Tests Beam/MonteCarlo comparisons

Munich , May 2006

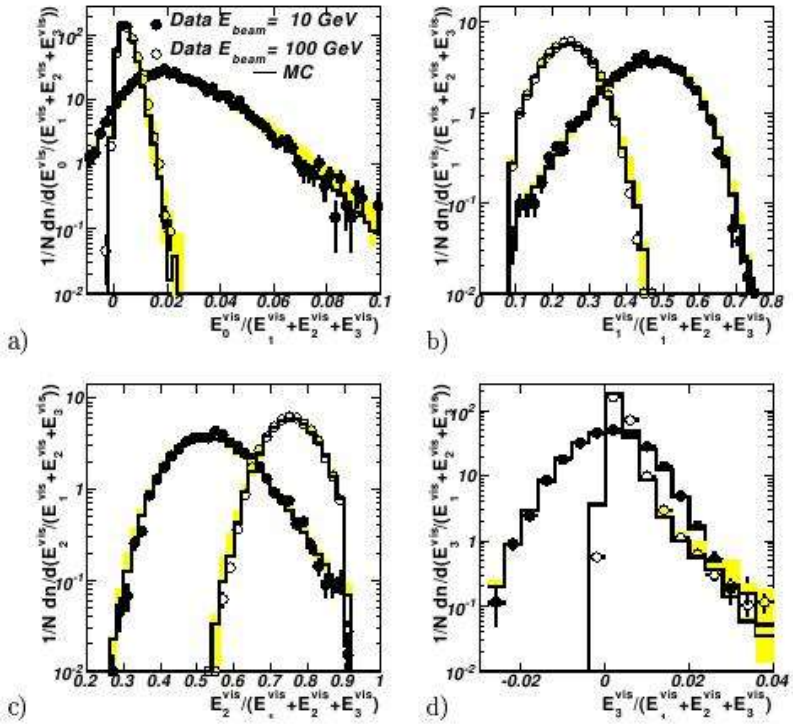
T. Carli, B. Dekhissi, M. Monnier, V. Niess, C. Serfon,
A. Soukharev, J. Toth, G. Unal

Context

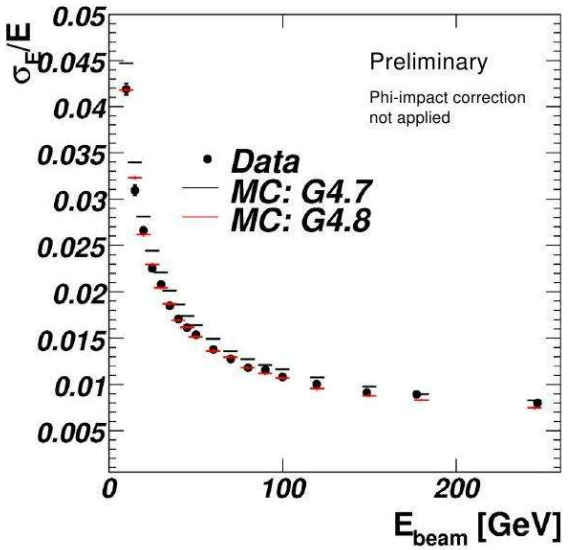
- Beam test 2001-2002 (not CTB).
- Will more emphasize on EMEC where situation more complicated than EMB (Varying gap, sampling fraction, HV…)
- Simulation performed under GEANT4
- Signal reconstruction :
  - EMB : Current map
  - EMEC : Various methods tested
- Test beam simulation has been Updated to knew framework, Going Live in 11.5.0
  - G4AtlasApps (common to CTB)
  - GeoModel Description of TB
- Many improvements propagated to G4 simulation :
  - Geometry (sagging, varying slant angles)
  - "Signal reconstruction" (gap adjustment or charge collection)

Barrel

- Good description of energy deposition in various samplings
- G4.8 seems to give better results as G4.7 (e.g. energy resolution)



Energy deposit in the samplings



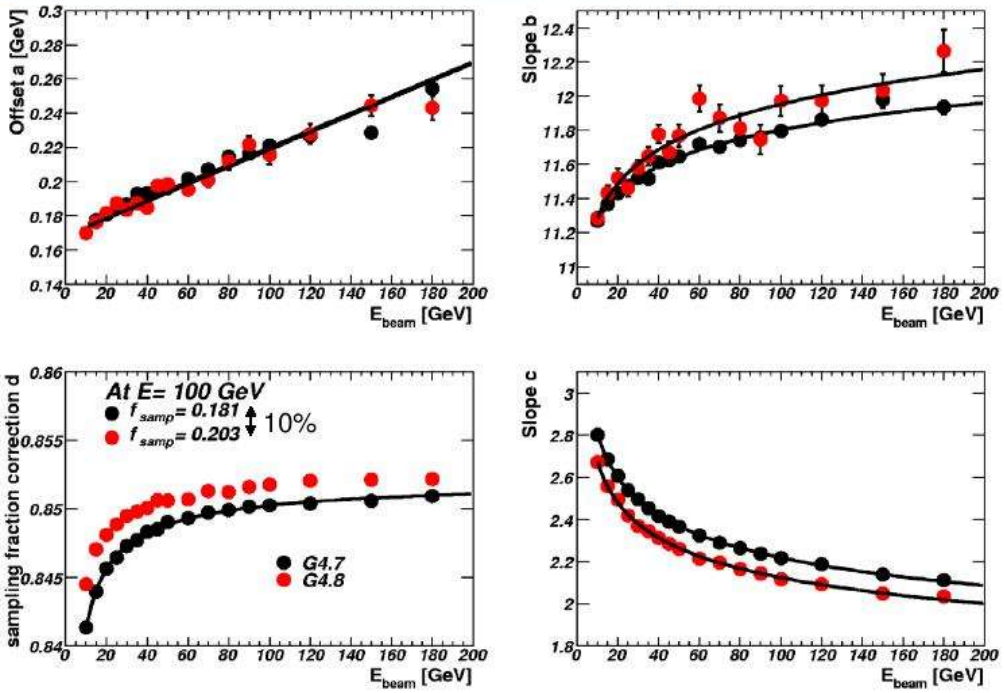
Energy resolution

Barrel

- Use of MC to develop calibration scheme to optimize linearity and energy resolution
- Once again, some differences between G4.7 and G4.8

$$E_{rec} = a(E) + b(E)\,E_{PS} + c(E)\,\sqrt{E_{PS}\,E_{strips}} + \frac{1}{d(E)\,f_{samp}^{E=100}}\,E_{acc}$$

Preliminary



- Concerning absolute energy scale :

Assuming calo is simple condensator and knowing Lar drift time:

$$\langle f_{I/E} \rangle \approx 15\ \text{nA/MeV}$$

From calculation using field-Maps:

$$\langle f_{I/E} \rangle = 14.2\ \text{nA/MeV}$$

From comparison of data and MC:

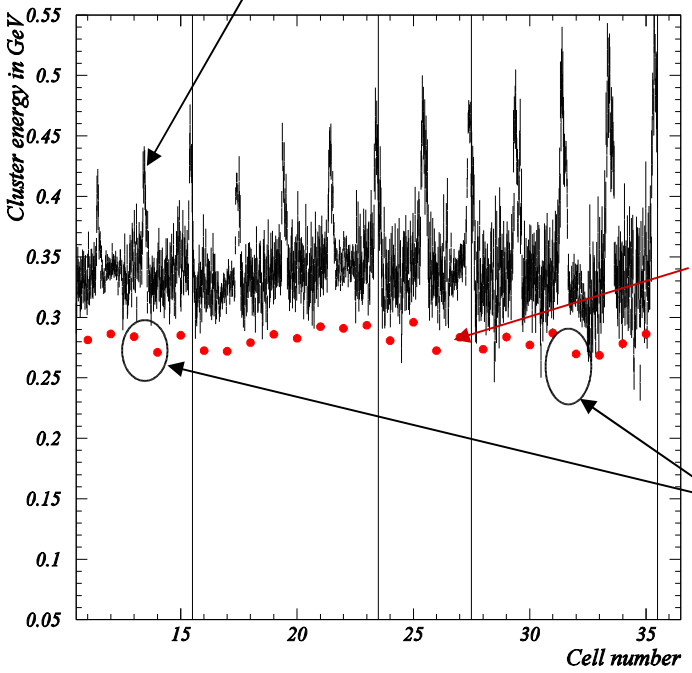
$$\text{G4.7}: f_{I/E} = 16.0\ \text{nA/MeV}$$
$$\text{G4.8}: f_{I/E} = 14.4\ \text{nA/MeV}$$

Endcap

- As already said, situation more complicated :
  - Gap and sampling fraction = f(eta)
  - HV sectors (7 in outer + 2 in inner wheel)
- No current maps available for signal reconstruction. Various methods tried :
  - Gapadj : Basic version of gap adjustement
  - Gap_e : Same as gapadj, but with drift velocity, description of HV sector and ion recombination
  - Gap_se : Same as gap_e but signal produced less than 150µm from electrodes killed (electronic integration time)
  - Charge collection : detailed Electric field map

Muons

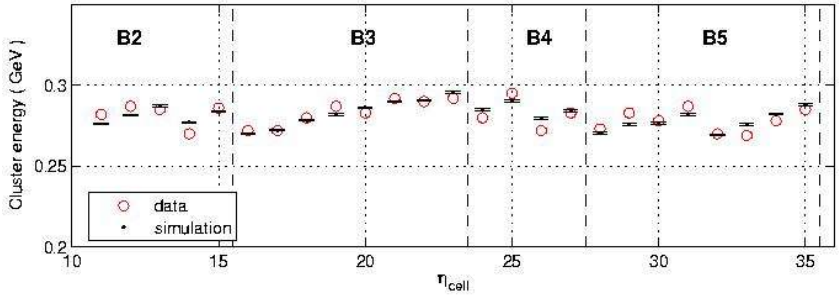
HV strips

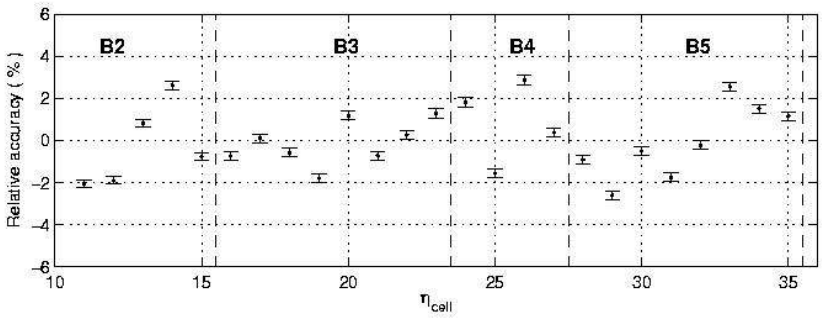


Peak of the Landau

Drops in middle's length

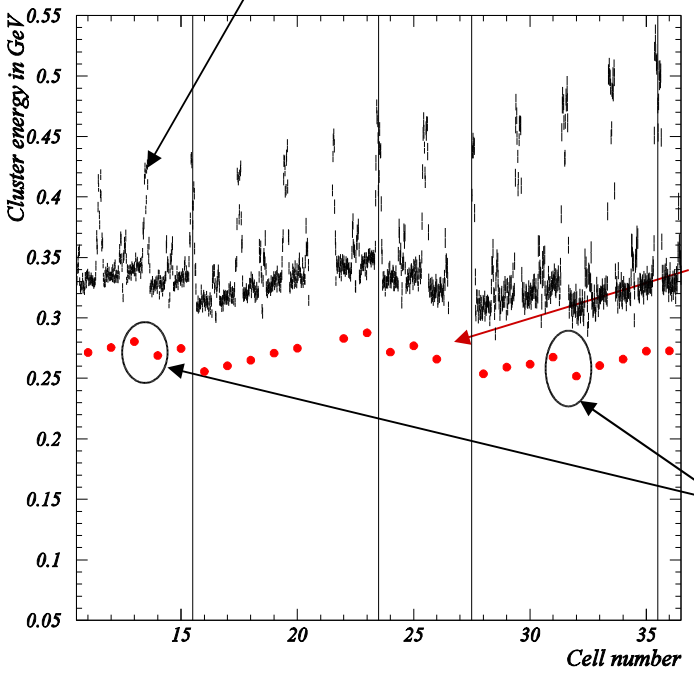
Data





Muons

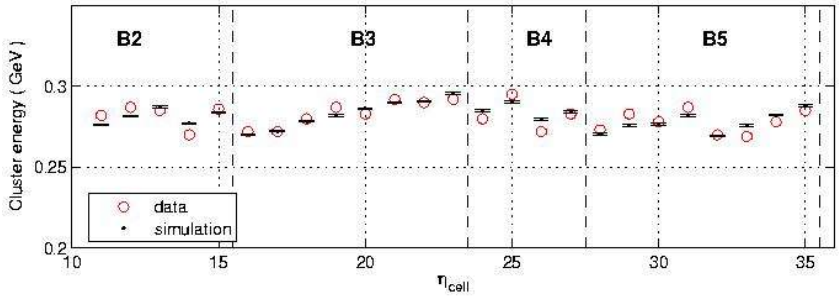
HV strips

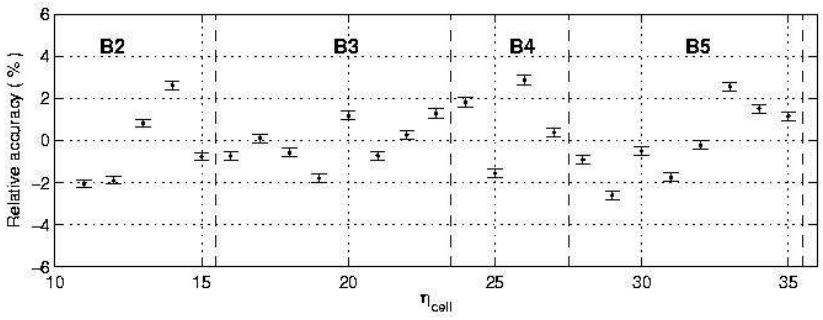


Peak of the Landau

Drops in middle's length

Simulation

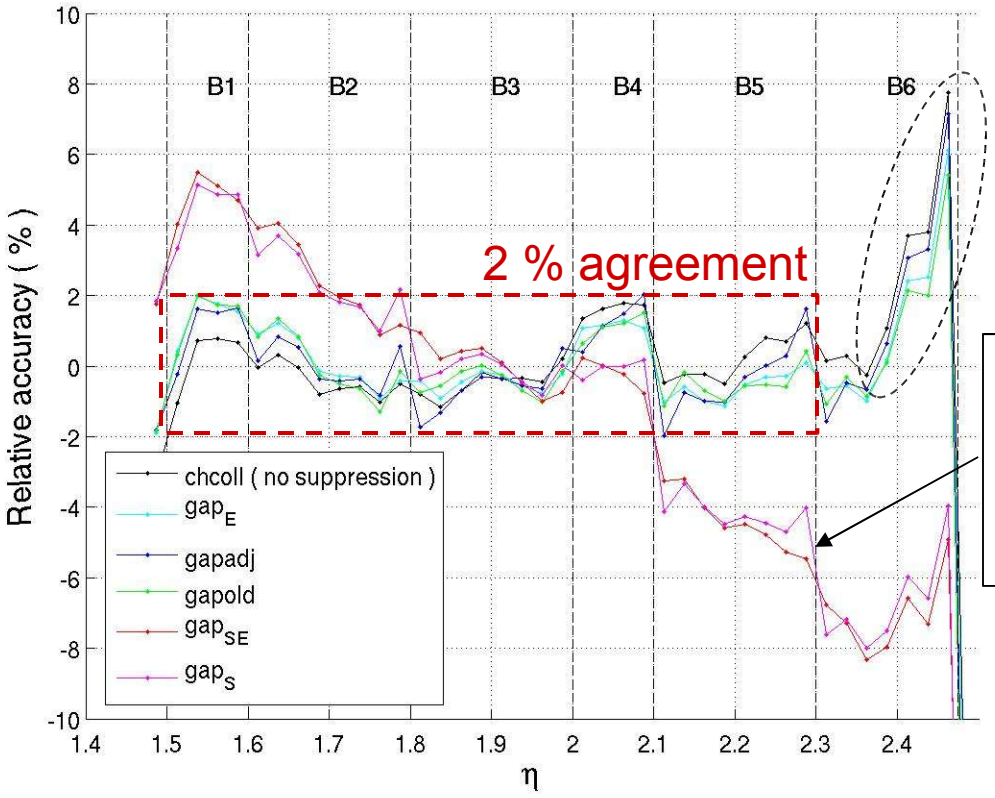




Good agreement

Fine structure (HV strips, changes of middle's length well reproduced)

Response :Test beam vs Simulation for Electrons



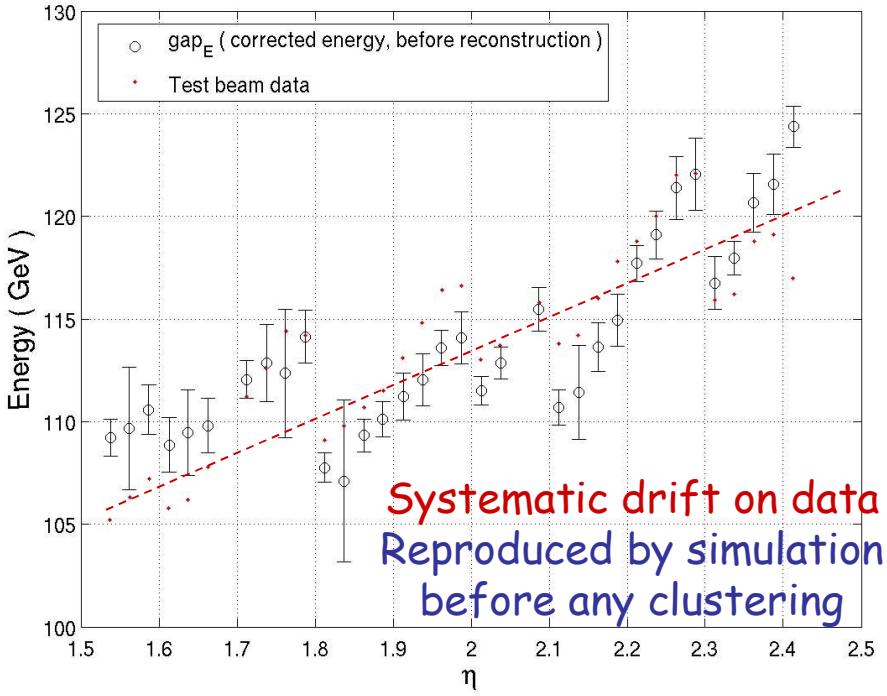
Crack region is badly simulated

Disagreement due to electrode suppression
Corrected for 11.5.0
To be validated …

Apart from suppression, no clear differences between various improvements of gap adjustment

About HV Values

HV Chosen to ensure flat response in η (ATLAS-LARG-NO-47) but …



Systematic drift on data
Reproduced by simulation
before any clustering

HV values are set as following :

$$\frac{I_0}{E} \propto F_s \times \frac{v_d}{gap}$$

V_d : Drift velocity : updated with detailed expression (ATLAS-LARG-99-008) + Ion recombination Included

⇒ no significant change

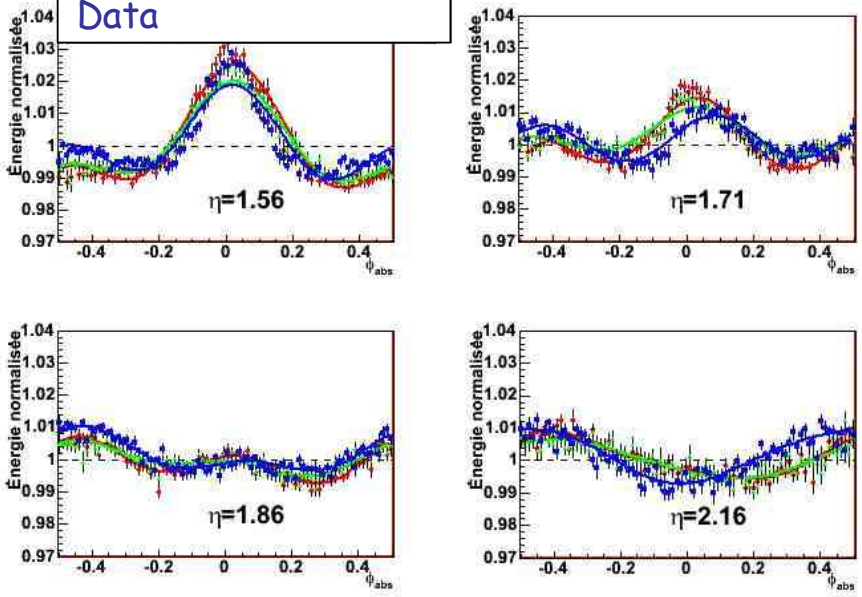
F_s : Sampling fraction, updated from GEANT 4 simulation (10.0.1)

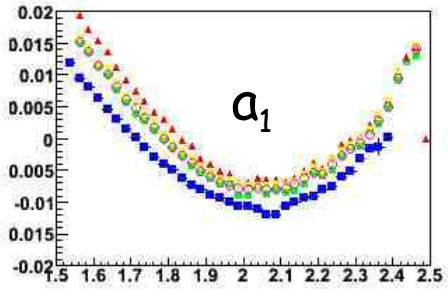
⇒ even worse

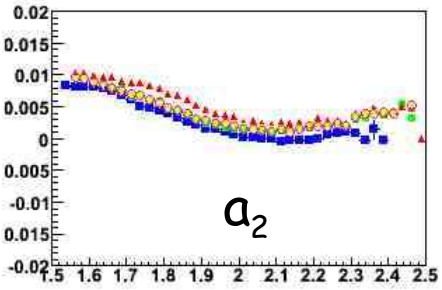
Conclusion : The model is not accurate enough for showers (~10 %)
A detailed simulation is required to adjust HV values

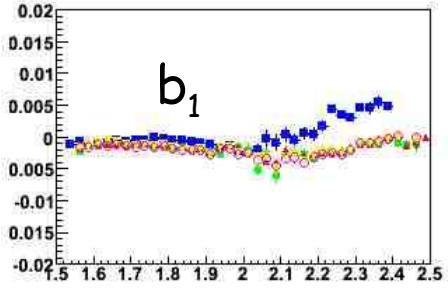
Electrons : φ modulations

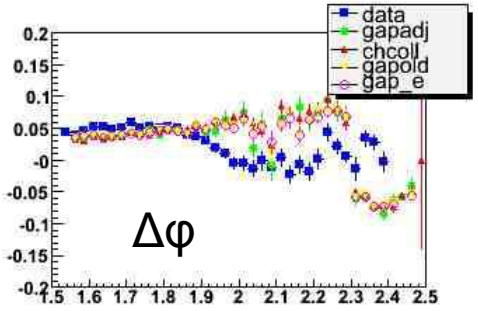
Charge collection
Gap adjustment
Data







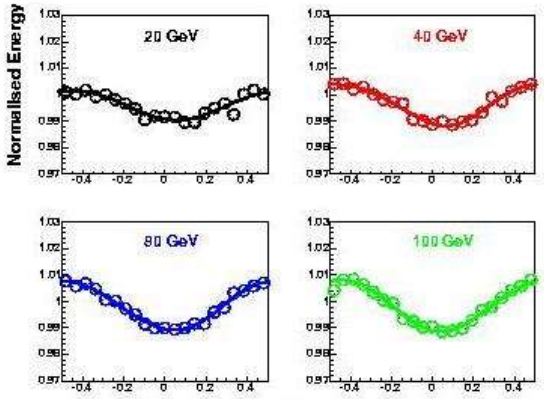




$$a_0\left(1+\sum_{i=1}^{2} a_i \cos\left(2i\pi\left(\phi_{abs}-\Delta\phi\right)\right)+b_1 \sin\left(2\pi\phi_{abs}\right)\right)$$

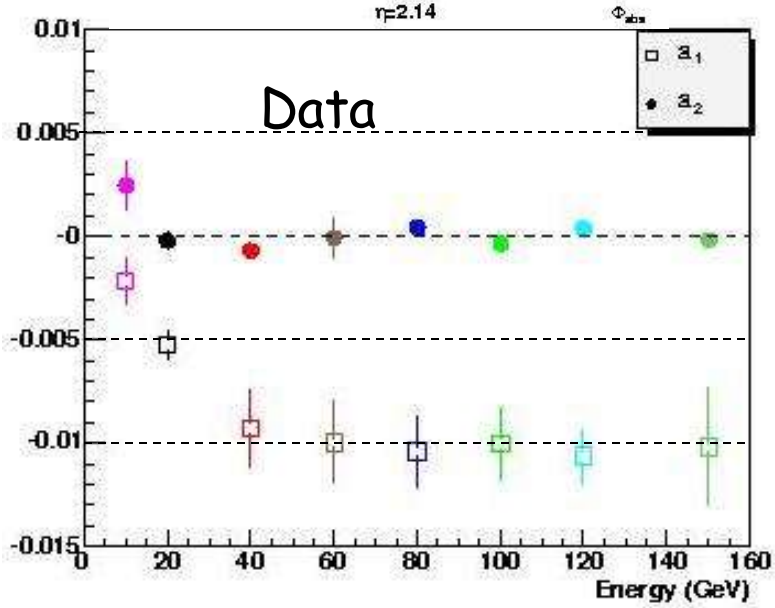
- Evolution of cosine term in agreement with data, but amplitude too high
- Clear disagreement for sinus and phase term at high η

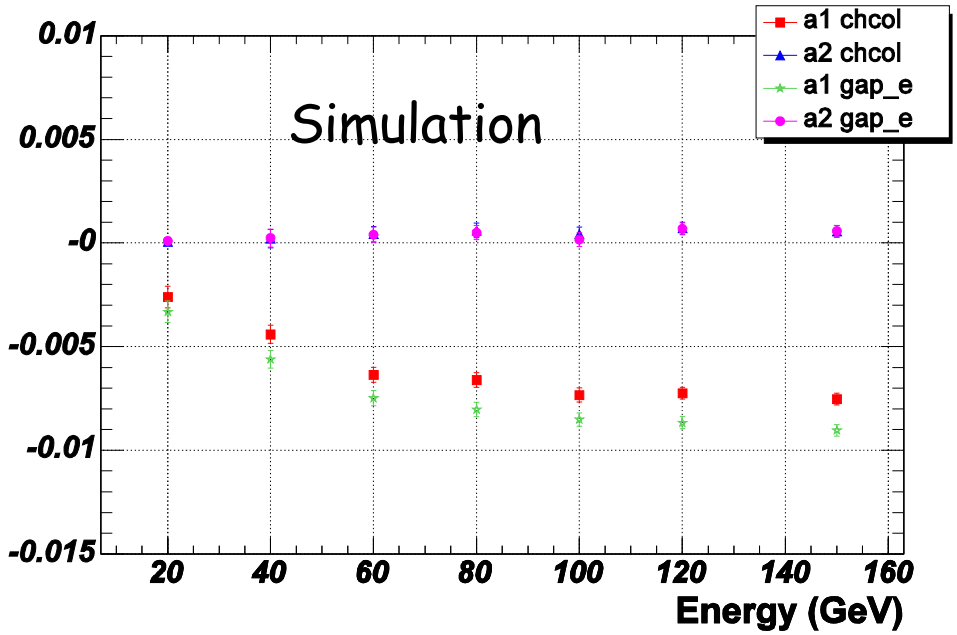
Electrons : φ modulations



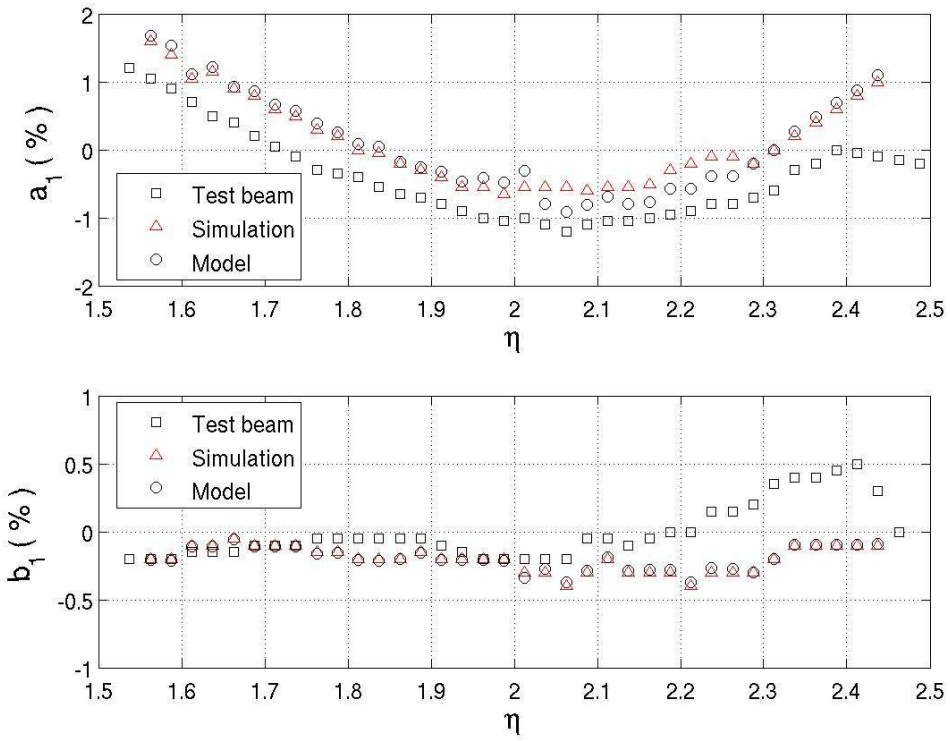
Evolution of φ modulations with energy (ECC0, cell (29,19))

- Here again, coefficients smaller for data than for simulation





Electrons : φ modulations



Differences in $\Delta\phi$ could be related to systematics in η ?

$$a_1^{TB} = a_1^{MC} - b_1^{MC} \frac{\sin\left(2\pi\left(\Delta\phi^{TB} - \Delta\phi^{MC}\right)\right)}{\cos\left(2\pi\Delta\phi^{TB}\right)}$$

$$b_1^{TB} = b_1^{MC} \frac{\cos\left(2\pi\left(\Delta\phi^{TB} - \Delta\phi^{MC}\right)\right)}{\cos\left(2\pi\Delta\phi^{TB}\right)}$$

Not consistent with the observed shift
The effect is too small …

Sagging & Slant angle : Studies under progress …

Conclusions

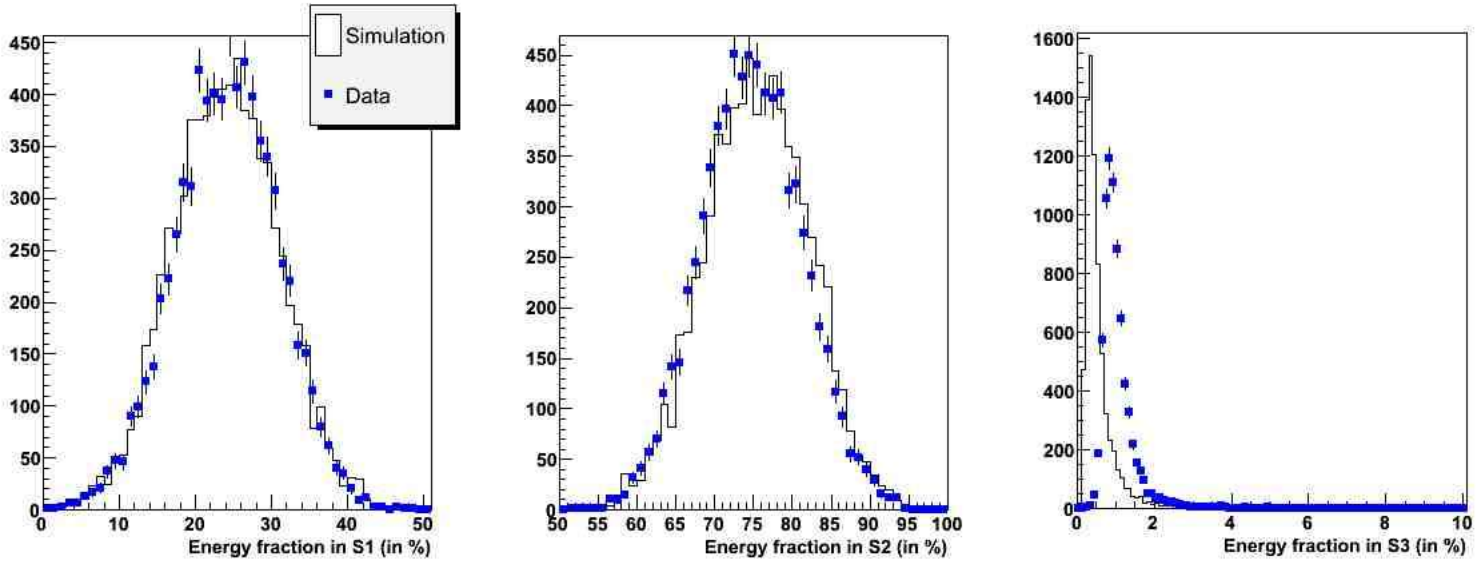
- Good agreement on energy deposition, HV corrections energy resolution
- Main issue : φ modulations still not well described, work under progress to understand differences
- G4.8 seems to give better results (energy resolution, absolute energy scale) than G4.7
- Many updates implemented in TB simulation 11.5.0 (Geometry description, Suppression, Configuration parameters, …) that require validation

Backups

EMEC

- Simulation made with 10.0.1 (release available on the grid)
- Noise and Xtalk in strips added in simulation
- No sagging
- Studies on muons as well as on electrons :
  - Muons :
    - η scan in outer wheel with ~100k events by cell
  - Electrons :
    - η scan in outer wheel with ~10k events by η cell value
    - Energy scan (10 GeV to 150 GeV) in one cell. ~10k events by cell and energy

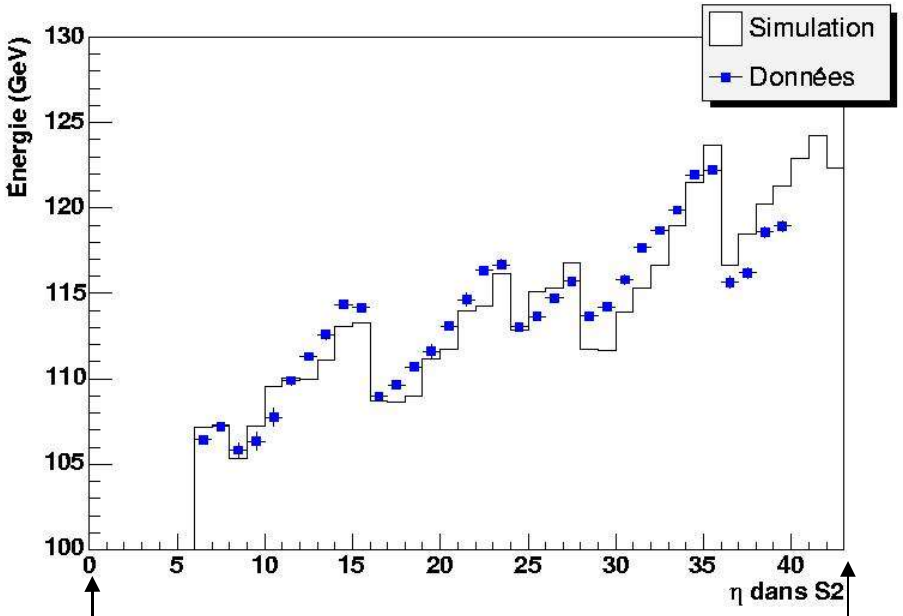
Electrons : Energy deposition



Energy fraction deposited in the three sampling of the EMEC

- Energy deposition well reproduced by simulation
- Disagreement in the 3rd sampling due to inductive Xtalk

Electrons : HV corrections



HV modulation

η=1.4

η=2.5

Parameters of the HV correction for data and simulation :

- α : Slope
- β : Normalisation to the beam energy

HV sector	Data		New simulation		Old simulation	
	α	β	α	β	α	β
B1	0.46	1.12	0.45	1.12	-	-
B2	0.50	1.08	0.38	1.09	0.29	1
B3	0.47	1.055	0.44	1.07	0.31	1
B4	0.46	1.045	0.39	1.040	0.32	1
B5	0.49	1.01	0.46	1.025	0.33	1
B6	0.55	1.00	0.41	1.015	-	-