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

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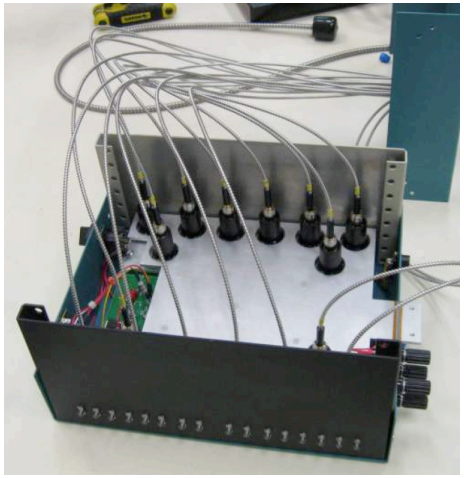
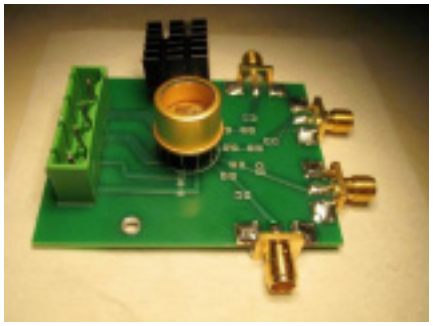
Objective

- Develop a 1x16 APD detector array at 1.06μm 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 1.06μm 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 fW/rt(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 GHz;
- - Quantum efficiency = 85% @ 1.06 micron;
- - NEP of 150 fW/rt(Hz) for 75 mm diameter (individual device);
- - NEP of 250 fW/rt(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 fW/rt(Hz), compatible with 16-channel 300-micron diameter fiber bundle on airborne instrument (A-LIST)

Co-Is/Partners:
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$TRL_{in} = 2$ $TRL_{out} = 4$