Implementing the Near → Far Extrapolation within DUNE-PRISM software

DUNE-PRISM Analysis Meeting

Ioana Caracas

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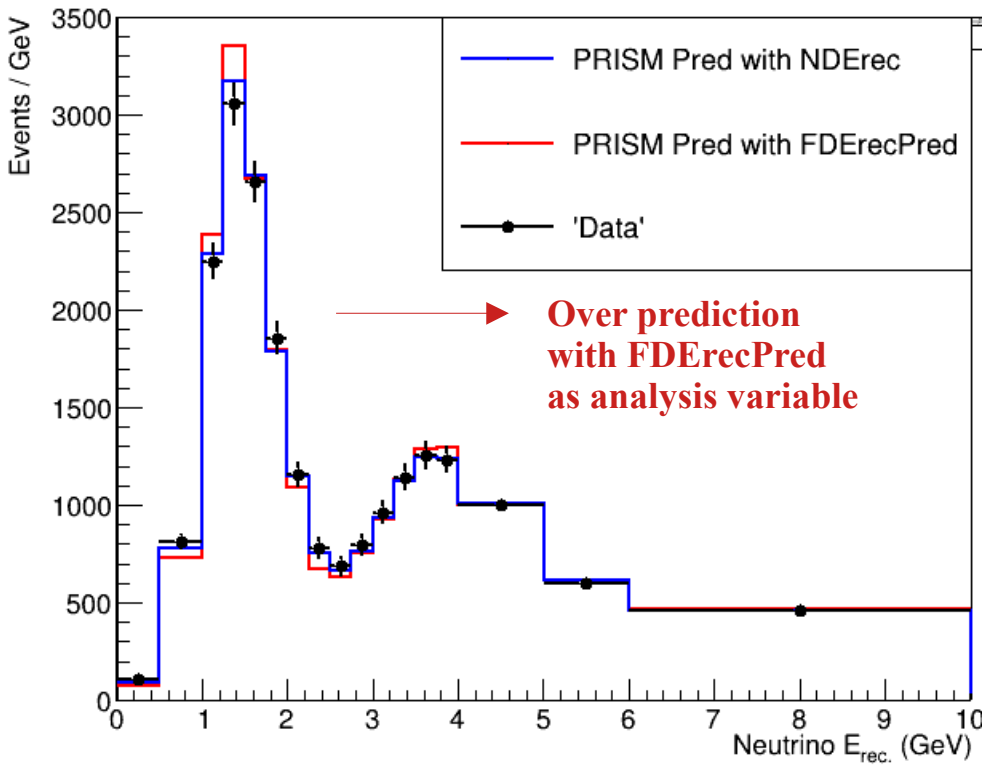
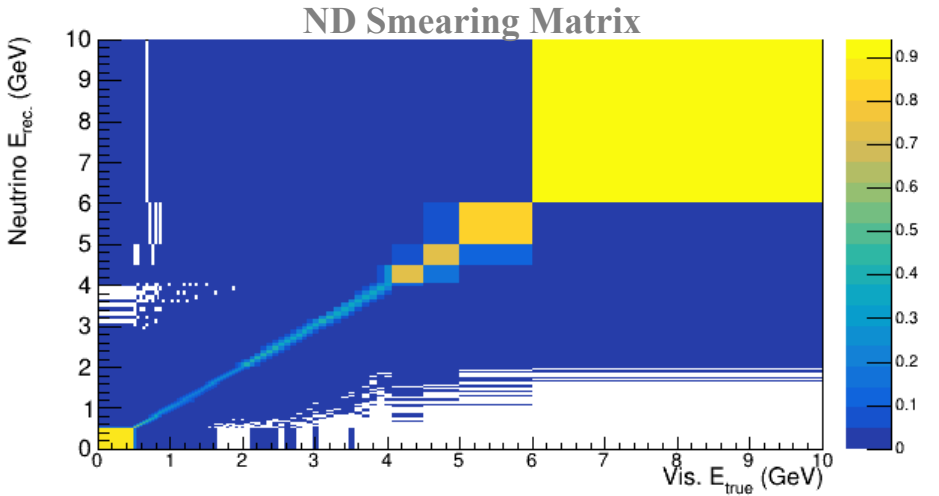
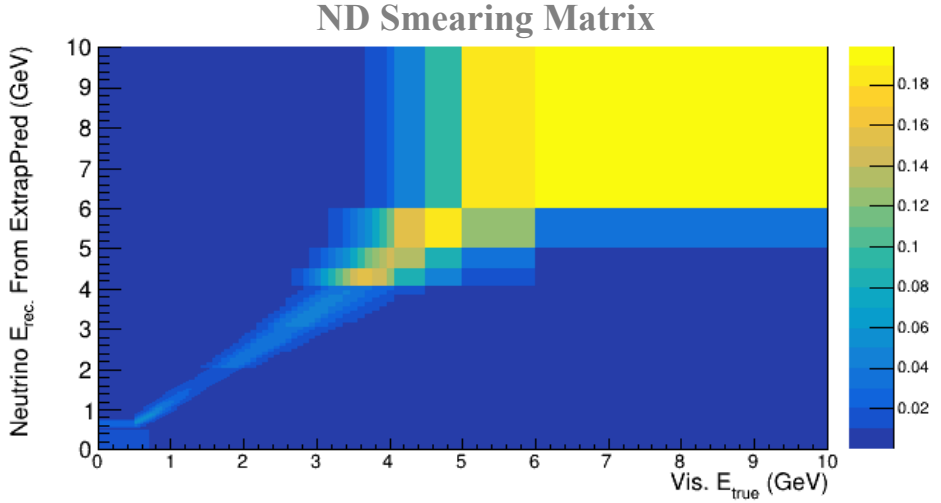
PRISM Analysis with FDErecPred

- Same PRISM analysis as before but working with **FDErecPred as analysis variable** does not produce perfect match → different ND smearing matrices..



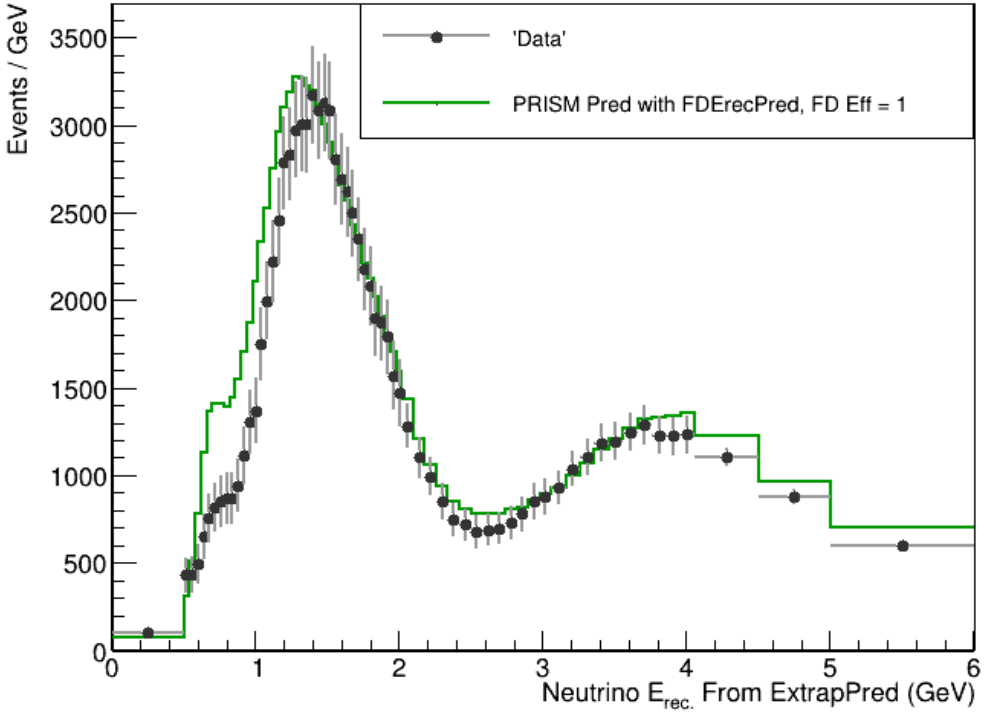
* classic FD Erec binning





Tailored PRISM Analysis with FDErecPred : applying coefficients

ND Selected EventsCC (FDErecPred) —ND Efficiency (smearing matrix)→ ND Generated Events (ETrue) —Smear (smearing matrix)→ ND Generated Events (FDErecPred) —FDEfficiency (= 100%)→ **FD Selected Events (FDErecPred)** ← **Apply coefficients**

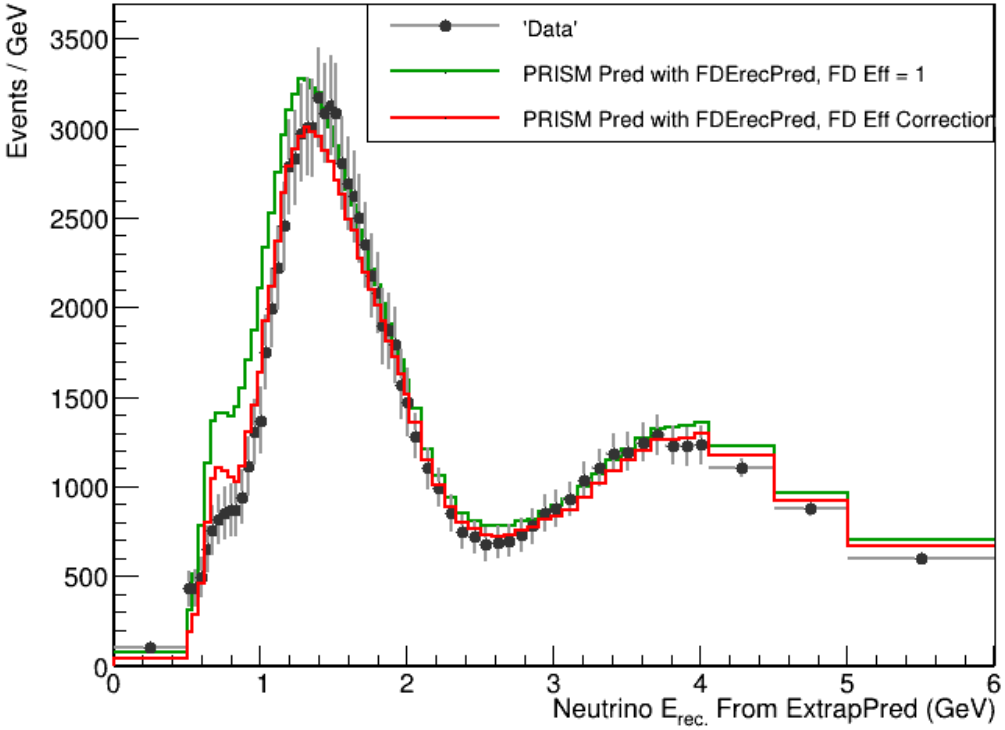


ND Extrapolated Spectrum from FDErecPred has a nice **oscillated shape** with the **oscillation maximum correctly predicted**

ND Extrapolated Spectrum from FDErecPred: **over prediction + oscillation minimum shift**
– apply FD Efficiency

Tailored PRISM Analysis with FDErecPred : applying coefficients

ND Selected EventsCC (FDErecPred) —(ND Efficiency, smearing matrix)→ ND Generated Events (ETrue) —(Smear, smearing matrix)→ ND Generated Events (FDErecPred) —(FDEfficiency from MC (FDErec))→ **FD Selected Events (FDErecPred)** → **Apply coefficients**



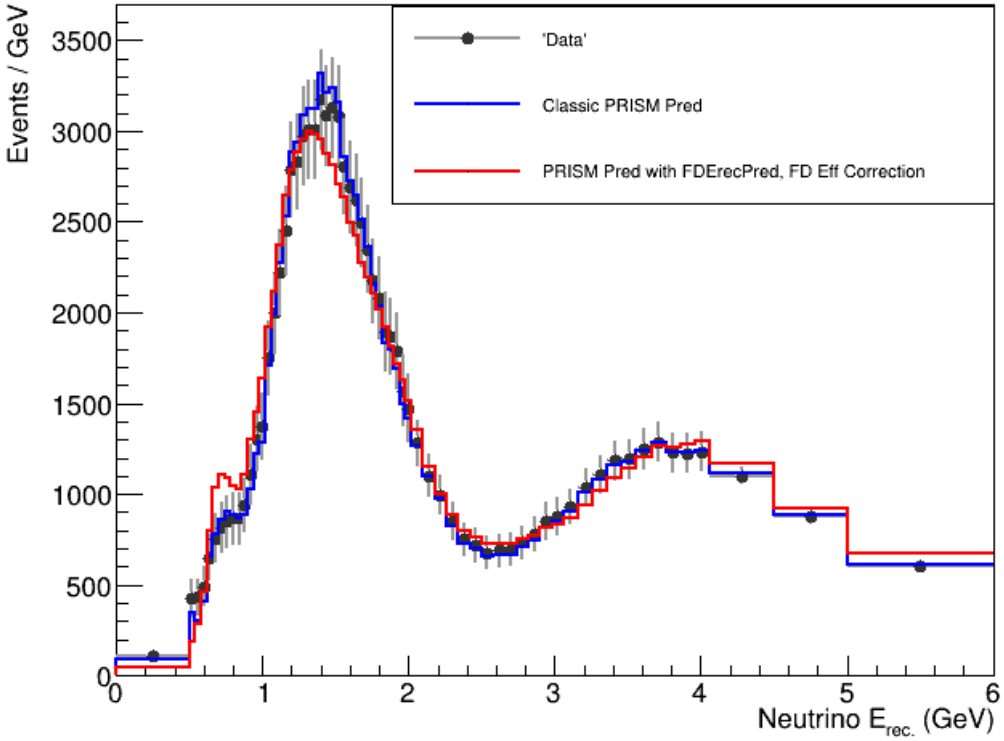
ND Extrapolated Spectrum from FDErecPred has a nice **oscillated shape** with the **oscillation maximum correctly predicted**

ND Extrapolated Spectrum from FDErecPred: over prediction + **oscillation minimum shift**

– FD efficiency correction solved the over prediction issue
– spectrum still has slight over prediction at low energies + small shift for the peak @ 1.5 GeV

Tailored PRISM Analysis with FDErecPred : applying coefficients

ND Selected EventsCC (FDErecPred) —(ND Efficiency, (smearing matrix))→ ND Generated Events (ETrue) —(Smear, (smearing matrix))→ ND Generated Events (FDErecPred) —(FDEfficiency from MC (FDErec))→ **FD Selected Events (FDErecPred)** ← **Apply coefficients**



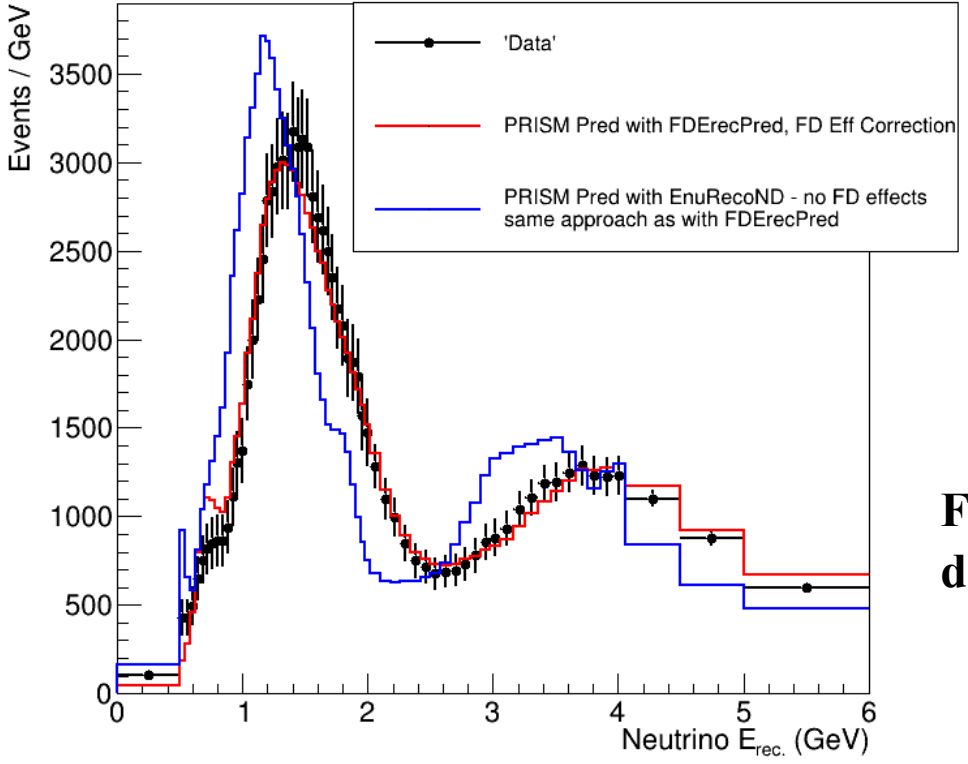
ND Extrapolated Spectrum from FDErecPred has a nice **oscillated shape** with the **oscillation maximum correctly predicted**

ND Extrapolated Spectrum from FDErecPred: over prediction + **oscillation minimum shift**

– not as good as classic PRISM prediction.. (expected)

Sanity Check: apply same analysis to NDErec

ND Selected EventsCC (FDErecPred) —(ND Efficiency, (smearing matrix))→ ND Generated Events (ETrue) —(Smear, (smearing matrix))→ ND Generated Events (FDErecPred) —(FDEfficiency, from MC (FDErec))→ **FD Selected Events (FDErecPred)** → **Apply coefficients**



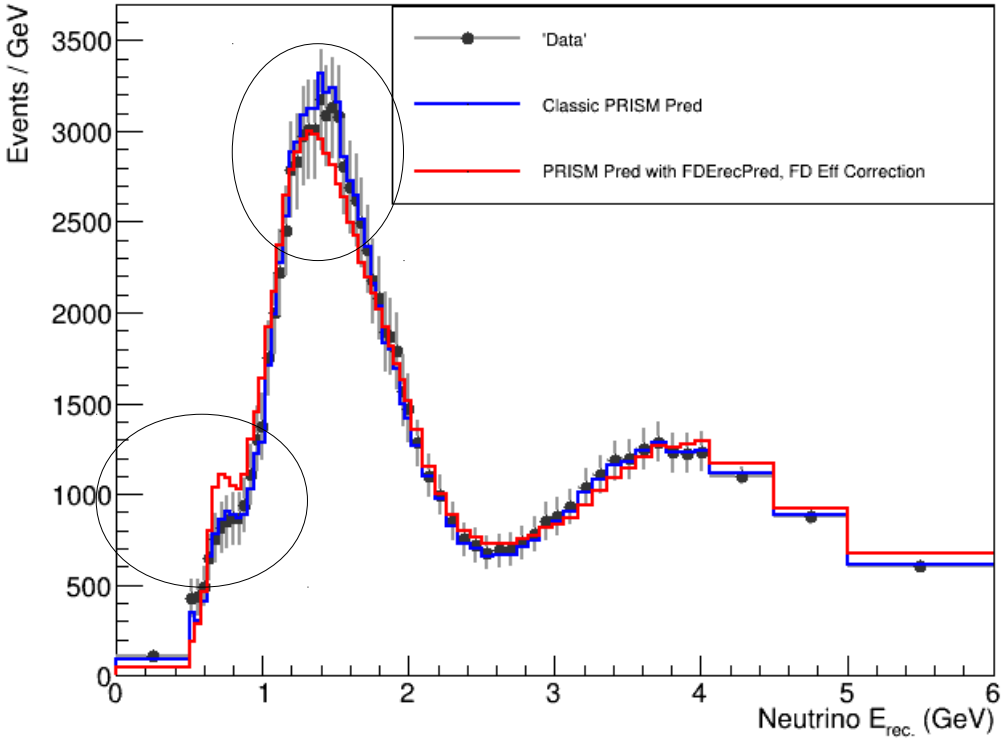
- Check how well does the prediction – FDErecPred work: apply same analysis by using NDErec (exclude FD effects)

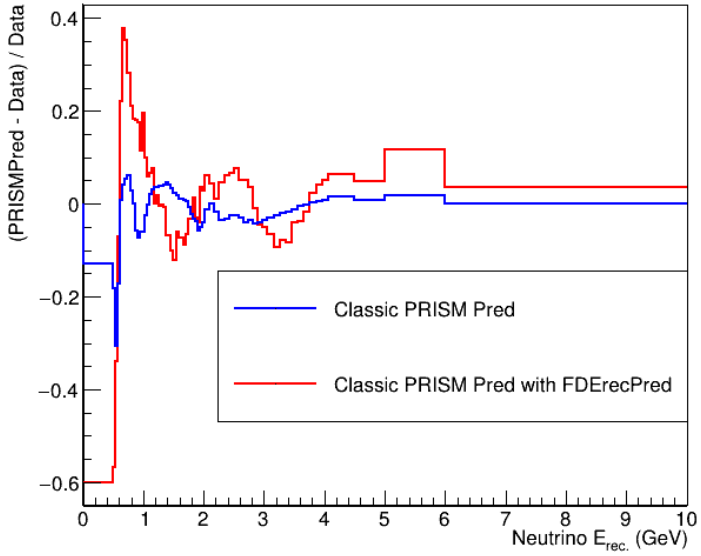
  – no match for oscillation minimum, peak shifted, resulted PRISM prediction not describing the data properly

FDErecPred does a very nice job in properly describing the reconstructed energy in the FD!

Tailored PRISM Analysis with FDErecPred : applying coefficients

ND Selected EventsCC (FDErecPred) —(ND Efficiency, (smearing matrix))→ ND Generated Events (ETrue) —(Smear, (smearing matrix))→ ND Generated Events (FDErecPred) —(FDEfficiency from MC (FDErec))→ **FD Selected Events (FDErecPred)** → **Apply coefficients**

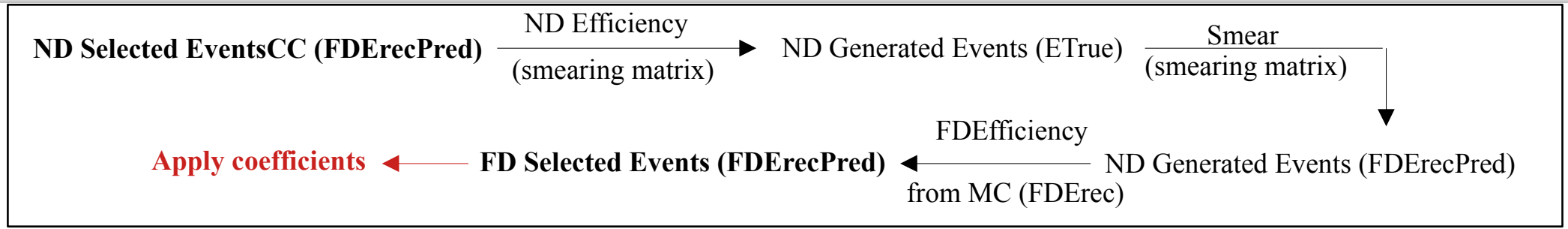


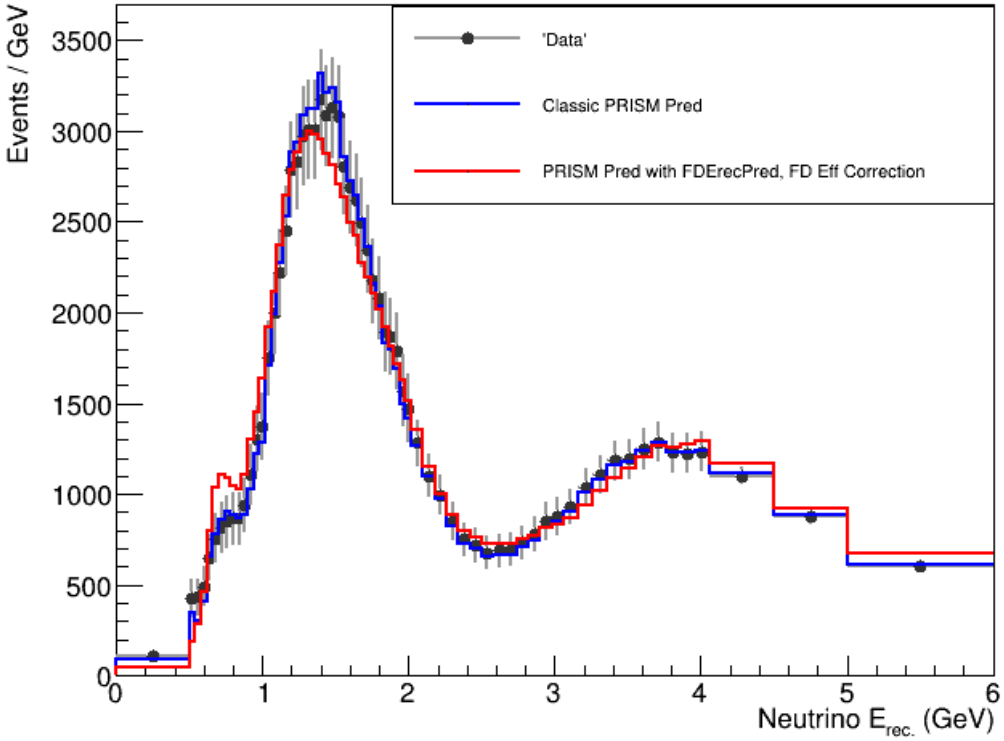


– should we go for MC correction at this point ?

Resolution of FDErec to FDPred from network? Do we have such function/distribution? could we get it?

Tailored PRISM Analysis with FDErecPred : applying coefficients





- Still some open questions:

– **FD Efficiency correction**: can we do better than using MC?

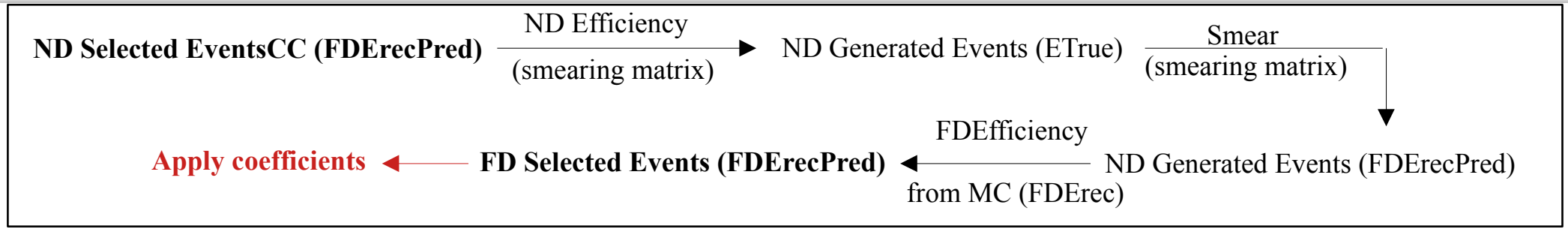
– FD efficiency based on cvn cut: could we maybe retrain the network for all events (not only selected in ND) and get the FDErec only from selected ones but use the "total cvn "

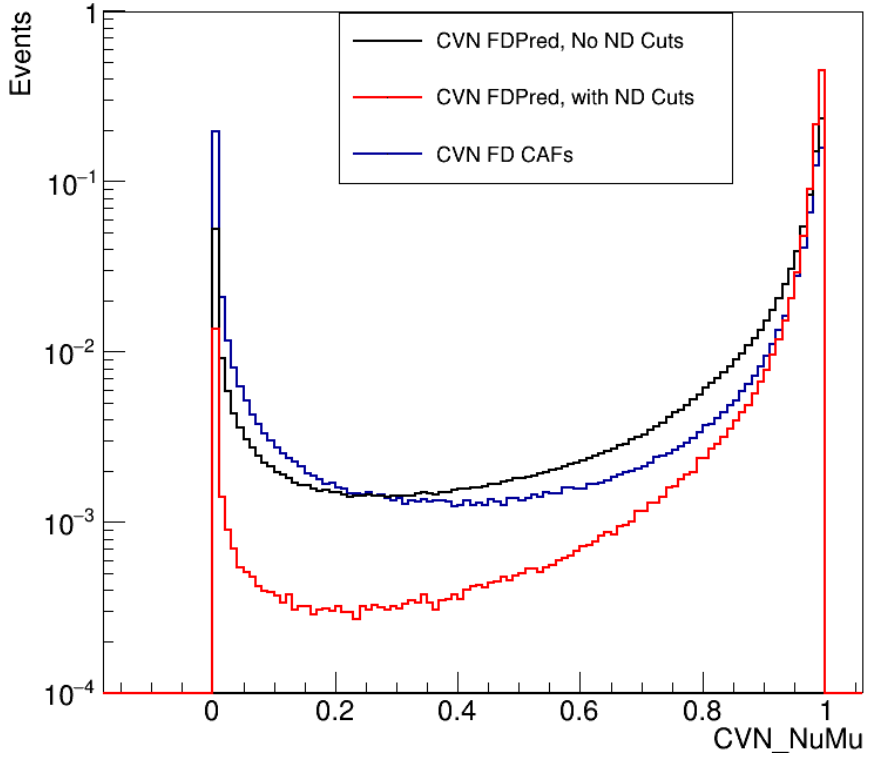
–what would the MC correction be ?

Resolution of FDErec to FDPred from network?

– smearing matrix of "trained" events with the FDErecPred value and the corresponding "expected" FDErec?

FD Efficiency (FDErecPred)





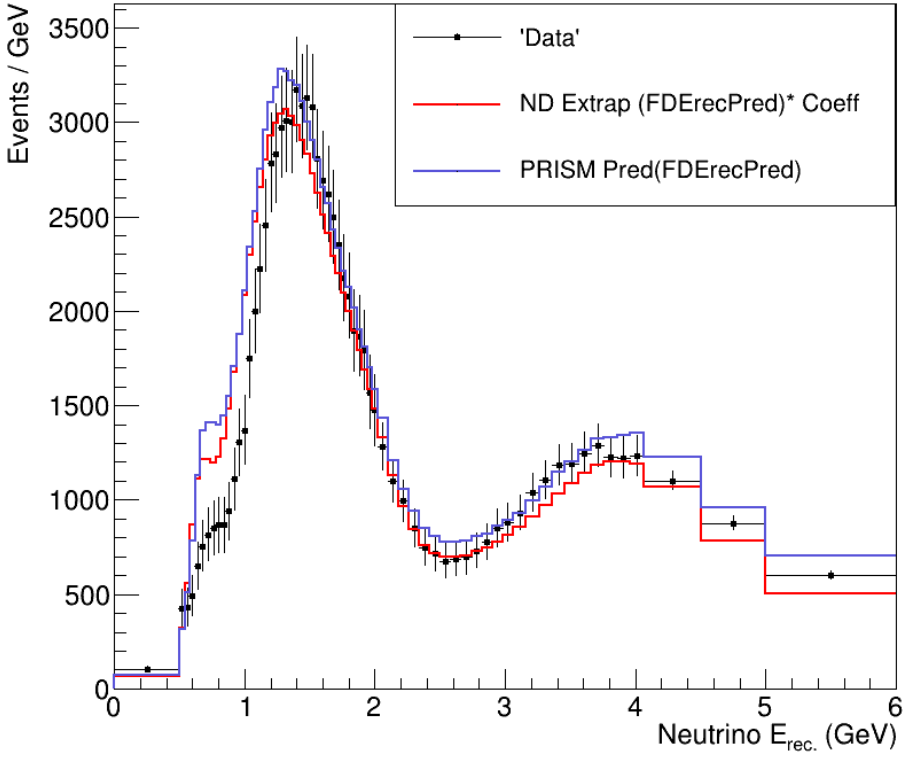
– we need to apply efficiency correction for all generated events (not only for those with ND Cuts)
– CVN score for events with no ND cuts is not reliable → network was not trained with this events

Idea/question: should one train the network for all events and save the corresponding CVN scores, but keep on using the FDErecPred for selected events (ND Cuts) only?

– ideally CVN FDPred would look "same" as CVN FDCAFs → FDEfficiency (FDErecPred) correction would have the same shape + magnitude as FDEfficiency(FDErec)

PRISM Analysis with FDErecPred : applying coefficients

ND Selected EventsCC (FDErecPred) —(ND Efficiency / (smearing matrix))→ ND Generated Events (ETrue) —(Smear / (smearing matrix))→ ND Generated Events (FDErecPred) —(FDEfficiency / (=100%))→ **FD Selected Events (FDErecPred)** —**Apply coefficients**→ + FD Bkg → **PRISM Prediction (FDErecPred)**



- ND Extrapolated Spectrum from FDErecPred has a nice **oscillated shape**

  – bug in the previous version (more than 1 order of magnitude difference + weird shape) due to wrong summing in energy bins: was not summing over all NDErec (I.e FDErecPred) bins, but rather less bins (by default in PRISM analysis different NDErec and FDErec bins)

- ND Extrapolated Spectrum from FDErecPred: over prediction + peak shift

- We do have over prediction even in the standard PRISM case (FDErecPred as analysis variable) – some idea where to start looking for problems ...

Correct for ND Effiency

Network trained for "Selected Events" only

1. Start with NDSelected Events (FDErecPred)
2. Subtract ND Background (FDErecPred)

→ **NDSelectedEventsCC (FDErecPred)** = NDSelectedEvents (FDErecPred) - ND Background (FDErecPred)

ND Selected EventsCC (FDErecPred)

$(M^{ND}_{ij})^{-1}$ (FDErecPred Vs Etrue) – normalized to ND efficiency (Etrue)

Unfolding:

$(M_{ij}^{ND})^{-1}$ × ND SelectedEventsCC (FDErecPred)

ND Generated Events (ETrue)

M^{ND100}_{ij}(FDErecPred Vs Etrue) – normalized to 1 (100% efficiency)

Forward Folding:

M_{ij}^{ND100} × ND Generated (Etrue)

ND Generated Events (FDErecPred)

x FDEfficiency (=100%)

FD Selected Events (FDErecPred)

Apply coefficients

Correct for ND Efficiency + FD Efficiency standard

Network trained for "Selected Events" only

1. Start with NDSelected Events (NDErec)
2. Subtract ND Background (NDErec)

→ **NDSelectedEventsCC(Erec)** =
NDSelectedEvents (NDErec) - ND Background (NDErec)

ND Selected EventsCC (NDErec)

$(M^{ND}_{ij})^{-1}$ (Erec Vs Etrue)
– normalized to ND efficiency (Etrue)

Unfolding:
$(M_{ij}^{ND})^{-1}$ × ND SelectedEventsCC (NDErec)

ND Generated Events (ETrue)

M^{FD}_{ij} (FDErec Vs Etrue)
normalized to FD efficiency (Etrue)

Forward Folding:
M^{FD}_{ij} × ND Generated (Etrue)

FD Selected Events (FDErec)

Apply coefficients