



CMS, US CMS

Status of CMS

Dan Green

US CMS RPM

October 13, 2006

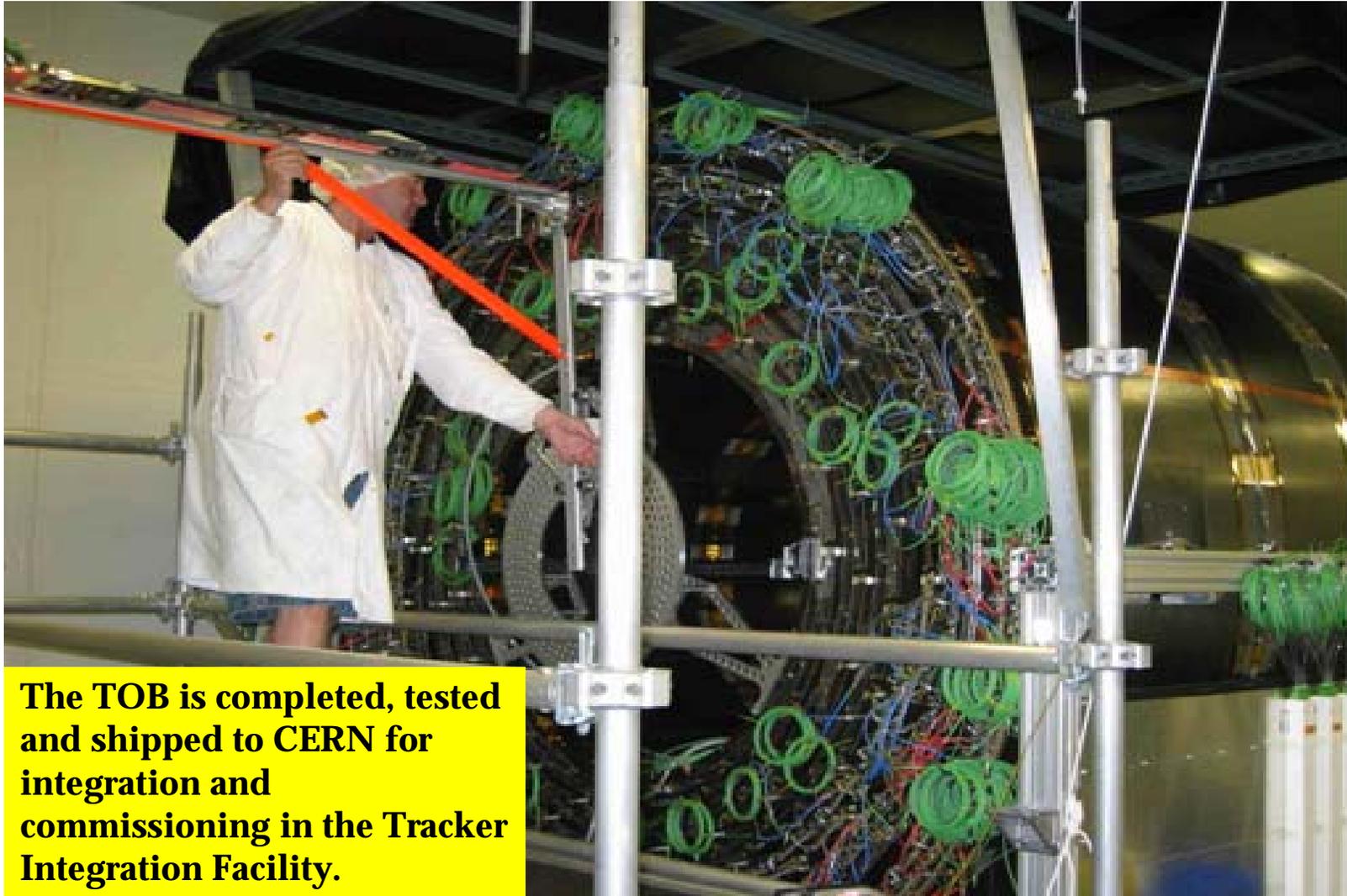


Outline

- **Detector Project**
 - TOB completed
 - FPIX Fully Baselined and in Production
- **Magnet Test and Cosmic Challenge (MTCC)**
 - Magnet
 - Tracker
 - ECAL
 - HCAL
 - Trigger
 - DAQ
 - SW, DQM, DCS
- **TB2006 – HCAL + ECAL**
- **RP**
 - Reporting
 - Schedule
 - Evolution
 - Costs
- **CMS, US CMS, FNAL_CMS Evolution**
- **LHC 2007 Accelerator Plan**
- **SLHC and Upgrades**



TOB – 100 m² of Si



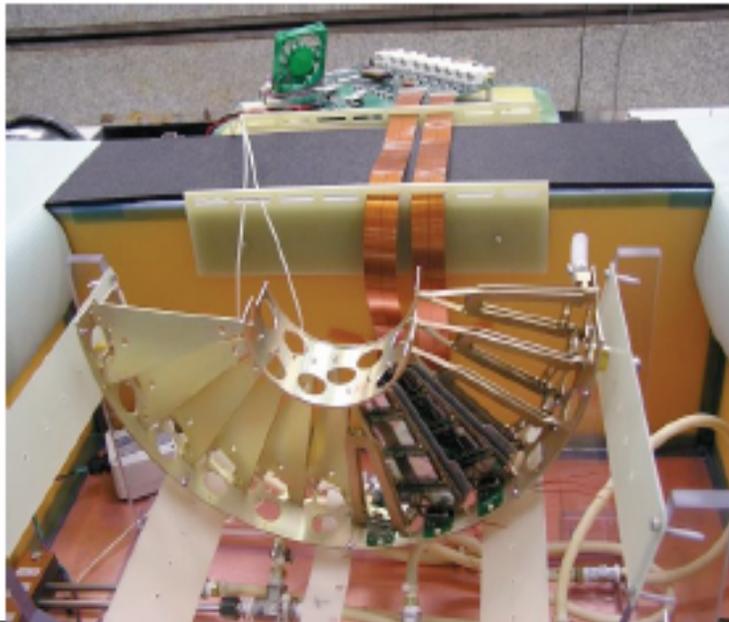
The TOB is completed, tested and shipped to CERN for integration and commissioning in the Tracker Integration Facility.



FPIX – Coming Now in 2007

New plan for Pixels is to install a “slice” for the 2007 run to gain crucial operational experience – thus advancing the schedule for Pixel commissioning with interactions.

- Plan for Pilot run Detector to be completed end of November 06 and shipped to Tracker Integration Facility at CERN





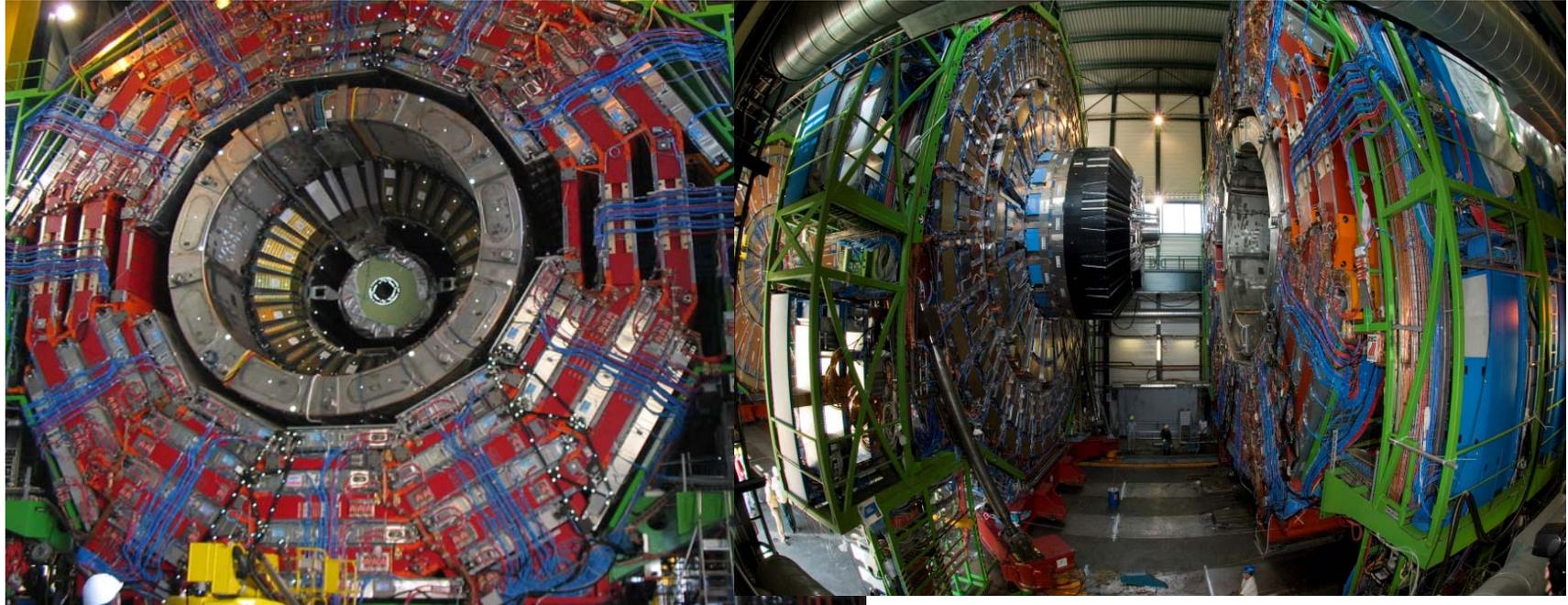
HF in the “On Deck Circle”

HF moved into SX5 this summer. Waiting for infrastructure to be ready in UX before lowering is scheduled – now in October





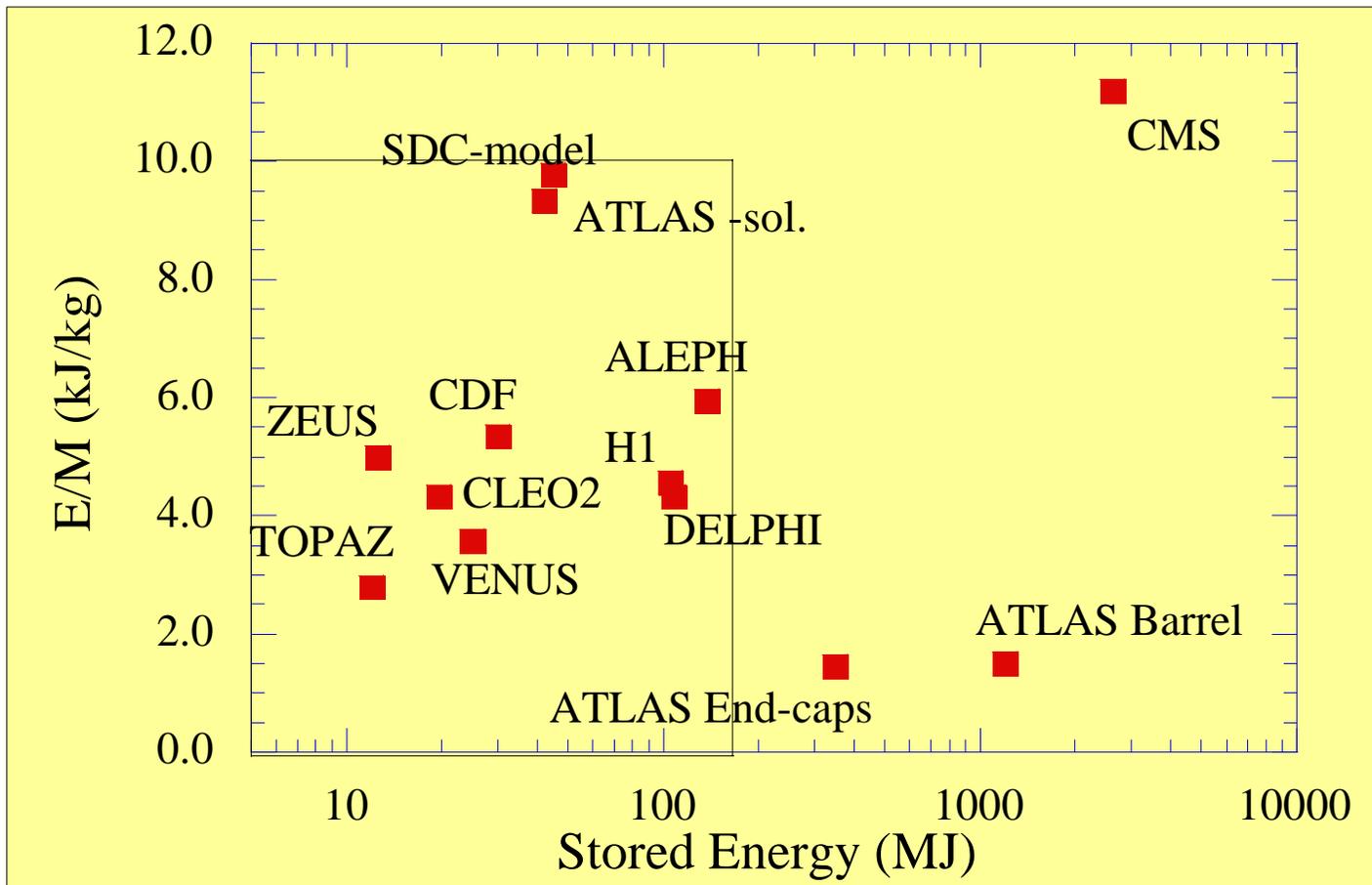
Magnet Test and Cosmic Challenge (MTCC)



Goals were to test magnet to 4T and to read out each CMS subsystem – jointly – with cosmic ray muons. Note Tracker, EB, HB installed in magnet coil, MB chambers, ME CSC, HE.



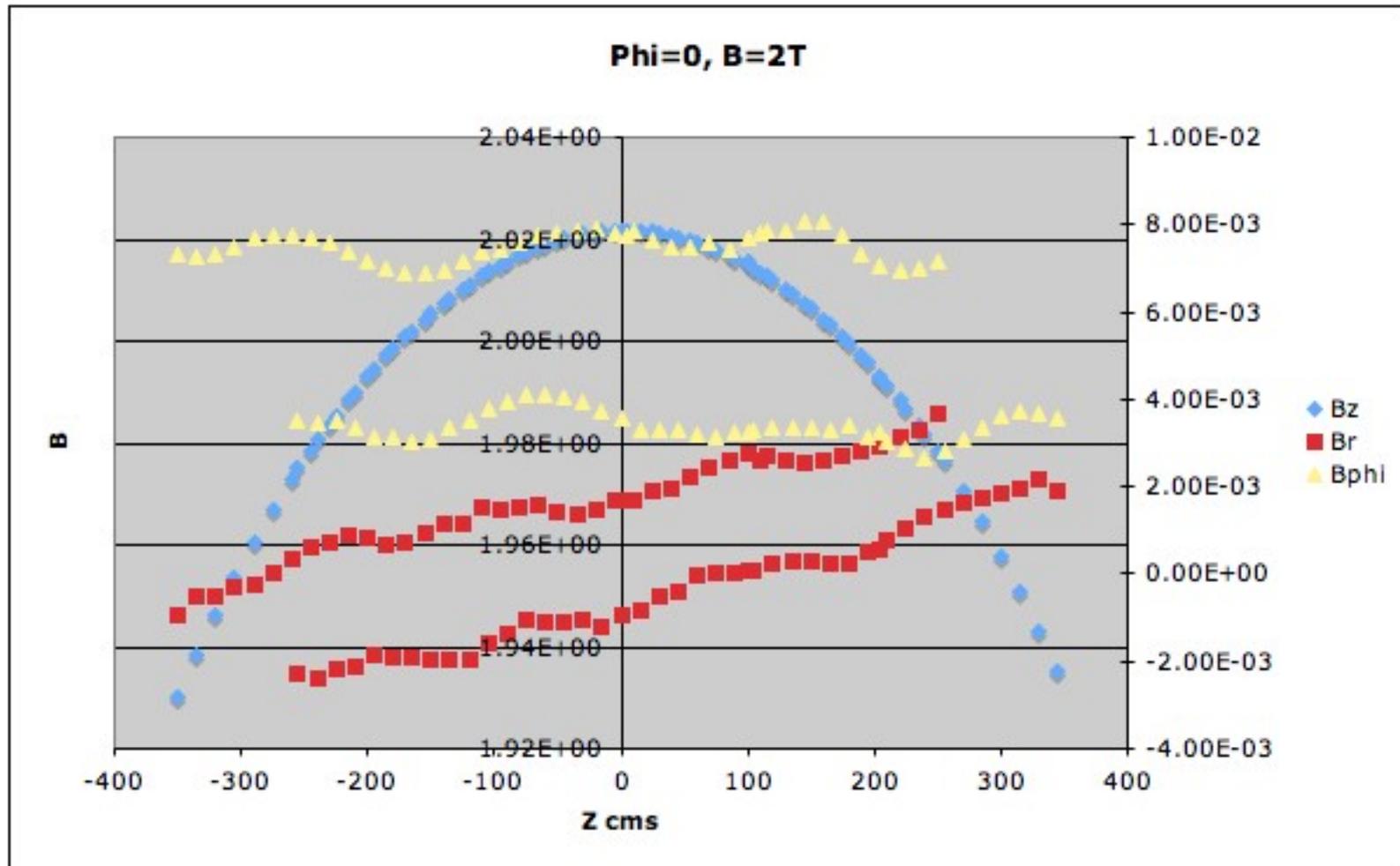
Magnet is ~ 3 GJ



CMS is the world's largest electromagnet – well beyond in MJ and kJ/kg.



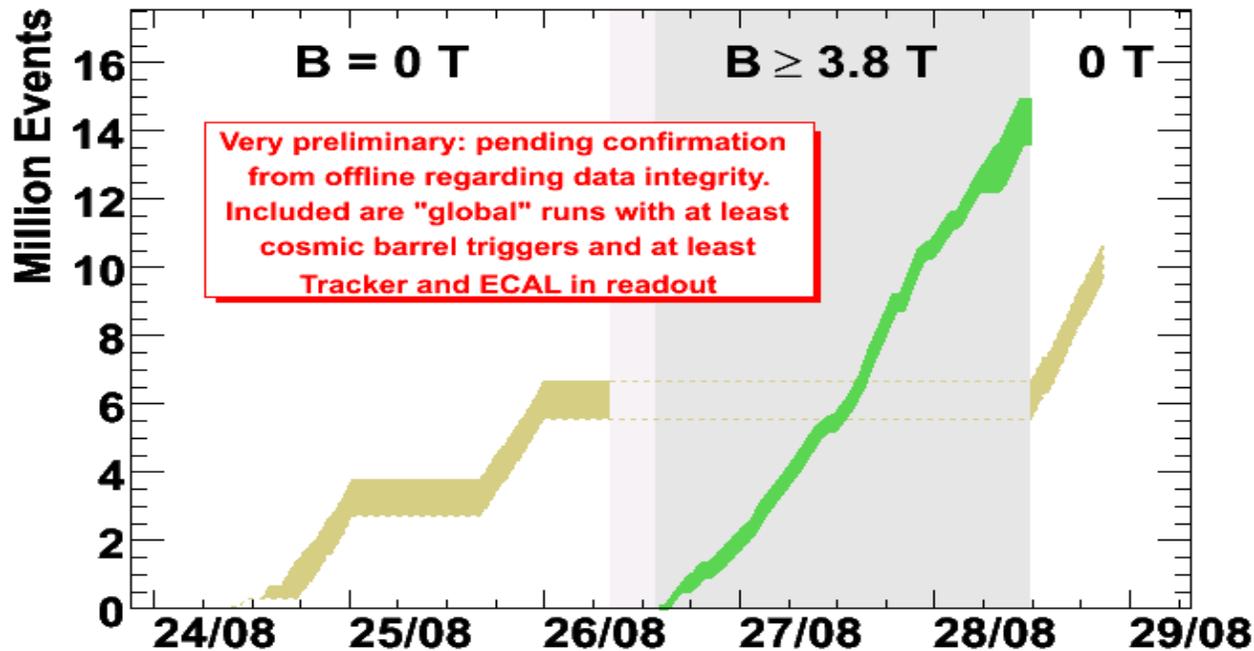
Field Mapping – 2 T





MTCC

Most Recent MTCC Data with $B = 0$ T and $B \geq 3.8$ T

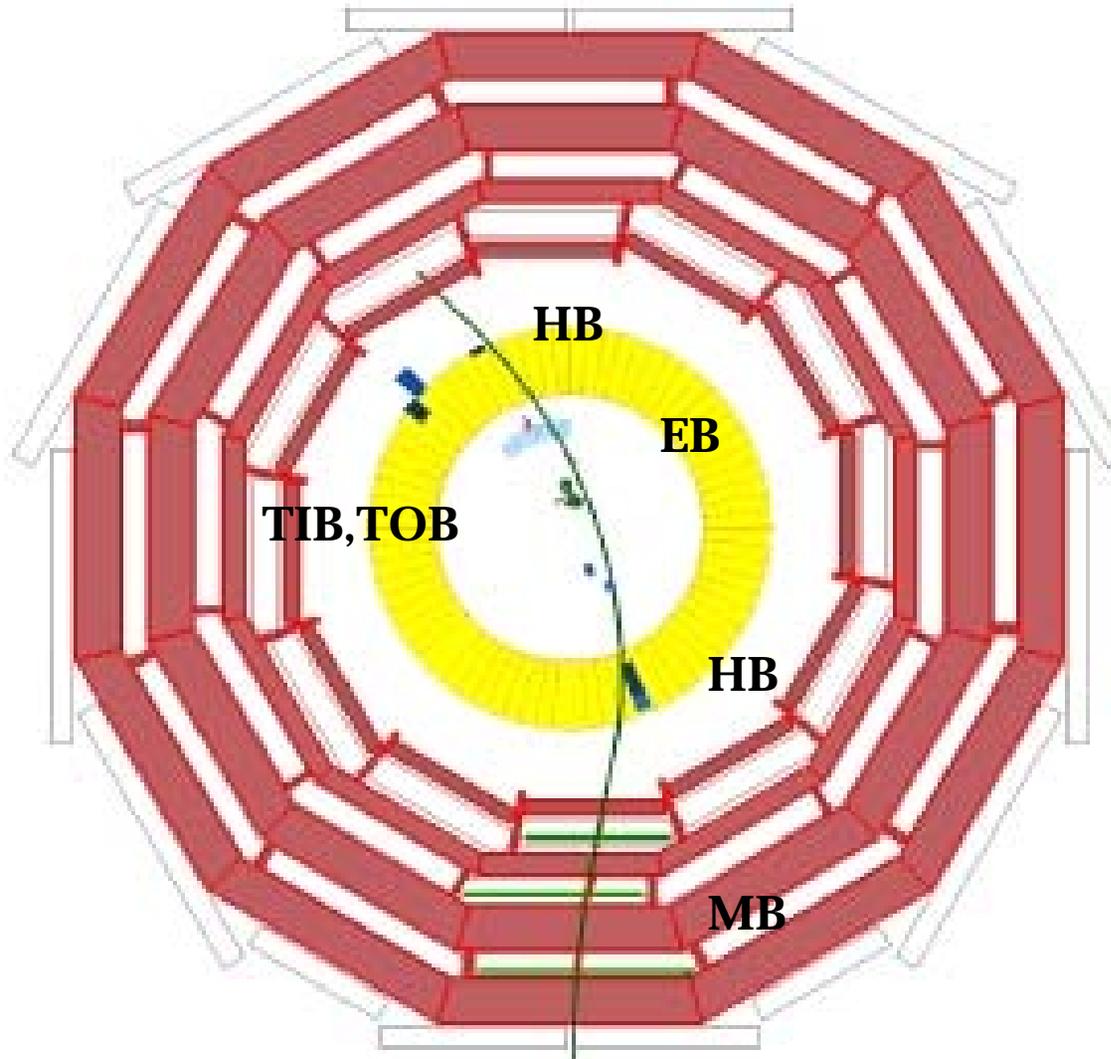


Collected > 25 M events in roughly 4 days

- Running a mixture of barrel (DT, RBC, RPC-TB) and endcap (CSC) cosmic triggers for most of the time at raw rates between 120 and 200 Hz
- High data taking efficiency: $\sim 90\%$



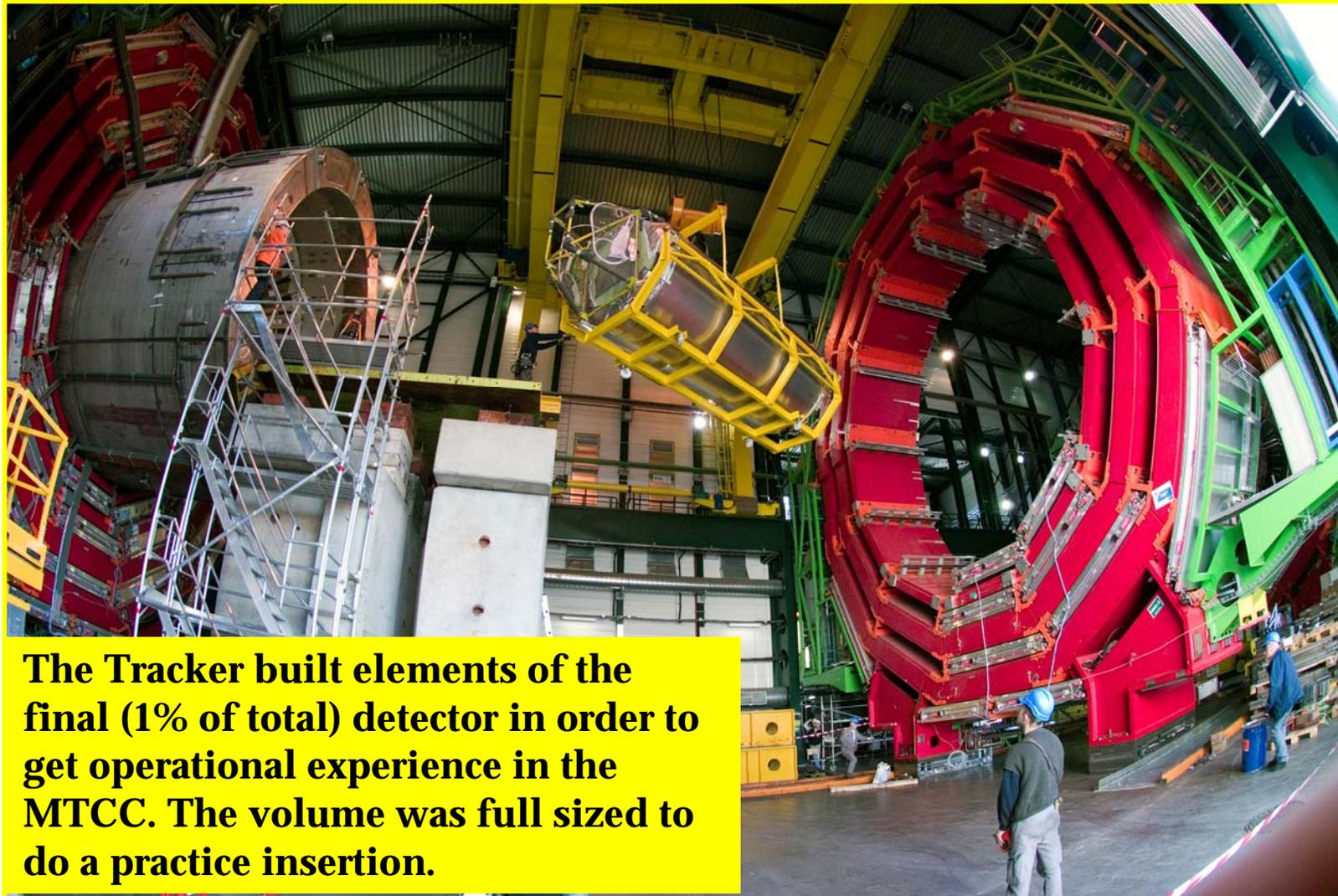
MTCC



Test of CMS magnet at 4T. All CMS subsystems logged in global DAQ and synchronized. This is a major milestone on the way to CMS data taking. Muons can be used to cross check the HB and HE calibration and to align the muon chambers.



Tracker Rigged into Magnet



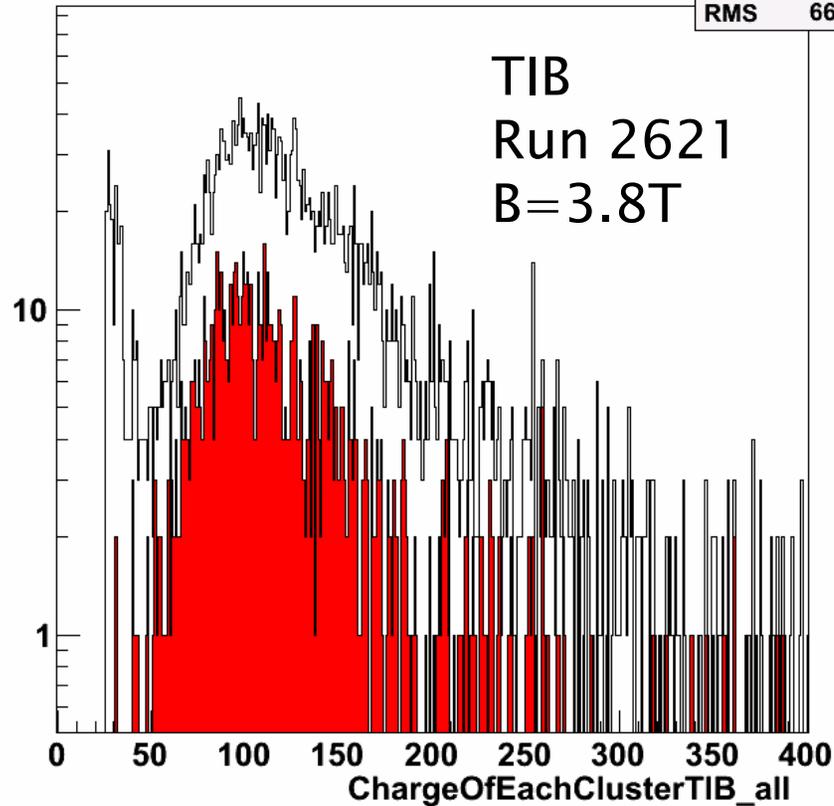
The Tracker built elements of the final (1% of total) detector in order to get operational experience in the MTCC. The volume was full sized to do a practice insertion.



MTCC – Tracker Clusters

2621_ChargeOfEachClusterTIB_all_and_passedfilter

Entries	3681
Mean	131
RMS	66.07



Obtained S/N in the expected range ~ 27 (TIB) ~ 45 (TOB,TEC). Track alignment and fitting are now in progress.



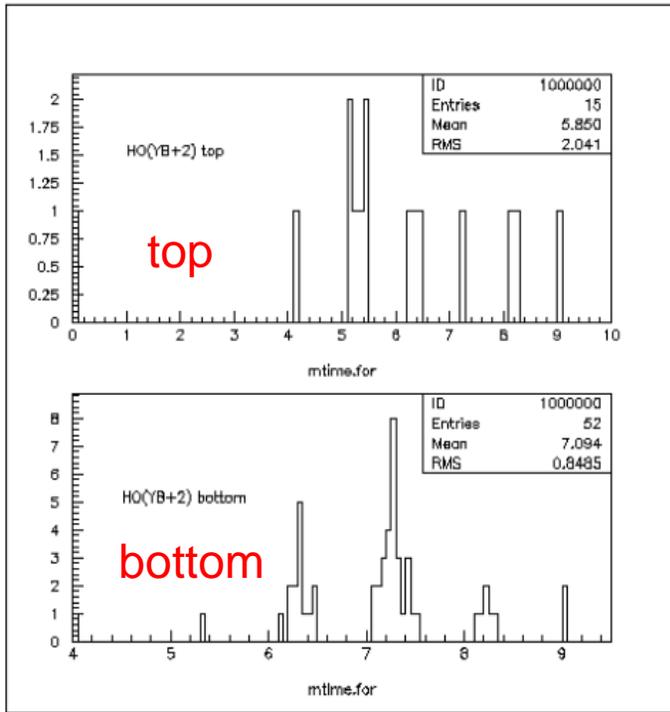
ECAL – MTCC, H2, H4 and Cosmics





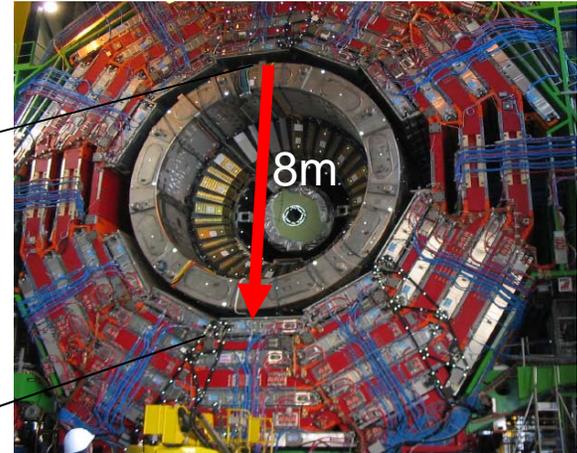
HCAL Timing wrt to MB Trigger

HO, YB+2 top vs bottom

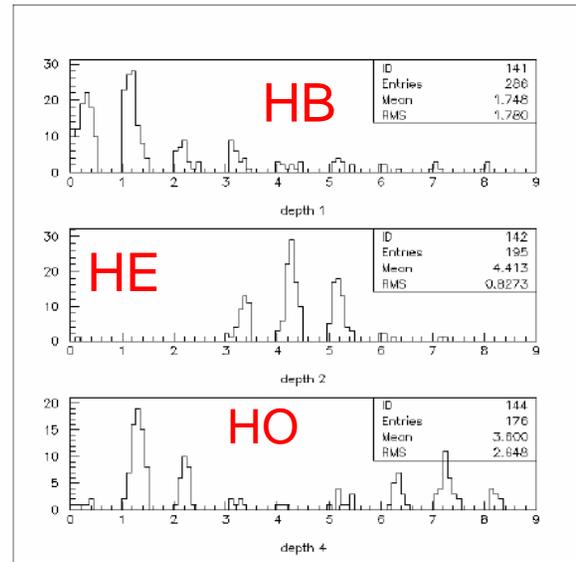


Top: 5.85 bx
Bottom: 7.08 bx

Distance ~ 8m or 25ns



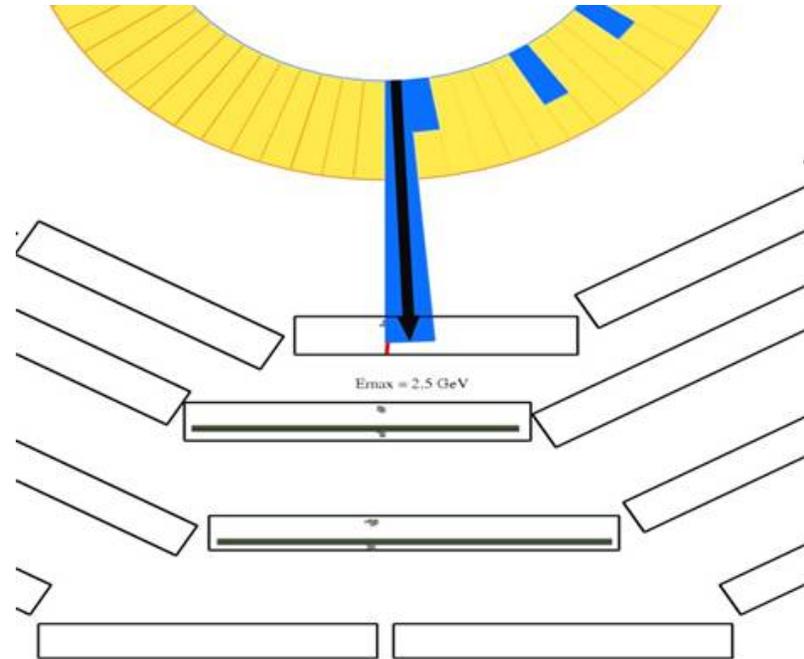
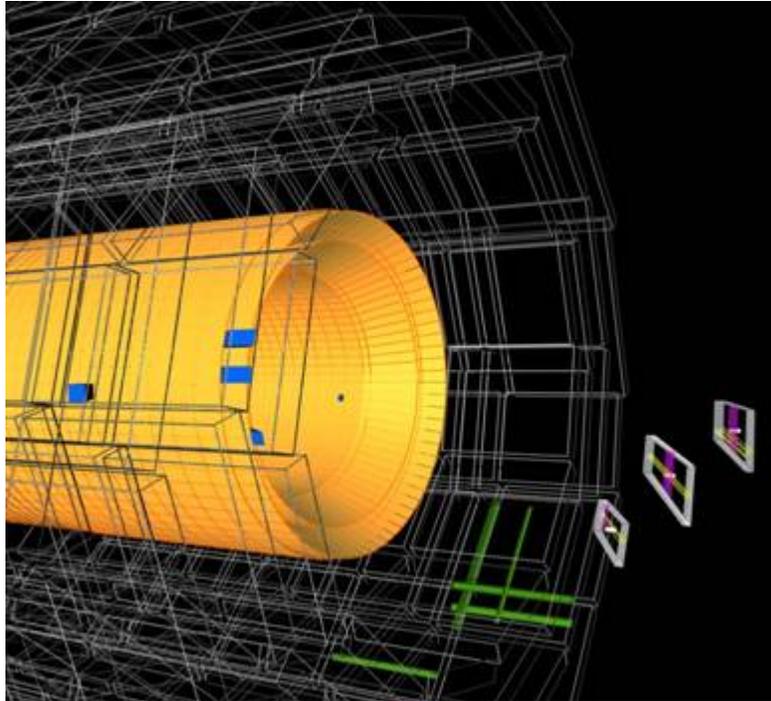
Timing of HB, HE, HO, r2242



Difference in timing corrected by adjusting pipeline delay in HTRs to achieve synchronization.



ME Muons and HB

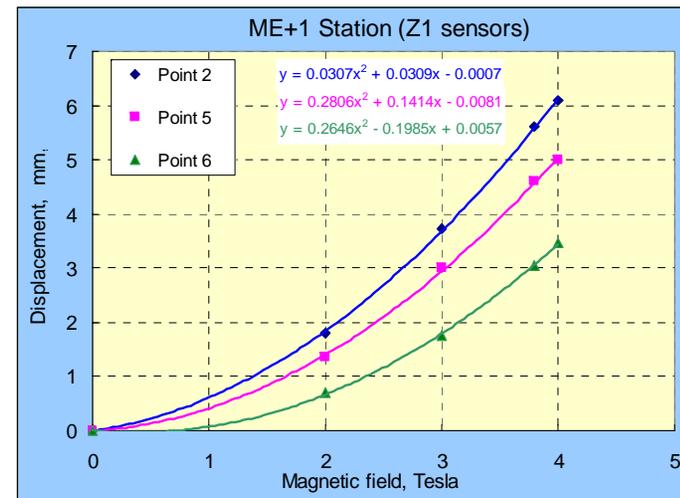
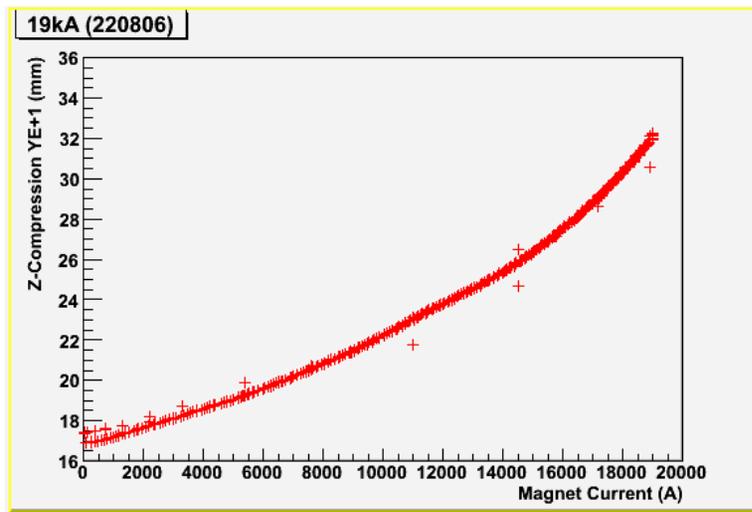


All the CMS subsystems are synched and are taken globally through the 1/8 DAQ Slice. Note CSC tracking, HB and MB data.



Muon Alignment at MTCC

Very good experience to understand the performance of the alignment system itself, the closing procedure and the yoke behavior under magnetic forces.



Note that the scale is ~ cm. Must track alignment over wide range to ~ 200 um accuracy.



MTCC Trigger

Major success!

25 million events at a trigger rate of ~ 200 Hz

- Mixture of DT, CSC, RBC, RPC-TB triggers
- Trigger requirements easily configurable

Stable operation

- Stable run uptime > 1 hr
many runs > 500K L1A.

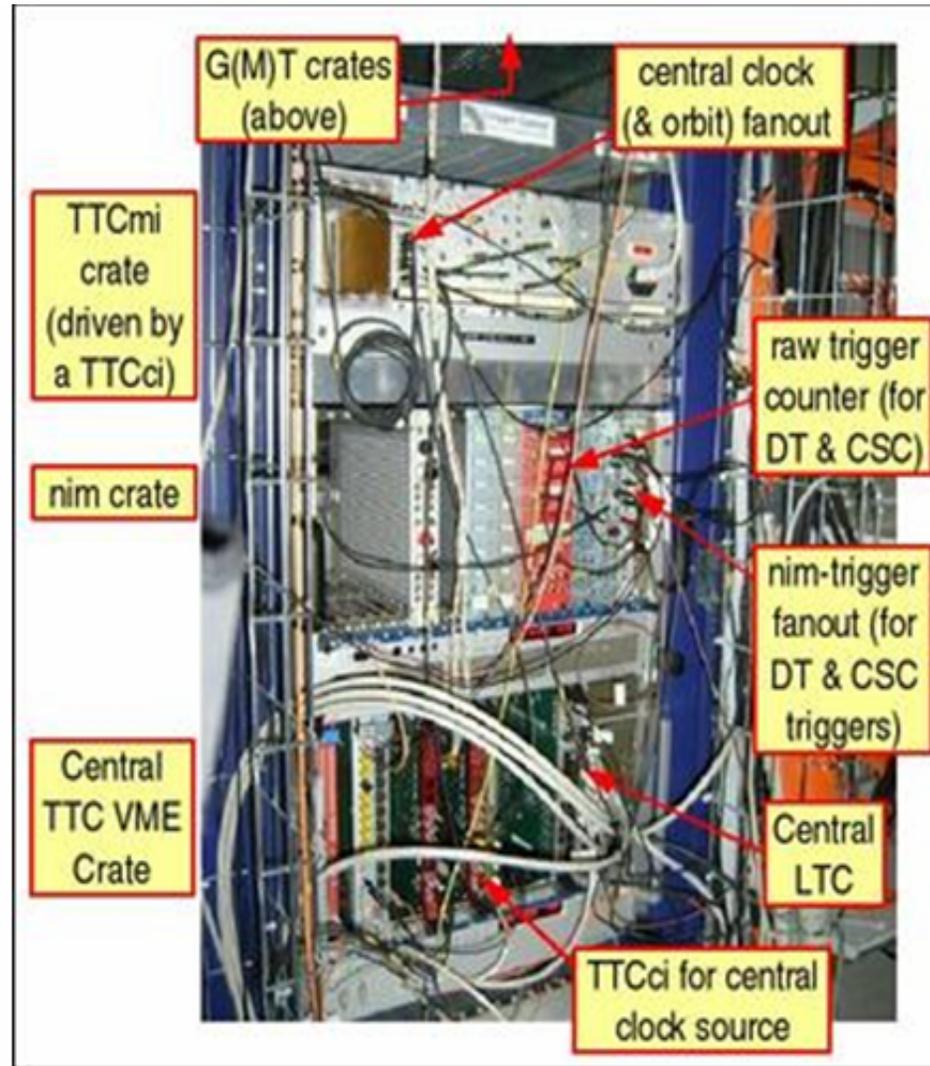
All subsystems synchronized

- Tracker, ECAL, HCAL, RPC*, DT*, CSC*
- Readout & Trigger*

Trig. throttling worked

- Even when trigger problems or noise > 1 kHz

Impressive teamwork!





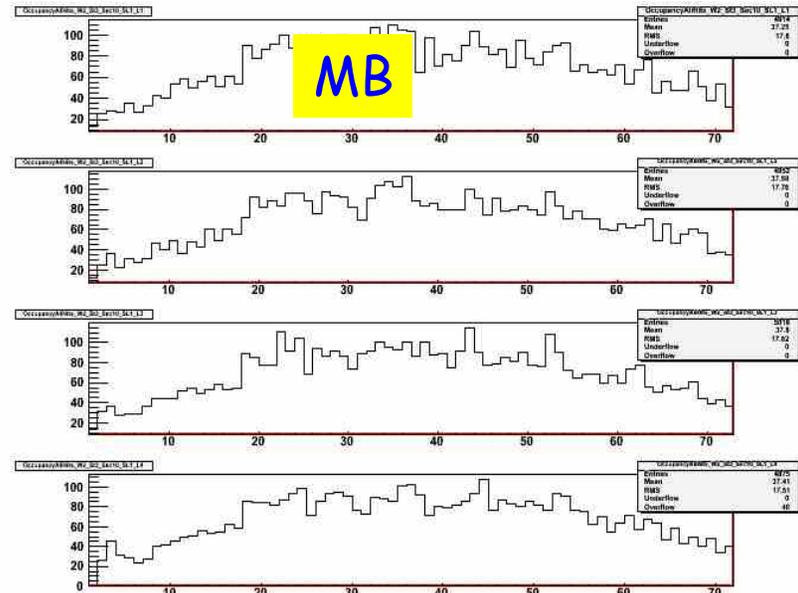
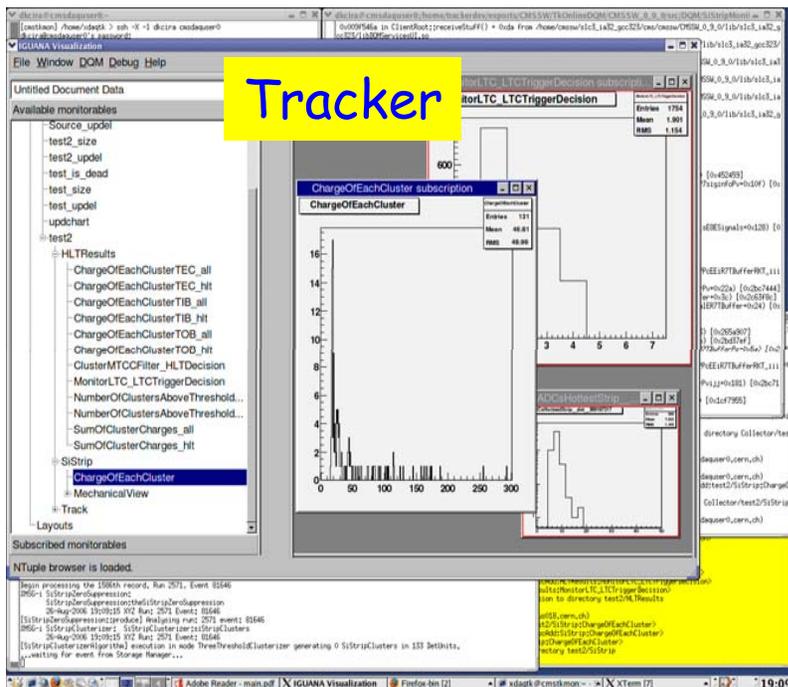
DQM during MTCC

All DQM applications constantly ran offline

- With 0.5-1 hr delay wrt data taking

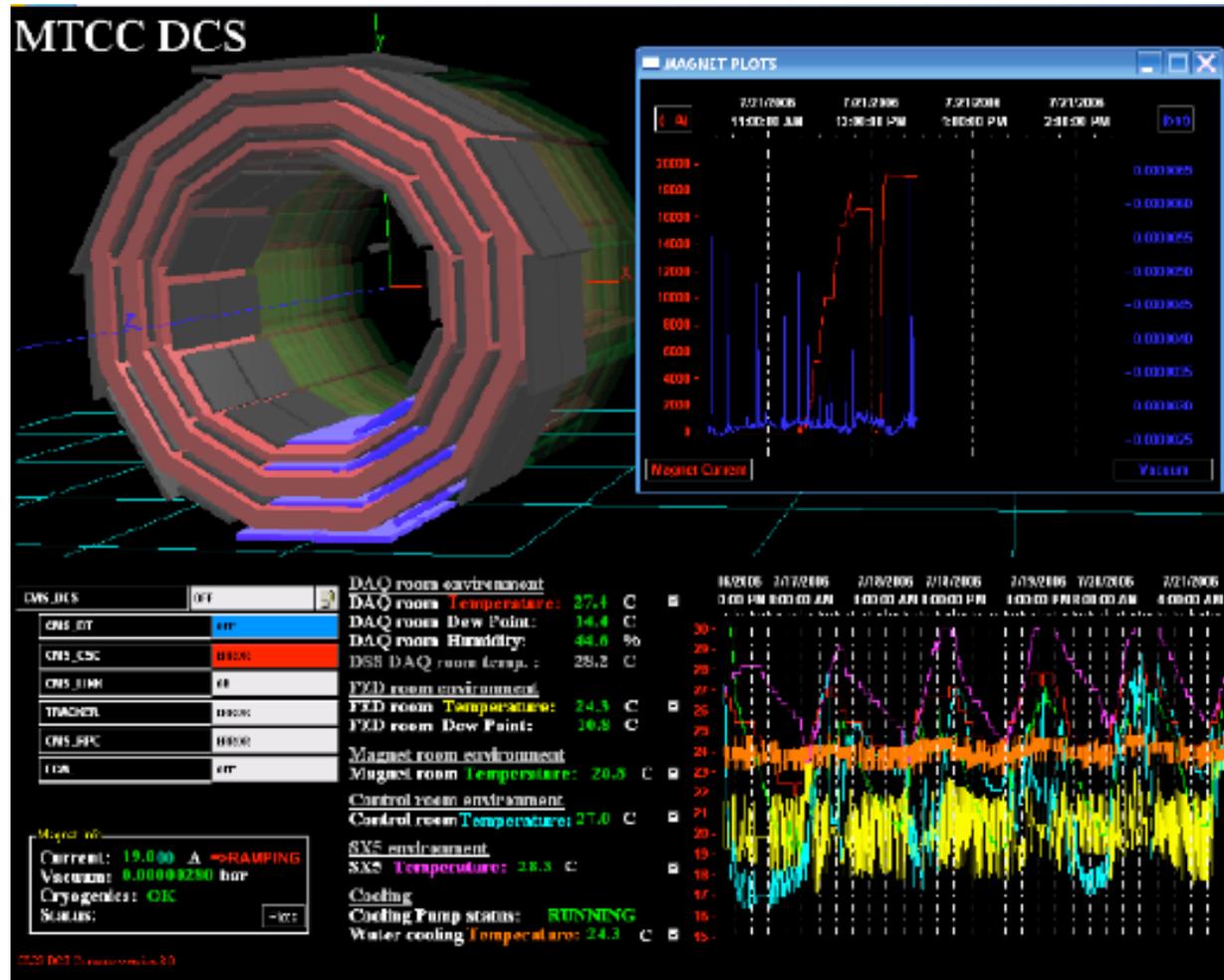
Online DQM from parasitic online stream from the storage manager ran for most of the field-on period (HCAL, Tracker, CSC), monitoring LTC even in the farm

After MTCC phase 1 DT, CSC and tracker integrated in the FF





DCS in MTCC



The Detector Control System (DCS) was in place during the MTCC and checked voltages, temps, etc.



Remote Analysis at the ROC (FNAL)

Successfully exercised and established a foundation of quasi-online MTCC data monitoring/analysis at FNAL ROC during phase-1 which involved:

- Data Transfer (the T0/T1 facility)[SX5-CASTOR(phedex)-dcache]
- Automatic and systematic running of Event-Display and various DQM programs (HCAL, Trigger, Tracker, CSC)
- Making the results (Histograms) of DQM programs readily and easily available to the sub-detector/DAQ/Trigger experts anywhere, during a run and also for all runs which were taken.

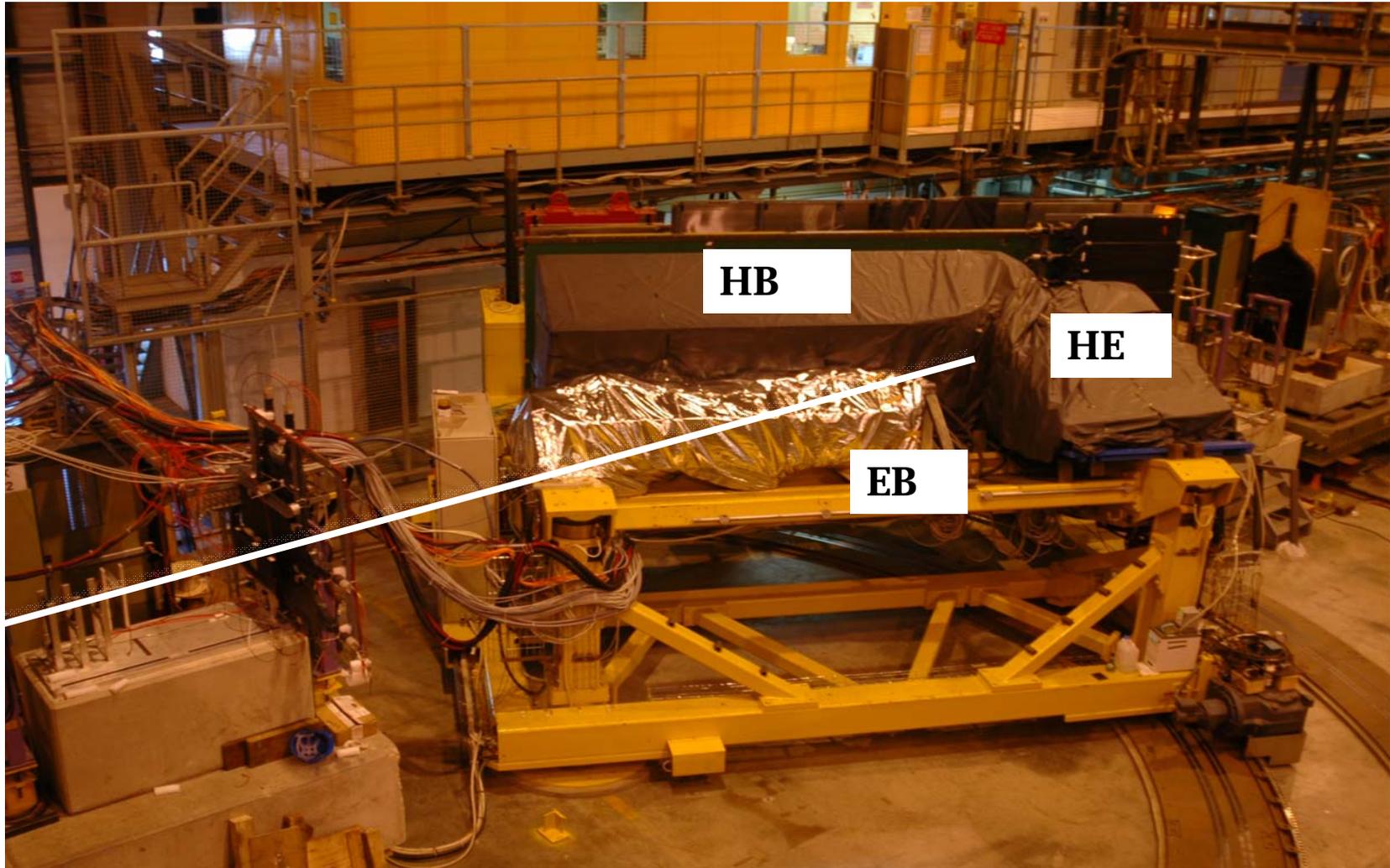
In order to accomplish above, (starting from the raw data files arriving at FNAL), we needed to write a script which performed following multiple functions

- o detect incoming files,
- o convert .data to .root file and store in dcache
- o check DQM job status on the data file
- o create necessary cfg files and automatically submit DQM jobs
- o merge output histograms files from the same run
- o put them in the appropriate directories for viewing.

ROC stood ~ 1/2 of all MTCC data and DQM shifts.

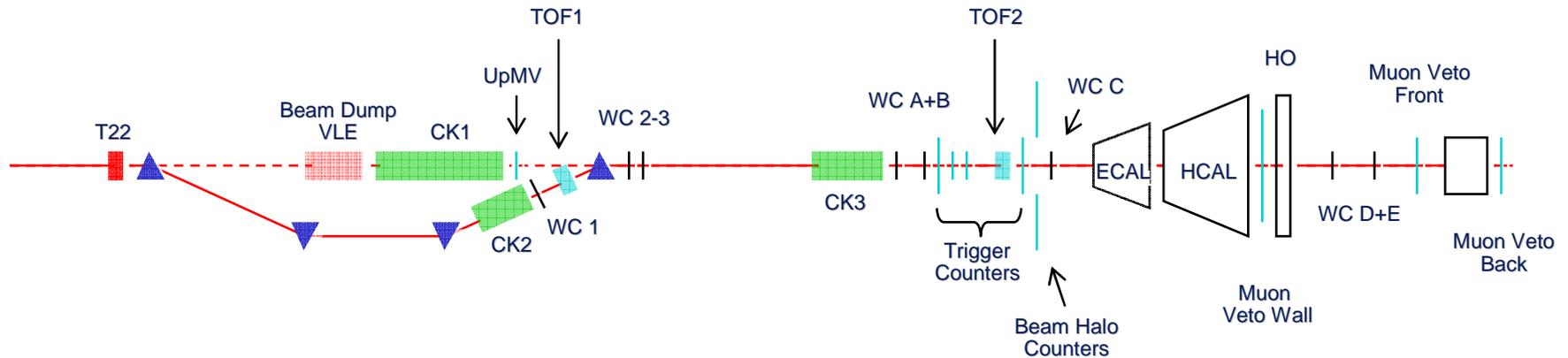


TB06 at H2 - ECAL+HCAL





H2 Beam Line



Very Low Energy (VLE) line is able to give 1 to 9 GeV/c h^+ , h^- , e^+ and e^- with good rate, a few hundred/spill using a tertiary target (T22). At lower end of the range, particles are mostly electrons. There is a significant muon contamination as well.

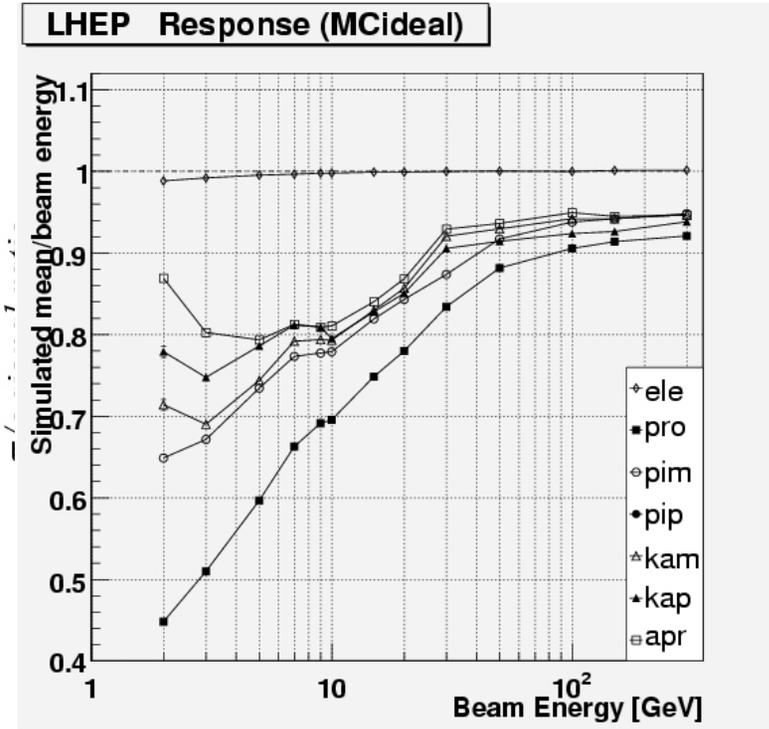
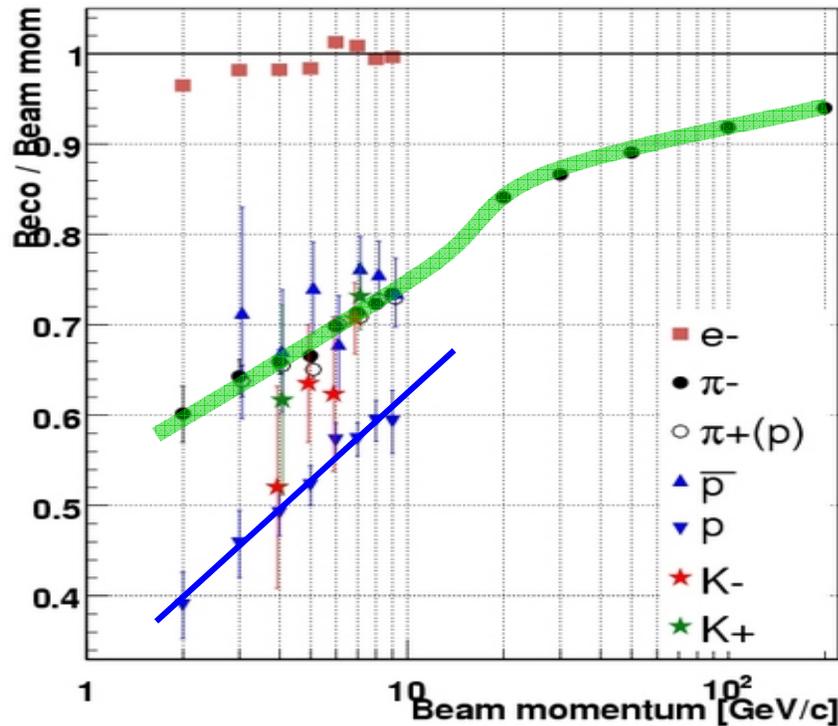
Particle ID is accomplished by TOFs, Cerenkovs and muon veto counters.

High energy line covers a momentum range from 10 to 300 GeV/c for hadrons through secondary particle production. For electrons/positrons, the range is 10 to 150 GeV/c.

This test beam run was our first and last chance to exercise a “real” HCAL+ECAL calorimetric system before LHC beam, so that much effort was put into TB2006



Reconstructed Response

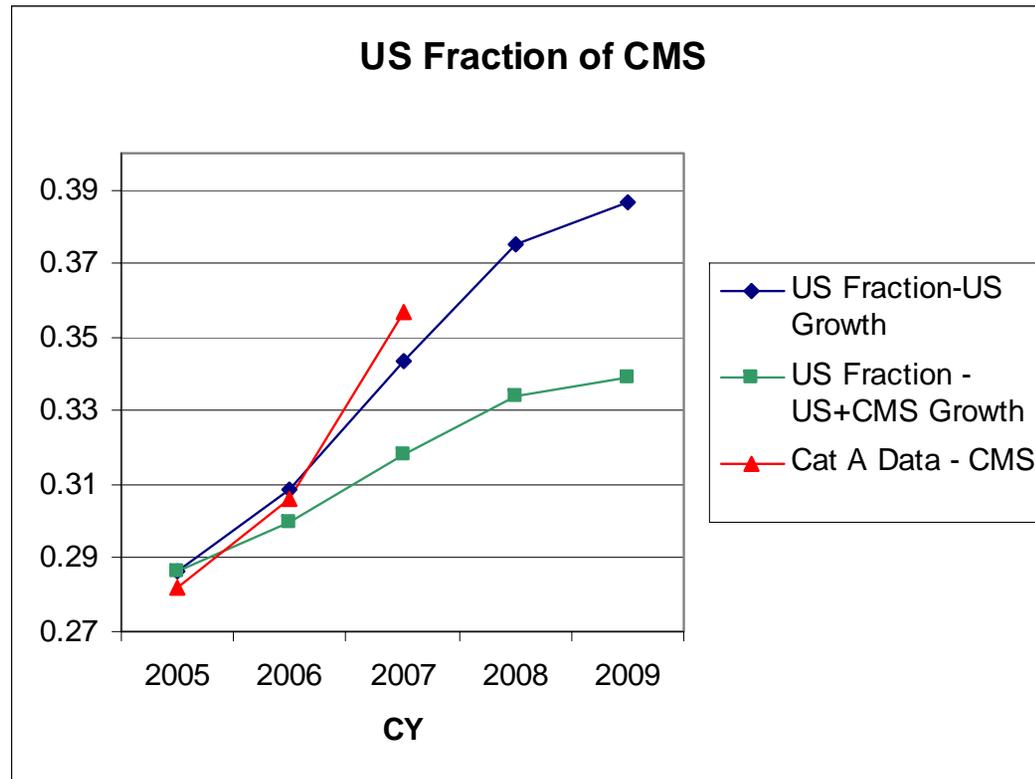


For the first time, we have a complete set of low energy data for pions, kaons and (anti)protons for the combined ECAL+HCAL. These data are essential to correctly estimate the jet response of the CMS calorimeter system.

Confront G4 Monte Carlo with TB2006 data.



Growth of US CMS



US CMS is now 36% of CMS by Category A metric. This has been caused not by many new groups in 2006 but by shifts of faculty to CMS and by the arrival of many postdocs now working on CMS (e.g. FNAL – “tipping point”)



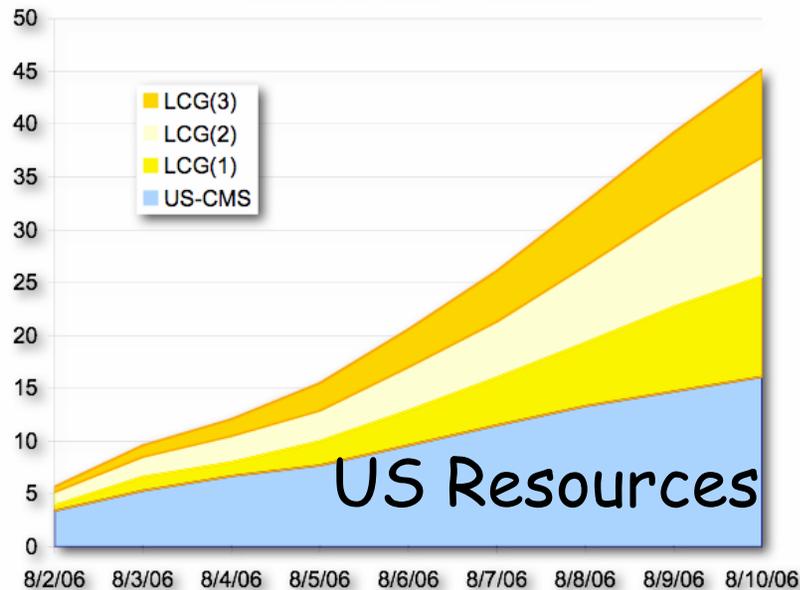
Grid Computing Service Challenge

World Wide LHC Computing Grid: establishing the Grid Service
CMS has struggled to achieve the technical goals

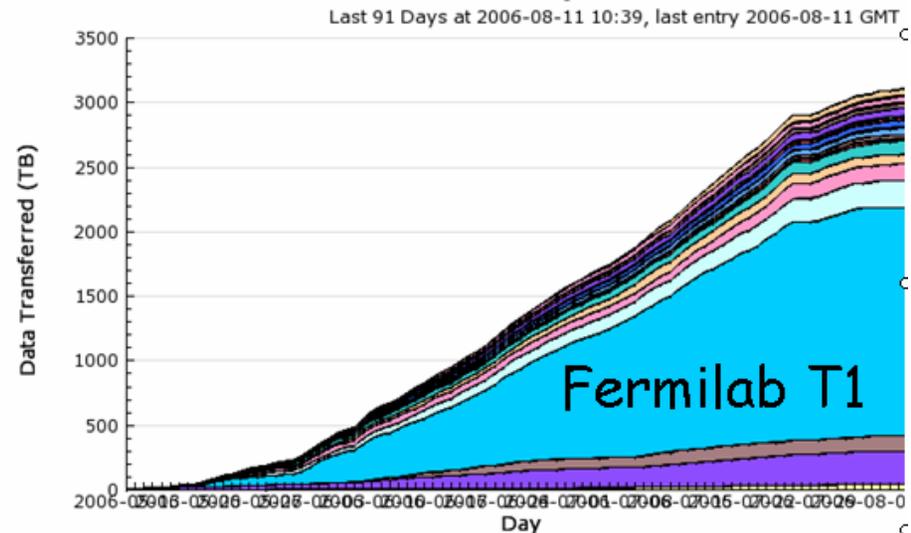
- for running analysis and MC production jobs
- for transferring data between T0/T1/T2 centers

The U.S. through the RP and OSG has been a major contributor

Million Events Produced



PhEDEx SC4 Data Transfers By Sources n





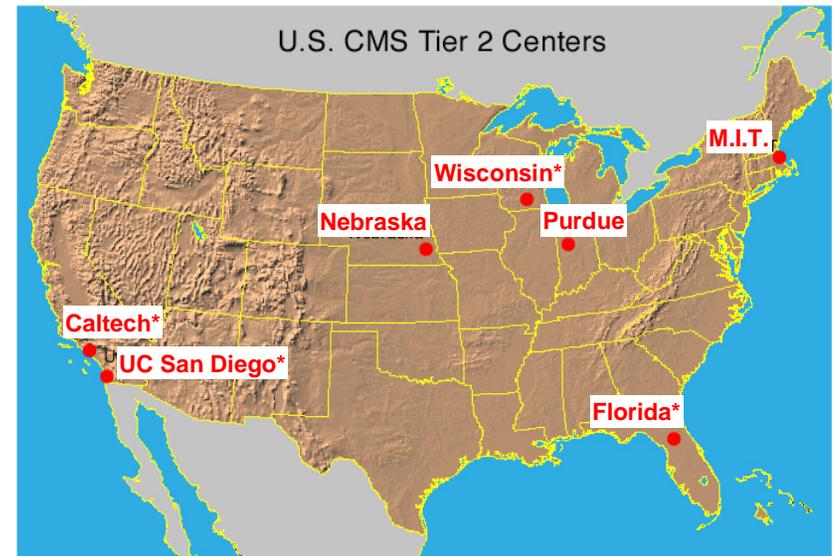
CSA - 2006

- **Launched Oct. 2. Goal is to establish data handling at a level of 25% of 2008 operations.**
- **Test of new CMSSW tools.**
- **As of Oct. 5, 8M events processed at T0 (50 Hz) and data exported to the 7 T1 centers at 50 MB/s. Will also exercise T1->T2 transfers.**
- **Test will run for 6 weeks.**
- **CSA Coordinator is Darin Acosta.**



U.S. CMS S&C: Tier 2 Centers

- **Builds on NSF-Funded Grid and Network Innovations.**
- **Enables all aspects of discovery-oriented physics analyses by scores of university physicists accessing each site.**
- **Integrated synergistically into local university infrastructures.**
- **Four sites (DISUN) additionally funded by NSF OCI for even broader impact to other sciences and data-intensive GRIDs.**



Want now to think through the roles of T2 in US physics analysis, e.g. connections to LPC.



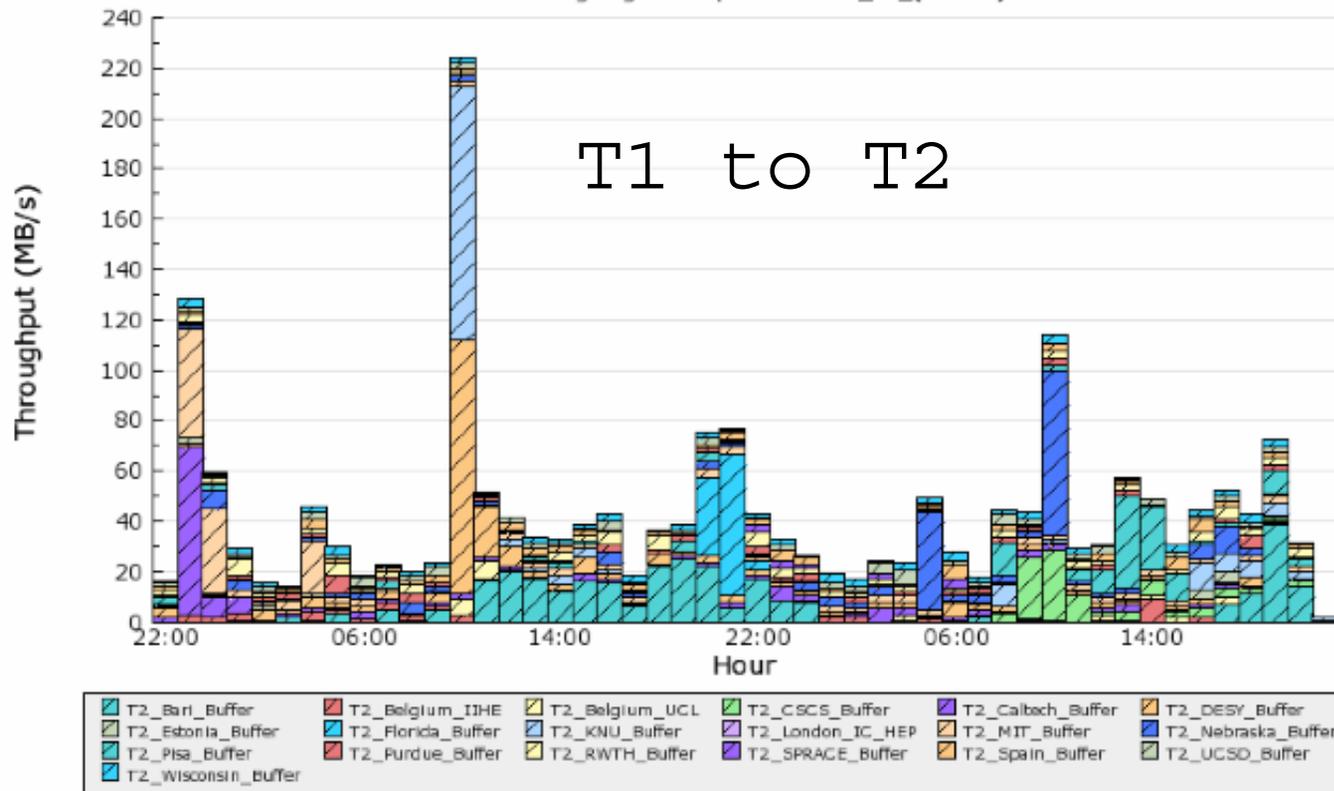
Data Transfers to T1, T2

Grid Data Transfers,
including to the US
working ok-

PhEDEx Prod Data Transfers By Destination

48 Hours from 2006-10-04 22:00 to 2006-10-06 21:00 GMT

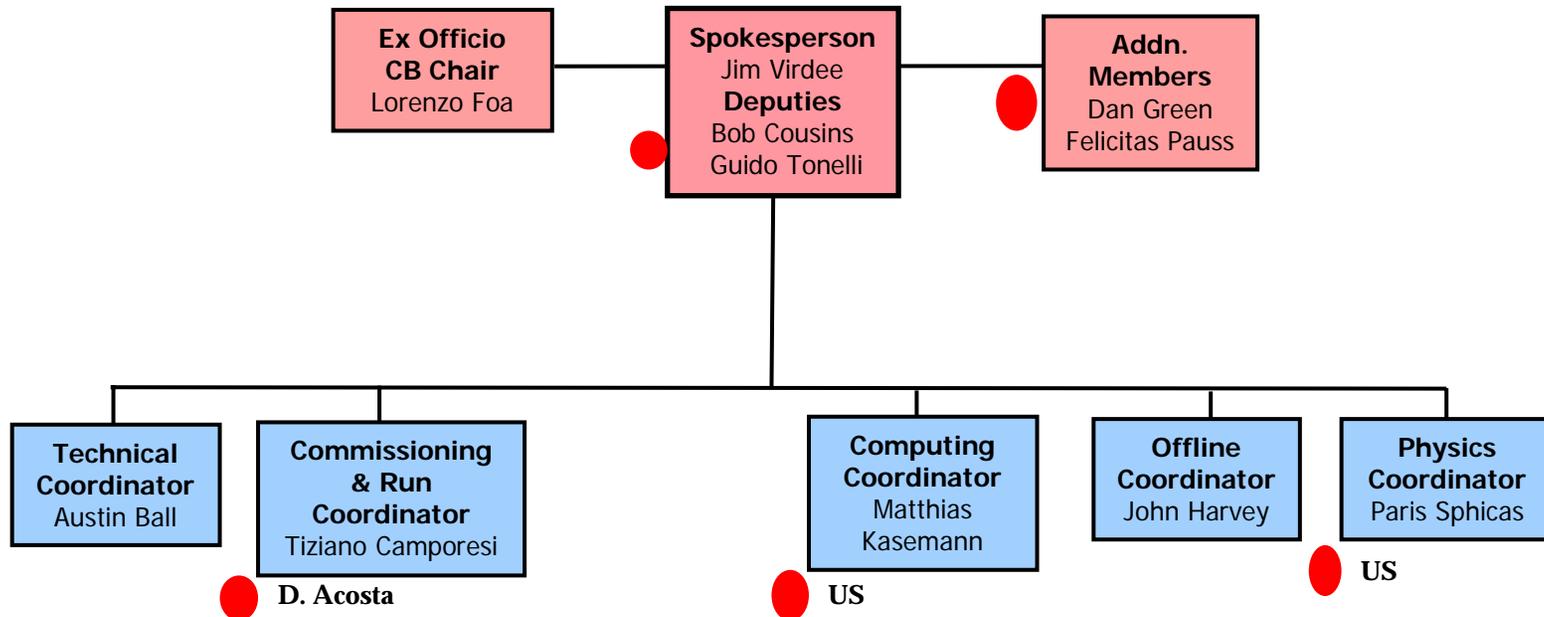
Nodes matching regular expression 'T2_*_(?!MSS)'





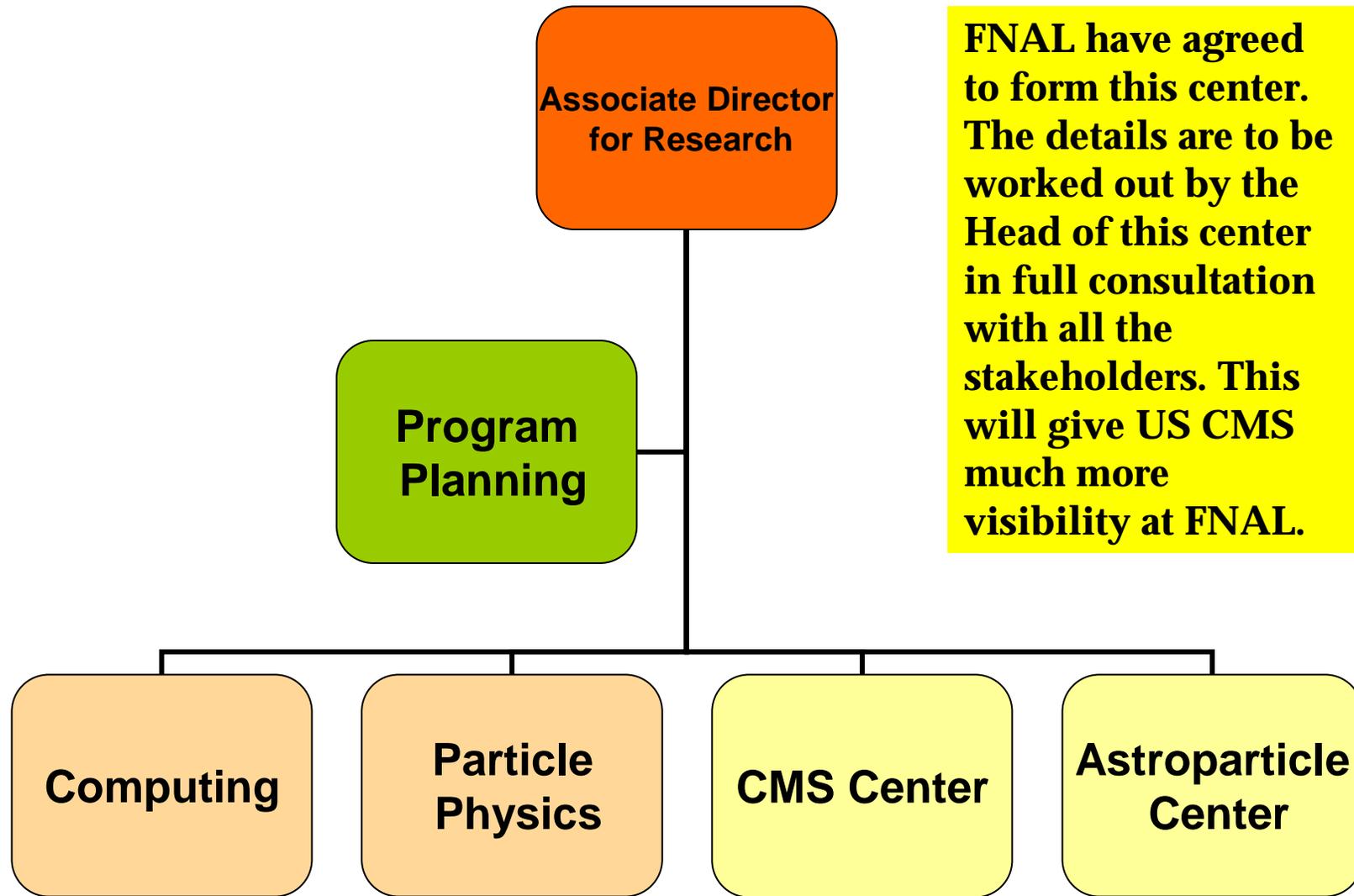
CMS - Executive Board

The organization within the coordinator's purview will be discussed collectively by the EB as will the interconnects between boxes. This is no longer a "federated" but a "unitary" organization.





FNAL Research Sector



FNAL have agreed to form this center. The details are to be worked out by the Head of this center in full consultation with all the stakeholders. This will give US CMS much more visibility at FNAL.



450 GeV – 2007 Calibration Run

Operations' aims:

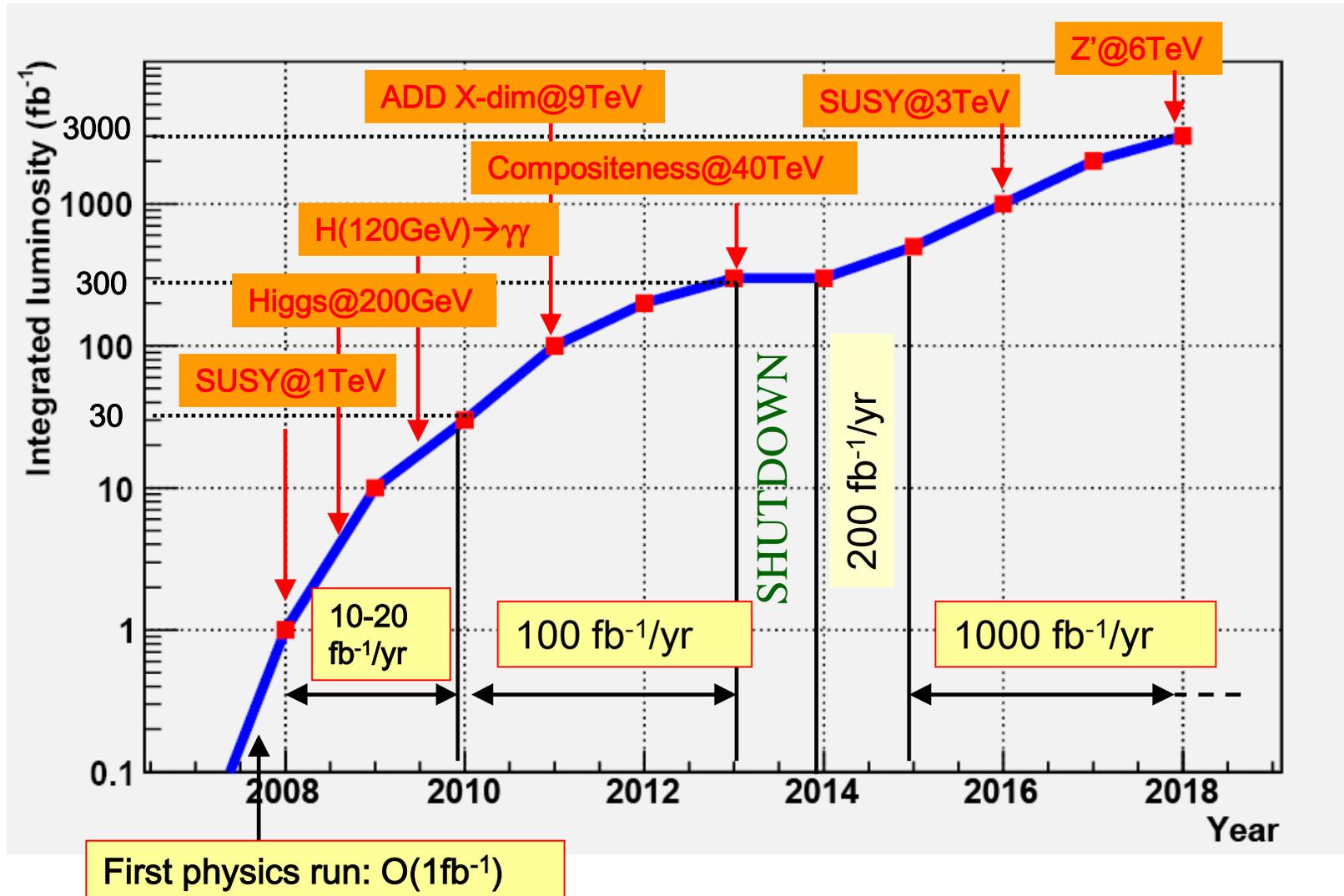
- **Commission essential** safety systems
- **Commission essential** beam instrumentation
- **Commission essential** hardware systems
- **Perform beam based measurements to check:**
 - Polarities
 - Aperture
 - Field characteristics
- **Establish collisions**
- **Provide stable two beam operation at 450 GeV**
- **Interleave collisions with** further machine development, **in particular, the ramp.**

**Presented by
Mike Lamont at
Sept. CMS Week.**

Should provide a firm platform for eventual commissioning to 7 TeV and provide adequate lead time for problem resolution.

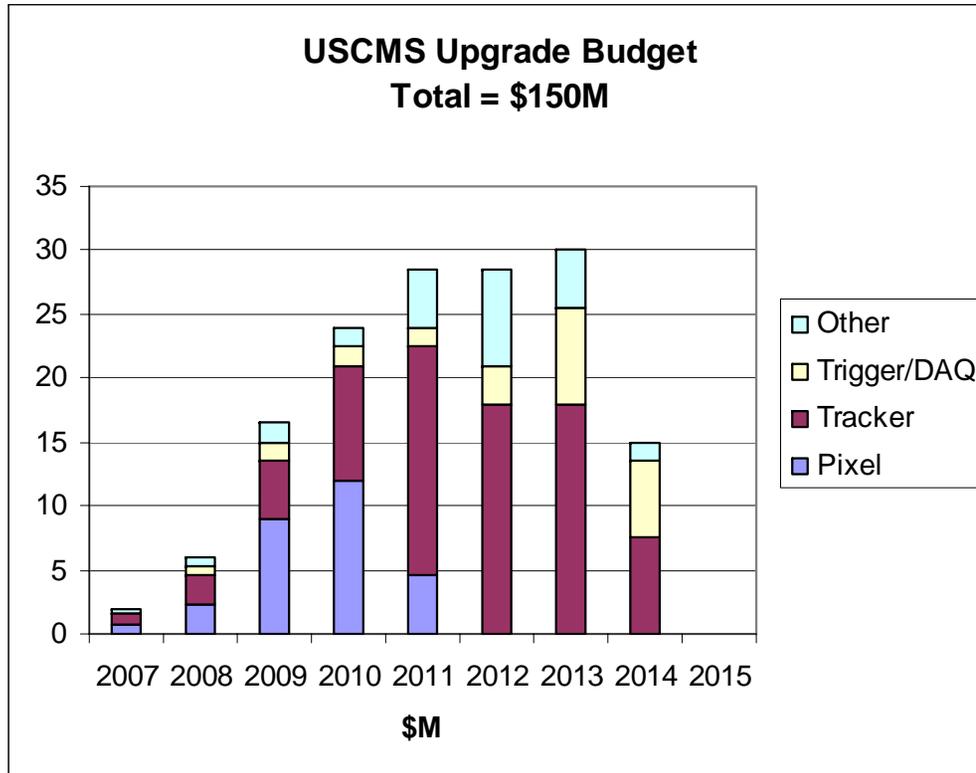


LHC Luminosity Profile





Upgrade Budget Profile - Draft



Major activity in Pixel replacement frontloads budget profile. Major items are Tracker replacements - pixels and strips plus triggering ability in order to confront the much greater trigger rates.



Summary

- **The Detector Project is on track for completion in 2008.**
- **The MTCC has been a great success in learning how to operate CMS.**
- **The TB2006 data set will provide many important checks of the Monte Carlo modeling of CMS.**
- **CMS is restructuring to confront data taking and analysis. The US has leadership roles in the new EB management. Fermilab is restructuring to place more emphasis on CMS.**
- **Attention now shifts to the 2007 data taking and strategy.**
- **Planning for the SLHC Upgrades has begun with a rampup to major construction by 2009.**