

Key Preliminary Considerations

- Signal: with respect physics signal contribution:
 - there is a delayed contamination from low-energy particles
 - p-gas background rates are 3 times larger than DIS
 - e-gas background rates are 2 times larger than DIS and concentrate close to the beam pipe
- At maximum luminosity:
 - 40 hits/event at 500 kHz interaction rate x 10 (safe estimated of addition from background beams) → **2 10⁸ hits/s**

dRICH background (and throughput) is SiPM-background dominated

At maximum DCR (300 kHz) we have:

- 300 kHz * 3.2 10⁵ channels → 9.6 10¹⁰ hits/s → **10¹¹ hits/s**

The dRICH throughput receives the largest contribution from SiPM DCR background from the beginning and is largely dominated by SiPM DCR background at maximum radiation damage.

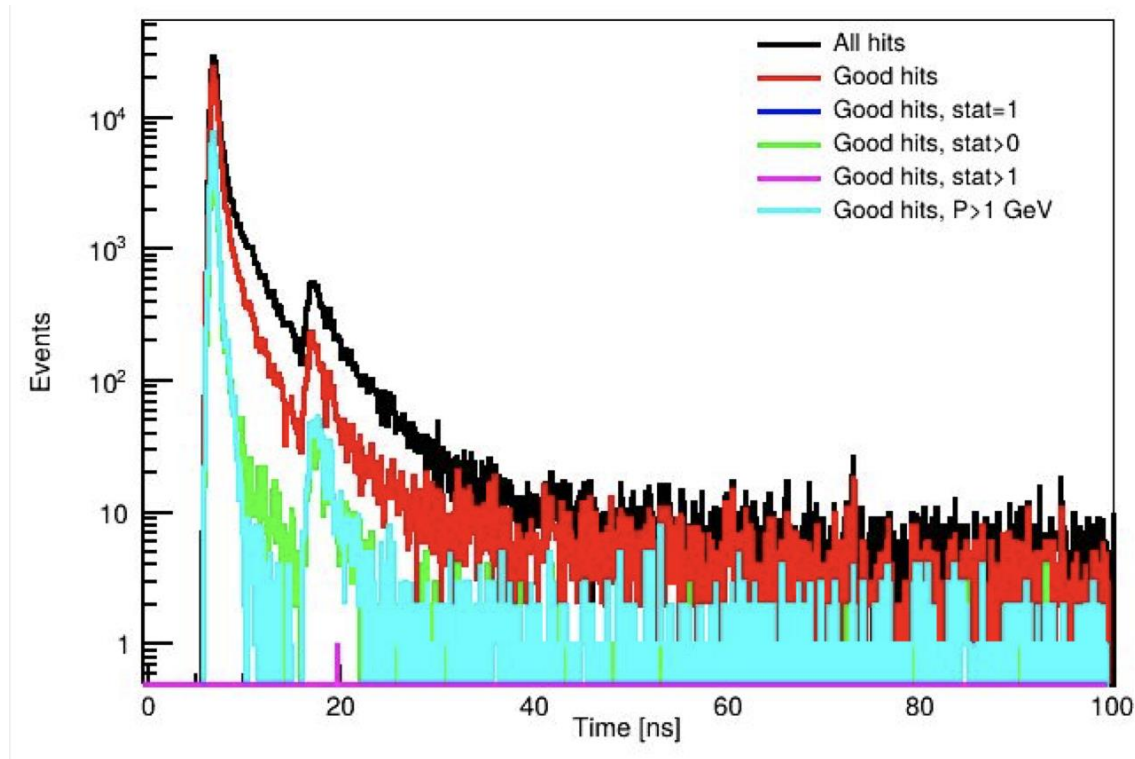
Even assuming a safe factor for physics background, the contribution from DIS+background (@max lumi) remains < 1% of SiPM DCR (@ max damage).

Data readout modeling currently includes only the SiPM DCR (at max rate)

dRICH Impacting Particles

- hit time distribution has a Gaussian shape with a long r.h.s. tail;
- the tail is mostly generated by secondaries (GenStat=0);
- the **second peak at +10 ns is due to rescattering** from structural material;

To be updated to
the last campaign

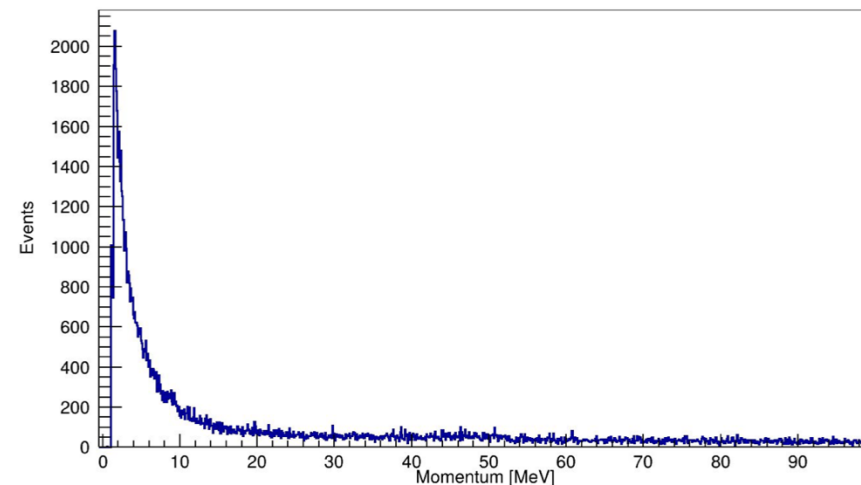
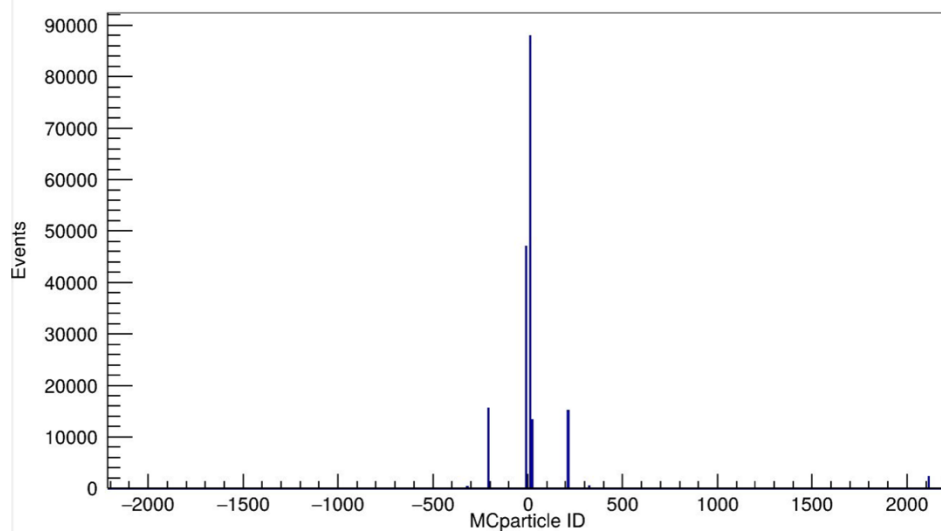
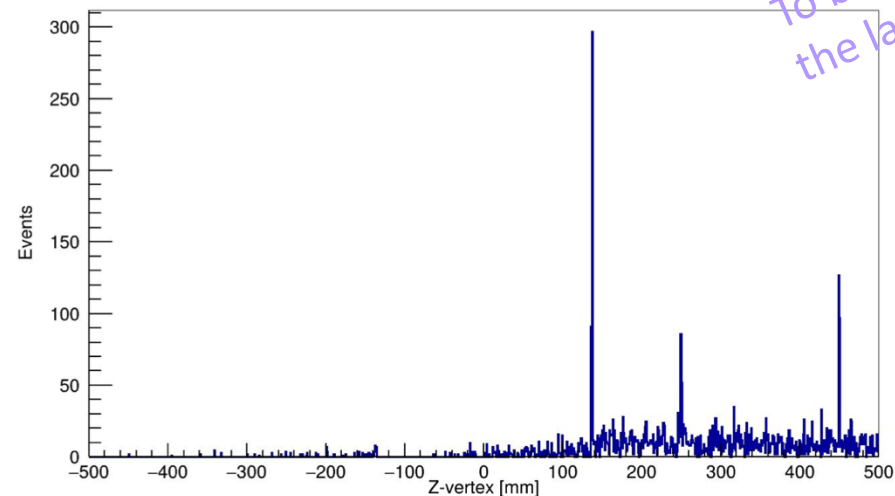


dRICH Background

Secondaries with GenStat=0

- most of GenStat=0 particles are e^+/e^- ;
- momenta of these particles are <10 MeV;
- production vertex is far from IP, and has peaks at 137 mm, 250 mm, 450 mm;
- these tracks are forward ($\theta < 60$ deg.), hitting dIT located at $Z=1979$ mm.

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Total dIT Rates at 10x100 GeV

- DIS rate at $Q^2 > 1 \text{ GeV}^2$ ($\sigma = 0.556 \mu\text{b}$) and luminosity of $10^{34} \text{ 1/cm}^2/\text{s}$ ($0.58 \mu\text{b}$ with low Q^2):

$$R_{DIS}(Q^2 > 1 \text{ GeV}^2) = \sigma_{ep} L \frac{N_{hits}}{N_{generated}} = 70 \text{ kHz}$$

- beam-gas background rates:

$$R_{p-gas} = 210 \text{ kHz} \quad R_{e-gas} = 115 \text{ kHz}$$

- total rate - one trigger every 250 bunch crossing:

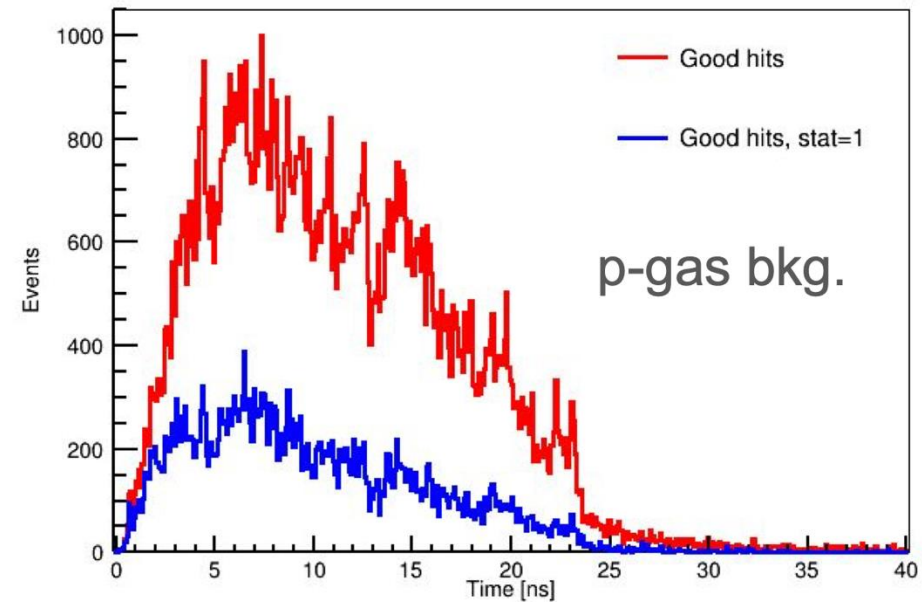
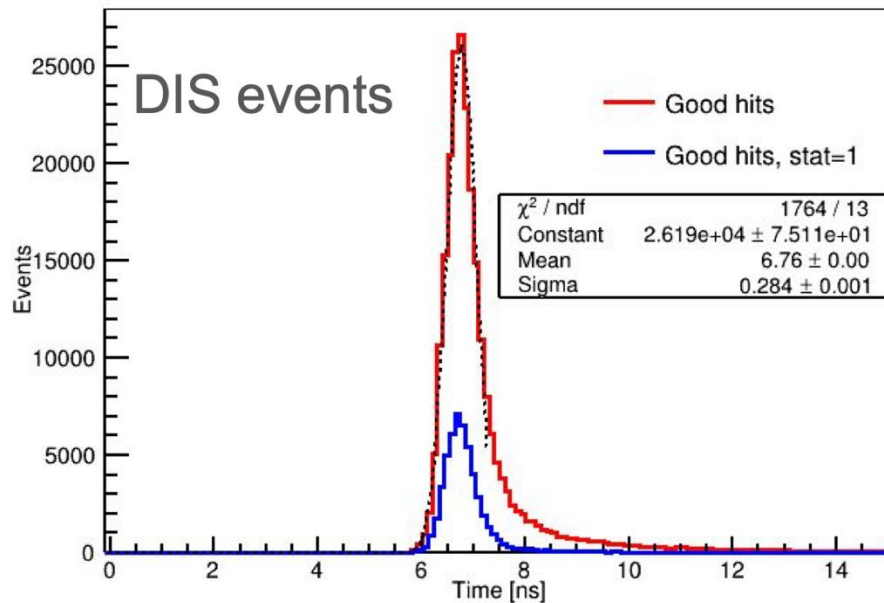
$$R_{tot} = 395 \text{ kHz} \quad \frac{R_{tot}}{RF} = \frac{395 \text{ kHz}}{100 \text{ MHz}} = 0.004 \frac{\text{triggers}}{\text{bunch crossing}}$$

dRICH Background

hadron beam-gas background hit time

- background events are distributed from 2 to 25 ns, while signal is at 6-8 ns;
- it can be significantly reduced applying signal time gate, but overlap from nearby bunches will add more background;

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dRICH DAQ parameters	
RDO boards	1248
ALCOR64 x RDO	4
dRICH channels (total)	319488
Number of DAM	30
Input link in DAM	42
Output links from DAM to TP	1
Number of DAM Trigger Processor	1
Input link to DAM Trigger Processor	30
RDO-DAM Link Bandwidth (VTRX+) [Gb/s]	10
DAM to Echelon-0 Switch Bandwidth [Gb/s]	100 ▼
External Trigger reduction factor	5 ▼
External trigger latency [s]	1,00E-04
EIC parameters	
EIC Clock [MHz]	98,522
Orbit efficiency (takes into account gap)	0,92

dRICH backend DAQ 30+1 FLX-155:
30 DAMs + 1 Trigger Processor (TP)

Limits / bottlenecks

Reduction factors / “handles”

External trigger can be NN on DAMs, dIT or signal provided by other detectors via GTU (or a combination of them)

NN studies and dIT simulations shows that a reduction factor 5 can be comfortably achieved

ALCOR parameters		Notes
Front end limit [kHz]	4000	
ALCOR Clock [MHz]	394,08 ▼	We get 39.4 from recovered clock
Channels/serializer	8	
Bits per hit	64	2 32-bit words per hit (also TOT or time slewing)
Bits per hit encoding 8/10	80	
Serializer band limit [Mb/s]	788,16	
Theoretical Serializer limit/ channel [kHz]	1231,5	this would be with 0 control words
Serializer limit single ch [kHz]	800	this is expected to improve with ALCOR v3
Number of serializer per chip	8	
Channel/chip	64	
Shutter Acceptance width (ns)	7 ▼	(if you put 10 ns == no shutter)

Limits / bottlenecks

Reduction factors / “handles”

The shutter is a gated signal: when it is on no ALCOR digitization happens. Given BC is every 10 ns an acceptance window of 7 ns, drops 30% of data (“off signal with respect to bunch crossing”)

Limits / bottlenecks

dRICH data stream analysis		Limit	Comments
Sensor rate per channel [kHz]	300,00 ▾	4.000,00	
Rate post-shutter [kHz]	193,20	800,00	
Throughput to serializer [Mb/s]	120,75	788,16	
Throughput from ALCOR64 [Mb/s]	966,00		limit FPGA dependent: - check with RDO
RDO data reduction	20,31%		assume 51 bits AWORD NEW
Throughput from RDO [Gb/s]	3,01	10,00	based on VTRX+
Input at each DAM [Gbps]	126,29	420,00	we have 42 links operated at 10 Gbps
Buffering capacity at DAM [Mb]	12,93		to be checked but seems manageable
Output from each DAM [Gbps]	25,26	100,00	
Aggregated dRICH data throughput		Comments	
Total input at DAM [Gb/s]	3.788,77	This is only "inside" DAM, not to be transferred on PCI	
Total output from DAM [Gb/s] to Echelon	757,75	Reduction from external trigger (NN on DAMs or det. based)	

Reduction factors / “handles”

Note that the “usual” 1.3 Tbps is back assuming an external trigger reduction factor = 3