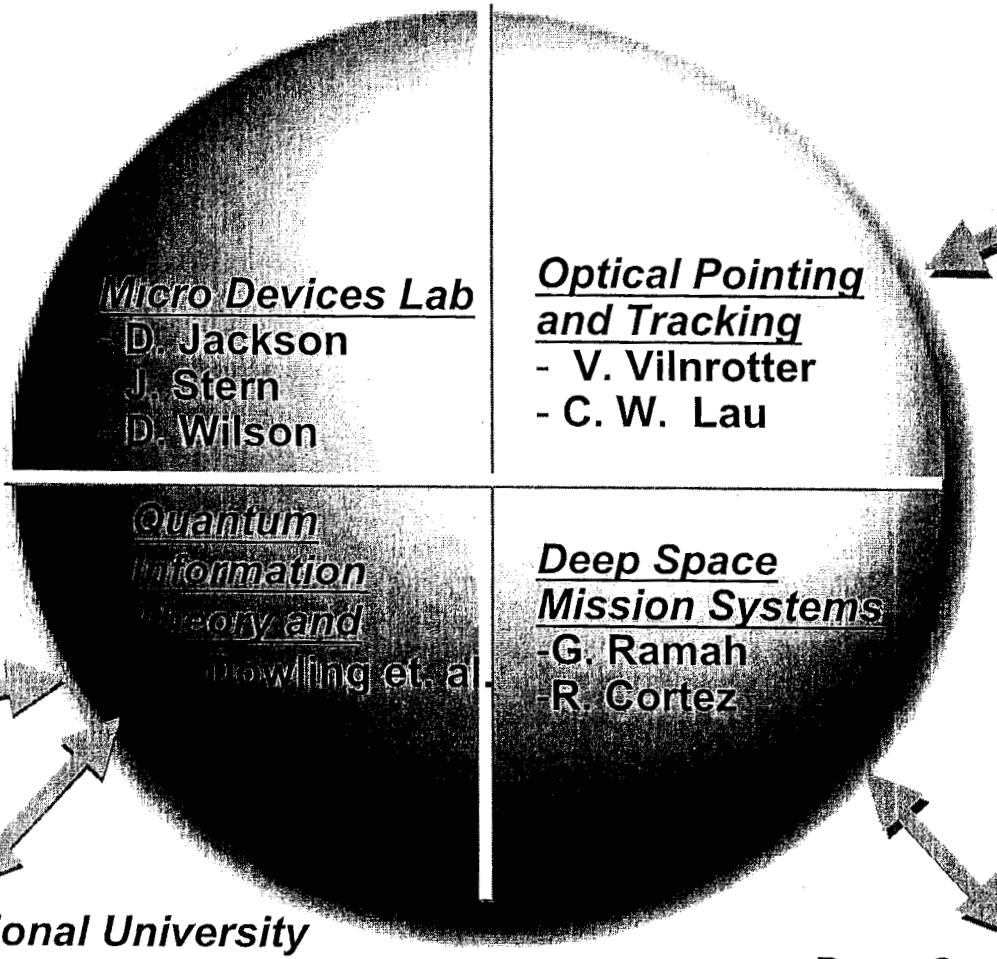
JPL

JPL Core Capabilities for Quantum Key Distribution Applications

D. J. Jackson, C. P. Williams, Jeff A. Stern, and J.P. Dowling

Team Technology Areas



NASA Dryden

RAND Corporation
- M. Juncosa

Australian National University
- G Milburn
- R. Clark

Deep Space Communication Complex (as testbed facility)

JPL

High Bandwidth, High quantum Efficiency Detector

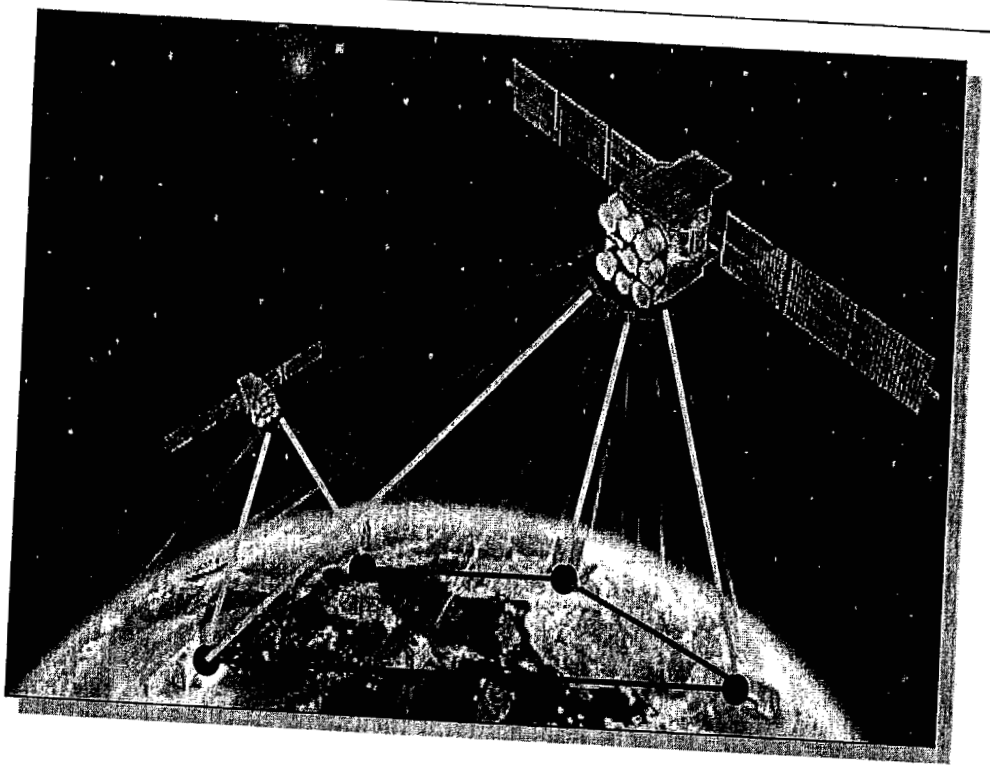
Deborah Jackson

Jeff Stern

Outline-- Detector only

- QKD Detector Development Program
  - Performance objectives
  - Design approaches
- JPL Fabrication Capabilities
  - Microdevices Laboratory- NbN detector fabrication
  - Quantum Internet Testbed
- Programmatics
  - Development Schedule
  - Budget
- JPL Objective

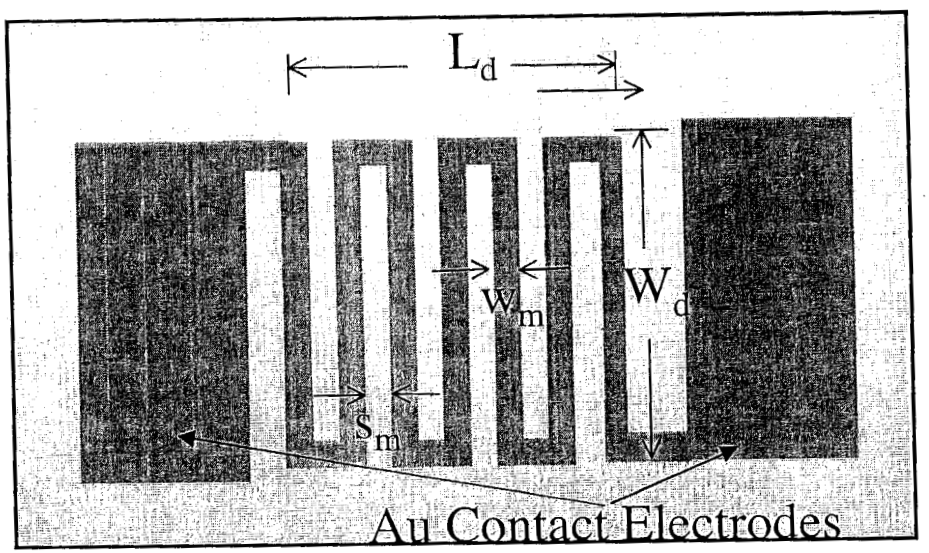
JPL Long Term QKD Network Vision

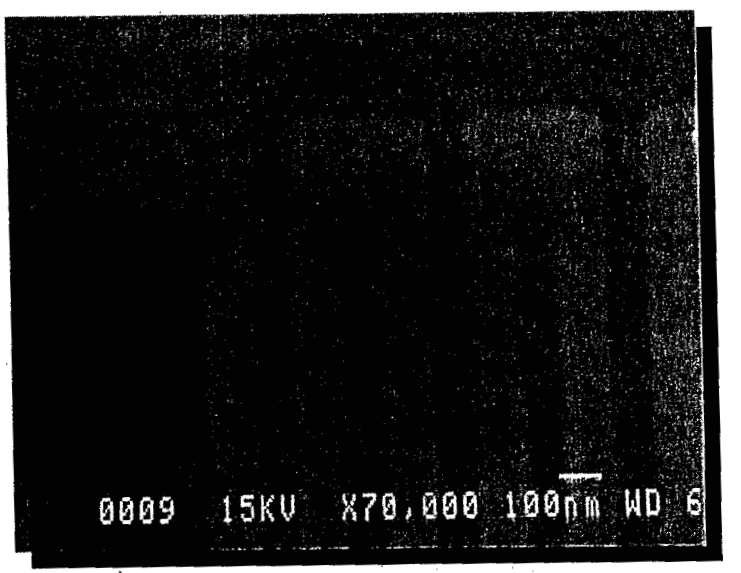


- Performance Requirements
  - Long term secure satellite key updates (0.5 - 0.7 μm)
  - Key distribution using existing fiber networks (1.5 μm)
  - High bandwidth (10GHz) throughput
  - High quantum efficiency

- SATCOM .....
- Fiber ——
- SATCOM/Fiber Interface

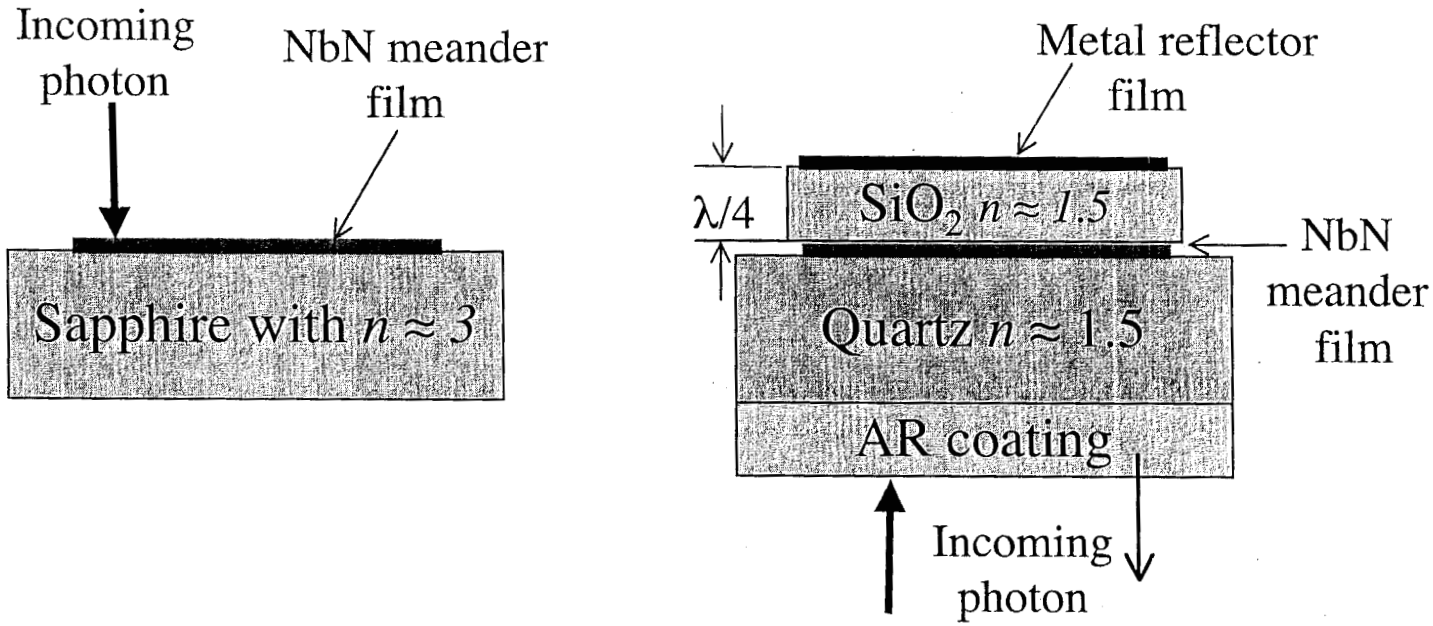
Meander Architecture has Limited performance





- Small spacing of meander lines limits bandwidth
- Quantum efficiency limited by
  - Reflections off of surface
  - Ratio of spacing to meander widths
  - Non-uniformity of film width and thickness

Improve Quantum Efficiency (QE) by Reducing Optical Losses



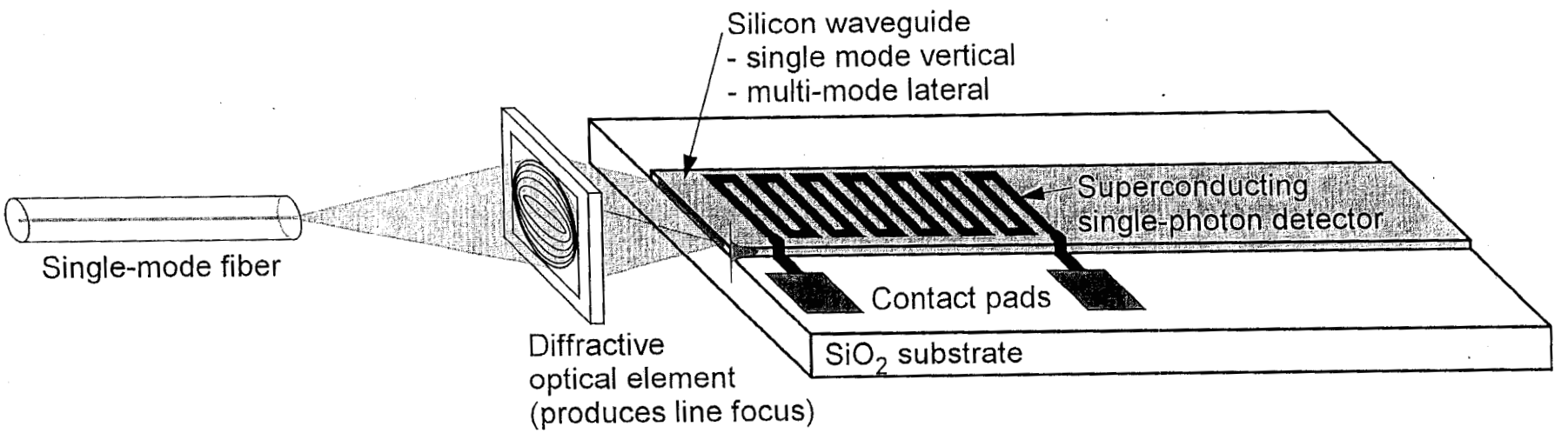
(a) (b)

Z_1= 2 kohm/sq
Z_2= Z_0/n
Z_0= Free space impedance = 377 Ω
n = refractive index

$$Abs = 1 - \Gamma = 1 - \frac{|Z_1 - Z_2|^2}{|Z_1 + Z_2|^2}$$

Maximum *Abs* ~ 40%

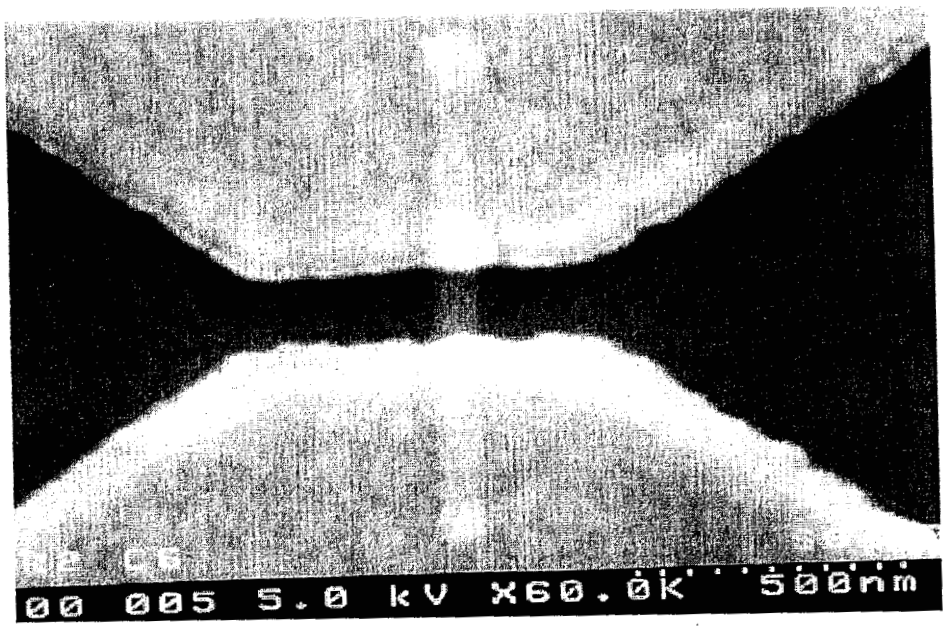
High QE Waveguide Architecture



- PROS:
  - Relaxes spacing requirement between meander lines.
  - Design eases impedance matching requirements
  - Potential for approaching 100% quantum efficiency
- CONS
  - Requires custom focusing optics

Micro Devices Lab (MDL)

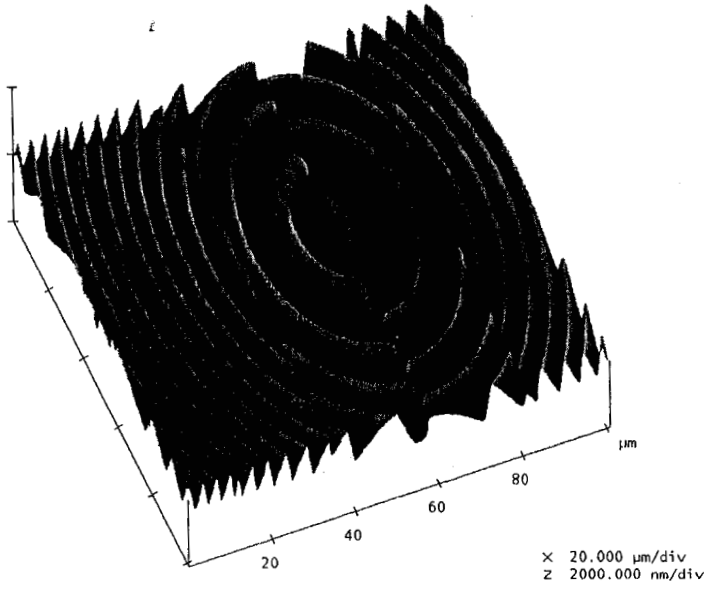
Single photon detector fabrication requirements:



SEM image of a 80 nm wide Nb microbridge

- SOA Class-10 clean room facility
- E-beam lithography with 4 nm resolution
- NbN and NbTiN superconducting material fabrication.
- Prototyping and design capability

Custom Focusing Optics for Waveguide Detector



- Improve coupling with E-beam fabricated diffractive optical element
- Diffractive Optical Element (DOE) permits compact, efficient coupling into waveguide detector.