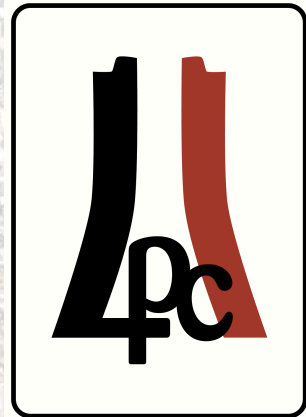


Hadronic SUSY Searches and HCAL Data Performance for 2016

Kenichi Hatakeyama
Baylor University

LPC Distinguished Researcher 2016

May 24, 2016





Summary of My Projects

- **Inclusive SUSY search (RA2/b, SUS-15-002)**
 - Generic SUSY search in all-hadronic final state with HT and MHT variables
 - Collaboration: [Baylor](#), [Colorado](#), [FNAL](#), [FSU](#), [Hamburg](#), [IISER Pune](#), [TIFR](#), [TAMU](#), [UCR](#), [UCSB](#)

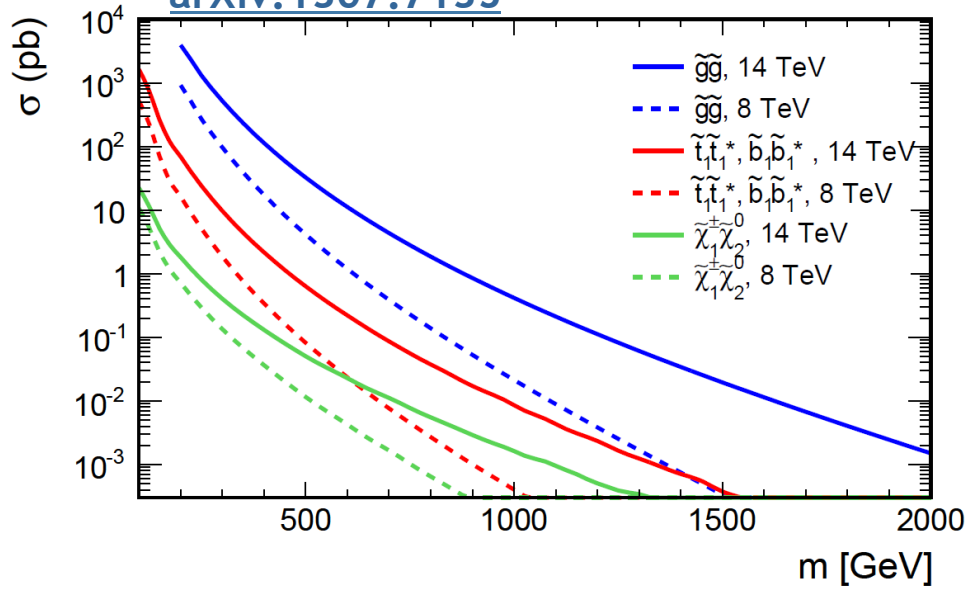
- **SUSY search with top quark tagging (SUS-15-007/009)**
 - Search for SUSY signatures with top quarks in the final state - direct and gluino-mediated top squark production
 - Collaboration: [Baylor](#), [FNAL](#), [FIU](#), [NISER](#), [IISER Pune](#), [UCR](#), [UIC](#), [Puerto Rico](#)

- **HCAL data performance group (HCAL DPG)**
 - Reconstruction algorithm, noise rejection, data quality monitoring, software development & validation (including phase 1 upgrade software), trigger developments, calibration
 - Collaboration: [Baylor](#), [Bristol](#), [Brown](#), [Caltech](#), [FNAL](#), [MIT](#), [Notre Dame](#), [Rochester](#), [Rockefeller](#), [Rutgers](#), [KSU](#), [Iowa](#), [IISER Pune](#), [TIFR](#), [RDMS](#)

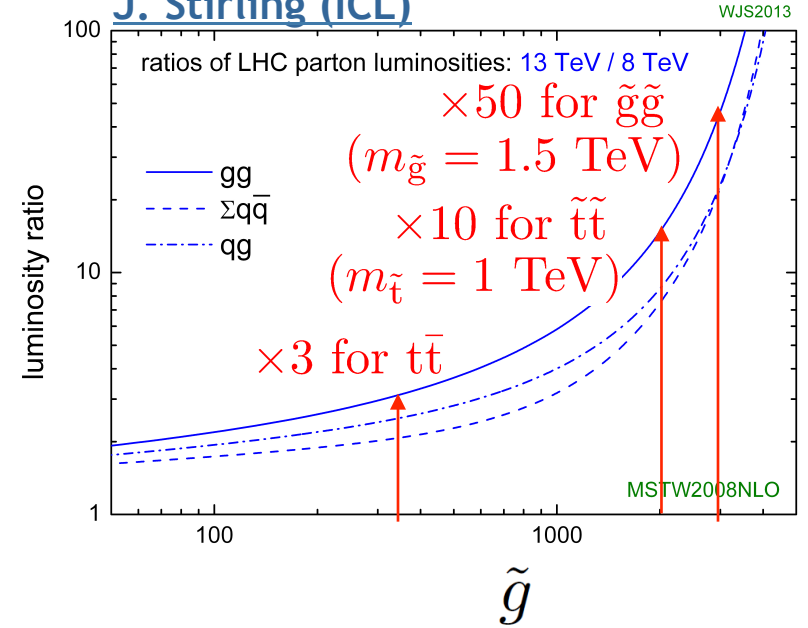


SUSY Searches at 13 TeV

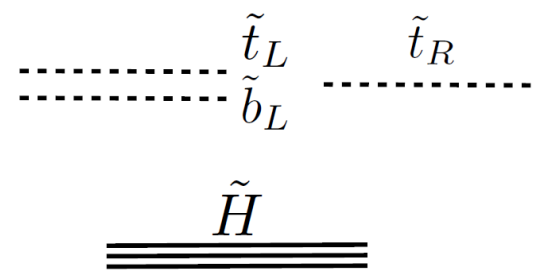
[arXiv:1307.7135](https://arxiv.org/abs/1307.7135)



J. Stirling (ICL)



- Natural SUSY is one motivation to expect light gluinos, stops, sbottoms, and higgsinos at electroweak scale
- Gluinos, stops, sbottoms are produced strongly – largest cross sections, branching fractions – good sensitivity from the beginning of Run 2



natural SUSY

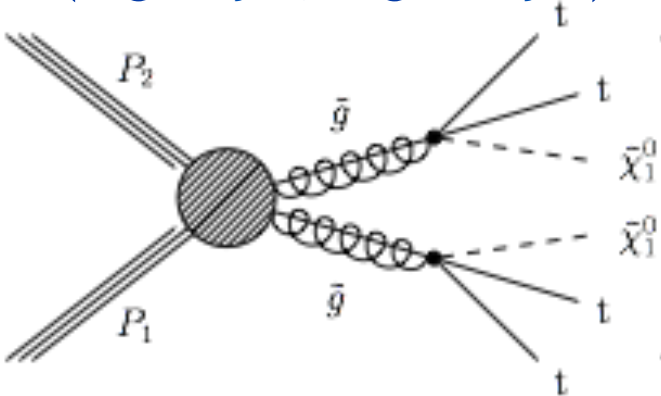
[arXiv:1110.6926](https://arxiv.org/abs/1110.6926)

Inclusive SUSY Search - RA2/b

- Inclusive fully-hadronic analysis targeting strong production of gluino pairs decaying to jets + missing energy
 - General enough to be sensitive to a variety of gluino/squark decays
- Search binned in simple variables MHT, HT, N_{jets} , and $N_{\text{b-jets}}$
 - $N_{\text{jets}}=4-6, 7-8, 9-;$ $N_{\text{b-jets}}=0,1,2,3-$
- SM backgrounds estimated with robust data-driven methods
 - Main background: $W+\text{jets}$, $t\bar{t}$, $Z(\text{inv})+\text{jets}$, QCD multijets
- Analysis is sensitive to a wide range of strong SUSY models:

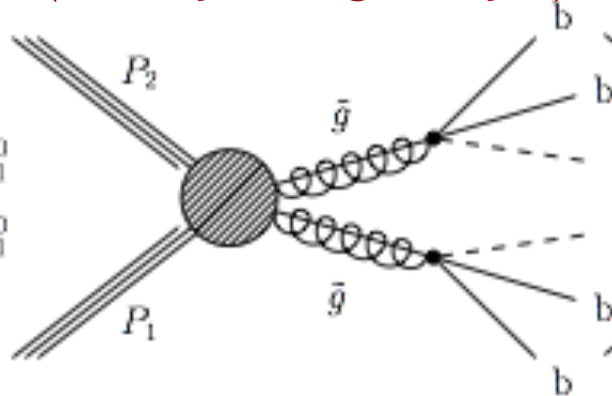
T1tttt

(high N_{jets} , high $N_{\text{b-jets}}$)



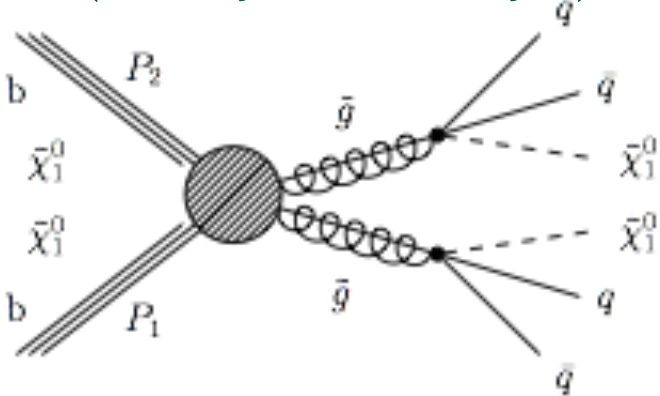
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(low N_{jets} , high $N_{\text{b-jets}}$)



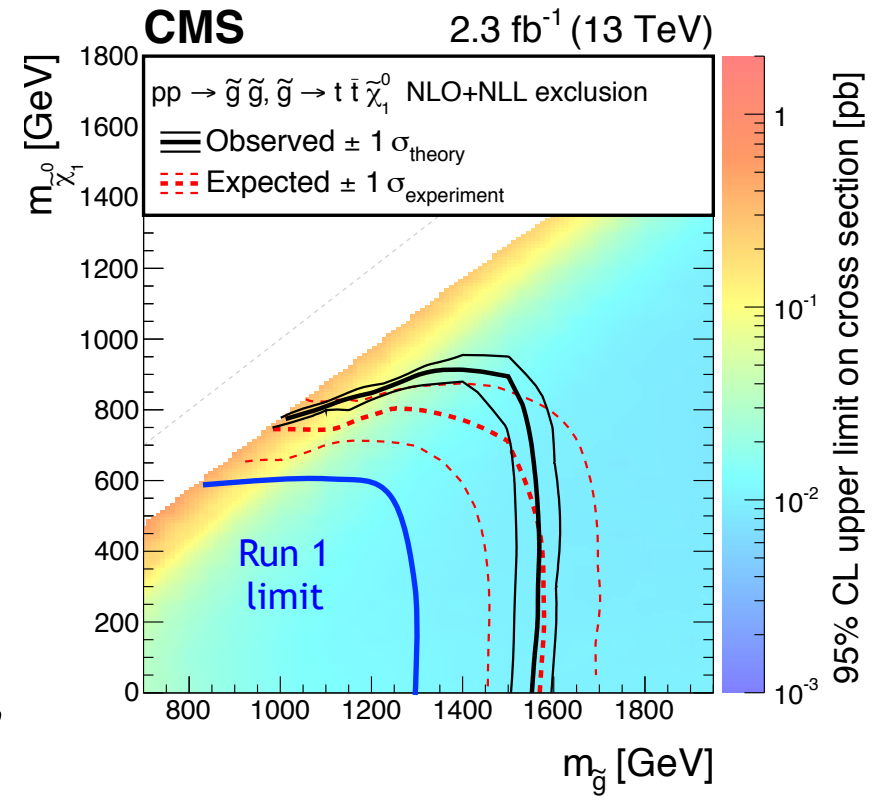
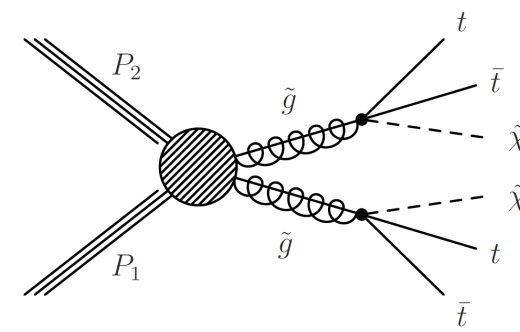
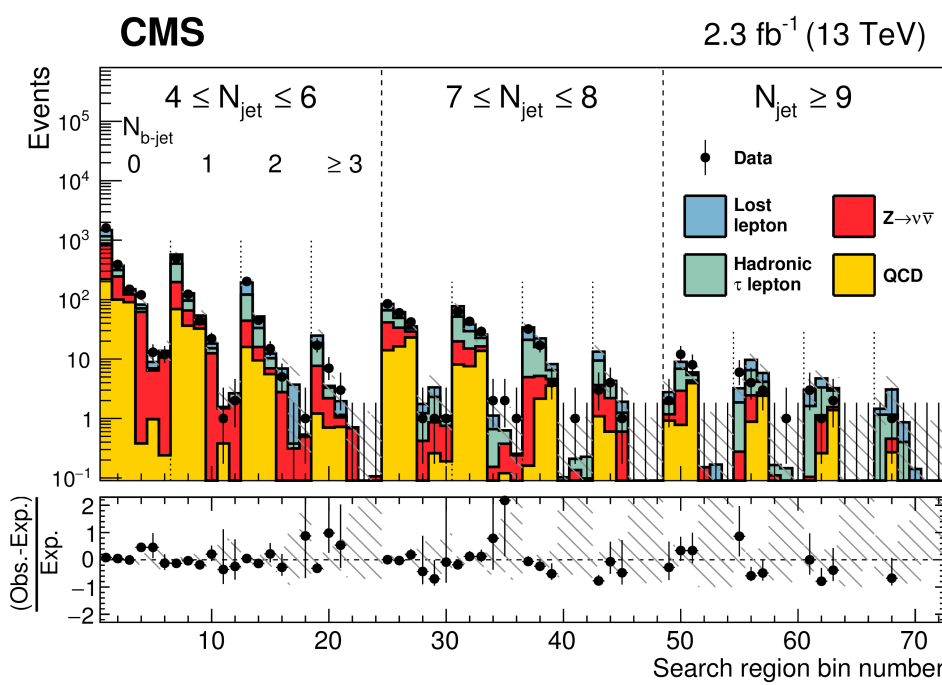
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(low N_{jets} , low $N_{\text{b-jets}}$)



Results

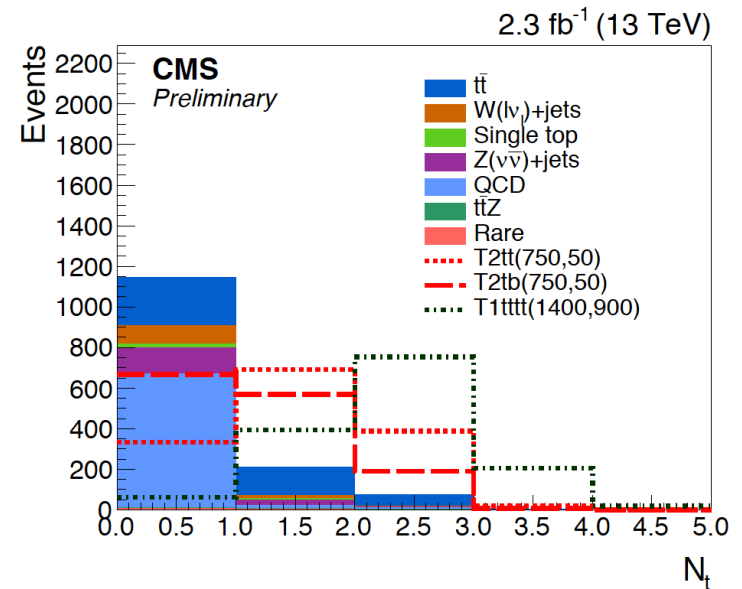
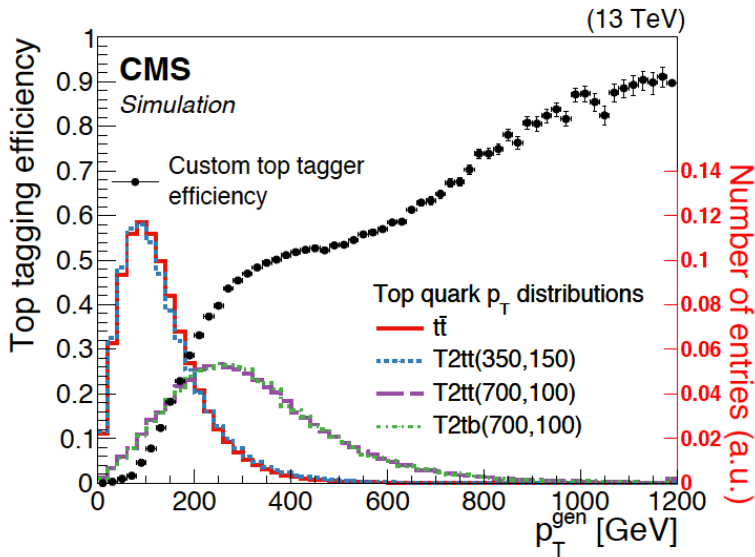
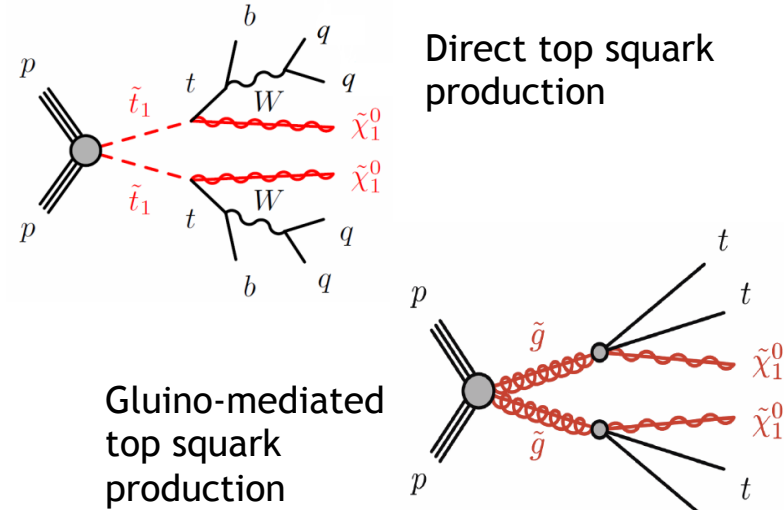
PLB 758
(2016) 152



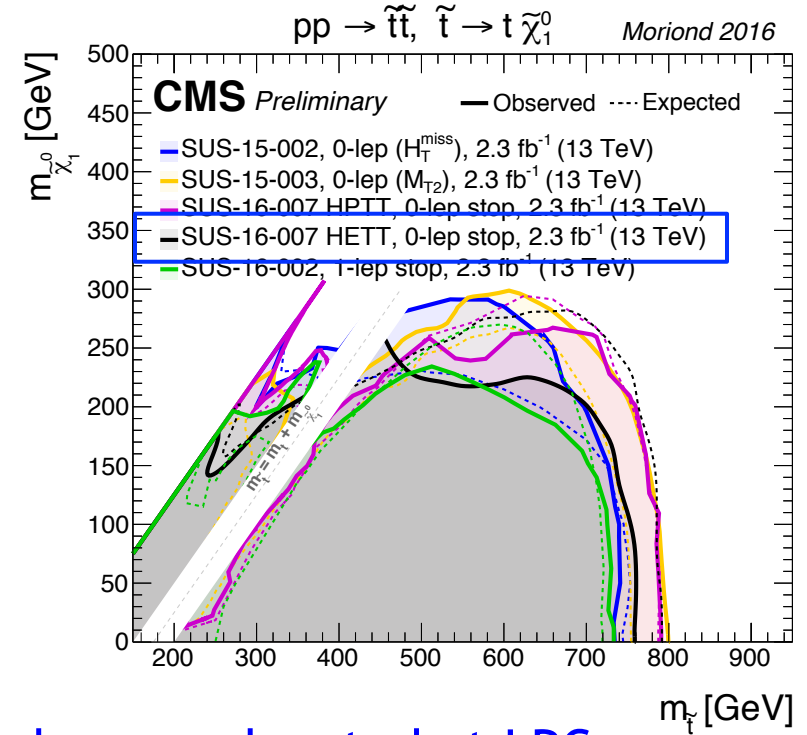
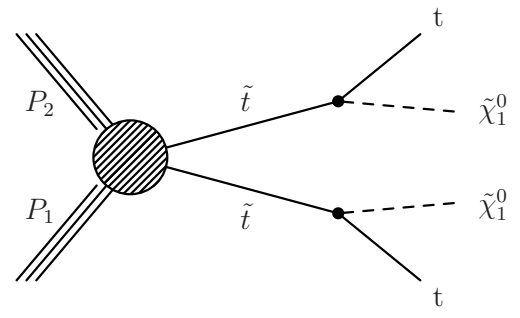
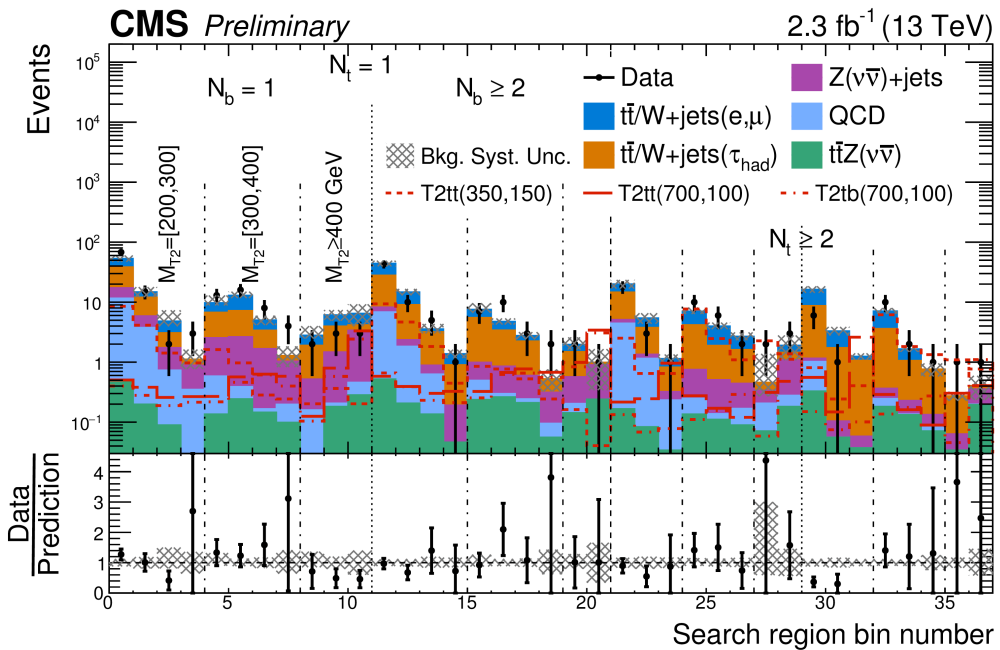
- Observations are consistent with background predictions
- Significantly extending the Run1 exclusion limits
- Presented at the Dec. Jamboree, first SUSY publication @ 13 TeV

Stop Searches with Top Tagging

- SUSY signatures involving top squarks often have top quarks in the final state
- Use top quark tagging to identify such events and top candidates to define kinematics such as M_{T2}
- Use customized high eff. top tagger
- Events are binned in N_{tops} , $N_{\text{b-jets}}$, MET, M_{T2}



Results



- Extending the Run1 exclusion limits
- Shown at the Moriond 2016, publication underway

A large fraction of the team members are located at LPC

HCAL Data Performance Group (DPG)

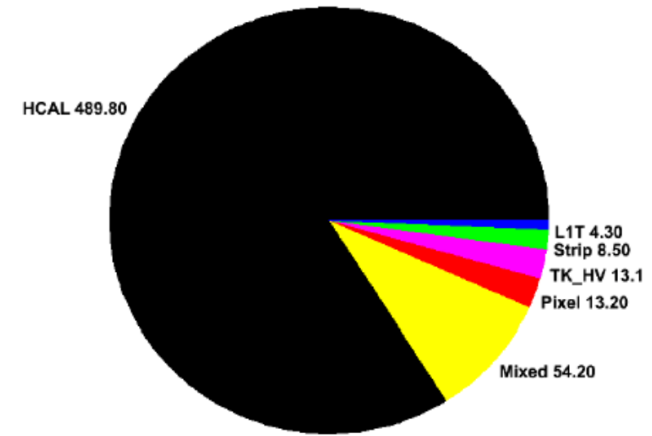


- I started as the CMS HCAL DPG co-convener starting in February 2016, joining John Paul Chou from Rutgers (2014 LPC DR)
- Two main thrusts of the HCAL DPG group in 2016:
 - Re-organization of data quality monitoring and certification process
 - Preparations for Phase 1 upgrade reconstruction software
- Other important ongoing tasks
 - Improve Method 2 - our default reconstruction method for Run 2, in particular pulse shape and goodness of fit for better performance at high energies
 - Detailed calibration of HB/HE/HF
 - Isotrack selection re-tuning for Run 2 conditions is being worked
 - Improvements to $Z \rightarrow ee$ calibration of HF underway
 - Fully commission fine-granularity HCAL trigger primitives

HCAL Data Quality Monitoring

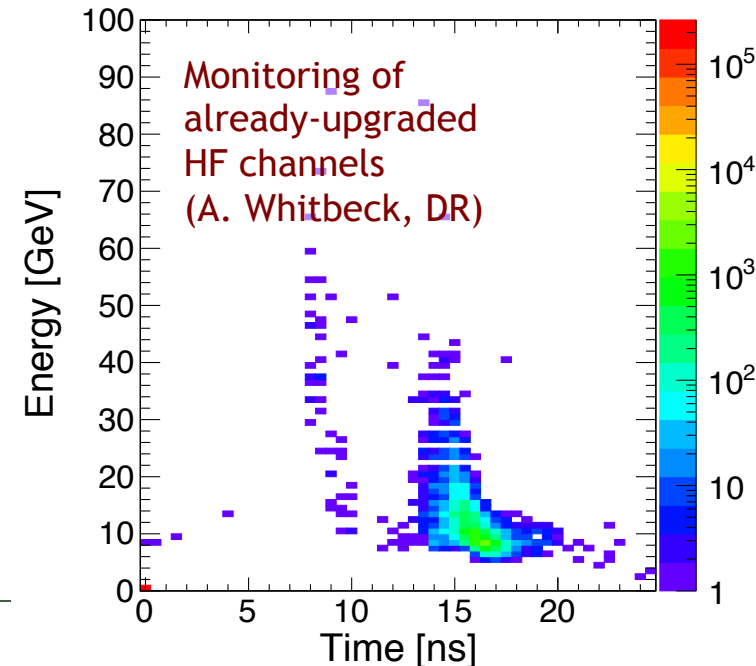
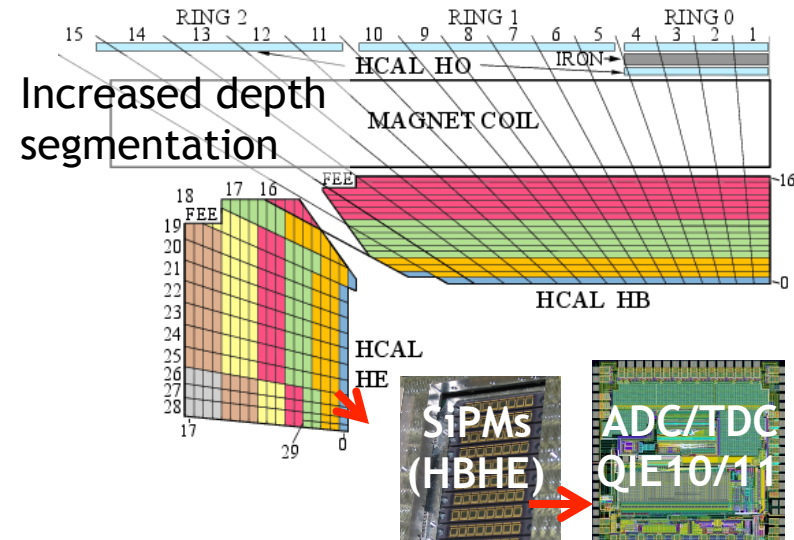
- In 2015, 85% of CMS data loss was attributed to HCAL (490 out of 580/pb)
- This year, HCAL DPG re-organized the monitoring effort
 - Significant revision of DQM during 2015 year-end technical stop
 - Re-organized HCAL remote operation center (ROC) for daily data quality checks
 - In 2016, ROC is re-instated in US
 - US ROC shift is organized by [Shuichi Kunori \(TTU, LPC guest\)](#) and FNAL LPC HCAL ROC is organized by [Andrew Whitbeck \(FNAL, LPC DR\)](#). Students from TTU, Iowa, UCSB are involved.

Exclusive Luminosity Losses in /pb



Phase 1 HCAL Upgrade & Software

- Phase 1 upgrade addresses sensitivity of present detector to anomalous signals generated in photodetectors and improve performance with high pileups
- During 2016 YETS, HF and HE upgrade is expected to complete
 - Need reconstruction software & calibration workflow in place
- Phase1 software task force (led by F. Chlebana, FNAL) leads this effort.
 - Other LPC resident/visitor members: K. Pedro, S. Banerjee, I. Volobouev, A. Whitbeck, H. Liu, K. Call, K.H. et al





LPC Guest & Visitor Program

- I have been chairing the LPC guest & visitor program committee since the beginning of 2015.
 - Committee members: Rick Cavanaugh (UIC/FNAL), Eva Halkiadakis (Rutgers), Ulrich Heintz (Brown), Lenny Spiegel (FNAL), Mayda Velasco (Northwestern), Frank Wuerthwein (UCSD)
- The program facilitates CMS members to spend time at the LPC working on projects (hardware/software/physics) that advance, enrich, and impact the CMS experiment
- The solicitation of application happens twice a year, Spring & Fall
FY2015:
 - Spring -35 proposals; 30 funded (9 international)
 - Fall -27 proposals; 22 funded (7 international)

The program is an important backbone of the LPC success

Summary

- **LPC has been a great place for many reasons**
 - All projects I am involved with for both physics analyses and detector performance studies are centered around the LPC
 - Allows very close collaboration between lab members and different university members

- **LPC DR allows one to benefit from great resource**
 - Allows to focus on research projects with the travel resource and with reduced teaching load
 - Thanks to this opportunity, I enjoyed active roles in two physics analyses while quickly ramping up as the HCAL detector performance group co-leader



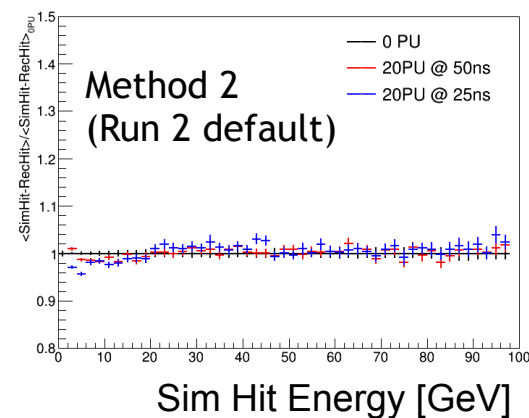
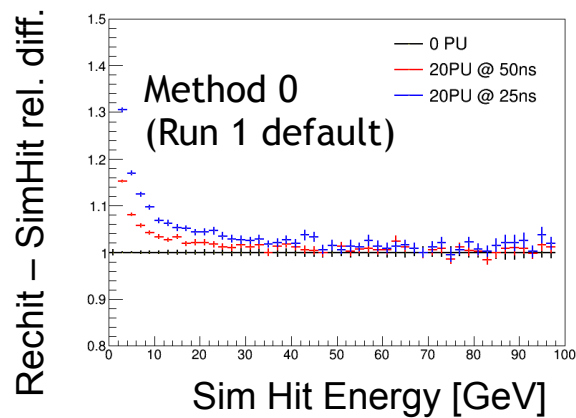
Backup





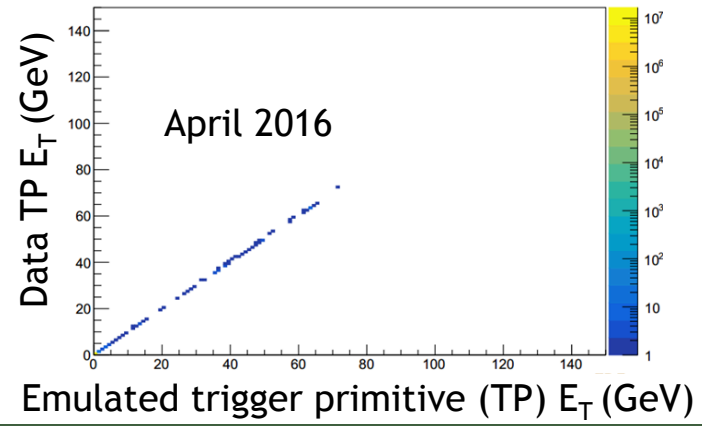
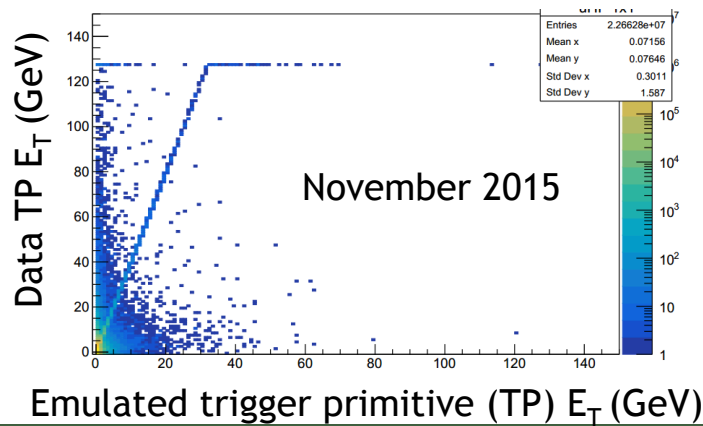
Other HCAL DPG Developments

- Method2, newly employed for Run 2 for HCAL barrel and endcap, fits pulses to minimize the effects of out-of-time pileups



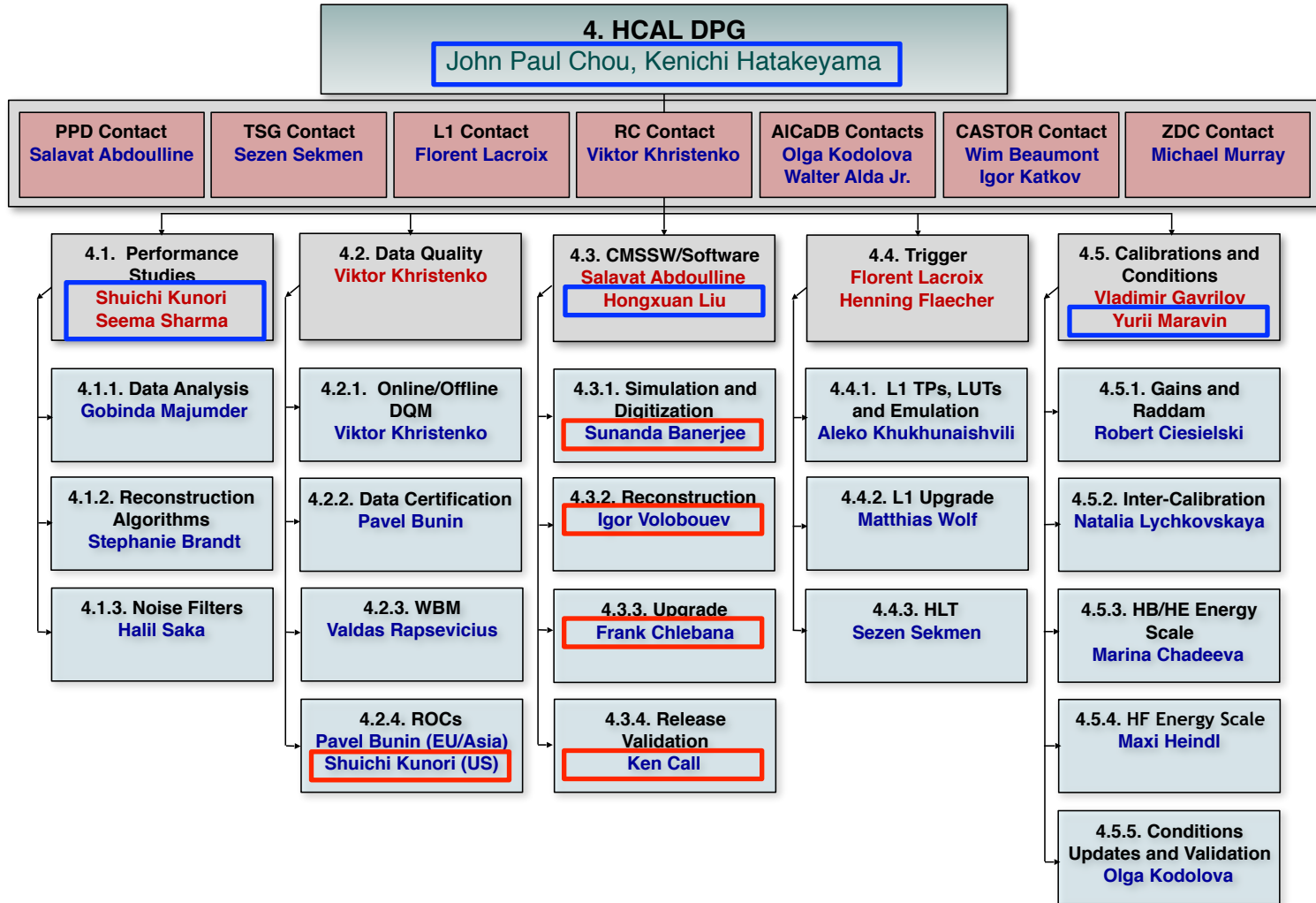
Significantly-reduced pileup effects

- In progress: re-evaluating high energy pulse shapes and chi2 modeling
- High granularity HF trigger primitives are now fully commissioned





HCAL DPG Organization



Highlighted people are LPC-affiliated physicists