Target Injection/Positioning Update

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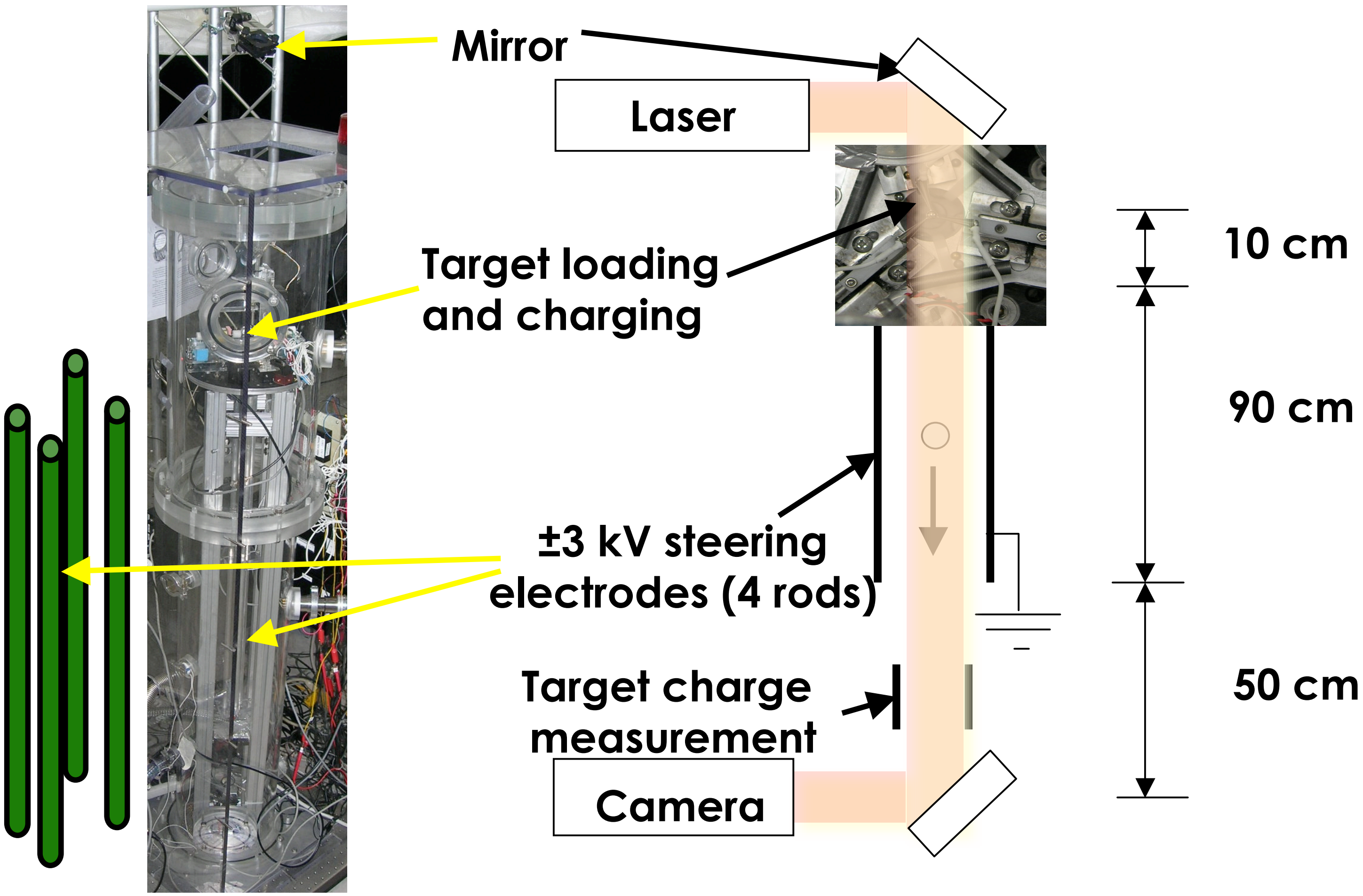
HAPL Project Review
Sante Fe, NM
April 8-9, 2008

1. General Atomics
2. UCSD
3. Kentech Instruments, UK

GENERAL ATOMICS

Targets are loaded, charged, released, tracked and steered in a vacuum chamber



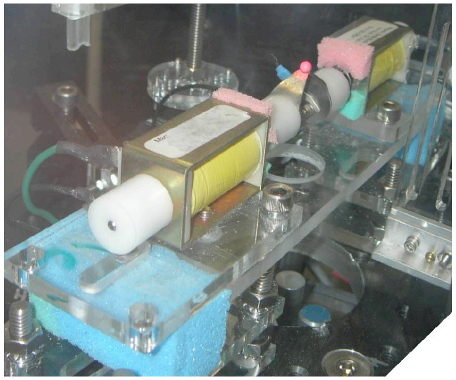
20 µm placement accuracy required

Recent progress in target injection and positioning (target steering)

1. Achieved 13 µm final placement repeatabilty (1σ) in each transverse direction with solid delrin spheres.
   - Centroid Offset X=-3 µm, Y= 6 µm
   - Designed, built and tested an improved target release mechanism
   - Revised LABVIEW code to properly feedback charge to mass ratio changes to calculated acceleration, velocity and position
2. Achieved 9 µm X & 7 µm Y repeatability (1σ) with 1 mg shells!
   - Centroid Offset X=-1 µm, Y= 4 µm
   - Improved charge measurement sensitivity
3. Continued electrostatic accelerator work
   - Procured and tested electrode circuit boards
   - Designed, fabricated and began testing electronics and optical components for axial position measurement
   - Designed vacuum chamber extension and mounting for accelerator components

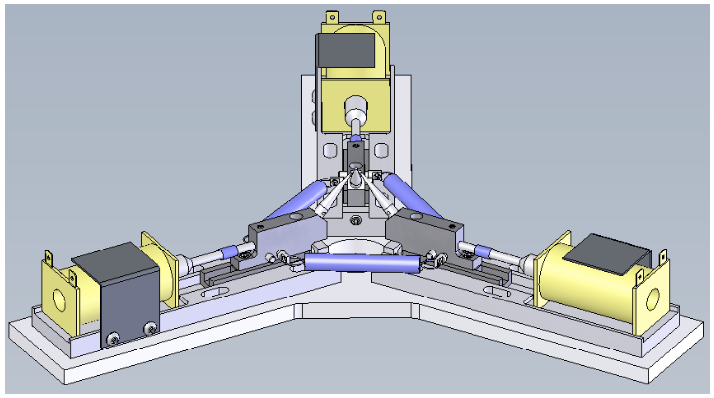
New release mechanism has reduced system vibration during steering

Old

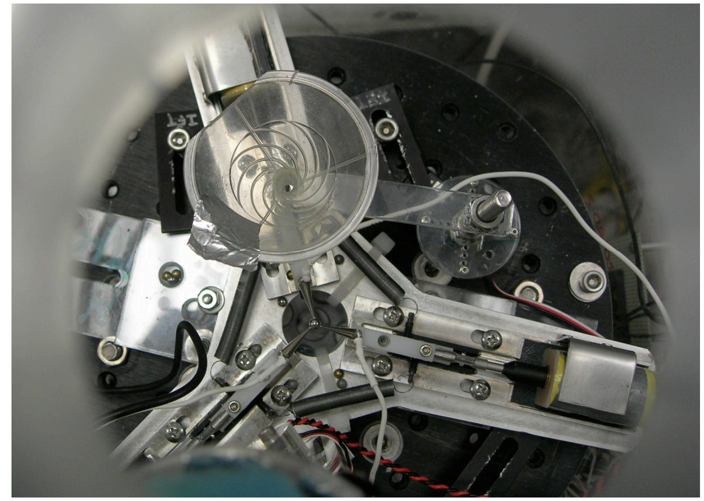


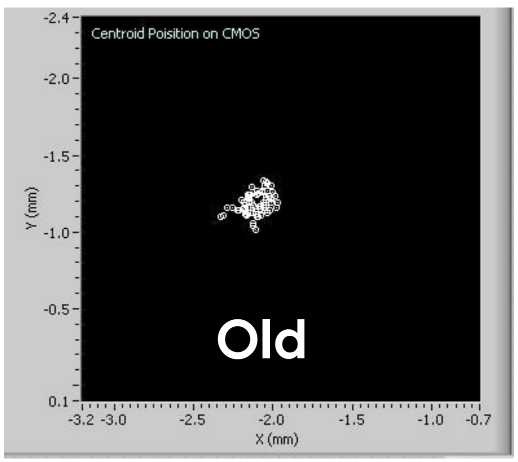
4 points of contact
Hard stop

New

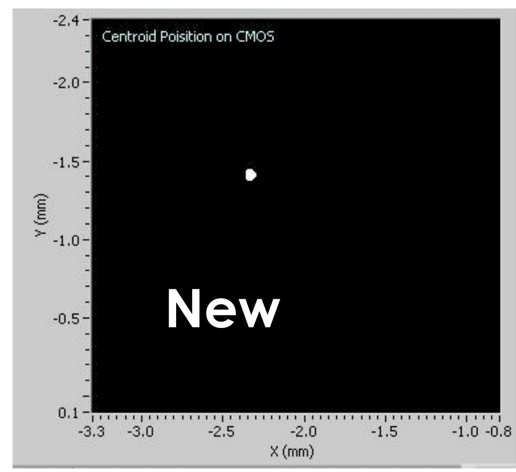


3 points of contact
Soft stop

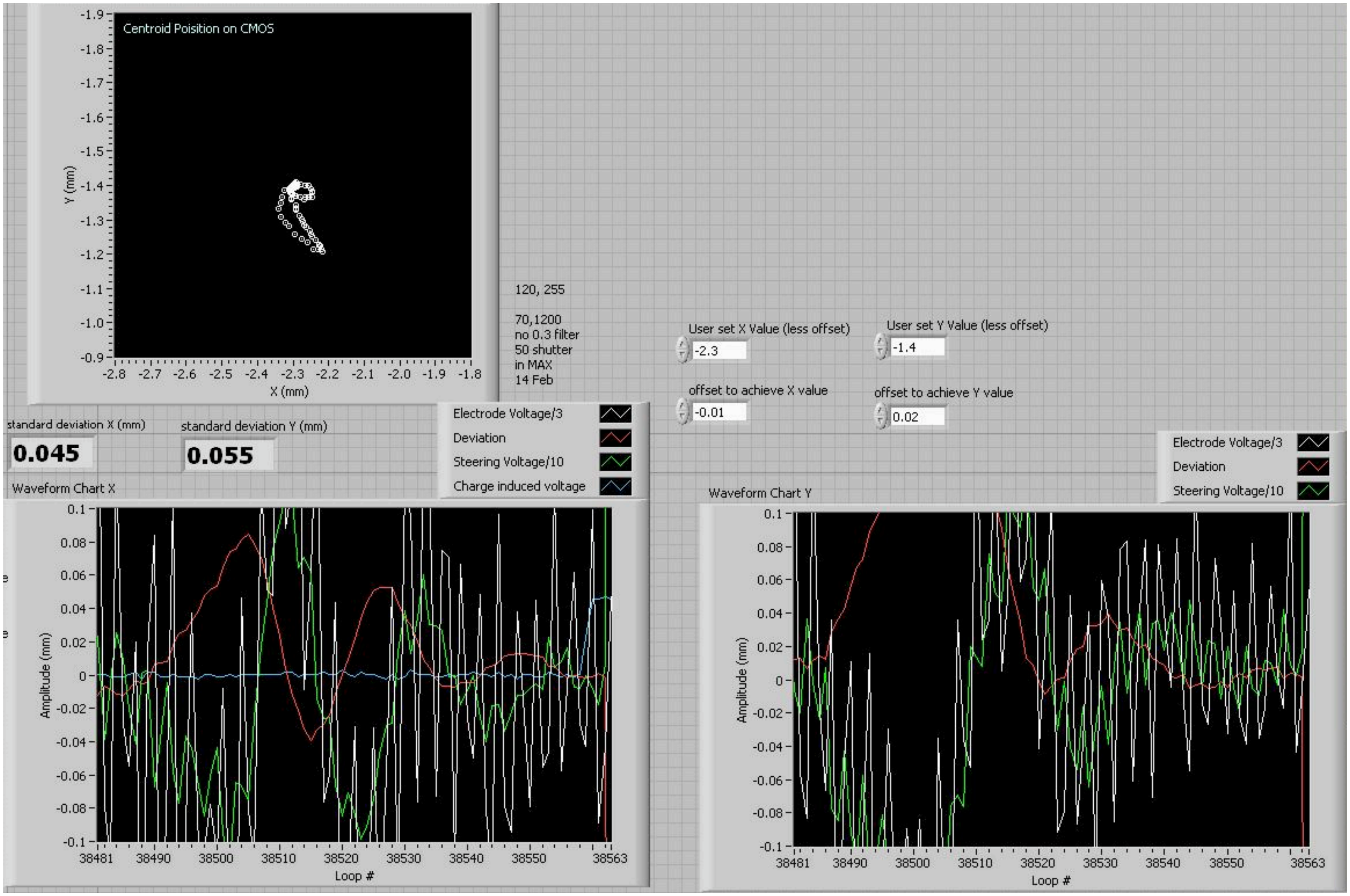




Vibration comparison
Stationary targets with
mechanism activated

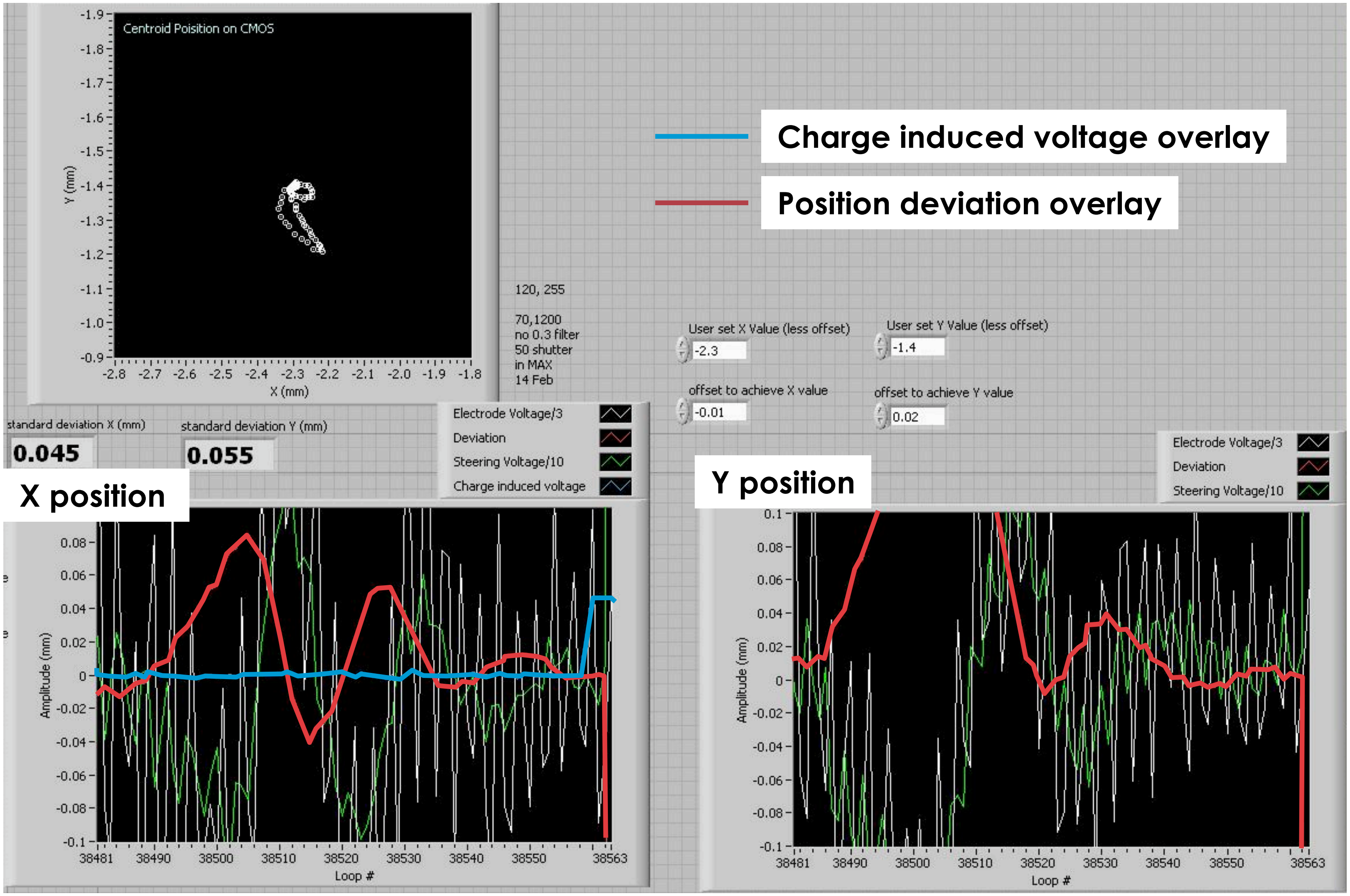


Example Labview screen shot shows accurate target steering

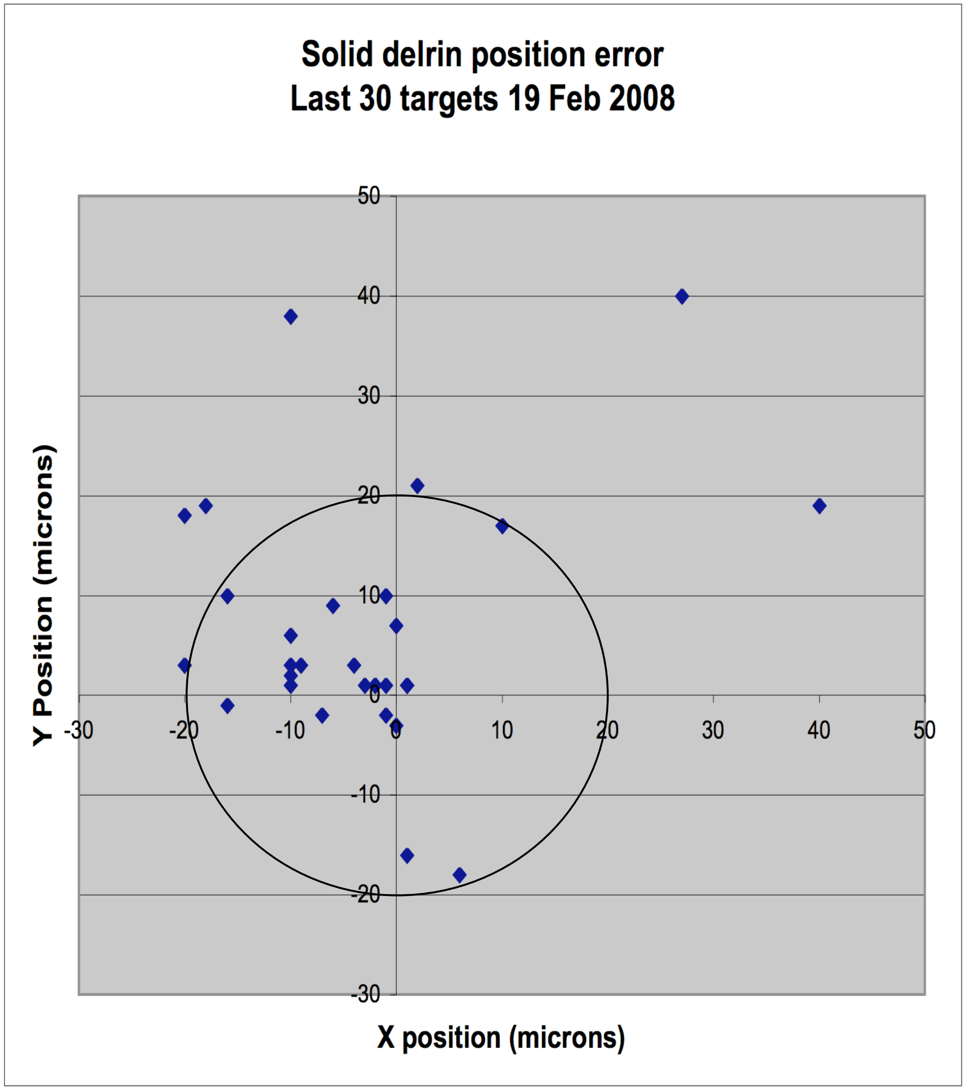


GENERAL ATOMICS

Example Labview screen shot shows accurate target steering



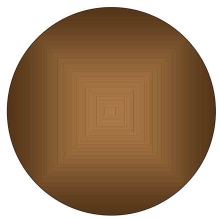
We achieved 13 μm target positioning repeatability with solid delrin targets



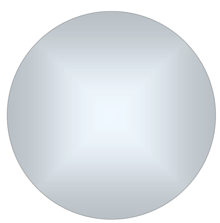
σ_x = 13 μm σ_y = 13 μm

- X offset = -3 μm, Y offset = 6 μm
- 23 of 30 in 20 μm radius from aim point
- 2 to 4 times better than best previous results…

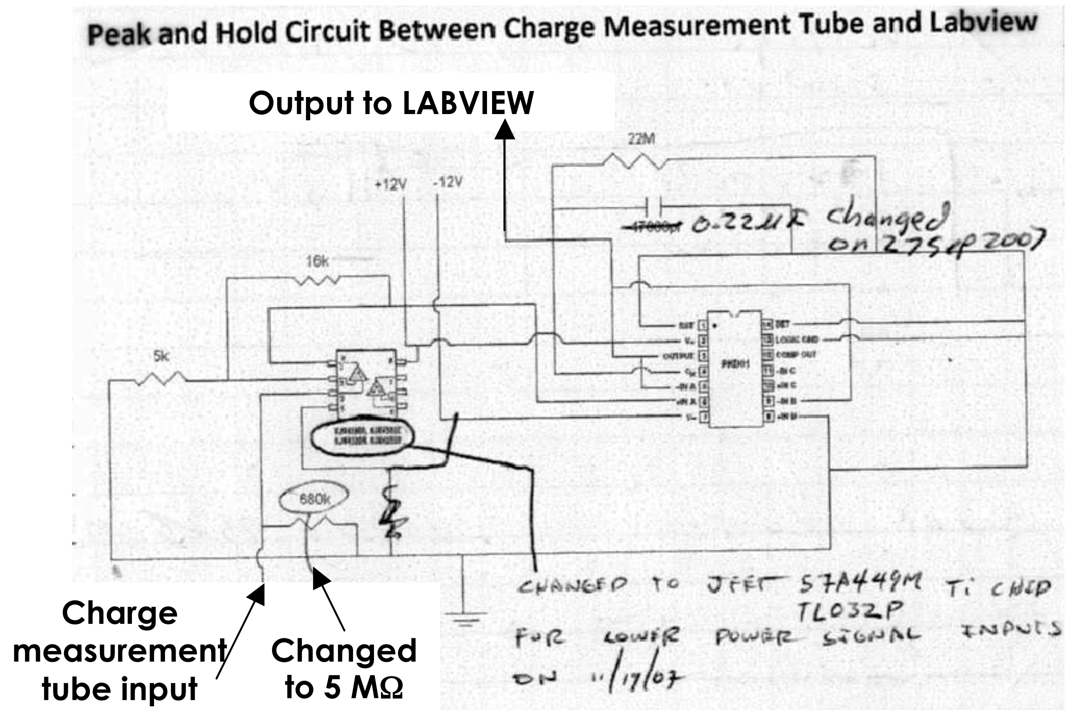
Charge measurement must be more sensitive for low-charge hollow shells



300 mg brass sphere
-2500 V, -0.25 nCoul



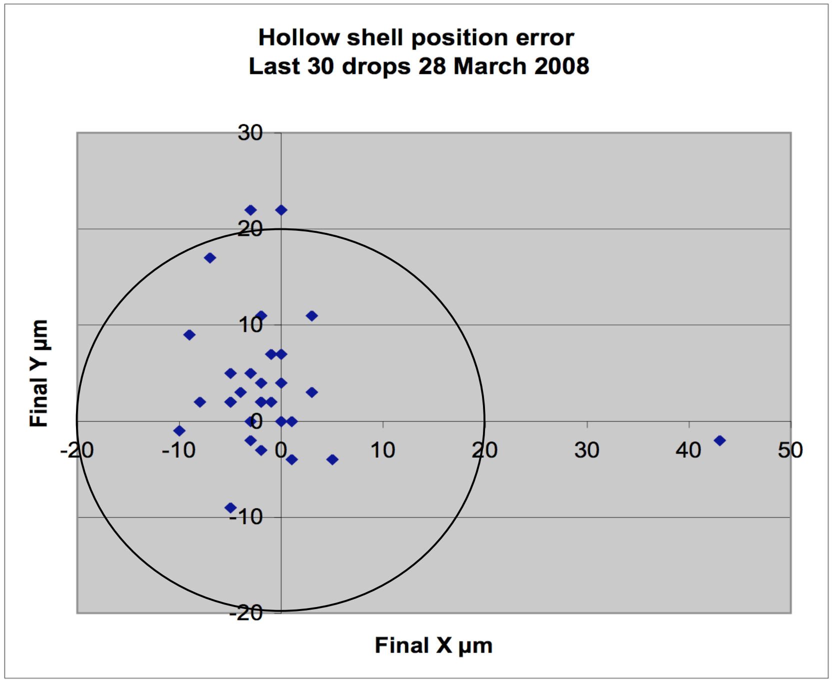
1 mg hollow shell
-200 V, -0.02 nCoul



Sensitivity improvements

- Larger resistance to ground
- Shielding screen
- Low pass filter
- Increased amplification
- Low-leakage op amp

Excellent target positioning repeatability achieved with hollow shells



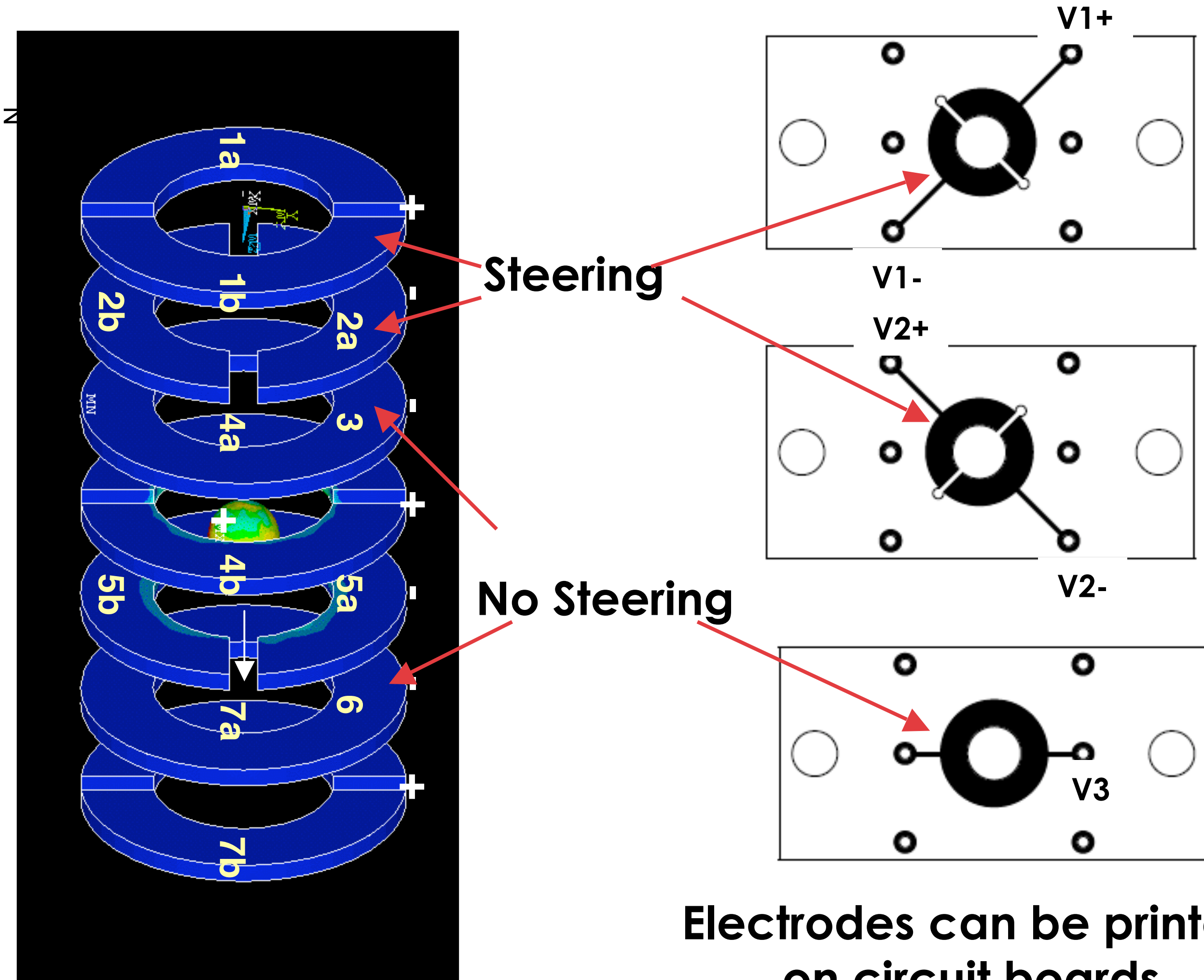
σ_x = 9 µm σ_y = 7 µm

- X offset = -1 µm; Y offset = 4 µm
- 27 of 30 in 20 µm radius from aim point
- 5 times improvement!!

Last 30 consecutive targets, but we occasionally have had problems

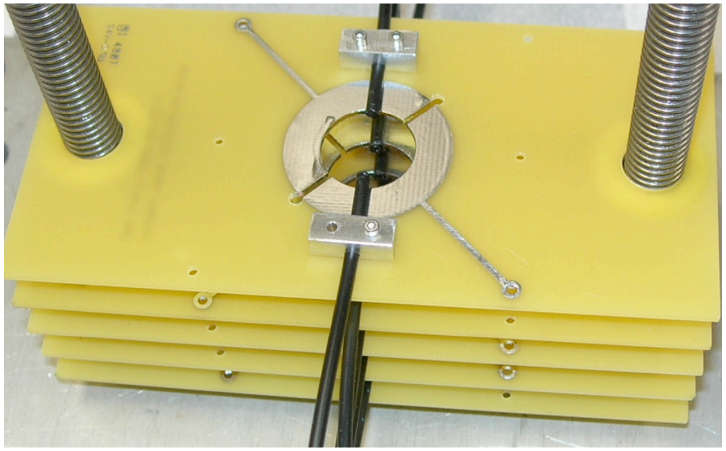
- Measured target charge changes, initial target transverse velocity increases
- Probably due to static charge in vicinity of target release
- Currently correct by venting vacuum and use of polonium strip
- UV light is possible solution

An electrostatic accelerator provides increased speed and clear tracking beam path

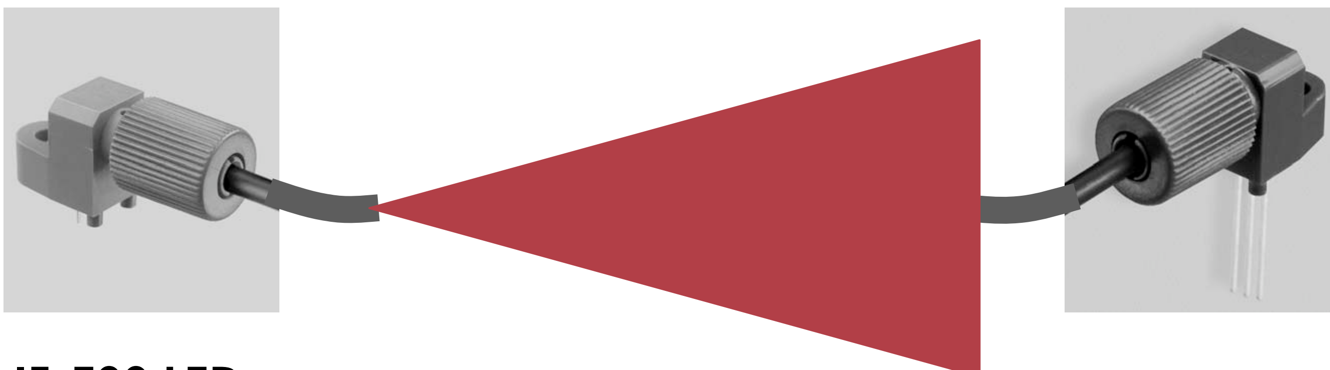


Electrodes can be printed on circuit boards

Electrodes and crossing detectors were tested



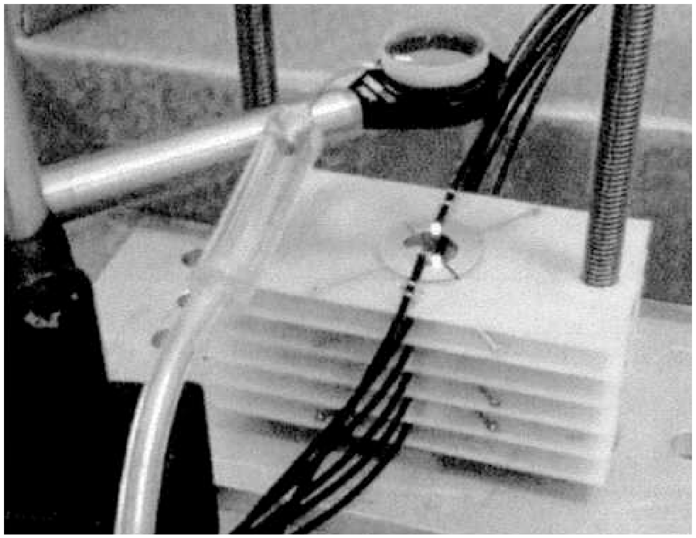
1 kV standoff between electrodes on single board demonstrated

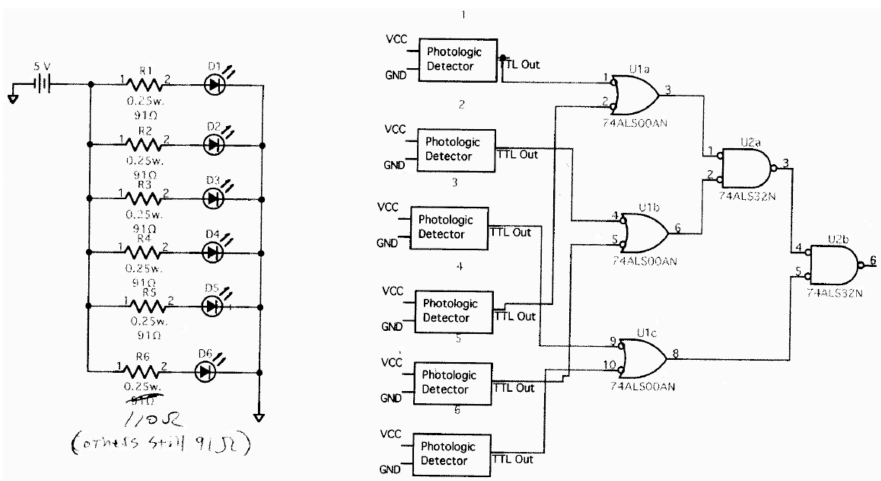


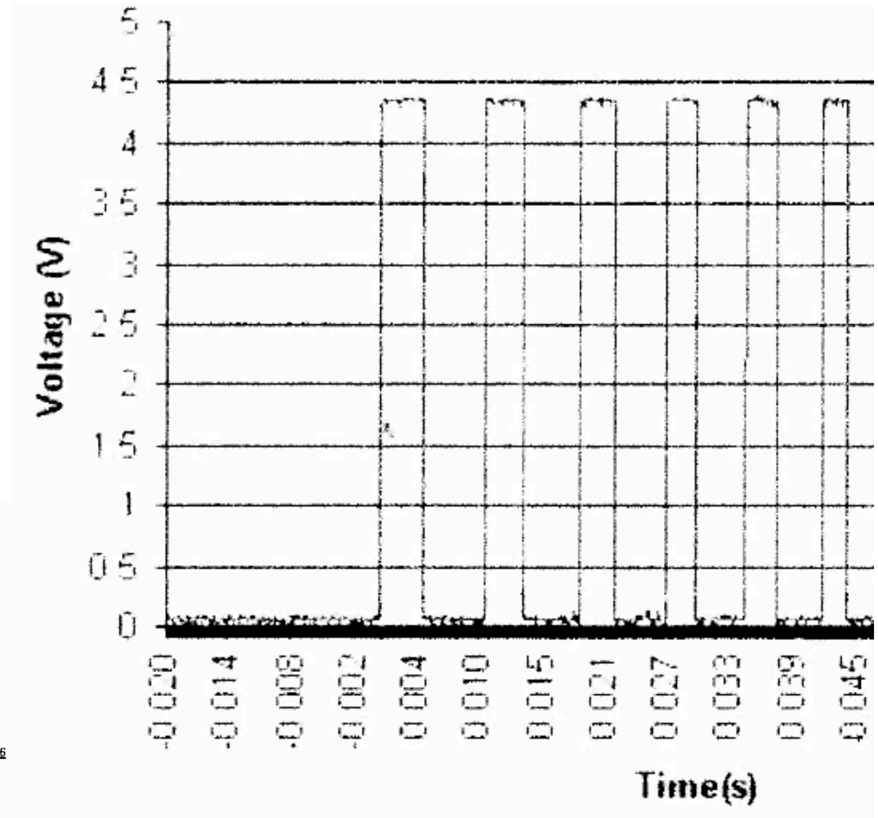
IF-E99 LED
875-1050 µW
@20 mA

IF-D95
Photologic Detector
High TTL at 1.0 µW

We tested the axial position monitoring system

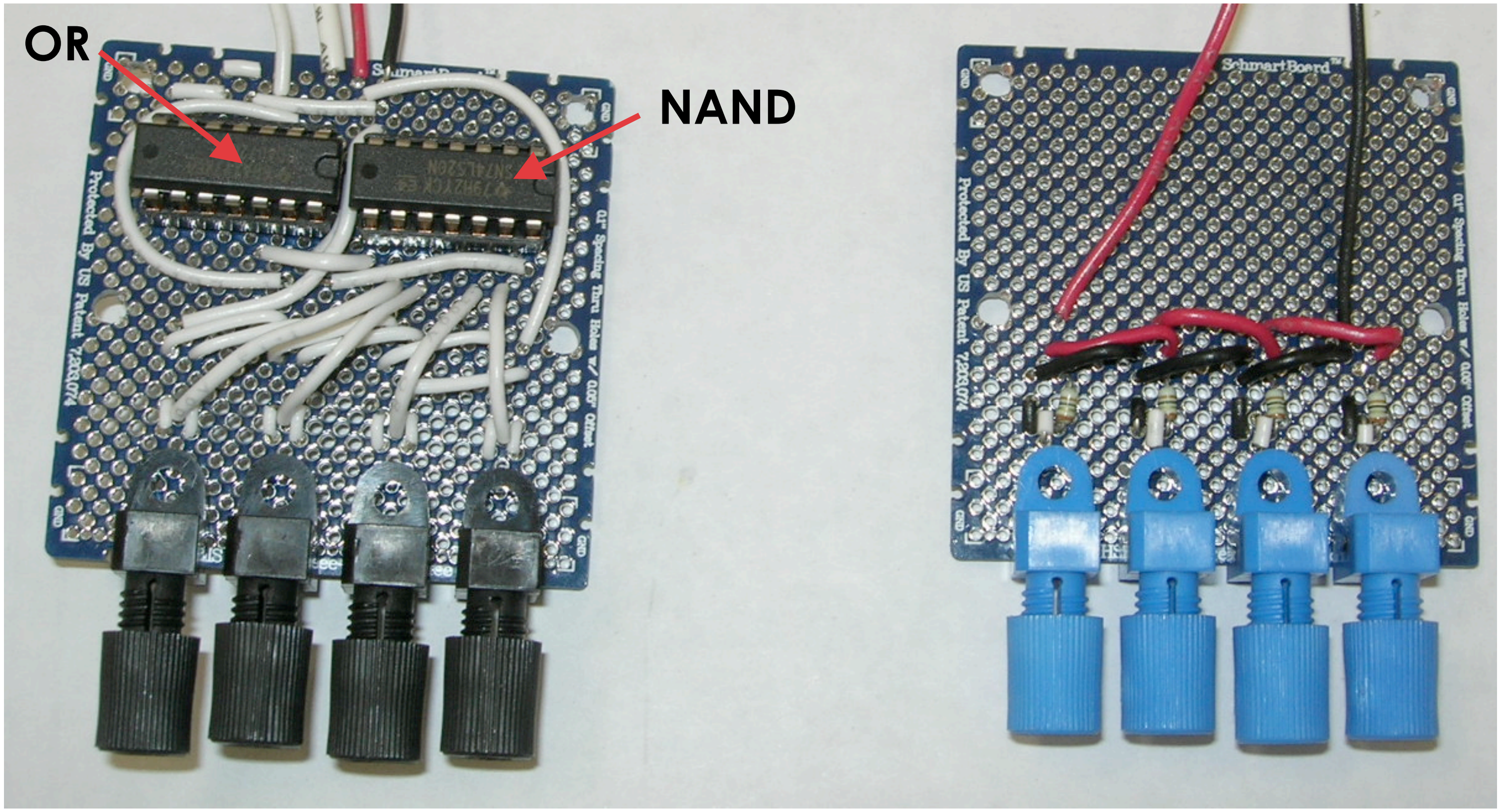






Detector response using NAND and OR gates

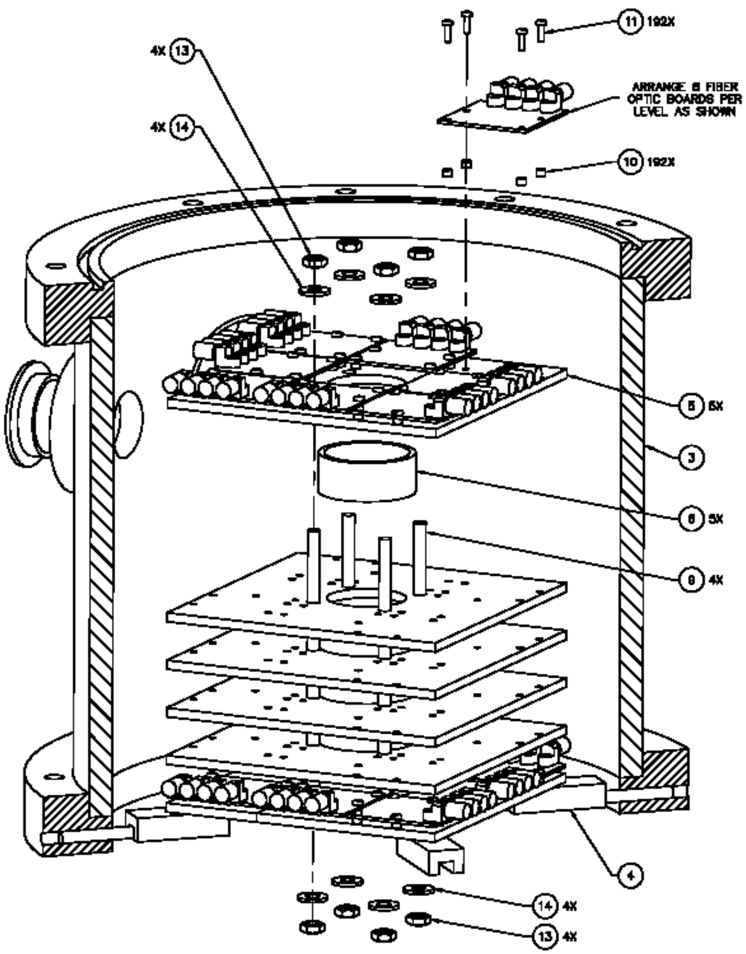
We designed and fabricated circuit boards for LED’s and photo-logic detectors



Detectors
24 boards

LED’s
24 boards

Extension for vacuum chamber designed to support LED's and detectors



8 boards mounted on each of 6 levels

Summary of injection/positioning progress

In-flight target steering substantially improved

- **Achieved 9 μm X & 7 μm Y repeatability (1σ) with 1 mg shells!**
  - Centroid Offset X = -1 μm, Y = 4 μm
  - Low-vibration target release mechanism developed
  - Improved charge measurement sensitivity
  - Static charge issues may require more work

Electrostatic accelerator is under construction

- **Procured and tested electrode circuit boards**
- **Designed, fabricated and began testing electronics and optical components for axial position measurement**
- **Designed vacuum chamber extension and mounting for accelerator components**