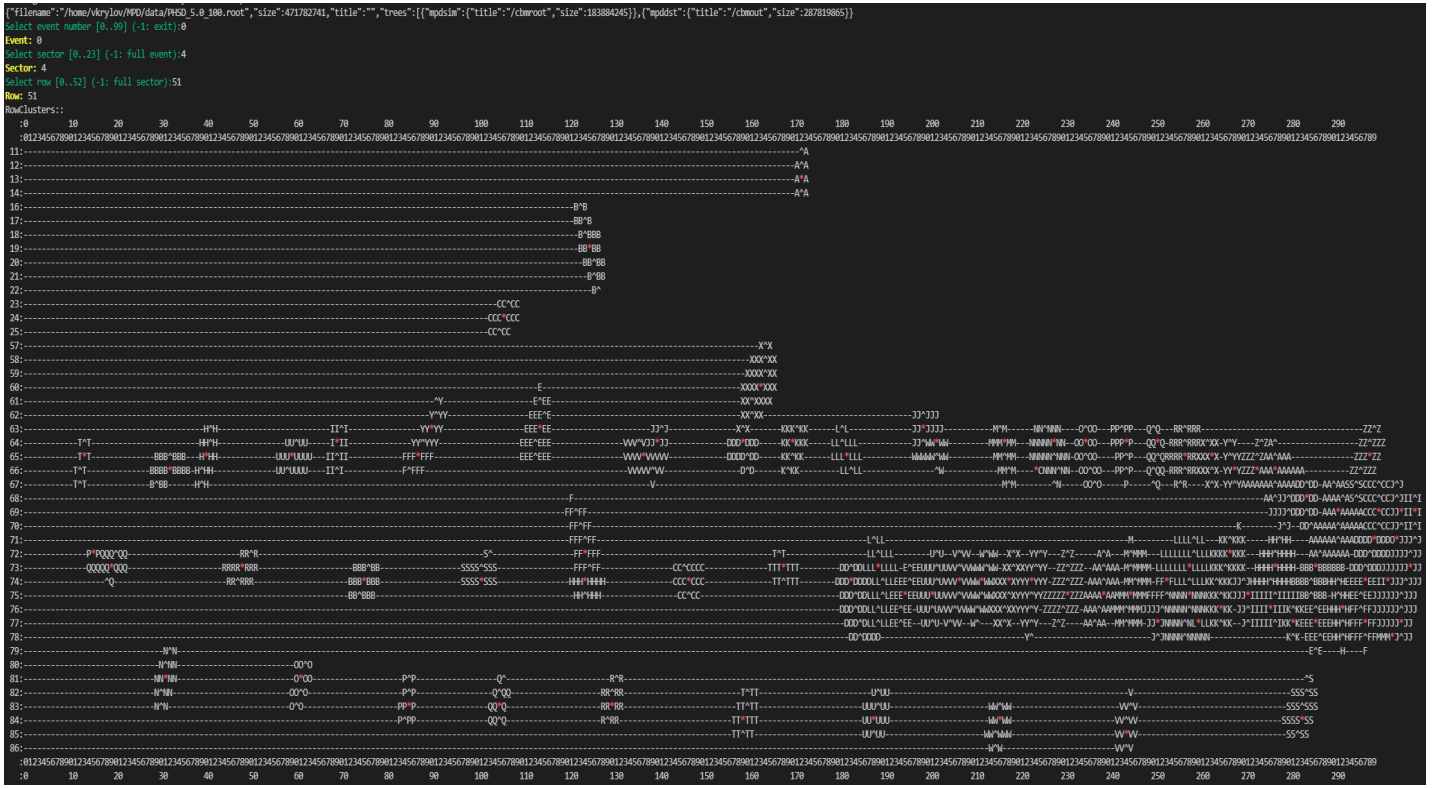
Krylov V.







Time for clustering per event



SAMPA data transcoding and Clustering time per event (24 sectors x 1,624,240 Bytes)

Different Methods for Event Processing	Processing time, ms	Thread Numbers
Serial (host CPU)	314	1
Parallel (host CPU)	4.9	24
GPU kernel (per row)	36.7	24x(53x124: 6,572)
GPU kernel (per timebins and rows)	34.5	24x(53x311: 16,483)
GPU kernel (per Pad)	20.6	24x(4,112x311: 1,278,832)

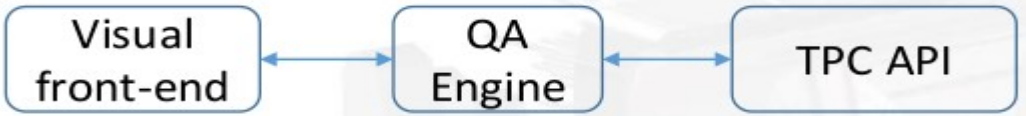
Preliminary

GPU Device

- GPU Device 0: "Pascal" with compute capability 6.1
- CUDA Device name: NVIDIA GeForce GTX 1080 Ti
- Total amount of global memory: 11169 MBytes
- GPU Max Clock rate: 1633 MHz (1.63 GHz)
- Multiprocessors: 28
- CUDA Cores/MP: 128
- CUDA Cores: 3584

Quality Assurance engine (S.Hnatic & A.Krylov)

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

Online QA hists for TPC

Krylov A.

- Inner pads ADC distribution per sector – 24 histograms
- Outer pads ADC distribution per sector – 24 histograms
- Inner pads ADC distribution per timebucket – 24 histograms (per each sector)
- Outer pads ADC distribution per timebucket – 24 histograms (per each sector)
- Inner pads ADC distribution for current event – 24 histograms (per each sector)
- Outer pads ADC distribution for current event – 24 histograms (per each sector)
- General clusters information – 6 histograms

Total number of histograms – 150

MC data for MPD physics group

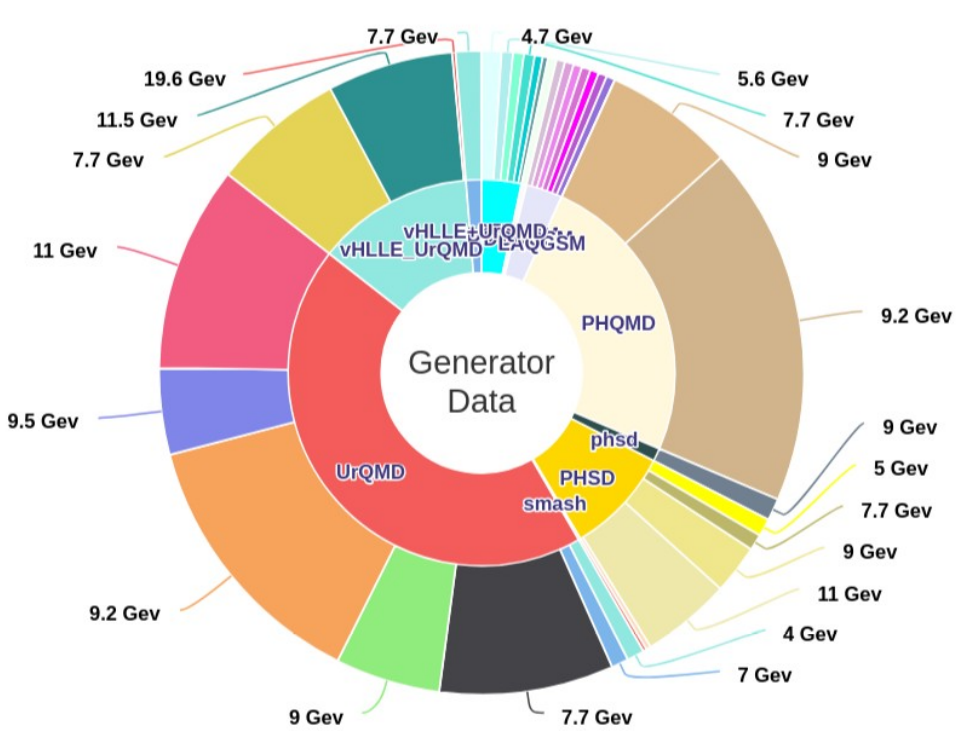
Generator	PWG	Coll.		# of events()	Reco
UrQMD	PWG4	AuAu	11	15	+
		BiBi	9	10	+
			9.46	10	+
			9.2	95	+
	PWG2	AuAu	11	10	+
	PWG3	AuAu	7.7	10	+
		BiBi	7.7	10	+
			9	15	+
		pp	9	10	+
		BiBi fix target	2.5	12	+
		BiBi fix target	3.0	12	+
		BiBi fix target	3.5	12	+
		XeW fix target	2.5	15	+
		XeXe fix target	2.5	15	+
	PWG1	BiBi	9.2	76	+
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				1412	568

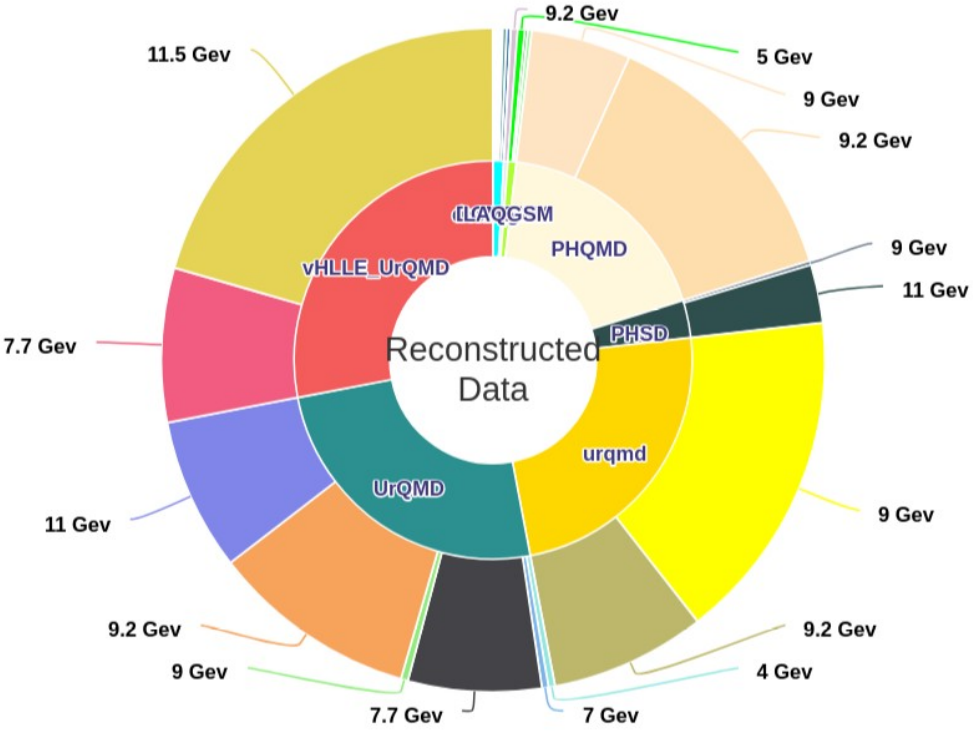
1.6 PB

MPD mass production database

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

all mass production requests done in time





All production data stored in Dirac File Catalog

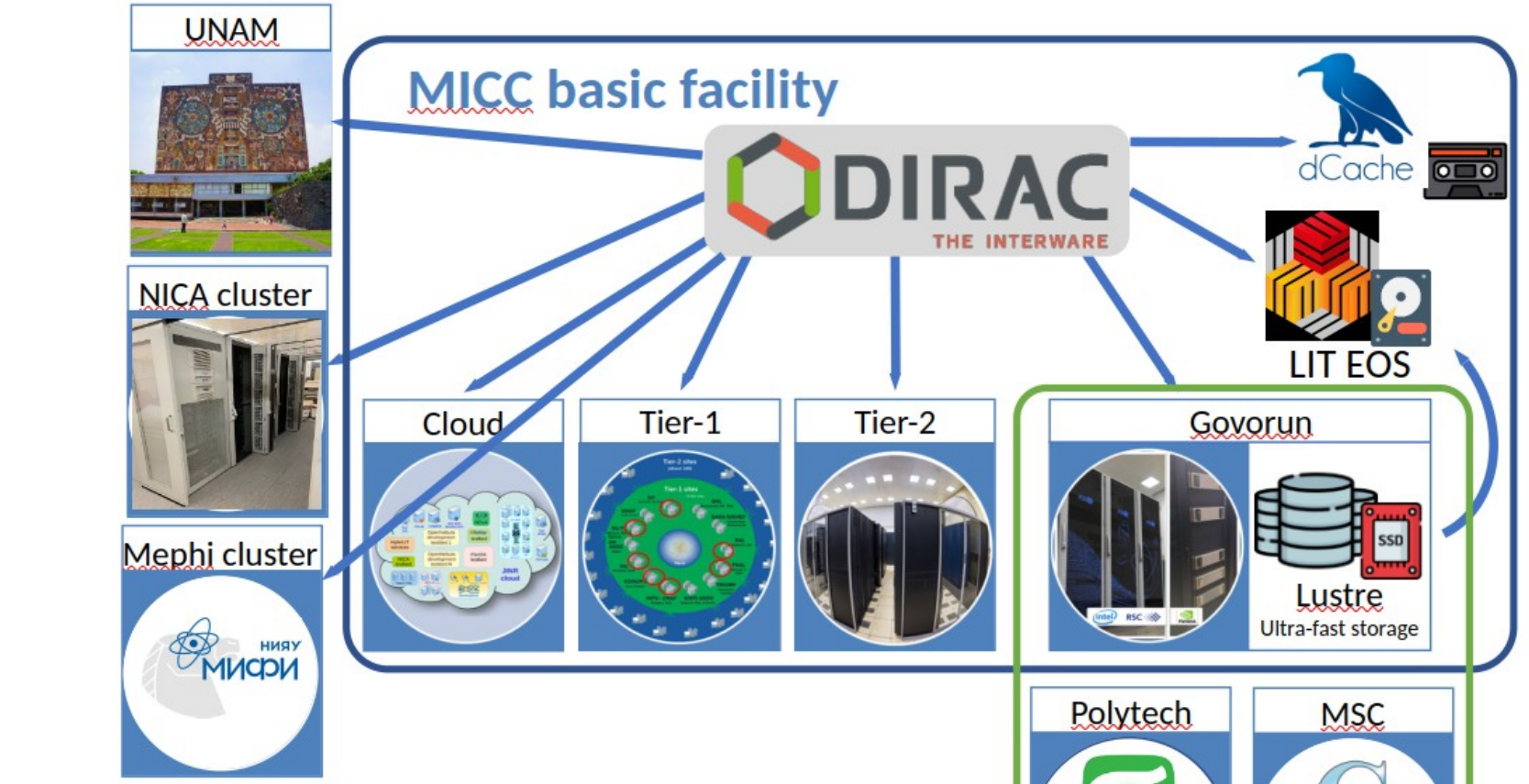
Mass production data

- Centralized Analysis Framework for access and analysis of data:
  - ✓ consistent approaches and results across collaboration, easier storage and sharing of codes and methods
  - ✓ reduced number of input/output operations for disks and databases, easier data storage on tapes
- Analysis manager reads event into memory and calls wagons one-by-one to modify and/or analyze data:

Analysis manager	Centrality wagon	Reaction plane wagon	DCA, PID, Match wagon	Analysis wagon #1	Analysis wagon #2	Analysis wagon #N

- Ten productions of physical analysis of simulated data already done.

Computing resourses for MPD



- NICA offline cluster 1000 cores(limit for users)
- GOVORUN up to 3260 cores in last production
- Tier1 1400 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 6,2 PB.

+ SOSNY

Thanks for your attention