# NASA John C. Stennis Space Center

# PITTCON 2002
# New Product Forum
# March 17, 2002

## Presented by:



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# Radiant Temperature Nulling Radiometer

(NASA Stennis Case Number: SSC-00124)

# Polarization Enhanced Thermal Radiometer

(NASA Stennis Case Number: SSC-00134)



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# 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



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# 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



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# Radiant Temperature Nulling Radiometer

## (NASA Stennis Case Number: SSC-00124)



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# 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



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# Research & Development Status



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



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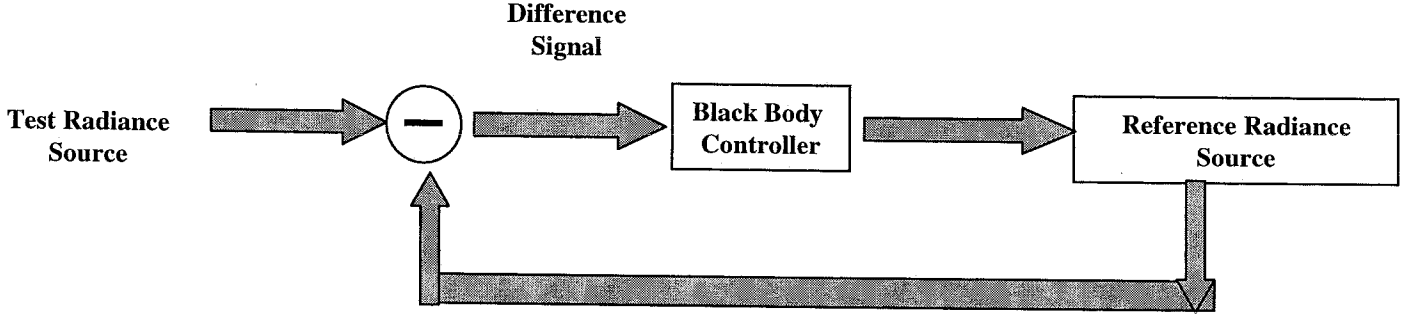
# Nulling Radiometer Principles





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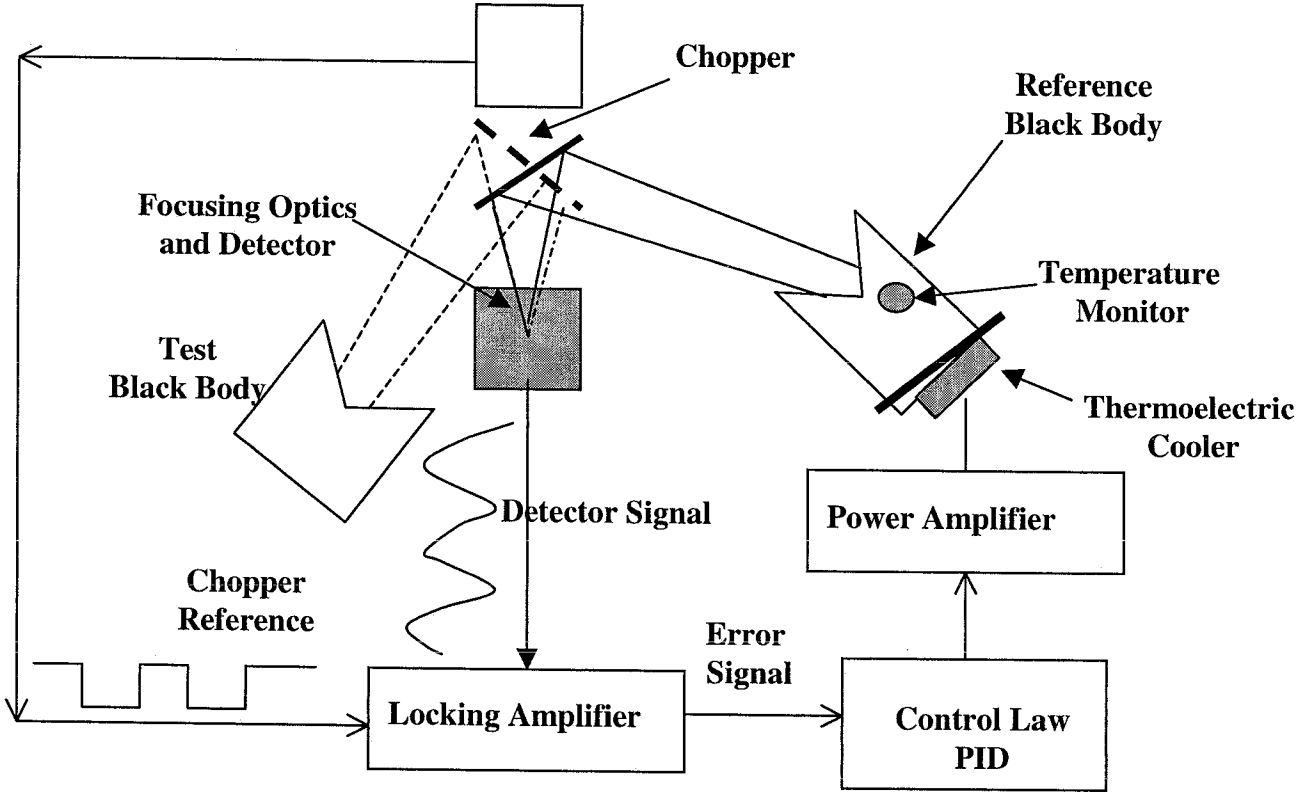
# Nulling Radiometer Subsystems





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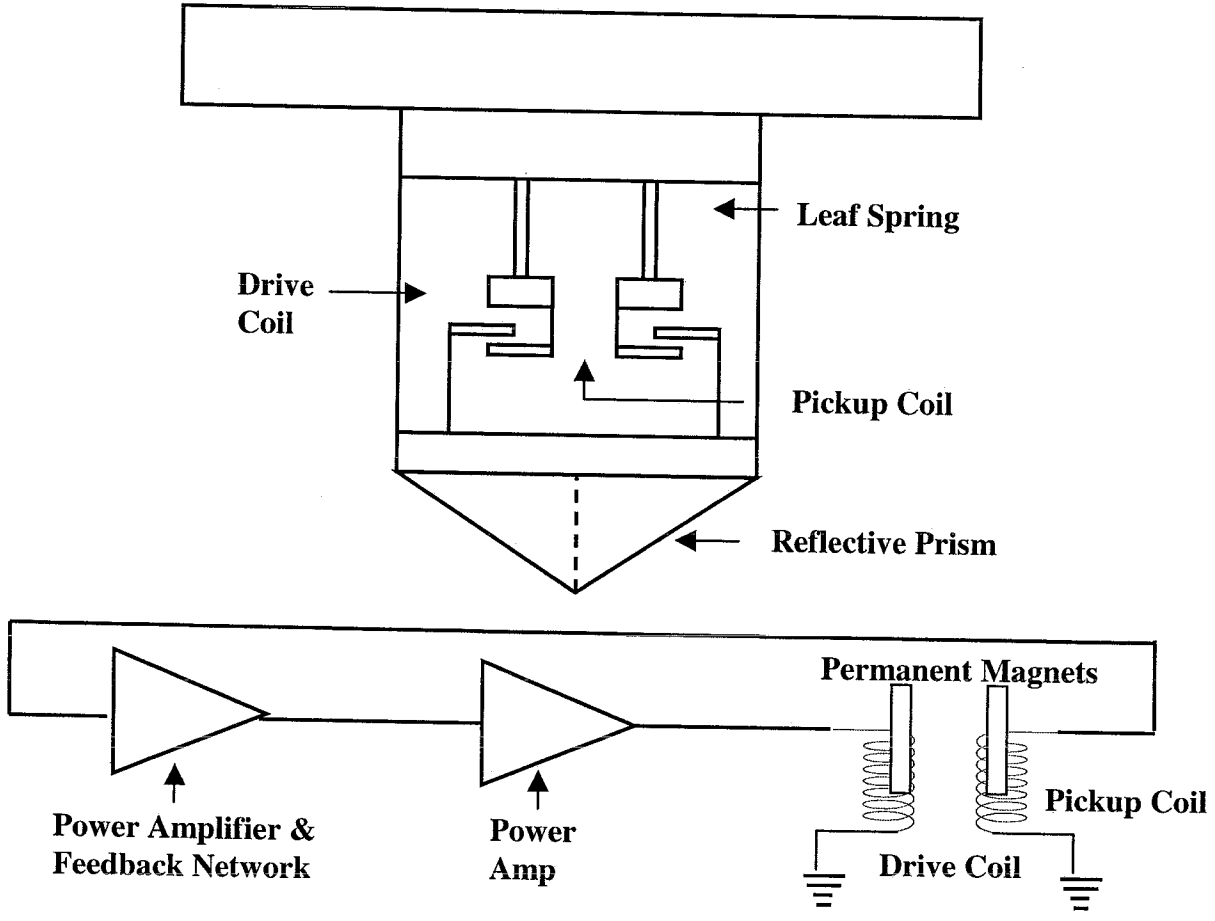
# Nulling Radiometer Chopper





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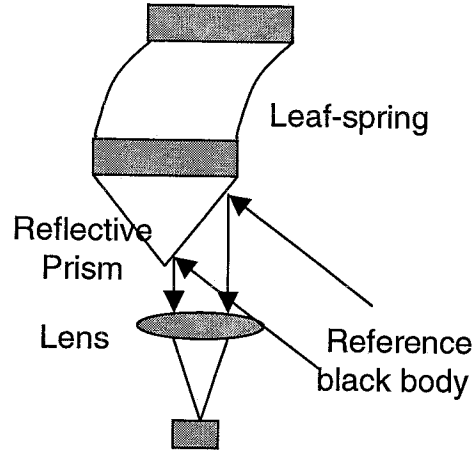
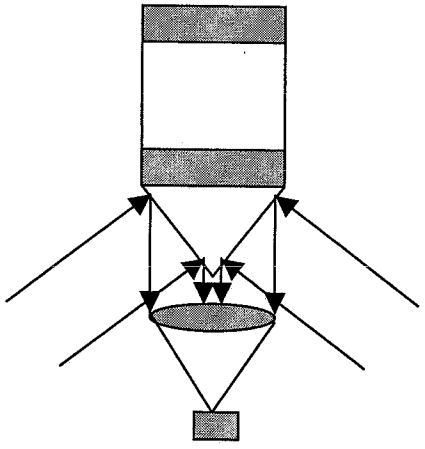
# Nulling Radiometer Chopper (cont)

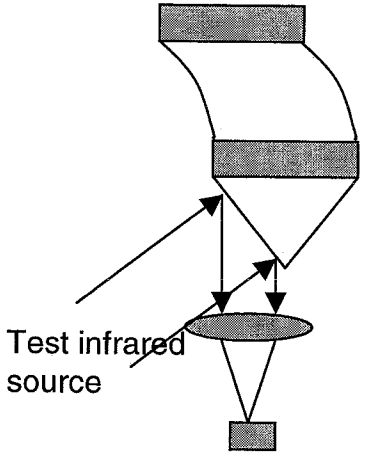





a) Reference black body only



b) Both reference and test infrared source only




c) Test infrared source only



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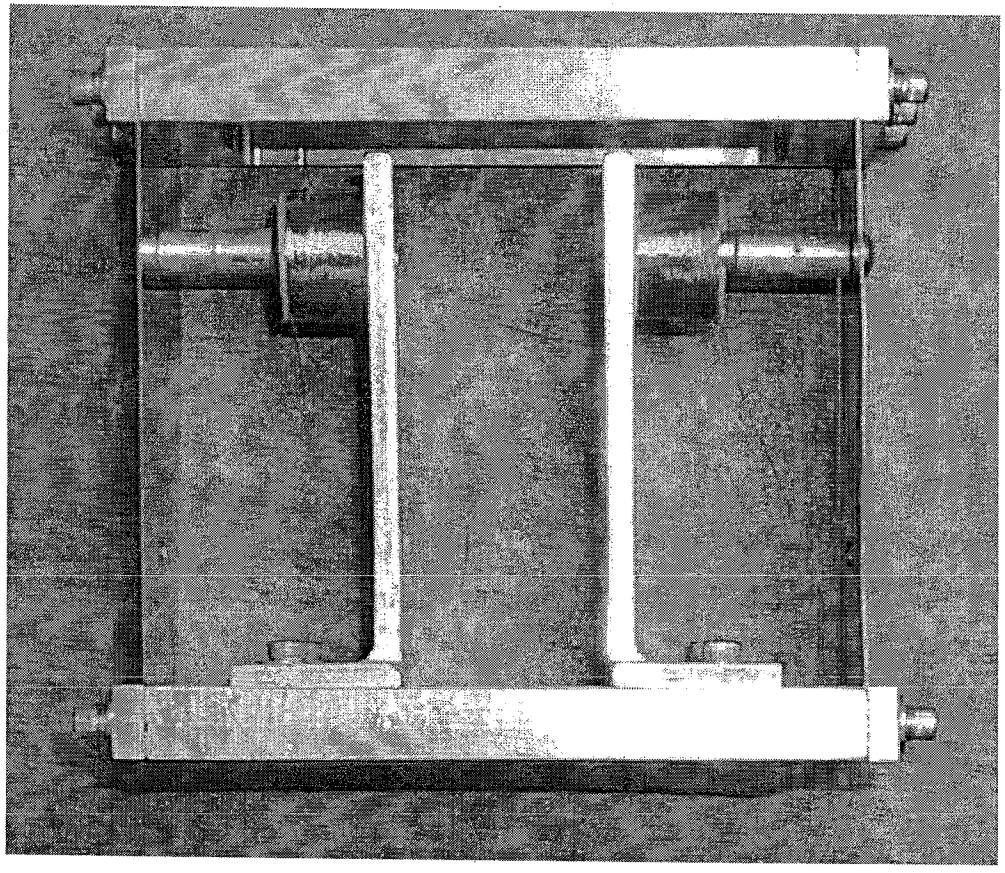
# Nulling Radiometer Hardware







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# 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


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# Polarization Enhanced Thermal Radiometer

## (NASA Stennis Case Number: SSC-00134)



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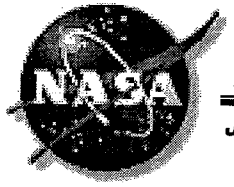

# Brewster Angle Radiometer



- 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



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# 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



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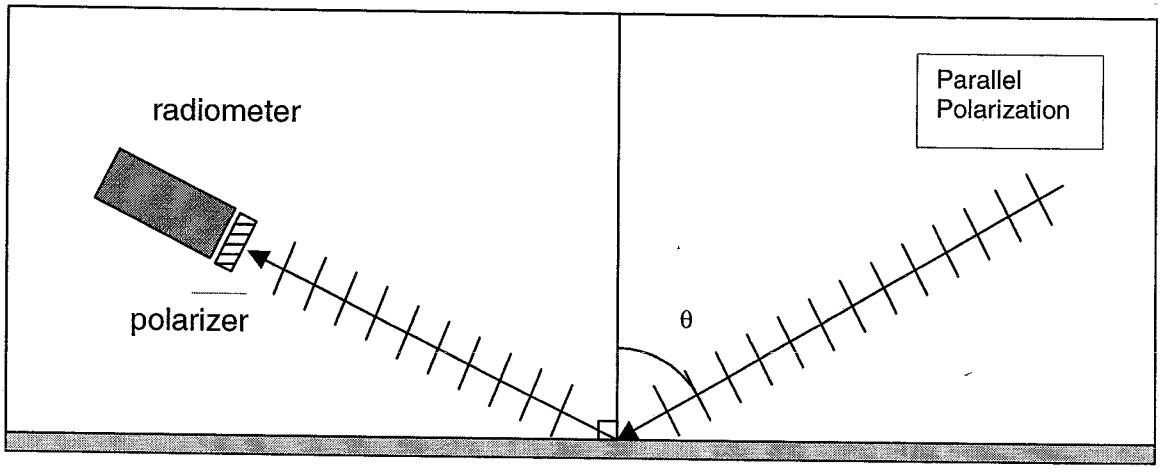
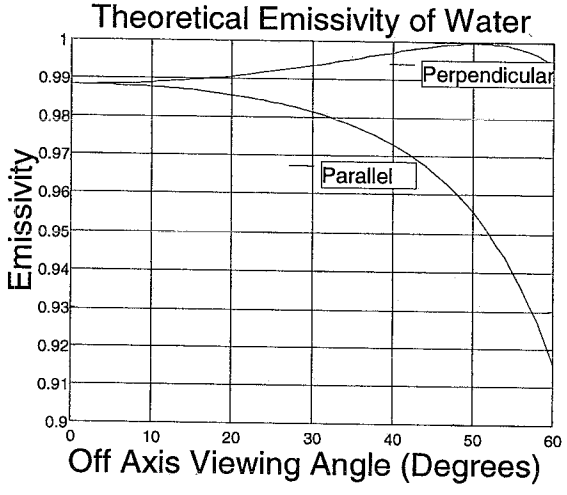
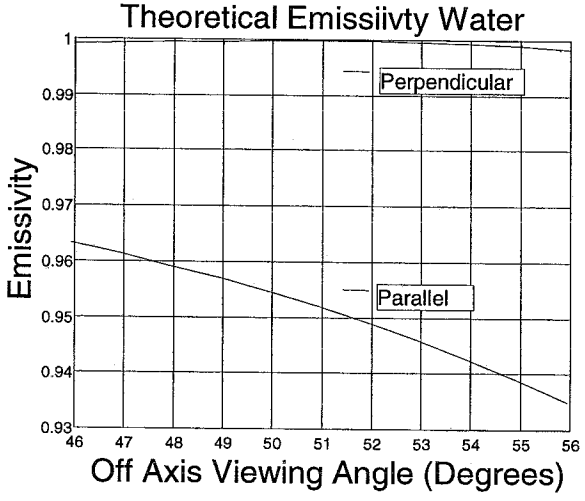
# Theory of Operation





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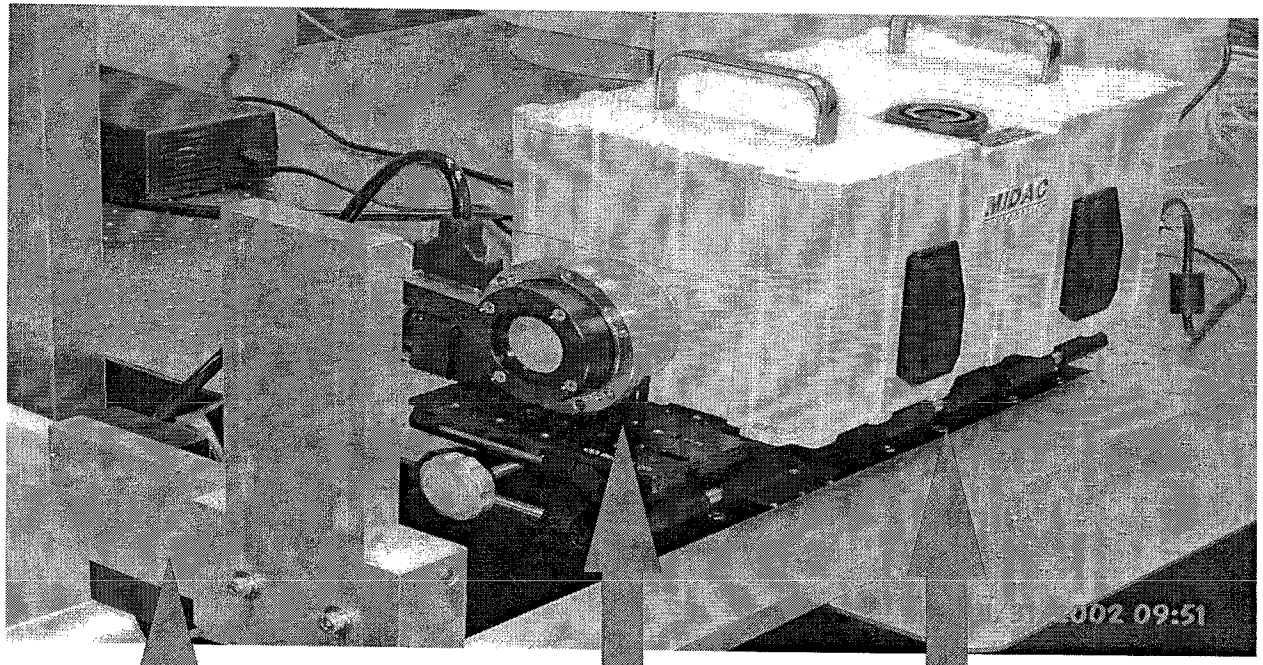
# Experimental Approach






Scan Mirror

Polarizer

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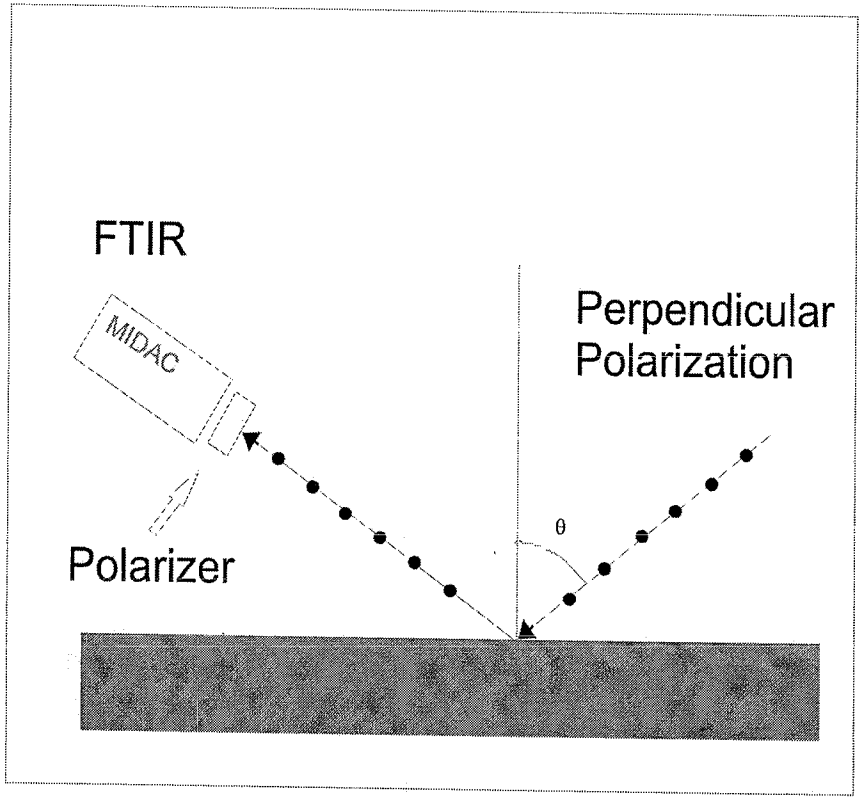
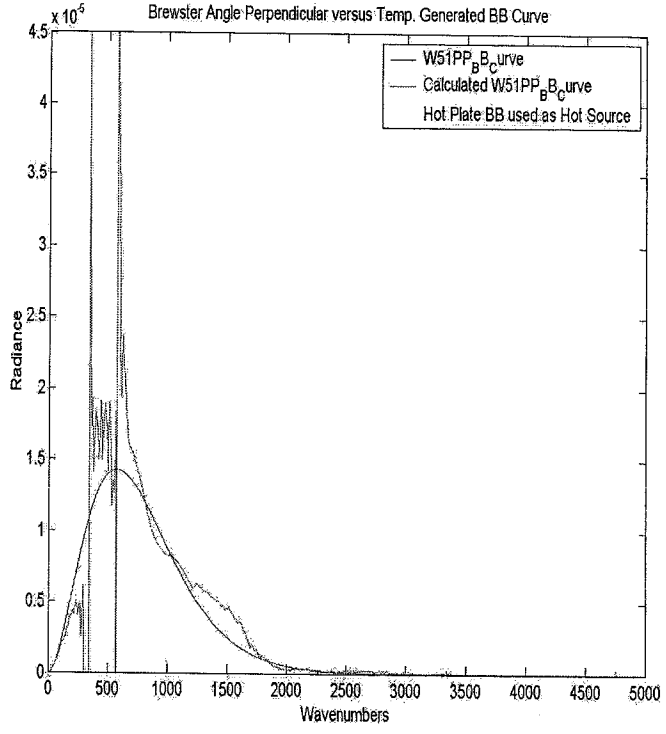
# Perpendicular Polarization





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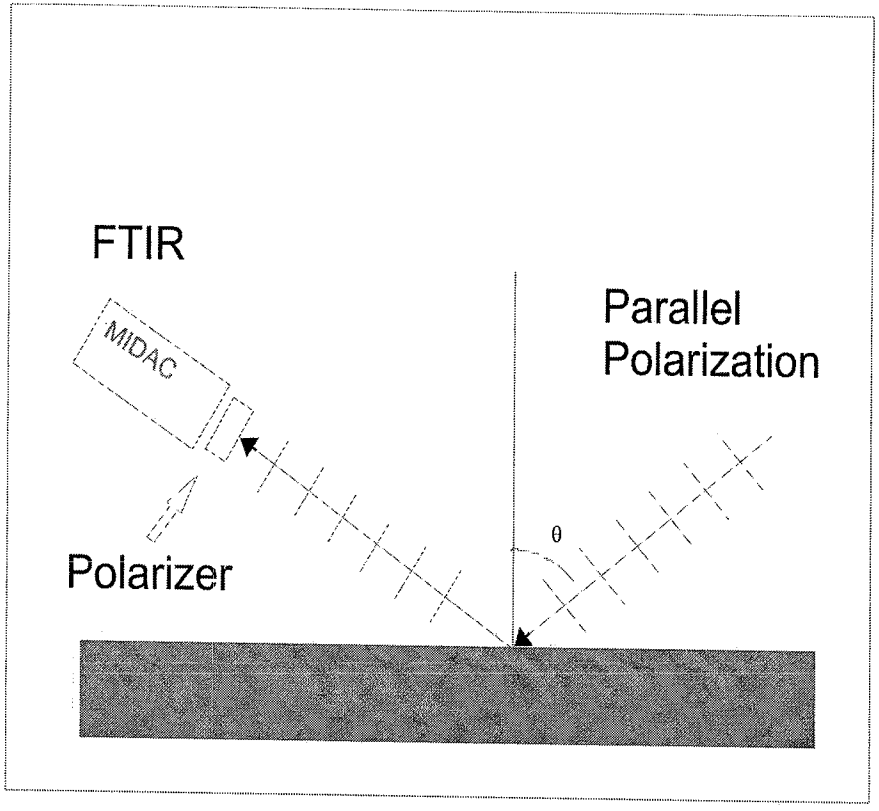
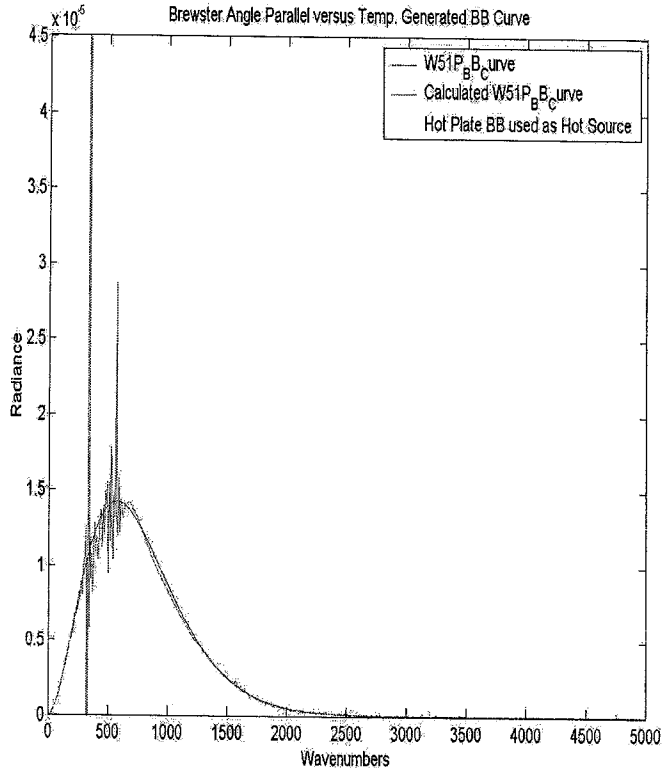
# Parallel Polarization






Note Excellent Agreement in Atmospheric Window



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# 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



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# 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



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# 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



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# 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



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# NASA Plans/Options

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



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# 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



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# 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**



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# THANK YOU

# Questions?

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