Integrated Plasmonic Terahertz Detector

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In Partnership with Sandia National Laboratories

This project is funded by the National Science Foundation

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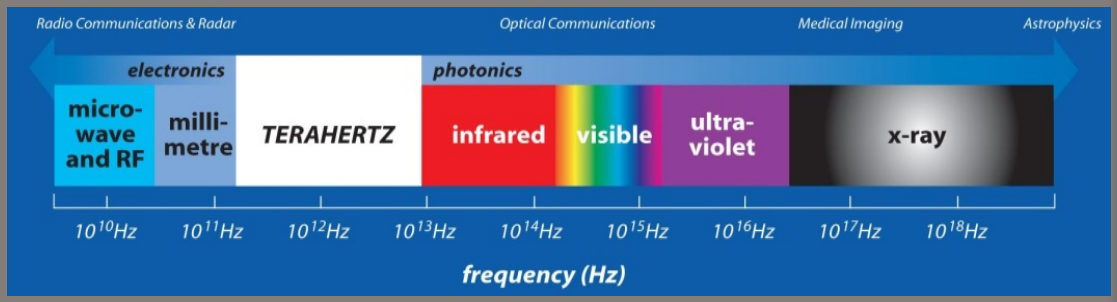
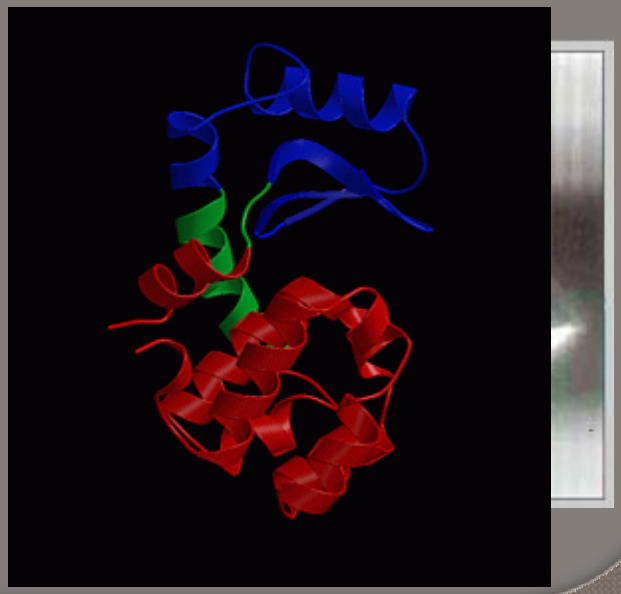
What are Terahertz



- Terahertz Spectrum
  - Technology gap
  - Engineering difficulties
  - No known health risk
- Applications in:
  - Medical
  - Military and Homeland Security
  - Categorizing proteins and molecules

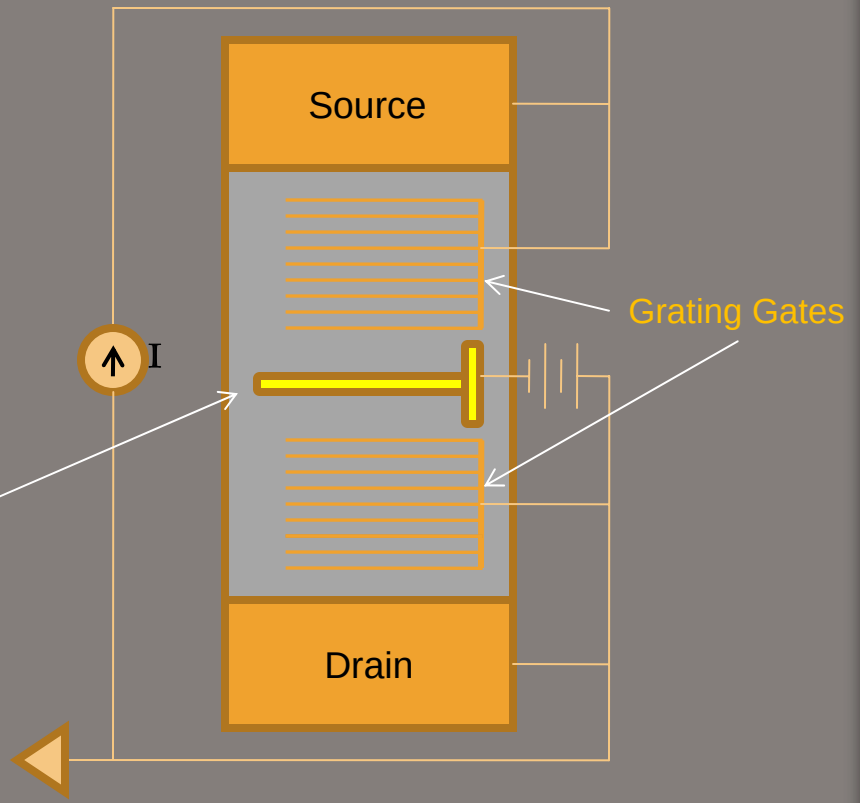


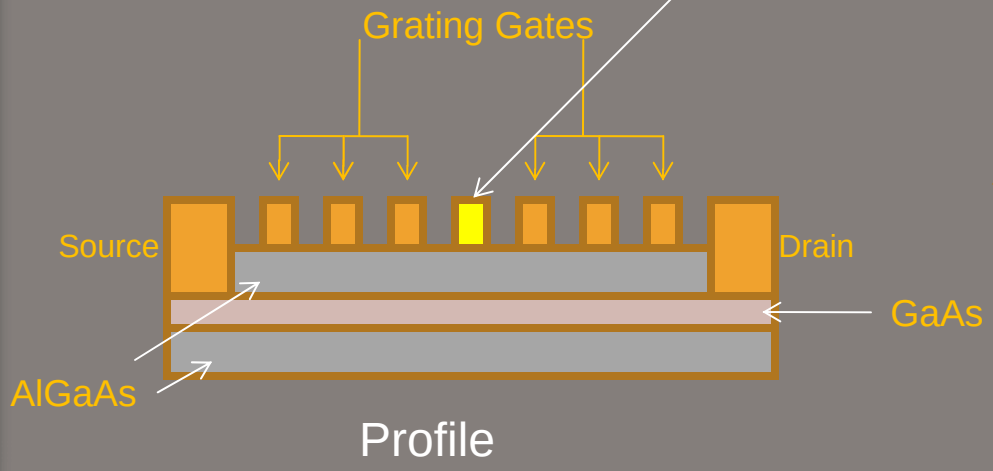
Project

- Characterize terahertz detectors
  - Special type of transistor
- Plasmonic THz Detector
  - THz radiation excites plasmons (electrons)
  - Tunable, narrow-band detection
- Focus on a single device
  - Measure THz response
  - Correlate transport characteristics
  - Develop a model of transport within the device

Plasmonic Terahertz Detector

- High Electron Mobility Transistor (HEMT)
  - Uses electrons for transport
  - Thin layer of electrons creating 2D electron gas
  - Gate is applied with negative voltage to limit flow



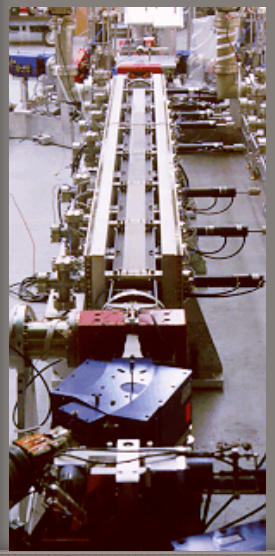


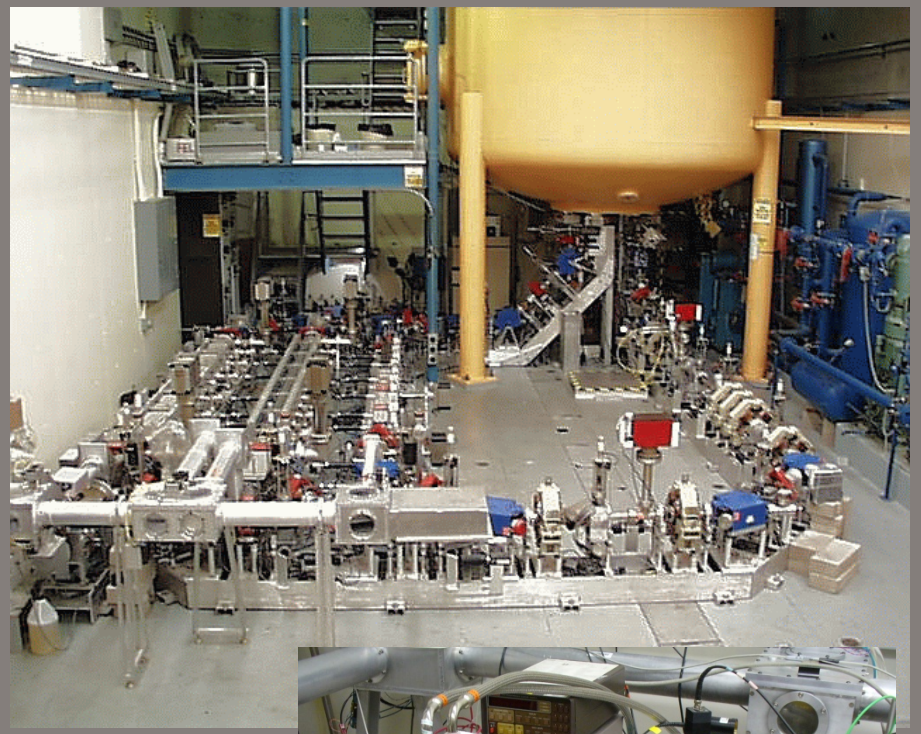
Profile

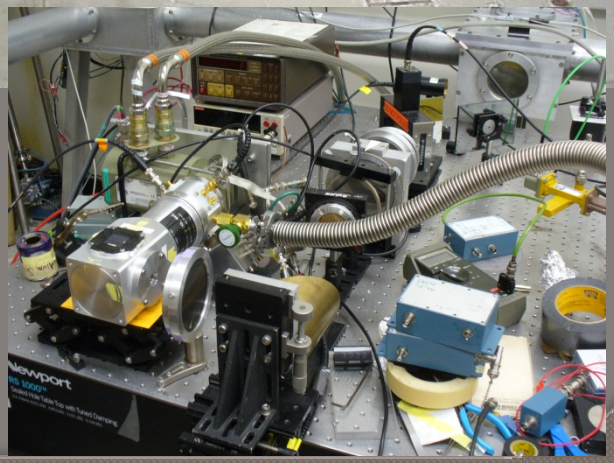
- Grating Gates couples radiation with the 2D electron gas in the GaAs layer

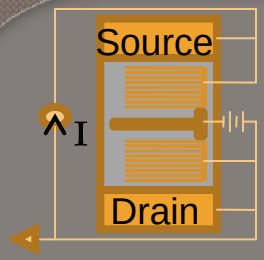
Set Up

- The Free Electron Laser (FEL) produces THz radiation
  - This is done by sending electrons through a resonator
  - The radiation is then positioned by mirrors and focused on the detector

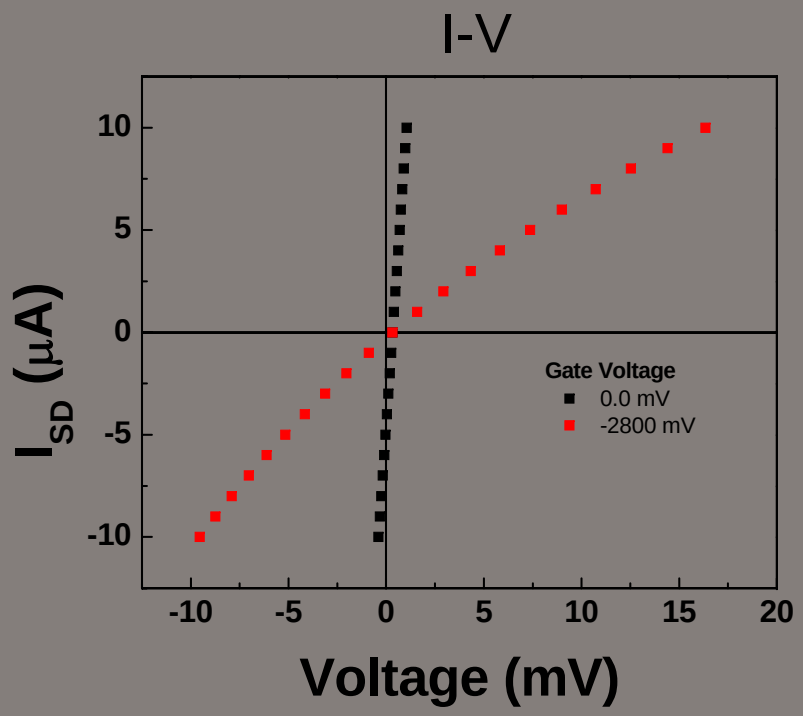






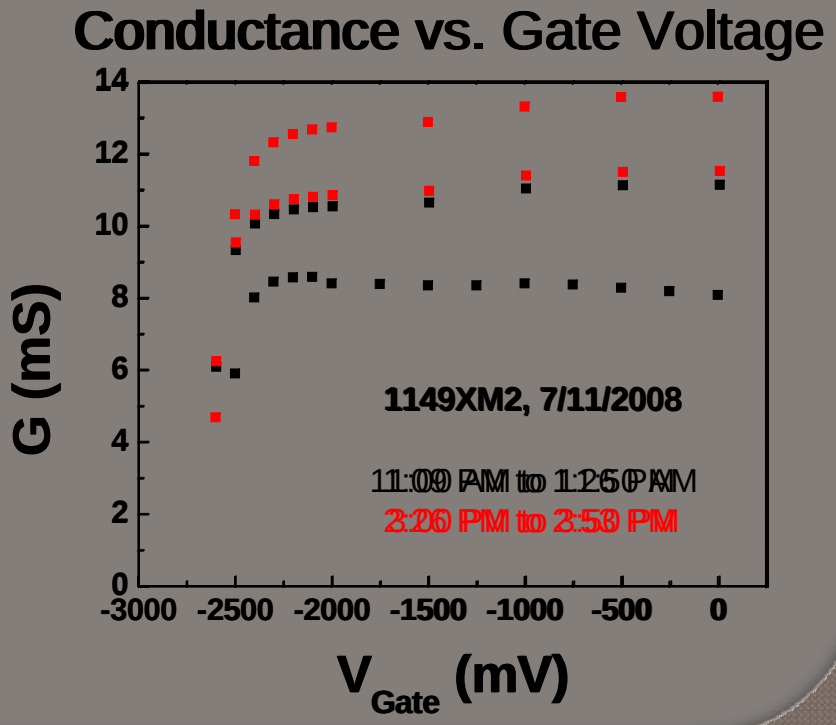


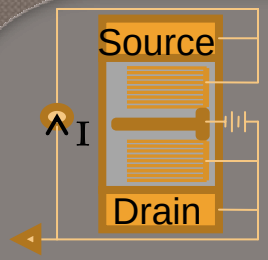
I-V Curves



- I-V curve shows on and off state

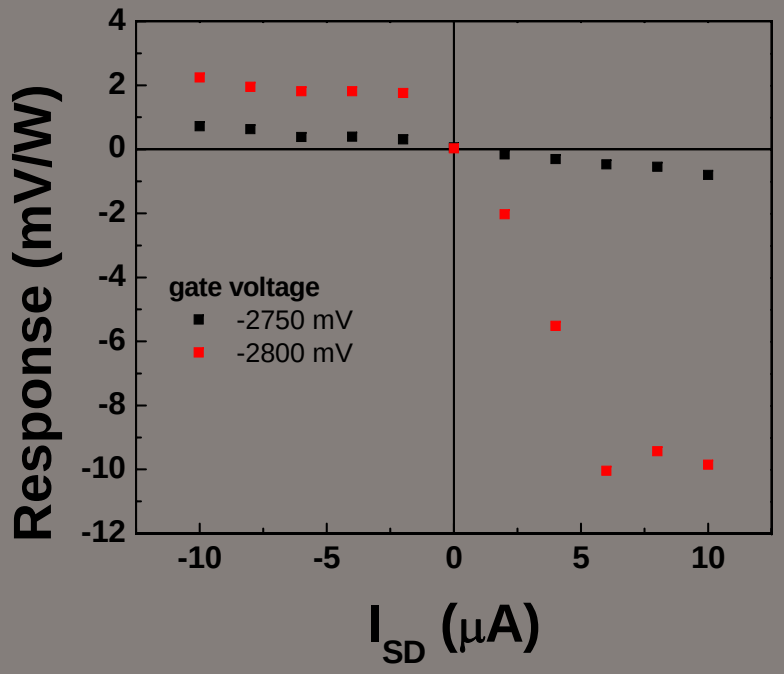
- Pinch off
  - Limits current between source and drain
- Graph show variation over time
  - Pinch off differs



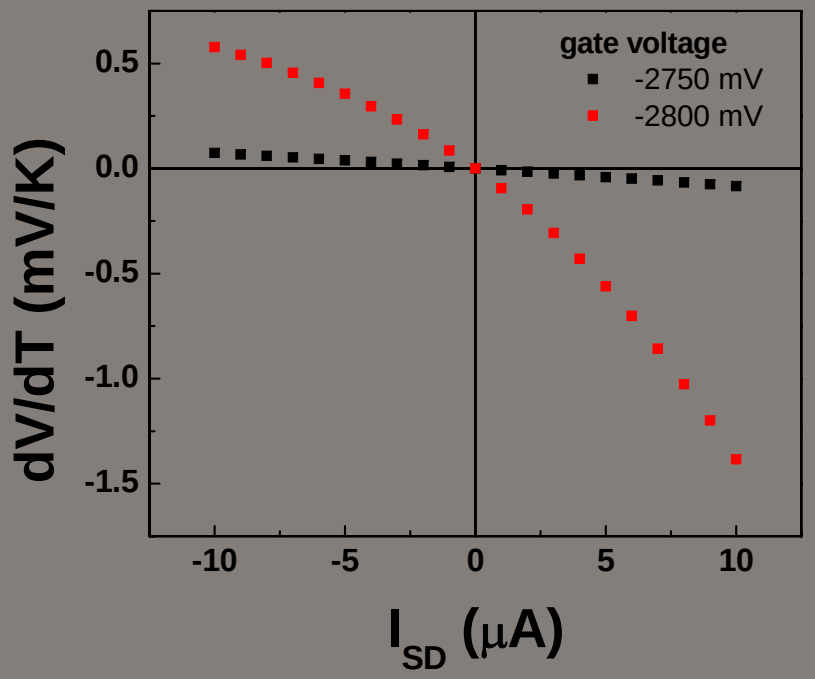


Detector Response

Corrected Response

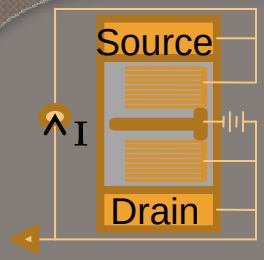


dV/dT

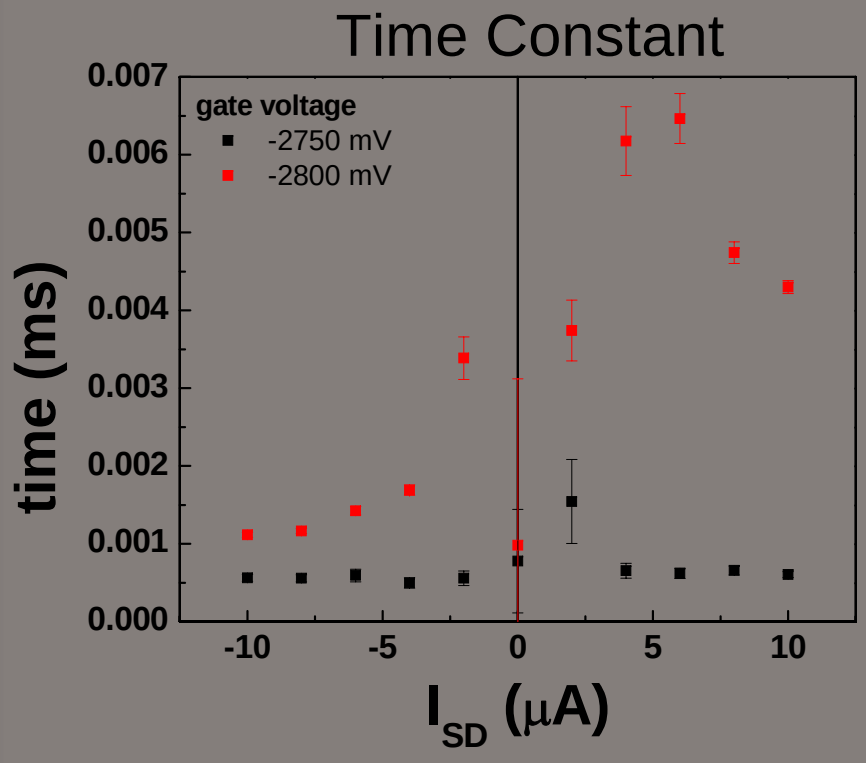


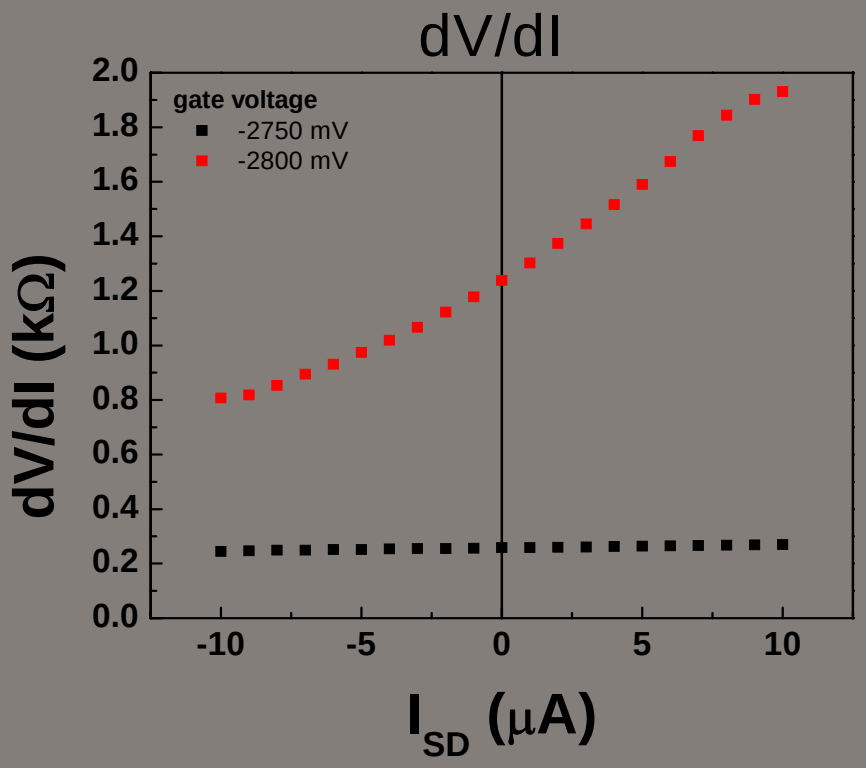
Voltage shift when hit by THz radiation
-Hot electron effect (2D gas heating)

Change in temperature from 20K to 25K



Time Constant Data





Time for voltage to return to ground state(EQ)
-Hot electron effect

Change in resistance at the bias point

Conclusion

- Summary
  - Data is reasonably close to other collected data
  - Plasmonic Terahertz detectors hold great potential
  - Have improved the stability of I-Vs
- Future Research
  - Use of grating gates to tune the detector
  - Minimize grating gates
  - Optimize finger gate
  - Array of detectors

Acknowlegdements

- INSET
- Partner: Sandia National Laboratories
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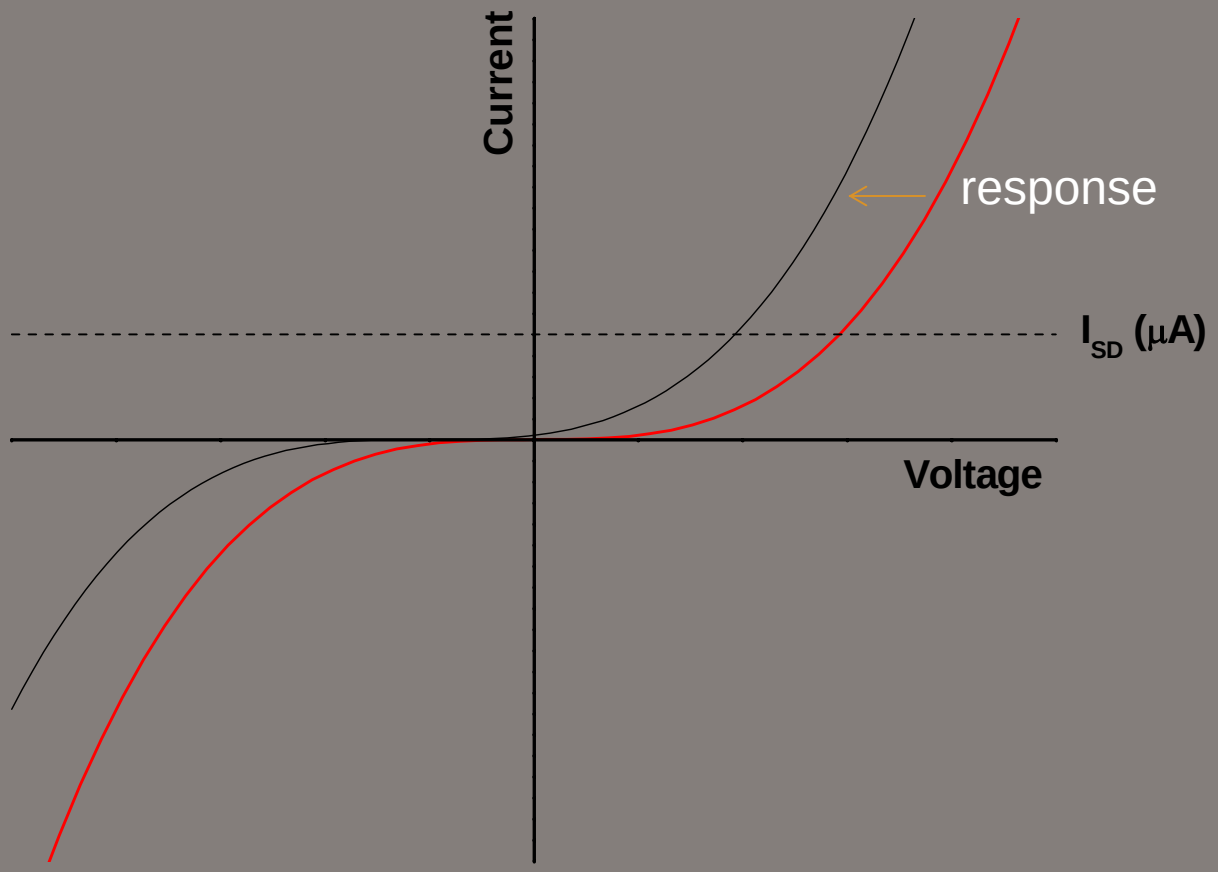
- Allen Group


Current
response
I_{SD} (μA)
Voltage