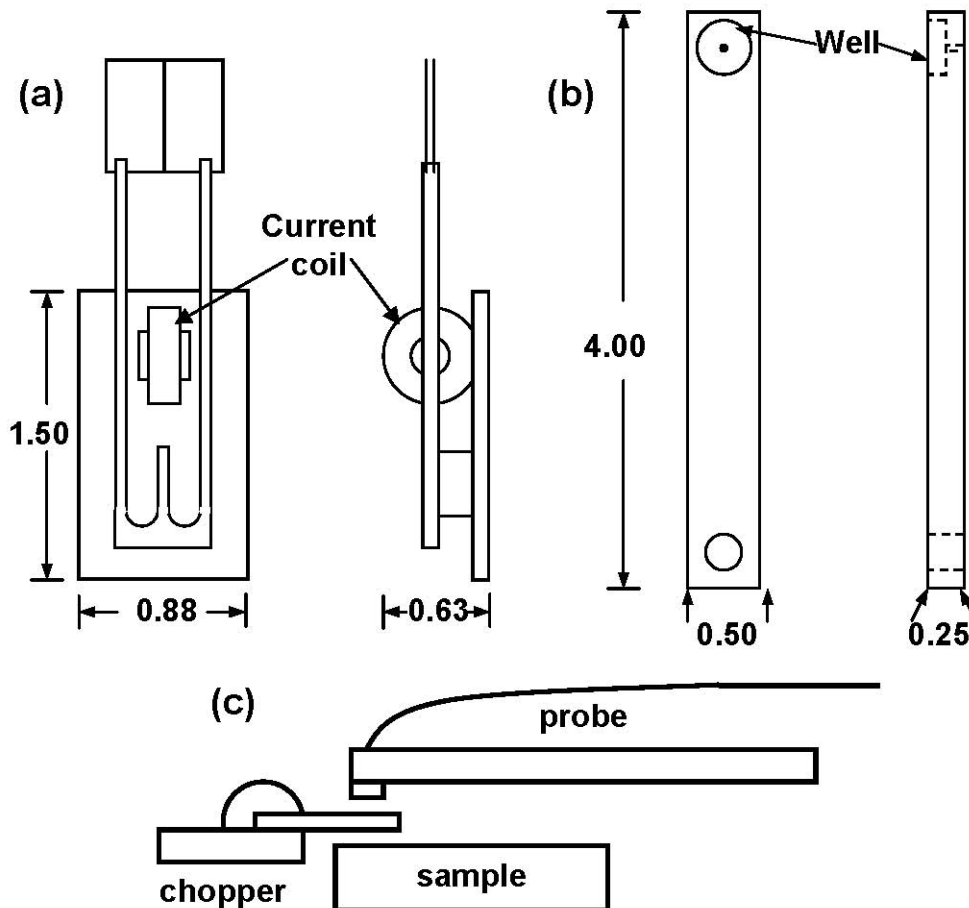


Progress Report on Charging Measurements at Trinity University

Dennis Ugolini, Robert McKinney, Mark Girard
Trinity University
March LSC Meeting
March 21, 2007

Goal: To develop a vacuum-compatible capacitive probe to measure the charge magnitude and relaxation time constant on LIGO optics

The Capacitive Probe

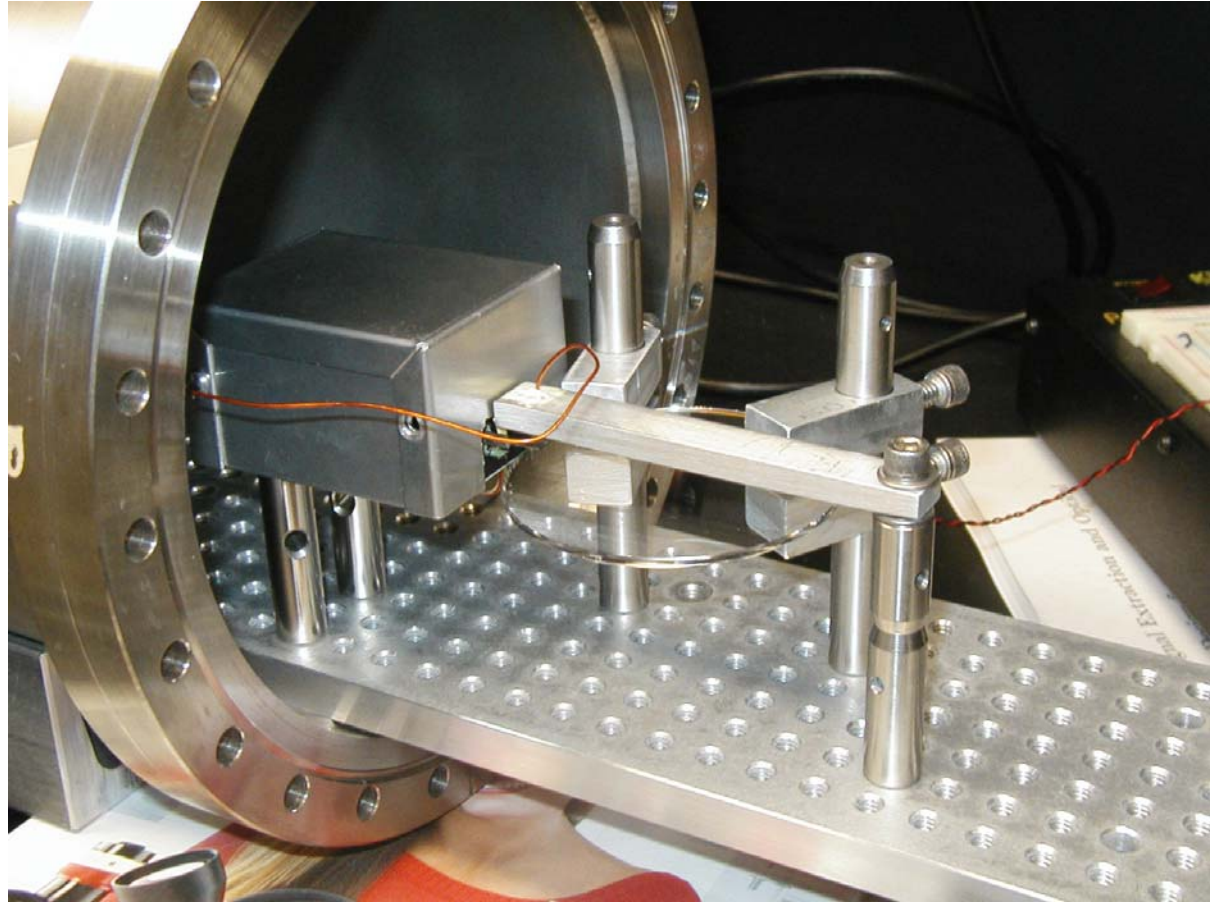


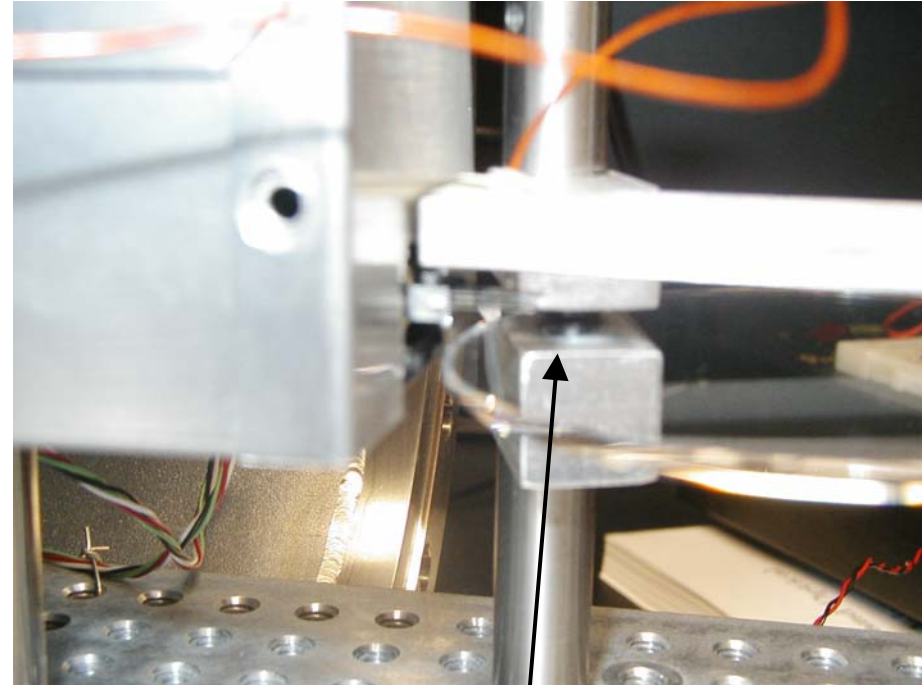
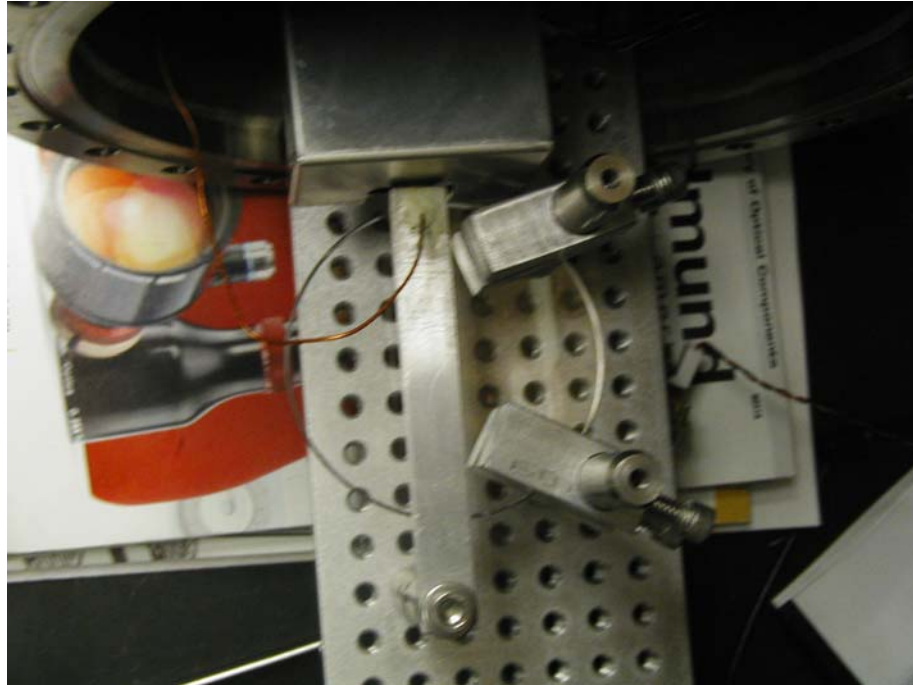
- Use chopper to alternately expose/occlude sample
- Aluminum probe body with Kapton-shielded wire
- Sensitivity calibrated with surface DC voltmeter to be $(3.5 \pm 0.5) \times 10^5 e^-/cm^2$ (to be published in Rev. Sci. Instr.)





- Chopper shielded by aluminum box
- Optic held by viton O-rings epoxied to aluminum clamps



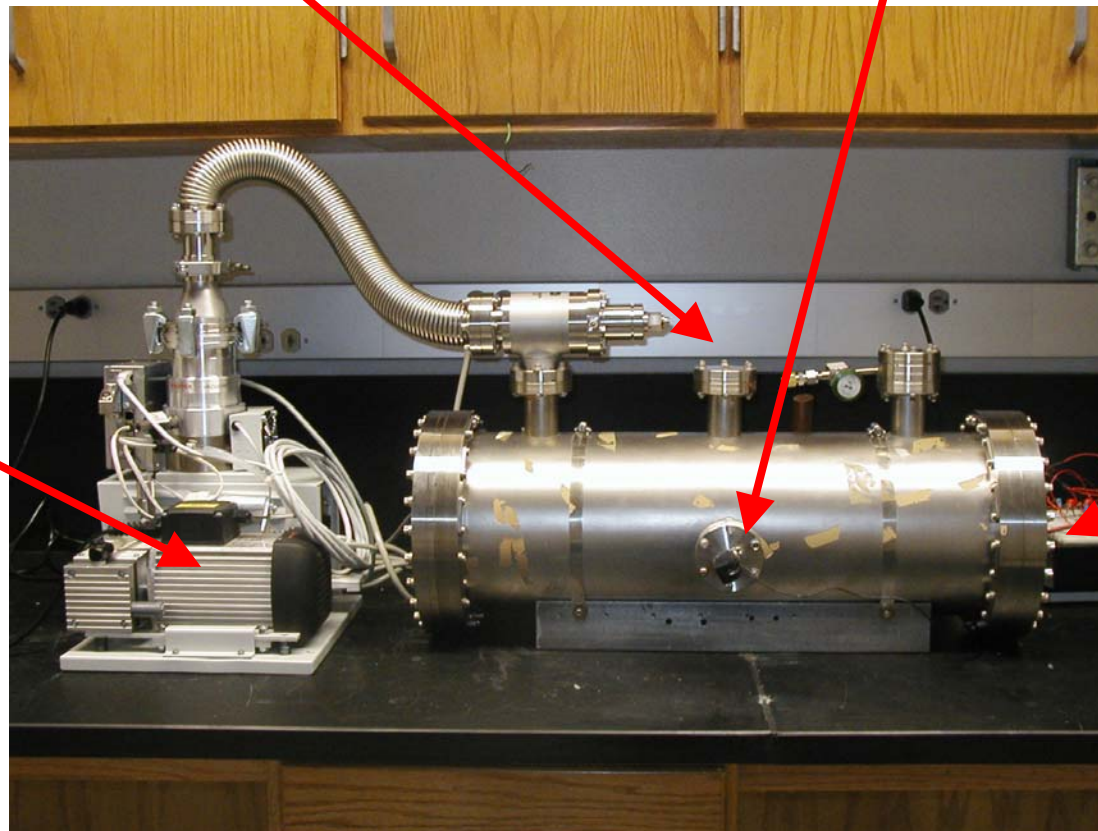


Viton O-rings

Vacuum System

Pressure gauge goes here
(returned for servicing)

Feedthrough
(on either side)



Glass
viewport

Pfeiffer-Balzers
Turbomechanical
drag pump
($\sim 10^{-5}$ torr)

Obstacles in Moving to Vacuum

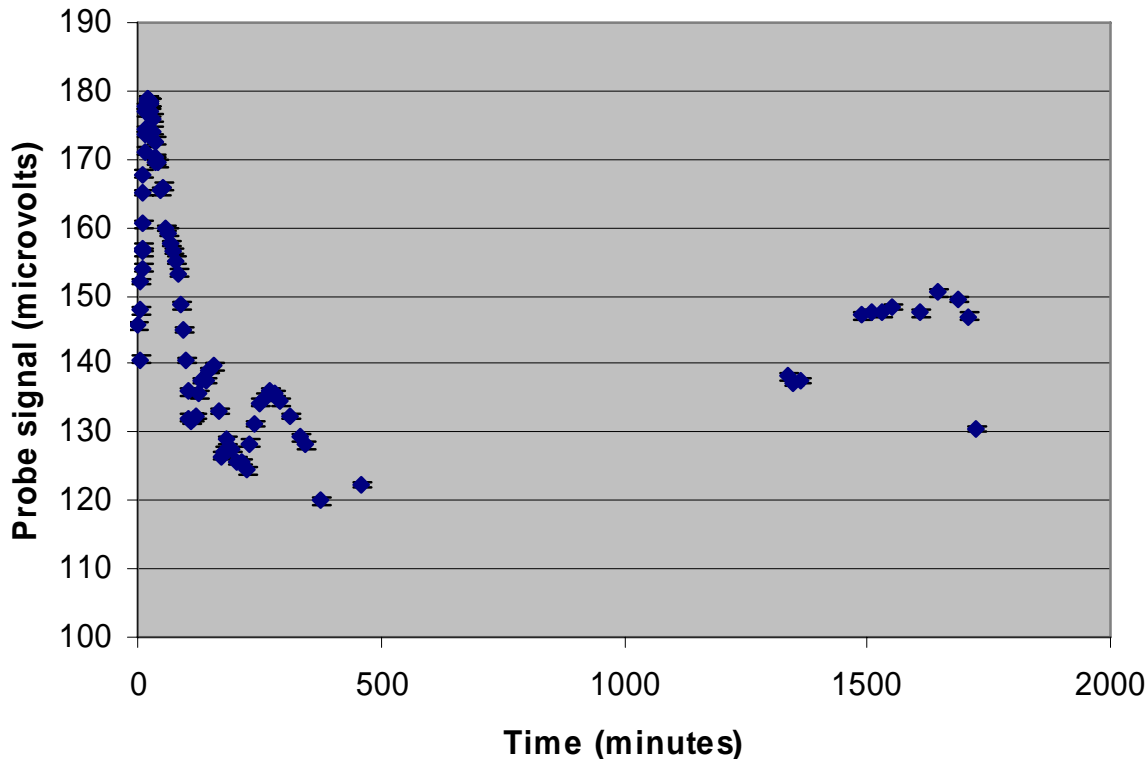
- Pickup by probe signal lead from chopper driver wires
 - » Used two feedthroughs, one for chopper, one for probe
 - » Chopper wires tied to optical table, kept far from probe lead

- Intermittent probe noise peak
 - » Caused by contact between probe lead and nearly anything (chopper shielding box, optical table, walls of the vacuum chamber)
 - » Vibrational or electrical?
 - » Kapton wire is rigid, hold position well

- Applied charge decays too rapidly to pump down system
 - » Strong function of humidity, dehumidifier purchased
 - » Spark?
 - » Options for applying charge inside chamber (brush?)

Readout Problem

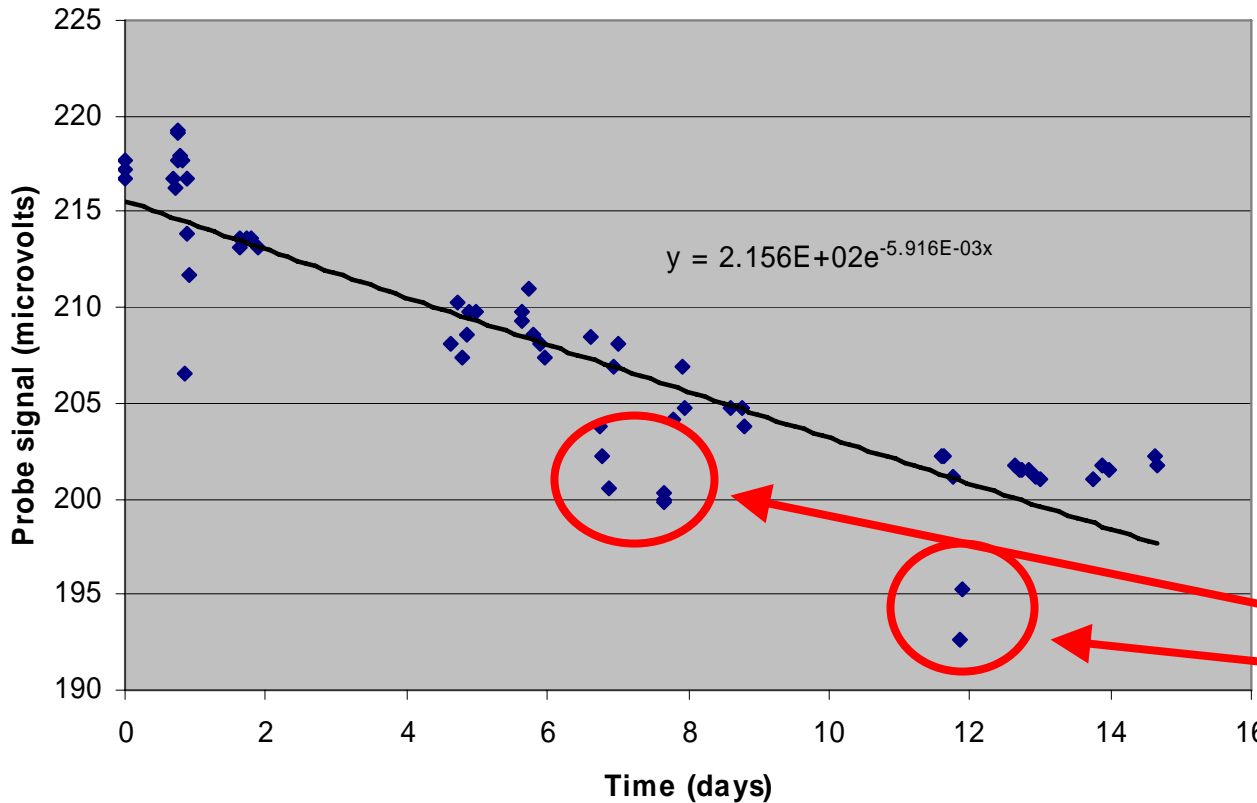
Charge on LIGO Optical Sample 02/20/07



- Finally trapped large charge on optic on February 20th
- Probe readout oscillated, didn't damp out over many hours
- Drift in chopper frequency shifted peak on spectrum analyzer
- Switched to lock-in amp, used chopper driver as reference

16-Day Results

Charge on Optical Sample 2/21/07

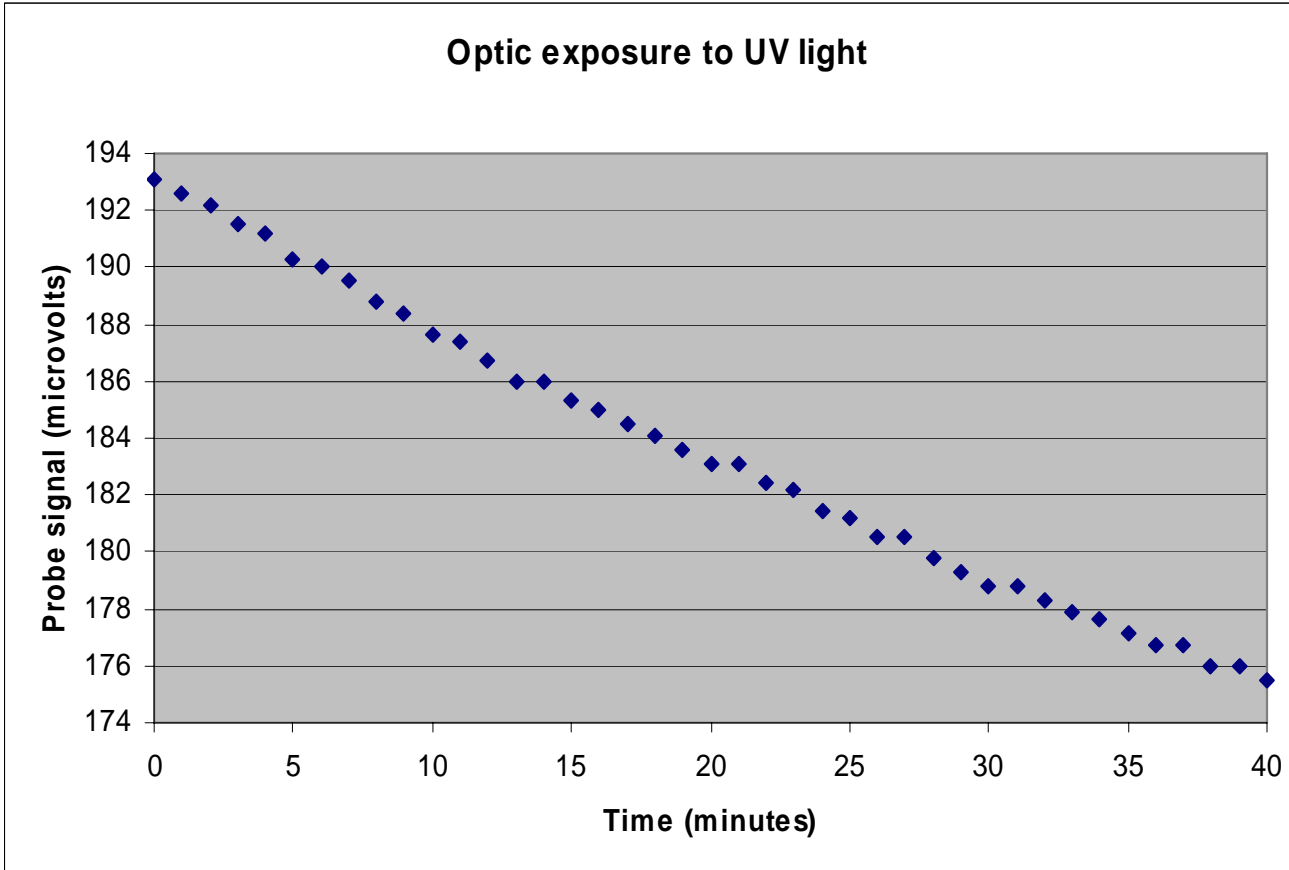


Corresponds to time constant of ~170 days

Appears to level off around day 13

Large phase change on "dropouts" – problem with reference?

UV Discharging



Exposed to Hg discharge tube (no UV) for several hours – no effect

Exposed to Pen-Ray UV Lamp (253.7nm, 4.4mW/cm² at 19mm), exhibits discharging shown

Glass viewport has ~15% transmission at this wavelength

Summary

- Probe has been successfully moved to vacuum
- Decay of charge deposited on optical sample has been observed with a time constant of ~ 170 days
 - » What are the differences between this setup and Moscow State?
Optical substrate? Surface contact? Pressure?
- Demonstrated UV discharging with glass viewport
- Next steps
 - Longer time
 - Charge vs. position
 - Besocke Kelvin probe
 - Discharging vs. λ ?
 - Triplicate setup
 - Different substrates, coatings, etc.
 - Quartz viewport?