Fermilab JDEM Development Efforts

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Outline

- Who we are
- Experiences in middleware and development for Astrophysics and High Energy Physics (HEP)
- Goals and tasks for this year

Who we are

- JDEM Ground Data System team at Fermilab
  - Stu Fuess (HEP), Erik Gottschalk (HEP), Steve Kent (SDSS,DES, *Deputy Project Scientist for JDEM/DOE*), Jim Kowalkowski (HEP), Eric Neilsen (SDSS, DES), Marc Paterno (HEP), Vince Pavlicek (HEP), Don Petravick (SDSS,HEP)
- As members of the Fermilab Computing Division, we provide core infrastructure software to experiments and projects, including development and integration.
- Part of the service we provide is to help improve software through better problem analysis, design, and implementation techniques and we provide improved tools to help scientists perform their work.

SDSS Computing

- Imaging
  - Total of more than 1 million fields (750 science imaging runs, 6 fields wide, averaged about 200 fields long)
  - 5 minutes per field processing time on a single CPU
  - Automated submission of jobs to Fermilab's batch and GRID processing facilities. Up to about 20 CPUs were used in parallel to process imaging data.
- Spectroscopy
  - Total of more than 1.5 million spectra (average of 4 exposures on each of ~2500 spectroscopic plates. Each plate contained fibers for 640 spectra)
  - 7 hours per spectroscopic plate processing time on a single CPU.
  - The data processing system could process the entire set of plates with almost no human interaction
  - 50 to 100 CPUs in parallel on Fermilab's grid computing infrastructure.

SDSS Data Volumes

Image

Data Type	Volume	Notes
raw data	17TB	includes calibration, engineering, and poor quality runs
corrected frames	16TB	
other data	27TB	includes masks, jpeg images, catalogs, and other support data
CAS database	18TB	most of the volume is the object catalog

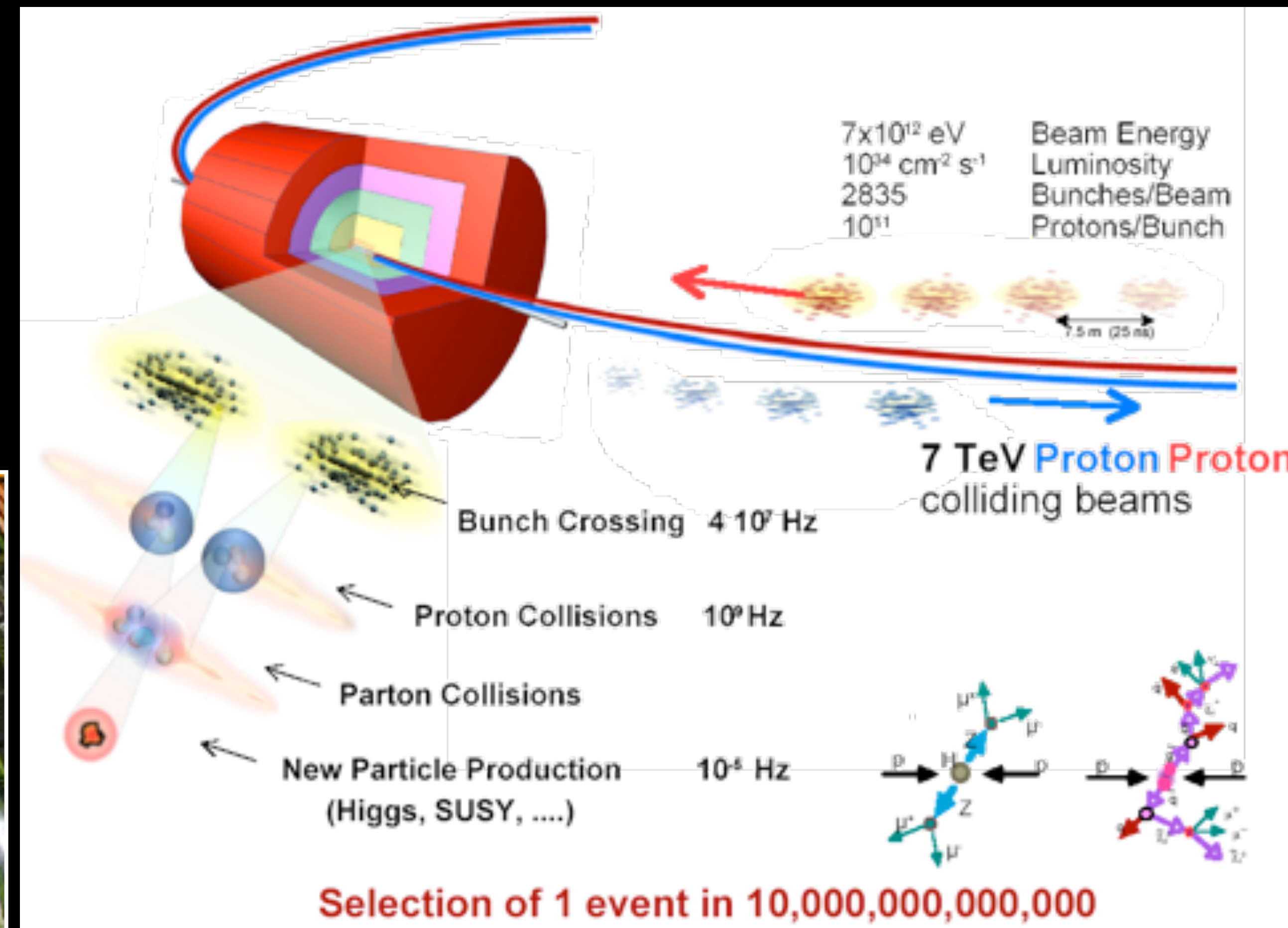
Spectroscopic

Data Type	Volume	Notes
raw data	1TB	
2D output	3.4TB	co-added, calibration spectra; noise estimates; masks; etc.
1D output	450GB	line measurements, redshifts, classifications, etc.

HEP Environment

D0 at Fermilab

CMS at CERN



Detector Properties

Projects our group
has worked on

HEP Project Facts

D0 Experiment (completing)

- 2.5 MHz particle bunch crossing rate
- Mean Interaction count per crossing of 1.3
- ~1 M ADC channels
- ~250KB/event
- ~100 Hz events from filter
- ~6777 TB stored
- Filter > 300 nodes

CMS Experiment (just starting)

- 40MHz particle bunch crossing rate
- Mean Interaction count per crossing of 15
- ~60 M ADC channels
- ~1 MB/event
- ~200 Hz events from filter (now 2000 Hz)
- Need ~2.2PB for first year
- Processing Event Filter > 1000 nodes

CMS will require ~32.8 Million hrs of CPU time/year for 10 years just for one pass of reconstruction.

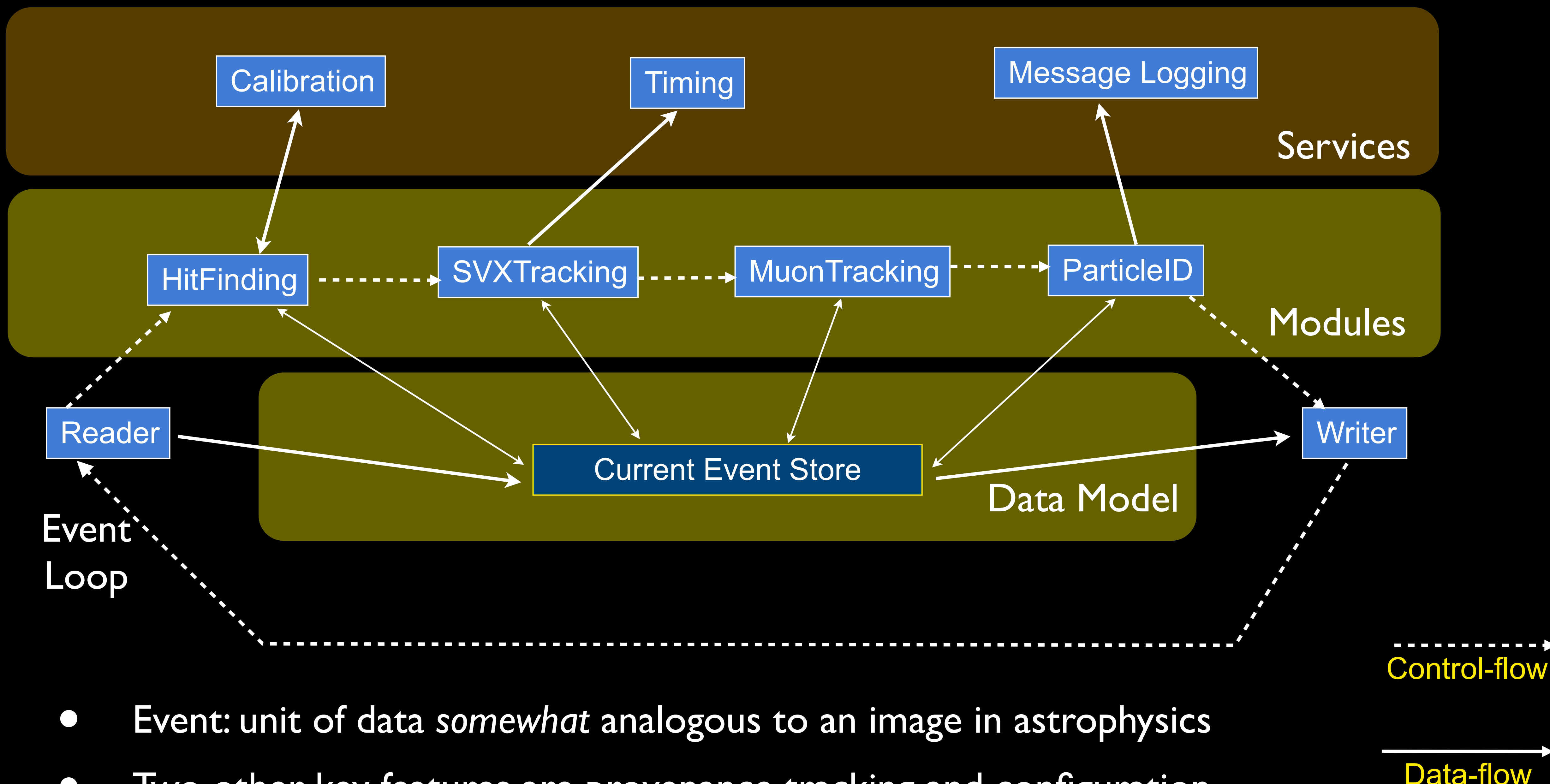
- >2.5M lines
- ~300 libraries
- ~400 developers over lifetime

- >3M lines & growing
- >1000 DLLs
- 423 external libs
- >1000 active developers

- Each experiment has a unique framework and set of modules.
- Each has basically one executable that fills several roles: event generation, simulation, reconstruction, and analysis.
- Many of the external libs are large HEP developed toolkits.
- Modules sequences are constructed based on run-time configuration.

HEP: What we provide

Event Processing Framework: Software that coordinates the processing of *collision events* by pluggable *reconstruction, filtering,* and *analysis* modules. Events and modules are independent. Modules add data to and retrieve data from one event at a time.



- Event: unit of data *somewhat* analogous to an image in astrophysics
- Two other key features are provenance tracking and configuration

What we do

- We support the needs of large collaborations (100's to 1000's of people)
  - efficient processing of large data volumes (including reprocessing)
  - provide ways for everyone to contribute to software development
- We've delivered systems that are relatively easy for scientists to use:
  - to configure and run,
  - to know what has been processed and how,
  - to extend with new algorithms and services,
  - to diagnose problems
- We build software that can be deployed in large cluster environments
- We provide an end-to-end solution: from raw data to final analysis

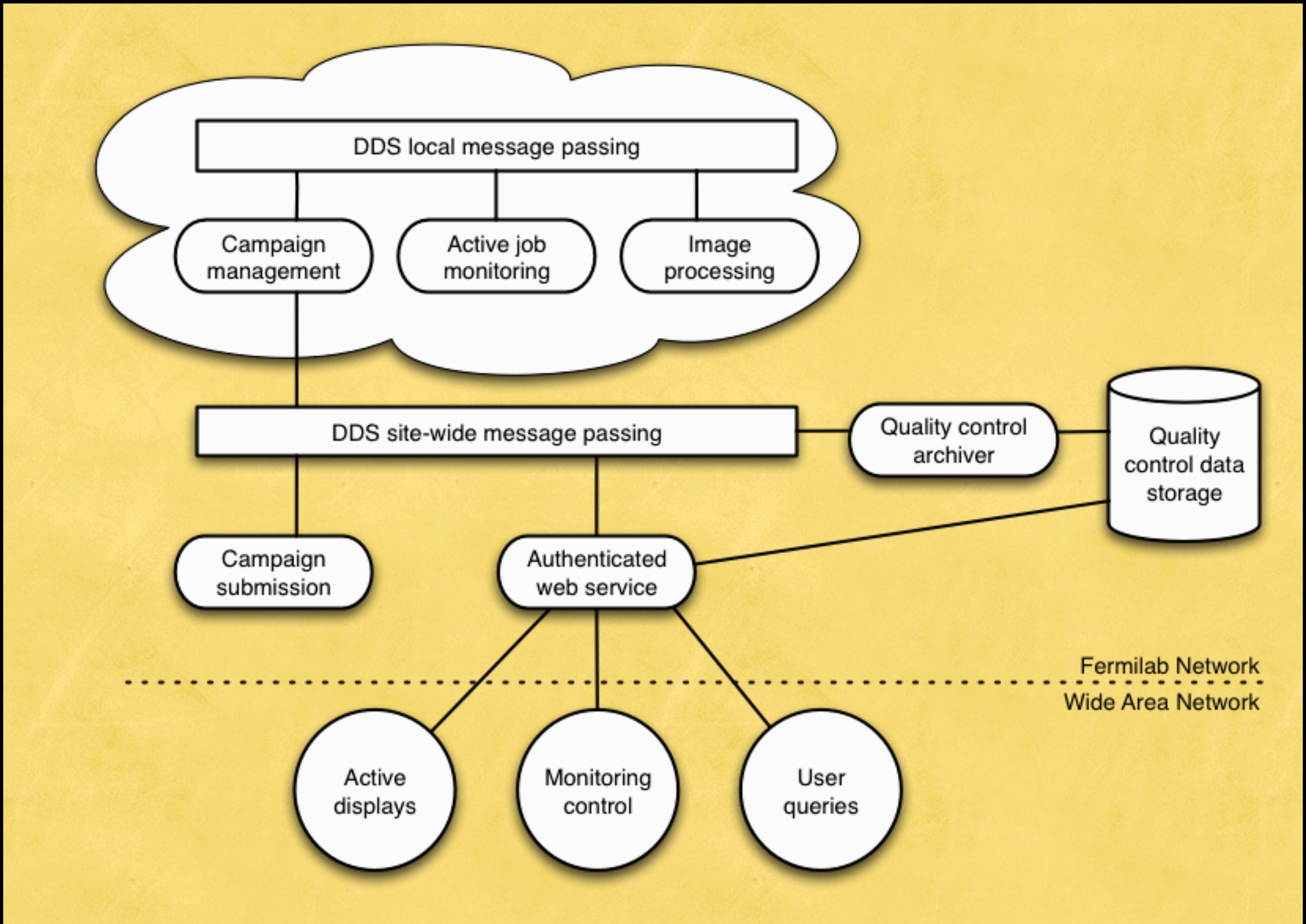
JDEM tasks and goals

- Plan of work for FY2010
  - Slitless spectroscopy for BAO science (not the focus of this talk)
  - Core Infrastructure R&D for JDEM
- Goals of core infrastructure work
  - Calibration and slitless spectroscopy algorithms for science operations
  - Work with other laboratory projects and experiments to combine experience, technology and tools to make a more maintainable and useable set of infrastructure software (LQCD, Neutrino Experiments)
  - Development of JDEM prototype

Aspects of Prototype

- Workflow (Kepler Project, LQCD): The tools needed to specify the problem being solved, map the problem onto a set of resources, and reliably carry out the entire task. Kepler is our primary target as the engine for driving the workflow.
- Enterprise message passing system (OpenSplice DDS, NOvA, LQCD, LSST): Reliable and efficient bidirectional communications of control and monitoring messages from applications, the workflow system, and the cluster.
- Quality control (LQCD/Vanderbilt/Tech-X): We will define messages, data structures, and plots necessary to ensure data quality and efficient data processing. The message passing system will be used as an underlying tool.
- Configuration, progress tracking, and provenance management (LQCD): a database and set of manipulation libraries to be used to manage this information. Will be integrated with the workflow system.
- Security: Transport data safely through various networking levels: local clusters to intranets through the internet.
- Clouds and clusters: Understand the problem of running complex job sequences on available computing resources. Includes storage and maintenance of development and runtime system images.

JDEM Prototype



Summary and Objectives

- Explain who we are
- Describe what we are working on
- Discover the kind of work being done
- Discover common interests