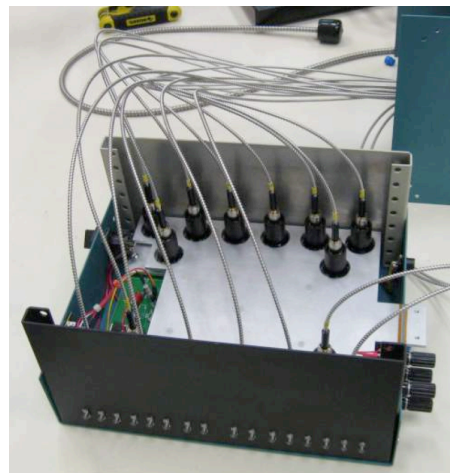


Ultra-Sensitive Near-Infrared Optical Receiver using Avalanche Photodiodes (APDs)

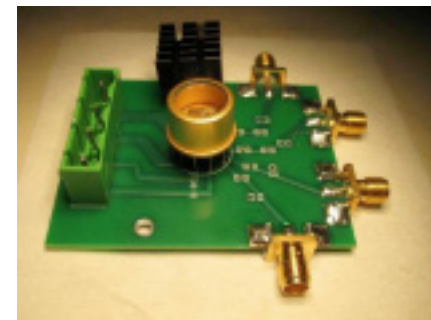
PI: Michael Krainak, NASA GSFC

Objective

- Develop a 1x16 APD detector array at $1.06\mu\text{m}$ with integrated fiber optic coupling to support various Decadal Survey missions (LIST, ASCENDS, ACE, 3-D Winds)
- Improve the performance of linear mode APD arrays at $1.06\mu\text{m}$ by:
 - Improved quantum efficiency (QE) $>75\%$ (GLAS/CALIPSO QE is 37%)
 - Reduced noise through material engineering
 - Improved sensitivity with reduced Noise Equivalent Power (NEP) $< 300 \text{ fW}/\text{rt}(\text{Hz})$
 - Maintaining a 1 GHz RF bandwidth (GLAS bandwidth is 140 MHz)



16-channel I2E APD photoreceiver



Single APD with built-in Thermal Electric Cooler

Accomplishments

- Designed, built and demonstrated InAlAs-based Impact Ionization Engineered (I2E) APDs with:
 - - Gain > 50 ;
 - - Bandwidth $> 1 \text{ GHz}$;
 - - Quantum efficiency = 85% @ 1.06 micron;
 - - NEP of 150 $\text{fW}/\text{rt}(\text{Hz})$ for 75 mm diameter (individual device);
 - - NEP of 250 $\text{fW}/\text{rt}(\text{Hz})$ for 16-channel receiver
- Demonstrated 1 x 128 I2E APDs array with excellent uniformity
- Demonstrated 16-channel photo-receiver with I2E APD devices with 900 MHz bandwidth (electronic preamp limited), NEP $< 300 \text{ fW}/\text{rt}(\text{Hz})$, compatible with 16-channel 300-micron diameter fiber bundle on airborne instrument (A-LIST)

Co-Is/Partners:

Xiaogang Bai, Ping Yuan, Rengarajan Sudharsanan, Spectrolab Inc.

TRL_{in} = 2 TRL_{out} = 4