NASA John C. Stennis Space Center

PITTCON 2002
New Product Forum
March 17, 2002

Presented by:

Radiant Temperature Nulling Radiometer

(NASA Stennis Case Number: SSC-00124)

Polarization Enhanced Thermal Radiometer

(NASA Stennis Case Number: SSC-00134)

Technology Background

- NASA and other government agencies routinely calibrate thermal remote sensing satellites and airborne imaging systems by measuring water body temperatures
- Temperature measurements approaching 0.1 °C accuracy are required
- Existing technologies are extremely power hungry, drift over time, do not allow for continuous monitoring, and are subject to complex atmospheric correction

NASA Relevance

- Remote monitoring of the temperature of water bodies
- Improved calibration of thermal imaging systems
- Ground truth for thermal applications
  - Handheld infrared thermometer
- Expected further support

Radiant Temperature Nulling Radiometer

(NASA Stennis Case Number: SSC-00124)

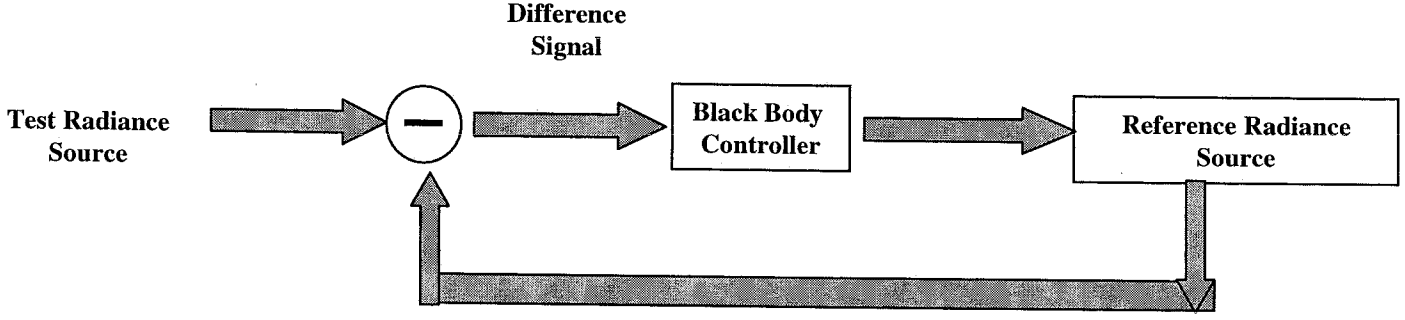
Nulling Radiometer

- Using a controllable thermal source and a infrared thermometer a very accurate and stable thermometer can be achieved
- Intrinsically self calibrating
- Low Power

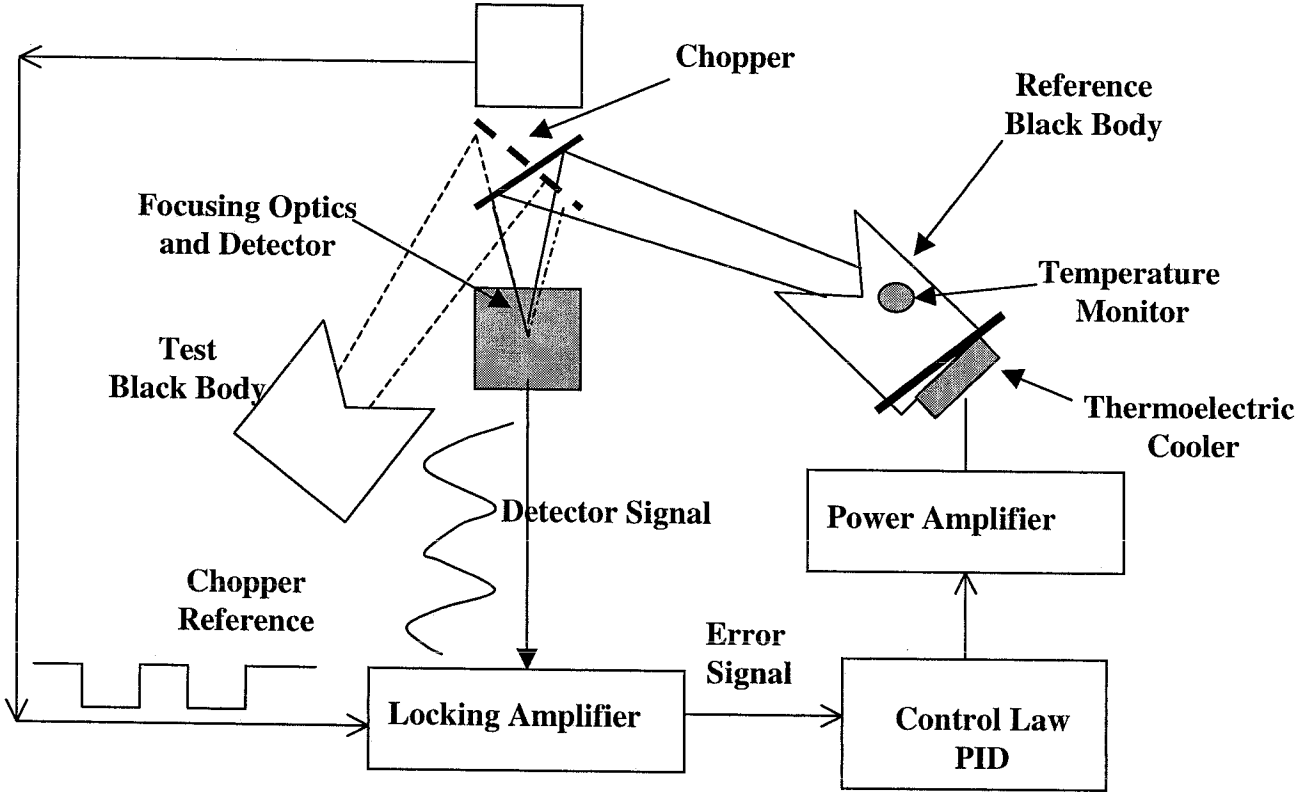
Research & Development Status

- Development stage
  - Design Stage
    - General radiometer is designed
  - Critical electromechanical subsystems have been prototyped
- Development hurdles
  - Full integration and packaging

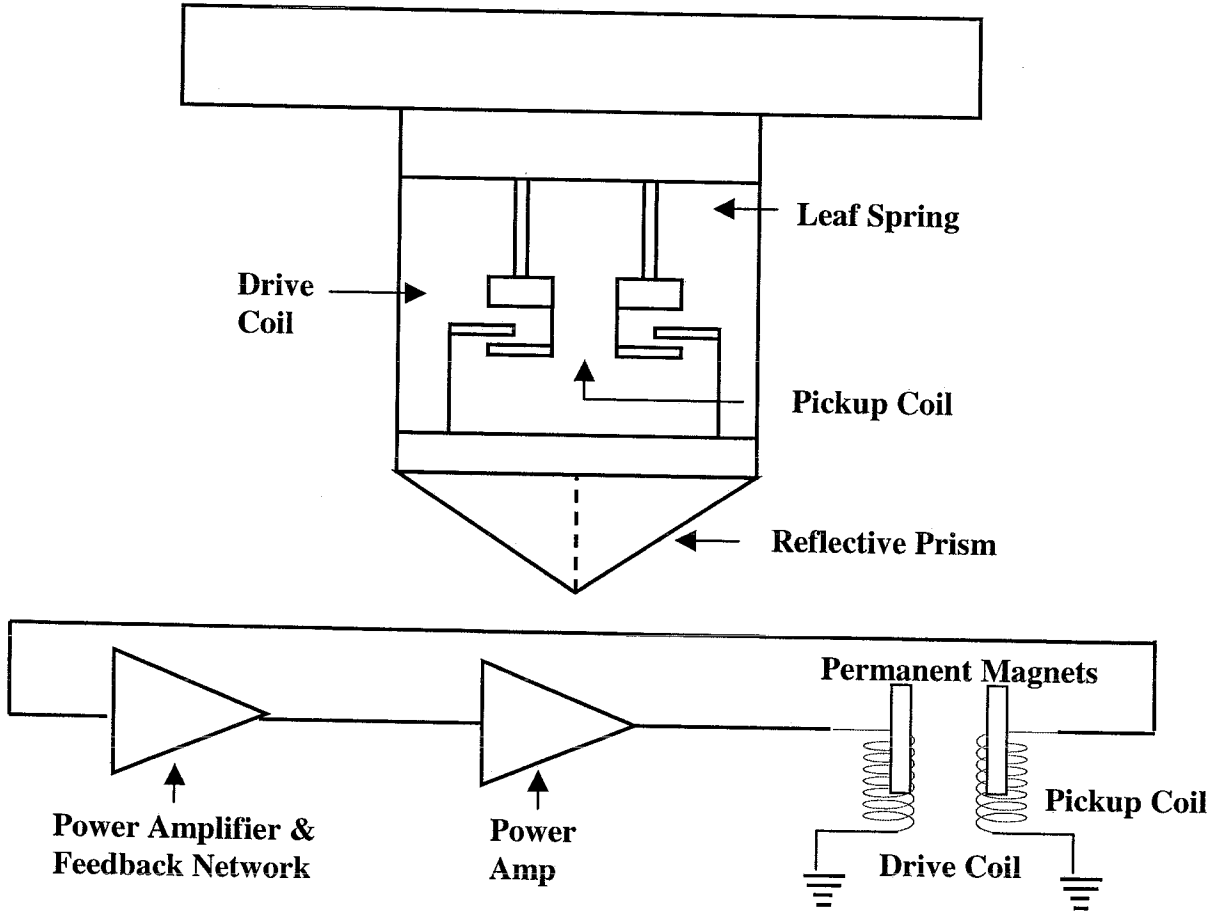
Nulling Radiometer Principles



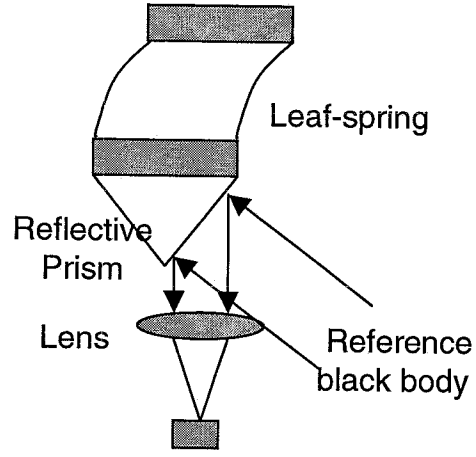
Nulling Radiometer Subsystems



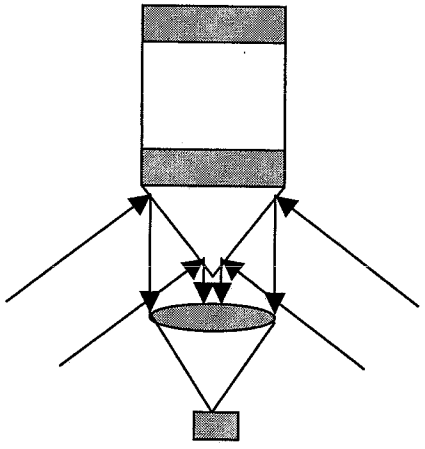
Nulling Radiometer Chopper



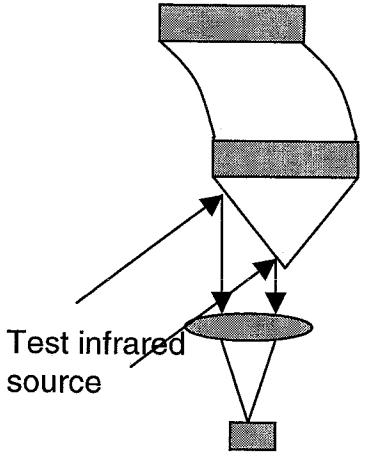
Nulling Radiometer Chopper (cont)



a) Reference black body only

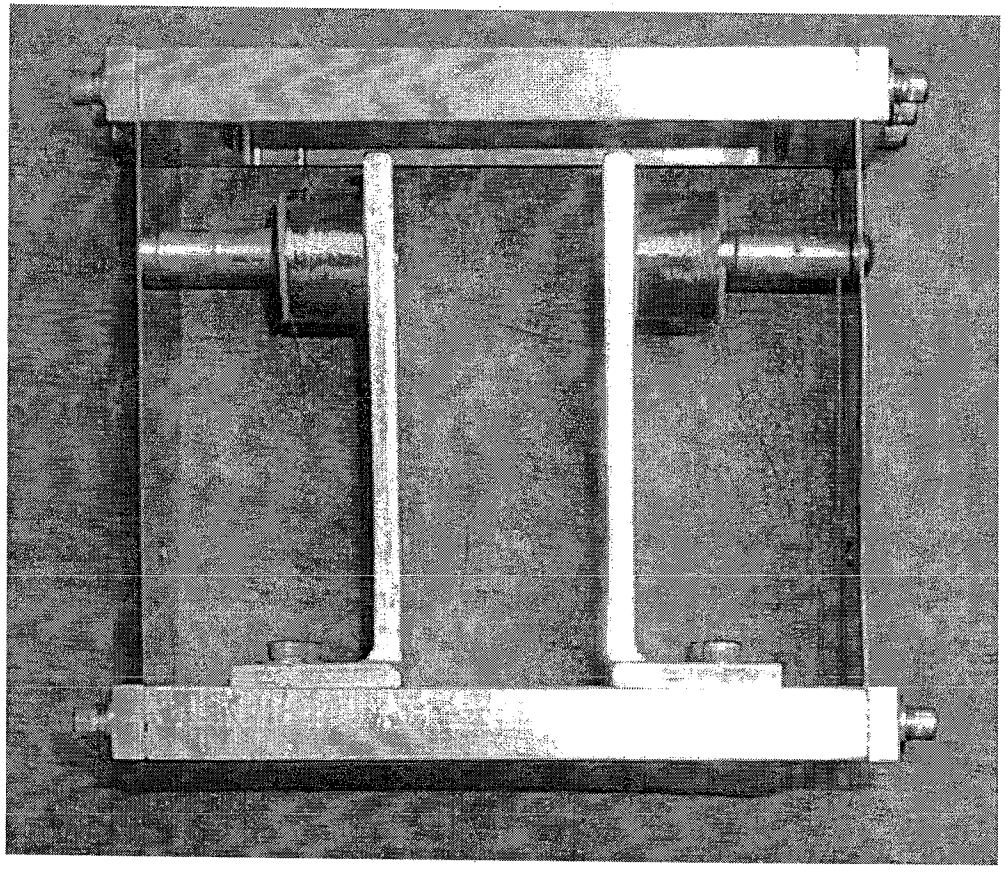


b) Both reference and test infrared source only



c) Test infrared source only

Nulling Radiometer Hardware

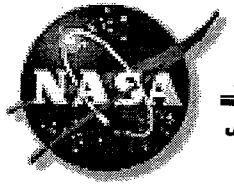


Technical Advantages of the Nulling Radiometer

- Requires only a single calibration source near the temperature of the test object
- Novel low power electromechanical optical chopper
- Self calibrating
- Faster time response and lower power than other accurate and stable systems
- Continuous monitoring
  - High duty cycle
- Low power
- Temperature accuracies on the order 0.1 °C are achievable

Polarization Enhanced Thermal Radiometer

(NASA Stennis Case Number: SSC-00134)



Brewster Angle Radiometer

- Measures polarized infrared emission at the Brewster angle where the emissivity of the surface is unity
- Improves overall temperature accuracy of infrared thermometer for weakly absorbing dielectrics by eliminating stray sources

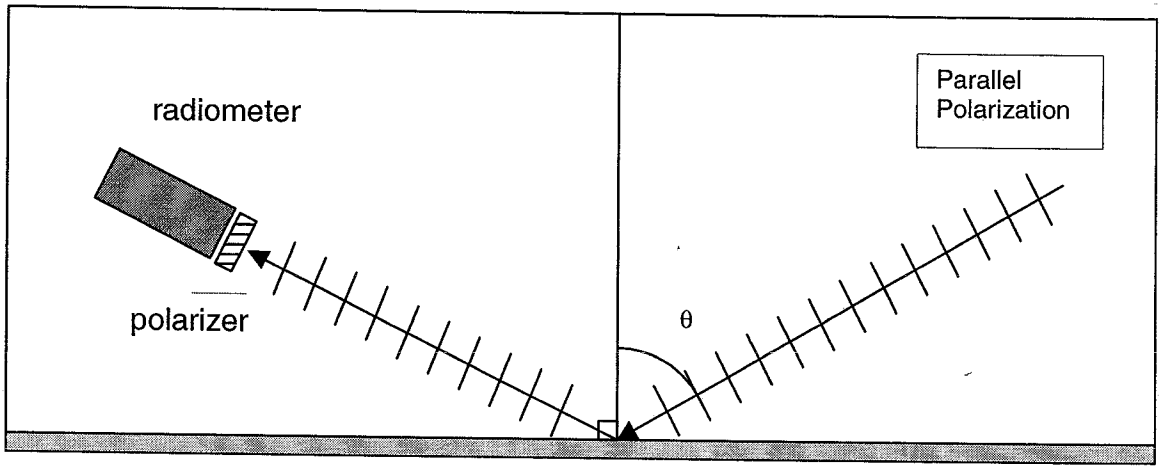
Research & Development Status

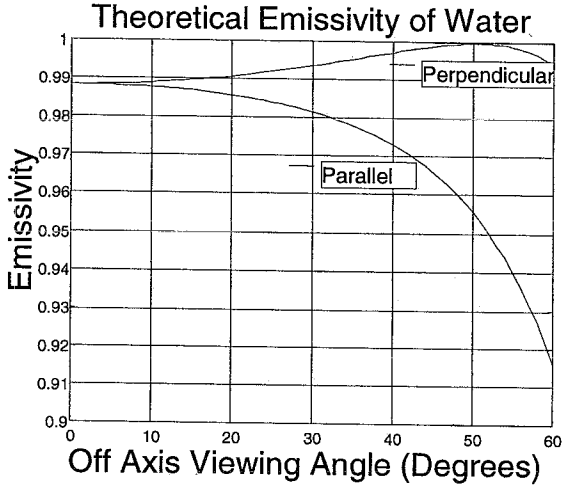
- Modeling of the phenomena has been made along with sensitivity to design parameters
- Laboratory proof of concept has been made

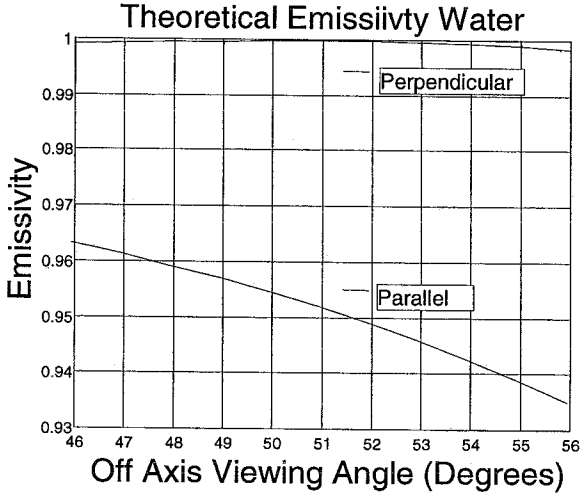
Development hurdles

- Full integration and packaging

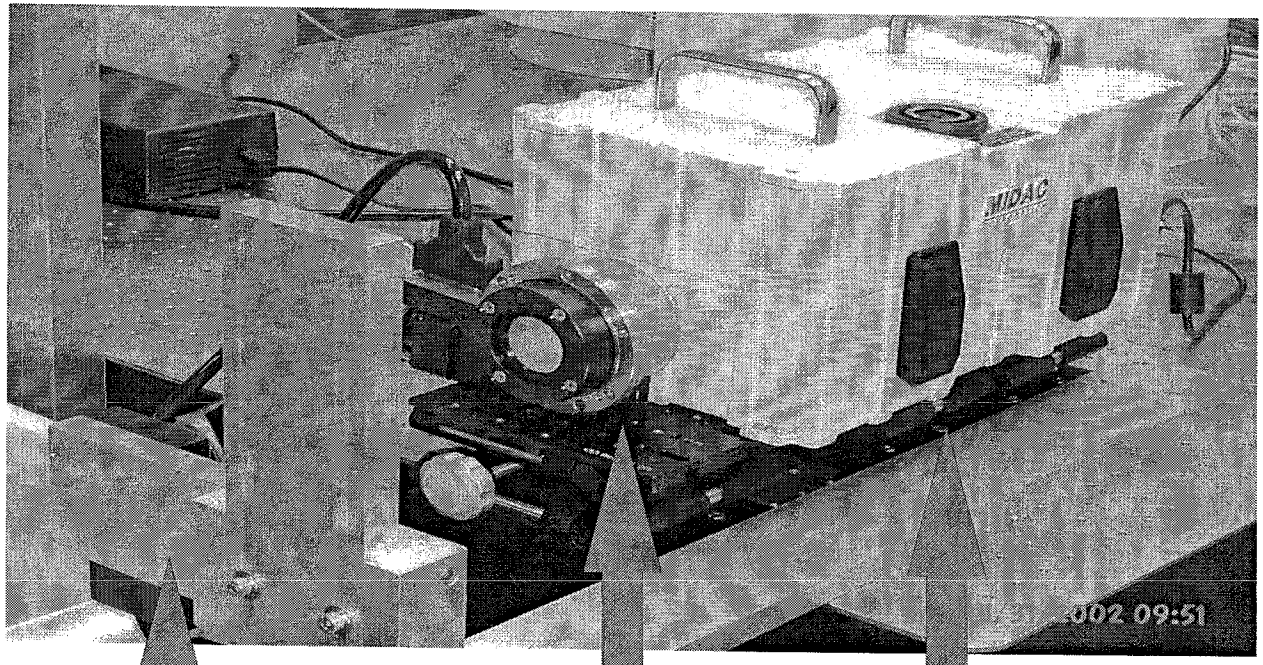
Theory of Operation







Experimental Approach

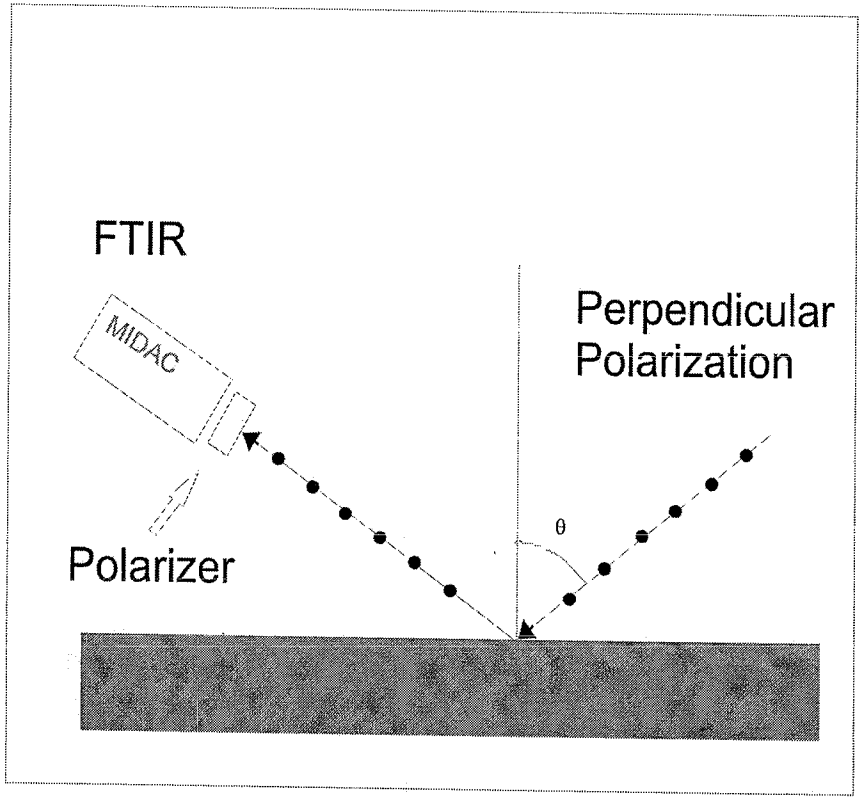


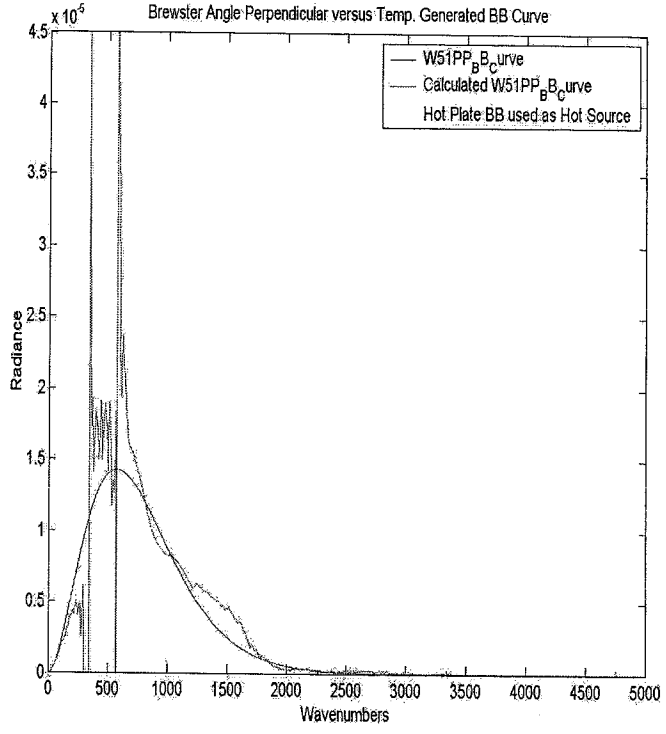
Scan Mirror

Polarizer

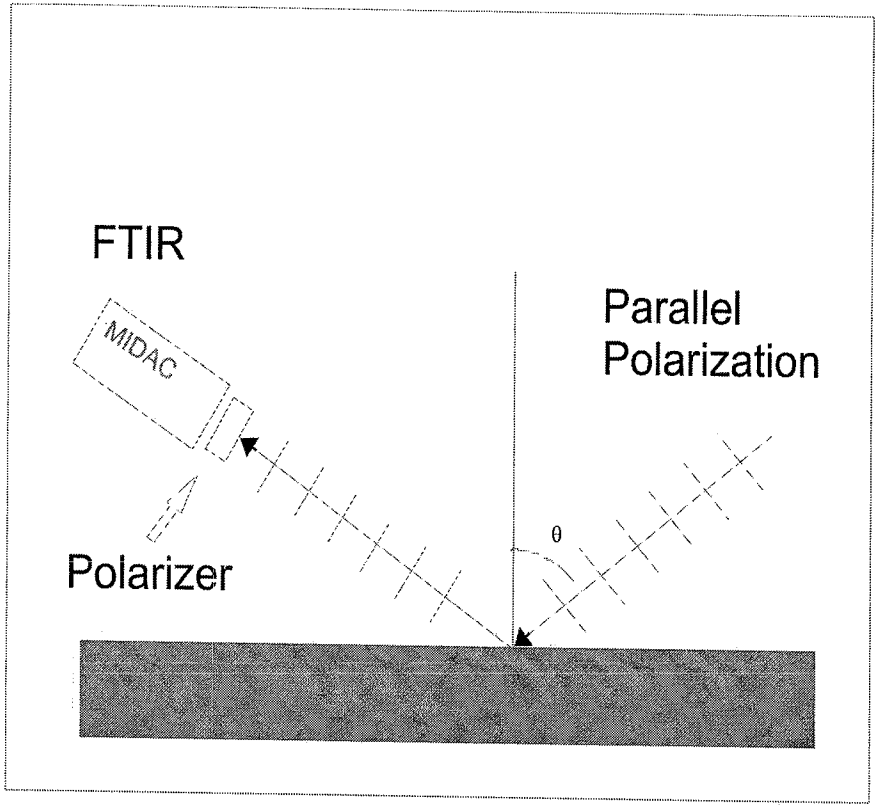
MIDAC FTIR

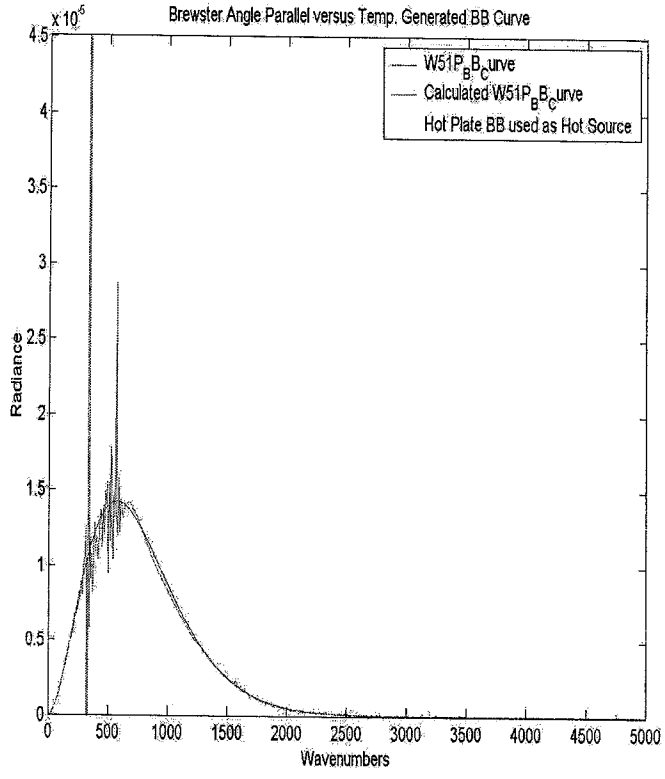
Perpendicular Polarization





Parallel Polarization





Note Excellent Agreement in Atmospheric Window

Technical Advantages of the Brewster Angle Radiometer

- Polarized thermal radiometer at Brewster angle eliminates the need for complex corrections for emissivity and surroundings
- Temperature accuracies on the order of 0.1 °C are achievable
- Simple to implement
- Minimal modeling necessary to determine temperature
- Easy to calibrate

Remaining Research & Development for Both Technologies

- Technical risk
  - Low cost polarizer (Nulling Radiometer)
  - Low (Brewster Angle Radiometer)
- Remaining milestones
  - Full integration (Both Technologies)
- Future enhancements
  - Combination of technologies into one package
- Need for outside expertise or resources
  - Outside packaging expertise needed

Technology Benefits for Both Technologies

- Both technologies minimizes calibration needs
- Both technologies improves accuracy
- Nulling Radiometer increases utility in harsh thermal environments
- Nulling Radiometer reduces human intervention
- Nulling Radiometer - Low Power Requirement
- Brewster Angle Radiometer decreases complexity of measurement
- Brewster Angle Radiometers ease of integration into existing radiometers

Potential Applications for Both Technologies

- Commercial / Government
  - NASA and NOAA satellite calibration
  - Department of Defense Applications
  - Global Warming
- Process Control
  - Chemical/petrochemical
  - Power Generation
  - Aerospace
  - Materials
- Infrared radiometers for weakly absorbing dielectrics
  - Water
  - Polymers

NASA Plans/Options

- Continued internal development of both technologies
- Partnering
  - Dual Use Technology Development
  - Interagency Partnering
- License Technology for Commercialization

Intellectual Property

- Patent Pending
  - NASA has filed a Patent Application on both technologies
- NASA has the authority to license the technologies pursuant to 35 USC 207-209
- NASA has the authority to grant Exclusive, Partially Exclusive, or Nonexclusive licenses on both technologies

Licensing Opportunity

- Parties interested in licensing this technology or partnering with NASA for further development should contact the Commercial Technology Program at John C. Stennis Space Center at:

  Phone: (228) 688-1929

  E-mail: technology@ssc.nasa.gov

  http://technology.ssc.nasa.gov

  Reference Technology Case Numbers:

  SSC-00124, Radiant Temperature Nulling Radiometer

  SSC-00134, Polarization Enhanced Thermal Radiometer

OR

While at PITTCON come see us at booth number 5619

THANK YOU

Questions?

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14. ABSTRACT