

# Study of filter event rates for CAL energy calibration

- Brief reminder of GCRcalib algorithms
  - **GCRRecon** (1st stage of GCRcalib) extrapolates tkr1 track to the CAL: finds CAL hits potentially useful for calibration and computes the exact path-length in each of them
  - **GCRSelect** (2nd stage) selects layers (starting from the top of the CAL) which have a low hit multiplicity = not more than 1 set of adjacent hits above Eth, with <3 hits in that “cluster”
  - **GCRcalib now processes events passed by HIP, GFC, DFC and MIP filters**
- Choice of energy threshold
  - Sequence for choosing Eth is based on Johann's preliminary study (see March 25 CAL meeting)
    - If (HIP), then Eth=100 (**heavy ions**)
    - Else if (GFC), then
      - If (engine 4 triggered), then Eth=100 (**heavy ions**)
      - Else Eth=5 (**p + He**)
    - Else if (DFC || MIP), then Eth=5 (**p+He**)
- Code status and simulation
  - New package in GR recent builds (e.g. V15r3)
  - Next slides results obtained with a background-day sample simulated with GlastRelease-HEAD1.1085.4.2
    - 1140 jobs of 0.2 sec

# Event selection

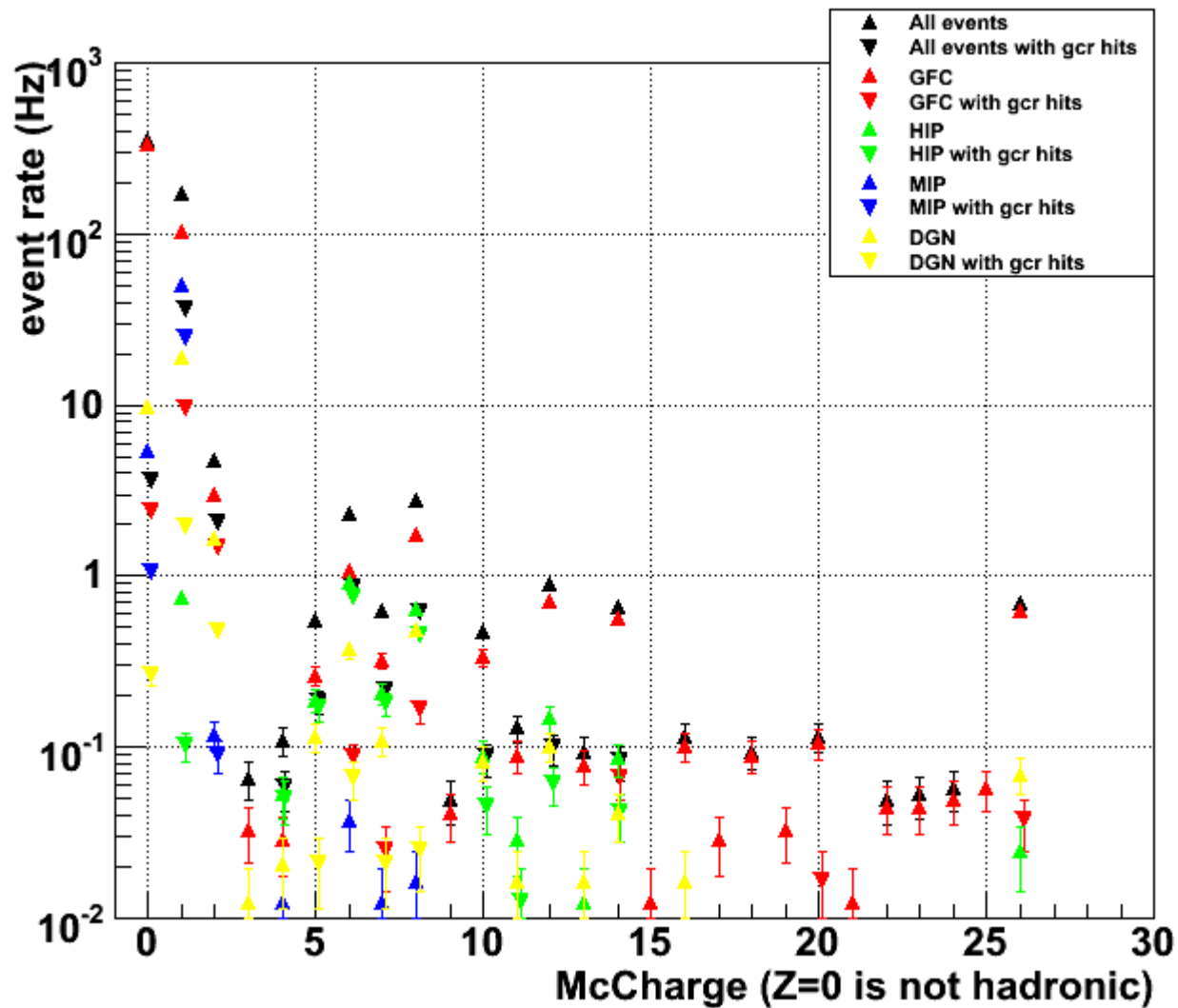
- **Triggers and filters are not enabled in simulations of background-day sample**
- **Require that one engine triggered, with prescale expired**  
if (merit->GltGemEngine<=0 || merit->GltGemEngine>=11 || !merit->GltPrescaleExpired)  
continue;
- **Extract filter decision from ObfStatusBytes in merit**  
//--- GFC  
unsigned long int statusb = merit->ObfStatusBytes;  
unsigned long int sb=statusb;  
GFCpass0=((sb&0xF)==0);  
GFCpass6=((sb&0xF)==6);  
GFCpass=(GFCpass0 || GFCpass6);  
//--- HIP  
sb = statusb >>4;  
HIPpass0=((sb&0xF)==0);  
HIPpass6=((sb&0xF)==6);  
HIPpass=(HIPpass0 || HIPpass6);  
//--- MIP  
sb = statusb >>8;  
MIPpass0=((sb&0xF)==0);  
MIPpass6=((sb&0xF)==6);  
MIPpass=(MIPpass0 || MIPpass6);  
//--- DGN  
sb = statusb >>12;  
DGNpass0=((sb&0xF)==0);//note that this actually never happens  
DGNpass6=((sb&0xF)==6);  
DGNpass=(DGNpass0 || DGNpass6);

# Rates and histograms

- Compute filter rates from GFCpass, HIPpass, MIPpass and DGNpass (**rates are not exclusive here**)
- For each selected event, look for “gcr hits” (or just “hits” in the following slides), i.e. hits selected by GCRSelect
  - Compute filter rates for those events with  $\geq 1$  gcr hit(s) – still not exclusive
  - Fill the corresponding histograms (spectra, etc – see next slides) using the ObfStatusWord() gcr.root

```
if ((ObfStatusWord & 2)>0)//HIP
{
...
}
else if ((ObfStatusWord & 1)>0)//GFC
{
...
}
else if ((ObfStatusWord & 8)>0)//DGN
{
...
}
else if ((ObfStatusWord & 4)>0)//MIP
{
...
}
```
  - **All histograms are exclusive**

# Event rates for all species (1/6)



# Event rates for all species (2/6)

## Protons

rate= 169.890 +- 0.829 Hz Total  
rate= 35.339 +- 0.378 Hz Total w/ GCRSelected hits  
rate= 103.350 +- 0.647 Hz GFC  
rate= 9.322 +- 0.194 Hz GFC w/ GCRSelected hits  
rate= 0.744 +- 0.055 Hz HIP  
rate= 0.101 +- 0.020 Hz HIP w/ GCRSelected hits  
rate= 49.882 +- 0.449 Hz MIP  
rate= 24.326 +- 0.314 Hz MIP w/ GCRSelected hits  
rate= 18.785 +- 0.276 Hz DGN  
rate= 1.941 +- 0.089 Hz DGN w/ GCRSelected hits

## Heliums

rate= 4.659 +- 0.137 Hz Total  
rate= 1.998 +- 0.090 Hz Total w/ GCRSelected hits  
rate= 2.928 +- 0.109 Hz GFC  
rate= 1.444 +- 0.076 Hz GFC w/ GCRSelected hits  
rate= 0.000 +- 0.000 Hz HIP  
rate= 0.000 +- 0.000 Hz HIP w/ GCRSelected hits  
rate= 0.117 +- 0.022 Hz MIP  
rate= 0.089 +- 0.019 Hz MIP w/ GCRSelected hits  
rate= 1.626 +- 0.081 Hz DGN  
rate= 0.469 +- 0.044 Hz DGN w/ GCRSelected hits

# Event rates for all species (3/6)

## Carbon

rate= 2.281 +- 0.096 Hz Total  
rate= 0.833 +- 0.058 Hz Total w/ GCRSelected hits  
rate= 1.072 +- 0.066 Hz GFC  
rate= 0.085 +- 0.019 Hz GFC w/ GCRSelected hits  
rate= 0.906 +- 0.061 Hz HIP  
**rate= 0.736 +- 0.055 Hz HIP w/ GCRSelected hits**  
rate= 0.036 +- 0.012 Hz MIP  
rate= 0.004 +- 0.004 Hz MIP w/ GCRSelected hits  
rate= 0.368 +- 0.039 Hz DGN  
rate= 0.065 +- 0.016 Hz DGN w/ GCRSelected hits

## Oxygen

rate= 2.754 +- 0.106 Hz Total  
rate= 0.607 +- 0.050 Hz Total w/ GCRSelected hits  
rate= 1.735 +- 0.084 Hz GFC  
**rate= 0.162 +- 0.026 Hz GFC w/ GCRSelected hits**  
rate= 0.643 +- 0.051 Hz HIP  
**rate= 0.445 +- 0.042 Hz HIP w/ GCRSelected hits**  
rate= 0.016 +- 0.008 Hz MIP  
rate= 0.000 +- 0.000 Hz MIP w/ GCRSelected hits  
rate= 0.477 +- 0.044 Hz DGN  
rate= 0.024 +- 0.010 Hz DGN w/ GCRSelected hits

# Event rates for all species (4/6)

## Neon

rate=	0.465 +- 0.043	Hz Total
rate=	0.085 +- 0.019	Hz Total w/ GCRSelected hits
rate=	0.332 +- 0.037	Hz GFC
rate=	0.044 +- 0.013	Hz GFC w/ GCRSelected hits
rate=	0.089 +- 0.019	Hz HIP
rate=	0.044 +- 0.013	Hz HIP w/ GCRSelected hits
rate=	0.004 +- 0.004	Hz MIP
rate=	0.000 +- 0.000	Hz MIP w/ GCRSelected hits
rate=	0.081 +- 0.018	Hz DGN
rate=	0.008 +- 0.006	Hz DGN w/ GCRSelected hits

## Magnesium

rate=	0.878 +- 0.060	Hz Total
rate=	0.097 +- 0.020	Hz Total w/ GCRSelected hits
rate=	0.712 +- 0.054	Hz GFC
rate=	0.061 +- 0.016	Hz GFC w/ GCRSelected hits
rate=	0.146 +- 0.024	Hz HIP
rate=	0.061 +- 0.016	Hz HIP w/ GCRSelected hits
rate=	0.000 +- 0.000	Hz MIP
rate=	0.000 +- 0.000	Hz MIP w/ GCRSelected hits
rate=	0.101 +- 0.020	Hz DGN
rate=	0.000 +- 0.000	Hz DGN w/ GCRSelected hits

# Event rates for all species (5/6)

## Silicon

rate=	0.647 +- 0.051 Hz	Total
rate=	0.081 +- 0.018 Hz	Total w/ GCRSelected hits
rate=	0.562 +- 0.048 Hz	GFC
rate=	0.065 +- 0.016 Hz	GFC w/ GCRSelected hits
rate=	0.085 +- 0.019 Hz	HIP
rate=	0.040 +- 0.013 Hz	HIP w/ GCRSelected hits
rate=	0.000 +- 0.000 Hz	MIP
rate=	0.000 +- 0.000 Hz	MIP w/ GCRSelected hits
rate=	0.040 +- 0.013 Hz	DGN
rate=	0.000 +- 0.000 Hz	DGN w/ GCRSelected hits

## Iron

rate=	0.679 +- 0.052 Hz	Total
rate=	0.036 +- 0.012 Hz	Total w/ GCRSelected hits
rate=	0.627 +- 0.050 Hz	GFC
rate=	0.036 +- 0.012 Hz	GFC w/ GCRSelected hits
rate=	0.024 +- 0.010 Hz	HIP
rate=	0.004 +- 0.004 Hz	HIP w/ GCRSelected hits
rate=	0.004 +- 0.004 Hz	MIP
rate=	0.000 +- 0.000 Hz	MIP w/ GCRSelected hits
rate=	0.069 +- 0.017 Hz	DGN
rate=	0.000 +- 0.000 Hz	DGN w/ GCRSelected hits



# Event rates for all species (6/6)

## All Z>0

rate=	184.490 +- 0.864	Hz Total
rate=	39.601 +- 0.400	Hz Total w/ GCRSelected hits
rate=	112.737 +- 0.675	Hz GFC
rate=	11.316 +- 0.214	Hz GFC w/ GCRSelected hits
rate=	3.171 +- 0.113	Hz HIP
rate=	1.860 +- 0.087	Hz HIP w/ GCRSelected hits
rate=	50.104 +- 0.450	Hz MIP
rate=	24.419 +- 0.314	Hz MIP w/ GCRSelected hits
rate=	21.891 +- 0.298	Hz DGN
rate=	2.556 +- 0.102	Hz DGN w/ GCRSelected hits

## All Z>2

rate=	9.941 +- 0.201	Hz Total
rate=	2.265 +- 0.096	Hz Total w/ GCRSelected hits
rate=	6.459 +- 0.162	Hz GFC
rate=	0.550 +- 0.047	Hz GFC w/ GCRSelected hits
rate=	2.427 +- 0.099	Hz HIP
rate=	1.759 +- 0.084	Hz HIP w/ GCRSelected hits
rate=	0.105 +- 0.021	Hz MIP
rate=	0.004 +- 0.004	Hz MIP w/ GCRSelected hits
rate=	1.480 +- 0.077	Hz DGN
rate=	0.146 +- 0.024	Hz DGN w/ GCRSelected hits

# 4-range event rates

Engine 4 && any filter = 20.177 Hz, including:

EM = 0.174 Hz

p = 11.704 Hz

He = 0.004 Hz

Z>2 = 8.295 Hz

\*\*\*\*\*

Engine 4 && any filter && FilterEnergy>20GeV = 10.442 Hz, including:

EM = 0.121 Hz

p = 6.366 Hz

He = 0.000 Hz

Z>2 = 3.955 Hz

\*\*\*\*\*

Engine 4 && HIP filter = 3.171 Hz, including:

EM = 0.000 Hz

p = 0.744 Hz

He = 0.000 Hz

Z>2 = 2.427 Hz

\*\*\*\*\*

Engine 4 && GFC filter = 12.853 Hz, including:

EM = 0.154 Hz

p = 7.648 Hz

He = 0.000 Hz

Z>2 = 5.051 Hz

\*\*\*\*\*

Engine 4 && GFC filter && FilterEnergy>20GeV = 10.442 Hz, including:

EM = 0.121 Hz

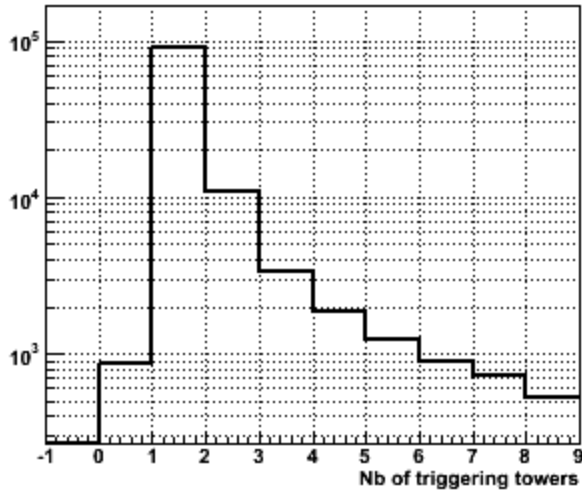
p = 6.366 Hz

He = 0.000 Hz

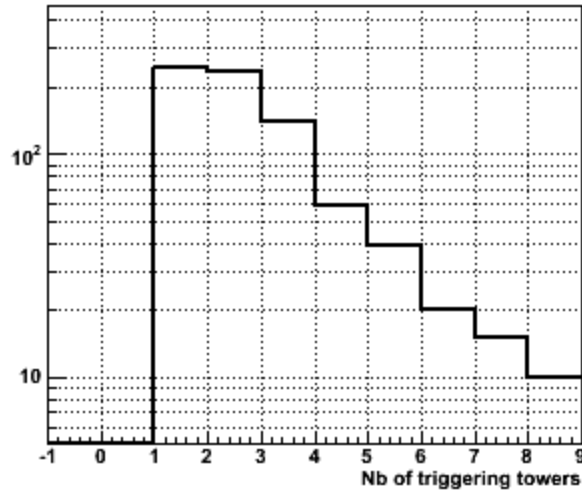
Z>2 = 3.955 Hz

# Number of triggering towers

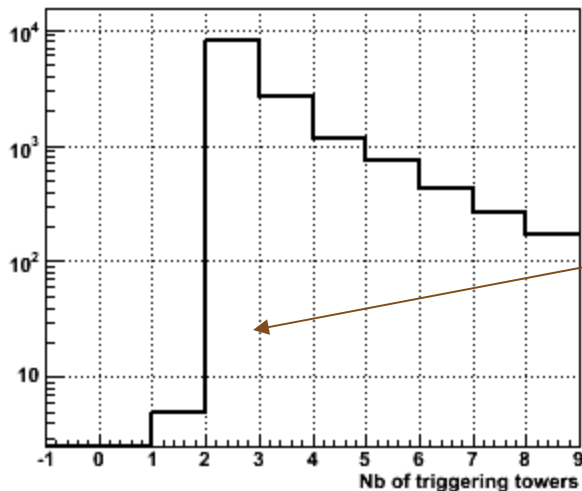
**GFC filter**



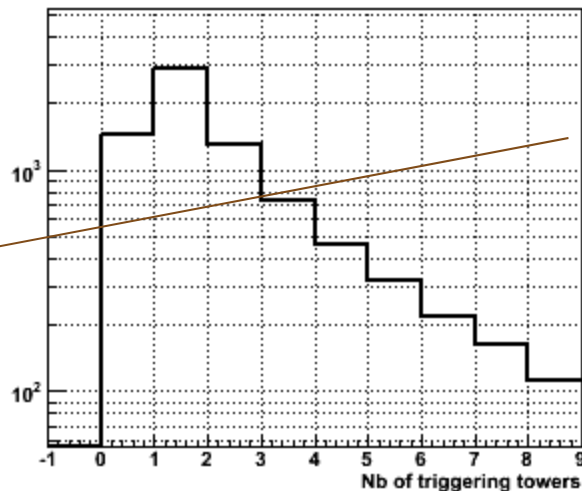
**HIP filter**



**MIP filter**

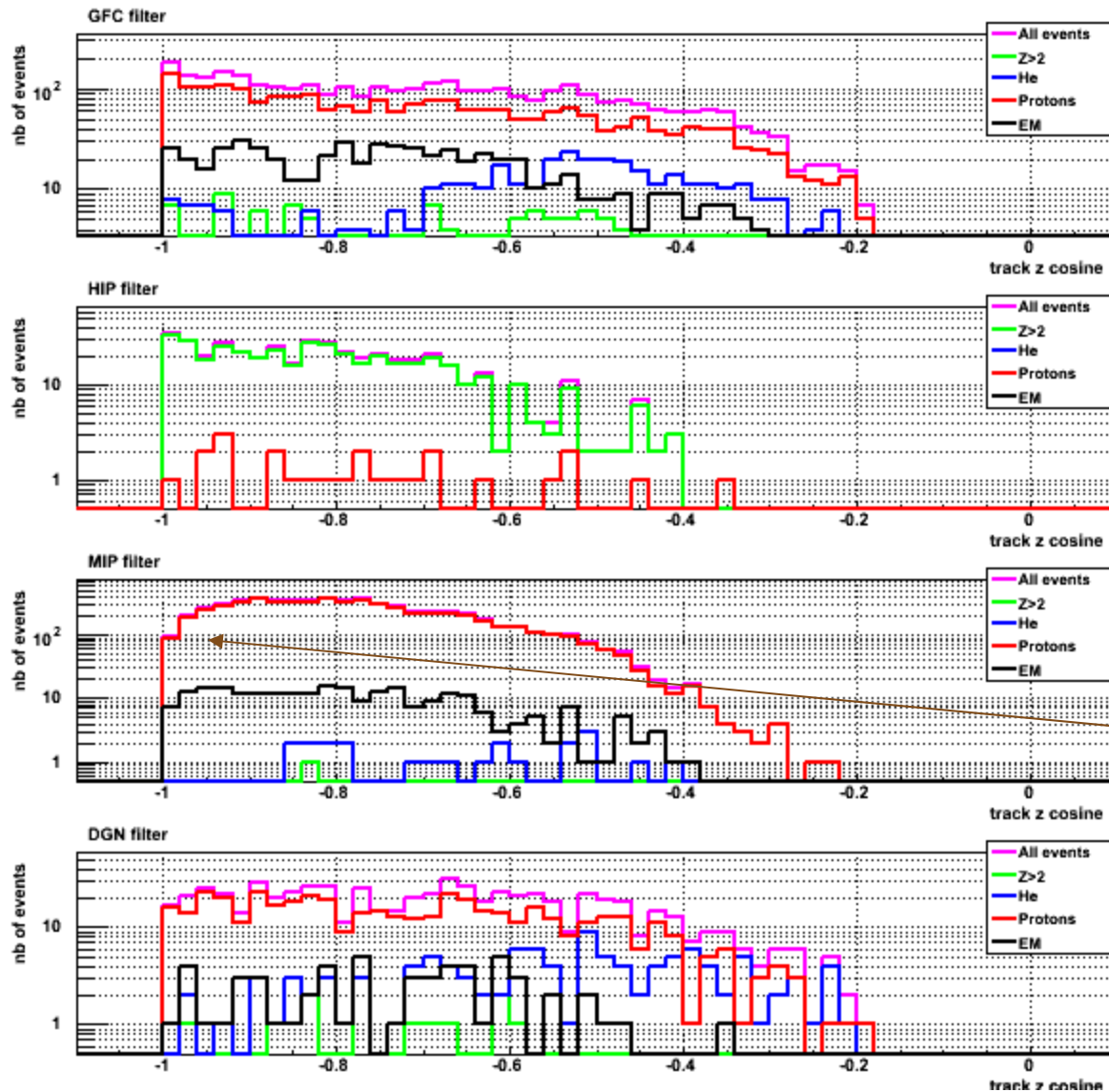


**DGN filter**



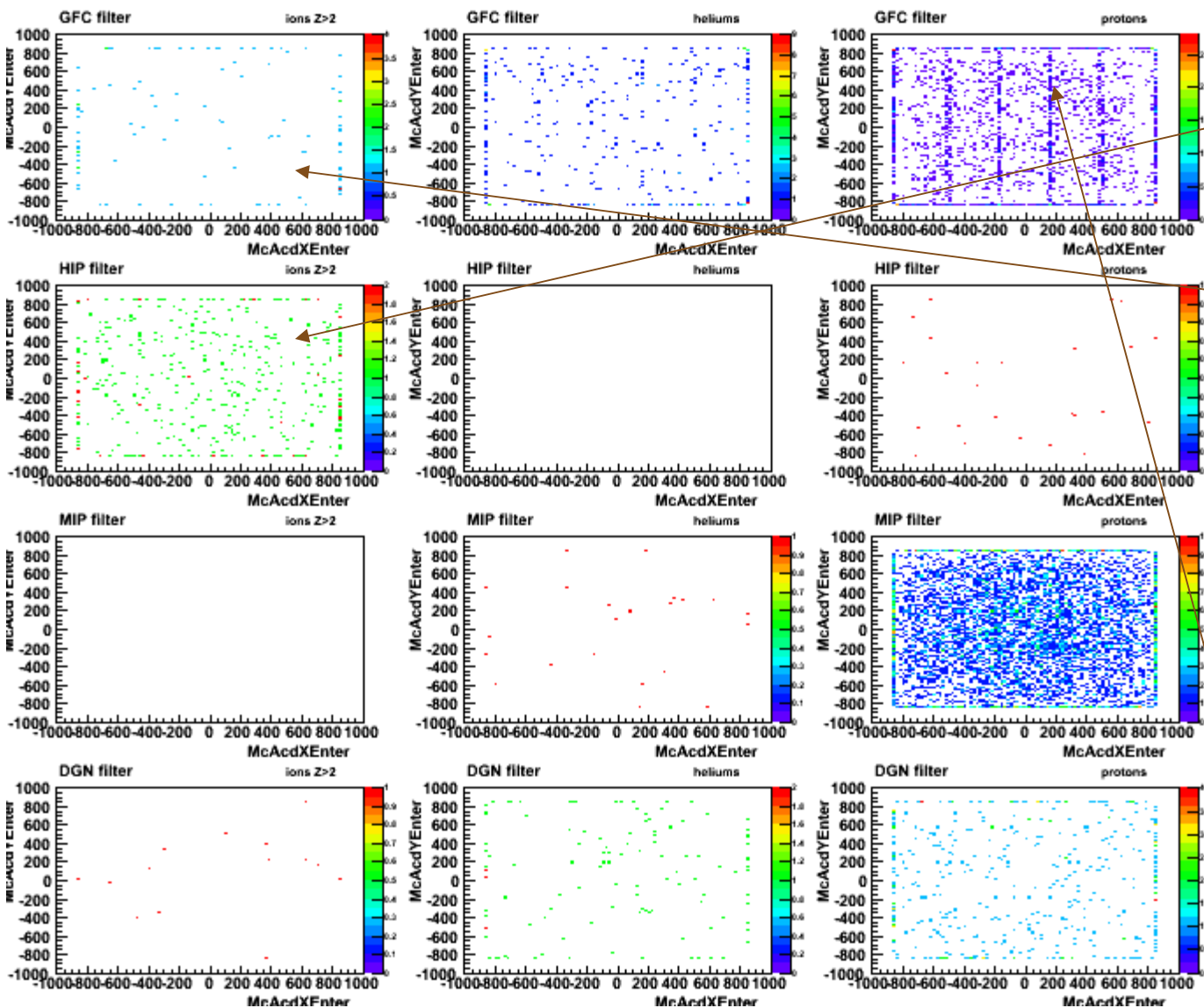
MIP filter is MIP\_off\_axis  
and not MIP\_all\_axis as in  
calibOps config

# Direction (z cosine)



No normal incident events  
in MIP filter – see previous  
slide

# McAcidYEnter vs McAcidXEnter

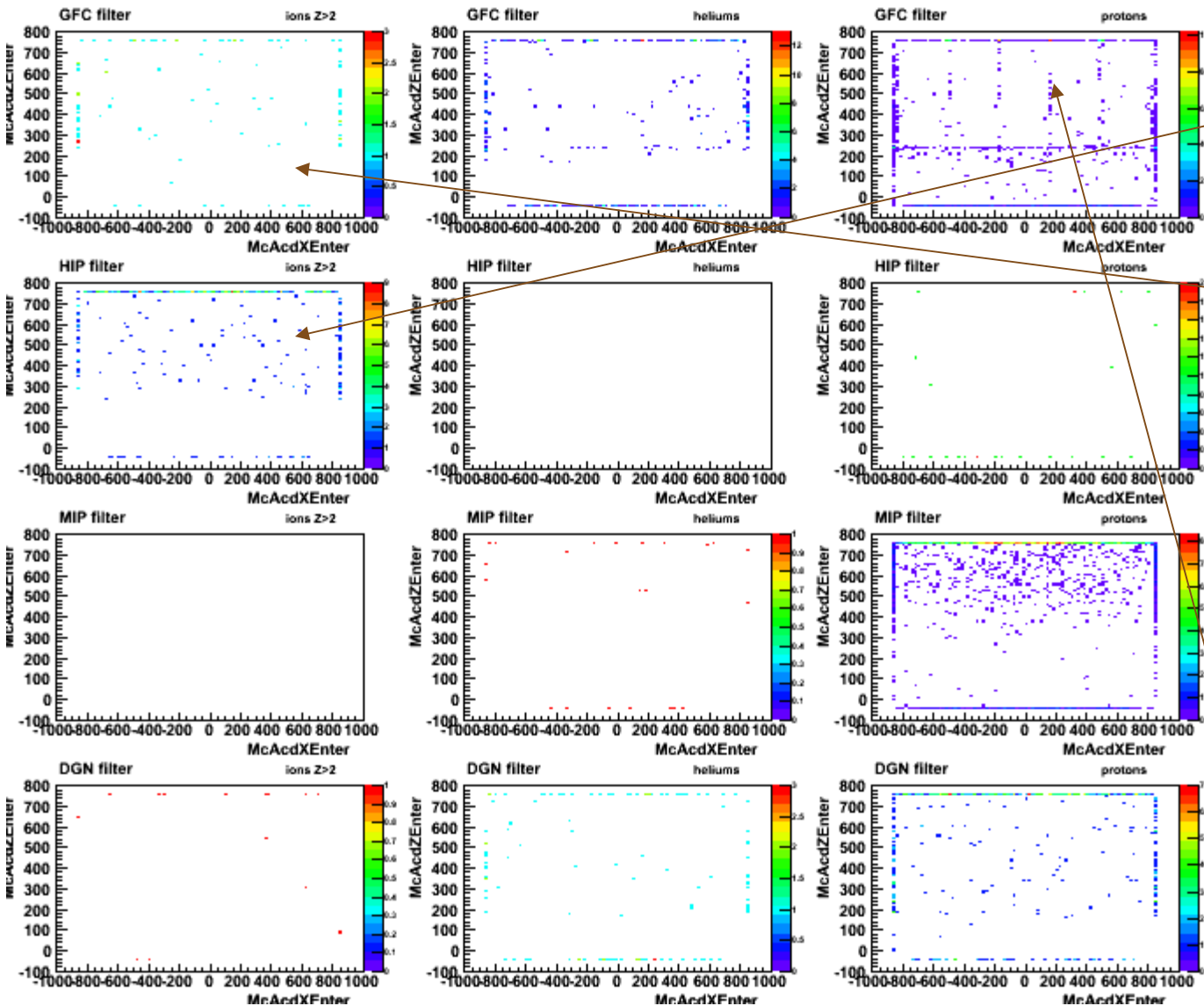


Heavy ions in HIP come rather from the top

Heavy ions in GFC come rather from the sides

Protons and heliums in GFC passed through the ACD (e.g., ribbons)

# McAcidZEnter vs McAcidXEnter

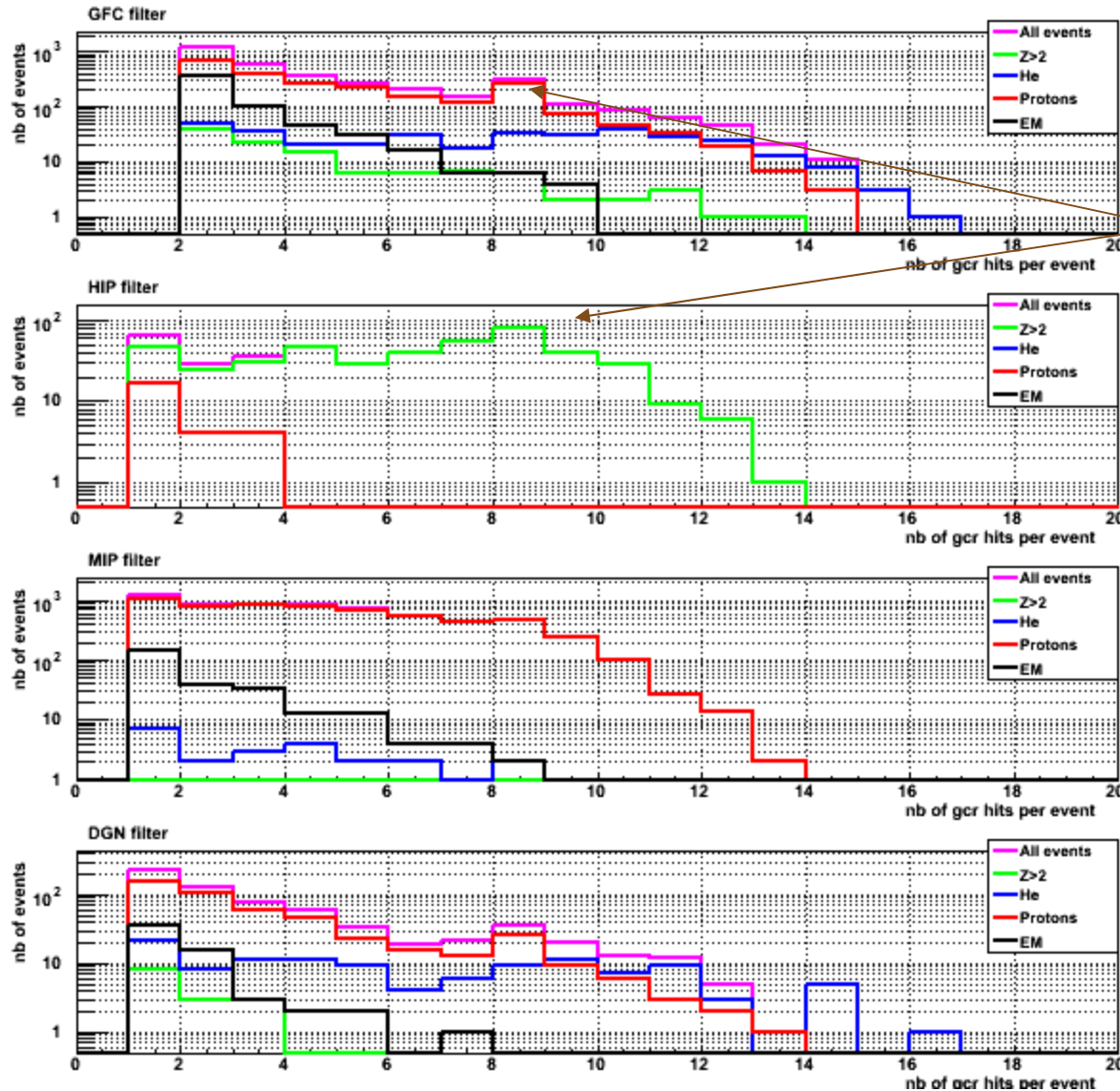


Heavy ions in HIP come rather from the top

Heavy ions in GFC come rather from the sides

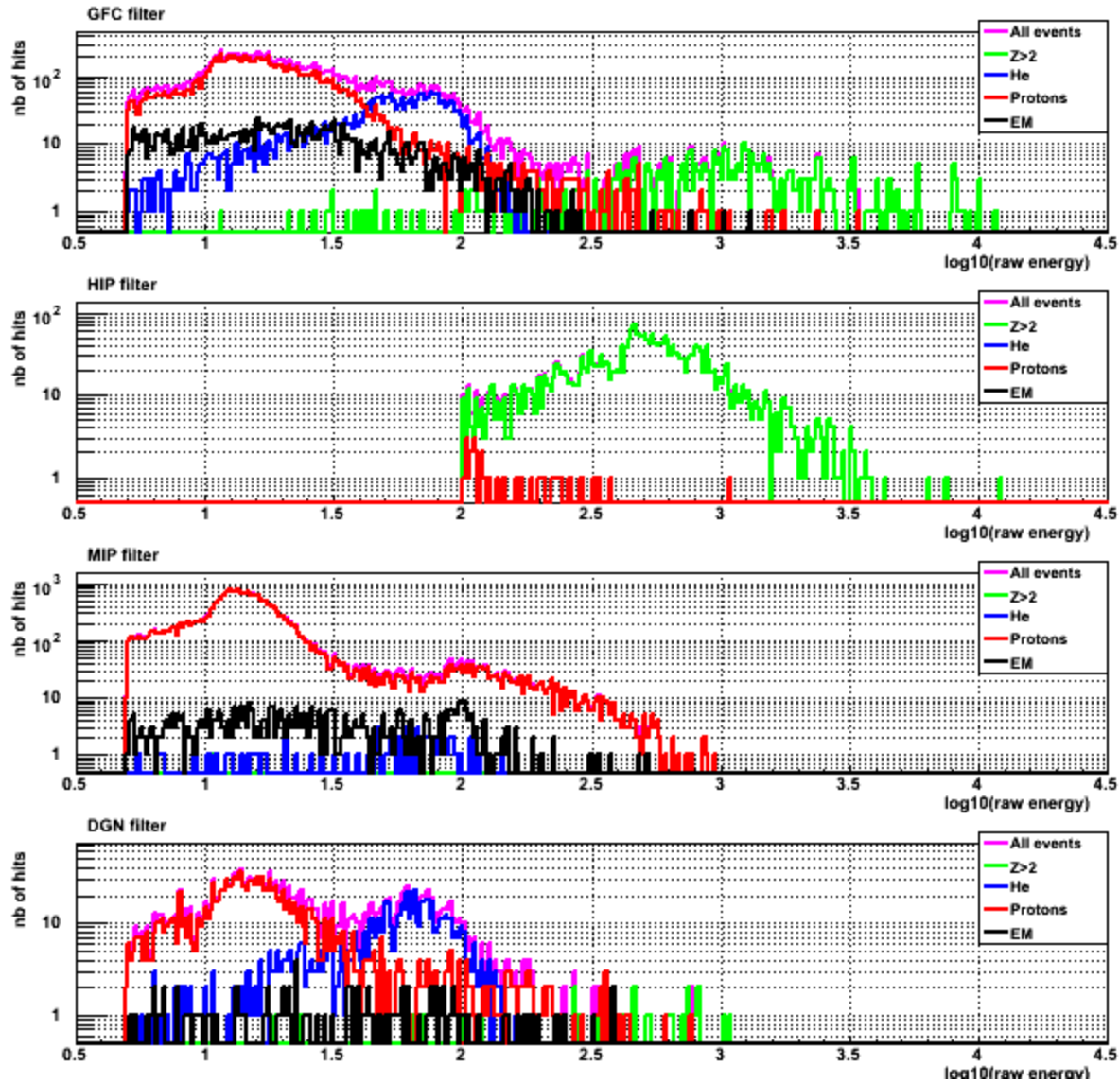
Protons and heliums in GFC passed through the ACD (e.g., ribbons)

# Number of GCR hits selected per event



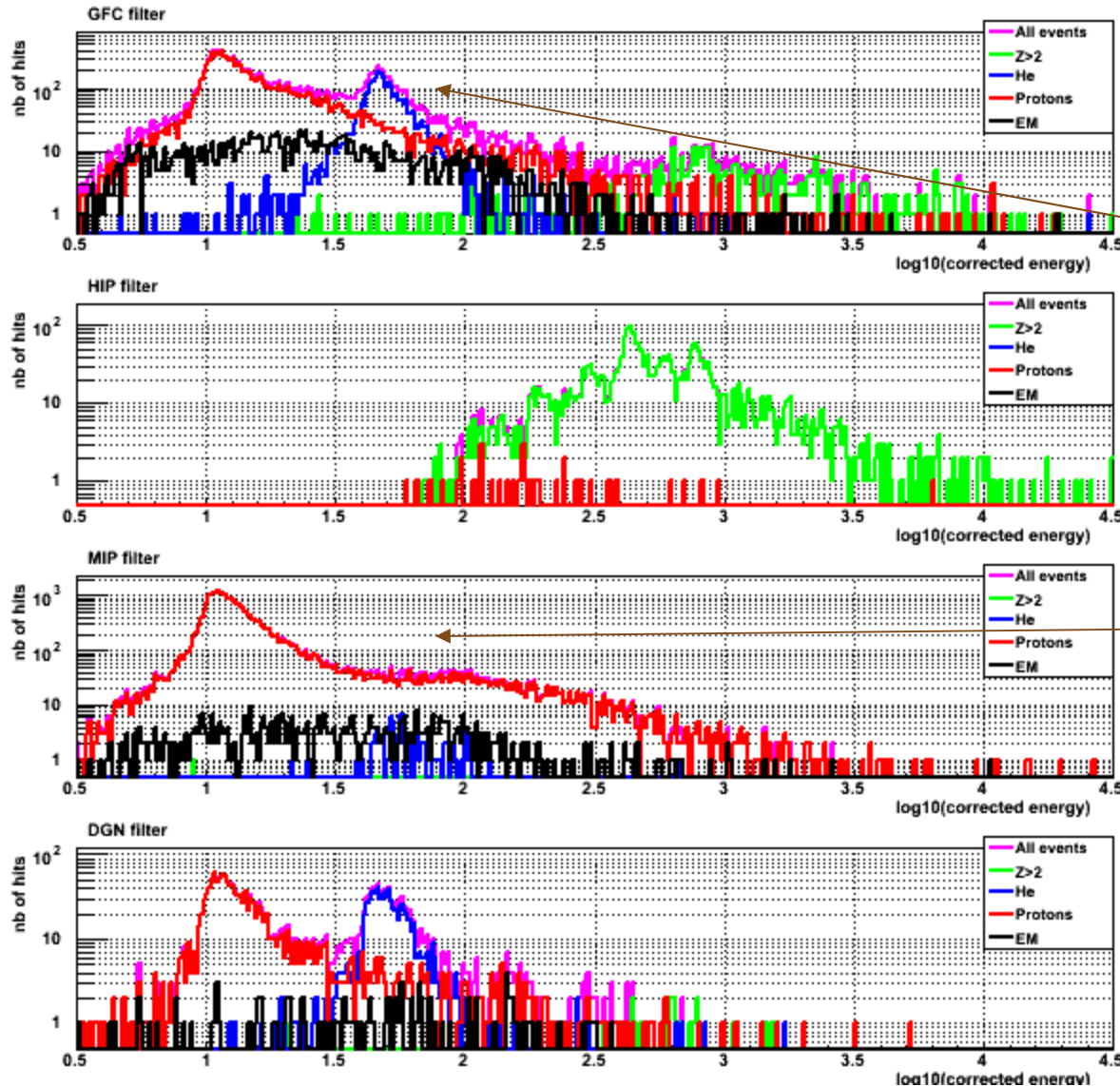
Peak at 8 for ~ vertical events

# Hit raw energy distribution





# Hit corrected energy distribution



Helium peak is less contaminated by proton tail and EM events than w/ previous version of GCRcalib since we require trigger engine 4 to set  $E_{th}$  at 100MeV

Clean proton peak in MIP filter, w/ 3-4 times more statistics than in GFC

DGN peaks are broad...

# Conclusions

- **To do**
  - **Must check available statistics per crystal**
  - **Predict calibration accuracy at different times during LEO**
    - **See discussion on CAL LEO calibration sequence**
  - **Need for a larger simulation?**
  - **Work on quenching corrections still pending**