

Update on Sensitivity Study

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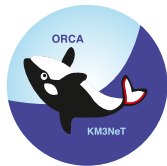
Nikhef, Amsterdam

ORCA call
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KM3NeT

Opens a new window on our universe



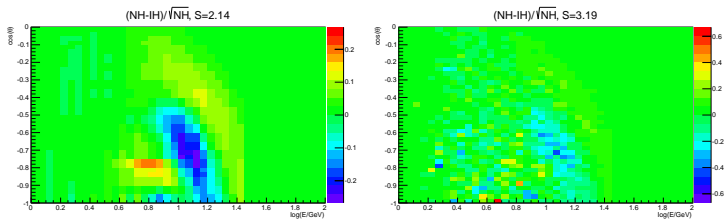
New Approach to Include y

- ▶ Normally: smearing in three steps with response matrices:
 - ▶ Bjorken y , 2D: $y_{\text{true}} \rightarrow y_{\text{reco}}$
 - ▶ Zenith angle, 3D: $(E_{\text{true}}, \cos(\theta_{\text{true}})) \rightarrow \cos(\theta_{\text{reco}})$
 - ▶ Energy, 2D: $E_{\text{true}} \rightarrow E_{\text{reco}}$
 - ▶ Filled from MC events
 - ▶ Correlations between reconstructed values are neglected
- ▶ Idea from Maarten: instead, model detector response by looping over all MC events
- ▶ Automatically takes into account all correlations between true/reconstructed E , $\cos(\theta)$ and y
- ▶ I call it **“Ntuple smearing”**
- ▶ Equivalent to one huge 6D response matrix

$$(y_{\text{true}}, E_{\text{true}}, \cos(\theta_{\text{true}})) \rightarrow (y_{\text{reco}}, E_{\text{reco}}, \cos(\theta_{\text{reco}}))$$

But... it is very sparse. This could be a problem (artifacts)

Ntuple smearing

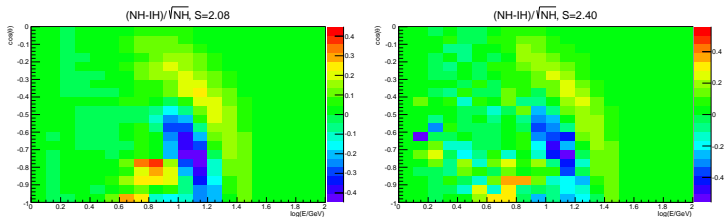


*Track channel asymmetry.
Left: normal smearing. Right: Ntuple smearing.*

- ▶ This is an example with my usual 40x40 binning
- ▶ The Ntuple smearing causes artifacts
- ▶ Signature and χ^2 -significance are wrong

Ntuple smearing

- ▶ **Solution:** reduce the number of bins



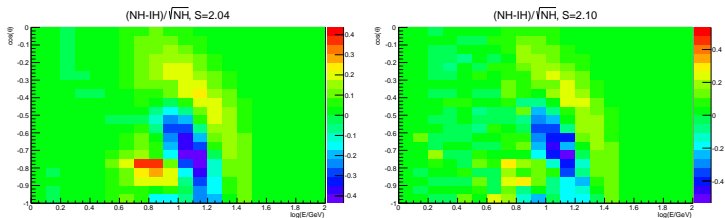
Track channel asymmetry.

Left: normal smearing. Right: Ntuple smearing.

- ▶ This is an example with 20x20 binning
- ▶ Normal smearing looks too coarse
- ▶ Ntuple smearing still has artifacts (especially at low energies)

Ntuple smearing

- ▶ **Solution:** sample each bin multiple times

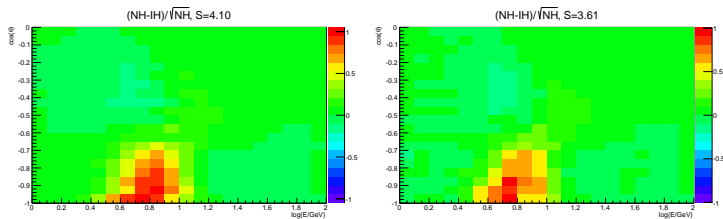


Track channel asymmetry.

Left: normal smearing. Right: Ntuple smearing.

- ▶ This is an example with 20x20 binning **and 2x2 oversampling**
- ▶ Ntuple smearing now looks okayish
- ▶ track channel χ^2 's are comparable $2.04 \approx 2.10$

Ntuple smearing



Cascade channel asymmetry.

Left: normal smearing. Right: Ntuple smearing.

- ▶ cascade channel χ^2 's are rather different: 4.10 and 3.61 (corresponds to $\approx 30\%$ difference in operation time)
- ▶ pattern looks the same and artifacts seem to be under control

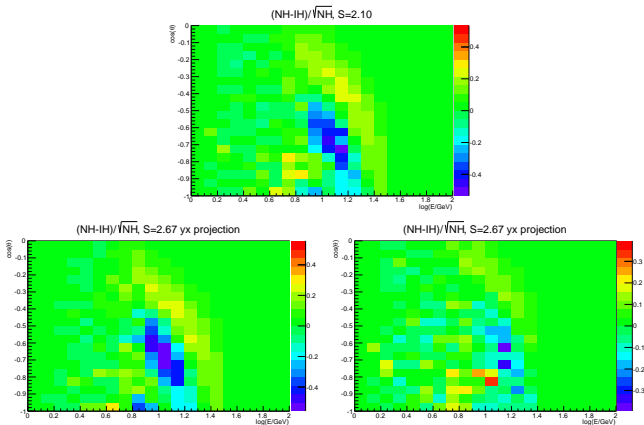
Bin Size Dependence?

- ▶ Note: normal smearing sensitivity changes with bin size
 - ▶ track channel 2.14 (40x40) \rightarrow 2.04 (20x20)
 - ▶ track channel 4.23 (40x40) \rightarrow 3.61 (20x20)
- ▶ Probably the large bin size artificially worsens the resolution
- ▶ But... the effect is largest in the cascade channel
- ▶ Should investigate

Bjorken y

- ▶ Ntuple smearing now yields reasonable but different results
⇒ Can be used to estimate effect of Bjorken y but only roughly
- ▶ Compare using 2 y_{reco} bins (boundary at 0.5) to the usual 1 bin.

Bjorken y - track channel

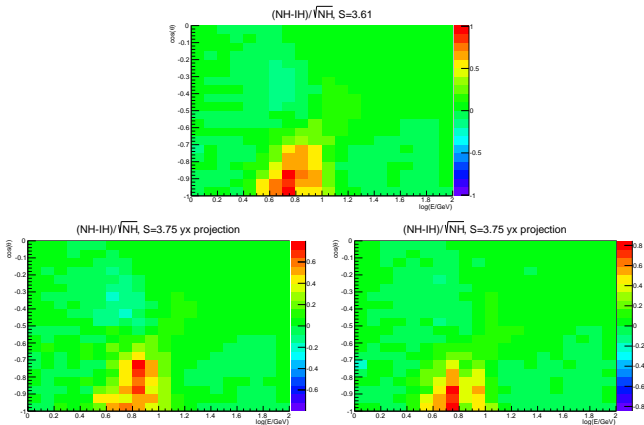


Top: 1 Bjorken y bin.

Bottom: 2 Bjorken y bins (left: $y_{reco} < 0.5$, right: $y_{reco} > 0.5$).

Note: titles show combined χ^2 for both Bjorken y bins

Bjorken y - cascade channel



Top: 1 Bjorken y bin.

Bottom: 2 Bjorken y bins (left: $y_{reco} < 0.5$, right: $y_{reco} > 0.5$).

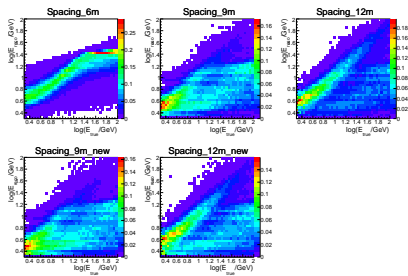
Note: titles show combined χ^2 for both Bjorken y bins

Bjorken y - summary

- ▶ Very simple study of effect of Bjorken y
- ▶ Compared 2 bins (some sensitivity) to 1 bin (no sensitivity)
- ▶ Large difference in track channel (low Bjorken y has clearer signature)
 χ^2 2.10 \rightarrow 2.67 (\approx 60% improvement expressed in operation time)
- ▶ Small difference in cascade channel
 χ^2 3.61 \rightarrow 3.75 (\approx 8% improvement expressed in operation time)
- ▶ Looks very promising
- ▶ But we must be cautious
 - ▶ sensitive to statistical artifacts
 - ▶ no fit of parameters or systematics included

Spacing Studies

- ▶ Currently on a halt due to lack of proper input
- ▶ Received files for 9m and 12m spacing from Thomas on 26 August
- ▶ Generated effective masses and resolutions
(/sps/km3net/users/mjongen/spacing_comparison/figures)
⇒ these look very weird
- ▶ Problem is probably found but Thomas should comment



Example: track energy response for the different spacings

Other Lol Preparations

- ▶ Working on method to fit systematics without changing the oscillation parameters at the same time
⇒ could drastically shorten simulation time and allow us to put in more systematics
- ▶ Don't know yet whether the Ntuple smearing is fast enough for minimization. Have to optimize the code.
- ▶ Proposal: after final ingredients (effective masses, resolutions, PID and muon rejection cut) for the three spacings are finalized we should take some time to study them before running the final simulations.