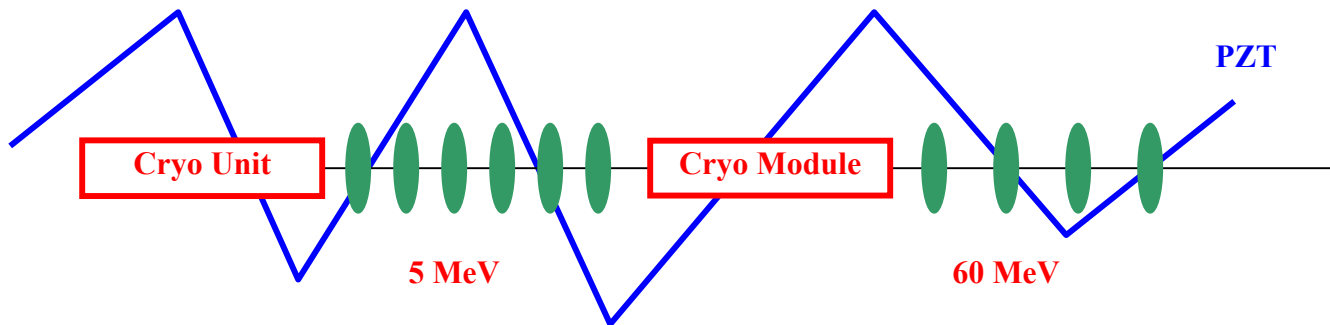


## Controlling Transport in the Low Energy Area (100 keV-60 MeV)

Focus on the transport through cryo-module (5 MeV – 60 MeV)



### Goal

Adjust 6 quads to

- Minimize the PZT orbit at 60 MeV
- Preserve matching beyond 60 MeV

### What do we need?

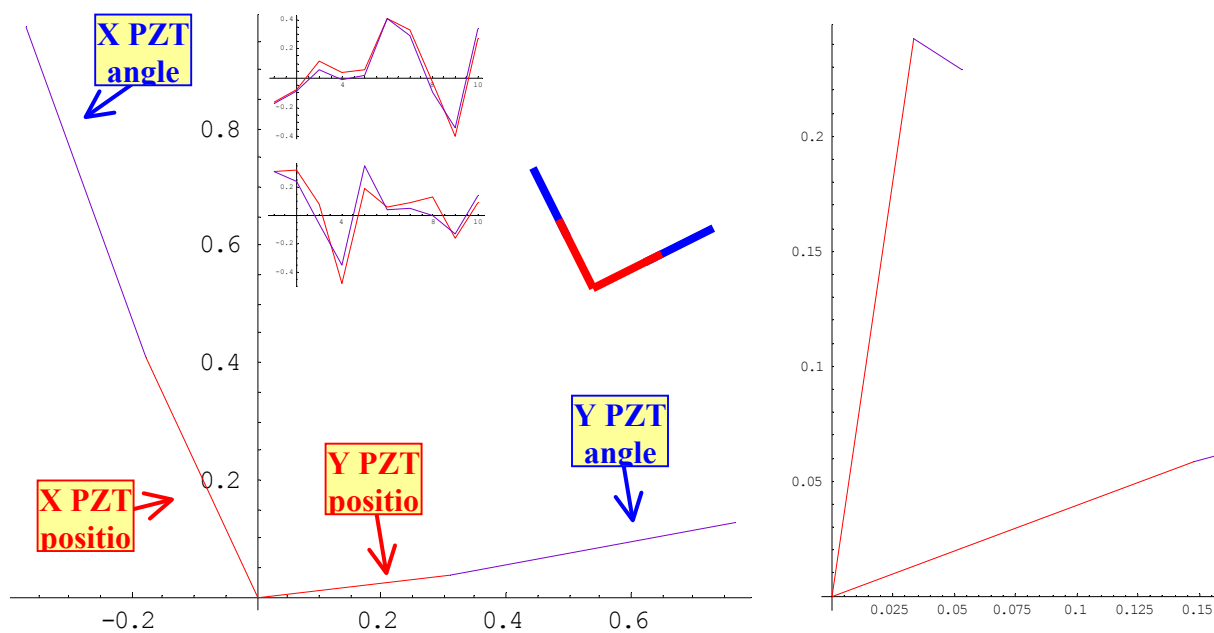
- PZT signature exiting cryo-unit
- Transfer matrix of cryo-module
- Procedure to achieve the goal

## PZT signature exiting cryo-unit

### Improvements in signal quality

- High quality 30 hz PZT signal has been elusive until early Feb.
- DC PZT signal was not good
- Question of long term stability

Solenoid induced rotation produced 4 independent PZT signals that must be minimized simultaneously



at IPM1I04

at IPM0L01

## Transfer matrix of cryo-module

Measurements based on 5 MeV correctors or 5 MeV BPMs at 2 different amplitudes give very similar results

- Significant XY coupling. This complicates beam restoration downstream.
- Does not exactly explain PZT transport through CM

### Transfer matrix across CM measured by FOPT

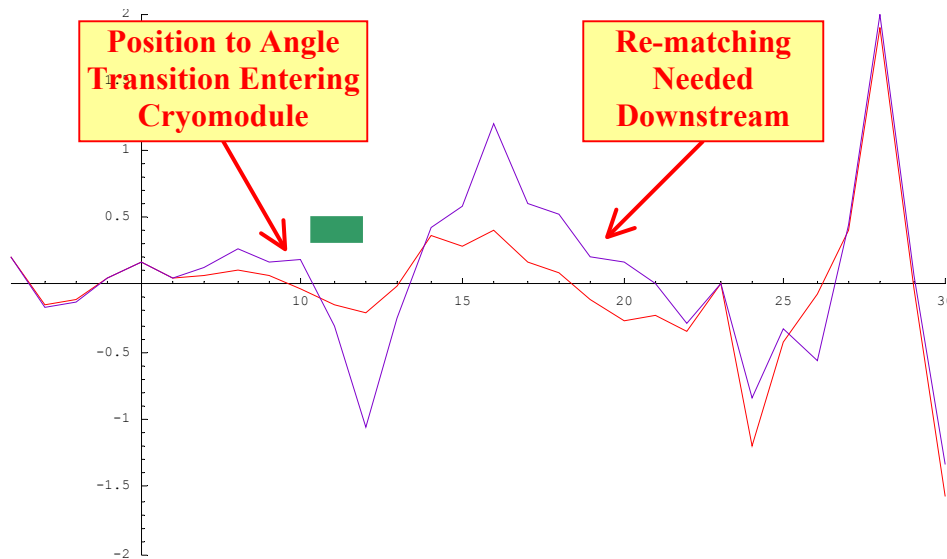
$$\begin{pmatrix} -1.52432 & 2.46252 & 0.012997 & 0.689894 \\ -0.0938983 & 0.0808547 & 0.00948916 & 0.030035 \\ -0.00311391 & 0.476694 & -0.848993 & 1.13378 \\ 0.011086 & -0.00799127 & -0.0173357 & -0.0685924 \end{pmatrix}$$

### Transfer matrix across CM deduced from PZT

$$\begin{pmatrix} -1.64694 & 2.0362 & 0.348181 & 0.438286 \\ -0.0844356 & 0.0543432 & 0.0365349 & -0.0200736 \\ 0.203194 & -0.388871 & -0.82577 & 0.113033 \\ -0.00880742 & 0.0338422 & -0.0475192 & -0.0322117 \end{pmatrix}$$

## December 2003 Test

- A solution calculated offline was downloaded and appeared to reduce 3 of the 4 PZT orbits. The exception was likely due to changed optics upstream between measurements.

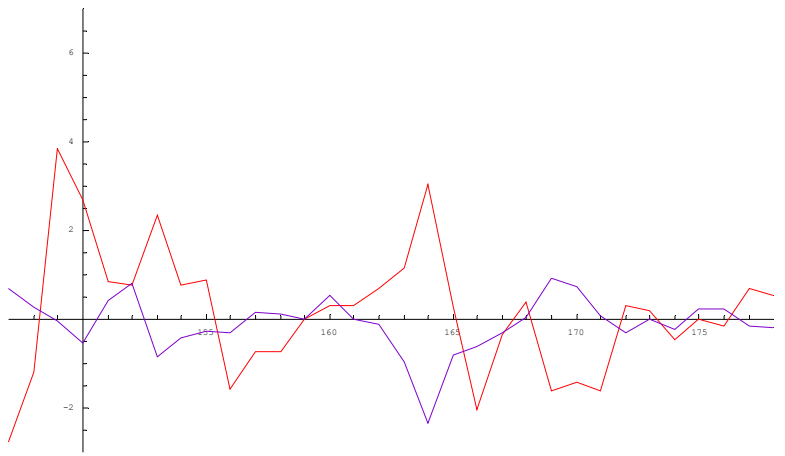
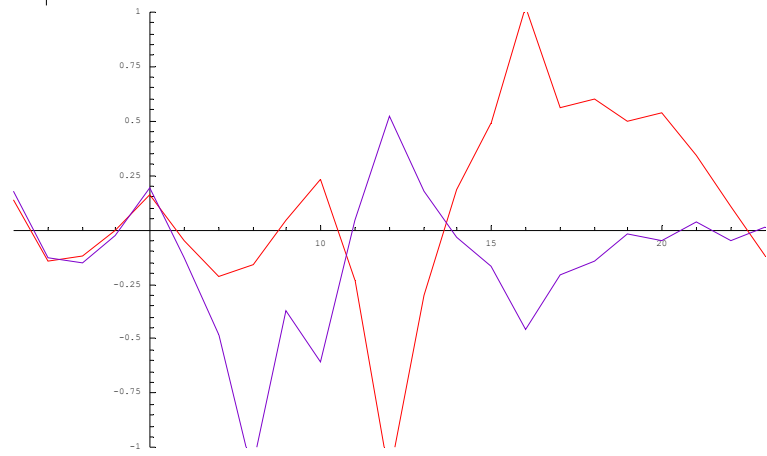
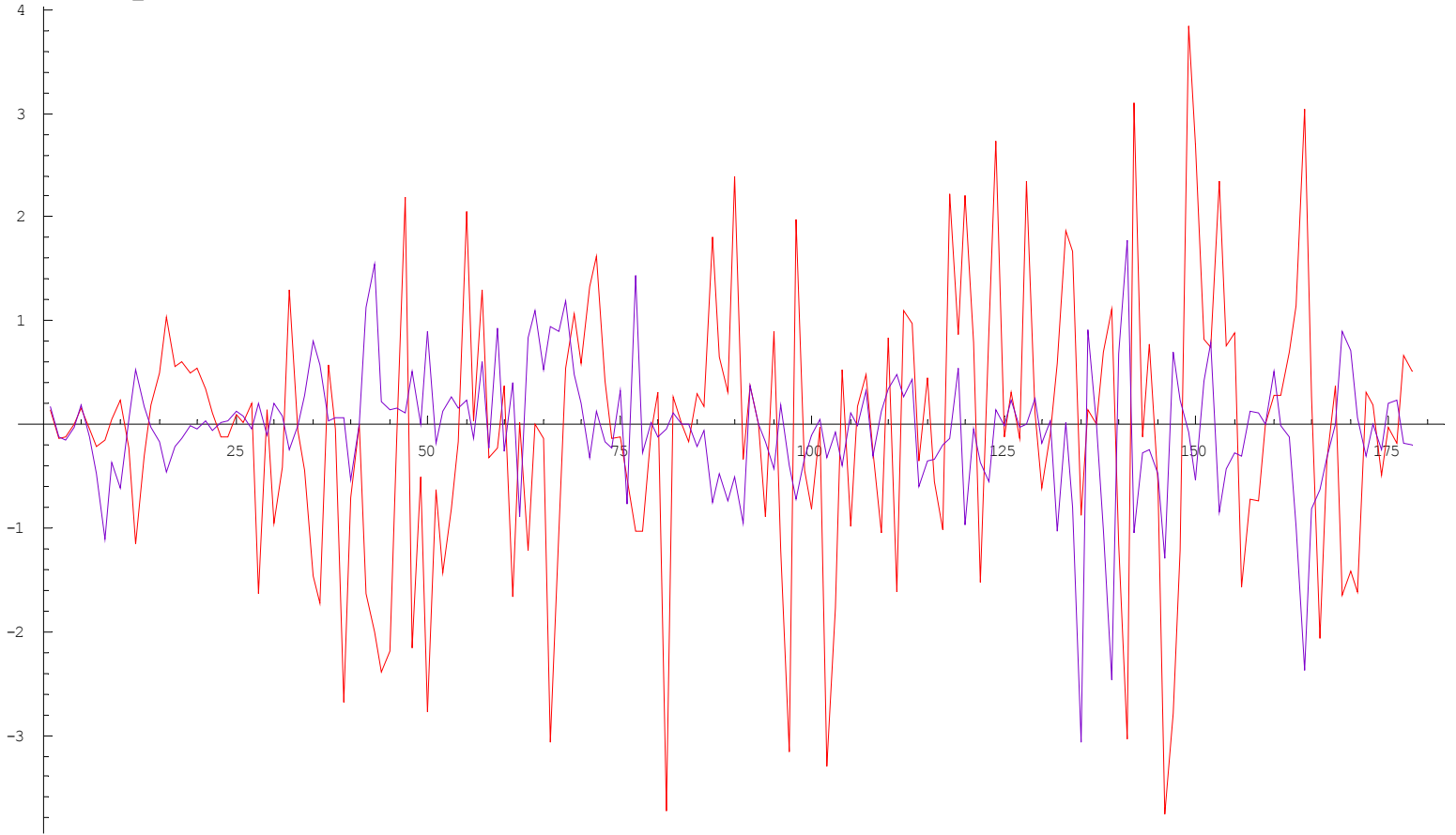


## February 2004 Test

- Many previous issues have been addressed (quad steering, PZT GUI, PZT quality, **downstream matching**) with some remaining (CM coupling, upright signal, ...)
- Intermittent measurement/correction/download/rematch scattered over a 24 hour period 02/08-02/09.
- Final measurement may be contaminated by restored 60 MeV quads
- “Control” data was not available until 02/21.
- The machinery is pretty streamlined and tested online.

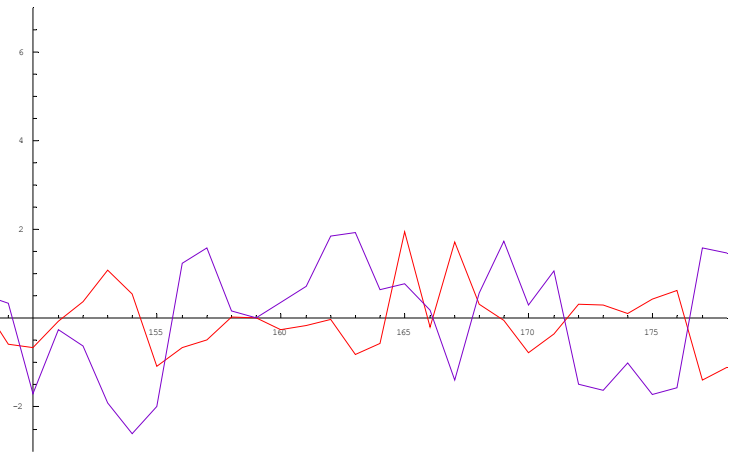
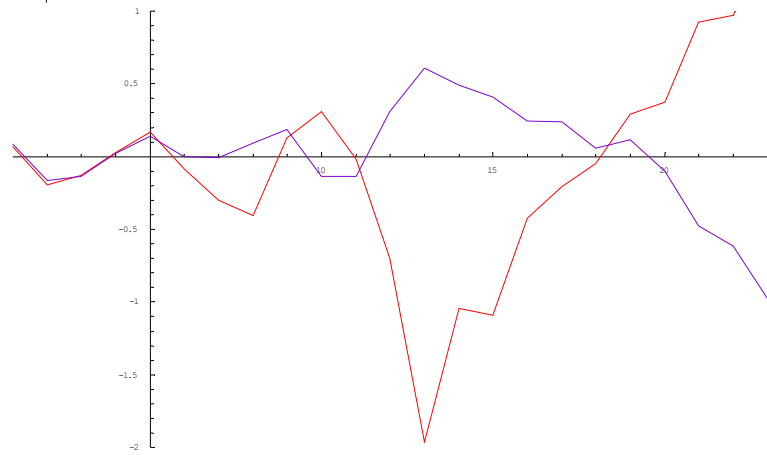
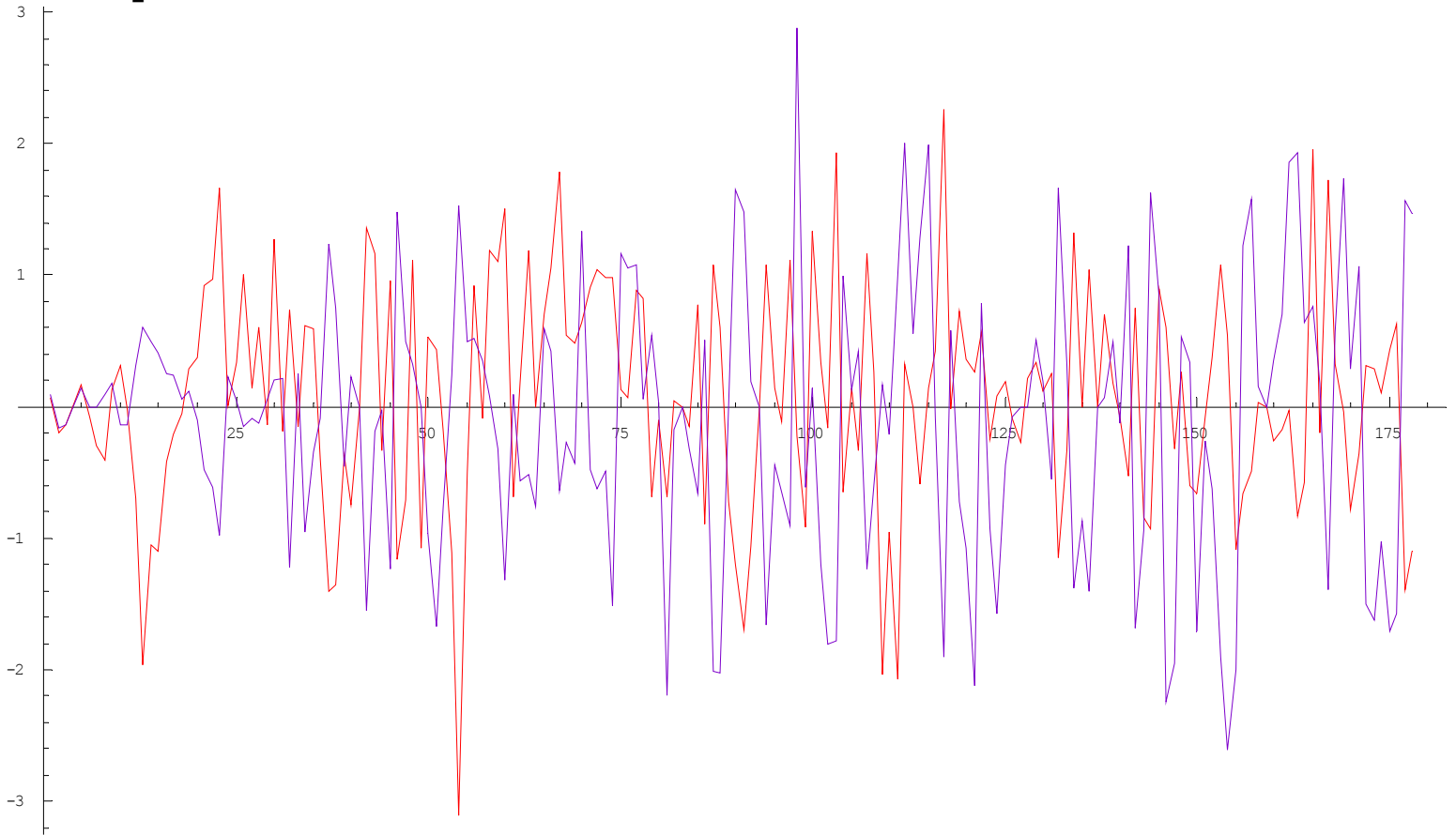
**Red: 02/21 nominal; Blue: Corrected on 02/09.**

**X response to Y momentum enhanced**



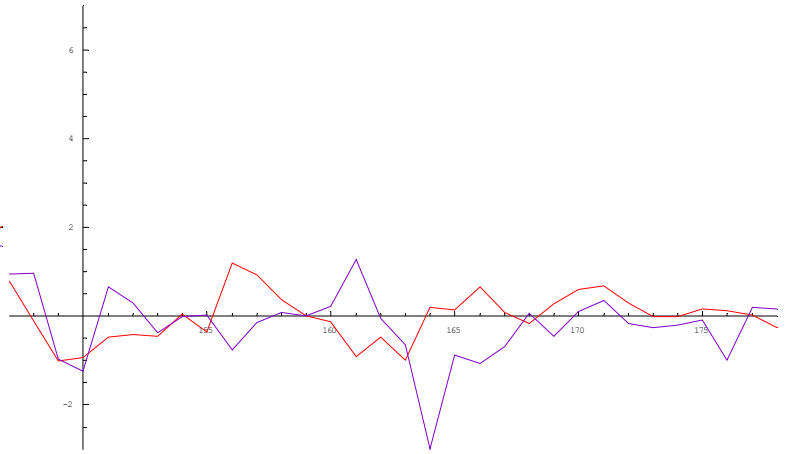
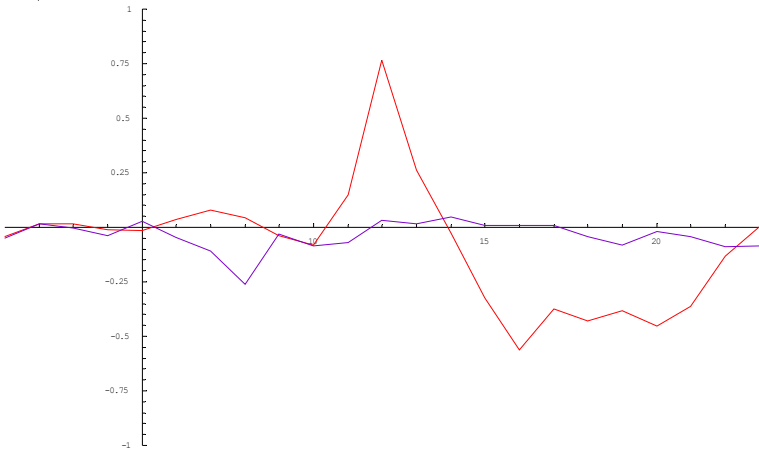
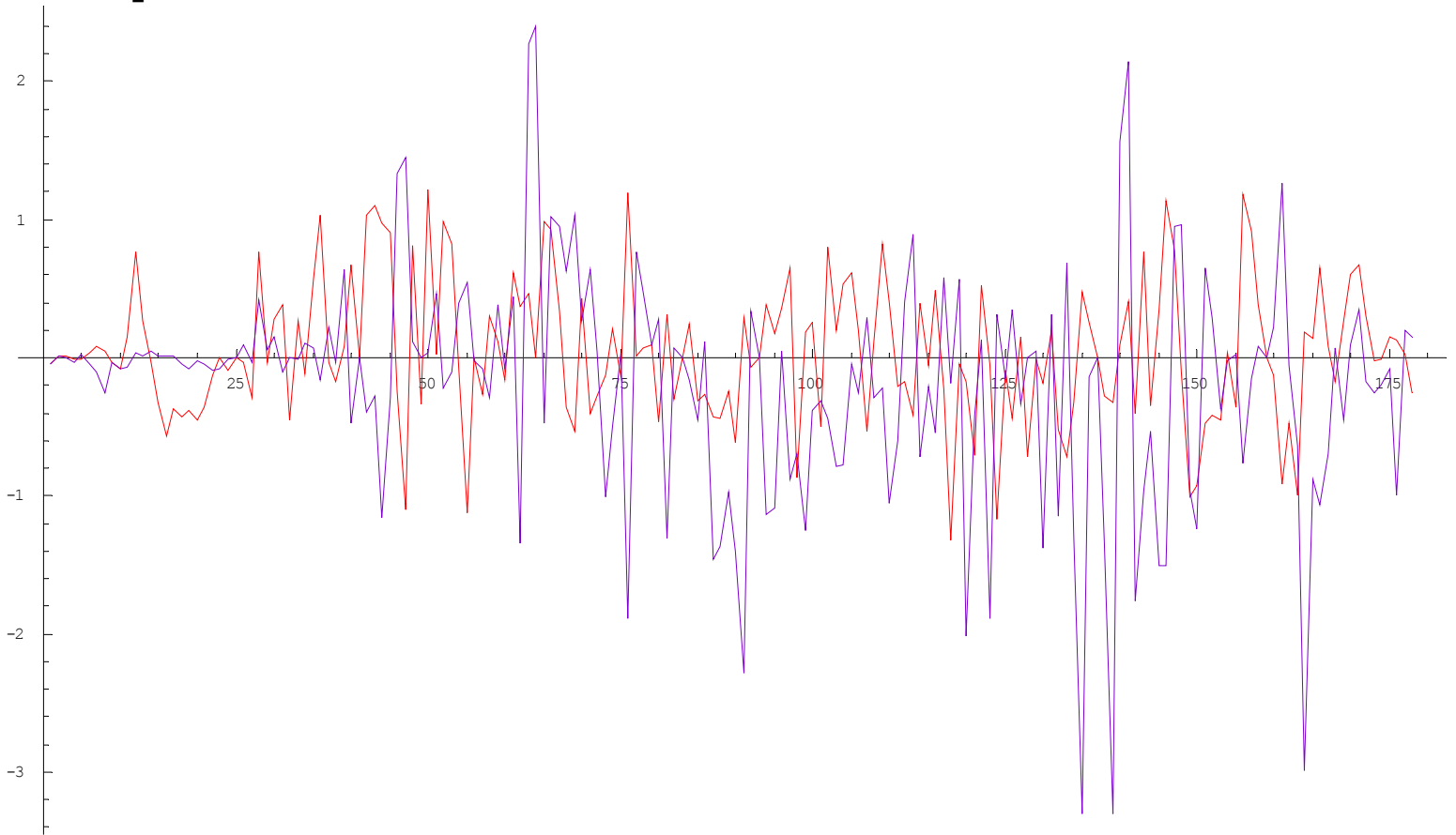
**Red: 02/21 nominal; Blue: Corrected on 02/09.**

**Y response to X momentum enhanced**



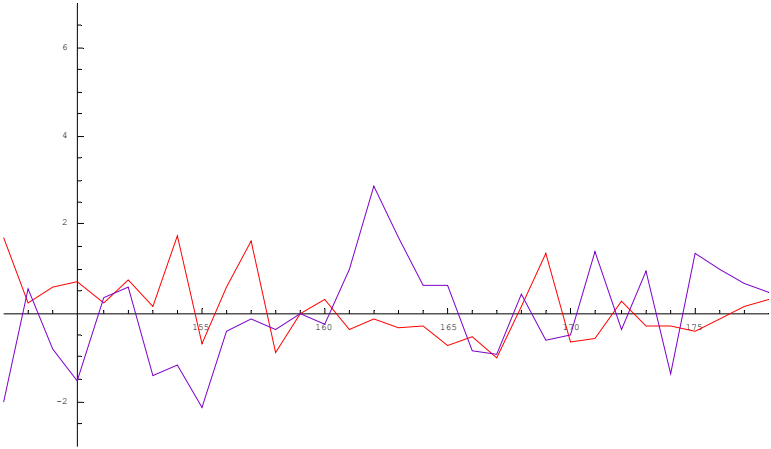
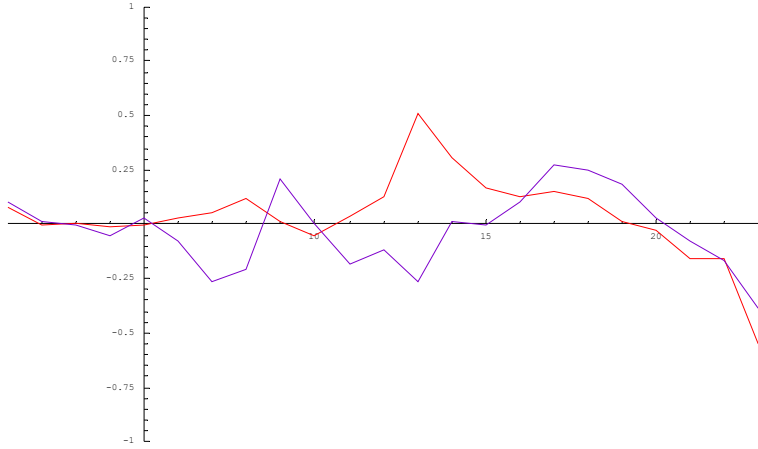
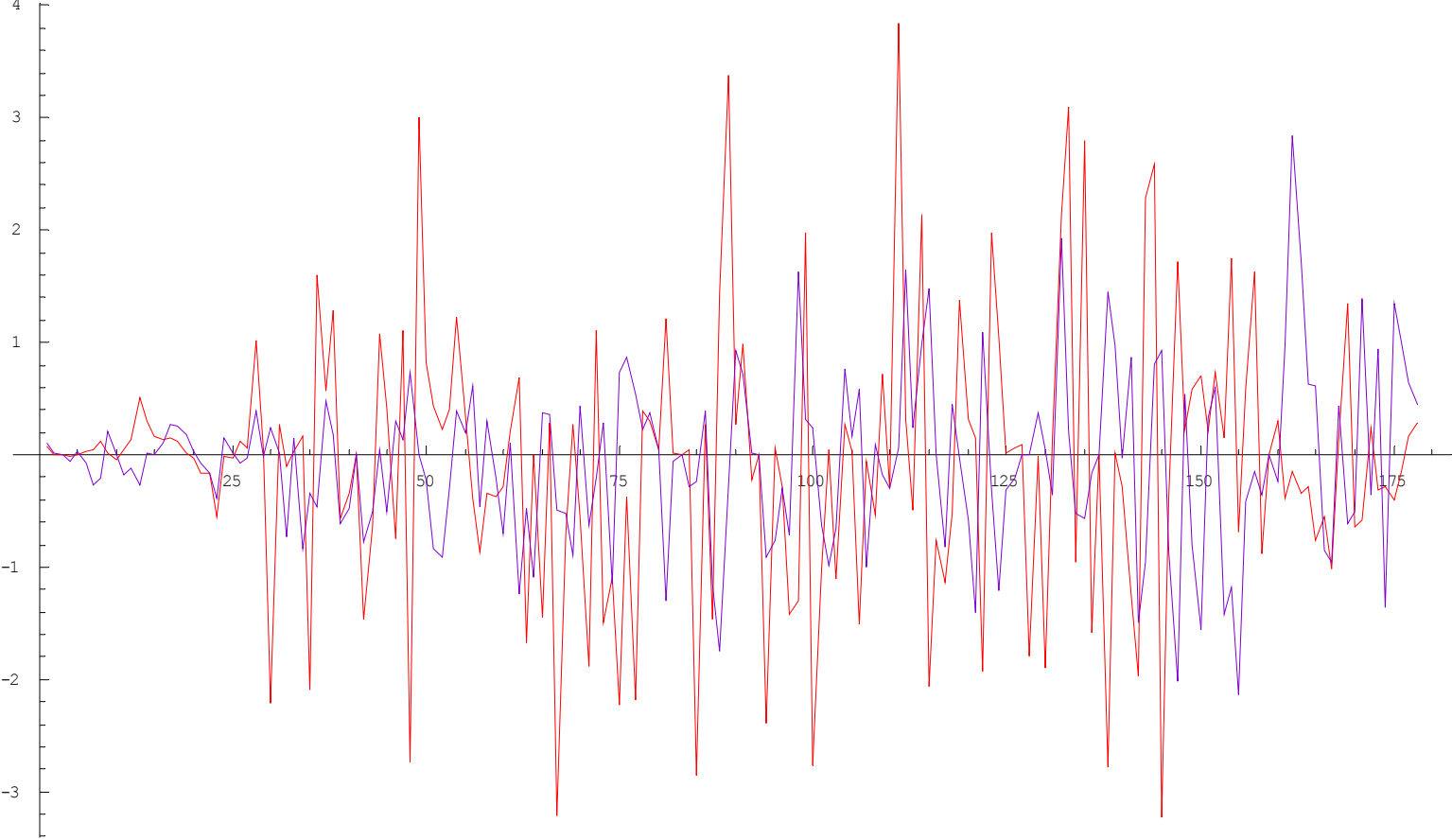
**Red: 02/21 nominal; Blue: Corrected on 02/09.**

**X response to X momentum enhanced**



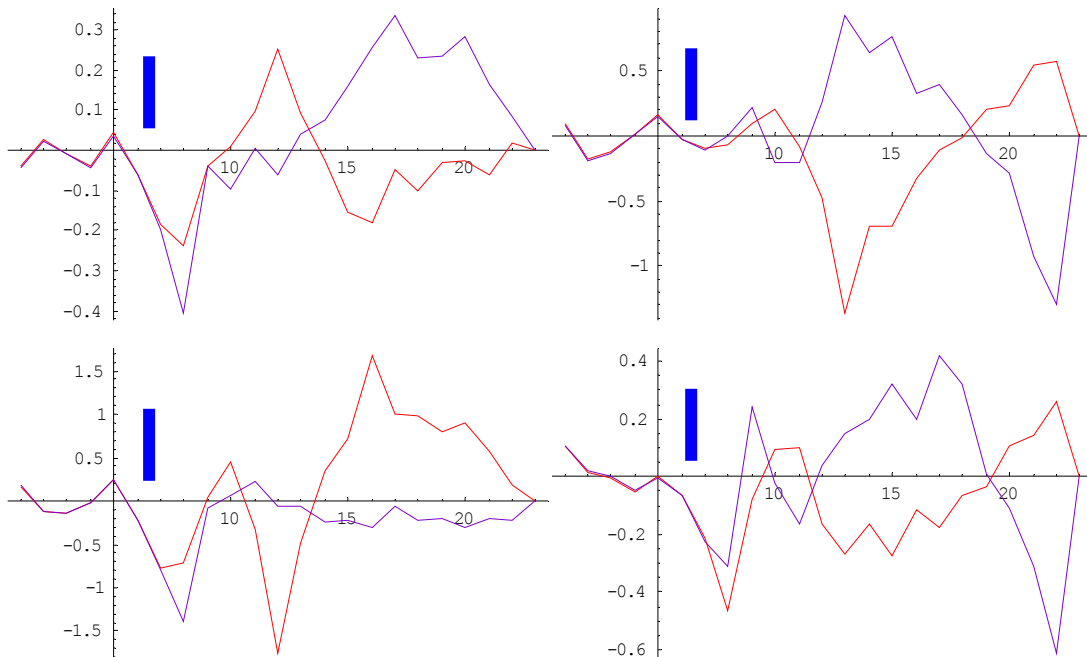
**Red: 02/21 nominal; Blue: Corrected on 02/09.**

**Y response to Y momentum enhanced**



## Are We Simply Playing The Magnetic Phase Trombone?

- Create a real phase trombone in 5 MeV. Maybe we just have to do this empirically.
- Measure beam profile at 5 MeV & 60 MeV. Need to pay closer attention to what is done to the beam.
- Do we need to impose more stringent demand on orbit reproducibility?
- XY coupling through CM needs be addressed.
- PZT Zoom Tool – May take a more important role. Make it look more like 30 hz CS?
- There may be more to gain across the cryounit



## Tasks

- ❖ Optics drift in 6T-3C
- ❖ Decouple 100 keV PZT orbits
- ❖ Source setup for HAPPEX
- ❖ Phase trombone
  - HLA
  - Test plan
- ❖ Low energy transport/matching
  - Method
  - Tests
  - HLA
- ❖ Low energy end simulation
  - Effects of scraping
  - HLA
- ❖ CM coupling fix

❖ **Missing damping of Pockels cell induced (?) oscillation – CASA Injector simulation team?**

❖ **Stability of feedback calibration - ongoing study**

❖ **Interplay between halo, spot, and PZT response - pending resolution of generic issues**

■ **HAPPEX Issues**

❖ **Trade-off between position & angle (phase trombone) – Bogacz, Bevins**

❖ **Other (to be discussed by Kent)**

■ **Generic Issues**

❖ **Transport at low energy end (100 keV – 60 MeV) - Chao**

❖ **How scraping affects everything – CASA Injector simulation team?**

❖ **Making 30 Hz PZT a robust tool (inc. BPM) – Hansknecht, Poelker**