

Still, the best way to prepare → RunII analysis

# CMS - Preparing for Physics at Fermilab

PAC meeting, Nov 2004

Avi Yagil

# Fermilab's Role:

- a *CMS* collaborating institution
- host lab for detector construction
- host lab for US *CMS* Research Program (RP) management (*SWC* and *M&O*)
- location of the US Tier1 computing center for *CMS*

# Some Basic Questions:

- US HEP in LHC era
  - What's the landscape? Other experiments, projects.
- How do we want to function?
  - Mode of participation in an LHC experiment
- How do we transition between RunII and LHC?
  - Importance of successful completion of RunII
  - Need to start on LHC
  - How do we do both, well?

# Wish List:

Would like:

- us to play a significant role in the analysis phase of LHC, not only detector building etc.
- successful completion of RunII with timely ramp-up of CMS analysis and commissioning efforts
- preserve community

# Brief History

- Part of Dan Green's "not just detector building" vision. Secured a place within the RP
  - FNAL LRP - ambitious vision for Lab's role in LHC Physics (John Womersly *et. al.*)
  - Discussions ~1 year ago with Dan Green, John Womersly, Mike Witherell
  - Agreed that it would be good to try...
- ➔ Invited a few University colleagues to think about it, in the dead of winter...

# Discussion on Feb 12<sup>th</sup>

- **Semi-random group**
- **Interested in LHC Physics**
- **Most on CDF or D0**
- **CMS collaborators**

- Darin Acosta (Florida)
- Claudio Campagneri (UCSB)
- John Conway (Rutgers)
- Sridhara Dasu (Wisconsin)
- Regina Demina (Rochester)
- Greg Landsberg (Brown)
- Christoph Paus (MIT)
- Chris Tully (Princeton)
- John Womersley (FNAL)
- Lothar Bauerdick (FNAL)
- Bob Cousins (UCLA)
- Dan Green (FNAL)
- Sarah Eno (Maryland)
- Avi Yagil (FNAL)

## Since Added:

- Max Chertok (Davis)
- Cecilia Gerber (UIC)

**Standing Advisory Board**

*A few slides from that mtg...*

# Why worry now? "Day-One"

- Commissioning
  - Complex detectors, environment
  - Took CDF ~18 months (just for RunII startup!!)
  - Period to build credibility for future physics results
- Partially instrumented detector (?)
  - No pixels → Very different tracking strategy and capabilities. Study now!
  - Tracking always slower to mature, big impact
- New Energy regime
  - Some (possibly exciting) physics is accessible with calorimetry only. Need to work on it now.

# Need to have for Physics:

- Detector description (Geometry, Simulation)
- Calibrations, Alignment, dead/hot ch., etc.
- Basic reconstruction code (Clustering, Tracking, stub finding, Jet finding, Met)
- High level objects (Vertexing, Electron, Muon, Tau...)
- Physics tools (conversion, cosmic, b-tagging, jet corrections, etc.)
- Trigger information, emulation

# The Opportunity

Many currently travel to FNAL to work at the Tevatron.

→ Can use this natural (but temporary!) “clustering” to build something in advance of day 1.

This will allow us to be in position to:

- Exploit opportunity for getting to first physics results at day 1.
- Real participation in the commissioning and the physics, not just the building of hardware and low-level computing infrastructure.

# Why do we cluster?

- Detector location
  - Operations: Shifts, Data validation, Maintenance
  - Computing: Data reconstruction, Storage, Simulation
  - Critical mass for complex analyses
  - Experts (mainly tracking, calor, calib, sim...)
  - Presentations & Meetings
  - New students & post-docs education
  - Gossip and other "social" activities
- In the end, our common goal is Physics output.
- Can "remote clustering" be successful?

# Remote Clustering

- Natural for us to build a user community here at FNAL, especially on the "short" time scale (2004/2005/2006)
- Leveraging the CDF/D0 communities and Tevatron know-how
- If successful, will survive into the LHC era and enable us to function as a community

# Agreed on a "Plan"

- Establish the LHC Physics Center (LPC), so that we can:
  - Build local low-level software expertise and infrastructure
  - Learn: what's available (in CMS)? How good is it? What should we concentrate on?
  - Enable University participation by leveraging initial lab effort
  - Invite and encourage sharing of CDF/D0 collaborations efforts (specifically of post-docs and students)
  - Establish skeleton local algorithm groups
  - Participate in CMS activities as a community

Sent a letter to Mike, requesting Lab support



13 February 2004

Mike Witherell, Director  
Fermi National Accelerator Laboratory  
P.O. Box 500  
Batavia, IL 60302

Dear Professor Witherell:

I am writing to you on behalf of a group of University professors who met on February 12, 2004 at FNAL to discuss how to organize an effort to prepare for data taking and physics analysis with the CMS detector at the LHC while at the same time fulfilling our ongoing commitments to experiments currently running in the US, such as BaBar, CDF, and DØ. We invited Dan Green, Avi Yagil, John Womersley, and Lothar Bauerdick to our meeting, to help us understand whether our interests/needs coincide with the lab's plans for an LHC physics center (LPC). The purpose of this letter is to inform you of our thoughts on this subject, and also of the ways we hope the lab can help us on what we think is an effort which could very well determine the health of our field in the United States, both during the LHC era and afterwards.

We unanimously agreed that the only way in the short term we could both prepare for CMS data taking and continue our vital work on running experiments is to find a way to make it effective for postdocs and students to work on both efforts at the same time, and the only way to do this is to cluster them in a place like the proposed LPC. We were also all hopeful that, if started now, such a center could become our preferred place for clustering even after the start of CMS data taking, so that we travel to CERN only approximately 4 times per year, and travel regularly instead to FNAL to interact with our students and postdocs. Whether this works or not depends crucially on the LPC becoming a power research center well before the LHC data taking starts in 2007.

Most of the current indirect evidence for the scale of new physics hints that the LHC may be able to make a major discovery shortly after turn on. The discovery will go to the collaborations and physicists that are best prepared at the start of data taking. CMS takes this possibility very seriously, and has established the "Physics Reconstruction and Selection" (PRS) groups to make sure the collaboration is prepared. Over the next two years, this preparatory work will take the form of the writing of a "Physics TDR". If US CMS wants to play a leading role in these discoveries, we need to lead in the preparation of this TDR through participation in the PRS groups. We also need to do the kind of activities that are going on now within CMS that will enable us to have an intimate understanding of the detector, especially participating in test beams, but also understanding calibration systems, and the development of robust analysis tools. To be successful, we decided we need the following:

- In the next 6 months: establish a physical place at FNAL in the Hirse with first class computing and video conferencing for a core team of about six researchers working full time on CMS who will collectively develop expertise in all areas of the CMS reconstruction code and prepare to support and help the postdocs who will join them, working part-time on CMS.
- Within the next year: have an additional 10 University postdocs and some number of students working part-time on CMS and part time on a running experiment join the core team. These part-time postdocs and students would need desks in the same physical location as the 6 core researchers.
- In the following years: increase the number of University postdocs shared between CMS and a running experiment to 20 by the end of 2005 and 35 by the end of 2006, and start to have students who will do an LHC thesis working at the center.

Letter to Mike:

# Letter to the Lab:

● Page 2

April 13, 2004

- We need to establish milestones to judge our progress, especially over the timescale of the next year, when the success or failure of this project will become clear.
- Over the coming year, meet monthly to make sure we are making the required progress towards our goals that is needed to make the LPC a success.

We unanimously felt we cannot do this alone, and that we would need strong support from FNAL in order to make this a success. We want to take responsibility for the success or failure of this project on the University side. We would like somebody at FNAL to also have the formal responsibility, on the laboratory organization chart, for the success on the lab's behalf. This person would work with us over the next 2 months to establish milestones for the coming year. We would hope, during the first year, when the success or failure of this project will be established, that the lab could match or exceed the Universities in physicist manpower assigned to the project. As the years increase, the fraction of the work force from the Universities would increase. Also, obviously, we need the physical space for desks and desktop computing, a state-of-the-art video conferencing system, and the kind of computing infrastructure/data storage system that Lothar is developing. We also need a team of about three scientists in the next six months to help us understand (and improve) the complex low-level code that ensure a physicist's ability to access, calibrate, and analyze the data. By the end of 2006, we would need support commensurate with that being provided to current running experiments. Without support for the LPC, we believe that we will only be able to keep our postdocs/students on CDF/DØ until about 2006. We will be forced to relocate our research groups en masse to LHC causing major disruption and inefficiency at a critical time. This will compromise both the final stages of CDF/DØ analyses and our leadership in extracting physics from early LHC data. We cannot let this happen.

We hope that you would agree that this is an effort that lab should support. We understand that all of the lab personnel who came to our meeting are very enthusiastic about supporting this effort, and are willing to do whatever is in their power to make LPC a success.

Sincerely,

Sarah Eno  
Associate Professor of Physics  
University of Maryland

For

Darin Acosta, U. Florida  
Claudio Campagnari, UCSB  
John Conway, Rutgers University  
Sridhara Dasu, University of Wisconsin  
Regina Demina, University of Rochester  
Greg Landsberg, Brown University  
Christoph Paus, MIT  
Chris Tully, Princeton University

# Lab's Response:



Fermi National Accelerator Laboratory  
P.O.Box 500 • Batavia, IL • 60510-0500  
630-840-3211 FAX 630-840-2900

Director's Office

April 28, 2004

Darin Acosta, University of Florida  
Claudio Campagnari, UCSB  
John Conway, Rutgers University  
Sridhara Dasu, University of Wisconsin  
Regina Demina, University of Rochester  
Sarah Eno, University of Maryland  
Greg Landsberg, Brown University  
Chris Tully, Princeton University

Dear Colleagues:

I am writing to respond to your letter concerning the LHC Physics Center at Fermilab. In that letter you expressed interest in the development of such a center and stated how important it would be for U.S. university groups to take full part in research with the CMS data sample.

Both Fermilab and the leadership of the US-CMS research program have also expressed support for the LHC Physics Center (LPC). One goal of the center is the one you articulated, that is, to make it possible for U.S. physicists working on CMS to be innovative leaders in LHC physics. The other is that Fermilab remain an intellectual center for collider physics in the LHC era. I think that both of these goals serve the larger purpose of advancing particle physics in the U.S.

A broad group of the involved parties recognizes the need of a transition period in which physicists will share effort between CDF or D0 and one of the LHC experiments. This sharing will make it possible to sustain the needed effort to operate CDF and D0 effectively, at the same time that it brings a lot of experience from the Tevatron program to the LHC. At our Annual Program Review, both CDF and D0 said that they are moving to make it easier for scientists to be an active member of their collaborations while sharing time with CMS or ATLAS. P.K. Williams expressed to me his encouragement of the LHC Physics Center here as an effective way of sharing university physicists between CDF or D0 and CMS.

I want to make the LHC Physics Center into one of the leading centers in the world for producing particle physics results, and am ready to commit resources to that end. In planning this startup we will work closely with you and with leadership of the US-CMS research program to make sure that we are establishing an institution that serves all of the interested parties well.

We plan to increase Fermilab staffing for CMS computing and analysis. We will work to provide the appropriate level of support from computer professionals. We would also like to attract a few Research Associates with primary assignment to CMS over the course of the next year. In addition, we should be able to attract a Wilson fellow to CMS, a position that is at the level of an Assistant Professor. Finally, we are emphasizing the importance of this effort by

# Lab's Response:

having Avi Yagil invest a large part of his time in making it work. We have encouraged him to attract additional help from Fermilab scientific staff on CDF and D0.

We hope that this initiative will help Fermilab to take a role in CMS and LHC physics that is larger than remote laboratories have been able to do on previous experiments. The benefits of doing so will be large for Fermilab and for the U.S. physicists working on CMS.

Sincerely,

Michael Witherell

cc  
Lothar Bauerdick  
Bob Cousins  
Dan Green  
Jim Freeman  
Avi Yagil  
Hugh Montgomery  
Ken Stanfield  
John Cooper  
Vicky White  
John Womersley

## Calendar

Tuesday, May 4

3:30 p.m. DIRECTOR'S COFFEE

BREAK - 2nd Flr X-Over

4:00 p.m. Accelerator Physics and

Technology Seminar - 1 West

Speaker: S.G. Tantawi, Stanfr

Linear Accelerator Center

Title: Multimoded RF S

Band Future Linear C

Wednesday, May 5

3:30 p.m. F

BREAK

4:00 p.m. - 1

W Louisiana

Drives Physics

Wall Cafe

ay, May 4

Golden Broccoli & Cheese soup

Hickory Smoked BBQ Pork \$4.75

Japanese Breaded Pork Cutlet \$3.75

Hawaiian Marinated Chicken w/

Grilled Pineapple \$3.75

Toasted Almond Chicken Salad on

Low Carb Bread \$4.75

Portabella Mushroom Baked Pizza

Wrap

Chicken Fajita Tacos \$4.75

[Wilson Hall Cafe Menu](#)

[Chez Leon](#)

## Weather



Chance Thunderstorms 69°/44°

[Extended Forecast](#)

First Data from Deep Underground  
Experiment Shows Search for Dark  
Matter



Project manager Dan Bauer from Fermilab holds one tower of detectors as Vuk Mandic from UC Berkeley examines them.

With the first data from their underground observatory in Northern Minnesota, scientists of the Cryogenic Dark Matter Search have peered with greater sensitivity than ever before into the suspected realm of the WIMPS. The sighting of Weakly Interacting Massive Particles could solve the double mystery of dark matter on the cosmic scale and of supersymmetry on the subatomic scale.

The CDMS II result, described in a paper submitted to Physical Review Letters, shows with 90 percent certainty that the interaction rate of a WIMP with mass 60 GeV must be less than  $4 \times 10^{-43} \text{ cm}^2$  or about one interaction every 25 days per kilogram of germanium, the material in the experiment's detector. This result tells researchers more than they have ever known before about WIMPS, if they exist. The measurements from the CDMS II detectors are at least four

## Director's Corner

Good Morning!

In recent weeks I set in motion the next steps in establishing an LHC Physics Center (LPC) here at Fermilab. The Fermilab Long-Range Planning Committee has emphasized the importance of the LPC for Fermilab and for particle physics in the U.S. The goals of the center are to make it possible for U.S. physicists working in the CMS collaboration to be innovative leaders in LHC physics and to ensure that Fermilab remains an intellectual center for collider physics.



Mike Witherell

A group of university faculty members wrote me a thoughtful letter recently pointing out the particular value of the LHC Physics Center to groups that are part of the CMS collaboration in addition to either CDF or DZero. These groups will be able to share people across the two research programs more efficiently because of the LPC. This sharing will also ensure that physicists bring important experience from the Tevatron to the LHC research program.

As a result of what we are doing now, the LHC Physics Center will be an important institution at Fermilab for decades to come.

• Strong (un-provoked) support  
• Very public

# Some General LPC Resources

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

## LPC



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## The LHC Physics Center at FNAL

The LHC Physics Center (LPC) at FNAL was established in April 2004 by Mike Witherell and Dan Green for the following purposes:

- a "brick and mortar" location for CMS physicists to find experts on all aspects of data analysis, particle ID, software, and event processing within the US, working during hours convenient for U.S.-based physicists
- a center of physics excellence within the US for LHC physics
- a place for workshops/conferences/gatherings on LHC physics
- a place for the training of graduate and postgraduate scientists from URA Universities.
- a "remote control room" that CMS physicists can use to participate in data taking and quality control for the CMS experiment in the U.S.
- a tool to help provide a graceful transition between the Tevatron and LHC experiments for those physicists participating in both, maximizing the manpower available to each during the transition time.

The center is run by [Avi Yagil](#) (FNAL) and [Sarah Eno](#) (UMD) and is located on the 11th floor of the FNAL hi-rise. The level-2 manager is [Kaori Maeshima](#). The members of our advisory board can be found [at this link](#). Our milestones can be found [at this link](#). The LPC makes use of the proximity of the [FNAL "Tier-1" computing center](#) and the Tevatron experiments. To learn more about our center, choose one of the following options.

### [Working Groups](#)

# LPC Working Groups



## LPC Working Groups

One of the main goals of the LPC is to have a place in the U.S. where CMS Physicists can find experts in all areas of CMS software and reconstruction. Our current working groups and their conveners are:

[Agenda Server for LPC Meetings](#)

[LPC Offline Coordinators](#): Liz Sexton-Kennedy and Hans Wenzel

[Tracking](#): Kevin Burkett and Sasha Khanov

[Electron/Photon](#): Yuri Gershtein and Heidi Schellman

[Muon](#): Eric James and Martijn Mulders

[Jet/Met](#): Rob Harris and Marek Zielinski

[Trigger](#): Sridhara Dasu and Stephan Lammel

[Simulation](#): Daniel Elvira and Boaz Klima

Please click on the link to get to each group's web page.

# Workshops

Jan 2004: Jet/Met

Apr 2004: Muon

Aug 2004: tracking

Sep 2004: CMS101 course at FNAL

Sep 2004: Tev4LHC

Nov 2004: e/gamma

Nov 2004: CMS101 course at FNAL

Next Week

# University Involvement

edm/tools: Northwestern, Nebraska

e/gamma: Brown, Northwestern, Minnesota, Florida State, Yale

Muon: Carnegie Mellon, Northeastern, Northwestern

jet/met: Rochester, Maryland, Rutgers, Florida

Trigger: Wisconsin, Florida, Northwestern

Simulation: Notre Dame, UIC, Kansas, Maryland

Tracking: Nebraska, UC Davis, Rochester

# Summer activities

- Build experts/community by forming working groups in each area of particle ID.
- Within working groups, study the current code and understand the strengths/limitations of current CMS software.
- Encourage US CMS to send people to LPC to interact with the working groups. Make *\*all\** of US CMS feel ownership of the LPC.
- Plan 11<sup>th</sup> floor layout and seating; Purchase and construct 11<sup>th</sup> floor
- build computing environment and support system



# Advisory Council Review of LPC

[ last update: Friday 22 October 2004 ]

**Date/Time:** Friday 22 October 2004 from 08:00 to 18:00**Location:** FNAL, Hornet's Nest**Chairperson:** [Eno, S.](#)

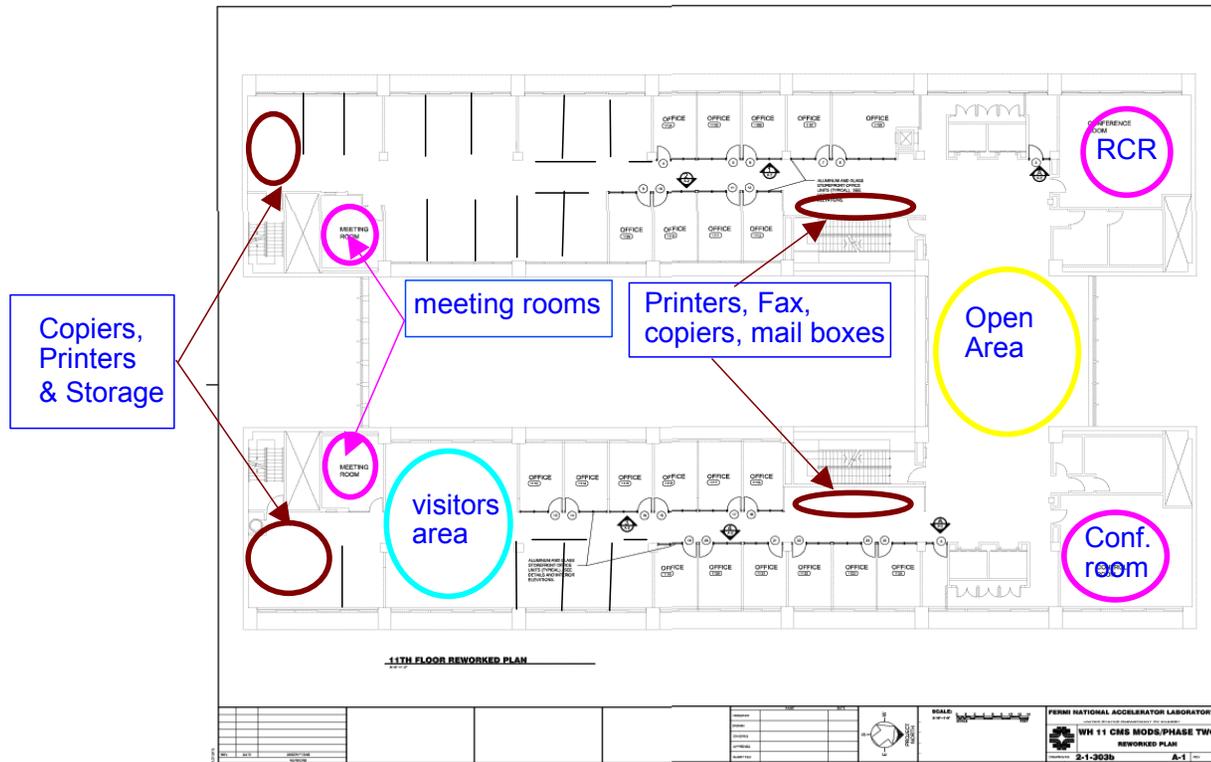
Friday 22 October 2004

11:00	<b>Introductory Comments</b> (05)	Mike Witherell
11:05	<b>Overview of the LPC</b> (15) ( <a href="#">more information</a> )	S. Eno
11:20	<b>LPC Facilities</b> (10) ( <a href="#">more information</a> )	K. Maeshima
11:30	<b>LPC computing and software environment</b> (15) ( <a href="#">more information</a> )	<a href="#">Hans Wenzel</a>
11:45	<b>EDM</b> (15) ( <a href="#">more information</a> )	Liz Sexton
12:00	<b>Tracking</b> (30) ( <a href="#">more information</a> )	Kevin Burkett/ Sasha Khanov
12:30	<b>e/gamma</b> (30) ( <a href="#">more information</a> )	Yuri Gershtein, Heidi Schellman
13:00	Lunch	
14:00	<b>Trigger</b> (30) ( <a href="#">transparencies</a> )	Sridhara Dasu/ Stephan Lammel
14:30	<b>Muons</b> (30) ( <a href="#">transparencies</a> )	Eric James/ Martijn Mulders
15:00	<b>Simulations</b> (30) ( <a href="#">more information</a> )	Daniel Elvira, Boaz Klima
15:30	<b>Jet/Met</b> (30) ( <a href="#">more information</a> )	Rob Harris/ Marek Zielinski
16:00	<b>Concluding Remarks</b> (05) ( <a href="#">transparencies</a> )	Avi Yagil
16:05	<b>Close Out</b> (55)	Advisory Council/ Eno/ Yagil

# 11<sup>th</sup> Floor (Kaori Mashima)

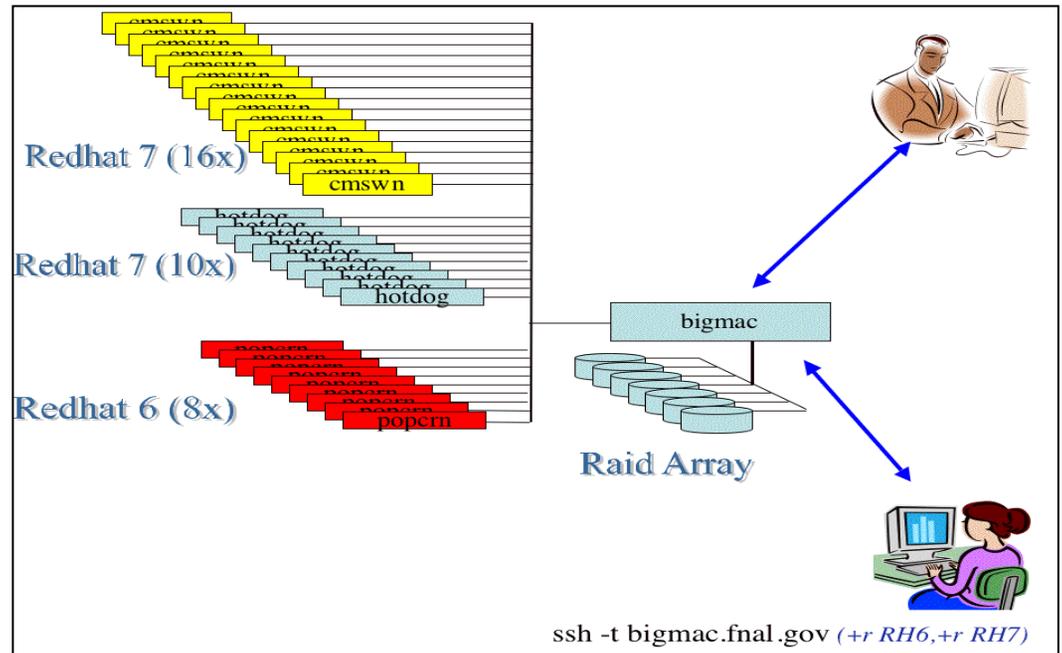


## 11<sup>th</sup> Floor General Factionality Plan



# Example, UAF (Hans Wenzel)

- Commissioned a facility for analyzing CMS physics data
  - Large simulated data samples to be analyzed for physics TDR
  - Emerging user base at Fermilab - LHC Physics Center (LPC).  
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

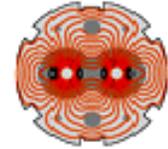


# Example, Jet/Met

## (Robert Harris & Marek Zielinski)



### Ongoing Efforts II - HCAL/Test Beam



- TB2002-TB2004 analysis -- data taking finished this Monday
  - Extraction of key parameters for detector simulation and event reconstruction
    - Pulse shape, pulse timing, electronics noise, ADC-to-GeV, etc.
  - Checking detector effects
    - Gaps, uniformity, abnormally large signal, etc.
  - Development of algorithms for calibration, monitoring and data validation
  - Test of GEANT4 physics
    - $e/\pi$ , resolution, longitudinal & transverse shower profiles
    - 3--300 GeV beams, with particle-ID ( $p$ ,  $K$ ,  $\pi$ ,  $e$ ) below 9 GeV
- Physics benchmark studies starting – Goals:
  - Identify issues in reconstruction and triggering, develop/improve algorithms
  - Provide experience of physics analysis to young members
- Software development and maintenance
  - JetMET RootMaker (J. Damgov)
  - HF Shower library (T. Yetkin)
  - HCAL database

# Example, Tracking

(Sasha Khanov & Kevin Burkett)

## Future Plans for LPC Tracking Group (I)

- For current group members, we are considering a series of projects:
  - Studies of tracking in more realistic environment
  - Studies of tracking without pixels using current algorithms (A. Dominguez)
  - Development of tools for measuring tracking performance in real data
    - \* Evaluation of material distribution in the tracker using conversions
    - \* Determination of  $p_T$  resolution from observed width of resonances (e.g.  $J/\psi \rightarrow \mu^+\mu^-$ )
    - \* Track embedding for track finding efficiency measurements
  - Silicon-only outside-in tracking algorithm (does not exist currently)
    - \* Most are needed for Physics TDR but none are well-covered
- New groups are joining, some with projects they have already chosen
  - e.g. Neeti Parashar (La.Tech) will work on forward pixel geometry/alignment
    - \* Currently not well-covered for Physics TDR
    - \* Coincides well with hardware work of La. Tech group

# 1<sup>st</sup> Adv. Board Review

- Letter can be found in:

<http://mit.fnal.gov/~paus/lpc/>

Some carefully chosen quotes:

- “The board was unanimously impressed by the amount of progress that has been made in the first half year since the foundation of the LPC. “
- “Our initial concerns about the success of such a center have been carefully addressed by you and the other LPC members. “
- “We are quite encouraged by the excellent support for the foundation of the center from all involved parties, and especially from FNAL.”

Please take a look...

# Main Current Commitments

- Contribute to CMS Computing Model and Data Management definitions
- Leading, organizing and hosting a comprehensive CMS software re-engineering effort
  - As a part of this, define the CMS analysis data structure
- Jet/Met code development & maintenance
- Develop a new, Si-only tracking algorithm

# Status & Summary

Benefit from:

- CDF/D0/CMS sharing of RA's
- PPD/CD/Tier1/RP cooperation
- 11<sup>th</sup> Floor nearing completion (Kaori Maeshima)  
Expected move - Mid Dec
- Strong interest and participation from University community
- Well integrated into CMS collaboration

under discussion: Joint LHC/CMS "control" room in hi-rise

# Tevatron -> LHC Transition

- The big concern (e.g. HEPAP meetings):  
How to manage the transition gracefully
- Tension:
  - Exploit RunII data (have only ~10% of expected RunII data sample!!)
  - Move to LHC in order to establish bona fides prior to first data
- Given the schedules, uncertainties - tough decision!
- The LPC is a planned attempt to allow for a smoother, US based, and cost effective multiplexing of physicists so that they can work simultaneously on CDF/D0 and LHC.