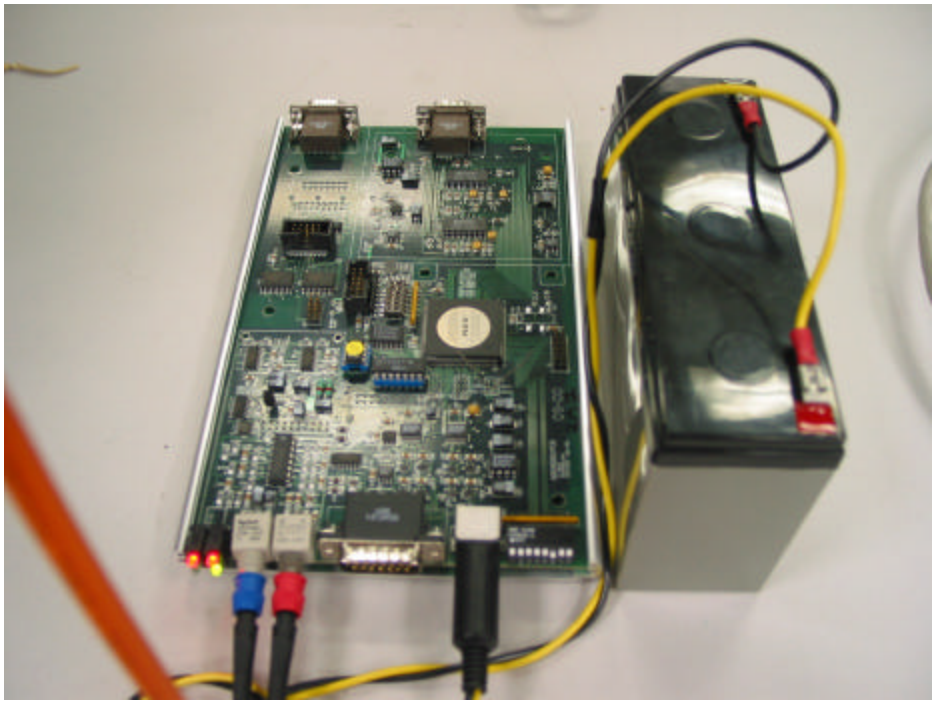
Hardware and EPICS Software for the APS Quad Electrometer for X-ray Beam Position Monitors

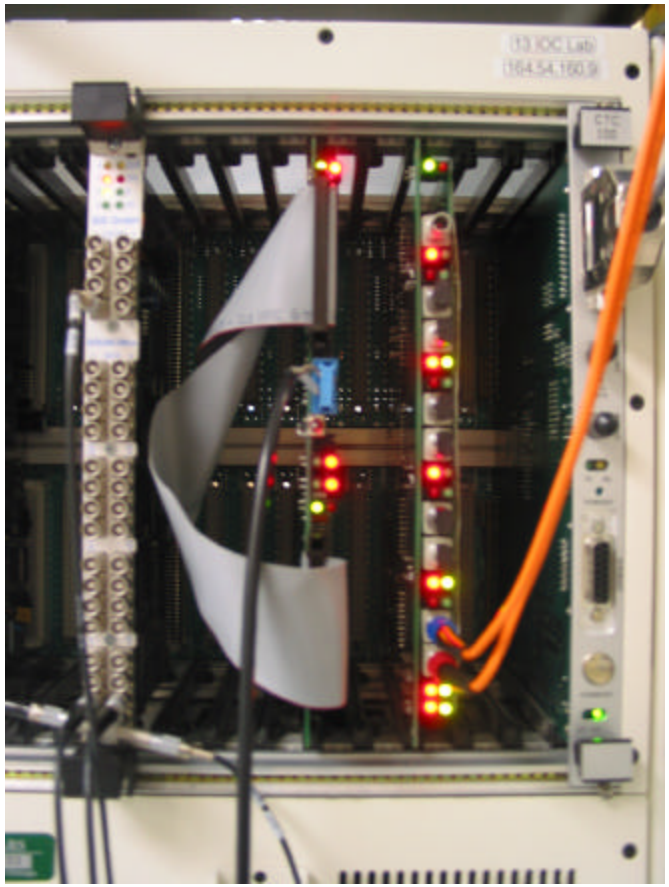
Mark Rivers (CARS) and Steve Ross(APS)

- 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

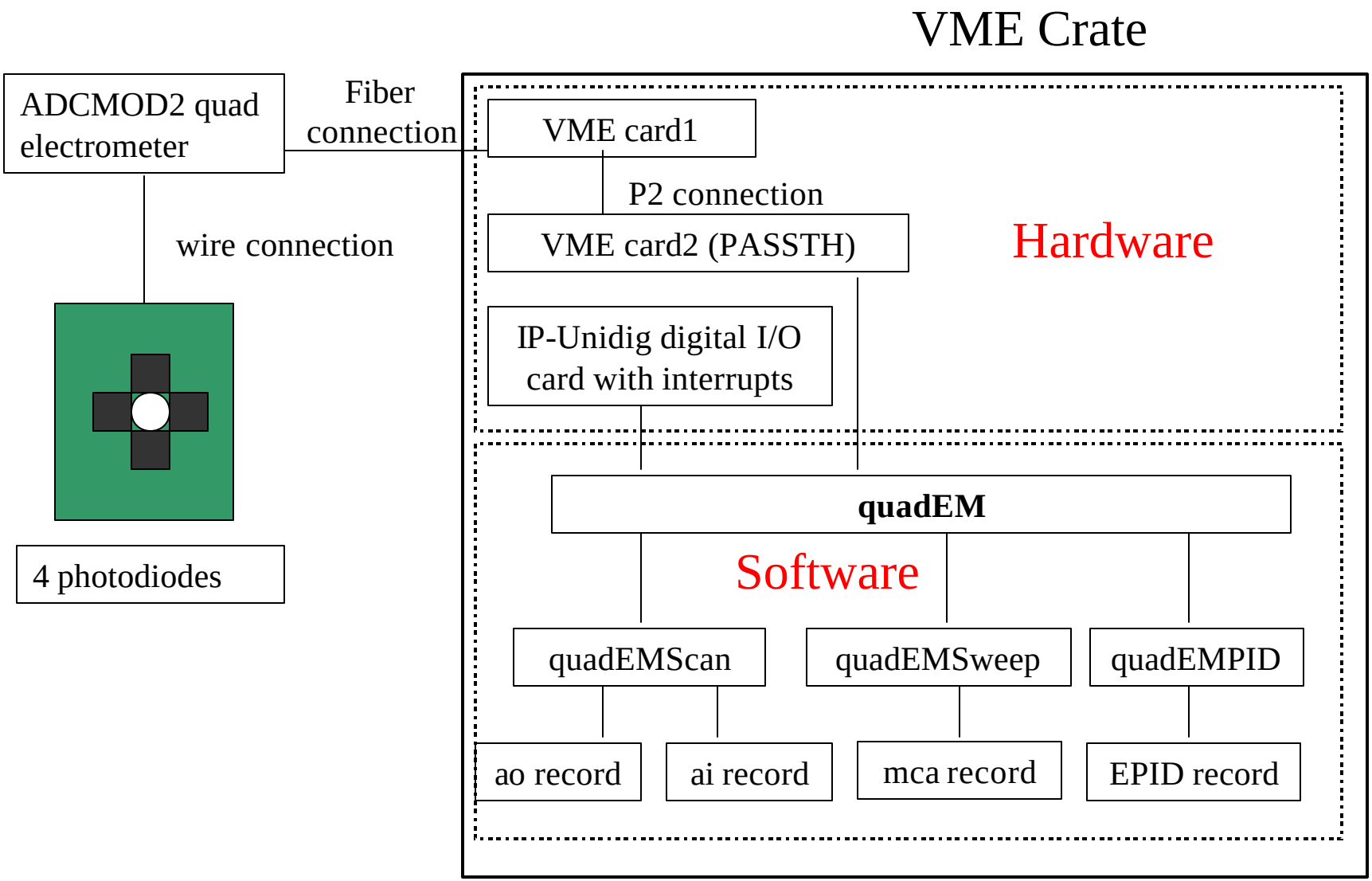
Applications

- 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

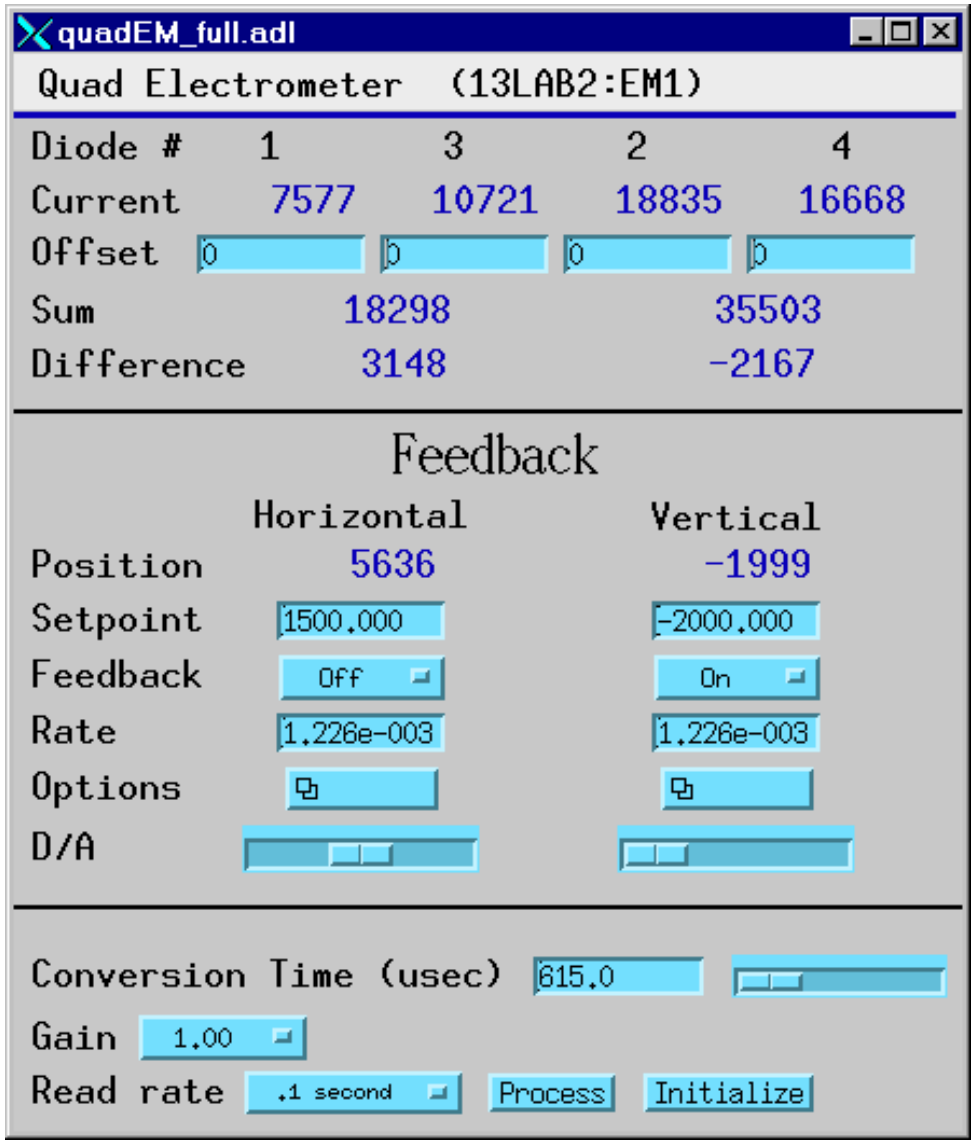
EPICS Software

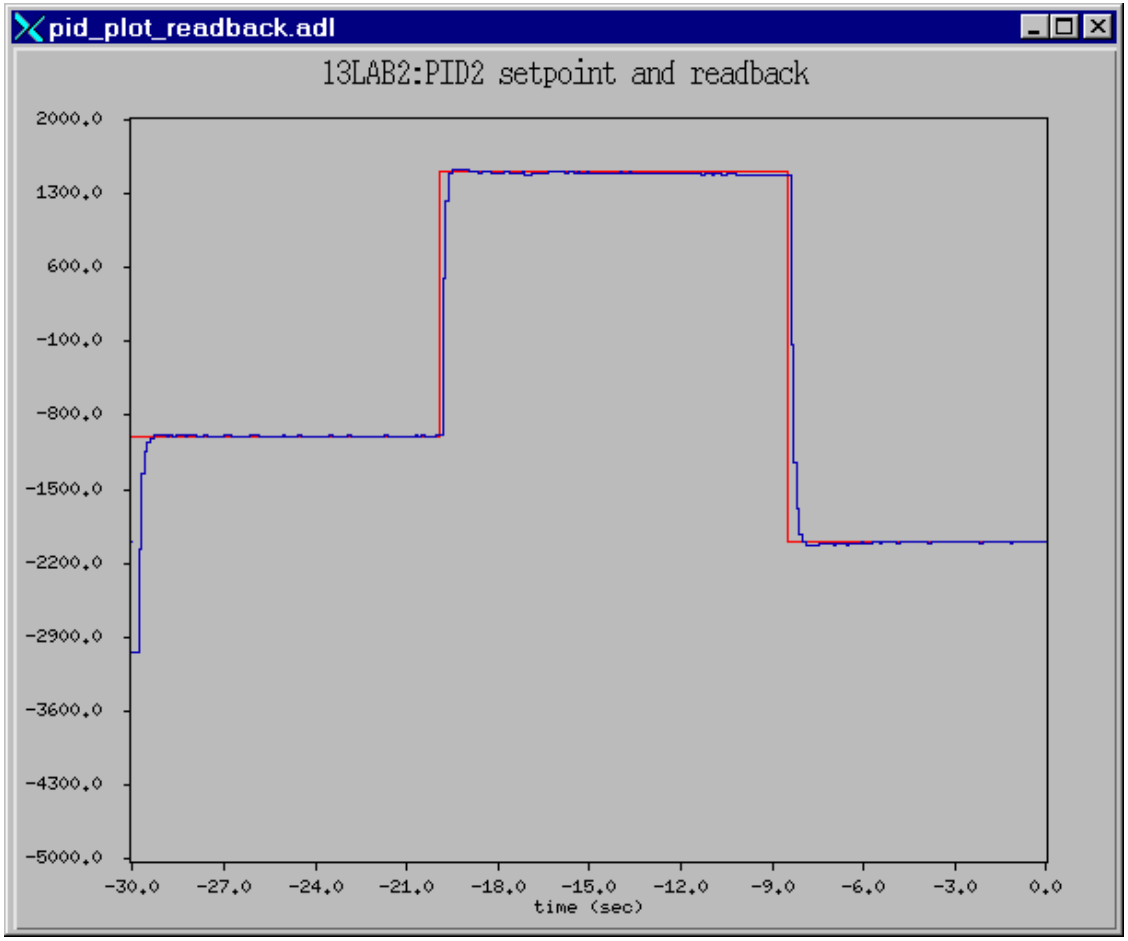
- I have developed a EPICS software (quadEM) to read the digital data from the electrometer.
- Interrupt driven, reads the digital data stream at 815Hz.
- Provides the current in each of the 4 photodiodes, as well as the sum, difference and position for opposite pairs of diodes.
- Device support is provided 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

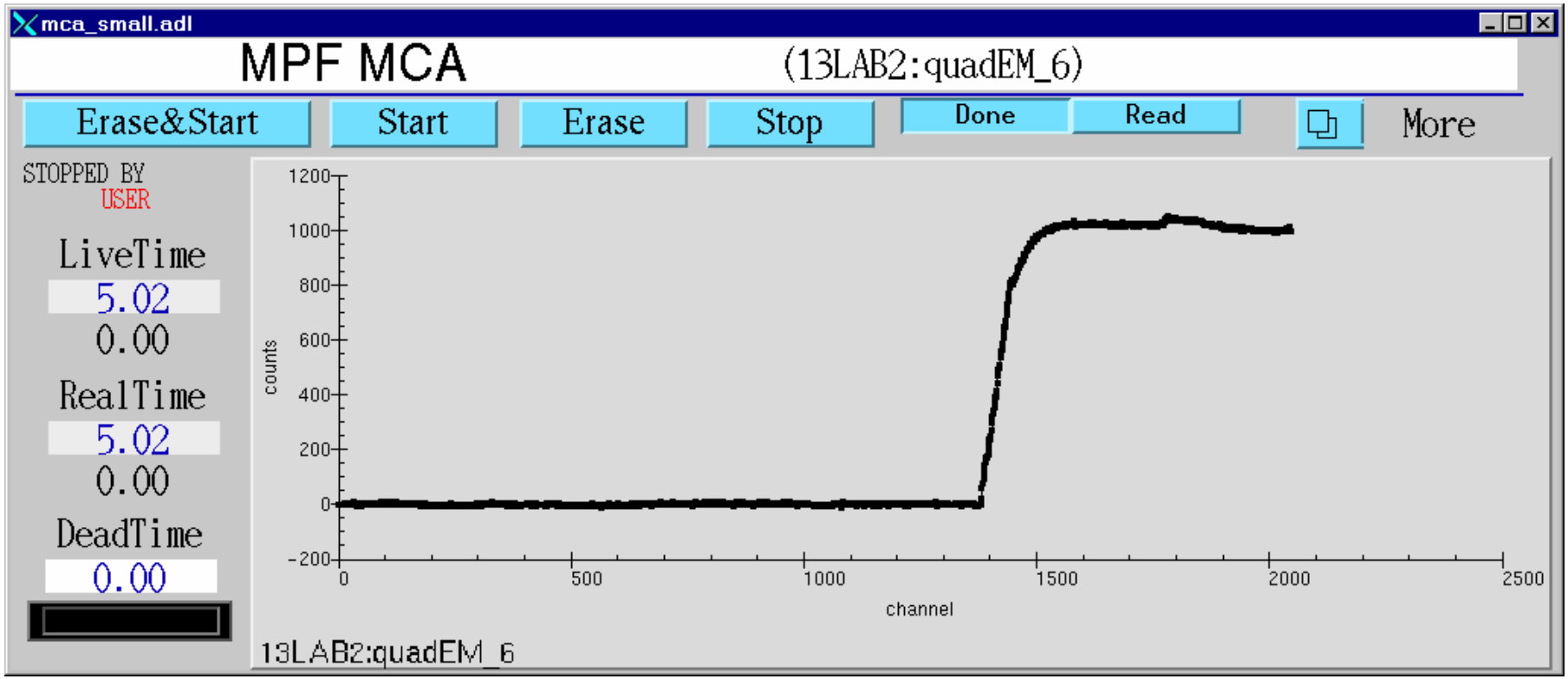


Main medm screen for analog input





Plot of the setpoint and readback of the laser beam position as the setpoint of the feedback system is changed. The feedback loop is running at the full 815Hz of the electrometer, but this plot is a 10Hz subsample of the beam position.

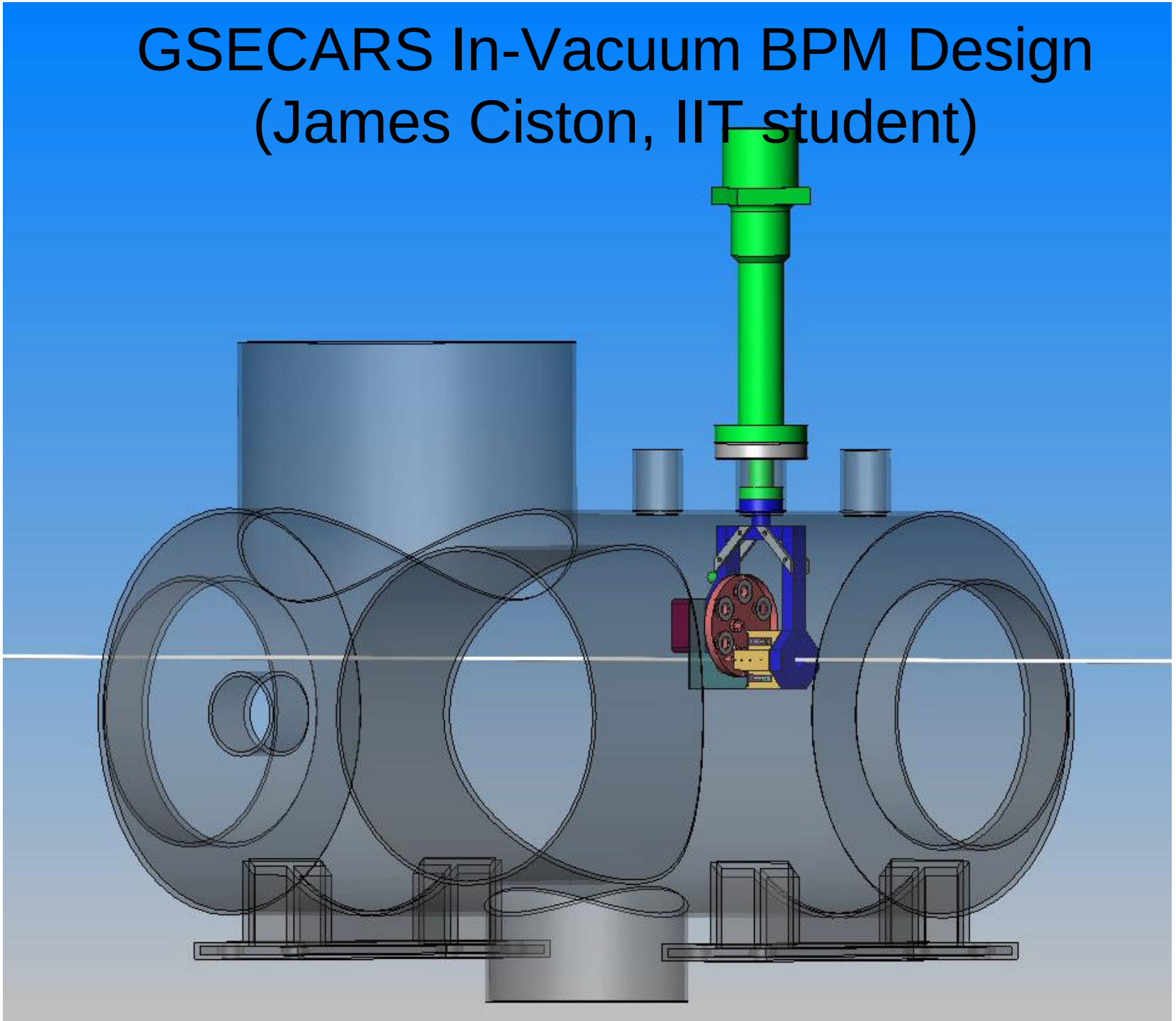


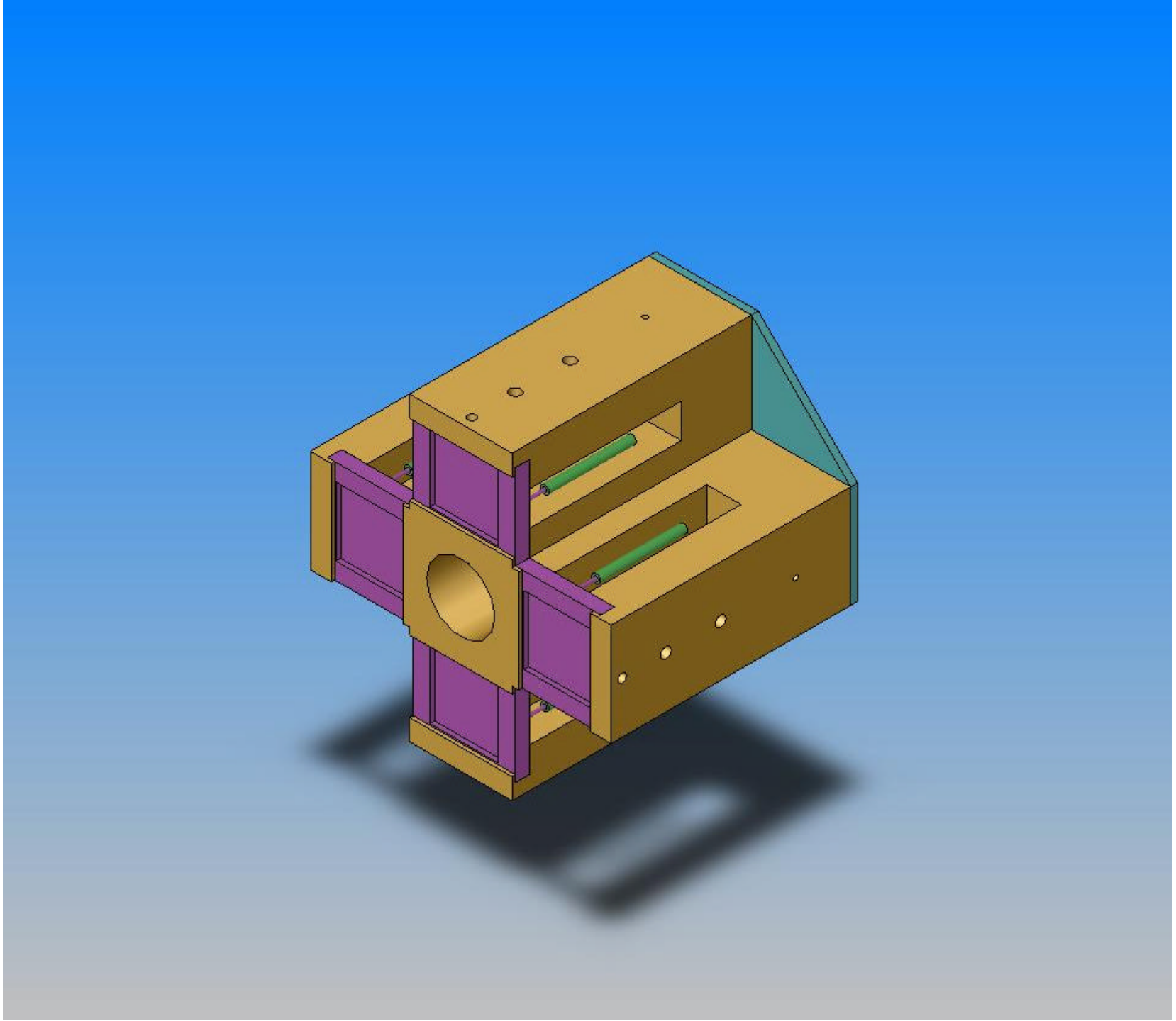
Plot of the laser beam position measured at 2.5 msec/point as the mirror is moved. This is the quadEMSweep server being read with the EPICS MCA record. Times as fast as 1.2 msec/point are available. These data can be read into an application like IDL to do spectral analysis of noise components, etc.

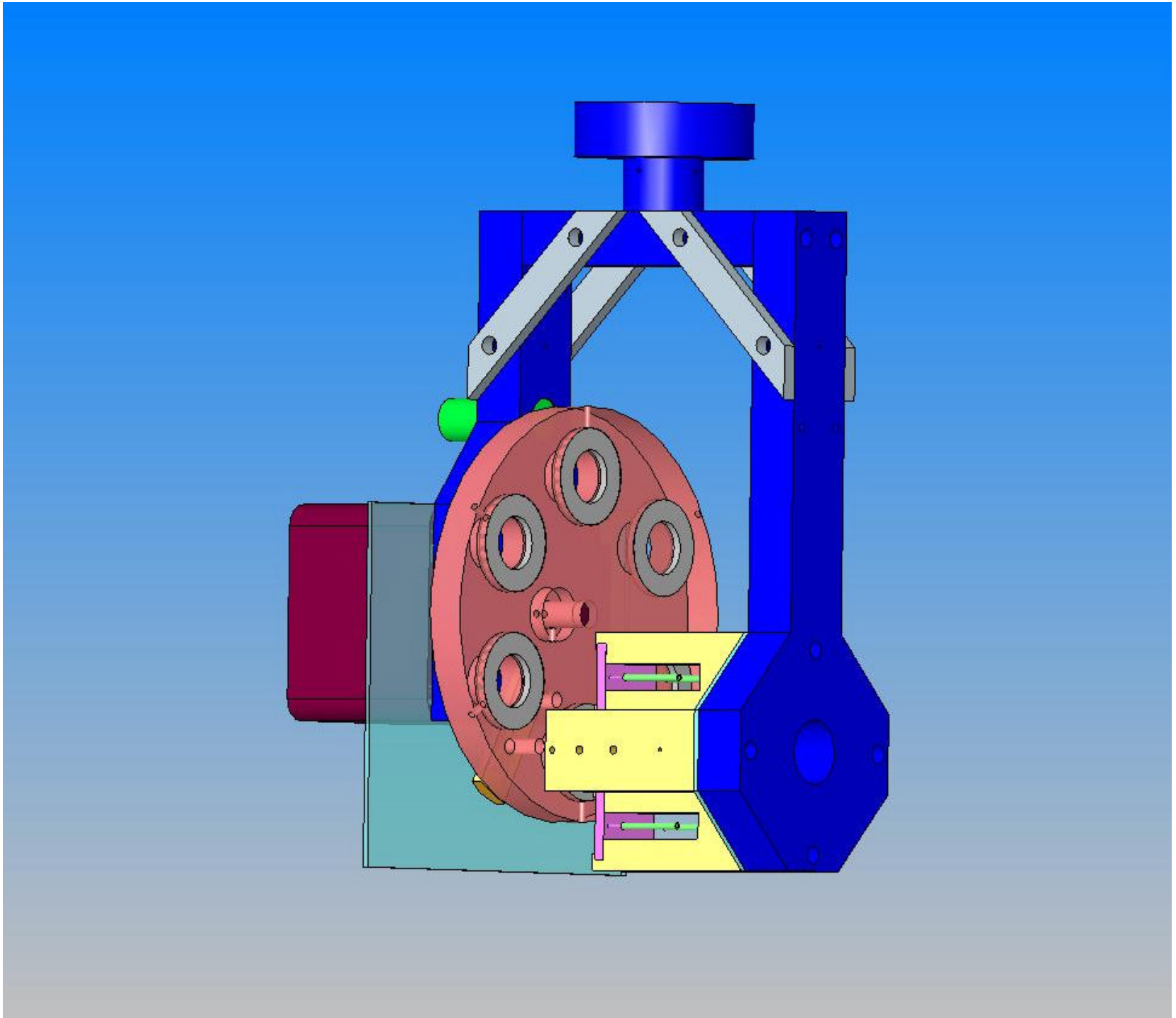
Implementation Details

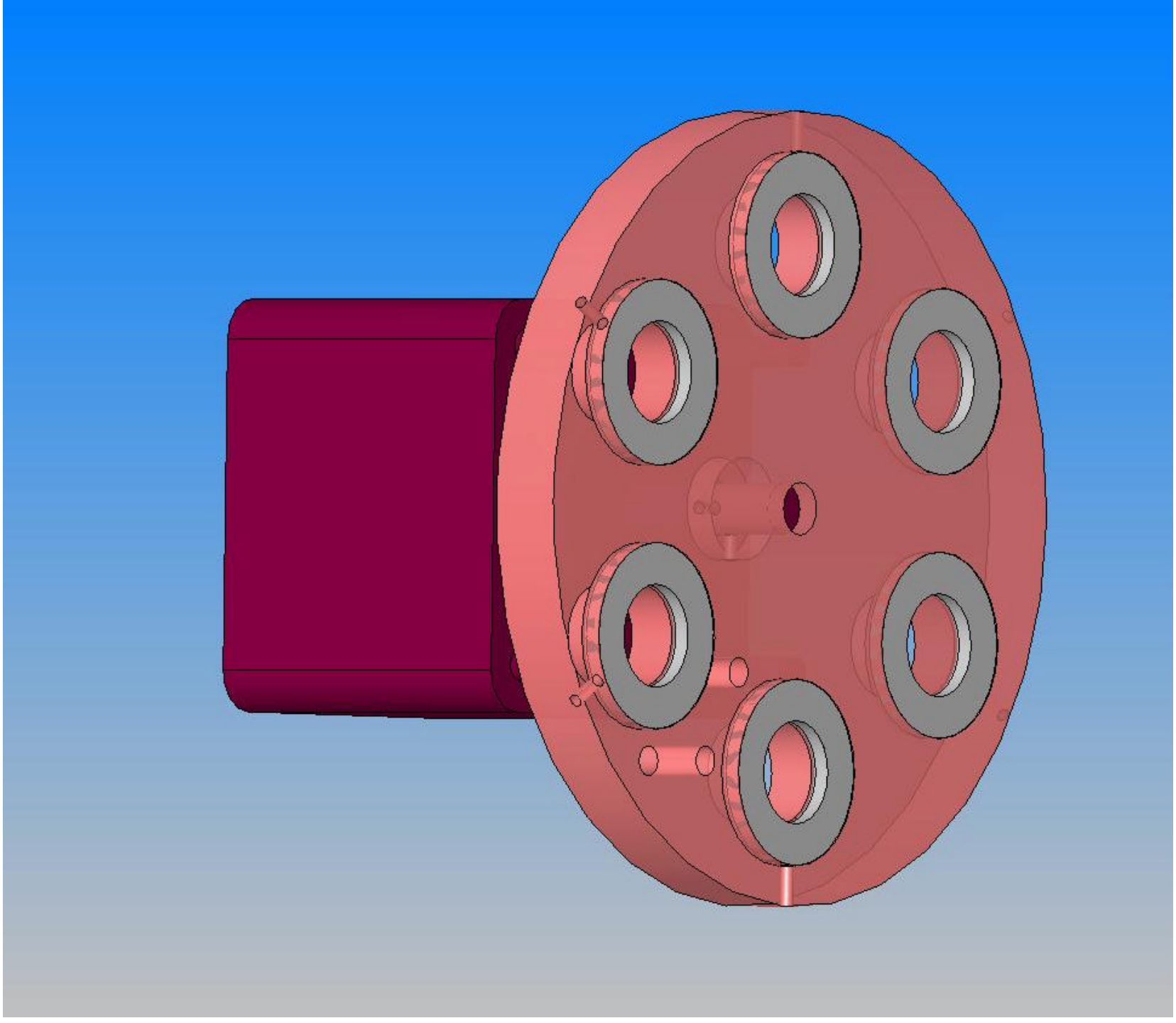
- Data comes from the electrometer into the VME system at up to 815Hz.
- Current VME boards do not support interrupts
- They do put out a TTL pulse when new data arrives, up to 815Hz.
- This pulse is input to an IP-Unidig Industry Pack I/O module, which does support interrupts.
- IP-Unidig interrupt 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.

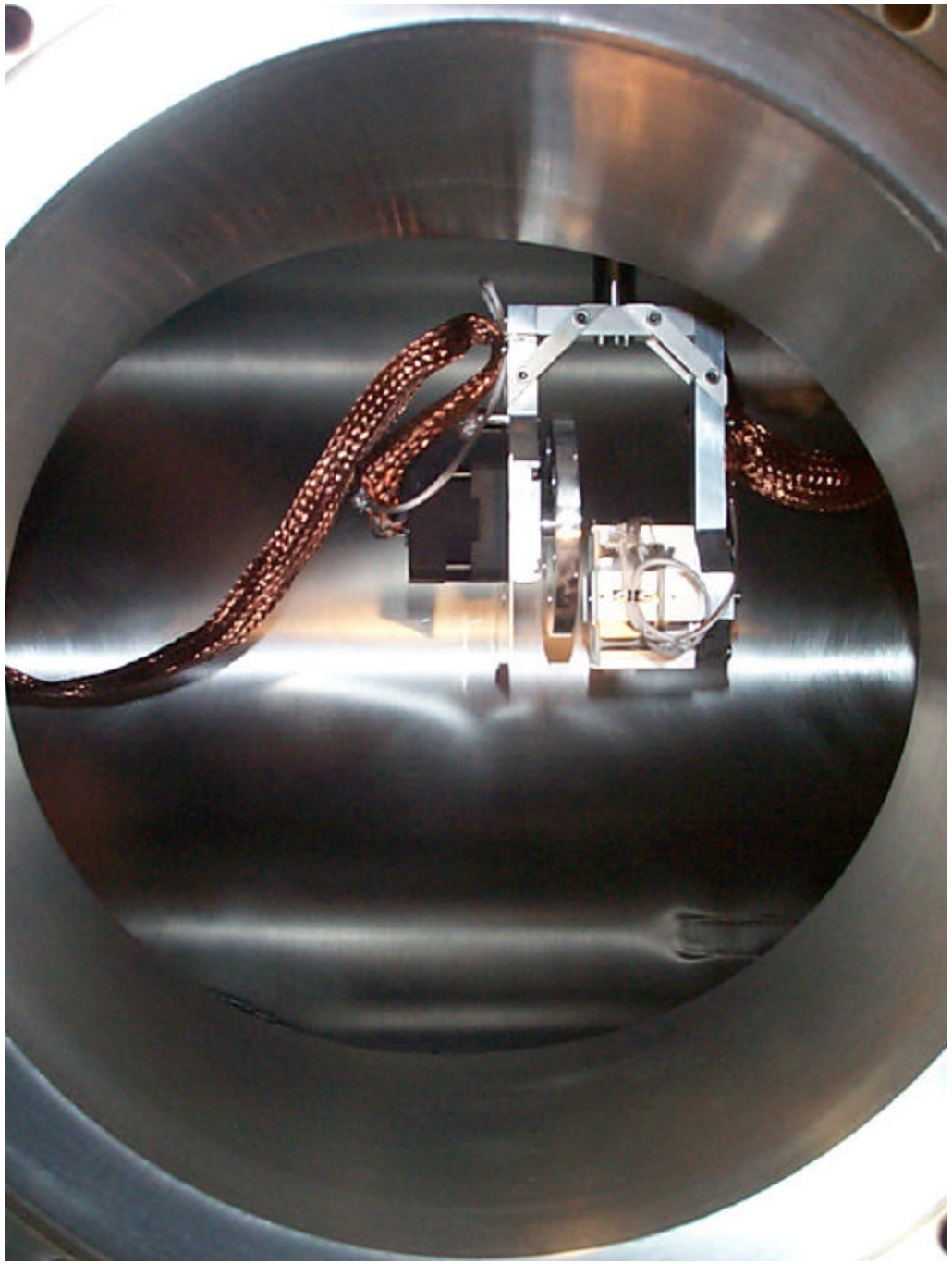
GSECARS In-Vacuum BPM Design (James Ciston, IIT student)











Current Status

- System “works” now but Steve Ross is working on the following problems/enhancements
  - Clean powerup/reset behavior
    - Biggest problem, hard to get VME and remote ADC units to initially communicate. In future both will reset with either switch or VME reset.
  - VME interface problems (?). Could be same problem as above, could be software. Hangs IOC.
  - Interrupt support directly on VME board, no IP-Unidig needed
  - Convenient battery charge/switchover
  - Reduced gain by increasing capacitor. We saturated it with full undulator beam with 0.5 micron fluorescent foils
- EPICS software for 3.13 and 3.14 available now