Focusing and Alignment for a New 3MV Dust Accelerator

P. Northway, S. Auer, K. Drake, E. Grün, M. Horányi, T. Munsat, A. Shu, E. Thomas

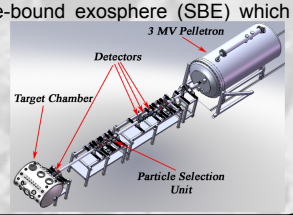
University of Colorado, Boulder; Max-Planck-Institut für Kernphysik; NASA Lunar Science Institute;

Colorado Center for Lunar Dust and Atmospheric Studies; A&M Associates, Basye, VA

Contact: paige.northway@colorado.edu

Accelerator

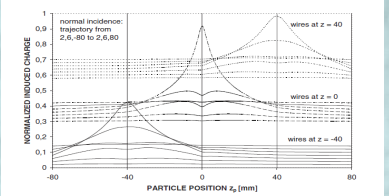
The Colorado Center for Lunar Dust and Atmospheric Studies (CCLDAS) has recently assembled a 3MV dust particle accelerator. The accelerator and dust source together are designed to accelerate particles with a range of sizes and velocities which simulate the hypervelocity micrometeorites that regularly impact the lunar regolith. Studying these impacts will give insight on mechanisms involved in sustaining the surface-bound exosphere (SBE) which makes up the lunar atmosphere. This will also influence the understanding of Mercury, icy satellites, the rings of Saturn, large asteroids, and Kuiper Belt objects, which have similar SBEs. Detectors giving the velocity, charge, and mass will also allow for the calibration of instruments. The focusing and alignment of the beamline and accelerator ensure that the particles reach the desired impact site.



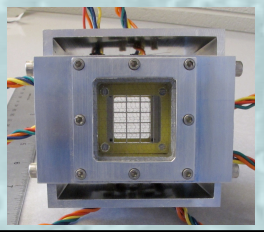
Particle Position Detector

- Grids of 4 wires in X and Y directions
- Compact: 2.5" x 2.5" x 2.8"
- Charged particles generate image charge on wires
- Comparative signals gives X-Y position of particles
- Modeled after larger Dust Trajectory Sensor (DTS) (Auer, et al., 2008)

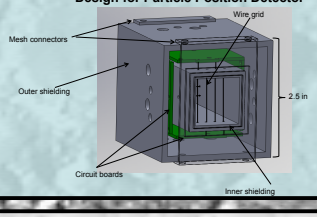
Computer models for DTS signals



Actual assembly in progress

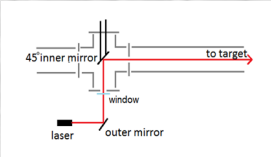


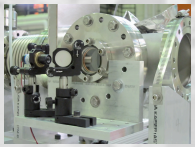
Design for Particle Position Detector

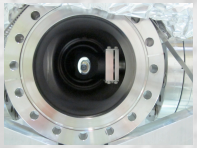


Laser Alignment System

- Illuminates beam path for placing targets
- Comprised of a laser and 2 mirrors
- Mirror on programmable motorized linear positioner
- Position repeatable to .001mm
- Inside mirror doubles as a beam block



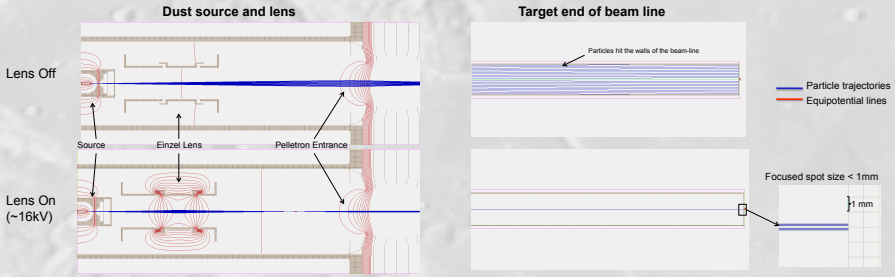




Einzel Lens Focusing

I. Requirements

- Collimated beam < 1 cm in diameter required for particles to pass through detectors to target
- Ideally, the beam would stay <1cm through the 9m of beamline and focus to a point at the target
- Pinhole focusing with 3 apertures provided by dust source
- Fringe fields from the accelerator over-focus beam in absence of additional focusing



II. Einzel Lens Simulations

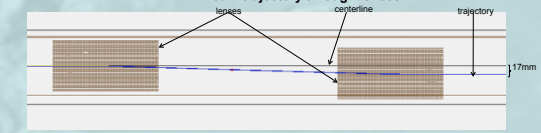
- Focusing is achieved with an Einzel lens consisting of 3 ciylindrical electrodes
- The lens used is a standard model provided by NEC with a range of 20kV
- Voltage on center electrode optimized to smallest spot size of < 1mm
- ±1 kV range from optimal voltage allows most particles through detectors
- All simulations run in SIMION ion optics program

Electrostatic Bending

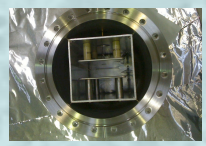
At the accelerator facility at MPI-K, it has been observed that particles occasionally lose their charging while in the beamline. This renders them invisible to detectors while still generating data on impact. Simulations are currently being run to explore the feasibility of bending the charged particles' trajectories using parallel plates or a modified version of a Sikler lens.

Preliminary results show the cylindrical Sikler lenses maintaining a better focus but smaller deflection compared to parallel plates of similar dimensions.

Beam trajectory through lenses



Parallel Plate Setup



Comparative spot sizes