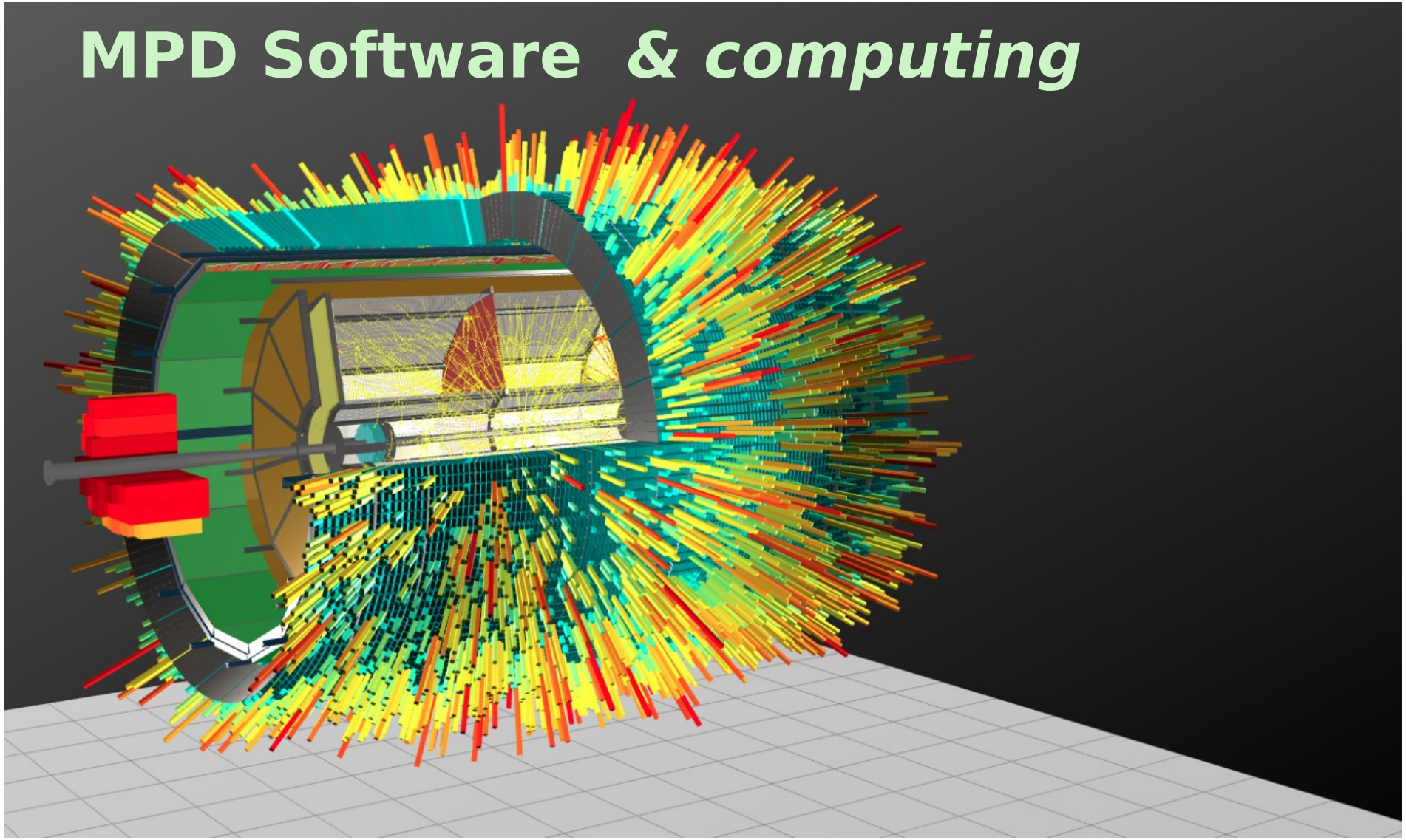
MPD Software & computing



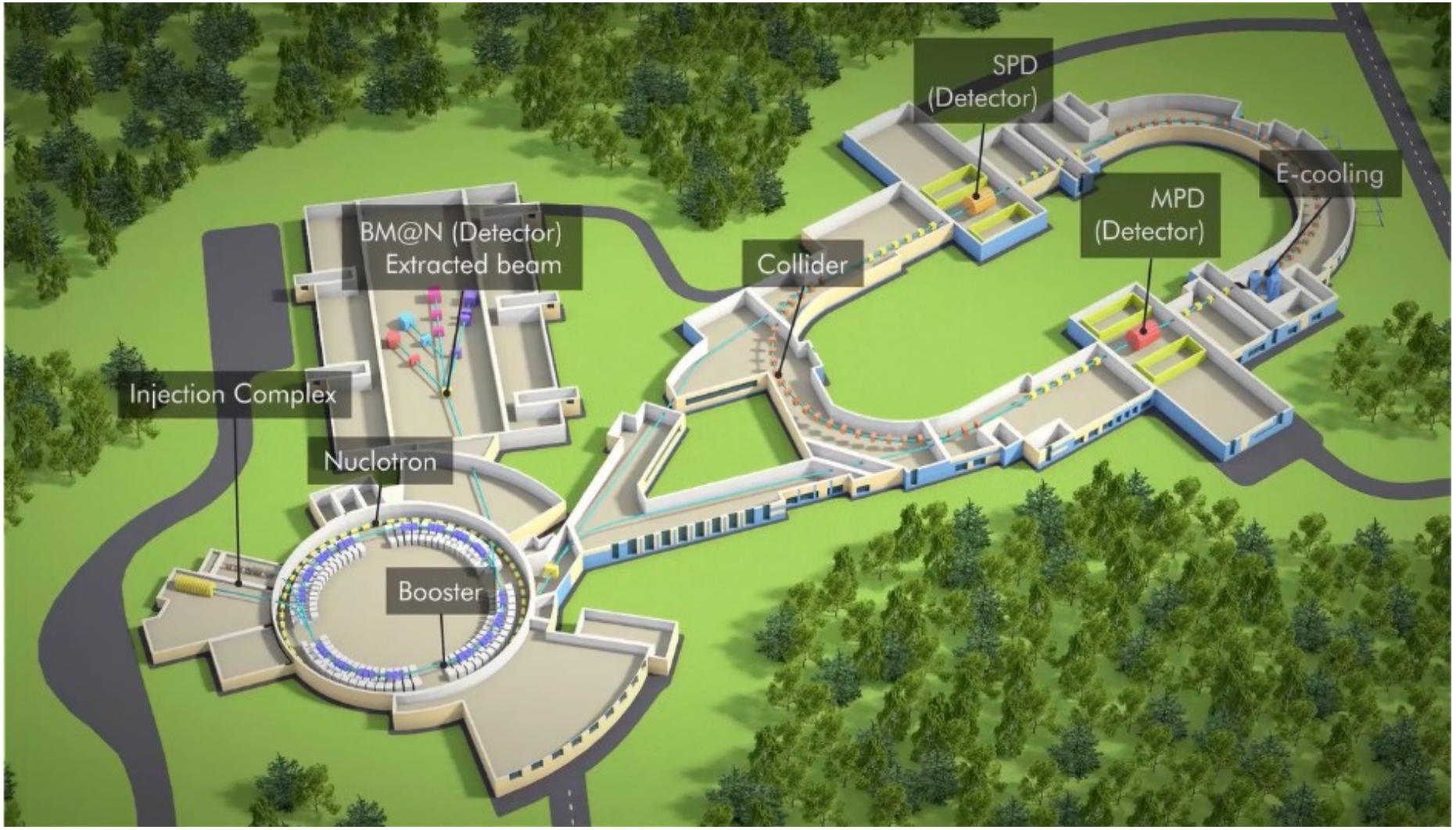
Rogachevsky Oleg
for MPD collaboration

IT school LIT
15.11.2022
Dubna

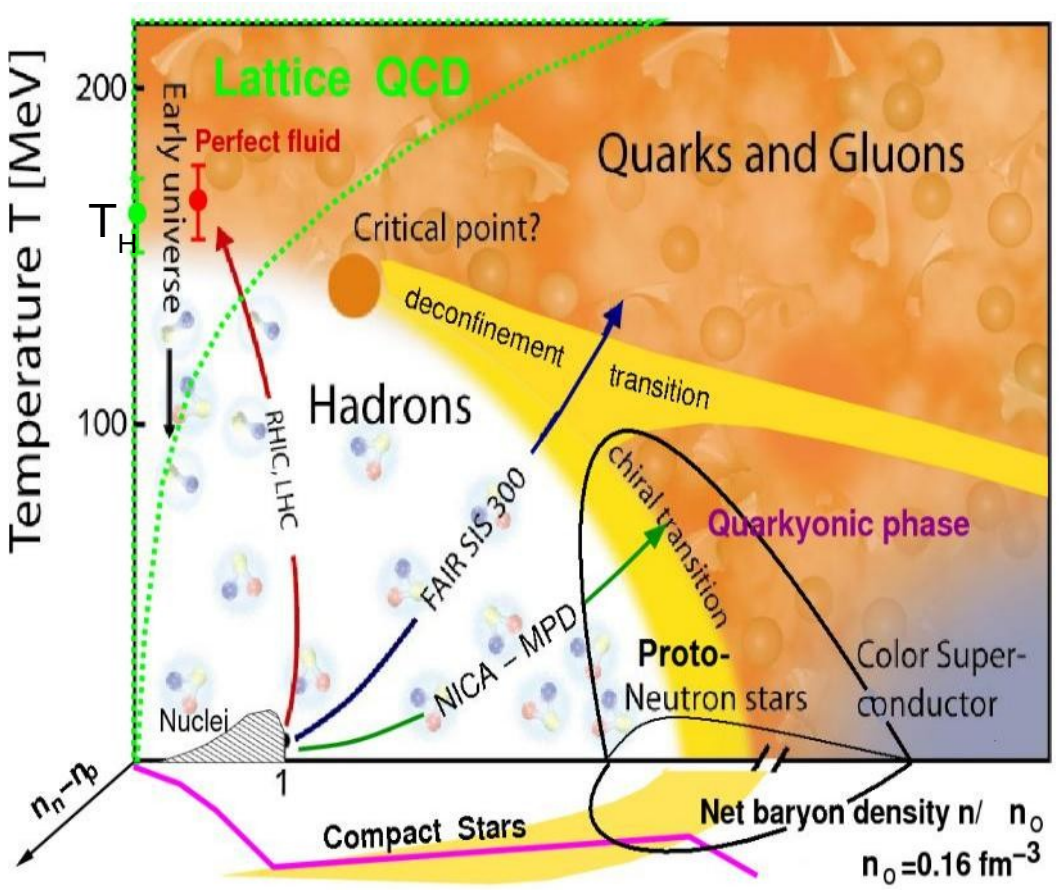
NICA storage rings

May 2022

Mpd @ NICA


SPD
(Detector)
E-cooling
MPD
(Detector)
BM@N (Detector)
Extracted beam
Collider
Injection Complex
Nuclotron
Booster

QGP phase diagram



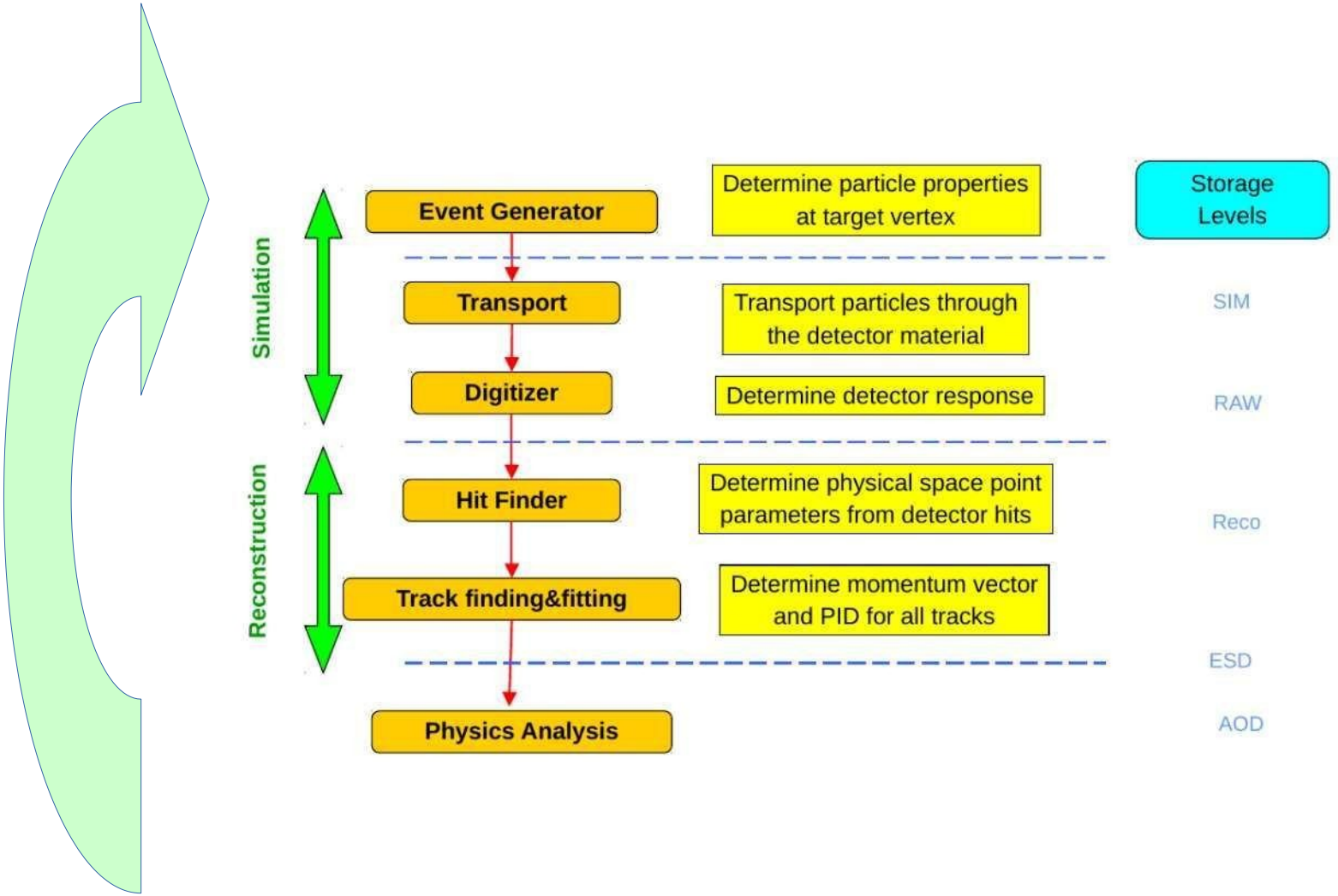
The collision of two heavy nuclei which approach and smash against each other with almost the speed of light. According to Einstein's theory of special relativity they look like thin pancakes. This "Little Bang" creates in the laboratory the primordial state of matter, called Quark-Gluon Plasma (QGP). The QGP expands like a fireball, cools and finally turns into ordinary matter, not unlike vapour turning into water

. The thousands of particles produced will be recorded by detectors. The tracks that those particles leave in the detectors will be analysed by modern powerful software tools.

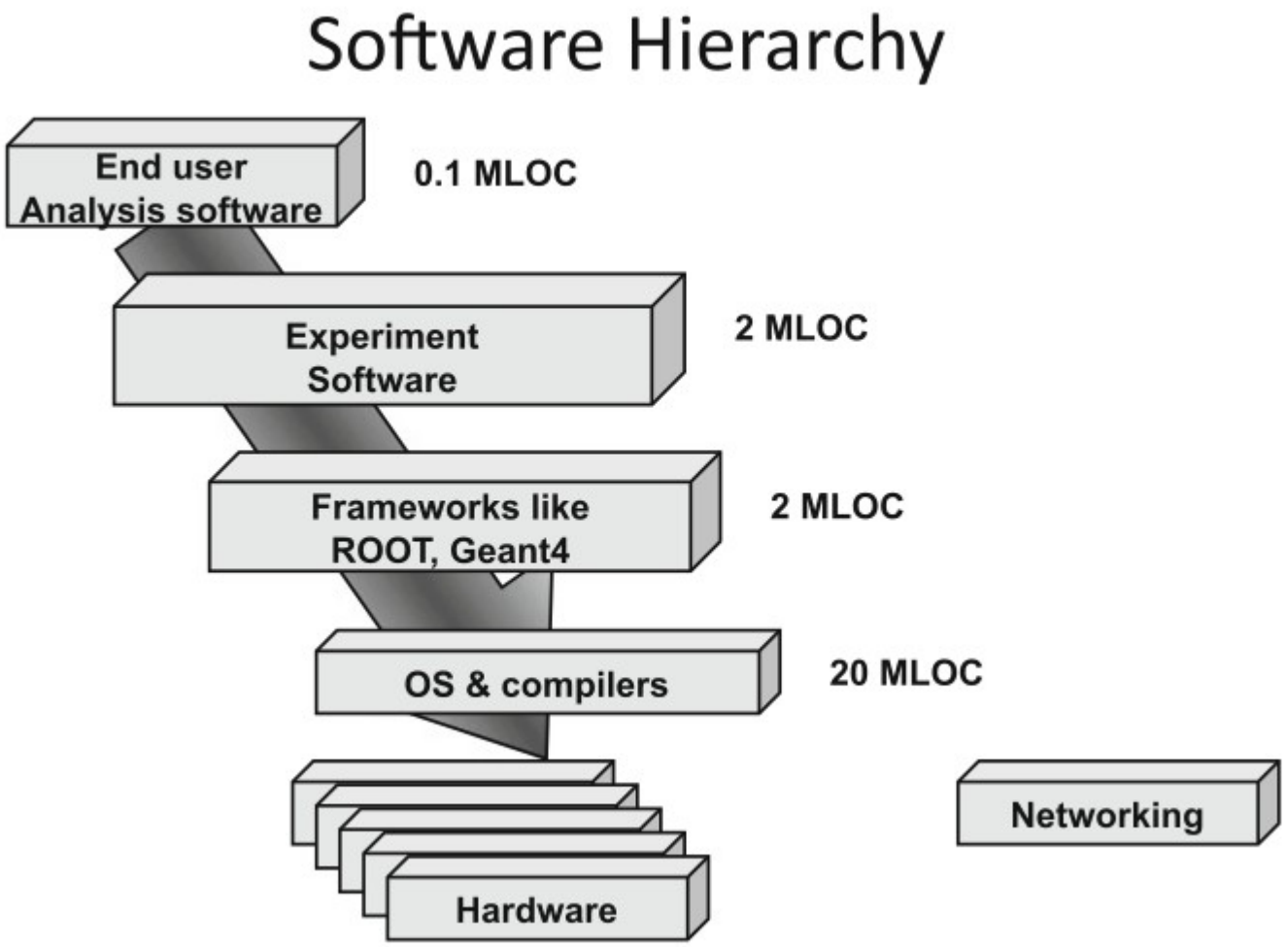
The challenge is to infer the properties of the QGP state of matter by studying the different particles that arrive in the detectors.

HEP experiments data flow

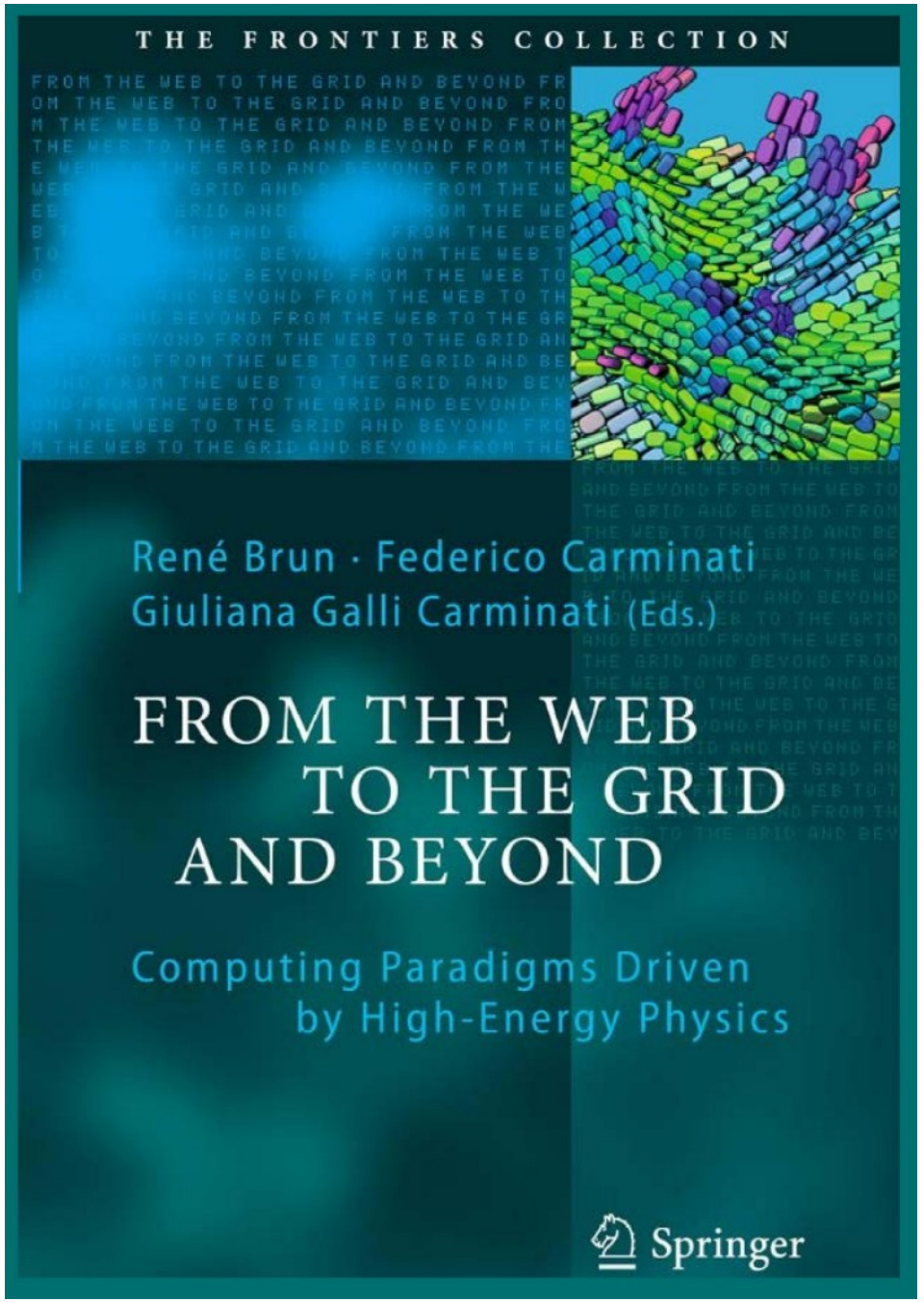
Simulation, the third way to scientific knowledge after theory and experiment.



Software Hierarchy



History of CERN computing



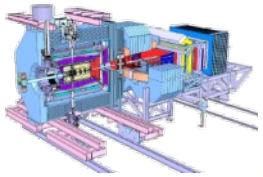
History of CERN computing

1.2 Hardware and Operating Systems

At the end of the fifties, the first computer at CERN was a man, Wim Klein. He was hired to help physicists in computing complex mathematical expressions. His operating system and clock cycle were such that he was able to evaluate in a few seconds any trigonometric, square root, exponential or logarithmic function. His memory was able to store several MegaBytes of data where he could store the phone directory of Amsterdam at the end of the Second World War, then later tables of logs, prime numbers or large matrices. He was able to compete with the first CERN computer, a Ferranti Mercury in 1958, or even more elaborate machines in the early sixties. It was only when the first really powerful computer, a Control Data CDC 6600, came to CERN in 1964 that Wim "retired" and gave TV shows or famous lectures for CERN summer students.

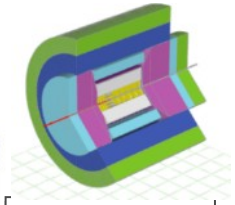
MpdRoot history

Start testing the VMC concept for CBM

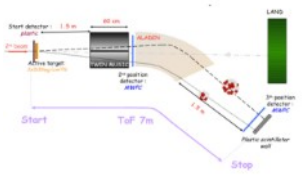


Panda decided to join → oct.
FairRoot: base package for experiments

R3B joined

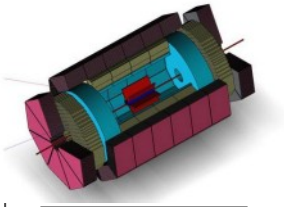


EIC (Electron Ion Collider BNL)



SOFIA (Studies On Fission with Aladin)

SHIP (Search for Hidden Particles)

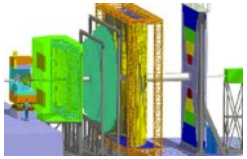


SPD@NICA joined

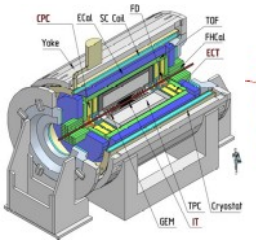
2004 | 2006 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015

ALICE
FAIR

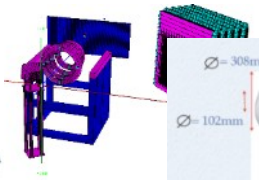
First Release of Cbm Root



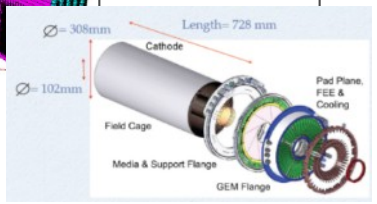
MPD@NICA started with FairRoot



ASYEOS joined

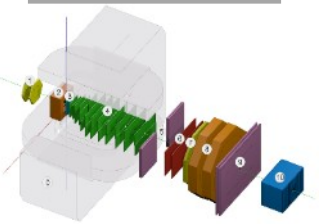


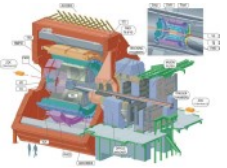
GEM-TPC separated from PANDA branch



ENSAR-ROOT
Collection of modules used by structural nuclear physics exp.

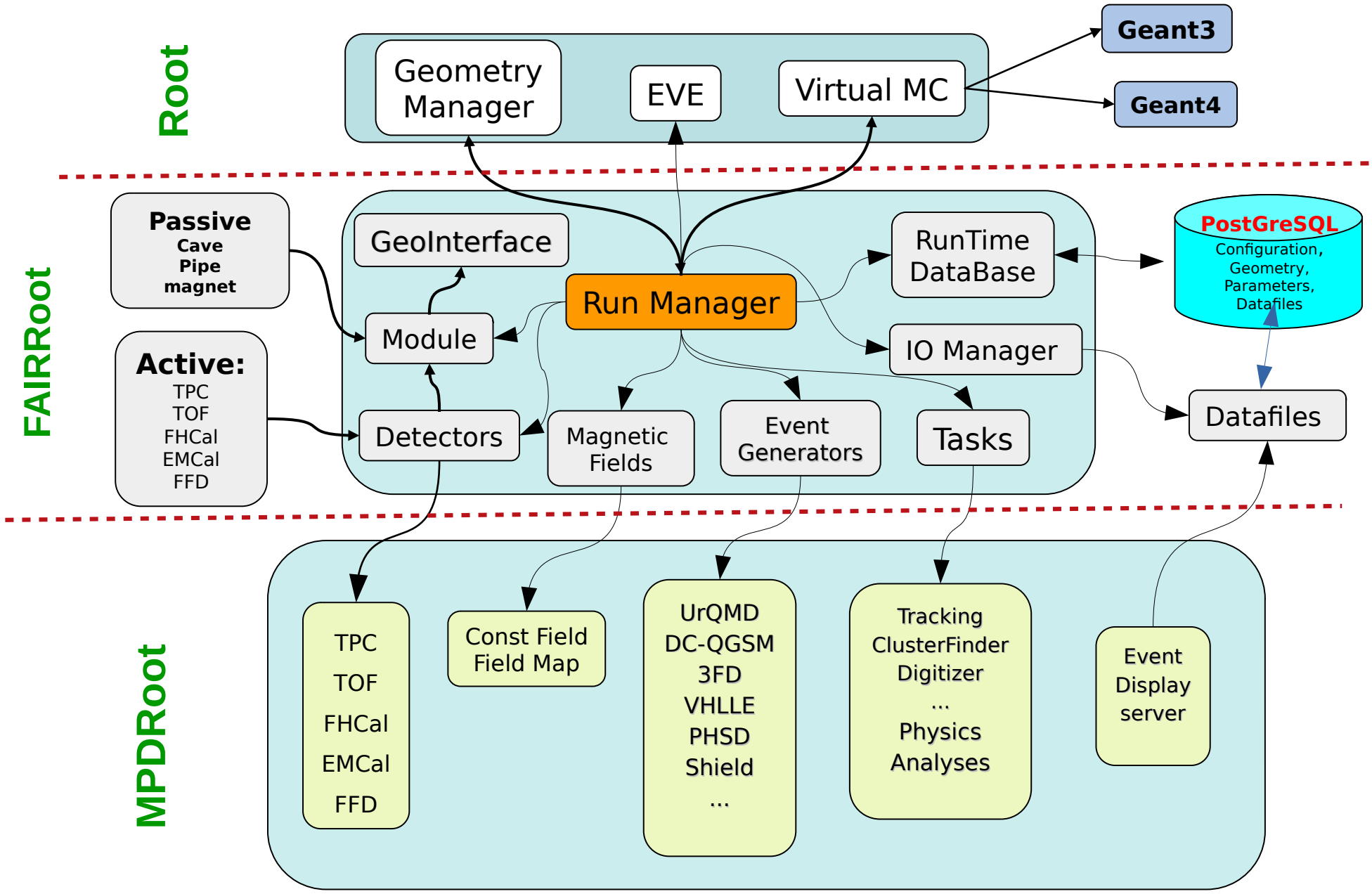
BM@N@NICA started with FairRoot





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

MpdRoot structure



MPDroot code development

Hnatic Slavomir

SOFTWARE ENGINEERING

PRODUCT DEVELOPMENT

- R&D valid concepts integrated into whole
- Not in conflict with existing development
- User/developer friendliness
- Extensible
- Maintainable
- Not requiring unmanageable (geeky) support
- Compact, modular
- Follows SE principles & best practices

MPDROOT CODING RULES

Basic truths

1. It's harder to read the code, than to write it
2. Capability based approach being the most effective

Focus

- readability
- design
- general rules:

https://mpdroot.jinr.ru/mpdroot-naming-convention/

Test-Driven Development (TDD)

Cluster Hit Finder

Preparatory work

- get rid of geometry singleton
- create **invariant** Base class for geometry

Create interface

- inheriting from FairTask
- interface dependencies should be passed by **injection**
- clusterhit finder units, candidates for pure virtual methods: findClusters, findHits

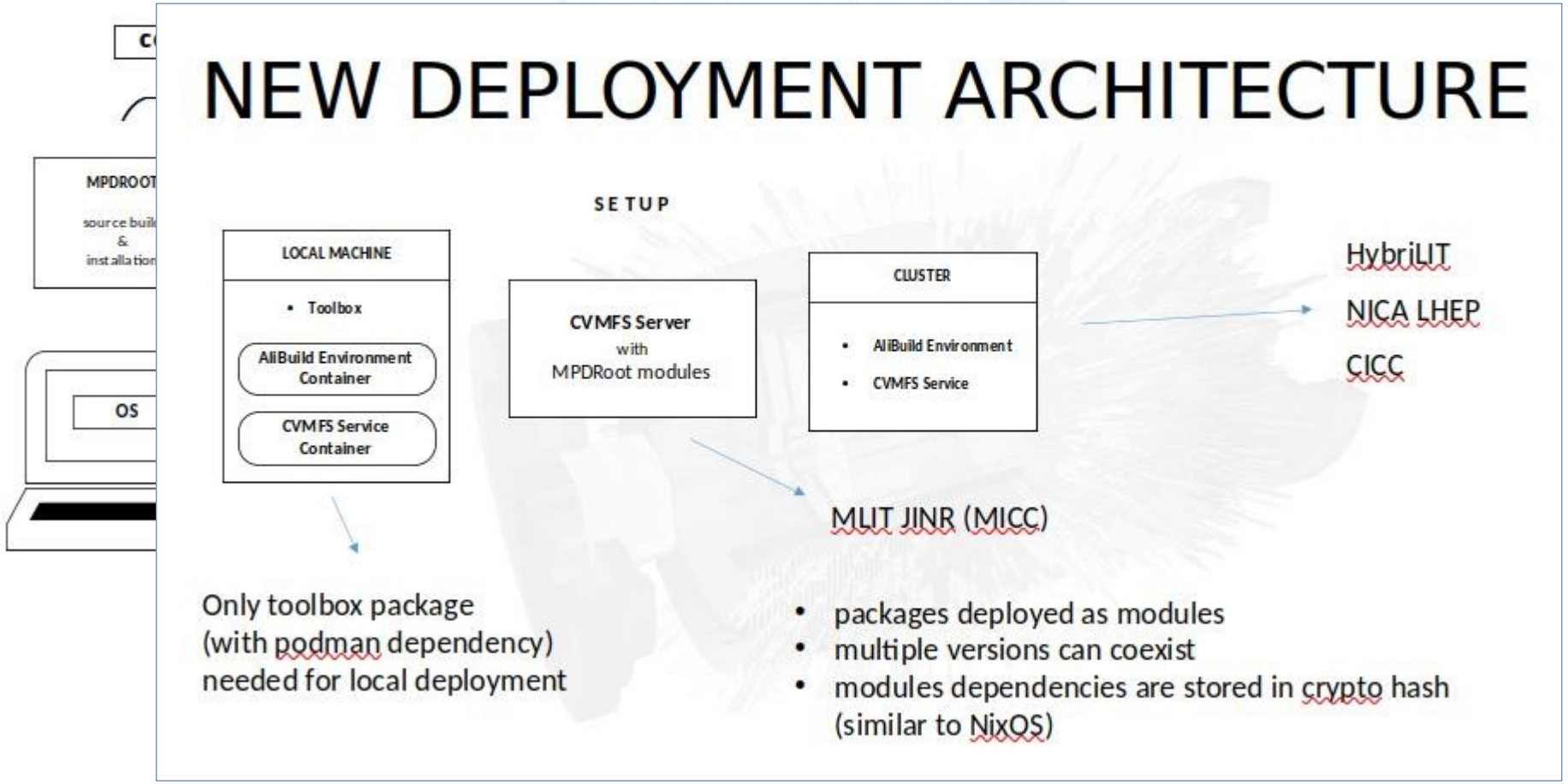
Implementation

- current Mlem algorithm to be adapted to interface (reconstruction identity criterion)
- new fast clusterhit finder to be adapted to interface
- both algorithms are standardized and testable on levels of:
  - implemented pure virtual methods
  - implemented interface
  - reconstruction

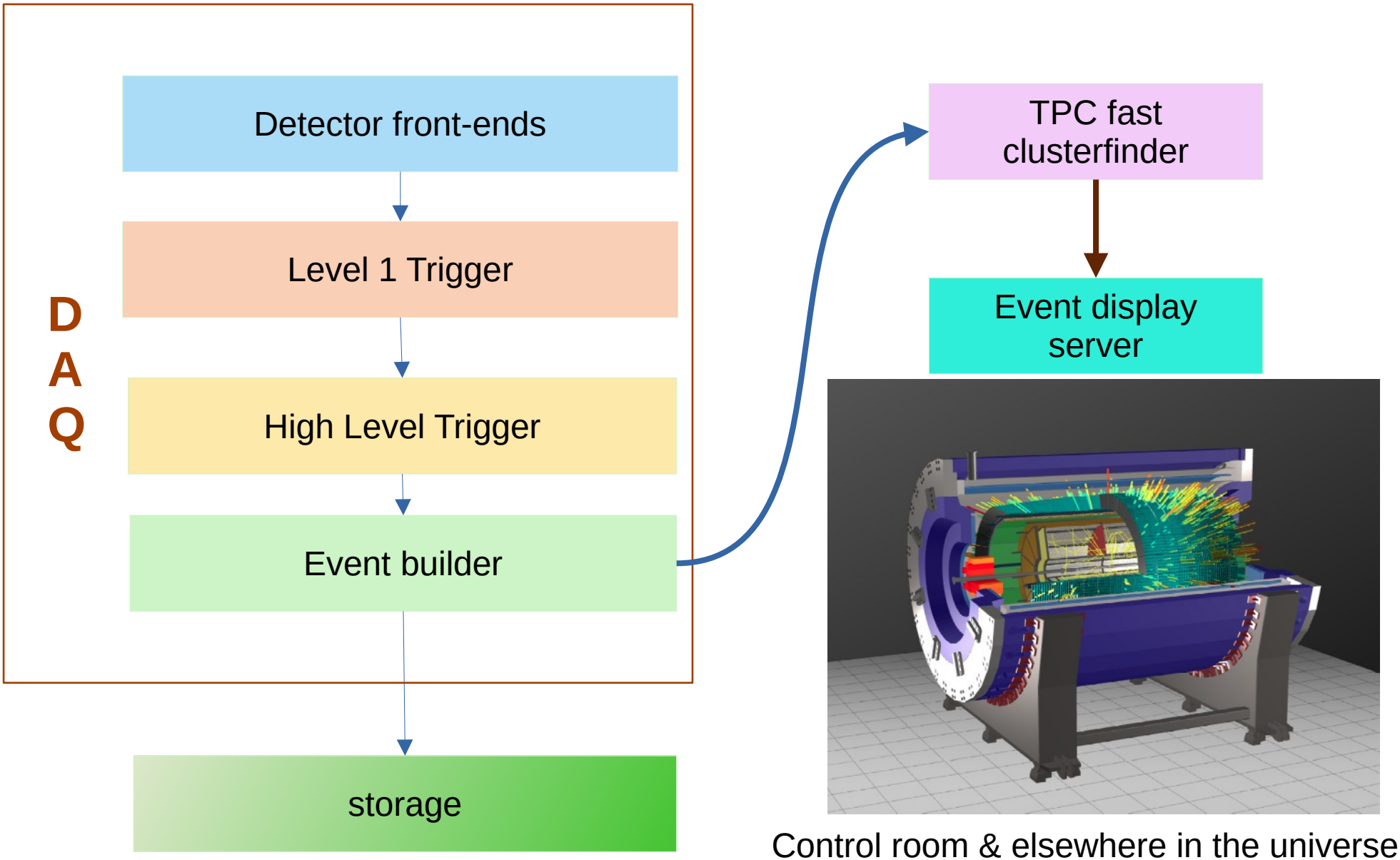
MPD deployment

Hnatic S.,
Vala M.,
Busa J.

PREVIOUS DEPLOYMENT PROCEDURE



MPD dataflow (very raw)



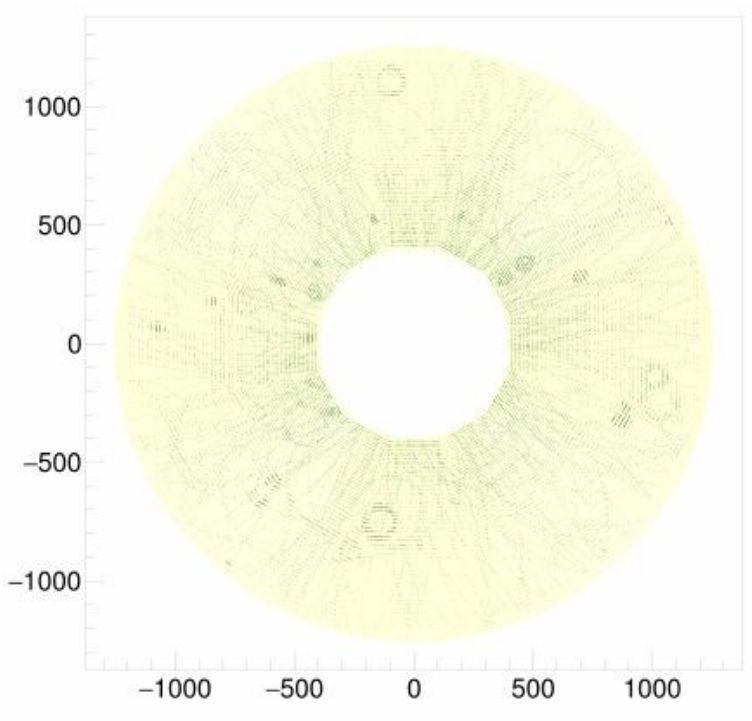
Control room & elsewhere in the universe

TPC tracking with ACTS

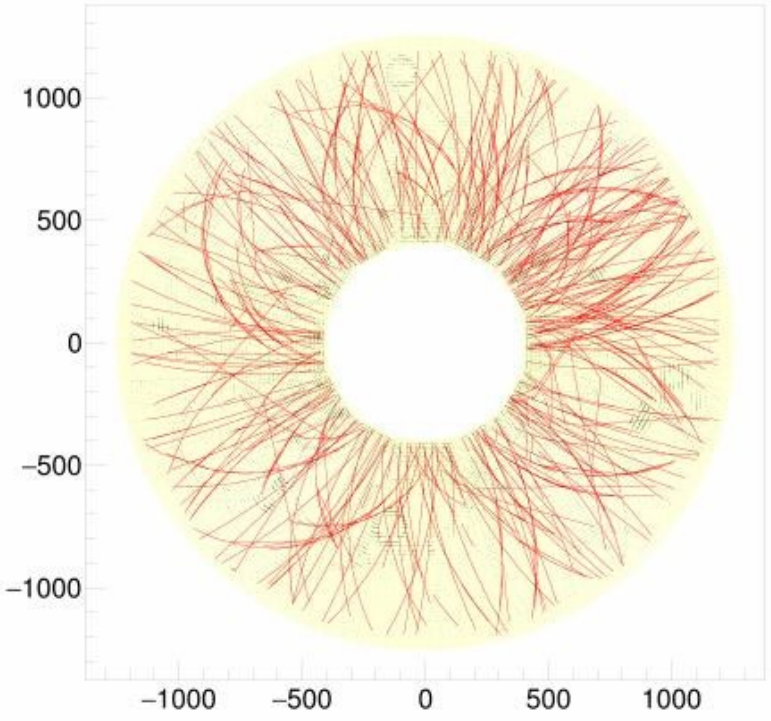
The A Common Tracking Software (Acts) project is an attempt to preserve and evolve the track reconstruction software of the LHC era towards HL-LHC and beyond.

UrQMD AuAu
√s = 9 GeV

Hits

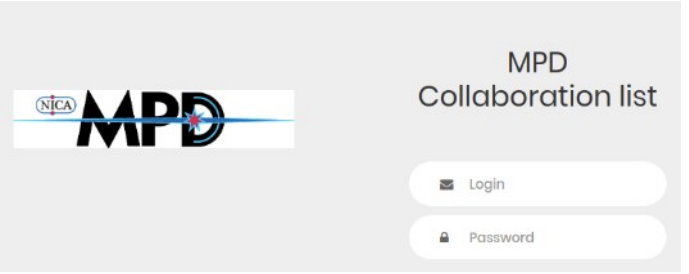


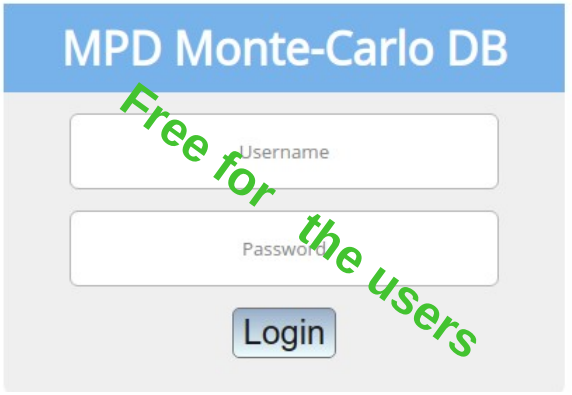
Tracks



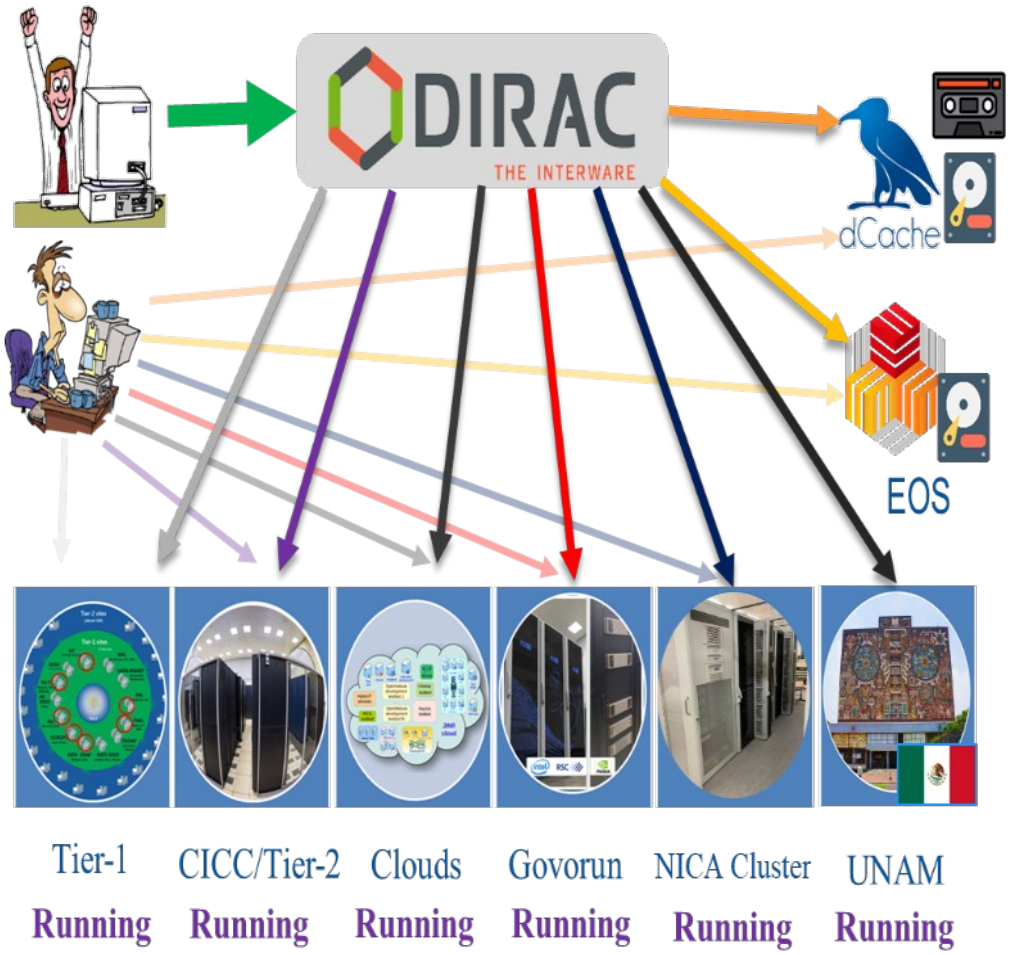
MPD databases

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





DIRAC resources

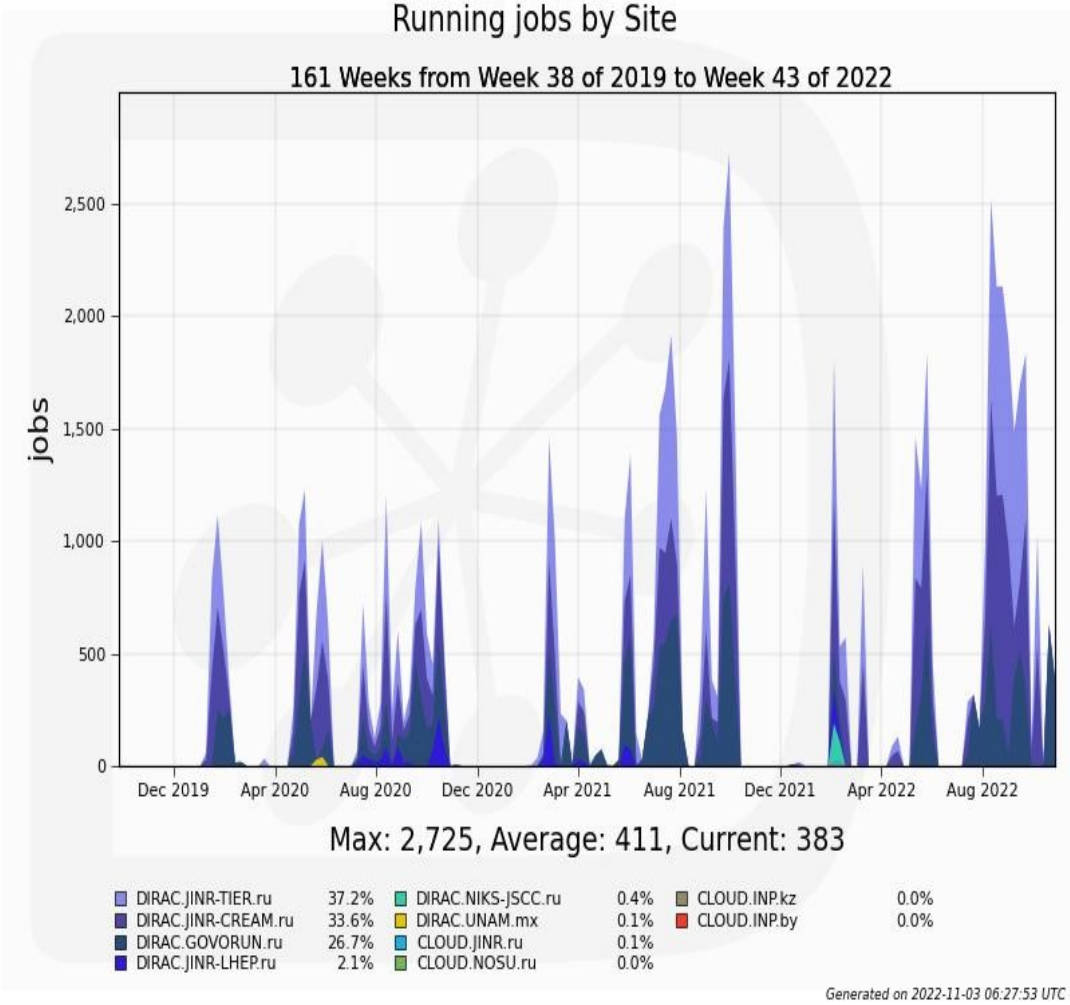


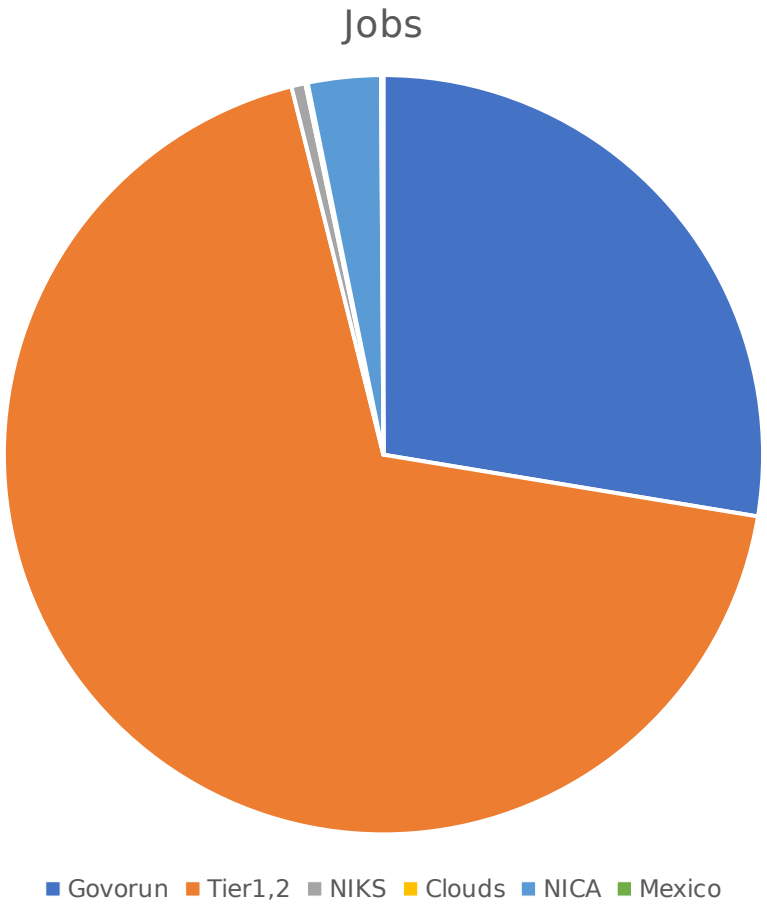
- NICA offline cluster **300** cores
  (limited for the users)
- GOVORUN up to **2256** cores in last production
- Tier1 **920** cores
- Tier2 **1000** cores
- Clouds(JINR and JINR Member States) **70** cores
- UNAM(Mexico University) **100** cores
- National Research Computer Network of Russia (now resources from SPBTU and JSCC) 672 cores – New resource, added in 12.2021.

All software packages are centrally stored in /cvmfs and are available on all computing clusters

Mass production storages integrated in Dirac File Catalog have size **1,7** PB.
We expect another 0.4 PB during the modernization of Govorun

MPD mass production 2019-2022 summary(1):





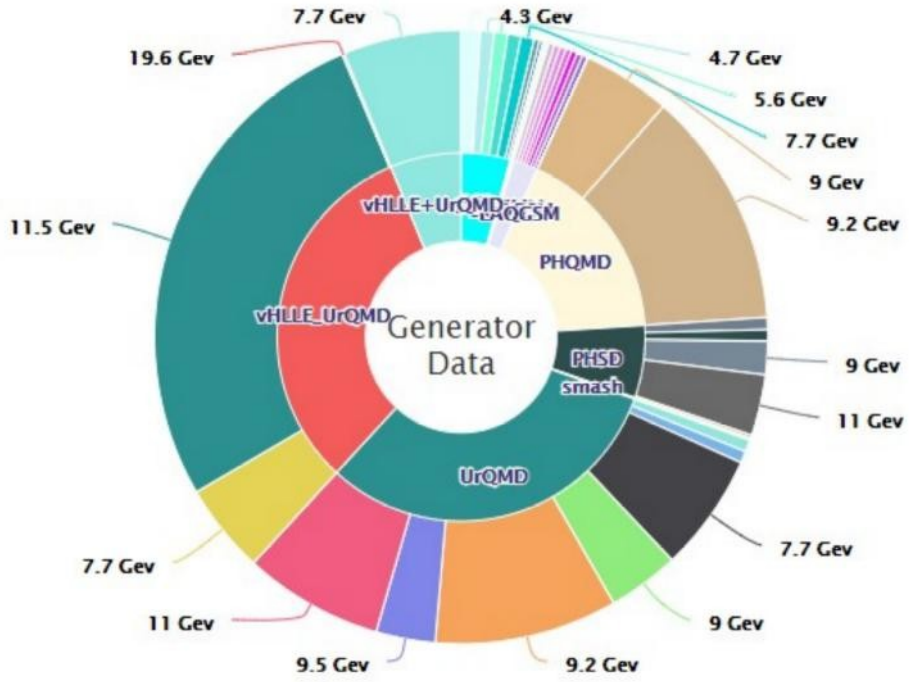
MPD mass production 2019-2022 summary(2):

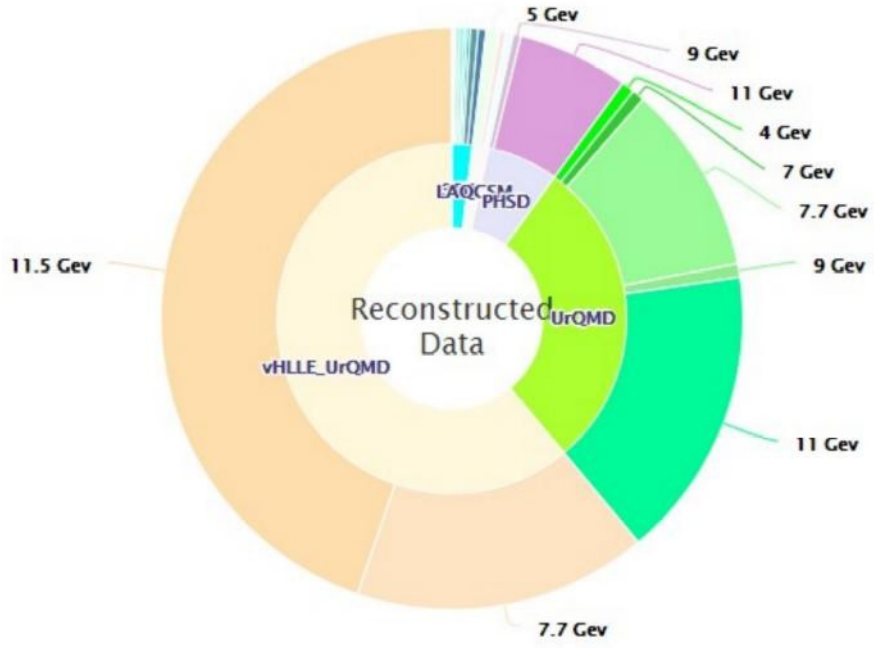
Generator	PWG	Coll.		# of events()	Reco
UrQMD	PWG4	AuAu	11	15	+
		BiBi	9	10	+
			9.46	10	+
			9.2	95	+
	PWG2	AuAu	11	10	+
	PWG3	AuAu	7.7	10	+
		BiBi	7.7	10	+
			9	15	+
		pp	9	10	+
	PWG1	BiBi	9.2	11(50 underway)	+
DCM-SMM	PWG1	BiBi	9.2	1	+
PHQMD	PWG2	BiBi	8.8	15	+
			9.2	41(+20 underway)	+
			2.4/3.0/4.5	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	10/(15 underway)	+
Total				1198(85 underway)	354(85 underway)

MPD mass production database

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

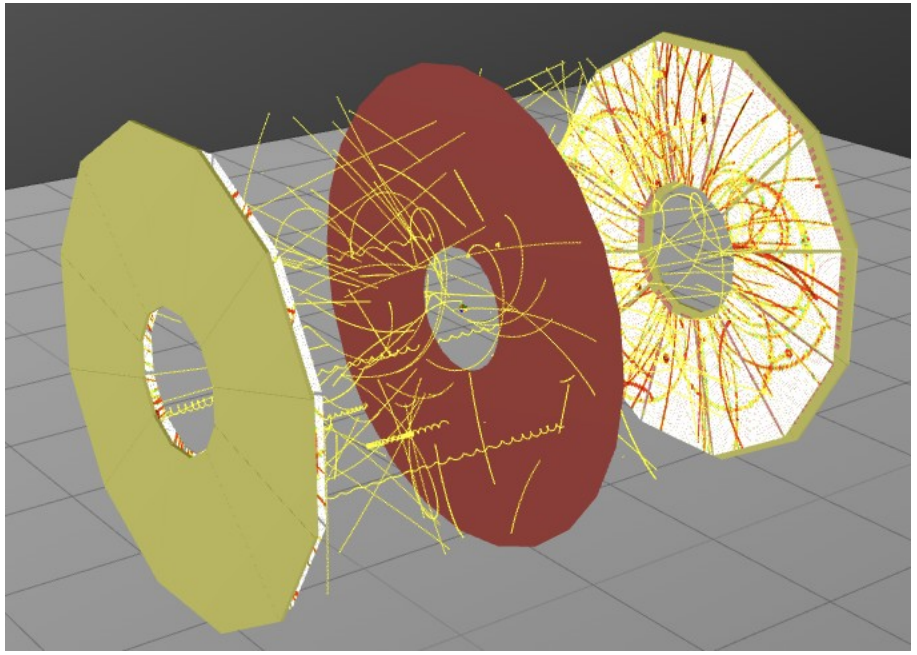
23 mass production requests were done

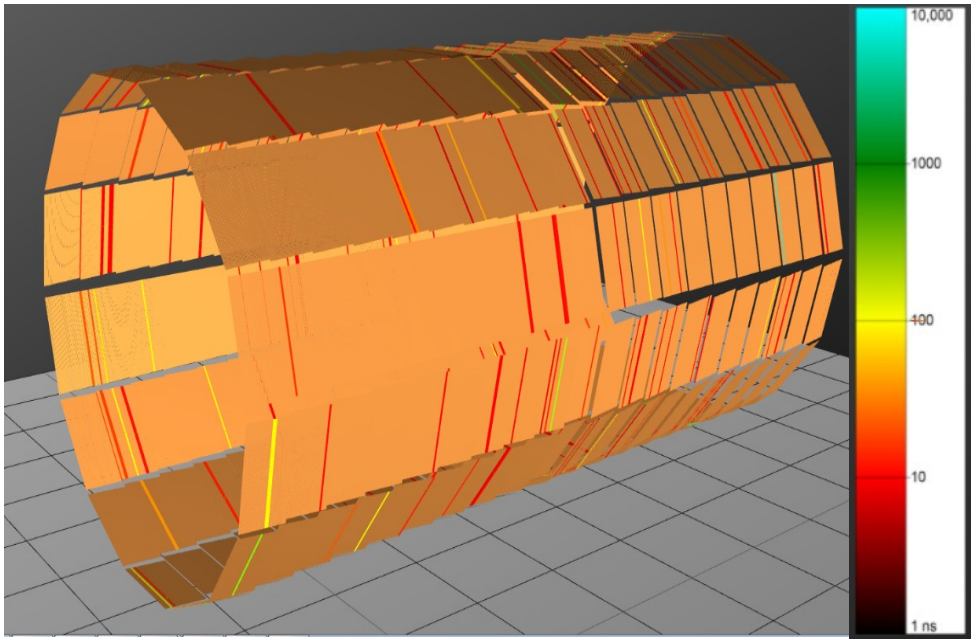


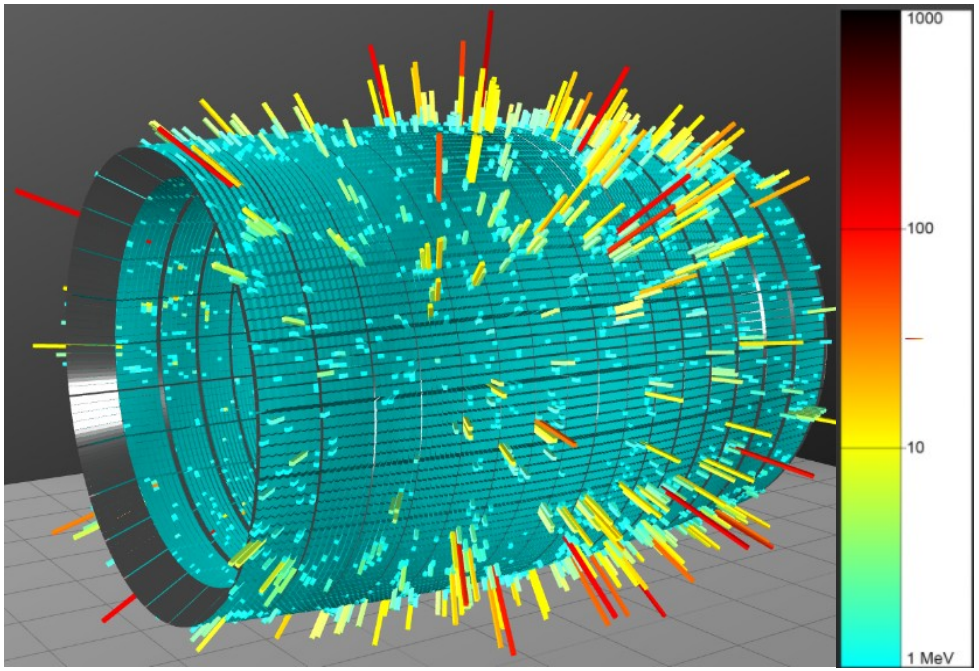


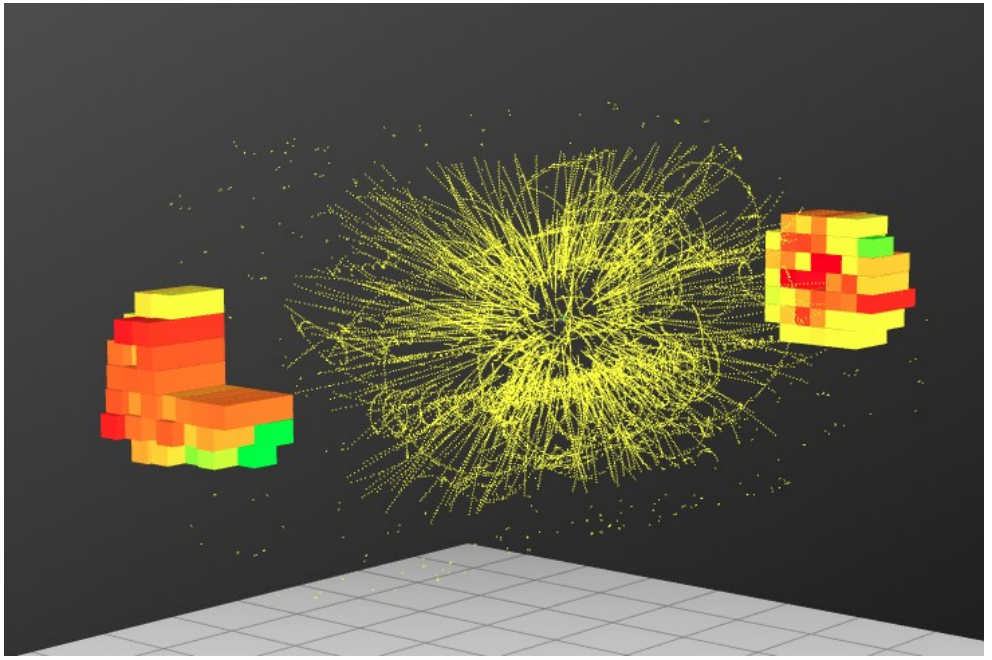
All production data stored in Dirac File Catalog

MPD EventDisplay: TPC



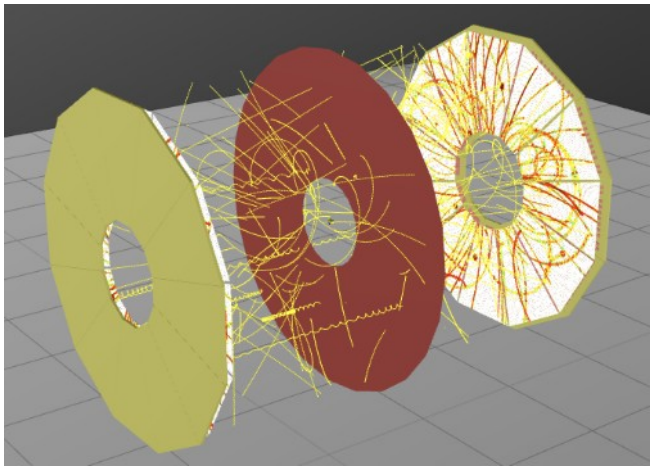






TPC control dashboard

TPC eventdisplay



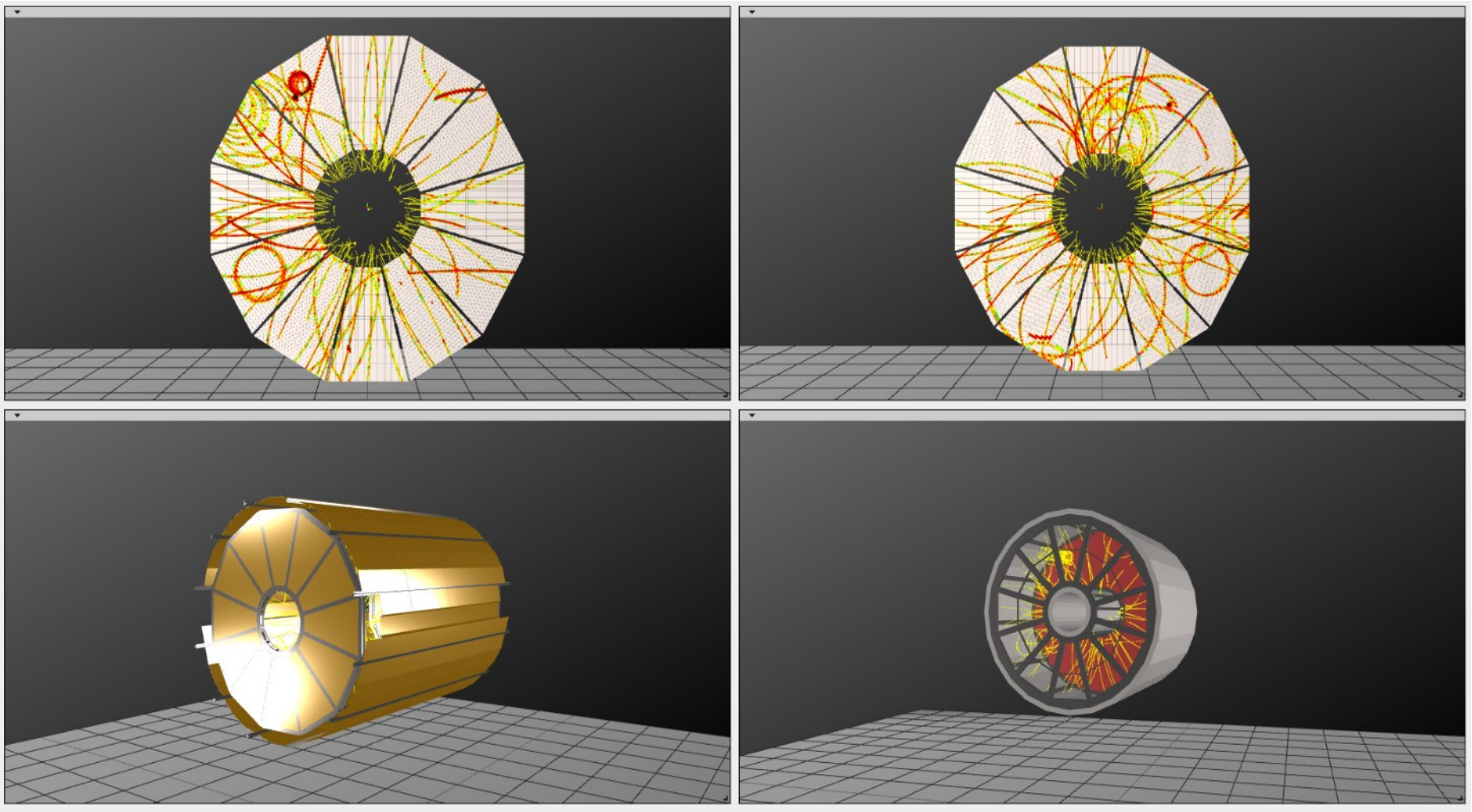
A free open source device-oriented controls toolkit for controlling any kind of hardware or software and building SCADA systems...

TPC control system

TPC online pad planes

West

East



TPC dashboard

TPC sectors time buckets

HEP physics & computing

The further we go,
The further you go

Thanks for your attention