DØ Calorimeter Task Force Final Report

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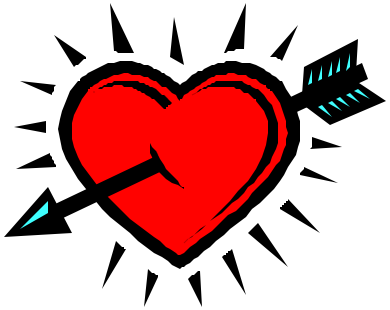

DØ Collaboration Meeting

February 14, 2003

Calorimeter Task Force

Set up in early August 2002

Charge:

The task force will determine the zero-suppression threshold for the calorimeter readout.

In order to fully understand the consequences of the zero-suppression threshold the Monte Carlo should be tuned to observed calorimeter energy and multiplicity distributions. Simulated data and collider data should be used to optimize the reconstruction and properties of physics objects as a function of threshold.

Selection of the threshold will also require an understanding of the L3 processing time and the dataset size at L3 and off-line all as a function of threshold.

Specifically, the task force should:

1. **Characterize the calorimeter performance on the cell level.**
2. **Characterize particle identification (such as energy response and resolution) as a function of threshold.**
3. **Tune the Monte-Carlo to the data at the cell and physics object levels.**
4. **Understand the consequences of the threshold level on L3 computing and data size and offline data size.**
5. **Recommend a zero-suppression threshold.**

The task force will report to the spokespersons.

A preliminary recommendation should be available by October 15th and a final report by January 15, 2003 ✍ February 14, 2003.

Many people to acknowledge…

- Mark Adams, Berard Andrieu, Ursula Bassler, Stephanie Beauceron, Gregorio Bernardi, Volker Buescher, Emmanuel Busato, Christophe Clement, Greg Davis, Silke Duensing, Laurent Duflot, Mingcheng Gao, Anna Goussiou, Leslie Groer (co-chair), Marumi Kado, Markus Klute, John Krane, Alexander Kupco, Steve Muanza, Vivian O'Dell, Nirmalya Parua, Serban Protopopescu, Lee Sawyer, Dean Schamberger, Joe Steele, Sophie Trincaz-Duvoid, Vu Anh Tuan, Andre Turcot, Jean-Roch Vlimant, Andy White, Daniel Whiteson, Junjie Zhu, Marek Zielinski (co-chair), Robert Zitoun, Vishnu Zutshi

  CTF committee members

- UTA Team – Drew Meyer, Mark Sosebee, Jae Yu, Andy White

- Software releases - Alan Jonckheere, Paul Russo, Harry Melanson, Serban Protopopescu, Iain Bertram, Dave Evans

- SAM Team

People working overtime…

- **Dec 26 18:52:21**

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PINE 4.21   MESSAGE TEXT          <Mail> d0caltf  Msg 1,107 of 1,449 80%

Date: Thu, 26 Dec 2002 18:52:21 -0600
From: Drew Meyer <ddmeyer@attglobal.net>
To: Guilherme Lima <lima@ml7-dfnae.fis.uerj.br>
Cc: Jae Yu <yu@hepmail.uta.edu>, Mark Sosebee <sosebee@uta.edu>,
     Leslie Groer <groer@fnal.gov>, Marek Zielinski <marek@fnal.gov>
Subject: Re: Any resolution?
```

- **Dec 31 21:59:56**

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PINE 4.21   MESSAGE TEXT          <Mail> d0caltf  Msg 1,115 of 1,449 ALL ANS

Date: Tue, 31 Dec 2002 21:59:56 -0600
From: Drew Meyer <ddmeyer@attglobal.net>
To: Leslie Groer <groer@fnal.gov>, Marek Zielinski <marek@fnal.gov>
Cc: Mark Sosebee <sosebee@uta.edu>, Jae Yu <yu@hepmail.uta.edu>
Subject: RCP substitution
```

- **Jan 01 14:09:38**

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PINE 4.21   MESSAGE TEXT          <Mail> d0caltf  Msg 1,116 of 1,449 TOP ANS

Date: Wed, 01 Jan 2003 14:09:38 -0600
From: Drew Meyer <ddmeyer@attglobal.net>
To: Leslie Groer <groer@fnal.gov>
Cc: Marek Zielinski <marek@fnal.gov>, Mark Sosebee <sosebee@uta.edu>,
     Jae Yu <yu@hepmail.uta.edu>
Subject: Re: RCP substitution
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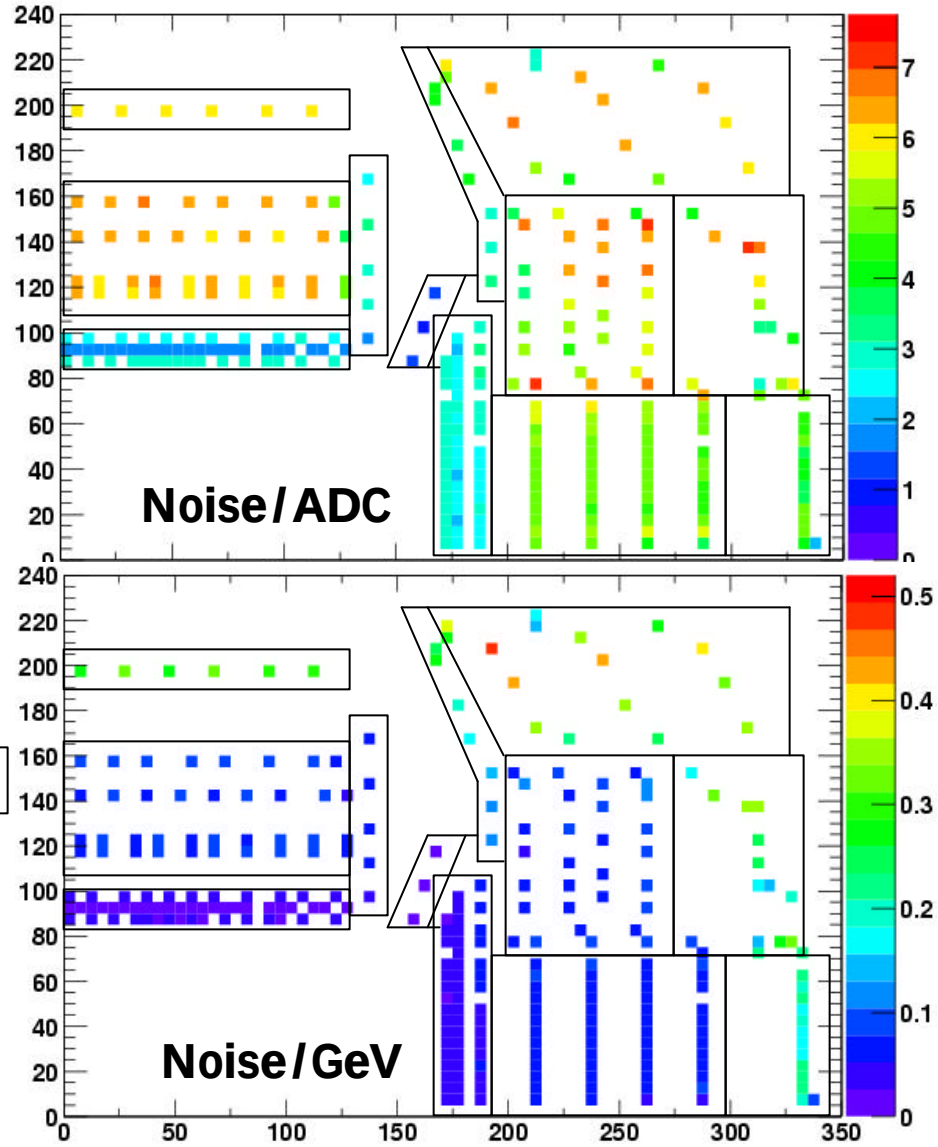
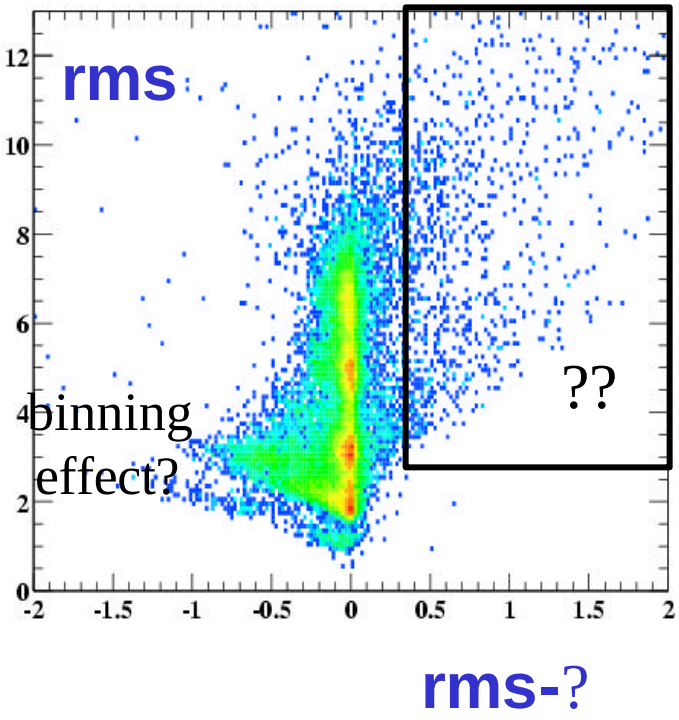
What's all the noise about?

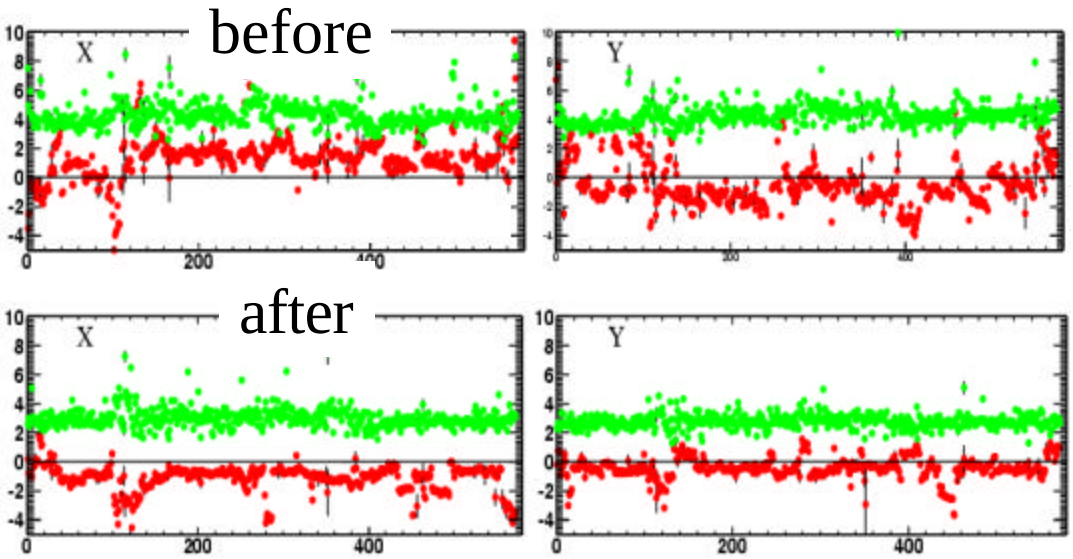
- ADC noise depends on the cell size and/or the preamp: Larger cells ✍ larger noise esp. Coarse Hadronic
- Amplified by cal_weights (total to visible energy ratio)
  EM/HAD ~10 MeV/ADC
  CH ~30 MeV/ADC
- ×1.6 for non linearity



Understanding Noise Characteristics

- At 2.5sigma, occupancy should be ~ 1%
- Some channels exhibit 10-15% occupancy
  - significant impact on MET
  - Not due to pedestal shifts mainly
- Non-gaussian noise from L1SCA dispersion and difference in L1 upper and lower chips
- Current offline noise file can have mismatches with individual calibration run
- Suppressing these channels improves MET





- Implement 2.5x online ? cut on TMB

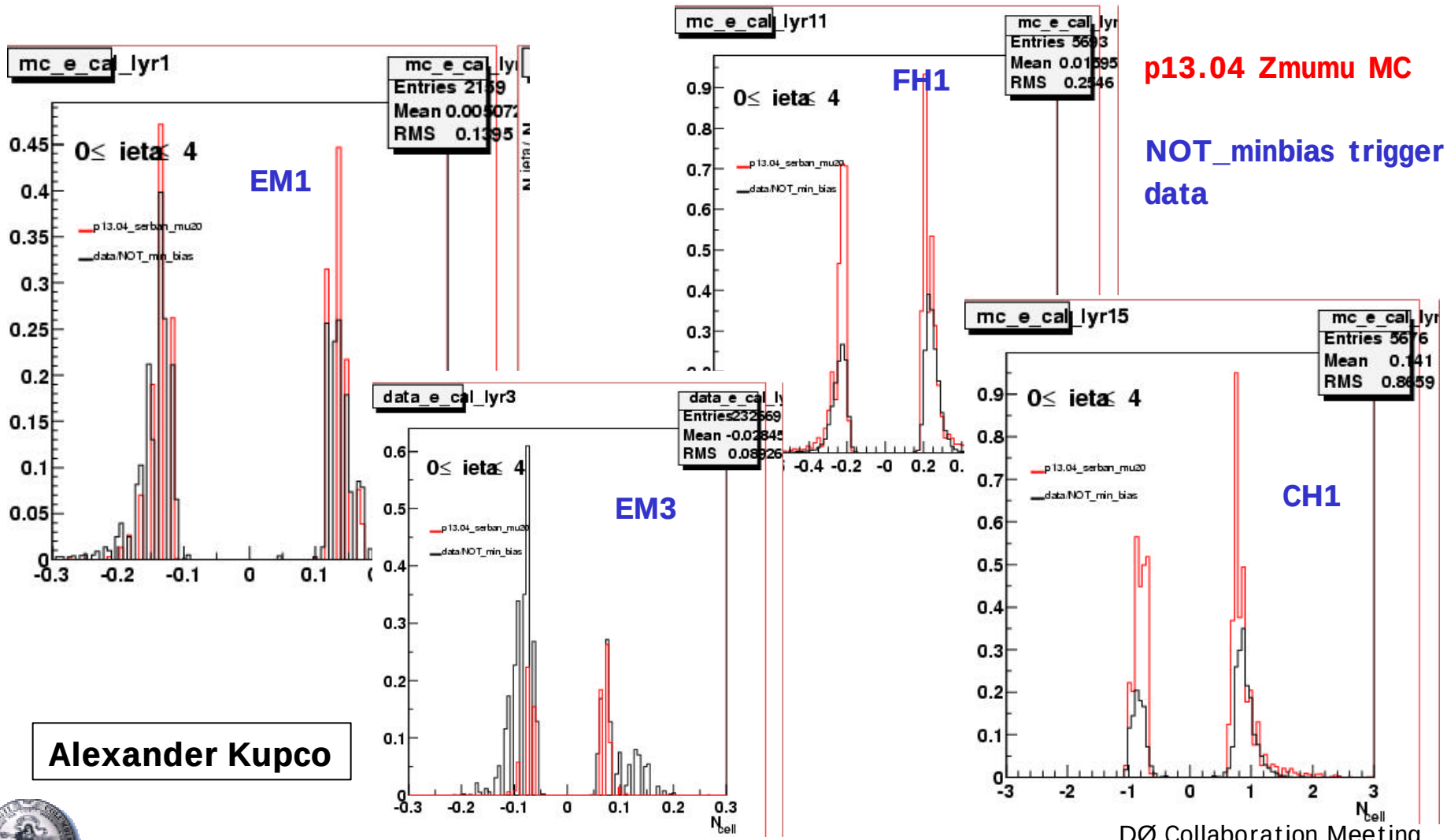
Robert Zitoun

Calorimeter Software Improvements

- p11
  - Non-linearity corrections
  - Offline zero suppression (but “<“ not “<=“)
  - Tweak of calorimeter electronic weighting factors
  - Correction of ICD layer map
  - Added more realistic noise simulation file (symmetrized)
  - Introduced “offline” zero suppression in Level 3 trigger
    - but not NLC, NADA…
- p13
  - Further corrections for electronic weighting factors in ICR (5pF ✍ 10pF)
  - ICD weight increased 35%
  - Rewrite of pileup noise simulation
    - Can overlay raw data (zbias) or simulate noise in ADC
    - GeV ✍ Linearized ADC
    - Individual noise channels used in MC
  - Same noise file used for both simulation (LADC) and zero suppression (RADC)
  - Offline zero suppression cut corrected
  - Correct switch of gain x8/x1 in MC and add persistence for all levels
  - Apply zero suppression to MC

Simulation of Gaussian Noise in pileup

P13 noise turn on, shape and suppression modeled much better than in p11

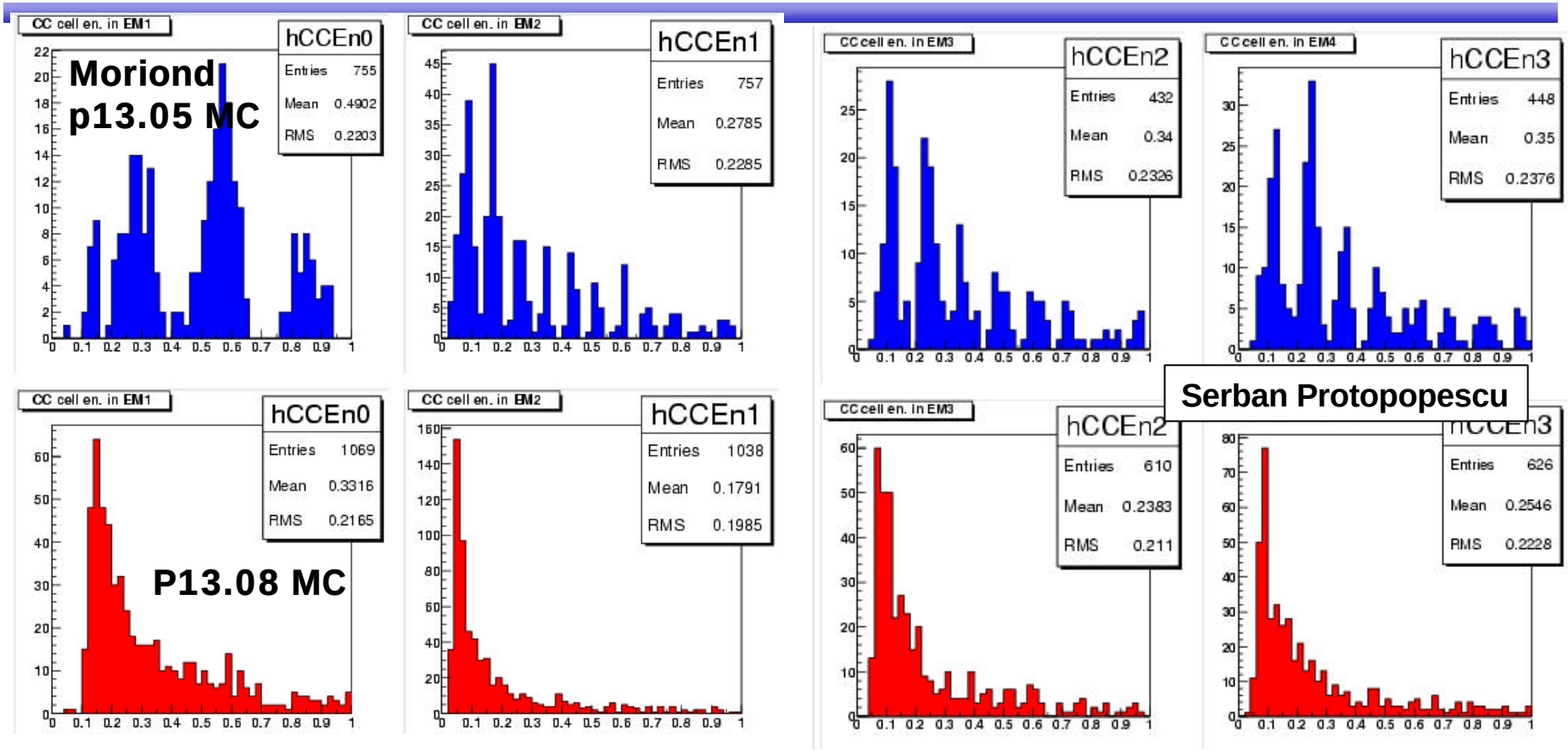


p13.04 Zmumu MC

NOT_minbias trigger data

Alexander Kupco

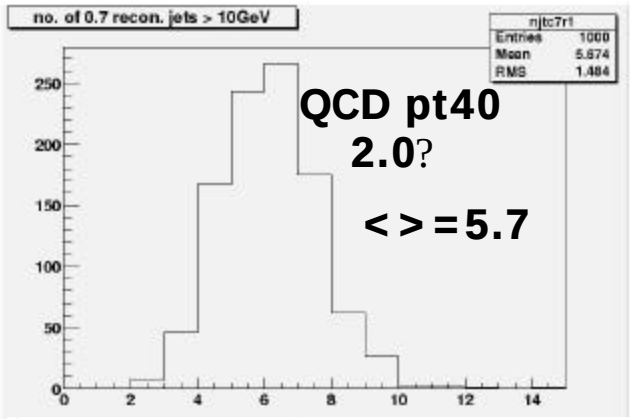
Few glitches on the way…

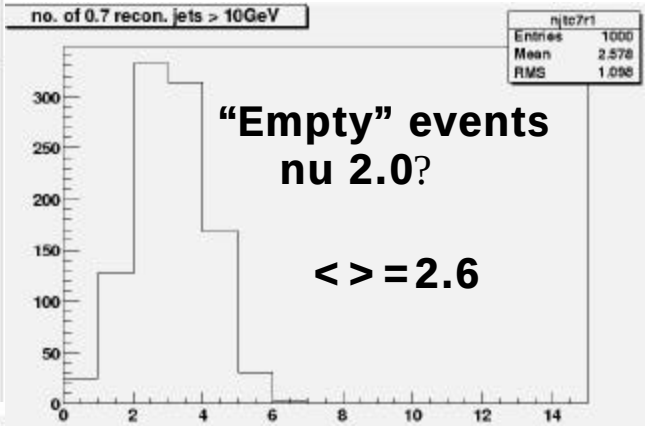


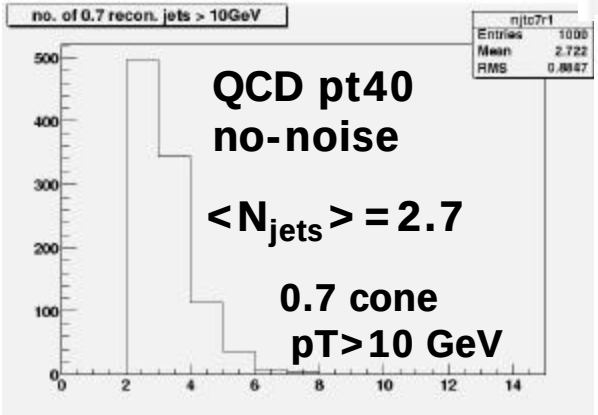
- Offline zero suppression cut not exactly matched to online
- mc_runjob parameters tweaked in p11 and not removed in p13
- Zsup file not copied for d0sim and changed file format
- NLC file inadvertently moved
- d0gstar using thumbnail packing
- etc,…

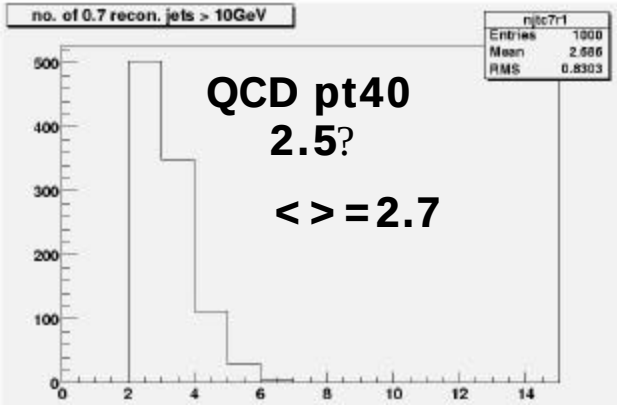
Effect of Gaussian Noise on Jet Reconstruction

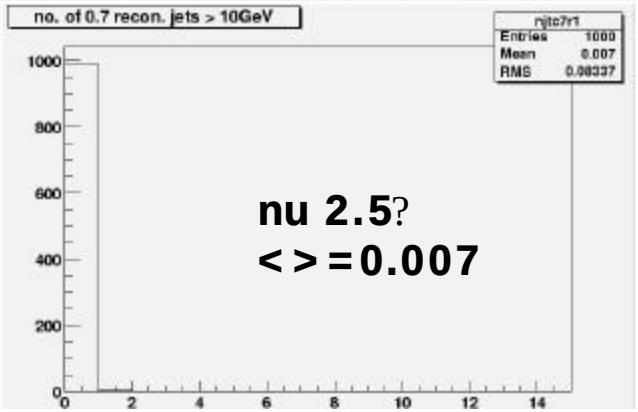
Vishnu Zutshi





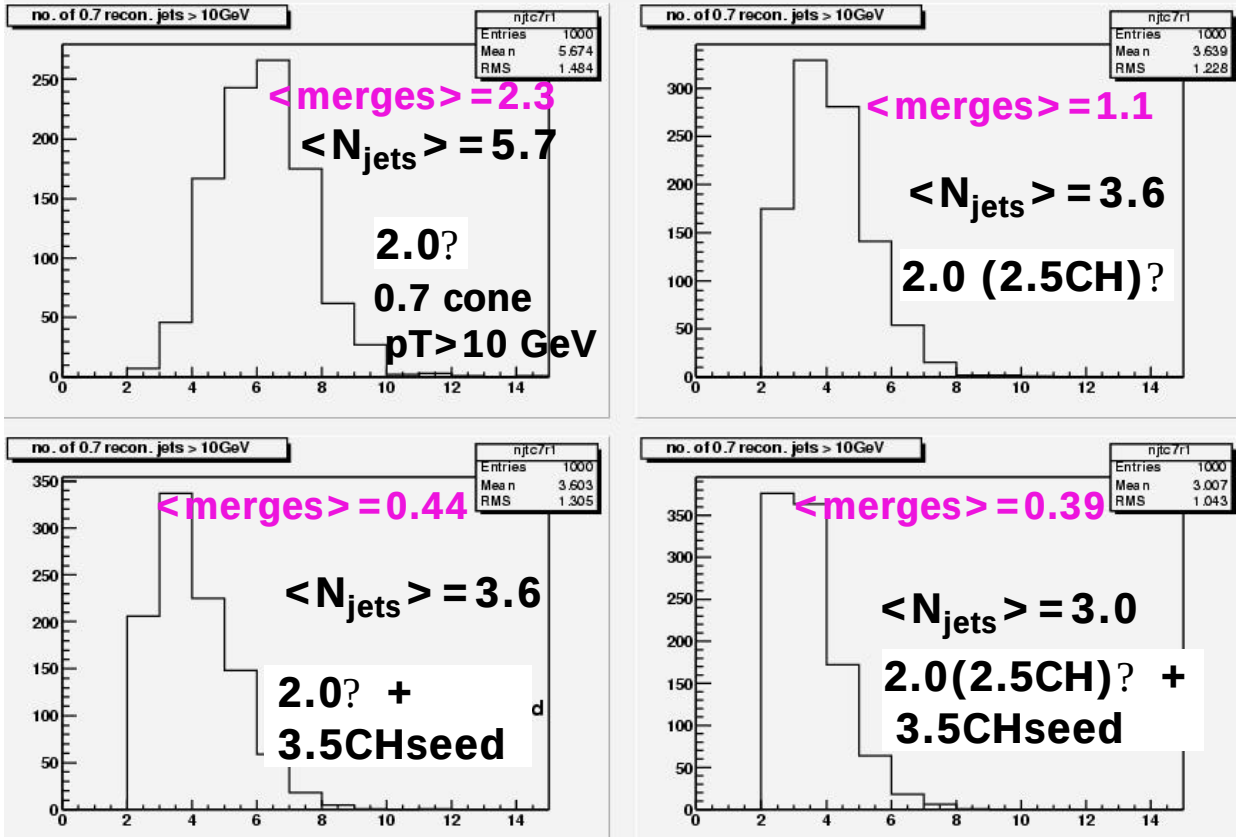




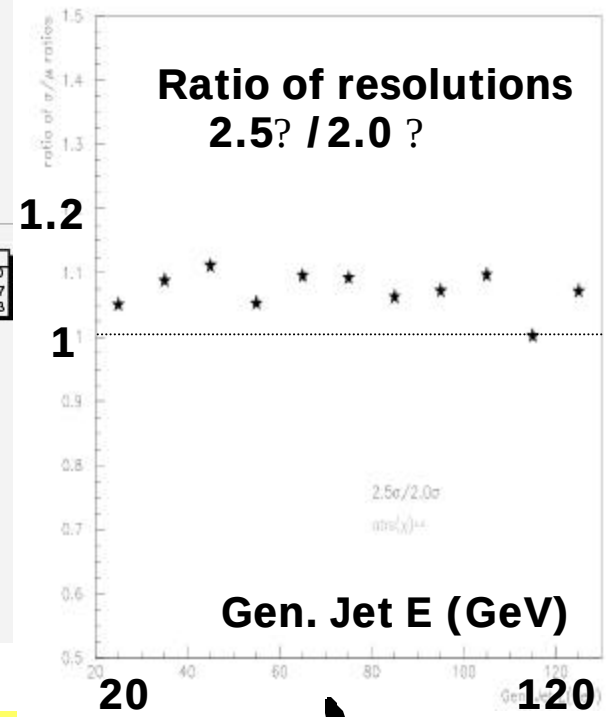


Can we clean up the CH noise?

Vishnu Zutshi

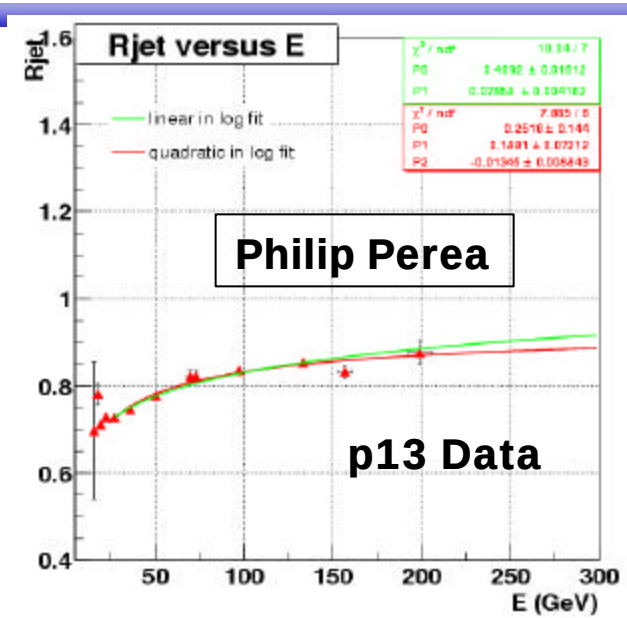


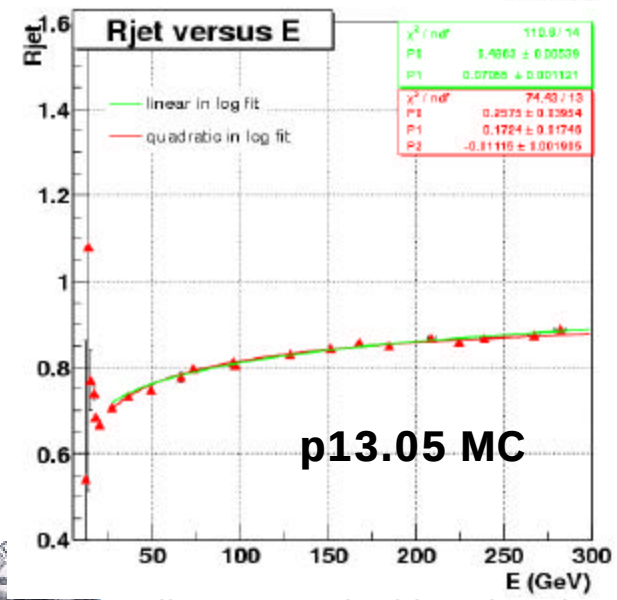
QCD pt40

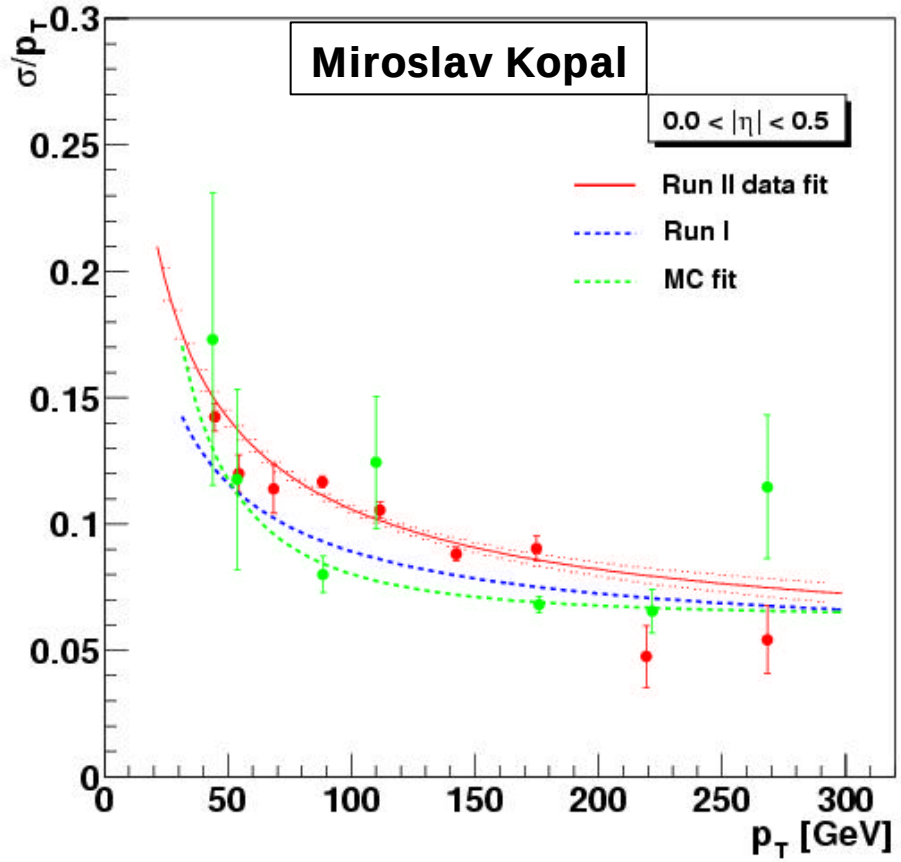


- Effective at cleaning up fakes
- Improves response
- May be able to improve resolution ? / ? by 5-10%
- Needs to be verified in p13 MC and data

Certified p13 Jet Response and Resolution

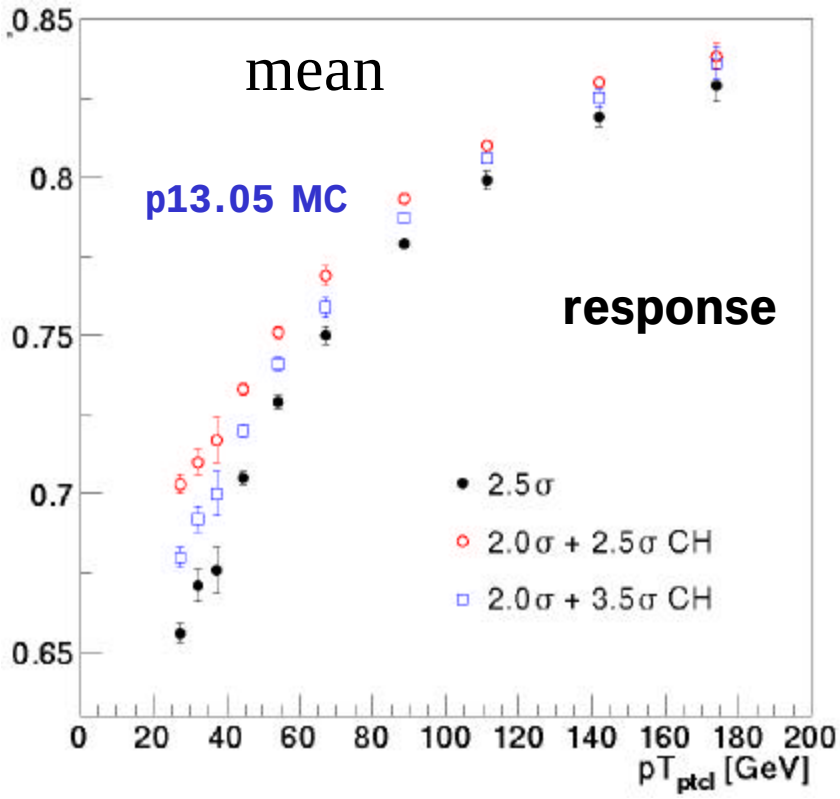


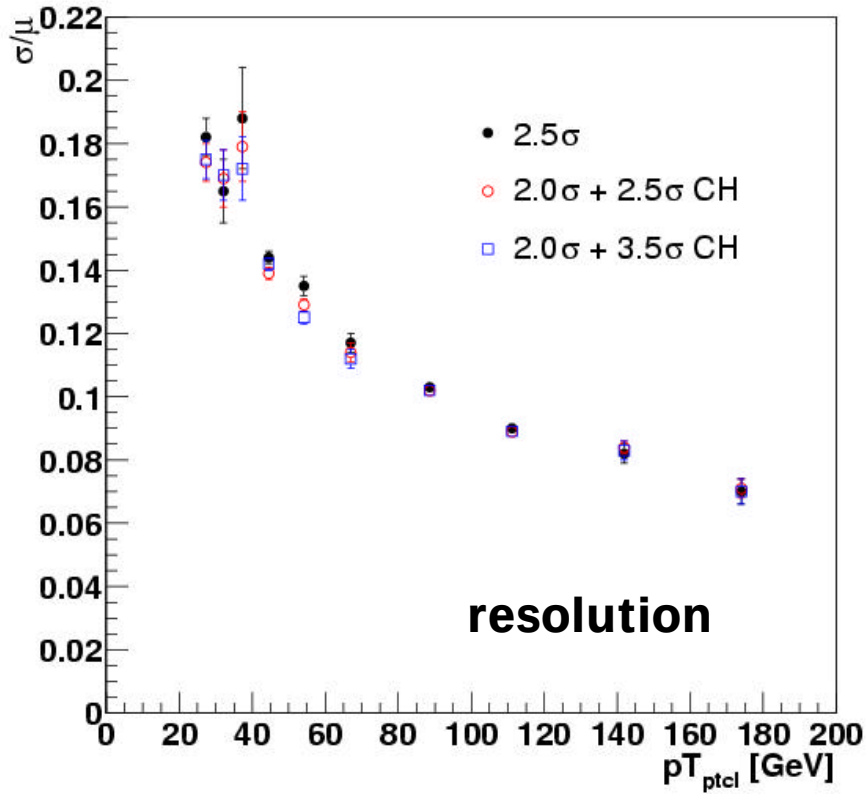




- MC and data agree reasonably well for Jet response
- MC resolution about 30% better than data for p13

Jet Response and Resolution vs Zsup



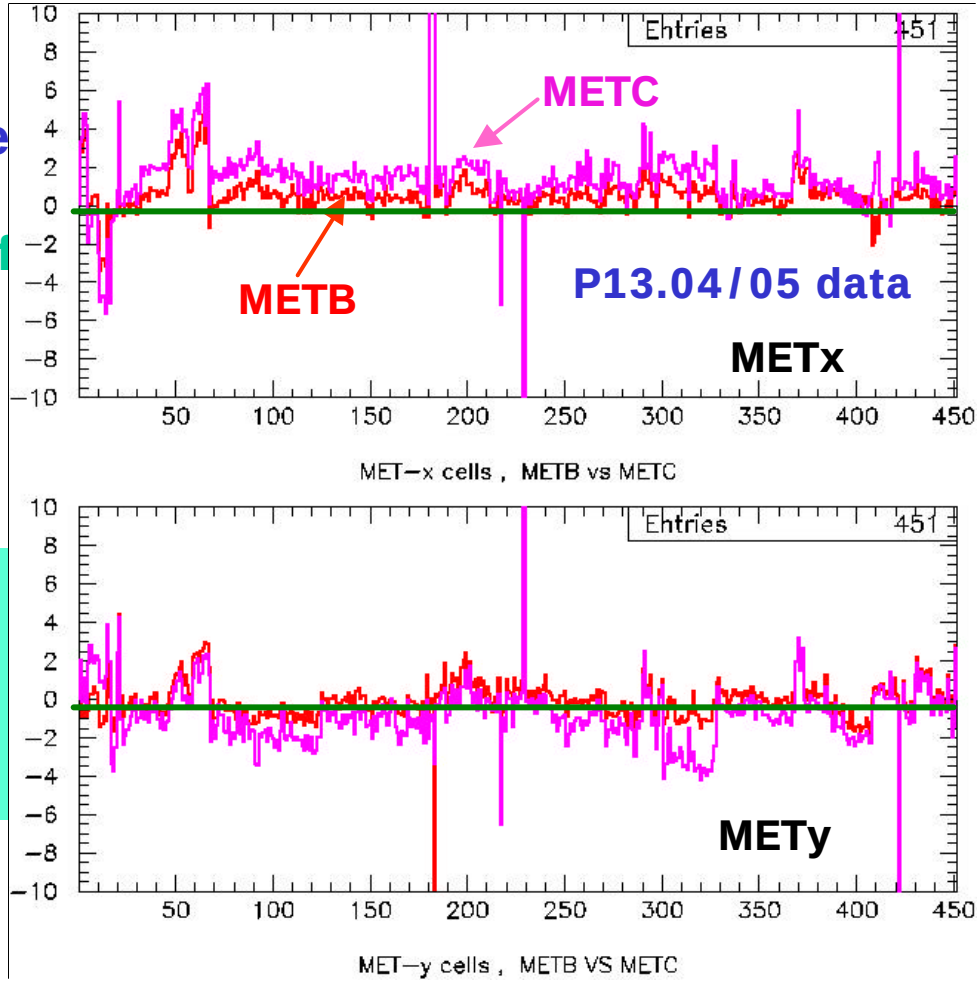


- P13.05 MC with full noise simulation (but d0gstar packing "feature")
- Cone R=0.7 jets, |detector eta|<0.5
- QCD MC pt20,40,80 GeV
- Fit pt_det/pt_particle for matched jets and calculate ? /?
- Plotted vs Energy does show improvement – under study

Alexander Kupco

Improvements in MET

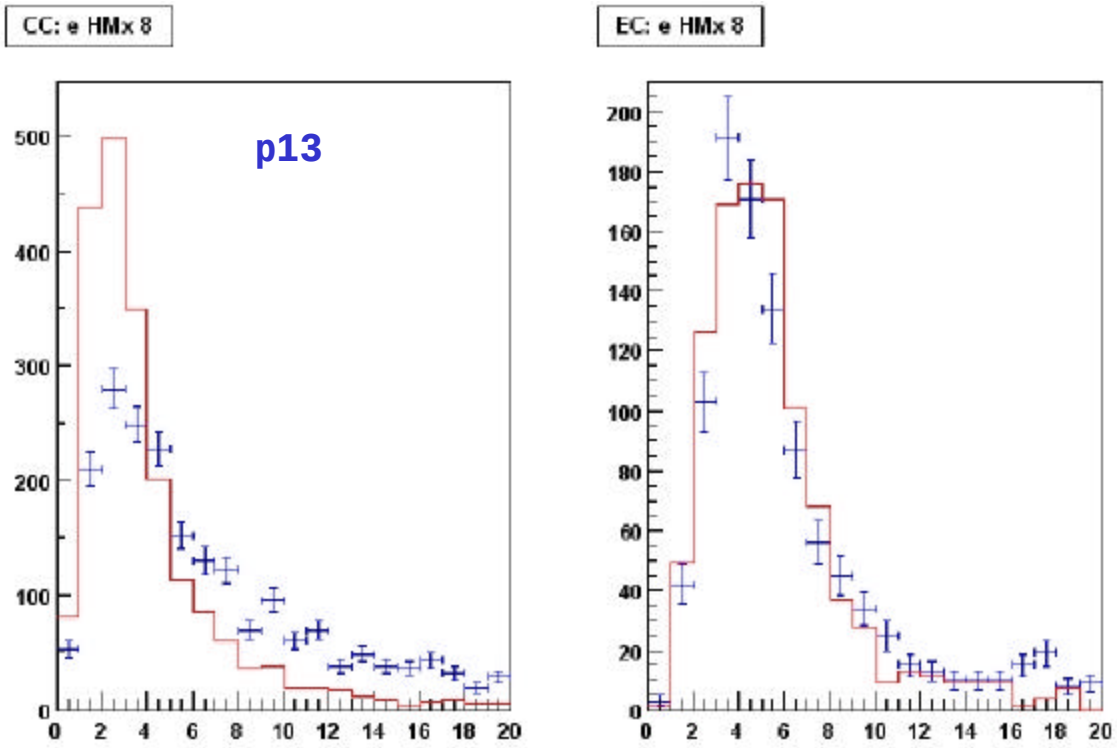
- p13 prescription
- All MET calculations should not use the unclustered energy in the CH (layers: 15,16,17)
  - Only use CH cells in towers of a jet passing good Jet ID criteria
- 100 MeV threshold on cells for p13 prevents some pathologies (expect to go to 0 MeV in p14)
- METB – MET excluding unclustered CH cells
- METC – MET including CH cells
- METD – MET from Layers 1-14
- Store sufficient cell information in TMB for recomputation
- ✍ Coherent treatment of CalDataChunk for all object IDs



Gregorio Bernardi

EM ID

- Need realistic MC description to tune H-matrices, shower shapes to model efficiencies and fakes
  - Sensitive to low energy cells
- P13 H-matrix still leads to 10% inefficiency
- Junjie Zhu and Vu Anh Tuan investigating tuning and optimizing Emreco parameters
  - Cell energy thresholds
  - Cone size
  - Object layer weights
  - Preshower

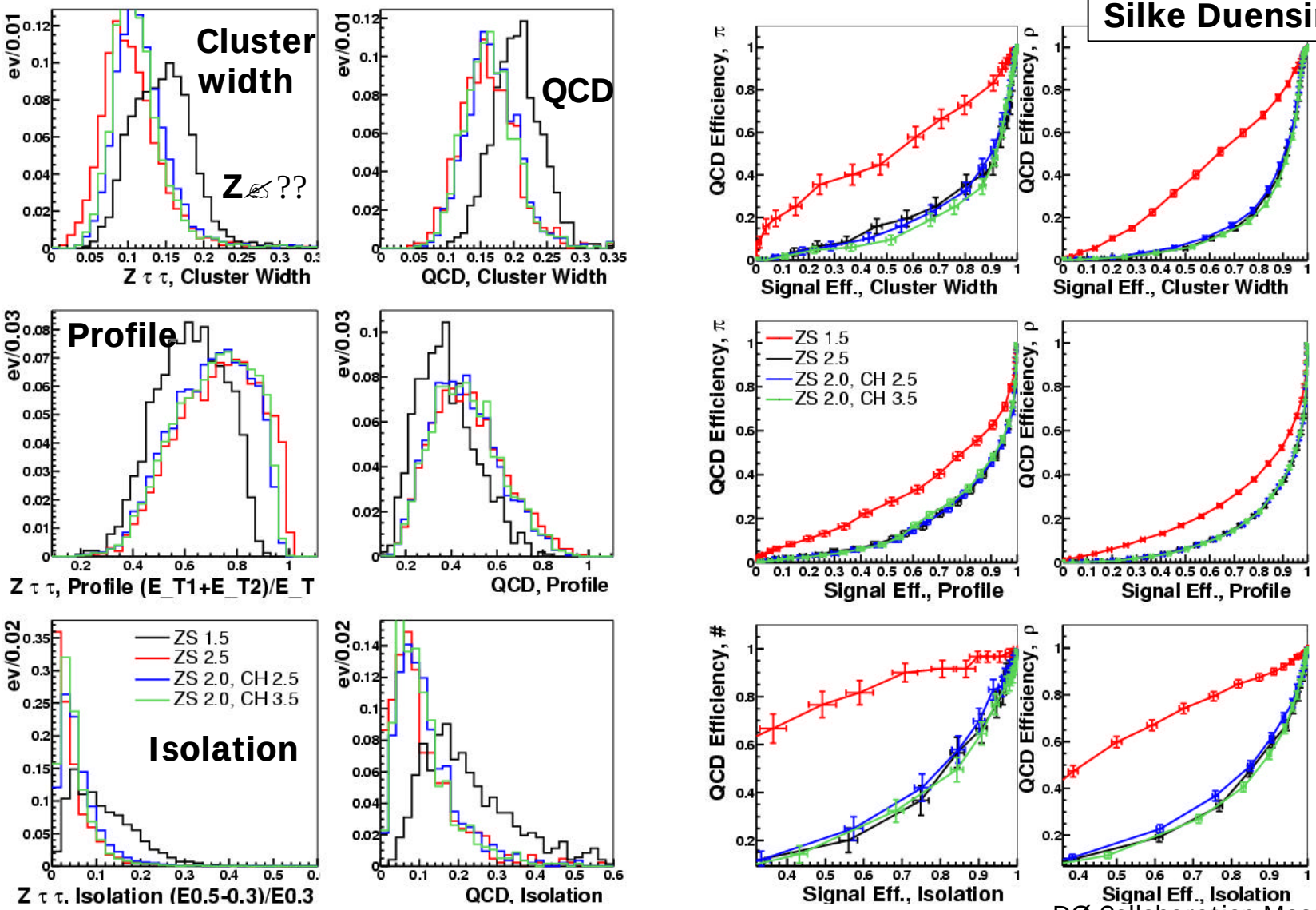


HMx8

Volker Buescher

Tau Profiles – still unclear

Silke Duensing

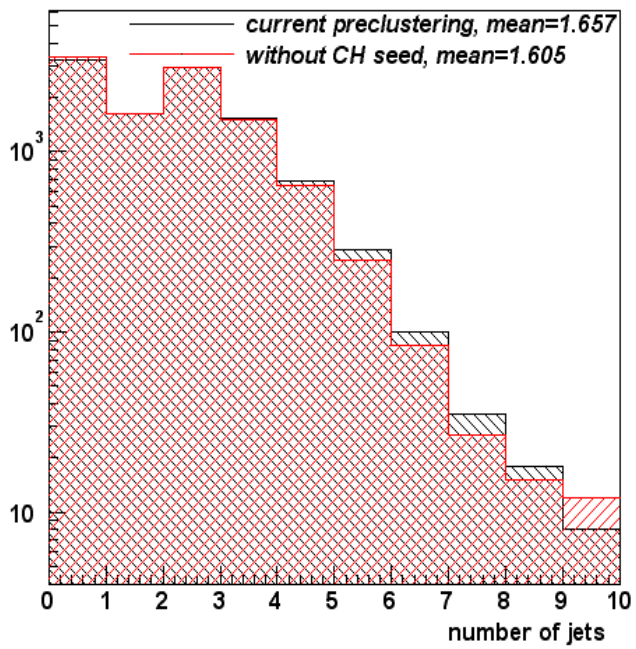


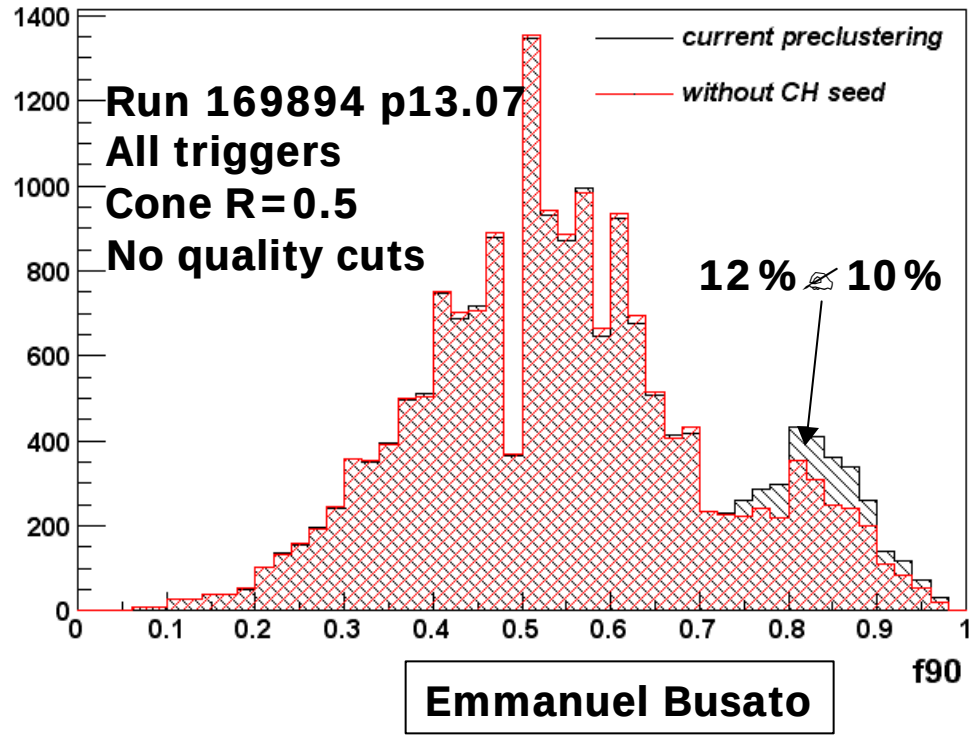
Near Future Developments

- Obtain zero suppression thresholds, NLC coefficients, offline pedestal and gain corrections from calibration database
  - Remeasure after shutdown
  - Need to track stability
- Allow for different zero suppression of layers (and eta's?)
  - CH layers may need different suppression (2.5?)
  - Higher suppression at high eta's suggested (|eta| > 3.2)
- ICD channels need correction factor for 22pF/5pF from calibration (3.8x)
- Channel to channel calibration corrections for ICD
- Code cleanup and improve maintainability; History tracking for different reco versions rather cumbersome to maintain
- Provide persistent data structures for all packages to use
- Implement CH-seed weights
- NADA style block for T42 scheme
  - Consistent handling of CalDataChunk for all object reconstruction
- In-spill unsuppressed data for monitoring and corrections

Modified Simple Cone Jet preclustering
Anti-CH seeding

- Full implementation of CH-seed protection for low significance cells underway
- Preclustering uses >500 MeV towers
- Do not let low-significance CH cells (<3.5?) produce seeds in preclustering but do include in tower
- Emmanuel Busato implemented software and testing
- First results

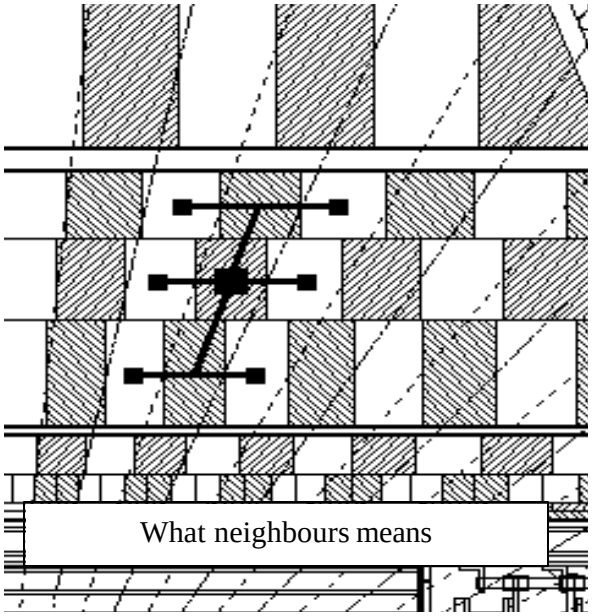


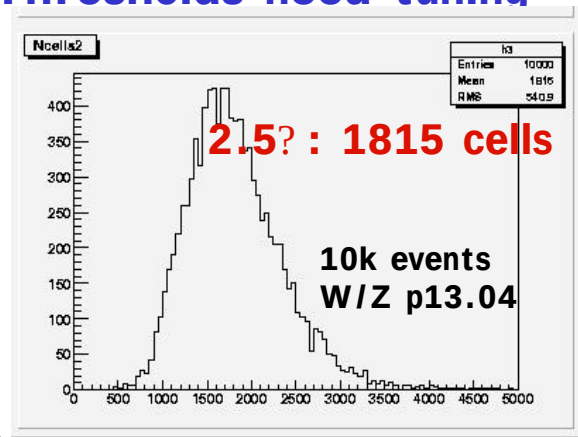


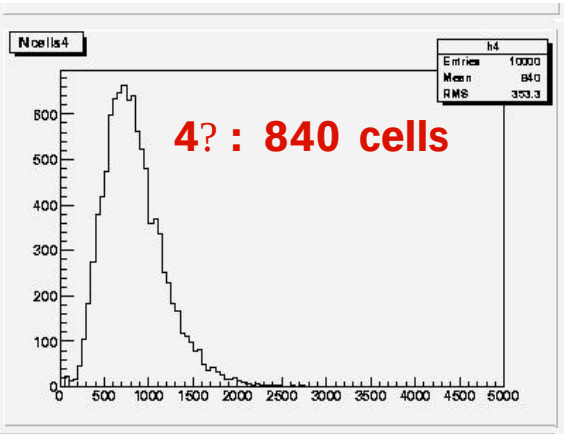
"T42" Scheme (à la H1)

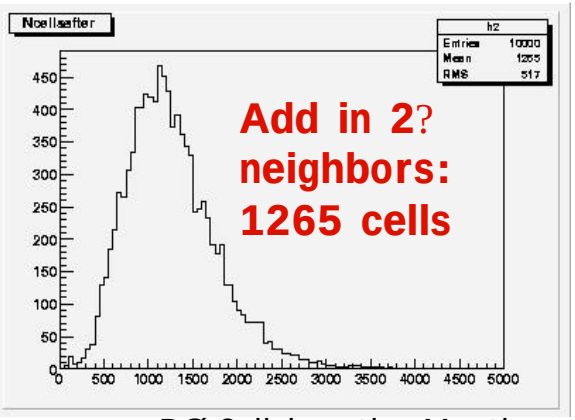
Jean-Roch Vlimant

- Select significant energy cells in the calorimeter and reject medium isolated cells
- Method:
  - Select high energy cells above threshold (4 sigma)
  - Select all significant neighbors above second threshold (2 sigma)
- Algorithm implemented (similar to NADA; linear performance) and creates new Calt42Chunk
- Initial tests on W/Z skim look promising
- Thresholds need tuning









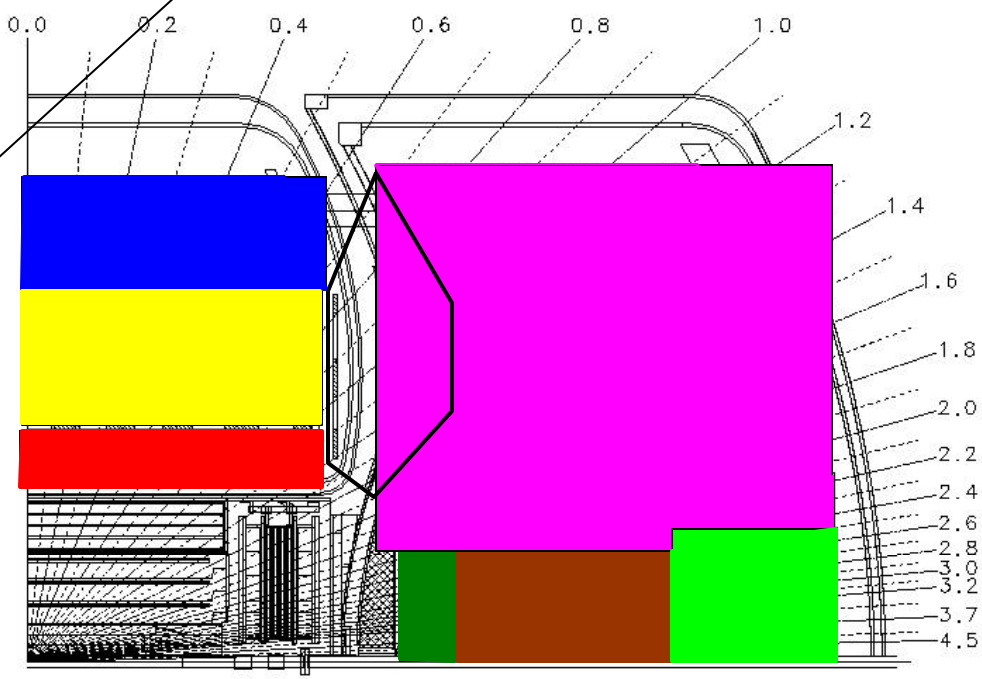
Cleaning effect per layer in W/Z sample

Jean-Roch Vlimant

Layer	2.5?		t42	NN (<4?)
CCEM:	237	✍	138 (60%)	40%
CCFH:	55.6	✍	17.9 (32%)	38%
CCCH:	7.87	✍	0.23 (3%)	60%
ECEM:	762	✍	601 (78%)	31%
ECIH:	600	✍	435 (73%)	37%
ECOH:	56.5	✍	6.2 (11%)	41%
ECCH:	54	✍	36 (67%)	42%
ICD/MG:	43	✍	28 (65%)	12%

Clustered cells

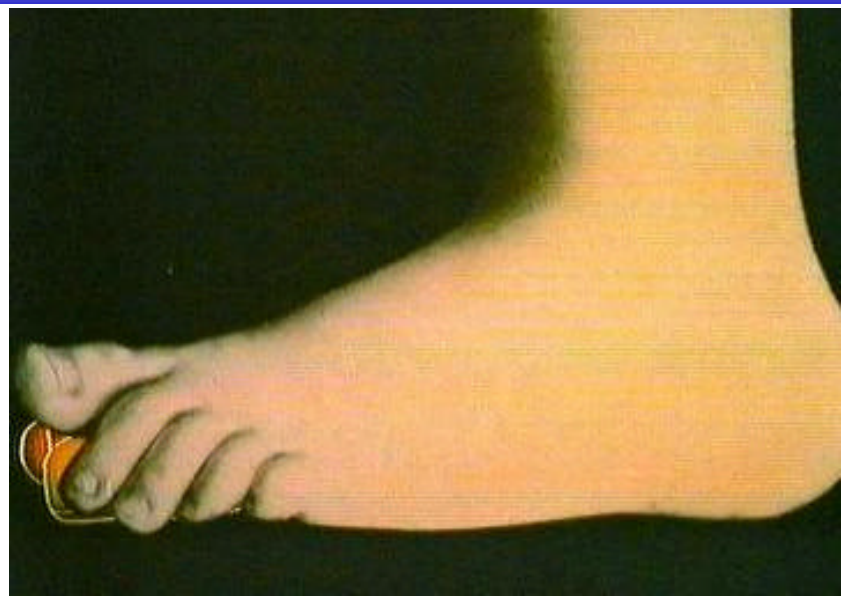
Isolated cells



- Initial indications that tightens EM ID variables
  - Isolation, EMF, HMx8
- Recenters METx,y and smooths distributions

What else have we learned

- Studies need to be able to be conducted outside of the production release cycle
  - "Emergency mode" fixes applied – sometimes painfully and publicly!
- Running relatively large amounts of MC on production farms in non-standard mode ain't easy
- "Beta" testing cycle needed
- Getting clear, focused attention from many people from many groups is very, very useful…



Summary & Conclusions

- CTF achieved many technical improvements and significant progress in understanding
- Several new approaches are ready for studies (jet seeding in CH, T42, multi-threshold zesu, ZeroBias data overlays…)
- We still can take advantage of the UTA farm setup to produce samples for studies past CTF.
- Proposal:

  Generate all samples intended for p13.05 using p13.08.
  - Any additional samples?
- Constraints from the release schedules and farm production were painful. Future work of this type needs to be more structured and/or independent.
- Hardware and calibration require continuing effort and attention.
- Bad/ugly channels, warm zones etc are not in current simulation.
  - Will data ZB overlays account for such effects?
- Reasons for deteriorated jet and EM resolutions not (yet) fully understood. Luckily, much physics still can be done, but results suffer.
- Do not drop CalDataBlock yet…

Recommendations

- The CTF effort needs to be continued, at similar intensity, for the next several months.
  - The software+simulation+data quality group should be (re)established with sufficient manpower
  - Quick feedback to online/hardware experts is essential
  - For now, need to preserve the tmb CAL block for data quality studies
  - Level-3 studies urgently need manpower
- Interaction of calorimeter-related detector, software, ID and physics efforts is crucial, and a mechanism for this should be put in place.
- We recommend that conservative settings for the zero suppression be preserved while the algorithmic developments and studies are in progress, so that future solutions could be applied to data collected until the implementation of the final choices.

Channel Noise

- 1st line = raw noise/ADC 2nd = cal weights 3rd = noise/MeV

>100 MeV

CC EM1	CC EM2	CC EM3	CC EM4	CC FH1	CC FH2	CC FH3
3.10	3.16	2.01	2.90	6.62	6.53	6.69
31	9	26	28	25	23	28
47.9	14.7	25.2	39.4	79.4	76.3	92.3

EC EM1	EC EM2	EC EM3	EC EM4	EC IH1	EC IH2	EC IH3	EC IH4
3.15	3.22	2.71	3.01	5.69	5.62	5.52	5.34
32	17	33	40	27	26	26	28
49.7	26.3	42.9	56.7	76.6	70.1	69.18	71.0

				EC MH1	EC MH2	EC MH3	EC MH4
				5.13	6.17	6.73	6.22
				30	24	25	29
				74.5	72.9	80.1	86.7

CC CH	EC ICH	EC MCH	EC OH1	EC OH2	EC OH3
6.40	4.63	6.00	6.682	5.86	6.12
96	**91**	**89**	**107**	**104**	**117**
297	204	255	290	296	343

very high noise

CC MG	ICD	EC MG
2.95	1.61	3.97
~40	70	**~90**
58.2	15.9	178

Robert Zitoun