



Material for FNAL Review: May 2013

Kalanand Mishra, Fermilab

Summary: contribution to calibration & upgrade



☑ Jet commissioning (JES, jet ID) with early data in 2008–10

- JES absolute calibration using Z+jet balance (included in the JINST paper on jet commissioning in CMS)

☑ Commissioning of electron with early data → calibration using Z peak

- Led Egamma electron reco, ID & trigger efficiency subgroup in 2008–10

☑ Led development of CMS Tag&Probe tool for lepton efficiency measurements

Calibration works for POGs resulted in ≥ 5 ANs + 1 PAS + 1 publication

New

Currently contributing to CMS Level-1 trigger upgrade (stages 1,1b,2)

- improvements in L1 calorimeter triggers, muon isolation

Details of upgrade activities: Level-1 trigger



- The current Level-1 triggers will severely compromise CMS physics capability at 13 TeV, 50–100 pileup
 - E.g., single lepton threshold at HLT to go up to ~50 GeV
 - Will lose most of W,Z,top, Higgs events
 - Similar issues with jet, MET, tau, b-tag, cross triggers
- Having painfully dealt with the HLT rate increase of ℓ +jj triggers, I decided to invest my effort on L1 upgrade
 - Working closely with Andres Osorio, Christian Vega (FIT & LPC) and Sergo Jindariani
 - Goal is to improve L1 objects in calorimeter by doing pileup subtraction in isolation computation and better algorithms
 - We started with performance studies, rate and efficiency computation etc, provided feedback for L1 upgrade TDR

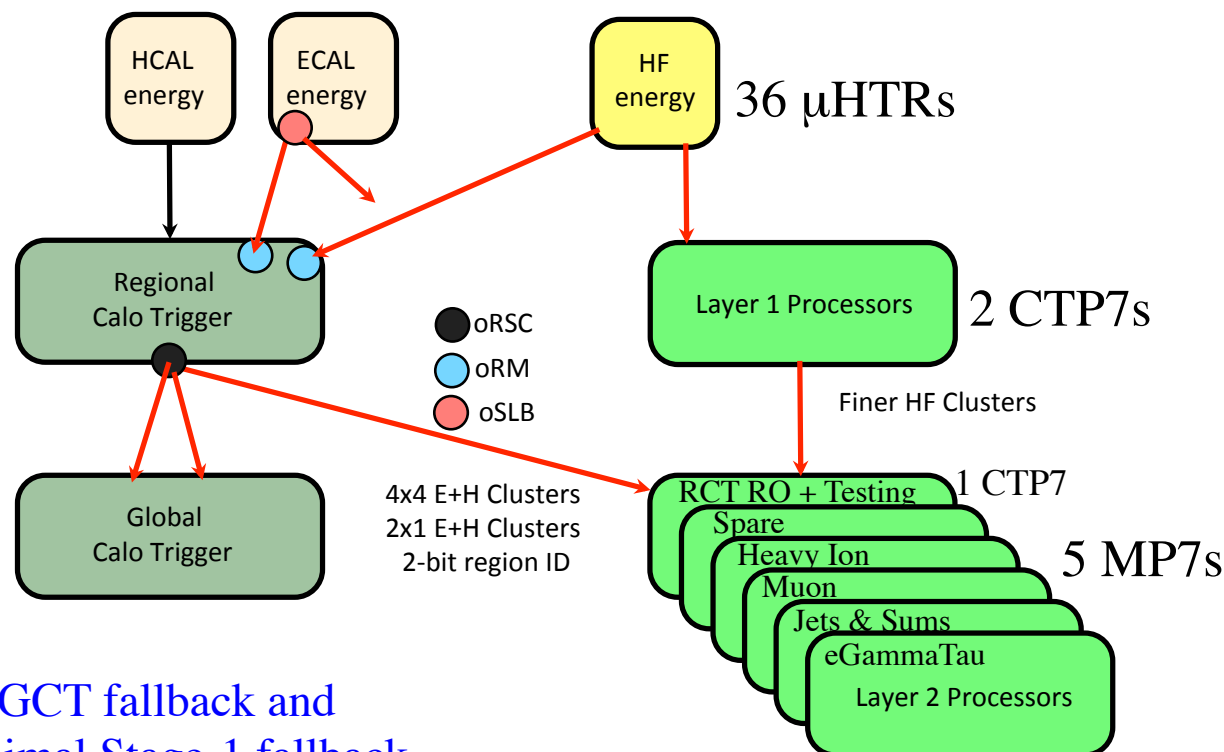


CMS L1 trigger upgrade: the stage-1 plan

The Stage-1 uses reprogrammed RCT clusters with improved algorithms in Layer-2
Also, brings in all the power of finer grain HF using “Slice Test” of Layer-1 & 2

Better stage-1 (a.k.a. “stage-1b”) plan: EM improved

- Can bring forward all the power of finer grain EM Clusters from 2015
- Uses 9 Layer-1 (CTP7) Processor cards – later used in the Stage-2 System
- Improved PU subtraction, Isolation, and Half-tower Position Resolution

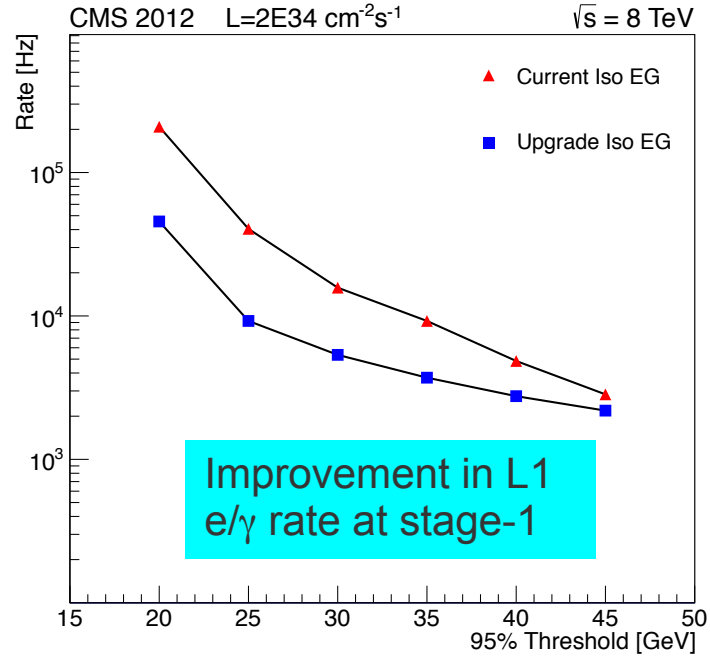
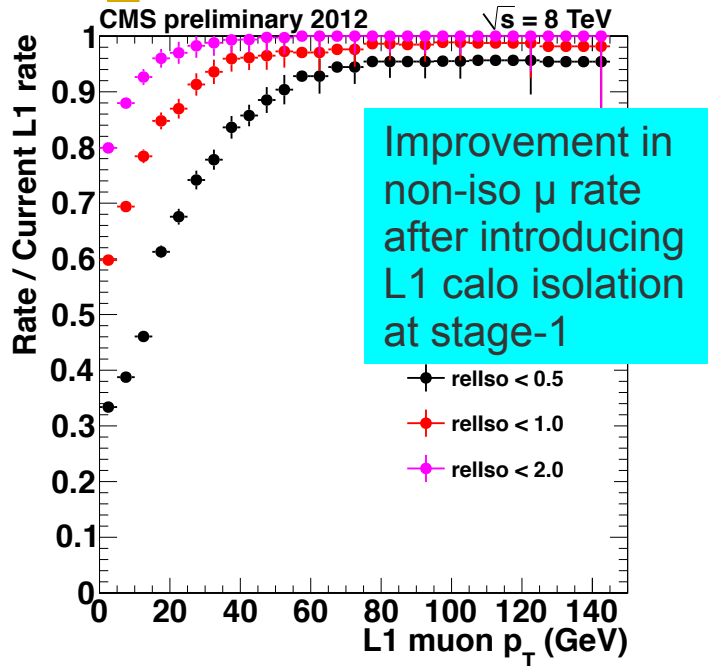


GCT fallback and Minimal Stage-1 fallback remains available

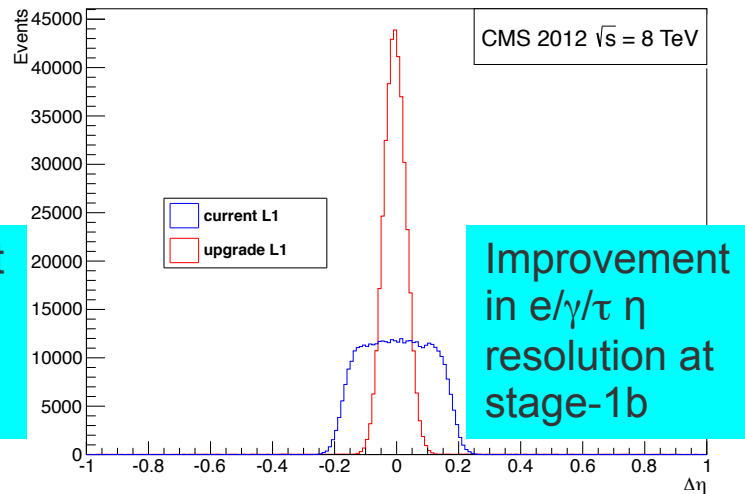
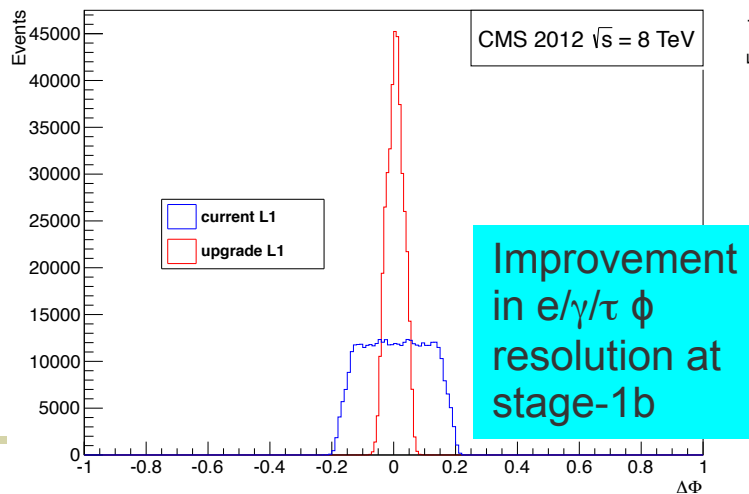
Derive all the benefits of HF

Replace Source Card system with oRSC: **x6 duplicator 6.4 Gbps** + **1x leaf card compatible**
More sophisticated GCT => improved τ -logic, e/ γ / μ / τ isolation, HF jets, PU subtraction ...

Some key performance studies



Examples of performance studies carried out by FNAL team (KM, S. Jindariani, A. Osorio, C. Vega)



We work closely with Wisconsin folks

Summary: physics analysis



2010
36 pb⁻¹

Inclusive W,Z cross
section and properties

2 papers, published in JHEP



2011
5 fb⁻¹

M_{jj} in W+2-jet events

Published in PRL



2011
5 fb⁻¹

Jet substructure in dijet
and W/Z+jet events

Accepted, JHEP

Published
in 2013

WW+WZ semi-leptonic:
xsection & anomalous
gauge couplings

Published in EJPC



2012
5 fb⁻¹

H→WW semi-leptonic:
excl. limit in 2M_W-600 GeV

Submitted to EJPC, use data
up to ICHEP12

2012
19 fb⁻¹

H→WW semi-leptonic

Approved public results for
HCP12, Moriond13, LHCP13

Details of physics contribution



Inclusive W,Z analysis: Co-led the Z analysis team, delivered the first cross section results for ICHEP 2010, and two papers with 3 pb⁻¹ & 36 pb⁻¹. A high visibility analysis.

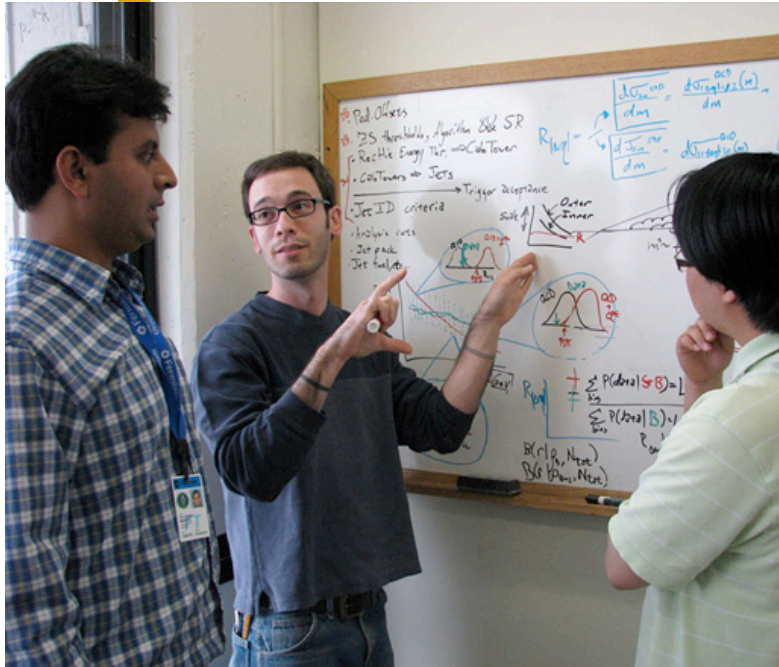
M_{jj} in W+jj analysis: Co-led the analysis team; edited the paper. Exclude CDF bump & several models to explain the effect (technicolor, leptophobic Z'). A high visibility analysis.

Diboson WW/WZ → ℓνjj: Led the analysis effort, edited the paper. The most stringent limits on anomalous triple gauge couplings at a hadron collider, in some cases improving upon the LEP results.

H → WW → ℓνjj: Led the analysis effort. Exclude SM Higgs in mass range 170–600 GeV. Part of high mass Higgs paper. Important channel for 2012 analysis of VBF/ WW scattering.

Jet substructure: First comprehensive study of boosted jets in dijet and W/Z+jet events in CMS. Part of the 4-member of analysis team.

Activities at LPC, Snowmass, BOOST,



LPC Fellow for 2013

Taught CMSDAS jet short & long exercises in 2010, 2011, 2012, 2013.

Snowmass 2013: Energy Frontier Workshop on QCD Physics

31 January 2013
Fermilab
US/Central timezone

Search

Scale choices for complex processes

Kalanand MISHRA

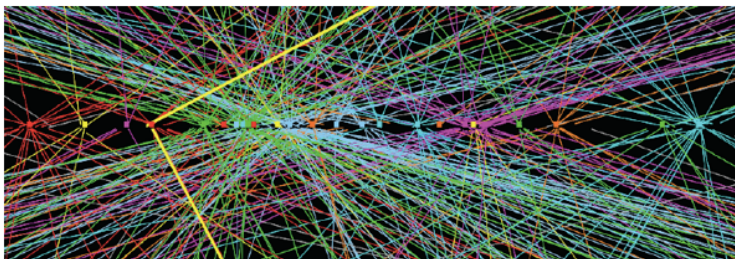
WH11NE (Sunrise), Fermilab

13:00 - 13:40

Also provided initial help to the local LPC based effort on performance studies for future high luminosity LHC detectors.

Jet substructure performance at high luminosity BOOST 2012 working group

Conveners: Gregory Soyez and Ariel Schwartzman



Pile-up subtraction plus grooming

Coordinator: Mishra Kalanand

- Study the application of jet-areas pile-up subtraction during grooming
- Compare jet substructure performance with the use of pile-up subtraction after grooming (CMS approach)
- Consider all luminosity scenarios separately
- Figures of merit include: mass vs. number of vertices, mass resolution, S/\sqrt{B} , etc. <https://twiki.cern.ch/twiki/bin/view/Main/BOOST2012-pileup>

Other miscellaneous contributions



Anomalous Quartic Gauge Couplings

from 30 September 2013 to 02 October 2013 (Europe/Berlin) *TU Dresden*
Europe/Berlin timezone

I'm in the organizing committee (with C Grojean, M Herndon, B Jaeger, S Lammers, Y Maravin, J Reuter, T Schoerner-Sadenius, A Vest)

ASPEN 2014: "Frontiers in Particle Physics: From Dark Matter to the LHC and Beyond"

In the organizing committee with K Cranmer, M Papucci, T Volansky, J Zupan

- Organizing the first Hands-on Advanced Tutorial Sessions (**HATS**) at the LPC on **Jet Substructure** on May 29, 2013.
- Organizing LPC workshop on **Gauge Boson Couplings** on August 19-21, 2013.

Plans for the rest of the year



CMS Physics, upgrade

- ◆ Push the current 8 TeV analysis to publication
 - extend m_{WW} mass range >1 TeV for resonant WW searches
 - probe gauge couplings at the percent level
- ◆ Focus now on a deeper probe of EWSB using WW+ 2 tag jets events in VBF topology
 - Establish VBF WW signal, probe quartic gauge couplings
- ◆ Continue ramping up on CMS Level-1 trigger upgrade

Career

- ◆ Got selected as LPC fellow for 2013
 - plan to take advantage of this opportunity to travel to more conferences and work with more collaborators
- ◆ Look for tenure-track position in the academic year 2014

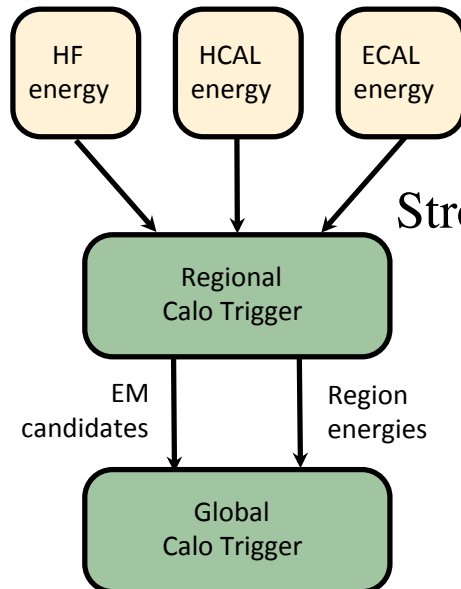
BACKUP SLIDES

L1 trigger hardware components



Type	Name	Purpose
TCC	Trigger Concentrator Card	Existing ECAL trigger primitives (TP)
oSLB	Optical Serial Link Board	Transmit ECAL TPs to RCT & CTP
μ HTR	HCAL Trigger & DAQ Board	Create and transmit HCAL TPs
RCT	Regional Calorimeter Trigger	Existing trigger system
oRM	Optical Receiver Modules	Receive ECAL TPs on RCT
oRSC	Optical Regional Summary Card	Convert & transmit RCT output/readout
CTP	Compact Trigger Processor	Large FPGA w/ optical & backplane
CIOX	Compact IO cross-point switch	Intra-crate sharing switch
MP7	Multipurpose Processor	Large FPGA w/ only optical links

Current L1 trigger system



Strengths worth retaining

- Programmable clusters using LUTs
 - Addressed by E & H TPGs
 - Independent Jet & eGamma paths
- Adder ASICs for bulk processing
 - 4x4 sums with low latency

New features worth acquiring

- Cross correlate “EM” and region clusters
- Ability to process all clusters in one FPGA
- Additional processing capability

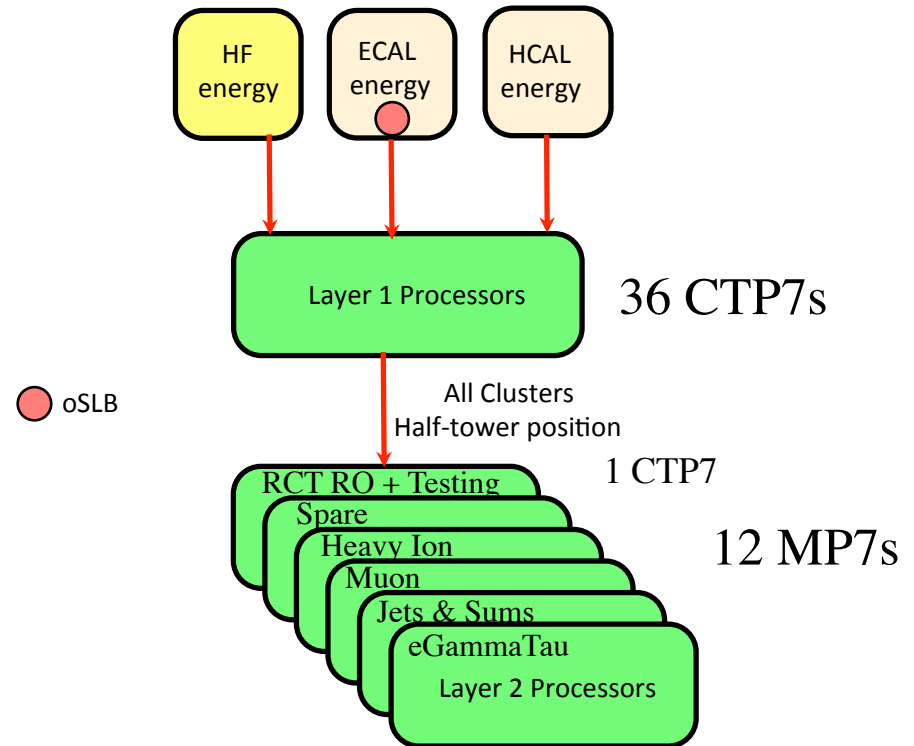
Stage-2 plan



Stage-2 – complete upgrade including optical input from HB/HE

The benefits from HB/HE upgrade are only seen after LS2, when improved HCAL signals and trigger primitives are available.

However, we are planning to finish the Stage-2 sooner (operating in 2016 per the approved plan), because it can remove the 4x4 constraint from the RCT in Stage-1, providing some improvement to jet trigger.



Derive all the benefits promised and expected when fully upgraded frontend and backend of HCAL (HB and HE)



People I work with: the lvjj team

Nural Akchurin¹, **Jake Anderson²**, Chayanit Asawatangtrakuldee¹¹, Andrea Benaglia³,
Andrew Beretvas², Jeffrey Berryhill², Pushpa Bhat², Sarah Boutle⁴, Chris Clarke⁵,
Fabio Colombo³, Analu Custodio¹⁰, Jordan Damgov¹, Leonardo Di Matteo³, Phil Duderø¹,
Ricardo Eusebi⁶, Pietro Govoni¹², **Dan Green²**, Joey Goodell⁴, Robert Harr⁵, Pratima Jindal¹³,
Ajay Kumar⁷, Kristina Krylova⁵, Kevin Lannon⁹, Sung-Won Lee¹, Qiang Li¹¹, Shuai Liu¹¹,
Wuming Luo⁹, Yajun Mao¹¹, Kellen McGee⁵, **Kalanand Mishra²**, Md. Naimuddin⁷,
Chris Neu⁴, Ilya Osipenkov⁶, Alexx Perloff⁶, Kirti Ranjan⁷, Sasha Sakharov⁵, Ram K
Shivpuri⁷, Kevin Siehl⁵, Andre Sznajder¹⁰, **Nhan V. Tran²**, Zijun Xu¹¹, Weimin Wu²,
John Wood⁴, **Fan Yang²**, Francisco Yumiceva², and Wei Zou¹¹

¹ Texas Tech University, Lubbock, Texas, USA

² Fermi National Accelerator Laboratory, Batavia, Illinois, USA

³ Milano-Bicocca University and INFN, Milan, Italy

⁴ University of Virginia, Charlottesville, Virginia, USA

⁵ Wayne State University, Detroit, Michigan, USA

⁶ Texas A&M University, College Station, Texas, USA

⁷ Delhi University, Delhi, India

⁸ University of Nebraska at Lincoln, Nebraska, USA

⁹ University of Notre Dame, Notre Dame, Indiana, USA

¹⁰ Universidade do Estado do Rio de Janeiro (UERJ), Brazil

¹¹ Peking University, China

¹² CERN

¹³ Princeton University, New Jersey, USA

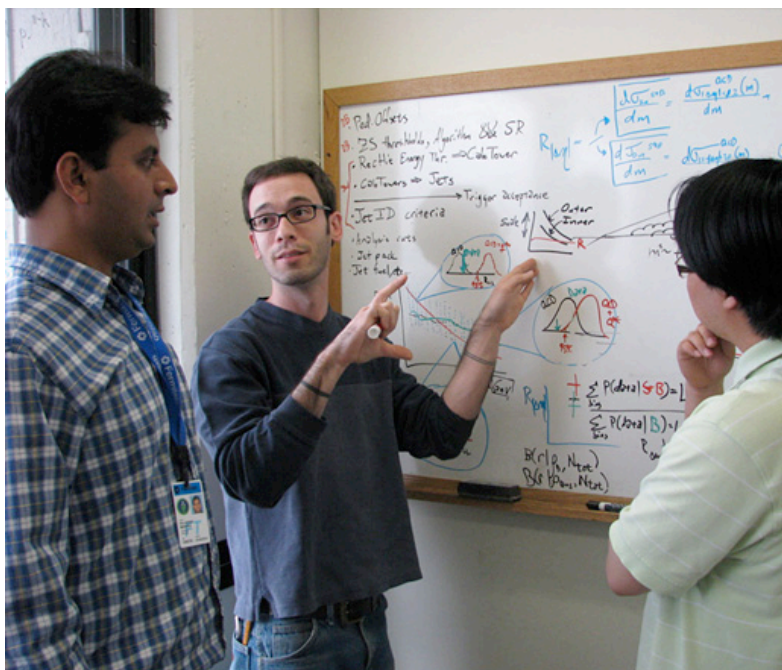
**Well established
team, well oiled
machinery**

**Supervisor
at FNAL:
Jeffrey
Berryhill**

LPC Fellow for 2013: my activities at LPC



- 1) Taught/facilitated CMSDAS jet short & long exercises in 2010, 2011, 2012, and 2013 including the ones at Pisa and Taipei
- 2) Regularly help LPC-based students with physics & data analysis



<http://lpc.fnal.gov/>

- 3) Mentored a number of undergrad and graduate students at LPC

2013: Kevin Siehl (Wayne State), Cristian Vega (Universidad San Francisco de Quito, **UG**)

2012: Wei Zou (Beijing), Ajay Kumar (Delhi), Kevin Siehl (Wayne State), Geoffrey Fatin (Buffalo, **UG**), Joseph Flanigan (Wayne State, **UG**)

2011: Kristina Krylova (Buffalo, **UG**), Kellen McGee (Johns Hopkins, **UG**)

2008–10: Mikhail Makouski (Kansas State), Sunil Bansal (Panjab, India), Mehmet Deliomeroğlu (Bogazici, Turkey), Kittikul Kovitangoon (Texas Tech), David Bjergaard (Johns Hopkins, **UG**)

Summary of my Snowmass 2013 activities



Snowmass 2013: Energy Frontier Workshop on QCD Physics

31 January 2013
Fermilab
US/Central timezone

Search

13:00

Scale choices for complex processes

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WH11NE (Sunrise), Fermilab

13:00 - 13:40

To the Snowmass QCD report, I am contributing to sections on jet substructure (boosted systems), and scale choice and jet veto in top/Higgs/electroweak processes.

◆ I also provided initial help to the local LPC based effort on performance studies for future high luminosity LHC detectors.