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Nu/DM meeting
13 June 2018

**PROGRESS**

- NEUT cards
- ncgamma meeting
- Ashida-san ncgamma, svn
- t2kposc and mawgt

**ONGOING, trying to understand why less nc other events**

- no weights SelectionPlots.py, don't plot data (ontime and offtime)
- original MC neutrino energy, as well as neutrino mode
- try to confirm oscillation applied for cc in Jan2016 but not in current analysis
- compare SelectNCgamma.py and SelectNCgamma_data.py to SelectionPlots.py, and probably remove

# NEUT work

- asked Koshio-san for more detail on 3 changes to card

# 1) NEUT-MDLQE 1

**NEUT-MDLQE has come up often**

Hayato-san email 02 September 2017

NEUT-MDLQE 402
→ to be consistent with ND280, which used spectral function mode and thus both CCQEand NCEL are using spectral function model consistently. However, those are reweighted to CCQE and we are not sure how correct the NCEL cross-section is

Hayato-san email 27 February 2016

MDLQE = 402 NCEL cross section by Callum
(MDLQE = 22 is NCEL cross section by Huang-san and Mori-san)

~/ncgamma/mc/neut/neut_5.3.3_v1r27p3/src/t2kflux_zbs/neut_numu.card

```
C MDLQE    : CC Quasi-elastic / NC elastic model
C          : xx1 : Smith-Moniz for CC
C          : xx2 : Smith-Moniz for CC with BBBA05
C          : x0x : Scaling to CCQE     ( same as 5.0.x )
C          : x1x : Scaling to Spectrum func. with Dipole (prior to v5.1.2)
C          : x2x : Scaling to Spectrum func. with BBBA05 (default from v5.1.2)
C          : 1xx : Transverse enhancement (0: off, default)
C
NEUT-MDLQE 402
```

(no results in 5.3.6 or 5.3.2 or 5.4.0 on svn)

**Koshio-san asked Hayato-san again, 402 is better**

https://kmcvs.icrr.u-tokyo.ac.jp/svn/rep/neut/tags/neut_5.4.0/src/neutsmpl/README.CARD

```
////////////////////////////////////////////////////////////////////
4) CCQE/NCEL/2p2h related

NEUT-MDLQE
         CC Quasi-elastic / NC elastic model selection
         ( Not all the combinations are supported )

        Simple Fermi-Gas mdels
         xxx1 : Smith-Moniz with dipole
         xxx2 : Smith-Moniz with BBBA05
         xxx3 : Smith-Moniz with BBBA07

         xx0x : NCEL cross-section scaling to CCQE
         xx1x : NCEL cross-section scaling to Spectrum func. with Dipole
         xx2x : NCEL cross-section scaling to Spectrum func. with BBBA05
         xx3x : NCEL cross-section scaling to Spectrum func. with BBBA07

        Transverse enhancement ( only for partial )
         x1xx : CCQE with Transverse enhancement ( Bodek et al. )

        Spectral functions ( CC & NC )
         x4xx : Spectral function model ( Ankowski et al. )
         x6xx : TEM spectral function
         x7xx : Effective spectral function

        RPA correcton on/off
         1xxx : RPA correction ( Nieves et al. )

        Nieves 1p1h model
         2XxX : Nieves 1p1h ( X digits are ignored for now )
```

comments have been updated

Can we use 402 in 5.3.3 (g77), just comments aren't updated?

# 2) NEUT-MDLQEAF 0

- NEUT-MDLQEAF does not exist in current card, nor on svn for 5.3.2 or 5.3.6 or 5.4.0
- Is 0 is the same as not adding it?
  - /disk01/usr3/koshio/t2k/ncgamma/171229/neut/neut_5.3.3.g77/src/t2kflux_zbs/neut_nue.card
  - Koshio-san just added it to end of card for 5.3.3 (g77)
- It should be needed, after 5.3.3 (g77), it must be NEUT-MDLQEAF 0
  - after, but not during 5.3.3 (g77)?

https://kmcvs.icrr.u-tokyo.ac.jp/svn/rep/neut/tags/neut_5.4.0/src/neutsmpl/README.CARD

```
NEUT-MDLQEAF ( One has to specify consistent with MDLQE )
         CC Quasi-elastic / NC elastic Axial vector form factor
         ( Not all the combinations with MDLQE are supported )
         1 : Dipole
         2 : BBBA07
         3 : 2 component Axial form factor
         4 : 3 component Axial form factor
         5 : Z-expansion Axial form factor
```

again, comments have been updated

# 3) NEUT-MODE -1

- 0 means default
- 2p2h is on by default in 5.3.3

- Koshio-san says we want to turn off 2p2h

- -1 turns off 2p2h

- what about CRSNEUT?
- not CRSNEUT, but should change NEUT-CRS or NEUT-CRSB

Does that mean:
5.1.4.2 – no 2p2h
5.3.2 – 2p2h
(5.3.3 assume same as 5.3.2)
5.3.6 – 2p2h

~/ncgamma/mc/neut/neut_5.3.3_v1r27p3/src/t2kflux_zbs/neut_numu.card

```
C MODE : Interaction mode
C                     0 : normal ( default )
C                    -1 : input cross section by CRSNEUT
C                     n : sellect one mode ( n > 0 )   See nemodsel.F
C                           n =  1 : charged current Q.E.
C                           n = 11,12,13
C                                  : charged current Single pi production
C                           n = 16 : coherent Single pi production
C                           n = 21 : charged current Multi pi production
C                           n = 31,32,33,34
C                                  : neutral current Single pi production
C                           n = 36 : coherent Single pi production
C                           n = 41 : neutral current Multi pi production
C                           n = 51,52 : neutral current elastic
C                           n = 22,42,43 : single eta production
C                           n = 23,44,45 : single  K  production
C
C
C  nu                    nub
C  1:      CC Q.E.
C  2-4:    CC 1pi
C  5:      CC DIS 1320
C  6-9:    NC 1pi
C  10:     NC DIS 1320
C  11-13: NC els         11-14:NC els
C  14,15: coherent       15,16:
C  16:     CC eta        17:
C  17,18: NC eta         18,19
C  19:     CC K          20:
C  20,21: NC K           21,22:
C  22:     dummy
C  23:     CC DIS
C  24:     NC DIS
C
NEUT-MODE   0
```

- /disk01/usr3/koshio/t2k/ncgamma/171229/neut/neut_5.3.3.g77/src/t2kflux_zbs/neut_nue.card

```
C CRS  :  Multiplied factor to cross section on each mode. ( neu )
C CSRB :  Multiplied factor to cross section on each mode. ( neu-bar )
C
C          1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
NEUT-CRS   1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 0.
NEUT-CRSB  1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 0.
```

~/ncgamma/mc/neut/neut_5.3.3_v1r27p3/src/t2kflux_zbs/neut_nue.card

```
C          1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
NEUT-CRS   1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
NEUT-CRSB  1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
```

Add 28 and 0.0 for NEUT-CRS and NEUT-CRSB?

# NEUT summary

- Hayato-san told me to use 5.3.3 in September 2017

- **If it’s ok, I don’t want to change mine**
- 5.3.3 and g77
- NEUT-MDLQE 402
- no NEUT-MDLQEAF
- NEUT-MODE 1

# TN

- Fukuda-san and I write it
- update to include Run 9 FHC MC, plus neutron tagging
- ask for data open by August CM
- RHC later, maybe by someone else in future

# Ashida-san using ncgamma

- NEUT cards, Hayato-san updates for gammas from pions, lines for dumptotpau, and NEUT-MDLQE 402
- mk_num.sh (nue,nmb), updates to flux
- problems with qsub, not sure about t2kneut_sk and libCore.so, fixed with environment variables?
- Roger gave Ashida-san  a set of decoder, for .dat files I think /disk01/usr5/assy/neutfile/decoder_neut
- neut_select/ problem, solved, probably because of DISK to LOCAL in skcount_num.sh (nue,nmb)
- difference between neutfile/hbk/*.dat and neutfile/select/*.dat, ntuple vs zbs?
- t2kflux_zbs/seed/random.tbl.*** don’t exist, is that ok?

- svn, neutron tagging too?

# mawgt and t2kposc

- without absolutely all the details of the roundabout way I took to figure this out (I was thinking T2KReWeight)

**recall problems**

- mawgt does not exist for current analysis
- t2kposc=0 for data, so I was multiplying by non-zero t2kposc instead of only for mc t2kposc

before

```
try:      mawgt = tree.mawgt * tree.t2kposc
except:   mawgt = 1.
weights = map( lambda x: x * mawgt, weights )
```

mawgt did not exist, therefore mawgt=1 and t2kposc neglected

last time

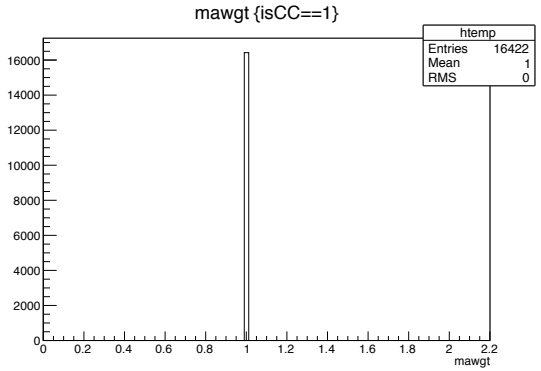
```
t2kposc = tree.t2kposc
if t2kposc!=0: weights = map ( lambda x: x * t2kposc, weights)
```

commented out mawgt,
multiplied by nonzero t2kposc

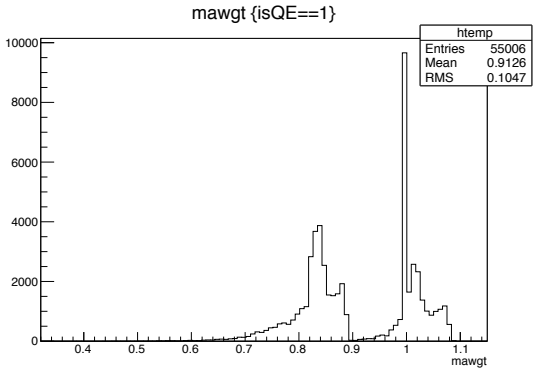
# mawgt no longer exists, how is it considered now

- check 17Jan2016 ncgamma.xsec_prefit.ankowski.nosel.root
- mawgt weights ncqe signal, doesn't weight cc or ncoth bg

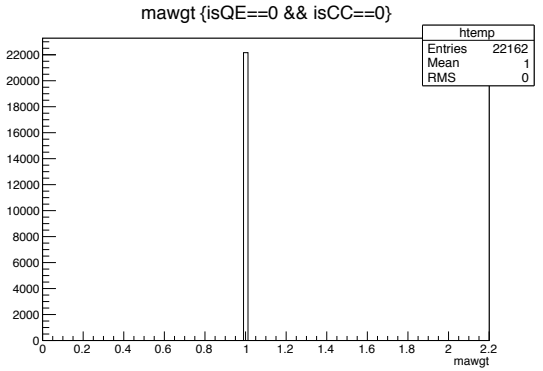
cc bg has no mawgt




ncqe signal has mawgt
**(should be in weight4 now, but how to confirm?)**




ncoth bg has no mawgt



**mawgt from neutrw/ when madir used in ScrapeLE.py**

ncgamma.xsec_prefit.ankowski.nosel.root made by runscrape.csh, which uses ScrapeLE.py

ScrapeLE.py

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```
magraphs = False
if options.madir:
    scrape.AddVar('mawgt', float)
    magraphs = {}
    nus = [ "nu", "nub" ]
    targets = [ "p", "n" ]
    vs = [ "enu", "q2" ]
    patterns = { "enu":".dat", "q2":"_"+options.maval+ ".dat" }

    for v in vs:
        search = join(options.madir, v, "*"+patterns[v])
        filenames = glob(search)
        print "%i MA files found in %s" % (len(filenames), search)
        for fn in filenames:
            parts = basename(fn)
            parts = parts.replace(patterns[v],"")
            parts = parts.split("_")
            t = parts[-1]
            n = parts[-2]
            if v not in magraphs: magraphs[v] = {}
            magraphs[v][n,t] = TGraph(fn)
            print "Graph ",v,n,t," from ",fn
```

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```
if magraphs:
    mawgt = 1.
    if not iscc and isqe:
        if mctree.ipnu[1] == 2112: t = "n"
        else:                      t = "p" # 2212

        for var, mags in magraphs.items():
            if var == "enu":
                if mctree.ipnu[0] > 0:     n = "nu"
                else:                      n = "nub"
                x = mctree.pnu[0]
            else:
                if mctree.ipnu[0] < 0:     n = "nmb"
                elif mctree.ipnu[0] == 12: n = "nue"
                else:                      n = "num"
                x = q2(mctree)
            #print "Apply",var,"weight at",n,t
            mawgt *= mags[n,t].Eval(x)

    scrape.SetVar('mawgt', mawgt)
```

- mawgt is mags
- mags is for magraphs
- magraphs is from .dat files in neutrw/
- pick out ma value for nu/nub and n/p for enu/q2

but we don’t use madir option in runscrape.csh anymore…

ScrapeLE.py

```
from optparse import OptionParser
usage = "usage: %prog [options] infiles1 infiles2 ..."
parser = OptionParser(usage=usage)
parser.add_option("-f", "--friend", dest="frienddir", default="",
                  metavar="DIR", help="Directory containing friend trees.  Only used in MC mode.")
parser.add_option("--data", dest="mcmode", default=True, action="store_false",
                  help="Data Mode (instead of MC)")
parser.add_option("--nosel", dest="nosel", default=False, action="store_true",
                  help="Skip selection")
parser.add_option("-s", "--suffix", dest="suffix", default="")
parser.add_option("-w", "--storeweights", dest="storeWeights", default=False, action="store_true",
                  help="Store all the thrown weights in addition to reweighting the main event weight.")
parser.add_option("--madir", dest="madir", default="",
                  help="Directory with MA reweighting files")
parser.add_option("--ma", dest="maval", default="1.21",
                  help ="Value of ma to use (1.01, 1.21, 1.41)")
parser.add_option("--datafriend")
parser.add_option("--dttext")
parser.add_option("--exclude")
parser.add_option("--ontiming", default=False, action="store_true")
parser.add_option("--offtiming", default=False, action="store_true")
parser.add_option("--videtiming", default=False, action="store_true")
(options, args) = parser.parse_args()
```

from runscrape.csh, madir=/home/cnantais/July2015/ncgamma/neutrw/ratios/… ma/ or ankowski/

```
~/ncgamma/neutrw/ratios@sukap001[90]_% ls
ankowski  ma  neut
~/ncgamma/neutrw/ratios@sukap001[91]_% cd ankowski/
~/ncgamma/neutrw/ratios/ankowski@sukap001[92]_% ls
enu
~/ncgamma/neutrw/ratios/ankowski@sukap001[93]_% cd enu/
~/ncgamma/neutrw/ratios/ankowski/enu@sukap001[94]_% ls
ratio_ank_to_neut_nu_n.dat  ratio_ank_to_neut_nub_n.dat
ratio_ank_to_neut_nu_p.dat  ratio_ank_to_neut_nub_p.dat
```

runscrape.csh

```
#These 5 for data

#python ScrapeLE.py --suffix=data.ontising --data --ontising /disk01/usr4/cnantais/lowedata/ntuple/data.lowfit.*.merge.root

#python ScrapeLE.py --suffix=data.ontising.nosel --data --ontising --nosel /disk01/usr4/cnantais/lowedata/ntuple/data.lowfit.*.merge.root

#python ScrapeLE.py --suffix=data.offtising.nosel --data --offtising --nosel /disk01/usr4/cnantais/lowedata/ntuple/data.lowfit.*.merge.root

#python ScrapeLE.py --suffix=data.videtising.nosel --data --videtising --nosel /disk01/usr4/cnantais/lowedata/ntuple/data.lowfit.*.merge.ro\
ot

python ScrapeLE.py --suffix=xsec_prefit.ankowski.nosel --friend=/disk01/usr4/cnantais/leac/weights_postfit_banff/xsec_prefit/ --nosel --sto\
reweights /disk01/usr4/cnantais/leac/lentuple/*.root


#These 2 for MC

#python ScrapeLE.py --suffix=xsec_prefit.ankowski --friend=/disk01/usr4/cnantais/leac/weights_postfit_banff/xsec_prefit/ --storeweights /di\
sk01/usr4/cnantais/leac/lentuple/*.root

#python ScrapeLE.py --suffix=flux_prefit.ankowski --friend=/disk01/usr4/cnantais/leac/weights_postfit_banff/flux_prefit/ --storeweights /di\
sk01/usr4/cnantais/leac/lentuple/*.root

#I don't use the following

#python ScrapeLE.py --suffix=banff.ankowski --friend=/disk/usr4/huang/alex/leac_ankow/weights_postfit_banff_v7/banff/ --madir=/home/cnantai\
s/July2015/ncgamma/neutrv/ratios/ankowski --storeweights

#python ScrapeLE.py --suffix=xsec_prefit.ma1.21 --friend=/disk/usr4/huang/alex/leac_ankow/weights_postfit_banff_v7/xsec_prefit/ --madir=/ho\
me/cnantais/July2015/ncgamma/neutrv/ratios/ma /disk/usr4/cnantais/leac/lentuple/*.root

#python ScrapeLE.py --suffix=xsec_prefit.ma1.01 --friend=/disk/usr4/huang/alex/leac_ankow/weights_postfit_banff_v7/xsec_prefit/ --madir=/ho\
me/cnantais/July2015/ncgamma/neutrv/ratios/ma --ma=1.01 /disk/usr4/cnantais/leac/lentuple/*.root

#python ScrapeLE.py --suffix=xsec_prefit.ma1.41 --friend=/disk/usr4/cnantais/leac/weights_postfit_banff_v7/xsec_prefit/ --madir=/home/cnant\
ais/July2015/ncgamma/neutrv/ratios/ma --ma=1.41 /disk/usr4/cnantais/leac/lentuple/*.root


# --madir because NEUT 5.1.4.2 doesn't include Ankowski NCQE cross section, e.g.

#python ScrapeLE.py --suffix=xsec_prefit.ankowski.nosel --friend=/disk/usr4/cnantais/leac/weights_postfit_banff_v7/xsec_prefit/ --nosel --m\
adir=/home/cnantais/ncgamma/neutrv/ratios/ankowski --storeweights /disk/usr4/cnantais/leac/lentuple/*.root
```

**don’t use madir option anymore**

# I made this change, on svn

```
[~/ncgamma/Processing@sukap001[77]_% svn log runscrape.csh
------------------------------------------------------------------------
r23781 | cnantais | 2016-02-02 23:57:32 +0900 (Tue, 02 Feb 2016) | 1 line

Removed weighting for Ankowski xsec
------------------------------------------------------------------------
r23653 | cnantais | 2015-12-01 07:49:14 +0900 (Tue, 01 Dec 2015) | 1 line

Update from Huang-san
------------------------------------------------------------------------
```

why did I do this…

- PhD notebook #4 p.186 ~02 February 2016
- working in person with Huang-san at SK

Because NEUT 5.3.2 has Ankowski's spectral function, we don't need to do madir in runscrape.csh

- I don't really understand
- It is in 4 places
- Huang-san checked

- 5.1.4.2 did not include cross section
  - have to weight root files of MC event to include Ankowski's cross section with madir

- 5.3.2 has SF for CCQE (Ankowski's paper)
- doesn't have edit from Huang-san for nudeex_n.F and nudeex_p.F, added to svn
- we checked neut_5.3.2/src/crsdat → it has NCQE xsec from Ankowski PRL108 052505 (2012)
- ncel_nu(nubar)_n(p)_xsec_bbba05_ma1.2.dat

- removed madir from runscrape.csh in 4 places: xsec_prefit.ankowski.nosel, niwg.ankowski, xsec_prefit.ankoski, flux_prefit.ankowski

- Ankowski uses mA=1.2, so we don't do others, might need for systematic errors

- upload to svn runscrape.csh

# Conclusion: cleaned up SelectionPlots.py for mawgt and t2kposc

now

```
#CMN cleanup for when mawgt does not exist
#try:     mawgt = tree.mawgt * tree.t2kposc
#except:  mawgt = 1.
#weights = map( lambda x: x * mawgt, weights )

#CMN mawgt doesn't exist in data, or if no madir used in runscrape.csh
try:     mawgt = tree.mawgt
except:  mawgt = 1.

#CMN t2kposc is 0 for data
t2kposc = tree.t2kposc

if fc == "mc":
    mawgt2kposc = mawgt*t2kposc
    weights = map( lambda x: x * mawgt2kposc, weights )
```

which date?
cc ovaq_f 2.03

# Problems with number of events

(erec, dwall_f, effwall_f, ovaq_f and angle (16Nov))

SelectionFigures/
SelectionPlots.py
selections.root

| | TN-244 | 17Jan2016 | 25Oct2017 | 16Nov2017 |
|---|---|---|---|---|
| **ontime** | 59 | 59 | 59 | 59 |
| **ncqe** | 42.8 | 44.3 | 43.0 | 42.9 |
| **ncoth** | 18.4 (1.2) | 15.6 | 10.0 | 10.0 |
| **cc** | | 2.7 | 9.2 | 2.1 |
| **offtime** | | 1.2 | 1.2 | 1.2 |

**TN-244:** official
**17Jan2016:** Huang-san confirmed it was close enough
**25Oct2017:** because mawgt no longer exist, t2kposc was neglected
**16Nov2017:** nonzero t2kposc included in weight, size of array, angle weights

Now there are too few events.
Background 10.0 + 2.1 + 1.2 = 13.3, instead of 18.4 (17Jan2016 was 19.5)
Is ncoth the only problem?

# Turn off weights and compare to 17Jan2016

SelectionPlots.py

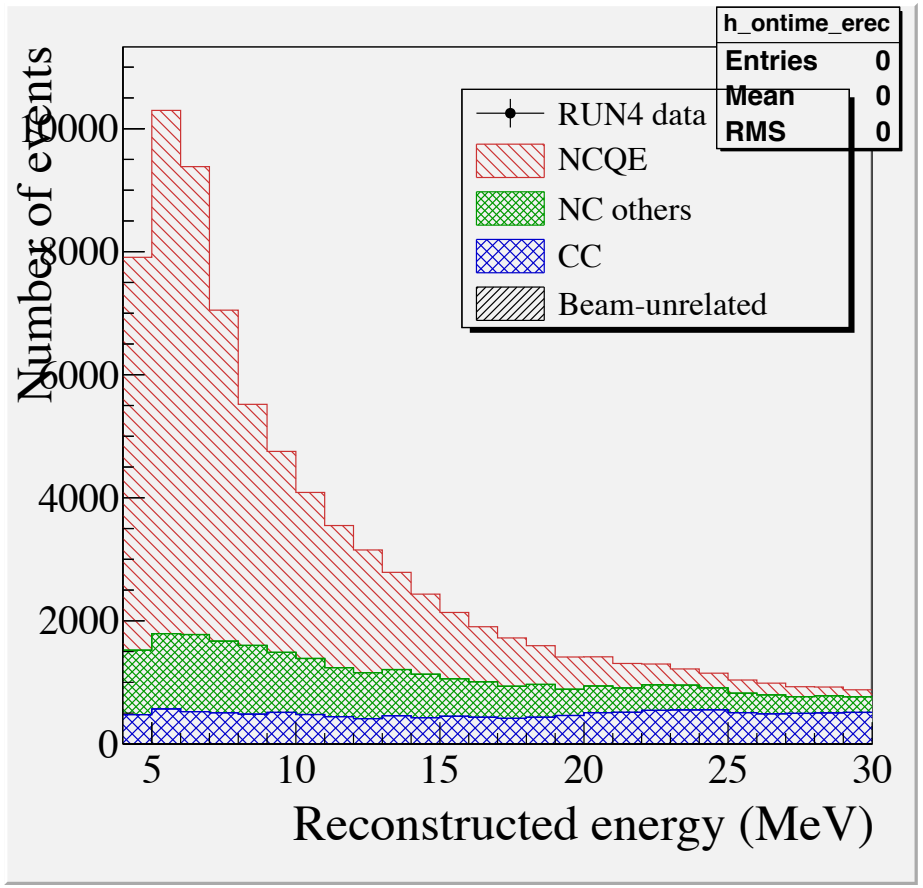
- turn off weights
- don’t plot data (ontime and offtime)

```
# Post basic selection

#if fc in [ "mc", "ontime", "offtime" ]:
#CMN mc only, no ontime or offtime
if fc=="mc":
    #hists[c, "erec"    ].Fill(erec,  Weight([weights, pot, p_energy, p_vali, p_evali, p_ovaq, p_prea, p_angle] ) )
    #w = Weight([weights, pot, p_energy, p_vali, p_evali, p_ovaq, p_prea])
    w = Weight([weights, pot, p_energy, p_vali, p_evali, p_ovaq, p_prea, p_angle])
    #hists[c, "angle"   ].Fill(angle, w)
    #CMN angle didn't have angle cut, want it to have same cuts as others
    #hists[c, "angle"   ].Fill(angle,  Weight([weights, pot, p_energy, p_vali, p_evali, p_ovaq, p_prea, p_angle] ) )

    #hists[c, "dvali_f"].Fill(dvali,  Weight([weights, pot, p_energy, p_vali, p_evali, p_ovaq, p_prea, p_angle] ) )
    #hists[c, "effvali_f"].Fill(effvali,  Weight([weights, pot, p_energy, p_vali, p_evali, p_ovaq, p_prea, p_angle] ) )
    #hists[c, "ovaq_f"].Fill(ovaq,  Weight([weights, pot, p_energy, p_vali, p_evali, p_ovaq, p_prea, p_angle] ) )

    #CMN turn off weights
    hists[c, "erec"    ].Fill(erec)
    hists[c, "angle"   ].Fill(angle)
    hists[c, "dvali_f"].Fill(dvali)
    hists[c, "effvali_f"].Fill(effvali)
    hists[c, "ovaq_f"].Fill(ovaq)
```

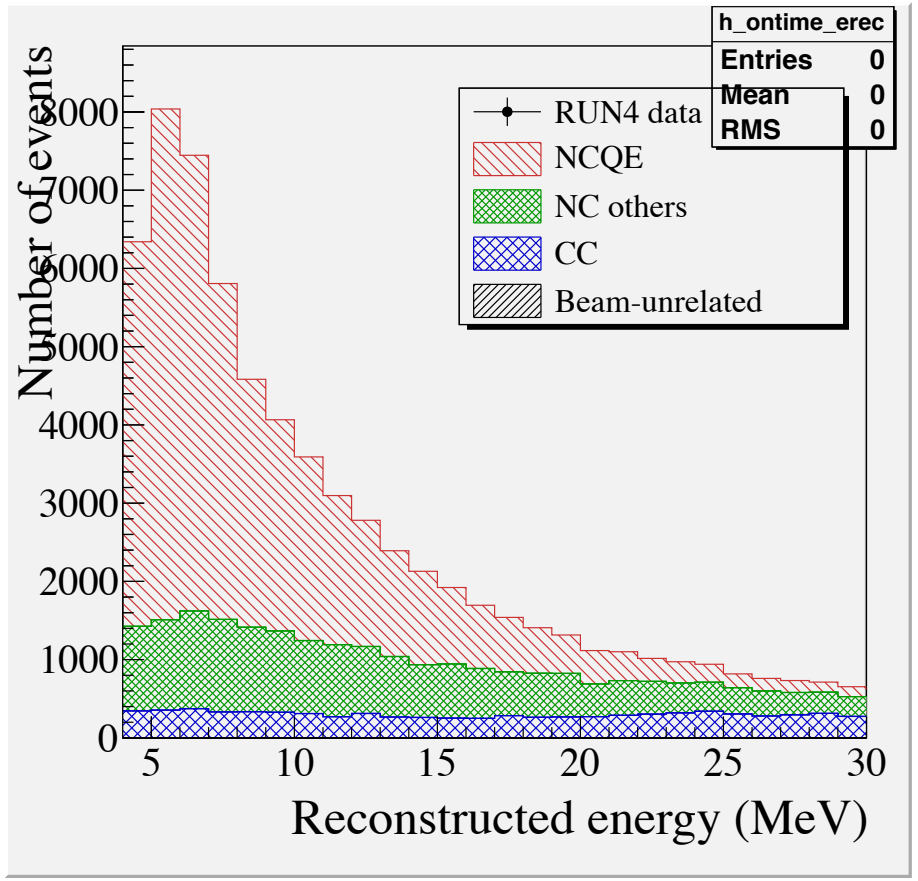
# erec

scales are different, hard to compare

current



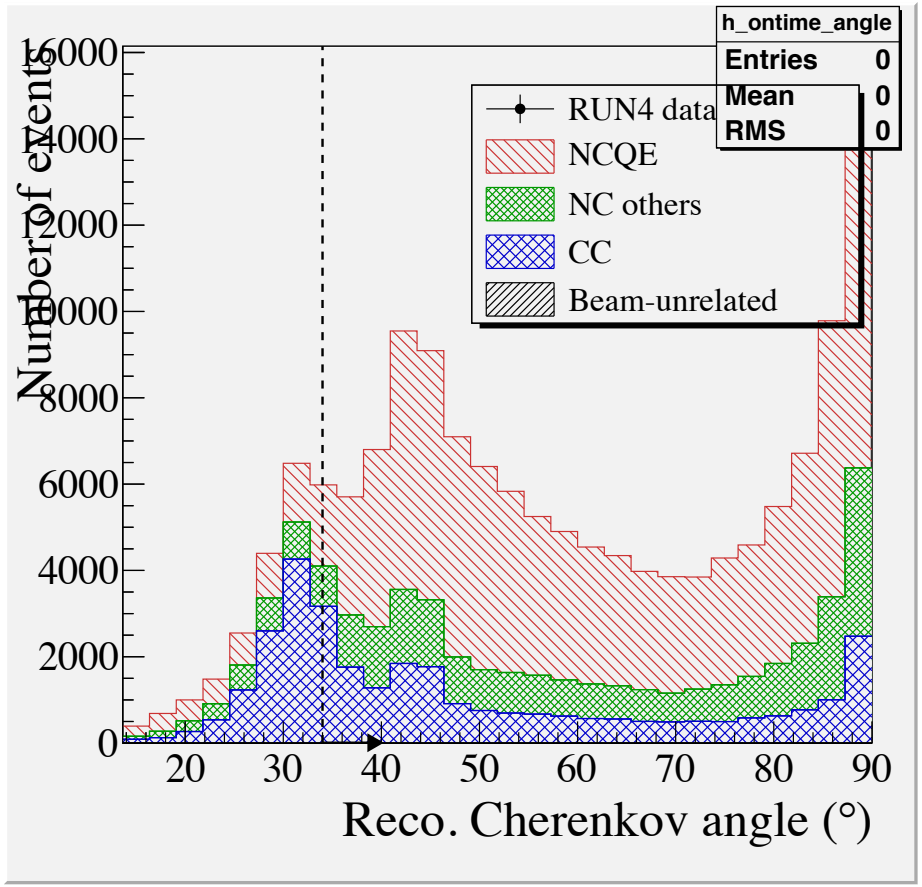

17Jan2016



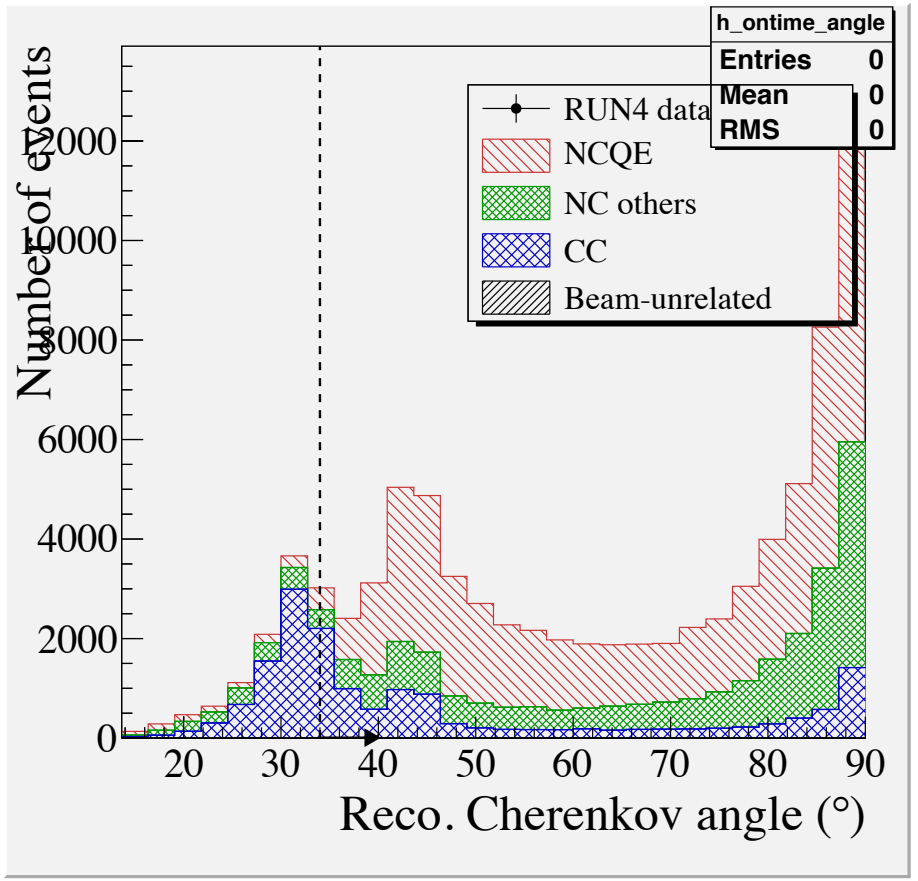
# angle

scales are different, hard to compare

current



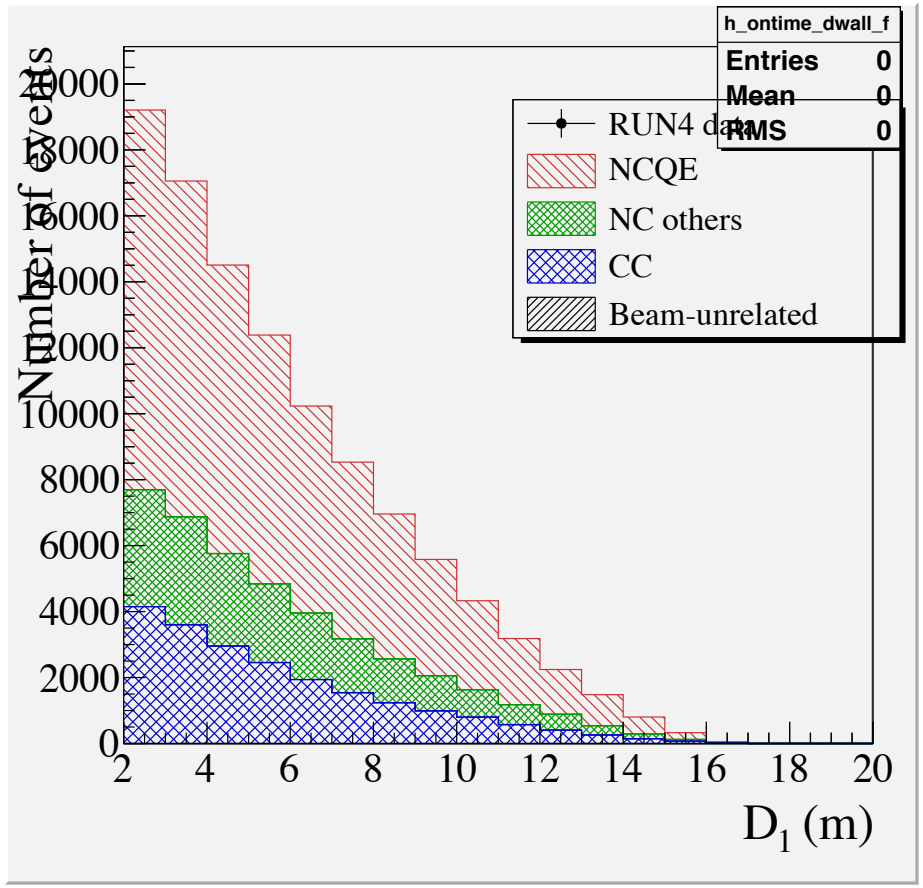

17Jan2016



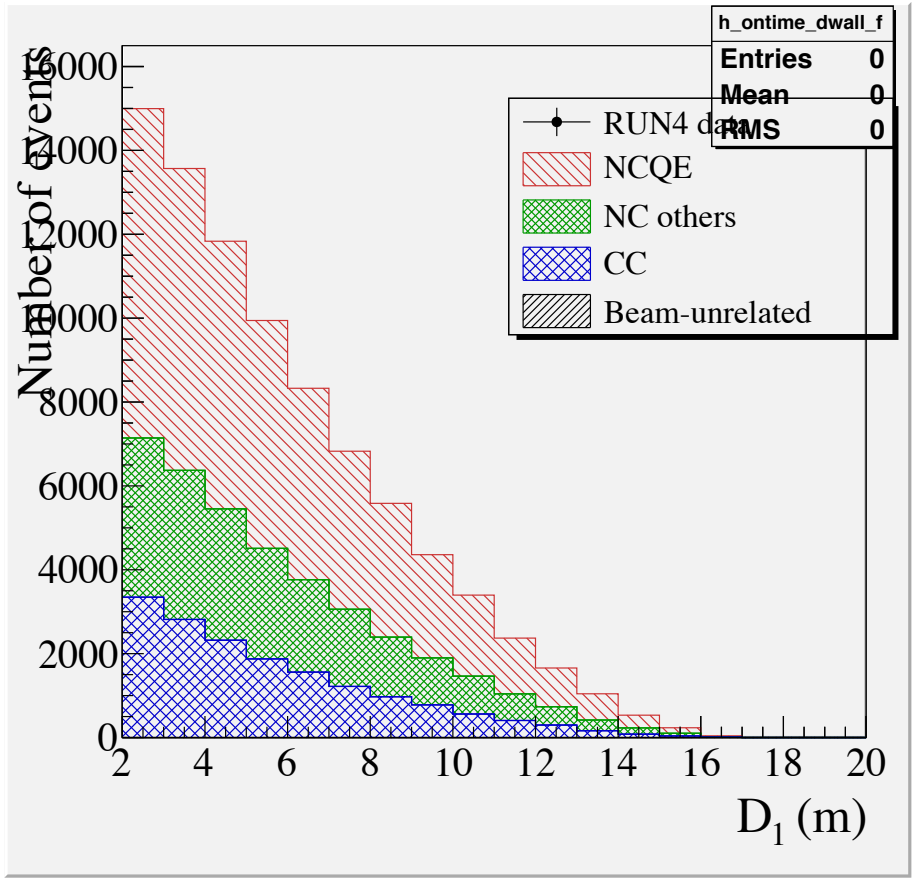
# dwall_f

scales are different, hard to compare

current




17Jan2016

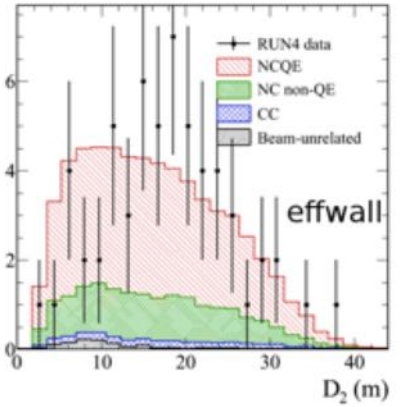


# effwall_f

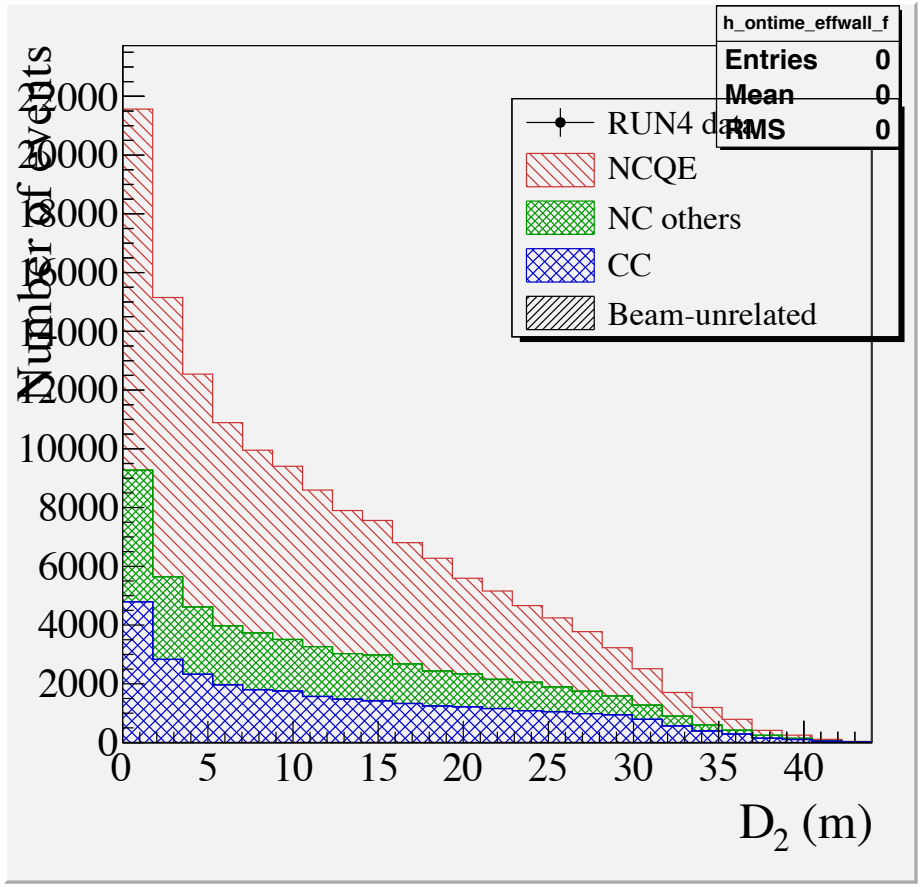
scales are different, hard to compare

**very different shape?**
**TN-244 looks like 17Jan2016**

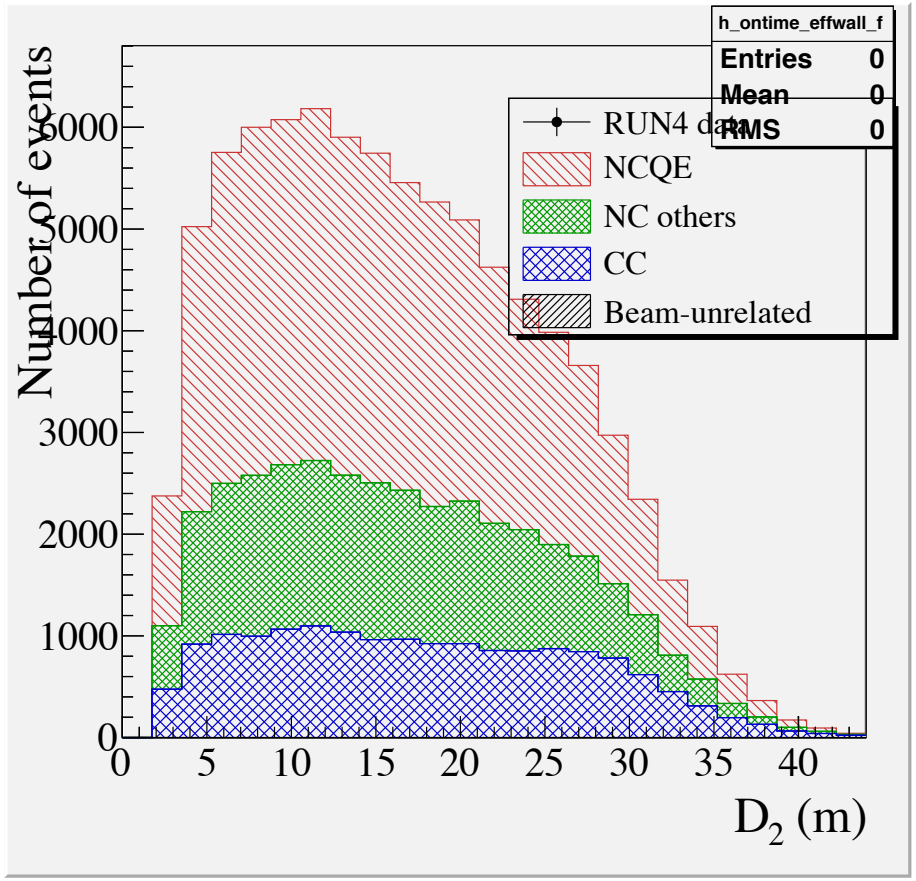
TN-244




current



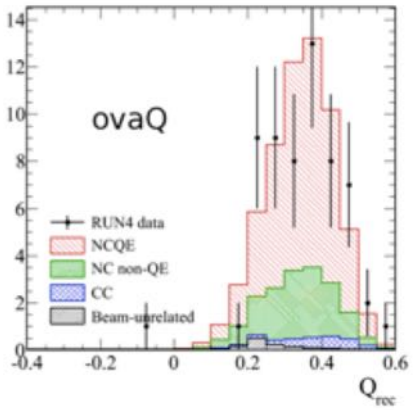

17Jan2016



# ovaq_f

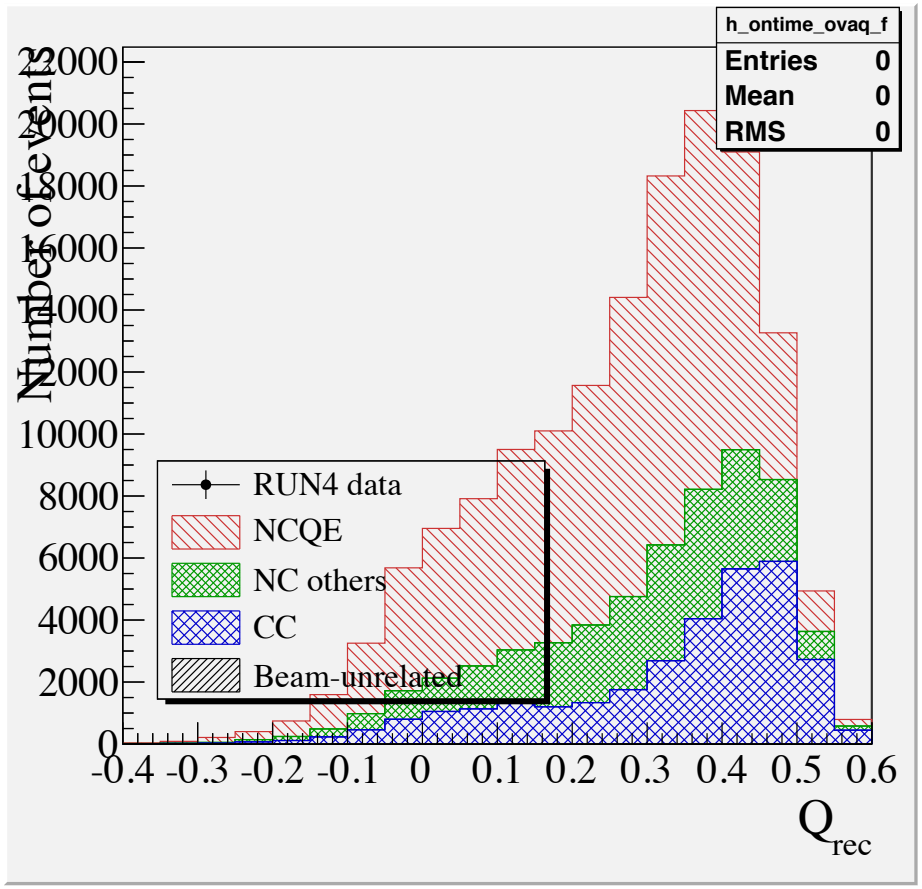
scales are different, hard to compare

TN-244

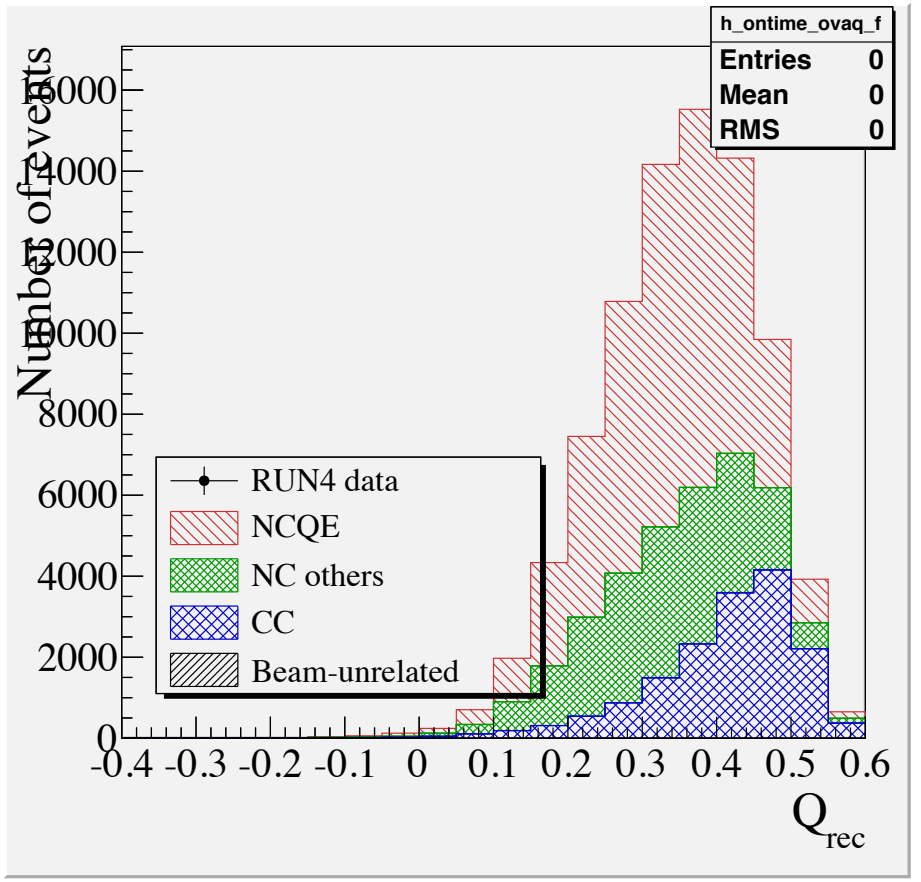



**very different shape?**
**TN-244 looks like 17Jan2016**

current




17Jan2016



# Number of events different

- no weights selections.root
- erec, for example

| | **17Jan2016 (15May2018)** | **16Nov2017** | |
|---|---|---|---|
| **ontime** | 1313 | 1313 | same |
| **ncqe** | 41735 | 51411 | +23% |
| **ncoth** | 17457 | 16792 | -4% |
| **cc** | 7784 | 12633 | +62% |
| **offtime** | 402457 | 402456 | -1? |

what to do?
→ trying to confirm cc must have had oscillation applied in Jan2016 and not in current
→ trying to follow ncoth all the way through

# I have been comparing histograms for 17Jan2016 and now

ncgamma.xsec_prefit.ankowski.nosel.root

- t2kposc
- mode
- pnu

I don’t notice any differences in shape for cc (isCC==1), ncqe (isQE==1), or ncoth (isCC==0 and isQE==0)

Suggestions?

# Are SelectNCgamma.py and SelectNCgamma_data.py redundant?

SelectNCgamma.py to look at MC

- after simulation, reconstruction, ntuples, and reweighting
- takes in lemc/lentuple/
- it has optimization, flux, scales, and POT inside
- (I can't tell from Processing/ProcessNCEL_mc.sh if xsec is there, I see weights_postfit_banff/xsec_prefit/)

**Is this fundamentally different than SelectionPlots.py? if not, remove it and SelectNCgamma_data.py.**

- not like SelectionPlots.py, but like Sel.py, ScrapeLE.py, and Scrapper.py
- at first glance, not exactly the same

- more work and cleanup to do, leave it for now

# PhD outline

- feedback
- neutrino analysis and DM in parallel for summer
- finish neutrino this summer

- timelines were either 1 month or 3 month
- goal of graduating by end of 2019

- (still need to work on committee meeting slides and writeup)