



US CMS Status

US CMS: Project and Research Program

Dan Green

US CMS Program Manager

March 19, 2003

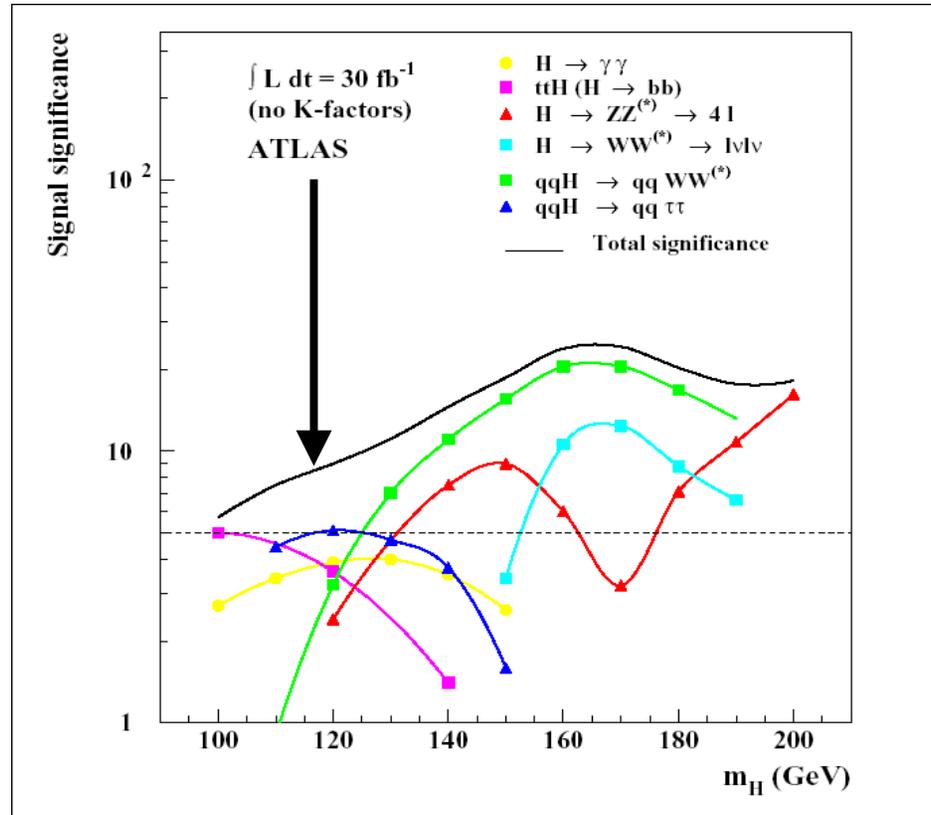


Outline

- **Detector - Technical Status**
- **Detector - Financial Summary**
- **Research Program – Startup**
 - **M&O Plans**
 - **SWC Plans**
- **Issues**



LHC - SM Higgs



The LHC detectors are designed to find the SM Higgs - shown is 1 yr at 1/3 design L. Low mass is covered by $\gamma\gamma$, $ttH(bb)$, $qqH(WW^*, \tau\tau)$. A low mass Higgs has many accessible decay modes \rightarrow couplings measured.

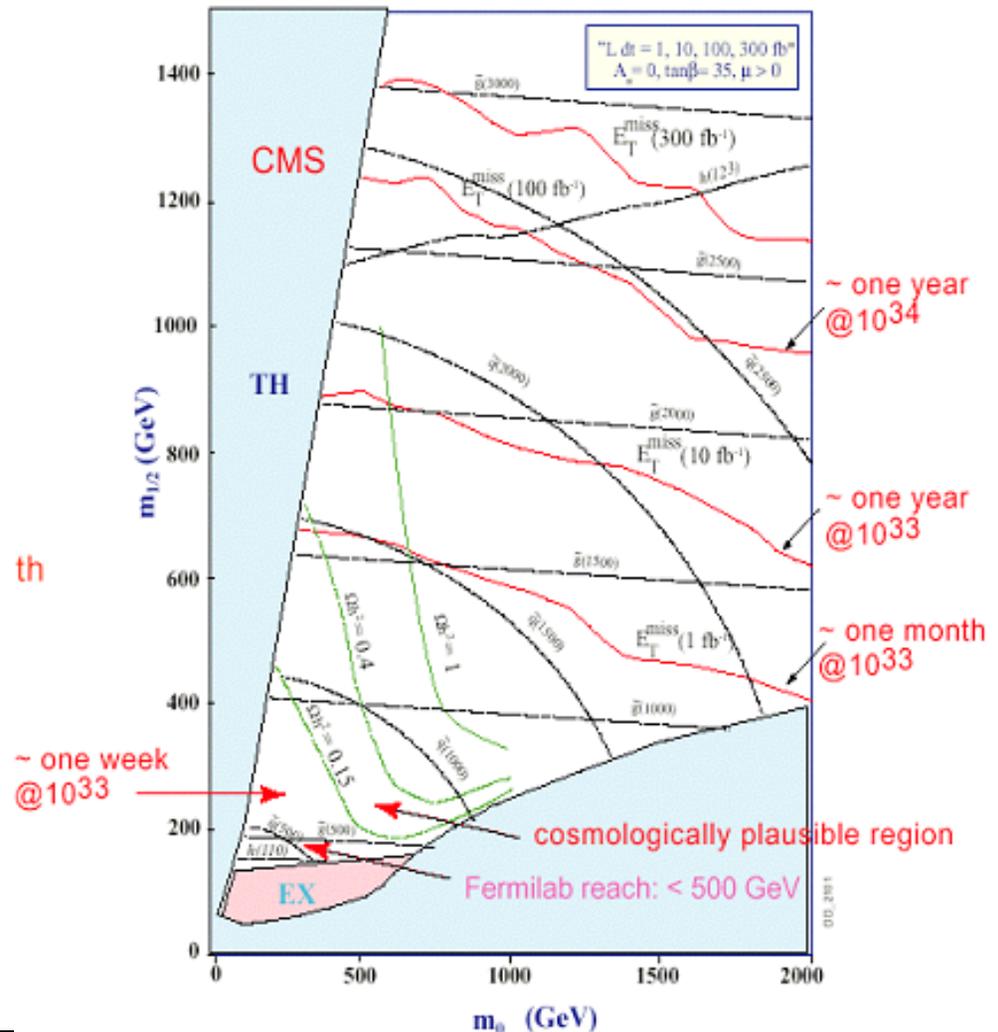


SUSY

Energy matters! One month at 1/10 design luminosity extends mass reach by a lot – covers dark matter neutralino region.

LHC experiments must be ready on “week one” for new Physics.

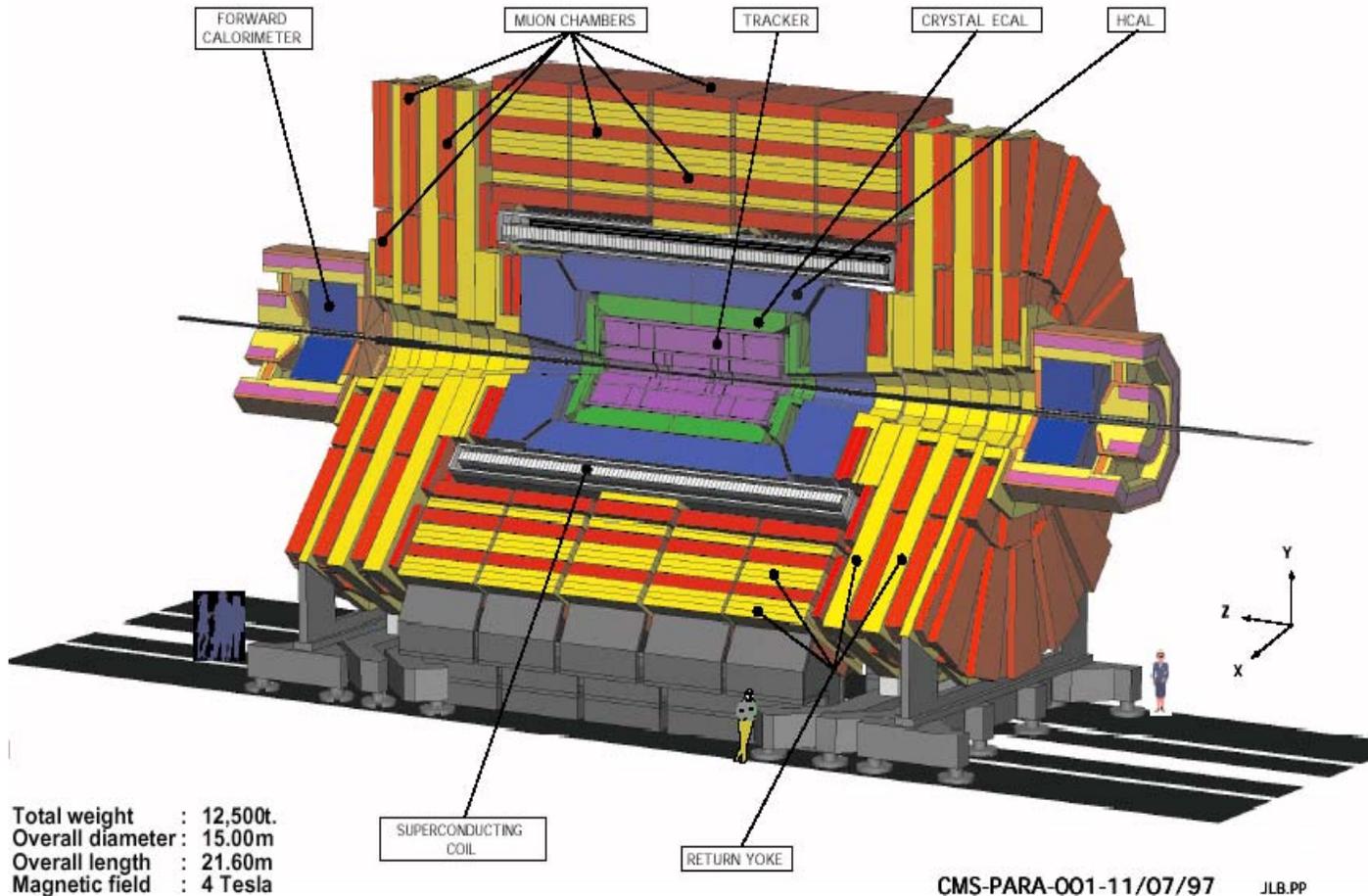
CMS \tilde{q}, \tilde{g} mass reach in $E_T^{\text{miss}} + \text{jets}$ inclusive channel for various integrated luminosities





CMS

CMS A Compact Solenoidal Detector for LHC





Civil Engineering at USC

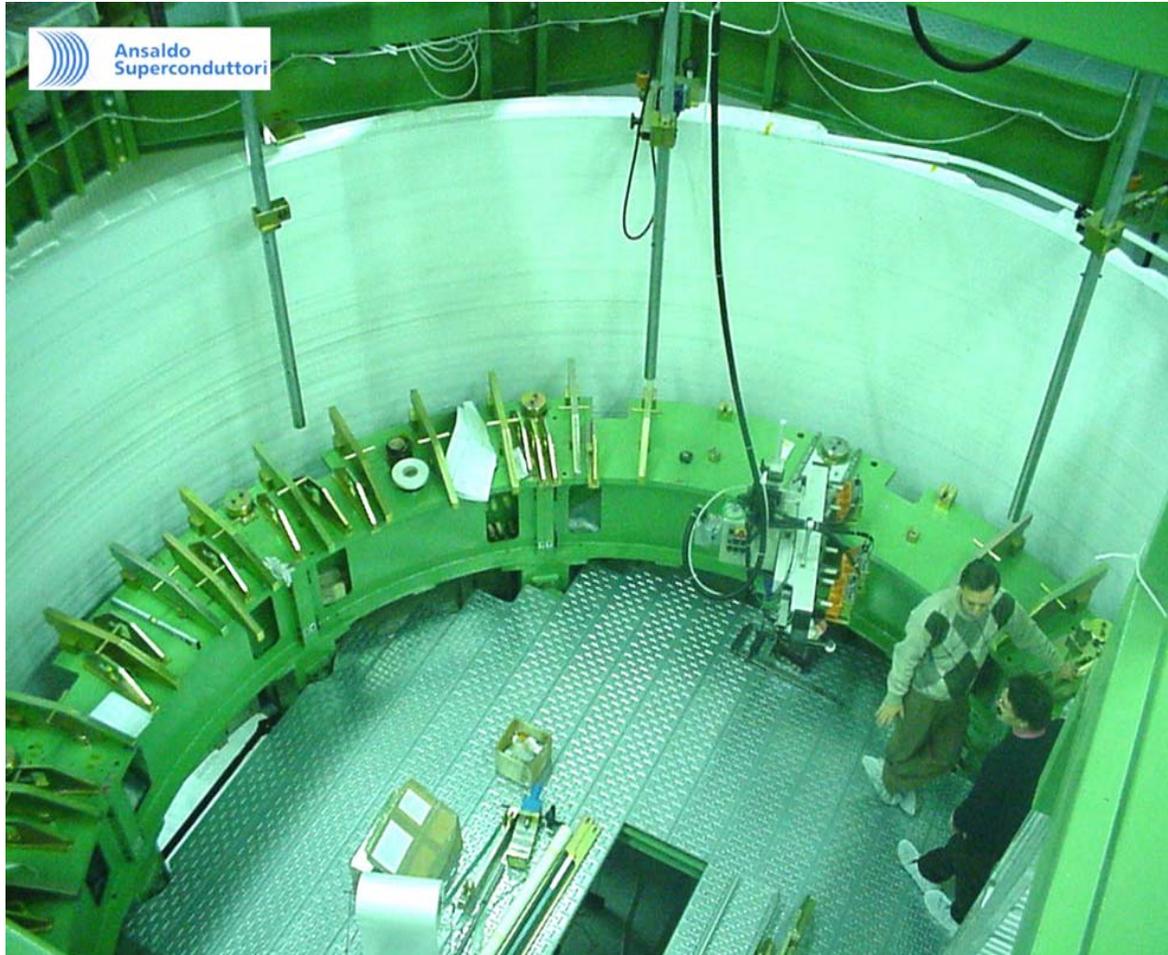


Limited first access to USC55
in February 2004; full access
on 16 Oct. 2004

LHC Point 5 - USC 55 - ST/CE 11-2002



COIL: Winding of External Layer of CB-2 Completed



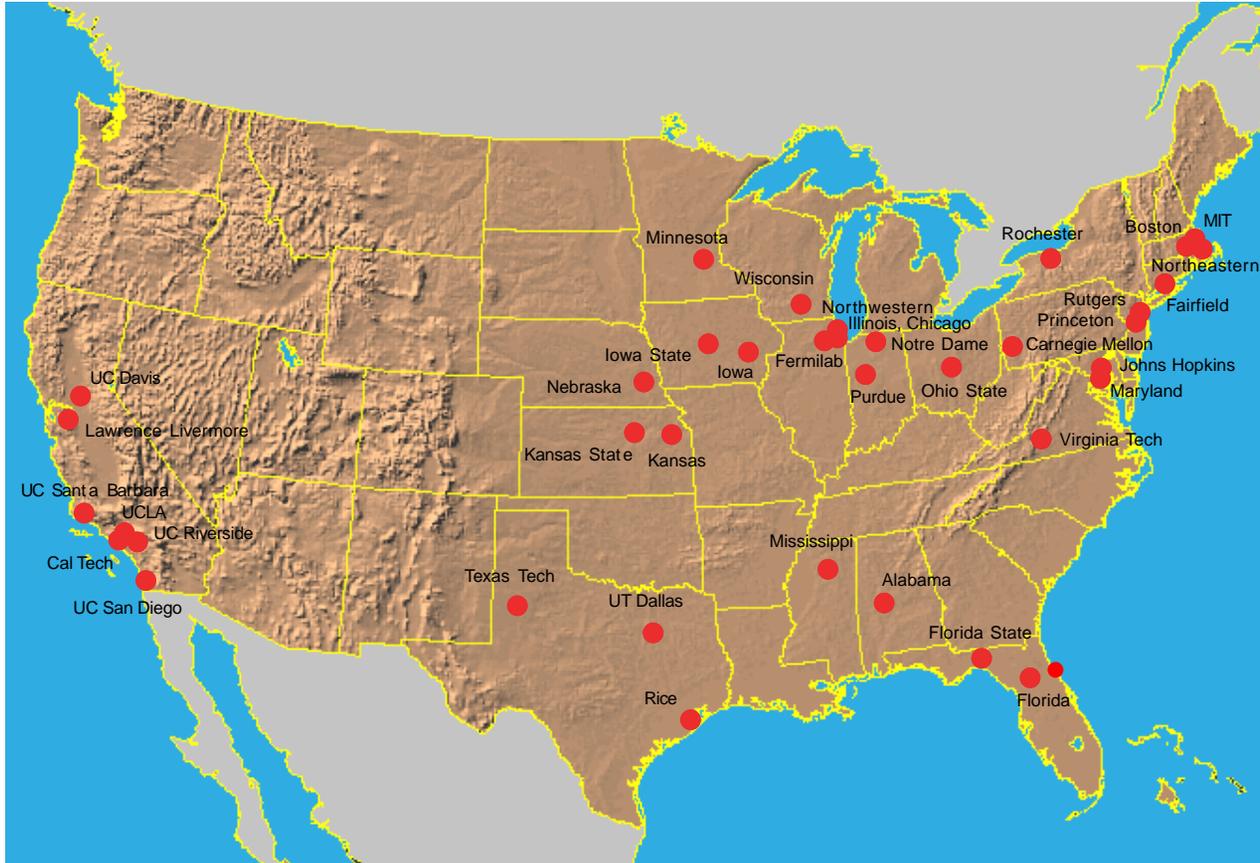
The winding of the coil is critical. Last coil module to be delivered at CERN in Feb 04.

The Completion of the coil at CERN in 2004 and the test of the Magnet on the surface in early 2005 are on the critical path.



US CMS

387 Members from 38 Institutions

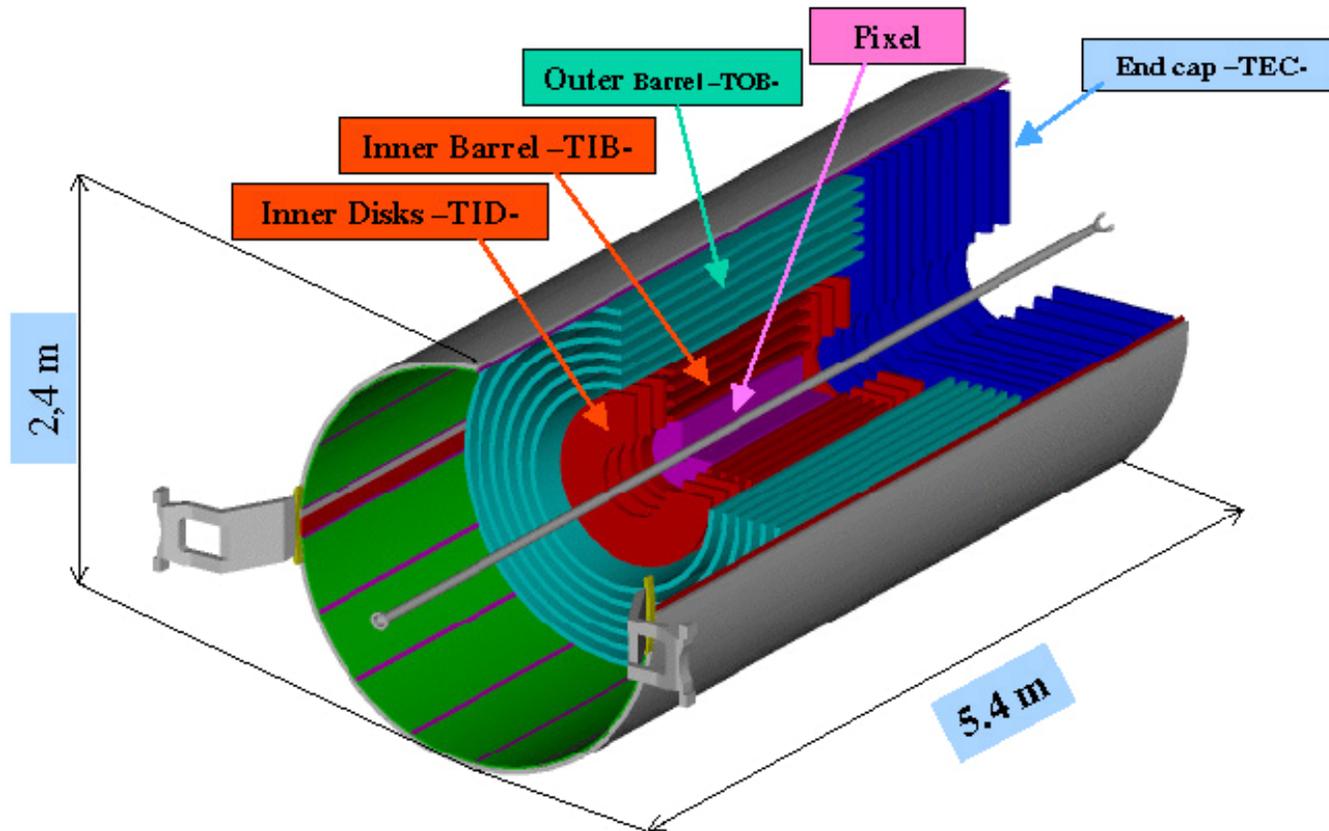


November 10, 2000

New groups - FIT added. FIU and Yale (Zeller) applying.



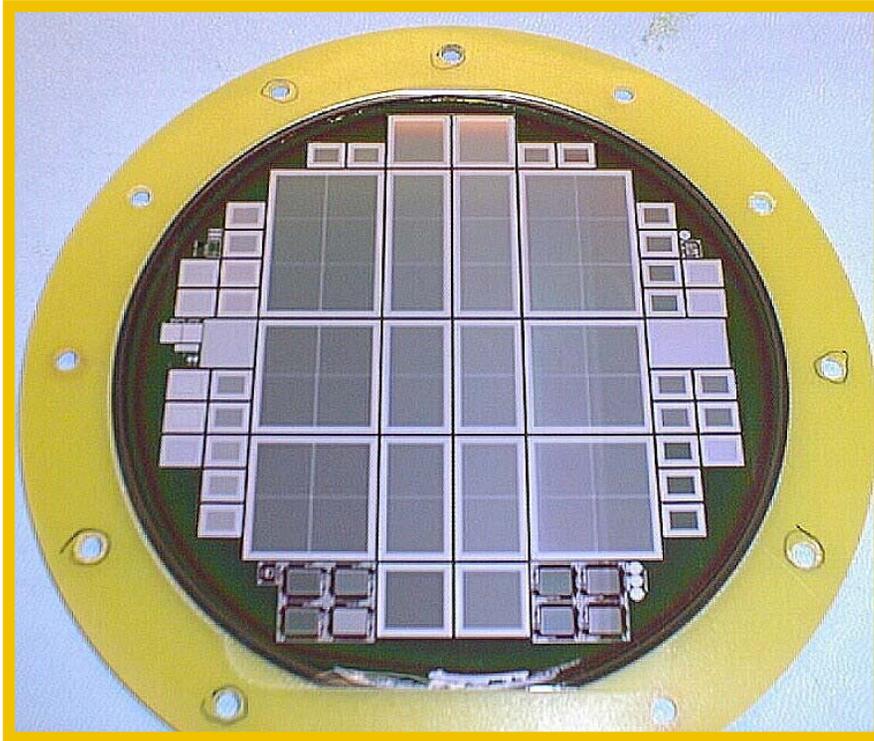
CMS Tracker



All Si tracker: US builds FPIX with L2 managers for FPIX - Gobbi - NW, and TOB - Incandela - UCSB.



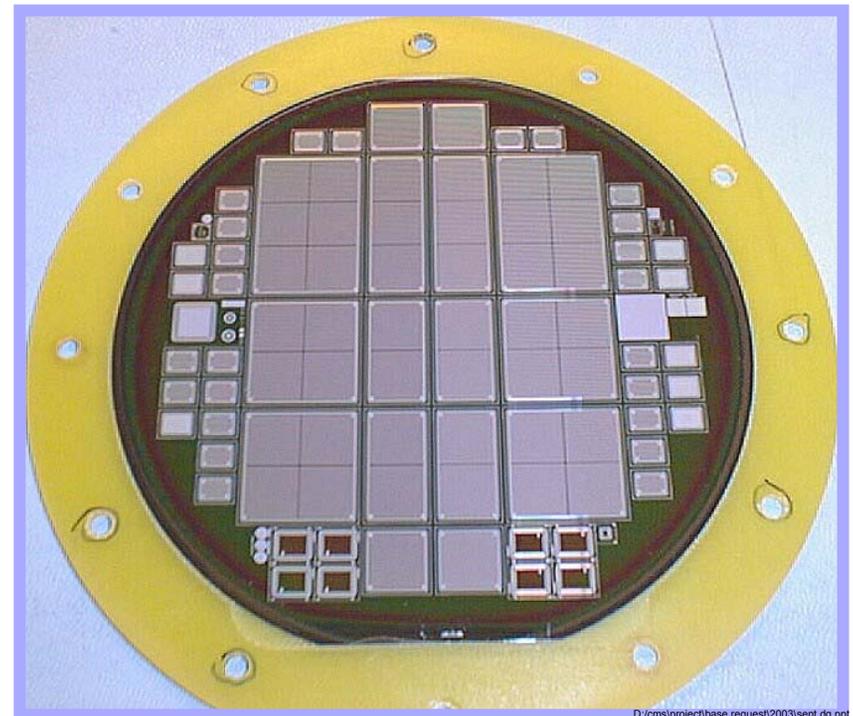
Pixel Wafer Sensors



Wafer n-side

Second Submission
SINTEF. Purdue

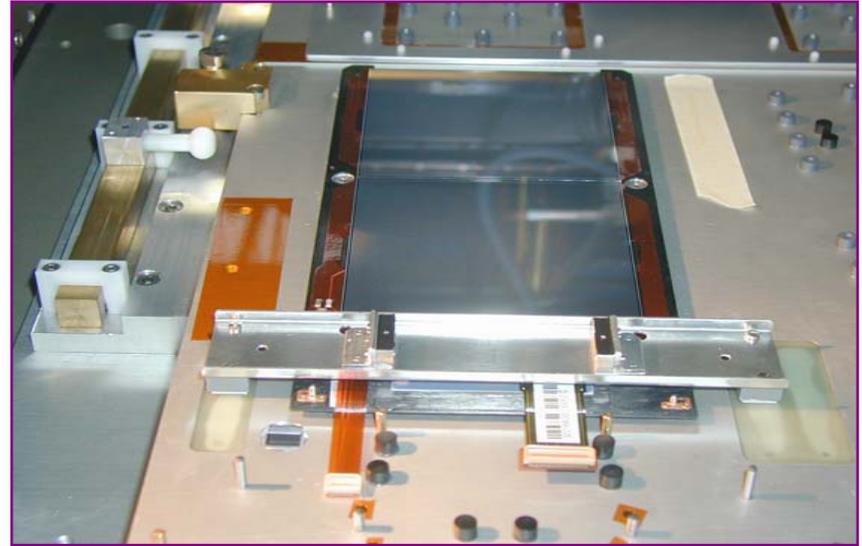
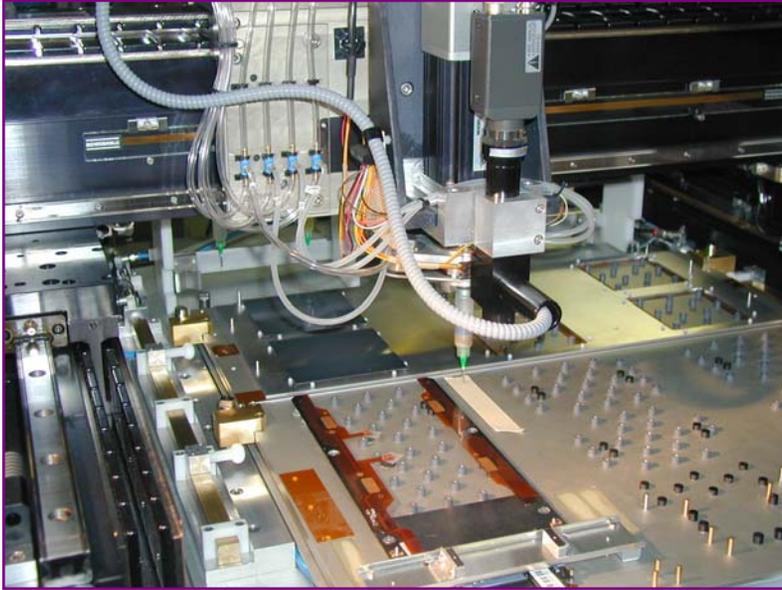
Wafer p-side



- 15 wafers delivered 06-12-02
- Tested at Purdue
- Irradiated at $\Phi=10^{15}n_{eq}/cm^2$
- Testing of irradi. sensors has started



Robotic Assembly at FNAL & UCSB

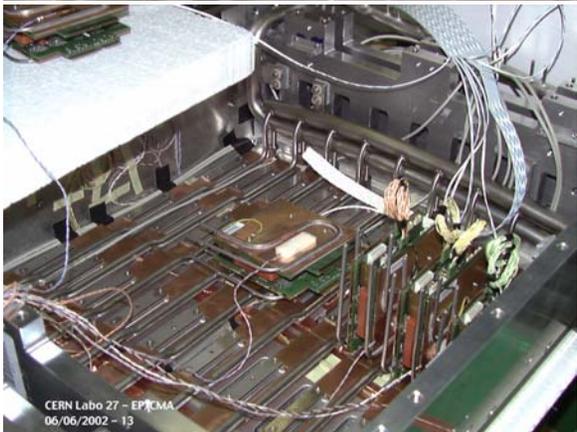
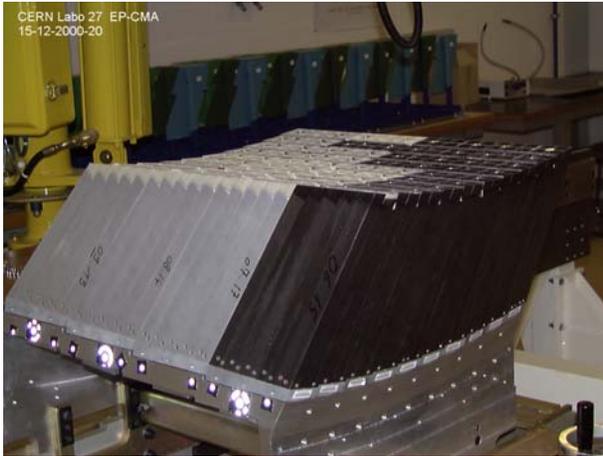


FNAL pick and place gantry

- Fully qualified for production
- Starting first modules now at FNAL.



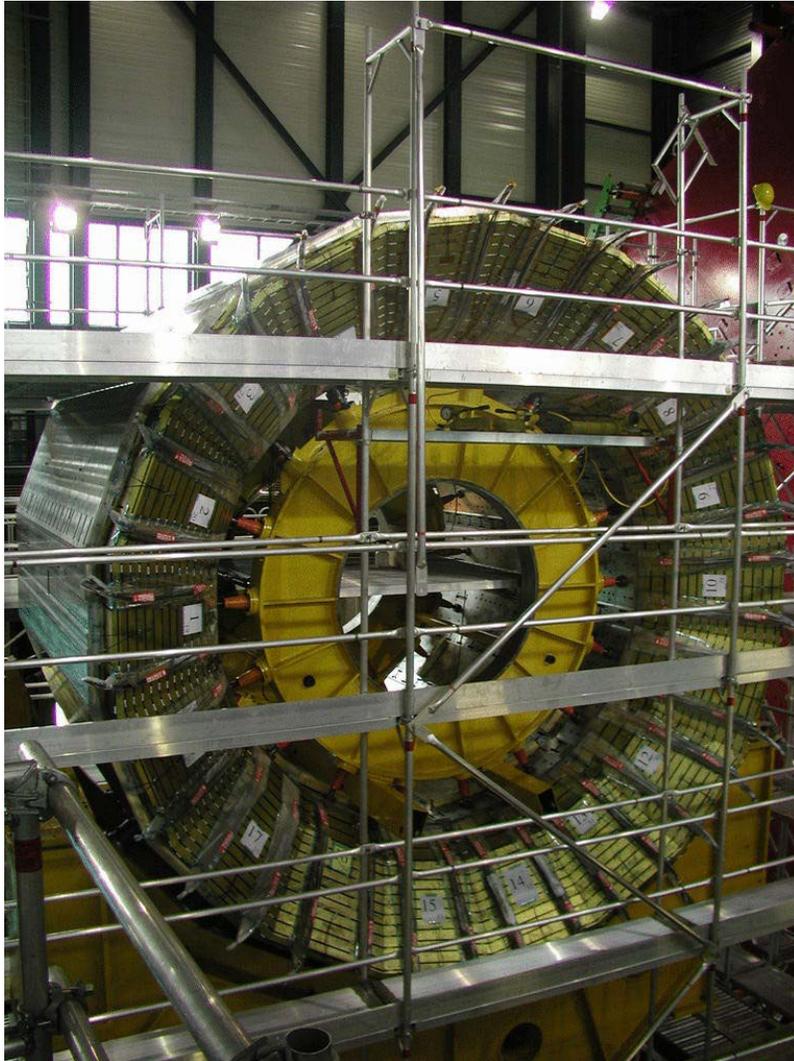
ECAL – H4 Test Beam



Rusack (U. Minn) is L2 manager



HB+ Assembly



The assembly of absorber and scintillator tiles for HB is now complete in SX5 - 1000 T of precision detector. There are ~ 2 years before the next V33 ML1 for HB.



On to the commissioning.

Skuja (U. Maryland) is L2 manager



HB + "ECAL" Test Beam Layout



Calibrate 4 wedges '02. In May '03 use PPP to study 40 MHz beam and HE/HB transition region. ME will also need 40 MHz operation to verify all the electronics chain. Then into SX5.



CSC Arrival at CERN



The Final Assembly and Test Sites are operational. Checkout in ISR tunnel. Loveless - U. Wisconsin is L2 manager.



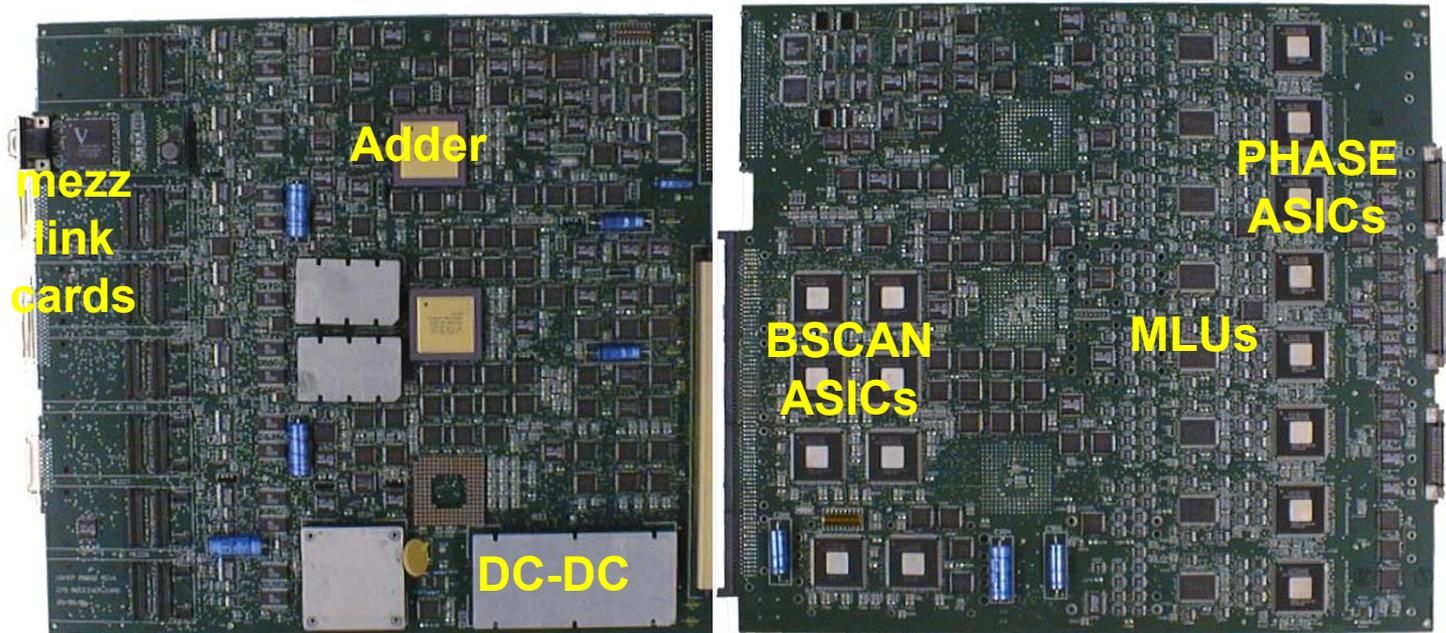
CSC Installation



Installation of cables and services going on now - prior to chamber installation. CSC commissioning on FY03.



Trigger - Receiver



Trigger L2 manager is Smith - U. Wisconsin. Second round of prototypes. Trigger will supply portable system for SX5 "slice" tests.



Trigger Tables

Level-1 Trigger at low luminosity ($2 \times 10^{33} \text{cm}^{-2} \text{s}^{-1}$)

- Total Rate: 50 kHz. Factor 3 safety, allocate 16kHz**

Trigger	Threshold ($\epsilon=90-95\%$) (GeV)	Indiv. Rate (kHz)	Cumul rate (kHz)
1e/γ, 2e/γ	29, 17	4.3	4.3
1μ, 2μ	14, 3	3.6	7.9
1τ, 2τ	86, 59	3.2	10.9
1-jet	177	1.0	11.4
3-jets, 4-jets	86, 70	2.0	12.5
Jet * Miss-E_T	88 * 46	2.3	14.3
e * jet	21 * 45	0.8	15.1
Min-bias		0.9	16.0

Tables exist for 1/5 and design L. "Discovery" modes covered well. We think we know how to trigger CMS and acquire the Physics.

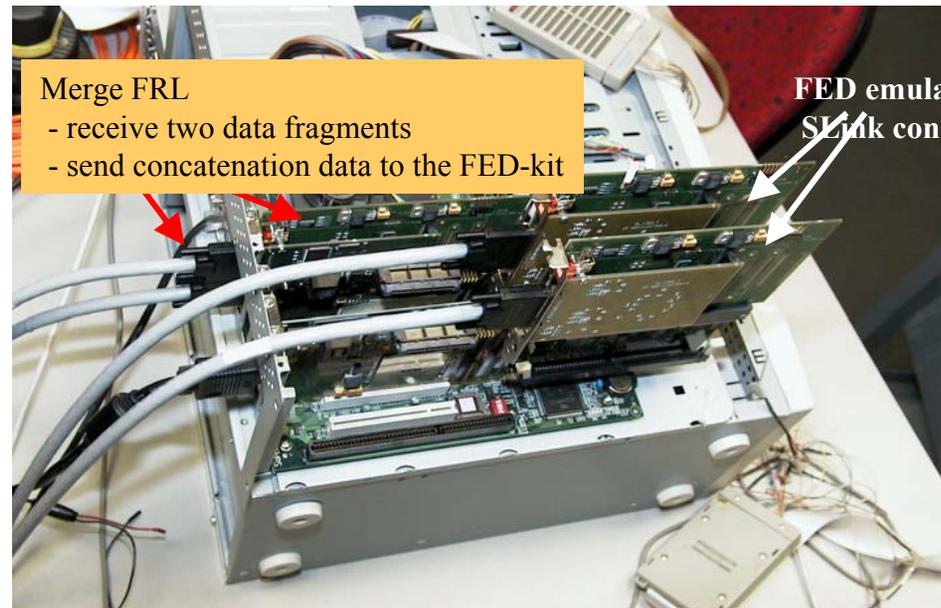


US-CMS Data Acquisition

- **Next major milestone - Dec. 2003**
 - **Event Builder Preseries and DAQ slice ready**

Work focussing on

- front end drivers and links
- integration and event building software
- event manager

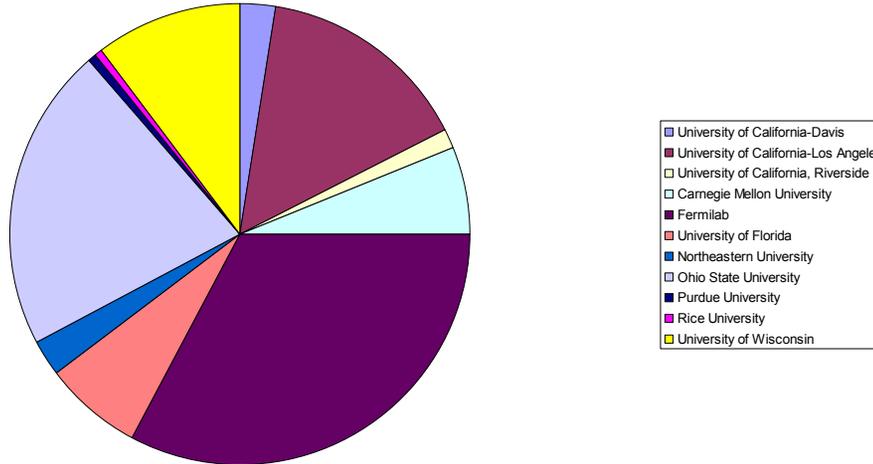


This system will be used for the detector slice tests. US will build first 1/8 of DAQ. O'Dell – FNAL is the L2 manager.



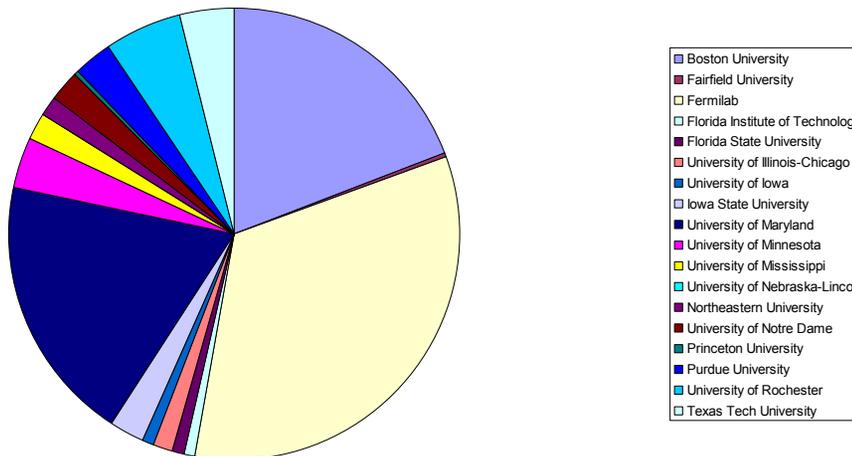
US CMS is Broad Based

EMU SOWs FY02 -- \$5.0M



The design and construction of the US CMS detector is distributed over the full collaboration.

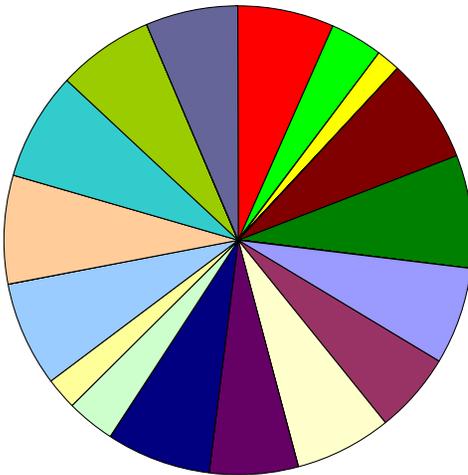
HCAL SOWs FY02 -- \$7.0M





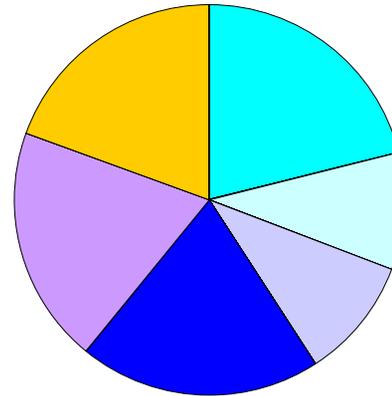
Base Support

DOE - FY03 Base Requests
17 Requests, 1119 k\$



- Boston
- UC Davis
- UCLA B (Cline -DOE)
- UCLA E (Hauser - DOE)
- UCLA F (Arisaka - DOE)
- UCLA (Schlein-NSF)
- UC Riverside
- UC San Diego (DOE)
- UC San Diego (NSF)
- UC Santa Barbara
- Caltech
- Carnegie Mellon
- Fairfield
- Fermilab
- Florida
- Florida Institute Tech
- Florida State
- Illinois Chicago
- Iowa
- Iowa State
- Johns Hopkins
- Kansas
- Kansas State
- Maryland (DOE)
- Maryland (NSF)
- Minnesota
- Mississippi
- MIT
- Nebraska
- Northeastern
- Northwestern
- Notre Dame
- Ohio State
- Princeton
- Purdue - Bortoletto
- Purdue - Shipsey
- Purdue D (Gutay)
- Purdue G (Barnes)
- Rice
- Rochester
- Rutgers
- Texas Tech
- Virginia Tech
- Wisconsin

NSF - FY03 Base Request
6 Requests, 404 k\$

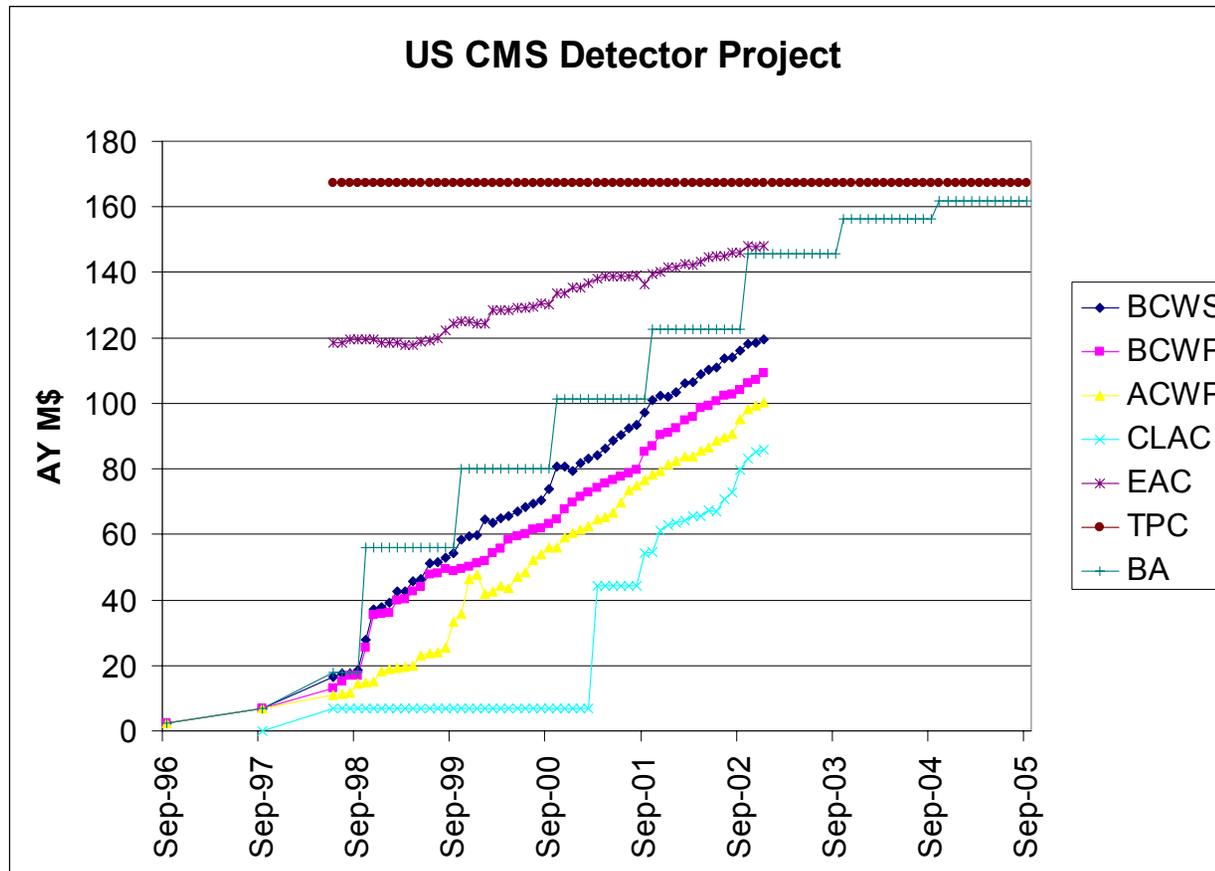


- Boston
- UC Davis
- UCLA B (Cline -DOE)
- UCLA E (Hauser - DOE)
- UCLA F (Arisaka - DOE)
- UCLA (Schlein-NSF)
- UC Riverside
- UC San Diego (DOE)
- UC San Diego (NSF)
- UC Santa Barbara
- Caltech
- Carnegie Mellon
- Fairfield
- Fermilab
- Florida
- Florida Institute Tech
- Florida State
- Illinois Chicago
- Iowa
- Iowa State
- Johns Hopkins
- Kansas
- Kansas State
- Maryland (DOE)
- Maryland (NSF)
- Minnesota
- Mississippi
- MIT
- Nebraska
- Northeastern
- Northwestern
- Notre Dame
- Ohio State
- Princeton
- Purdue - Bortoletto
- Purdue - Shipsey
- Purdue D (Gutay)
- Purdue G (Barnes)
- Rice
- Rochester
- Rutgers
- Texas Tech
- Virginia Tech
- Wisconsin

The US CMS Project requires base supported postdocs and engineers to succeed. They are not project supported, however, so the Project must be in good communication with the DOE and NSF base programs.



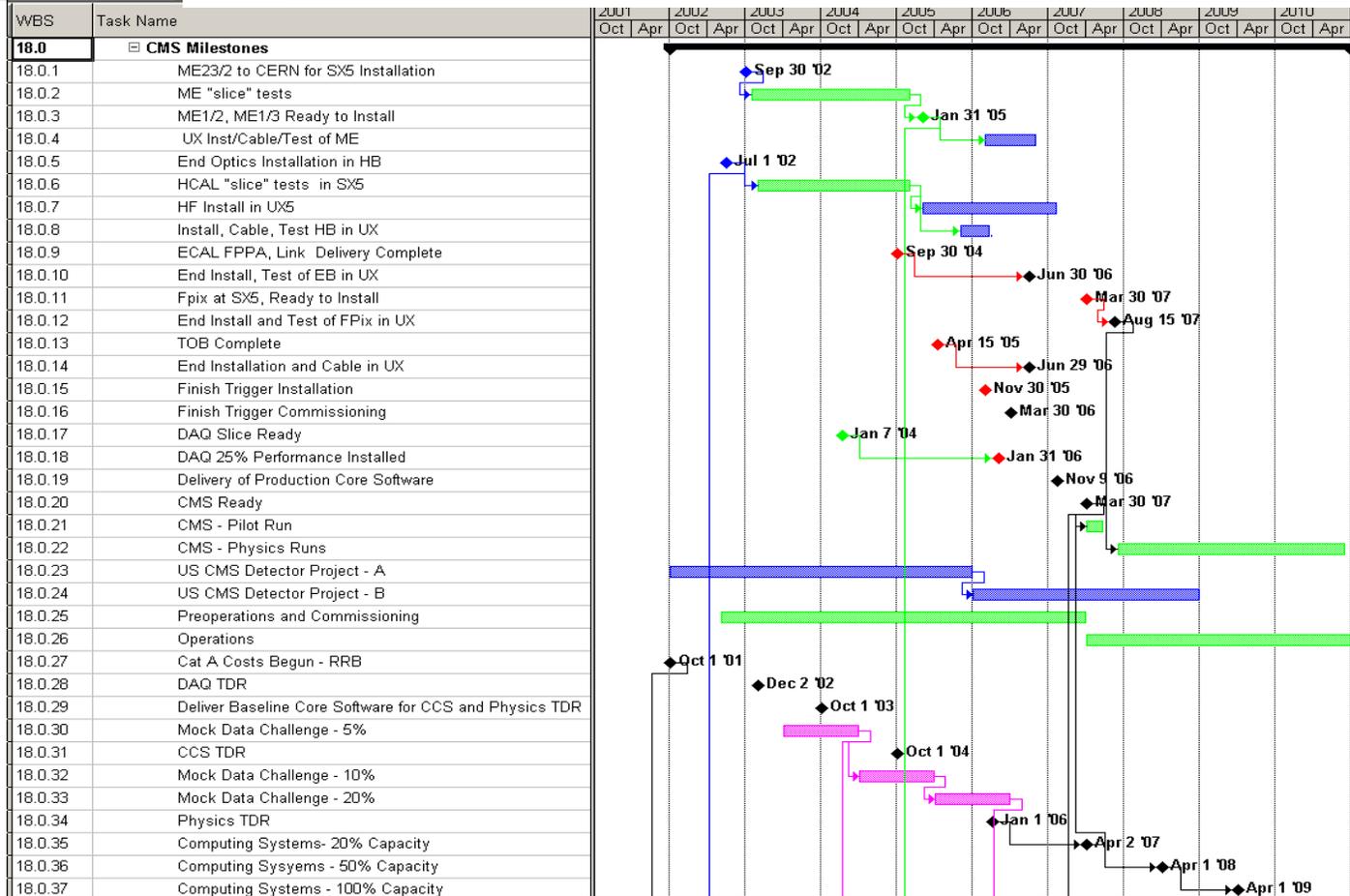
Project Financial Summary



55 months of reporting. Note BA in FY06 (4.2 M\$) and FY07 (1.3 M\$). CD4-a, CD4-b. Will ~ end in FY05. Softer profile helps SWC.



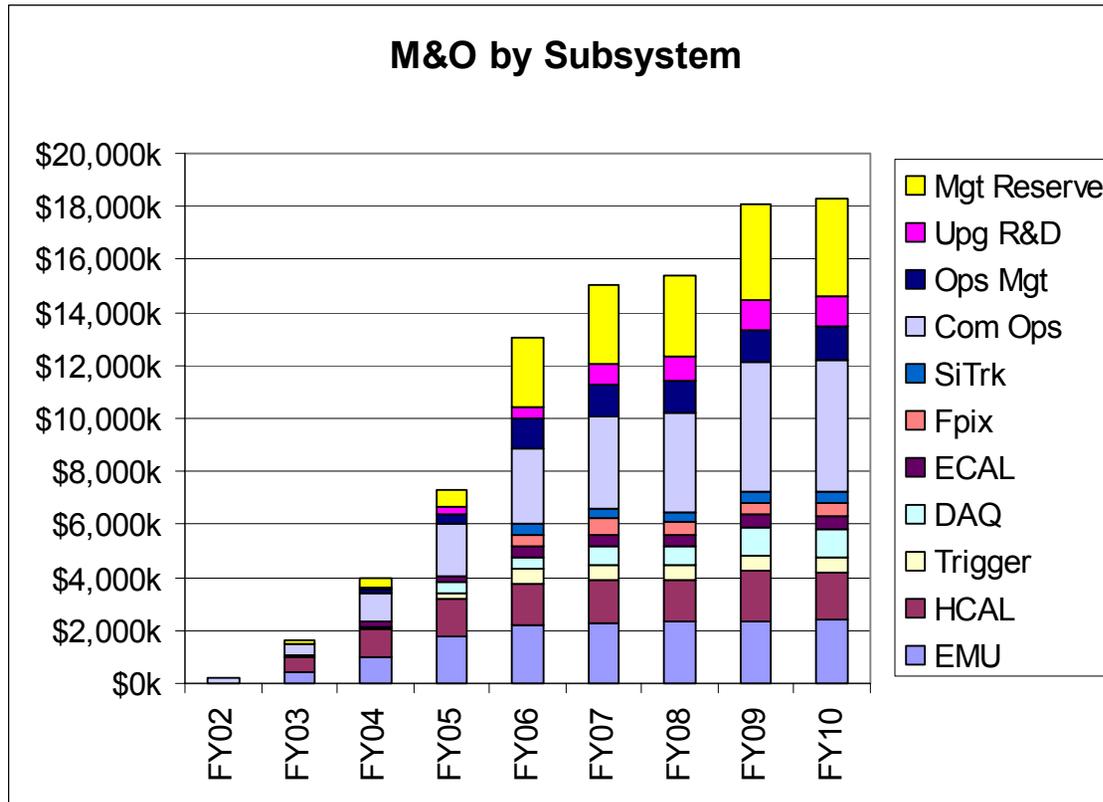
> M&O



M&O begins with commissioning and preops in SX5 in FY03. Aim to ~ end Project in FY05, with completion in FY08 – UX5 installation. Tie to DC and SWC schedule ML too.



“Scrubbed” M&O

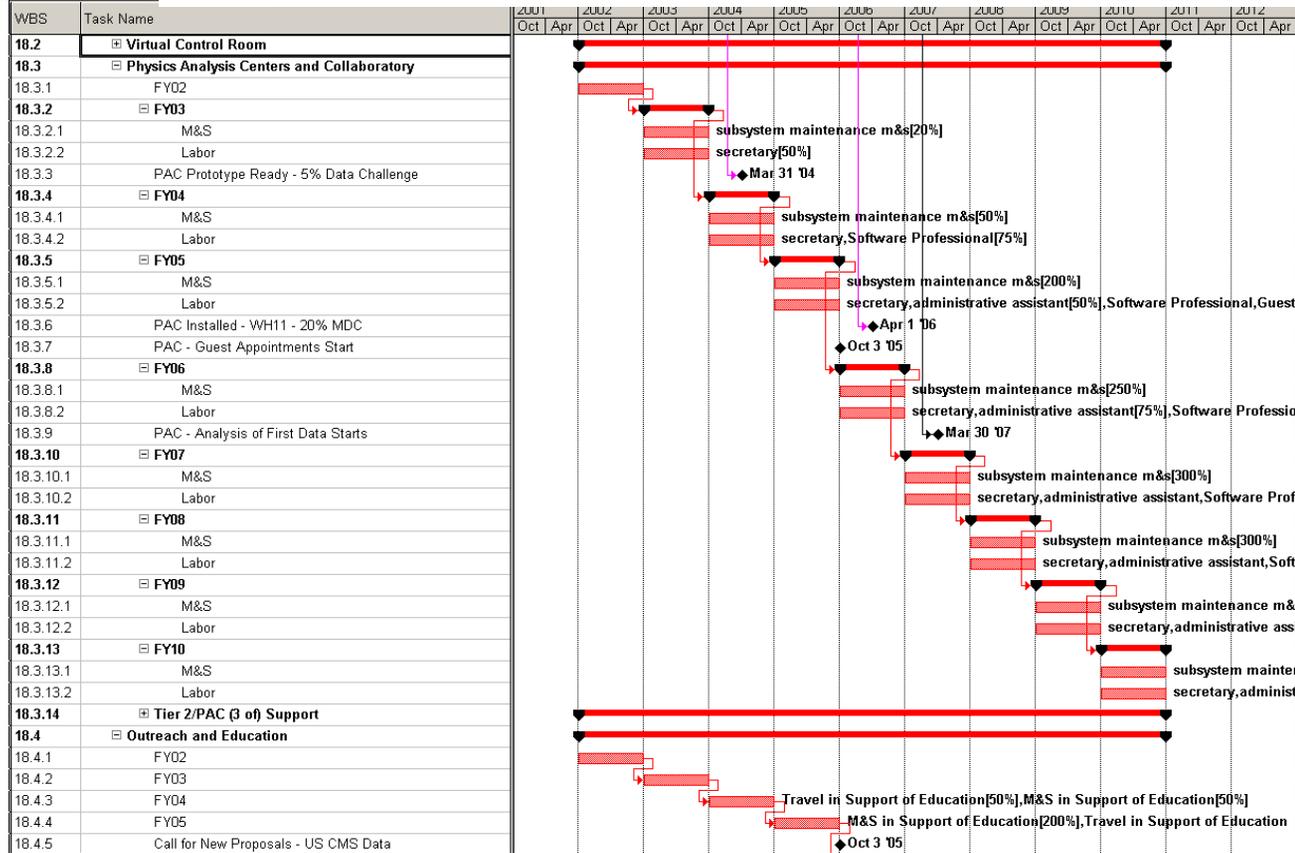


n.b. ~no MR, Ops Mgt, R&D, slow rampup

Have had resource loaded schedule and reviews since June 2001. We would like to do more to support US physicists doing analysis at their home institutes or at a local PAC. There will be an external review on April 8-10 of M&O.



LHC Physics in the US



In US CMS, planning is in place for a “collaboratory” or virtual laboratory. Elements are Virtual Control Room (commissioning, shifts) and Physics Analysis Centers (teleconf, analysis groups). This support will go directly and solely to US HEP physicists.



Main US CMS SWC Activities

Develop the US CMS T1/T2 system into a working “Data Grid”

- high throughput data transfers
- Grid-wide job scheduling
- monitoring
- Middleware is “VDT”: Condor, Globus et al
- US CMS-developed DPE toolkit and procedures, underlying the
- standard CMS production environment (Impala, RefDB etc)

“Integration Grid Testbed” (IGT) was very successful first large-scale Grid

Next steps: preparing the US CMS Production Grid

- Major coming milestones:
 - participation in the CMS “5% data challenge” DC04
 - be operational as part of “LCG Production Grid” in June 2003

Major development efforts are still needed for those milestones

- Providing a viable storage management solution for multi-Terabytes data sets
 - building on dCache, SRM, etc
- End-to-end throughput with the goal of TBs/day sustained rates from mass storage to mass storage
- Interfacing the Grid VO system to the local user registration/security requirements
- Consolidating the production system, data bases, production configuration and meta-data systems (MC_Runjob, catalogs, scheduling)



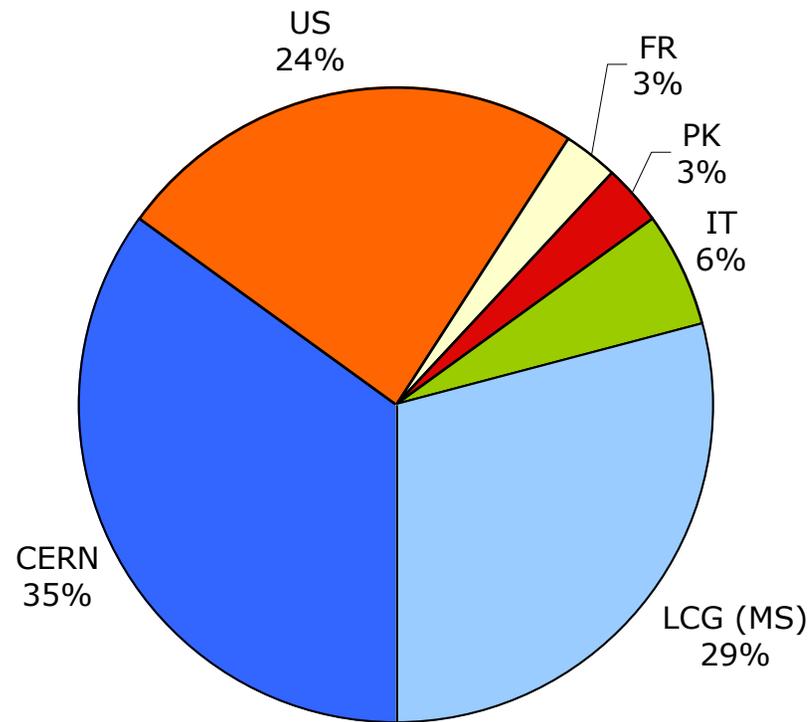
Accomplishments

- **Prototyped Tier-1 and Tier-2 centers and deployed a Grid System**
- **Participated in a world-wide 20TB data production for HLT studies**
 - US CMS delivered key components: IMPALA, DAR
- **Made available large data samples (Objectivity and nTuples) to the physics community**
 - → successful submission of the CMS DAQ TDR
- **Worked with Grid Projects and VDT to harden middleware products**
- **Integrated the VDT middleware in CMS production system**
- **Deployed Integration Grid Testbed and used for real productions**
- **Decoupled CMS framework from Objectivity**
 - allows to write data persistently as ROOT/IO Files
- **Released a fully functional Detector Description Database**
- **Released Software Quality and Assessment Plan**



USCMS Contributions to CMS Software

Contributions to CMS Manpower in Computing and Core Software (CCS)



US CMS contributions to CAS will be ~ cont. for 2 years with the present funding guidance.

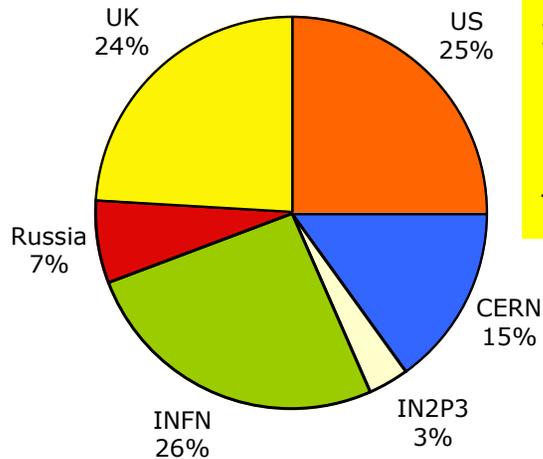


US Contribution to CMS Production

Contribution in #events produced

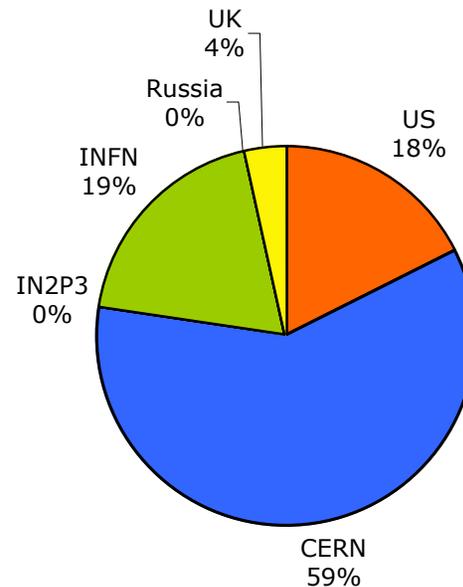
- This is not a complete metric, but gives a good indication
- US CMS is providing a fair share of the CMS resources for simulations to support trigger and physics studies

events simulated



US will do its share of SWC "service" work.

events high lumi pile-up





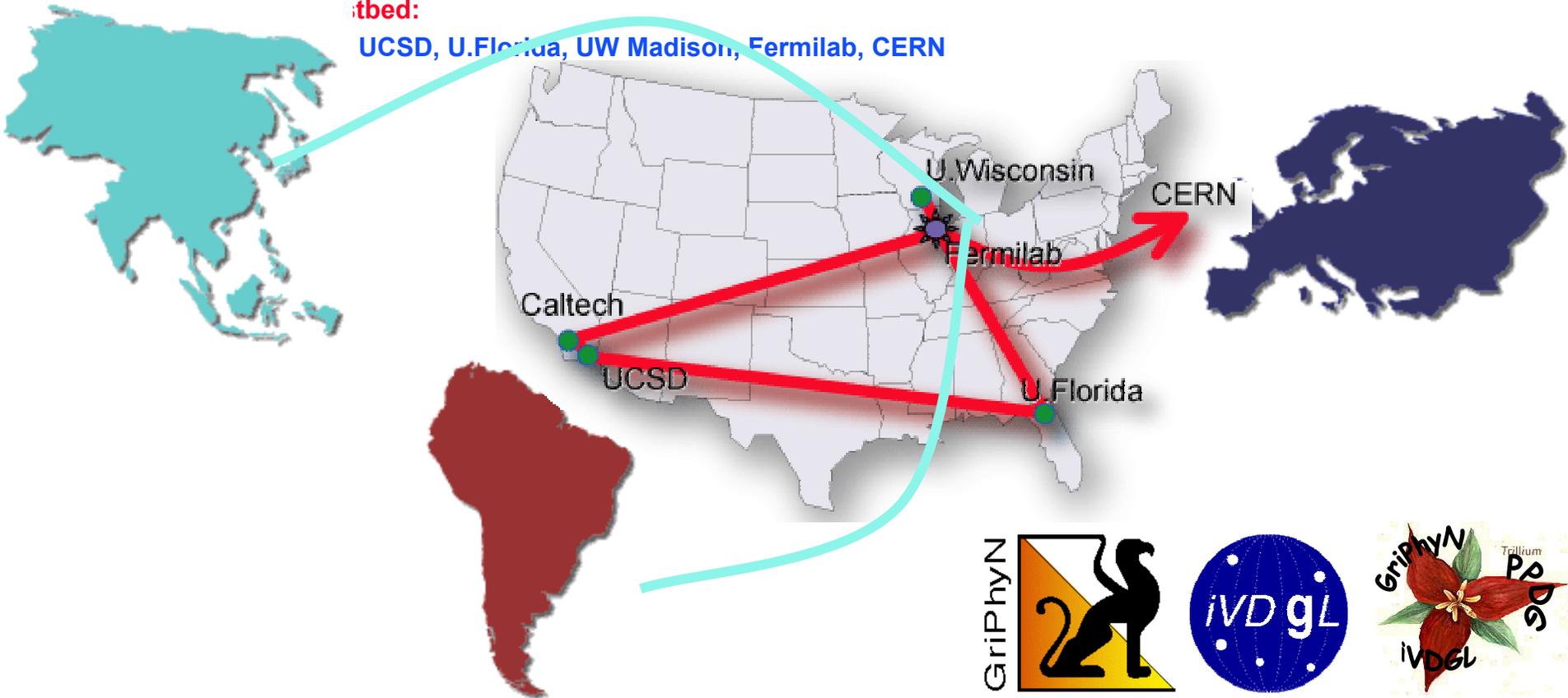
Grid Testbeds And Production Grids

Grid Testbeds: Research, Development and Dissemination!

- LHC Grid Testbeds first real-life large Grid installations, becoming production quality
- Strong Partnership between Universities, Labs, with Grid (iVDGL, GriPhyN, PPDG) and Middleware Projects (Condor, Globus)
- Strong dissemination component, together with Grid Projects

Testbed:

UCSD, U.Florida, UW Madison, Fermilab, CERN





High Level Milestones FY03

Integration Grid Testbed deployed, running PRS production

- **October 2002, Done**

SC2002 demonstration of Grid distributed production and “WorldGrid”

- **November 2002, Done**

review of SC2002 demo, promotion and termination

- **December 2002, Done**

Farm Configuration Definition and Deployment

- **February 2003., being release now**

Fully Functional Production Grid on a National Scale

- **February 2003, delayed by 1 Months due to lack of available effort (but on track)**

Migration of TestBed functionality to Production Facilities

- **March 2003, in progress**

Start of LCG 24x7 Production Grid,

- **June 2003 -- definition from the LCG/GDB has been received during this month**

Start of CMS DC04 production preparation, PCP04

- **July 2003**

Running of DC04

- **Feb 2004**



Resource Expectations for Data Challenge 04

Estimates for CPU and Storage Requirements for CMS Data Challenge DC04

Year.Quarter	03Q3	03Q4	04Q1	04Q2
Computing Power (kSI95 Months)				
Total Requirement for Simulation, Pile-up, Recon	100	215	25	
Total Requirement for Analysis / Challenge Proper			50	50
CERN T0 (1/3 simulation, all Recon)	33	72	25	
CERN T1 (1/3 of Challenge proper)			17	17
Offsite T1+T2 (Challenge only), assumi	67	143	33	33
Storage (TeraBytes)				
Data Generated CERN	19	39	25	
Data Generated Offsite	39	78		
Data Transferred to CERN	17	33		
Sum Data Stored CERN	36	108	133	133
Active Data at CERN	25	75	100	100
Sum Data Stored Offsite (3 T1)	39	117	192	192

Estimated CMS resources outside CERN (prelim. & incompl.) at end of 2003

	De	Es	Fi	Fr	It	Kr	Ru	UK	USA	CMS total	
CPU [kSI95]	6	2.5	2	10	10	7	2.5	20	31	91	kSI95
Disk [TB]	10	5	1.2	0.5	30	30	1.2	20	41	139	Tbyte
Tape fast				20	15		15	50	100	200	Tbyte fast
Tape archive	30	5	1.2				5				
Peak CPU(?)	12	7.5		20	20			40	60	160	kSI95 Peak



Conclusions on US CMS SWC

US CMS S&C Project is delivering a working Grid environment, with a strong participation of Fermilab and U.S. Universities

- We need to do a lot more R&D to build the system for physics
- Our customers (CCS, PRS and US CMS Users) are happy (last time we were asking...), but need and want more support
- US CMS is presently driving the US Grid integration and deployment work

We have a unique opportunity to bring in our ideas of doing science in a global and open international and collaborative environment

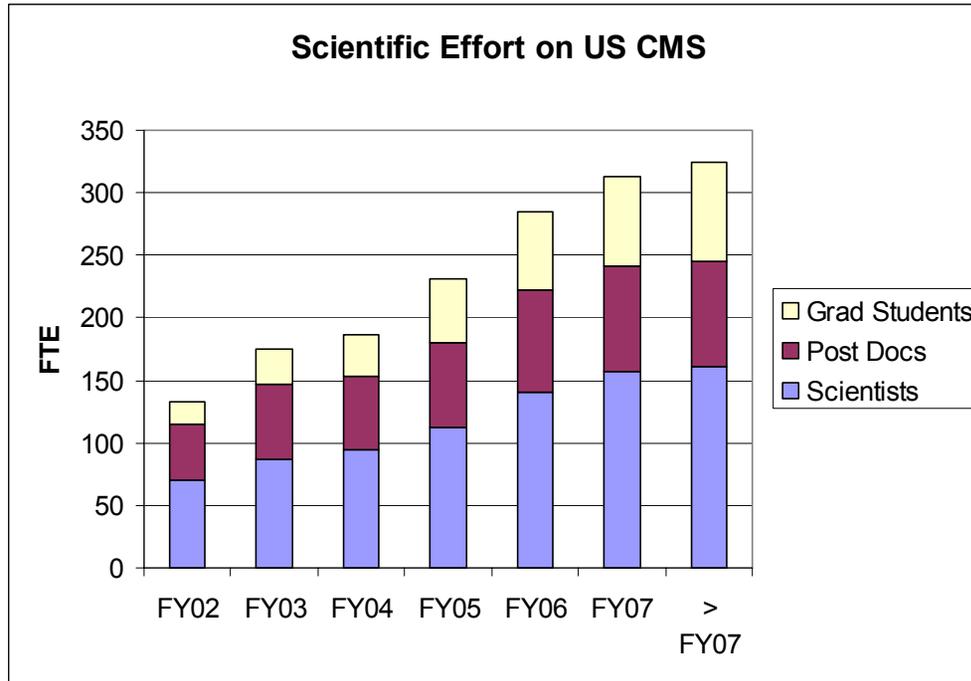
- Proposal to the NSF ITR solicitation to Globally Enable Analysis Communities
- That goes beyond the LHC and even HEP

US CMS has shown that the US Tier-1/Tier-2 User Facility system can indeed work to deliver effort and resources to US CMS!

- We definitely are now on the map for LHC computing and the LCG
- We will need the manpower and equipment at the lab and universities to participate in strongly in the CMS data challenges,
- bringing the opportunity for U.S. leadership into the emerging LHC physics program is an opportunity not to be missed.



US LHC and the RP



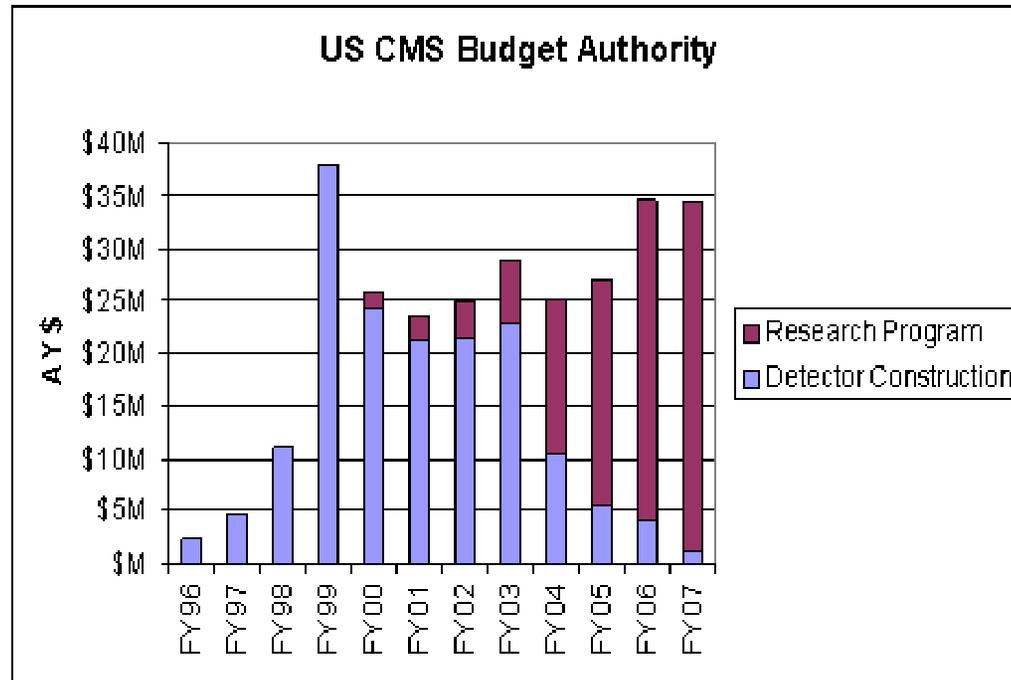
US CMS has made a survey of intent. It appears US CMS will grow by a factor ~ 2 by FY07.

In addition, new groups will join before first beam.

We would like to have the flexibility to plan for these additional physicists and the priority support for US LHC Physics.



Cost Estimates for the RP



The US CMS community has carefully estimated and scrubbed the costs for the Research Program since 2001. We estimate that more support is needed . Present planning, within the guidance provided delays R&D for upgrades, slows the SWC ramp up (bare bones - loan in FY02, FY03), slows the SX5 commissioning, limits the PAC/VCR Physics support in Tier 1 and Tier 2 sites and reduces the contingency fund to a level which limits management agility.



Issues

- **The ramp up of the RP is crucial. FY03 and FY04 will either get us a good start on preparation for Physics (PAC/VCR) or we will drop the ball on Data Challenges and the Physics TDR.**
- **A firm commitment by NSF and DOE is absolutely necessary if we are to plan rationally. The M&O Evaluation Group and SWC Reviews is a start.**
- **We want to be able to realize the investments made in the successful detector construction Project.**



Summary

- **US CMS is on schedule and on budget for the Detector Construction.**
- **CERN and CMS appear to be holding schedule. Beam in 2007 with luminosity $\sim 1/10$ design is quite thinkable. The US must be ready to do Physics.**
- **For the RP the BA is \sim known up to increments. The ML use the CMS schedule. Start FY02 tracking of the RP under SOW agreements for M&O and SWC. The RP has been (over)scrubbed.**
- **A cornucopia of Physics awaits us and we need to be ready for the harvest. This is not the time to flag or falter.**