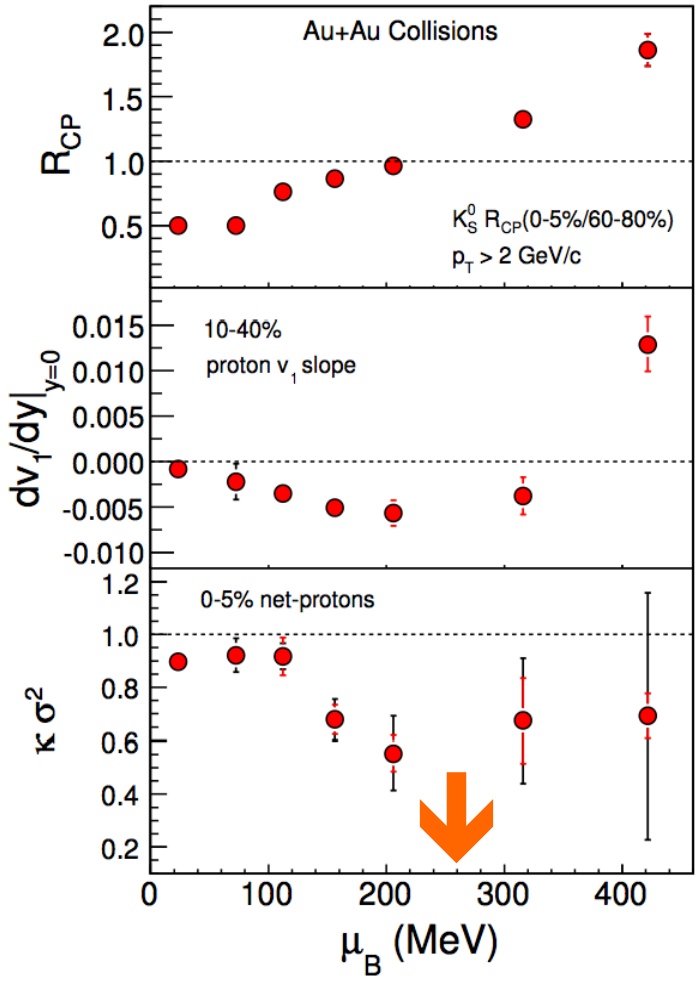
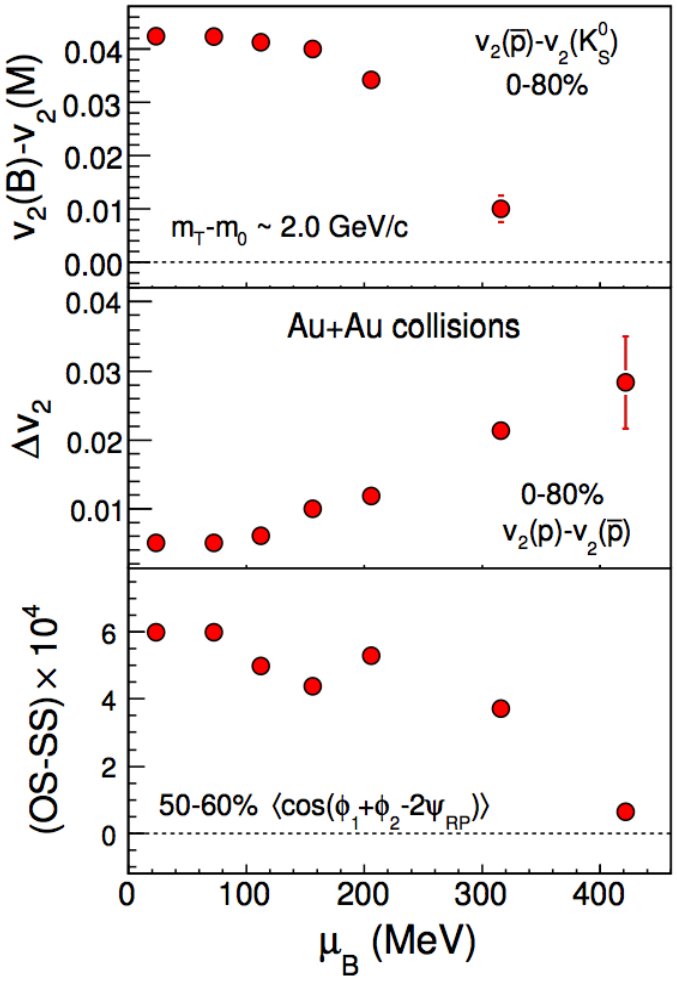
Run-14 Au+Au 14.5 GeV – initial QA and multiplicity cumulants

w.j. llope, 3/19/2014

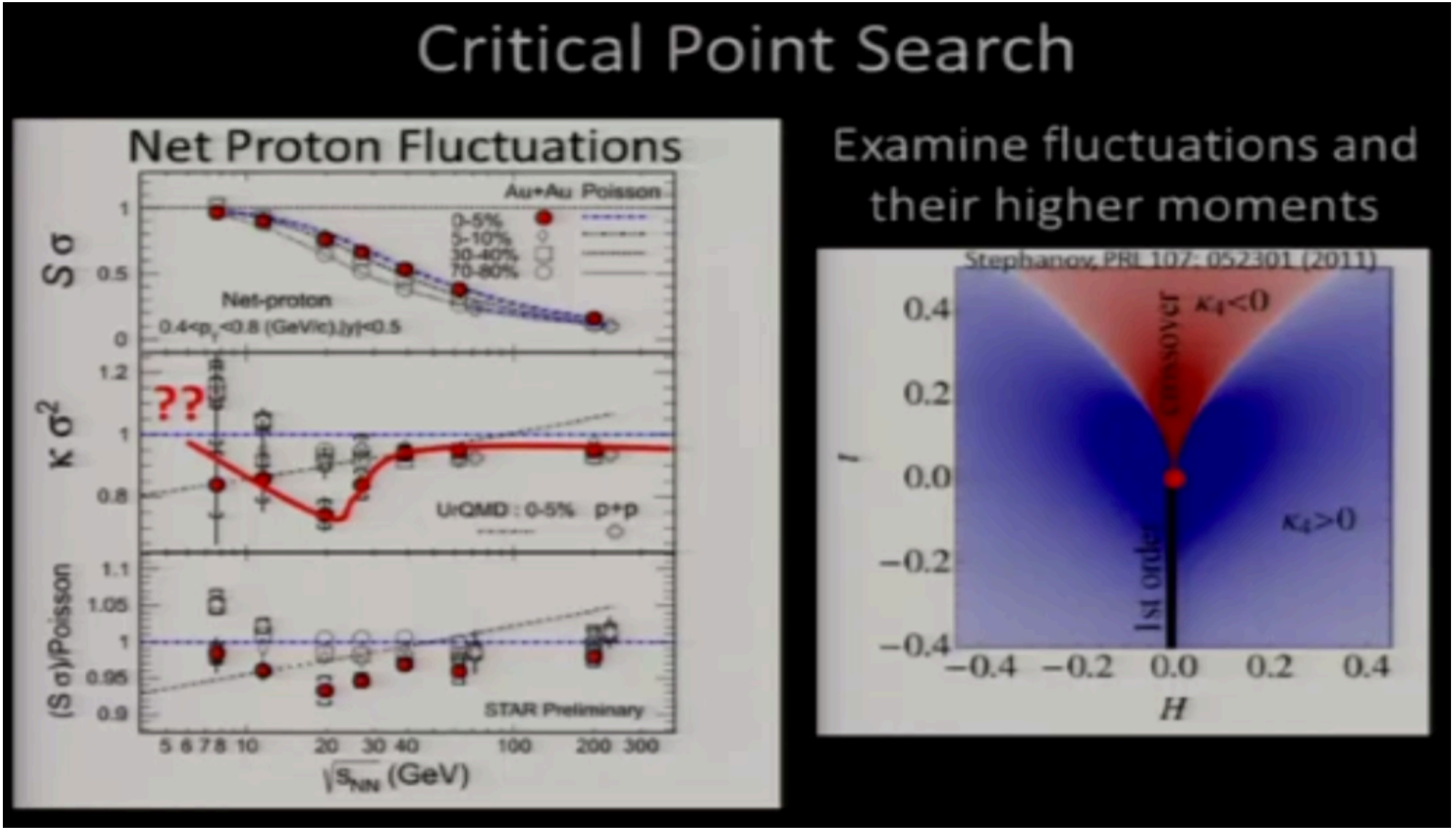




14.5 GeV data (μ_B ~ 260MeV) inside large μ_B gap between 7.7 and 19.6 GeV

Net-p moments products results at QM2012 got lots of attention!

J. Nagle, last talk at QM2012

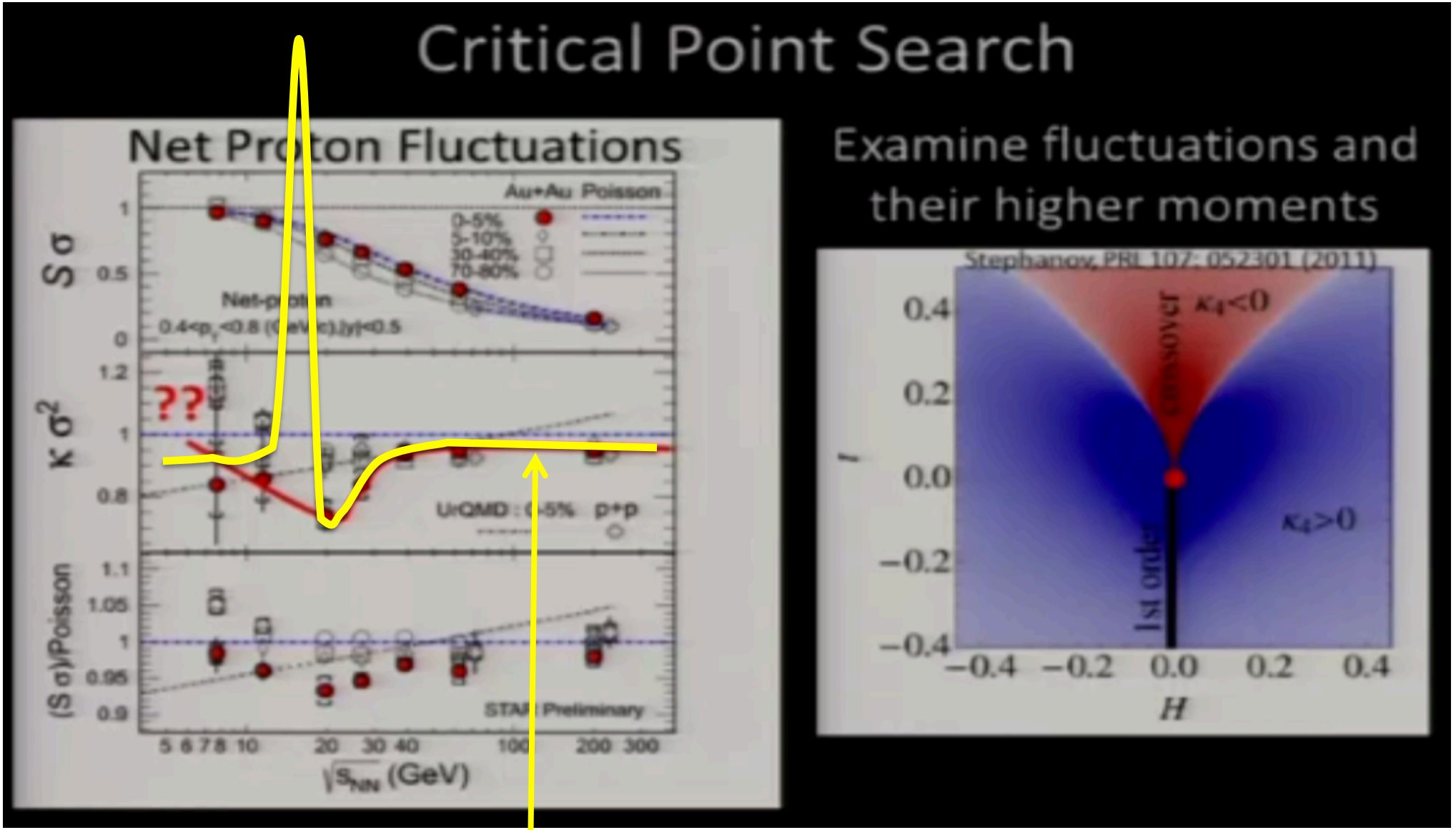


Kurtosis < Poisson for $\sqrt{s_{NN}}$ just above CP?

M.A. Stephanov, Phys. Rev. Lett. 107, 052301 (2011)

Non-linear sigma model of Stephanov *et al.*

J. Nagle, last talk at QM2012



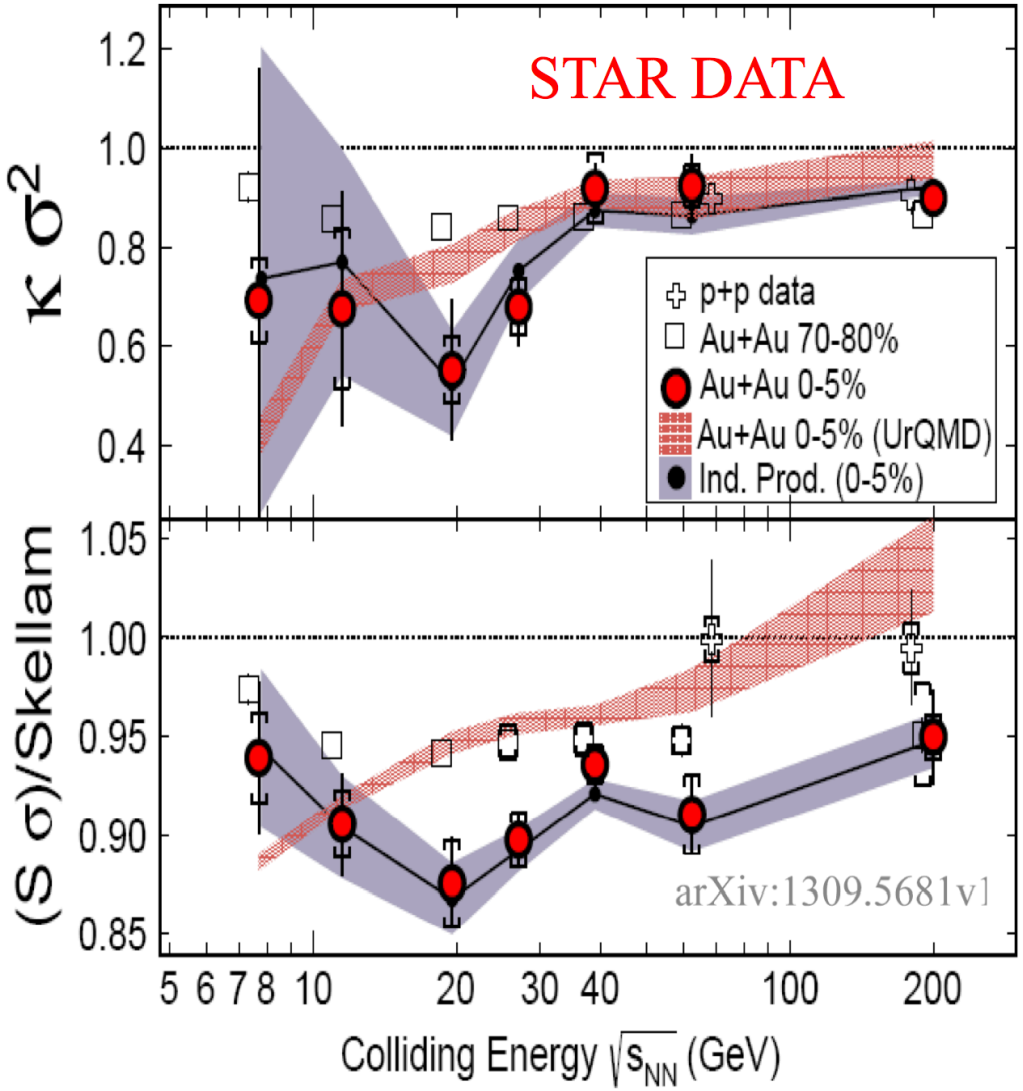
what the NLSM would *actually* expect for a CP at $\sqrt{s_{NN}}$~15 GeV

We now have data at 14.5 GeV!

Hints of critical behavior?

K. Redlich, International Conference on New Frontiers in Physics, Crete, August 2013

STAR data on the first four moments of net baryon number



Deviations from the HRG

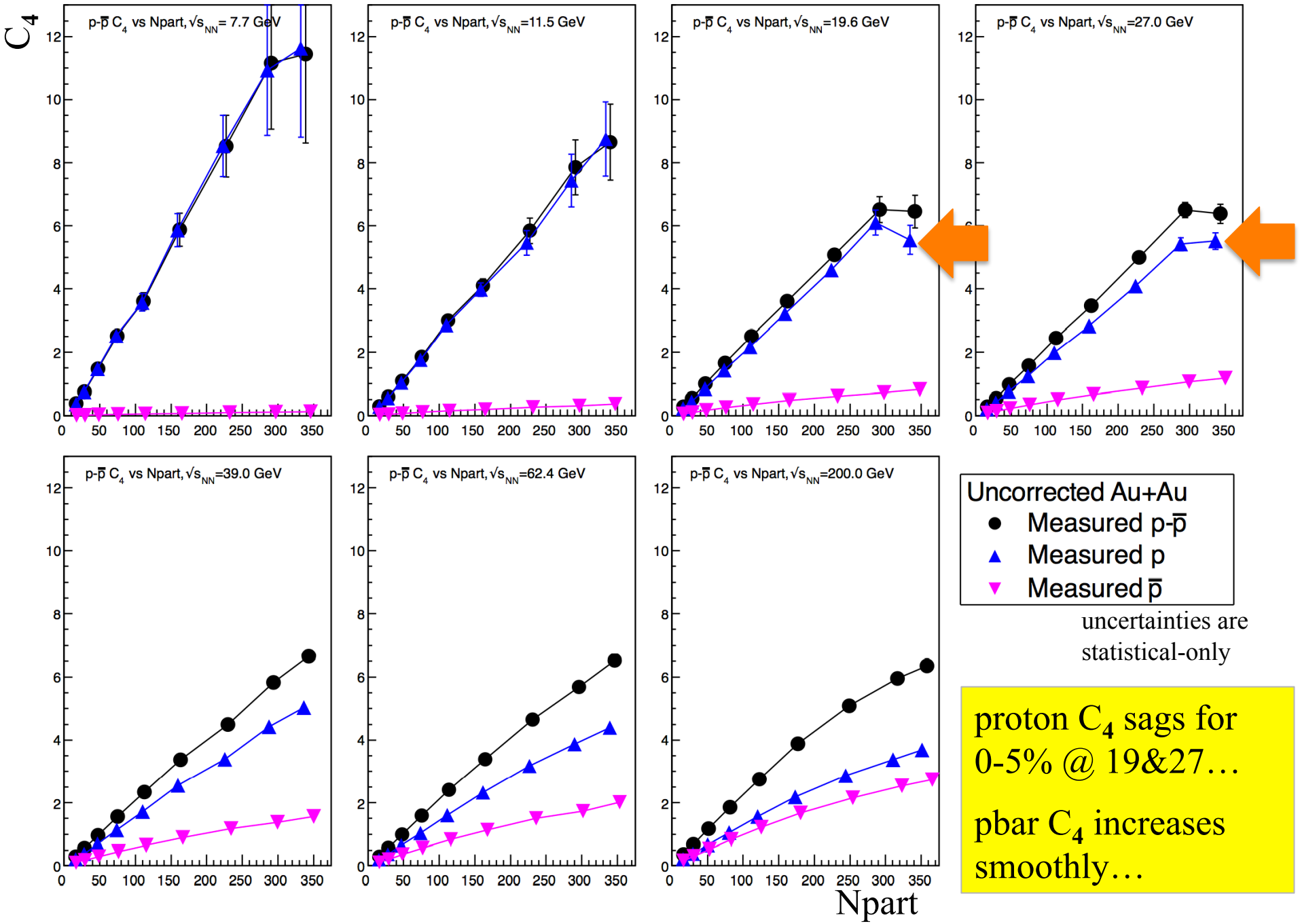
$$S\sigma = \frac{\chi_B^{(3)}}{\chi_B^{(2)}} \quad , \quad \kappa\sigma^2 = \frac{\chi_B^{(4)}}{\chi_B^{(2)}}$$

$$S\sigma|_{HRG} = \frac{N_p - N_{\bar{p}}}{N_p + N_{\bar{p}}} \quad , \kappa\sigma|_{HRG} = 1$$

Data qualitatively consistent with the change of these ratios due to the contribution of the O(4) singular part to the free energy

Deconstructing the STAR net-p moments products - **it's about the proton C_4**

WJL, Plenary Session, STAR Analysis Meeting, Purdue University, July 16, 2013.



uncertainties are statistical-only

proton C_4 sags for 0-5% @ 19&27…

pbar C_4 increases smoothly…

14.5 GeV Run Totals

Run Totals :

RUN LABEL	RUN TYPE	RUNS	EVENTS	RUNNING TIME (HRS)	% QUESTIONABLE	% BAD	PRODUCTION CANDIDATE	PROD.CAND., readable
production_15GeV_2014	PHYS	919	348506767	253.16	2.51		339761490	339.76 M
Totals		**919**	**348.51 M**	**253.1556**	**avg: 2.51%**	**avg: 0%**		

hlt-good-vpd	4	2	[CP]	3	98239	98.24 K	0%
hlt-good-vpd	4	440065	[CP]	97	4866106	4.87 M	1.4%
hlt-good-vpd	2	440075	[CP]	65	2307954	2.31 M	0.7%
hlt-good-vpd	2	440085	[CP]	676	29417649	29.42 M	8.4%
					Total hlt-good-vpd (4 versions)	*36.69 M*	*10.53%*

37M

bbc_mon_tof	2	1	[CP]	139	18599091	18.6 M	5.3%
bbc_mon_tof	1	2	[CP]	2	704195	704.2 K	0.2%
bbc_mon_tof	1	440006	[CP]	72	20090531	20.09 M	5.8%
bbc_mon_tof	1	440016	[CP]	670	164465198	164.47 M	47.2%
					Total bbc_mon_tof (4 versions)	*203.86 M*	*58.49%*

204M

BBC_mb	10000	8		3	601	601	0%
BBC_mb	10000	440005	[CP]	147	21781307	21.78 M	6.2%
BBC_mb	8000	440015	[CP]	752	180058858	180.06 M	51.7%
					Total BBC_mb (3 versions)	*201.84 M*	*57.92%*

202M

VPD_mb	20000	9	[CP]	68	620838	620.84 K	0.2%
VPD_mb	20000	440001	[CP]	837	69410004	69.41 M	19.9%
					Total VPD_mb (2 versions)	*70.03 M*	*20.09%*

70M

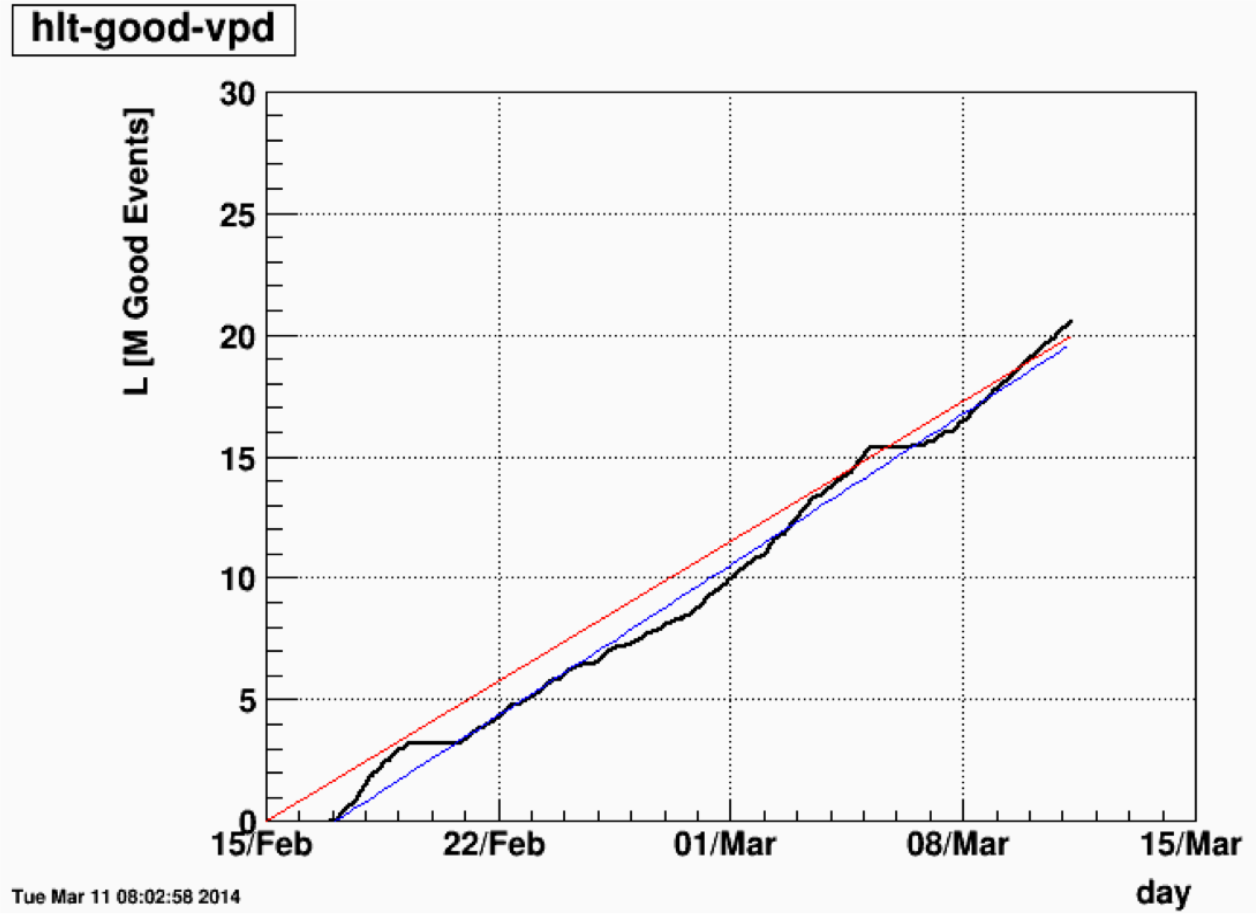
tofmult4	20	2	[CP]	4	1206	1.21 K	0%
tofmult4	10	4	[CP]	2	228053	228.05 K	0.1%
tofmult4	10	440007	[CP]	79	5435377	5.44 M	1.6%
tofmult4	8	440017	[CP]	671	49288546	49.29 M	14.1%
					Total tofmult4 (4 versions)	*54.95 M*	*15.77%*

55M

14.5 GeV Run Tracking

Like BES-I, most of the these 350M events are not Au+Au collisions in the center of STAR

overall goal was “20M min-bias events, |Vz|<30cm”
http://www.star.bnl.gov/protected/common/PAC/Run14/Trigger_List.docx



tracking by J. Dunlop:
http://www.star.bnl.gov/protected/common/common2014/trigger2014/lumiau15GeV/tracker.html

Runs available

Automatic fastoffline production was not in place during the data collection.

Lidia produced the MuDsts from a few runs... I've been producing runs as well.

Day	Run Numbers
54	15054005, 15054028
57	15057029
59	15059040
61	15061003
63	15063036, 15063040
65	15065013
66	15066010, 15066018
67	15067019
68	15068007 (in progress: 15068024, 15068026, 15068036)
69	15069007, 15069020, 15069022
70	15070014, 15070015, 15070016, 15070017, 15070018

Clock readout issue propagates to offline code (drift velocity, vertex splitting)...
All runs above that I'm using have the correct clock read-out value of **9.307 MHz**

Data QA code "dataqa"

"dataqa" code written to see fractions of good events in each run and to display a number of 1D and 2D distributions for each trigger separately.

"good events" in this code (& also in HLT) are those with the following cuts:

|Zvtx| < 70cm, Rvtx w.r.t. the beam spot (x,y)~(0,-0.9) < 1.5cm, Nprimary>5

PDFs: http://www4.rcf.bnl.gov/~llope/files/dataqa_[stream]_[runnum].pdf

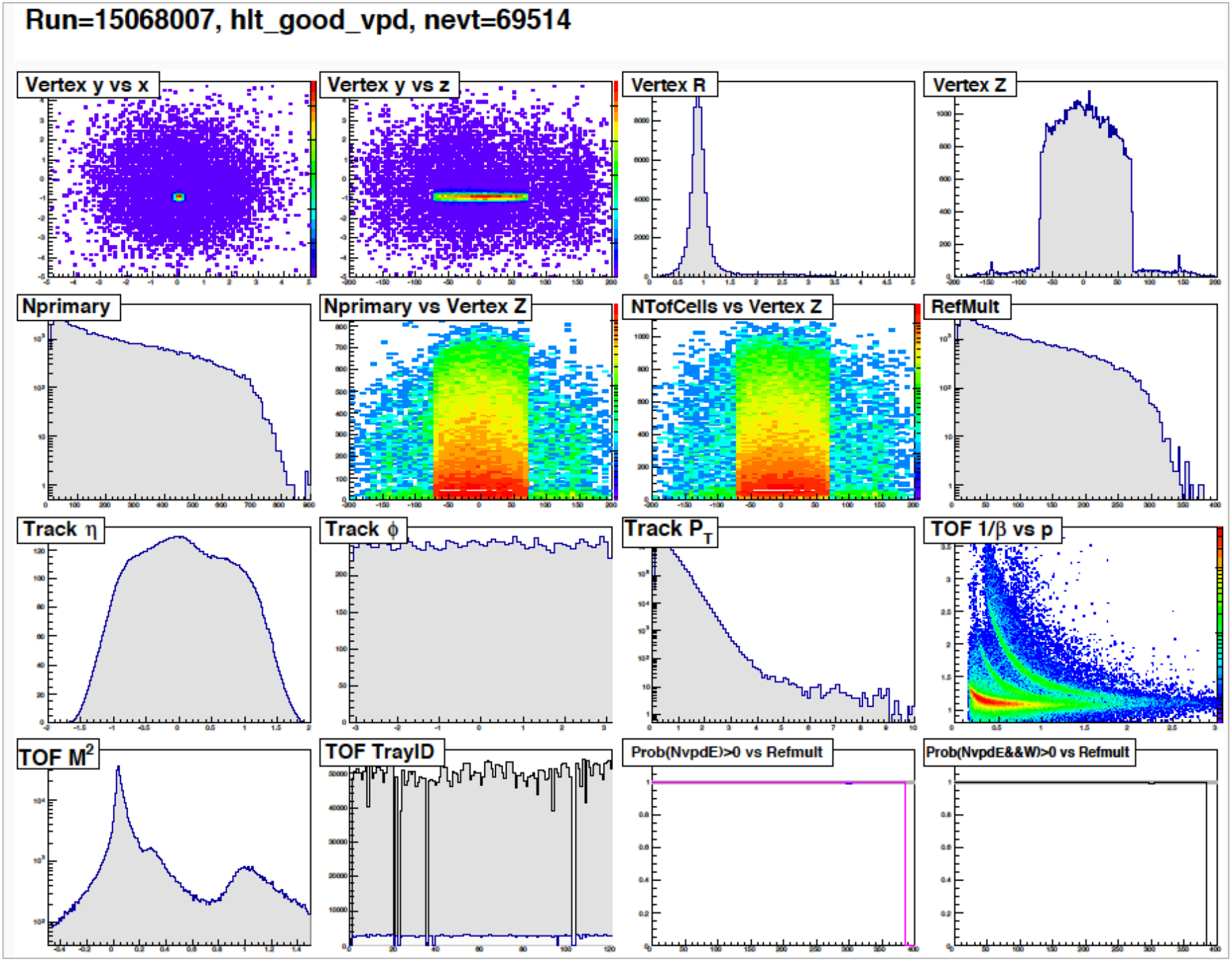
stream = "physics" or "hltgood"

example of page 1

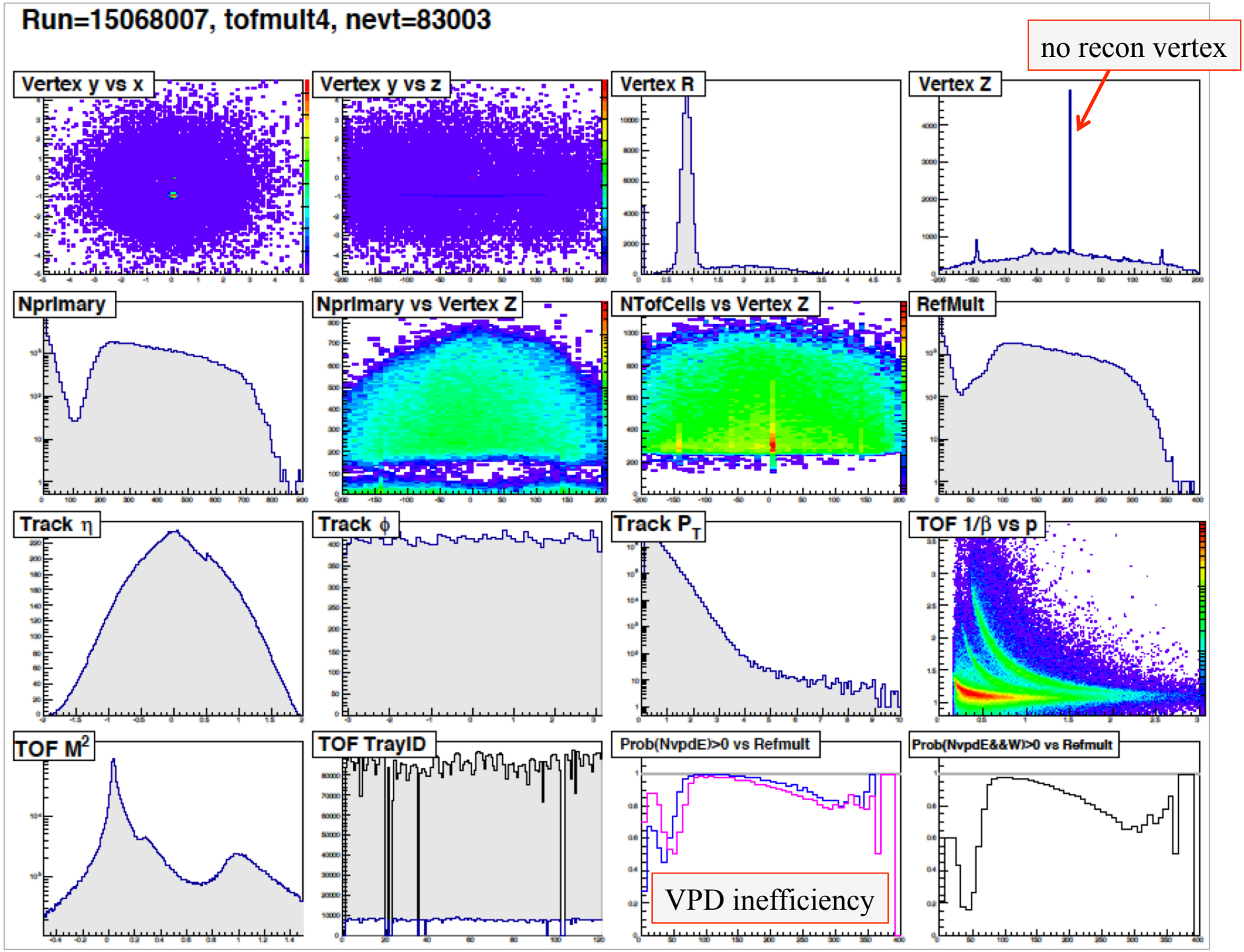
```
Run Number = 15068007,  Nevts = 610303
Nevt good  =   82518,   fraction = 13.5%

bbc_mon_tof           Ntrig= 329055  Ngood=  66843  Ngood/Ntrig=20.3%  Ngood/Nevt=11.0%
hlt_good_vpd          Ntrig=  69514  Ngood=  61984  Ngood/Ntrig=89.2%  Ngood/Nevt=10.2%
hlt-bes-mon           Ntrig=    106  Ngood=     35  Ngood/Ntrig=33.0%  Ngood/Nevt= 0.0%
tofmult4              Ntrig=  83003  Ngood=  31131  Ngood/Ntrig=37.5%  Ngood/Nevt= 5.1%
mtdsingle             Ntrig=  23635  Ngood=  12445  Ngood/Ntrig=52.7%  Ngood/Nevt= 2.0%
mtd-double            Ntrig=   4071  Ngood=   2310  Ngood/Ntrig=56.7%  Ngood/Nevt= 0.4%
mtd-e-muon            Ntrig=   7635  Ngood=   4512  Ngood/Ntrig=59.1%  Ngood/Nevt= 0.7%
bbc_mon_tof_hltgood   Ntrig=  68122  Ngood=  60090  Ngood/Ntrig=88.2%  Ngood/Nevt= 9.8%
tofmult4-hltgood      Ntrig=  33988  Ngood=  29176  Ngood/Ntrig=85.8%  Ngood/Nevt= 4.8%
BBC_mb-hltgood        Ntrig=  77573  Ngood=  66527  Ngood/Ntrig=85.8%  Ngood/Nevt=10.9%
BBC_mb                Ntrig= 502437  Ngood=  74302  Ngood/Ntrig=14.8%  Ngood/Nevt=12.2%
VPD_mb                Ntrig= 136663  Ngood=  63862  Ngood/Ntrig=46.7%  Ngood/Nevt=10.5%
ZDC-mb                Ntrig=   7692  Ngood=   3427  Ngood/Ntrig=44.6%  Ngood/Nevt= 0.6%
UPC_cosmic            Ntrig=   9653  Ngood=    220  Ngood/Ntrig= 2.3%  Ngood/Nevt= 0.0%
VPD_mb-emcped         Ntrig= 136663  Ngood=  63862  Ngood/Ntrig=46.7%  Ngood/Nevt=10.5%
```

Data QA code "dataqa" – example of trigger-specific plots page



Data QA code "dataqa" – example of trigger-specific plots page

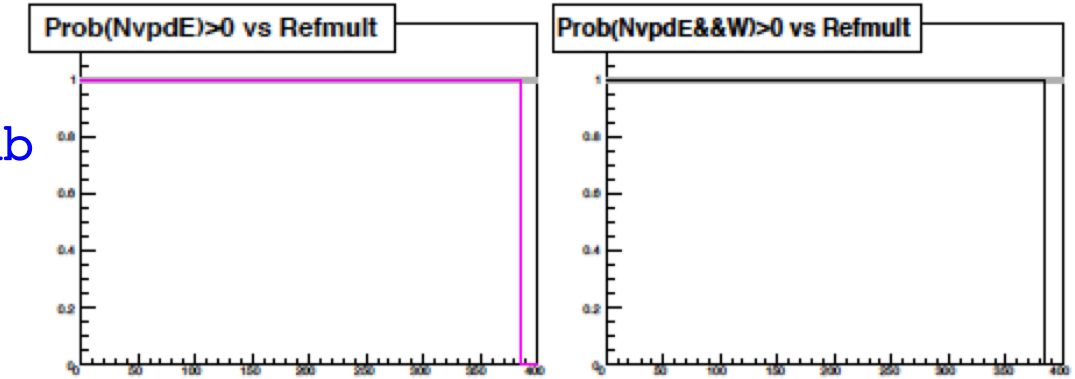


VPD inefficiency

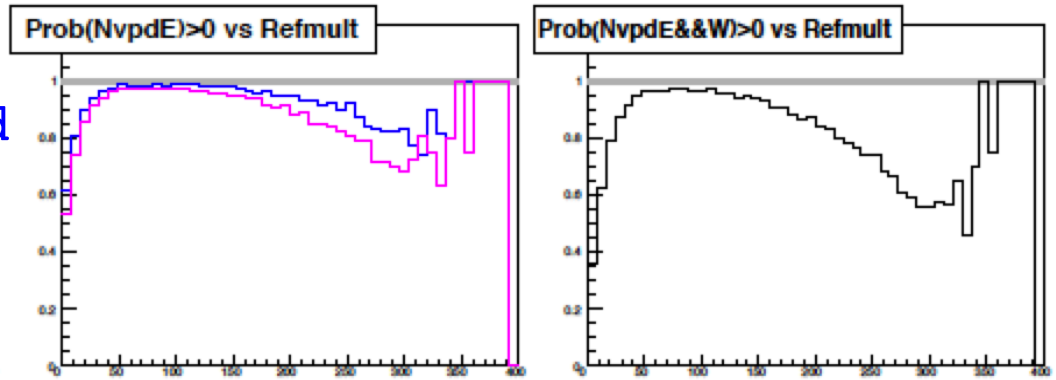
Good event tracking done with `hlt_good_vpd`.... (see page 3)

VPD is not efficient over the entire impact parameter range at this beam energy...

Base for a number of triggers is `VPD_mb`
Requires VPD E&&W

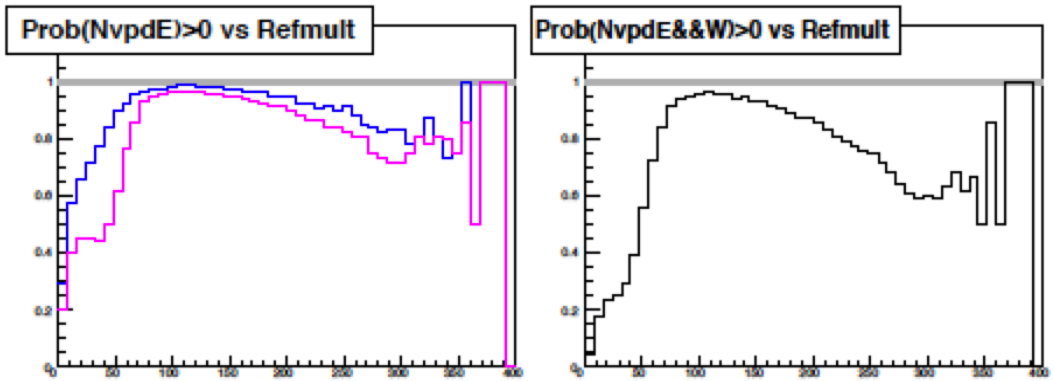


`BBC_mb_hltgood`



So, I'm concentrating on BBC_mb for my analyses at the moment...

`BBC_mb`



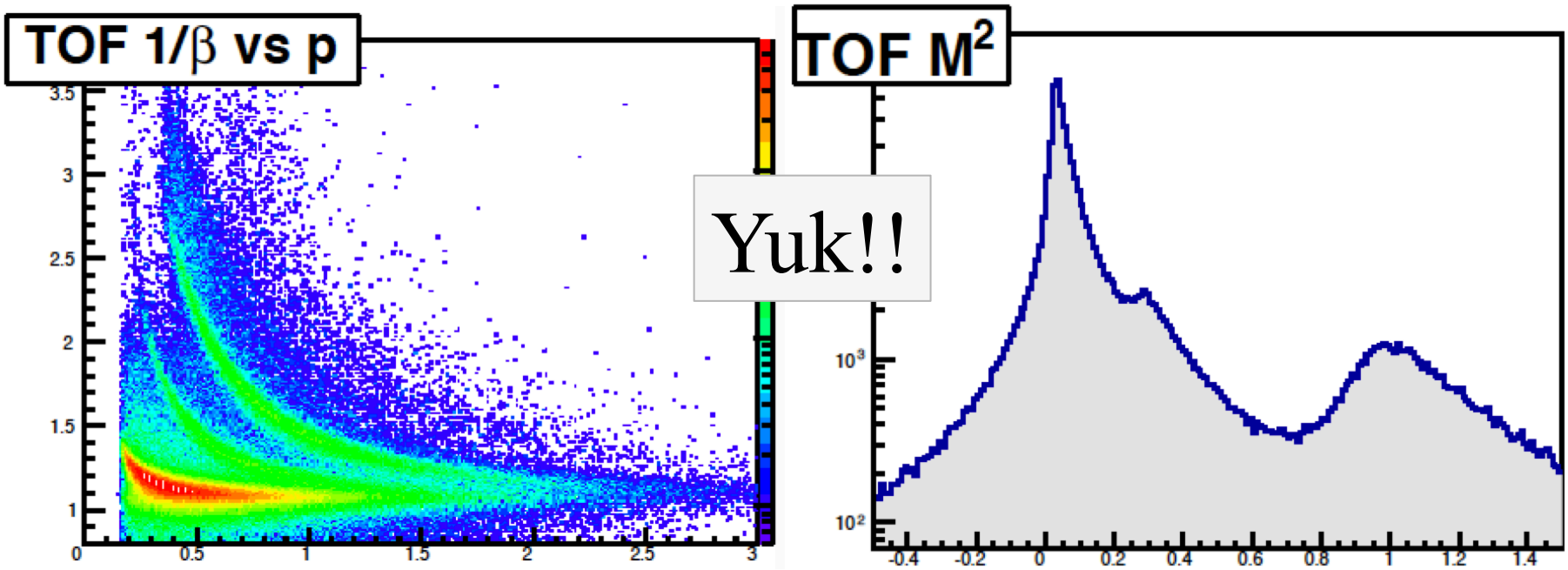
TOF PID

Default offline chain

...requires VPD is used for the start-time

...uses slewing/offset tables from Run-13 p+p 500 for VPD & BTof

Resulting TOF information in the MuDsts thus has very poor resolution.



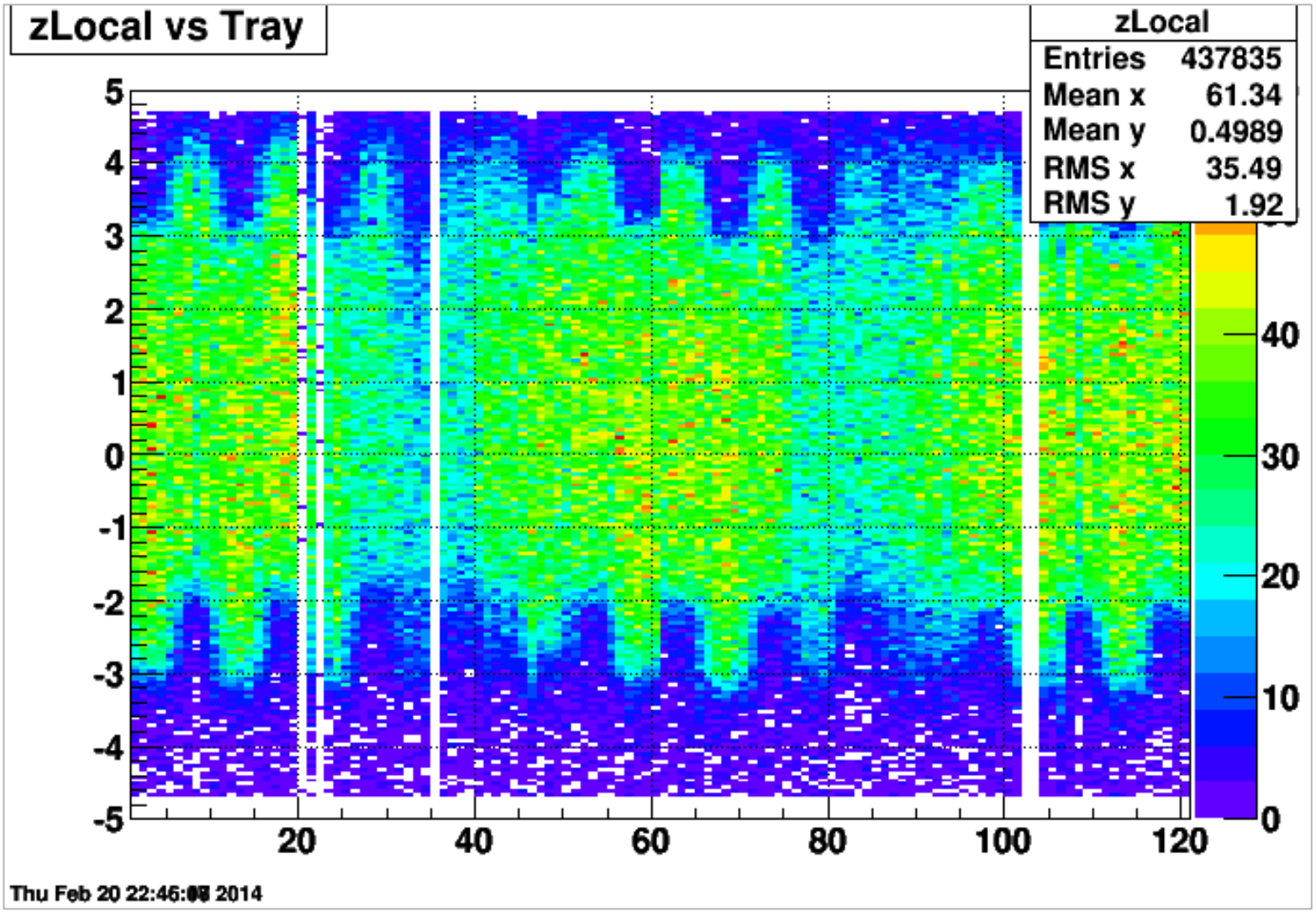
Startless mode in the BTofCalibMaker works much better.

I produce MuDsts with the default chain, & run the BTofCalibMaker startless in "afterburner" mode when producing my pDSTs...

TOF PID (Alignment issues)

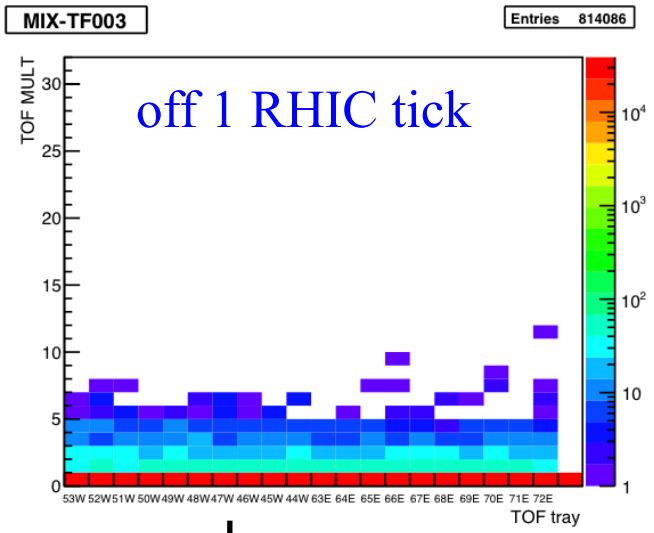
Good BTof matching requires a calibrated TPC...
Some "alignment" issues seen in Zlocal, related to lack of TPC "T_0" calibration

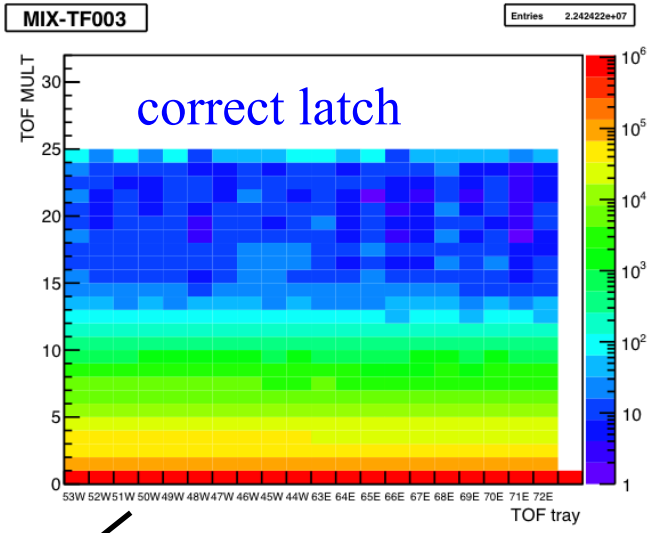
(plot by Joey Butterworth)



TF003 issue

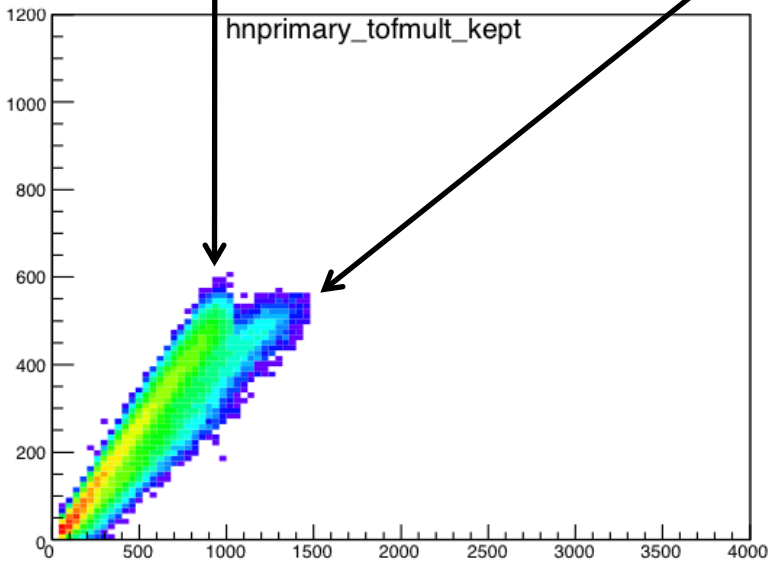
TF003 measures the tofMult for 20 trays.
Result "splits" – half reported as tray mult values, other half sent to TF101 for triggering
Sometimes at BOR the first part of this split sees the wrong crossing...



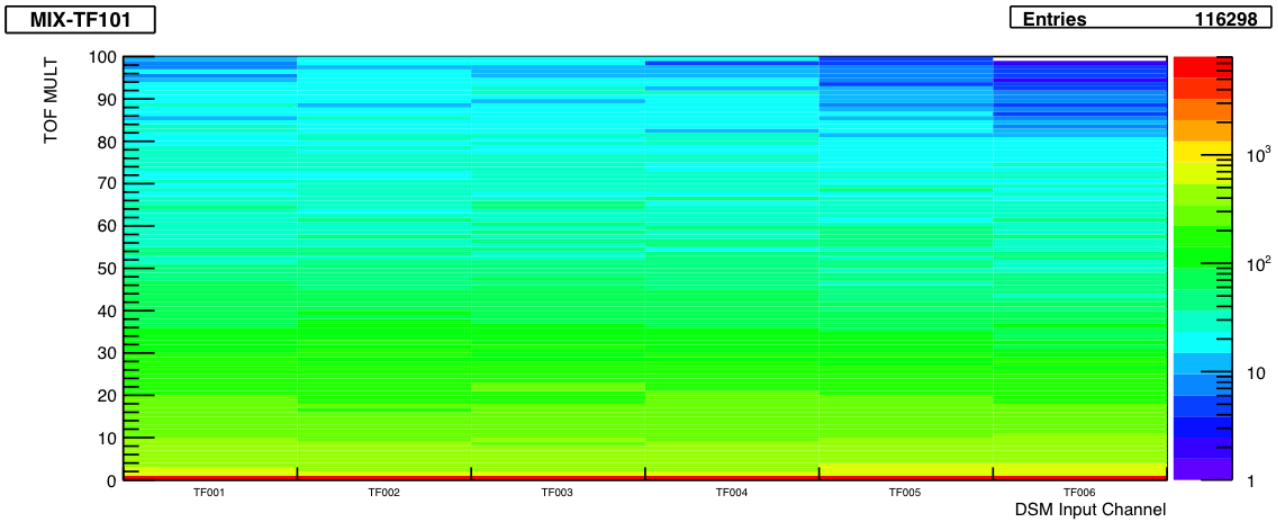


MuDst TRG trayMultiplicity values are from the side that may or may not latch in a run

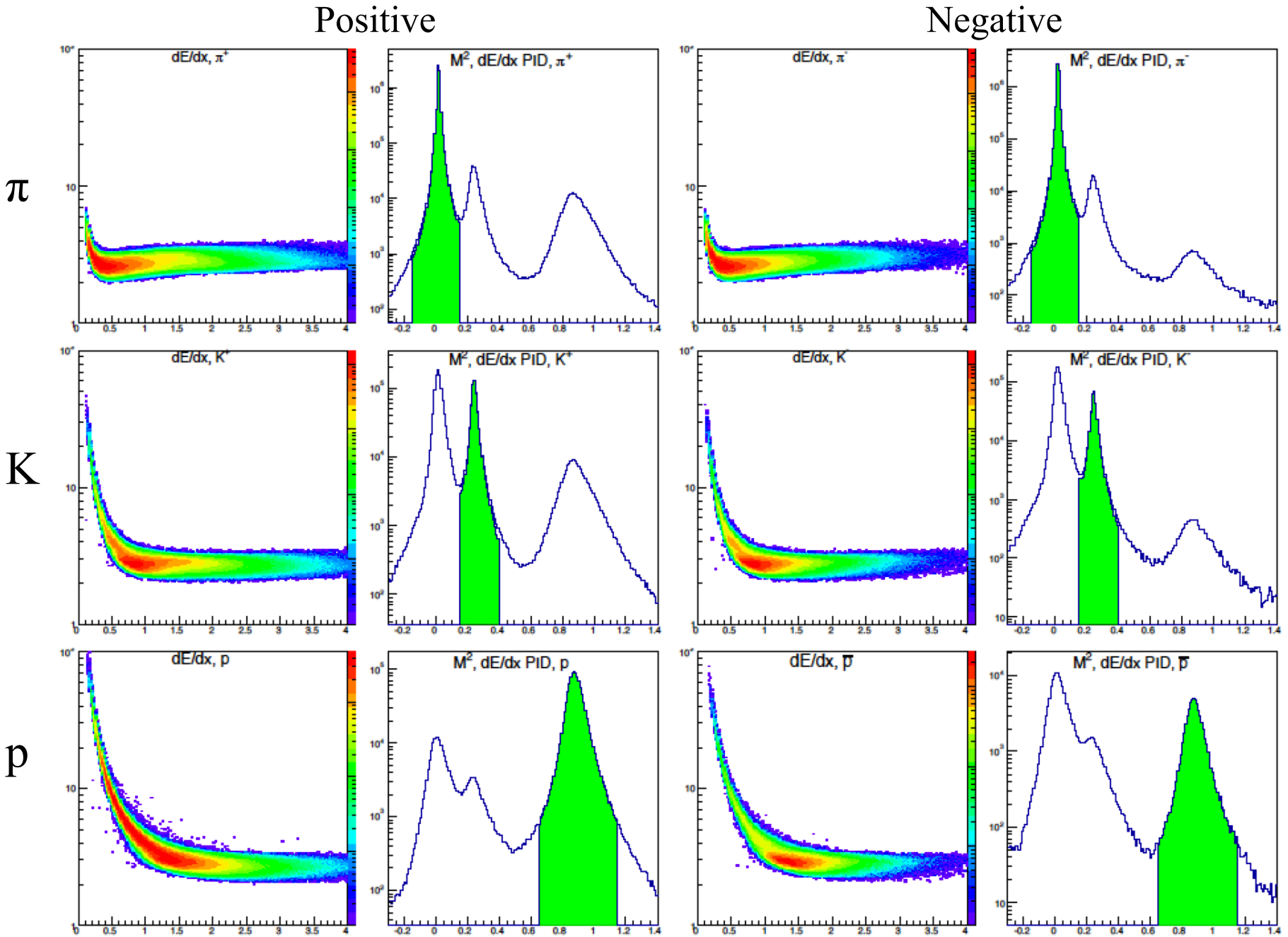
"tofMult" is a commonly used QA variable...



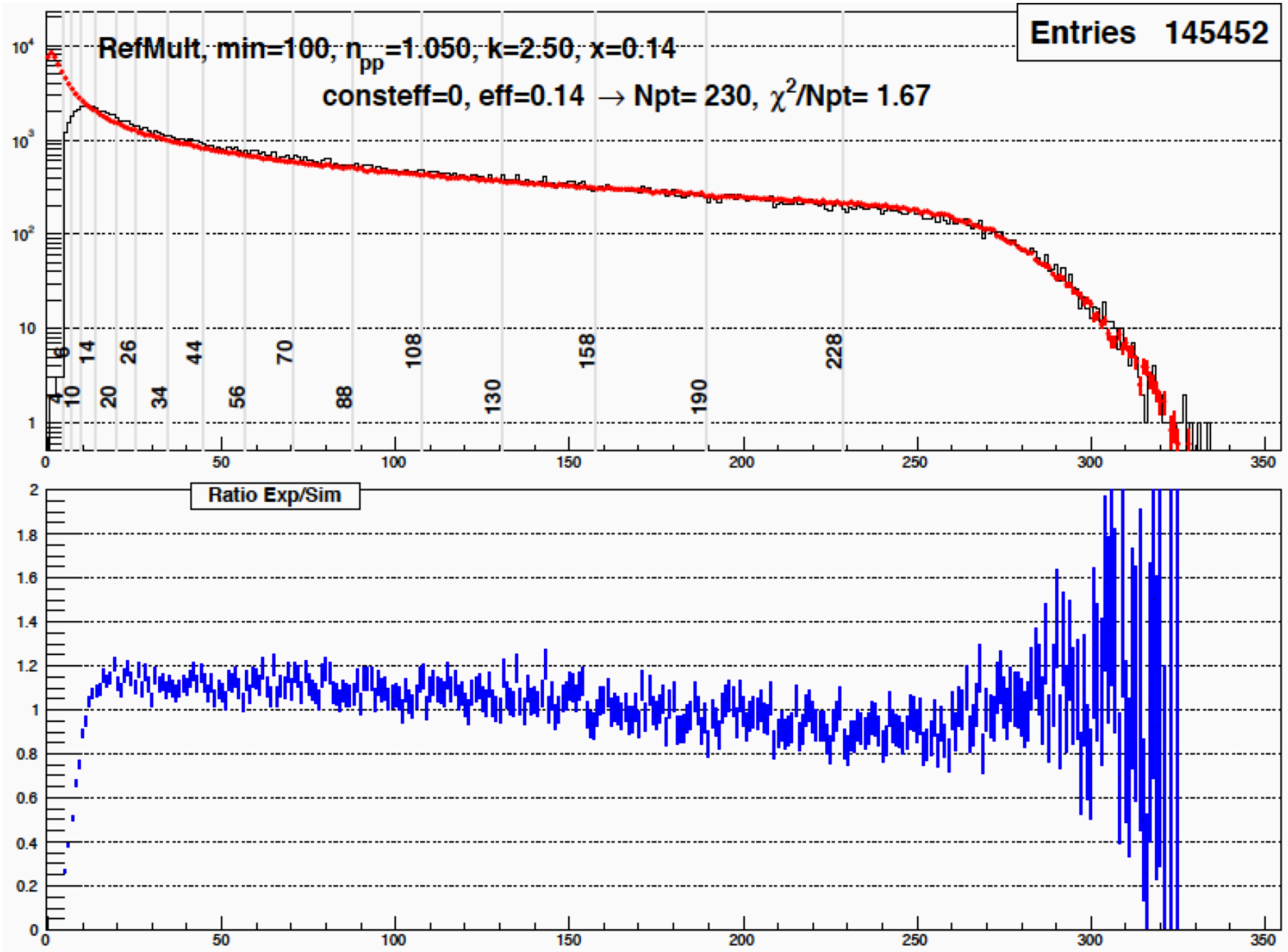
TF101 info used in trigger is always o.k....



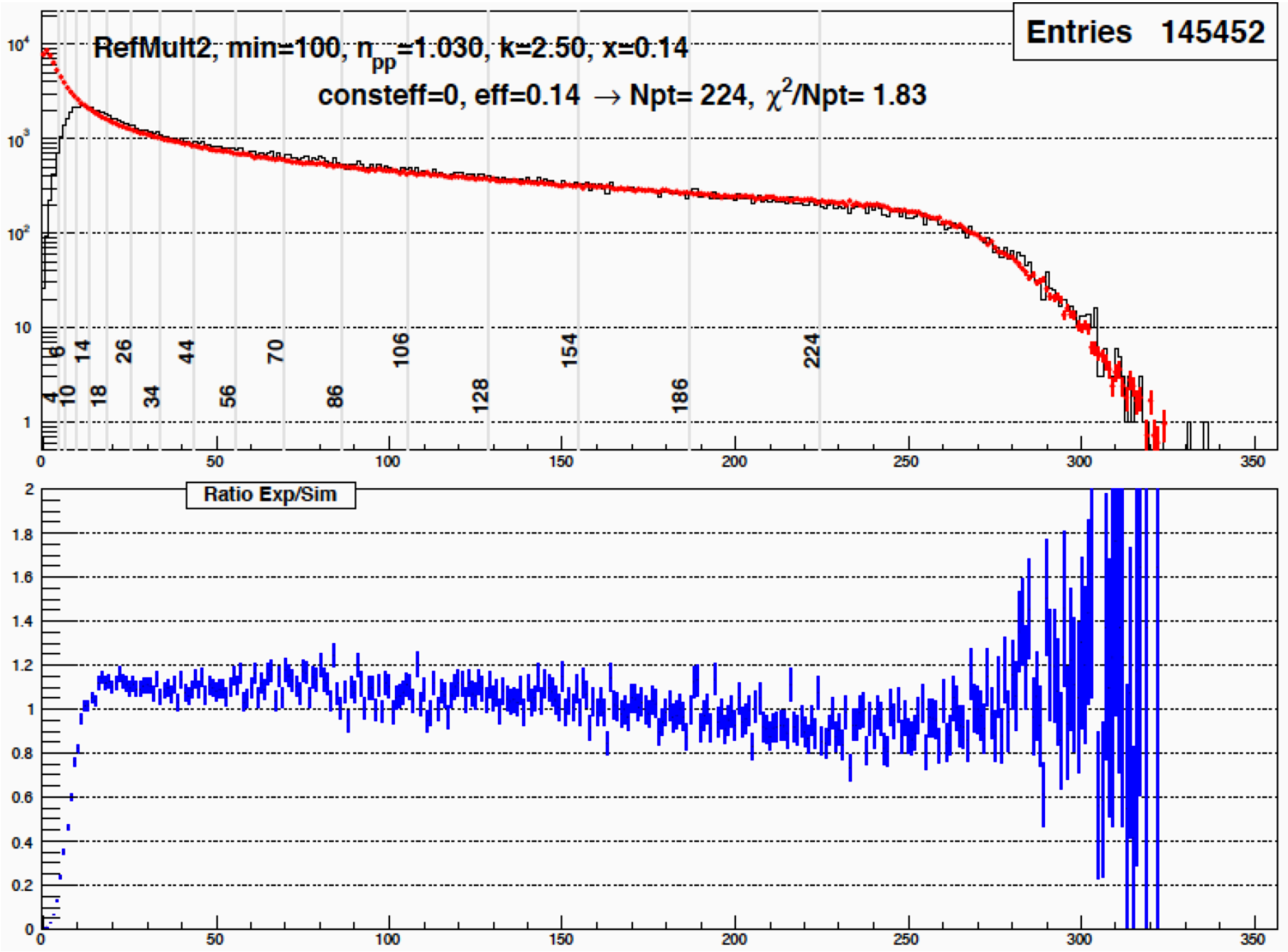
PID with BTof in startless mode



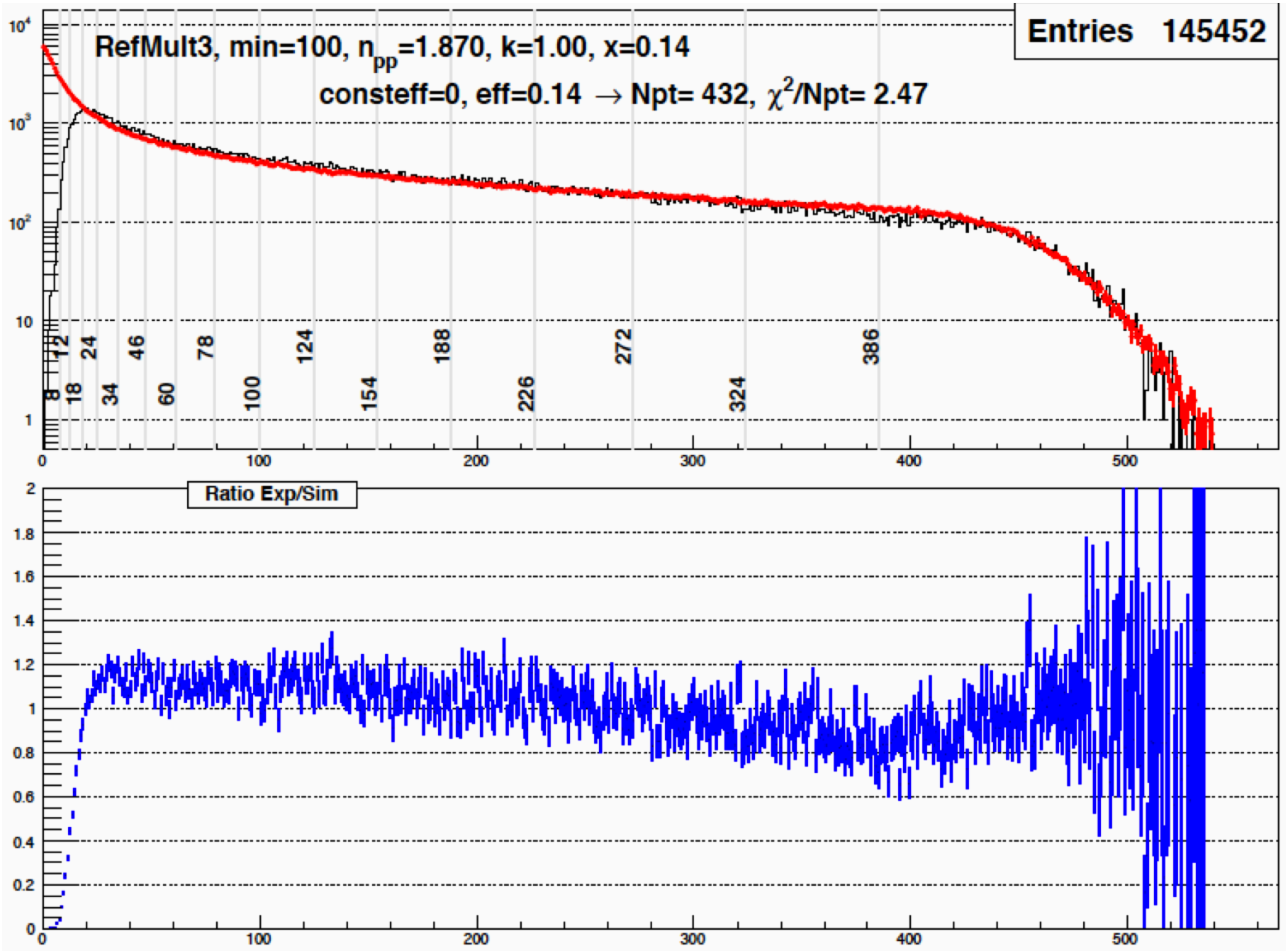
Refmult


RefMult, min=100, n_pp=1.050, k=2.50, x=0.14
consteff=0, eff=0.14 → Npt= 230, χ²/Npt= 1.67
Entries 145452
Ratio Exp/Sim

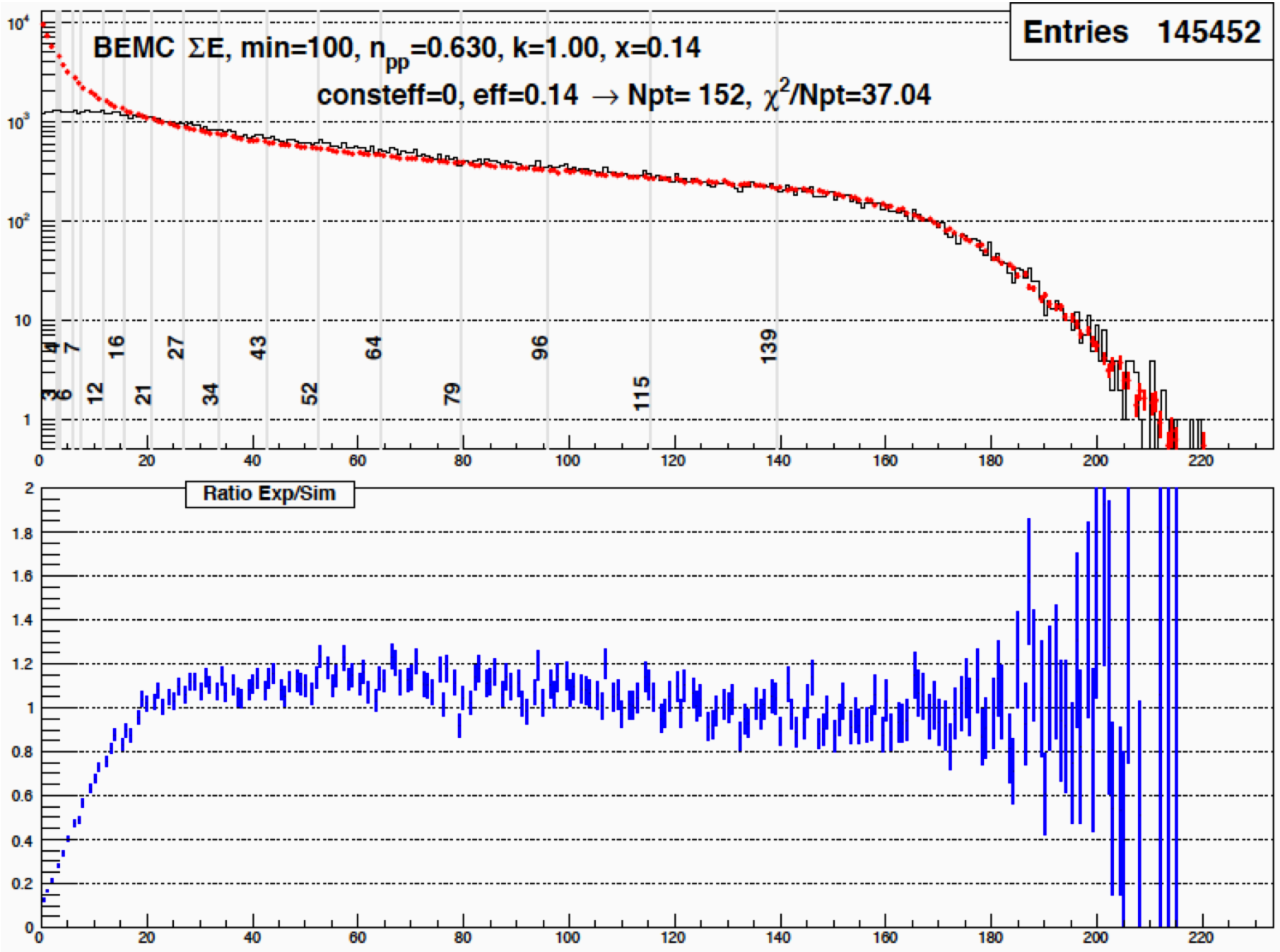
Refmult2


Entries 145452
RefMult2; min=100; n_{pp}=1.030, k=2.50, x=0.14
consteff=0, eff=0.14 → Npt= 224, χ^2/Npt= 1.83
4
6
10
14
18
26
34
44
56
70
86
106
128
154
186
224
Ratio Exp/Sim

Refmult3

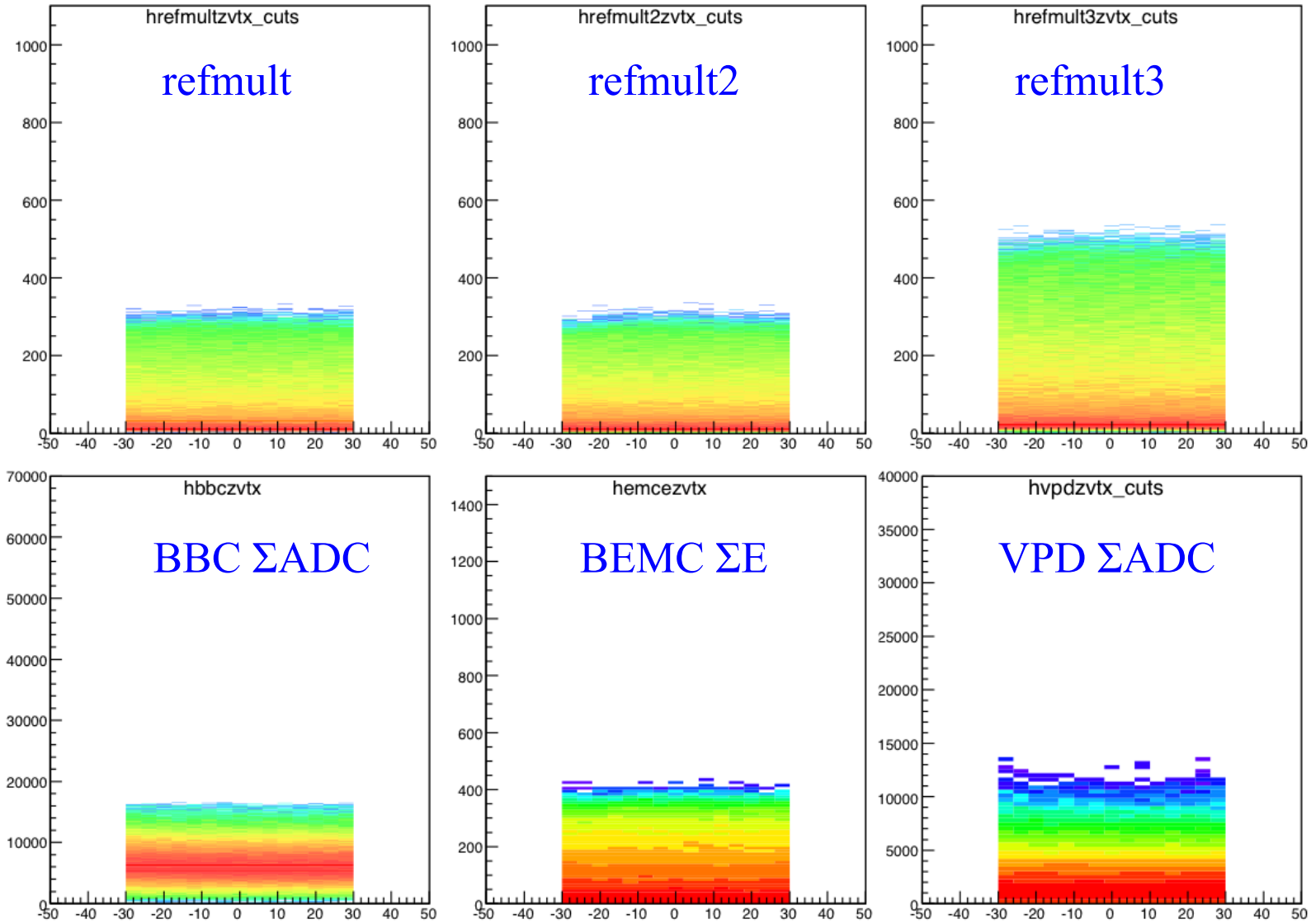

RefMult3, min=100, n_{pp}=1.870, k=1.00, x=0.14
consteff=0, eff=0.14 → Npt= 432, χ^2/Npt= 2.47
Entries 145452
8
12
18
24
34
46
60
78
100
124
154
188
226
272
324
386
Ratio Exp/Sim

BEMC ΣE


BEMC ΣE, min=100, n_pp=0.630, k=1.00, x=0.14
consteff=0, eff=0.14 → Npt= 152, χ²/Npt=37.04
Entries 145452
3
6
4
7
12
16
21
27
34
43
52
64
79
96
115
139
Ratio Exp/Sim

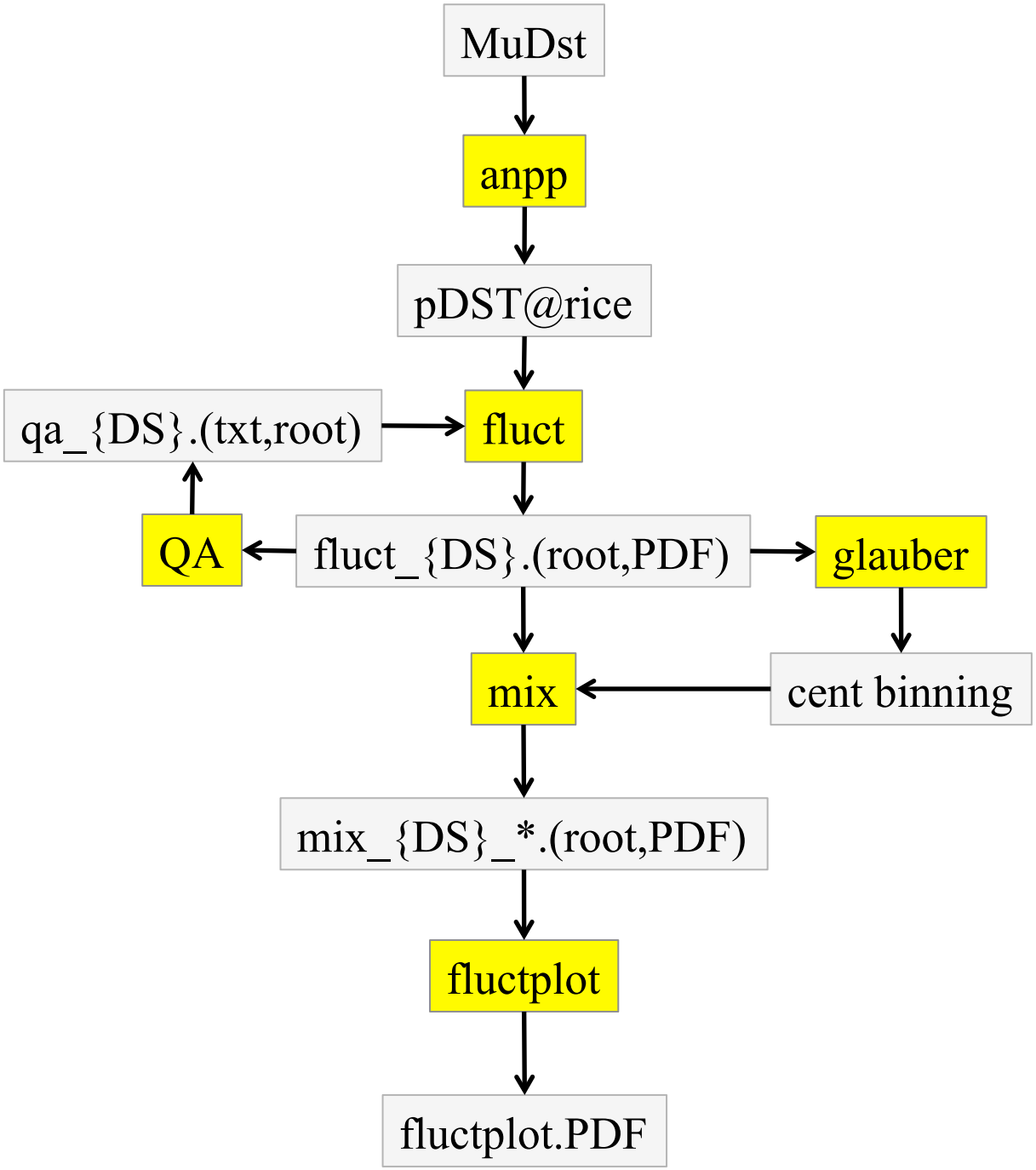
Zvtx dependence of centrality variables

refmultXcorr classes use fit functions to flatten the Zvtx and luminosity dependence



No Zvtx dependence -- but then again I am requiring |Zvtx|<30cm...

Very well tested software environment



{DS} unique identifier for year and $\sqrt{s_{NN}}$

- Data
- Compiled C++ code

anpp:
select minbias trigger, apply |Zvtx| cut. calculate refmultX
save event info and all primary tracks to TTrees

fluct:
fill 4 "base" TH2Ds for specific track cut sets
(net,tot,pos,neg) vs. centrality variable

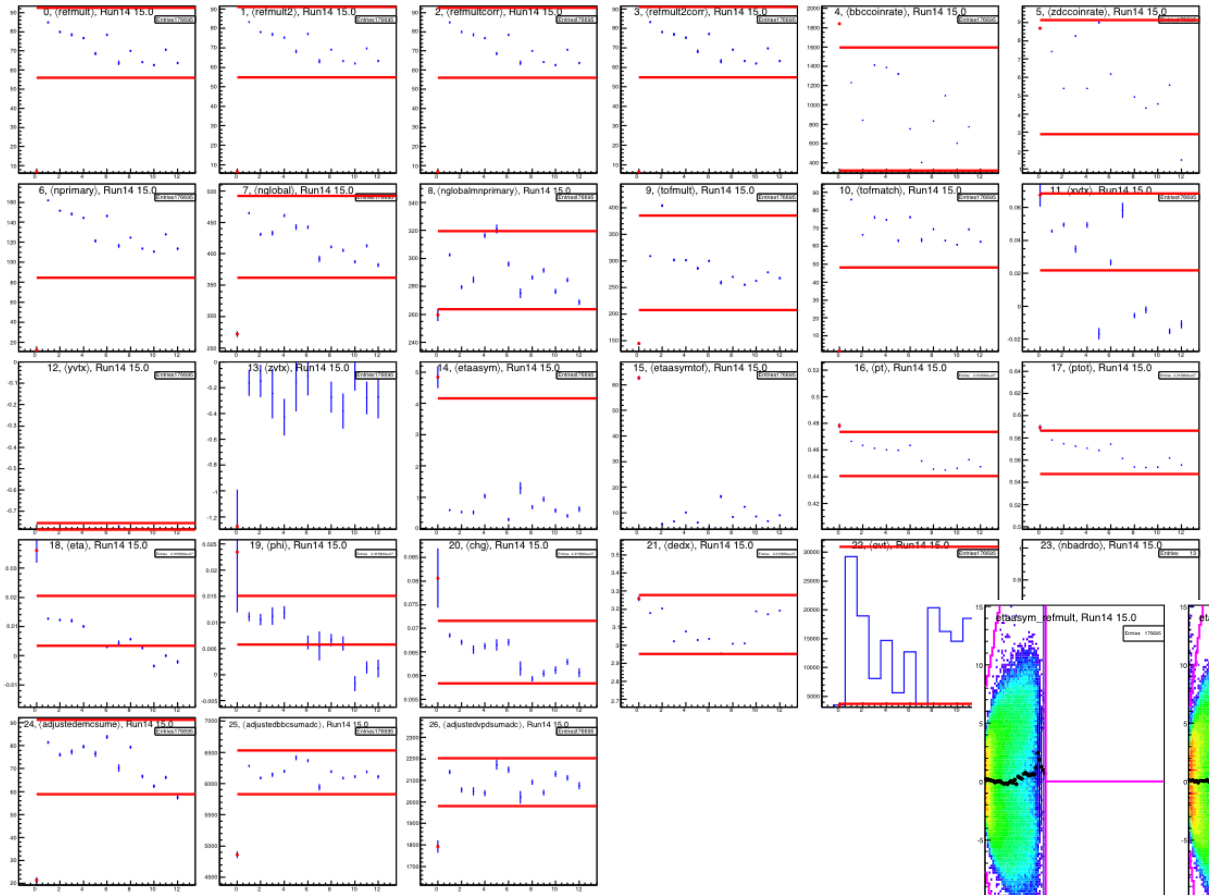
qa:
bad runs: 30 variables, check 6, require ≥4 vars fail
bad events: 10 2D correlation plots, check 2, ±Nσ cuts

mix:
read TH2Ds from net-p paper, net-q paper, or fluct
calculate Cx, Rxy *vs.* centrality variable
efficiency corrections
CBW averaging
bootstrap errors
Sampled singles/IRV cumulant arithmetic

fluctplot:
collect results from all sources and make final plots
make connections to LQCD

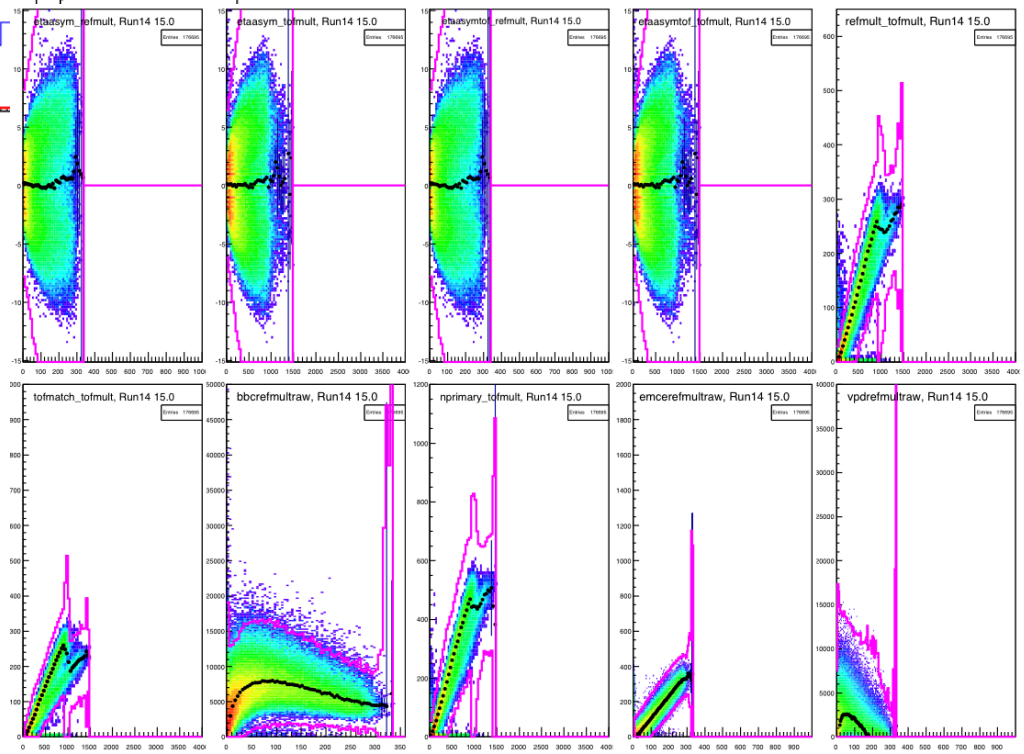
Bad run and bad event QA

http://wjllope.rice.edu/files/qa.pdf



Detailed check of many 1D and 2D distributions...

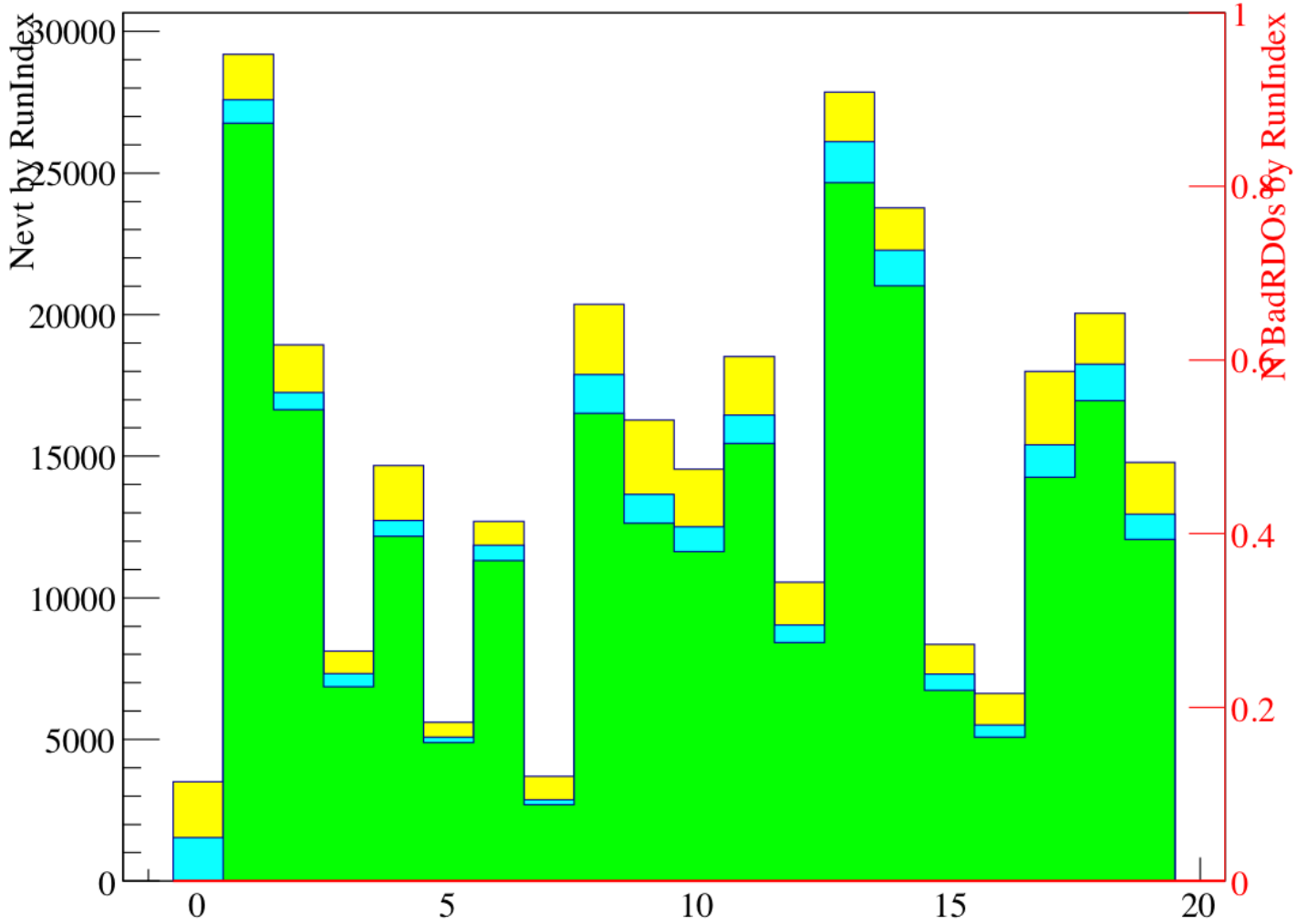
Day 54 data presently rejected...



Bad-event QA in otherwise good runs is important... even with “good event” cuts on Zvtx, Rvtx, Nprimary...

Available Nevents so far...

Typical runs are ~200-500k events, and only a small fraction of these are "good events"
(see e.g. page 5)

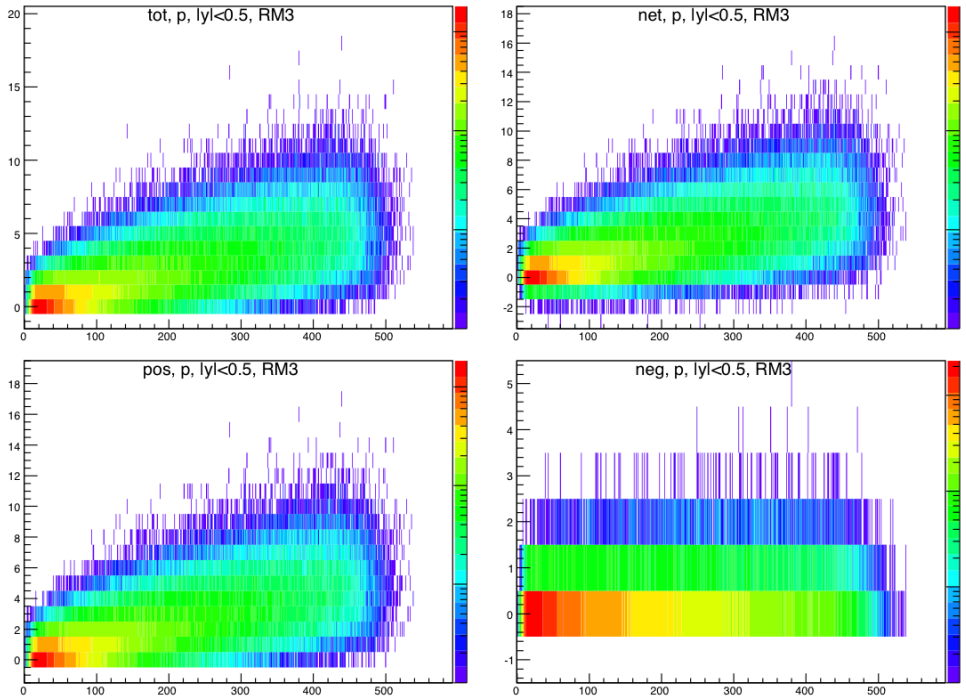


So far I have ~300k good events.... I am still processing runs w/ good clock values...
Limited by low good event fraction + 400GB data03 limit, & number of slow queue slots...

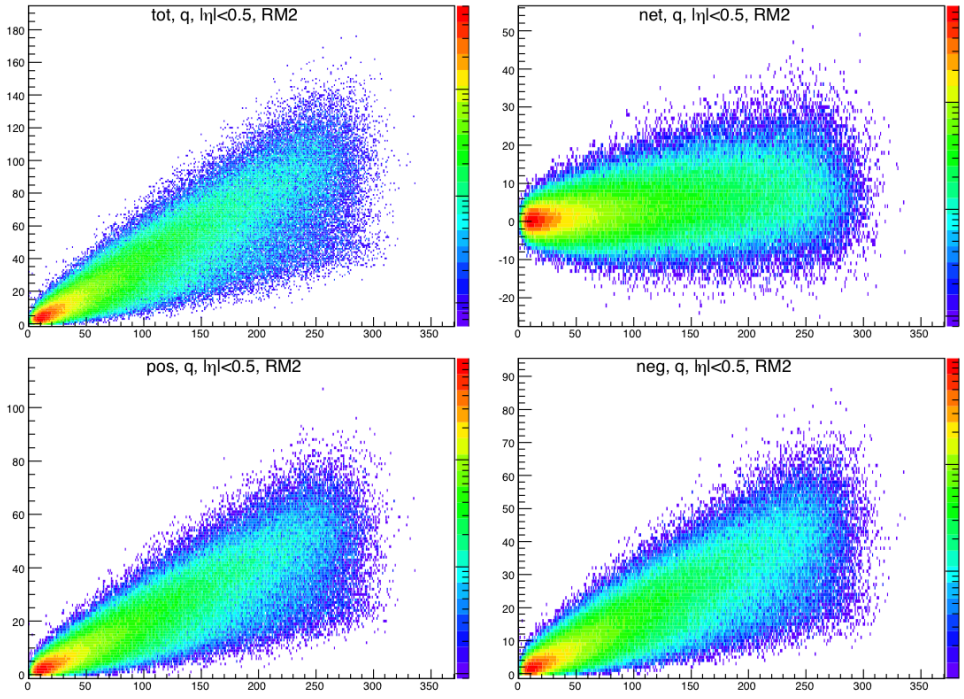
Base TH2Ds...

The usual set of four "base TH2Ds" allow all moments products calculations....

net-p



net-q



Nnetx, Ntotx, Npos, and Nneg *vs.* centrality variable

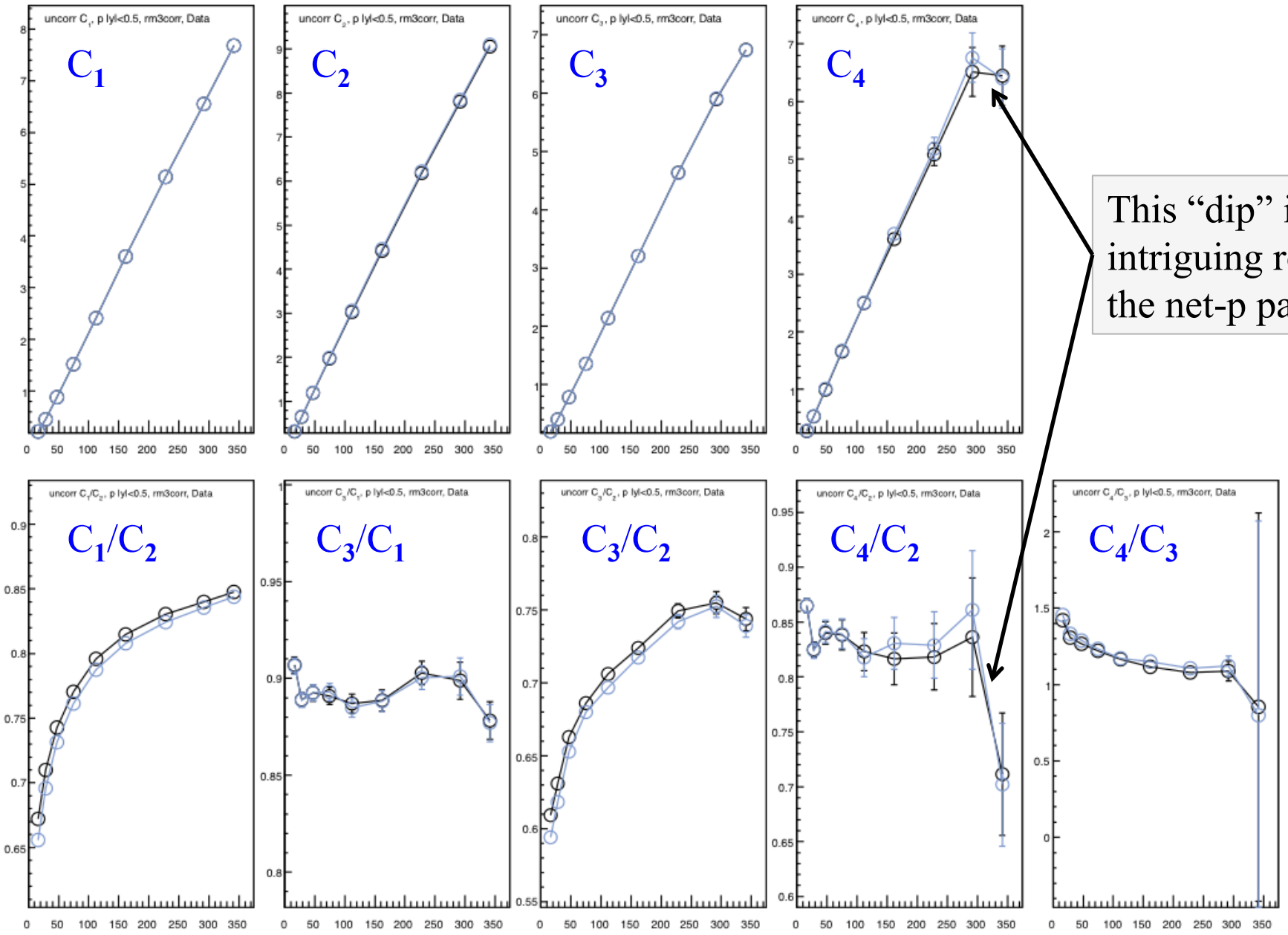
net-p: refmult3

net-q: refmult2

Net-p and Net-q TH2Ds use exactly the same cuts as in recent papers...

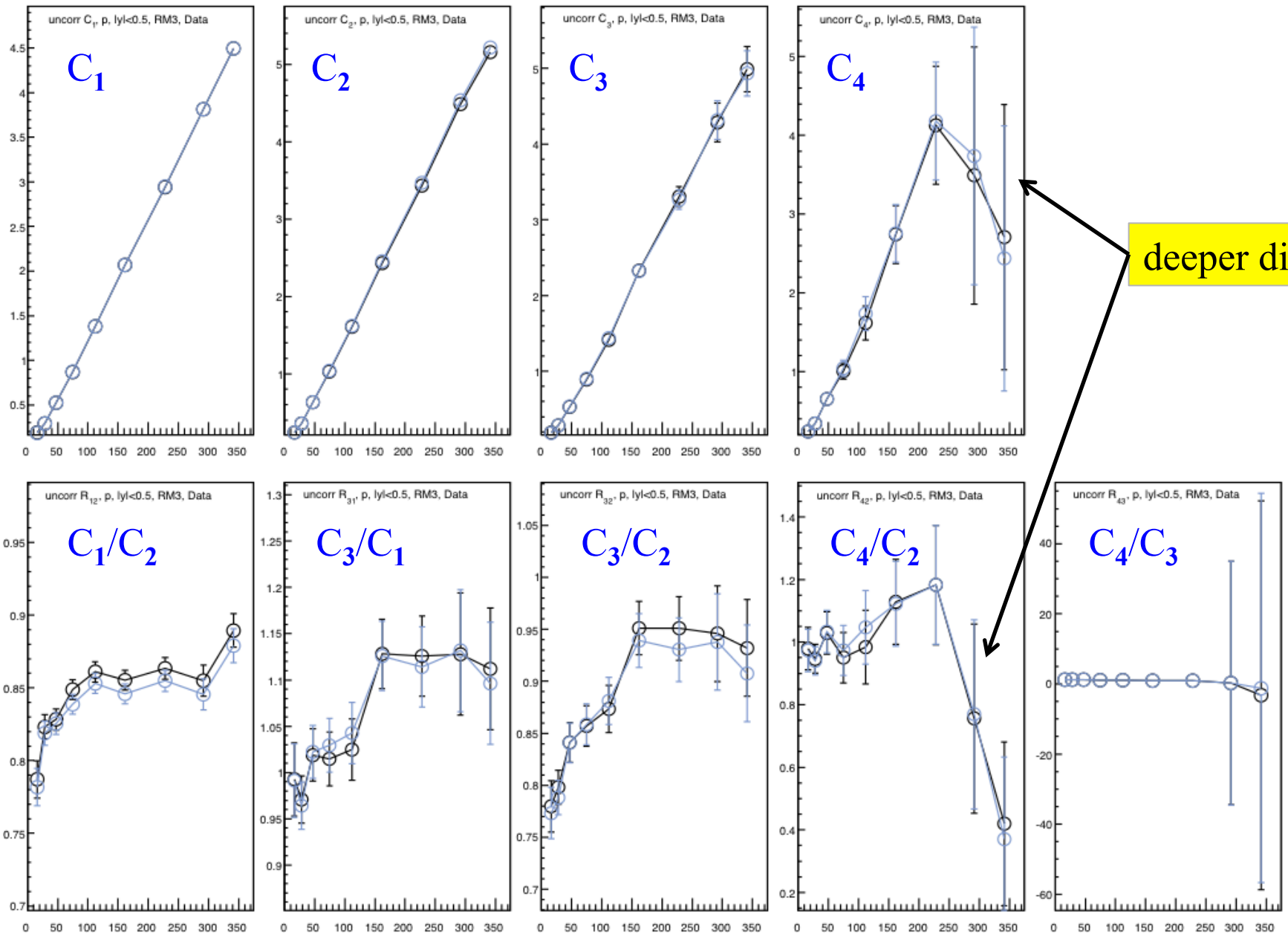
Net-p cumulants and cumulant ratios: 19.6 GeV

Reminder of the 19.6 GeV cumulants and cumulant ratio values....



This "dip" is the intriguing result in the net-p paper

Net-p cumulants and cumulant ratios: 14.5 GeV



Summary

This 14.5 GeV data is clearly of very high interest to the community.

Centered in very wide μ_B gap between 19.6 and 11.5 GeV...

Please get involved in the QA so we can have a good "real" production a.s.a.p.!

There are lots of "features" in these data.

TPC T_0 and other calibrations are not yet in place...

Clock issue – important for tracking. Check the runlog if you are producing MuDsts!

Be aware of the VPD inefficiencies when selecting your trigger ID...

TF003 issue can affect apparent tofmult – generally a good "good-event" QA variable.

Run BTofCalibMaker in startless mode.

Relatively low rate for actual Au+Au collisions centered in STAR – do careful event QA!

With all of that in mind, I've been producing MuDsts, and doing bad run and bad event QA...
And then, what the heck, my fluctuations codes are just sitting there so I ran them too.

I'm up to ~0.3M good BBC_mb events now... Tiny fraction of the available data!

It's clearly *way* too early to get too serious here, and the uncertainties are large, but

...no hint yet of the NLSM prediction of a dramatic enhancement of $K\sigma^2$ just below 19.6...

...if the $K\sigma^2$ dip of the proton C_4 at 19.6 was interesting, the $K\sigma^2$ dip of the proton C_4 at 14.5 might be deeper, and also extend into the 5-10% centrality bin...