X-ray detector development in APS/ASD

- ASD Electrical Systems Group working with detector pool staff and other ASD groups.
- Goal is to develop detector electronics and beamline instrumentation, and provide support on into the future.

Several different detector systems

- PIN Diode detector into electrometer amplifiers for beam position, beam intensity monitoring -- mature design, delivering to sectors
- Avalanche photodiode detectors for time resolved x-ray studies, counting/integrating electronics – “my” part of work really just beginning.
- Other detectors

Beam position monitoring

Detector is a quad array of PIN diodes which detect x-rays backscattered from a thin foil. [Ref Alkire et.al. J. Sync Radiation (2000) 7 p.61]

First application of electronics at ComCAT (Wasserman,D'Amico) for fast EXAFS – they use 3 quad arrays, plus a monitor of mono. keV

We can design varied mechanical diode holders, to match specific sector needs e.g. KF40,KF50

Electrometer amplifier spec's

- 4 Channels – currents from 4 unbiased PIN diodes processed in each module
- Readout rate 1500 samples/sec per diode
- Noise of electronics <25 pA RMS
- Noise of system, including UDT S100-VL 1 cm^2 diode <100 pA RMS (battery), 200 pA RMS (lab supply)
- Dynamic Range: 20 bit ADC, LSB = 1 pA, full = 5 uA
- Typically all charge collected (one amplifier is collecting while another is processing through ADC)
- Variable gain, variable integration time, set by VME commands, but usually not needed
- Fiber optic digital readout back to/from VME
- www.ti.com search on the ddc112 chip

VME data acquisition

- Setup data from VME system sent to electrometer card via fiber, to monitor 4 PIN diodes.
- Data from each electrometer card returns via fiber to a VME card. This card can accept signals from 4 electrometer cards at a time (e.g. 16 PIN's).
- Second VME card does signal averaging, puts data onto VME bus (A16/24, D16 registers).
- Cost of system $2K-$3K. I have about 10 systems built up, am working to install at beamlines.
- Other data formats can be discussed.
- Software work done by others, can discuss.

APD array detector electronics

- Application to high count rate, time resolved studies.
- APD is a nanosecond detector, used either in counting mode (we may develop ultrafast counters), or integrating mode (we work with fast gated integrators). TBD
- Work with SRI-CAT.

General electronics for beamlines

- Various sectors ask for specialized hardware development. We have a set of things we can do quickly, and we also work with ASD,AOD Controls groups. Examples include:
- Custom digital “glue” logic designs using FPGA cards. Applied to timing modules that divide down bunch clock to pulse synchronized lasers etc.
- Circuits to pass data around a hutch along a daisy chained 2-wire link –string all the station monitoring together.
- Various amplifiers
- Miscellaneous simple circuit boards.

Future and Past

- Future, low cost, CMOS high frame rate x-ray detector (500 fps, 1280 x 1024 12um pixels, 10 of 10 bit ADC), smaller ROI’s can be read 2 us per line. The electronic part of this is fairly simple: http://www.micron.com/imaging/
- Past work, CCD, amorphous silicon, infrared, mm wave detectors, etc.
- Have a Sarnoff 500 frame/sec 512x512 CCD, a 16 port, frame transfer device. www .sarnoff.com/consumer_electronics/imagers/v_ccd.asp
- Always of interest: detecting thin films, detector calibration, test stands etc.

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