ATLAS Distributed Computing
Overview & Outlook

BNL Splinter Meeting
2025-01-23

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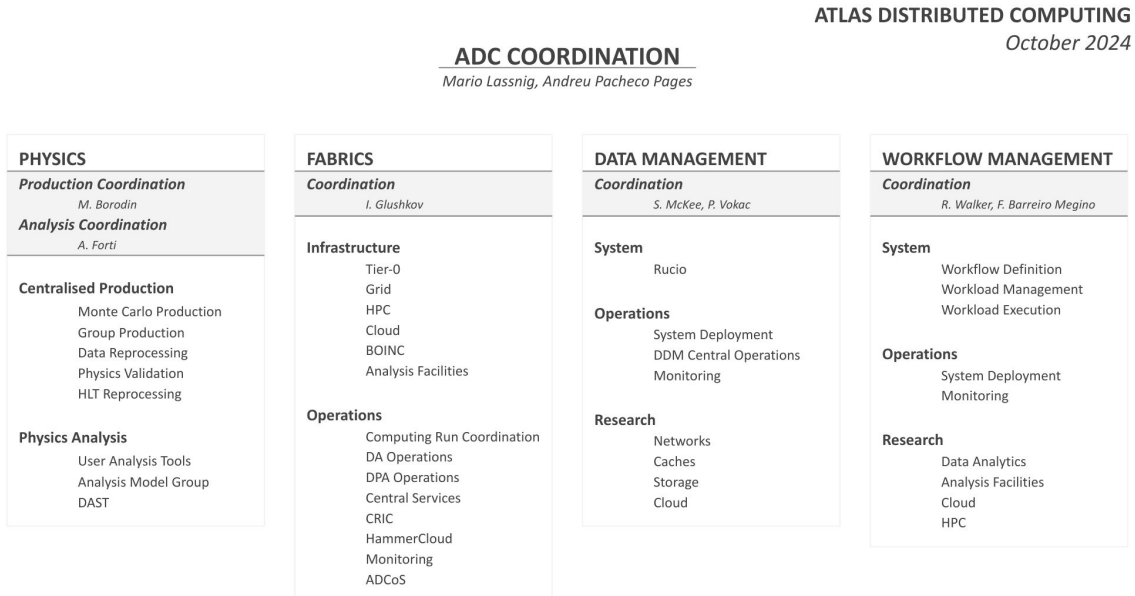
ATLAS EXPERIMENT

ADC Overview

- ATLAS Distributed Computing (ADC) comprises the hardware, software, and operations to
  - Support **distributed computing activities** of the experiments
  - Research and develop the **evolving computing needs** of the experiment
- Running 24 / 7 / 365
  - **Computing never stops**
  - 80+ people contributing centrally
  - 50+ people across the world
- Four major areas
  - Physics computing activities
  - Infrastructure, operations & support
  - Data management
  - Workload & workflow management



- Plus many task forces and working groups, including HPCs and monitoring

ADC communication flow

- Full information here

- The central point of communication dissemination is the Operations Morning Meeting, 09:00 CERN time daily
  - Content is brought by everyone via the pre-filled minutes and is typically about ongoing issues
  - The discussions and eventual decisions are then sent to ELISA shortly after the meeting
- The second important meeting is the ADC Weekly
  - This is to give quick reports by the various areas relevant to ADC
  - This meeting is the prime place to learn about upcoming campaigns/workloads

- ATLAS Virtual Control Room for real time chats
  - https://mattermost.web.cern.ch/adcvcr/channels/adc-operations

- Emails
  - ATLAS users who need general support — hn-atlas-dist-analysis-help@cern.ch
    - Already hosted by Discourse, new email address — atlas-comp-dist-analysis-help@cern.ch
  - Specific help with data management — atlas-adc-ddm-support@cern.ch
  - Specific help with workflow management — atlas-adc-dpa@cern.ch
  - If you don't know who to contact — atlas-adc-expert@cern.ch

A humble request

- It is often times difficult to really understand site's needs
  - Even with years of experience we still have to resort to educated guesses
  - We'd like to streamline this a bit better

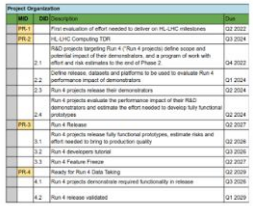
- We are currently fully rebuilding our documentation
  - Migration of content from TWiki from hosted CERN mkdocs-material based service
  - Website https://atlas-computing.docs.cern.ch/
  - Content https://gitlab.cern.ch/atlas/computing-docs/atlas-computing-docs

- If you have any suggestions to improve our documentation
  - Do not hesitate to open a ticket in gitlab
  - Do not hesitate to submit new documentation merge requests
  - Do not hesitate to update existing documentation merge requests

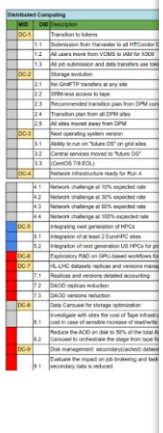
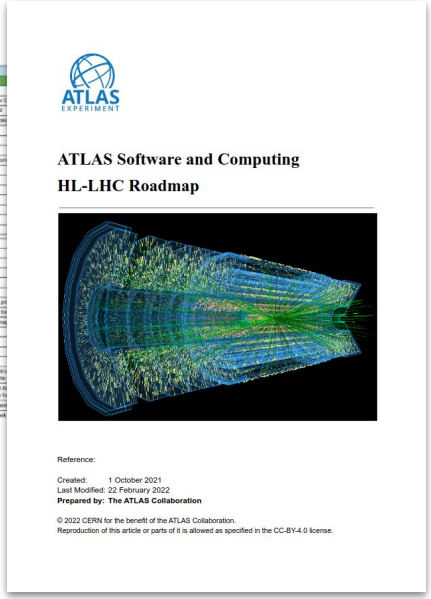
R2R4 - The Road to Run-4

- LHCC performs a series of reviews of the Software and Computing plans of the LHC experiments towards HL-LHC
  - The ATLAS HL-LHC Computing Conceptual Design Report was published in May 2020

- A follow up ATLAS Software and Computing HL-LHC Roadmap was published in March 2022 with clearly defined *milestones* – nicknamed "The Road to Run-4" (R2R4)





- ATLAS HL-LHC Computing TDR is planned for this year

ADC Milestones

- **DC-1** Transition to tokens
- **DC-2** Storage evolution
- **DC-3** Next operating system
- **DC-4** Network infrastructure
- **DC-5** Integration of HPCs
- **DC-6** Non-x86 hardware
- **DC-7** Replication management
- **DC-8** Data Carousel
- **DC-9** Storage usage
- **DC-10** Cloud computing
- **DC-11** Analysis experience
- **DC-12** Sustainability
- **DC-13** Workflow management

Demonstrators

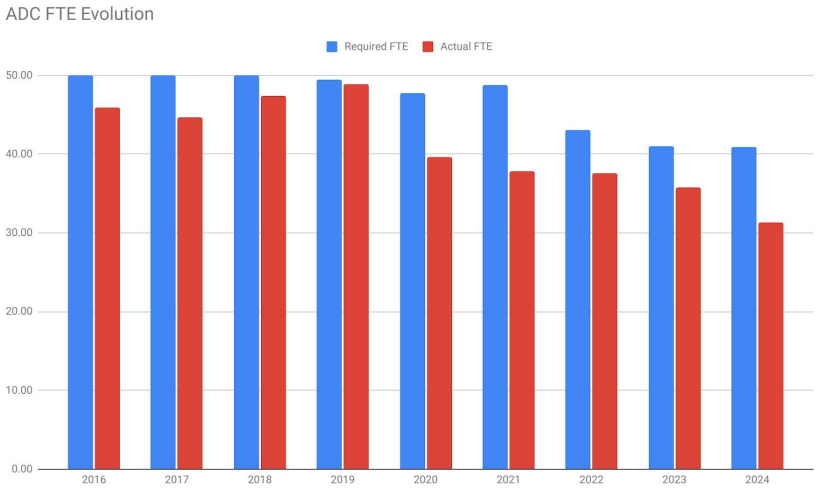
- **DONE**
  - ATLAS-Google as a fully integrated site
  - ATLAS-Google as “bursty” resources
  - ARM based PanDA queues
  - Sustainability in ATLAS Computing
  - Recreate DAODs on demand with Data Carousel ✅
- **ONGOING**
  - Optimized writing to tape for efficient reading
  - Simulation of grid scheduling R&D NEW!
  - Complex workflows R&D NEW!
- **ON HOLD**
  - Using Xrootd to seamlessly integrate S3 storage
  - General ARM OSG queue at BNL
  - Measurement of ATLAS energy consumption
  - Storage for data intensive application

Distributed Computing Risk Register

Category	Risk	Likelihood	Impact	Severity	Owner	Effect
Consensus	Stagnant interactions between key community projects	3	4	12	WLCG, CERN-IT, ADC	Long-winded discussions with no clear decisions and outcomes; Non-working APIs; Incompatible implementations
Catastrophes	Significant downtimes related to environmental disasters	2	5	10	WLCG	Unavailability of large volumes of data for extended periods
Capacity	Not enough available storage, CPU, network and/or dedicated hardware (GPUs)	2	5	10	WLCG, ATLAS	Cannot execute jobs; Cannot distribute data; Cannot store data
Dependencies	Loss and/or frequent changes in software dependencies	3	4	12	CERN-IT, WLCG, ADC	Failures in software execution; Additional development effort; Being stuck with old unsupported software
Procurement	Mismatch of ATLAS requested resources vs. site-provided resources	2	4	8	WLCG, ATLAS	Starvation of tasks due to limited resources; Additional costs for sites due to unclear schedules; Loss of allocations
Central support	Lack of persons to support analysis users, production managers, and to follow-up daily operational tasks	4	4	16	ADC	Prolonged task execution; Task submission delays; Storage resource overloads; Angry users
Personpower	Difficulty in retaining key personnel, impact on progress of ongoing projects	5	5	25	ADC	Impact on progress of important projects; Long delays; Potential cancellation of projects
Organisation	Insufficient number of suitable persons in leading roles	4	3	12	ADC	Destabilise ADC organisation, effectiveness, and follow-up of tasks

ADC Devolution

- Continuous loss of FTEs since 2019
  - With even bigger drops '19-'20, and '23-'24
    - Funding cycles ended, R&D projects ended
    - Lots of these people were involved in operations
  - Now, operations at critical level
    - *Production* 2.4 FTE (4 persons)
    - *Data management* 0.7 FTE (3 persons)
    - *Analysis support* 1.7 FTE (4 persons)
  - Central systems development
    - Rucio stable due to CERN & Community
    - PanDA/ProdSys stable due to USATLAS & Community
  - Infrastructure
    - Hinges on 0.05 commitments across tens of people
    - Issues with non-ADC systems, e.g., CVMFS or IAM, still require valuable ADC expert time
    - Monitoring effort has almost vanished



- Observations
  - The majority of the 77 persons in ADC have contributions of < 0.2 FTE
  - Many critical services depend on single persons who are already overwhelmed with work
  - Big '21-'22 drop in *Required FTE* due to acceptance that many R&D projects won't continue
  - Barely any young/fresh persons join computing, and senior experts are getting dragged into coordination

ADC Evolution

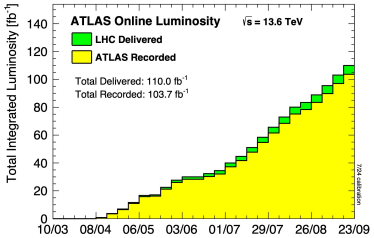
- We consider the following topics important for the TDR

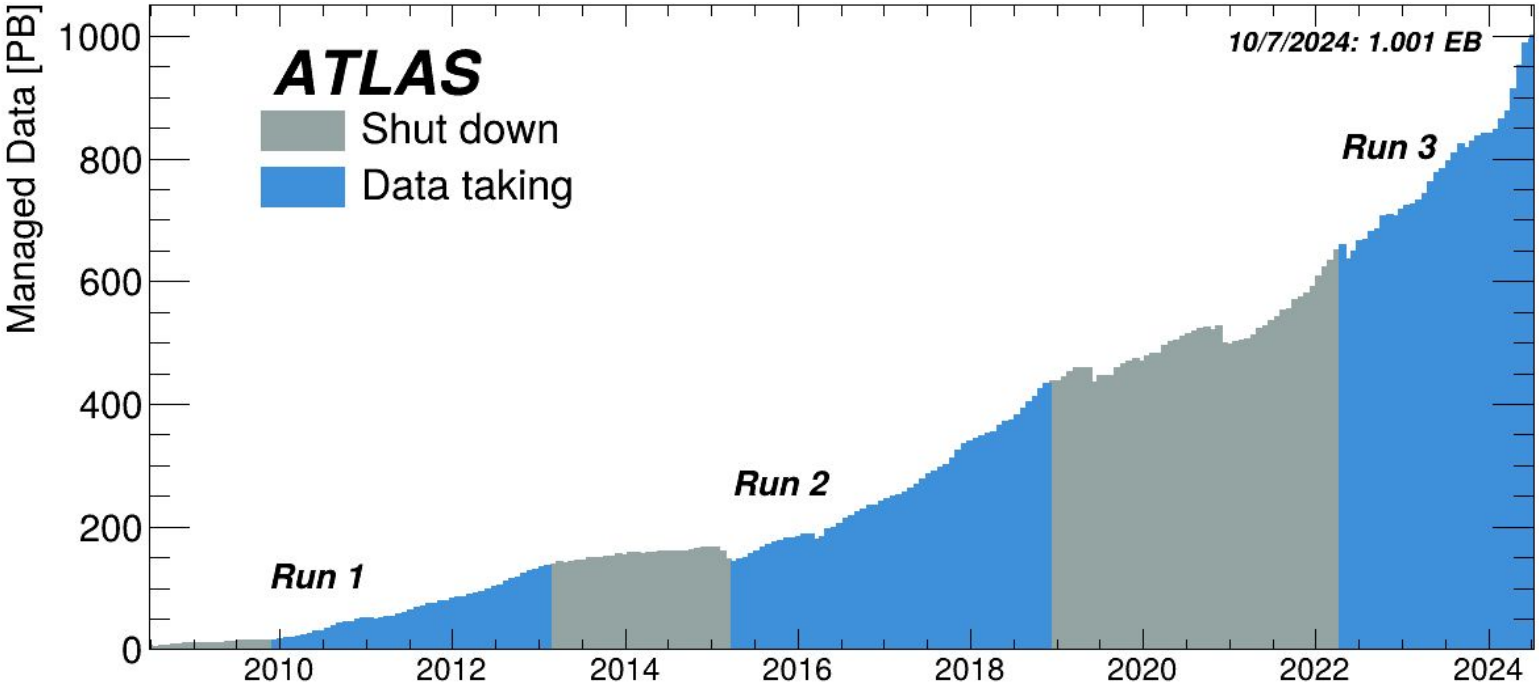
- The new security model: Shift from X.509 to tokens
  - Has a profound impact on infrastructure, systems, and users
- Community computing as foundation of our shared infrastructures
  - Rucio already established and constantly pulling in new communities, recently SKA
  - PanDA is going the same way, which is very much appreciated
  - If we do not actively engage and cooperate with other big sciences we will be left out eventually
- Infrastructure stress-testing and system upgrades
  - ADC is driving the HL-LHC Data Challenges with our people in key positions
  - We need to continue to invest here
- Allowing more flexibility for our computing models
  - R&D projects to evaluate different approaches (Recreation, Data Carousel, Clouds, …)
- Opportunistic resources (Clouds & HPCs)
  - Fundamental shift in infrastructure procurements from countries / funding agencies
  - We need to continue to invest here
- Sustainable computing (beyond ARM)
  - Unfortunately we do not have enough effort here, but we need to raise awareness

Backup

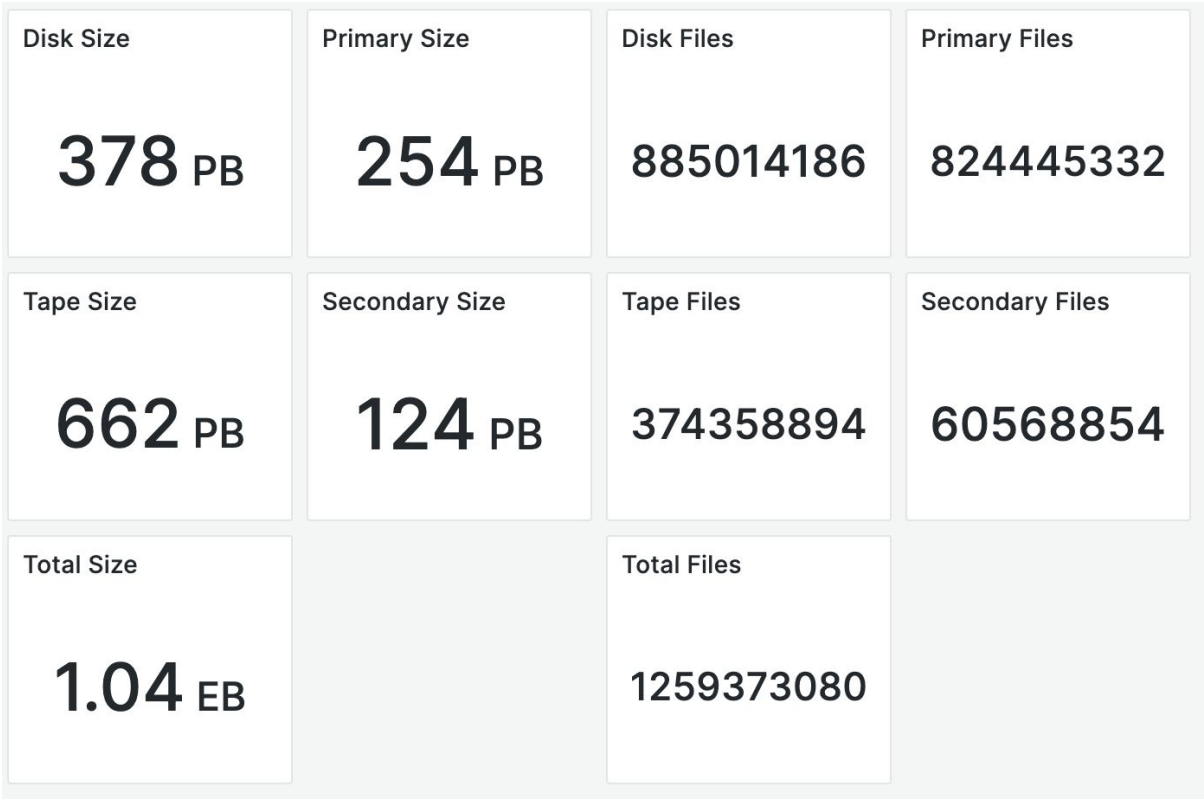
Major Rucio milestone - July 2024

- ATLAS has reached 1 Exabyte of Rucio-managed data
  - LHC delivered more than full 2024 **pp** target of 110/fb^{-1} early
  - Data-taking efficiency at 94.3% !
  - Frequent applications of Lifetime model and Catmore-rule necessary

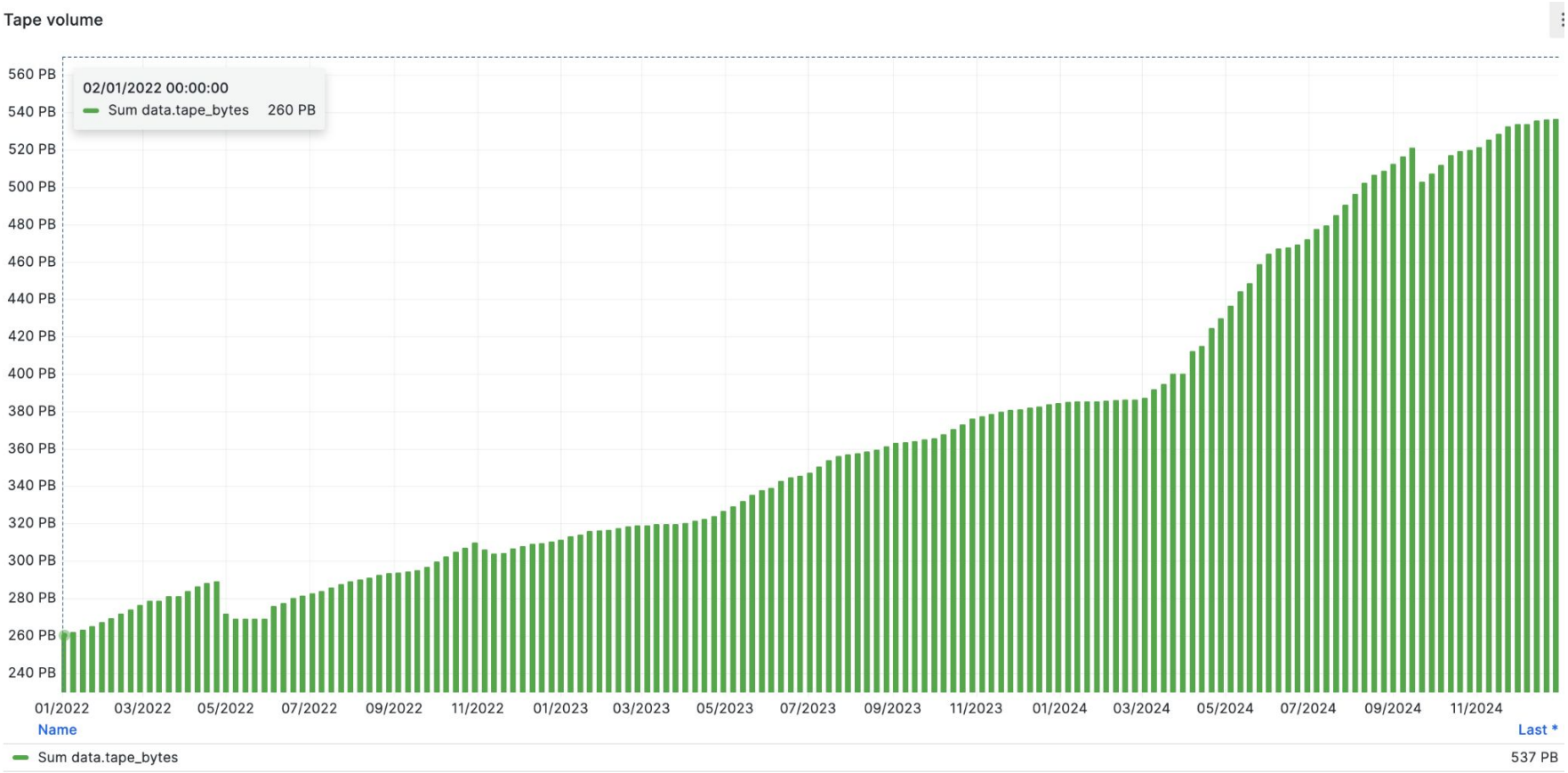




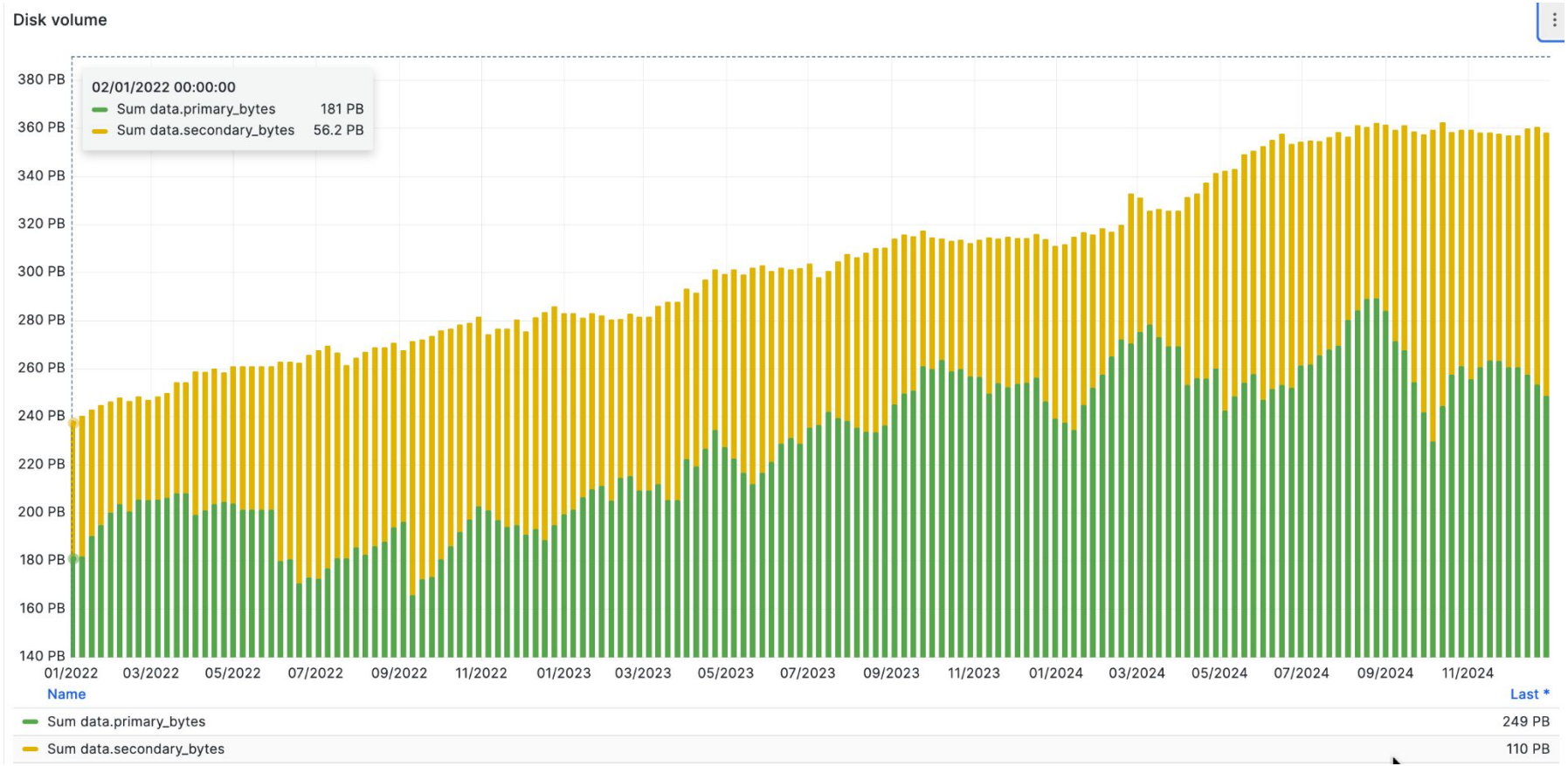
Where we are: Data in Rucio - 17 Jan 2024 (source)



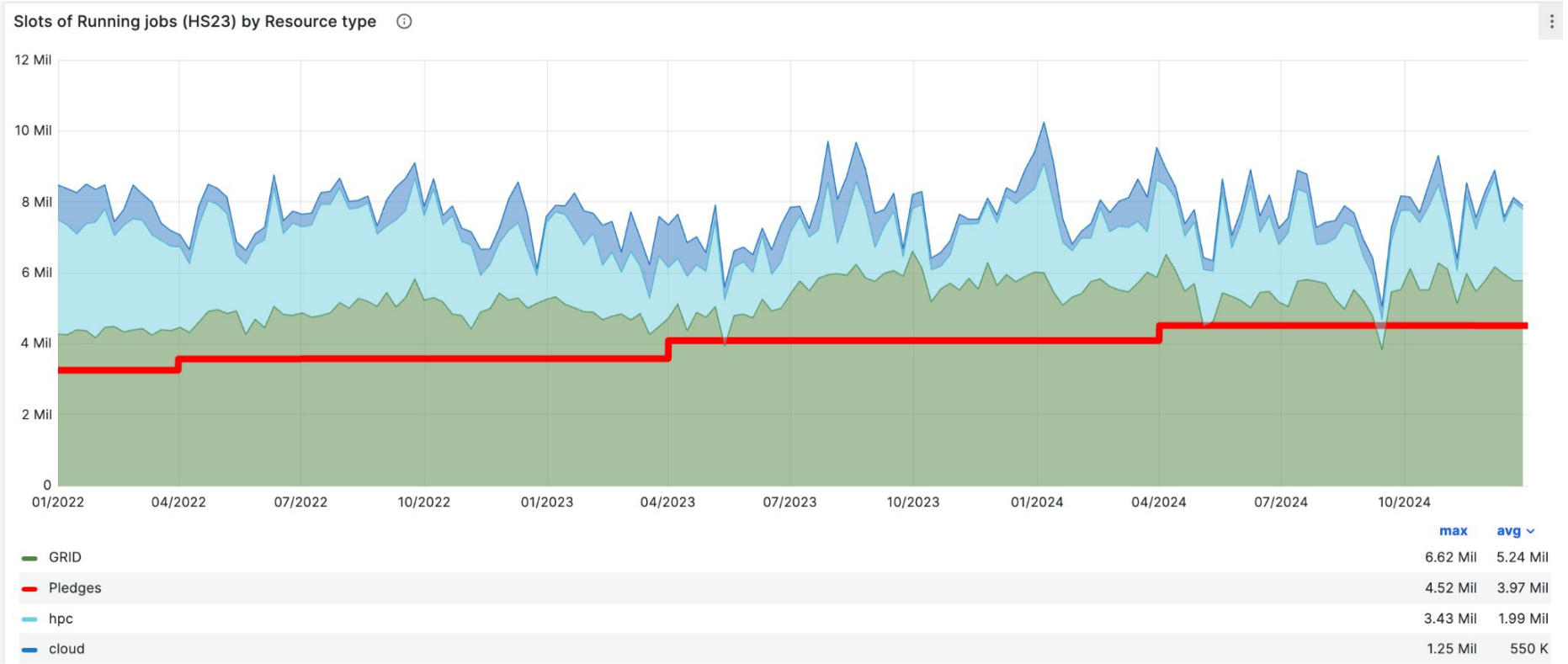
Where we are: 3-year pledged data volume on tape (source)



Where we are: 3-year pledged data volume on disk (source)



Where we are: 3-year normalized slots of running jobs (source)



- Centralised production and user analysis have been running at full steam
  - Multiple concurrent campaigns of various intensity and duration
  - Physics Validation, Production, Reprocessing, Derivation