

**TG13**

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

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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.



- 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



Some topics worthy of continued consideration:

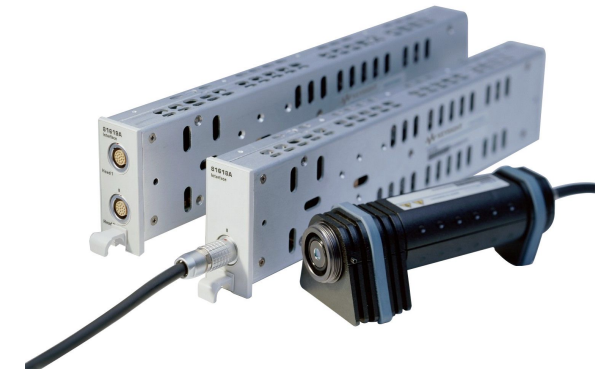
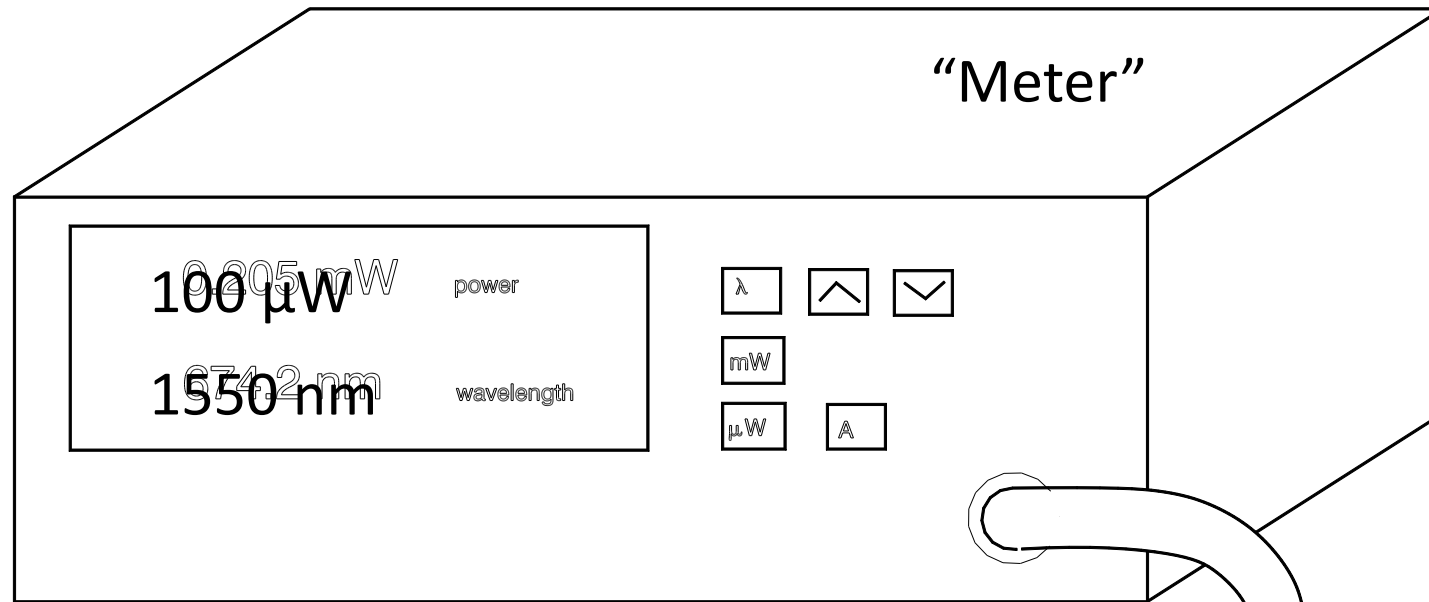
- Polarisation and PM fibre
- Fibre bending and temperature dependence
- Beam splitter and/or switching ratios
- 1550 nm wavelength to achieve 0.1 % repeatability
- Free space comparisons ongoing at CENAM



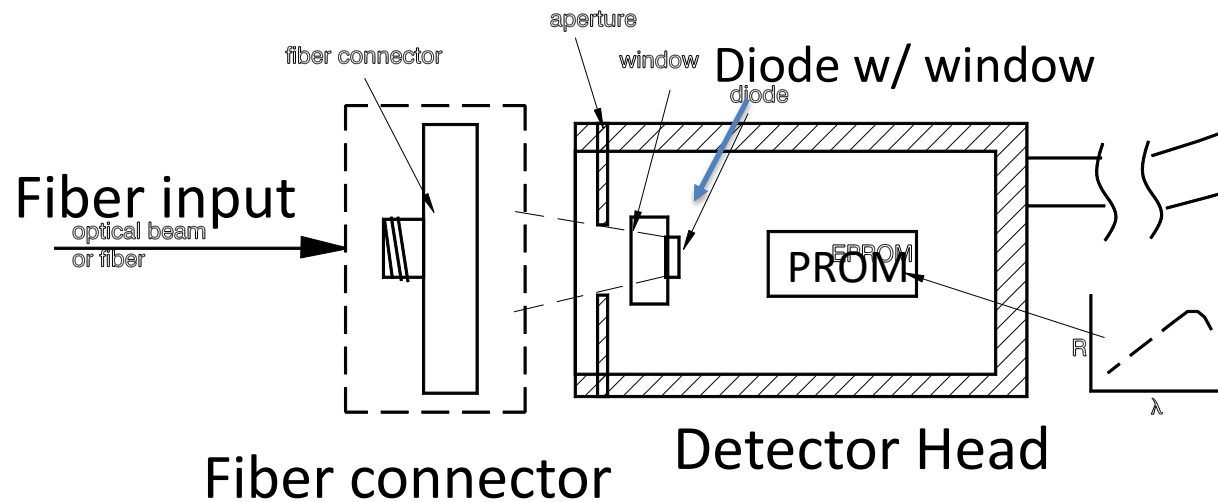
# Notes from the NIST/CENAM/CMI campaign

- 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.



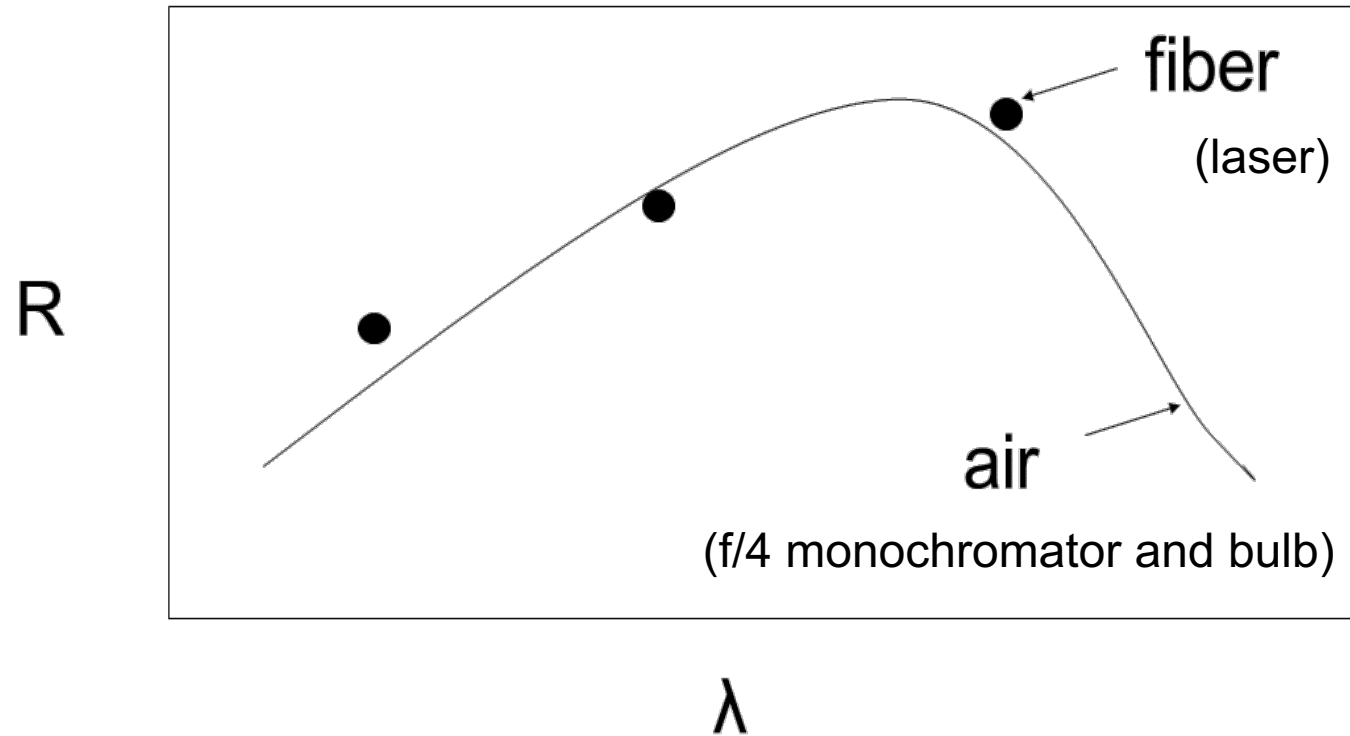


(not and endorsement)

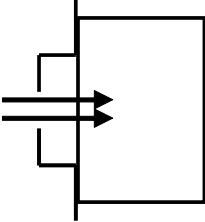
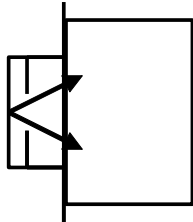
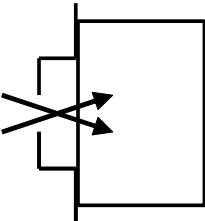


*We typically serve OFPM mfgs.  
Who do disseminate our reference  
historically, one every 8 hours*

## Absolute and Spectral Responsivity

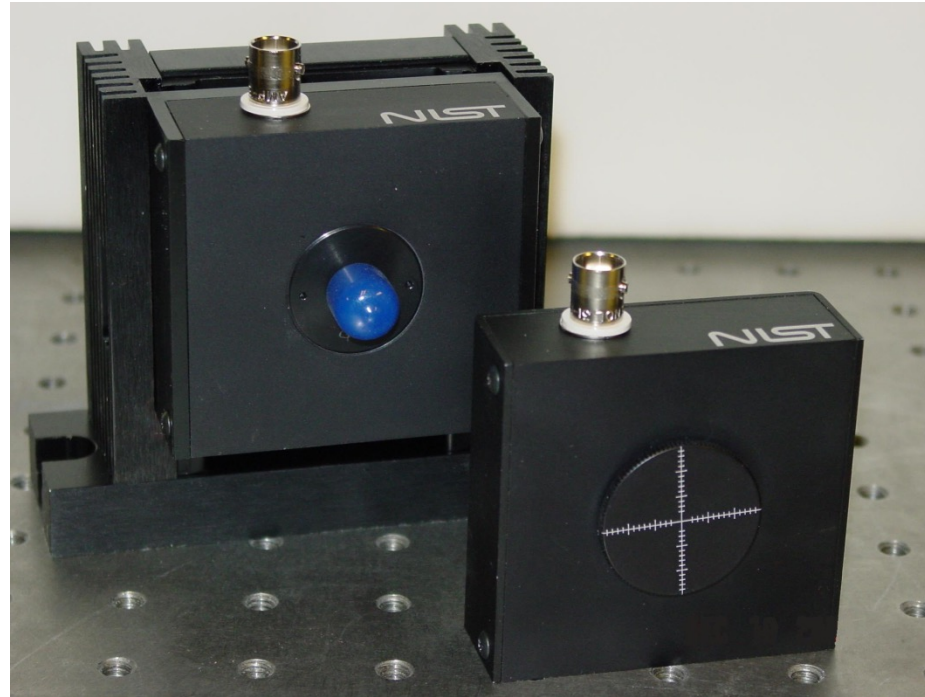
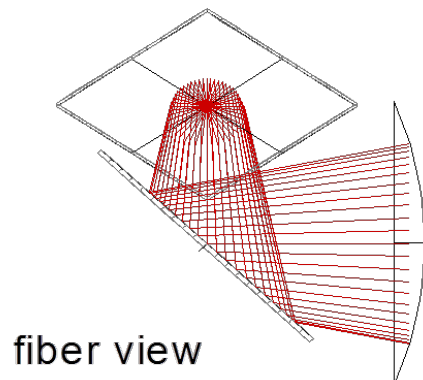
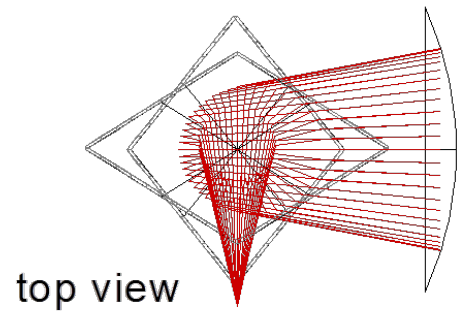
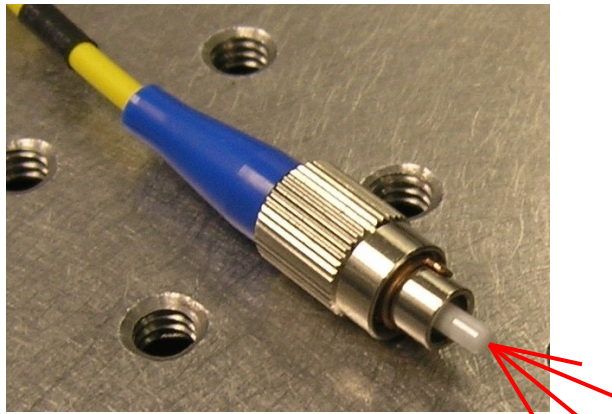


J. H. Lehman, C. M. Wang, M. L. Dowell, and J. A. Hadler, *Journal of Research of the National Institute of Standards and Technology*, **114**, 287-291, 2009.

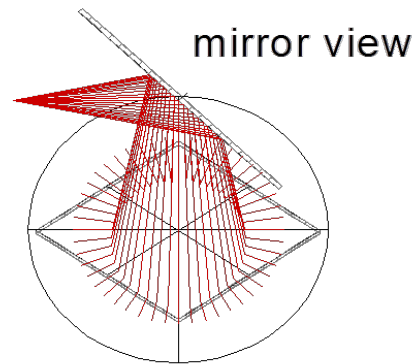
Beam geometry	Detector	Measurement system
Nearly collimated		1. C-series 2. LOCR <i>Absolute</i>
Diverging from fiber		3. Fiber-based responsivity with FC connector <i>(The customer)</i>
Diverging from monochromator (6 nm bandwidth)		4. Spectral responsivity <i>“Relative”</i>



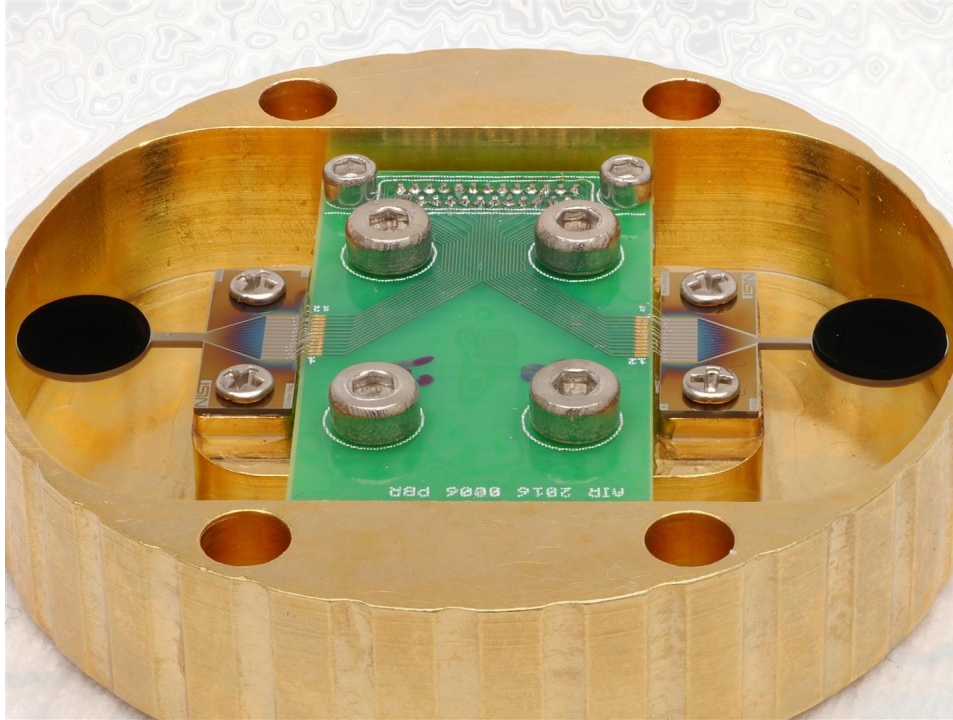
# Transfer Standards



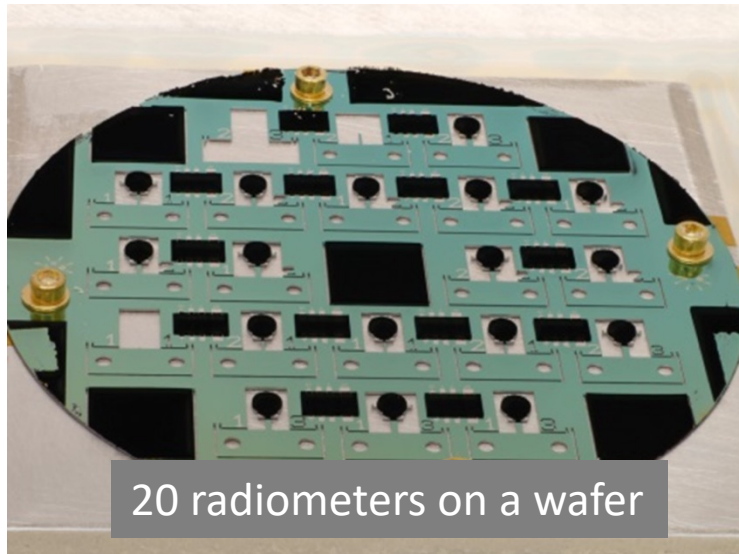
4x Trap detectors



# Carbon Nanotube-based Chip-scale Radiometers



Packaged radiometer for 'embedded' standard



20 radiometers on a wafer





# Output (NMI-Grade radiometer)

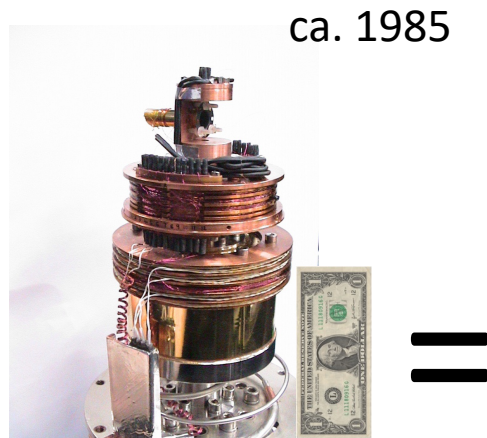
Temperature controlled stage  
for thermal bias and stability  
(complete for any fridge)

mechanically cooled

FPGA electronics  
either/or “COTS”

Carbon nanotube radiometer  
Shipping to CENAM in 2017  
for intercomparison

5  $\mu$ K pk/pk stability (for days)  
Cost reduced  $\sim$  \$750k to \$150k



With  
Malcolm White  
Igor Vayshenker  
Michelle Stephens  
Nathan Tomlin  
Chris Yung