NAST-I Lessons Learned

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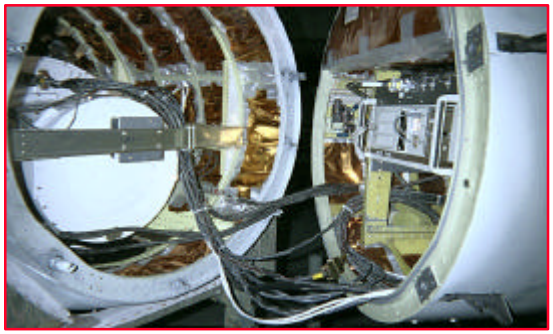
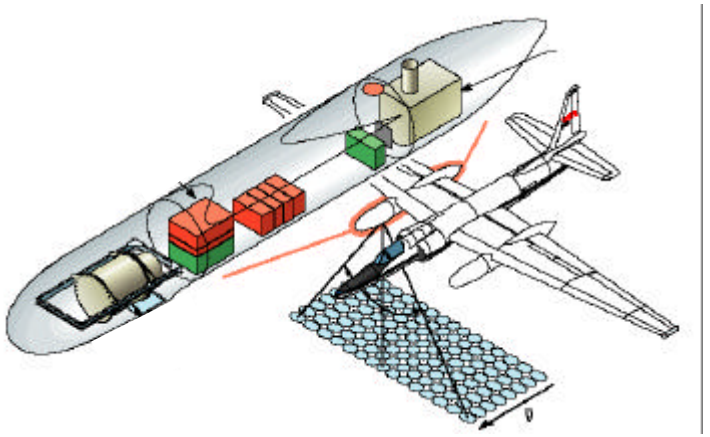
July 10, 2003

NASTER-I Workshop

NAST-I Overview

- Developed by MIT Lincoln Laboratory in 18 months for NPOESS using a COTS BOMEM Interferometer, detectors, and optics
- Flown aboard NASA's high-altitude ER-2 aircraft by LaRC





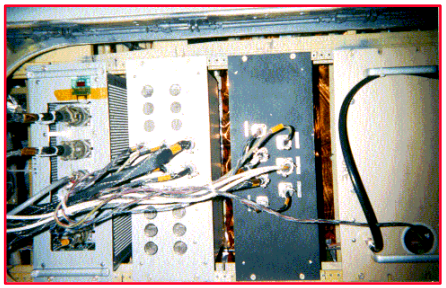
- Produces high spatial and spectral resolution data suitable for synthesizing data products of candidate NPOESS sounders
- NAST-I has achieved excellent performance logging over 100 operational hours to date

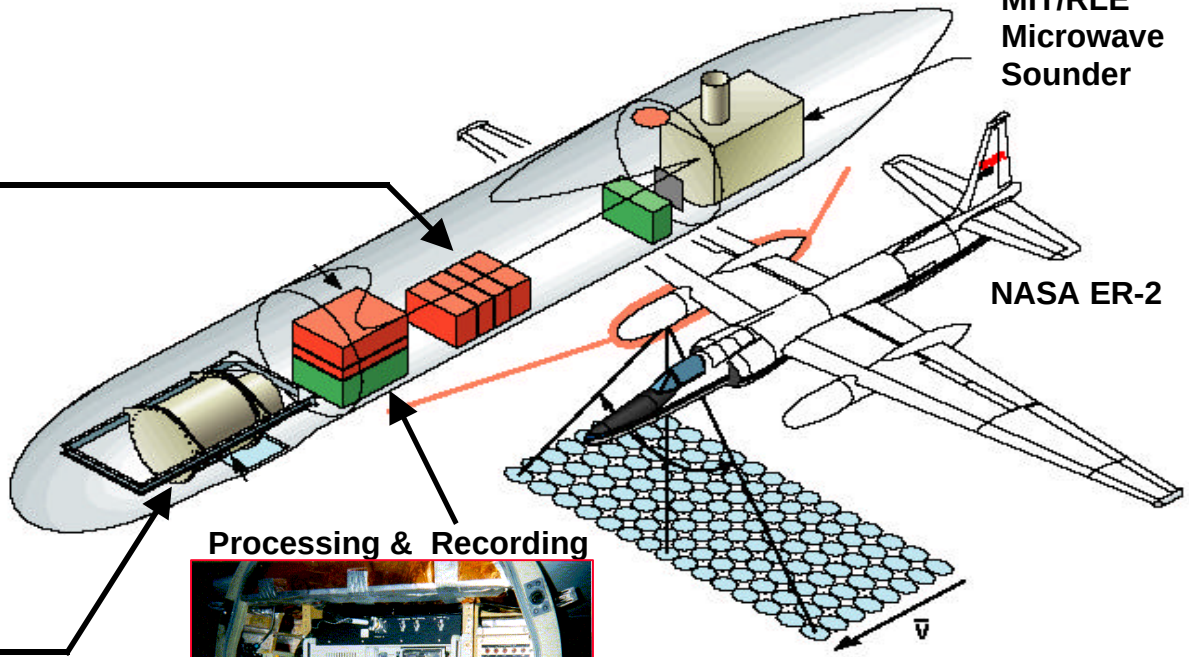
NAST Layout In ER-2 SuperPod

ER-2 at Patrick AFB

MIT/RLE Microwave Sounder

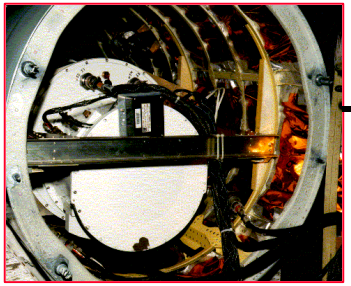
Electronics, Control & Navigation



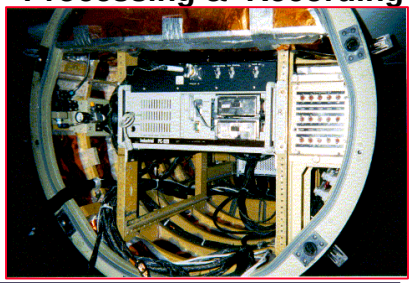


NASA ER-2

Scanning Interferometer Sounder 4 – 16 m



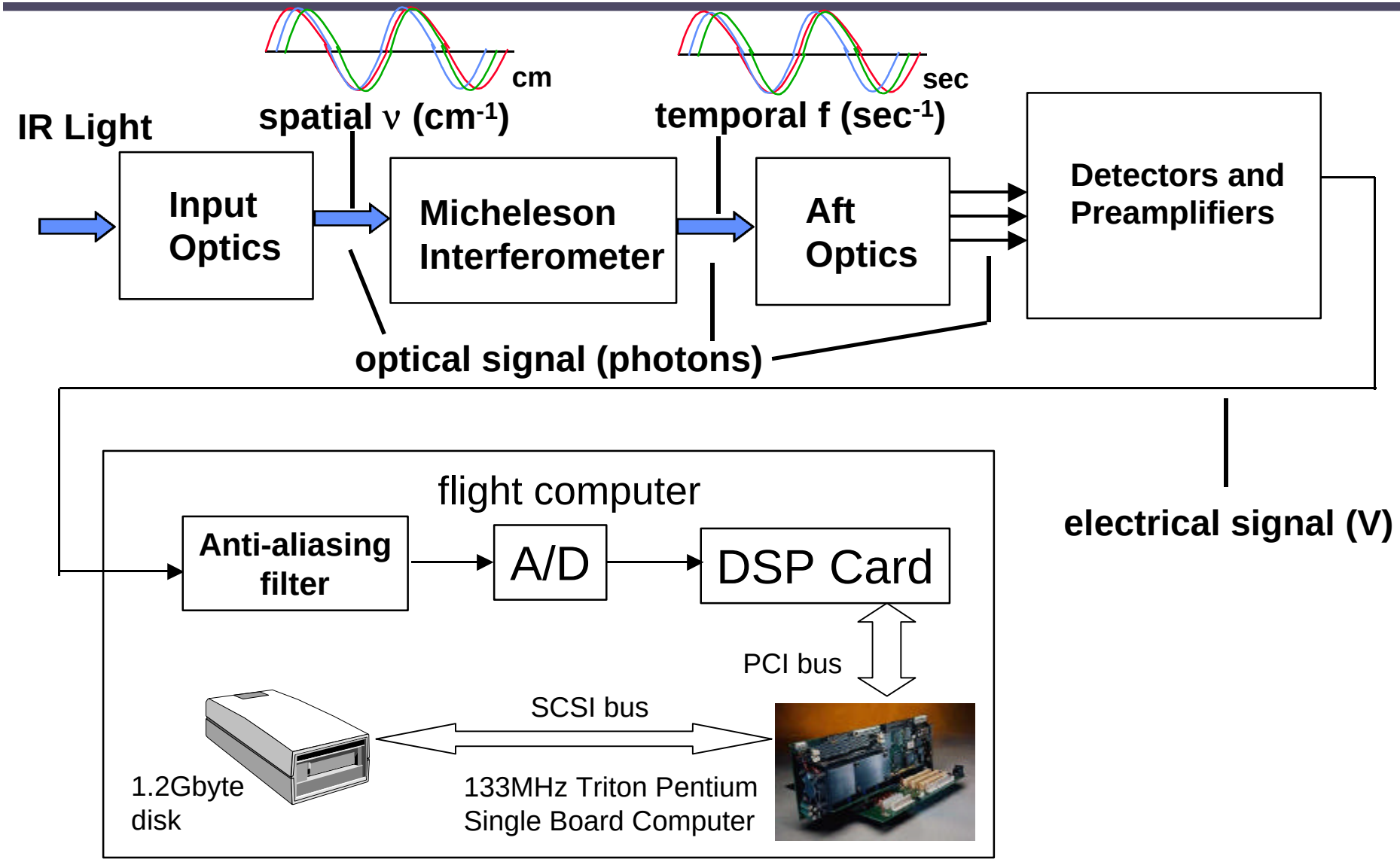
Processing & Recording



NADIR 2.6km IFOV
20km Altitude
+/- 23km Ground Swath

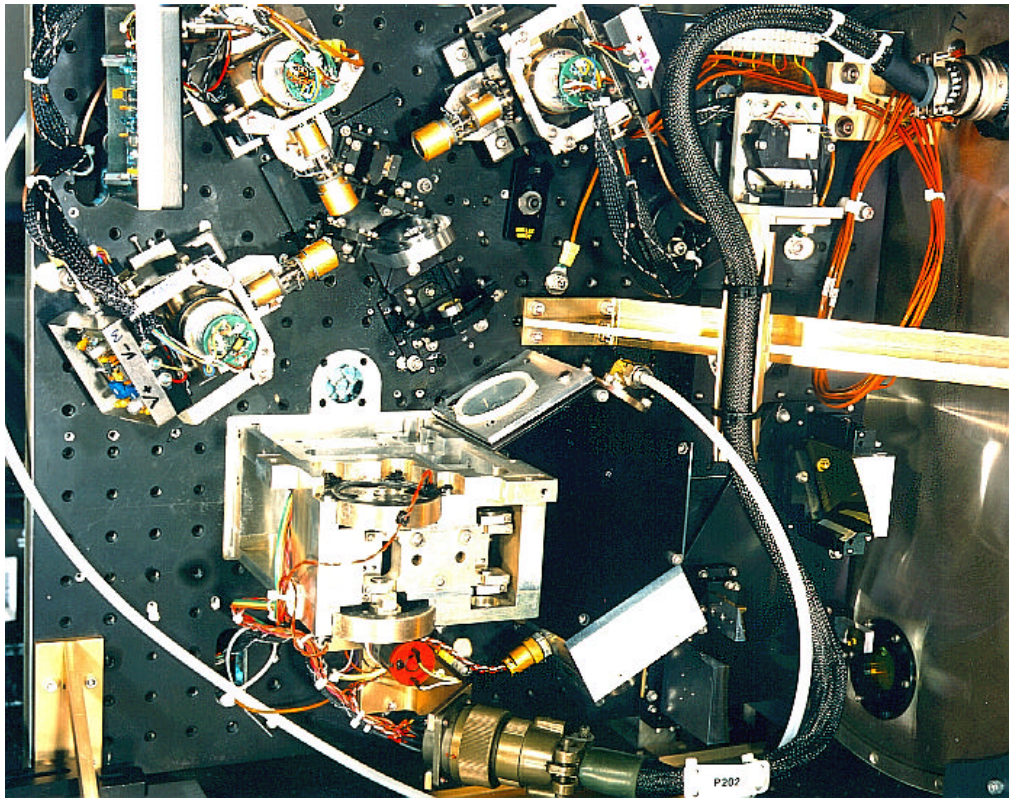
NASA Langley Research Center

NAST-I System Diagram



Optical Bench

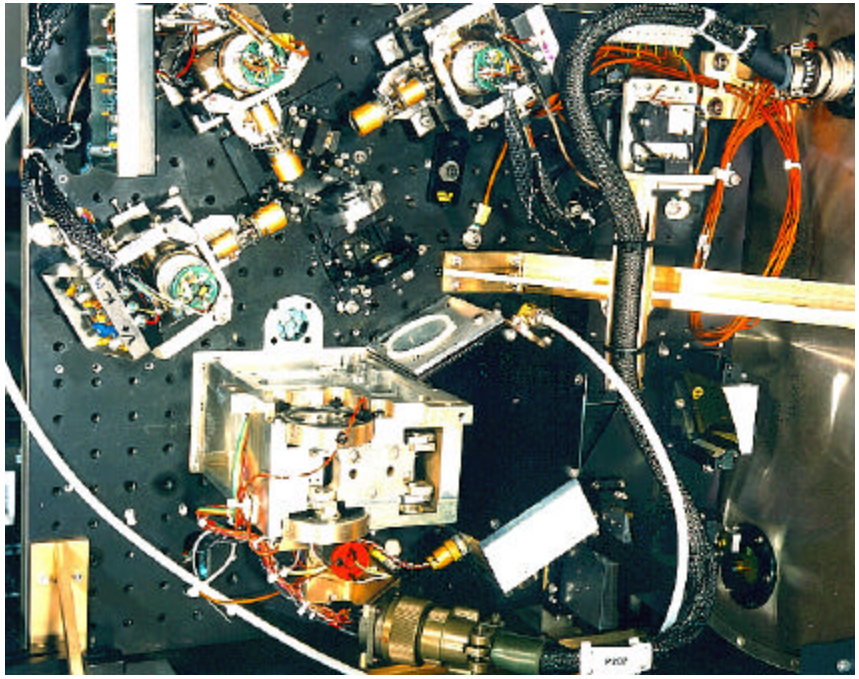
- NAST-I operates at room temperature (ground and flight)
- Al Honeycomb structure
- Mounted vertically in housing
- Compact optical design



Optical Bench

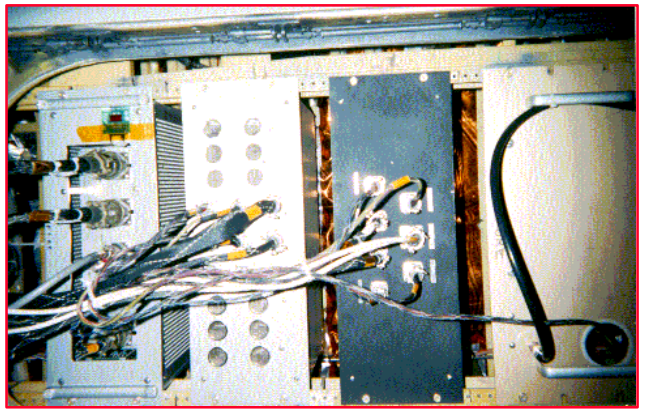
NAST-I Lessons Learned

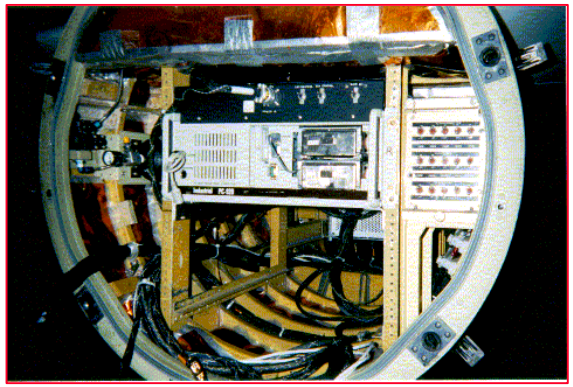
- **Worked well**
  - **Integrated Dewar Cooler Assembly (IDCA)**
  - **Stirling cycle cooler**
  - **Reflective optical design**
  - **Coregistration**
  - **Bomem interferometer**
  - **MIT LL Porch swing**
  - **Simple design: reliability**
  - **Eventually reduced impact of aircraft vibration**



NAST-I Lessons Learned

- What could be better
  - LW detector performance
  - Data quicklook analysis
  - Vibration isolation
  - BS/CS wedge
  - More housekeeping measurements
  - Improved GPS
  - Programmable operating modes (operation flexibility)
  - Dependent on 400Hz aircraft power
  - Data storage medium
  - COTS electronics





Control and Record Electronics

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Flight Computer

Signal Processing

- DSP
  - FFT or FIR
  - Maintain ASM
  - Lifetime
- FPGA
  - Maintenance
  - Lifetime

Instrument Control

- Processor
  - RTOS
  - Interfaces
    - BB
    - Scan
    - FTIR
  - Thermal control
  - Visible and/or IR camera

Data Storage & Communication

- Processor
  - RTOS
  - File management
  - Network

Data Archive

Control and Record Electronics

- **Challenges**
  - **Data rates**
    - **17Mbytes/sec for 128x128 size arrays**
  - **Data storage capacity**
    - **192 Gbytes for 6hr mission for 128x128 size arrays**
  - **Control multiple devices**
    - **Main signal processing stream**
    - **BB control**
    - **Temperature control**
    - **Scan mirror**
    - **Housekeeping**
  - **Able to be maintained for 15 years**
    - **OpenSource**
  - **Support graphical status and “smart” fault diagnosis**
    - **Display key instrument parameters**
    - **Determine if shut-down required**
    - **Suggest troubleshooting procedures**
  - **Support downlink and uplink**
    - **Data and housekeeping**
    - **Instrument control via uplink**

Flight Computer

- **Smaller, faster, use real-time OS**
  - **PC104+ form factor**
  - **QNX, VxWorks, DSP BIOS, LINUX**
- **Data storage medium**
  - **Solid-state Flash Disks**
  - **Hundreds of gigabytes capacity, reasonable cost ($1/Mbyte)**
  - **Fast enough (14-20Mbytes/sec)**
  - **Wear-leveling issue**
- **Separate processor for signal processing**
  - **DSP or FPGA**
  - **1GFLOP for 128x128 size arrays**
- **Ability to transfer data without removing HW**
  - **Network link to ground station**

Telemetry

- **Support downlink and uplink capability**
  - **Transmit housekeeping and some data**
  - **Over-the-horizon or LOS?**

- **Uplink**
  - **Ability to reset instrument and change key parameters such as scan pattern and resolution**

- **Telemetry units**
  - **Separate units**
    - **S-band LOS PCM based units**
    - **Achieve 10Mbps**
    - **$5-15K**
  - **Use aircraft system**
    - **Proteus**
    - **UAV**

Quicklook Capability

- **Need SW to analyze flight data immediately after mission**
  - **Ability to adjust/fix before next flight**
  - **Must be very efficient and maintainable**
  - **MATLAB or Scripting tools**

- **Data format**
  - **Common data format**
  - **Larger number of smaller files better than a few huge files**
  - **Enable fast archiving operation**