Mid-IR spectroscopy for flame and surface characterization

En'Urga Inc.

 765-497-3269

 765-463-7004

http://www.enurga.com

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Outline

- Company and product overview
- Fundamentals of Mid-IR Spectroscopy
- Practical examples

Company and Products Overview

En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Mission,Vision and Values

En'Urga's vision is to apply research findings in basic science and engineering towards the development of innovative products and processes that harmonizes the human spirit and technology.

Our mission is ***"To become the leader in Industrial Process Tomography systems throughout the world"***

En'Urga strives to provide exceptional service with the state of the art technology to meet our customer's objectives

En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

SETscan Optical Patternator

US Patent number 6,184,989

- **Used for testing automotive and aeroengine injectors, as well as coating, paint, and consumer nozzles**
- **Customized database including CFR Part 11 compliance for Pharmaceutical Industry**
- ***Sample customers: Abbot, Delphi, GE, GM, Honeywell, Eaton, Rolls Royce, Tenneco, United Technology, Pfizer***

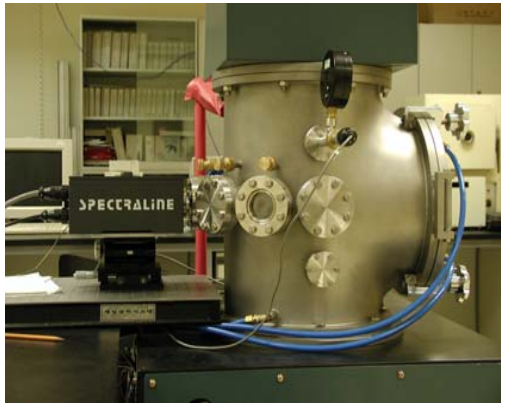
En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Spectraline Hyperspectral Imager

US Patent number 6,355,930



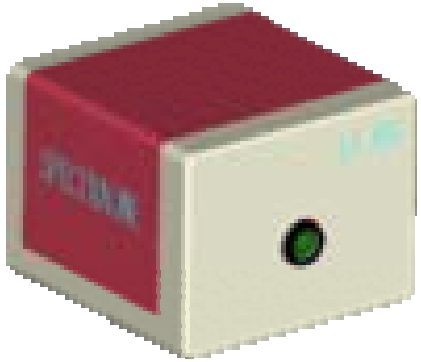
- **Used for monitoring high temperature events**
- **Database include determination of temperature, emissivity, and gas concentrations**
- ***Representative customers: Siemens, Dow Corning, Poohang Steel, Jupiter Aluminum, and FM***

En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Spectraline Infrared Line Imagers



US Patent number 6,355,930

- **Used for monitoring hot ignots, plastic webs, and surface coating on sheets**
- **Database include determination of temperature, emissivity, cracks, and defects**
- ***Representative customers: Poohang Steel, 3M, Hevea Engineering, and Hyundai Automotive***

En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

SCIvel velocimeter

US Patent number 8,134,703

- **Used for measuring velocities in fires, sprays, belts, and two phase flows**
- **Fully customized for multiple applications**
- ***Representative customers: 3M, Air Force, Dow Corning, and NASA***

En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

X-Ray Inspection Systems

US Patent number: Application on file

- **New product introduced in FY2014**
- **Industrial measurement of powder flow, optical dense sprays, product defects, and two phase flows**
- **Configured to meet customer quality audit needs**
- ***Representative customers: Virgina Tech., Purdue University, Ekamber, Air Force***

En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

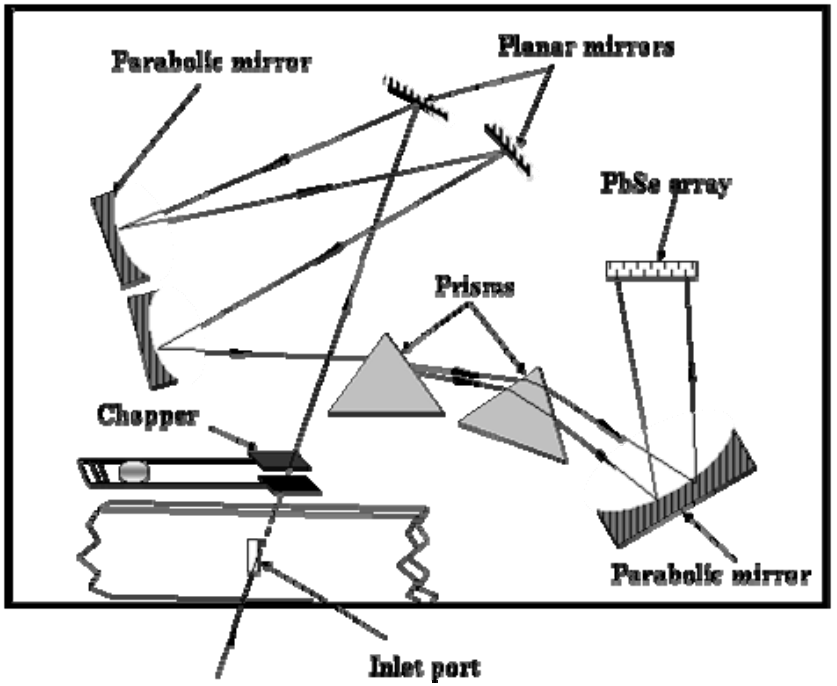
Mid-IR Spectroscopy

En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Hardware



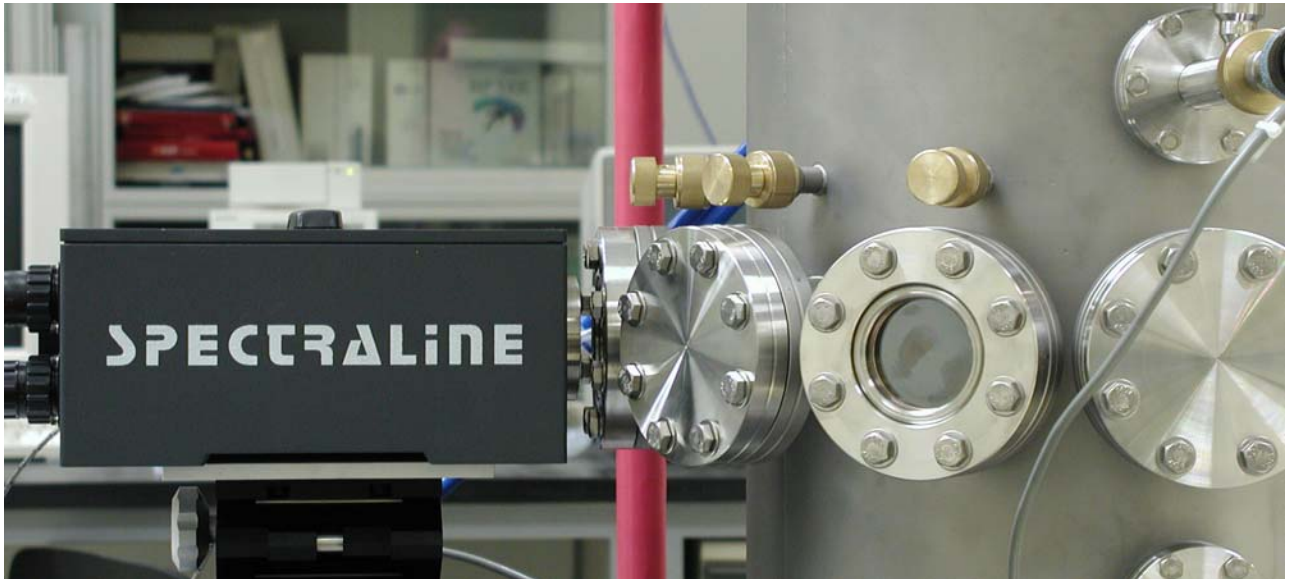
- **Co-registry of all wavelengths**
- **High speed to eliminate turbulence/radiation fluctuations**

En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Line of Sight Measurements



- Path integrated measurement of radiation intensity
- Converted to temperature, gas concentrations using models

En'Urga Inc.

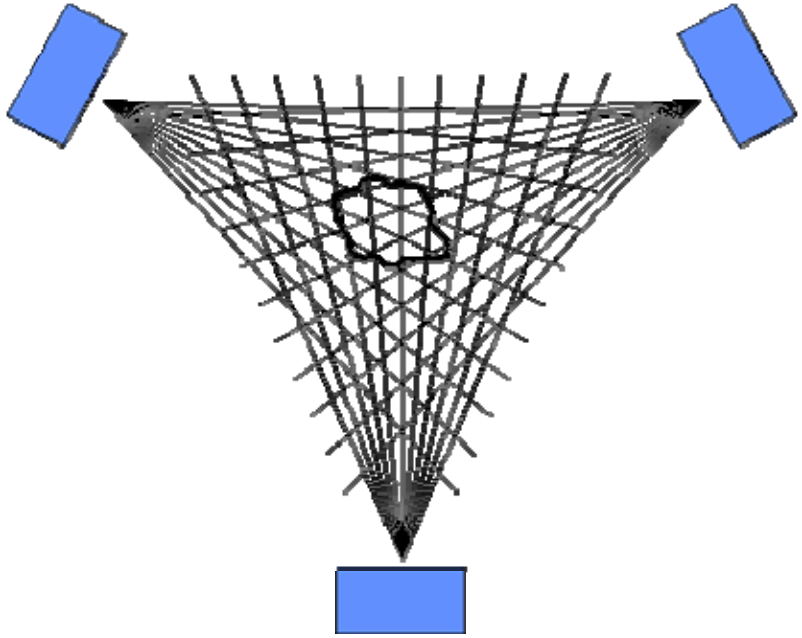
1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Radiation Models

- Assume homogeneous or parabolic profiles of T and CO_2
- Forward calculation using either RADCAL and HITRAN narrow band models
- Using difference between calculations and input values to update values and recalculate
- Convergence is typically in less than 1 second per point

Fan Beam Arrangement



Emission tomography with high spatial resolution
Used for non-homogeneous paths
Detailed profile-not an online monitoring tool

En'Urga Inc.
1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Emission Tomography

- **DECONVOLUTION PROCEDURE:**
- Step 1: Measure path integrated spectra
- Step 2: Deconvolute for the local emission spectra (neglecting self absorption)
- Step 3: Calculate temperatures and local properties from spectra.
- Step 4: With known local properties estimate absorption field and perform deconvolution with absorption.
- Step 5: Iteratively (~ 5 to 6 loops) obtain local properties and absorption till converge is obtained.

Practical Examples

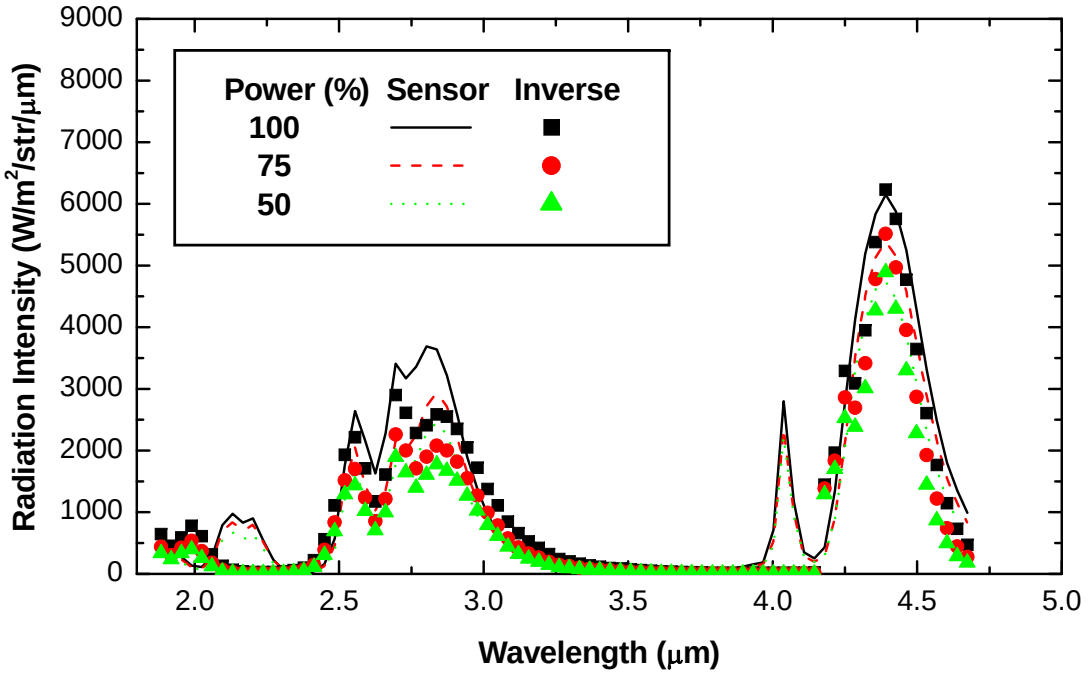
En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Measured Intensities

Siemens Westinghouse Power Corporation
Natural Gas Combustor, P = 6.2 bar

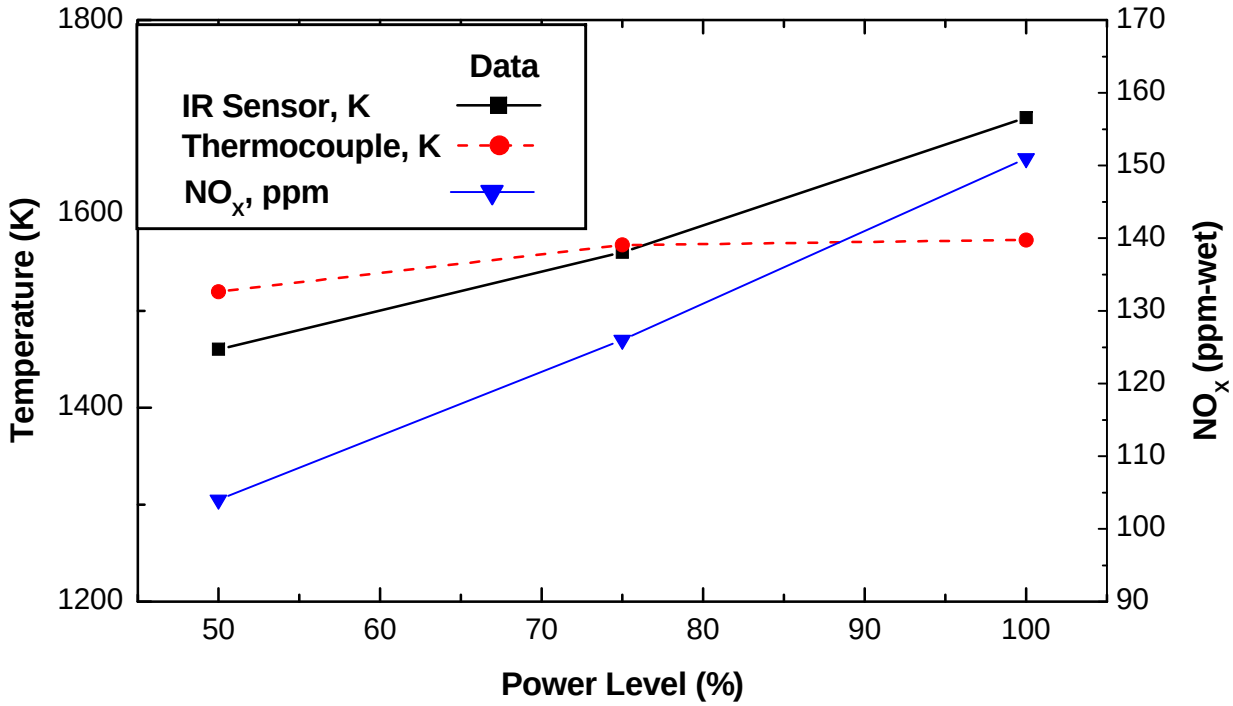


En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Estimated Temperatures

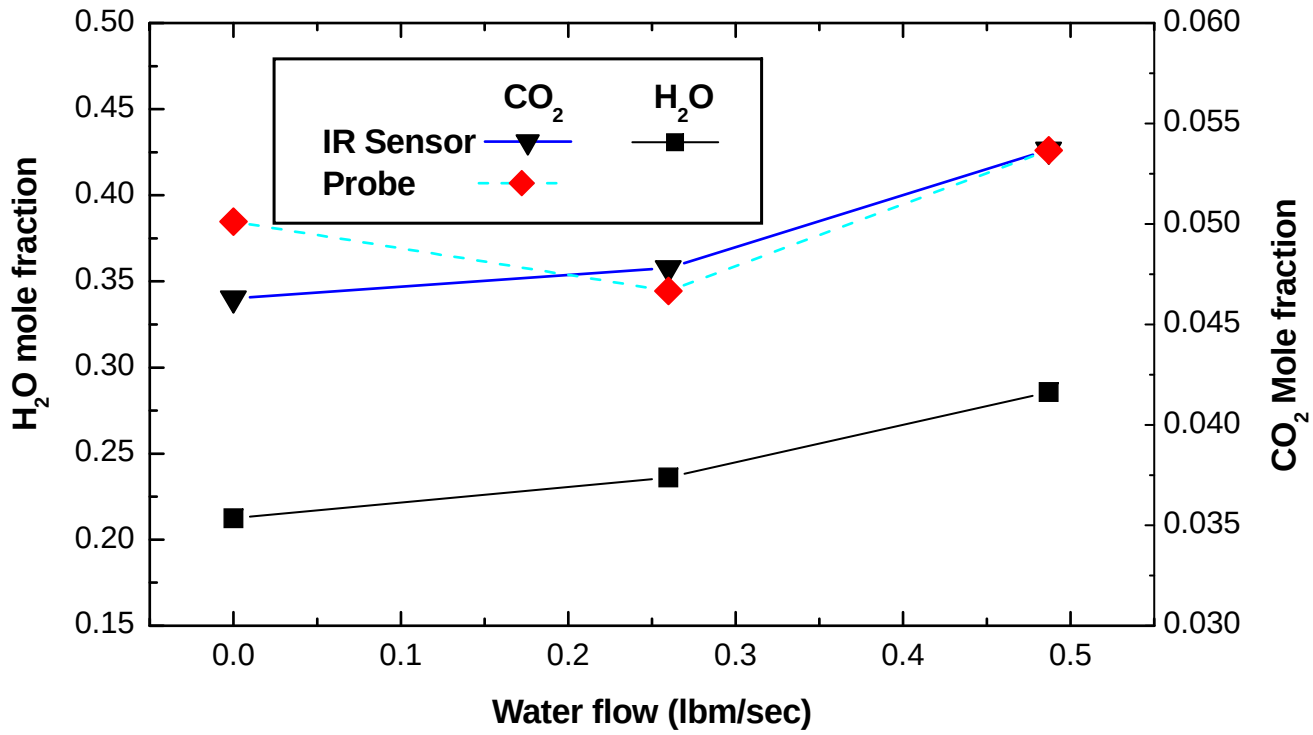


En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Gas Concentrations

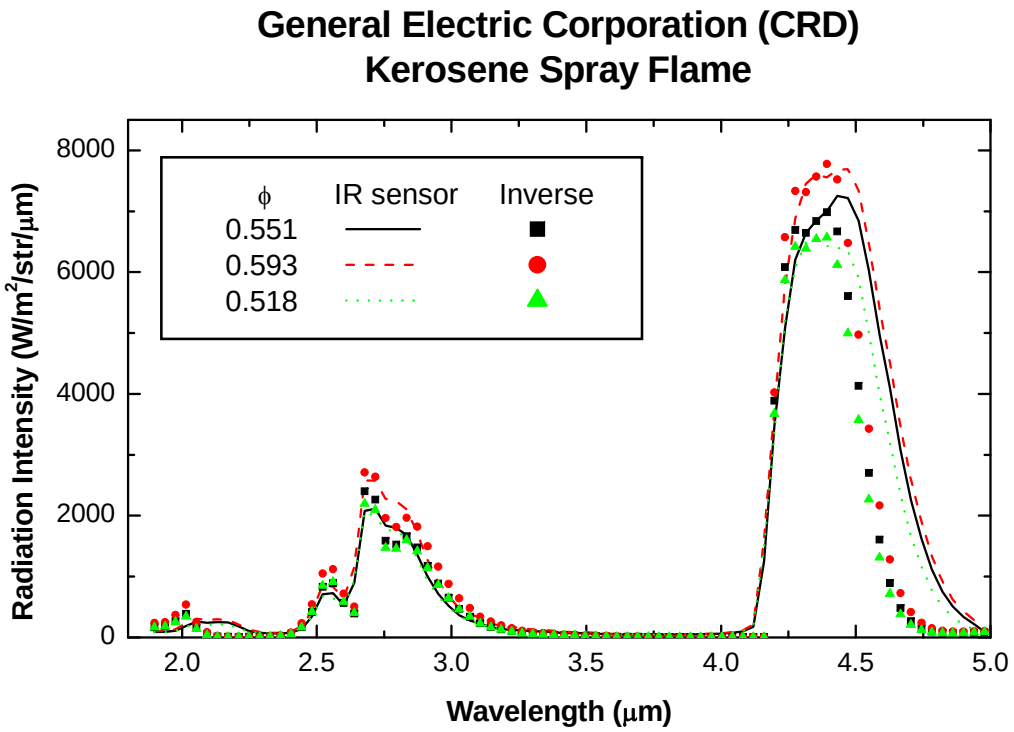


En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

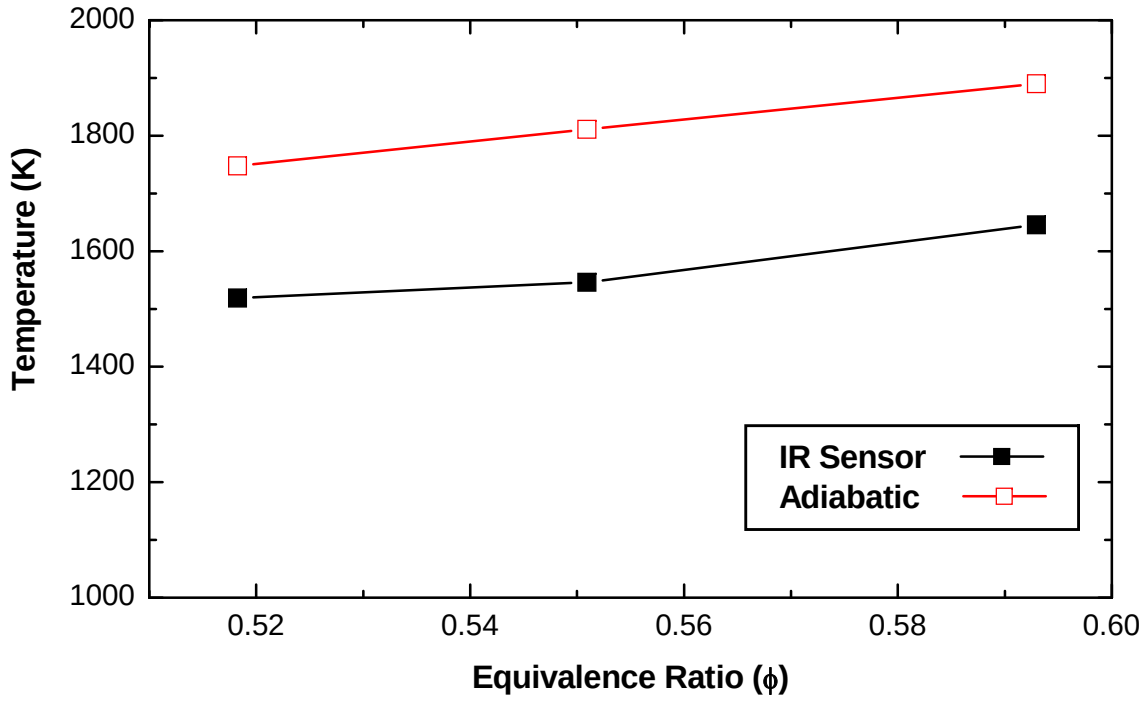
Measured Intensity



1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Estimated Temperature



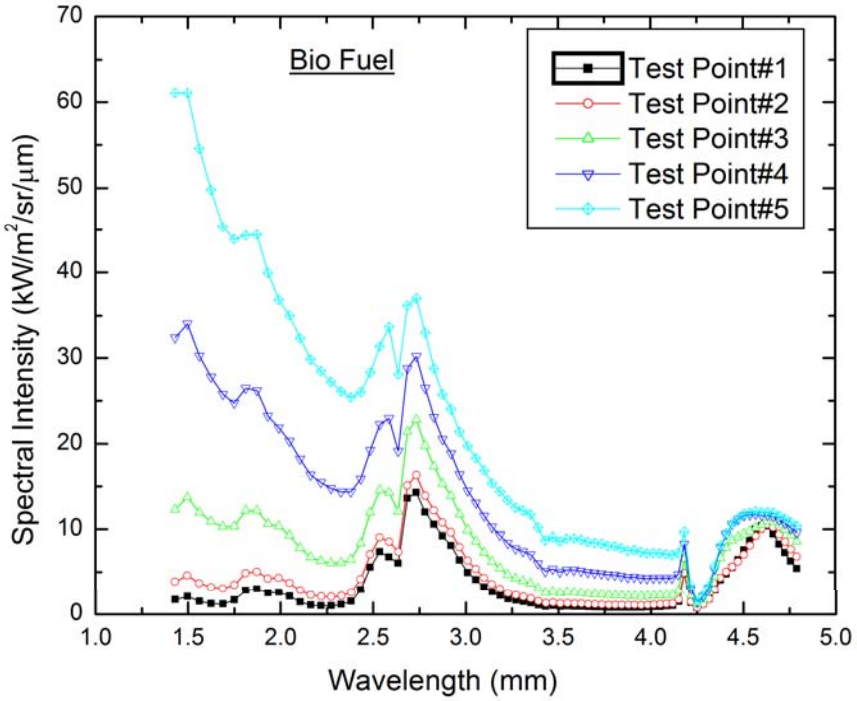
En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Measured Intensity

Rolls Royce Bio-fuel Combustor

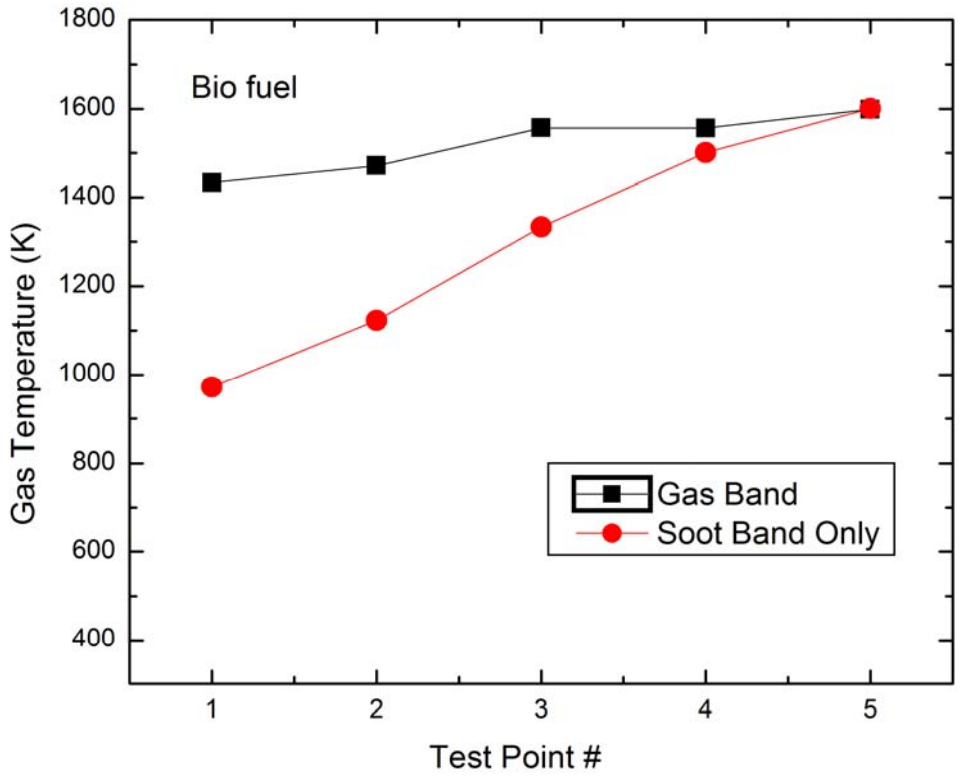


En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Estimated Temperatures

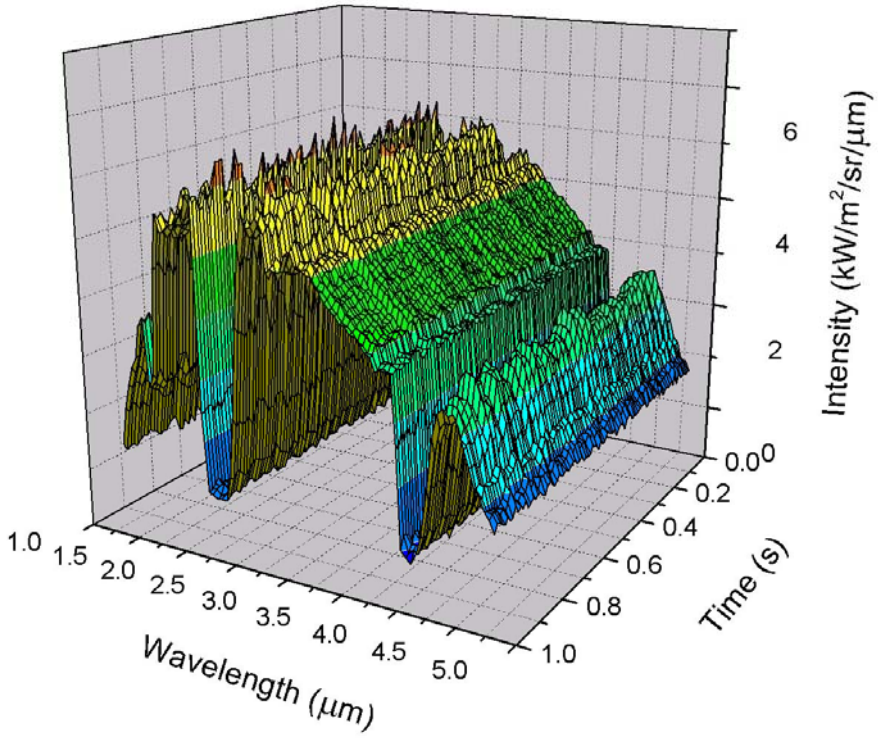


En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Turbine Blade Monitoring

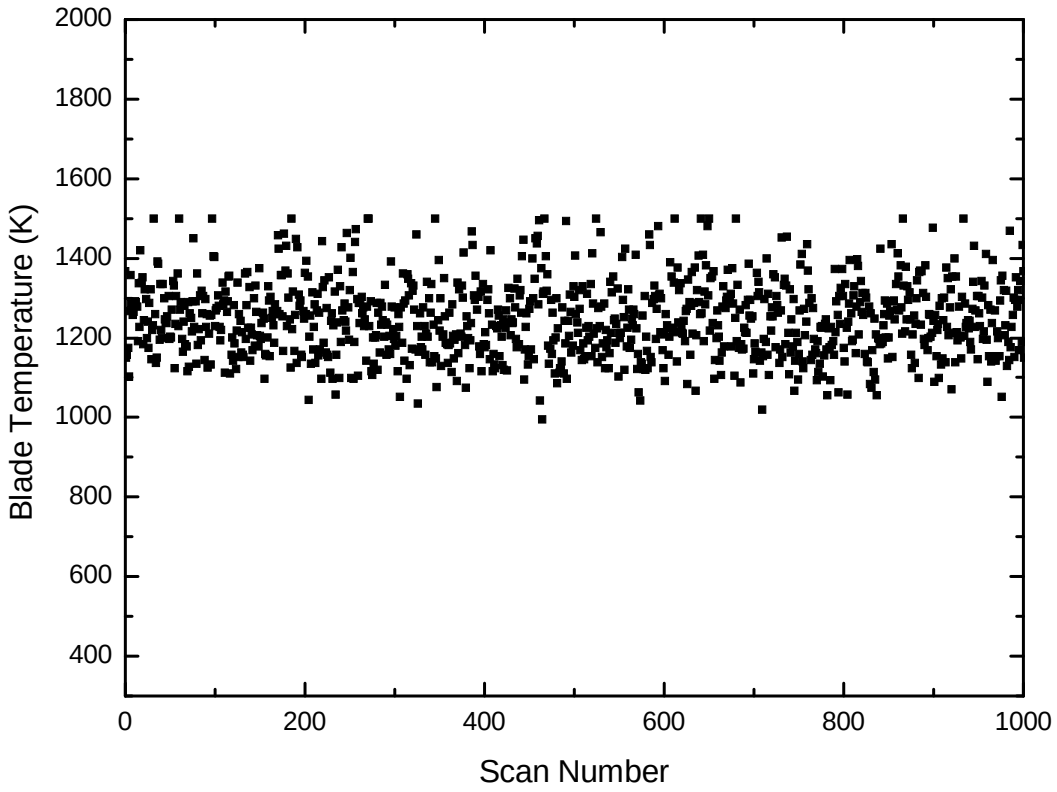


En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Blade Temperature



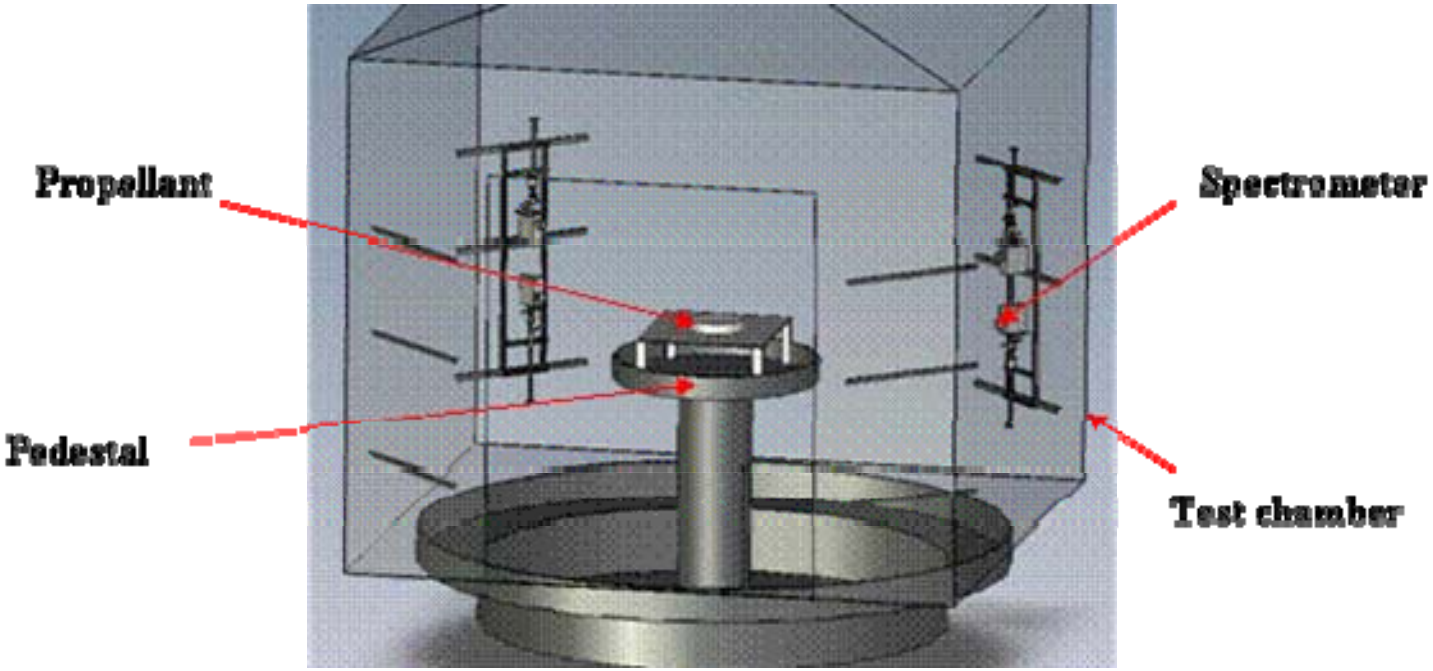
En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Monopropellant Flames

Jet Propulsion Laboratory/Sandia National Laboratory

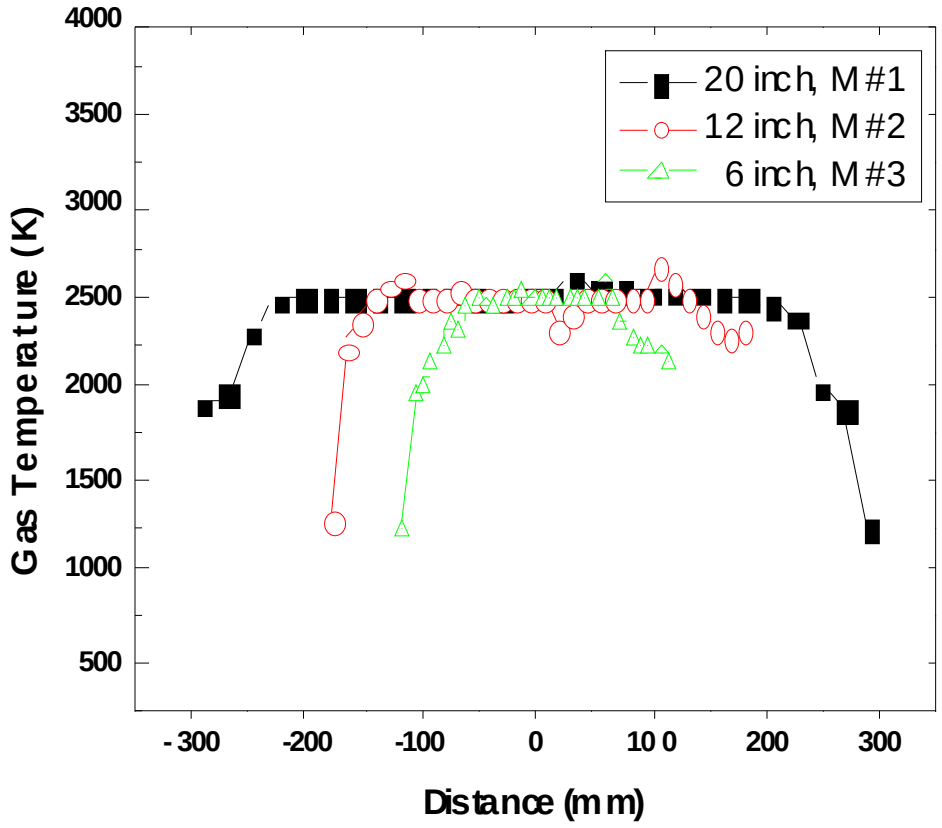


En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control

Estimated Temperature Profile



En'Urga Inc.

1201Cumberland Ave., Ste. R, West Lafayette, IN 47906

innovations in quality control