EXPLORE: A Scalable Infrastructure for LHC Open Data Analysis and FAIR Data Provisioning

Baida Achkar*, Arnulf Quadt, Sebastian Wozniewski

Georg-August-Universität Göttingen

*** Corresponding author: baida.achkar@phys.uni-goettingen.de**

PUNCHLunch Online Seminar

18.09.2025 - 12:30-13:30

Part I – Motivation & Concept

Why EXPLORE? Lowering barriers to LHC Open Data

Why EXPLORE?
Barriers to Public Use of LHC Open Data

🔧 Technical Barriers

Specialized High Energy Physics (HEP) software & tools required to handle ROOT-format multi-GB datasets efficiently.

Limited runtime & computing resources constrain online analysis environments (e.g. SWAN, Binder).

🔑 Access Barriers

CERN credentials required to access certain advanced tools (e.g. EOS storage, SWAN).

Obscure & complex interfaces make data access & analysis tools difficult for non-experts to use.

Why EXPLORE?
Overcoming Barriers to Public Use of Open Data

EXPLORE’s Role

💻 Technical Solution:

Ready-to-use containers with ROOT, libraries, & dependencies (No local install).

Batch mode on EXPLORE’s distributed computing (GoeGrid Cluster) enables large-scale analyses.

🌐 Access Solution:

No CERN account required to use computing resources or access datasets & tutorials.

Preconfigured remote data access inside job containers (no manual setup).

Outcome with EXPLORE

Enables public & unaffiliated scientists to run real analyses without hardware, credential, or setup hurdles.

Provides researchers & educators a ready-to-use environment for both training & research.

Supports compute-heavy LHC analyses.

Serves as a bridge from Open Data in theory to Open Data in practice.

EXPLORE within PUNCH4NFDI & Göttingen GoeGrid

EXPLORE, part of **PUNCH4NFDI** initiative, promoting cross-disciplinary **FAIR** data practices in physics.

GoeGrid , a Tier-2 WLCG site at the University of Göttingen, historically serving ATLAS Monte Carlo production & analysis.

EXPLORE repurposes part of GoeGrid as "**Open Analysis Resources**" to serve **non-affiliated users.**

This enables LHC Open Data analysis **without the need for direct CERN/Institution affiliation.**

EXPLORE leverages Göttingen's computing resources, as **Open Analysis Resources**, enabling **LHC–CERN Open Data analysis** without requiring CERN or institutional affiliation.

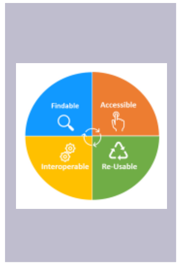
EXPLORE Objectives

Bridging Open Data from theory to practice

Accessibility: Lower barriers for non-CERN & non-PUNCH users to access & analyze HEP data.

Education & Outreach: Provide hands-on LHC Open Data experience for high-school students, educators.

Scalability: Support diverse workloads with dynamic resource allocation.



FAIR Principles: Ensure data & tools are Findable, Accessible, Interoperable, and Reusable.

Sustainability: Leverage existing infrastructure with minimal overhead.

EXPLORE: Empowering global participation in high-energy physics research!

Part II – Infrastructure & Operation

How EXPLORE works: batch system, containers, and monitoring!

Scalable Infrastructure for FAIR Open Data Analysis: Core Components

HTCondor Overlay Batch System (OBS):

- Aggregates distributed compute resources from GoeGrid Cluster into a unified job execution pool with dynamic scheduling.

Dynamic Resource Management (COBalD/TARDIS):

- Continuously monitors real-time workload demands & coordinates automatic scaling of compute resources to ensure optimal performance & cost-efficiency

Drone Architecture & Environments

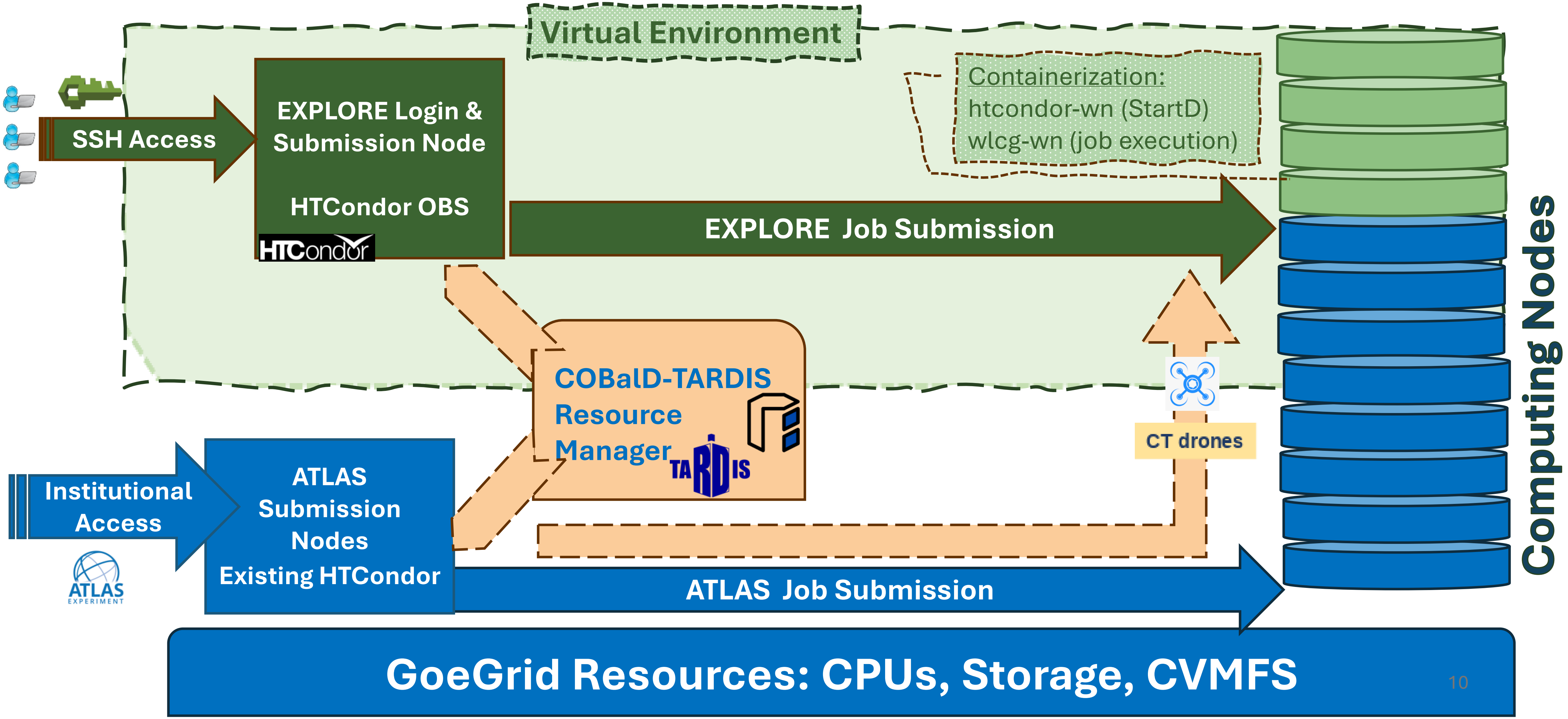
Drone Architecture & Scheduling:

- Placeholder jobs ("drones") submitted, each runs an HTCondor StartD daemon & automatically registers as a Worker Node.
- Drones integrate into the OBS, forming a seamless, unified execution pool.
- HTCondor Scheduler (Schedd) manages job queuing, matching, & dispatch across dynamically provisioned resources, pairing queued jobs with available drones for efficient execution.

Drone Environments:

- Version-controlled containerized setups with ROOT, libraries, and dependencies, deployed dynamically at runtime for reproducibility using HTCondor tools.

EXPLORE setup within GoeGrid cluster-Göttingen



Software Environment Provisioning

Containerized Analysis Environments with **Apptainer** & **CERN CVMFS** provide standardized setups.

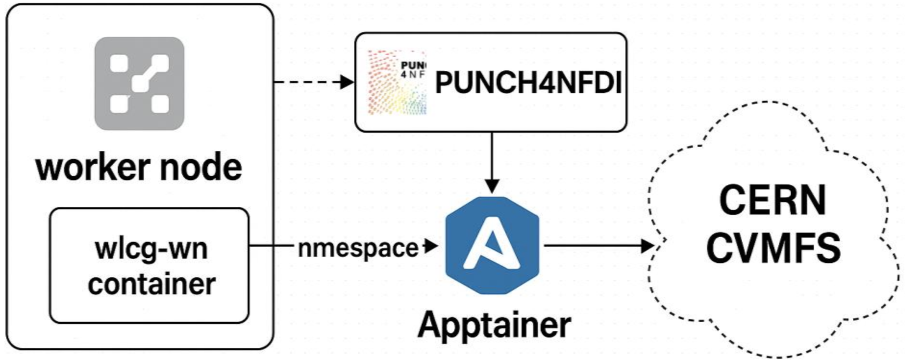
Jobs run inside **wlcg-wn Apptainer container**, defined in **PUNCH4NFDI Container Registry,** delivered unpacked via **CVMFS**.

CVMFS (CernVM File System):

Installed on all GoeGrid worker nodes.

Mounted via namespace to each drone (HTCondor-wn).

Automatic setup: HTCondor job configuration specifies the container, triggering retrieval & environment initialization at runtime.



Real-Time Monitoring with Prometheus & Grafana

Prometheus collects & stores real-time metrics from EXPLORE’s Access/Submit Node.

Node_exporter gathers:

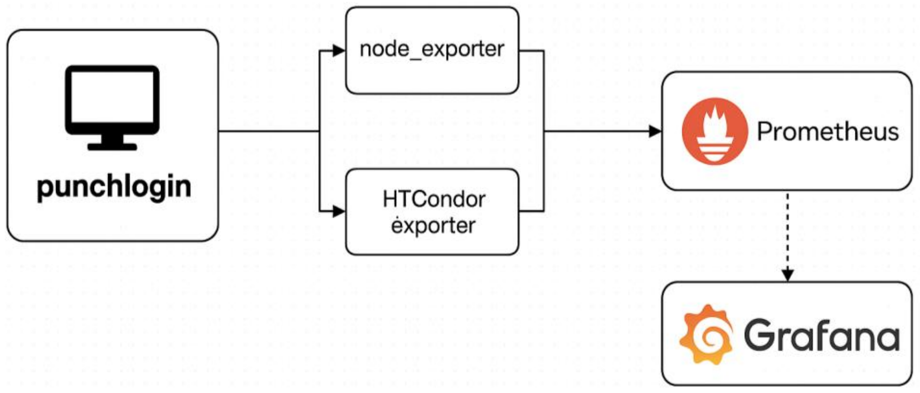
CPU, Memory utilization, Disk I/O, Network stats,..

Custom HTCondor exporter configured to track **HTCondor metrics** (queue status, execution stats,..)

Grafana provides the visualization layer:

Real-time dashboards for system health & HTCondor performance

→ **Proactive monitoring** and **issue detection**



Registration Workflow & User Access

1. 🔍 **Fill out form (with valid Email)**
2. 🔑 **Submit SSH key pair**
3. ✅ **Receive confirmation & access instructions**
4. 💻 **Log in via Submission Node:**

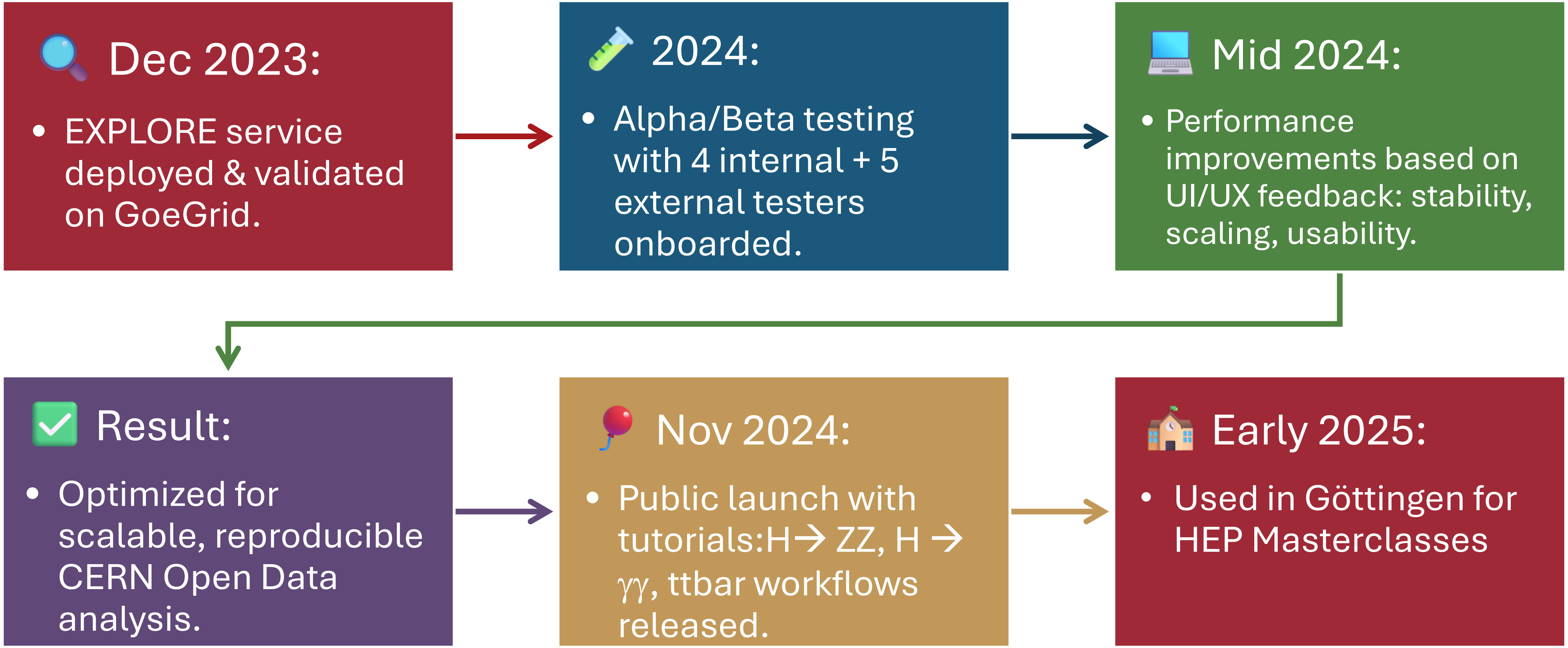
- `ssh -i .ssh/id_rsa <username>@punchlogin.goegrid.gwdg.de`

🔒 🌍 **Custom Authentication Model**

- Independent of institutional identity providers
- Enables flexible, open access for global users
- Secure, SSH-based login

👉 Register Now: https://punchlogin.goegrid.gwdg.de

From Prototype to Production: EXPLORE Adoption Journey



🔍 Dec 2023:

- EXPLORE service deployed & validated on GoeGrid.

🧪 2024:

- Alpha/Beta testing with 4 internal + 5 external testers onboarded.

💻 Mid 2024:

- Performance improvements based on UI/UX feedback: stability, scaling, usability.

✅ Result:

- Optimized for scalable, reproducible CERN Open Data analysis.

🎈 Nov 2024:

- Public launch with tutorials:H→ ZZ, H → γγ, ttbar workflows released.

🏫 Early 2025:

- Used in Göttingen for HEP Masterclasses

EXPLORE: From validation to public adoption in under 2 years.

Part III – Showcase: $t\bar{t}$ Analysis

Case study: demonstrating EXPLORE capabilities with ATLAS Open Data!

Why tt̄? Physics Motivation - l+jets Channel

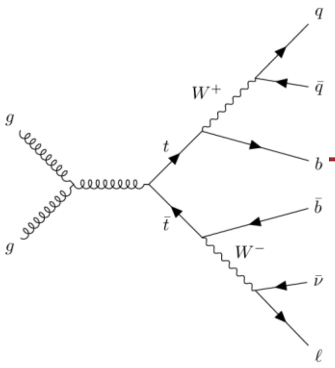
Top–antitop (tt̄) production is a key process at LHC:

- **Test the Standard Model** (QCD at high energies)
- **Search for new physics** beyond the SM
- **Background** for Higgs and BSM studies

Educational value:

- Realistic yet manageable complexity
- Rich variety of physics objects: leptons, jets, MET
- Ideal for teaching event selection, reconstruction, and statistical analysis

The l+jets Channel:



Final state:	1 high-p_t lepton (e/μ)
	≥4 jets (2 b-jets, 2 from W → qq')
	Missing transverse energy (ν from W → ℓν)
Advantages:	Large statistics, clean event signature
	Balance between complexity and yield
Dataset:	From **ATLAS Open Data 2025 Beta Release** (>100M events across samples)
	Includes MC simulations for validation and comparison

This analysis is implemented on EXPLORE-GoeGrid resources to demonstrate the platform’s ability to process large datasets efficiently, reproducibly, and at scale.

ATLAS Open Data 2025 Beta

Released: February 2025

Release Overview

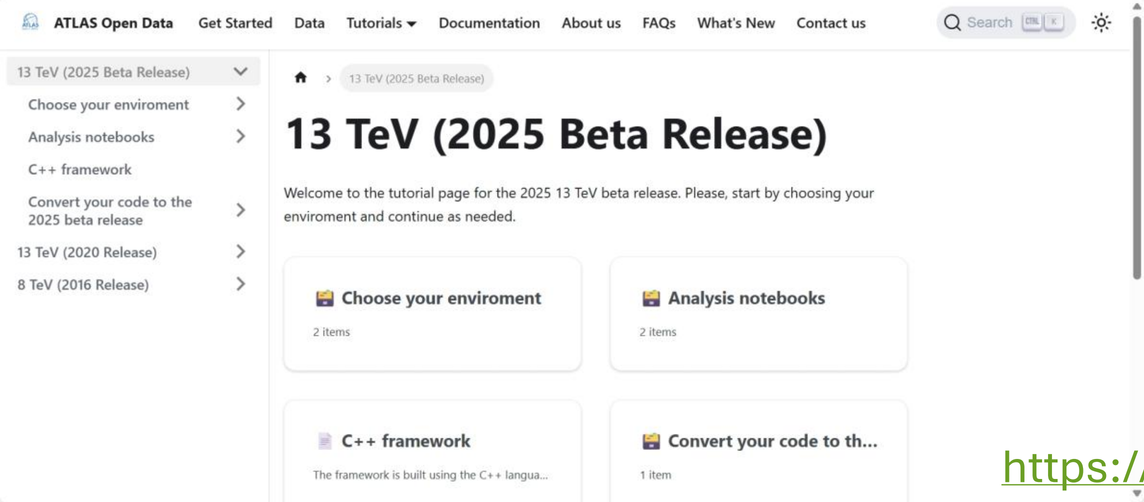
- 36 fb^{-1} of pp collisions at $\sqrt{s}$ = 13 TeV (2015–2016)

- For Education & Outreach, largest ATLAS educational release to date

- Provided as flat ROOT Ntuples (~80 branches) for ease of use

- Includes real collision data and Monte Carlo simulations

- Fully calibrated and ready for analysis



13 TeV (2025 Beta Release)

Welcome to the tutorial page for the 2025 13 TeV beta release. Please, start by choosing your enviroment and continue as needed.

Choose your enviroment
2 items

Analysis notebooks
2 items

C++ framework
The framework is built using the C++ langua...

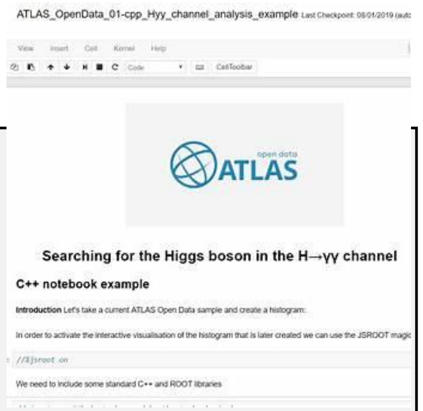
Convert your code to th...
1 item

https://opendata.atlas.cern/docs/category/13-tev-2025-beta-release

ATLAS Open Data & EXPLORE: Complementary Tools for Education and Research

ATLAS Open Data

Jupyter Notebooks (Interactive)



ATLAS_OpenData_01-cpp_Hyy_channel_analysis_example Last Checkpoint: 08/01/2019 (auto

Searching for the Higgs boson in the H→γγ channel

C++ notebook example

Introduction Let's take a current ATLAS Open Data sample and create a histogram:

In order to activate the interactive visualisation of the histogram that is later created we can use the JSROOT magic

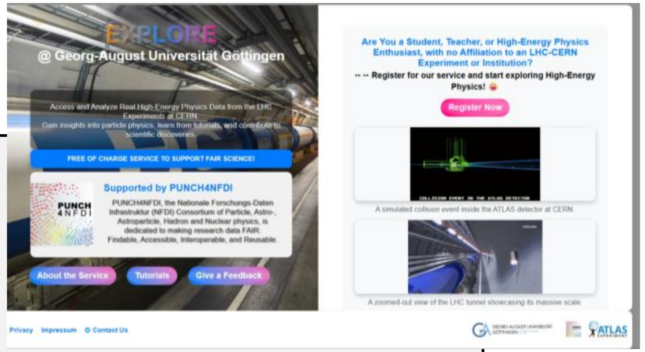
```
//%jsroot on
```

We need to include some standard C++ and ROOT libraries

- Developed by the ATLAS Open Data group
- Designed for teaching and outreach
- Runs in interactive environments: CERN SWAN, Google Colab, Binder
- Ideal for small datasets and quick demonstrations
- Supports Python/C++ with ROOT libraries
- Covers Higgs, Z bosons, top quarks, W bosons, etc.
- Purpose: Learn concepts, data formats, analysis basics

EXPLORE Service

(Batch / Large-scale Analysis)


EXPLORE
@ Georg-August Universität Göttingen
FREE OF CHARGE SERVICE TO SUPPORT FAIR SCIENCE!
PUNCH 4NFDI
About the Service
Tutorials
Give a Feedback
Register Now
COLLISION EVENT IN THE ATLAS DETECTOR
Privacy
Impressum
Contact Us
GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN
ATLAS EXPERIMENT

Access and Analyze Real High-Energy Physics Data from the LHC Experiments at CERN.
Gain insights into particle physics, learn from tutorials, and contribute to scientific discoveries.

Supported by PUNCH4NFDI

PUNCH4NFDI, the Nationale Forschungs-Daten Infrastruktur (NFDI) Consortium of Particle, Astro-, Astroparticle, Hadron and Nuclear physics, is dedicated to making research data FAIR: Findable, Accessible, Interoperable, and Reusable.

Are You a Student, Teacher, or High-Energy Physics Enthusiast, with no Affiliation to an LHC-CERN Experiment or Institution?

➡➡ Register for our service and start exploring High-Energy Physics! 😊

A simulated collision event inside the ATLAS detector at CERN.

A zoomed-out view of the LHC tunnel showcasing its massive scale.

- Provided by Göttingen computing resources (GoeGrid → Emmy HPC by 2030)
- Designed for large datasets and complex workflows
- Uses HTCondor batch submission, no interactive execution
- Pre-configured environment and software stack for LHC analysis
- Scales to many CPU cores and long jobs without local setup
- Purpose: Realistic, high-statistics research-grade analyses

Workflow Summary & Execution

- Analysis: TTbarAnalysis (lepton + jets channel) based on C++ framework (latest)
- Data: ATLAS Open Data 2025 Beta release
- Platform: EXPLORE service – HTCondor Overlay Batch System
- Environment: punch4nfdi/wlcg-wn container with XRootD-based data access
- Scripts: Executable & Job description file for HTCondor submission
- Submission: 1 sample per job, 58 jobs in parallel

✓ All 58 jobs completed successfully

✓ First complete workflow validated for EXPLORE using the 2025 Beta release

✓ Added to the EXPLORE material/resources portfolio

Quantitative Job Summary

Total jobs: 58, 35 Jobs with analyzed events ≥ 1,000,000

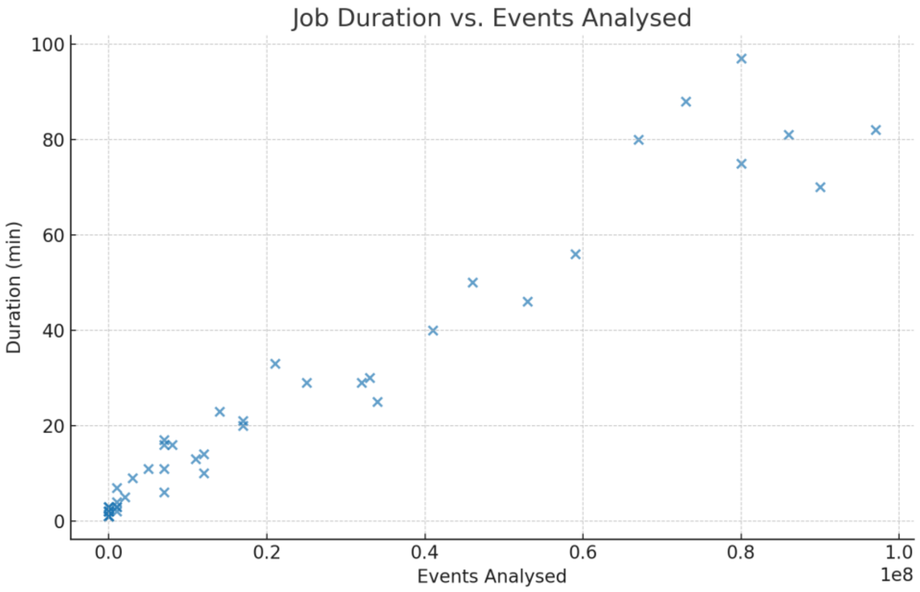
Jobs with <1,000,000 events: 23 (shown as 0)

Average duration: 20.0 min, Duration range: 1 to 97 min

Event range: 1,000,000 to 97,000,000 events

Outputs stored on EXPLORE storage (User's home directory)

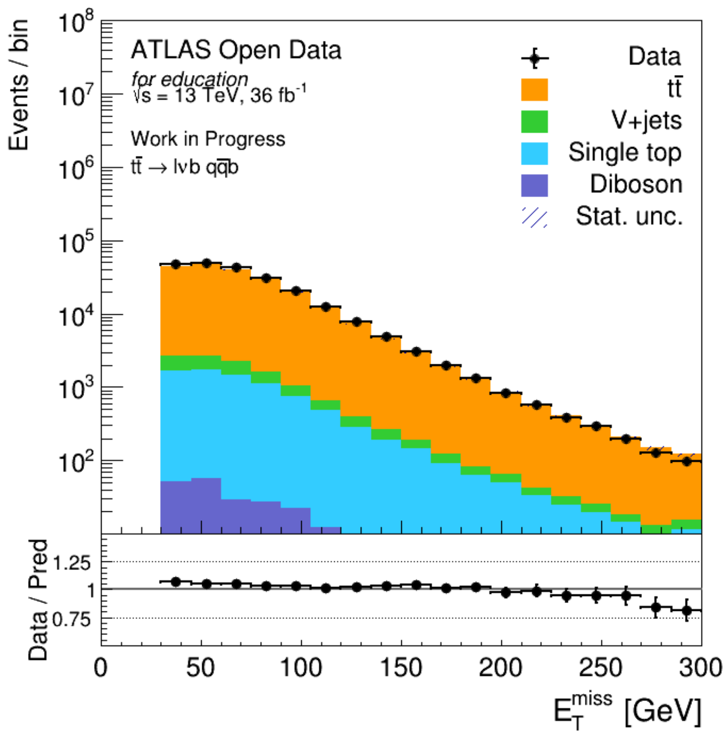
Output includes **histograms(396K)** and **ROOT files (1.1M)**



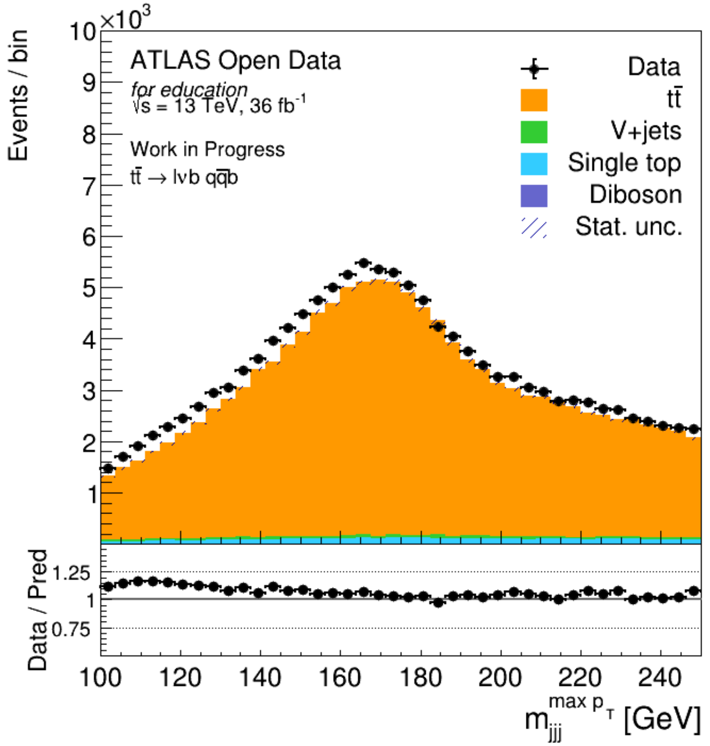
📌 This workflow demonstrates **reproducibility, scalability,** and **compatibility of ATLAS Open Data Beta Release with EXPLORE infrastructure**

Top-Antitop Analysis Plots

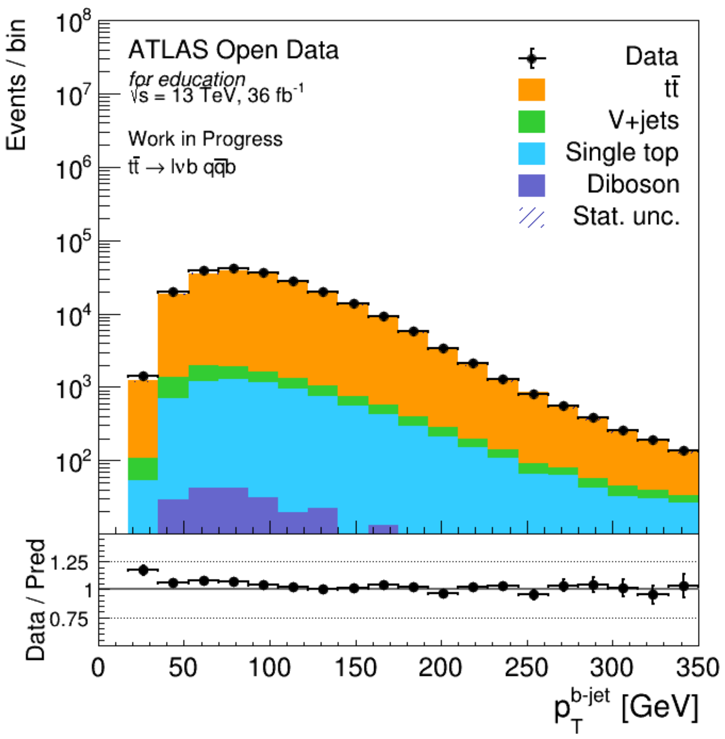
Missing transverse energy



Invariant mass of the three leading jets



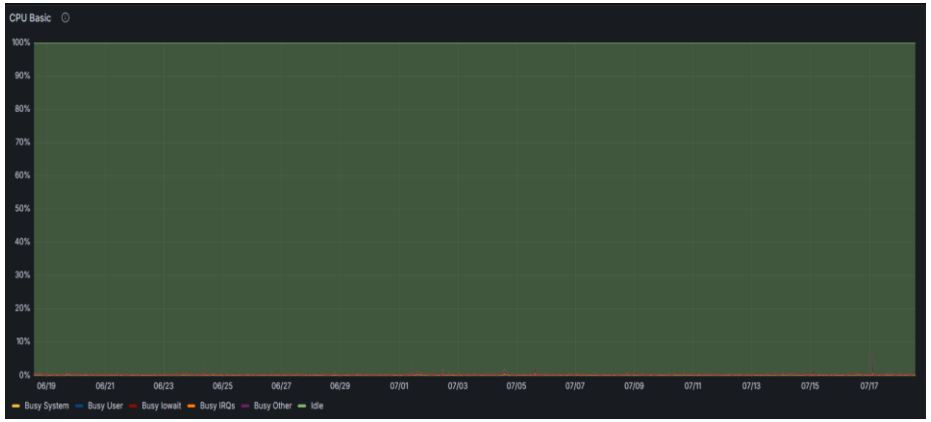
Transverse momentum of the leading b-jet



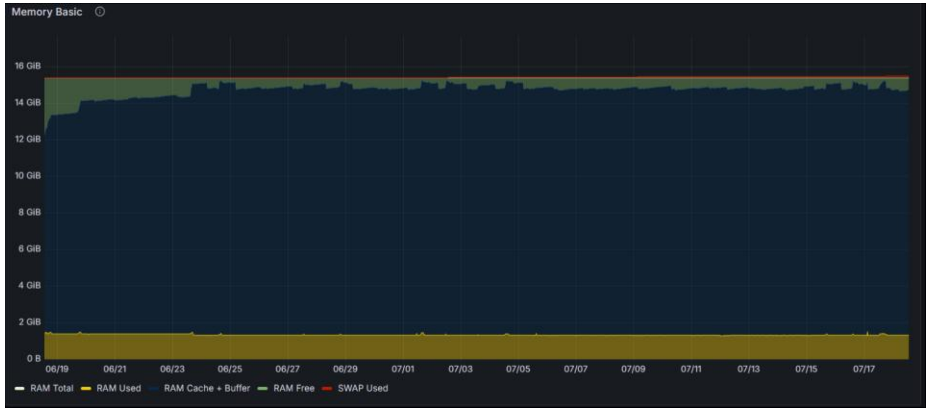
Part IV – Operational Insights & Outreach

What we learned: usage, performance, dissemination!

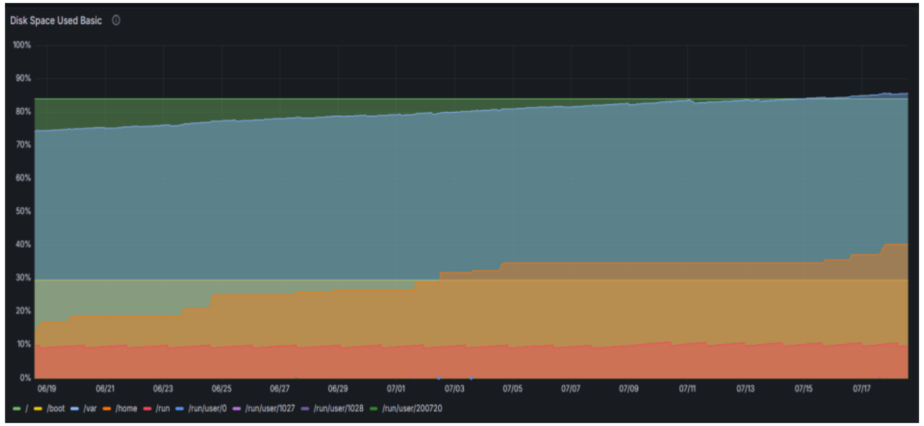
Submit Node Resource Footprint (CPU, Memory, Disk, Network)



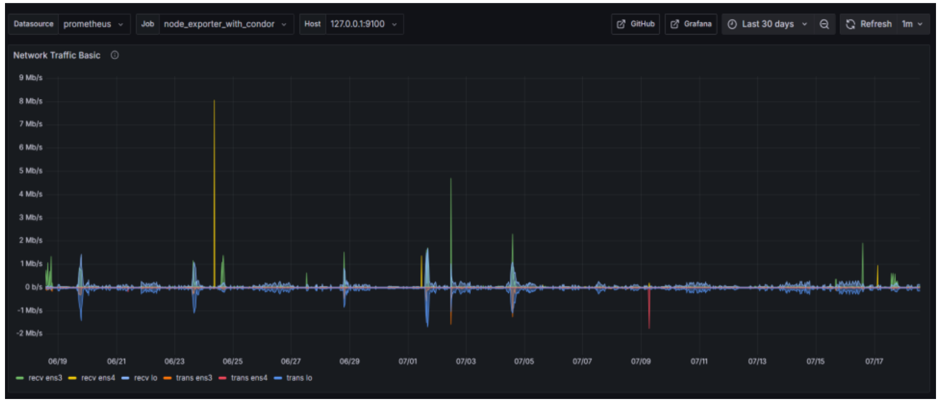
CPU: efficient job scheduling and no overloads.



Memory: stability across time.



Disk: growing gradually, as users run jobs and store outputs.



Datasource prometheus

Job node_exporter_with_condor

Host 127.0.0.1:9100

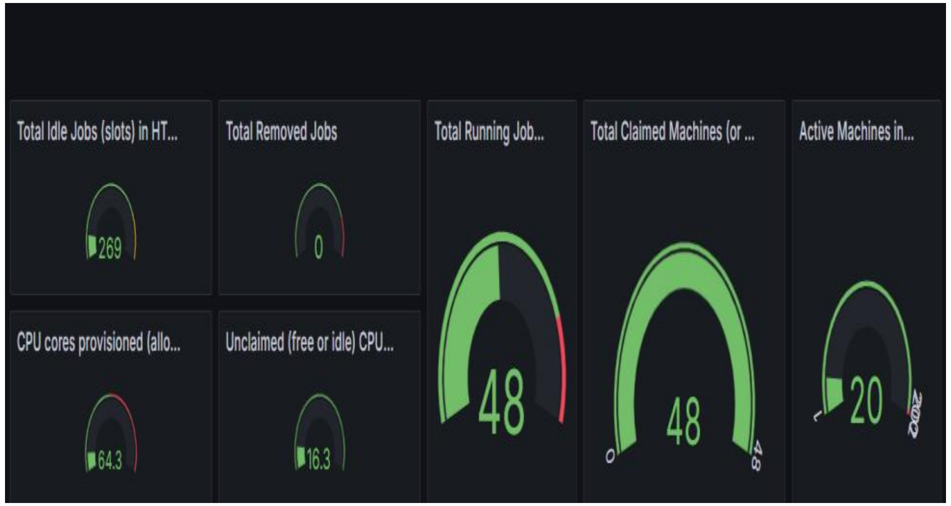
Last 30 days

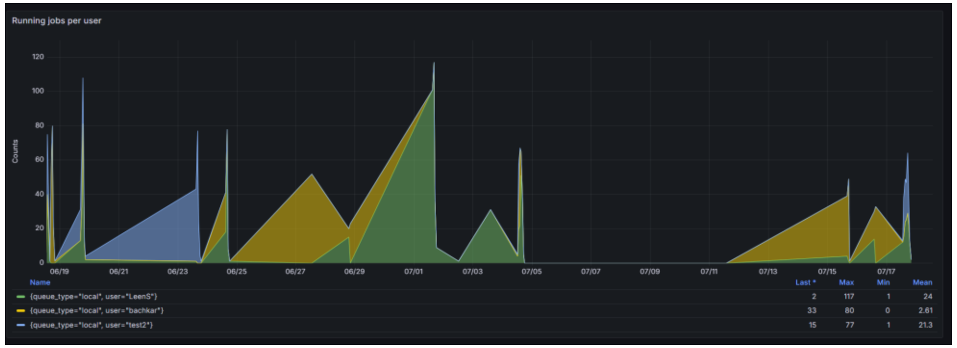
Refresh 1m

Network traffic: healthy data transfer with occasional peaks, reflecting data access bursts.

Preliminary Usage Statistics & Operational Insights

- **Registration Page**: ~200 visitor
- **Users**: 14 (students from different fields, scientists)
- **Total Clusters Submitted @EXPLORE Access Point**: ~4,000
- **Jobs per Cluster**: 9 to 33 (varies by workflow)
- **Estimated Total Jobs**: ~36,000 to 132,000
- **Design**: Modular & parallel job execution = scalable performance
- **Datasets**: 130 real ATLAS data samples made available!
- **Key Insight**: User feedback has shaped UI, documentation, and system stability


Total Idle Jobs (slots) in HT...
269
Total Removed Jobs
0
Total Running Job...
48
Total Claimed Machines (or ...
48
0
48
Active Machines in...
20
CPU cores provisioned (allo...
64.3
Unclaimed (free or idle) CPU...
16.3



Name	Last *	Max	Min	Mean
🟩 {queue_type="local", user="LeenS"}	2	117	1	24
🟨 {queue_type="local", user="bachkar"}	33	80	0	2.61
🟦 {queue_type="local", user="test2"}	15	77	1	21.3

Promotional Contribution: *EXPLORE Dissemination*

ATLAS Open Data Weekly Meetings

Regular service updates to the collaboration

Key contributions:

- July 18, 2024
- December 12, 2024

ATLAS Week Outreach

Outreach Parallel Session

Speaker: *Miguel Ángel García Ruíz* (for ATLAS Open Data team)

February 19, 2025

Link

Advertising & Outreach

- PUNCH4NFDI Website.
- NFDI Newsletters.
- GAU Newsletters
- DPG Meetings
- Email/Letter Campaigns: Targeting Lower Saxony High Schools (# 59 Gymnasien) to expand accessibility.

Conference Contributions

CoRDI 2025 *(Conference on Research Data Infrastructure)*

Aachen, August 26–28, 2025

- Abstract

EXPLORE

PUNCH 4NFDI

Perfect for students, educators & enthusiasts!

LEARN. ANALYZE. DISCOVER.

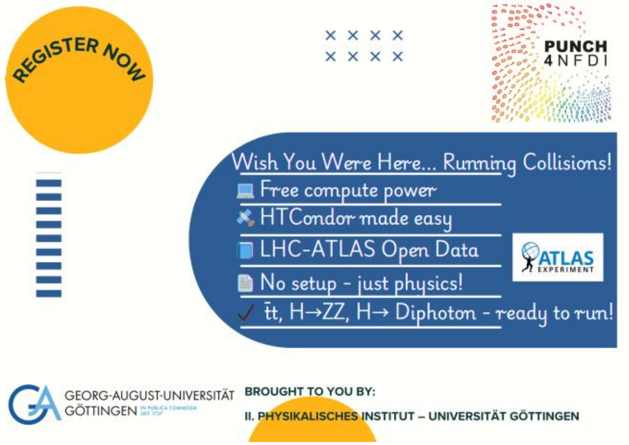
DISCOVER THE POWER OF EXPLORE!

- FREE of Charge
- 90-Day Account
- Easy Access & Usage

https://punchlogin.goegrid.gwdg.de/

Dive into Real LHC-ATLAS Open Data with:

✓ Powerful Computing Resources
✓ Pre-configured Analysis Tools



REGISTER NOW

PUNCH 4NFDI

Wish You Were Here... Running Collisions!

Free compute power

HTCondor made easy

LHC-ATLAS Open Data

No setup - just physics!

✓ $t\bar{t}$, $H\to ZZ$, $H\to$ Diphoton - ready to run!

ATLAS EXPERIMENT

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN IN PUBLICA COMMODA SEIT 1737

BROUGHT TO YOU BY:

II. PHYSIKALISCHES INSTITUT – UNIVERSITÄT GÖTTINGEN

Part V – Conclusion & Impact

Takeaways: from open data in theory to open science in practice!

Conclusion & Impact

Conclusion

- EXPLORE removes long-standing technical and access barriers to ATLAS Open Data.
- By eliminating the need for CERN or university credentials, it opens participation to high school students, educators, and independent researchers.
- Ready-to-use containers, distributed computing, and remote data access make real analyses possible without specialist infrastructure.

Impact for Target Users

- **High School & University Students:** Early exposure to real HEP data and analysis workflows.
- **Educators:** Ready-made environment for teaching particle physics data analysis.
- **Researchers Without Institutional Affiliation:** Access to computing resources and datasets without credential barriers.

Key Takeaways – EXPLORE Service

✓ Simplifies complex technical setups into accessible, batch-based workflows.
✓ Supports compute-heavy analyses beyond online service limits.
✓ Acts as a bridge between Open Data in theory and practical, hands-on analysis.
✓ Positions LHC Open Data as an inclusive resource for education, outreach, and independent research.

Part VI – Future Scope

Sustainability & Integration of EXPLORE into PUNCH-2.0

Migration & Integration Roadmap

Transition contingent on PUNCH-2.0 approval & funding

- EXPLORE @ GoeGrid → phase-out by **2030**
- Transition to **NHR EMMY (GWDG Göttingen, NHR Alliance)**
  - *Provided PUNCH-2.0 gets approved and funded..*
- Ensures:
  - **Scalability** – national HPC resources
  - **Sustainability** – long-term, federated ops
  - **Integration** – PUNCH-2.0 & FAIR ecosystem

Towards Inclusive & Sustainable Access

AAI migration contingent on new features for unaffiliated & under-18 users

- Migration to **PUNCH AAI infrastructure**
  - *Provided AAI extensions for unaffiliated & young users are implemented*
- **Requirements** before migration:
  - ***Email validation*** *for unaffiliated users*
  - ***Parental consent & GDPR compliance*** *for <18*
- Renewable accounts beyond 3-month limit

Goal: EXPLORE accessible via PUNCH Portal → lasting, open entry point to LHC Open Data

Time for Questions

THANK YOU

Acknowledgements

This work was [in part] supported by DFG fund „NFDI 39/1“ for the PUNCH4NFDI consortium.

PUNCH
4NFDI

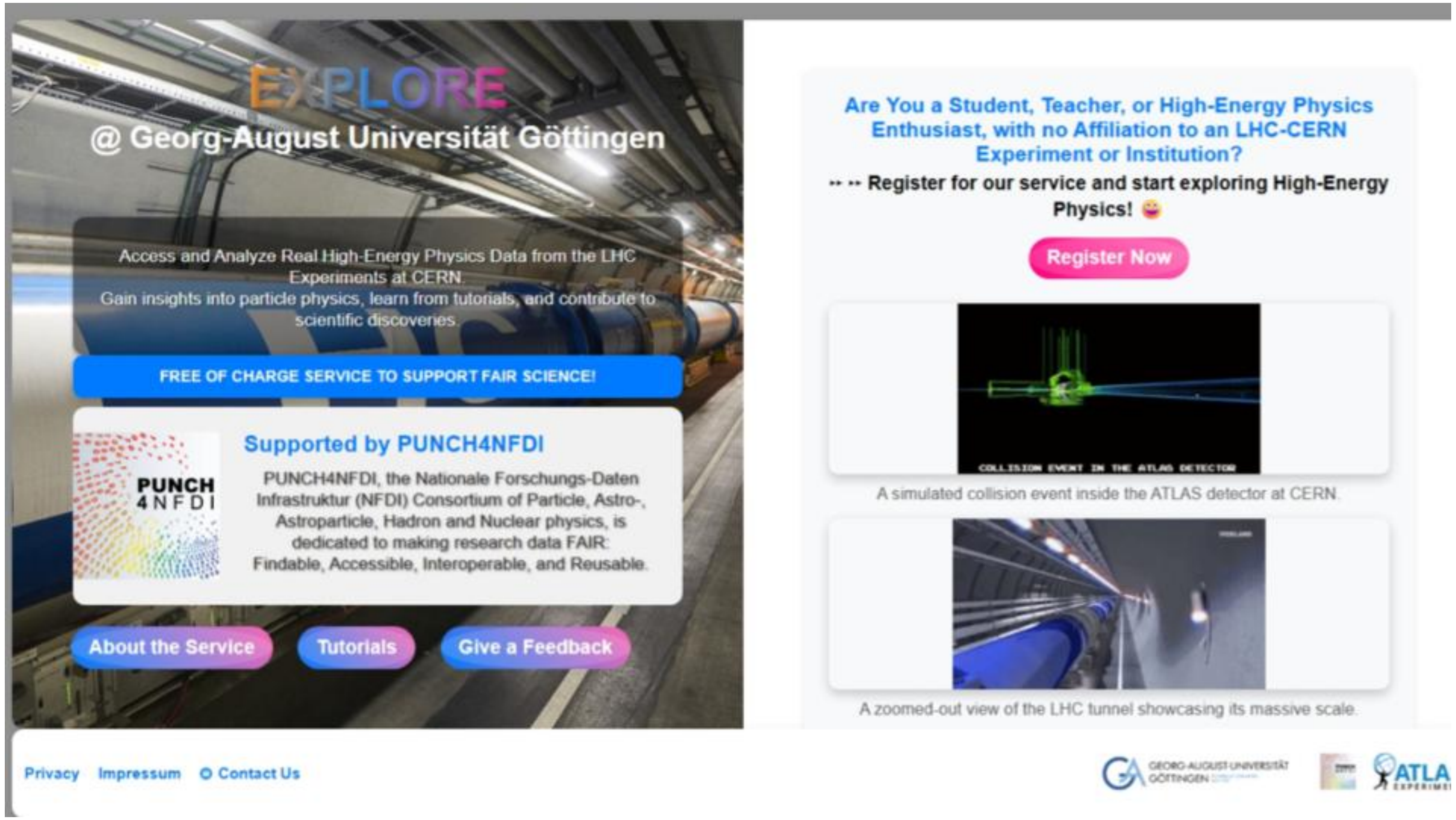
Funded by

DFG Deutsche
Forschungsgemeinschaft
German Research Foundation

Backup

EXPLORE: A Scalable Infrastructure for LHC Open Data Analysis and FAIR Data Provisioning

Access and Analyze LHC Open Data Using EXPLORE-GoeGrid Resources for All Users



EXPLORE

@ Georg-August Universität Göttingen

Access and Analyze Real High-Energy Physics Data from the LHC Experiments at CERN.
Gain insights into particle physics, learn from tutorials, and contribute to scientific discoveries.

FREE OF CHARGE SERVICE TO SUPPORT FAIR SCIENCE!

Supported by PUNCH4NFDI

PUNCH4NFDI, the Nationale Forschungs-Daten Infrastruktur (NFDI) Consortium of Particle, Astro-, Astroparticle, Hadron and Nuclear physics, is dedicated to making research data FAIR: Findable, Accessible, Interoperable, and Reusable.

Are You a Student, Teacher, or High-Energy Physics Enthusiast, with no Affiliation to an LHC-CERN Experiment or Institution?

↔ ↔ Register for our service and start exploring High-Energy Physics! 😜

A simulated collision event inside the ATLAS detector at CERN.

A zoomed-out view of the LHC tunnel showcasing its massive scale.

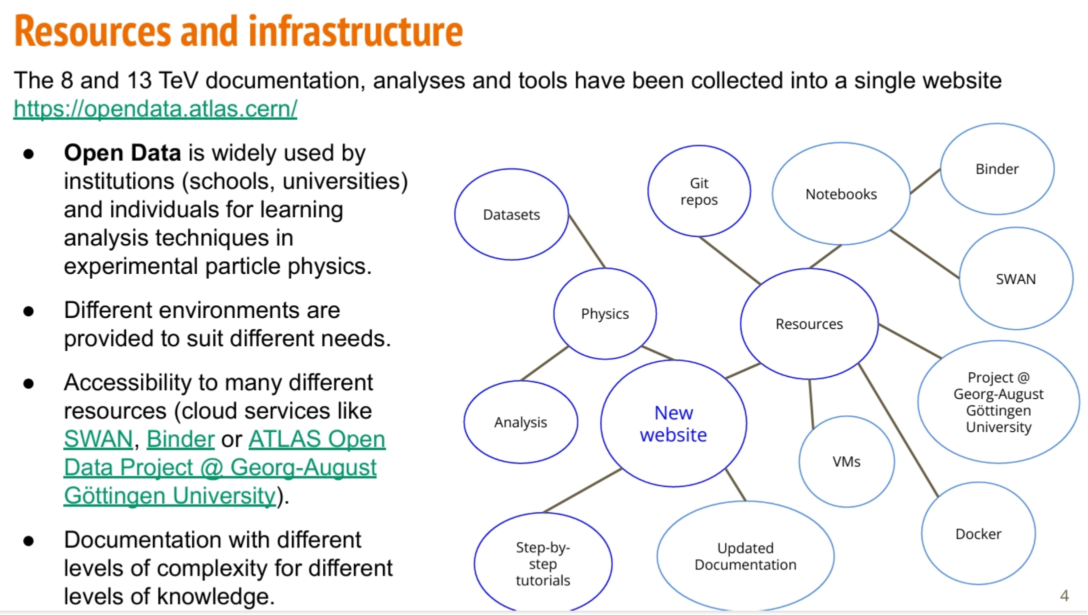
EXPLORE Service @ GAU Göttingen Promoting!

ATLAS Week & Open Data Weekly Meetings

- **ATLAS Open Data Weekly Meetings:** Regular Updates
  - Contribution on 18.07.2024
  - Contribution on 12.12.2024
- **ATLAS Week Outreach:** The service was presented during the **ATLAS Week Outreach parallel session** *(Speaker: Miguel Ángel García Ruíz on behalf of the ATLAS Open Data team).*
- ATLAS WEEK Outreach Parallel Session February 19, 2025

Advertising & Outreach

- **GAU Newsletters:** Promoting the service within academic networks (**Approximately 2,000 recipients**.).
- **Email/Letter Campaign:** Targeting **Lower Saxony High Schools (# 59 Gymnasien**) to expand accessibility.



Resources and infrastructure

The 8 and 13 TeV documentation, analyses and tools have been collected into a single website https://opendata.atlas.cern/

- **Open Data** is widely used by institutions (schools, universities) and individuals for learning analysis techniques in experimental particle physics.
- Different environments are provided to suit different needs.
- Accessibility to many different resources (cloud services like SWAN, Binder or ATLAS Open Data Project @ Georg-August Göttingen University).
- Documentation with different levels of complexity for different levels of knowledge.

New release of ATLAS open data

❖ ATLAS Open Data for Research

- ➢ Particularly useful for theoreticians but not only
- ➢ DAOD_PHYSLITE format 2015-2016 Open Data for Research
  - ■ CERN Open Data Portal. DOI:10.7483/OPENDATA.ATLAS.9HK7.P5SI
    - ● There are 3 publications referring to these data
- ➢ Dataset characteristics: **9'058'437'931 events**. **70'611 files**. **65.3 TiB** in total.
- ➢ A framework allows processing the research data for analysis, see also Zenodo

Heavy Ion data stored as DAOD_HION14 (similar to PHYSLITE)

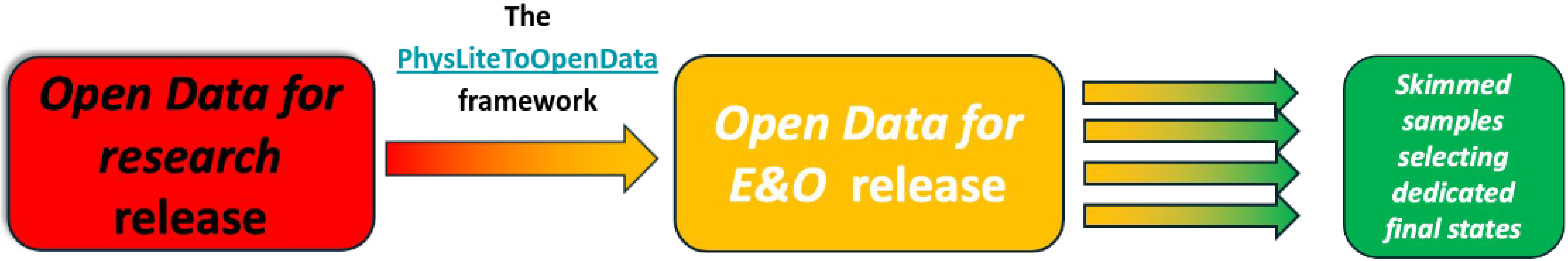
PHYSLITE format:

- *designed to efficiently manage and analyze large datasets generated in ATLAS at high LHC luminosities*
- *same format (ROOT xAOD) as all reconstructed data & simulations from the experiment*

New release of ATLAS open data

- ATLAS Open data for education
  - ROOT ntuple format 2015-2016 proton-proton Open Data for Education and Outreach beta release from the ATLAS experiment
  - A framework allows processing the research data to produce ROOT ntuples, see also Zenodo
  - CERN Open Data Portal. DOI:10.7483/OPENDATA.ATLAS.B5M9.44TN
  - Dataset characteristics: **9’837’961’169 events**, **4668 files**, **2.5 TiB** in total.

Open Data for Education and Outreach



Open Data for research release

The PhysLiteToOpenData framework

Open Data for E&O release

Skimmed samples selecting dedicated final states

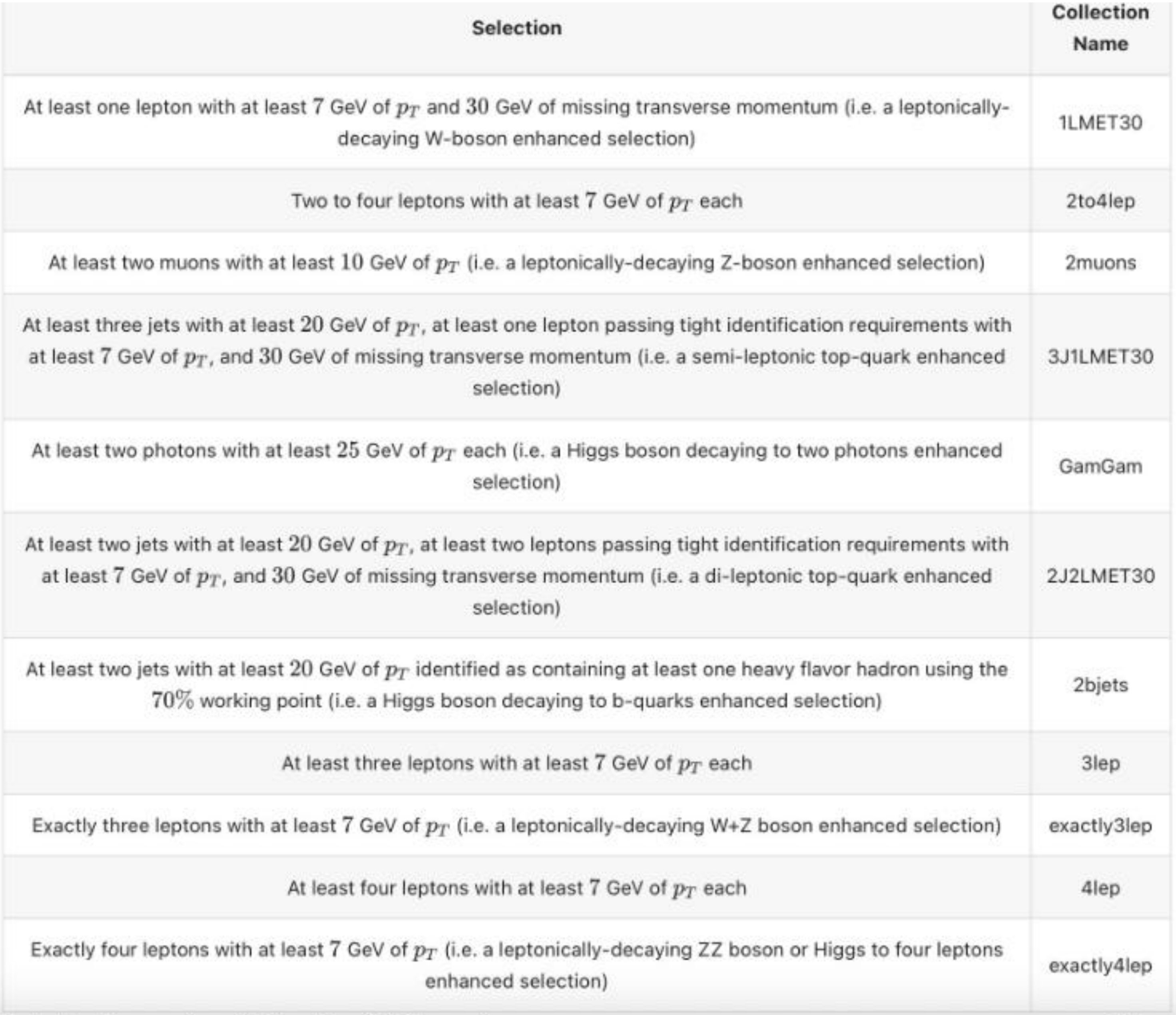
- Total: **65 TB**
  - 36 fb^{-1} of data recorded in 2015 and 2016
  - 2 billions of simulated events
- **Data format**: PHYSLITE

- Total: **2 TB**
- Research samples with only very basic cuts such as event cleaning, good run lists, overlap removal, … 36 fb^{-1} of data recorded in 2015 and 2016
- **Data format**: ROOT Ntuples

- Selected data samples from **~1.5 GB to ~350 GB**
- Targeted analyses
- **Data format**: ROOT Ntuples

Datasets available for Open Data for Education

- ❖ Several final-state collections specifically tailored towards physics analysis example notebooks
- ❖ Original full 36 fb^{-1} samples are also available



Selection	Collection Name
At least one lepton with at least 7 GeV of p_T and 30 GeV of missing transverse momentum (i.e. a leptonically-decaying W-boson enhanced selection)	1LMET30
Two to four leptons with at least 7 GeV of p_T each	2to4lep
At least two muons with at least 10 GeV of p_T (i.e. a leptonically-decaying Z-boson enhanced selection)	2muons
At least three jets with at least 20 GeV of p_T, at least one lepton passing tight identification requirements with at least 7 GeV of p_T, and 30 GeV of missing transverse momentum (i.e. a semi-leptonic top-quark enhanced selection)	3J1LMET30
At least two photons with at least 25 GeV of p_T each (i.e. a Higgs boson decaying to two photons enhanced selection)	GamGam
At least two jets with at least 20 GeV of p_T, at least two leptons passing tight identification requirements with at least 7 GeV of p_T, and 30 GeV of missing transverse momentum (i.e. a di-leptonic top-quark enhanced selection)	2J2LMET30
At least two jets with at least 20 GeV of p_T identified as containing at least one heavy flavor hadron using the 70% working point (i.e. a Higgs boson decaying to b-quarks enhanced selection)	2bjets
At least three leptons with at least 7 GeV of p_T each	3lep
Exactly three leptons with at least 7 GeV of p_T (i.e. a leptonically-decaying W+Z boson enhanced selection)	exactly3lep
At least four leptons with at least 7 GeV of p_T each	4lep
Exactly four leptons with at least 7 GeV of p_T (i.e. a leptonically-decaying ZZ boson or Higgs to four leptons enhanced selection)	exactly4lep

Latest releases of ATLAS Open Data for Education and Research by Prof. Farid Ould-Saada (University of Oslo (NO)) at **The fourth African Conference of Fundamental and Applied Physics, ACP2025**, **will be a hybrid event, jointly organized by ASP and the University of Lomé, Togo, from September 14 to 20, 2025:** https://indico.cern.ch/event/1458227/

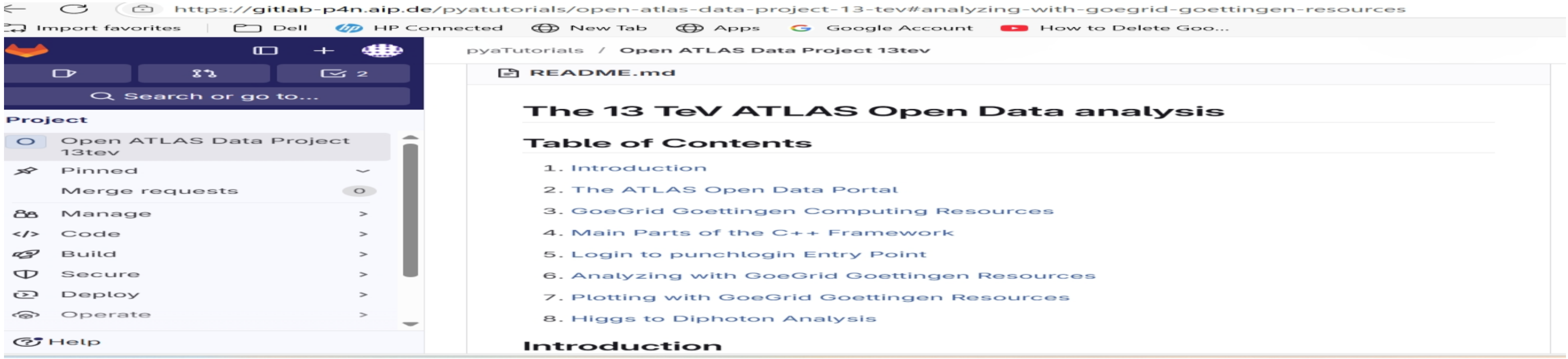
Tutorials, Repositories, and Analysis Framework

Public GitLab Repository
Hosts code, frameworks, and step-by-step analysis guides

Pre-built Analysis Templates:
HZZ, TTbar, Hyy
C++ framework with ready-made scripts

Guides Included:
- Accessing ATLAS Open Data Portal
- Running analysis scripts
- Plotting & interpreting results

Educational Focus:
Tailored for both novices and experienced users


https://gitlab-p4n.aip.de/pyatutorials/open-atlas-data-project-13-tev#analyzing-with-goegrid-goettingen-resources
Import favorites
Dell
HP Connected
New Tab
Apps
Google Account
How to Delete Goo...
Search or go to...
Project
Open ATLAS Data Project 13tev
Pinned
Merge requests 0
Manage
Code
Build
Secure
Deploy
Operate
Help
pyaTutorials / Open ATLAS Data Project 13tev
README.md

The 13 TeV ATLAS Open Data analysis

Table of Contents

1. Introduction
2. The ATLAS Open Data Portal
3. GoeGrid Goettingen Computing Resources
4. Main Parts of the C++ Framework
5. Login to punchlogin Entry Point
6. Analyzing with GoeGrid Goettingen Resources
7. Plotting with GoeGrid Goettingen Resources
8. Higgs to Diphoton Analysis

Introduction