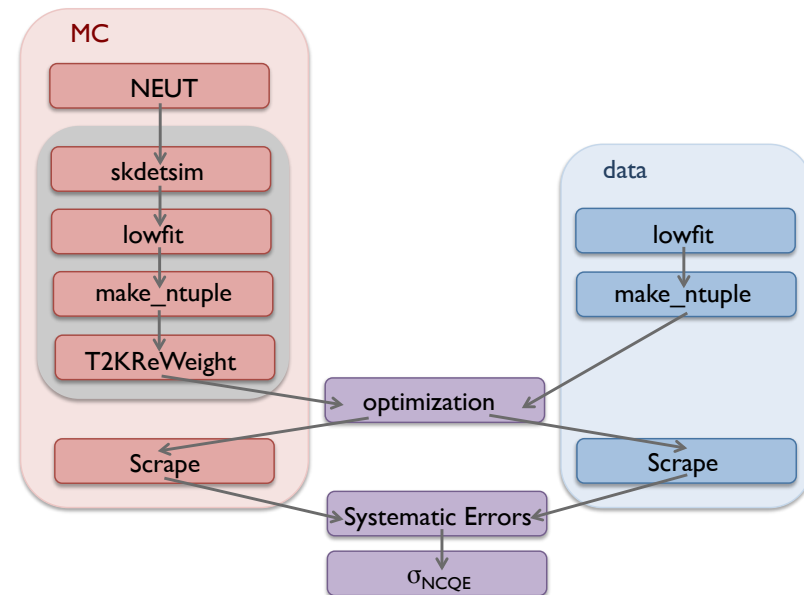


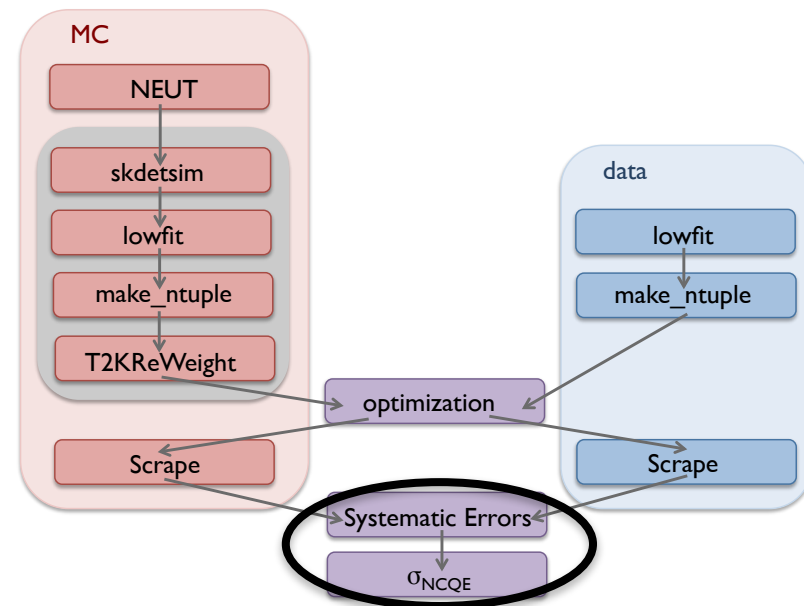
ncgamma analysis tools

Corina Nantais
group meeting
19 July 2017



Systematic Errors and σ_{NCQE}

- t2k.org
- NominalXsec.py calculates the mean and median flux, as well as the flux-averaged nominal cross section based on NEUT and Ankowski
- SysError.py calculates the systematic uncertainties
- StatError.py calculates the uncertainty on the final cross section introduced by the statistical uncertainty in the data



Mistake with Prob3++ replacing SterileAna

- Prob3++ is simpler than SterileAna
- I need some if statements for
 - tree.isCC
 - tree.appeared
- followed old ncgamma/SterileAna/SterileAna/SterileOsc.cc

```
if (tree.isCC !=0 and tree.isCC!=1): print "isCC = ",tree.isCC
if tree.appeared !=0: print "appeared = ",tree.appeared

if tree.isCC == 1:
    if tree.appeared == 1: posc = b.GetProb(2,1)
    elif tree.inu == 14 or tree.inu == 12 or tree.inu == -14: posc = b.GetProb(nuf lav,nuf lav)
    else: posc = 1
else:
    if tree.appeared == 1: posc = 0
    elif tree.inu == 14 or tree.inu == 12 or tree.inu == -14: posc = 1
    else: posc = 1
```

```

~/ncgamma/SystematicErrors@sukap001[588]_% python SysError.py --total --force-xsec --force-all
[xsecs:      ['ankowski']]
rws:        {'ankowski': ['flux_prefit', 'niwg', 'xsec_prefit']}
categories: ['ncel', 'ccqe', 'ccother', 'ncother', 'bkgd']
flavors:    ['numu', 'numubar', 'nue', 'total']
Counting...
Initialize the event counts by category

Saving counts to syserr_nums.p
Xsec Systematic Calculation
x,r: xsec_nom = (D - nomB)/nomS * xavg[x]
ankowski, flux_prefit: 1.854627 = (59.000000 - 18.530660)/44.005329 * 2.016675
ankowski,      niwg: 1.854627 = (59.000000 - 18.530660)/44.005329 * 2.016675
ankowski, xsec_prefit: 1.773317 = (59.000000 - 20.304906)/44.005329 * 2.016675
ankowski xsec_prefit

ankowski xsec_prefit : 1.77 -> 1.81 +/- 0.155 (8.7%)
ankowski flux_prefit

ankowski flux_prefit : 1.85 -> 1.94 +/- 0.31 (16.7%)
ankowski gamma

ankowski gamma      : 1.77 -> 1.89 +/- 0.479 (27.0%)
ankowski det

ankowski det        : 1.77 -> 1.81 +/- 0.0596 (3.4%)
ankowski all

ankowski all        : 1.77 -> 1.93 +/- 0.674 (38.0%)
Saving xsecs to syserr_xsec.p

```

D = 59

nomB = 19 or 20

nomS = 44

ankowski = 2.017

nomB and

nomS

from Scraped/

root files

Run 4 only

102 - 43 = 59 D

34.6 - 16.2 = 18.4 nomB

(77.6+34.6)-(34.8-16.2) = 61.2

77.6-34.8 = 42.8 nomS → new value is low?

Table 22: Summaries of NCQE cross-section of T2K RUN1-3 and T2K RUN1-4.

T2K RUN	N^{obs}	N_{sig}^{exp}	N_{bg}^{exp}	$\langle \sigma_{\nu, NCQE}^{obs} \rangle$	Stat. error	Sys. error
1-3	43	34.8	16.2	$1.55 \times 10^{-38} \text{cm}^2$	$\pm 25.48\%$	+41.93% -21.29%
1-4	102	77.6	34.6	$1.75 \times 10^{-38} \text{cm}^2$	$\pm 15.42\%$	+40.0% -17.63%

sigma = ((59-18.4)/(61.2-18.4))*2.01

sigma = ((59-18.4)/42.8)*2.01

sigma = 1.91

screen 2 of 3

nomS = 44

```

Category: ncel
Flavor: total
  ankowski flux_prefit : 44.01 -> 44.53 +/- 4.81 (10.9%)
  ankowski niwg       : 44.01 -> 45.16 +/- 13.01 (29.6%)
  ankowski xsec_prefit : 44.01 -> 44.84 +/- 0.00 (0.0%)
Category: ccqe
Flavor: total
  ankowski flux_prefit : 1.64 -> 1.64 +/- 0.19 (11.7%)
  ankowski niwg       : 1.64 -> 1.64 +/- 0.00 (0.0%)
  ankowski xsec_prefit : 1.64 -> 1.64 +/- 0.18 (11.1%)
Category: ccother
Flavor: total
  ankowski flux_prefit : 0.75 -> 0.74 +/- 0.09 (11.4%)
  ankowski niwg       : 0.75 -> 0.75 +/- 0.03 (3.6%)
  ankowski xsec_prefit : 1.17 -> 1.18 +/- 0.31 (26.3%)
Category: ncother
Flavor: total
  ankowski flux_prefit : 14.11 -> 14.00 +/- 1.43 (10.2%)
  ankowski niwg       : 14.11 -> 13.42 +/- 0.49 (3.5%)
  ankowski xsec_prefit : 15.46 -> 15.50 +/- 3.15 (20.4%)
Category: bkgd
Flavor: total
  ankowski flux_prefit : 17.33 -> 16.38 +/- 1.68 (9.7%)
  ankowski niwg       : 17.33 -> 15.81 +/- 0.49 (2.8%)
  ankowski xsec_prefit : 19.10 -> 18.32 +/- 3.31 (17.3%)
Cross-section Measurement:
ankowski all      : 1.77 -> 1.93 +/- 0.674 (38.0%) was 2.017
ankowski det     : 1.77 -> 1.81 +/- 0.0596 (3.4%) was 2.017
ankowski flux_prefit : 1.85 -> 1.94 +/- 0.31 (16.7%) was 2.017
ankowski gamma   : 1.77 -> 1.89 +/- 0.479 (27.0%) was 2.017
ankowski xsec_prefit : 1.77 -> 1.81 +/- 0.155 (8.7%) was 2.017

```

events?

need to understand what these are exactly

```
ankowski flux_predit
Nominal xsec[ ankowski flux_predit ]= 1.85462745028
68% CI: 1.60 - 2.24
90% CI: 1.52 - 2.52
95% CI: 1.40 - 2.68
100% CI: 1.24 - 3.24
Info in <TCanvas::Print>: pdf file total_ankowski_flux_predit.pdf has been created
ankowski xsec_predit
Nominal xsec[ ankowski xsec_predit ]= 1.77331739078
68% CI: 1.64 - 2.00
90% CI: 1.52 - 2.08
95% CI: 1.48 - 2.12
100% CI: -0.04 - 2.24
Info in <TCanvas::Print>: pdf file total_ankowski_xsec_predit.pdf has been created
ankowski banff_predit
Skipping banff_predit
ankowski gamma
Nominal xsec[ ankowski gamma ]= 1.77331739078
68% CI: 1.44 - 2.36
90% CI: 1.24 - 2.84
95% CI: 1.12 - 3.12
100% CI: 0.88 - 0.00
Info in <TCanvas::Print>: pdf file total_ankowski_gamma.pdf has been created
ankowski det
Nominal xsec[ ankowski det ]= 1.77331739078
68% CI: 1.72 - 1.88
90% CI: 1.68 - 1.92
95% CI: 1.68 - 1.96
100% CI: 1.64 - 2.00
Info in <TCanvas::Print>: pdf file total_ankowski_det.pdf has been created
ankowski all
Nominal xsec[ ankowski all ]= 1.77331739078
68% CI: 1.26 - 2.66
90% CI: 0.94 - 3.34
95% CI: 0.78 - 3.77
100% CI: -0.01 - 0.00
Info in <TCanvas::Print>: pdf file total_ankowski_all.pdf has been created
```

zero because histo overflow,
I think

total_ankowski_flux_prefit

current work

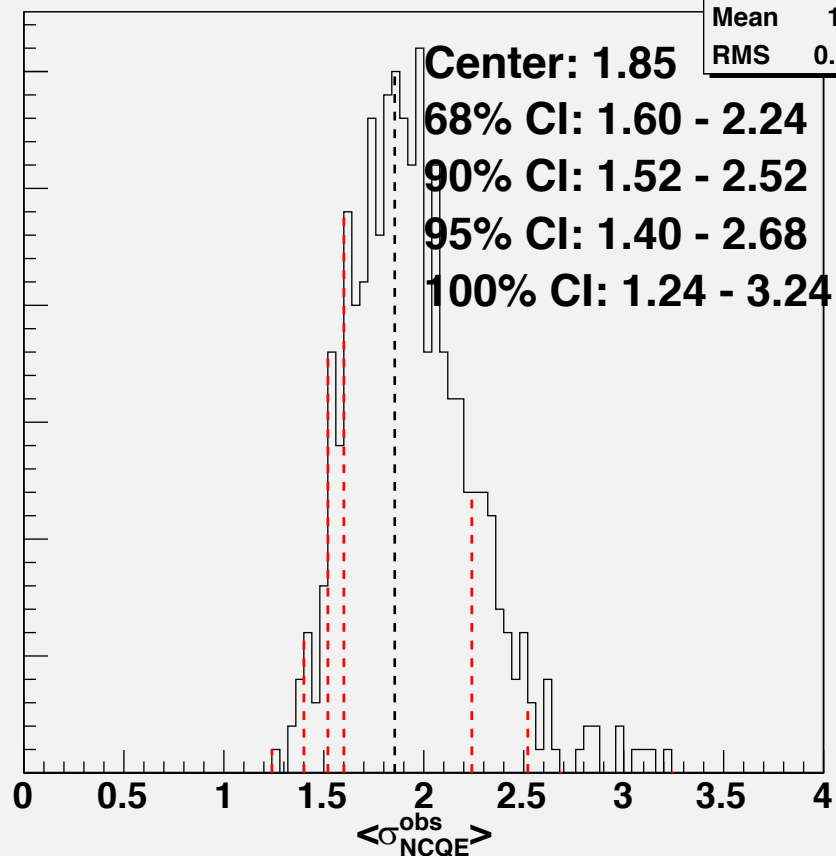
07Jan2016

Systematic Error

hxsec_ankowski_flux_prefit

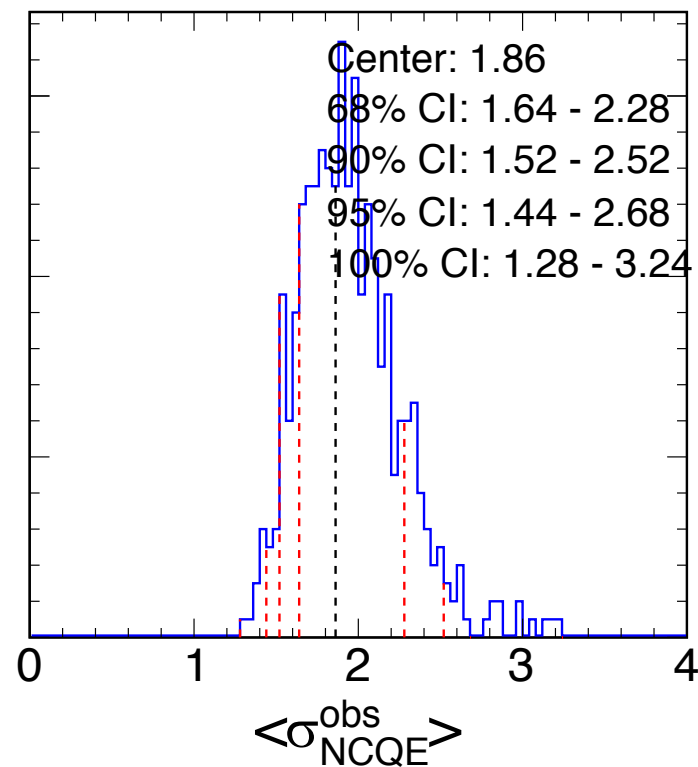
Entries	500
Mean	1.943
RMS	0.3097

Fake Experiments



Systematic Error

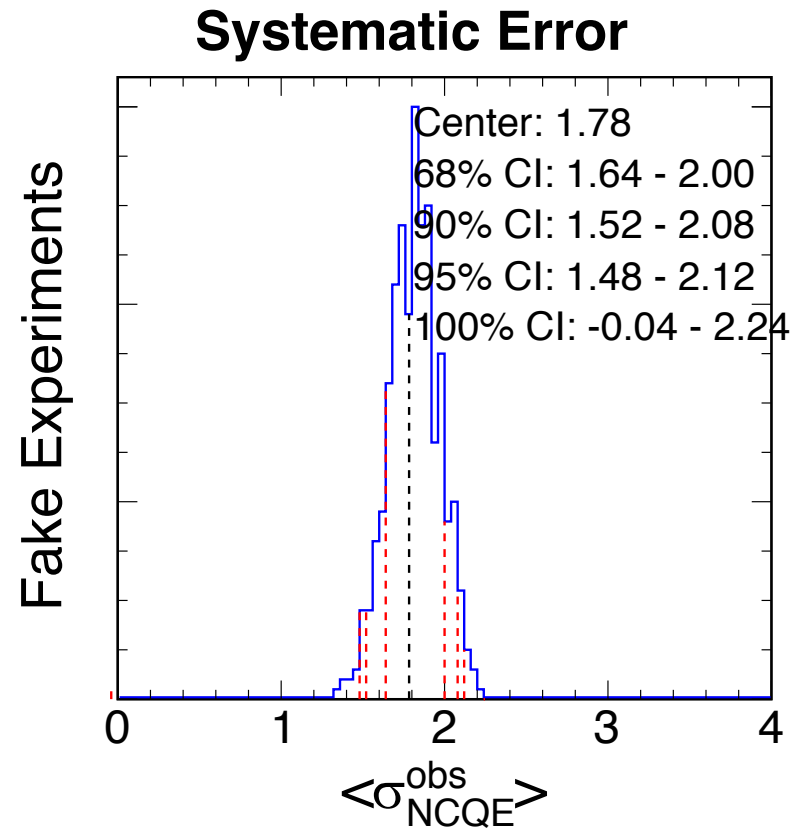
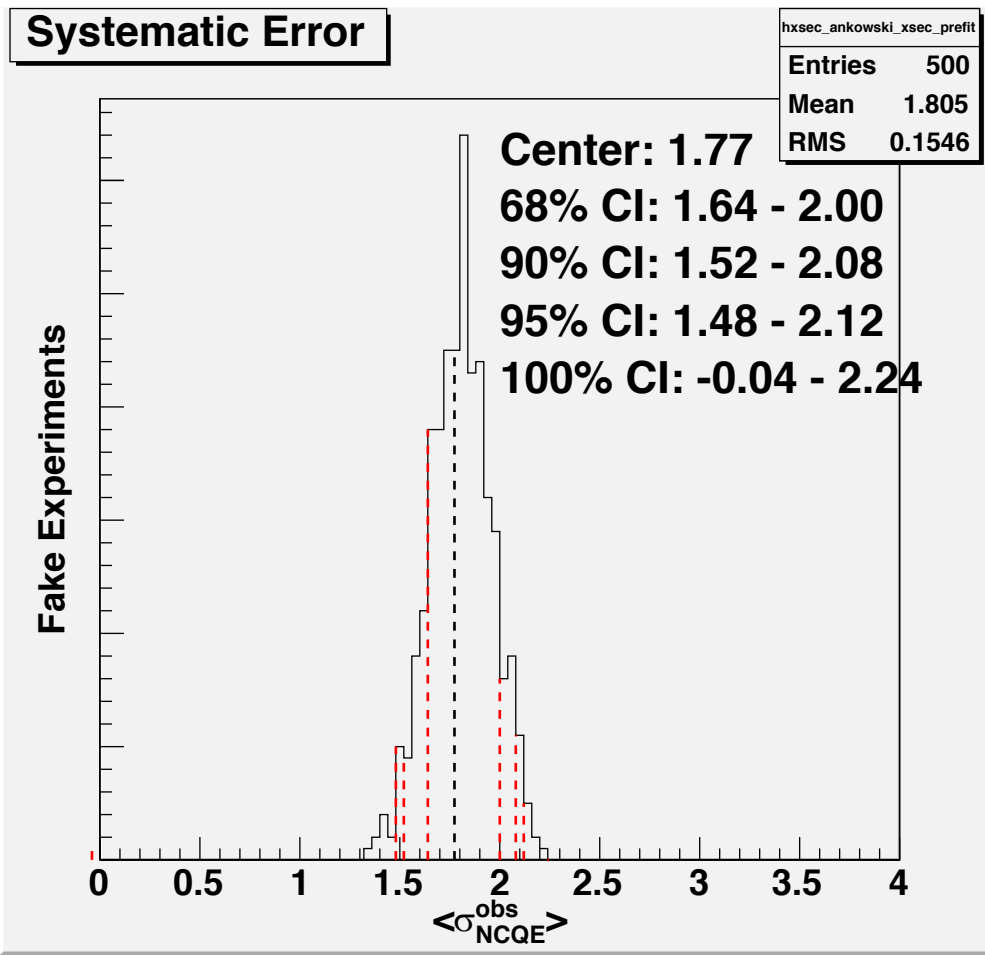
Fake Experiments



total_ankowski_xsec_prefit

current work

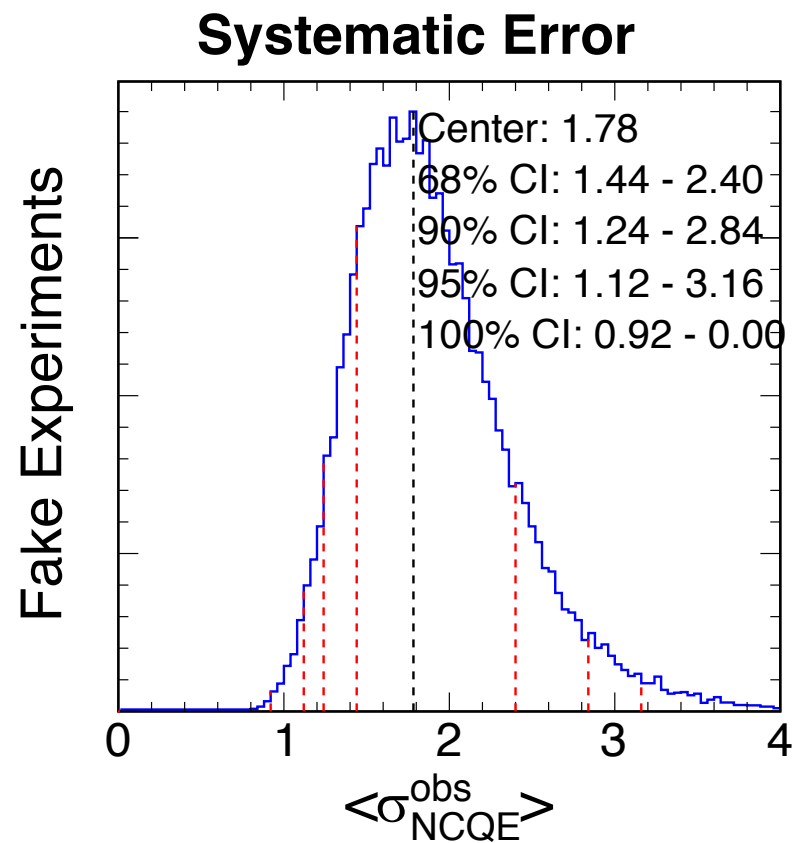
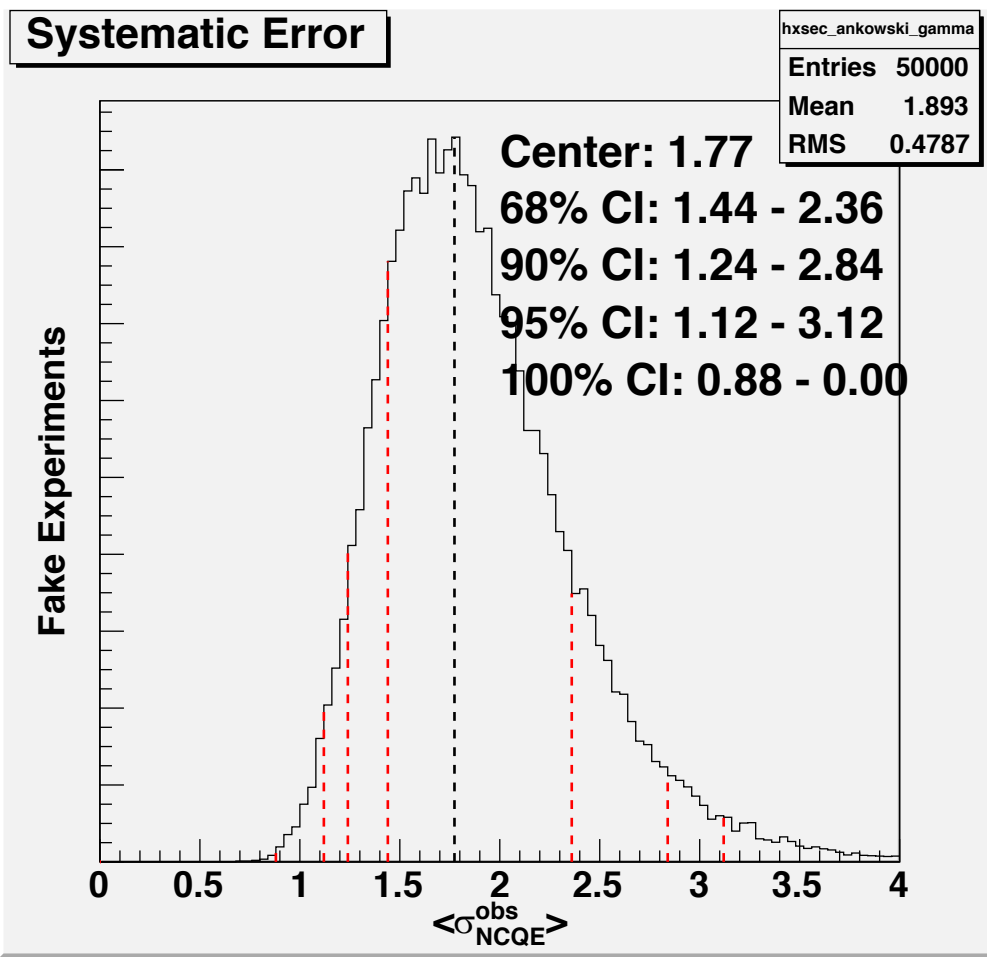
07Jan2016



total_ankowski_gamma

current work

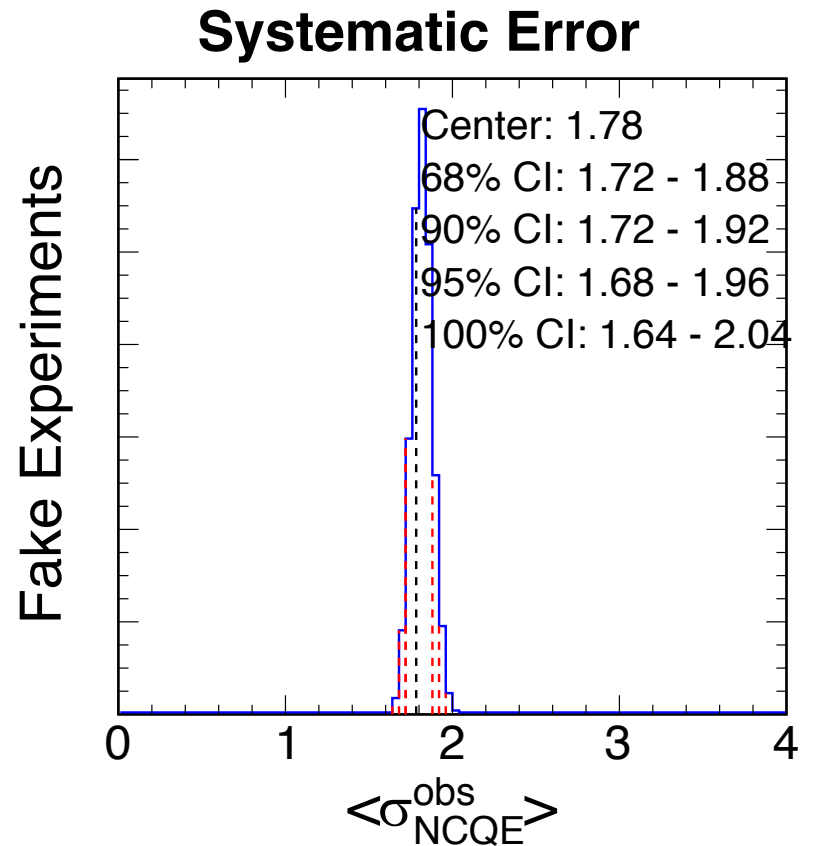
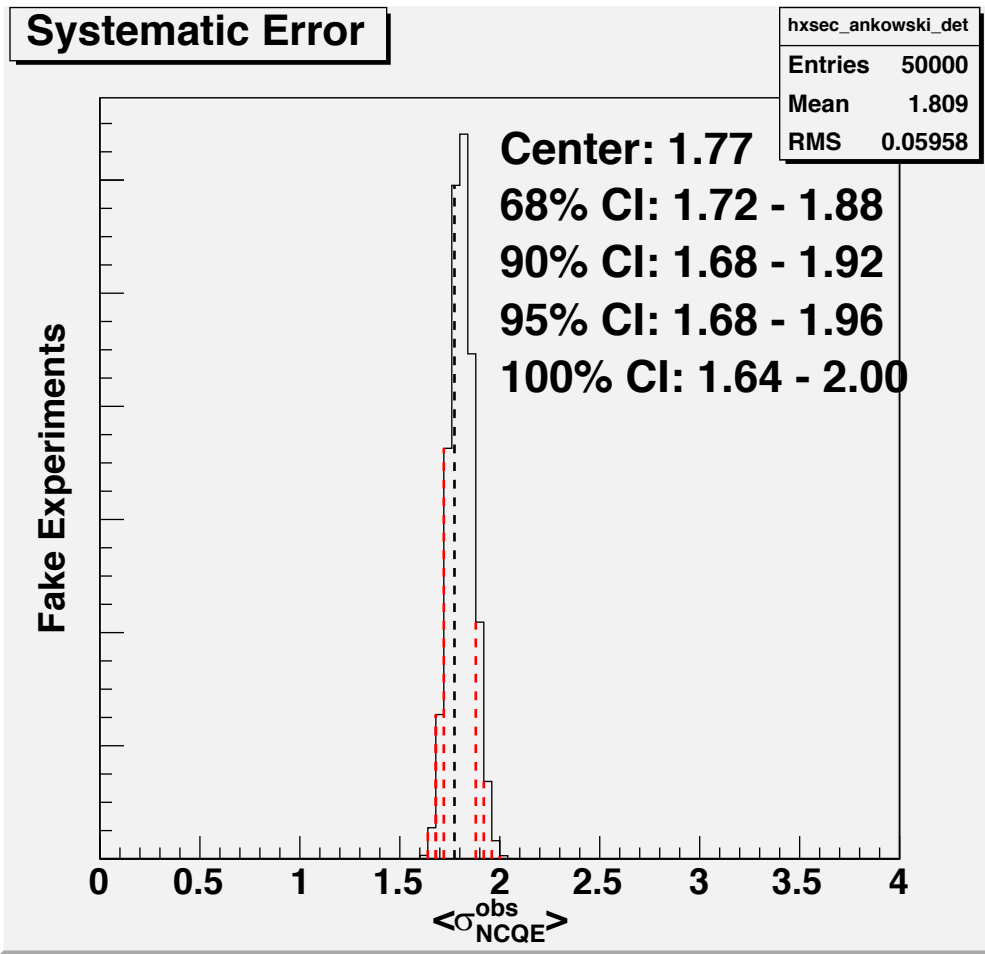
07Jan2016



total_ankowski_det

current work

07Jan2016

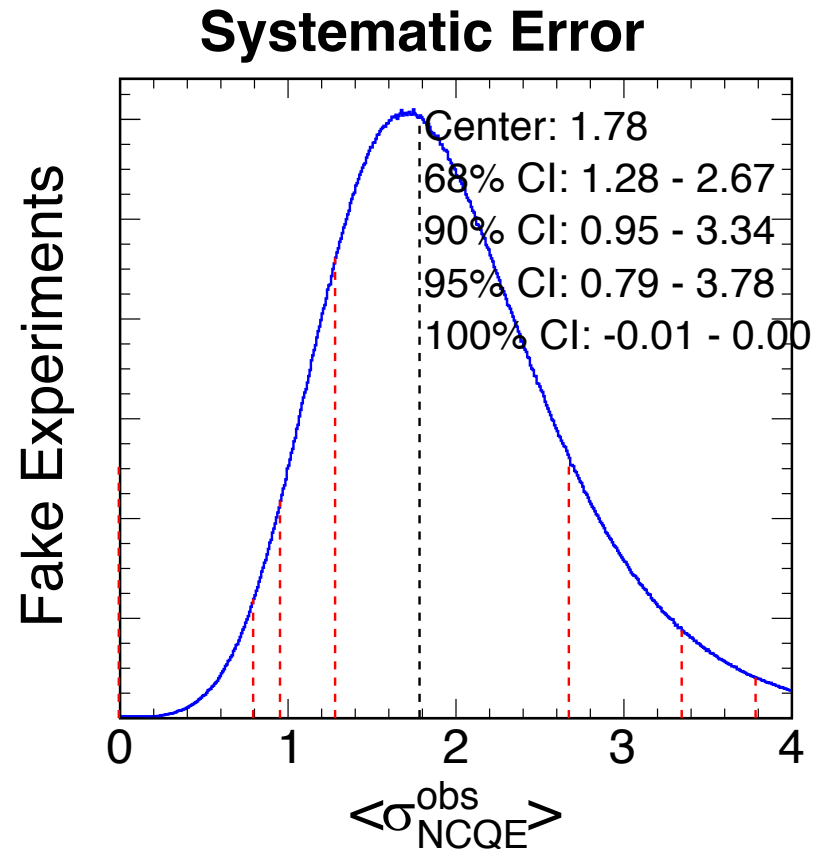
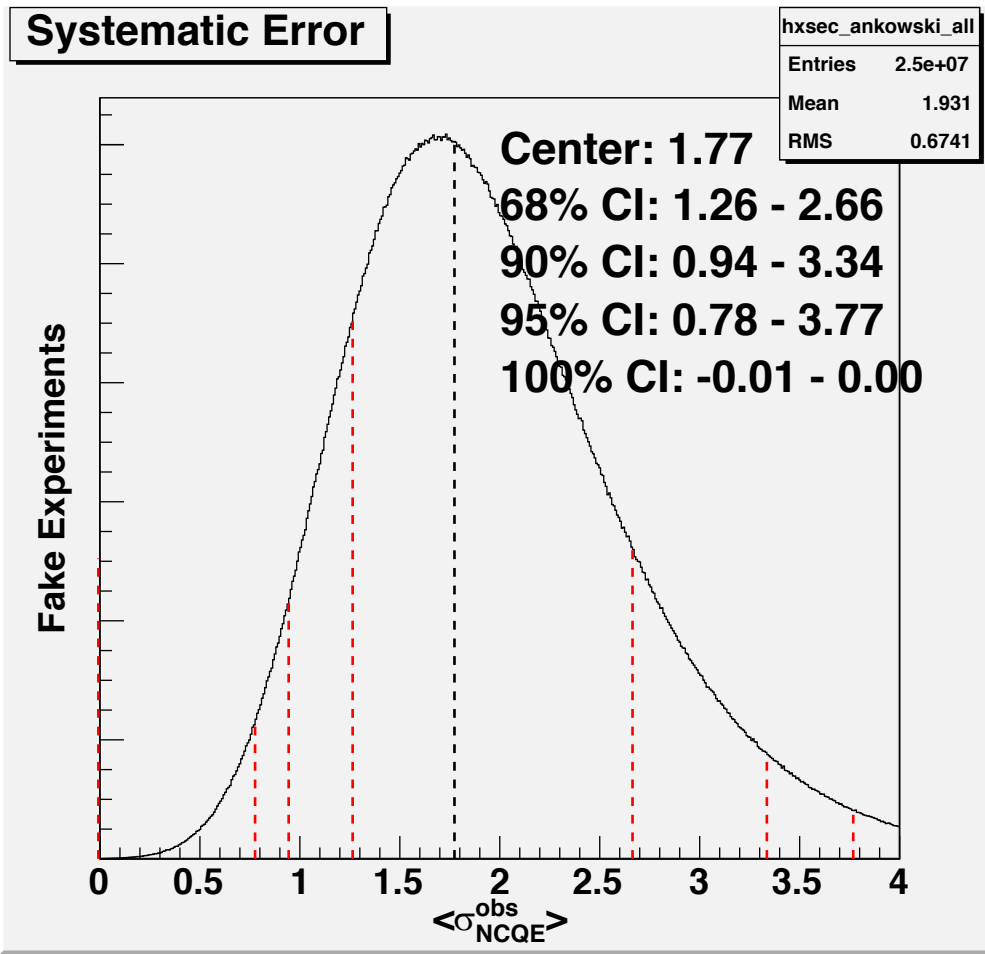


total_ankowski_all

zeroes because histogram overflow, I think

current work

07Jan2016



StatError.py

```

~/ncgamma/SystematicErrors@sukap001[585]_% rm staterr.p
~/ncgamma/SystematicErrors@sukap001[586]_% python StatError.py
Loading counts from syserr_nums.p
D = 59
xavg = 2.01667465452
B = 18.2715631209
S = 44.8386719554

FCN=770.129 FROM MIGRAD      STATUS=CONVERGED      68 CALLS      69 TOTAL
          EDM=1.9426e-12    STRATEGY= 1      ERROR MATRIX ACCURATE
EXT  PARAMETER
NO.  NAME      VALUE      ERROR      STEP      FIRST
   1  Constant  2.30887e+04  1.26420e+01  1.40017e-01  1.10819e-07
   2  Mean      1.77751e+00  1.54544e-04  2.09548e-06  1.03761e-02
   3  Sigma     3.45522e-01  1.09149e-04  1.16600e-06  8.32538e-03
Stat error on Nsignal: 59 +/- 7.681 (13.0%)
Stat error on Sigma: 1.778 +/- 0.346 (19.4%)
Info in <TCanvas::Print>: gif file stat_ankowski_xsec_prefit.gif has been created
Info in <TCanvas::Print>: pdf file stat_ankowski_xsec_prefit.pdf has been created

```

StatError.py

current work

07Jan2016

Statistical Error

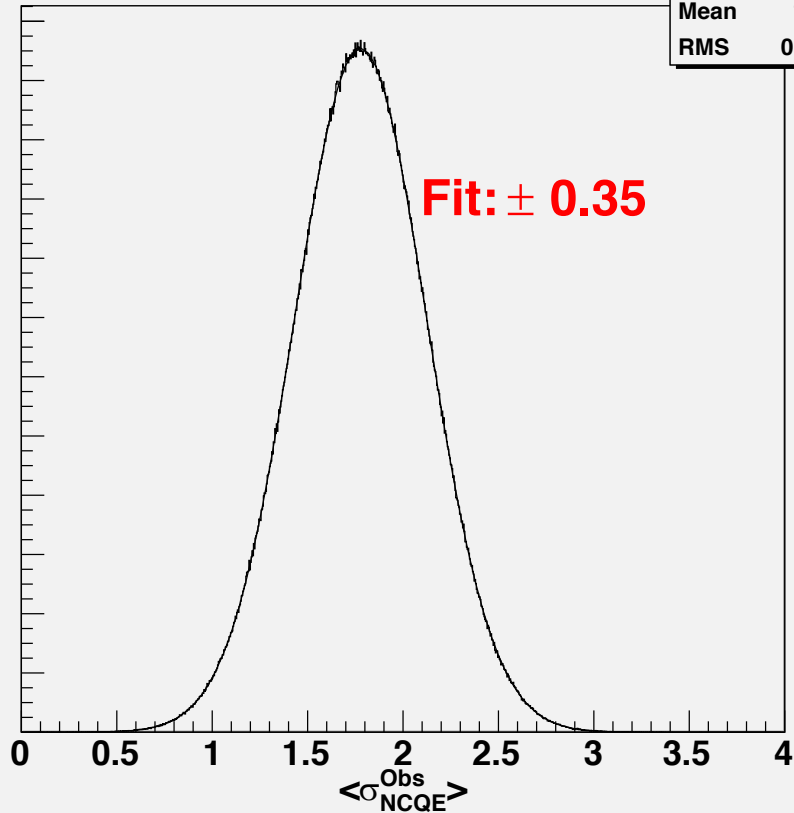
hstat_ankowski_xsec_preft

Entries 5000000

Mean 1.778

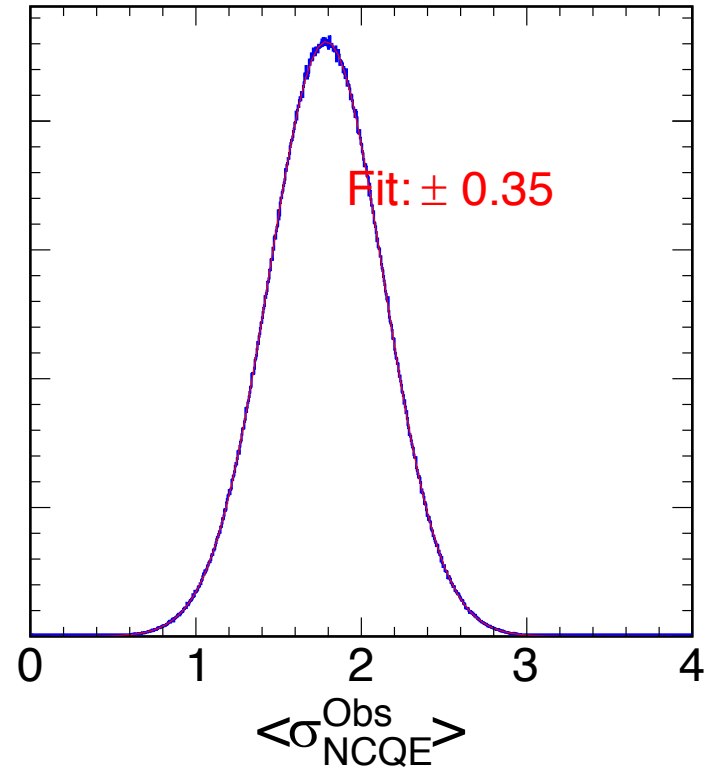
RMS 0.3456

Fake Experiments



Statistical Error

Fake Experiments



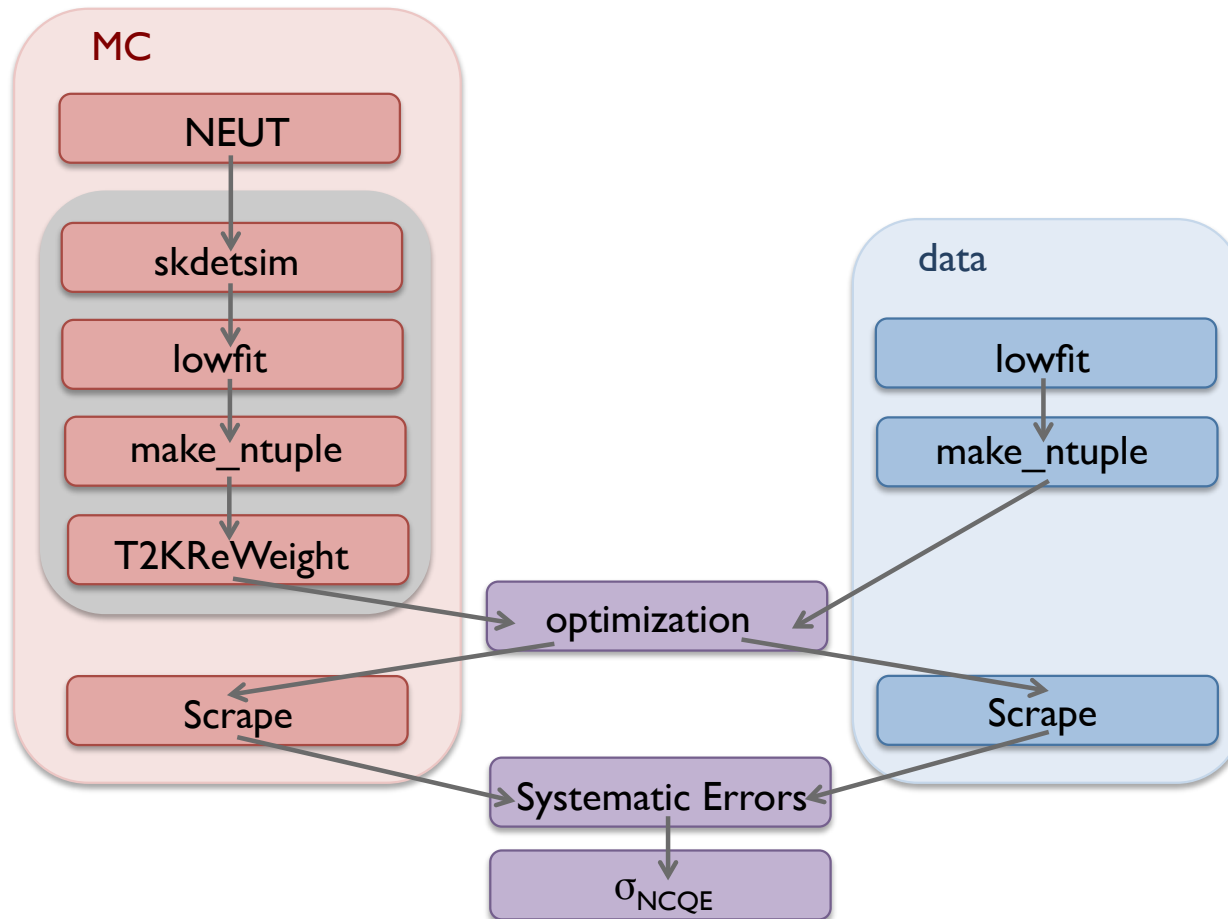
Summary

I have been through all ncgamma MC and data analysis for Run 4 on the new computer, in the meantime making improvements to:

- NEUT 5.1.4.2 → NEUT 5.3.2
- SterileAna → Prob3++
- Alex T2KReWeightvIp15 → T2KReWeightvIr27p3 (with NCQE)
- FHC → FHC and RHC

Summary

- You'll never see this schematic again...



Summary

... hopefully

I haven't updated the flux yet

Huang-san	my improvements
I 1a nominal flux, I 1b v3.2 tuning	I 3 a nominal flux, I 3a v1.1 tuning

I plan to update the flux, and run through Run 4 again (quickly!)

Next Steps

- analyze Run 1–4, and compare results to TN-244
- carefully analyze Run 5, which has both FHC and RHC
- analyze Run 1–7, possibly Run 8 too

Extending to DM search

- sensitivity study, with Rose's scattering events in skdetsim and FLUKA for production
- timing cut improvements, reduce +/- 100 ns of beam pulse
- background and systematics studies