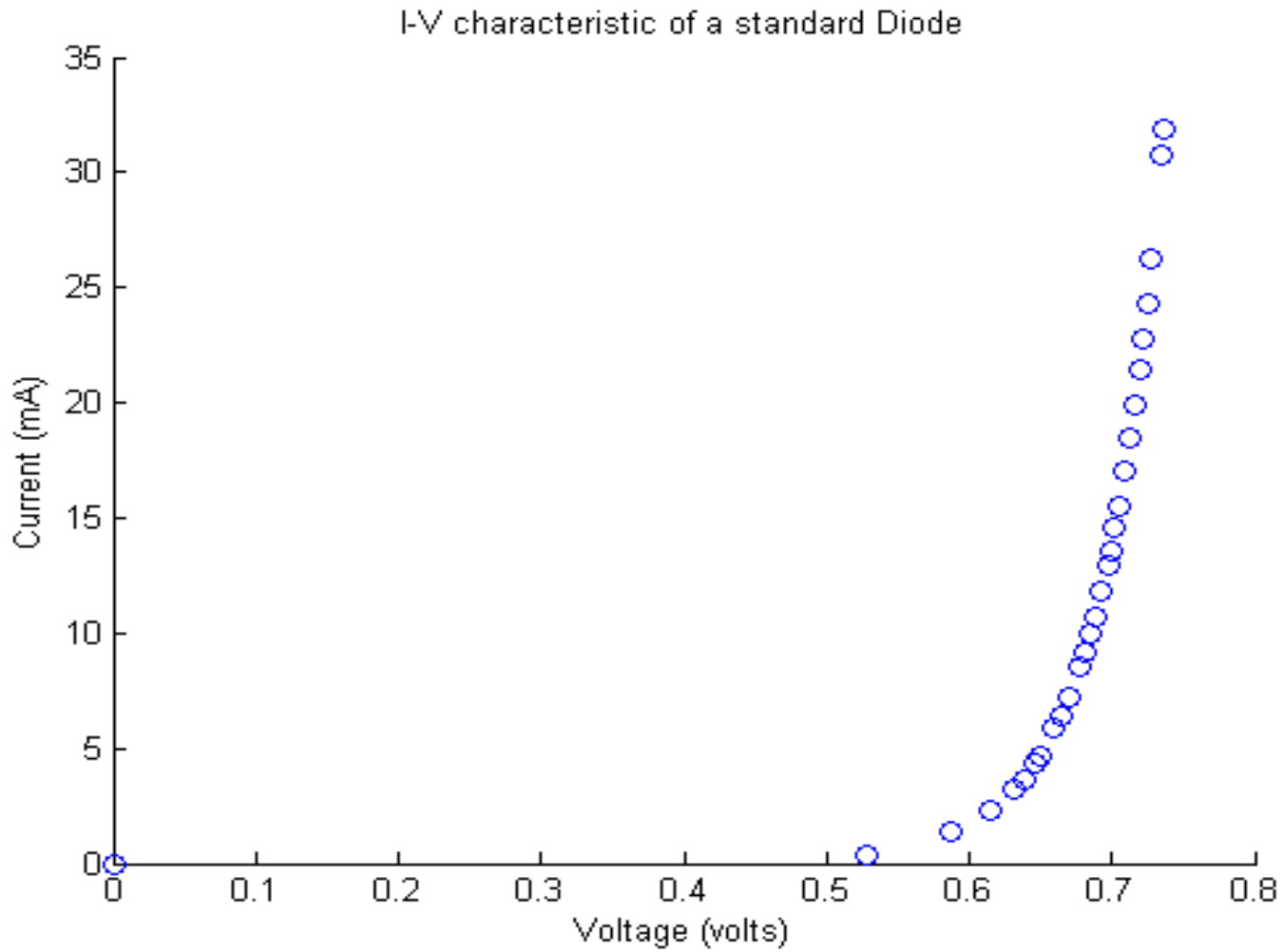
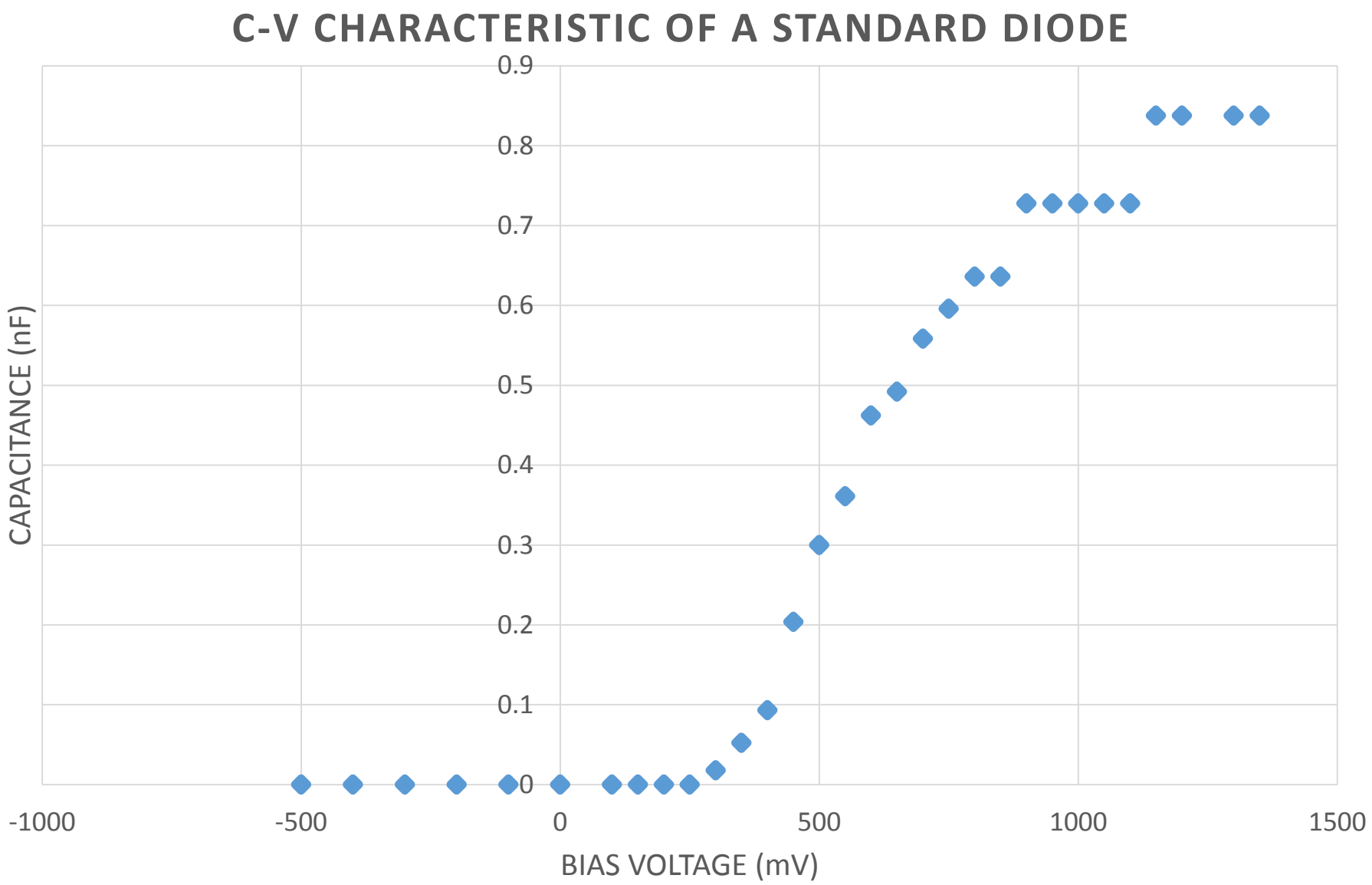
Semiconductors

Chris Luetjen

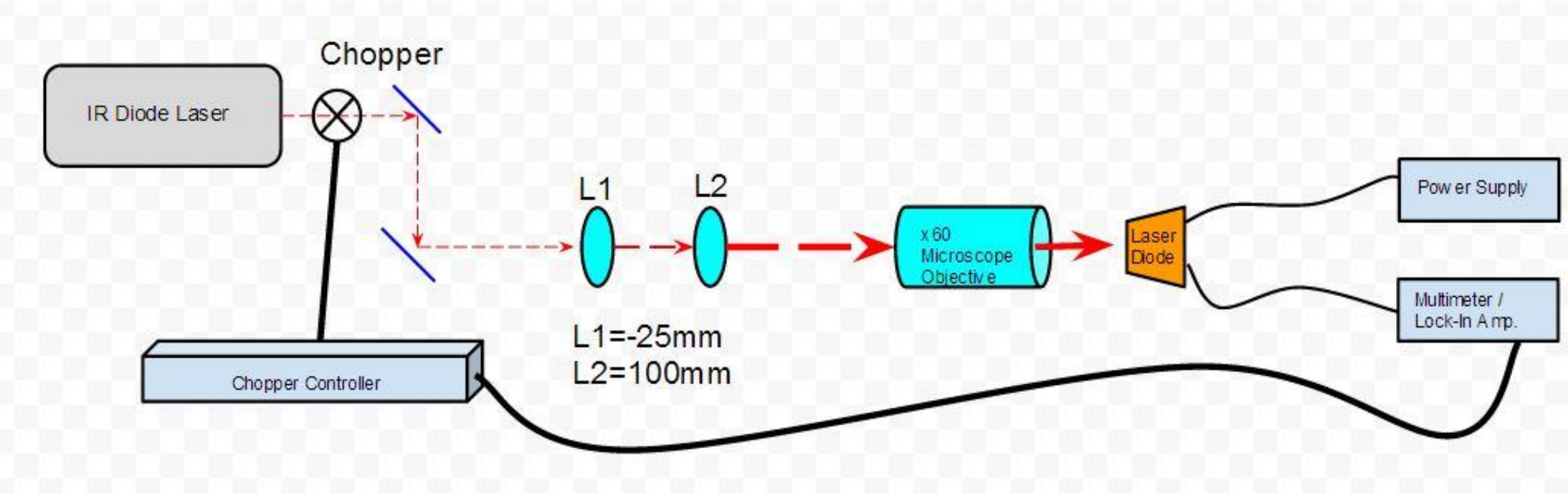
Zach Small

Diode Characteristics

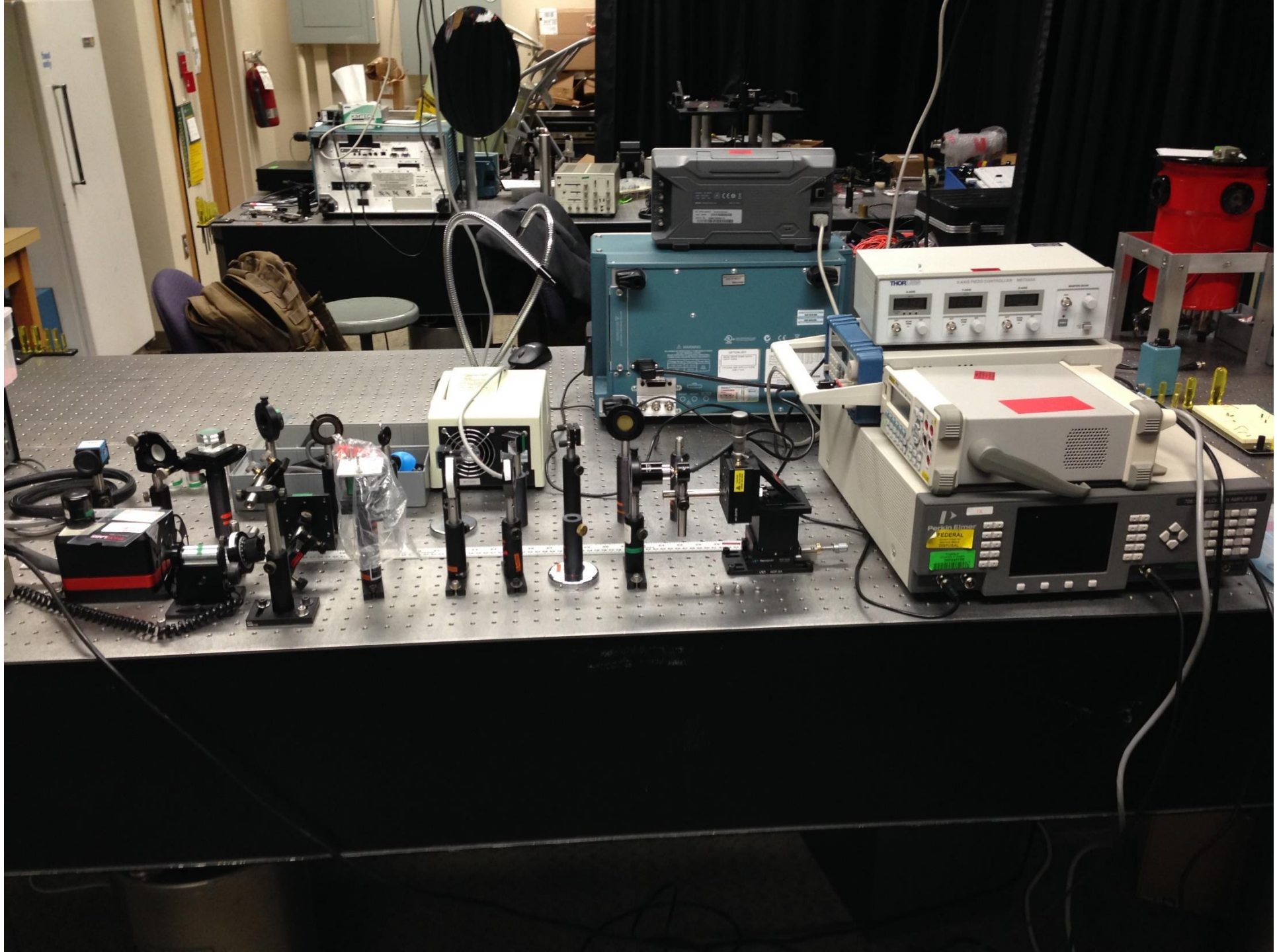



C-V CHARACTERISTIC OF A STANDARD DIODE
CAPACITANCE (nF)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-1000
-500
0
500
1000
1500
BIAS VOLTAGE (mV)

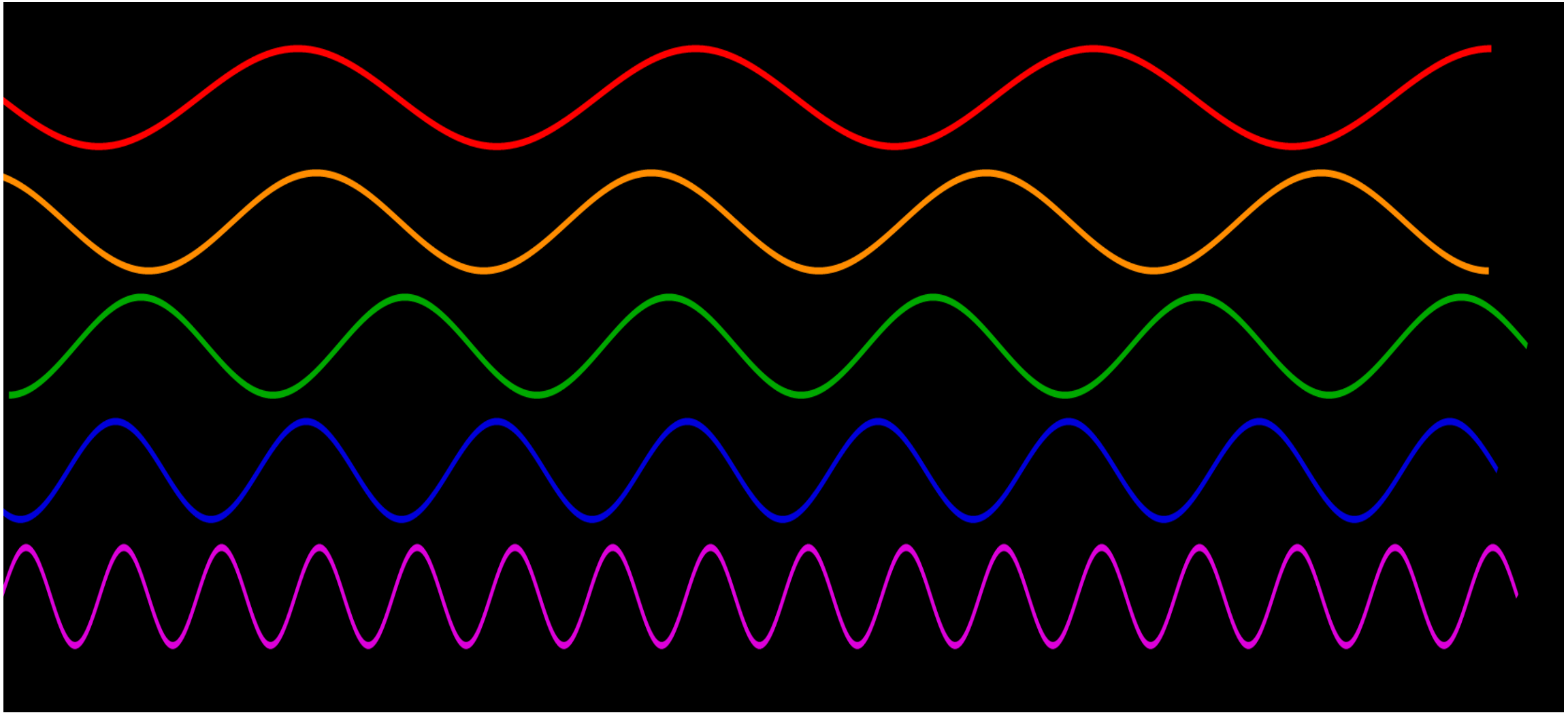
Optical Setup for Carrier Dynamics

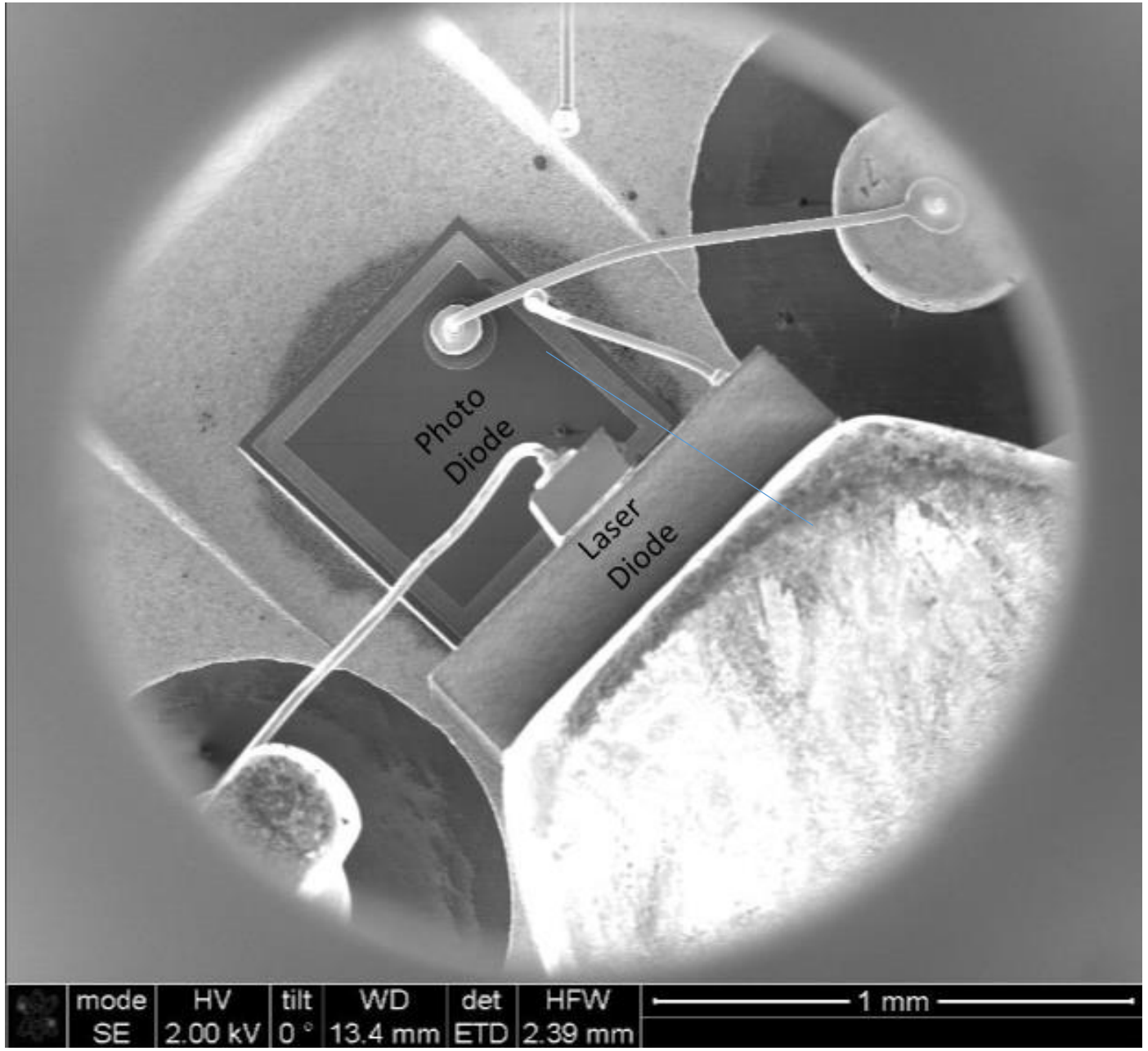


Gooooo! Get to the choppa!!!!!


THORLABS
Perkin Elmer
FEDERAL

Lock In Amplifier



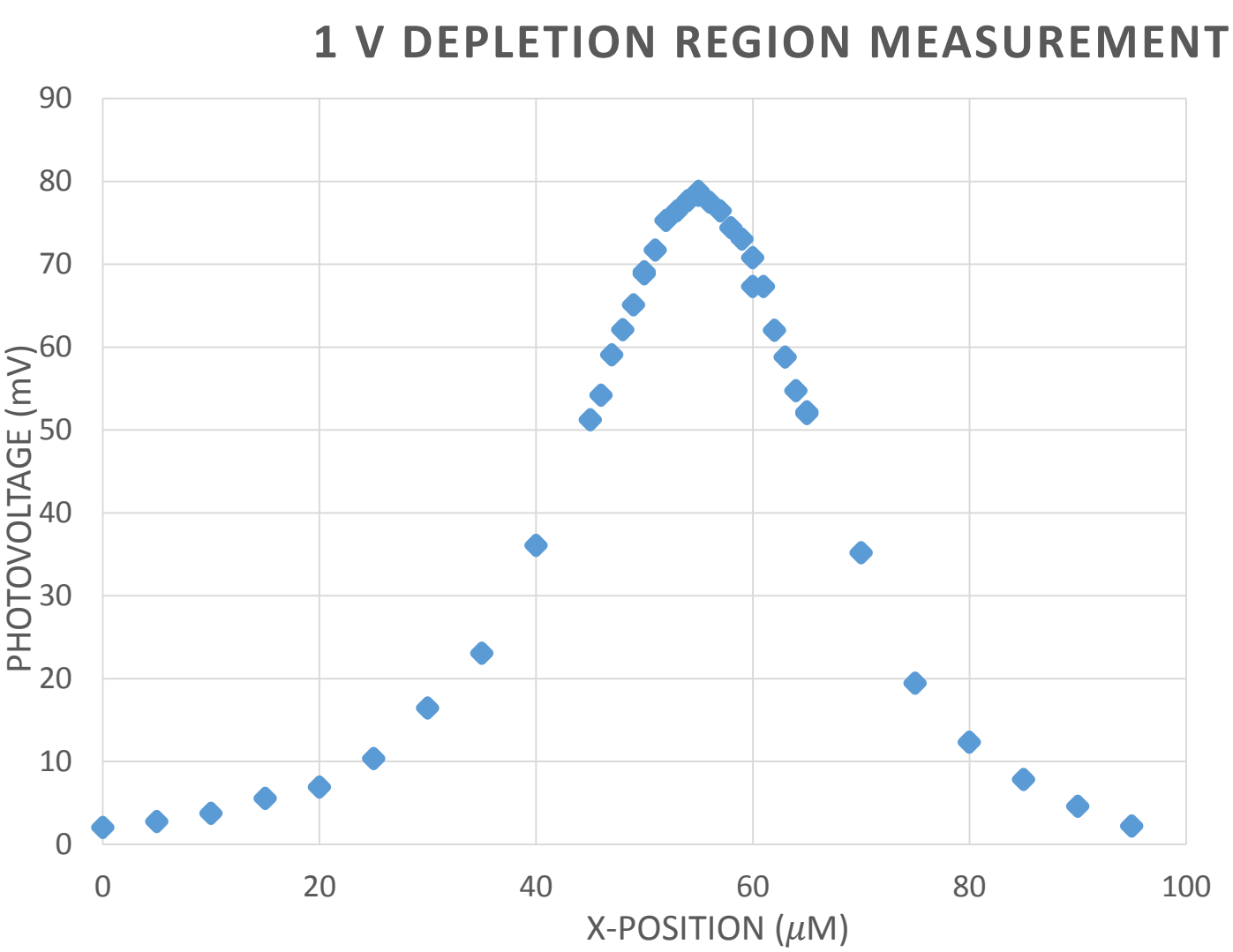


Max resolution$= \frac{1.22\lambda}{NA}$

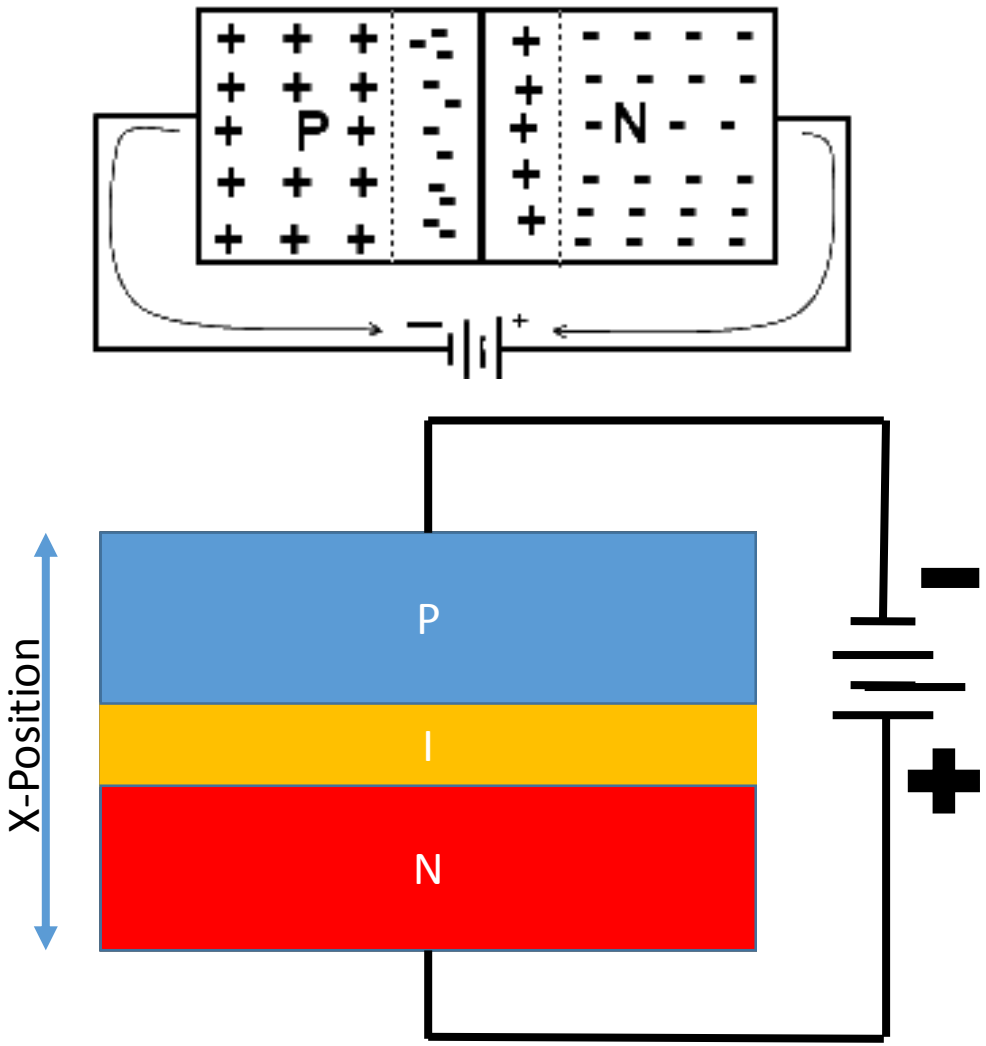
Our Ideal resolution
1.25 microns

Our Beam needs to be measured…

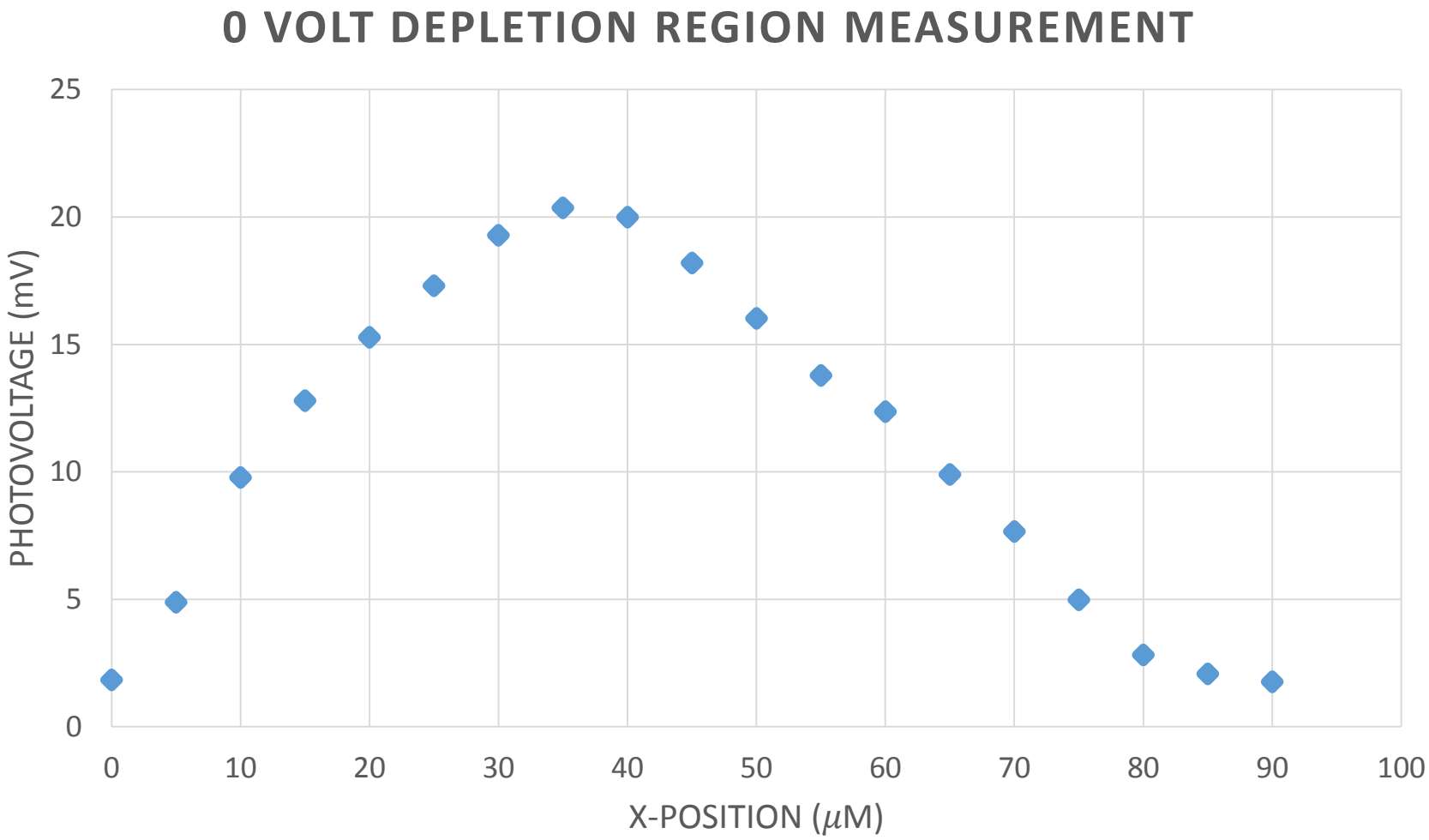
Image from last years group



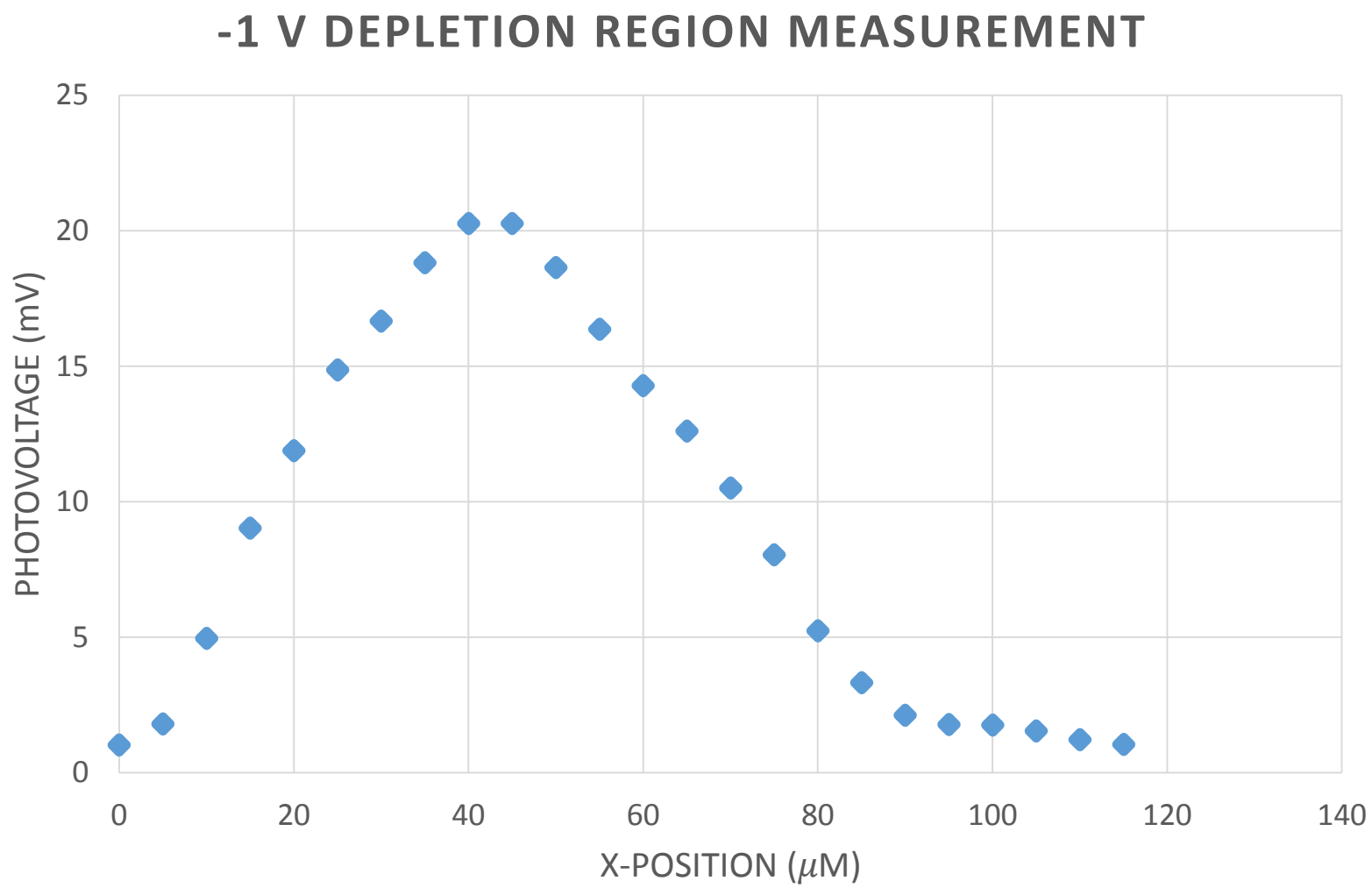
Approx. 30 μm



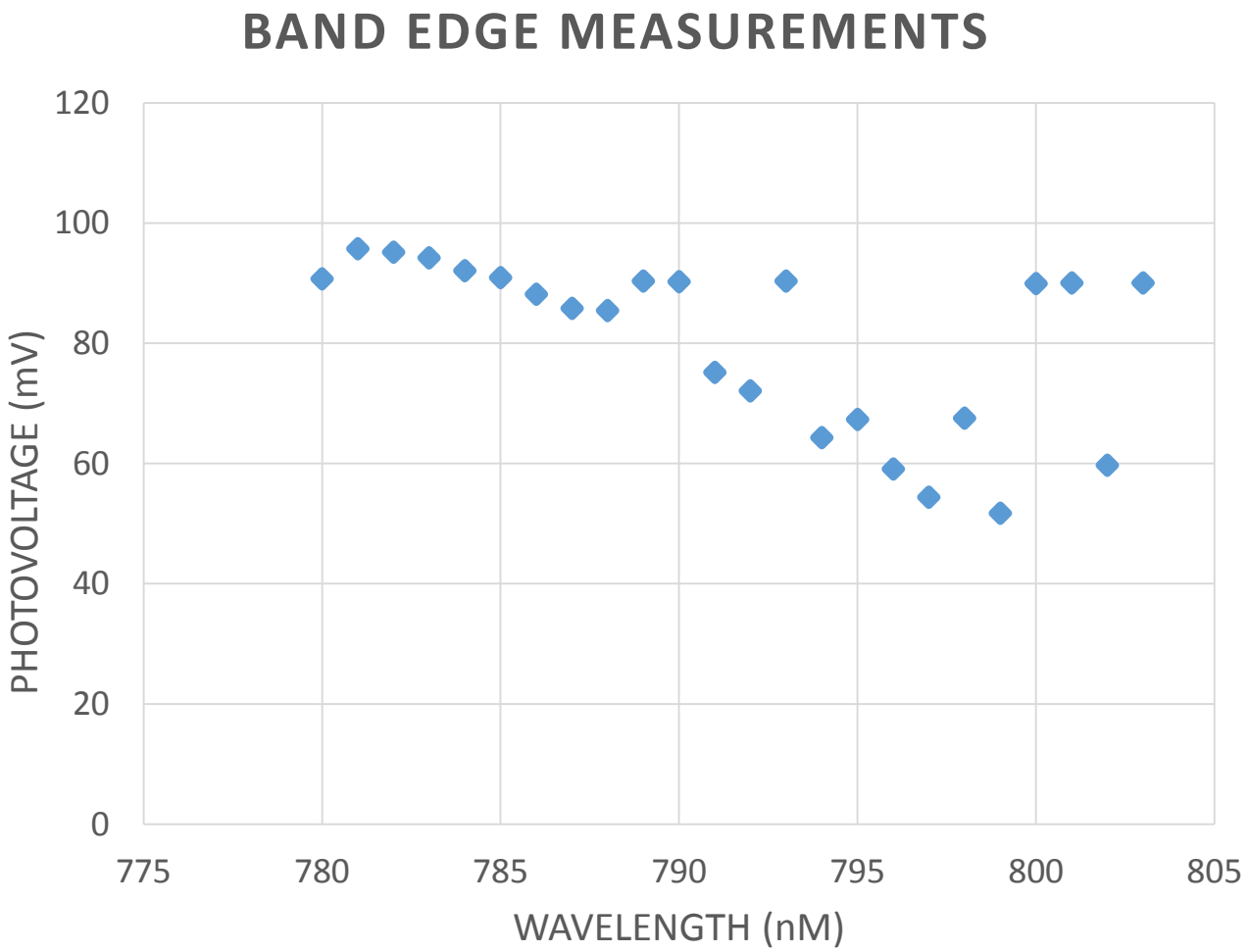
I=Intrinsic region: pure semiconductor without doping

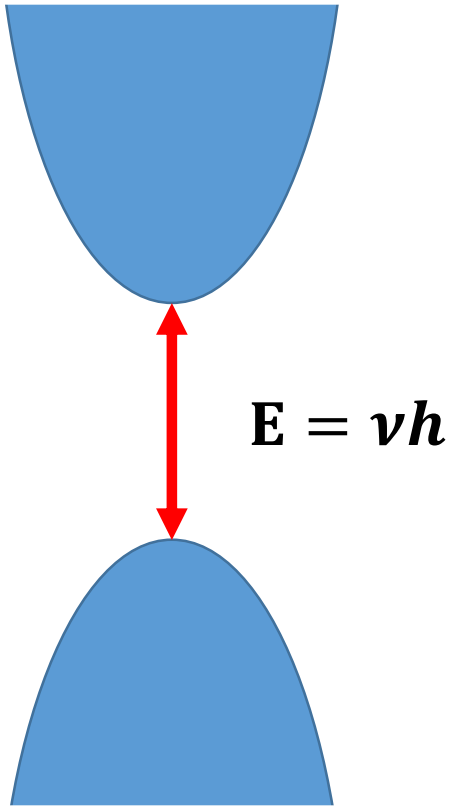


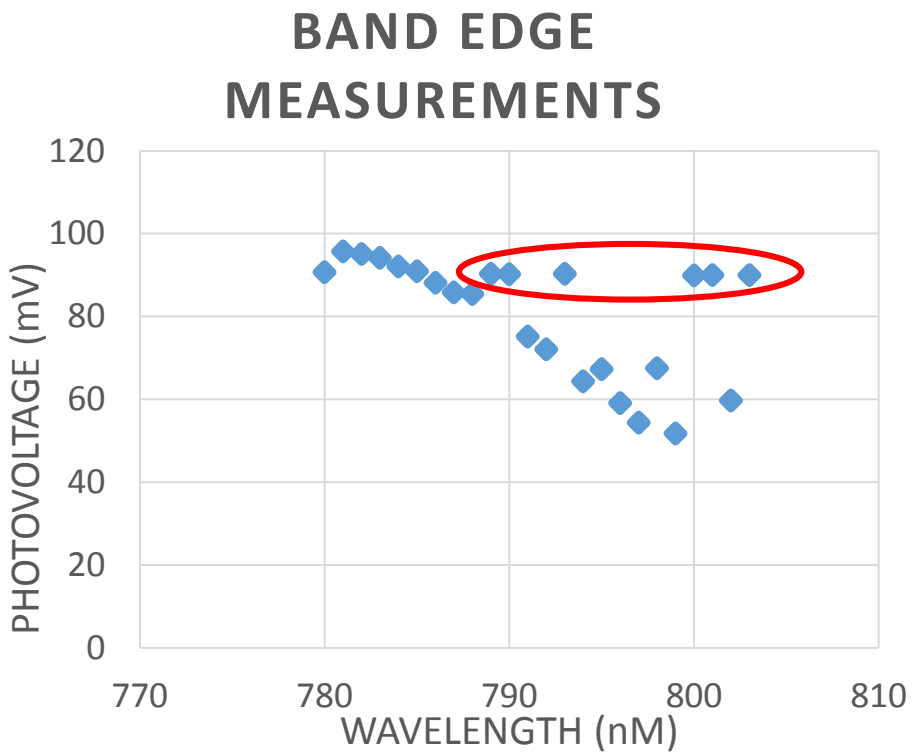
Approx. 40 μ**m**



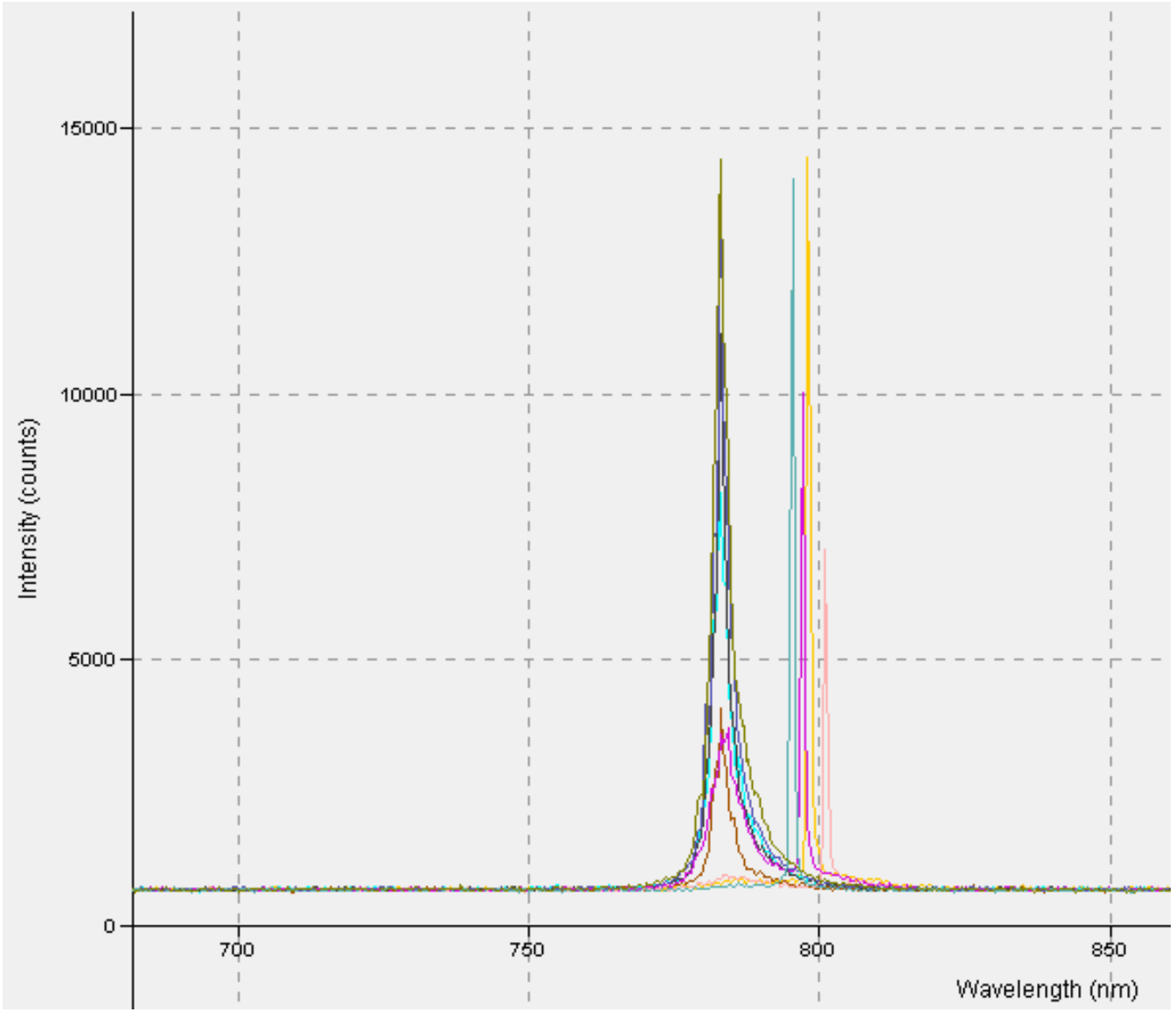
Approx. 45 μ**m**


BAND EDGE MEASUREMENTS
120
100
80
60
40
20
0
PHOTOVOLTAGE (mV)
775
780
785
790
795
800
805
WAVELENGTH (nM)


$\mathbf{E} = \boldsymbol{vh}$



Functions properly from 780 nm-786 nm



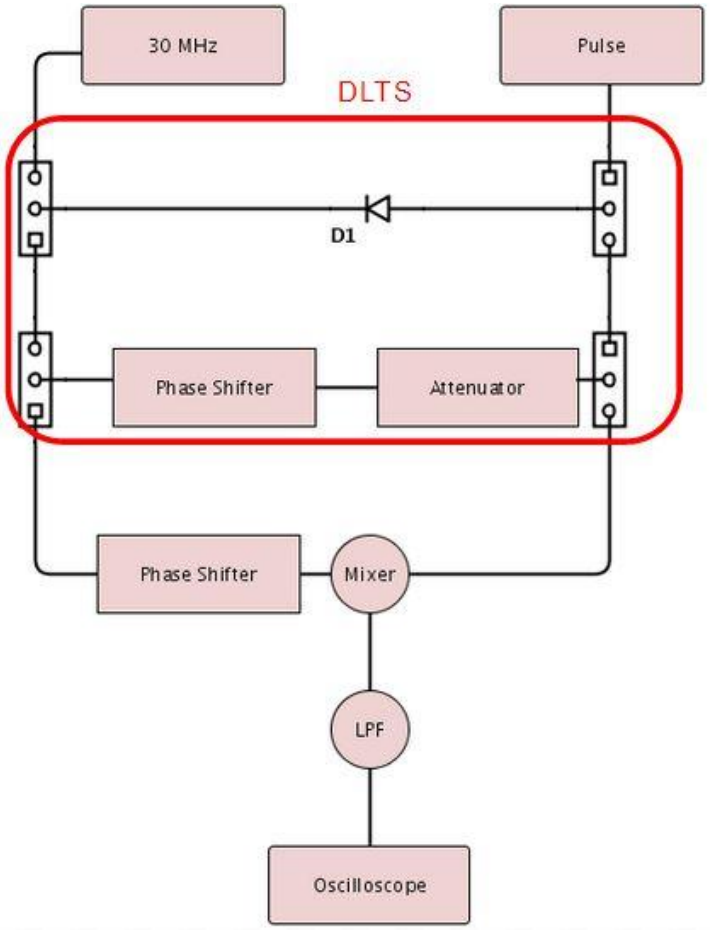
Deep Level Transient Spectroscopy (DLTS)

- Measures the electrically active defects in semiconductors (known as carrier traps).
  - Traps hold electrons or holes.

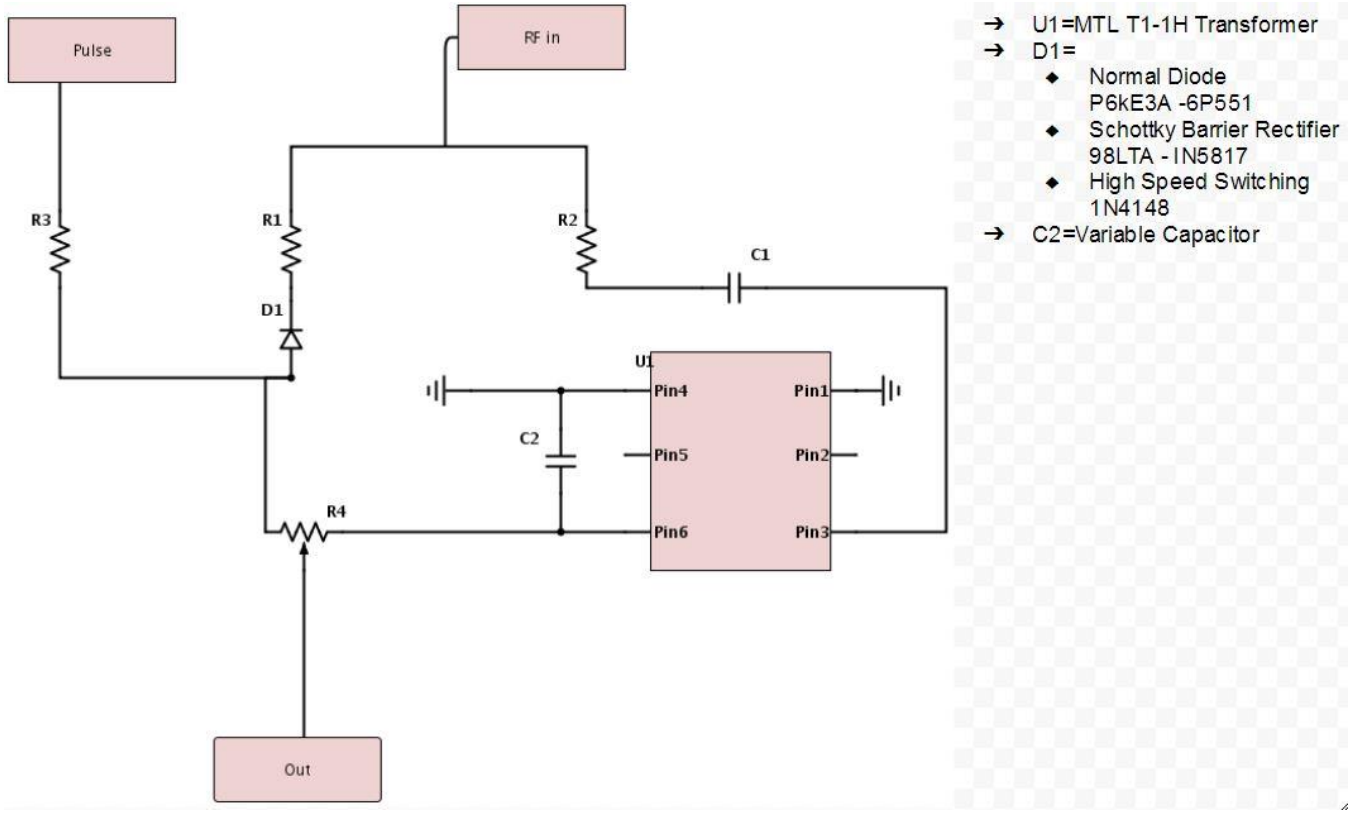
1. Steady state voltage is disturbed with a voltage pulse, causing carriers to be trapped.
2. After the pulse the trapped carriers can be emitted back to their steady state.
3. The total voltage decays back to 0 slower than the applied pulse.

DLTS Setup

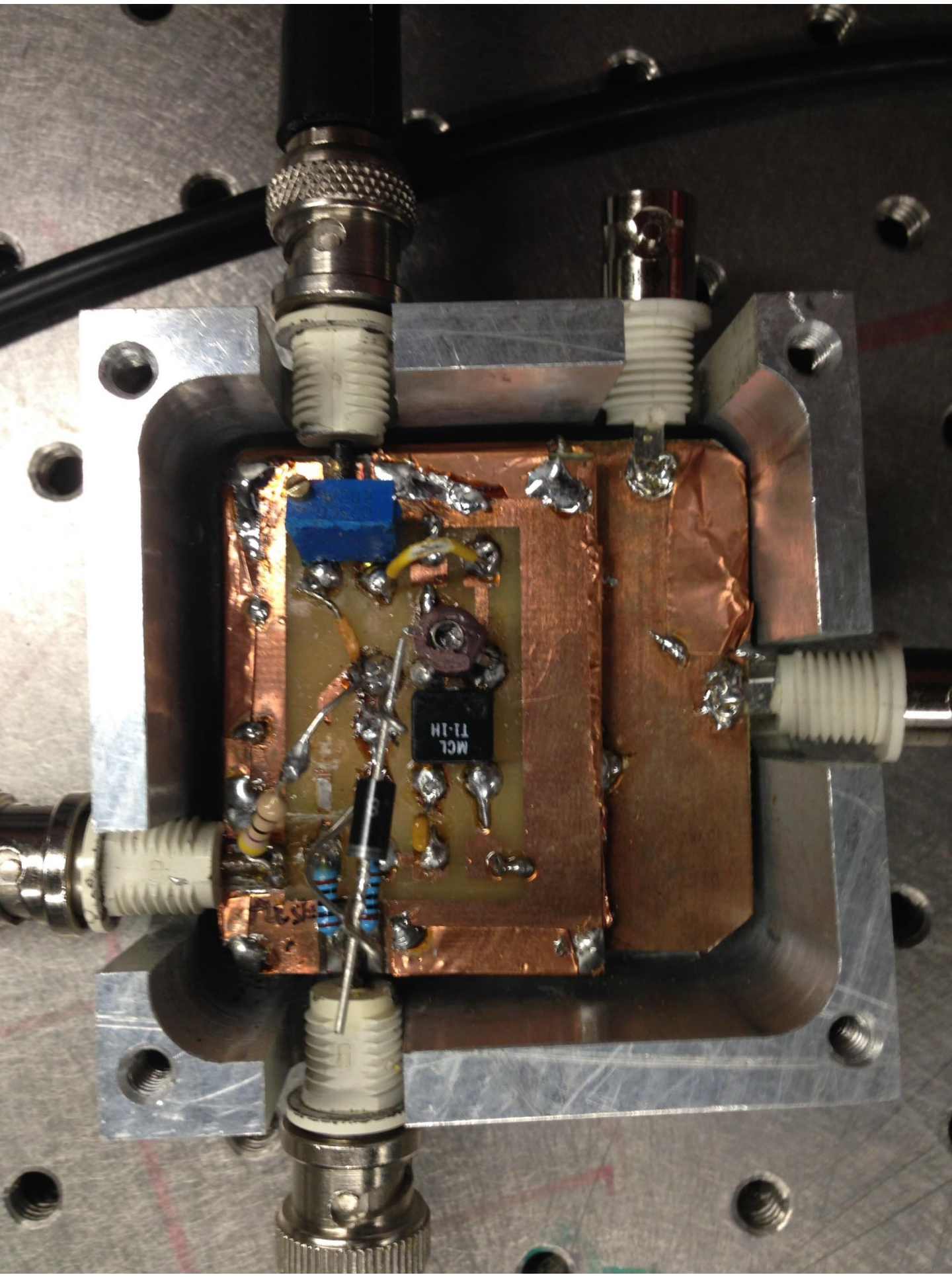
Whole Overview



DLTS Circuit

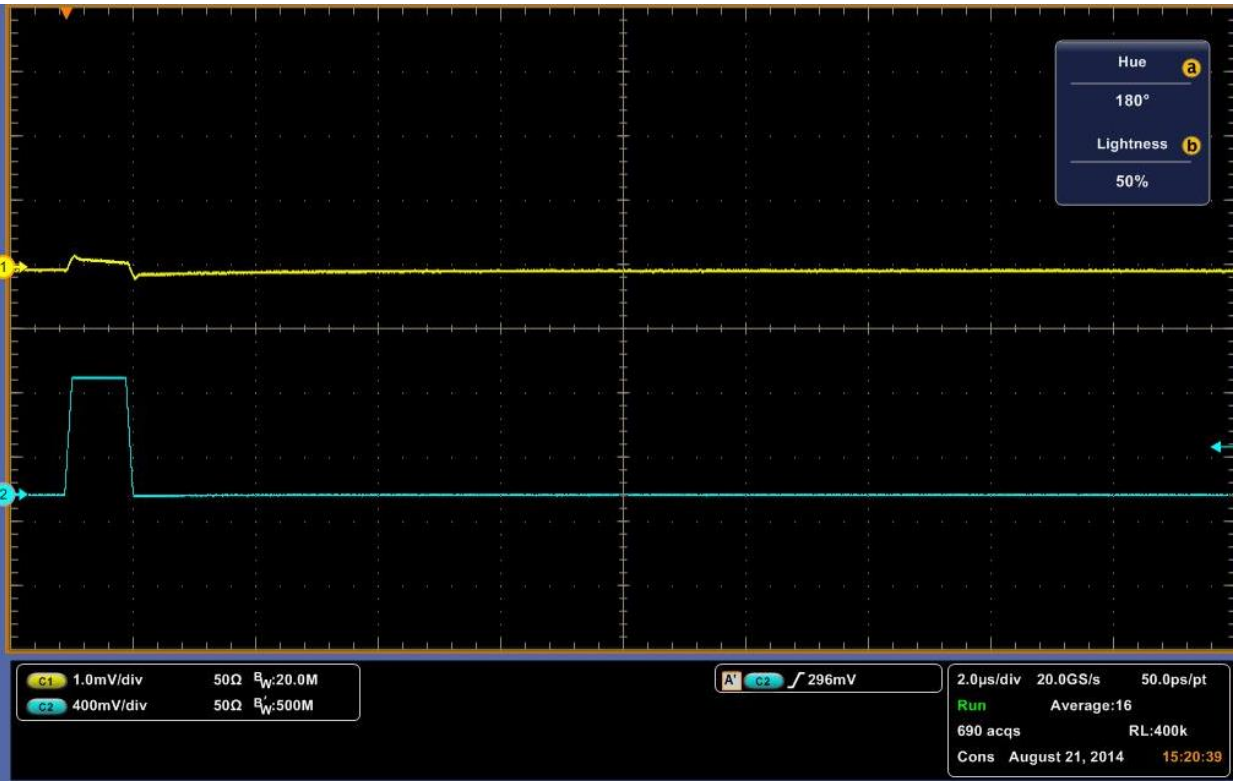


- U1=MTL T1-1H Transformer
- D1=
  - Normal Diode P6kE3A -6P551
  - Schottky Barrier Rectifier 98LTA - IN5817
  - High Speed Switching 1N4148
- C2=Variable Capacitor


MCL
T1-1H

Measurements

Pulse



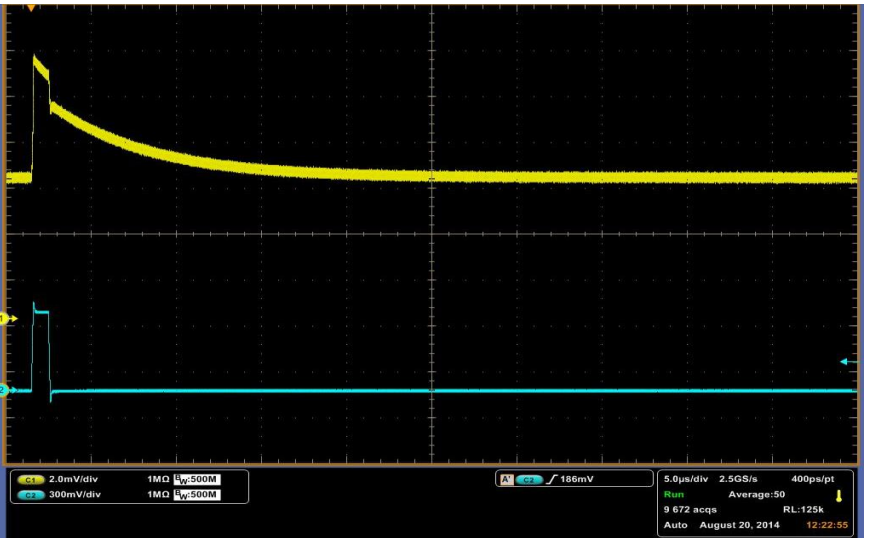
What We would expect

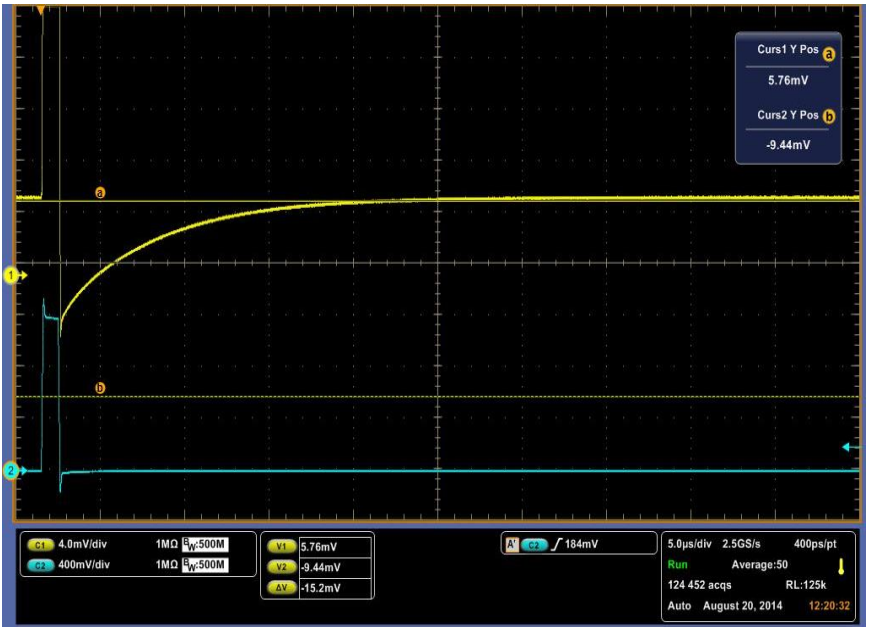
This pulse is with no diode attached. Without the diode we would expect no decaying curve and a fast rise and decay for the pulse in our circuit.

Measurements with Diodes

Standard Diode

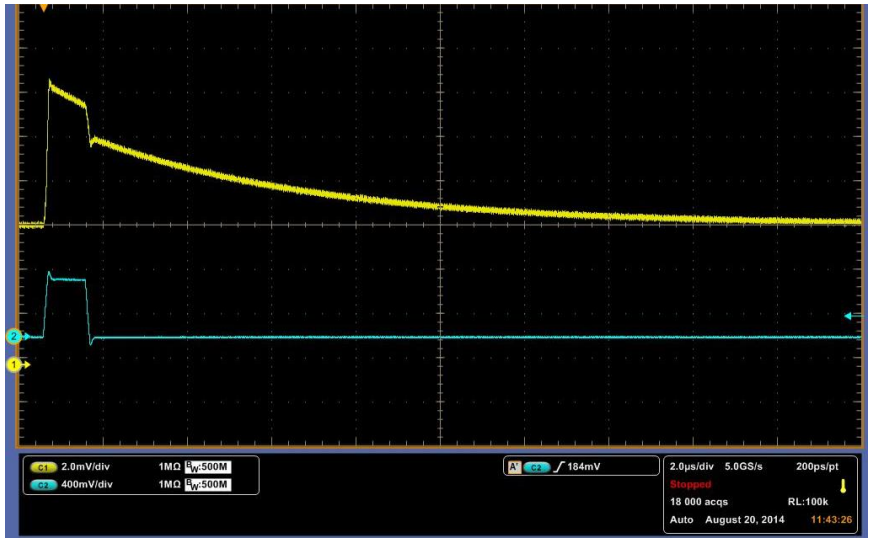
P6KE

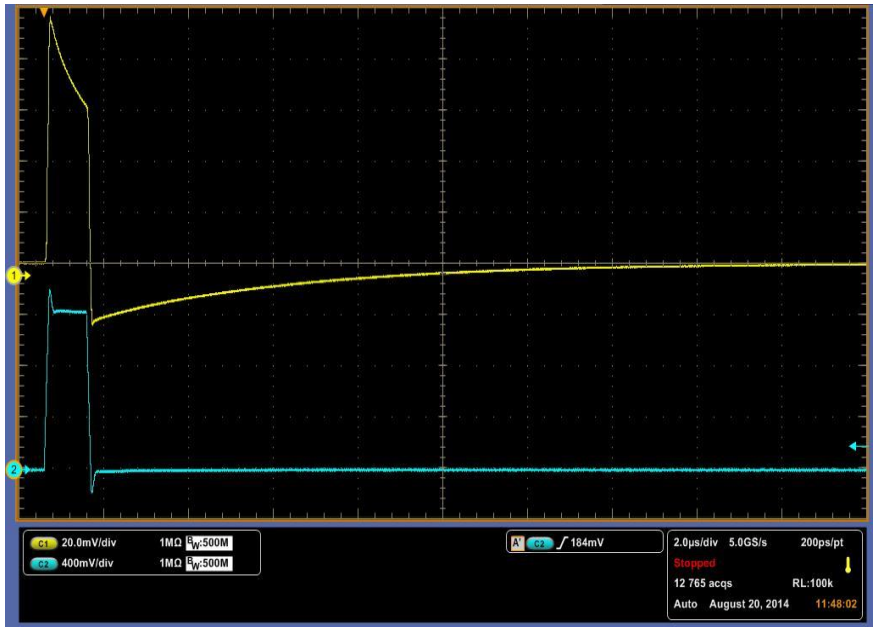




Schottky Barrier Rectifier

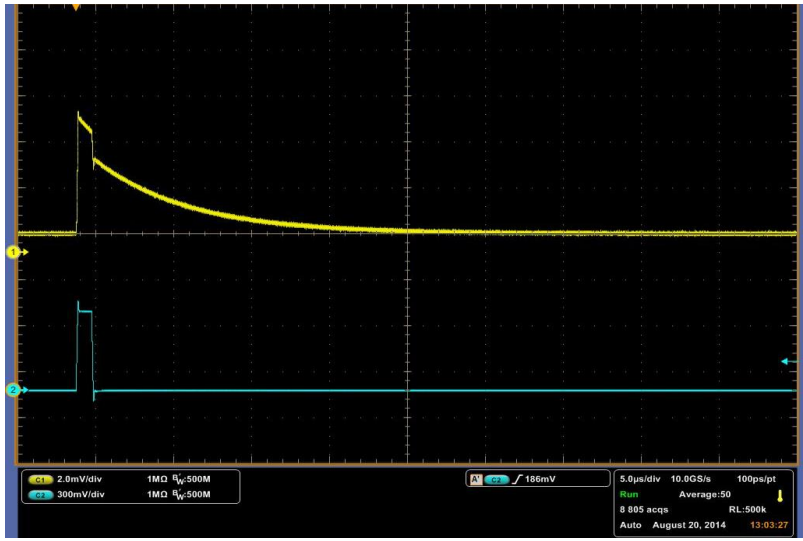
1N5817

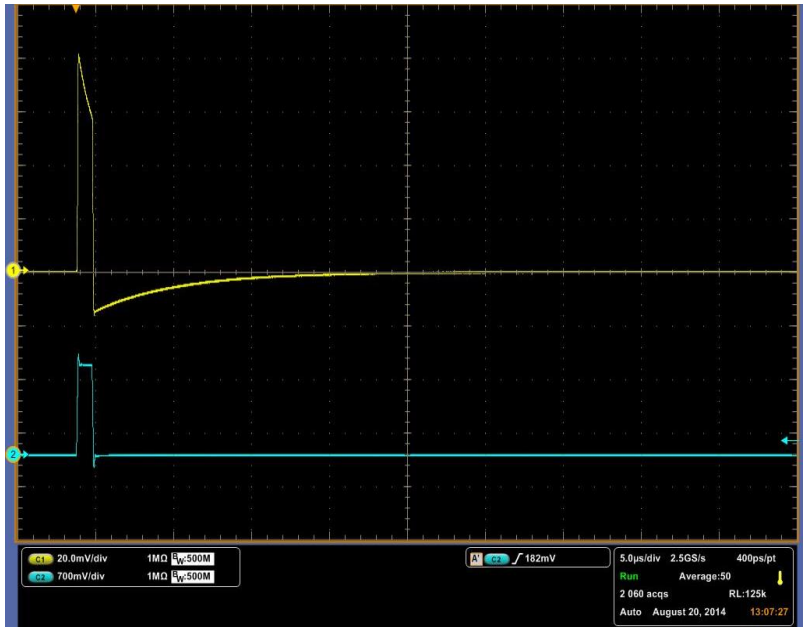




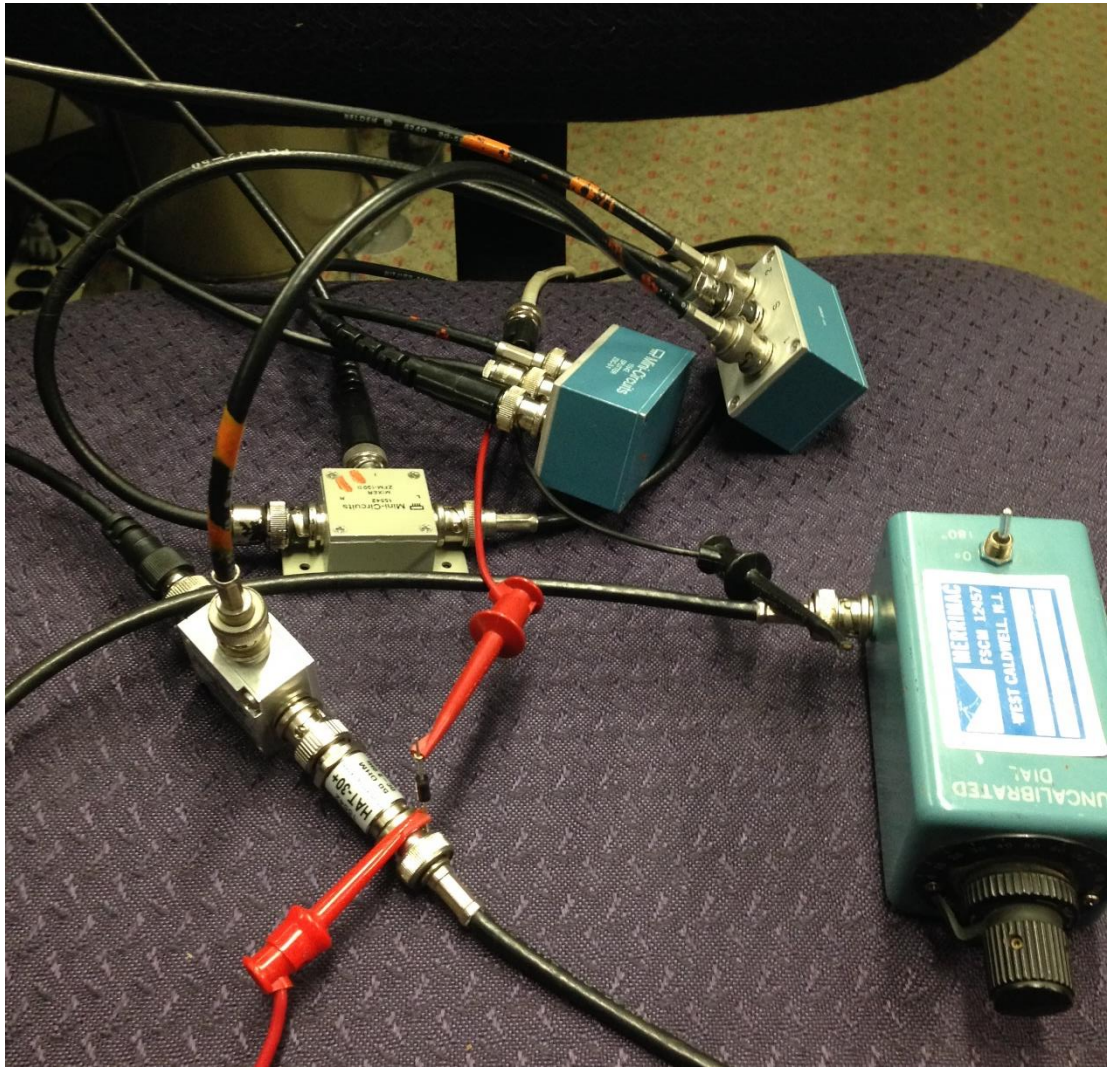
Fast Response Diode

1N4148



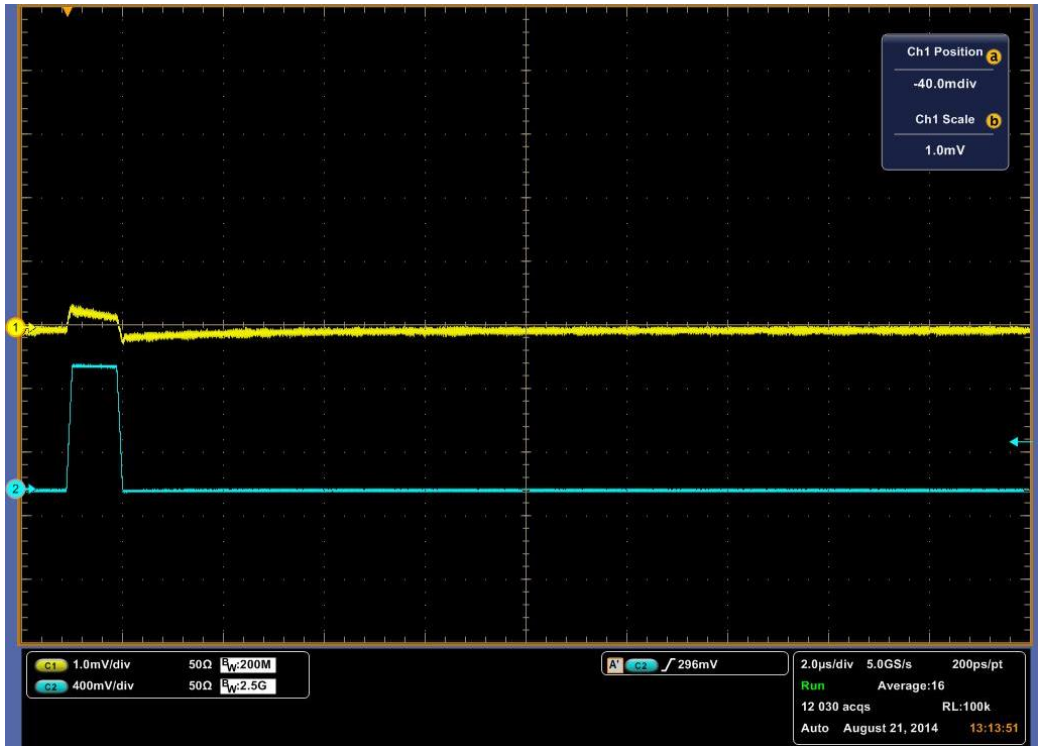


Stand Alone Component Set-up

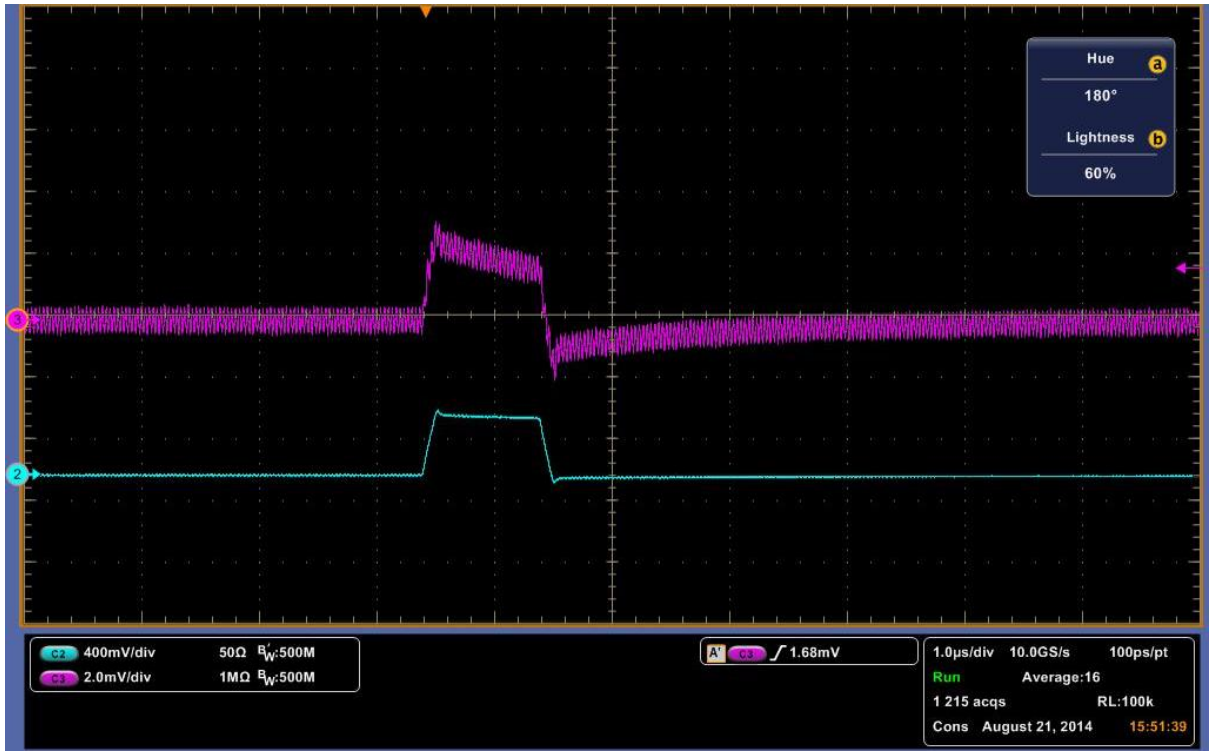


DLTS vs. Stand Alone Components

DLTS

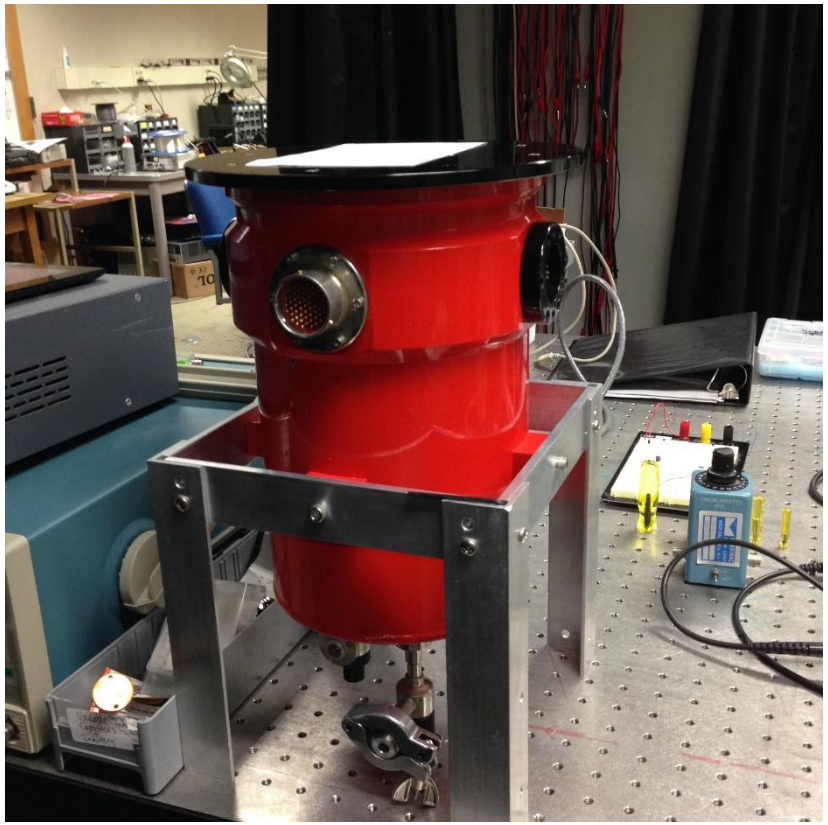


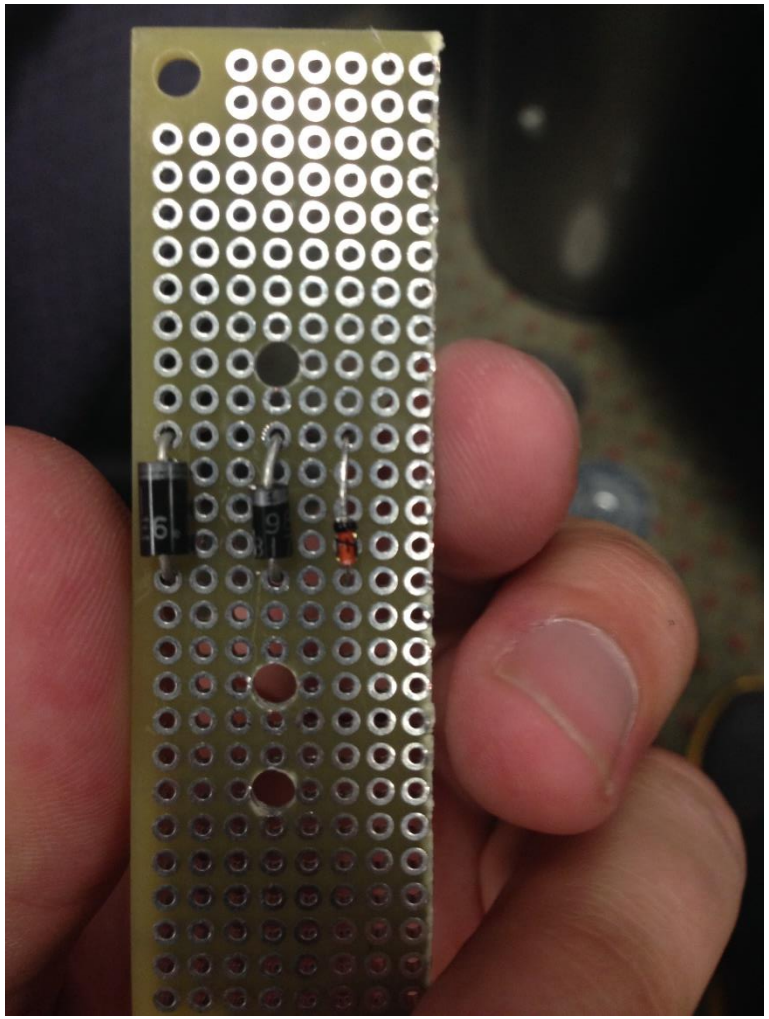
Stand Alone Components



Cryostat

- **Mounted diodes in cryostat for liquid nitrogen temperature measurements**





What's Next

- Verify spot size
  - Knife Edge measurement
- Explore band edge issues
  - Need a tunable Laser
- DLTS (Deep-Level Transient Spectroscopy)
  - Explore Pulse and Pulse response through system
  - Take measurements cooling the diodes through use of the Cyrostat
  - Consider using a Amplifier/Lock-in Amplifier and adding a capacitor to the end of the DLTS circuit