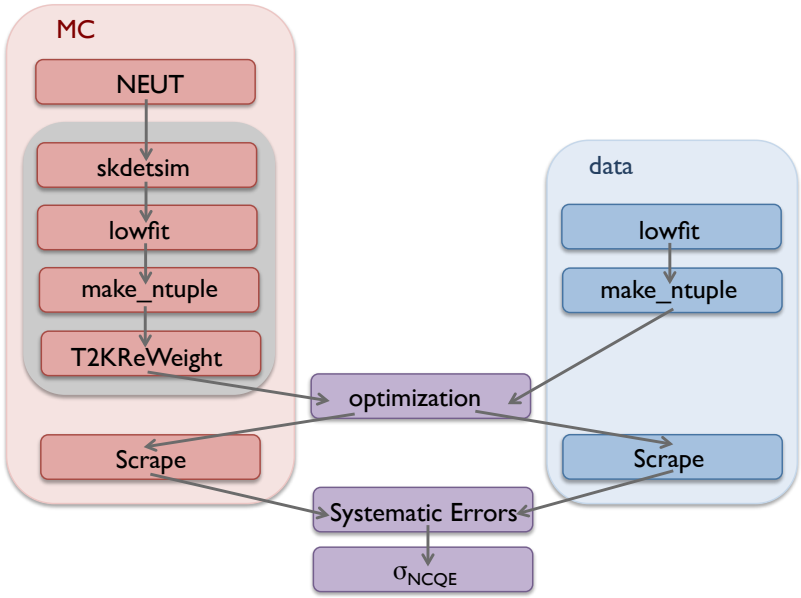
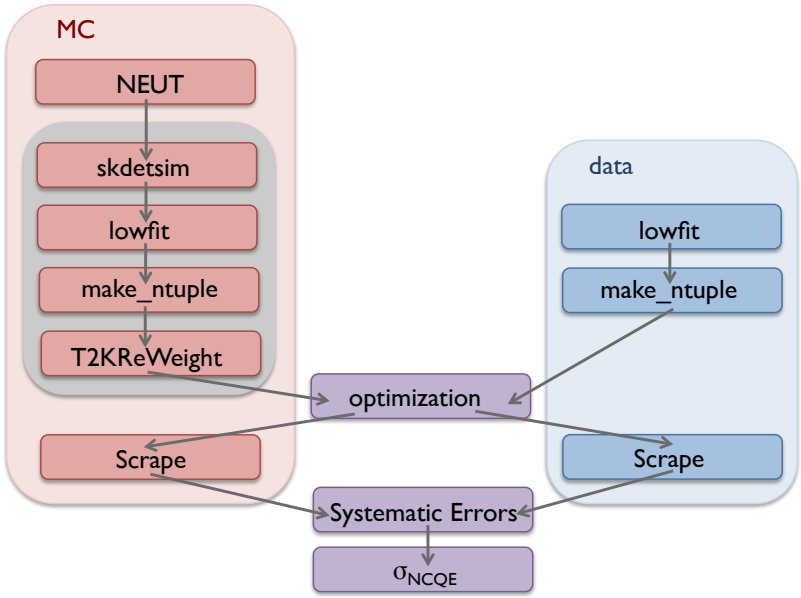
Corina Nantais
group meeting
25 October 2017



Processed all Run 4 MC again

- since I had turned off NCQE weighting in T2KReWeight

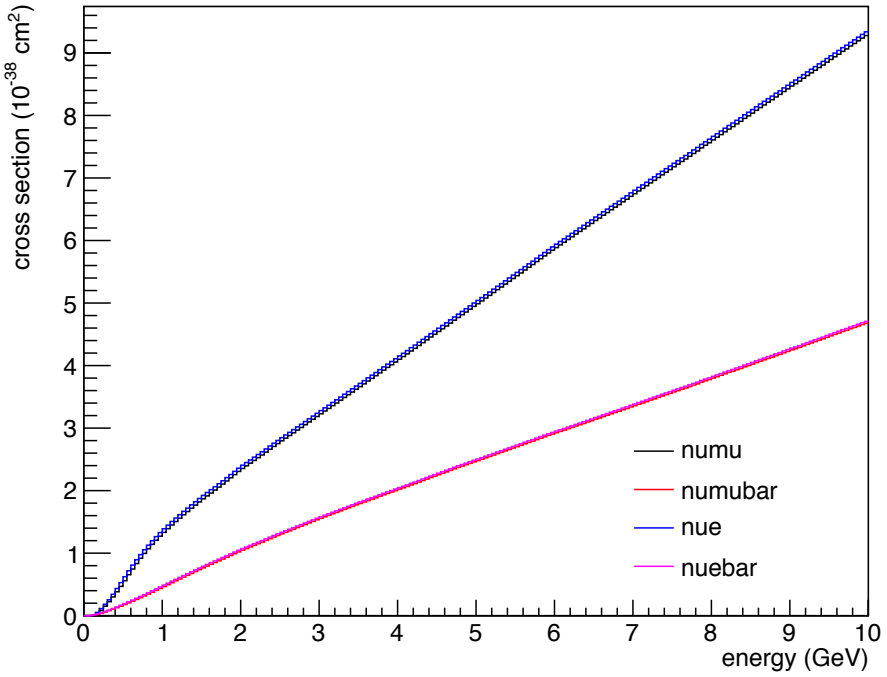


MC scales
cross section

totpau.tbl

src/neutsmpl/
./Linux_pc/dumptotpau ../t2kflux_zbs/neut_numu.card

Energy	numu	numubar	nue	nuebar
0.025	0.000100	0.000115	0.000100	0.000645
0.075	0.000836	0.000672	0.000836	0.003755
0.125	0.005751	0.006164	0.015285	0.013294
0.175	0.027179	0.018720	0.052714	0.028255
0.225	0.082770	0.038478	0.112983	0.046936



up to 9.975 GeV
cross section (e-38 cm^2)

50 MeV bins from 0.025 GeV to 9.975 GeV → 200 bins

untuned flux

tuned release > nominal release (< 1%)

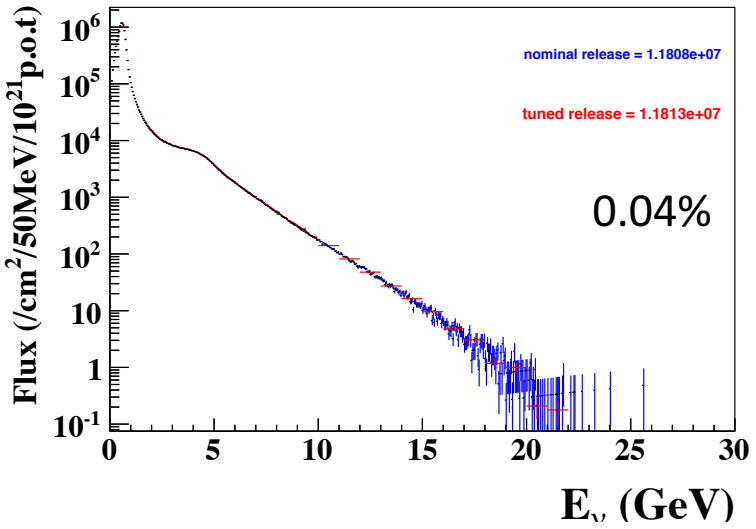
→ emailed Tom

nominal: 50 MeV bins from 0 – 30 GeV → 600 bins

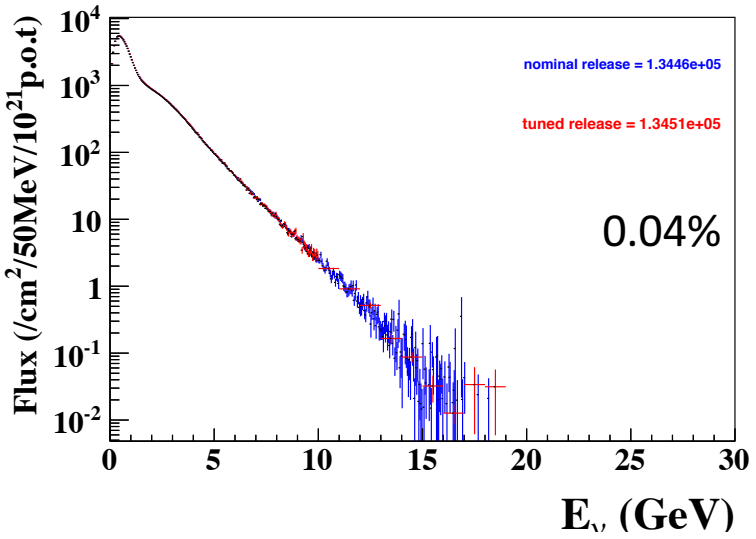
tuned: 50 MeV bins from 0 – 10 GeV, then 1 GeV bins 10 – 30 GeV → 220 bins

print integral 0–10 GeV (bins 1–200)

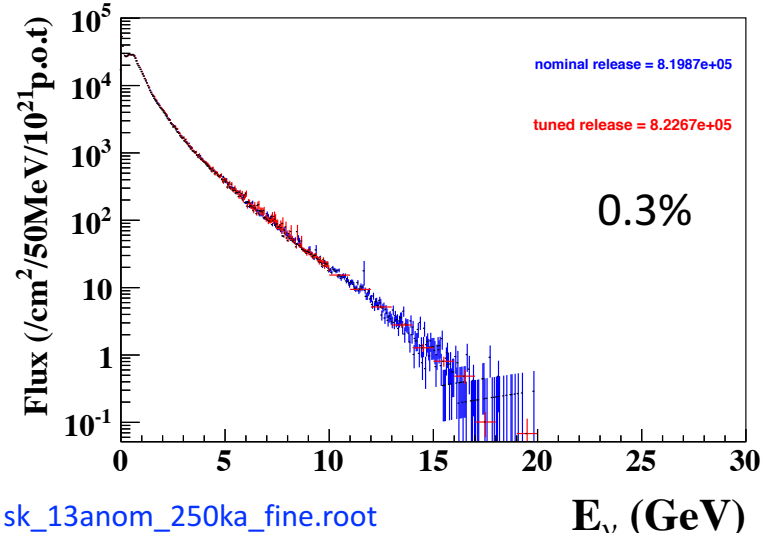
numu



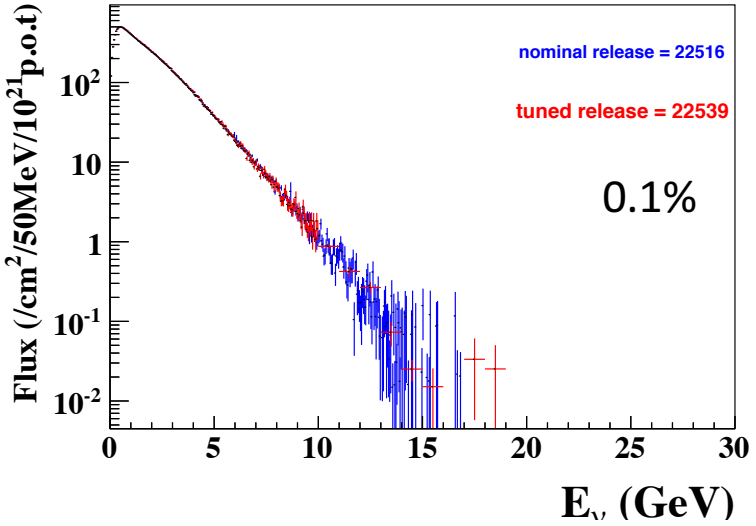
nue



numub



nueb

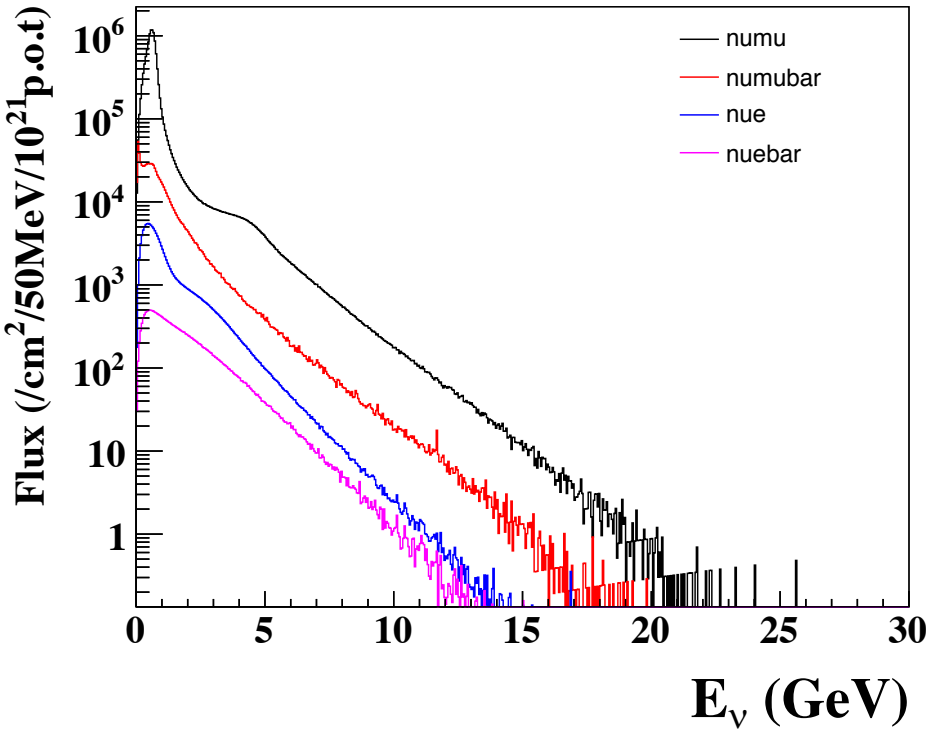


sk_13anom_250ka_fine.root

sk_tuned13av2_13anom_run1-8_numode_fine.root

MC scales
flux

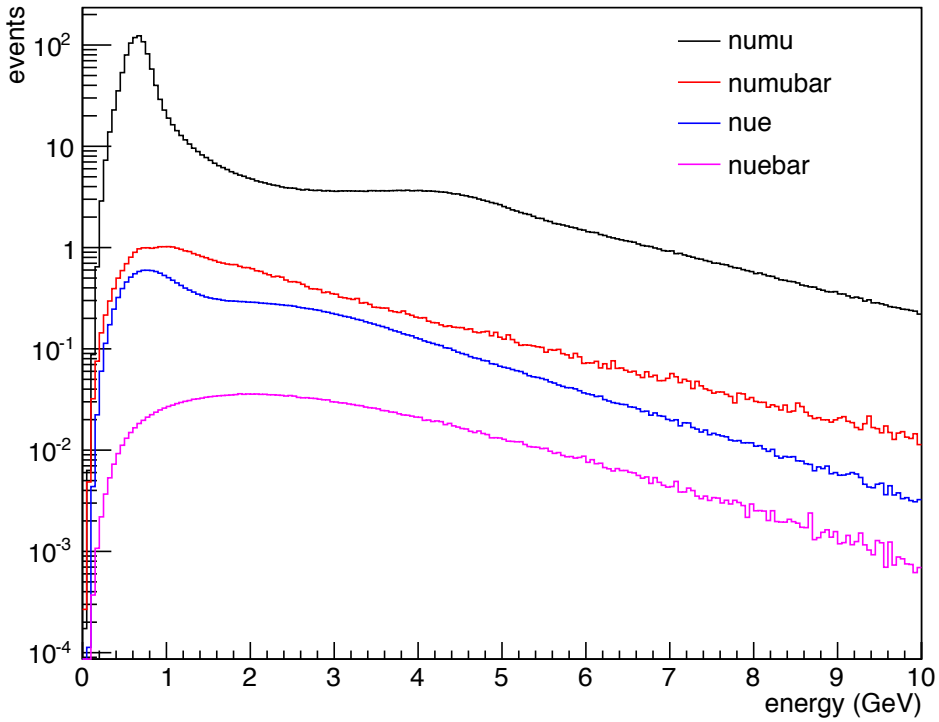
- use nominal release for now
- https://www.t2k.org/beam/NuFlux/FluxRelease/13arelease/sknom13aflux
- sk_13a_fluxrelease.tar.gz
- ncgamma/SystematicErrors/beamweights/sk_13a_fluxrelease/
- sk_13anom_250ka_fine.root
- enu_sk_13a_real_numu
- enu_sk_13a_real_numub
- enu_sk_13a_real_nue
- enu_sk_13a_real_nueb



MC scales
events

events = alpha*xs*flux in each bin

factor related to target mass
alpha = 22.5 *1e9* 6.02e23 * 1e-38



MC scales per POT

integrated entire histogram for "events"

scale = events*(35.4/22.5)*(1e23/1e21)

```
Scale numu 218314
Scale numubar 7956.51
Scale nue 4180.9
Scale nuebar 451.619
```

(100 files)*(3000 events) = 300,000 NEUT events

pot = 300,000*1e23/scale

```
Scale numu (per POT) 1.37416e+23
Scale numubar (per POT) 3.7705e+24
Scale nue (per POT) 7.17549e+24
Scale nuebar (per POT) 6.64277e+25
```

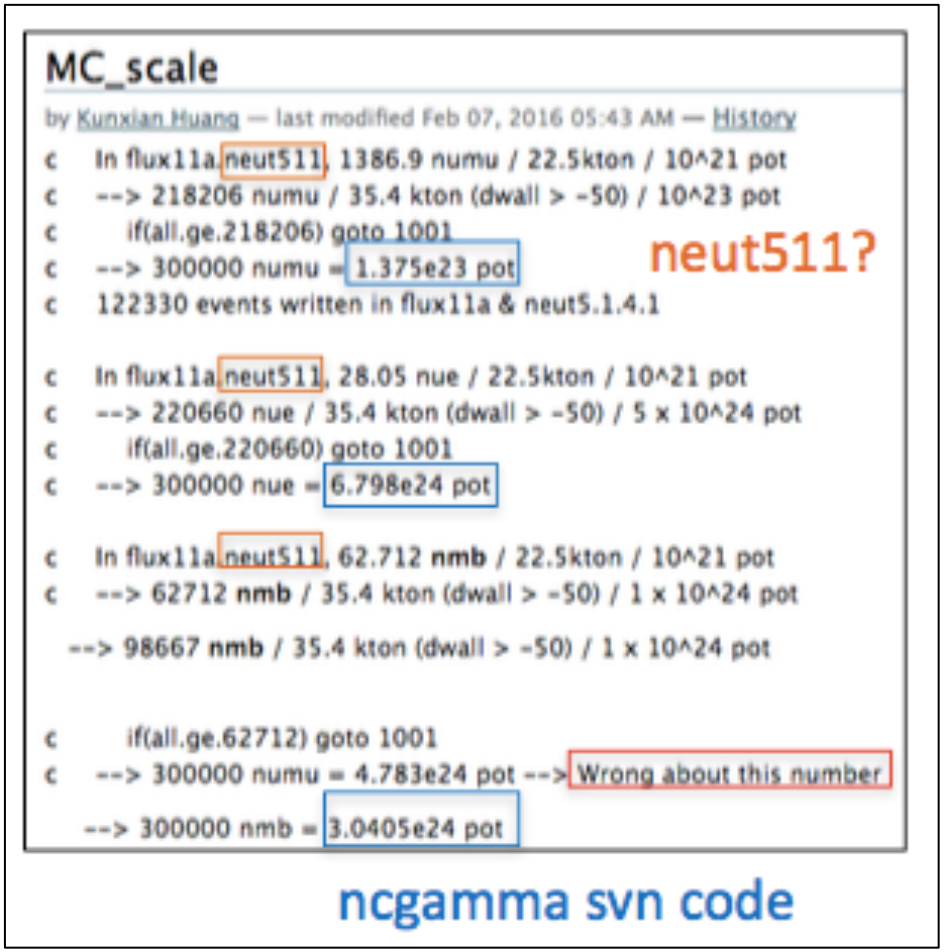
current work

```
Scale numu (per POT) 1.37416e+23
Scale numubar (per POT) 3.7705e+24
Scale nue (per POT) 7.17549e+24
Scale nuebar (per POT) 6.64277e+25
```

Feb 2016

```
Scale numu (per POT) 1.29632e+23
Scale numubar (per POT) 3.62742e+24
Scale nue (per POT) 6.79801e+24
Scale nuebar (per POT) 6.35302e+25
```

Scale per POT is higher compared to my exercise from Feb 2016
→ difference is totpau.tbl based on NEUT 5.4.1.2 (or maybe older)
xs is now a bit lower in every energy bin, events and scale are lower, so per POT is higher



Compared to ncgamma svn

- numu is slightly lower (0.06%)
- nue is higher (6%)
- numubar is higher (24%)

Updated MC scales

1) ScrapeLE.py
2) SelectNCgamma.py
3) Calcmc.py

(and updated POT in SysError.py)

Proceed with analysis tools → look at MC

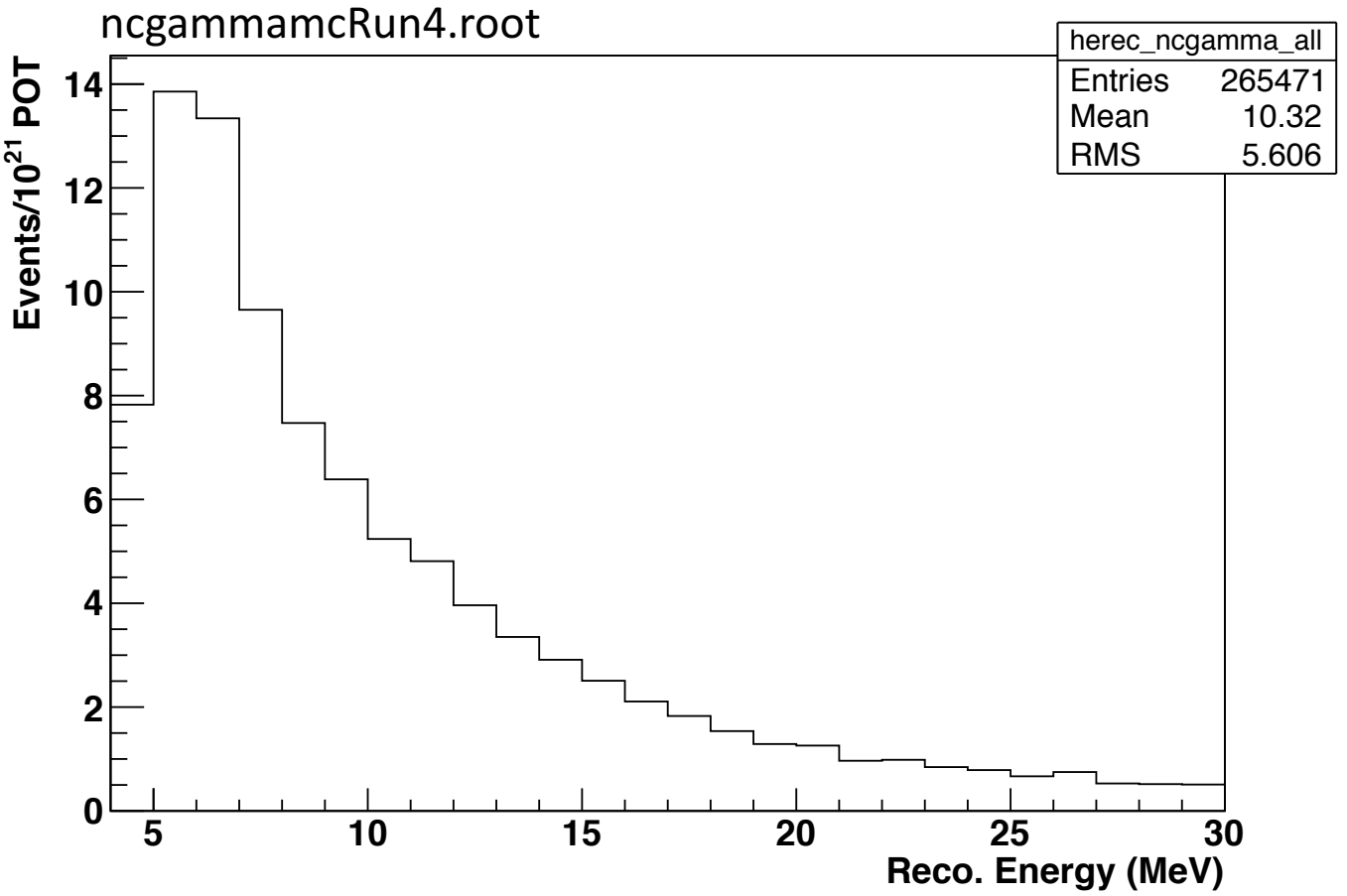
- SelectNCGamma.py

- python SelectNCGamma.py –o ncgammamcRun*.root /disk/…/lemc/lentuple/lentp_nu*.root
- <1 min (not 15 min?)

enu erec dwall effwall ovaq angle	nosel ncgamma	all ccnqe ncother ccqe ccnue → intrinsic & appearance? others osc signal →ncqe?

Look at MC

As an example, reconstructed energy

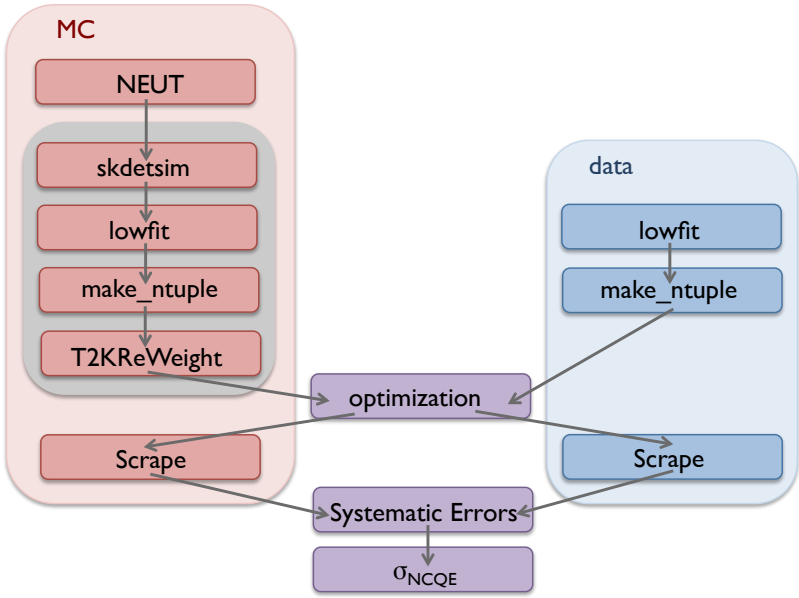


expected behaviour

Optimization

- para/
- make clean
- make
- warning about deprecated header? probably ok?

```
In file included from /usr/lib/gcc/x86_64-redhat-linux/3.4.6/../../../../include/c++/3.4.6/backward/fstream.h:31,
                 from fom_off.C:1:
/usr/lib/gcc/x86_64-redhat-linux/3.4.6/../../../../include/c++/3.4.6/backward/backward_warning.h:32:2: warning: #warning This file includes at least on
e deprecated or antiquated header. Please consider using one of the 32 headers found in section 17.4.1.2 of the C++ standard. Examples include substitu
ting the <X> header for the <X.h> header for C++ includes, or <iostream> instead of the deprecated header <iostream.h>. To disable this warning use -Wn
o-deprecated.
```



Optimization

- python Calcmc.py /disk/…/lemc/lentuple/lentp_nu*.root
- generated:
- fom_off (binary)
- hist/calmcRun4.root
- (dat/)

- python Calcoffbeam.py /disk/…/lowedata/ntuple/
- generated:
- hist/caloffbeamRun4.root
- dat/

- python fom_3para.py
- root –l
- .L fitpara.C
- fitpara("fomRun4_3parahist.root") → created by fom_3para.py

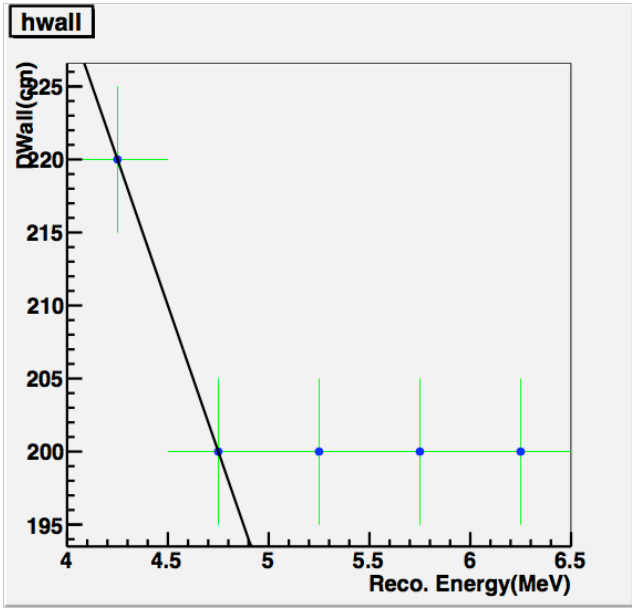
Optimization results printed to screen

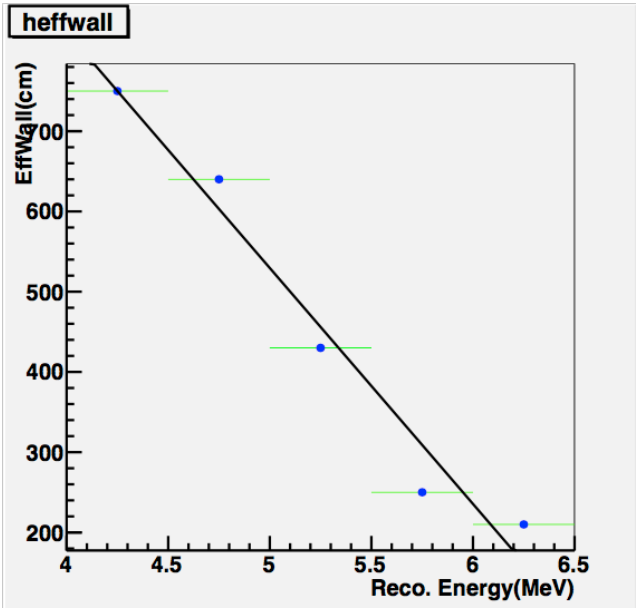
```
root [1] fitpara("fomRun4_3parahist.root")
Error in <TGClient::TGClient>: can't open display "10.30.4.24:0.0", switching to batch mode...
 In case you run from a remote ssh session, reconnect with ssh -Y
Info in <TCanvas::Print>: .pdf file fit.pdf has been created

****************************************
Minimizer is Linear
Chi2                      =   4.6101e-21
NDf                       =            0
p0                        =          390   +/-   63.7377
p1                        =          -40   +/-   14.1421
Info in <TCanvas::Print>: Current canvas added to .pdf file fit.pdf
fitlow4fitup6.5

****************************************
Minimizer is Linear
Chi2                      =        313.2
NDf                       =            3
p0                        =       1999.5   +/-   16.7519
p1                        =         -294   +/-   3.16228
Info in <TCanvas::Print>: Current canvas added to .pdf file fit.pdf

****************************************
Minimizer is Linear
Chi2                      =         42.8
NDf                       =            3
p0                        =       0.4765   +/-   0.0167519
p1                        =       -0.058   +/-   0.00316228
Info in <TCanvas::Print>: Current canvas added to .pdf file fit.pdf
Info in <TCanvas::Print>: Current canvas added to .pdf file fit.pdf
(int)0
root [2]
```

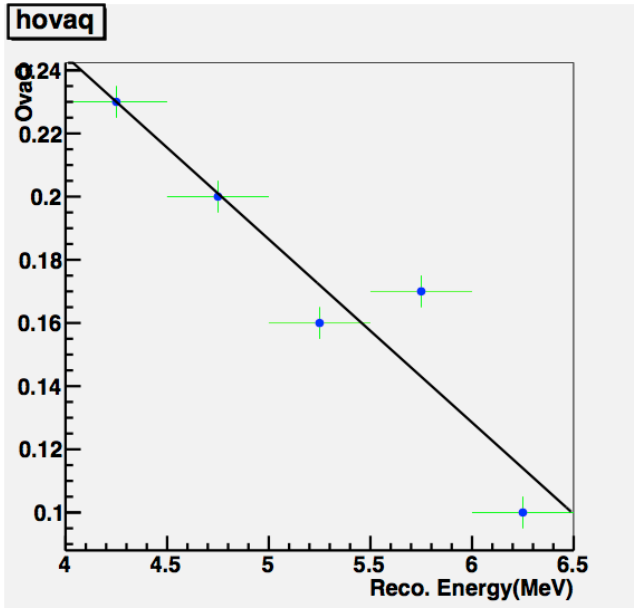
cut criteria	dwall ≥ 200	effwall ≥ 200	ovaQ
p_0	200.	2200	0.4095
p_1	0.	-328.0	-0.046

a bit different, maybe ok?

fit.pdf


hwall
Reco. Energy(MeV)


heffwall
Reco. Energy(MeV)


hovaq
Reco. Energy(MeV)

Then enter optimization fit results

- Processing/Sel.py
- Processing/SelectNCGamma_data.py
- Processing/SelectNCGamma.py
- SelectionFigures/Sel.py

- both Sel.py → separate 3 into 3b & 3c?

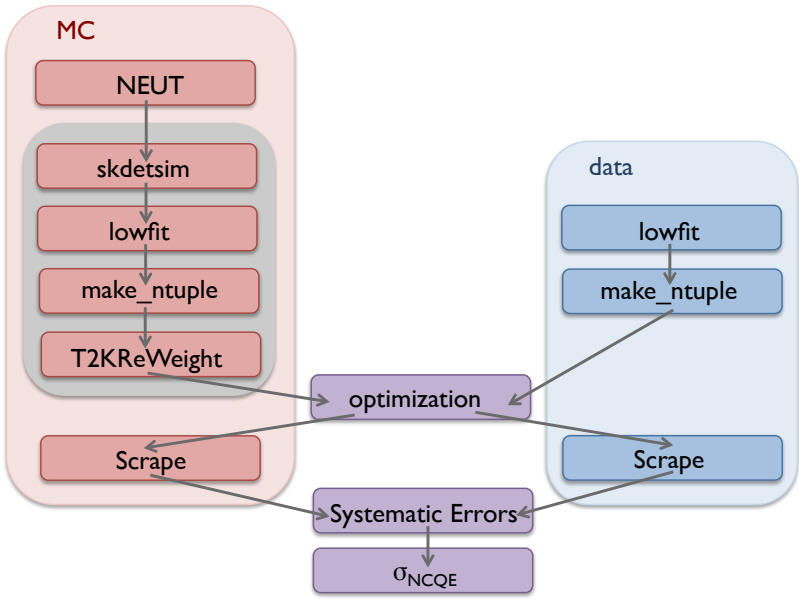
Should I change Run 4 (and Run 1–3) optimization, or not?

Scrape

- ScrapeLE.py, using runscrape.csh
- generated 5 root files for data
- 4 extra branches (3 separated into 3b & 3c: weight3c, wallpass3c, effwallpass3c, ovaqpass3c)

runscrape.csh

```
#These 5 for data

python ScrapeLE.py --suffix=data.ontiming --data --ontiming /disk01/usr4/cnanta\
is/lowedata/ntuple/data.lowfit.*.merge.root

#python ScrapeLE.py --suffix=data.ontiming.nosel --data --ontiming --nosel /dis\
k01/usr4/cnantais/lowedata/ntuple/data.lowfit.*.merge.root

#python ScrapeLE.py --suffix=data.offtiming.nosel --data --offtiming --nosel /d\
isk01/usr4/cnantais/lowedata/ntuple/data.lowfit.*.merge.root

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

#python ScrapeLE.py --suffix=xsec_prefit.ankowski.nosel --friend=/disk01/usr4/c\
nantais/lemc/weights_postfit_banff/xsec_prefit/ --nosel --storeweights /disk01/\
usr4/cnantais/lemc/lentuple/*.root


#These 2 for MC

#python ScrapeLE.py --suffix=xsec_prefit.ankowski --friend=/disk01/usr4/cnantai\
s/lemc/weights_postfit_banff/xsec_prefit/ --storeweights /disk01/usr4/cnantais/\
lemc/lentuple/*.root

#python ScrapeLE.py --suffix=flux_prefit.ankowski --friend=/disk01/usr4/cnantai\
s/lemc/weights_postfit_banff/flux_prefit/ --storeweights /disk01/usr4/cnantais/\
lemc/lentuple/*.root
```



SelectionFigures

- python SelectionPlots.py

- pdf, eps, and png
- dwall
- effwall
- ovaq
- angle
- erec
- dwall_f
- effwall_f
- ovaq_f
- dt0
- ovaq_both
- dwall_both
- effwall_both

also printed 8 bunch times

```
Bunch Time: 0.0995
Bunch Time: 0.6805
Bunch Time: 1.2615
Bunch Time: 1.8425
Bunch Time: 2.4235
Bunch Time: 3.0045
Bunch Time: 3.5855
Bunch Time: 4.1665
```

I thought they looked exactly the same as July 2017, but I didn't clean up the .p file

Since last SelectionFigures

- T2KReWeight turned off NCQE reweighting ~05 October 2017
- Prob3++ improved ~19 July 2017

- (NEUT is different: 5.1.4.2 vs. 5.3.2 & 5.3.3)

Hiro suggestions

- integrate for total number of events in each background category
- has neut mode changed? now have 2p2h in NEUT (not done yet)

Run 3 separated into 3b & 3c

- SelectionPlots.py
- input branches already changes, so must change here

```
#p_wall  = [ tree.wallpass1, tree.wallpass2, tree.wallpass3, tree.wallpass4 ]
#p_ewall = [ tree.effwallpass1, tree.effwallpass2, tree.effwallpass3, tree.effwallpass4 ]
#p_ovaq  = [ tree.ovaqpass1, tree.ovaqpass2, tree.ovaqpass3, tree.ovaqpass4 ]

p_wall  = [ tree.wallpass1, tree.wallpass2, tree.wallpass3b, tree.wallpass3c, tree.wallpass4 ]
p_ewall = [ tree.effwallpass1, tree.effwallpass2, tree.effwallpass3b, tree.effwallpass3c, tree.effwallpass4 ]
p_ovaq  = [ tree.ovaqpass1, tree.ovaqpass2, tree.ovaqpass3b, tree.ovaqpass3c, tree.ovaqpass4 ]
```

Noticed POT in SelectionPlots.py

```
otscale = 1
for fc, fn in files.items():
    f = TFile(fn)
    tree = f.Get("ncgamma")

    if fc == "ontime" or fc == "widetime":
        pot = [1.]*4
    elif fc == "offtime":
        pot = [6*0.2/495.*otscale] + [8*0.2/495.*otscale]*3
    else:
        #pot = [ 0.323e20/1.e21, 1.108e20/1.e21, 1.580e20/1.e21, 3.560e20/1.e21 ]
        pot = [ 0.32875e20/1.e21, 1.13406e20/1.e21, (0.21777e20+1.39028e20)/1.e21, 3.63628e20/1.e21 ]
```

what does this mean?

what does this mean?

I think I want 1,2,3b,3c,4 instead of 1,2,3,4

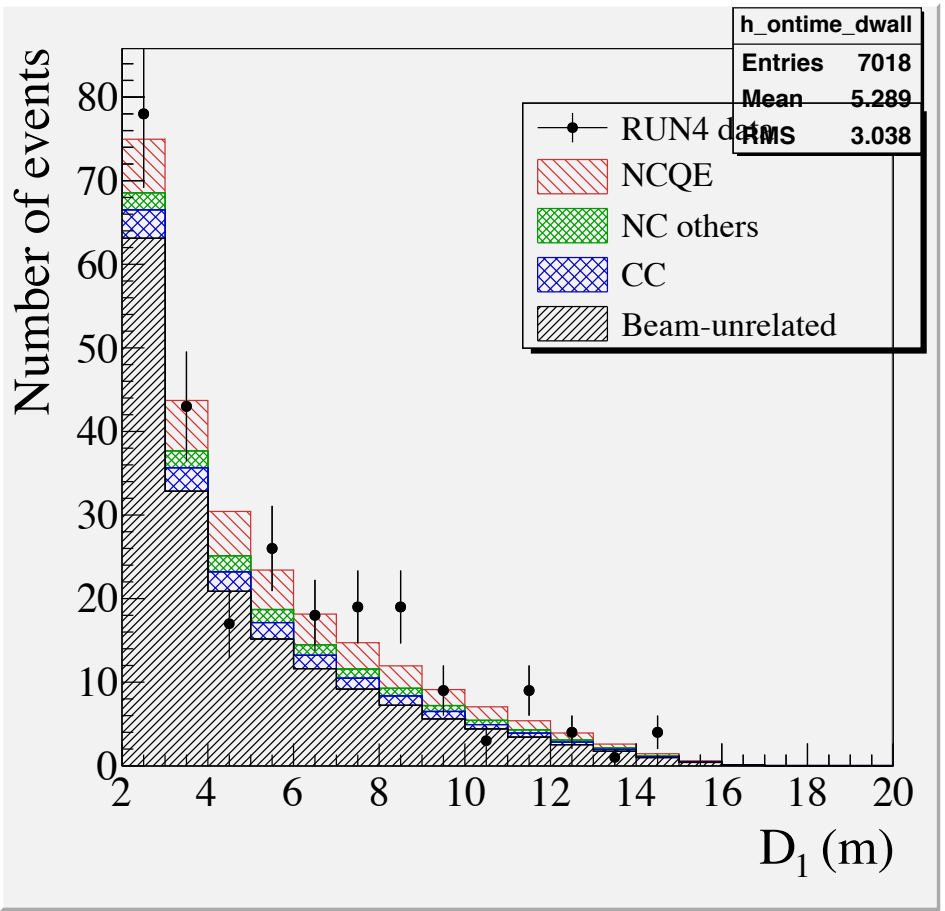
Come back to this!

before optimization?

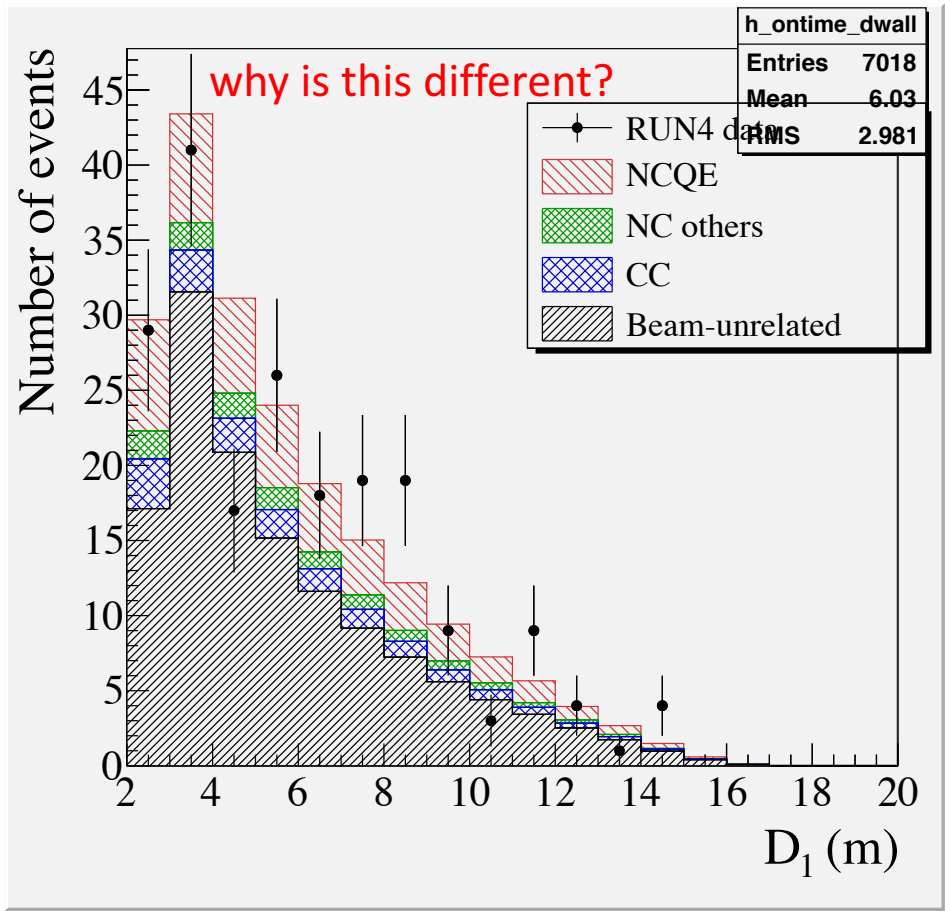
why so much beam unrelated?
before ovaq?

dwall

NCgamma 20170711



26 October 2017

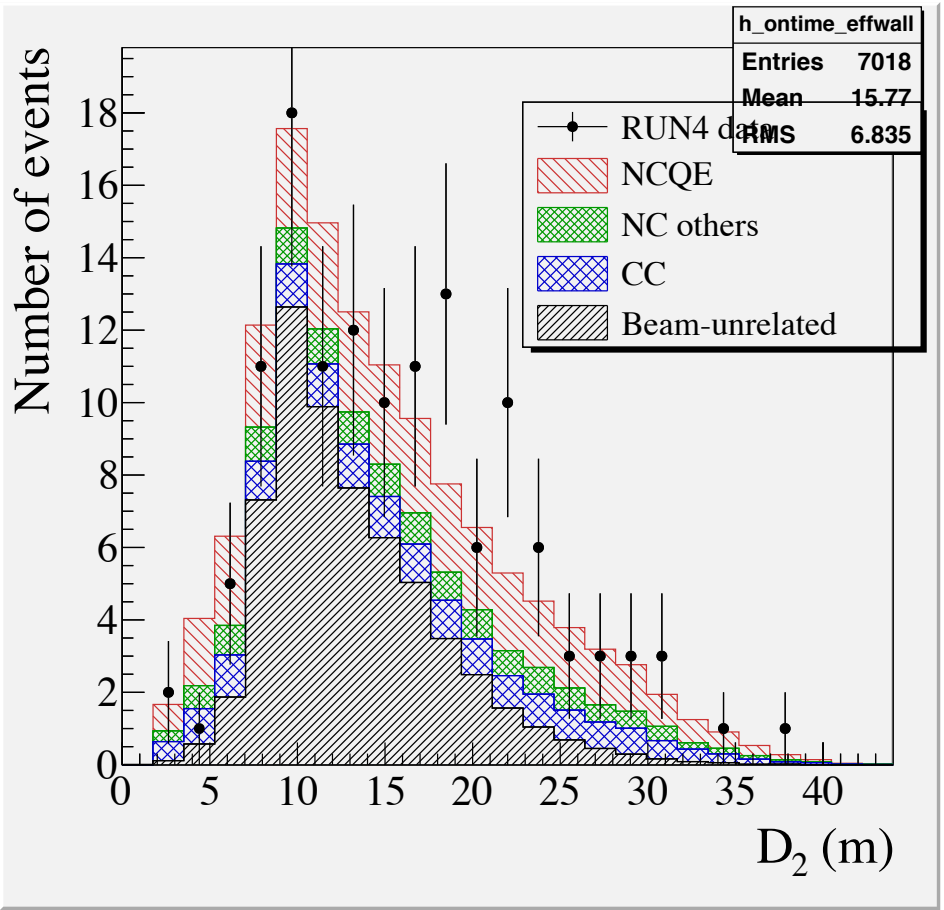


before optimization?

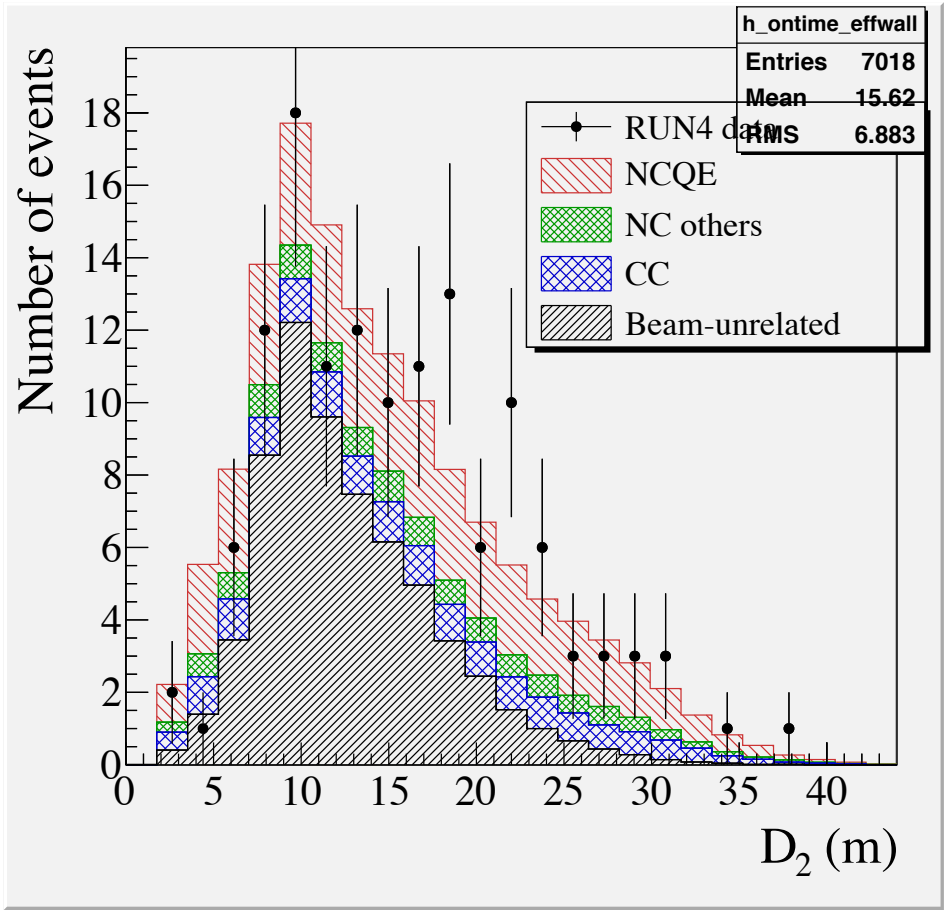
why so much beam unrelated?
before ovaq?

effwall

NCgamma 20170711



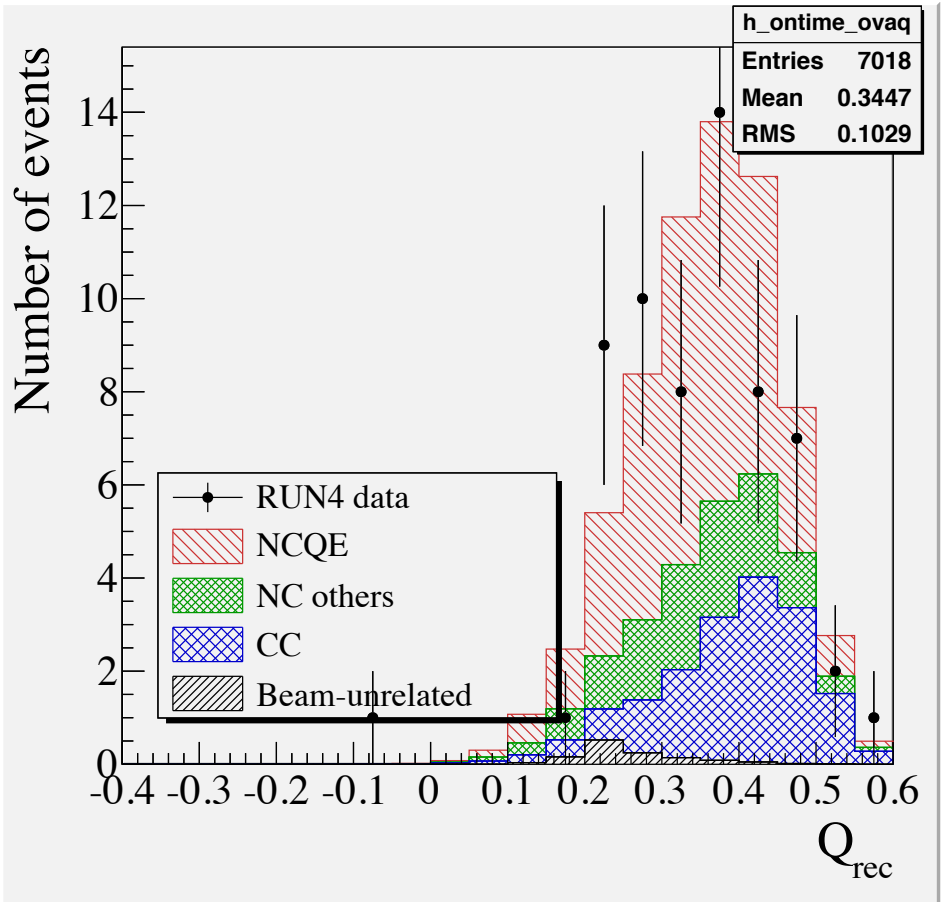
26 October 2017



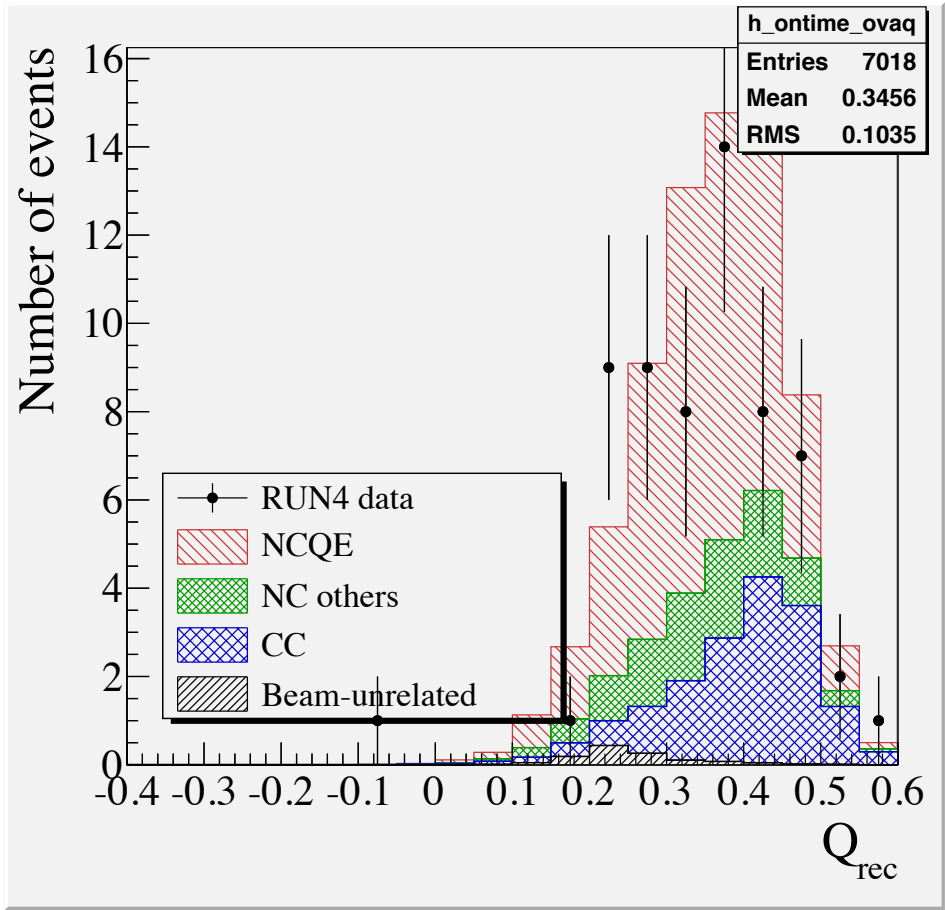
ovaq

before optimization?
no, I don't think so because beam unrelated is already gone

NCgamma 20170711



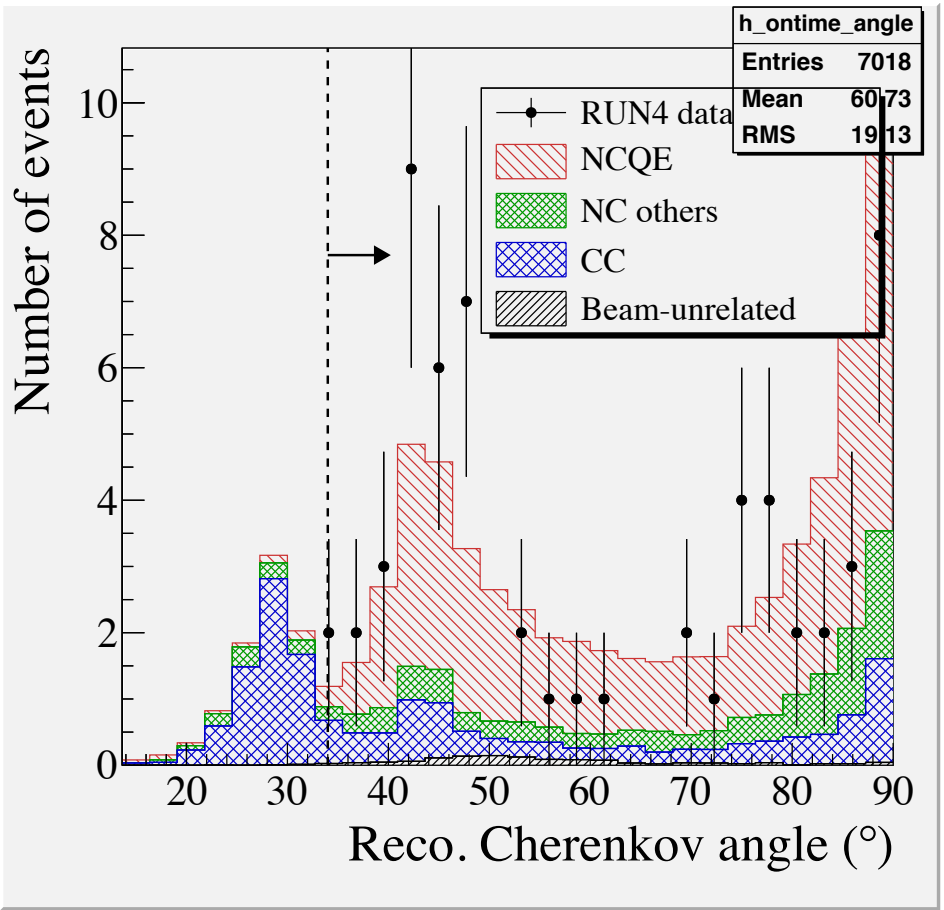
26 October 2017



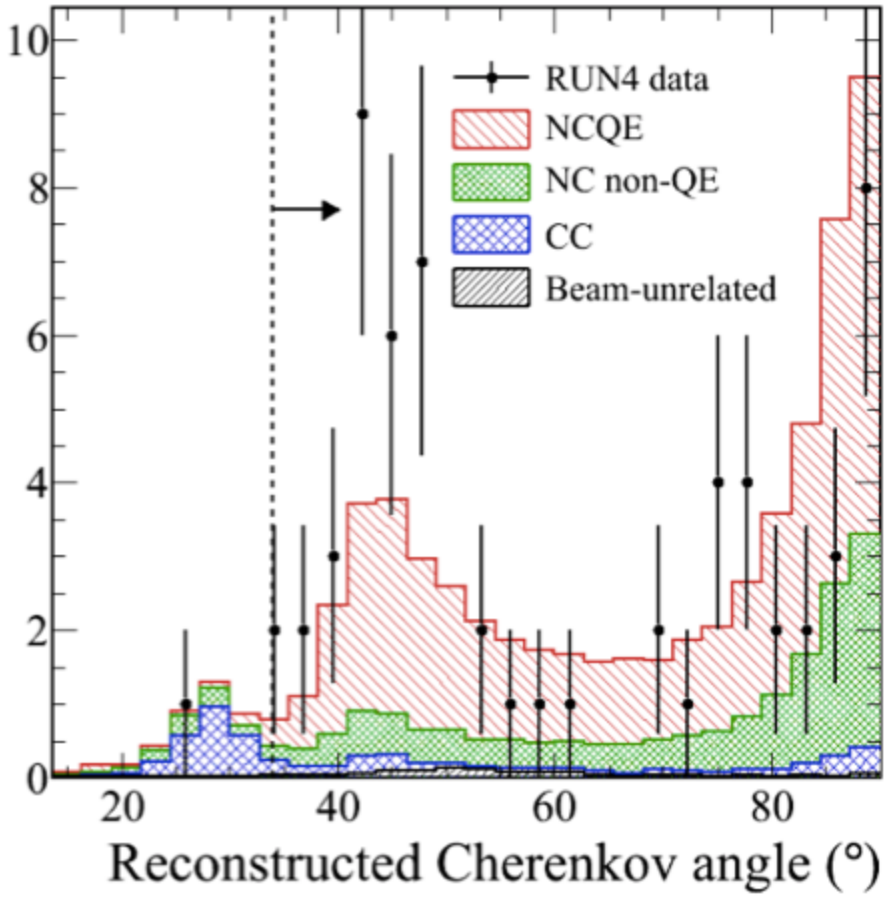
angle

more CC and less NCoth?

26 October 2017



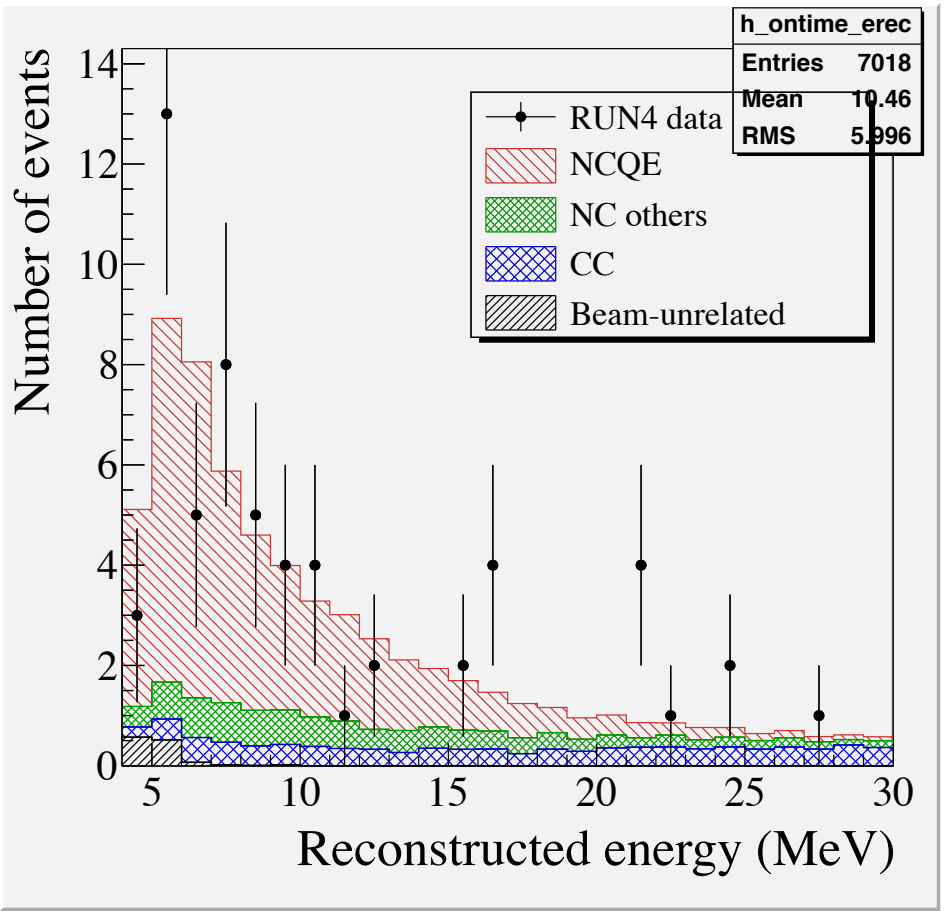
TN-244



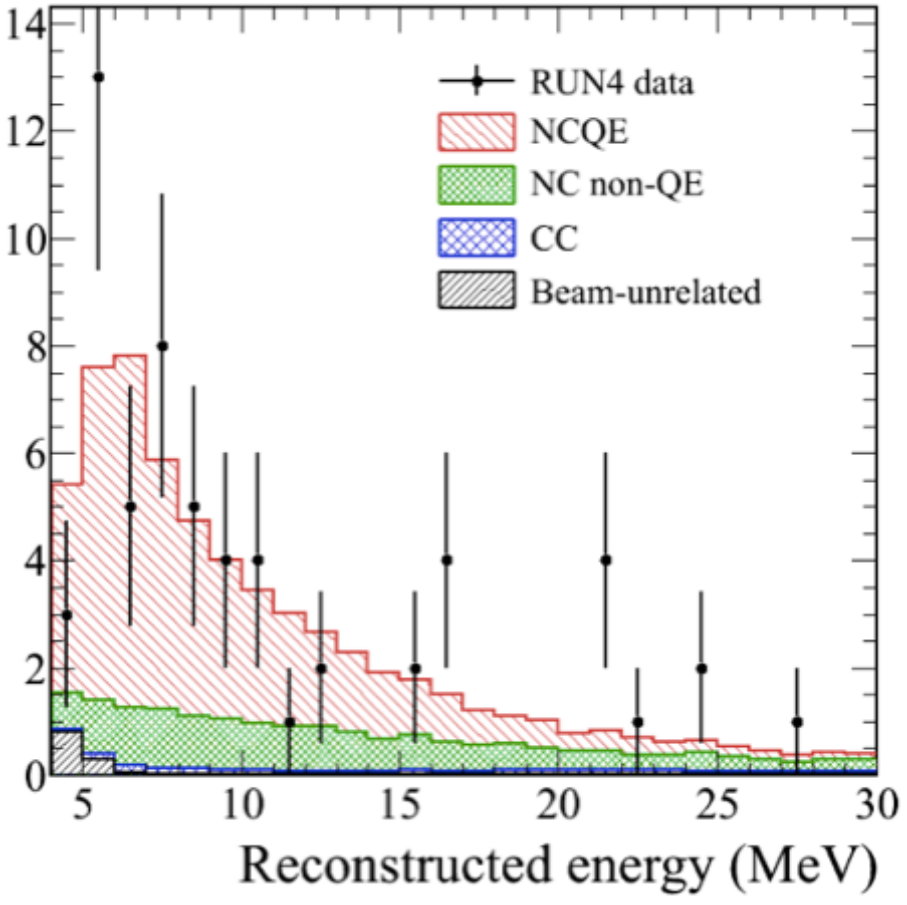
erec

more CC and less NCoth?

26 October 2017



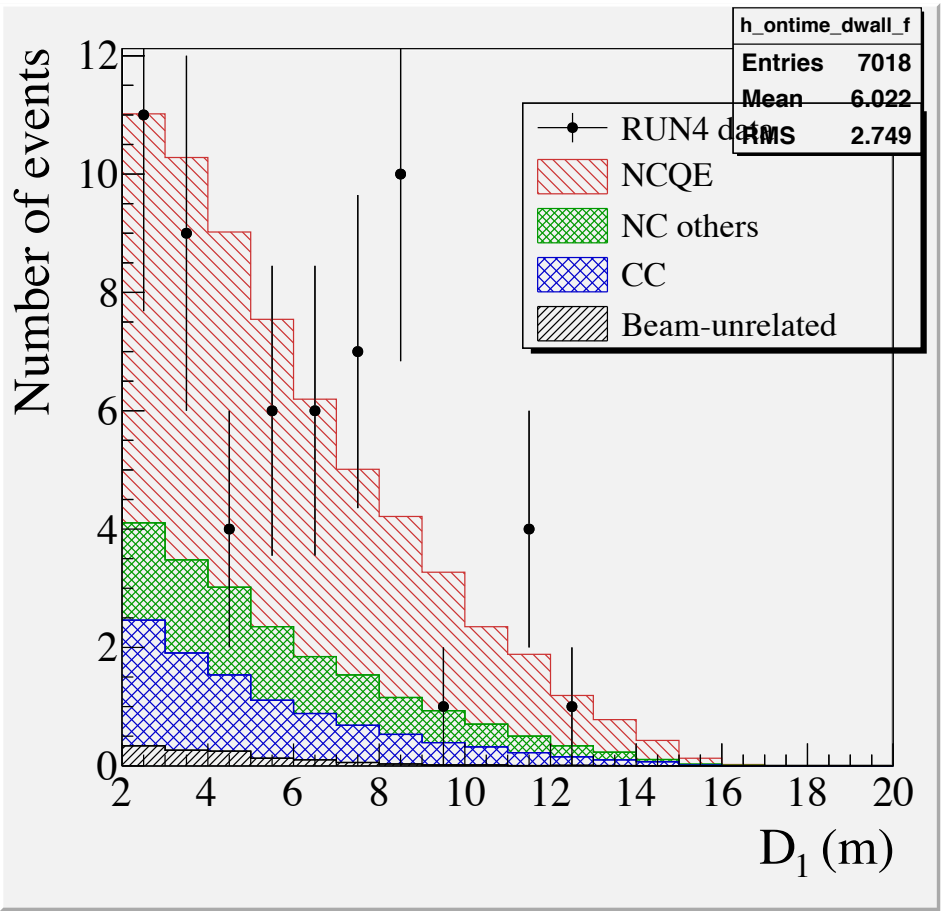
TN-244



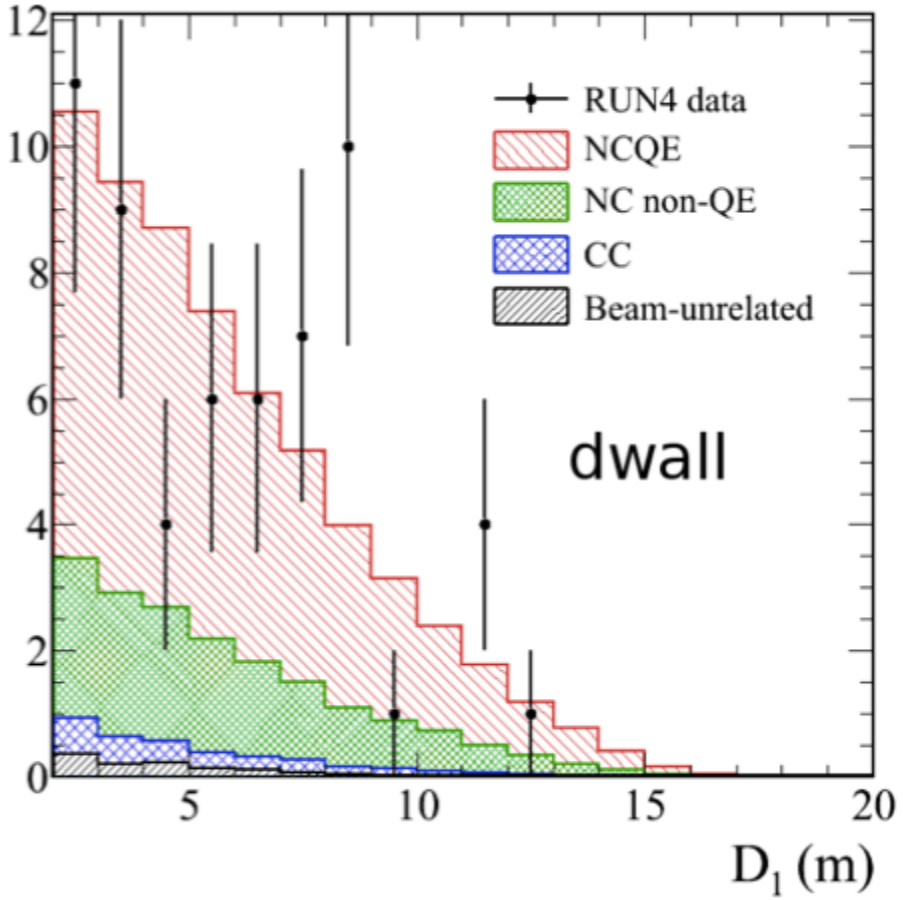
dwall_f

more CC and less NCoth?

26 October 2017



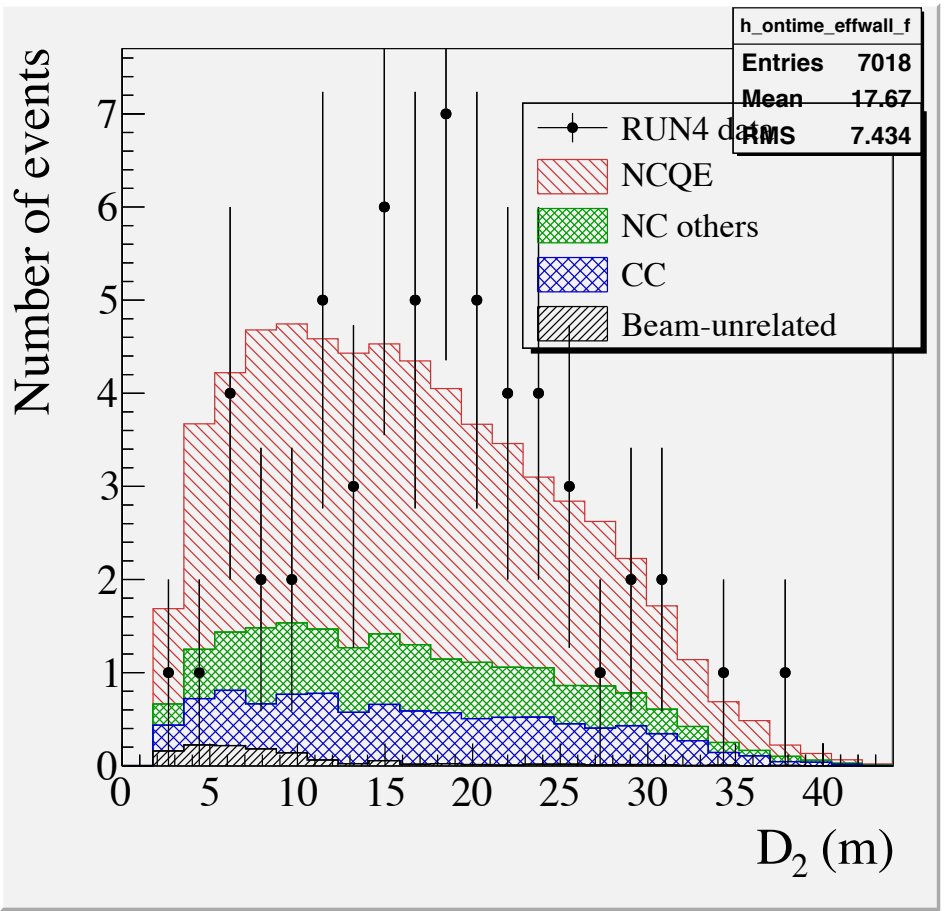
TN-244



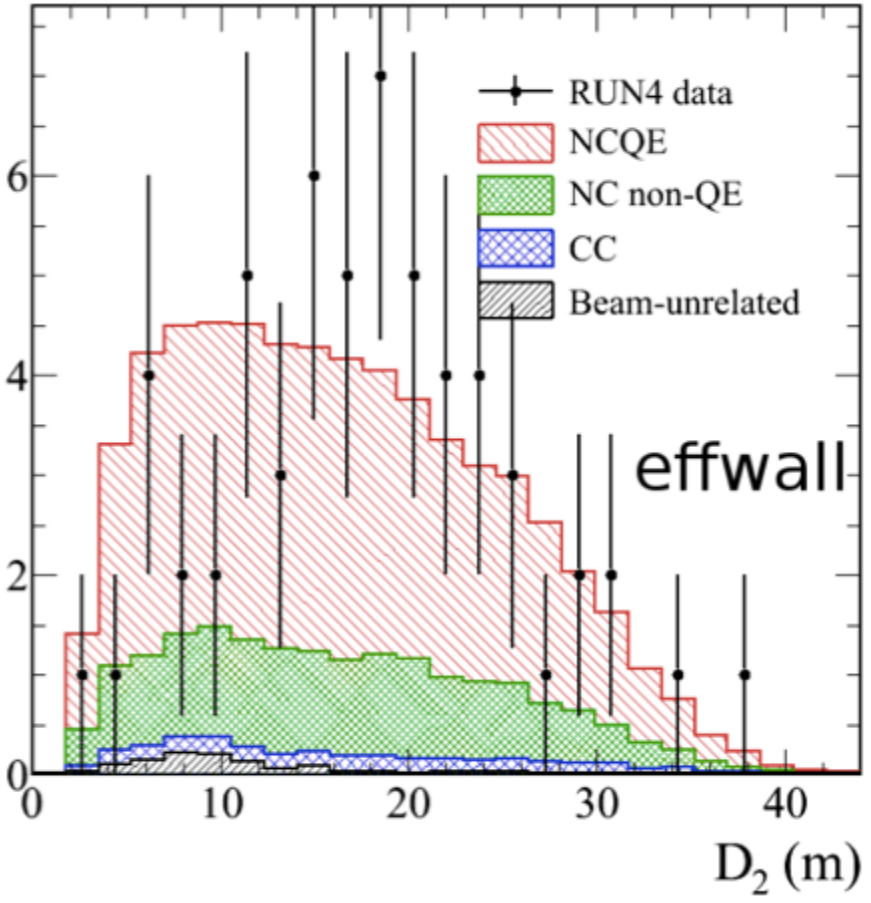
effwall_f

more CC and less NCoth?

26 October 2017



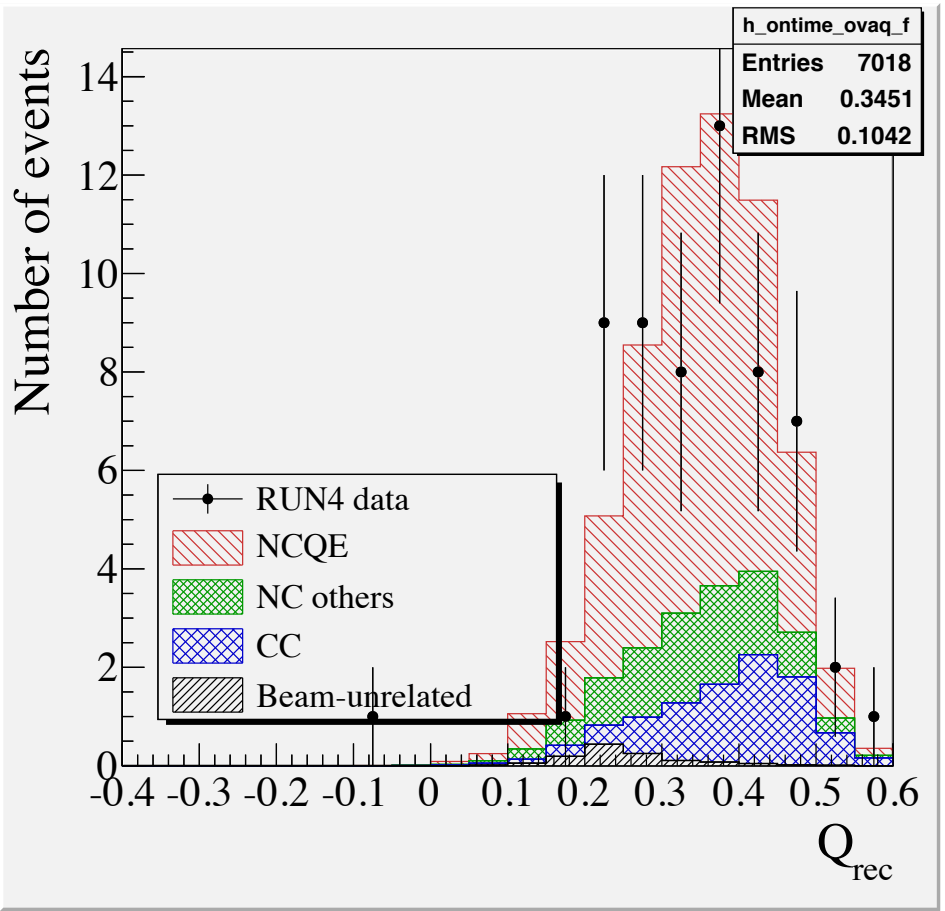
TN-244



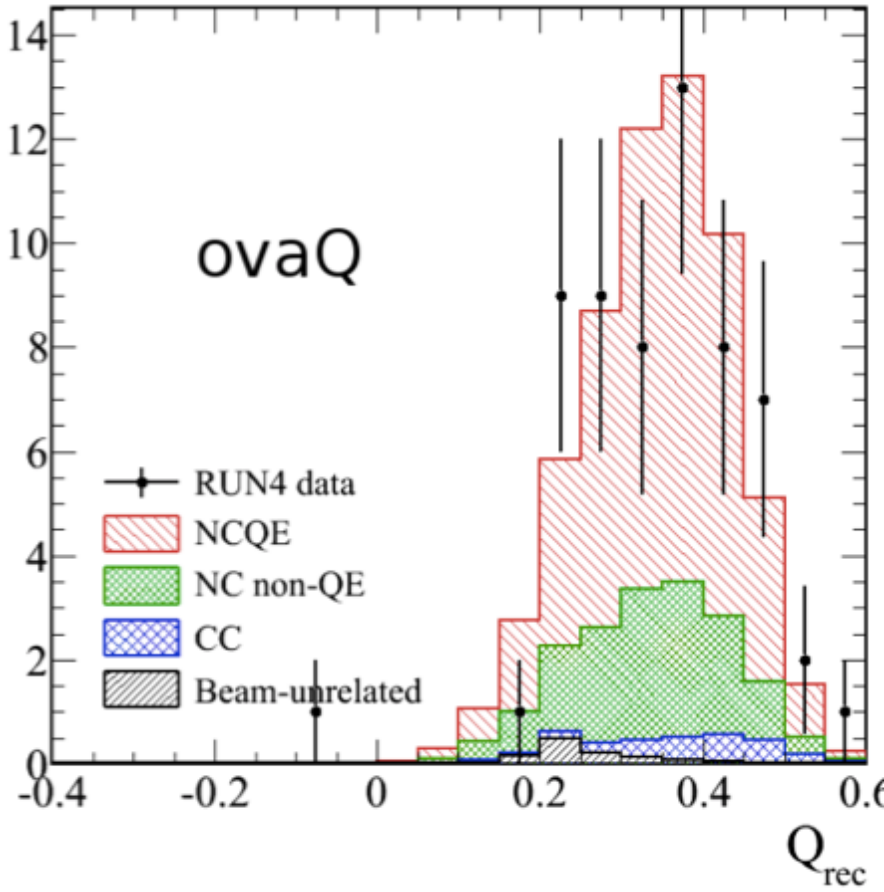
ovaq_f

more CC and less NCoth?

26 October 2017



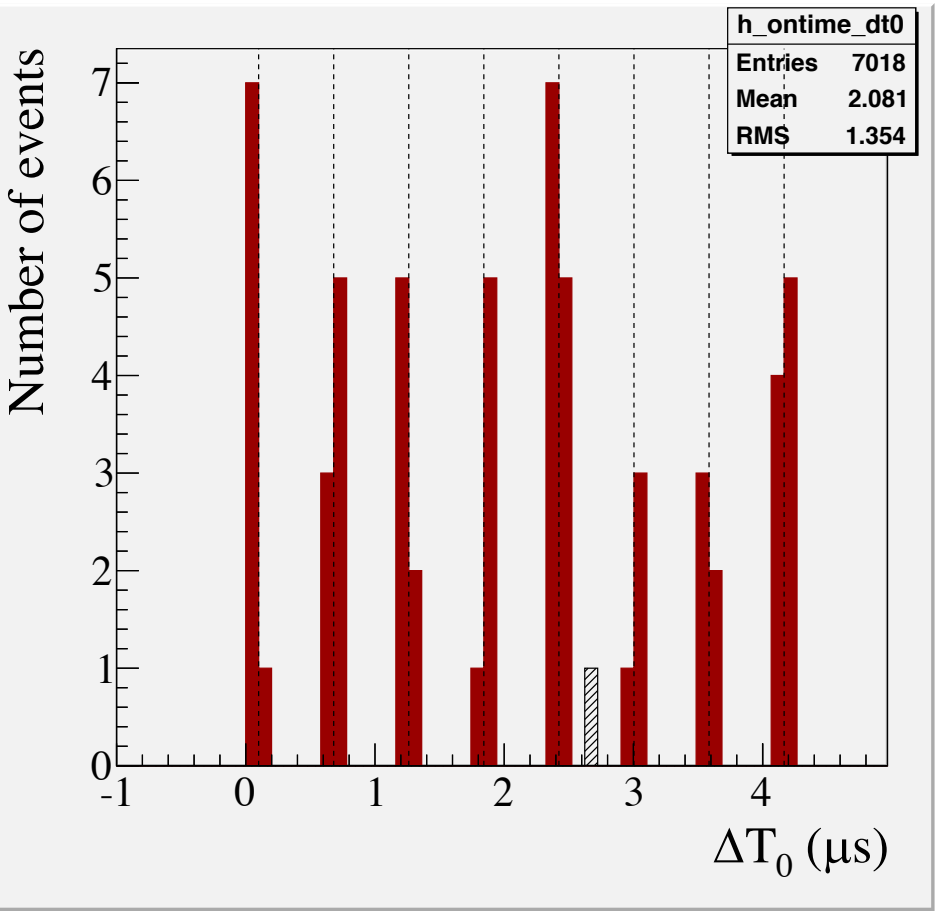
TN-244



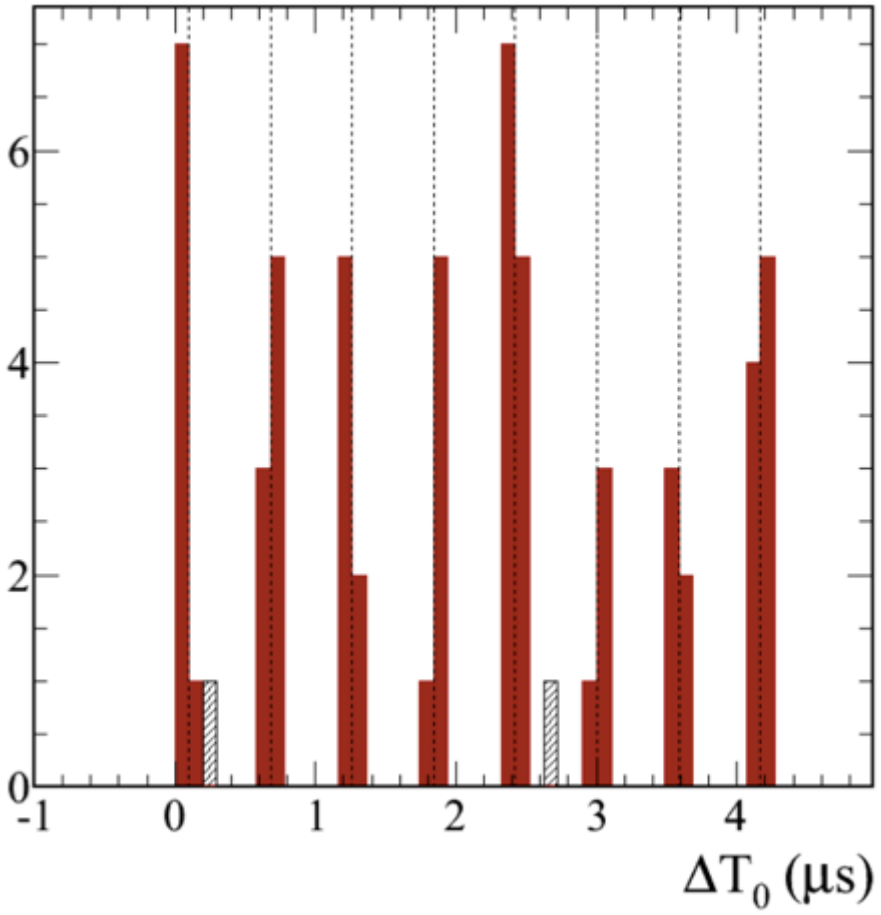
dt0

(looks the same)
data only

26 October 2017



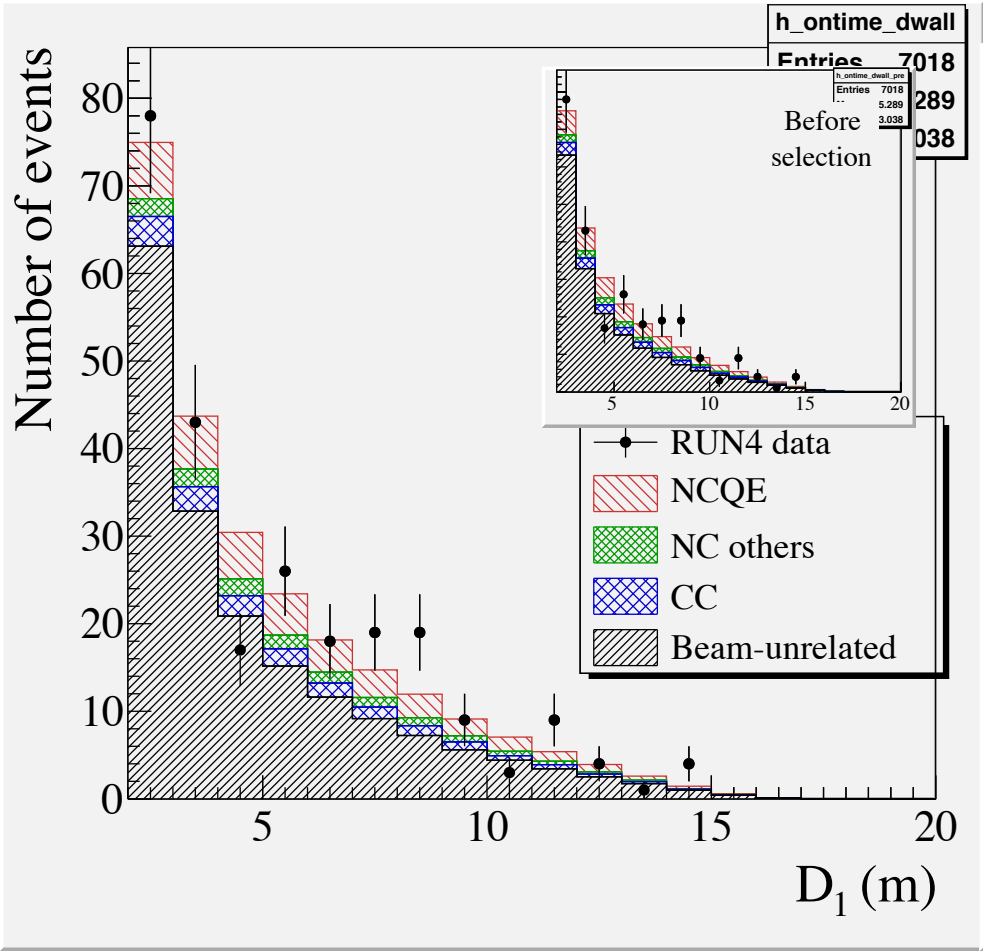
TN-244



dwall_both

before and after optimization?
before ovaq cut?

NCgamma 20170711



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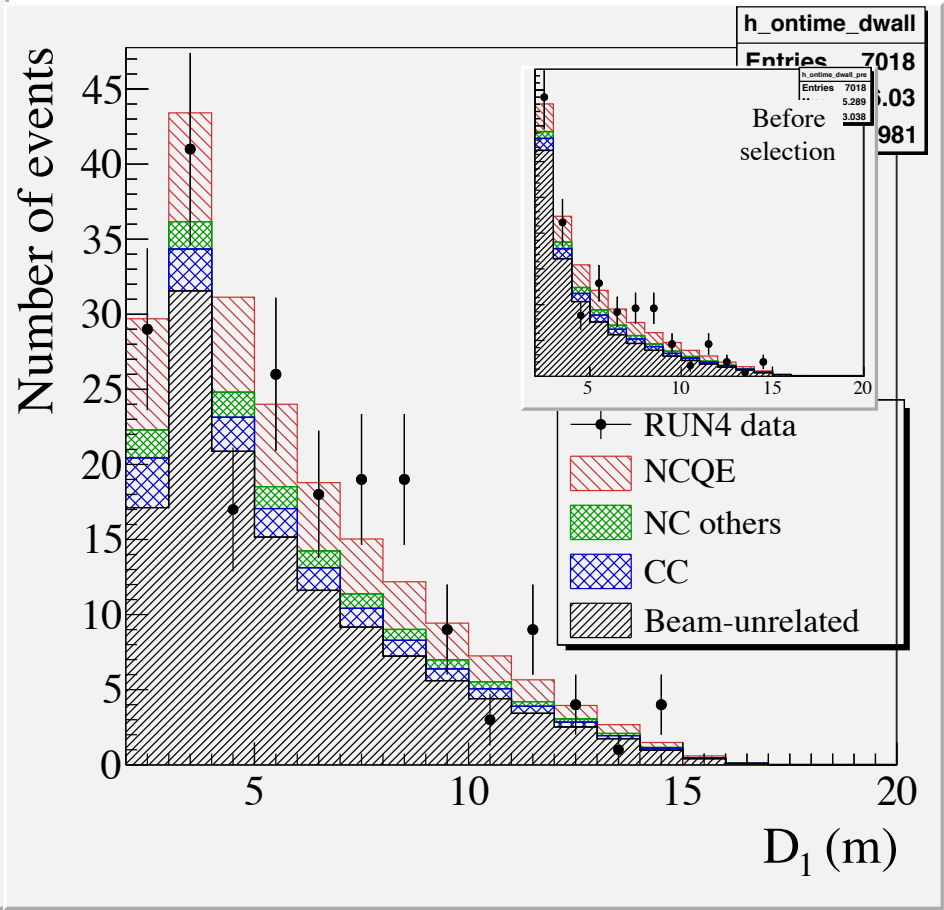
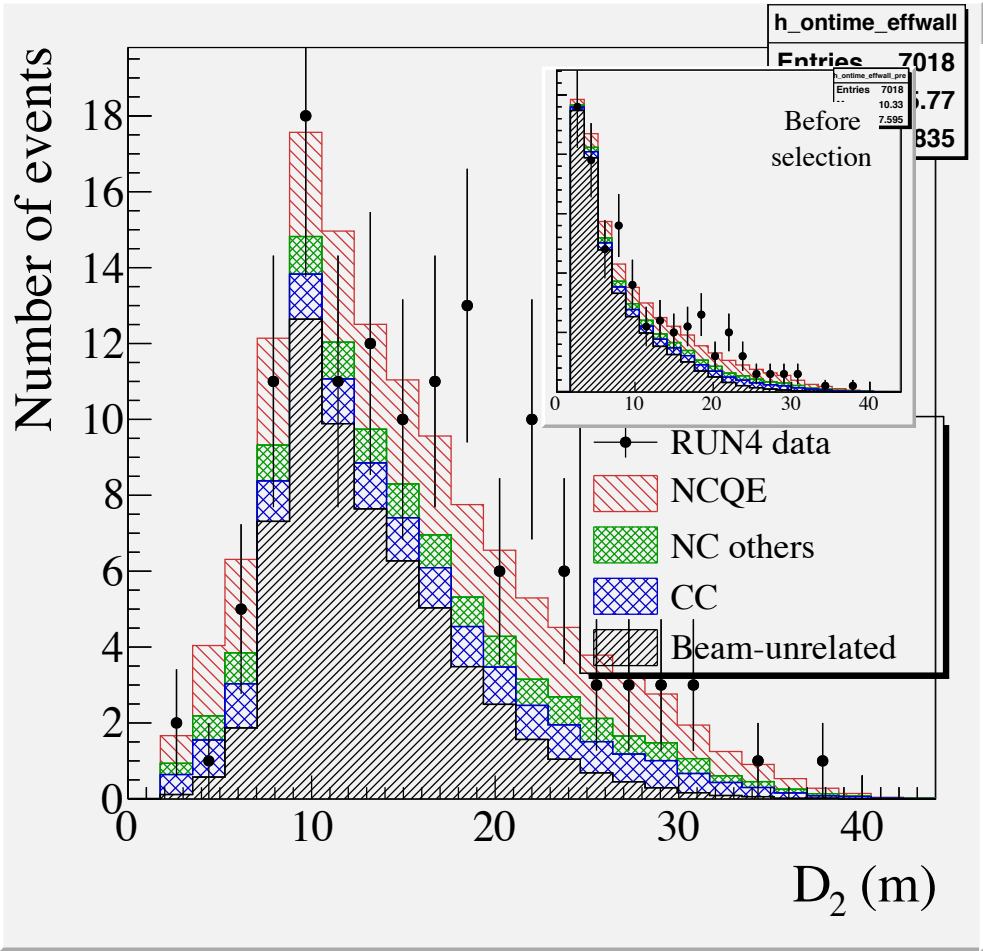


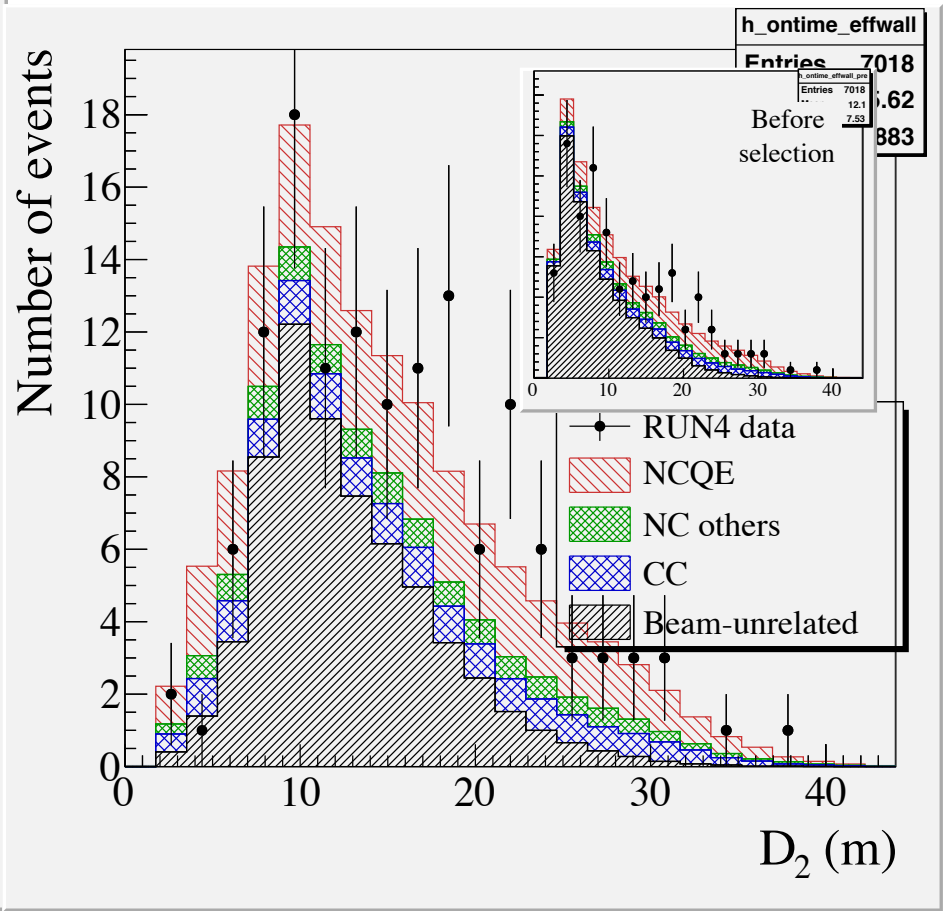
effwall_both

before and after optimization?
before ovaq cut?

NCgamma 20170711



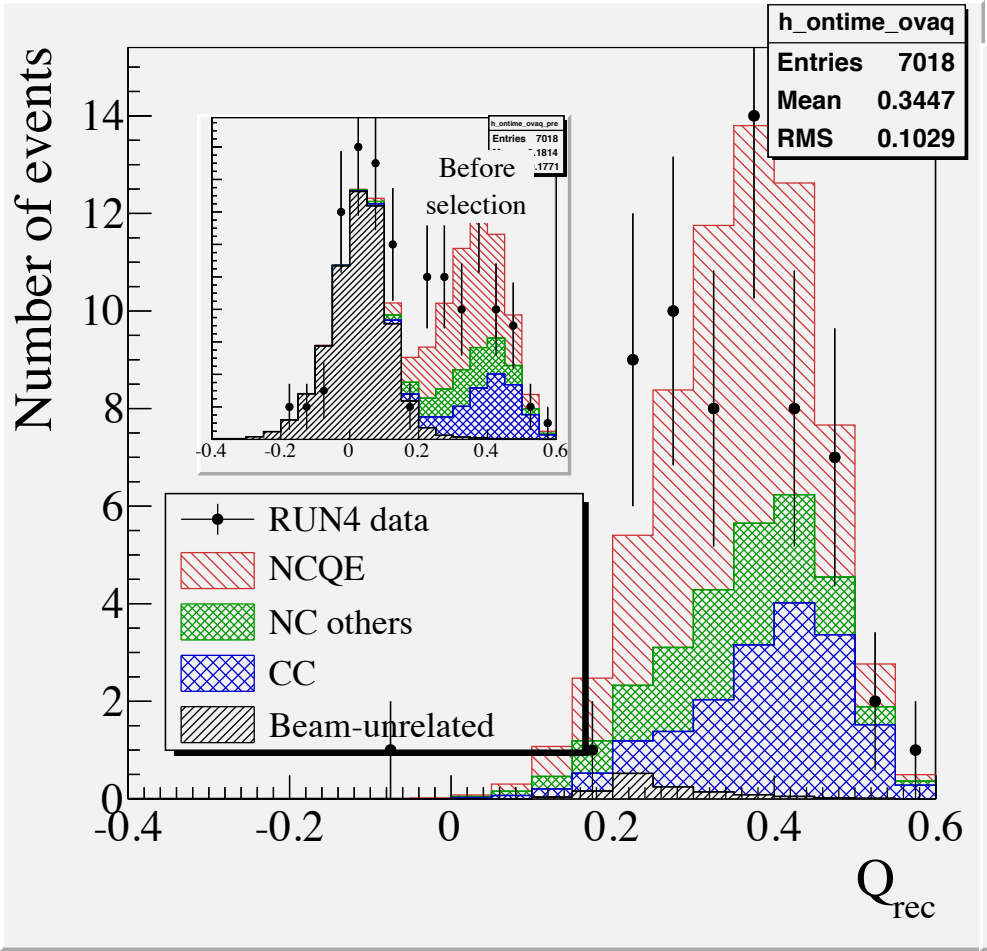
26 October 2017



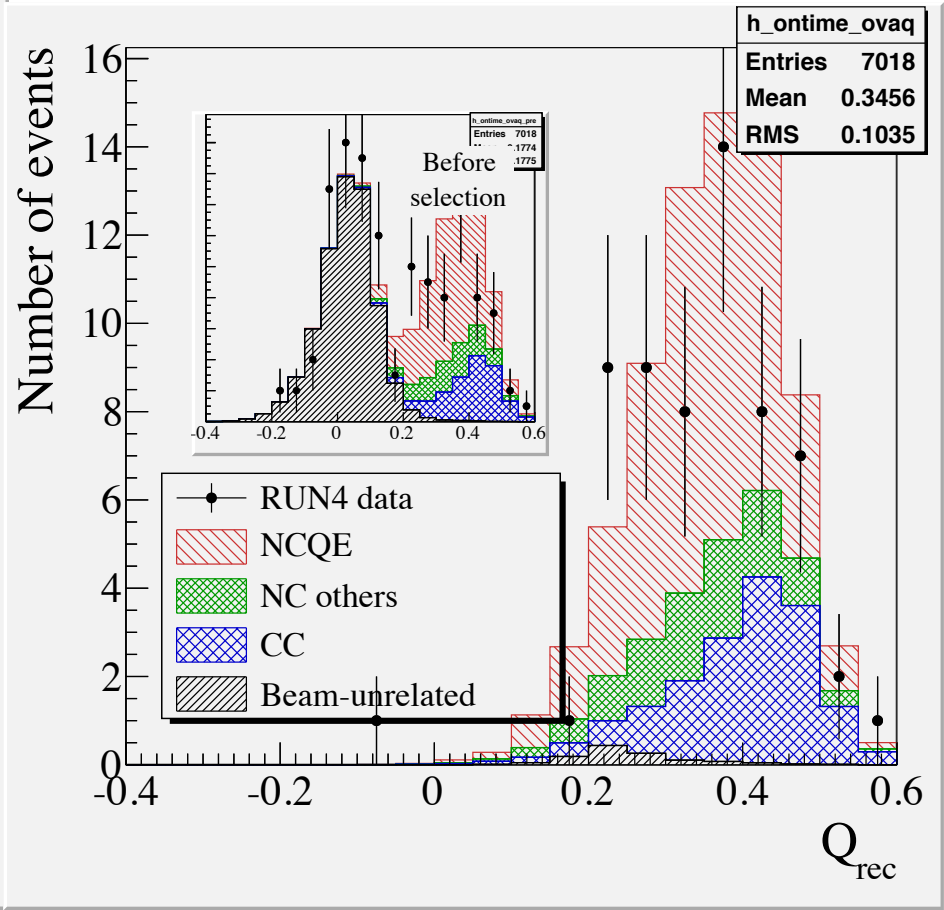
ovaq_both

before and after optimization?

NCgamma 20170711



26 October 2017



numbers of events
selections.root
erec

- h_ontime_erec->Integral() = 59
- h_ncqe_erec->Integral() = 43.0
- h_ncoth_erec->Integral() = 10.0
- h_cc_erec->Integral() = 9.2
- h_offtime_erec->Integral() = 1.2

10.0 + 9.2 + 1.2 = 20.4 for background

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

T2K RUN	N^{obs}	N^{exp}_{sig}	N^{exp}_{bg}	$< \sigma^{obs}_{\nu,NCQE} >$	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	$1.75 \times 10^{-38}\text{cm}^2$	$\pm 15.42\%$	$^{+40.0\%}_{-17.63\%}$

TN-244

Run 4 only
102 - 43 = 59 data
77.6 - 34.8 = 42.8 signal
34.6 - 16.2 = 18.4 background

numbers of events
selections.root
angle

- h_ontime_angle->Integral() = 60.0
- h_ncqe_angle->Integral() = 43.6
- h_ncoth_angle->Integral() = 11.1
- h_cc_angle->Integral() = 16.3
- h_offtime_angle->Integral() = 1.2

11.1 + 16.3 + 1.2 = **28.6** for background

Run 4 only
59 data
42.8 signal
18.4 background

different than erec (and others)?

numbers of events
selections.root
dwall_f

- h_ontime_dwall_f->Integral() = 59
- h_ncqe_dwall_f->Integral() = 43.0
- h_ncoth_dwall_f->Integral() = 10.0
- h_cc_dwall_f->Integral() = 9.2
- h_offtime_dwall_f->Integral() = 1.2

10.0 + 9.2 + 1.2 = 20.4 for background

Run 4 only
59 data
42.8 signal
18.4 background

same as erec (and others), so that's good

numbers of events
selections.root
effwall_f

- h_ontime_effwall_f->Integral() = 59
- h_ncqe_effwall_f->Integral() = 43.0
- h_ncoth_effwall_f->Integral() = 10.0
- h_cc_effwall_f->Integral() = 9.2
- h_offtime_effwall_f->Integral() = 1.2

10.0 + 9.2 + 1.2 = 20.4 for background

Run 4 only
59 data
42.8 signal
18.4 background

same

numbers of events
selections.root
ovaq_f

- h_ontime_ovaq_f->Integral() = 59
- h_ncqe_ovaq_f->Integral() = 43.0
- h_ncoth_ovaq_f->Integral() = 10.0
- h_cc_ovaq_f->Integral() = 9.1
- h_offtime_ovaq_f->Integral() = 1.2

10.0 + 9.1 + 1.2 = 20.3 for background

Run 4 only
102 - 43 = 59 data
77.6 - 34.8 = 42.8 signal
34.6 - 16.2 = 18.4 background

practically the same

Conclusion

- Since the overall background (CC + NCoth + offtime) is not much different, is it ok that it seems like there is less CC and more NCoth?

- Why is angle different than others (erec, dwall_f, effwall_f, and ovaq_f)?

Next step:

- look at NEUT mode
- all MC comes from ncgamma.xsec_prefit.ankowski.nosel.root
- this is made by runscrape.csh
- takes in lemc/weights_postfit_banff_xsec/ and lemc/lentuple

- there is a mode branch in ncgamma.xsec_prefit.ankowski.nosel.root
- scp is taking forever…