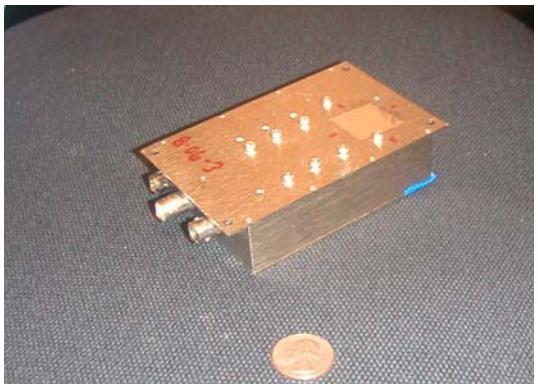
From: Steve Ross
To: Detector Pool
Subject: APD detectors plus RF Pre-amplifiers made available
Date: August 2006

The detector pool can now provide several copies of an avalanche photodiode (APD) plus radio frequency (RF) amplifier. There is not much cost (<$200) to the RF electronics, so we can work with you on your own APD's etc. The arrangement of the APD in the present enclosure will be useful for some beamlines, not for all. Work is continuing to:

- make the detectors more robust,
- add other features to the electronics,
- package things in ways acceptable to beamlines with tight mechanical constraints,
- multiply this electronics to be suitable for existing 8x8 APD arrays,
- support experiments using "integrating", or current mode
- support development of APD-ASIC array detectors currently under active pursuit by industry.

This first round of APD amplifiers is based closely on the work by Alfred Baron at SPring8 (see for example "Detectors for nuclear resonant scattering experiments", in Journal of Hyperfine Interactions, November 2004, or many earlier works), and work by Thanh Deschaux at ESRF, and on previous work by the German engineer Karl Geske. Thanks also to APS RF group member Art Grelick.

This first version consists of a 3" x 4" x 1" box. While this box is considerably larger than it needs to be for a beamline, it is a very convenient place to explore RF design. Inside is an EG&G C30703F 1cm x 1 cm, 210 um thick, silicon avalanche diode, typically covered with a thin piece of aluminized mylar. The user must supply a diode bias voltage of some +320-340 volts, through an SHV cable. The user must supply an electronics power supply voltage of about +11 to +15 volts through a BNC cable. The RF pulses come out from a BNC connector. These detectors are not perfectly robust – they can be made to oscillate if you try hard enough.

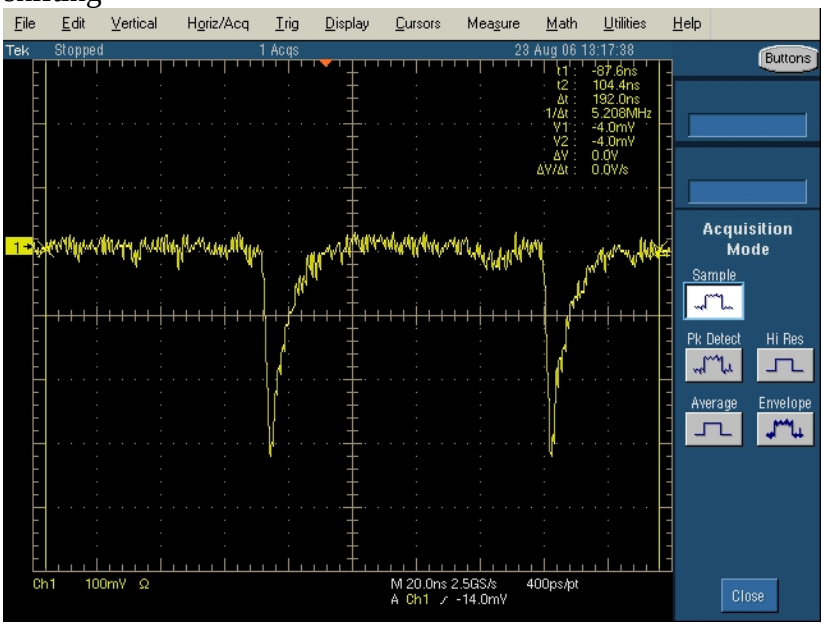


I have also tested the same electronics with an RMD 1mm^2 beveled edge, high gain APD, courtesy of PNC-CAT. [Ref: Richard Farrell et. al., NIM-A 442 (2000) p. 171] useful because it has a fast time response, and it mimic's a single "pixel" of APD arrays owned by PNC-CAT. See data below.

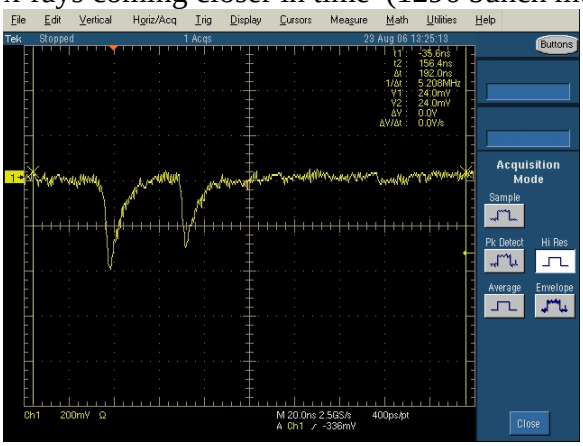
There are *many* other steps to take. *However if this first step is useful to you, and you purchased EG&G APD's during the group order a while back, then your APD can be put into such an amplifier system, just tell me you want this done. The actual parts value of the RF amplifier is perhaps $200, so we do not charge for this. I do not do anything to your EG&G APD except trim the leads to about 8 mm or so, they do not need to be soldered into the RF amp. I have not yet cooked an APD itself, at least so far!*

The EG&G detectors plus RF amplifiers put out a 200 mV negative going signal (though this can be reversed with an RF transformer). They have been tested so far as counting detectors to about 20 MHz before things like baseline shift stop things from working. False count rates depends on voltages and of course thresholds, but is seems in range of 0.1 Hz. The synchrotron data taken below is from 7-ID-C, running at 14.3 keV in the 1296 bunch mode.

+340 bias, no signal averaging. X-rays resolved, limit of resolution, pileup, baseline shifting

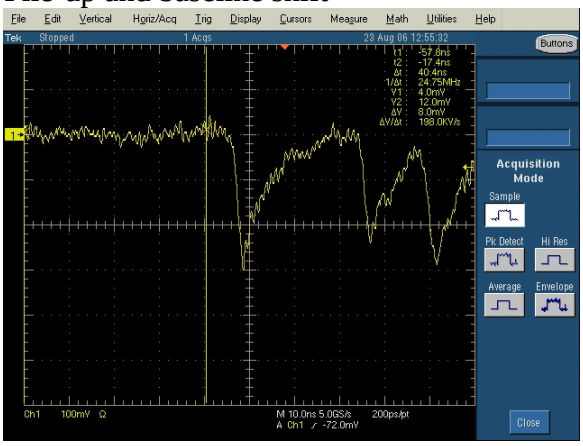


x-rays coming closer in time (1296 bunch mode)

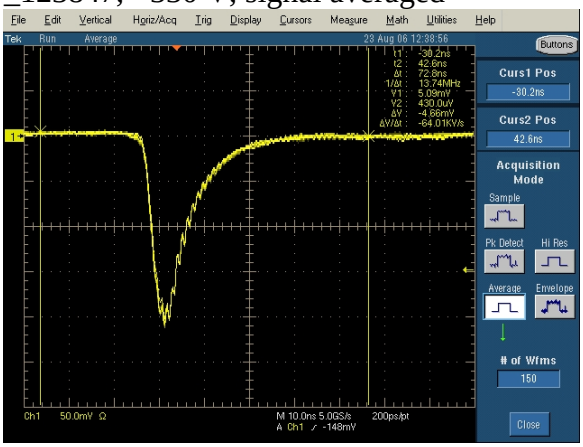


Beginning of pile-up

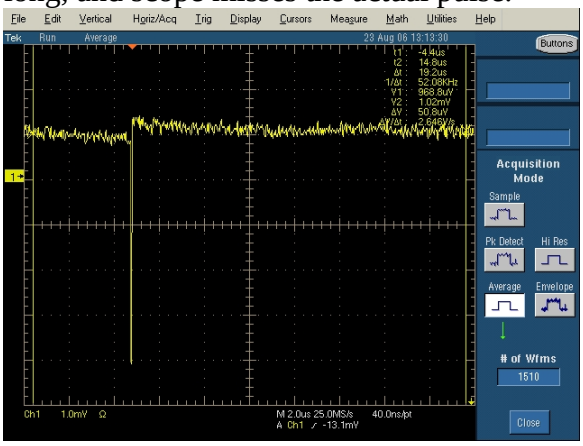
Pile-up and baseline shift



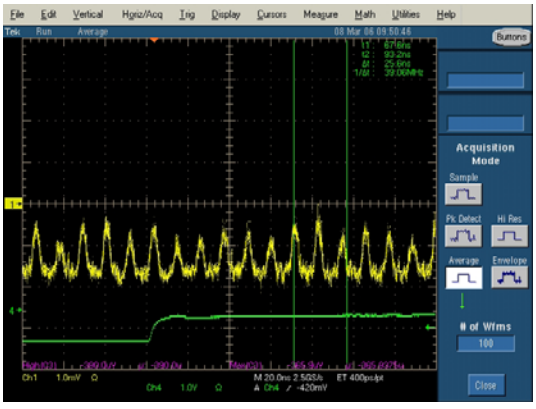
_123847, +330 V, signal averaged



_131317, examination of baseline before and after, signal averaging, note time base is long, and scope misses the actual pulse.

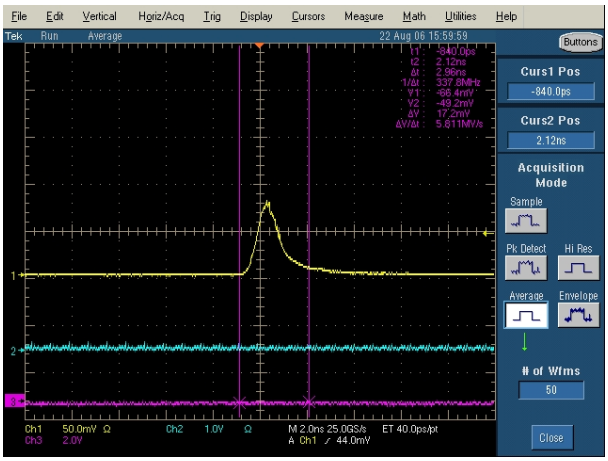


Fe55, radioactive source, and another day at 7ID-C, in 324 bunch mode, 11keV, baseline stable at this high count rate, and at low count rate. It is the intermediate ranges that are more difficult.

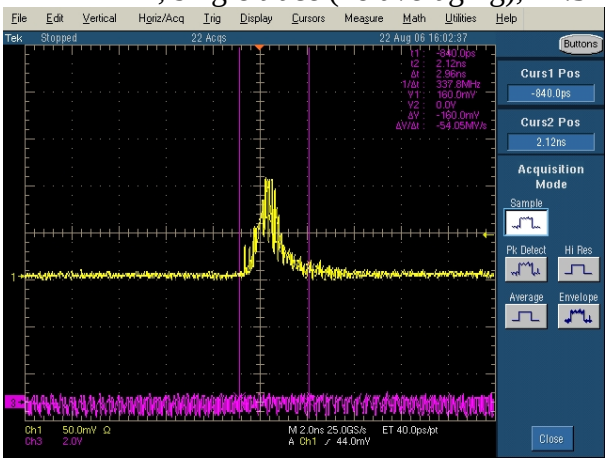


Data, continued, now the 1mm^2 RMD fast APD, high gain (hence RF amplifier has lower gain), 7ID-C, 14.3 keV

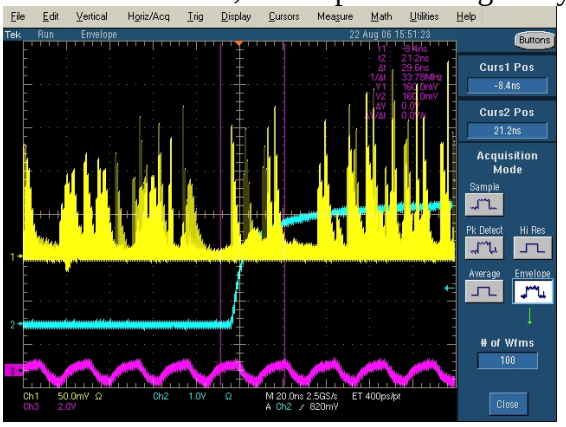
RMD 1mm^2 APD, 1650 VDC bias, fastest pulse, cyan lines about 2.8 ns apart, 1296 bunch mode



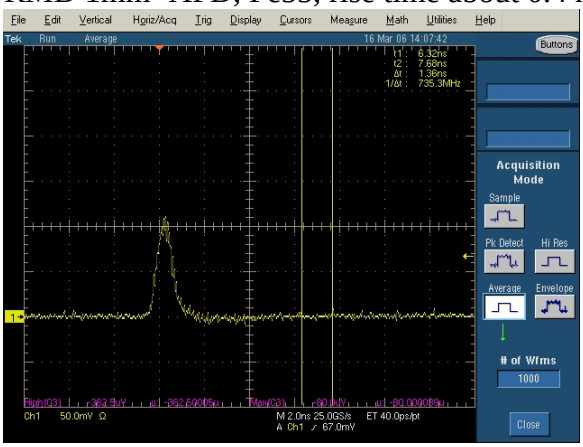
1mm2 APD, single trace (no averaging), 14.3 keV, 1296,



1296 bunch mode, envelopes showing many x-rays, blue trace is P0 clock, trigger,



RMD 1mm^2 APD, Fe55, rise time about 0.4 ns, fall time about 0.6 ns. Signal averaging



APPENDIX: EG&G 1 cm^2 data sheet.