

Dbar search in Bologna: status

# SKIMMING PROCEDURE OF PASS 8 DATA

Skimming: select useful data for antimatter search to have a simpler processing  
Prescaling: not useful data are not discarded but kept with a large prescaling factor

## PRESELECTION:

- Physics trigger
- InnerTracker (Chisquare X - GBL < 10 && Chisquare Y - GBL < 10)
- InnerTracker (No secondary track)
- InnerTracker (Pattern L2 && (L3 || L4) && (L5 || L6) && (L7 || L8))
- TOF (Chisquare Coo < 10 && Chisquare Time < 10)
- TOF (Ncluster == 4)
- TOF (beta > 0.3)
- For Z=1 events only: TRD (Nhits > 10)

## UPGOING EVENTS ARE DISCARDED

### PRESCALING:

Negatives that pass the selection: 1  
Negatives that doesn't pass the selection: 1/80  
Positives that pass the selection: 1/800  
Positives that doesn't pass the selection: 1/800

## ANTIMATTER ANALYSIS SKIMMED NTUPLES:

- Processed 206000 ntuples in blocks of 50 runs (total 4120 root files)
- Total disk space: 3.6 TB
- Processing time: 7 days

# SAMPLE DEFINITION

ALL THE ANALYSIS IS DONE USING 50000 NTUPLES

12 samples defined in the TOF analysis range using:

- beta -> betaH (TOF)
- Rigidity -> GBL (InnerTracker)
- Charge -> InnerTracker
- $0.3 < \beta < 0.8$

MASS SELECTION is used to discriminate “bad” and “good” samples:

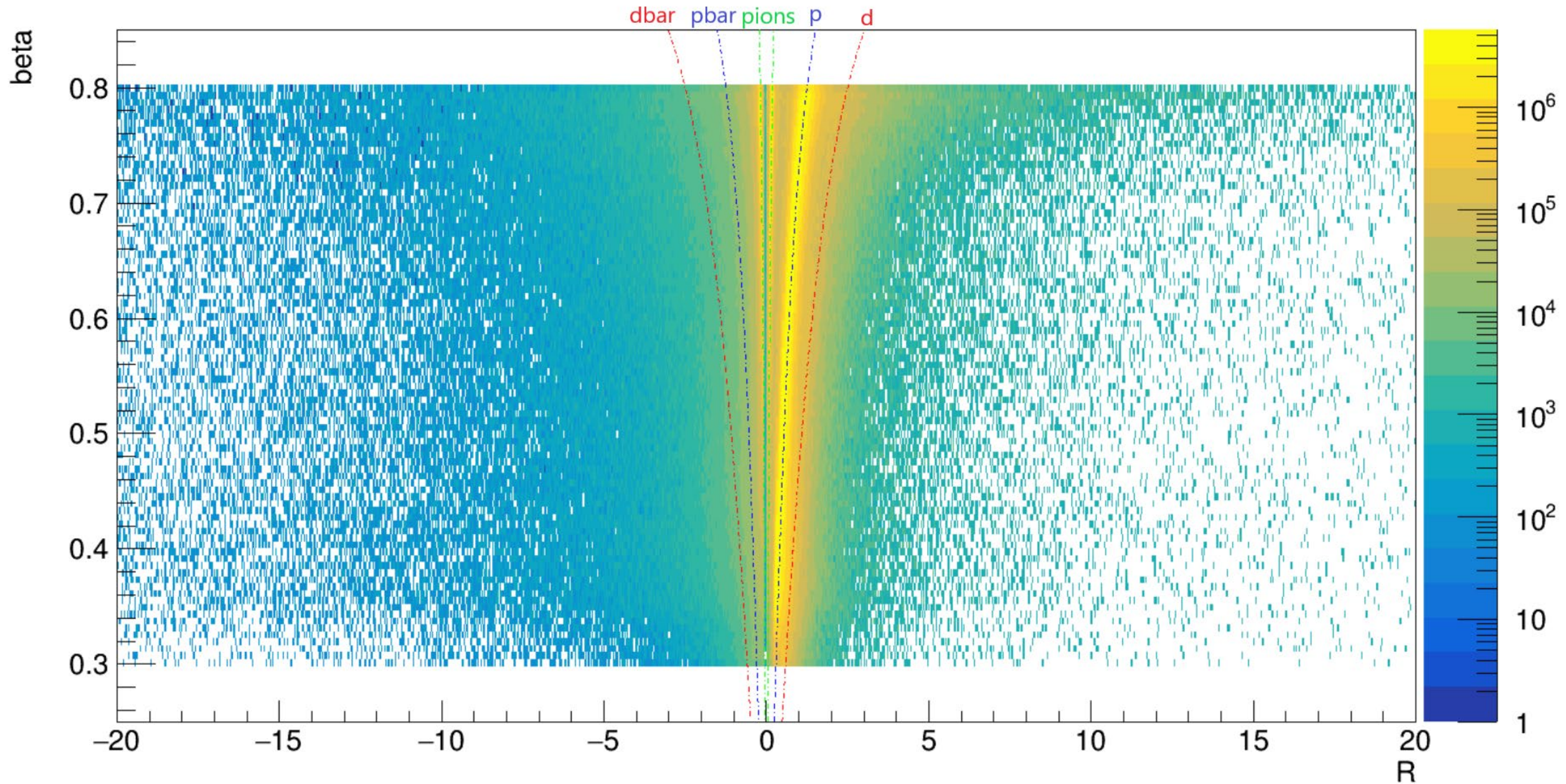
$$\frac{\sigma_m}{m} = \frac{\Delta R}{R} \oplus \frac{1}{(1 - \beta^2)} \frac{\Delta \beta}{\beta}$$

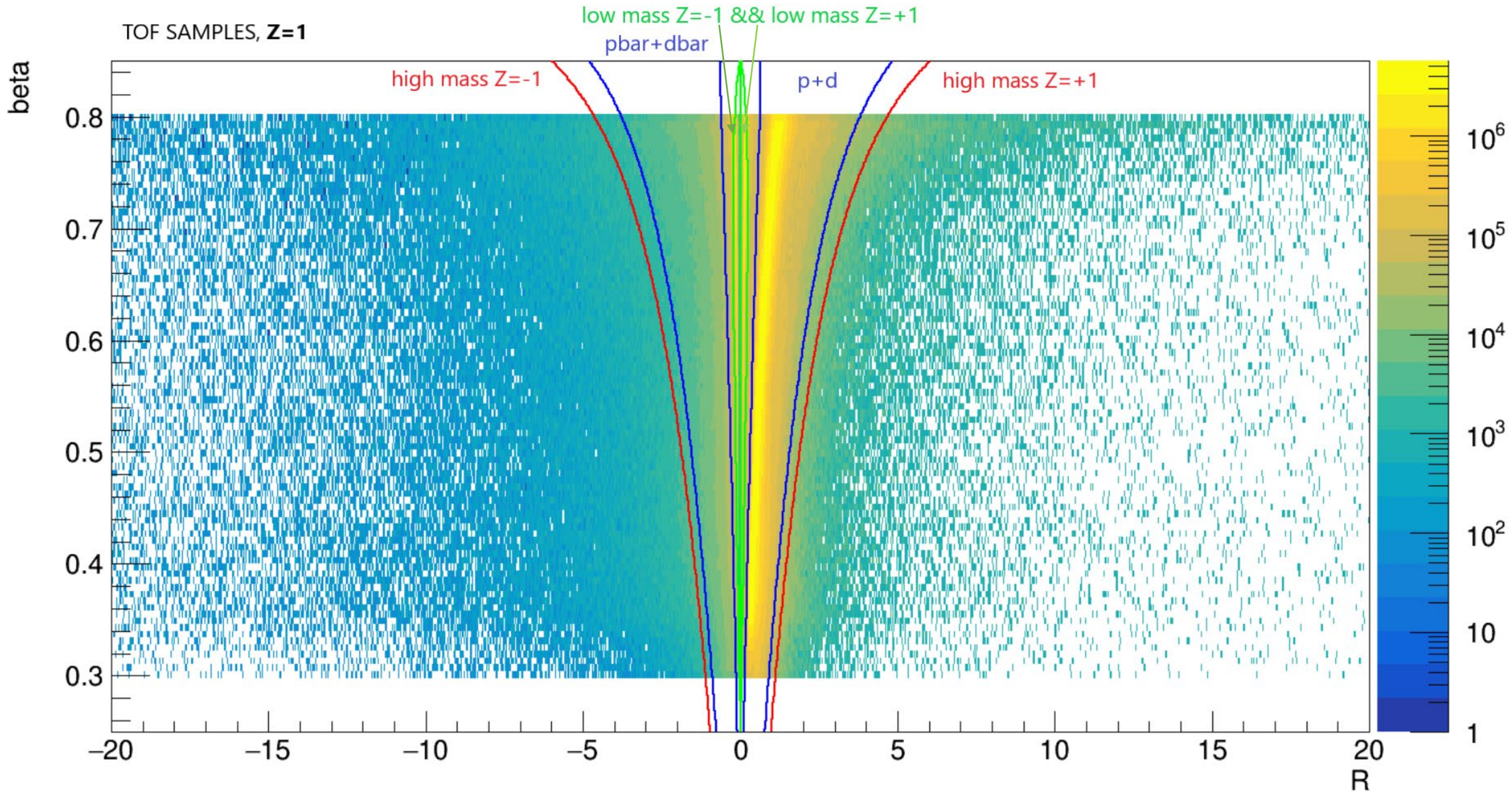
Assuming:  $\frac{\Delta R}{R} \cong 0.1$  for  $R < 100$  GeV

$\Delta \beta \cong 0.04$  at  $\beta = 1$  and  $Z=1$

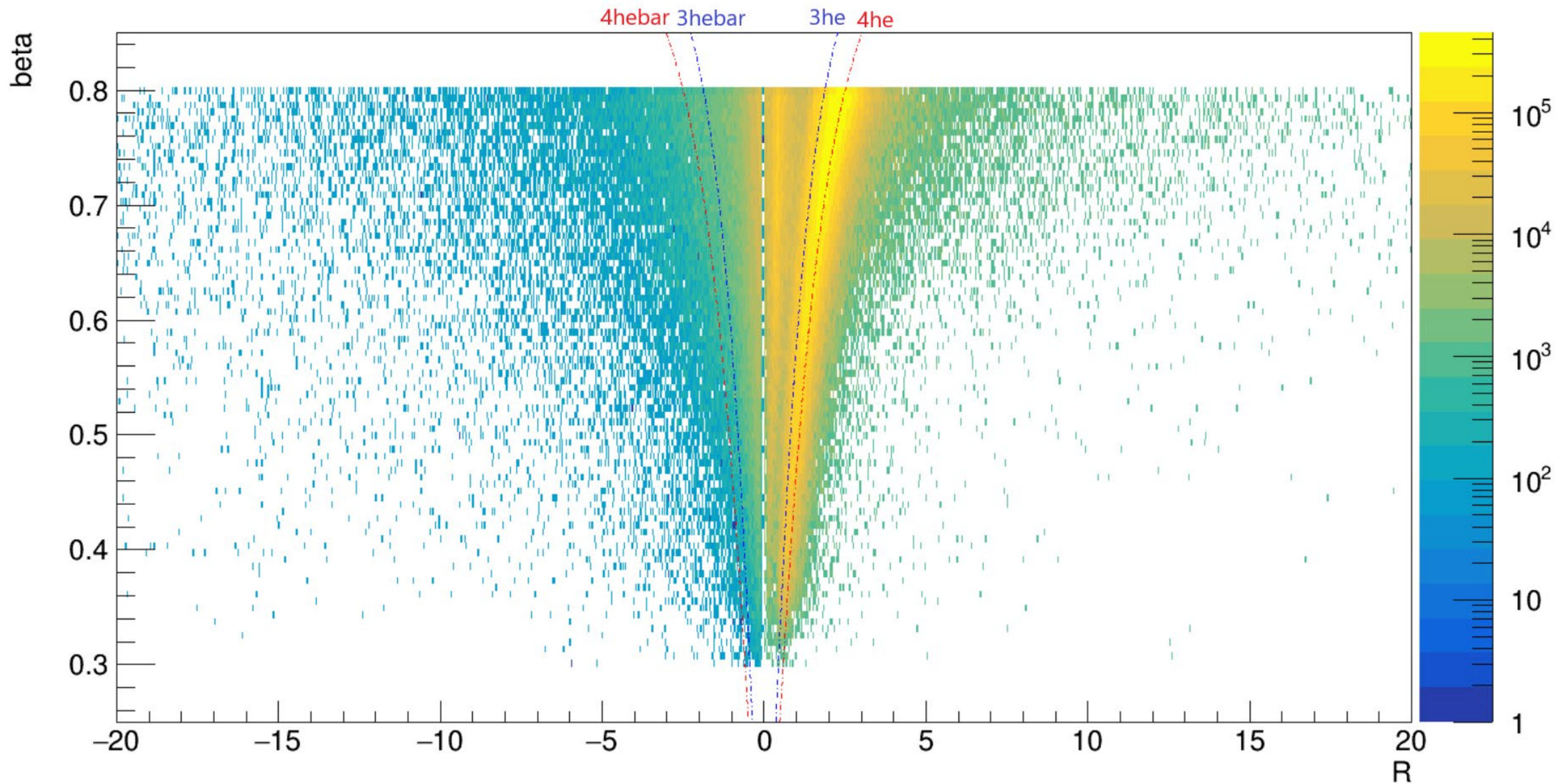
	POSITIVES	NEGATIVES
Z = 1	Low mass Z=+1: $m < m_p (1 - 5\sigma_m)$ p+d: $m_p (1 - 3\sigma_m) < m < m_d (1 + 3\sigma_m)$ High mass Z=+1: $m > m_d (1 + 5\sigma_m)$	Low mass Z=-1: $m < m_p (1 - 5\sigma_m)$ pbar+dbar: $m_p (1 - 3\sigma_m) < m < m_d (1 + 3\sigma_m)$ High mass Z=-1: $m > m_d (1 + 5\sigma_m)$
Z = 2	Low mass Z=+2: $m < m_{3he} (1 - 5\sigma_m)$ He: $m_{3he} (1 - 3\sigma_m) < m < m_{4he} (1 + 3\sigma_m)$ High mass Z=+2: $m > m_{4he} (1 + 5\sigma_m)$	Low mass Z=-2: $m < m_{3he} (1 - 5\sigma_m)$ Hebar: $m_{3he} (1 - 3\sigma_m) < m < m_{4he} (1 + 3\sigma_m)$ High mass Z=-2: $m > m_{4he} (1 + 5\sigma_m)$

TOF SAMPLES, **Z=1** EVENTS



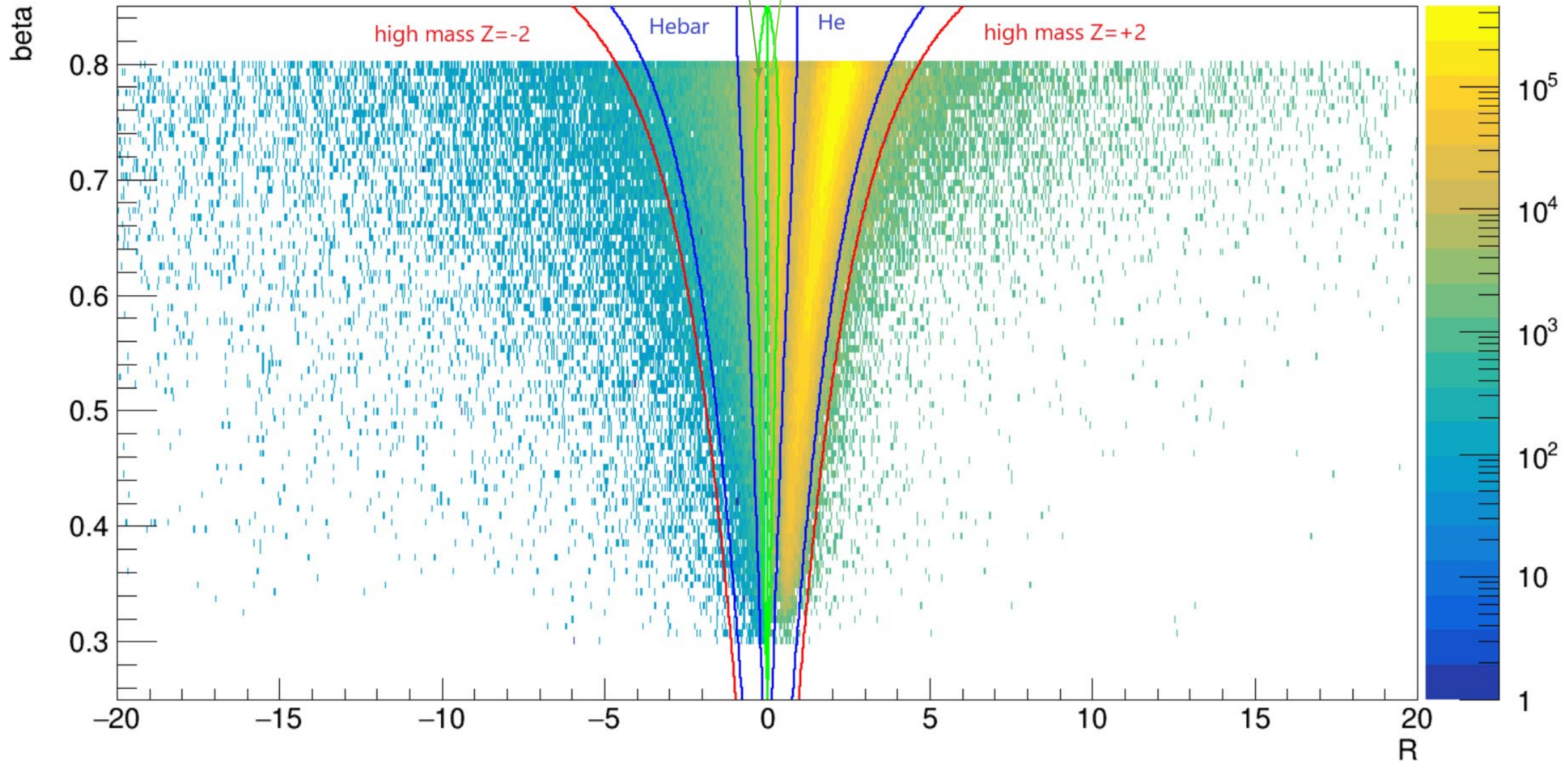


TOF SAMPLES, Z=2 EVENTS



TOF SAMPLES,  $Z=2$

Low mass  $Z=+2$  && Low mass  $Z=-2$

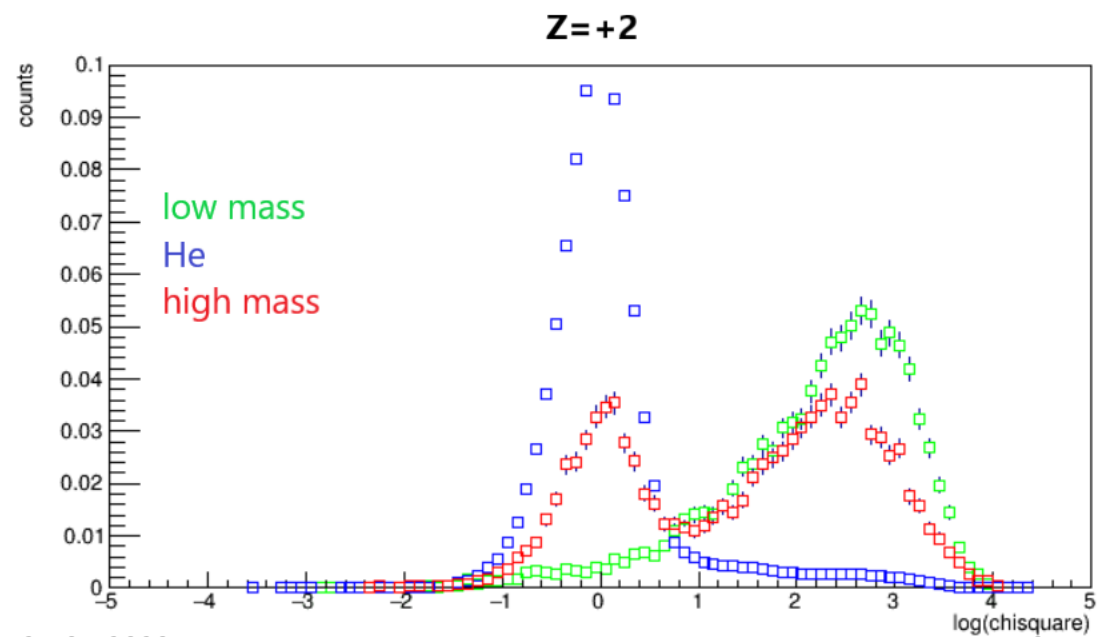
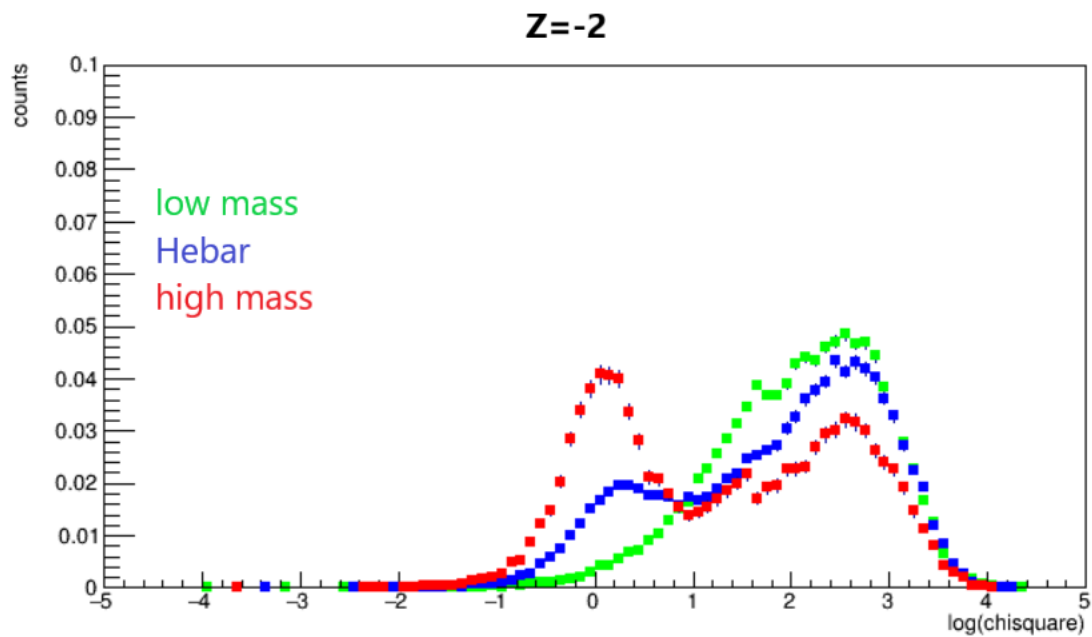
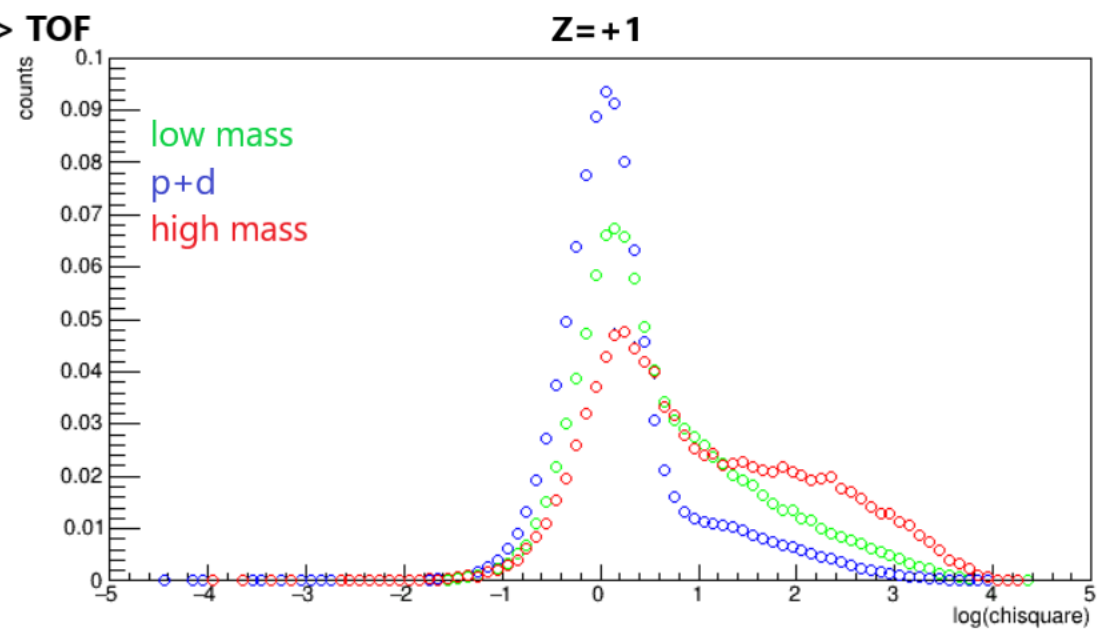
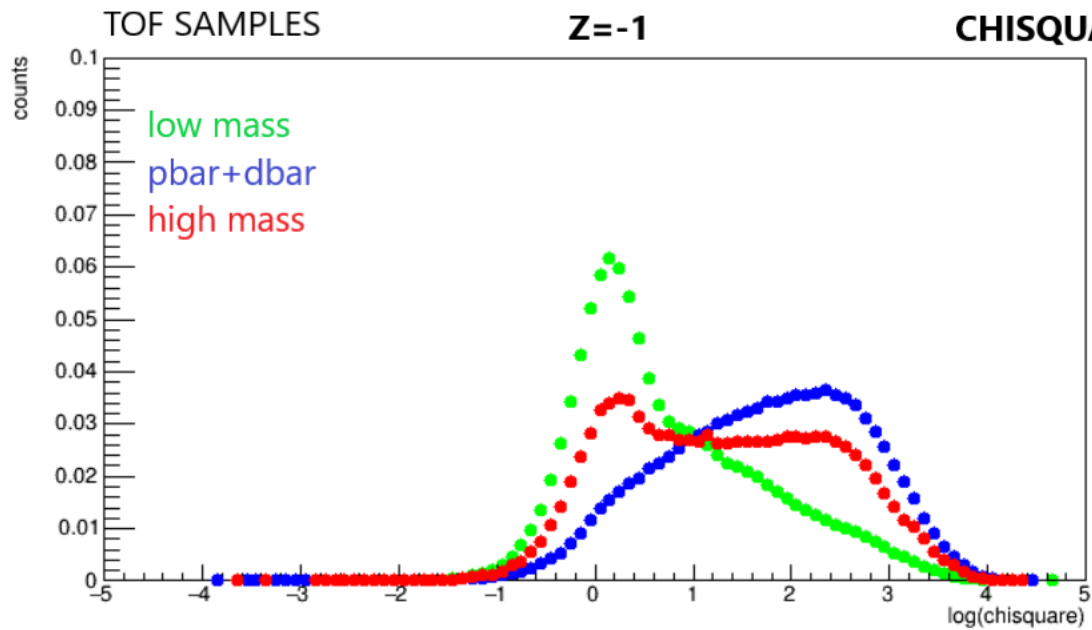


# FIRST LOOK STRATEGY

ALL THE VARIABLES ARE TREATED AS INDEPENDENT FROM EACH OTHER

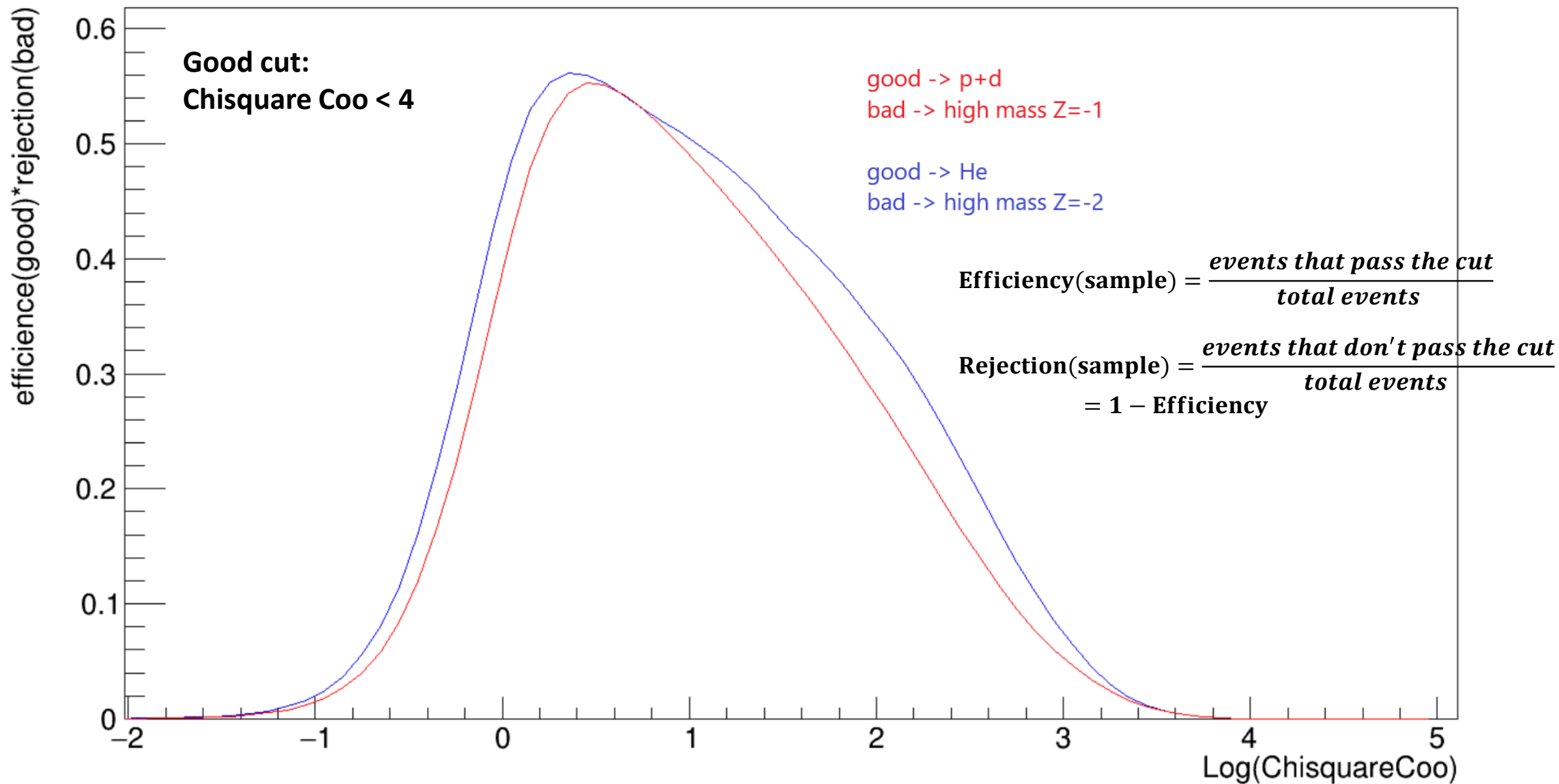
1. Plot the distributions for all the samples
2. Calculate the efficiency and the rejection
3. Choose the cut in order to maximize the product of efficiency of the good events and the rejection of the bad ones
4. Evaluate the results of the cut

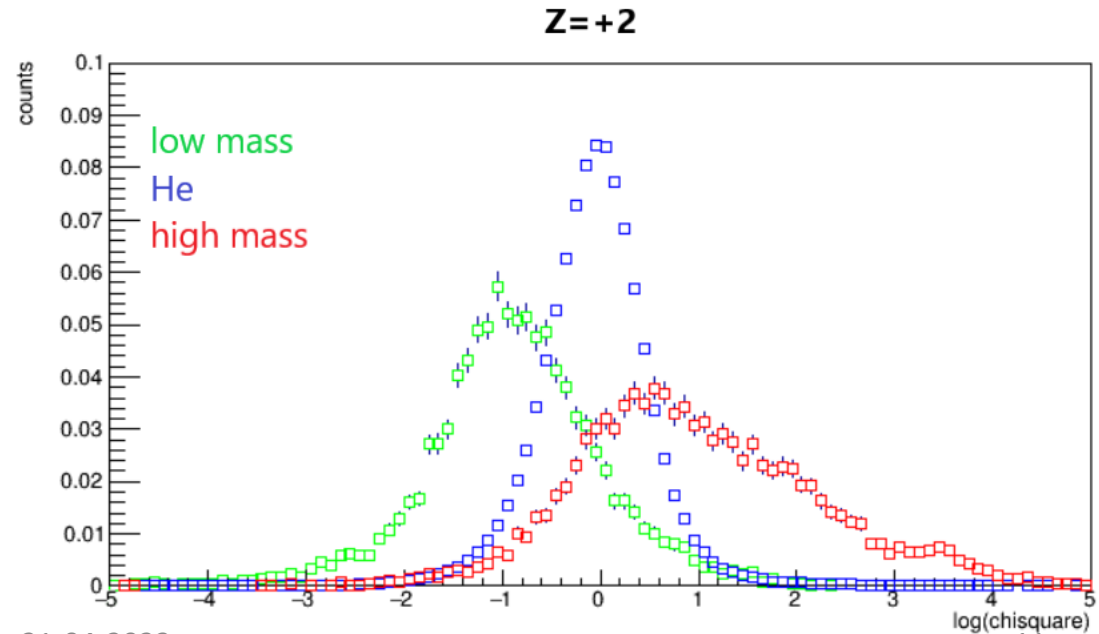
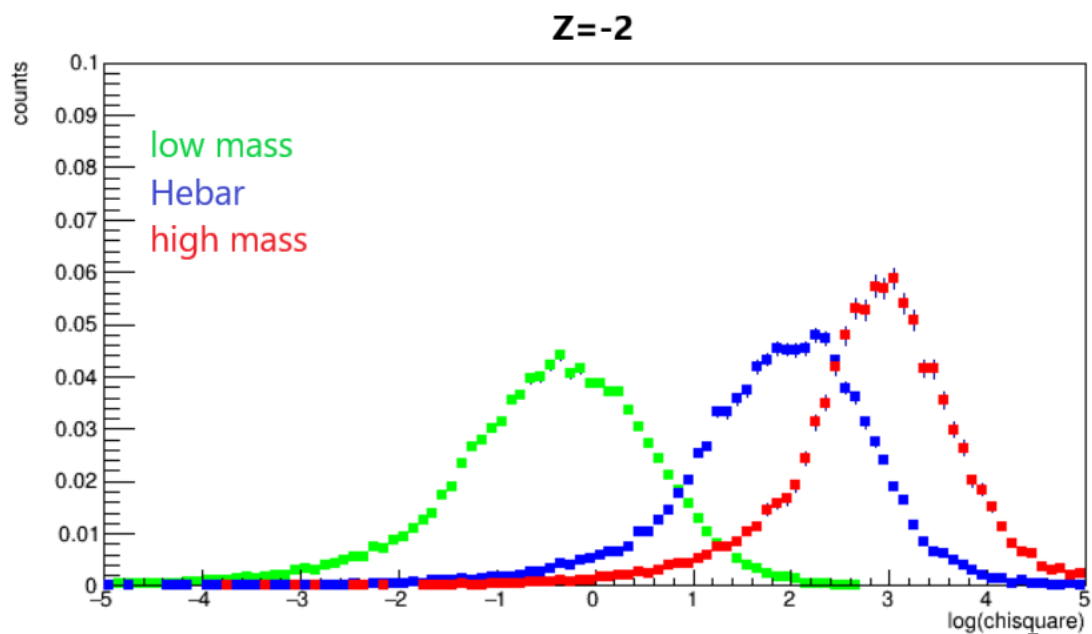
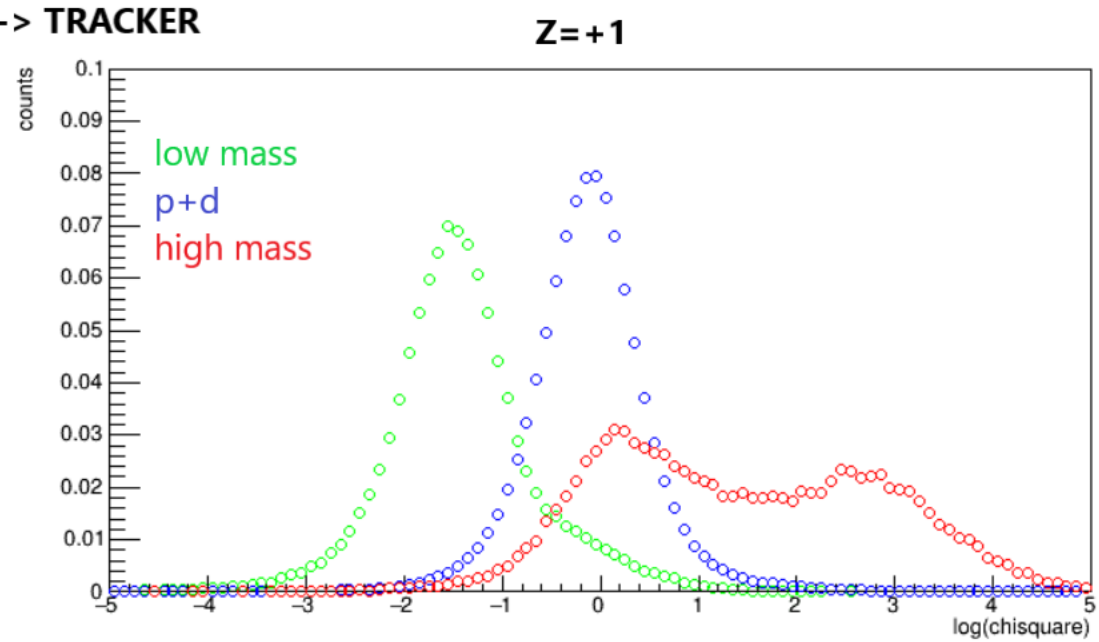
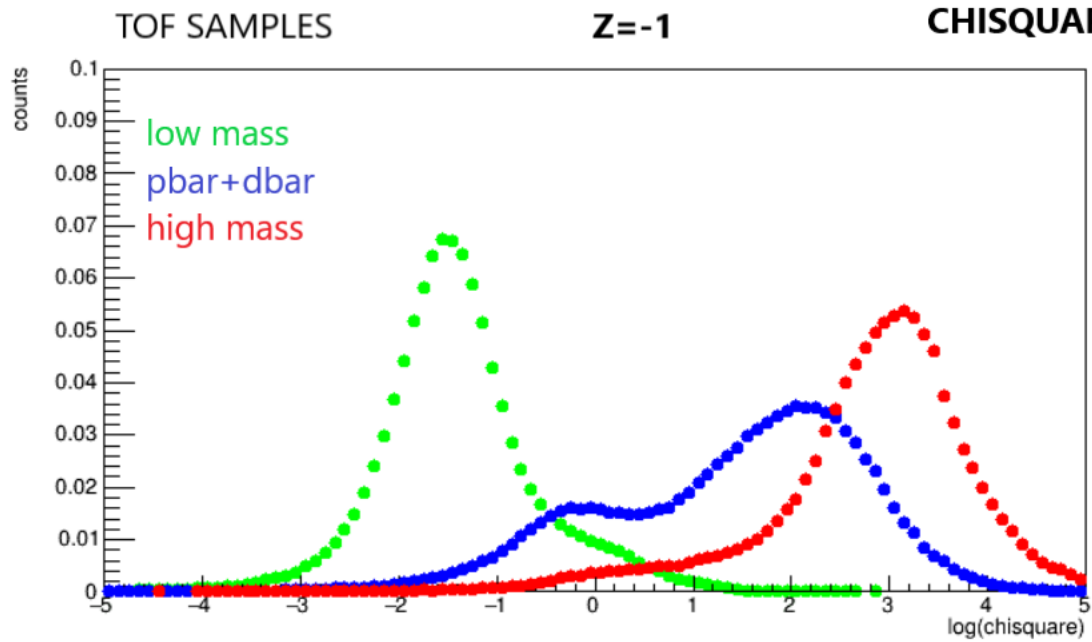


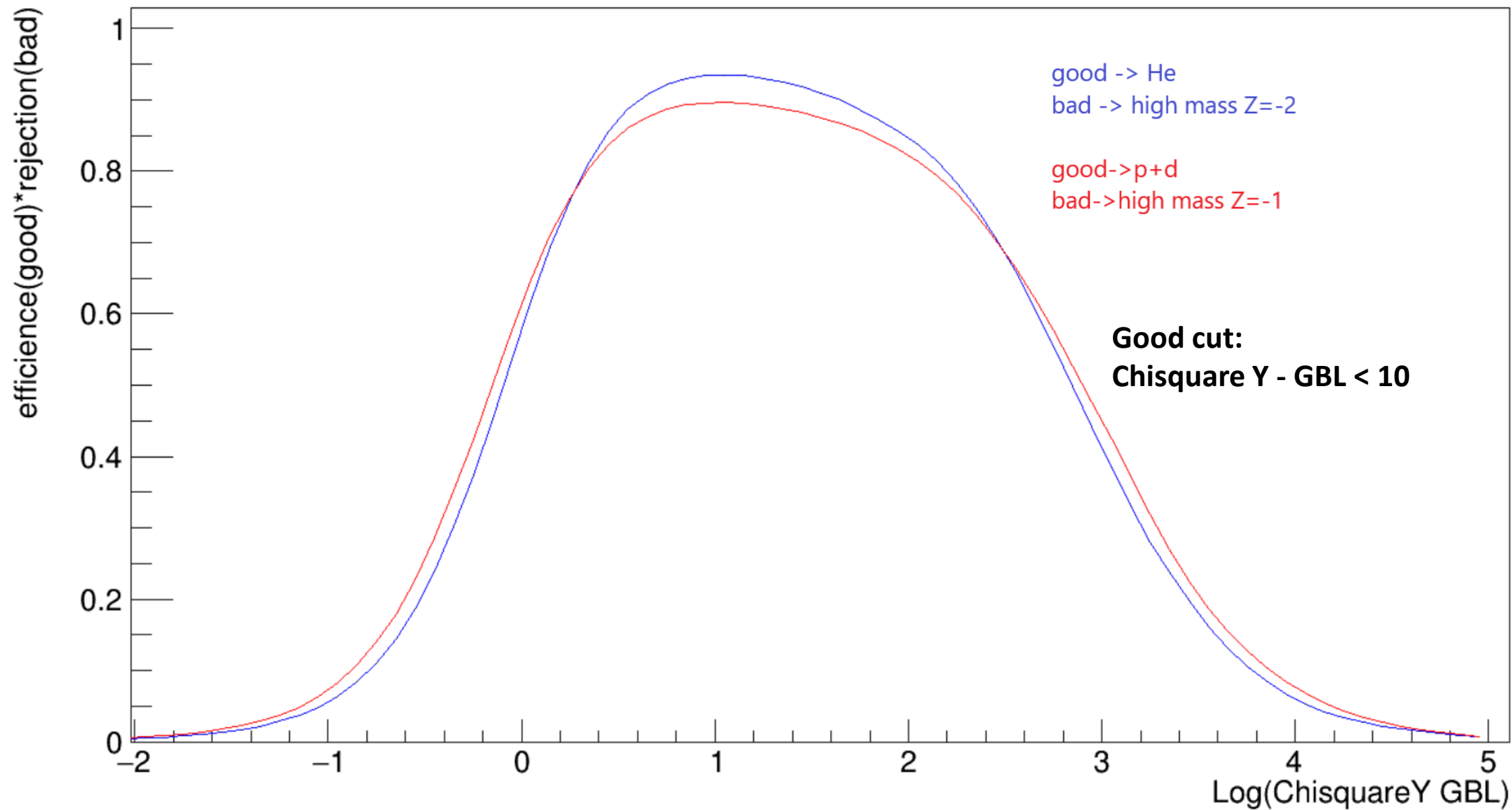


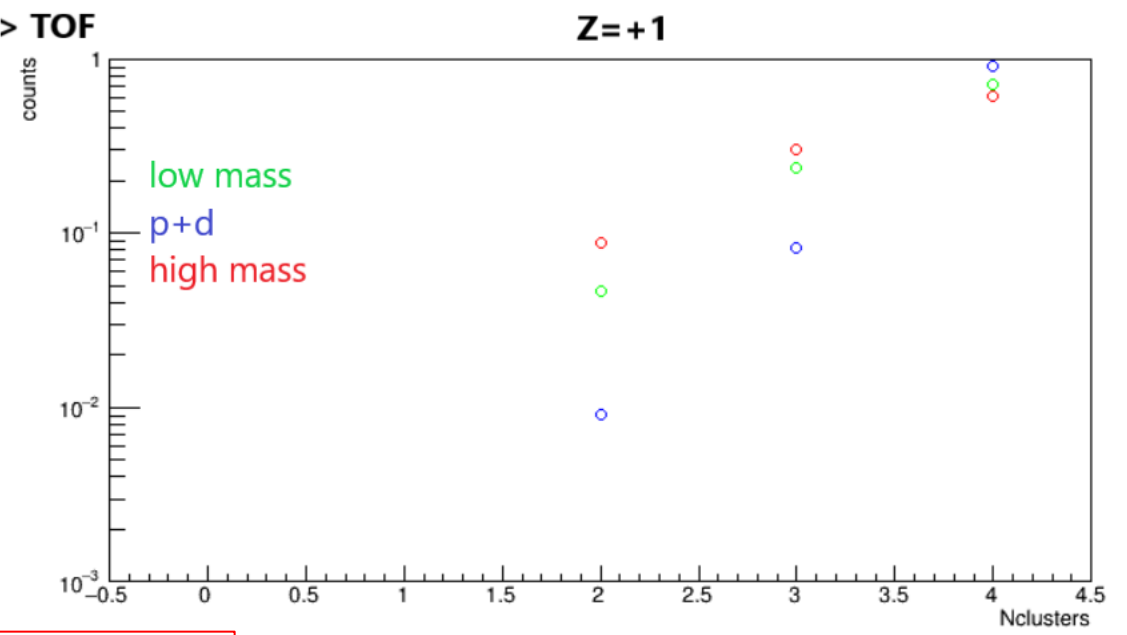
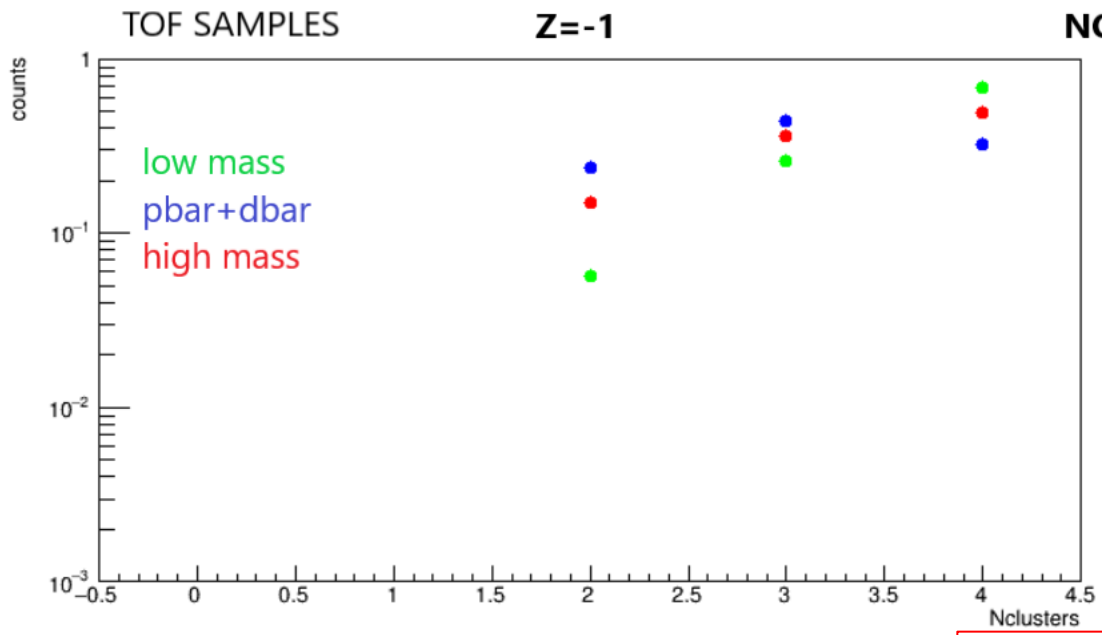
TOF SAMPLES

CHISQUARE COO -> TOF

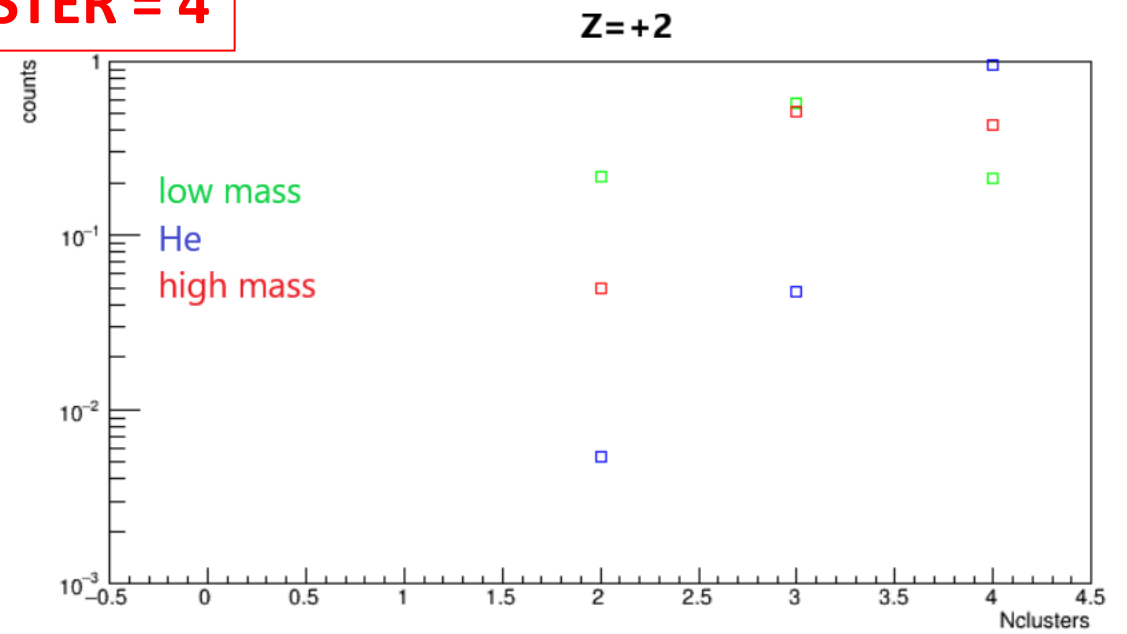
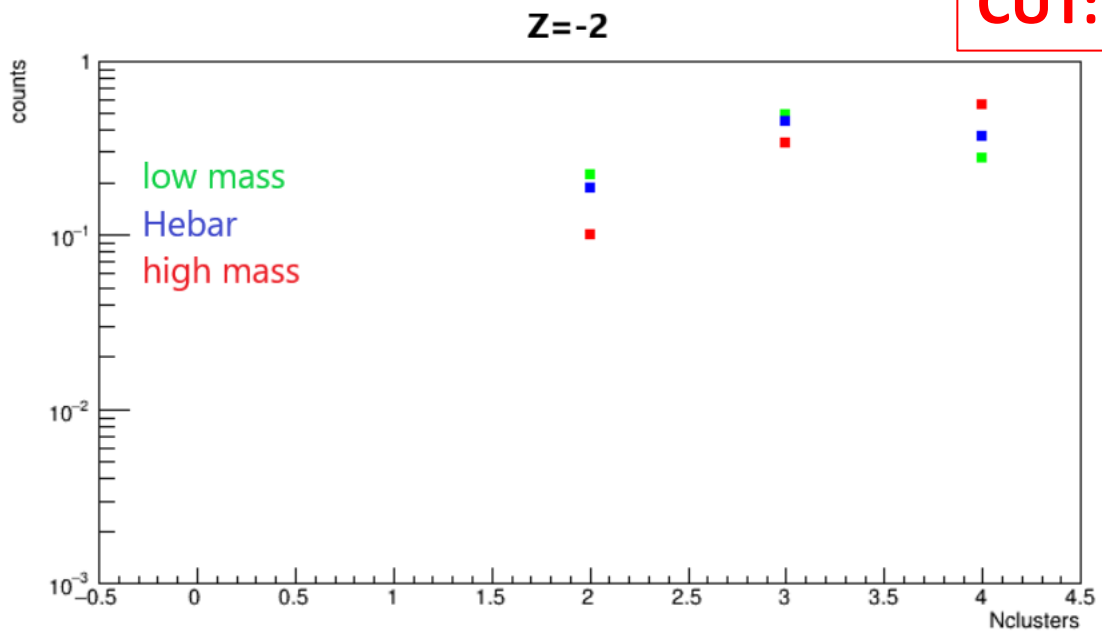


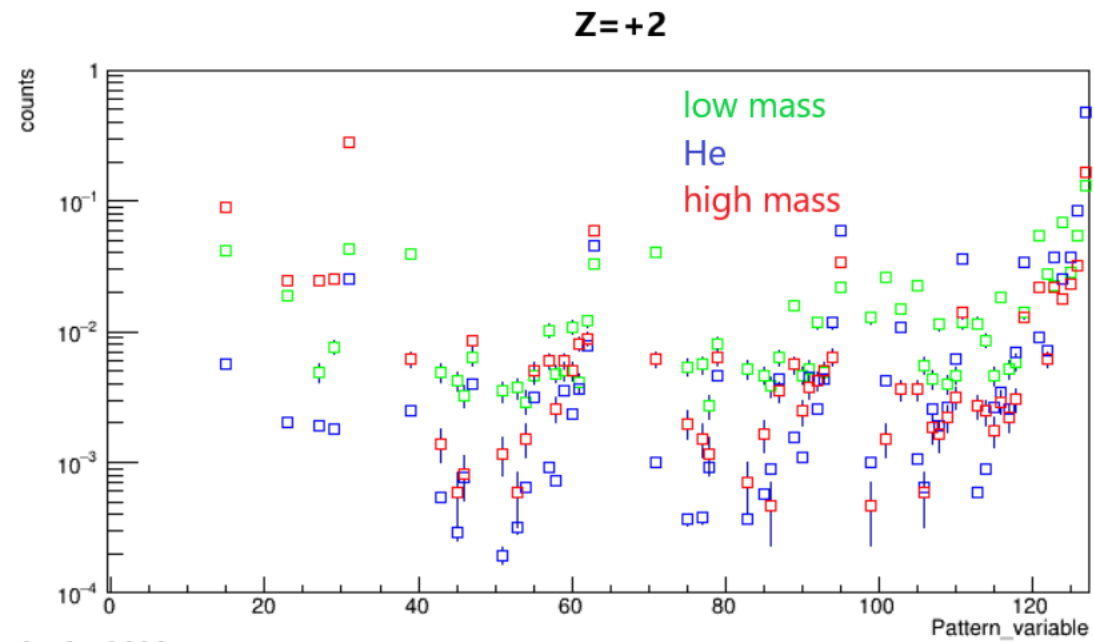
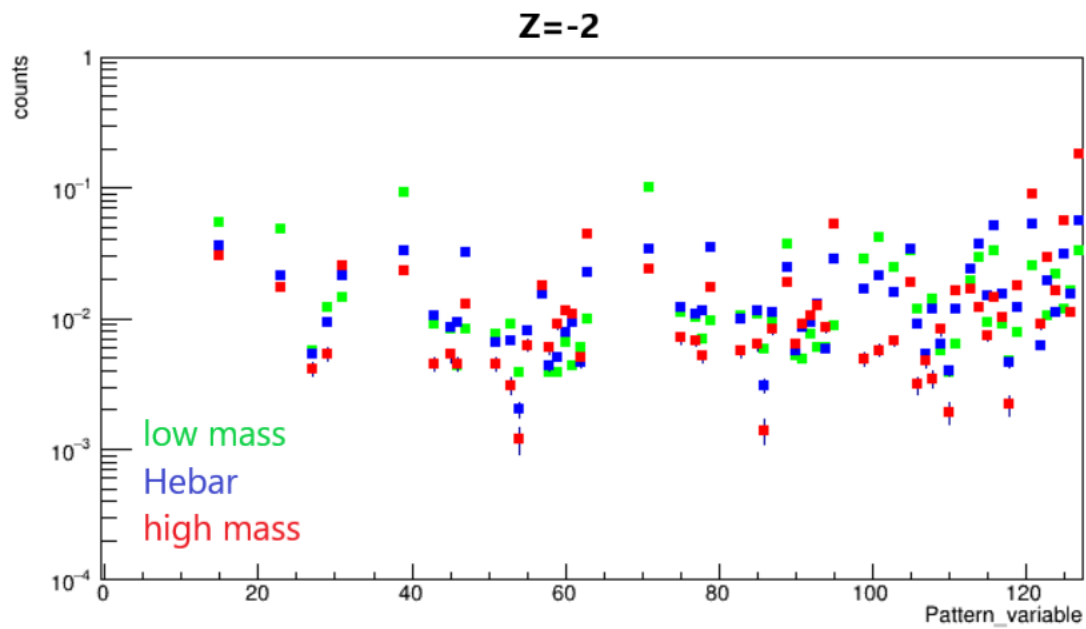
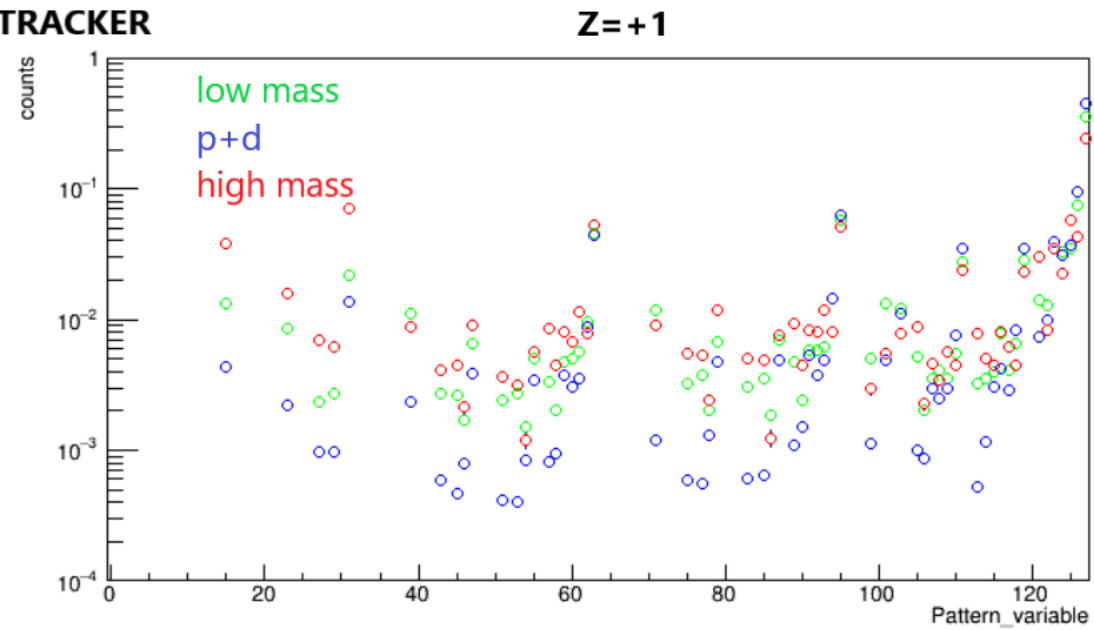
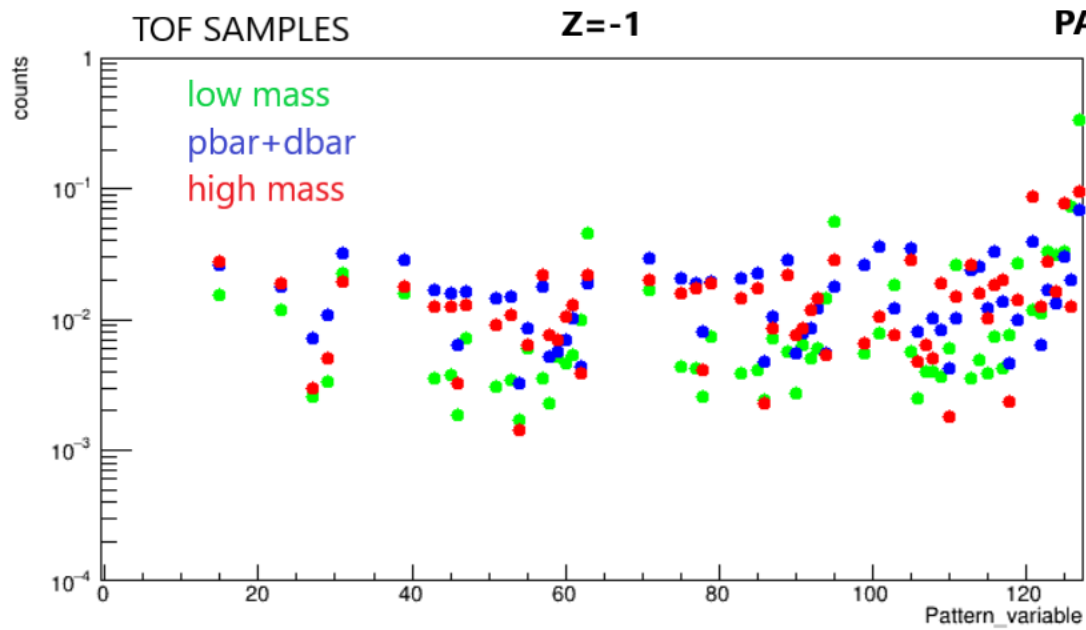


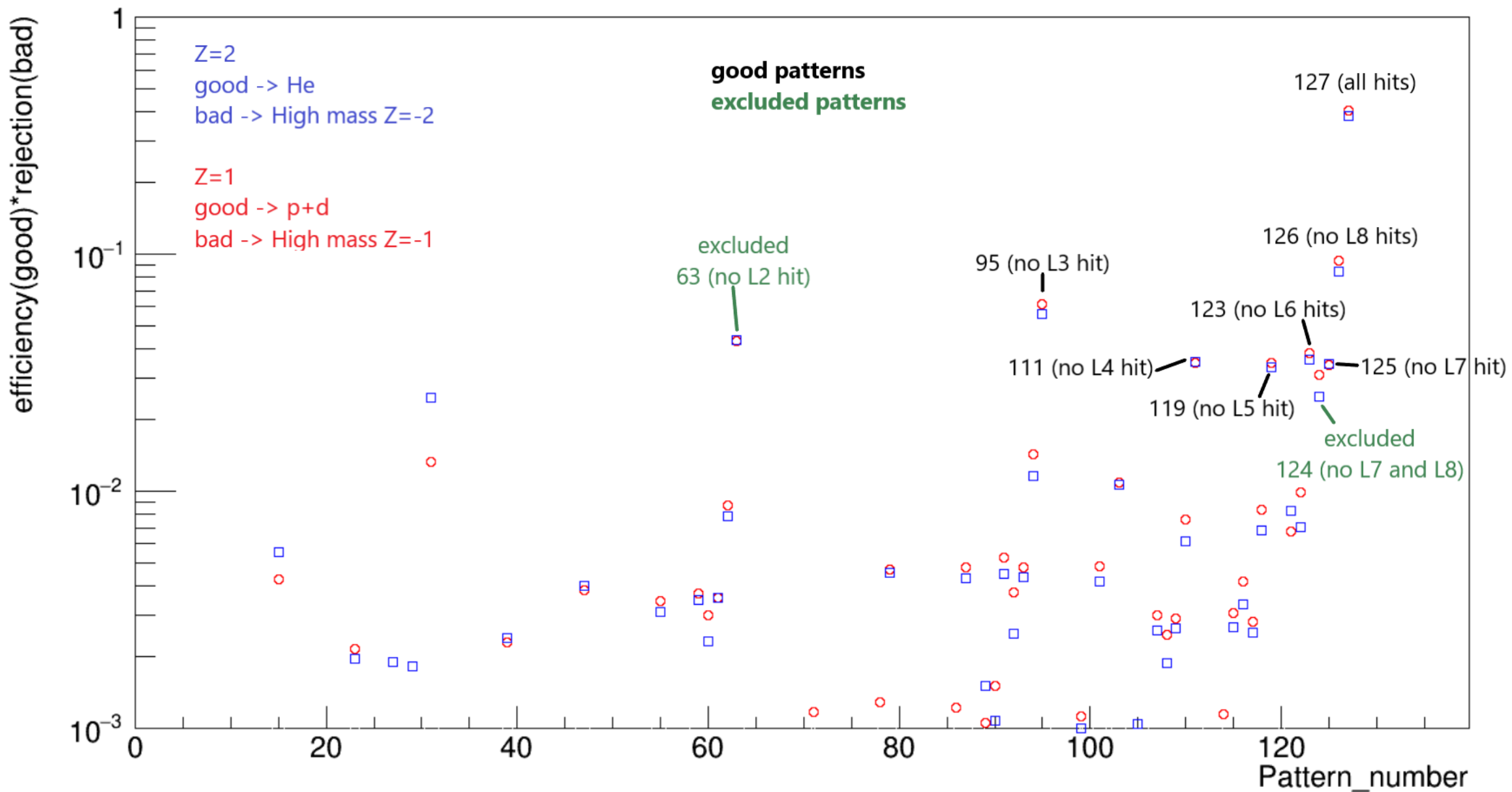


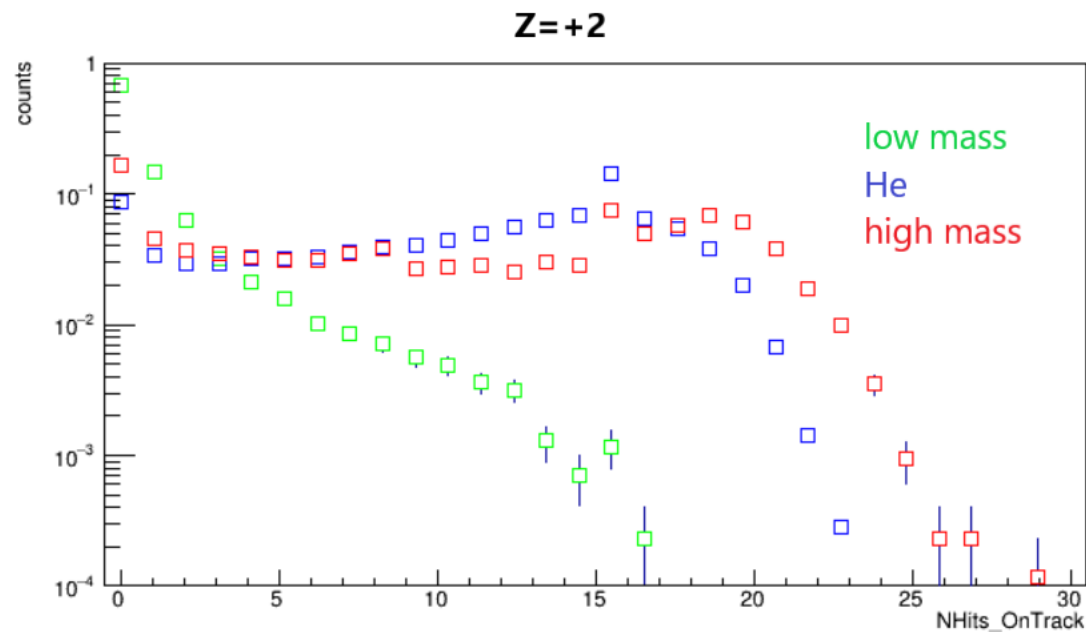
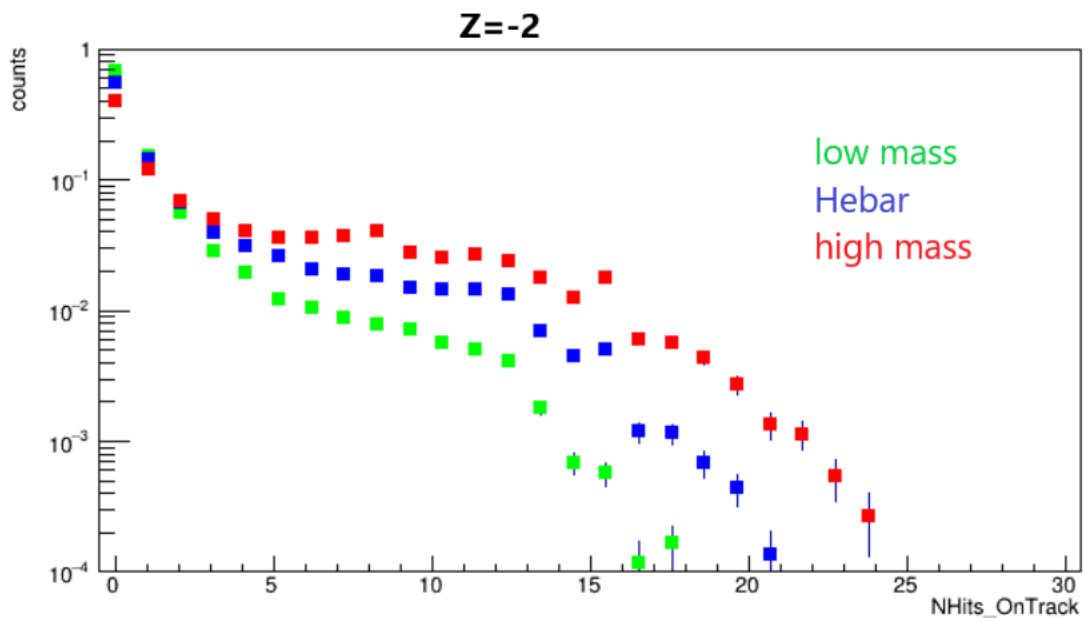
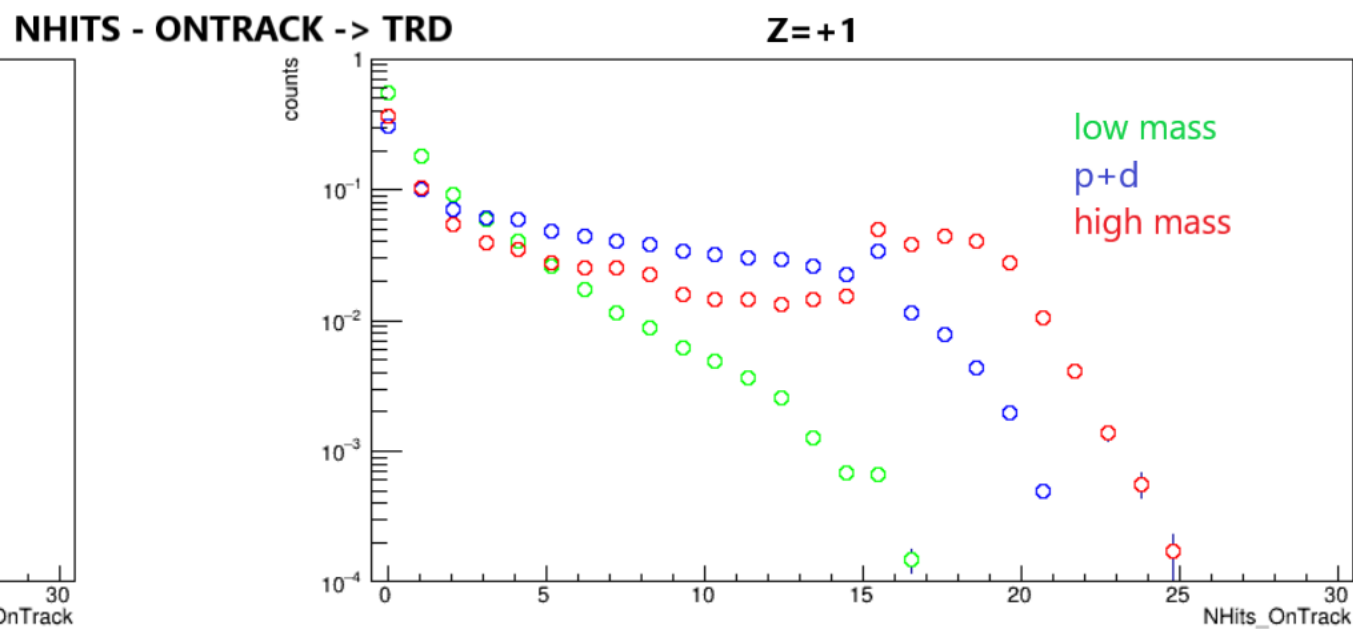
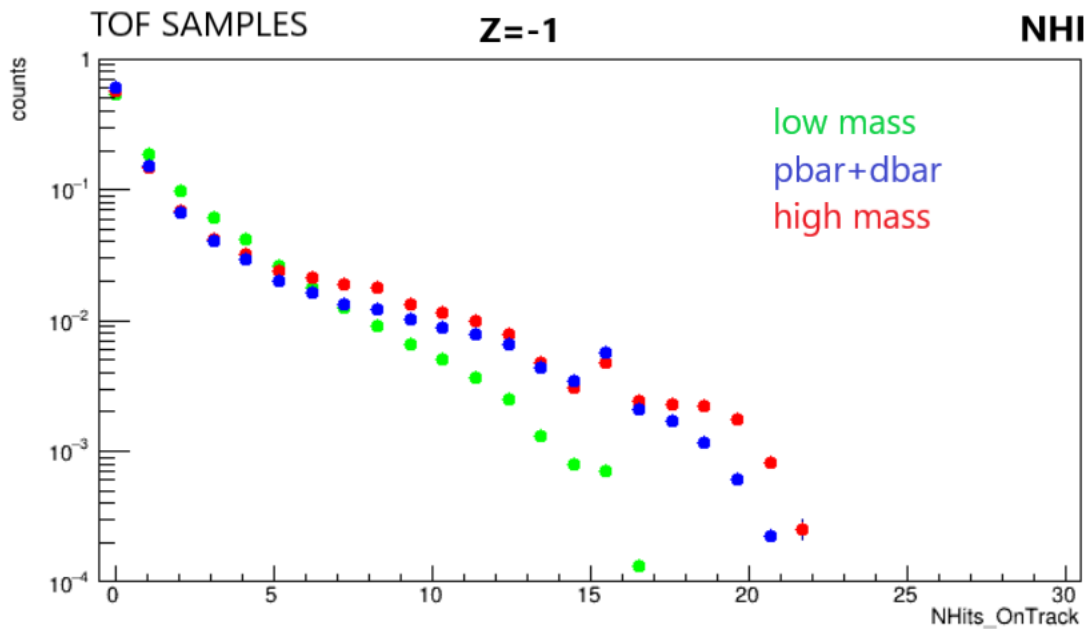


**CUT: NCLUSTER = 4**



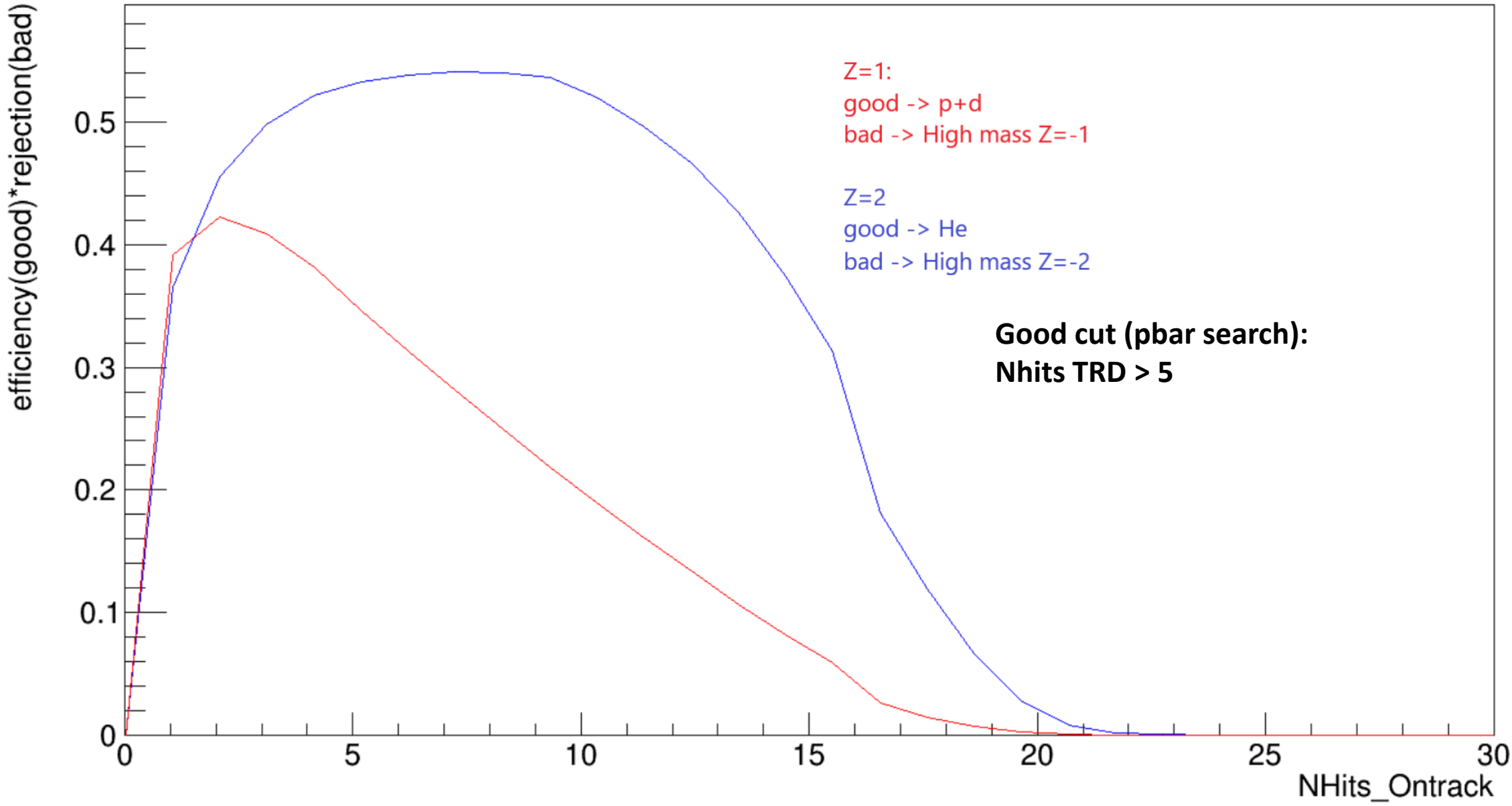




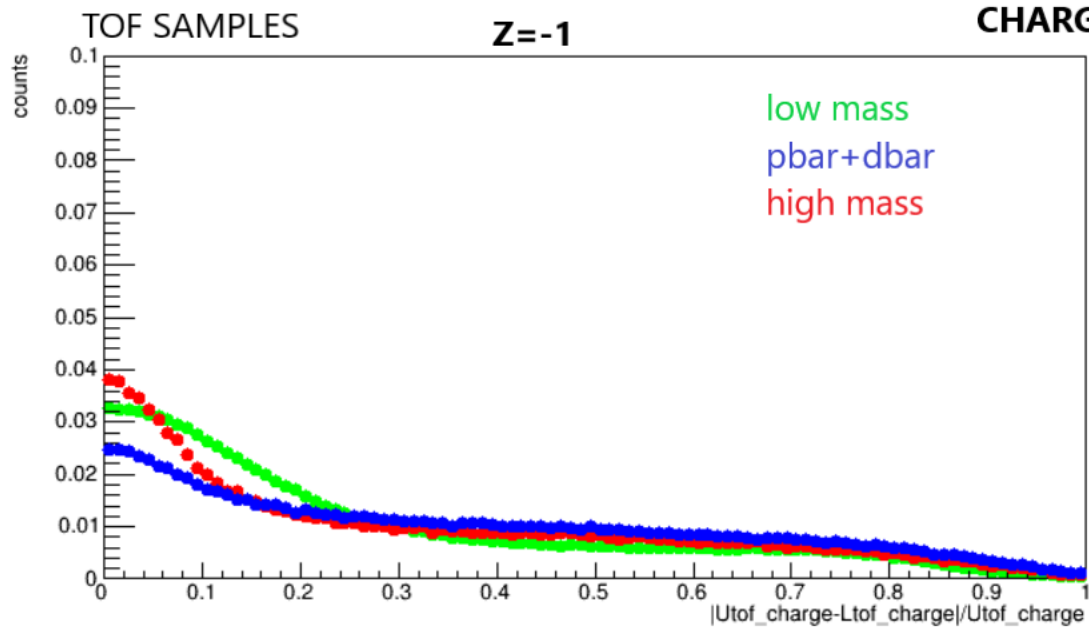




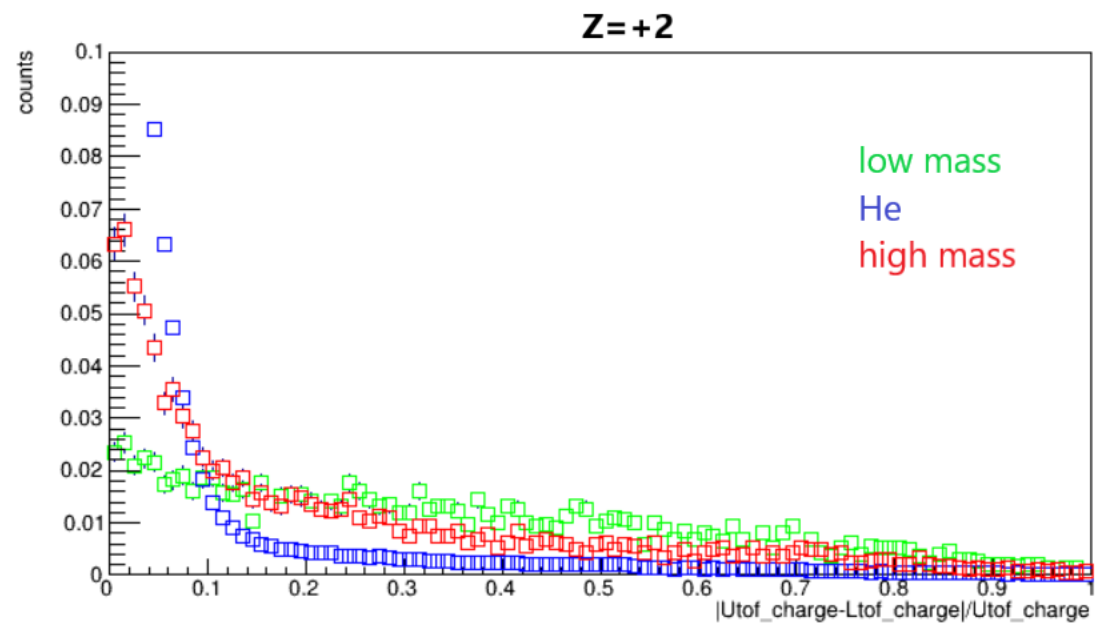
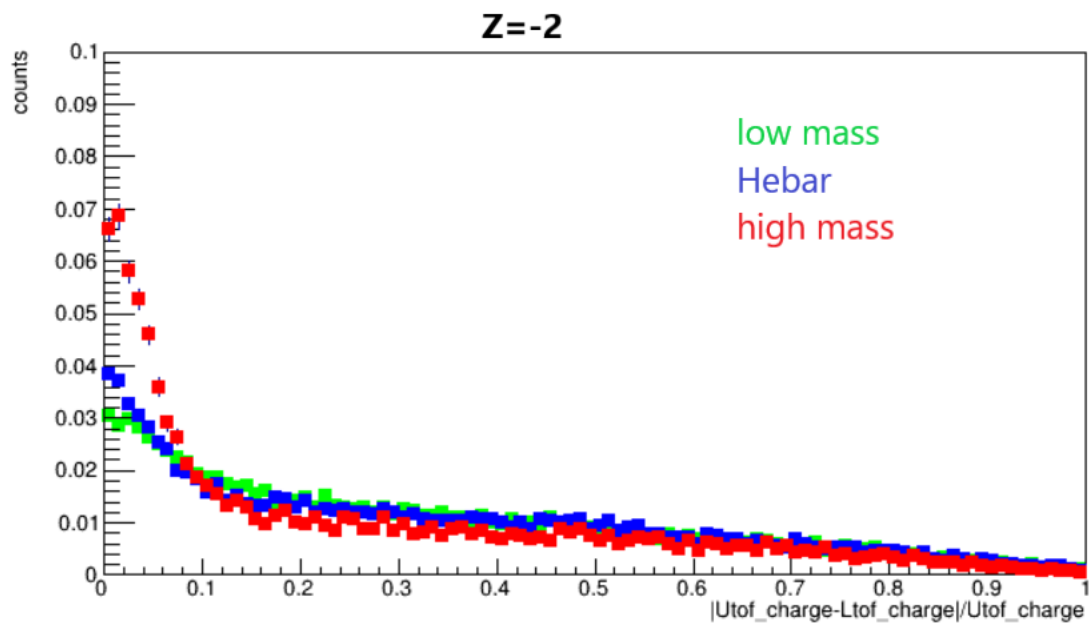
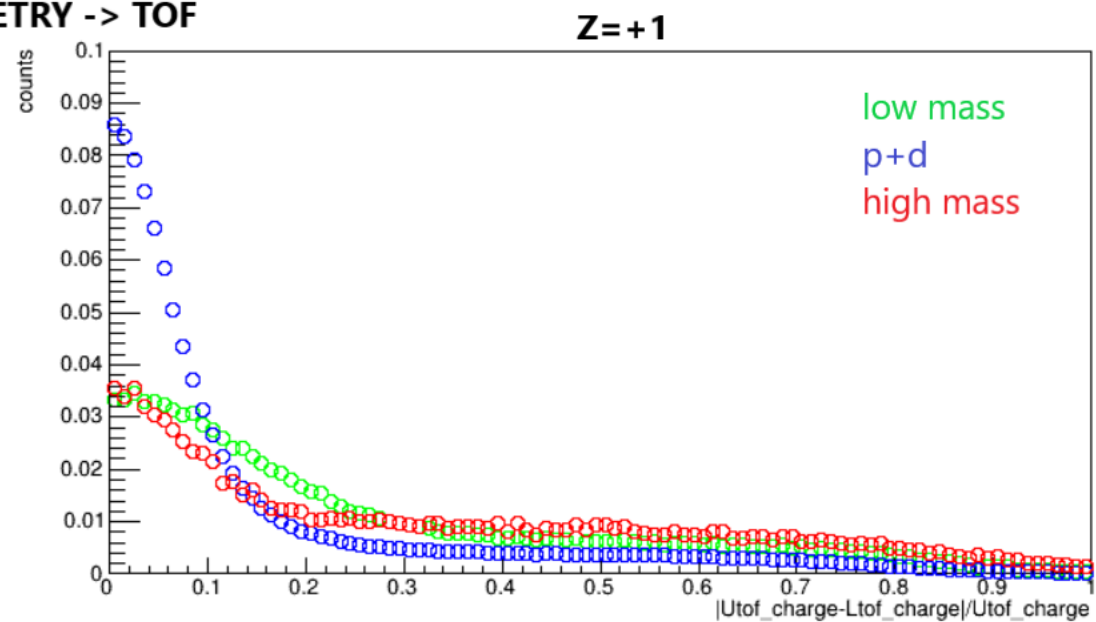
### NHITS - ONTRACK -> TRD



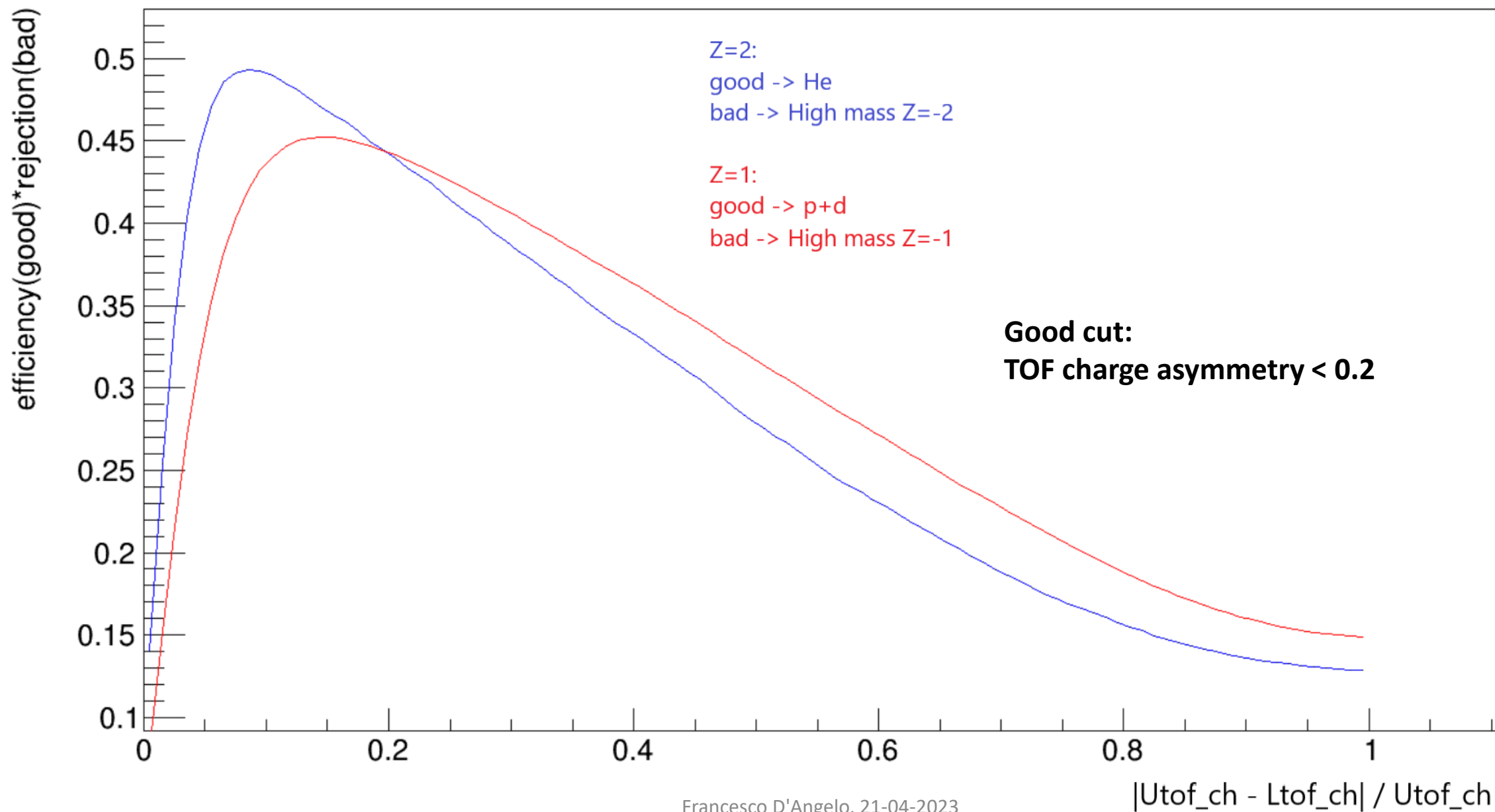
**Good cut (pbar search):  
Nhits TRD > 5**

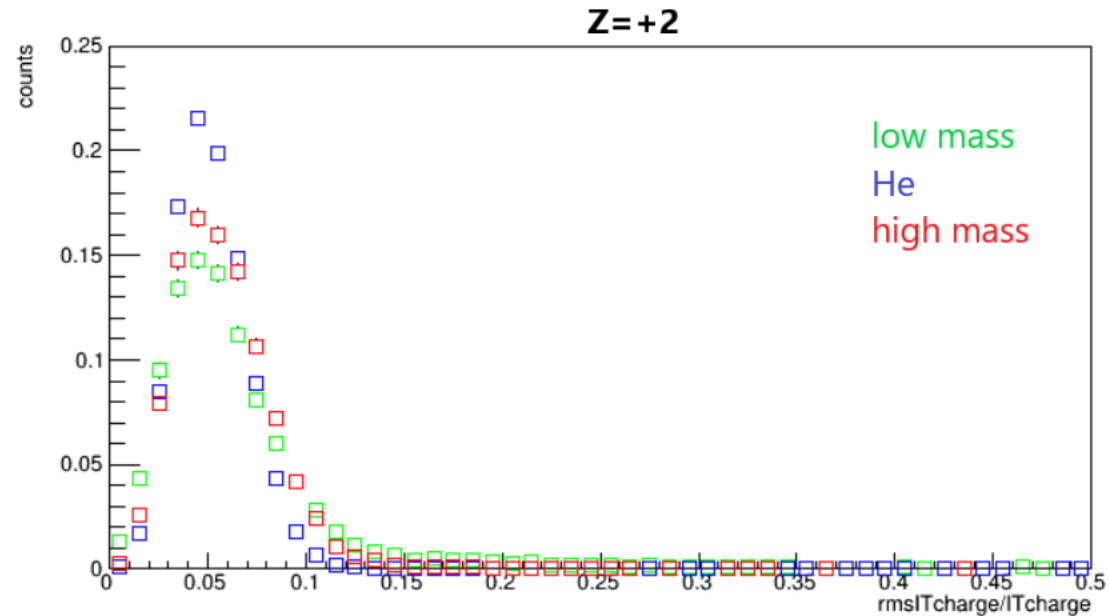
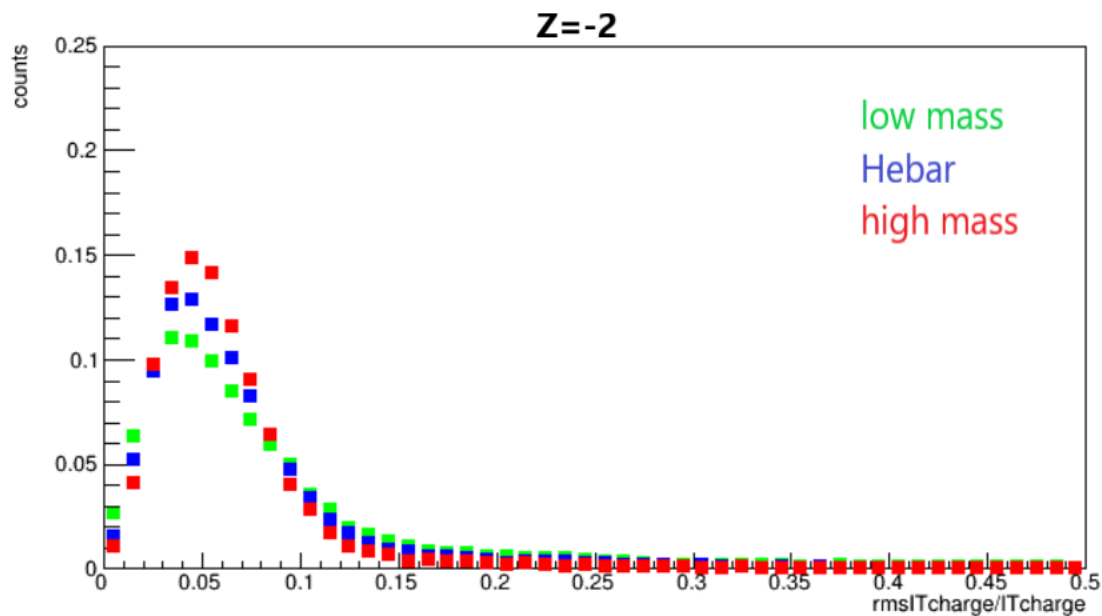
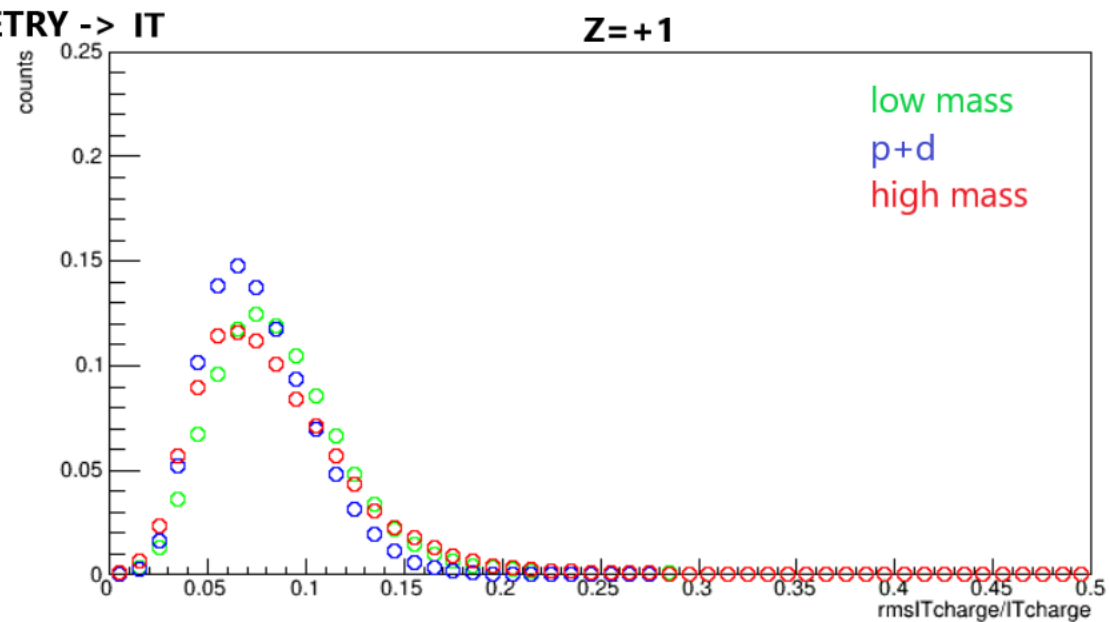
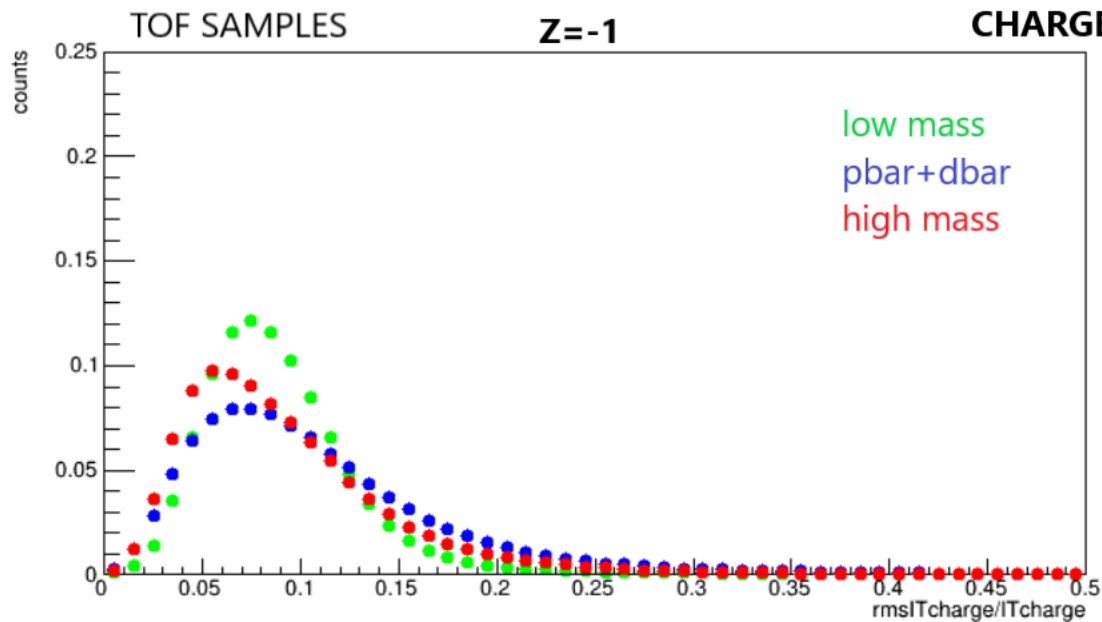


**CHARGE ASYMMETRY -> TOF**

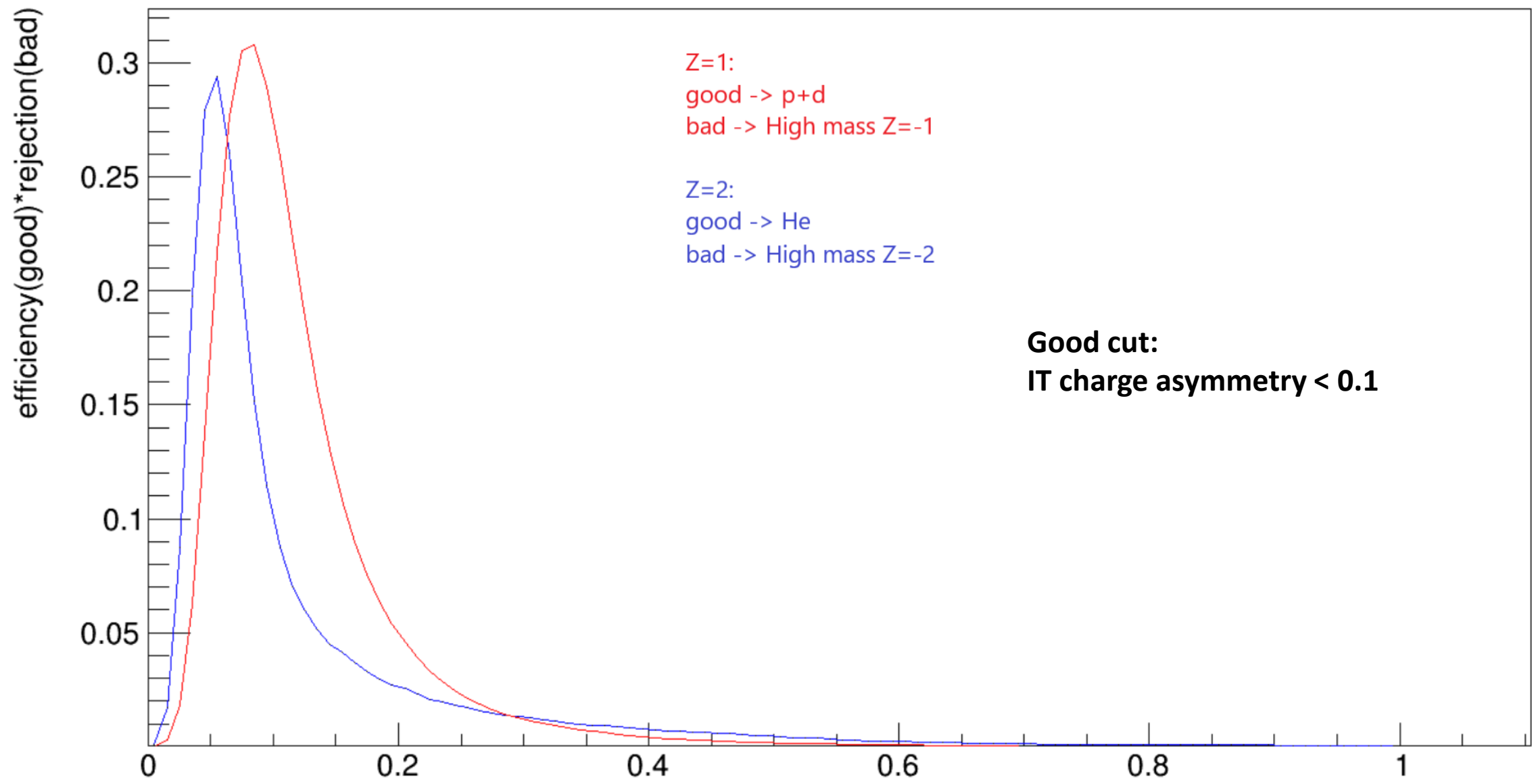


TOF SAMPLES, **CHARGE ASYMMETRY -> TOF**





TOF SAMPLES, **CHARGE ASYMMETRY -> IT**

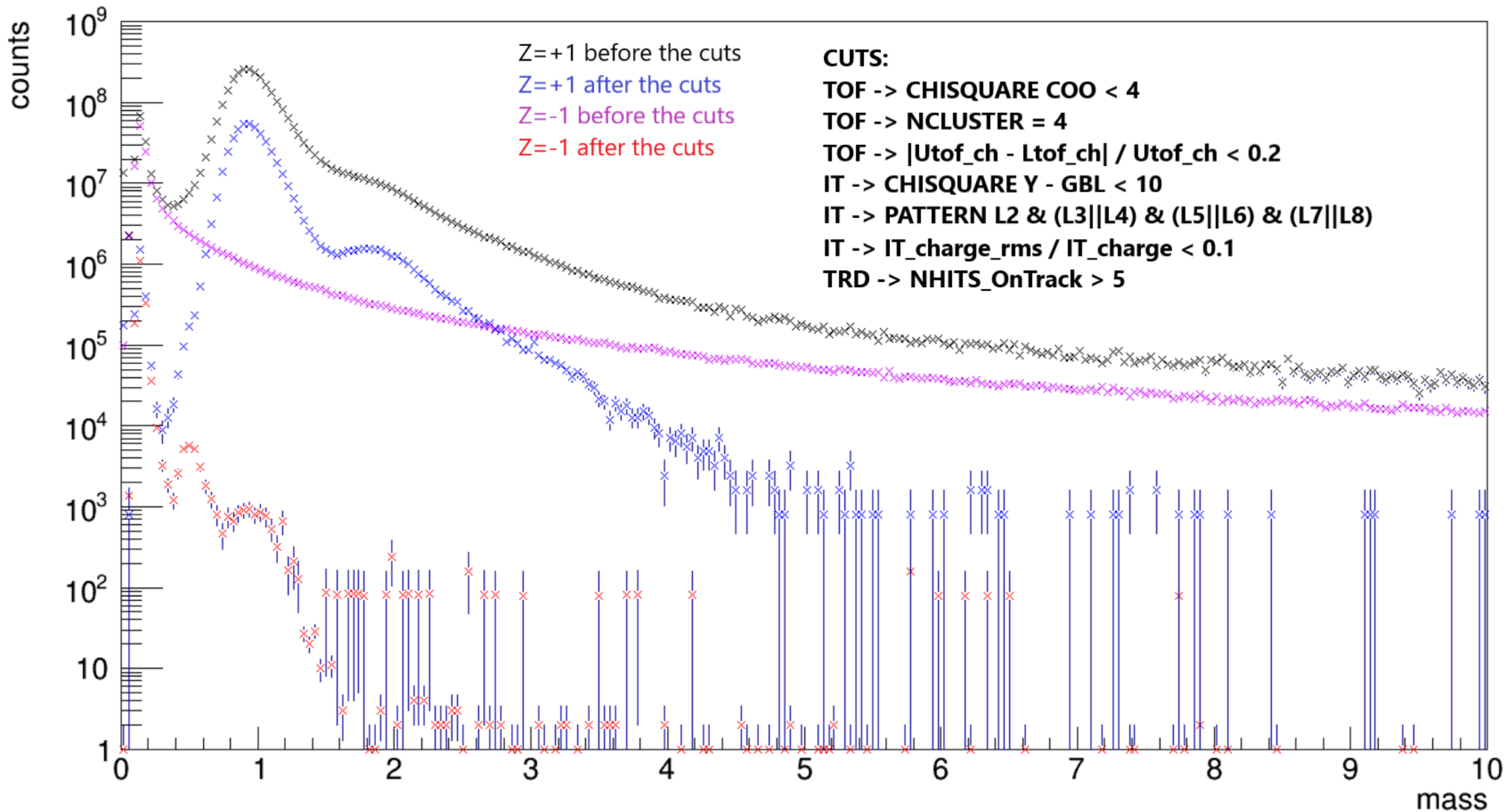


Z=1:  
good -> p+d  
bad -> High mass Z=-1

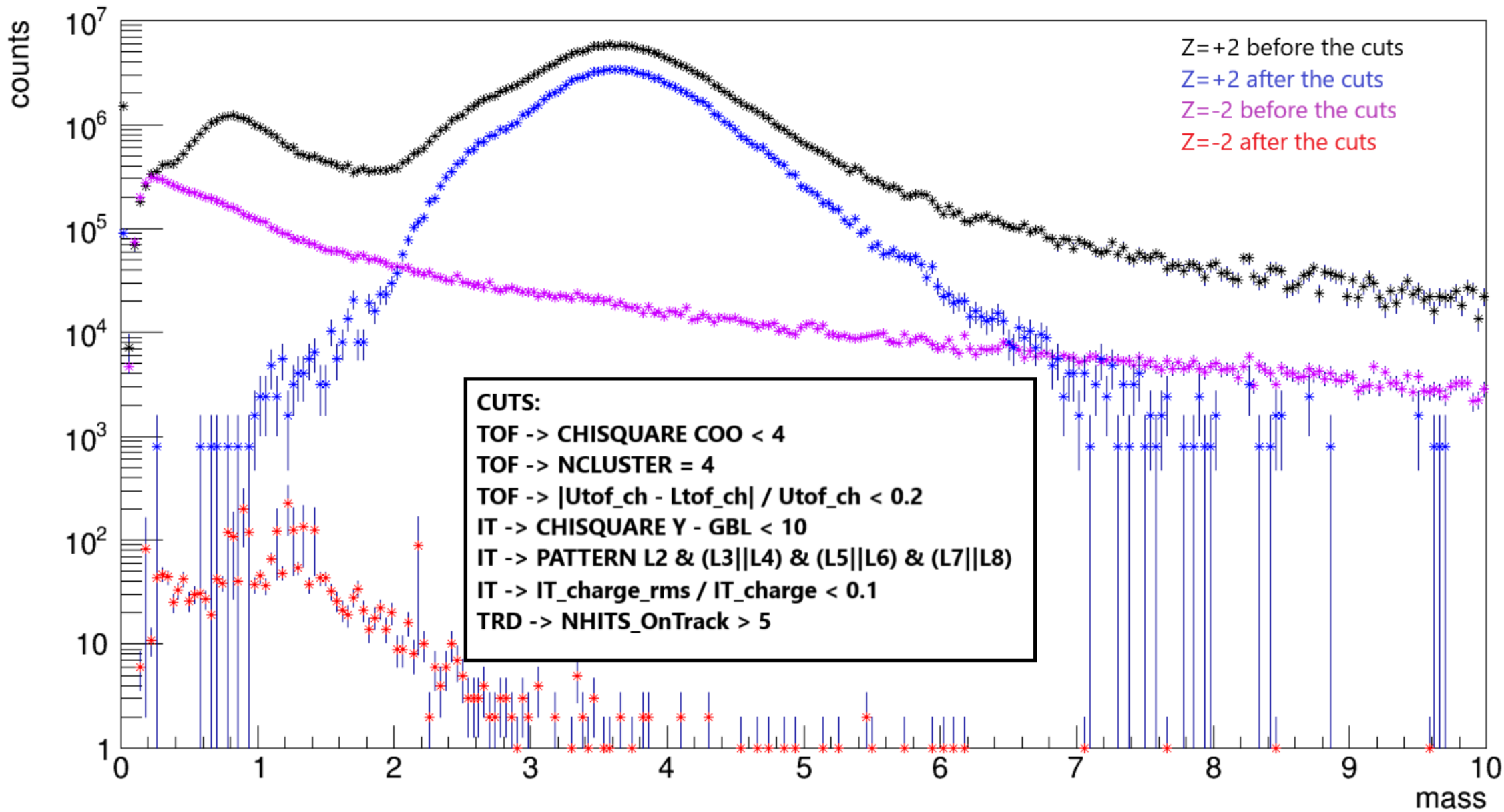
Z=2:  
good -> He  
bad -> High mass Z=-2

**Good cut:**  
**IT charge asymmetry < 0.1**

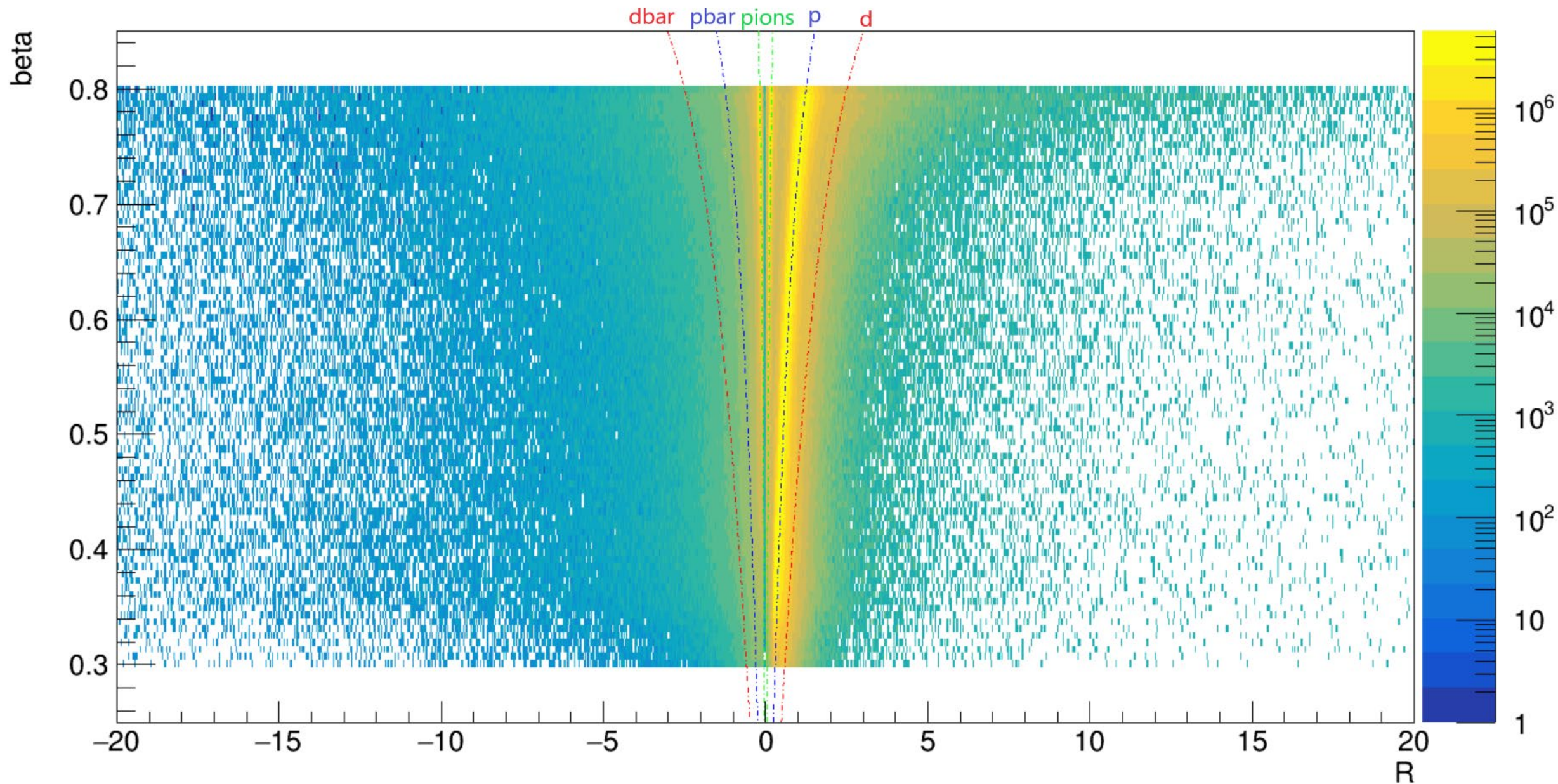
# TOF SAMPLES, Z=1 MASS



TOF SAMPLES, **Z=2 MASS**

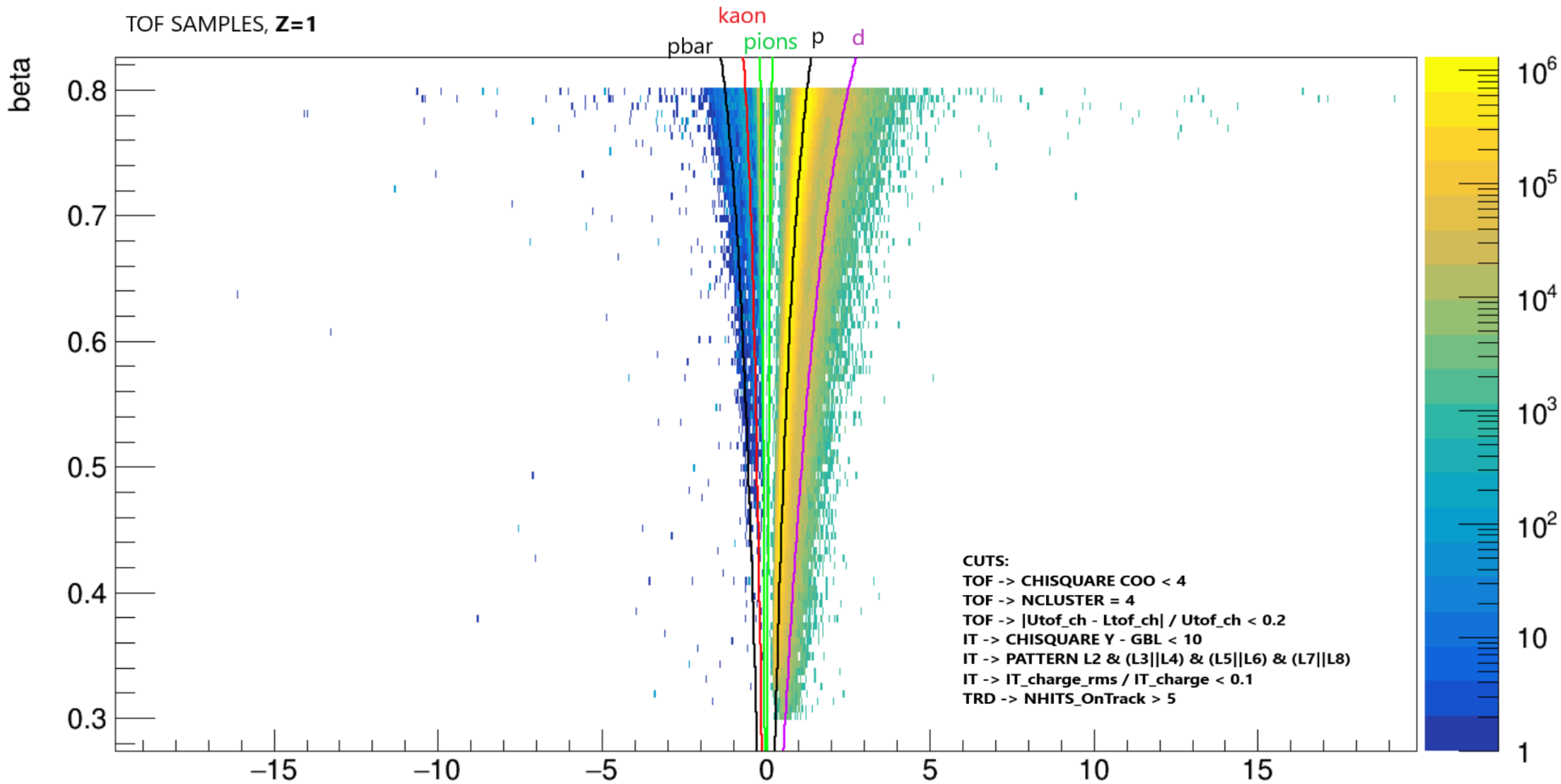


TOF SAMPLES, Z=1 EVENTS

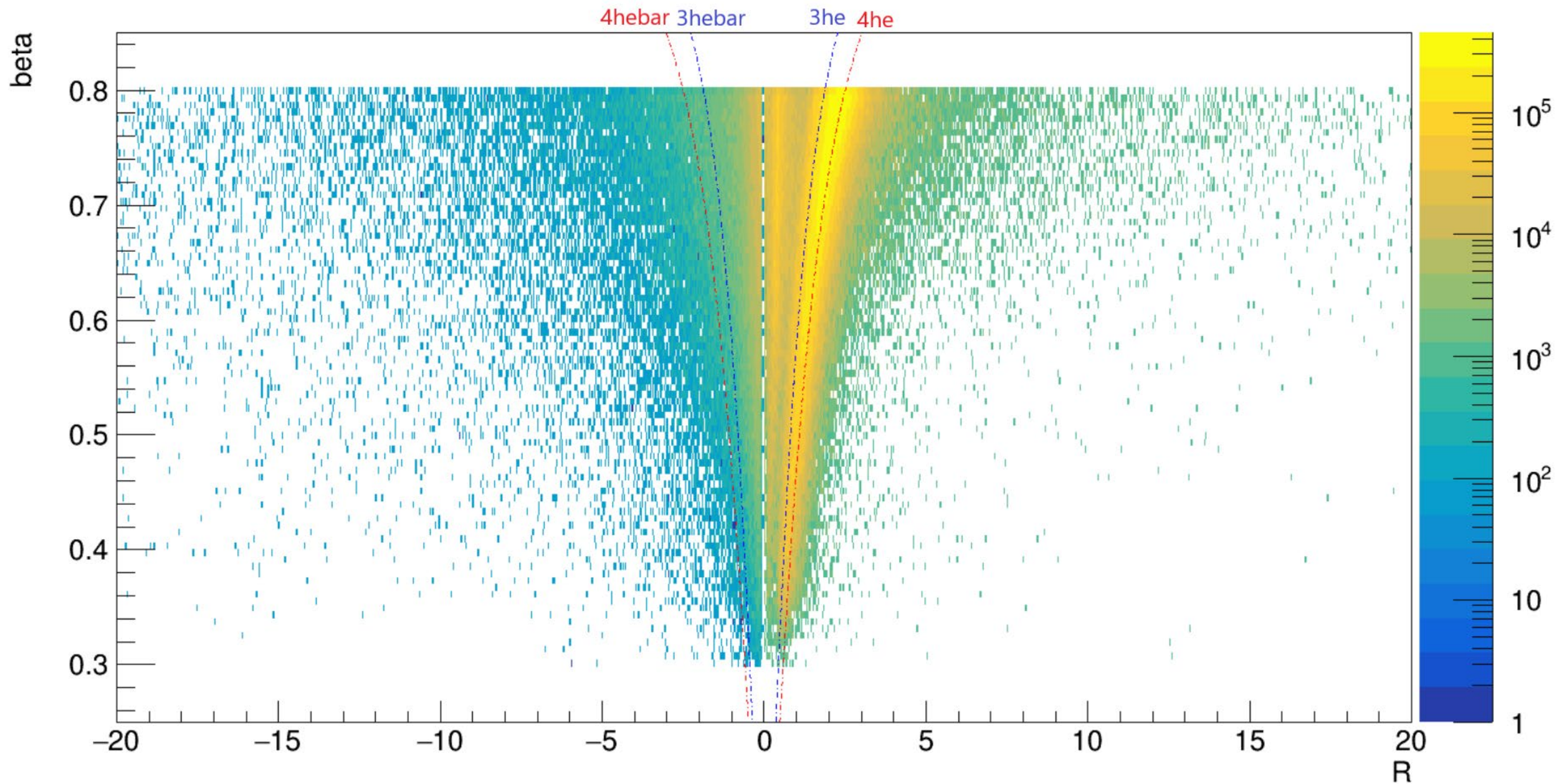




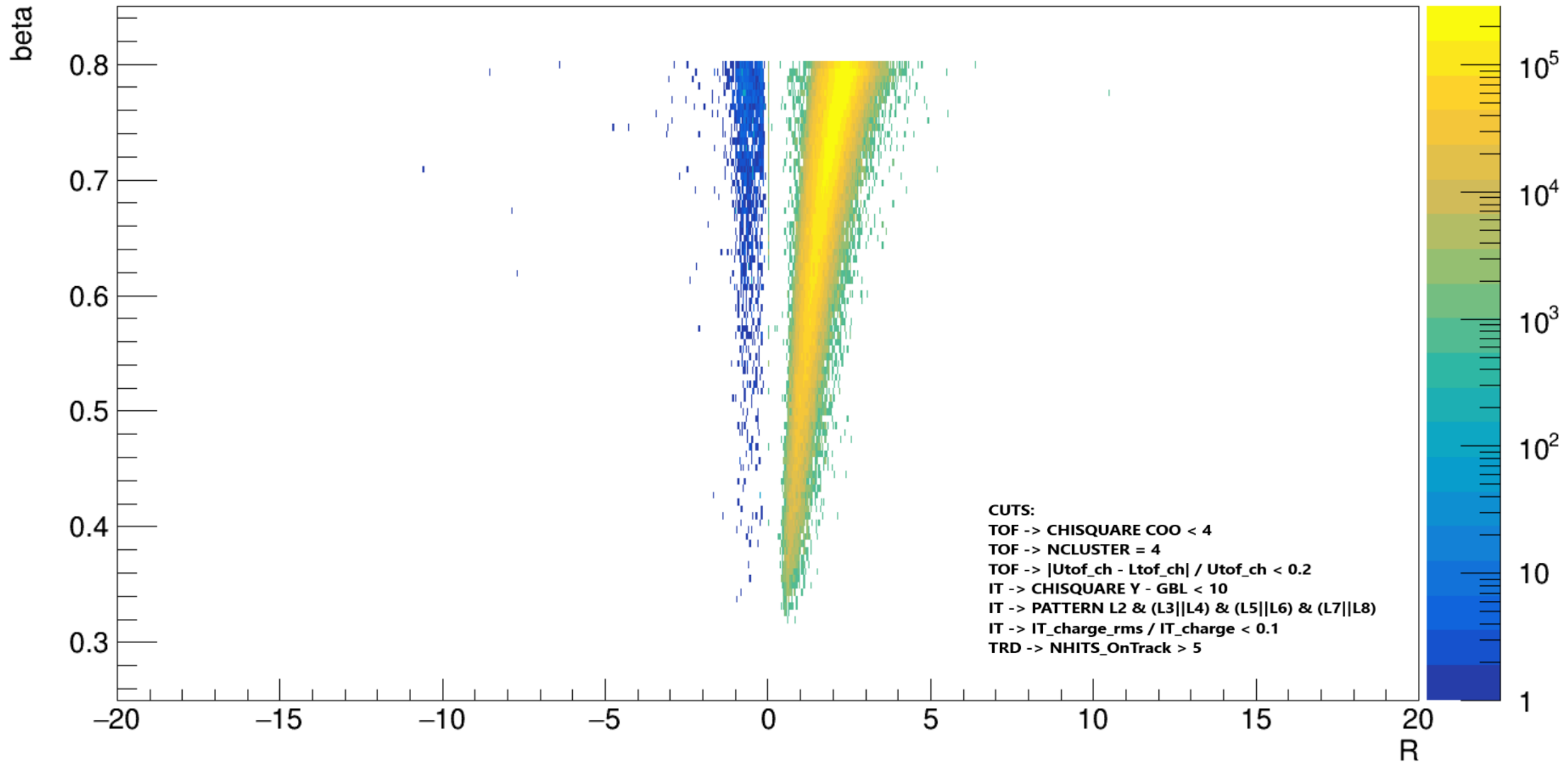
TOF SAMPLES, **Z=1**



TOF SAMPLES, Z=2 EVENTS



TOF SAMPLES, **Z=2**



# SUMMARY & CONCLUSIONS

## SKIMMING

A first version skimming for antiparticle search has been done (3.6 TB) -> Available for everybody.  
The prescaling code must be applied again to have the correct weighting factors.

## FOR THE NEXT NAIA PRODUCTION

Add rigidity fit without MS correction

## FIRST-LOOK ANALYSIS

Basic idea:

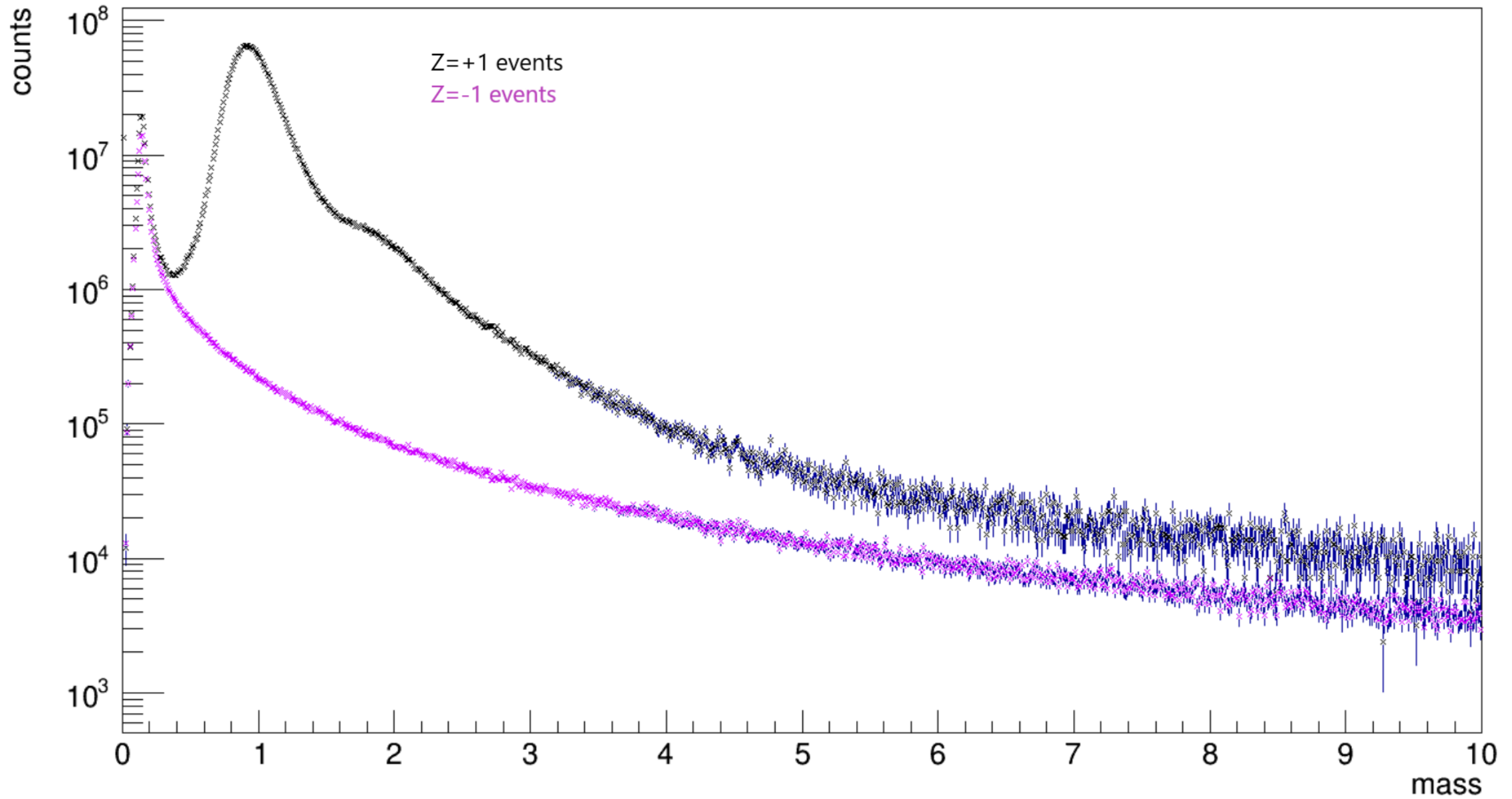
- Look at the same time  $|Z|=1$  and  $|Z|=2$  in 12 mass samples to understand the properties of well-reconstructed positive particles and background-dominated negative samples
- We studied only mass in the beta range between 0.3 and 0.8 measured with the TOF
- Developed cuts based on efficiency and rejection of the mass samples
- Pbar mass peak has been observed
- Observed a residual background both in  $Z=+2$  and  $Z=-2$  at low mass

## FUTURE

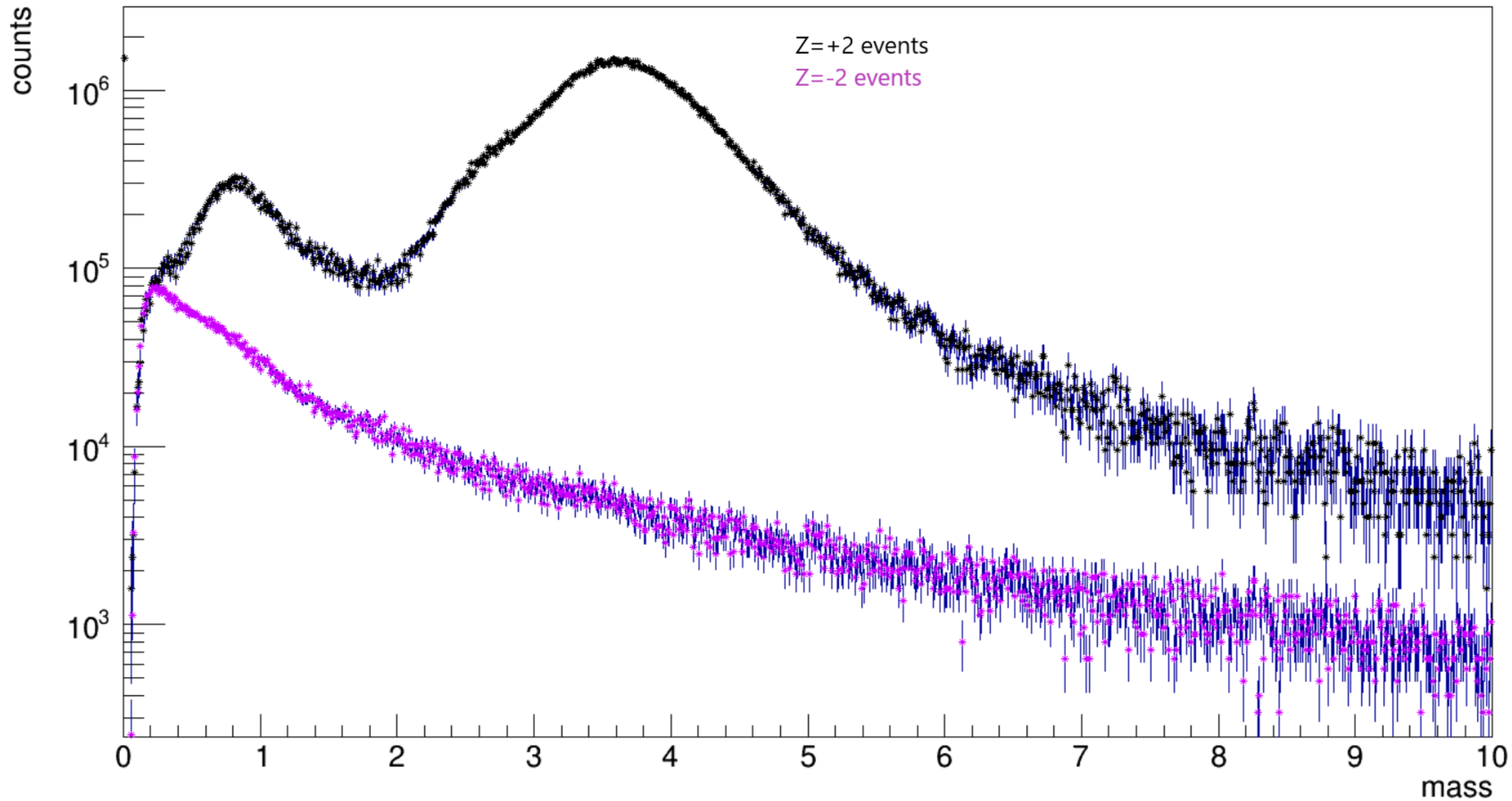
- Extend the analysis on the complete dataset and add other variables
- Extend the analysis to the RICH range
- Study how to optimize the selection (MonteCarlo studies, Machine Learning)

# BACKUP

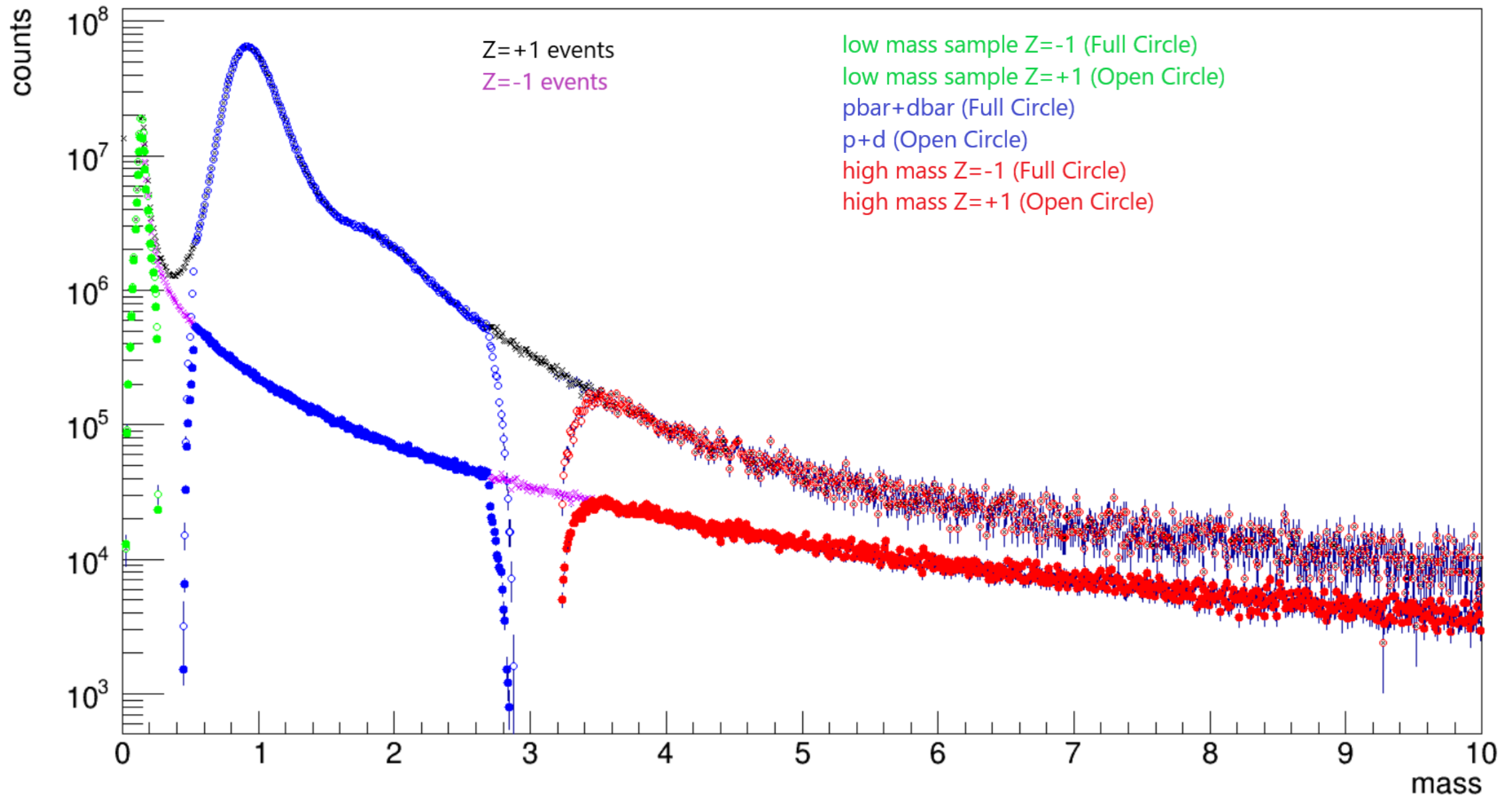
TOF SAMPLES, **Z=1 MASS**



TOF SAMPLES, **Z=2 MASS**

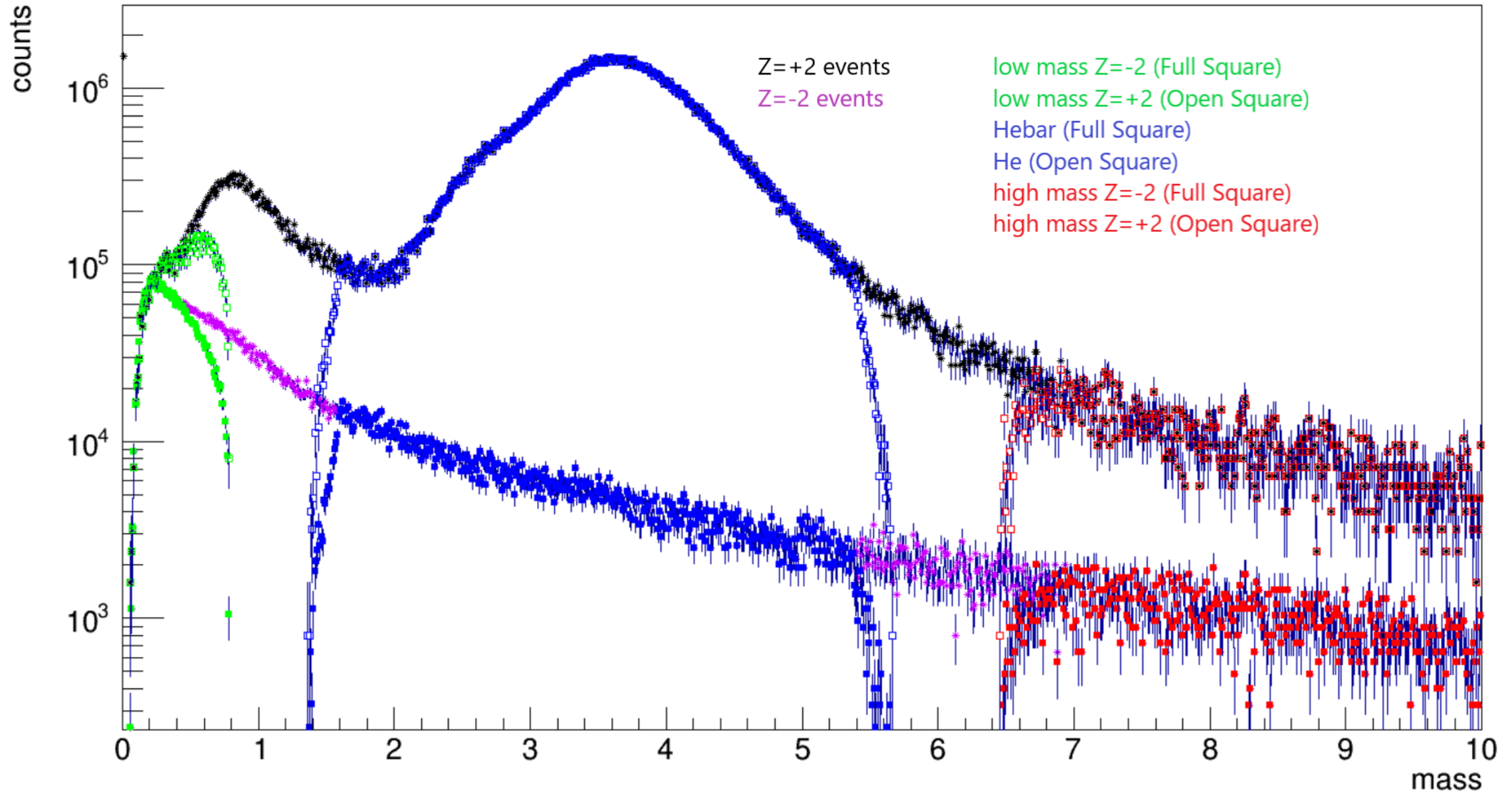


TOF SAMPLES, **Z=1 MASS**





TOF SAMPLES, Z=2 MASS



	A	B	C	D	E	F	G	H	I	J	K	L	M
1		<b>Z=1 POSITIVES</b>			<b>Z=1 NEGATIVES</b>			<b>Z=2 POSITIVES</b>			<b>Z=2 NEGATIVES</b>		
2	<b>TOF SAMPLES 0.3 &lt; beta &lt; 0.8</b>	<b>light</b>	<b>p+d</b>	<b>heavy</b>	<b>light</b>	<b>pbar+dbar</b>	<b>heavy</b>	<b>light</b>	<b>he</b>	<b>heavy</b>	<b>light</b>	<b>hebar</b>	<b>heavy</b>
3	TOTAL NUMBERS	125004800	2727076000	33002400	95221820	33919590	10822077	6852800	216979200	6851200	3405949	2370979	1201311
4	NTOFCluster = 4	0,713566199	0,908610394	0,612197901	0,682453454	0,32303427	0,490397268	0,211417231	0,947335044	0,434726763	0,279871777	0,36728246	0,559148297
5	NTOFCluster >= 3	0,952936207	0,990796883	0,911618549	0,94306347	0,763971204	0,849559378	0,78099463	0,994675987	0,950607193	0,775498694	0,812600618	0,900375506
6	ChisquareCoo < 10	0,712087856	0,871334426	0,553026447	0,659292376	0,254847125	0,427444473	0,117557787	0,928059464	0,37856142	0,106034764	0,246151062	0,450333844
7	ChisquareCoo < 8	0,684664909	0,85938111	0,527791918	0,630741746	0,228043971	0,400659873	0,103548914	0,922333569	0,367702008	0,089631407	0,228693295	0,436414883
8	ChisquareCoo < 6	0,655411632	0,84616373	0,499793954	0,60153448	0,202588622	0,373671986	0,090473967	0,915571631	0,356025222	0,074607694	0,213088349	0,420897669
9	ChisquareCoo < 5	0,62474401	0,830191164	0,468062929	0,571157672	0,178984711	0,345818829	0,07950035	0,906885084	0,343647828	0,061587534	0,195893764	0,402983074
10	ChisquareCoo < 4	0,590588521	0,808887468	0,43475626	0,537657125	0,156491838	0,318068149	0,071328508	0,894751202	0,331387202	0,05108767	0,178187154	0,382271535
11	ChisquareTime < 10	0,829491348	0,885941133	0,700409667	0,809182391	0,655137341	0,719388432	0,593509223	0,934614931	0,818542737	0,633370905	0,613931629	0,698329575
12	ChisquareTime < 8	0,807796181	0,868468059	0,671369355	0,787665128	0,634826423	0,69710343	0,570277843	0,919586762	0,792737039	0,61314776	0,593196313	0,673889609
13	ChisquareTime < 6	0,782075568	0,846020573	0,642086636	0,762983967	0,61325983	0,672823987	0,547513425	0,900034658	0,765179823	0,592862078	0,570258109	0,645853572
14	ChisquareTime < 5	0,752719896	0,817448725	0,610016241	0,734354101	0,591124008	0,645333886	0,52509923	0,875549361	0,732718356	0,572131291	0,546644656	0,615749793
15	ChisquareTime < 4	0,71770684	0,78072925	0,574164303	0,700642122	0,568182575	0,614500802	0,500817184	0,843409875	0,696520318	0,550049927	0,524207933	0,582585192

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		Z=1 POSITIVES			Z=1 NEGATIVES			Z=2 POSITIVES			Z=2 NEGATIVES		
2	TOF SAMPLES $0.3 < \beta < 0.8$	light	p+d	heavy	light	pbar+dbar	heavy	light	he	heavy	light	hebar	heavy
3	TOTAL NUMBERS	125004800	2727076000	33002400	95221820	33919590	10822077	6852800	216979200	6851200	3405949	2370979	1201311
14	ChisquareXGBL < 10	0,919939074	0,963227427	0,610185926	0,907962272	0,66780023	0,311836351	0,858977352	0,967016193	0,712984587	0,733877401	0,590413918	0,28211762
15	ChisquareXGBL < 8	0,919868677	0,958102818	0,573097714	0,907913417	0,64761455	0,276784022	0,858977352	0,960191576	0,67666978	0,733736471	0,564216301	0,247552049
16	ChisquareXGBL < 6	0,919855878	0,950618465	0,538409328	0,907872103	0,625401663	0,244325835	0,858743871	0,950620152	0,638369921	0,733572053	0,534405408	0,215318098
17	ChisquareXGBL < 5	0,919817479	0,939777843	0,501733207	0,907814784	0,602109843	0,213779573	0,858627131	0,936233519	0,601004204	0,733477806	0,50337814	0,186681051
18	ChisquareXGBL < 4	0,91977908	0,924575626	0,464038979	0,907744034	0,576900163	0,187016041	0,85851039	0,916493378	0,558267165	0,733148676	0,471977609	0,160373958
19	ChisquareXGBL < 0.001	0,842009267	0,101187939	0,023271035	0,828213113	0,110555582	0,01021024	0,704296054	0,053645695	0,027440448	0,598604383	0,059025407	0,007528442
20	ChisquareYGBL < 10	0,995968155	0,963747545	0,441979977	0,993640113	0,336833965	0,070492661	0,978169507	0,970887532	0,545539468	0,940198752	0,158389847	0,038317305
21	ChisquareYGBL < 8	0,994489812	0,954864771	0,420139141	0,991599467	0,31781758	0,064866384	0,973266402	0,962178863	0,514946287	0,924539387	0,138310799	0,033984539
22	ChisquareYGBL < 6	0,992640283	0,943032024	0,397231716	0,989158787	0,300183316	0,05982992	0,965795004	0,949134295	0,480616534	0,906245513	0,12078808	0,029586843
23	ChisquareYGBL < 5	0,990073981	0,927101702	0,373209221	0,986019874	0,284213341	0,0550581	0,957856643	0,931665339	0,447804764	0,88496099	0,106269182	0,025522117
24	ChisquareYGBL < 4	0,987136494	0,905814726	0,346956585	0,982103083	0,268611472	0,050152203	0,94956806	0,907165295	0,411022887	0,860806489	0,093734698	0,022523726
25	ChisquareYGBL < 0.001	0,726941685	0,049164746	0,019028919	0,714317307	0,041169513	0,004554394	0,38571095	0,037625726	0,028841663	0,238312729	0,01219918	0,002332452