JetMET Status and Plans

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Fermilab

CMS Week

Sept 22-26 2008

Plans and Activities

Detailed "planning document" linked from the JetMET twiki

https://twiki.cern.ch/twiki/bin/view/CMS/JetMET

Commissioning

Global Run analysis / optimization of thresholds
Jet ID / treatment of dead and hot channels
Characterize JPT and PFlow jets
Performance with pileup
Data driven techniques to derive
reco / pT / position resolutions
Fast / FullSim validation
Jet Algo software development / validation
JetMET DQM
Trigger

Topics covered are shown in red

First 10 pb-1

Provide JEC from data driven methods
Algorithm validation
Measure Jet Energy resolution vs pT / eta
Commission Jet Algorithms / ID with first data

Jet Energy Corrections

CMS plans for Jet Energy Corrections are discussed in PAS JME-07-002

Jet Energy Corrections derived from Monte Carlo truth are available

- **Corrections using CSA08 MC described in the CMSSW210 workbook**

Corrections will be produced from the 21X simulation samples

- **Contains latest pion response tuning and calibration conditions from DPG**
- **These will become the MC truth corrections for startup**

Data driven corrections will be produced from the first collision samples

- **Offset corrections will be studied first, but they should be negligible**
  - Noise in jet measured in random cones in zero-bias triggered events
- **Relative correction vs η will come from dijet p_T balance**
  - Correction should be available shortly after we have jet data
- **Absolute correction vs p_T from γ + jet p_T balance (early), Z + jet balance (later).**
  - Correction should be available shortly after we have photon data; a little after jet data
- **Each data driven correction will replace its MC truth counterpart.**
  - Differences between MC truth and data will set the earliest systematic uncertainties.

R.Harris
I.Iashvili

Offset Correction

Offset is due to pileup + noise

- Pile-up will be small for L < 5 x 10^{31} cm^{-2} s^{-1}

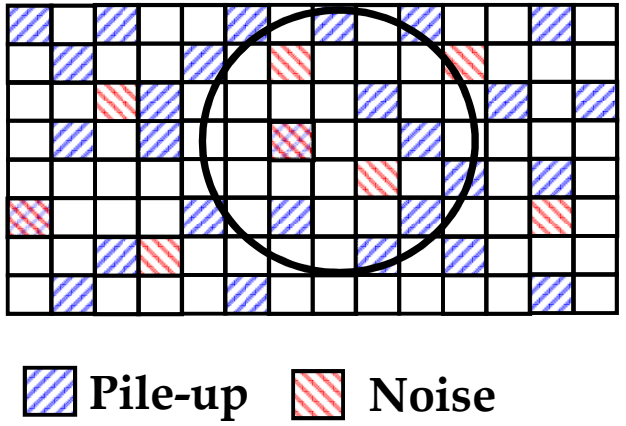
Offset kept small by applying threshold cuts

- Thresholds for inclusion in CaloTowers may need to be adjusted based on observed noise in actual conditions.

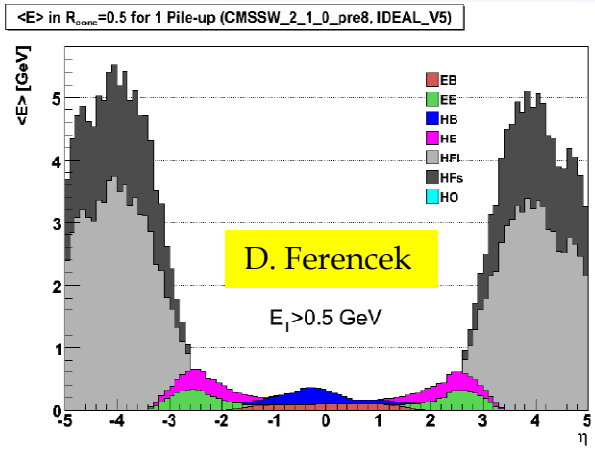
Example below for HO from MC

- HO temporarily removed from jet energy, if included would need a threshold of 2.5 GeV

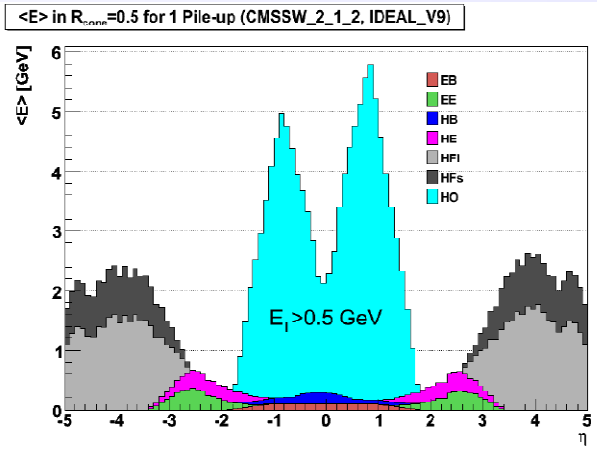
Offset in Jet Area In Calorimeter



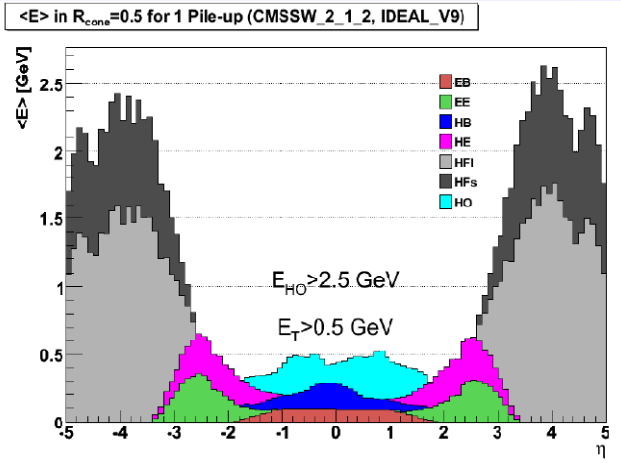
Old HCAL Calibration



New HCal Calibration



New+HO Threshold = 2.5 GeV



Relative Correction vs Jet η

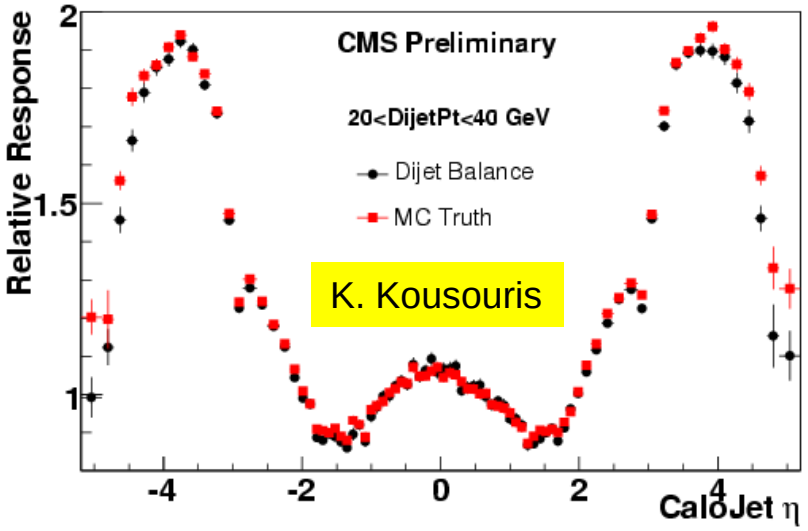
Dijet p_T balance measurements are a high priority

- **Will determine the jet response of the calorimeter as a function of η relative to the barrel (|η|<1.3).**
- **Measurement should be done for each period of stable conditions.**
  - Redone if calorimeter calibrations change significantly.

Dijet average p_T HLT trigger will provide large samples with minimal trigger bias

- **Specifically designed for this analysis**
- **Should work even better with new L1 uncorrected jet p_T threshold.**
  - Designed as an uncorrected trigger

Dijet Balance at low Dijet p_T



Dijet Average p_T Trig for 2e30 $cm^{-2}s^{-1}$

HLT (GeV)	L1 Prescale	HLT Prescale	Rate (Hz)
15	200	2	2.2
30	20	1	2.9
50	10	4	2.1
70	1	1	2.3

Absolute Correction vs Jet p_T

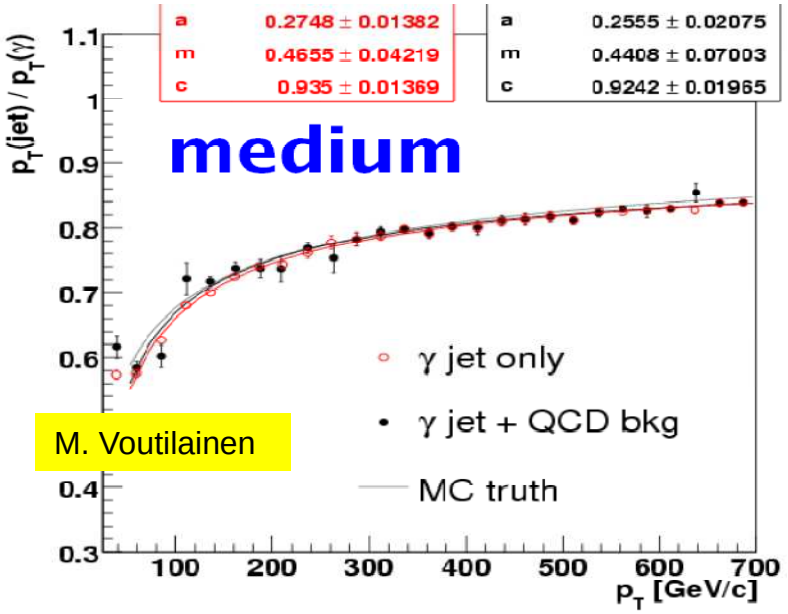
Photon + jet balance analysis is ready for data

- **Cut based selection completed (loose, medium, tight)**
- **p_T balance including QCD background is comparable to true γ in MC**
  - Because the purity of γ signal is now expected to be greater than 90% !
  - First analysis may not need to subtract QCD background

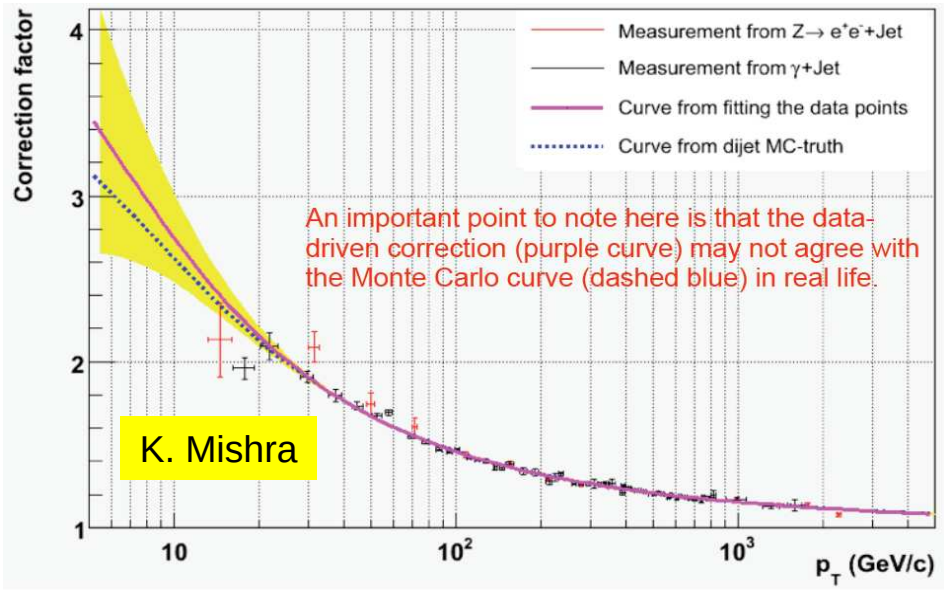
Ready to combine γ + jet and Z + jet and extrapolate using the MC

- **Z + jet balance will give valuable confirmation but samples will be small**

γ + jet balance and background



Combining & Extrapolating Corrections



Thresholds for Jet Reco

CaloTower thresholds:

- **Online Zero Suppression**
  - Driven by channel occupancy requirements
  - "Typical" ZS in HCAL: 1-3 ADC; in HB 3ADC ~600 MeV avg
- **Offline thresholds for cells (RecHits) and towers**

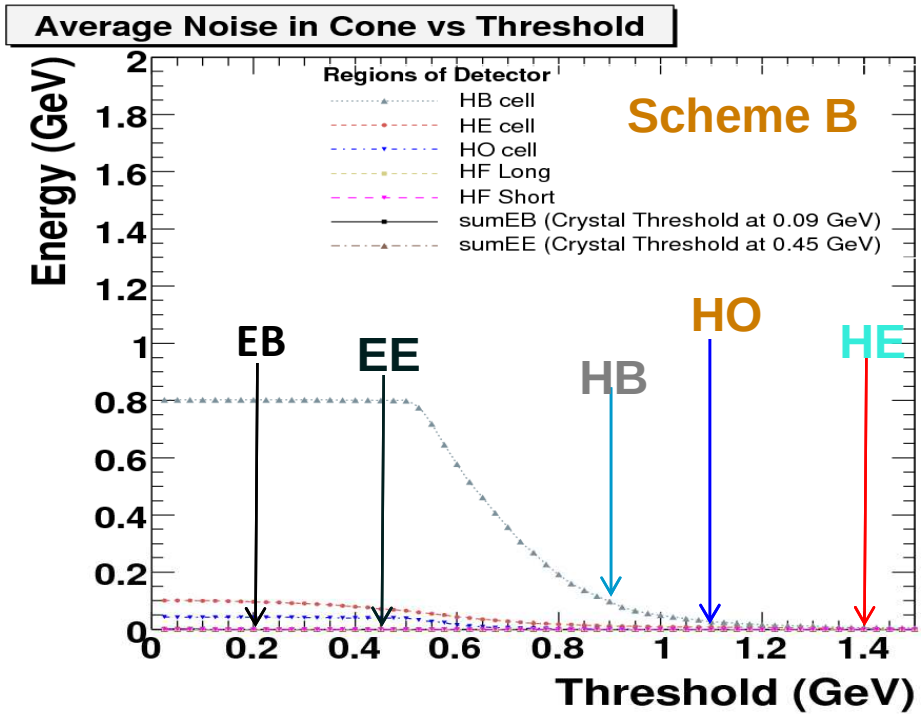
Current scheme for offline thresholds

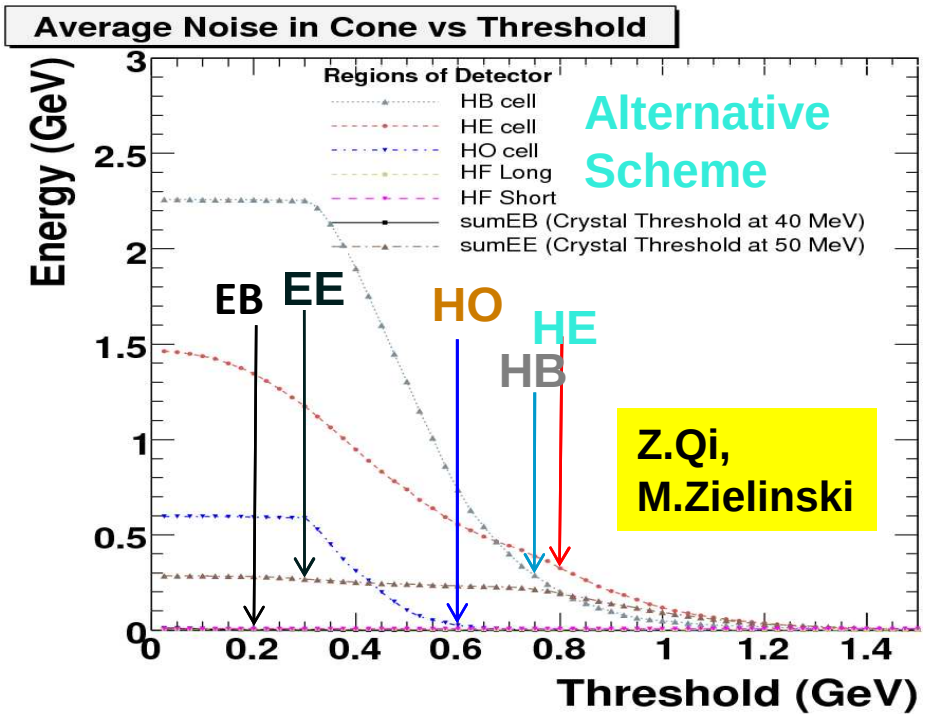
- **Energy cell thresholds cut out majority of noise**
- **ET tower thresholds cut out majority of pileup**
- **Default used in CMSSW: "Scheme B" for cells + tower ET>0.5 GeV**

HB	HO	HE	HF1	HF2	EB crystal	EBSum	EE crystal	EESum	Tower E_T Cut
0.9	1.1	1.4	1.2	1.8	0.09	0.2	0.45	0.45	0.5

For the threshold studies it is essential to have a MC that described the noise in the data

Noise in Cone vs Threshold





With zero suppression for both ECAL and HCAL & with tower cut

In GeV →	HB	HE	HO	EB	EE
Scheme B	0.09	0	0	0	0
Alt. Scheme	0.28	0.32	0.02	0	0.27

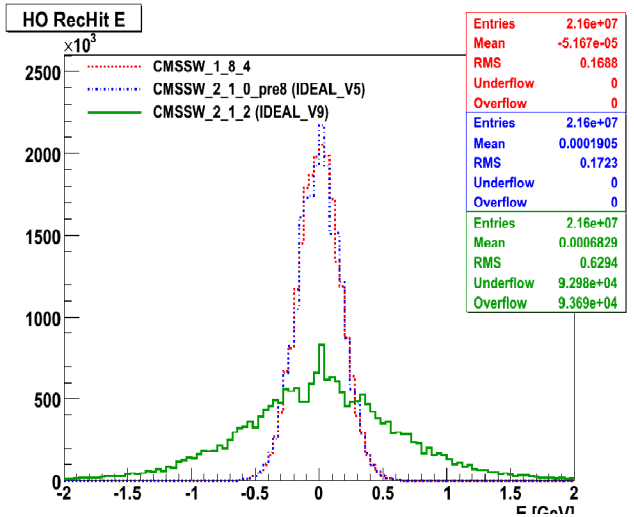
Studies indicate that we can get 3-5 GeV of jet pT (or 5-10% response), if detector noise conditions will allow us to lower the thresholds to levels indicated in the recent simulation CMSSW210pre6

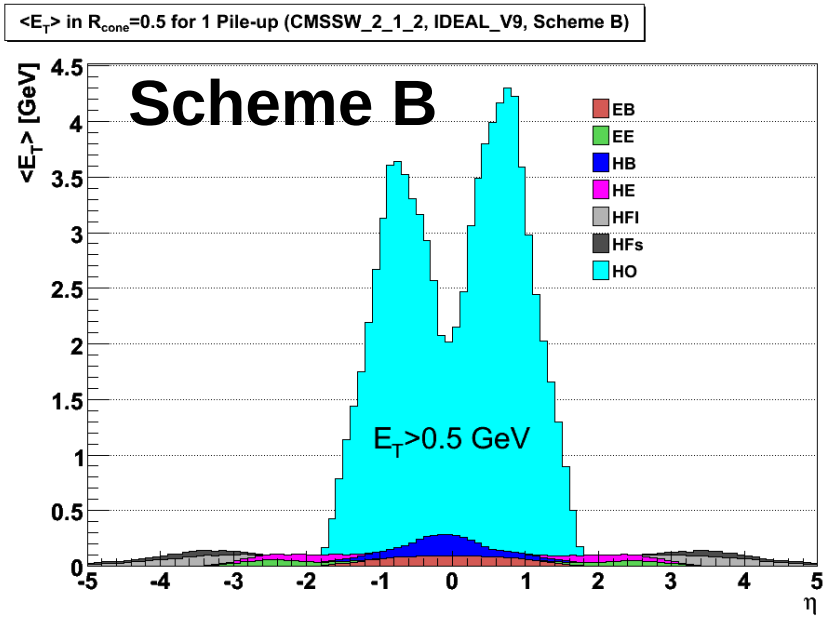
Threshold Studies

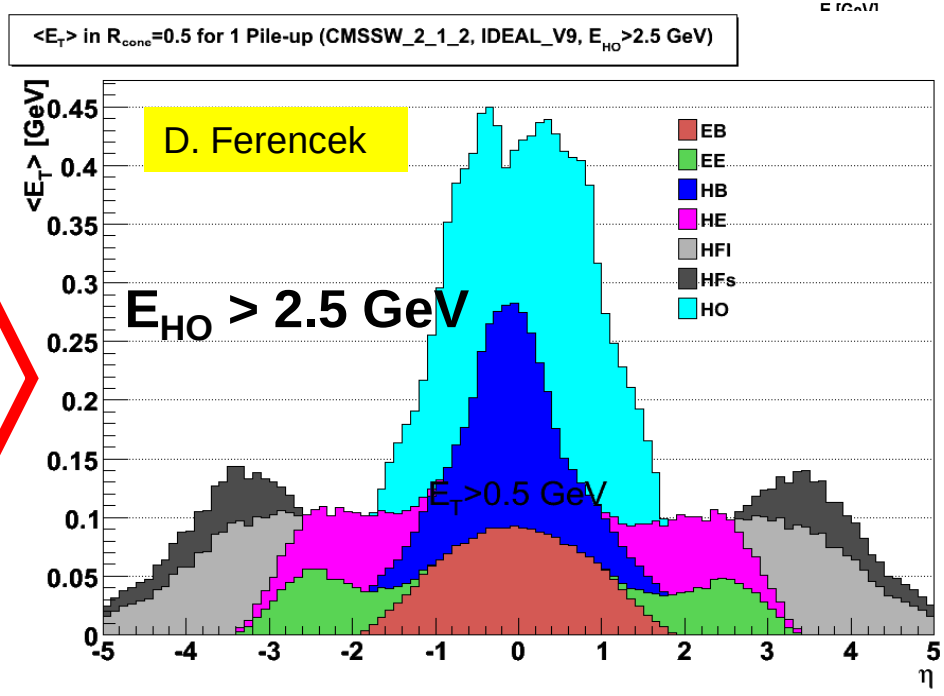
The HO noise in HCAL conditions IDEAL_V9 is a few times larger than before

→ Increases offset energy from 0.5 to 4-6 GeV in the central eta region

→ Low p_T jet region dominated by fakes







CaloTower Thresholds

Temporarily remove HO from jet and MET reconstruction

Keep HO information in CaloTowers for re-reconstruction
→ *provides maximum flexibility*

Proposal for startup period

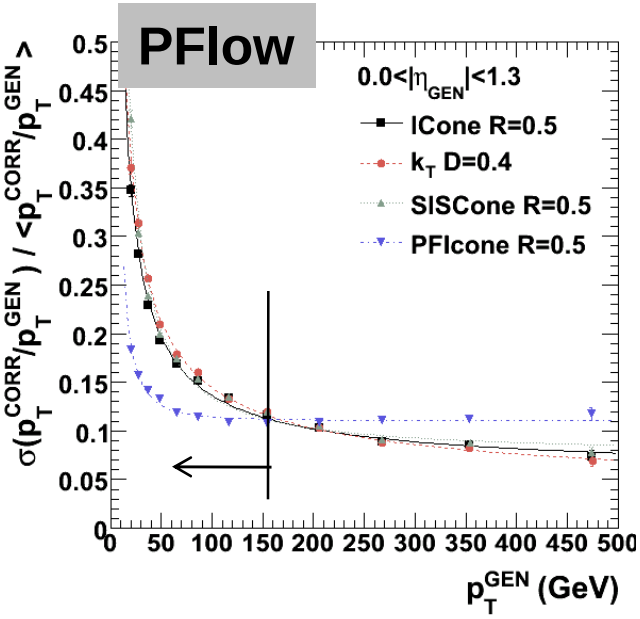
Do not use of the new thresholds before we see first data in the data-taking configuration of CMS (at least noise events)

Have alternative scheme ready to be implemented quickly at beginning of data taking if opportunity arises and all looks OK

New Proposal…

Now have more time for studies
Use data with magnetic field
Will be able to understand the noise much better

Using Track Information to Improve Jet Resolution and Response



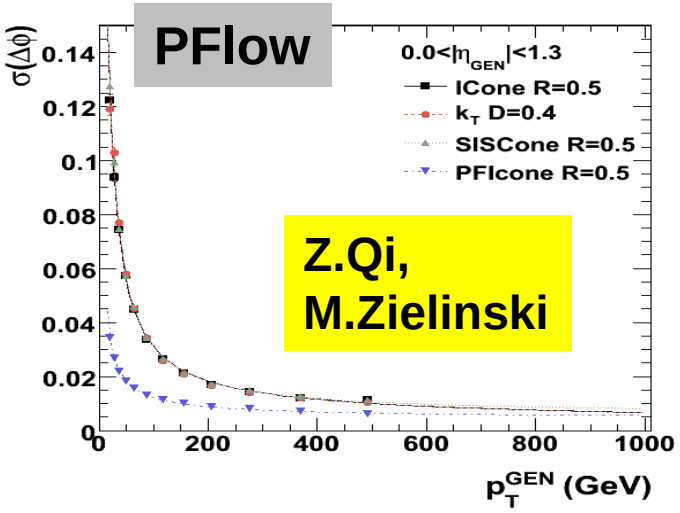
A fair "apples to apples" comparison

Using CSA08 samples and JEC

- ***PFlow yields better resolution for low p_T***
- ***Corrected CaloJets have better resolution than PF >150 GeV in barrel (80 GeV in EndCap)***

Updated PF plot with improvements to be shown on Friday → <u>better resolution up to ~700 GeV</u>

Improved φ resolution



Track only jet reconstruction and performance compared with CaloJets have been studied and documented in the CMS AN and PAS

Final approval was on Wed…

Better resolution at low pT
Better for jet counting

Jets Plus Tracks

Jet Plus Track subgroup formed

Group convenors : A. Nikitenko, F. Chlebana
https://twiki.cern.ch/twiki/bin/view/CMS/JPT
JPT HN forum started

First meeting already held on Sep 18 2008

- ***Packaging code***
- ***Try to use JEC framework***
- ***Request MC with PileUp***
- ***Special runs and triggers:***
  no-zero suppression, low pT isolated track trigger

Will try to combine requests with other groups

Meetings every other Thursday
16:00-17:30 CET (back to back with Jet Algo Meeting)

Jet Algorithm Development

1. **From CMSSW 22X (!) on, jets are by default reconstructed w.r.t. the best primary vertex candidate (HLT jets (0,0,0))**

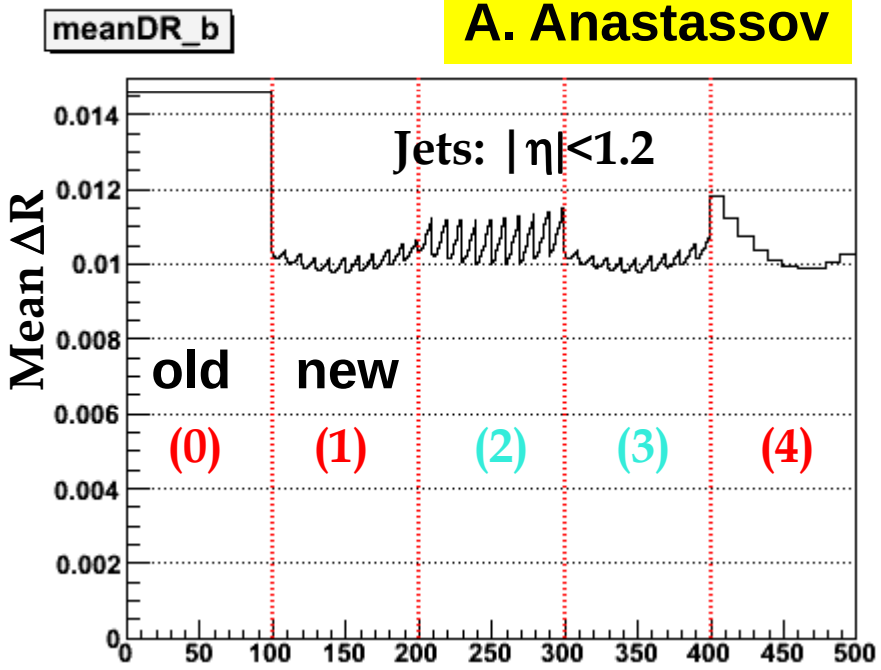
2. **Strategies to reconstruct the jet direction based on the energy deposits in individual ECAL cells were studied**
   → *yields improved jet position reconstruction, small ΔR*

Five methods of defining the tower directions were studied, scan over the depth parameters for ECAL and HCAL.

Three methods implemented in the reconstruction code (selectable through cfg files)

Scheme (1) selected as new default

A. Anastassov



X-axis: method/parameter scan point

What is included in the code

- ✓ **(0) *Old default***

  Simplest case, least number of assumptions

- ✓ **(1) *New default.* Separate p4's for ECAL / HCAL: ECAL from energy weighted xtal positions; HCAL point along tower axis; Tower p4 is taken as the sum**

  Good performance, uses *EM and HAD*

- ✗ **(2) One p4 with common direction for ECAL, HCAL, direction from energy weighted ECAL and HCAL**

  Somewhat smaller improvement

- ✗ **(3) Similar to (1) but with separate p4's for all crystals**

  Good performance, but more complicated vertex correction

- ✓ **(4) Log energy weighted EM position for direction of the tower, when E_{EM}=0 use default (from Chris Rogan)**

  Good performance, smaller reliance on HCAL

MET Algorithms and Objects

MET significance *using additional objects*

- algorithm established
- improvements shown for W->eν
- implementation in PAT ongoing

MET using Tracks and Particle Flow

- improves resolution and tails
- work ongoing by various groups

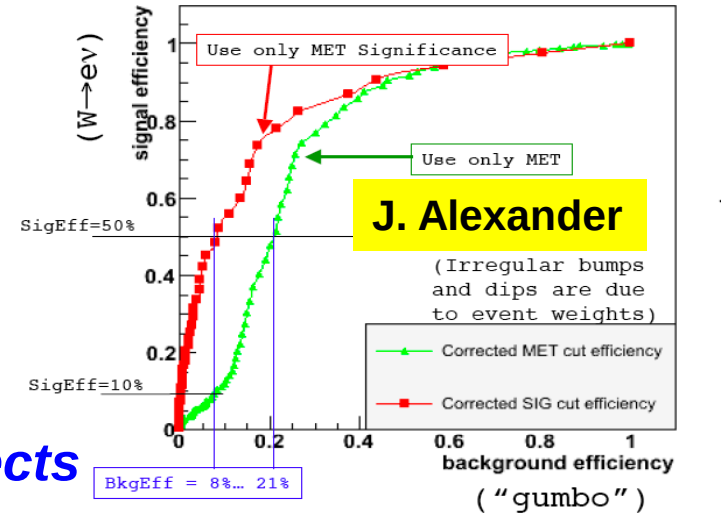
Significant improvements gained from including other detectors and physics objects

MET collections stored in the AOD

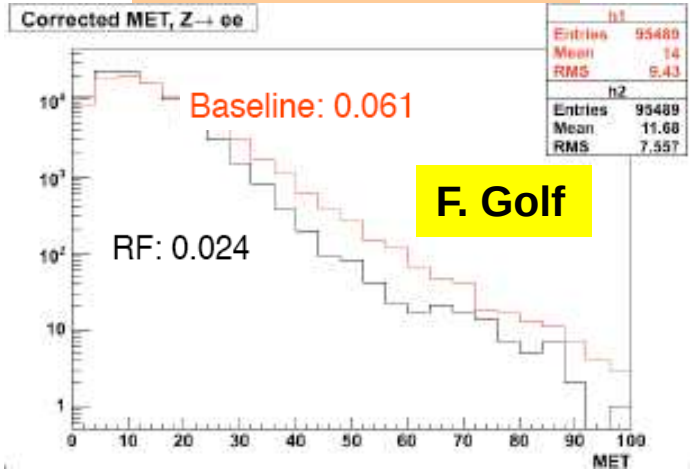
- ***MET from CaloTowers, with / without HF, scheme B / optimized thresholds, with / without HO***
- ***MHT (= MET from jets), with all official jet algorithms***

MET objects, including the MET corrections, accessible in PAT

MET significance algorithm



MET using Tracks



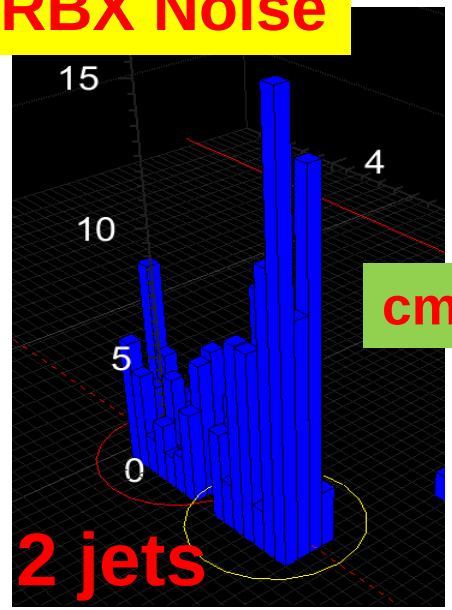
Jet Quality

Goal of determining the jet Quality is to provide a minimal set of essential cuts, recommended for all CMS analyses using jets.

Studies of GR data suggest EMF, n90, nHPD, possibly timing information, track confirmation (some, not all of the above!)

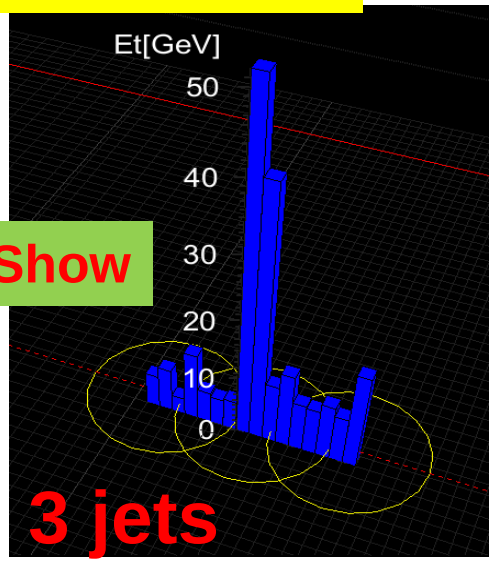
Additional clean up cuts would be analysis specific

RBX Noise



12 Hz for MET > 50 GeV

HPD Noise



3 (1) Hz for MET>50 (100) GeV

cmsShow

Real data essential, study global run data for now

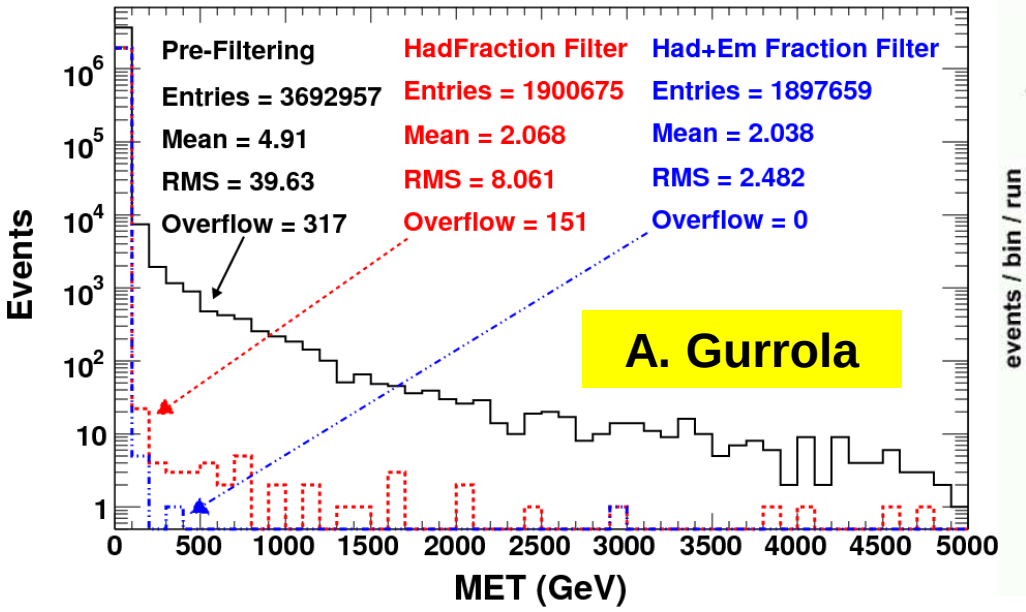
Cross-check for high signal efficiency in MC before first collisions

Data overlay tools developed for a all detector components and being validated
→Mix MC signal with noise data

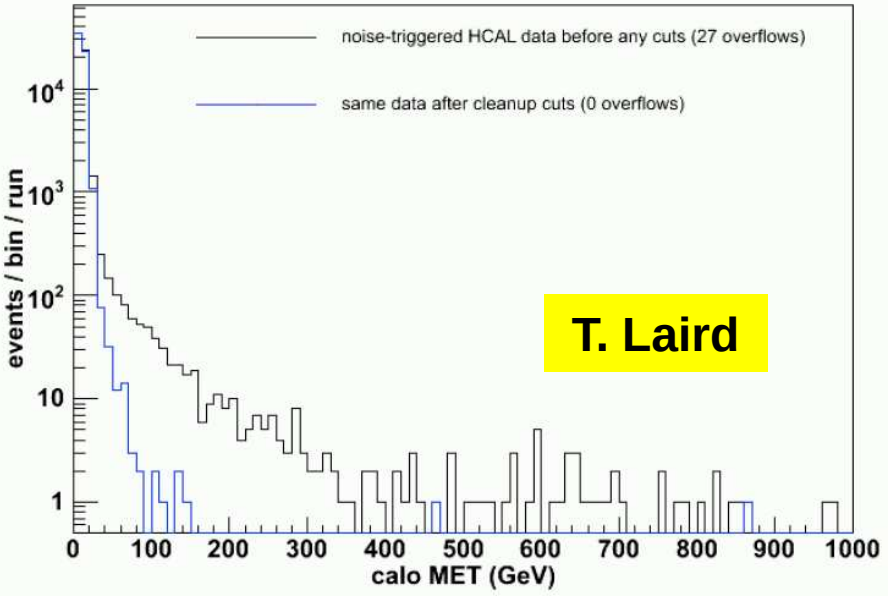
Missing E_T in CRUZET Data

Several groups looking at MET in the Global Runs

- Focus on reducing non-Gaussian tails from the HPD noise and estimate the rate of noisy events
- Several algorithms are being considered (HPD pulse shape, HPD occupancy, etc.)
- Event Display is an essential facility to scan data and identify noisy events



HAD/EM fraction filter



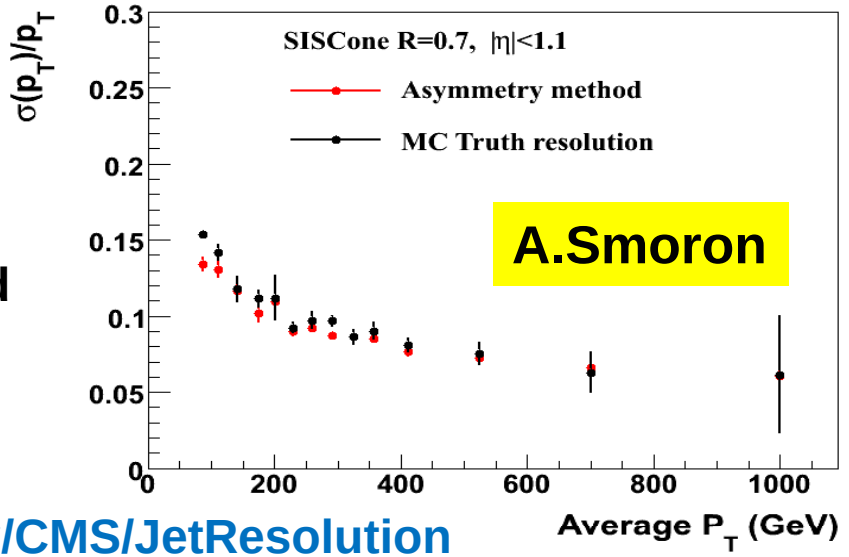
HPD pulse shape filter

Data Driven Methods

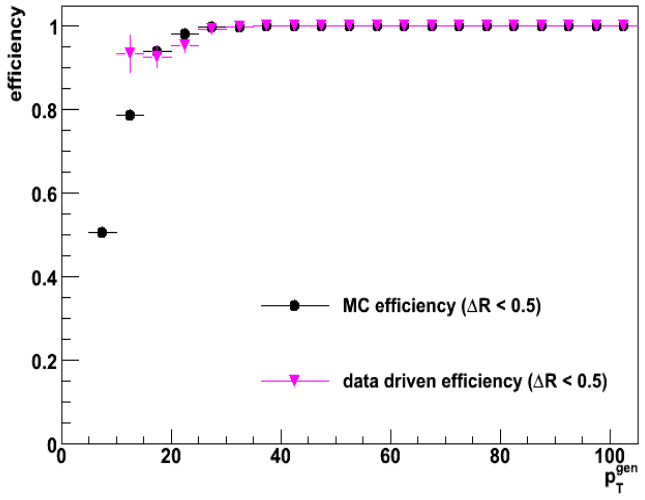
Asymmetry method to measure jet energy resolution using dijet events
Developed as part of the CSA08 exercise

Extended to algorithms other than ICone and to both Barrel & EndCap

→ good agreement with MC truth for pT>100 GeV



Details at: https://twiki.cern.ch/twiki/bin/view/CMS/JetResolution



ME_T: Bad Cell Handling

ME_T is arguably the most sensitive quantity to hot and dead cells in the detector

A lot of effort put in understanding use cases of hot/dead cells and their effect on ME_T

Several iterations with the Offline Software/Reco group

Flags have been defined in the DQM interface to identify several types of hot/dead cells:

- Intermittent hot cells
- Always on/off hot cells

ECAL / HCAL DPG ↔ JetMET

Fill a status word in CaloTower that summarizes the quality of contributing cells

For each RecHit distinguish the following categories:

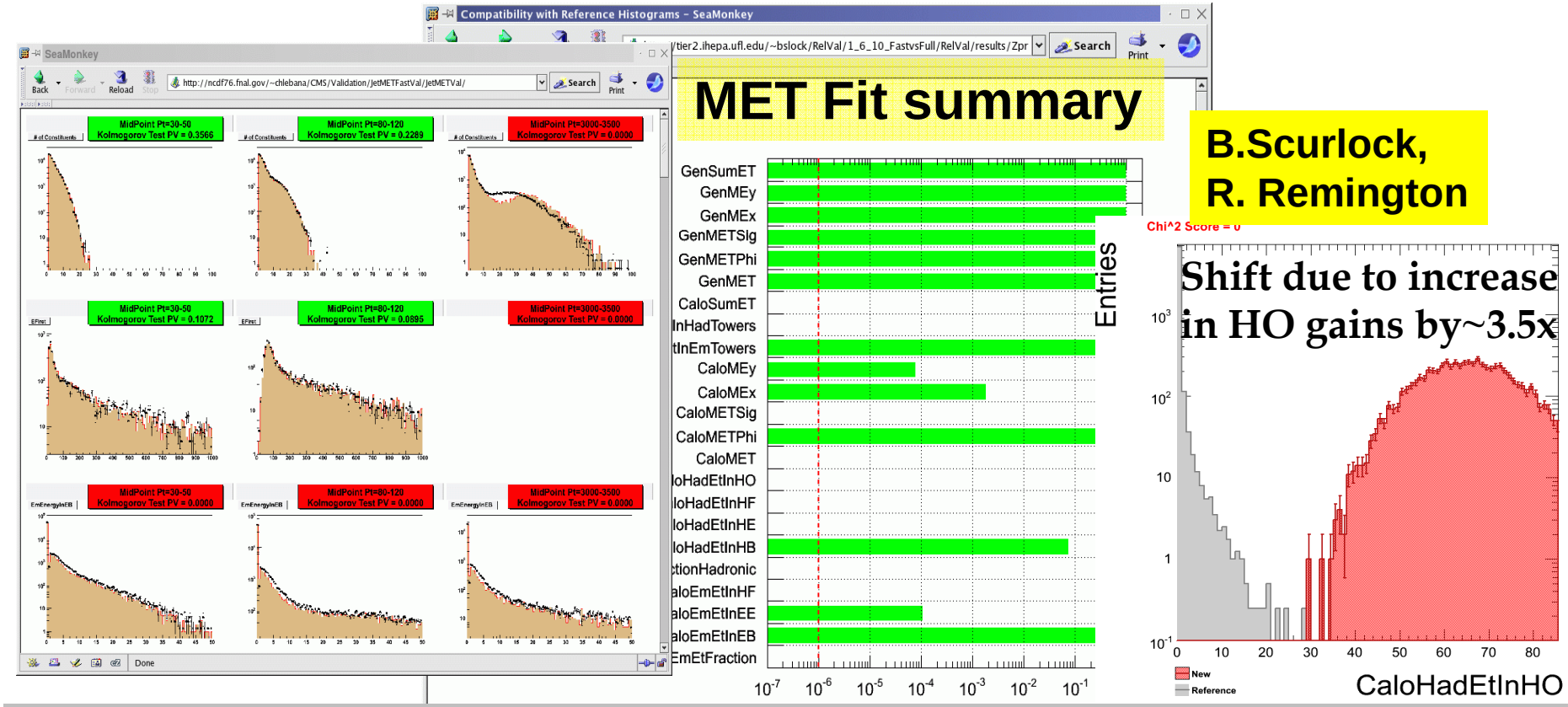
- Bad (dead/masked)
- Recovered (energy assigned using a recovery algorithm)
- Problematic (mostly noisy)

JetMET Release Validation

Procedure streamlined, uses low / high pT QCD samples

Provides quick feedback

Used for FastSim / FullSim comparisons



Will migrate to the RelVal Framework to automate validation

Startup Strategy for Jet Triggers

Remove jet energy corrections at L1 and HLT

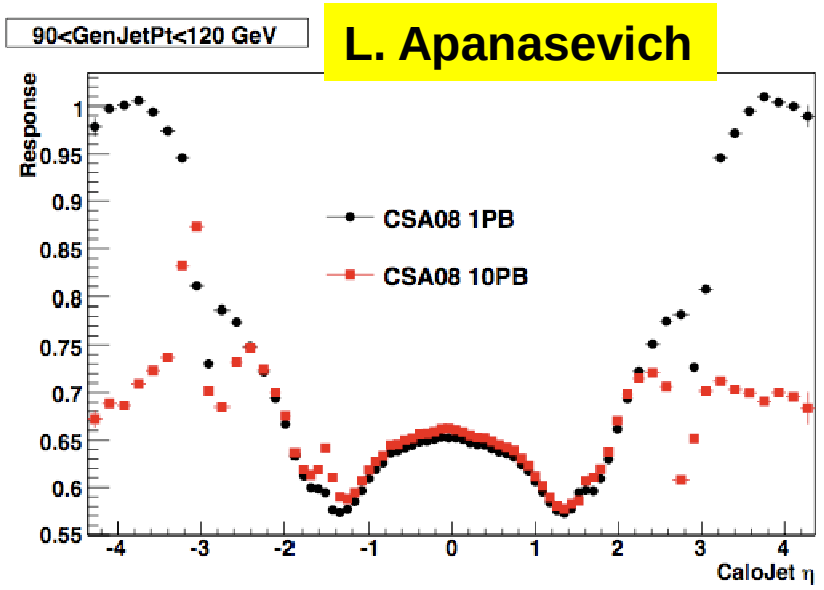
- Overall scale not so important but it is desirable to flatten the jet rate vs η
- However, we do not really trust the simulation to evaluate this complicated correction early on

Scale HF response to help flatten the rate

- Under investigation

After initial HCAL calibration, scale factor can be removed

- Recently HCAL DPG unveiled plans to use dijet balancing to calibrate HE/HF
- Provides a much flatter initial calibration for jets



- Using standard HCAL calibration scheme

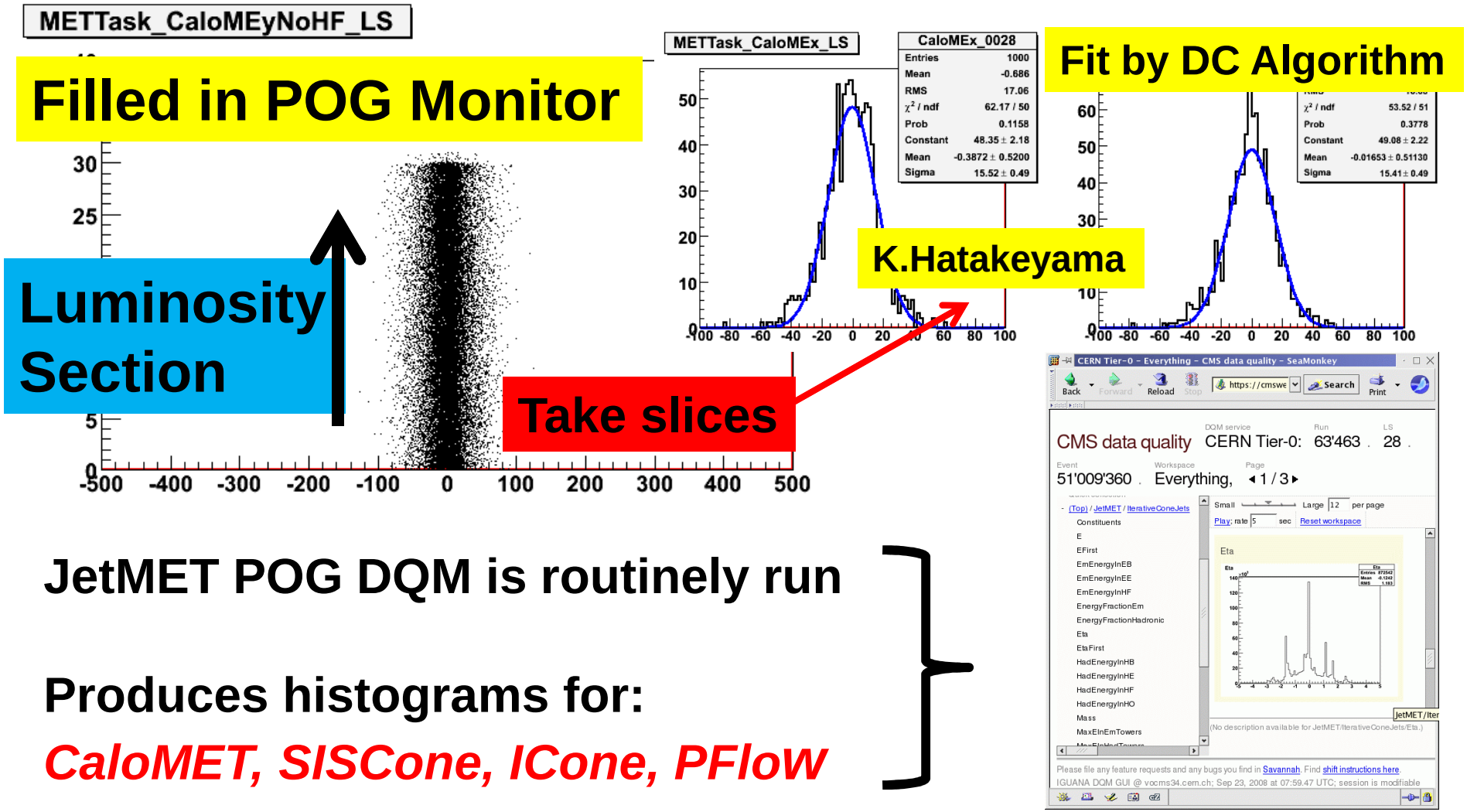
•After dijet balancing

Proposal for New L1 and HLT Thresholds

Corrected (old)			Uncorrected (New)		
Path Name	L1 Trigger	HLT Threshold (GeV)	Path Name	L1 Trigger	HLT Threshold (GeV)
HLT_L1Jet15	L1_SingleJet15	—	HLT_L1Jet5	L1_SingleJet5	—
HLT_Jet30	L1_SingleJet15	30	HLT_Jet15	L1_SingleJet5	15
HLT_Jet50	L1_SingleJet30	50	HLT_Jet30	L1_SingleJet20	30
HLT_Jet80	L1_SingleJet50	80	HLT_Jet50	L1_SingleJet35	50
HLT_Jet110	L1_SingleJet70	110	HLT_Jet80	L1_SingleJet50	80
HLT_Jet180	L1_SingleJet70	180	HLT_Jet130	L1_SingleJet50	130

JetMET POG Offline DQM

Determining Data Quality in a Luminosity Section



JetMET POG DQM is routinely run

Produces histograms for:

CaloMET, SISCone, ICone, PFloW

New Meeting Structure

New meeting schedule starting in ~October

Joint DPG-PH JetMET

Biweekly, Monday 16:00-19:00 CET
Starting Sep 29

MET

Biweekly, Friday 16:00-17:30 CET
Starting Oct 10

JEC

Biweekly, Friday 16:00-17:30 CET
Starting Oct 3

Algo + JPT+(PFlow)

Biweekly, Thursday 16:00-19:00 CET
Starting Oct 2

Summary

- **Algorithm improvements**
  - ***Jet position, MET***
- **Using GR data to study noise**
- **Using tracks to improve jet and MET resolutions**
- **Thresholds studies**
  - ***Ready to apply to real data***
- **JEC developing data driven methods**
  - ***Ready to apply to real data***
- **Participating in Offline DQM**
- **Well defined startup conditions**
  - ***Triggers, thresholds***

JetMET Ready! → Will Be Abosolutely Ready!!