Energy reconstruction using MVA in SDHCAL

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Outline

- The introduction of Input and BDT ,MLP structure
  - varList1,2
  - Huge varList
- Energy reconstruction
  - linearity
  - Resolution
- Scikit learn
- Conclusion

Input variables

- **Training events:**
  - 400K 1-120GeV Uniform distributed
- **Application events:**
  - each energy point 20K from 10 to 80GeV
- **Full Input variables:**

  nhit1,nhit2,nhit3

  nHough, Ncluster, nTrack

  nLayer,Density,Radius

  nShowerLayer

  begin

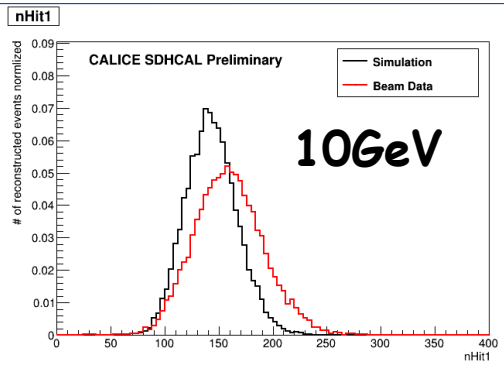
Huge varList: number of hit1,2,3 of every four layer of SDHCAL , So total 36 variables

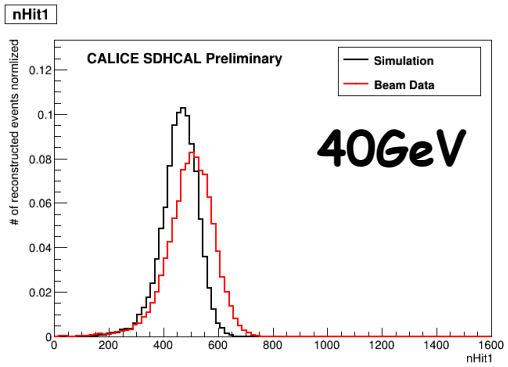
BDT structure:
NTree 2000, MaxDepth 5, learing rate 0.1

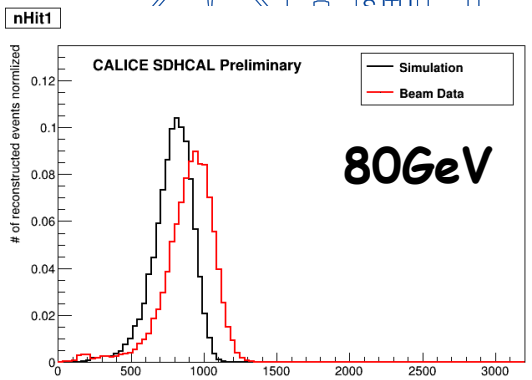
MLP structure:
varList1,2: 3 hidden layer with 8,4,2 neurons for corresponding hidden layer
Huge VarList: 5 hidden layer with 6,12,24,12,6 neurons for corresponding hidden layer

Input Variables

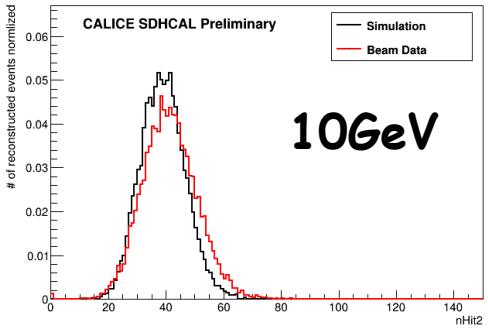
nHit1

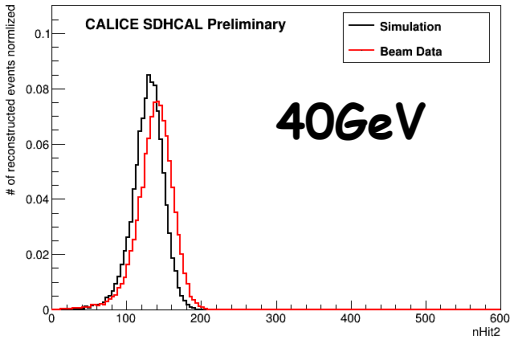


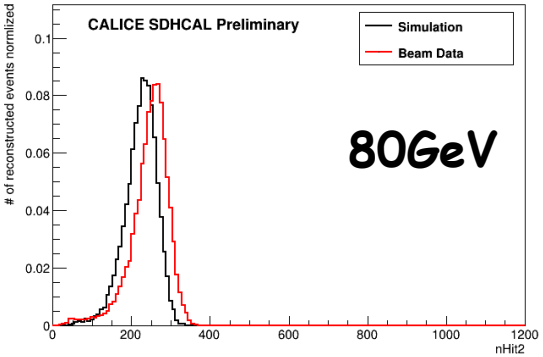




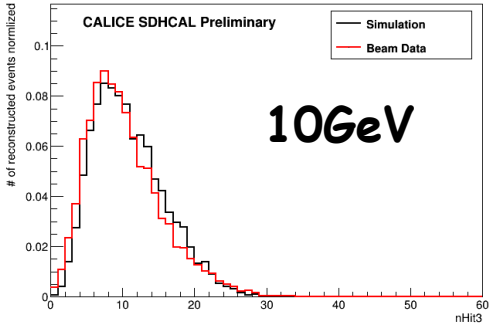
nHit2

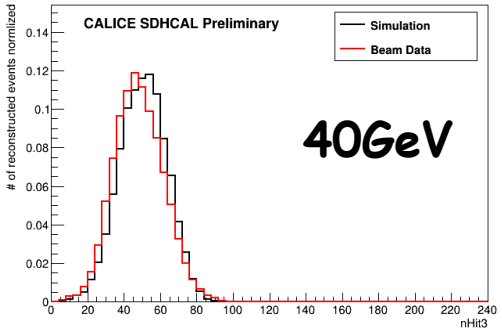


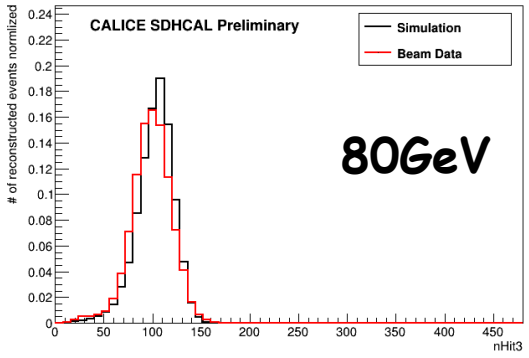




nHit3

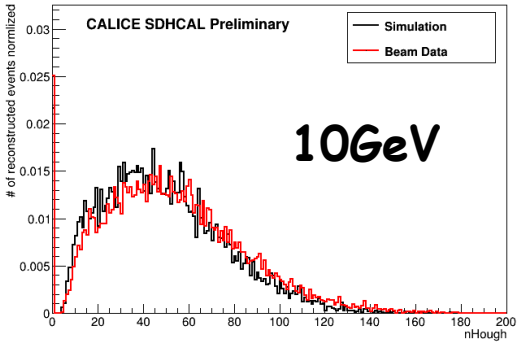


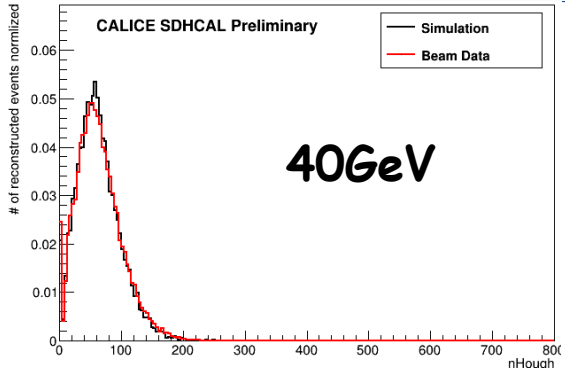


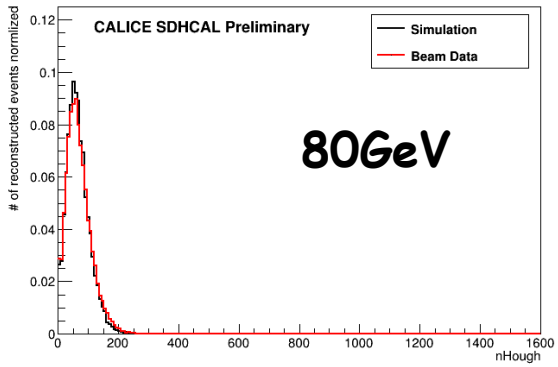


Input Variables

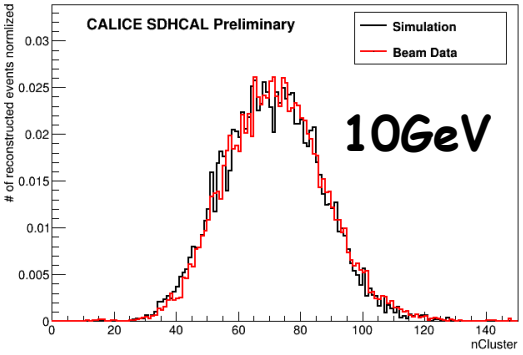
nHough

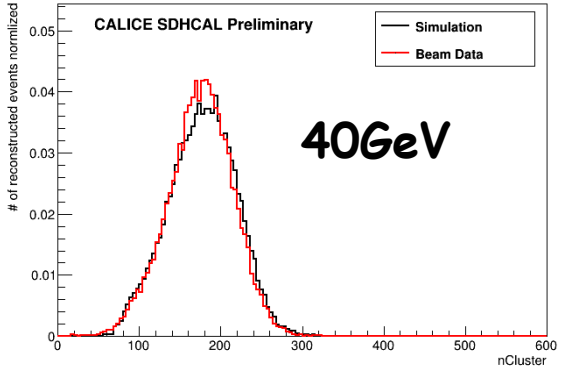


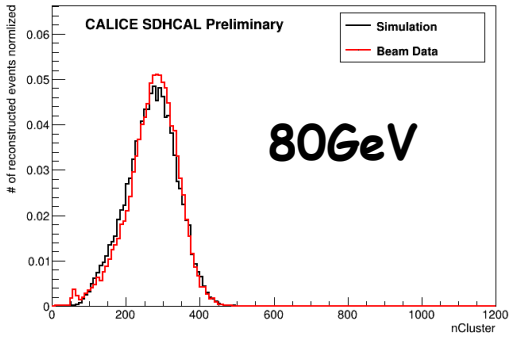




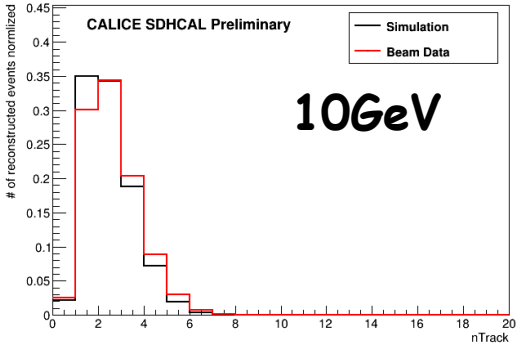
nCluster

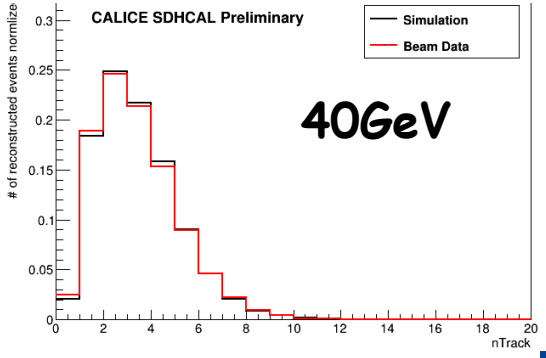


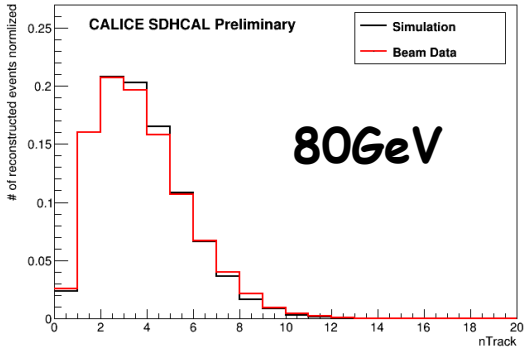




nTrack



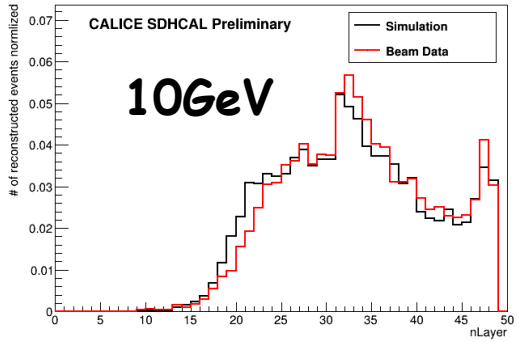


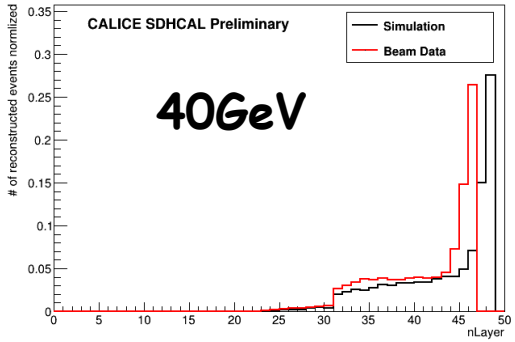


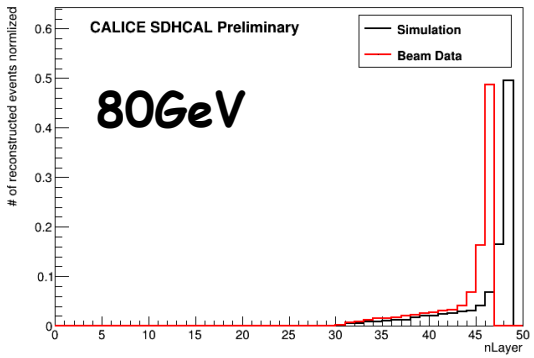
Input Variables

SJTU

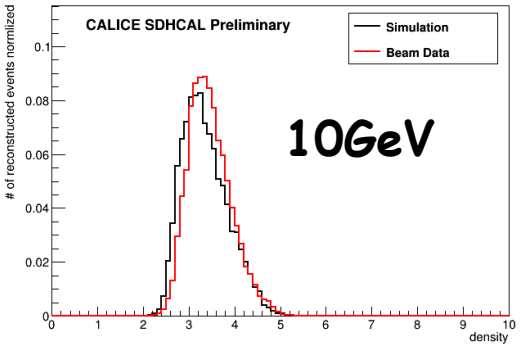
nLayer

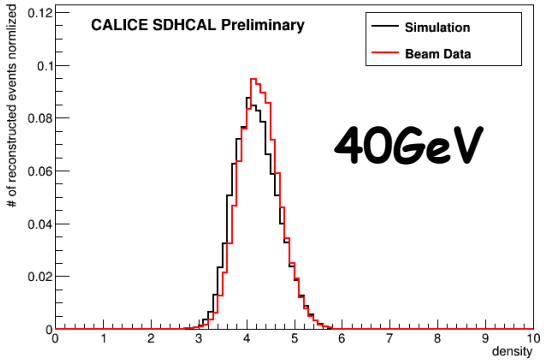


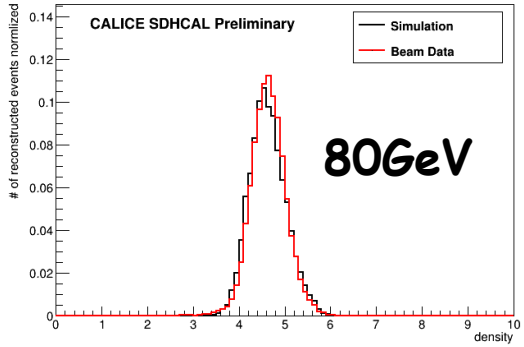




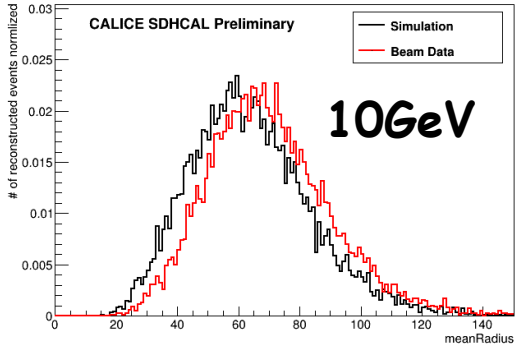
density

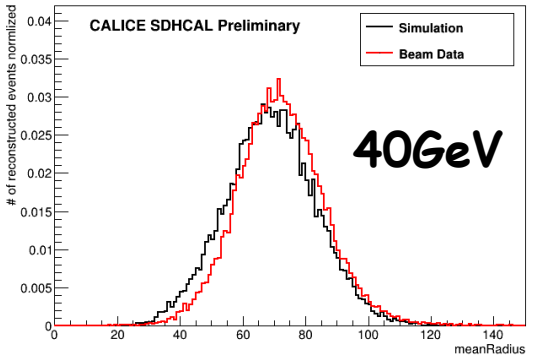


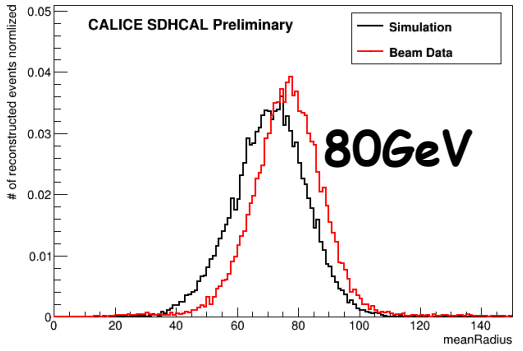




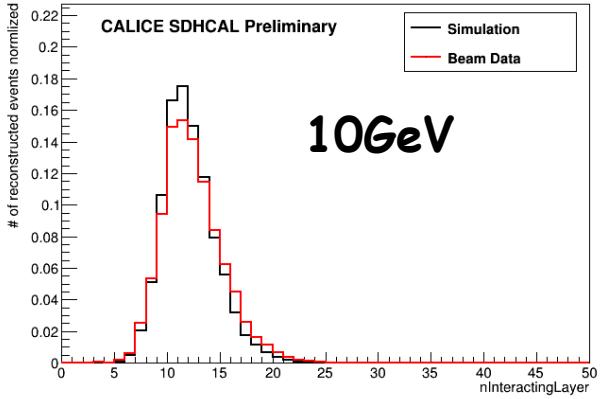
Radius

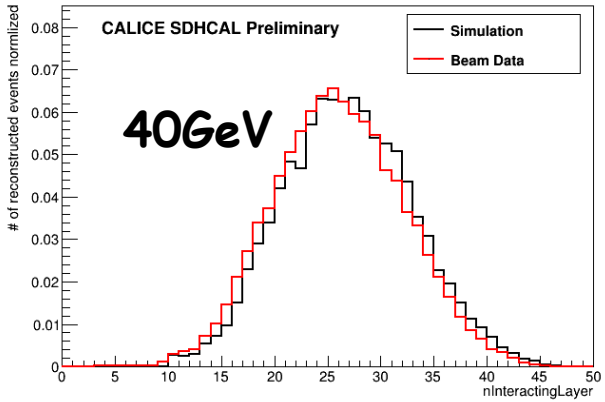


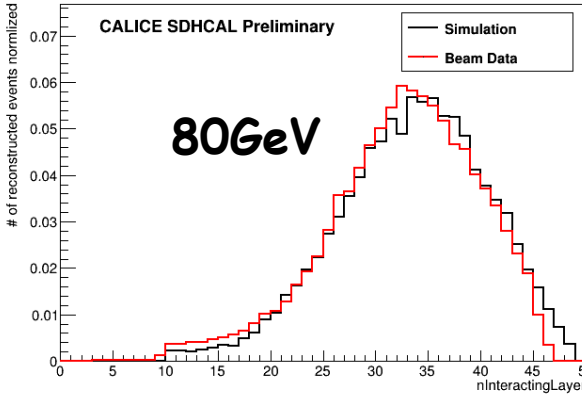




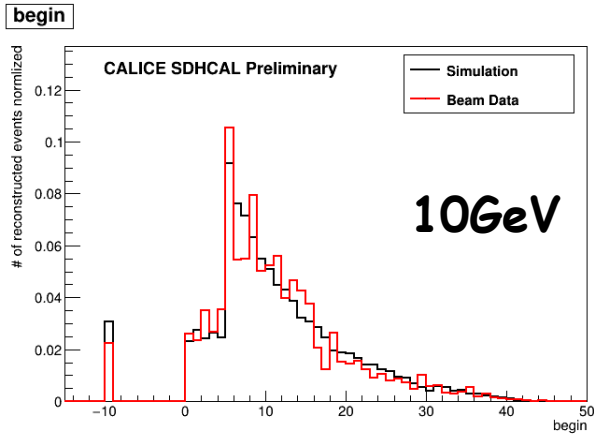
Input Variables

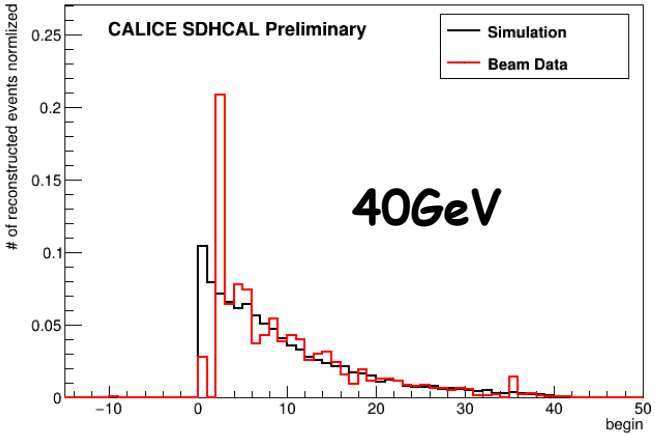


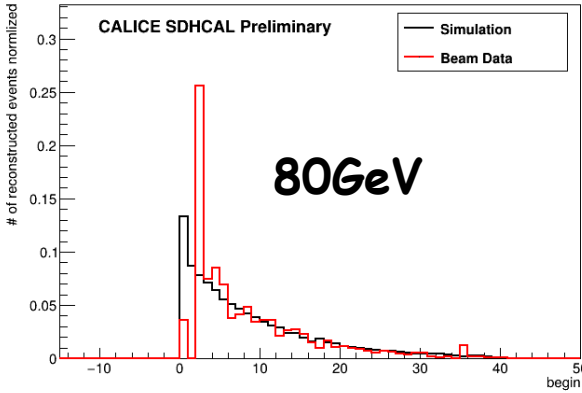




nShowering Layer



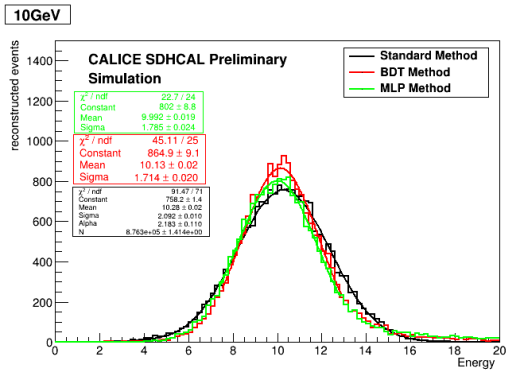




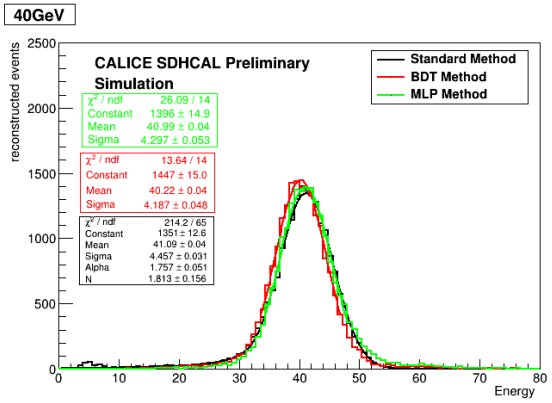
Shower starting layer

Energy recostruction

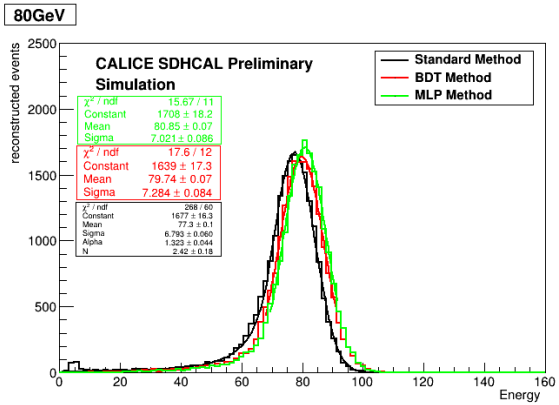
Full VarList training



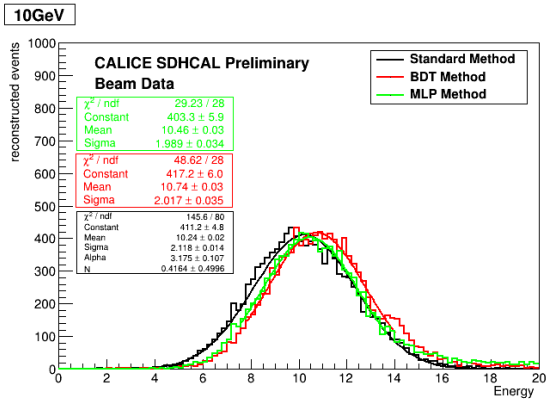
10GeV



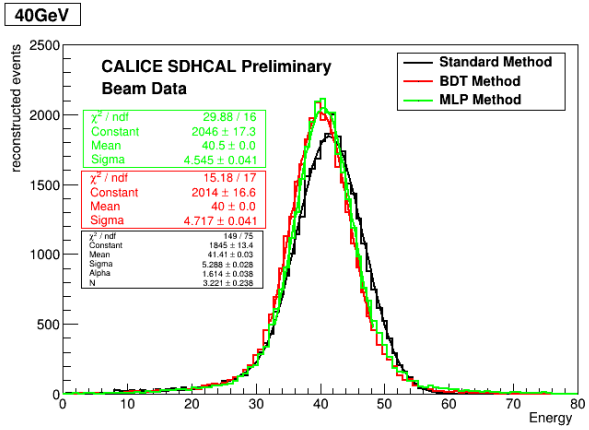
40GeV



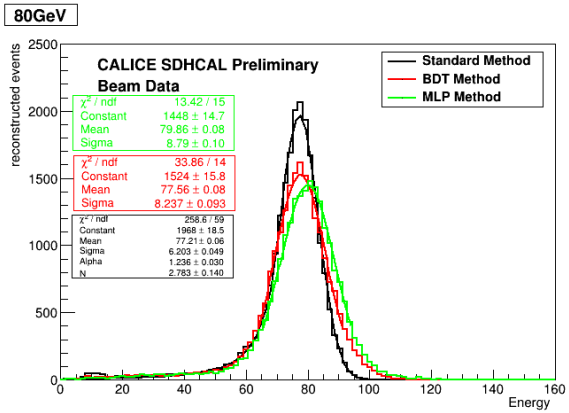
80GeV



10GeV

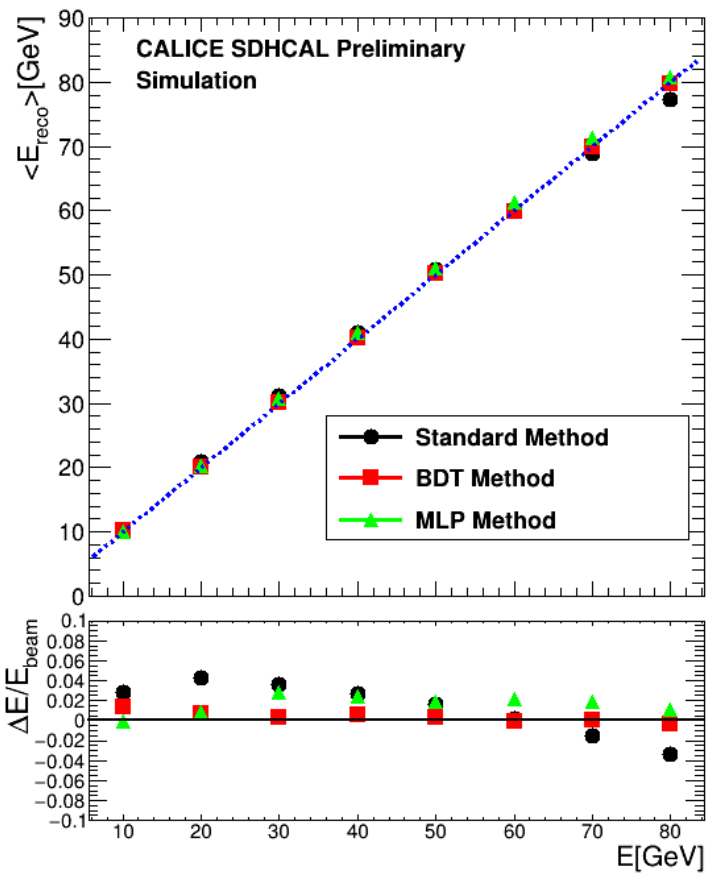


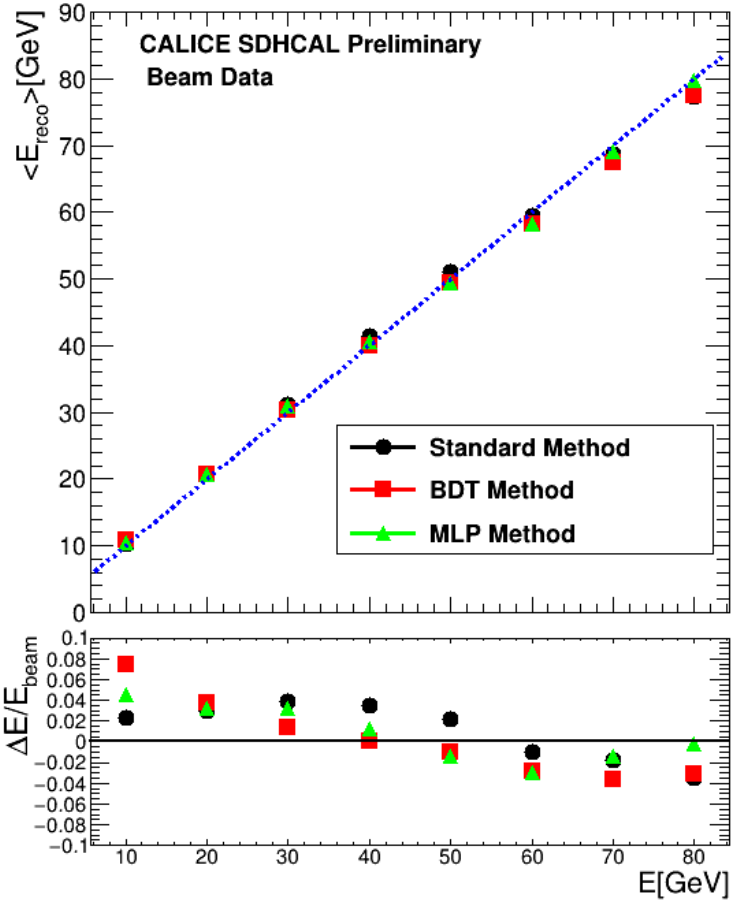
40GeV



80GeV

Linearity


CALICE SDHCAL Preliminary
Simulation
<E_reco>[GeV]
Standard Method
BDT Method
MLP Method
ΔE/E_beam
E[GeV]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Beam Data
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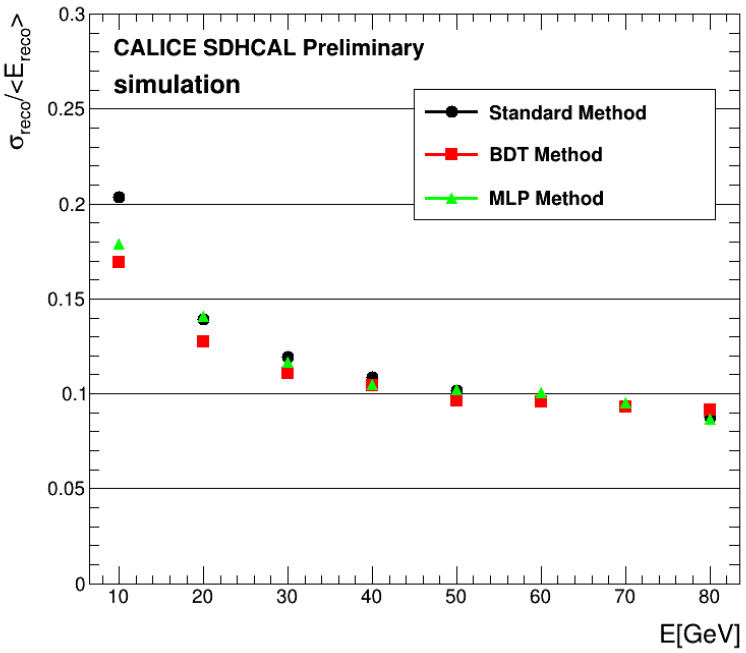
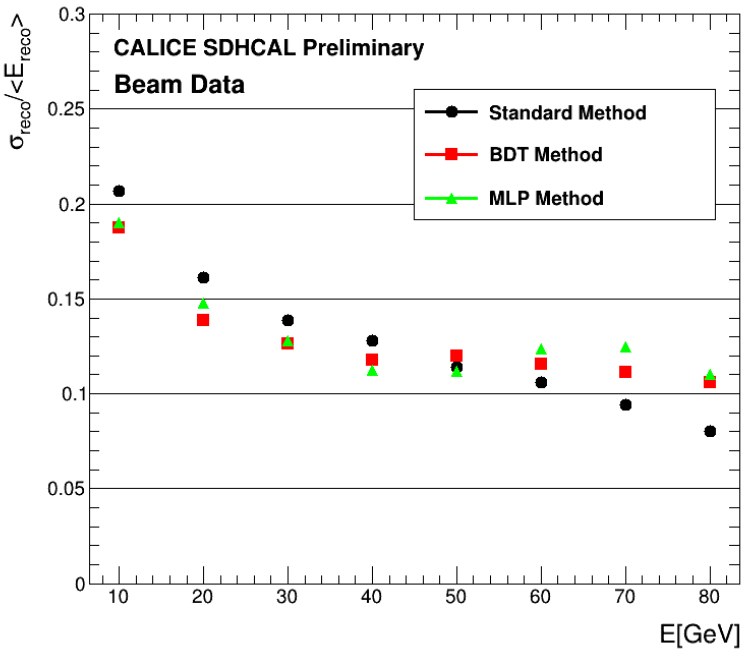
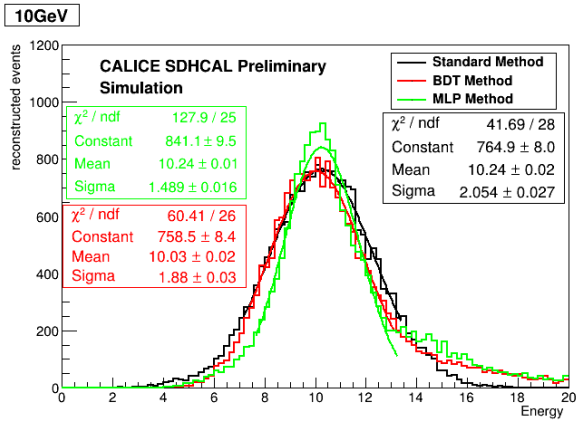
Standard Method
BDT Method
MLP Method
ΔE/E_beam
E[GeV]

Resolution

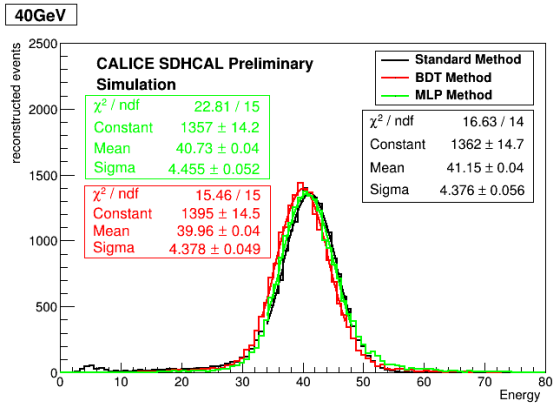

CALICE SDHCAL Preliminary
simulation
Standard Method
BDT Method
MLP Method
σreco/<Ereco>
E[GeV]


CALICE SDHCAL Preliminary
Beam Data
Standard Method
BDT Method
MLP Method
σreco/<Ereco>
E[GeV]

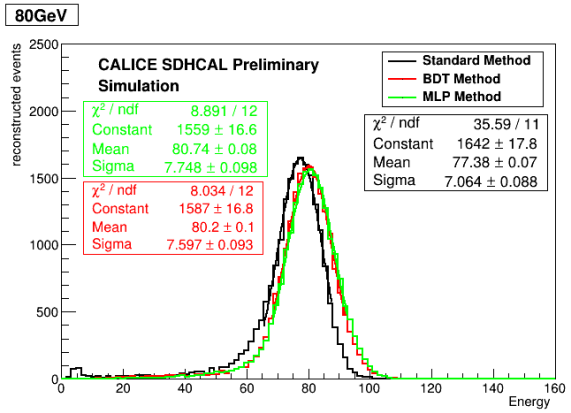
Huge VarList training



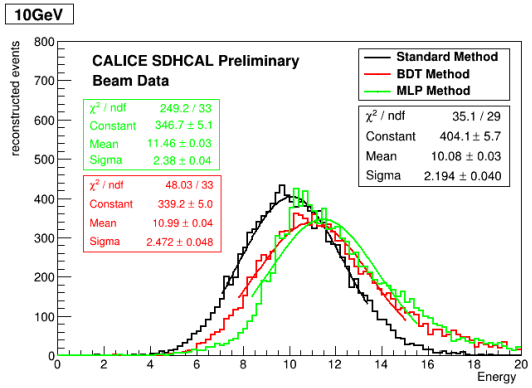
10GeV



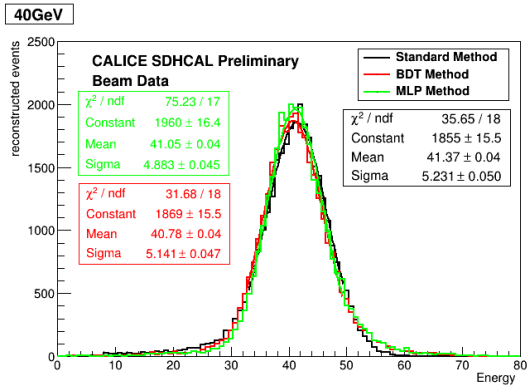
40GeV



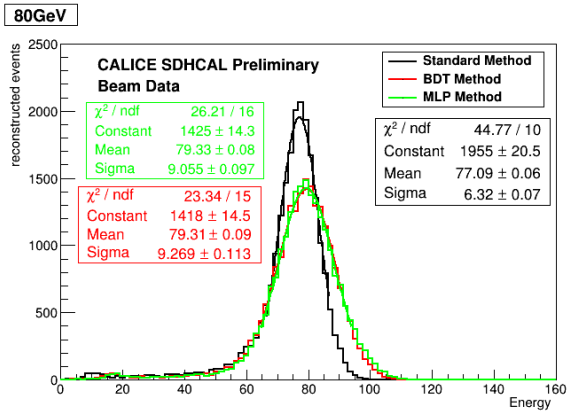
80GeV



10GeV

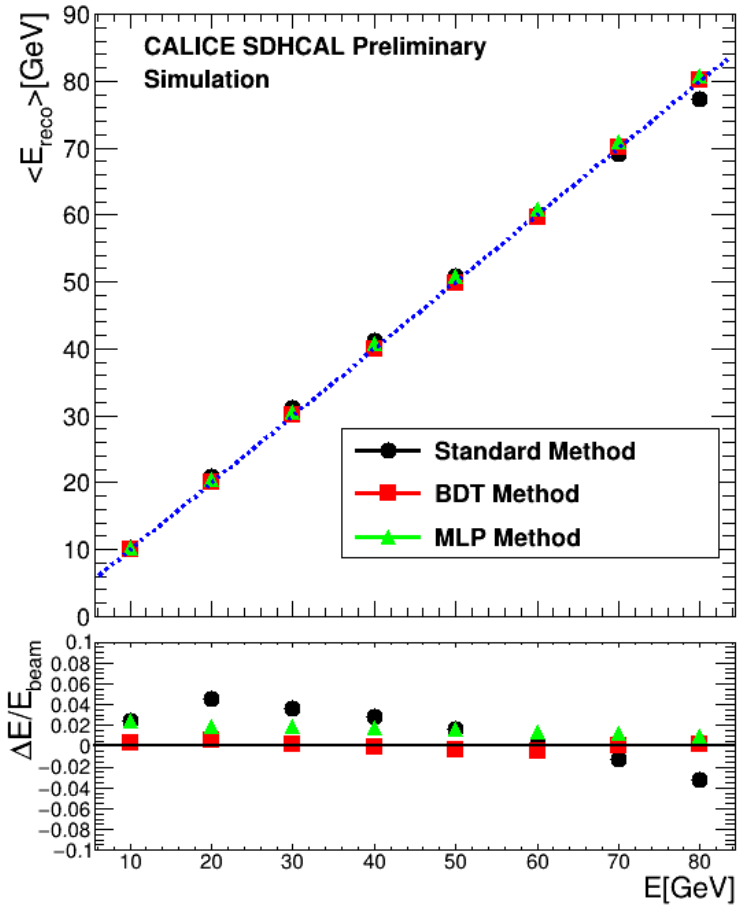


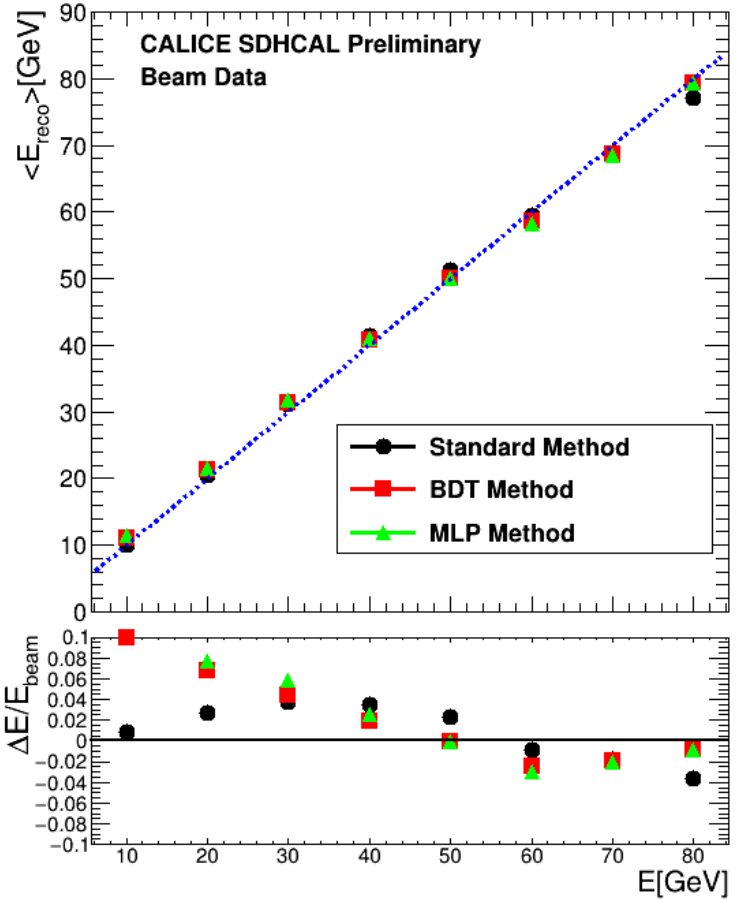
40GeV



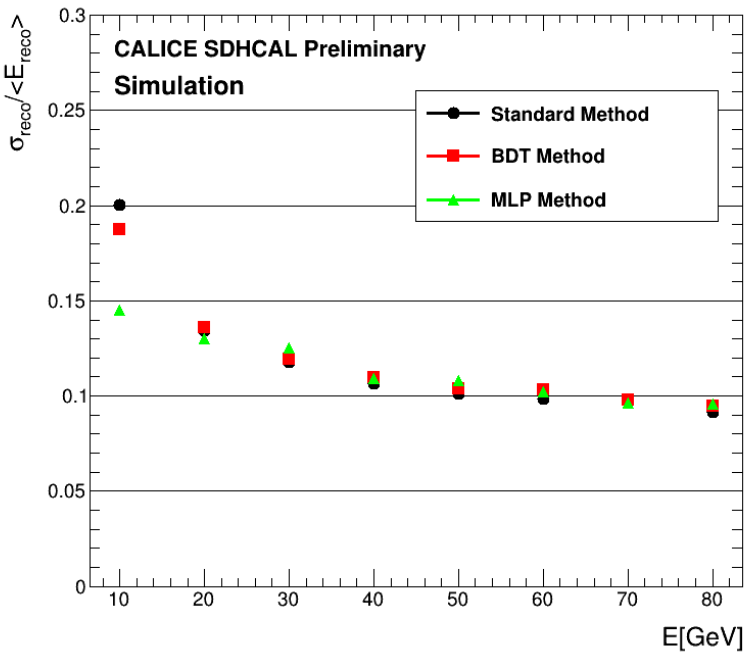
80GeV

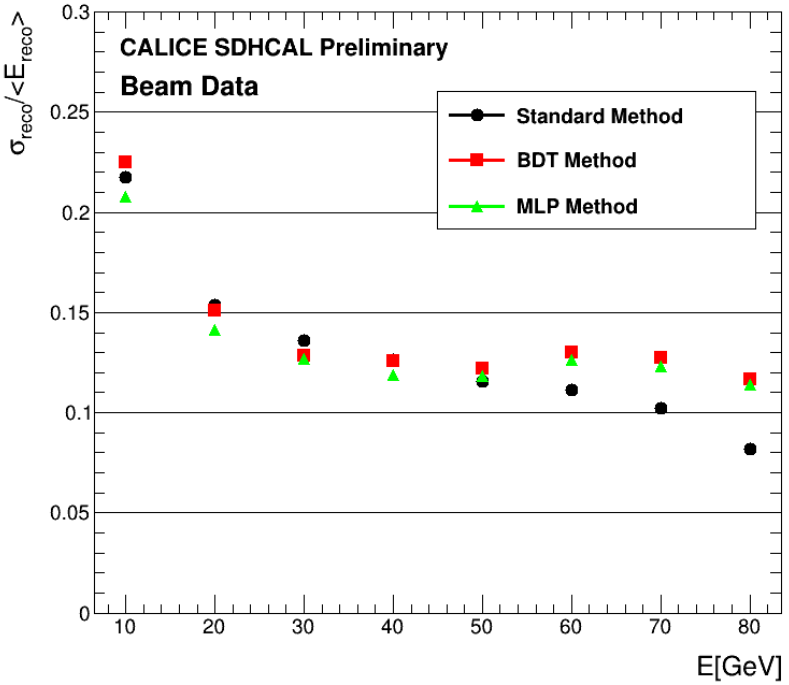
Linearity


CALICE SDHCAL Preliminary
Simulation
<E_reco>[GeV]
Standard Method
BDT Method
MLP Method
ΔE/E_beam
E[GeV]


CALICE SDHCAL Preliminary
Beam Data
<E_reco>[GeV]
Standard Method
BDT Method
MLP Method
ΔE/E_beam
E[GeV]

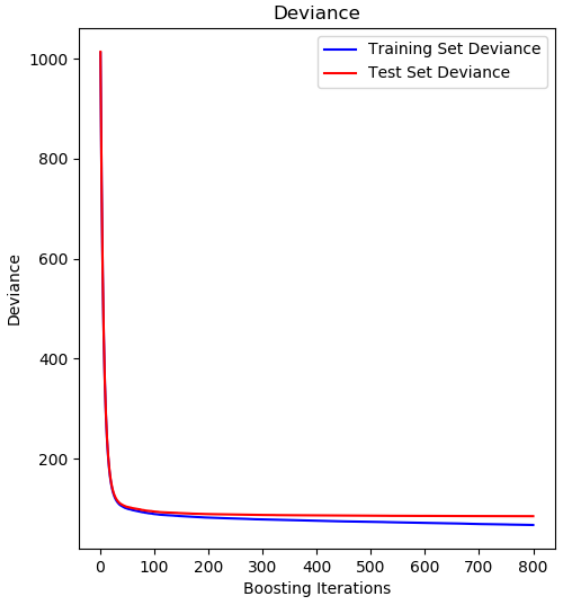
Resolution

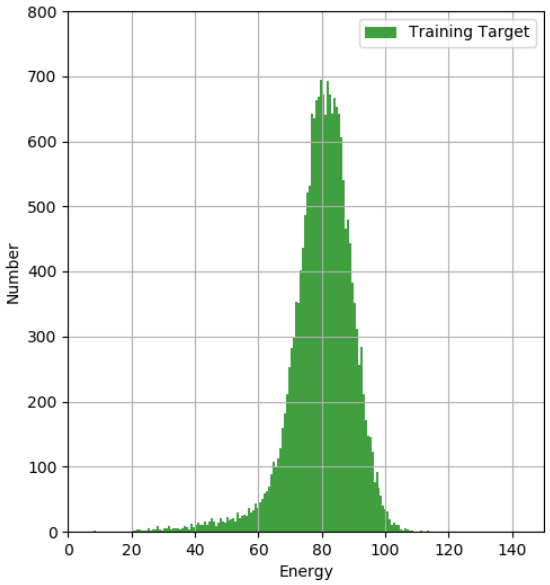

CALICE SDHCAL Preliminary
Simulation
Standard Method
BDT Method
MLP Method
$\sigma_{reco}/<E_{reco}>$
E[GeV]
0
0.05
0.1
0.15
0.2
0.25
0.3
10
20
30
40
50
60
70
80


CALICE SDHCAL Preliminary
Beam Data
Standard Method
BDT Method
MLP Method
$\sigma_{reco}/<E_{reco}>$
E[GeV]
0
0.05
0.1
0.15
0.2
0.25
0.3
10
20
30
40
50
60
70
80

Scikit Learn

VarList: number of hit1,2,3 of every layer of SDHCAL , So total 144 variables
400K events from 1GeV-120GeV





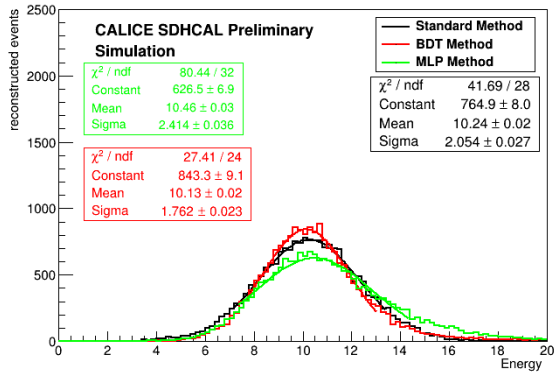
The analysis is ongoing, roughly it is comparable with TMVA

Conclusion & Next plan

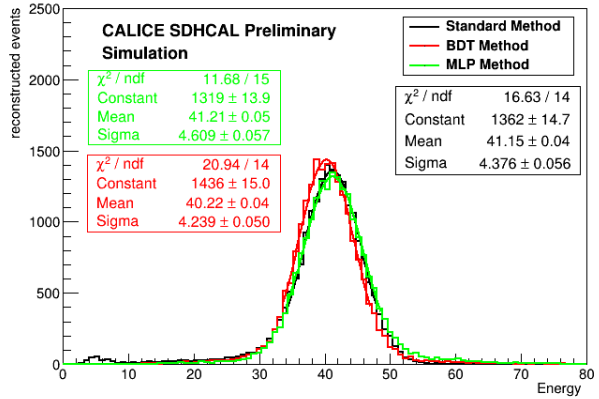
- **Energy reconstruction using MVA in SDHCAL**
  - **Simulation**
    - Good Linearity(±%2)
    - A improvement of resolution in the low energy
  - **Data**
    - It doesn't work well
- **Next plan**
  - Using data samples as training set
  - To fine tuning the scikit learn model

Backup

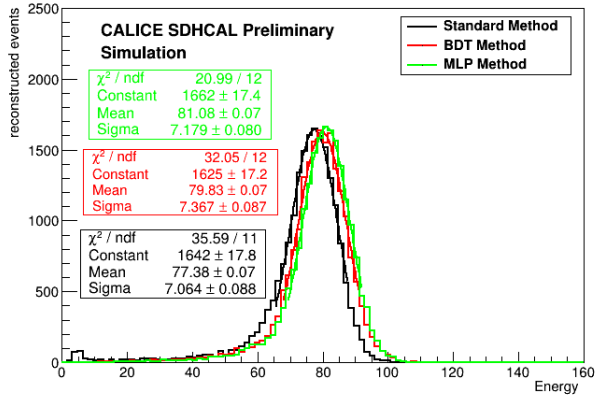
10GeV



40GeV



80GeV



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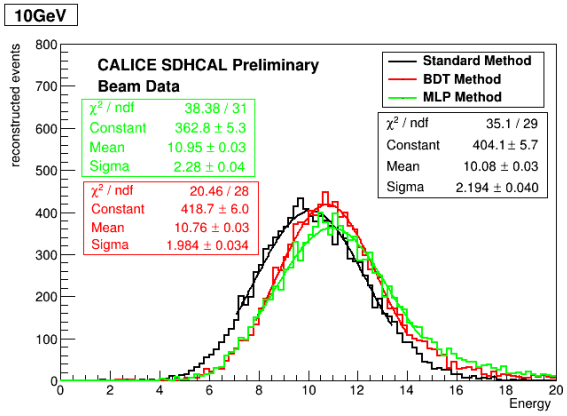

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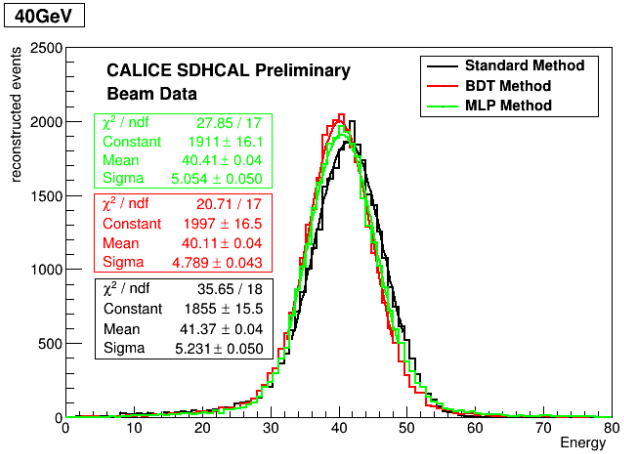
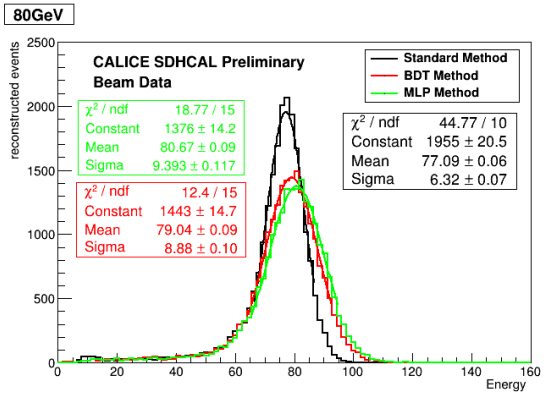
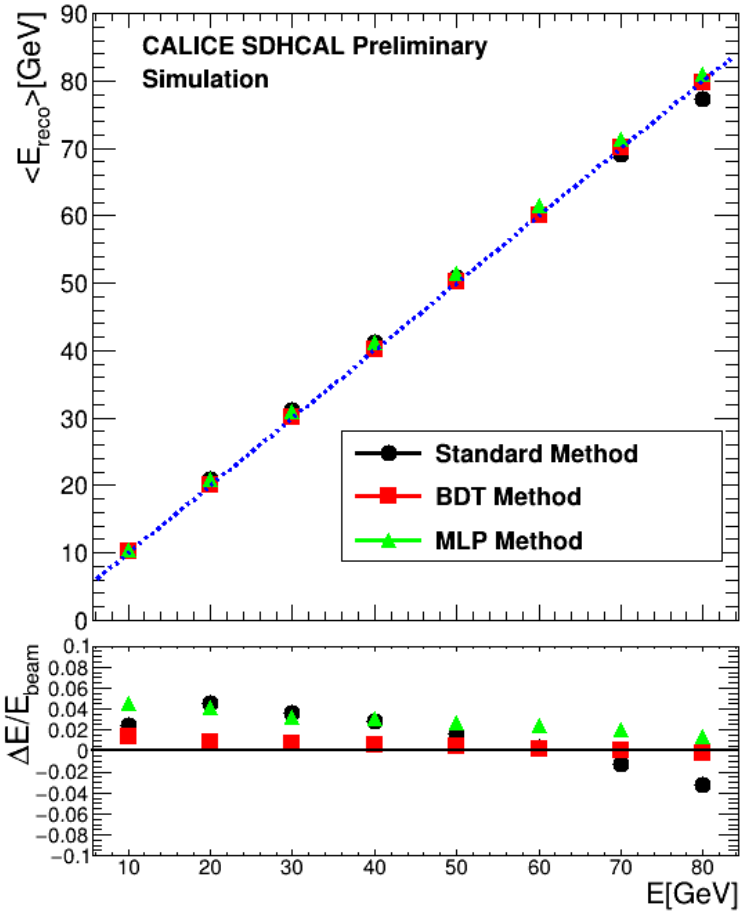
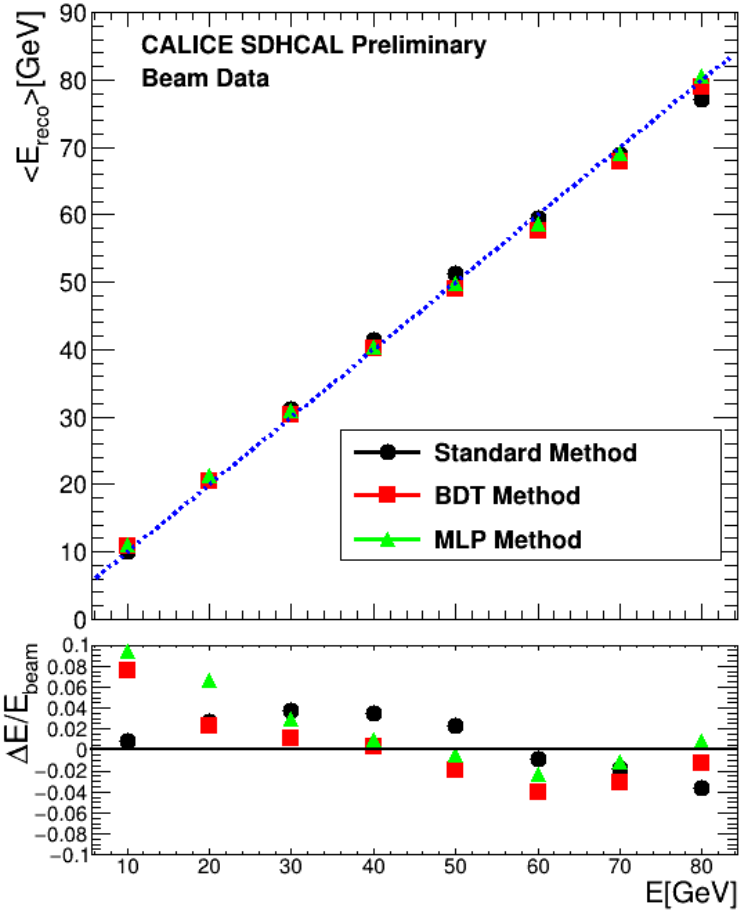
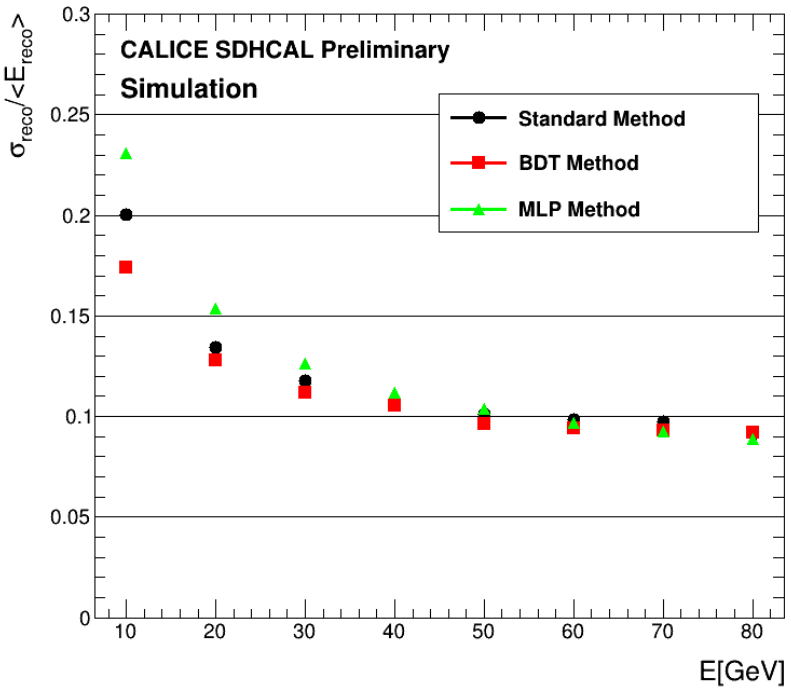


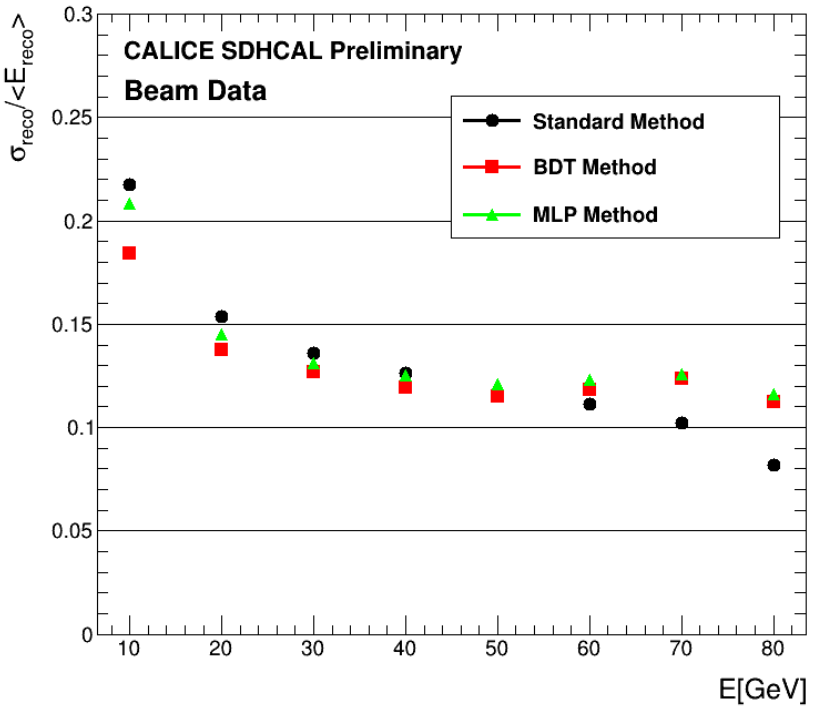
80GeV




CALICE SDHCAL Preliminary
Simulation
<E_reco>[GeV]
Standard Method
BDT Method
MLP Method
ΔE/E_beam
E[GeV]


CALICE SDHCAL Preliminary
Beam Data
<E_reco>[GeV]
Standard Method
BDT Method
MLP Method
ΔE/E_beam
E[GeV]


CALICE SDHCAL Preliminary
Simulation
Standard Method
BDT Method
MLP Method
$\sigma_{reco}/<E_{reco}>$
E[GeV]


CALICE SDHCAL Preliminary
Beam Data
Standard Method
BDT Method
MLP Method
$\sigma_{reco}/<E_{reco}>$
E[GeV]