Results from Run 13 W-test production analysis

Apple - to - Apple comparisons

Devika Gunarathne / Matt Posik / Salvatore Fazio

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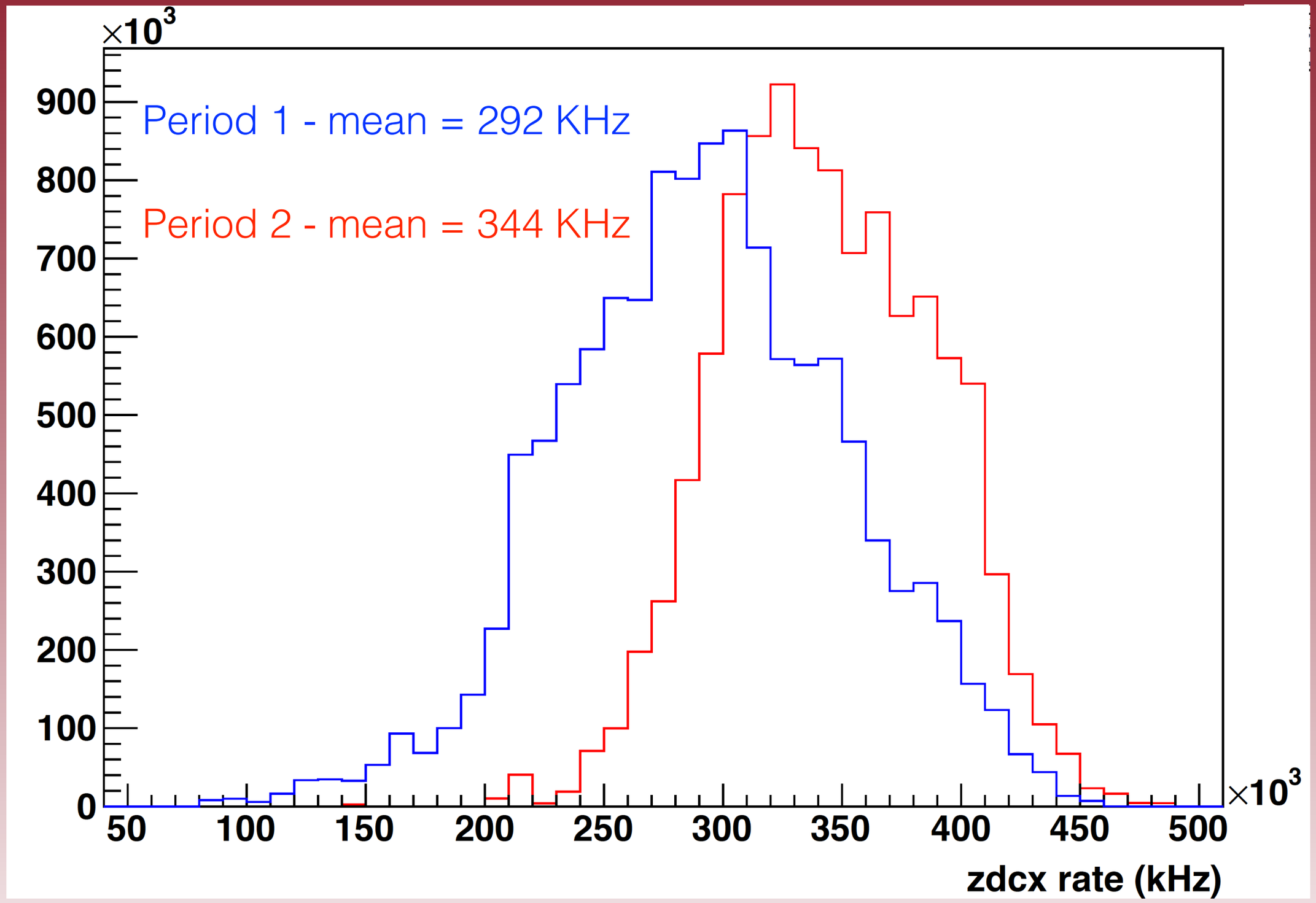
Big thanks to Elke and everyone else for all the help / comments ! and Yuri for the productions!

W Test Production Details

Production	Library	Vertex-Finding algo	Tracking algo	nEvents (M)
Evals 1	SL16b	PPV_W	STI	~12 [only period 1]
Evals 2	EVAL	PPV_W	STI_updated*	~12 [only period 1]
Evals 4	EVAL	PPV_W	STICA	~12 [only period 1]
P14ia [run 13 official period 1]	SL14a	PPV_W	STI	~12 [only period 1]
P14ig [run 13 official period 2]	SL14g	PPV_W	STI	~10 [only period 2]
Yuri - period 1	DEV2/TFG16a	PPV_W	STICA**	~12 [only period 1]
Yuri - period 2	DEV2/TFG16a	PPV_W	STICA**	~10 [only period 2]

- * : STI_updated - some changes to STI code from Yuri
- ** - Yuri's code

Run 13 Luminosity



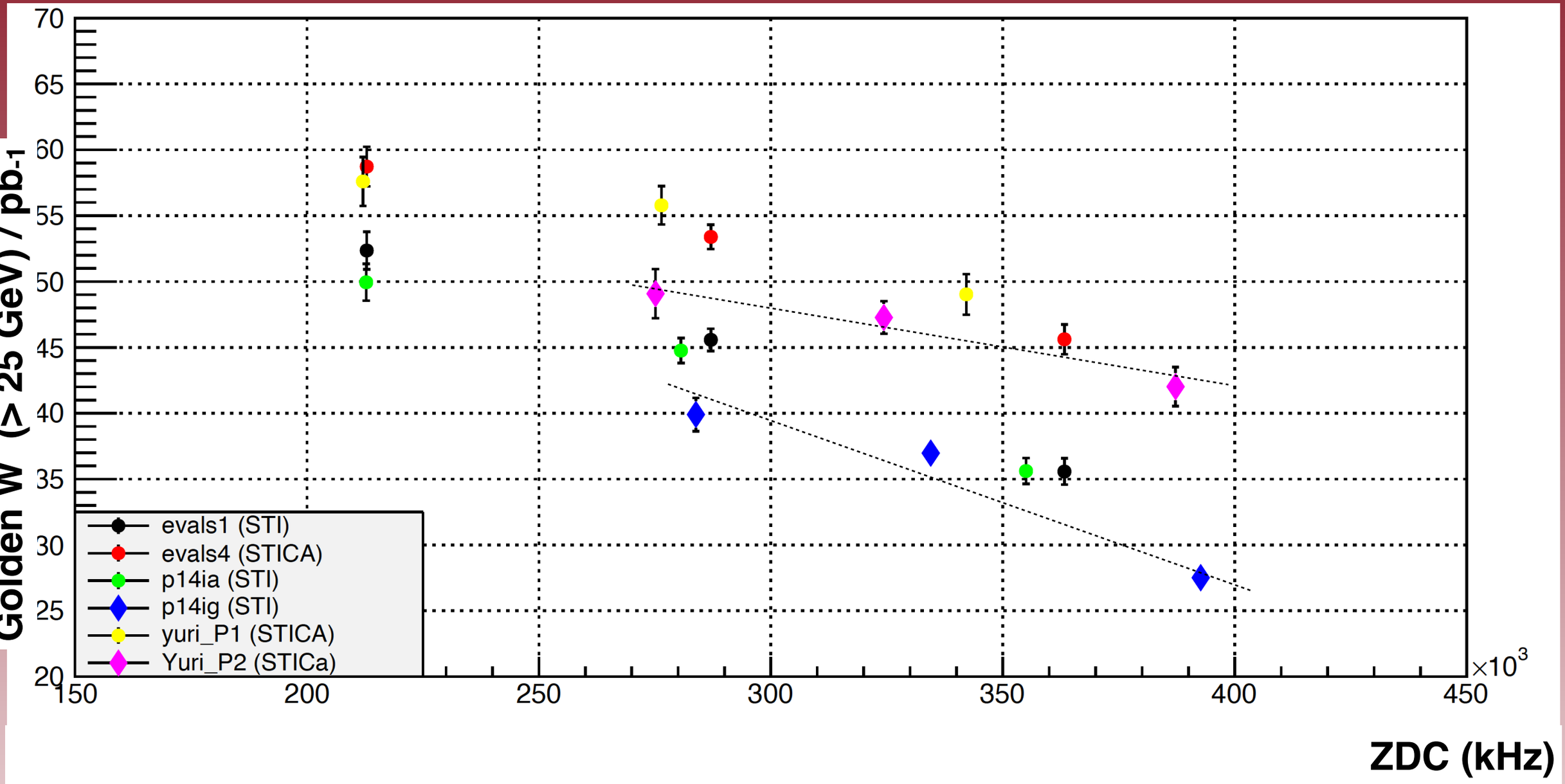
- ~90% of Period 2 statistics is above 300 KHz.
- ~50 % of Period 1 statistics is above 300 KHz.

W Test Production analysis- Comparisons

Comparisons	Purpose	Result
EVALS 1 vs EVALS 2	difference between STI vs STI_updated	No difference
EVALS 1 vs EVALS 4	difference between STI vs STICA	18 % enhancement in Final W
EVALS 1 vs p14ia	difference between with and without new HFT material in STAR library	4 % enhancement in Final W
Yuri's - P1 vs p14ia	difference between STI vs STICA **	20 % enhancement in Final W
Yuri's - P2 vs p14ig	difference between STI vs STICA **	29 % enhancement in Final W

- ** - Yuri's code

W efficiency as a function of ZDC



- Black(P1) , Green (P1) and Blue (P2) used STI tracking
- Red(P1) , Yellow (P1), Magenta (P2) used STICA tracking
- Enhancement in efficiency increases with increasing ZDC .

Evals 1 vs Evals 2

Apple- to -Apple comparison

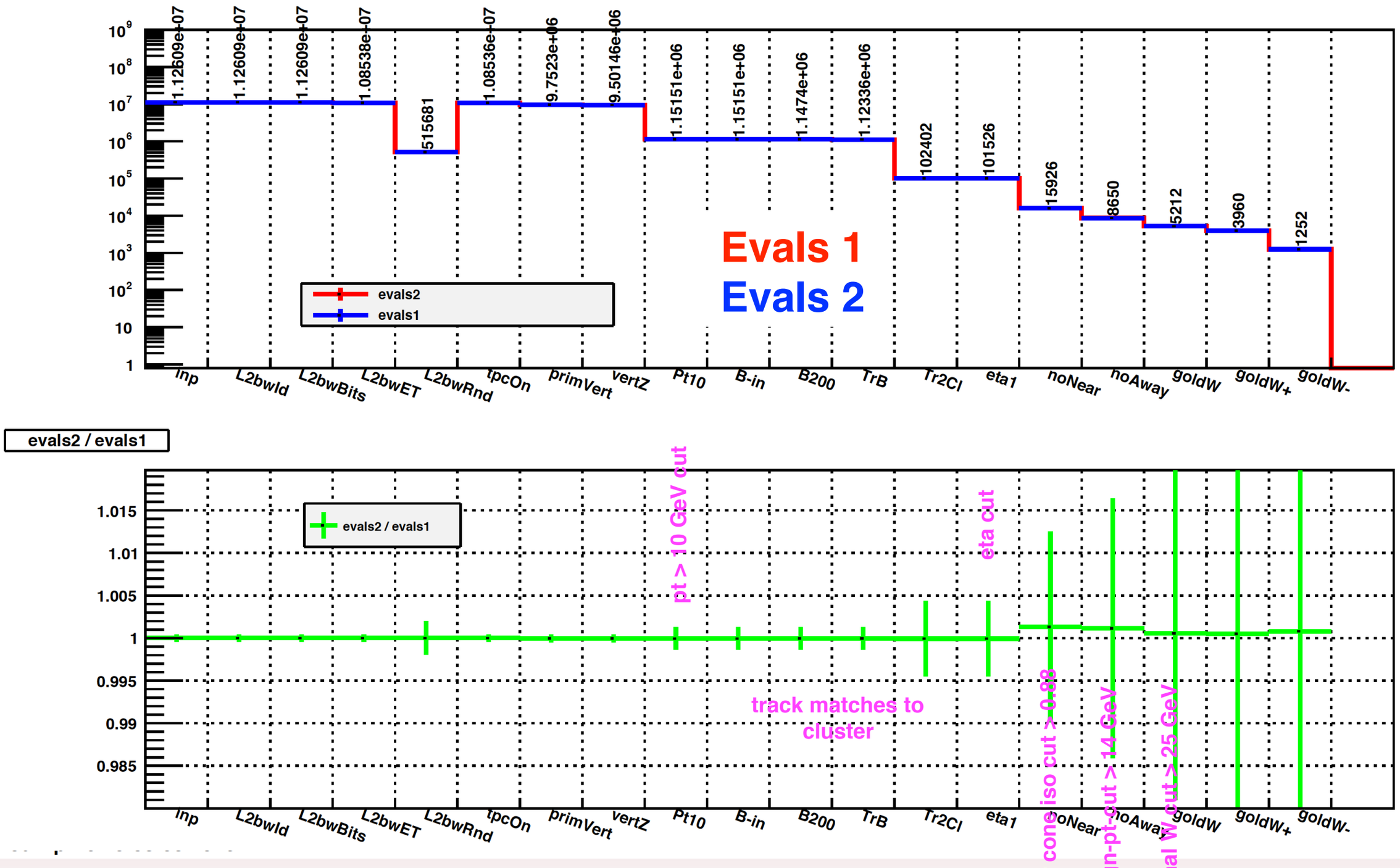
Details / Notes

Production	Production Library [also W-code compiled	Tracking	vertex finding	BEMC-gains	# of runs used in the comparison	# of events
“evals2”	EVAL	Sti [updated]	PPV_W	run 12 - 200 GeV	896	11.26 M
“evals1”	SL16b	Sti	PPV_W	run 12 200 GeV	896	11.26 M

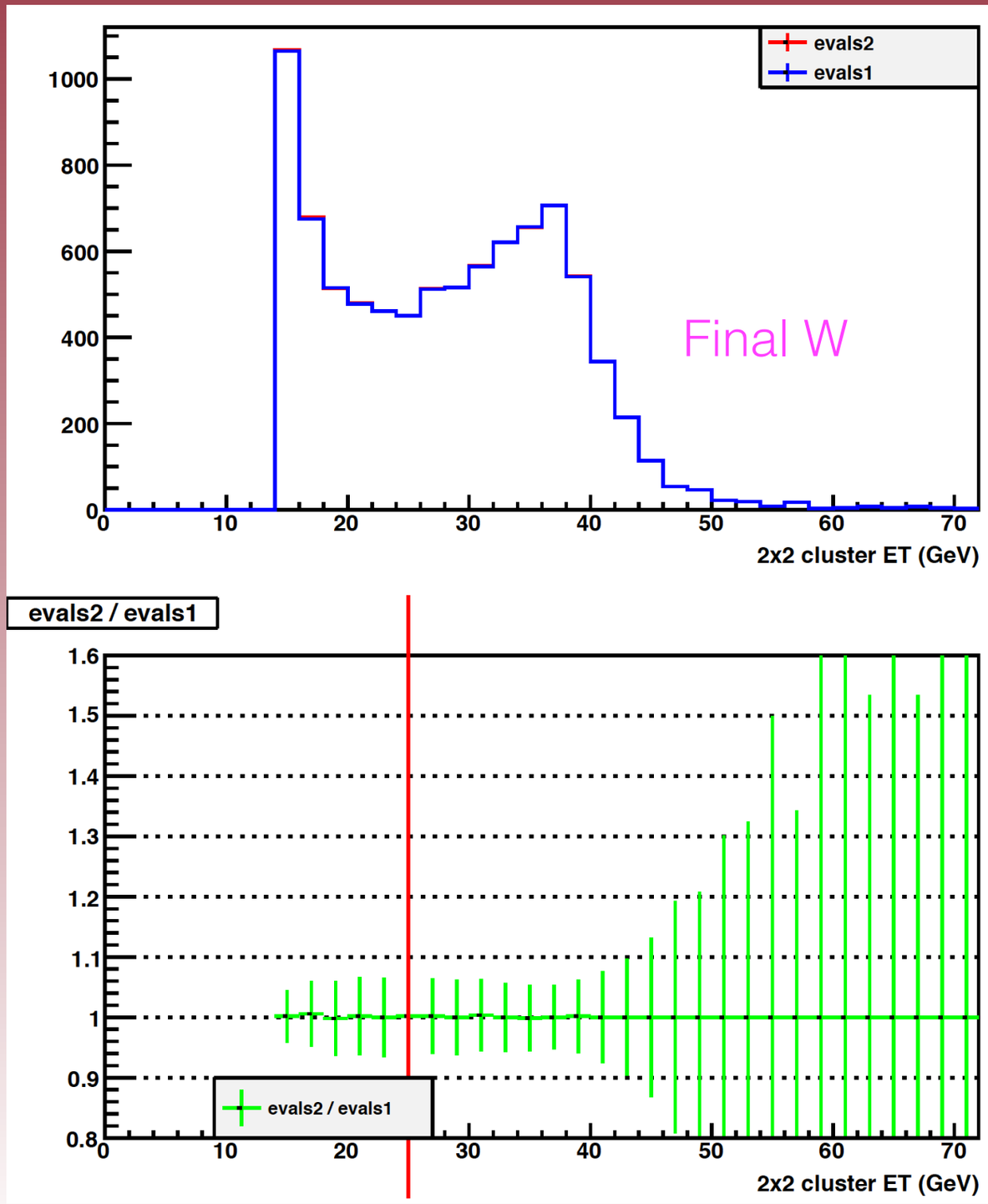
- **All the runs which were used for the comparison compared for # events processed. Runs which have processed exactly the same # of events were chosen.**

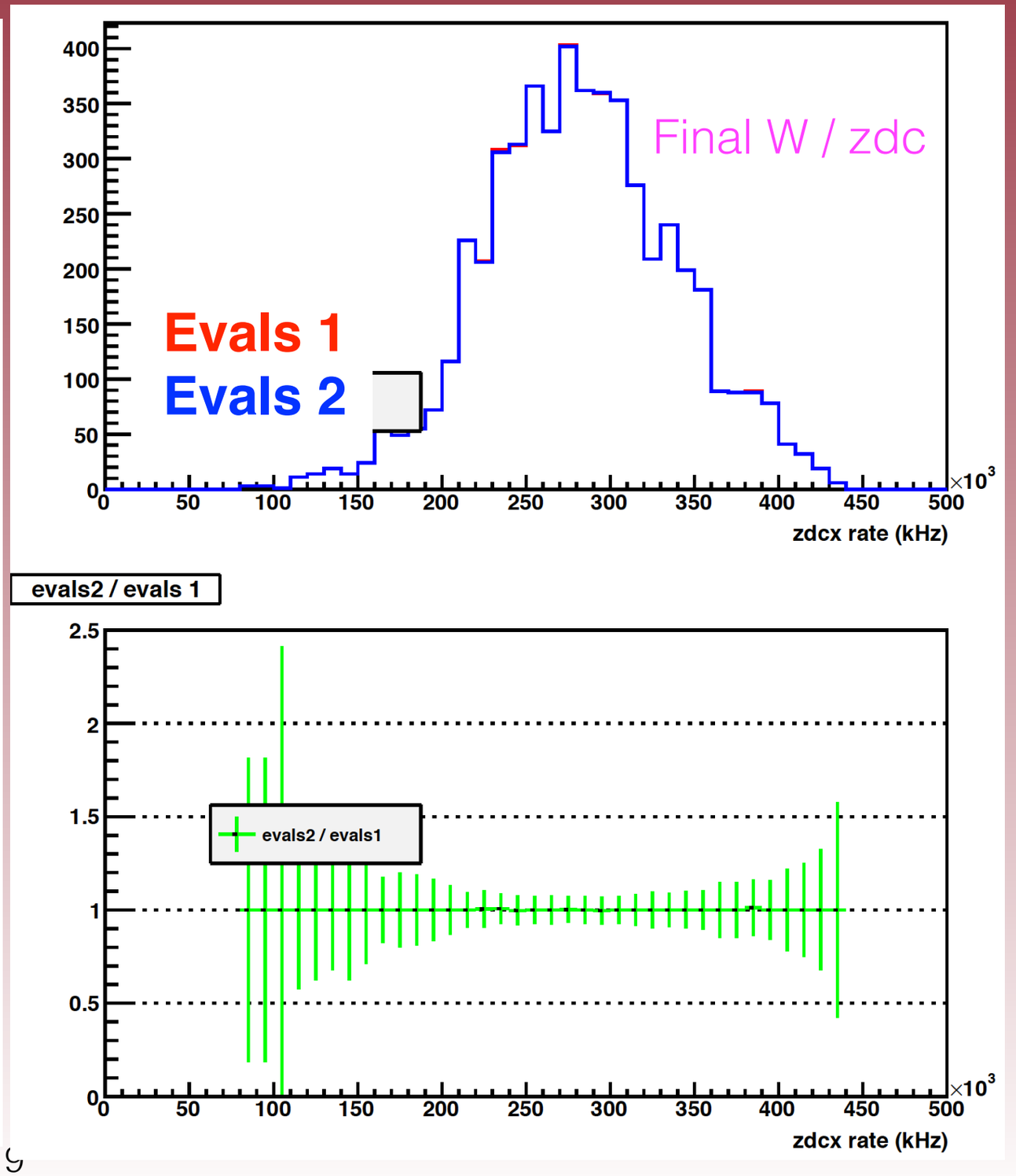
- **SL16b - https://drupal.star.bnl.gov/STAR/comp/sofi/soft-n-libs/library-release-history/2016-0#SL16b**
- **STi_Updated : some changes to STI code from Yuri**

Events Counts



Final W, Final W ZDC





Summary

- No observable / considerable difference between Evals 1 vs Evals 2. Meaning **no difference** between **STI vs STI_updated** [sti_updated]

Evals 1 vs Evals 4

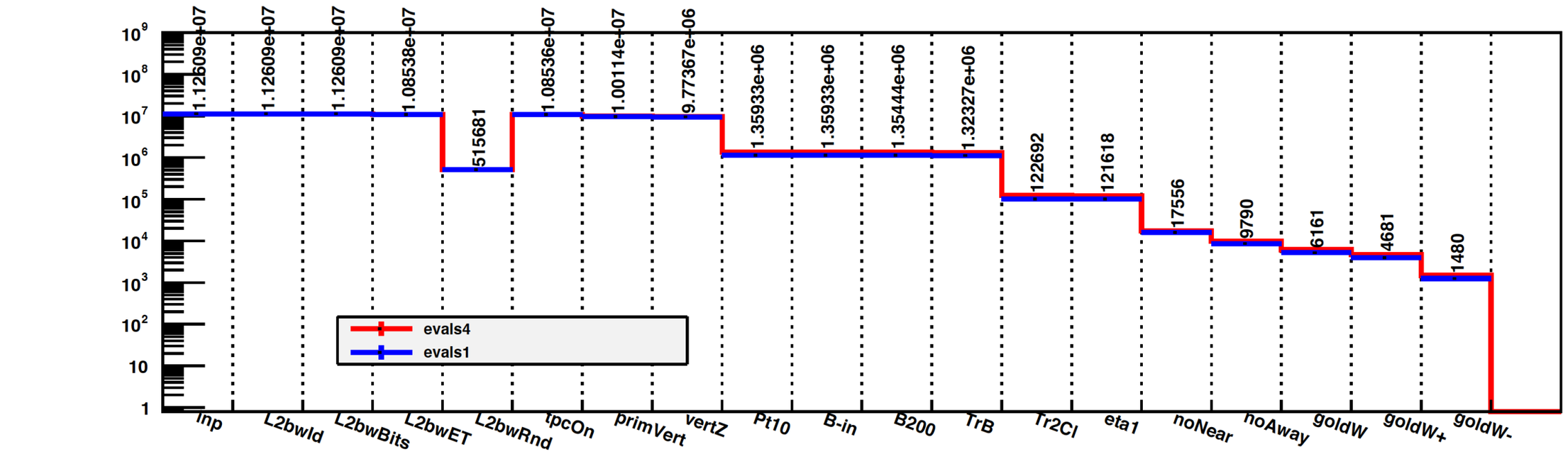
Apple- to -Apple comparison

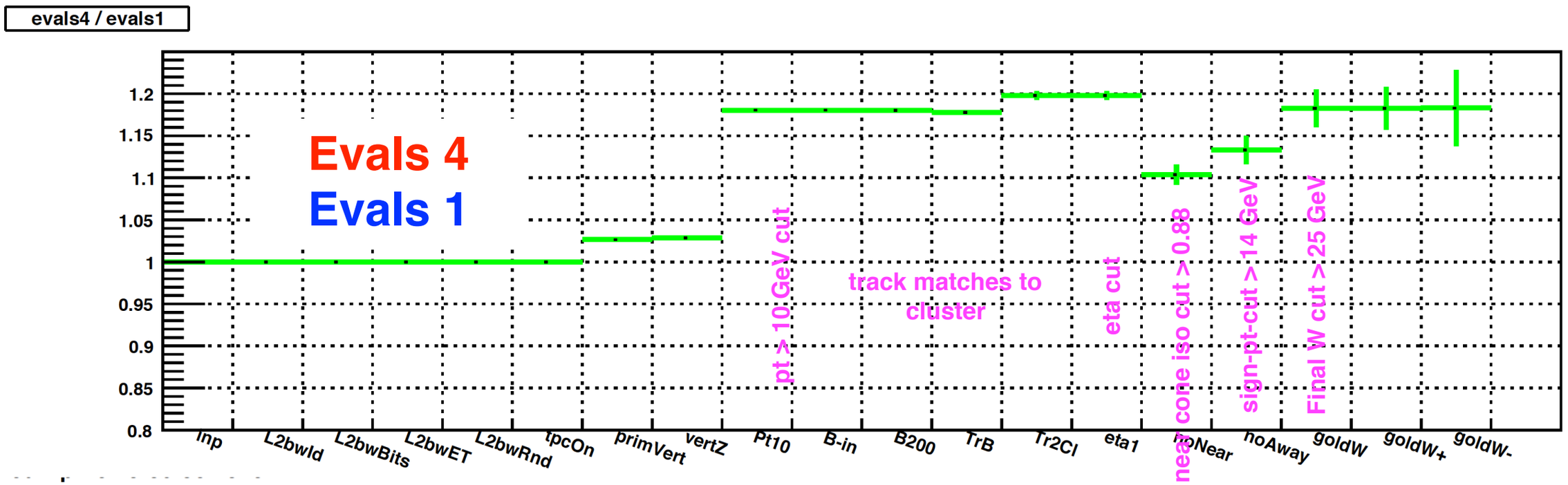
Details / Notes

Production	Production Library [also W-code compiled	Tracking	vertex finding	BEMC-gains	# of runs used in the comparison	# of events
“evals4”	EVAL	StiCA	PPV_W	run 12 - 200 GeV	896	11.26 M
“evals1”	SL16b	Sti	PPV_W	run 12 200 GeV	896	11.26 M

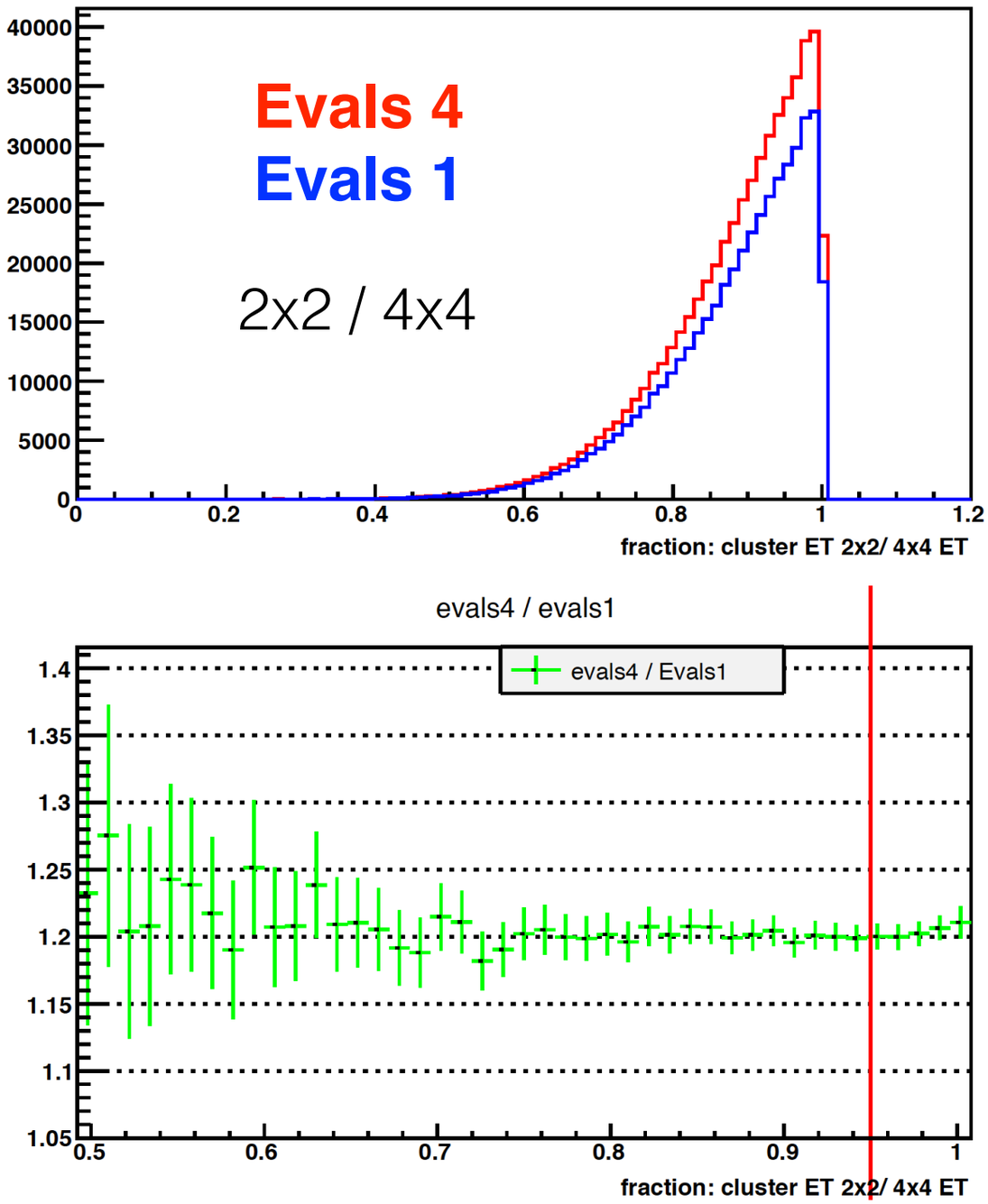
- **Runs which have processed exactly the same # of events in both sets were chosen.**
- **SL16b - https://drupal.star.bnl.gov/STAR/comp/sofi/soft-n-libs/library-release-history/2016-0#SL16b**

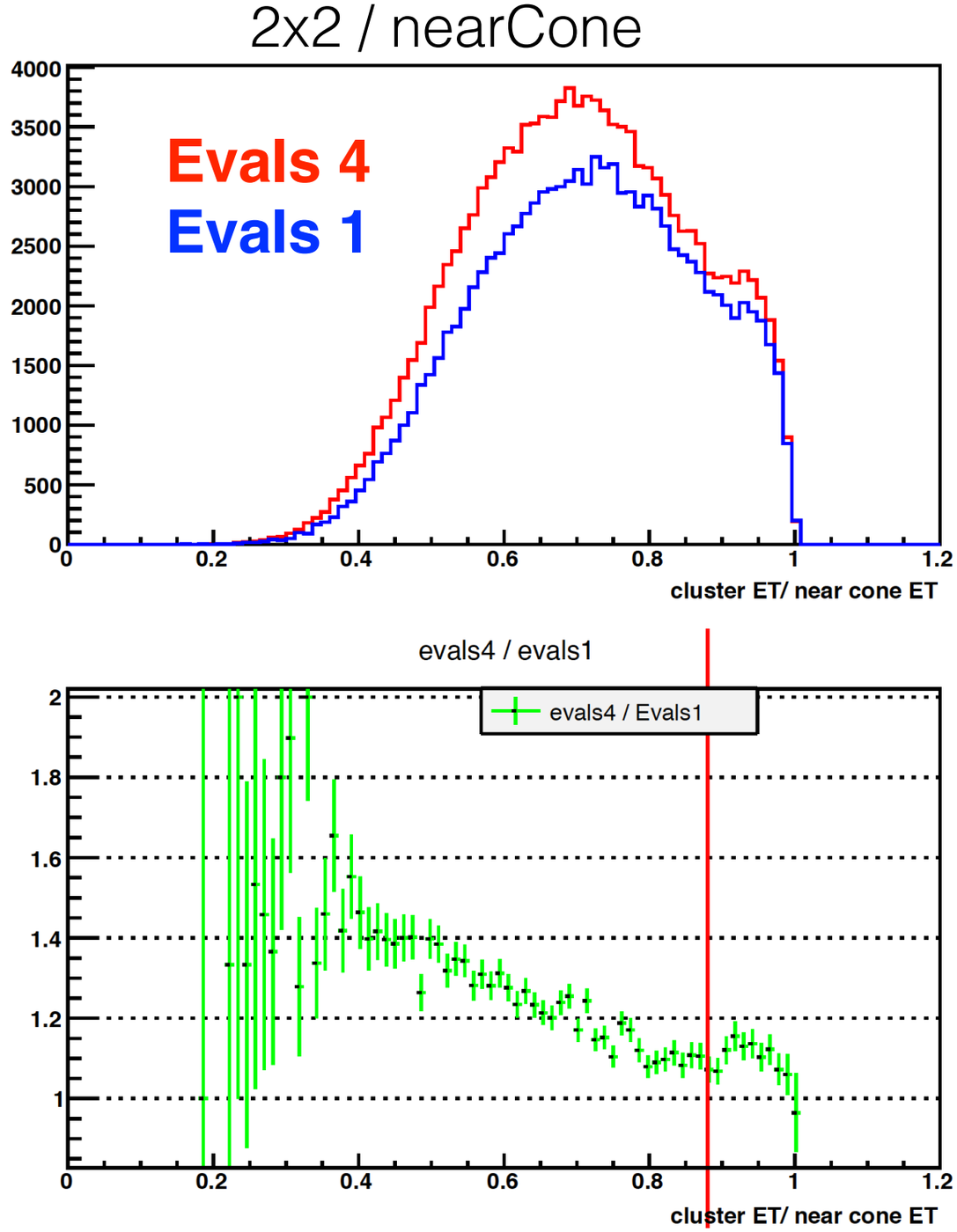
Events Counts



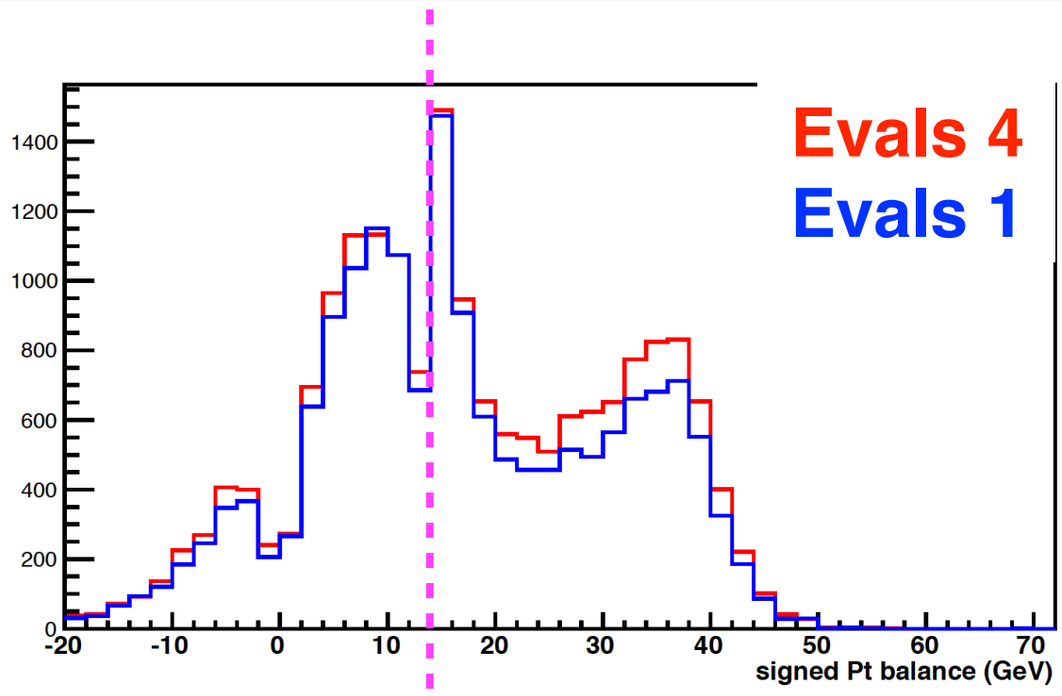


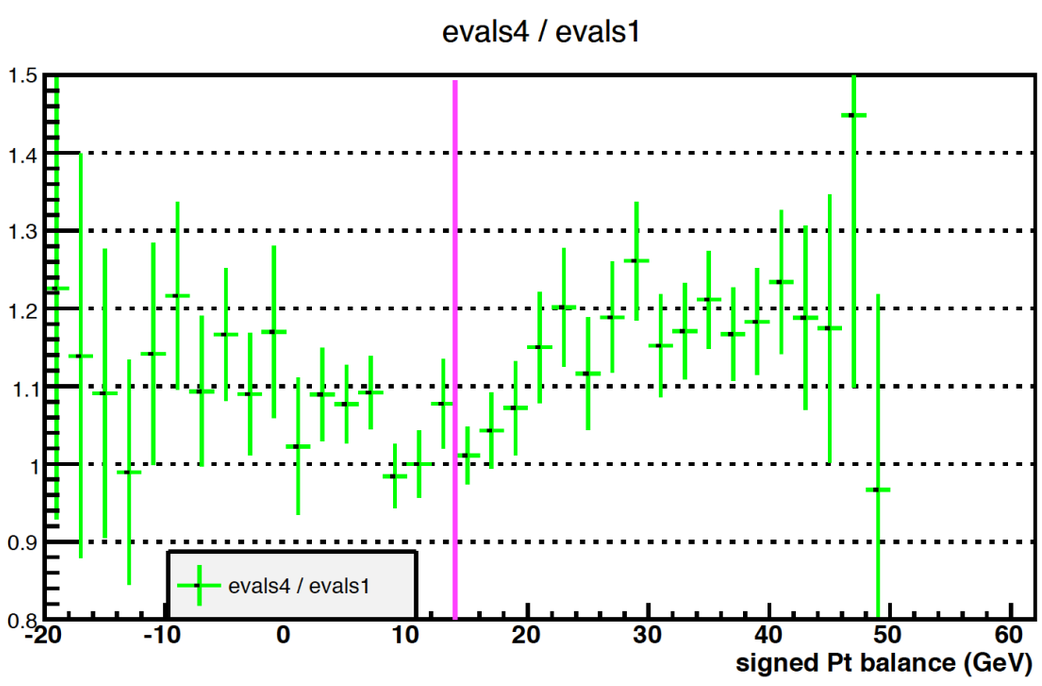
Isolation cuts

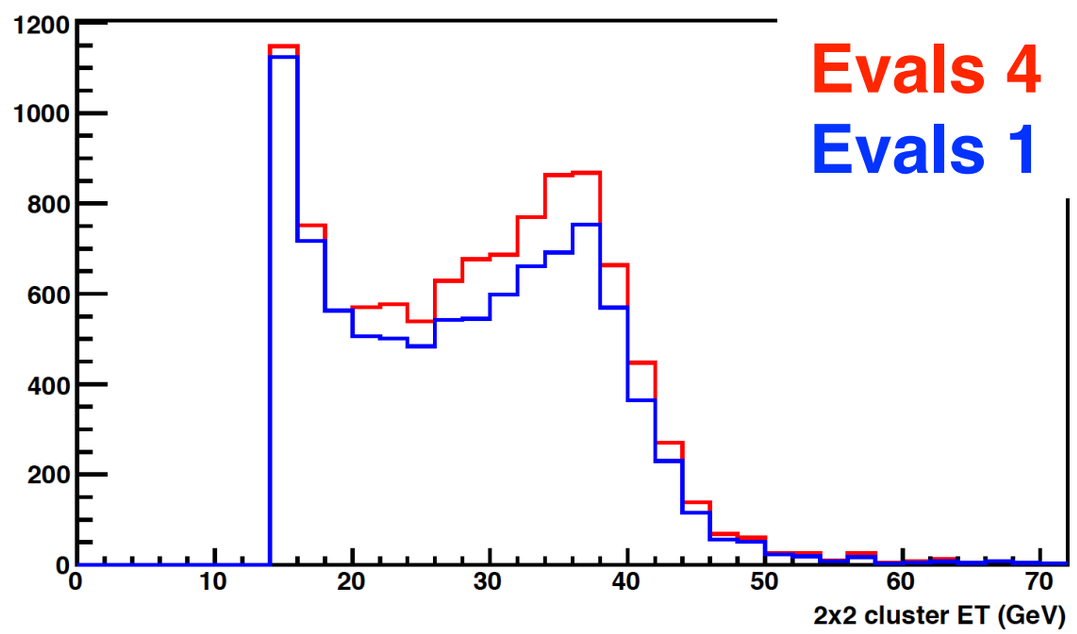


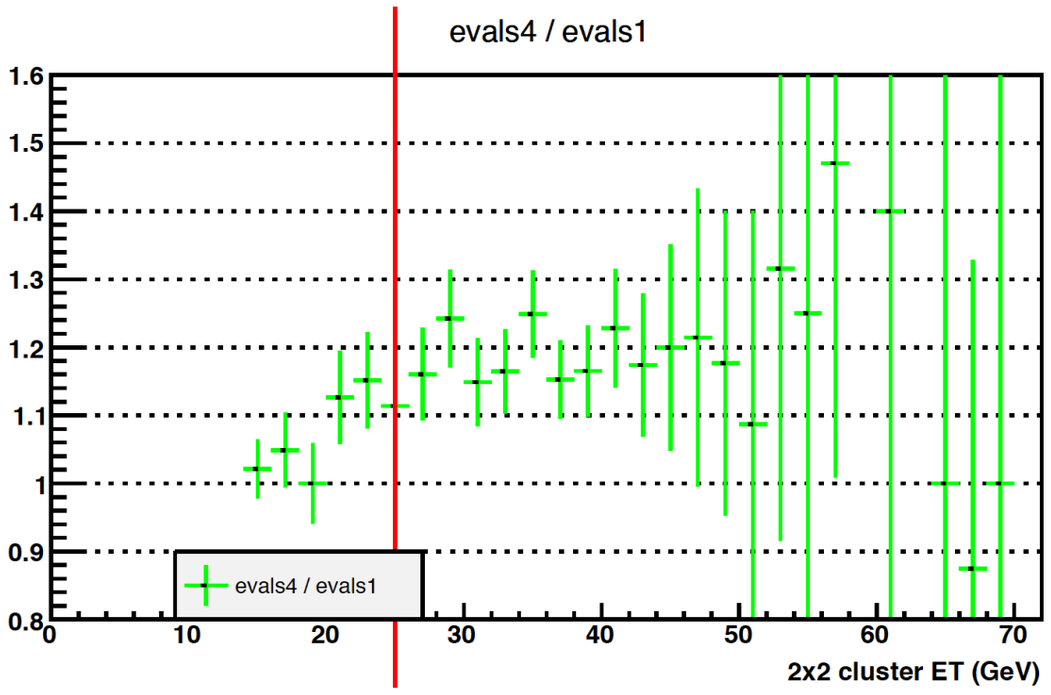


Sign Pt, Final W

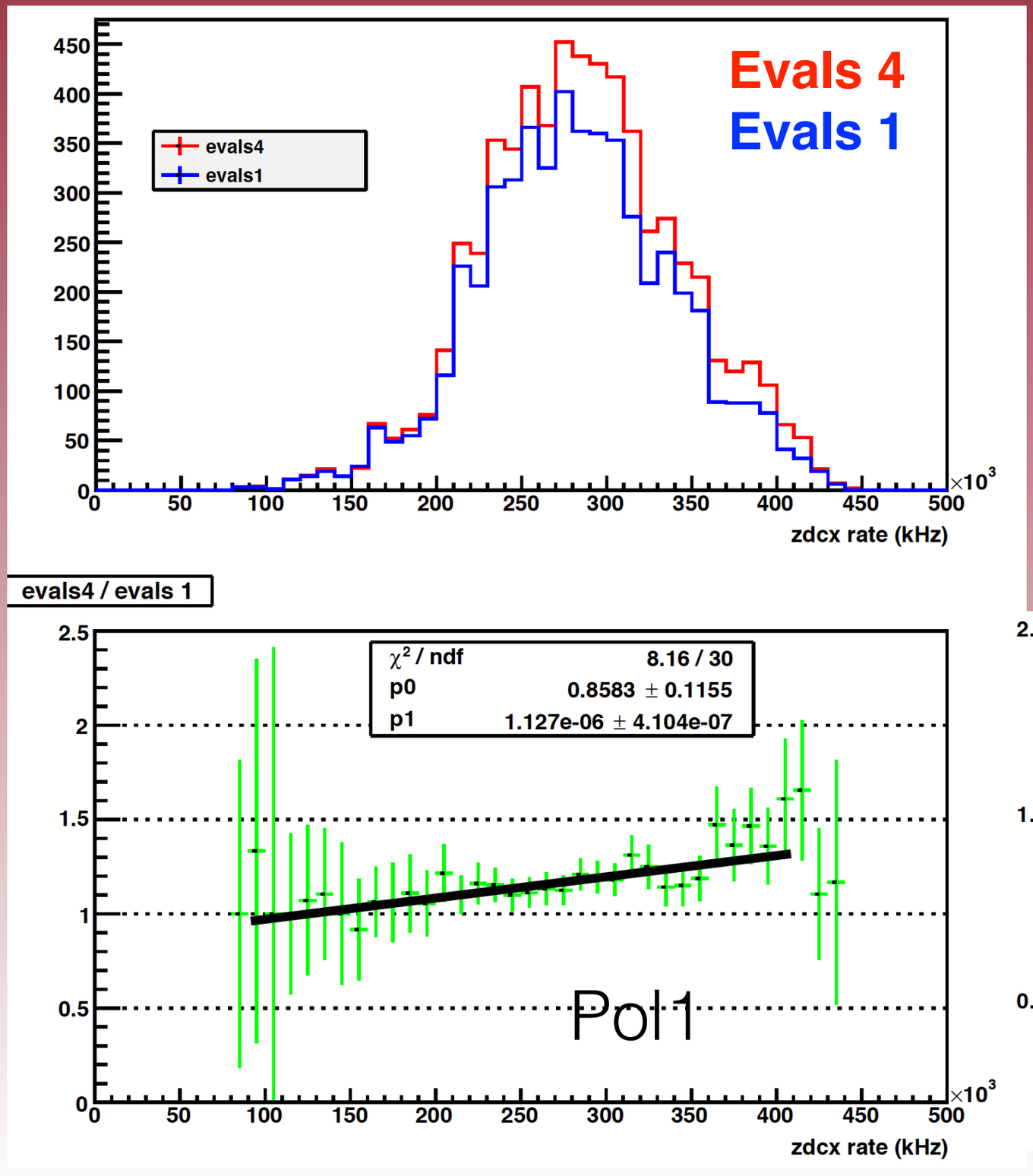




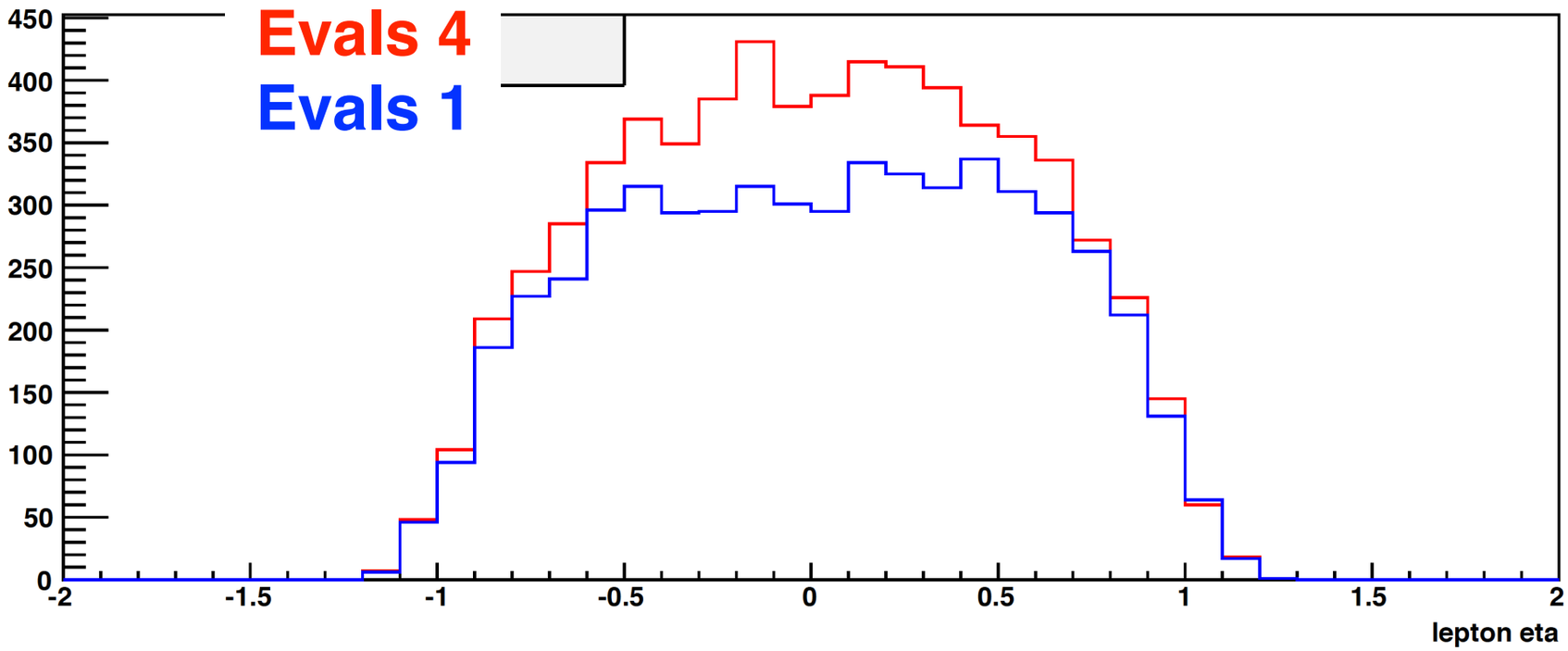


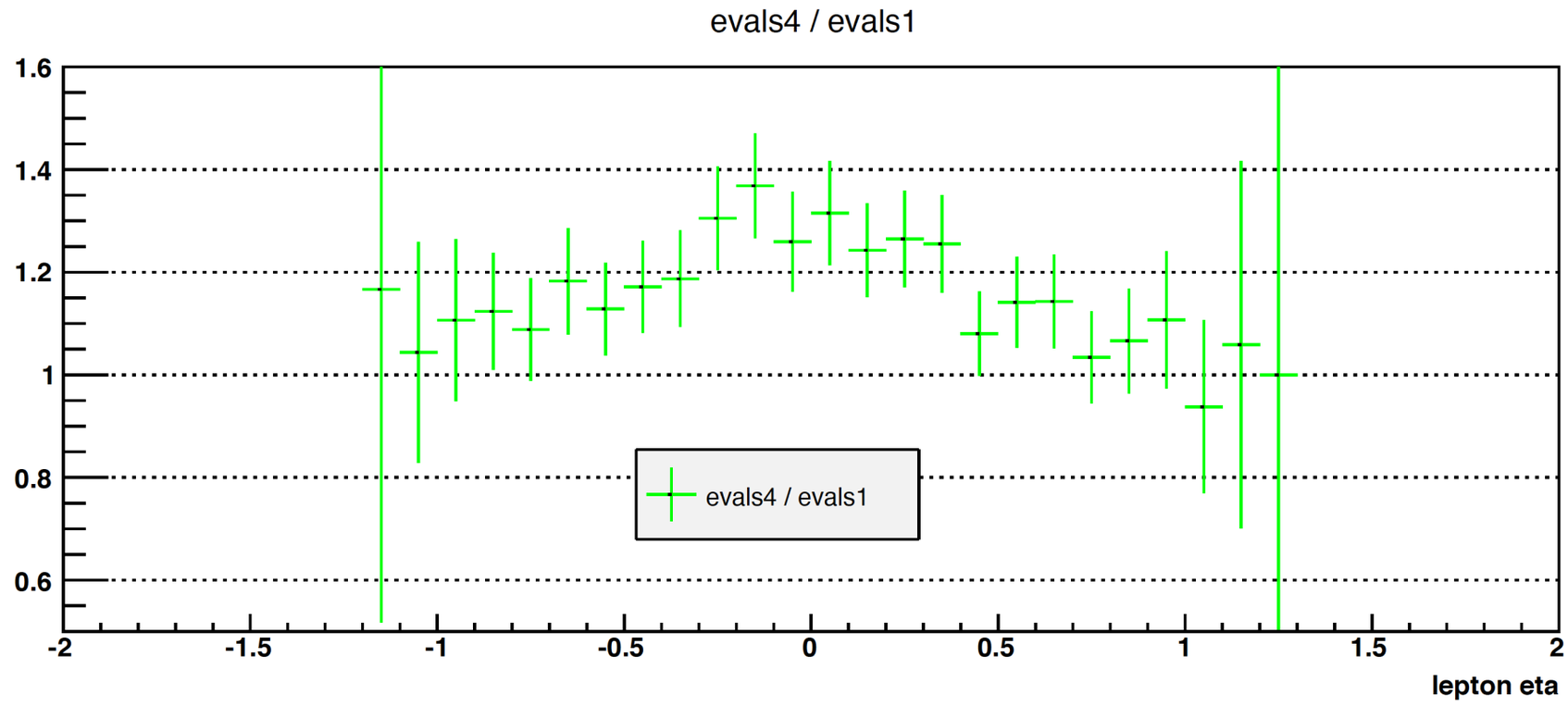


Final W ZDC

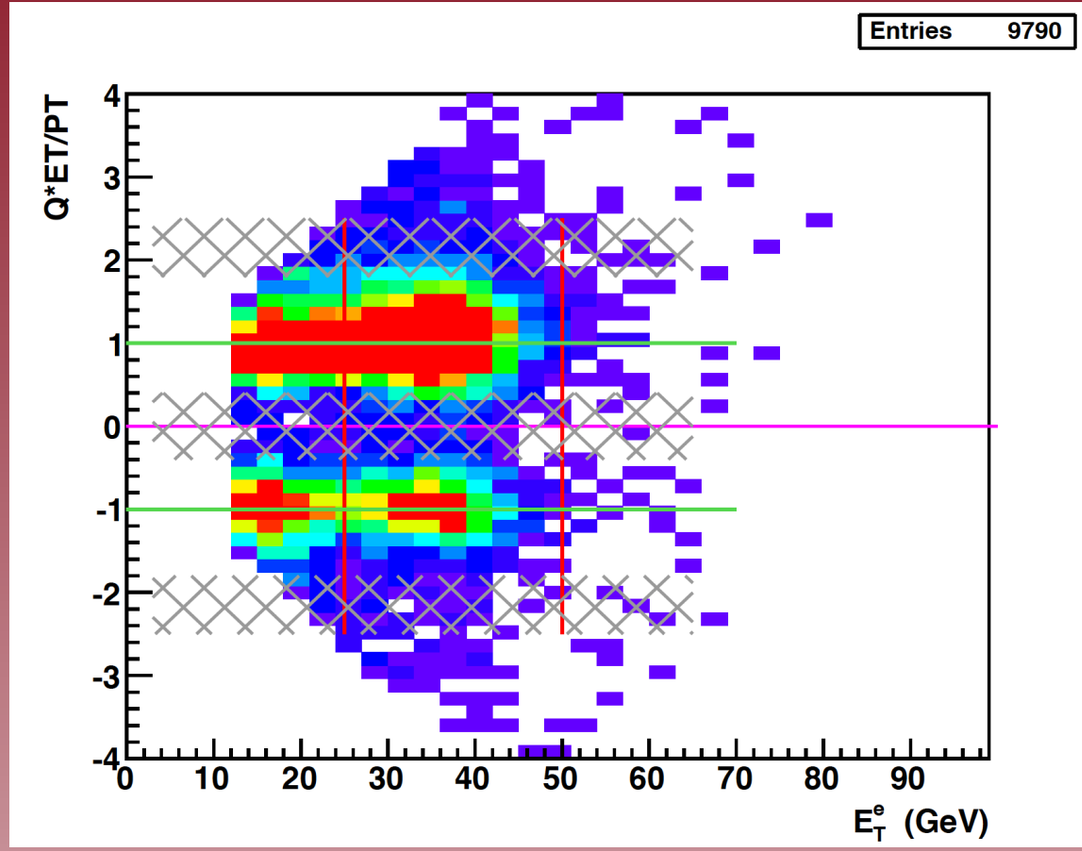

evals4
evals1
Evals 4
Evals 1
zdcx rate (kHz)
evals4 / evals 1
χ² / ndf 8.16 / 30
p0 0.8583 ± 0.1155
p1 1.127e-06 ± 4.104e-07
Pol1
zdcx rate (kHz)
χ² / ndf 17.49 / 34
p0 1.171 ± 0.022
Pol0
zdcx rate (kHz)

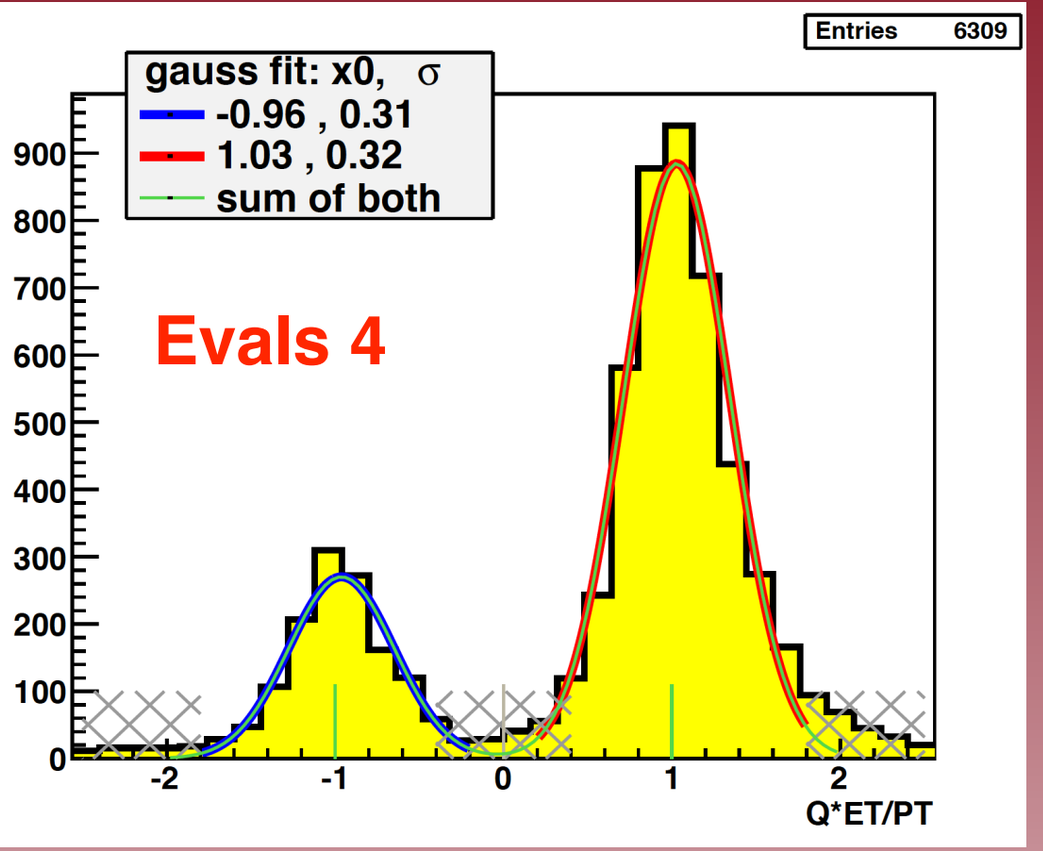
Final W Eta

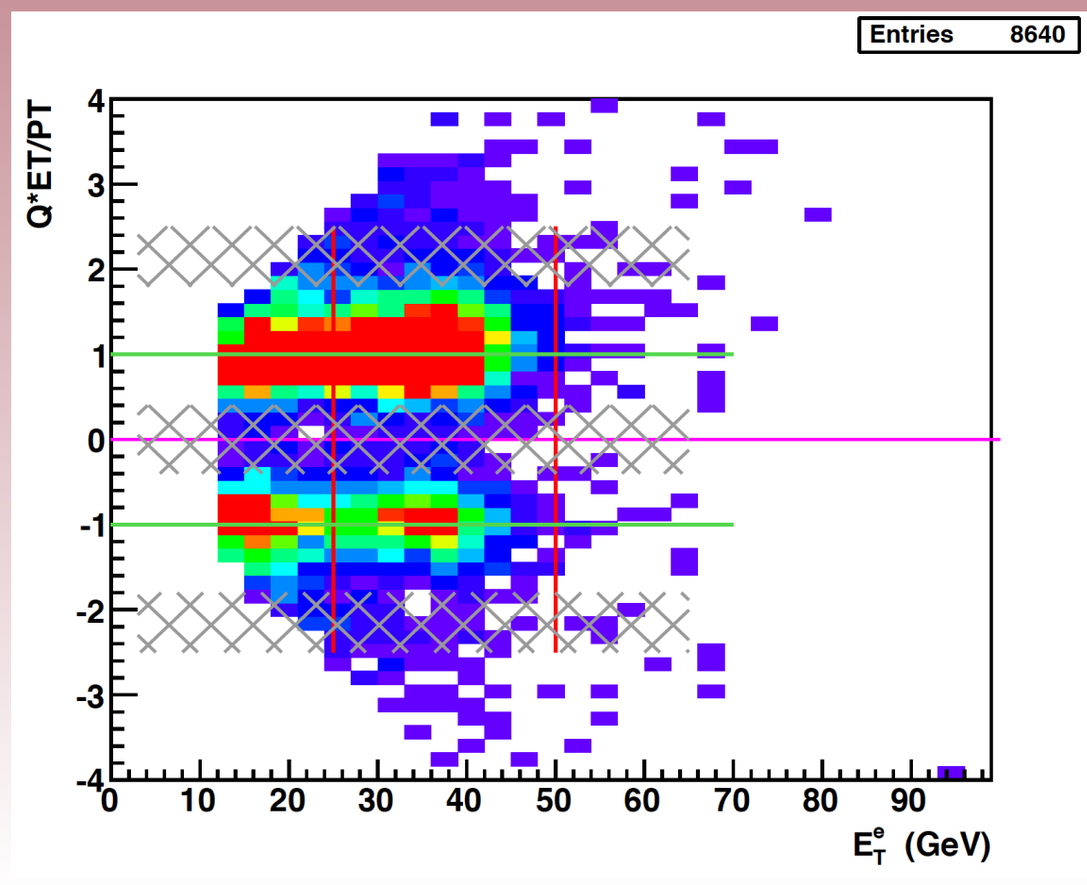

Evals 4
Evals 1
450
400
350
300
250
200
150
100
50
0
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
lepton eta

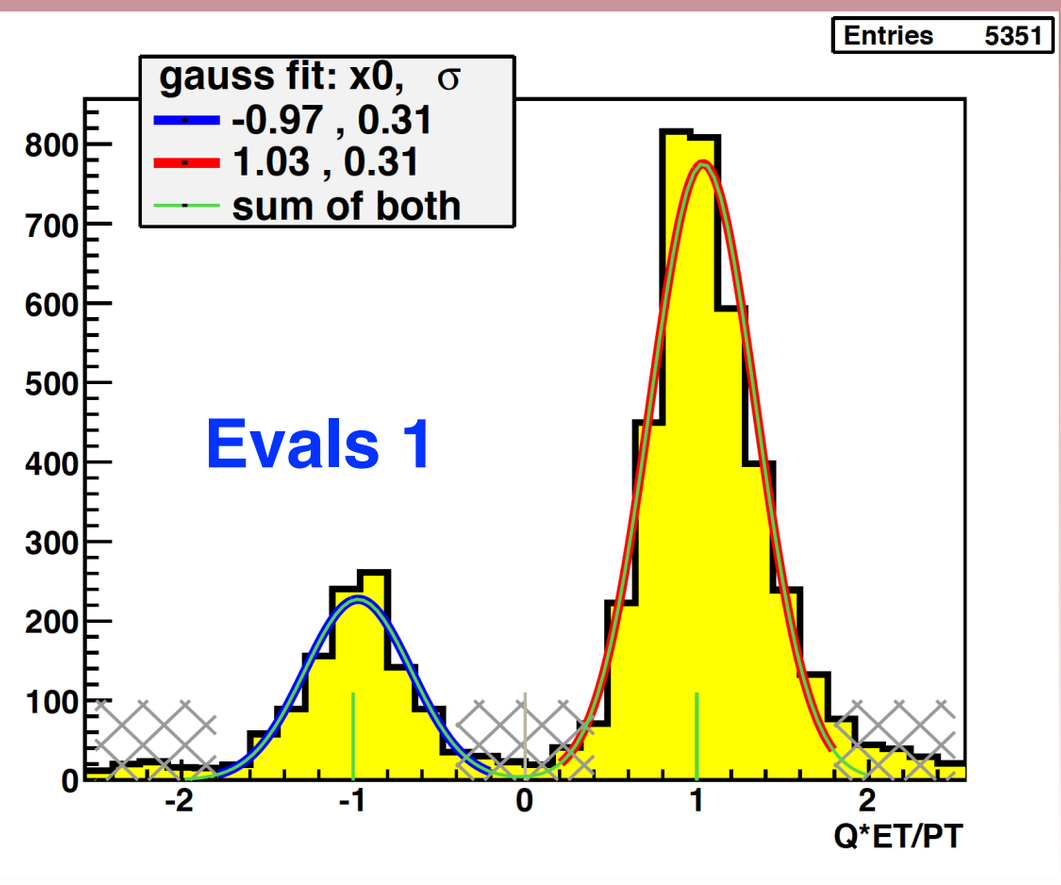

evals4 / evals1
1.6
1.4
1.2
1
0.8
0.6
evals4 / evals1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
lepton eta

W charge Separation

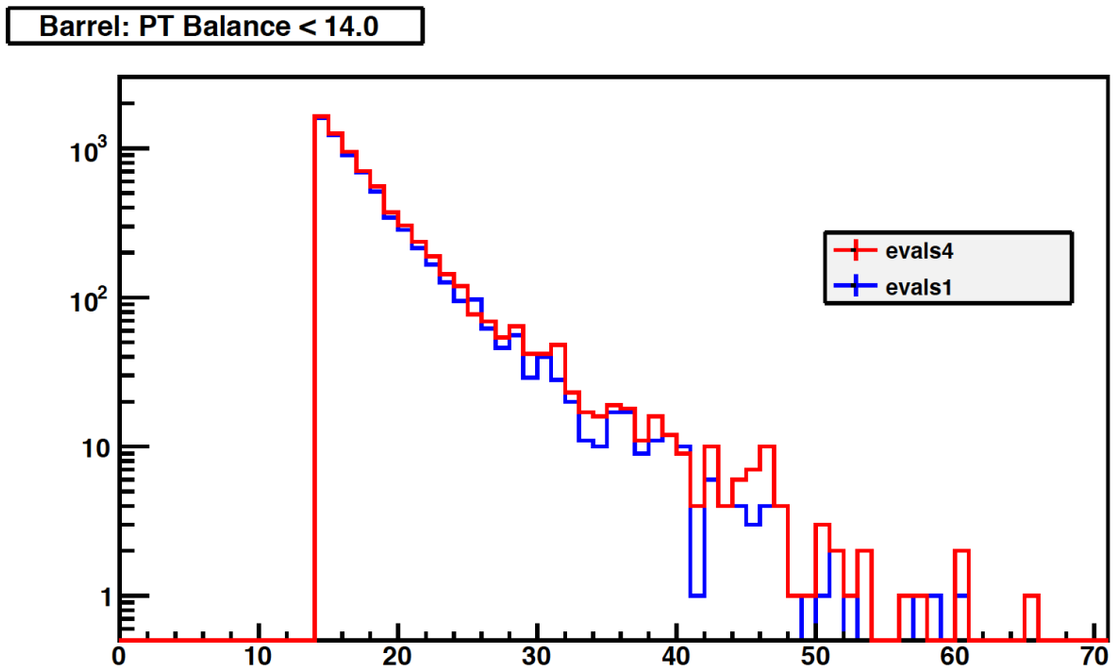


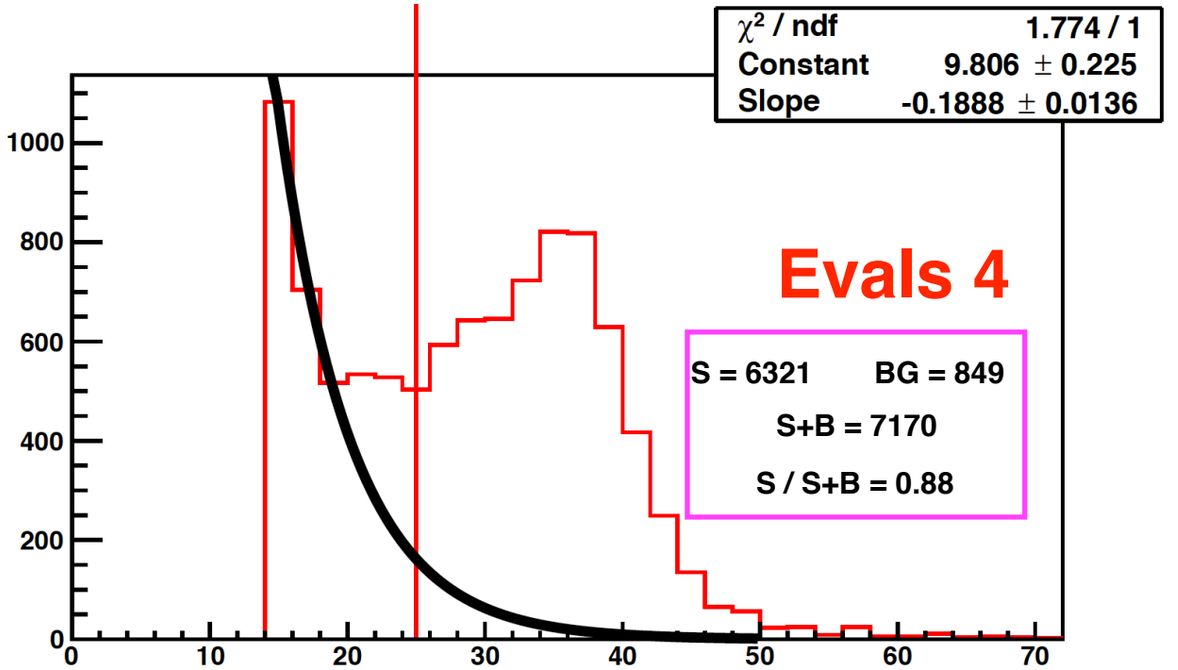


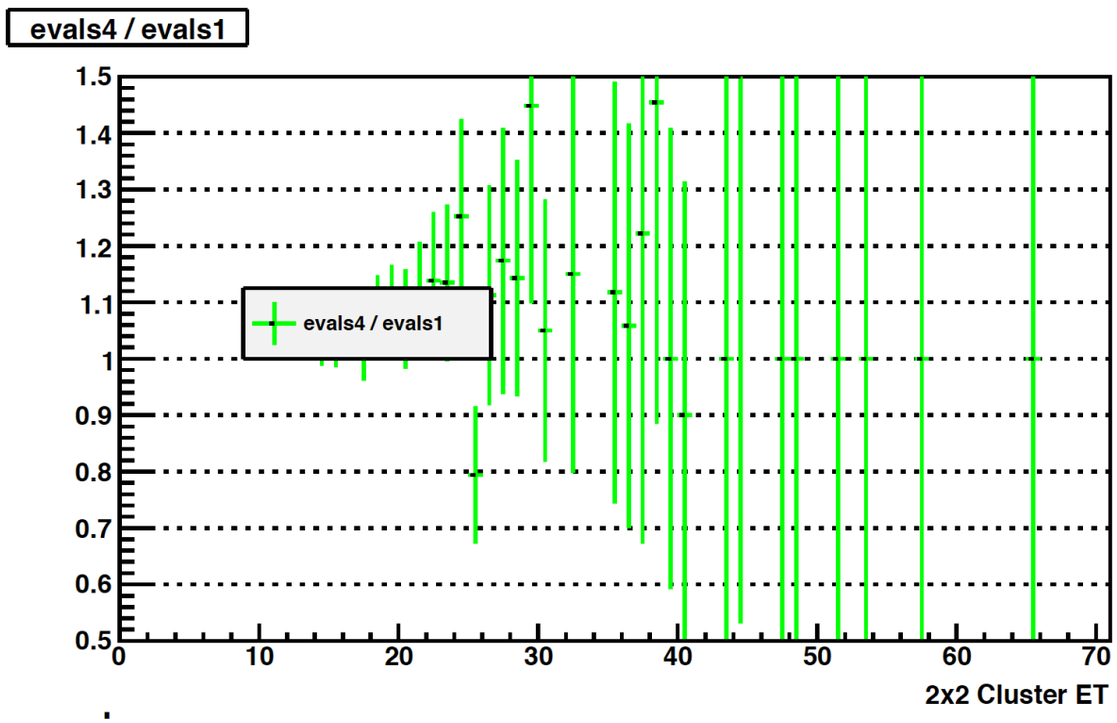


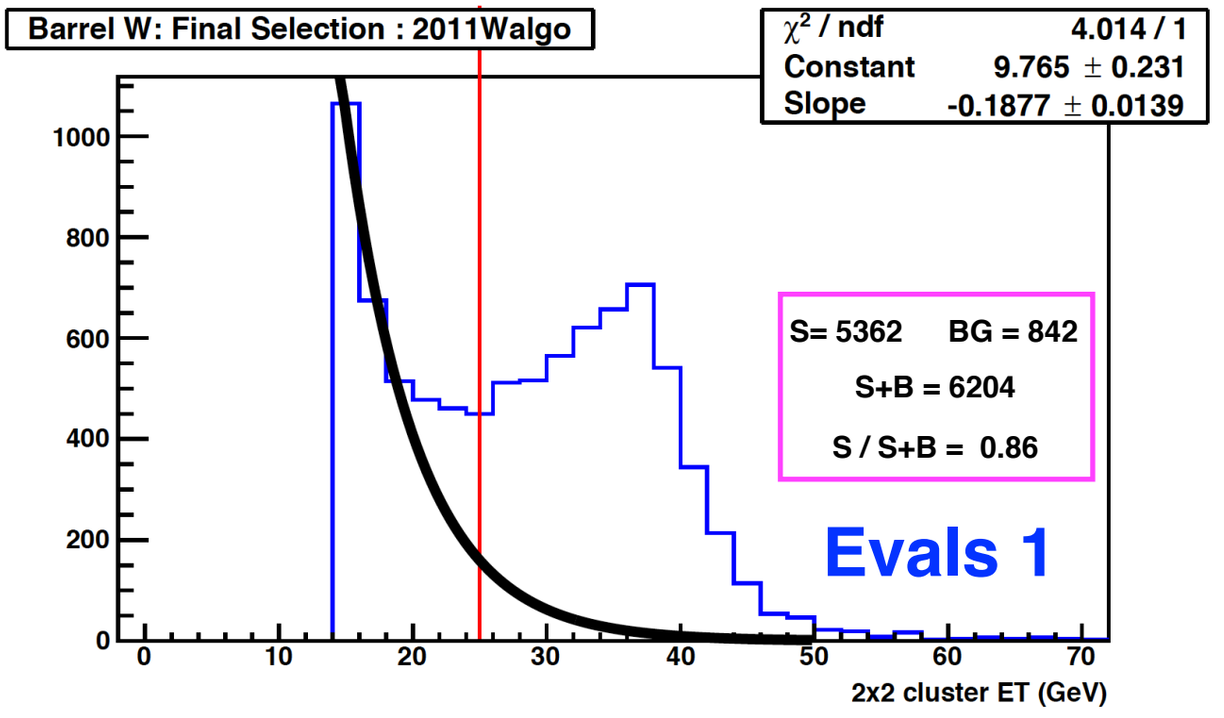


QCD BG


Barrel: PT Balance < 14.0
evals4
evals1
2x2 Cluster ET


χ² / ndf 1.774 / 1
Constant 9.806 ± 0.225
Slope -0.1888 ± 0.0136
Evals 4
S = 6321 BG = 849
S+B = 7170
S / S+B = 0.88
2x2 cluster ET (GeV)


evals4 / evals1
evals4 / evals1
2x2 Cluster ET


Barrel W: Final Selection : 2011Walgo
χ² / ndf 4.014 / 1
Constant 9.765 ± 0.231
Slope -0.1877 ± 0.0139
S= 5362 BG = 842
S+B = 6204
S / S+B = 0.86
Evals 1
2x2 cluster ET (GeV)

Summary

- StiCA reuses hits in TPC which increases track finding efficiency.

- We see ~20 % enhancement in tracks above Pt = 10 GeV and similar enhancement in final W [> 25 GeV] tracks.

- Significant enhancement of final W Eta in mid rapidity region where a “dip” was observed previously.

- improvement in signal to background ratio.

Evals 1 vs p14ia

Apple- to -Apple comparison

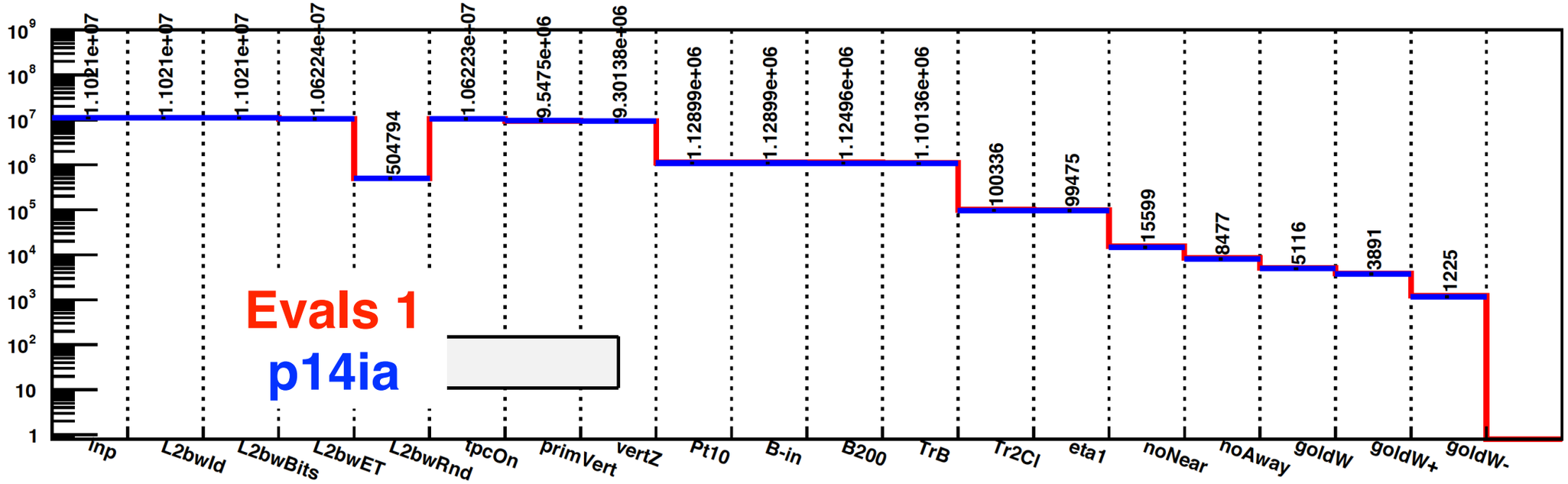
Details / Notes

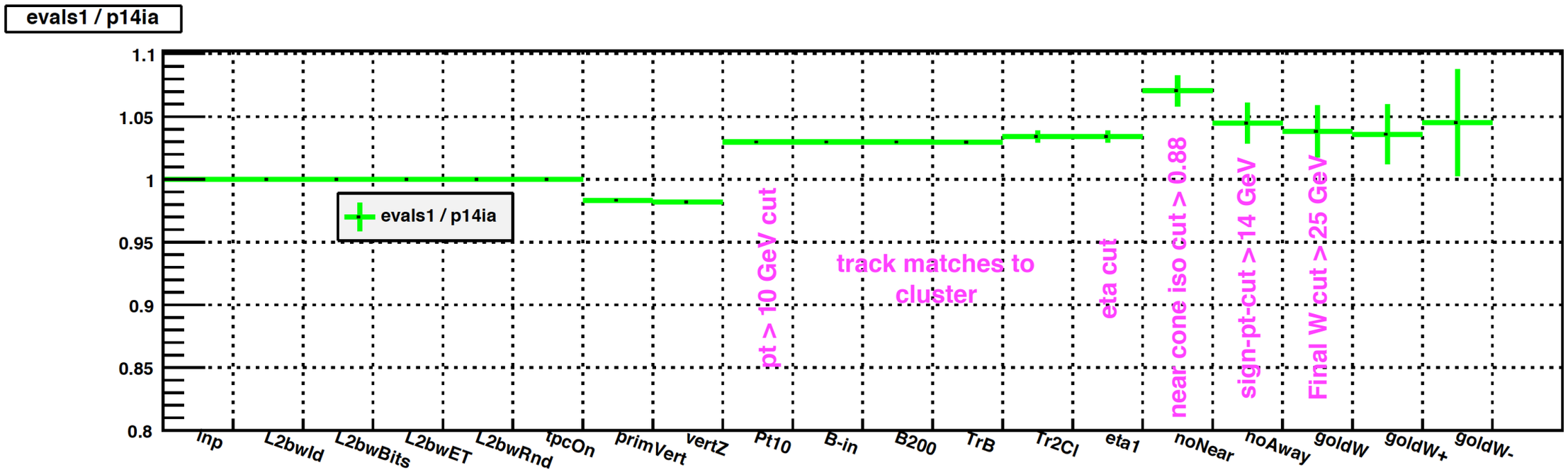
Production	Production Library [also W-code compiled	Tracking	vertex finding	BEMC-gains	# of runs used in the comparison	# of events
P14ia [official run 13 - P1 (day 76-128)	SL14ia [SL14g]	Sti	PPV_W	run 12 - 200 GeV	885	11.021 M
“evals1”	SL16b	Sti	PPV_W	run 12 200 GeV	885	11.021 M

- **All the runs which were used for the comparison compared for # events processed. Runs which processed exactly the same # of events were chosen.**

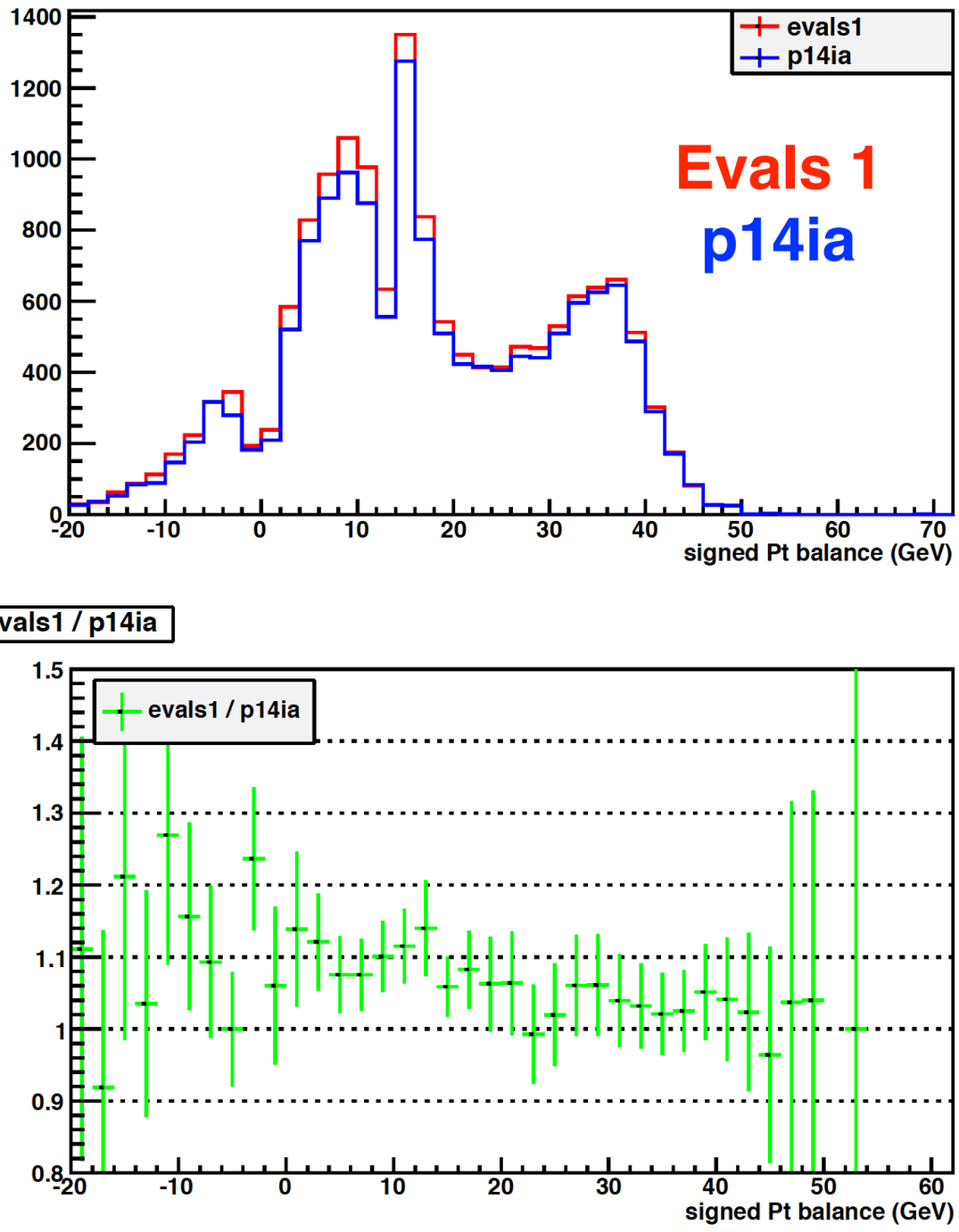
- **SL16b - https://drupal.star.bnl.gov/STAR/comp/sofi/soft-n-libs/library-release-history/2016-0#SL16b**

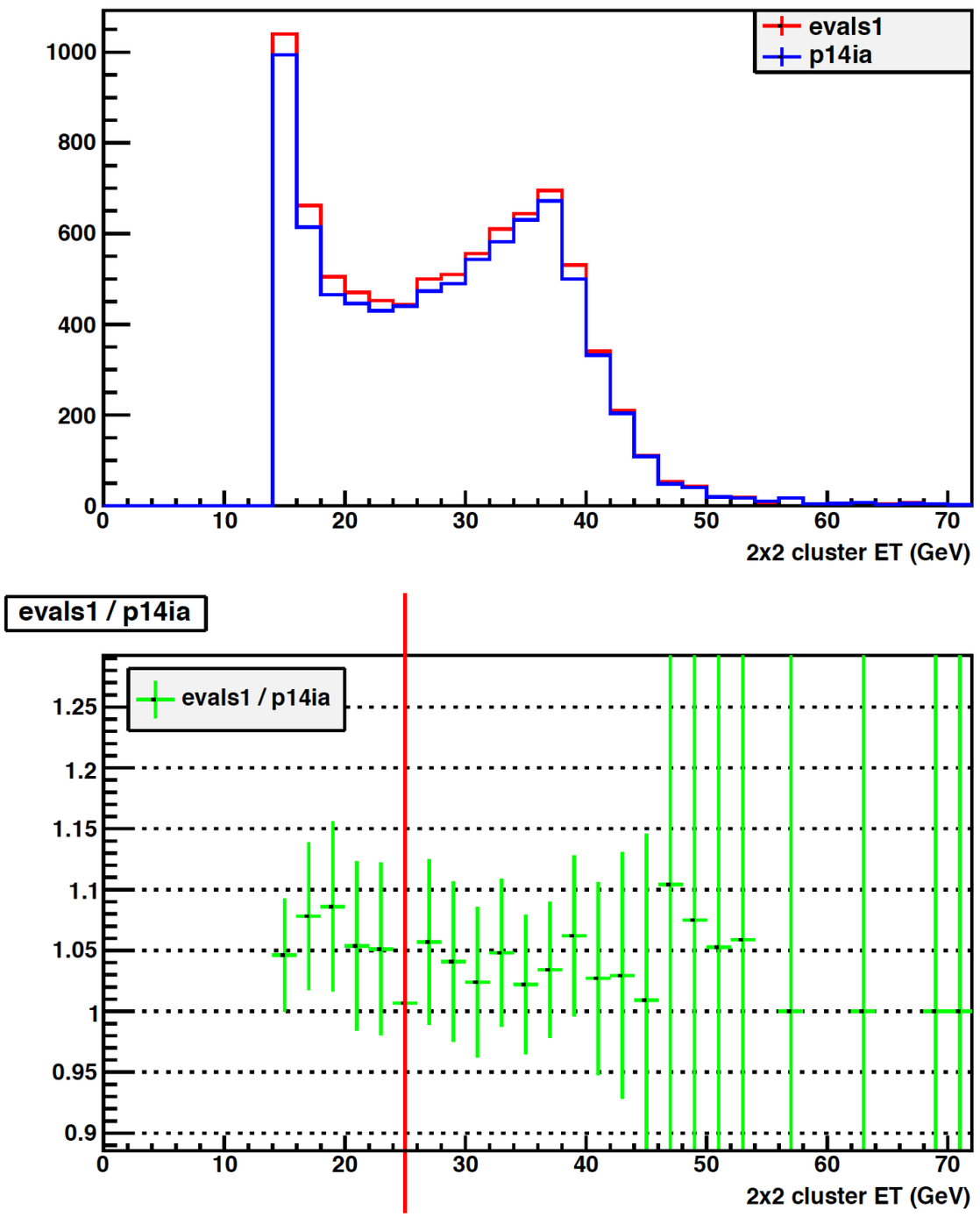
Events Counts



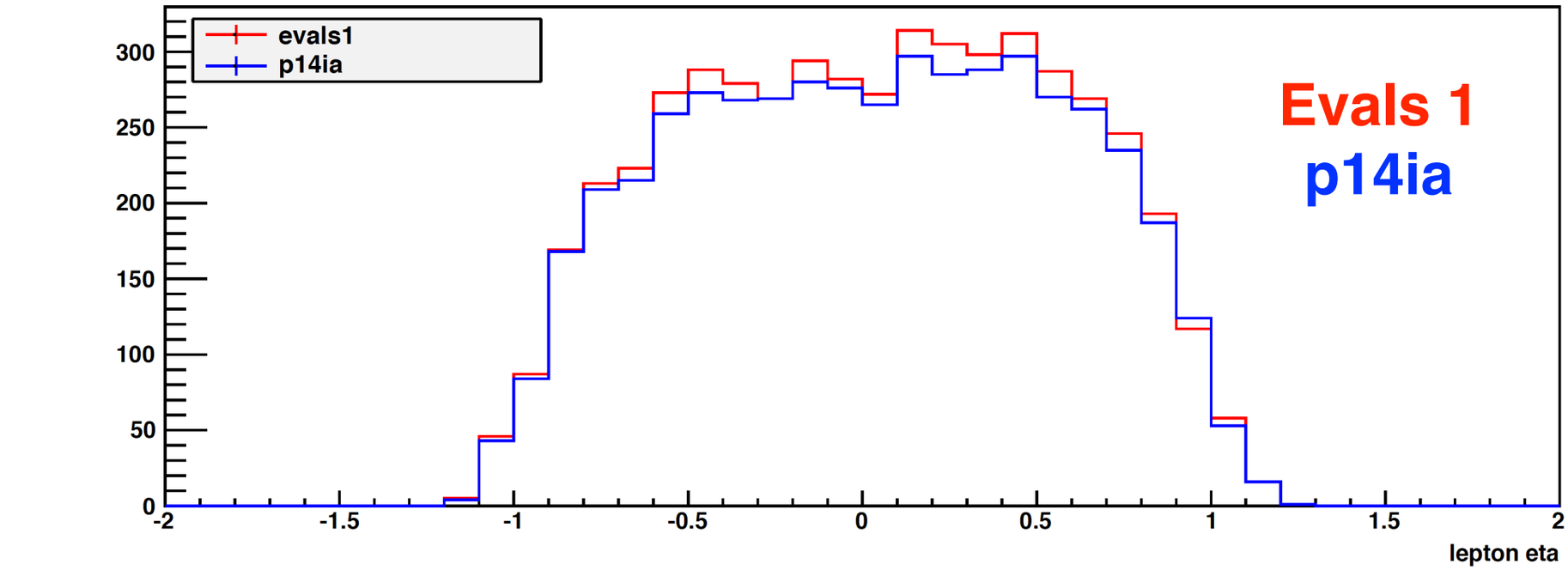


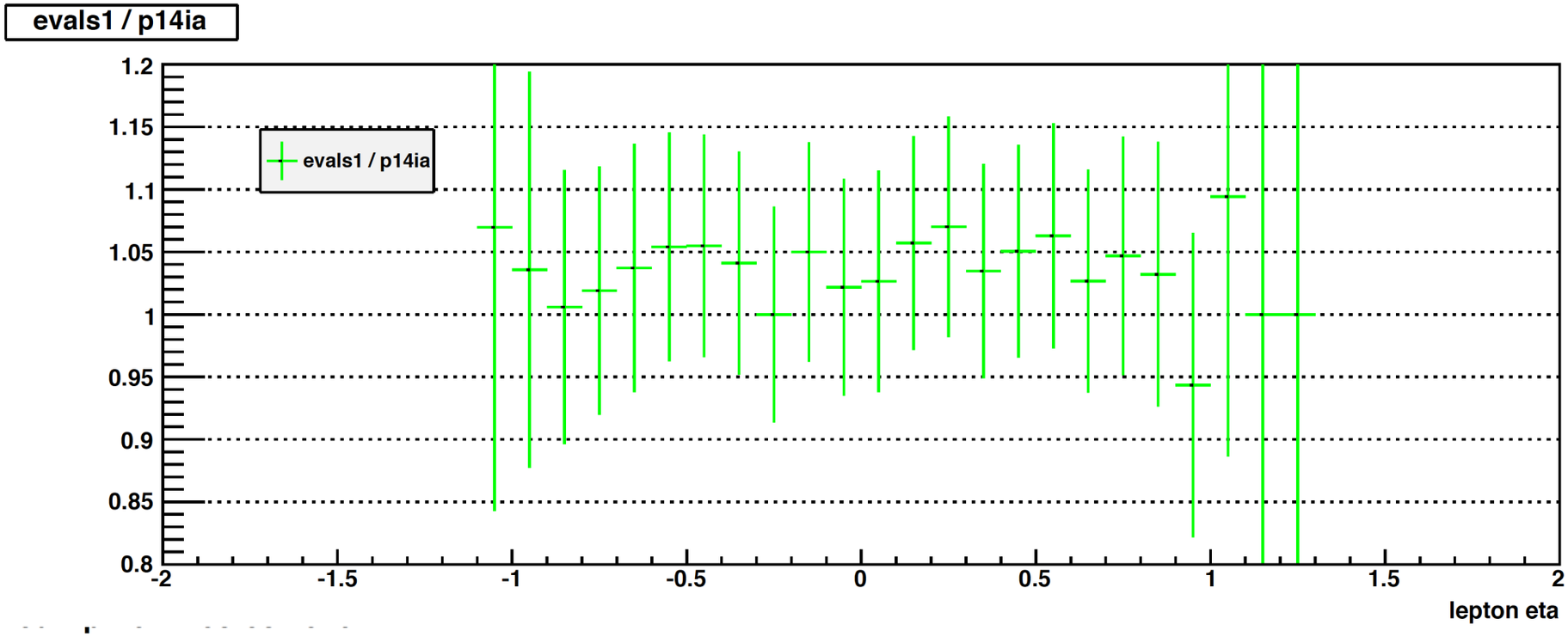
Final W


evals1
p14ia
Evals 1
p14ia
signed Pt balance (GeV)
evals1 / p14ia
evals1 / p14ia
signed Pt balance (GeV)

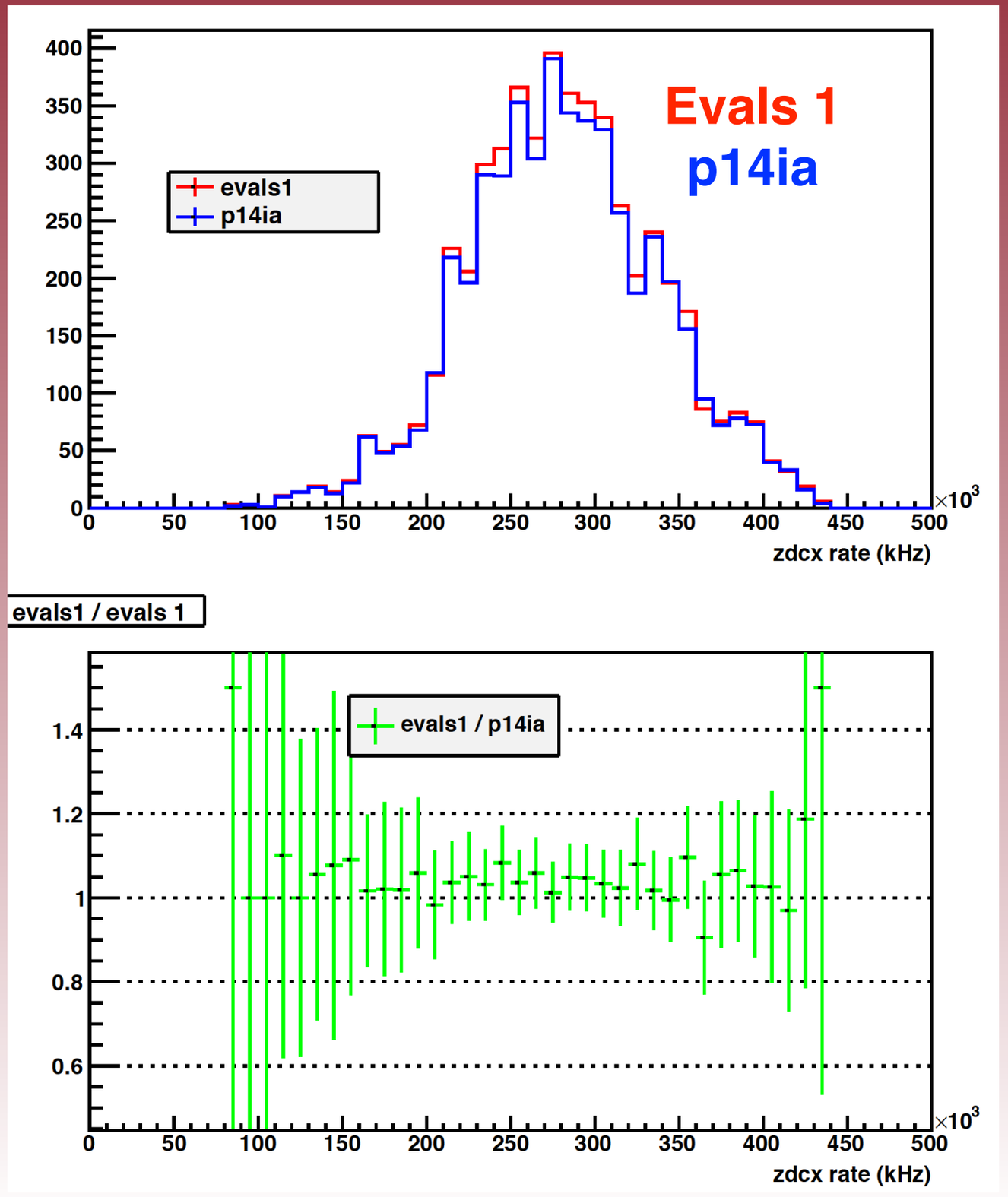

evals1
p14ia
2x2 cluster ET (GeV)
evals1 / p14ia
evals1 / p14ia
2x2 cluster ET (GeV)

Final W Eta

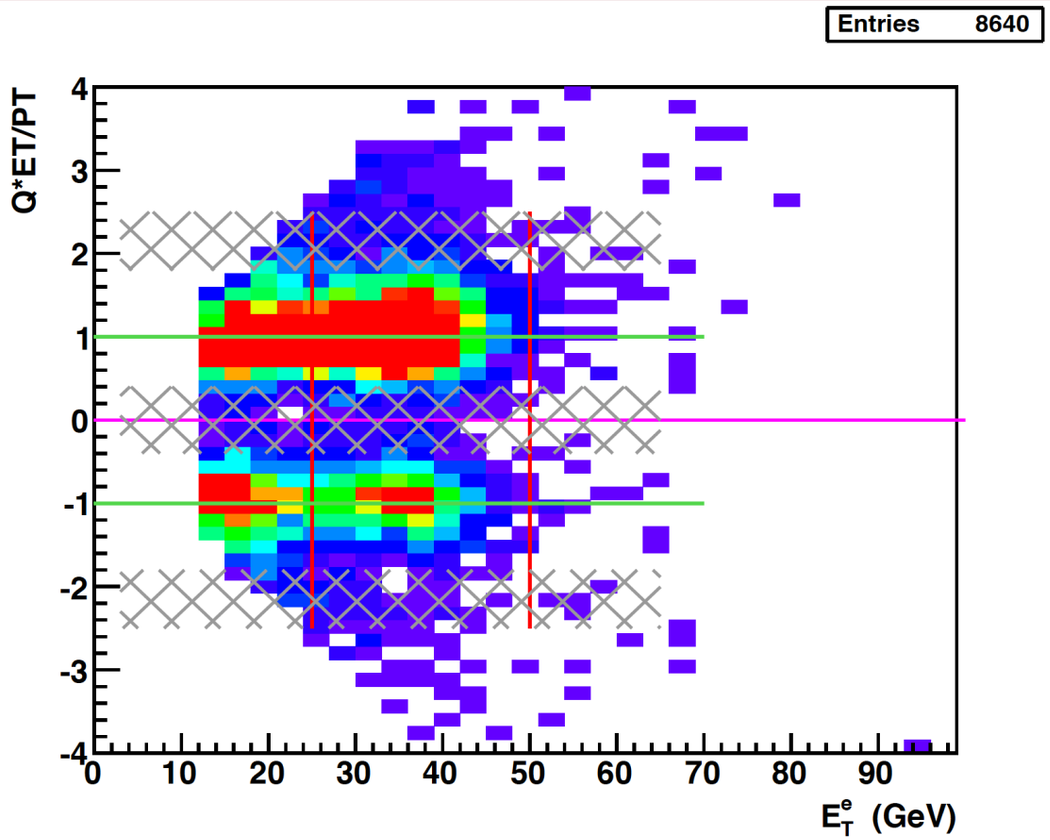

evals1
p14ia
Evals 1
p14ia
300
250
200
150
100
50
0
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
lepton eta

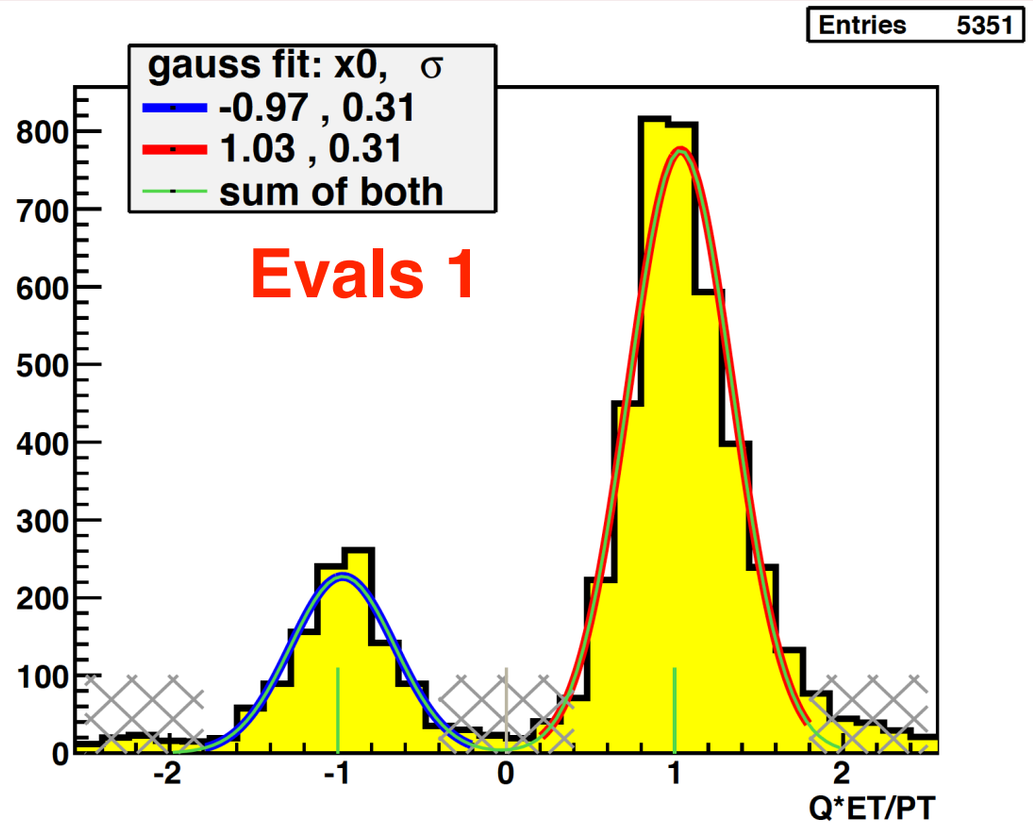

evals1 / p14ia
evals1 / p14ia
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
lepton eta

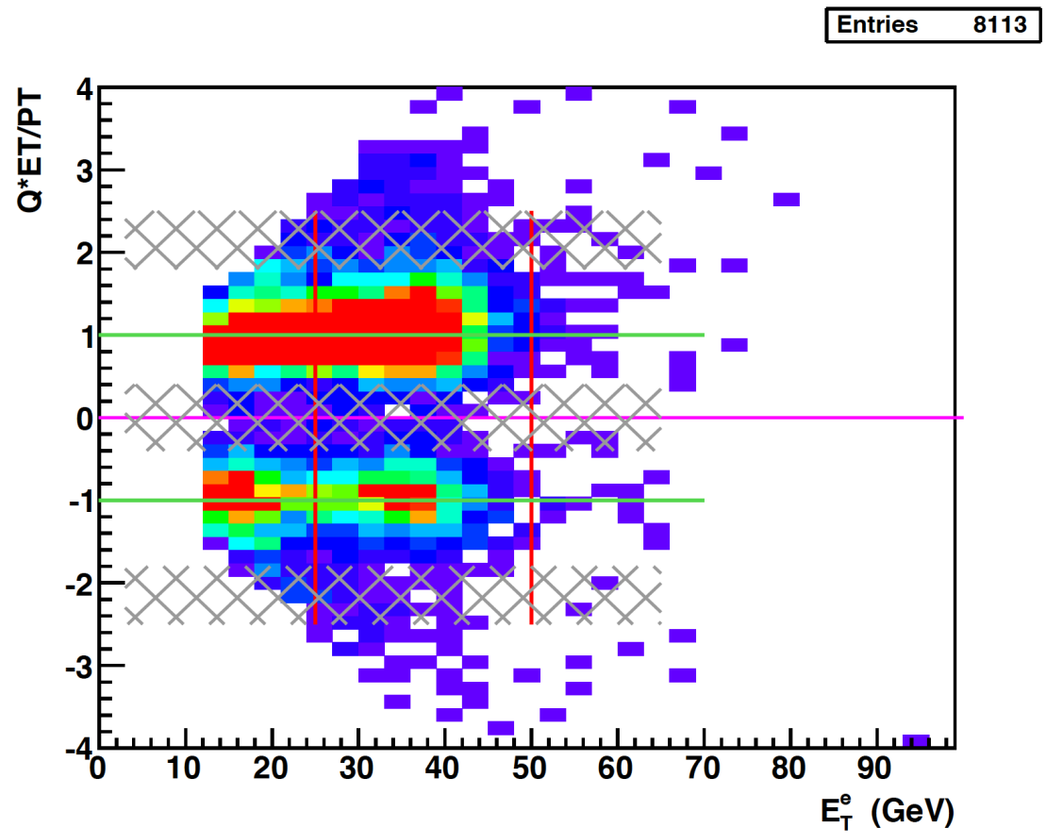
Final W / ZDC

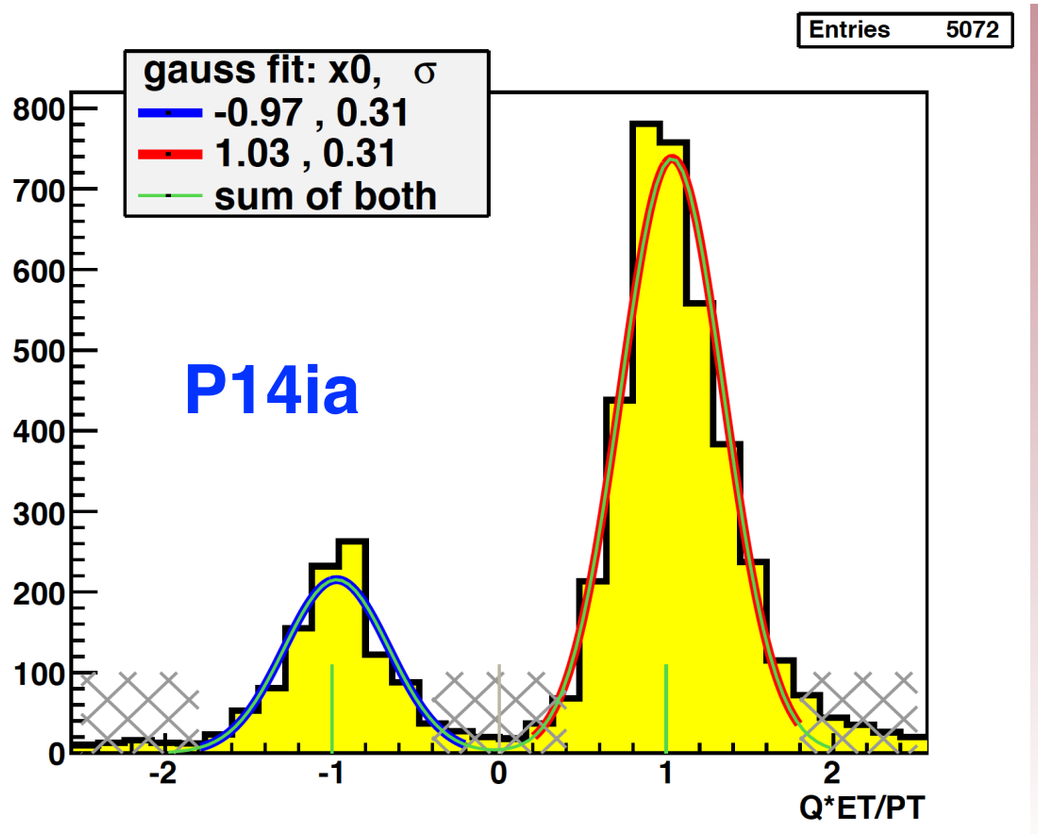

evals1
p14ia
Evals 1
p14ia
zdcx rate (kHz)
evals1 / evals 1
evals1 / p14ia
zdcx rate (kHz)

W Charge Separation

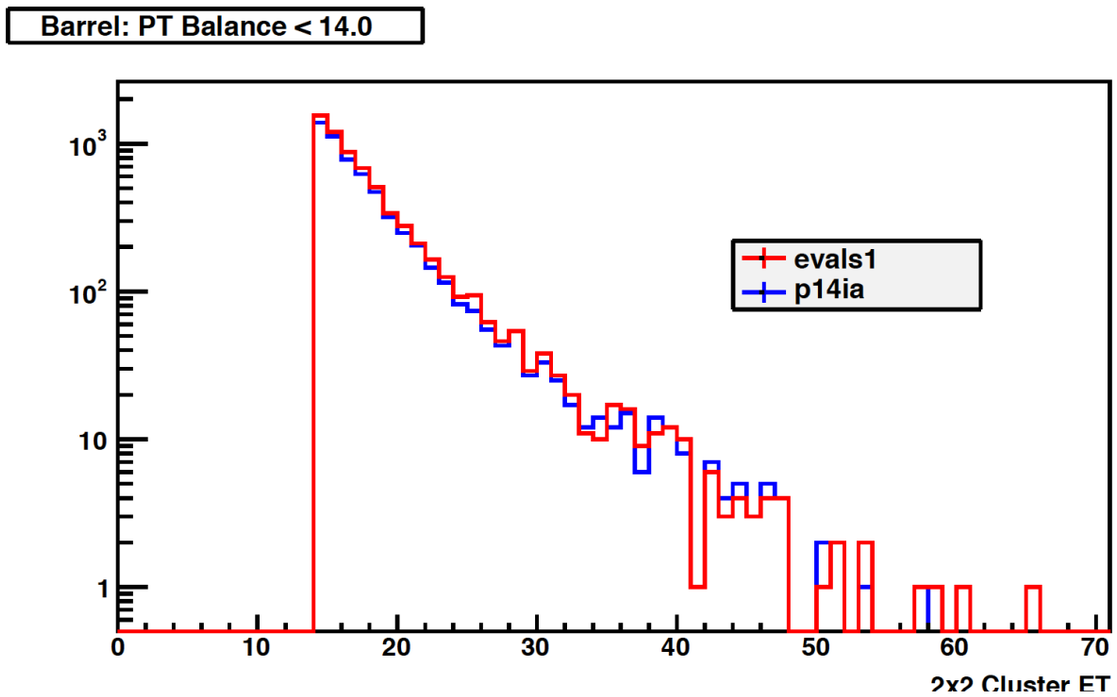


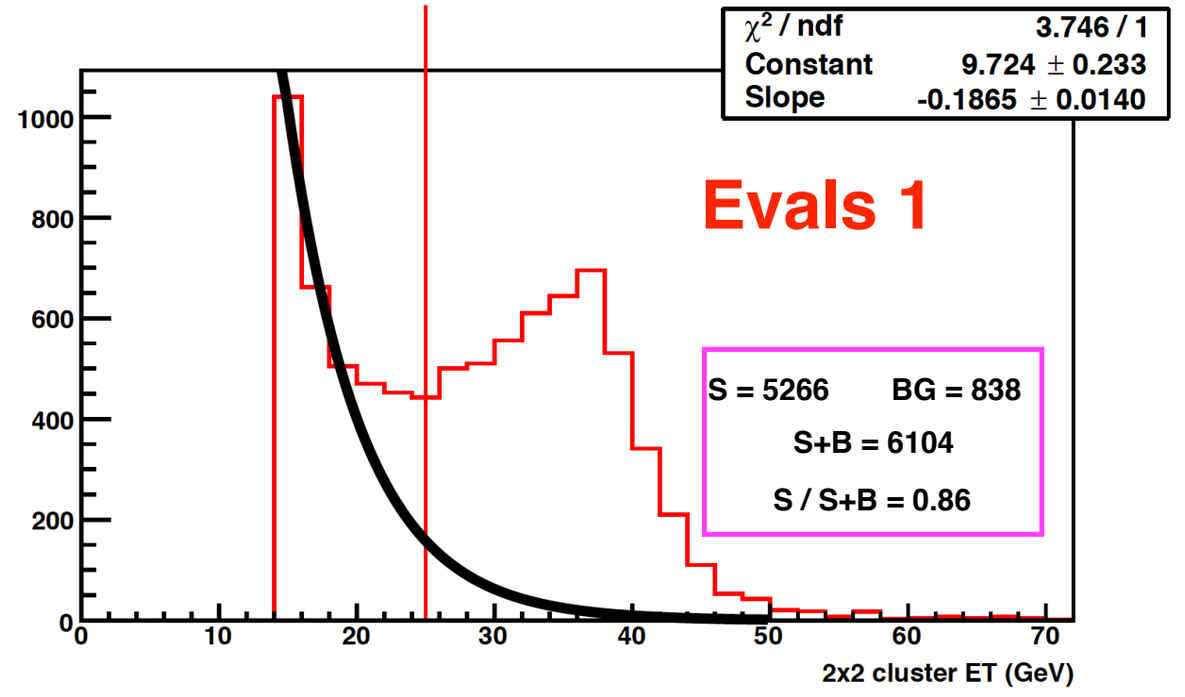


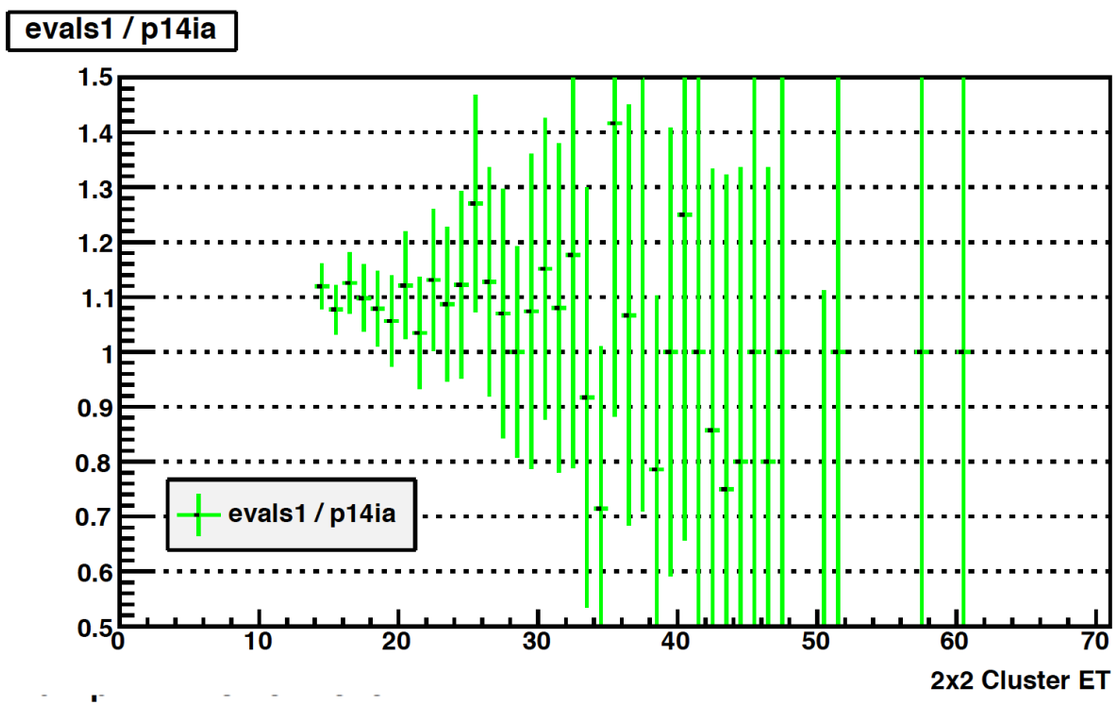


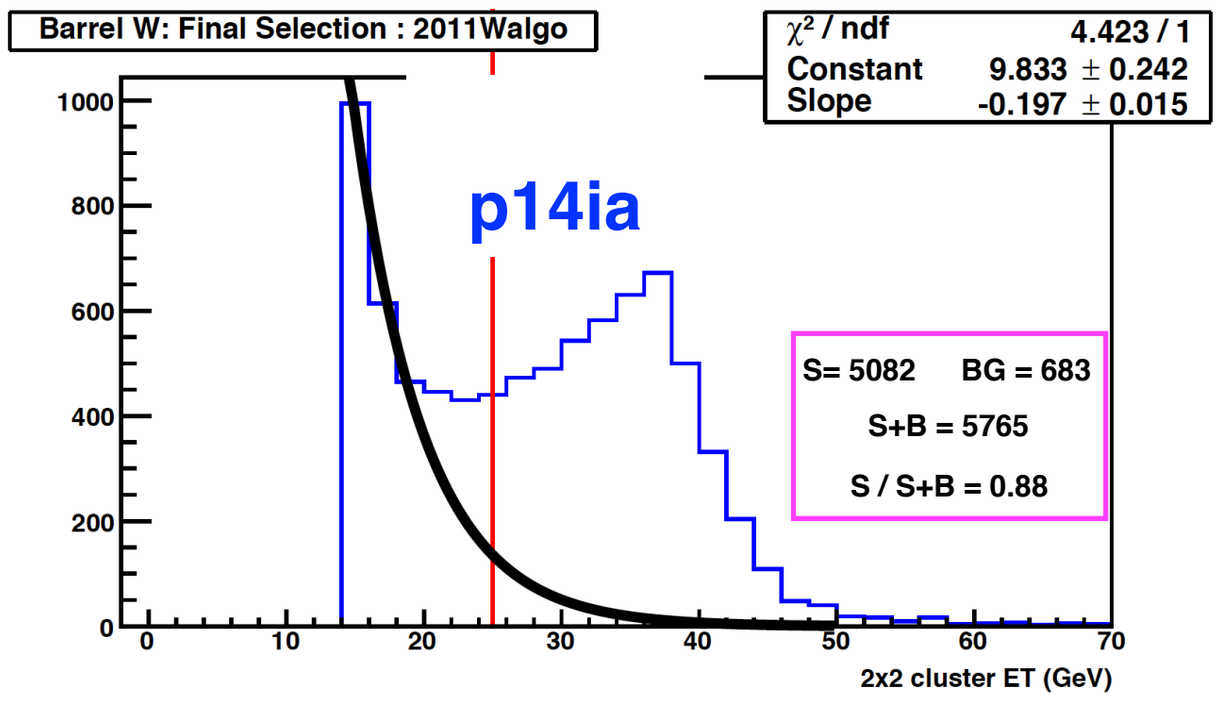


QCD BG


Barrel: PT Balance < 14.0
evals1
p14ia
2x2 Cluster ET


χ^2 / ndf 3.746 / 1
Constant 9.724 ± 0.233
Slope -0.1865 ± 0.0140
Evals 1
S = 5266 BG = 838
S+B = 6104
S / S+B = 0.86
2x2 cluster ET (GeV)


evals1 / p14ia
evals1 / p14ia
2x2 Cluster ET


Barrel W: Final Selection : 2011Walgo
χ^2 / ndf 4.423 / 1
Constant 9.833 ± 0.242
Slope -0.197 ± 0.015
p14ia
S= 5082 BG = 683
S+B = 5765
S / S+B = 0.88
2x2 cluster ET (GeV)

Summary

- ~ 4% enhancement in tracks and final Ws.
- This could be caused by new HFT material / tracking definitions in new SL16b library.
- Nothing will change in the physics due to this.

Yuri's-P1 vs P14ia [run 13 -official -P1]

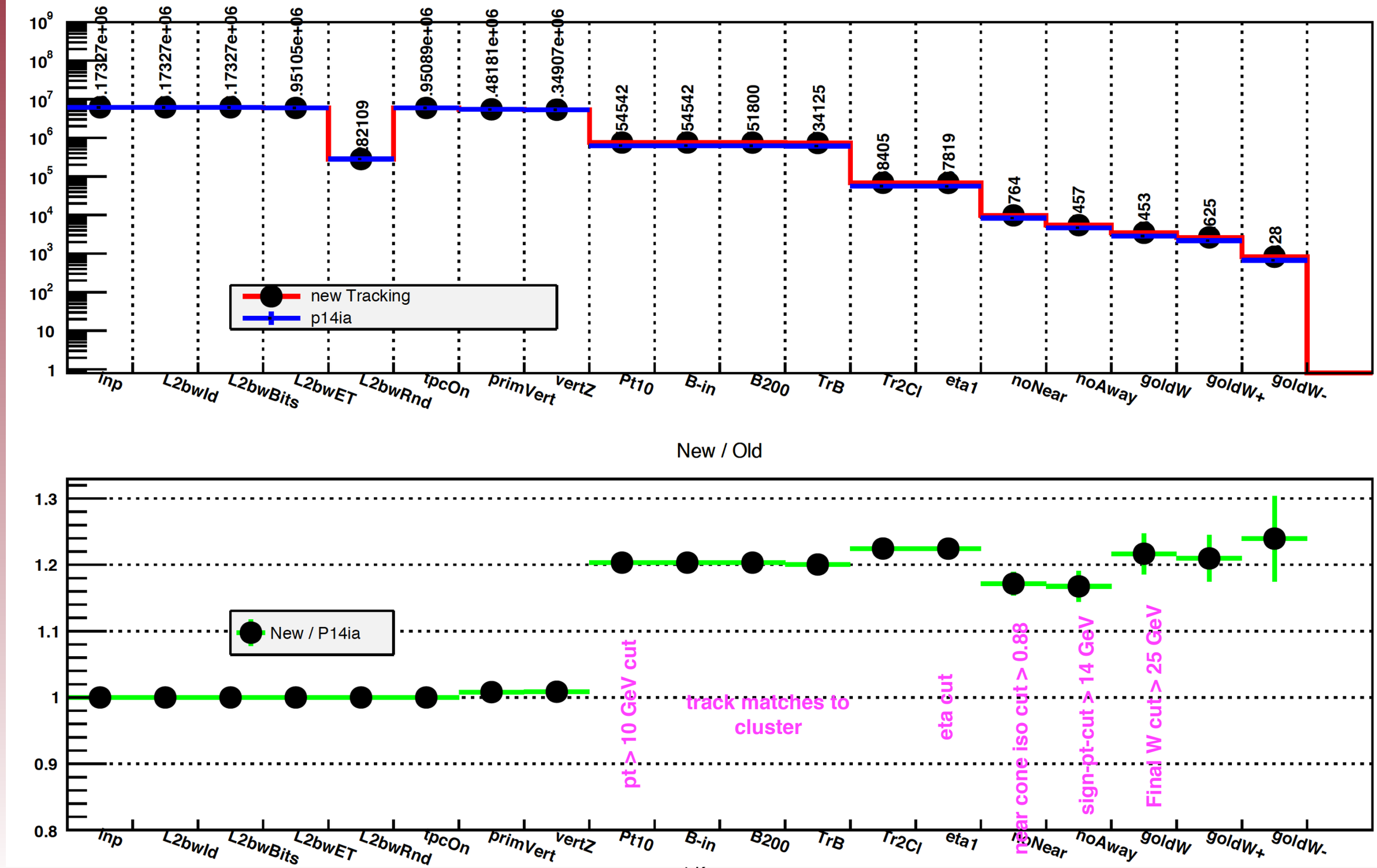
apple- to -apple comparison

Details / Notes

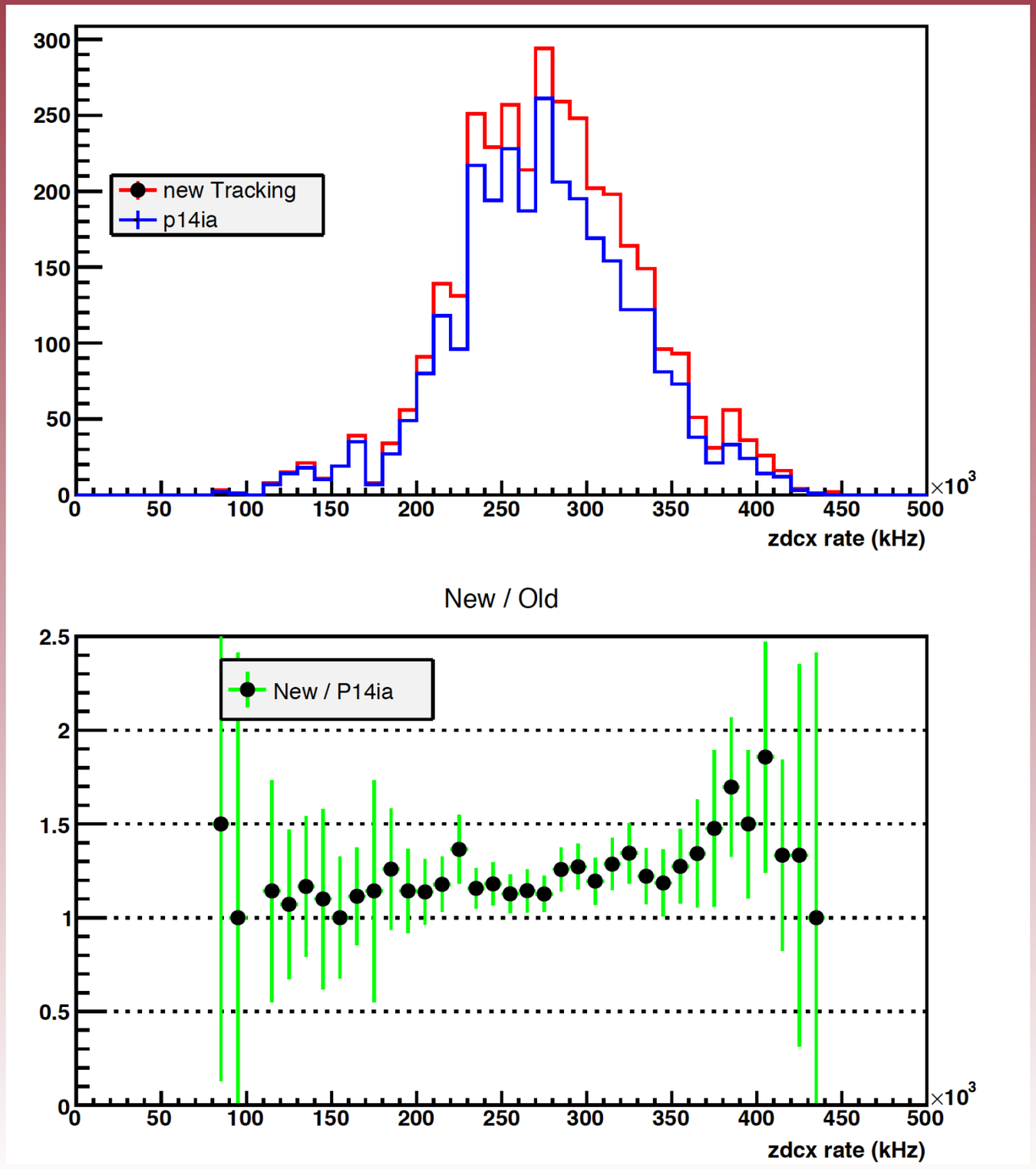
Production	Production Library [also W-code compiled library]	Tracking	vertex finding	BEMC-gains	# of runs used in the comparison	# of events
P14ia [official run 13 - P2 (day 129-161)	SL14a	Sti	PPV_W	run 12 - 200 GeV	585	6172606
Yuri's - P2 (day 129-161)	DEV2/ TFG16a	StiCA [Yuri's code]	PPV_W	run 12 200 GeV	585	6172606

- **All the runs which were used for the comparison compared for # events processed. I chose runs which processed exactly same # of events or runs where events differ by 1 or 2 events. Yuri's production had ~ 100 runs with only 1 or 2 events higher. Since 1-2 events difference is negligible this can be considered as apple to apple.**

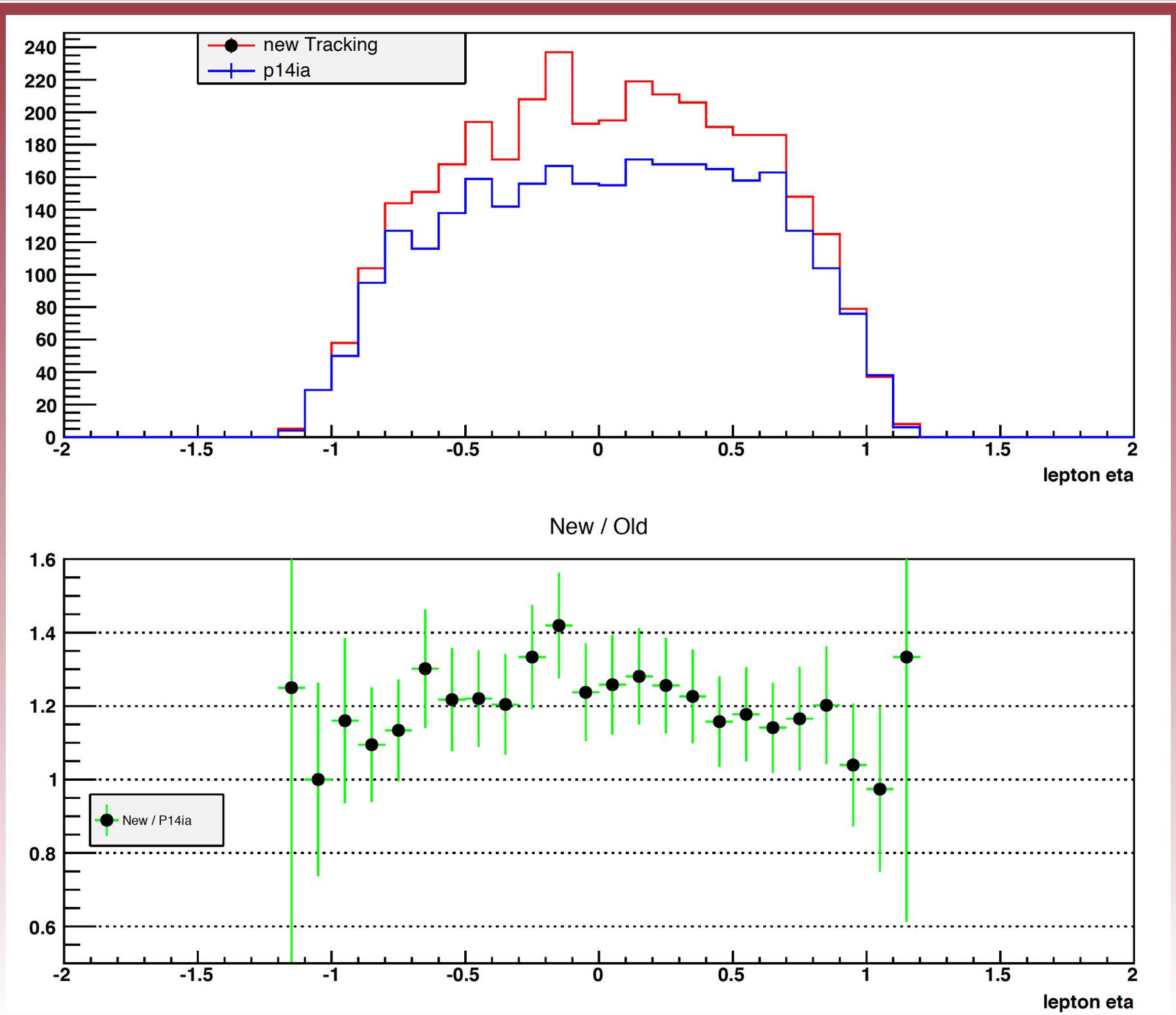
Events Counts



Final W per ZDC



Final W eta


new Tracking
p14ia
240
220
200
180
160
140
120
100
80
60
40
20
0
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
lepton eta
New / Old
1.6
1.4
1.2
1
0.8
0.6
New / P14ia
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
lepton eta

Summary

- ~20 % enhancement in tracks above Pt = 10 GeV and similar enhancement in final W [> 25 GeV] tracks.

- Yuri's production period 1 shows similar results to that of "evals4" which also use "STICA" code on period 1.

Yuri's-P2 vs P14ig [run 13 -official -P2]

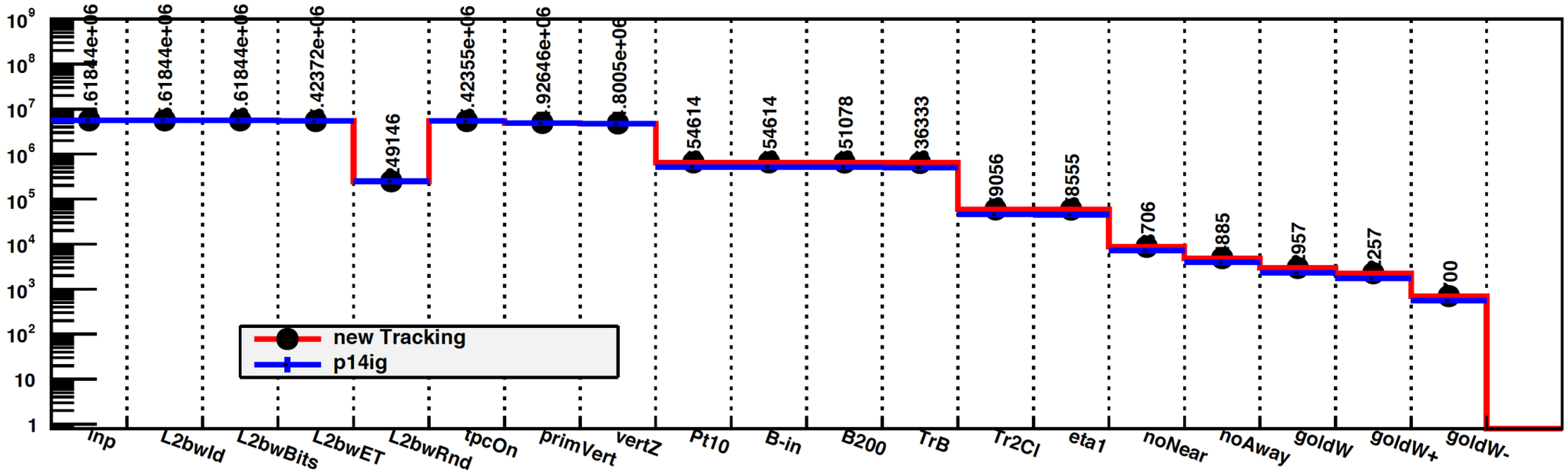
apple- to -apple comparison

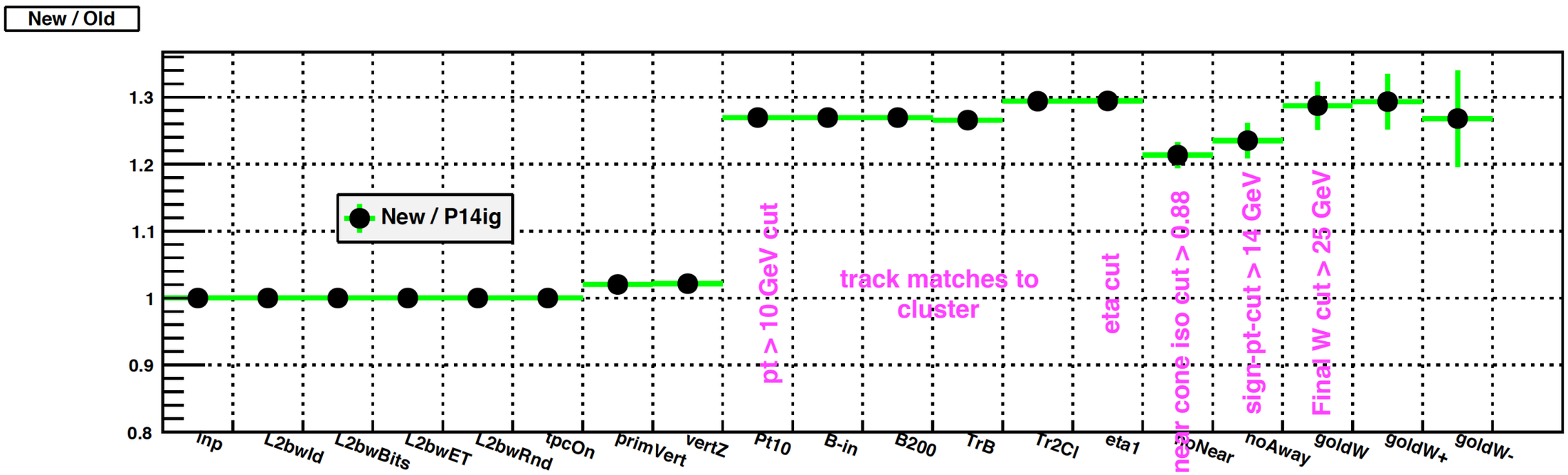
Details / Notes

Production	Production Library [also W-code compiled library]	Tracking	vertex finding	BEMC-gains	# of runs used in the comparison	# of events
P14ig [official run 13 - P2 (day 129-161)	SL14ig	Sti	PPV_W	run 12 - 200 GeV	436	5618340
Yuri's - P2 (day 129-161)	DEV2/ TFG16a	StiCA [Yuri's code]	PPV_W	run 12 200 GeV	436	5618485

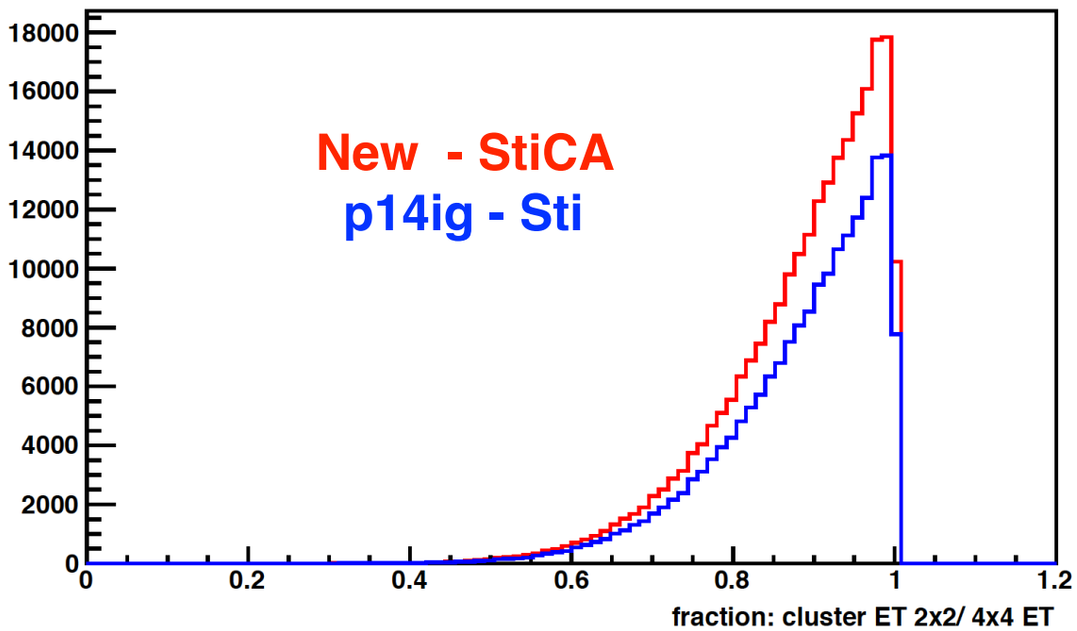
- **All the runs which were used for the comparison compared for # events processed. I chose runs which processed exactly same # of events or runs where events differ by 1 or 2 events. Yuri's production had ~ 100 runs with only 1 or 2 events higher. Since 1-2 events difference is negligible this can be considered as apple to apple.**

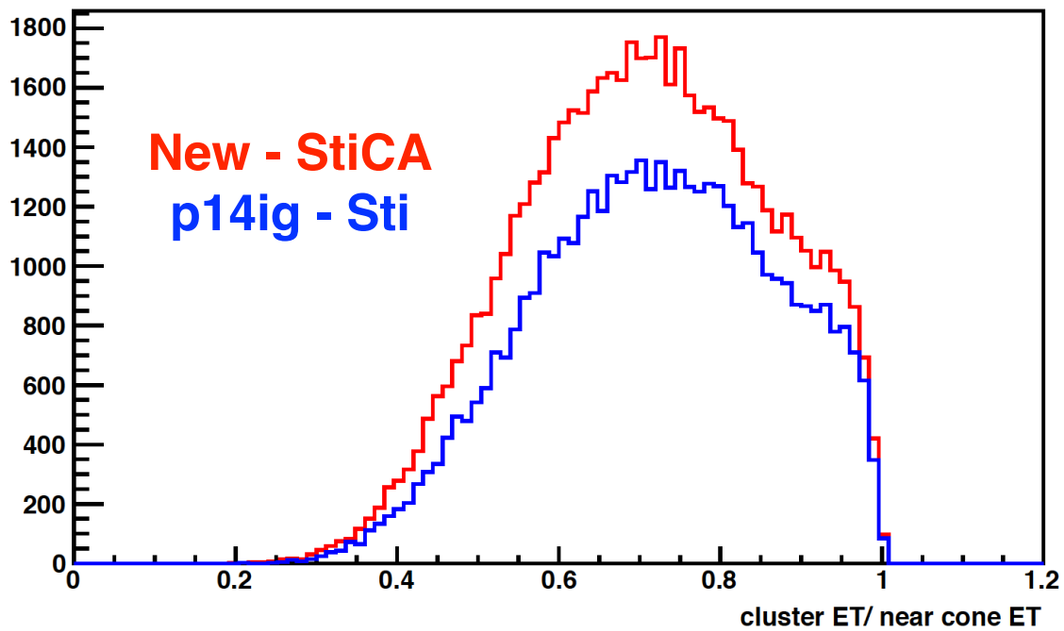
Events Counts

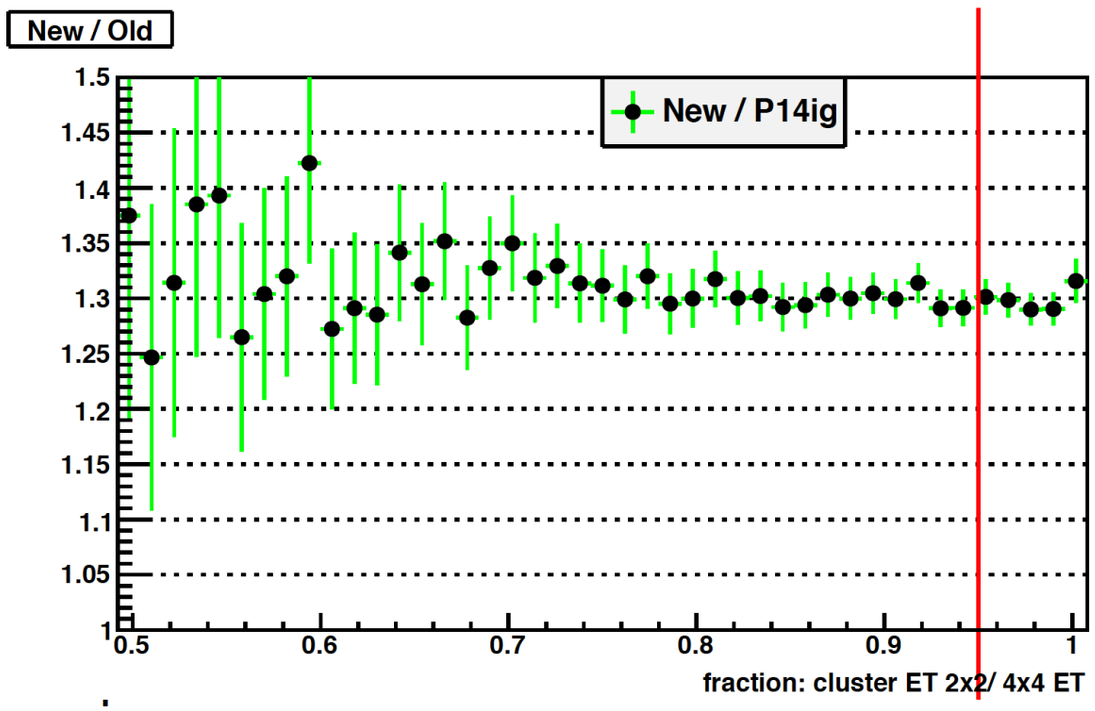


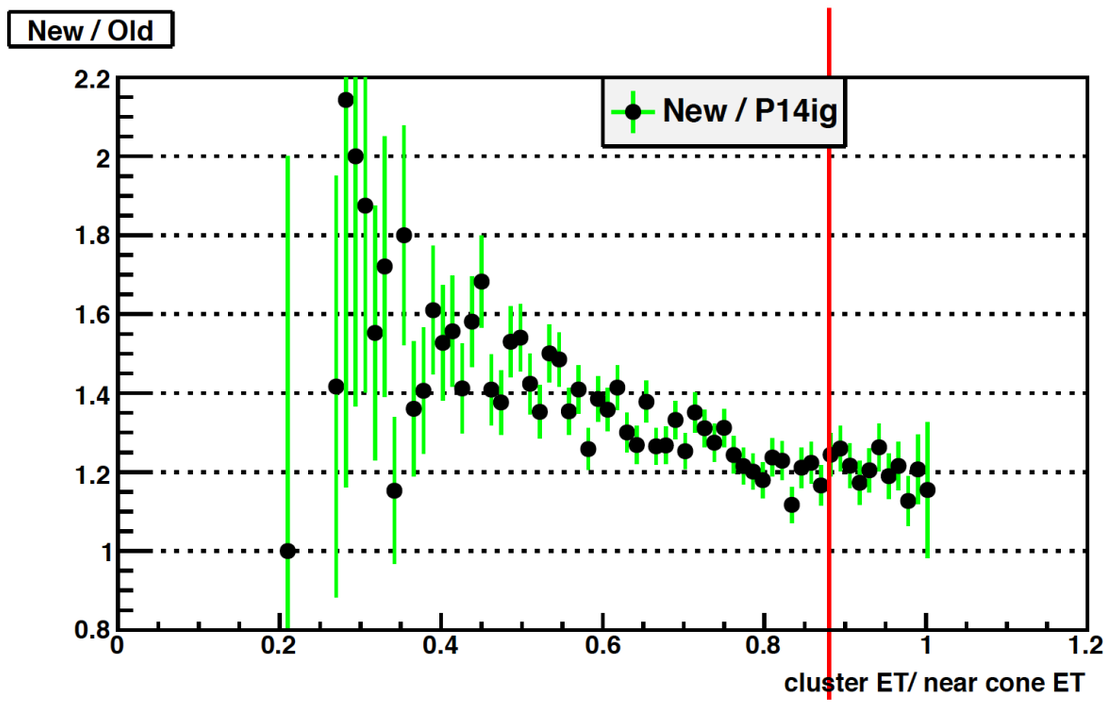


Isolation cuts

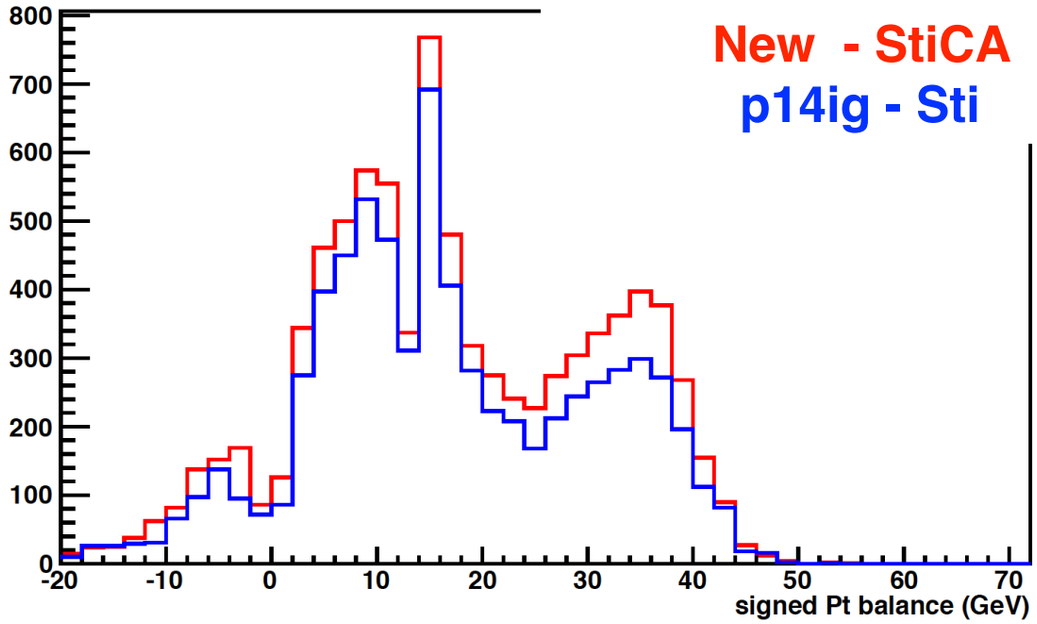


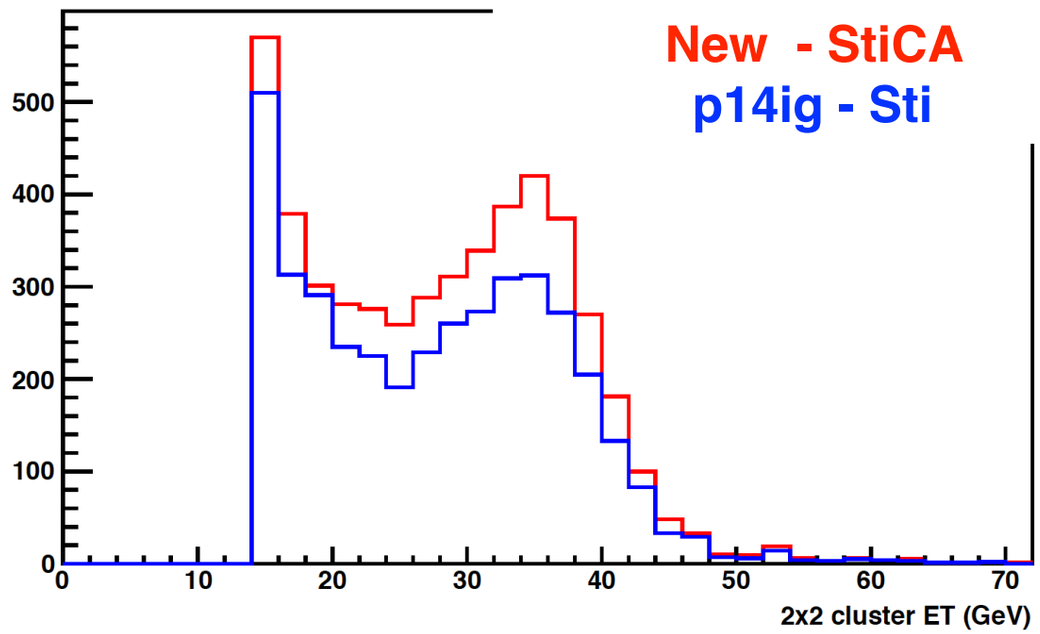


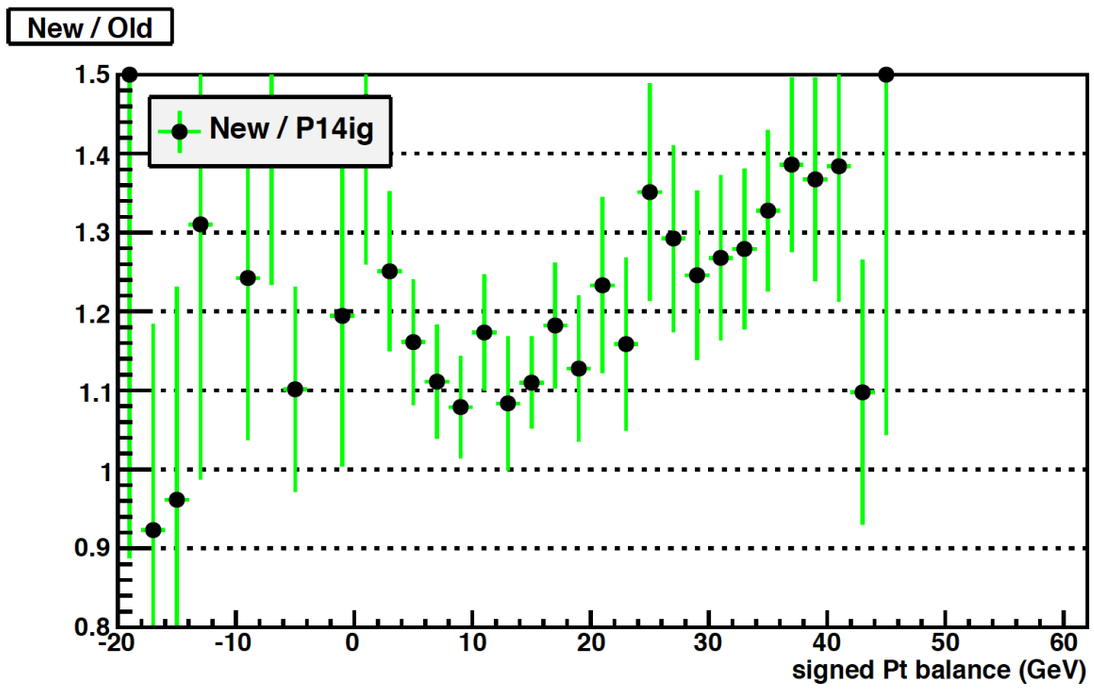


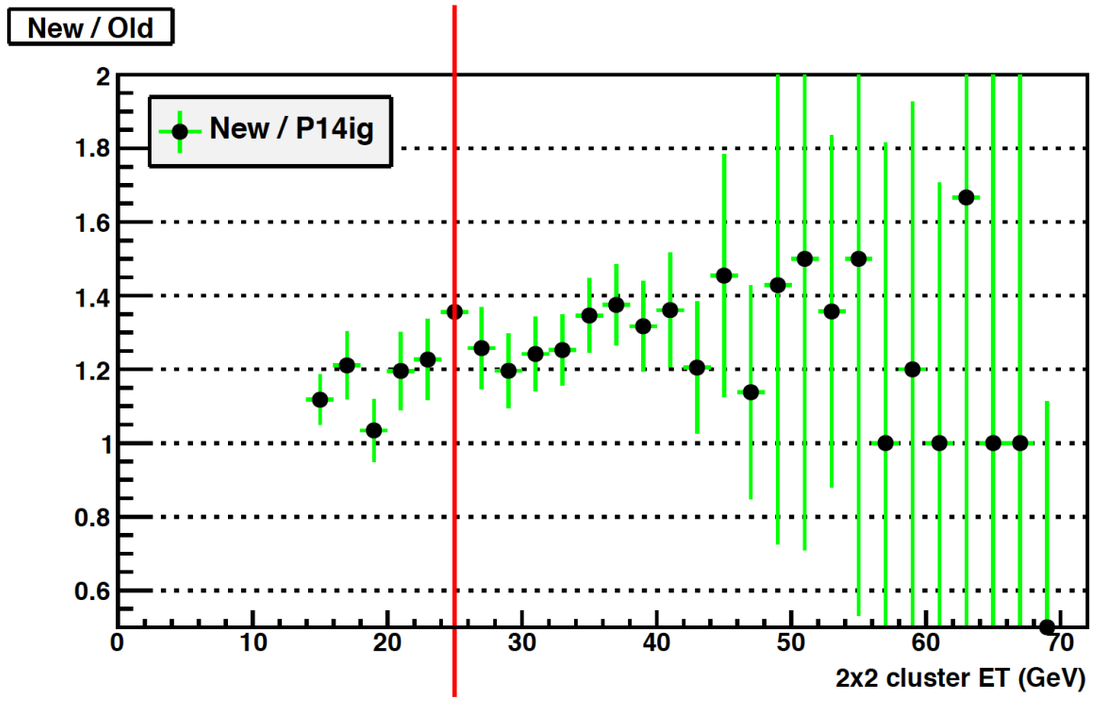


Sing Pt , Final W

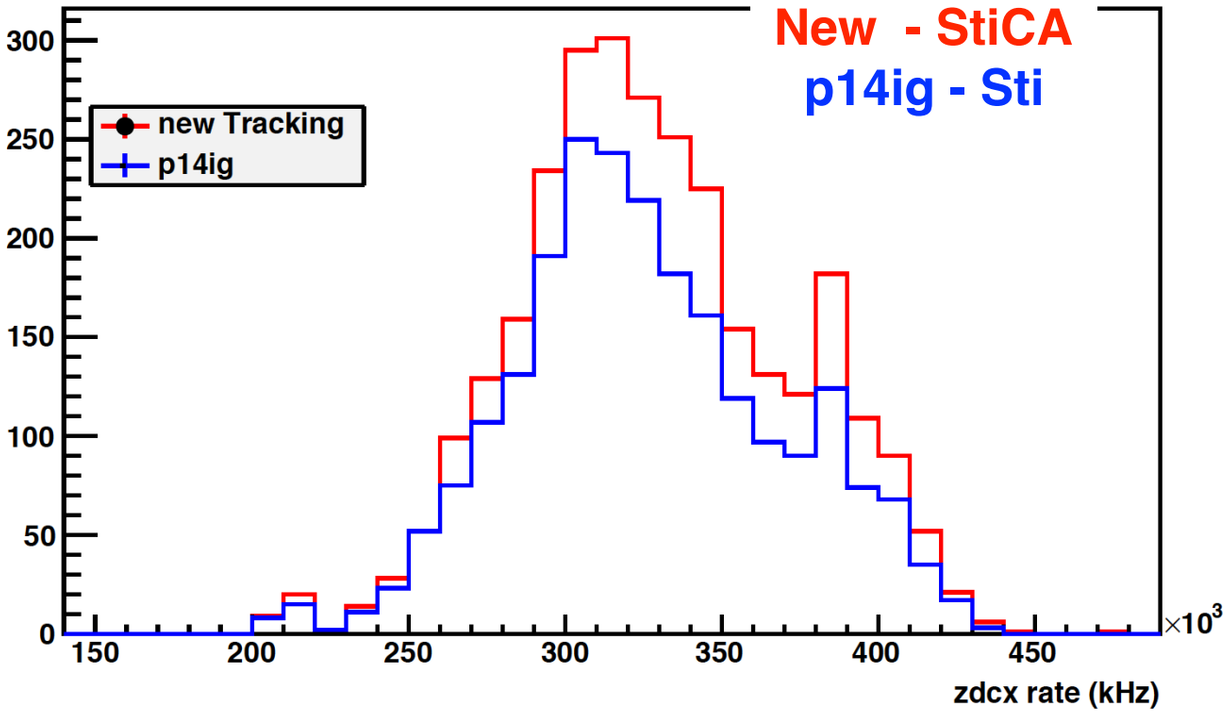


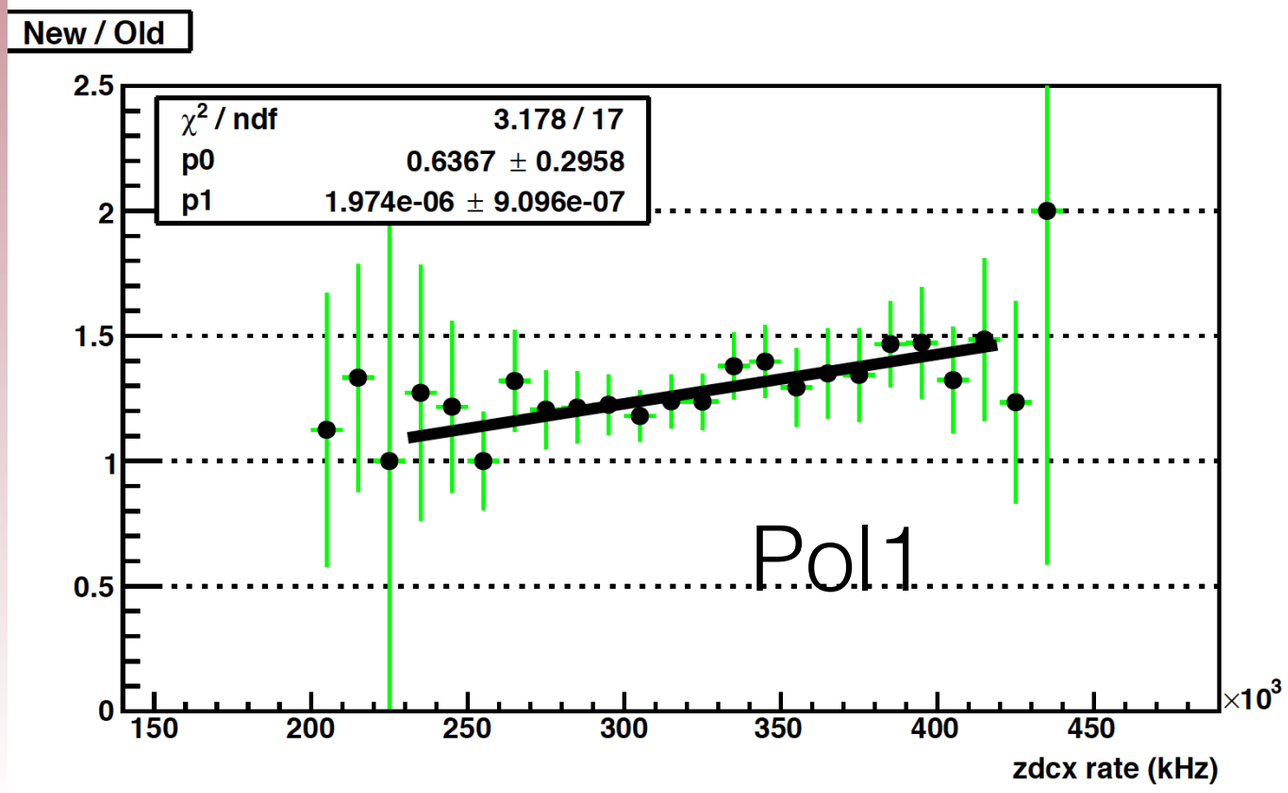


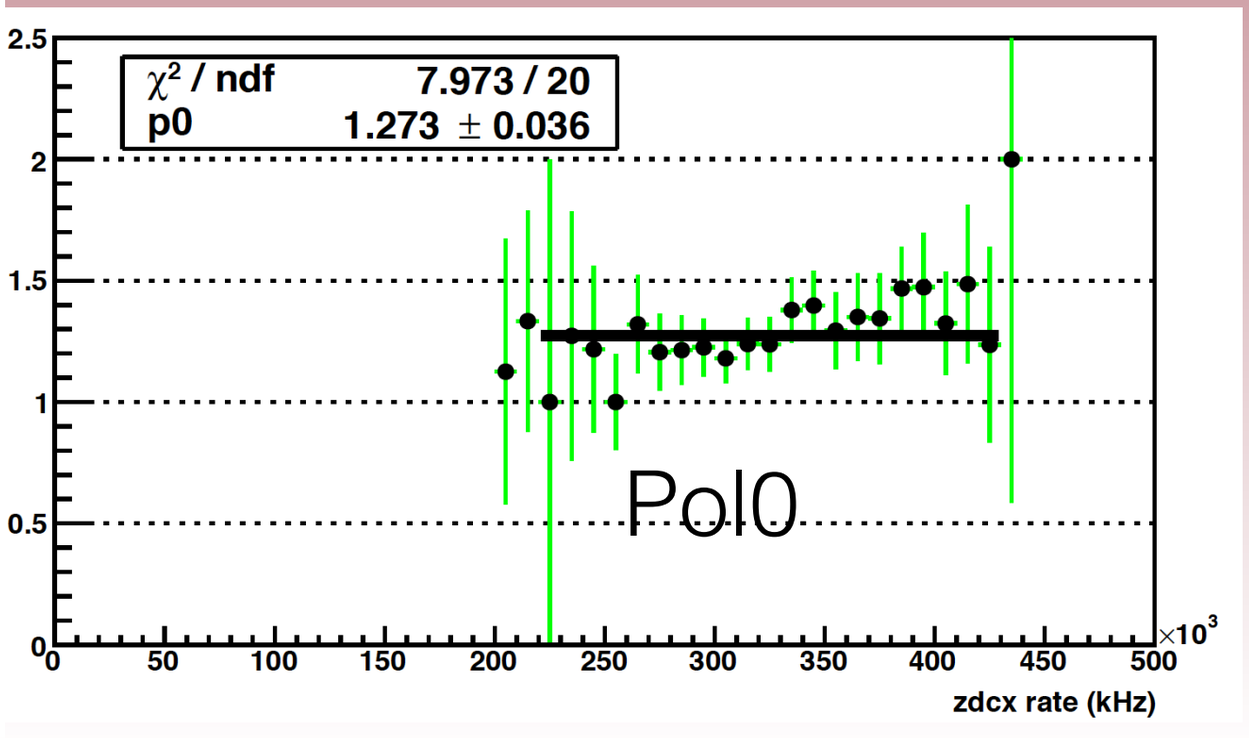




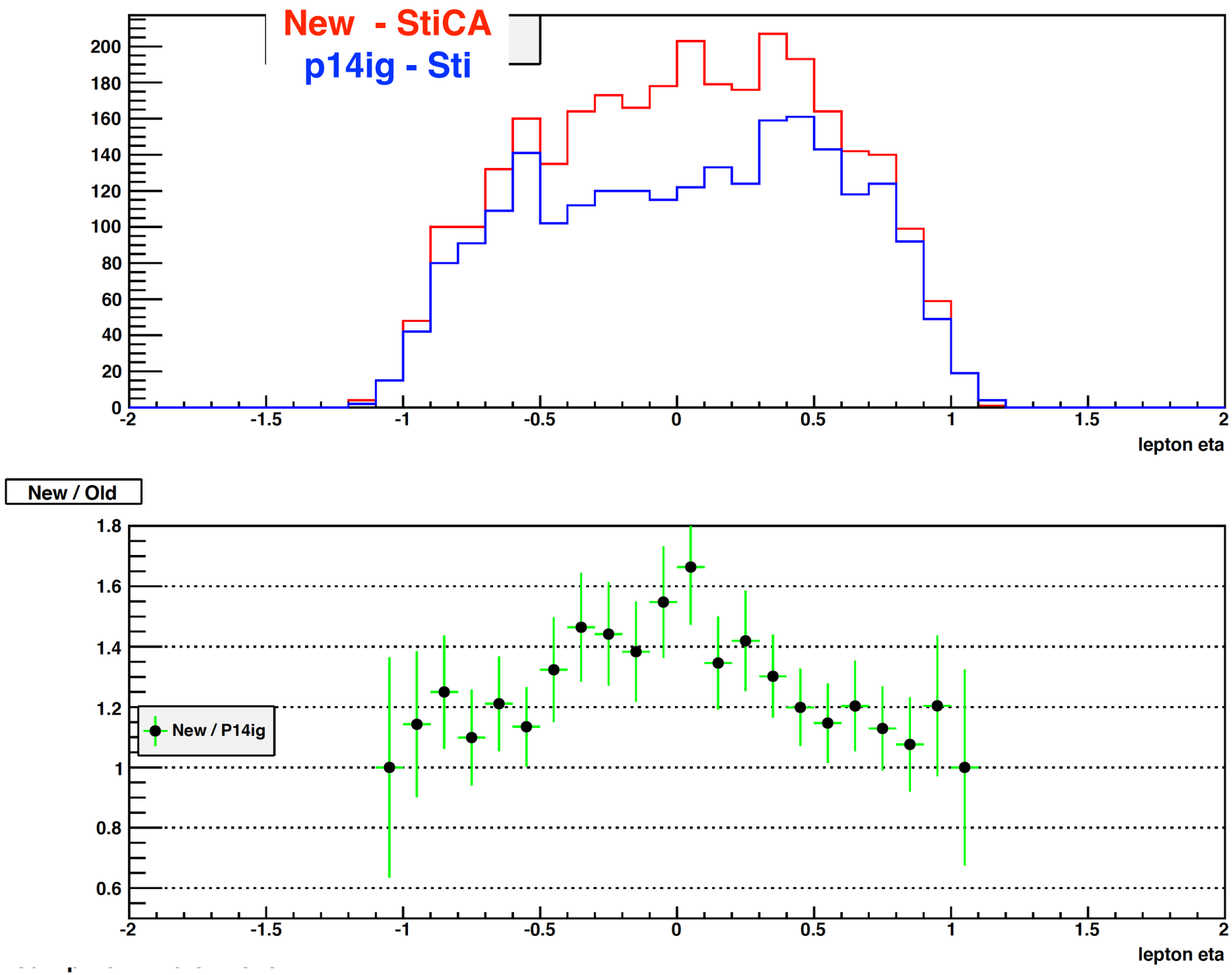
Final W per ZDC



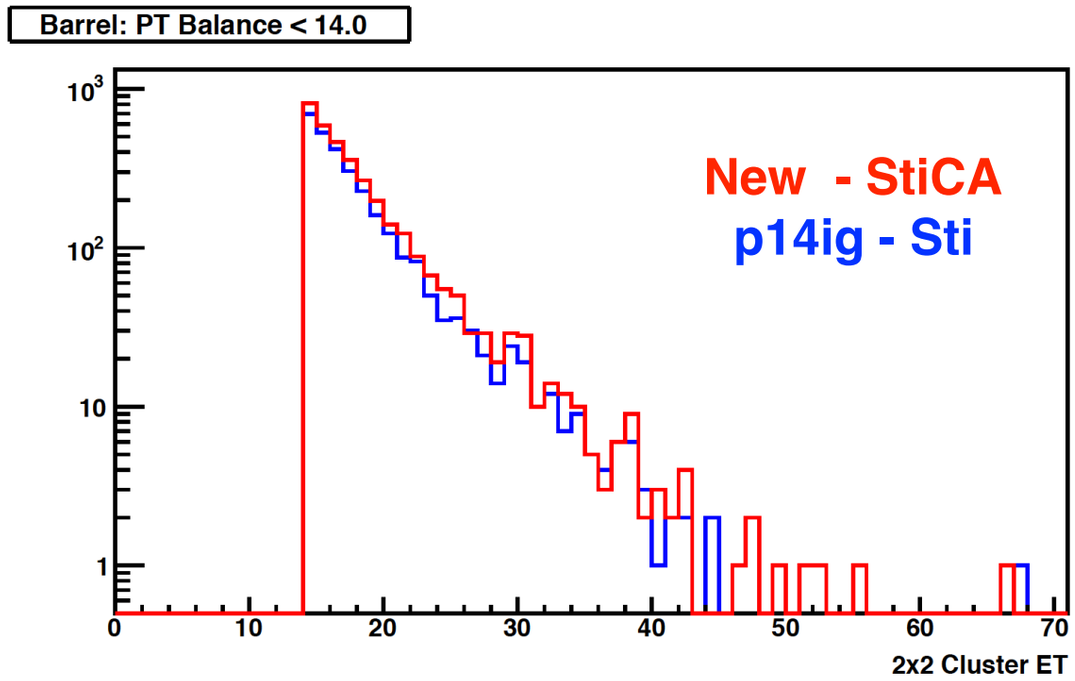


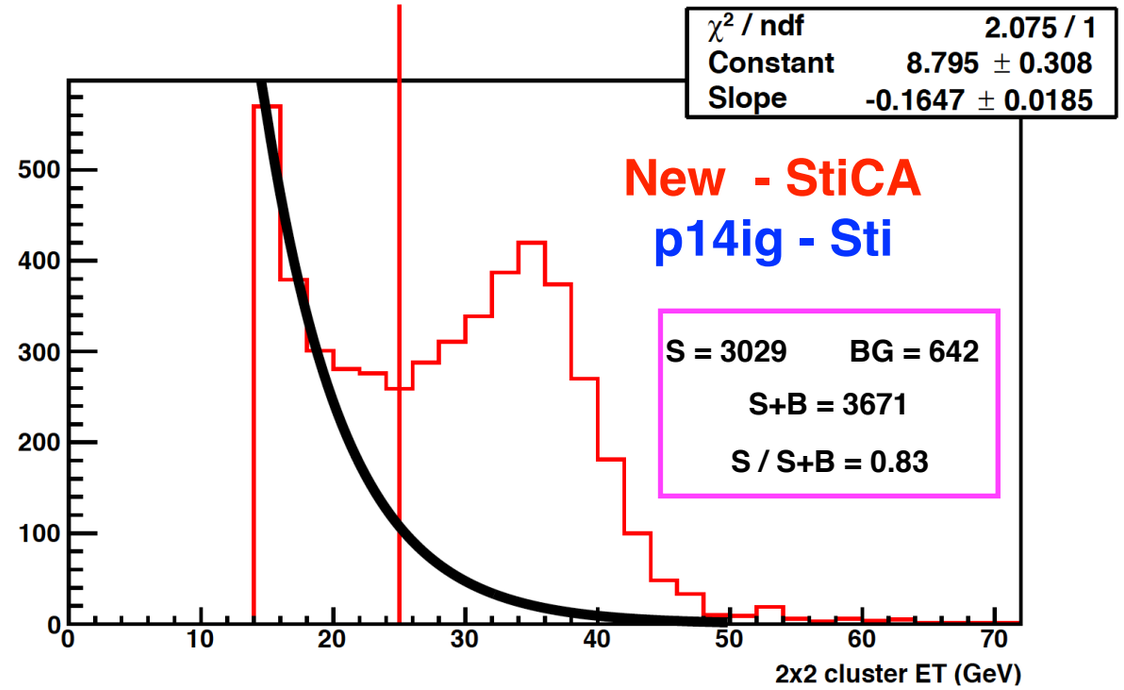


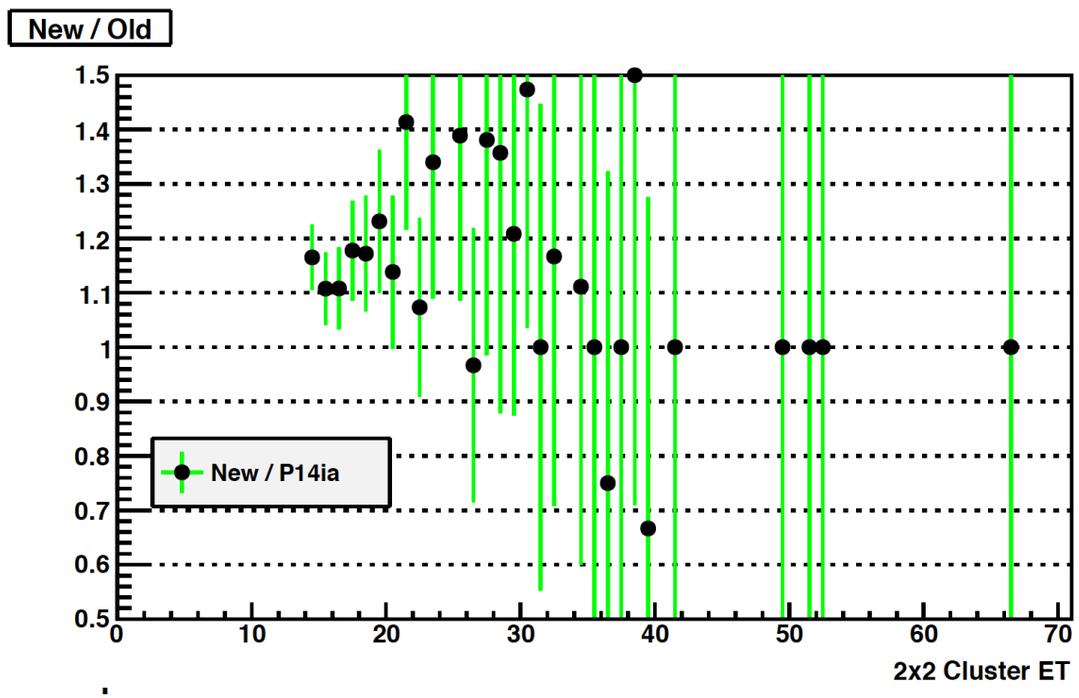
Final W Eta

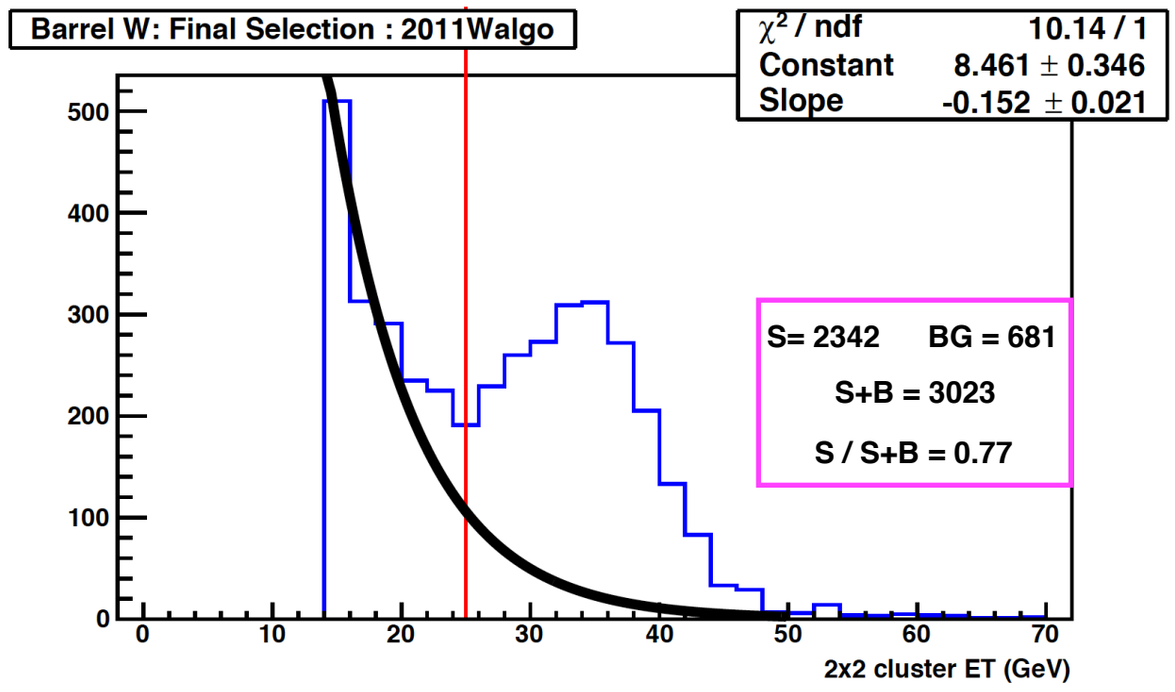


QCD BG

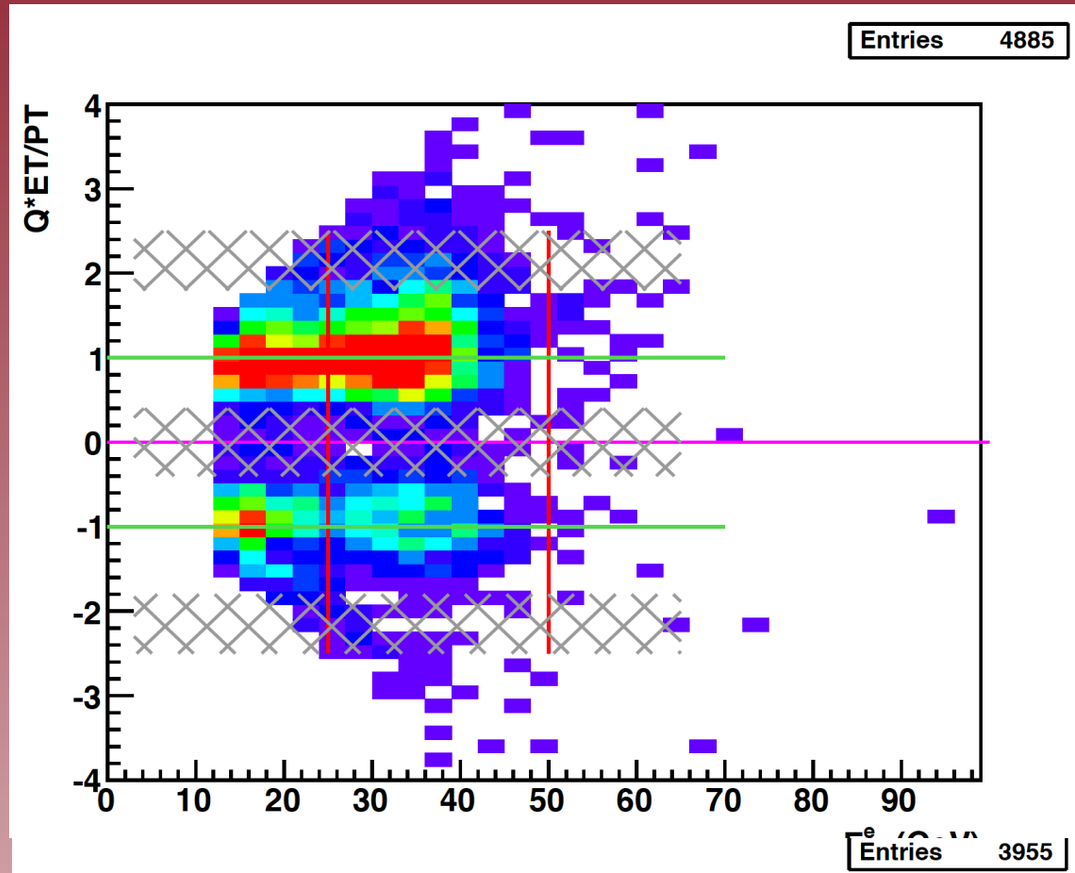

Barrel: PT Balance < 14.0
New - StiCA
p14ig - Sti
2x2 Cluster ET

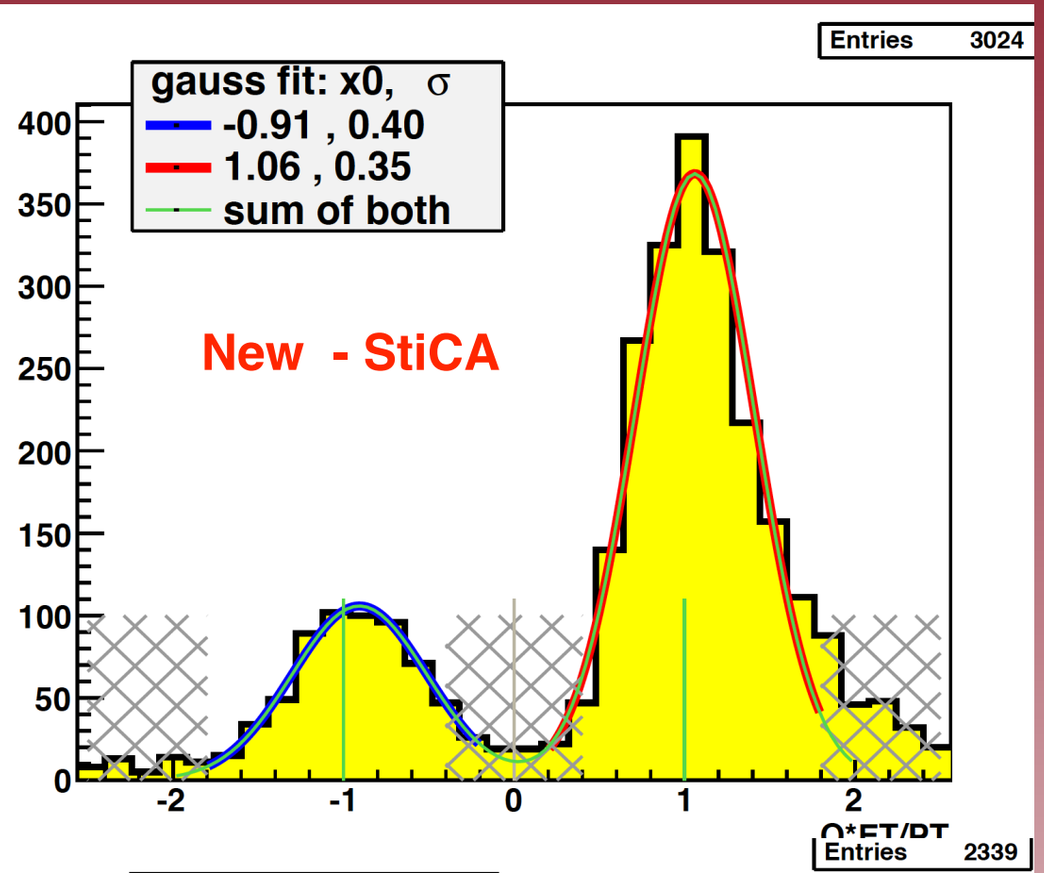

χ² / ndf 2.075 / 1
Constant 8.795 ± 0.308
Slope -0.1647 ± 0.0185
New - StiCA
p14ig - Sti
S = 3029 BG = 642
S+B = 3671
S / S+B = 0.83
2x2 cluster ET (GeV)

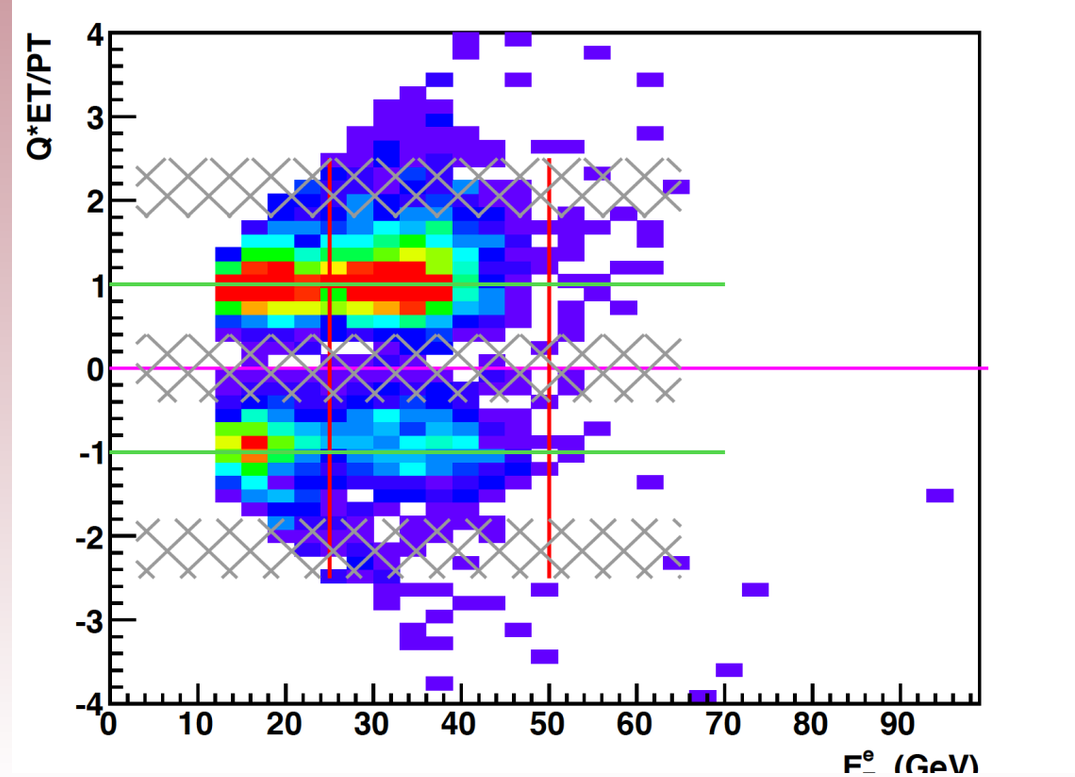

New / Old
New / P14ia
2x2 Cluster ET

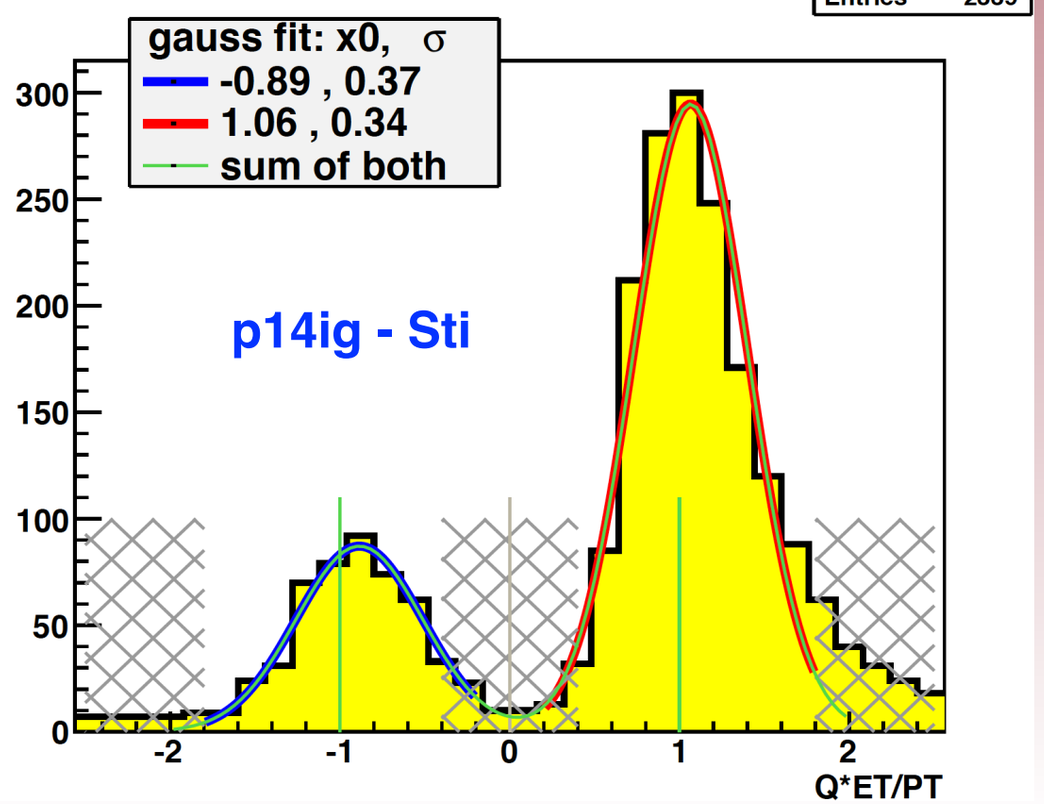

Barrel W: Final Selection : 2011Walgo
χ² / ndf 10.14 / 1
Constant 8.461 ± 0.346
Slope -0.152 ± 0.021
S= 2342 BG = 681
S+B = 3023
S / S+B = 0.77
2x2 cluster ET (GeV)

W -Charge Sign - Separation









Summary

- ~30 % enhancement in tracks above Pt = 10 GeV and similar enhancement in final W [> 25 GeV] tracks.

- Significant enhancement of final W Eta in mid rapidity region where a “dip” was observed previously.

- Significant improvement in signal to background ratio .

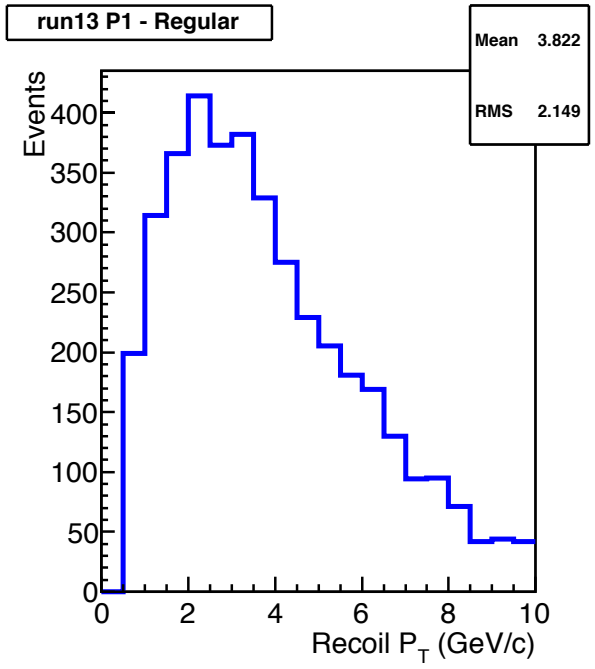
Summary_all

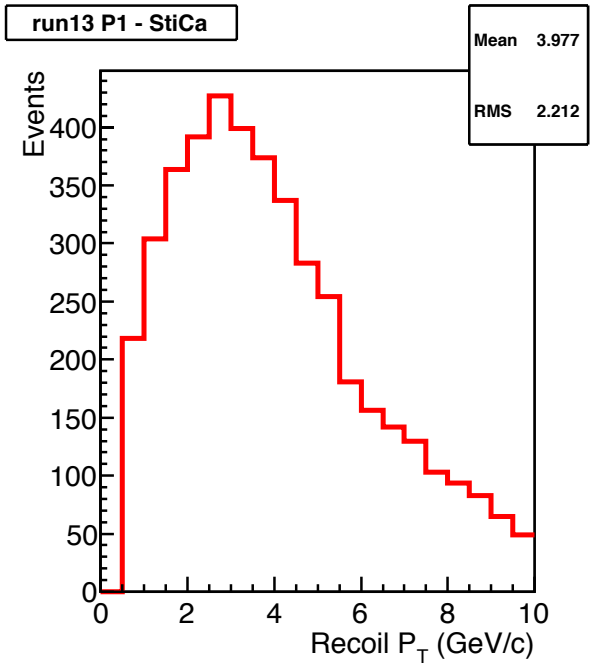
- STICA reuses hits in TPC which increases track finding efficiency.
- STICA tracking shows significant improvement in W tracking and final W efficiency.
- The improvement increases with increasing luminosity.
- Reproduction of Run 13 data with STICA+PPV_W settings is urgently requested !

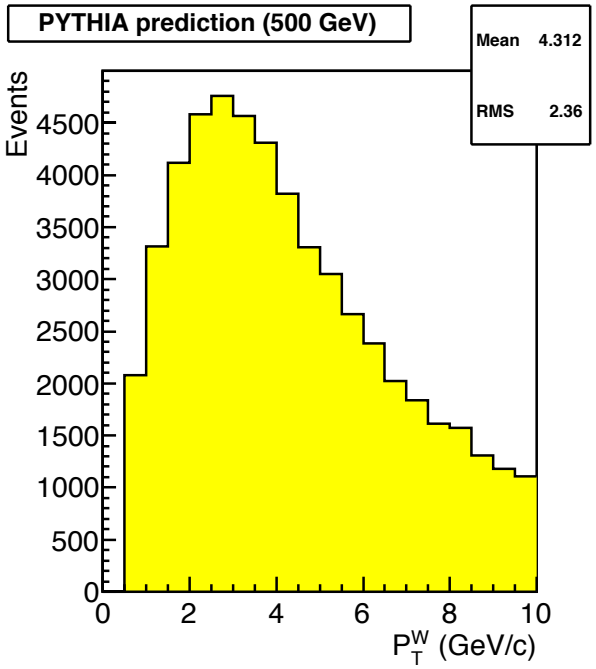
Analysis from Salvatore

reconstruction of the W-recoil

Production comparison







Regular: Sti official production (SL14a)

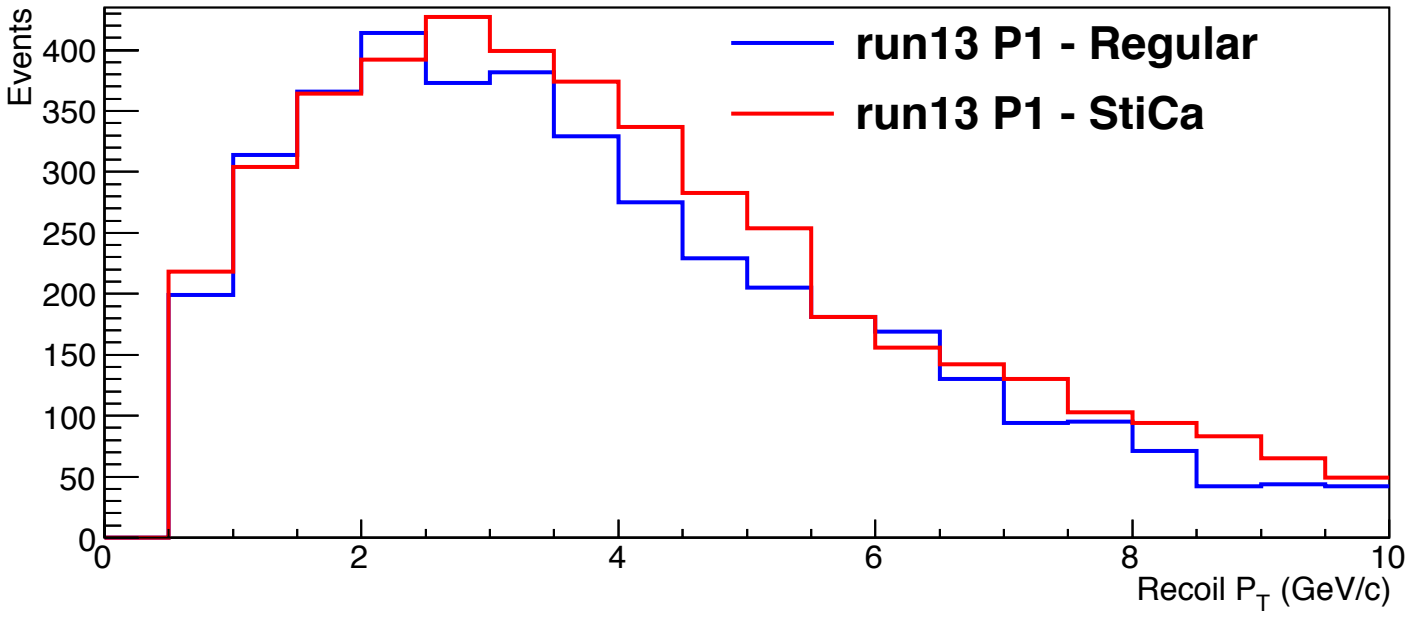
StiCa: Yuri's StiCa private production (dev2)

All W reconstruction cuts applied

No MC correction to get full recoil Pt done**!**

Sti Mean = 3.82 GeV **StiCa Mean= 3.98 GeV** **PYTHIA prediction = 4.31**

Production comparison



Regular: Sti official production (SL14a)

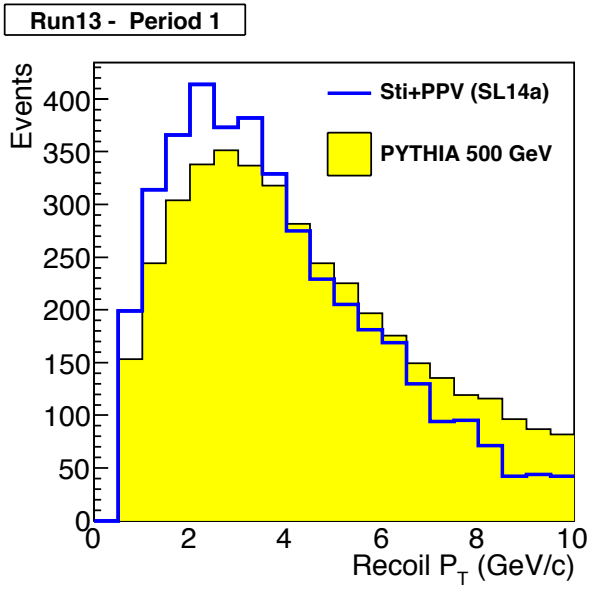
StiCa: Yuri's StiCa private production (dev2)

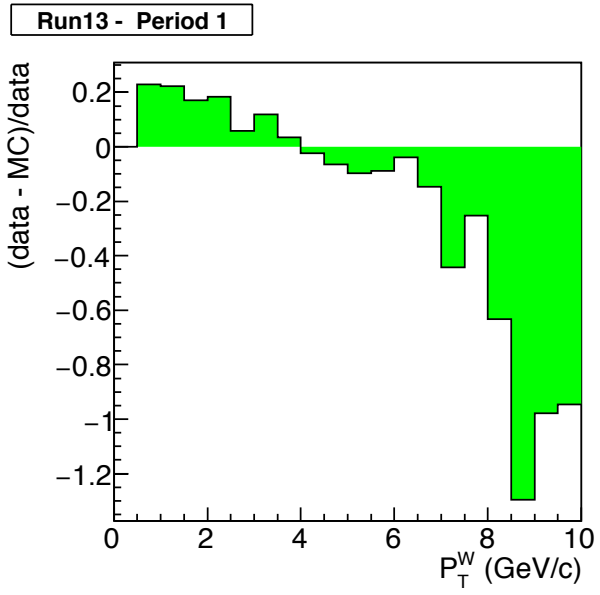
All W reconstruction cuts applied

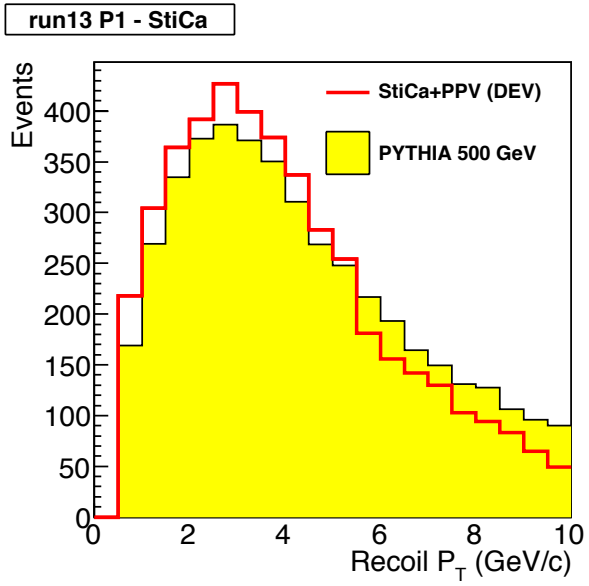
No Pt correction done!

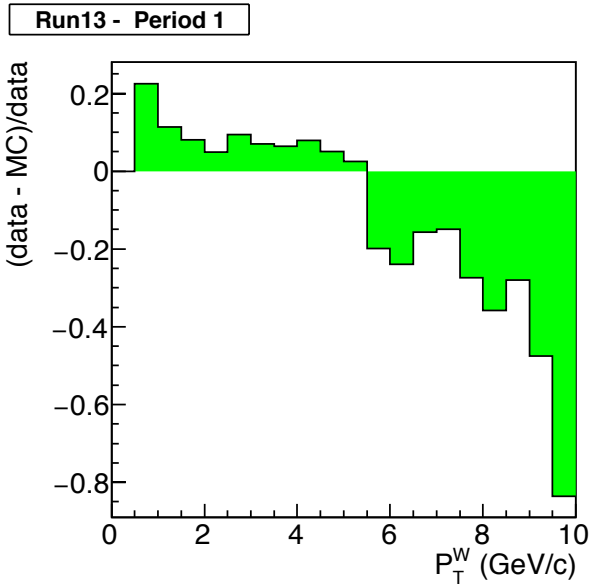
- Overall ratio StiCa(Yuri's)/Sti(regular) = 1.11 after W reco. cuts for run 13 period 1
- StiCa W-Pt peak and distribution shifted to the right... lets compare to expectation

Production comparison







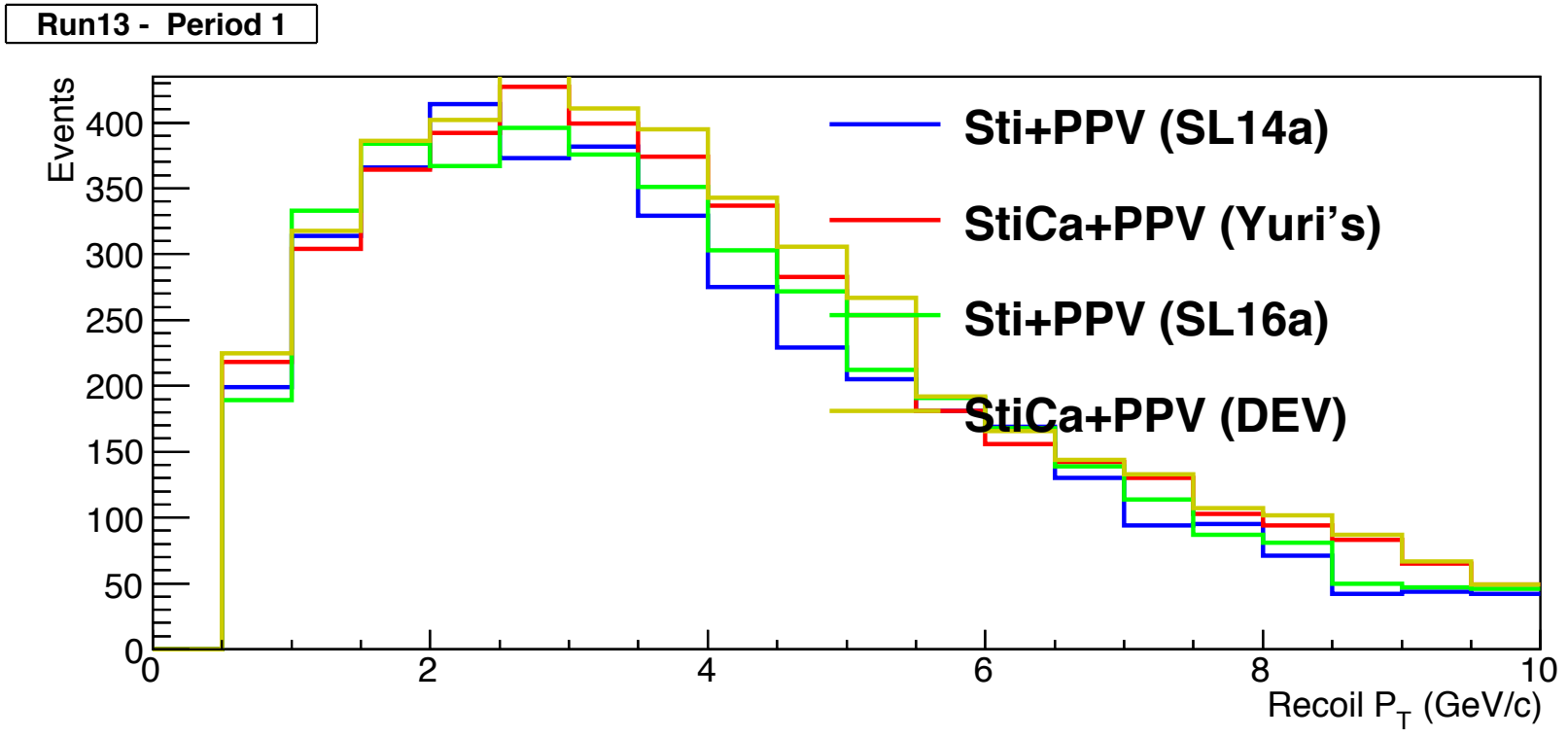


StiCa peak on top of the prediction peak

→ less correction needed!

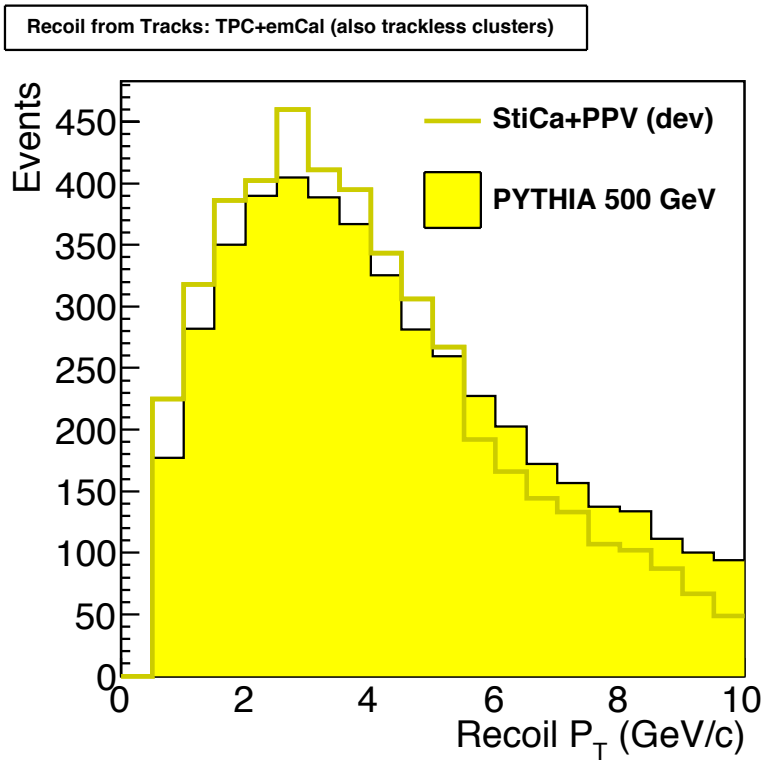
Lets look at all the TEST productions

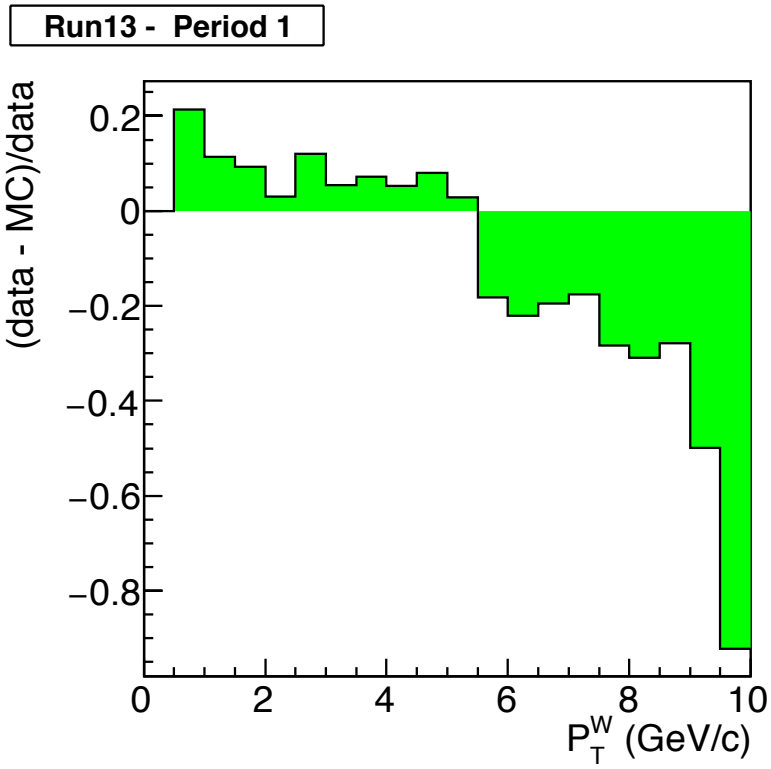
Production comparison



Regular: Sti official production (SL14a)
StiCa: Yuri's StiCa private production (dev2)
TEST Evals1: Sti+PPV test production (SL16a)
TEST Evals2: Sti+PPV test production (dev)
TEST Evals4: StiCa+PPV test production (dev)

StiCa+PPv: evals4

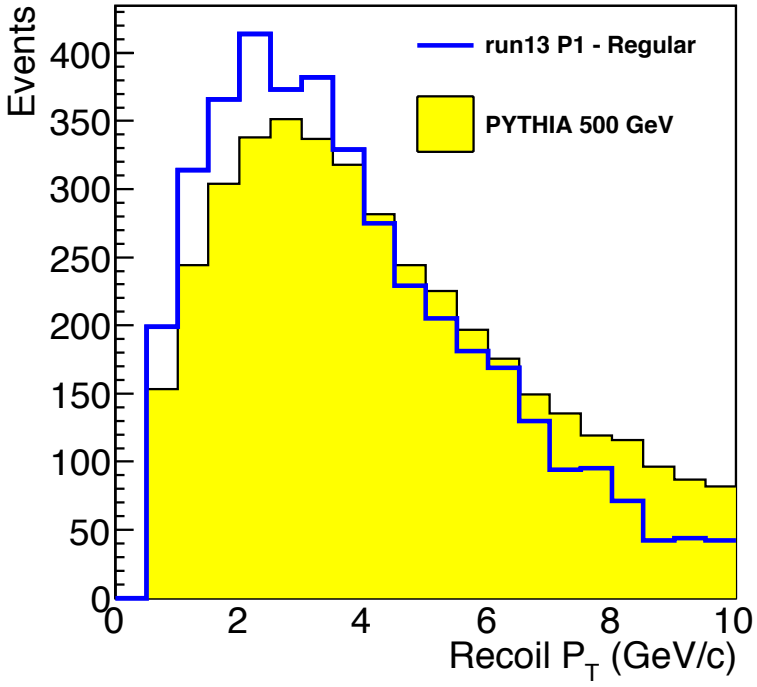


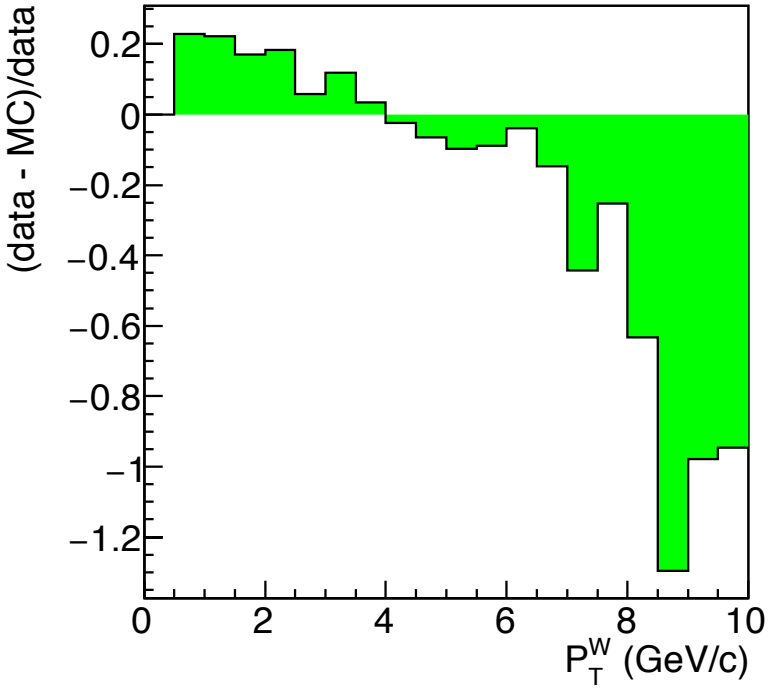


StiCa+PPV: test production evals4

Yellow filled histo is PYTHIA prediction at generated level (no experimental effects)

Sti+PPv: official current production (SL14a)

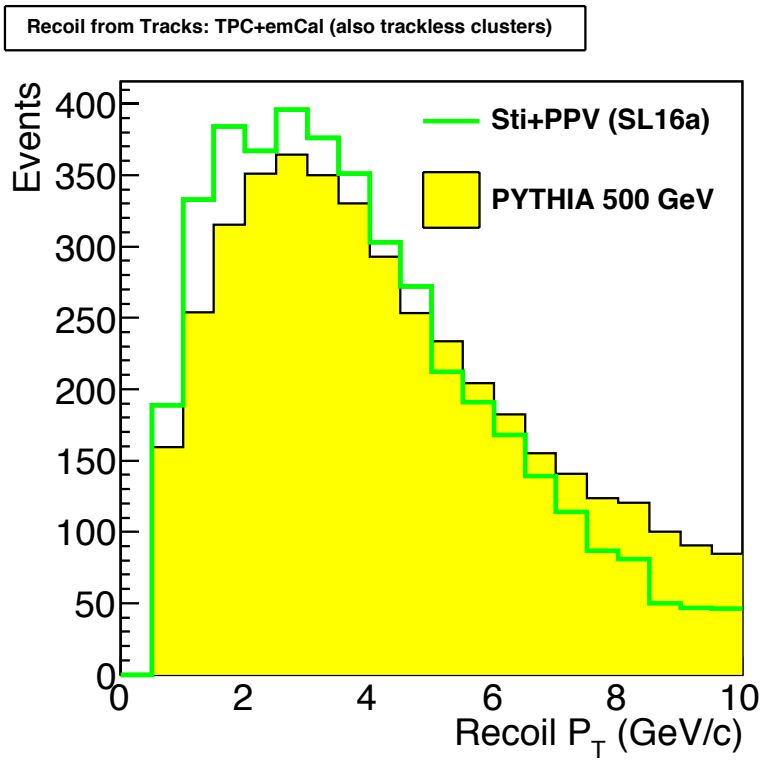


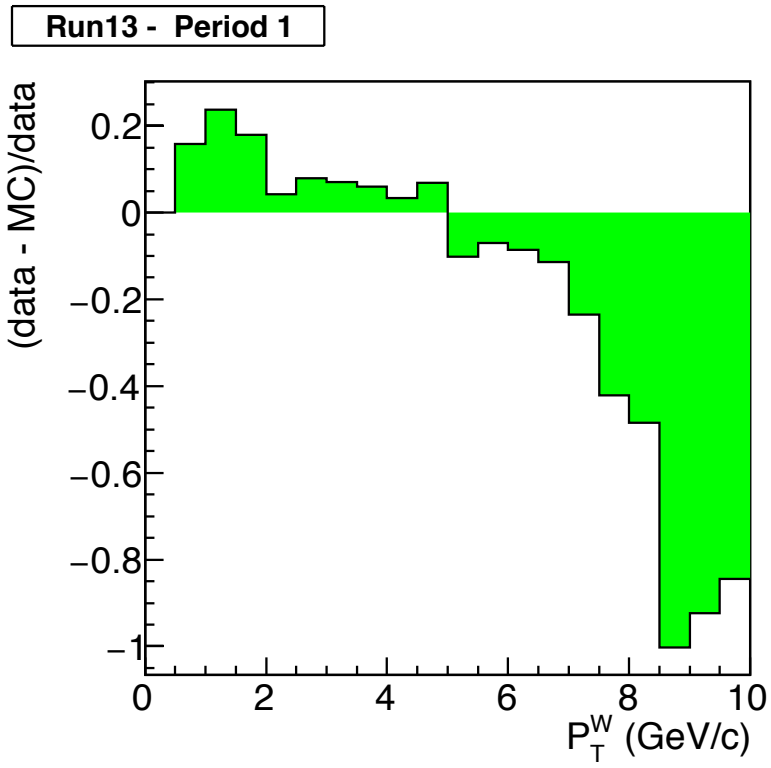


Regular: Sti official production (SL14a)

Yellow is PYTHIA prediction at generated level (no experimental effects)

Sti+PPv: evals1

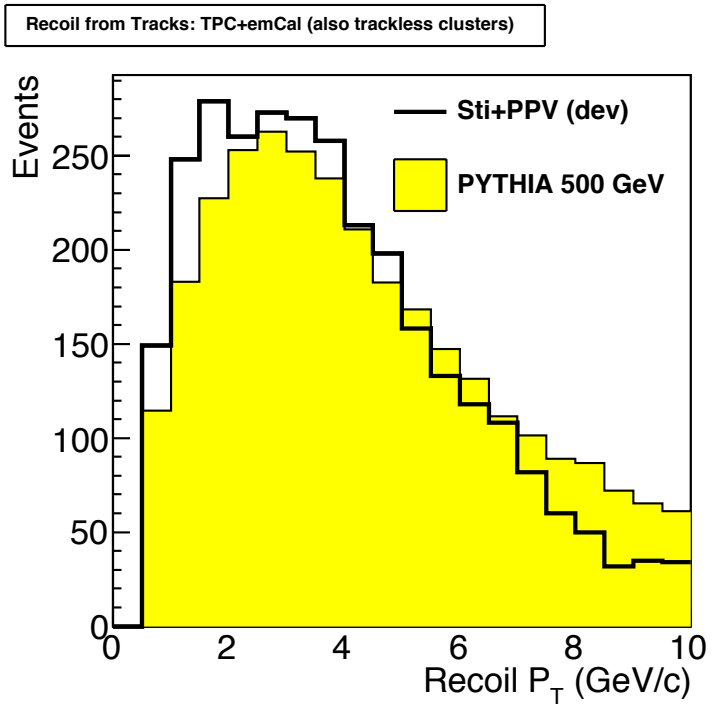


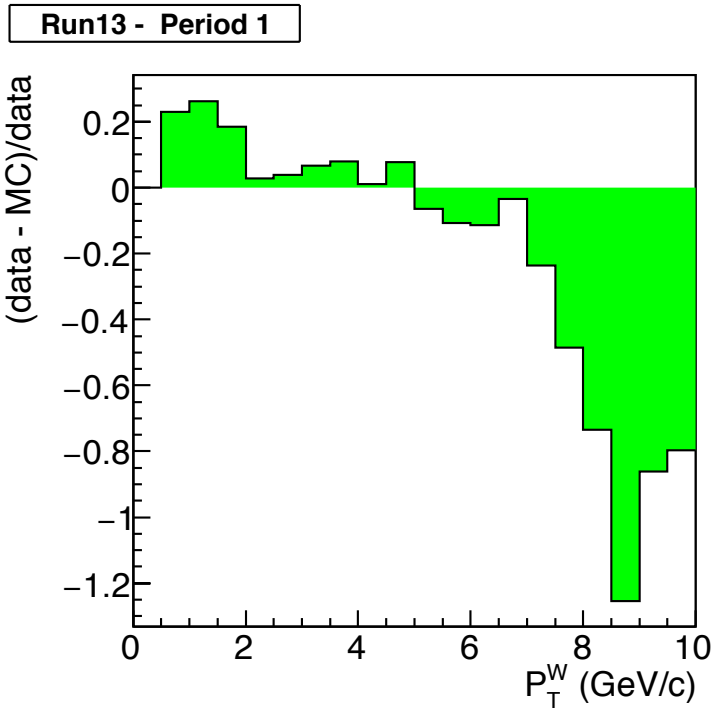


TEST Evals1: Sti+PPV test production (SL16a)

Yellow is PYTHIA prediction at generated level (no experimental effects)

Sti+PPv: evals2





TEST Evals2: Sti+PPV test production (dev)

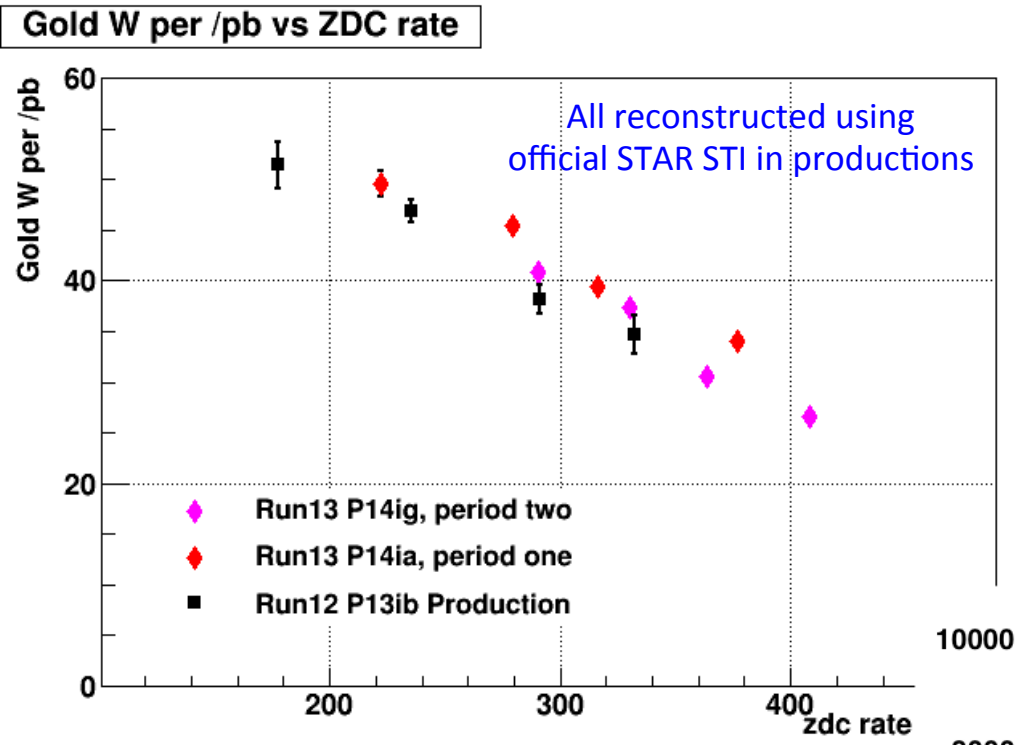
Yellow is PYTHIA prediction at generated level (no experimental effects)

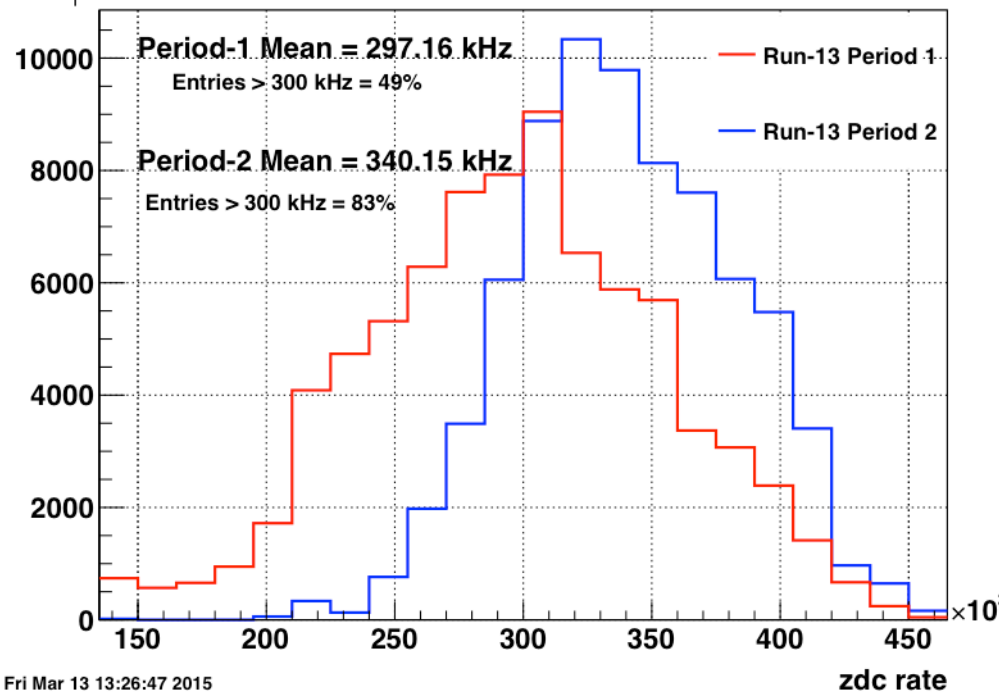
Conclusions

- StiCa shows a better W-selection efficiency also after the reconstruction cuts
- StiCa reconstructs more hadronic recoil → the reconstruction of the boson Pt before any MC correction is better → correction required will be smaller

W-reconstruction efficiency
→ impact on Run-17

W-Efficiency and ZDC rates Run-12 & 13

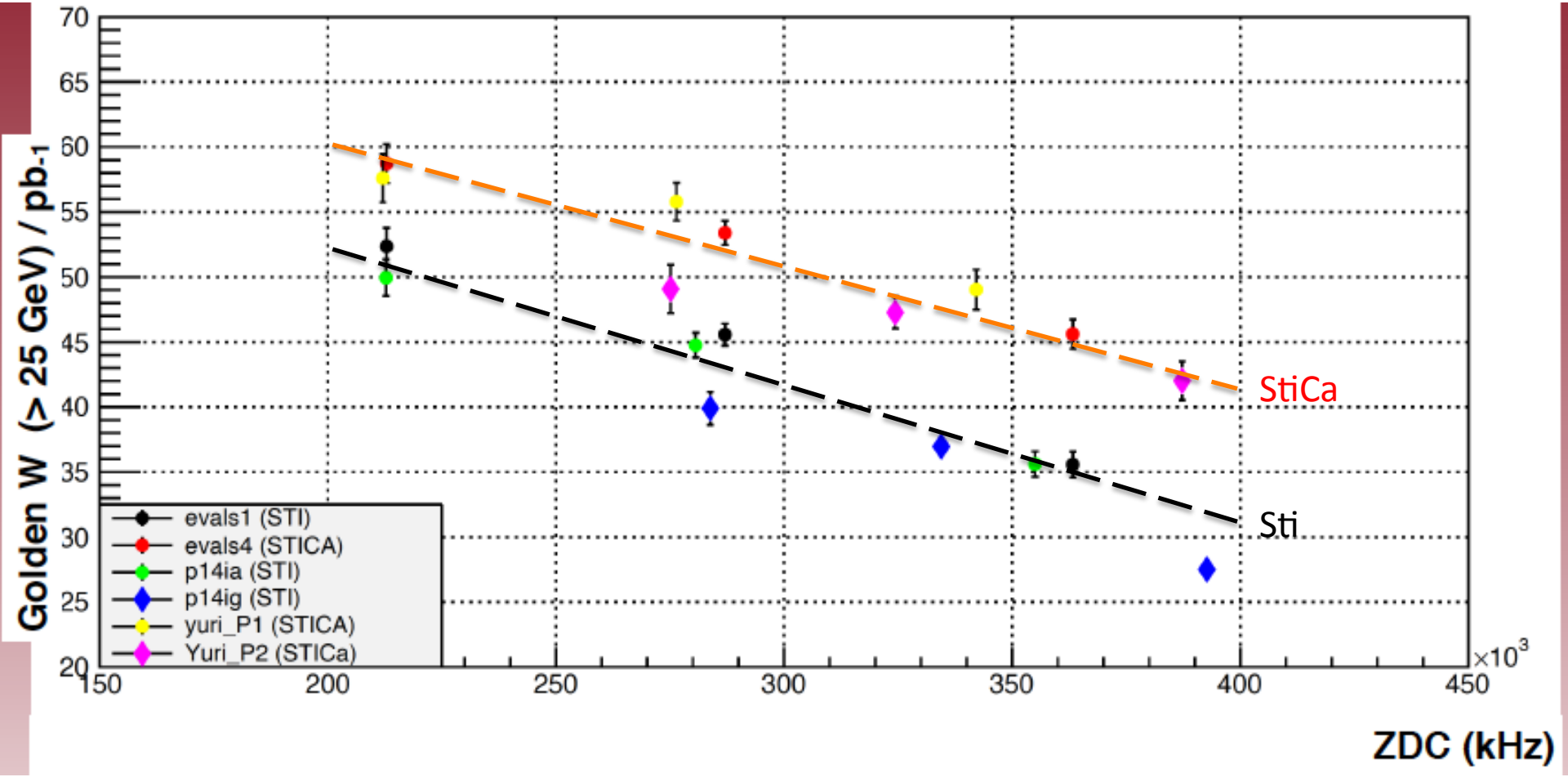




For 2017/18 BUR
results from new tracking studies

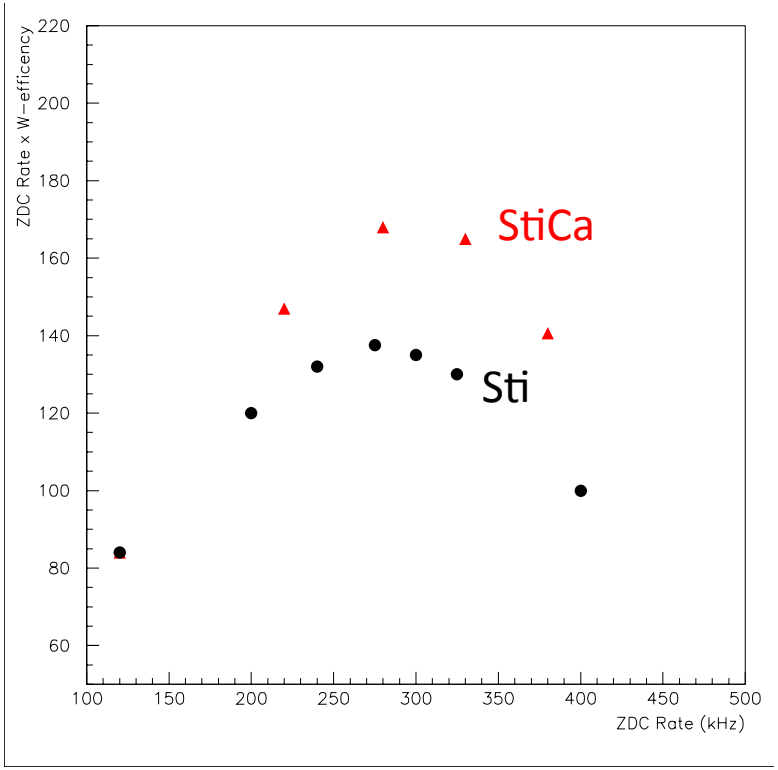
W-Efficiency and ZDC rates Run-13

Different colors represent different tracking methods
mainly Sti vs. StiCA



Summary

For Sti at a ZDC rate > 300 kHz we overall start loosing W's despite the increased luminosity therefore we decided for last years BUR the best Lumi to run is
ZDC 300 kHz = 1.285 x 10**32 cm^{-2} s^{-1}



This was based on using the correlation of singles corrected ZDC rates to uncorrected ZDC rates and the info from the 2013 vernier scan you get:

200 kHz raw ZDC coincidence rate is
for a 500 GeV pp luminosity of 7.3 x 10**31 cm^{-2} s^{-1}
410 kHz raw ZDC coincidence rate is
for a 500 GeV pp luminosity of 1.84 x 10**32 cm^{-2} s^{-1}

But for StiCA we only start loosing at a ZDC rate > 350 kHz
→ this corresponds to the average ZDC rate of period 2 in 2013

Suggestion how to run in 2017:
Still level the luminosity but at a significant higher level
→mean zdc rate for 2017: 350 kHz → 1.57 x 1032 cm^{-2} s^{-1}**
this should be easily doable for CAD by one beta squeeze through out the fill