



Hit and channel rates in MPGD detectors with backgrounds

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MPGD rates



What is simulated:

- One DIS event $Q^2 > 1 \text{ GeV}^2$ per event (either on average or forced)
- $2 \mu\text{s}$ equivalent of background hits merged to every DIS event
- Either $5 \mu\text{m}$ or $10 \mu\text{m}$ gold coating of the beam pipe

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

```
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```

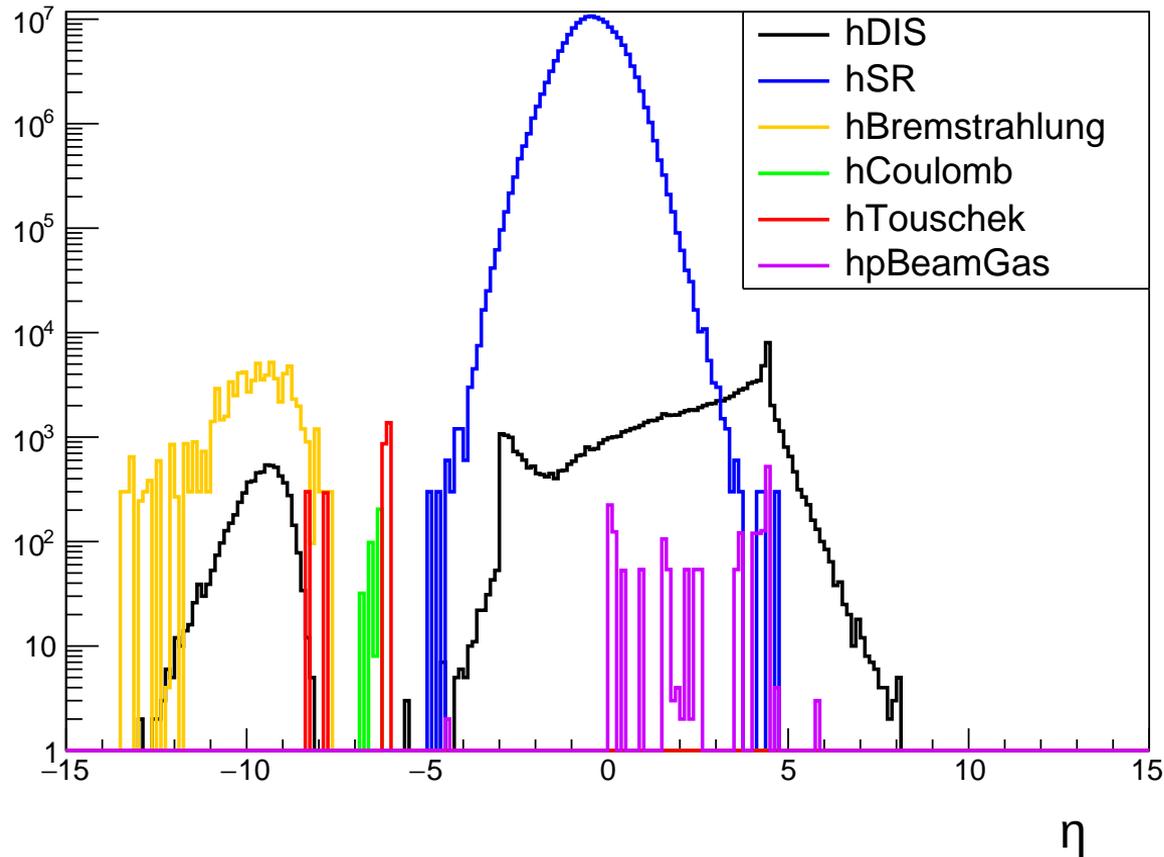
Methodology:

- The readout is (still) a pixel grid of $150 \times 150 \mu\text{m}^2$
- Fill histograms in z or R, with 1 cm wide bins.
- Take the maximum, divide by the annular (or cylindrical) area to estimate the Hz/cm²
- Multiply by the readout strip area to get the Hz/channel

Remarks:

- No cluster size considered all channel rates must be multiplied by a factor 3 or 4

Sources: MC Particle level



e-p 10 GeV x 100 GeV

Synchrotron radiation
dominates at mid rapidity

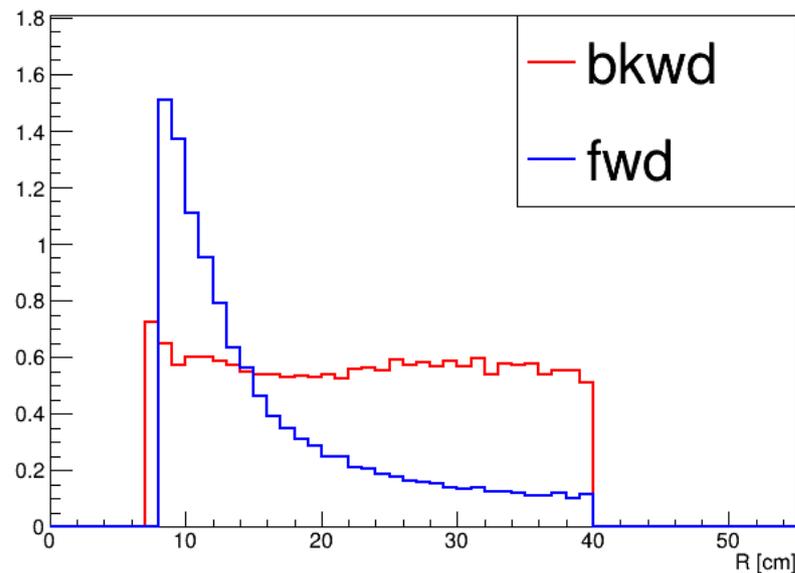
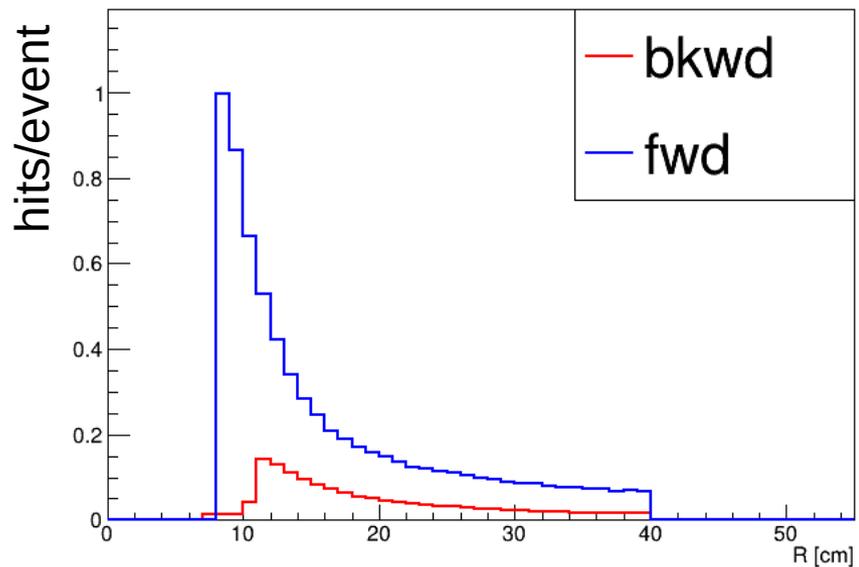
ECT

10x275

Strip area: 40cm x 615 μ m

w/o background

w/ background



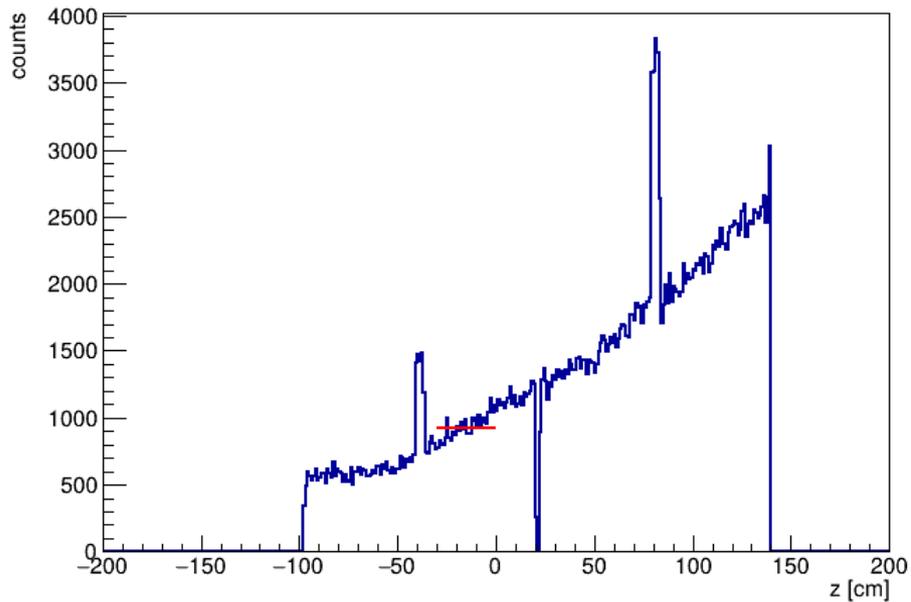
	Hz/cm2	Hz/channel
ECT Backward Near	9.00E+02	2.21E+03
ECT Forward Near	8.35E+03	2.06E+04

	Hz/cm2	Hz/channel
ECT Backward Near	6.77E+03	1.67E+04
ECT Forward Near	1.26E+04	3.11E+04

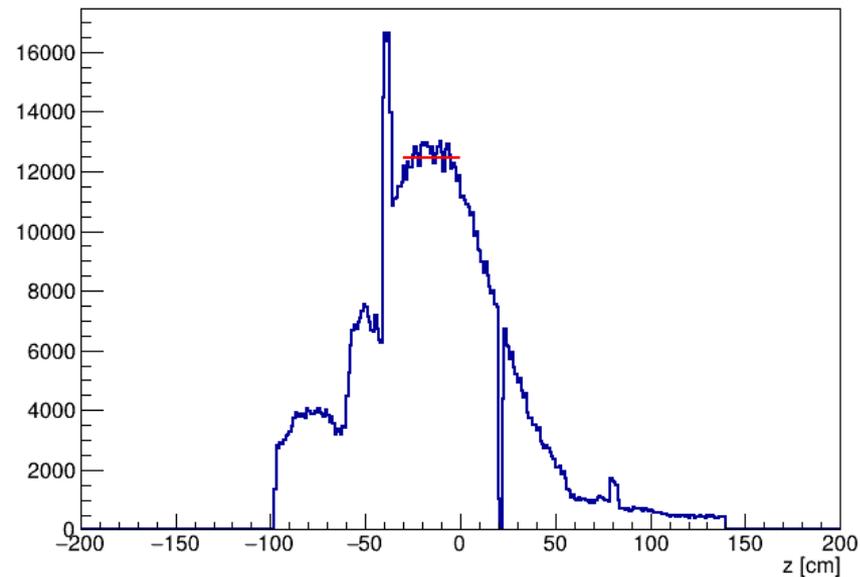
CyMBaL

10x275

w/o background



w/ background



Strip area: 58cm x 1mm

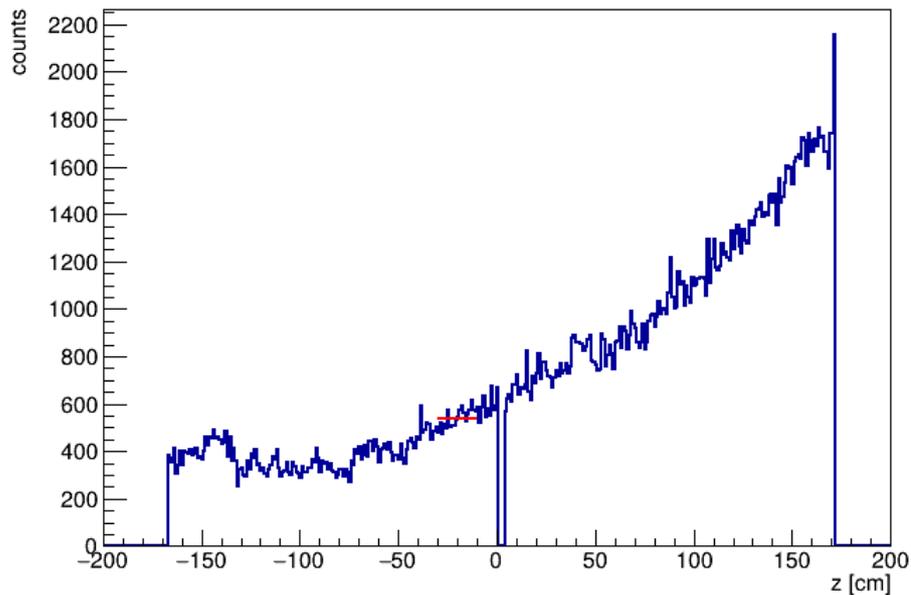
	Hz/cm2	Hz/channel
CyMBaL	1.95E+01	1.13E+02

	Hz/cm2	Hz/channel
CyMBaL	3.10E+03	1.80E+04

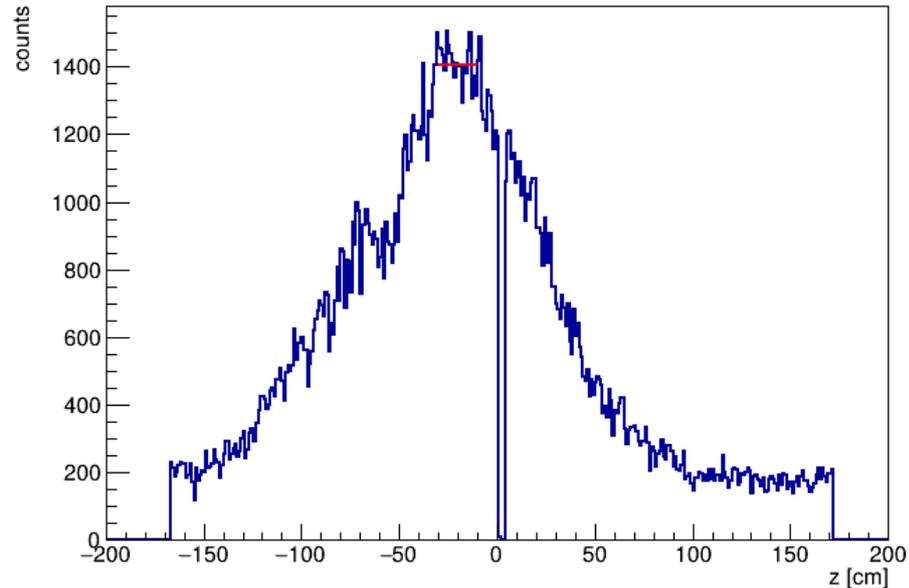
BOT

10x275

w/o background



w/ background



Strip area: 33cm x 1.13mm

	Hz/cm2	Hz/channel
BOT	8.58E+00	3.20E+01

	Hz/cm2	Hz/channel
BOT	2.65E+02	9.88E+02

5 μ m



	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

10 μ m

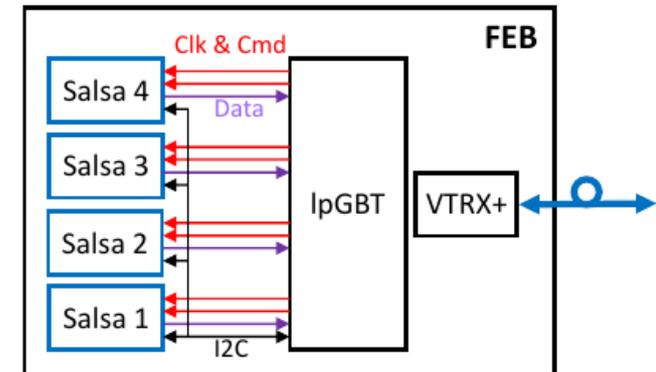
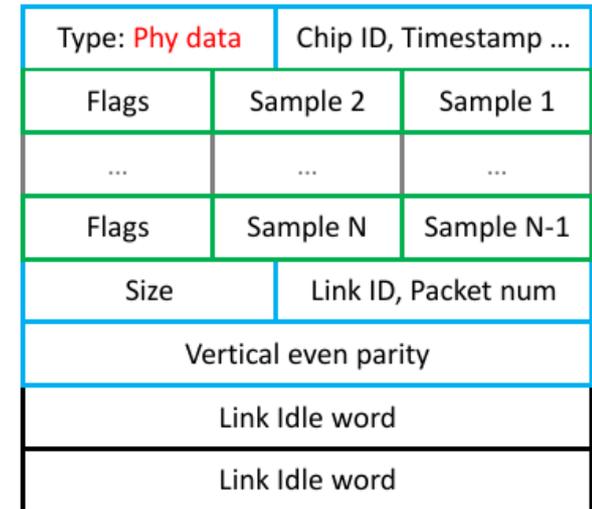


	10x275		10x100	
	Hz/cm2	Hz/channel	Hz/cm2	Hz/channel
CyMBaL	1.67E+03	9.69E+03	1.67E+03	9.68E+03
BOT	1.70E+02	6.35E+02	1.70E+02	6.34E+02
ECT Backward Near	6.63E+03	1.63E+04	5.99E+03	1.47E+04
ECT Backward Far	6.48E+03	1.59E+04	5.73E+03	1.41E+04
ECT Forward Near	1.25E+04	3.08E+04	1.24E+04	3.06E+04
ECT Forward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

Construction parameters

- Channel data
 - 12-bit ADC samples
 - 2 samples per 32-bit word
 - 3-word channel overhead
 - Header, Trailer, Parity
- 64-channels per ASIC
- Single serial TX data link per ASIC
 - 1.28 Gbit/s bandwidth
 - Two 32-bit words of overhead after each packet
 - Idle words

Channel packet



Salsa physics data rate : 40 MHz sampling

- Sampling period : 25 ns
- Signal shape ZS readout
 - 500 ns readout window when signal is above threshold
 - 200 ns peaking time
 - 20 samples
 - 13-word packet + 2-word link overhead

Channel rate kHz	Channel BW Mbit/s	Salsa BW Mbit/s	Link load %	Comment
10	4.6	293	23	Initial value
20	9.2	586	46	Zone of comfort
25	11.4	732	57	
30	13.7	879	69	Uncomfortable
40	18.3	1172	92	Inacceptable

Salsa physics data rate : 50 MHz sampling

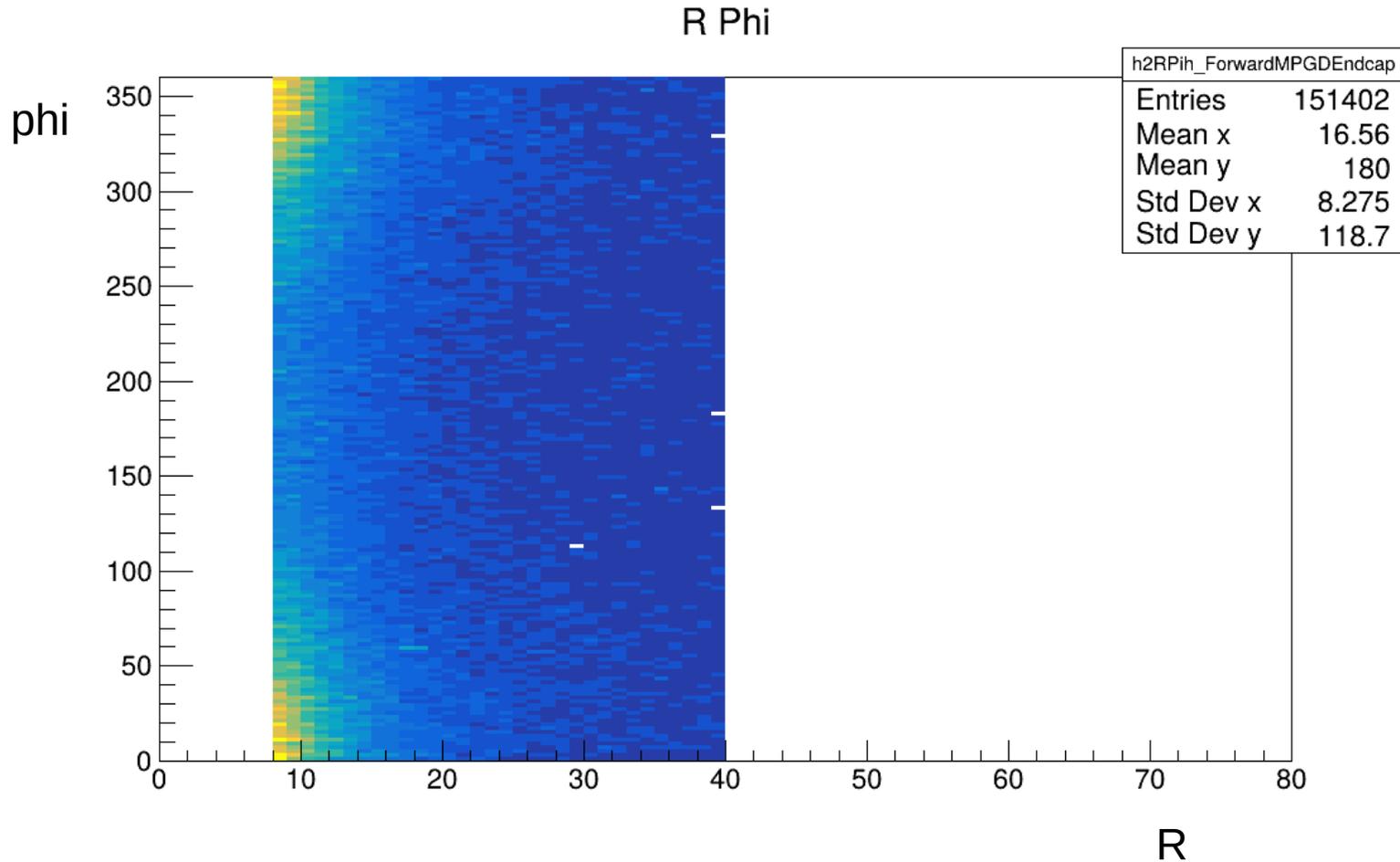
- Sampling period : 20 ns
- Signal shape ZS readout
 - 500 ns readout window when signal is above threshold
 - 200 ns peaking time
 - 25 samples
 - 16-word packet + 2-word link overhead

Channel rate kHz	Channel BW Mbit/s	Salsa BW Mbit/s	Link load %	Comment
10	5.5	352	27	Initial value
20	11.0	703	55	Zone of comfort
25	13.7	879	69	Uncomfortable
30	16.5	1055	82	Inacceptable
40	22.0	1406	110	

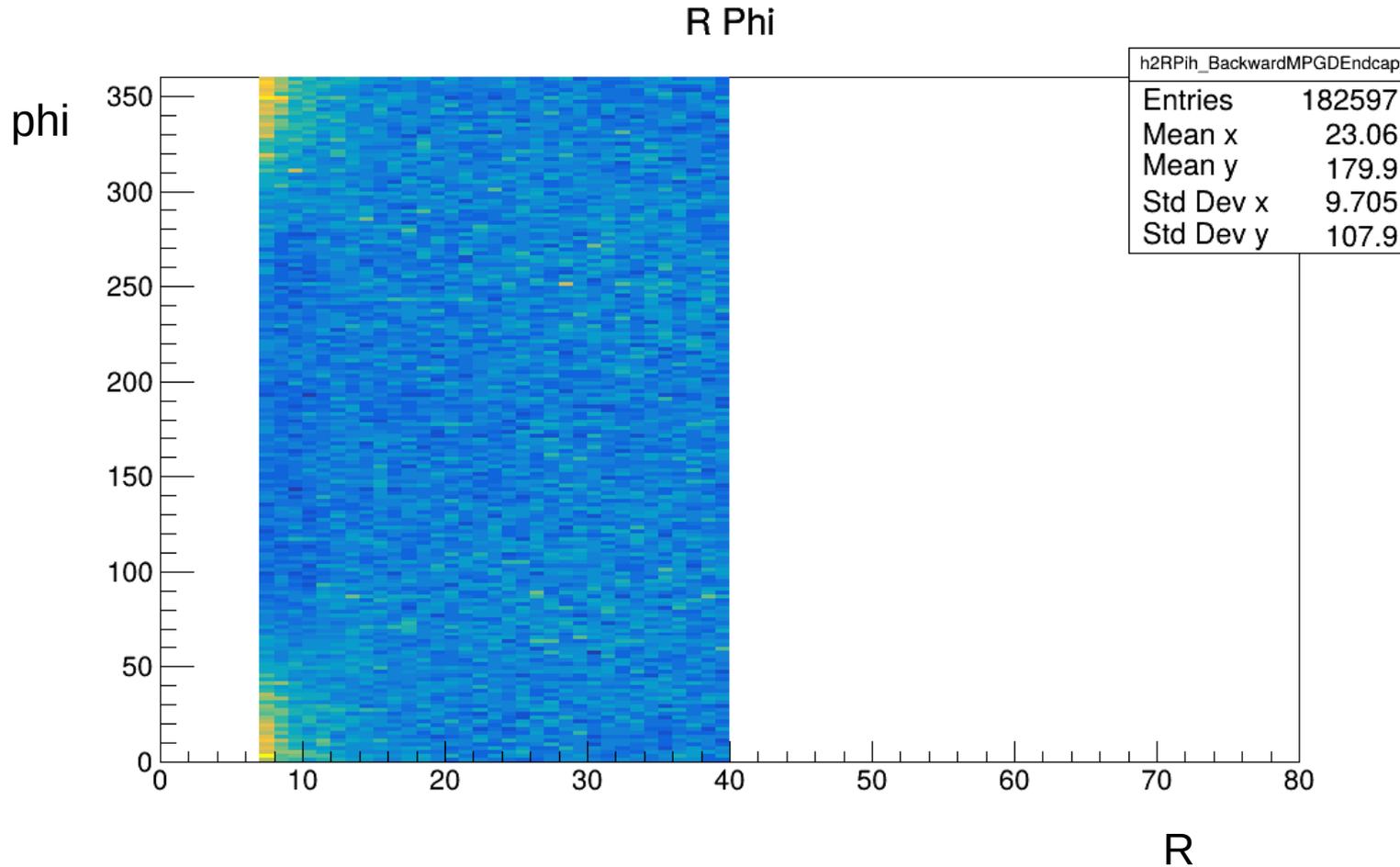
Summary

- 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 $5\mu\text{m}$ to $10\mu\text{m}$
 - rates in CyMBaL (and BOT) decrease by a factor ~ 2
 - for ECTs, decrease of 5%
- SALSA is being designed for rates higher than 100 kHz/channel \rightarrow no issues
- The limiting factor is the link SALSA-IpGBT. One can double it, but this has impacts on design of the chain, i.e. modified FEBs, more DAMs...
- TODO for the three MPGD systems:
 - Check if performances are OK with smaller number of samples (spatial and time res)
 - Currently the threshold in npsim for hit formations is 100 eV. To be checked again.

R – phi ECT Forward



R – phi ECT Forward

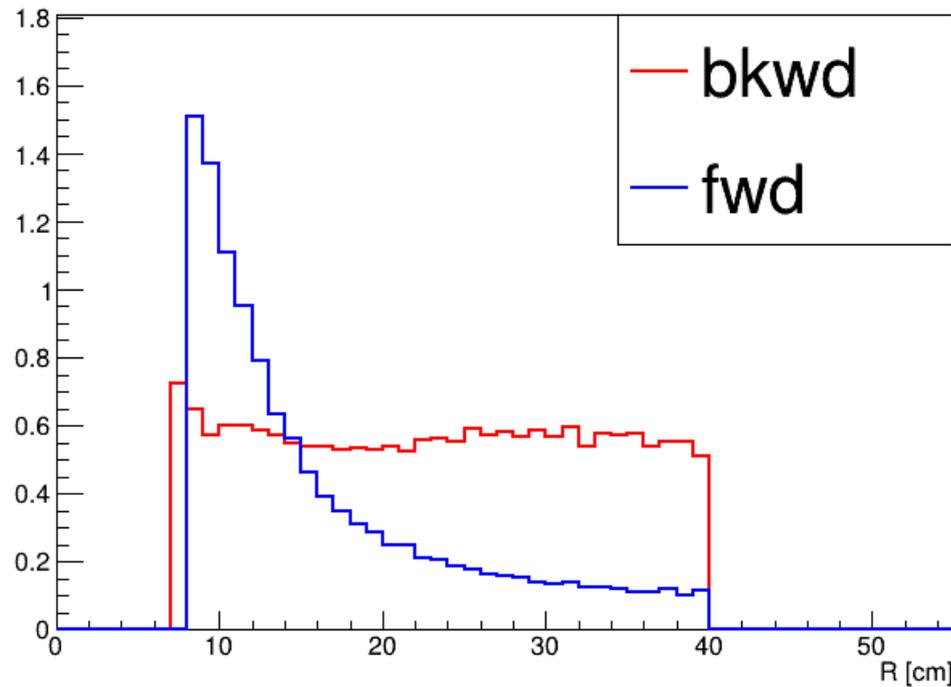
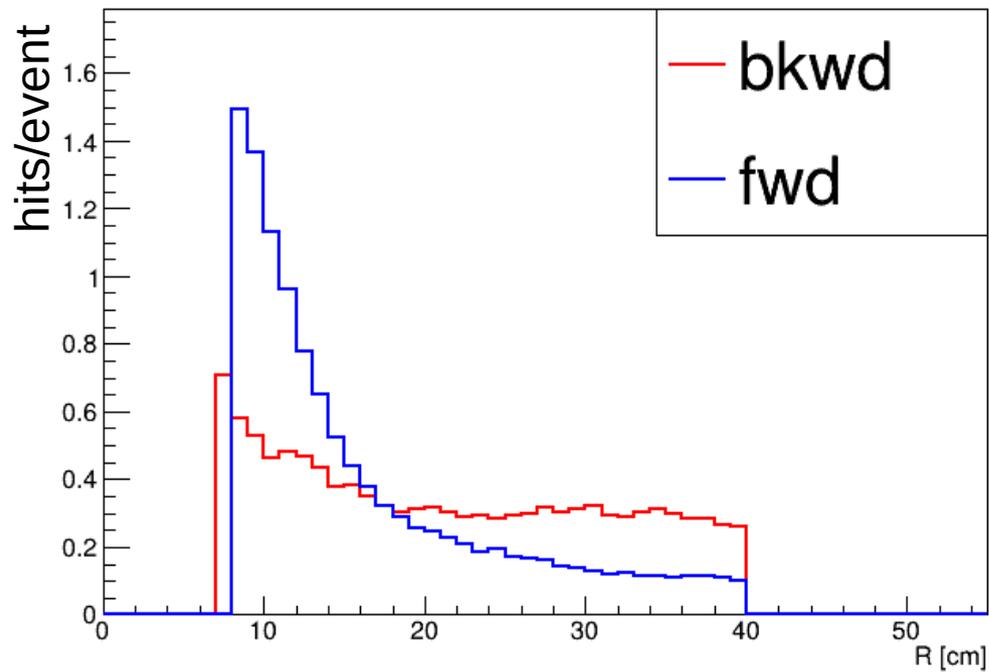


ECT



10 μ m

5 μ m



5 μ m 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