Progress on optical photon calibration source for X-ray microcalorimeters

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LTD-18 338

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Abstract

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High-resolution X-ray microcalorimeters are challenging to characterize and calibrate at low energies because of the difficulty of obtaining narrow calibration lines approaching the detector resolution. Short pulses of optical light, e.g. generated by a 405 nm laser diode, can be used to provide combs of very narrow calibration lines for TES detectors as long as the detector can resolve the photon number. We have demonstrated this scheme for high resolution X-ray micro-calorimeter pixels for photon numbers up to about n=130, i.e. about 400 eV. Further improvements to our setup have allowed us to push this further to resolve up ~ 300 photons (0.92) keV) with 0.75 eV pixels. New experiments currently underway with 0.25 eV FWHM resolution detectors should allow us to gain a better understanding of degradation mechanisms that lead to loss in photon number resolution for higher energies.





Improvements made to setup

- Added **405 nm band-pass** to IR filter assembly
- Carbon-coated fiber for delivery to detectors
- FiberCore GIMMSC(50/125) CHT
- carbon layer blocks light between cladding & coating \Rightarrow no fluorescence observed
- reduced stray power by improved optical coupling
- built monochromator to eliminate shifts of photon energy (pulse width/height, temperature) • available, but not yet tried: longer wavelength lasers (450 & 488 nm)



Improved optical coupling







- 300 centroids to determine non-linearity correction
- detector about 30% non-linear at 800 eV
- high-order polynomial fit is required to reduce centroid errors

Fastie-Ebert grating monochromator

• LD linewidth ~0.7 nm (5.3 meV) • For a future satellite mission, even narrower optical line width is desirable • slit selects ~3 cavity modes of the laser (spacing ~70 pm), optical line width ~1.6 meV







• NASA/GSFC 60x60 pixel TES array see poster #135 by Kazu Sakai et al.

• 20x20 µm² Mo/Au TES

• 46x46x1 µm³ Au absorbers

- 25 µm diameter aperture aligned above one single pixel
- Line shape fit with simple Gaussians
- Collimator misalignment or broken fiber results in average photon number < 1

• thermal cross talk shifts spectra $\sim 1 \text{eV}$ • 0.25 eV (FWHM) resolution for low

count rates



20

• Optical monochromator setup resolves laser cavity modes and can provide narrower linewidth if needed

References

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Acknowledgements

This work was supported in part by NASA grant NNX16AM31G. We thank the TES groups at NIST and GSFC/NASA for providing the devices used in this work, Karen Moore of FiberCore for providing a sample of the carbon coated fiber, and Mark Saffmann (UW Madison) for loaning us the wavemeter.