Department of Physics

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managed by Brookhaven Science Associates
for the U.S. Department of Energy

September 28,2009

Chris dePalma
Sales Engineer
Hamamatsu Corp.

Dear Chris,

our group at Brookhaven would like to develop a Time of Flight particle detector capable of 10-20 psec resolution at sustained rates of 10^6-10^7 Hz. This performance is needed for planned experiments at the LHC (in Geneva), the electron-Ion collider (in the US) and Superbelle (in Japan).

The required timing resolution has been demonstrated in test devices based on MicroChannel Plate (MCP) PMT's but in all such designs operation at the above rates could not be sustained because of the MCP-PMT's rated lifetime (integrated anode current).

In High Energy Physics the Higgs boson is the subject of intense study and a strong focus of the LHC experiments. In the last 4 years our R&D collaboration, FP420, investigated the possibility of searching for and measuring the properties of the Higgs in central exclusive production. This unique process has several important features including the possibility of establishing the properties (ie that it is, in fact, the Higgs).

In our summary report (http://arxiv.org/abs/0806.0302) we concluded that, though most technical challenges have been met, the high rate TOF one has not. Subsequent reviews by ATLAS and CMS have reached the same conclusion. We only have the technology today to reach an intensity of 0.1*LHC design. Even so the collaborations are moving forward with this project.

That is our goal. To achieve another factor of 10 with the high speed Hamamatsu HPD.

We expect a similar impact in eIC (which we are involved in) and SuperBelle.

As I reported earlier we have had excellent results characterizing the R10467u with a femtosecond laser and made measurements in a fluorescence microscopy application where short fluorescence lifetimes of scintillating fibers and quantum dots have been characterized. (see attachment)

Our plan is to complete the design of a Cerenkov radiator in the next 2 weeks, which will produce a light signal at the HPD with very low time spread.

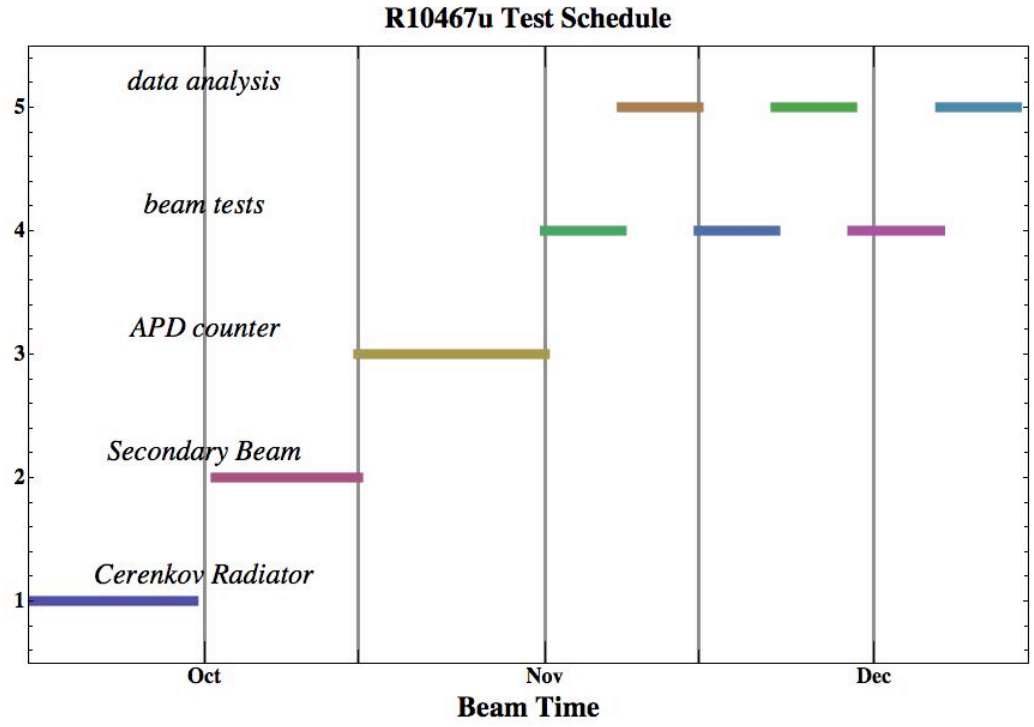
The Brookhaven Accelerator Test Facility has a unique time structure suited to our tests. We are preparing a secondary beam produced by a scattering foil from the 80 MeV electron primary beam. This facility was out of commission for several months recovering from a fire so we weren't able to get access earlier. It is starting operation this week.

We expect that it will take 3 months to complete the measurements. In the first 2 weeks we will prepare a secondary beam with the appropriate intensity. An important step in this project is the installation of a known resolution "start signal" from a second detector in the beam. We have a design that we will have to evaluate in the beam. Once we have run our test we plan to analyze the data and, if necessary, perform a second measurement.

Therefore, we would like to ask you to extend our original evaluation period of the PO BNL# 0000147428 for 3 more months to Dec. 15, 2009 (Hamamatsu quote #4830 dated 3/13/2009) so that we can complete these tasks.

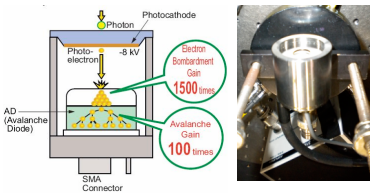
Sincerely,

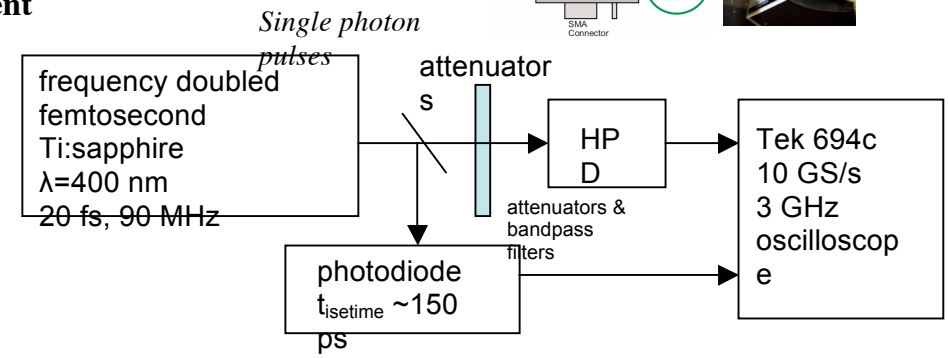
Sebastian White, Ph.D.



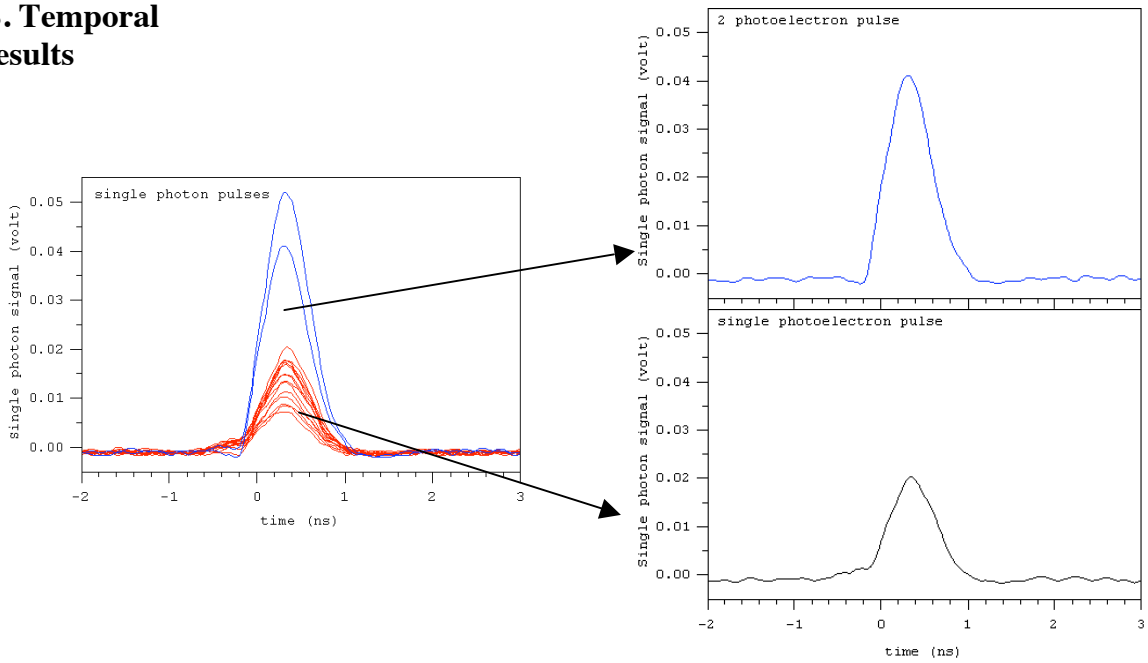
Temporal response of Hamamatsu HPD R10467-06

A. Experiment





B. Temporal results

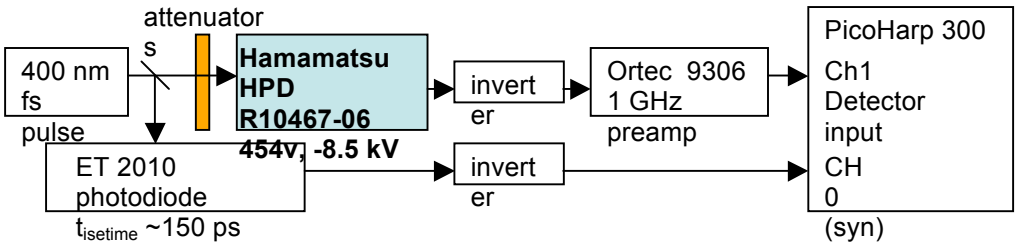


C. Summary

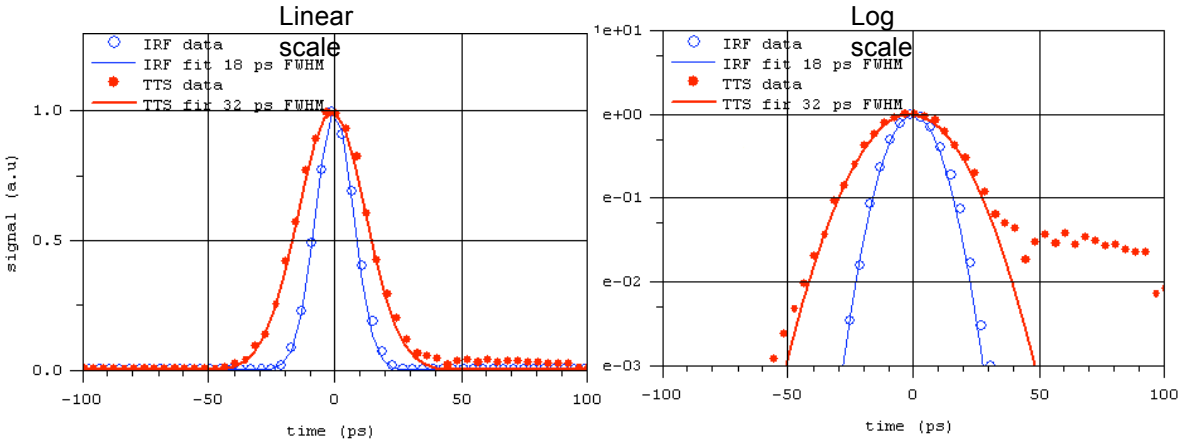
- HPD has good temporal response with a rise/fall time of ~0.3/0.4 ns (both are not instrument limited).
- One and two photoelectron pulses were observed.

Transit time spread (TTS) & time jitter, using PicoHarp

A.
Experiment



B. TTS results (IRF = instrument response function)



C. Summary

- Deconvolved transit time spread of Hamamatsu HPD R10467-06 is ~**26.5 ps** FWHM at the single photon rate of ~ 3 kHz (excitation rate ~ 90 MHz)
- There is a weak exponential tail of ~80 ps (1/e) on the HPD response.