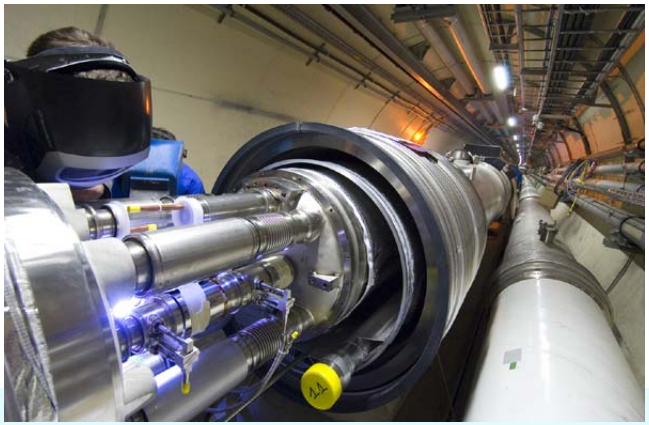
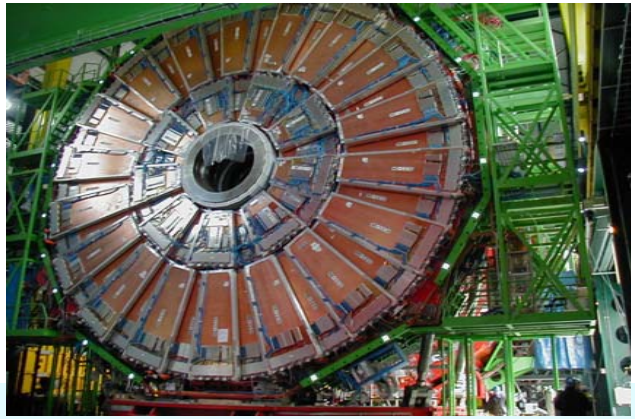




LPC and ROC at Fermilab

(LHC Physics Center)

(Remote Operation Center)

Kaori Maeshima

Feb. 22, 2006

ANL HEP Seminar

The Energy Frontier: Hadron Colliers

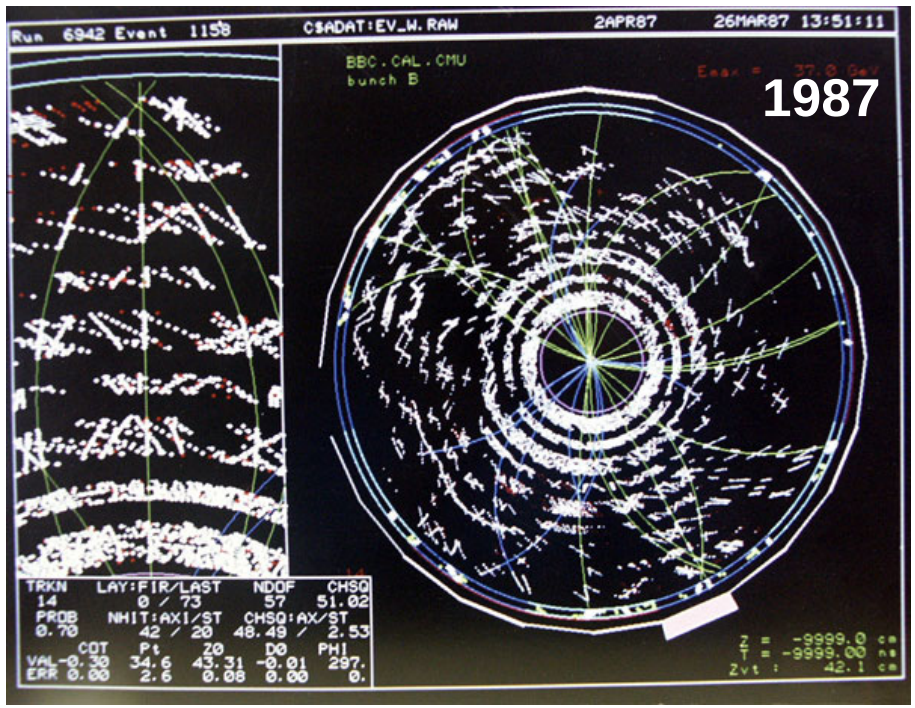
1983: Tevatron reaches 500 GeV

1985: Tevatron reaches 800 GeV

1987: First collisions in CDF

It's been a long time…

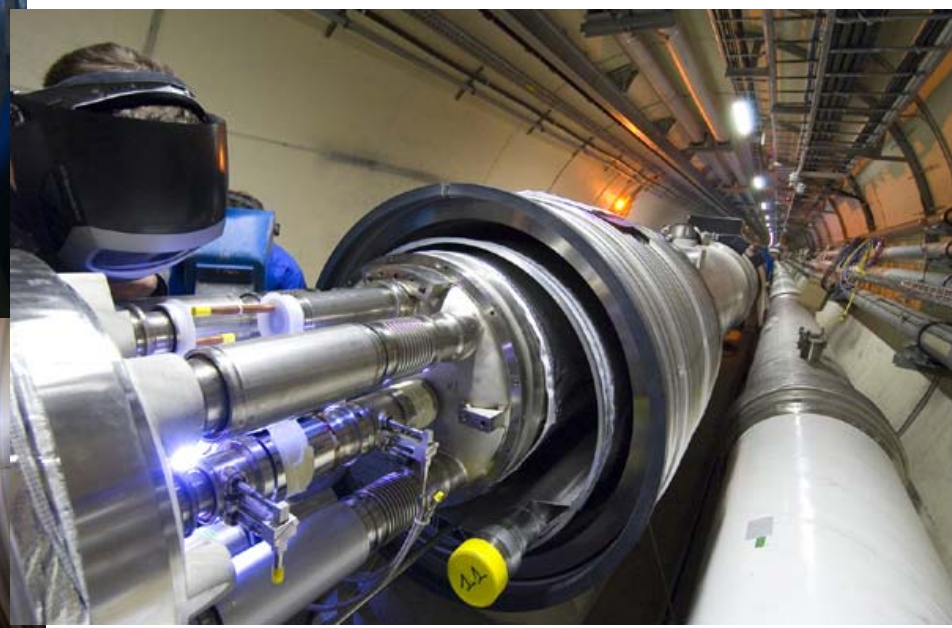
20 years!



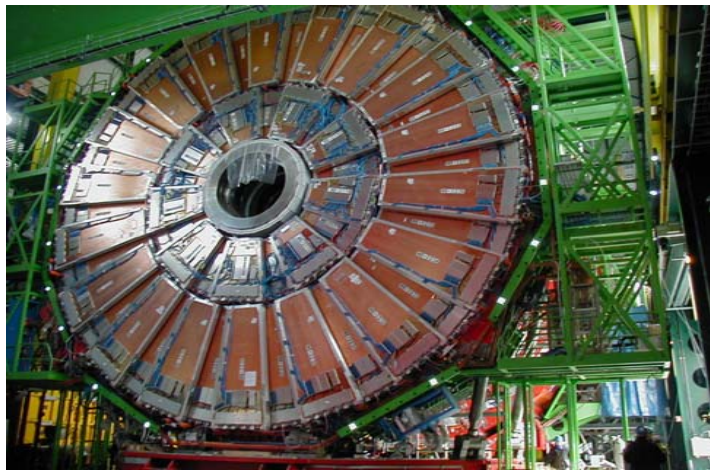
Installing main ring dipole magnets

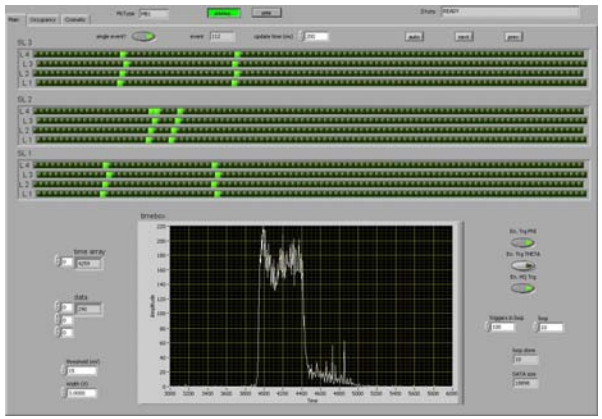
Now

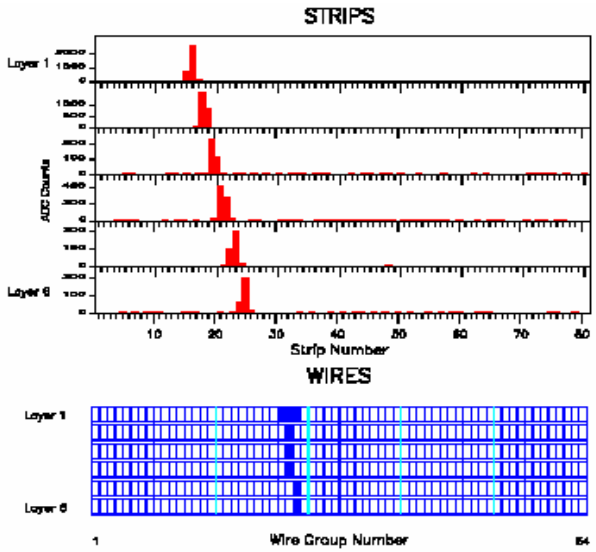
Installation of LHC dipole magnets



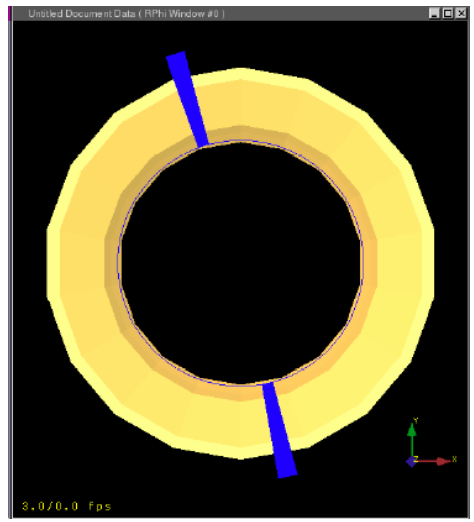
Now






STRIPS
Layer 1
Layer 6
ADC Counts
10
20
30
40
50
60
70
80
Strip Number
WIRES
Layer 1
Layer 6
1
Wire Group Number
54

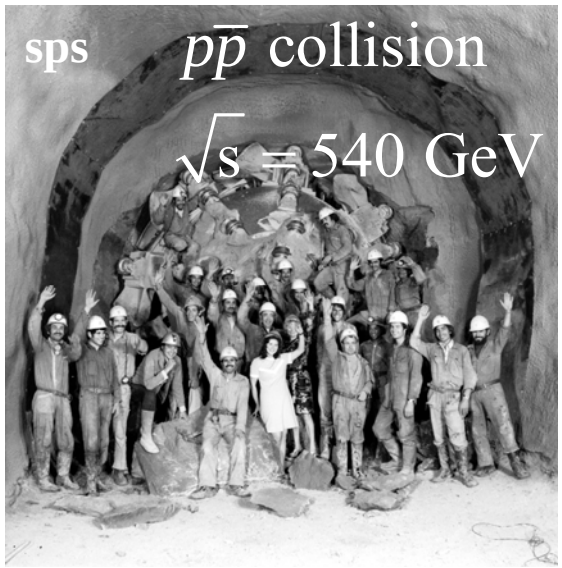
"data"

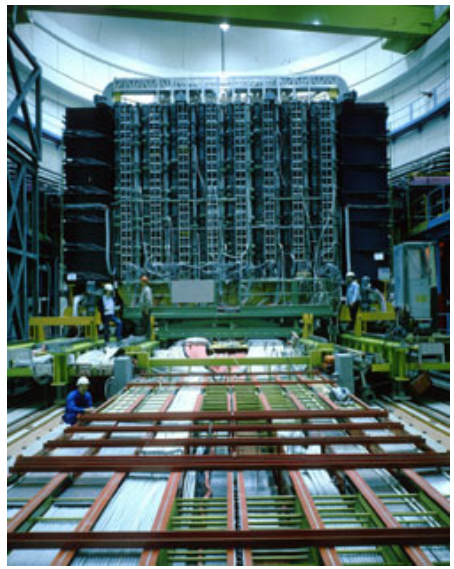

3.0/0.0 fps

Hadron Colliders: a Brief History

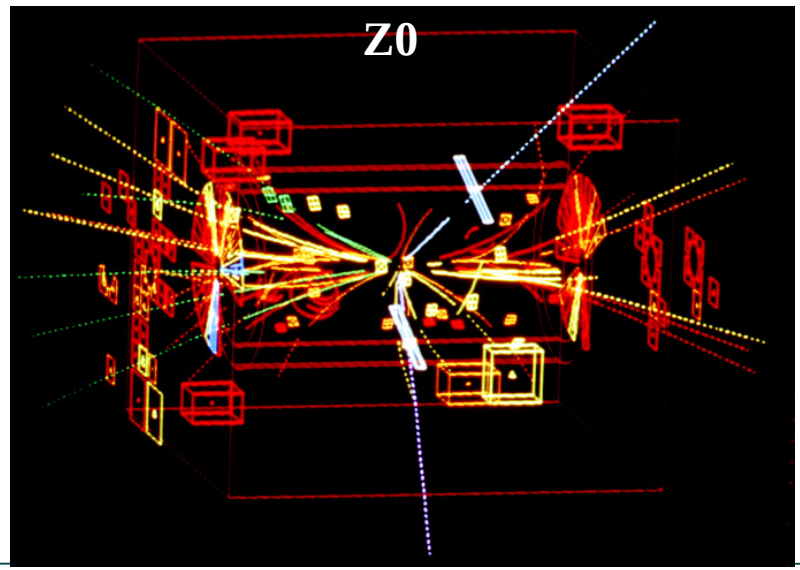
		Energy ($\sqrt{s}$)	First physics run	First High Lum. run	Discovery paper
ISR (pp)		x10 (first) up to 61 GeV	Jan. 1971	1973	(jets)
spps (pbarp)		x 8 (ISR)	Dec.1981 (20 μb^{-1})	1983 (120 nb^{-1}) (~5 pb^{-1}total)	W/Z (20 nb^{-1}) 1983
TeV (pbarp)		x3 (spps)	Summer 1987 (20 nb^{-1})	1992-1994 (20 pb^{-1}) (>1fb^{-1},2006)	TOP (60 pb^{-1}) 1995
HERA (ep)		ep, unique	May 1992 (25 nb^{-1})	1993 (15 pb^{-1})	n/a
LHC (pp)		x7 (TeV) 14 TeV			???

If we are lucky…





The SppS turned on at 1% of final instaneous luminosity, but in the first run of a few months discovered the W and Z bosons.

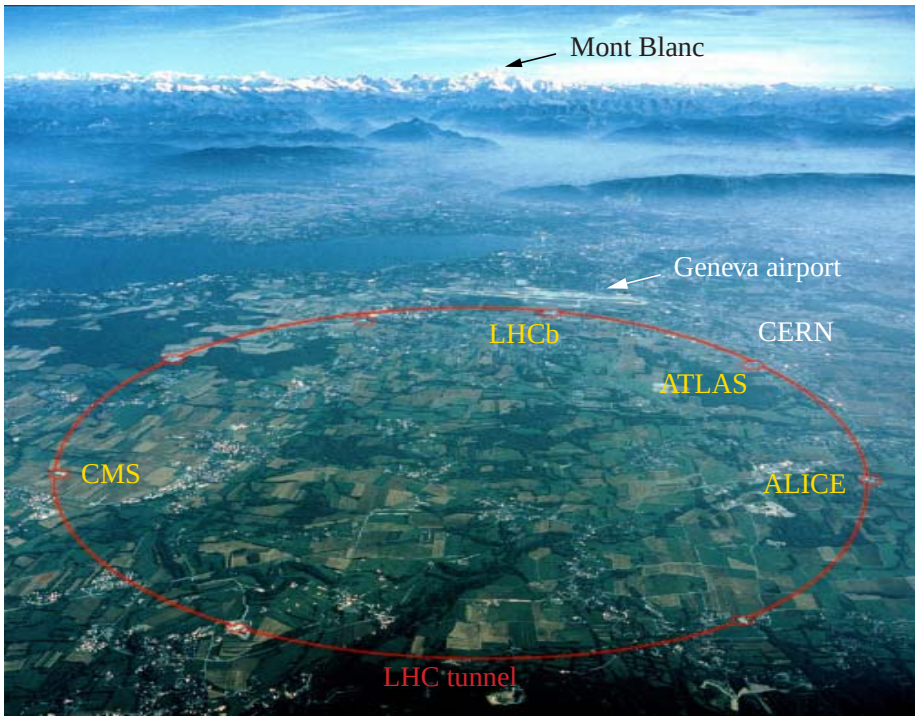


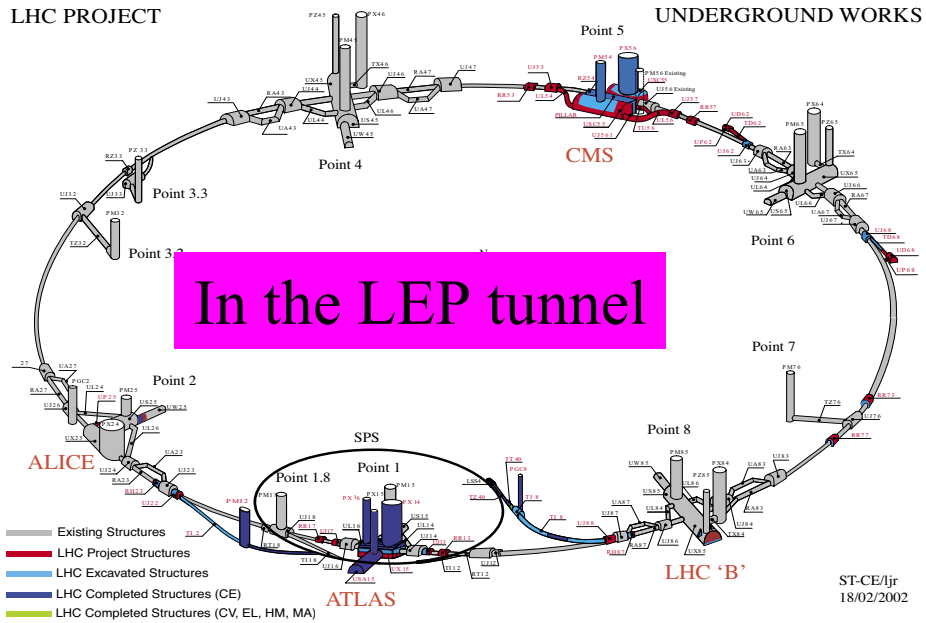
While these experiments did some nice measurements after this, they never again did anything **<u>anywhere near</u>** as exciting as this early discovery.

Outline

- LHC
- The CMS Experiment
- Why an “LHC Physics Center” & “Remote Operation Center” here at FNAL
- Impact of the LPC and ROC
- Future of LPC and ROC

LHC





- pp $\sqrt{s}$ =14 TeV, L=10^{34} cm^{-2} s^{-1}
- crossing rate 40 MHz (25 ns)
- circumference of 27 km (16.8 miles) → *(1h20min by P.T.)*
- **Cost of about $3B?** (depending on accounting method, conversion rate, etc)

LHC & Tevatron

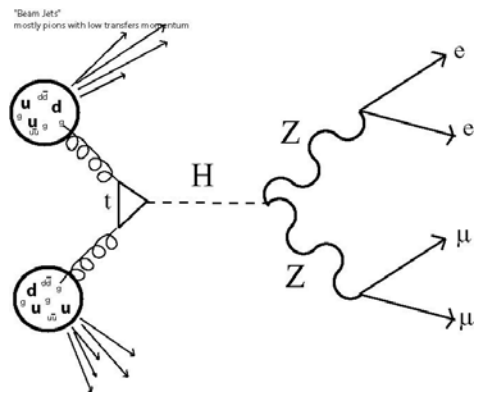
	Tevatron	LHC
Center-of-mass energy	1.96 TeV	14 TeV
Crossing time	396 ns	25 ns
Design luminosity	$3x10e^{32}$ $cm^{-2}s^{-1}$ (record, ave. 1.67e32, Feb.12- cdf=182e30, D0=152e30)	$10e^{34}$ $cm^{-2}s^{-1}$
Number of experiments	2	4

LHC & Tevatron

Particle	Tevatron (ppbar, 0.2 $nb^{-1}s^{-1}$ = 2 fb^{-1}/year, at 1.96 TeV)	LHC (pp, 10 $nb^{-1}s^{-1}$ = 100 fb^{-1}/year, at 14 TeV)
Top quarks	$1x10^4$/year*	$9x10^8$/ year *
W's	$4x10^7$/year	$2x10^{10}$/year
anything	$1x10^{14}$/year	$1x10^{16}$/year

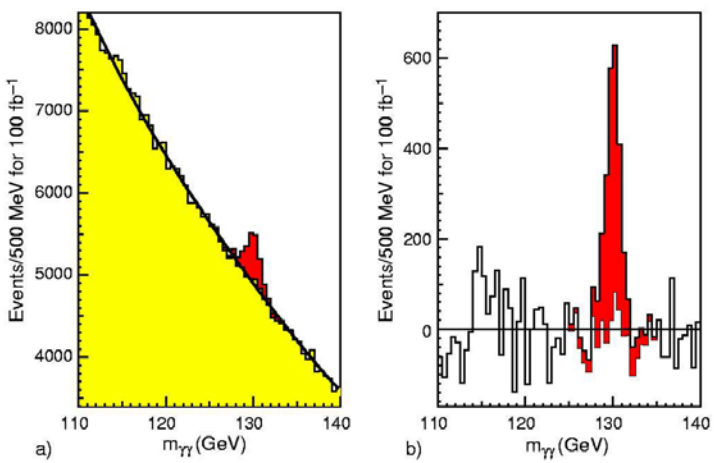
* 1 "snowmass" year = 10^7 s

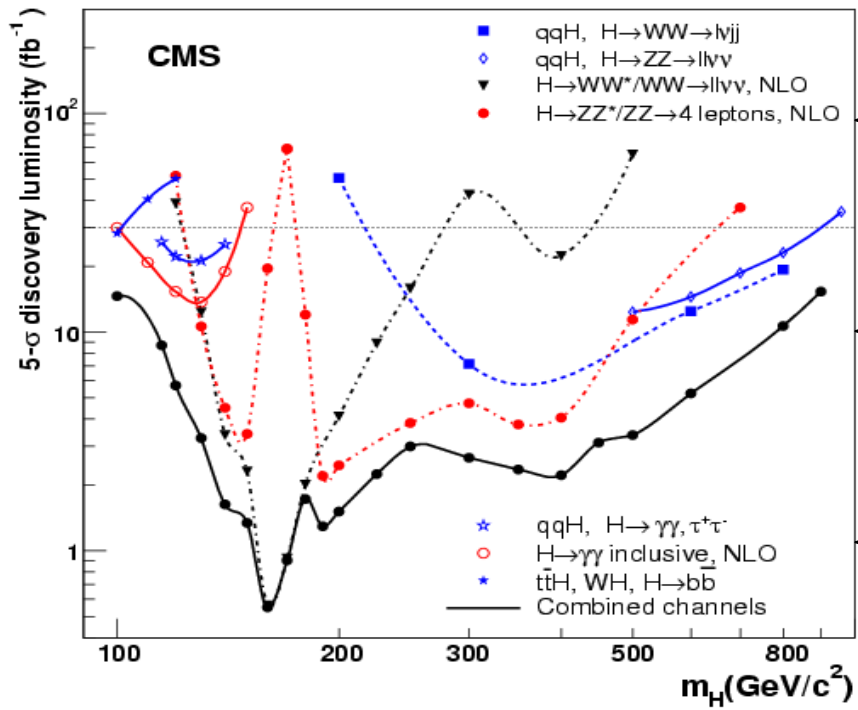
Prospects for SM Higgs at LHC



M(H) >114.4 GeV
direct search
(LEP, Apr.2003)

M(H) < 219 GeV
EW Fits, updated
summer 2005





1 year
design lum

1 year
1/10th lum

1 month
1/10th lum

If we can start up at 1/10th design luminosity, we'll discover a Higgs with mass greater than 130 GeV within 1 year. Will cover entire theoretically allowed range with 1 year of design luminosity.

Physics Goals

- Higgs (SM, SUSY…..)
- SUSY
- Other discoverties
  - Z'
  - extra dimensions
  - compositeness
  - TC
  - leptoquarks
  - 4th generation
  - ……

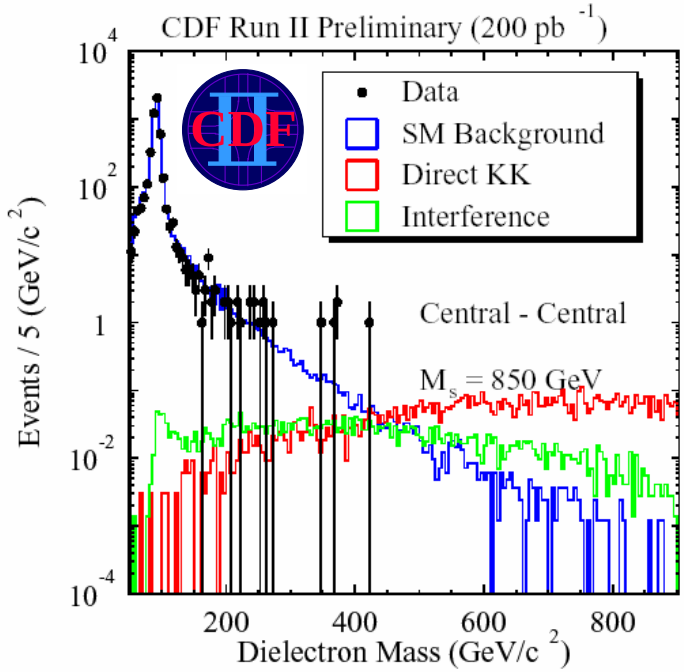
at the beginning with low luminosity runs:

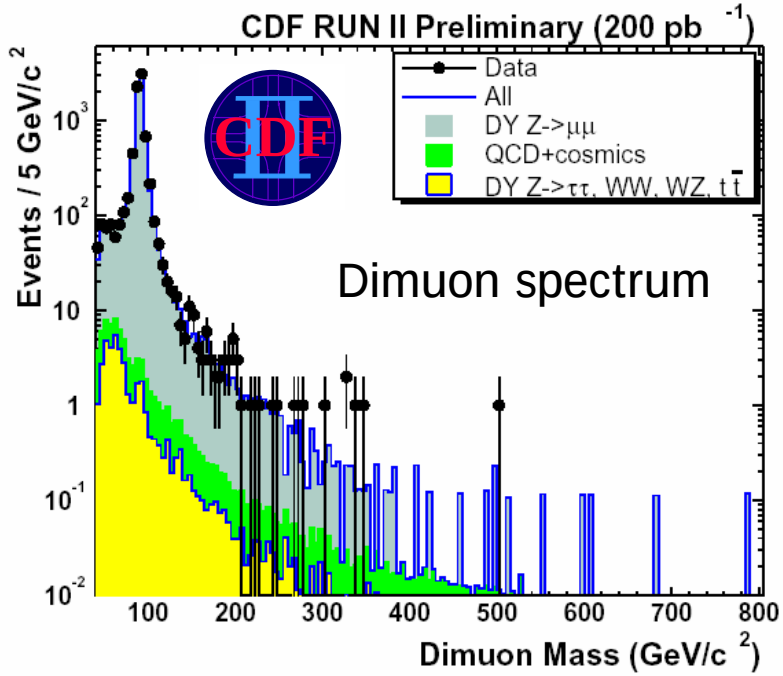
Think of Simpler Signatures with less background, first !!!!!

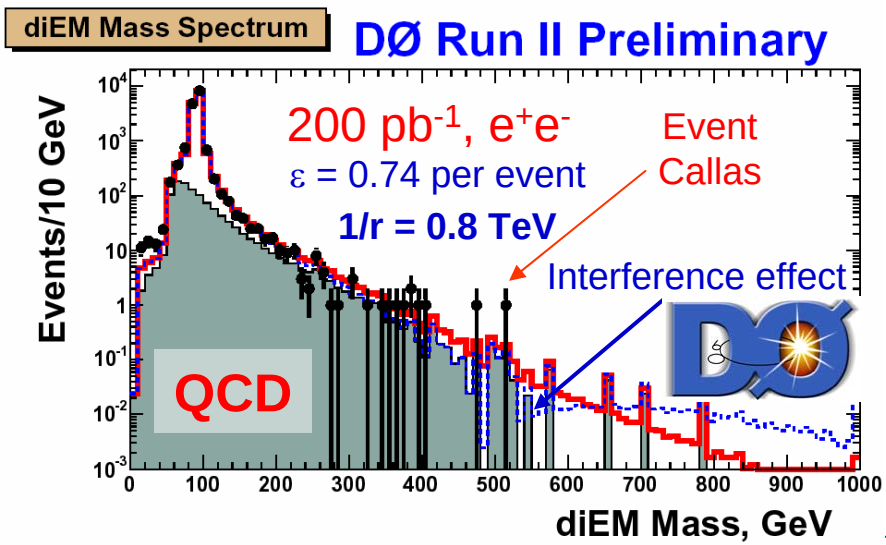
dileptons (ee, $\mu\mu$), diphotons, dijets, etc….

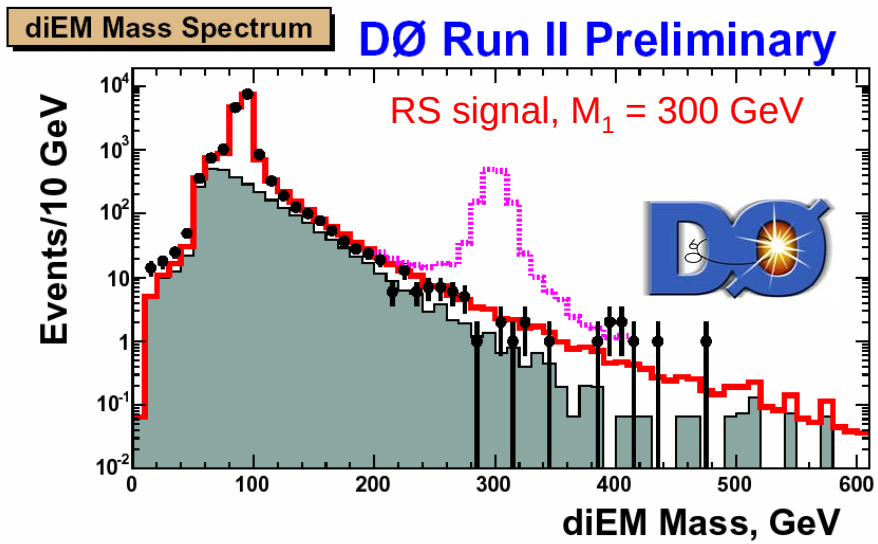
Huge advantage of having calibration peaks

Invariant Mass Spectra









LHC Accelerator Status

- All key objectives have been reached for the end of 2005 (L. Evans).
  - End of repair of QRL, reinstallation of sector 7-8 and cold test of sub-sectors A and B.
  - Cool-down of full sector 8-1.
  - Pressure test of sector 4-5.
  - Endurance test of full octant of power converters.
- Magnet installation rate is now close to 20/week, with more than 200 installed. This, together with interconnect work, will remain the main bottleneck until the end of installation.

Nominal Settings of the Machine

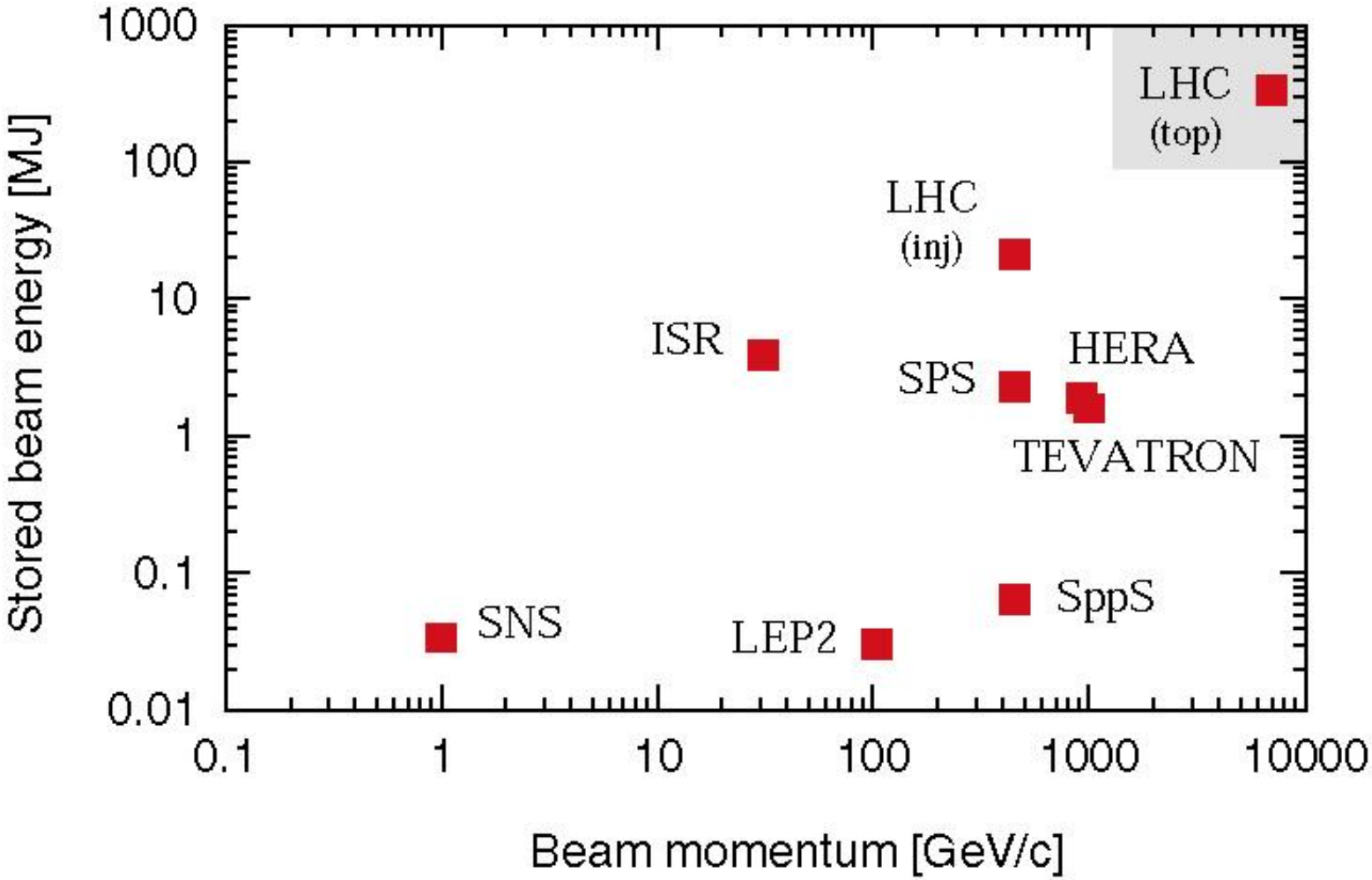
Nominal settings	
Beam energy (TeV)	7.0
Number of particles per bunch	$1.15\ 10^{11}$
Number of bunches per beam	2808
Crossing angle (μrad)	285
Normalized transverse emittance (μm rad)	3.75
Bunch length (cm)	7.55
Beta function at IP 1, 2, 5, 8 (m)	0.55,10,0.55,10

Related parameters	
Luminosity in IP 1 & 5 ($cm^{-2}\ s^{-1}$)	10^{34}
Transverse beam size at IP 1 & 5 (μm)	16.7
Stored energy per beam (MJ)	362

Bailey, Sept CMS week

$10^{34}\ cm^{-2}s^{-1} = 10\ nb^{-1}s^{-1} = 100\ fb^{-1}y^{-1}$ $(1y=10^7 s)$

365 MJ is a lot of energy ……



Proposal for early proton running

Phase I collimators and partial beam dump

1. **Pilot physics run with few bunches**
   - 43 bunches, unsqueezed, low intensity
   - Push performance →156 bunches
2. **75ns operation (936 bunches per beam)**
   - establish multi-bunch operation
   - work on machine parameters (squeeze, crossing angle)
3. **25ns operation with Phase I collimators + partial beam dump**

Phase II collimators and full beam dump

4. **25ns operation (2808 bunches per beam)**
   - Push towards nominal performance

Bailey, Sept CMS week

The LHC Start-Up

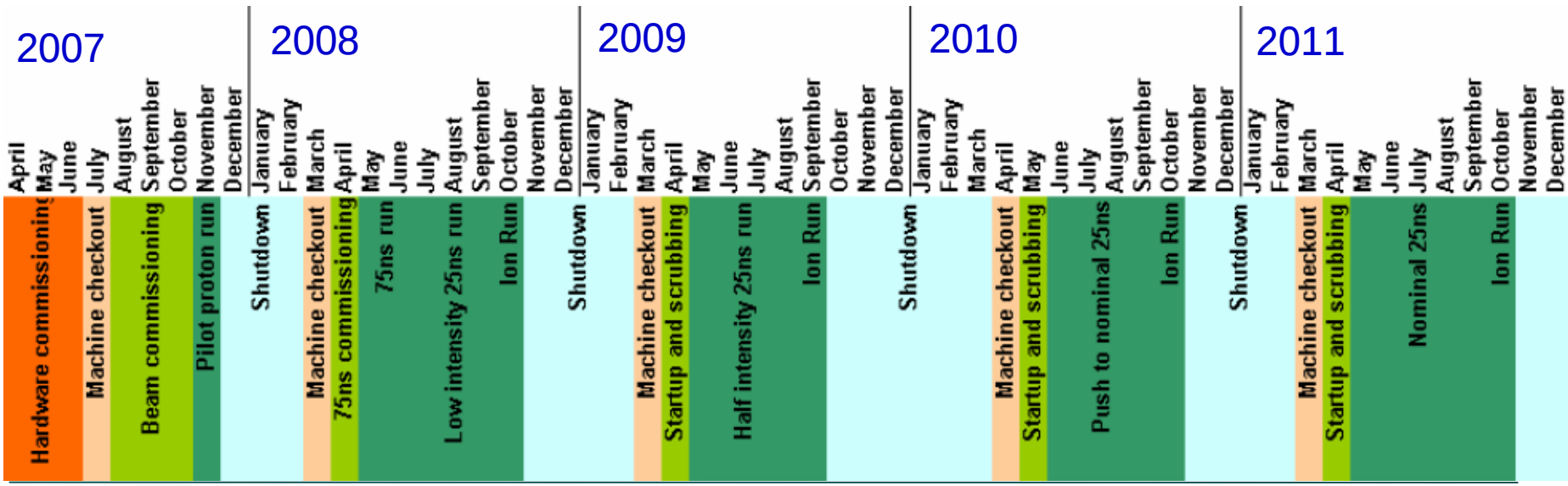
- **Physics running: 140 days/year**
- **ATLAS/CMS running: ~100 days/year**
- **Typical efficiency for physics: 40%**
- **Effective ATLAS/CMS running time/year: ~1000 hours ~ 4 x 10^6 s ~ 4 x 10^{38} cm^{-2} = 4 x 10^{14} b^{-1} = 400 pb^{-1} @ $10^{32}cm^{-2}s^{-1}$**
- **Note that the schedule below [R. Bailey, LHCAC, 6/5/05] is "all goes well" scenario**

Pilot run, 75ns
L~5x10^{30} $cm^{-2}s^{-1}$
$\int$Ldt ~ 20 pb^{-1}

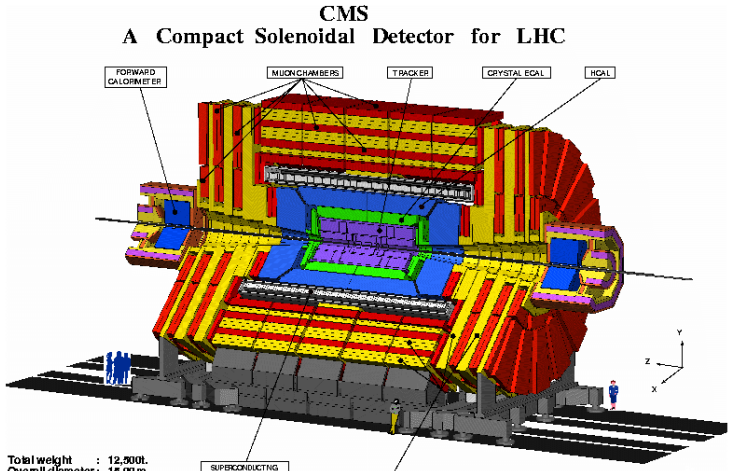
2008, 75/25ns
L~3x10^{32} $cm^{-2}s^{-1}$
$\int$Ldt ~ 1.2 fb^{-1}

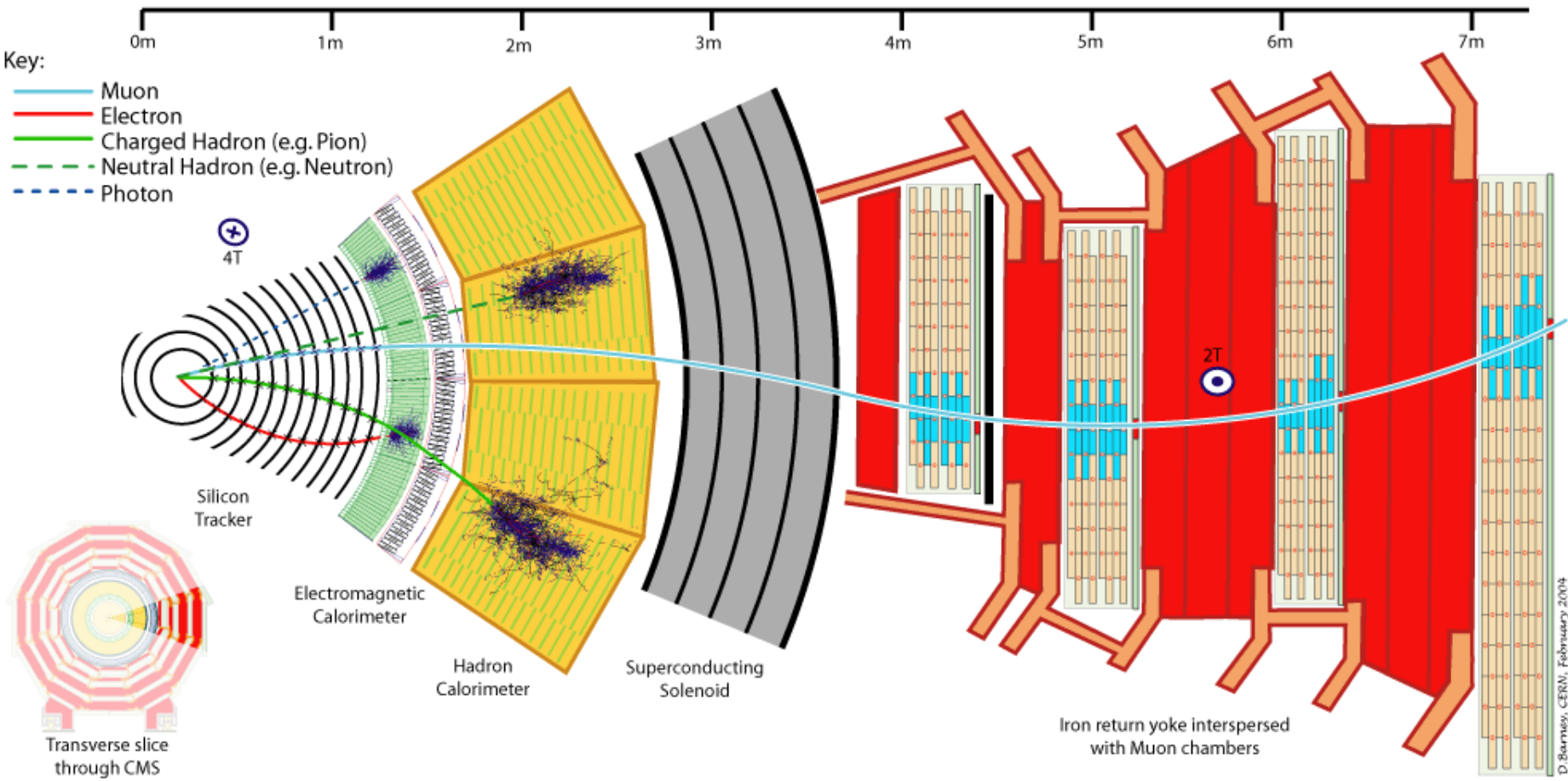
2009, 25ns
L~1x10^{33} $cm^{-2}s^{-1}$
$\int$Ldt ~ 4 fb^{-1}

2010, 25ns
L~1x10^{34} $cm^{-2}s^{-1}$
$\int$Ldt ~ 40 fb^{-1}



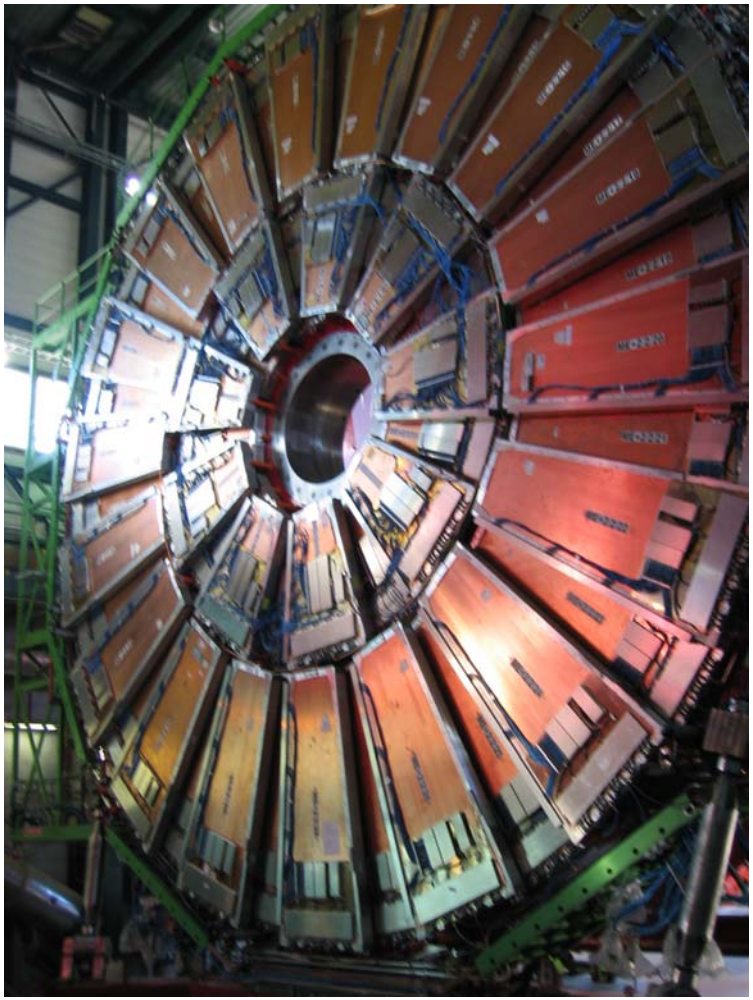
CMS

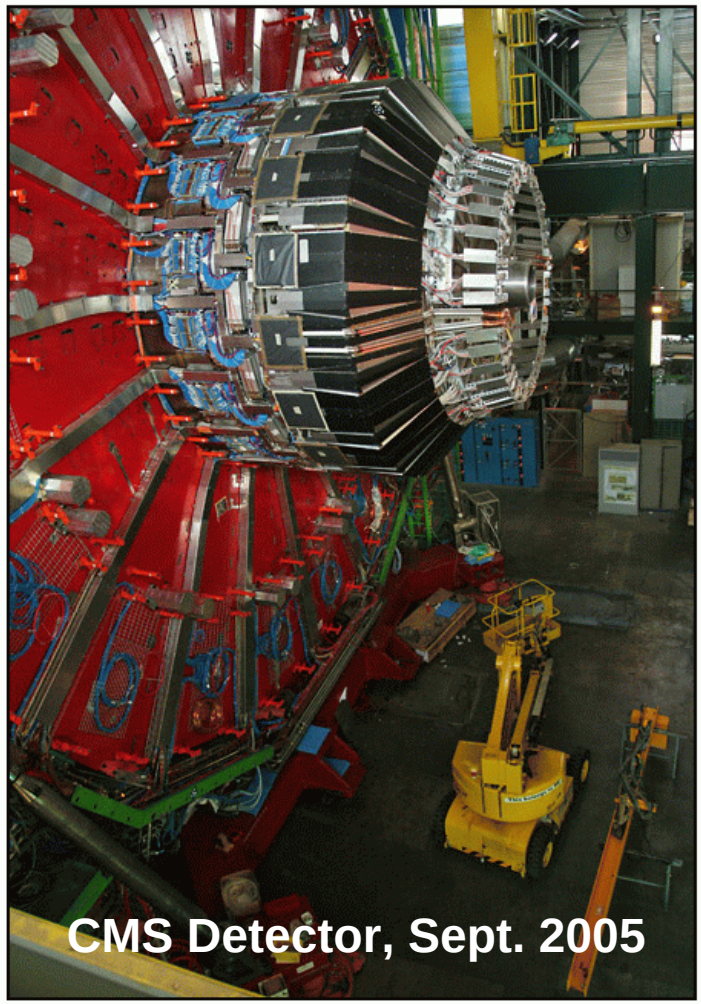

CMS
A Compact Solenoidal Detector for LHC
FORWARD CALORIMETER
MUON CHAMBERS
TRACKER
CRYSTAL ECAL
HCAL
SUPERCONDUCTING
Total weight : 12,500t.


0m
1m
2m
3m
4m
5m
6m
7m
Key:
Muon
Electron
Charged Hadron (e.g. Pion)
Neutral Hadron (e.g. Neutron)
Photon
4T
2T
Silicon Tracker
Electromagnetic Calorimeter
Hadron Calorimeter
Superconducting Solenoid
Iron return yoke interspersed with Muon chambers
Transverse slice through CMS
D.Barney, CERN, February 2004

CMS

It's real!



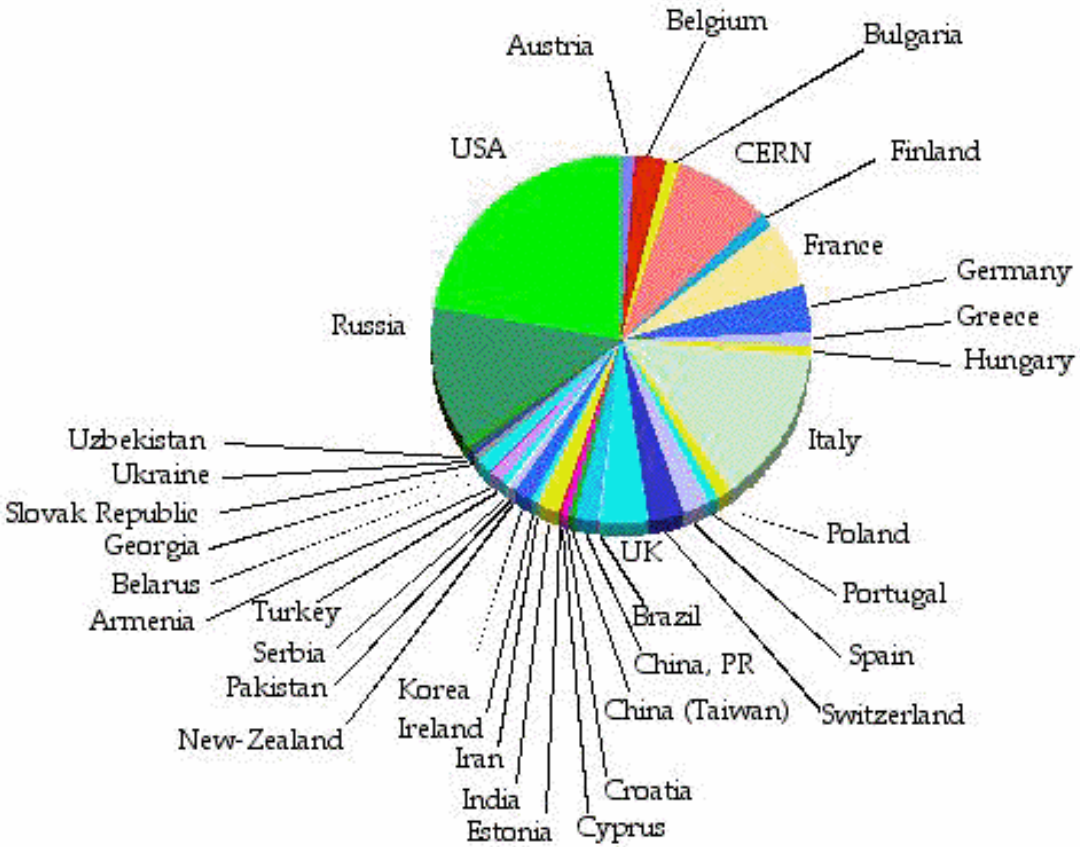


CMS Schedule 06-07

Magnet closed:	: Apr 06
Magnet test/cosmic challenge: (MTCC)	: Apr-Jul 06
EB+ installation	: Jul 06
USC ready for crates:	: Feb-Mar 06
UXC floor shielding & cable chains installed	: April 06-Jun 06
HF lowering:	: May 06
YE+/YB+ cable chains cabled	: June 06
YE3+ lowering start	: July 06
UXC ready for crates	: Jul 06
First connection to USC	: Jul 06
EB- installation	: Nov 06
Tracker installation	: Dec 06
ECAL/Tracker cabling complete	: Feb 07
Heavy lowering complete	: Feb 07
BPix and FPix:	: Nov 07

CMS ready to close 15 June 07

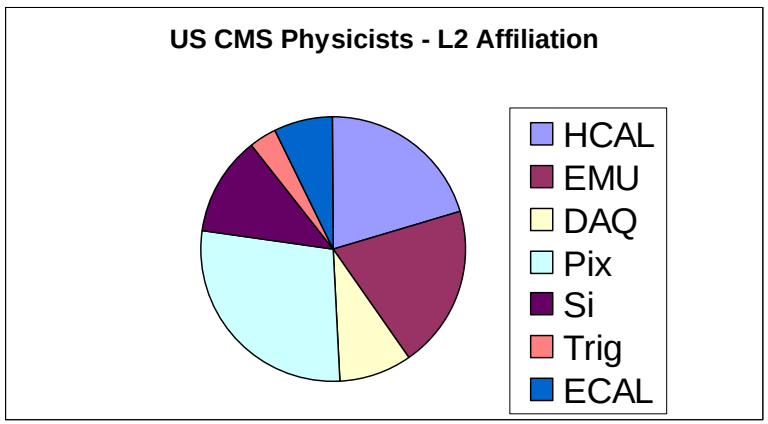
CMS Collaboration



1935 Physicists and Engineers
36 Countries
152 Institutions

Ordered by size: USA (525 collaborators), Italy (398), Russia (326), CERN (204), France (146), UK (117), Germany (116)

USCMS



By size (physicists)

FNAL: 58

Florida: 21

UCLA: 15

Davis: 13

MIT: 13

Rochester: 13

Rutgers: 11

Tiered System for Data Mgmt

T0 at CERN

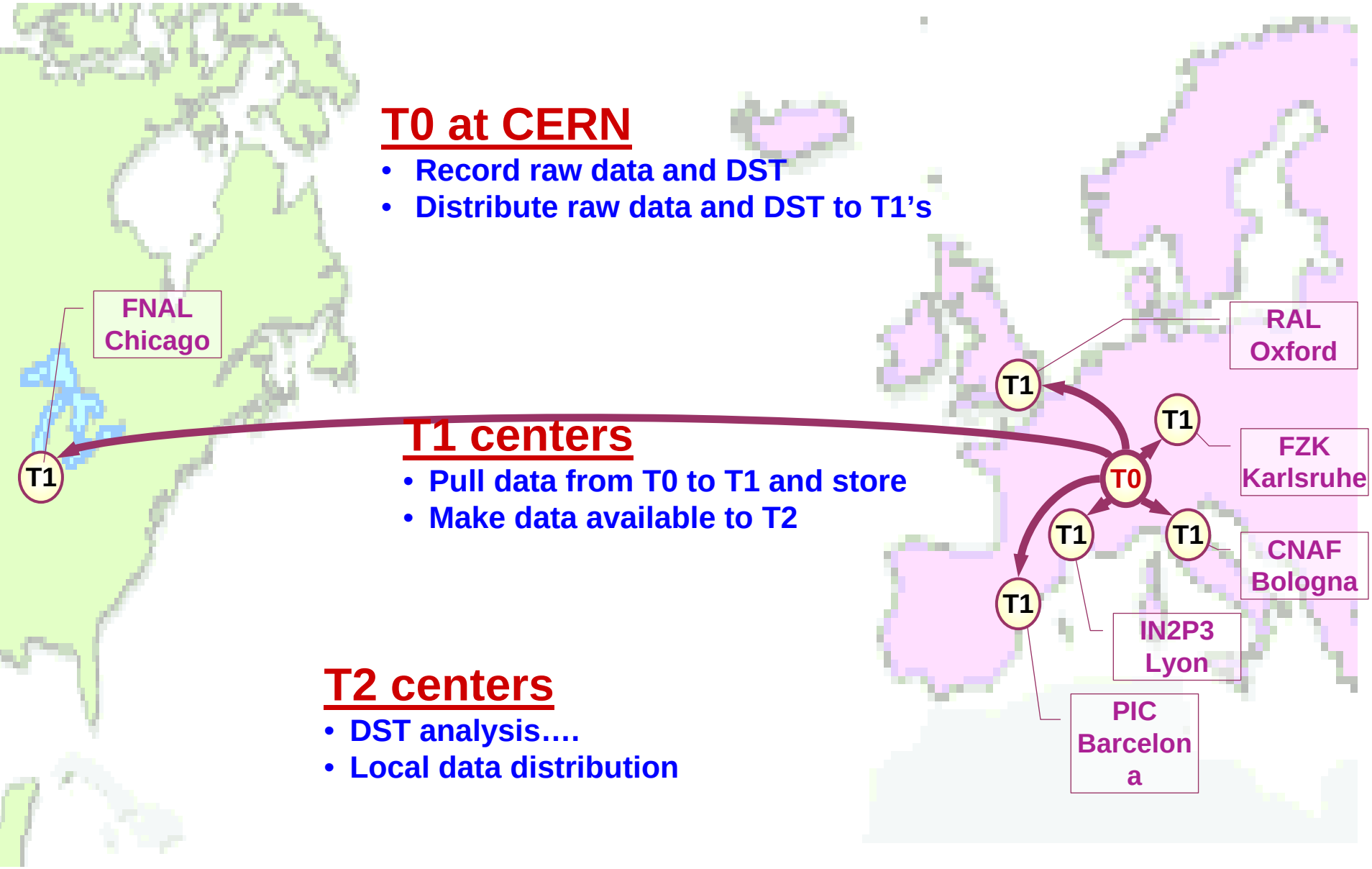
- Record raw data and DST
- Distribute raw data and DST to T1's

T1 centers

- Pull data from T0 to T1 and store
- Make data available to T2

T2 centers

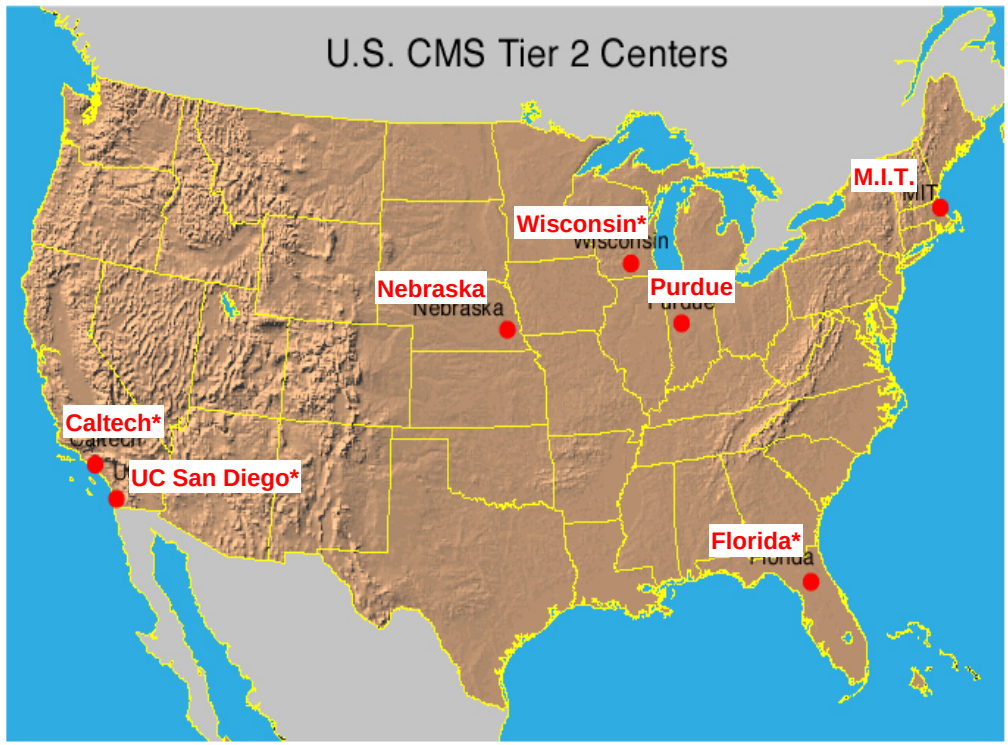
- DST analysis….
- Local data distribution



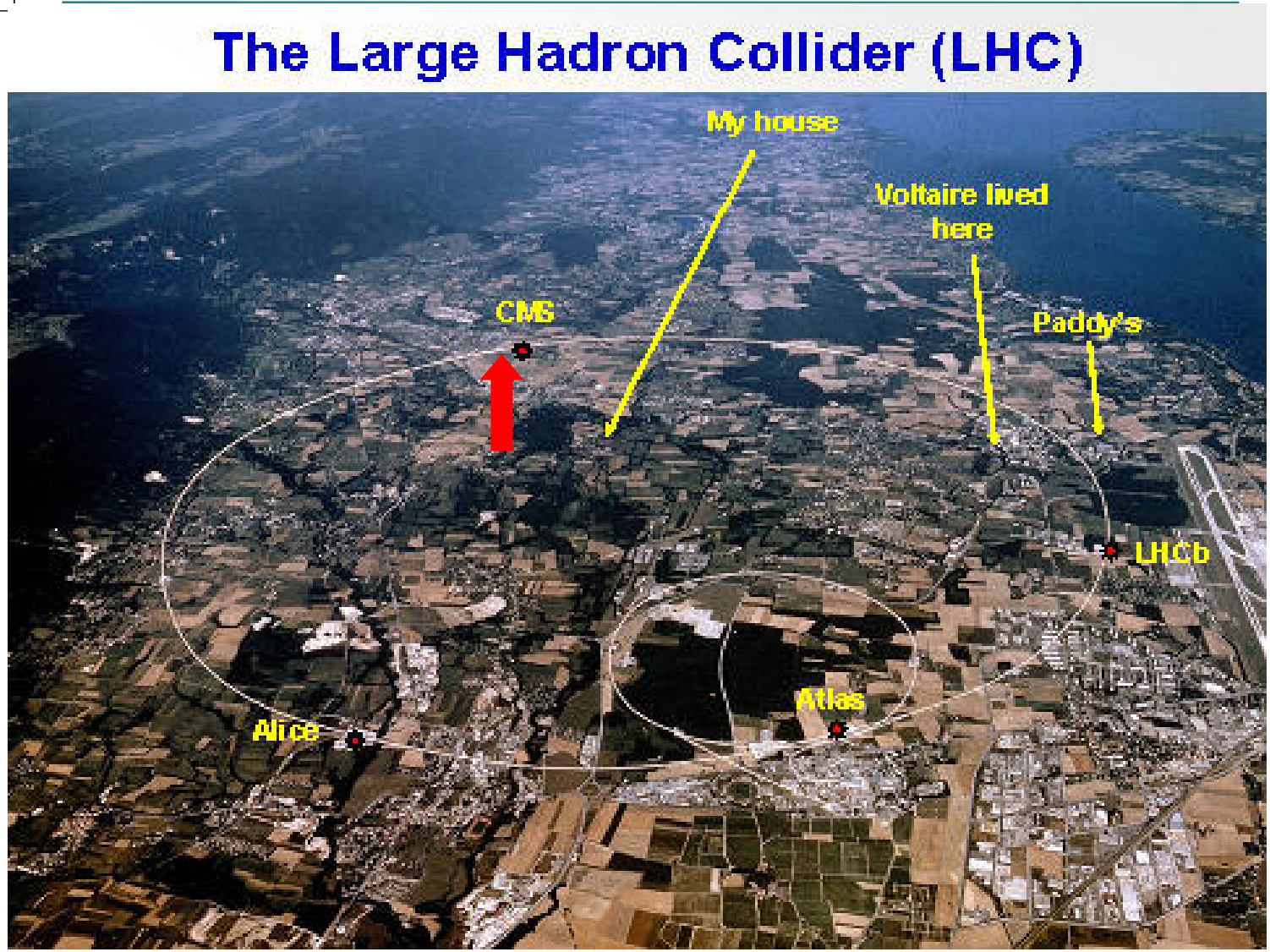
Computing in the US

T0 at CERN, T1 at Fermilab as US CMS national center ("super" Tier 1 with twice the resources of other Tier1s),

T2 at UCSD, Caltech, UFlorida, Wisconsin, MIT, Nebraska and Purdue as regional US CMS centers. (+ Brazil + China)

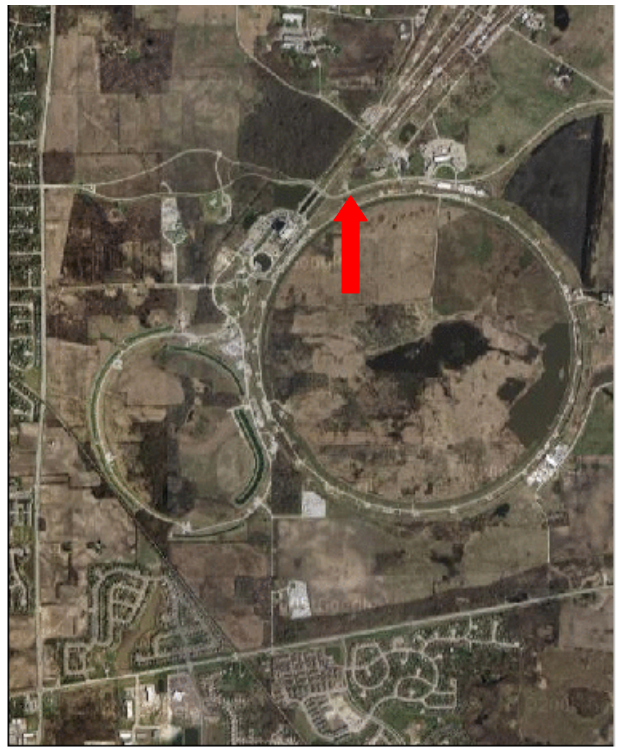


Why an LPC?



Why not we all at Point-5?

Why at the Trailers?



This building is orange, looking from the side

Why the Trailers?

- to do shifts, hear the alarms, smell smoke
- to check and fix hardware
- to run software and get information which <u>can not</u> be accessed from the outside world

or can we?

Why the Trailers? (Cont.)

- to keep informed about the status of the detector
- to have access to various subsystem experts
- to have access to software experts
- to give talks and establish a reputation that could lead to the next job
- ……..

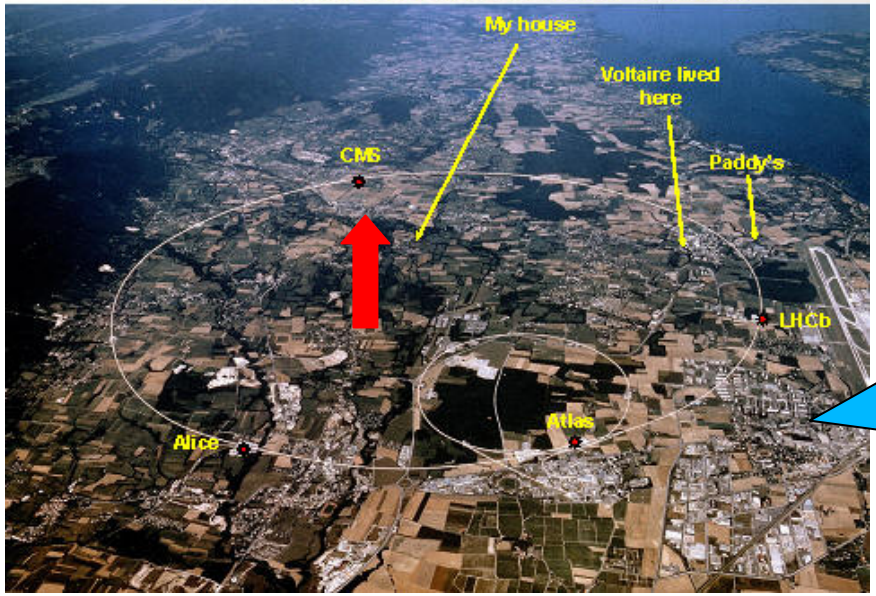
Why the Trailers? (Cont.)

We, then, stop and think each of above reason and question ourselves:

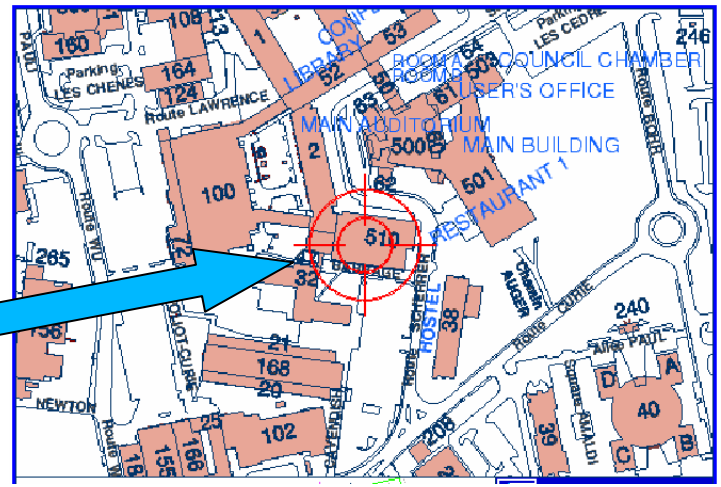
Could we create a place (LPC&ROC) which can accomplish most of above, but located not right at the experiment?*

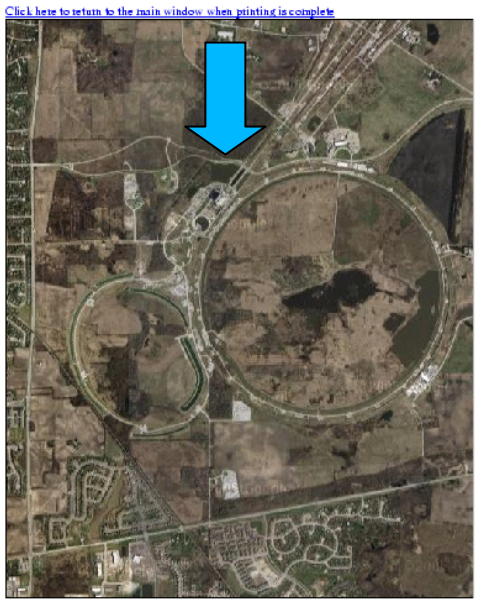
* It is terribly important to recognize how much work (people with knowledge and skills) it takes to run a large experiment at the site of the experiment and work tightly together as a collaboration of a single experiment working remote should not contradict, but complement..

Why an LPC?



Gmaps Pedometer http://www.gmap-pedometer.com/





What is it that we really need?

LPC Founded Feb 2004

Located on the 11th floor of the FNAL high rise, the purpose of the LPC is to ensure the US gives the strongest possible assistance to international CMS in software preparations for Day 1 and to enable physics analysis from within the U.S.

- a critical mass (clustering) of young people who are actively working on software (reconstruction, particle identification, physics analysis) in a single location (11th floor of the high rise),

- a resource for University-based US CMS collaborators; a place to find expertise in their time zone, a place to visit with their software and analysis questions,

- a brick-and-mortar location for US-based physics analysis, with such physical infrastructure as large meeting rooms, video conferencing, large scale computing, and an “espresso machine” for informal discussions of physics.

ROC (Remote Operation Centre)

We need data, information, people, facility and support to do:

support taking the good quality data

monitor CMS data as real time as possible, feed back findings to the CMS control room to support the high efficiency/quality data taking.

→ monitoring shift operation at ROC is expected.

knowing the quality data taken

help to record/catalog the data quality findings in an orderly manner to aid speedy/reliable offline analyses.

(archive/access of information of the Data quality tied with the luminosity information)

note1- needless to say: work at the ROC must be well coordinated with work at CERN.
note2- considering resources available, we think that Fermilab is a well suited place to do this.
note3- Physical location of the ROC is WH11 now, but it can be elsewhere (i.e. WH01, etc….)

LPC and ROC

- physical facilities
- people and organization
- impact
- future plans

LPC (Dec. 2004 ← move-in-date)

The same space, not so long ago… middle of renovation ... summer 2004

CMSSW tutorial, 12th Jan., '06
> 70 Grad. Students attended.

Conf. Room (SunRise)

Resources: 11th Floor

- **Meeting Rooms/Video Conferencing/Internet**
- **terminals/printers/office supplies**
- **secretarial and computer support**
- **Coffee machines**
- **Space and Lockers for transient use**

Remote operations center

ROC

Meeting rooms

Transient space

Room for 60 transients from Universities plus 60 permanent residents

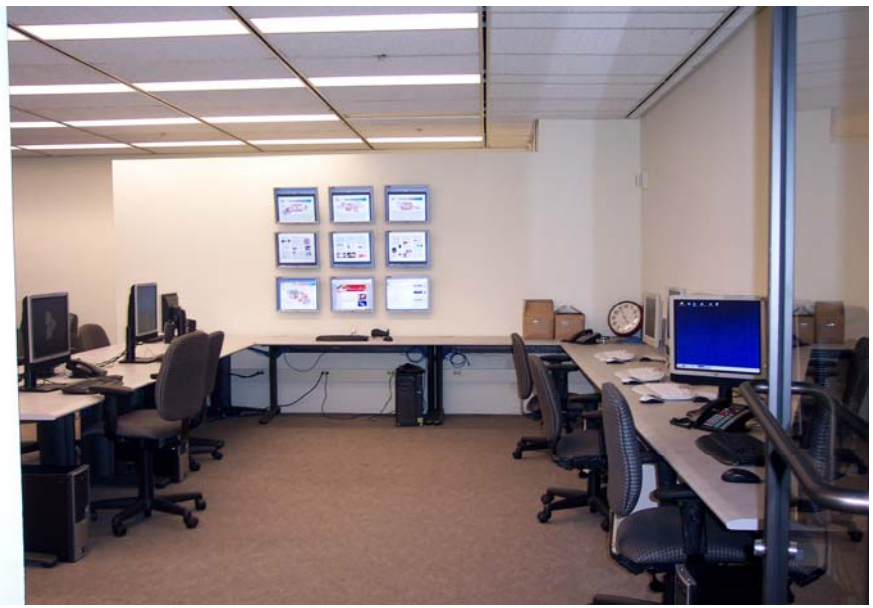
Of the 60 permanent slots, 25% are University physicists.

ROC at WH11

July '05

Aug. '05

15th Sept. '05



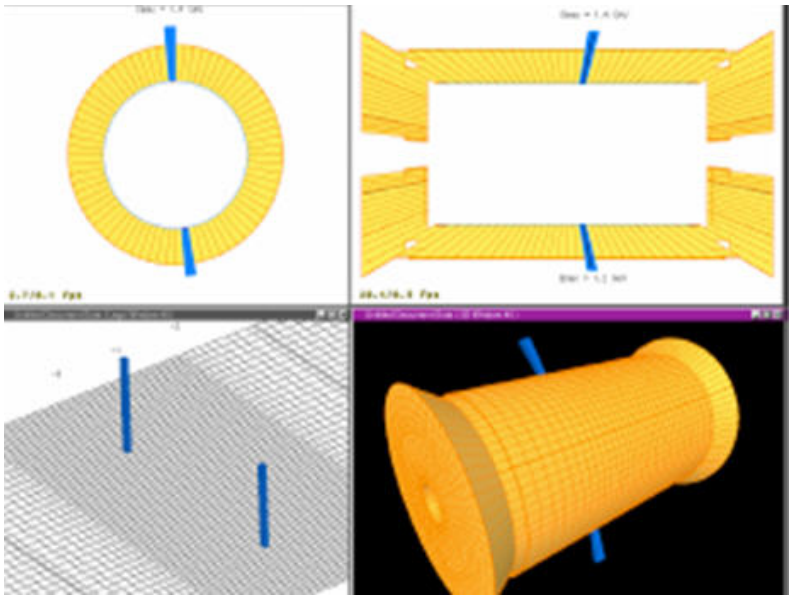
NOW

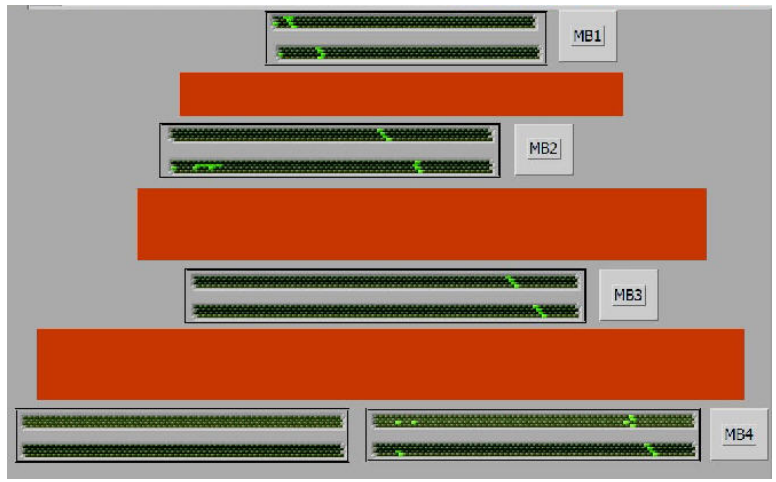
ROC at WH11

The facility is basically complete.

We now are concentrated on filling in the ‘CONTENTS’ to do the job!

We've got data!

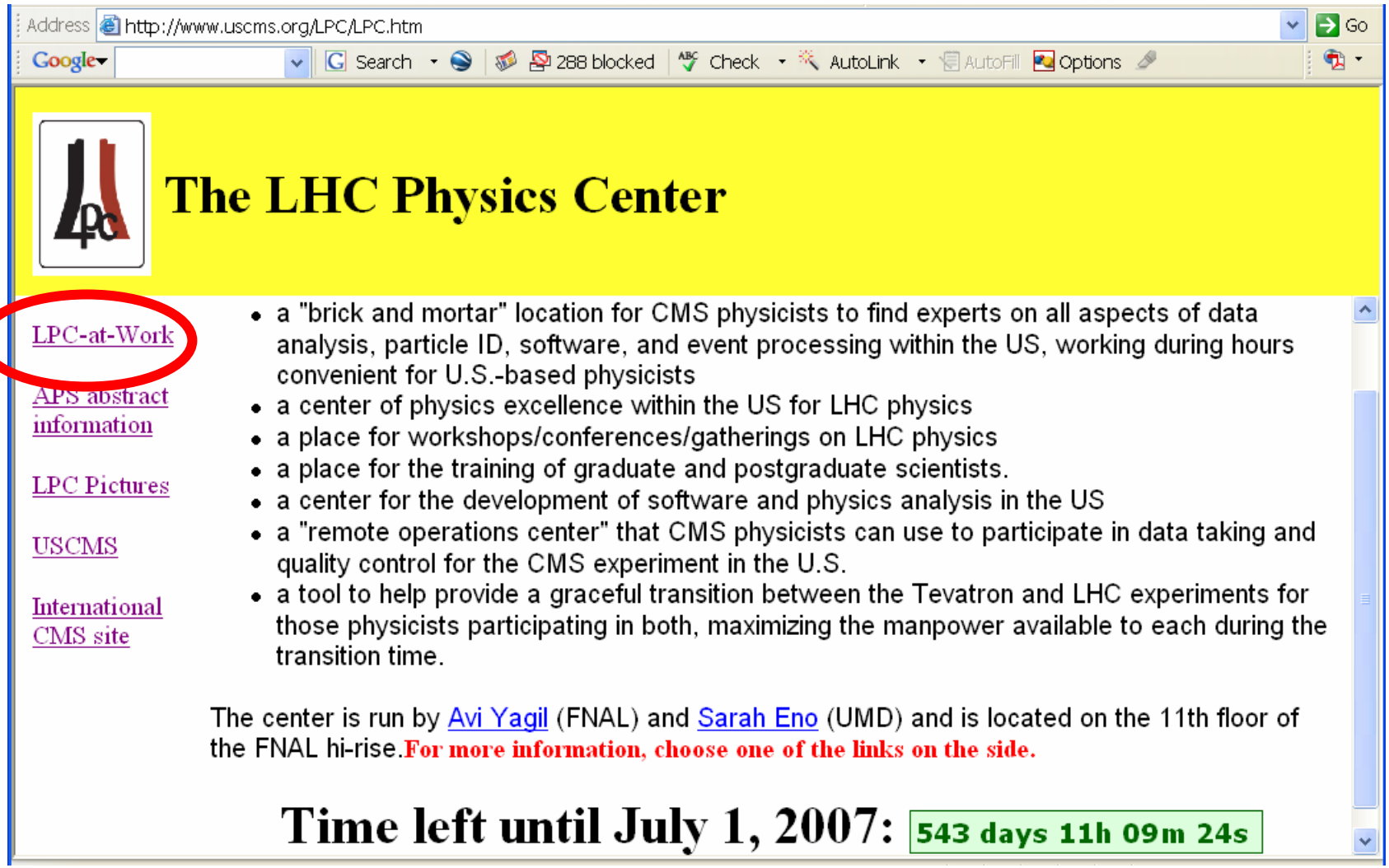




(working in conjunction with the FNAL CMS Tier1 team)

Web Information

http://www.uscms.org/LPC/LPC.htm



Web

Address http://www.uscms.org/LPC/lpc-at-work.htm

Google Search 292 blocked Check AutoLink AutoFill Options

APS Abstract Information NEW!

Meetings	Resources	Communication
All US CMS Meetings Workshops	meeting room information and schedules Computing at the LPC FNAL Remote Operations Center Theory Connection	• mailing lists • LPC Agenda Server • USCMS Agenda Server • LPC Document Database • Private Web Pages
For Newcomers	**Working Groups**	Other Useful Links
new to the LPC?	Working Groups Information on LPC cosmic slice test particpation	• Library of Talks • various logos for your talks • LPC History & Documents • Advisory council • Roommate Connection • US CMS Jobs • Other Useful Links

ROC home page

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop http://uscms.org/LPC/lpc_roc/index.html Search Print

Home Bookmarks Members WebMail Connections BizJournal SmartUpdate Mktplace

LPC - ROC (Remote Operations Center)

The ROC (FNAL Remote Operations Center) is located on the northwest corner of the 11th floor of the FNAL high rise. It provides remote access to data for the test beams and calibrations. Also we are planning and working towards monitoring of the MTCC and real data-taking. The ROC is run by Kaori Maeshima (maeshima@fnal.gov).

- There are log books for the various test beam efforts. These can be found at this link.
- Information about data sets at FNAL of current calibration and cosmic run is available.
- Preliminary version of "Task list" by Andris can be found at this link.
- There is a committee called LHC@FNAL examining a remote operation center for combined LHC accelerator and CMS for future. You can learn more about this effort at this link.

ROC					
ROC meetings	ROC mailing list	ROC Task List	HCAL data at FNAL	LHC@FNAL	MTCC@ROC
slice-test info. (yurii/Nick)	HCAL DQM				

CMS							
Trigger/DAQ	EvF	DQM	logbooks/data sources	IGUANA	CMS web home	CMS agenda	CMSDOC

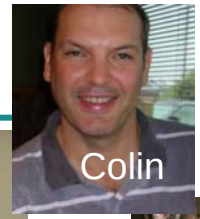
US CMS			
US CMS	Software & Computing	Construction/M & O	LPC Home

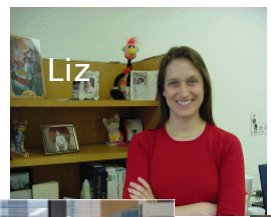
Questions, comments and requests should be sent to the alstone@fnal.gov
Last modified: Thu Feb 9 17:23:07 CST 2006

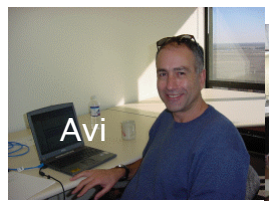
More than just furniture…

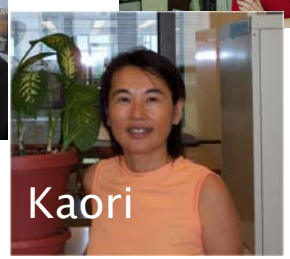
LPC: Run by Avi Yagil, Sarah Eno

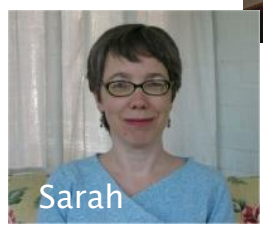
- **offline/edm:** Liz Sexton-Kennedy (FNAL), Hans Wenzel (FNAL)
- **tracking:** Kevin Burkett (FNAL), Steve Wagner (CO)
- **e/gamma:** Yuri Gershtein (FSU), Colin Jessup (Notre Dame)
- **muon:** Eric James (FNAL) , Michael Schmitt (Northwestern)
- **jet/met:** Rob Harris (FNAL), Marek Zielinski (Roch)
- **simulation:** Daniel Elvira (FNAL), Harry Cheung (FNAL)
- **trigger:** Greg Landsberg (Brown) , Kaori Maeshima (FNAL)
- **Physics:** Boaz Klima (FNAL)











ROC kind of people….

ROC: run by Kaori Maeshima

Michiel Sanders, Wade Fisher, Yurri Maravin, Alan Stone, Mike Weinberger, Dave Toback, Nikoli Terentiev, Zongru Wan, Sarah Eno, Nick Hadley, Andris Skuja, Sung-Won Lee, Kaori Maeshima, Bill Badgett, LHC@FNAL people(Patty McBride, Erik Gottschalk, Kurt Biery,

Alan Stone - the ROC man working full time for the ROC since beginning of this month.

and many other people support us…

Yujun Wu, Jo Bakken, Lothar, Ian, Liz, Hans, Patrick, Tony, Ichiro, Christos, Emilio, Austin, Laza, and many more….
thank you……

ROC and LHC@FNAL

- The LHC@FNAL includes LHC accelerator operation.
- The proposed location of the LHC@FNAL operation is the ground floor of WH, which is a good location for the public relation.
- The LHC@FNAL committee was formed about 1 year ago, since then:
  - prepared a requirement document (available since last summer)
  - site visits of 'control rooms' (fall 2005) (summary attached) .
  - just submitted wbs request for LHC@FNAL (Jan. 2006).
- The ROC is a part of the approved US-CMS plan, and the ROC room at WH11 is done. Current effort of the ROC is "to Fill the CONTESNTS with something useful !!". This will be a long-term on-going effort.
- All the experience and work which will be done for the ROC will not be wasted when/if LHC@FNAL gets approved and built. If we can ROC at WH11, we can also ROC from WH01.

http://uscms.org/LPC/lpc_roc/index.html ← ROC home page

http://cd-amr.fnal.gov/remop/remop.html ← LHC@FNAL home page

Inform/Educate

- weekly All USCMS meeting Fridays
- 5 well-attended sessions of CMS 101, 4 successful Tevatron/LHC workshops, 4 well-attended sessions of "software tutorials", tutorials on software tools
- a mini-workshop on LHC turn-on physics, a workshop to initiate LPC cosmic slice effort, hosted the international CMS "physics" week, a US CMS Meeting, a 2-week mini summer school , a "January Term" that gives 1st and 2nd year graduate students an in-depth introduction to the detector, many detector sub-system workshops, a workshop to initiate the "physics" working group

Summer '05

Over 50 University-based physicists visited the LPC for at least 2 weeks this summer.

- Summer school
- CMS 101
- tutorials

J-Term Intro to CMS at LPC

Address http://www.uscms.org/LPC/workshops.htm

Google Search 292 blocked Check AutoLink AutoFill Options

J-Term at the LPC

Want to learn more about the physics potential of the LHC? Want to learn everything there is to know about the CMS detector? Want a detailed introduction to the new software framework, CMSSW? Come to J-Term at the LPC. The list of registered attendees can be found here.

Jan 10, 2006 Jan 11, 2006 Jan 12 2006. Jan 13, 2006

The theory session is on the afternoon of Jan 11. Chris Quigg has recommended reading for students attending this session

- E. Eichten, I. Hinchliffe, K. Lane, and C. Quigg, Supercollider physics, Rev. Mod. Phys. 56, 579 (1984).
- C. Quigg, Nature's Greatest Puzzles, http://arxiv.org/abs/hep-ph/0502070.
- F. Gianotti and M. Mangano, LHC physics: the first one--two years, http://arxiv.org/abs/hep-ph/0504221.
- K. Wilson, Some Experiments on Multiple Production, CLNS-131 (1970) http://lutece.fnal.gov/Papers/KenWilson.pdf

On the afternoon Jan 12, 2006, there will be a tutorial on CMSSW, run by Jeremy Mans. To participate in this tutorial, to be held in the LPC transient area, you will need a UAF account (http://www.uscms.org/SoftwareComputing/UserComputing/GetAccountFermilab.html) We prefer you use your own lap top, but there are a limited number of public terminals available. Contact Jeremy Mansif you would like to reserve one of these (jmmans@fnal.gov)

Attended by over 70 1st and 2nd year grad students!

All US CMS Meeting

- (almost) every Friday 2:30 PM FNAL time
- well-attended both in person and via vrvs

Typical Agenda

- News from Dan
- News from Ian/Jon
- one topical talk

May 13 EDM report – Liz Sexton-Kennedy
May 20 sLHC – Wesley Smith
May 27 e/gamma – Yuri Gerstein
Jun 3 trigger – Sridhara
Jun 10 jet/met – Rob Harris
Jun 17 (cancel due to cms week?
Jun 24 (cancel due to cms annual review?)
Jul 1 The CMS Forward Pixel Project – John Conway
Jul 8 Making contact with theorist – Steve Mrenna
Jul 15 muon alignment – Marcus Hohlmann
Jul 22 LPC muon group – Eric James
Jul 27 due to Dan's lecture series
Aug 5 Authorship list requirements – Dan Green
Aug 12 Magnet studies – Rich Smith
Aug 19 Data bases for Cosmic Ray test – Lee Lueking
Aug 26 luminosity preparation – Dan Marlow
Sep 2 cosmic analysis in the U.S. – Yurii Maravin
Sep 9 cosmic workshop
Sep 16 ROC – Kaori
Sep 23 CMS week
Sep 30 Simulation Certification Project – Daniel Elvira
Oct 7 physics workshop
Oct 14 (HCAL meeting at FNAL) MET – Richard Cavanough
Oct 21 Calorimetry Task Force – Jeremy Mans
Oct 28 HCAL calibration – Shuichi Kunori
Nov 4 P420 Proposal – Mike Albrow
Nov 11
Nov 18 Tier 2's for me and you – Ken Bloom

Impact

So….., but what have you DONE?

Event Data Model

FNAL, Cornell

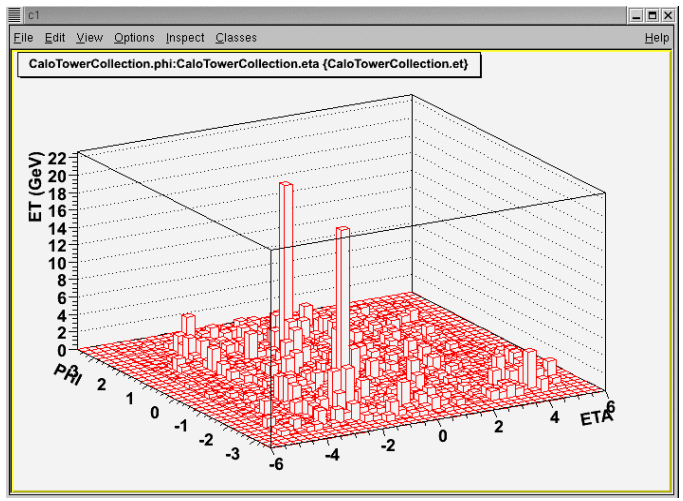
Ease of accessing data / changing calibrations / updating geometry / using computing → speed for results on Day 1

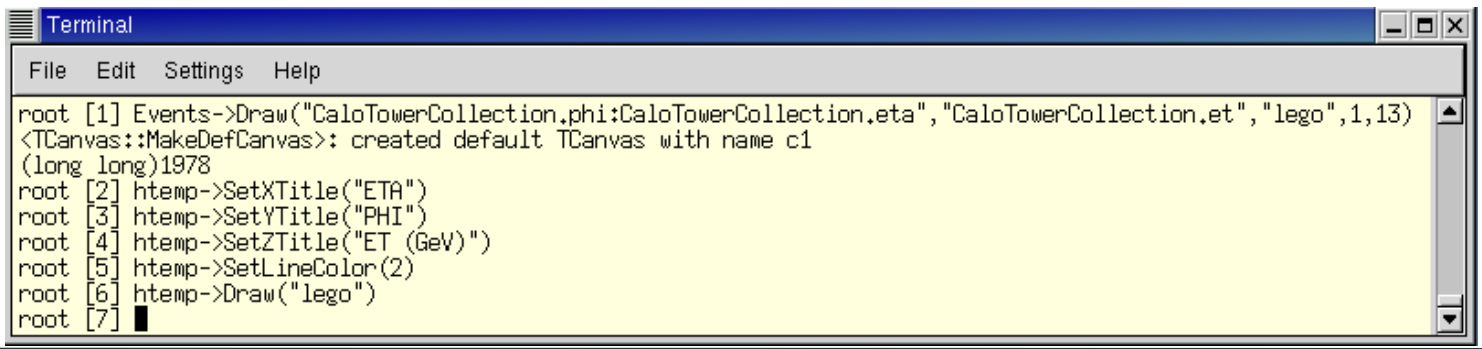
Tevatron experts on Event Data Model (EDM) available to bring their experience with a working system to the CMS effort and to review and provide scientific leadership in the redesign of CMS EDM, working closely with others in CERN/Italy/France

Example

Event Data Model

- working with CMS EDM primary author, began review in early November, 2005
  - presented to the collaboration in Jan 11, 2005
  - approved in Feb 9, 2005
  - early prototype work demonstrated during March 2005 CMS week
  - first implementation delivered June 2005
  - beginning 2006: all major components of redesign are in place; now in incremental improvements/maintenance phase





Algorithms

- wrote the jet code for the new framework
- visitor wrote MET code in coordination with the jet code authors
- wrote one of the two main tracking algorithms in CMS

Event Data Model

Ready for the magnet test/ cosmic challenge

Address http://agenda.cern.ch/fullAgenda.php?ida=a057880

Google Search 309 blocked Check AutoLink AutoFill Options

Thursday 12 January 2006

09:00	**Computing Basics within CMS** (30') (transparencies)	Gutsche, O. (FNAL)
09:30	**Introduction to CMSSW** (30') (transparencies)	Sexton, L. (FNAL)
10:00	**CMSSW Calorimetry** (30') (transparencies)	Mans, J. (MN)
10:30	**CMSSW Tracking** (30') (transparencies)	Oliver Gutsche (FNAL)
11:00	**CMSSW Muons** (30') (more information)	Alex Tumanov (Rice)
11:30	LUNCH	
14:00	**CMSSW Tutorials** (3h00')	Mans, Jeremy (MN)

The tutorial will be held in the transient area of the LPC on the east side of the 11th floor.

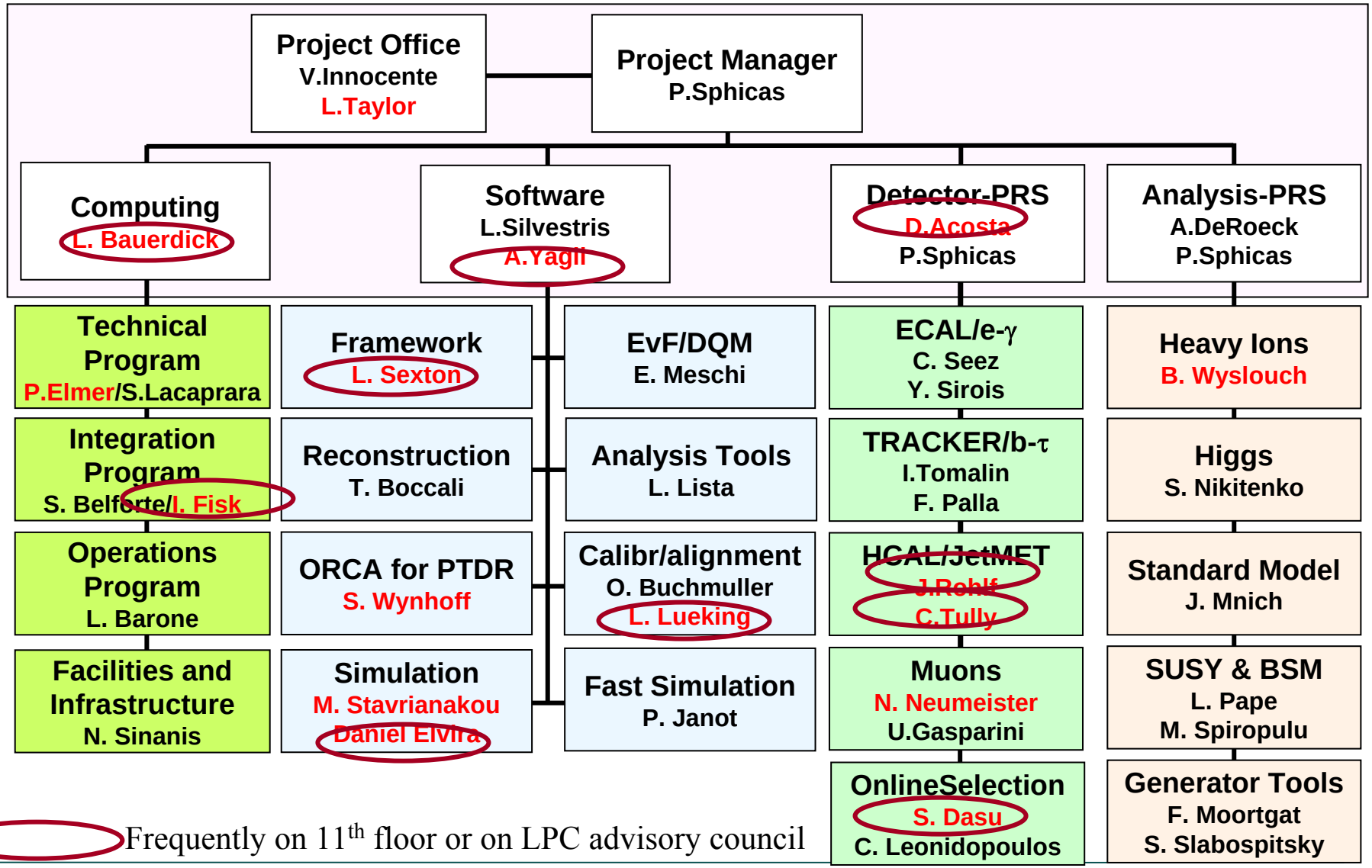
- **Instructions for the Tutorial** (15') (document)

Done Internet

Other LPC "Firsts"

- Trigger group (Dasu) → CMS online selection group
- Simulation Group (Elvira & Klima)
- ROC (Maeshima) → CERN CCAR concept

Integration with CMS "CPT Project" for Computing, Software, Physics Reconstruction and Selection



Frequently on 11th floor or on LPC advisory council

PHSICS TDR

CERN/LHCC 05-???
CMS TDR 8
** Final Date here **

CMS Physics

Technical Design Report

Volume I:
Software and Detector Performance

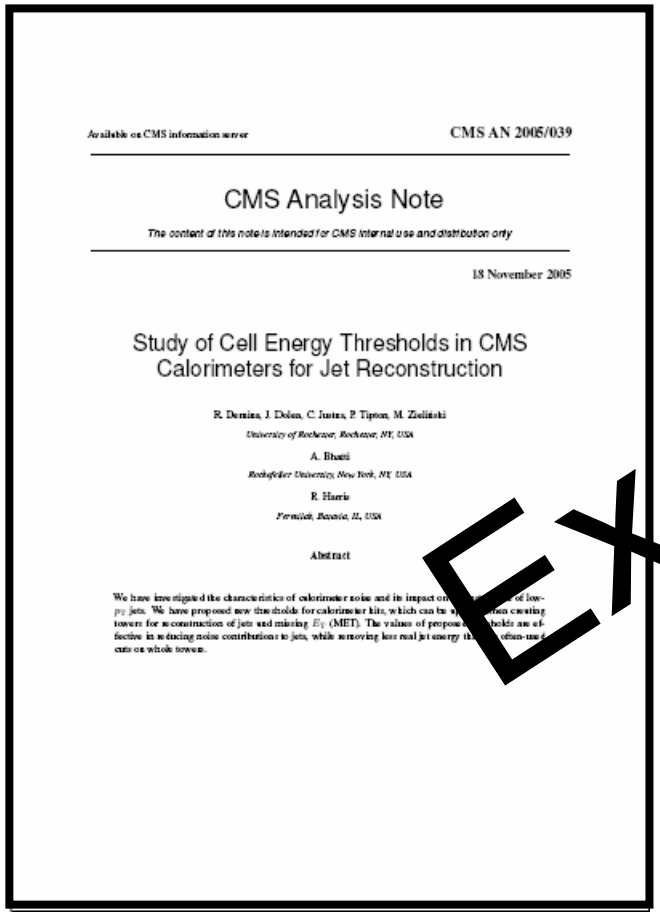
Also available at:
http://FIXME

*** Draft Version 2.0***
October 7, 2005

CMS Software and Physics, Reconstruction and Selection (PRS) Projects		
CMS Spokesperson	Michel Della Negra, CERN	Michel.Della.Negra@cern.ch
CMS Technical Coordinator	Alain Herve, CERN	Alain.Herve@cern.ch
CMS Collaboration Board Chair	Lorenzo Foa, Pisa	Lorenzo.Foa@cern.ch
CPT Project Manager	Paraskevas Sphicas, CERN and Athens	Paraskevas.Sphicas@cern.ch
CPT Detector PRS Coordinator	Darin Acosta, Florida	Darin.Acosta@cern.ch
CPT Analysis PRS Coordinator	Albert De Roeck, CERN	Albert.De.Roeck@cern.ch
CPT Software Coordinator	Lucia Silvestris, Bari	Lucia.Silvestris@cern.ch
CPT Software Coordinator	Avi Yagil, FNAL	Yagil@fnal.gov

Jet/MET

Jet Reconstruction/Calibration



Available on CMS information server CMS AN 2005/039

CMS Analysis Note

The content of this note is intended for CMS internal use and distribution only

18 November 2005

Study of Cell Energy Thresholds in CMS Calorimeters for Jet Reconstruction

R. Damina, J. Dolen, C. Justus, P. Tipton, M. Zielinski

University of Rochester, Rochester, NY, USA

A. Bhati

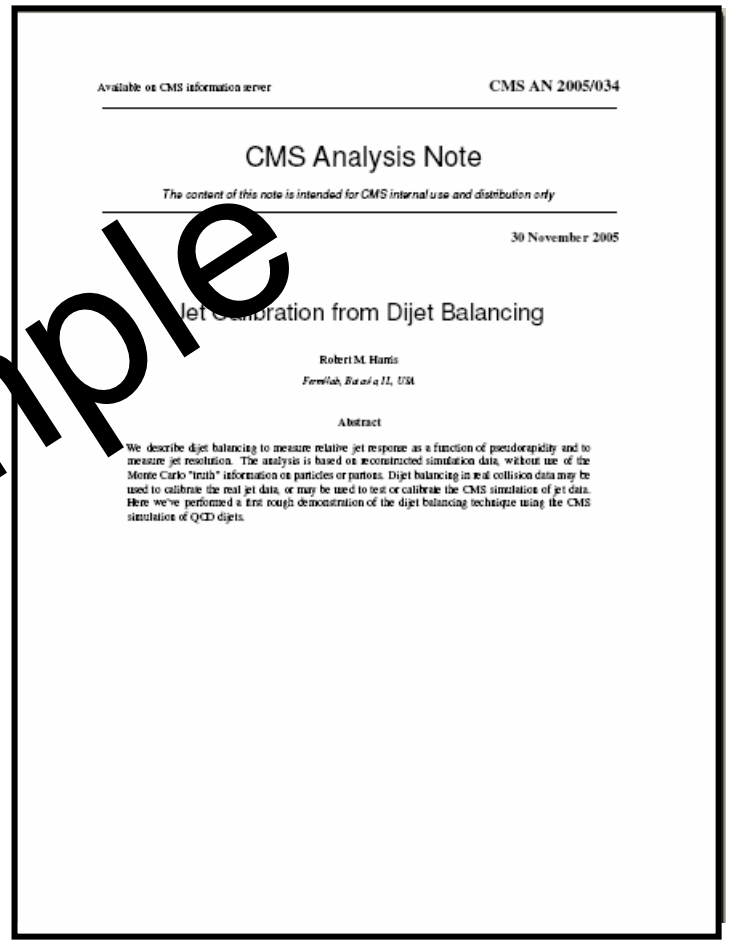
Rockefeller University, New York, NY, USA

R. Harris

Fermilab, Batavia, IL, USA

Abstract

We have investigated the characteristics of calorimeter noise and its impact on [illegible] of low-p_T jets. We have proposed new thresholds for calorimeter hits, which can be [illegible] when creating towers for reconstruction of jets and missing E_T (MET). The values of proposed [illegible] thresholds are effective in reducing noise contributions to jets, while removing less real jet energy than [illegible] often-used cuts on whole towers.



Available on CMS information server CMS AN 2005/034

CMS Analysis Note

The content of this note is intended for CMS internal use and distribution only

30 November 2005

Jet Calibration from Dijet Balancing

Robert M. Harris

Fermilab, Batavia IL, USA

Abstract

We describe dijet balancing to measure relative jet response as a function of pseudorapidity and to measure jet resolution. The analysis is based on reconstructed simulation data, without use of the Monte Carlo "truth" information on particles or partons. Dijet balancing in real collision data may be used to calibrate the real jet data, or may be used to test or calibrate the CMS simulation of jet data. Here we've performed a first rough demonstration of the dijet balancing technique using the CMS simulation of QCD dijets.

Example

Impact - ROC

- Since 2004 summer time, Testbeam/cosmic runs/calibration runs of HCAL and MUON data has bee transferred to the Fermilab and experts has been analyzing the data.
- working with CERN Evf/DQM (high level trigger event filter and Data Quality Monitor) group from early on. As the software design/develop, we always remote access in mind.
- Initiated to have MTCC remote monitoring meeting at CERN in Dec. 2005. with MTCC operation group with DAQ and detector experts → page1, e-log, remote access of information, etc…
- Feb. 3rd. influenced to have the 1st CCAR (CERN remote command and control room) meeting.

Feb.1,Wed. Afternoon:MTCC session

- **Example: a slide from Emilio's talk, titled "SW for MTCC" :**

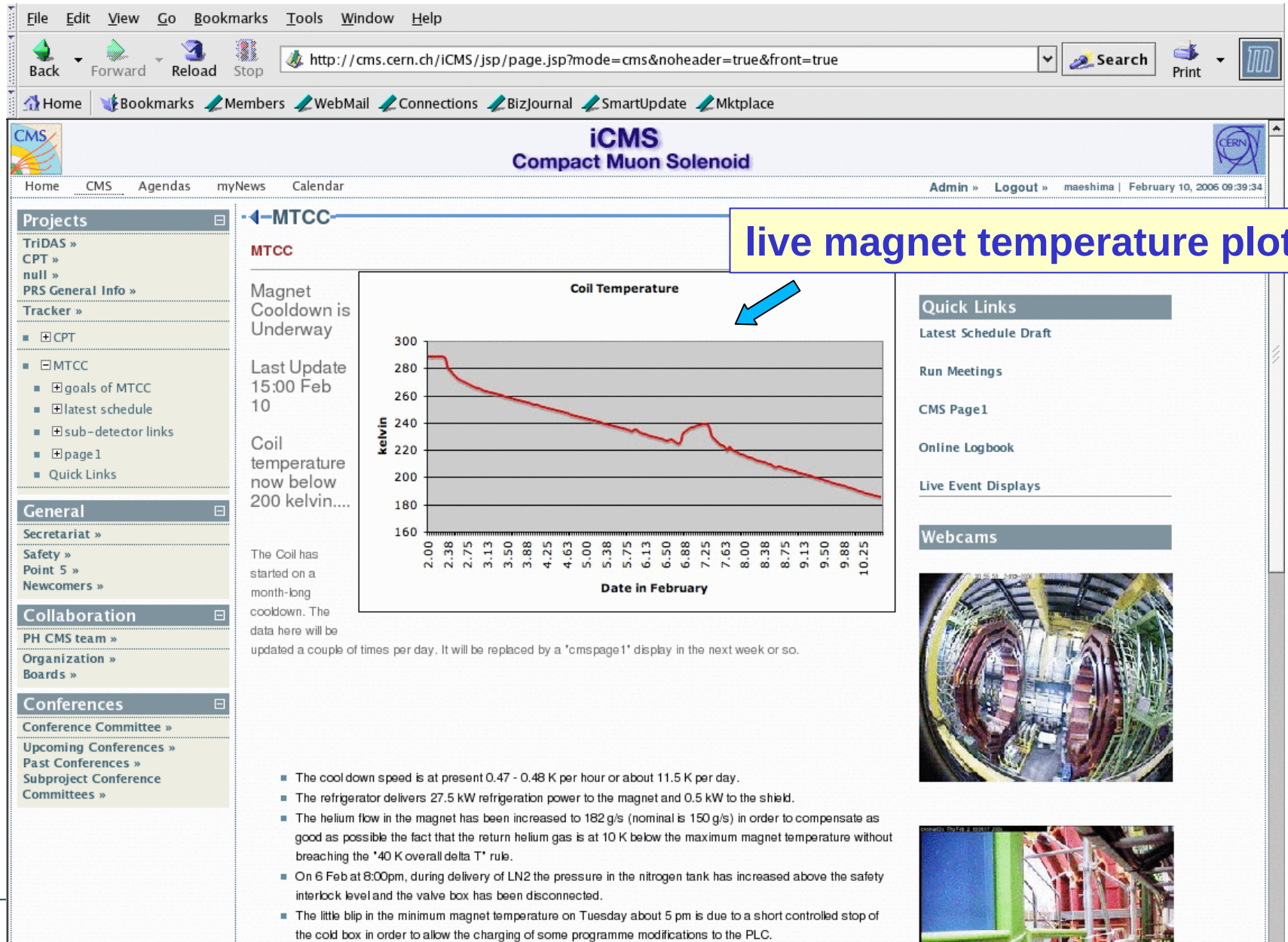
<u>already being announced (will be) 'available' for MTCC,</u>

Monitoring

- Event Display for all participating sub-detectors, with off-site web access
- DQM
  - DQM infrastructure in place over entire filter farm
  - At least one DQM module per sub-detector
  - At least one specialized client per sub-detector plus one for "HLT"
    - Using standardized components
  - Control structure in place for DQM clients using RunControl
  - Web access for entire DQM system from off-site

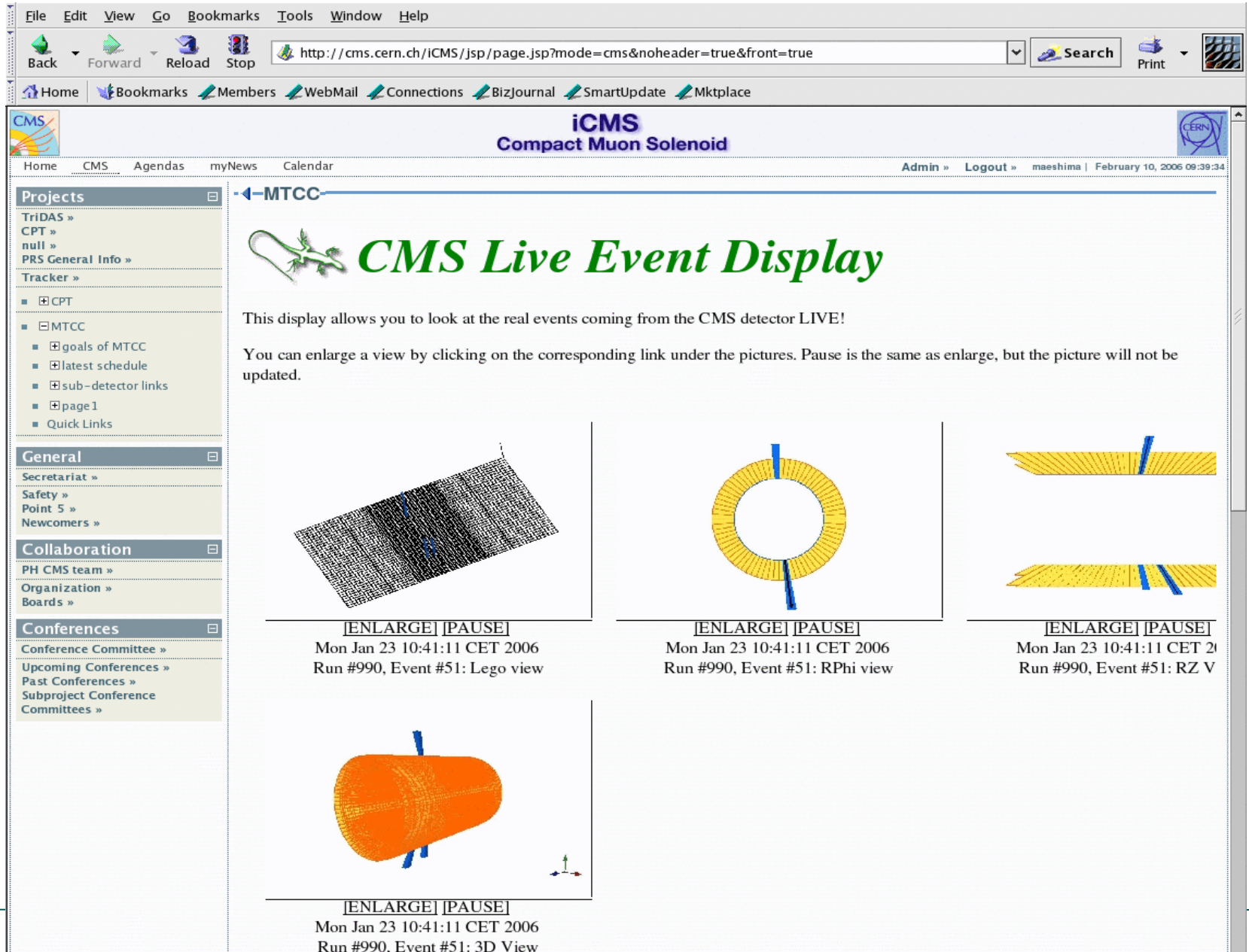
at ROC, we are trying to exercise as much available things as possible.

MTCC information from CERN

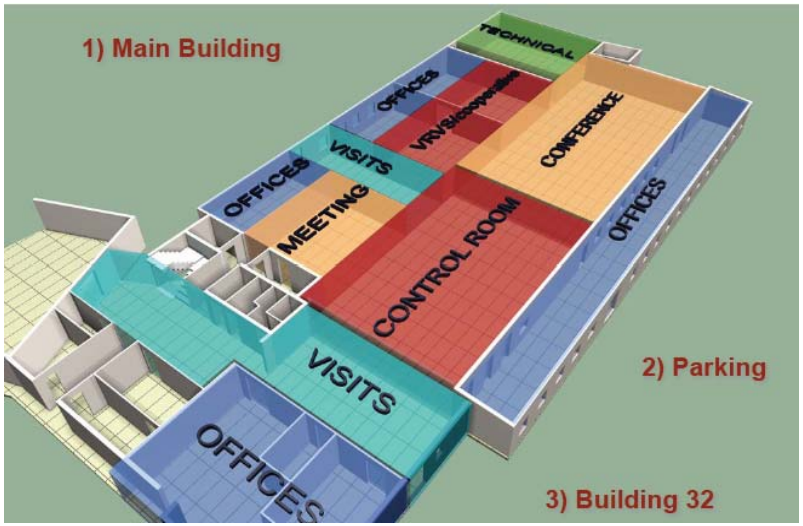


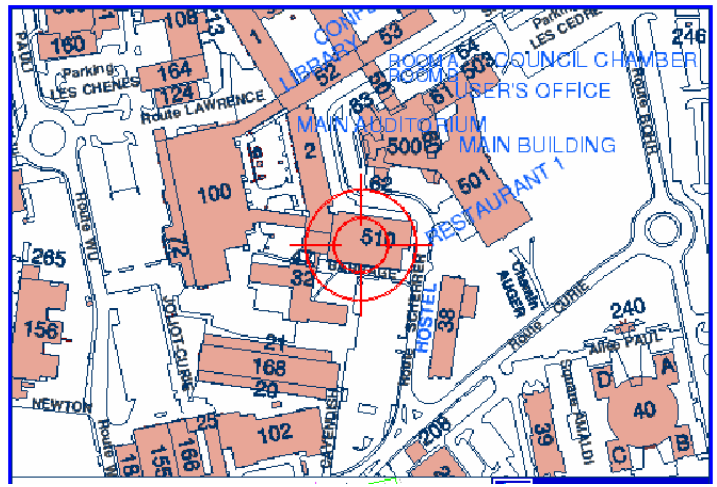
live magnet temperature plot

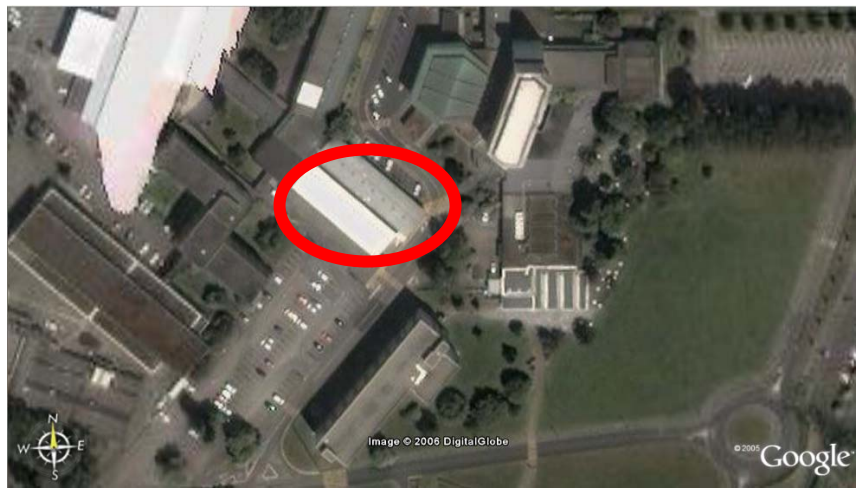
Live Event Display from CERN



Meyrin Site CCAR (LPC+ROC at CERN)







Even CERN has realized the clustering doesn't need to be near the detector

(After thinking about our own LPC-ROC effort… ☺)

The first CCAR meeting held on <u>Feb. 3rd (a few weeks ago!)</u> at CERN.

Impact of LPC and ROC

- Although not formally commissioned until early 2005, LPC scientists have already had a big impact on CMS. Tevatron experience is a key!
- Review of software framework led to overhaul, and increased placement of U.S. scientists in management positions.
- Location at Tier 1 means the LPC is a place where interfaces between M&O and S&C can be worked out, with many meetings to make coherent the efforts of both.
- 2005: concentration on the physics-enabling environment and reconstruction tools. Aspects ranging from muon identification to trigger tables to jet calibration and online monitoring.
- 2006: movinv closer to physics analyses, via the path of understanding the detectors during the cosmic challenge and test beam.

The LPC/ROC & Universities

- a postdoc who is stationed at FNAL working on both CMS and a Tevatron experiment can have a desk on the 11th floor and be near people from both experiments.
- a CMS postdoc can be stationed at FNAL and benefit from having many people close by to interact with
- a postdoc stationed at a university can come for a month, to get up to speed on analysis basics and to form personal connections that will help his/her later work
- students can come for the summer to interact with a wide variety of experts and learn the basics on the CMS environment
- Faculty can come every other week to keep their connections with the experimental community .
- Faculty can come for a day or two for help with a particularly knotty software or analysis problem

Participation in the groups will both help them do physics and allow them to serve the US and International CMS

US University Involvement

Simulation: FNAL, FSU, Kansas State, Kansas, Louisiana Tech/Calumet, Maryland, Northwestern, Notre Dame, Rutgers, UIC, SUNY Buffalo, Nanjin, Ciemat, Tata, Puerto Rico

Jet/Met: FNAL, Rochester, MD, Rutgers, Boston, Cal Tech, I Princeton, Texas Tech, Iowa, Mississippi, Minnesota, Santa B

Muon: FNAL, Carnegie Mellon, Florida, Florida Tech, Purdu Northwestern

e/gamma: FNAL, Northwestern, FSU, Minnesota, MD, Brov Diego, Cal Tech

Tracking: FNAL, Colorado, Cornell, Nebraska, UC Da Riverside, Wisconsin, Kansas State, Calumet

About 1/4 of the non-transient physicists on the 11th floor are University employees. All the (many) transients from Universities.

Trigger: Wisconsin, Florida, Northwestern, FNAL, Vanderbilt, Texas A&M, Brown, Maryland, UIC

Offline/edm: FNAL, Cornell

Physics: all

Plans for Coming Year

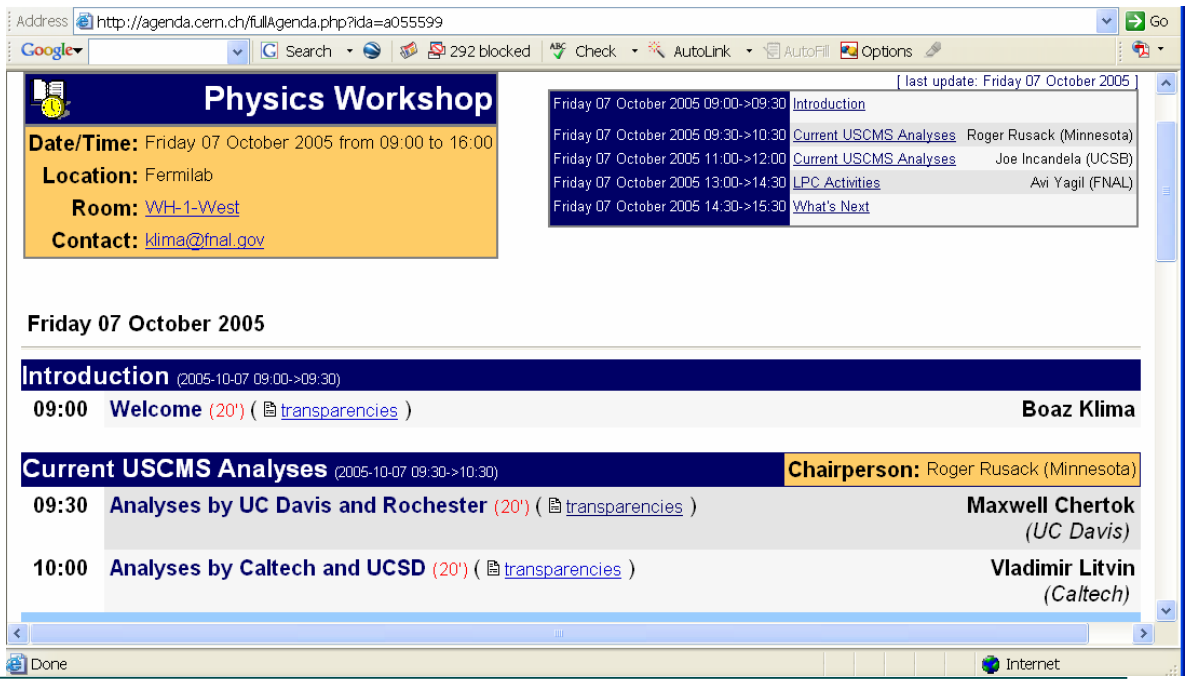
- Commissioning of ROC / Cosmic slice test
- Strengthening of working groups, especially the brand-new physics group
- Development of realistic “run plan” for early data taking
- working with detector groups
- Full summer school

“Physics” Group

International CMS meetings have very crowded agendas, very large audience. More like a conference than a working group.

Main goal: to provide to US people doing “physics analysis” an informal atmosphere conducive to mentoring.

Kick-off Workshop was October, 2005.



CMS is Already Doing a Lot

(slides from Klima)

- USCMS has made tremendous contributions to the hardware of the CMS
- Many of our USCMS colleagues are extremely busy these days and have little (or no) time to think about Physics analysis
- It's our job at the LPC to create an environment in which everyone can get help and support whenever (s)he is ready for Physics
- The LPC is already playing a key role in quite a few areas; will do even more in the future
- We recently started a new group/effort, Physics
- Leader – Boaz Klima (ex DØ Physics Coordinator)

Long-Term Plans

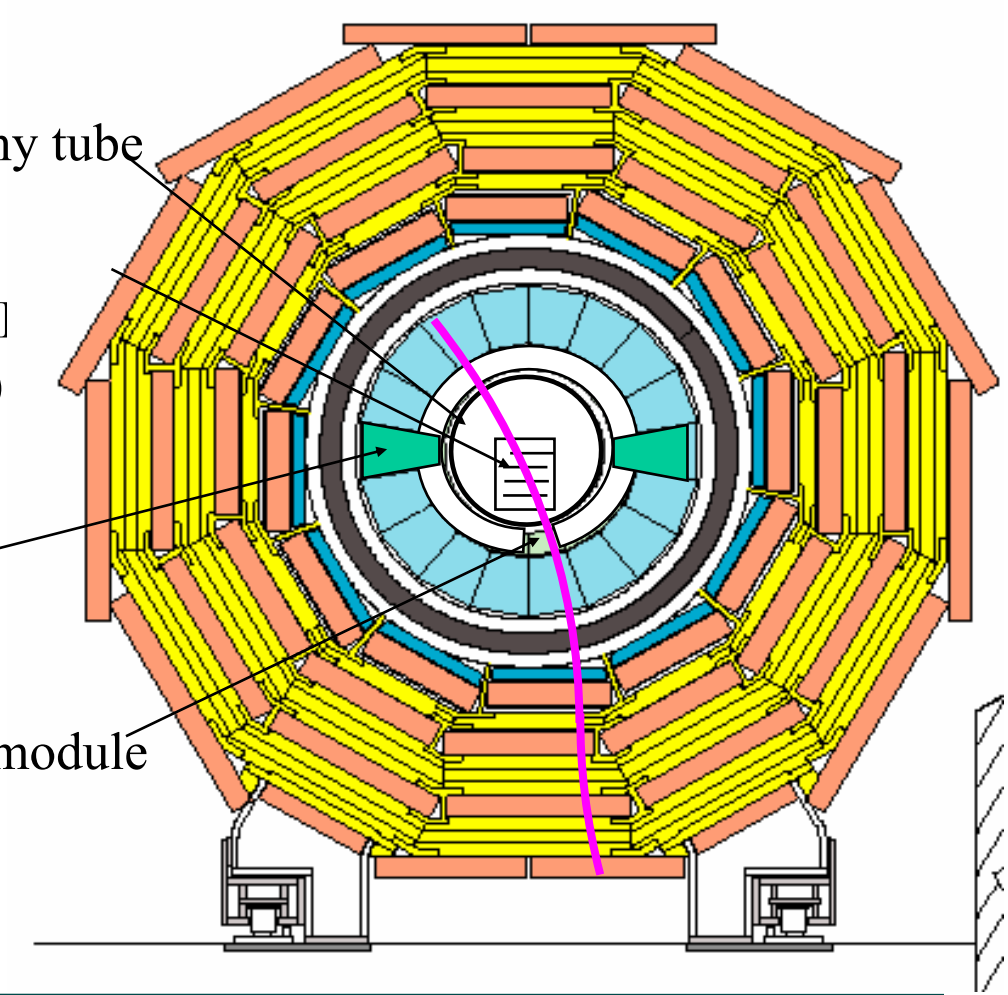
Modeled after CDF, DØ, …

- Do most (all?) USCMS physics analysis at the LPC?
- Not necessarily physically @FNAL
- Create physics groups (&subgroups) as needed
- Provide forum for informal (and formal) discussions
- Bring analyses to completion
- Work closely with International CMS – be transparent!

The Vision - CMS/LPC's analysis effort will be equivalent to the effort at CERN

Magnet/Cosmic Slice Test

May '06 (then, heavy lowering!)



***ambitious* integration test:**

issues:

-compatibility with basic programme of tests

-special installations

-muon, rpc, hcal, ecal, trk detectors

-cabling & services (esp LV)

-controls and safety

-trigger

-off-det electronics

-DAQ & Run Control

-DAQ integration requires:

-local DAQ (over VME)

-FED Slink

Common trigger (ad-hoc with LTC?

-databases

-data-structure/storage

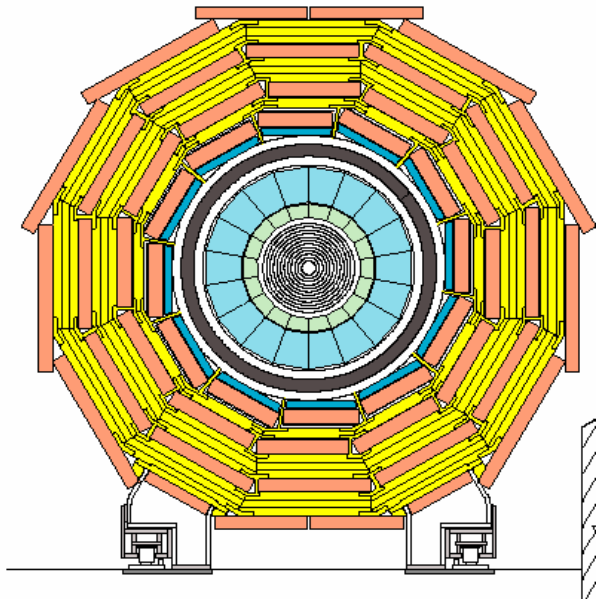
-analysis software etc etc etc

ROC and Cosmic Test

- **Data access**
  - **Being able to analyze the data efficiently is of a paramount importance: bring the data to LPC!**
- **Remote Operation Center: infra-structure for**
  - **Data taking monitoring (feedback to CERN)**
  - **Data transfer monitoring**
- **Data analysis**
  - **Setup the infrastructure for the data analysis at LPC**
  - **Reconstruction software, development and optimization of algorithms, calibration etc**

Extremely Important for CMS and LPC

Cosmic Muon Challenge



Summer Test Beams 2006

The CMS HCAL and ECAL groups will perform a Combined Test starting in mid-July and run for 9 weeks according to the following plan:

- 1 week: Set-up time
- 3 weeks: High-energy beam (10-300 GeV pions/electrons/muons; negative beam if possible).
- 1 week: Switchover from High Energy to Very Low Energy beam
- 4 weeks: Very Low Energy beam (2-9 GeV pions/electrons)

Typical intensities of 10 kparticles/spill.

The programme will be dedicated to measuring the response of the combined ECAL +HCAL to pions in the momentum range 2 - 300 GeV. The groups will also use electron (muon) beams to establish the calibration of ECAL (HCAL). Preferred time is July 19th (week 29th) to September 20th in week 38th , i.e. just before structured beam period.

Step-by-step use of luminosity

- **Before beam:**
- **Set timing to 1 nsec using lasers, pulsers**
- **Set ADC counts to Et conversion to 5% using sources, muons, and test beam transfer of calib – ECAL and HCAL.**
- **Set alignment of muon chambers using cosmics and optical alignment, MB and ME. Track motion with field on (first test in SX5 in cosmic challenge).**
- **Set alignment of tracker (pixels + strips) using muons, optical alignment and survey.**

Then…

hep-ph/0601038

An LHC Run Plan –
The First Inverse Femtobarn

Dan Green
Fermilab

January, 2006

From 10^{23} to 10^{27} /(cm^{2}sec)

L for 1 month run (10^6 sec)	Integrated L	Trigger	Process	Comments
10^{23}	100 mb^{-1}	None σ_I~ 50 mb	Inelastic non-diff	Input to tweak Pythia
10^{24}	1 μb^{-1}	Setup Jet	Inelastic non-diff	Calib in azimuth
10^{25}	10 μb^{-1}	Jet σ(gg) ~ 90 μb σ(ggg) ~ 6 μb	g+g -> g+g g+g -> g+g+g	Establish JJ cross section
10^{26}	100 μb^{-1}	Jet	g+g -> g+g g+g -> g+g+g	Dijet balance for polar angle – Establish MET
10^{27}	1nb^{-1}	Jet Setup Photon $\sigma(q\gamma)$ ~ 20 nb	g+g -> g+g g+g -> g+g+g q+g -> q+γ	Dijet masses > 2 TeV, start discovery search. J+γ calib

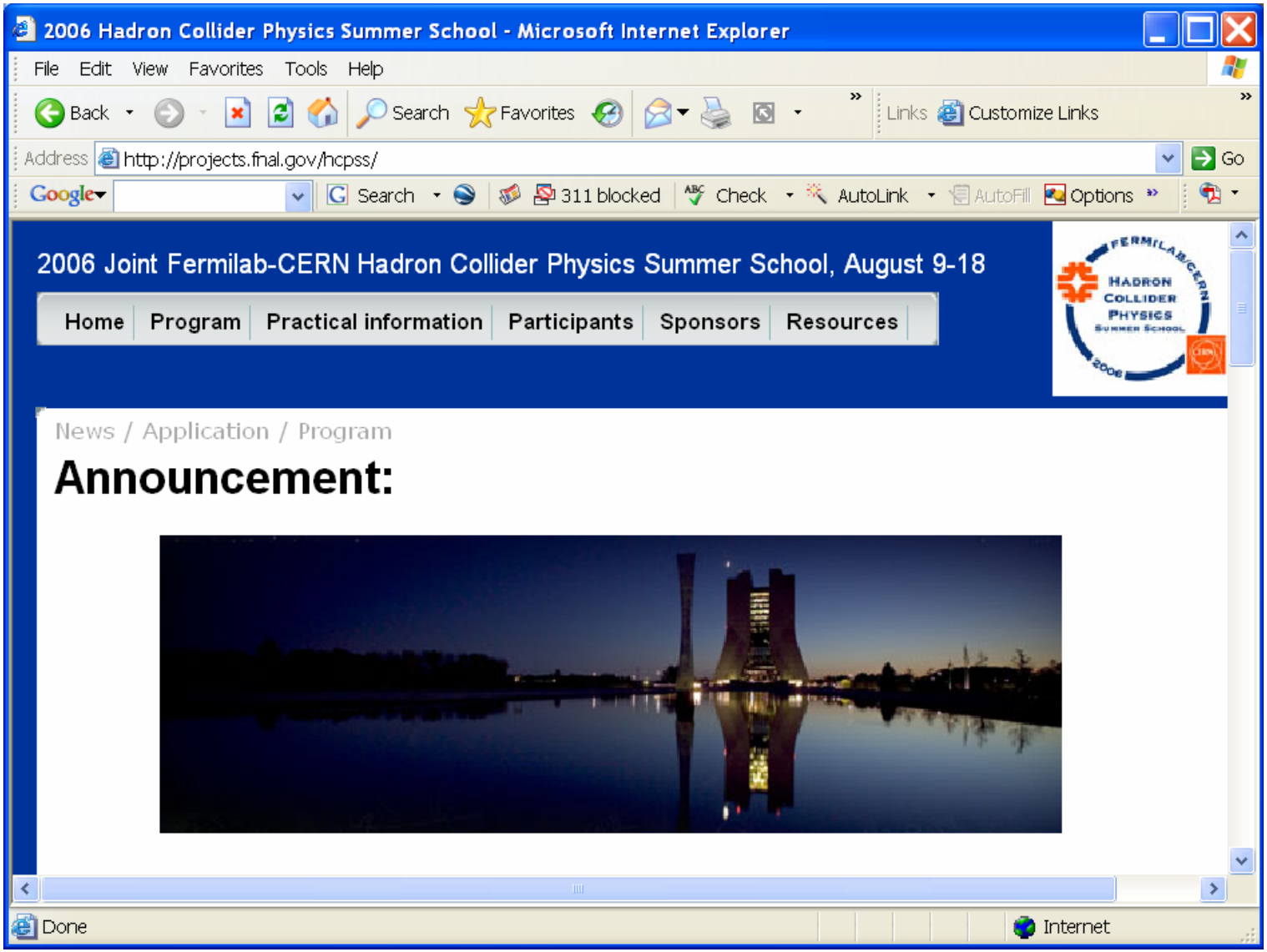
From 10^{28} to 10^{33} /(cm^{2}sec)

L for 1 month run	Integrated L	Trigger	Process	Comments
10^{28}	10nb^{-1}	σ_{bB} ~ 600 nb. Setup – run single electron, muon, photon	g+g -> b+B	900,000 JJ, 6000 bB, 1200 1μ, 60 2μ Establish μ jet tag
10^{29}	100 nb^{-1}	Setup dimuon, dielectron $\sigma_{\mu\mu}$ ~ 10 nb	q+Q->W->μ+ν (D-Y)	1000 μ from W->μ + ν Lumi – standard candle (look at high Mt tail)
10^{30}	1 pb^{-1}	Run dilepton trigger $\sigma_{\mu\mu}$~ 1.5 nb σ_{tT} ~ 630 pb	q+Q->Z->μ+μ (D-Y) g+g->t+T	1500 dimuons from Z-mass scale, resolution Lumi- standard candle, high M 600 t + T produced
10^{31}	10 pb^{-1} End of '07 Pilot Run	Setup, J*MET $\sigma_{q\mu\mu}$~ 40 pb $\sigma_{\gamma\gamma}$ ~ 24 pb	g+q->Z+q->μ+μ+q q+Q->γ+-γ (tree)	400 Z + J events with Z->dimuons – Z+J balance, calib Estimate J + MET (q + ν) 240 diphoton events with M > 60 GeV
10^{32}	100 pb^{-1}	σ_{qQZ} ~ 170 pb σ_{qgZg} ~ 32 pb σ_{tT} ~ 630 pb	g+g->q+Q+Z g+q->q+g+Z+g	3000 J+J+Z->νν events, Pt>30 500 J+J+Z->μ+μ events, Pt>30 600 J+J+J+Z->νν events 12000 J+J+J+J+μ+ν events
10^{33}	1 fb^{-1} (1% of design L for 1 yr) End of '08 Physics Run			M of dijet in 120000 top events, W-> μ +ν – set Jet energy scale with W mass. Dimuon mass > 1 TeV, start discovery search, dimuons, diphoton search, SUSY search

Run Planning Summary

- **Understanding detector response, trigger, reconstruction, and backgrounds.**
- **Pre-operations will prepare CMS for first beam.**
- **The first 5 orders of magnitude in luminosity, up to 10^{27}, will allow calibration checks, jet and MET establishment, and dijet mass search.**
- **The next 6 orders of magnitude, to 10^{33}, allow the setting up of lepton triggers, standard candles for cross sections (W and Z), jet mass scale (W from top) and dilepton and diphoton mass searches.**
- **Look in tails of $\ell + \nu$, $\ell + \ell$ and $\gamma + \gamma$ masses.**
- **Look at Jets + MET. Estimate Z backgrounds using dilepton Z events.**

Summer School



http://hcpss.fnal.gov/.

August 9-19, 2006

My Last Slide today

When a discovery happens, we want to be where the action is.

We are creating the place (in addition to CERN) where the action is!

With the modern technology and size of the experiment, it should be possible and make sense to have more than ONE.