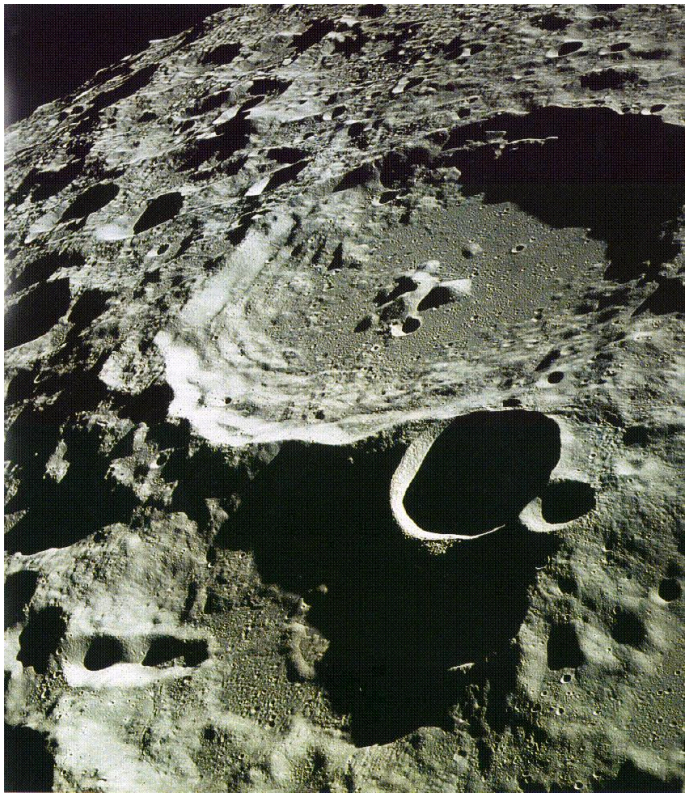
Focusing and Alignment for a 3MV Dust Accelerator

Paige Northway
University of Colorado Boulder
LunGradCon, July 17th, 2011

Outline:

- Background
- Focusing
- Beam Alignment
- Questions



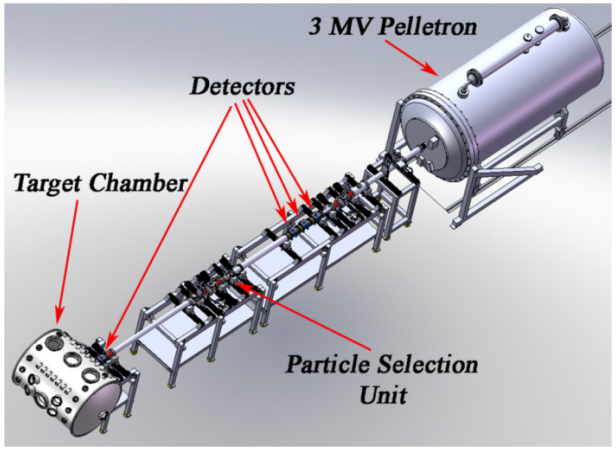
Background

Work

•Synthesize surface bound exosphere environment

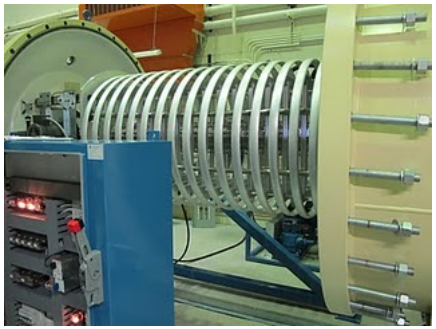
•Study micrometeorite impacts on various surfaces

•Calibrate instruments to be used in space



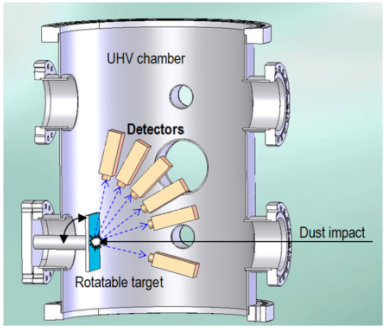
Facilities

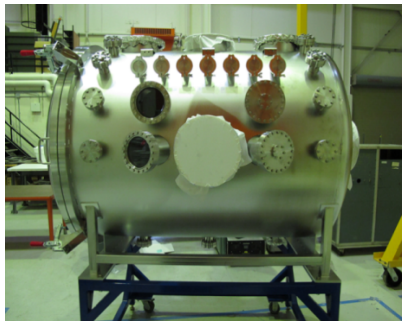
• 3MV Pelletron accelerator with particle detection and selection



•Lunar environment impact chamber (LEIL)

•Ultra High Vacuum Chamber (UHV)

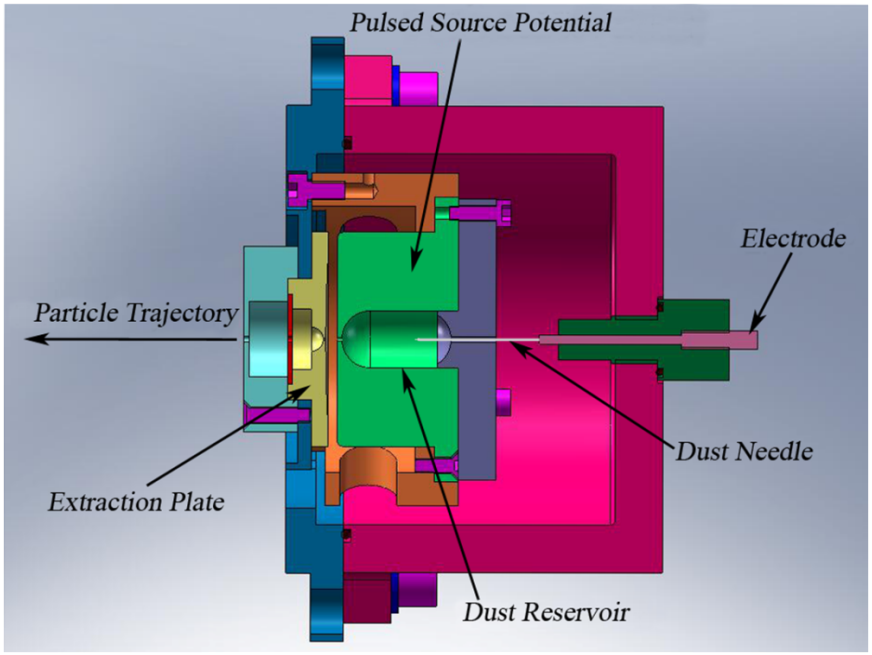




Focusing: Need

- Small solid angle leaving dust source
- Fringe fields from the accelerator
- Detectors ≈1cm diameter
- Experimental requirements

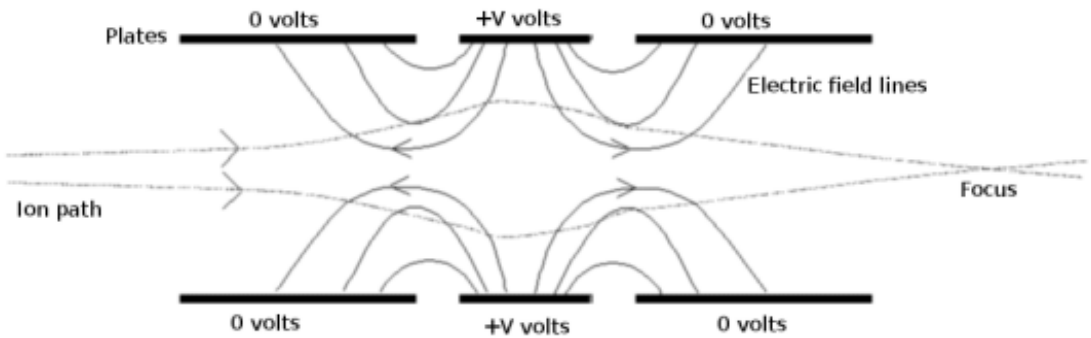
Dust Source



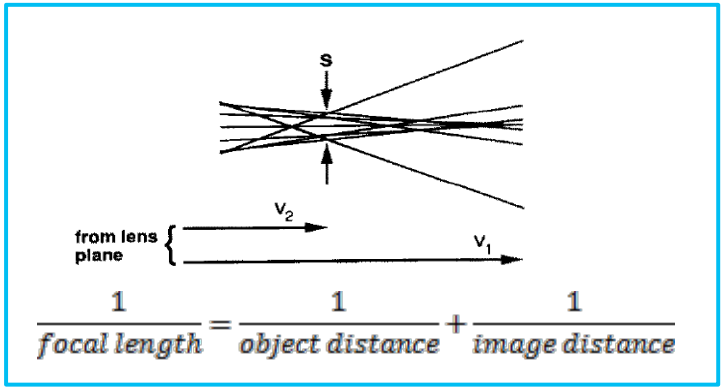
*All simulations run in SIMION (versions 7 and 8), an electrostatic lens analysis and design program, which utilizes the Laplace equation to compute electrostatic potential fields

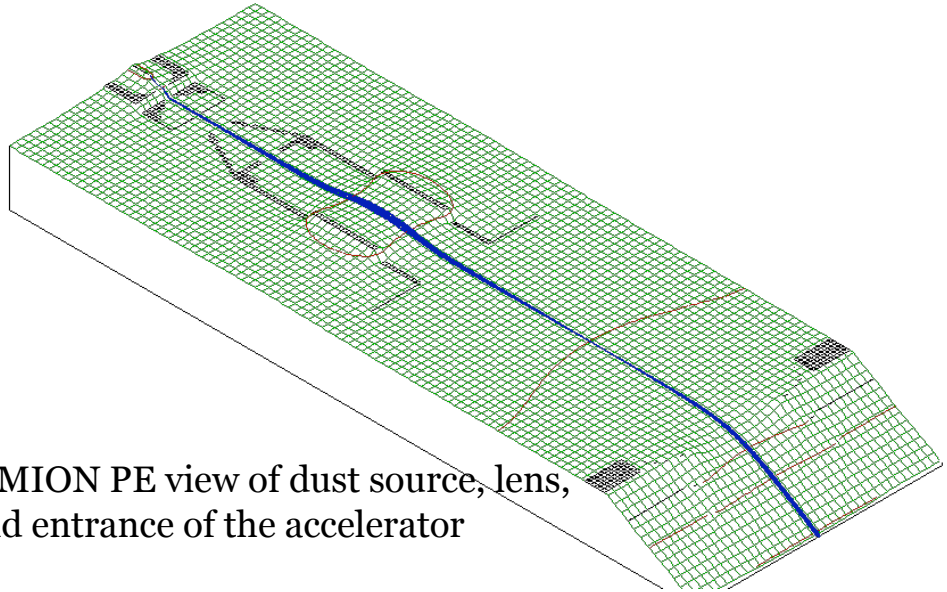
Focusing: Einzel lens

- Einzel lens setup
- Analogous to optics
- Focusing aberrations



http://en.wikipedia.org/wiki/Einzel_lens



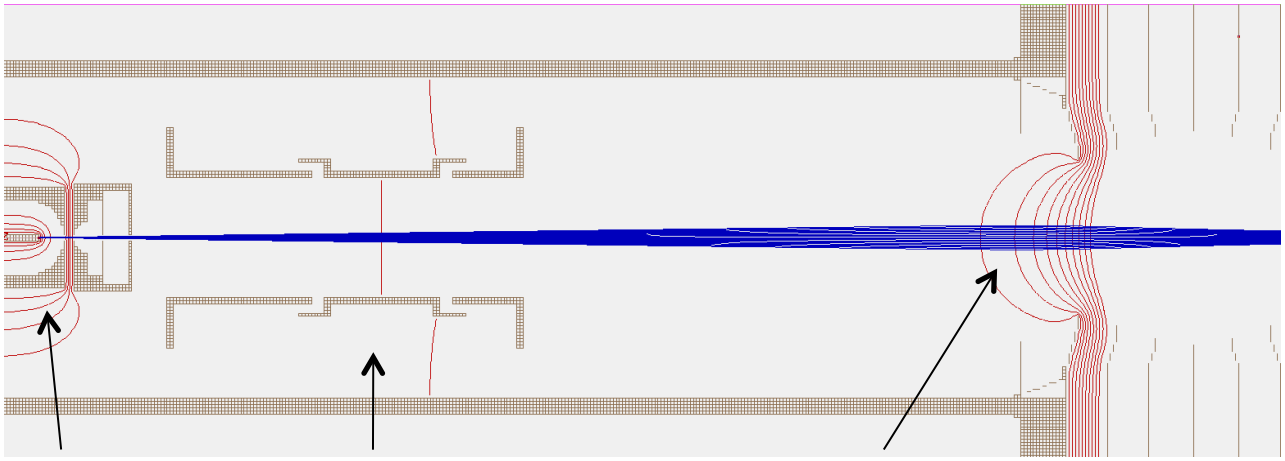


SIMION PE view of dust source, lens, and entrance of the accelerator

The design of the Einzel lens used in the simulations is based off existing drawings from National Electrostatics Corp. (NEC)

Focusing: Simulations

Dust Source and lens



Beam without Focusing

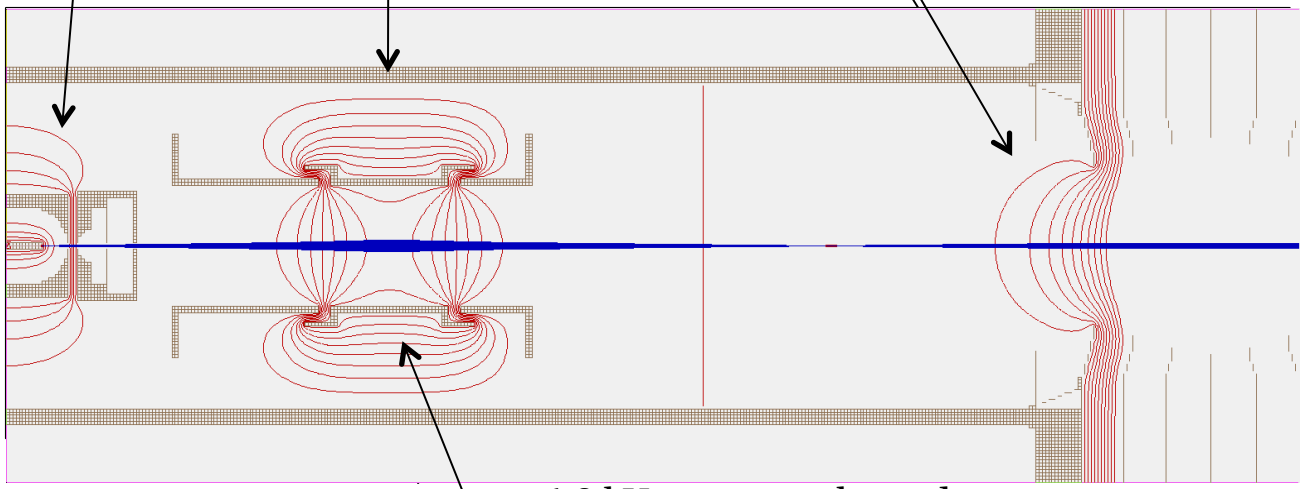
Equi-potential lines (2000V)

Particle trajectories

Dust source

Einzel Lens

Pelletron entrance

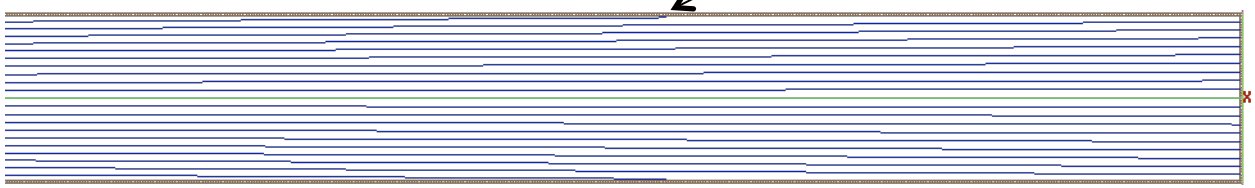


Beam with Focusing

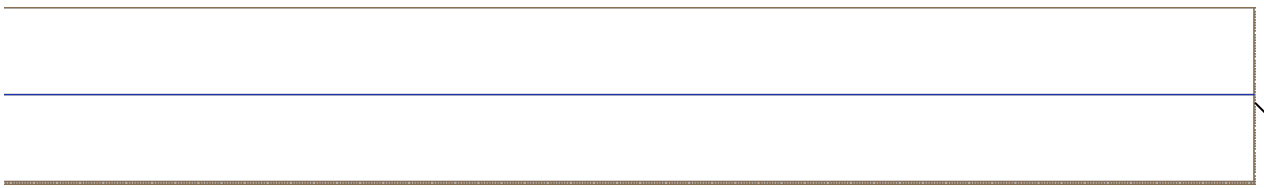
≈ 16.8 kV on center electrode

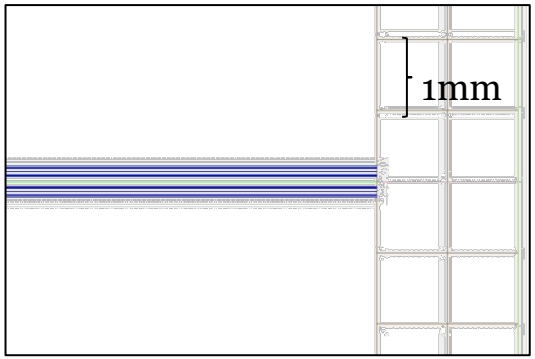
Focusing: Results

Without Focusing



With Focusing



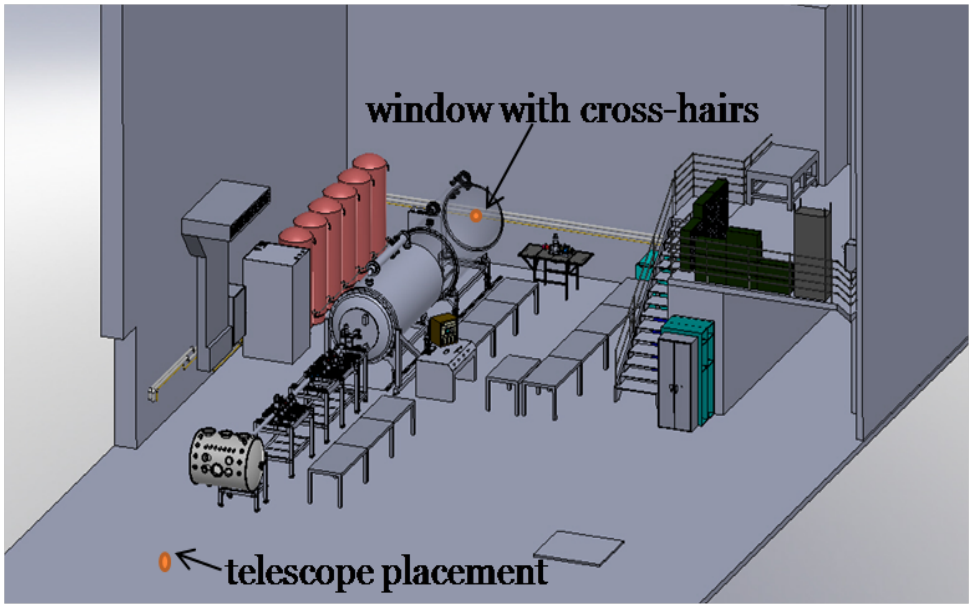


- ≈ last 1m of the beam-line
- Unfocused particles spread to fill the entire beam-line
- Focused particles have a spot size < .5mm in diameter
- ± 1kV from optimal focus keeps particles within 1cm
- Programming in Lua to optimize focusing voltage

Beam Alignment: Techniques

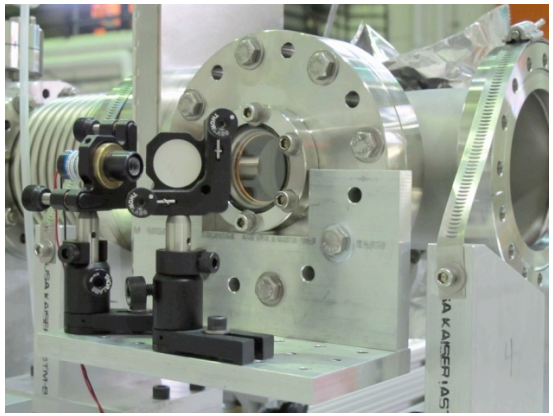
- Initial laser alignment with transit and medallions
- Secondary alignment for placing targets
- Beam “finder” in connection with X-Y steering
- Possible jog in the beam line for particle selection using Sikler lenses

Lab Rendering



Beam Alignment: Target Placement

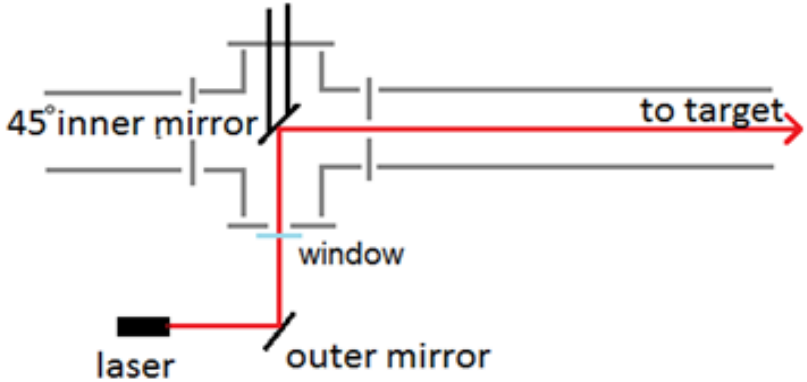
Laser setup



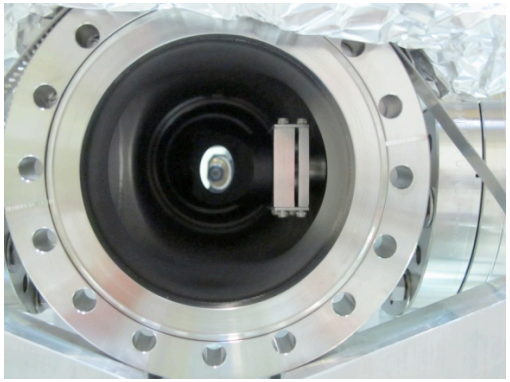
Features:

- Illuminates dust particle trajectory
- Adjustable laser and mirror
- Precisely placed (.002 in) 45◦ mirror, retractable

Laser path



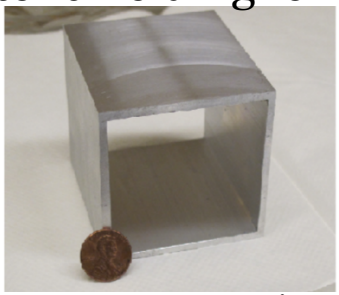
Mirror in extended position



Beam Alignment: Beam Finder

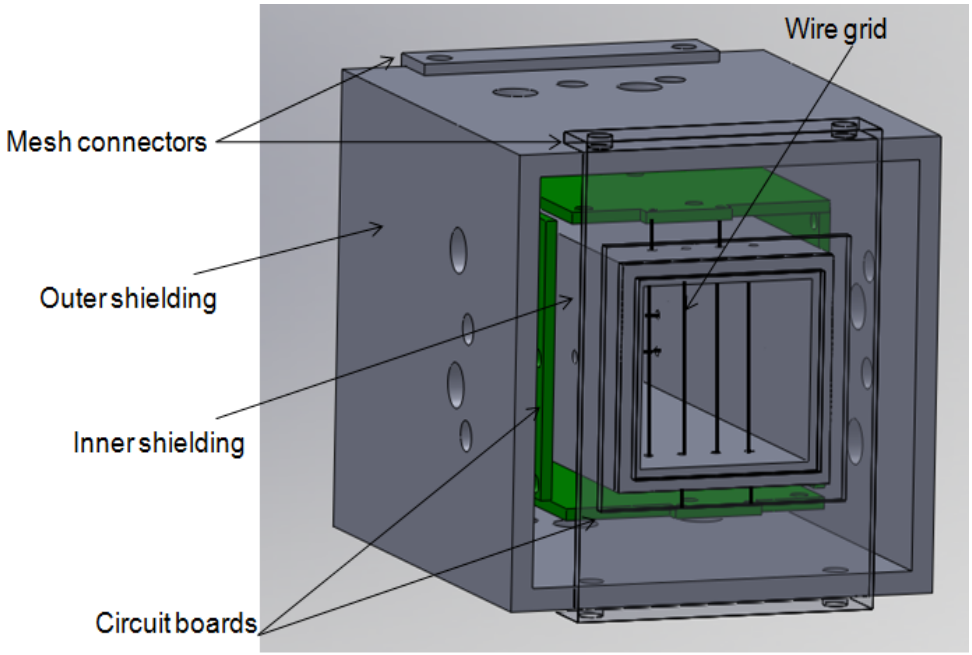
- Modeled from Dust Trajectory Sensor (DTS)
- Downscaled to give particle position
- 4-wire grids .2” between wires
- Small and removable via 6” Tee, feed-through flange

Outer shielding for scale

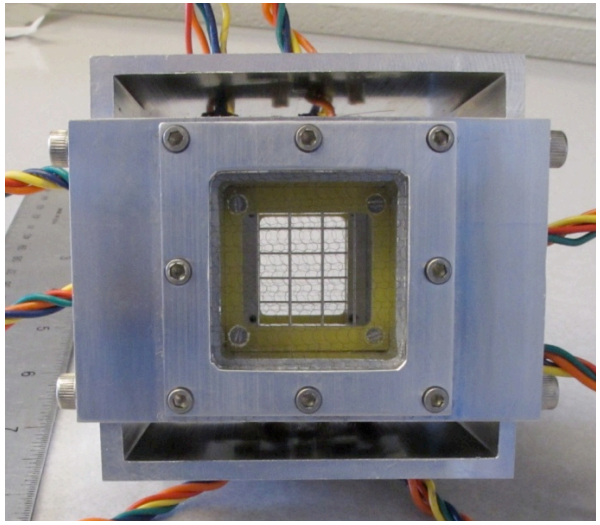


2.5 x 2.5 x 2.8 in

Rough SolidWorks Rendering



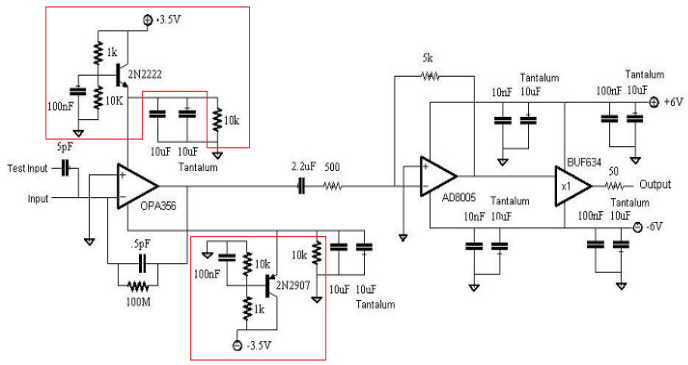
Assembly in progress



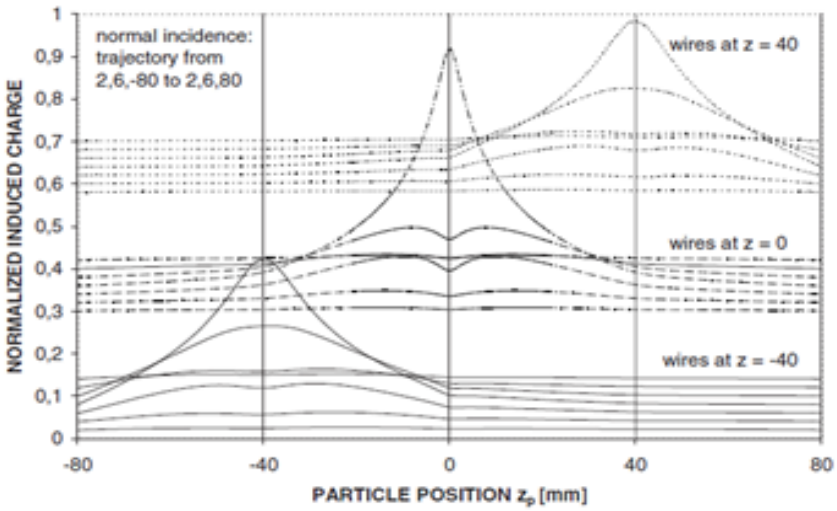
Beam Alignment: Beam Finder

- Position from relative heights of induced pulses
- 1 circuit needed for each wire
- Components in red on separate board
- Circuit used in ELDA

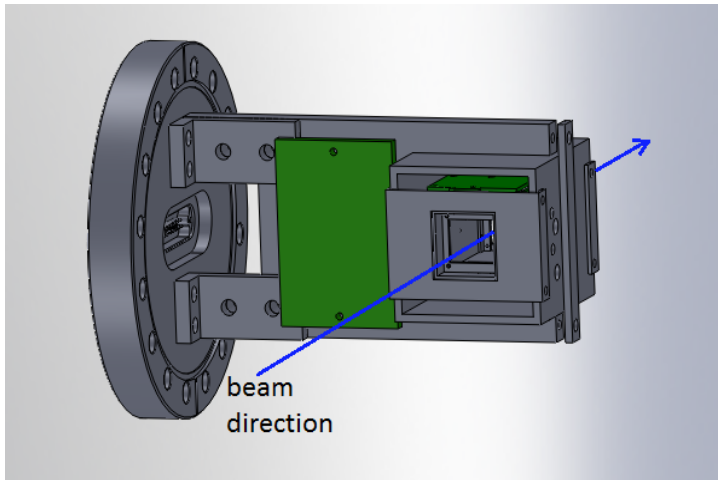
DTS circuit schematic



Simulated DTS signals



Full assembly

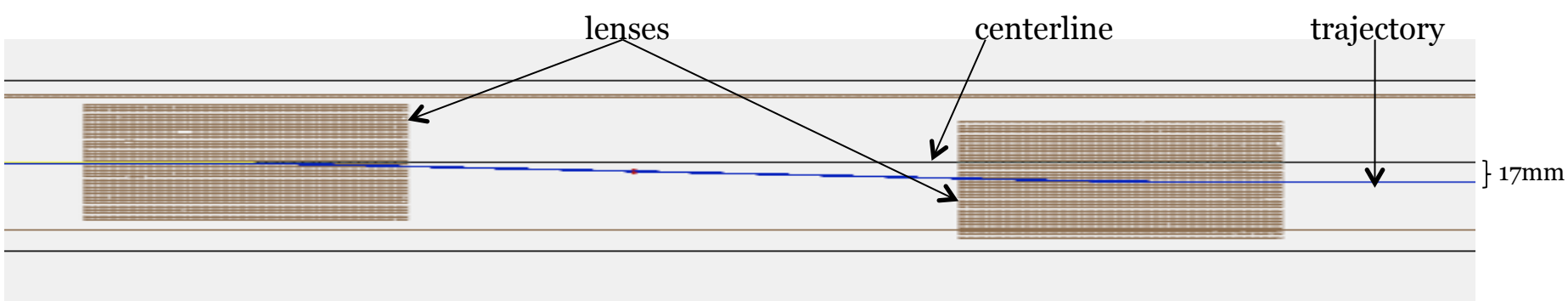


Particle Selection: Possible Jog

- Loss of charge observed at Heidelberg facility
- Electrostatic "jog" to eliminate uncharged particles
- Deflection independent of particle parameters:

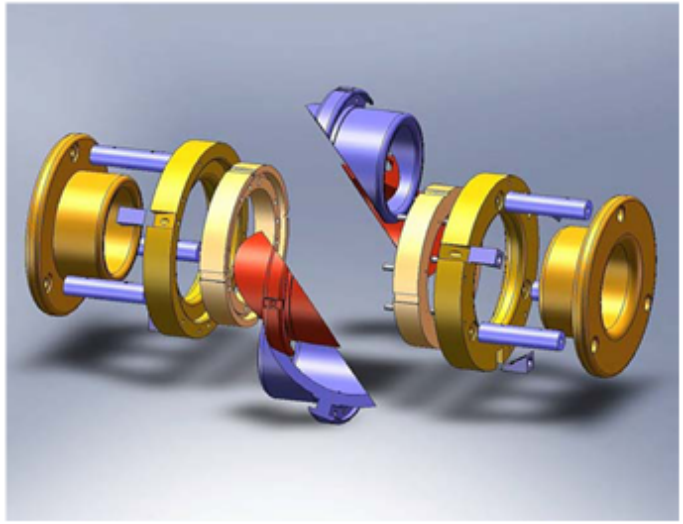
$$Y = \frac{1}{4}\left(\frac{U_{def} * L}{U_{accel} * d}\right) * (2D + L)$$

- Preliminary considerations testing two methods of deflection



Particle Selection: Possible Jog

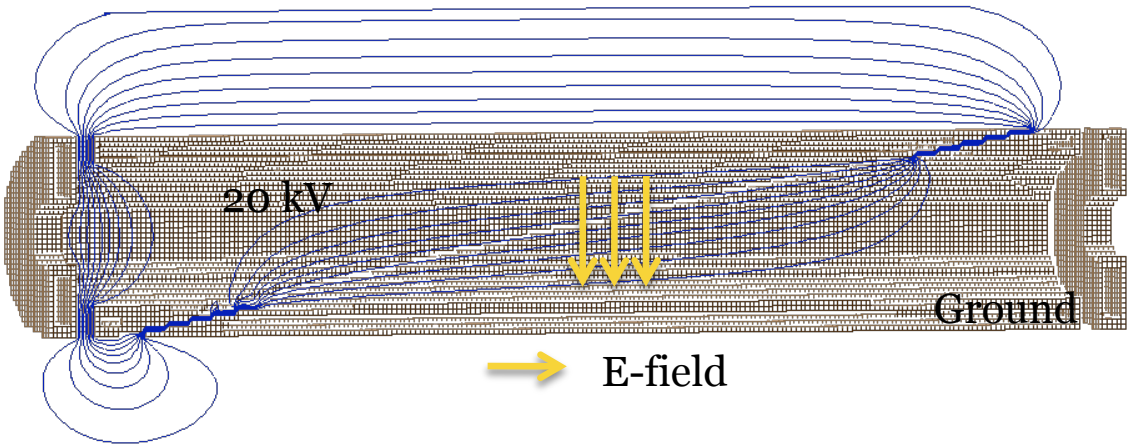
Heidelberg EBIT Sikler Lens



2 Possible Geometries

- Parallel plates
- Modified "Sikler" lens

Modified Sikler Lens

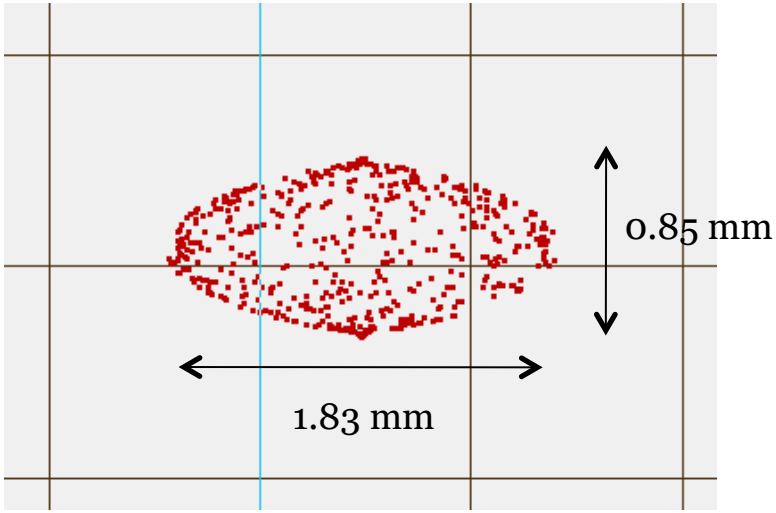


Deflector parallel plates

Particle Selection: Possible Jog

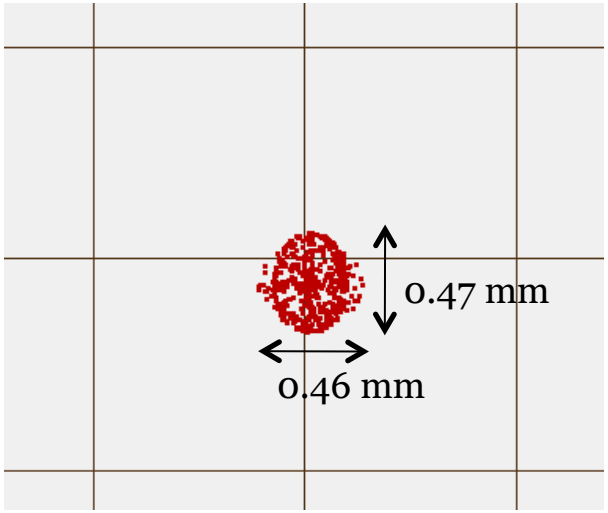
- Preliminary Results

Parallel Plates



Deflection: 20 mm

Sikler Lens



Deflection: 15 mm

Thank You

Questions?