CALOR 2010 HIGHLIGHTS

Group Meeting - 31 June 2010

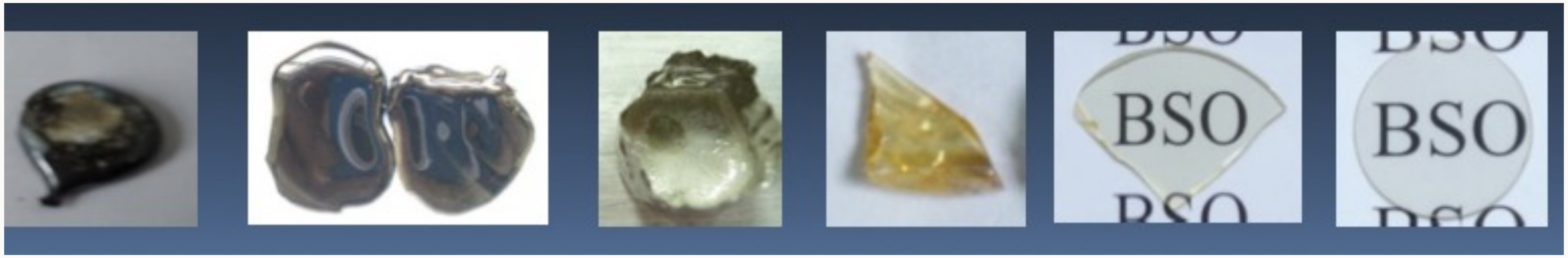
A. Dotti

FEW NUMBERS

- Location: IHEP , Beijing China
- Web site: http://bes3.ihep.ac.cn/conference/calor2010/
- 120 Registered participants
- All talks in plenary: 6 sessions, 97 talks
- Sessions: materials & detectors; readout technique; algorithm & simulation ; astrophysics & neutrino calorimetry ; operating calorimeters & calibration ; future calorimetry

MATERIALS & DETECTORS

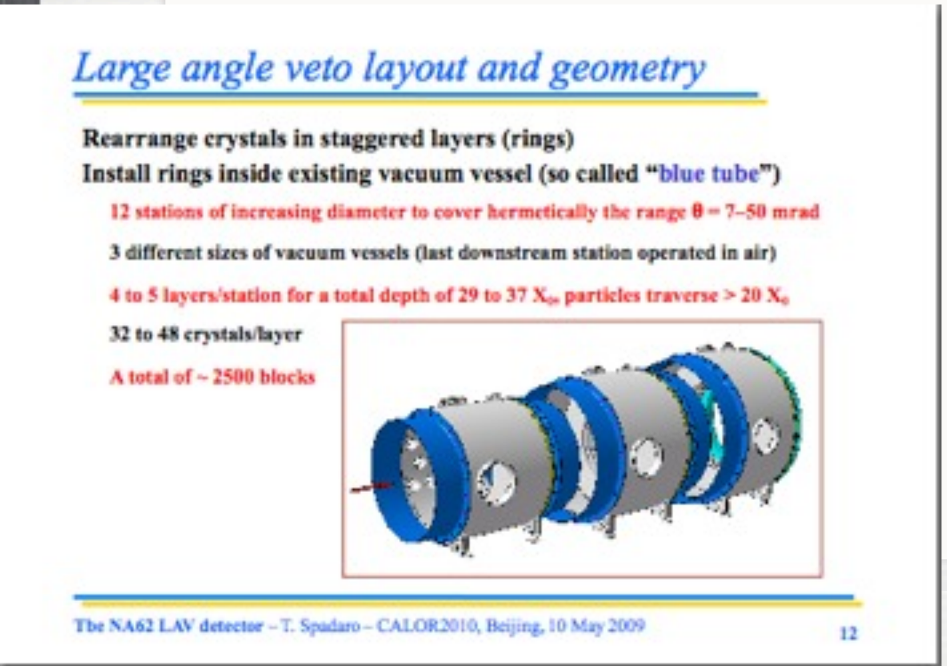
- Session for R&D for future calorimeters
- Main topics:
  - Crystals: industrial issues, new directions
  - Conference was following second Homogenous Hadron Calorimetry workshop
    - Summary: need for highly transparent scintillating crystals
    - Need for dual read-out ready crystals: scintillation/cherenkov (industrial challenge)
    - Investigating use of glasses as alternatives to crystals (Cher. aspects need to be addressed)

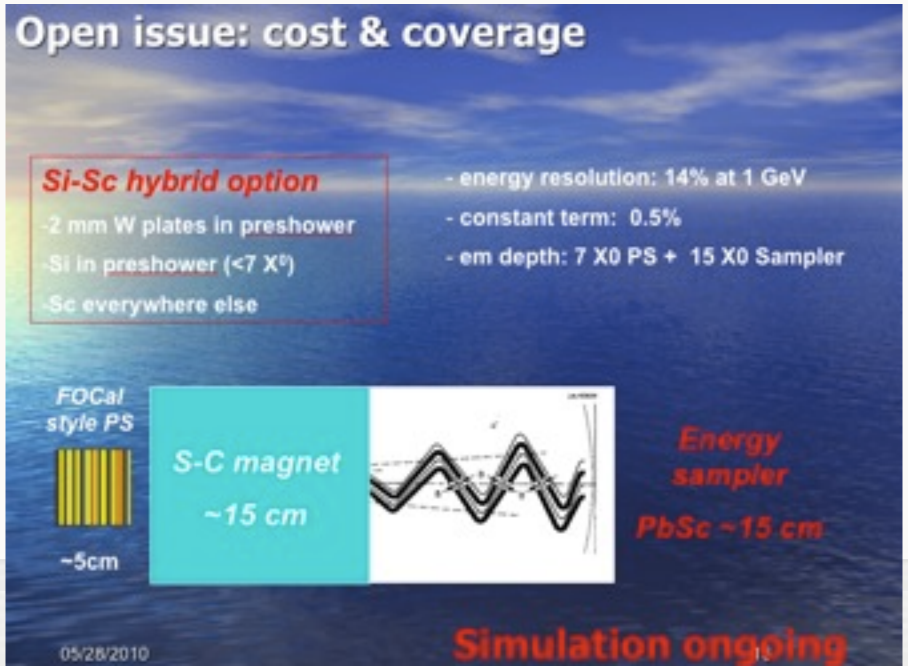


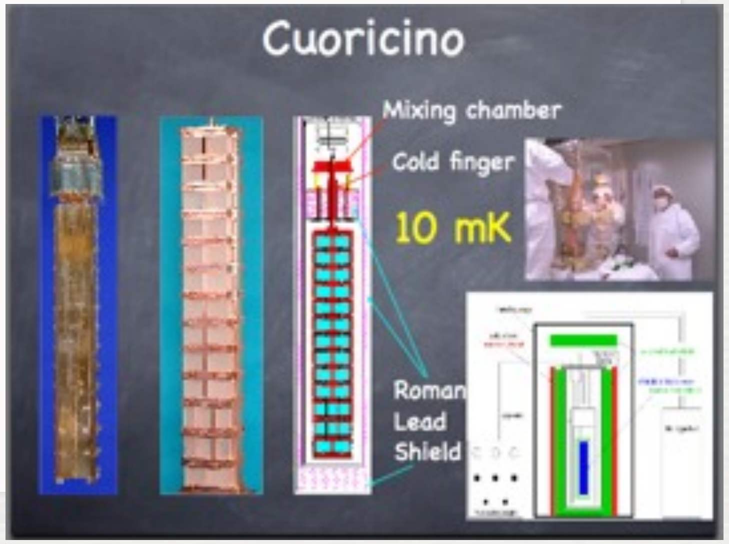
- Ohter topics:
  - Strip-scintillator, WLS fiber, Pixelated PD and custom electronics R&D
  - Calorimetry at 10mK (Crystals for Double Beta Decay)
  - W-Si calorimeters: CALICE and PHENIX
  - NA62 large-angle photon veto system

NA62 will use G4!

PHENIX upgrade W-Si

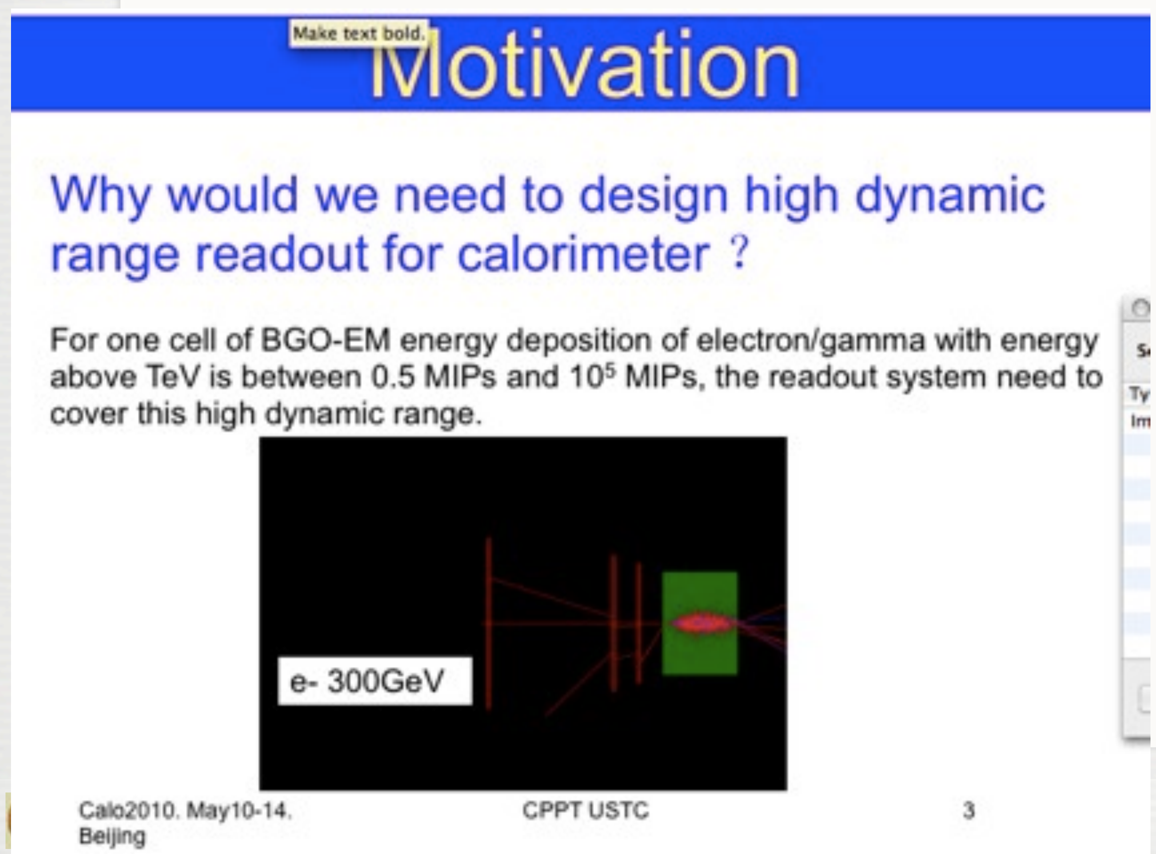


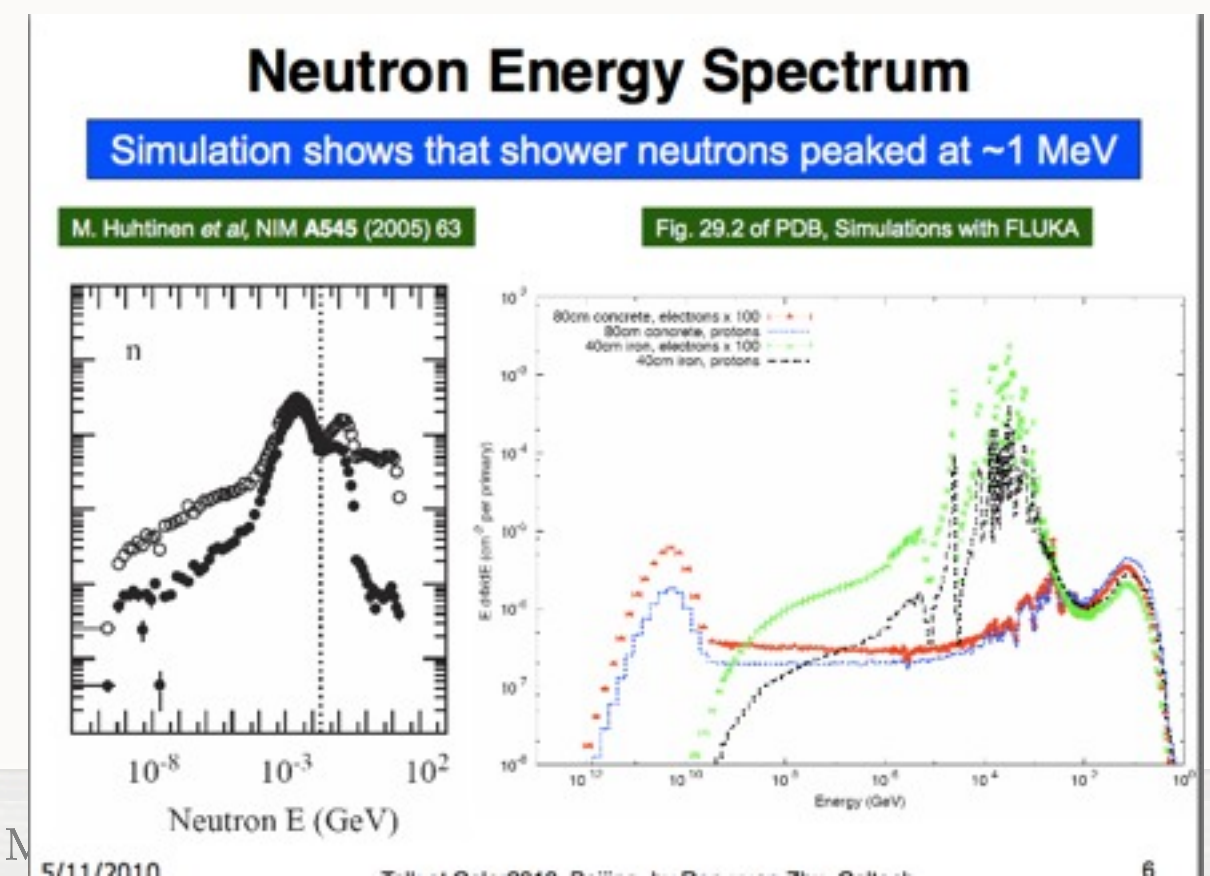




READOUT TECHNIQUE

- Read-out electronics studies
- New developments in Photo Detectors: PMTs, SiPM
- Effect of MeV neutrons on APD





ALGORITHM & SIMULATION

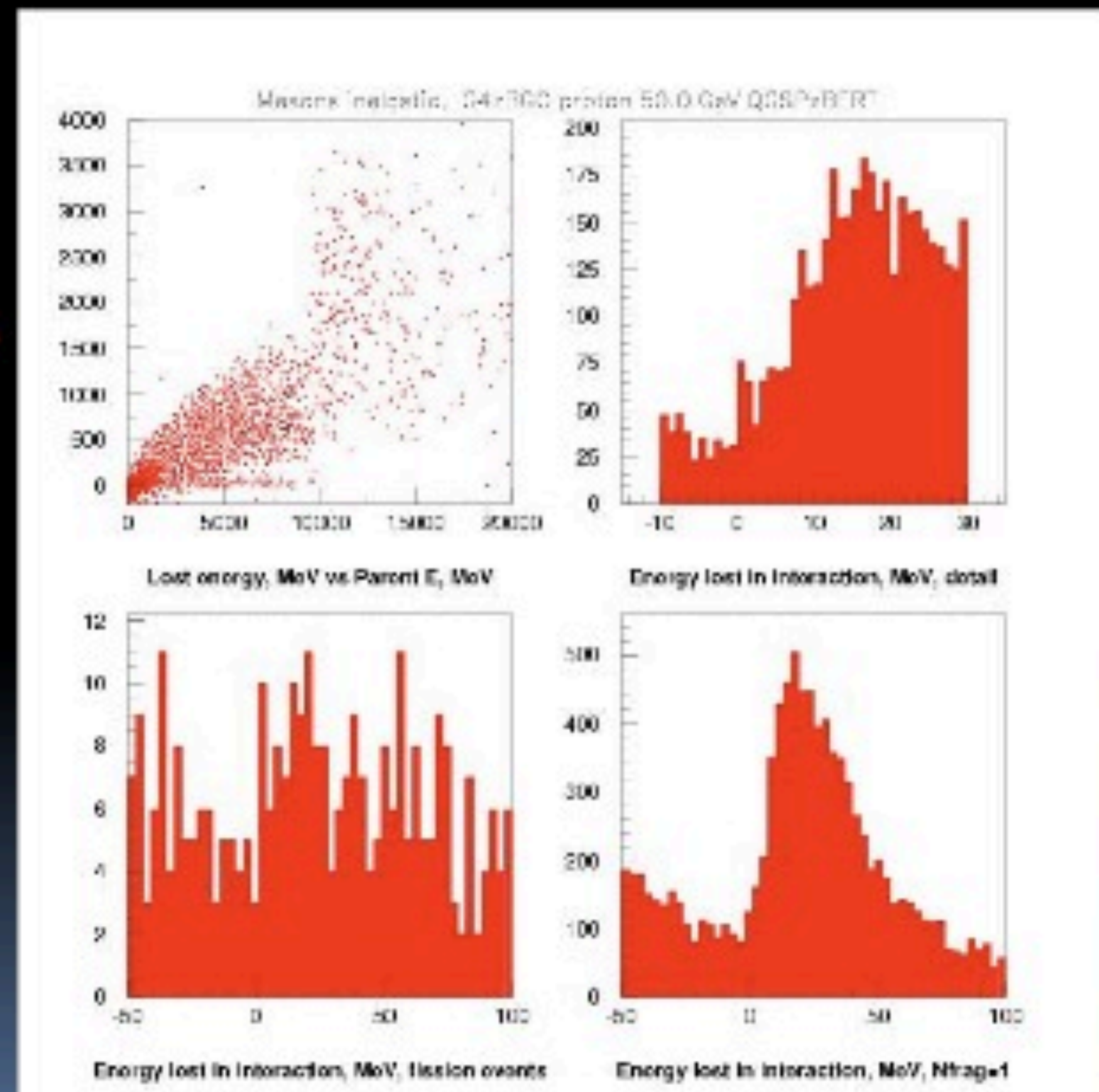
- Only two talk on (general aspects of) simulation.
- Our talk was followed by a talk on hadron shower studies with G4 by Adam Para
- Gflash use in CMS and fast showers in H1
- M. Simonyan: hadron showers in ATLAS
- Other topics:
  - General talks on reconstruction algorithms (ALICE PHOS, muon/pion ID in BESIII, particle flow)
  - One talk on jet "theory" and one on jet corrections
  - Combine dual-readout and particle flow techniques

Impression From Our Talk

- Audience was quite interested in talk
- Some questions:
  - "In response plot, can you repeat where data are?"
  - "Why there is difference between CHIPS and QGSP_BERT response?"
  - "CMS has some public results on anti-p, kaons" (discussion with Sunanda started. First comparison expected at next LCG Phys. Val. Meeting, 7 July)
- Contacted during coffee breaks by few people that are interested in further studies for neutrons (A. Para, G. Sguazzoni), both interested in trying CHIPS in the near future

Kinetic Energy (non) Conservation in a Collision

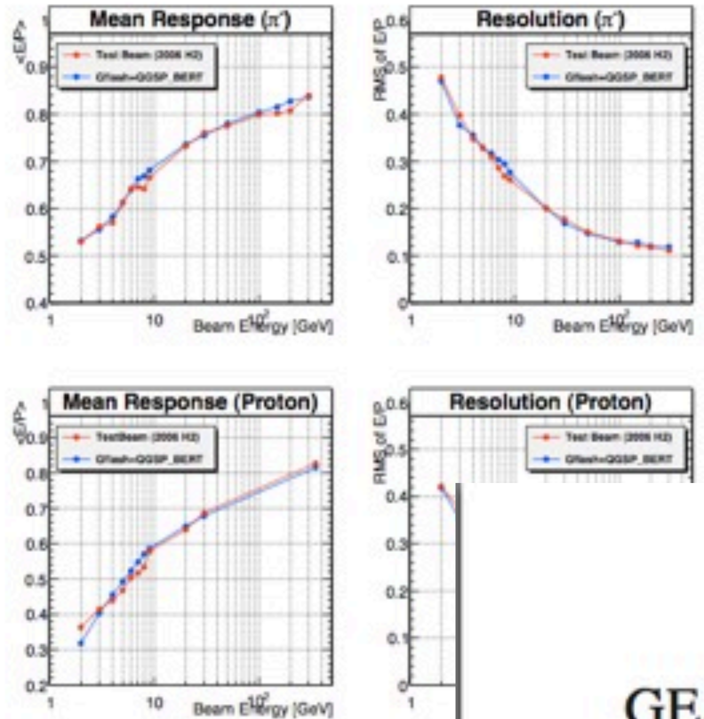
Total kinetic energy, after – before interaction vs energy of the interacting particle



very different modeling of hadron-nucleus interaction below and above 10 GeV

Hadronic Energy Response and Resolution

$\langle E/P \rangle$ as P and its RMS compared to 2006 test beam data (π^- and p)



S. Y. Jun @CALOR2010 5/10-14/2010

CMS GFlash

H1 Fast simu

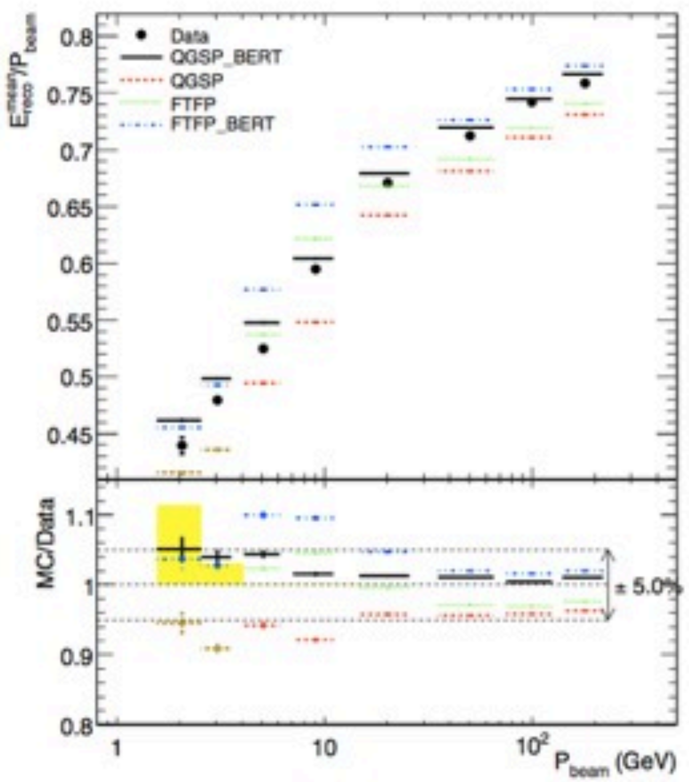
Simulation of Electromagnetic Showers

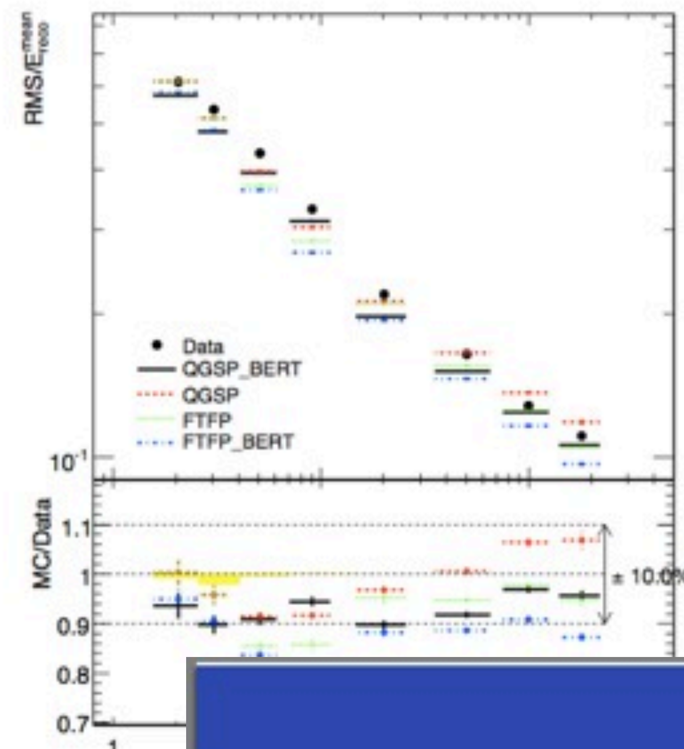
GEANT simulation of electromagnetic showers often takes dominate part of the simulation time. Several methods are used to speedup simulation:

- GFLASH parameterization of higher energy showers. GFLASH becomes inefficient for detectors with a lot of material in front of calorimeter.
- Shower libraries, pre-simulated sets of showers. Limited to calorimeters with translational symmetry of readout elements.
- “Frozen showers” (ATLAS), libraries of GEANT hits for soft particles.

For H1 detector, GFLASH is used for LAr calorimeter, Shower libraries for SpaCal.
Speedup vs GEANT simulation: about factor 3 – 6, depending on event topology.

Response and Resolution





QGSP_BERT describes the response within ±5%

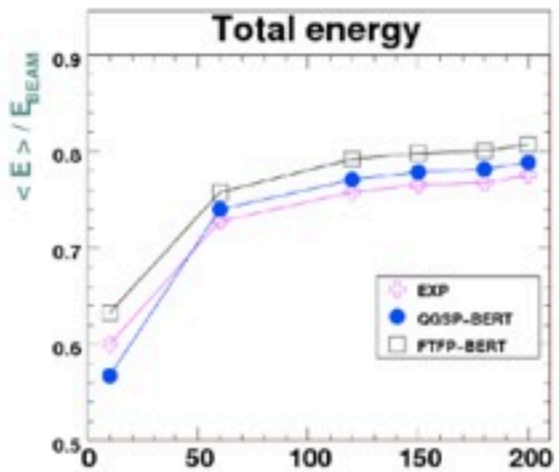
QGSP_BE
(RMS/mea
but still wit

M. Simonyan:
shower development s in ATLAS calos

Conclusion

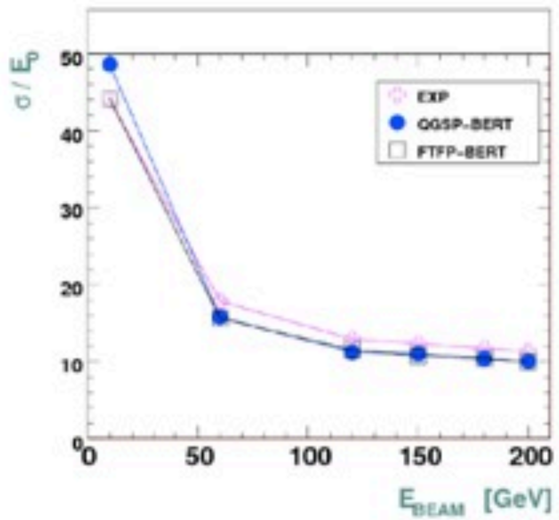
- The response of the ATLAS calorimeters to hadrons is described within 5% in the energy range 2–350 GeV.
- Simulation is able to describe the resolution with 10% accuracy.
- Proton induced showers are shorter than pion induced ones, but they are laterally wider.
- Geant4 models predict shorter and narrower showers compared to the data.
- Addition of Bertini cascade model results in longer and wider showers as well as higher response and better resolution, which is generally in better agreement with the data.

Pions in endcap region: energy response and resolution at e.m. scale



Ratio of reconstructed energy at e.m. scale to the beam energy as a function of beam energy

- Monte-Carlo predicts higher response than seen in the experiment (+4% for FTFP_BERT, +2% for QGSP_BERT)



Energy resolution at e.m. scale as a function of bea

- Mo
a b

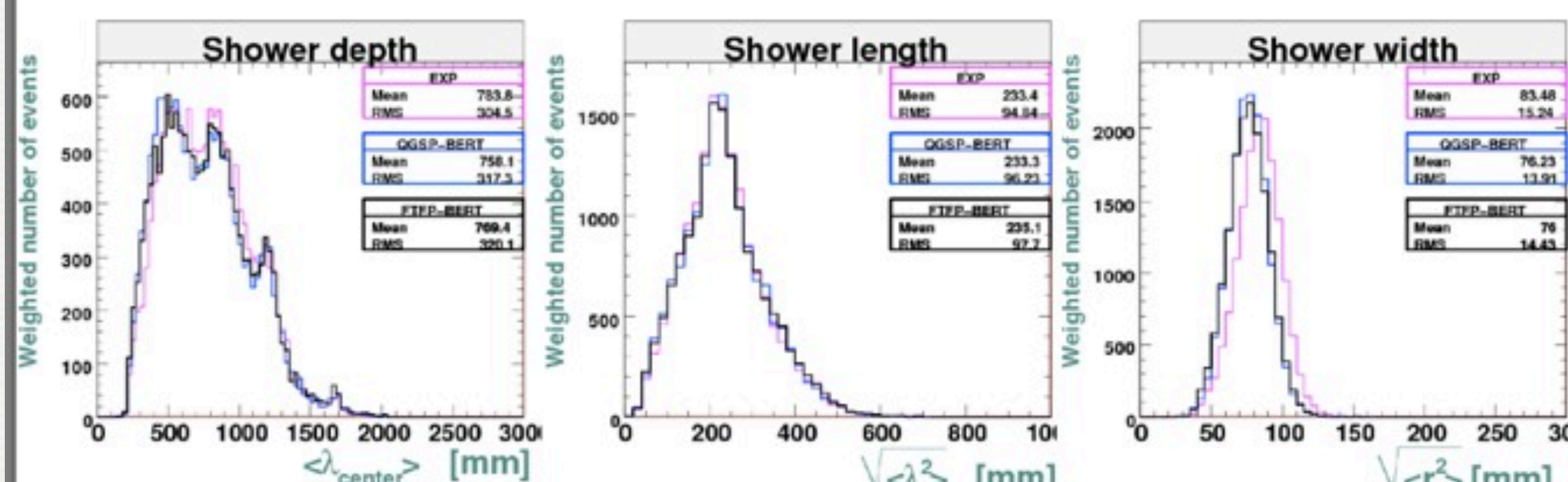
Gennady Pospelov, MPI Munich

CALOR

G. Pospelov:
local hadron calibration in
ATLAS combined test beams

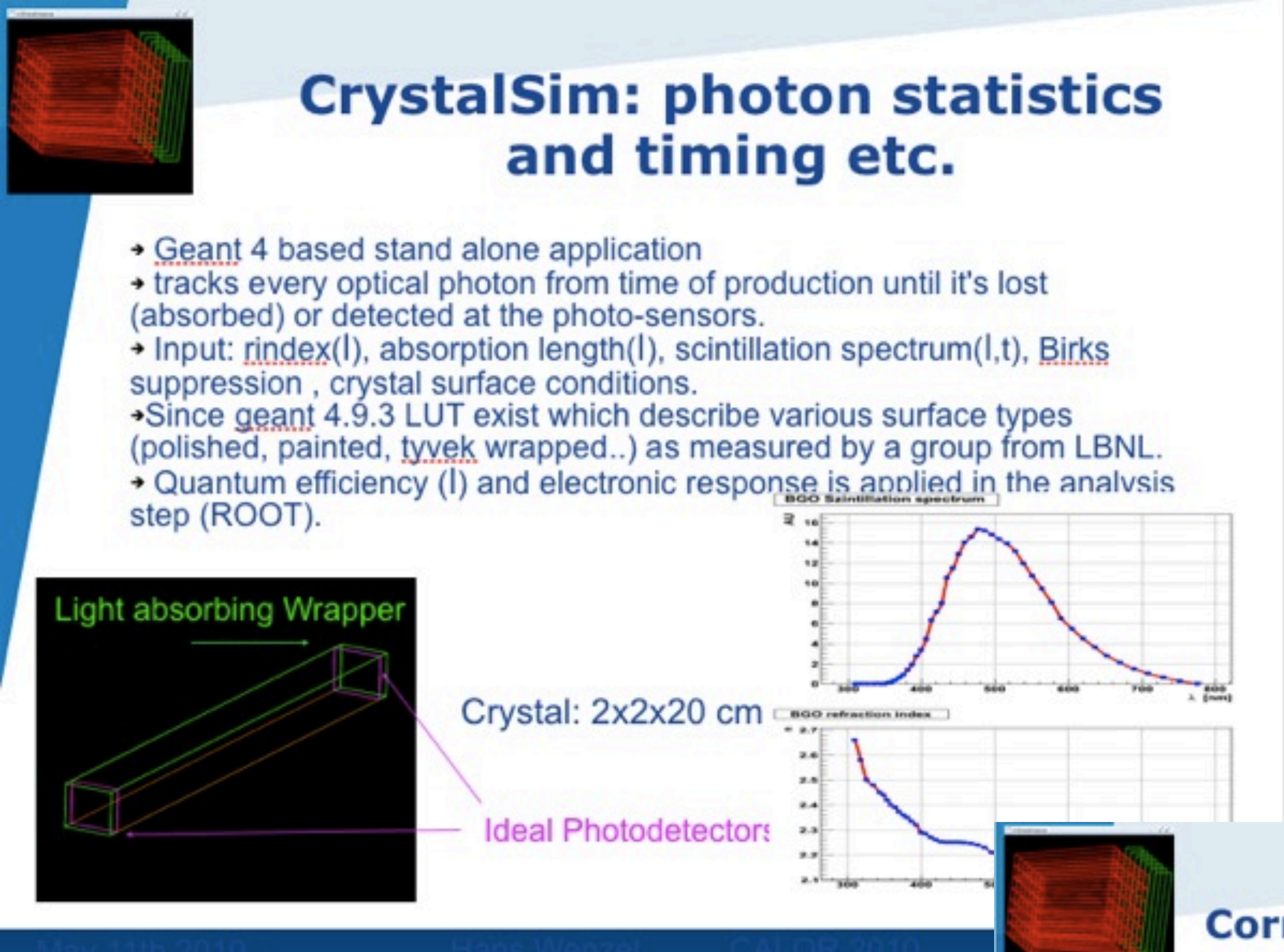
Pions in endcap region: shower shape studies

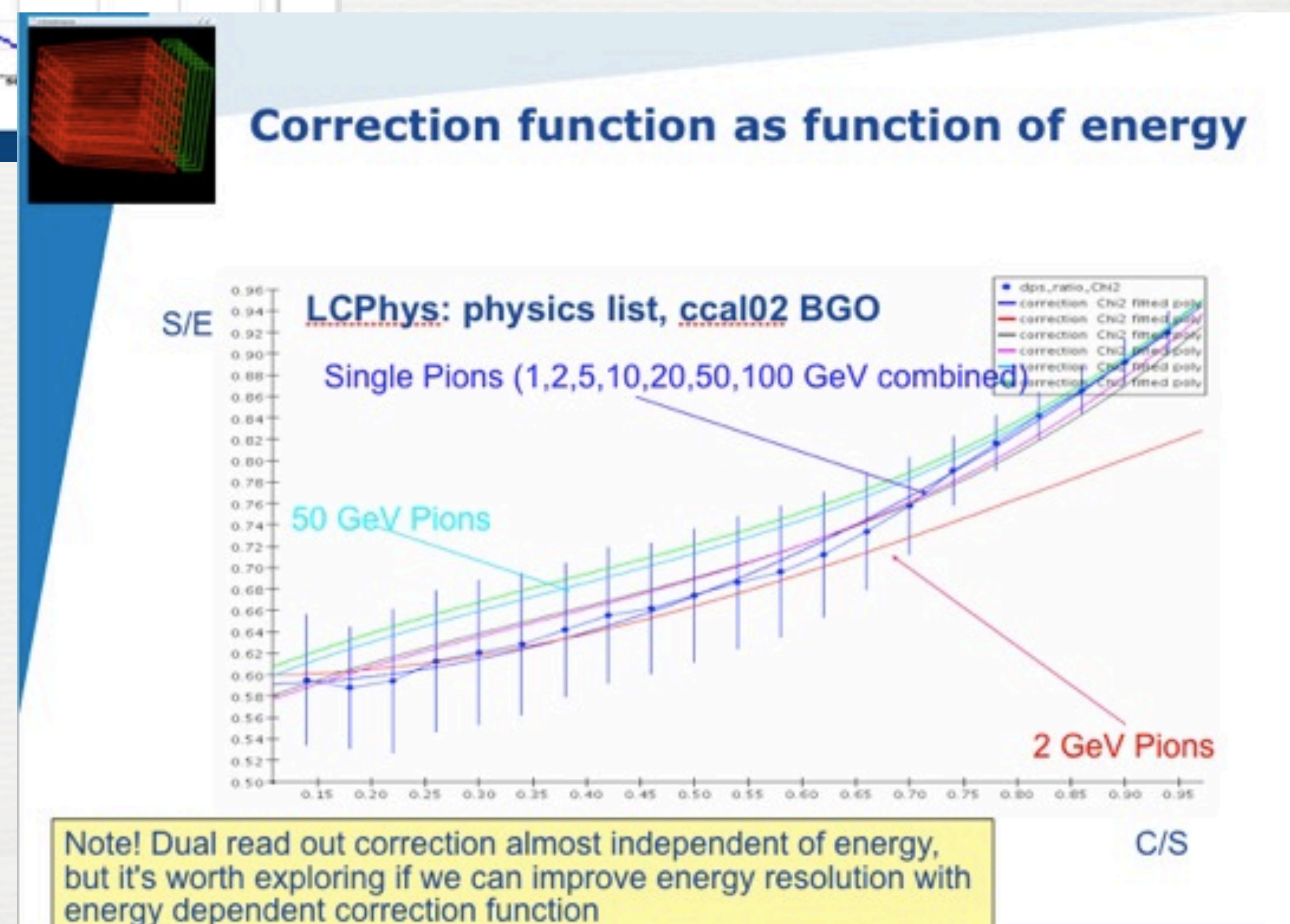
- Comparison of shower depth (left), shower length (center) and shower width (right) in Monte-Carlo and experiment
  - 200 GeV pions
  - QGSP_BERT and FTFP_BERT physics lists show similar results
  - Shower depth: shower starts slightly earlier in Monte-Carlo
  - Shower length: very good agreement in description
  - Shower width: Monte-Carlo has more compact shower



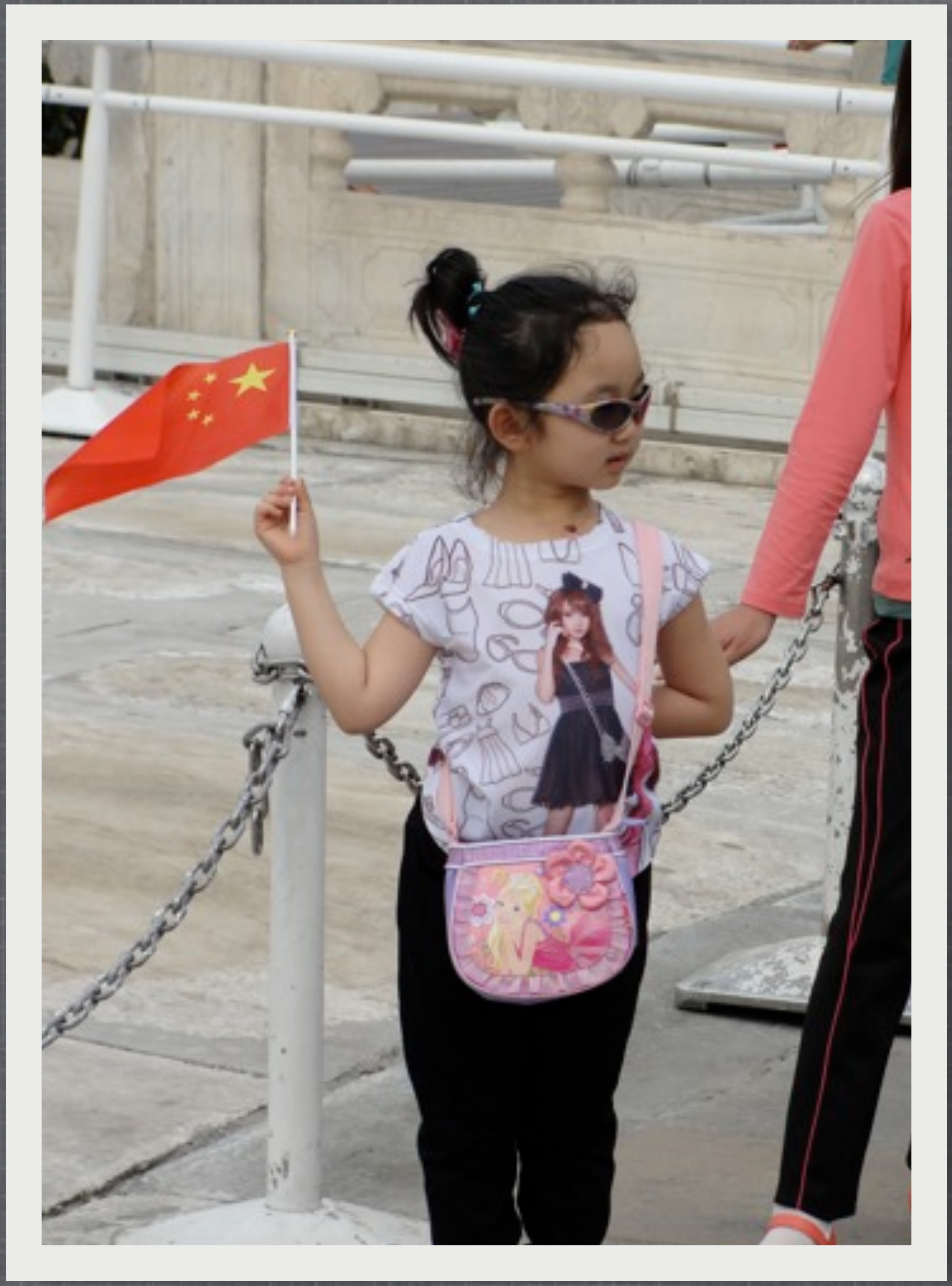
Geant 4 A. Dotti

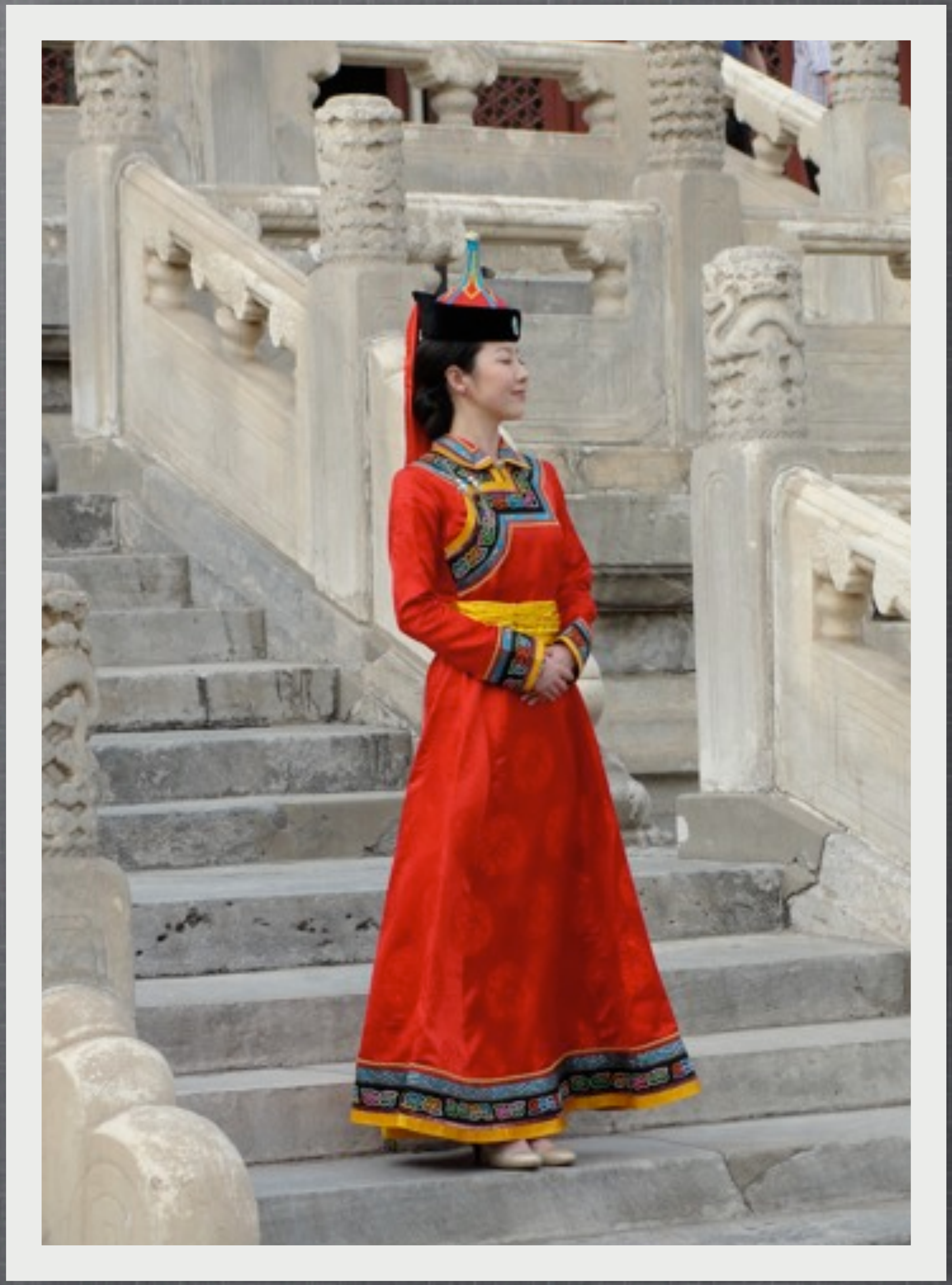
Dual read-out simulation with G4 (SLIC)





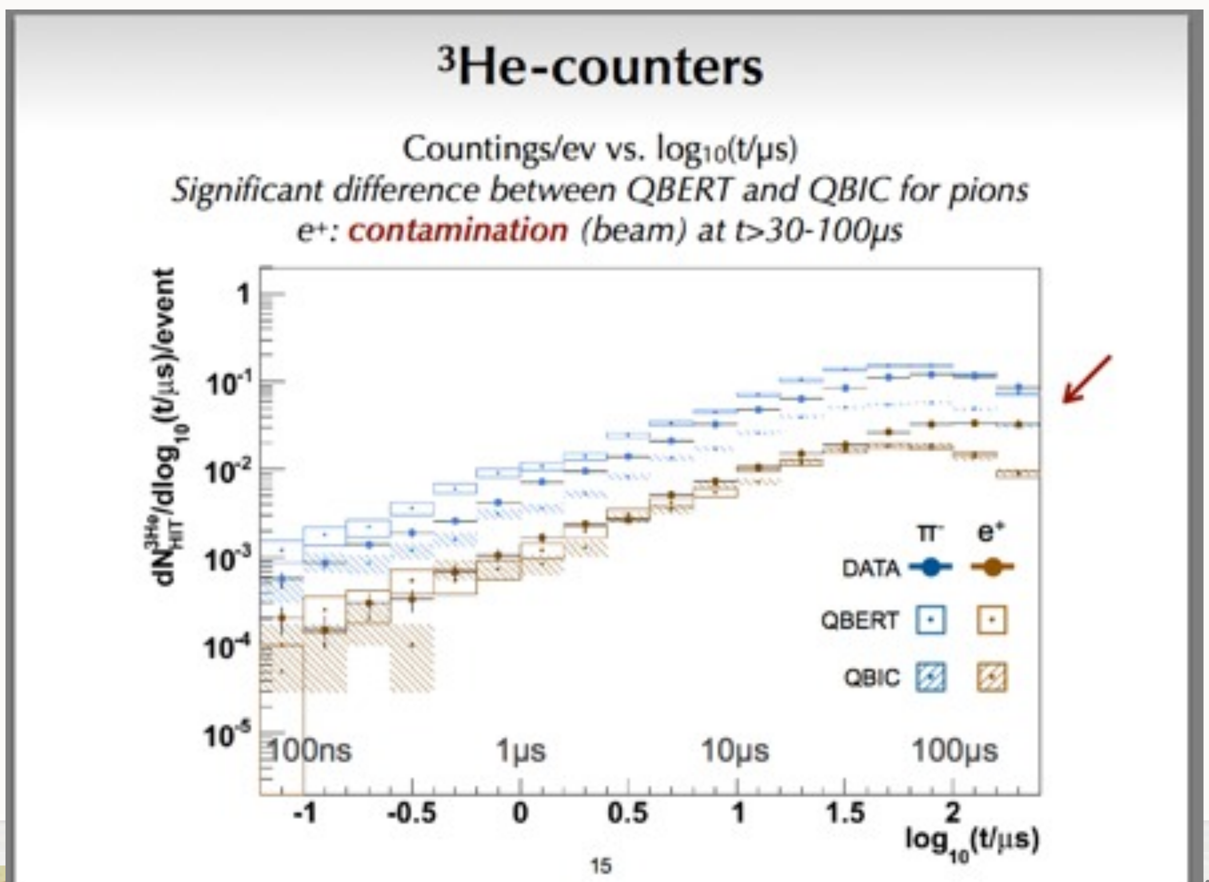
ASTROPHYSICS AND NEUTRINO CALORIMETRY



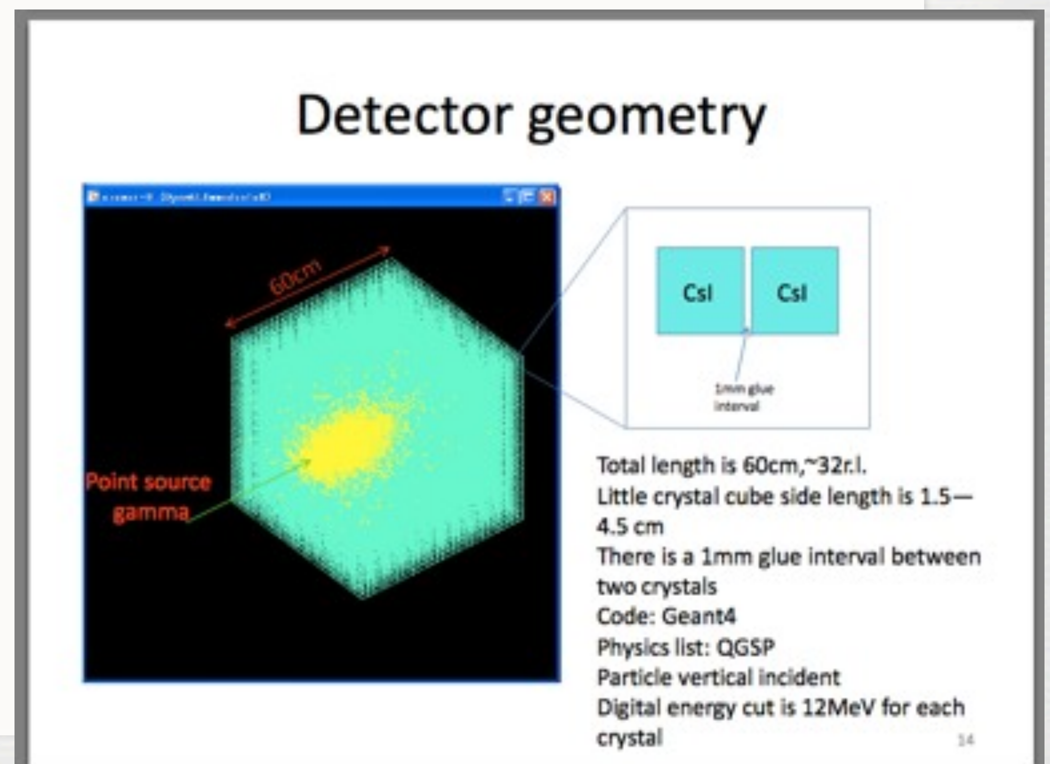


- Overview of: SuperNemo, Liquid Xeon, Digital Calos for dark matter in space, Pierre Auger
- Started contacts with Giacomo Sguazzoni (NEUCAL Experiment): adding a neutron counter to a small calorimeter. Will compare QGSP_BERT_HP Vs CHIPS in the future (second half 2010)

Measuring neutrons in showers:
done with QGSP_BERT / BIC_HP, will test CHIPS ,
some comparisons with Fluka



Initial studied with G4 for calos in space



OPERATING CALORIMETERS AND CALIBRATION

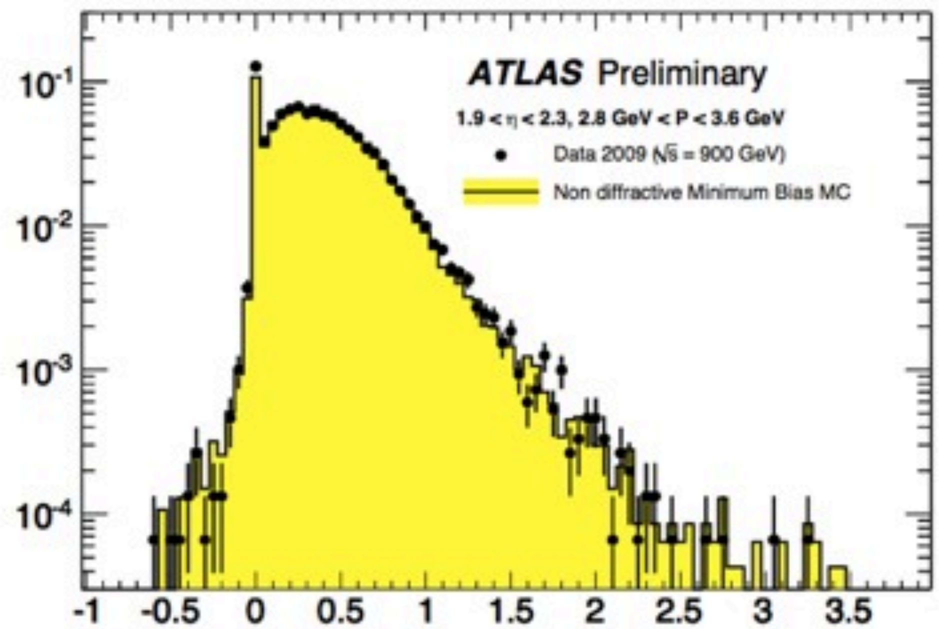
- Session focused on LHC experiments, mainly to present commissioning results with cosmics and first beams
- Comparing MC and data:
  - M. Simonyan: ATLAS response to single isolated particles
  - P. Giovannini: ATLAS Local Hadron Calibration
  - D. Miller: ATLAS first observation of jets and measurement of missing ET
  - K. Theofilatos: CMS ECAL status and performance (em physics)
  - I. Machikhiliyan: LHCb calos status
  - C. Ming Kuo: CMS preshower status
  - C. Liu: BESIII em calorimetry absolute energy scale (em physics)

E/P Distribution

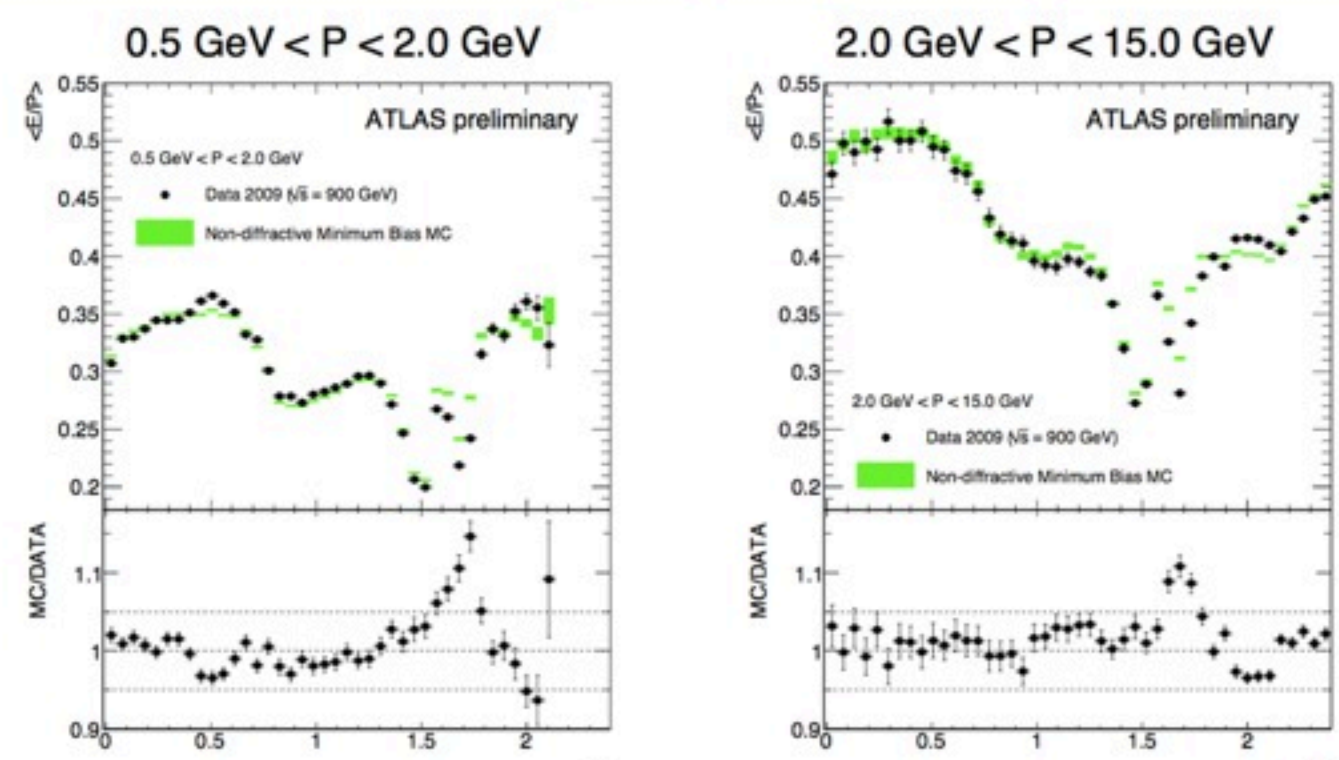
- The peak 0 corresponds to tracks with no matching cluster.

Define probability of calorimeter response being compatible with zero as a fraction of events with E/P < σ where σ corresponds to the bin in the negative side with $\sqrt{e}$ times fewer events compared to $E/P = 0$.

2.8 GeV < P < 3.6 GeV
1.9 < $|\eta|$ < 2.3



Pseudo-rapidity Dependency



Good agreement between data and MC except $|\eta| = 1.7$ region corresponding

M. Simonyan:
single isolated hadrons in ATLAS

900 GeV data results

ATLAS-CONF-2010-016

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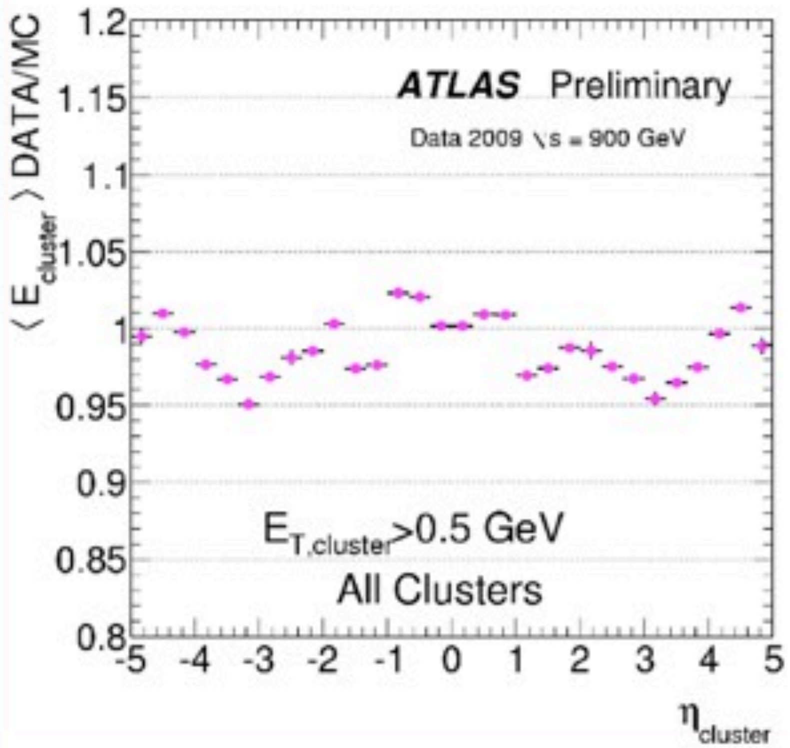
mean energy of clusters versus η



un-calibrated scale

the overall agreement between DATA and MC is very good :
barrel region ± 2%
end-cap/forward region ±5%

differences have to be understood with more statistics and MC tuning

P.Giovanini, MPP Munich, CALOR10 Beijing

900 GeV data results

ATLAS-CONF-2010-016

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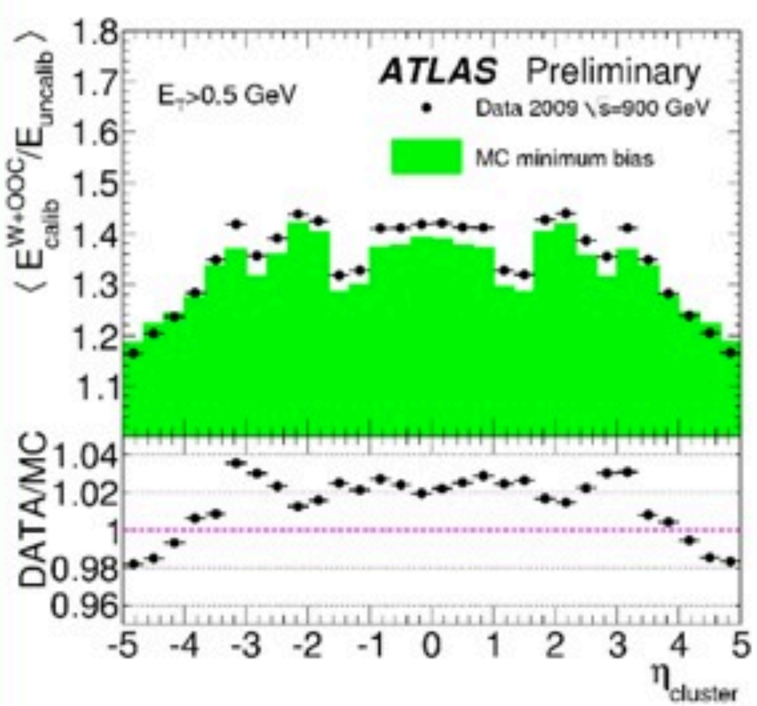
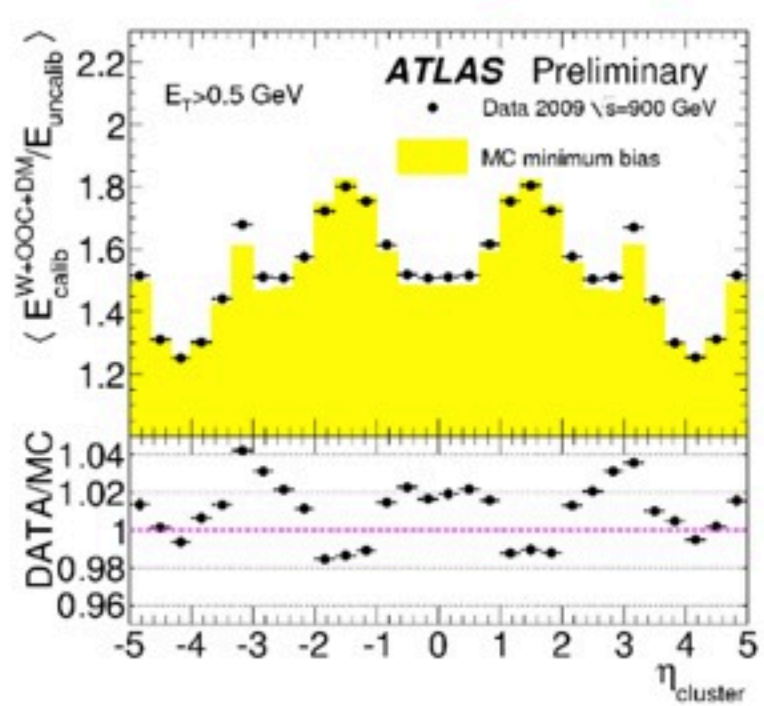
hadronic and out of cluster corrections Data/MC ± 4 %

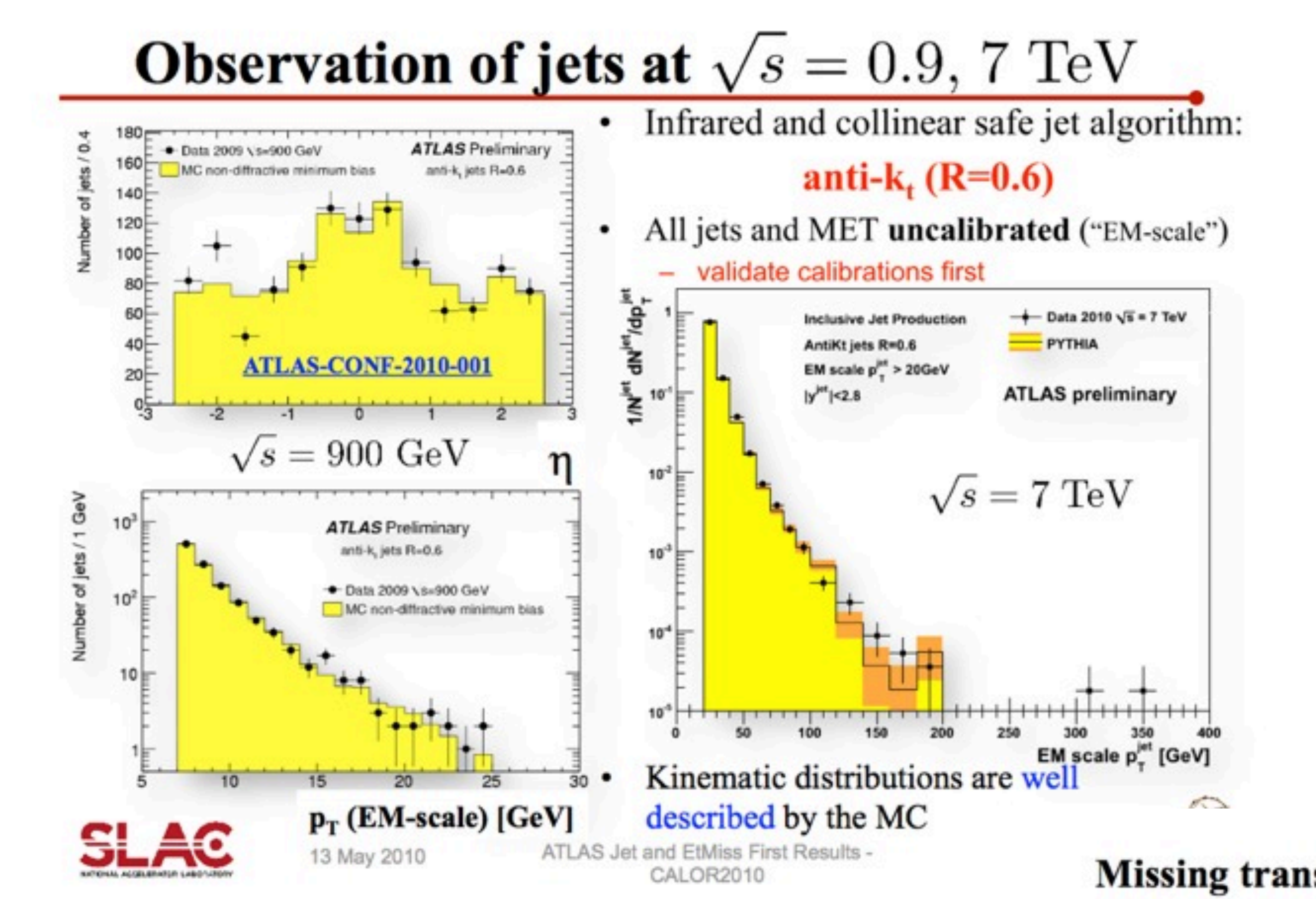
hadronic and out of cluster and dead material: Data/MC ± 5 %



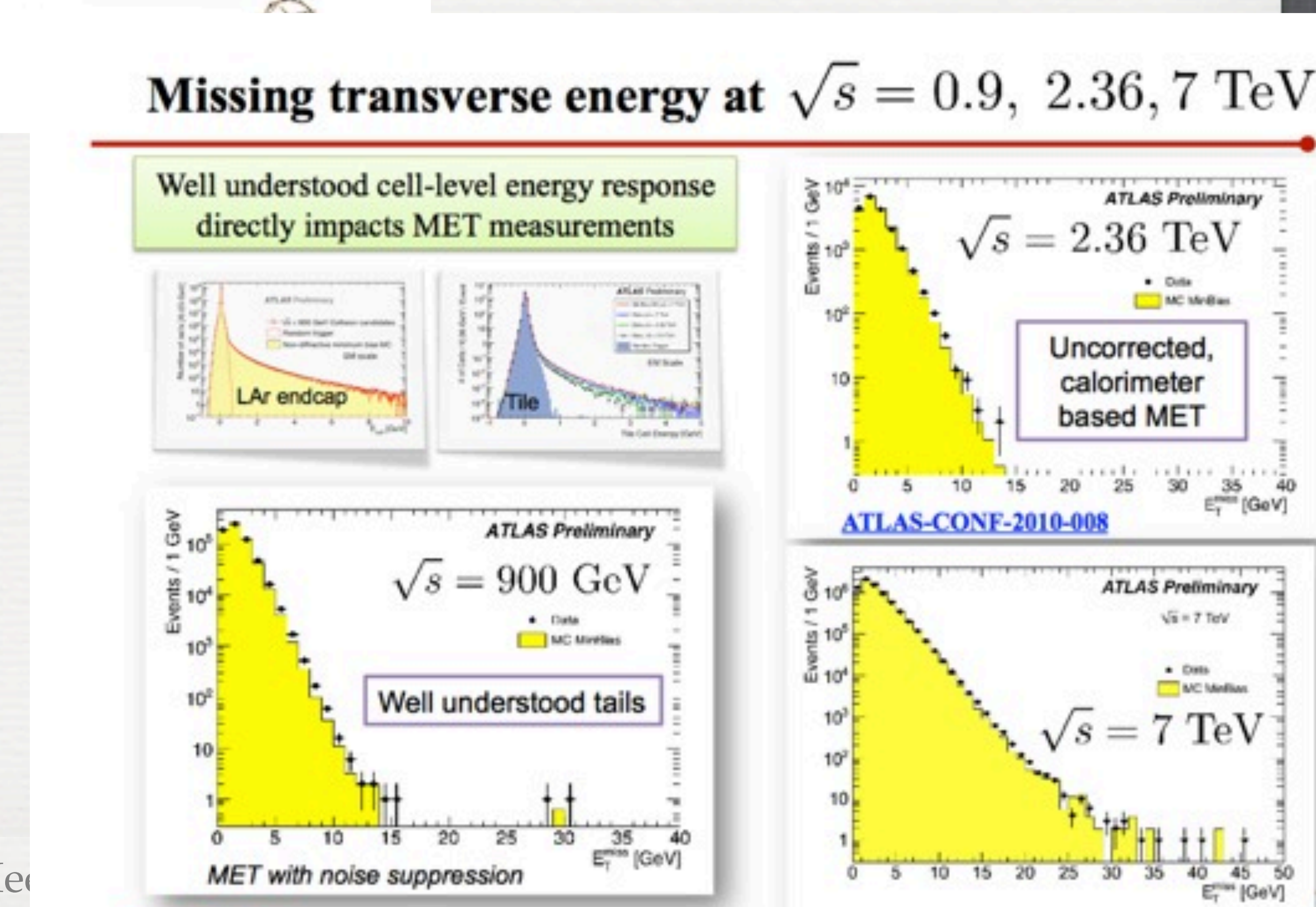


P.Giovanini, MPP Munich, CALOR10 Beijing 5/10/10

P. Giovannini: local hadron calibration in ATLAS

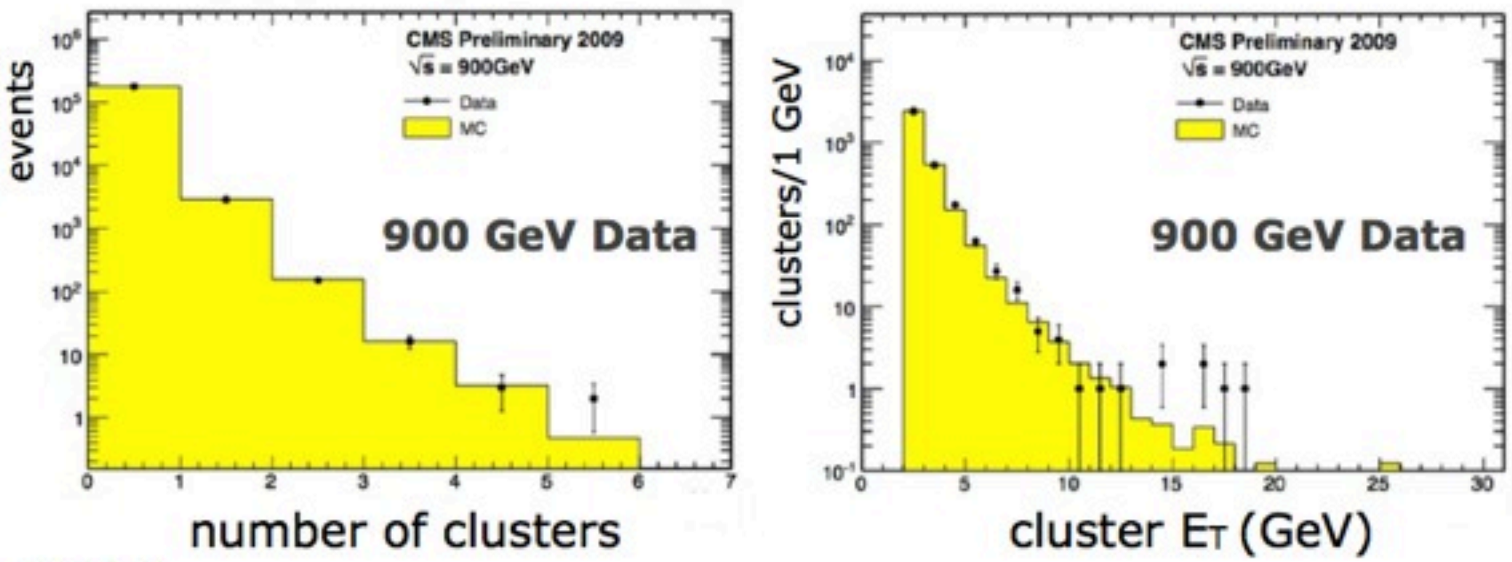


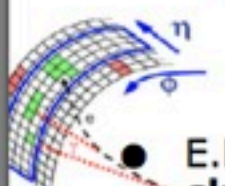
D. Miller: first observations on jets and missing ET



K. Theofilatos: ECAL status and performances

ECAL clusters





- E.M. showers deposit their energy in several crystals in the ECAL; **clusters** of channels extended along φ (bending direction) are used to reconstruct their energy
- MC provides good description of the observed data distribution

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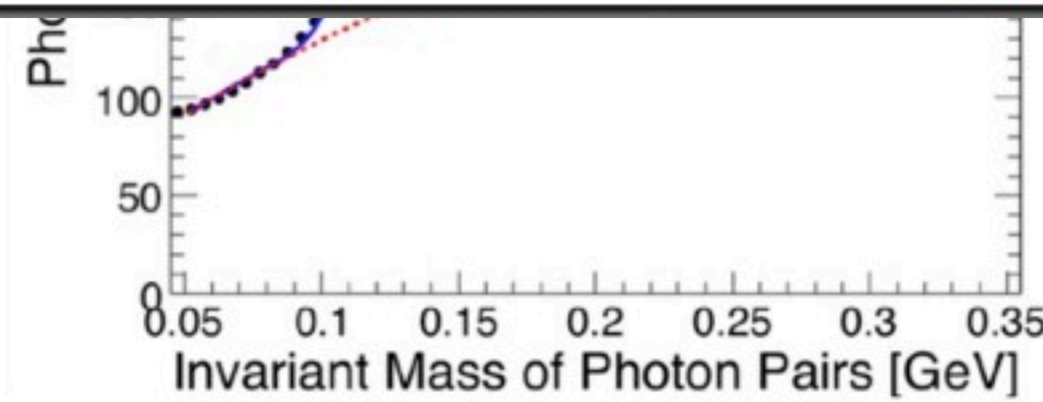
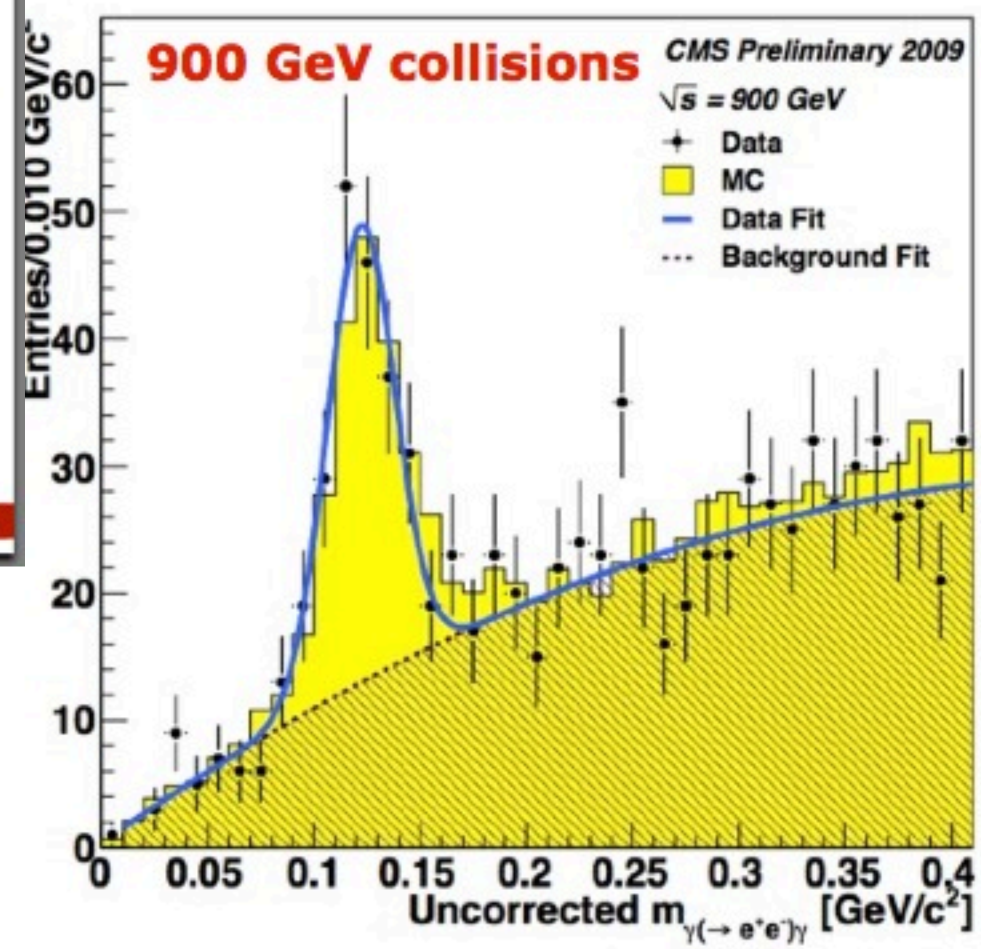
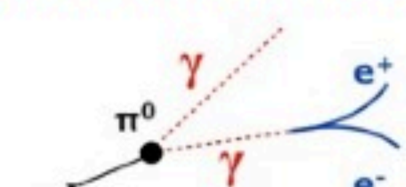


$\pi^0 \rightarrow \gamma\gamma$ in **7 TeV** data about 1461 thousands candidates for $\int L = 0.43 nb^{-1}$

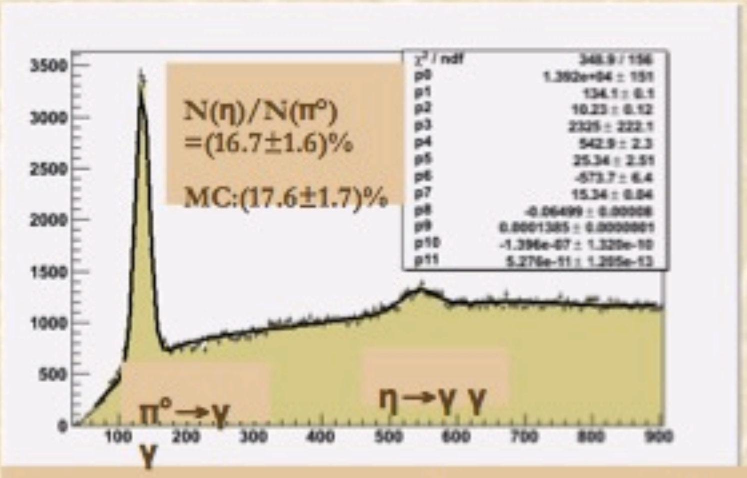


$\pi^0 \rightarrow \gamma\gamma$ where one of the two photons is reconstructed as a conversion

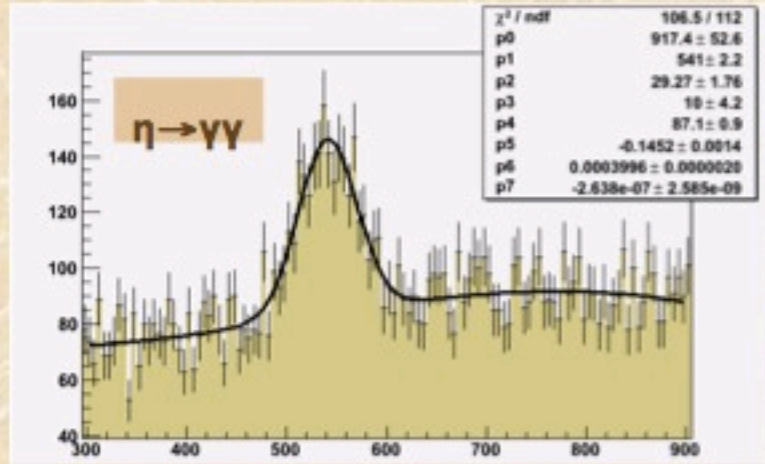


Physics with Ecal (2010)

(also for PS and SPD)

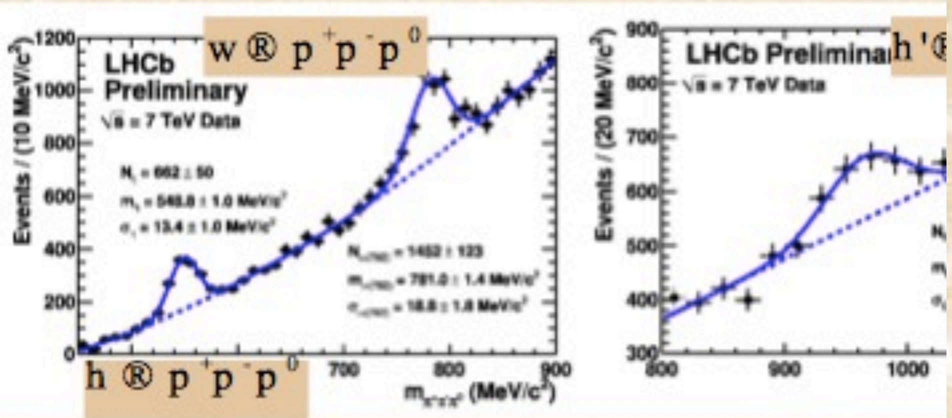


Di-photon invariant mass distribution, MeV/c²

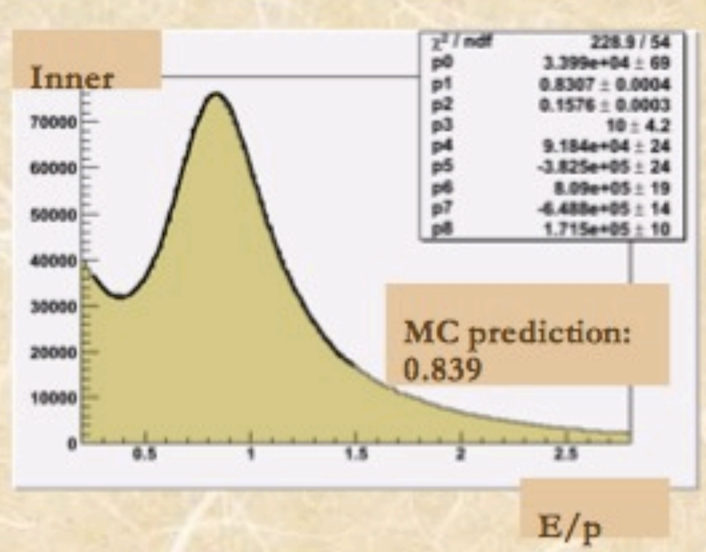


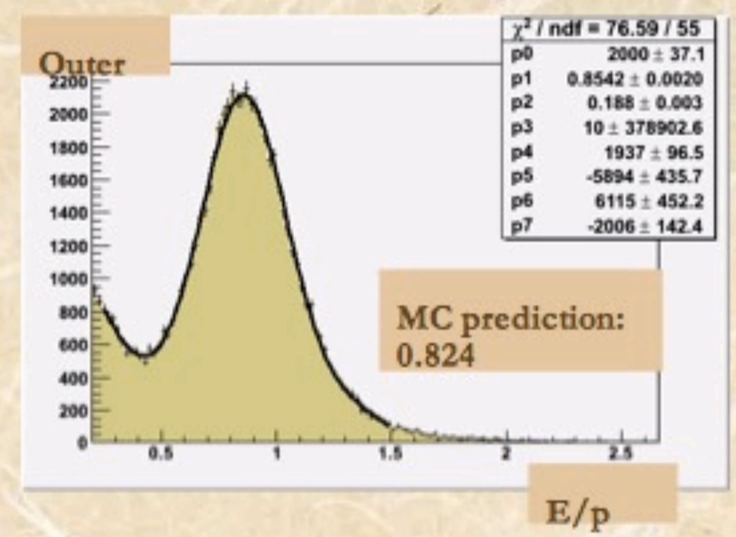
Di-photon invariant mass distribution, MeV/c²

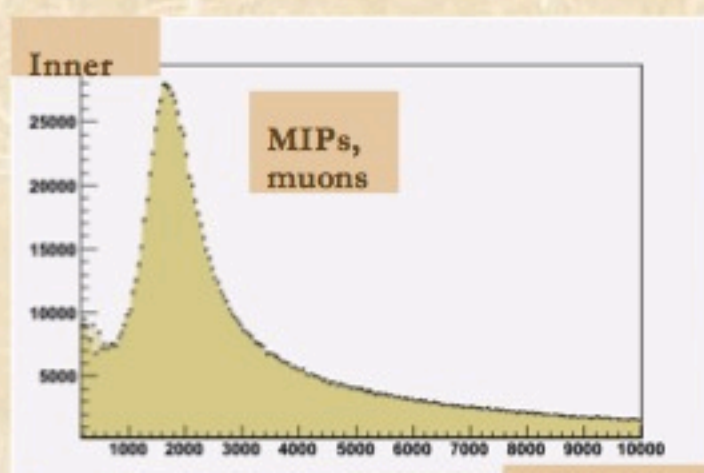
Detailed presentation from LHCb at next LCG Phys. Validation Meeting

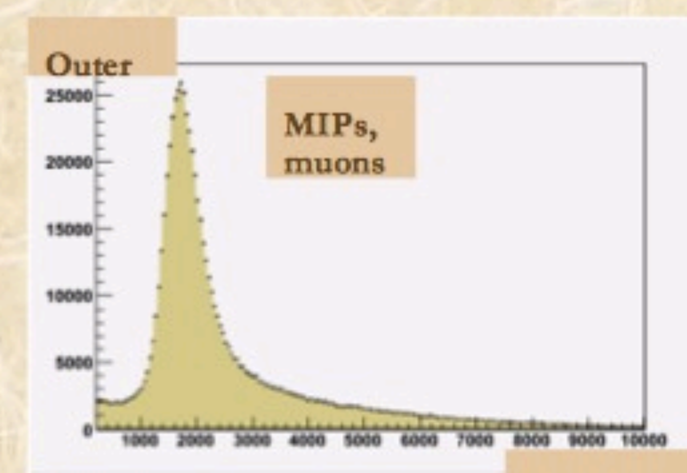


Hcal: basic signals(2010)









I. Machikiliyan:
LHC calos

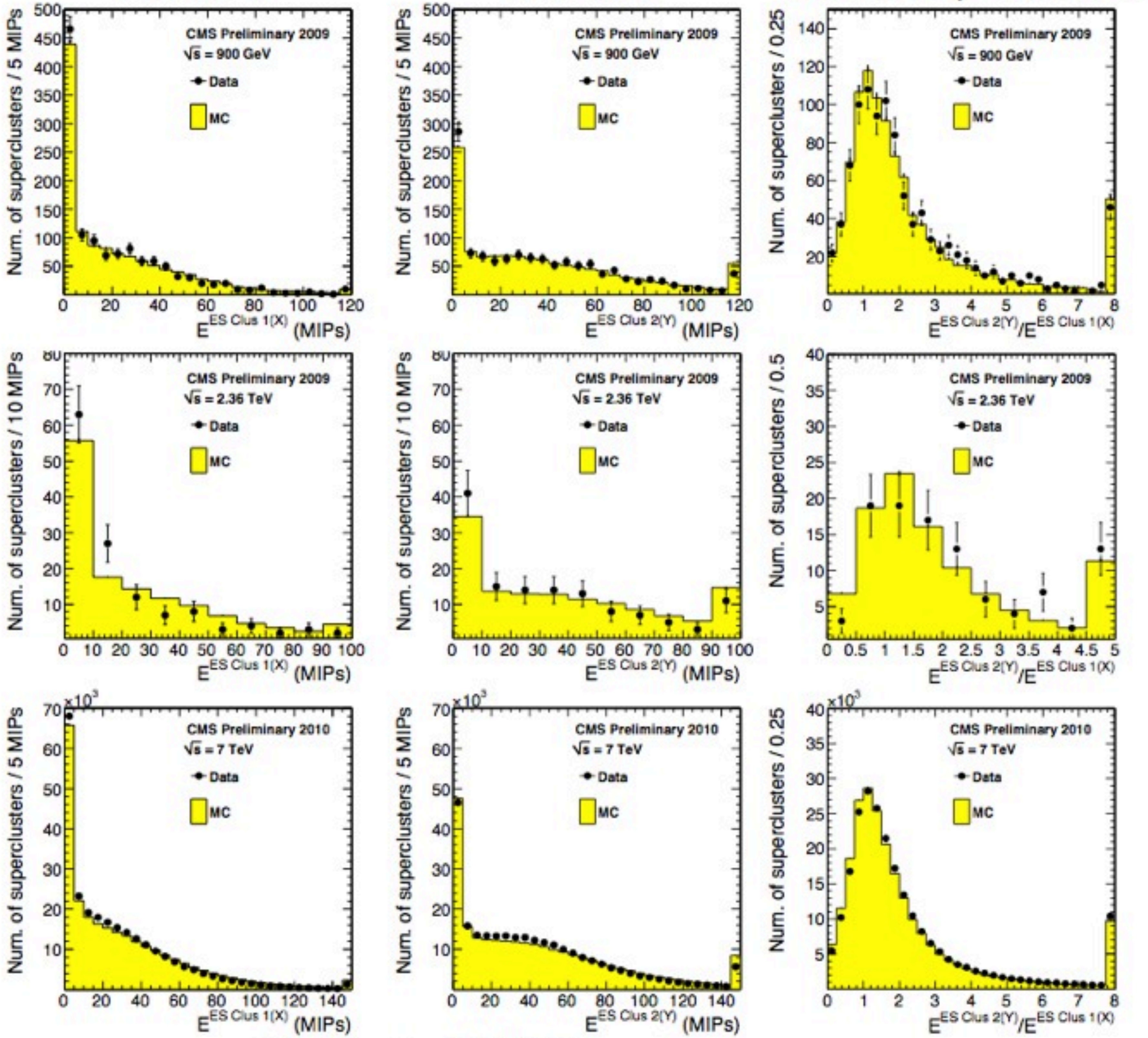
Energy deposit on Preshower planes

Plane 1 | Plane 2 | Plane 2 / Plane 1

900 GeV

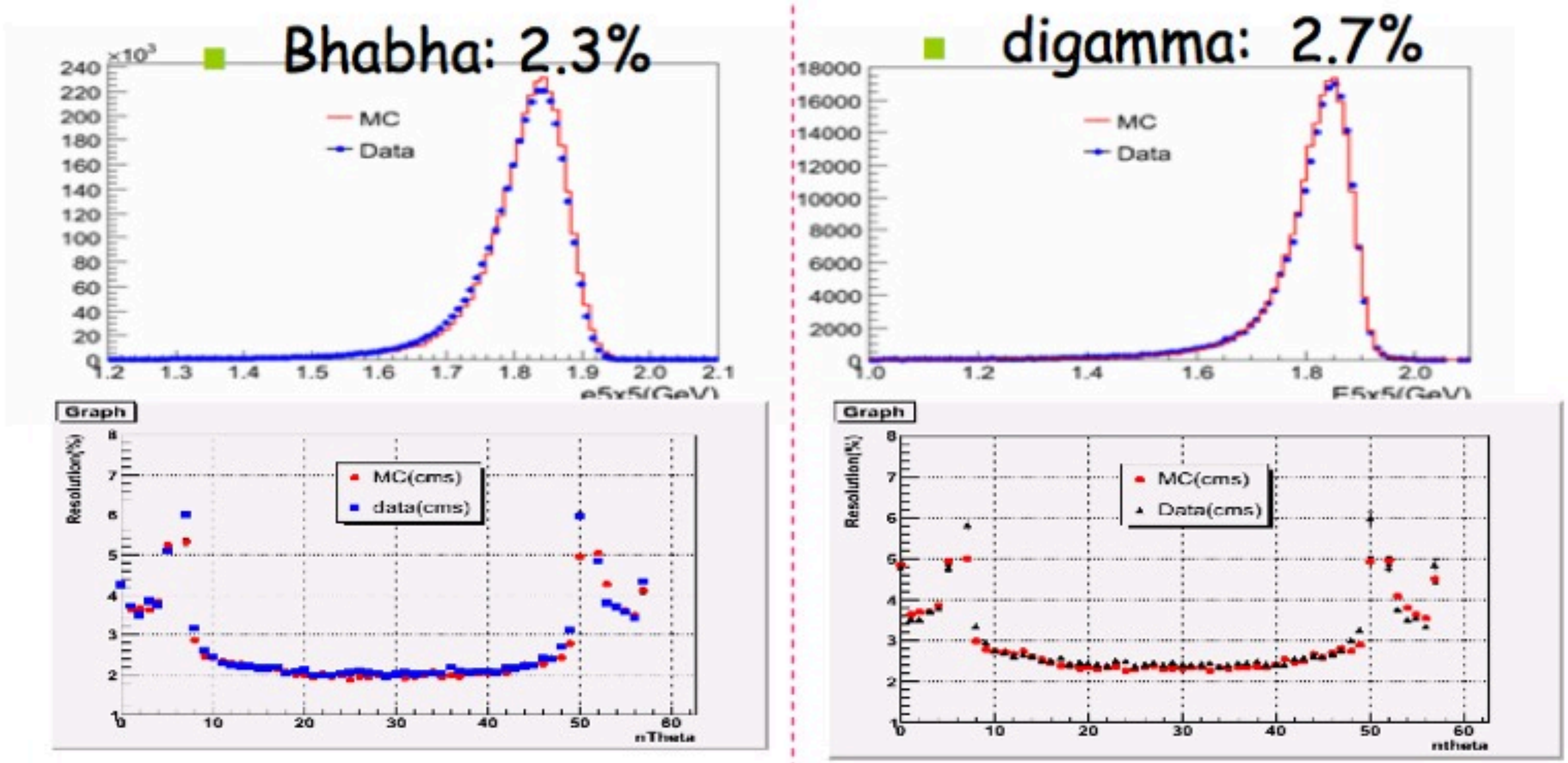
2.36 TeV

7 TeV



BESIII EM Calorimeter performance

Data @3.686GeV



Energy resolution for electrons (from $e+e- \rightarrow e+e-$) 2.3% in barrel and 4.1% in endcap, for photons (from $e+e- \rightarrow \gamma\gamma$) reaches 2.7% in barrel and 4.2% in endcap

Impressions/Comments

- LHC experiments: already good understanding of the detectors
- Confirmed what has been seen in TB: in general there is a satisfactory agreement between data and MC
  - No particular issues
  - disentangle generator/G4 effects? what are the experiment plans (if any)?
  - (my personal) guess: before end 2010 many more plots!

FUTURE CALORIMETRY

- Except two talks (SuperB and CMS upgrade related) all others talks on ILC:
  - Two philosophies: total absorption, double read-out OR particle-flow algorithms calorimeters. DREAM or CALICE
  - Some moments of really "intense" discussion :-)
- Digital Calorimeters: work on what to use for hadronic (investigating also RPC)
- Maybe the most interesting part of the conference (at least the most interesting discussions)

- If I would be asked for a very short summary:

  - Digital Readout / Particle Flow idea: “hadronic physics is difficult, let’s try to avoid measuring hadrons: identify neutral hadrons and measure them badly. We have to rely heavily on MC”

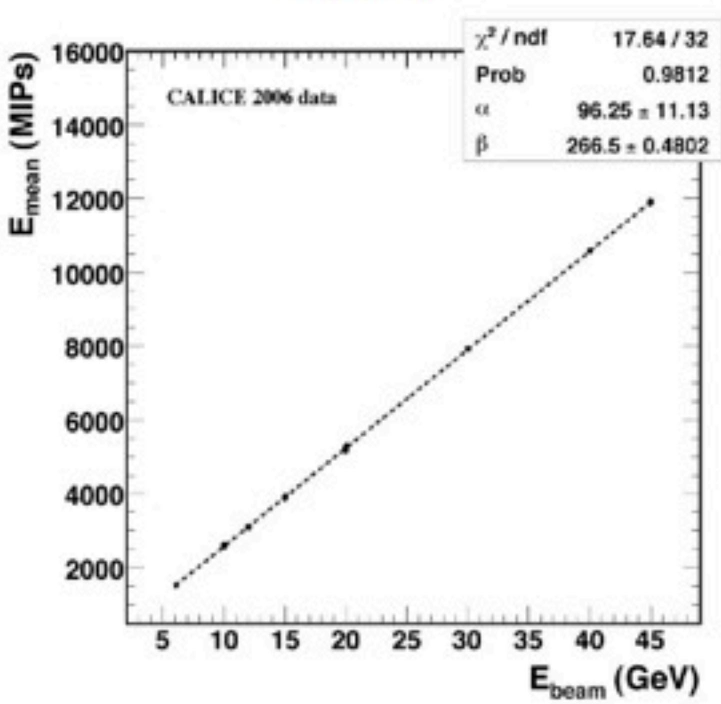
  - Dual Read-out / Crystals: “hadronic physics is difficult, let’s try to measure very well hadrons: let’s use Cher./Sci light and time signature of neutrons. MC are bad, we have to avoid them”

- (my personal) Opinion: it’s a pity there is such a strong division, we (G4) could really learn a lot from both approaches (shower shapes from CALICE, simulation of neutrons from DREAM)

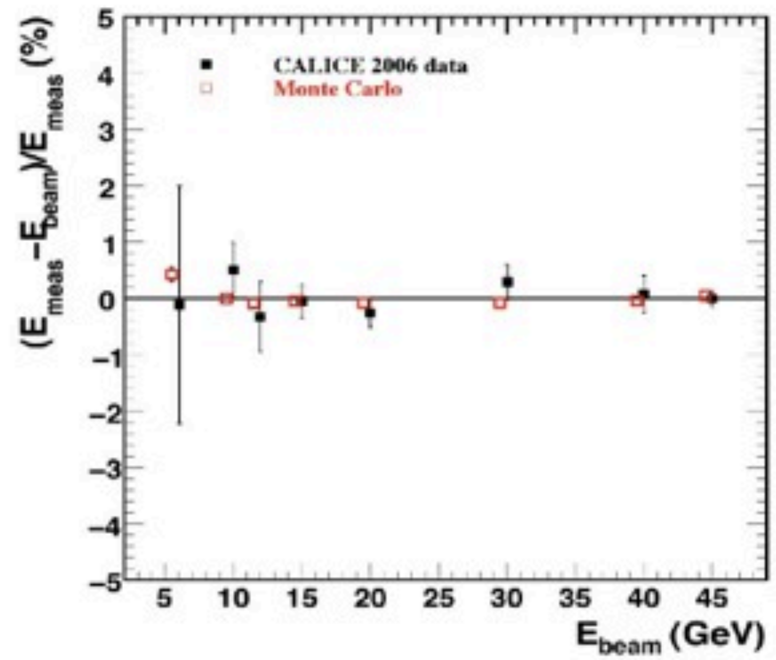
CALICE summary

Linearity of Response

Overview



Residuals



- Highly linear response over large e
- Linearity well reproduced by MC
  MIP/GeV ~ 266.5 [1/GeV]
- Non-Linearity O(1%)

CALOR 2010 Beijing China May 2

Energy depositions in different calorimeter depths

Layer 1-3:

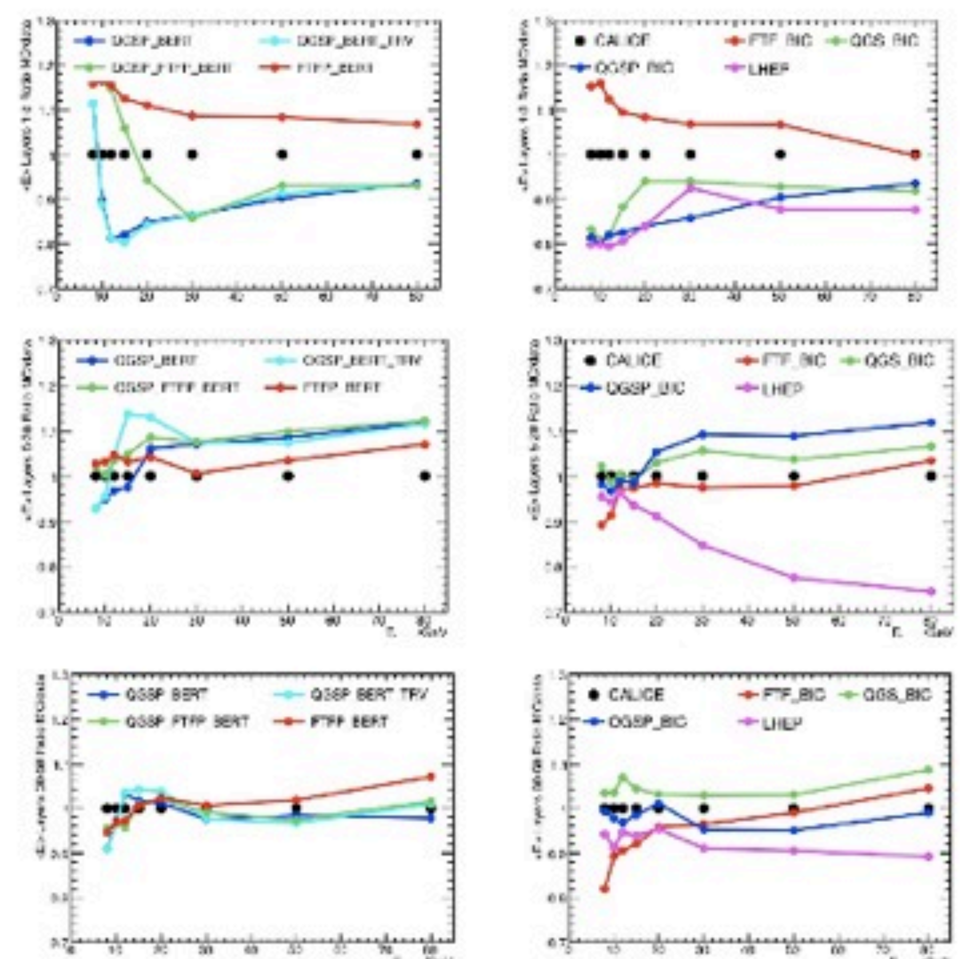
Nuclear breakup

Layer 5-20:

elm. component

Layer 30-50:

Shower hadrons



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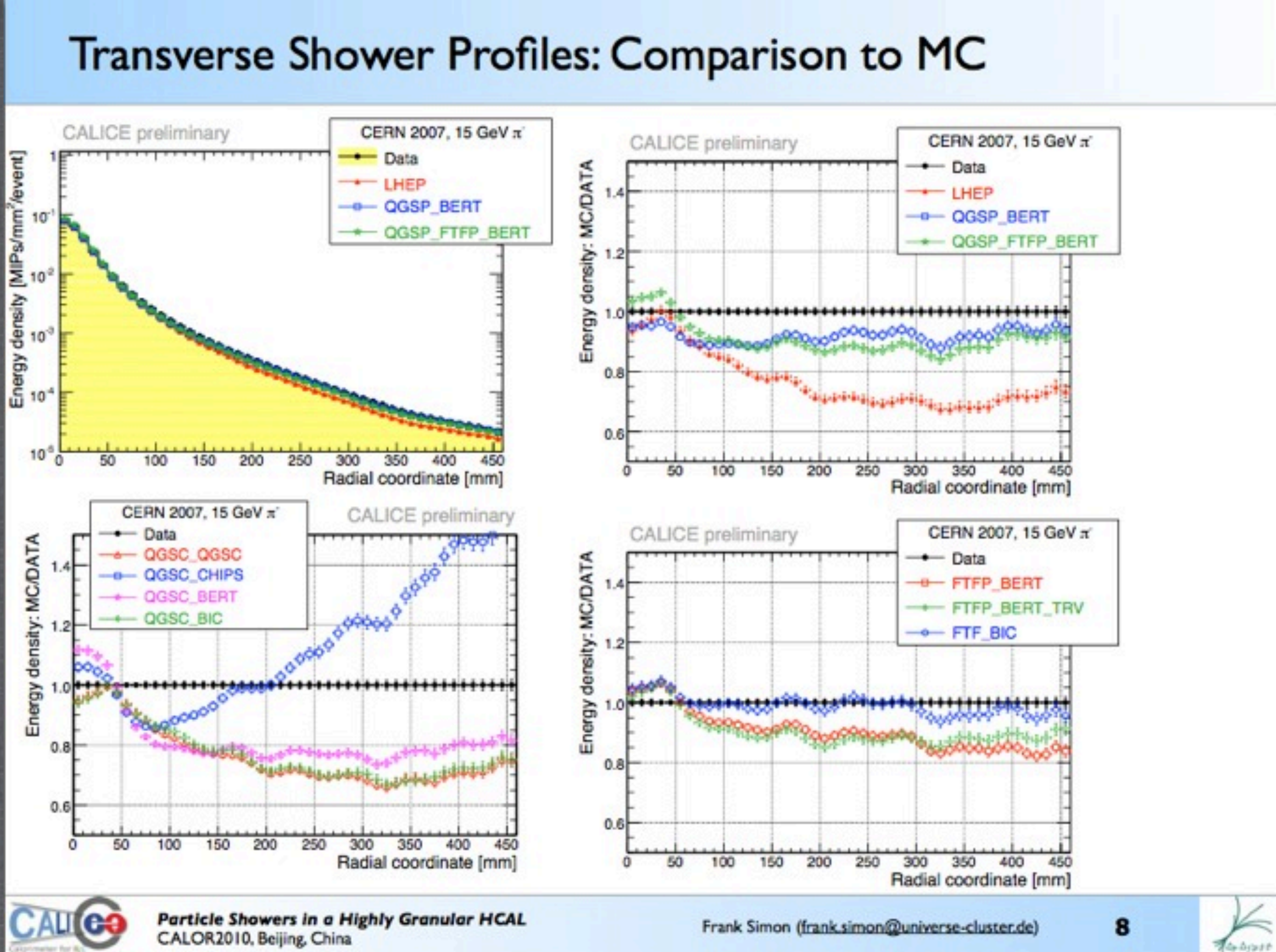
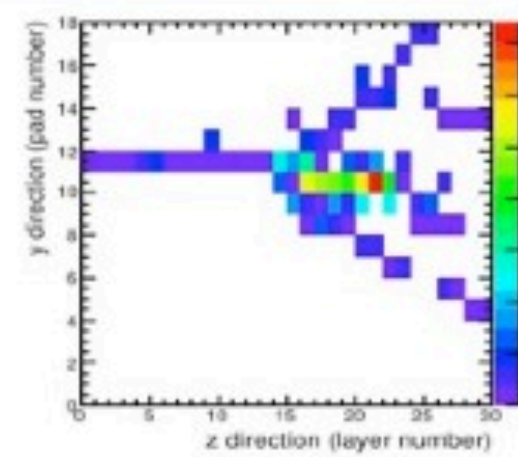


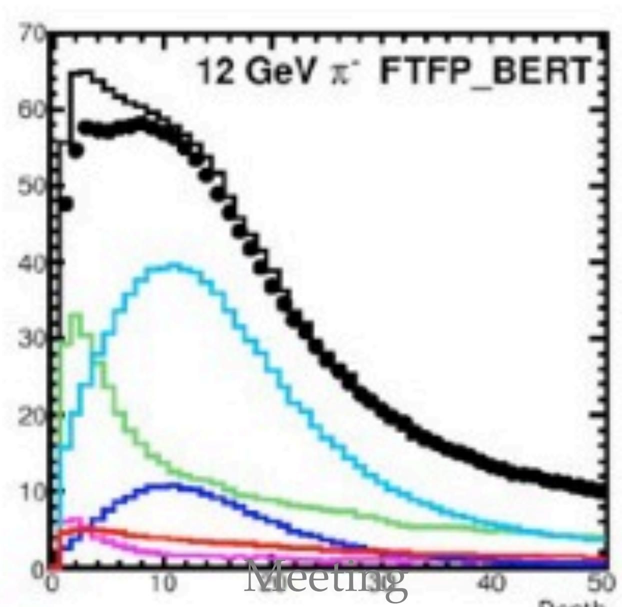
F. Simon: showers in HCAL

he SiW ECAL



pad

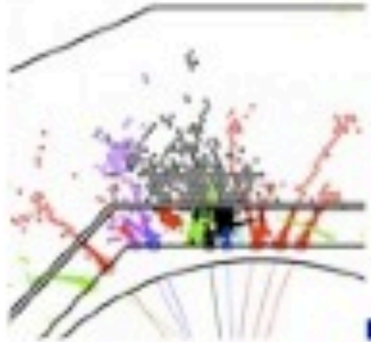
either!



Shower Components:

- electrons/positrons
  knock-on, ionisation, etc.
- protons
  from nuclear fragmentation
- mesons
- others
- sum

F. Sefkow overview

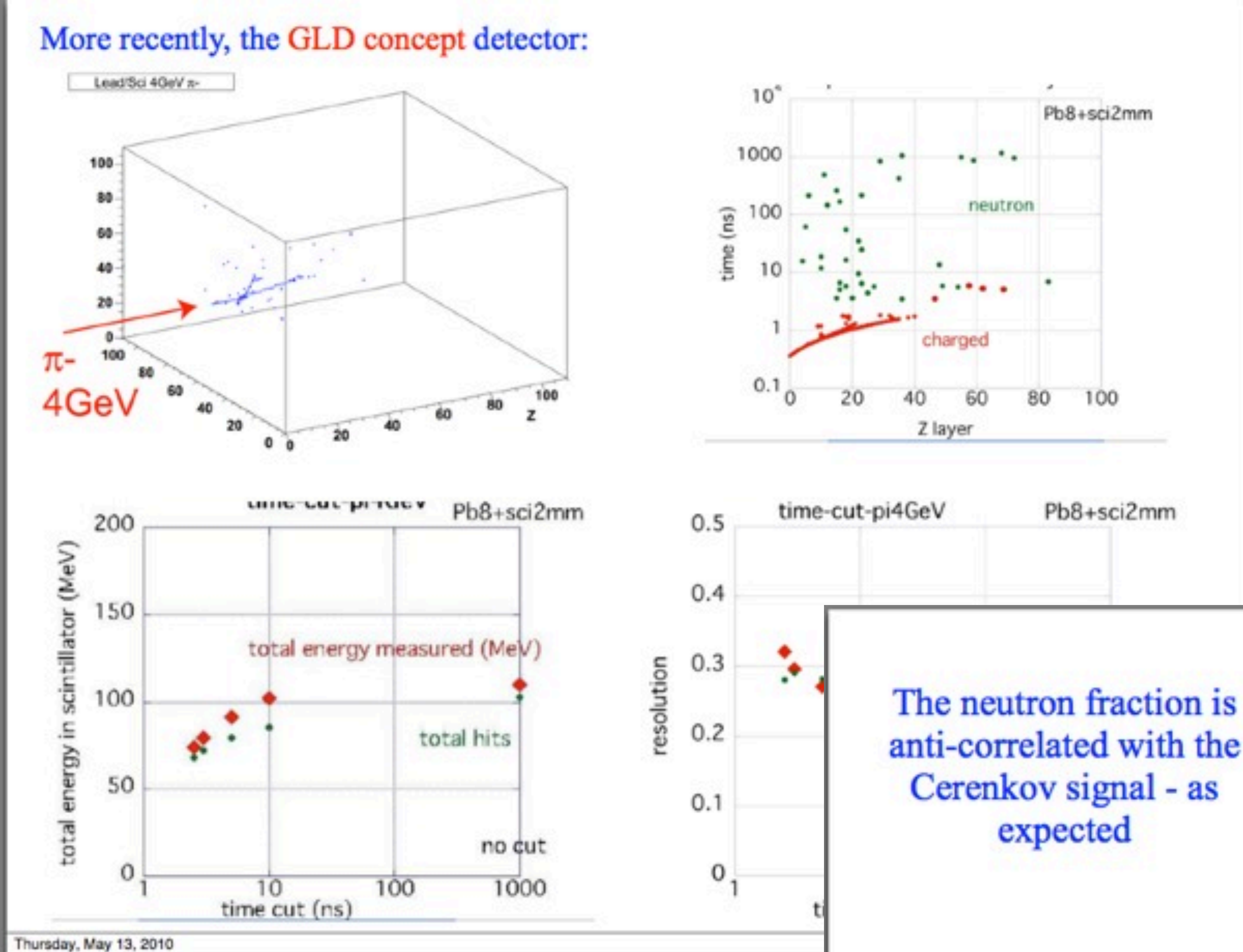


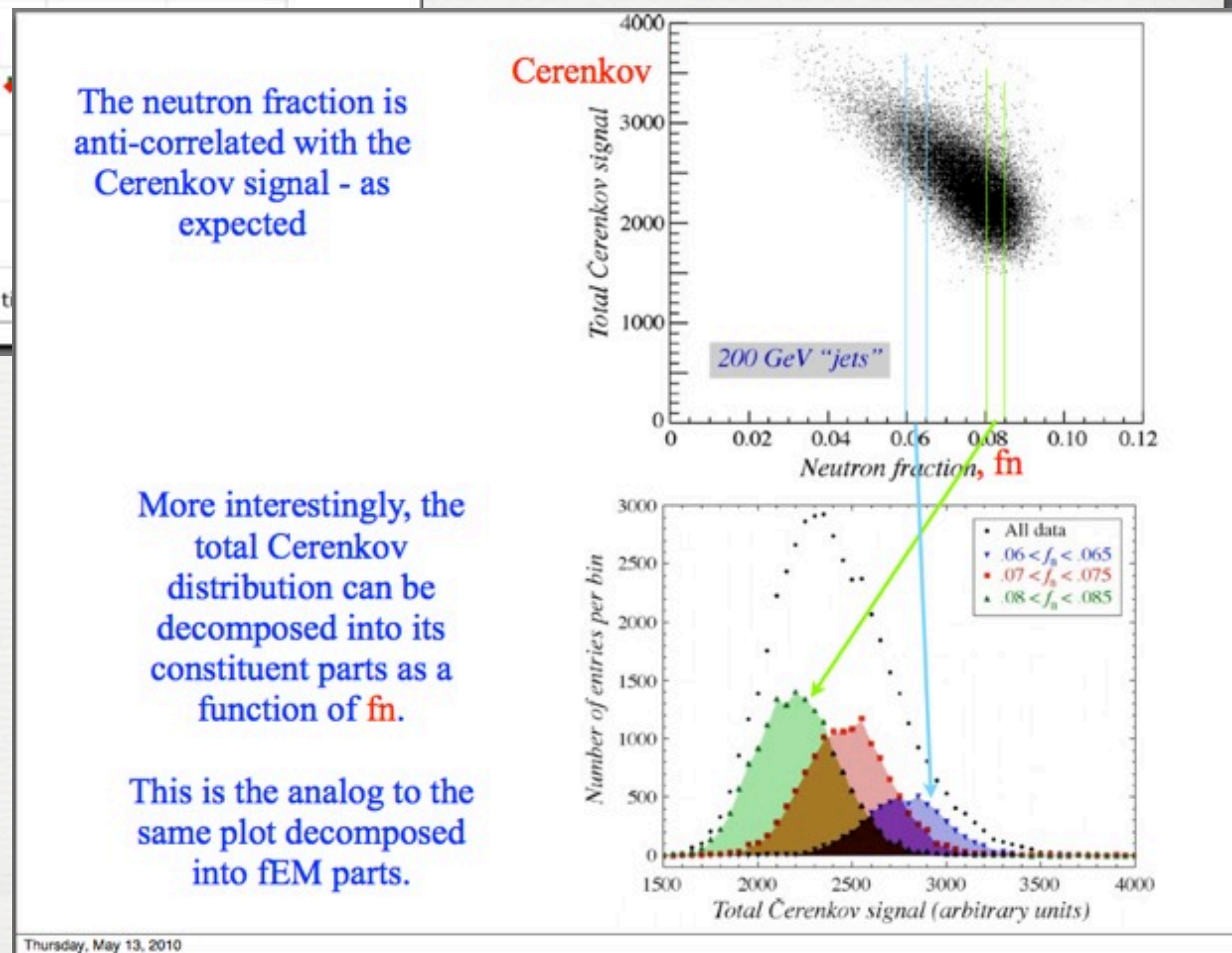
Summary on validation:

- The particle flow detectors perform as expected
  - support predictions for full-scale detector
- Geant 4 simulations not perfect, but also not as far off as feared a few years ago
  - fruitful close cooperation with model builders ongoing
- Predicted shower sub-structure is seen
  - detailed checks possible, benefits for all calorimeters

F. Sefkow overview

J. Hauptman: neutron fraction event-by-event in DREAM





CONCLUSIONS

- Very interesting topics covered
  - Status of LHC first analysis: in general good agreement with MC
  - CALICE: good agreement, power of shower shapes
- Future directions in calorimetry? Crystals Vs imaging calorimeters. Hope to see comparisons with G4 for both in future
- Many “smaller” projects use G4 and we could gain some interesting feedback (NEUCAL, NA62?)
- I had some “offline” chats during coffe breaks with people: I had the impression a “G4 expert” is very welcome in these occasions. Experimentalists are in seek of expertise to improve their simulations. We should participate also in the future

Not everybody agrees....

What has been learned since 1990?

From Monte Carlo simulations:

NOTHING

(of meaningful importance)*

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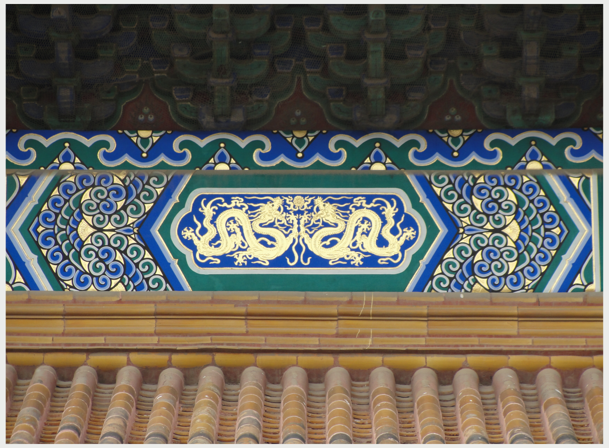
* *Monte Carlo simulations of em shower development were, for example, crucial for solving complicated calibration problems in ATLAS, AMS*

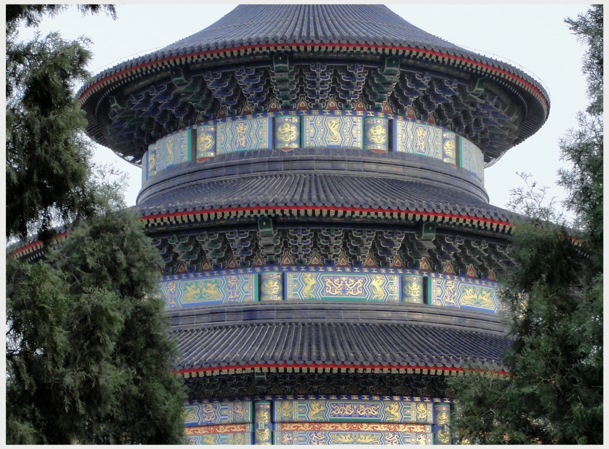
Monte Carlo simulations of hadronic shower development did, for example, NOT foresee the "spike" problems in the CMS ECAL









Meeting