Upgrade Data Rates and Noise Rate Limits

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Gen2 hardware call

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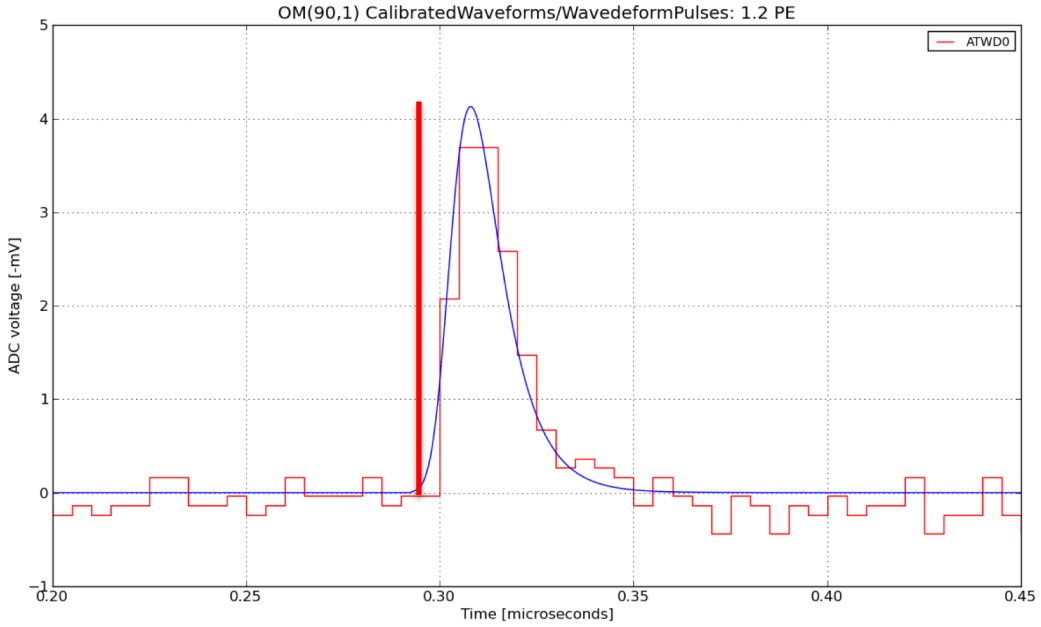
Cable bandwidth considerations

- DOM assumptions
  - 3 or 4 DOMs / pair
  - **no** local coincidence (multi-sensor or multi-DOM)
  - every hit to the surface

- Software hit bundling in the DOM
  - package up hits every second or so
  - responsibility of DOM software
  - reduces overhead of long timestamps, DOM id

SPE Hit Size Estimates

- In-DOM SPE unfolding per-pulse information
  - trigger flag? (probably optional)
  - channel number
  - sample timestamp (DOM clock)
  - pulse time (offset from DOM clock)
  - pulse amplitude



Hit Timestamp

- Require sub-nanosecond resolution with rollover of minutes to days (36 to 48 bits)

- Break into
  - course timestamp (clock counter MSBs)
    - sent once / hit bundle
  - sample timestamp (clock counter LSBs)
    - rollover must be greater than time between hits
  - pulse offset
    - wavedeform basis shift, ~0.1 to 0.5 ns

Information breakdown

Field	Bits required	Notes
Channel ID	$\lceil \log_2 N_{\mathrm{ch}} \rceil$	number of PMTs / module
Trigger flag	1–2	could be skipped if all discriminator
Clock LSBs	$\lceil \log_2 (\tau_{\mathrm{rollover}} / \tau_{\mathrm{clock}}) \rceil$	rollover period > ~10 * minimum Poisson noise tau
Pulse amplitude	$\lceil \log_2 (q_{\mathrm{max}} / q_{\mathrm{res}}) \rceil$	q_{res} is pulse charge resolution
Pulse offset	$\lceil \log_2 (\tau_{\mathrm{clock}} / \tau_{\mathrm{res}}) \rceil$	τ_{res} is pulse time resolution

Example (mDOM)

Field	Bits required
Channel ID	5
Trigger flag	0–2
Clock LSBs	20–25
Pulse amplitude	7–8
Pulse offset	7–8
Total	**39–48 (5–6B)**

Cable Bandwidth

- Measured 8b10b data throughput (Gen1 DOM, cable filter box): 1.5 Mbps

- Subtract overhead for:
  - complex waveforms (20%???)
  - bundle headers, moni info, etc. (5%?)

- Max zero-deadtime noise rate / wire pair: **24–28 kHz**

Caveats / Warnings

- SPE feature extraction in an FPGA has not yet been demonstrated
  - feasibility studies promising
  - single-iteration WaveDeform is relatively simple
  - requires accurate baseline subtraction

- ~~8b10b bandwidth on real cable not measured~~
  - K. Sulanke measured on 3.5km cable

- Need better estimates for complex waveform fraction
  - use HitSpool data for DeepCore DOMs?