Summary of ongoing longitudinal shower profile effort in the HCAL group

Erika Garutti on behalf of

Marina Chadeeva, Riccardo Fabbri, Alex Kaplan, Angela Lucaci, Beni Lutz

Several HCAL long. profile plots presented in this or other meetings

➔Try to review the main differences between analysis, and the current status of longitudinal shower shape data/MC comparison

Pion analysis which look at long. profile

- Oliver: data set: 2006 HCAL + ECAL
                shower start in HCAL using cuts on ECAL

- -

- Beni: data set: 2007 HCAL only, rotated calo at 30°
                shower start finder II own development

- Alex: data set: all 2007 HCAL (+ ECAL) and 0°
                shower start finder from Marina processor

- Marina: data set: 2007 pion and proton runs, 0° rotation
                shower start finder I own development

- Angela/Riccardo: data set: 2007 HCAL+ECAL , 0° rotation
                        shower start finder from Marina processor
  - analysis of lateral shower prof. look at long. only for comparison

Pion analysis which look at long. physics

- Oliver: data set: 2006 HCAL + ECAL
              shower start in HCAL using cuts

  Not directly comparable because diff. calorimeter

- Beni: data set: 2007 HCAL only,
            shower start finder II own

- Alex: data set: all 2007 HCAL (+
            shower start finder from M

  Meant to deliver long shower physics

- Marina: data set: 2007 pion and pr
              shower start finder I own p

- Angela/Riccardo: data set: 2007 HCAL+ECAL , 0° rotation
                   shower start finder from Marina
        ➔ analysis of lateral shower prof. look at l

  Use same software + calibration as Alex

Additional differences

- Beni: data = official reconstruction + special geometry treat
      of rotated coordinates   ➔

  MC = MOKKA*, official digi (optical Xtalk) + reco
      no smearing

- Alex+   data = official reconstruction

Angela/Riccardo   MC = MOKKA*, official digi (optical Xtalk) + reco
      no smearing

- Marina: data = official reconstruction

  MC = No MOKKA, private digi (no Xtalk) + reco,
   + additional smearing to match resolution

➔ Provide excellent opportunity to crosscheck the physics message

* New MOKKA version mokka-07-00 includes HCAL changes: individual absorber layer thickness from measurements, reduced air gap, corrected rotation behavior
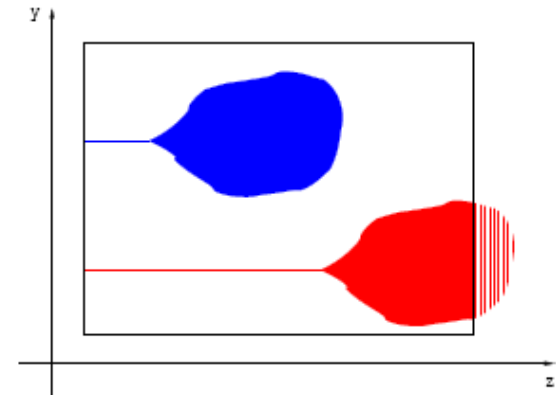
Beni method

All details in an internal note circulated to the referees yesterday
Some innovative features w.r.t. other analysis:

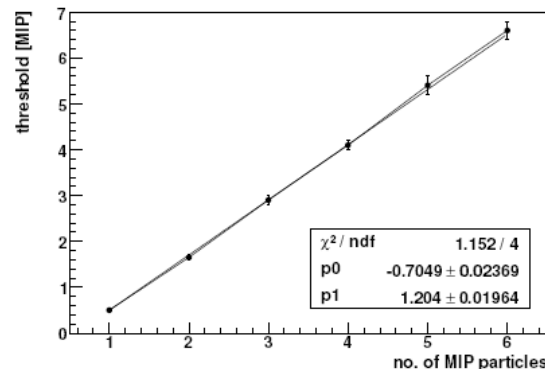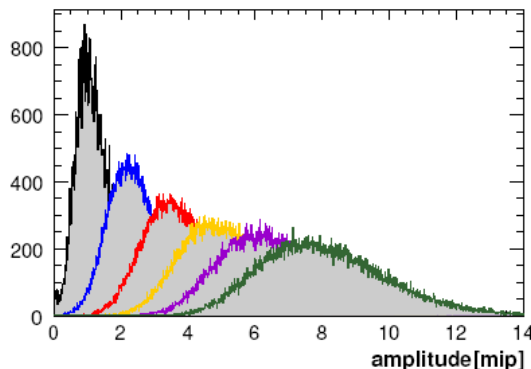Solve the problem of rotated geometry
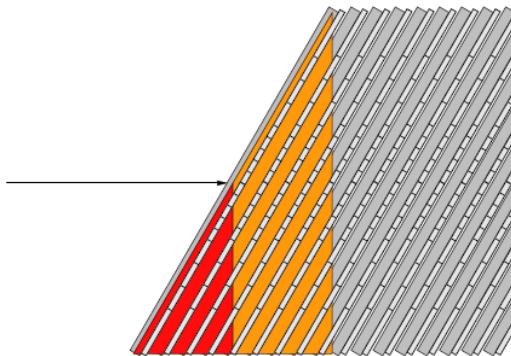
Use appropriate normalization for events with leakage

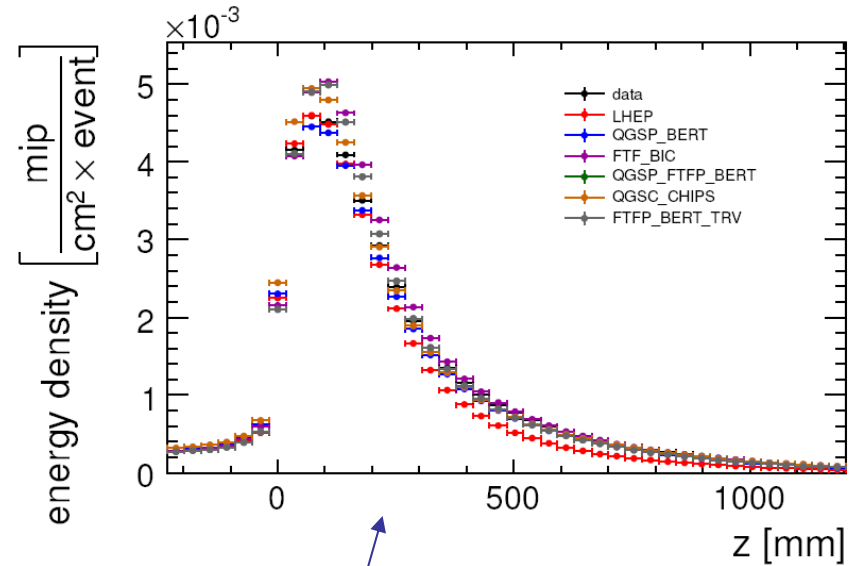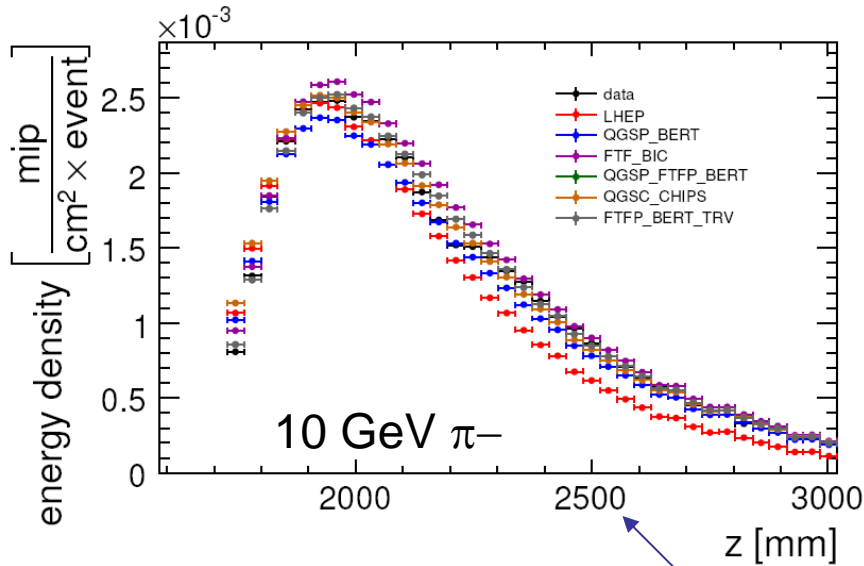How to assign the cell energy to different bins, if the bin size is != cell size:
Distributes energy on tile surface according to the estimated number particles at give E

Other two existing methods:
- assign all hit E to one point on tile, randomize
- assign all hit E to all grid elements of one tile & normalize properly

- Lyon

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Beni method / results

Presents longitudinal profiles from detector start and from shower start for various energies and MC models

➔longitudinal shower quantitative analysis has to follow

Here the question is: can we relay on this results ?   ➔ crosscheck helps

From EM analysis
see talk of Sergey in AHCAL session for more details

- One word of caution:

  unfortunately validation of reconstruction/ calibration and digi

  goes in parallel, feedback to hadron analysis requires time

What is not yet in the official reco but already discovered:

- MC energy scale too low by 10% due to "wrong" Xtalk corretion
- wrong T correction for some cells with wrong T slope (data & MC)
- local corrections to some SiPM saturation curve (effects data)

Still missing in all analysis:

- Exclusion of dead cells in MC ➔ can impact shower shape from start of shower (data/MC difference smeared to different bins)

Crosscheck between analysis I

Angela/Riccardo vs Alex: same code used, just histogramming part differ
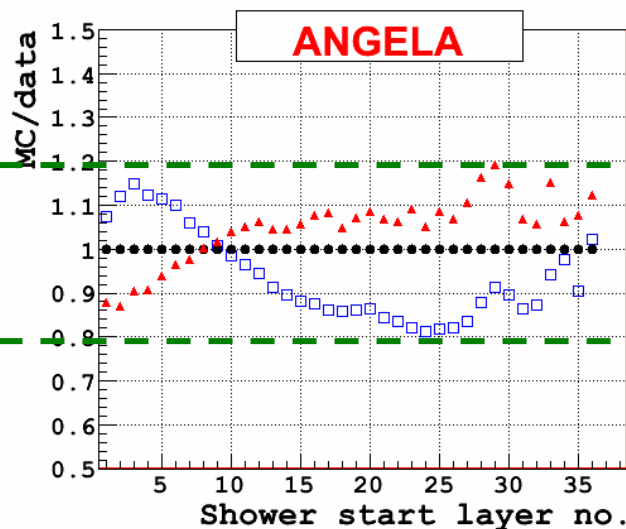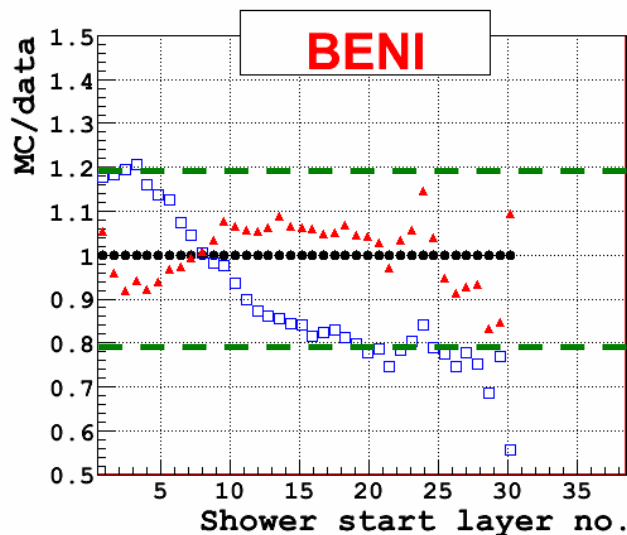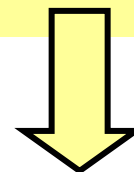crosschecked on same run ➔ excellent agreement

Angela/Riccardo vs Beni: same code used up to event selection and rotation
- crosschecked on same run without shower start
➔ excellent agreement
- second step: crosscheck shower start method

Crosscheck between analysis II

same 80 GeV pion run
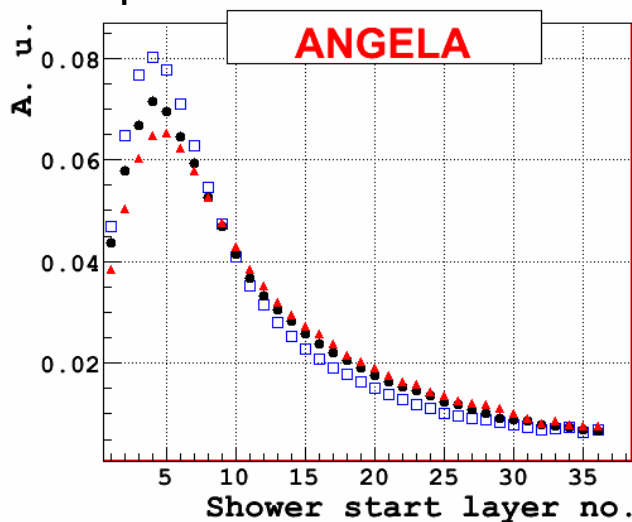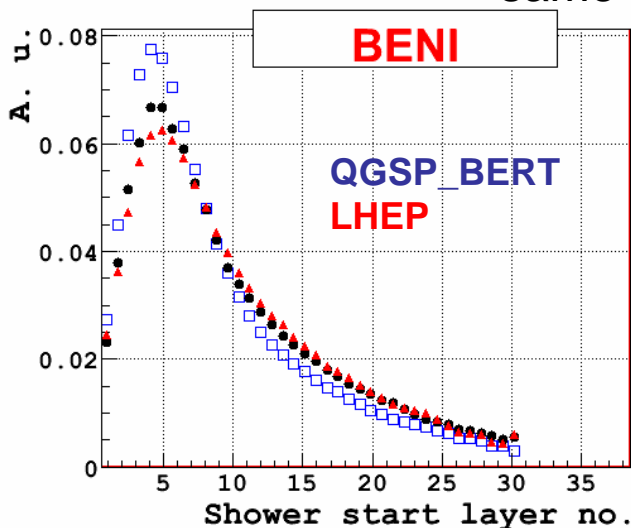
Look more at the Comparison of physics message

- Same shape of disagreement data/MC
- Similar order of magnitude
- Some difference in the first layers (bias?)
- Different weighting in the tails

Conclusion: the physics message does not change significantly

Crosscheck between analysis III

Oliver, released 2006 data

10 GeV π

Beni, 2007 data, rotated HCAL

10 GeV π

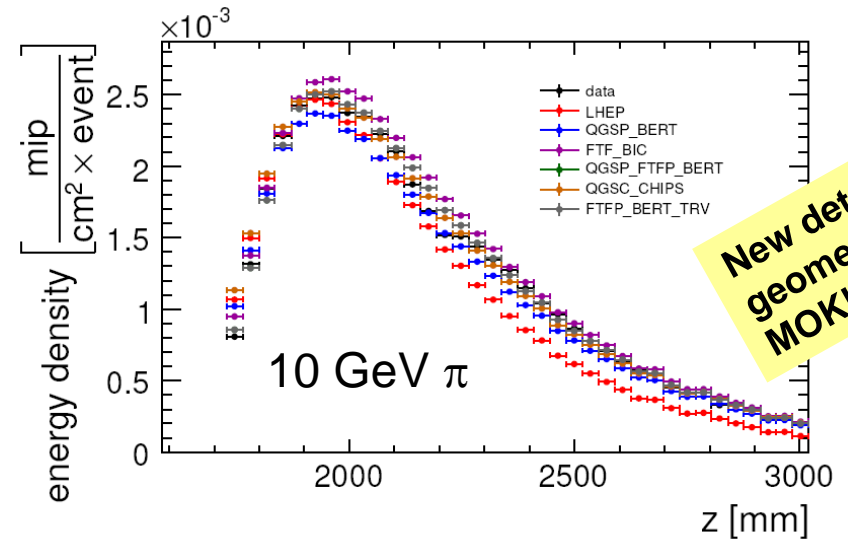*New detector geometry in MOKKA*
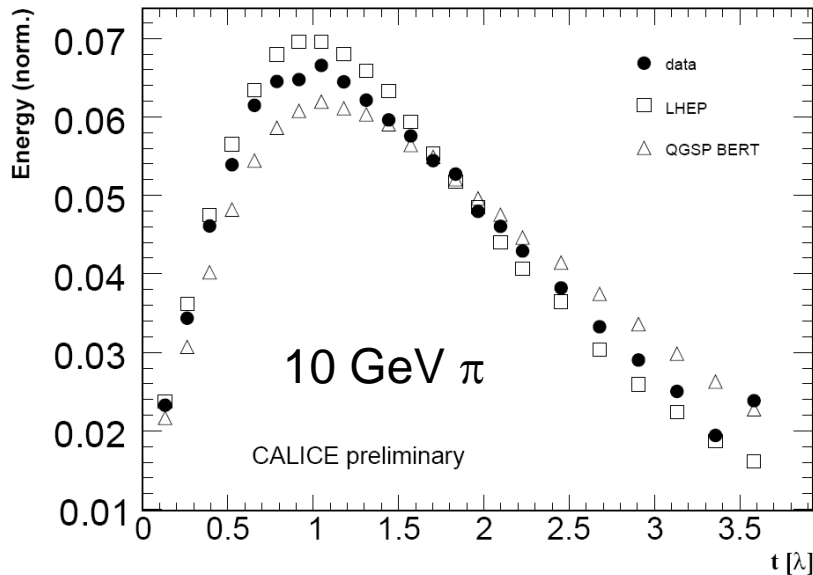
E scale w.r.t. data:
QGSP_BERT 6% higher
LHEP 6% lower
In shower max
QGSP_BERT 8% lower
LHEP 5% higher

LHEP shower too short

QGSP_BERT shower too long

E scale w.r.t. data:
QGSP_BERT within 3% match
LHEP >5% lower
In shower max
QGSP_BERT 5% lower
LHEP agrees with data

LHEP shower too short

QGSP_BERT shower agrees

A look at the current results

From detector start

From shower start

possible bias from selection
high BG, no ECAL in front

10 GeV π

10%
increase
expected
in MC
E scale

80 GeV π

data
LHEP
QGSP_BERT
FTF_BIC
QGSP_FTFP_BERT
QGSC_CHIPS
FTFP_BERT_TRV

Which model is best: E dependent answer
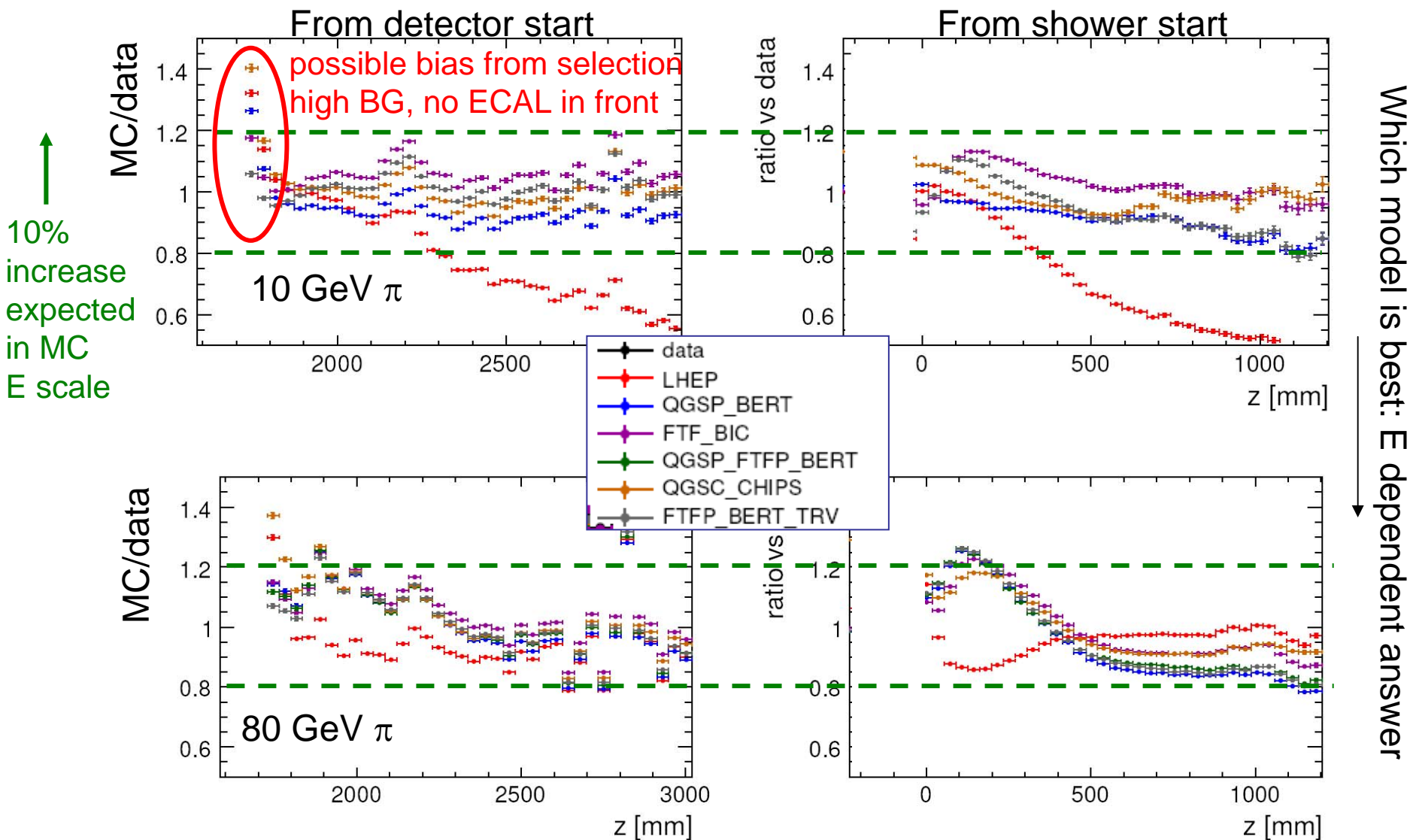
→ We are still not ready to discuss long. shower physics, but getting closer

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Crosscheck between analysis IV

ANGELA

80 GeV π
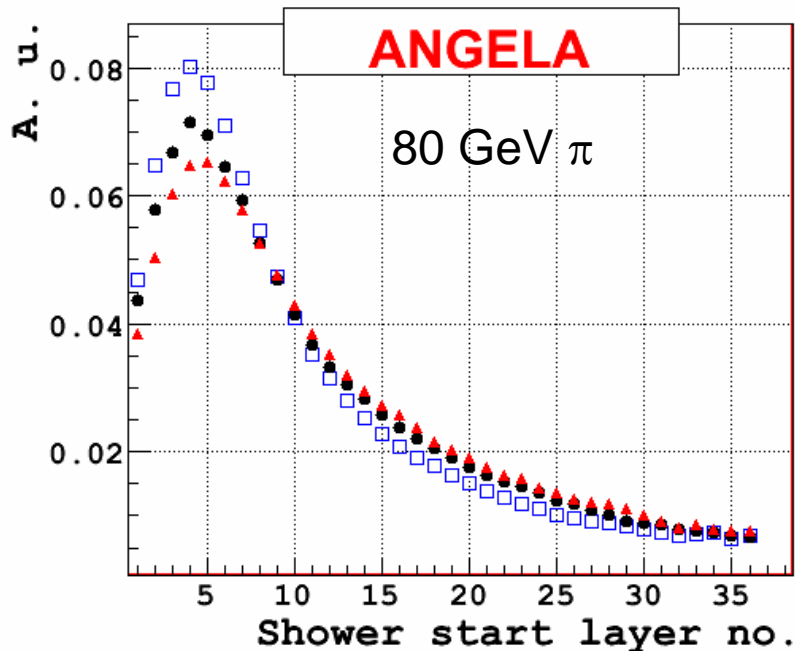
In shower max
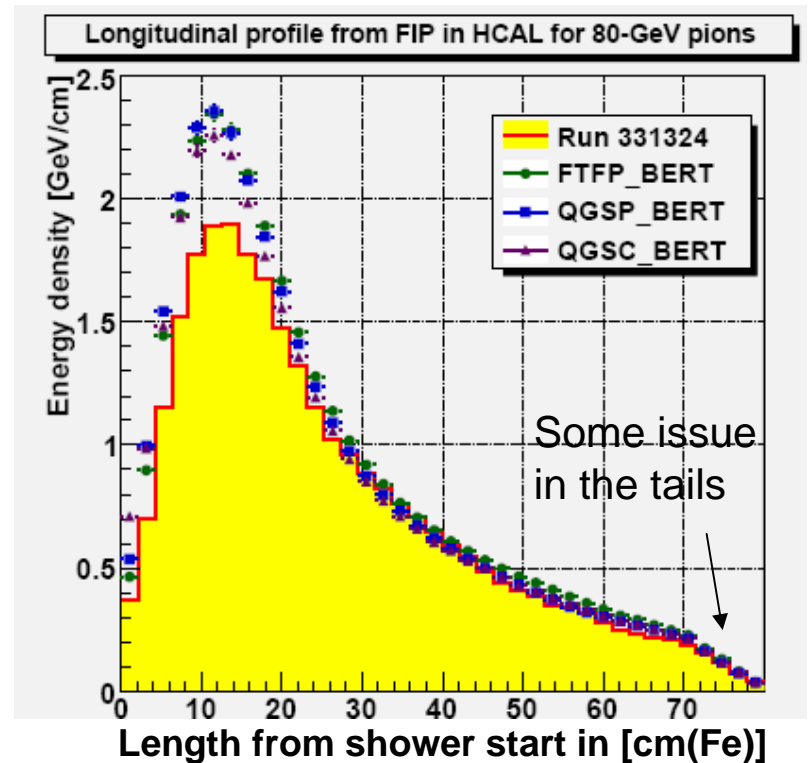QGSP_BERT 12% higher

QGSP_BERT shower shorter than data

➔ From EM analysis: scale MC by 10% higher in official digi

Marina does not use official digi
➔ no xtalk correction / no re-scaling

Marina

Longitudinal profile from FIP in HCAL for 80-GeV pions

Some issue in the tails

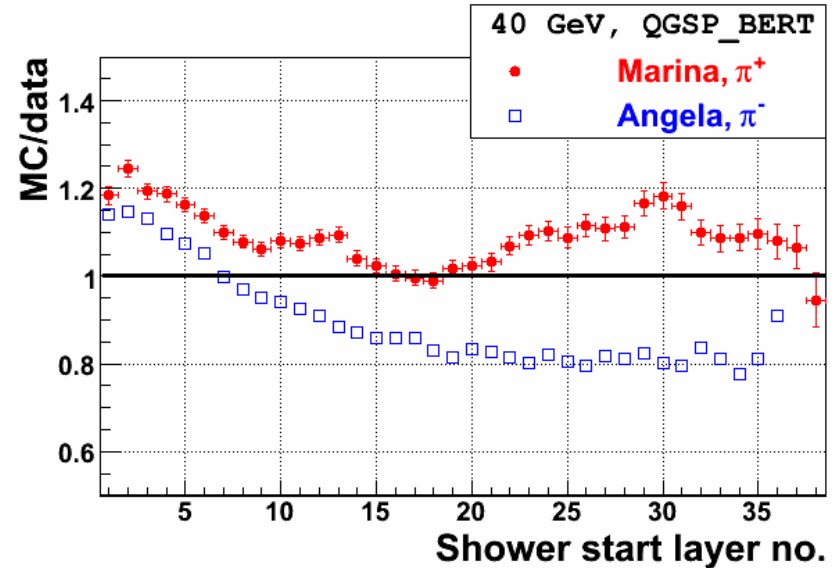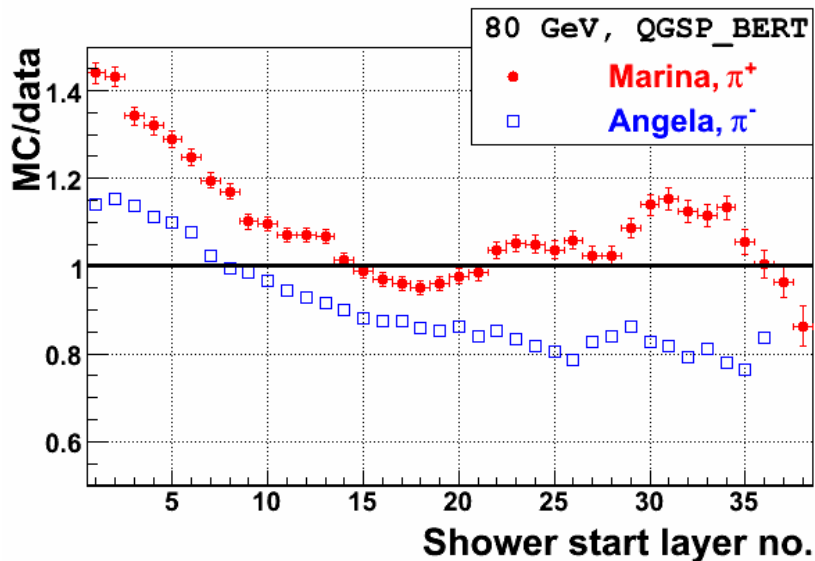**Length from shower start in [cm(Fe)]**

In shower max
QGSP_BERT 20% higher

QGSP_BERT shower shorter than data

Crosscheck between analysis IV

10% Different scale in MC already discussed
Remaining ~10% difference in scale + difference in shape to be further investigated

➔ Similar message from both analysis but better agreement is desirable

Shower start finder methods

Crosscheck with MC true shower start: determine shift and z-resolution

!! quantities energy and model dependent

Beni

physics list \ energy [GeV]	shift [mm]									
	8	10	12	15	20	30	40	50	60	80
LHEP	-14	-10	-12	-15	-17	-21	-26	-29	-30	-34
QGSP_BERT	-15	-16	-11	-12	-13	-16	-18	-20	-21	-23
FTF_BIC	-7.6	-9.6	-11	-14	-16	-17	-20	-21	-22	-25
FTFP_BERT_TRV	-5.9	-4.3	-6.1	-8.2	-11	-12	-14	-17	-18	-20
QGSC_CHIPS	-4.2	-14	-17	-19	-21	-23	-27	-28	-30	-33
QGSP_FTFP_BERT	-5.9	-4.3	-6.1	-8.7	-12	-15	-18	-19	-19	-22

physics list \ energy [GeV]	resolution [mm]									
	8	10	12	15	20	30	40	50	60	80
LHEP	29	27	26	27	27	28	30	32	32	34
QGSP_BERT	39	34	26	26	28	30	31	31	31	33
FTF_BIC	35	34	33	32	32	31	32	31	32	33
FTFP_BERT_TRV	36	33	32	31	31	30	32	31	31	32
QGSC_CHIPS	54	37	37	36	36	36	37	37	37	39
QGSP_FTFP_BERT	36	33	32	31	30	30	30	31	31	32

z-resolution consistent between models and energies RMS ~ 30 mm ~ 1 layer

difference in shift: as large as 1 layer at high E difference ~10mm between models

Marina
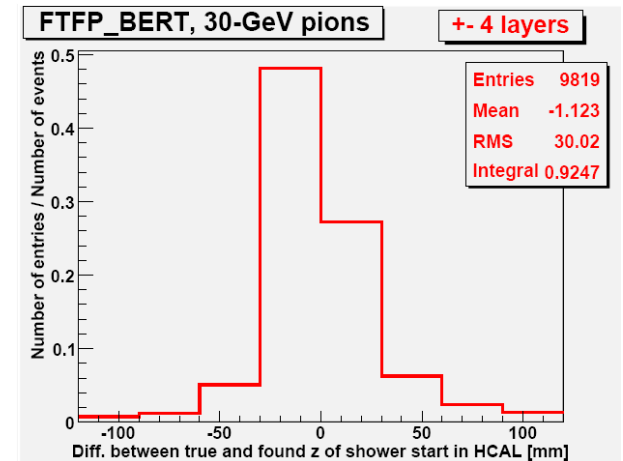
Looks at 30 GeV pion in only 1 model
Limit shower start +/-4 layers from true
92% of statistics
RMS = 30 mm = 1 layer z-resolution

➔ Systematic uncertainty

Conclusions

- First level of detailed crosscheck between analysis of long. shower profile done
- It helped to fix bugs, find errors, establish methods

- Consistent physics message between analysis   checked
- Consistent physics message with rotated calorimeter checked
- Different physics message vs energy   expected!

Still missing:
- Treatment of dead cells in MC
- Implementation of all "fixes" from EM analysis
- Detailed systematic studies (including bias on shower start methods)

➔ Quantitative analysis of long. profiles (comparison of higher momenta, $L_{95\%}$, double differential, …)