Analysis Facility - US ATLAS Perspective

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Future Analysis Systems and Facilities Workshop

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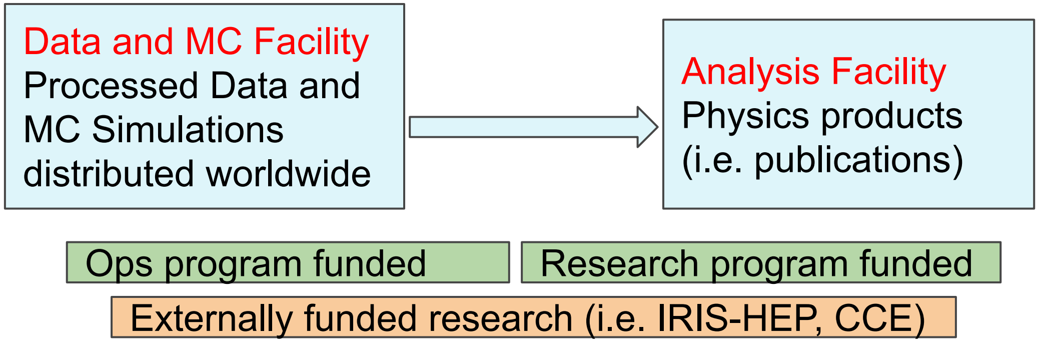
What is an Analysis Facility

- Much has been said already - however, Analysis Facility (AF) probably means something different for every participant
- From US ATLAS Ops (Operations Program) perspective:



Data and MC Facility
Processed Data and MC Simulations distributed worldwide

Analysis Facility
Physics products (i.e. publications)

Ops program funded

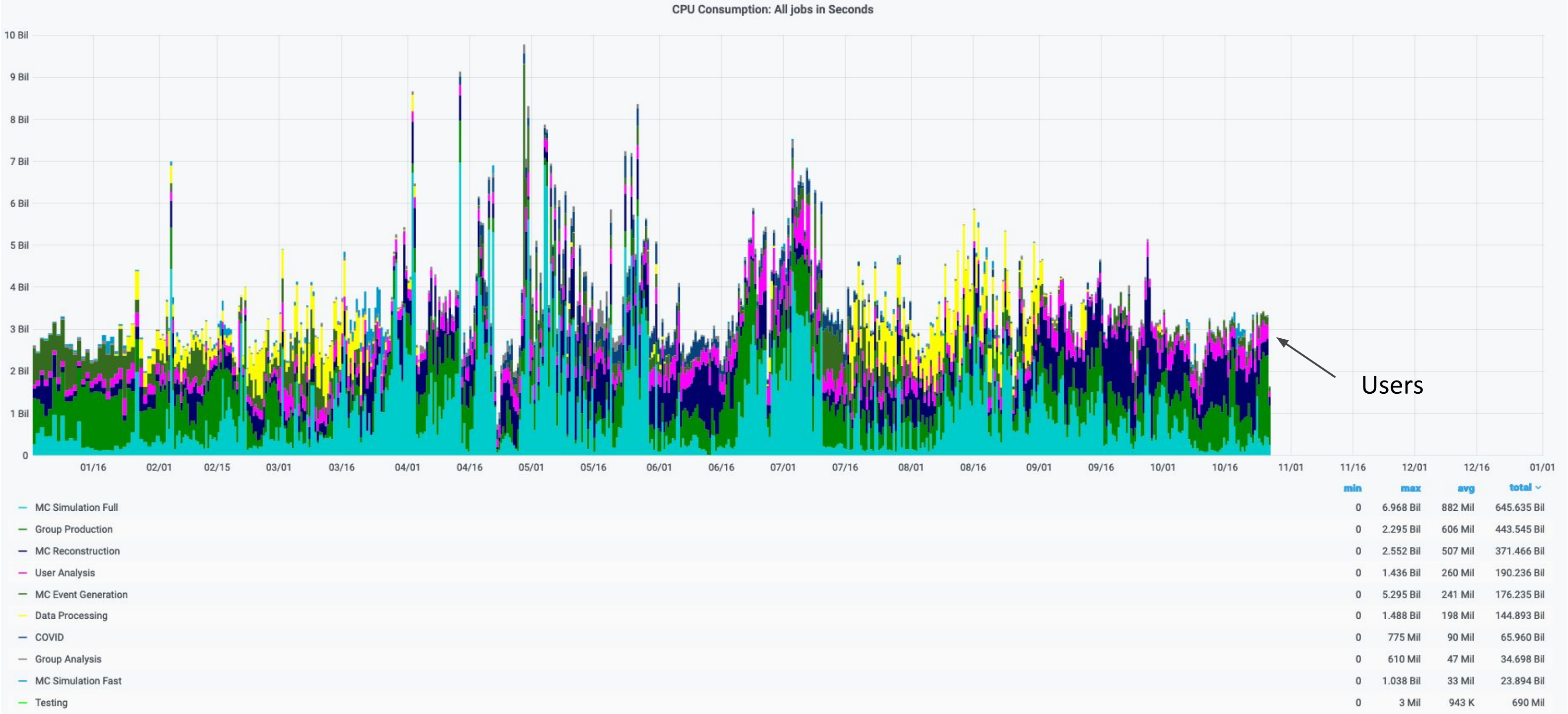
Research program funded

Externally funded research (i.e. IRIS-HEP, CCE)

- The boundary is fuzzy - often the focus of many discussions
  - Who pays for what - at the most basic level?
  - What is the functionality in each box - constantly evolving?
  - What infrastructure is needed for each box - this talk

Data and MC Facility

- US ATLAS Tier 1 and Tier 2 sites
  - We add HPC’s and commercial clouds as allocated
  - Also some opportunistic (non-tiered, non-pledged) resources
- About 10% of usage comes from user analysis jobs on the grid
  - Simulations, derivations, streaming, slimming, merging, HPO...



	min	max	avg	total ⌄
— MC Simulation Full	0	6.968 Bil	882 Mil	645.635 Bil
— Group Production	0	2.295 Bil	606 Mil	443.545 Bil
— MC Reconstruction	0	2.552 Bil	507 Mil	371.466 Bil
— User Analysis	0	1.436 Bil	260 Mil	190.236 Bil
— MC Event Generation	0	5.295 Bil	241 Mil	176.235 Bil
— Data Processing	0	1.488 Bil	198 Mil	144.893 Bil
— COVID	0	775 Mil	90 Mil	65.960 Bil
— Group Analysis	0	610 Mil	47 Mil	34.698 Bil
— MC Simulation Fast	0	1.038 Bil	33 Mil	23.894 Bil
— Testing	0	3 Mil	943 K	690 Mil

Analysis Facility

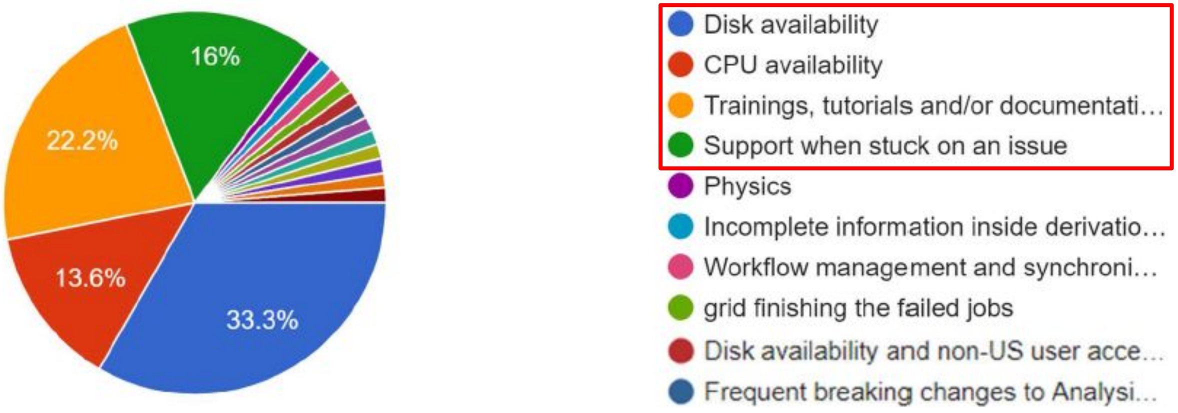
- Terminology in US ATLAS - Tier 3 or AF is interchangeable
  - They are very different from distributed T1/T2 grid facilities
- For many users, AF is their laptop/desktop
  - In addition to being the portal to ATLAS apps and services, many users actually do their computation on laptops/desktops
- For most users, AF is a small batch system
  - This is still the most popular user analysis facility - a local Tier 3 site
  - However, it is getting harder and harder for small groups to find funding for, maintain, and operate local Analysis Facilities
- For many users, AF is a big shared batch system
  - All US ATLAS users have access to two Shared T3s, a 3rd is being built
  - These AFs have been battle hardened during Run 2 (~4 years)
  - They provide usability apps, grid tools, ATLAS software and apps, derived data access, batch slots, local storage, Jupyter etc
  - These shared AFs are funded by US ATLAS - not research groups

Lessons Learned so far

- We have >10 years experience with AFs in US ATLAS
  - Every user needs something different to be productive
  - We provide the facility, training and support - users do analysis
  - Users vote with their feet - top down seldom works
  - We need robust, flexible, and easy to use systems that can evolve
  - All of the above are obvious - but worth repeating

What is your biggest limitation when you are trying to do analysis?

81 responses



Recent US ATLAS user survey

Ideal US ATLAS AF

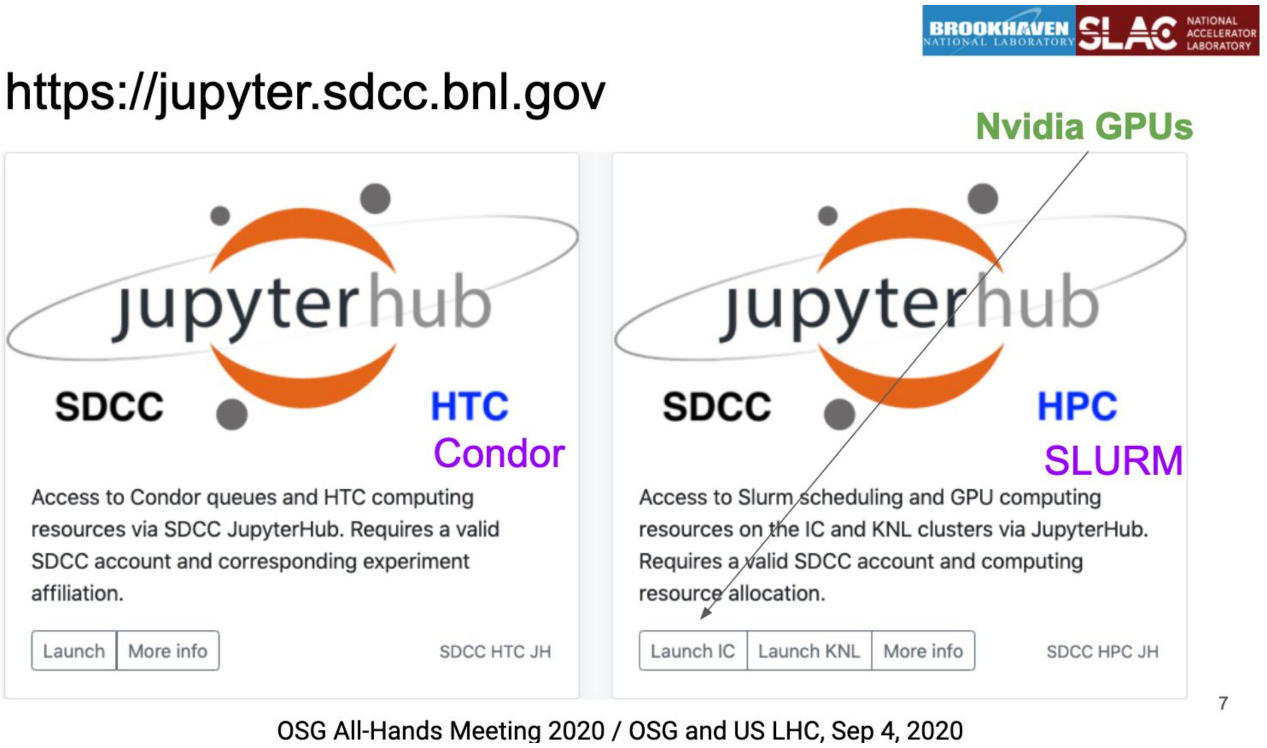
- 24x7 uptime, accessible worldwide, support ~300 active physicists, storage for all derived data, easy collaborative access, provide access to a wild world of apps and tools
  - Current level of derived storage ~100 PB - grow ~20% per year
  - Current analysis CPU+GPU needs ~50k cores - grow ~20% per year
  - Current users ~300 physicists - not expected to change a lot
  - Allow sharing of workspace with ~2000 international collaborators
  - Scalable, sustainable, interactive, (new) user friendly...
- Build at BNL T1 - roughly x2-x4 current facility cost
- At a dedicated large facility - see Paolo’s talk next
- On a cloud - see Johannes’ & Harinder’s talks this afternoon
- Hybrid facility - rest of this talk
- Choice is often driven by the source(s) of funding

Hybrid AF

- Current US ATLAS AF model
  - If gold plated AF not affordable, assemble many nuggets
- US ATLAS is supporting the following - on best effort basis
  - Enable the use of small local systems - limited support
  - Support most common workflows at T1/T2 facilities
    - Scalable and affordable for all users - not limited to US sites
  - Fund and support shared T3 facilities for end-stage analysis
    - At BNL, SLAC and UChicago (new - operational 2021)
    - Provide some support for new users (documentation, tutorials)
  - Support widely used tools that are scalable and sustainable
  - US ATLAS Ops funding is limited - x5 smaller than external sources of funding for analysis tools, services and facilities

BNL Shared Tier 3

- See talks by William Strecker-Kellogg (BNL) at OSG All Hands
- Easy-to-use interactive nodes, batch systems, local storage…
  - ~2200 CPUs, access to GPUs, scratch space, local storage…
  - Traditional batch systems and Jupyter



https://jupyter.sdcc.bnl.gov

Nvidia GPUs

BROOKHAVEN NATIONAL LABORATORY
SLAC NATIONAL ACCELERATOR LABORATORY
jupyterhub
SDCC
HTC
Condor

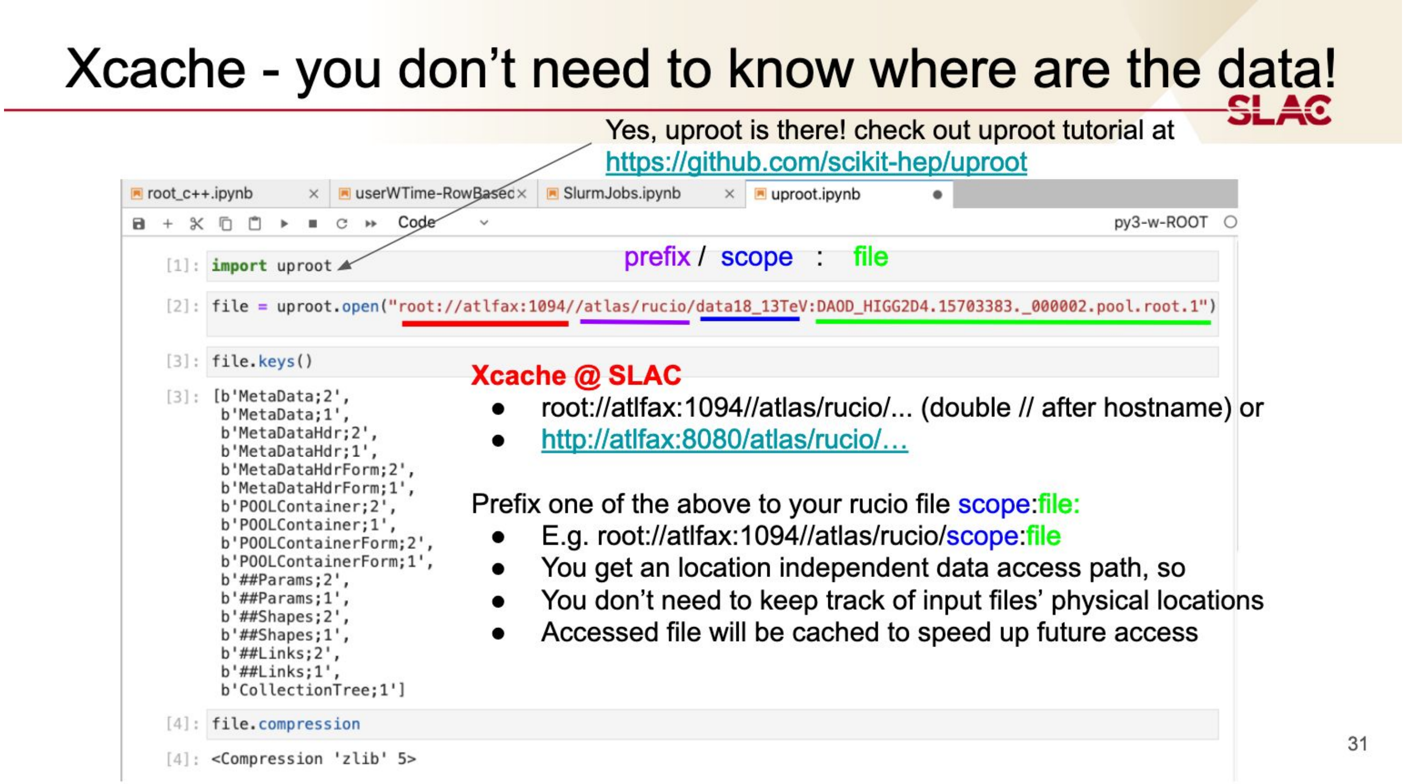
Access to Condor queues and HTC computing resources via SDCC JupyterHub. Requires a valid SDCC account and corresponding experiment affiliation.

Access to Slurm scheduling and GPU computing resources on the IC and KNL clusters via JupyterHub. Requires a valid SDCC account and computing resource allocation.

OSG All-Hands Meeting 2020 / OSG and US LHC, Sep 4, 2020

SLAC Shared Tier 3

- See talks by Wei Yang (SLAC) at OSG All Hands/WLCG
  - ~3400 CPUs, some GPUs, few PB storage
  - Interactive logins, batch jobs, Jupyter, xcache, containers...



Xcache - you don’t need to know where are the data!

Yes, uproot is there! check out uproot tutorial at https://github.com/scikit-hep/uproot

prefix / scope : file

```
[1]: import uproot

[2]: file = uproot.open("root://atlfax:1094//atlas/rucio/data18_13TeV:DAOD_HIGG2D4.15703383._000002.pool.root.1")

[3]: file.keys()

[3]: [b'MetaData;2',
      b'MetaData;1',
      b'MetaDataHdr;2',
      b'MetaDataHdr;1',
      b'MetaDataHdrForm;2',
      b'MetaDataHdrForm;1',
      b'POOLContainer;2',
      b'POOLContainer;1',
      b'POOLContainerForm;2',
      b'POOLContainerForm;1',
      b'##Params;2',
      b'##Params;1',
      b'##Shapes;2',
      b'##Shapes;1',
      b'##Links;2',
      b'##Links;1',
      b'CollectionTree;1']

[4]: file.compression

[4]: <Compression 'zlib' 5>
```

Xcache @ SLAC

- root://atlfax:1094//atlas/rucio/... (double // after hostname) or
- http://atlfax:8080/atlas/rucio/...

Prefix one of the above to your rucio file scope:file:

- E.g. root://atlfax:1094//atlas/rucio/scope:file
- You get an location independent data access path, so
- You don’t need to keep track of input files’ physical locations
- Accessed file will be cached to speed up future access

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Towards a Gold Plated AF

- Can we do better than Hybrid/Tier 3 model
  - Yes - user surveys show some shortcomings of current model
  - A large well staffed high performance data center would be better
  - But need additional funding - current budgets will pay <10% of cost
- Build AF at BNL (colocated with US ATLAS Tier 1)
  - Gold plated == full featured, full scale
  - Interactive, easy to use, well connected, all derived data local…
  - Need to be x3-x4 current T1 capacity, large support staff
- Build AF at large ASCR or CISE funded facility
  - Similar concept to BNL AF
- Provision AF on commercial cloud
  - AWS, Google, MS, Oracle - many capable vendors
  - Limited only by funding
  - Simple list price based cost model shows x5-x10 cost of BNL T1

Summary and Speculations

- Many things will change during Run 3
- And again at the HL-LHC
- Analysis Systems being developed now will drive this change
    - Looking forward to many of the tools described in talks yesterday moving to production quality services
    - US ATLAS is/will partner in most of these tools
        - We also continue to support some limited ATLAS specific tools
    - Important metric - benefit and scalability on our infrastructure
        - Ease of installation and use in our Shared T3s
    - Additional metric - support cost
        - Sustainability is critical to long term success
- US ATLAS will continue to support the development and deployment of software and computing systems that our users need to accelerate their physics products