LAPPD window material, Online monitoring for Test Beam

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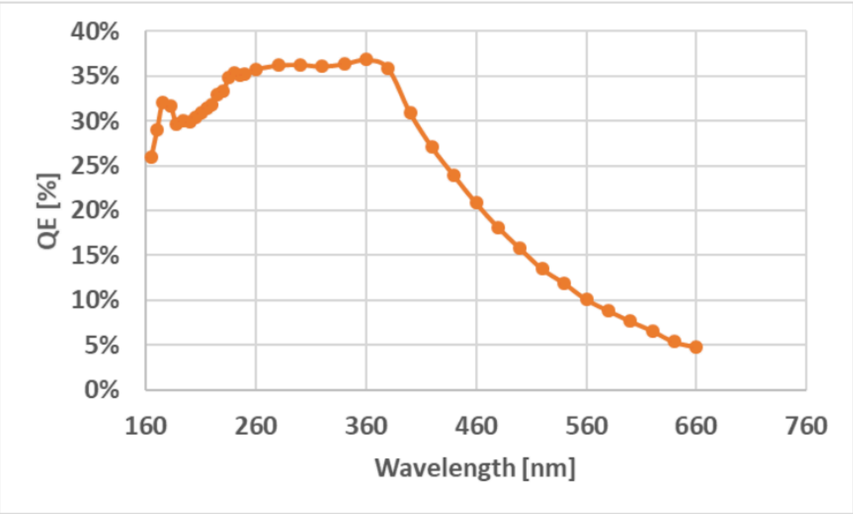
Cherenkov photon counts

$$\frac{d^2N}{dxd\lambda} = \frac{2\pi\alpha}{\lambda^2}\left(1 - \frac{1}{\beta^2 n^2}\right)$$

$$\frac{dN}{dx} = 2\pi\alpha\left(1 - \frac{1}{\beta^2 n^2}\right)\int \frac{1}{\lambda^2} QE(\lambda)\, d\lambda$$



- Assume:
  - n doesn't vary much over the range of wavelength (varies with wavelength 1.4x ~ 1.5x), chose n for ~500nm for the calculations
  - β ~ 1
- Numerically integrated over the range (λ_{cutoff}, 660nm) weighted with the QE curve

Material	Refractive index n	Transmission λ cutoff (nm)	dN/dx	#photons for 5mm window
Borofloat glass	1.47	300	11385	**57**
UV grade fused silica	1.47	170	31507	**158**

- Note:
  - Assuming ~10mV single p.e. response and signal will be distributed in area with ~1cm diameter
  - Signal will be shared between pixels
  - Even with UV grade fused silica, we are within the DRS4 dynamic range (1V)
  - Even if top of the signal is saturated, we can still use the whole leading edge for timing measurement
  - Expect actual #photons will be smaller than the numbers from the table

Timing measurement

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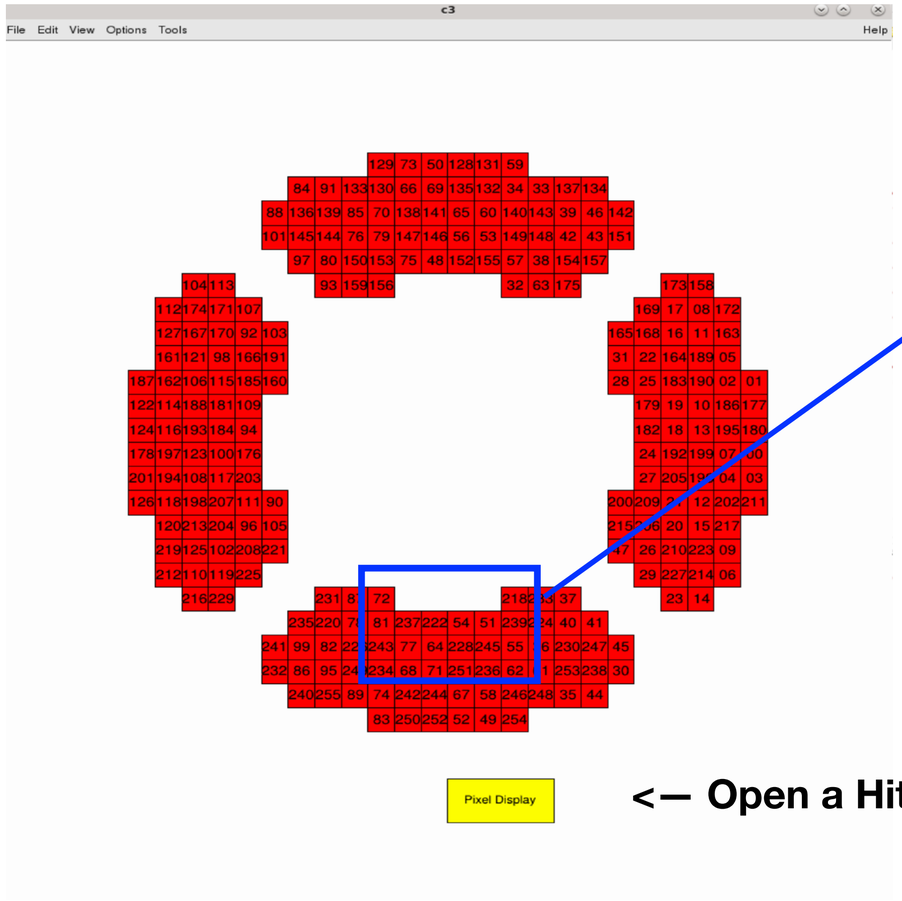
THEORETICAL LIMIT OF THE ACHIEVABLE TIME RESOLUTION Δt FOR CERTAIN SIGNAL AND SAMPLING PARAMETERS

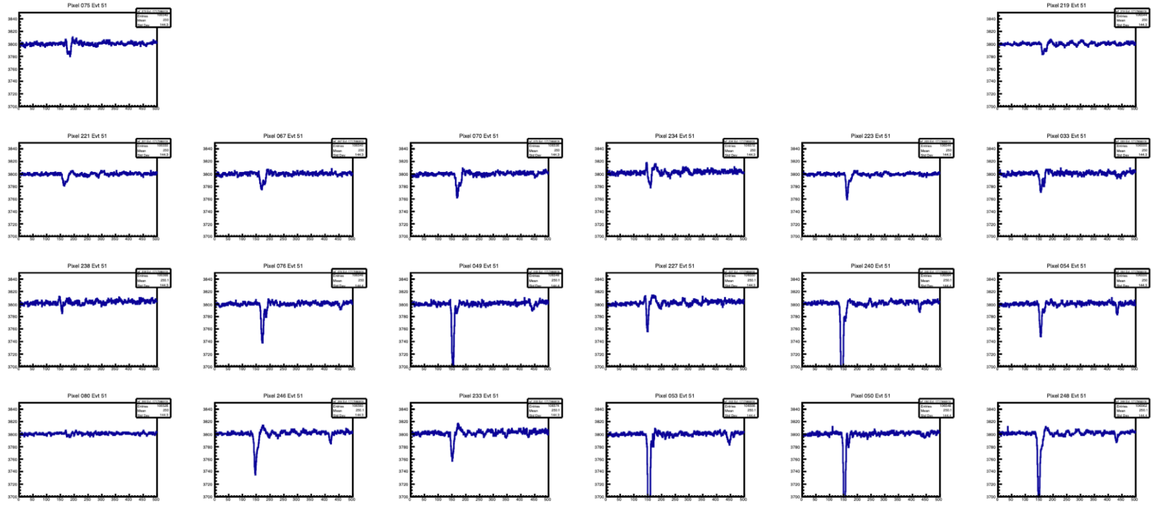
Case	U (mV)	Δu (mV)	t_r (ns)	f_{3dB} (MHz)	f_s (GSPS)	Δt (ps)
a	10	1	1	333	5	45
b	450	1	1	333	5	1
c	100	1	0.35	950	5	2.6
d	500	0.35	1.6	-	5	0.5
e	63	0.35	0.2	-	5	1.1

- The table is only a theoretical limit, but ps timing measurement seems feasible

Online monitoring/fast offline analysis for 2022 Test Beam

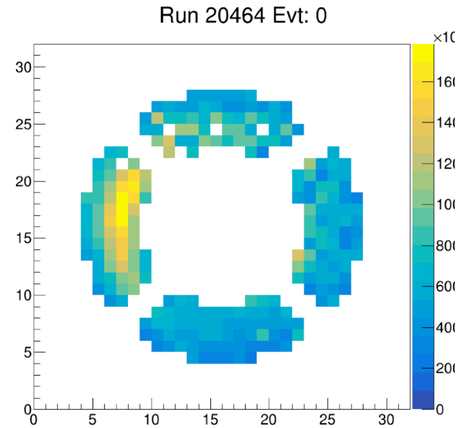
- Online monitor from last year





Select area with a mouse opens up a canvas with waveform distributions, update periodically

<— Open a Hitmap canvas



* Note: waveform plots and hitman here are from two different runs

Online monitoring/fast offline analysis for 2022 Test Beam

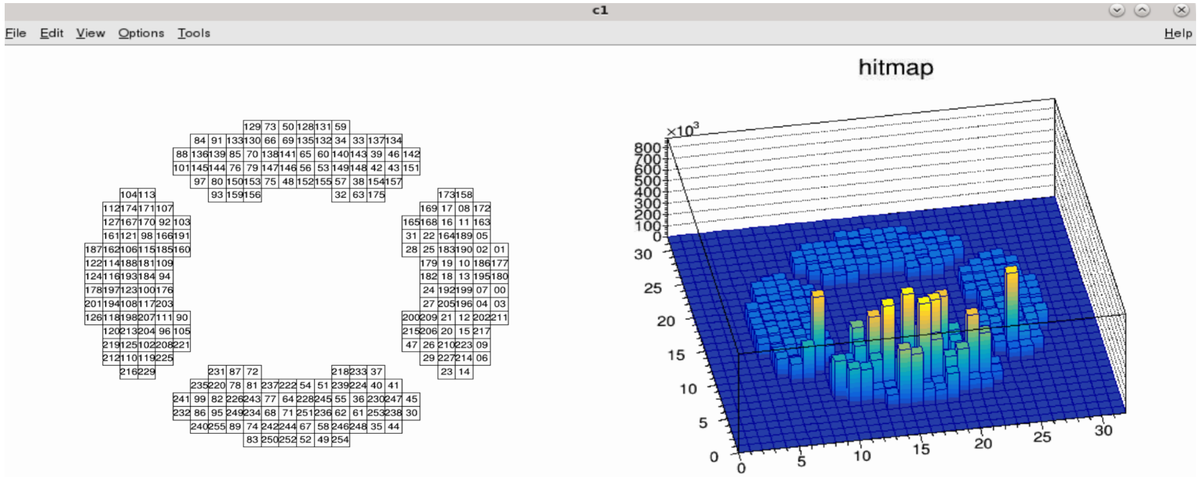
- Online monitor

  Waveforms and hitman were useful to see a single photon hit

  - Option 1: keep the current functionality, improve area selection and visibility (font size, for example)
  - Option 2: multiple canvas cover all area (could slow down the processing, will have to increase time)
  - Option 3: Plot only top channels? (Mickey had something does this)
  - Suggestions are welcome!

Online monitoring/fast offline analysis for 2022 Test Beam

- Fast offline analysis
  - For first 50k events
  - Produce a few performance plots for each run
  - 2x2 canvas with readout patterns and a few accumulated plots
  - Pattern map, hitmap with threshold cut, Cherenkov ring radius histogram, ..
  - Re-check clustering, centroids calculations
  - Save the canvas for each run with run# tag



Ring radius (if we use radiator)

/Residuals w.r.t position measured by the reference tracker

Timing measurement?

- Notes on the fast offline (near-online) analysis:

  - Add GEM tracker information:
    - beam profile and track coordinates
    - Event by event determination of the beam position

  - GEM-LAPPD alignment:
    - Correlate LAPPD hits with beam projection

  - Timing measurement:
    - Make it a separate panel
    - Leading edge timing measurement, or using a simple threshold method
    - Reference timing from two Planacon MCPs (will be in the same data stream)

  - Will prepare a general framework:
    - Straightforward to change what histograms to include
    - Master script to automatically start the analysis and generate plots