

# U.S. CMS Computing

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*DOE Annual Program Review, March 24th 2004*

*credit for the slides to*

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# CMS Software and Computing



Building up software systems for physics through series of “Data Challenges”

→ Performance milestones for software and computing infrastructures

1997

Magnet, May 1997  
HCAL, June 1997  
ECAL & Muon, Dec 1997

Tracker, Apr 1998  
Addendum: Feb 2000

Trigger, Dec 2000

TriDAS, Dec 2002

2003

DC04  
(C-TDR validation)

2004

DC05  
(LCG-3 validation)

DC06  
(physics readiness)

## ❖ Computing TDR, Fall 2004

- ◆ Technical specifications of the computing and core software systems
  - for DC06 Data Challenge and subsequent real data taking
- ◆ Includes results from DC04 Data Challenge
  - successfully copes with a sustained data-taking rate equivalent to 25Hz at 2x10<sup>33</sup> for a period of 1 month

## ❖ Physics TDR, Dec 2005

## ❖ CMS Physics, Summer 2007



## U.S. CMS Regional Center

- Provides management and core components of U.S. CMS User Facilities.
- Collaborates with Cern Tier-0 on distributed computing infrastructure
- Collaborates with other CD departments and Run II on common services and leveraged developments.

Contributes to the U.S. Core Application Software developments and support for CMS-wide collaboration.

- Software librarian and distribution support.
- Contributions to distributed production environment, job management, pool persistency libraries, etc.

CMS Department Scientists contribute to algorithm development and ongoing analysis tasks.

CD and PPD CMS collaborate on other software and computing tasks such as database applications, remote control room, etc.



# Current Tier -1 Activities



## Preparations for Major Milestones

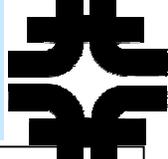
- DC04 Data Challenge
- Data Streaming Project between CERN Tier-0 and Tier-1
  - Select, transfer, archive streams of events to provide reliable data transport and network optimization; archiving and storage; event selection and identification.
- Preparation for the Computing TDR
- Preparation for the Physics TDR
- Roll out of the LCG Grid service at Tier-1
- Interoperability and Federation between LCG and U.S. Grids

## Production and Analysis Facility Infrastructures

- Equipment Upgrades
- Commission and support incremental Local and Grid capabilities
- Increase the capabilities in support of User Analysis



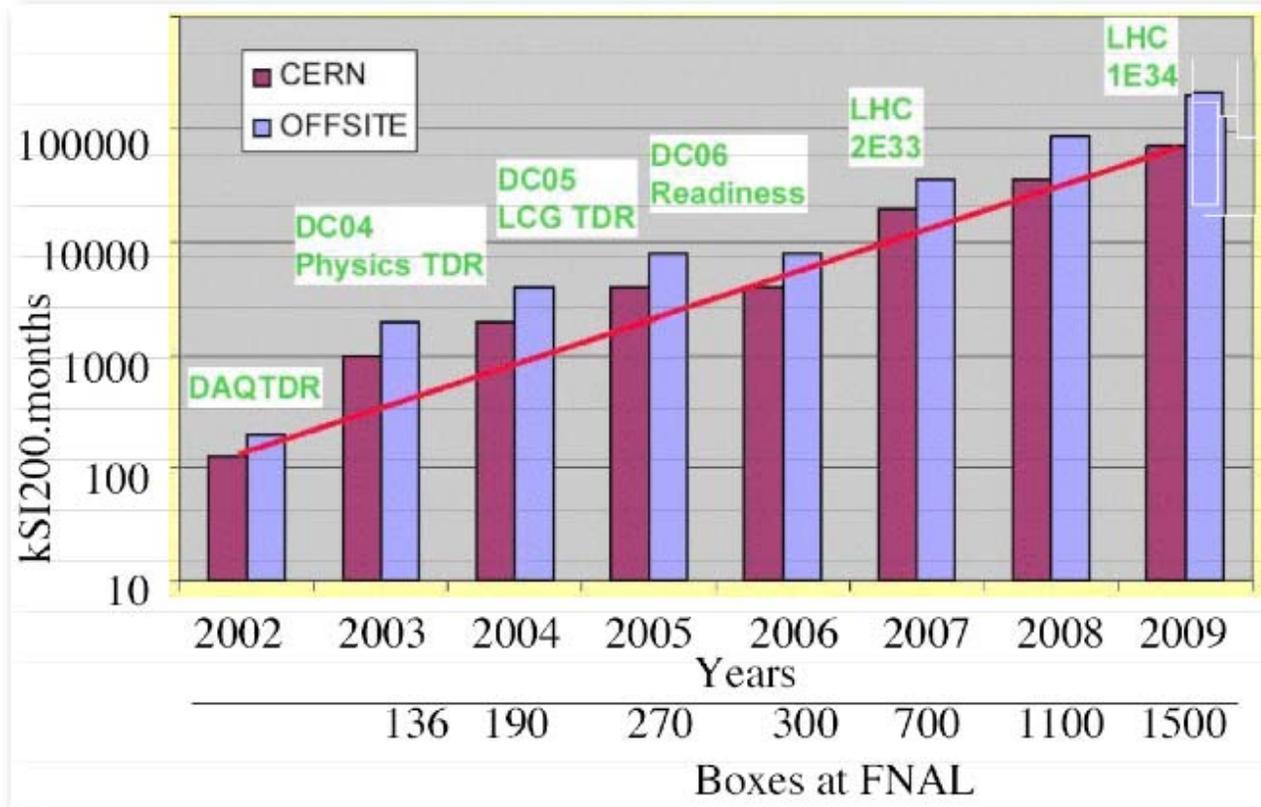
# Upgrade Path for Tier-1 Facility



## Scaling up the Tier-1 equipment

- ➔ On track for the baseline plan
- ➔ preparation for DC04: U.S. share to CMS CPU, storage, data access
- ➔ Planned procurement for next upgrades

	2002	2003
CPU	75	200
Storage	10 TB	34 TB
Throughput	200 MB/s	700 MB/s





## Major milestone for CMS software and computing

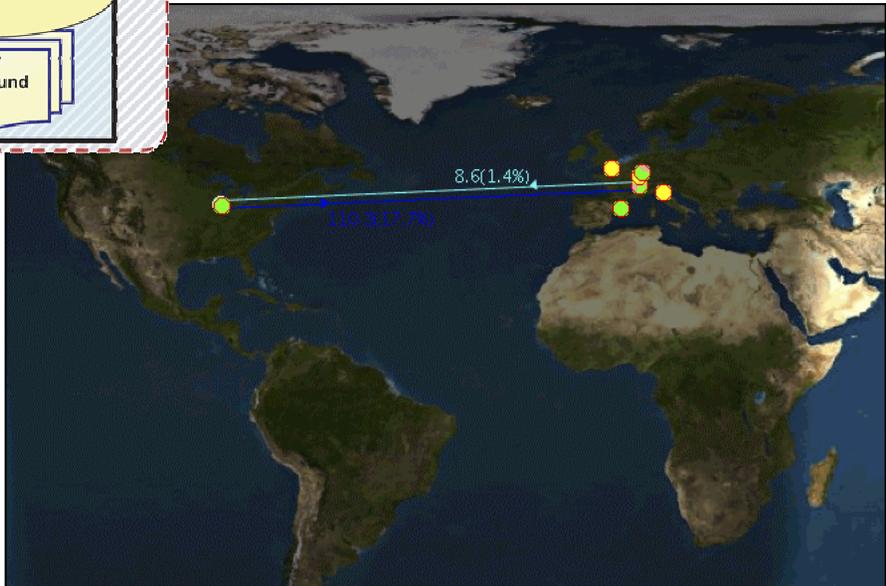
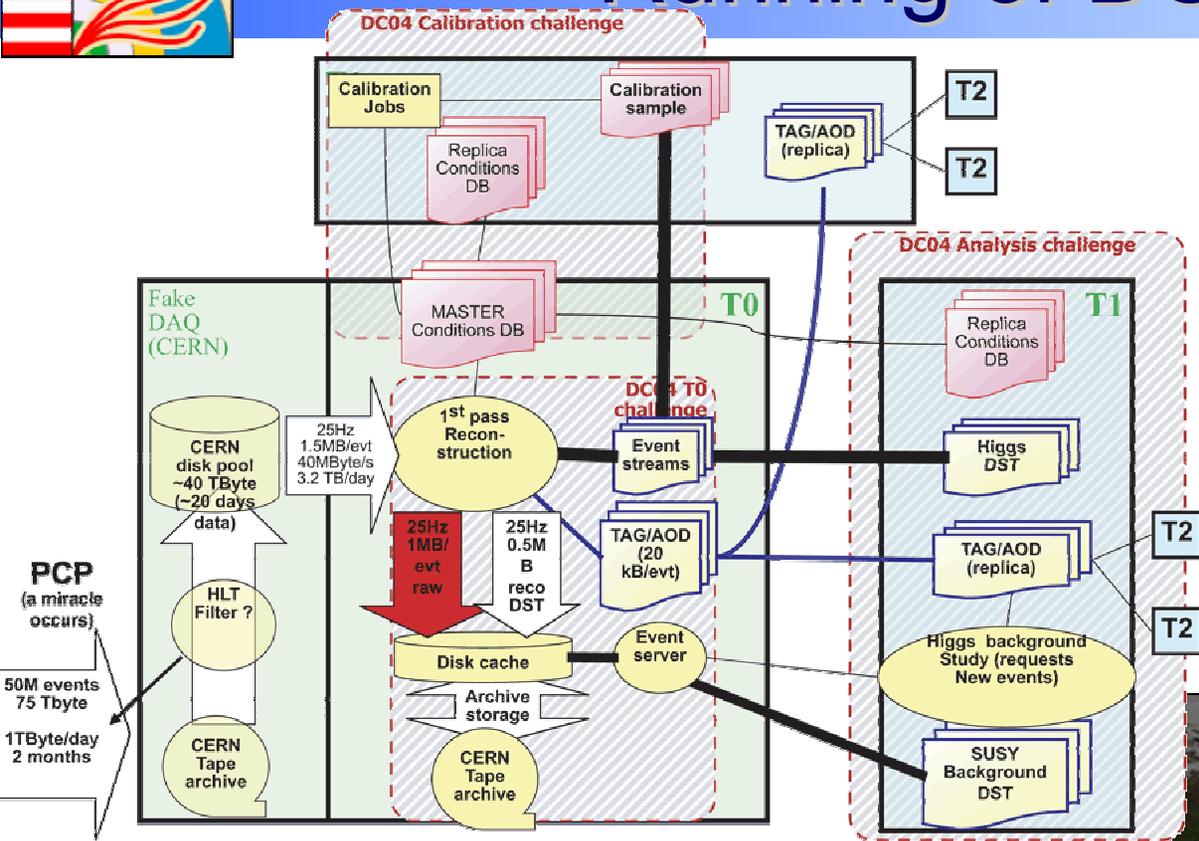
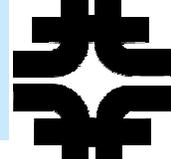
- Validate software and get input for computing model
- Reconstruction at Tier-0, data streams with DSTs
- Streaming data to Tier-1s using Grid tools
- making data sample available for analysis at Tier-1 and Tier-2 centers

## DC04 Preparations and Milestone

- 69M events being simulated, including pile-up and shipped to CERN Tier-0 center.
  - Massive CPU, storage and data transfer needs: worldwide production. U.S. share done on U.S. CMS Grid and Grid3
  - Geant-3 to Geant-4 transition complete
- Sustained data-transfer rate equivalent to 25Hz at  $.2 \times 10^{34}$  luminosity for a period of 1 month and validate the computing model on sufficient number of Tier-0 and Tier-1 sites.
- DC04 data samples to be used for physics studies in preparation of physics TDR in 2005



# Running of DC04



Running of the Data Challenge underway

➔ Detailed info at <http://www.uscms.org/s&c/dc04/>



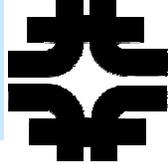
# Leading to LHC Production Grids



Putting real Grids to do real work for CMS

- ➔ Grid3 in the U.S. running massive production of simulated events
- ➔ LCG-2 getting ready for DC04

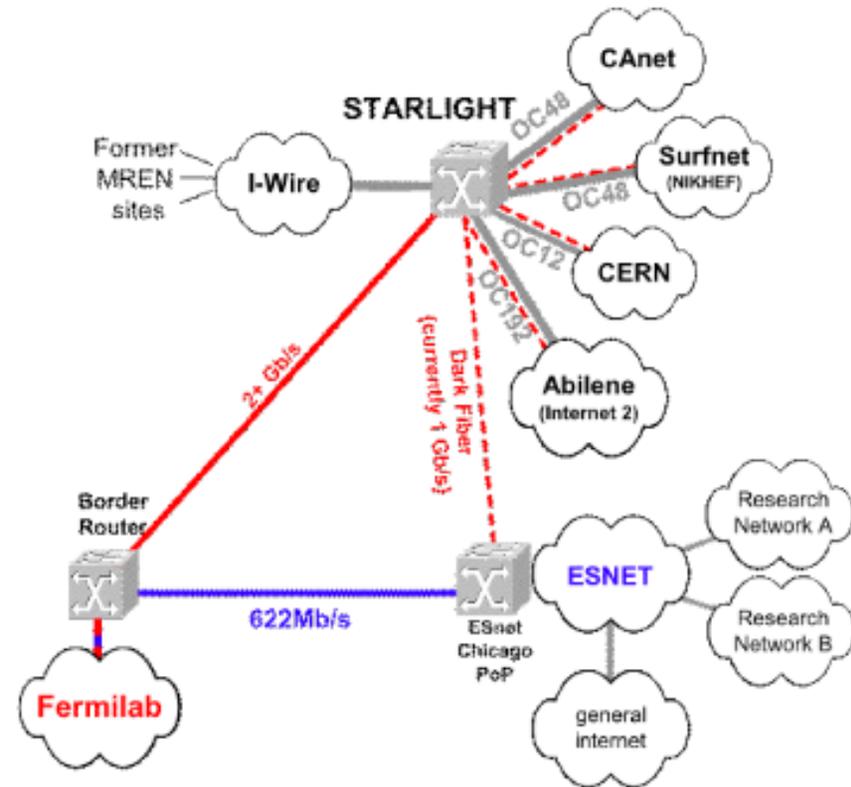




Advances in Networks required to meet CMS data transport needs.

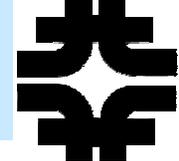
Fermilab providing Dark Fiber connections as alternate path to Starlight connected networks.

Enhance middleware and application capabilities to exploit advanced networks (DOE Ultranet Proposal)





# User Analysis Facility



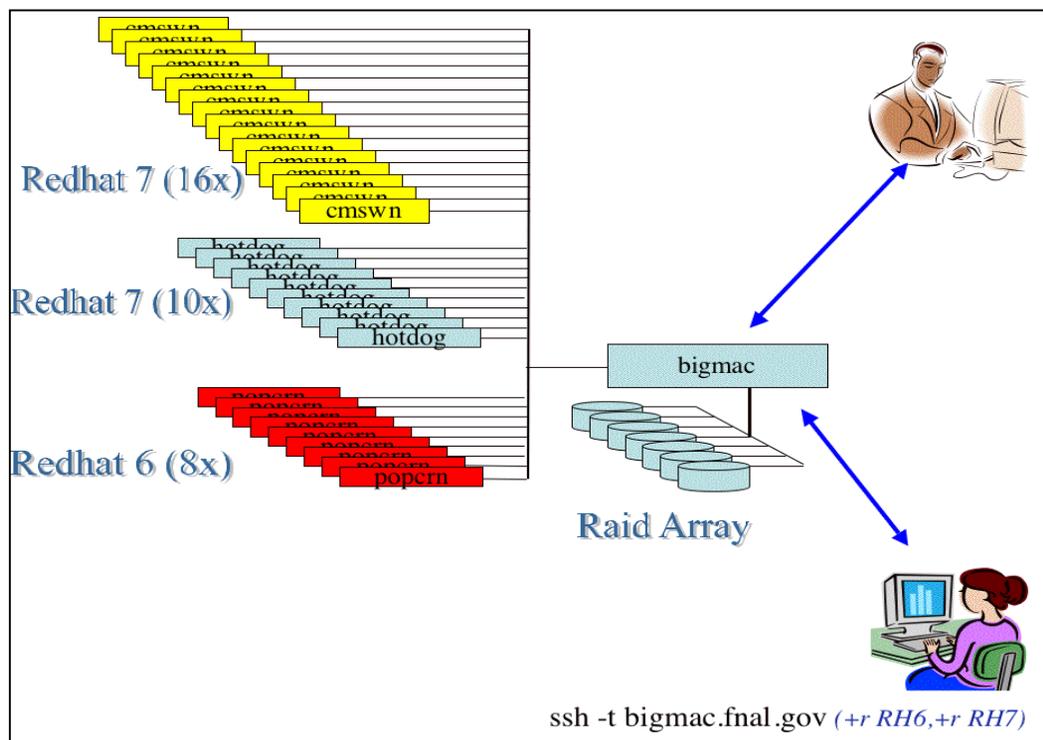
Commissioned a facility for analyzing CMS physics data

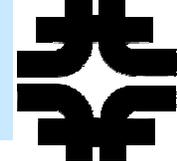
- ➔ Large simulated data samples to be analyzed for physics TDR
- ➔ Emerging user base at Fermilab Physics Analysis Facility

Massive Data Serving + Analysis Disk Space for Users

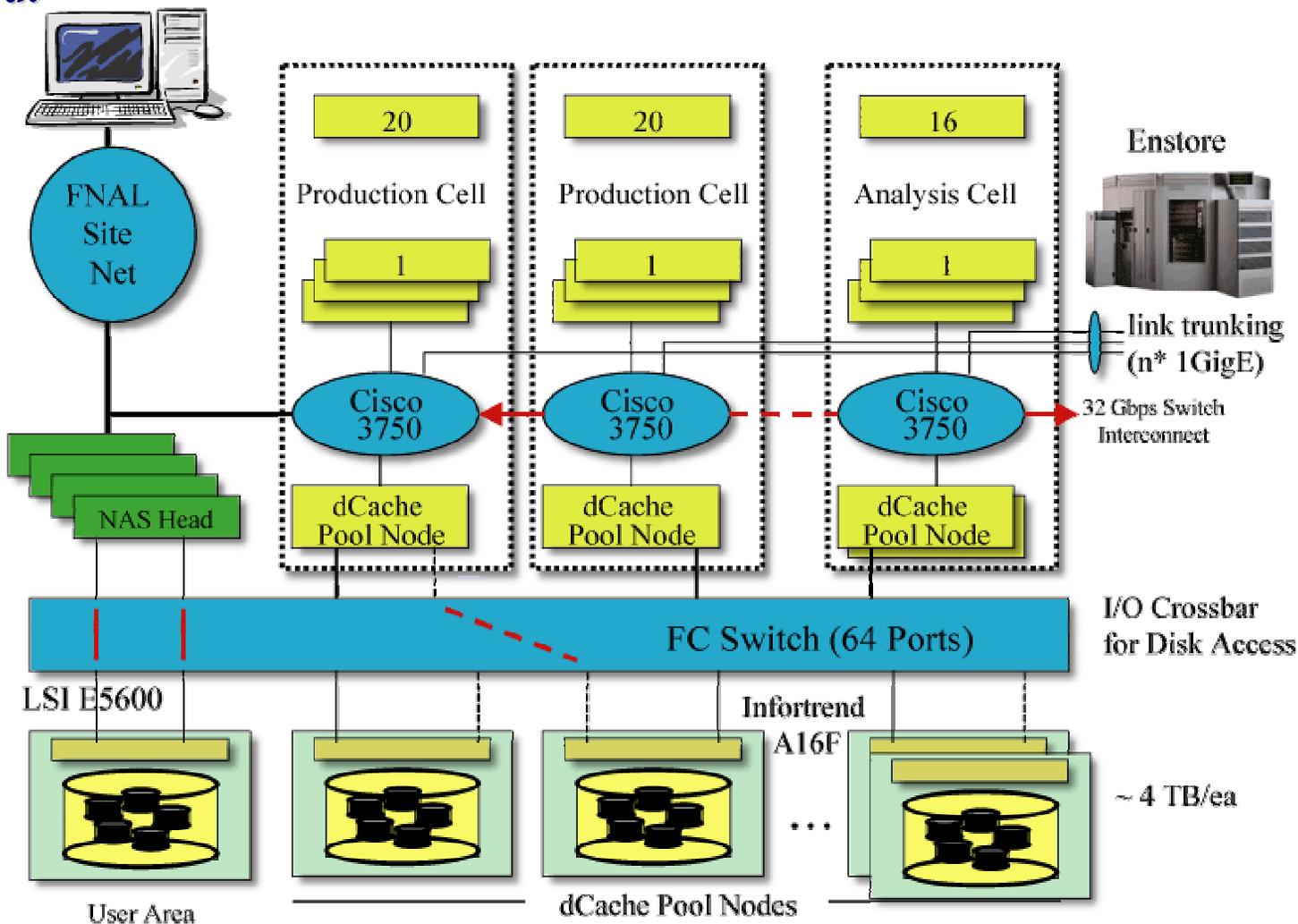
- ➔ R&D work on system architectures and software components
- ➔ Developing the CMS analysis environment end-to-end

Provide production team, physics groups and individual physicists seamless and high-throughput access to CMS data



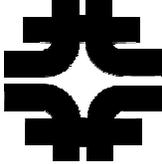


## CPU and Storage Services -- Interfaced to the Grid — Scalable High-Throughput Layout

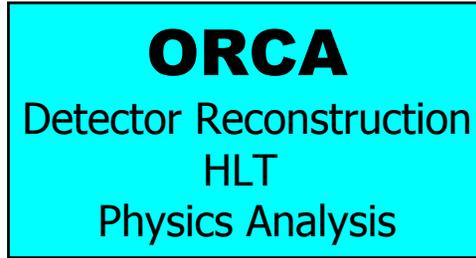




# U.S. Software Contributions



e.g. Event I/O, Geometry Databases, Production System Infrastructure, Visualization, Geant-4



## U.S. CMS Contributions





# US CMS Computing 2004..



Experience from DC04 will guide Computing Model and TDRs.

Analysis Opportunities from DC04 will increase user base and interest in data management, event model and end to end analysis software.

Increase in scale of Facilities will give needed CPU and Storage for CMS production and analysis.

New capabilities and scales for U.S. grid demonstrators, initial Open Science Grid engineering for common Grid environment and shared Facilities will push the deployment of Distributed Services.

Advanced Network R&D will give Opportunities for increase in throughput and intelligent exploitation of management capabilities.

Delivery of first ARDA distributed analysis middleware and end-to-end analysis prototypes will give experience and drive requirements and priorities for additional capabilities for Grid based collaborative science.