

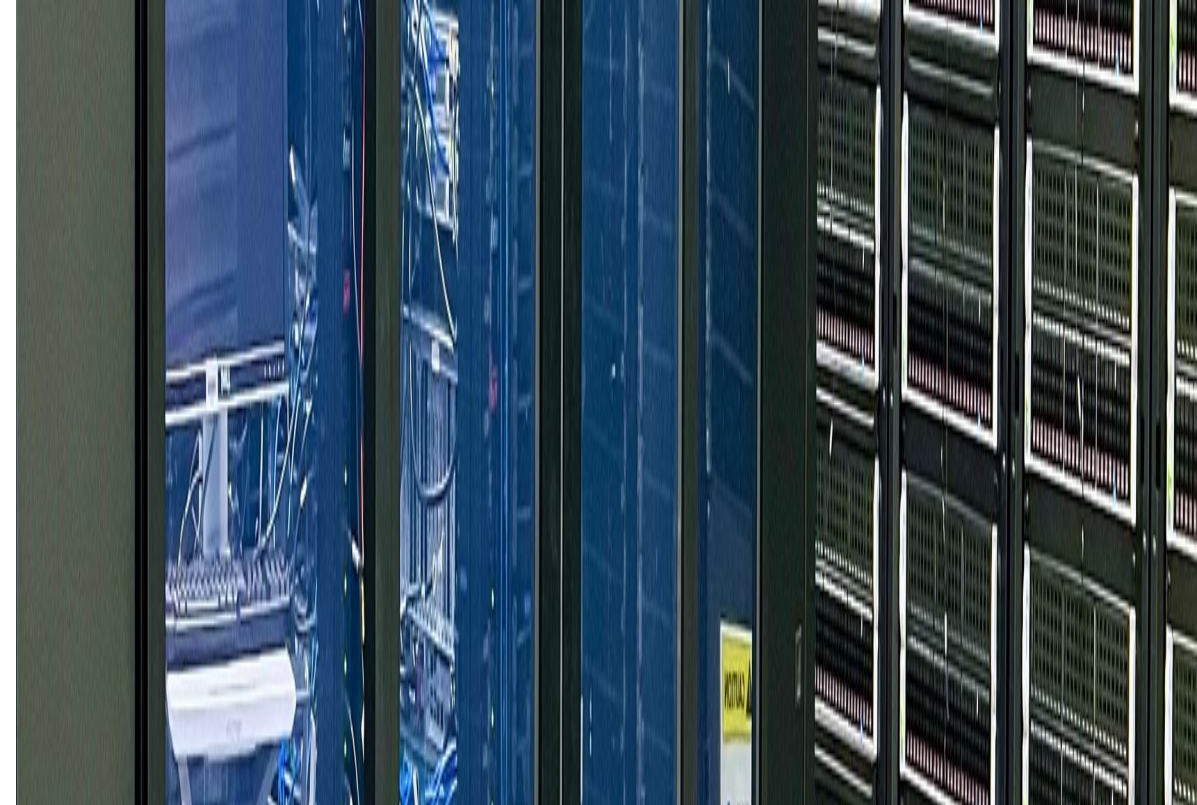
Jefferson Lab Scientific Computing Infrastructure Update

CLAS Collaboration Meeting
November 2023

Brad Sawatzky

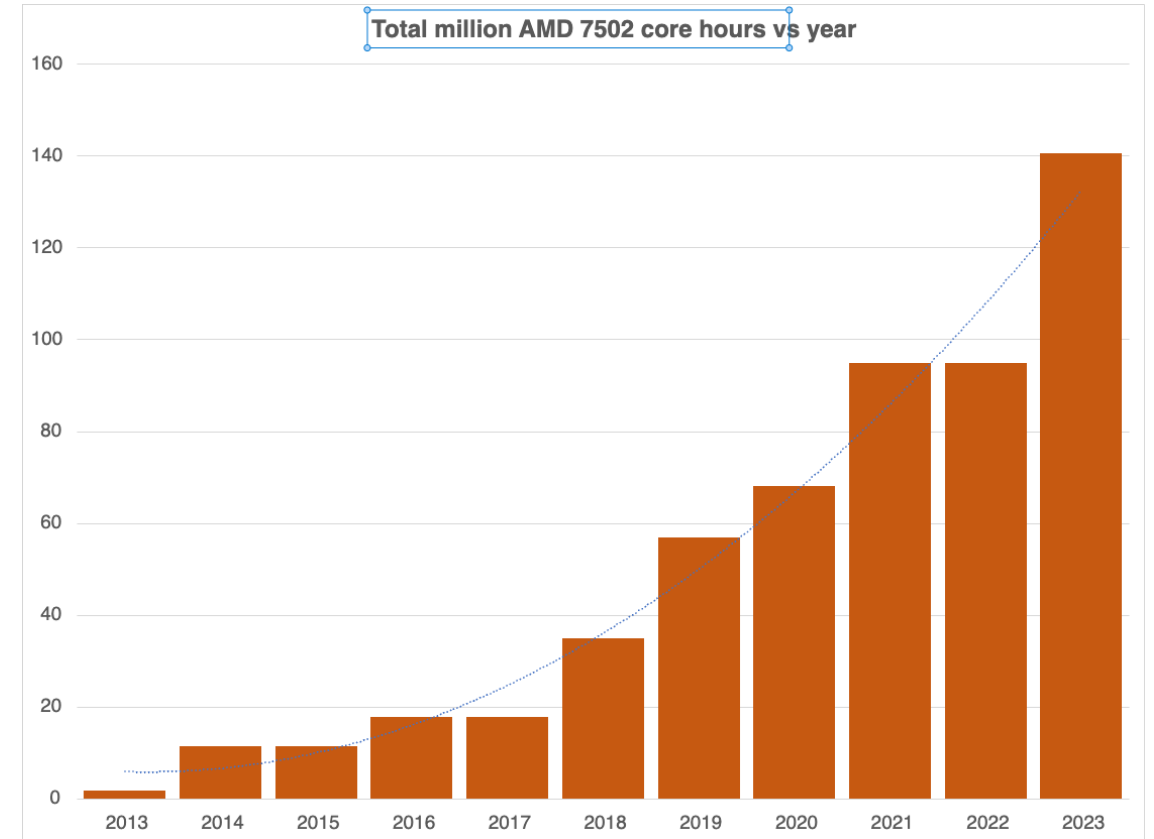
Tuesday, November 7, 2023

Jefferson Lab



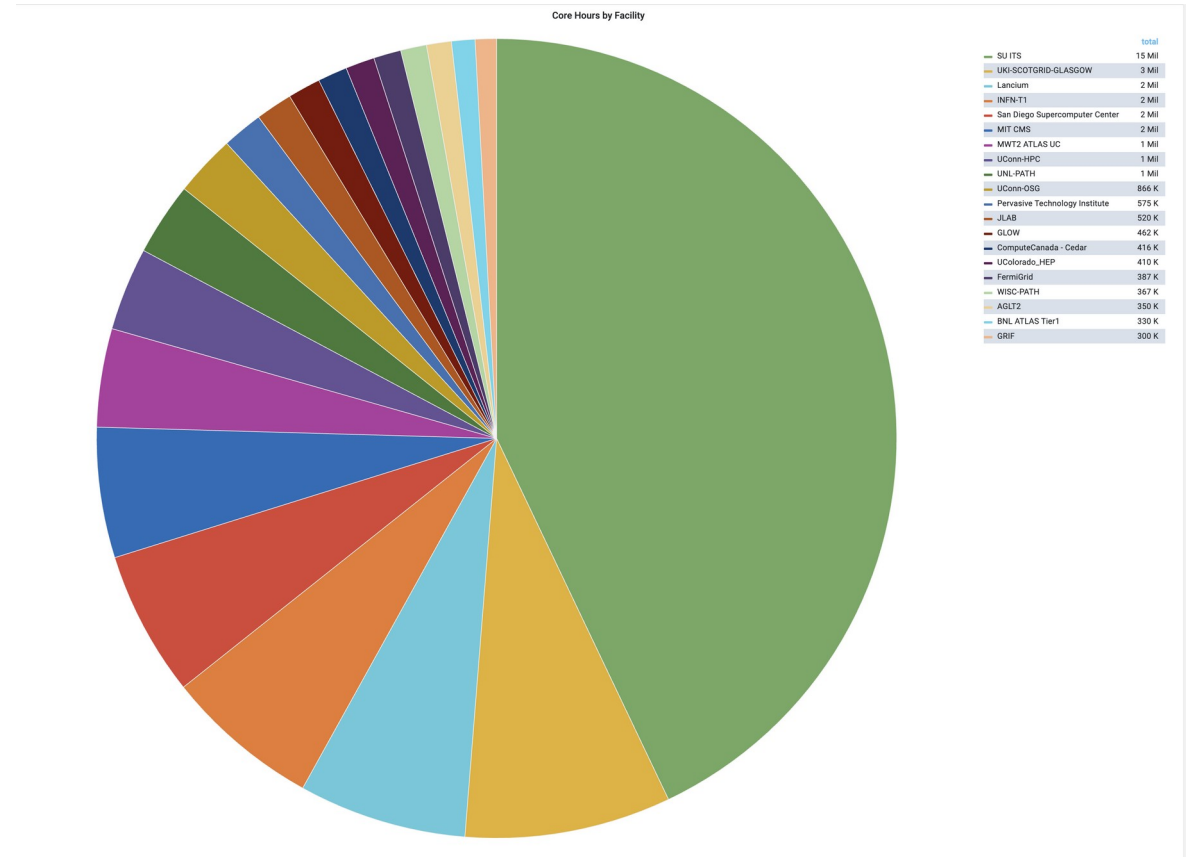
Jefferson Lab's High Throughput Computing – The Farm

- In FY23 3072 EPYC 7763 AMD “Milan” cores added to the farm
- FY19 – FY21 Were EPYC 7502 “Rome”
- 140 Million Core Hours (Using 7502 as normal)
- Farm14 nodes are being decommissioned now
 - Oldest HW, nodes reused for ad-hoc projects and/or excessed
- The farm is routinely busy, Utilization is almost always over 80%
- FairShare allocations are used to balance consumption between the halls
 - B&D ~40% each
 - A&C ~20% each
 - Bursts beyond share when cycles are free
 - CLAS routinely claims free cycles.
 - **NB: Hall A data volumes and analysis requirements are rising to Hall B/D levels (SBS program, Moller)**
 - Allocations will need rebalancing in 2024/5



Off-Site Computing: Open Science Grid use by CLAS12

- CLAS12 consumed an additional 37M Core Hours on the Open Science Grid in FY23
 - This is MC load that would not be achievable on the JLab farm without scheduling pressure
- We are moving to a model with the OSG where each Project (CLAS12, GlueX, ePIC, Moller) have their own OSG servers
 - Enables pilot job tuning and data storage strategies that match the collaboration's needs.
- **NERSC has cycles available on Perlmutter at no cost (but must apply); Lawrenceium not 'free' but arrangements can be made**
 - Code in SWIF already supports NERSC
 - If interested, email brads@jlab.org



Farm Operating System Upgrade

- The Farm is presently running CentOS 7.9, which is approaching EOL.
- The next OS for the Farm will be AlmaLinux9
 - CentOS project was disbanded by RH; replacement distributions are similar, but not “bug for bug” identical to RHEL
 - Switch to Alma9 aligns with CERN, OSG, and other HEP/NP groups
- The Farm will be upgraded slowly, starting with early access to an Alma 9 partition
 - Alma9 farm partition (and ifarm node) will be made available within weeks for testing
 - The size of the Alma9 partition will grow over time
 - As an incentive, the best CPUs (ie. farm23 nodes) will move first.
- Containerization as a strategy for legacy code using Apptainer (formerly Singularity)
 - *More on this later...*
- We are gradually pruning legacy dependencies on CUE filesystems that have cybersecurity or operational gaps (e.g. /u/scratch)
 - We will do this in small, announced steps
 - Removing: /site, /u/scratch
 - Deprecating (but still supporting): /apps

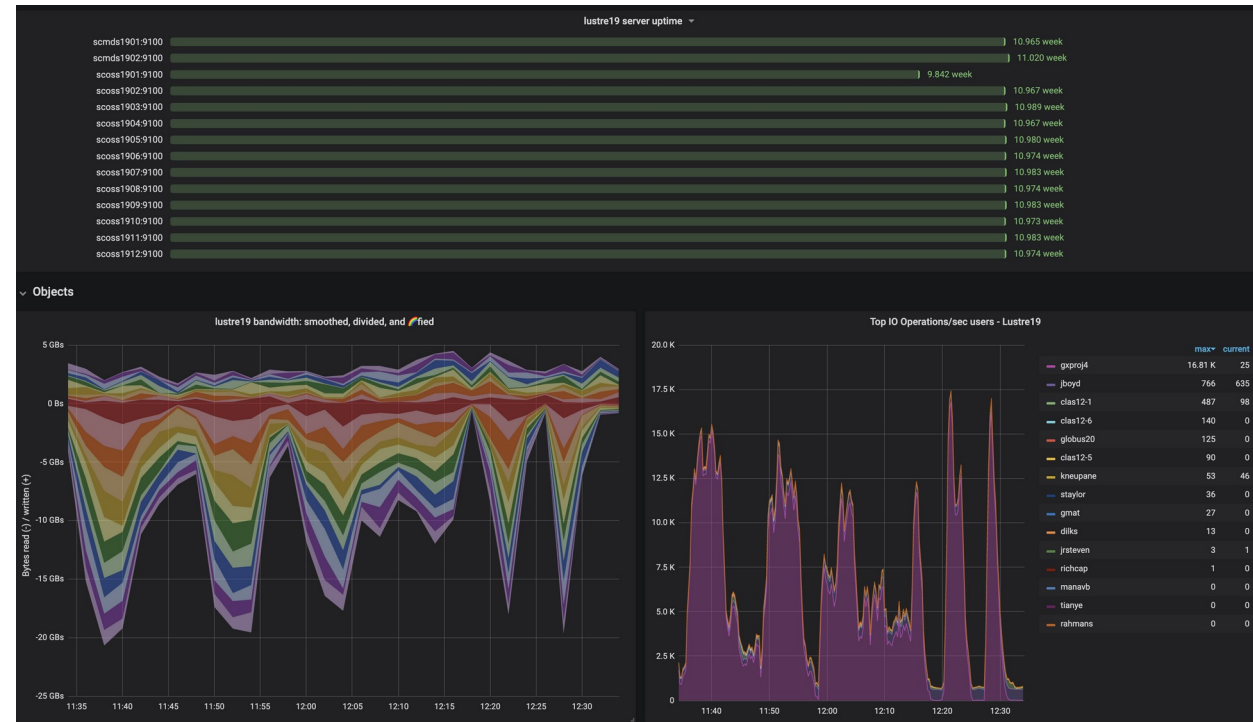
Disk Storage Areas and Their Uses

- *There is strong demand for more disk. This is an explicit priority for for us.*
 - High performance, reliable disk and associated infrastructure is still expensive and has been long lead...
 - We are trying to get “ahead of the curve” on disk with FY23, and FY24 purchases
- Lustre Storage is good for large files, streaming, large block I/O, production farm runs.
- Lustre is not good for small files, high IOPS, and frequent metadata operations (worst case: open,write 1kB, close, loop)
- /work will not scale for large farm campaigns.
- Node-local /scratch is good for jobs with high IOPS to working files.
 - MSS files are automatically copied to node-local working directory
- We are reevaluating the role of /work areas as legacy NFS spinning disk storage.
 - *More on this later...*

Path	Best Use	FS Type	Deletion	backup
/cache	Bulk I/O, Migration to tape	Lustre	Once on tape	/mss
/volatile	Bulk I/O Temporary storage	Lustre	auto	NO
/work	User Managed	NFS+ ZFS	manual	NO
/home	Dot files, personal documents, etc	NFS ssd	manual	YES
/farm_out	Farm job stdout/stderr	NFS ssd	auto	NO
/group or /scigroup	Code	NFS ssd	Manual	YES
/scratch	Farm job I/O to node local disk	ssd	auto	NO
/u/scratch	<i>CUE scratch. Deprecated.</i>			
/cvmfs	Software stack. Configuration.			

Disk Update Coming for Lustre (/cache, /volatile)

- The Current Lustre System (“Lustre19”) for /cache and /volatile is End of Life; Replacement on order
- The new Lustre23 system
 - Target: Double sustained I/O to >40GB/sec.
 - HDR InfiniBand (200Gbit/sec)
 - Build out in two steps
 - 4PB in FY23 (HW finally arriving!)
 - +5PB in FY24
 - Aim to double current capacity
- Down-cycle old HW to support *non* user-visible ‘read-cache’ and backing-store applications
- At right: example full load performance
 - 20GB/sec reads
 - Now stable server uptime
 - IOPS monitoring



/volatile User Experience Issues

- Working on improving user experience for /volatile
 - People get surprised when files in /volatile disappear on them
 - Option: Remove/discourage the ‘over-subscription’ (“High Quota”) feature.
 - Can lead to rapid ‘purges’ when other groups fill their ‘unused space’ and trigger an unexpected purge
 - Option: need HW, under investigation
 - Provide a modest ‘Recovery Pool’ area where purged files go for a week before they are really gone.
 - 200TB would seem to provide a ~7 day buffer at current volumes
 - “Best effort” fall-back, not guaranteed

Scicomp Volatile Disk 820 (TB)

Project Usage	Usage By User	Small File Stat	File Size Distribution	File atime Distribution		
Project Name	High Quota (GB)	Guarantee (GB)	Used (GB)	Used/Quota	Small File(MB)	SmallFileCount
▶ halla	162,350	120,750	106,573	65.64%	78,922	921,935
▼ hallb	465,400	187,050	479,168	102.96%	423,024	3,713,579
clas12	361,000	150,500	377,393	104.54%	388,283	3,499,495
clase1-6	500	250	0	0%	0	0
clase2	100	50	3	3.00%	1	2
claseg2	1,000	500	0	0%	29	8,012
claseg3	500	200	0	0%	39	630
claseg4	100	50	0	0%	0	0
claseg6	500	200	120	24.00%	21,337	116,291
clasg10	2,000	1,000	714	35.70%	5	65
clasg11	1,000	500	0	0%	0	0
clasg12	2,000	1,000	0	0%	0	0
clasg13	500	250	0	0%	0	1
clasg14	2,000	1,000	2,235	111.75%	0	0
hps	94,000	31,500	98,498	104.79%	9,745	51,035
prad	200	50	205	102.50%	3,585	38,048
	465,400	187,050	479,168	0%	423,024	3,713,579
▶ hallc	60,500	27,500	28,695	47.43%	9,494	113,906
cebaF24gev	10,000	5,000	83	0.83%	0	1
CIS	1,000	500	0	0%	0	0
cteqX	500	200	0	0%	0	0
eic	20,000	10,000	5,304	26.52%	9,590	196,873
halld	230,000	100,000	100,010	43.48%	249,268	1,822,885
JAM	10,000	2,000	223	2.23%	105,348	1,070,299
	959,750	453,000	720,056		875,646	7,839,478

[/volatile disk pool policy](#)

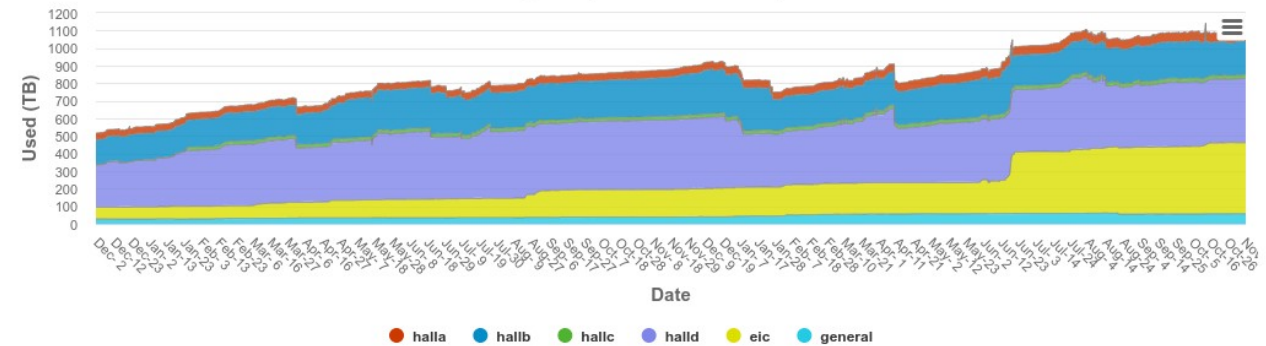
* Small file counts all files less than 1MB.

Disk Update Coming for /work

- Working on a plan to augment /work filesystem
 - Perhaps new “/project” space?
 - Deprecate “/work” name in favor of SciComp manged “/project” space that merges in the Exp Phys “/group” space
 - Upgraded hardware and increase storage
 - +1 PB with modern SSD-backed storage
 - Purchased in FY23; awaiting delivery
 - Tuned for fast, random I/O
 - Consistent backup policy
 - snapshots and nightly backups
 - Roll out in 2024
 - Details to be worked out with Hall Compute Coordinators
 - DO express concerns, wishlists to them and/or me!

Scicomp /work Disk Pool Usage History

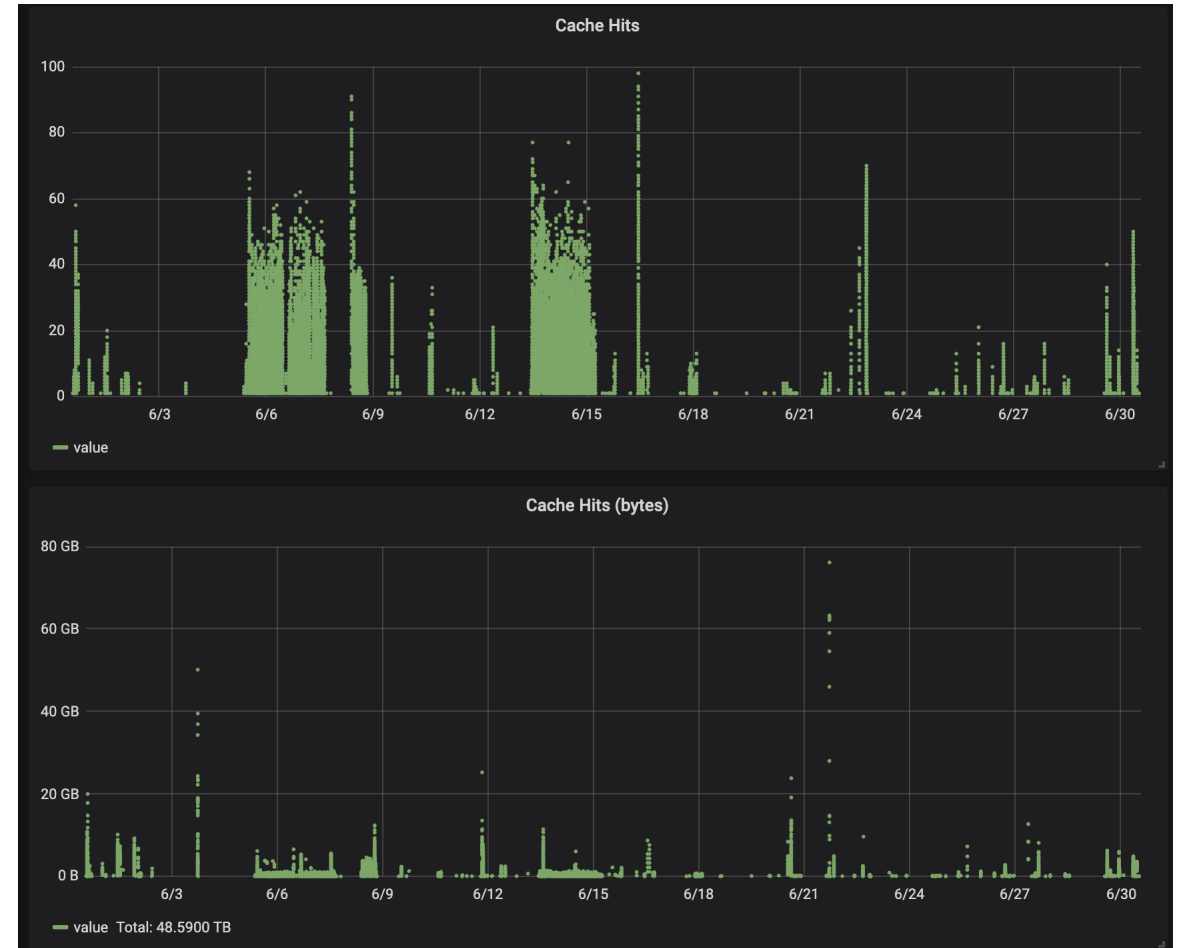
In this usage history chart eic is counted in general.



Project Name	Quota (GB)	Used (GB)	Used/Quota
▸ eic	523,629	377,068	72.01%
▸ general	102,509	53,226	51.92%
▸ halla	69,272	49,753	71.82%
▼ hallb	262,118	178,404	68.06%
clas	46,077	40,206	87.26%
clas12	169,963	104,203	61.31%
hps	25,598	19,787	77.30%
prad	16,384	12,225	74.61%
primex	4,096	1,983	48.42%
	262,118	178,404	
▸ hallc	25,224	19,960	79.13%
▸ halld	409,600	340,222	83.06%
	1,392,352	1,018,633	

Tape Library Strategy: Write Once, Read Rarely.

- Historically, access to Tape has been a bottleneck; This is no longer true
 - Consolidation of data to LTO8
 - Use of SWIF for data+cpu co-scheduling
 - Expansion of disk storage
- We are at an articulation point where it is becoming possible to cache “hot” data and avoid repeated round-trip churn to tape
- Implementation of a system Read Only Cache (distinct from user-visible cache)
 - **Keep all small files disk resident**
 - Aggressively cache hot files
 - Use XRootD storage
 - Repurpose EOL storage for RO Cache
 - RO cache failures well-tolerated since storage is not POSIX or user-facing. Worst case, go to tape for the file again.



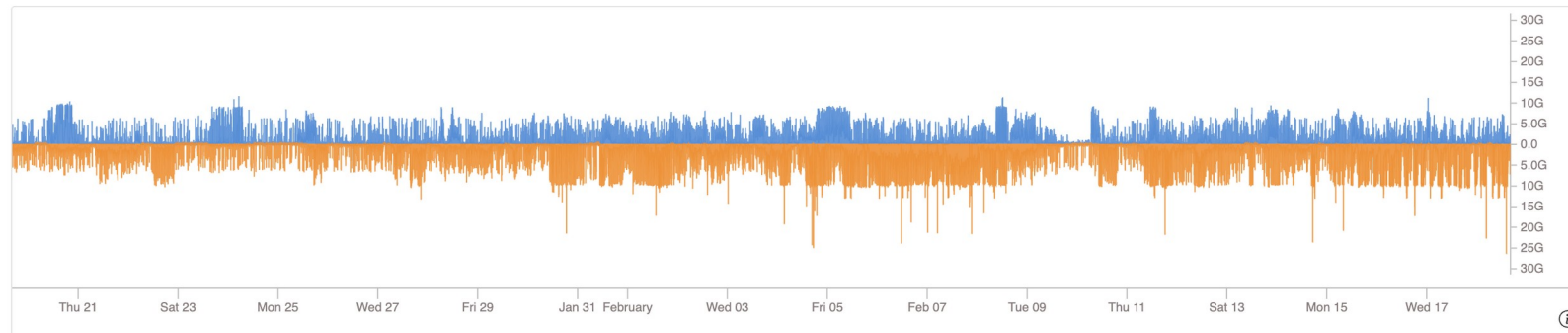
Networking

- The Lab's Internet is being upgraded from 2x10Gbit/sec to 2x100Gbit/sec by ESNNet
- Installation delays due to external work and long lead on 100Gig optical switch gear.
 - Hardware finally arrived and being installed in November
- Current forecast is for 100Gbit operations before the end of 2023
- Once connected, we will have 100Gbit connectivity directly to the scientific computing resources, including data transfer nodes for Globus, XRootD, and OSG.

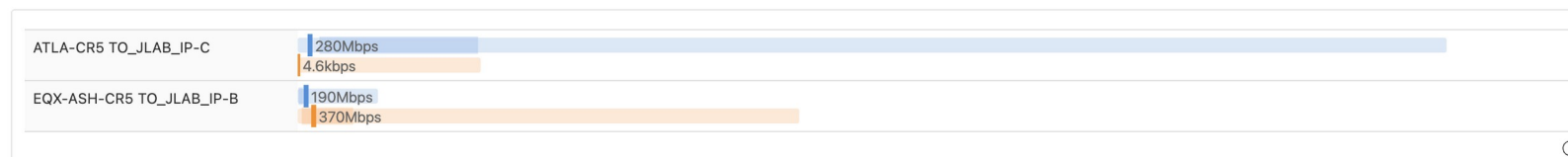
TOTAL SITE TRAFFIC

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TRAFFIC BY INTERFACE



Rucio

- Distributed data management system
 - Initially developed for ATLAS
 - Highly scalable & modular
- Features
 - Basic data operations
 - Storage, transfer, deletion
 - Policy based replication (automatic)
 - Designed with distributed storage and ‘protocol agnostic’ data transfer methods in mind
- Can serve as a Replica/File catalog and metadata service
 - Can search its DB and present files matching names, metadata, etc



- “Beta” JLab Rucio Instance under development
 - Initial customers will be EIC group
 - JLab ↔ BNL automated file registration and transport
 - GlueX (modest sub-project)
 - Load testing, solve authentication challenges, develop policy and namespace conventions
 - Integrate relevant metadata from RunDB and other sources
- Goal is progressive, but full fledged roll-out in 2024
 - Transparent Jasmine/tape integration
 - Full offsite DB query and data transport functionality
 - Backfill from existing tape library as needed

Containerization Support

- CST is developing formal containerization support for Users
 - Documentation
 - ie. Easy ‘on-ramp’ / how-to for common use cases
 - “Official” Infrastructure support
 - Apptainer / Singularity
 - Docker, Podman support for image building and deployment
 - JLab GitLab Container Registry
- Among other benefits, Containers can provide
 - ‘Plug and play’ software configurations
 - SW version / configuration snapshots
 - Ability to run ‘custom’ software frameworks on other datacenters, computers, laptops
- Will also support/streamline upcoming Farm transition from RHELX → Alma9
- New JLab GitLab instance
 - Public facing; support internal and remote users
 - Direct support for GitLab Container Registry
 - Image deployment
 - Automated container builds
 - Full CI/CD support
 - Federated authentication
- Note: Existing GitHub subscription will not vanish
 - Current Github ‘seat-based’ subscription model gets very expensive for our
 - Our current ‘legacy’ plan is based on private repo count, not #users
 - “cheap”, but not upgradable and we are bouncing off its limits...
 - Folks will be encouraged to use the GitLab instance
 - Using carrot not a stick! Goal is to make GitLab a win for the Users
 - Automated GitHub → GitLab repo migration tools exist

Hall ESX Virtual Machine Cluster

- VMs within the Hall experimental enclave are available now
 - High-uptime infrastructure explicitly targeted to support Hall operations, etc.
 - Update policy, downtime scheduling for VMs defined by Hall Compute Coords as usual.
 - Ex: Slow control systems
 - EPICS softIOCs
 - Windows/Rockwell control systems
 - ie. Hall C: cmagnets, skylla10
 - PXE boot hosts/services
 - Ex: Data-base hosts
 - RCDB, CCDB hosts
 - Ex: “Remote CH” support hosts
- VM hosts functionally operate within the Hall subnets (no firewall issues)
 - Direct access within respective subnets
 - 2-factor hop (via. hallgw) as with any existing Hall hosts
 - Take advantage of VM flexibility
 - snapshotting / backups
 - auto-failover on HW issues
 - advantages wrt “cloning”, load balancing, etc
 - **Keep this in mind for future deployments, HW upgrades, etc**
 - Cheaper / better than HW for many applications

JLab (internal) SciComp Director's Review 2024

- Tentative dates:
 - First week of Feb, 2024
 - Formal Charge and dates distributed soon (have draft charge in hand!)
- Nominal 2-day review following historical pattern
 - [Dec 2021 Review](#) Indico
[Access Key: “JLAB2021”]
 - See [Review Report](#) and [Responses](#) documents on that page
- Will require updates on
 - Scientific Computing Systems
 - incl. OSG / NERSC usage/plans
 - EPSCI Report
 - Hall Reports/Projections
 - Data Science Report
 - EIC, Theory Reports/Projections
- Possible special topics
 - SRO status and plans
 - AI/ML progress
 - HPDF status and pre-planning(?)

I want to hear from you

- What are the problems / pain-points in your workflows?
- Other question / comments?

Thank you!

SWIF, Slurm, and Workflow Management

- Slurm is the standard for batch processing, both HTC and HPC.
- SWIF is the Jlab workflow tool that co-schedules data and orchestrates workflows
- SWIF guarantees that data and jobs are scheduled together to increase farm utilization and throughput.
- SWIF pre-stages data for users and SLURM FairShare scheduling matches the jobs to resources
- Reference Guide
<https://scicomp.jlab.org/docs/swif2>

Documentation and Services

- Online Documentation
 - Experimental Physics Users Guide: <https://scicomp.jlab.org/docs/FarmUsersGuide>
 - Linked from the portal at <https://scicomp.jlab.org/scicomp/home>
- ServiceNow Expansion: Service Portal
 - <https://jlab.servicenowservices.com/scicomp>
 - Moving documentation to Knowledge Base Articles
 - Working to make articles more discoverable, both from on-site search and from search engines.