

Neural network technique for energy reconstruction study in SDHCAL

CALICE Meeting - KEK

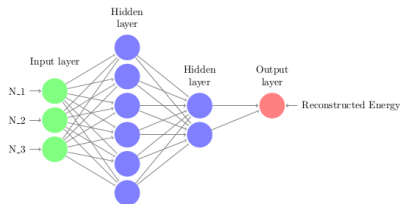
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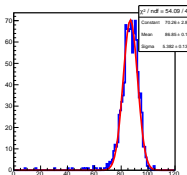
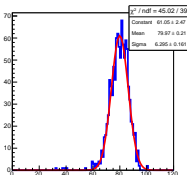
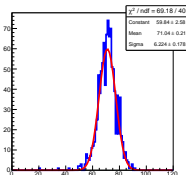
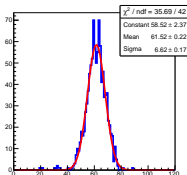
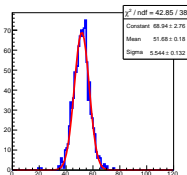
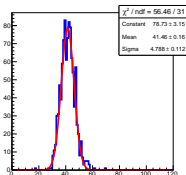
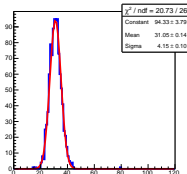
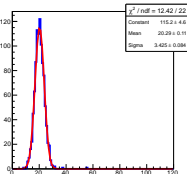
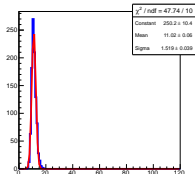
April 19-21 2015

- 1 Artificial Neural Networks in Monte Carlo Simulation
 - ANN Architecture and Energy samples
 - ANN Results
 - ANN results comparison with Quadratic parametrisation
- 2 Artificial Neural Networks in Data
 - Data Samples and Selection criteria
 - ANN results in Data
- 3 Conclusion

- TMultiLayerPerceptron of root package.
- 2 hidden layers with respectively 6 and 2 neurons.
- The input variables: N_1, N_2, N_3 .
- The output variable is the reconstructed energy: E_{REC} .
- Monte Carlo Simulation
 - Training Samples: Odd energies, 1-99 GeV (50 training samples)
 - Test Samples: Even energies, 10-90 GeV (40 test samples)



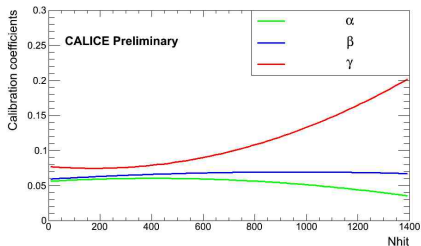
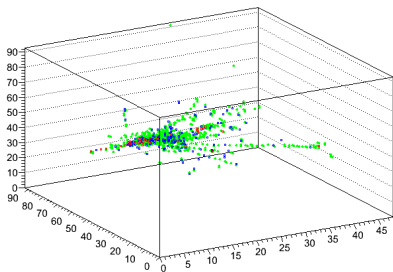
ANN Results: Energy estimation from ANN



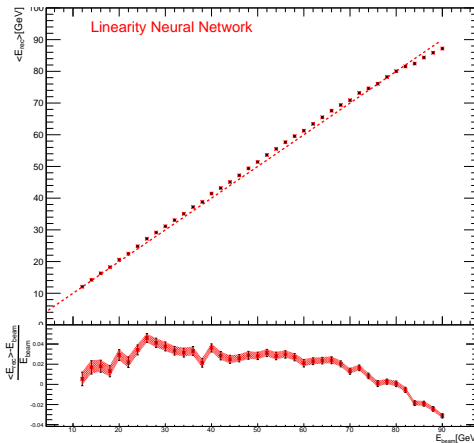
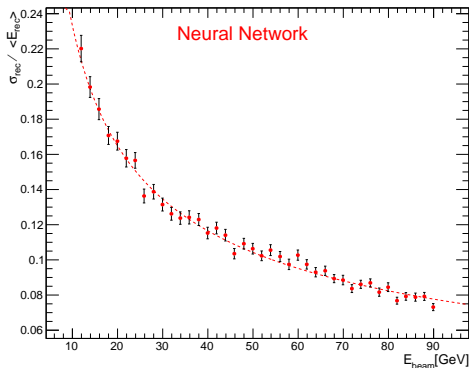
Energy reconstruction: Quadratic parametrisation

- $E_{\text{rec}} = \alpha(N_{\text{tot}}) \times N_1 + \beta(N_{\text{tot}}) \times N_2 + \gamma(N_{\text{tot}}) \times N_3$
- N_1, N_2, N_3 : number of hits for thresholds 1,2,3
 $N_{\text{tot}} = N_1 + N_2 + N_3$
 $\alpha(N_{\text{tot}}) = \alpha_1 + \alpha_2 \times N_{\text{tot}} + \alpha_3 \times N_{\text{tot}}^2$
 $\beta(N_{\text{tot}}) = \beta_1 + \beta_2 \times N_{\text{tot}} + \beta_3 \times N_{\text{tot}}^2$
 $\gamma(N_{\text{tot}}) = \gamma_1 + \gamma_2 \times N_{\text{tot}} + \gamma_3 \times N_{\text{tot}}^2$
- α, β, γ : quadratic weights of N_{tot} obtained from like χ^2 minimisation:
- $\chi^2 = \sum_{i=1}^N \frac{((E_{\text{beam}} - (E_{\text{rec}}))^2}{E_{\text{beam}}}$

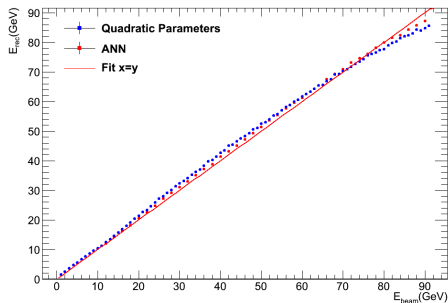
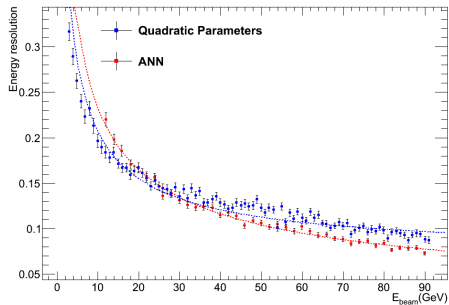
shower development pion 50 GeV



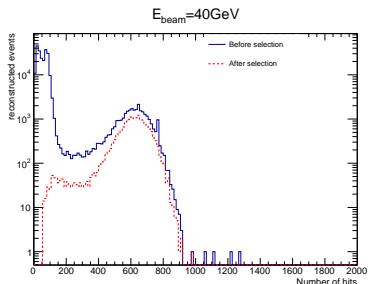
ANN Results: Energy resolution and linearity



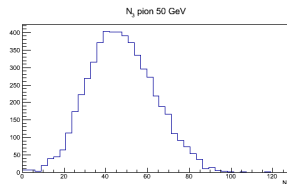
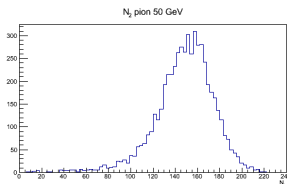
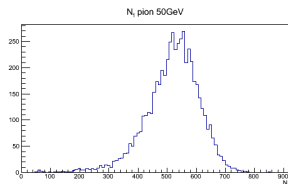
ANN results comparison with Quadratic parametrisation



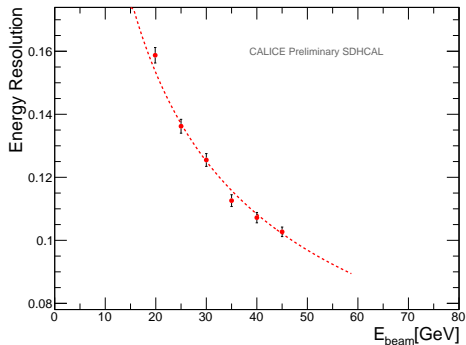
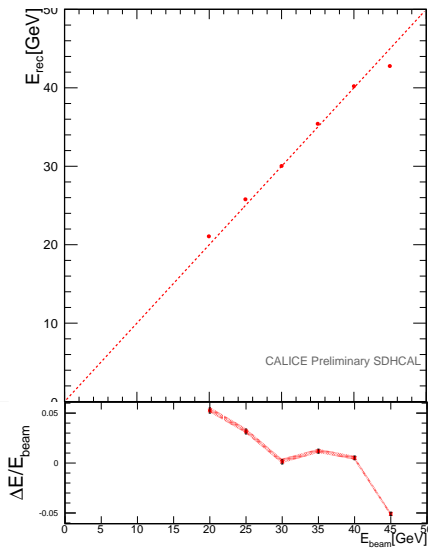
- Pions Data are contaminated with muons,cosmics, electrons \implies Event selection
 - **Electron rejection:** Shower Start > 4
 - **Muon rejection:** $N_{hit}/N_{layer} > 2.2$
 - **Neutral rejection:** N_{hit} in the first 5 layers > 4
 - **Double incident particles rejection:** distance between hits in each of the first 5 layers $\leq 5cm$



- Architecture of the ANN : One hidden layer of 8 neurons.
- The input variables: N_1, N_2, N_3 .
- The output variable is the reconstructed energy: E_{rec} .
- Data SPS H6 2014
 - Training Samples: Trained with Simulation samples(1000 events per energy, Energies:1-50GeV)
 - Test Samples: 2014 test beam data (4500 events per energy, Energies:20,25,30,35,40,45 GeV)



ANN results in Data



The ANN is used in energy reconstruction study for both Simulation and data.

ANN technique giving promised results: To be improved

- Ongoing study: To improve Energy resolution with ANN, more variables added as inputs to ANN is under investigation
- topologic variables of hadronic shower: shower start, Mean radius shower, Length of the shower...
- Add more energy points: Next test beam at Cern May 2015