report to G4

- Recent CALICE results on hadronic shower analysis are reported in the combined CALICE/G4 EUDET Memo-2010-15

  http://www.eudet.org/e26/e28/

- as well as in several CALICE internal notes (for CALICE members)
  https://twiki.cern.ch/twiki/bin/view/CALICE/CaliceAnalysisNotes

- In the following we present

      - CALICE comments to changes in various G4 releases

      - CALICE wish list to G4

G4 improvements: visible energy

Pion visible energy recorded by the Si-W ECAL 30 layers sampling, ~1 λ_{int}
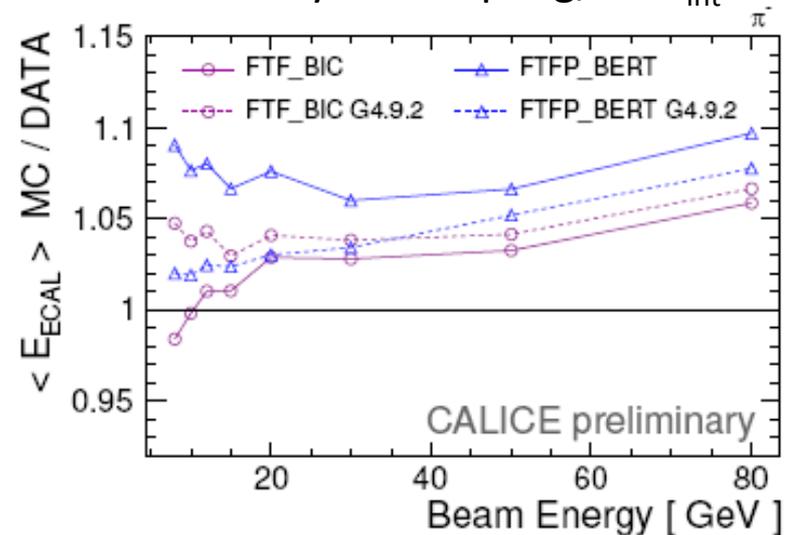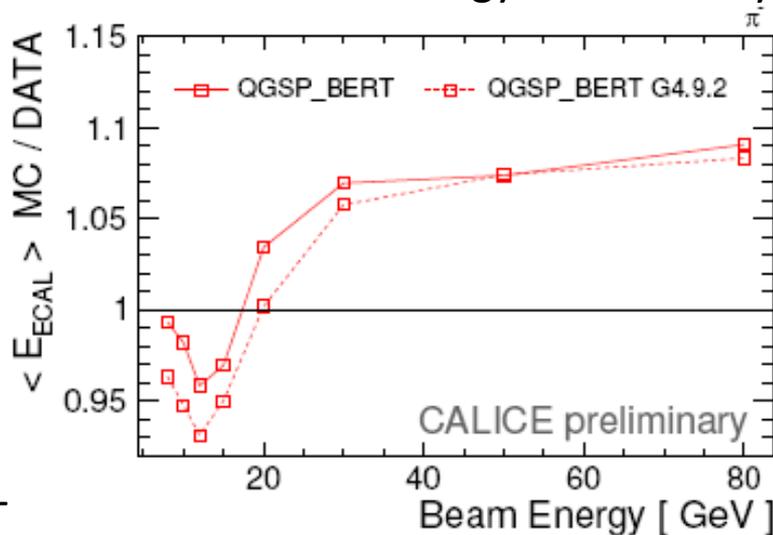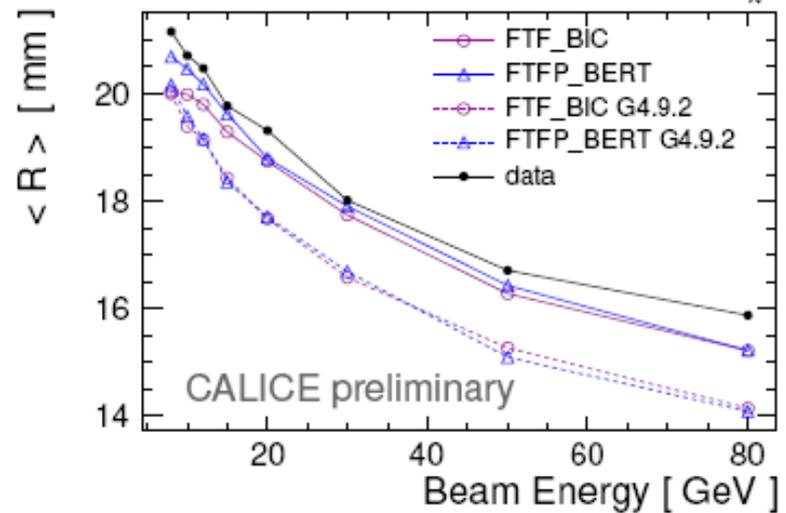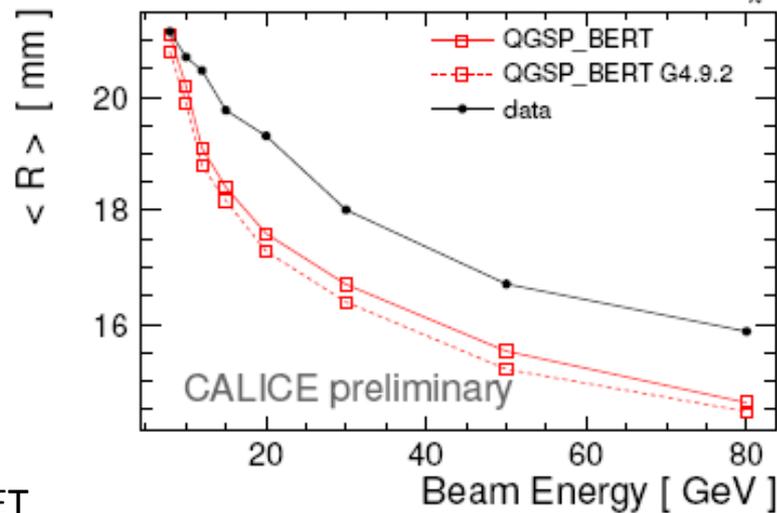

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Figure 19: Comparison of Geant4 version 9.3 (solid lines) and version 9.2 (dashed lines) for the total visible energy in ECAL as a function of beam energy, on the left for the QGS-based physics lists and on the right for the FTF-based physics lists.

➡ Improvements in the energy dependence of FTF_BERT, while significant E-dependence in FTF_BIC

➡ The absolute scale is strongly dependent on calibration and digi procedure.

G4 improvements: shower shape

Pion mean shower radius recorded by the Si-W ECAL 30 layers sampling, ~1 λ_{int}


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Figure 20: Comparison of Geant4 version 9.3 (solid lines) and version 9.2 (dashed lines) for the first moment of the radial shower profile in ECAL as a function of beam energy, on the left for the QGS-based physics lists and on the right for the FTF-based physics lists.

➔ Significant improvement of the FTF models
➔ G4.9.4 needs to be checked soon
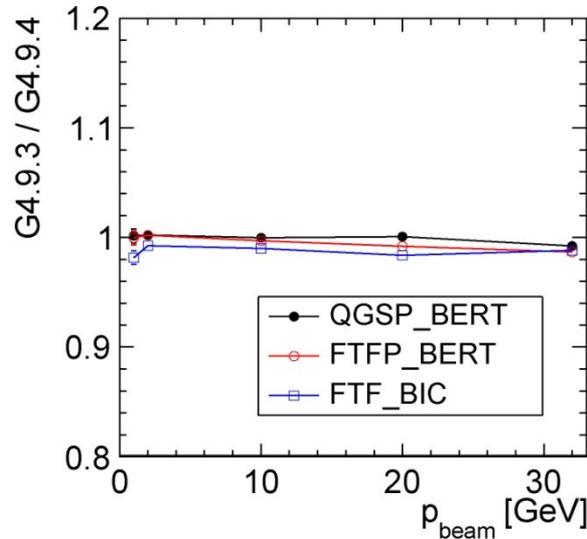➔ changes in phys. lists could be also confirmed by G4 group with basic CALICE geo.

G4 improvements: the latest release

Pion simulation in the Scint-Fe HCAL 38 layers sampling, ~5.3 λ_{int}
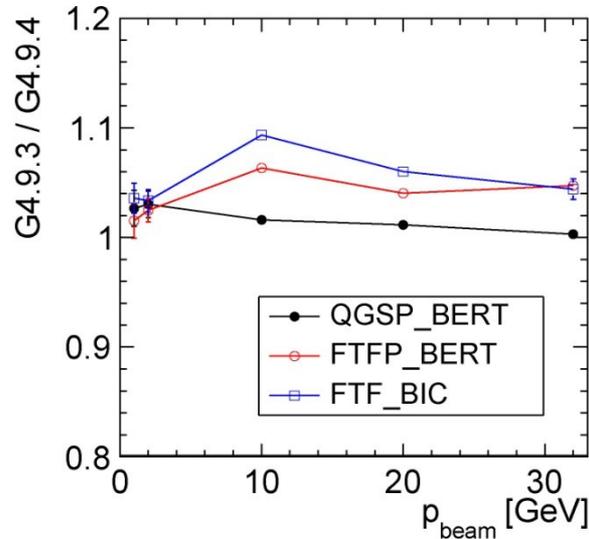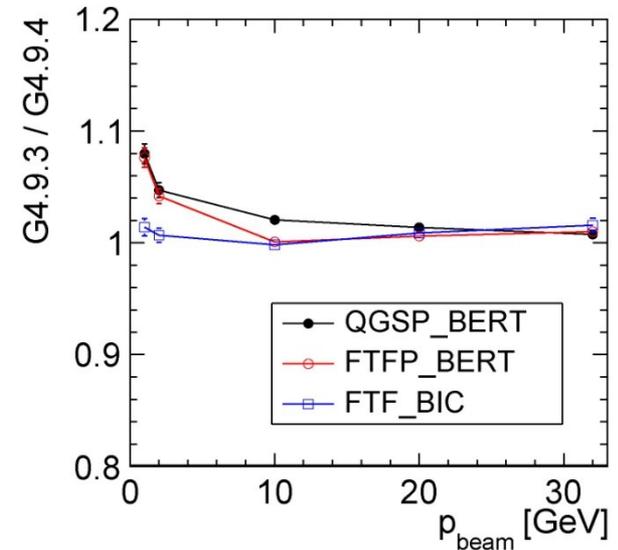

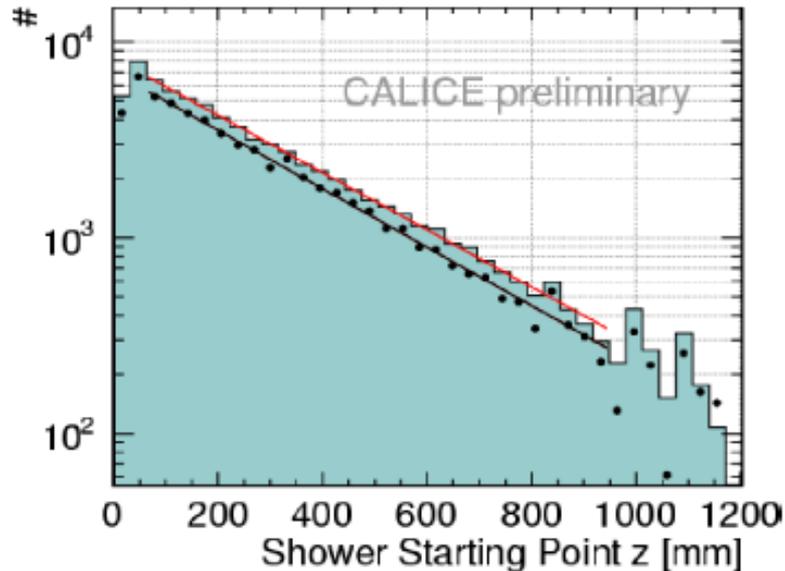Visible energy   Longitudinal mean   Lateral mean

FTF: decrease in visible energy by 5-8%
BERT: decrease of shower radius (affects low energies)
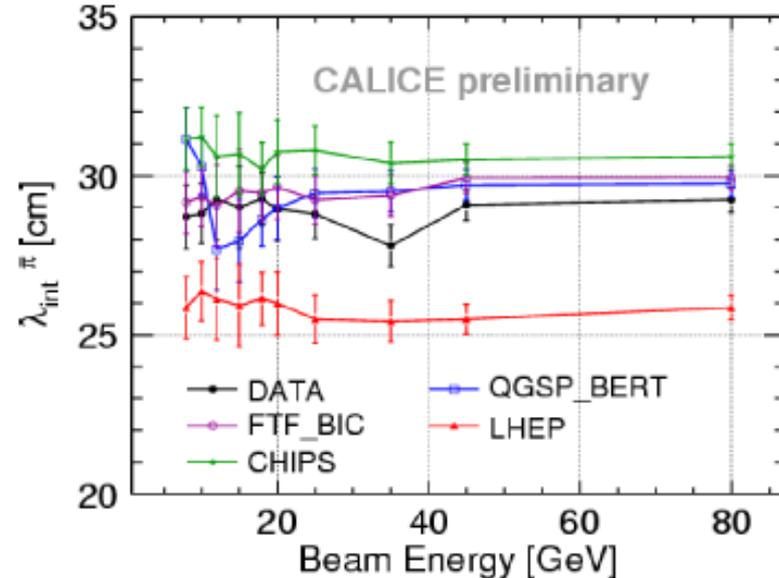Longitudinal shower mean is unchanged

Check of cross-section

Pion point of first hard interaction recorded by the Scint-Fe HCAL 38 layers sampling, ~5.3 λ_{int}


Distribution of the shower starting position in QGSP_BERT physics list (filled histogram) and in data (filled circles) for 45 GeV pions.

Extracted values for the interaction length in cm from data and MC models

- Extract λ_{int} with exponential fit (left plot) to data and simulation
- Cross section from most phys. lists agrees with data
- **CHIPS (G4.9.3)** has larger λ_{int} than data by more than the sys. error
➔ CHIPS uses different cross-section, to be clarified (which one is right?)

How to release CALICE data for G4?
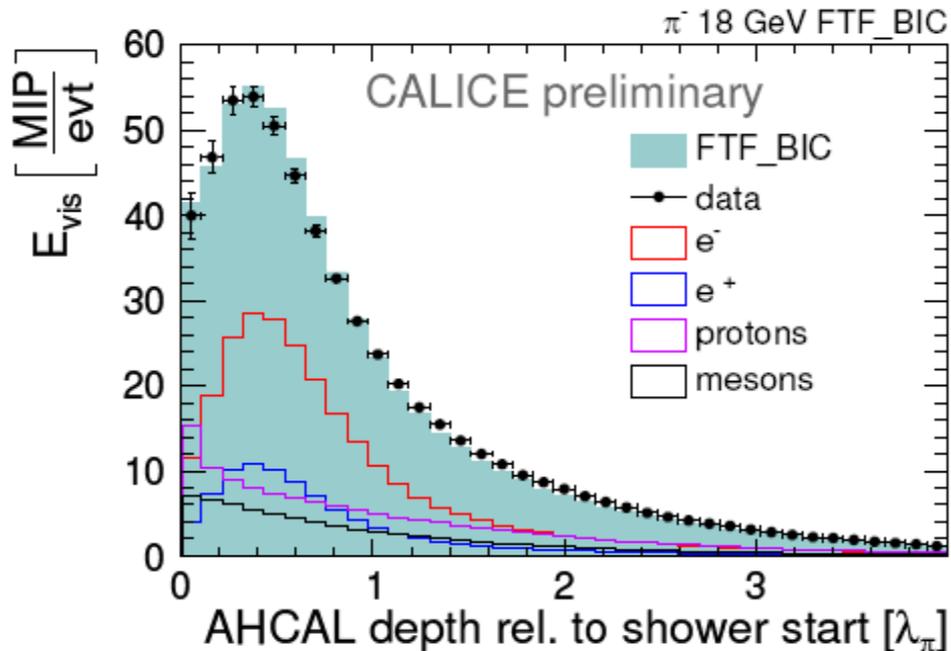
- CALICE plans to release a set of calibrated data, for use in G4 tuning
- Suggestions are welcome on the data format and treatment

IDEA: visible energy per layer calibrated to GeV, vs layer in units of X_0 and λ_{int} for various beam energies
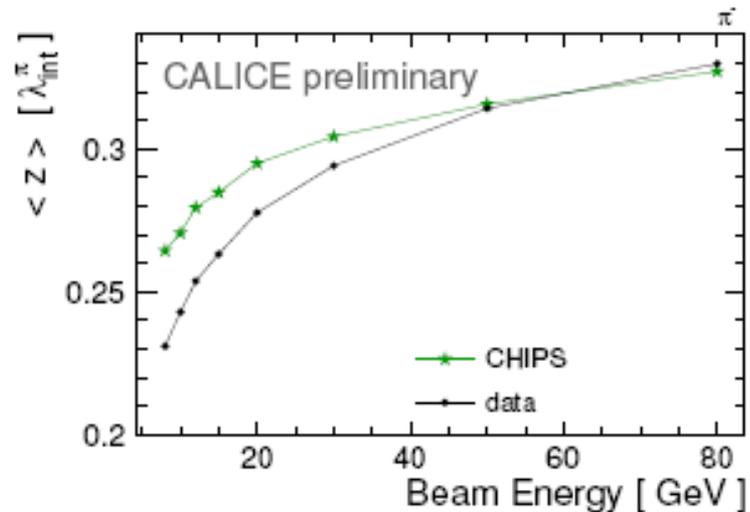
Options:
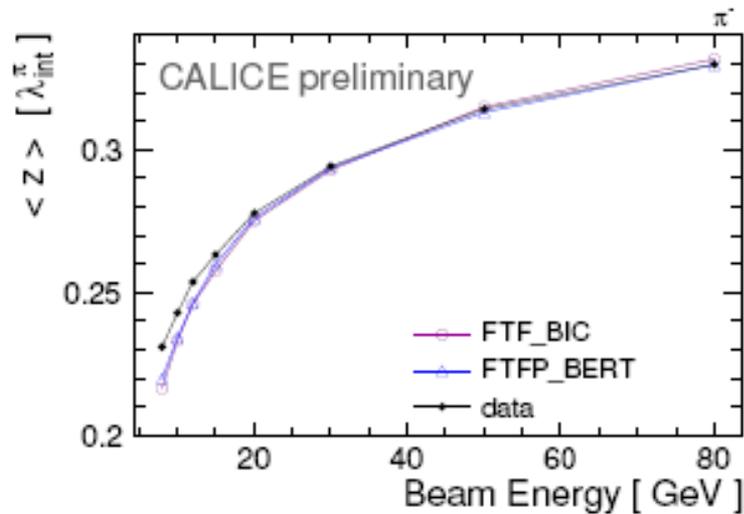- with or without MC calibration = data / MC_digi * MC_true ?
- Data shown from calorimeter start or from first interaction point?

Usual analysis constraint: shower start in first 5 AHCAL layers
➔ Implies containment in minimum 4.8 λ_{int}

- We would like to discuss these options with G4 experts

How to release CALICE data for G4?

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- shower longitudinal mean and shower longitudinal spread in units of λ_{int}

- Due to analysis cuts this is the truncated mean from 0 to 4.8-5.3 λ_{int}
  ➔ How well can G4 reproduce this with CALICE-basic geometry?

- limited dimension of prototype influences the transverse direction as well

Time structure of hadron shower

CALICE is investigating the 4th dimension of the hadronic shower

Measured with a set of scintillator tiles with very high time resolution electronics installed behind the W-AHCAL (~5 λ_{int})
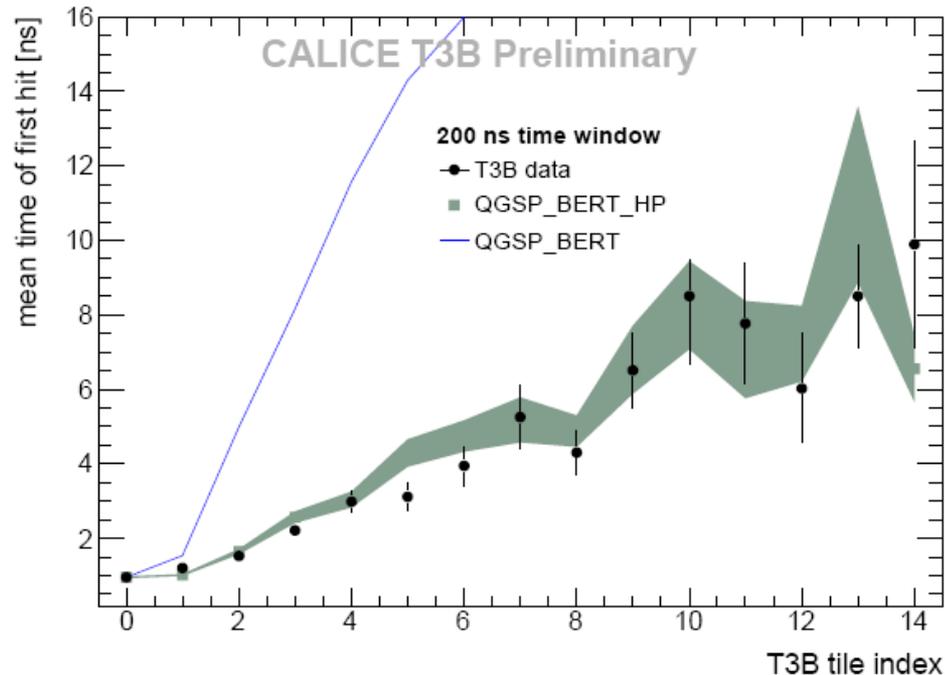

Figure 8. Mean time of first hit for 10 GeV π^- as a function of radial distance from the shower core (a tile index of 10 corresponds to approximately 30 cm). The data are compared with simulations using QGSP_BERT and QGSP_BERT_HP. The error bars and the width of the area in the case of QGSP_BERT_HP simulations show the statistical error, while for QGSP_BERT the errors are omitted for clarity.

- HP package needed to reproduce shower time structure in tungsten
- Does it also match the energy response and spatial profile? We will very soon be able to report on this.

CALICE wish list for G4

- Implement CALICE-like geometry in the check plots for new releases !!!

- Prepare for the imminent comparison Fe .vs. W with CALICE data
    - HP package, provisionally looks promising in CALICE at least for W

- Continue to improve CHIPS (fix cross section, lower visible energy, too long showers)

- Radial shower shape ➔ indications from CALICE: too narrow in all lists