Calibration of Infrared Cameras for Lasercom Evaluation (CIRCLE)

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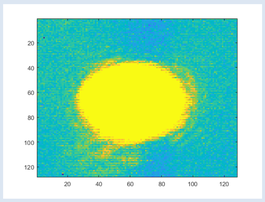
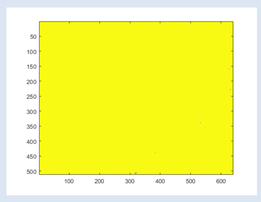
Motivation

Lasercom terminals must be highly accurate in order to function efficiently, which necessitates a system to verify new terminals. High-speed infrared cameras used in systems such as the Optical Terminal Verification Testbed (OTVT) are currently used in conjunction with optical power meters. Simplifying the current system by extending camera capabilities to power measurement would remove the need for a power meter.

Beam



Uniform Illumination



Software

- Designing a threading architecture which preserves order of operations
- Remaining memory-conscious in the design of the algorithms is a major challenge in implementing the CIRCLE system.

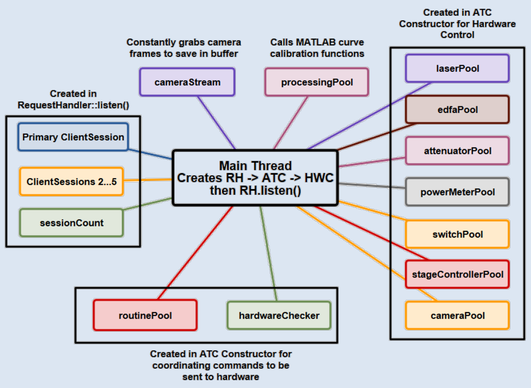
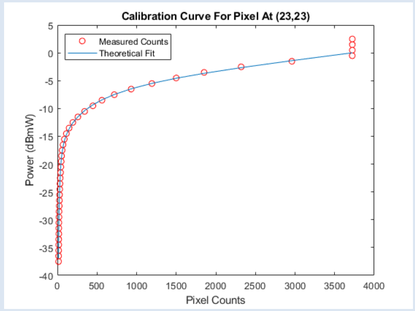
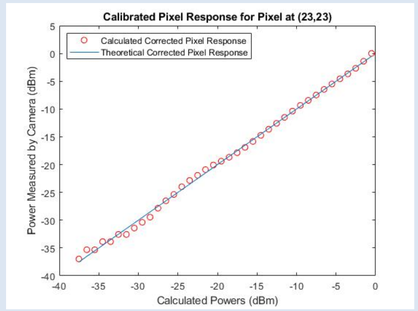


Image Processing

Frames are collected with an infrared camera, and processed using MATLAB. The camera is calibrated on a per-pixel basis





Calibration provides a mapping from pixel count to power hitting the camera's focal plane array (FPA)

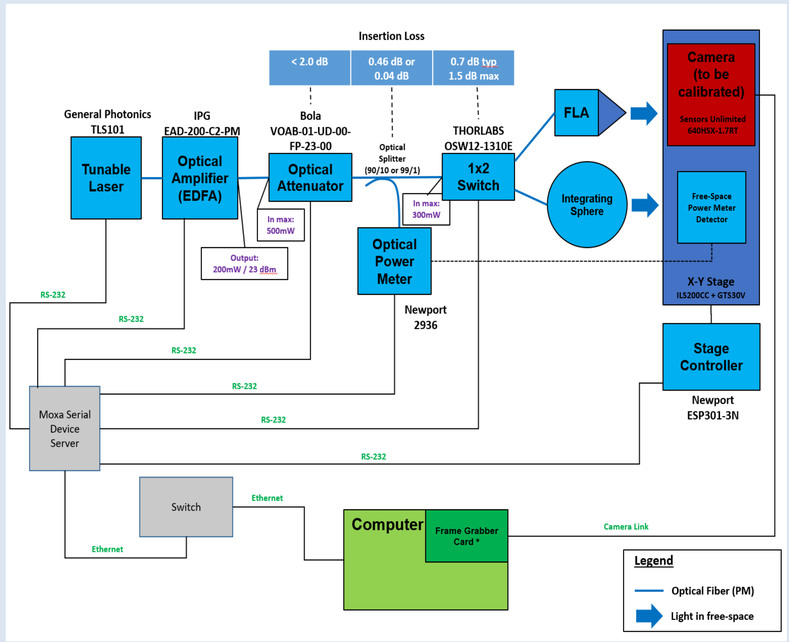
- The mapping varies for each combination of settings for the camera (i.e. Field of regard, exposure time, and FPA gain), thus a mapping must be calculated for each.
- Loss from various hardware as well as the integration sphere's inability to cover the entire FPA must be accounted for in the power calculation.

Bad pixels are present on the camera's FPA and are unable to be calibrated, for they blink, remain on or off indefinitely, or vary erratically.

- Light frequency analysis is able to detect a frequency which corresponds to an ideal pixel response, and the relatively less computationally expensive Tanimoto coefficient measures every pixels percent similarity to the initial response.

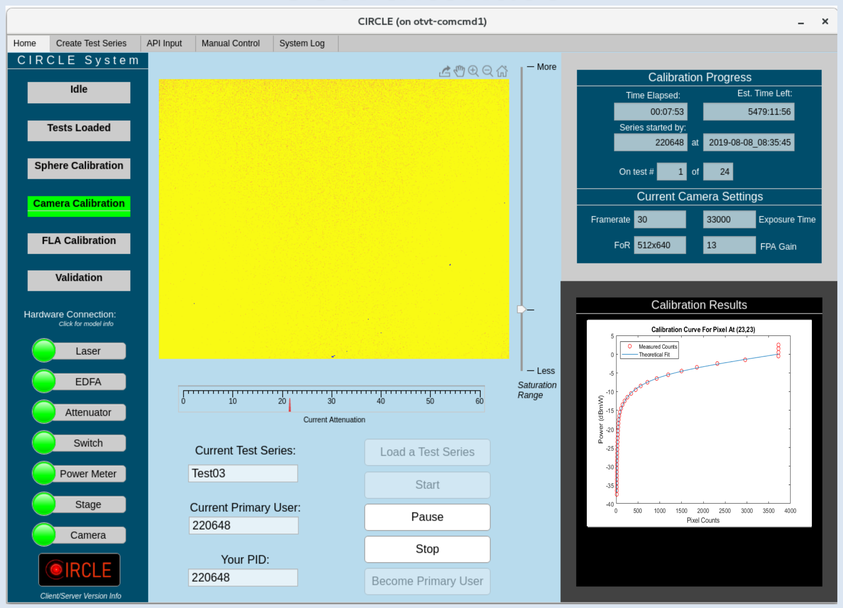
$$\frac{\sum_{i=1}^{n} a_i b_i}{\sum_{i=1}^{n} a_i^2 + \sum_{i=1}^{n} b_i^2 - \sum_{i=1}^{n} a_i b_i}$$

Hardware Schematic



Original diagram provided by Brett Reynolds.

User Interface



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