A New NASA Technology Program for Risk Reduction of Space-Based Lidar Missions

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Pulsed Lidar Space Missions: The Status Quo

- Insufficient TRL advancement funds
- Award of science space mission
- Unforeseen technology problems
- Cost & schedule overruns

Pulsed Lidar Space Missions: History

• Apollo 15	1971	Ranging	Success
• MOLA	1992	Ranging	Spacecraft lost
• Clementine	1994	Ranging	Success
• LITE	1994	Profiling	Success
• Balkan	1995	Profiling	Success
• NEAR	1996	Ranging	Success
• SLA-01	1996	Ranging	Success
• MOLA II	1996	Ranging	Success
• SLA-02	1997	Ranging	Success
• MPL/DS2	1991	Ranging	Spacecraft lost
• VCL	2000	Ranging	Cancelled
• SPARCLE	2001	Profiling	Cancelled
• Icesat/GLAS	2002	Ranging+Profiling	
• Calipso	2004	Profiling	

Earth Science Independent Laser Review Panel

- Steven Alejandro, Air Force Research Laboratory, Chair
- Michael Hardesty, NOAA
- John Hicks, National Reconnaissance Office
- Dennis Killinger, U. of South Florida
- Marshall Lapp, DOE/Sandia National Laboratories

27 Nov. 2000 Report, Recommendations:

NASA should examine its current mechanism to bring high risk components to TRL levels necessary for a high probability of success prior to the proposal process

NASA should consider identification and intensive development of critical fundamental technology elements applicable to multiple missions

NASA needs to develop guidelines that define how basic laser technology development is carried out among the Centers and private vendors

A technology alliance should be formed among NASA, USAF, NOAA, NSF, and DOE for the development of space-based active sensors and related enabling technologies such as lasers

Integrated NASA Lidar Systems Strategy Team

GSFC/LaRC

- Robert Afzal, **Technology Advisor, Laser Remote Sensing Branch**
- Norm Barnes, **Technology Advisor, Laser Systems Branch**
- Bruce Gentry, **Science Advisor, Mesoscale Atmospheric Branch**
- Bill Heaps, **Co-Lead, Head, Laser and Electro-optics Branch**
- Syed Ismail, **Science Advisor, Chemistry and Dynamics Branch**
- Upendra Singh, **Co-Lead, Head, Electro-Optics and Controls Branch**

ESTO:

- Frank Peri, **Instrument Program Manager**

LaRC/GSFC Co-ordinators:

- Steve Sandford, **LaRC**
- Mary Kicza, **GSFC**

HQ Co-ordinator:

- Tom Magner, **NASA, HQ**

Integrated NASA Lidar Systems Strategy Team Report

Ghassem R. Asrar
Associate Administrator
Earth Science Enterprise

Samuel L. Venneri
Associate Administrator
Aerospace Technology Enterprise

Jeremiah F. Creedon
Director, NASA LaRC

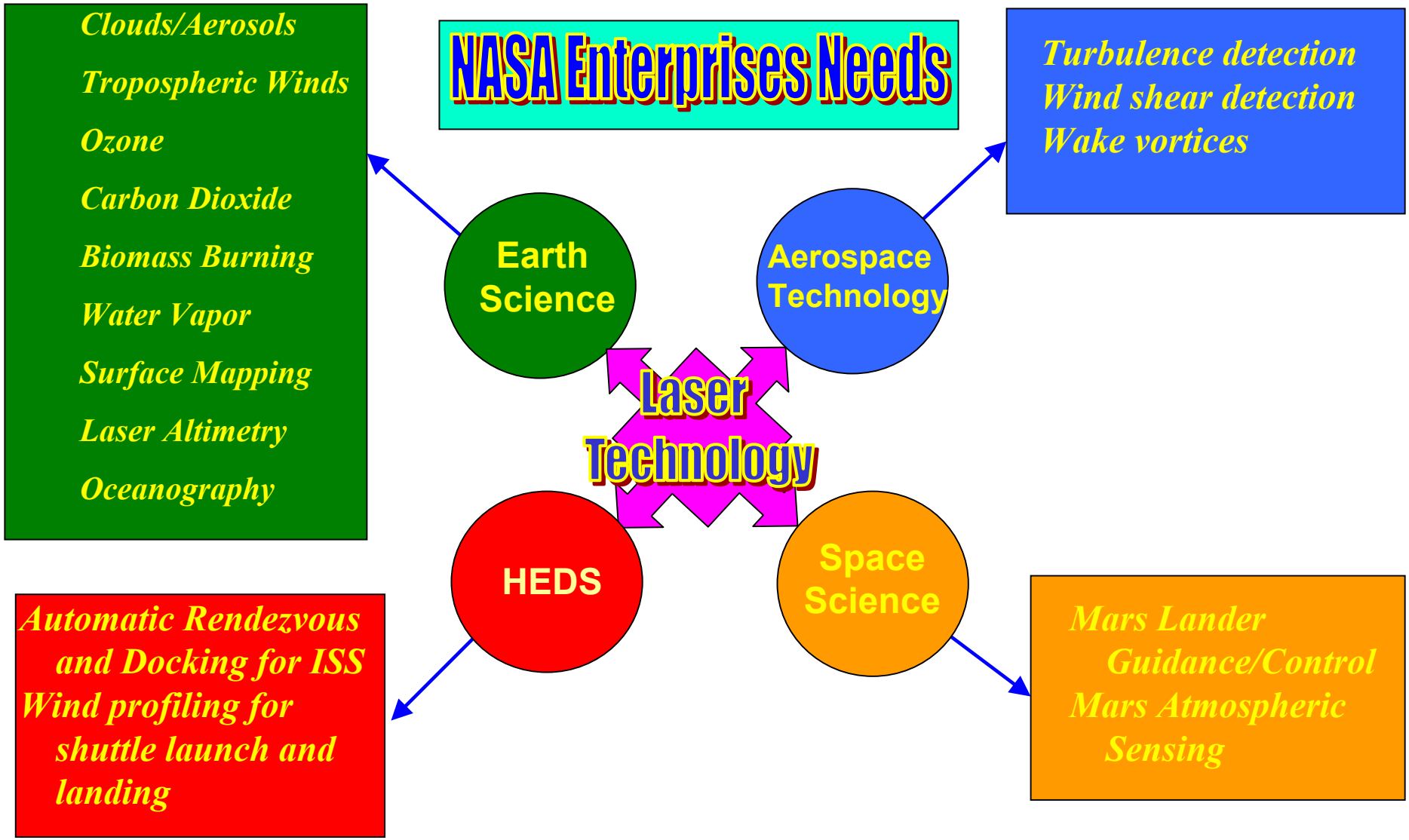
Alphonso V. Diaz
Director, NASA GSFC

William S. Heaps and Upendra N. Singh
Co-Leaders
Integrated NASA Lidar Systems Strategy Team (INLSST)

June 18, 2001

Presented to
Dan Goldin

Lidar is a Multi-Enterprise Need



Earth Sciences Application Focus

2 Lasers, 4 Techniques, 6 Priority Measurements

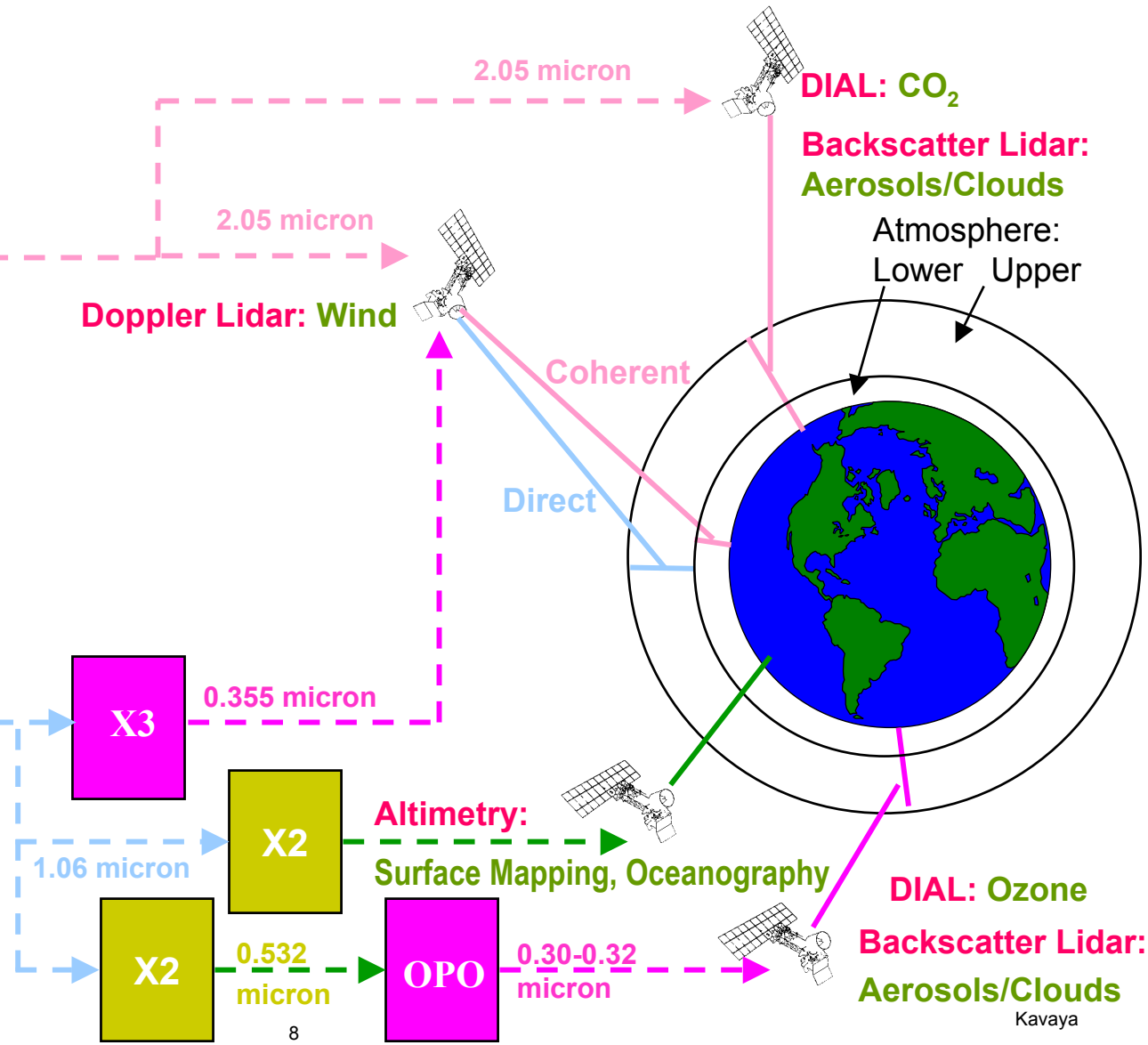
Pulsed Laser Development

2 MICRON

Key Technologies in Common

Laser Diodes
Laser Induced Damage
Frequency Control
Electrical Efficiency
Heat Removal
Ruggedness
Lifetime
Contamination Tolerance

1 MICRON



Recommendations

- **Establishing Space-hardened Laser Transmitter Test Beds (1 µm laser at GSFC & 2 µm at LaRC)**
- **Development and Qualifications of Space-based Laser Diode Arrays**
- **Advancing Wavelength Conversion Technology for Space-based Lidars**

Advanced Active Instrument Technology

Proposed Initiative for FY03

Code R

Advanced Active Instrument Technology

- **Major Program Elements**
  - Space-hardened Advanced Laser Transmitter Technologies Test Beds
  - Efficient, High-power, Conductive-cooled Space-hardened Laser Diode Arrays Technologies
  - Non-linear Optical Parametric and Harmonic Generation Technologies
  - **"Intelligent" Receivers, Tunable, Processing at the Focal Plane**
  - **Life Prediction Methods**

- **Budgetary Resources ($M)**

FY 03	FY 04	FY 05	FY 06	FY 07
12.0	16.0	16.0	16.0	10.0

Status Of Proposal

- FY02 Code Y Start Money Approved
  ($4M, LaRC PI- U. Singh, GSFC PI- W. Heaps)
- FY02 Code R Start Money Approved
  ($2M to LaRC, $2M to GSFC)
- Code R New Initiative Request was presented to OMB for New Line Approval for FY03 ($70M for FY 03-07)

LaRC FY02 Laser Technology Program

Code-Y
Laser Risk Reduction Program (LRRP)

- 2-Micron Laser Transmitter
- Laser Diodes
- Wavelength Conversion to UV

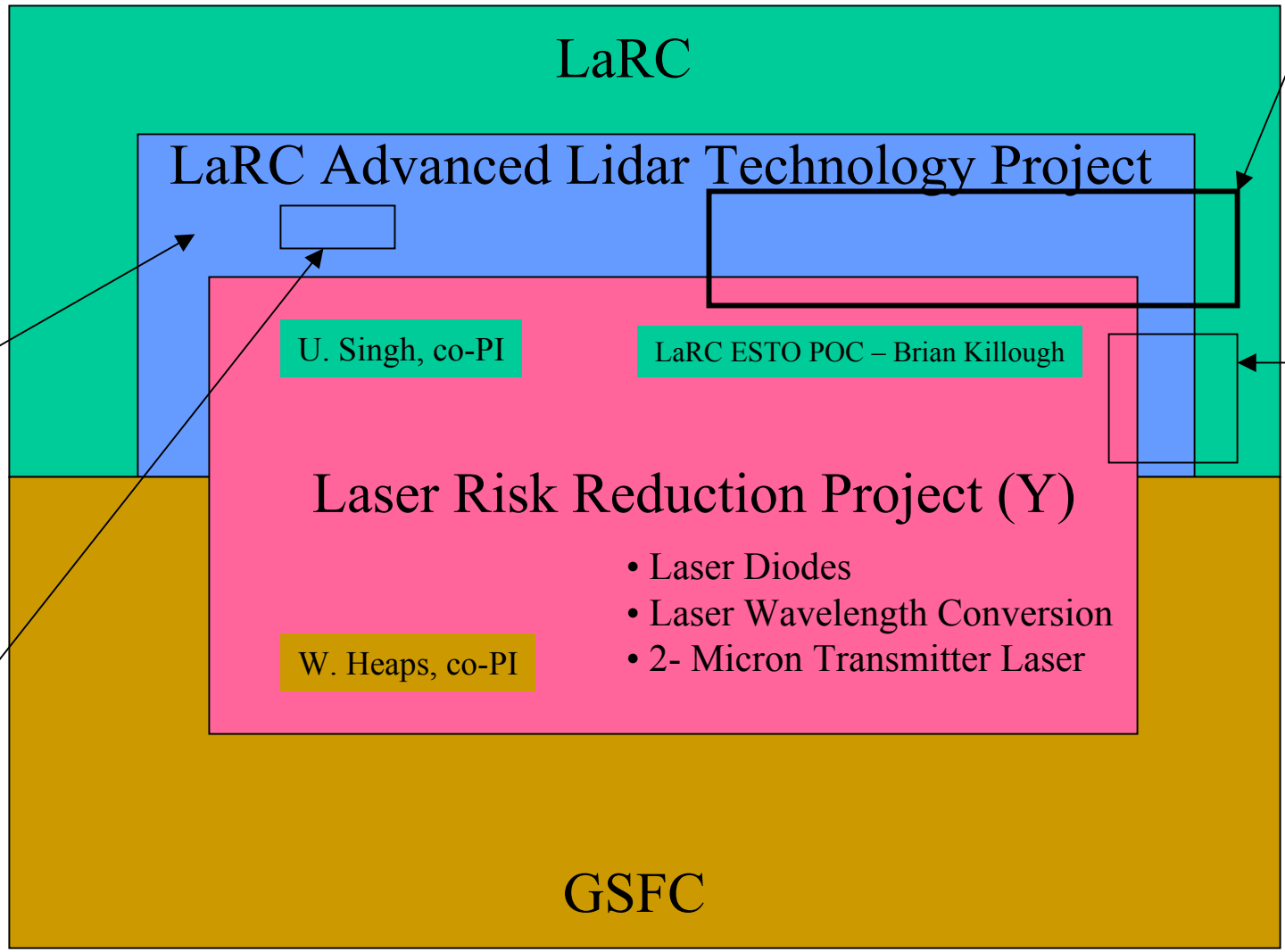
Code-R
Enabling Concepts and Technology Program (ECTP)

- 2-Micron Laser Transmitter
  - Breadboard CO2 DIAL
  - Breadboard WIND Transmitter
  - 2-um Detector Development
  - Receiver Subsystem
  - Wavelength Conversion to 3-9 um
  - Quantum Mechanical Modeling and Advanced Materials

Code-Y and Code-R
NRA Awards

- 2-Micron Laser Transmitter
  Code-Y ATIP
- Multi-Use Lidar Transmitter 3-9 um
  Code-R CETDP
- Water Vapor DIAL
  Code-Y ATIP

Advanced Lidar Technology Project



Code R
(Chief Technol.)
Enabling Concepts & Technology Pgm. (ECTP)
FY02
Brantley Hanks

Code Y
Existing LaRC Technology Projects

e.g., detectors, telescope, scanner, trailer ops, aircraft ops, space demo

Code Y/IPO
Existing Trailer Lidar Project

Advanced Lidar Technology Project

Project Manager

Lidar Systems Engineer
Business Manager
Resource Analyst
ESTO/Code R Tech. Mgr.

Laser Risk Reduction PI

Science/Technology Advisory Committee

Transmitter Laser

- **Pump Diodes**
- Design/Analysis
- Lifetime
- Contamination
- Crystal Research
- Breadboard Lasers
- Freq. Control Syst.
- QM Modeling & Advanced Laser Materials

Wavelength Conversion

- Crystal Res.
- Nonlinear Conv.
- OPO Cavities
- Spectroscopy

Opt./Rec. Sys.

- Telescope
- Scanner
- Autoalignment
- Integrated Rec.

Detectors

- Detectors
- Charact. Facilities

Electronics

- Laser Electronics
- Signal Proc. SW
- Display
- Control Electronics
- Data Acq./Processor
- Electronic Receiver
- Aircraft Interfaces

Lidar Int./Ops

- Breadboard Syst.'s
- Trailer Lidar
- Field Meas.'s
- A/C Syst. Int./Ops
- Calibration Facility

Systems Analyses/Sim

- Modeling
- Syst. Req'ments
- Cal/Val
- Data Analyses

Thermal, Mech. Eng., Fabrication

- Thermal
- Mechanical
- Fabrication

Conclusions

- Old way didn't work for lidar space missions
- Independent panel told NASA what to do
- NLSST (Singh/Heaps) developed implementation plan through teaming of LaRC and GSFC
- NASA managers liked plan
- Will NASA get the money to do it?
- Meanwhile, FY02 is funded to get started
- We have begun