Technical University of Munich

ATLAS EXPERIMENT

Introduction to PHYSLITE

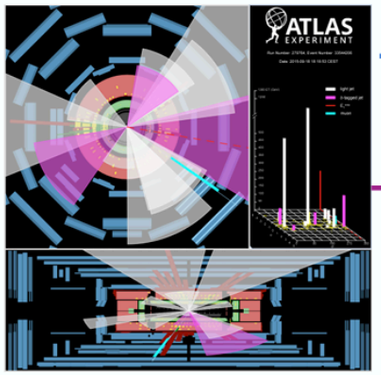
US ATLAS / IRIS-HEP Analysis Software Training Event 2024

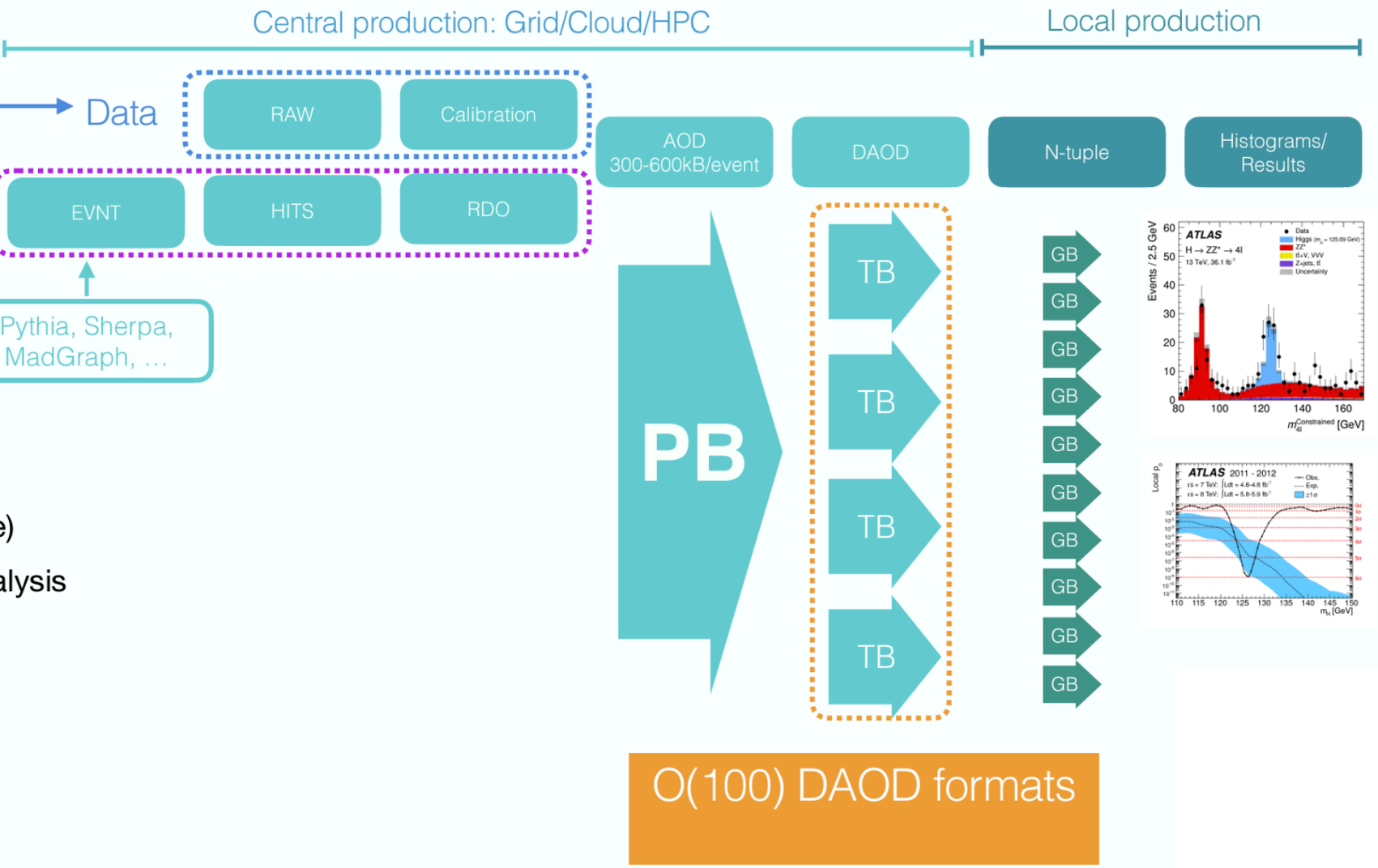
Vangelis Kourlitis - 18 July 2024

Data formats

Run 2

Figure: J. Catmore



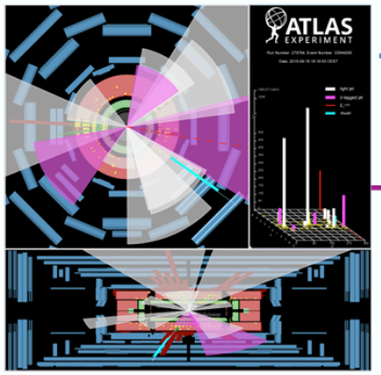


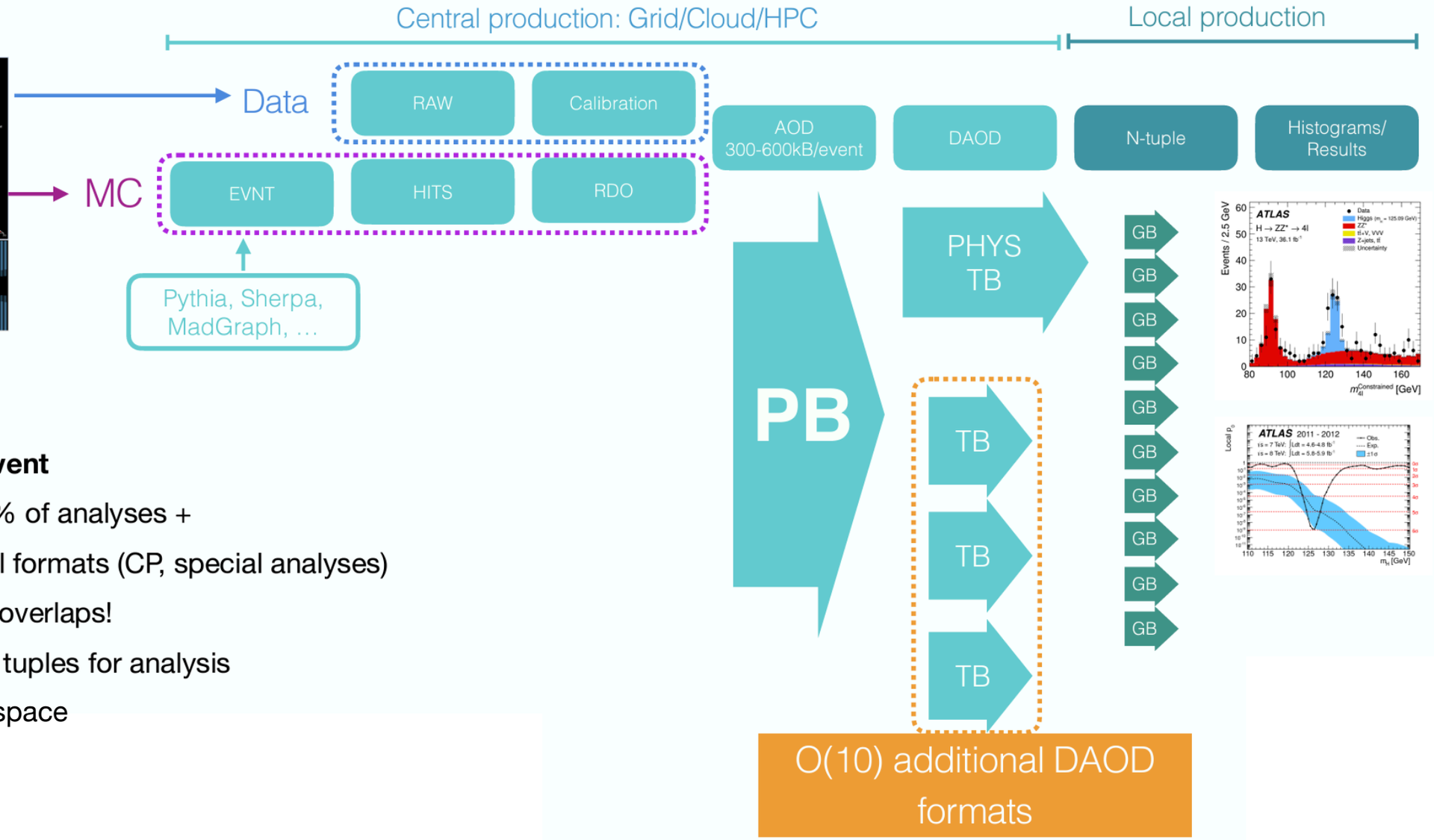
- O(100) DAOD formats
  - **30-50 kB/event** (Average)
- final flat ROOT tuples for analysis
- Large overlaps in contents,
- using a lot of disk space

Data formats

Run 3

Figure: J. Catmore

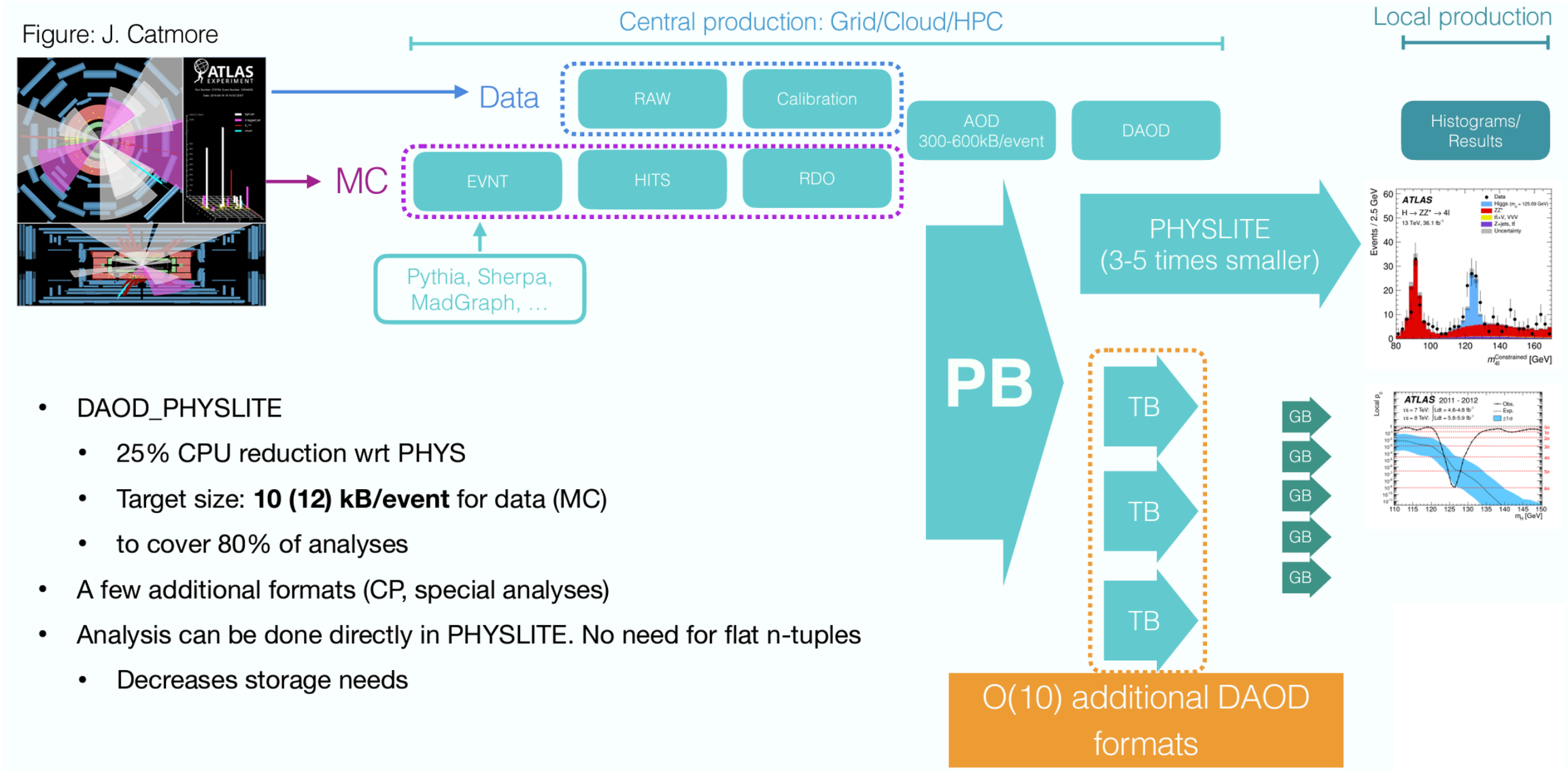




- DAOD_PHYS
  - **30-50 kB/event**
  - to cover 80% of analyses +
- A few additional formats (CP, special analyses)
- Highly reduces overlaps!
- Final flat ROOT tuples for analysis
- Less total disk space

Data formats

Run 4+



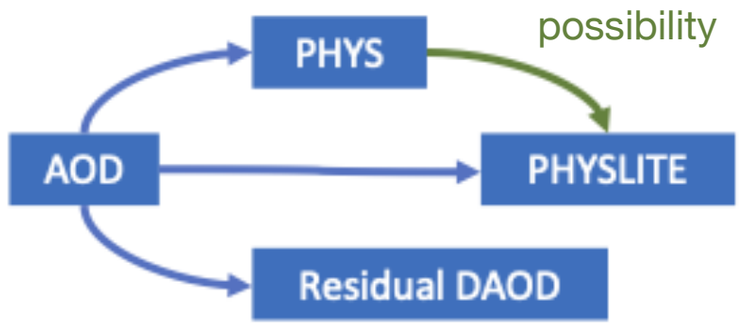
- DAOD_PHYSLITE
  - 25% CPU reduction wrt PHYS
  - Target size: **10 (12) kB/event** for data (MC)
  - to cover 80% of analyses
- A few additional formats (CP, special analyses)
- Analysis can be done directly in PHYSLITE. No need for flat n-tuples
  - Decreases storage needs

PHYSLITE

Main characteristics

1. Unskimmed and monolithic
2. Contains already calibrated objects
3. Objects are loosely preselected
4. Available since Release 22
5. Centrally produced ~4 times per year

   April ’23, September ’23, January ’24, June ’24, …

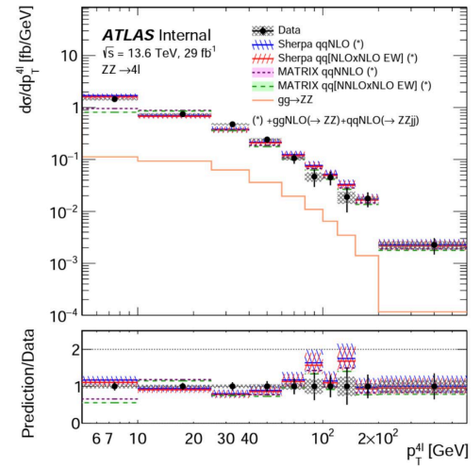


PHYSLITE

Status

First ATLAS result using PHYSLITE

arXiv:2311.09715



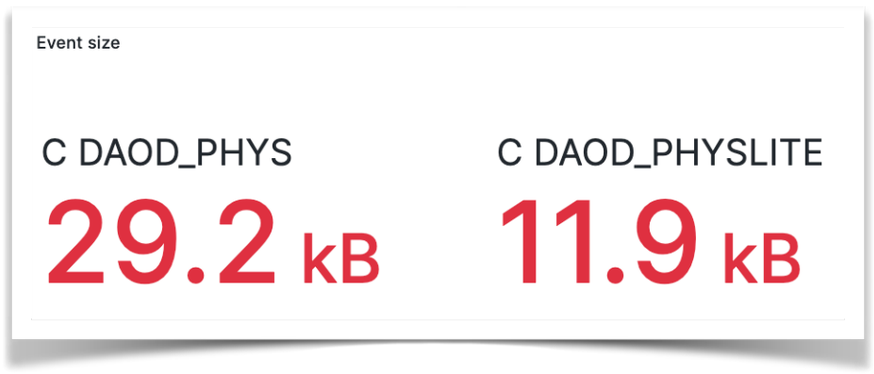
ZZ production cross-sections in the four-lepton final state

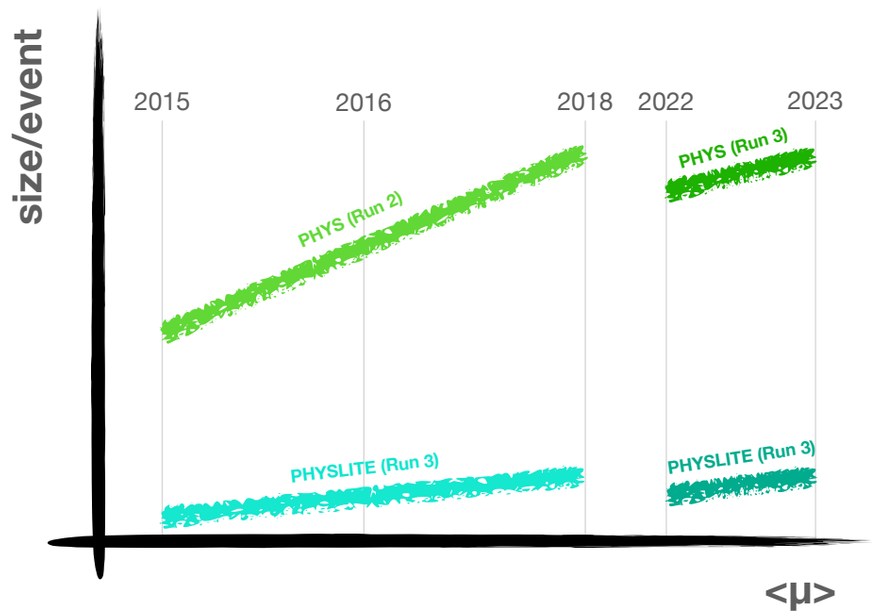
In general PHYSLITE model seems to provide good coverage of the bulk of analyses

Adoption plans from various PA groups (Top, di-Higgs, SM, etc.)
Current PHYSLITE usage is comparable to the most used SM-specific format

Special format needs only from BLS, HION and LLP searches

Current event size very close to the ~12kB target



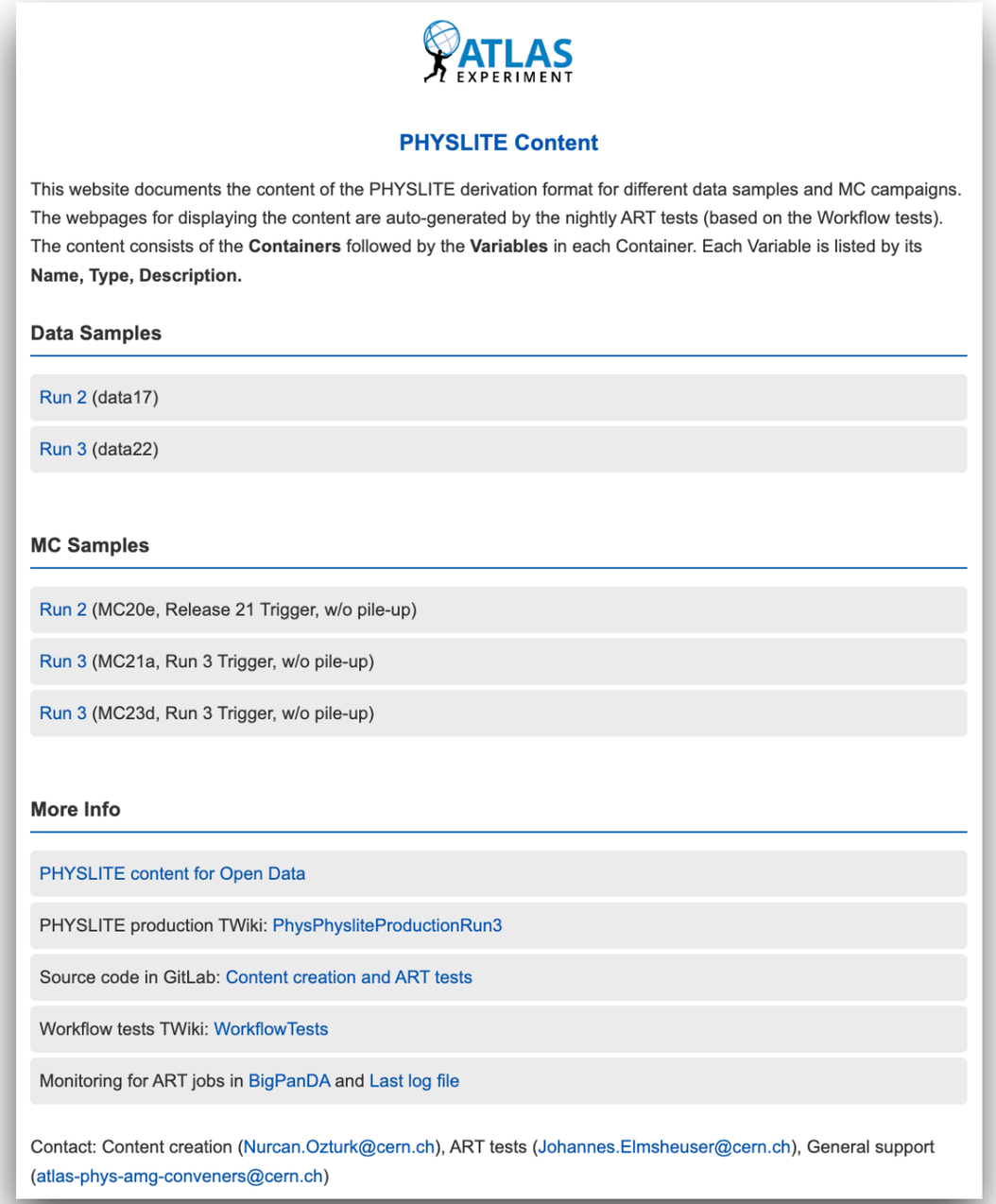


~85% more stable in pile-up increase, however projections show 15kB/event in HL-LHC <μ>
R&D continues!

PHYSLITE Content

New webpage!

- Summarising information from various CP and PA groups
  - Auto-generated by ART tests
- PHYSLITE is an **evolving data format**
  - TWiki on how to request modifications to PHYSLITE
  - The more analyses your request helps, the more likely is to be accepted!

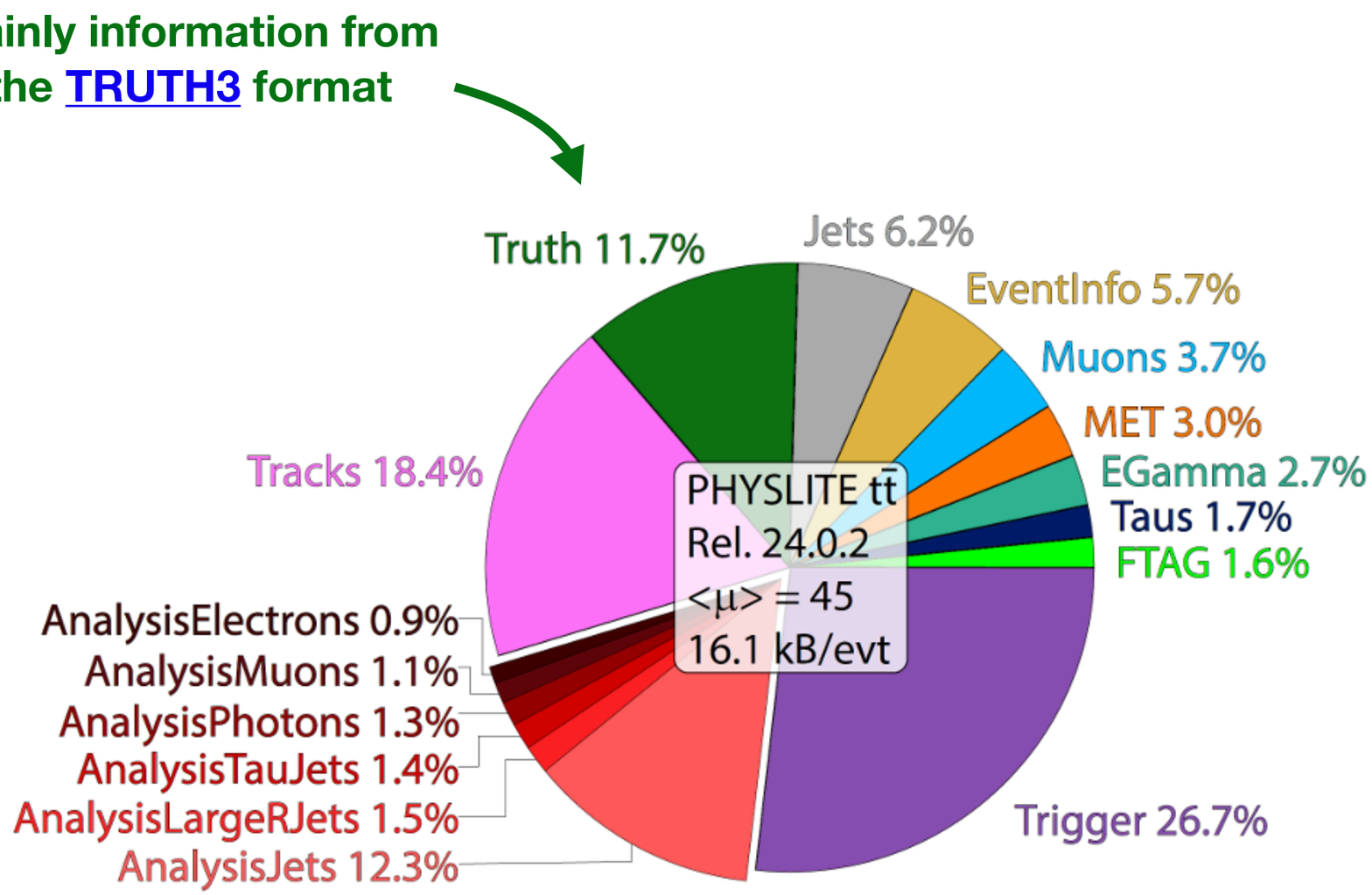


https://atlas-physlite-content.web.cern.ch/

PHYSLITE Content

Breakdown

Mainly information from the TRUTH3 format



PHYSLITE

R&D

2023

2024

2025

2026

Format development and early testing

R&D projects:

- GRL information
  incorporate variables indicated if an events passed a GRL
- Event augmentation
  add additional information only to a subset of events
- Lossy compression
  reduce variables precision — loose information but do not compromise physics
- RNTuple adoption
  TTree evolution offering space savings at least 10% and commensurate speed up
- **Columnar analysis**
  array programming methods for on the fly systematics

  Join the e-group atlas-sw-amg-columnar

PHYSLITE ready for super-fast lightweight physics data analysis

Open Data for Research

Imminent release of 2015+2016 physics main proton–proton data as PHYSLITE

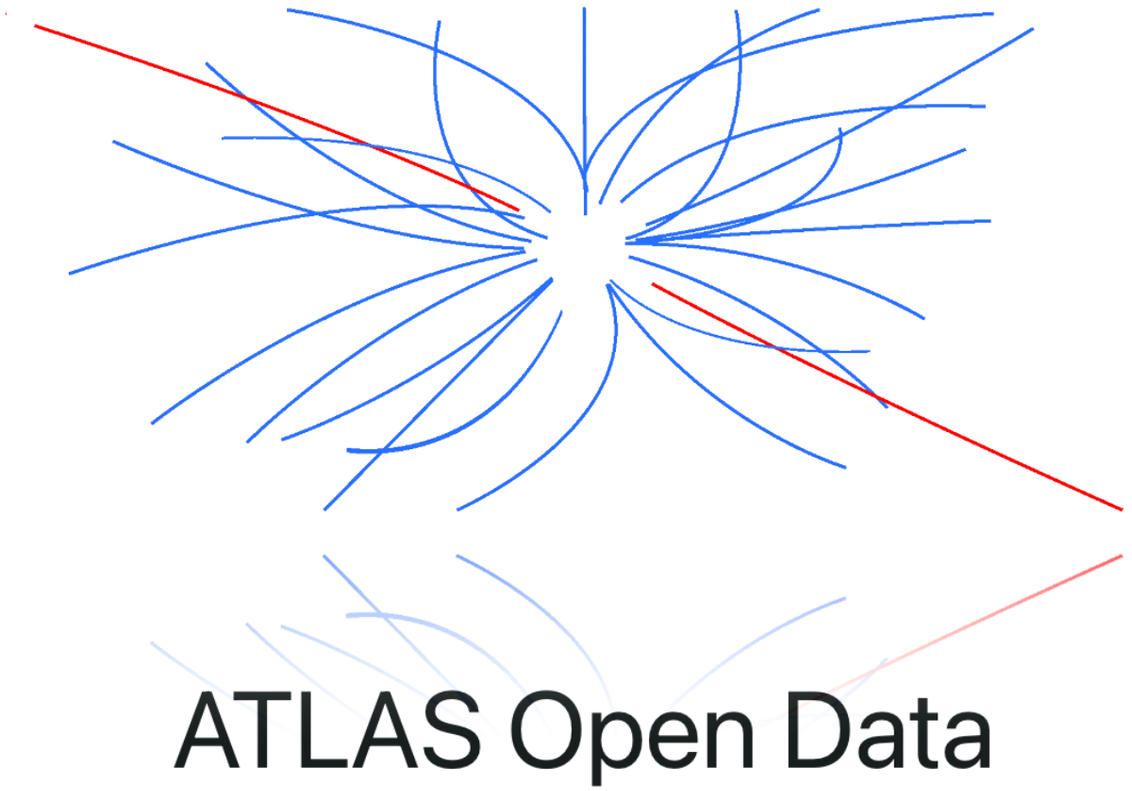
- 2015 Pb+Pb data too in PHYSLITE-like format

Support real (or at least realistic) full-blown analyses (including systematics)

- Accompany with “an appropriate set of simulated Monte Carlo samples”
- Distributed by opendata.cern.ch

Support material

- Analysis software (Athena) is already public
- ATLAS open data portal with extensive documentation: opendata.atlas.cern



Today

- Fetch a PHYSLITE file from the Open Data release
- Load it in memory using `coffea` `NanoEvents` and `PHYSLITESchema`
- Demonstrate basic data handling
  - More about `coffea` and actual analysis later: Coffea columnar analysis framework