SAND2015-6897PE

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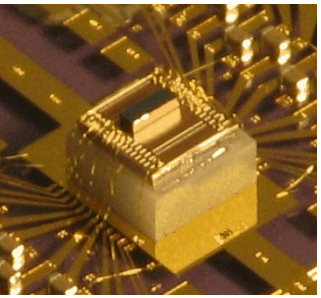
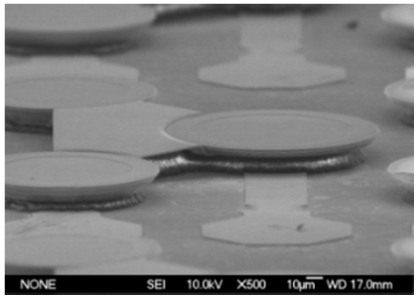

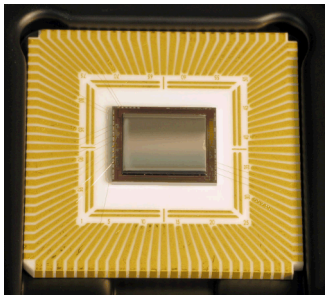
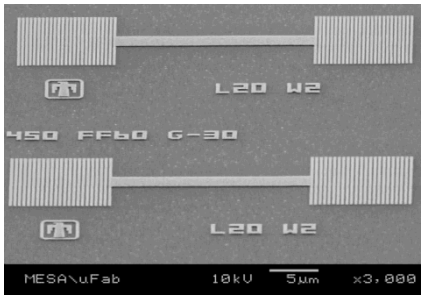

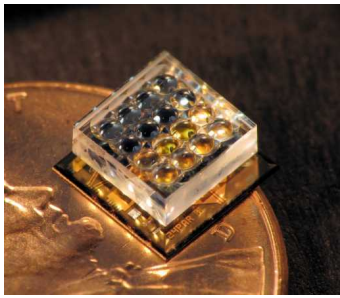

UNM OSE Orientation 2015
Majoring in Photonics? What Can You Do with That?
Some Career Advice and My Path

Gordon A. Keeler, Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY | NNSA

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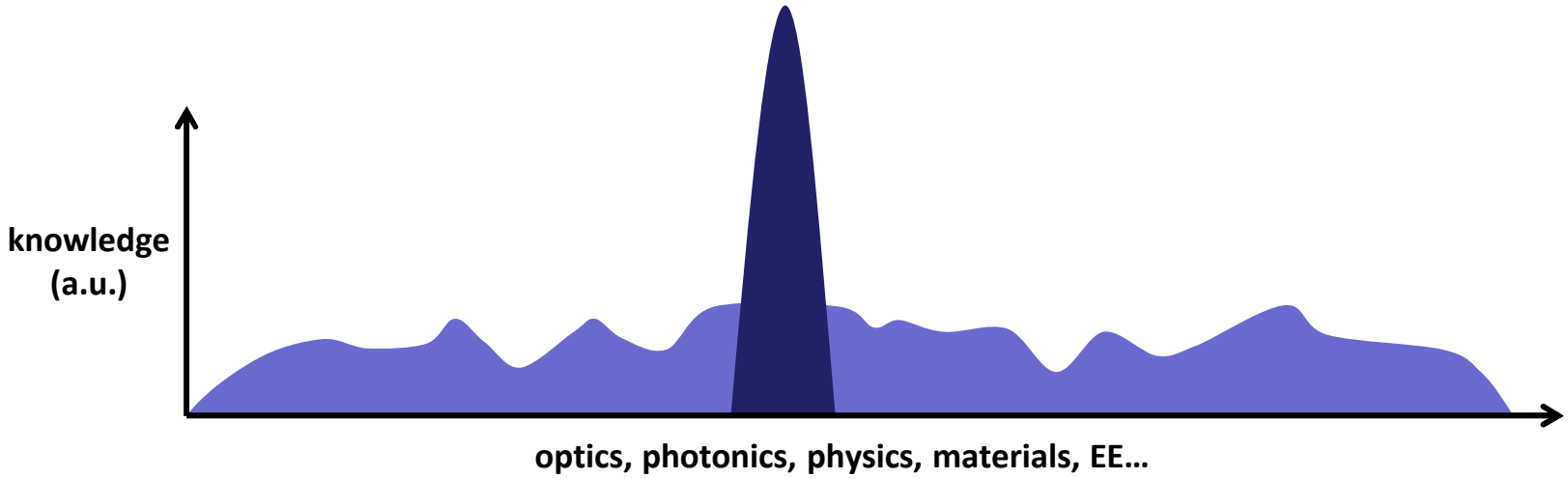
Graduate School Goal: Broad and Deep

Sandia National Laboratories

- My experience
  - hard work, good friends, learning every day
- Free advice:
  - this is your time to focus, take things seriously
  - maximize exposure: to classes, seminars, people, other fields
  - graduate degree goal: become broad **and** deep

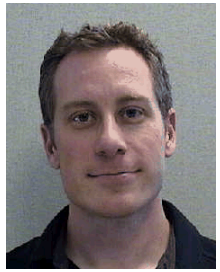
1996: young, excited, no job



Many Optics Career Choices: Look Around!

Sandia National Laboratories

- The job market is wide and healthy
  - academics
  - research
  - industry



2015:
old, but smarter,
with cool job

- Your career: start thinking about it now
  - graduate research
  - summer internships
  - networking
  - job fairs

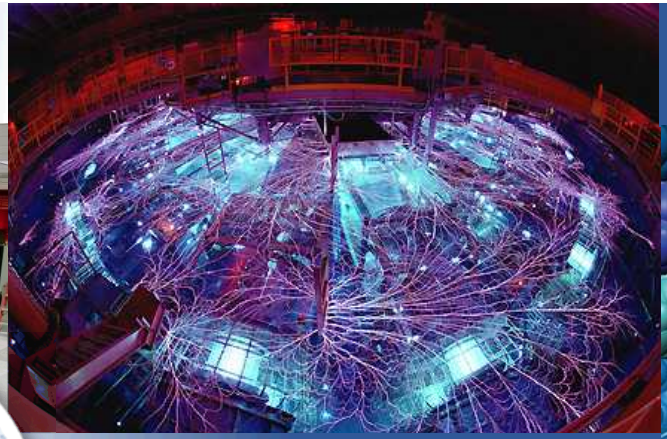
- Photonics at Sandia National Labs…

Sandia National Laboratories: Research

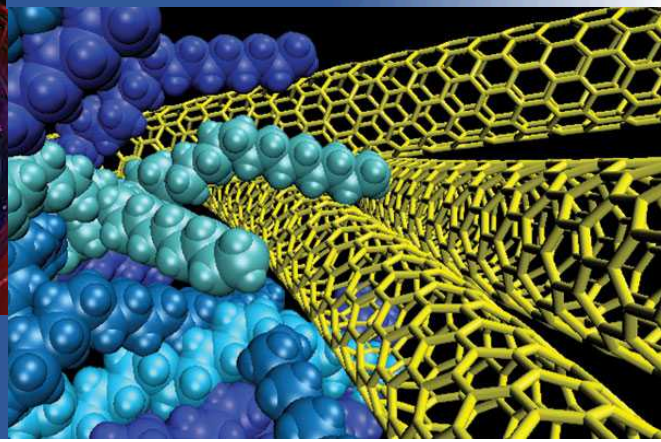
Strong research foundations play a differentiating role in our mission delivery

Computing & Information Sciences

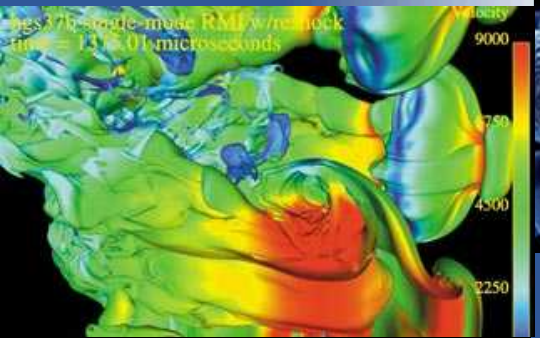
Radiation Effects & High Energy Density Science



Materials Sciences

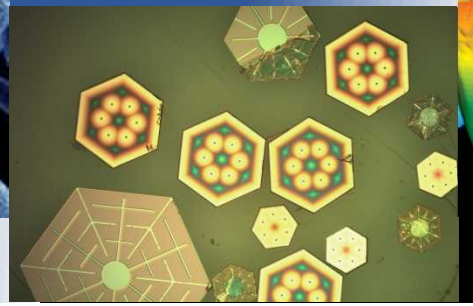


Engineering Sciences

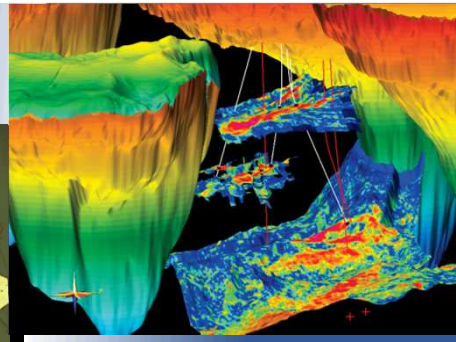


Bioscience

Nanodevices & Microsystems

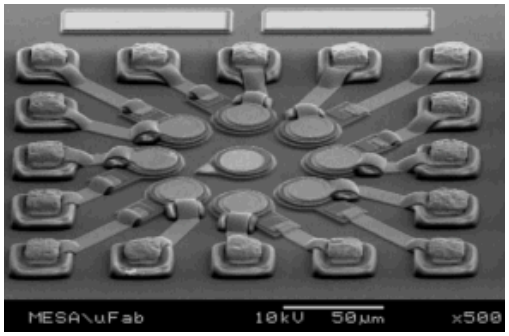


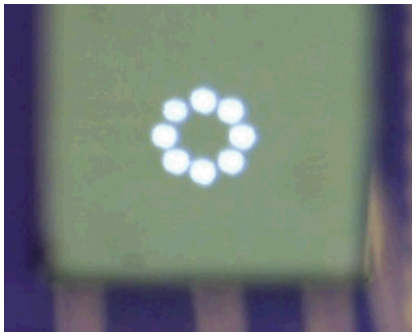
Geoscience

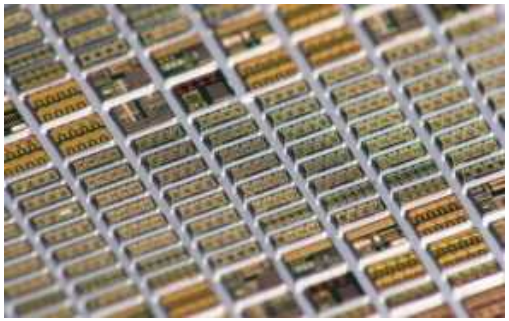


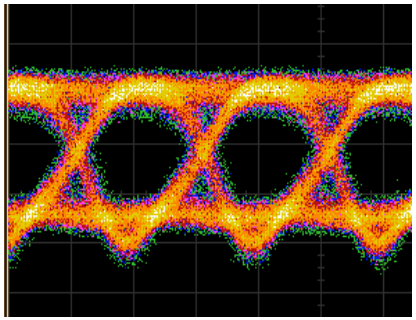
Optical Data Communications

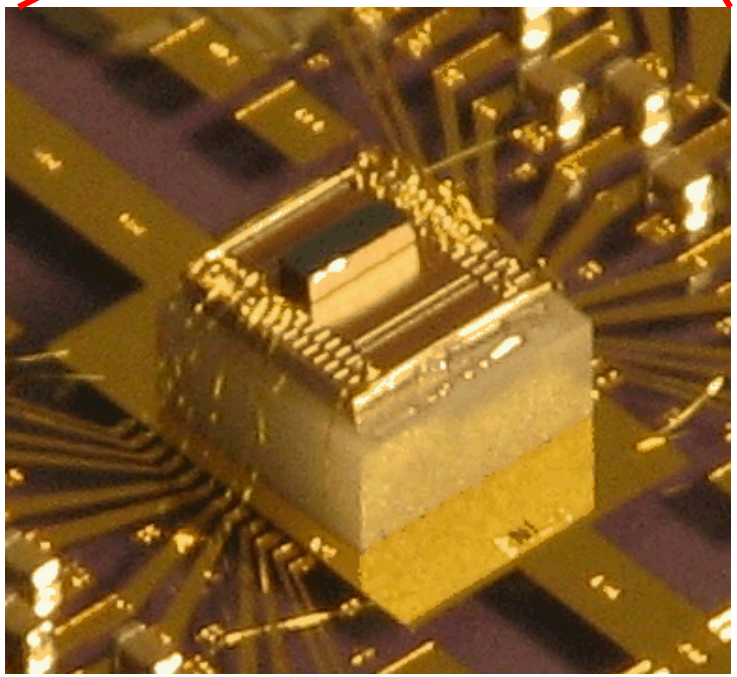
- VCSELs, modulators, photodiodes for high-speed data links
  - GaAs and InP based devices
  - custom high-speed driver and receiver circuits
- Dense integration with CMOS ICs
  - flip-chip attach reduces wiring for low parasitics
  - custom high-speed driver and receiver circuits





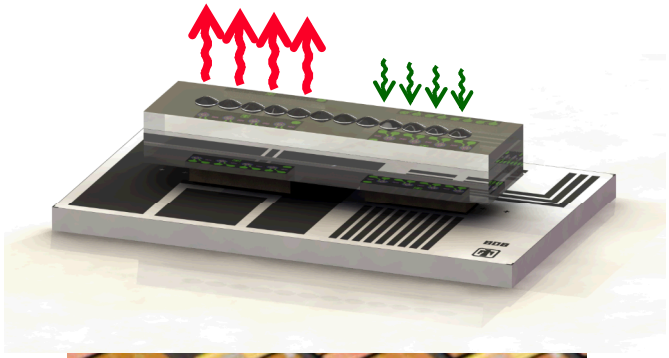


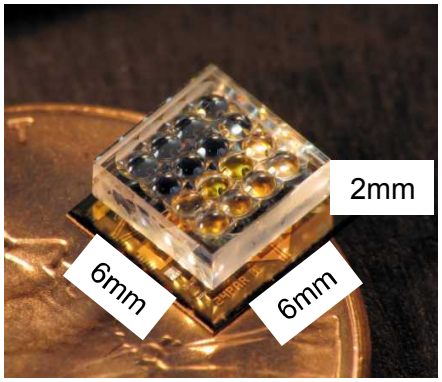




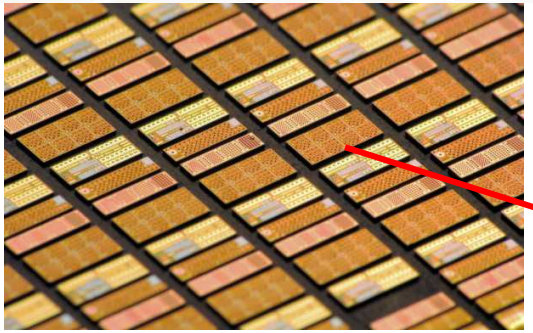
Photonic Sensors and Optical Microsystems

- Microsensors employ custom, flip-chip optoelectronics and micro-optic arrays:
  - very compact, g-hard; high sensitivity; narrow FOV; immunity to RF jamming
  - requires high-power VCSELs; fast photodiodes at 980nm; micro-optics
  - flip-chip integration of optoelectronics on AlN or diamond heat spreaders

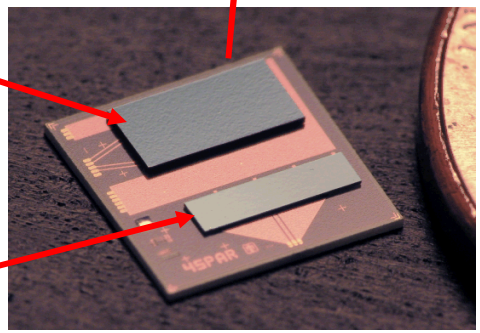




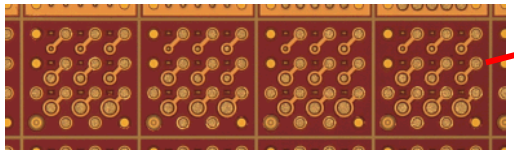
photonic assembly with custom lens array



2x4 InGaAs photodiode arrays



populated AlN submount

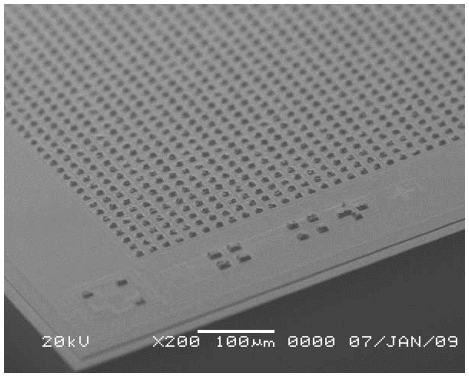


1x4 VCSEL array

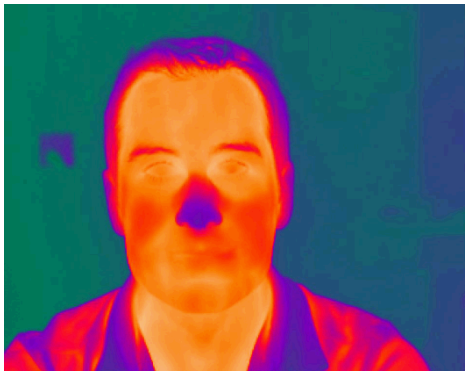
microsystem with support electronics

Infrared Imagers for Remote Sensing

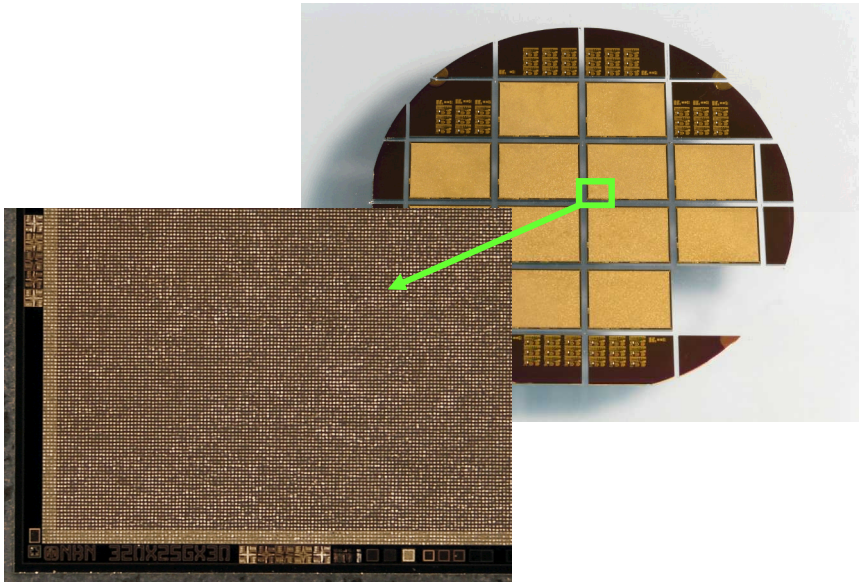
- New “nBn” detector technology, quickly leading to high-performance, large-area FPAs
  - first technology to challenge performance/manufacturing of II-VI HgCdTe (MCT) arrays
  - in-house III-V growth, fabrication, integration, and prototyping at Sandia
- Hybridization of large (1MP) GaSb detectors to CMOS readout ICs
  - 10-15µm indium bump bonding, underfill, substrate thinning, AR coating
  - hybridization of test die routinely achieves >99.99% interconnect yield

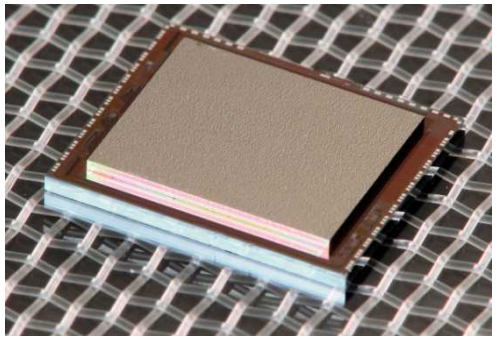


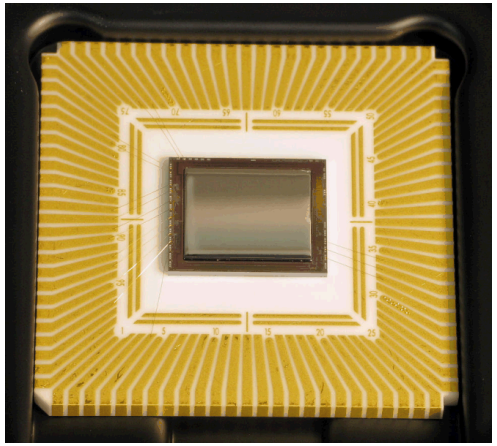
nBn detector array from MESA


still frame from Sandia FPA

detector arrays on GaSb

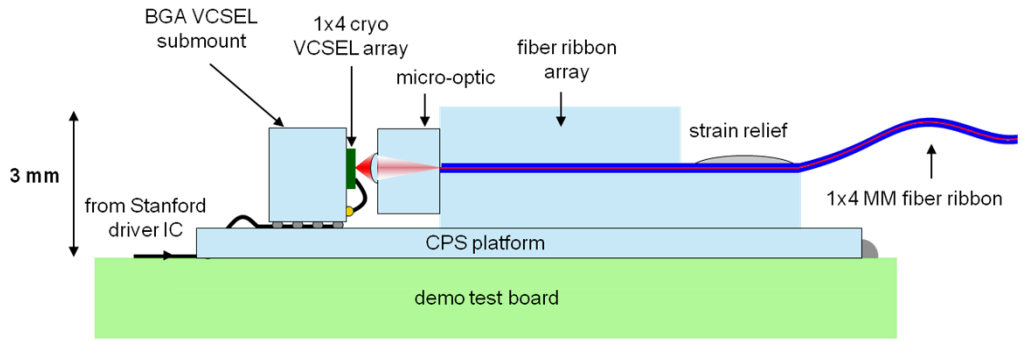

indium bumped pixels

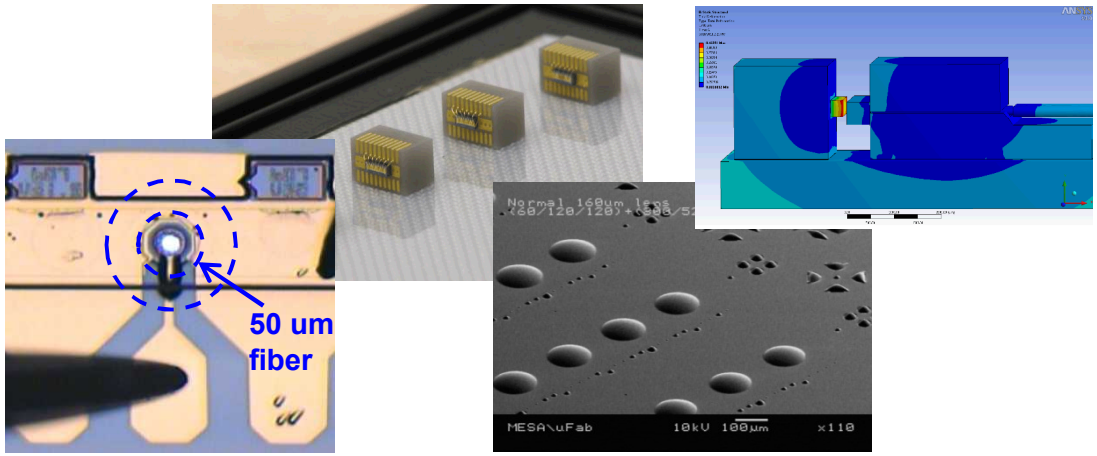

hybridized MWIR nBn FPA
on CMOS ROIC



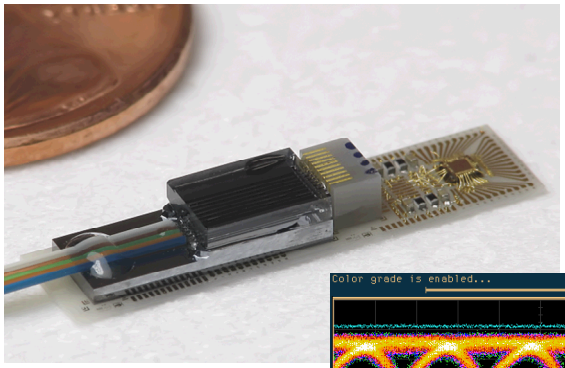
Optics for Extreme Environments

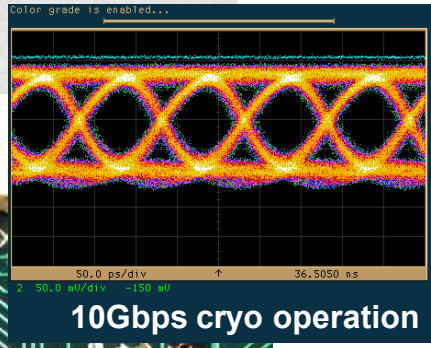
- Custom III-V photonics, microlenses, fiber optics, and electronics
  - cryogenic, high-speed operation
  - devices designed for radiation hardness

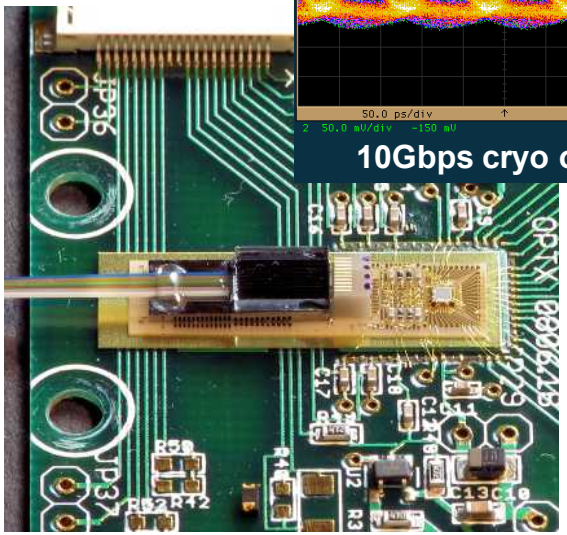




microfabrication, modeling, and assembly of transceiver elements







prototype assembled for cryo testing with FPA

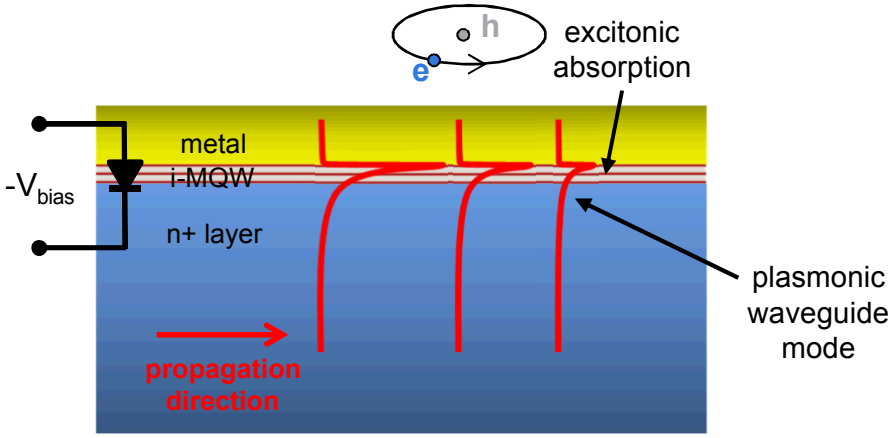
Active Plasmonics

Investigating NIR active plasmonics in semiconductor materials

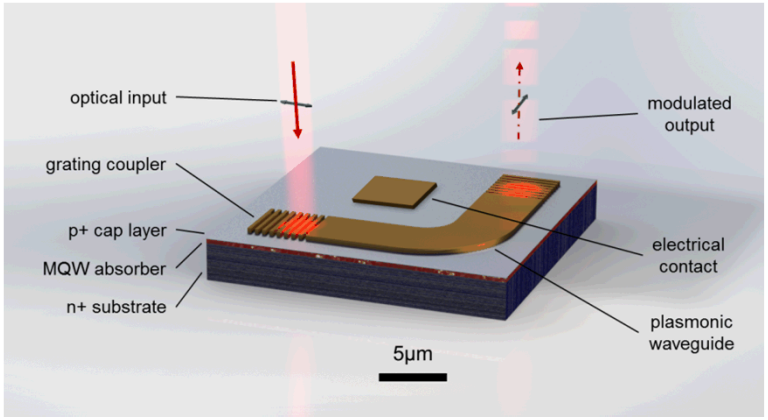
- modulators, nanoemitters, waveguides, detectors

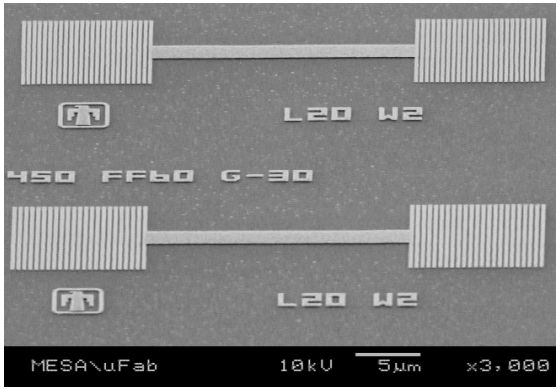
Plasmonics enables extreme field concentration and nanophotonic devices

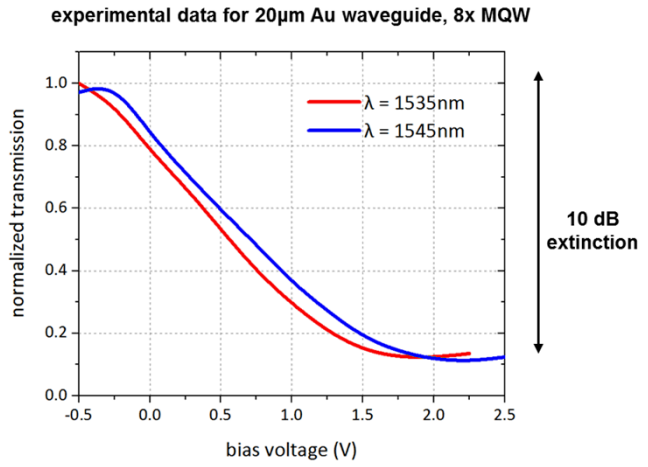
- devices promising for future photonic applications (speed, power, density)



MQW surface plasmon modulator







- **IEEE: Institute of Electrical and Electronics Engineers**
  - World's largest professional organization, focused on advancing technological innovation and excellence
    - >430,000 members
    - technical journals, standards, conferences
    - education, professional development, networking, job search
- **IPS: IEEE Photonics Society**
  - IEEE technical subgroup of photonics professionals
    - students, academics, professionals
    - lasers, optical devices, fibers, components, and optical systems
  - Student memberships are affordable!
    - $49 yearly (IEEE + IPS)
    - online journal access, reduced conference rates
  - Albuquerque chapter
    - local networking and education

IEEE

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