



Introduction & Plans

Kalanand Mishra, Fermilab

LPC Fellows Kickoff Meeting
(January 11, 2013)

Brief introduction



- Currently:

Postdoc at Fermilab CMS Center since 2008

- Past:

- Ph.D. (2008), Univ. Cincinnati, BaBar experiment at SLAC
- Measured quark mixing (CKM) phase γ using $B \rightarrow D^{(*)}K^{(*)}$ decay, set limits on CP violation in charm decays
- Ran Cherenkov detector operations, hardware upgrade
- Developed particle identification

Contribution to CMS detector 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

Currently contributing to CMS Level-1 trigger upgrade project

- improvements in L1 calorimeter triggers
- muon isolation in L1

Past physics analyses w/ significant involvement



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
	↓	
	WW+WZ semi-leptonic: xsection & anomalous gauge couplings	Published in EJPC
	↓	
	H→WW semi-leptonic: excl. limit in 2M _W -600 GeV	To be submitted to EJPC, use data up to ICHEP12
2011 5 fb ⁻¹	Jet substructure in dijet and W/Z+jet events	To be submitted to JHEP
2012 5-12 fb ⁻¹	H→WW semi-leptonic	Approved public results for ICHEP, HCP

Physics contributions & accomplishments



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.

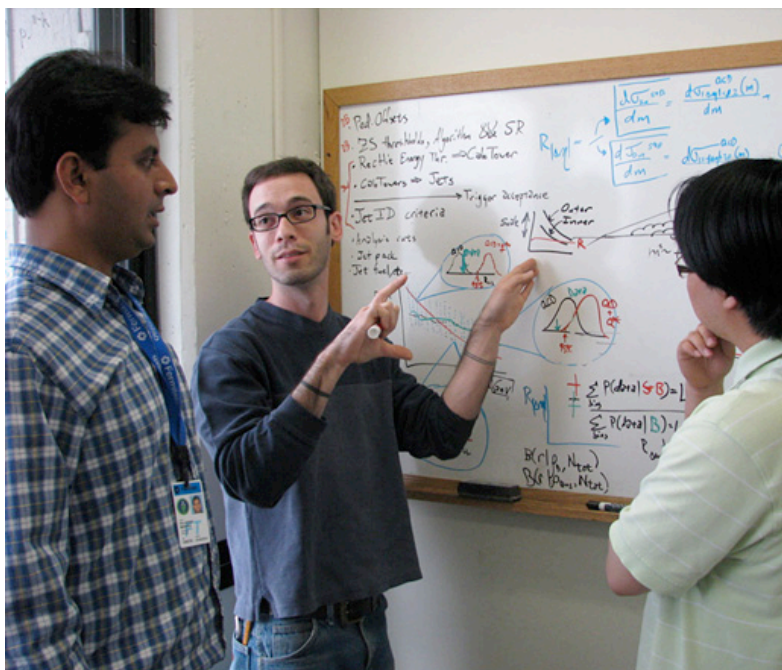
H → WW → ℓνjj: Led the analysis effort. Exclude SM Higgs in mass range 170–600 GeV. Important channel for 2012 analysis of VBF/WW scattering.

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

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



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

- 3) Have mentored a large number of undergraduate and graduate students at LPC

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**)

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**

Thinking of future: weak interaction @ high E

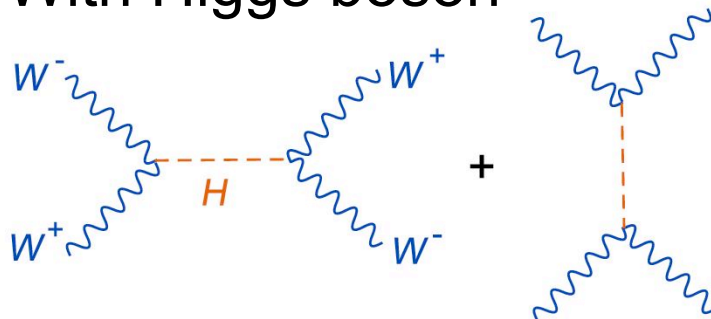


Without Higgs boson, WW scattering becomes divergent

$$= \frac{g^2 E^2}{2m_W^2} (1 + \cos \theta)$$

unitarity violated:
grows as E^2

With Higgs boson



$$= -\frac{g^2 E^2}{2m_W^2} (1 + \cos \theta)$$

no problem now!

Higgs exchange needed to prevent **unitarity** violation in WW scattering at high energies or **New Phenomena** possible. With 20/fb, $lvjj$ sensitive to weakly produced NP at 1 TeV.

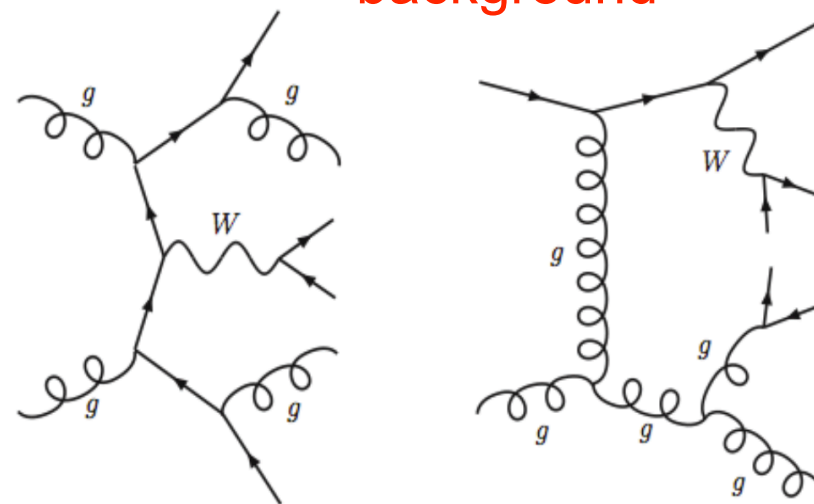
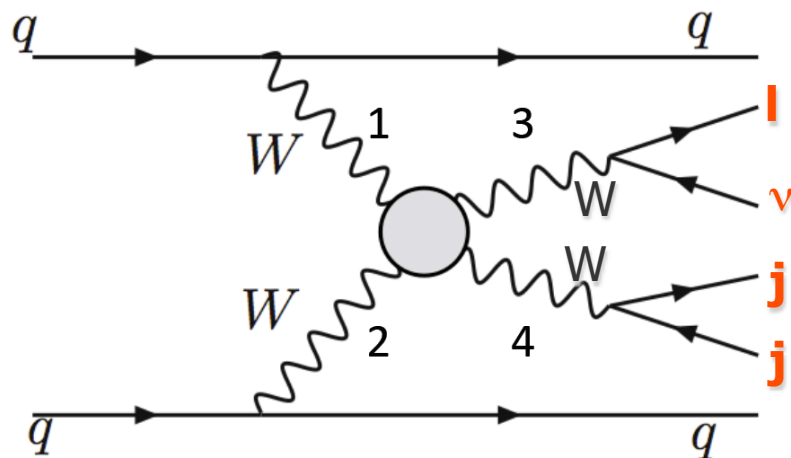
Ballestrero et al, JHEP 1205, 083 (2012) [arXiv:1203.2771]

Signal over noise



background

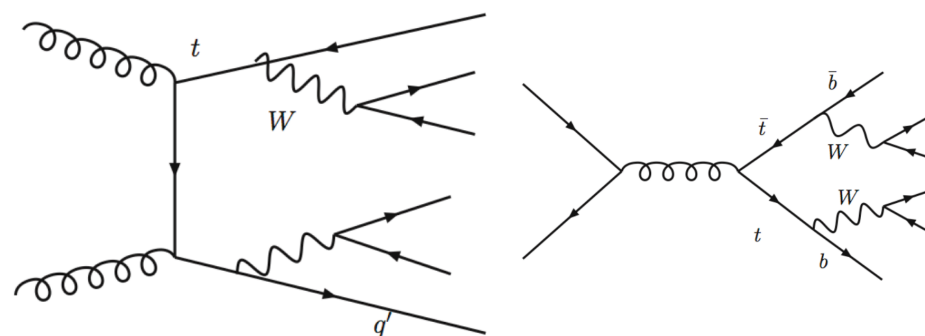
Signal: probes the quartic coupling



W+2jets+2tag jets: ~ 10 pb

WW+2tag jets: ~ 1 pb

- Large $\Delta\eta$ between tag jets
- Invariant mass > 500 GeV
- Standard WW selection



$t\bar{t}$ +2 tag jets: ~ 10 pb

Future analysis plans



- Reload the current analysis with full 8 TeV data for Moriond
 - push the m_{WW} mass range up to 1 TeV for Higgs analysis
 - probe triple gauge couplings at the percent level

- Focus now on a deeper probe of EWSB using WW+ 2-tag jet events in VBF topology
 - Need to first establish VBF production of WW
 - Check if data consistent with H(125) unitarized WW→WW scattering, probe quartic gauge couplings
 - Probe existence of weakly produced WW resonances

- Also interested in $H \rightarrow b\bar{b}$ in associated production mode (WH) and boosted topology using jet substructure

- Continue contributing to CMS Level-1 trigger upgrade