Ongoing Activities Report
Beginning of May 2020

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**The 19th of May 2020**

Historic village near SK

ND280 Upgrade

Cross-Sections Splines

- Norm splines are applied only on the right reactions
  - **https://www.t2k.org/asg/oagroup/inputs/FY19-oa-inputs/niwginputs**
  - X-check with BANFF

Parameter Name	Type	Nominal	Prior	Bounds	Type
MAQE	Spline, CCQE	1.21	1.03 ±0.06	0	Gaussian
2p2h norm. nu	Norm, 2p2h, neutrino, all targets	1	1.0	0	Flat
2p2h norm. nubar	Norm, 2p2h, anti-neutrino, all targets	1	1.0	0	Flat
2p2h norm. CtoO	Norm, 2p2h, oxygen targets only (multiplicative with other 2p2h weights)	1	1.0±0.2	0	Gaussian
2p2h shape C	Spline, 2p2h, carbon targets only	0	0±3.0	−1, +1	Gaussian
2p2h shape O	Spline, 2p2h, oxygen targets only	0	0±3.0	−1, +1	Gaussian
2p2h Low Enu nu	Spline, 2p2h, Enu < 0.6 GeV, neutrino	1		−1, 0 (mirrored above 0 to 0.5)	Flat
2p2h High Enu nu	Spline, 2p2h, Enu > 0.6 GeV, neutrino				
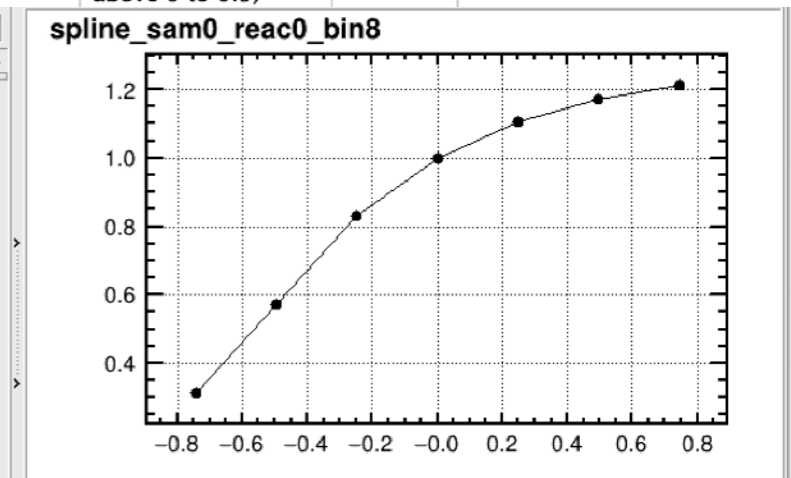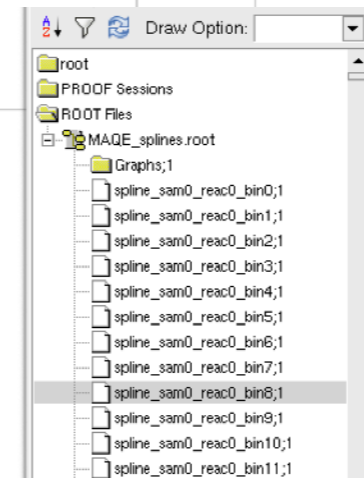
- Zeroed splines have been fixed
  - Needed to update genWeights **and NEUT**
  - Redownloaded neutcard (mine was actually broken)

- All splines have been regenerated with run8a and run8w simulations
  - Quick check : does every splines return 1 when the parameter is at the prior value ?
  - Every single spline were validated except 1:

```
Checking : ISO_BKG_splines.root
Checking : MAQE_splines.root
<ALERT> spline_sam0_reac7_bin13 -> spline->Eval(0)=0.796083
Checking : MARES_splines.root
Checking : NC_1gamma_splines.root
```

Running The Fitter

- Still the fit did not converge :

```
VariableMetric: Iteration #  36 - FCN =   41.26789862904 Edm =  1.05145e+10 NCalls =   7022
Info: VariableMetricBuilder: no improvement in line search
VariableMetric: Iteration #  37 - FCN =   41.26789862904 Edm =  1.05145e+10 NCalls =   7033
Info: VariableMetricBuilder: iterations finish without convergence.
Info in VariableMetricBuilder : edm = 1.0662e+10
Info in              requested : edmval = 2e-07
Info in VariableMetricBuilder: INVALID function minimum - edm is above tolerance, : edm = 1.05145e+10
Info in VariableMetricBuilder: Required tolerance  is 10 x edmval  : edmval = 2e-07
Info in Minuit2Minimizer::Minimize : Minimization did NOT converge, Edm is above max
Minuit2Minimizer : Invalid Minimum - status = 3
FVAL   = 41.2679
Edm    = 1.05145e+10
Nfcn   = 7022
[ERROR]: Fit did not converge while running Migrad
[ERROR]: Failed with status code: 3
```

- Chi^2 stat at the beginning of the fit is a lot lower but still not 0

```
[XsecFitter]: Func Calls: 1
[XsecFitter]: Chi2 total: 3.24122e+11
[XsecFitter]: Chi2 stat : 3.24122e+11
[XsecFitter]: Chi2 syst : 0
```

```
[XsecFitter]: Func Calls: 1
[XsecFitter]: Chi2 total: 4220.86
[XsecFitter]: Chi2 stat : 4220.86
[XsecFitter]: Chi2 syst : 0
```

What's Next ?

- **X-section splines generation**
  - Generate Validation Plots (reference ?)
  - Generate antineutrino splines: for the moment genWeights does not run on RHC runs (debug stage in discutions with devs…) **(solved -> processing all RHC runs)**

Clarence 7:00 PM
Yeah don't use head

with nd280 software any release that has an odd number on the revision is a stable release, even number is development

- **ND280Up Fit**
  - Fix non-Zero Asimov chi^2
  - Fix convergence problem
  - **Add detector covariance matrix** **(currently processing)**
  - **Implement better indexing of splines**
  - Implement other neutrino flavours to the Fit
  - Validate with BANFF data

T2K-SK Joint Fit

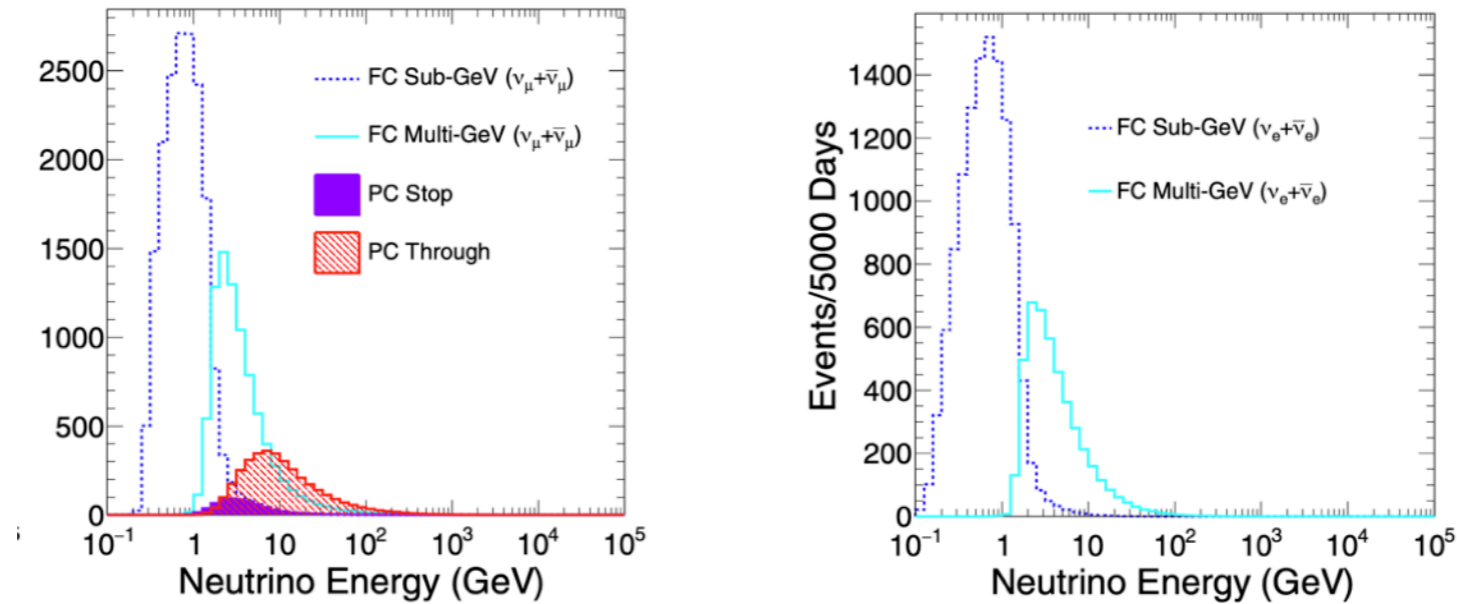# Generating Toy Spectra For P-Theta

- Goal : **Providing sensible spectra for a given propagation length as an input of p-Theta**
- Matter effects on oscillation patterns will be neglected as a first approx
- Converting cos_theta_Z to propagation length
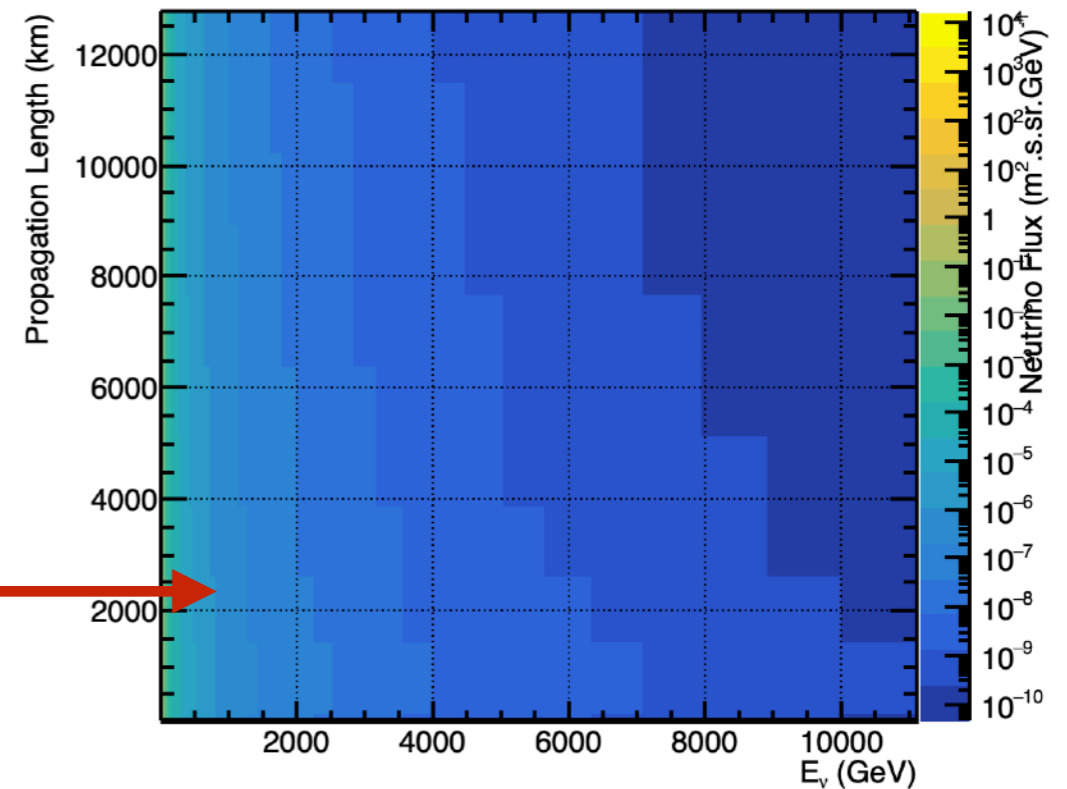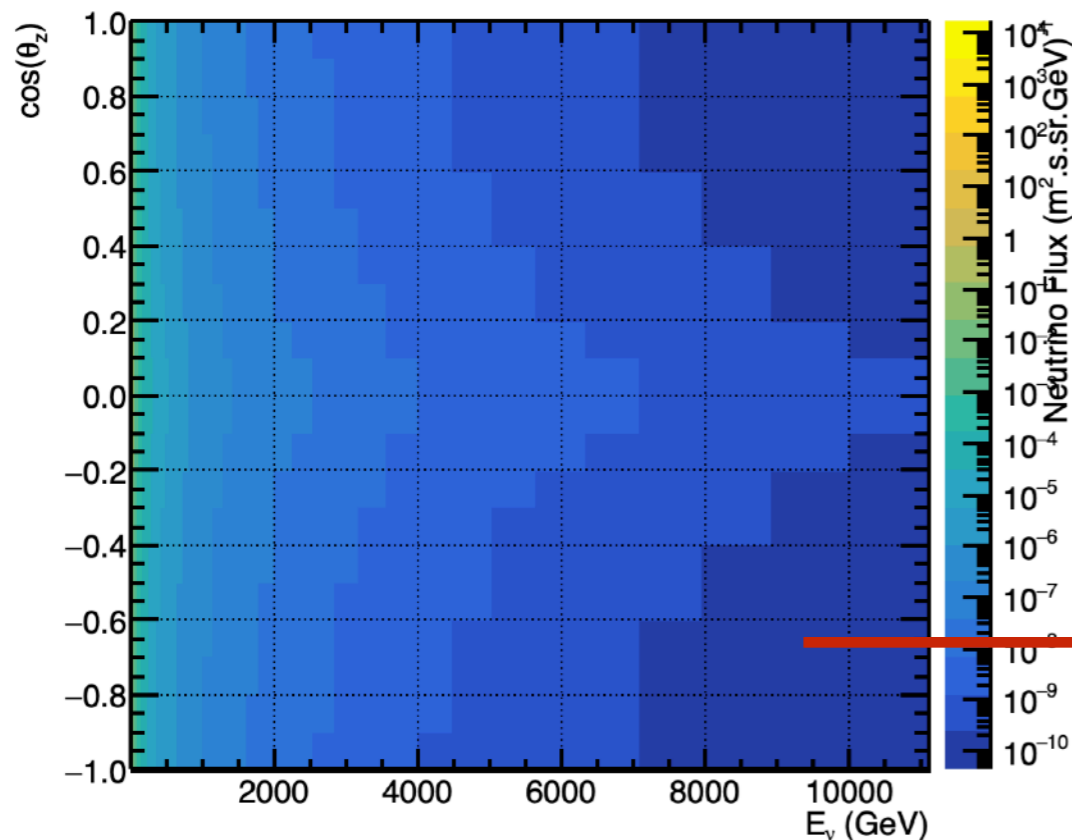
- Assuming a constant altitude of production : 15km
- Need to apply detector efficiency

- Assuming the the spectra from SK paper are the sum of all cos_theta_bins

- Reweighting spectra with the detection efficiency

$$\sum_c M_{ce} \times \varepsilon(E_e) = M_e^{SK} \quad \longrightarrow \quad \varepsilon(E_e) = \frac{M_e^{SK}}{\sum_c M_{ce}} \quad \longrightarrow \quad M_{ce}^{RW} = M_{ce} \times \varepsilon(E_e)$$
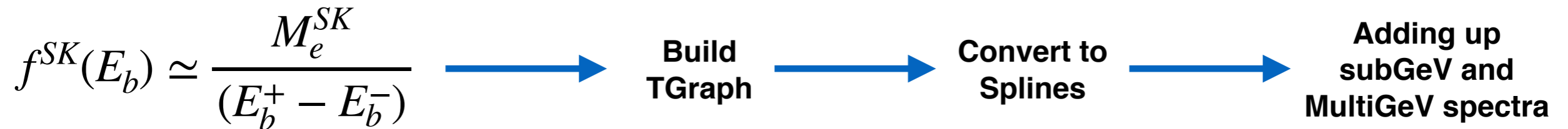
- Need to make sure the energy binning is coherent : switching to spectral density function

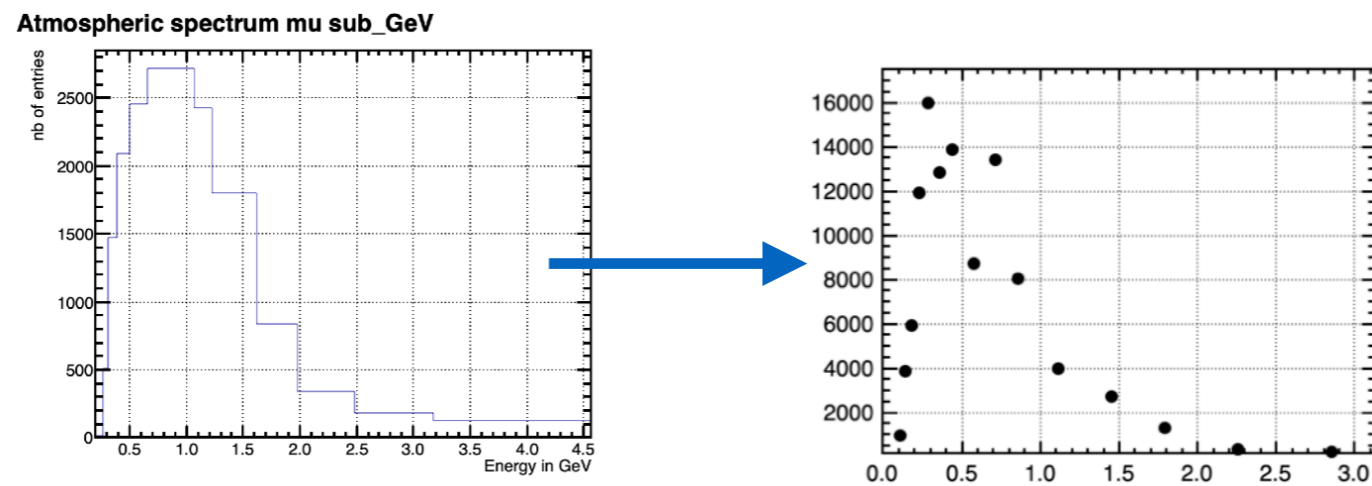$$M_e^{SK} = \int_{E_b^-}^{E_b^+} f^{SK}(E)dE \simeq f^{SK}(E_b) \times (E_b^+ - E_b^-)$$

$$M_e^{SK} = \int_{E_b^-}^{E_b^+} f^{SK}(E)dE \simeq f^{SK}(E_b) \times (E_b^+ - E_b^-)$$

- In partice :

$$f^{SK}(E_b) \simeq \frac{M_e^{SK}}{(E_b^+ - E_b^-)}$$

→ **Build TGraph** → **Convert to Splines** → **Adding up subGeV and MultiGeV spectra**
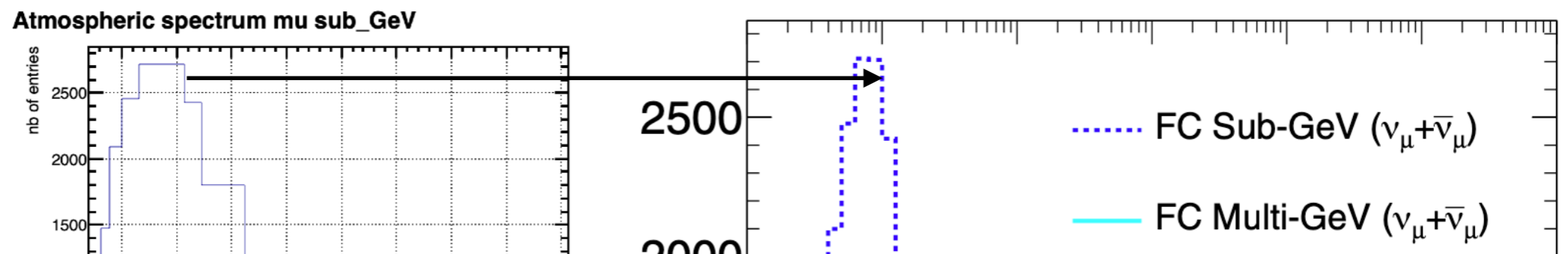
- Trying is with digitalised histograms by Lucile

- Need to be very careful with the binning

9

Next Steps

- **Generating Toy Spectra**
  - Re-digitalize SK spectra with a more precise binning
  - Compute the Energy dependent detection efficiency
  - Deduce the spectrum shape for a fixed propagation length

- **Work with P-Theta**
  - Implement 2D histogram fit with different propagation length
  - Validate the fitter with the toy spectra

Thanks for Listening