Implementing the Near → Far Extrapolation within DUNE-PRISM software
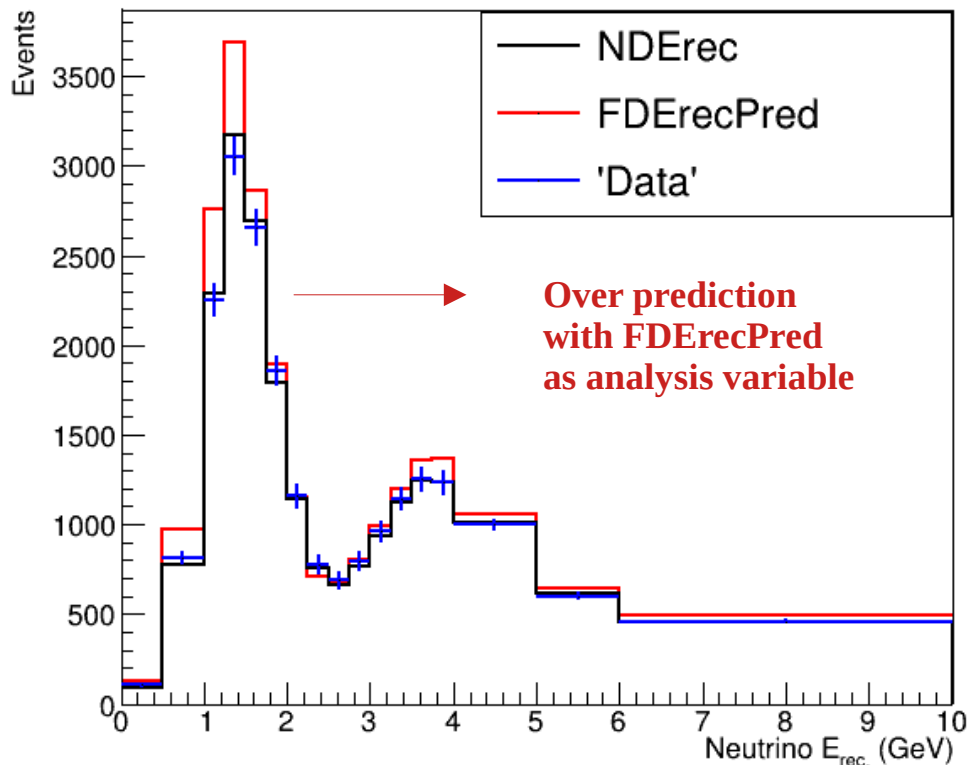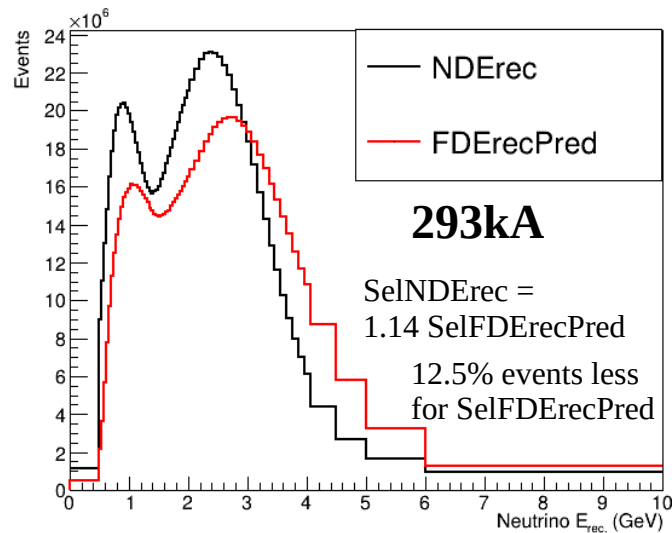
PRISM Analysis with FDErecPred

- Same PRISM analysis as before but working with **FDErecPred as analysis variable** does not produce perfect results yet… → why?

Over prediction with FDErecPred as analysis variable

* classic FD Erec binning

Still under investigation...

280kA

SelNDErec = 1.16 SelFDErecPred

13.85% events less for SelFDErecPred

293kA

SelNDErec = 1.14 SelFDErecPred
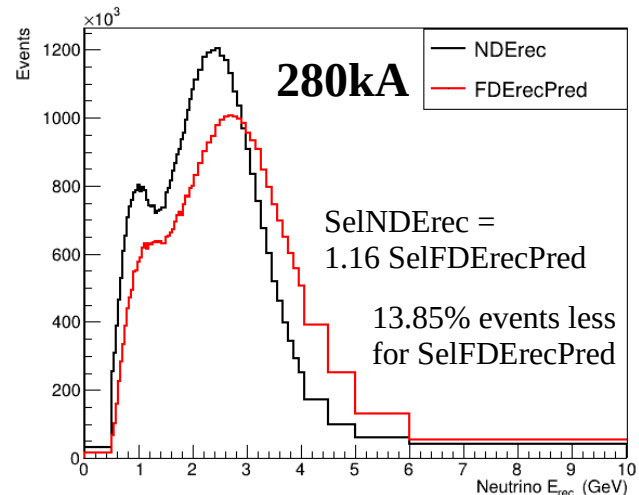
12.5% events less for SelFDErecPred

PRISM Analysis with FDErecPred

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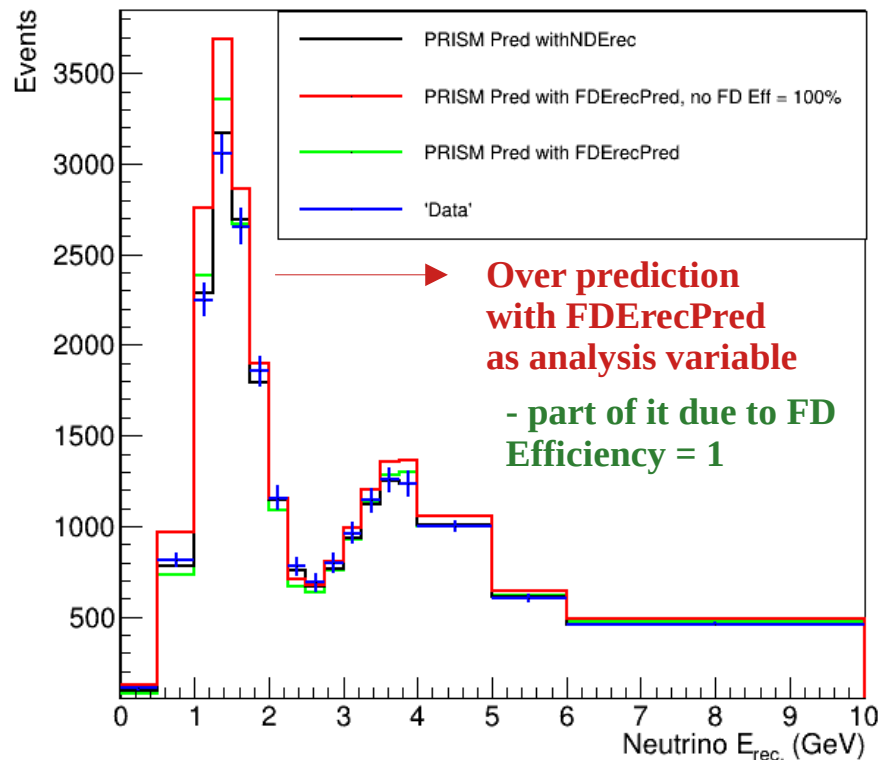

Over prediction with FDErecPred as analysis variable

- part of it due to FD Efficiency = 1

* classic FD Erec binning

Still under investigation...

280kA

SelNDErec = 1.16 SelFDErecPred

13.85% events less for SelFDErecPred

293kA

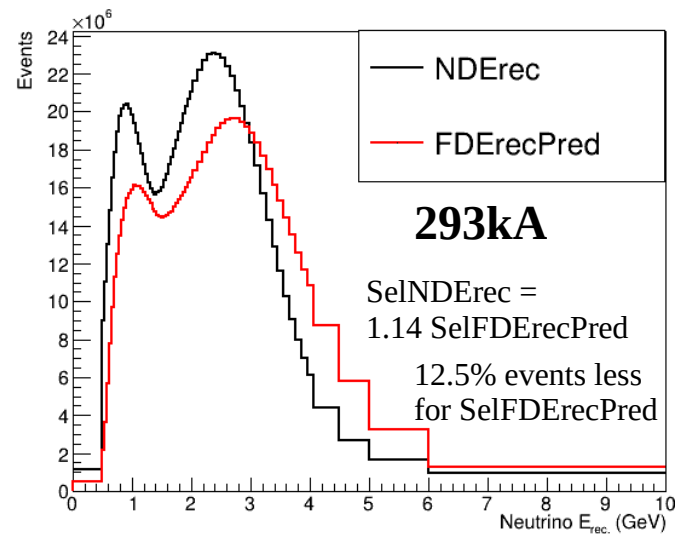SelNDErec = 1.14 SelFDErecPred
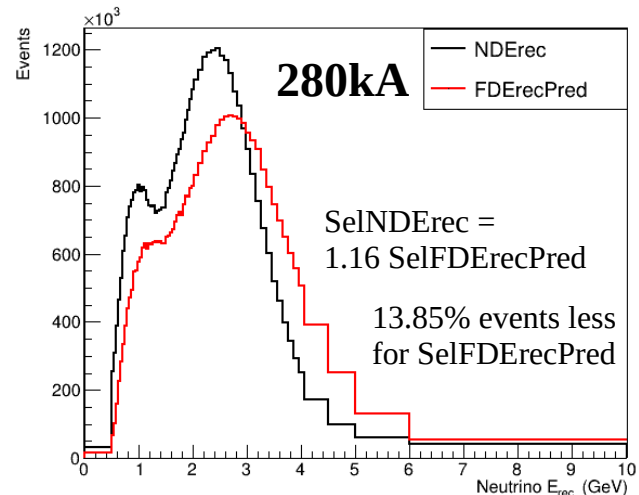
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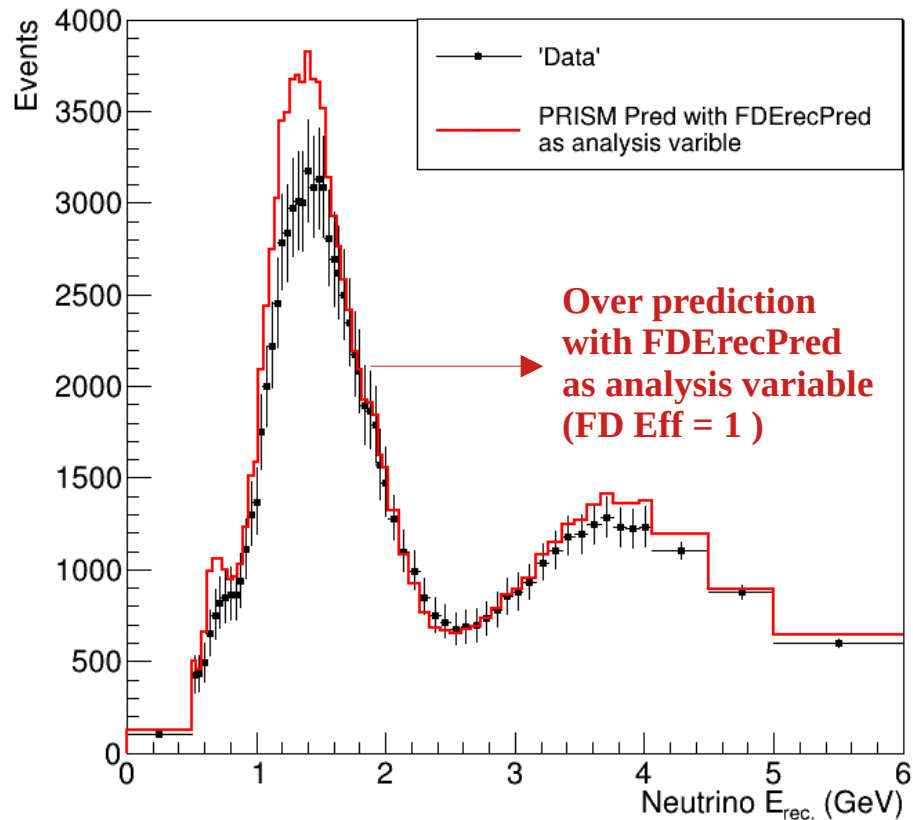

Over prediction with FDErecPred as analysis variable (FD Eff = 1)

* finer FD Erec binning (same as ND Erec)

Still under investigation...
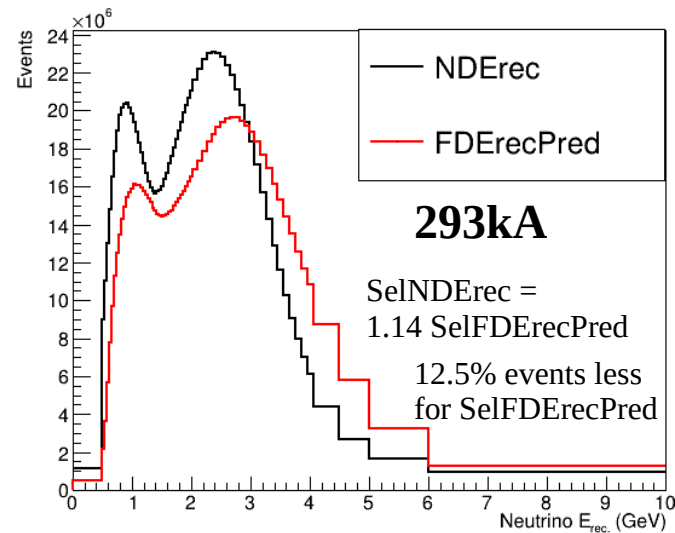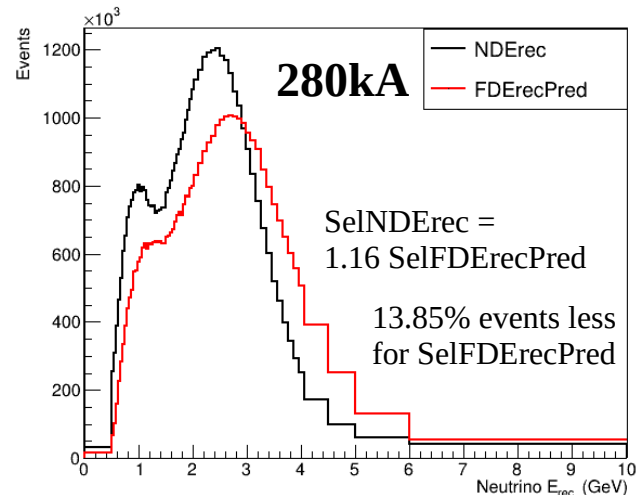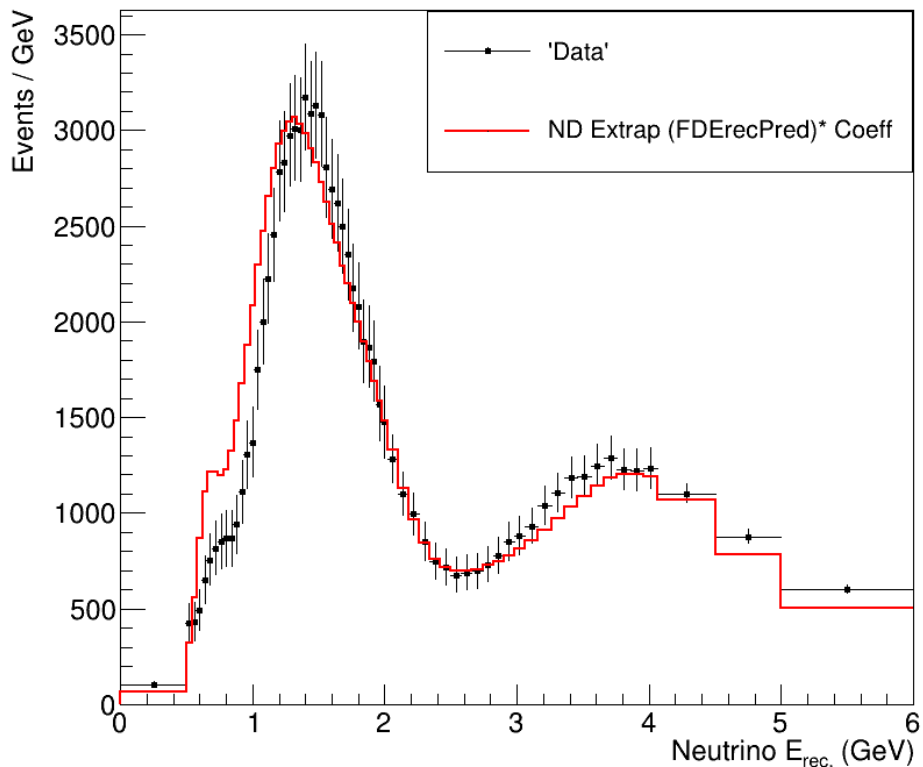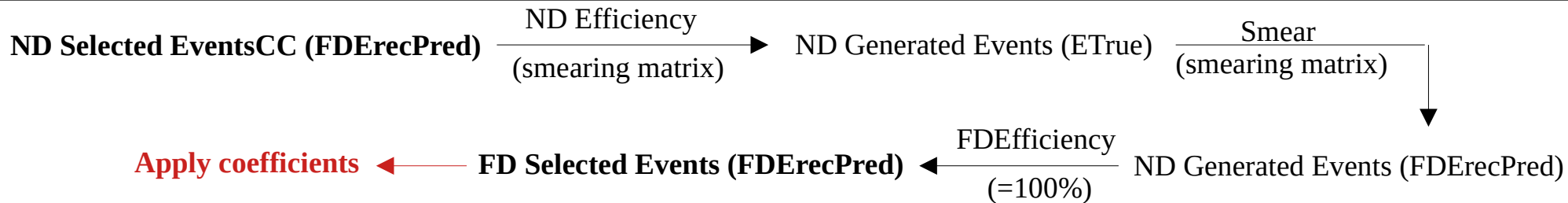
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PRISM Analysis with FDErecPred : applying coefficients

ND Selected EventsCC (FDErecPred) $\xrightarrow[\text{(smearing matrix)}]{\text{ND Efficiency}}$ ND Generated Events (ETrue) $\xrightarrow[\text{(smearing matrix)}]{\text{Smear}}$

Apply coefficients $\longleftarrow$ **FD Selected Events (FDErecPred)** $\xleftarrow[\text{(=100\%)}]{\text{FDEfficiency}}$ ND Generated Events (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 <u>not summing over all NDErec (I.e FDErecPred) bins</u>, but rather less bins (by default in PRISM analysis different NDErec and FDErec bins)

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

PRISM Analysis with FDErecPred : applying coefficients

ND Selected EventsCC (FDErecPred) $\xrightarrow{\text{ND Efficiency}}$ ND Generated Events (ETrue) $\xrightarrow{\text{Smear}}$

(smearing matrix)   (smearing matrix)

+ FD Bkg

Apply coefficients ◄—— **FD Selected Events (FDErecPred)** ◄—— $\dfrac{\text{FDEfficiency}}{\text{(=100\%)}}$ ND Generated Events (FDErecPred)

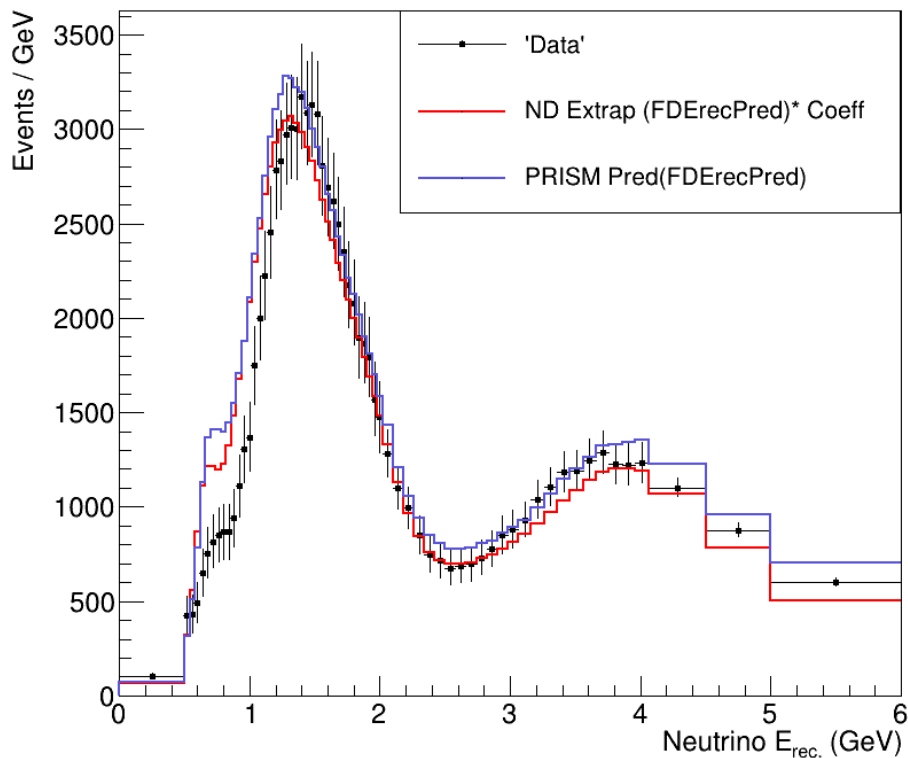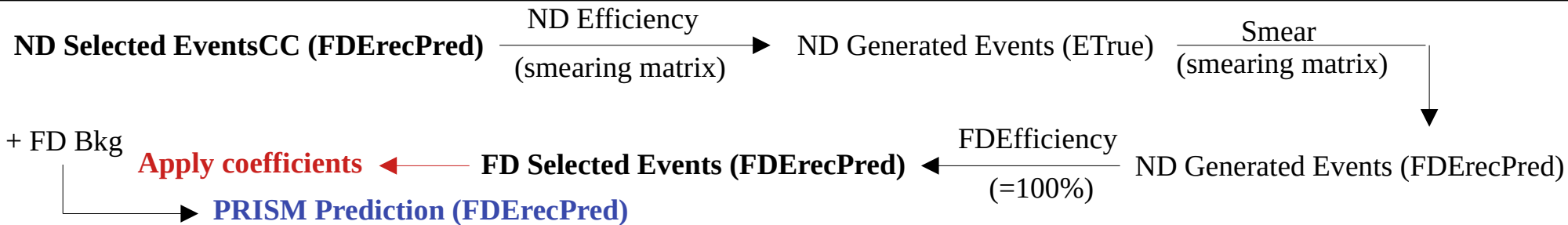**PRISM Prediction (FDErecPred)**

- 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 <u>not summing over all NDErec (I.e FDErecPred) bins</u>, but rather less bins (by default in PRISM analysis different NDErec and FDErec bins)

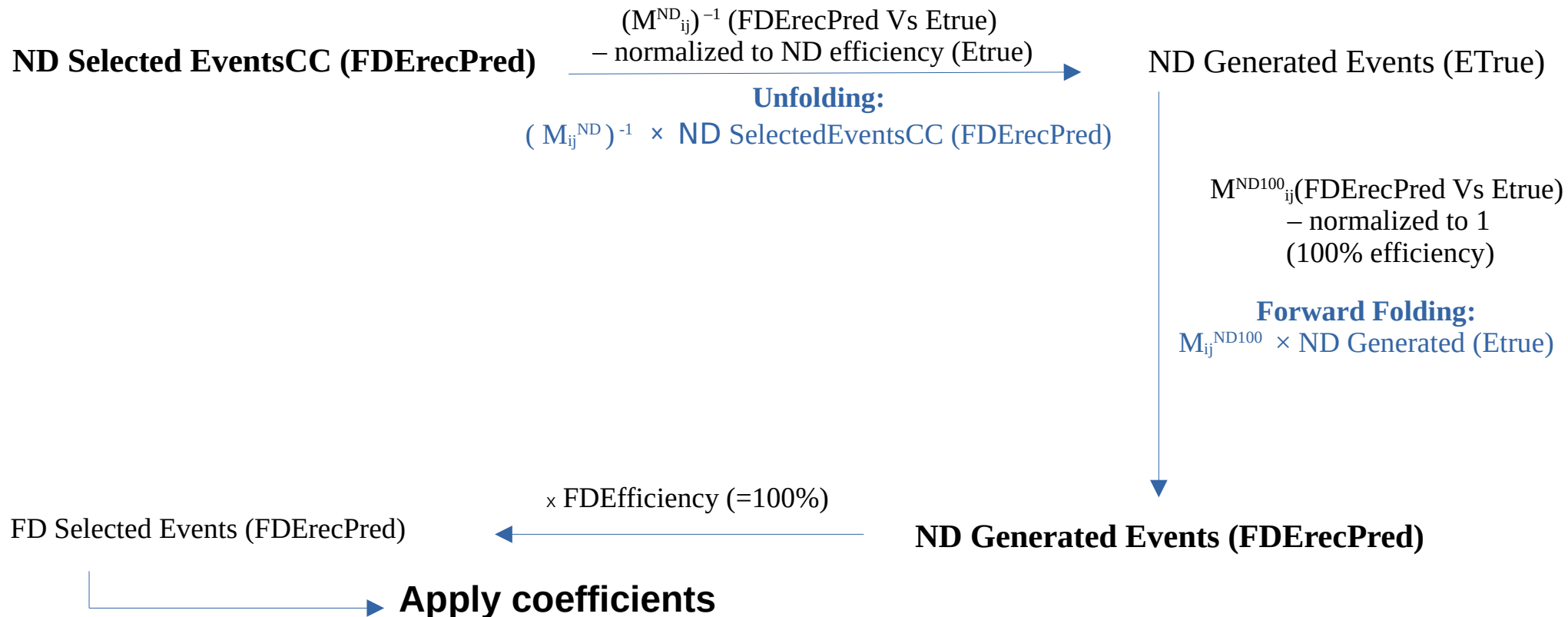- ND Extrapolated Spectrum from FDErecPred: over prediction + peak shift 🙁

- 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)

$\rightarrow$ **NDSelectedEventsCC (FDErecPred)** =
NDSelectedEvents (FDErecPred) - ND Background (FDErecPred)

ND Selected EventsCC (FDErecPred)

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

$\longrightarrow$

ND Generated Events (ETrue)

Unfolding:
$(M_{ij}^{ND})^{-1} \times$ ND SelectedEventsCC (FDErecPred)

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

Forward Folding:
$M_{ij}^{ND100} \times$ ND Generated (Etrue)

FD Selected Events (FDErecPred)

$_\times$ FDEfficiency (=100%)

$\longleftarrow$

ND Generated 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)

$\rightarrow$ **NDSelectedEventsCC(Erec)** = NDSelectedEvents (NDErec) - ND Background (NDErec)

ND Selected EventsCC (NDErec)

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

$\longrightarrow$

ND Generated Events (ETrue)

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

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

Forward Folding:
$M^{FD}_{ij} \times$ ND Generated (Etrue)

FD Selected Events (FDErec) $\longleftarrow$

$\longrightarrow$ **Apply coefficients**