Internal and External Data Rates

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atl-com-muon-2003-031

The data-volume is assumed to originate mainly from background. The evaluation of the throughput and rate requirements can be separated into three parts:

1. Calculate the background rates and simulate hits in the MDT
http://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/RADIATION/Radiation_Levels.htm

2. Calculate the corresponding datavolume

3. Simulate triggers and calculate the required buffering

Points 2 and 3 require knowledge of the DAQ system itself.

Simulating MDT hits

	Example: CSM EndCap MDT-chambers							
Tower	0	1	2	3	4	5	6	7
30	EIS1A14	EIS2A14	BEE1A14	BEE2A14	EMS3A14	EOS4A14	EOS5A14	EOS6A14
31	EIS1A16	EIS2A16	BEE1A16	BEE2A16	EMS3A16	EOS4A16	EOS5A16	EOS6A16
32	EIL1A01	EML1A01	EML2A01	EOL1A01	EOL2A01	EOL3A01		
33	EIL1A03	EML1A03	EML2A03	EOL1A03	EOL2A03	EOL3A03		
34	EIL1A05	EML1A05	EML2A05	EOL1A05	EOL2A05	EOL3A05		
35	EIL1A07	EML1A07	EML2A07	EOL1A07	EOL2A07	EOL3A07		
36	EIL1A09	EML1A09	EML2A09	EOL1A09	EOL2A09	EOL3A09		
37	EIL1A11	EML1A11	EML2A11	EOL1A11	EOL2A11	EOL3A11		
38	EIL1A13	EML1A13	EML2A13	EOL1A13	EOL2A13	EOL3A13		
39	EIL1A15	EML1A15	EML2A15	EOL1A15	EOL2A15	EOL3A15		
40	EMS1A02	EMS2A02	EOS1A02	EOS2A02	EOS3A02			

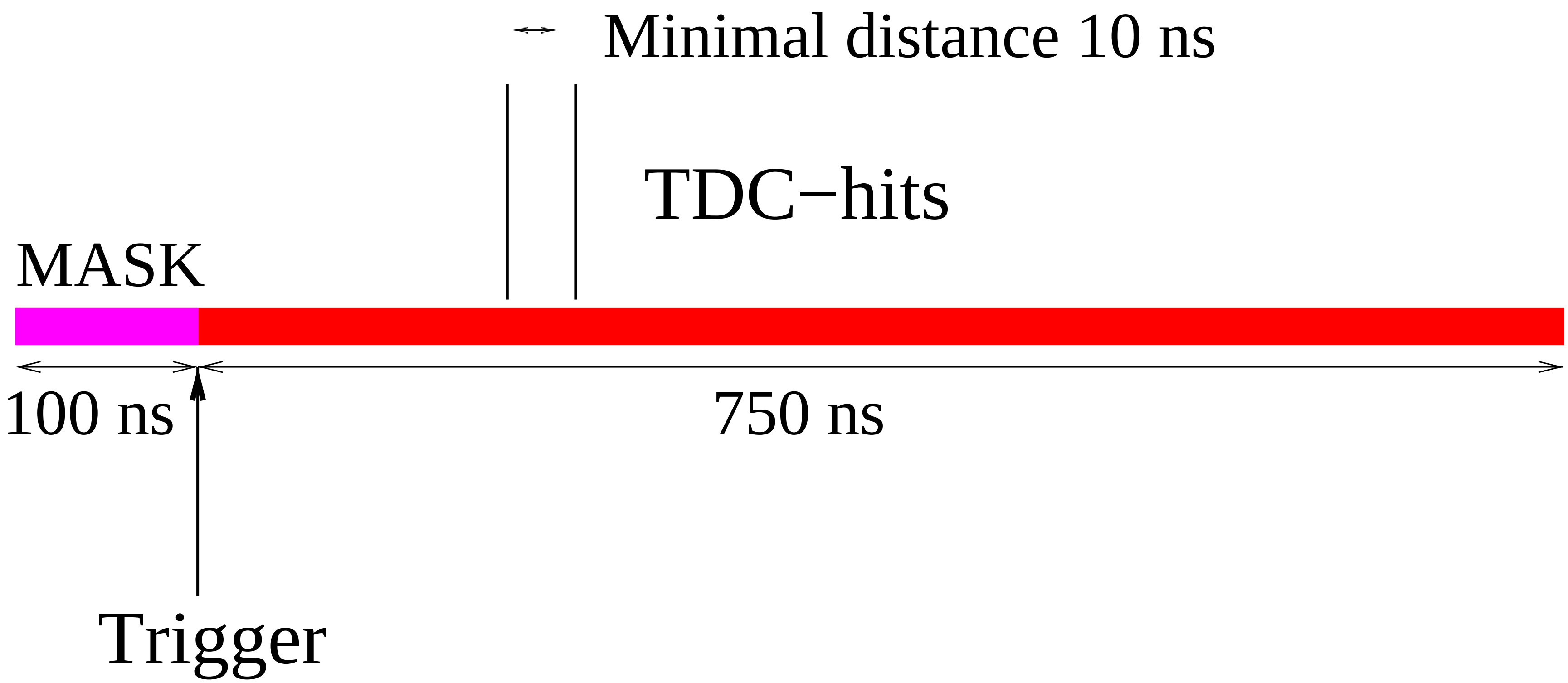
Simulating MDT hits

	Example: CSM EndCap MDT-rates							
Tower	0	1	2	3	4	5	6	7
30	43132	24962	13480	13923	14157	8104	8605	9173
31	43132	24962	13480	13923	14157	8104	8605	9173
32	72203	54082	30137	11389	12283	12744	-1	-1
33	72203	54082	30137	11389	12283	12744	-1	-1
34	72203	54082	30137	11389	12283	12744	-1	-1
35	72203	54082	30137	11389	12283	12744	-1	-1
36	72203	54082	30137	11389	12283	12744	-1	-1
37	72203	54082	30137	11389	12283	12744	-1	-1
38	72203	54082	30137	11389	12283	12744	-1	-1
39	72203	54082	30137	11389	12283	12744	-1	-1
40	37216	18190	7539	7447	7835	-1	-1	-1

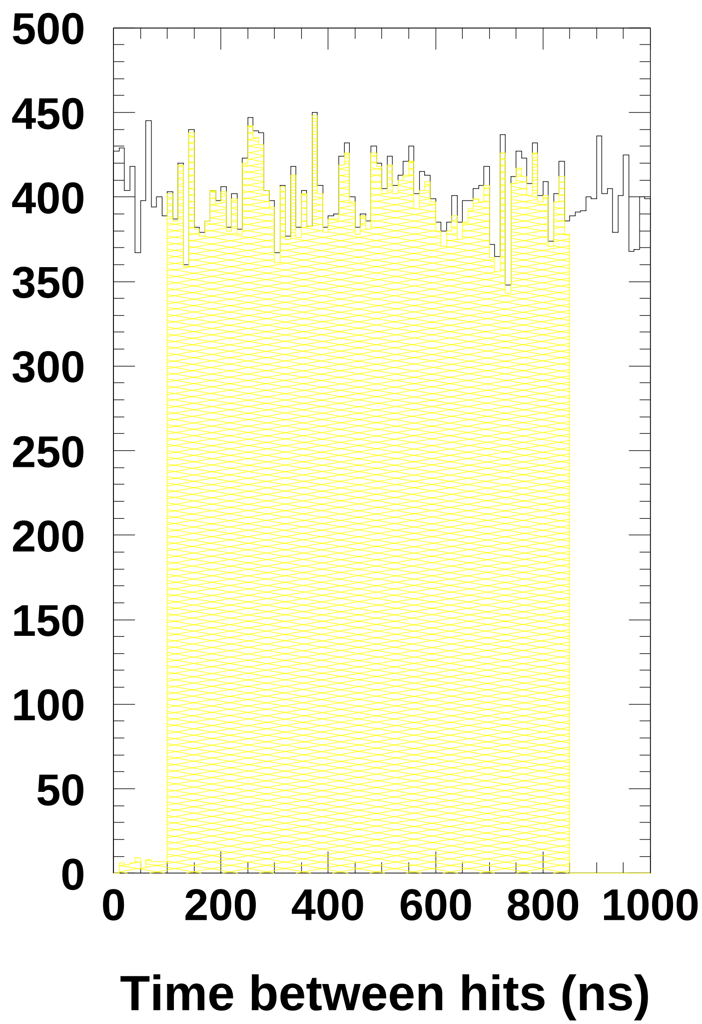
Simulations are made for the rates shown, double background rate, and five times the rate.

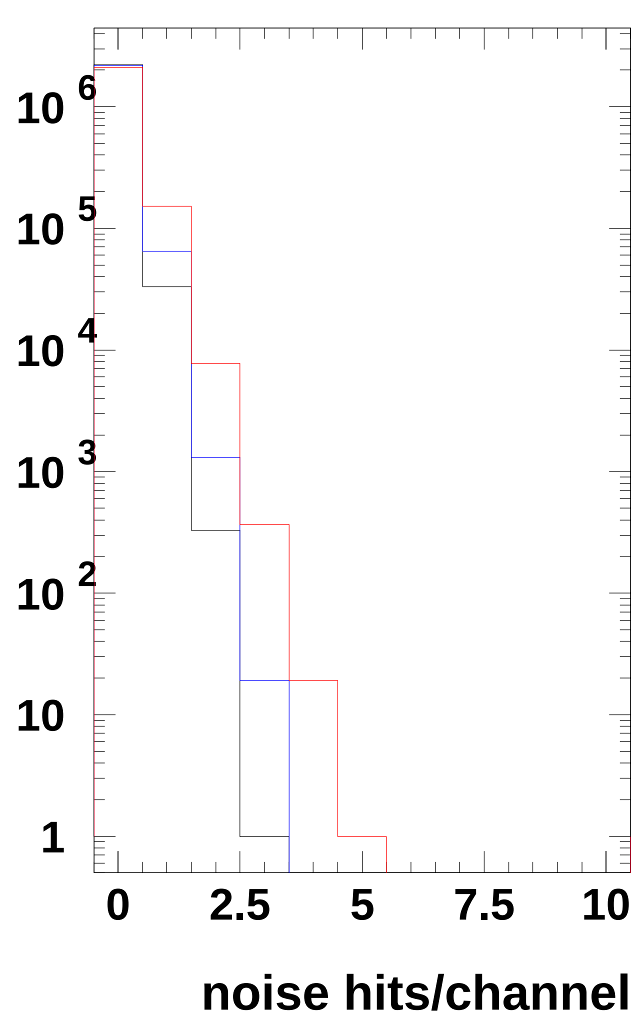
Simulating MDT hits

Hits are simulated for each individual tube according to a power-law distribution $e^{-t \times f}$, where t is the time between triggers and f the background rate. The simulation takes the following into account:



Simulating MDT hits





Data volume Calculation

The datavolume can be calculated as follows:

1. A TDC adds 1 word/pulse + 2 words (BOT,EOT) (+ mask)
   Note that with zerosuppression the BOT and EOT words are removed by the MROD when there is no TDC-hit present.

2. The CSM does not add to the datavolume

3. The ROD adds 13 header/trailer words

4. For each link, the ROD adds 4 words

Zerosuppression is implemented in the MROD, and for this presentation it is assumed to be applied.

Data volume Calculation

To get an idea:
Without any hits there would be

$$13 + 4 * 6 + 2 * (10 + 12 + 10 + 14 + 14 + 18) = 193$$

words generated for tower 0 in the barrel (without zerosuppression).

$$13 + 4 * 6 + 0 * (10 + 12 + 10 + 14 + 14 + 18) = 37$$

words generated for tower 0 in the barrel (with zerosuppression).

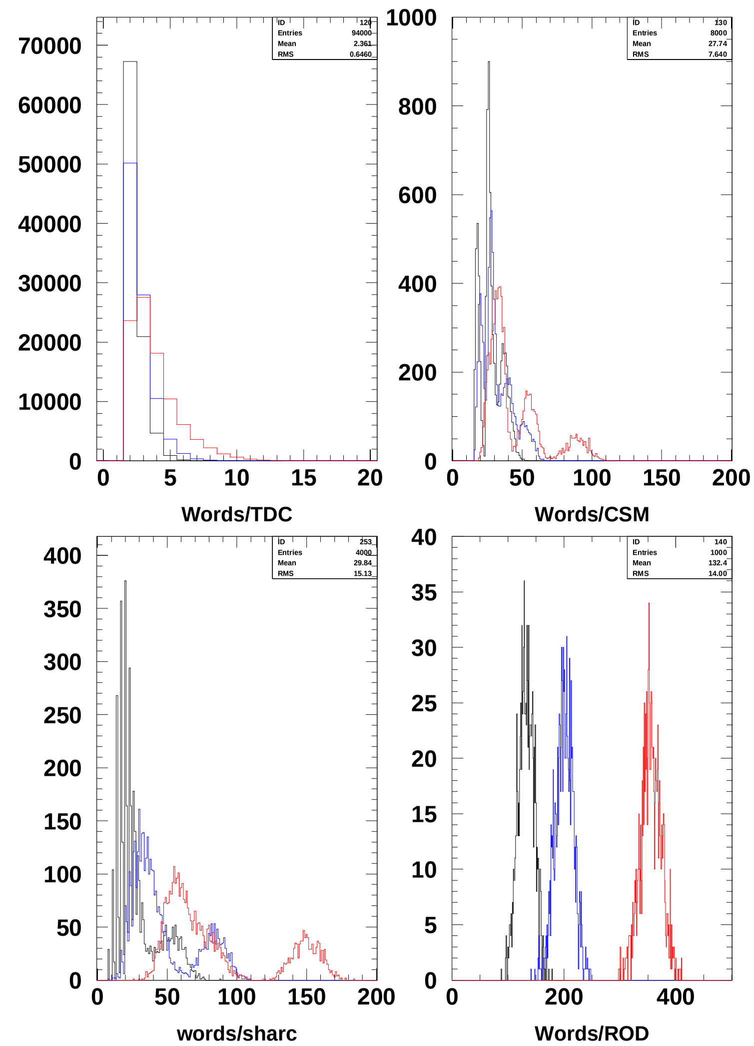
Data volume Calculation

Endcap tower	BG words	BG×2 words	BG×5 words
30	132.4	200.3	355.0
31	132.4	200.3	355.0
32	159.3	243.6	441.0
33	159.3	243.6	441.0
34	159.3	243.6	441.0
35	159.3	243.6	441.0
36	159.3	243.6	441.0
37	159.3	243.6	441.0
38	159.3	243.6	441.0
39	159.3	243.6	441.0
40	96.2	146.0	259.6

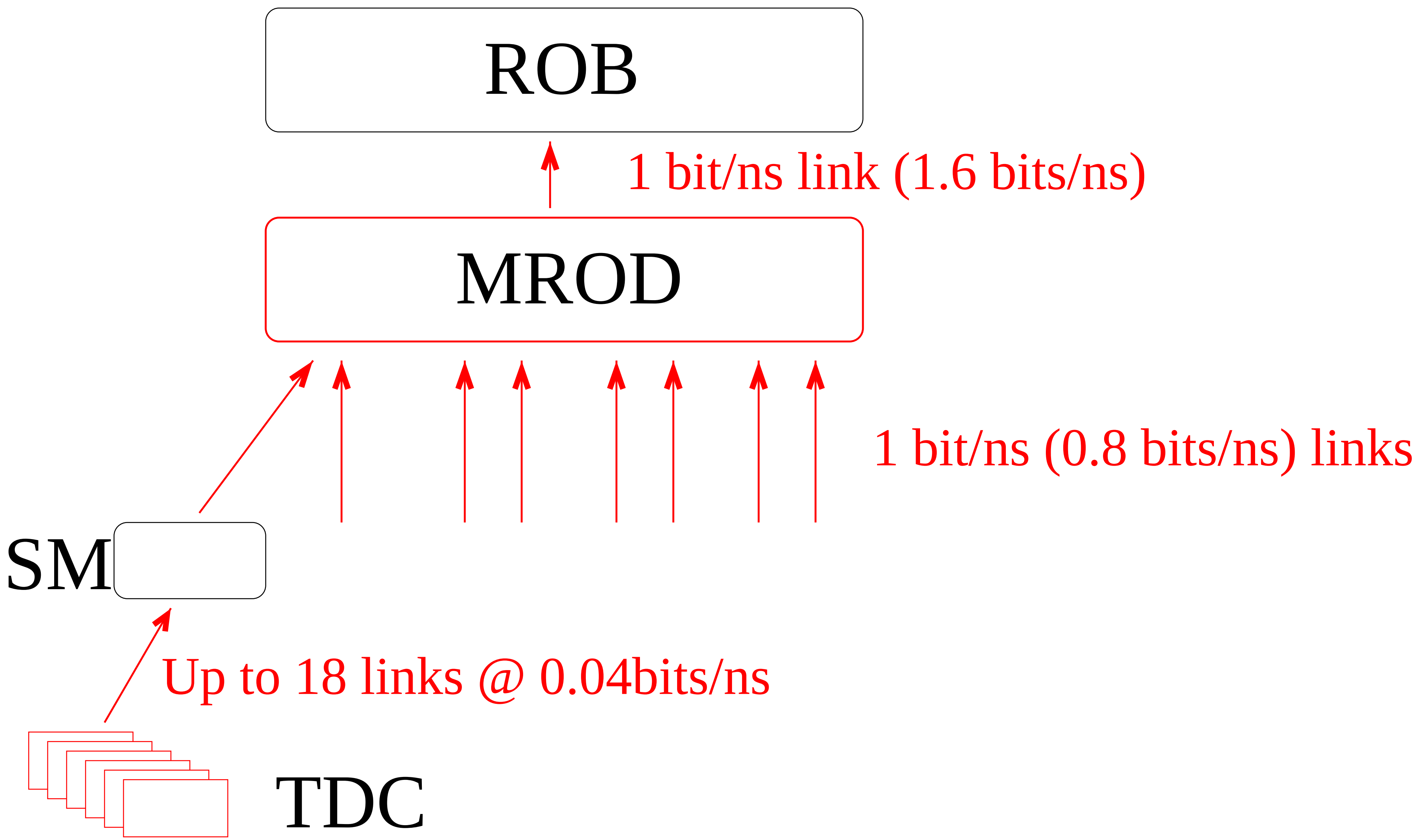
For illustration plots for endcap tower 31 are added.

Note: at a trigger rate of 100 kHz, 200 words correspond to a total throughput of 0.64 bits/ns.

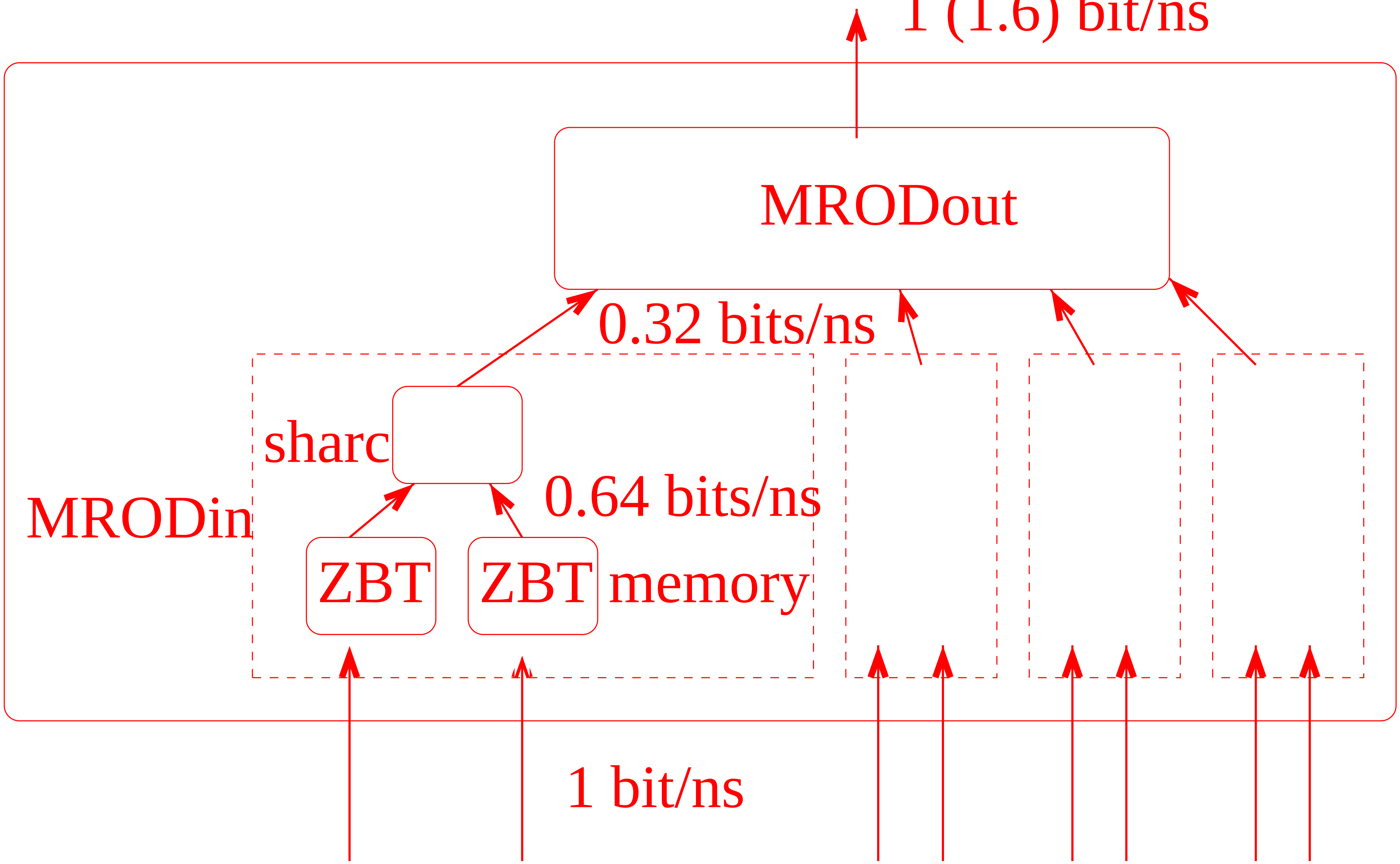
Data volume Calculation



The simulated DAQ-system



The simulated DAQ-system

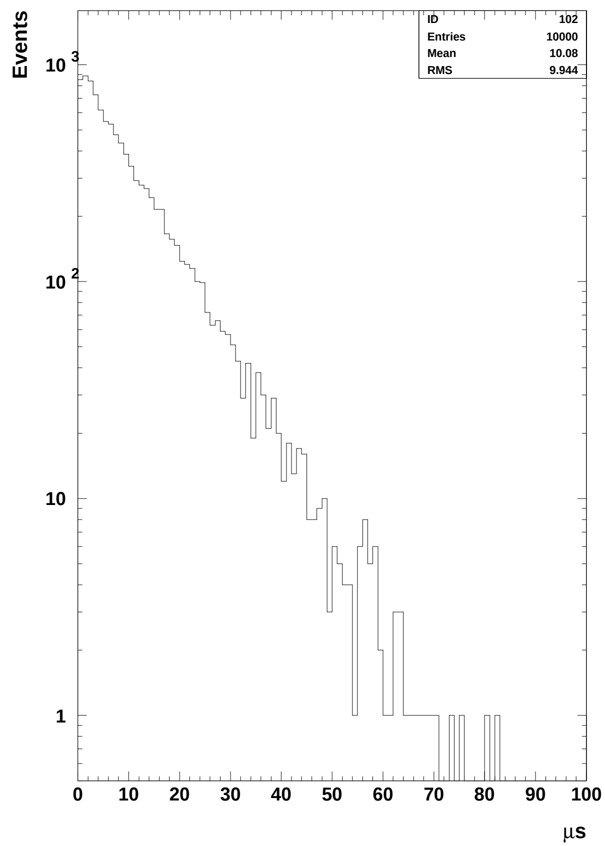


Example: a single event

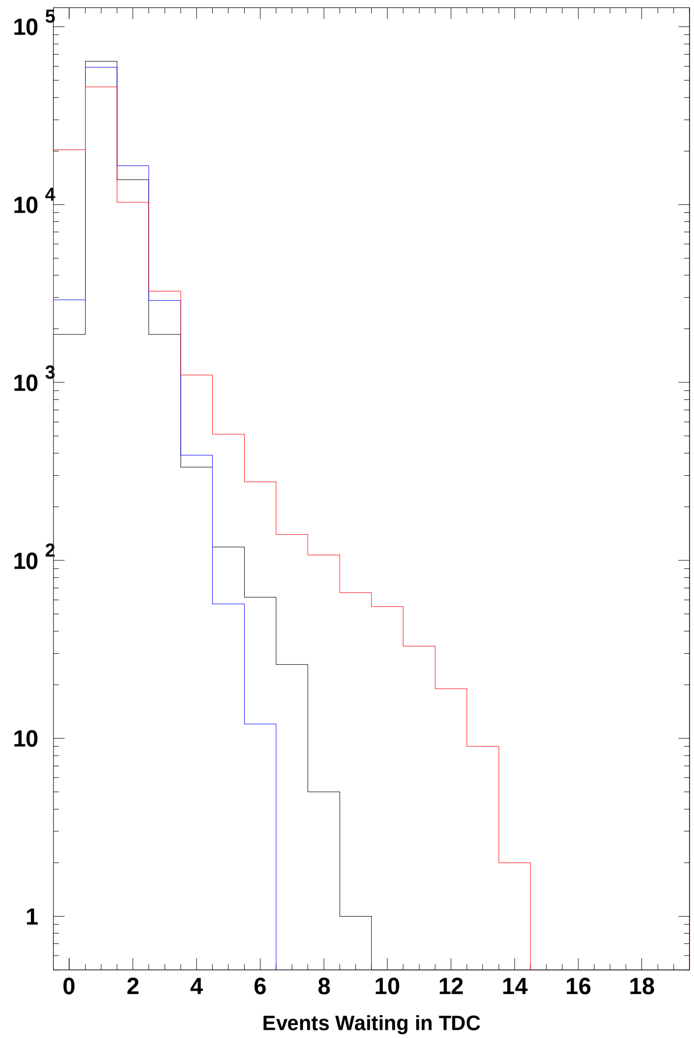
TDC	CSM	ZBT	SHARC	MRODOUT
2 words 1750 ns				
3 words 2625 ns				
3 words 2625 ns				
4 words 3500 ns				
4 words 3500 ns				
2 words 1750 ns				
2 words 1750 ns				
3 words 2625 ns				
2 words 1750 ns				
2 words 1750 ns				
	27 words 3500 ns	31 words 5050 ns		
....				
	28 words 2625 ns	32 words 4225 ns		
			63 words 11350 ns	
....				
	24 words 3500 ns	28 words 4900 ns		
....				
	33 words 3500 ns	37 words 5350 ns		
			65 words 11850 ns	
....				
	33 words 2625 ns	37 words 4475 ns		
....				
	41 words 2625 ns	45 words 4875 ns		
			82 words 13075 ns	
				223 words 20211 ns

trigger simulation

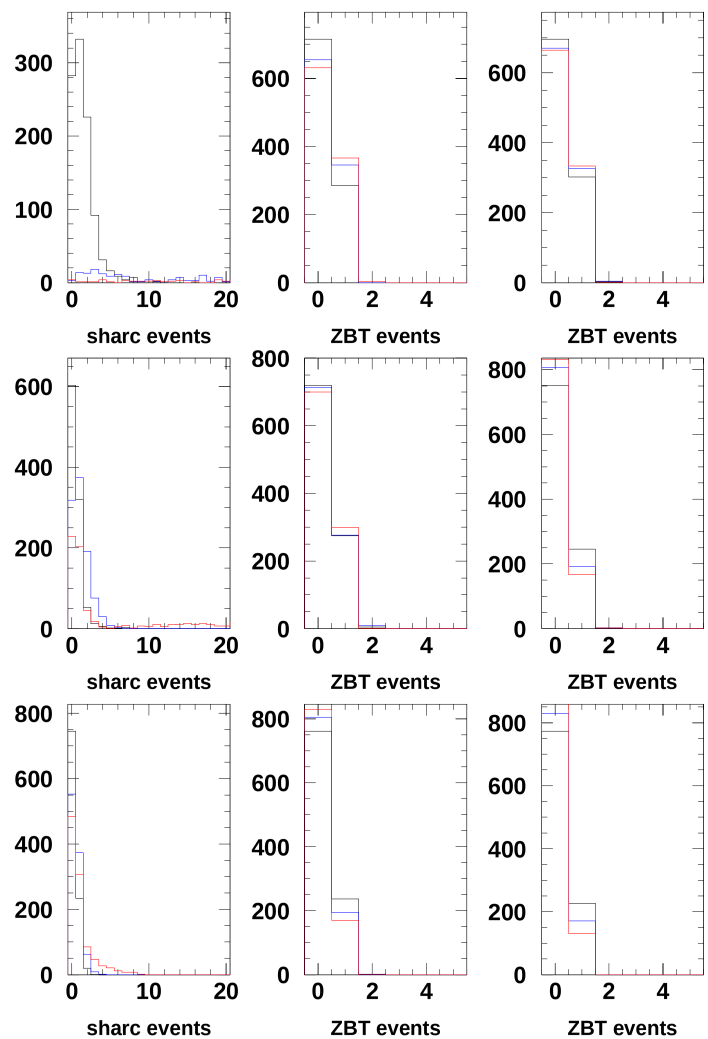
When evaluating bufer requirements, it is necessary to simulate the trigger. The trigger times follow $e^{-t \times f}$, where $f = 101\,\mathrm{kHz}$, to allow for the 100 ns deadtime between triggers and end up with 100 kHz on average.



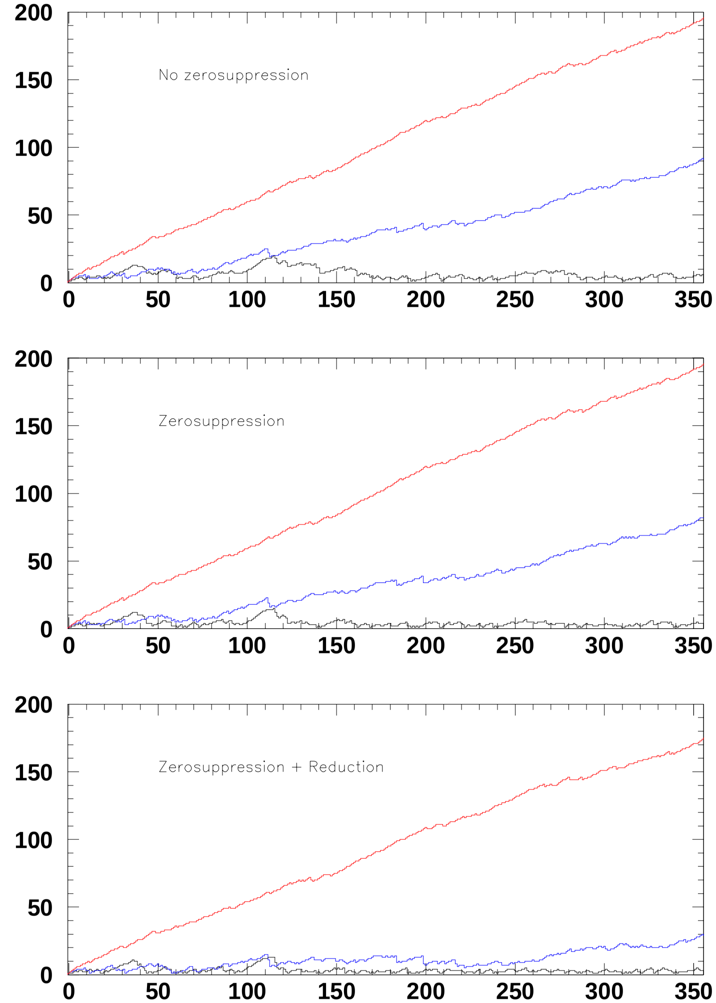
Buffering in the TDC



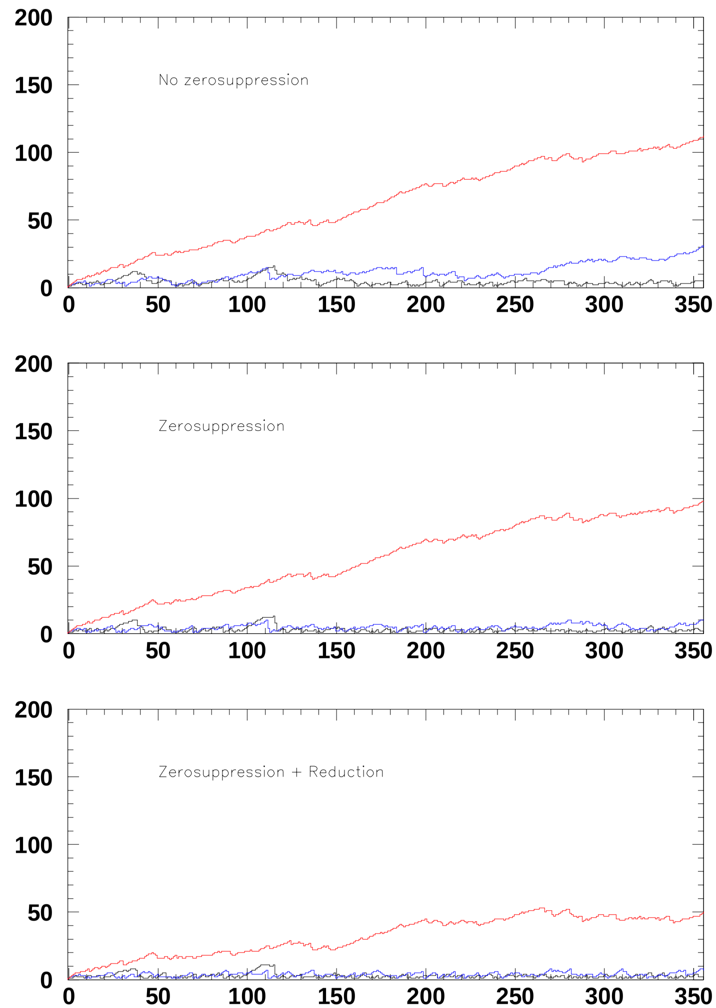
Buffering in the MROD



Events in the DAQ-chain



Events in the DAQ-chain assuming a double-sharc readout



Conclusions

- Even without zero-suppression all towers can handle the data rate caused by background, though sometimes a large buffer is needed in the MRODin

- With zero-suppression all towers in the barrel can handle a safety factor of two

- with zero-suppression all but towers 32-39 in the end-cap can handle a safety factor of two

- With zero-suppression only a fraction of the towers can handle a safety factor of five

Conclusions

In all cases the bottleneck is in the SHARC readout speed. A doubling of this speed would be helpful, and in most cases enough. A re-cabling of the MROD, thus spreading the load over the input SHARCs would be an easy option which would reduce the effect of this bottleneck considerably.