Recent Science Results from the CCLDAS Dust Accelerator

Tobin Munsat and the CCLDAS Team

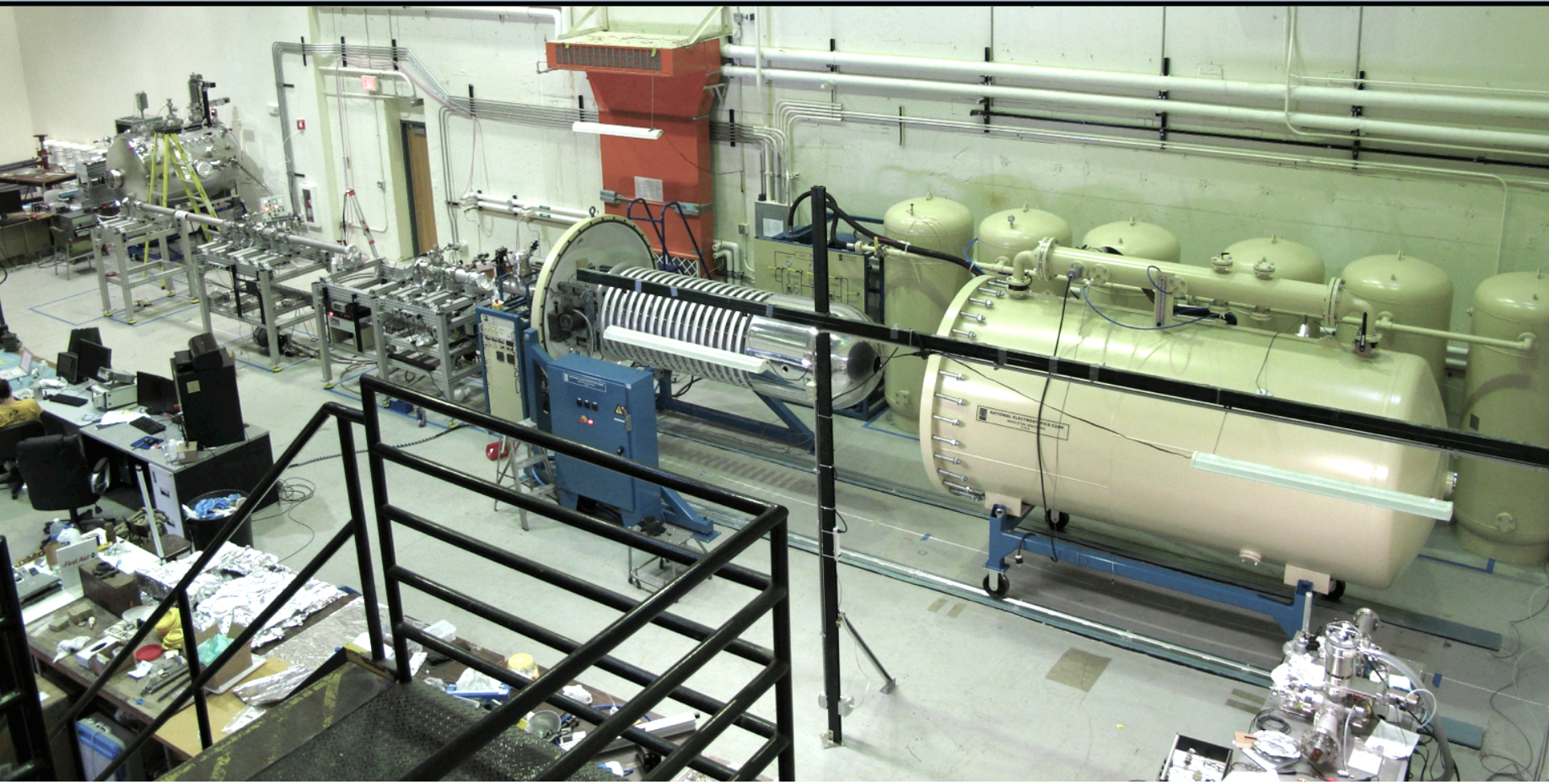
University of Colorado

Dust, Atmosphere, and Plasma Meeting
June 7, 2012

The CCLDAS Accelerator Team

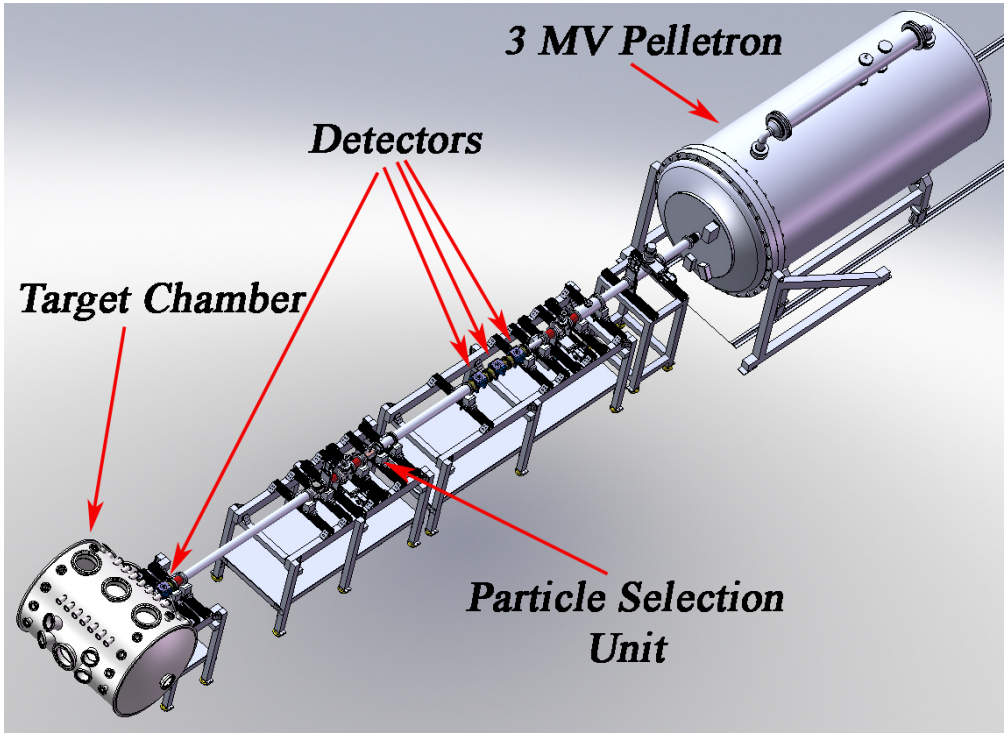
Principals	Mihaly Horányi	Grad Students	AJ Gemer
	Sascha Kempf		Leela O'Brien
	Tobin Munsat		Anthony Shu
	Scott Robertson		Evan Thomas
	Zoltan Sternovsky		Jianfeng Xie
		Undergrads	Chris Anaya
Physicists	Andrew Collette		Nick Beaty
	Keith Drake		Spenser Burrows
	Anna Mocker		Max Kempf
			Paige Northway
			Chris Warren

We have a dust accelerator…



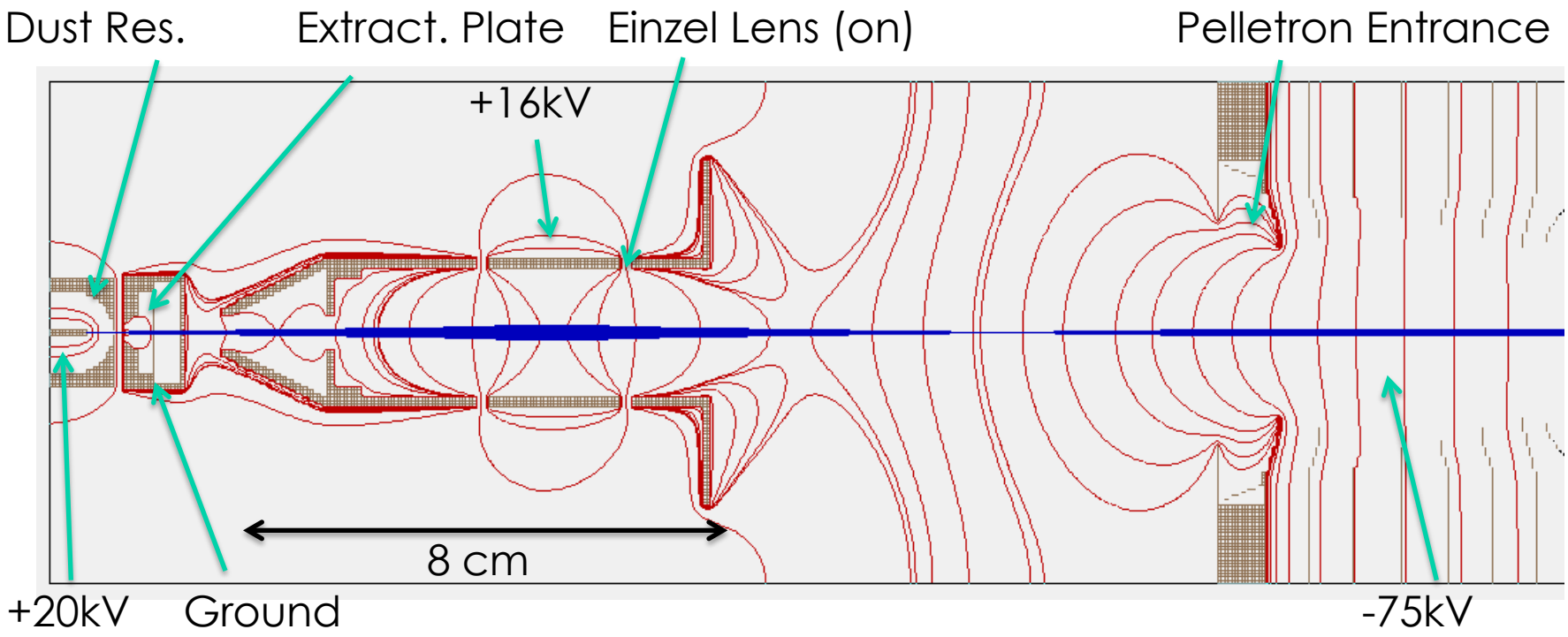
dustcam.colorado.edu

Technical Description



- Pelletron 3 MV Electrostatic Generator
- **Particle velocities: ≤ 100 km/s**
- Active selection of particles (charge/velocity)
- Particle materials: Fe, Al, Ag, Latex, ???
- **Particle sizes: 0.2 – 2.5 μm**

Simion Modeling of Beam Focusing

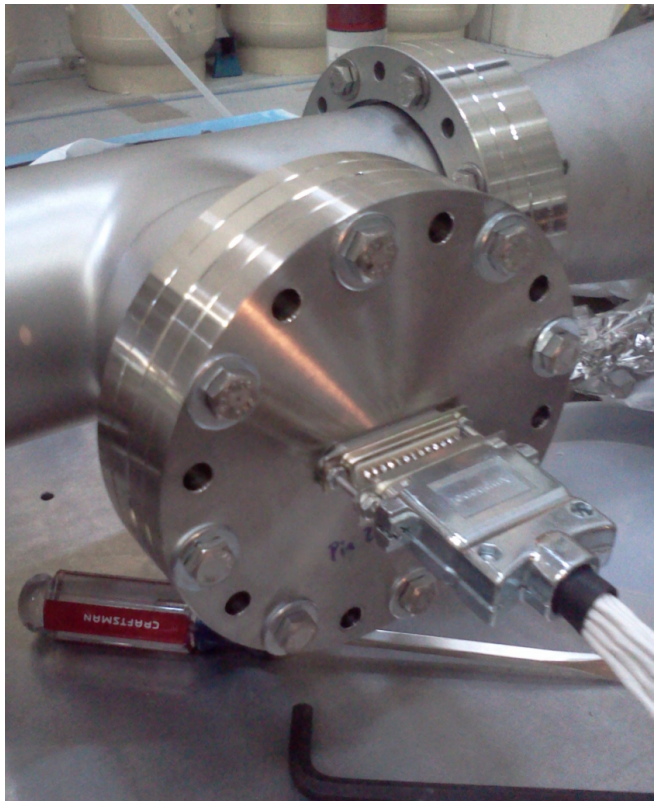


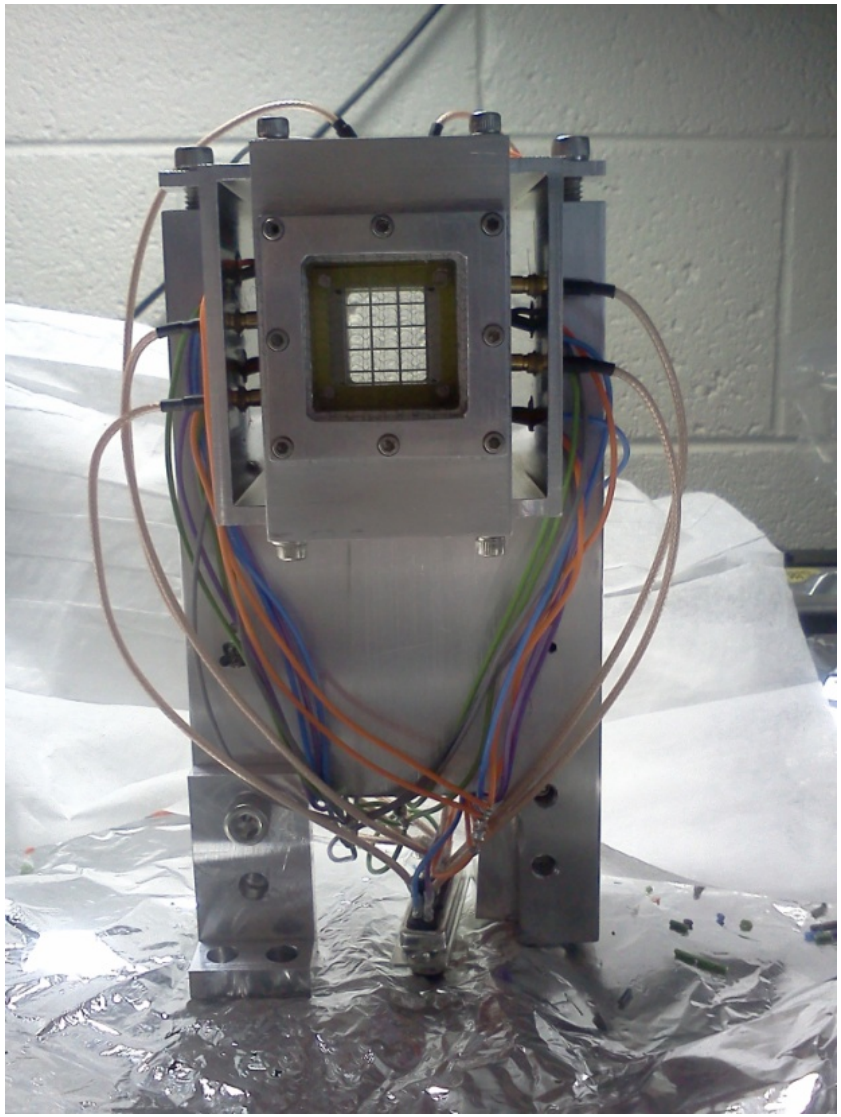
- Red: equipotential lines
- Blue: trajectories of dust particles

- Einzel lens "pre-focuses": forms beam waist before entering HV Pelletron stage, so final beam is properly focused.
- Beam aberrations analogous to optical lenses

Real-Time Beam Profiler

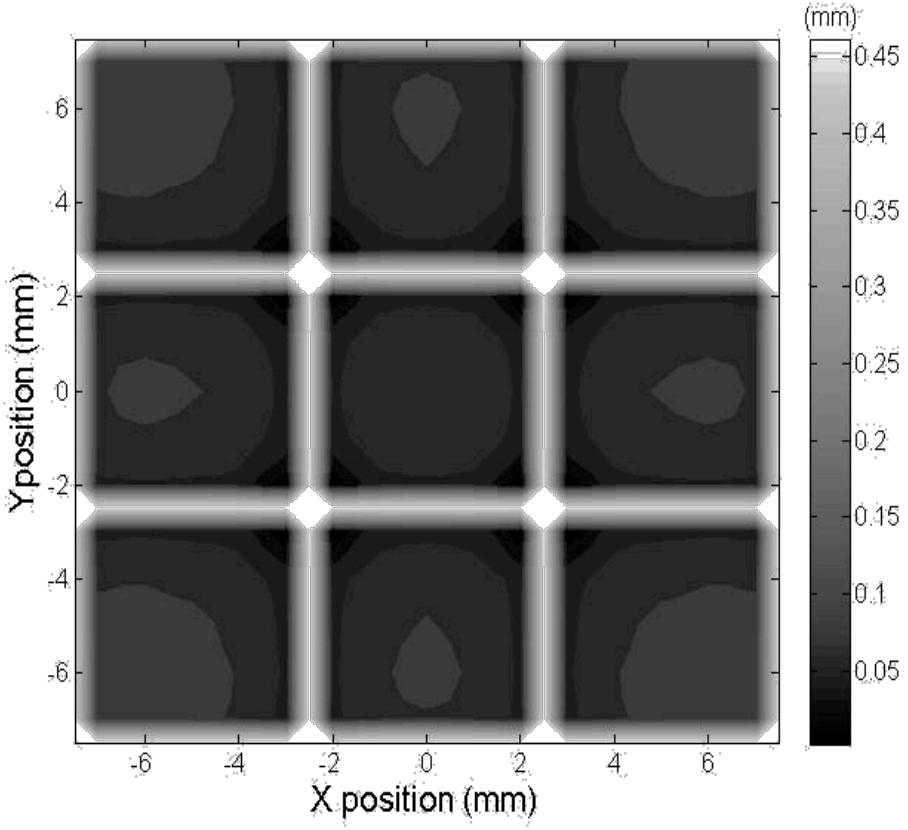
- Detects X-Y coordinates of each projectile in flight
- Technology borrowed from DTS

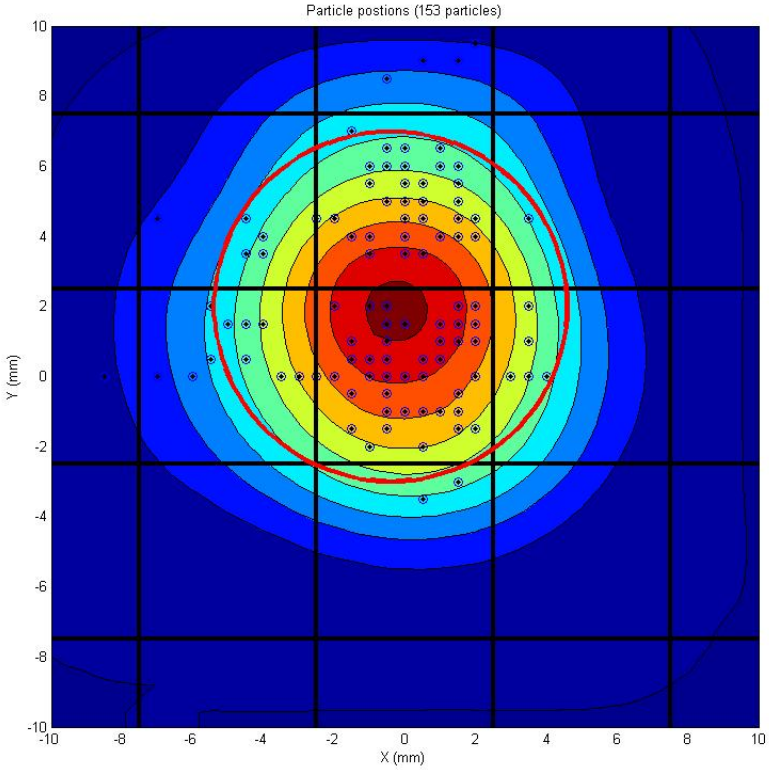




Real-Time Beam Profiler

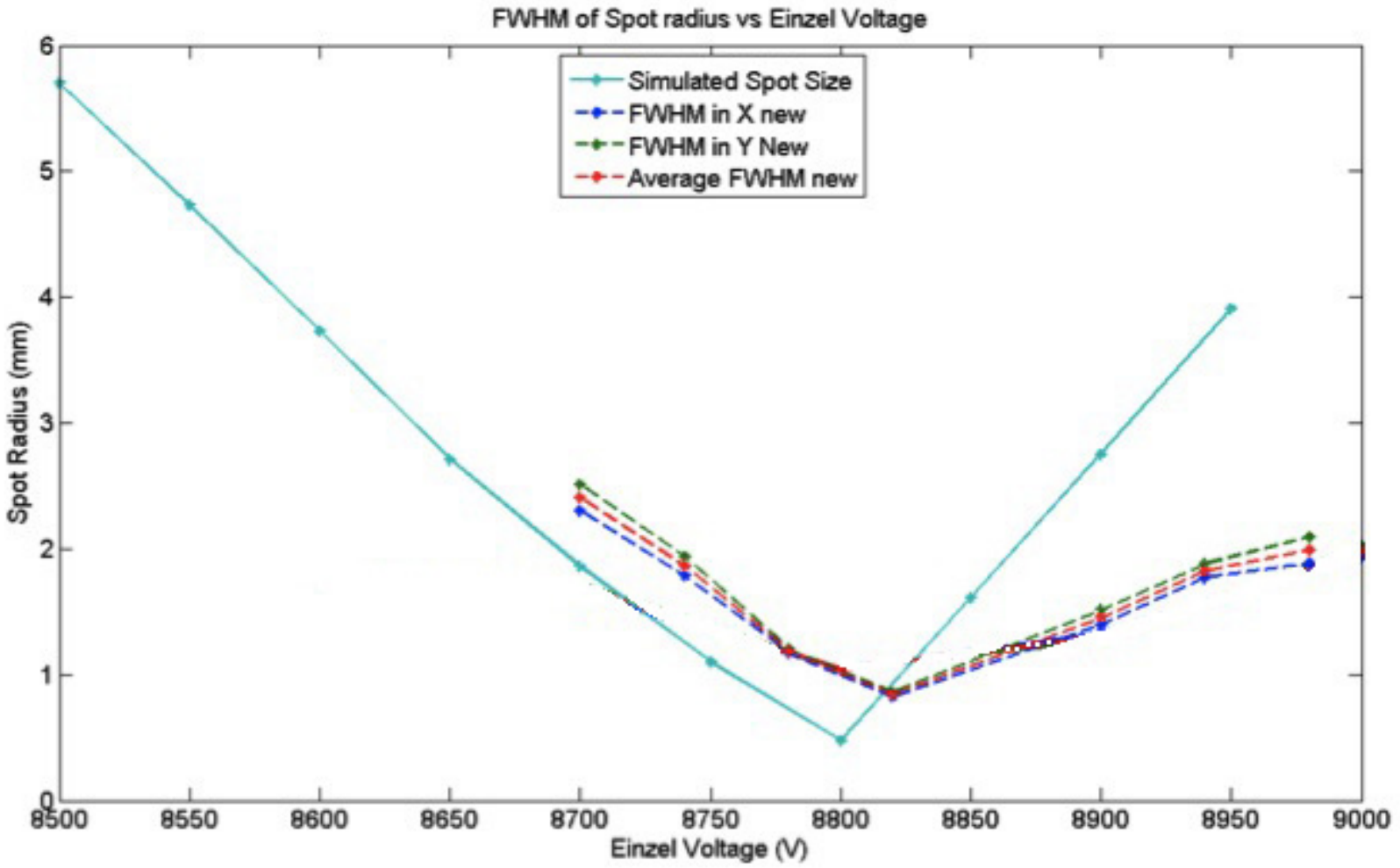
Precision of << 1 mm for typical particles



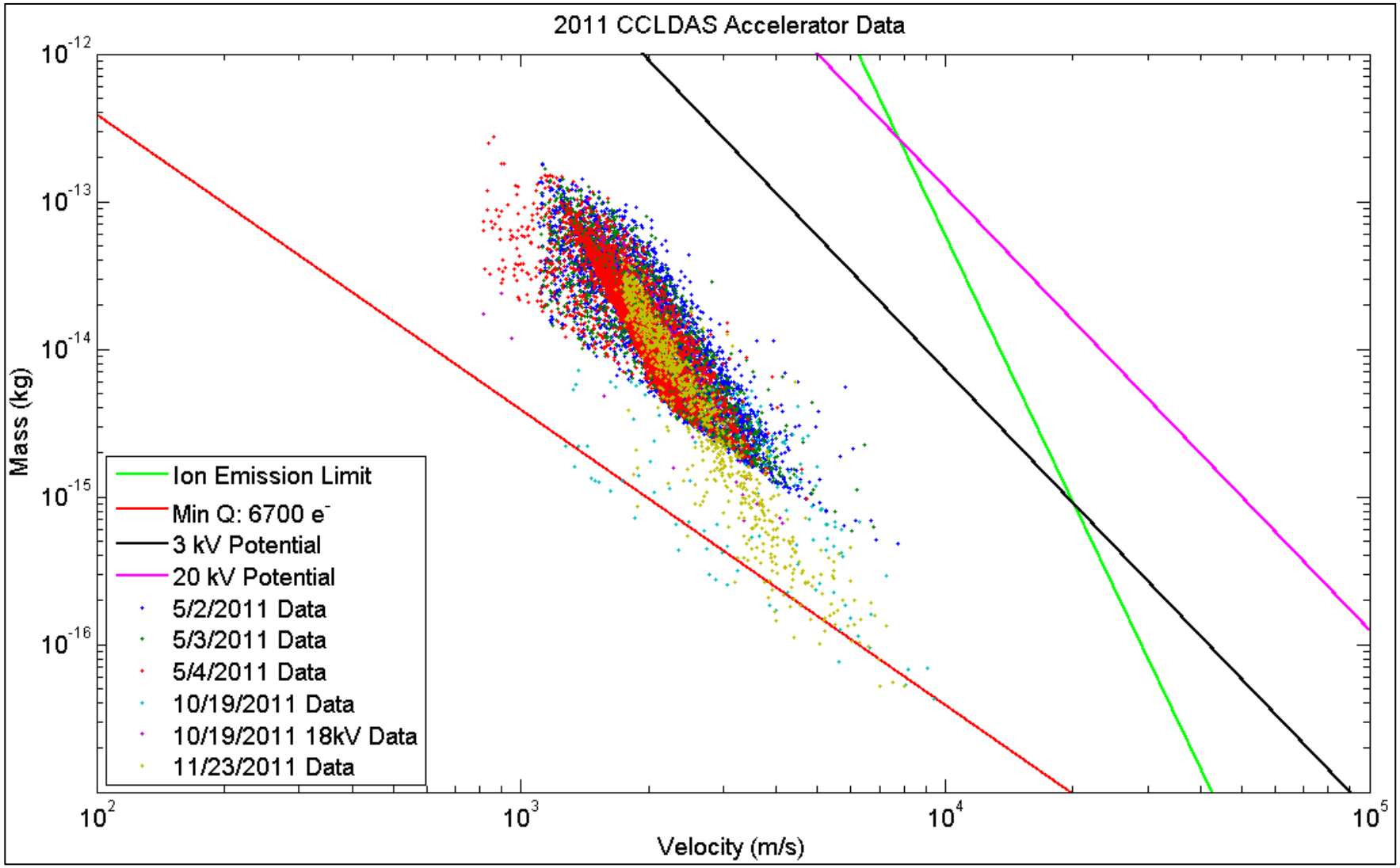


See poster by Paige Northway, Thurs. afternoon

Beam Profiling : Measured vs. Modeled

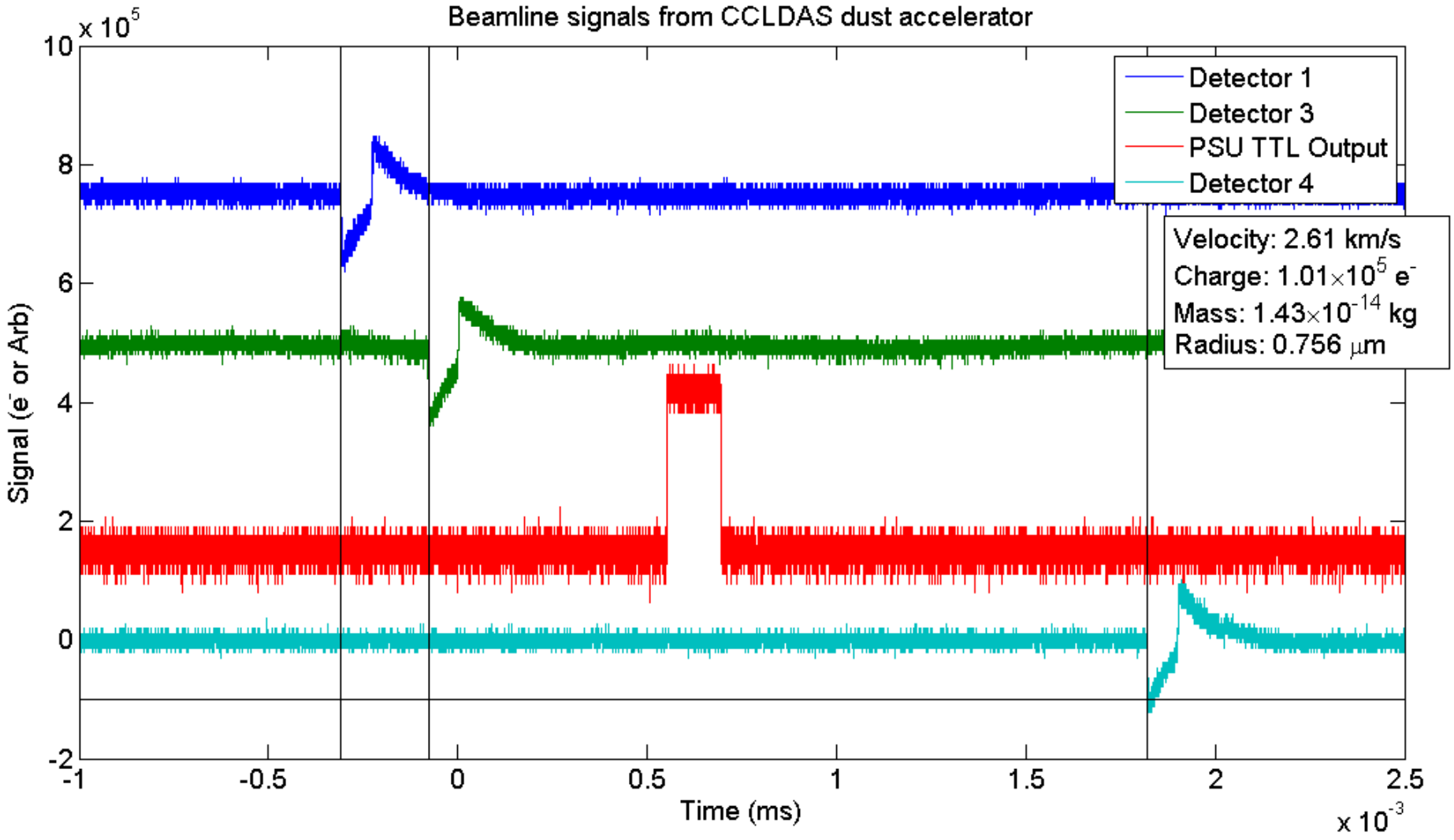


Hypervelocity Particle Parameters

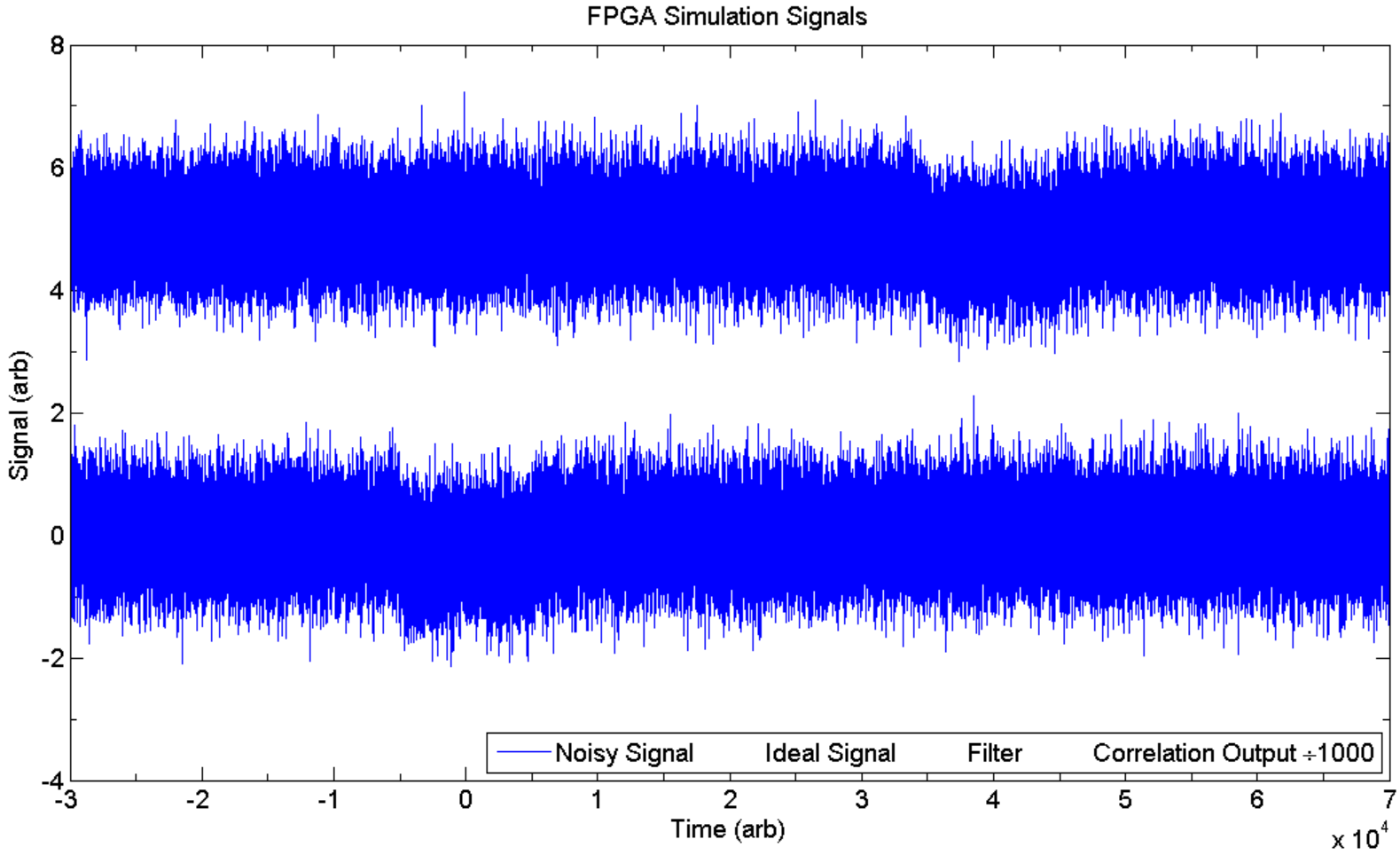


Highest velocity so far: 52 km/s

Active Particle Downselection



FPGA-based real-time filtering



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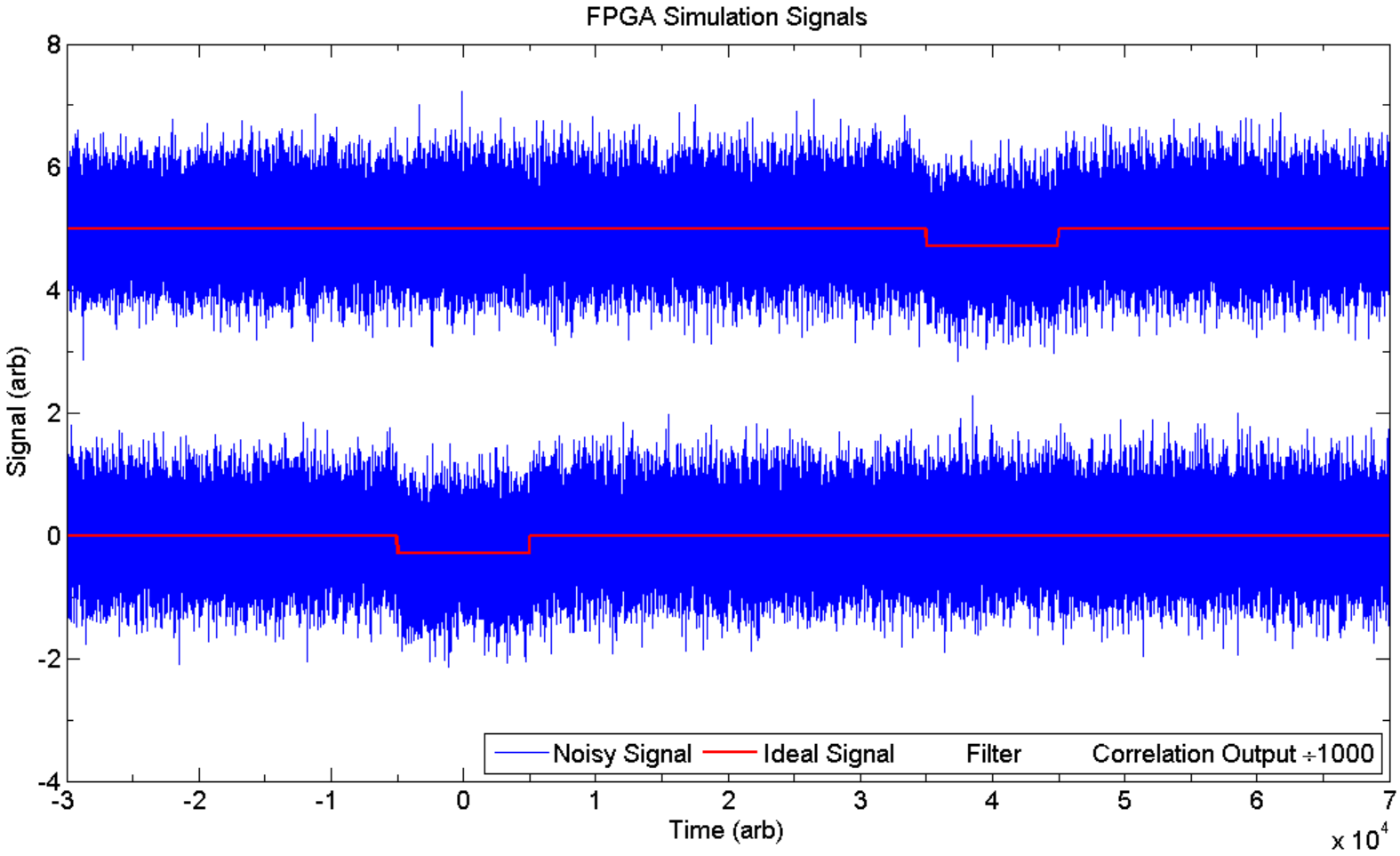

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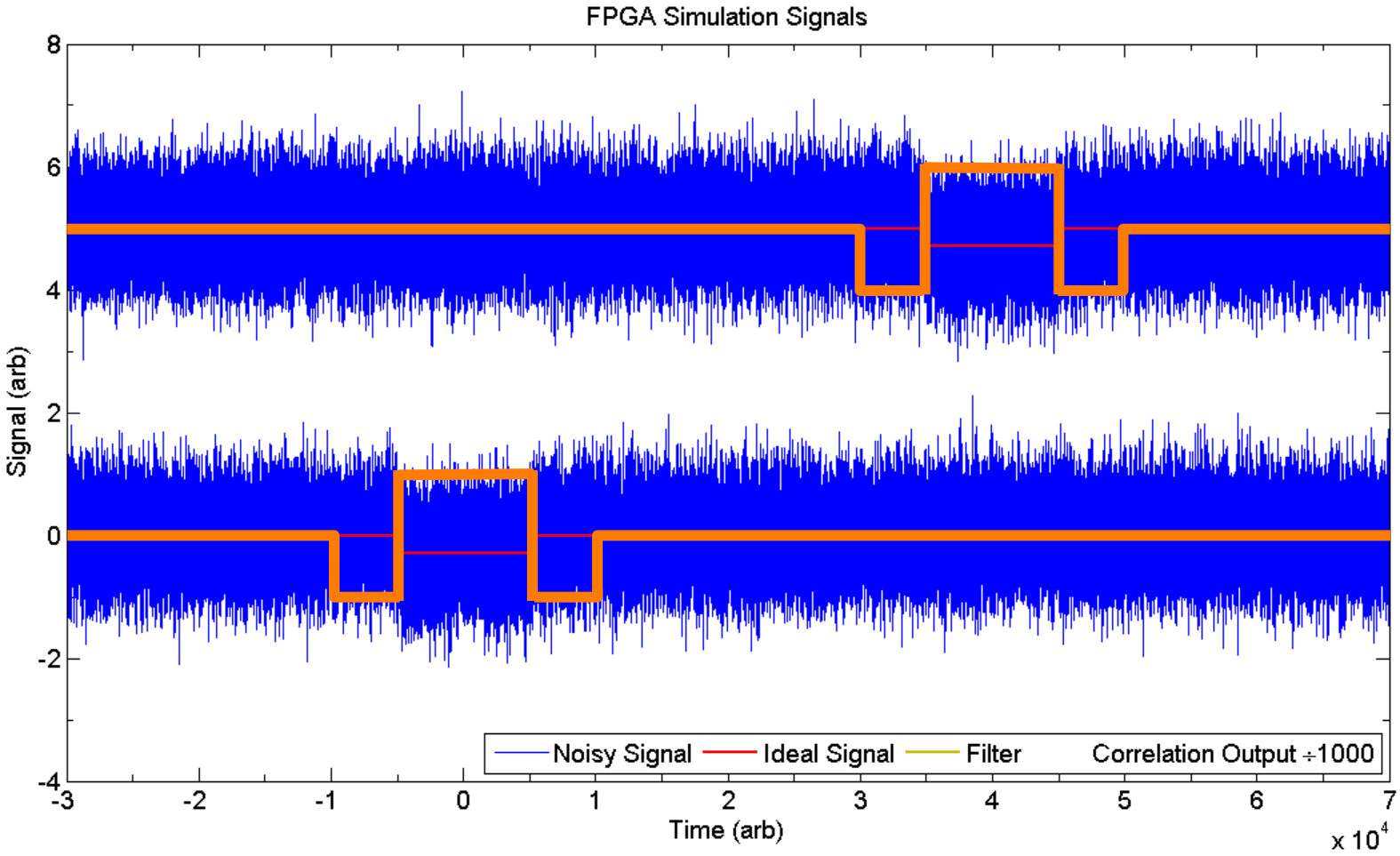

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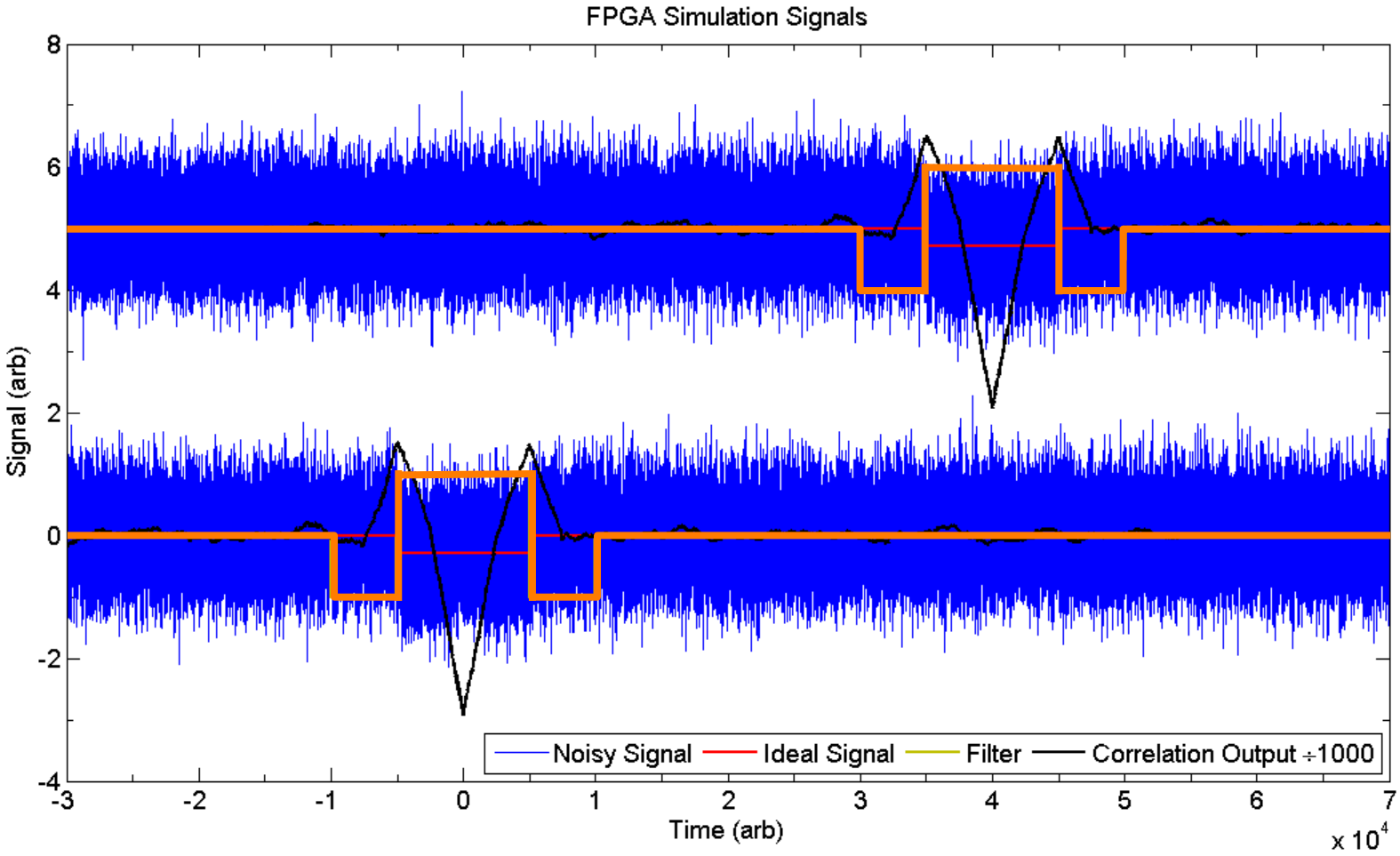


See poster by Evan Thomas, Thurs. afternoon

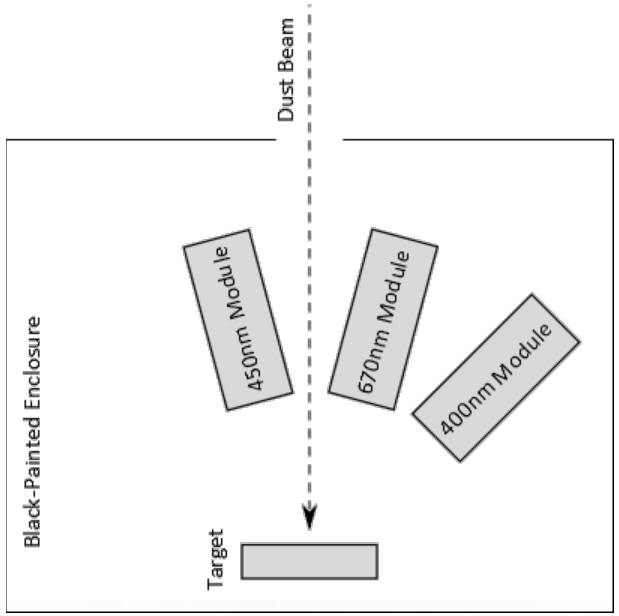
Performance Enhancements → Next Chapter of Experiments

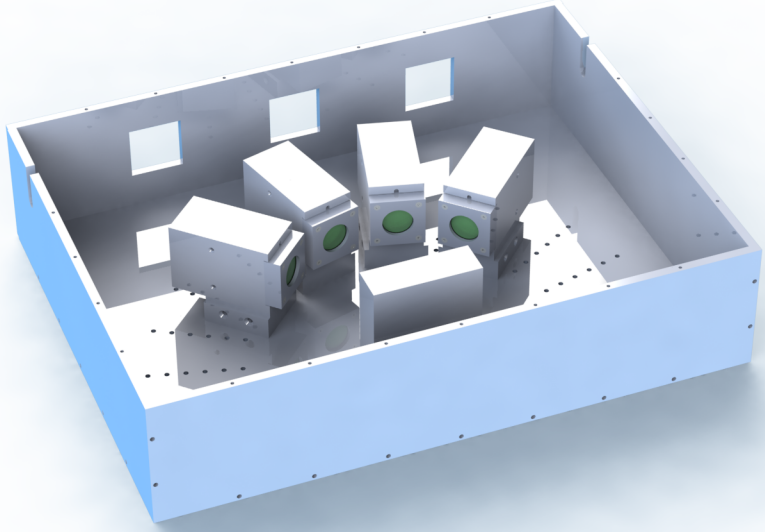
- **Assessment of impact products**
  - *Secondary Ejecta*
  - *Neutral gas*
  - *Plasma*

  } *Energy partition*
- **Light-flash experiments**
  - *PMT sets to resolve timing / angular distribution / spectral content*
- **Mini Bayard-Alpert gauges for neutrals**
- **Cratering studies (post-mortem)**
- **Instrument development and testing**

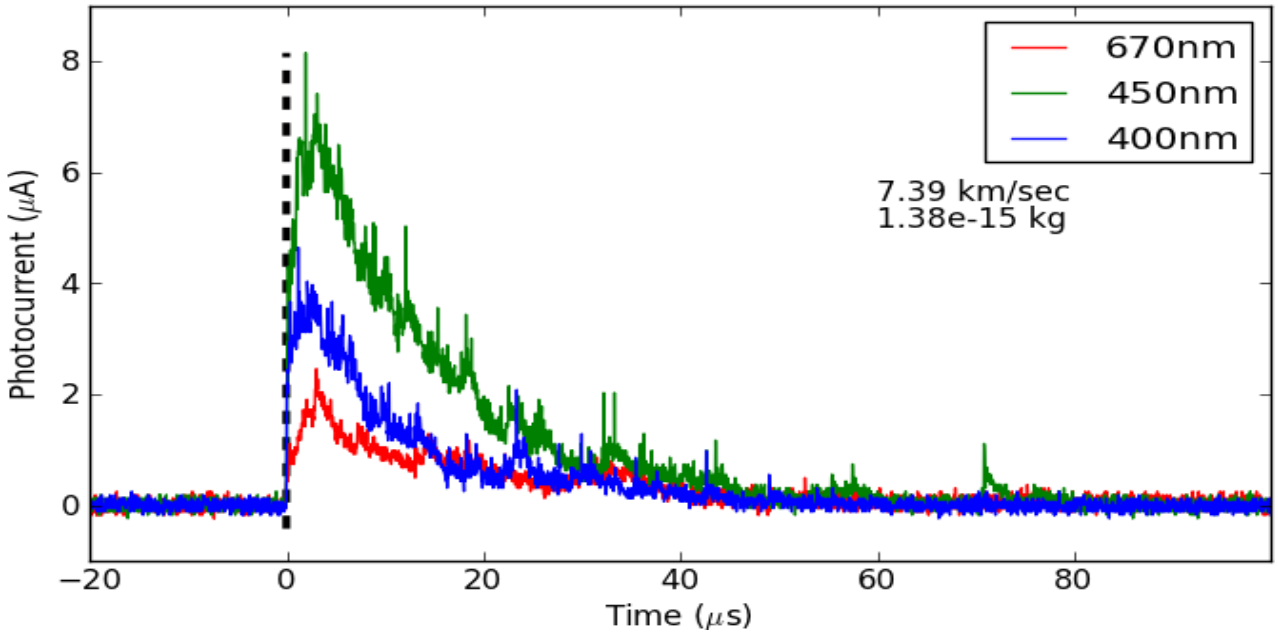
Temperature Measurements of Impact Plasma

- Measure $T_{blackbody}$, P_{rad} of impact-generated gas/ plasma (vs. time)
- Measure T variation with impact velocity
- Impact-generated light flash from 1-40 km/sec dust impacting metal target
- Flash diagnosed with PM tubes & interference filters, under the assumption of blackbody radiation





PMT Output (3 filters)



Temperatures in range of 2500K-5000K, increasing with velocity, *time resolved over ~20 μs flash lifetime*

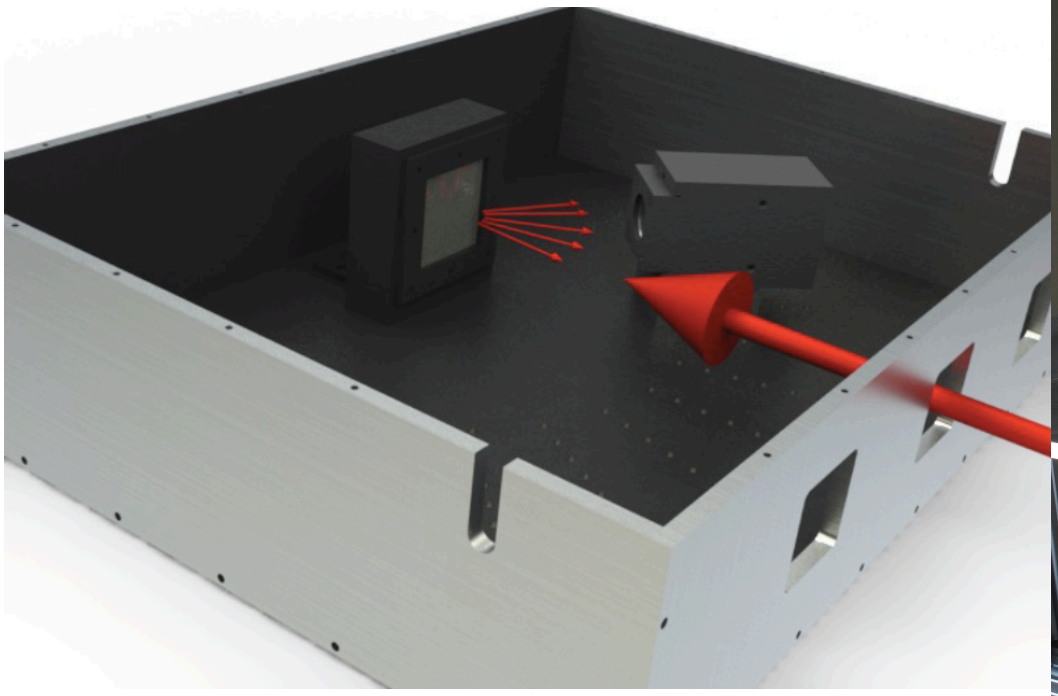
Many subtleties to interpretation of PMT signals, which are rich with information

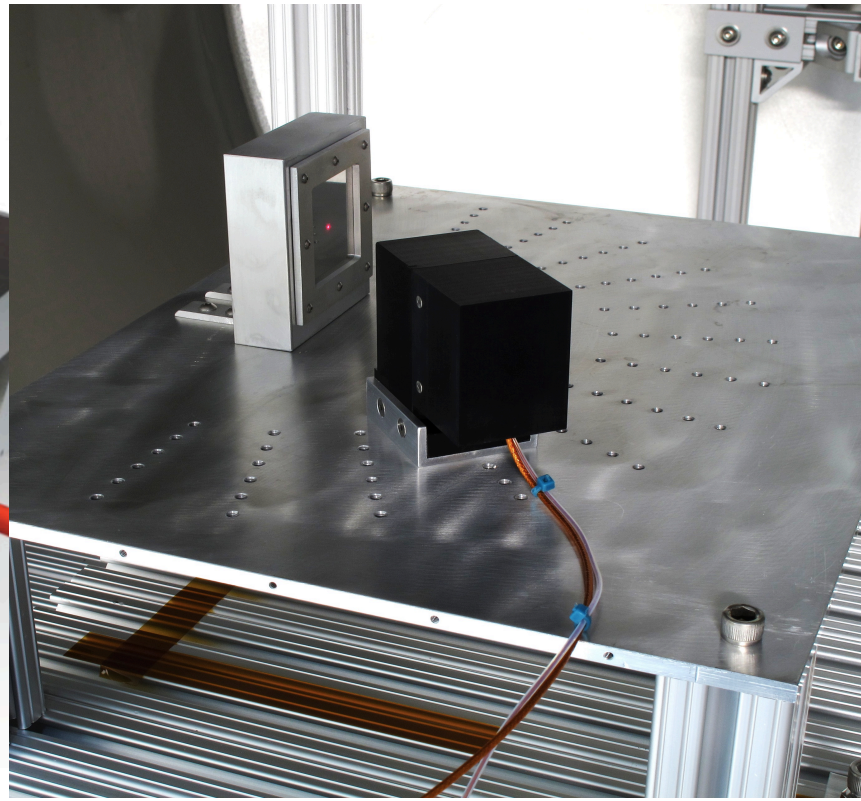
Full spectral measurement in the works…

Hear talk by Andrew Collette, Fri. 9:00 am

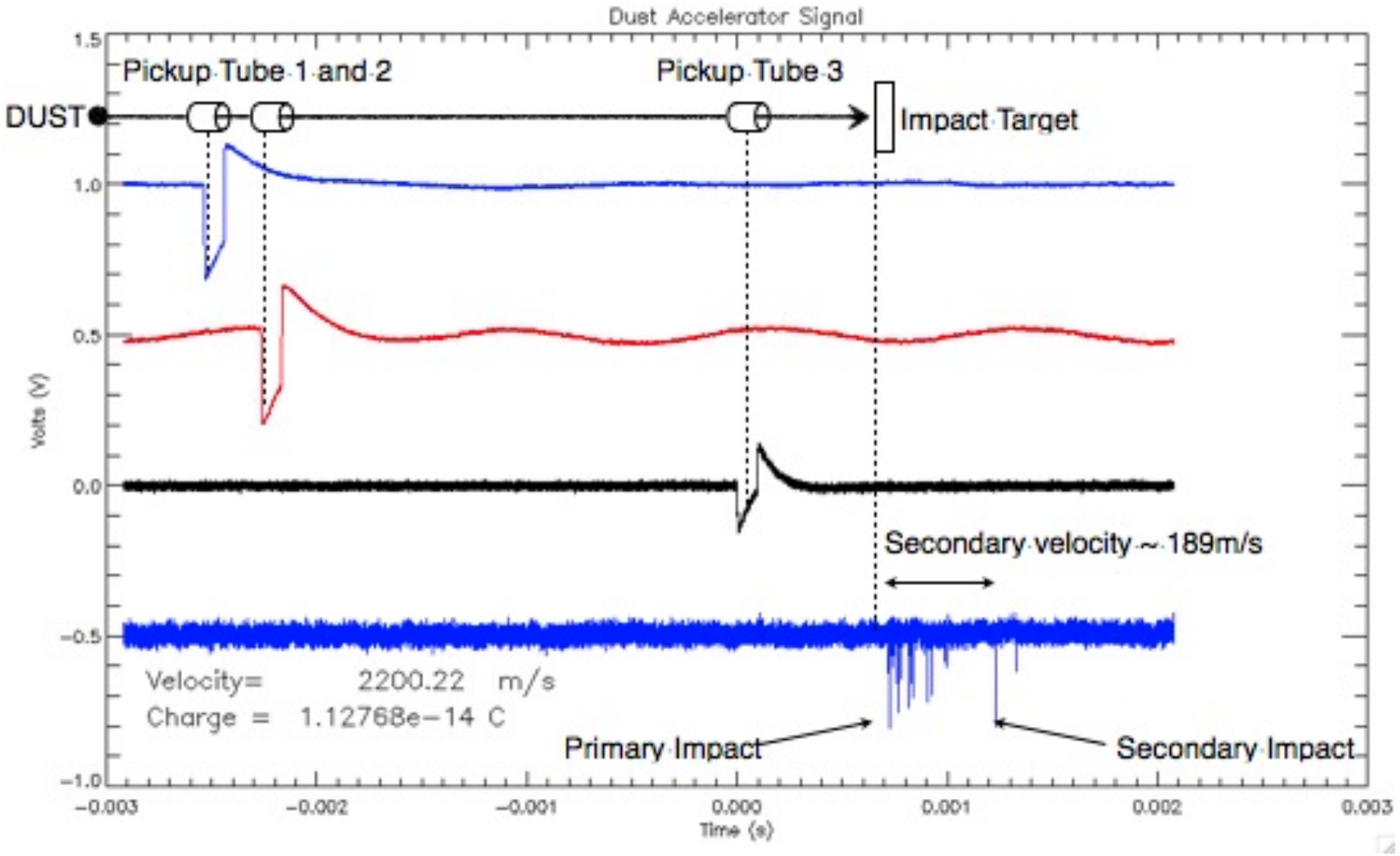
Secondary Ejecta Experiments

- Filtered photomultiplier tubes
- Angular resolution
- Control over impactors and targets
- Primary and secondary flashes

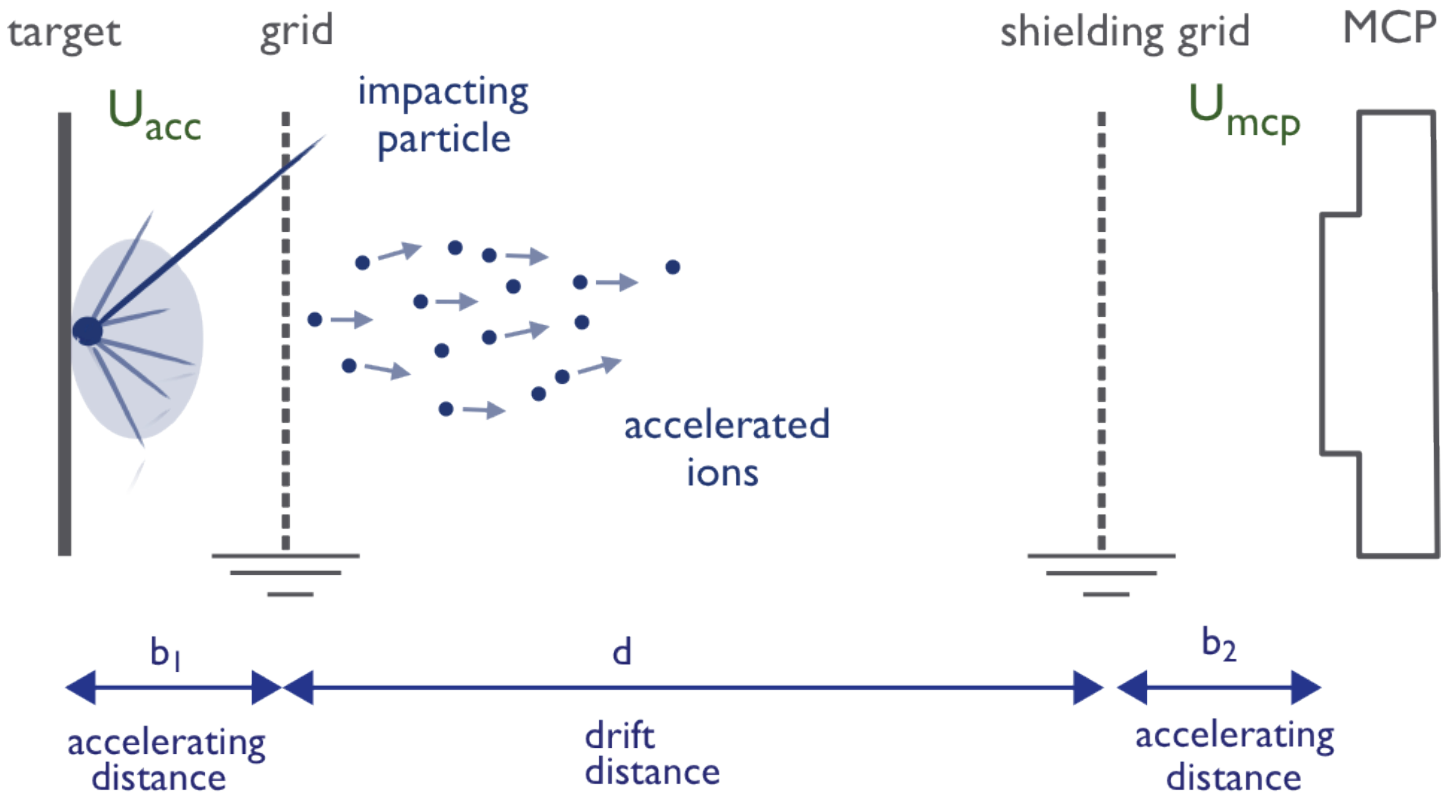




Secondary Ejecta Experiments

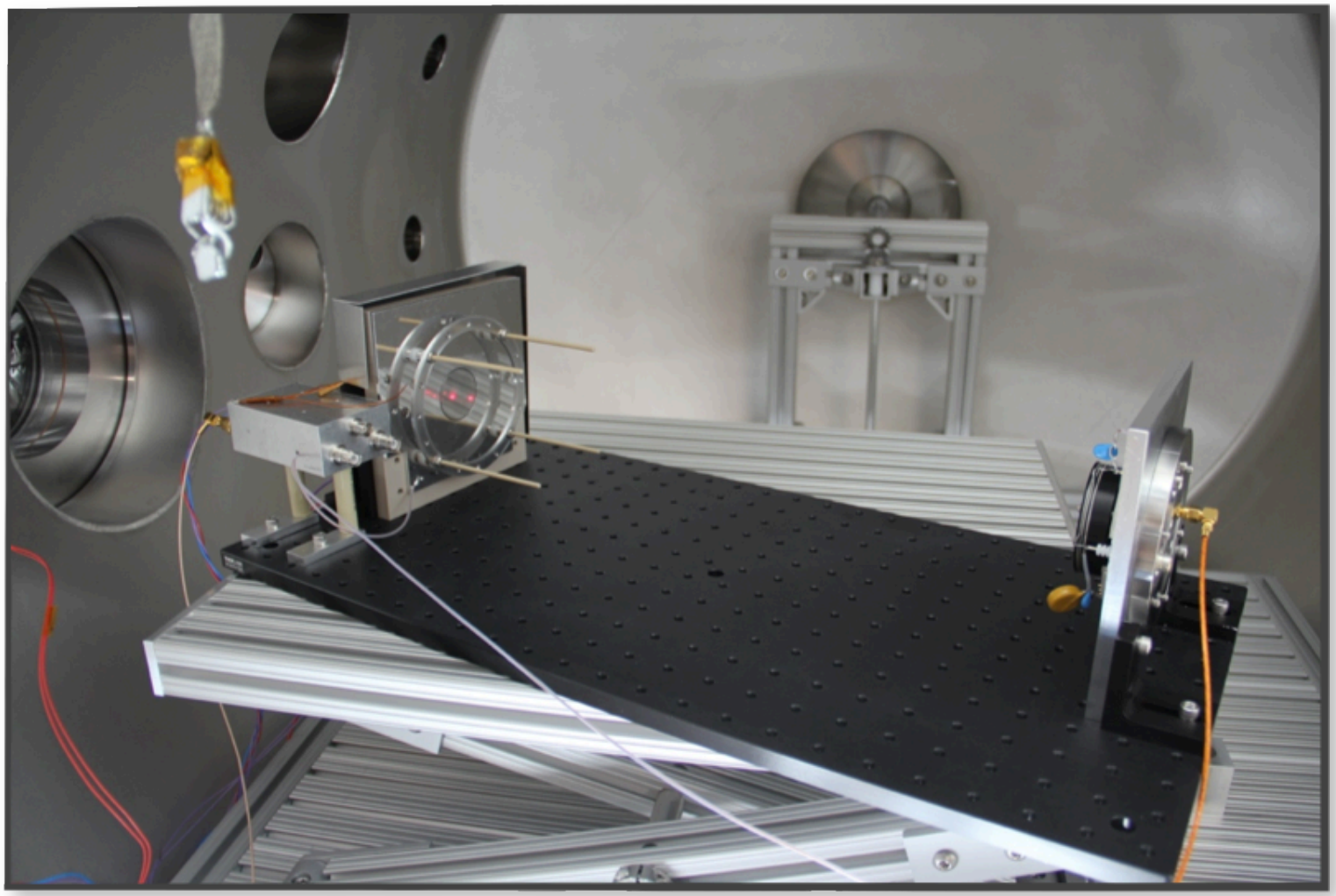


Linear Time-of-Flight Mass Spectrometer

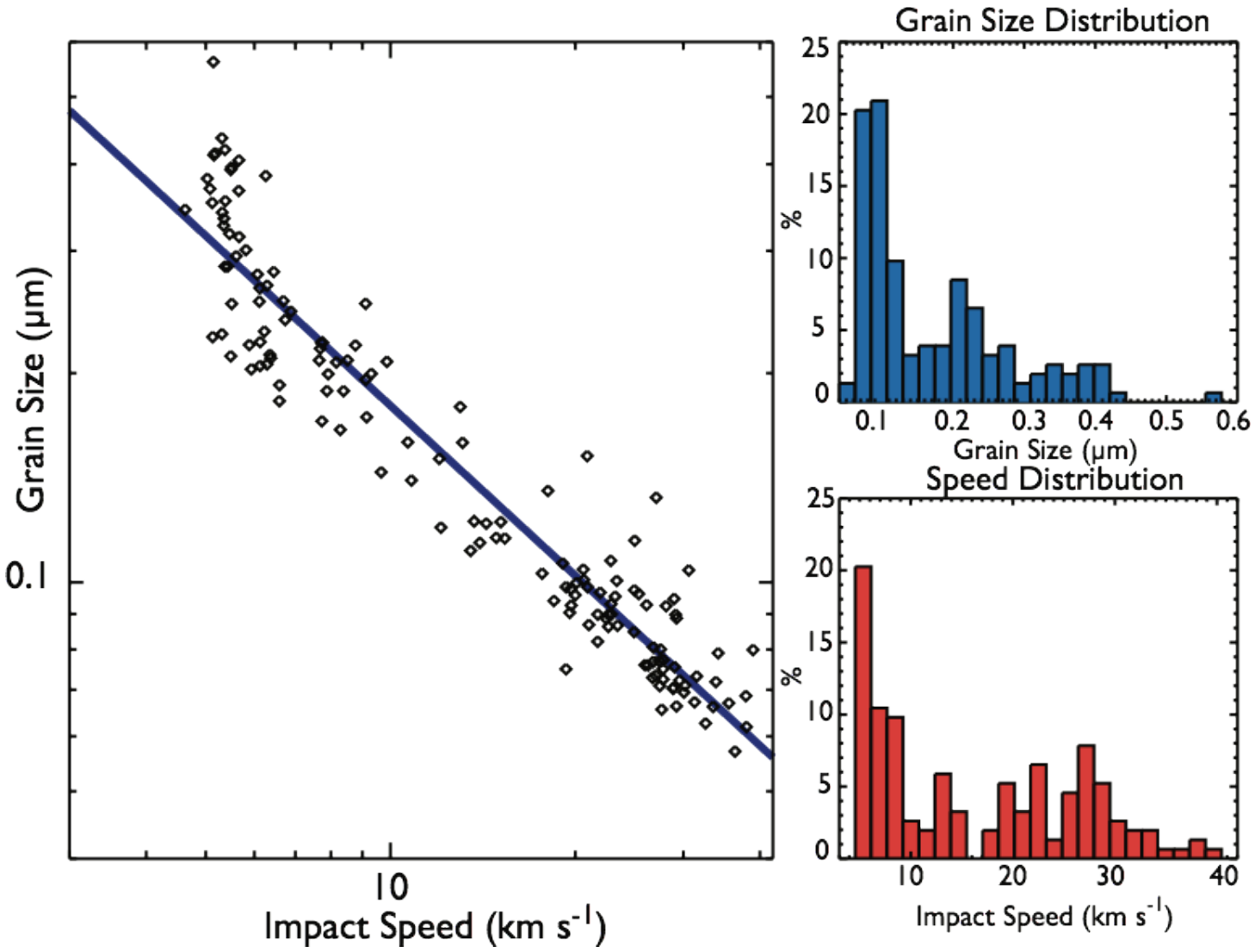


- Measures velocity distribution of the ions
- Narrow instrument aperture - filtering the angular distribution
- Few secondary ions due to ejecta

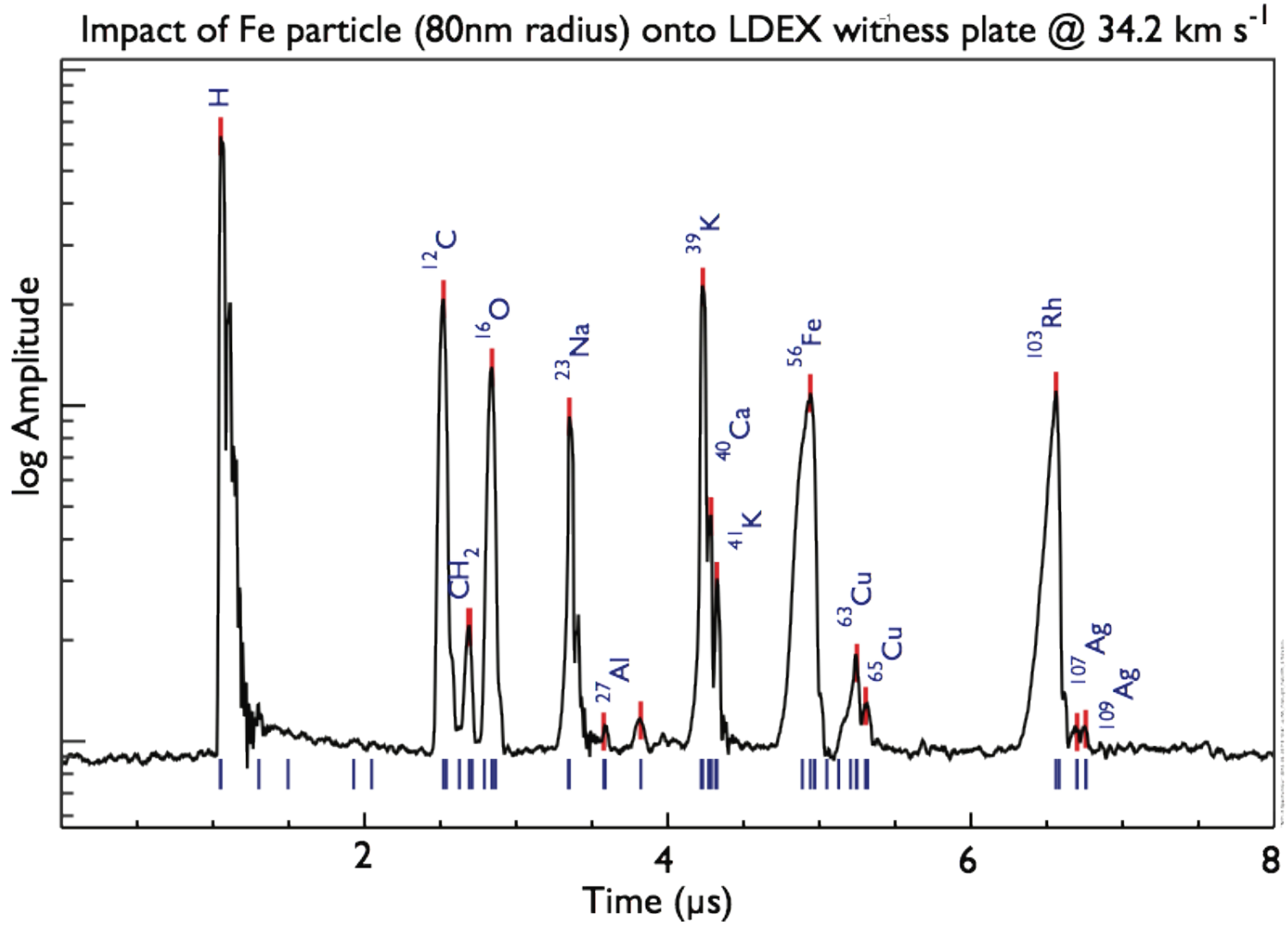
Linear Time-of-Flight Mass Spectrometer



Measured Properties of Fe Particles

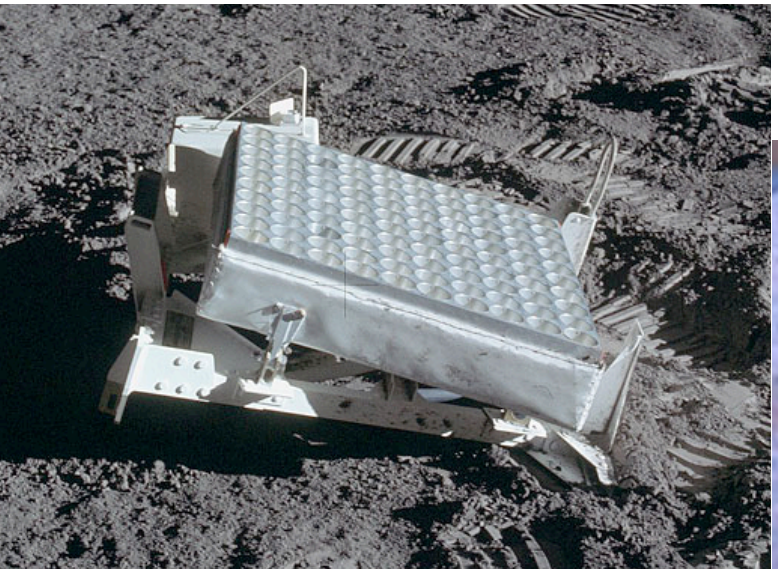


Time-of-Flight Mass Spectrum

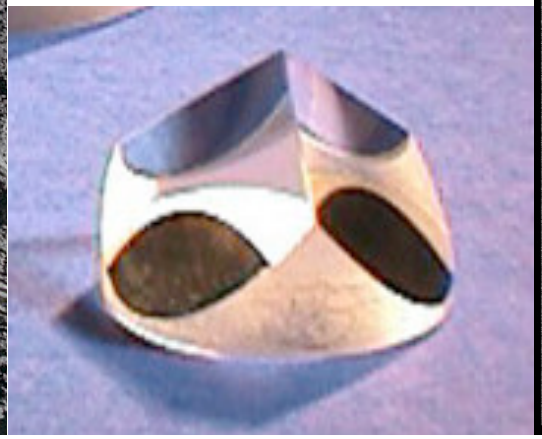


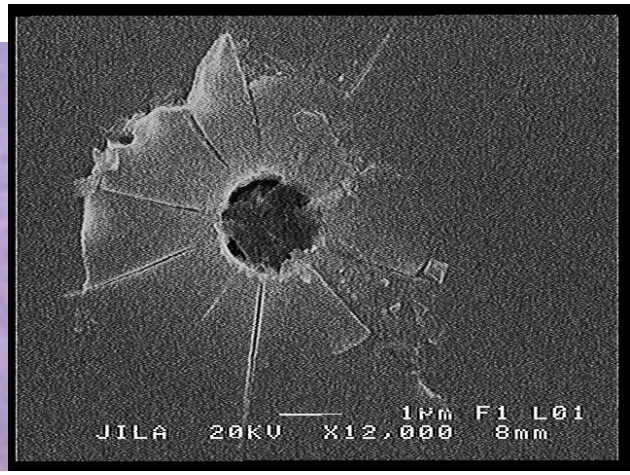
Hear talk by Anna Mocker, Fri. 8:40 am

Impact Effects on Retroreflector Faces



D. Currie (UMD)

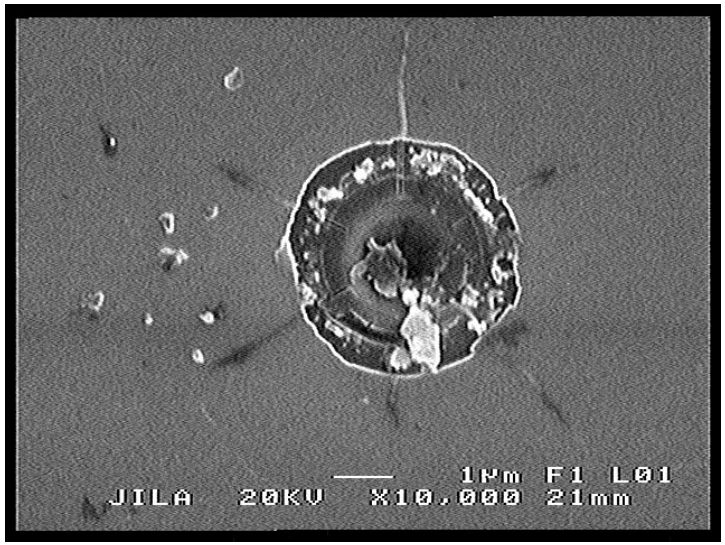




Initial results:

Impacts detectable, but not show-stoppers for reflector application

(will follow up with higher velocity tests)

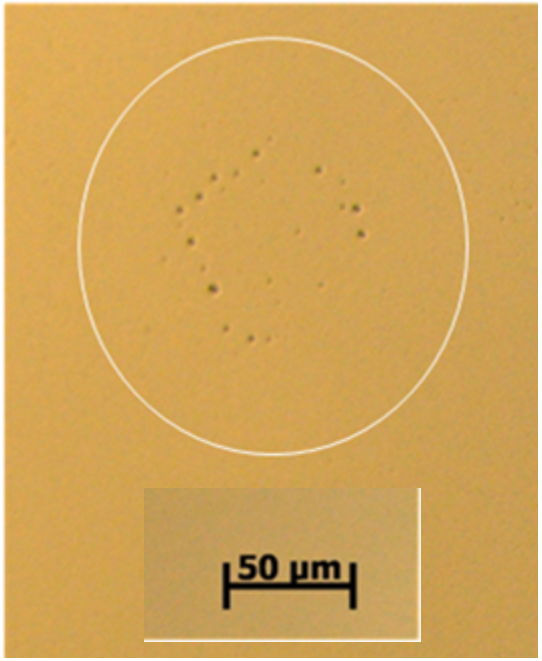


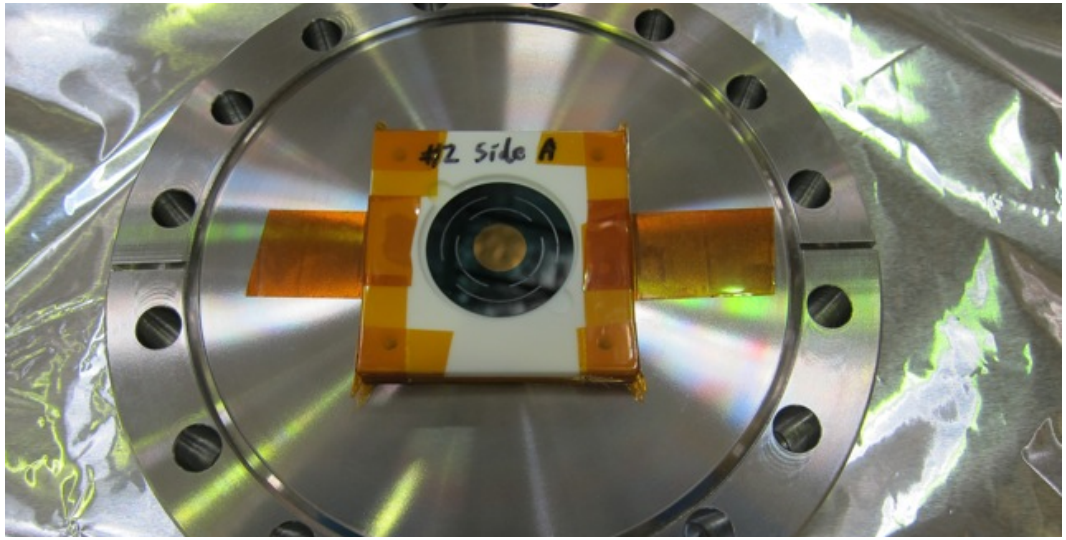
Windows for *Solar Probe Plus*

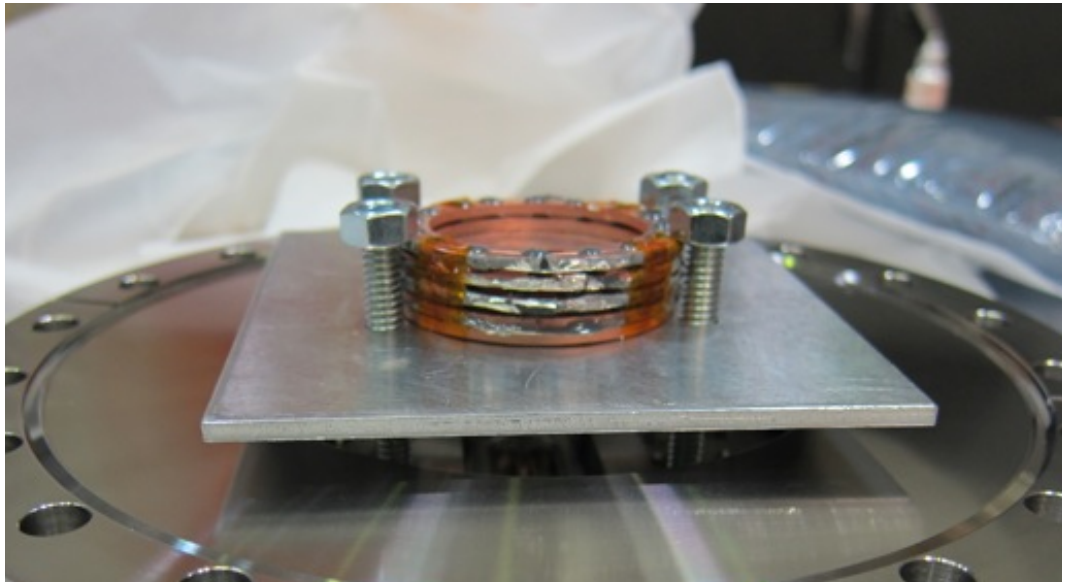
E. Christian (UMD)
Doug Mehoke

Silicon Nitride windows (thin!)

Thin Al foil stacks







SEM Chemical Assessment of Impact Site

Spectrum processing :

No peaks omitted

Processing option : All elements analyzed (Normalised)

Number of iterations = 3

Standard :

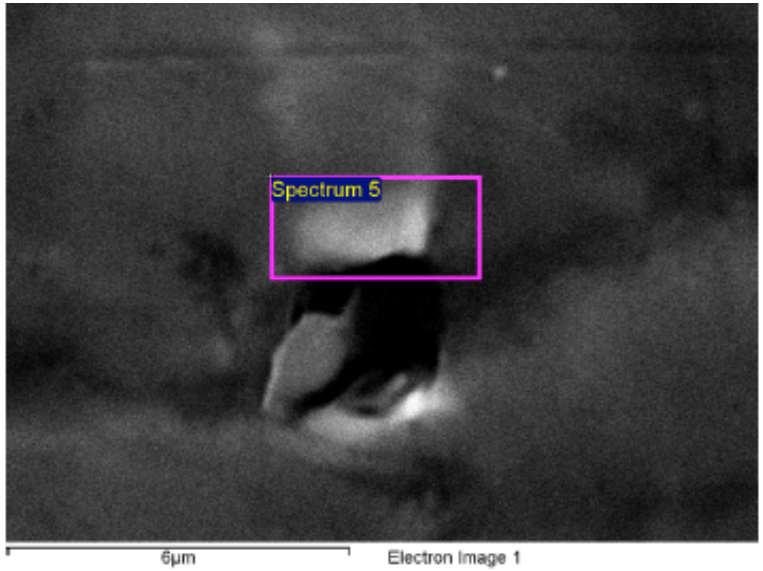
C CaCO3 1-Jun-1999 12:00 AM

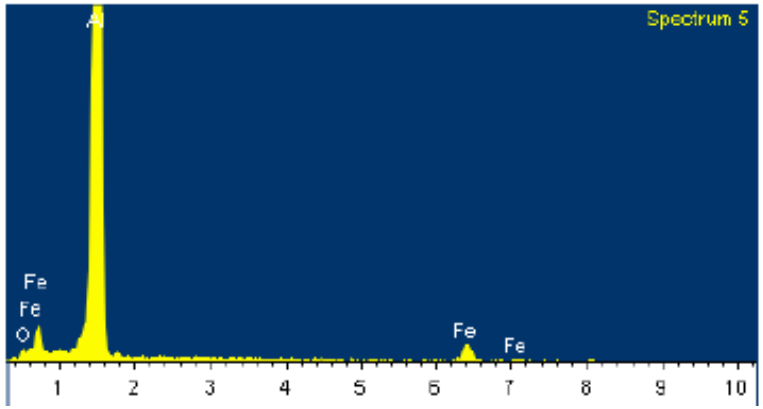
O SiO2 1-Jun-1999 12:00 AM

Al Al2O3 1-Jun-1999 12:00 AM

Fe Fe 1-Jun-1999 12:00 AM

Element	Weight%	Atomic%
C K	7.15	15.29
O K	2.42	3.89
Al K	79.67	75.86
Fe K	10.76	4.95

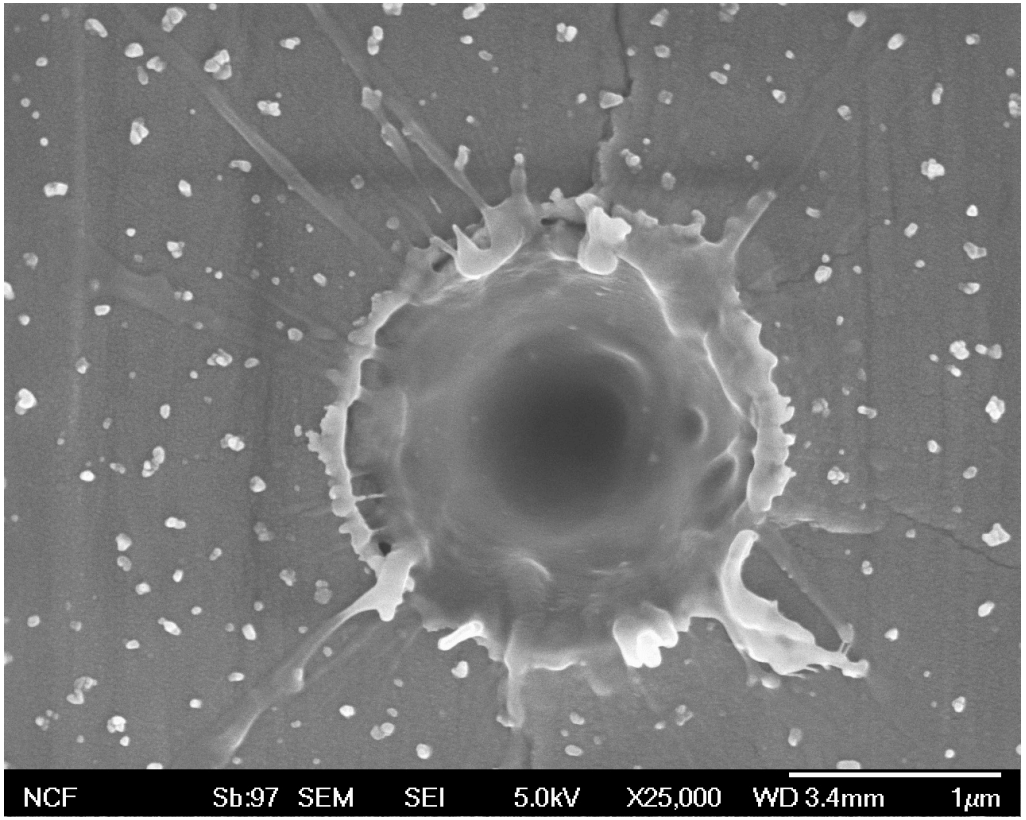




Cratering Studies

PVDF used as dust detector

- Permanent polarization of thin dielectric
- Impact crater removes material, leading to change in surface charge
- CSA measures signal
- Calibration critical!

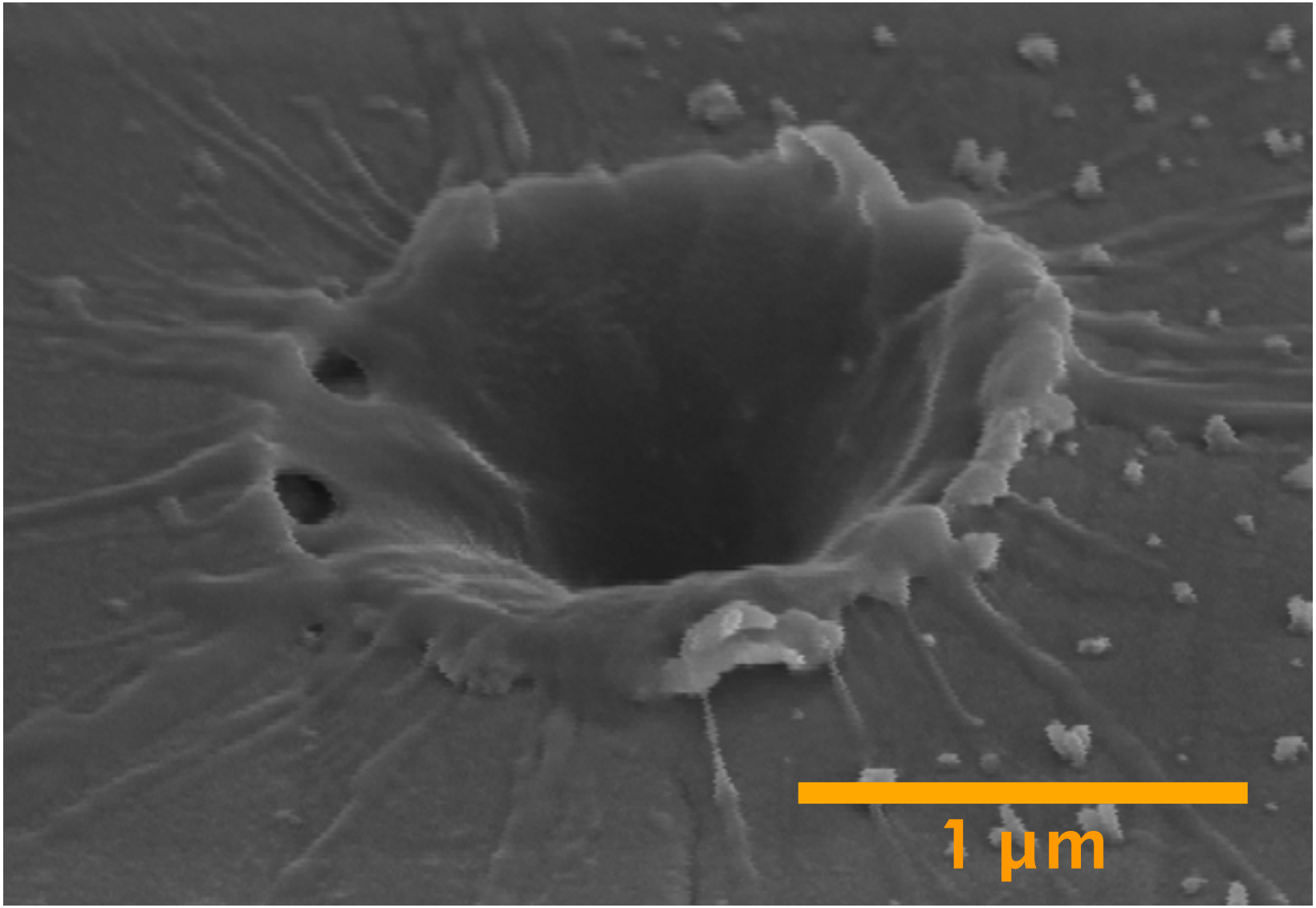


Dust Characteristics

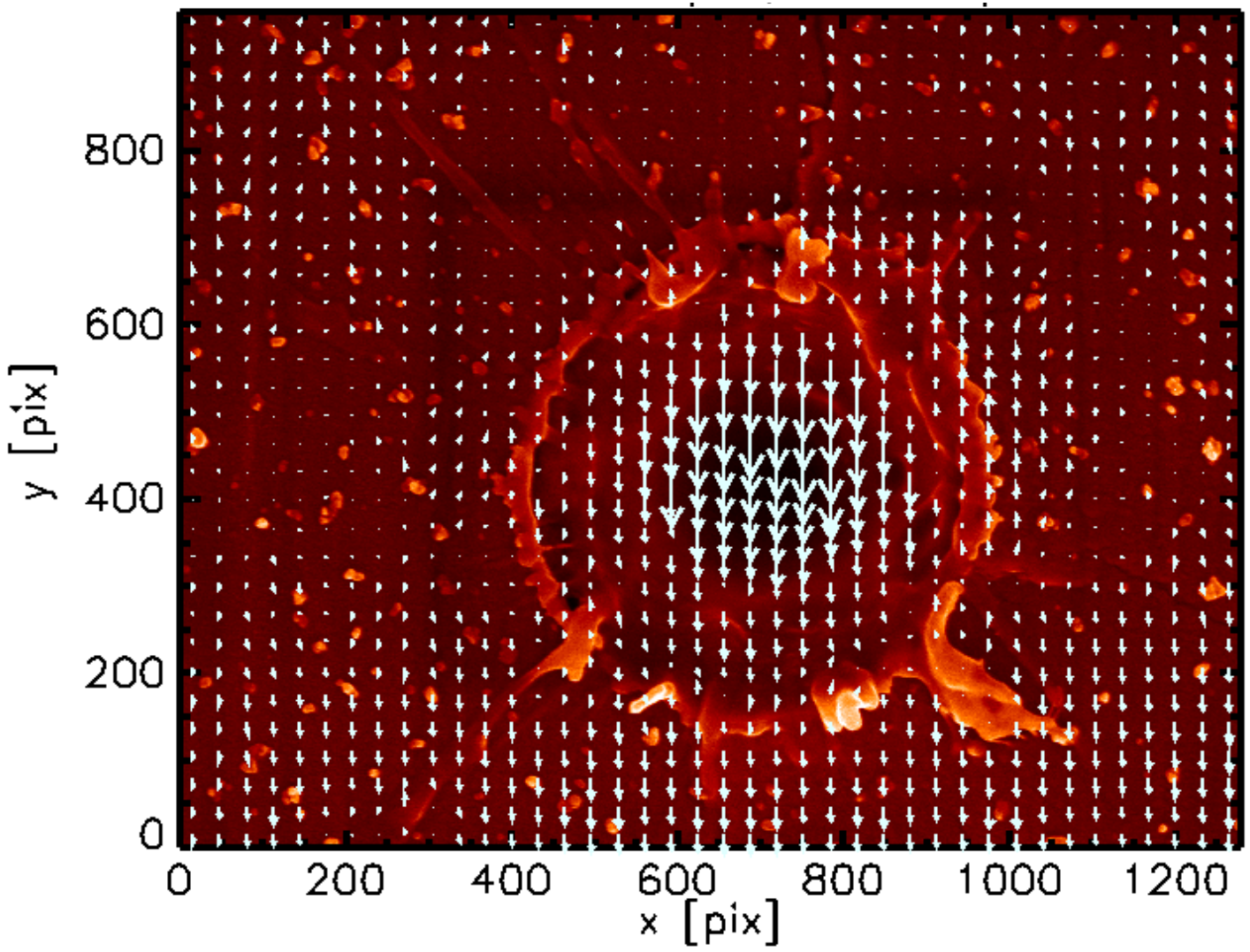
➔ Crater Characteristics

➔ Detector Signals

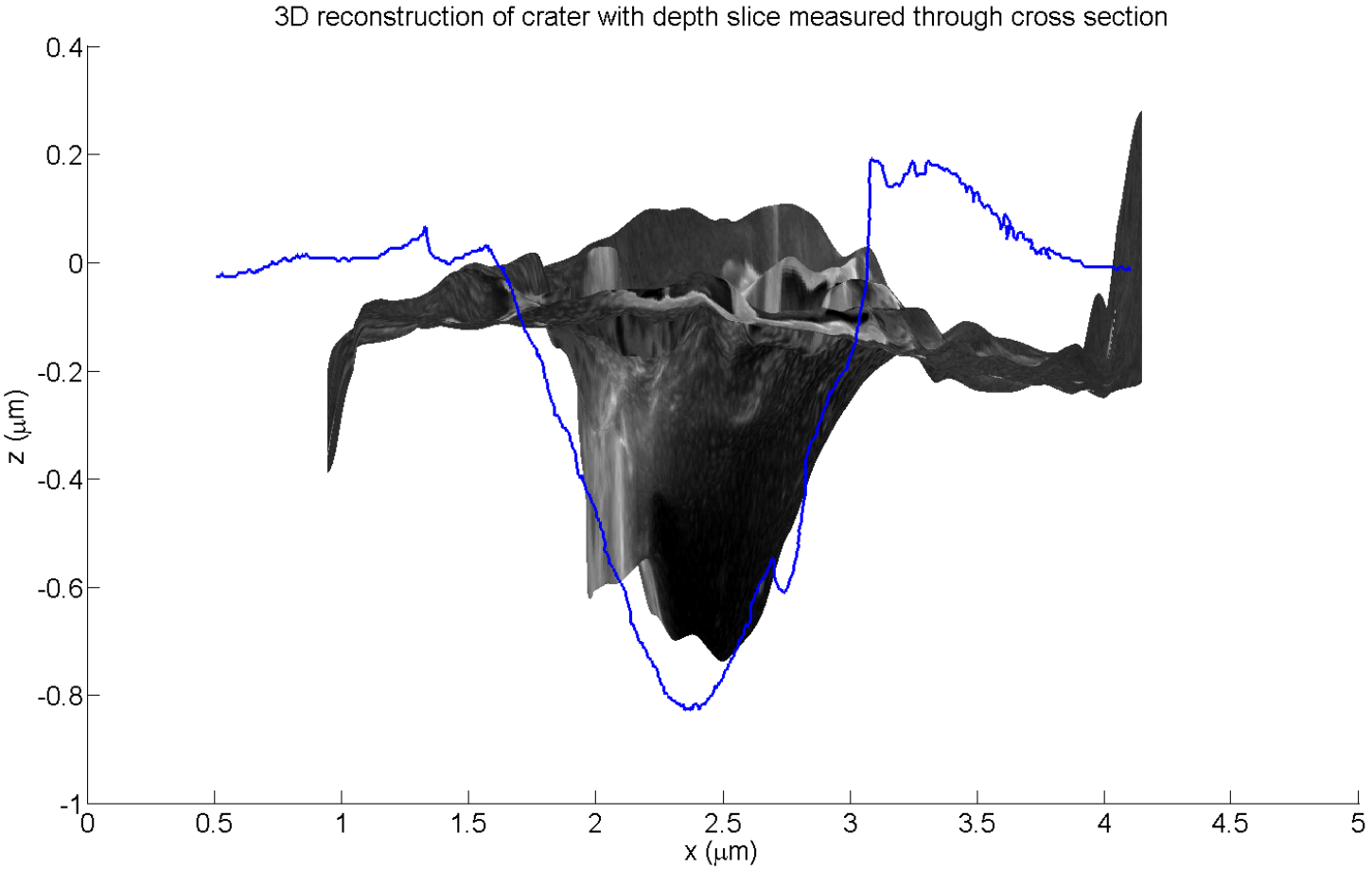
Cratering Studies



Stereoscopic Profile Reconstruction

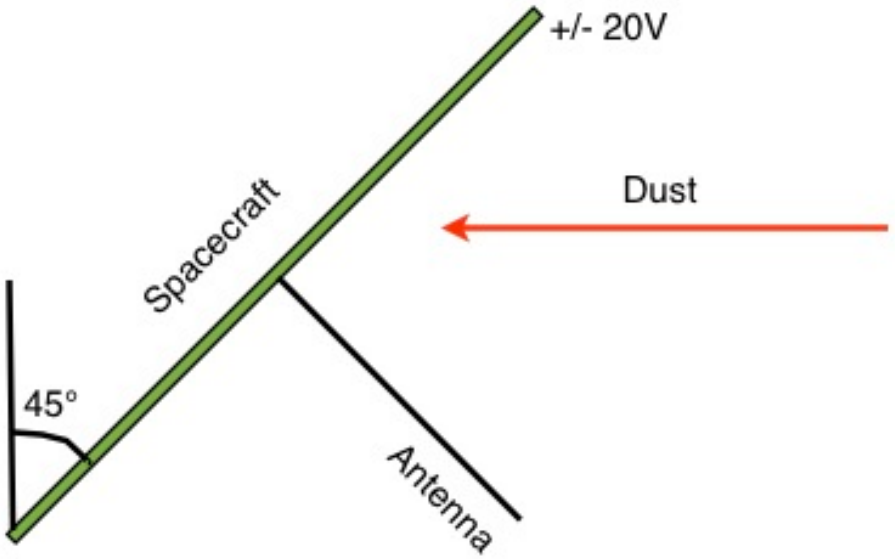


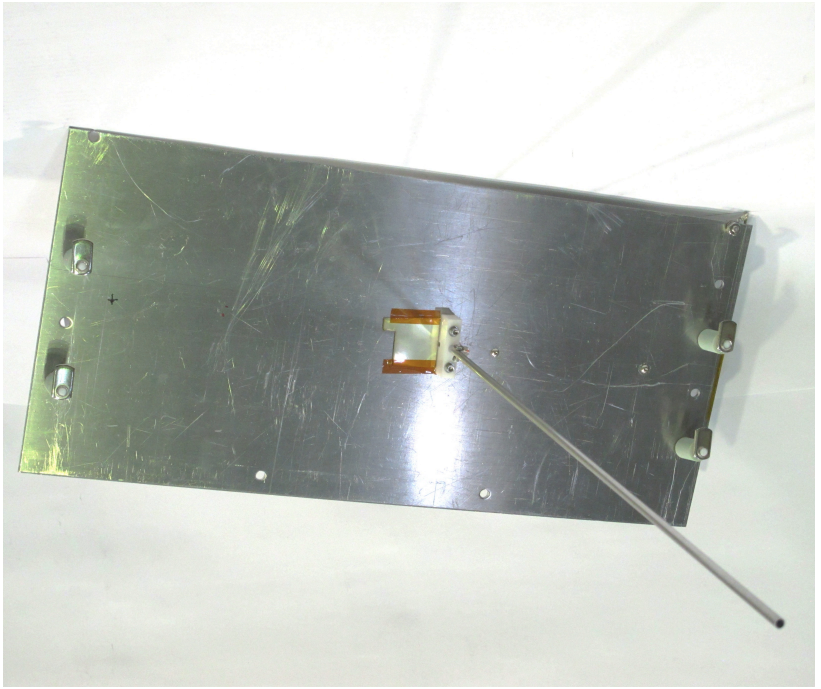
Stereoscopic Profile Reconstruction

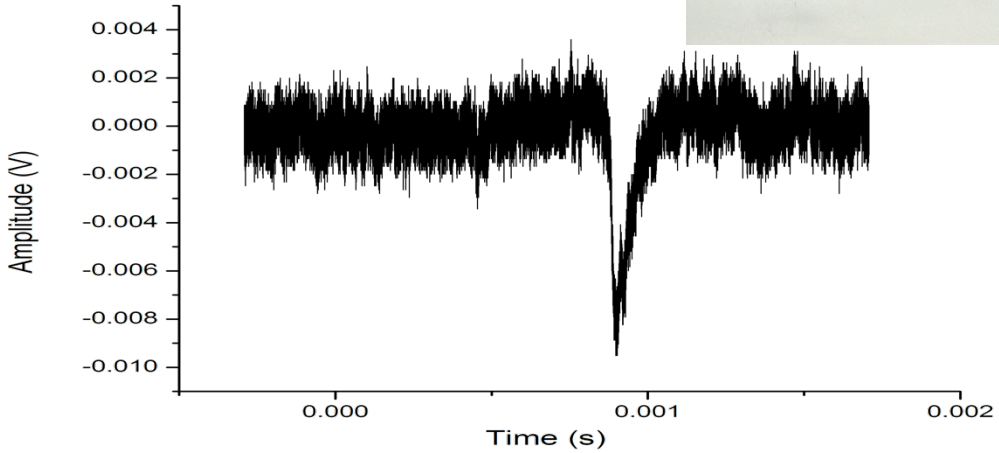


See poster by Anthony Shu, Thurs. afternoon

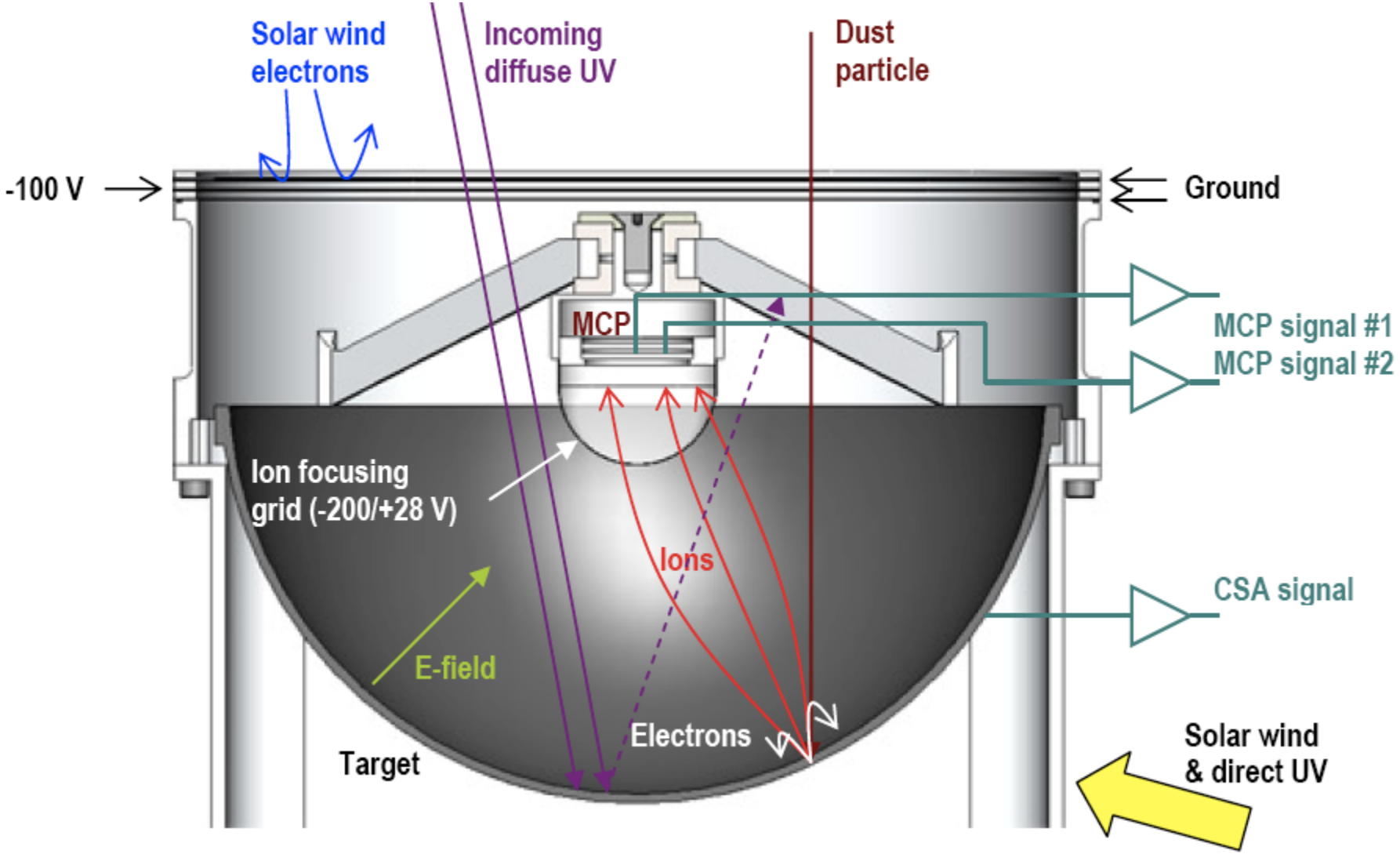
STEREO Antenna Tests



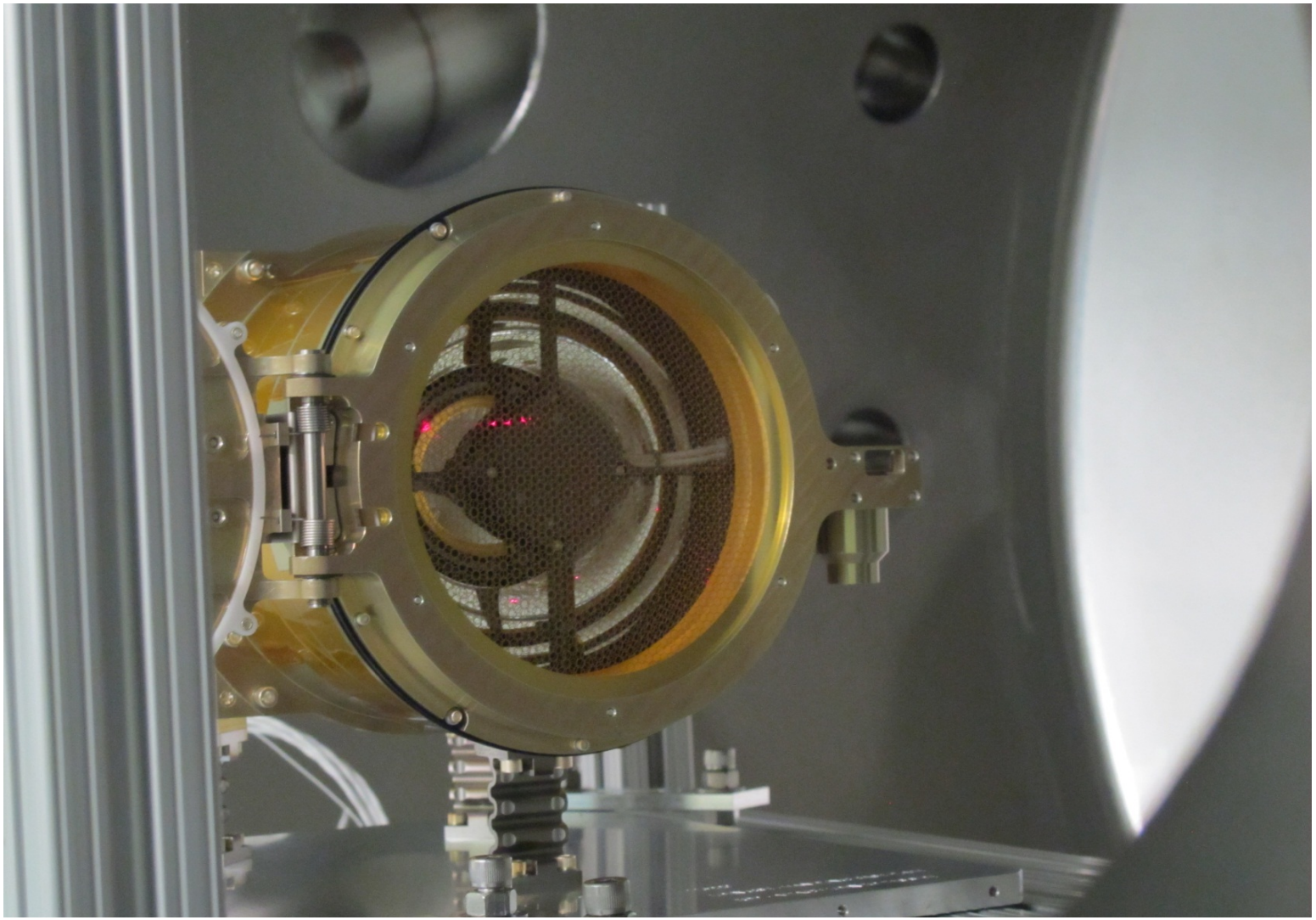




Lunar Dust EXperiment



Calibration of LDEX Engineering/Flight Models



Hear invited talk by Zoltan Sternovsky, Fri. 9:20 am

We Are Open To Collaborations!

This is a unique facility,
right here in the U.S.

Please take advantage of it!