Hit and channel rates in MPGD detectors with backgrounds

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MPGD rates

What is simulated:

- One DIS event $Q^2>1GeV^2$ per event (either on average or forced)
- 2μs equivalent of background hits merged to every DIS event
- Either 5μm or 10μm gold coating of the beam pipe

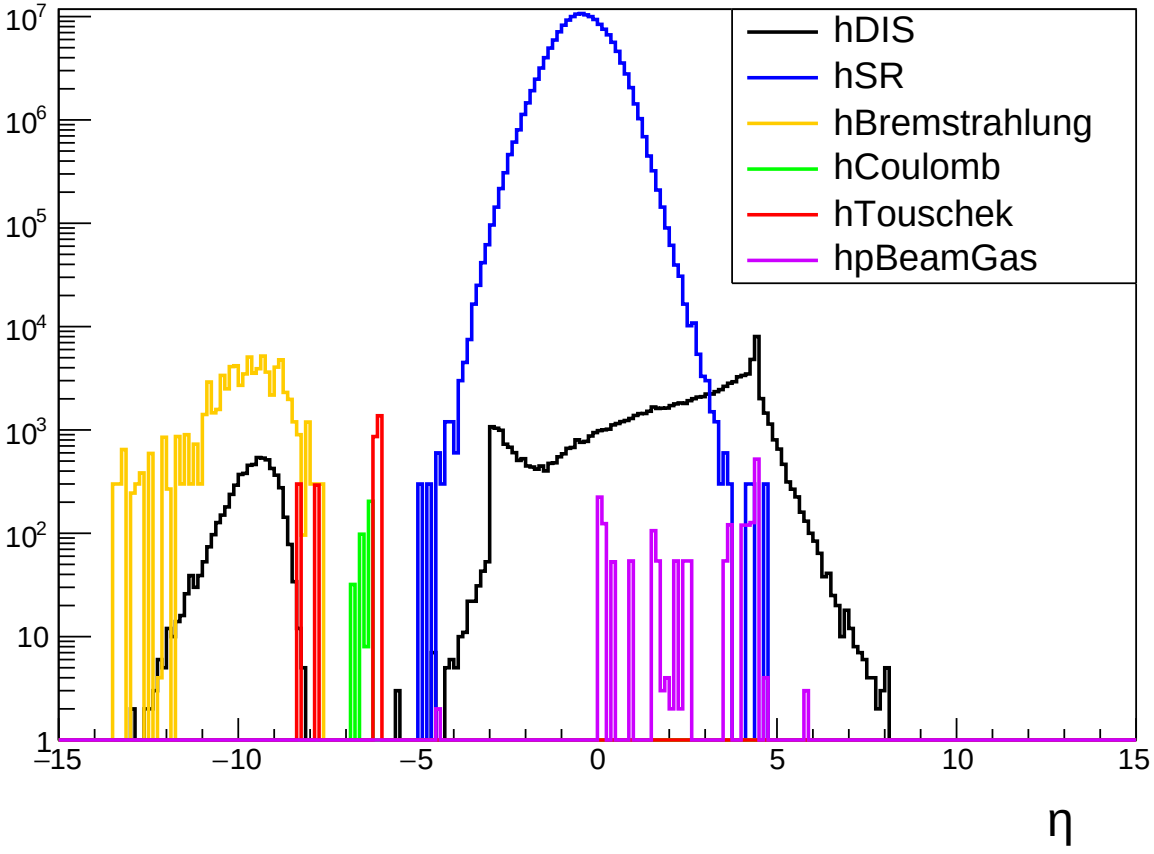
Simulations are accessible via xrootd (or on JLab /volatile)

epic:/RECO/25.12.0/epic_craterlake/Bkg_Exactly1SignalPer2usFrame/GoldCoating/5um/DIS/NC/10x275/minQ2=1
epic:/RECO/25.12.0/epic_craterlake/Bkg_Exactly1SignalPer2usFrame/GoldCoating/10um/DIS/NC/10x275/minQ2=1
epic:/RECO/25.12.0/epic_craterlake/Bkg_Exactly1SignalPer2usFrame/GoldCoating/5um/DIS/NC/10x100/minQ2=1
epic:/RECO/25.12.0/epic_craterlake/Bkg_Exactly1SignalPer2usFrame/GoldCoating/10um/DIS/NC/10x100/minQ2=1

Remarks:

- Why 2μs ? Because this is the expected time-frame window in the streaming r/o DAQ
- **No cluster size considered** all channel rates must be multiplied by a factor 2 or 3

Sources



e-p 10 GeV x 100 GeV

Synchrotron radiation dominates ad mid rapidity

5µm

	10x275		10x100	
	Hz/cm2	Hz/channel	Hz/cm2	Hz/channel
CyMBaL	3.10E+03	1.80E+04	3.10E+03	1.80E+04
BOT	2.65E+02	9.88E+02	2.61E+02	9.73E+02
ECT Backward Near	6.77E+03	1.67E+04	6.14E+03	1.51E+04
ECT Backward Far	6.78E+03	1.67E+04	6.06E+03	1.49E+04
ECT Forward Near	1.26E+04	3.11E+04	1.27E+04	3.12E+04
ECT Forward Far	1.34E+04	3.30E+04	1.35E+04	3.33E+04

10µm

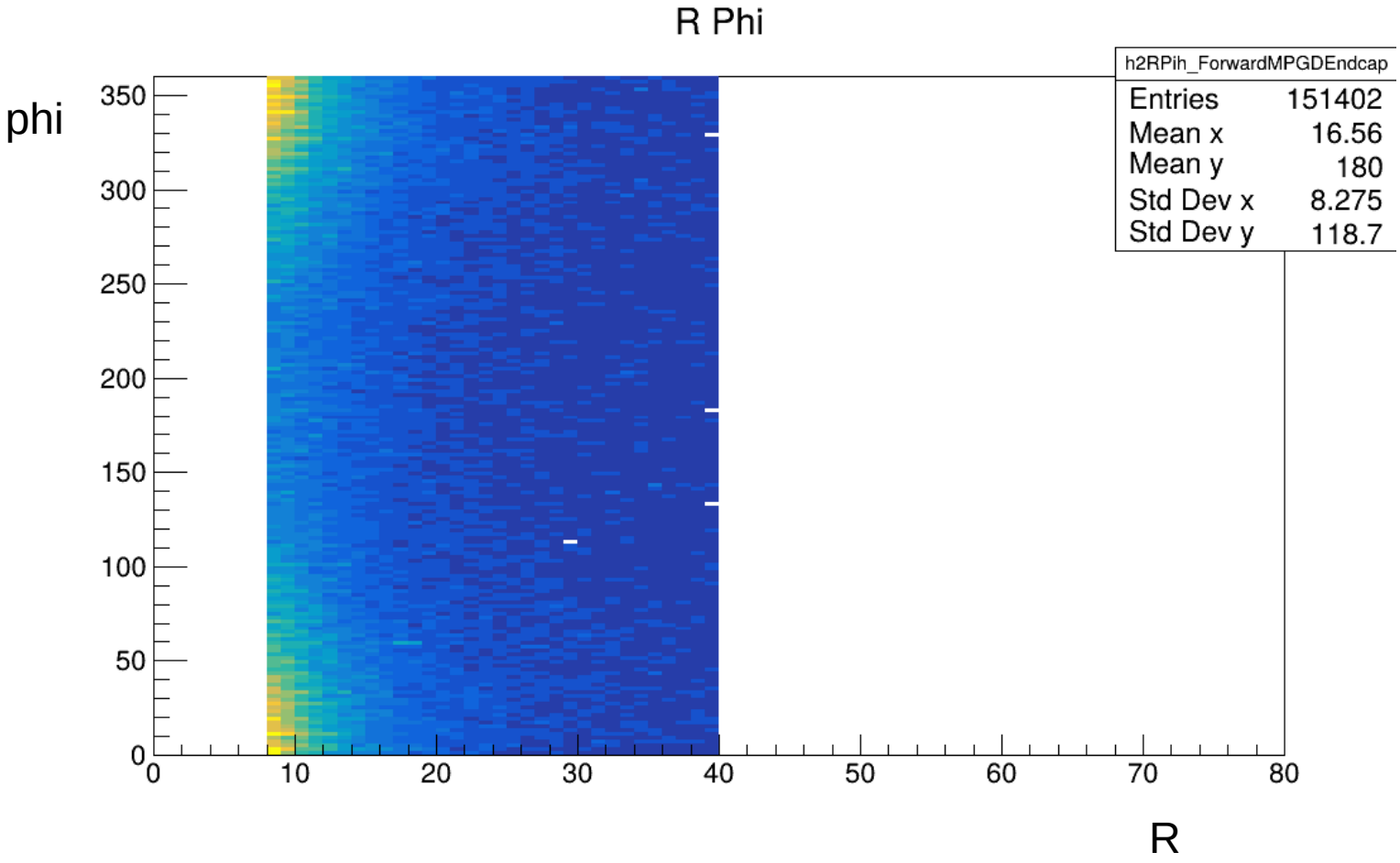
	10x275		10x100	
	Hz/cm2	Hz/channel	Hz/cm2	Hz/channel
CyMBaL	1.67E+03	9.69E+03	1.67E+03	9.68E+03
BOT	1.70E+02	6.35E+02	1.70E+02	6.34E+02
ECT Backward Near	6.63E+03	1.63E+04	5.99E+03	1.47E+04
ECT Backward Far	6.48E+03	1.59E+04	5.73E+03	1.41E+04
ECT Forward Near	1.25E+04	3.08E+04	1.24E+04	3.06E+04
ECT Forward Far	1.38E+04	3.39E+04	1.33E+04	3.27E+04

Summary

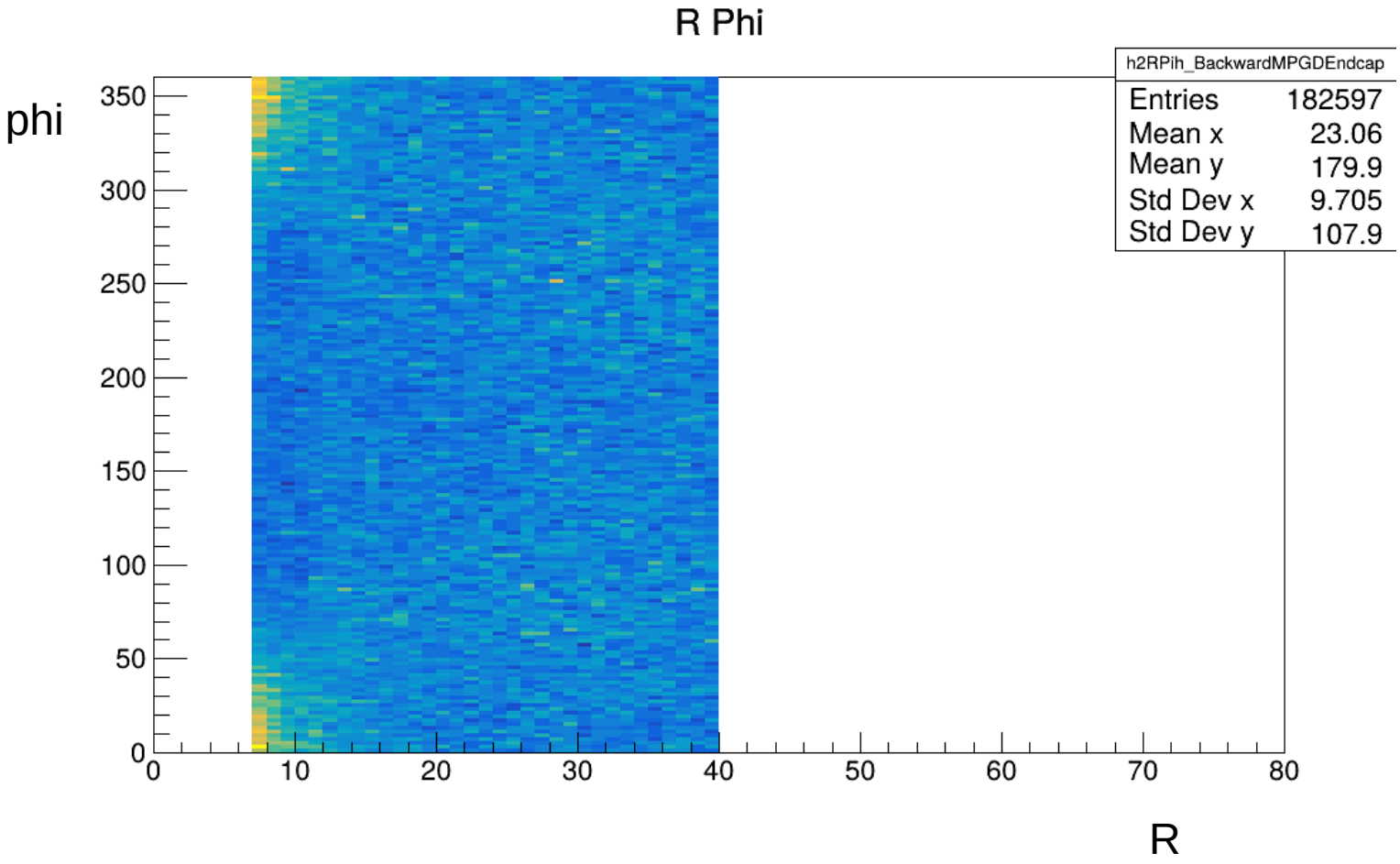
- Most of the rate in CyMBaL (and BOT) is given by the synchrotron radiation
- The rates in the forward ECT Disks are dominated by physics
- The increase of the gold coating from 5µm to 10µm
  - rates in CyMBaL (and BOT) decrease by a factor ~2
  - Rates in in ECT decrease by less than 10 %

Should we adapt the segmentation ?

R – phi ECT Forward

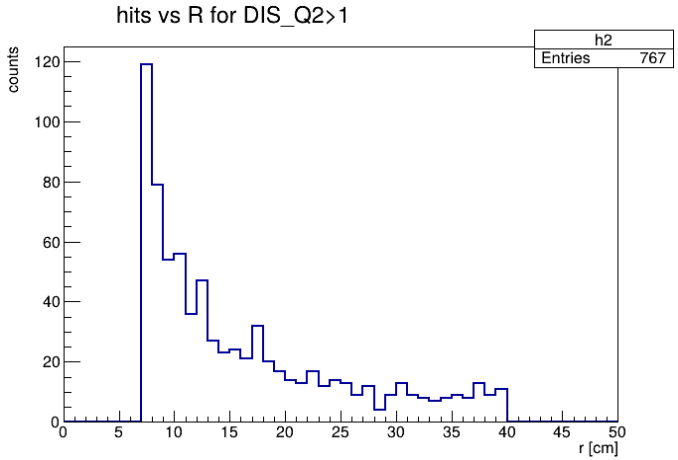


R – phi ECT Forward



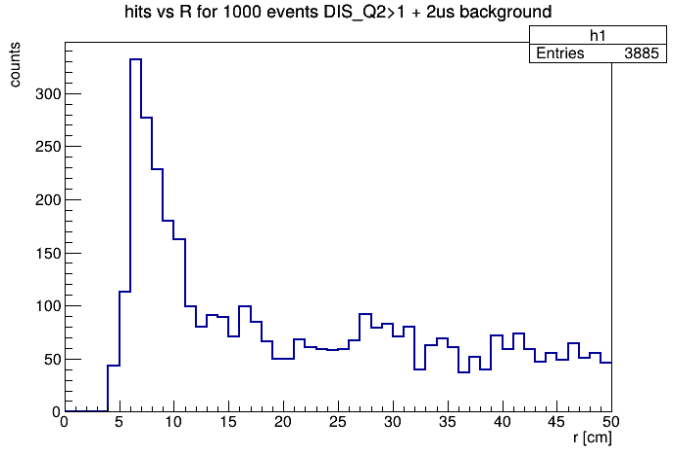
Backward ECT

DIS events, No bkg



Disk at z~-111cm
Max hit rate: ~1.8kHz/cm2
Max channel rate: ~4.5kHz
Disk at z~-121cm
Max hit rate: ~2.5kHz/cm2
Max channel rate: ~6.2kHz

DIS events, 2μs bkg



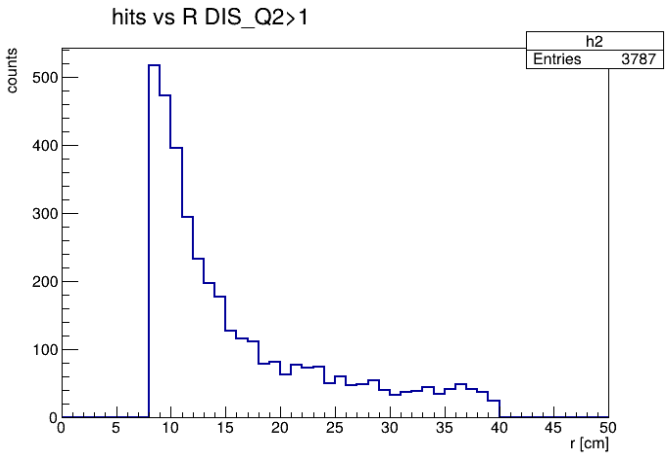
Disk at z~-111cm
Max hit rate: ~3.5kHz/cm2
Max channel rate: ~8.7kHz
Disk at z~-121cm
Max hit rate: ~2.8kHz/cm2
Max channel rate: ~6.9kHz

Strip area: 40cm x 615μm

Background impacts mostly the disk closer to the IP

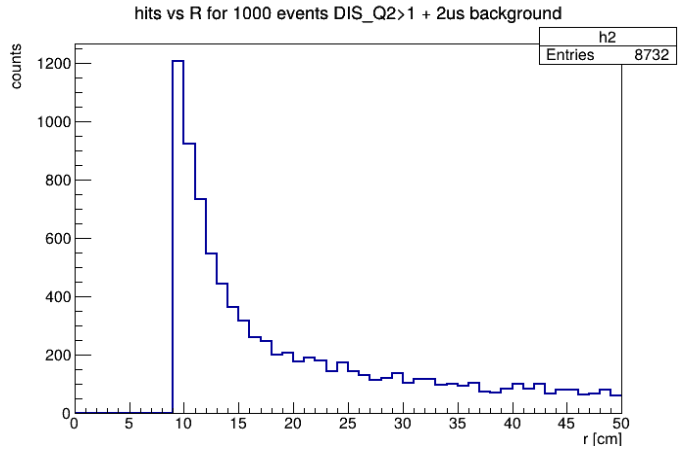
Forward ECT

DIS events, No bkg



Disk at z~ 150cm
Max hit rate: ~9 kHz/cm2
Max channel rate: ~22 kHz
Disk at z~ 163cm
Max hit rate: ~9.9 kHz/cm2
Max channel rate: ~24 kHz

DIS events, 2μs bkg



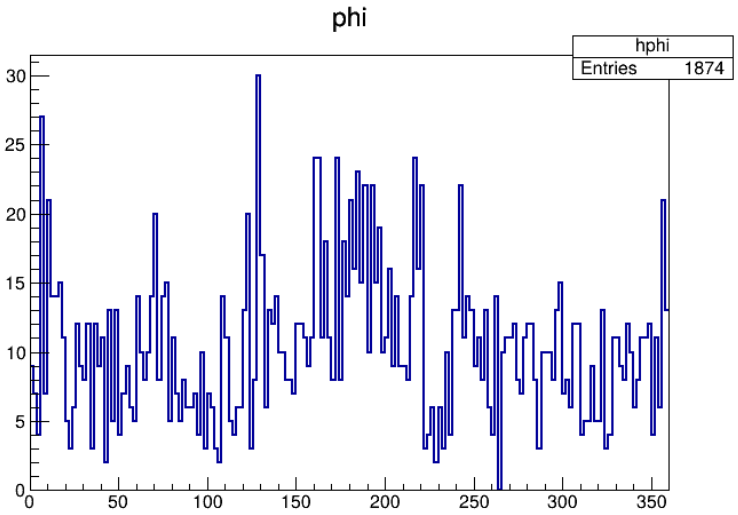
Disk at z~ 148cm
Max hit rate: ~7.7 kHz/cm2
Max channel rate: ~19 kHz
Disk at z~ 161cm
Max hit rate: ~9.1 kHz/cm2
Max channel rate: ~22 kHz

Strip area: 40cm x 615μm

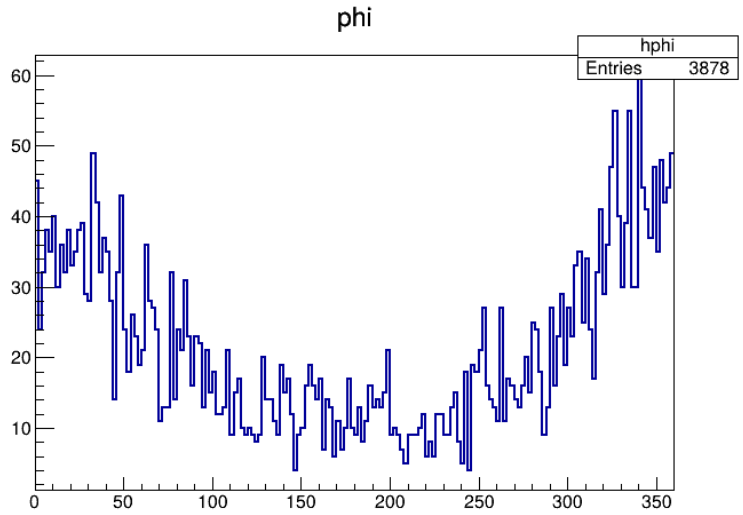
- Hit rates in the forward direction dominated by physics
- Small difference w/o and w/ bkg probably due to the non-exact identical implementations of ECT

ECT phi distributions

Backward



Forward

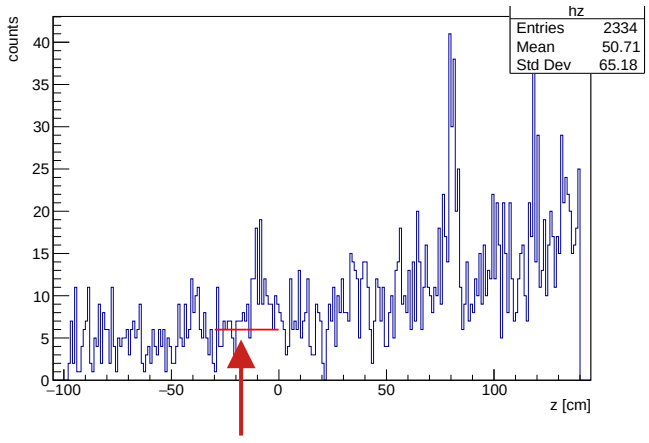


Hit distribution in phi associated to the maximum rate:

- Backward: uniform distribution
- Forward: visible effect of the crossing angle

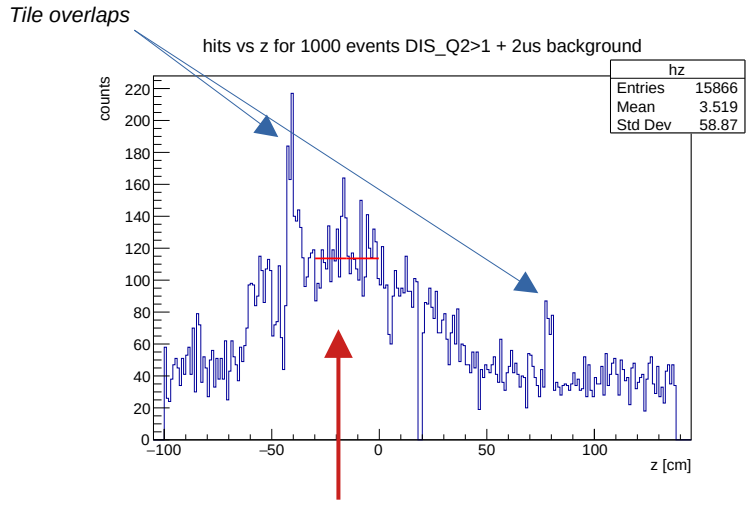
CyMBaL rates

DIS events, No bkg



Max rate ~ 20 Hits/cm2
Max channel rate : ~0.12 kHz

DIS events, 2µs bkg



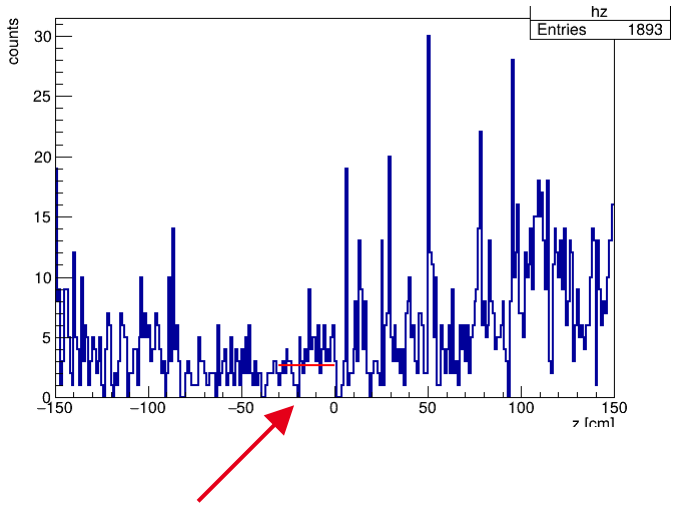
Max rate ~ 165 Hits/cm2
Max channel rate : ~1 kHz

Strip area: 58cm x 1mm

- Hit rates dominated by background hits, that have a significantly different longitudinal distributions

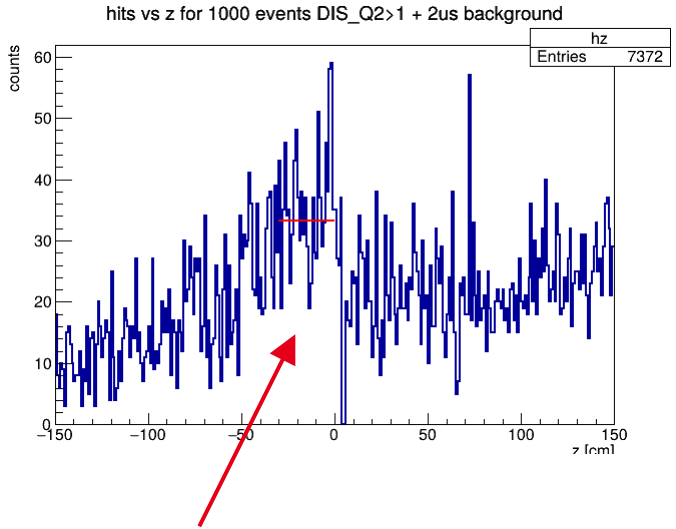
BOT rates

DIS events, No bkg



Rate ~ 6 Hits/cm2
Channel rate : ~25 Hz

DIS events, 2µs bkg



Rate ~ 36 Hits/cm2
Channel rate : ~140 Hz

Strip area: 33cm x 1.13mm

5µm coating

Beams	18x275		10x275		10x100	
	Hz/cm2	Hz/channel	Hz/cm2	Hz/channel	Hz/cm2	Hz/channel
CyMBaL	304	1.76E+03	3.09E+03	1.79E+04	3.09E+03	1.79E+04
BOT	37	137	265	987	260	972
ECT Backward Near	3.42E+03	8.42E+03	6.77E+03	1.67E+04	1.48E+03	3.65E+03
ECT Backward Far	3.58E+03	8.81E+03	6.27E+03	1.54E+04	4.99E+03	1.23E+04
ECT Forward Near	9.70E+03	2.39E+04	1.23E+04	3.02E+04	1.27E+04	3.14E+04
ECT Forward Far	1.08E+04	2.66E+04	1.34E+04	3.30E+04	1.32E+04	3.25E+04

Summary

- Simulations with embedded 2μs background really useful to estimate the MPGD rates
- **Even with backgrounds, hit rates are within standard MPGD capabilities.**
- The maximum rates are expected in the forward region, mostly due to DIS interactions
- CAVEAT. The values for channel rates reported here do not include estimates for cluster size. Therefore a factor 2-3 should be considered.