LFHCal rates

Aiden Wu
ORNL (NGSI)
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Introduction

- Thresholding overview
- Background occupancy
- Rate overviews
- Beampipe region
- NO Insert

Channel definition

1. Truth data from LFHCALHits

- hit level
- SimCalorimeterHits
  - Cell ID
  - Energy
  - Position
  - Contributions

2. Decode hit.getCellID() onto a Channel ID with:

- moduleIDx
- moduleIDy
- moduletype
- towerx
- towery
- rlayerz

3. Truth data for analysis

- aggregate data from multiple hits onto the same channel

MIP energy depositions

ddsim particle gun:

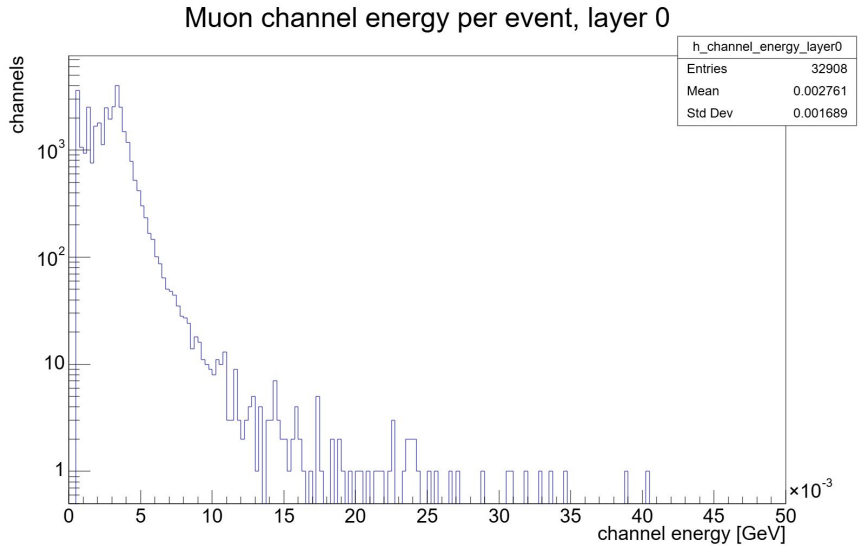
- 10 GeV muons
- sprayed in the direction of the LFHCal from (0,0,0)
- 100k events

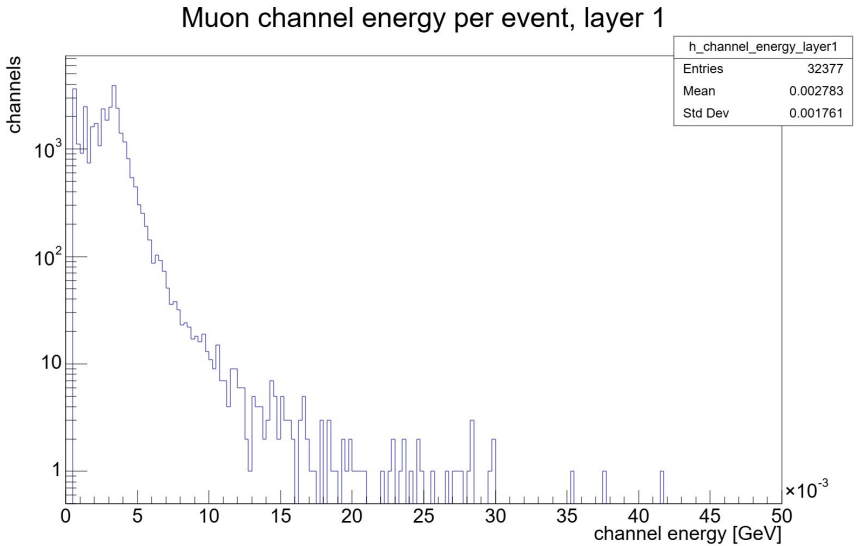
```
ddsim \
  --compactFile "$DETECTOR_PATH/epic_lfhcal_only.xml" \
  --enableGun \
  --gun.particle mu- \
  --gun.energy "10*GeV" \
  --gun.position "0 0 0" \
  --gun.distribution uniform \
  --gun.thetaMin "3.5*degree" \
  --gun.thetaMax "38.5*degree" \
  --gun.phiMin "0*degree" \
  --gun.phiMax "360*degree" \
  --numberOfEvents 100000
```

MIP energy deposition

Energy deposition peak around 3.5 MeV for the first two readout layers.

5 layers per readout layer.

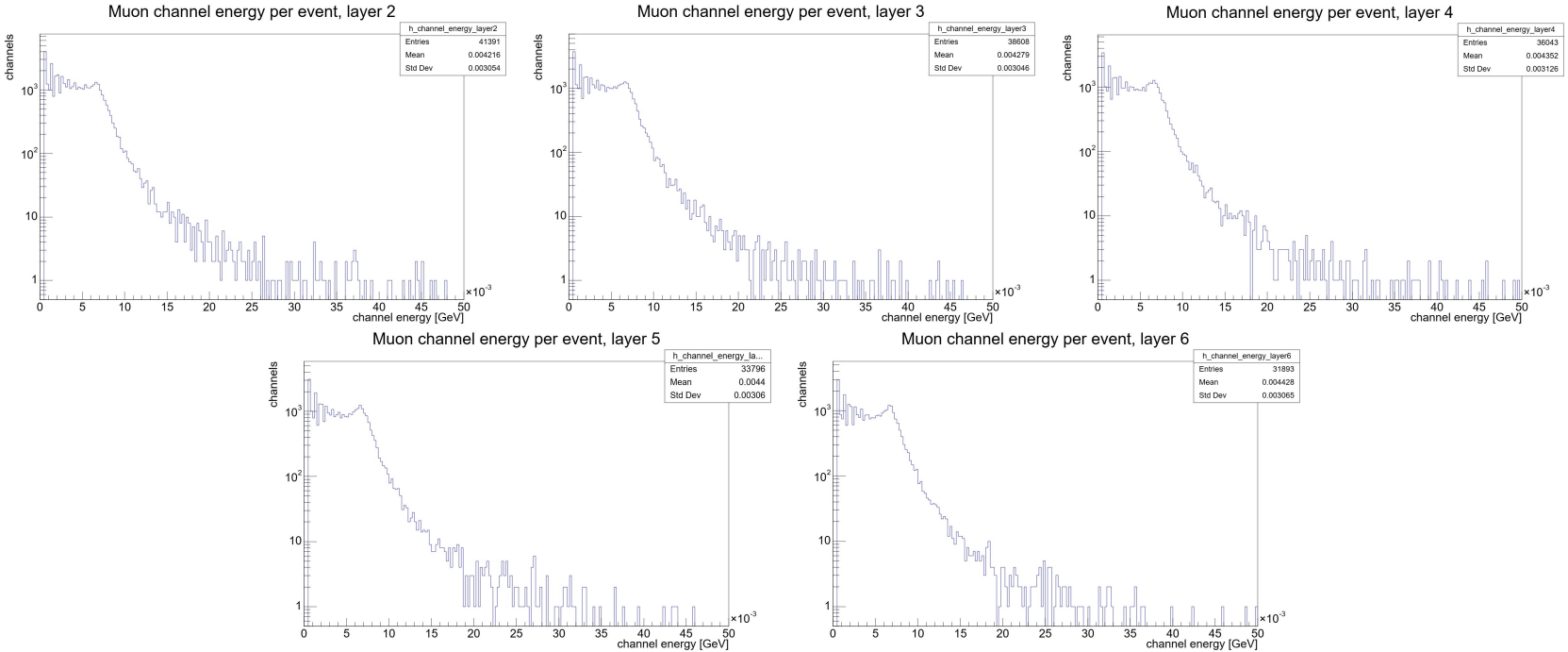




MIP energy deposition

Energy deposition peak around 7.0 MeV for the rest of the readout layers.

10 layers per readout layer.



MIP channel thresholds

First two readout layers: MIP = 3.5 MeV

Last five readout layers: MIP = 7.0 MeV

Energy thresholds per channel is expressed as some multiple of the corresponding MIP value for it’s readout layer.

- 0.1 MIP, 0.2 MIP, 0.3 MIP, etc..

Hit / rate definition

A hit is a channel whose summed hit energy in an event exceeds its corresponding layer’s MIP-based threshold.

Rate = (total passing hits) / (total events * 2 microseconds)

Data Source

April full background simulation data: NC, DIS, 10x275 GeV^2, $Q^2 > 1$:

- epic:/FULL/26.04.1/epic_craterlake/Bkg_Exact1S_2us/GoldCt/10um/DIS/NC/10x275/minQ2=1/pythia8NCDIS_10x275_minQ2=1_beamEffects_xAngle=-0.025_hiDiv_1.0000.edm4hep.root

Used the first 500 files, approximately 19k events.

GeneratorStatus mapping

Symbol	Process	Description	Status Code Shift
	signal	DIS NC 18x275 $Q^2>1$ (Deep inelastic scattering neutral current)	0
	synrad	Synchrotron Radiation	2000
	ebrems	Electron bremsstrahlung radiation	3000
	etouschek	Electron Touschek scattering (intrabeam scattering)	4000
	ecoulomb	Electron Coulomb scattering processes	5000
	p.b.gas	Proton beam gas interactions	6000

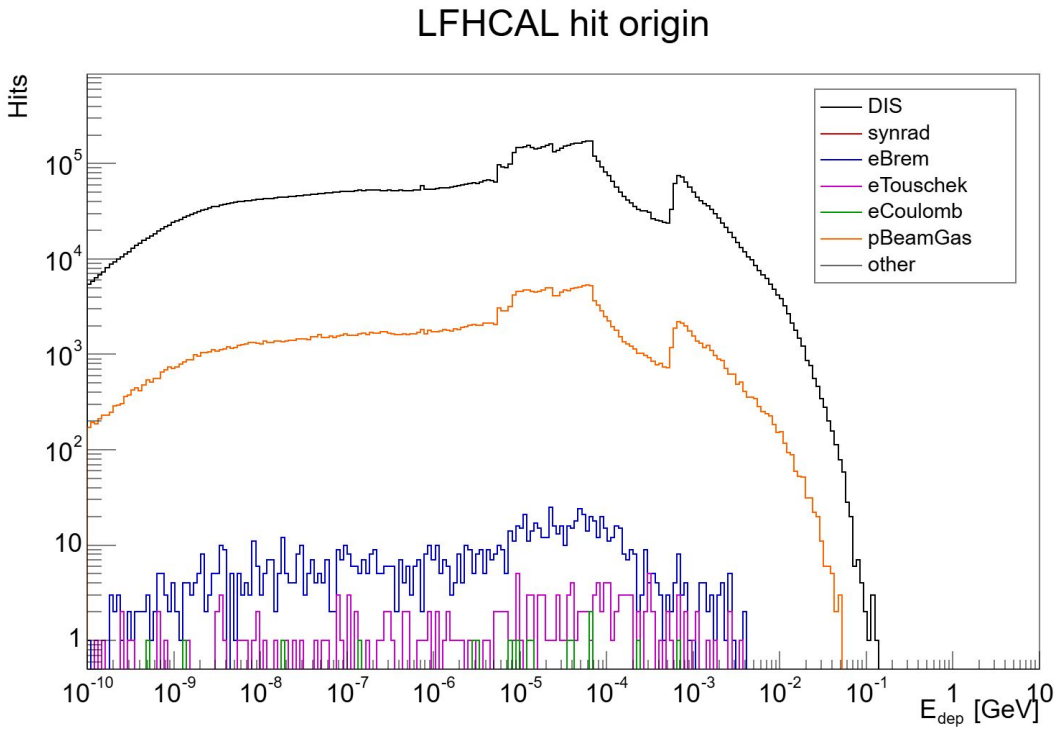
https://github.com/eic/eic.github.io/blob/master/_resources/background_mixed_samples.md

Background populations

Sum all hit contribs from the same background family per hit.

DIS (and pBeamGas) dominate.

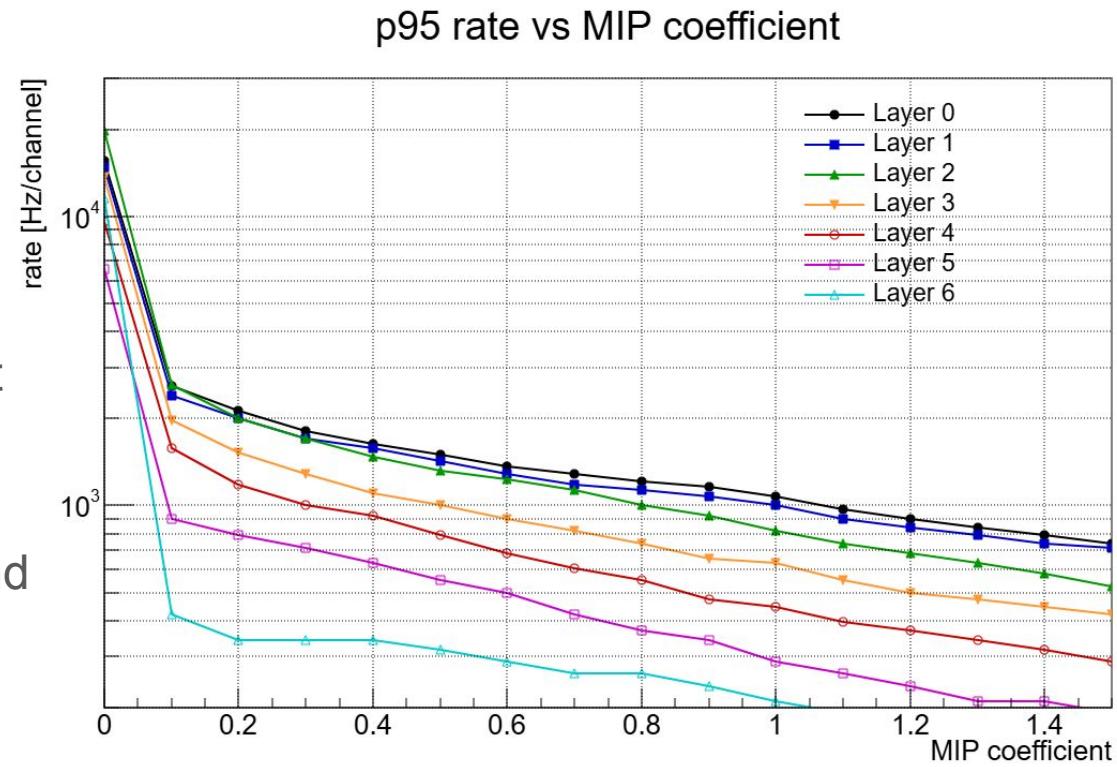
The rest are nonexistent/negligible.



All rates

95th percentile of ALL channel rates.

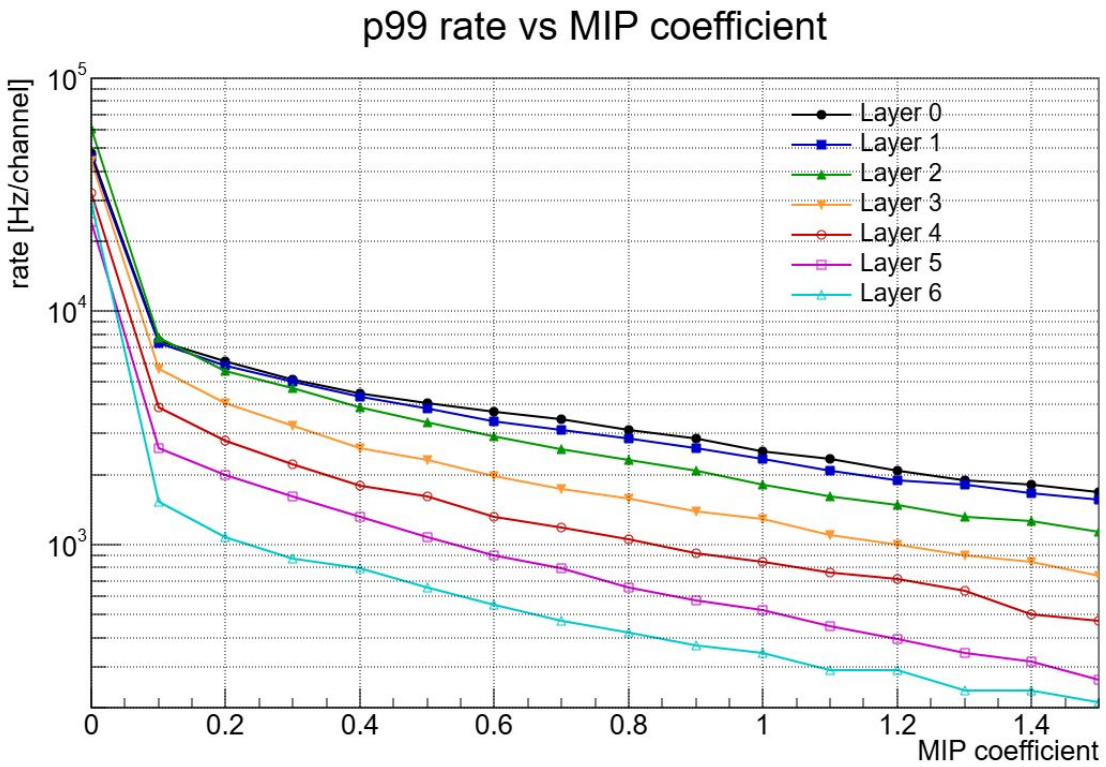
- ~10 kHz with no thresholds
- Mildly decreasing past 0.1 MIP
- 130 Hz to 2.5 kHz depending on layer and coefficient



All rates

99th percentile of ALL channel rates.

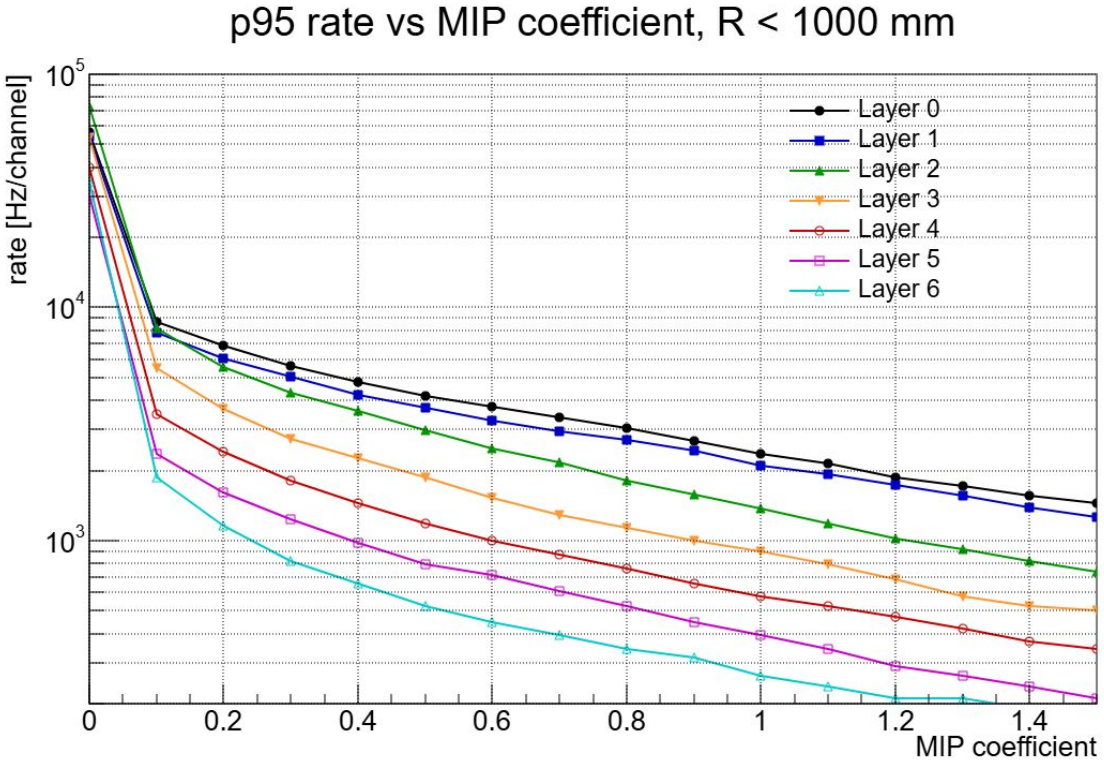
- ~30 kHz with no thresholds
- Mildly decreasing past 0.1 MIP
- 210 Hz to 7.5 kHz depending on layer and coefficient



Near-beampipe rates

95th percentile of channel rates within R < 1000 mm of the center.

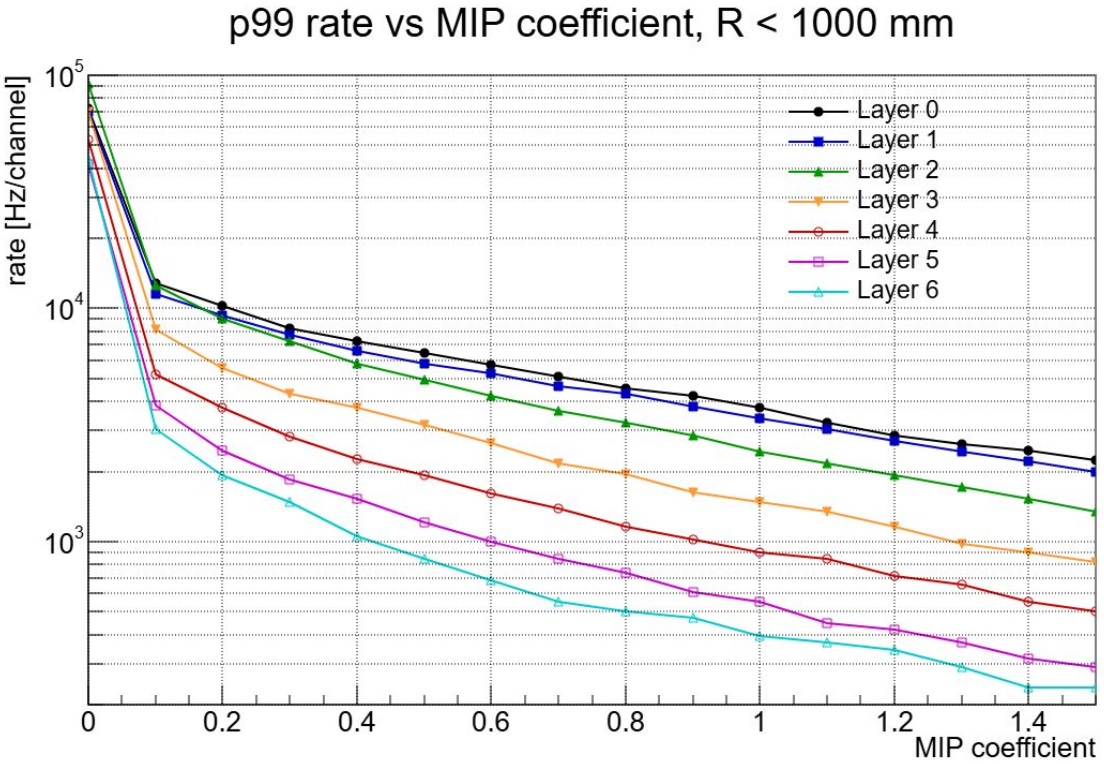
- ~60 kHz with no thresholds
- Mildly decreasing past 0.1 MIP
- 160 Hz to 8.7 kHz depending on layer and coefficient



Near-beampipe rates

99th percentile of channels rates within R < 1000 mm of the center.

- ~70 kHz with no thresholds
- Mildly decreasing past 0.1 MIP
- 240 Hz to 13 kHz depending on layer and coefficient

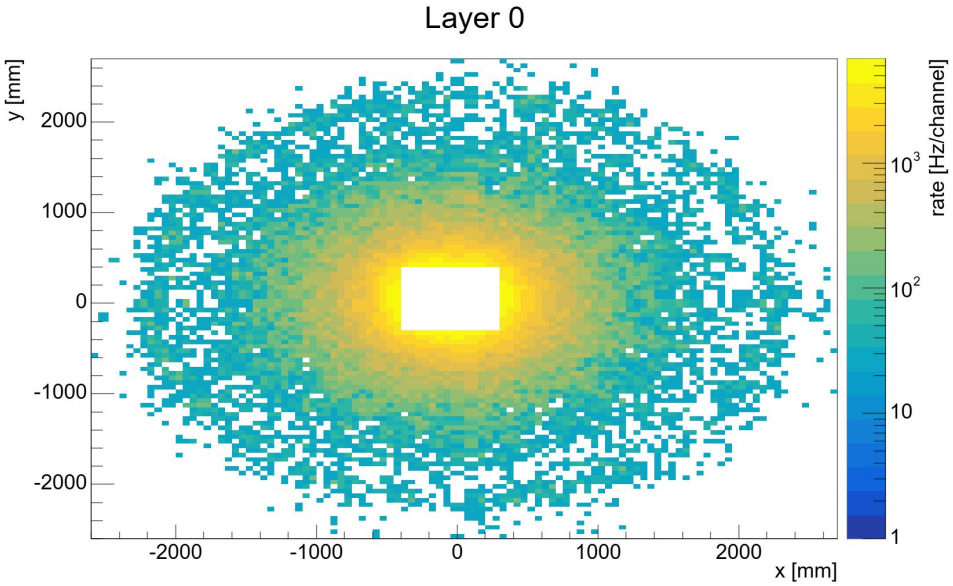


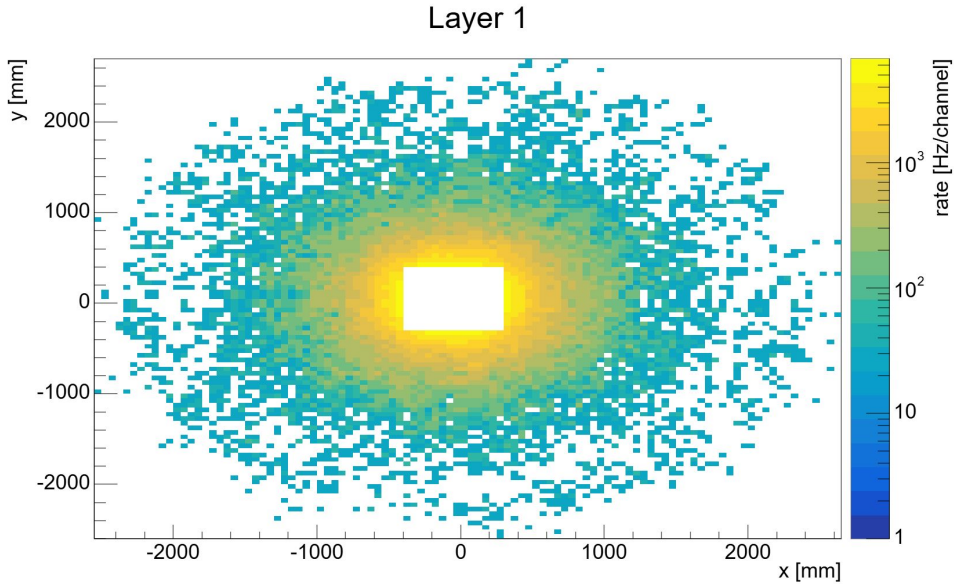
Threshold effect on rate

Thresholding past 0.1 MIP has small differences.

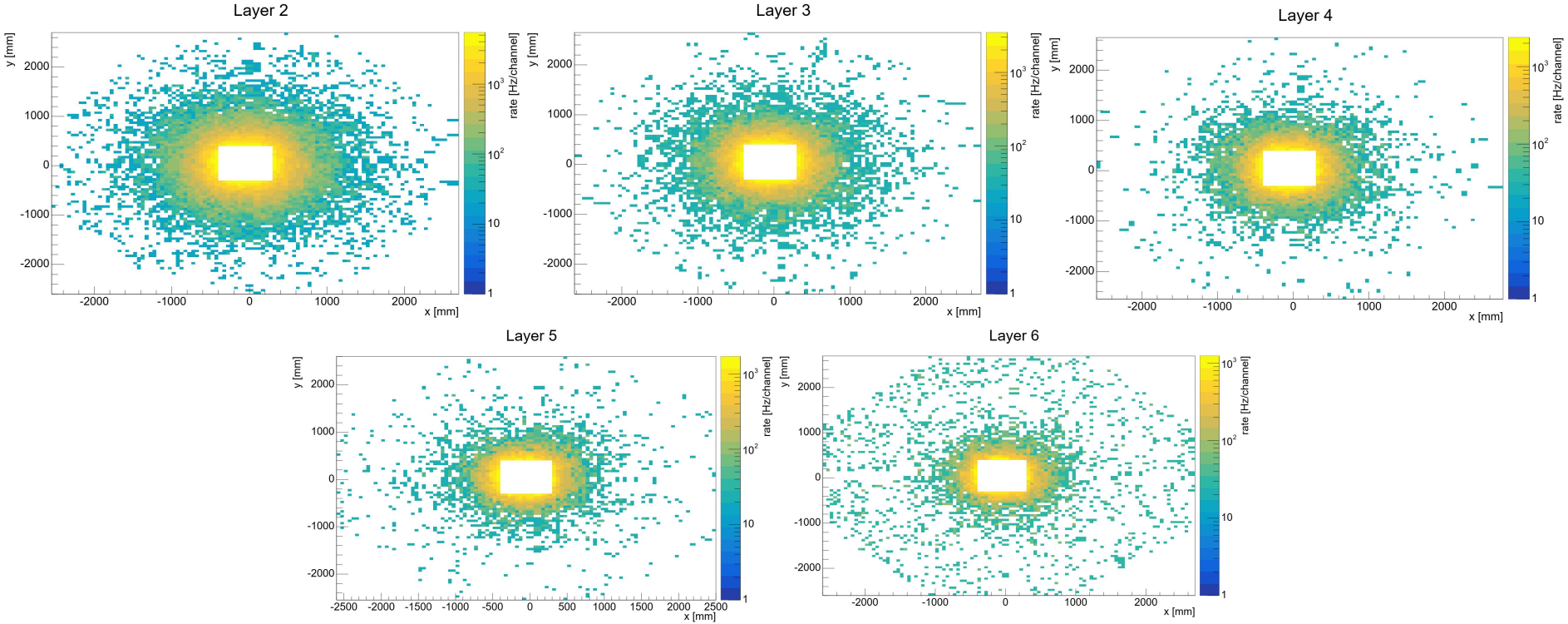
The following plots will use 0.5 MIP as the threshold.

Rates for DIS (first two layers)

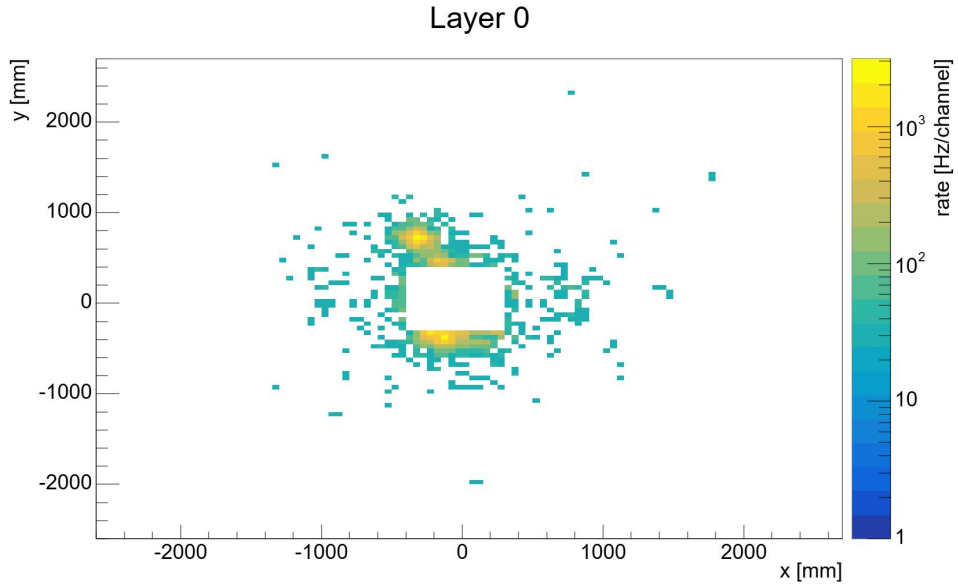


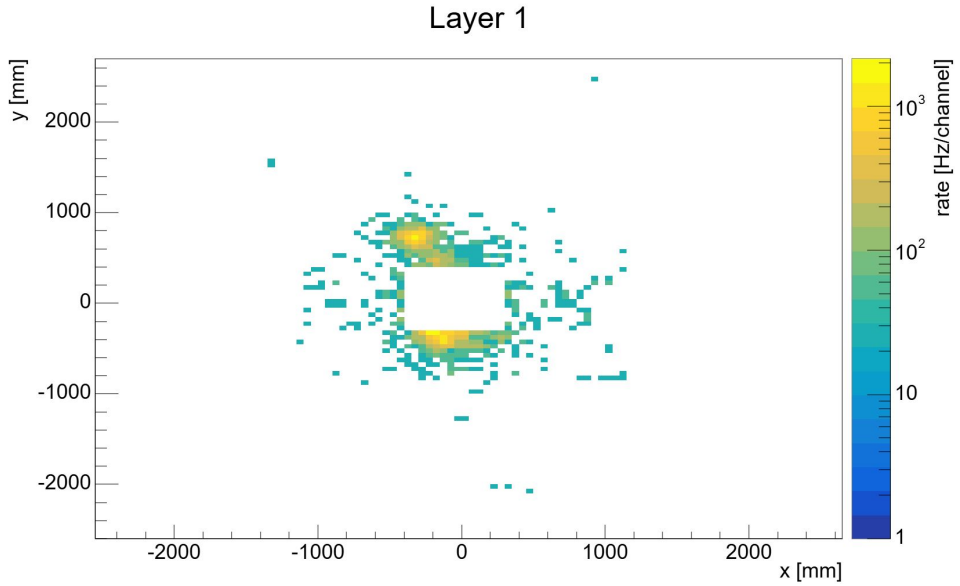


Rates for DIS (last five layers)

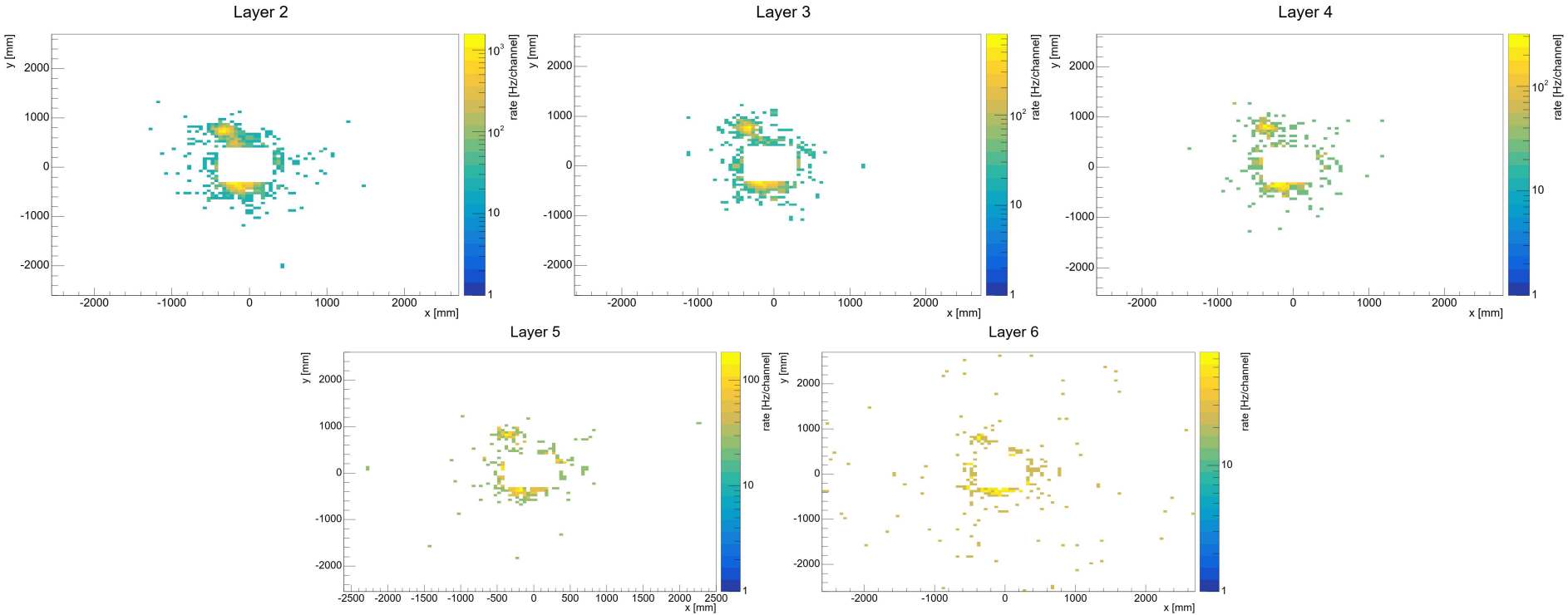


Rates for pBeamGas (first two layers)





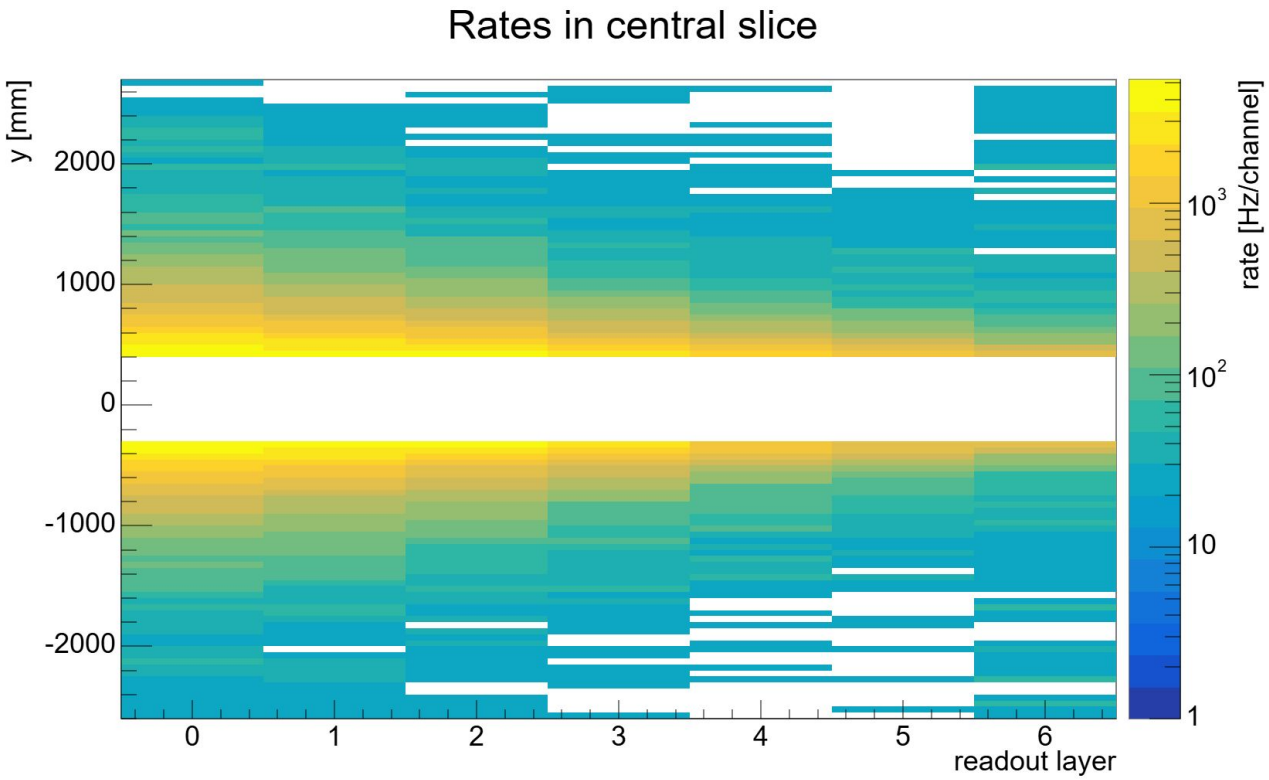
Rates for pBeamGas (last five layers)



Longitudinal view (DIS)

Average rate of channels in a central vertical slice of the LFHCal.

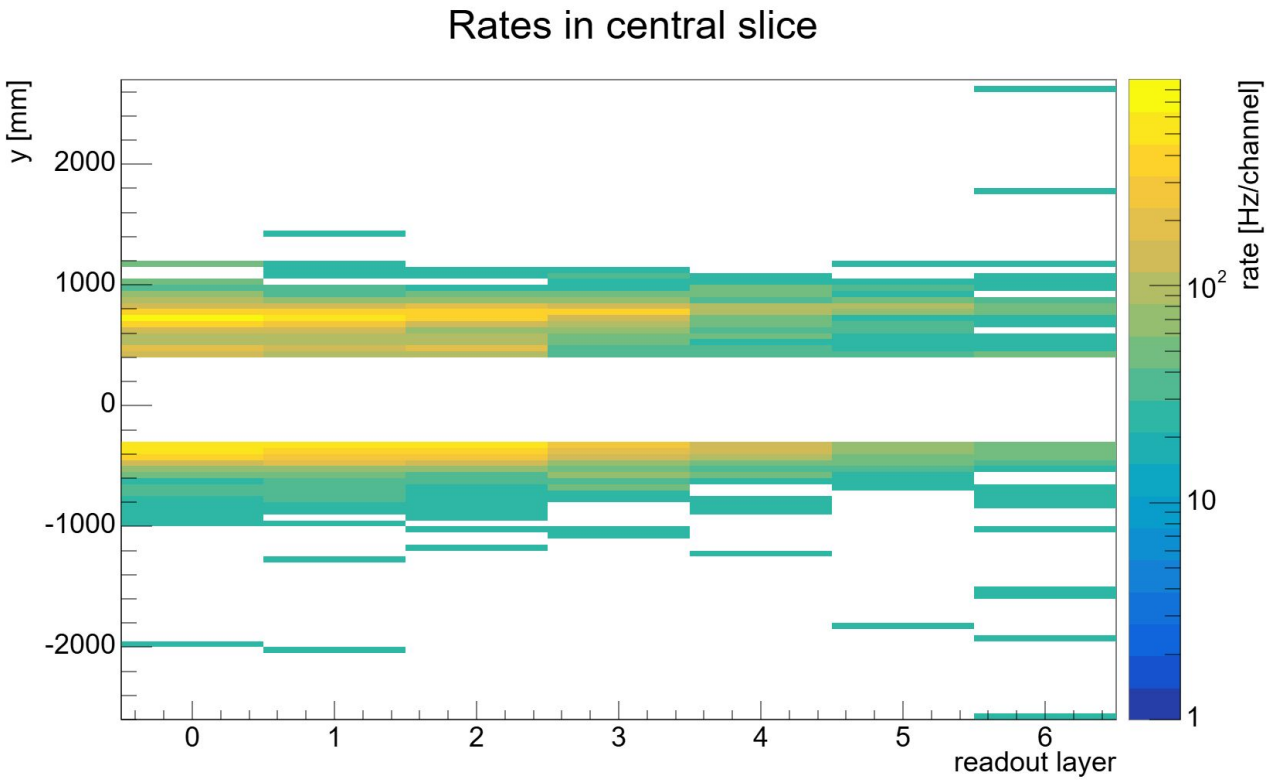
r < 1000 mm contains the most statistics and highest rates.



Longitudinal view (pBeamGas)

Average rate of channels in a central vertical slice of the LFHCal.

r < 1000 mm contains the most statistics and highest rates.



Summary

	All background families	DIS	pBeamGas
99th percentile of all channel rates at 0.5 MIP	3.11 kHz	2.42 kHz	0.947 kHz
95th percentile of all channel rates at 0.5 MIP	1.08 kHz	0.895 kHz	0.316 kHz