Recent Improvements to the AVIRIS Sensor

Michael Eastwood,
Chuck Sarture, BJ Chippindale, Chris Chovit, Jessica Faust, Robert Green, Dean Johnson, Steve Monacos, and James Raney

JPL/Caltech

OVERVIEW

- Performance Issues
- Performance Opportunities
- 1998 and 1999 Modifications
- Plans for 2000
- Current Status
- Challenges
-

PERFORMANCE ISSUES

- Spectrometer stability
- Focal Plane transient response
-

PERFORMANCE OPPORTUNITIES

- FPA background shot noise reduction in "B" and "D"
- Improved pointing knowledge - georectification
- Complete overhaul of flight computer system
-

1998 MODIFICATIONS

- Improved spectrometer thermal control
- Linear Variable Blocking Filter for "D"
- GPS/INS for 1st Low Altitude flights
-

1999 MODIFICATIONS

- Redesigned FPA multiplexer
- Hybrid Silicon/InGaAs array for "B"
- Modified FPA cold finger support
- GPS/INS for ER-2 flights
- Deactivated autofocus mechanism
-

SPECTROMETER STABILITY

- desire to improve toward 1% uncorrected stability
  - reduce "bumps and wiggles" effect
  - radiometric correctable with OBC, but spectral much harder
- spectrometer thermal control improvement
- dewar internal support structure rigidity
- run FPAs warm if possible
-

SPECTROMETER STABILITY

- Many modifications implemented, some improvement achieved
  - "peeling the onion"
- 8-zone thermal control per spectrometer implemented in 1998
- FPA cold finger support changed from G-10 fiberglass to 304 stainless steel
- "Bumps and Wiggles" persist

SPECTROMETER STABILITY

- Thermal measurements suggest using Invar-36 instead of 304 stainless
- FPA cold finger support thermal gradient always changing
- Invar-36 will minimize FPA shift with temperature
-

FOCAL PLANE TRANSIENT RESPONSE

- Asymmetric "slew" anomaly smears pixels at low flux
  - added background flux to minimize effect (1996 only)
- Multiplexer design modification using JPL-designed unit cell amp
  - Improved read noise but modest improvement to "slew" (allowed removal of extra flux)
- Further study required before next multiplexer design iteration
-

FOCAL PLANE TRANSIENT RESPONSE

-
-

A BRIEF FOCAL PLANE HISTORY

- Original FPAs: Reticon multiplexers
- 1991-1994: Incremental improvements to Reticon mux FPAs
- 1995: Flew first CE BDI unit cell muxes
- 1997: Flew JPL modified CE BDI muxes
- 1999: Flew JPL BDI muxes with new unit cell amp
- Future improvements will require deeper analysis of amplifier characteristics
-

1998 SHOT NOISE REDUCTIONS - "D"

- "D" FPA noise floor set by background flux
  - 750e- read noise vs. ~200 possible
    - 214x500 um detector area captures more background flux
- Blocking filter passband well-matched to required spectrometer passband
  - but lets each detector element "see" full range
  - each detector only needs to "see" 10nm FWHM band
  -

1998 SHOT NOISE REDUCTIONS - "D"

- Solution: a Linear Variable Blocking Filter
- Implemented with custom filter from OCLI
- Performance improved 3x at 1.9um, 2x at 2.5um
-

1999 SHOT NOISE REDUCTIONS - "B"

- "B" FPA noise floor set by background flux
  - 400e- read noise vs. ~200e- possible
- Blocking filter passed 1.3-2.8 um photons
  - VERY difficult to fabricate filter with good passband performance AND blocking over 1.3 - 2.8 um region.
- InSb sensitive throughout passband
-

1999 SHOT NOISE REDUCTIONS - "B"

- InGaAs response cutoff ~1.6-1.8um
  - eliminates background flux issue
  - and allows room temperature FPA operation
  - Silicon best for 660-950nm region, InGaAs for 950-1270 nm
- Switched "B" FPA to Silicon + InGaAs
  - UDT Sensors custom silicon array
  - Sensors Unlimited custom InGaAs array
- Performance improved 1.3x to 2.6x

Pointing Knowledge Improvement

- Georectified data collected for *almost* all 1999 data runs
- Program modified for ER-2 mode
- Hardware has proven robust, next step

Flight Computer Overhaul

PLANS FOR 2000

- Blue-optimized silicon array for "A"
  - 200x300 um active area
- Invar-36 cold finger supports
- Analyze FPA multiplexer, implement improvements (if funds allow)
- Implement optical fiber data interface between FPAs and flight computer
-

PLANS FOR 2000

CURRENT STATUS

CURRENT CHALLENGES

- Limited time before start of flight season may preclude some upgrades
- Limited funds may preclude concentrated workforce effort to prepare for next winter
-