

# Analysis of Hadron Data

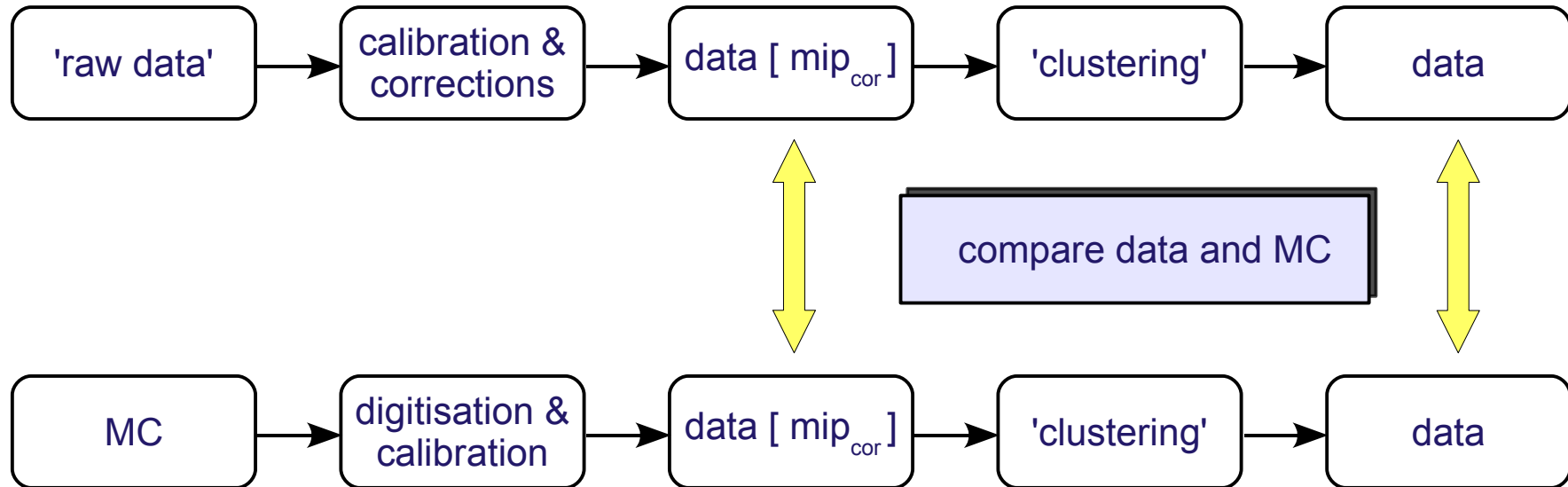
- *update* -

## Outline:

- Simulation and Reconstruction Chain
- Simple Analysis of Pion Data
- Comparison with several Monte Carlo Models
- Conclusions



# Simulation and Reconstruction Chain

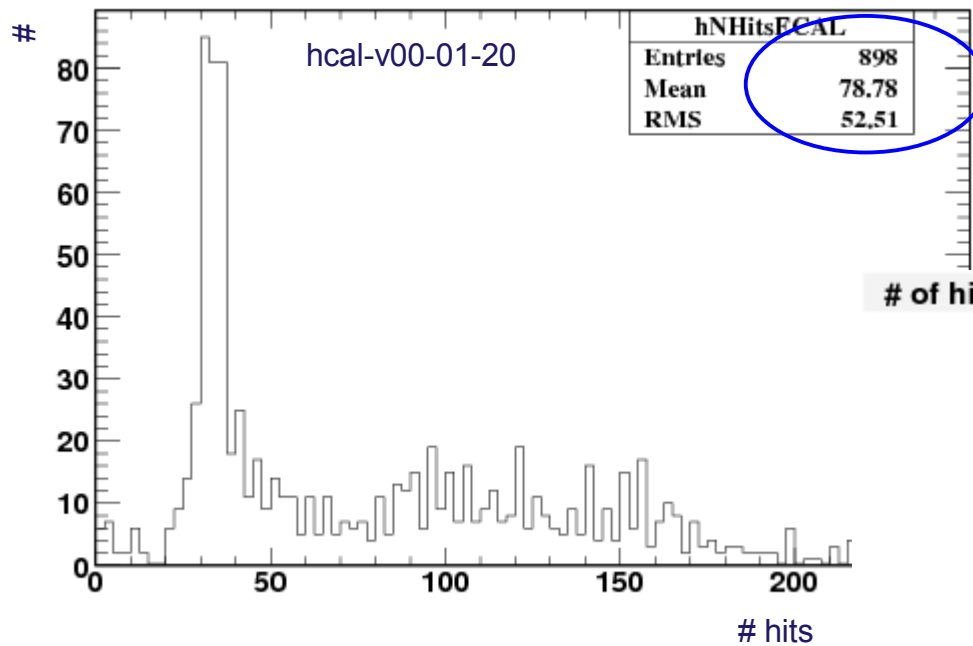


- implemented in 'semi-official' framework (**hcal-v00-01-20**, by Sebastian)
- **and** in **new official** HCAL framework ('=' official CALICE software)
  - same results
- run on raw data or centrally converted data (**v0405**)
- simple cut-based selection to find hadron showers fully contained in HCAL
- ( 'clustering' done by deep analysis processor )

# 'Official' CALICE Software vs. 'Semi-Official' Software by Sebastian

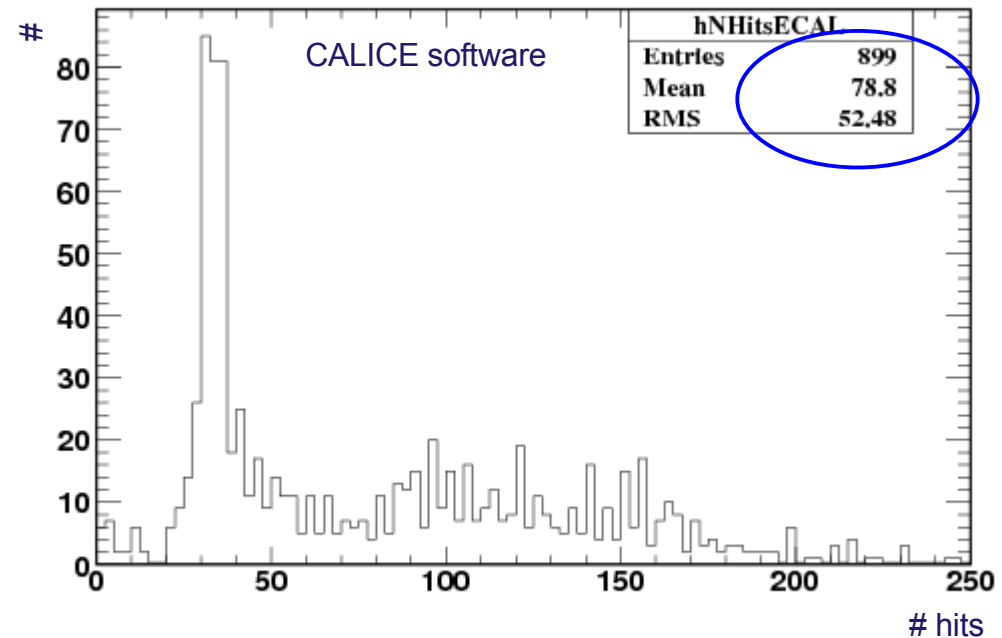
- compare **few numbers** reconstructed with both (hcal-v00-01-20 vs. CALICE software)
- only data chain, comparison for MC **missing**

# of hits in ECAL



- # hits in **ECAL**
- **w/o** cut-based selection
- pions, -10 GeV, Oct. 2006 (run 300660)
- identical results

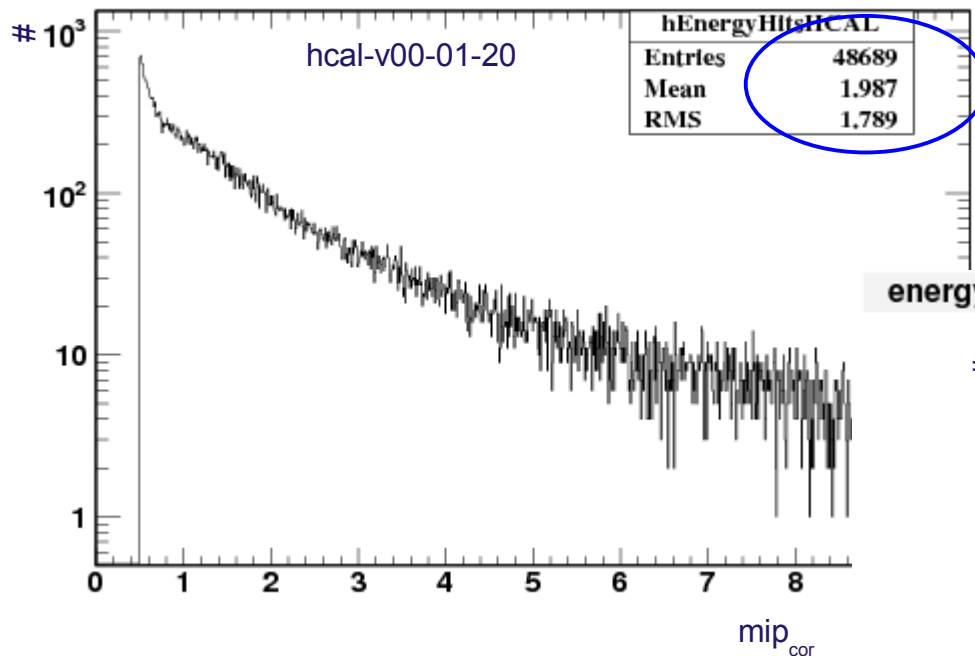
# of hits in ECAL



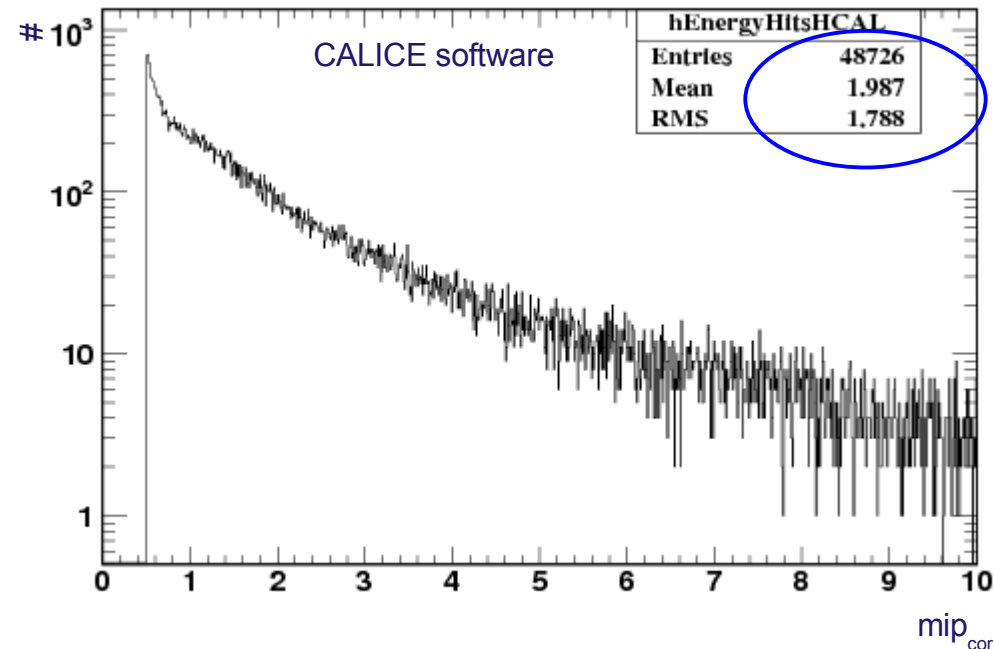
# 'Official' CALICE Software vs. 'Semi-Official' Software by Sebastian

- compare **few numbers** reconstructed with both (hcal-v00-01-20 vs. CALICE software)
- only data chain, comparison for MC **missing**

energy spectrum of hits in HCAL



energy spectrum of hits in HCAL

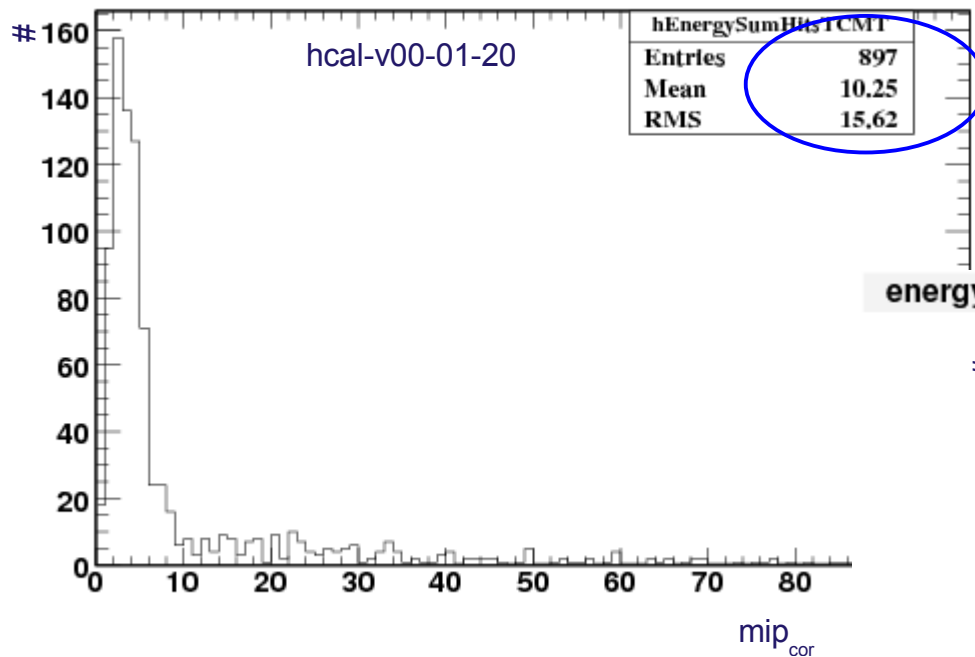


- hit energy spectra in **HCAL**
- **w/o** cut-based selection
- pions, -10 GeV, Oct. 2006 (run 300660)
- identical results

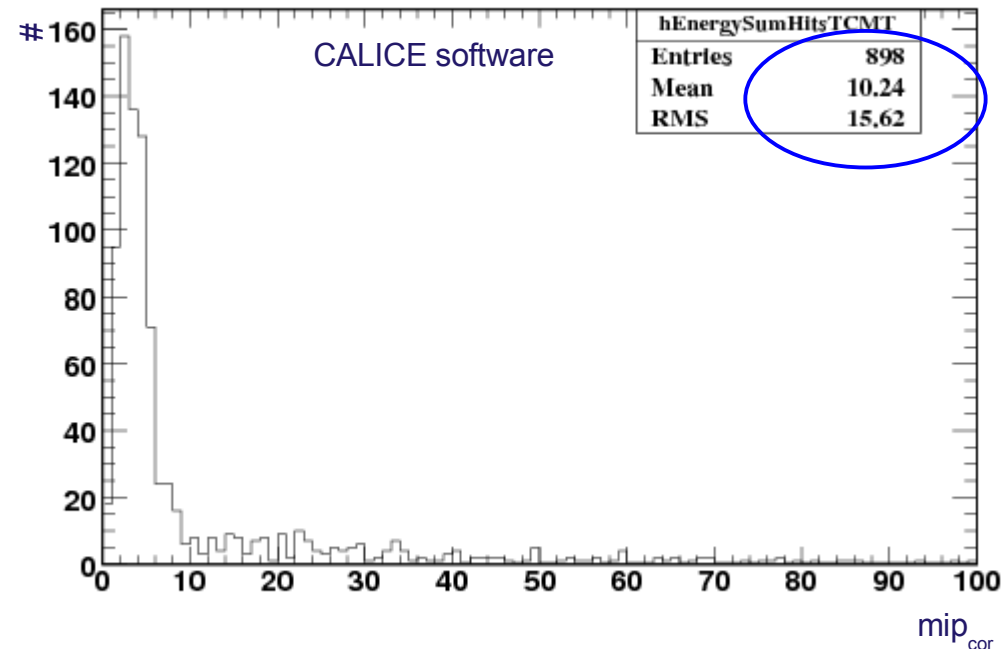
# 'Official' CALICE Software vs. 'Semi-Official' Software by Sebastian

- compare **few numbers** reconstructed with both (hcal-v00-01-20 vs. CALICE software)
- only data chain, comparison for MC **missing**

energy sum of hits in TCMT

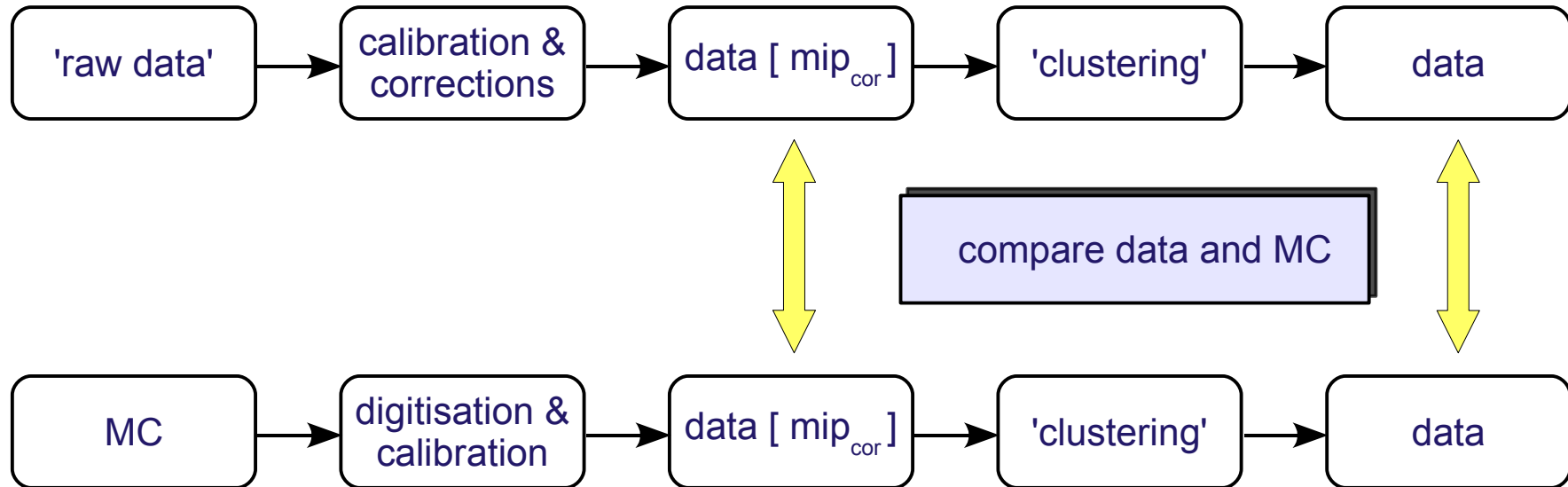


energy sum of hits in TCMT



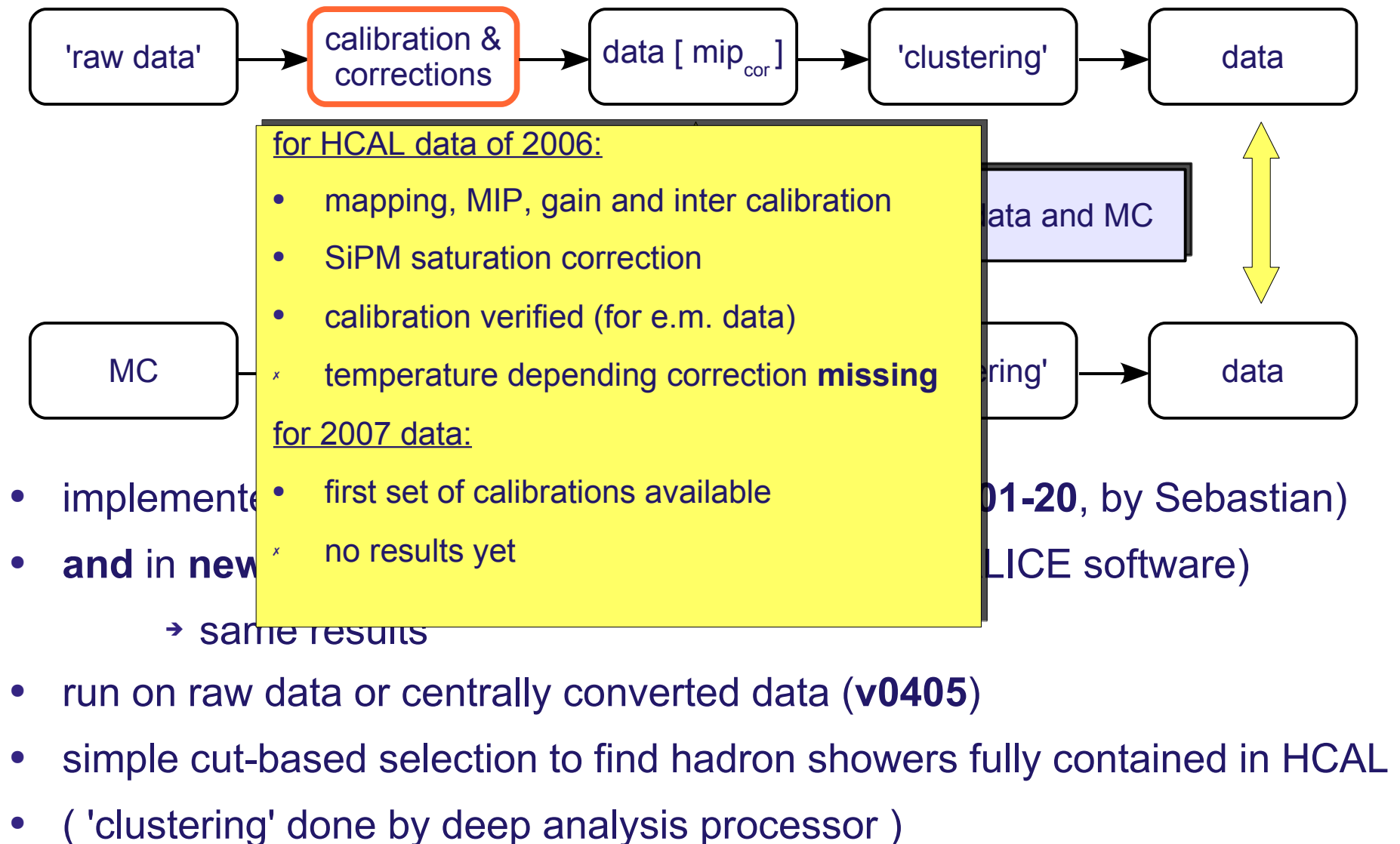
- energy sum in **TCMT**
- **w/o** cut-based selection
- pions, -10 GeV, Oct. 2006 (run 300660)
- identical results

# Simulation and Reconstruction Chain

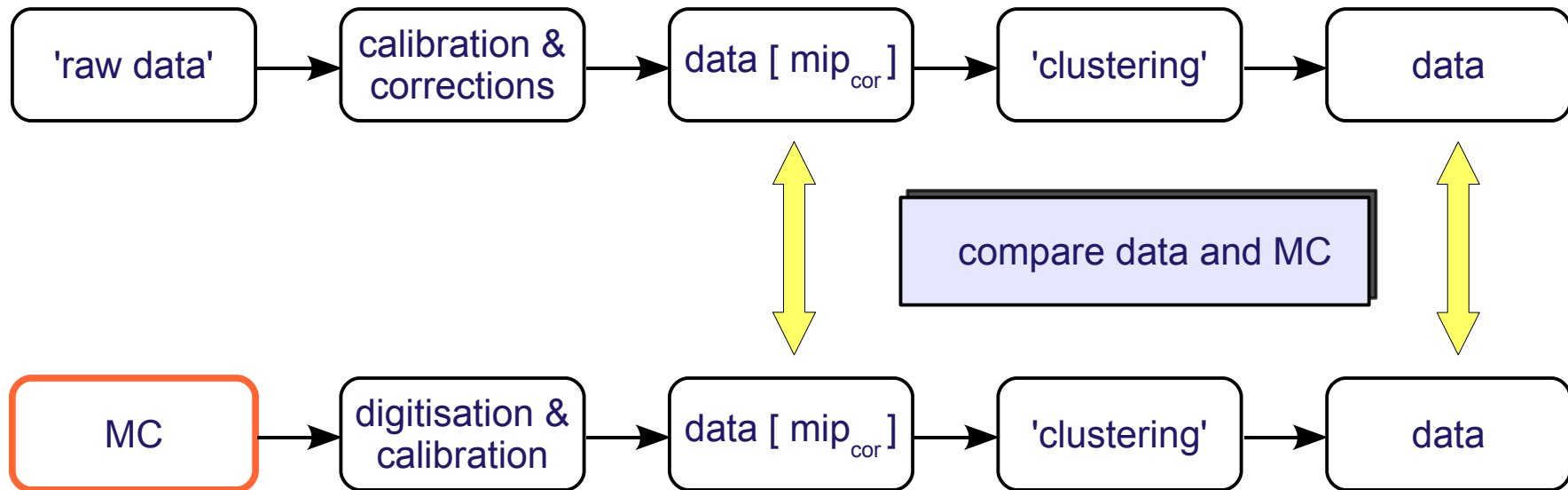


- implemented in 'semi-official' framework (**hcal-v00-01-20**, by Sebastian)
- **and** in **new official** HCAL framework ('=' official CALICE software)
  - same results
- run on raw data or centrally converted data (**v0405**)
- simple cut-based selection to find hadron showers fully contained in HCAL
- ( 'clustering' done by deep analysis processor )

# Simulation and Reconstruction Chain



# Simulation and Reconstruction Chain



for 2006:

- Mokka 06-03-p02, GEANT4 8.1.p02
- TBCern1006\_01
- several physics lists: QGSPxx, LHEPxx, LCPhys, ...
- simple beam profile (verification needed)

for 2007:

- HCAL model ready, full model implemented in next Mokka release (still waiting ... )

work (**hcal-v00-01-20**, by Sebastian)

rk ('=' official CALICE software)

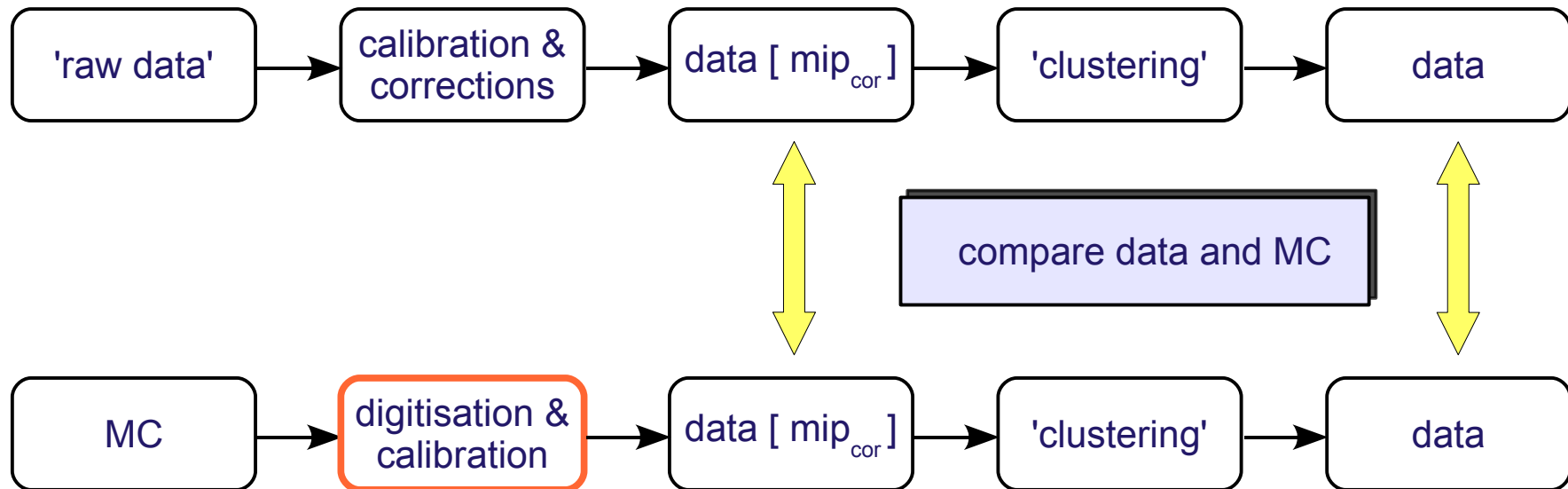
ed data (**v0405**)

adron showers fully contained in HCAL

processor )



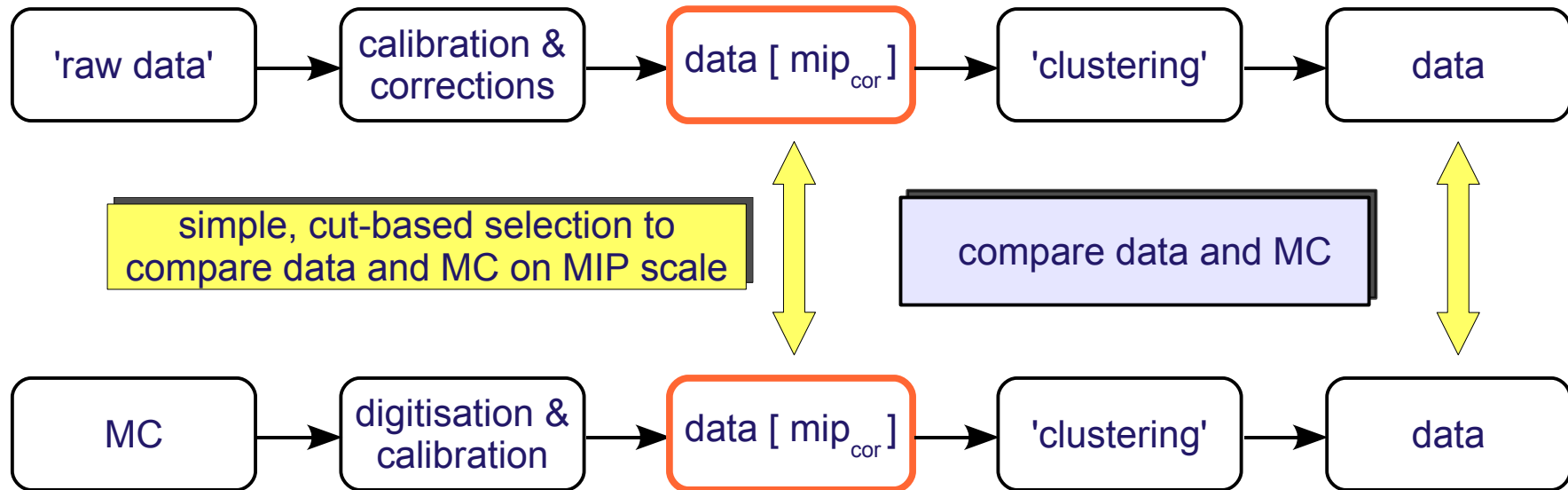
# Simulation and Reconstruction Chain



for 2006/2007:

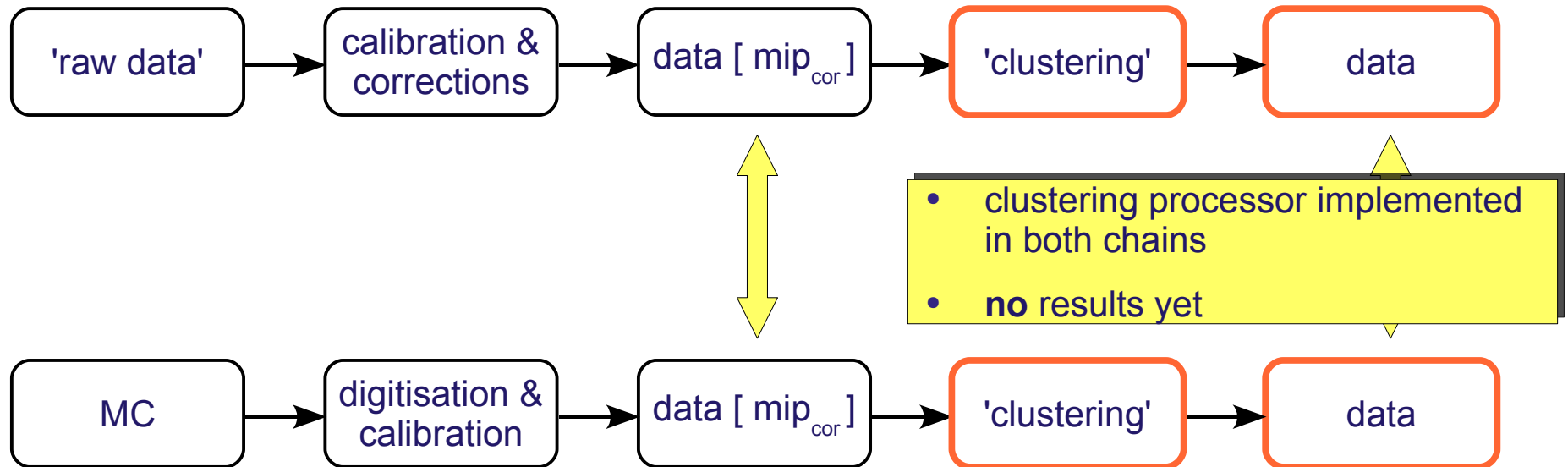
- implemented (Sebastian)
  - and in n (re)
  - S
  - run on r
  - simple c x
  - ('cluster x
  - mapping, **inverse** MIP, gain and inter calibration
  - **inverse** SiPM saturation correction
  - overlay **realistic** noise (real pedestal 'events')
  - light cross-talk correction
  - temperature dependency **missing**
  - **first version** of a digitisation, **revision** nearly finished
  - digitisation for ECAL & TCMT **not** implemented in this chain yet
- ed in HCAL

# Simulation and Reconstruction Chain



- implemented in 'semi-official' framework (**hcal-v00-01-20**, by Sebastian)
- **and** in **new official** HCAL framework ('=' official CALICE software)
  - same results
- run on raw data or centrally converted data (**v0405**)
- simple cut-based selection to find hadron showers fully contained in HCAL
- ( 'clustering' done by deep analysis processor )

# Simulation and Reconstruction Chain



- implemented in 'semi-official' framework (**hcal-v00-01-20**, by Sebastian)
- **and in new official** HCAL framework ('=' official CALICE software)
  - same results
- run on raw data or centrally converted data (**v0405**)
- simple cut-based selection to find hadron showers fully contained in HCAL
- ( 'clustering' done by deep analysis processor )

# Simple Analysis of Pion Data in 2006

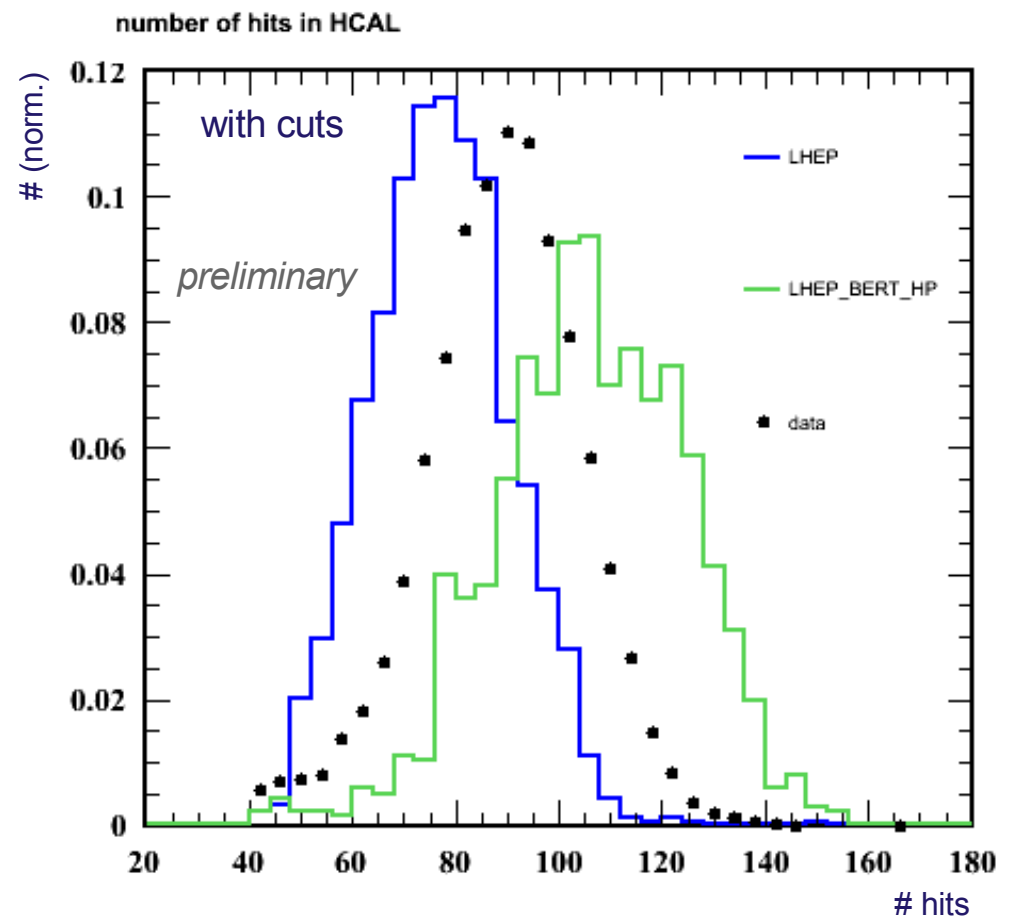
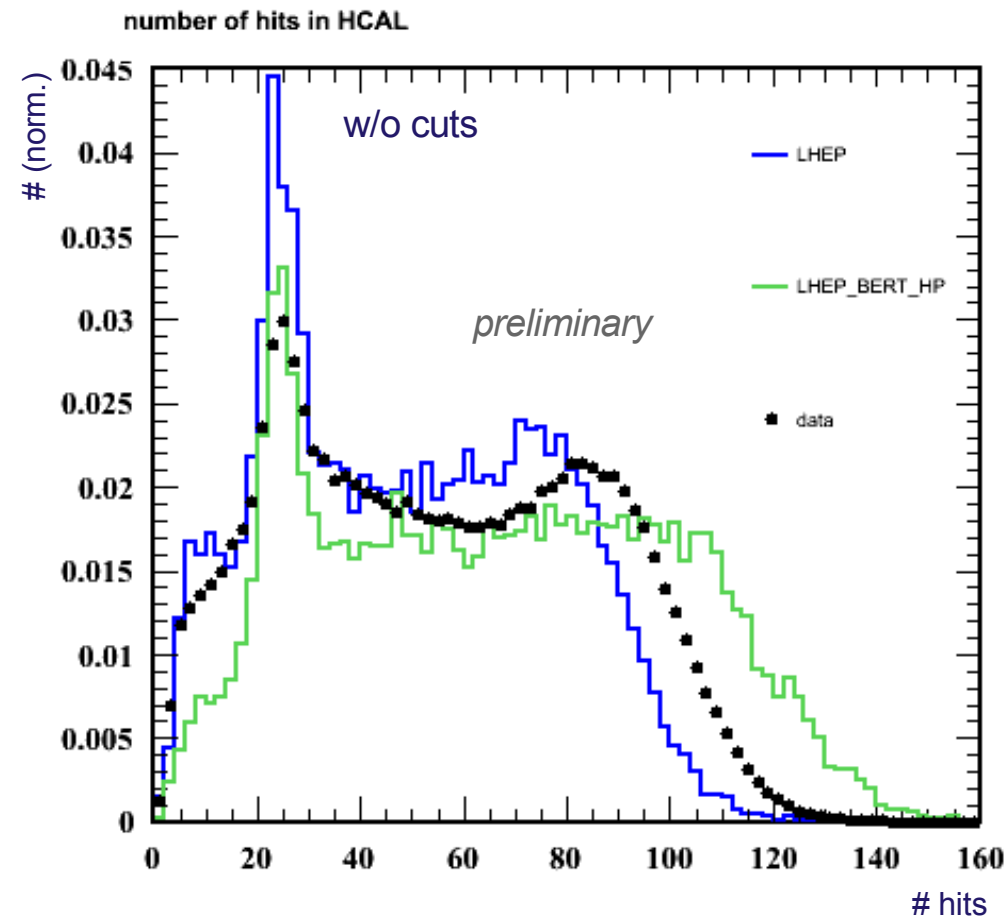
- cut based selection to find shower **fully contained** in HCAL
- take data of Oct. 2006 and of 2007
- following Marius studies, but with GEANT4 instead of GEANT3
- **simple** cut-based selection (muon data for comparison (run 300771)):
  - $\text{NHitsECAL} < 38$  (muon: approx. 32 hits in the ECAL)
  - $\text{EnergySumHitsECAL} < 55$  mips (muon: approx 48 mips)
  - $\text{NHitsHCAL} > 40$  (muon: approx. 24 hits)
  - $\text{NHitsTCMT} < 10$  (muon: approx. 22 hits)
  - $\text{EnergySumHitsTCMT} < 15$  mips (muon: approx. 28 mips)
- digitisation of ECAL and TCMT still **missing** in this study
  - impact on cuts on Monte Carlo (MIP scale)
- compare data and **several** hadron models in GEANT4
  - LHEP (Gheisha), QGSP, with and w/o Bertini and Binary Cascade, HP neutron data, LCPhys, ...

# Simple Analysis of Pion Data in 2006

- cut based selection to find shower **fully contained** in HCAL
  - take data of Oct. 2006 and of 2007
  - following Marius studies, but with GEANT4 instead of GEANT3
  - **simple** cut-based selection (muon data for comparison (run 300771)):
    - $\text{NHitsECAL} < 38$  (muon: approx. 32 hits in the ECAL)
    - $\text{EnergySumHitsECAL} < 55$  mips (muon: approx 48 mips)
    - $\text{NHitsHCAL} > 40$  (muon: approx. 24 hits)
    - $\text{NHitsTCMT} < 10$  (muon: approx. 22 hits)
    - $\text{EnergySumHitsTCMT} < 15$  mips (muon: approx. 28 mips)
  - digitisation of ECAL and TCMT still **missing** in this study
    - impact on cuts on Monte Carlo (MIP scale)
  - compare data and **several** hadron models in GEANT4
    - LHEP (Gheisha), QGSP, with and w/o Bertini and Binary Cascade,
- all following plots done for run 300660, pions, -10 GeV, October 2006**

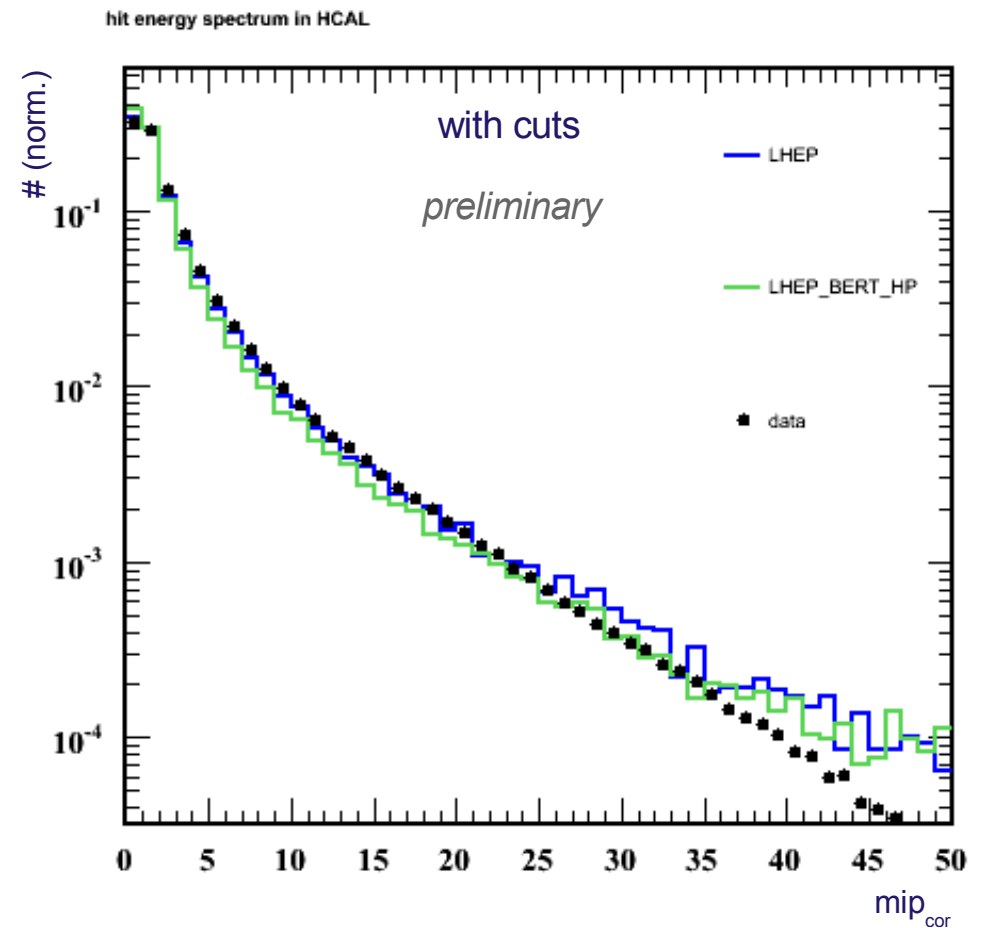
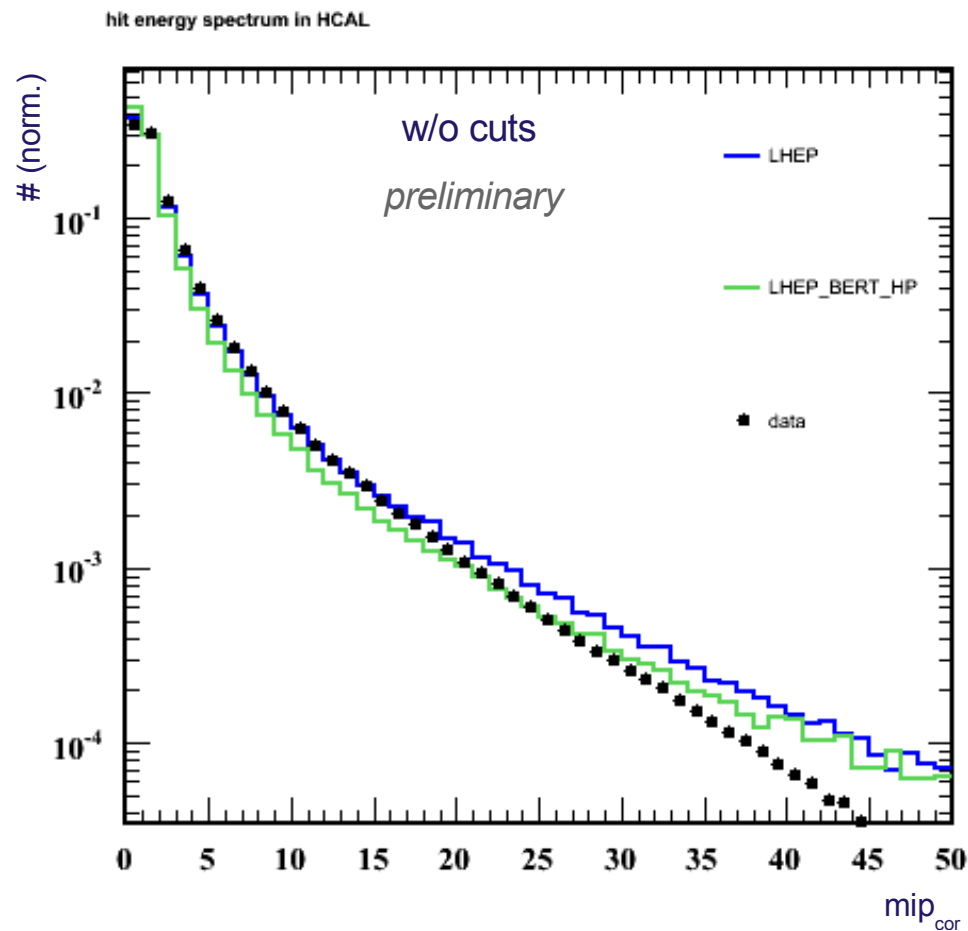
# First Look into Data/MC Comparison

run 300660, pi, -10GeV: number of hits in HCAL, two LHEP models



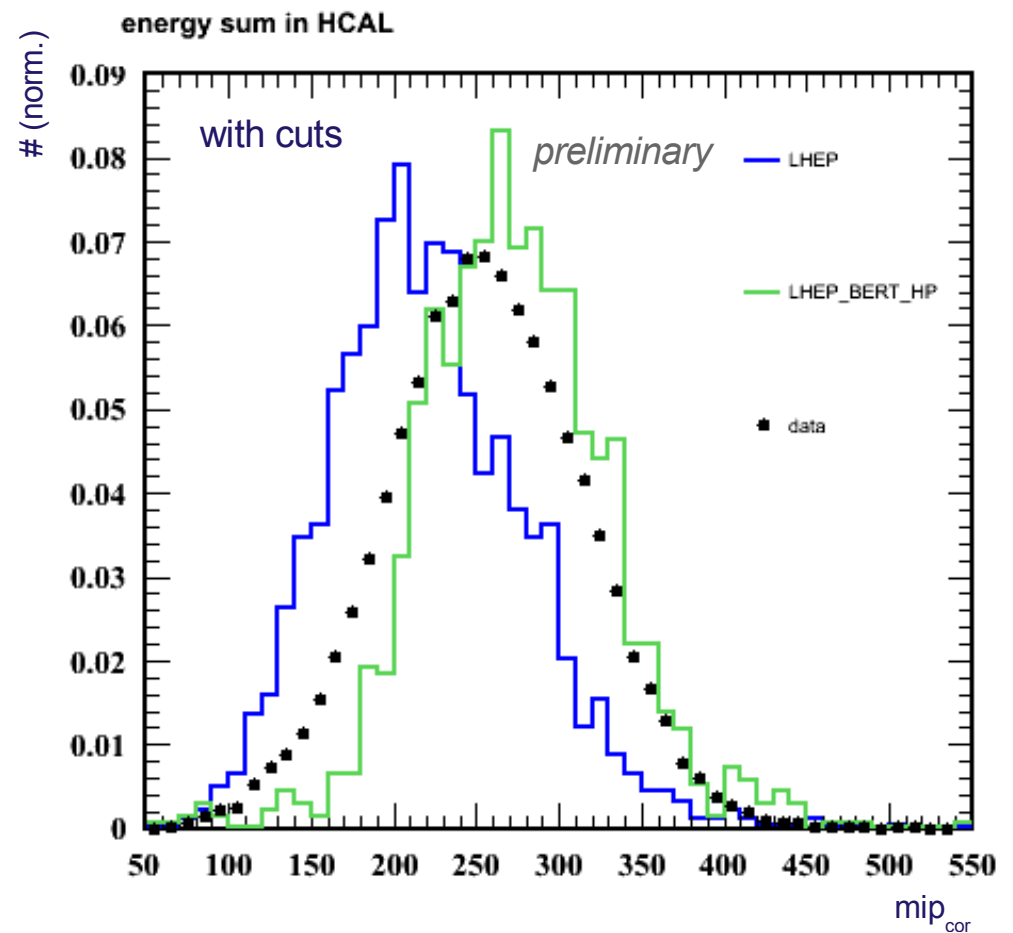
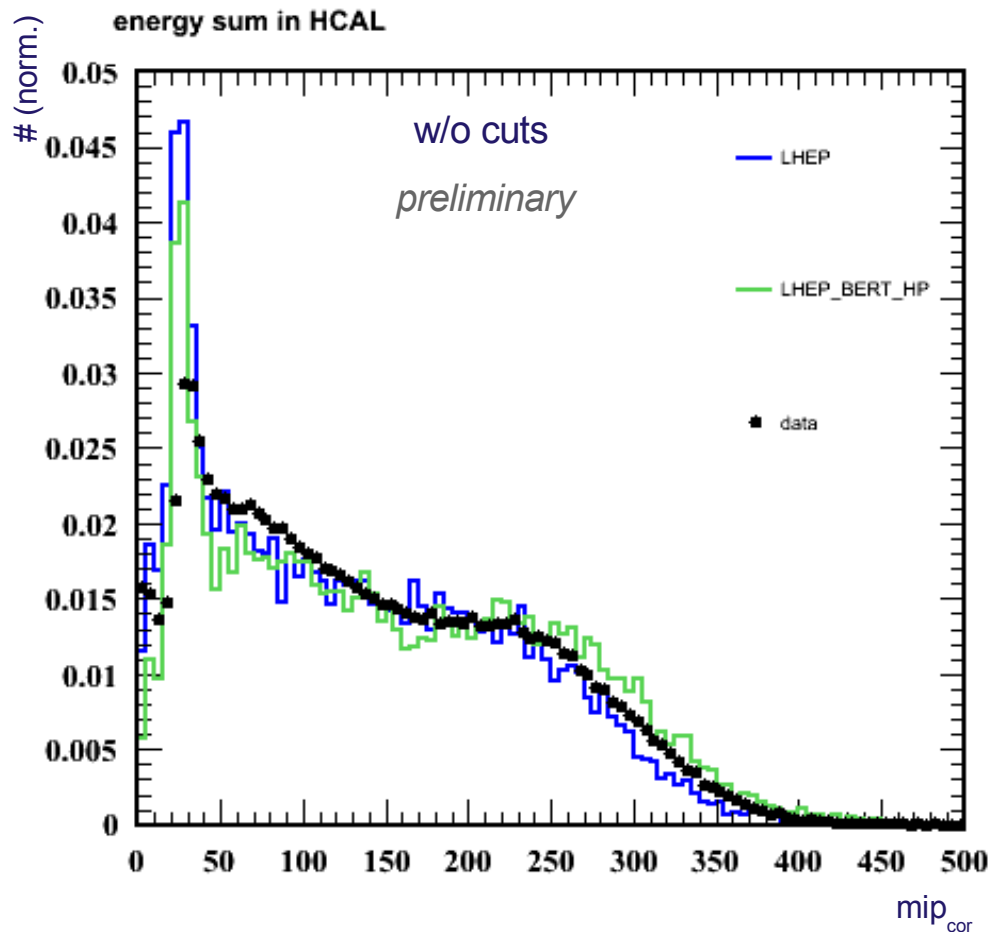
# First Look into Data/MC Comparison

run 300660, pi, -10GeV: hit energy spectrum in HCAL, two LHEP models



# First Look into Data/MC Comparison

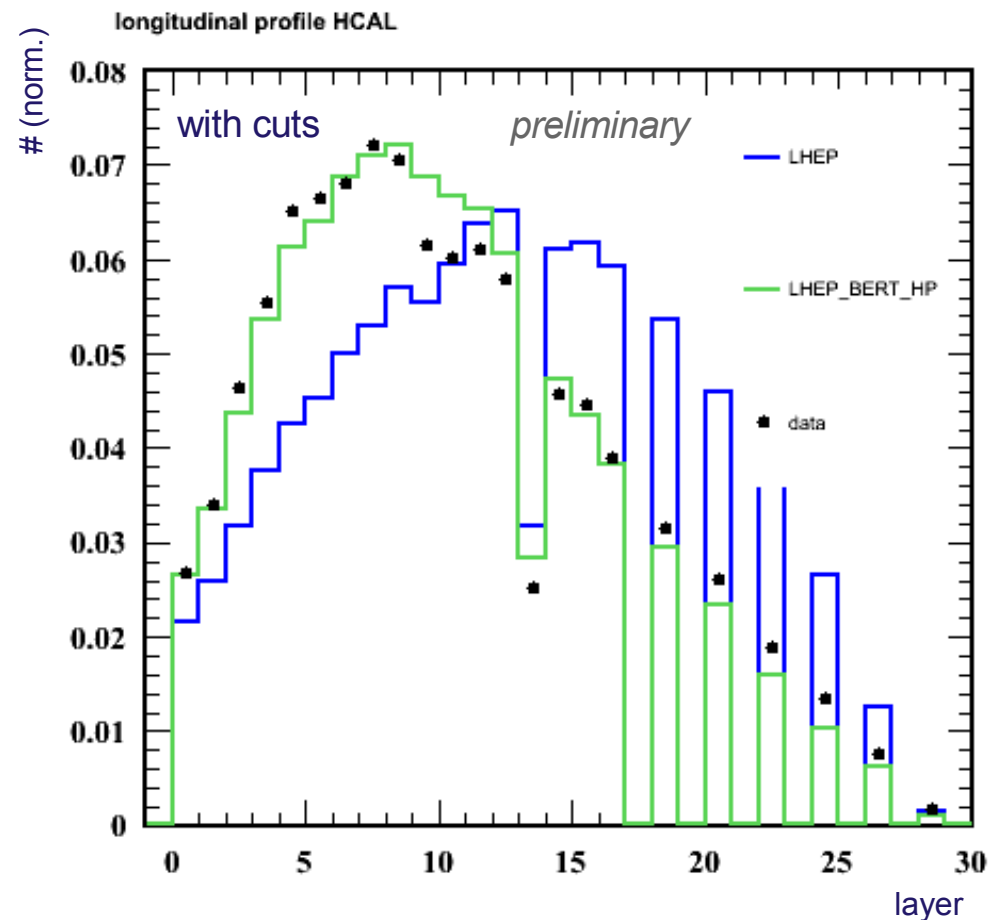
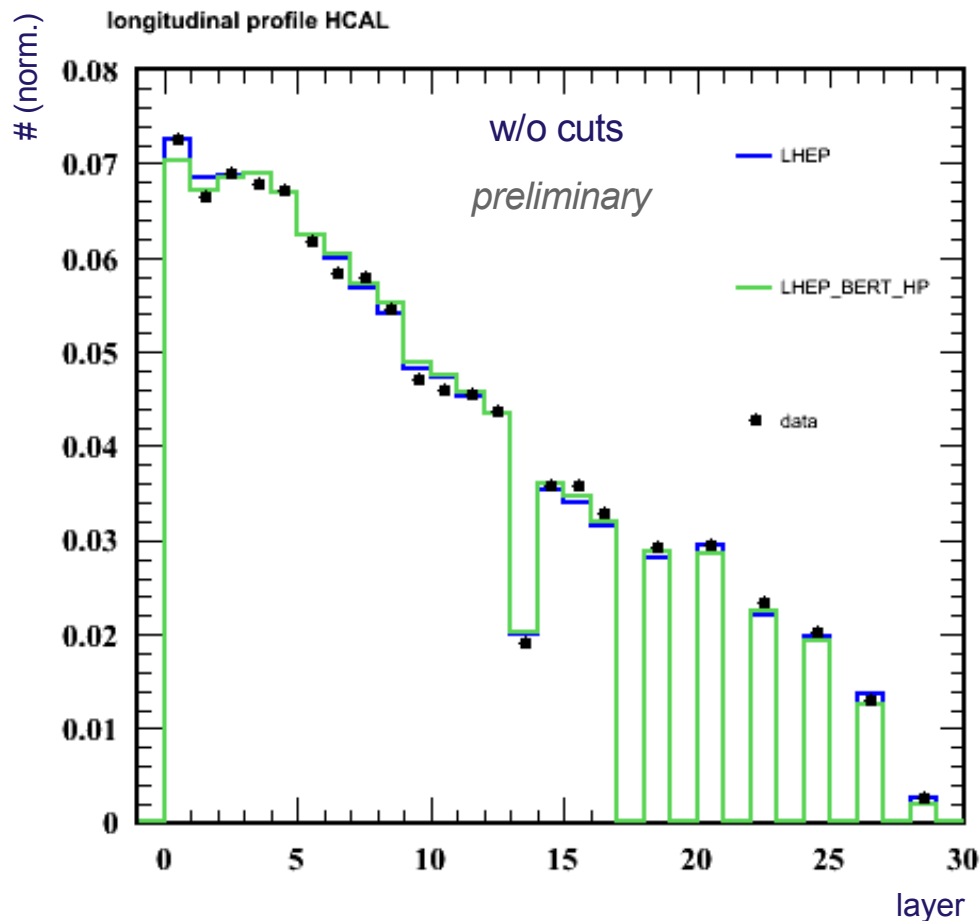
run 300660, pi, -10GeV: energy sum in HCAL, two LHEP models





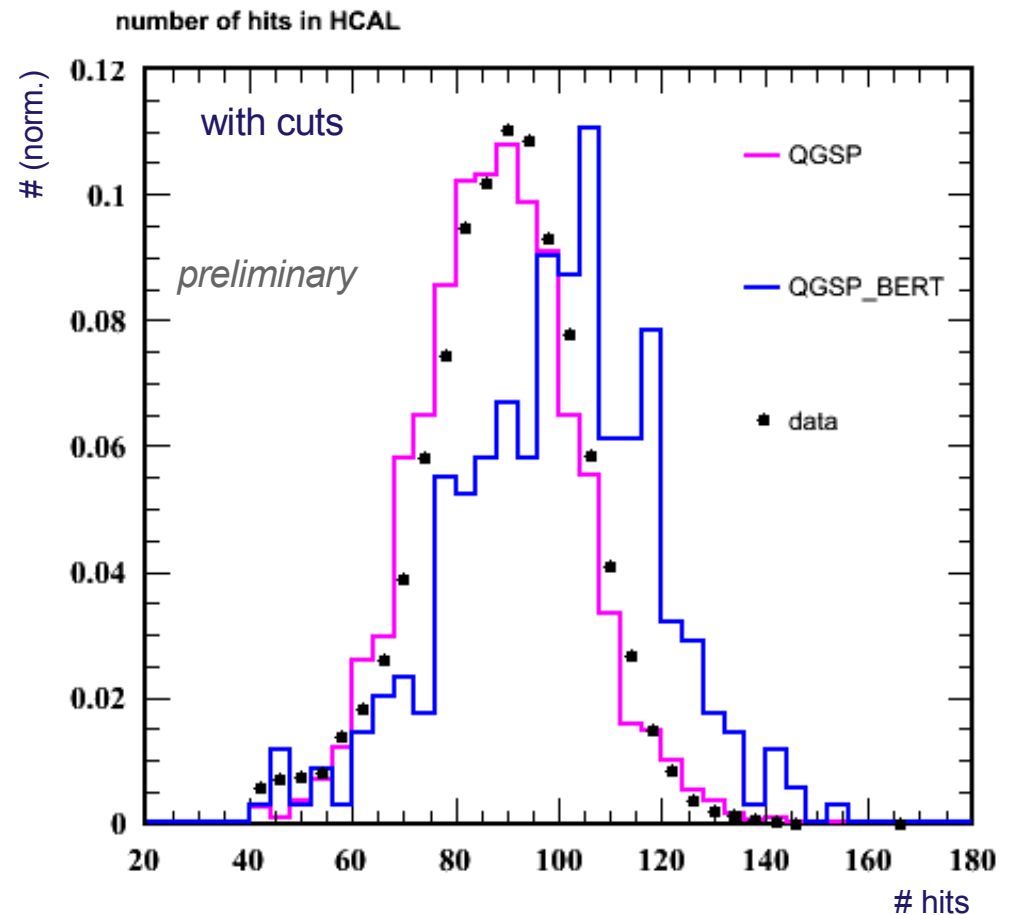
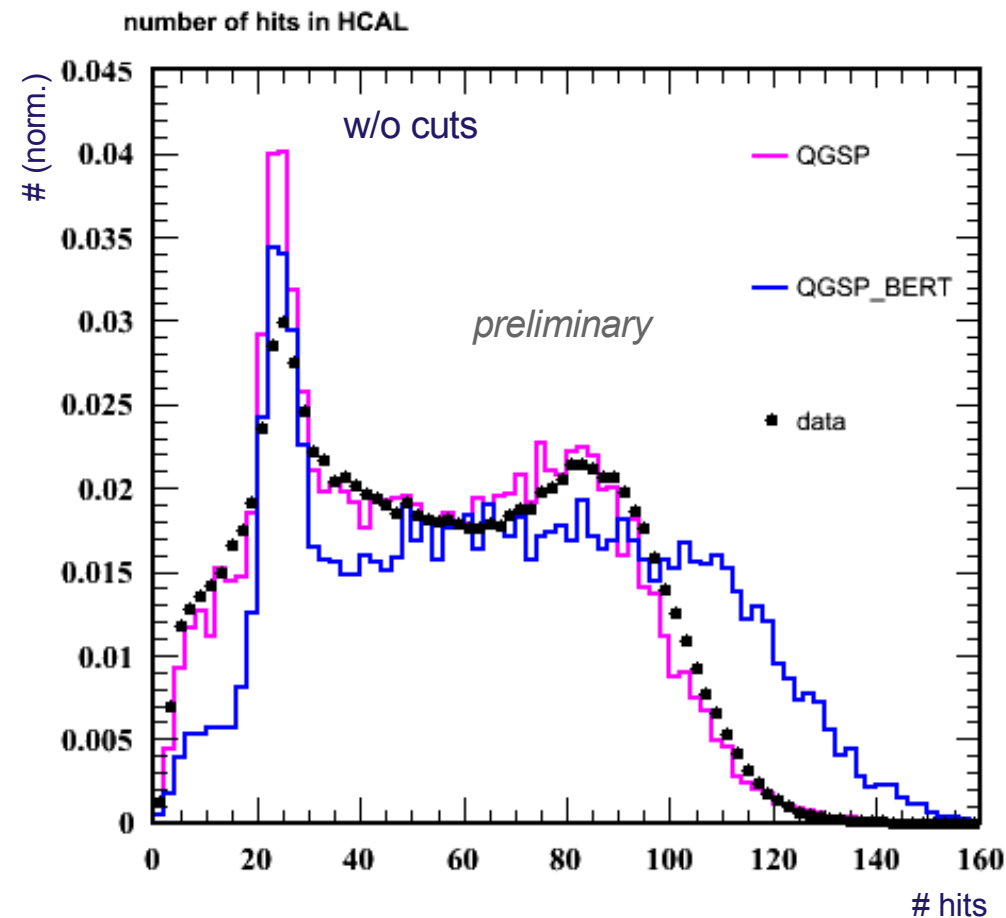
# First Look into Data/MC Comparison

run 300660, pi, -10GeV: longitudinal profile in HCAL, two LHEP models



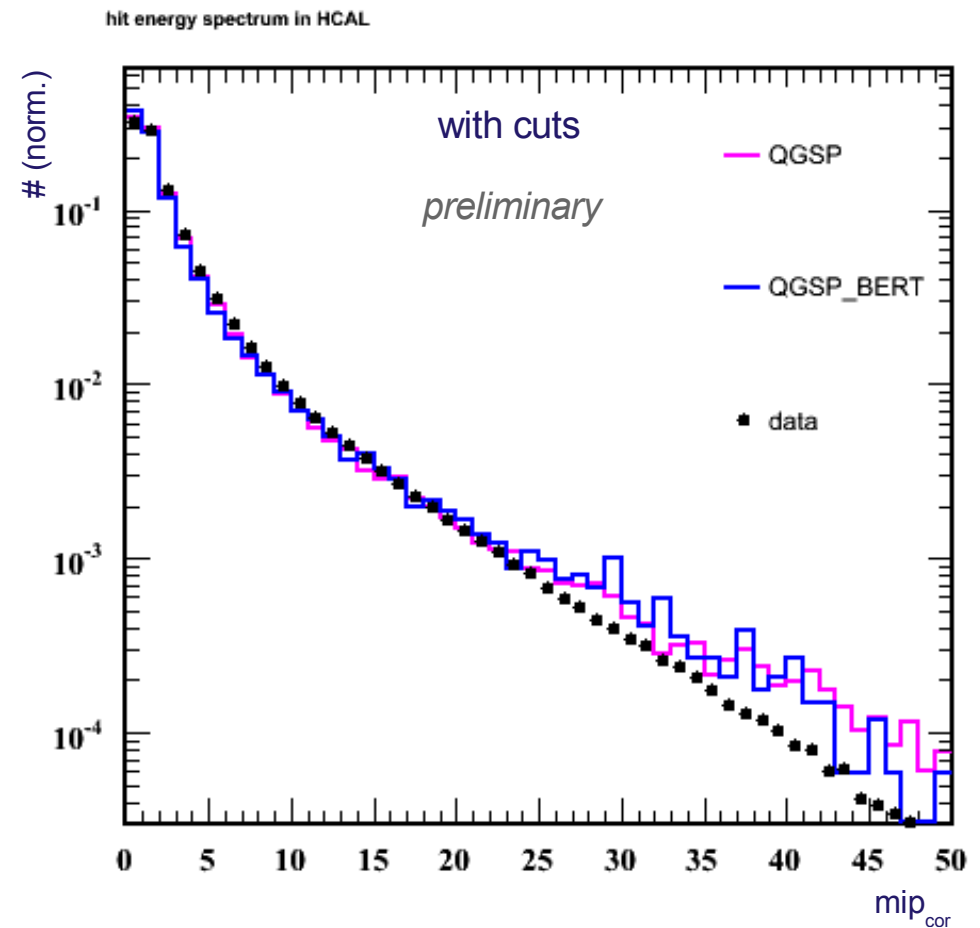
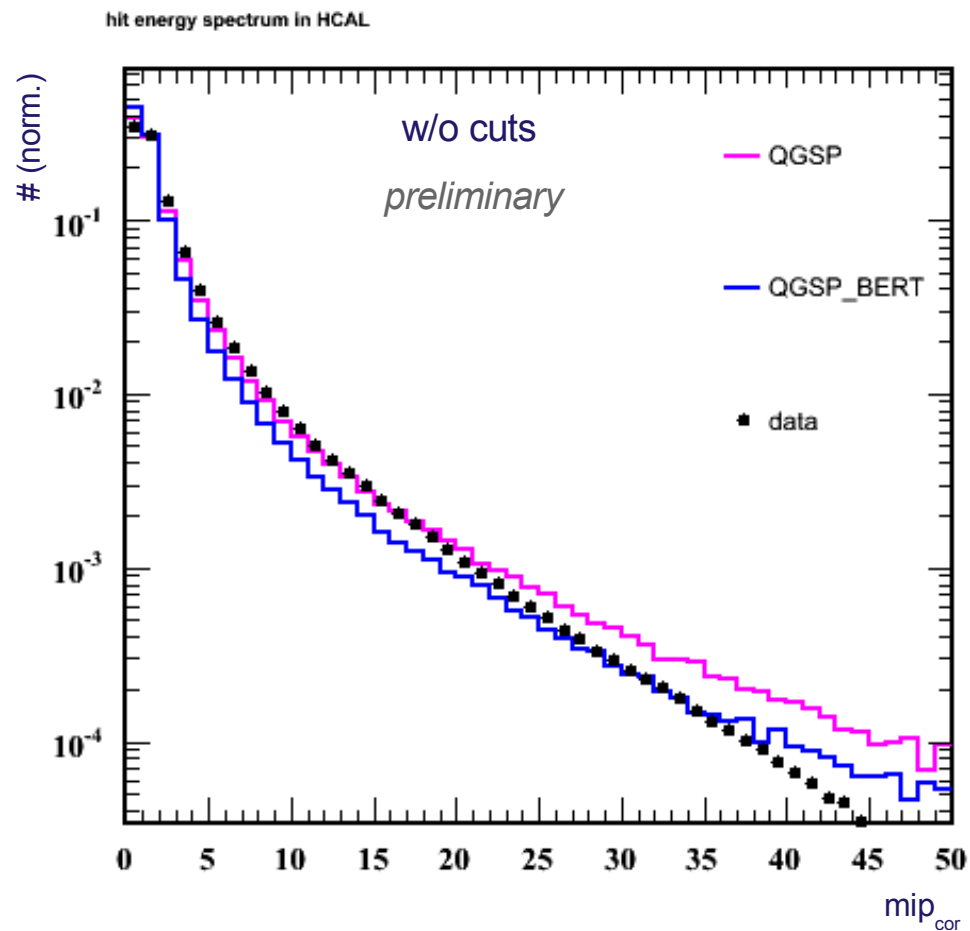
# First Look into Data/MC Comparison

run 300660, pi, -10GeV: number of hits in HCAL, two QGSP models



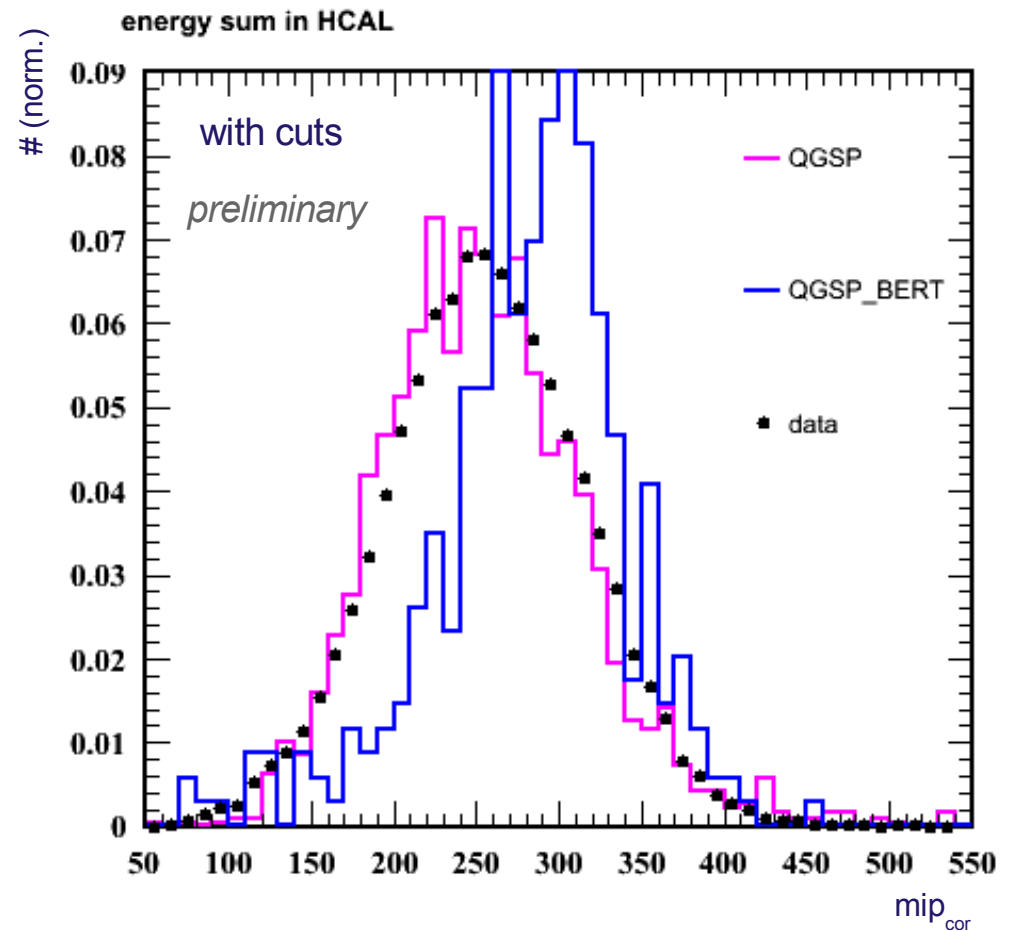
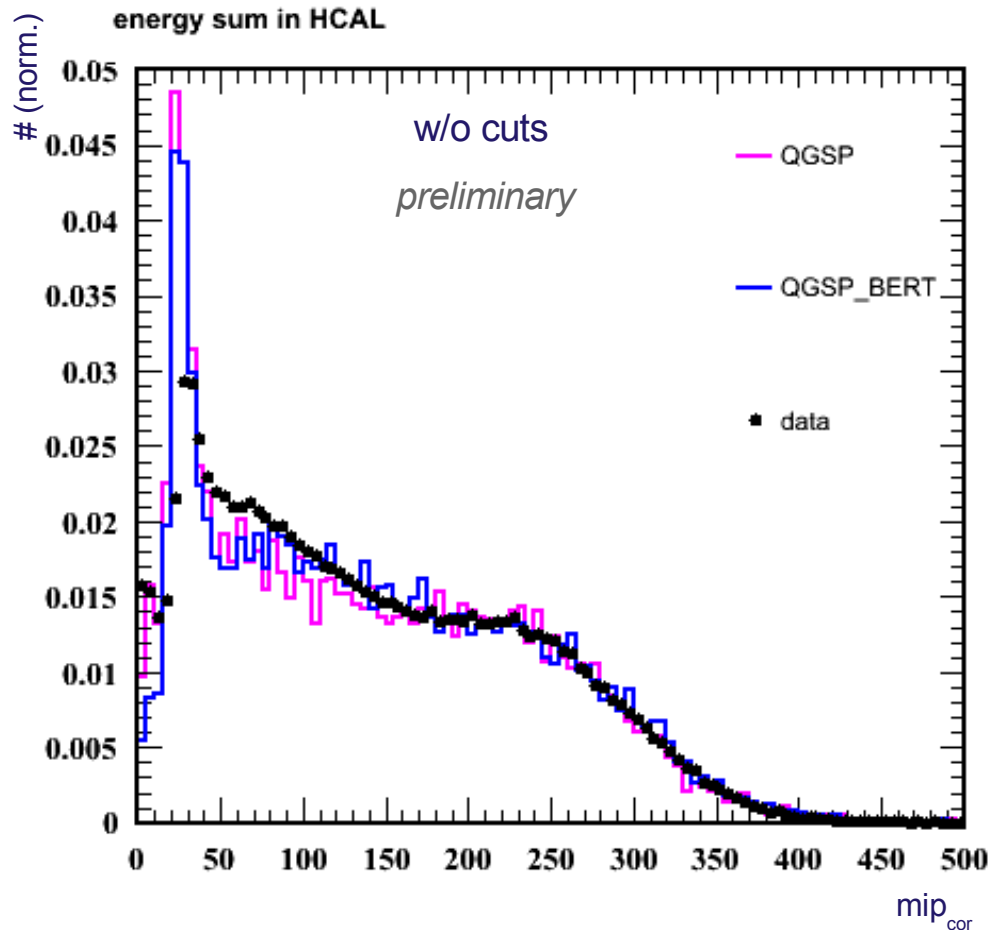
# First Look into Data/MC Comparison

run 300660, pi, -10GeV: hit energy spectrum in HCAL, two QGSP models



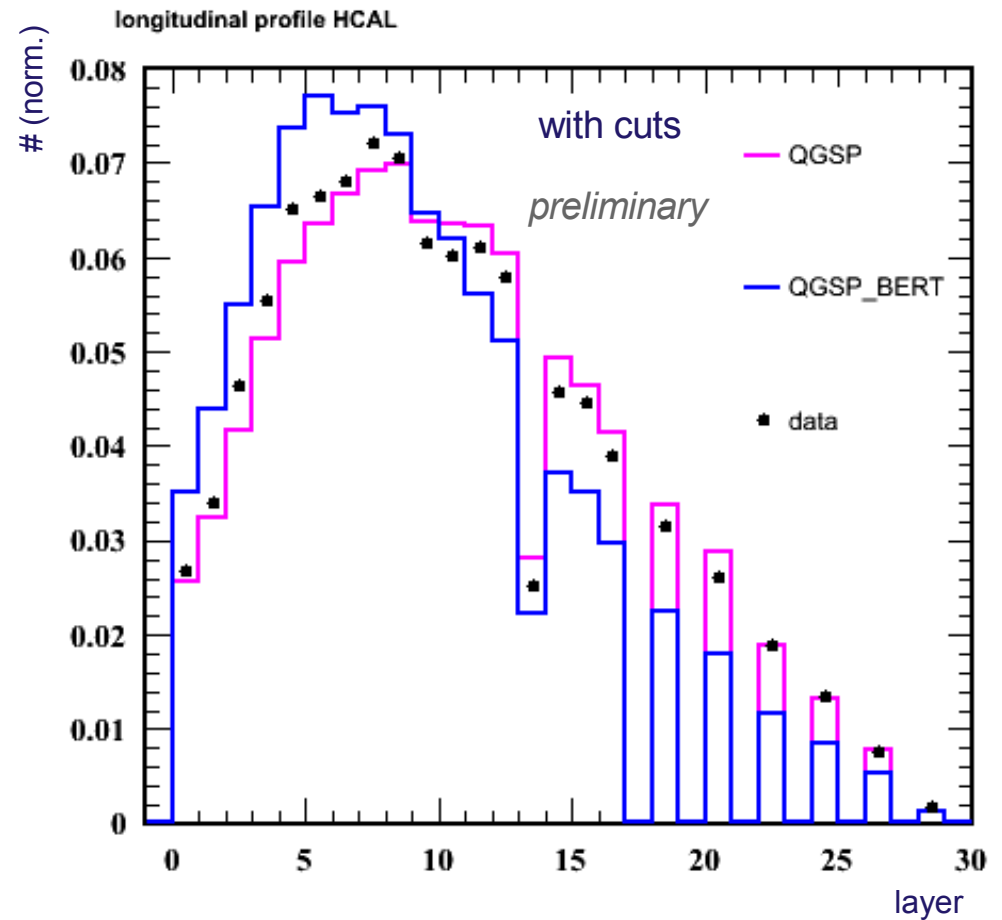
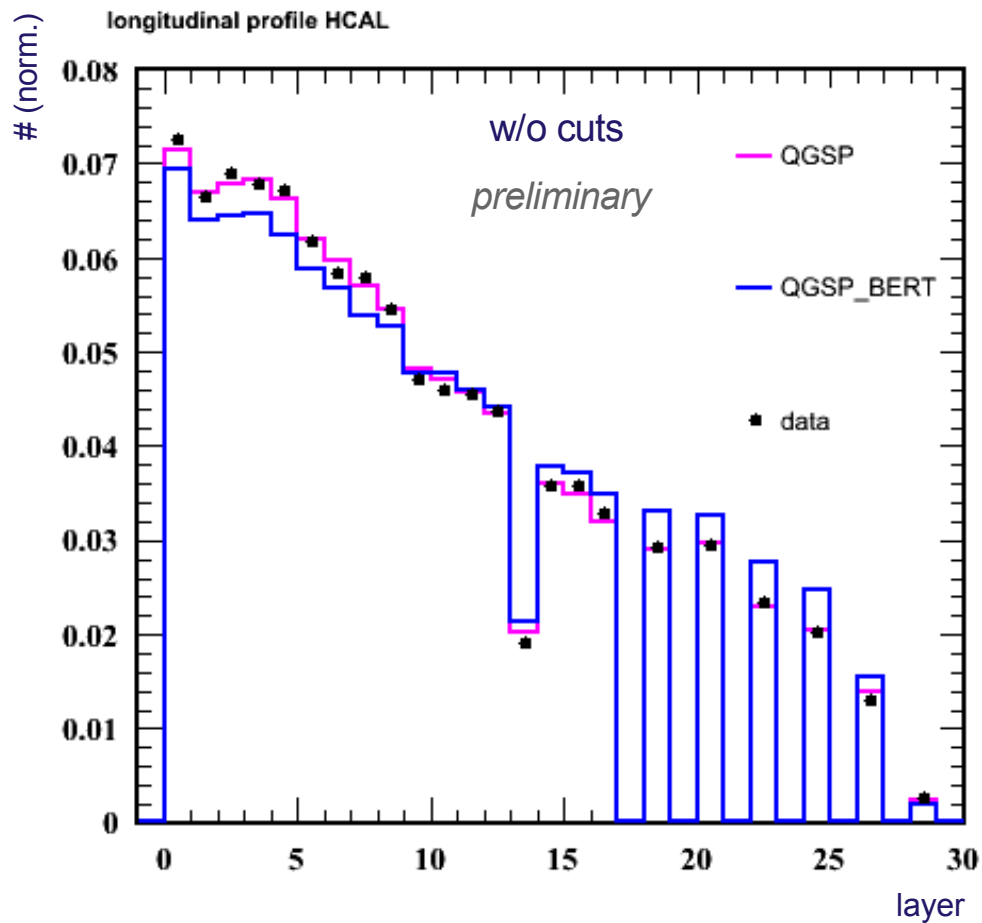
# First Look into Data/MC Comparison

run 300660, pi, -10GeV: energy sum in HCAL, two QGSP models



# First Look into Data/MC Comparison

run 300660, pi, -10GeV: longitudinal profile in HCAL, two QGSP models



# First Look into Data/MC Comparison

**too early** to draw physics conclusions from this study

- digitisation of ECAL and TCMT still **missing**
- data **and** Monte Carlo/digitisation chain for HCAL have been reviewed
  - improvements are **not** implemented yet
- ➔ **both** impact on cuts on Monte Carlo data (MIP scale)
- selection results in **high** purity and **low** efficiency
  - more statistics for MC needed (at the moment 20k events per physics model)
  - ➔ aim for full statistic for the runs of interest
- **systematic studies** of the cuts (ECAL and TCMT) are ongoing
- tracks from Drift Chambers will be implemented as well
  - particle impact point
  - beam profile → Monte Carlo

# Some Final Remarks

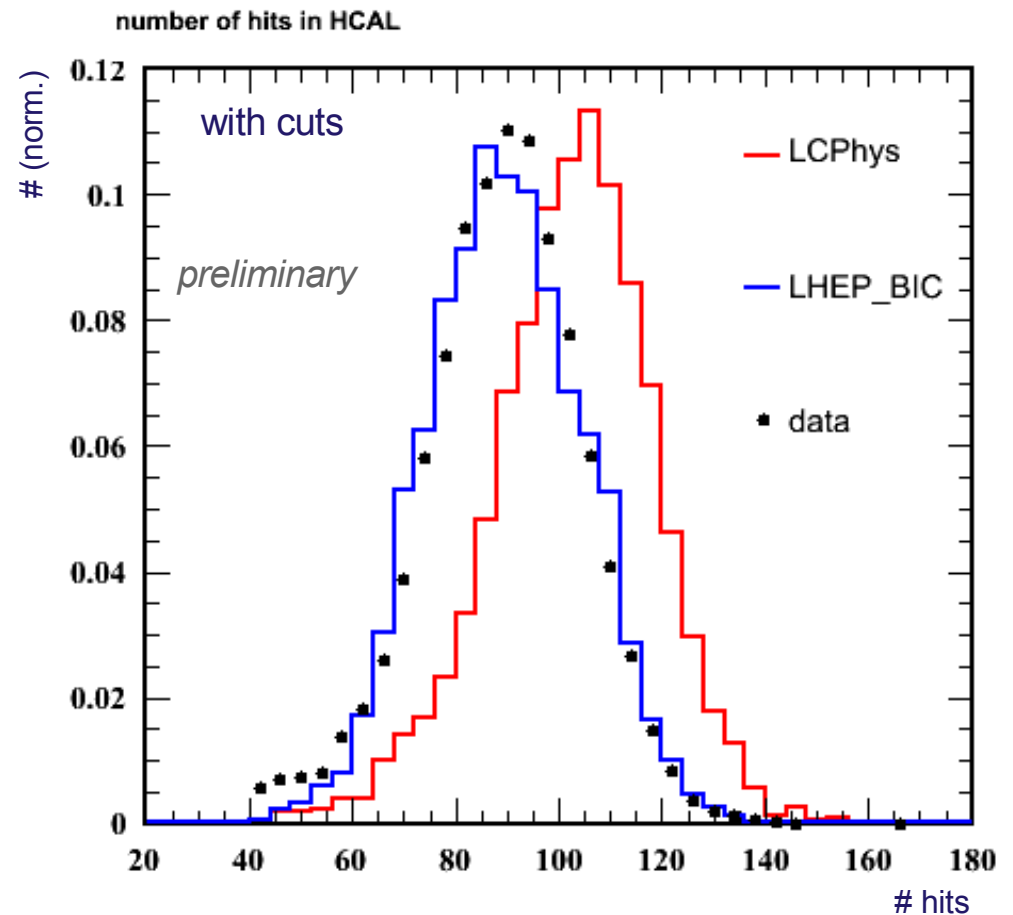
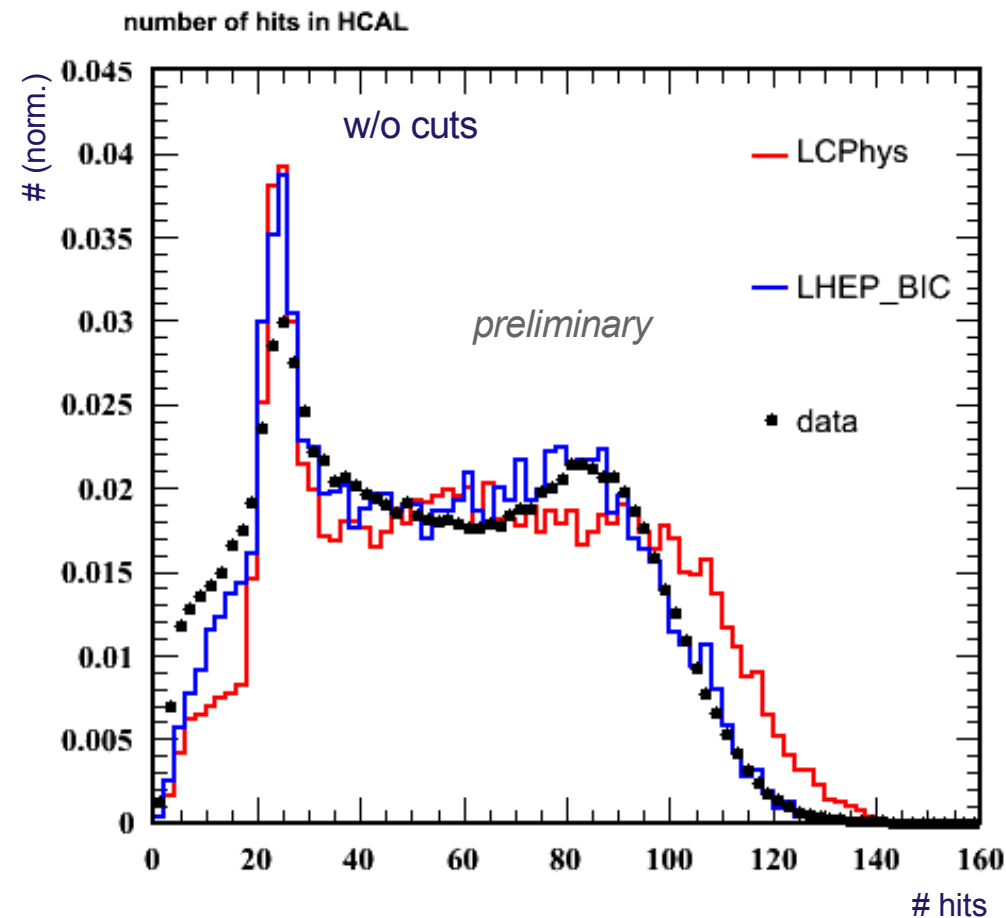
- just a **first** try of data and MC comparison using Mokka/GEANT4 **with** digitisation and several Physics Lists for the full setup at CERN
- **verification** of data **and** Monte Carlo/digitisation chain is nearly finished
- (HCAL) **group-wide** basis to use official CALICE software **is available**
  - data and MC chain
  - identical results
  - we **all** should use it

backup slides ...



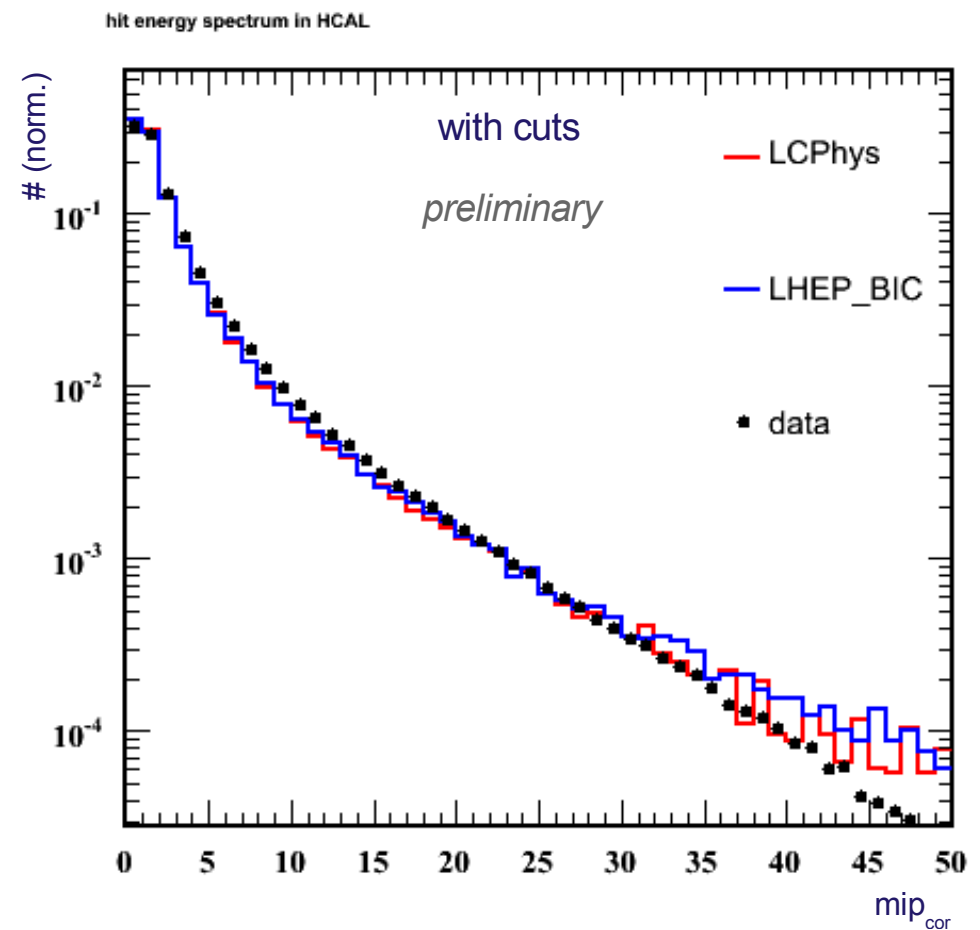
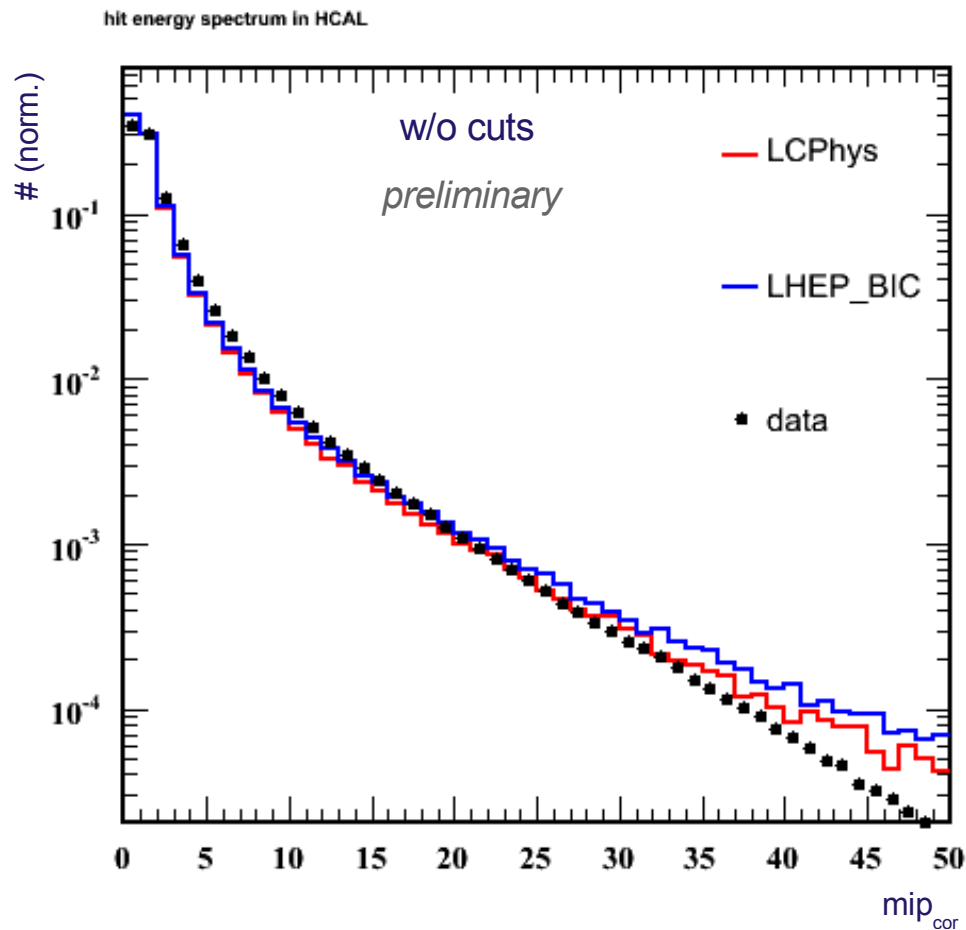
# First Look into Data/MC Comparison

run 300660, pi, -10GeV: number of hits in HCAL, LHEP\_BIC and LCPhys



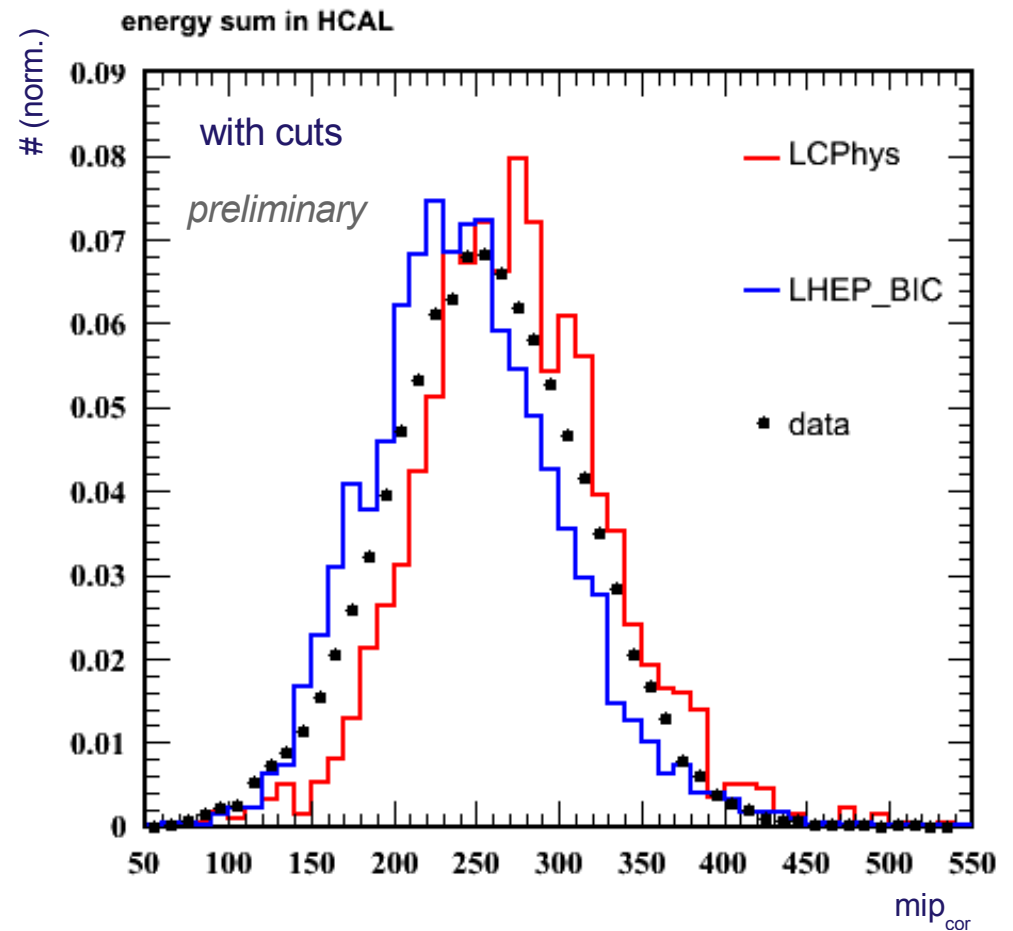
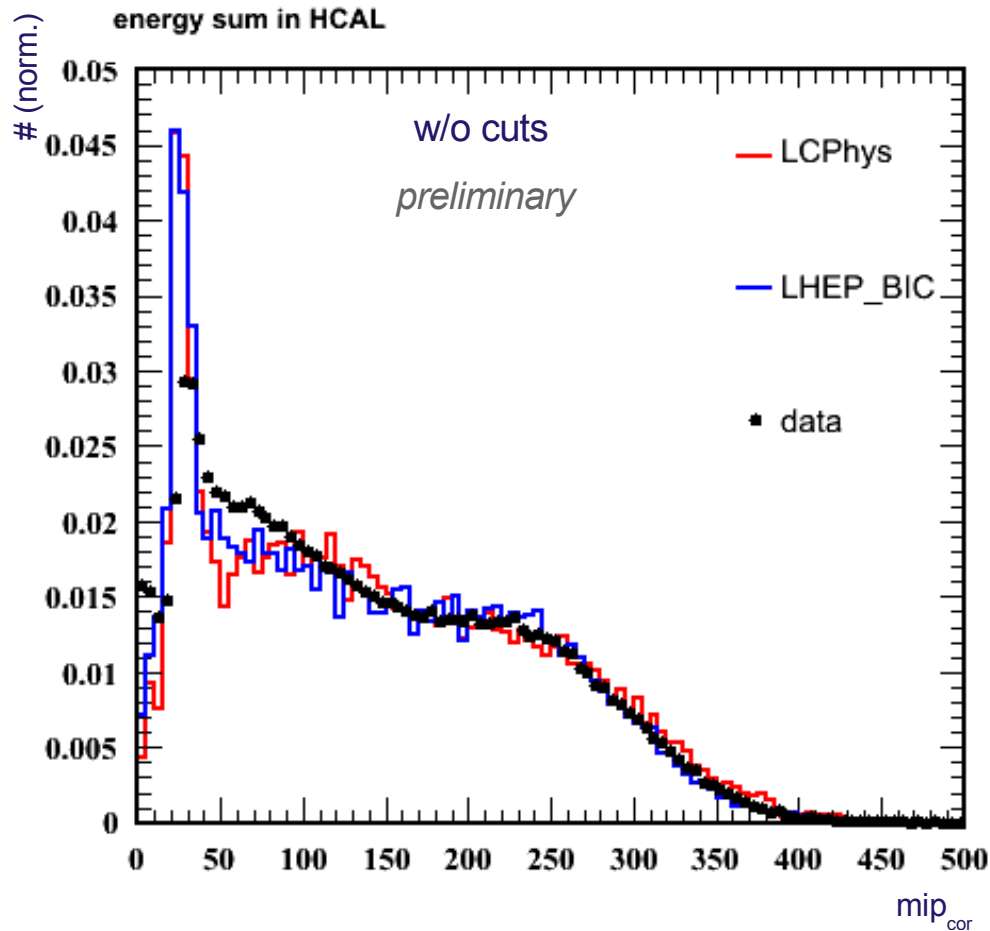
# First Look into Data/MC Comparison

run 300660, pi, -10GeV: hit energy spectrum in HCAL, LHEP\_BIC and LCPhys



# First Look into Data/MC Comparison

run 300660, pi, -10GeV: energy sum in HCAL, LHEP\_BIC and LCPhys



# First Look into Data/MC Comparison

run 300660, pi, -10GeV: longitudinal profile in HCAL, LHEP\_BIC and LCPhys

