OPTICAL TECHNOLOGY DIVISION

NIST

CEOS WGCV 28th Meeting
NIST Agency Report

Sanya, China
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Presented by Carol Johnson
Optical Technology Division, Physics Laboratory

Contributions from: David Allen, Steven Brown, Joe Rice, Eric Shirley, Allan Smith, Howard Yoon, Raju Datla, Keith Lykke, Gerald Fraser

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With apologies to those who attended the IVOS in Phoenix last month!

SUMMARY STATEMENT

The NIST Optical Technology Division continues to support and/or Partner with weather & climate related satellite programs. It maintains and improves radiometric tools, facilities and capabilities to do so.

HIGHLIGHTED ISSUES OF CURRENT/UPCOMING IMPORTANCE

* NISTstars: SI traceability of exoatmospheric irradiance of stars

* Partnering with recently funded CLARREO Mission

* Improved capabilities for measuring BRDF over solar reflected region sought

* Developments in Hyperspectral Imaging Projection capabilities (HIP)

* Proposed NIST-NOAA-NASA-Collaborations for Climate Change (N3C3) Portal

* Other items


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Establish a set of SI traceable stars for calibration

What is the Problem?

Present stellar light measurements are too inaccurate (2% to 5%) for various applications:

- Earth sciences, weather & astronomical satellite calibration
- Atmospheric monitoring
- Fundamental astronomy
- Astronomical surveys
- Navigation
- Physics and cosmology
- …

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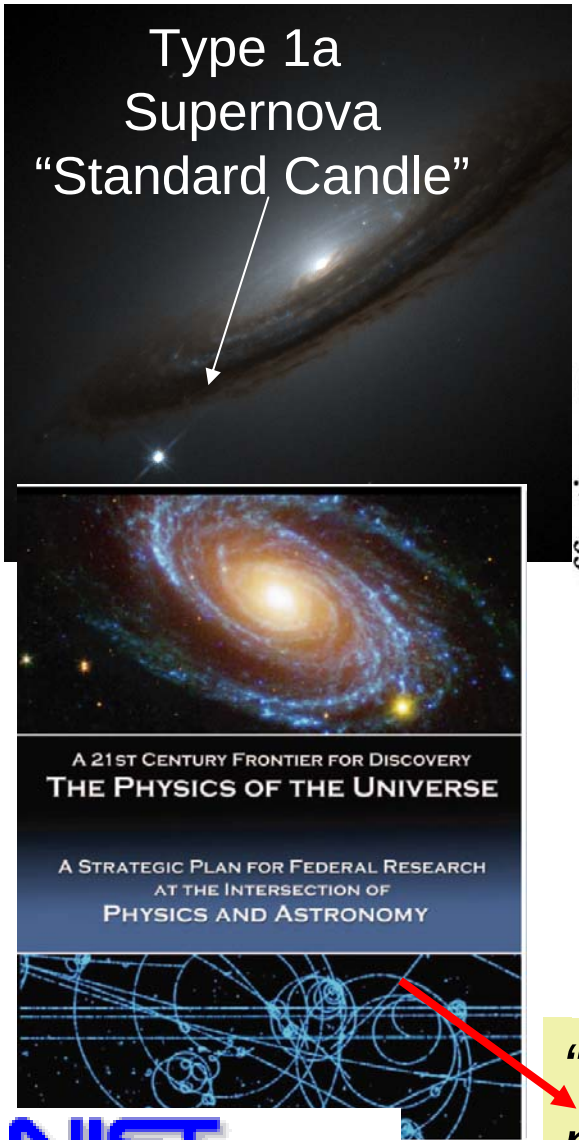
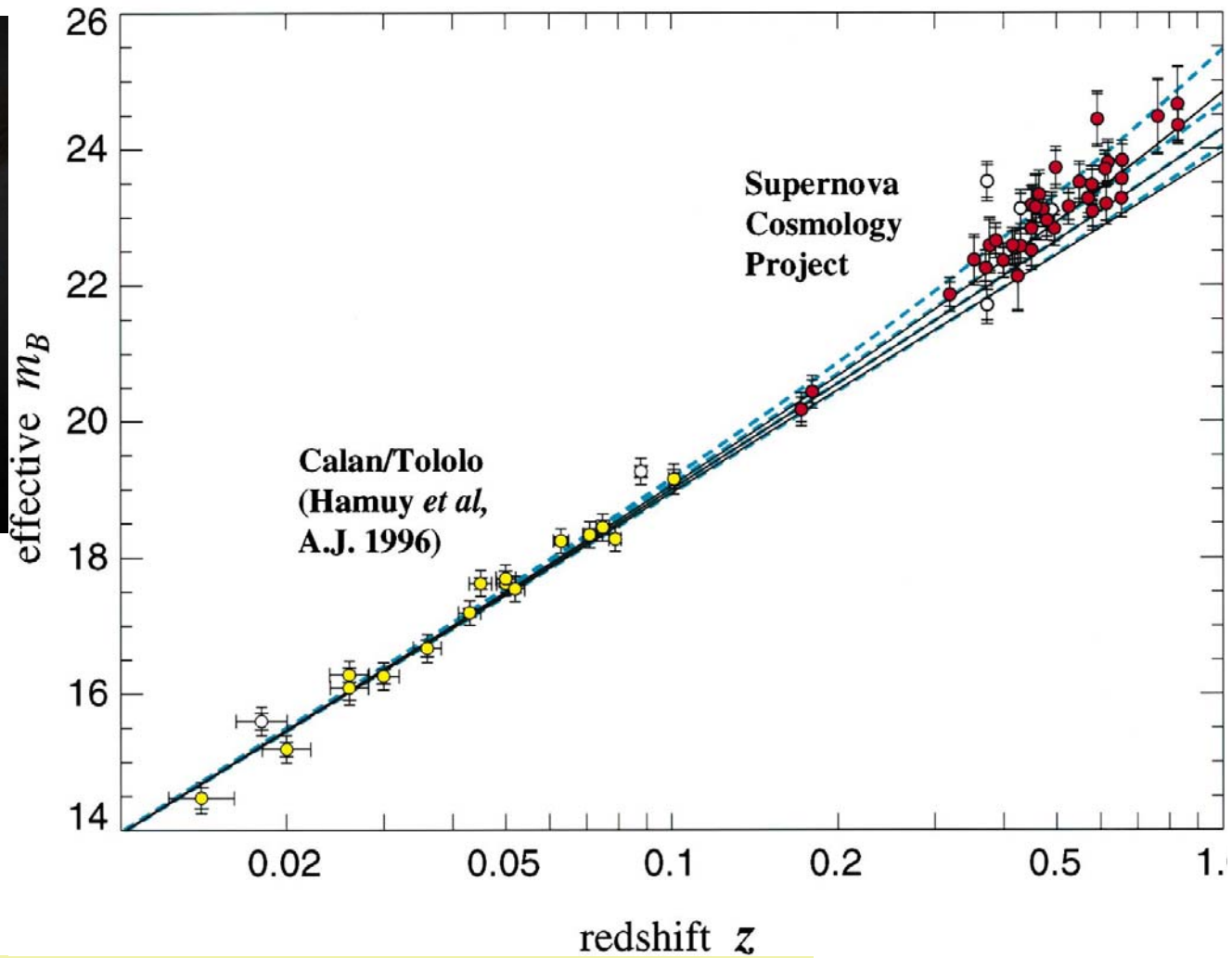
→ Applications require <1%; our goal is 0.5%.

The Extraterrestrial Standard Candle





“Such supernovae have great promise for shedding light on the nature of Dark Energy.”

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NISTstars activities (planned):

Working with ACCESS team (Absolute Color Calibration Experiment for Standard Stars) to calibrate telescope/spectrograph.
4 rocket launches to calibrate Vega, Sirius, and two dimmer (~9th magnitude) stars outside of the atmosphere for spectral irradiance from 350 nm to 1700 nm.

Use the 42" Hall telescope at Lowell Observatory in Flagstaff, AZ, to use these calibrations, along with atmospheric extinction, to extend the absolute calibrations to many other stars.

Work with Chris Stubbs from Harvard to calibrate the Pan-STARRS telescope (Panoramic Survey Telescope & Rapid Response System) on Haleakala, HI, and other telescopes.

To support climate and other research, including proposed CLimate Absolute Radiance and Refractivity Observatory (CLARREO) mission:

Realization/ validation of the IR spectral radiance scale for near-ambient radiation sources in laboratory conditions:

Scale realization and AIRI/FTS internal comparisons (accomplished in 2007).

Validation via comparison with other NMI's including PTB (Germany), NPL (UK) and NRC (Canada) is in progress (to be finalized and reported in 2008).

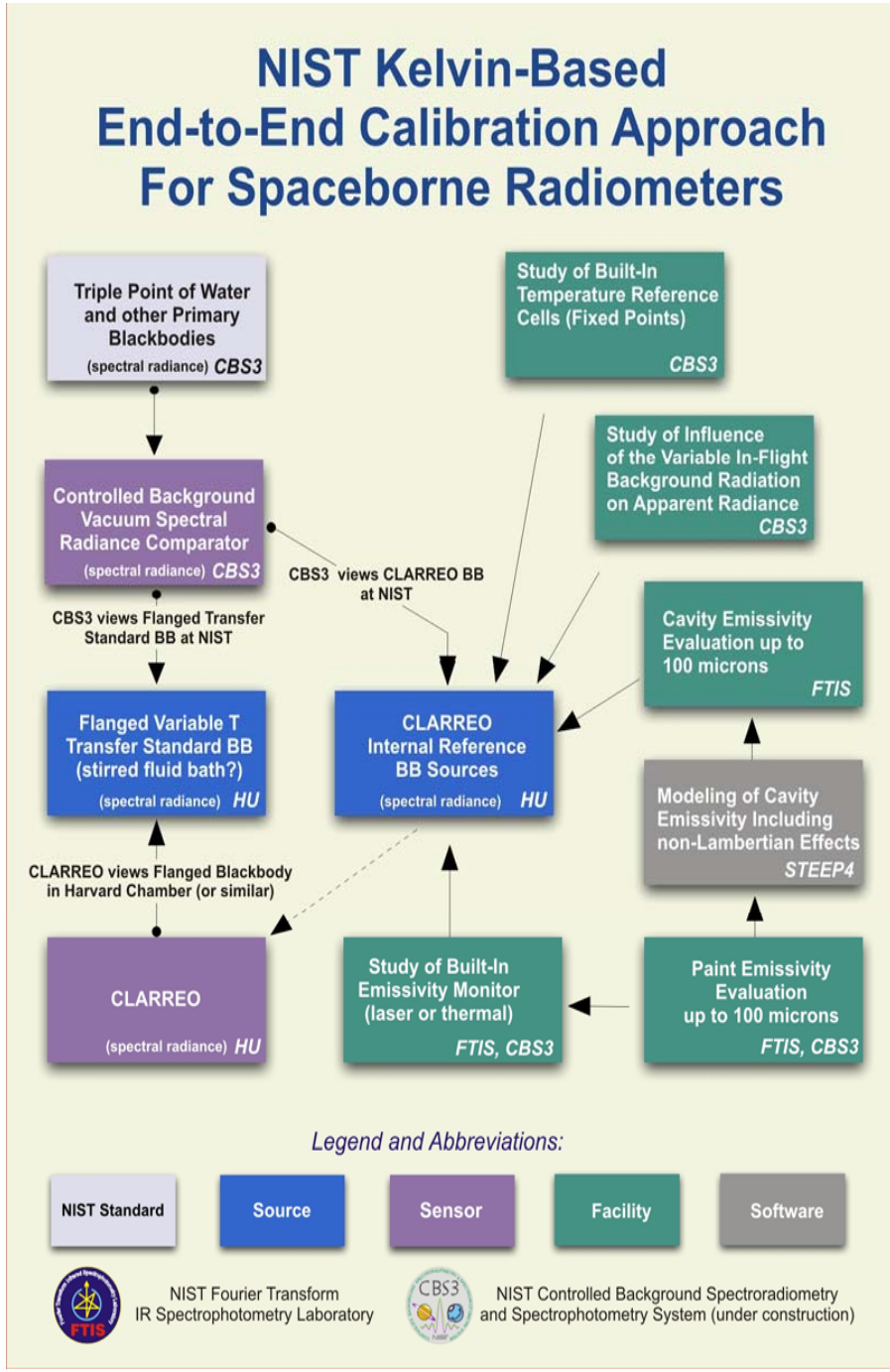
Support pre-flight calibration of space radiometric instruments:

Design of the vacuum spectral radiance comparator

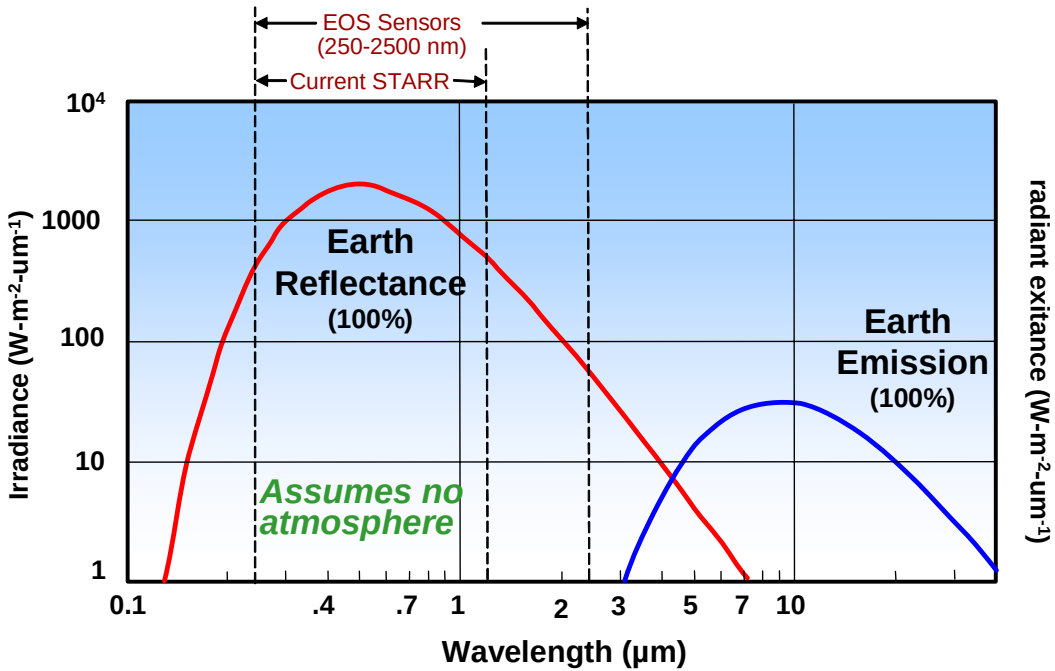
In 2008 we are planning to finalize the design and proceed with CBS3 construction.

Support of in-flight monitoring to maintain and validate traceability of spaceborne instrumentation.

Cooperation with the School of Engineering and Applied Sciences (Harvard University) and Space Science and Engineering Center (University of Wisconsin-Madison) aimed at development of self-calibrating spaceborne blackbody – a demonstration study is planned for accomplished in 2008.



STARR Reflectance (BRDF): effort to cover entire solar reflected region



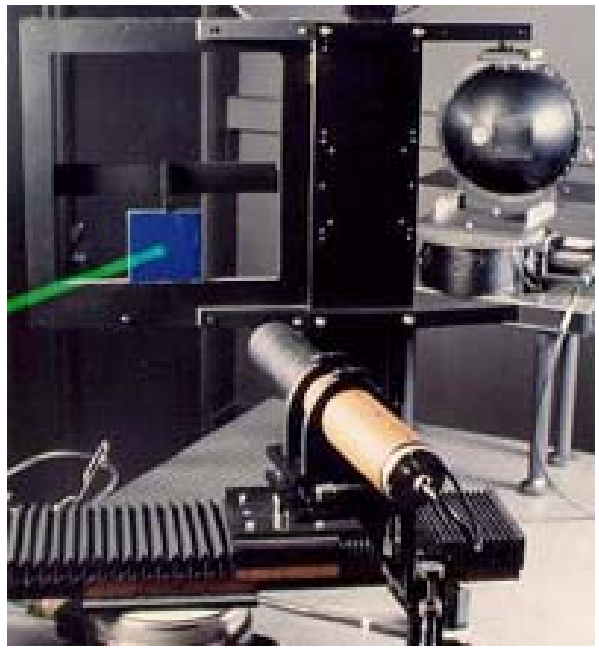


Photo of Spectral Tri-function
Automated Reference Reflectometer (STARR)

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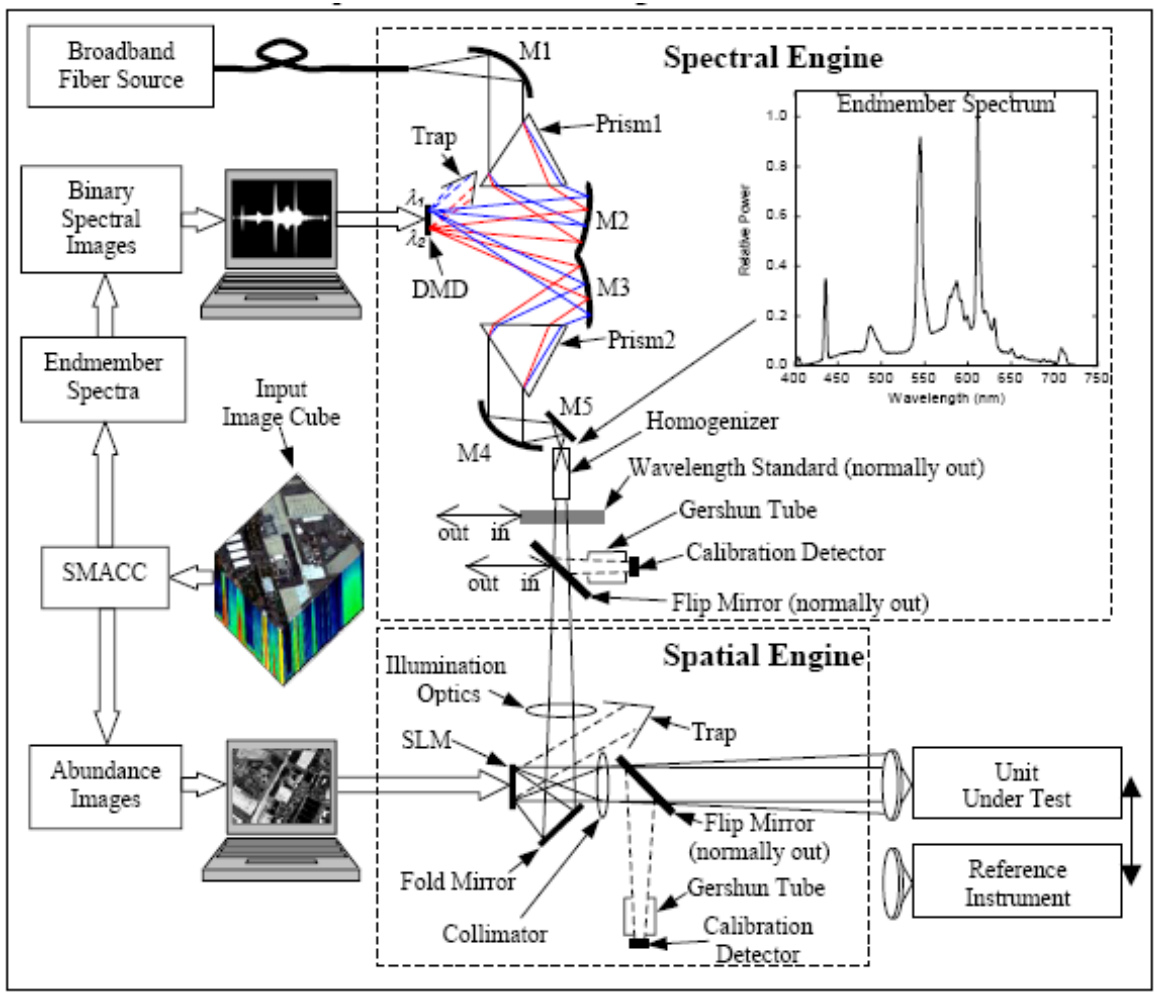
Hyperspectral Image Projector (HIP)



More information available at:: http://physics.nist.gov/Divisions/Div844/facilities/hip/hip.html

Acronyms: SMACC = Sequential Maximum Angle Convex Cone (automated endmember-finding algorithm)
DMD = Digital Micromirror Device SLM = Spatial Light Modulator (such as a DMD)

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N3C3 WEB Portal (proposed)
(Also provides Virtual Links to NOAA and NASA websites)

Goal: Easy access to satellite sensor radiometric calibration related information.

Contents: Covers optical & microwave sensors

- Proceedings of workshops, internal reports, articles on calibration methodologies, best practices and issues
- Adopted Pre-launch and post-launch calibration methodologies and lessons learned for sensors past, present and those under development.
- NIST data on components for calibrations of interest
- **Links to the CEOS CALVAL portal under Methods**
- **Links to NASA EOS and NOAA portals on sensors and their calibration issues**

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LUnar Spectral Irradiance and radiance (LUSI)

Proposed in collaboration with Steven R. Lorentz[1], Thomas C. Stone[2], Dave Pollock[3], and Joe Tansock[4]

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3. University of Alabama, Huntsville, AL
4. Space Dynamics Laboratory, Logan, UT

LUSI is a suite of instruments to develop the moon as an on-orbit SI-traceable absolute reference standard for satellite sensors.

The problem is that the radiometric accuracy requirements of satellite sensors needed to understand and monitor climate change are very stringent. Measurements spanning the lifetimes of many instruments must be combined with low uncertainties to detect small changes over decadal time periods. Observing such small climatic changes is complicated by the significant changes in optical sensor performance due to launch and during operation in space. At reflected solar wavelengths a low uncertainty absolute on-orbit reference standard is needed to mitigate such sensor changes and to put all sensors on the same radiometric scale. With further development the moon could be that reference.

Goals of LUSI

- Reduce the uncertainty of predicting the absolute lunar irradiance to 1% (k=1)
  - This is the best way to ensure a low uncertainty relative spectral scale that is needed for a cross-platform reference
  - A low uncertainty absolute scale allows validation of instrument performance and models used to deduce climate variables

- Increase the spectral resolution—320 nm to 2500 nm continuous with a resolution of approximately 0.3 %.
  - Continuous coverage allows SI-traceable calibration for all satellite instrument bands
  - High spectral resolution reduces sampling/interpolation errors when comparing sensors with different spectral bands

- Measure the lunar radiance to facilitate calibration and characterization of high spatial resolution sensors

- Use Earth-based instrumentation deployable to high-altitude balloon platforms and high-altitude mountaintop observatories to mitigate the effects of the atmosphere. Such an instrument can be based on the latest technology and calibrated in a laboratory frequently unlike satellite sensors that must use space-qualified components and are difficult to retrieve.

OTHER ITEMS:

Marine Optical BuoY (MOBY) assumed by NOAA as of April 2007, NIST radiance cal/val continues. MOBY helps with vicarious calibration of SeaWiFS and MODIS Terra/Aqua. Plans to continue MOBY/successor to support future satellites. NASA has provided funding toward developing the next-generation buoy, other funding being sought.

Aperture-area comparison related to total solar irradiance complete. Manuscript in final preparation. Discrepancies between TSI monitors remain unresolved.

TSI Workshop (July 2005) Report in preparation for NIST Journal of Research.