Optical Flash Expansion Geometry in Hypervelocity Impact Events

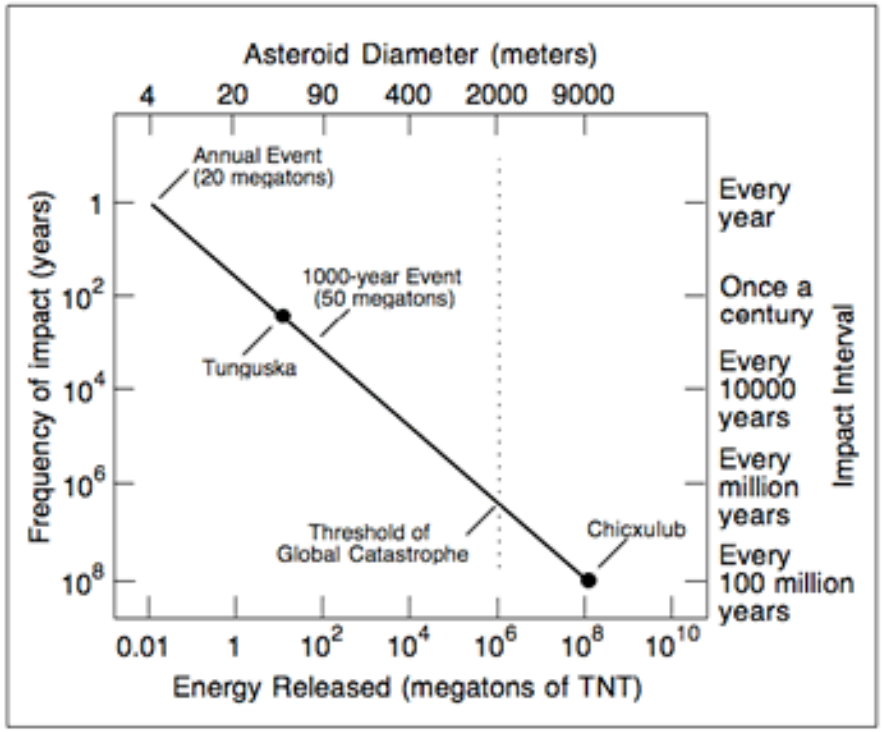
Investigation of Impact Flash Polarization Effect

Yayu Monica Hew, **Dr. Sigrid Close, Dr. Ivan Linscott**

June 6th, 2016

The Society of Taiwan Women in Science and Technology

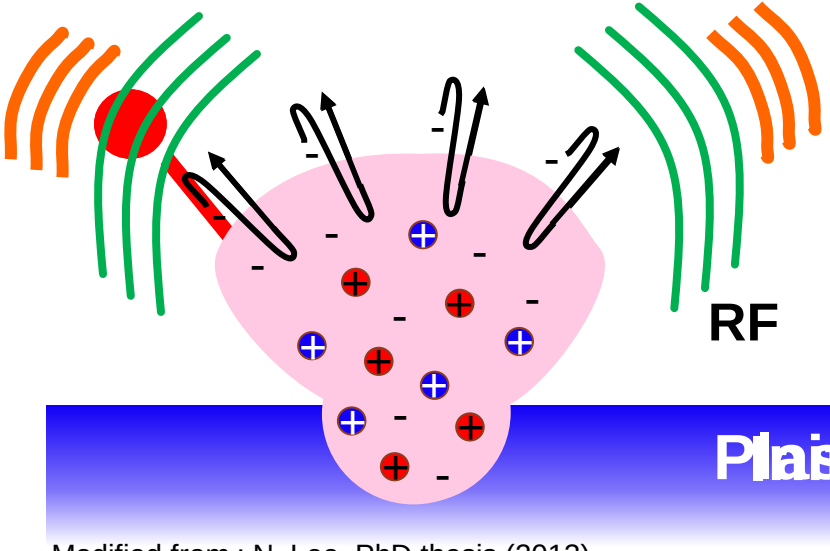
Stanford Graduate Fellowship

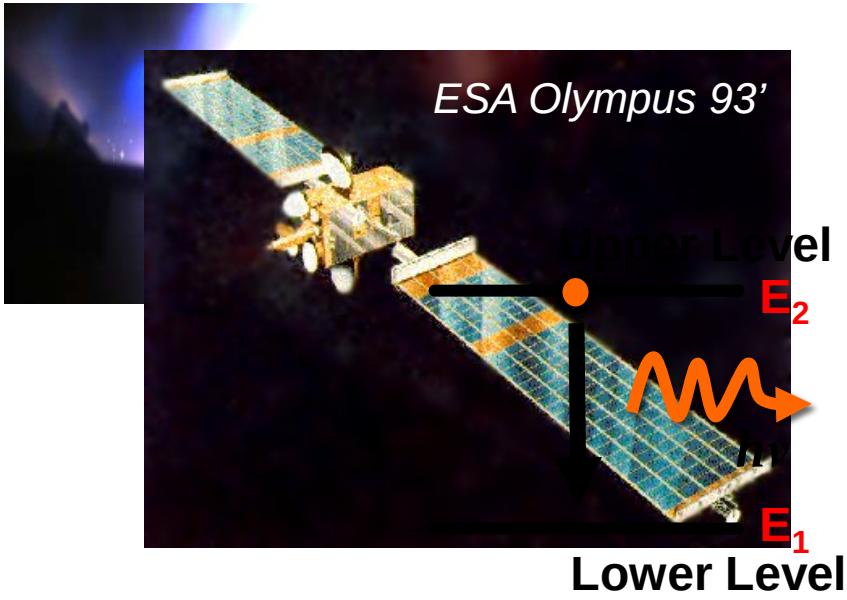


Source: NASA, Near Earth Impact.

Fine grain sand 0.0161 g @ 4.65 km/s
impacting a differentially charged target ~ ± 145V

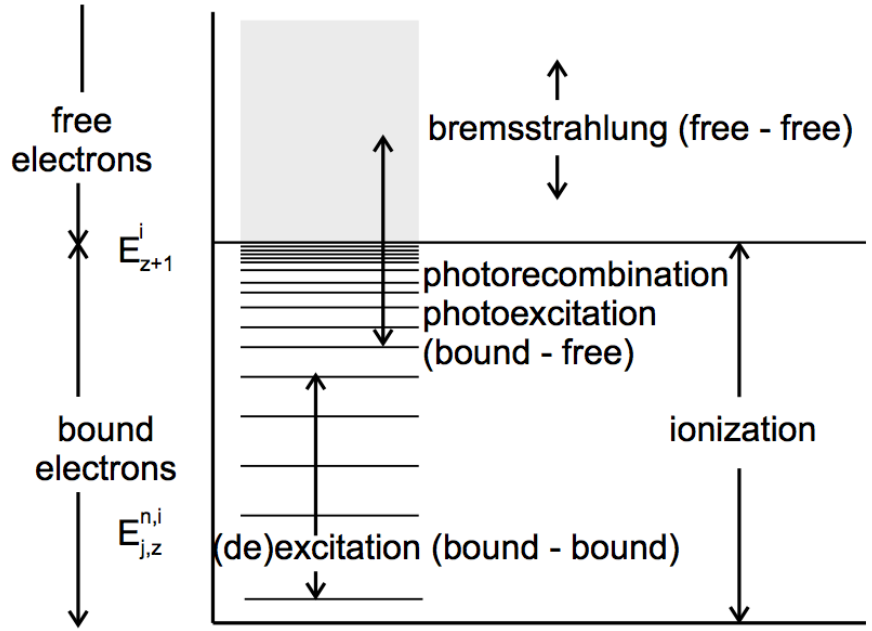
Hypervelocity Impact Phenomenon

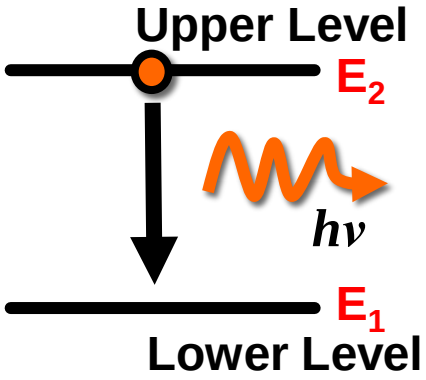




Modified from : N. Lee, PhD thesis (2013)

Radiation Mechanisms in Plasma





[1] Aubrecht et al. 2000.

Problem Overview

Science Question

How do the meteoroids and debris connect to the impact flash ?

Optical Impact Flash

Measured optical spectrum

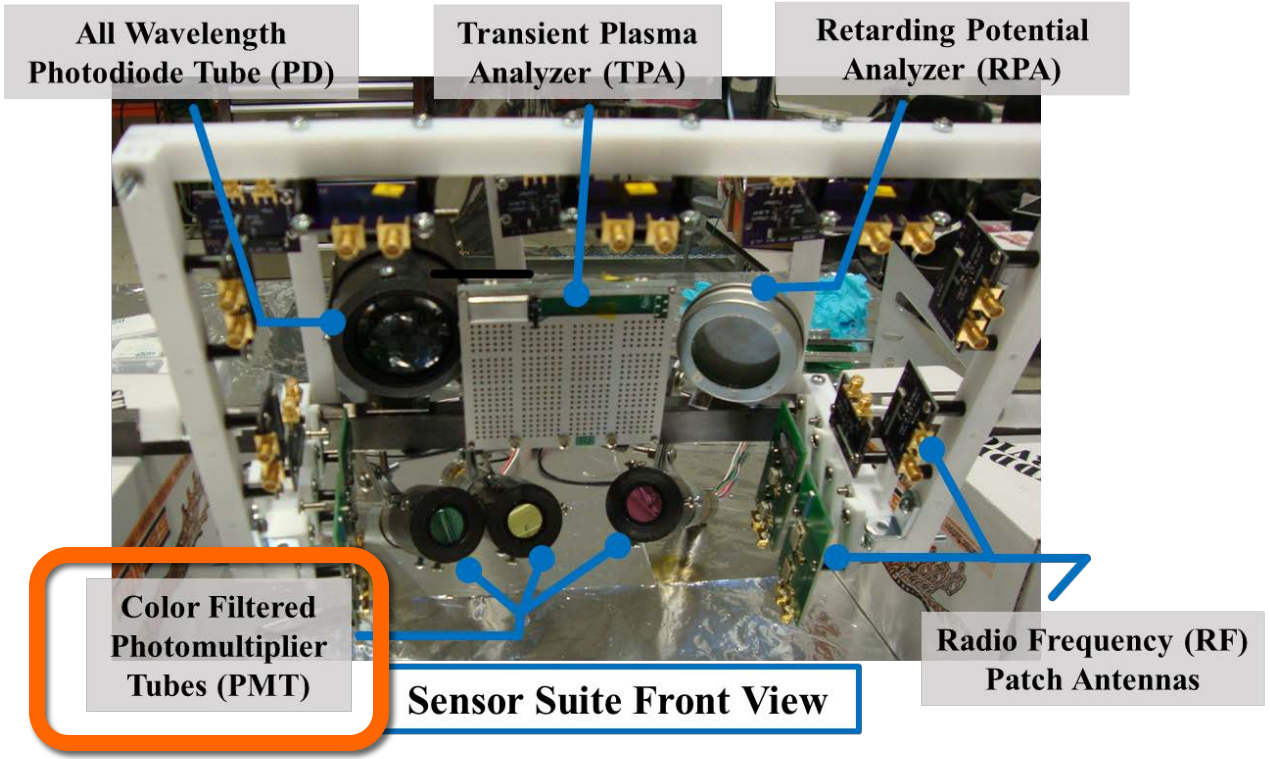
Plasma Parameters

Temperature, Density, Mobility…

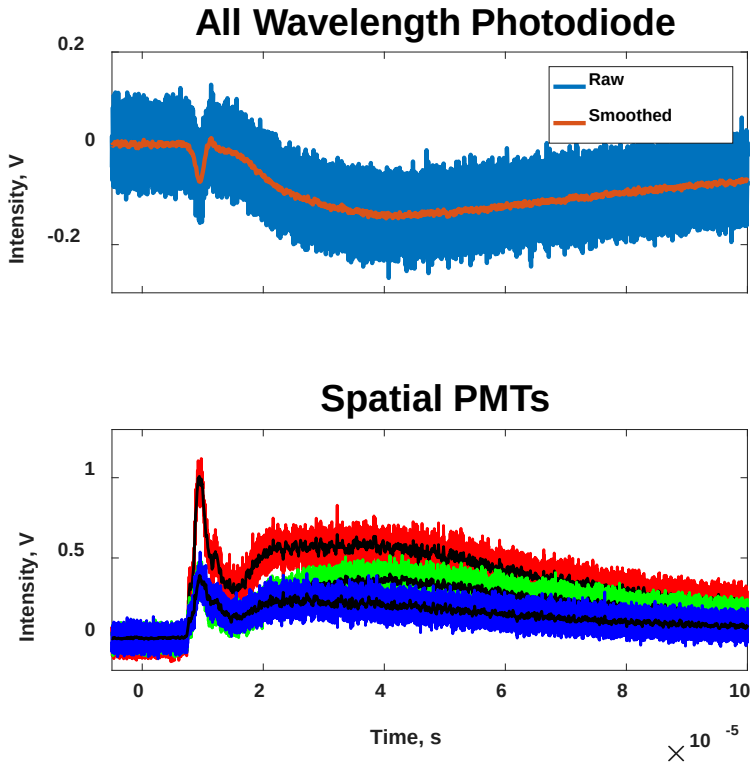
Impactor Characteristics

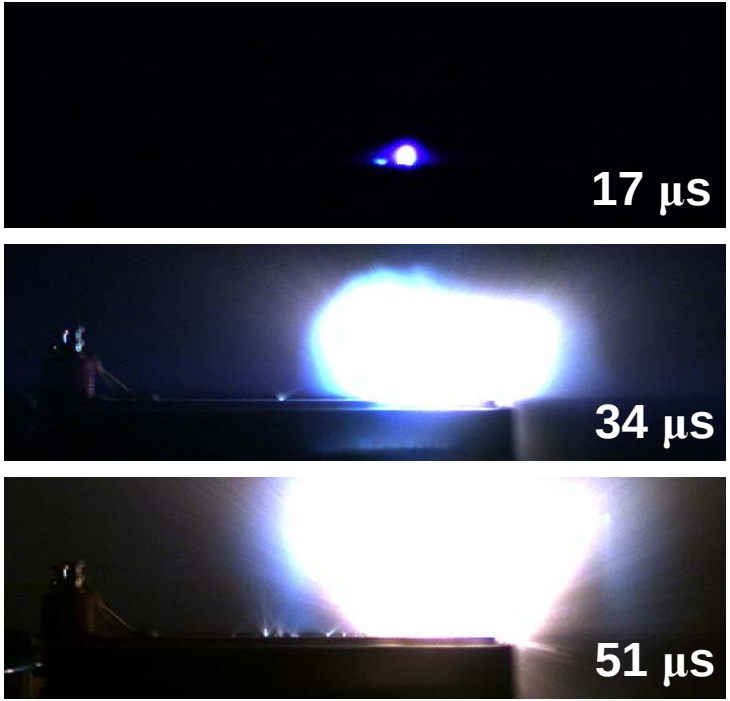
Mass, Velocity, Composition

Multi-Physics Sensor Suite

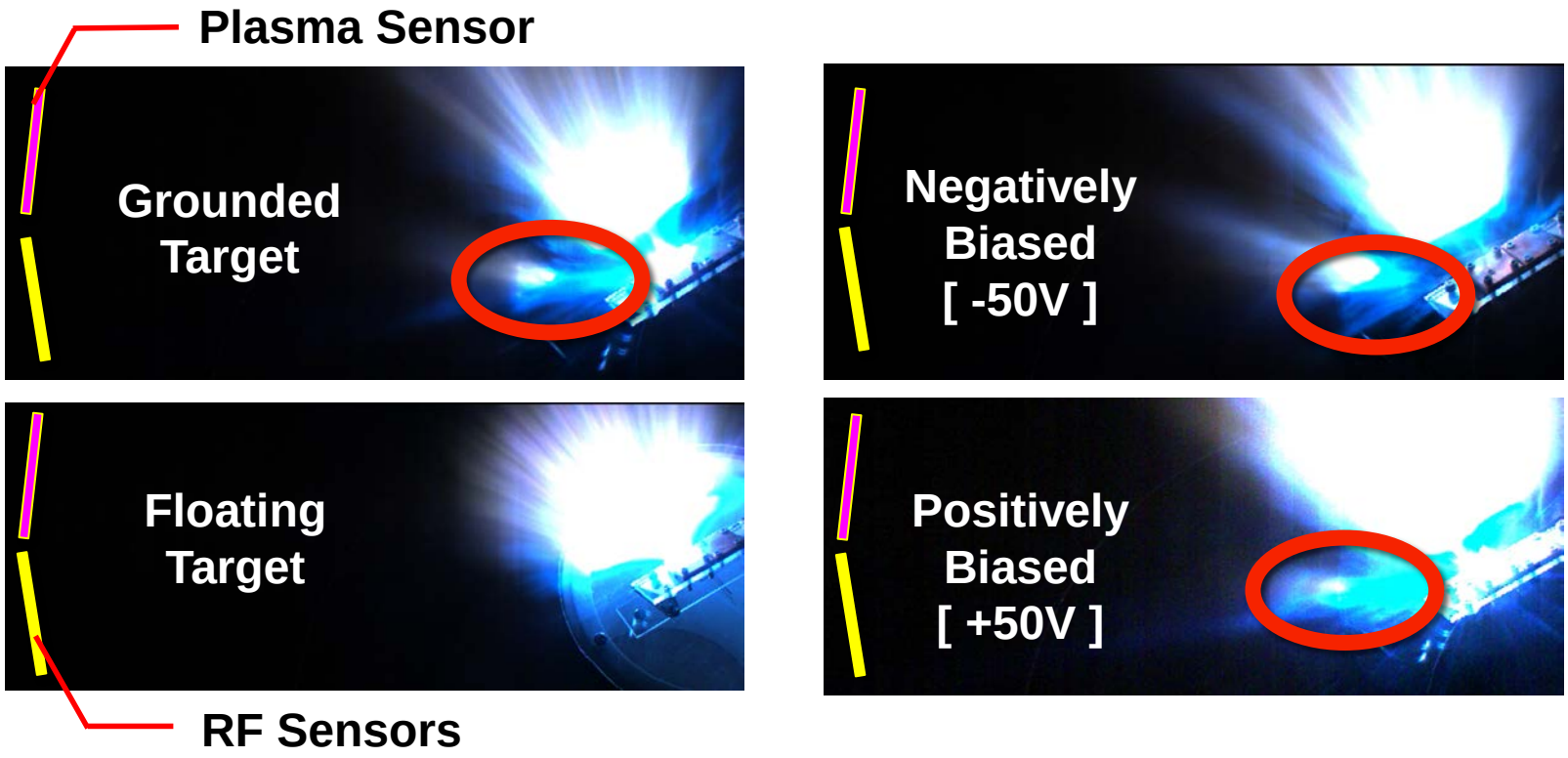


Impact Flash Spatial Measurement

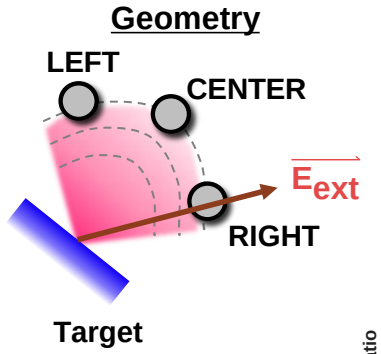


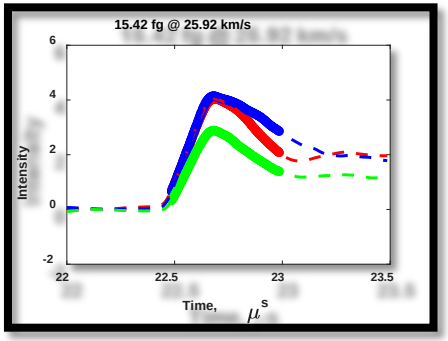


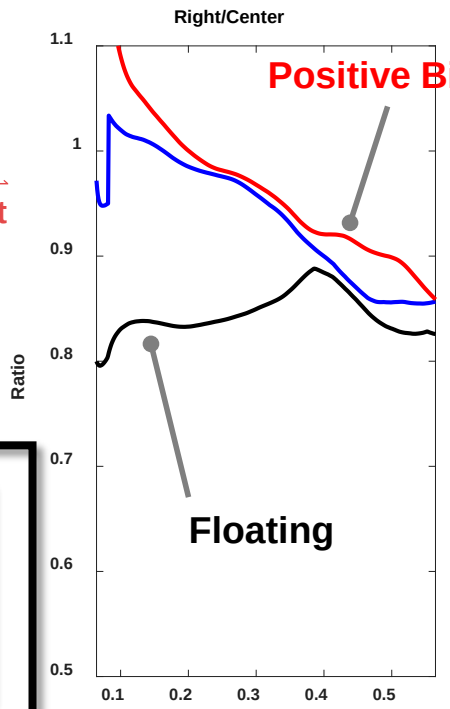
AVGR Optical Expansion Polarization

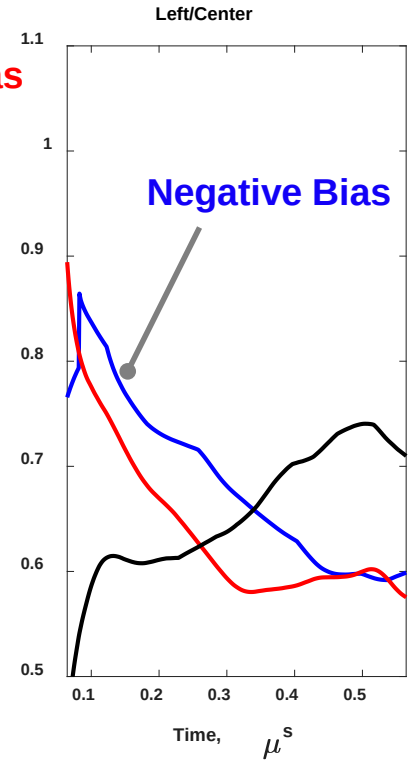


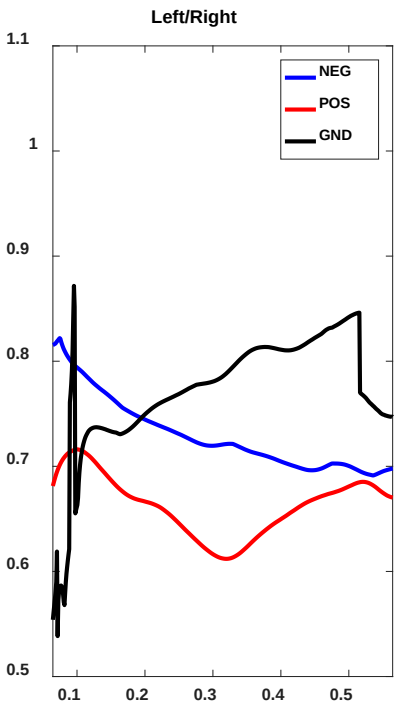
CCLDAS Dust Accelerator Impact Flash











Summary

- Potential **Polarization effect** observed in impact events at both dust accelerator and light gas gun facilities
- Impact Plasma Flash can be used as a diagnostic tool for hypervelocity impactors in space

Acknowledgement

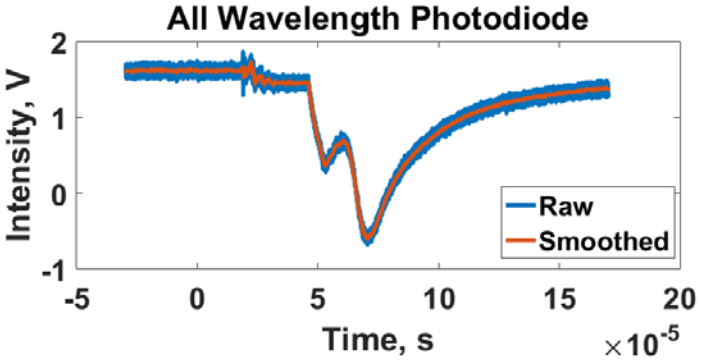
- SESS impact team members: **Dr. Ashish Goel, Mr. Andrew Nuttall, Mr. Paul Tarantino, and Dr. Dave Lauben**
- Help and support from staff members at Colorado Center for Lunar Dust and Atmospheric Studies **(CCLDAS),** CO, USA.
- Help and support from staff members at NASA Ames Vertical Gun Range **(AVGR)**, CA, USA.
- Support from U.S. Department of Energy, Career Award
- Student fellowship support from Stanford Graduate Fellowship
- Student travel support from The Society of Taiwan Women in Science and Technology (TWiST, **台灣女科技人學會)**

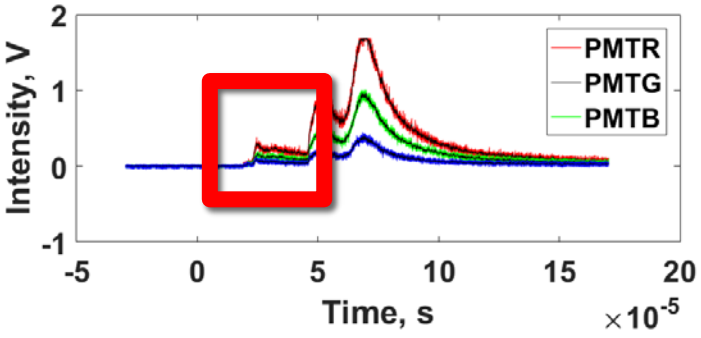
Thank you.

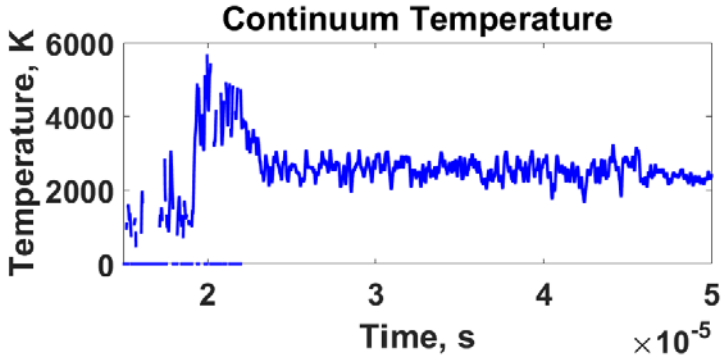
The Society of Taiwan Women in Science and Technology

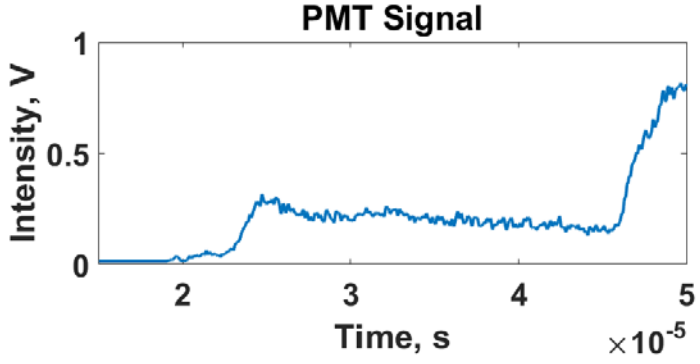
Stanford Graduate Fellowship

Ongoing Work : Temperature Measurement

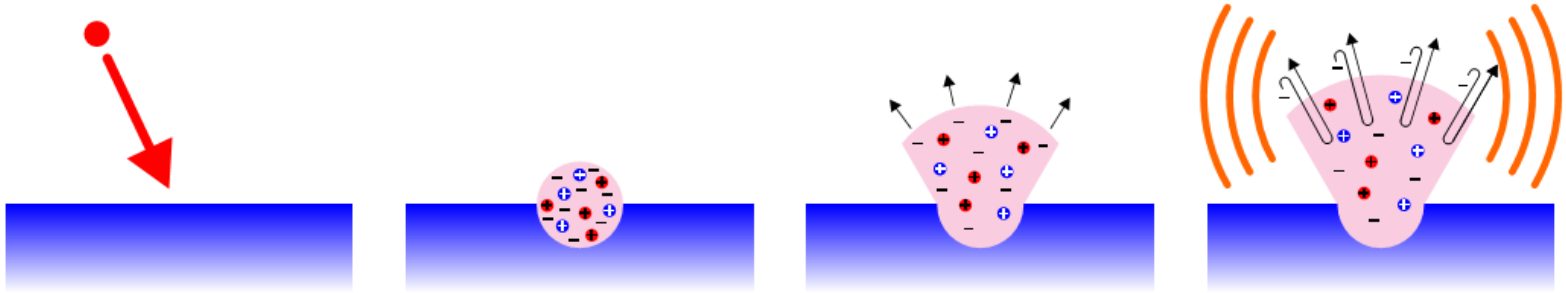






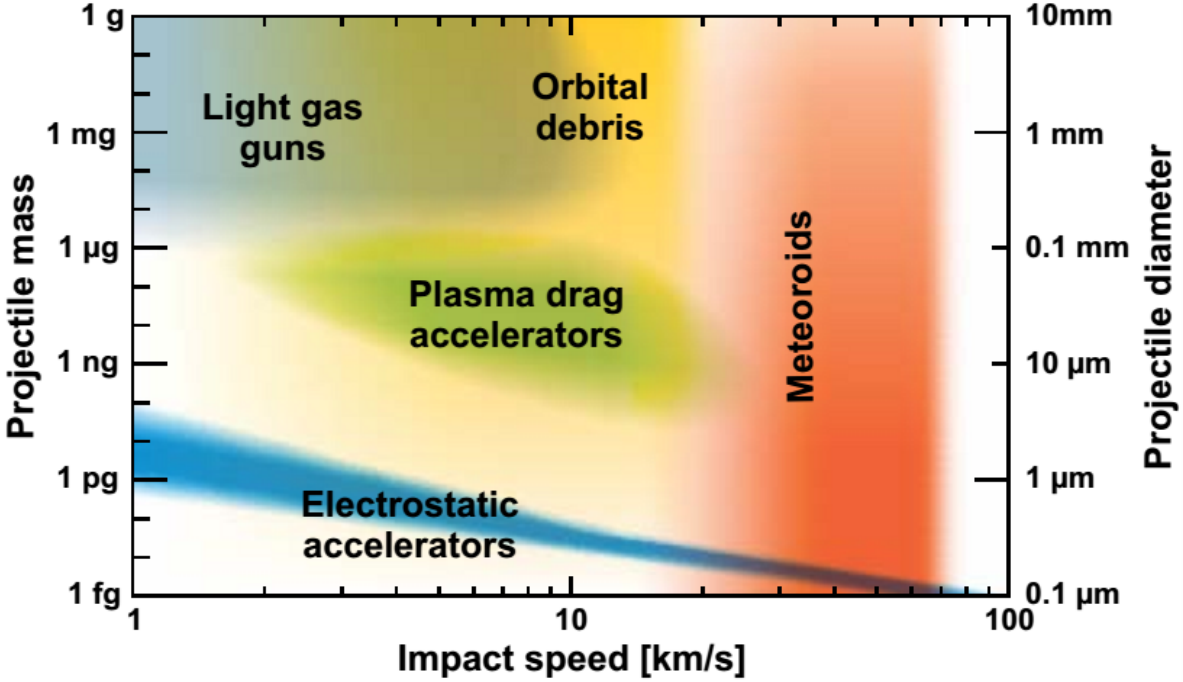


Hypervelocity Impact Plasma Proposed Model



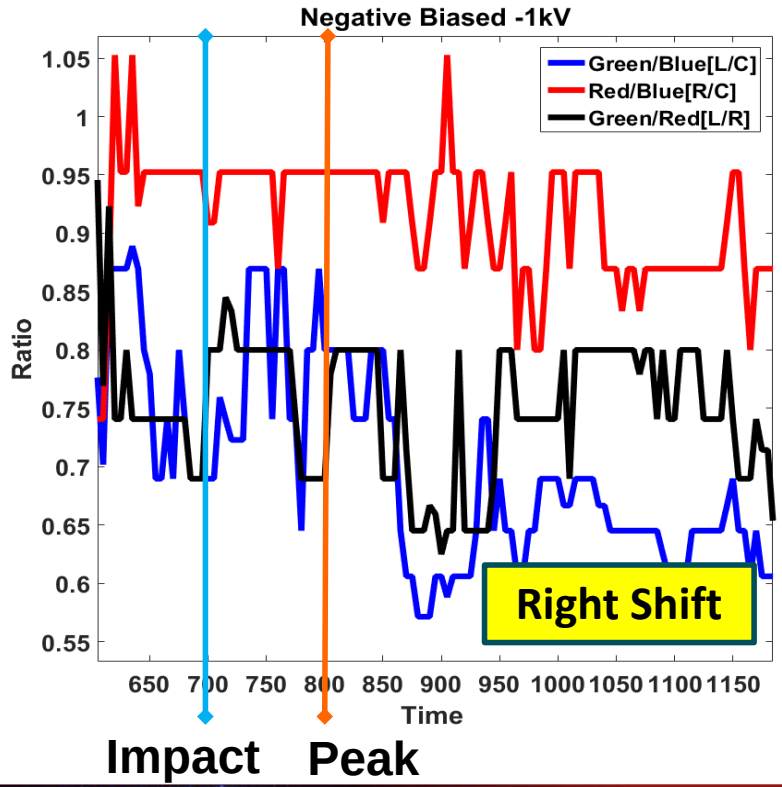
Source: N. Lee, PhD thesis (2013)

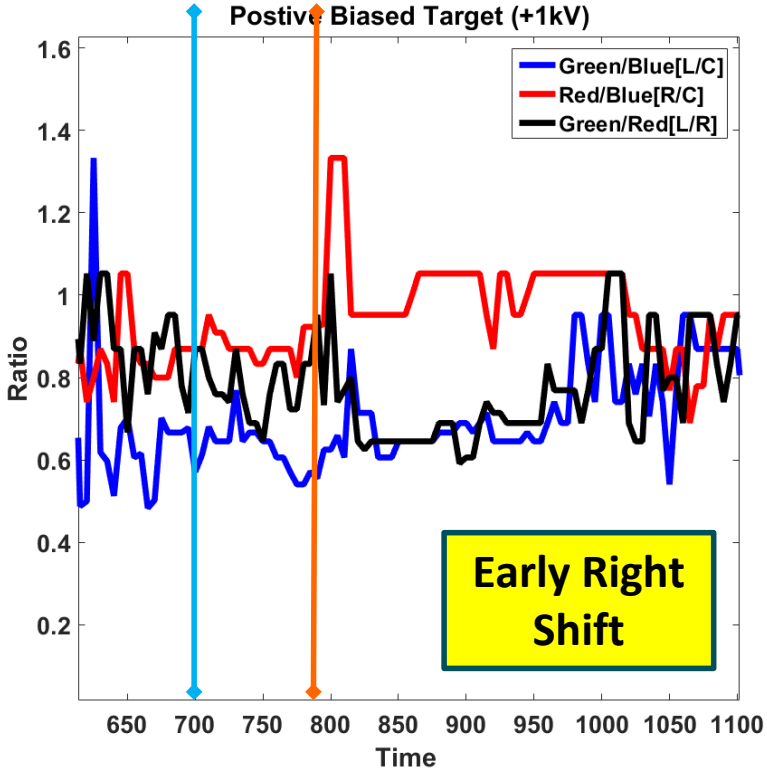
Hypervelocity Impact Facilities

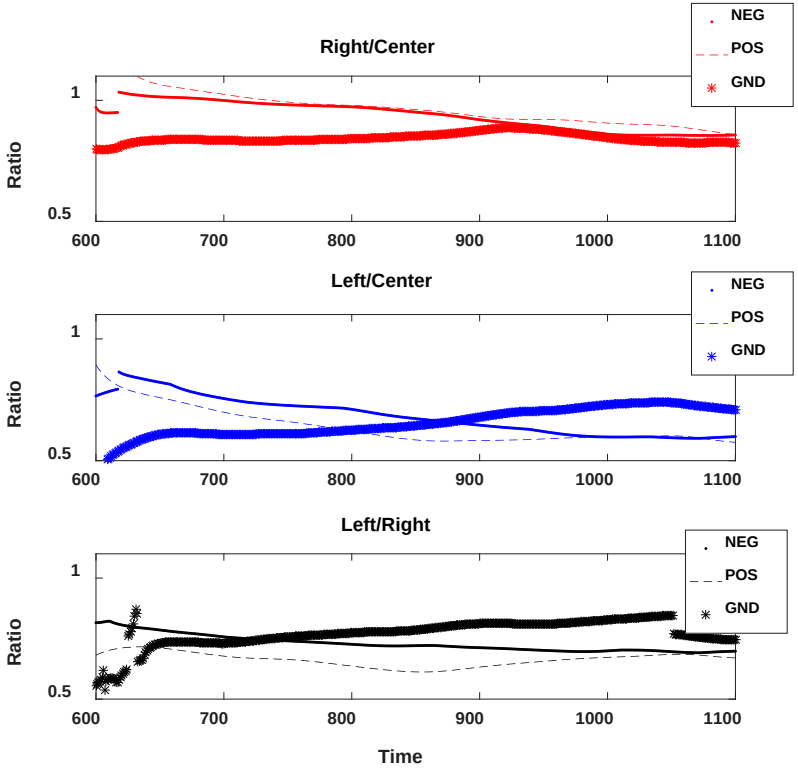


Source: N. Lee, PhD thesis (2013)

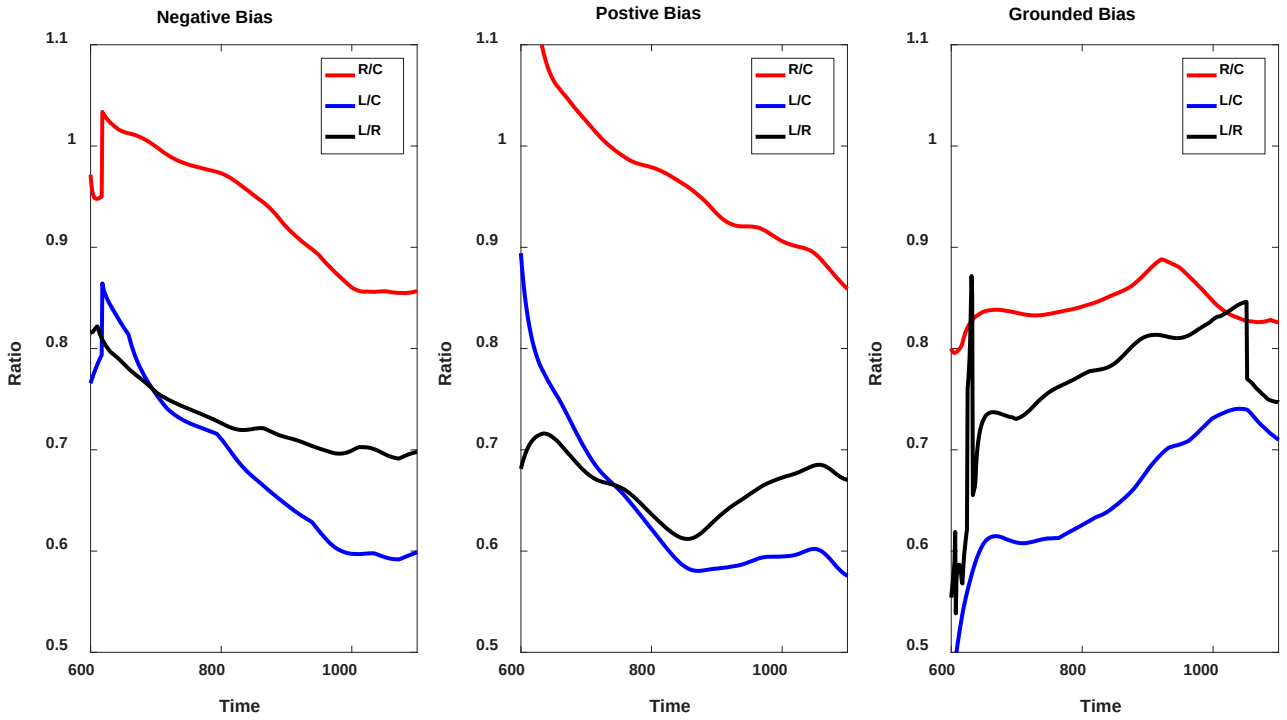
Polarization Effect



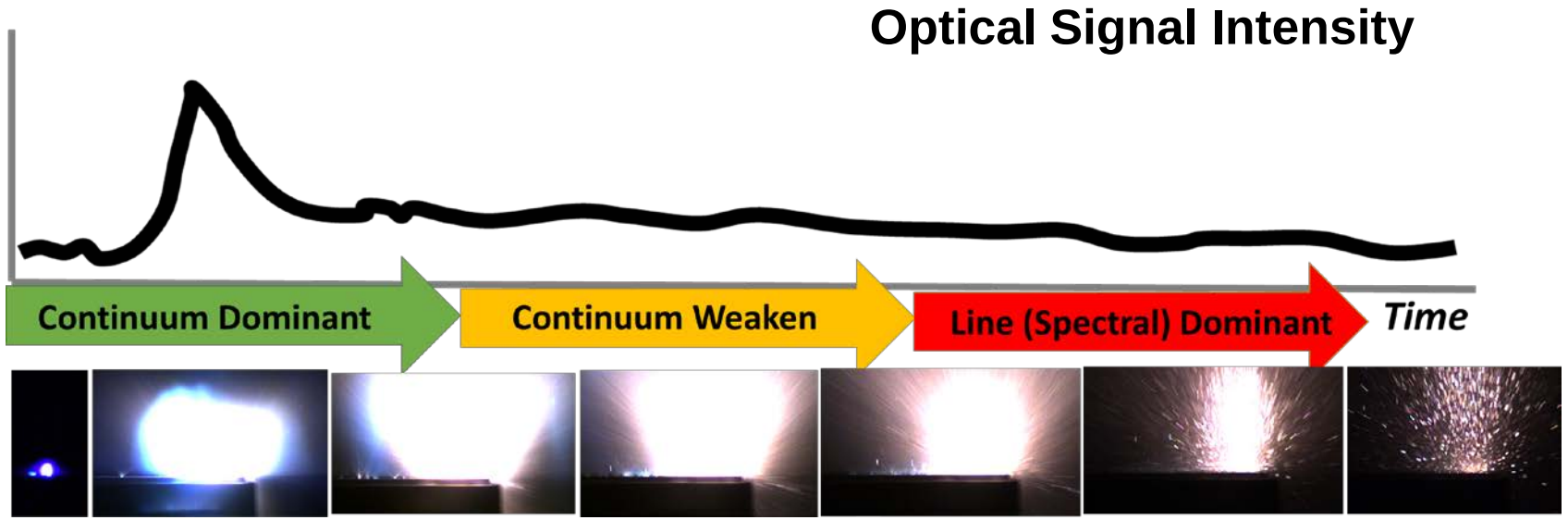



Right/Center
NEG
POS
GND
Ratio
1
0.5
600
700
800
900
1000
1100
Left/Center
NEG
POS
GND
Ratio
1
0.5
600
700
800
900
1000
1100
Left/Right
NEG
POS
GND
Ratio
1
0.5
600
700
800
900
1000
1100
Time

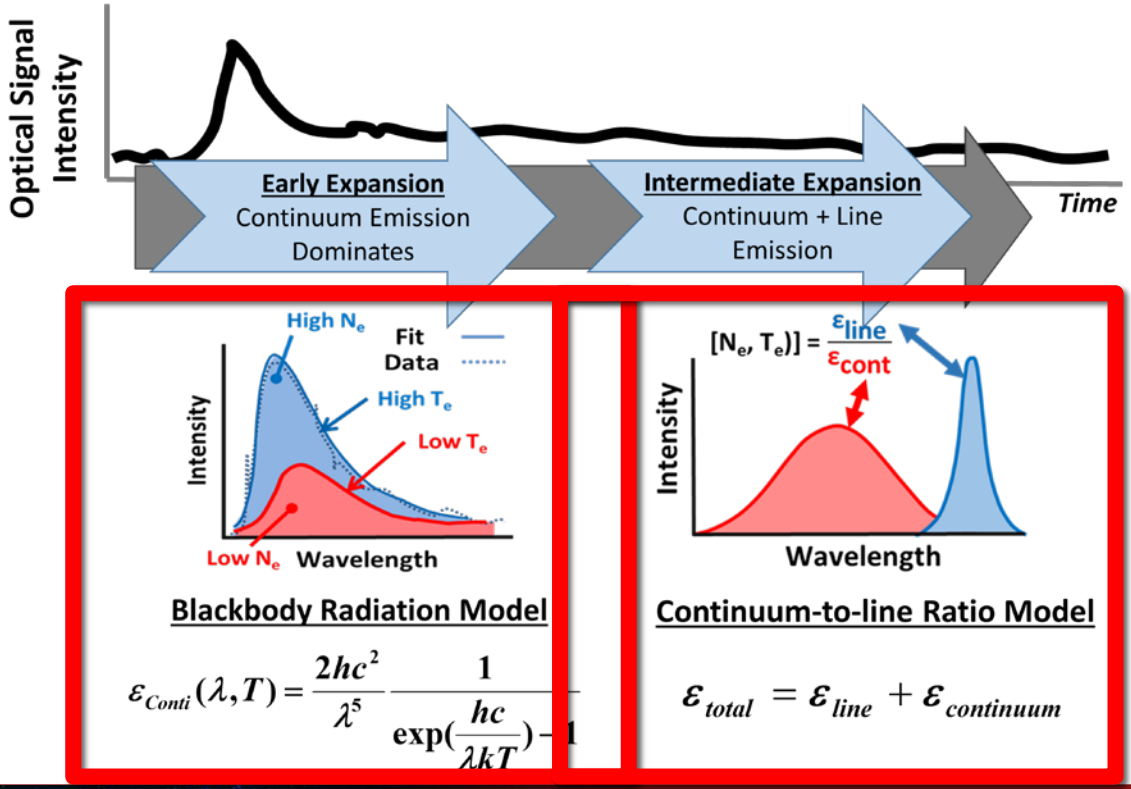
Different Bias Types



Measured Emission Radiation Evolution



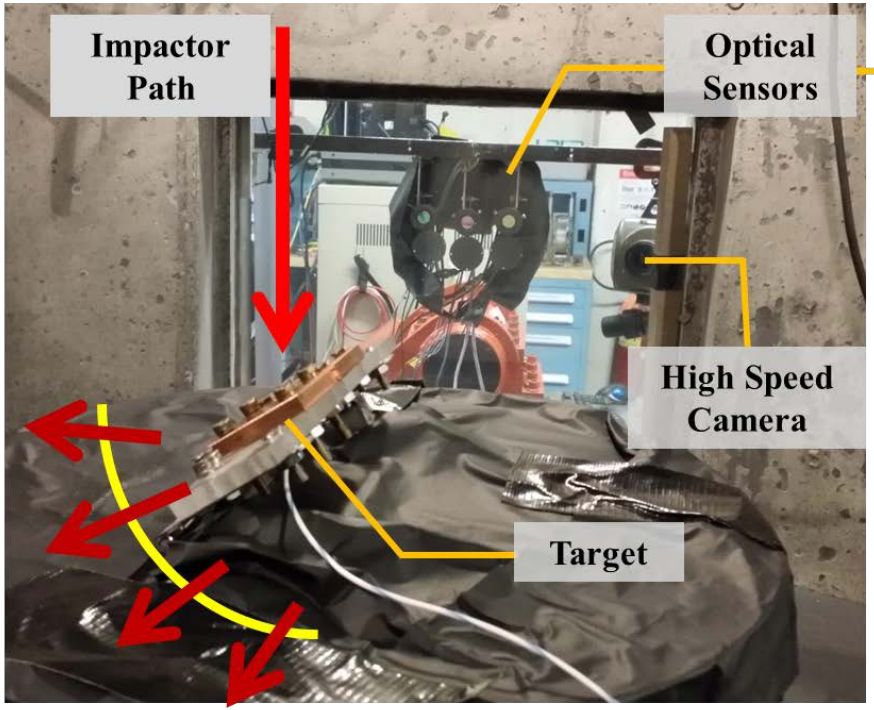
Hypervelocity Impact Radiation Model

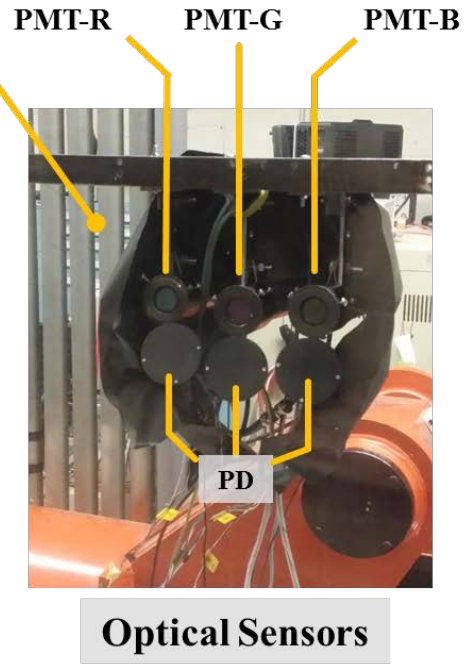


- Non-ideal / Collisional
- LTE
- Optically thick

- Ideal / Collisionless
- LTE breakdown
- Optically thin

Optical Sensor Setup for AVGR





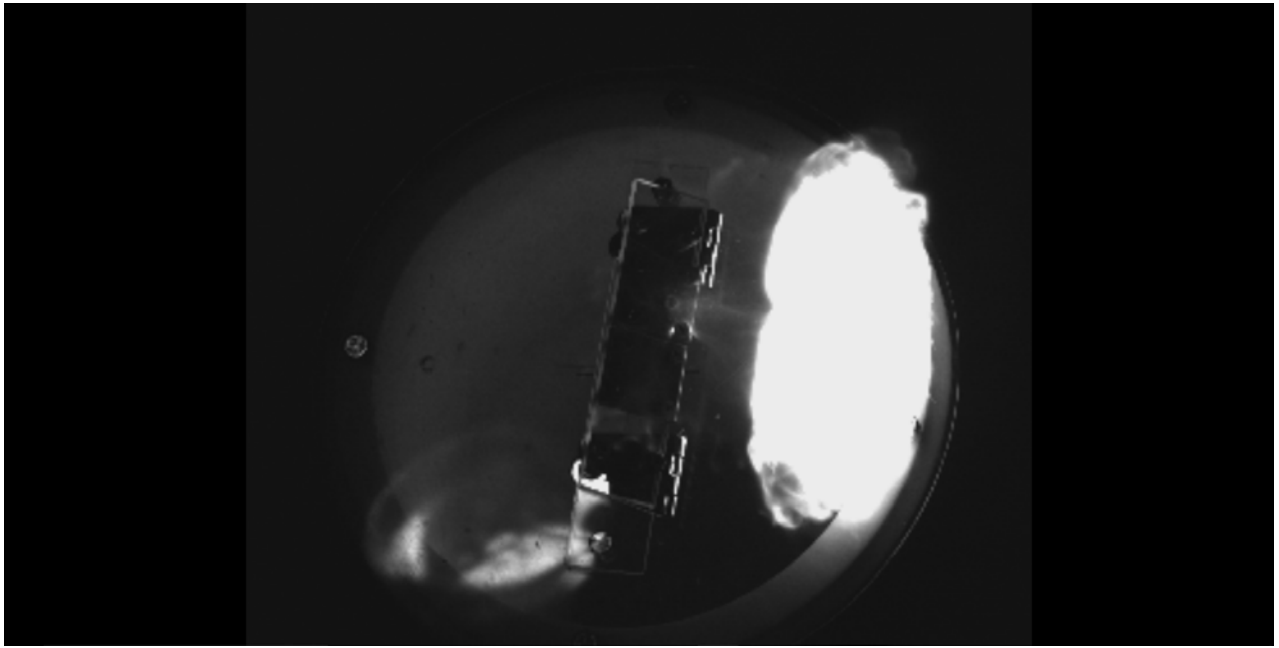
NGDC Database

Goel 2015.

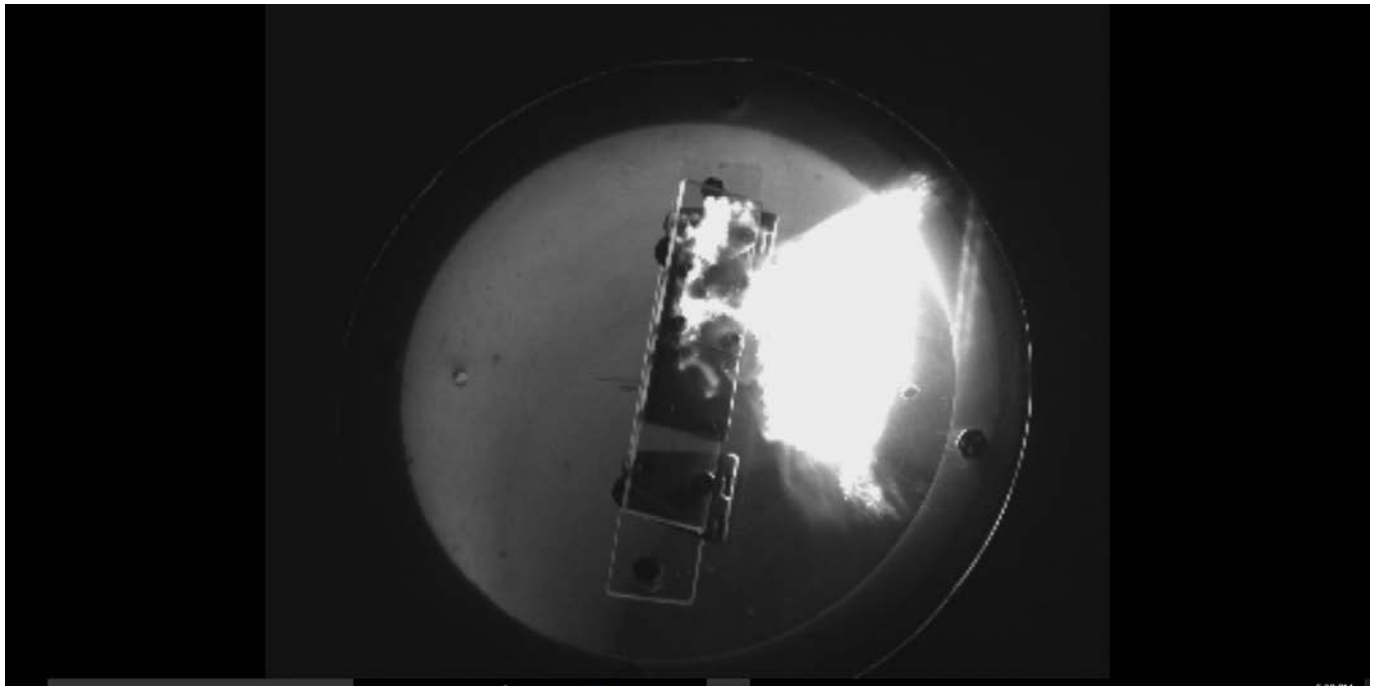
- **NGDC database**
  - NOAA Anomaly database for US satellites in MEO and GEO orbits
  - ~ 5000 satellite anomalies 1972 – 1992
  - Gives local time at impact, solar longitude etc.
  - Gives orbit type but not orbital parameters

Anomaly Diagnosis
Electron Caused EM Pulse (Deep Dielectric Charging) - 490
Electrostatic Discharge (Surface Charging) – 1072
Single Event Upset - 822
Radio Frequency Interference – 8
Unknown - 2587

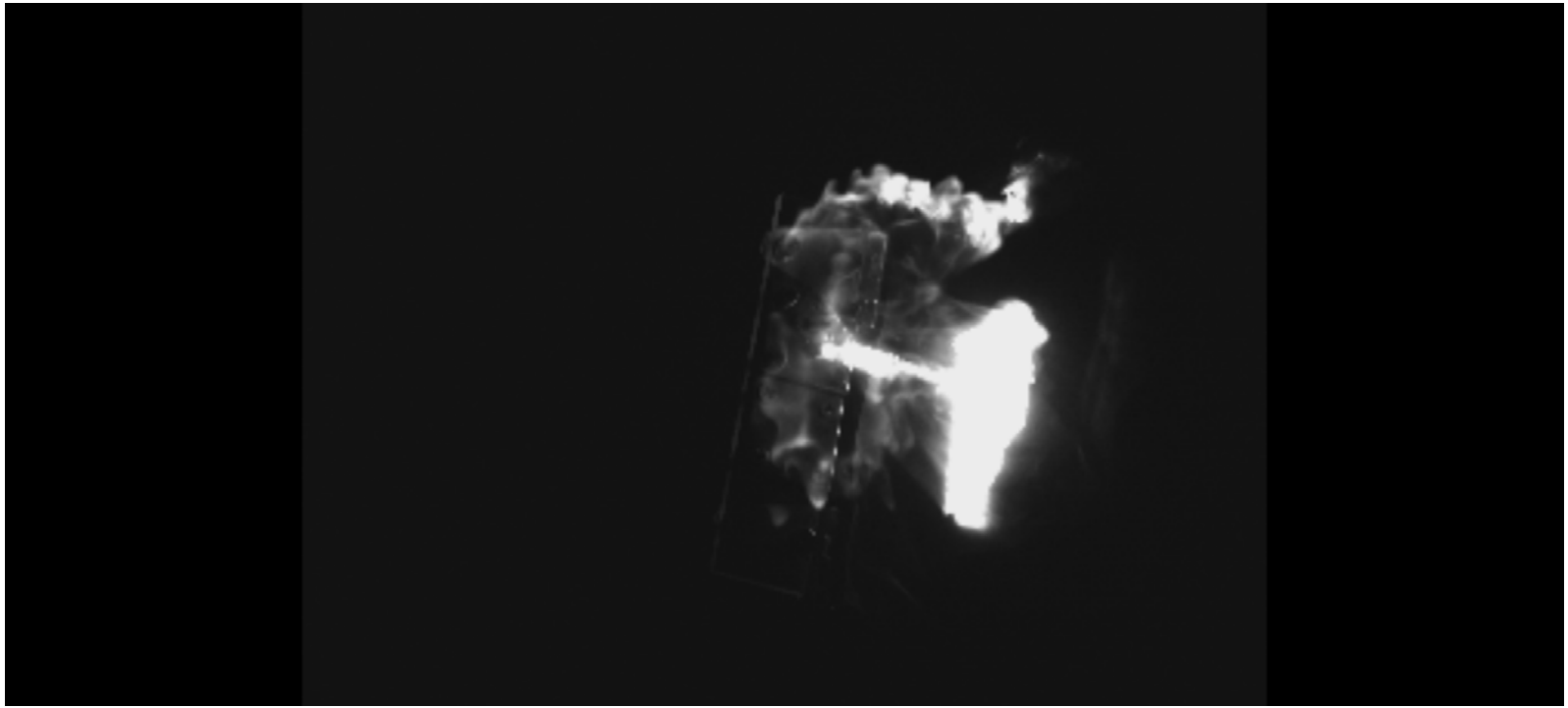
AVGR : Floating Target



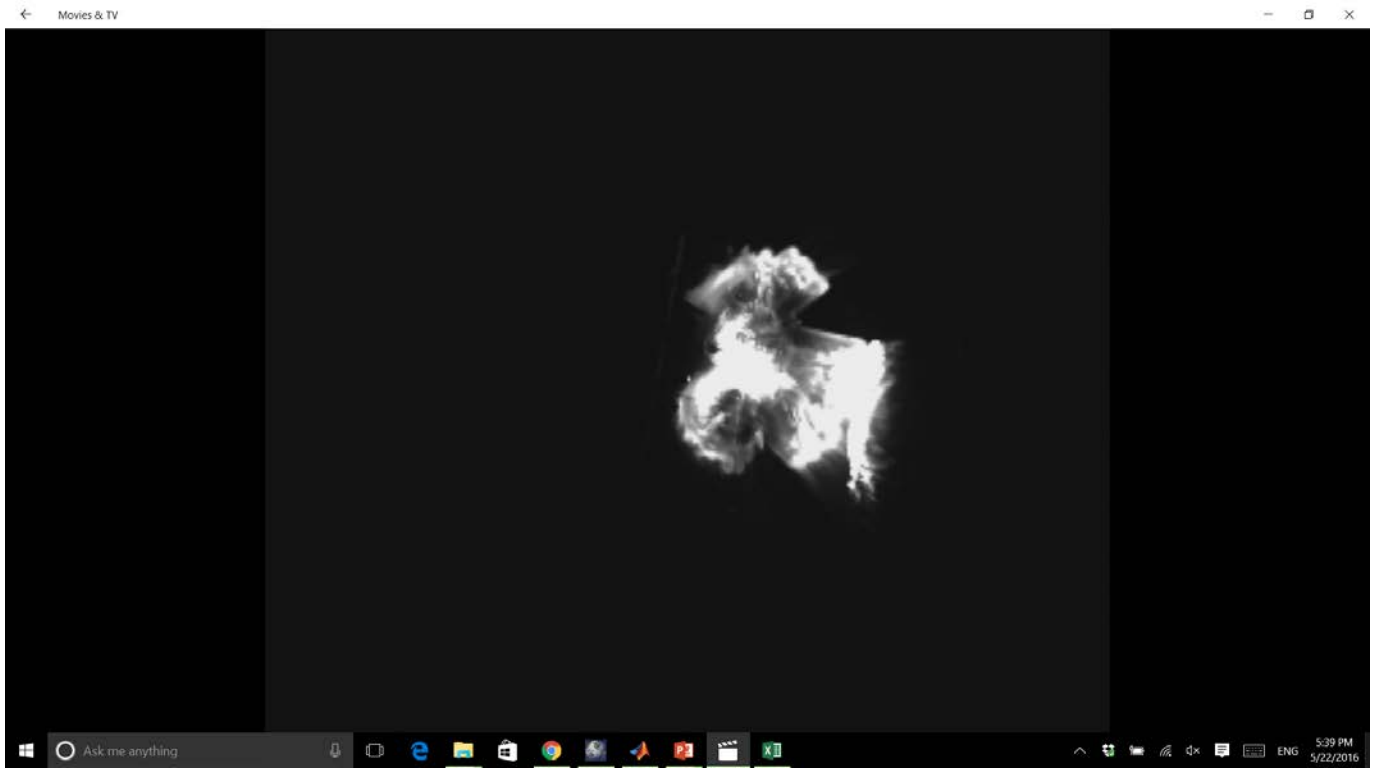
AVGR : Floating Target



Biased to Negative 50 V



Grounded Target



Positively Biased