Parity Lessons Learned:

Fixing Transport from Gun to 60 MeV (and Maybe beyond)

The Problem

Insufficient understanding of beam transport through low energy cryo-components (CU & CM) resulted in over-magnification of the helicity correlated orbit differences.

Attempted Solution

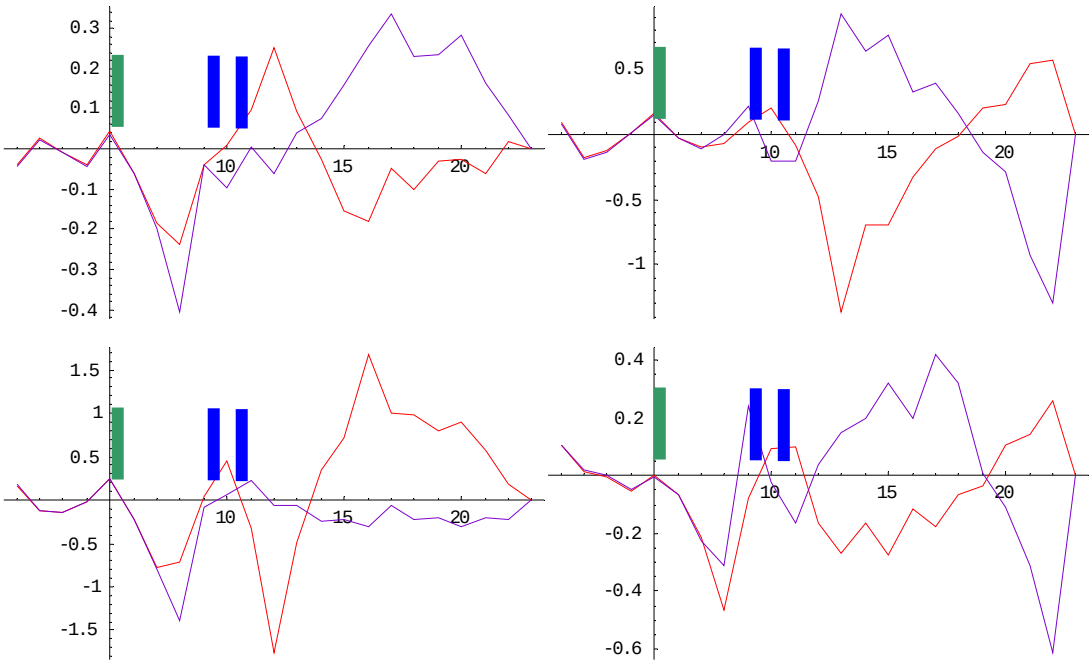
Determine transport characteristics of CU & CM (and possibly Chicane-Linac junction); implement optical solutions to restore good transport

Status

- **Measurement of transport through CU has been done once through an elaborate procedure including added correctors. Reasonable result was obtained.**
- **Measurement of transport through CM was done several times with decent outcome, with critical dependence on functional 5 MeV BPM and correct model.**
- **Measurement of transport through Chicane-NL junction was done several times, with critical dependence on correct modeling of quads at 60 MeV.**
- **Effort to correct transport (April-July 2004) was encumbered by many problems**
  - **Difficulty in measuring CU transport**
  - **Model (dimension, magnet field map, ….)**
  - **Diagnostics (general BPM performance, 30 hz PZT response at 4CH's, ……)**
  - **Non-reproducibility (100 keV transport, capture, 30 hz PZT, ……)**
  - **Logistics (turn-around time vs stability, setup time in 5 MeV, ……)**
  - **Tools (Optim, ……)**
  - **……**
- **The above problems are being addressed by many people at this point, with the goal of getting ready for a proof-of-principle test in Dec. where we can demonstrate reduction of selected PZT trajectories as predicted up to Arc 1.**
- **If successful, this should be closely followed by plans to configure the 100 keV region (optics & instrumentation) to allow effective measurement of CU transport in order to achieve global correction.**

All the problems come from 100 keV to 60 MeV (including Chicane-NL junction)

PZT orbits (spot displacement on cathode) in the Injector (times $\sqrt{P}$)



Green: Cryo-Unit **Blue: Cryo-Modules**

Source of blowup:

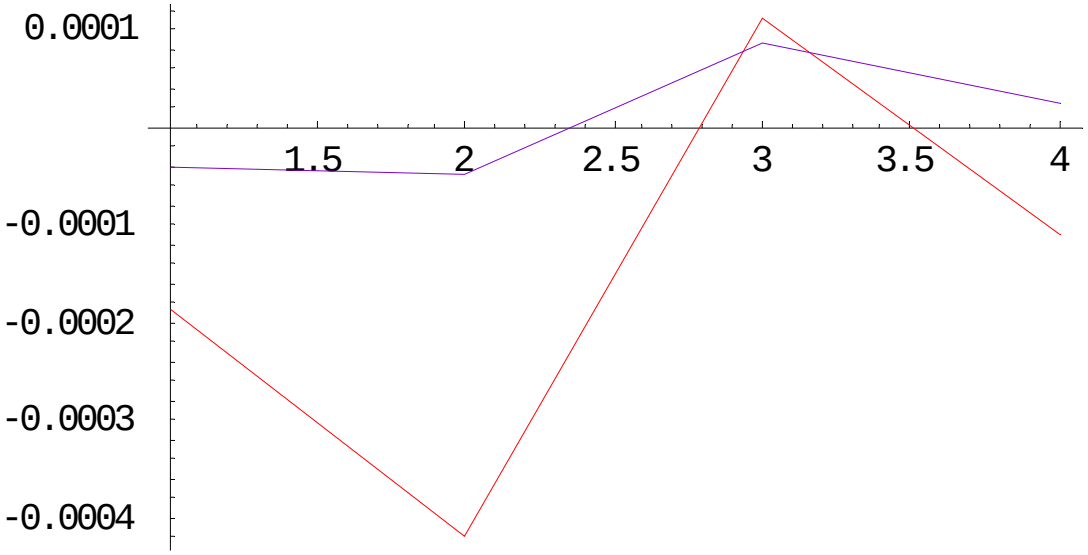
- **XY coupling in the cryo-unit and cryomodules. These are not well modeled at such low energy**
  → Increased phase space area
- **Mismatch of PZT orbits to the transport channel formed by the capture, the cryo-unit, the cryomodules and possibly the Chicane-NL junction, for which we don't have a good model.**
  → Orbit blowup

So the fundamental problem is that we don't know how to transport the orbit through this region correctly due to insufficient model information.

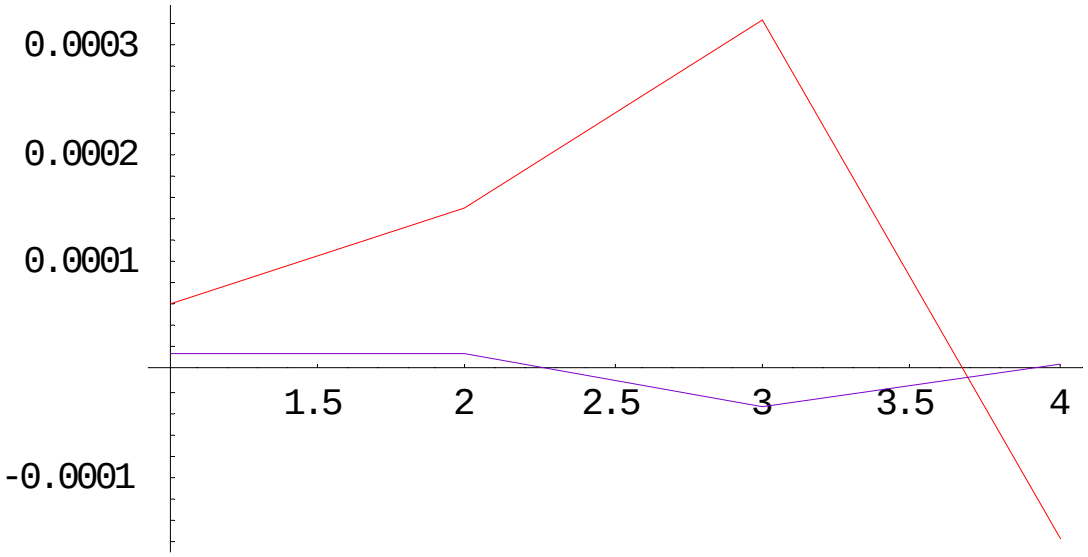
Example of predicted solution

Optimization applied only to the X components of X PZT and Y components of Y PZT

X, X'×10, Y, Y'×10 of X PZT trajectory at exit of CU (red, 5 MeV) and exit of CM (blue, 55 MeV)



X, X'×10, Y, Y'×10 of Y PZT trajectory at exit of CU (red, 5 MeV) and exit of CM (blue, 55 MeV)



These are also matched to the 55 MeV optics.

Preparation for December:

- **Model:**
  - **5 MeV and 60 MeV line model (excluding cryo components)**

  Re-confirm
  - **MQJ & MQD at higher fields**

  Test plan to be executed

  Offline analysis & correction action
- **Stability of transport from cathode to exit of cryo-unit**
  - **Test cycle**

  Revised test cycle
  - **PZT Zoom tool upgrade**

  Under testing
- **100 keV emittance measurement**

  Data to be analyzed
- **30 hz PZT signal at BPMs**
  - **Test to see if 4CH matches optics**

  Test plan to be executed
  - **Examination by system experts**

  Preliminary study indicates working system now. Pending beam test
- **BPMs at 5 MeV**

  Re-confirm
- **Optim**

  Fixed. Under testing