TG13

Optical Fibre Power Responsivity
(& Pilot comparison of optical fiber power)

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NIST

Objectives

The objectives of the CCPR-WG-SP Task Group 13 are:

- to discuss a pilot study on optical fibre power responsivity to improve calibration uncertainties;
- to create a questionnaire about a pilot study on optical fibre power responsivity for possible additional participants of such a pilot study;
- to organize and carry out a pilot comparison on optical fibre power responsivity using fibre-coupled cryogenic radiometer.

Centro Nacional de Metrología

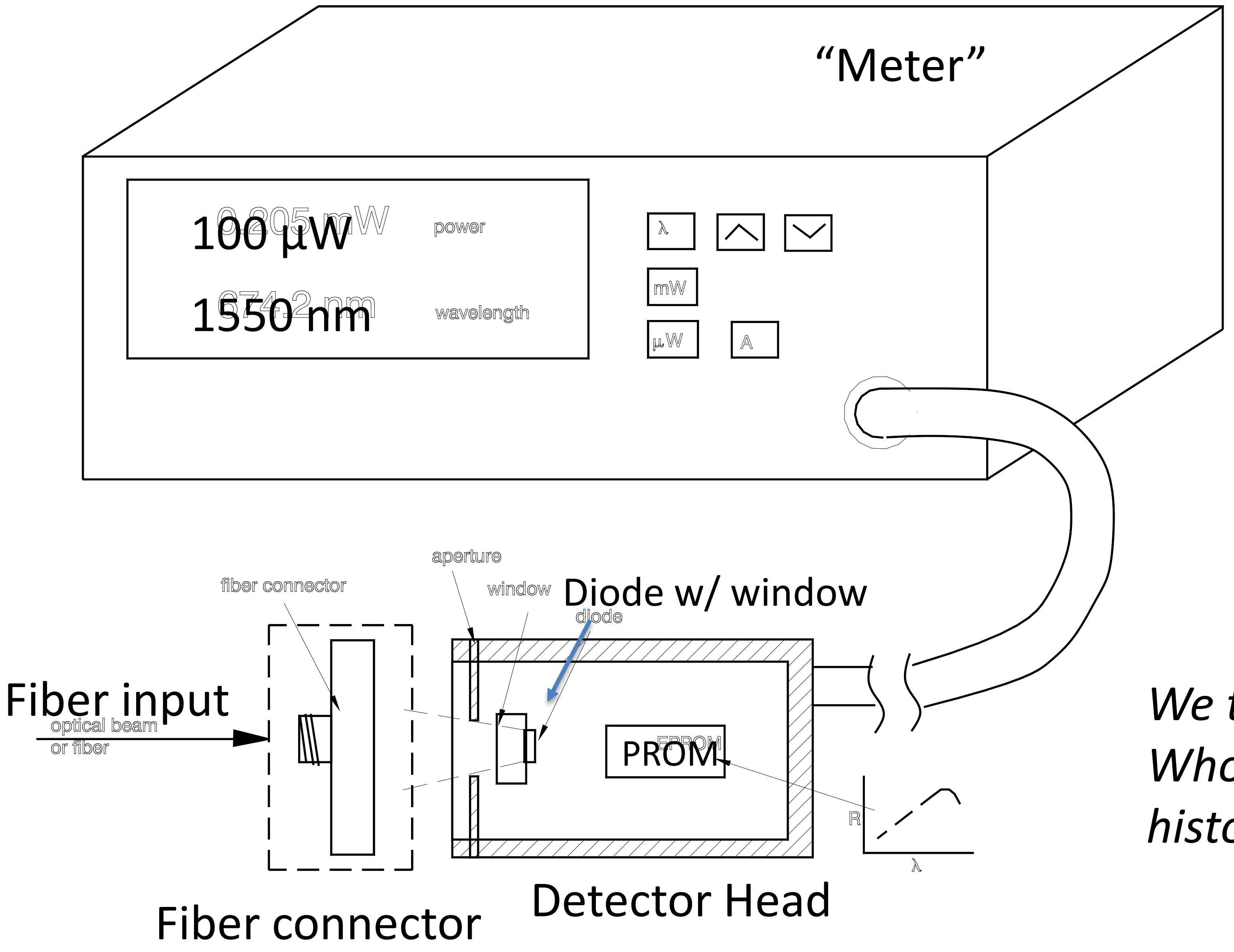
Timeline

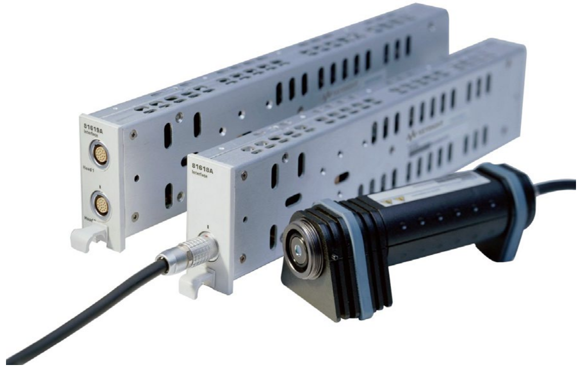
- Oct 2016, CMI to NIST with PQED and Brewster Window, Free Space
- Feb – Aug 2016 Adaptation with Fiber Coupling with CENAM
- August 2017, PBR travels to CENAM
- August 2017, CMI to NIST
- September 2017, NIST to CMI
- October 2017, NIST to CENAM
- December 2018 Demonstrated Comparison to Free space Cryo Rad
- 2018 Trap Detector Comparison
- Pilot study introduced
- 2022 CENAM to CMI
- 2023 CENAM to NIST
- 2024 Restart Comparisons

Timeline

Some topics worthy of continued consideration:

- Polarisation and PM fibre
- Fibre bending and temperature dependence
- Beam splitter and/or switching ratios
- 1550 nm wavelength to achieve 0.1 % repeatability
- Free space comparisons ongoing at CENAM

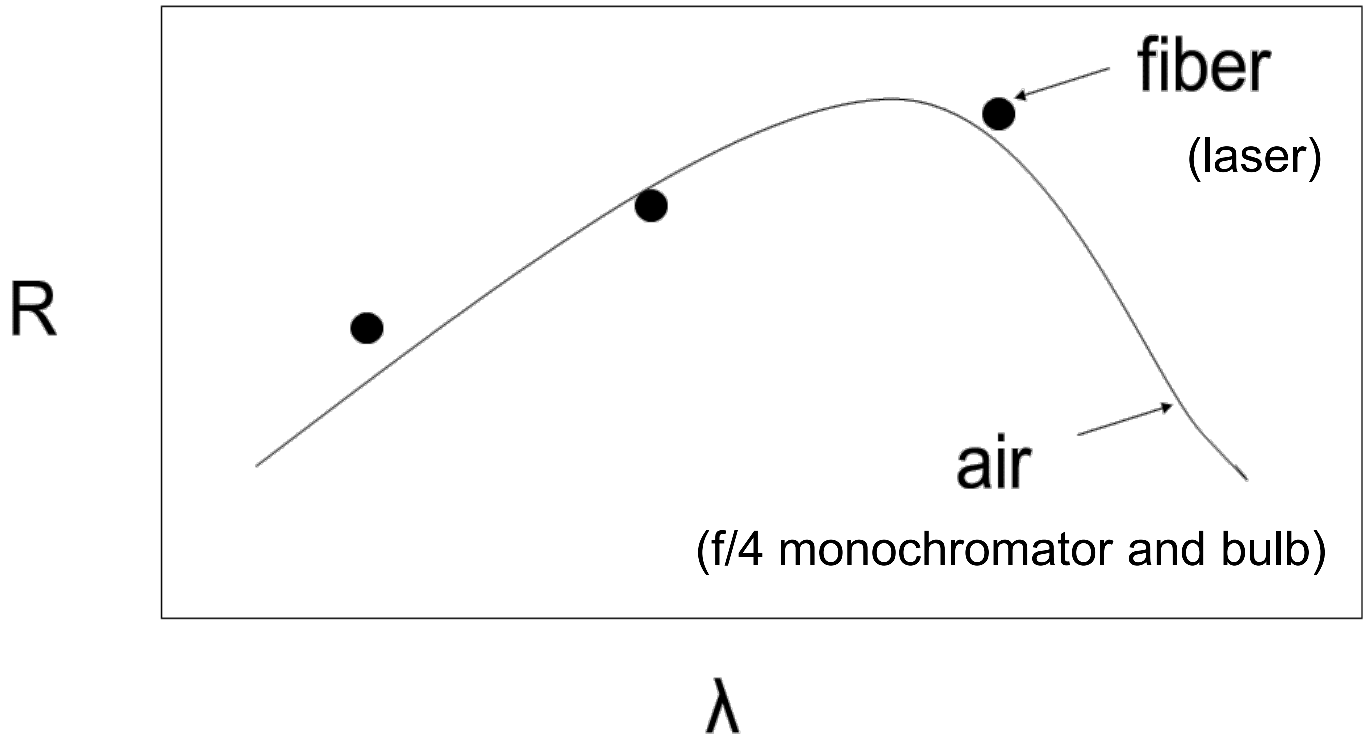




(not and endorsement)

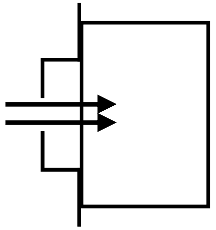
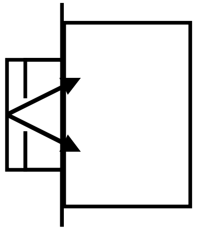
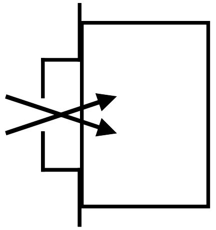
We typically serve OFPM mfgs.
Who do disseminate our reference
historically, one every 8 hours

Absolute and Spectral Responsivity

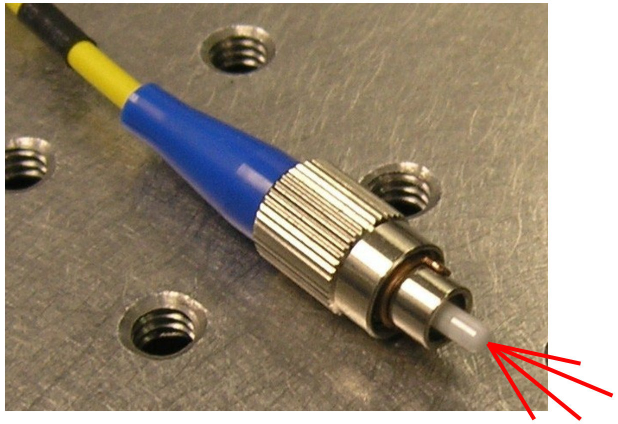


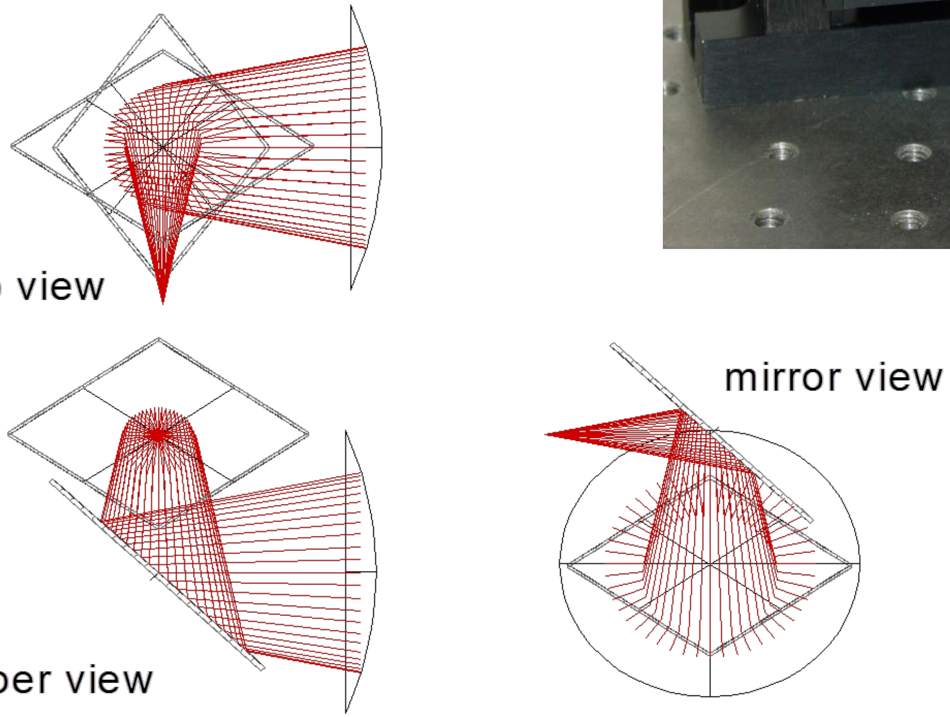
J. H. Lehman, C. M. Wang, M. L. Dowell, and J. A. Hadler, *Journal of Research of the National Institute of Standards and Technology,* **114**, 287-291, 2009.

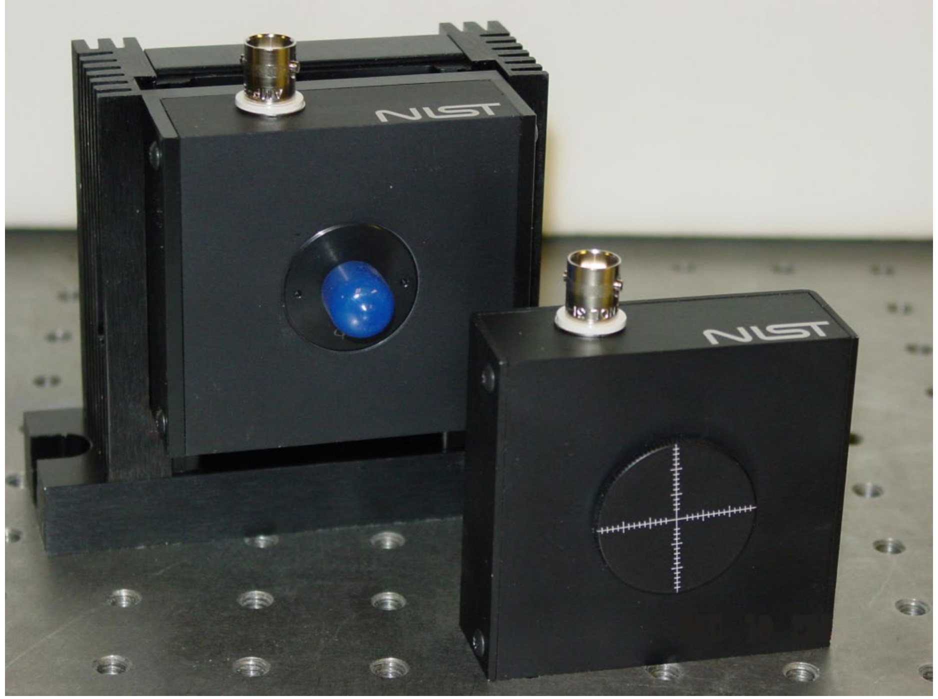
Motivation

Beam geometry	Detector	Measurement system
Nearly collimated		1. C-series 2. LOCR *Absolute*
Diverging from fiber		3. Fiber-based responsivity with FC connector *(The customer)*
Diverging from monochromator (6 nm bandwidth)		4. Spectral responsivity *“Relative”*

Transfer Standards



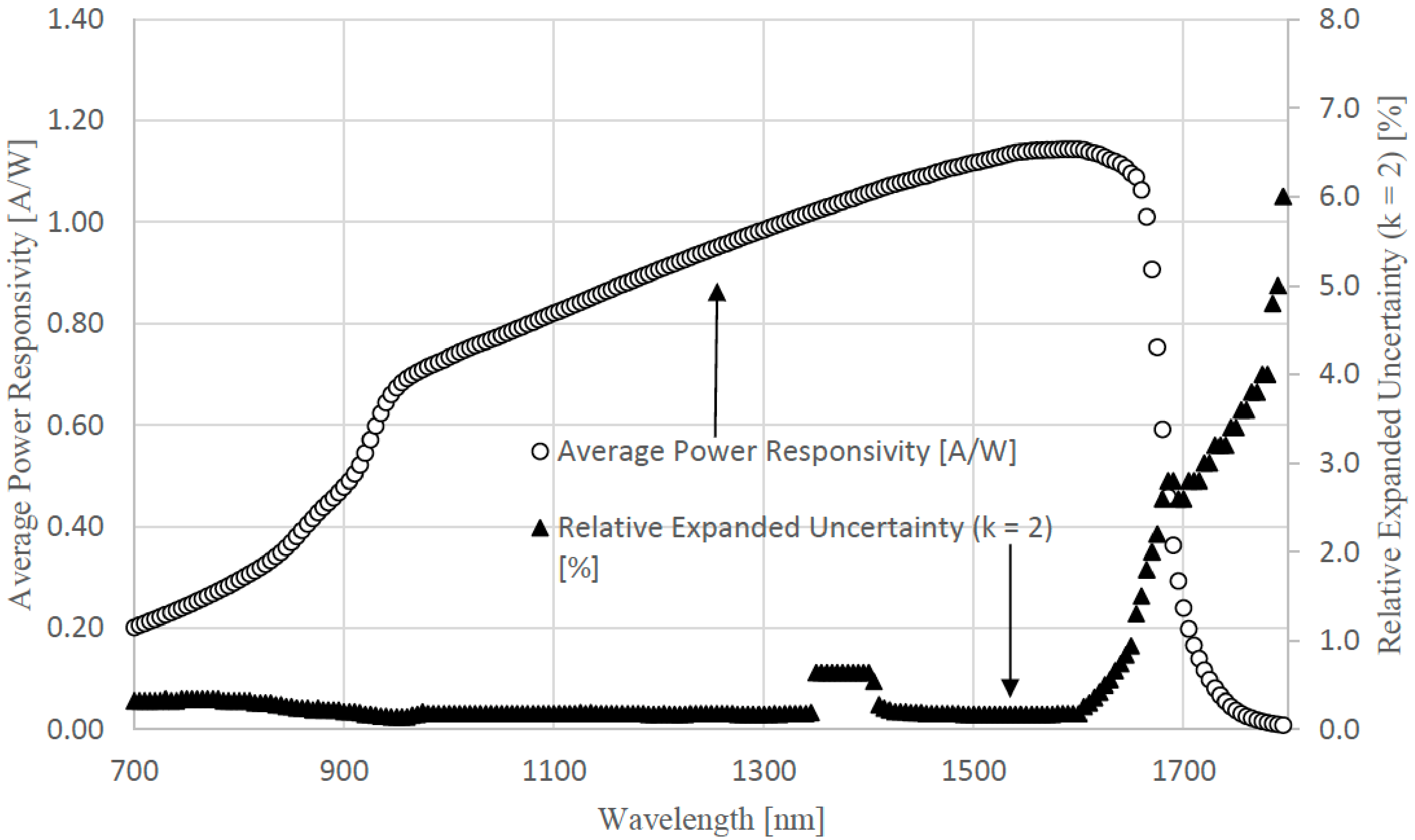




4x Trap detectors ca. 2000

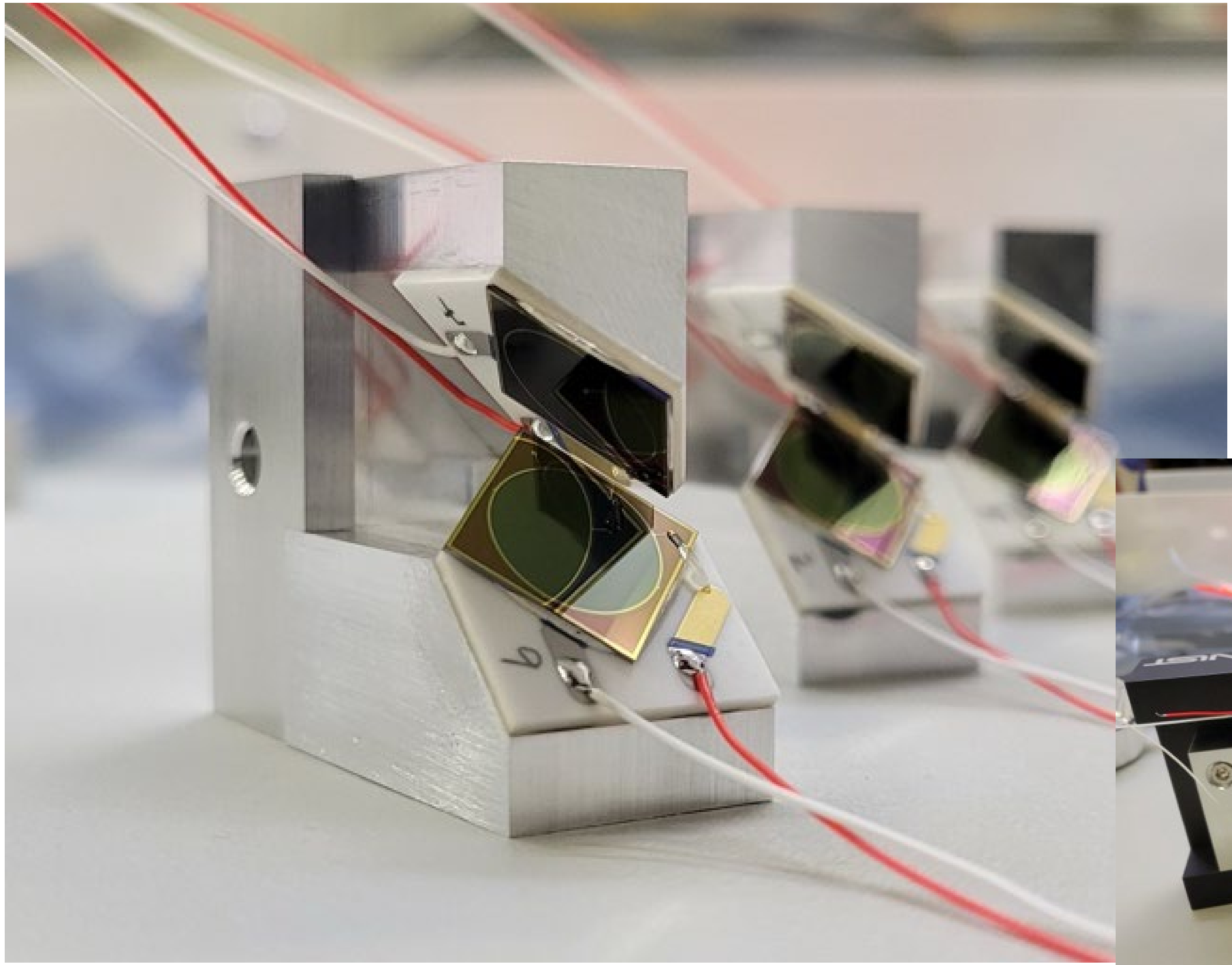
J. H. Lehman and C. L. Cromer, *Appl. Opt.*, **41**, 6531-6536, 2002.

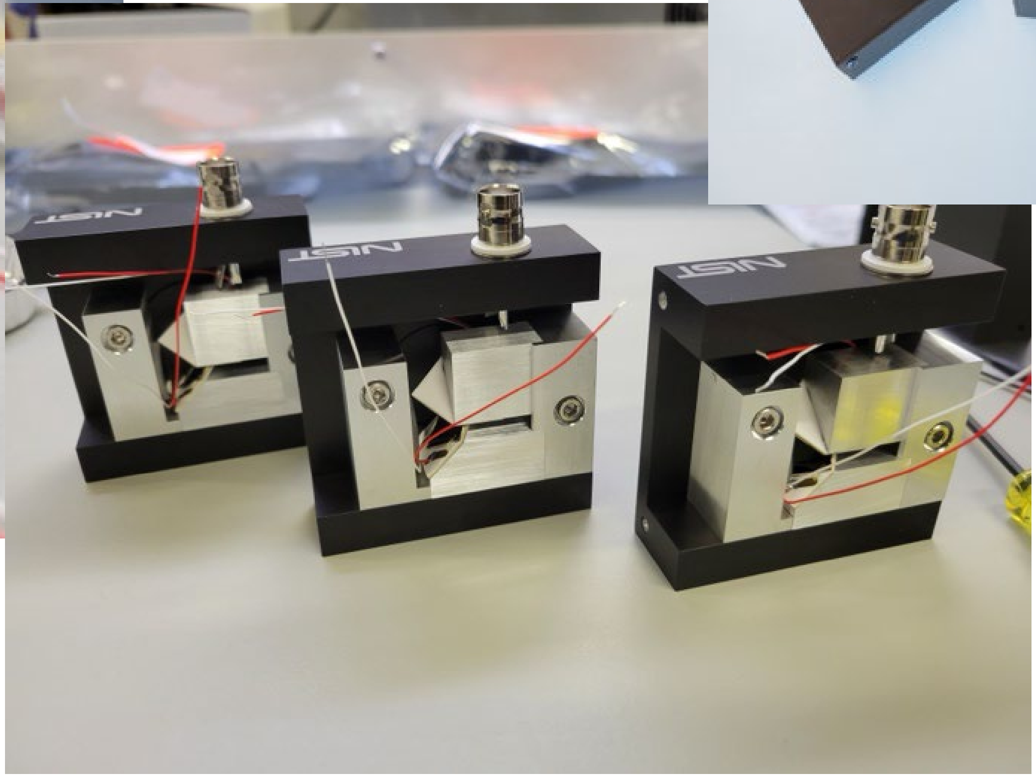
New Round of Transfer Standards (InGaAs diodes ca. 2023)



J. M. Houston, C. J. Zarobila, and H. W. Yoon: "Achievement of 0.005% combined transfer uncertainties in the NIST detector calibration facility", *Metrologia* 59 (2022) 025001.

New Round of Transfer Standards (InGaAs diodes ca. 2023)



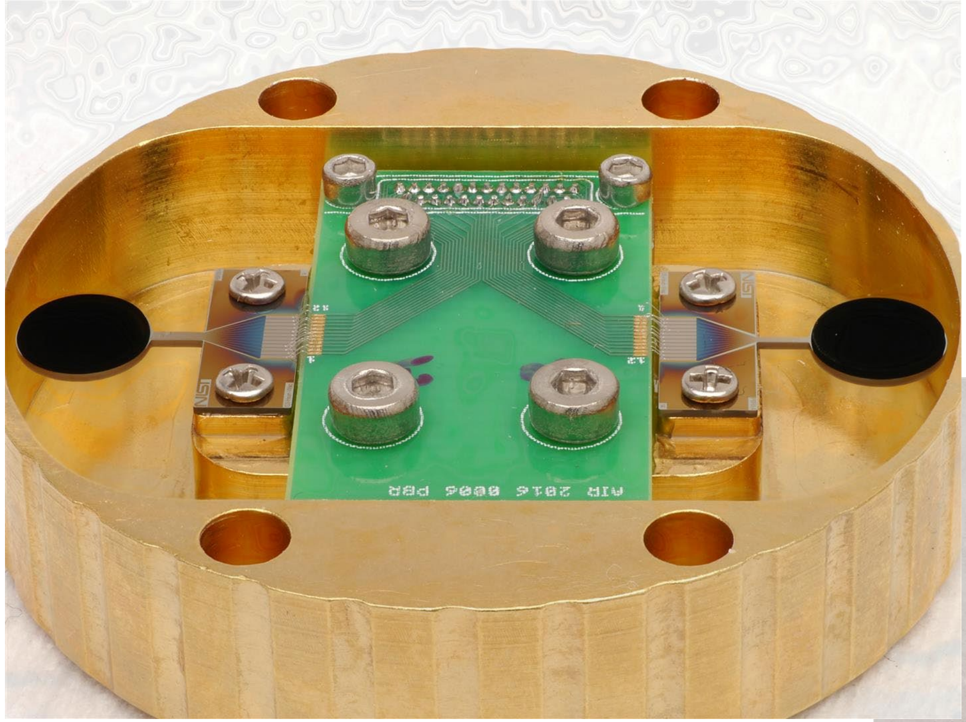


Notes from the NIST/CENAM/CMI campaign

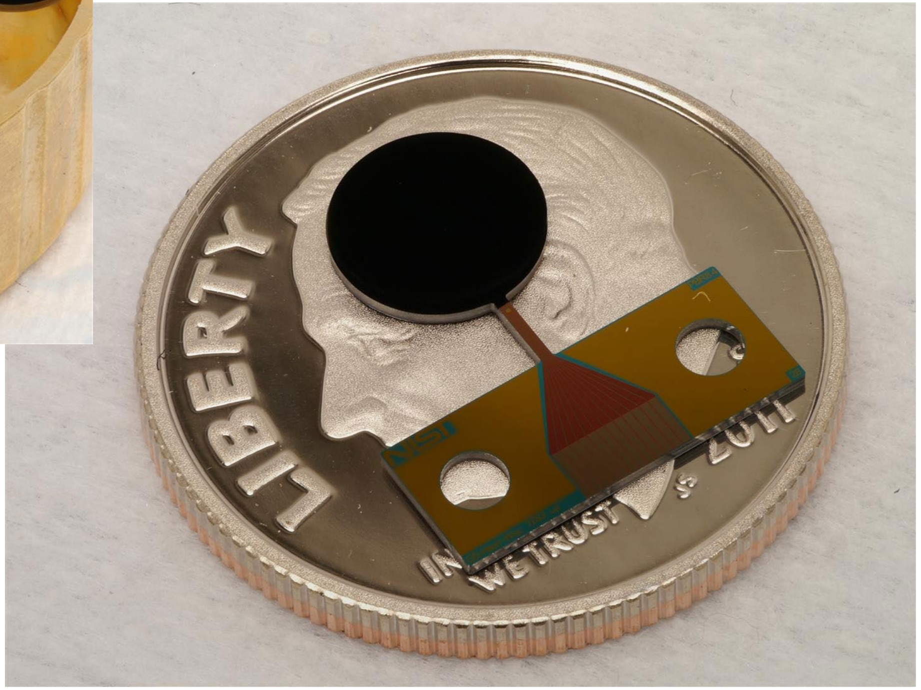
- Switching Ratio:
  - Measure the switching (SW) ratio multiple times with the same detectors.
  - Changing the attenuation level of the variable optical attenuator can change the SW ratio > 0.8%
  - Measure the switching ratio before and after performing every measurement.
- Use only FC/APC bulkhead adapters.
- When possible, use a monitor channel (0.3% improvement).
- Use the fiber scope and clean the fibers frequently!
- The InGaAs trap designated for this campaign was observed to have extremely poor spatial uniformity at the stage of the CMI measurements. This may be the result of aging or shipping damage, but ultimately puts the near infrared measurements into question.

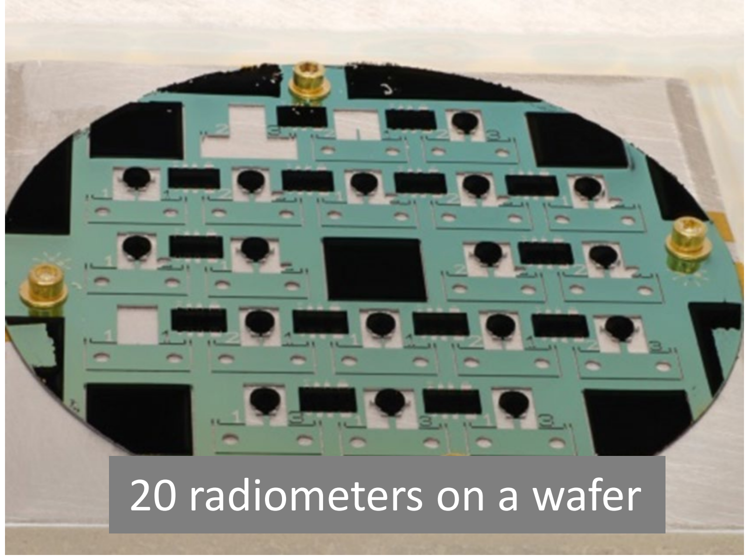
CMI CENAM Centro Nacional de Metrología NIST

Carbon Nanotube-based Chip-scale Radiometers



Packaged radiometer for ‘embedded’ standard





20 radiometers on a wafer

Output (NMI-Grade radiometer)

Temperature controlled stage
for thermal bias and stability
(complete for any fridge)

mechanically cooled

FPGA electronics
either/or "COTS"

Carbon nanotube radiometer
Shipping to CENAM in 2017
for intercomparison

5 µK pk/pk stability (for days)

Cost reduced ~ $750k to $150k

ca. 1985

=

ca. 2017

With
Malcolm White
Igor Vayshenker
Michelle Stephens
Nathan Tomlin
Chris Yung