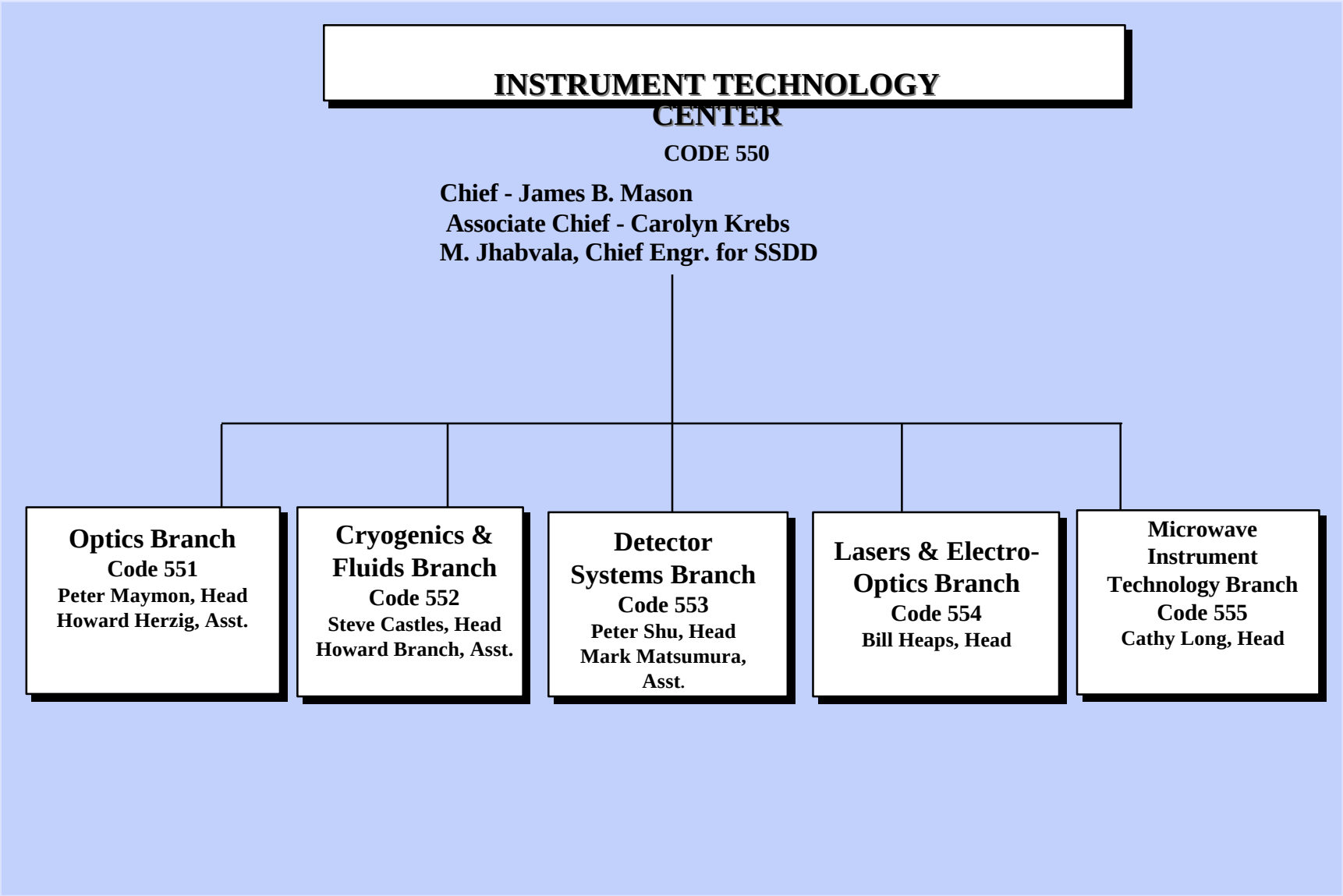
GSFC Instrument Technology Center Overview

Dr. William S. Heaps, Head
Laser and Electro-Optics Branch

March 11-12, 1998

ORGANIZATIONAL STRUCTURE



NASA - Goddard Space Flight Center
Cryogenics And Fluids Branch

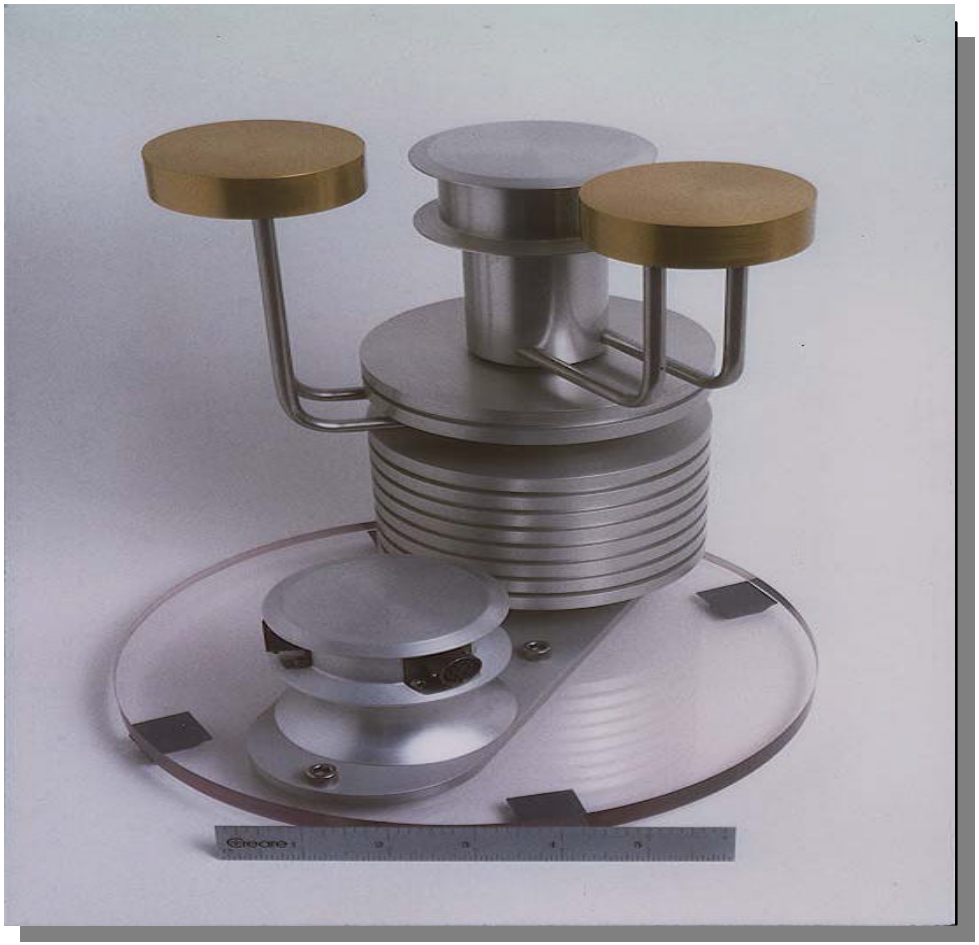
- **Capabilities**
- Instrument Cryogenic Systems Mgmt.
- Cryogenic Design, Analysis, and Test
- Cryogen Storage and Transfer
- Hardware Fabrication and Assembly
- Flight/Test Dewars Design/Construction
- Adiabatic Demagnetization Refrigerators
- Mechanical Refrigerators/Cryocoolers
- Superconducting Magnets
- Cryogenic/Sensors Technology
- Development/Test Laboratories
- Ground Support Equipment
- Superconducting sensors
- Computer Aided Design
- Instrument Fluid Systems
-

NASA - Goddard Space Flight Center
Cryogenics And Fluids Branch

- **Interest**
- Adiabatic Demagnetization Refrigerators
- Mechanical Refrigerators/Cryocoolers
- Superconducting Magnets
- Cryogenic/Sensors Technology
- Development/Test Facilities
- Superconducting sensors
- Laboratory testing
-
- **Facilities**
- Cryogenics Laboratory
- Cryogenic Research and Integration Facility (CRIF)
- Cryocooler Testbed
-

Yardstick MIR detector (SI:AS) *needs active cooler*

- **Brayton-Cycle Compressor Rotor runs at over 30,000 RPM, cooler reaches 6K and does not introduce spurious vibrations**
- **Sorption cooler is alternative**



Tunable Narrow Band Optical Filter

Years

1999 2000 2001

Enabling Science and Tecnolology

- Precision Optical Polishing
- Precision Optical Metrology
- Transparent conductive coatings
- Zinc Sulfide material processing

- Novel Optical glasses (PTR)
- Novel Holographic fabrication methods
- Transparent conductive coatings

Products

- Cleartran tunable narrow band optical filter
- Volume holographic tunable narrow band optical filter

Applications

- Mars Lander water vapor lidar
- Earth upper atmospheric water vapor lidar
- Missions
- SIRTF
- lidar
- NOAA weather lidar
- LANDSAT
- EOS GLAS II

- Discovery
- Europa topography
- Mars Orbiter
- ESSP Wind
- GOES

LEO Branch Projects

- Zephyr Tuneable etalon
- Zephyr Laser Procurement
- GLAS photodiode detectors
- GLAS 532nm detector assembly
- GLAS star tracker detector array
- EUROPA laser range finder
- Airborne Raman lidar

LEO Branch Facilities

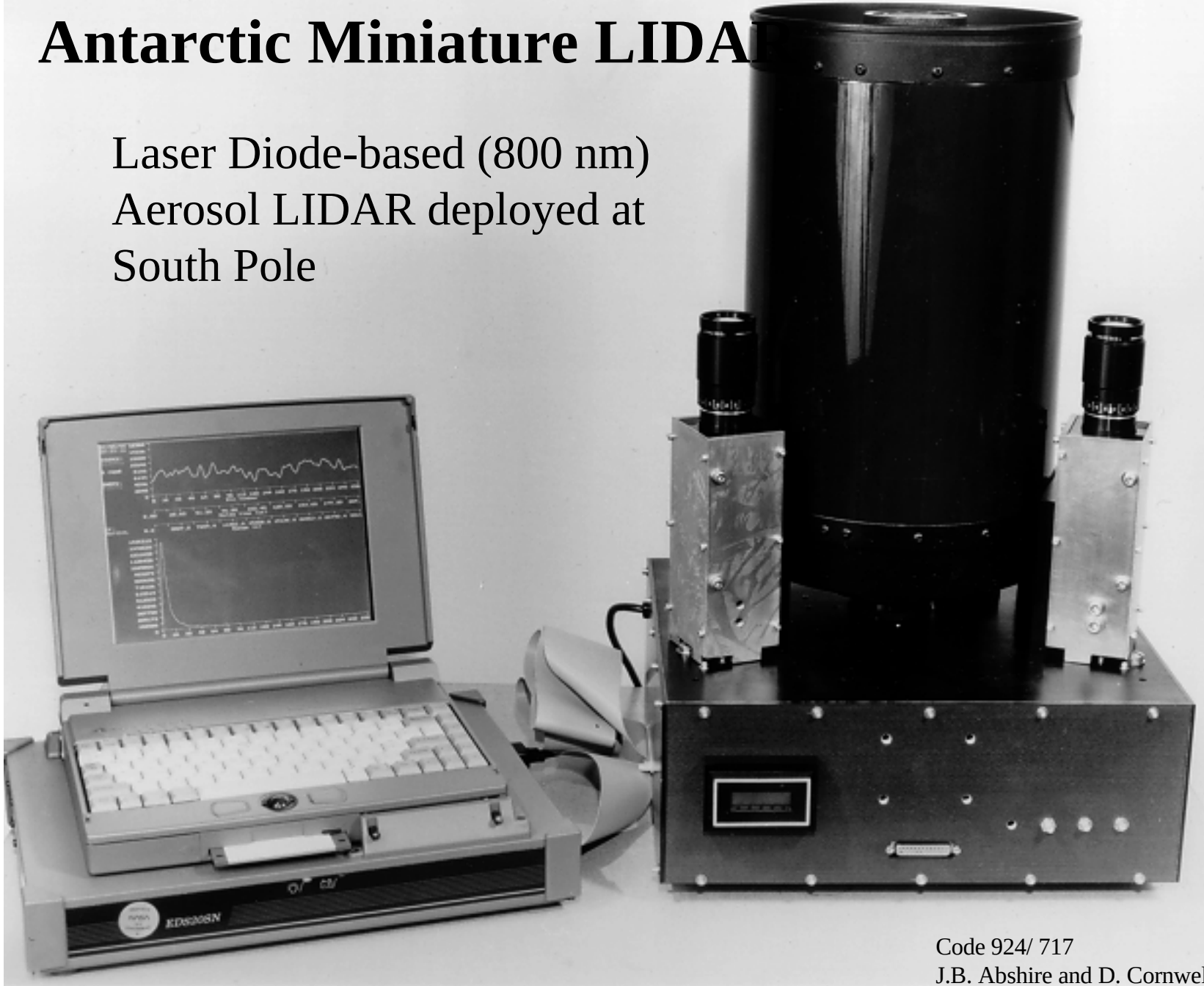
- 6 Optical Test Laboratories
- Laser diagnostic instruments
- Laser lifetime test facilities
- Diode lifetime test facilities
- Satellite tracking telescope facilities

LEO BRANCH TECHNOLOGY RESEARCH

- Photon Counting Component Development
- Tuneable filter development
- Fiber grating laser tuning
- Component Lifetime testing
- Lidar systems
- Space qualified lidar subsystems

Antarctic Miniature LIDAR

Laser Diode-based (800 nm) Aerosol LIDAR deployed at South Pole



Code 924/ 717
J.B. Abshire and D. Cornwell

Miniature Lidar

Years

1999 2000 2001

Enabling Science and Tecnolology

Semiconductor laser transmitters
Photon Counting detectors
Lightweight telescopes
Narrow optical filters

Miniature Nd:YAG lasers
Photon Counting detectors
Lightweight telescopes
Narrow optical filters

Products

Breadboard planetary surface miniature lidar

Breadboard planetary orbiting miniature lidar

Applications

Mars Lander water vapor lidar
Earth upper atmospheric water vapor lidar
Europa topography lidar
NOAA weather lidar

Mars Orbiter atmospheric lidar
ESSP wind lidar
Earth ice, atm lidar (GLAS II)

NASA/GSFC Optics Branch

Technologies of Special Interest to SBLRD

- Light-Weight and Active Optics
  - Modeling and Testing of Light-Weight Composite Telescopes (RTOP)
  - Development of Very Light-Weight Active Optics (RTOP)
  - Very Light-Weight UV Telescopes with Silicon Carbide Coatings (RTOP)
  - DCATT - Deployable Cryogenic Active Telescope Testbed for Next Generation Space Telescope
- Optical Materials and Thin Films Technology
  - Optical Studies of Thin Films in the EUV (RTOP)
  - Development of Silicon Carbide Mirror Technology for UV Applications
  - Advanced mirror technology for UV systems technology and EUV photolithographic systems (JSRA)
  - Diamond Membrane mirror technology

NASA/GSFC Optics Branch

Technology Program Summary

A broadly based technology program encompassing the core technologies for imaging and spectrographic remote sensing space instruments. Supported by Code S, Code Y, DDF, SBIR, STTR, and project specific technology initiatives

-
- Optical materials
- Diffractive optics
- Mirror and structure technology (includes SiC and composites)
- UV optical coatings
- X-ray and EUV multilayer mirrors
- Optical component development, fabrication, and test
- Light-weight optics technology
- Active Optics
- Survivability of optics in space
- Optical performance analysis based on as-built component metrology

NASA/GSFC Optics Branch

Other Technology Activities

- Diamond membrane mirror technology
- XRS blocking filter development
- Characterize Filters for HST Advanced Camera for Surveys (ACS)
- Cryogenic and non-cryogenic retroreflector and roof-top dihedral development
- Constellation X mandrel development for x-ray foil mirrors: need to improve to 0.5nm rms roughness to support 15 arcsec imaging req.
- Wavefront Sensing as applied to HST/IVT
- End-to-end optical instrument systems analysis/test including phase retrieval (SIRTF/IRAC and NGST/DCATT)
- NGST Deployable Cryogenic Active Telescope Testbed (DCATT)
-

NASA/GSFC Optics Branch

Major Technical Facilities

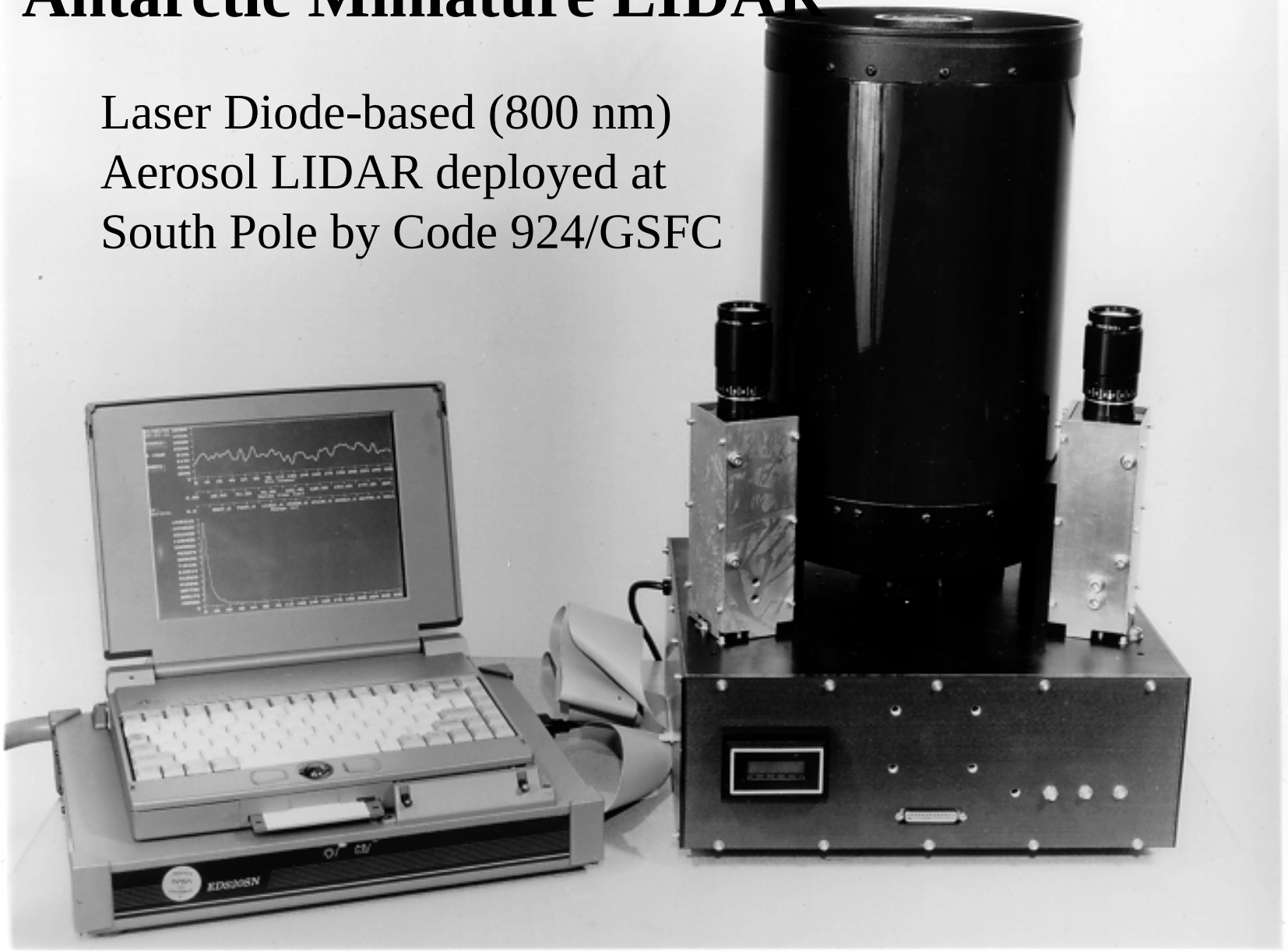
- Diffraction Grating Evaluation Facility (DGEF)
- Optical Metrology Laboratory
- Optical Measurement Laboratory (EUV through Far IR capability)
- Optical Coating Facility (EUV through Far IR)
- Calibration, Integration, and Assembly Facility
- Horizontal Flow Cleanroom
- Vertical Flow Cleanroom
- Cryo-test facilities
- Precision Optical Fabrication Facility including Diamond Turning capability
-

ITC Contacts

- Optics
  - Pete Maymon; 301-286-8937; Peter.W.Maymon.1@gsfc.nasa.gov
- Detectors
  - Pete Shu; 301-286-8006; Peter.K.Shu.1@gsfc.nasa.gov
- Cryogenics
  - Steve Castles; 301-286-5405; Stephen.H.Castles.1@gsfc.nasa.gov
- Electro-optics
  - Bill Heaps; 301-286-5106; William.S.Heaps.1@gsfc.nasa.gov
- Microwave
  - Cathy Long; 301-286-9589; Catherine.A.Long.1@gsfc.nasa.gov

Antarctic Miniature LIDAR

Laser Diode-based (800 nm)
Aerosol LIDAR deployed at
South Pole by Code 924/GSFC

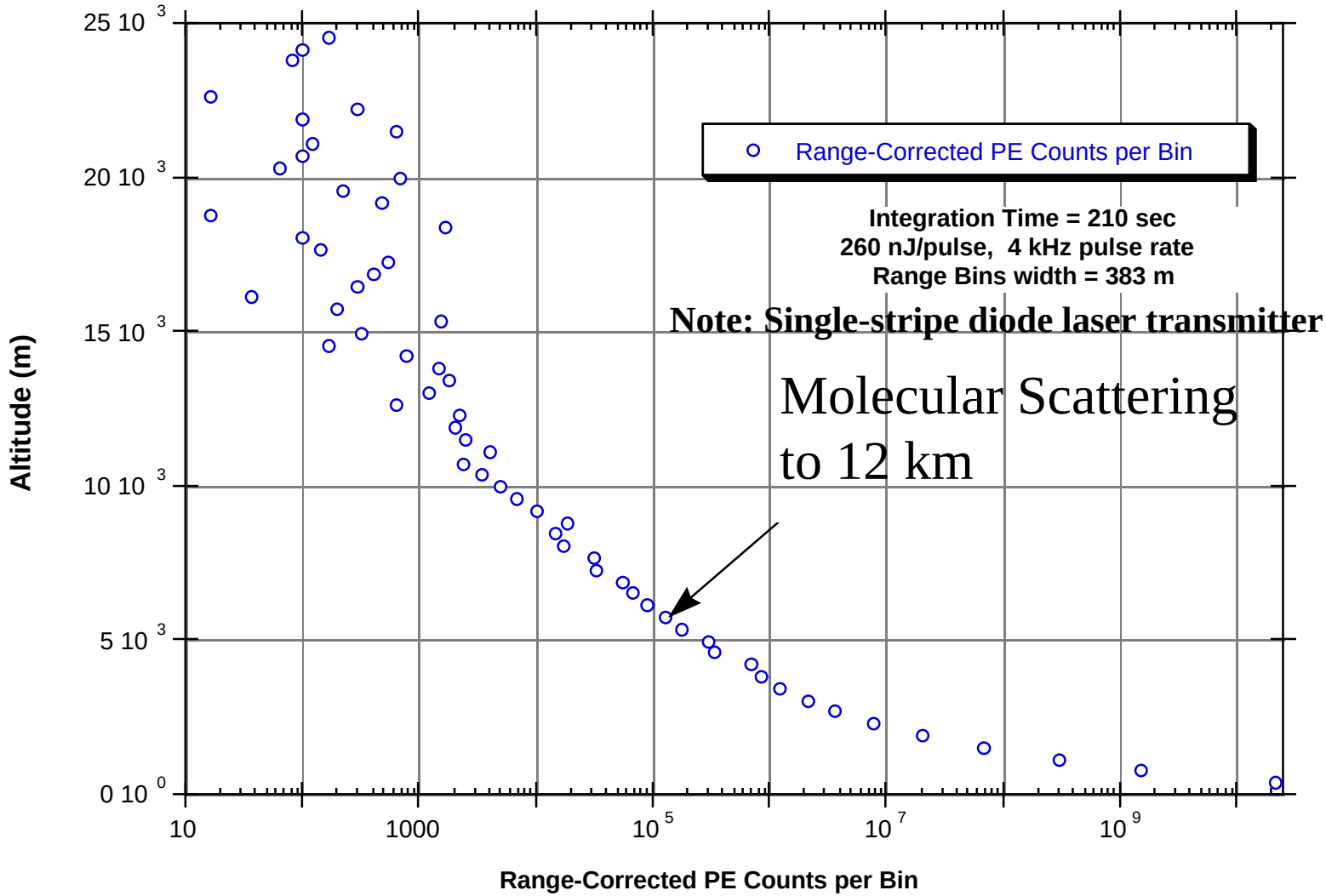


Miniature Lidar Component Technologies

- Laser diodes (830 nm and 670 nm)
- Photon-counting Si APDs
- 8” telescope, off-the-shelf
- histogrammer and correlator for PN coding
- Next generation: pulsed tapered amplifier external cavity laser, with no PN-coding

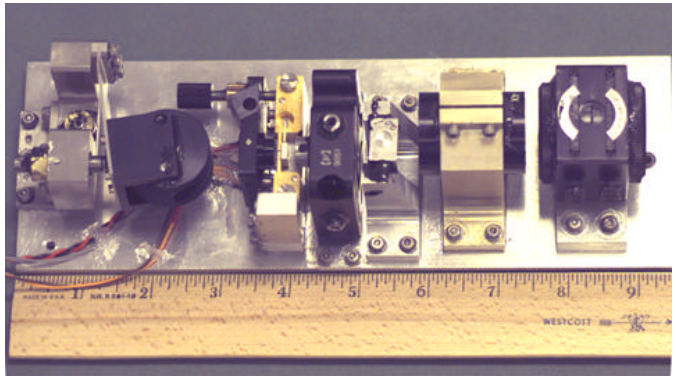
AGO1 Lidar Performance at Night

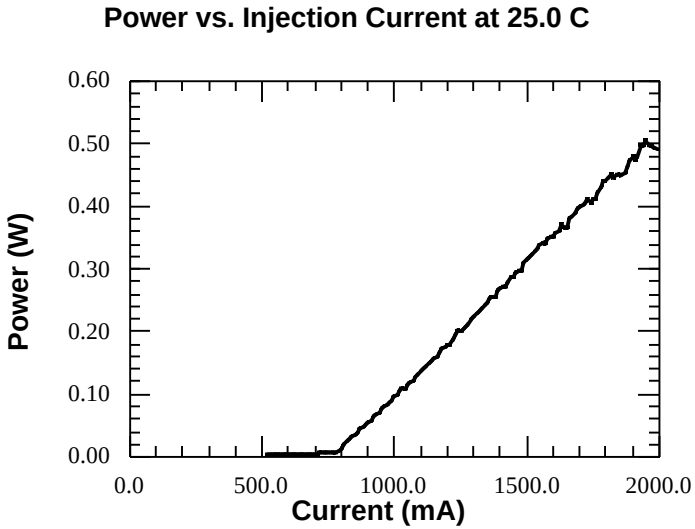
NASA-GSFC Codes 924 & 717



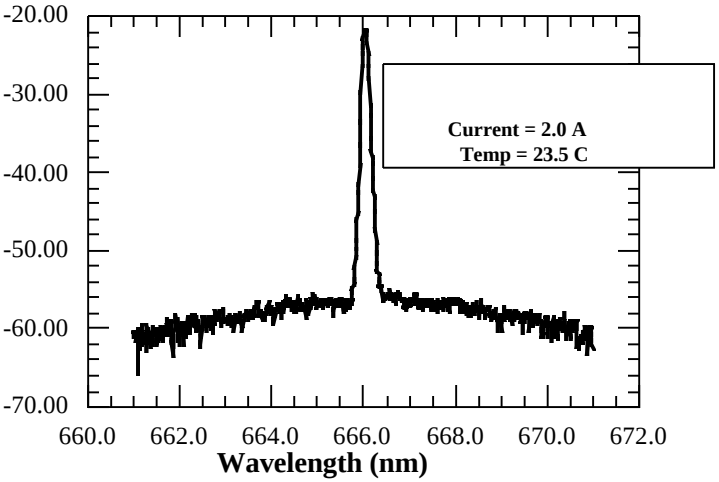
Antarctic Miniature Lidar Next Generation Transmitter:
Pulsed Tapered Amplifier External Cavity Laser

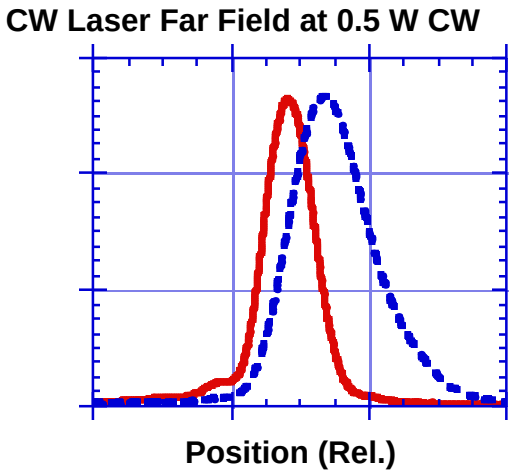
Transmitter Pkg. Based on SDL ExCav Design

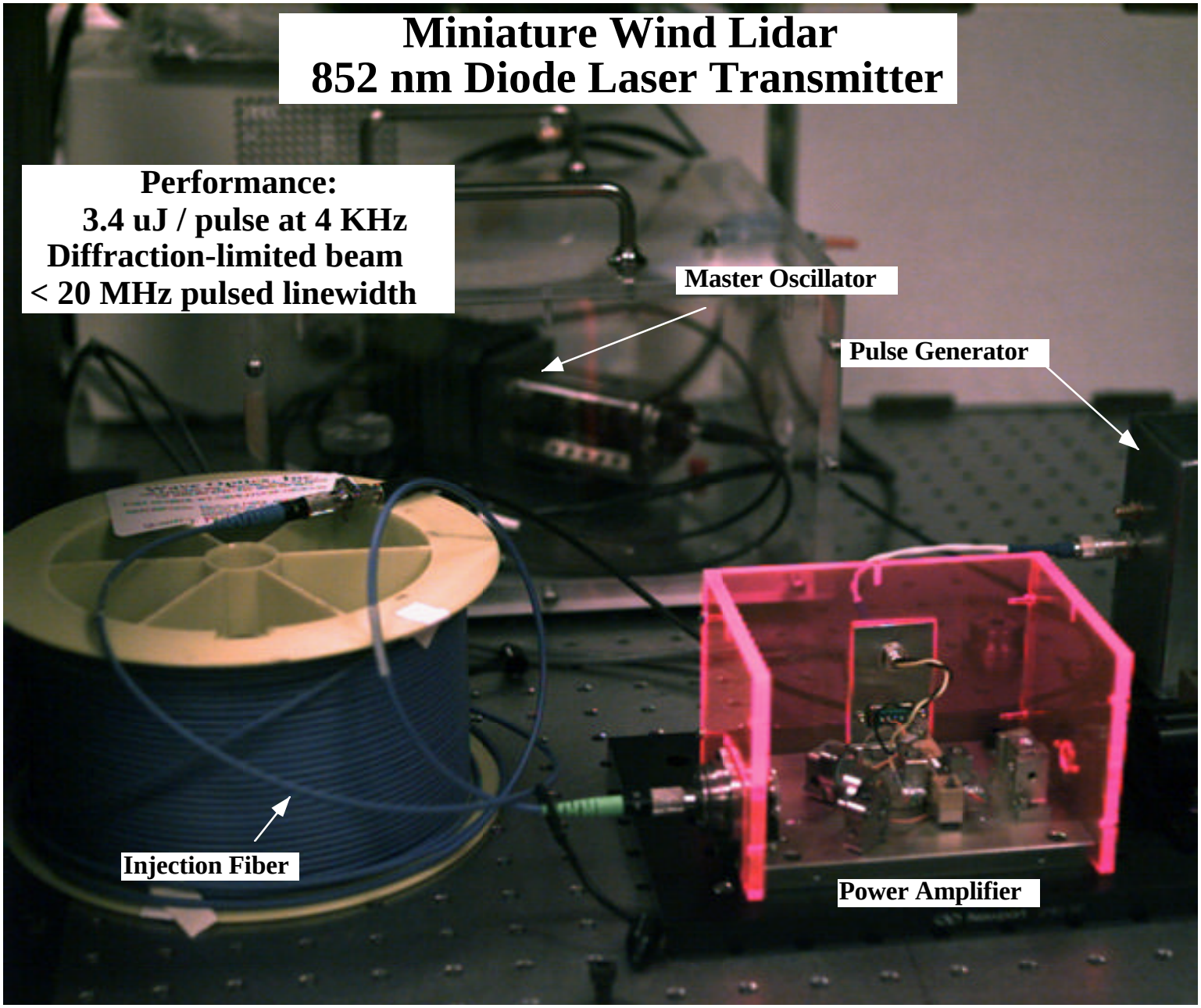




Optical Spectrum Under CW Conditions






Miniature Wind Lidar
852 nm Diode Laser Transmitter
Performance:
3.4 uJ / pulse at 4 KHz
Diffraction-limited beam
< 20 MHz pulsed linewidth
Master Oscillator
Pulse Generator
Injection Fiber
Power Amplifier

EUROPA OCEAN DISCOVERY MISSION MINIATURE LASER ALTIMETER

Pamela S. Millar
Donald M. Cornwell*
J. Marcos Sirota†
David E. Smith
Maria T. Zuber††

NASA-Goddard Space Flight Center, Earth Sciences Directorate
NASA-Goddard Space Flight Center, Engineering Directorate*
University of Maryland at Baltimore County, JCET†
Massachusetts Institute of Technology, Dept. of Earth, Atmospheric and Planetary Sciences

Jupiter's Europa Harbors Possible "Warm Ice" or Liquid Wat