

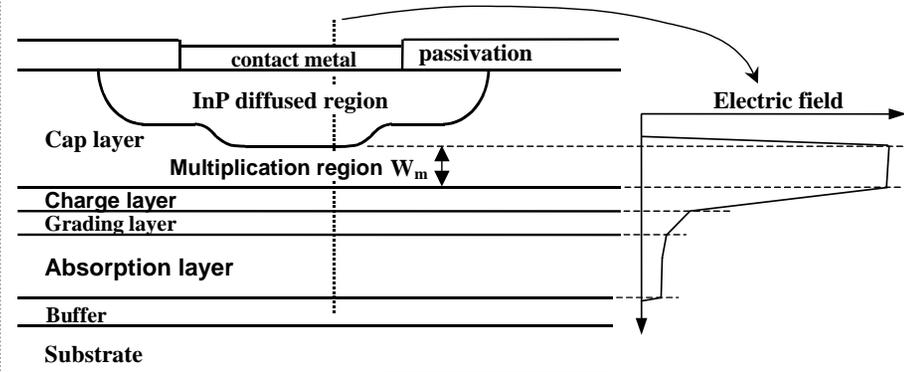
# High Performance Avalanche Photodiodes for Photon Counting at 1064 nm

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## Identification and Significance of Innovation

Progress in InP-based single photon avalanche diodes (SPADs) has not paralleled recent advances in avalanche photodiode “linear mode” operation, and device performance optimization specific to photon counting operation is needed. Moreover, work on InP-based SPADs to date has focused on wavelengths near 1550 nm, and there are no large area SPADs in this material system available for 1064 nm applications.

We will investigate the use of innovative bandgap engineering approaches to advance photon counting performance for 1064 nm SPADs. In particular, we will focus on achieving increased detection efficiency through the use of impact ionization engineered multiplication regions.



Schematic cross-section of an InP-based 1064 nm SPAD device platform (Fig 9 of proposal).

## Technical Objectives

- I. Feasibility for NASA 1064 nm photon counting targets:
  - gain > 1000, detection efficiency > 50%, saturation > 50Mcounts/s, 0.5 mm device diameter, 500 MHz bandwidth, non-gated operation
  - Establish space-qualifiable device reliability
- II. Performance comparison between bandgap engineered and bulk multiplication regions

## Work Plan

- Task 1. Epitaxial design
- Task 2. Device layout and photomask design
- Task 3. Epitaxial wafer growth and characterization
- Task 4. Wafer processing and device fabrication
- Task 5. Chip-level device characterization and data analysis
- Task 6. Assembly of prototypes for delivery to NASA

## NASA Applications

- Free-space optical communications, including space laser communications links.
- Active remote sensing optical instruments (lidar)

## Non-NASA Applications

- Range-finding and lidar applications
- Commercial lidar systems
- Free space optical (satellite) communications
- Single photon counting for fluorescence, photoluminescence and photoemission applications

## Firm Contact

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