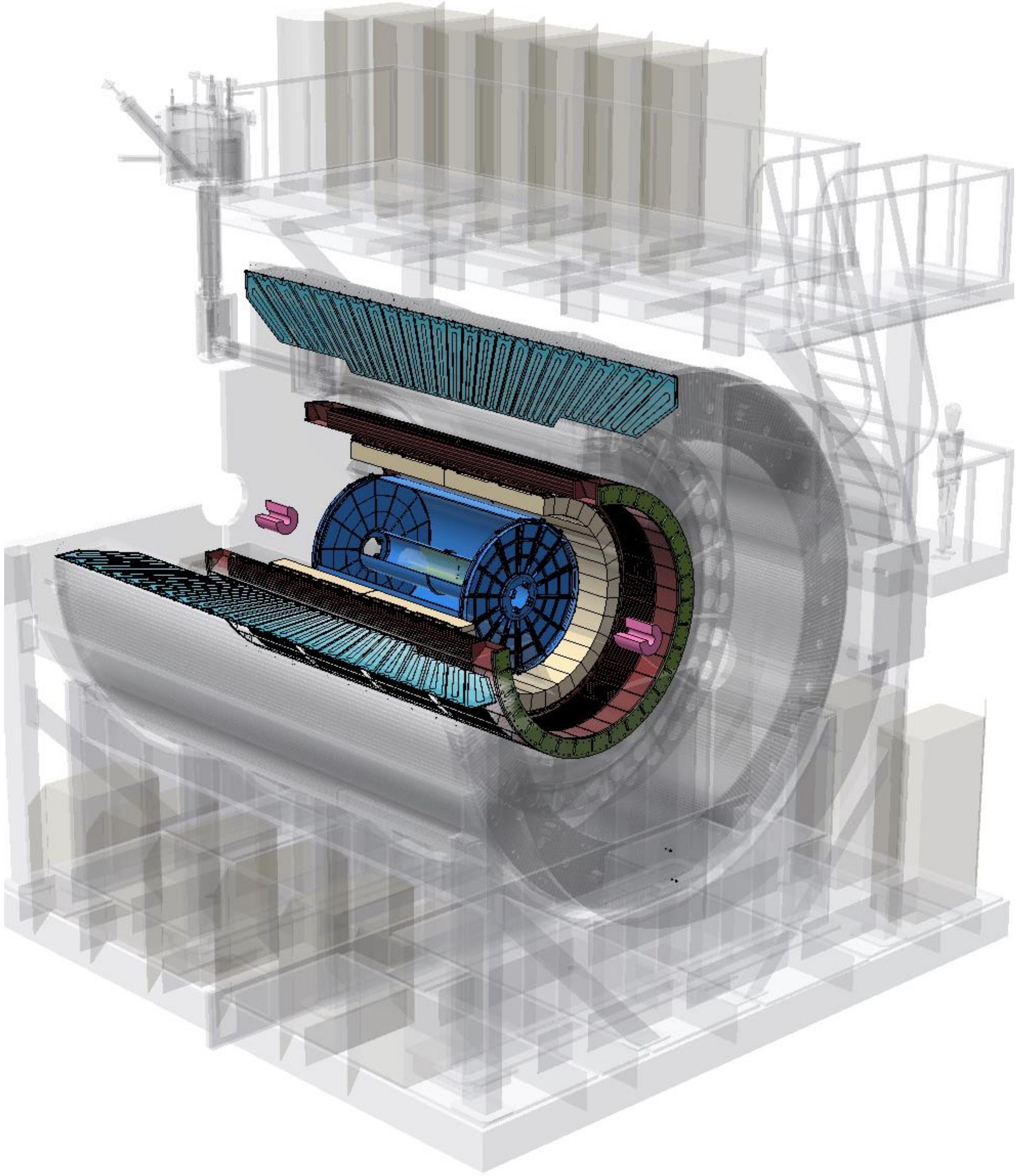
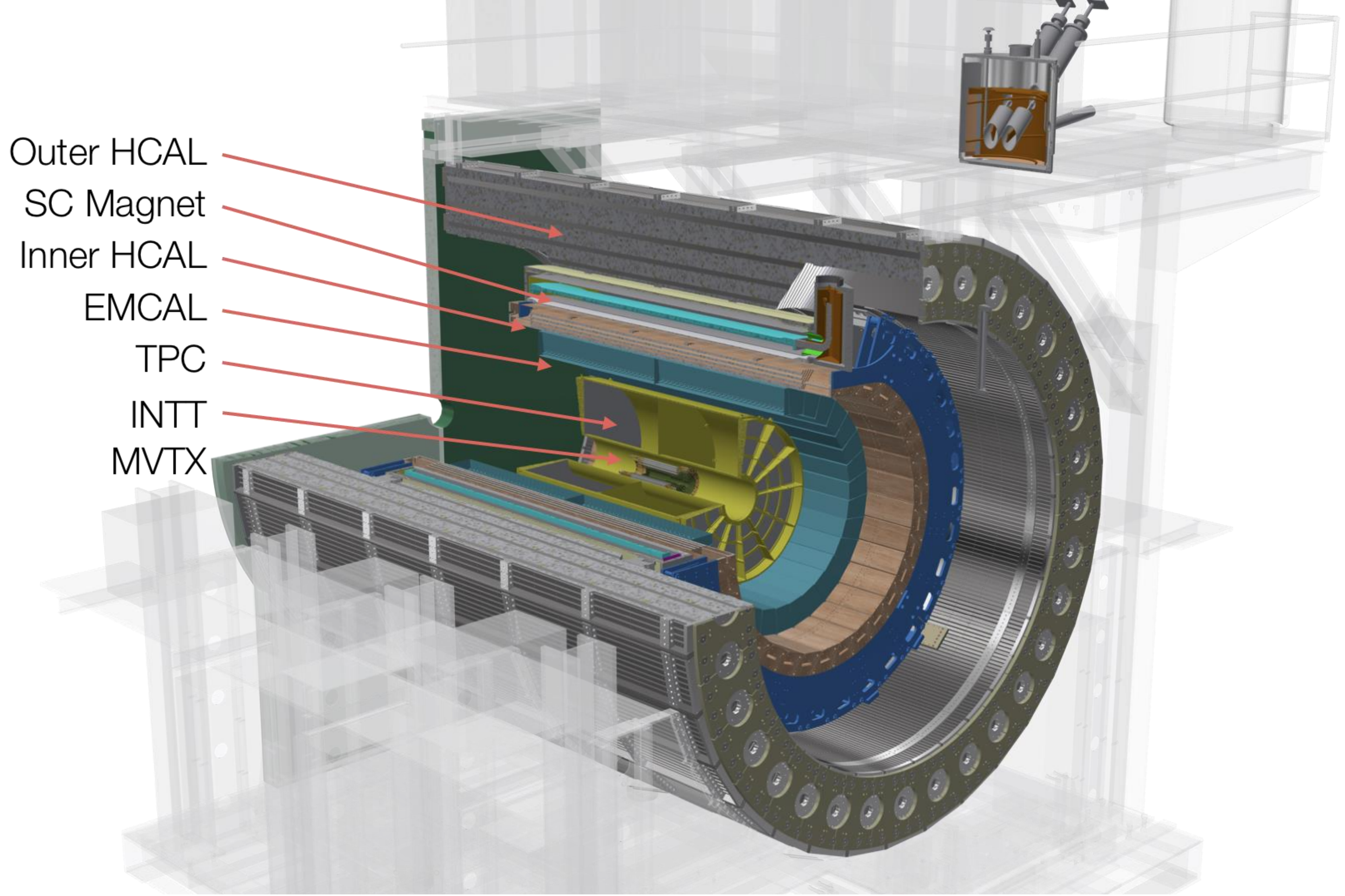


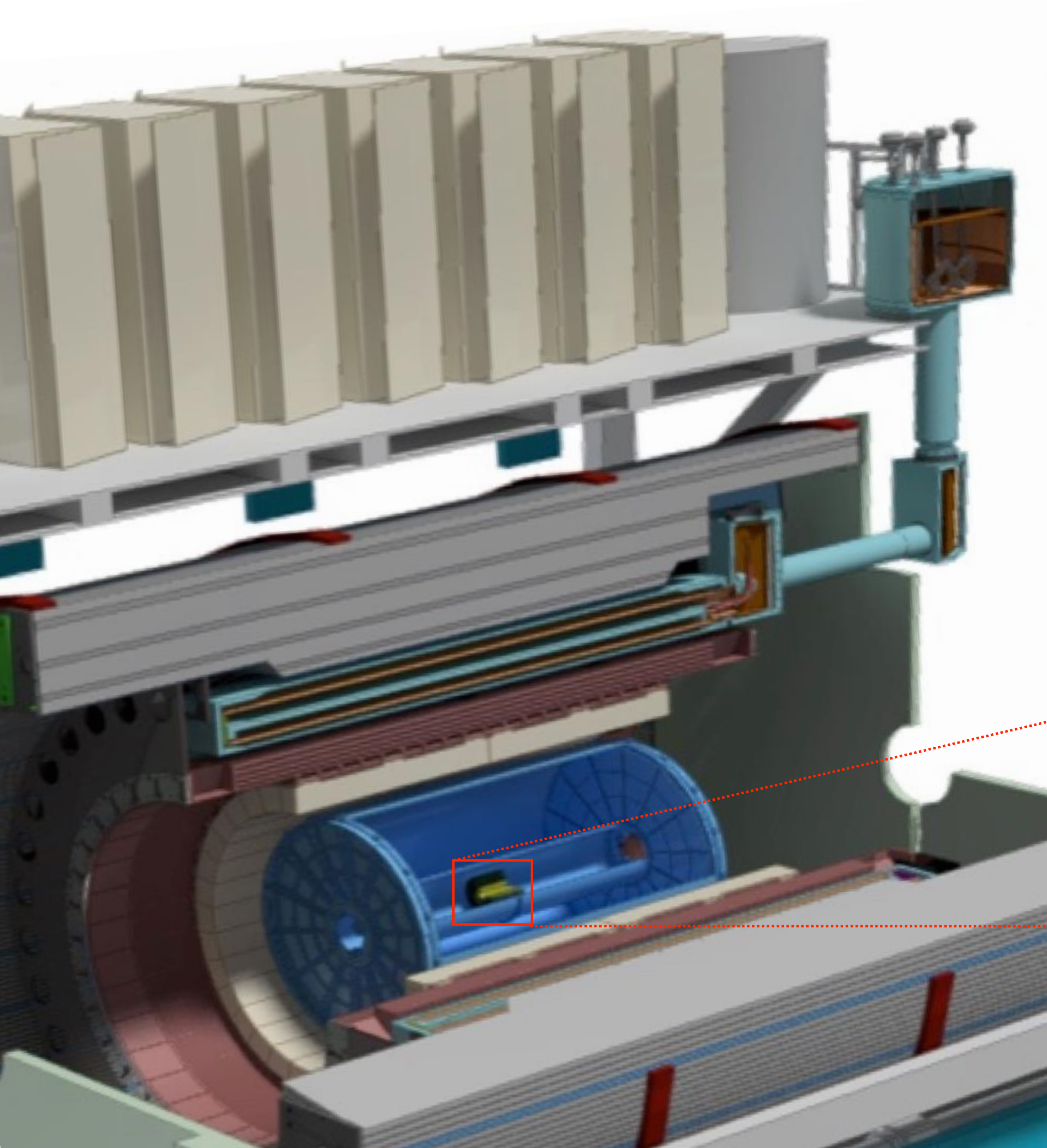
sPHENIX
Computing Needs

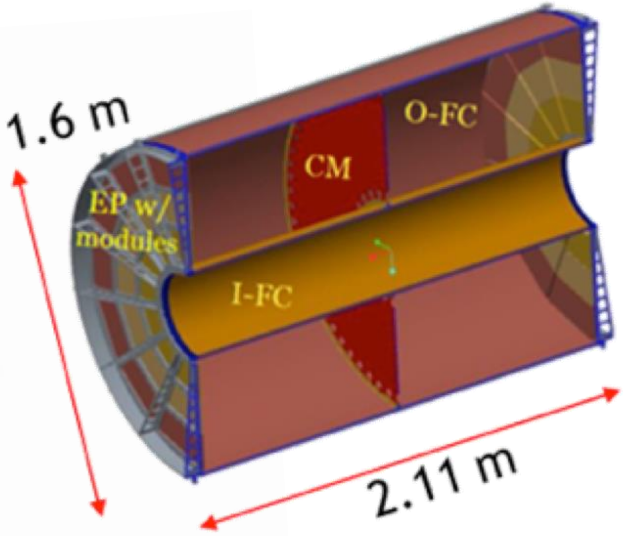


sPHENIX is
A standard collider detector
Coverage |η| < 1.1 (<1 fiducial volume)
Full em and hadronic calorimetry
Full tracking
No PID

Physics Program
Unbiased Jets (calorimetry)
Upsilons (tracking)

sPHENIX tracking detectors



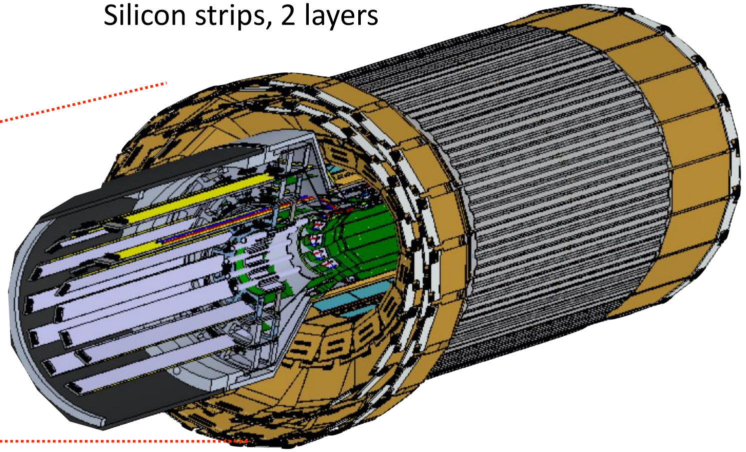


TPC

Continuous readout TPC
SAMPA based front-end card
Quad-GEM readout chambers
Close relation to ALICE TPC

INTT

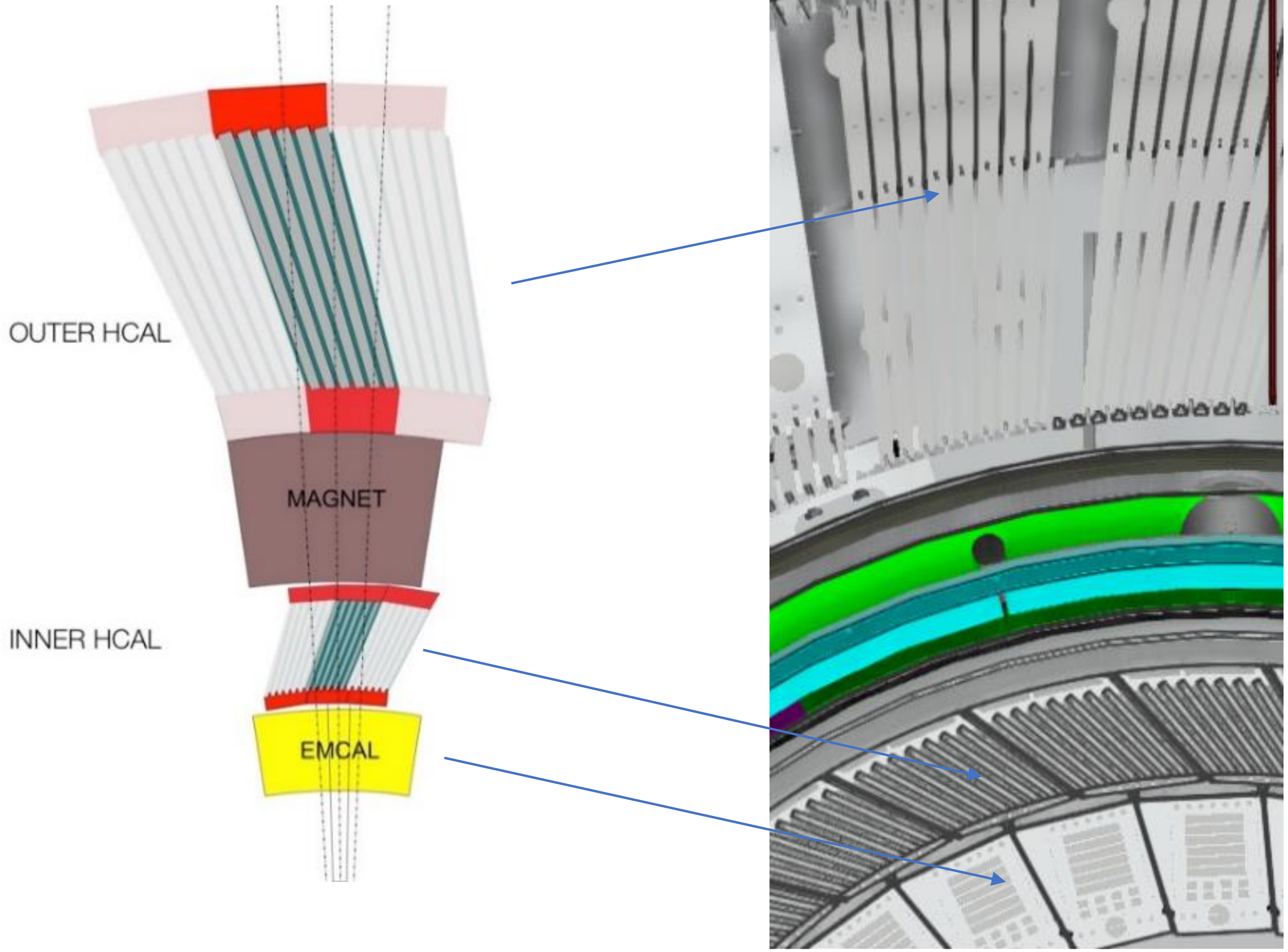
Silicon strips, 2 layers



MVTX

Monolithic Active Pixel Sensors (MAPS),
3 layers, based on ALICE ITS detector

sPHENIX calorimetry

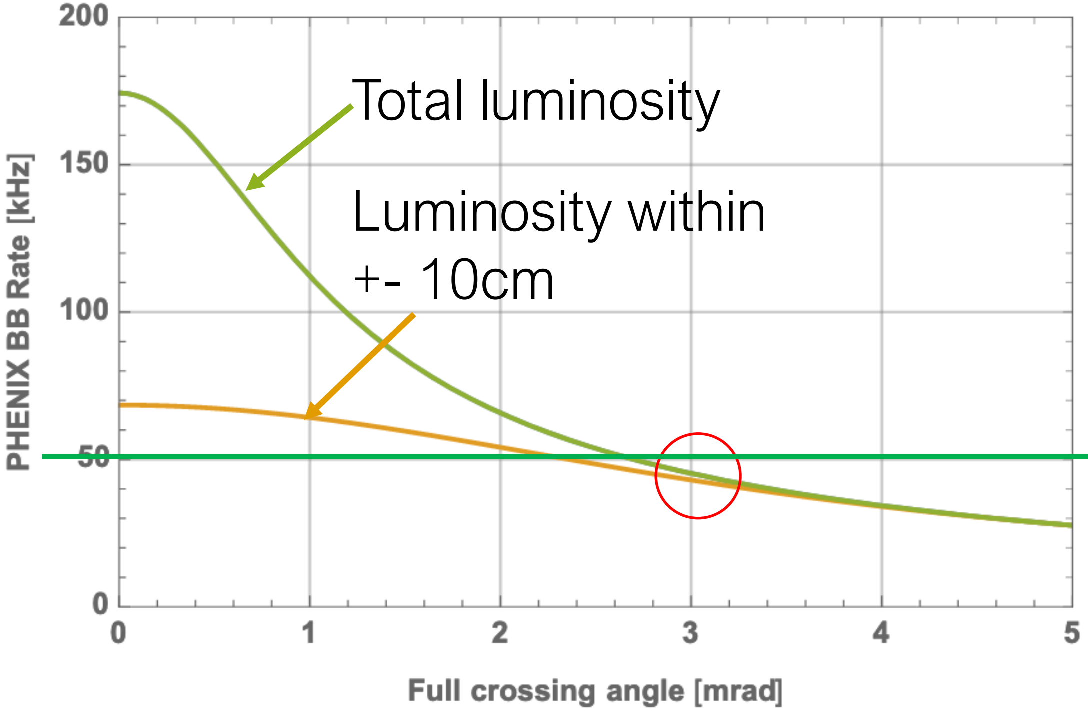


- Tilted and tapered steel plates with scintillator tiles between them
- Extruded polystyrene scintillator with wavelength shifting fiber in grooves
- Each tile read out by a 3x3 mm SiPM
- Five tiles analog summed to a $\Delta\eta x \Delta\varphi \sim 0.1$ tower

Status of ongoing discussions with C-AD

Focus on a beam crossing angle to narrow the vertex distribution

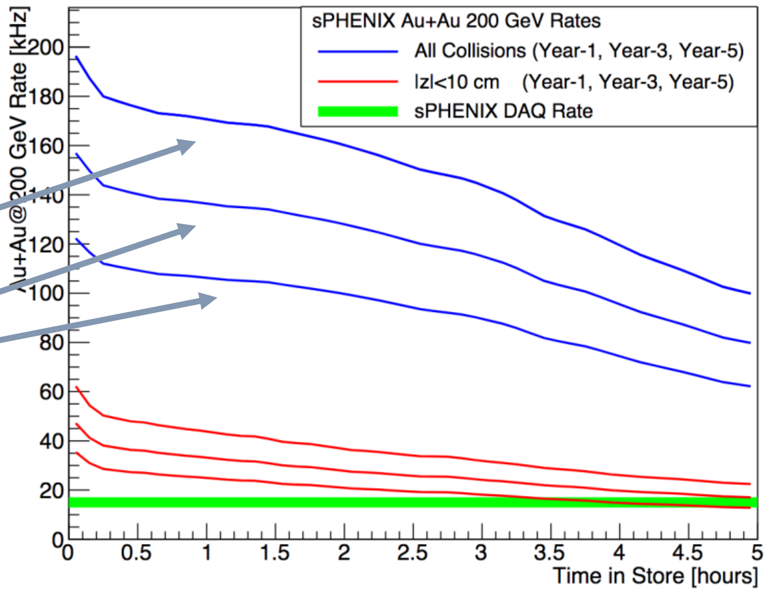
For a calculation of overall and desired luminosity as a function of crossing angle:



2/19/

50kHz "reasonable" background in the TPC

All Vertices
Year 5 (2027)
Year 3 (2025)
Year 1 (2023)



Naïve view of the collison of beam bunches:

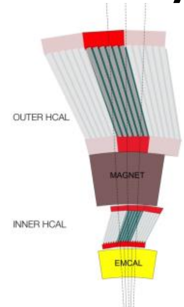
Collisions can happen anywhere along the overlap

No crossing angle

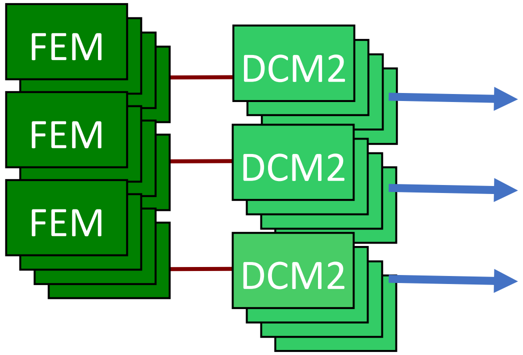
Small crossing angle

The overlap region is reduced

Hybrid of triggered and streaming readout

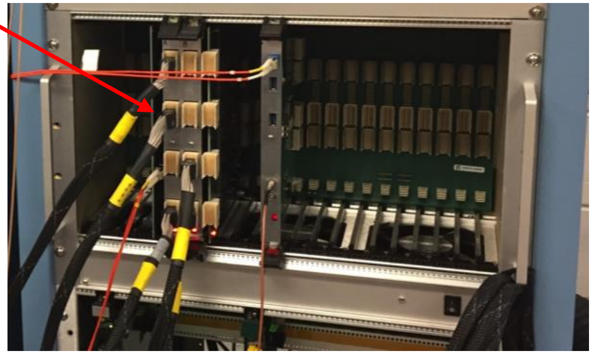


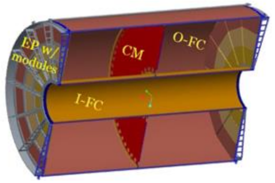
Calorimeters, MBD



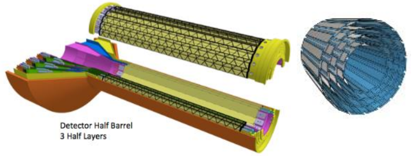
The calorimeters and the MBD re-use the PHENIX “Data Collection Modules” (v2)

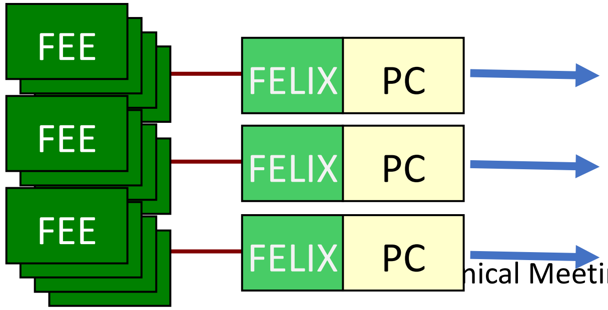
Triggered readout





TPC, MVTX, INTT





nical Meeting

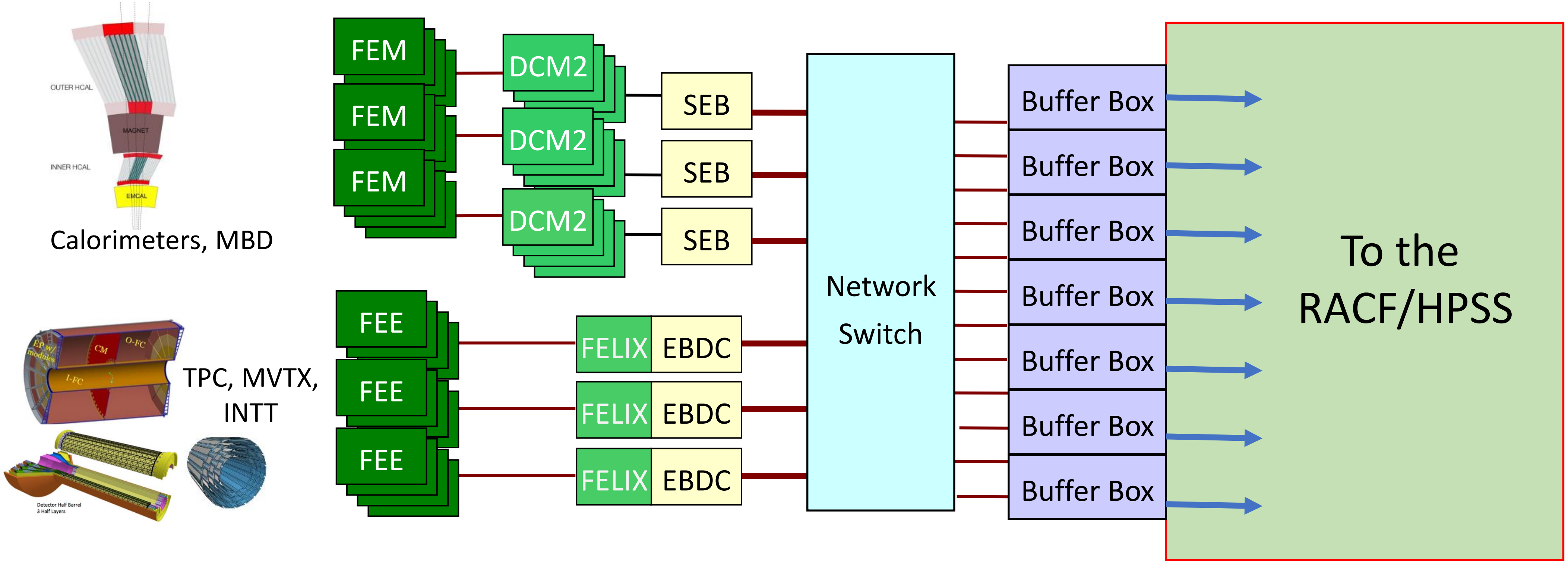
The TPC, the MVTX, and the INTT are read out through the ATLAS “FELIX” card directly into a standard PC

Streaming readout

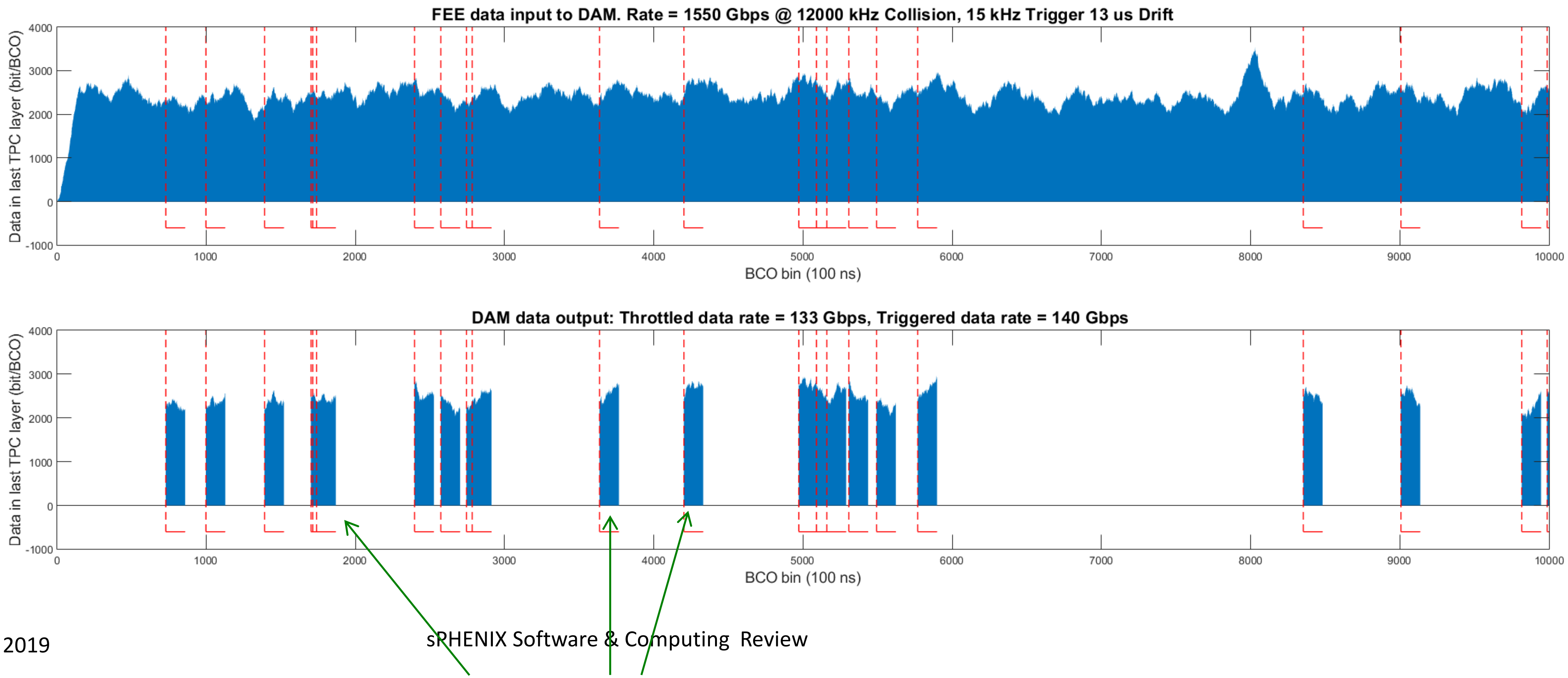
ATLAS FELIX Card

Installed in a PC

DAQ Architecture



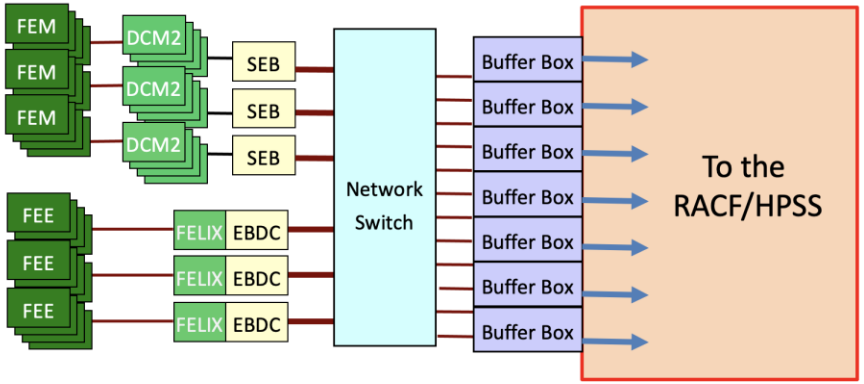
Large buffer space on buffer boxes to make use of RHIC downtimes
FELIX cards match streaming readout to triggers, drop data not correlated to trigger (some discussion to extend this window to take minbias pp)



Chunks correlated with triggered events

sPHENIX online/offline computing

- The sPHENIX detector construction is nearing completion
  - Most of the detector (by weight) rolls into the IR right after RHIC Run 22 (about one year from now, spring 2022)
  - One year later (February 2023), it begins its commissioning run at RHIC
  - Mature online software is essential to success
- There are many areas of software that we can use contribution (or better, commitment)
  - Offline event building is new to us (and everyone else)
  - At least some of our detectors use “streaming” readout
  - Time-averaged data rates of 150 Gbps, peak data rates of 300 Gbps



Technology areas where we could use help

- Databases
- User interfaces
- Middleware for distributed control and monitoring
- System management and monitoring

sPHENIX Raw Data

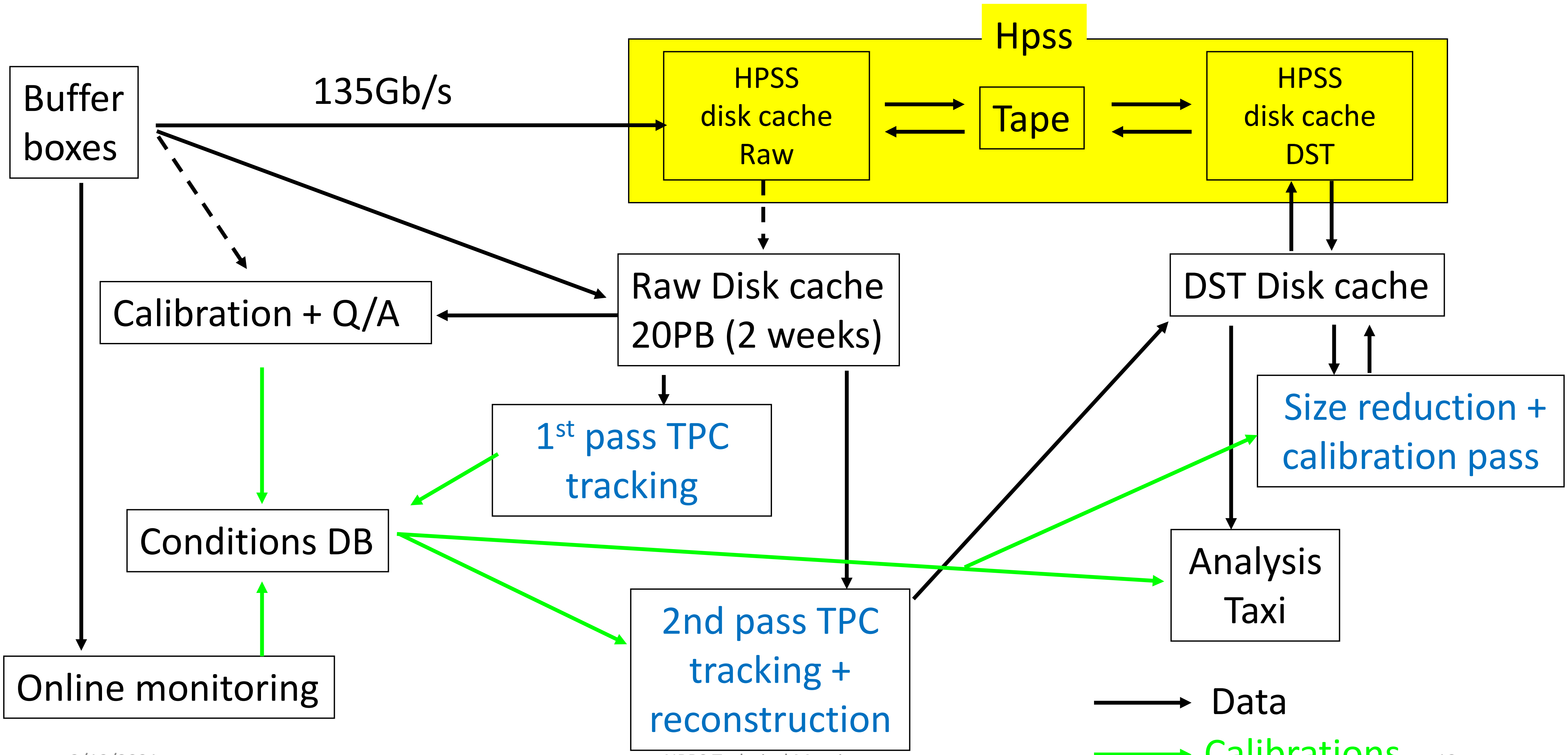
- No high level trigger based on events → no online Event builder needed, events are assembled during reconstruction
  - We are slaughtering a sacred cow!!!!!!!!
  - might become standard in streaming readout for EIC
  - Events are distributed over ~60 separate files
    - But events are time ordered
    - Streaming readout needs special treatment
    - Very likely files contain different numbers of events (subevent sizes vastly different+ streaming)
    - Need to estimate data loss due to broken tapes
      - Traditional loss of events changes to loss of efficiency for many more events (parts of events are missing)

- Use Lumi block concept for validation/calibration
  - Almost impossible to guarantee stability of detector over long time
- Daq is rate limited to 15 kHz, same rate in pp as in AuAu

Reconstruction in a nutshell

- Will be done in racf (not a lot of grid processing, phew)
- Offline event builder
  - Event number (triggered) + crossing counter (streaming) used for identifying event
  - difference to regular processing: 60 fopen calls instead of one
  - We have been doing this multiple file reading in PHENIX for analysis files since 2003 (proposed offline eventbuilder idea in 2010 for PHENIX - I planned to kill the cow a long time ago)
    - Also standard for mock data challenge
- Reco time budget 25sec/evt
  - TPC reco needs 2 distinct passes for distortion correction
    - Maybe run calorimeter reco as separate pass
    - Either run offline event builder 2(3) times or store intermediate event file
  - Reco job length ~ 24 hours, 25sec/ev → 4000 events in one job (or 12000 for 3 separate passes)
    - 2MB/evt → 8 (24) GB close to PHENIX (10GB), nice size to work with
    - @15kHz daq rate – 250 (750) ms of data

Reconstruction + Analysis Flow



What is the problem?

- Code speed – need to get to 25s/evt
  - Not only tracking – calorimeter (5s) blows its budget as well (pulse shape fitting)
- Memory – has gotten cheaper but 10GB/job won't fly
  - Unlike CERN Simulation needs "small" sim size is a secondary problem
- Scale
  - Rate is constant 20GB/sec in AuAu in year 3 (averaged by buffer boxes)
  - 200,000 cores need to be fed
  - Ramp up vs steady state, deliver data to those cores
  - Storage which can handle that abuse
- Reconstruction has to happen quasi online
  - Once data is deleted from buffer it will be very expensive to fetch from hpss
    - Data spread over 60 files is not helpful here
- Need to be ready, no time for debugging – we will get hit on day 1 by an accelerator (and crew) with 20 years of experience delivering high luminosity

Matching experience in NPPS

- Calibrations Database
  - We know our current DB approach does not scale – Belle II DB looks like a good solution (calibrations in files, metadata in DB)
  - Nice standalone task which doesn't require deep knowledge of sPHENIX
  - DB Maintenance
- Data reconstruction and movement choreography
  - All done locally – we have influence on hardware
  - PanDa and Ruccio?
  - Data Production Manager
- Refining TPC simulations (electron drift)
  - Tracking next talk
- GEANT4 (physics lists, calorimeters), ATLAS has interesting developments