# ALICE Online/Offline ($O^2$) Processing Overview

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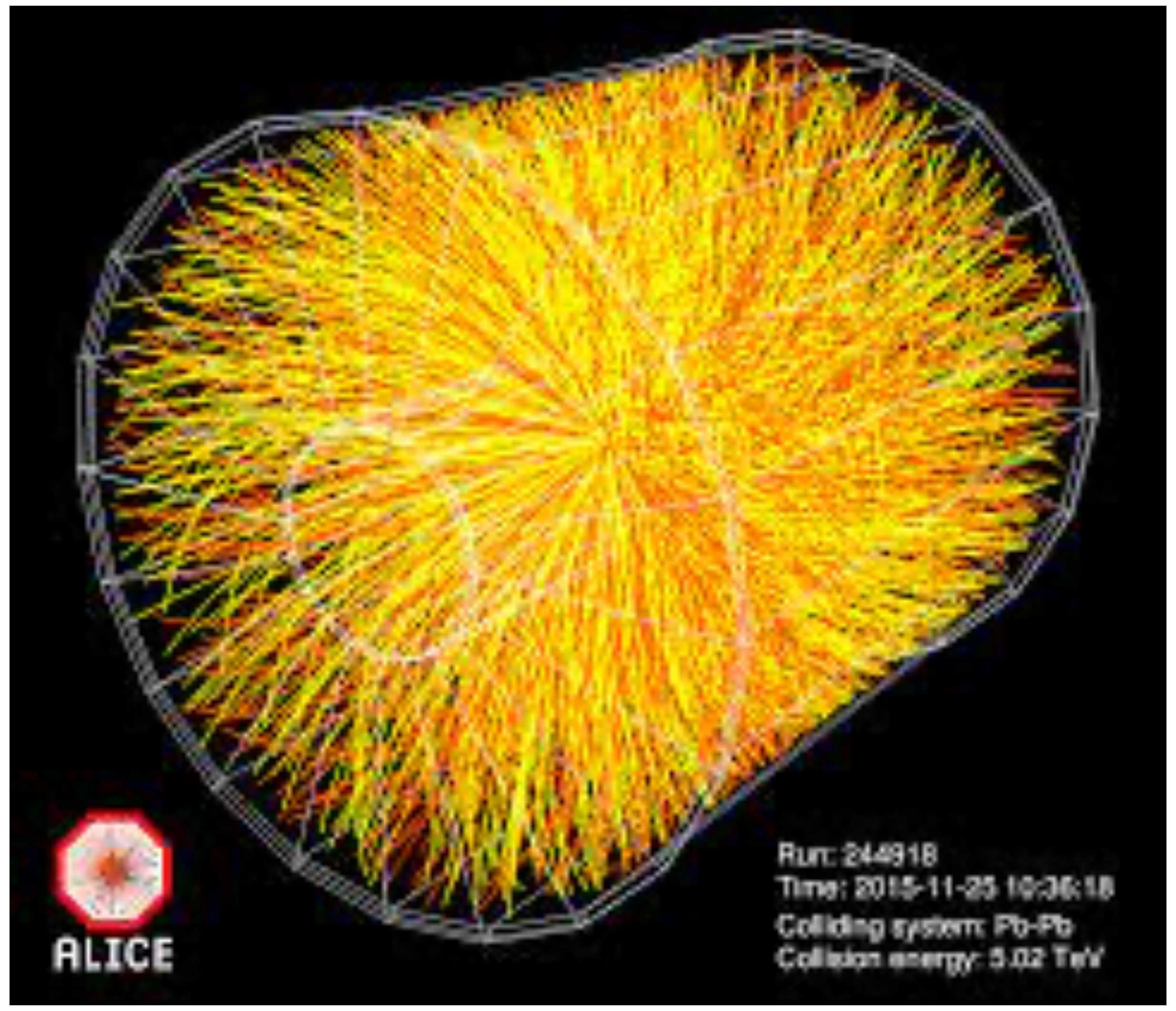
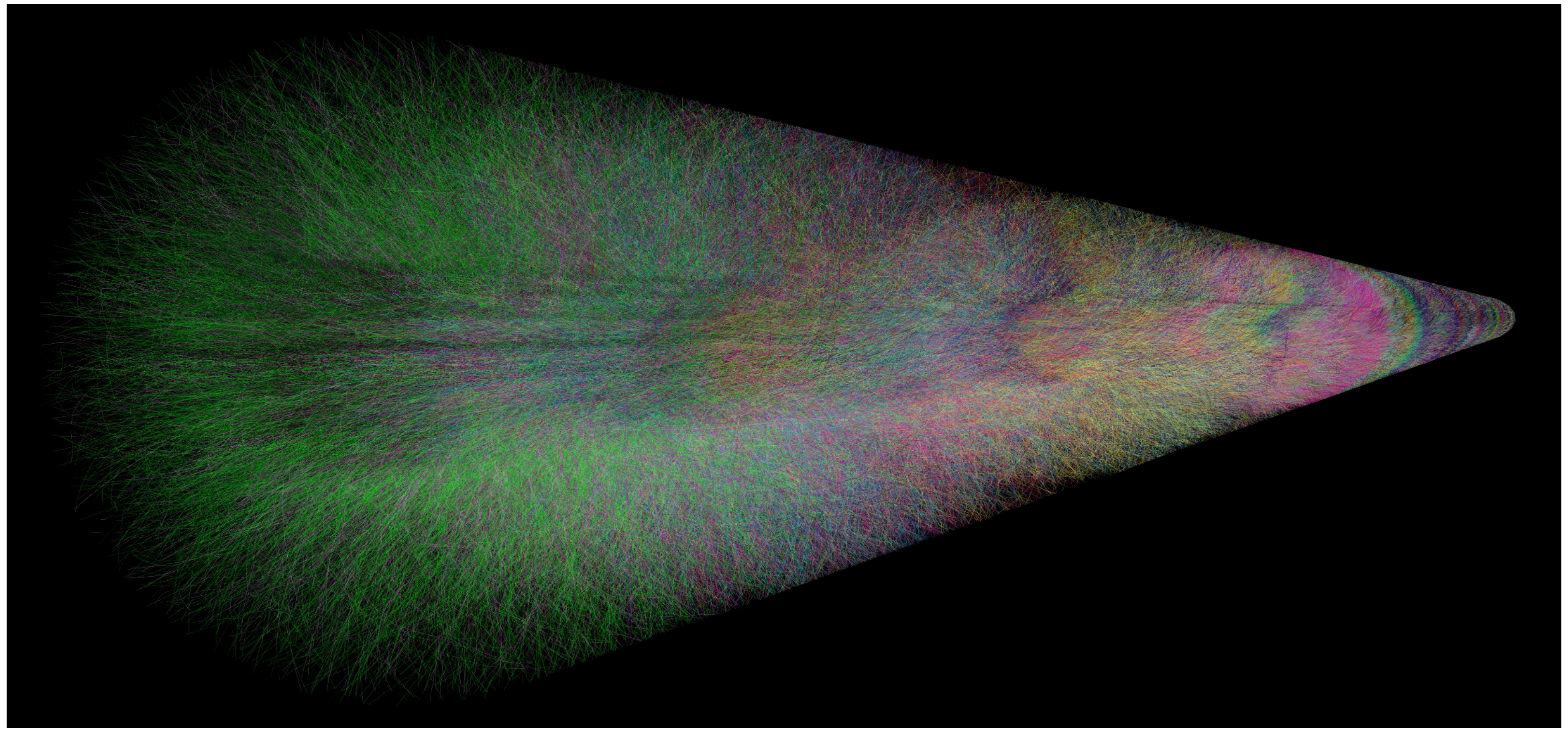
**CERN**

# Computing Challenges in Run 3/4

- $\mathcal{O}$(100) Increase of overall data rate and number of events to process
  - Raw data rate from detectors 50 kHz Pb-Pb, 3.5 TB/s
  - Dominated by the Time Projection Chamber (TPC)
- Continuous readout of majority of detectors




Run 2: Single Pb-Pb Event



Run 3: 1/5 of a Time Frame (~10 ms)

500 Pb-Pb collisions / TF

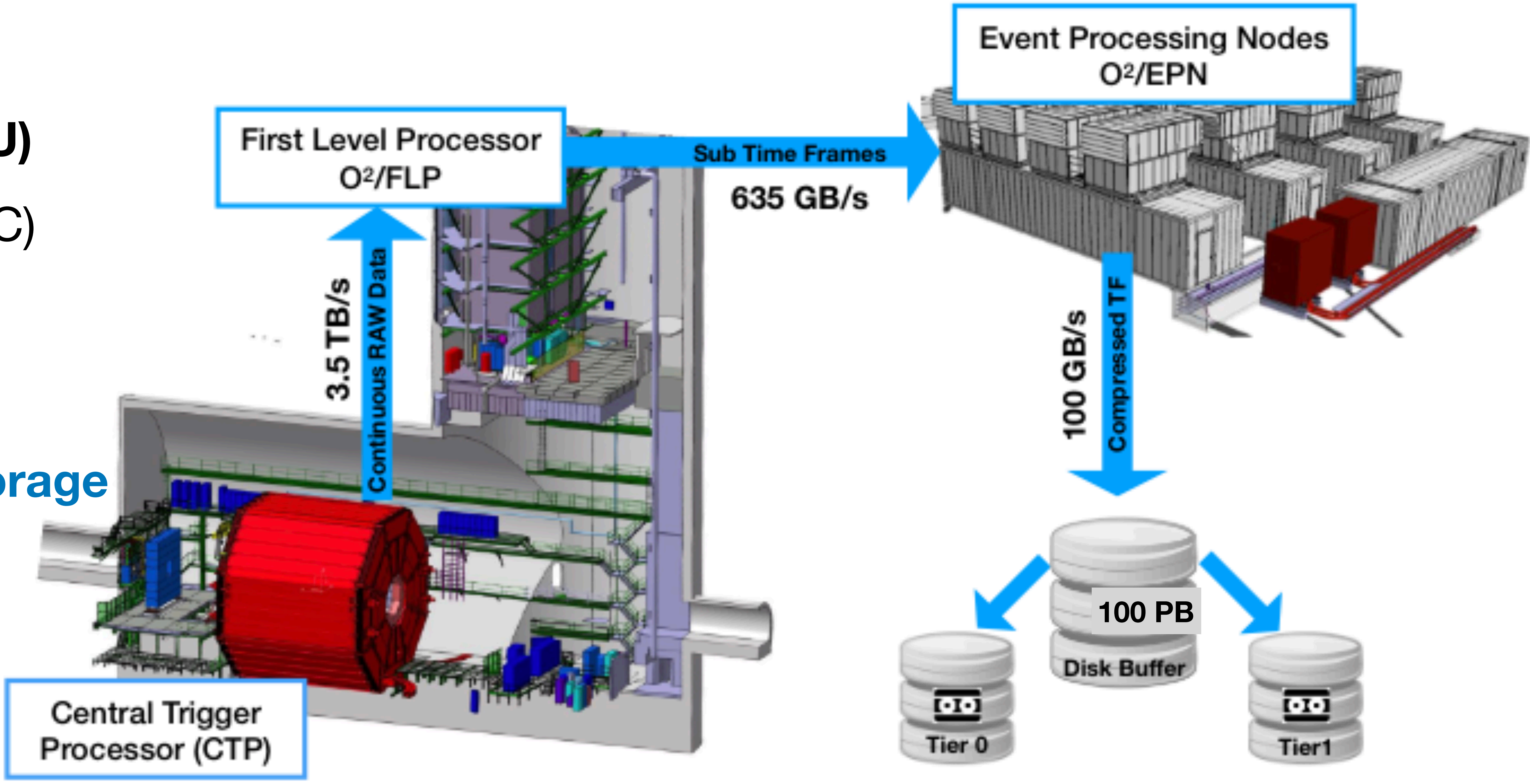
~5 events overlapping in TPC drift time

# $O^2$ Online (Synchronous) Processing

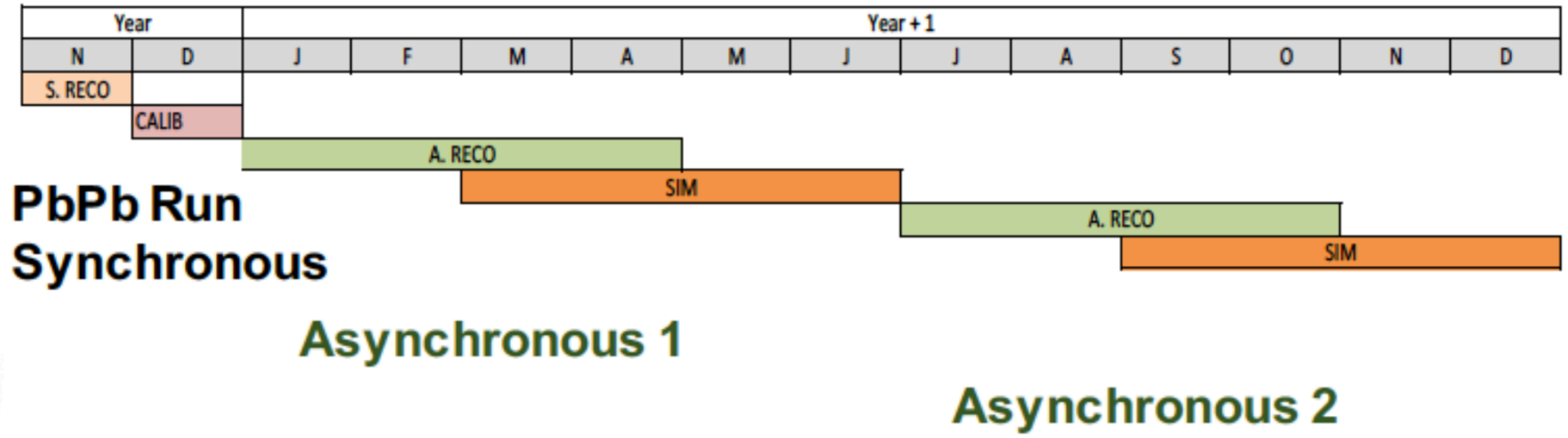
PDP

## Minimize storage costs and computing time

- **$O^2$ system designed for max. reduction of data volume synchronous with data taking**
- Achieved in two processing steps on two types of computing nodes
  - **First Level Processing (FLP) (-> next talk)**
    - data compression by 0-suppression
    - first calibration tasks
  - **Event Processing Nodes (EPN / CPU + GPU)**
    - first pass online reconstruction (mainly TPC)
    - extraction of calibration objects
    - data reduction and compression
- **Networking (Grid, Tier0 Storage) and Data Storage**
- **Condition and Calibration Data Base**

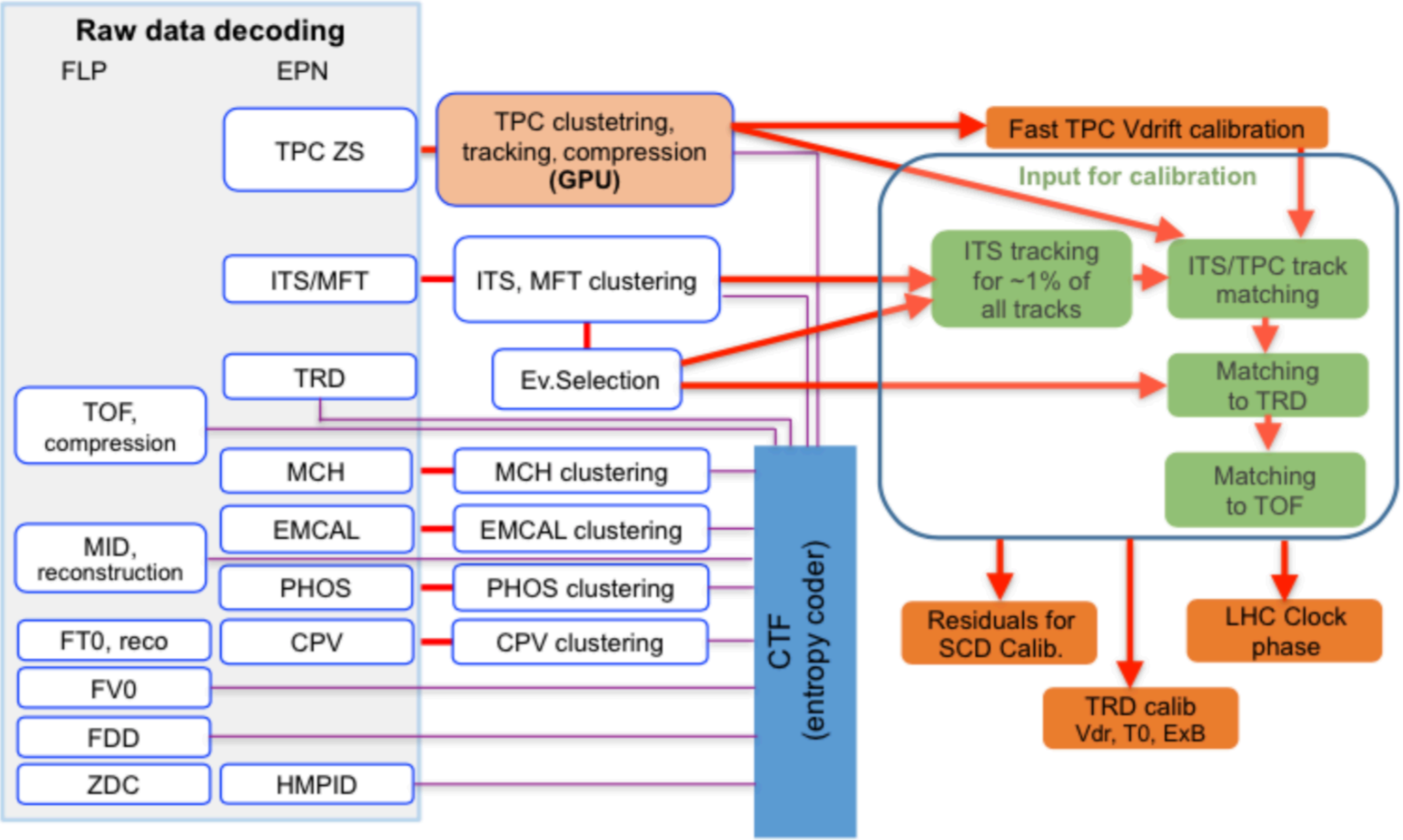


# $O^2$ Offline (Asynchronous) Processing




- Creation of Calibration Objects (short calibration run)
- Synchronous processing followed by 2 asynchronous reconstruction passes on GRID and EPN
  - Full calibration and reconstruction
  - Output stores as Analysis Object Data (AOD)
  - Input for Analysis
- **Monte Carlo production cycles** (taking into account the time dependent detector conditions)
- **Data Analysis**
  - 10% of data copied to dedicated Analysis Facilities
  - fast turnaround for task validation and cut tuning
- **Further data reduction for specific analysis**
  - filtering of interesting events and retaining only information strictly needed for analysis

# Synchronous Reconstruction

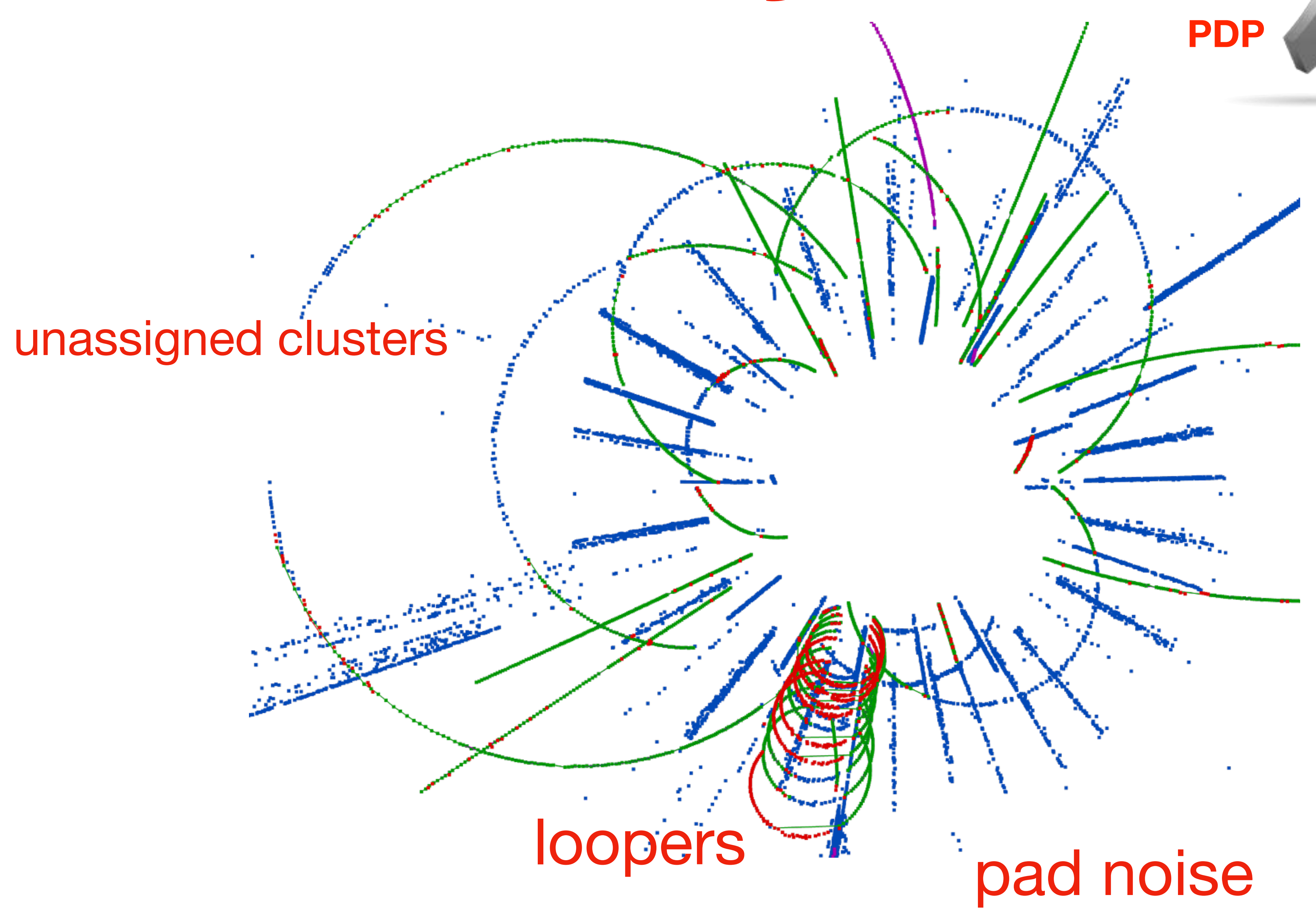


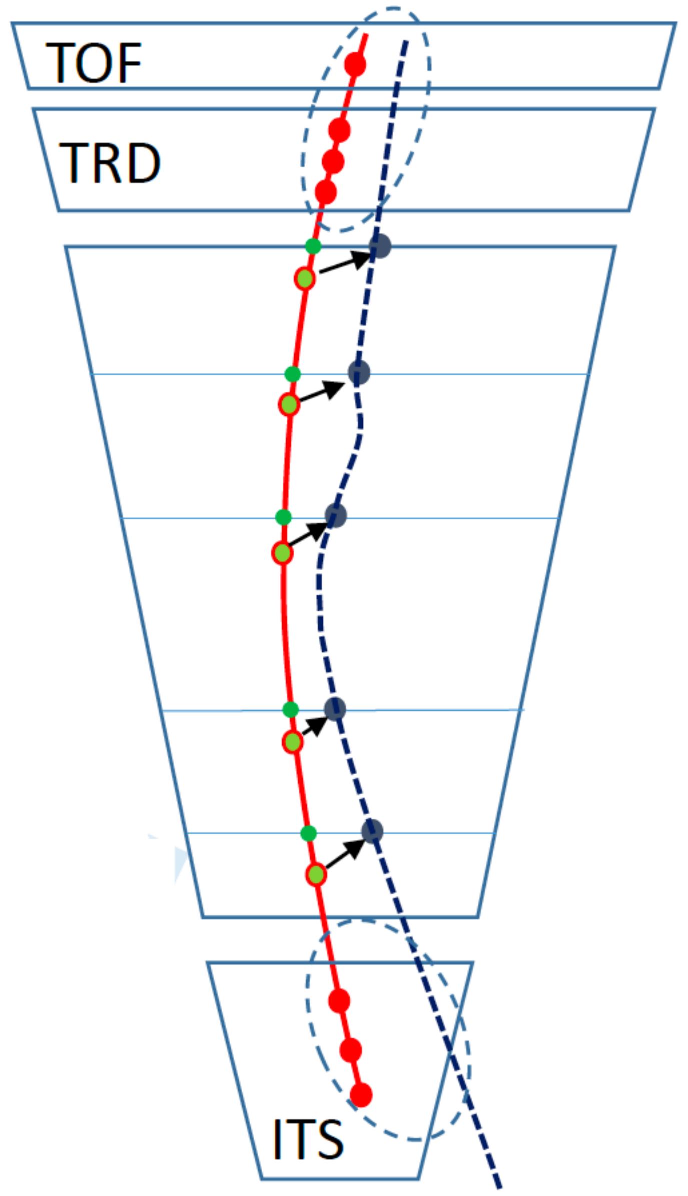
# TPC Data Reduction and Calibration Objects

PDP

- **Data Reduction**
- Reconstruct TPC Tracks
- Remove Clusters not needed for physics
    - Option A: identified background clusters
    - Option B: all clusters outside tracks used for physics analysis
- Entropy Encoding of remaining clusters rel. to track

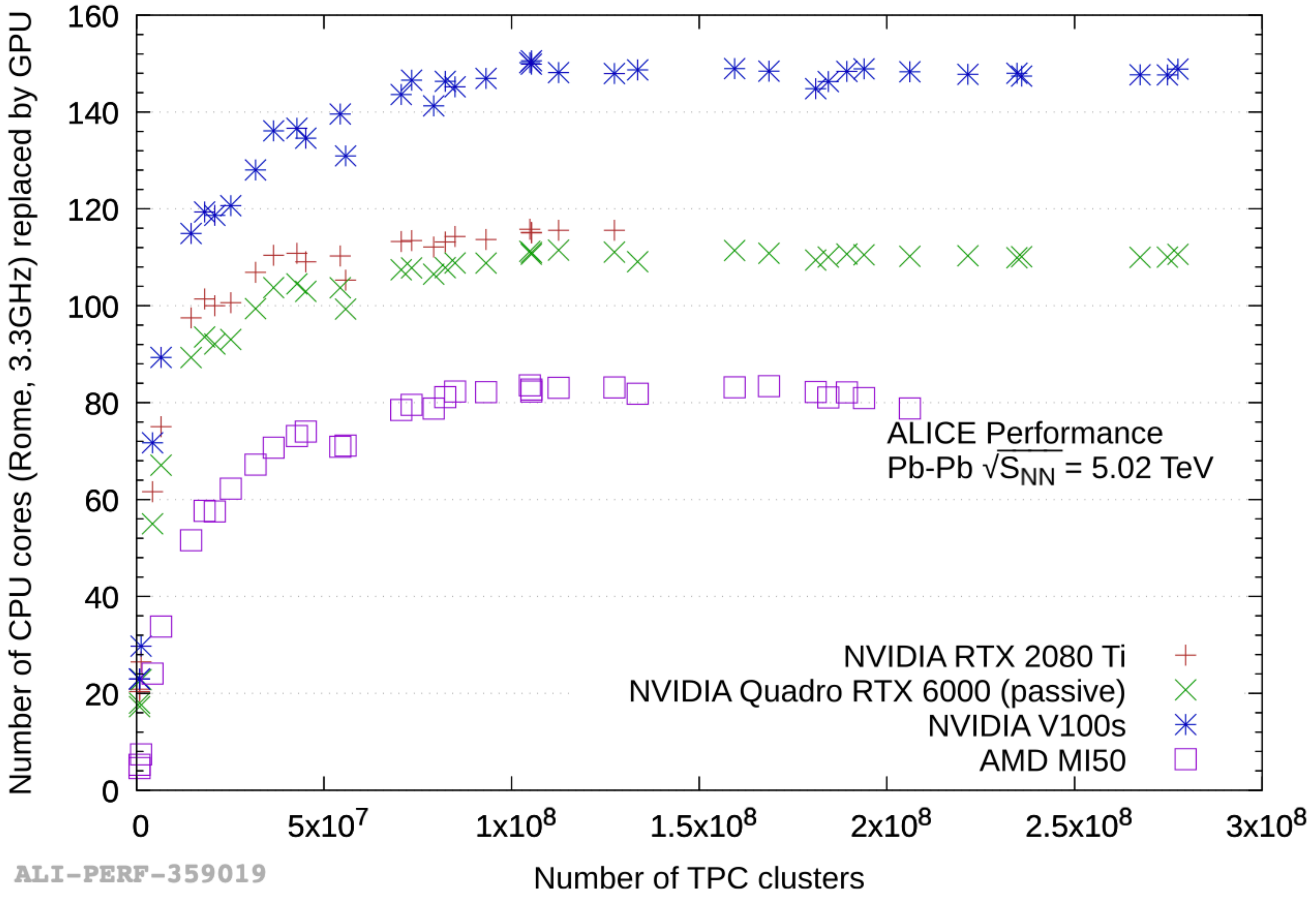
- **Spatial Distortion Calibration**
    - Global Track Reconstruction for small subset of events



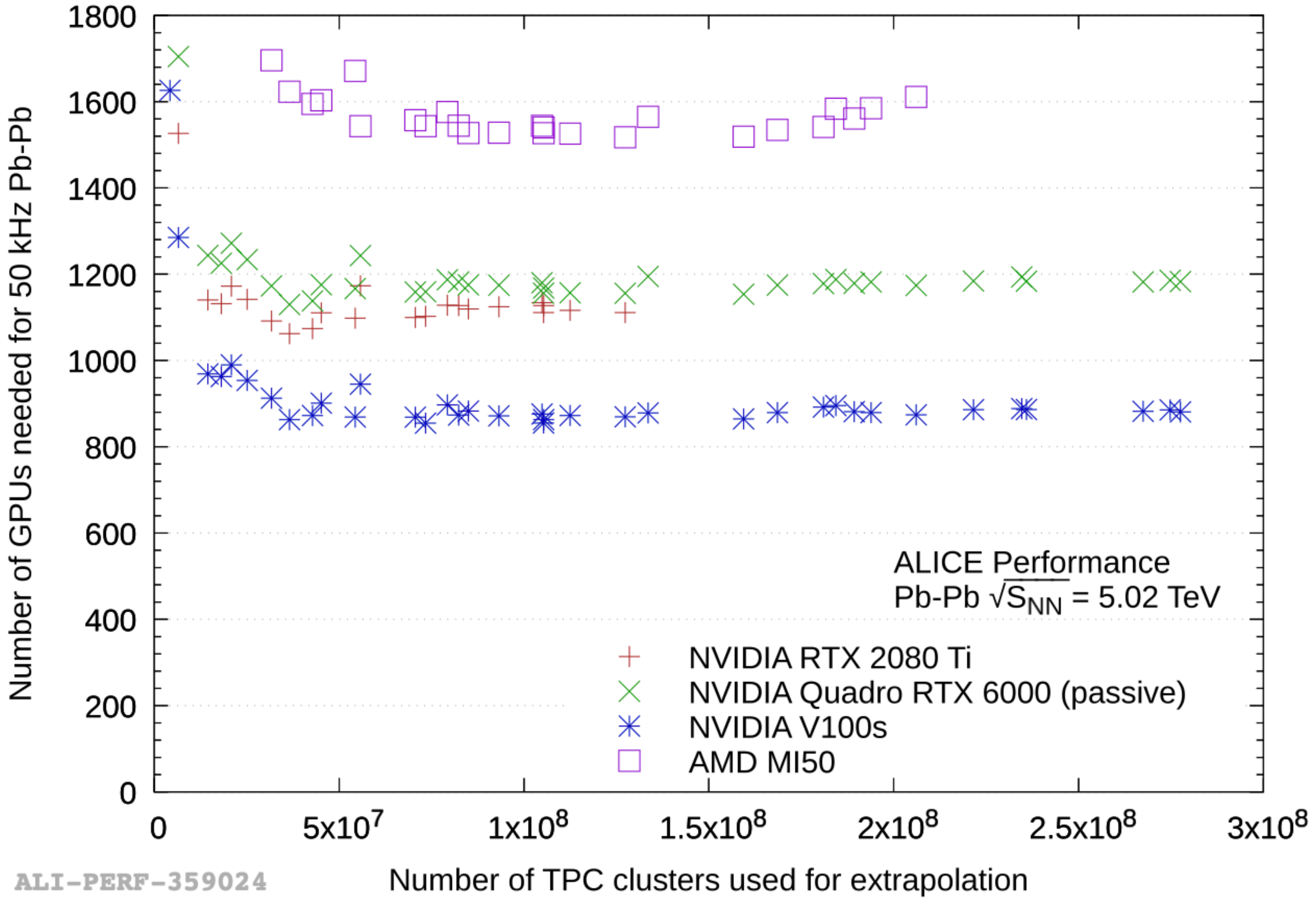



# TPC Reconstruction on GPUs

## 1 GPU = 80-150 CPU cores

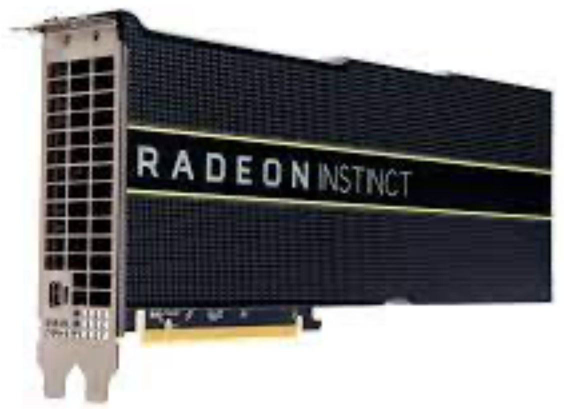



## ~1600 AMD MI50 needed to reconstruct Pb-Pb at 50 kHz




EPN server (1/250)

250 x

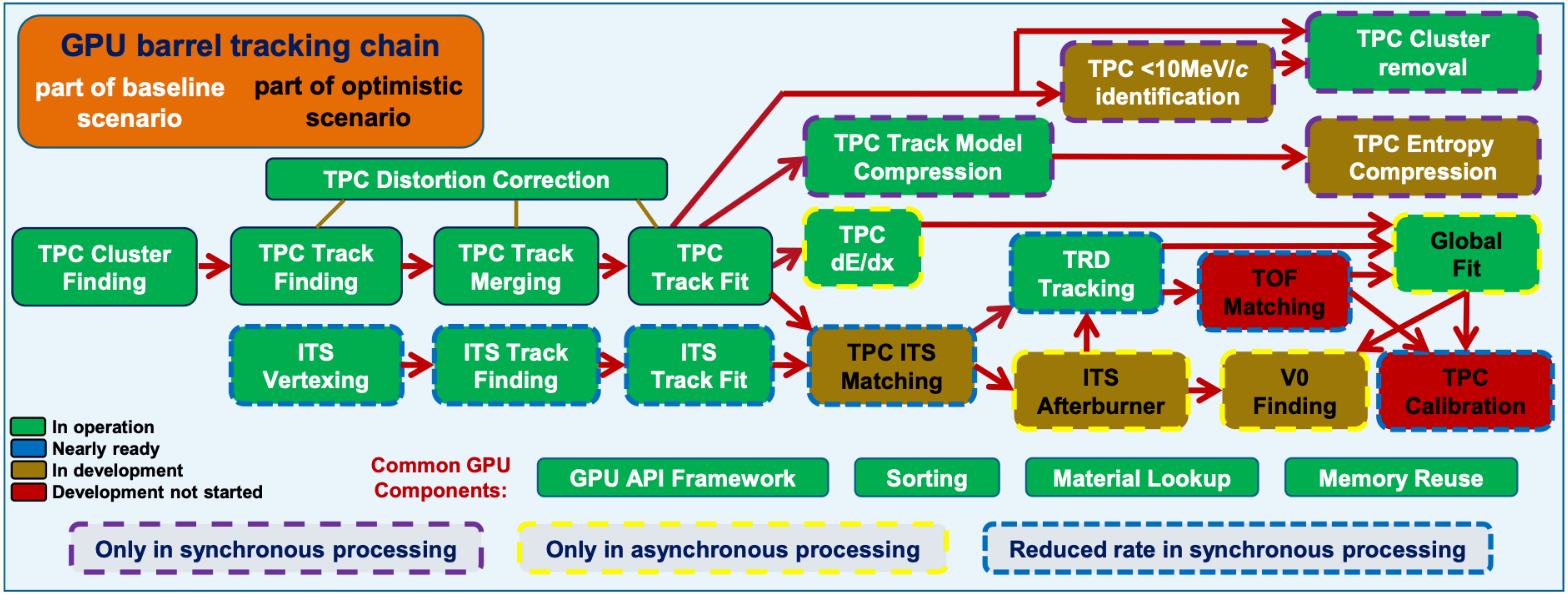

x 8


2x32 cores

CR0 EPN computing center at Point 2

# Overview Barrel Tracking Chain on GPU

Baseline scenario: synchronous TPC reconstruction on the GPU ✓

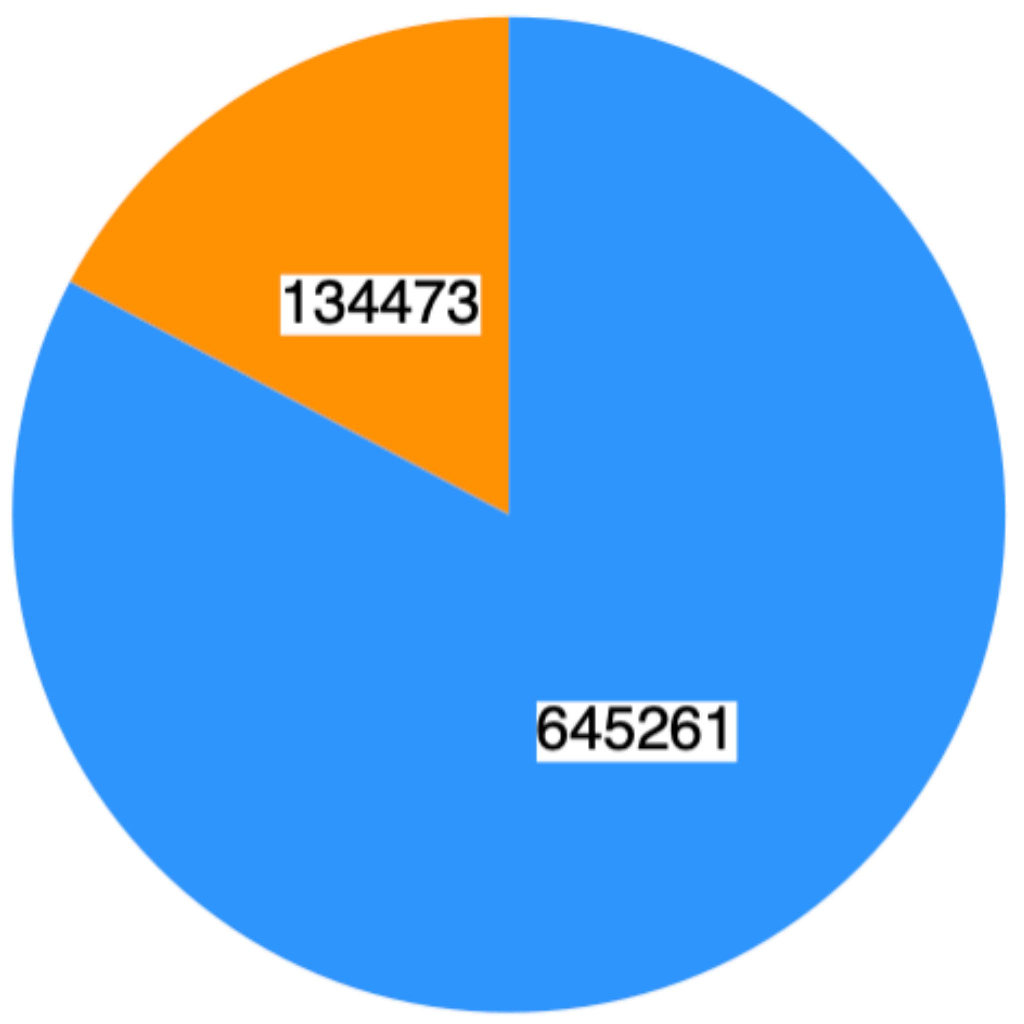



- Work to offload more tasks to GPU in **asynchronous reconstruction** ongoing.
- Efficient use of EPN Farm for Synchronous Reconstruction

# New Software Framework

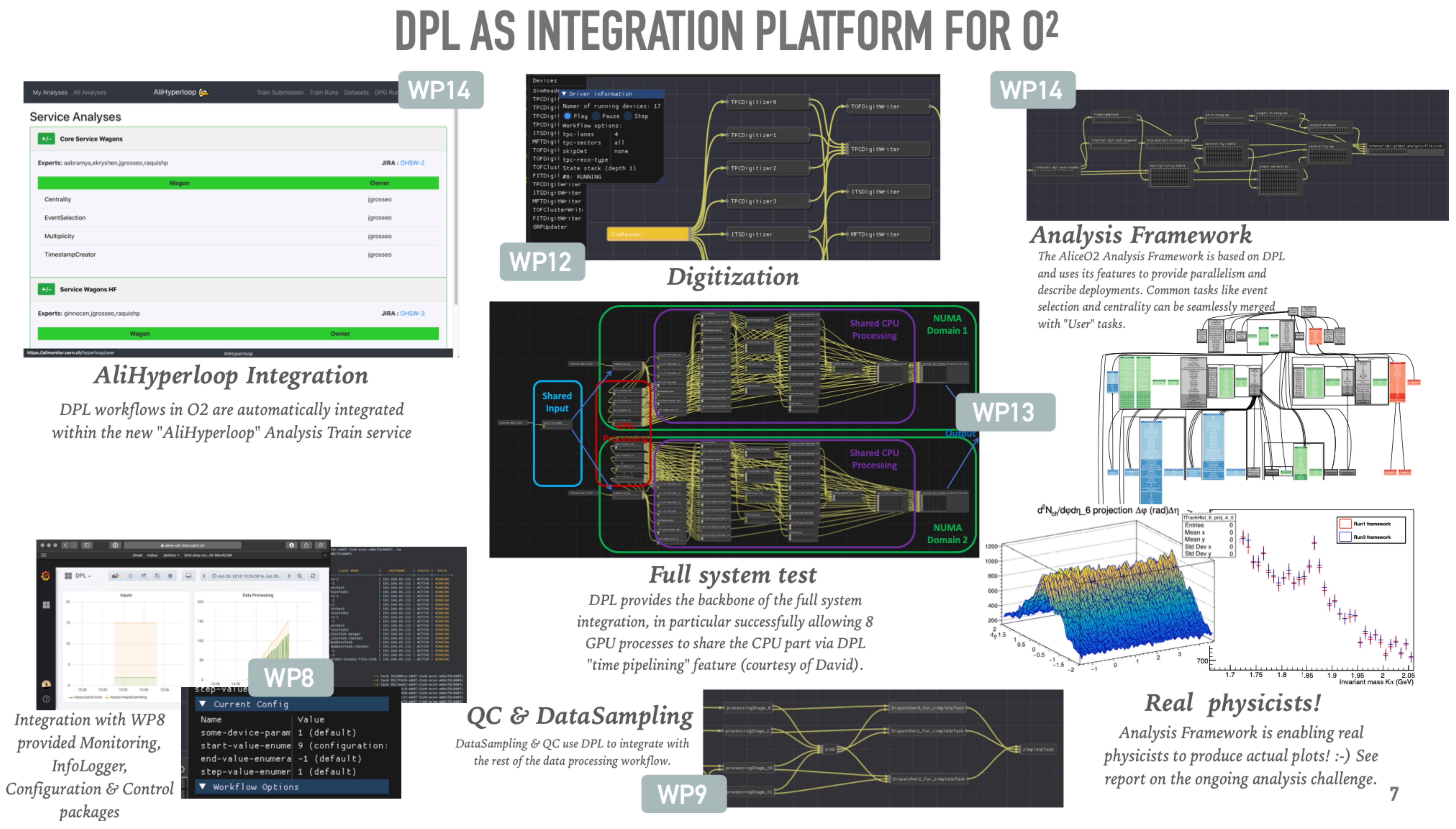
- **Transport Layer for Efficient Parallelism**
- **Data Model**
- **Data Processing Layer (DPL)**

Abstracts computation as a set of data processors organized in a logical data flow.




■ Shared with FAIR (17.2%) ■ O2 Project (82.8%)

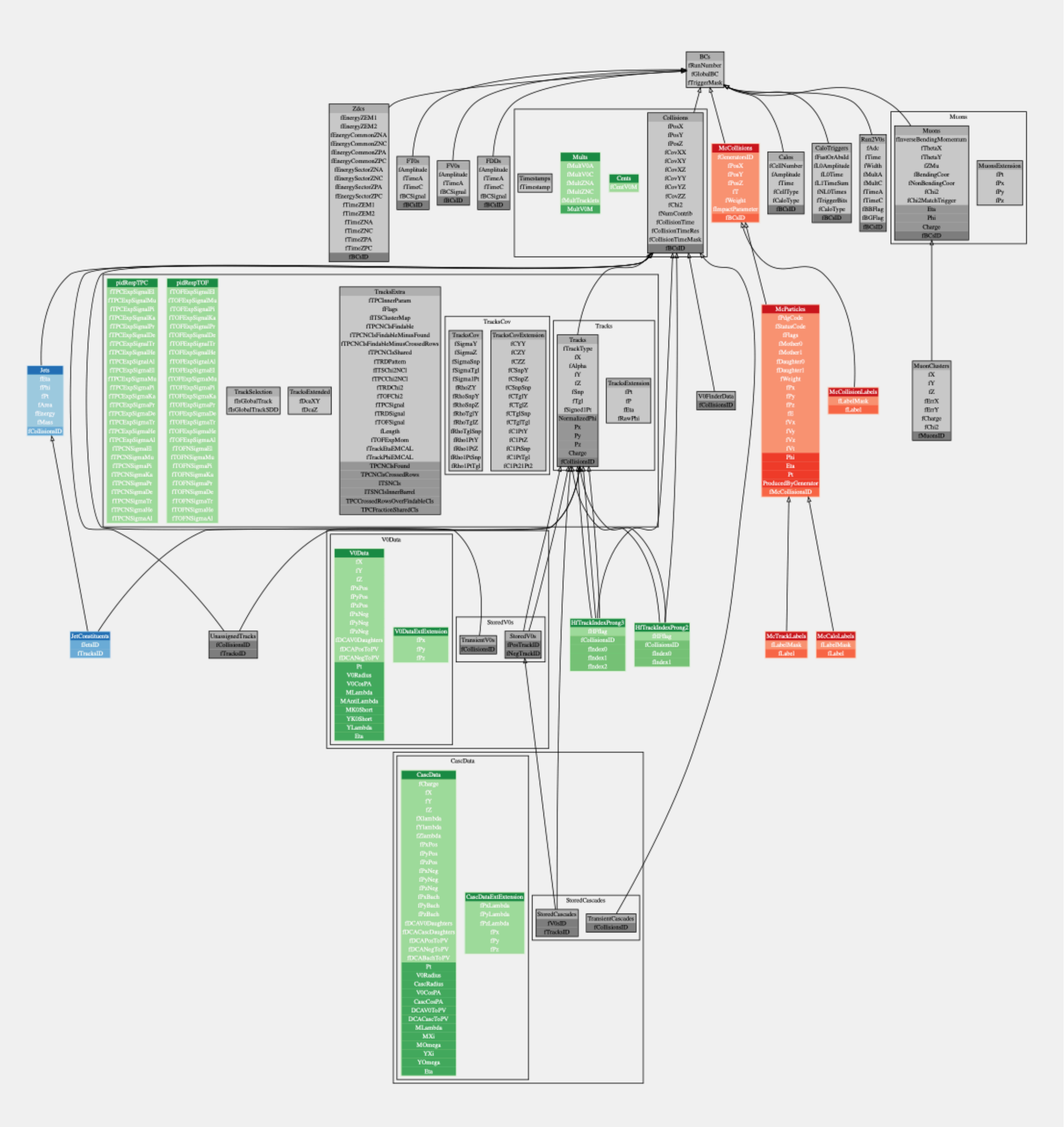
*November 2020*



# New Analysis Framework

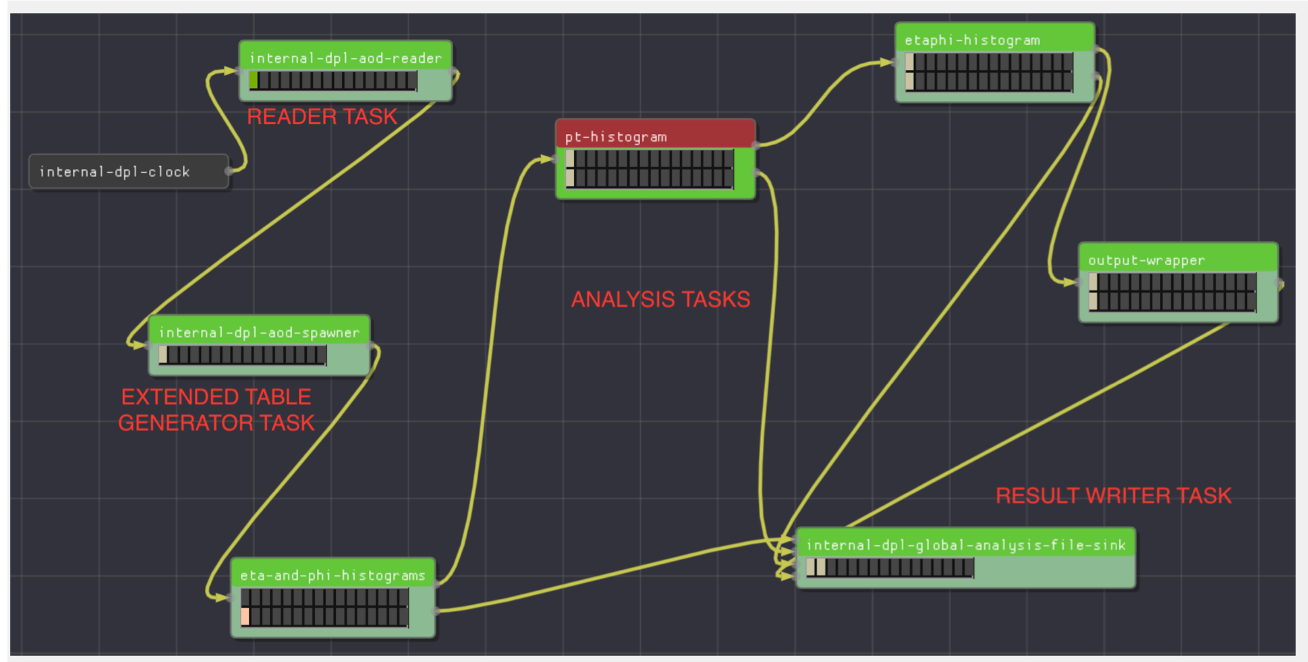
## Increases event throughput ....

### Data Model



Interconnected Tables

### Parallelism




Workflow as collection of

Interconnected tasks.

### Declarative Analysis

Define filter on $p_T$

```
float ptlow = 0.5f;
float ptup = 2.0f;
Filter ptFilter_a = aod::track::pt > ptlow;
Filter ptFilter_b = aod::track::pt < ptup;
```

Define filter on $\eta$

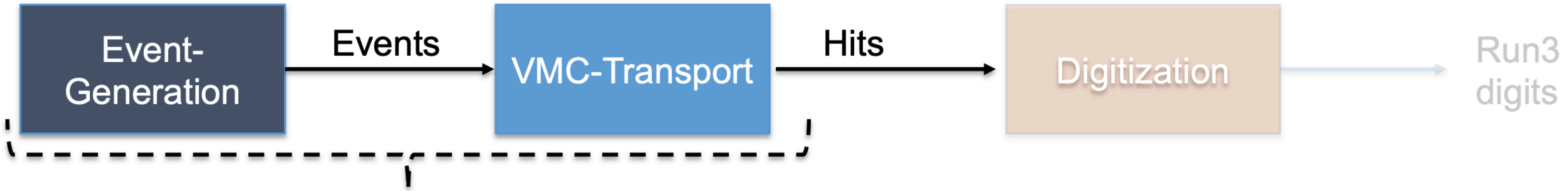
```
float etalow = -1.0f;
float etaup = 1.0f;
Filter etafilter = (aod::track::eta < etaup) && (aod::track::eta > etalow);

void process(aod::Collision const& collision, soa::Filtered<aod::Tracks> const& tracks)
```

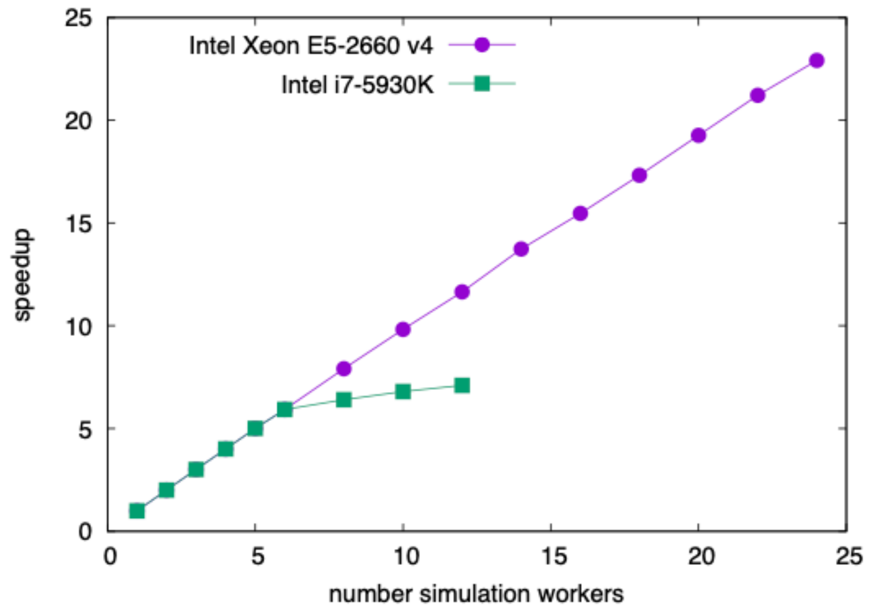
**only contains tracks passing the filter**

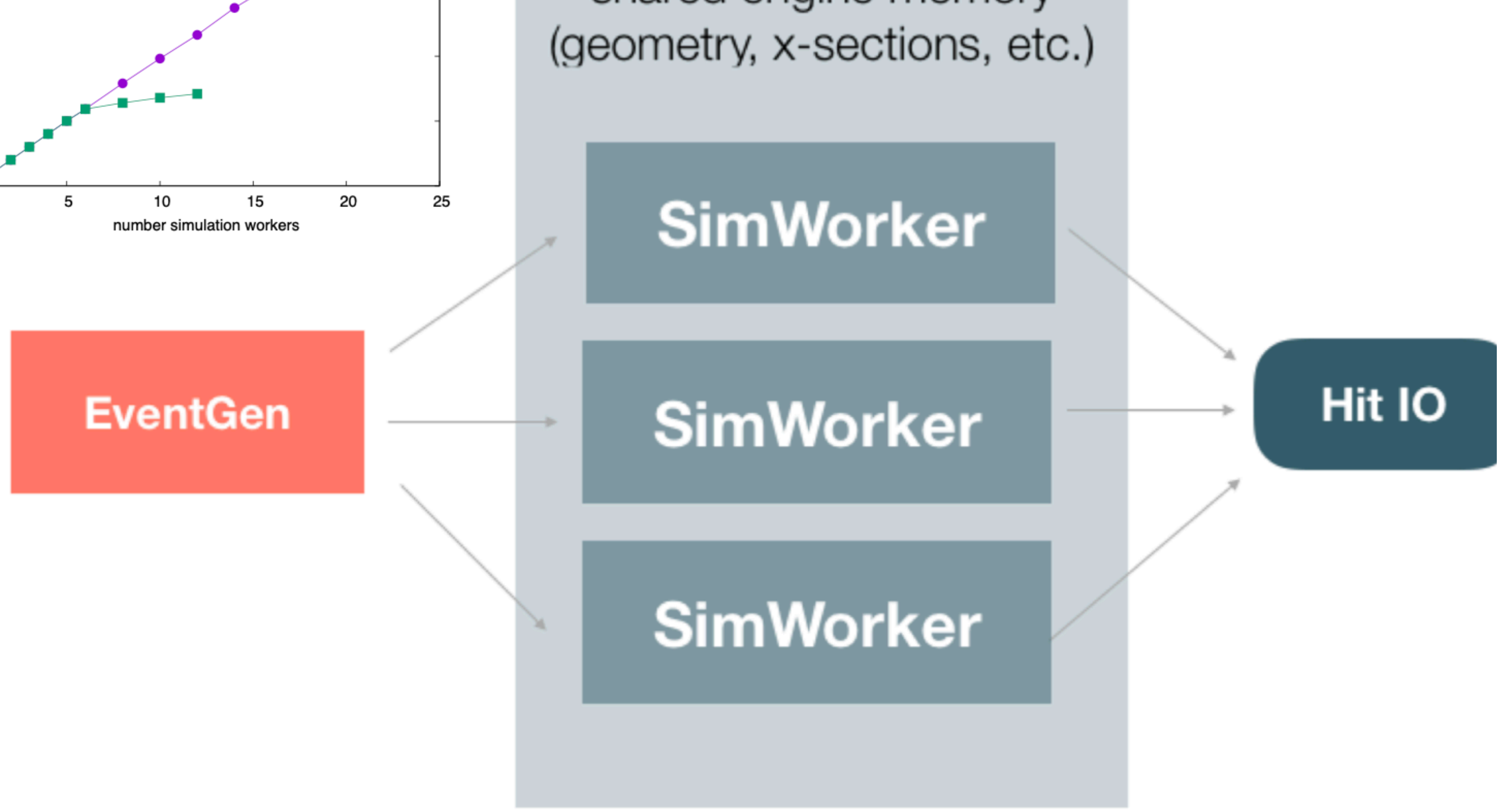
Avoid redundant calculations

- Currently running Analysis Challenge on converted Run2 data
- Soon Data Challenges on Run3 simulated and reconstructed data

# New Simulation Framework




S.Wenzel, talk at CHEP18

## Exploits Parallelism:

- Simulation process divided into individual actors
- Further parallelism achieved through sub-event processing
  - ease of use of opportunistic resources
- Transport code through **VMC** (Geant4, Geant3, FLUKA)

Provides input (fully simulated Time Frame) for reconstruction tests and optimisation.

# PDP Project within ALICE Computing

**S**oftware, Physics **D**ata **P**rocessing and **C**omputing