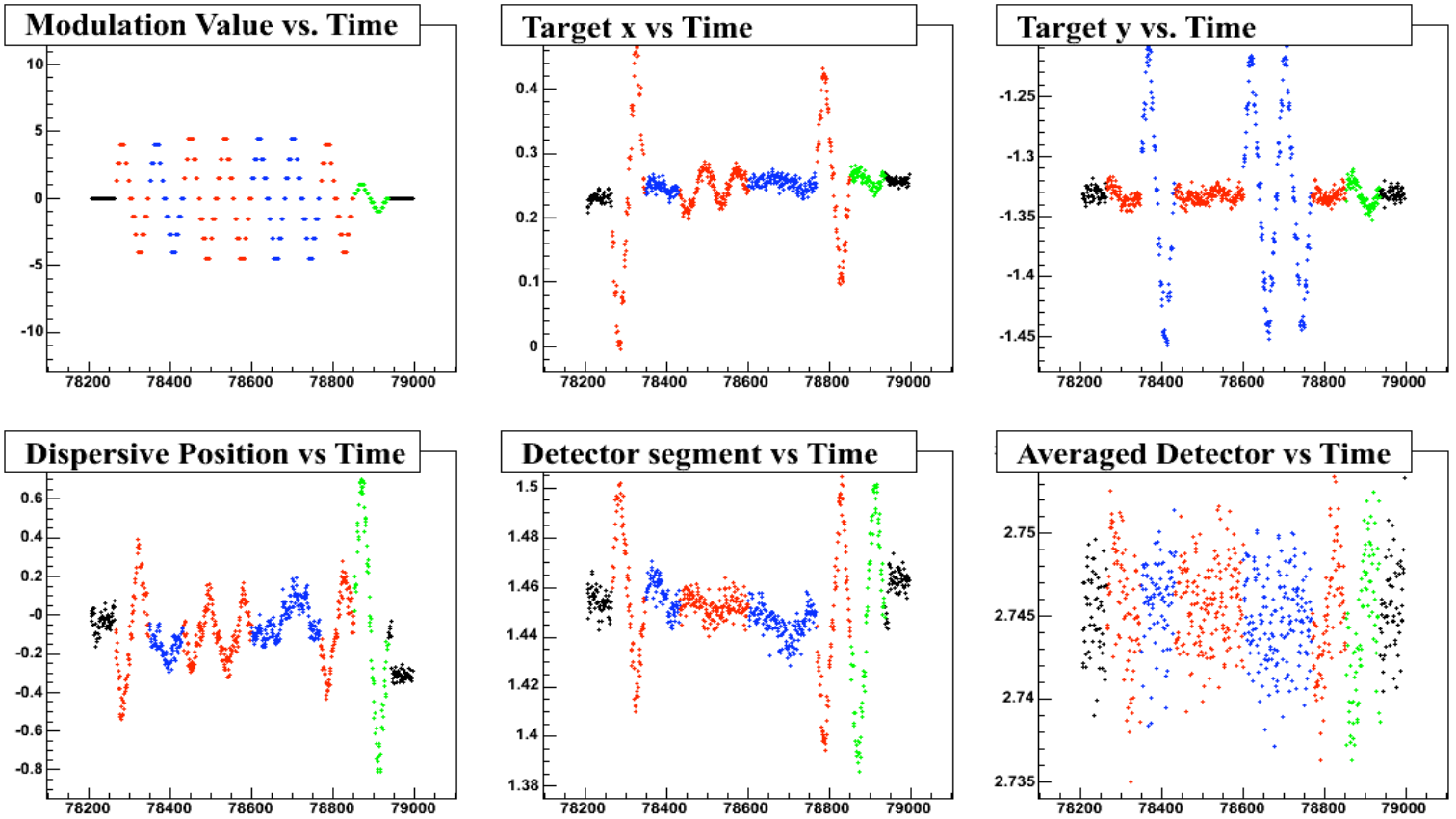
Beam Modulation

Classic beam modulation scheme



Measure $\partial S_k/\partial C_i$, $\partial x_j/\partial C_i$ use multi-dimensional analytic least-squares minimization to find $\partial S_k/\partial x_j$

Old Hardware, accelerator software exists.

Proposed new modulation system

Avoid slow drifts with faster differential measurement

- VME function generators (GE 4145) to drive sine waves
- Slower than DAQ readout frequency (120 Hz max for PREX)
- FFB must still be disabled
  - -“notch filter” at higher (>80Hz) frequencies?
- Uses standard Trim magnet P.S. cards
- driving function readout in DAQ (analog from BSY, V2F/scaler in CH)

Coil location

Coils located in arc, which allows use of 1C01-1C08 girders to restore design input specification and get to optics model

Still have coils at 1C01 (H), 1C02 (V), 1C03(H)... useful during HAPPEX-3

Nomenclature

"**supercycle**" : smalled complete unit of dithering: a series of up to 8 sequences

"**sequence**" : single step of dithering, composed of 1 or 2 magnets running in phase, with independent amplitudes but fixed frequency and number of periods

FG Board Operation

2 states:

CONFIG can set amplitude, N periods, frequency. Open relay separates FG output from TRIM card

TRIGGER with initiate function on front panel trigger, relays from FG to TRIM are closed.

Also: testing states

Trigger

trigger will launch FG sequence (N periods of specified amplitude on channels in TRIGGER state)

trigger formed in CH by coincidence of MPS and logic signal from CPU

Dithering Scheme

VXWorks Script **.crl trigger readout**

start supercycle
  pause FFB (E)
  loop over “sequence”
    Configure first sequence (E)
    Set FG to TRIG (E)
    request trigger — lift trigger inhibit, reassert on next readout
    count sequence + buffer time
    Set FG to CONFIG (E)
  end loop
Count til next supercycle

Words in data stream:
- 8 channels of FG readout
- bmw_cycle (arbitrary cycle count, useful for indexing)
- bmw_object (which sequence number is running)
- bmw_active (VXworks script thinks this sequence is still active)

Dithering Scheme

ISSUES:

- Long delays on configuration and triggering (5 seconds), must be fixed.
- Details like calibration of amplitudes (mA?)
- Testing with DAQ system
  - control software almost (but not yet) ready to go.
  - Need cabling and trigger
- Commissioning with beam

Fallback: old hardware remains in place, and can be re-wired

Dithering Analysis Rework

Each “Sequence” operates like the old “object” - there is no conceptual difference between one coil and two.

- so two-coil sequences have redundant function readbacks, one for each coil... ignore one

Calculate detector response correlation to function readback.

- modified .conf interface needed to specify readback channel
- otherwise, no difference
- NOT a true differential measurement!

Output and most of the software remains the same!

A true differential measurement will organize individual periods, and take the correlation from each period to supress slow drift effects... 2nd stage of analysis changes

Other changes: modify output file names to facilitate parallel dithering analysis chains

responsibilities

- Me: control software, first pass analysis update
- Dustin: maintain and tweak control software
- ??: differential analysis update

Beam modulation will average over many cycles

100 μm and 30 μrad can be created with reasonable independence

at ~10 ppm / μm (or μrad) for horizontal sensitivity

~1000 ppm (or 300 ppm for angle)

at ~1 ppm / μm (or μrad) for horizontal sensitivity

~100 ppm (or 30 ppm for angle)

Beam jitter <20 μm implies ~5 μrad can be measured using BPMs

Usual modulation scheme about 45 seconds every 8-10 minutes

Slopes to 1 ppm/μm precision take in about 1 day, 1 ppm/μrad in 10 days.