



Intermittency of charged hadrons in NA61/SHINE*

Pb+Pb@30A GeV/c

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30/11/2021

* the title coincides with the one we propose for the talk at QM 2021

What has been changed since the meeting with STAR: some technicalities

1. We learnt that previous production had wrong potential points and this quantity was in the denominator of differential ratio cut. Bartosz prepared a new production, so we are safe now:

/eos/experiment/na61/data/test/Pb_Pb_30_16/027_17c_v1r19p1_pA_centos7_phys/minishoe.root

2. Moreover, we discovered that something is wrong with number of track **fit clusters** in SHINE. And apparently it was used in the numerator of differential ratio cut. From now on, we decided to use only track number of **clusters**.
3. It seems to us now that we don't need to apply cut on the ratio of track number of clusters to their potential number in each TPC separately (differential ratio cut), but rather do it only for the sum of clusters (in all TPCs).
4. I learnt from Justyna that for acceptance map in fluctuations study she used not only a cut on the ratio of rec to sim tracks in the phase-space cell, but also she had a limit to have more than 10 sim tracks in each cell. I applied it.

With STAR we agreed that we will check additionally $F_q(M)$ for h^{+-} and h^- and for the standard non-cumulative quantities (mixed events subtraction).

Event and track selection criteria for Pb+Pb@30A GeV/c

Event selection

- removal of bad runs
- T2 trigger cut (semi-central inelastic collisions)
- no off-time particle in $\pm 25 \mu\text{s}$ window around triggering particle
- perfect quality of vertex fit
- good beam in transverse plane
- fitted vertex position lies in the vicinity of the target
- centrality cut based on PSD energy (10% most central events)

Track selection

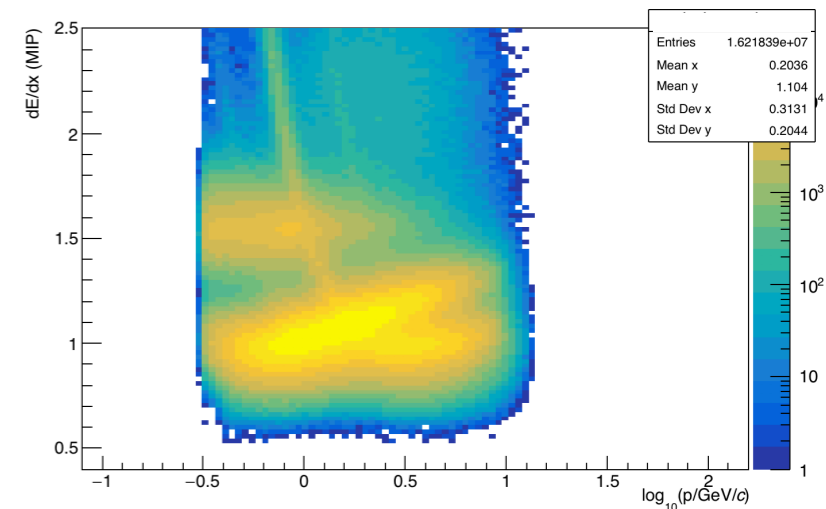
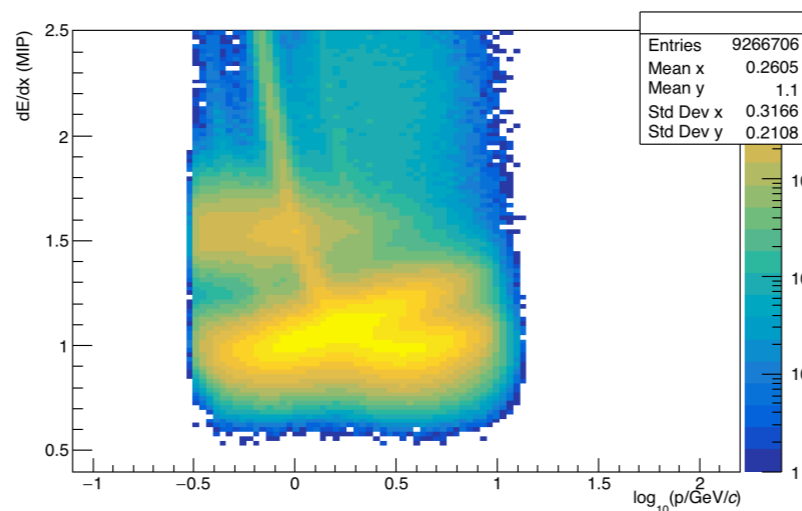
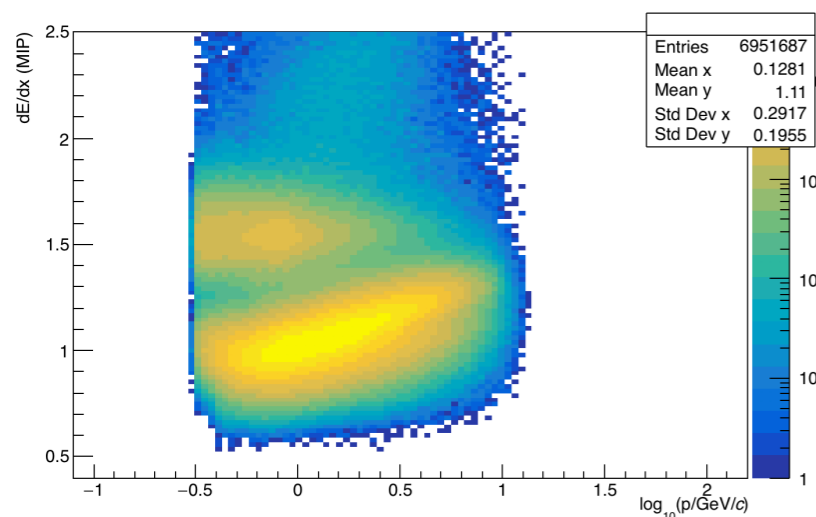
- properly fitted vertex track
- vertex track has enough clusters in VTPCs (inside magnets)
- vertex track has adequate number of clusters in all TPCs
- **actual number of track clusters is around the potential number of its clusters in all TPCs**
- vertex track is closely fitted to the main vertex in x and y
- vertex track has p_X and p_Y less than 1.5 GeV/c
- **charge < 0 or charge > 0 or charge != 0**
- **removal of e[±] by cut on dEdx:**
 - for h⁻ $0.5 < dEdx < BB_{\text{pion}}+0.25$
 - for h⁺ and h[±]
 1. $0.5 < dEdx < BB_{\text{pion}}+0.25$
 2. $dEdx > BB_{\text{electron}}+0.3$
- tracks with pion rapidity in (-0.5, 0.5) interval
- momentum based two track distance cut on the pair of tracks
- **acceptance map cut**

h-

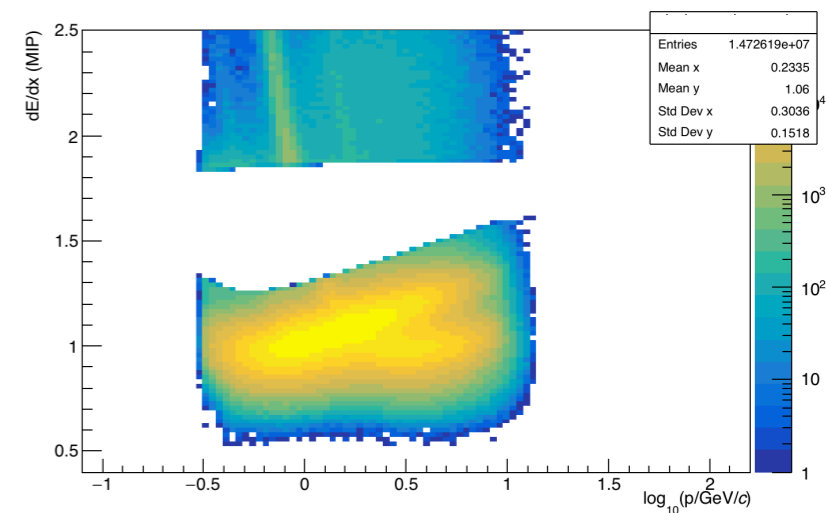
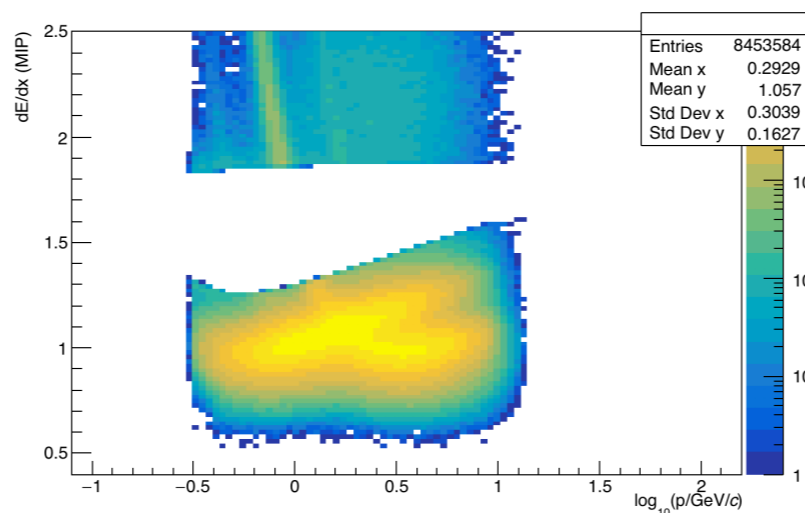
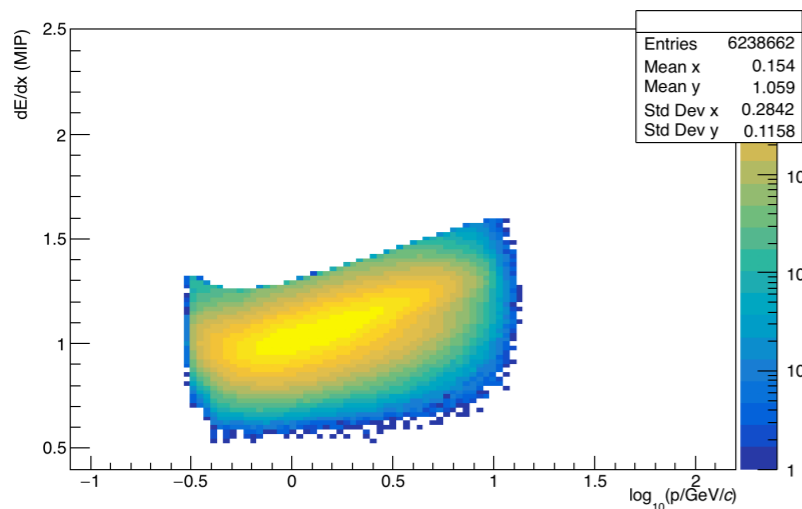
h+

h+-

Before dEdx cut



After dEdx cut



$0.5 < dE/dx < BB_pion+0.25$

$0.5 < dE/dx < BB_pion+0.25$
 $dE/dx > BB_electron+0.3$

$0.5 < dE/dx < BB_pion+0.25$
 $dE/dx > BB_electron+0.3$

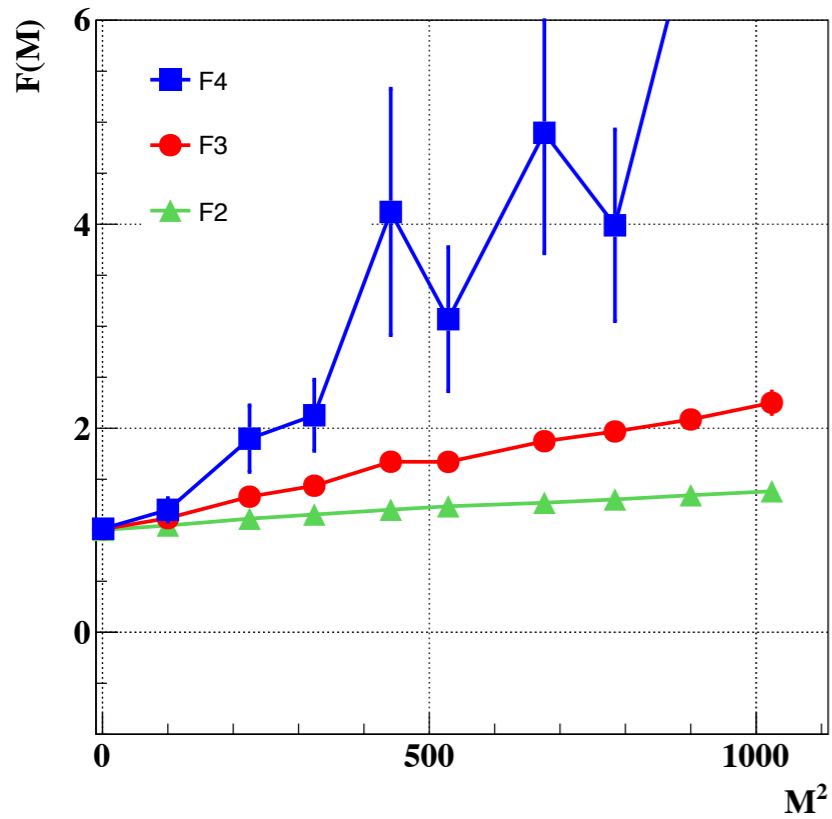
**what someone who doesn't care
about split+merged tracks may get**

(neither Global ratio cut
nor mTTD cut were used)

NO global ratio cut
NO mTTD cut

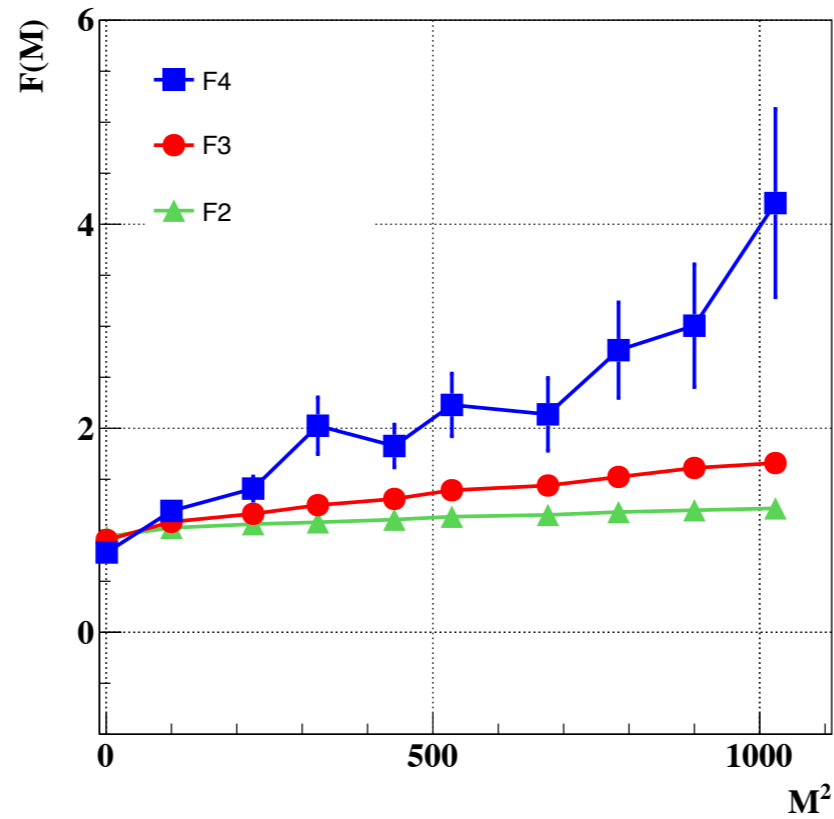
Cumulative Fq(M)

h-



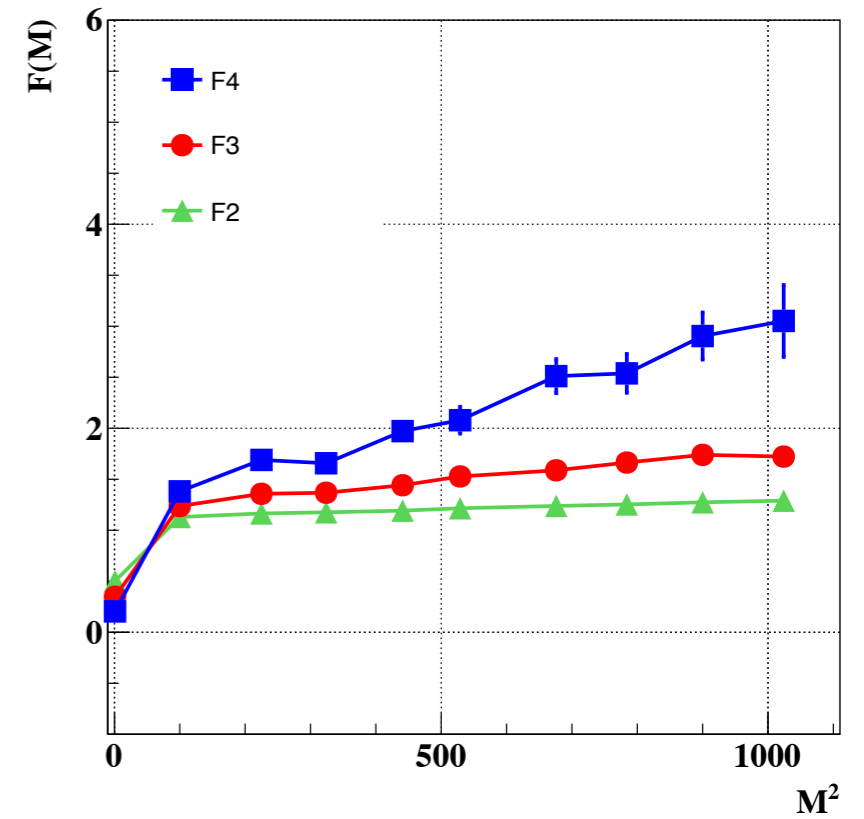
$\langle N \rangle = 37.6$

h+



$\langle N \rangle = 52.9$

h+-



$\langle N \rangle = 90.2$

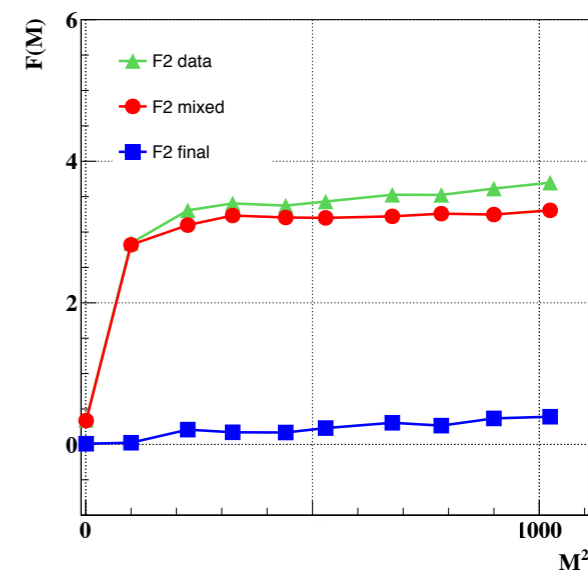
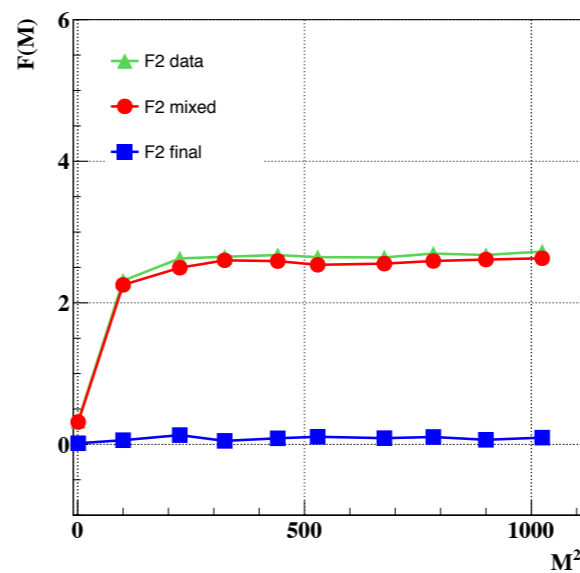
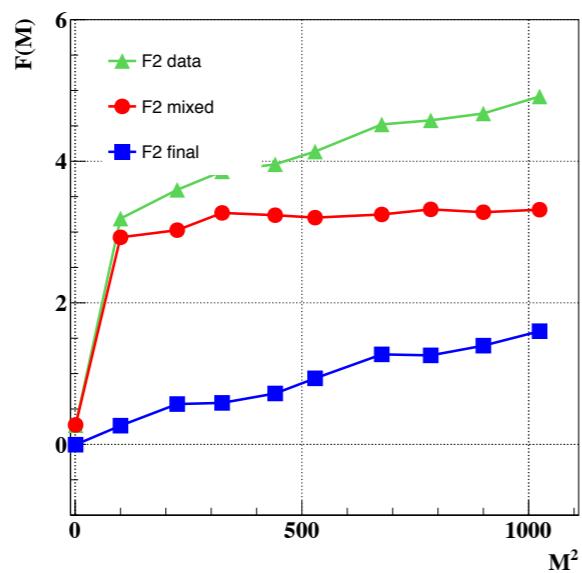
NO global ratio cut
NO mTTD cut

h-

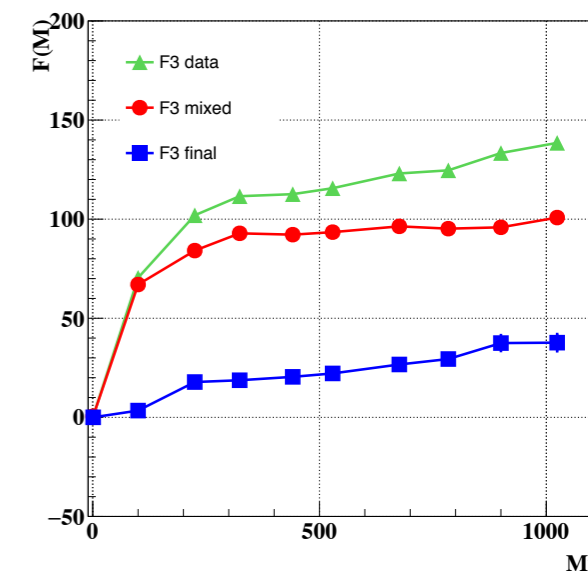
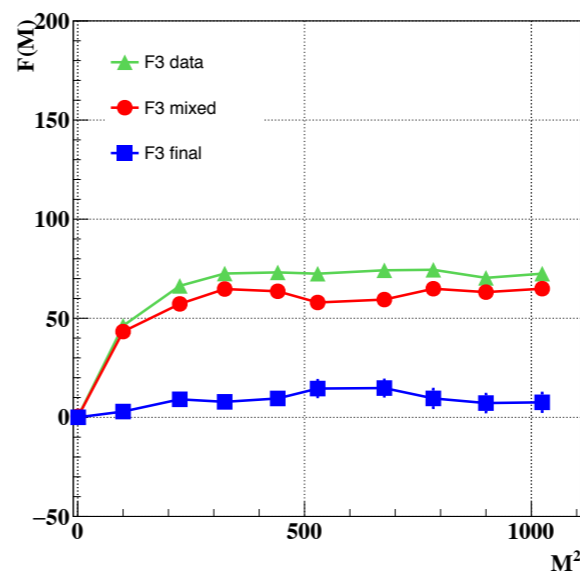
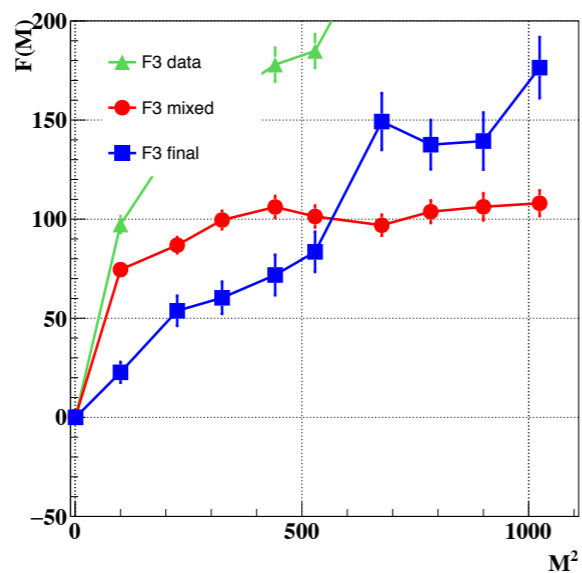
h+

h+-

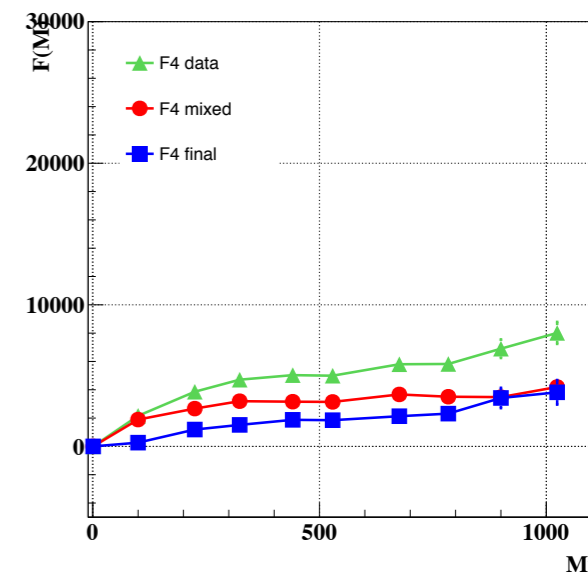
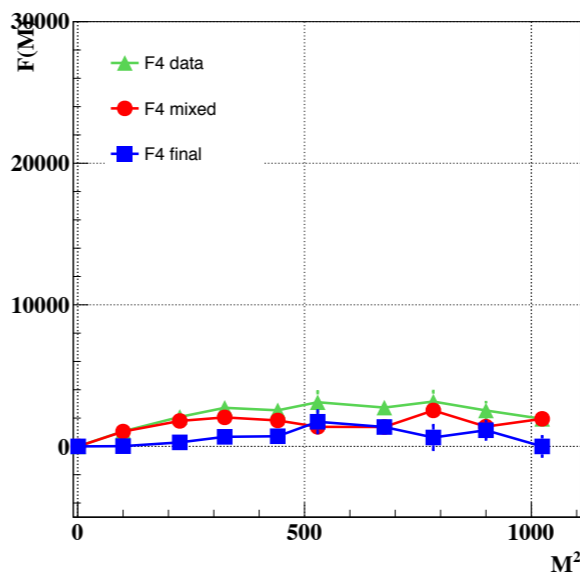
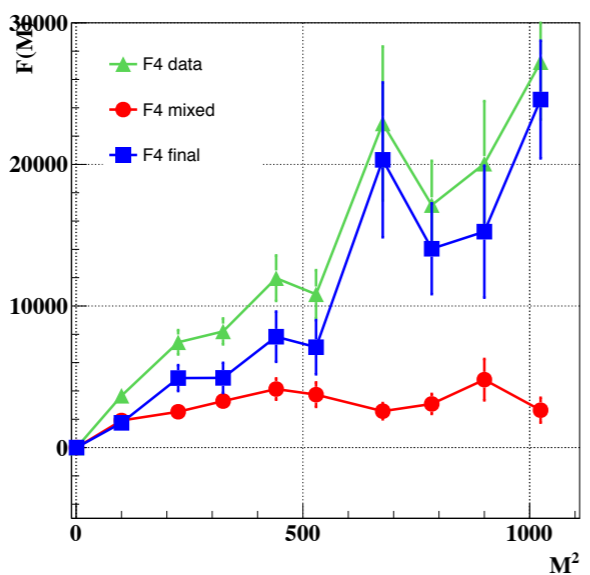
$\Delta F2(M)$



$\Delta F3(M)$



$\Delta F4(M)$



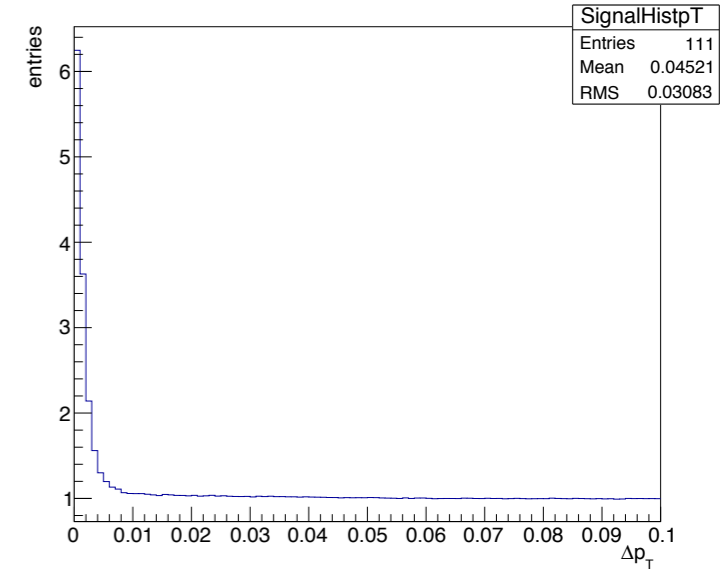
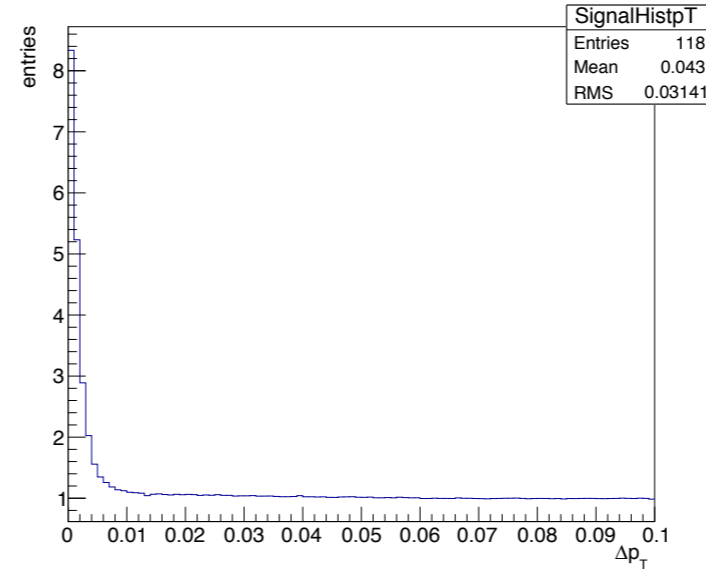
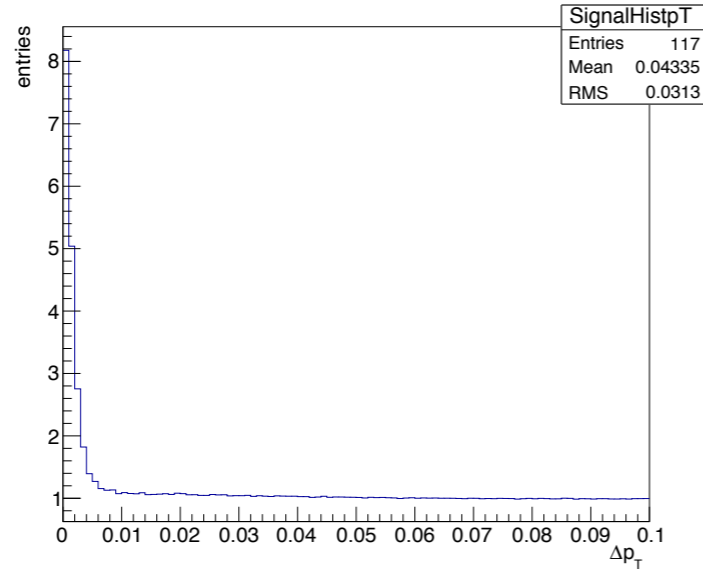
NO global ratio cut
NO mTTD cut

h-

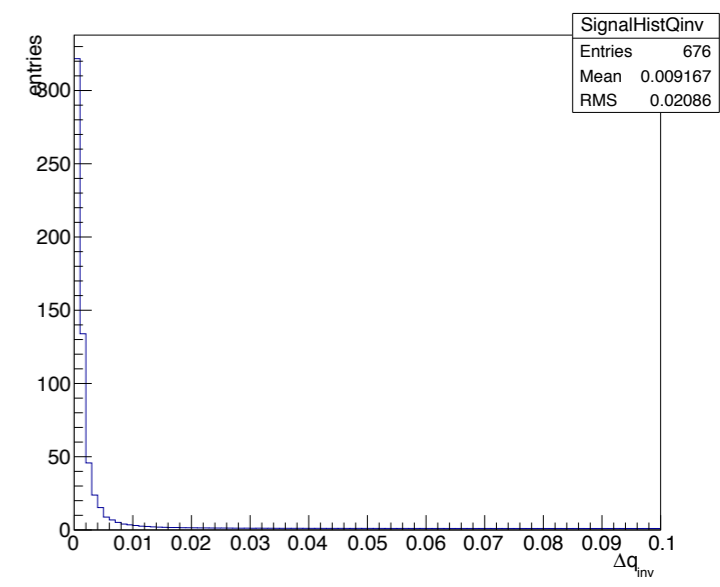
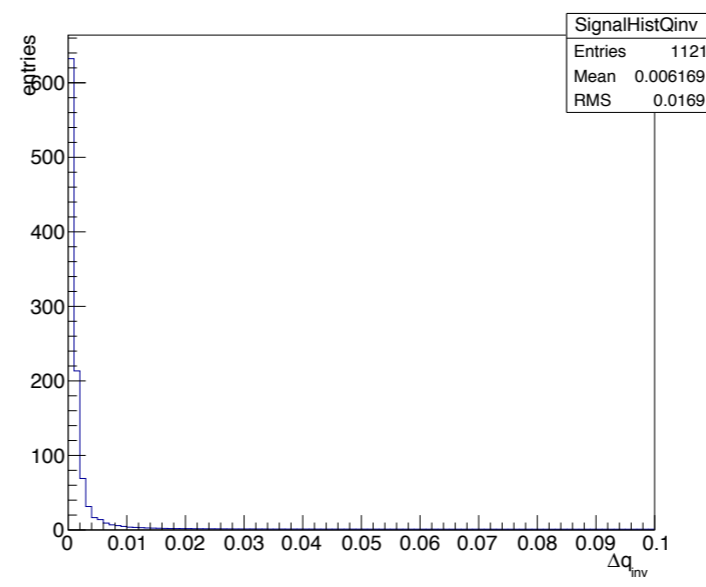
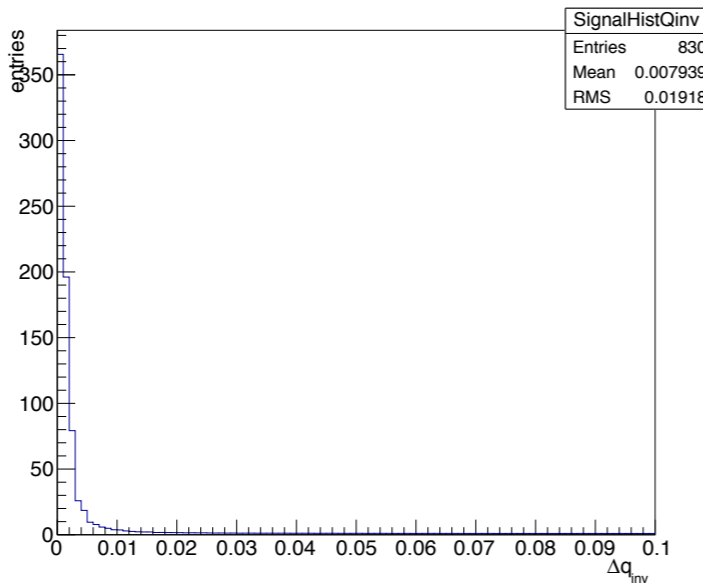
h+

h+-

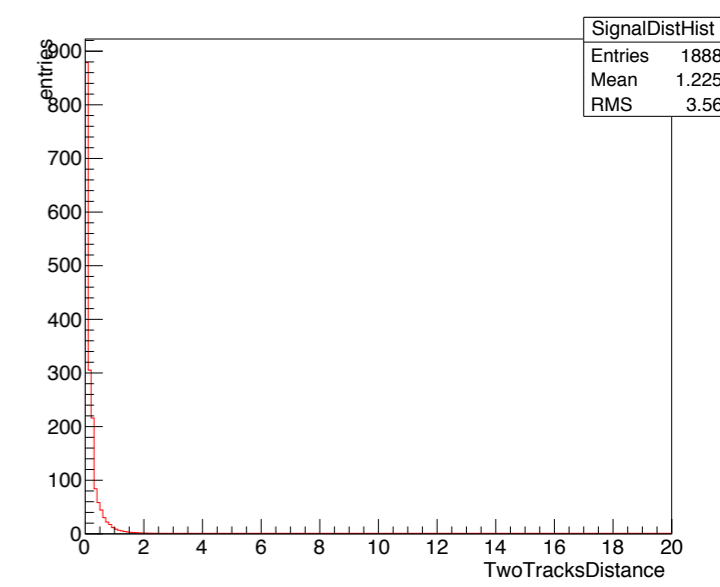
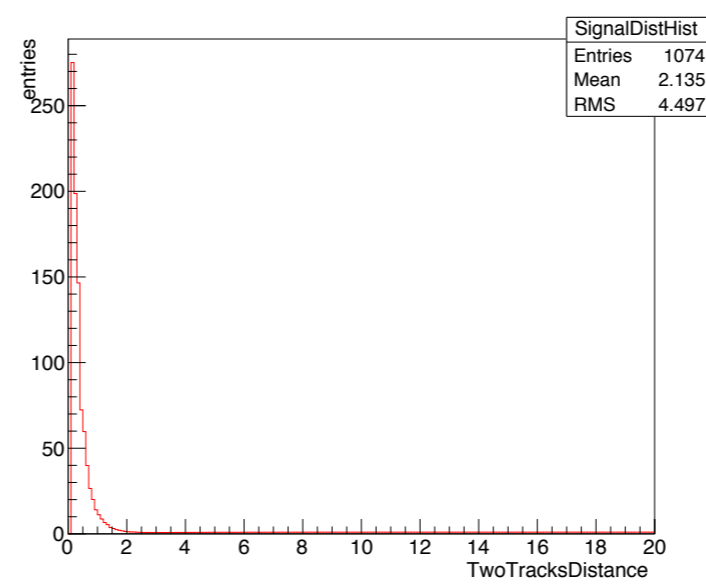
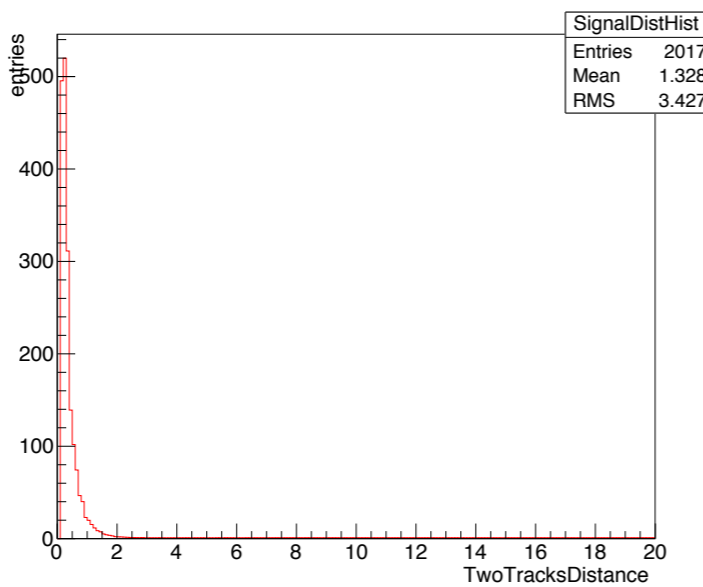
**data/mixed ratio
in Δp_T**



**data/mixed ratio
in Q_{inv}**



**data/mixed ratio
in TTD**



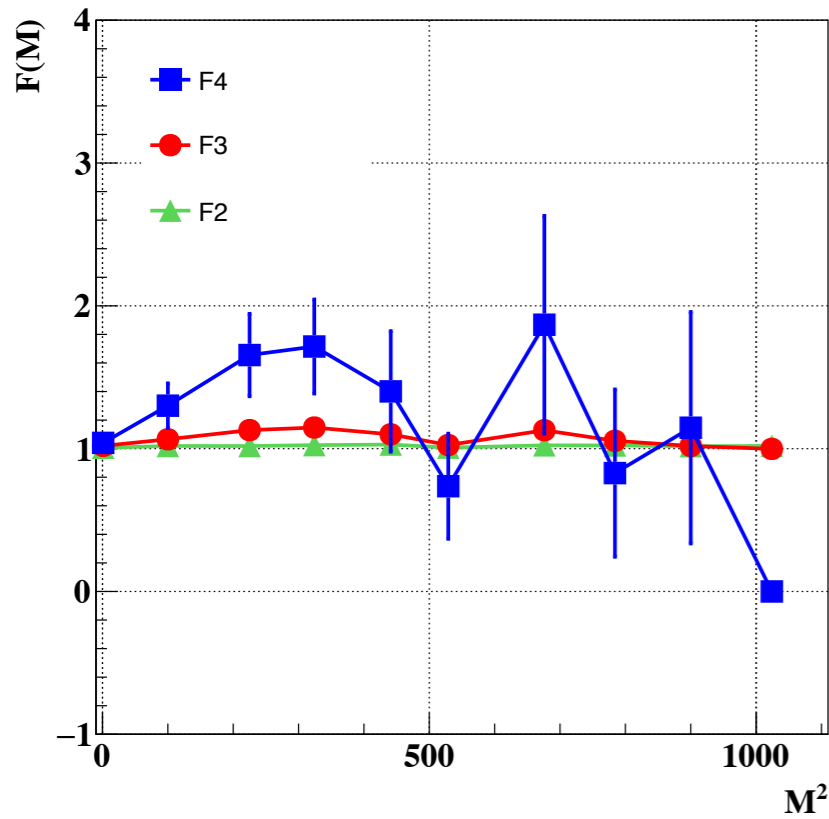
what STAR «does»

(only Global ratio cut
without mTTD cut was used)

global ratio cut
NO mTTD cut

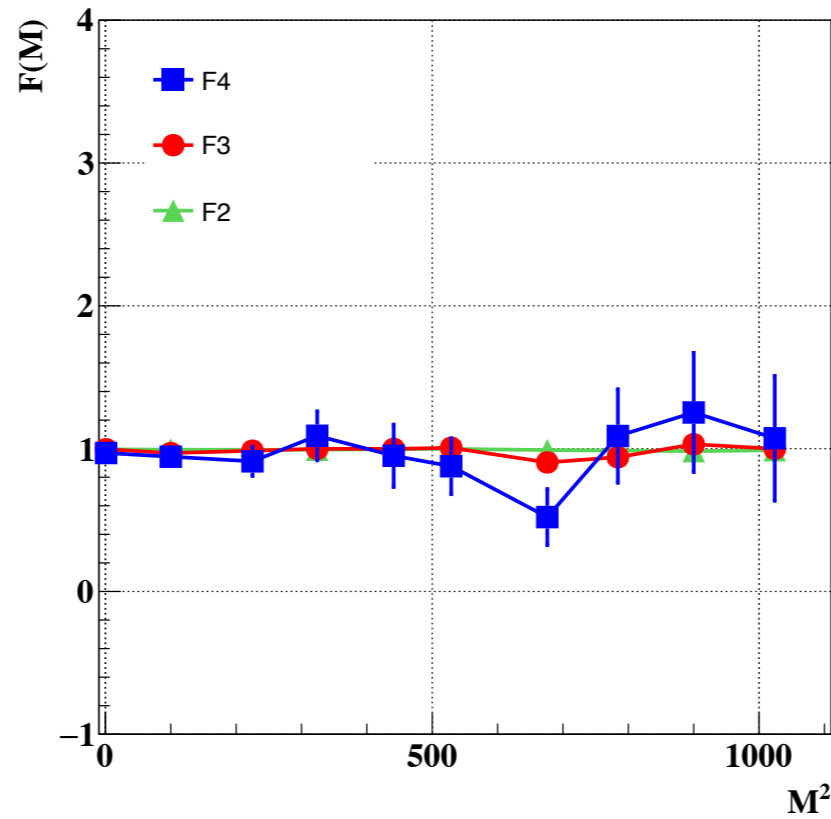
Cumulative Fq(M)

h-



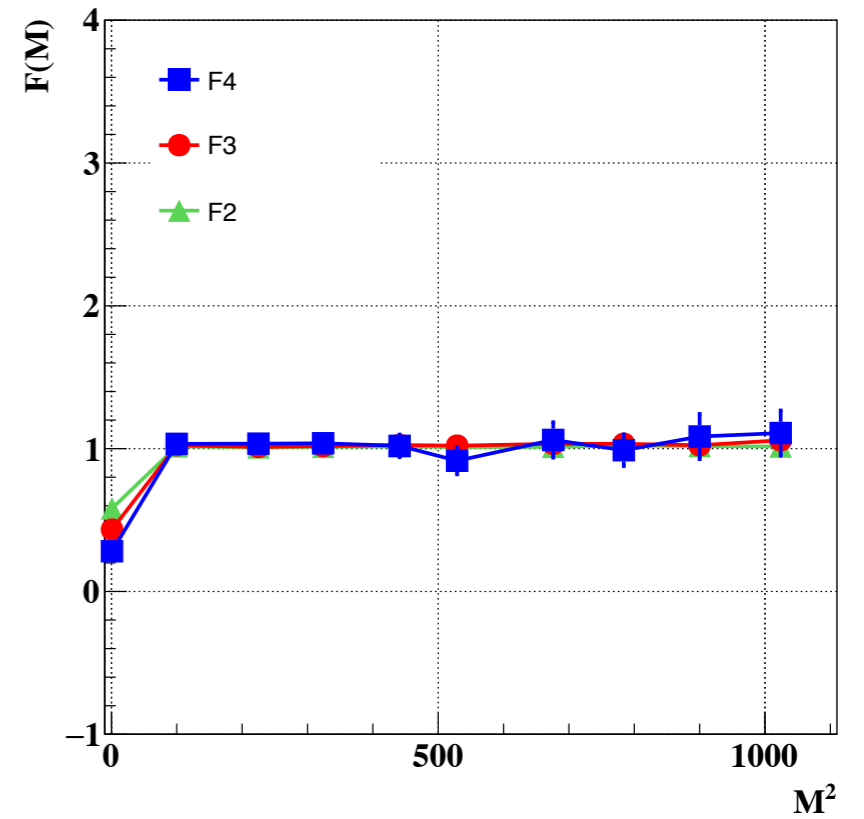
$\langle N \rangle = 32.2$

h+



$\langle N \rangle = 46.1$

h+-



$\langle N \rangle = 77.8$

* STAR claims to have $\langle N \rangle = 97$ for selected h+-

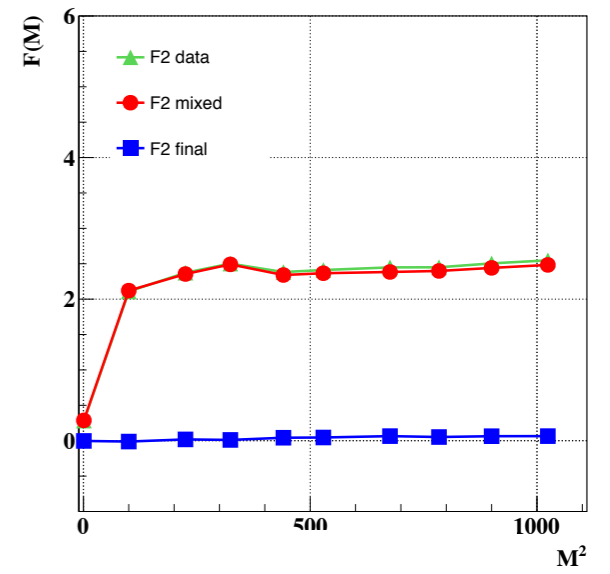
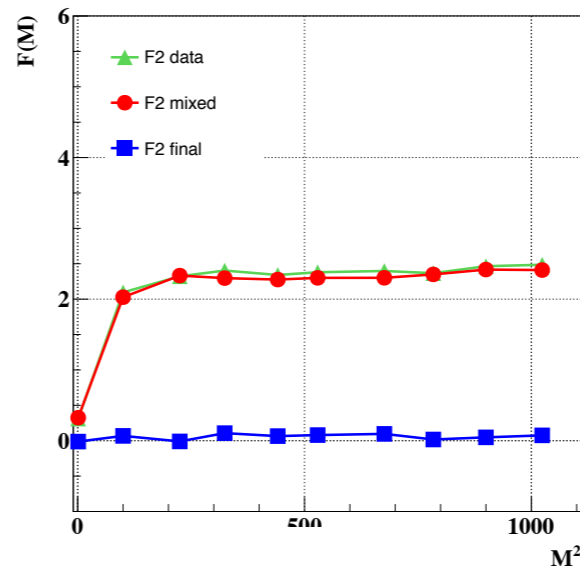
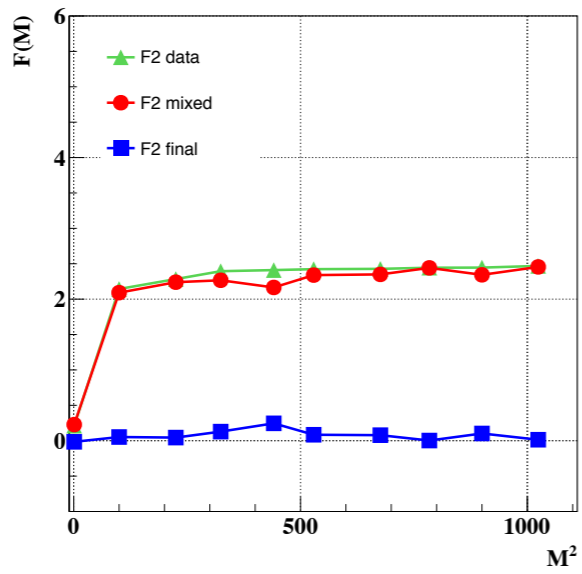
global ratio cut
NO mTTD cut

h^-

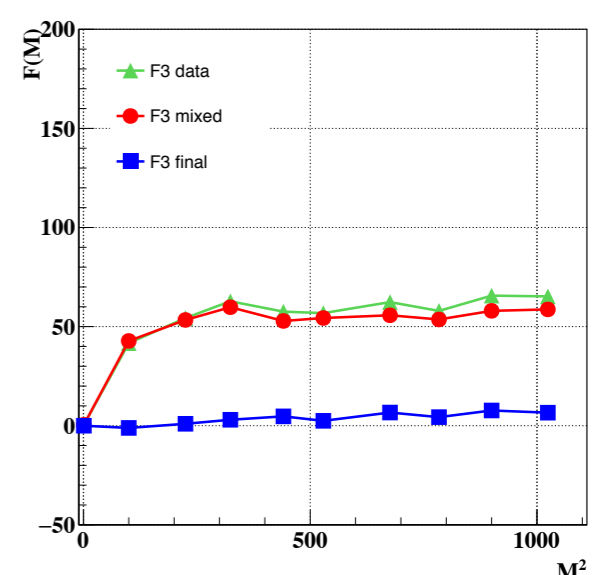
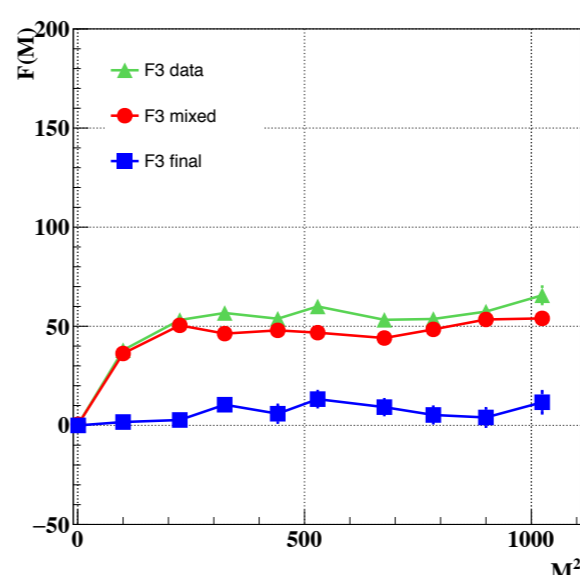
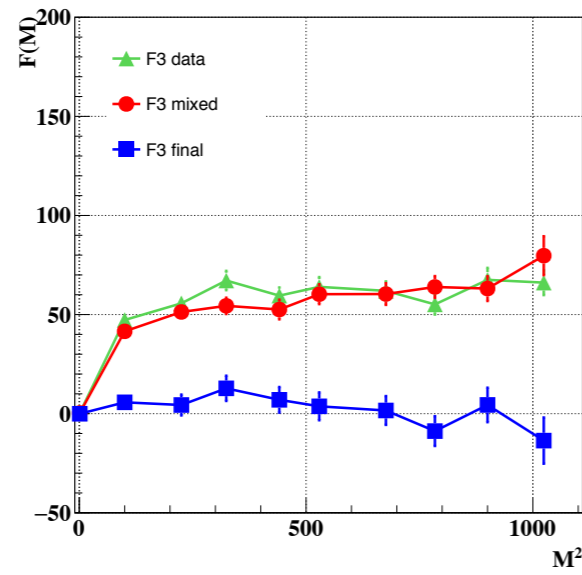
h^+

h^{+-}

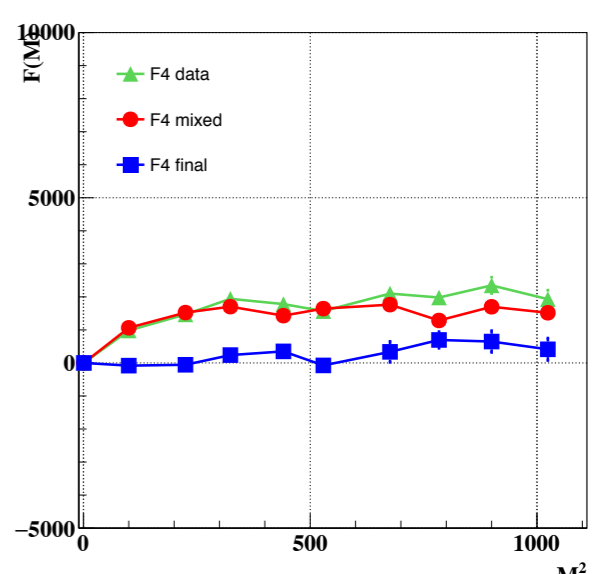
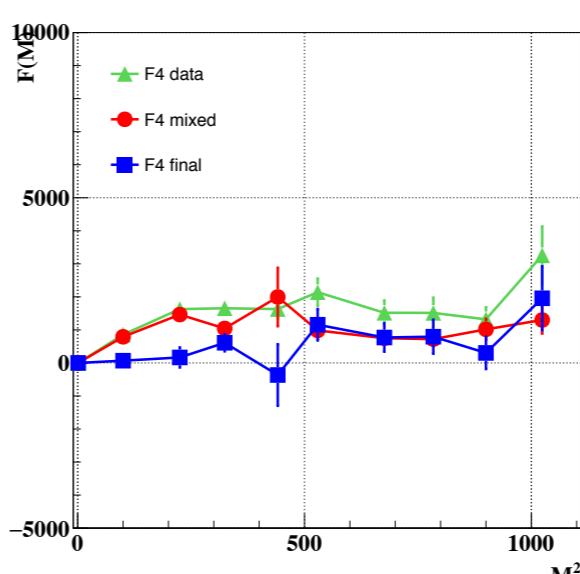
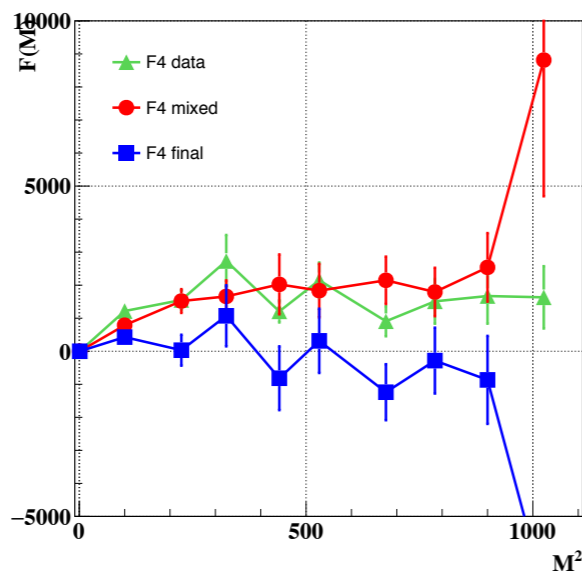
$\Delta F2(M)$



$\Delta F3(M)$



$\Delta F4(M)$



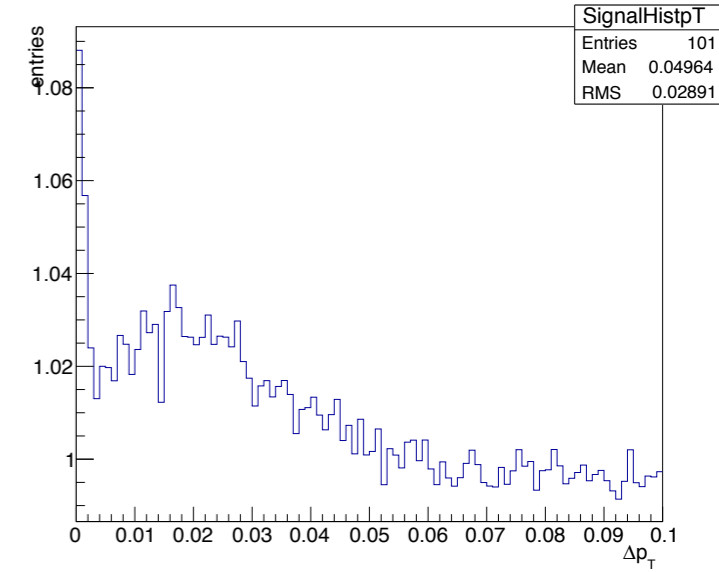
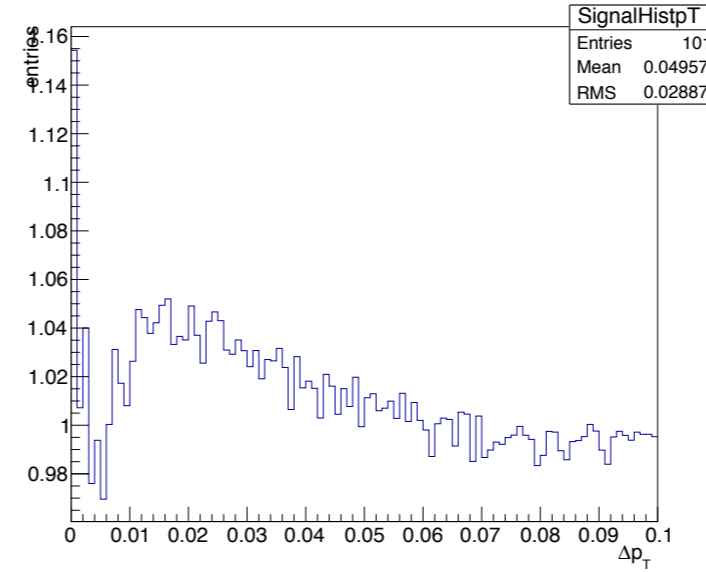
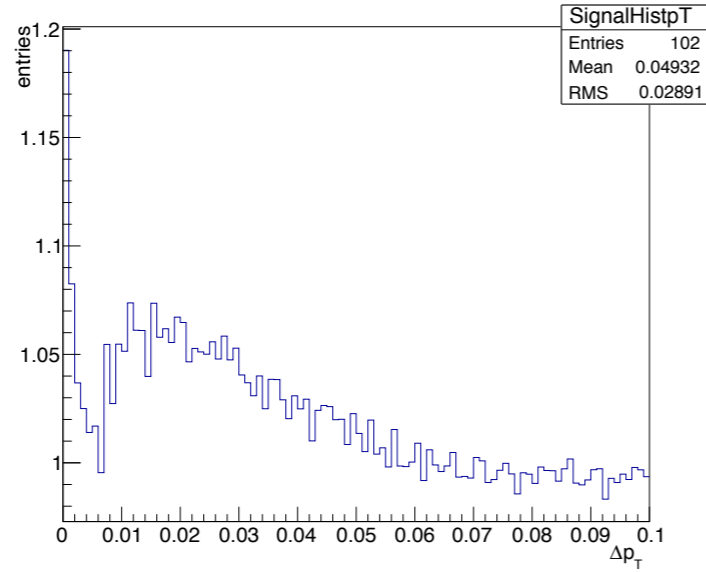
global ratio cut
NO mTTD cut

h-

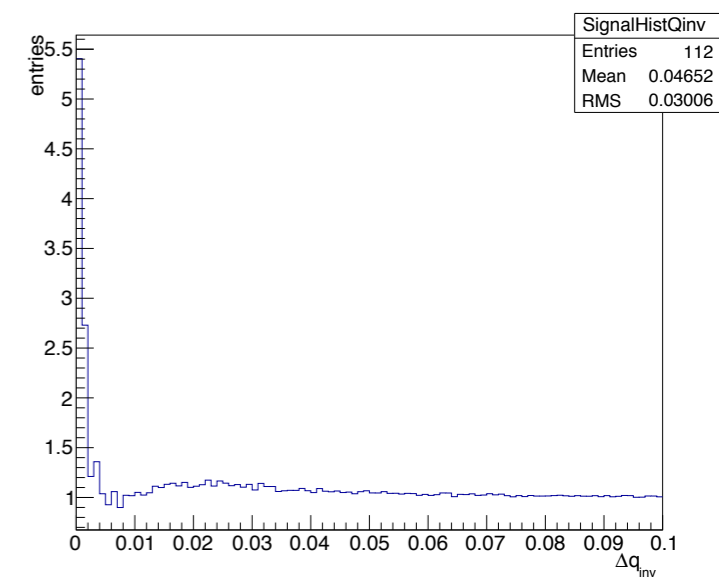
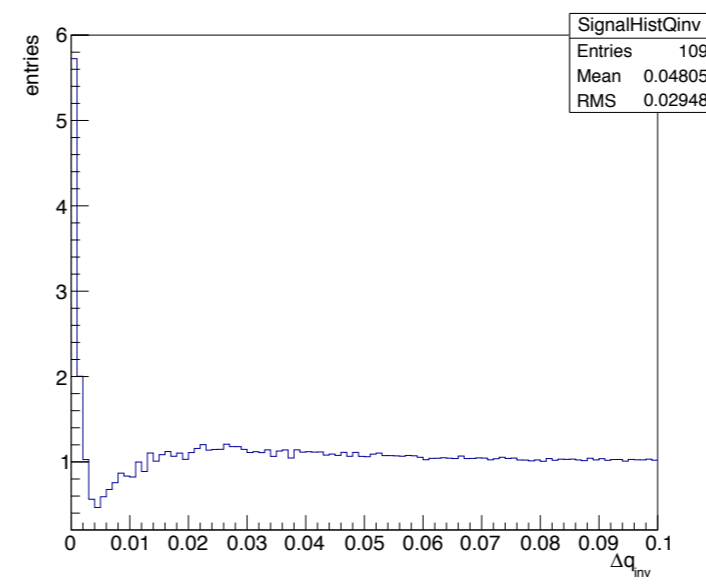
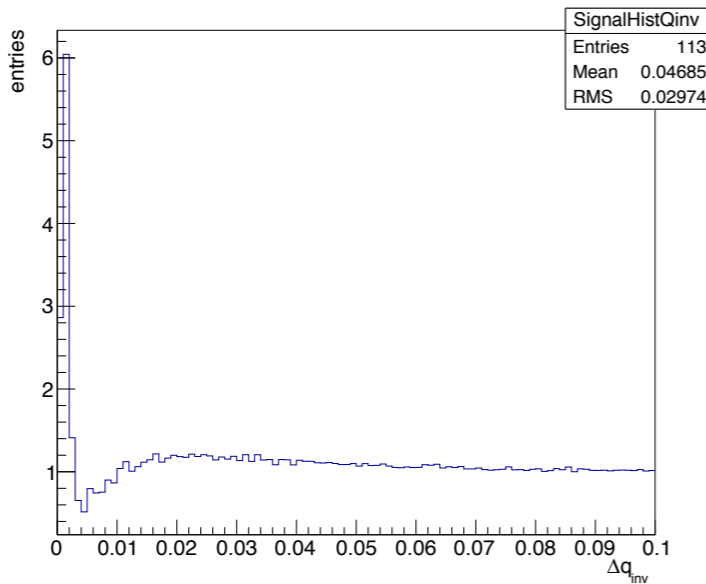
h+

h+-

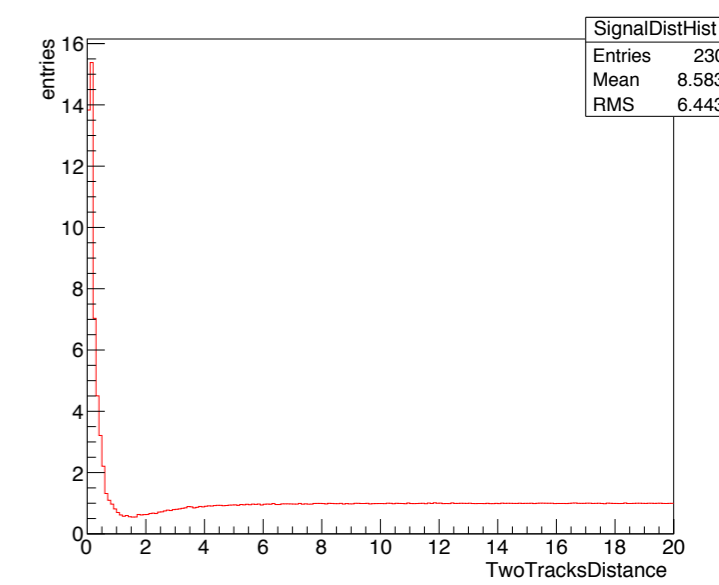
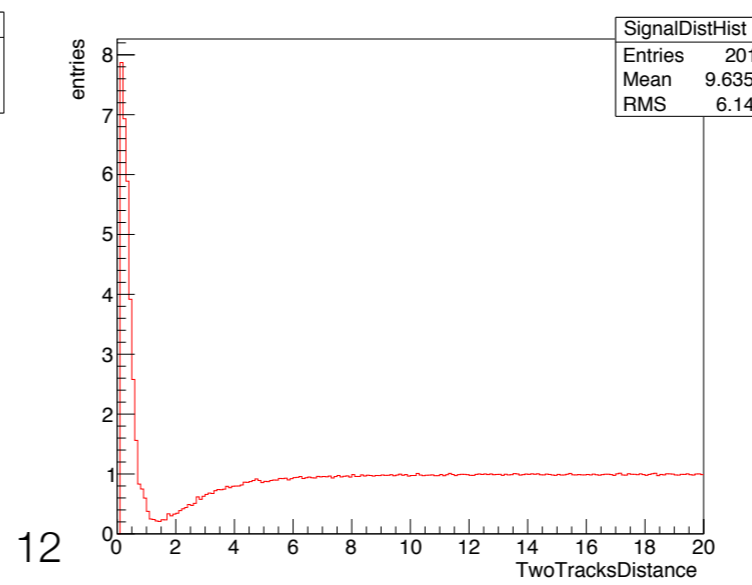
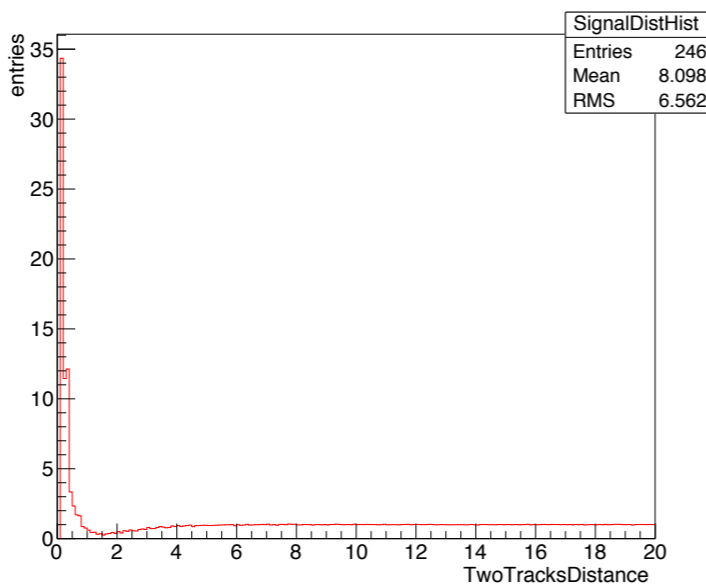
**data/mixed ratio
in Δp_T**



**data/mixed ratio
in Q_{inv}**



**data/mixed ratio
in TTD**



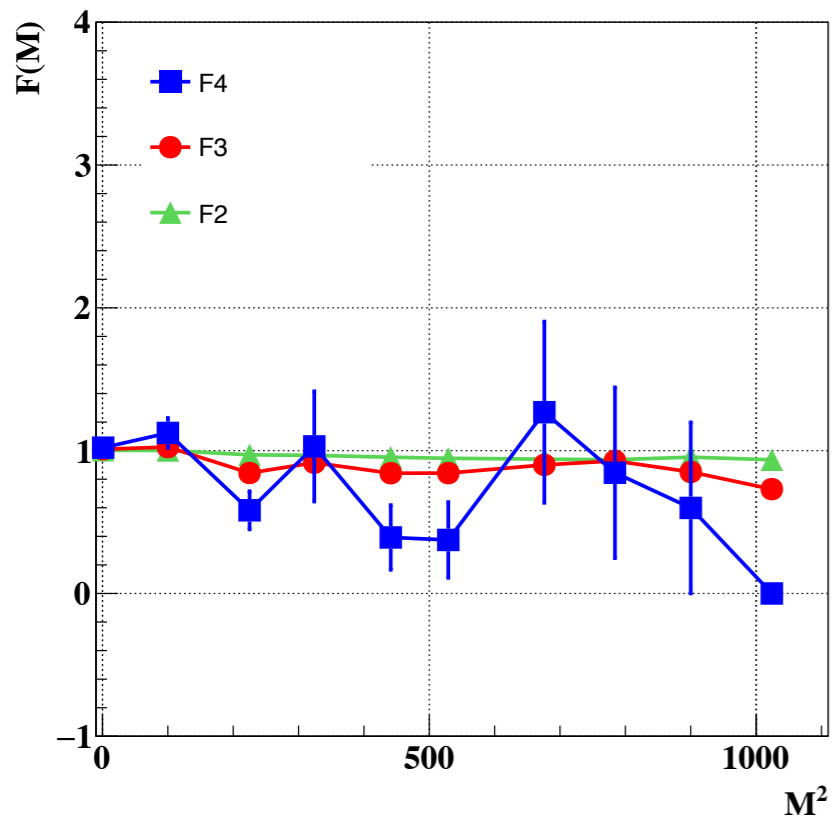
what we do

(both Global ratio cut
and mTTD cut were used)

global ratio cut
mTTD cut

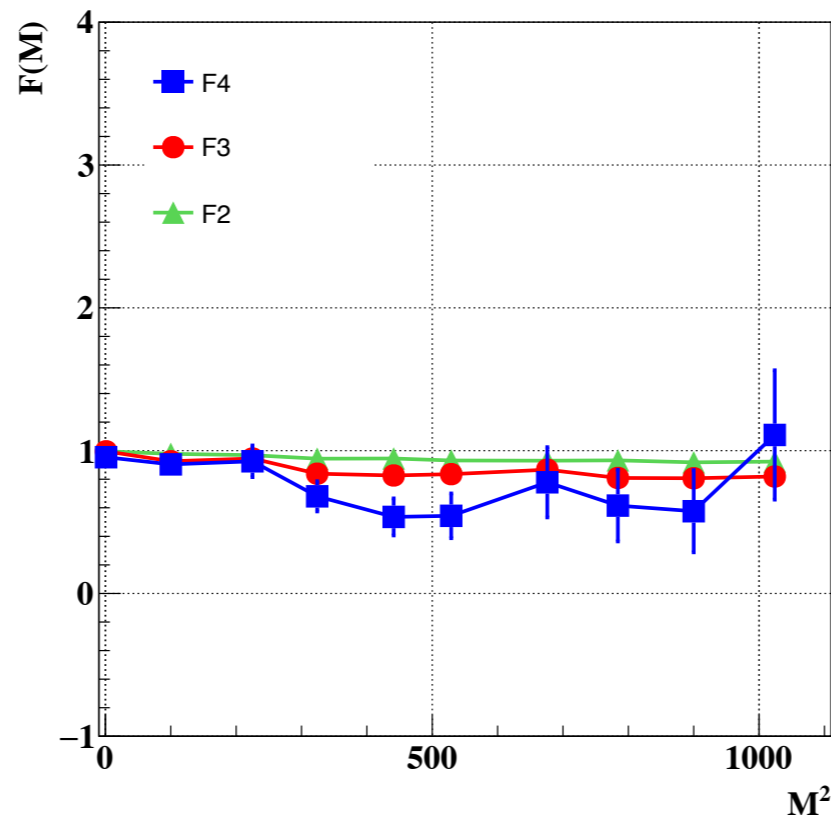
Cumulative Fq(M)

h-



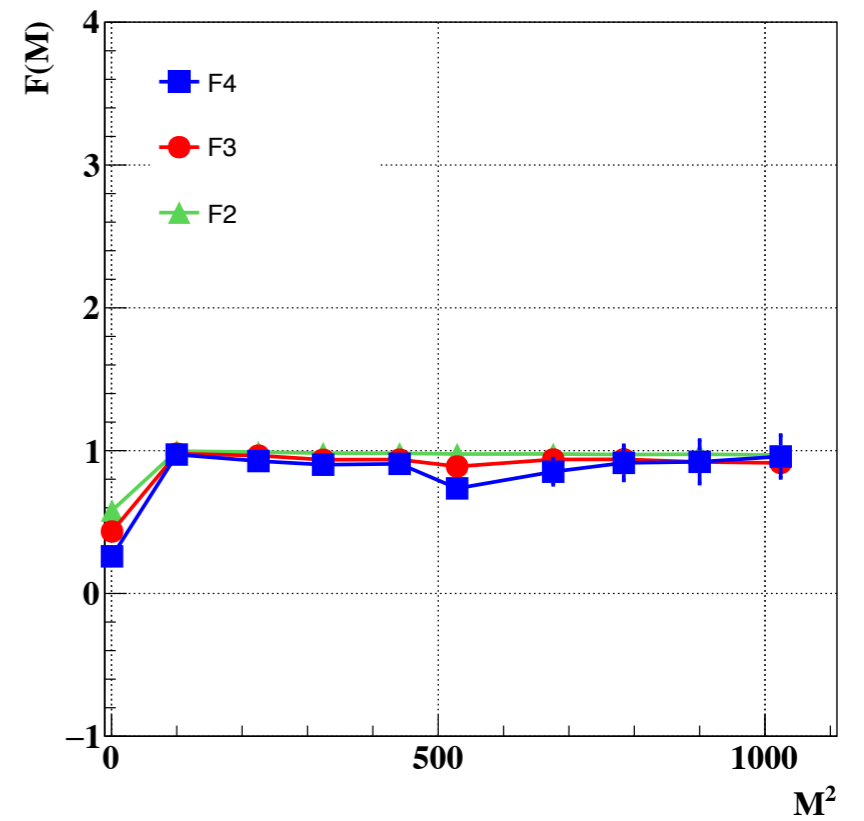
$\langle N \rangle = 32.0$

h+



$\langle N \rangle = 45.6$

h+-



$\langle N \rangle = 77.1$

* STAR claims to have $\langle N \rangle = 97$ for selected h^{+ -}

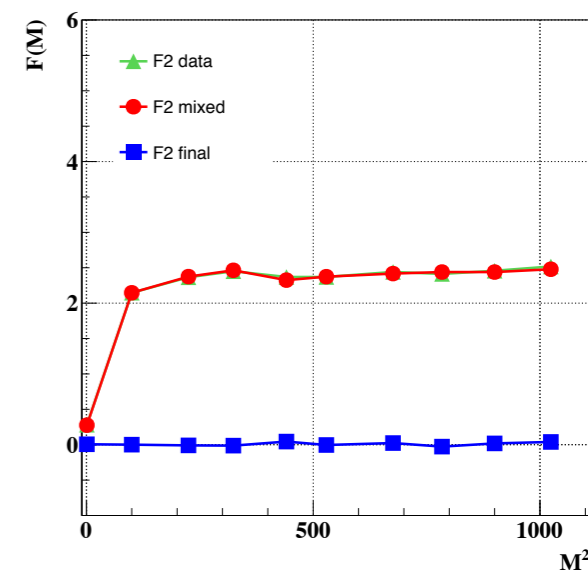
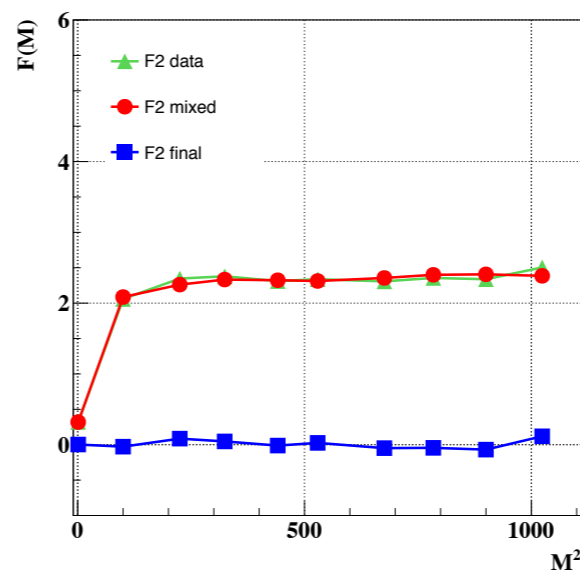
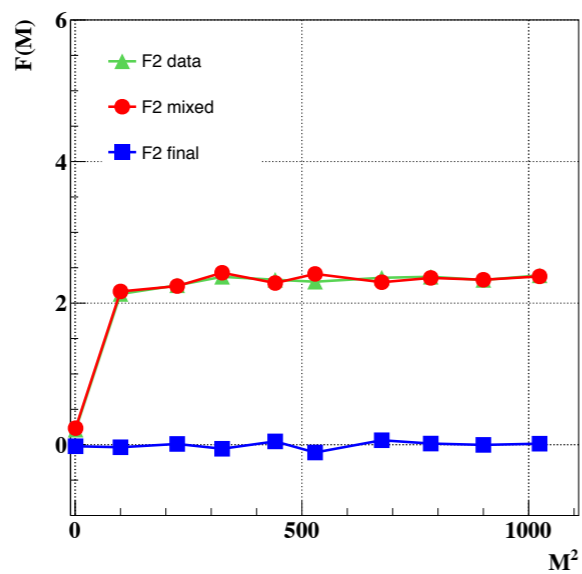
global ratio cut
mTTD cut

h^-

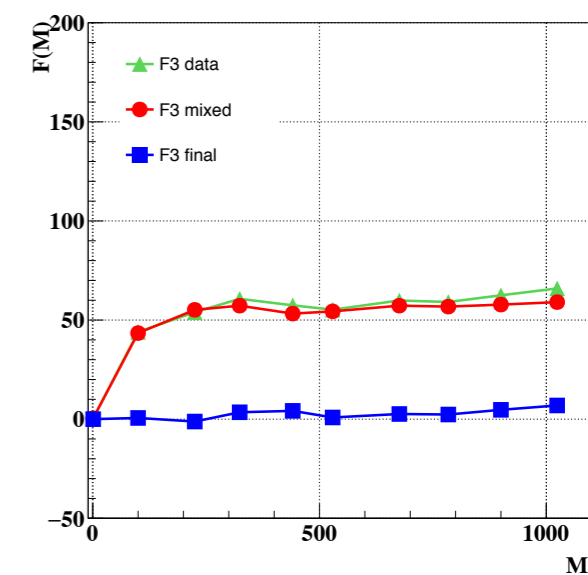
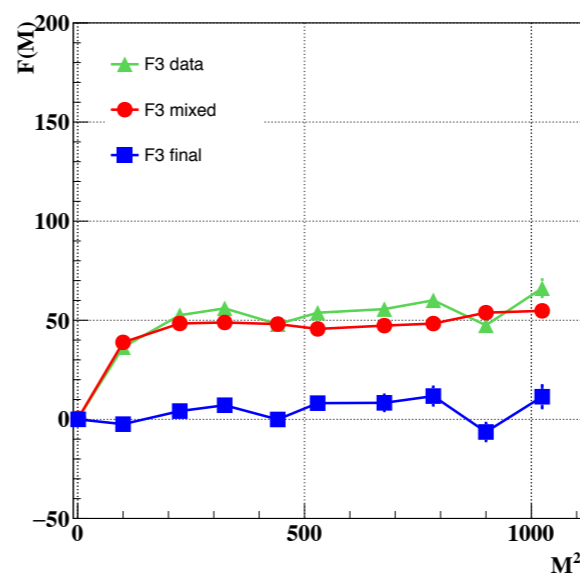
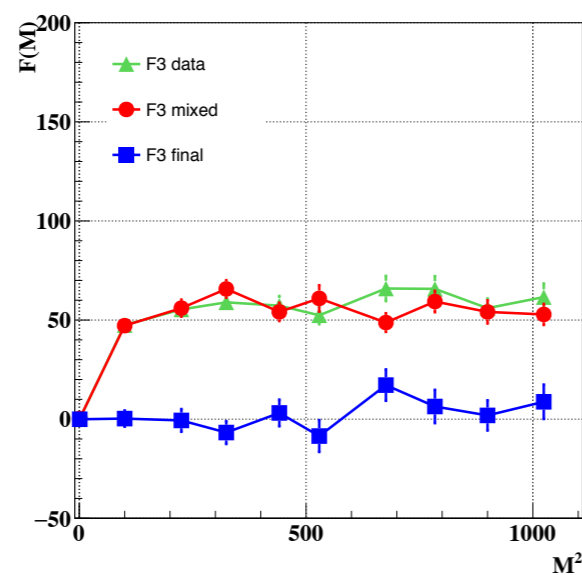
h^+

h^{+-}

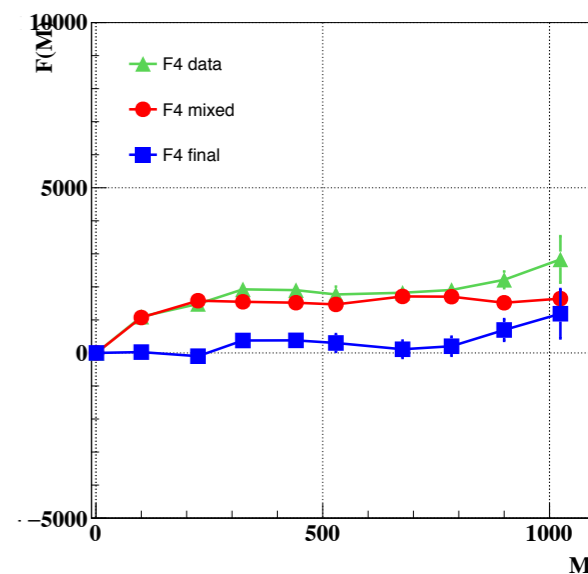
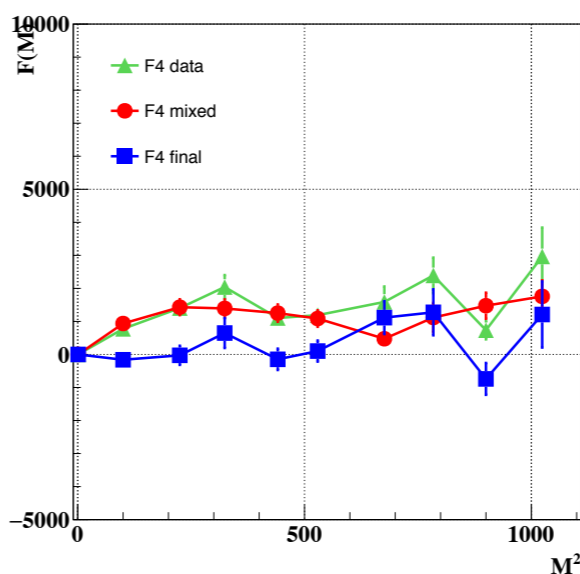
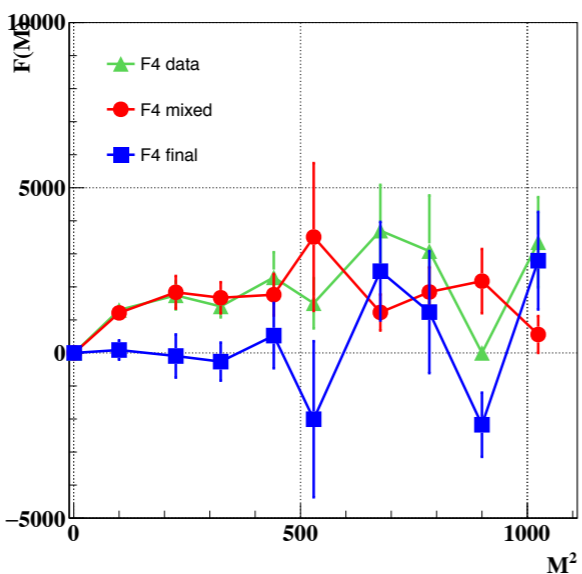
$\Delta F2(M)$



$\Delta F3(M)$



$\Delta F4(M)$



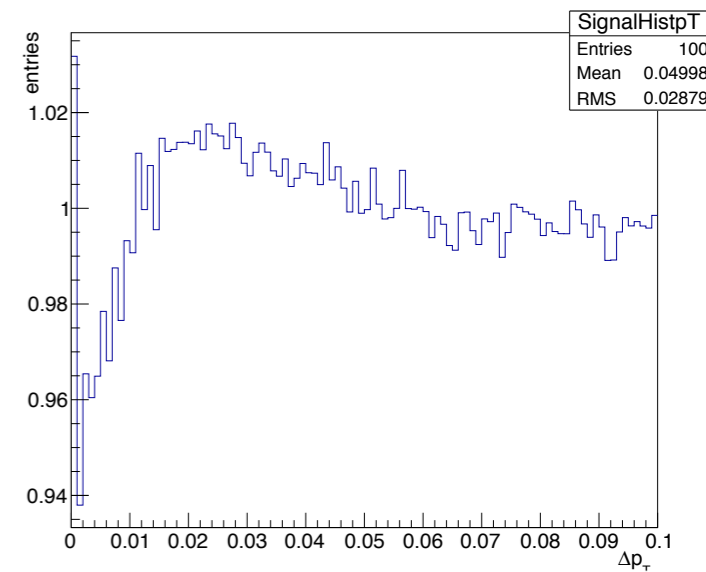
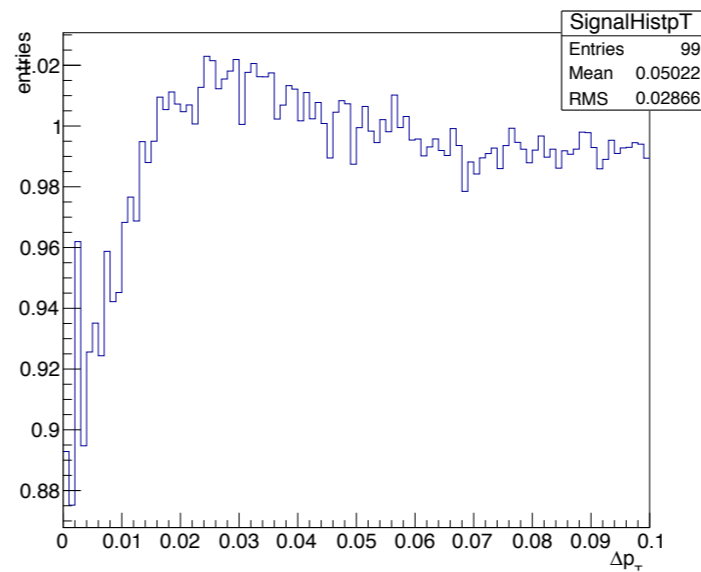
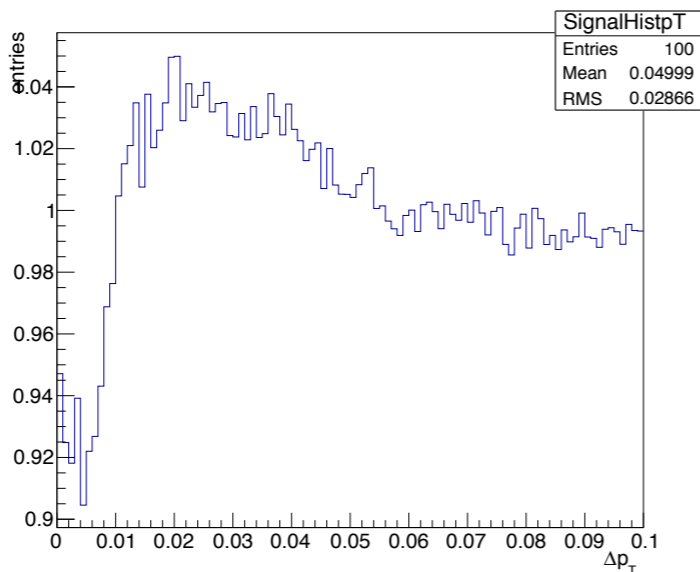
global ratio cut
mTTD cut

h-

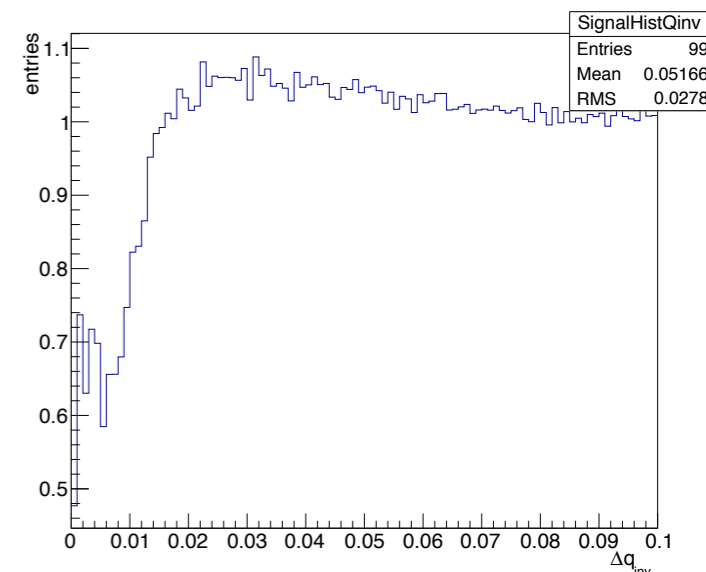
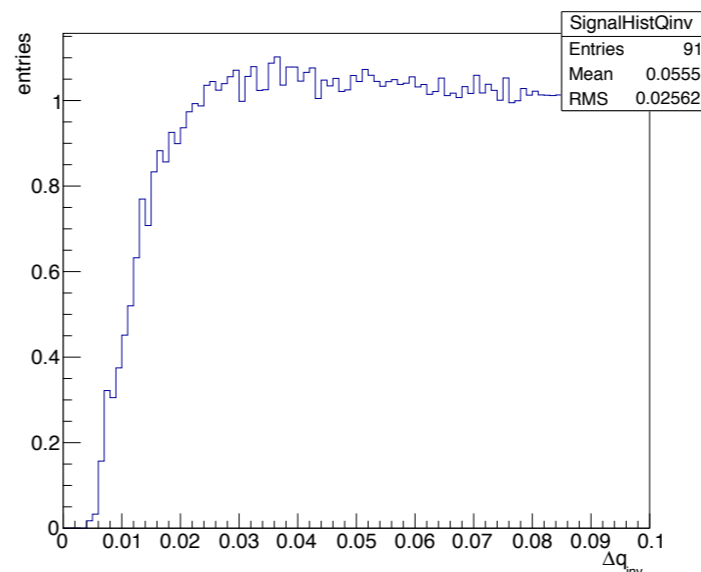
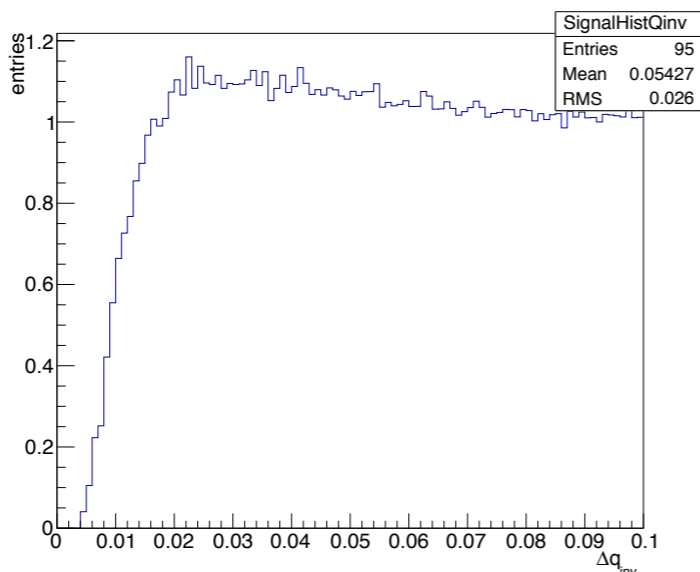
h+

h+-

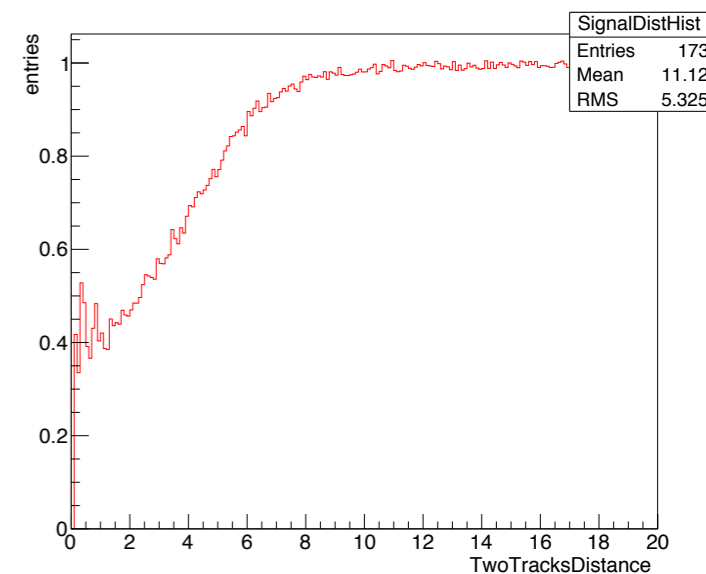
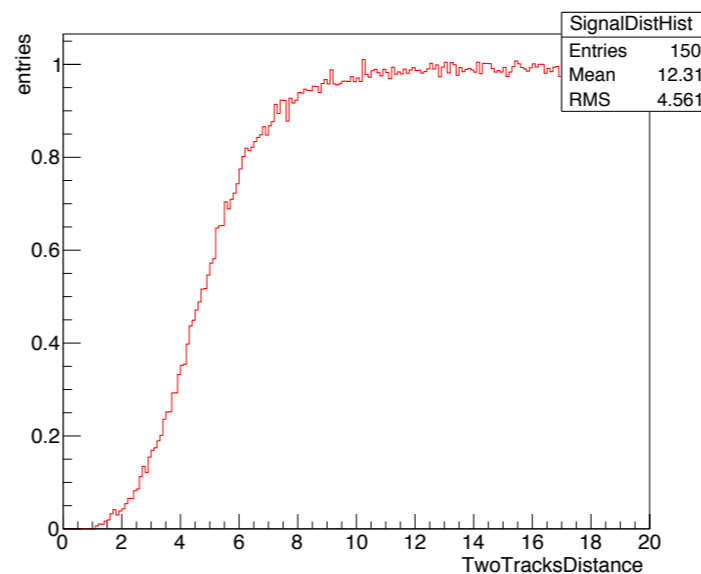
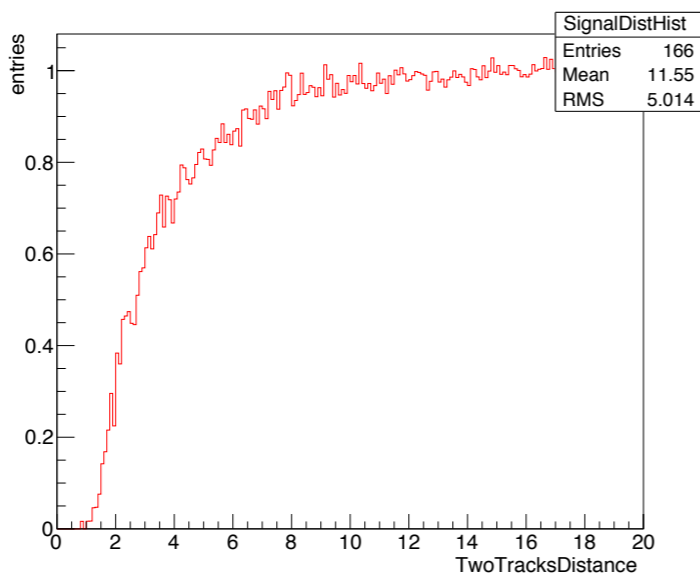
**data/mixed ratio
in Δp_T**



**data/mixed ratio
in Q_{inv}**



**data/mixed ratio
in TTD**



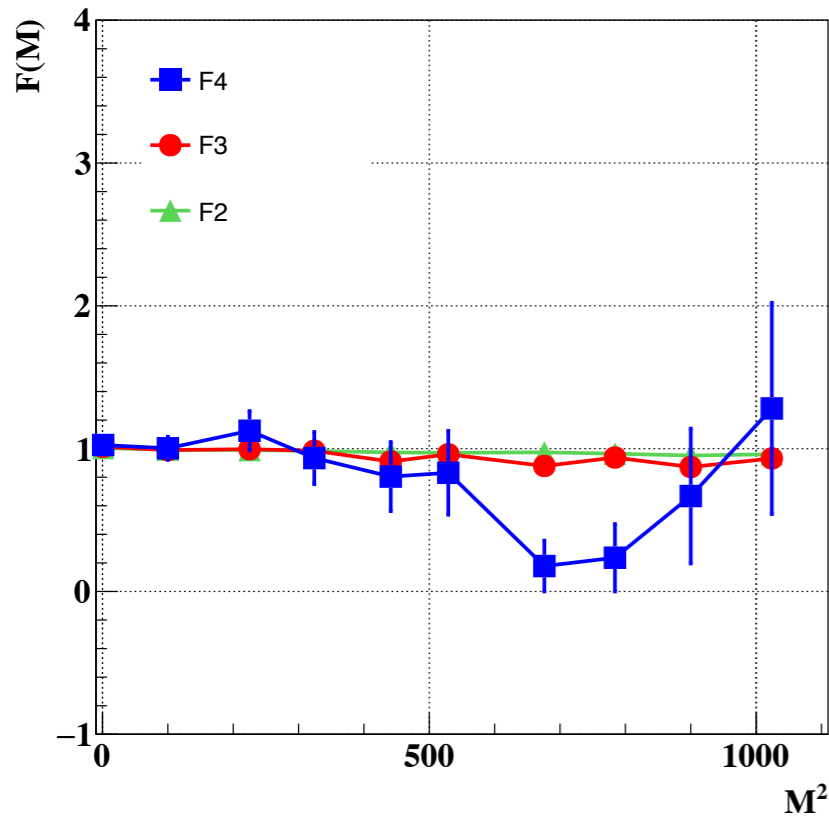
what we may want to do

(only mTTD cut
without Global ratio cut)

NO global ratio cut
mTTD cut

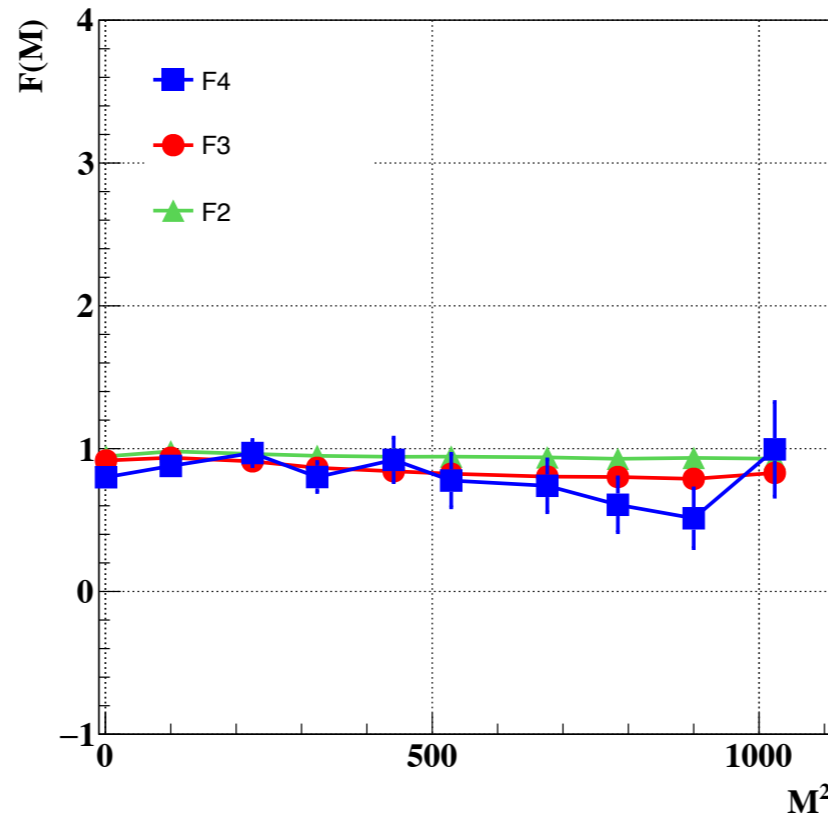
Cumulative quantities

h^-



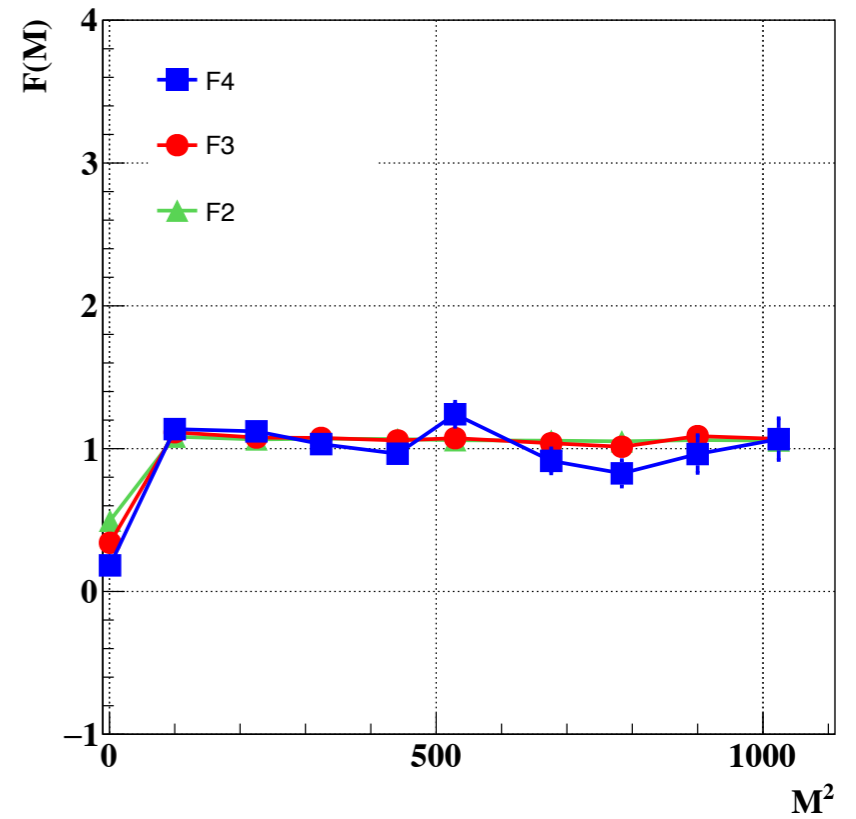
$\langle N \rangle = 37.1$

h^+



$\langle N \rangle = 52.0$

h^{+-}



$\langle N \rangle = 88.6$

* STAR claims to have $\langle N \rangle = 97$ for selected h^{+-}

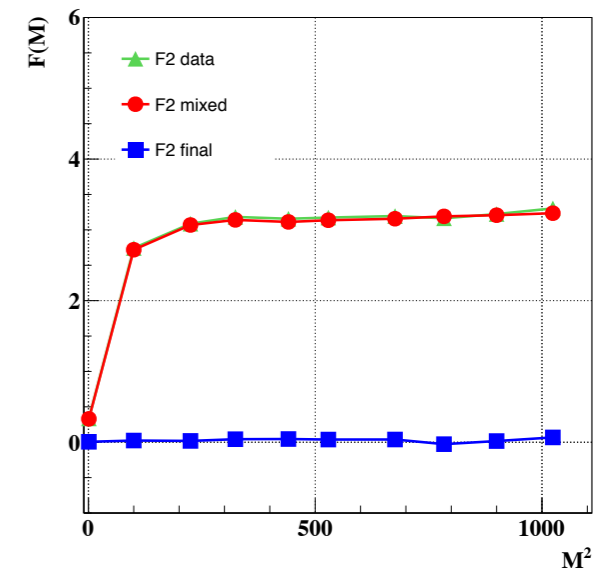
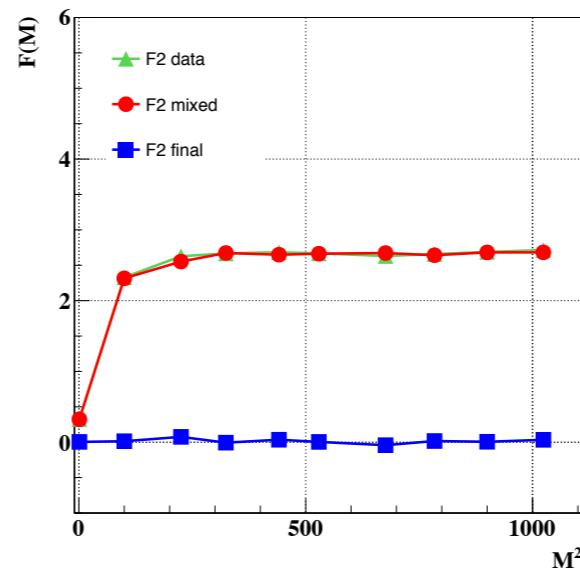
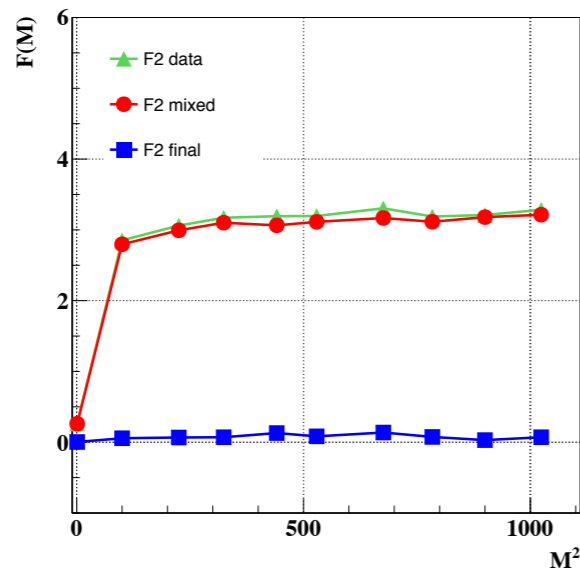
global ratio cut
mTTD cut

h^-

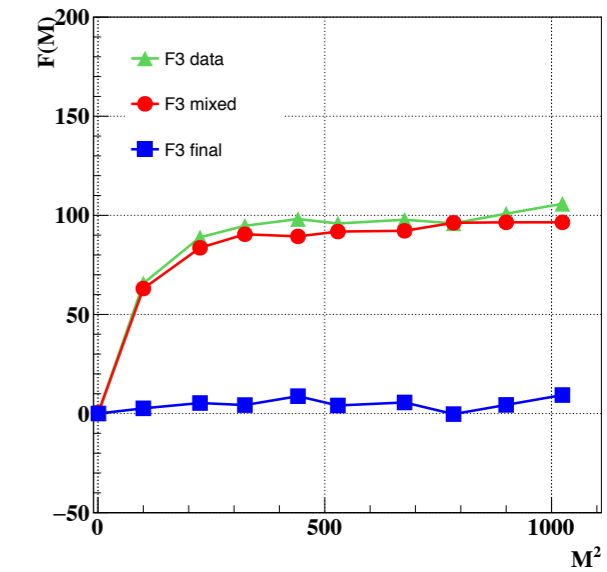
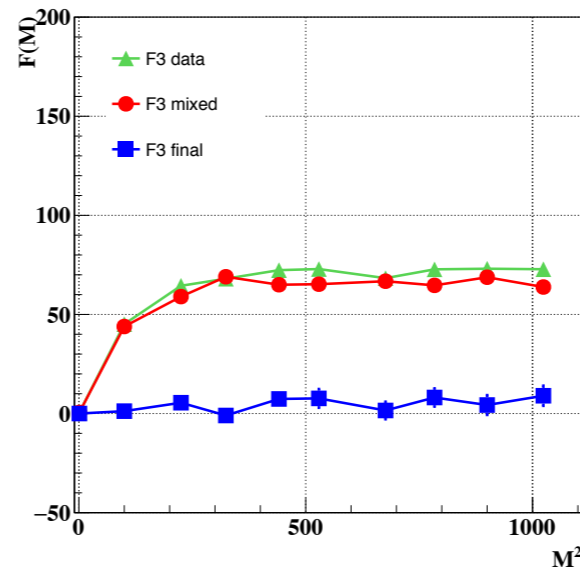
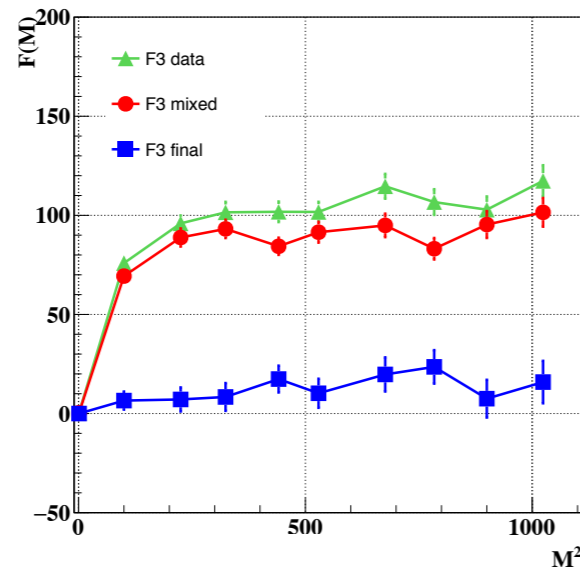
h^+

h^{+-}

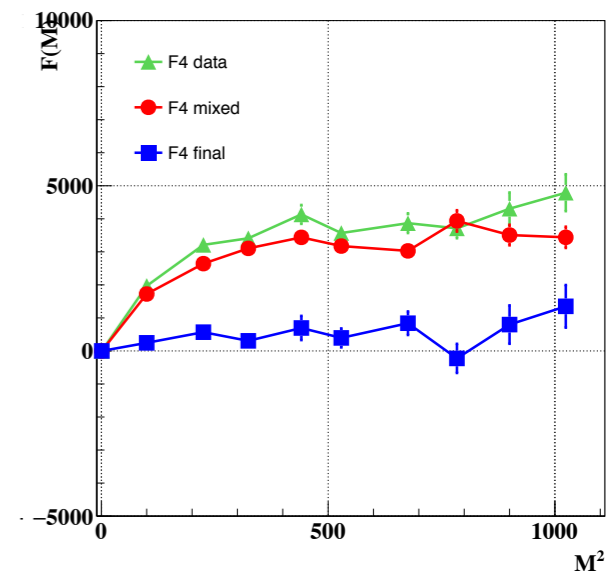
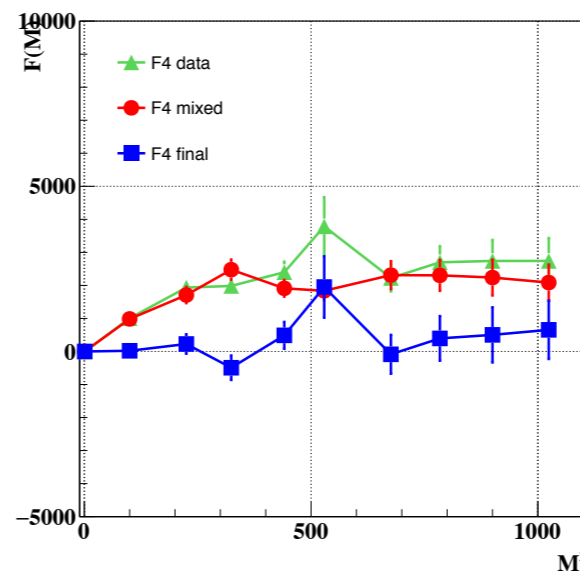
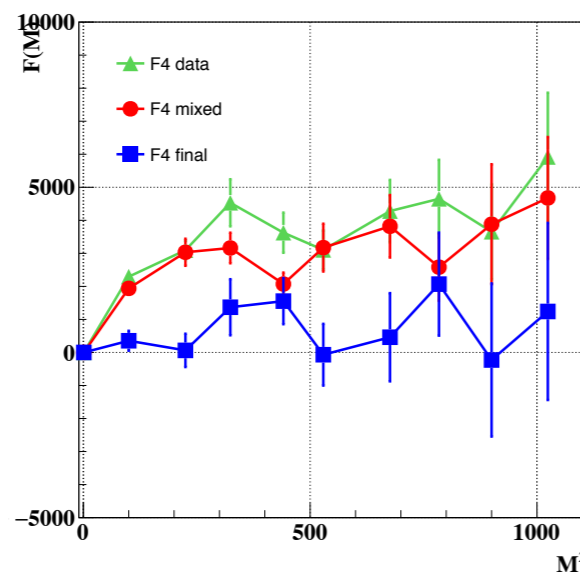
$\Delta F2(M)$



$\Delta F3(M)$



$\Delta F4(M)$



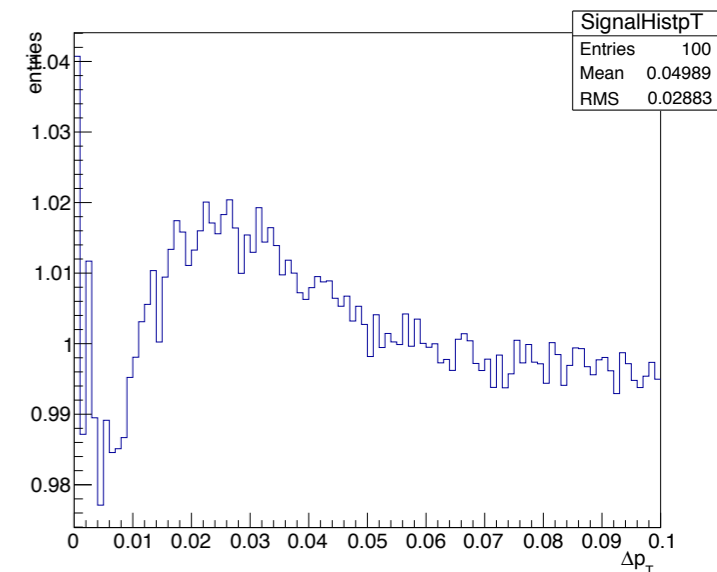
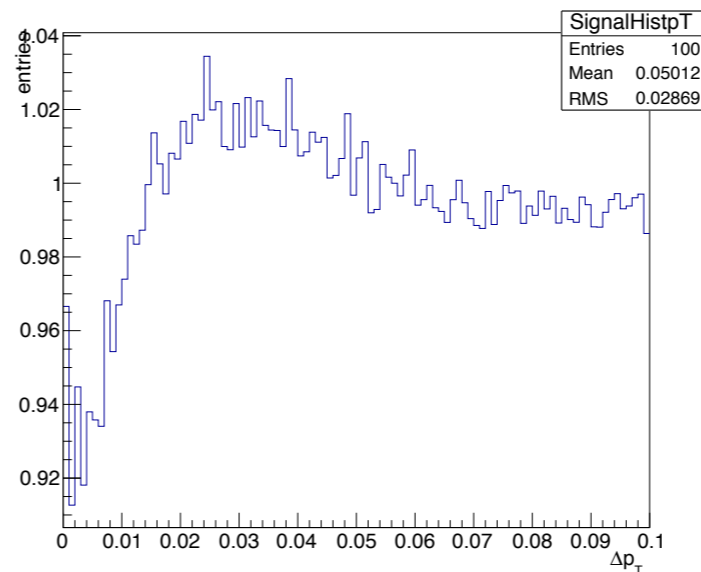
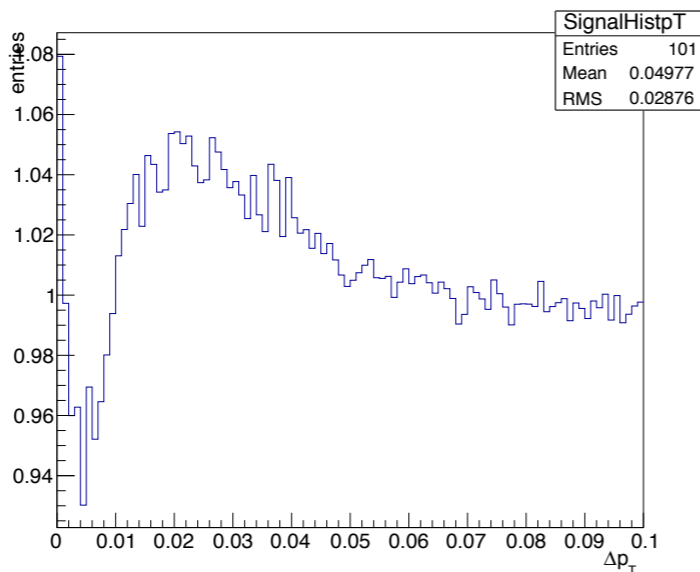
NO global ratio cut
mTTD cut

h-

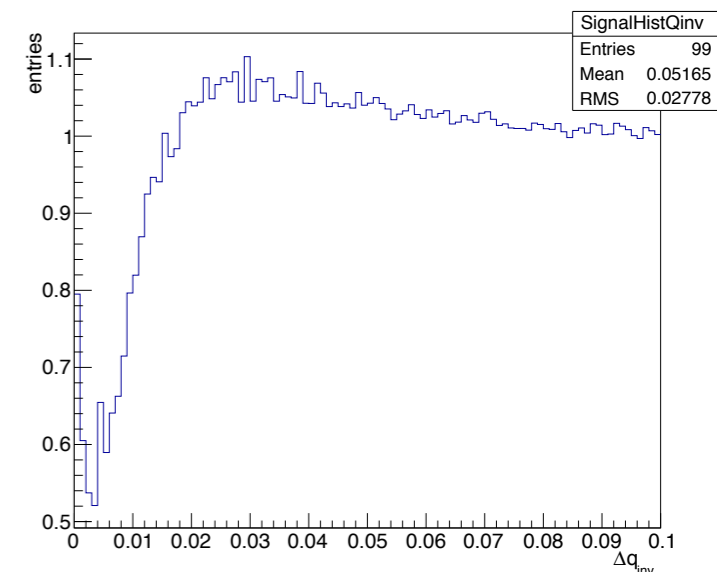
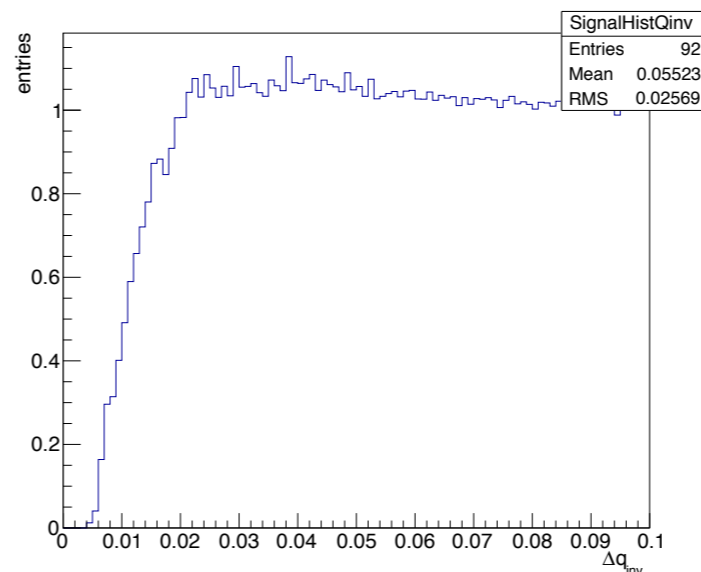
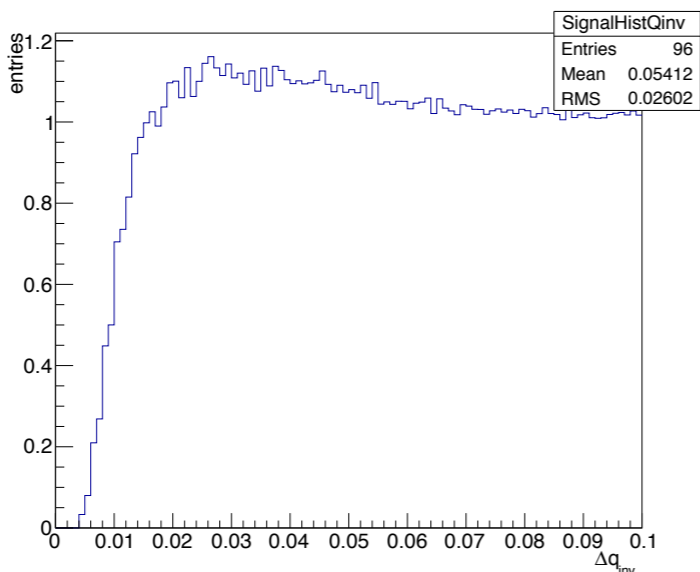
h+

h+-

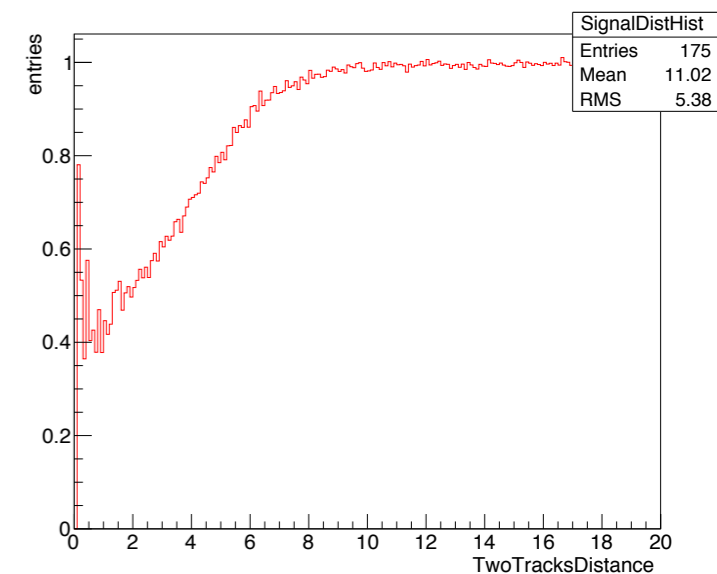
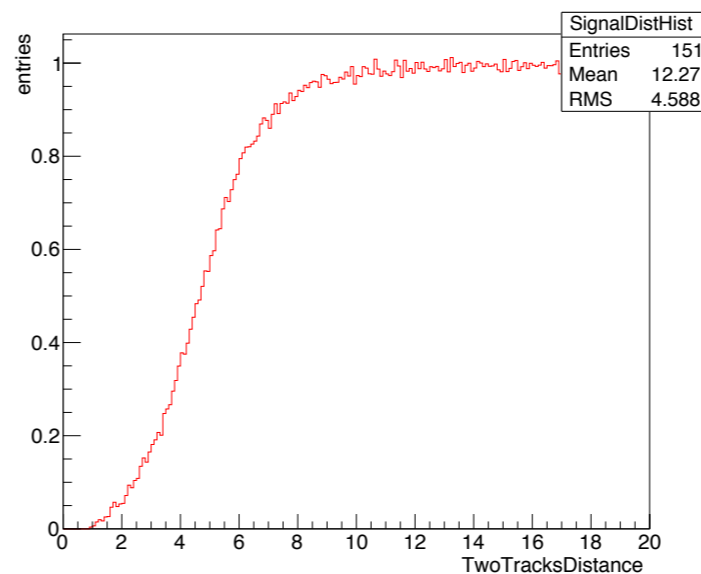
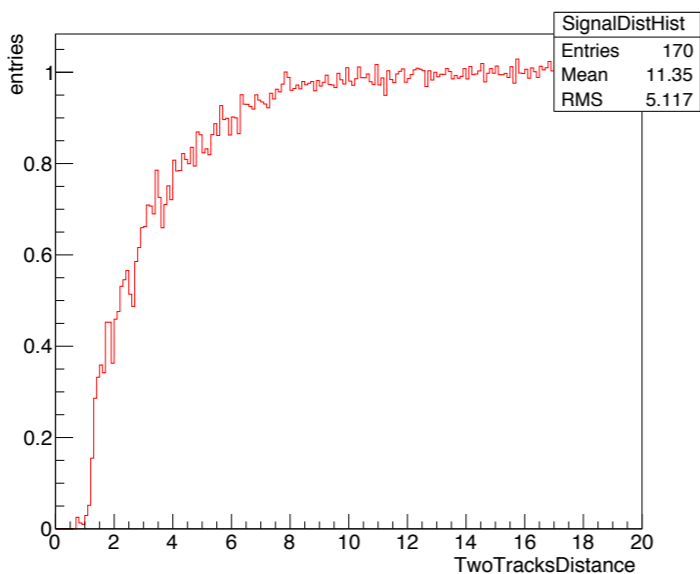
**data/mixed ratio
in Δp_T**



**data/mixed ratio
in Q_{inv}**



**data/mixed ratio
in TTD**



Conclusions

1. The results were shown on scaled factorial moments (up to 4th order) dependence on the transverse momentum bin size calculated in 10% most central Pb+Pb collisions at 30A GeV/c. $F_q(M)$ s were calculated for h^+ , h^- and h^{+-} hadrons produced in mid-rapidity.
2. Two types of analysis were done: with cumulative transformation and without it (mixed events subtracted from data).
3. The results show no signal of intermittent behavior.
4. At this moment we are ready to call the second meeting with STAR as we finished what we planned to do a comparison.

Plans

1. As for h_{+-} we have more statistics we can calculate even higher order moments
2. Maybe mTTD cut still requires better tuning

Thank you for your attention



BACK UP

STAR:

Here, i list the average multiplicity in 0-10% at $\sqrt{s_{NN}}=7.7$ GeV for protons, kaons, pions below:

Proton 16, antiproton 1

Kaon+ 4, Kaon 2

Pion+ 36, Pion- 38