JLab Farm: Overview & Tips and Tricks

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First up:
A Couple Quick Tricks to make your Computing Work Suck Less

How to find information

- JLab's web search and documentation kinda sucks…
  - → It is improving, but kind of slowly… and with mixed results...
    - » Baby steps: ServiceNow SciComp Portal "Knowledge Base"
    - » Getting Started and Experimental Physics User's Guide pages are being updated
      - – Searching is still an issue...
  - → Search trick: do this in Firefox:
    - » Go to www.google.com and search for this string: 'site:jlab.org OR site:jlab.servicenowservices.com foo'
    - » Right click on the bookmark and choose 'Properties'
      - – Give it a good name
      - – Give it a short 'keyword' like 'jj'
      - – Clean up the URL as shown, replace 'foo' with %s
  - → Now type 'jj jget' in URL bar
    - » %s in 'Location' string is replaced with text following Keyword
    - » 'site:jlab.org' is google-fu to restrict search to jlab.org domain

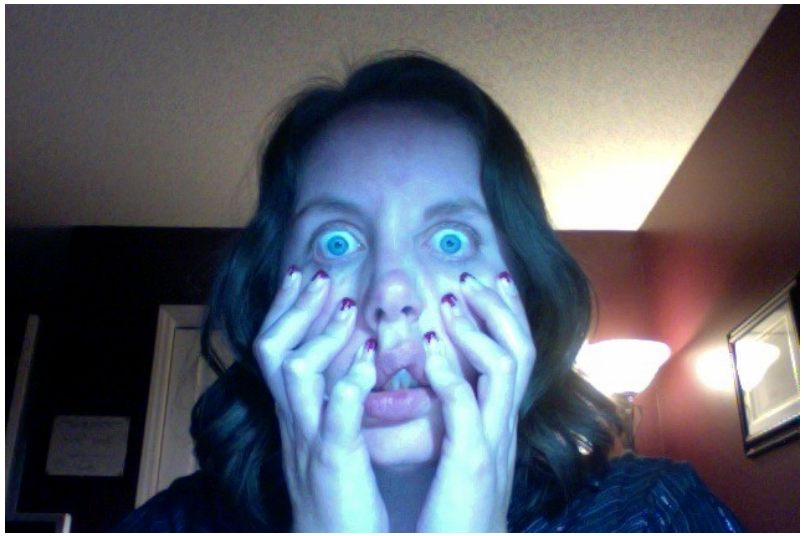
How to find information

- Trick works great for many things
  - →JLab staff page (https://misportal.jlab.org/mis/staff/staff.cfm)
    - » Keyword: 'jstaff'
    - » Location (can extract from search on 'smith' above):
    - » `https://misportal.jlab.org/staff_search?q=%s`
  - →ROOT / G4
    - » Keyword: 'gr'
    - » Location/URL:

      `https://www.google.com/search?hl=en&btnG=Search&q=site:cern.ch%20%s`
  - →Stackoverflow.com
  - →JLab Logbook (a little trickier, but you can work it out)
  - →...

How to work from Offsite

- How to work from offsite without tearing your eyes out because, holy hell, the graphics and menus are just so slow…



- Command-line (ssh) access
  - → Use 'ProxyJump'
    - » only 2-factor in once

- VNC + ssh tunnel to the rescue
  - → VNC: Virtual Network Computing
  - → ssh tunnel is used to securely move VNC traffic through jlab firewall

- Old VNC 'howto' I wrote for my collaboration
  - → adapt to vncserver host you use (ie. jlabl2)
  - → Search: 'jj vnc session'
    - » Pick: Using a VNC Server/Client

How to work from Offsite

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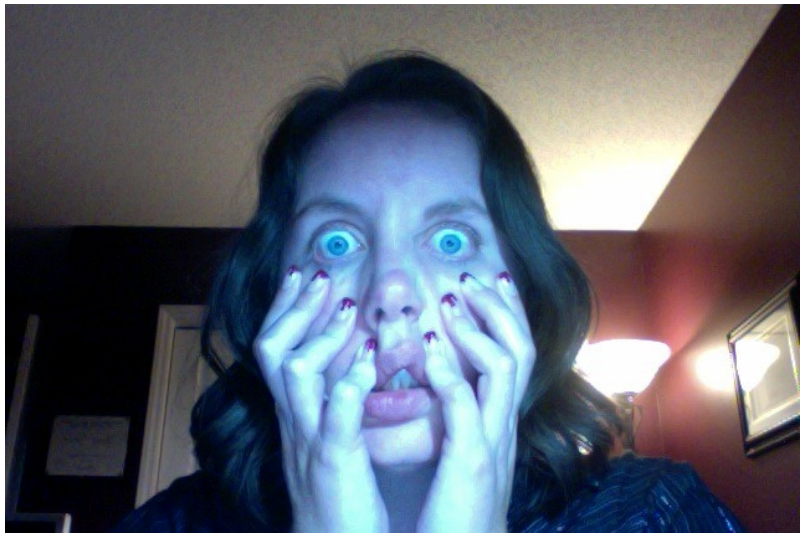
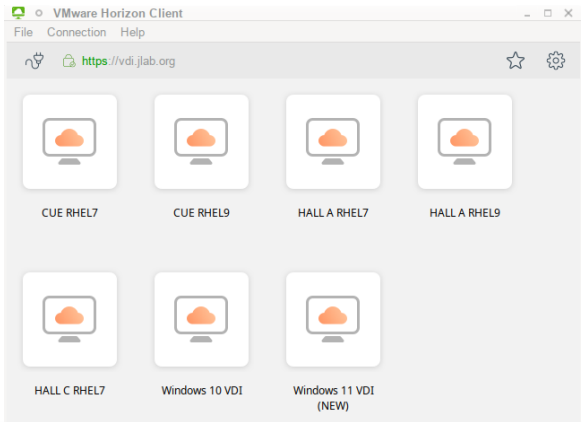
- Virtual Desktop Infrastucture (VDI)
  - → https://vdi.jlab.org
    - » works within browser OR native application
  - → Some Hall specific options require you be granted access
    - » Compute Coord or HelpDesk
  - → Fewer “hoops” than VNC, but...
    - » limited number of ‘slots’ available
    - » sessions not as persistent
  - → NOTE: Turn OFF the auto-screenlocker in the remote session!
    - » (*Not* your desktop/laptop screenlocker though.)



- Computer Center How-to
  - → Connecting using VDI



JLab Email

- Please monitor your @jlab.org address
  - →webmail.jlab.org
  - ~ OR ~
- Add JLab mail server to your preferred email client:
  - →Host settings
  - →Config Examples

(PSA: remember to update this when you update/reset your JLab password!)

» ~ OR ~

- Forward your JLab email to your 'main' account
  - →Helpdesk request

Offline Analysis
Farm Usage / General JLab Computing

Nuts to the Farm, I analyze on my Desktop

- Simple tasks, some analysis OK on the desktop, BUT!!
  - → Thou shalt backup your code!
  - → Thou shalt backup your results!
  - → Who among us has done
    - % rm -rf stuff/
    - » Followed by !@#$?
- Don't keep only copies on your laptop
- Don't keep only copies on your desktop's hard drive
- Do use git for all code and scripts!
  - → Commit early, commit often
  - → 'git push' often too!
    - » It's a backup!

- Hard drives die and the data are gone.
  - → Drives are large and cheap
  - → But reliability on consumer drives is worse that it used to be!
  - → SSDs are (weirdly) no better!

- IF your hard drive died today, how long would it take to recover?
  - » a day, a week,
  - » a month???

JLab Systems can help!

- /home, /group are automatically backed up
  - →They are snapshotted hourly!

```
% cd .snapshot/
% ls -lrt
```

  - →Longer term backups are on tape

- /work, /volatile are on heavily redundant filesystems
  - →NOT backed up
    - » Use tape
  - →More on this later...

- NOTE: Your JLab RHEL system *can* mount these directories if needed
  - →Talk to me if this would help

The JLab Farm • Power at your Fingertips

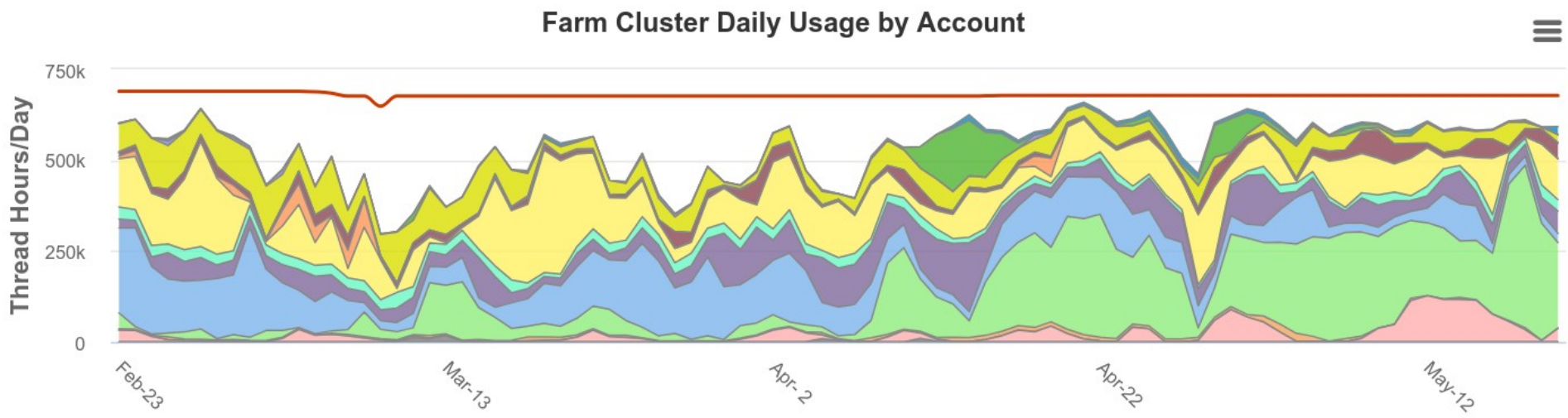
- Farm has many components
  - → ~30000 compute cores
  - → ~11 PB Lustre
  - → ~5 PB NFS/XRootD (ZFS)
  - → ~100+ PB of Tape
  - → Consumes ~400kW of power!
- Growth is $$$ and based on projections from Halls
  - → Expenditures generally switch between storage + CPU every other year

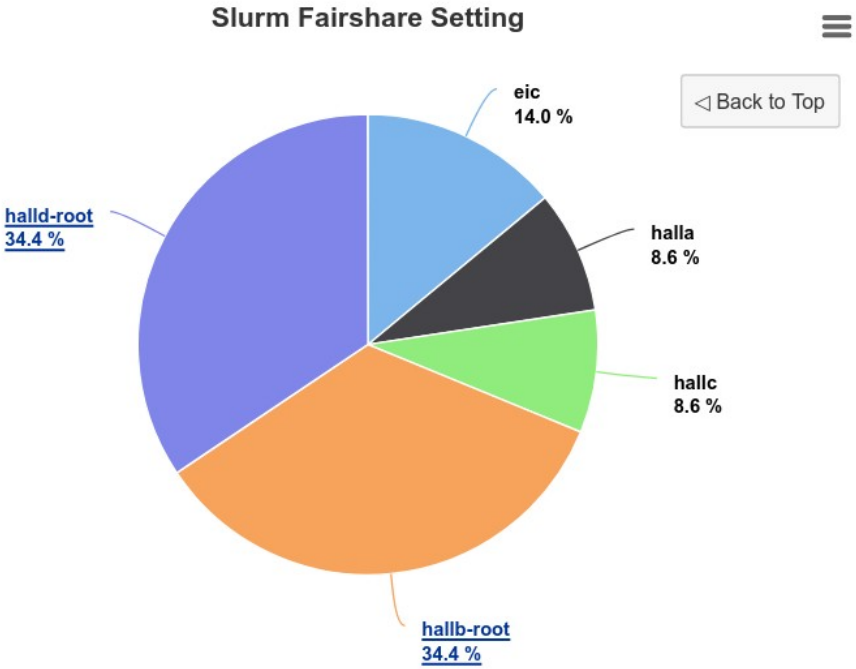
The JLab Farm • Batch Computing

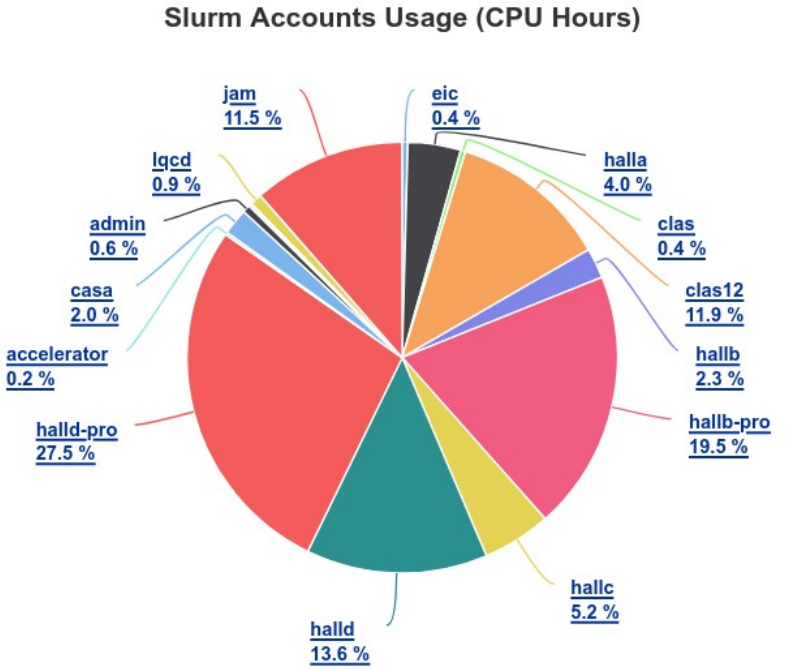
- The Farm: Batch Computing
  - → No direct access to these machines
    - » Use "Interactive" farm nodes for testing
      - ie. ifarm, ifarm240[12]
  - → DB and other network access (git, http, etc) generally constrained
  - → Batch Jobs controlled by automated system called "slurm"
  - → You submit a job via slurm or swif and slurm schedules it to run
- All about trade offs:
  - → "Latency" can be high (hours+ from submission to job execution)
    - » BUT!
  - → Throughput is enormous
    - » 100s (1000s) of your jobs can run simultaneously
    - » High bandwidth access to fast storage
  - → A full replay (1000s of runs) can be completed in the time it would take a few runs to complete in series on your desktop/laptop.

The JLab Farm • Scheduling

- The Farm is a Lab-wide shared resource
  - → Each Hall's budget includes $$$ to support their usage
  - → Rough allocation:
    - » A: 9%, C: 9%
    - » B: 34%, D: 34%
    - » EIC: 14%
- Ruled by Slurm workflow manager (*but you should use SWIF!*)
  - → Allocations *not* written in stone and are adjusted based on needs
- The balance is trickier to manage than you may think...
  - → Jobs take time to run (system doesn't know how long beforehand)
  - → Upcoming job load is hard to predict
  - → System balances allocations over a few days, not hours
- More documentation here:
  - → https://scicomp.jlab.org/
  - → https://data.jlab.org/







[Scicomp Farm Cluster Utilization]

Do use the Farm!

- The Farm is not your desktop
  - →Best to plan, test, and fire off groups of jobs
- Test your job first!
  - →Can it run reliably?
    - » If it doesn't run on ifarm, it won't run on the farm!
  - →Is the output what you want?
    - » Check before firing off 100 jobs

- Simple tasks, some types of analysis can be done on small systems, BUT!!
  - →Thou shalt back up your code!
  - →Thou shalt back up your results!
  - →IF your hard drive died today, how long would it take to recover?
- Don't keep only copies on your laptop

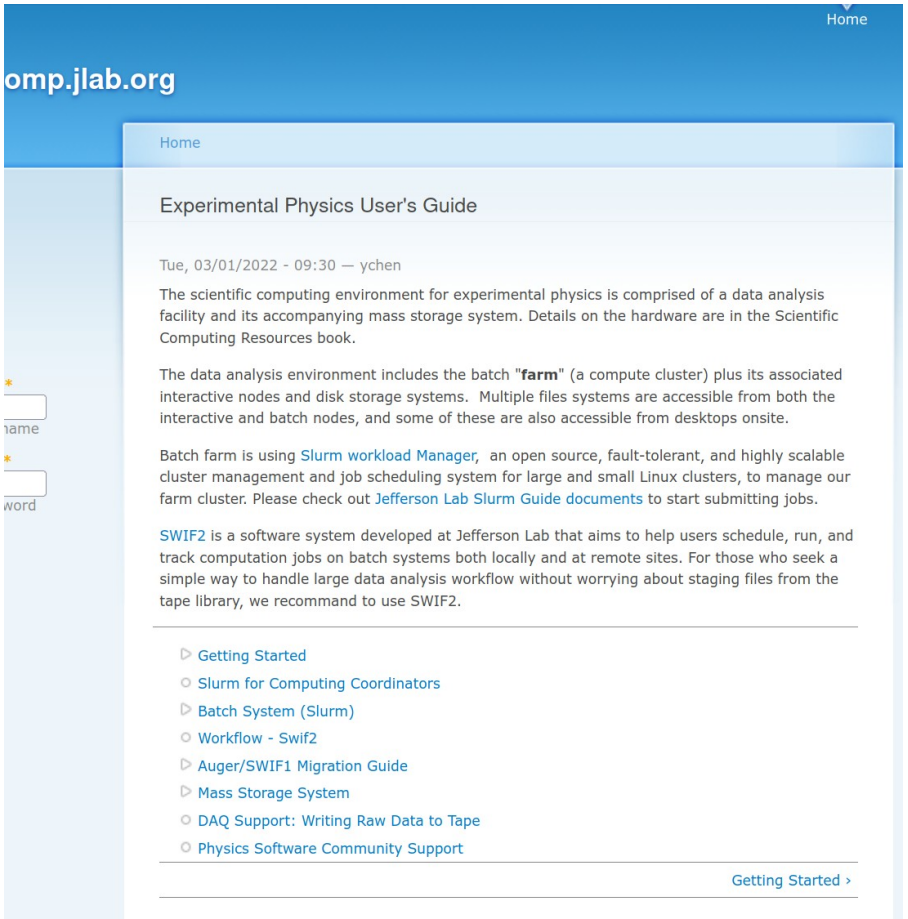
  Don't keep only copies on your desktop's hard drive

What's a “Job”?

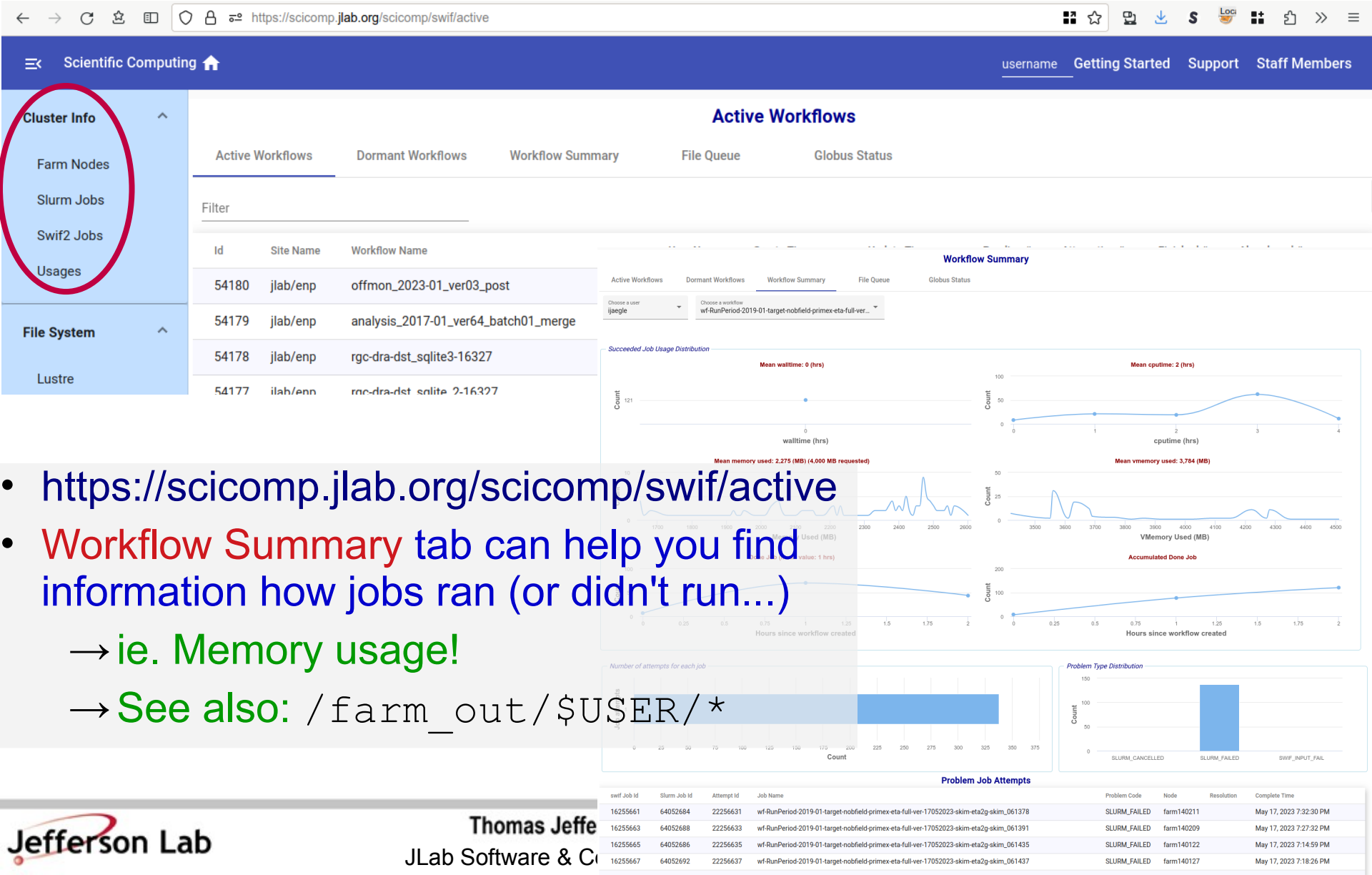
- A 'Job' often maps to a shell script
  - → It can do multiple things, but usually it executes a single instance of your software
    - » Analyze one run, or
    - » Simulate “1M” events,
    - » *etc...*
- *NOTE: Output that would normally go to a terminal (ie. stdout/stderr) goes to special file system:*

  /farm_out/$USER/job_id.out
  /farm_out/$USER/job_id.err

https://scicomp.jlab.org/docs/FarmUsersGuide



Check Job Status



- https://scicomp.jlab.org/scicomp/swif/active
- Workflow Summary tab can help you find information how jobs ran (or didn't run...)
  - → ie. Memory usage!
  - → See also: `/farm_out/$USER/*`

Debugging a job

- Generally want a single script that does everything!
  - → Set up full environment
  - → Use full paths
    - » `/group/myExp/myscript.sh`
    - » ~~`./myscript.sh`~~
- Testing your script:
  - → 1st: Run on ifarm *and check*
  - → 2nd: Submit job to Farm
- Test with 'priority' 'partition'
  - → Max priority, fast sched.
  - → Limited 4 hour runtime
  - → Limited jobs/user
- Test on ifarm

```
% ssh you@ifarm
% /group/myExp/myscript.sh
```

  - → Make sure it worked!
    - » check histos, report files
- Quick Test on Farm

```
% swif2 add-job -create \
-partition 'priority' \
<other options> ... \
/group/myExp/myscript.sh
```

  - → Make sure it worked!
    - » check histos, files
    - » check `/farm_out/$USER/`
- Then submit full set!
  - → SWIF2!

Swif/Slurm 'Debug' Commands

- How to debug a job failure on the Farm
- Note:
  - → "Job IDs" are not global
    - » SWIF job_id != SWIF job_attempt_id != slurm jid
  - → See Workflow Summary

- Find a failed SWIF job_id
  - → swif2 status -workflow <workflow> -user <user> -problems
- Look up failed job in swif:
  - → swif2 show-job -jid ####
  - → see info for each job attempt:
    - » *site_job_stdout*
    - » *site_job_stderr*
    - » slurm_id
    - » *job_attempt_problem*
    - » slurm_state
  - → seff <slurm_id>
- Use swif to rerun after fixes made:
  - → swif modify_jobs ...
  - → swif retry_jobs ...

Small I/O Problems

- Small read/write operations are *very* inefficient
  - → Old/legacy code defaults can be very small (~4kB)
  - → Should be closer to 4MB chunks for decent performance
  - → Buffered IO can bridge the gap if needed
    - » Common errors:
      - 'Debugging' output
        - » stderr << “got here” << endl;
        - » fprintf(stderr, “event %d\n”, eventNum);
      - Opening/closing files very frequently
      - Frequent random I/O
        - » ie. searching through a file for a parameter every event
- Workflows / procedures that may work on desktops or older systems do not scale well on modern systems (100s or 1000s of simultaneous jobs)
  - → Can take down / degrade system-wide filesystems
  - → Always be mindful you are on a large-scale shared system, not a personal desktop

Make your jobs schedule faster!

- Common Bottlenecks/ Mistakes
  - → CPU count
    - » use 1 core only (unless you *know* the job will multi-thread!)
  - → Memory allocation
    - » < 2GB is best!
    - » Smaller → Faster scheduling!
  - → Insufficient debugging/ cross checks
    - » Fire off 100s of jobs with bad config, buggy code

Make your jobs schedule faster!

- Scheduling jobs takes many things into account
  - →File availability from tape
  - →Memory request
  - →CPU/core request
    - » >1 is useless for podd/hcana
  - →'Fairshare' metric
    - » Average Hall utilization
    - » Hall Usage can be subdivided further
- Details
  - → Fairshare Web Page

- If a Hall / Project is not using 'their' fraction, then those Farm resources are available to anyone on a first-come, first-serve, basis!
  - →If the Farm is idle, you can take advantage!
    - » For example:

File Systems: Where do I put my stuff?

- SciComp/IT provides
  - →/home - your home dir; backed up by CST
  - →/group - a space for groups to put software and some files; system backed up by CST
    - » Like /home but for *groups*
  - →/volatile - acts as a scratch space for large files
  - →/work - unmanaged outside of quotas/ reservations
  - →/mss - a 'directory' of what is on tape
  - →/cache - where tape files are written for active use

Where do I put my JLab stuff?

- /home/<you>/
  - →hourly snapshots
    - » `cd .snapshot/`
  - →personal, non-analysis files
    - » papers, notes, thesis, etc...
  - →analysis scripts: ~OK
    - » use git!
  - →source code: ~OK
    - » /work better
  - →NEVER store ROOT files or CODA files in /home
- Your laptop / desktop
  - →Should really be just a front-end for working on JLab systems
  - →Everybody plans to do backups, but almost no one actually does backups until after they've lost data...

Where do I put my stuff?

- /group
  - → Think "/home" for work groups
    - » papers, thesis, etc
  - → hourly snapshots
    - » `cd .snapshot/`
  - → analysis scripts: YES
    - » use git!
  - → source code: ~OK
    - » /work is better
  - → papers, thesis, etc in user subdirs is great
- /work
  - → Tuned for speed, small files
    - » ie. source, binaries, etc.
  - → NOT backed up
    - » but is resilient
    - » snapshots under .zfs/snapshot/ for *some* directories
    - » Do NOT count on this
  - → Source code: YES
    - » use git!
  - → ROOT output: ~ick (don't)
  - → CODA data: No
  - → YOU must backup to tape
    - » tar + jput *(more on this soon)*

Where do I put my stuff?

- /group
  - → Think "/home" for work groups
    - » papers, thesis, etc
  - → hourly snapshots
    - » `cd .snapshot/`
  - → analysis scripts: YES
    - » use git!
  - → source code: ~OK
    - » /work is better
  - → papers, thesis, etc in user subdirs is great

- /work
  - → Tuned for speed, small files
    - » ie. source, binaries, etc.
  - → NOT backed up
    - » but is resilient
    - » snapshots may be available under .zfs/snapshot/

PSA: /work snapshots can be a pain because they count towards the quota for that space! (But you can't see them.)

- Generate big files, fill quota, whoops!
  - rm -rf <all the big files>
- quota still full!?!
- Talk to helpdesk… (nothing you can do)

Where do I put my stuff?

- /volatile
  - → Largest 'user' file system
    - » Petabyte scale
  - → High performance, tuned for large files
    - » ie. ROOT output
  - → NOT backed up
  - → Files auto-cleaned based on quota/ reservation/ and filesystem pressure
    - » https://scicomp.jlab.org/docs/volatile_disk_pool
    - » *Median file lifetime is >1 month*
  - → Analysis output goes here!
    - » Check, then push to tape if good!
- Tape System
  - → Much bigger
    - » 100+ PB and growing
  - → /mss/hallX/...
    - » "Stubs": shows what is in the tape system!
    - » not the actual files
  - → /cache/hallX/...
    - » actual files
    - » auto-clean up in play
      - next slide

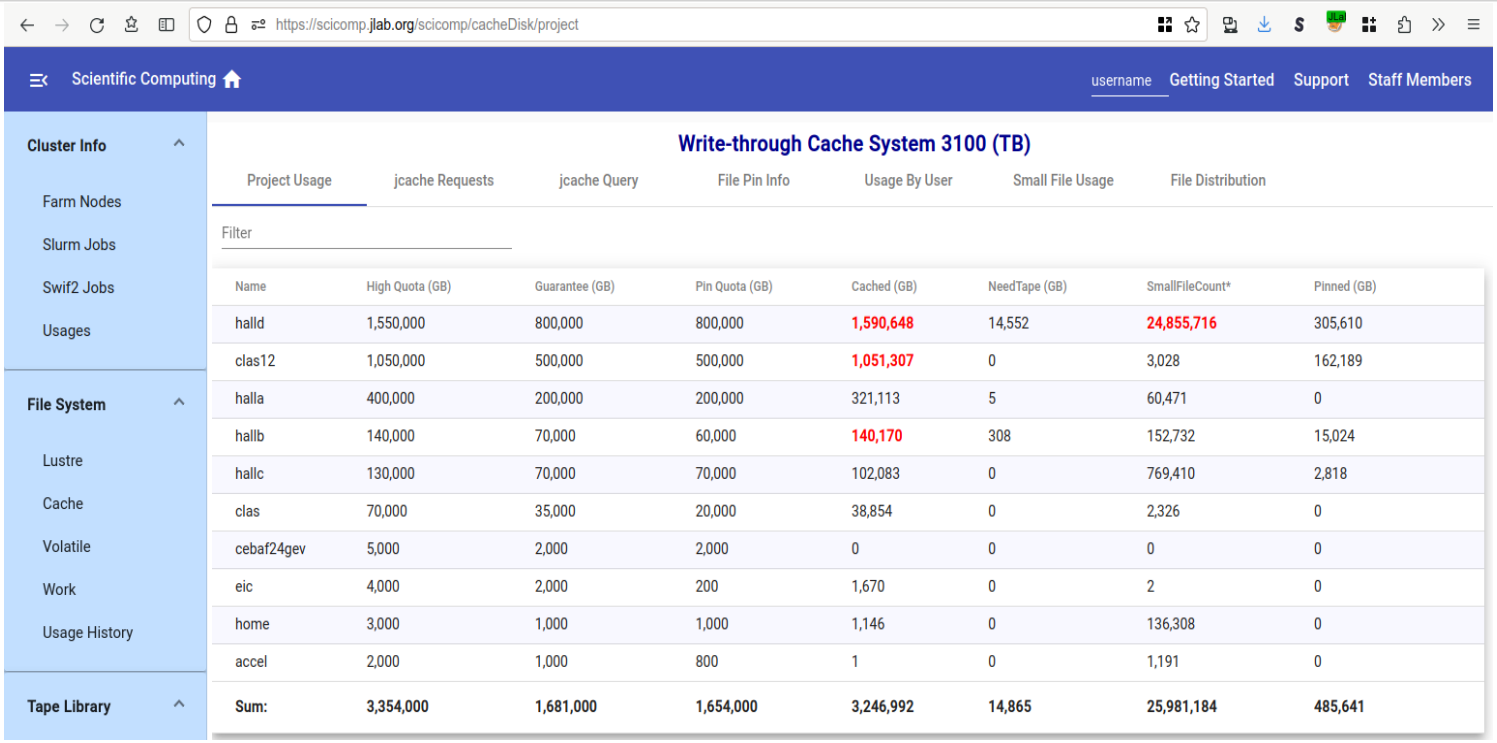
Accessing files from Tape

- Retrieving files from tape
  - →jcache get /mss/.../foo.dat
    - » Manual pull from tape to /cache/.../foo.dat
    - » Never call this (or jget) in a farm script!
      - – Let SWIF2 do it!
        - » List needed files as <Input> tag(s)
        - » Backend will pre-stage them for you in advance
    - » Please only pull the files you are going to use interactively.

      jcache get /mss/hallX/exp/raw/* ←

  - →jget /mss/.../foo.dat $PWD/
    - » pull file from tape to any filesystem
    - » generally *not* the right tool

File duration in /cache

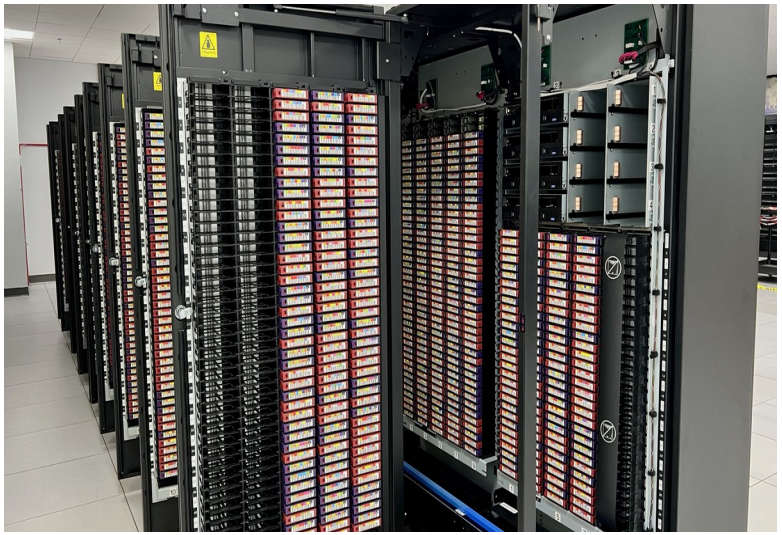


Name	High Quota (GB)	Guarantee (GB)	Pin Quota (GB)	Cached (GB)	NeedTape (GB)	SmallFileCount*	Pinned (GB)
halld	1,550,000	800,000	800,000	1,590,648	14,552	24,855,716	305,610
clas12	1,050,000	500,000	500,000	1,051,307	0	3,028	162,189
halla	400,000	200,000	200,000	321,113	5	60,471	0
hallb	140,000	70,000	60,000	140,170	308	152,732	15,024
hallc	130,000	70,000	70,000	102,083	0	769,410	2,818
clas	70,000	35,000	20,000	38,854	0	2,326	0
cebaf24gev	5,000	2,000	2,000	0	0	0	0
eic	4,000	2,000	200	1,670	0	2	0
home	3,000	1,000	1,000	1,146	0	136,308	0
accel	2,000	1,000	800	1	0	1,191	0
Sum:	**3,354,000**	**1,681,000**	**1,654,000**	**3,246,992**	**14,865**	**25,981,184**	**485,641**

- Files auto-cleaned based on quota and system pressure on /cache
  - → Clean up least-recently-used files first
  - → *Can* 'pin' files to keep them stable; but, *generally speaking, do not do this*
    - » If you do pin, you better be using the files interactively for the duration or you are literally getting in the way of your colleagues!
      - For Farm jobs, use SWIF and declared inputs; the system will take care of it.
    - » /cache is a shared resource, be mindful of your impact on others!

Copying files to Tape

- Storing files on tape
  - → jput file /mss/.../
    - » 'jput -h' Online Docs
  - → swif2 add-job
    - -output <src> <mss://….>
    - » see swif2 documentation



Note: the “Write-through” cache feature where your code could write directly to /cache/…. is deprecated and will be disabled in 2024

Write-through **/cache mechanism going away ...**

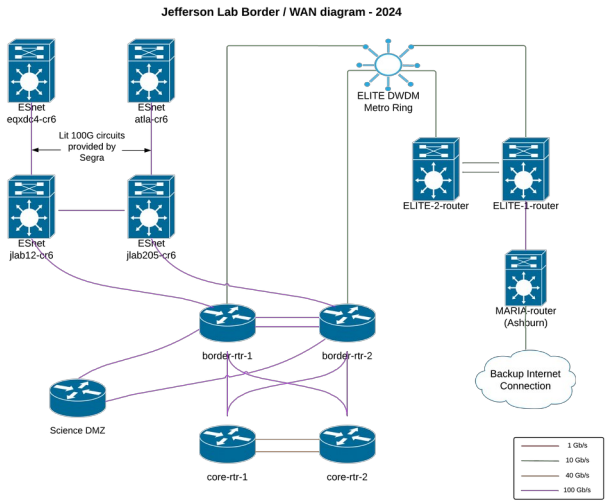
- Originally /cache was a user-facing read-only filesystem to store files located on tape
- In 2014 /cache was made user-writeable to address (in part) challenges with sufficient online storage for analysis campaigns
- *However*, this has caused a number of complications
  - → Small file proliferation: O(10^7)
  - → File ownership and permission mismatches
  - → 'Sync' issues: policy is that items on /cache are backed up to tape *but* there are quite a few corner cases
    - » Not always true for small (< 1MB) files
    - » 'duplicates' / file name collisions between files on tape and files in /cache
    - » significant delay between file close on disk and file on tape

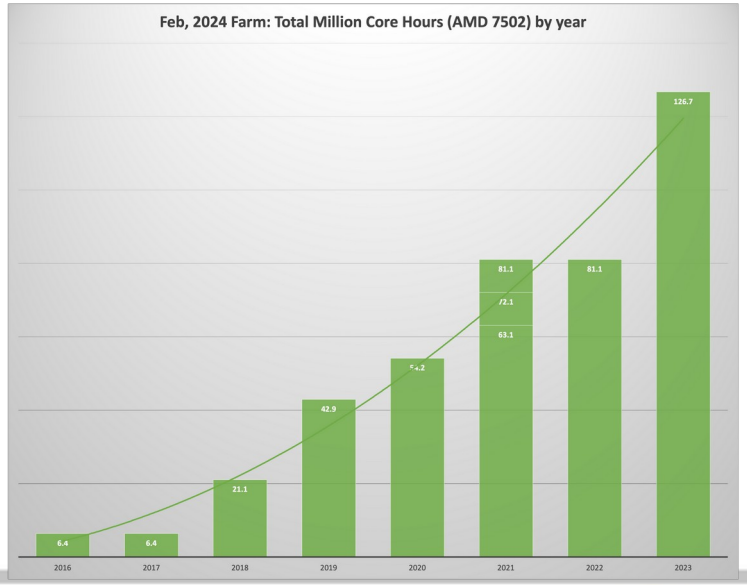
- SciComp plans to return to the read-only model in the fall (TBD!)
  - → Remove user-write permissions
  - → Jobs should declare output in SWIF2
    - » System will ensure writes to tape
    - » Files will still show up under /cache as soon as job completes
  - → Slurm workflows that interact with tape should really use SWIF2 instead
    - » otherwise, write to /volatile and then manually 'jput/jmirror' on ifarm


WHAT'S NEW?

Infrastructure Updates (HW) : 2024–25

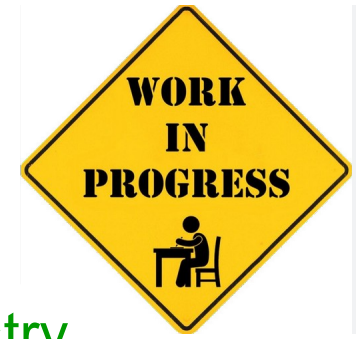
- JLab WAN connection
  - → 2x10 Gbit → 2x100 Gbit
    - » → 2x400 Gbit planned (2025/6)
- Significant disk space increases
  - → /cache, /volatile will increase 11 → ~20 PB in 2025
  - → "/work" → "/project" with upgraded HW (2024/25)
    - » Same use-cases
- Additional Tape Drives
  - → increased bandwidth
- CPU purchase focus of FY25
  - → Mostly CPUs, but GPUs are an option *if they will be used*





Infrastructure Updates (SW): 2024–25

- Farm transition to Alma9
  - → EL7 is gone
  - → Update old farm jobs to remove ‘el7’ tag
- code.jlab.org
  - → CI/CD
  - → Container registry
  - → JLab GitHub Org will remain while cost-effective
- Kubernetes for workflows that don’t fit Batch model
  - → OpenShift ‘enterprise’ K8 platform will become available this ~~summer~~ Fall



- Building out off-site compute support
  - → GlueX/CLAS12 already significant users of OSG
  - → SOLiD in progress
- Rucio
  - → Distributed (large-file) data management framework
  - → “beta”-test ongoing
    - » JLab MSS/tape integration now in ‘beta’ stage
- JLab Research DB
  - → “One stop shop” to locate data, publications, workflow information, logbook references, etc...

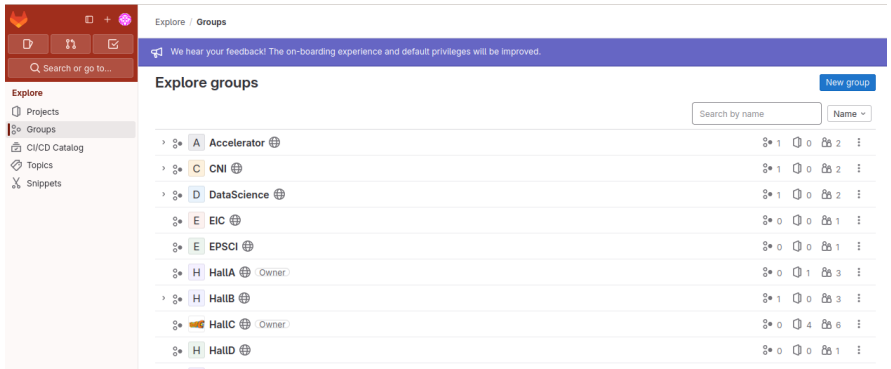
EL7 → Alma9 (Farm Transition)

- Farm OS recently transitioned from
  CentOS7 (~RHEL7) →
  Alma9 (~RHEL9)
- (Much) newer default software, but be mindful of changes
  - → 'ssh ifarm' for Alma9 interactive node
  - → must declare 'el9' constraint/ feature now
    - » Use:
      swif2 add-job -constraint el9 <other arguments>
    - » SWIF notes
    - » Slurm notes

- *Changes ...*
  - → */site, /apps* no longer mounted on farm nodes
    - » 'environment modules' framework (SW modules under /cvmfs, /group) instead
      - run 'modules avail'
    - » If something is missing, contact your Hall Compute Coordinator and/or open a Helpdesk ticket

code.jlab.org (GitLab Service)

- GitHub is getting $$$
  - → CI/CD, storage, *etc* are all metered costs
  - → JLab is on a 'legacy' license model for now but limitations are frustrating
- JeffersonLab GitHub Organization *will be maintained as-is*
  - → *BUT code.jlab.org should be a "value-added" proposition*
- code.jlab.org (GitLab instance)
  - → JLab run/managed
  - → Open / Offsite access
    - » Federated logins avail.
  - → CI/CD and Storage can leverage our Farm
  - → built-in Container Registry
  - → Supports several Data Management requirements for the Lab



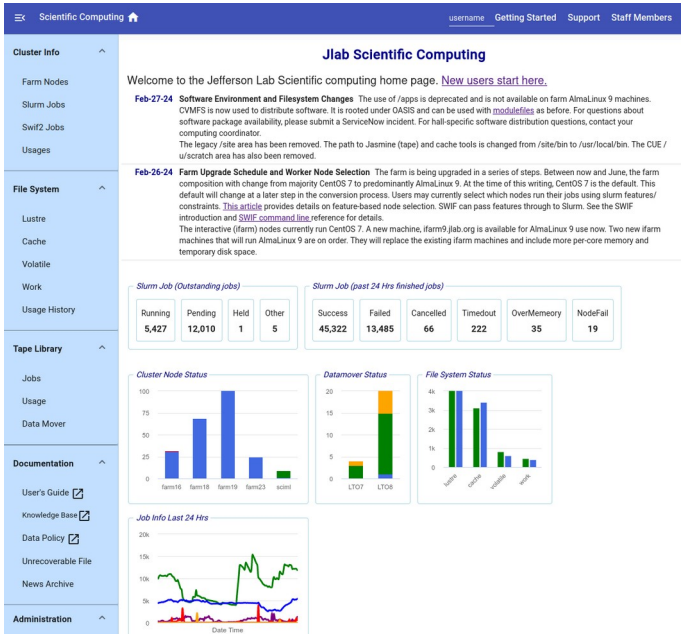
Containers: Podman / Apptainer

- Apptainer (was Singularity)
  - →works on both ifarm and farm
- Podman
  - →works on ifarm now
  - →*will* work on alma9 farm soon (this summer)
- Docker
  - →not happening on compute clusters
  - →but podman == docker (pretty much)
  - →Note: docker != dockerhub

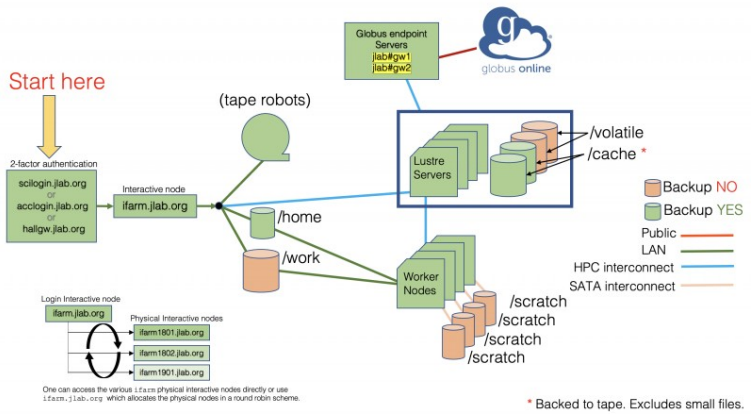
podman

Information Resources

- scicomp.jlab.org
  - →SciComp web page
- scicomp-briefs
  - →mailing list for JLab Scientific Computing



- Documentation links
  - →Getting Started
  - →SciComp Knowledge Base
  - →CST User Portal
  - →JLab Helpdesk
    - » helpdesk@jlab.org
    - » Incident Request

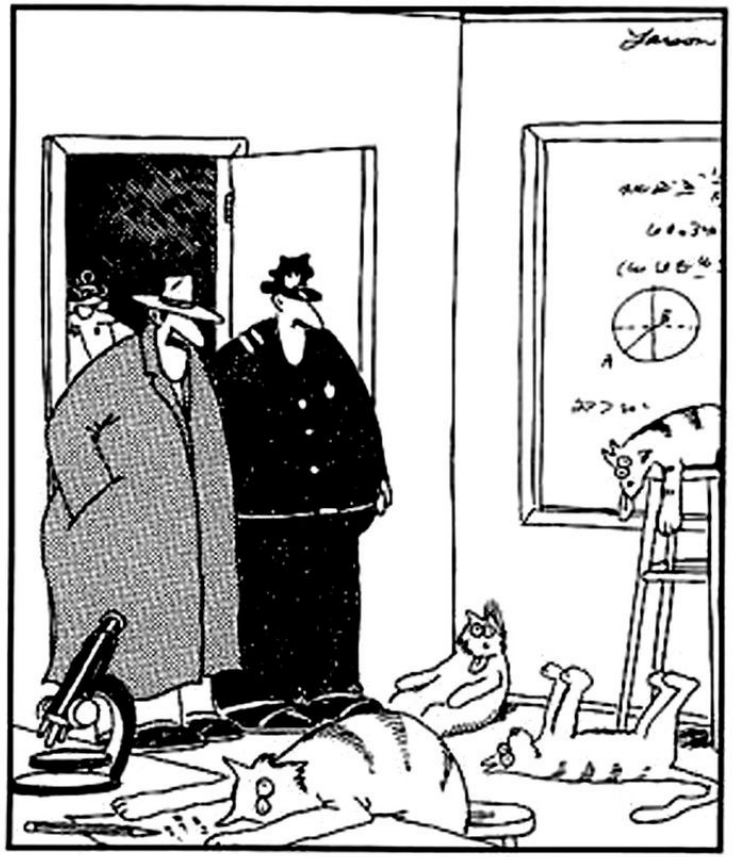


What do *you* need/want?

- Tell me what your challenges are!
  - →What resources are you missing?
    - » What are your bottlenecks?
  - →What applications/features do you want?
  - →Where do you / your collaborators struggle?

- Feedback is necessary for SciComp / CST to plan
  - →(Also gives me “ammunition” to talk to management.)
  - →Email brads@jlab.org anytime

Now *Please* ask Questions!



"Notice all the computations, theoretical scribblings, and lab equipment, Norm. ... Yes, curiosity killed these cats."