FabrIc for Frontier Experiments project at Fermilab

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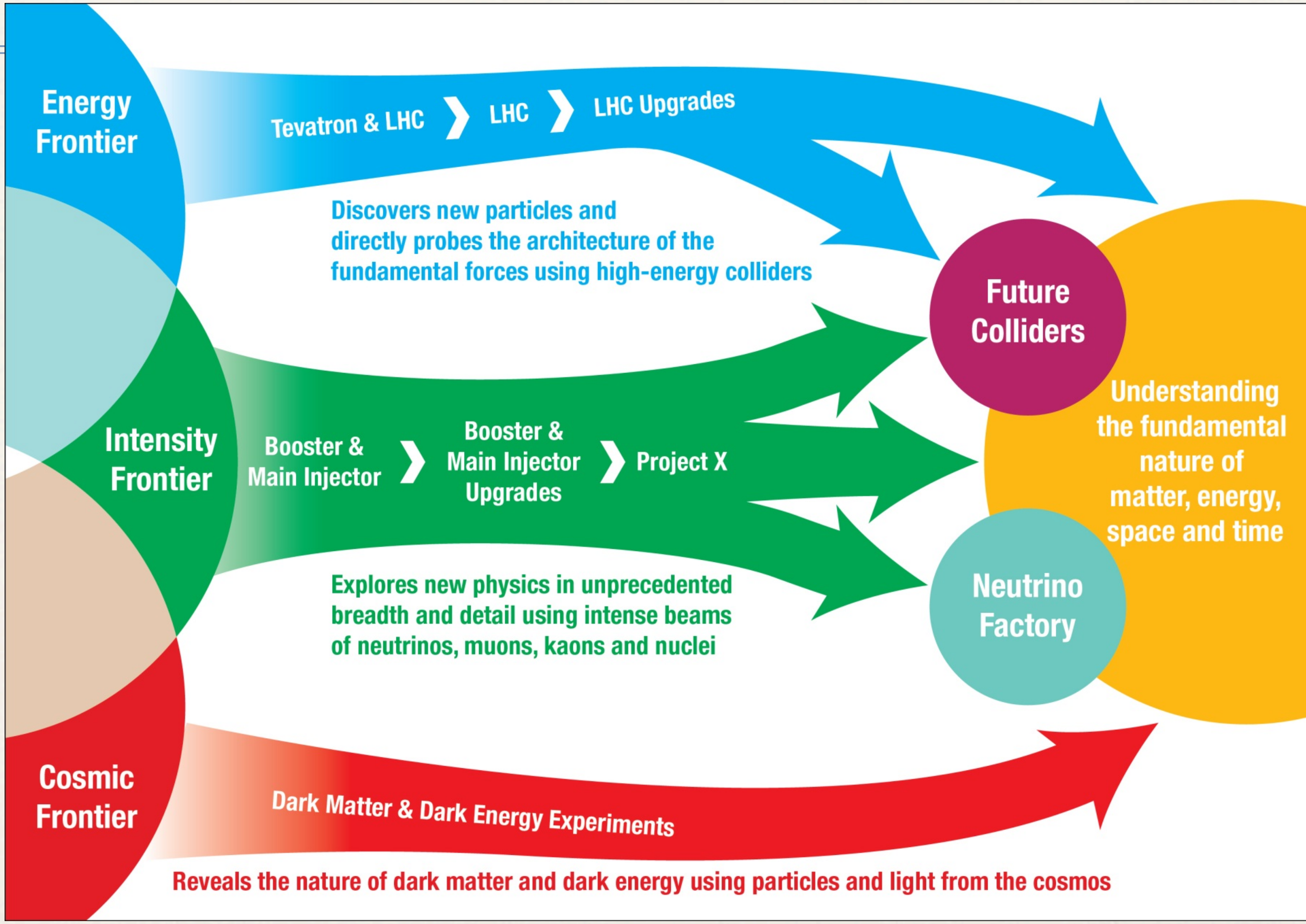
Oct 14, 2013

Fermilab Computing Sector

Outline

- Fermilab physics program in the coming decade
- Computing needs for frontier experiments at Fermilab
- FIFE strategy for providing computing resources
- Current services integrated in the FIFE model
- Recent successes and plans
- Summary

Fermilab Frontier Roadmap



Diverse program of experiments

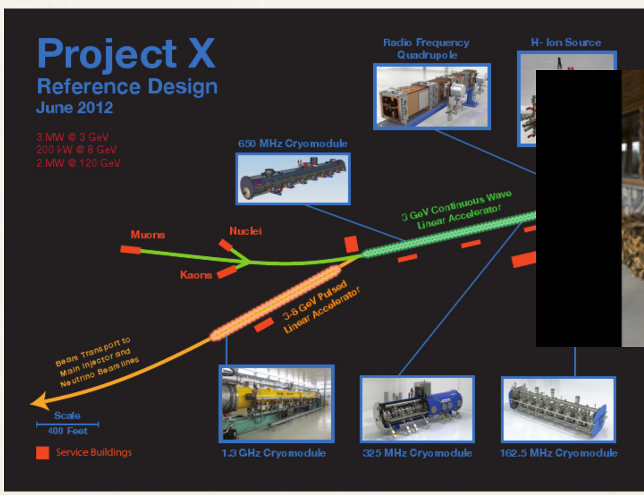
ArgoNeuT

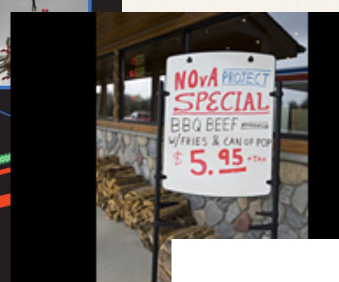
Mu2e

Main Injector Neutrino Oscillation Search

SciBooNE

seaQuest



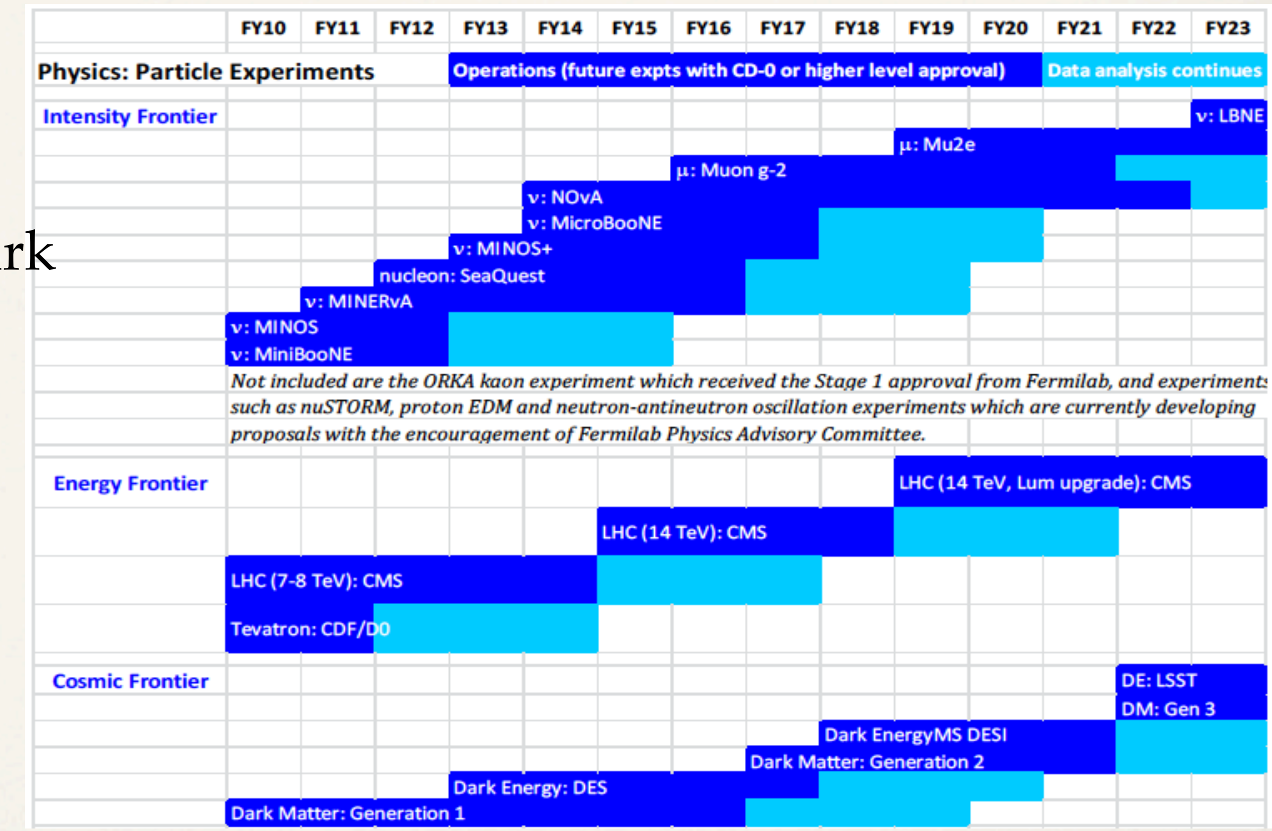


microboone

darkside
two-phase argon TPC for Dark Matter Direct Detection

Fermilab Experiment Schedule

- measurements at all frontiers -Electroweak physics, neutrino oscillations, muon g-2, dark energy, dark matter
- 8 major experiments in 3 frontiers running simultaneously in 2016
- sharing both beam and computing resources
- impressive breadth of experiments at FNAL



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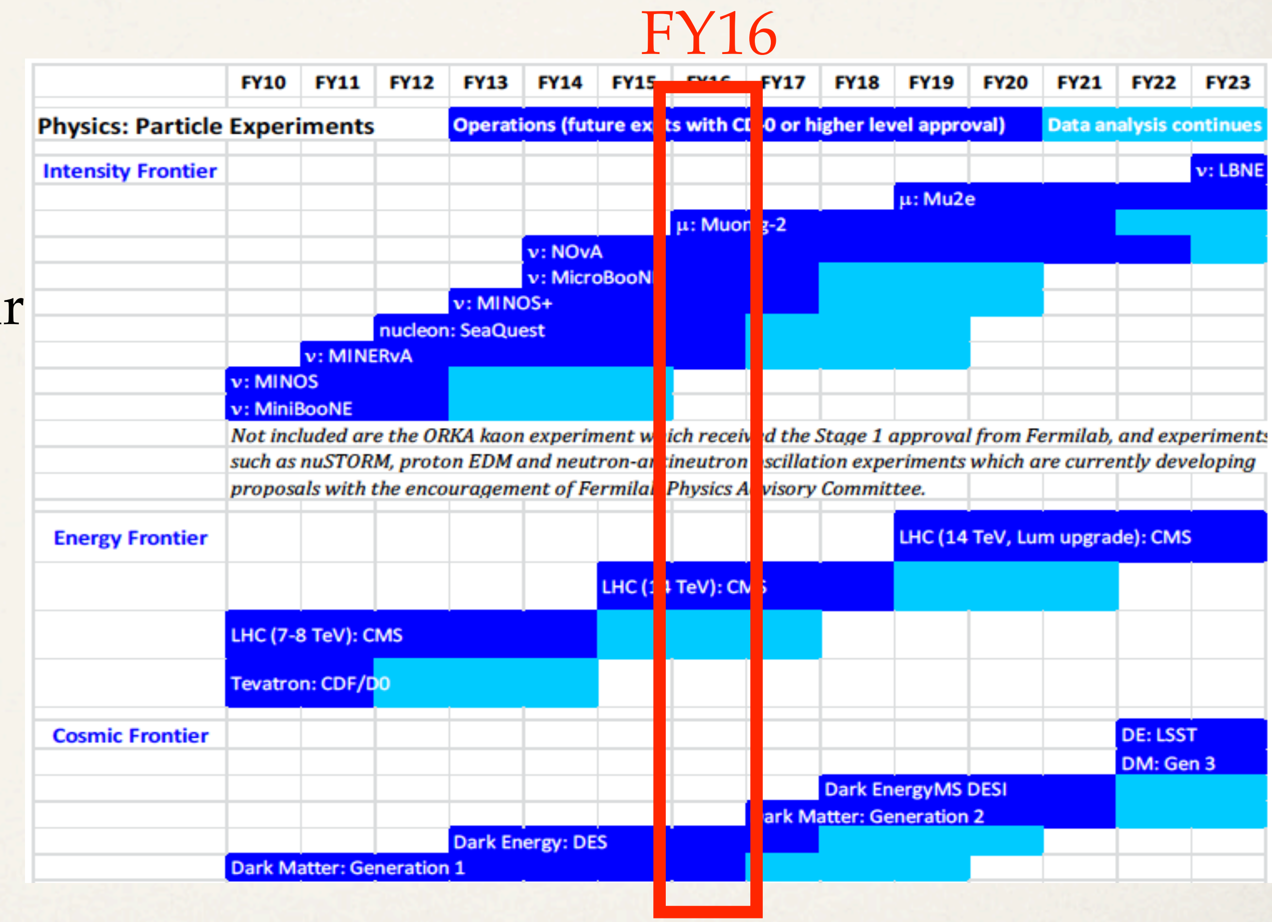
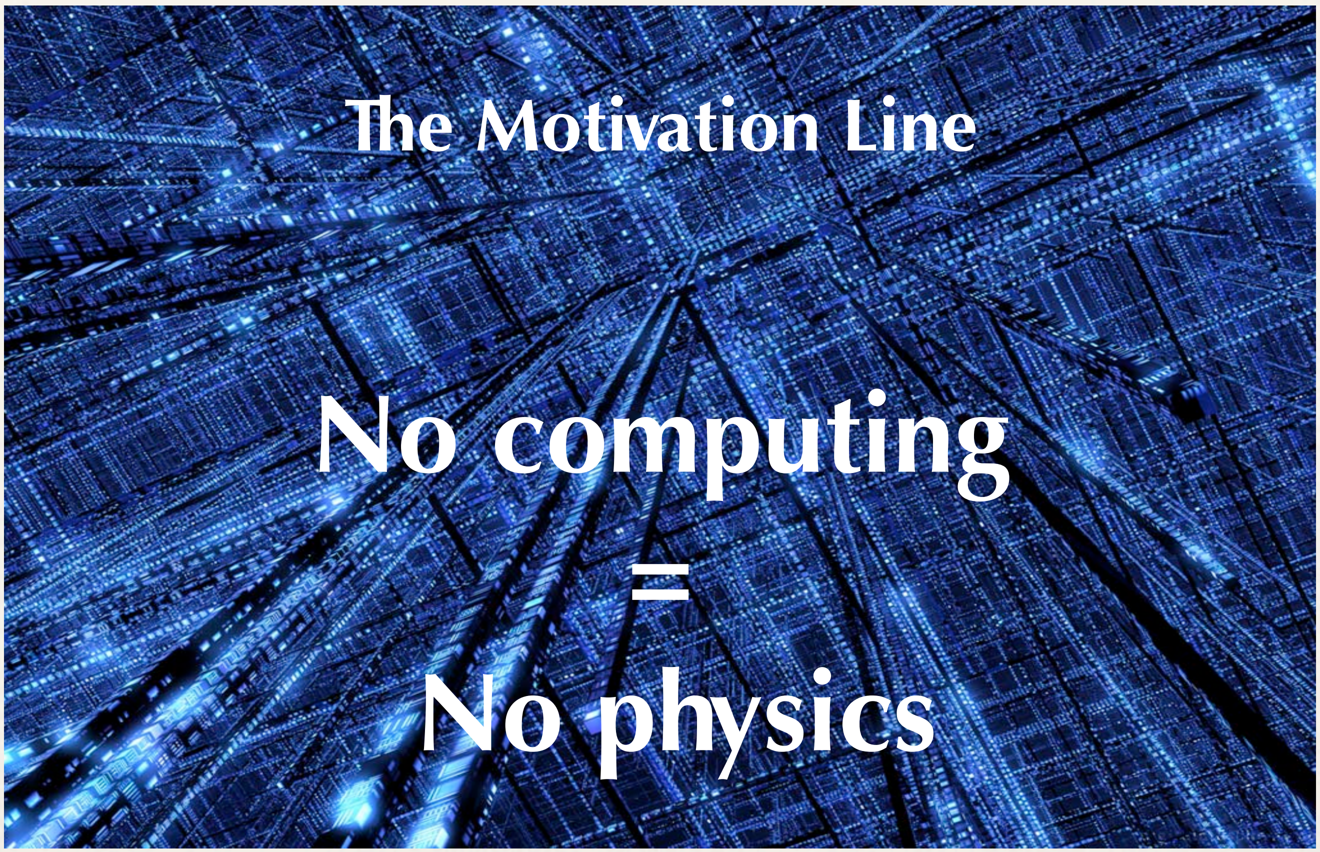


Computing's role in the success of experiments

- put simply....



From Mayly Sanchez, Snowmass 2013

Computing requirements for experiments

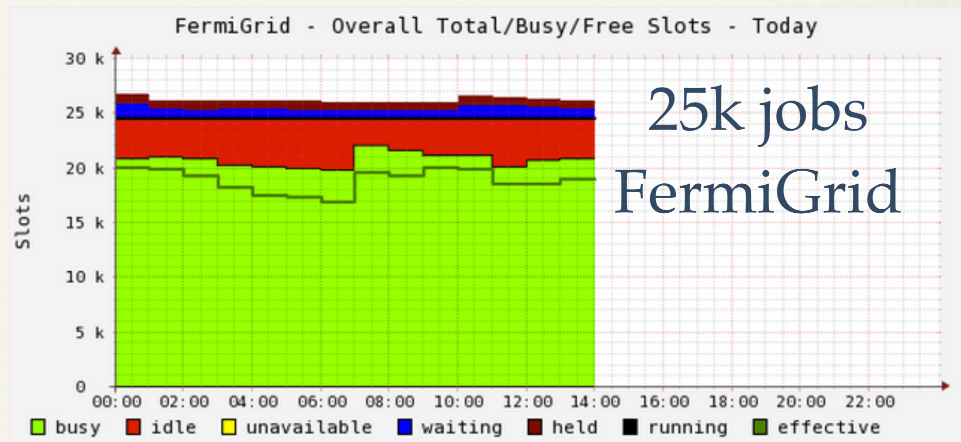
- higher intensity and higher precision measurements are driving request for more computing resources than previous "small" experiments
- beam simulations to optimize experiments - make every particle count
- detector design studies - cost effectiveness and sensitivity projections
- higher bandwidth DAQ and greater detector granularity
- event generation and detector response simulation
- reconstruction and analysis algorithms

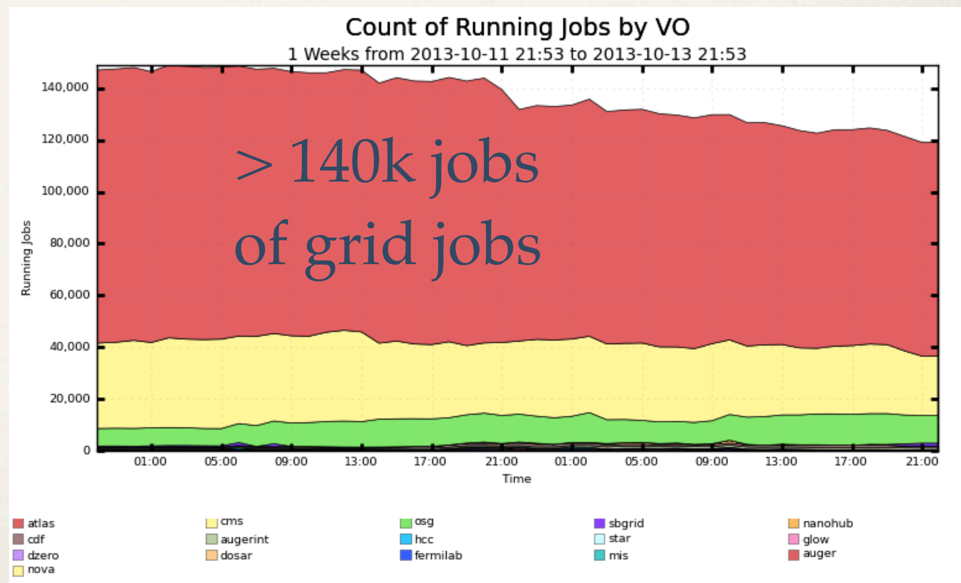
Fermilab Scientific Computing Review

Experiment	Allocation (Slots)	Average Utilization (last quarter) Average Slots	Peak Slots	FY13 Request (Slots)	FY13 Budgeted (Slots)	FY14 Request (Slots)
ArgoNeuT	200	75	1712	No change	0	No change
CDF	5400+800	2056	5746	-600	0	-990
CMS	7014	7018	8128	Assume will manage resources		
D0	5900+1200	5635	8691	-1940	0	-2000
Muon g-2	200	9	195	No change	+247	No change
LBNE	500	30	1202	+50	0	?
MARS MARS/g-2/LBNE/Mu2e	1225 25/200/200/800	212	1444	(in other requests)	0	(in other requests)
MicroBooNE	200	39	597	No change	0	+100
Minerva	800	667	3580	+500	+705	+500
MiniBooNE	500	0	0	Not part of this process		
Minos	1200	294	2427	No change	0	No change
Mu2e	500	597	2491	+500	+705	+500
Nova	800	410	1799	+200	+705	+500
General IF					+527	
Total Requested	25339	17042	38012	-1290	+2889	-1390
Total Available	24000			-2500		-3000

available onsite resources

- victim of our own success
- allowed smaller experiments to develop computing architectures focused on local resources
- now a need to reintegrate old architectures into a distributed computing model
- > 25000 Open Science Grid slots on-site
  - ~5000 slots for new smaller experiments
  - off-site resources will be needed to meet needs for experiments
  - using OSG model for processing provides an opportunity for universities and laboratories to contribute resources to experiments remotely

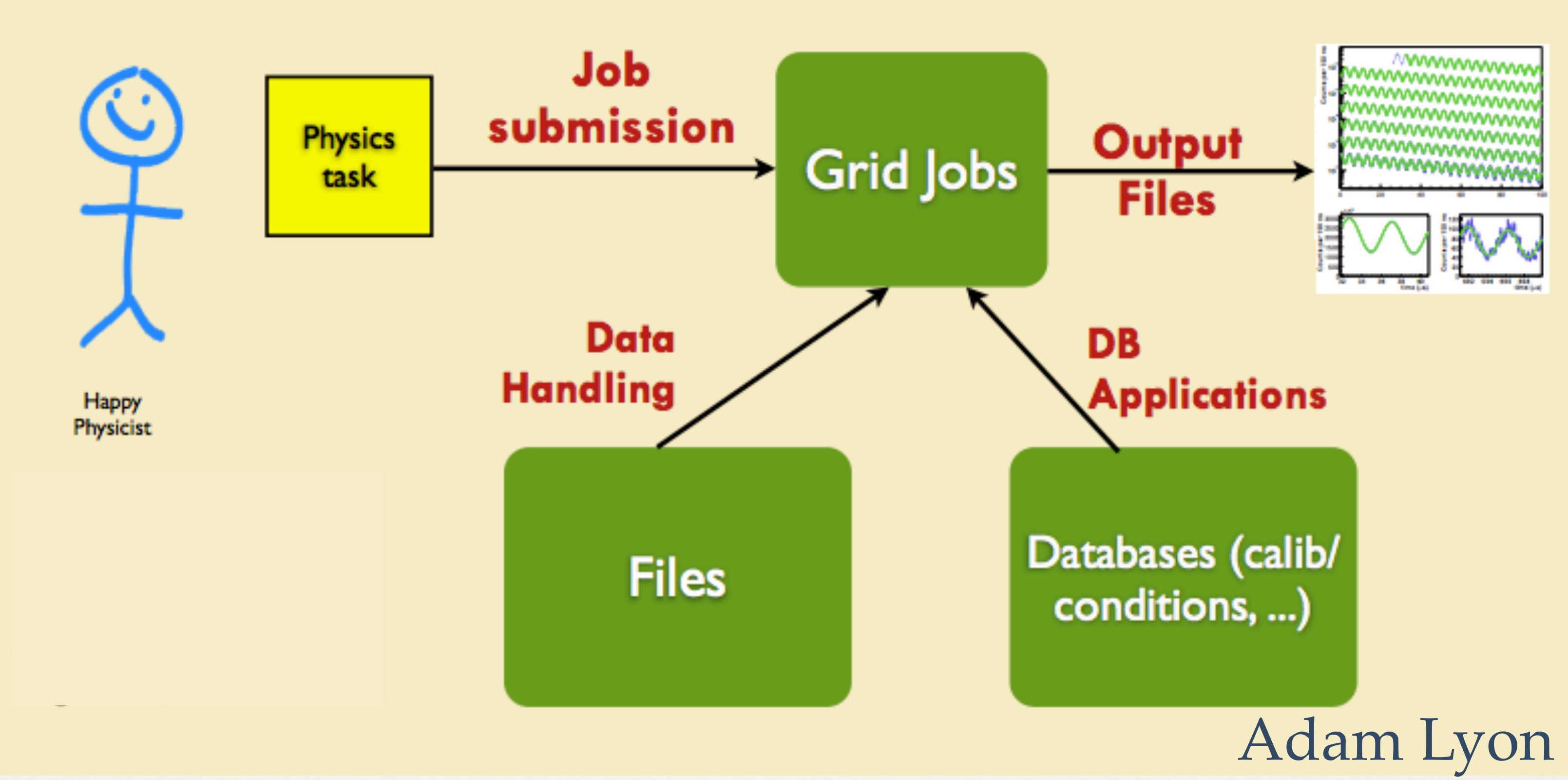




transition to OSG important for smaller experiments

- Most experiments are relatively small (~20-300 researchers)
- unlike Tevatron or LHC experiments do not have the person-power resources to develop large scale computing infrastructure
- architecting and implemented unique computing infrastructure too great of a burden
- Fermilab SCD's goal is to provide tools that are easily integrated to meet the needs of smaller experiments, flexible enough to meet needs and OSG focused
- need to both inform the experiments and gather requirements from them
- what resources are available?
- how do you get a job onto the OSG?
- what storage elements are available?
- how does it all fit together?
- FIFE is presenting an integrated solution based on new architecture

FabrIc for Frontier Experiments (FIFE)

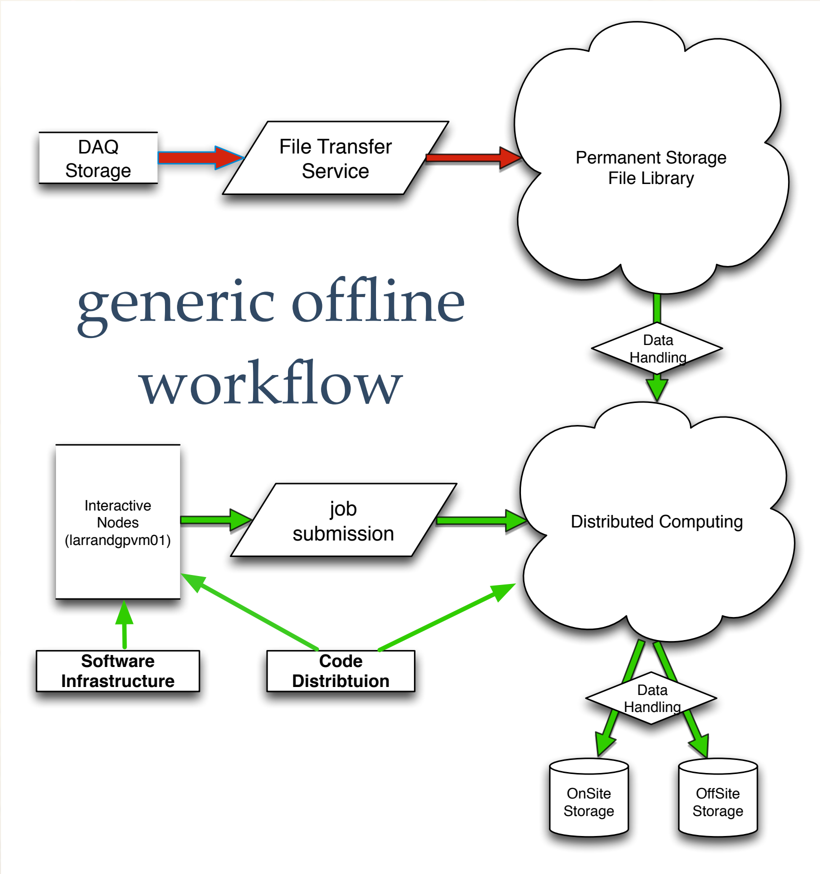


Adam Lyon

- provide infrastructure to experiments that get them to computing resources while focusing on their science
- utilize previous solutions and integrate together into seamless model

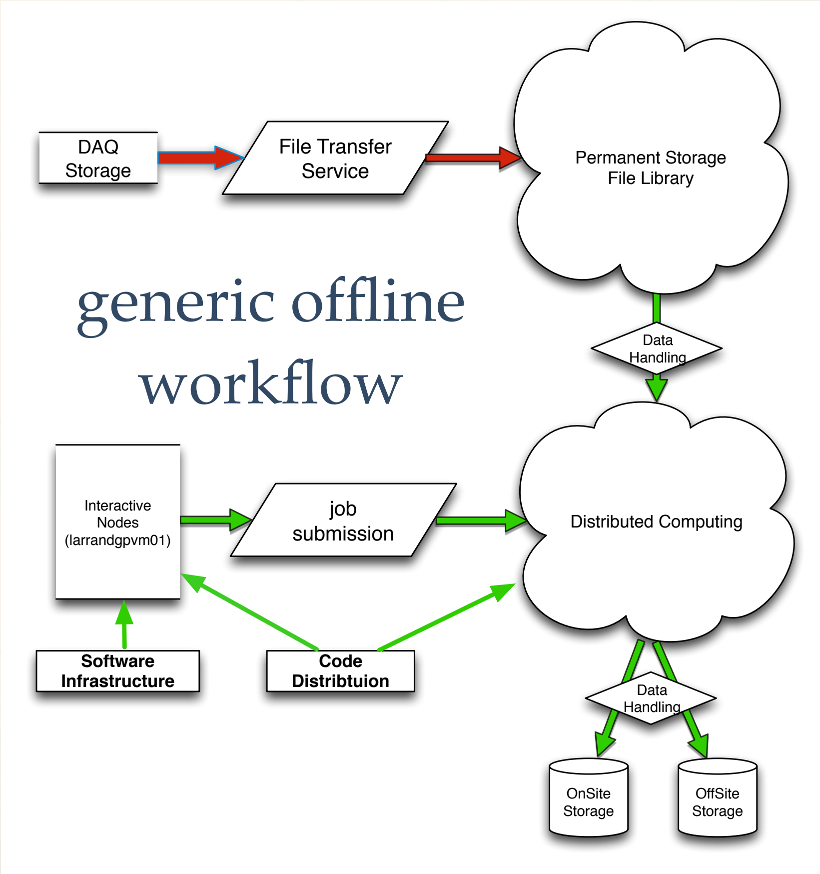
FIFE Strategy

- address all of the computing needs for experiments
- modular enough so that experiments can take what they need
- well enough designed so that while underlying solution may change, interface will be consistent
- provide mechanism for feedback from experiments to incorporate their tools and solutions
- help experiments utilize computing beyond the Fermilab campus
- integrate new tools and resources from outside Fermilab and other communities as they develop



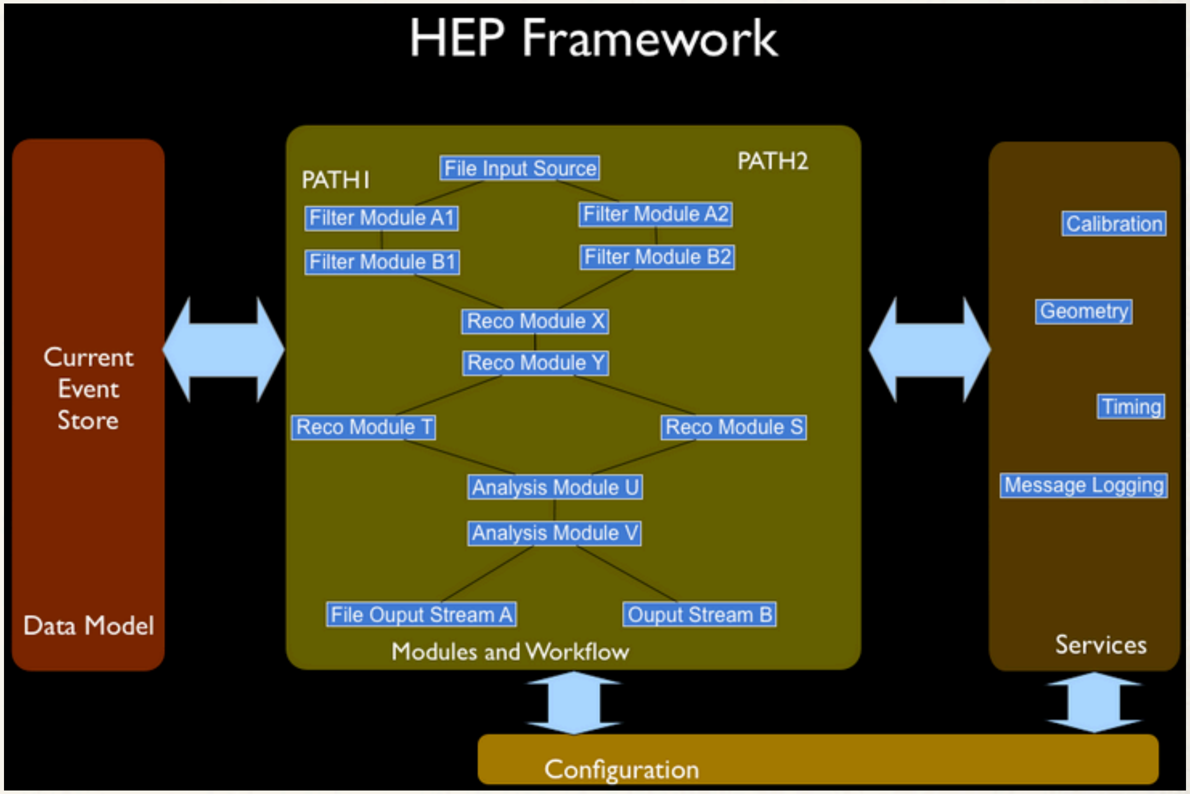
current FIFE implementations

- Software Framework - art has support of other services native
- build environment and distribution
  - git, svn, gmake, cmake and distribution with CVMFS - Andrew Norman's talk
  - build machine in development
- data handling - access to file catalog, tape storage, cache disk, and file transfer
- database infrastructure and access
- shared software (LArSoft for Liquid Argon TPC reco)
- additional infrastructure - authentication, electronic control log, new user accounts



art framework

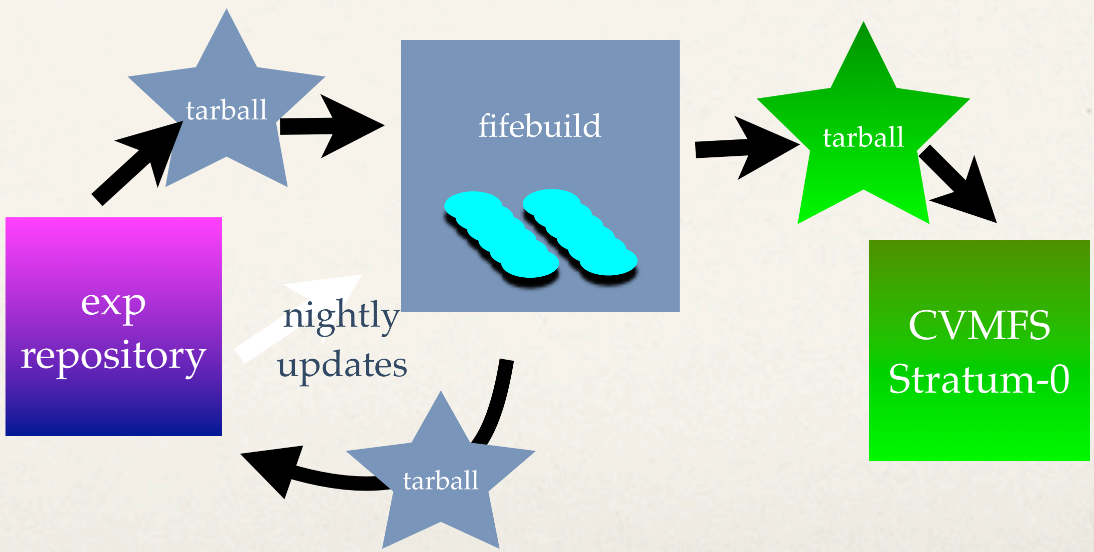
- well defined coding environment, designed to encourage best practices for algorithm development
- integrated data handling tools
- multiple path, provenance and metadata generation
- integration with generators, ROOT, Geant4
- active development with stakeholders
- integrated into the software environment of ArgoNeuT, g-2, μ2e, LBNE, MicroBooNE, NOvA, DarkSide-50



- talk by Adam Lyon

build and code distribution

- nightly build of experiment software important - multiple flavors, debug/opt/prof, OSs
- hardware and build configuration can have dramatic impact on build times - local disk and multithreaded
- construct dedicated hardware with VM with scheduled build times for each experiment
- considering integrating support for OS X
- interface with CVMFS servers for code distribution
- utilize relocatable UPS to distribute software and dependent packages
- LArSoft transitioning to product distribution and CVMFS
- OASIS server on the Open Science Grid
- move away from the central disk servers using NFS



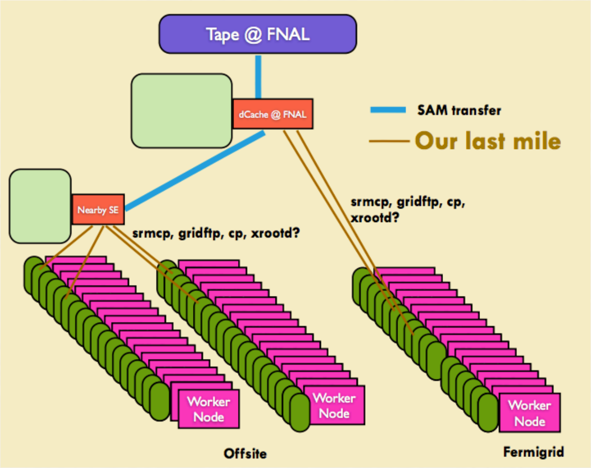
job submission tools

- where most of the heavy lifting for the experiments is being done
- transition to a new client-server submission system
- enable user code distribution through tarballs
- automatically interface with SAM, ifdhc, and OASIS
- generate DAG and workflows through dagNabbit.py
- focus on maintaining a consistent interface for the user, while potentially modifying the underlying solution
- utilize GlideinWMS (both FNAL and OSG factories) to access resource on-site and opportunistic off-site
- integrate new sites and resources quickly in an optimized manner
- currently used by 10 experiments
- poster by Dennis Box

Data Handling

- addressing the problem through three major services- file catalog, storage elements, and transfer clients
- SAMWeb project-Robert Illingworth talk
  - file catalog based on metadata and file location
  - web access to remove need for client
  - integrated with transfers to permanent storage
- storage element - transition away from NFS mounted storage to dCache implementation

- IF Data Handling Client - unified package of file transfer tools for grid jobs
  - SRM, gridftp, xrootd interfaces
  - handle SAMGrid projects
  - focus on new dCache storage elements



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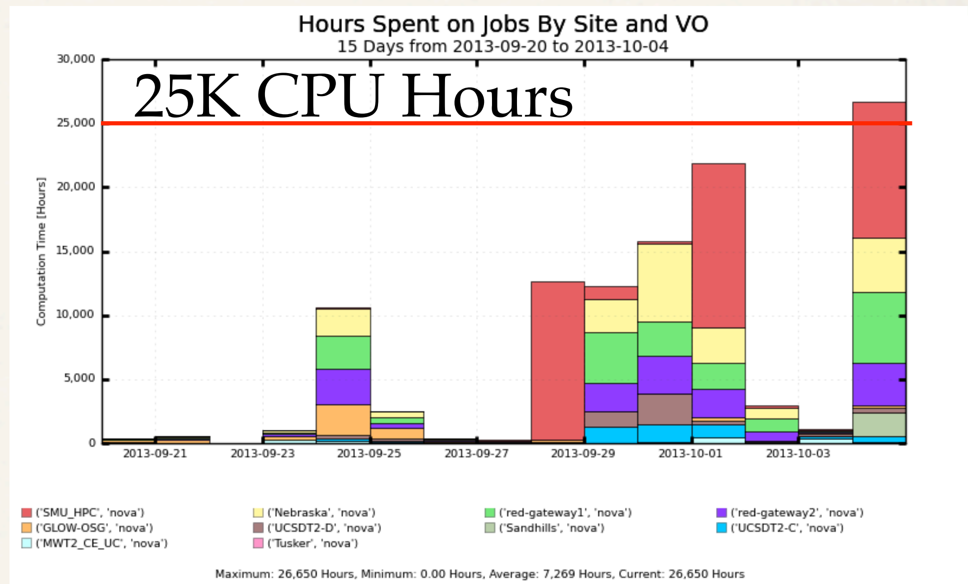
integration successes so far

- NOvA experiment has successfully moved MC Generation to OSG
- integrated 6 sites into operations UNebraska, Southern Methodist University, Wisconsin, UCSD.
- more than 10k jobs processed producing more than 1M simulated events
- Monitoring is an important part of assuring success of resource utilization



- using same submission command from user perspective, launched jobs “on-demand” at FermiCloud to provide proof-of-principle for Cloud bursting grid jobs

Plans for improvements

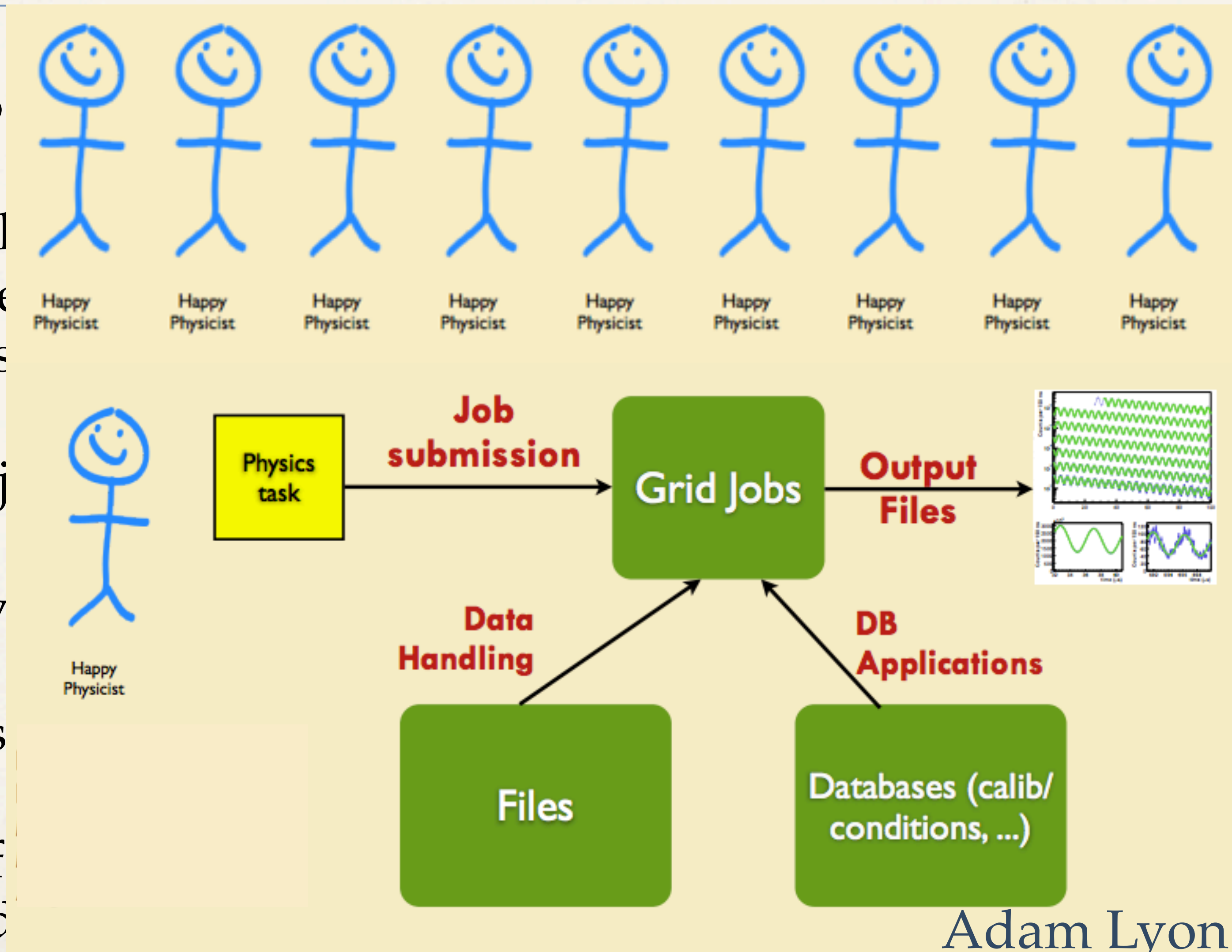
- FIFE architecture is currently undergoing re-evaluation and re-architecture process
- job submission infrastructure modify to client-server model
- local storage element making transition to shared dCache pools
- data handling project continues to integrate new resources without any change in user interface
- starting new integration push for several experiments in both the Intensity Frontier and Cosmic Frontier

Conclusions

- Fermilab physics program is extremely active at all three frontiers
- large scale computing needs for new "small" experiments encourages centralized services designed to ease integration to OSG and new resources
- FIFE project has developed a strategy and architecture to achieve this
- currently integrated OSG processing into the NOvA experiment
- from lessons learned from NOvA, working with other experiments
- looking forward to bring more resources and techniques to enable increased scientific output from frontier experiments

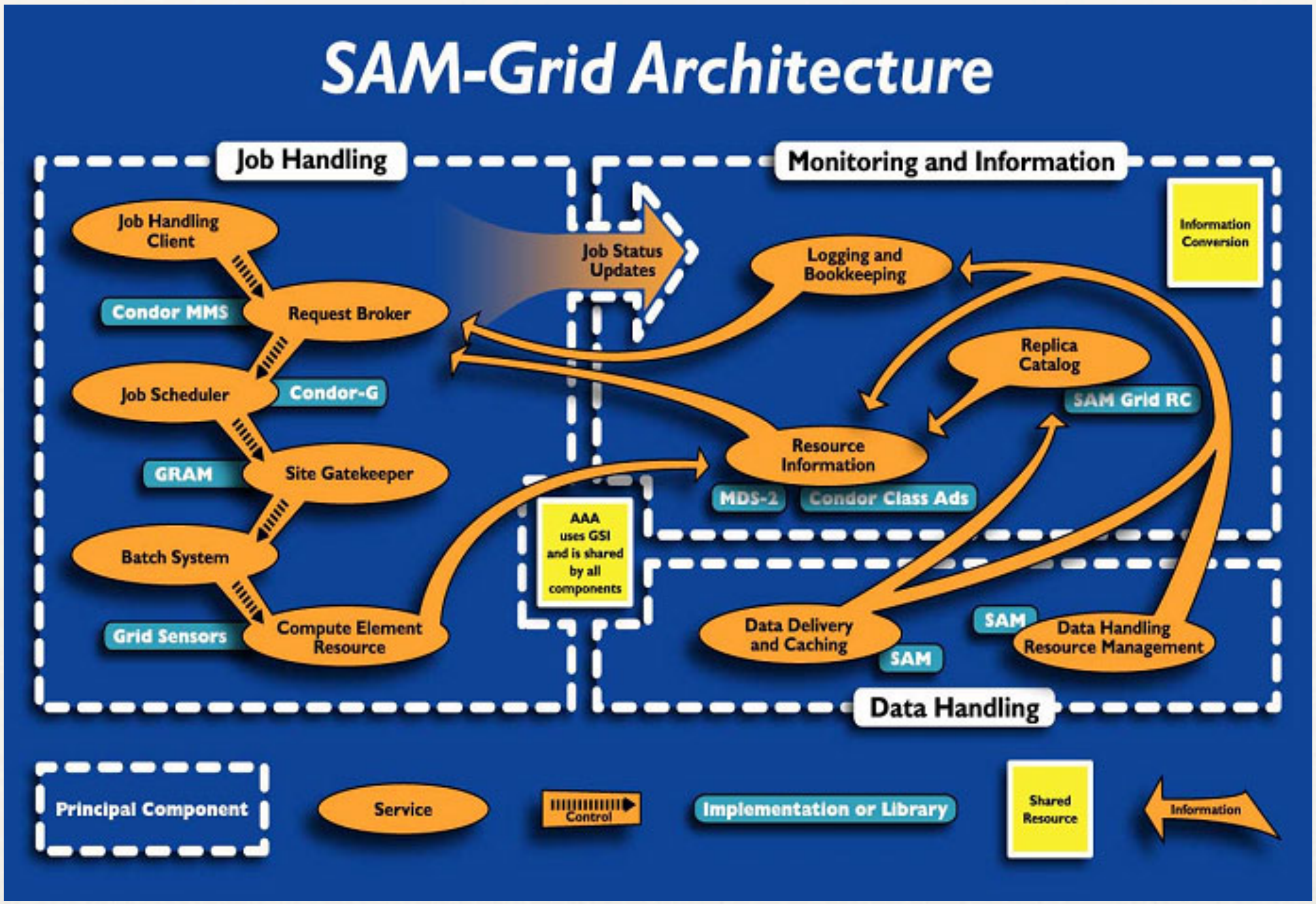
Conclusions

- Fermilab … ers
- large scal … urages centralize … ew resources
- FIFE proj … ve this
- currently … nt
- from less … ents
- looking f … ble increased



backup slides

SAM Grid Diagram



GlideinWMS

- Decided to try and reduce the number of GlideinWMS factories being maintained on site
- reduce from the current 8 factories to one service (2 redundant factories)
- also transition to use OSG factory to submit Glideins to offsite computing elements
- configure the new factory service, then transition all of the frontends one at a time to new factory
- also configure the onsite factory to be able to submit offsite, taking configuration from OSG factory and importing