

Hardware and EPICS Software for the APS Quad Electrometer for X-ray Beam Position Monitors

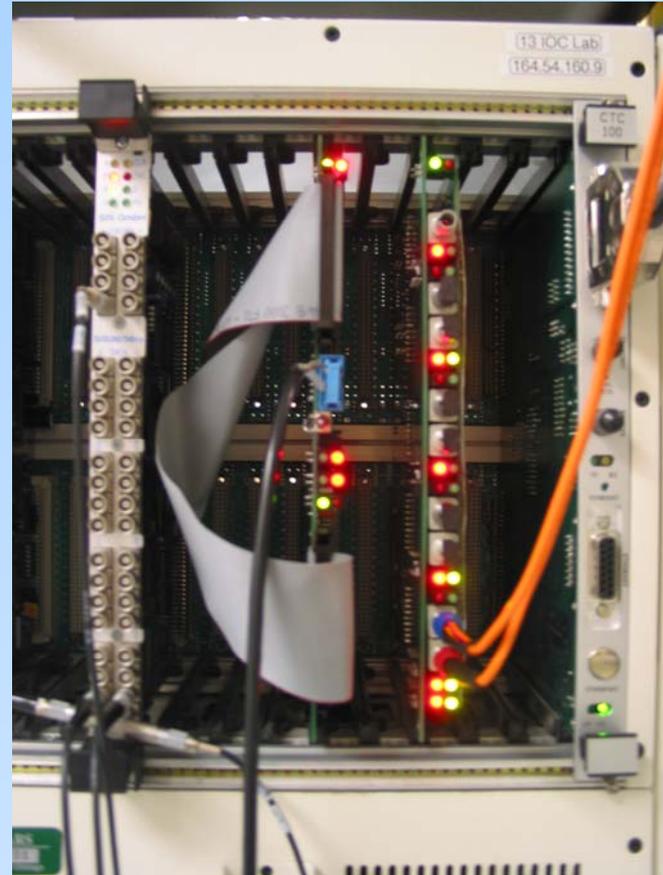
Mark Rivers (CARS) and Steve Ross(APS)

- Steve has designed a 4-channel electrometer for measuring currents in the nA to uA range.
- Intended primarily for reading x-ray beam positions using 4 photodiodes or split ion chambers.
- Compact and inexpensive, and can be placed close to the position monitor hardware to keep signal leads short.
- Outputs digital data at up to 815Hz over a fiber-optic cable
- Read by a pair of VME boards.
- Fiber allows reliable data transmission over long distances, for example from an experiment station to a VME crate in the FOE, where feedback to a monochromator crystal can be implemented.

Electrometer Hardware



Remote ADC unit and
battery



VME boards

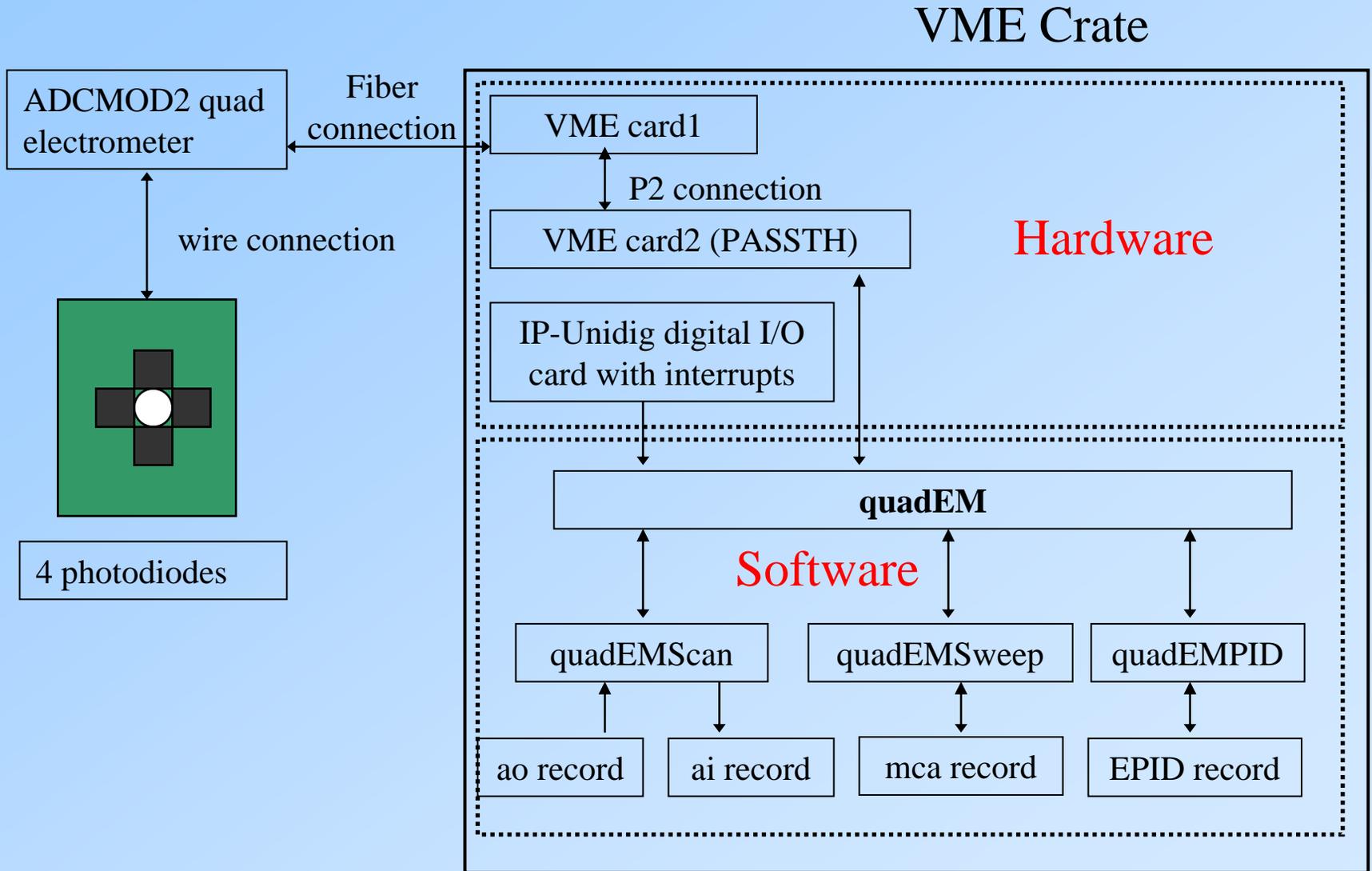
Applications

- Feedback of the pitch and roll of monochromator crystals based on the beam position in the beamline or experimental station.
- Feedback on mirror pitch for stabilizing the position of the beam downstream of a focusing mirror.
- In-vacuum fluorescent foils allow I0, beam position, and energy calibration to always be available
- Replaces:
 - 4 SRS570 current amplifiers
 - 4 ADCs, or 4 V/F converters and 4 scaler channels

EPICS Software

- I have developed a EPICS software (quadEM) to read the digital data from the electrometer.
- Interrupt driven, reads the digital data stream at 815Hz.
- Provides the current in each of the 4 photodiodes, as well as the sum, difference and position for opposite pairs of diodes.
- Device support is provided for 3 types of EPICS records:
 - analog input (ai) record at up to 10 Hz
 - multichannel analyzer (mca) record which functions as a “digital scope”, capturing the values at up to 815Hz
 - feedback (epid) record for fast feedback through an A/D converter at up to 815Hz.
- The mca and epid records can run slower than 815Hz as well, in which case they provide signal averaging.

System Architecture



Main medm screen for analog input

quadEM_full.adl

Quad Electrometer (13LAB2:EM1)

| | | | | |
|------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Diode # | 1 | 3 | 2 | 4 |
| Current | 7577 | 10721 | 18835 | 16668 |
| Offset | <input type="text" value="0"/> | <input type="text" value="0"/> | <input type="text" value="0"/> | <input type="text" value="0"/> |
| Sum | 18298 | | 35503 | |
| Difference | 3148 | | -2167 | |

Feedback

| | Horizontal | Vertical |
|----------|---|---|
| Position | 5636 | -1999 |
| Setpoint | <input type="text" value="1500.000"/> | <input type="text" value="-2000.000"/> |
| Feedback | <input type="text" value="Off"/> | <input type="text" value="On"/> |
| Rate | <input type="text" value="1.226e-003"/> | <input type="text" value="1.226e-003"/> |
| Options | <input type="text" value=""/> | <input type="text" value=""/> |
| D/A | <input type="text" value=""/> | <input type="text" value=""/> |

Conversion Time (usec)

Gain

Read rate

Implementation Details

- Data comes from the electrometer into the VME system at up to 815Hz.
- Current VME boards do not support interrupts
- They do put out a TTL pulse when new data arrives, up to 815Hz.
- This pulse is input to an IP-Unidig Industry Pack I/O module, which does support interrupts.
- IP-Unidig interrupt routines calls the function to read the quad electrometer VME board.
- On each interrupt up to 3 quadEM functions are called
 - quadEMScan averages the current reading and returns averaged readings to EPICS “analog input” records
 - quadEMSweep puts the current reading into an array for an EPICS “mca” record. Performs averaging if the channel advance time is less than the electrometer clock rate.
 - quadEMPID uses the current reading to perform fast feedback via a Systran IP DAC. Performs averaging if the feedback rate is less than the electrometer clock rate.