Validation of the ATLAS Hadronic Calibration with LAr End-Cap Beam Tests data

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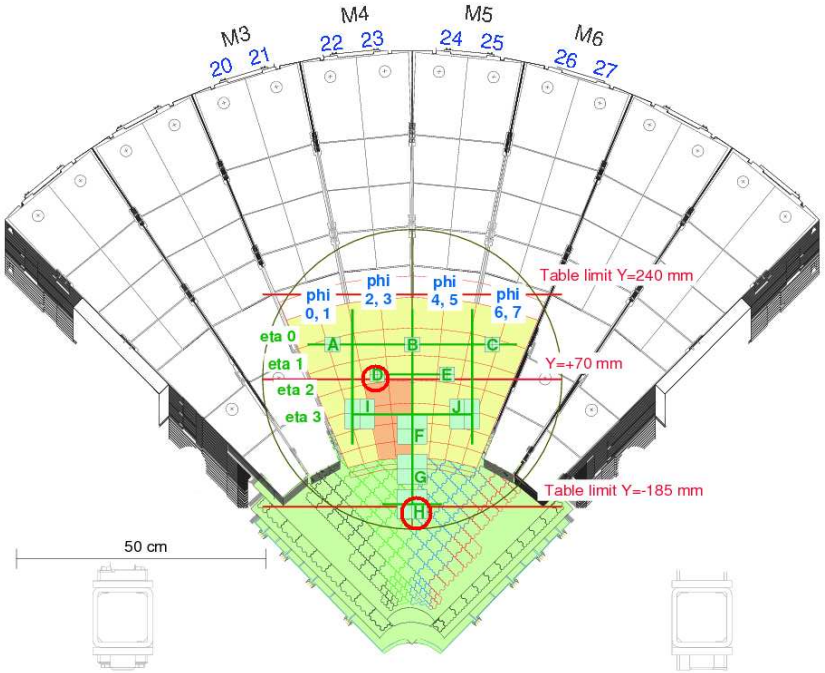
on behalf of the ATLAS LAr End-Cap Group:
Canada, China, France, Germany, Russia, Slovakia, Spain, U.S.A.

Introduction

- In this talk I will present the initial studies done to validate the MC simulation using the full ATLAS hadronic calibration procedure (see talk from G. Pospelov) with the EMEC-HEC-FCal beam tests data
- The data shown are πs obtained in the H6 2004 combined beam tests (see talk from P. Strizenec). They correspond to an ATLAS region $2.5 < |\eta| < 4.0$, and cover a energy range $40 \leq E \leq 200$GeV
- The MC simulation used in this analysis consists πs obtained using Geant 4 8.3 QGSP EMV
- To preliminary compare the MC with the beam tests data, the full ATLAS Geant 4 MC has been restricted so to approximately describe the beam tests area

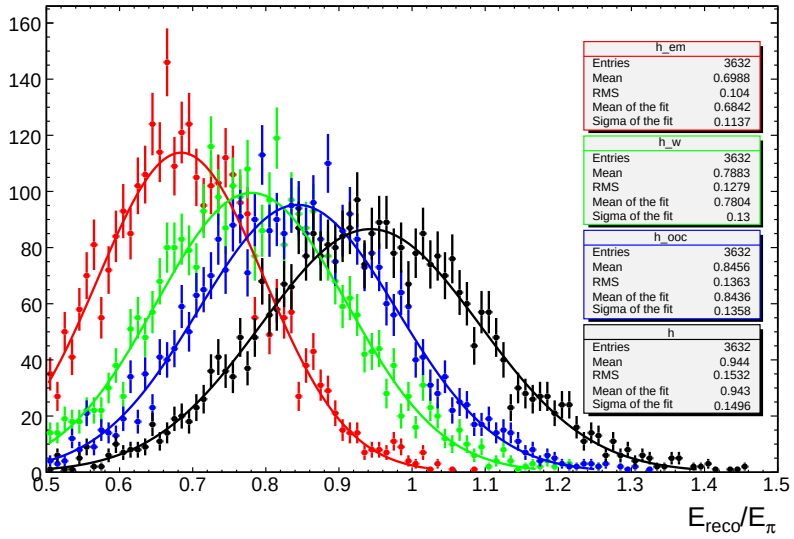


- Results are presented for data taken at point D (EMEC-HEC) and and at point H (FCal), see red circles in the right figure

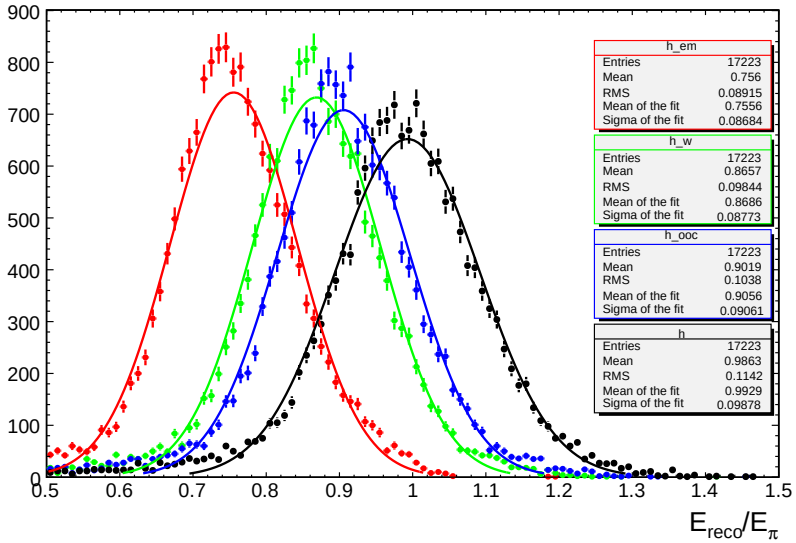
Hadronic Calib. Performance: πs at Point D

- Plots show the total reconstructed energy over the nominal beam energy for 60 GeVπ and 200 GeVπ at Point D for EM-scale (red); weighted (green); weighted + OOC (blue); weighted + OOC + DM (black)

- Data point D: 60 GeVπ
  - Mean improves in every step:
    after em $= 0.684$, after weight $= 0.780$,
    after ooc $= 0.844$, after dm $= 0.943$
  - Resolution remains about constant: after em $= 16.27\%$,
    after weight $= 16.41\%$,
    after ooc $= 15.7\%$, after dm $= 15.63\%$
  - Final deviation from $E_{reco}/E_{\pi} = 1$ is 5.7%



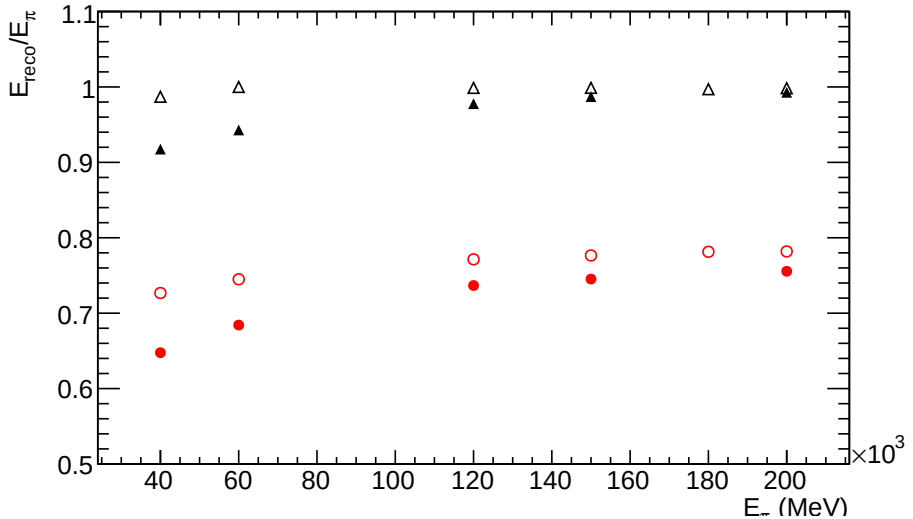
- Data point D: 200 GeVπ
  - Mean improves in every step
    after em $= 0.756$, after weight $= 0.869$,
    after ooc $= 0.906$, after dm $= 0.993$
  - Resolution improves in every step after em $= 12.61\%$,
    after weight $= 11.09\%$,
    after ooc $= 10.91\%$, after dm $= 10.39\%$
  - Final deviation from the $E_{reco}/E_{\pi} = 1$ is $\approx 0.7\%$



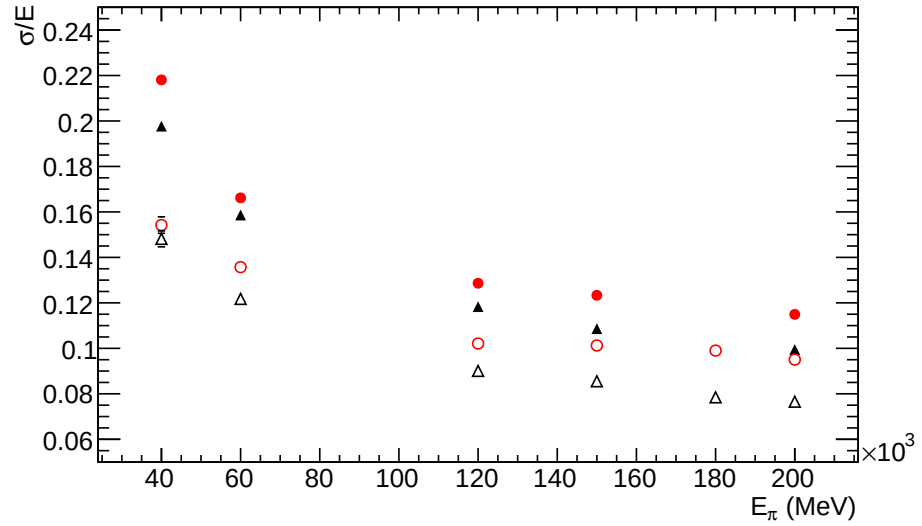
Linearity and Resolution at Point D

- Plots show the linearity and the resolution for $40\,\text{GeV} \leq \pi \leq 200\,\text{GeV}$, data and MC, at Point D. Full (open) red circles are data (MC) at EM-scale. Full (open) black triangles are data (MC) after weighting + OOC + DM corrections

- Linearity at point D:
  - There is a difference between data (π) and MC at 40 and 60 GeV. At higher energies the calibrated data are in fairly good agreement with the MC



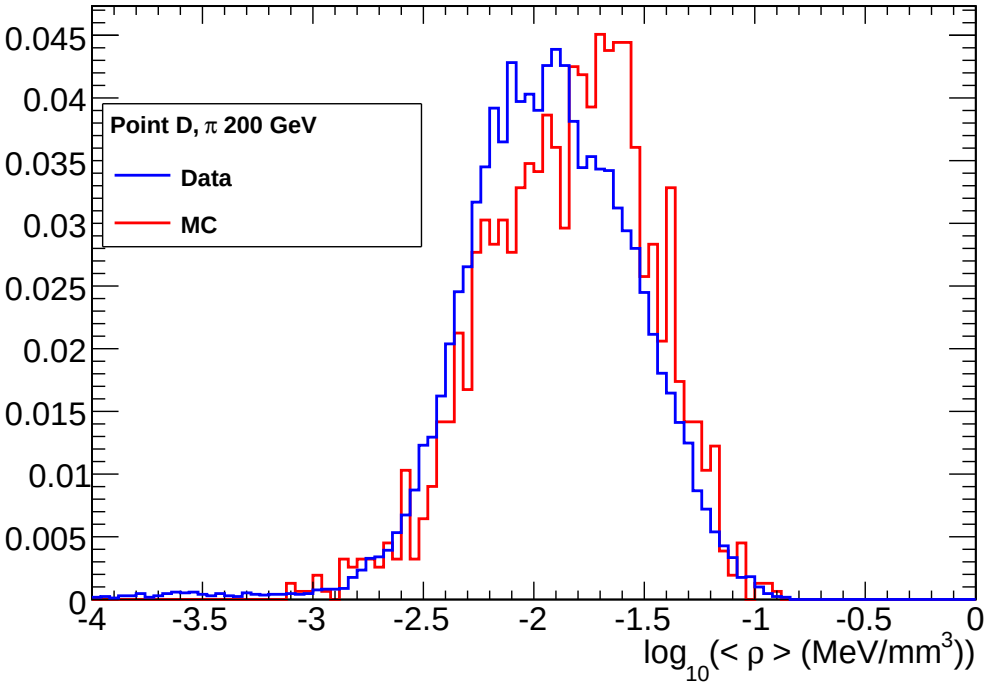
- Resolution at point D:
  - The MC gives an overall better resolution than the data, both at EM-scale and after calibration corrections

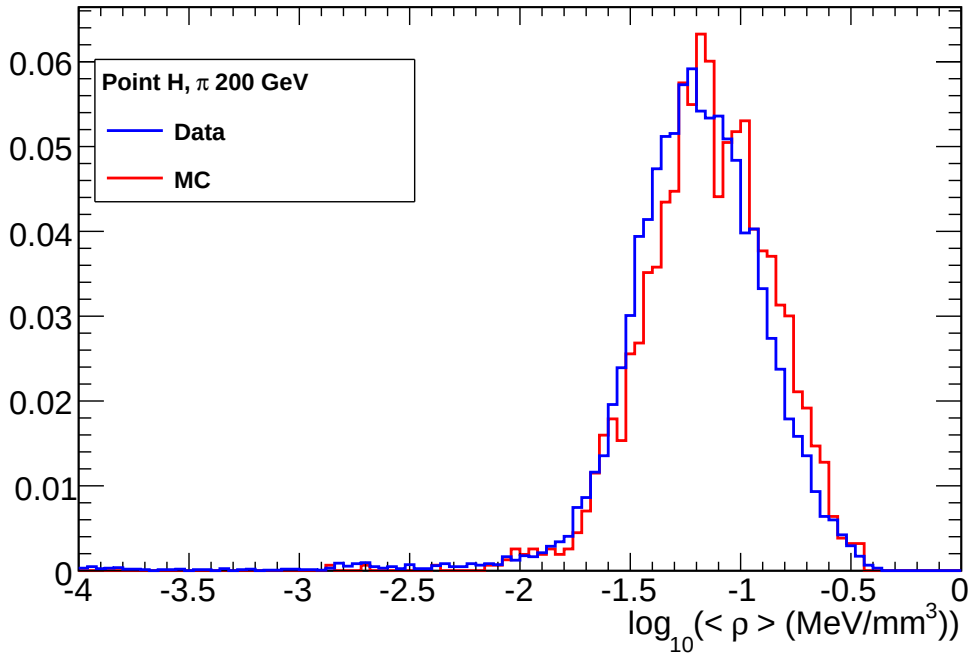


- We know the noise in the data is higher than in the MC. We also know that the lateral shower shape of Geant 4 QGSP doesn't describe data

Energy Density Moment at Points D and H

- Plots show the energy density cluster moment: $\log_{10}\left(\frac{\sum_{cells}\frac{E_{cell}}{V_{cell}} * E_{cell}}{\sum_{cells} E_{cell}}\right)$ for $200\,\mathrm{GeV}\pi$ at Point D (left plot) and H (right plot)

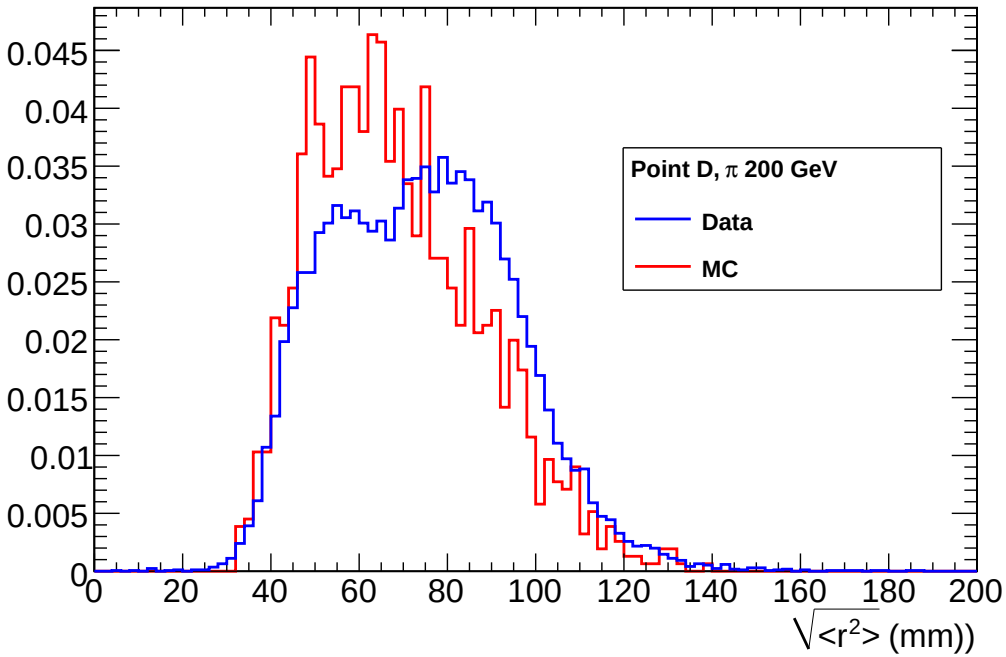


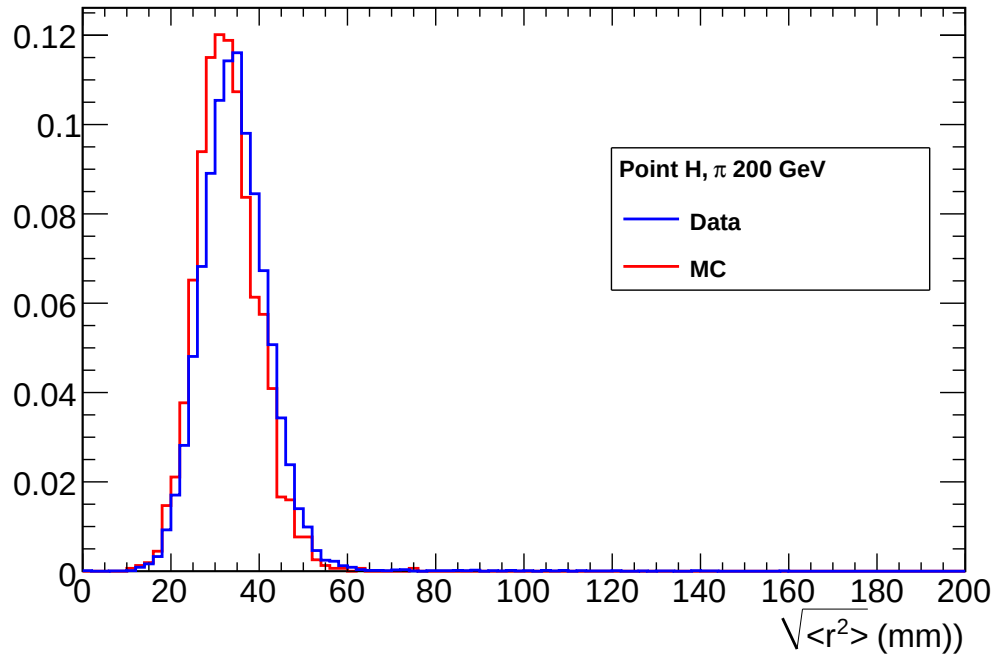


- At both points D and H the MC has slightly higher energy density than the data, we can say it reasonable describes the data
- The energy density moment is used in the calibration procedure for separation of hadronic from electromagnetic showers

Second Radial Moment at Points D and H

- Plots below show the sqrt of the second radial moment (lateral spread) for 200 GeVπ at points D (left plot) and H (right plot)





- Even though there is a shift to the right, at point H the MC describes the data. At point D the MC fails to describe the data
- The shower model used in MC physics list doesn't describe the data well

Outlook

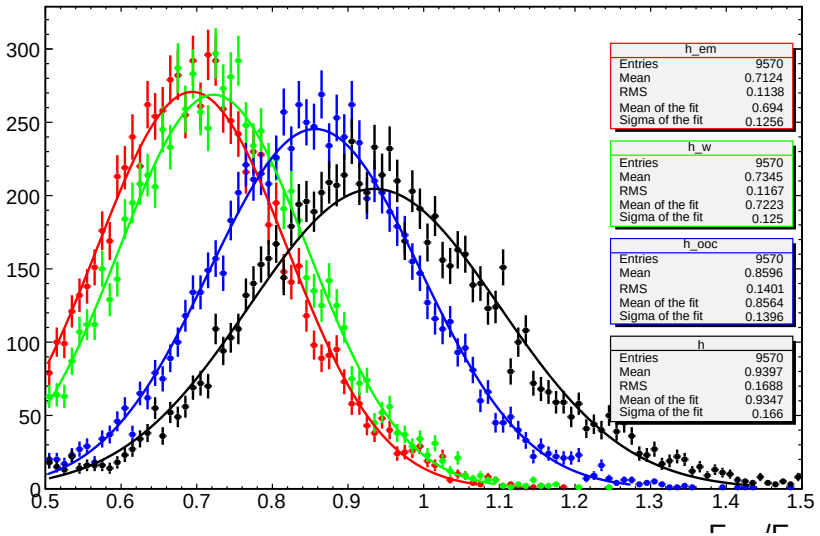
- We have started to validate the ATLAS Hadronic Calibration procedure using the LAr End-Cap Beam Tests data
- In the studies shown in this presentation we see that the MC Geant 4 8.3 QGSP EMV has problems to describe the data
- We need and we are working to have a proper beam tests MC simulation
- Once a test-beam MC simulation is available, further improvements for the hadronic calibration procedure (EM-scale, weighting, OOC and dead material correction) can be done
- These are the first validation results with LAr end-cap beam tests data obtained so far

BACKUP SLIDES

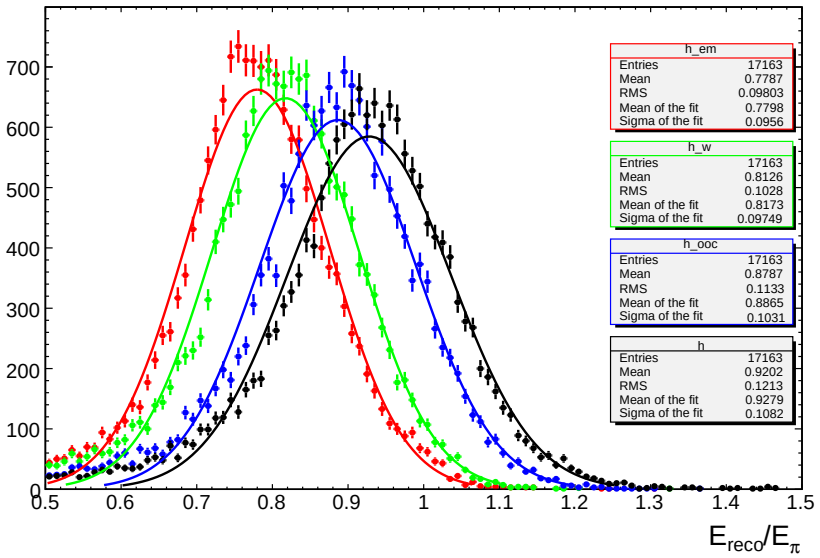
Hadronic Calib. Performance: πs at Point H

- Plots below show E_{reco}/E_{π} for π in Point H for EM-scale (red); weighted (green); weighted + OOC (blue); weighted + OOC + DM (black).

- Data point H: 60 GeVπ
  - Mean improves in every step, the resolution becomes worse
  - Final deviation from $E_{reco}/E_{\pi} = 1$ is 6.03%



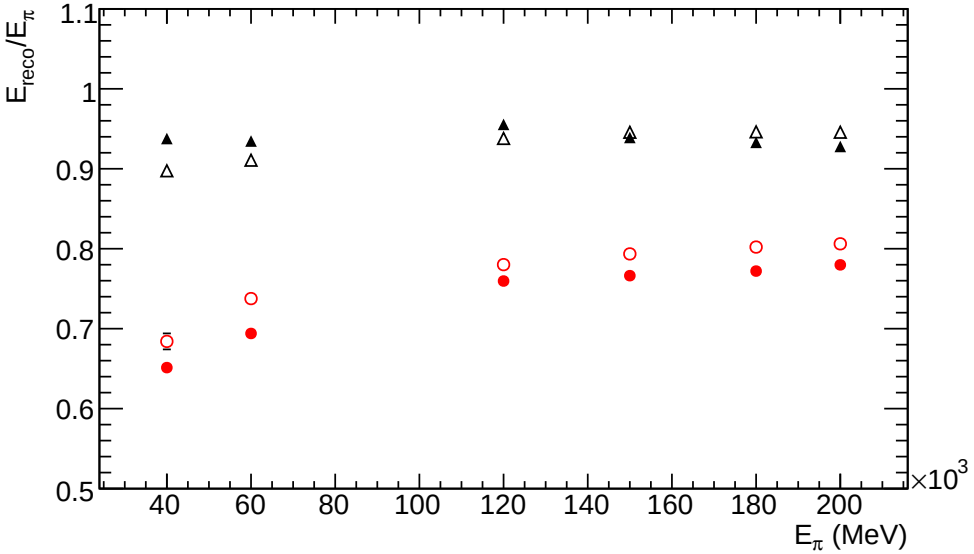
- Data point H: 200 GeVπ
  - Mean and resolution improve in every step of the corrections
  - Final deviation from the $E_{reco}/E_{\pi} = 1$ is $\approx$ 7.21%



Linearity and Resolution at Point H

- Plots show the linearity and the resolution for data and MC at Point H. Full (open) red circles are data (MC) at EM-scale. Full (open) black triangles are data (MC) after weighting + OOC + DM corrections

- Linearity at point H:
  - The calibrated data (for $E > 40\,GeV$) show a fairly good agreement with the MC



- Resolution at point H:
  - In the low energy region the data have a better resolution than the MC. In the higher energy bins the MC performs better. The dead material correction are problematic in this region for both data and MC.