

Online Stopping Muon Filter

Jonathan Insler

LSU

July 15, 2015

TPC5 Stopping Muon Filter Algorithm

1

- Simple TPC 5 filter produces very high purity of stopping muons
- High efficiency of 20% found to be due to a bug
- Filter now requires a minimum number of hits in TPC 5 and a maximum number of hits outside TPC 5
- Extremely high purities reached with efficiencies of 5% to 10%

TPC 5 Stopping Muon Filter Algorithm

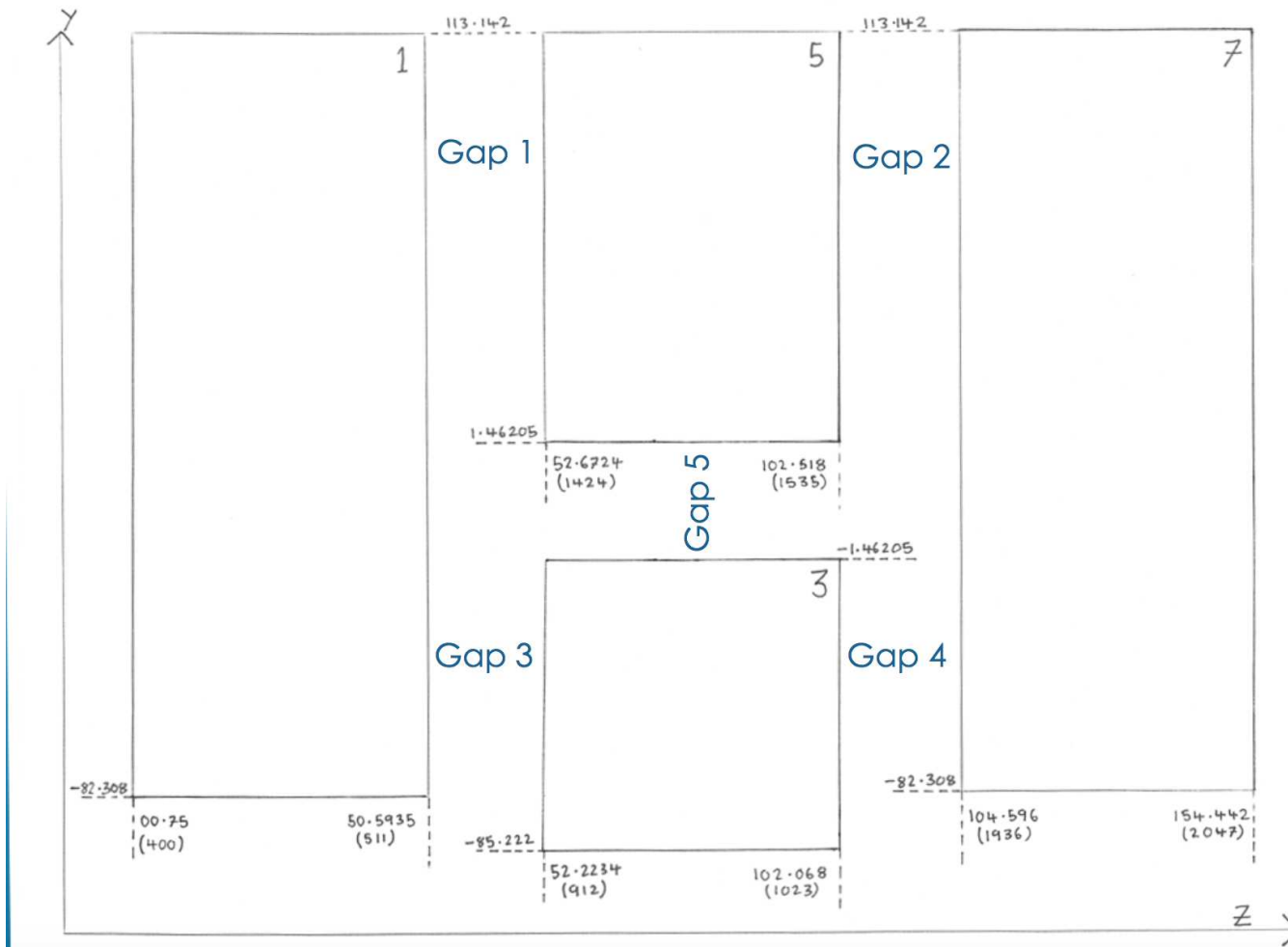


Figure 1: 35t TPCs with gaps shown

Gap-Based Stopping Muon Filter Algorithm

3

- 10000 μ^+ from MCC 3 LSU AntiMuon (DetSim) used
- 838 stopping muons enter active volume:
($-50 < x \leq 250$ cm, $-82 < y \leq 125$ cm, $-1 < z \leq 156$ cm)
- Hits reconstructed with FastHitFinder and DisambigCheater
- TPC 5 filter:
 - Event must have at least A hits inside TPC 5 and no more than B hits outside TPC 5
 - All hits in event must have $x < 220$ cm, where x is calculated from drift time by standard conversion

Purities and Efficiencies

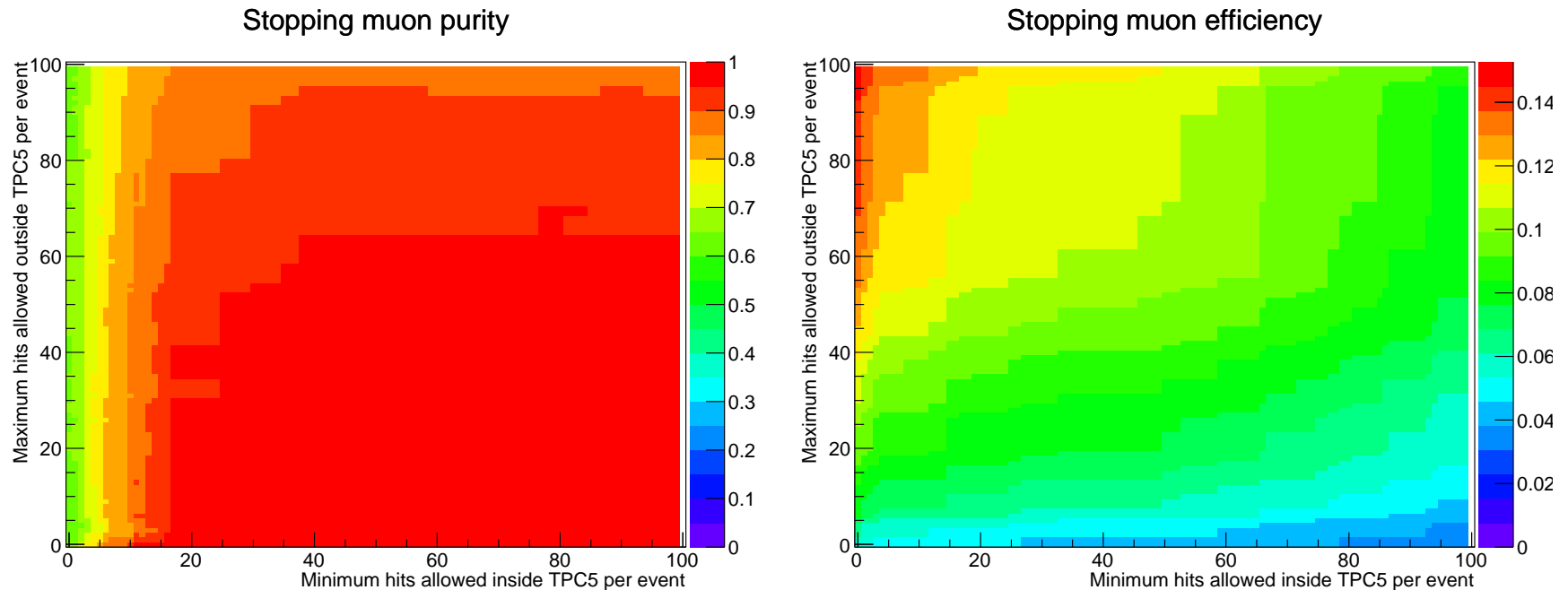


Figure 2: Purities and efficiencies with limits on hits inside and outside of TPC 5

Purity = Number of true stopping muons passing filter / Number of all muons passing filter

Efficiency = Number of true stopping muons passing filter / Number of all true stopping muons in sample

Purities and Efficiencies

Table 1: Maximum efficiency for given purity and numbers of allowed hits in/outside of TPC 5

Purity	Max. Efficiency	Min. TPC5 Hits	Max. nonTPC5 Hits
100%	4.77%	17	1
99%	4.77%	17	1
98%	9.19%	36	42
97%	10.13%	36	53
96%	10.62%	39	57
95%	10.74%	39	63
92.5%	11.10%	18	57
90%	11.46%	18	73
85%	12.41%	18	99
80%	13.25%	11	99
75%	13.37%	7	99
70%	13.48%	5	99
60%	15.27%	1	99
50%	15.27%	1	99

Stopping Muon Energy Spectra

Energy of Stopping Muons Passing Cuts

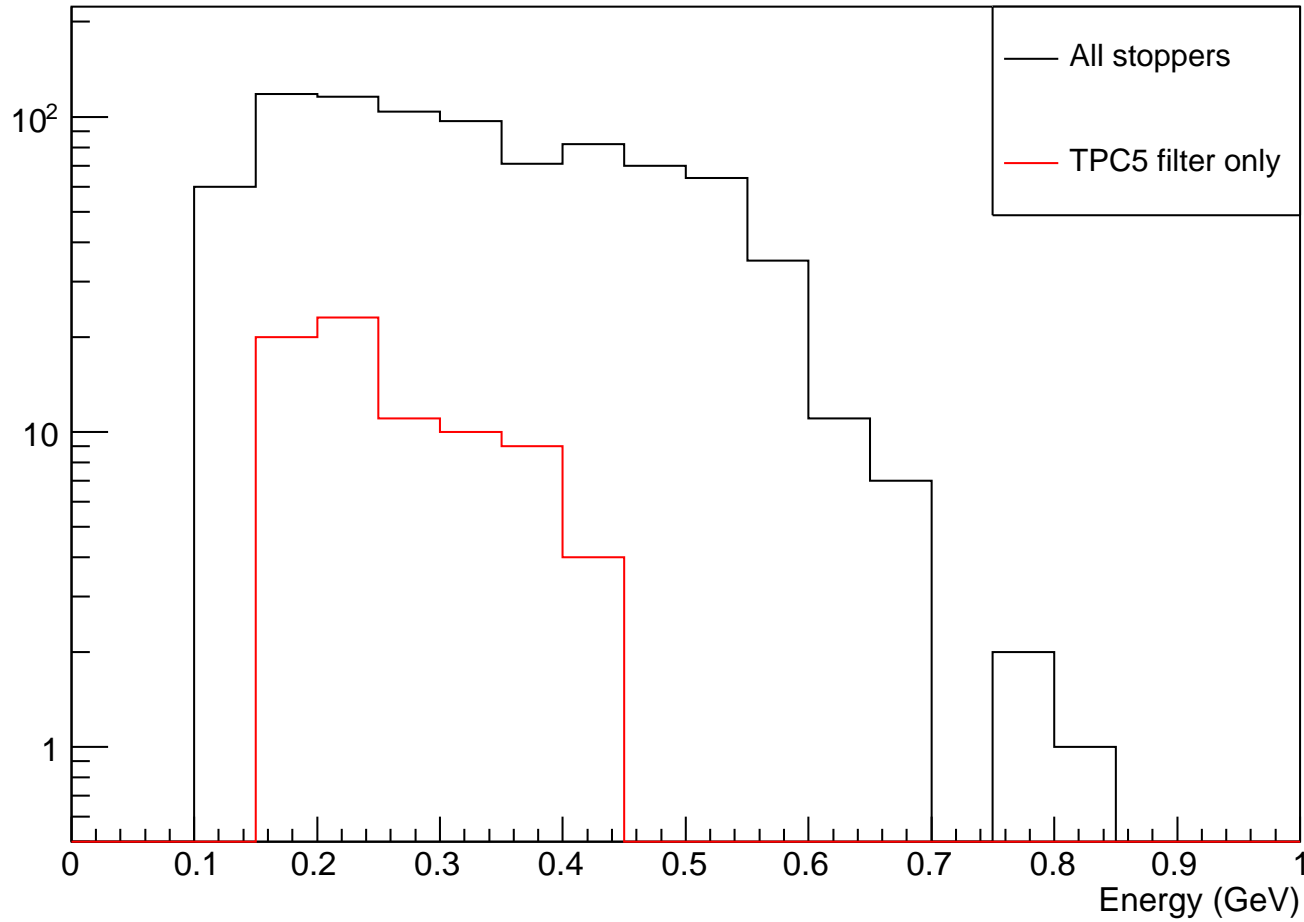


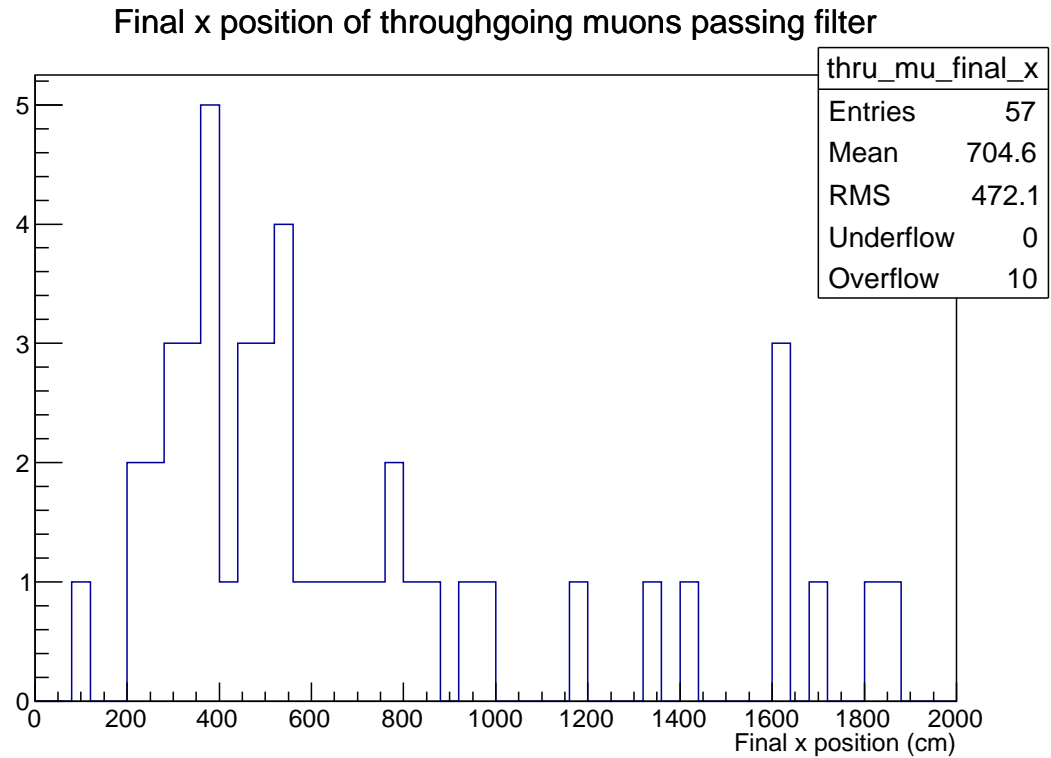
Figure 3: Stopping muon energies at point of detector entry

Muons Exiting Cathode

7

- Catch: Filter currently relies on determining x position from drift time
- Muons passing through near cathode are eliminated by cut on hits outside of TPC 5, which includes hits in near drift side
- t_0 is necessary for eliminating muons exiting through far cathode
- Using parameters that produce 98% purity: Min. TPC5 hits = 36, Max. nonTPC5 hits = 42:
- With cut on drift time-based $x < 220$ cm:
 - 77 out of 838 stoppers matched, 1 fake
 - Purity = 98.7%, efficiency = 9.19%
- Without cut on drift time-based $x < 220$ cm:
 - 93 out of 838 stoppers matched, 57 fake
 - Purity = 62.0%, efficiency = 11.1%

Muons Exiting Cathode



Nearly all throughgoing muons that pass TPC 5 based filter end up exiting through far cathode.

Stopping Muon Event Durations

- Raw data will be take in 10 event windows
- Other TPCs are very likely to be hit by other particles during 10 event length of time
- We can perform the filter check over the usual stopping muon event duration

Stopping Muon Event Durations

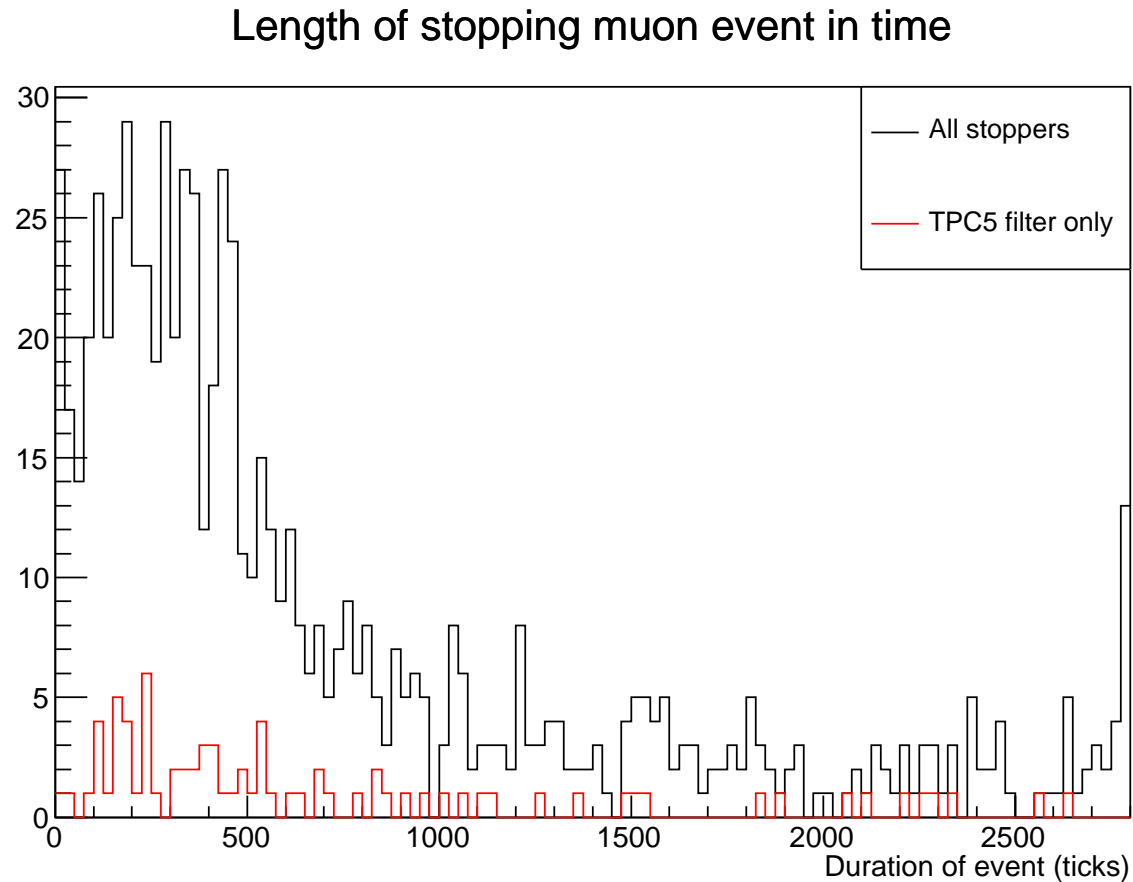


Figure 4: Duration in ticks between first and last hit for stopping muon events

Next Steps

- Run on MCC 3.0 1000 CRY 10 drift window events
 - Wire calibration currently crashes
 - Modify deconvolution to work with 10 drift window length
- Check background of other particles
- Convert algorithm to online filter code