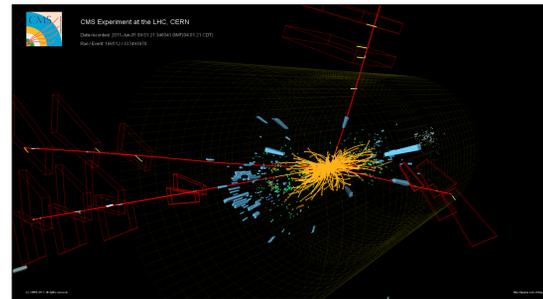


# Computing for the CMS Experiment – the US Contributes in many ways: Largest Tier-1 Center at Fermilab; CPUs, Tape Storage, Disk Caches; Software, People.

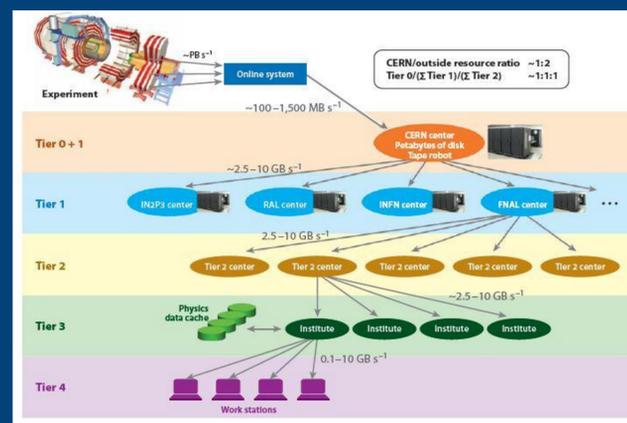
## Taking Collaborative Computing to the Extreme



### The LHC Computing Model is supported by the Fermilab Tier-1

The distributed computing system for LHC distributes hundreds of Terabytes a day outward from CERN to the 11 distributed Tier 1 sites (one at Fermilab) and then to more than 25 University Tier 2 (of which 7 are in the US), and access to more than 100 smaller Tier-3's (of which >25 are in the US).

Challenges faced are to: manage Petabyte data volumes at 10 to 100 Gigabit/sec rates; (b) efficiently use the requisite 100,000 CPU and data storage over ~100 different autonomous institutions; (c) enable effective physics analysis by 1,000s of users accessing the data, and (d) provide decades-long data archiving, curation and preservation in a robust way.



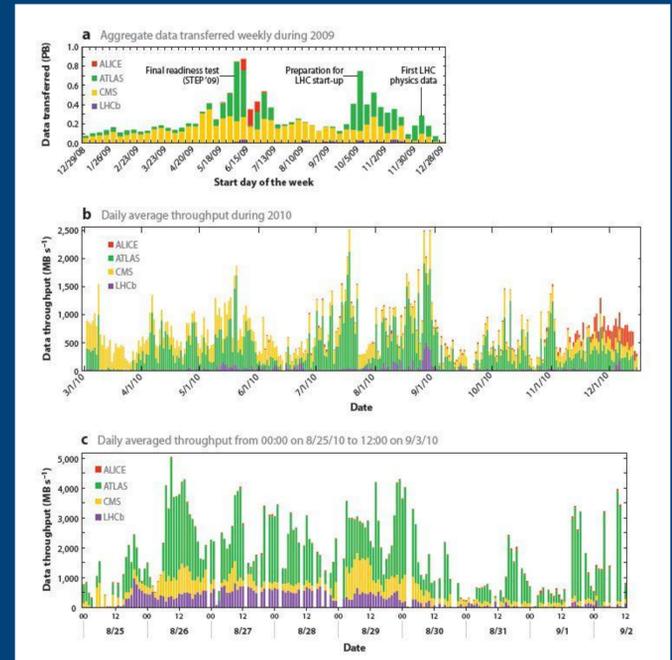
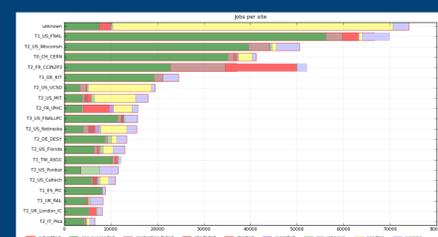
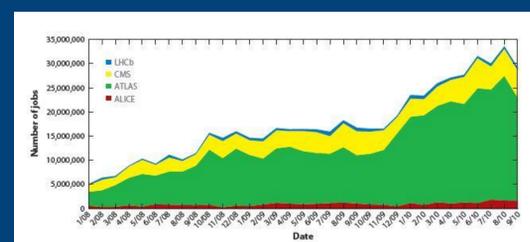
### Fermilab Remote Operations Center: one of several Worldwide

ROCs provide collaborative environments that monitor and analyze the data as it is acquired.



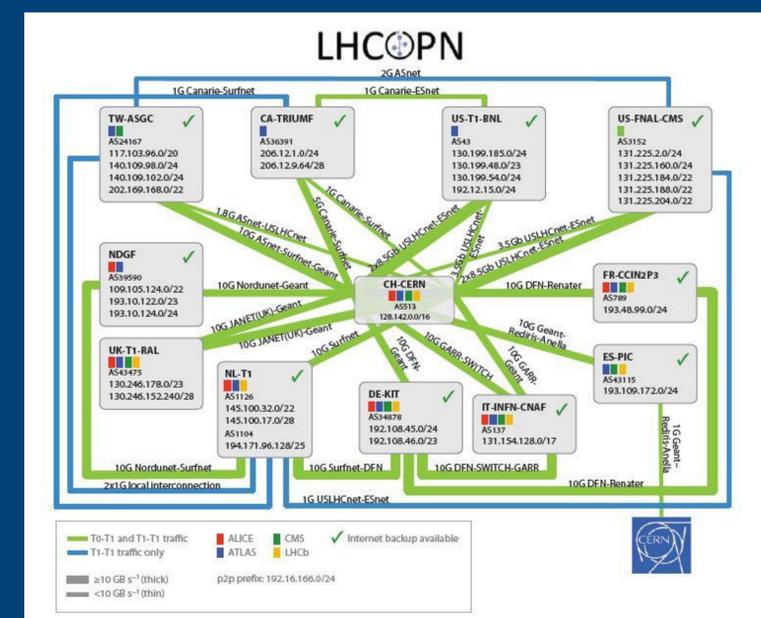
### Evolution of Grid Workloads

The number of jobs run per month, summed over the full Worldwide LHC Computing Grid (WLCG) infrastructure, is shown. More than 1 million jobs per day are currently run. In the US, the LHC jobs run through the Open Science Grid, which operates transparently with similar Grids in other countries. We also show the jobs completed over 24 hours.



### Data Rates

Achieved during: (a) 2009 simulation, (b) 2010, (c) an expansion of several days in 2010 shows peak transfer rates. The aggregate data rate out of CERN to the Tier1 sites is shown. The nominal rate of 1.3 GB s<sup>-1</sup> was often significantly exceeded. Data transfers to US sites over past year are also shown.



### The LHC Optical Private Network

Dedicated "dark-fiber" connections between CERN and each of the Tier 1 sites. These connections are supplemented with secondary connections to ensure reliability of the network. Connectivity between Tier1 and Tier2 sites is provided in the US by Internet2 and ESNET and by national and international research networks.

