Development of photon detectors for picosecond resolution, high rate, multichannel life science applications

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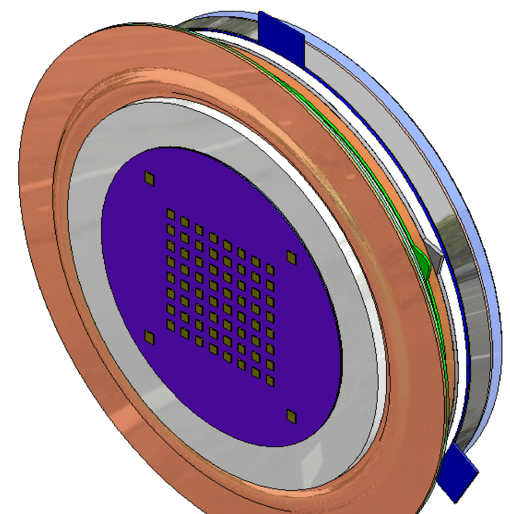
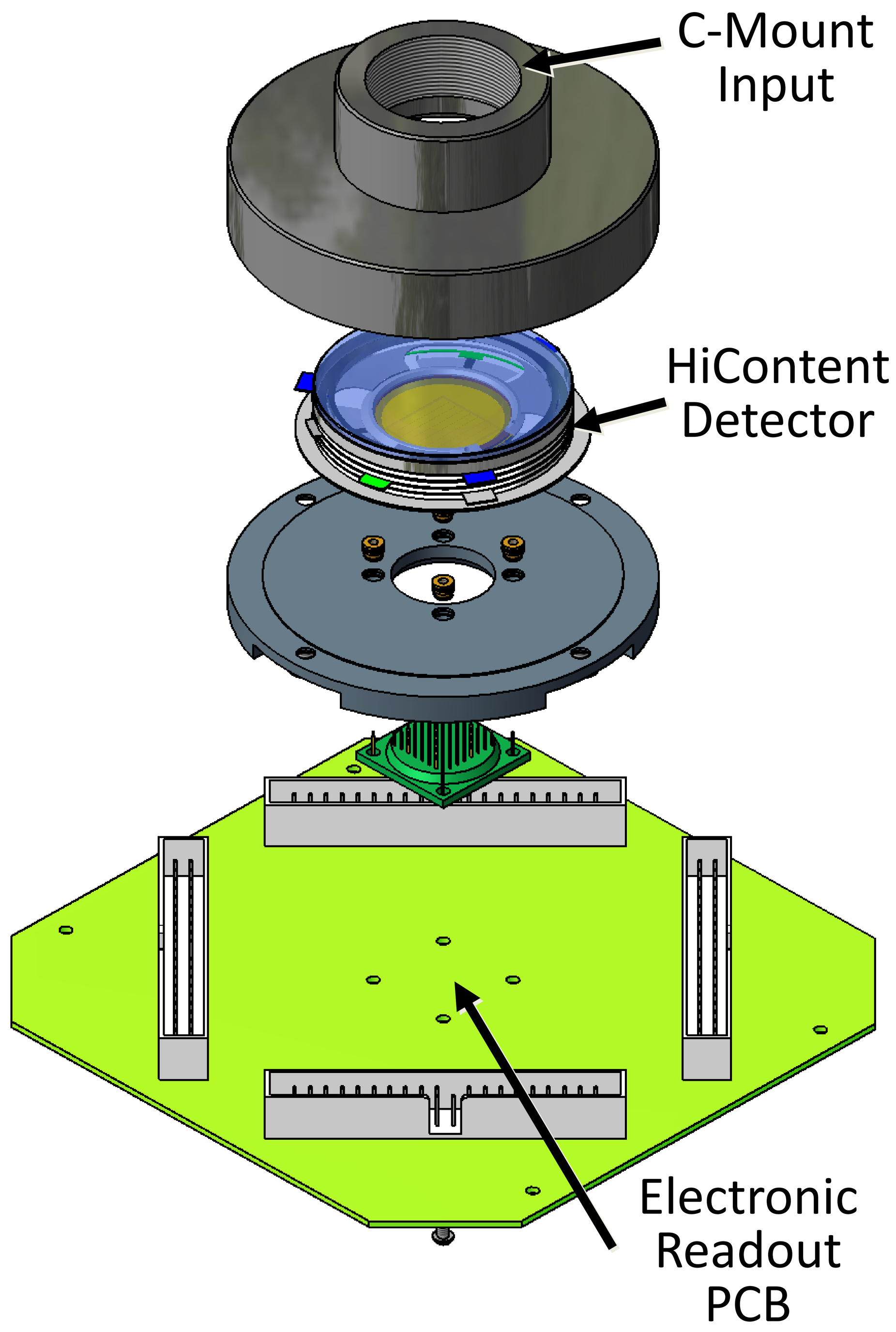
HiContent Detector

The HiContent project aimed to develop a multi-channel PMT for time resolved spectroscopy in life science applications, such as fluorescence lifetime imaging (FLIM), Förster resonance energy transfer imaging (FRET) and fluorescence correlation spectroscopy (FCS). These applications can place stringent demands on the detector and readout electronic's maximum throughput, hence the NINO amplifier/discriminator & HPTDC time-to-digital convertor combination were an ideal choice due to their high rate capabilities and excellent timing resolution.



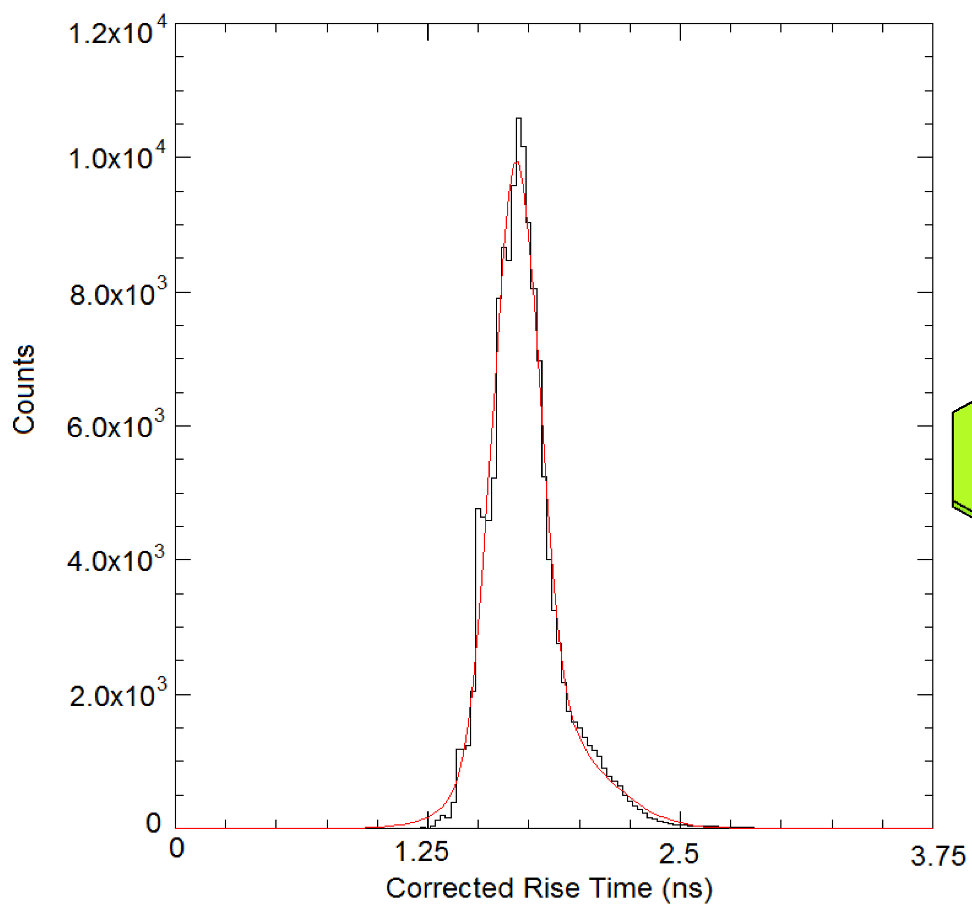


Detector Specifications

- 8×8 anode multilayer ceramic, incorporating anode pads and vacuum feed throughs into a single part to improve vacuum integrity
- C-Mount threading for microscope mounting
- Anode is mounted in an 18 mm diameter MCP detector
- Two chevron-stack 3 μm MCPs offer high gain of greater than 1×10^6
- Gold plated MCPs for improved rate capability

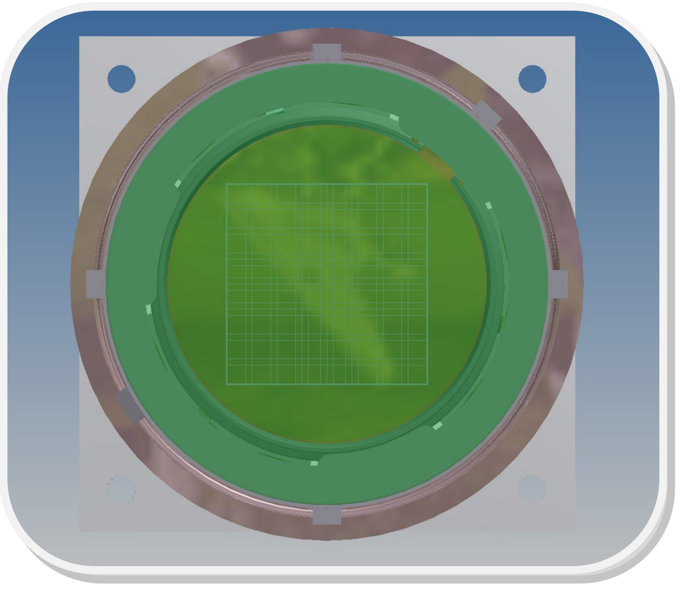
Timing Resolution

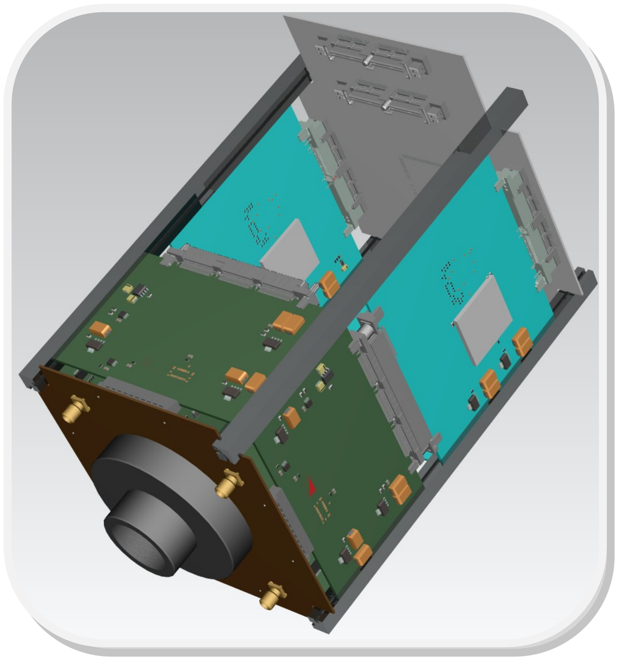
The typical timing performance of the HiContent detector and electronics was measured as 43 ps RMS. This includes a contribution from the laser pulse width of approximately 40 ps FWHM. From these value it is estimated the raw timing performance of the detector and electronics is 40 ps RMS (assuming a Gaussian contribution from the laser, and then subtracting in quadrature).



IRPPICS

The IRPICS project is a follow up for the HiContent project, increasing the detector size to a 40 mm diameter detector, and increasing the multi-anode density to 32×32. Modular readout electronics using the HPTDC and a 32 channel version of the NINO have been developed, which currently provide 256 readout channels, enough to have a 16×16 multi-anode detector.



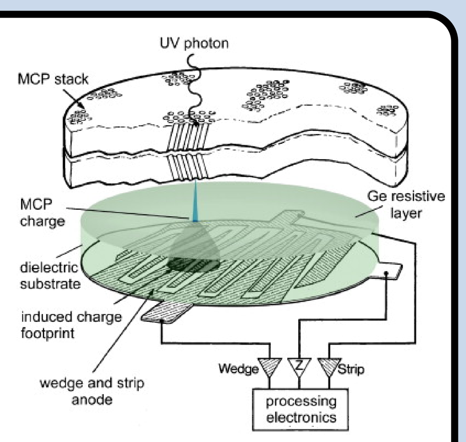


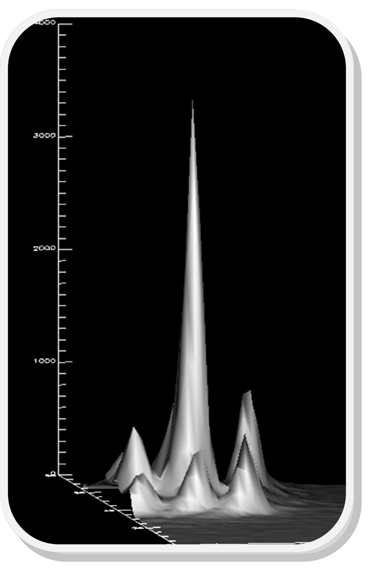
Detector Specifications

- 32×32 anode multilayer ceramic
- Multiplexing a 2×2 pads into a single channel
- Anode is mounted in an 40 mm diameter MCP detector, with 28×28 mm square active area.
- Two chevron-stack 10 μm MCPs

CDIR - Single Photon Wide-field Imaging

The CDIR (Charge Division Imaging Readout) is a novel imaging readout for MCP based resistive sea detectors (as shown in Figure 2). This detector provides single photon imaging, with a continuous readout and has been designed for use with the same electronics used for the IRPICS and HiContent detectors , which providing a time resolution better than 25 ps, at an event rate in excess of 10 MHz. Utilising such high rate and requires a compromise on spatial resolution, which is limited to 100×100 pixels equivalent. Further developments are planned for lower rate readout electronics which will provide a significant improvement in spatial resolution.

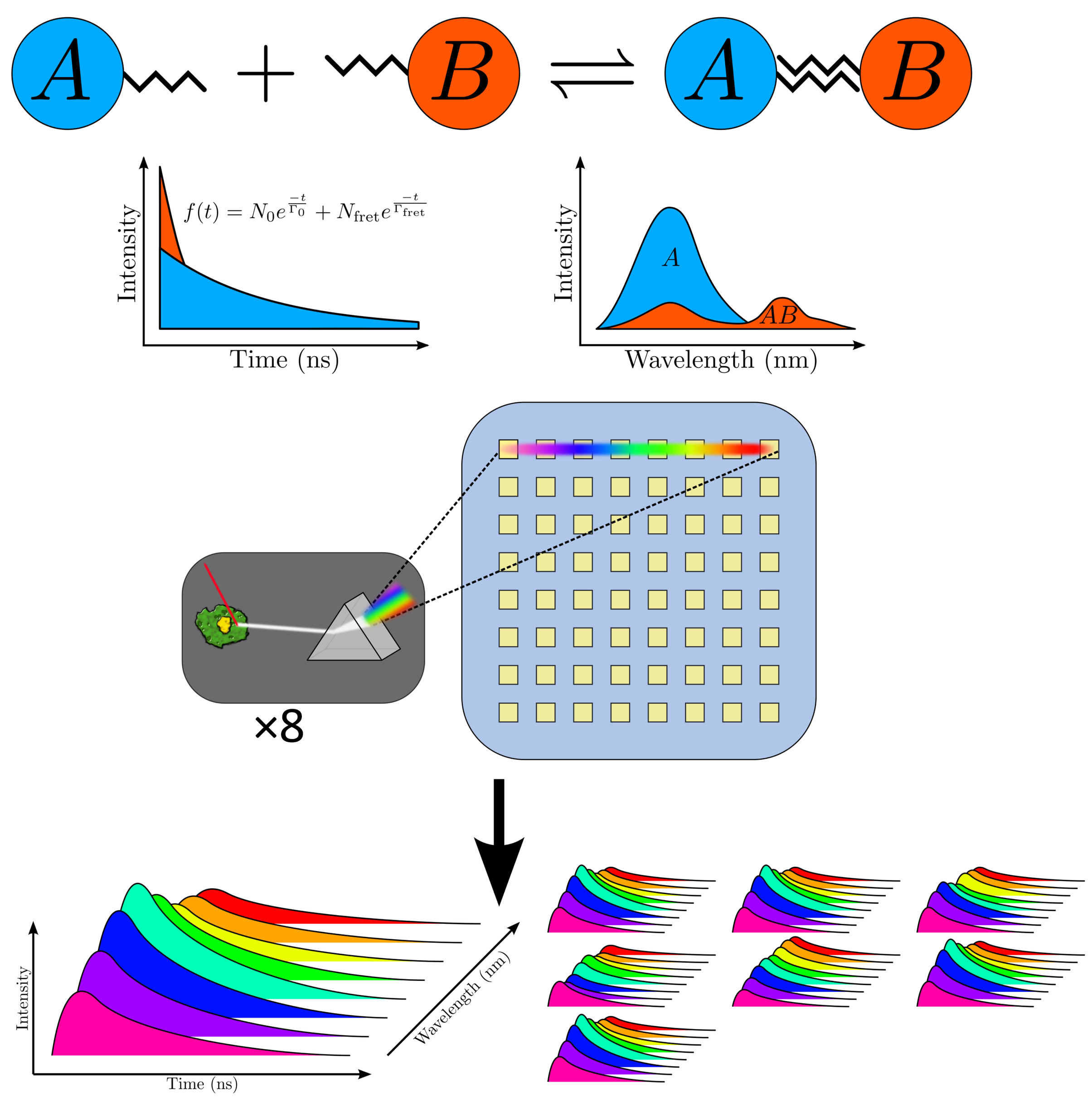




Life Science Applications

The HiContent and IRPICS detectors offer high time resolution, high rate, multi-channel photon counting. This combination of features makes these detectors a flexible option in time resolved Life Science applications such as FLIM/FRET.

- For multi-sample bioassay (e.g. Proteomics) each detector channel can be used independently. Providing parallel sample profiling in an integrated system.
- One dimension of the detector's channel array can be used to acquire data on additional parameters, such as wavelength (using suitable optics), whilst using the other dimension for multi-sample profiling.
- In confocal microscopy, parallel laser beam scanning can be performed, reducing acquisition times.



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