PERMANENT RADIOMETRIC CALIBRATION FOR COMPACT FTIR HYPERSPECTRAL IMAGERS: ENABLING HIGHER OPERATIONAL EFFICIENCY WITHOUT COMPROMISING PERFORMANCE

Jean-Philippe Gagnon, Martin Larivière-Bastien

Telops 2600 Ave Saint-Jean-Baptiste #100, Québec City, Québec G2E 6J5

Fourier Transform Infrared (FTIR) hyperspectral imagers traditionally rely on periodic calibration using onboard blackbody references to maintain radiometric accuracy. While this approach provides excellent measurement fidelity, it also increases system complexity, power consumption, instrument size, calibration time, and interrupts data acquisition. These constraints become increasingly important as hyperspectral imaging systems evolve toward compact, lightweight instruments intended for field deployment, airborne operation, and integration on unmanned aerial platforms.

This work presents the implementation of a permanent radiometric calibration approach across Telops' latest generation of compact LWIR and MWIR hyperspectral imagers, including the Hyper-Cam Mini xLW, Hyper-Cam Mini MWf, and Hyper-Cam Airborne Nano (refer to Figure 1). By eliminating the need for routine blackbody calibrations during operation, the proposed methodology significantly simplifies the instrument architecture while enabling continuous data acquisition throughout an acquisition mission.

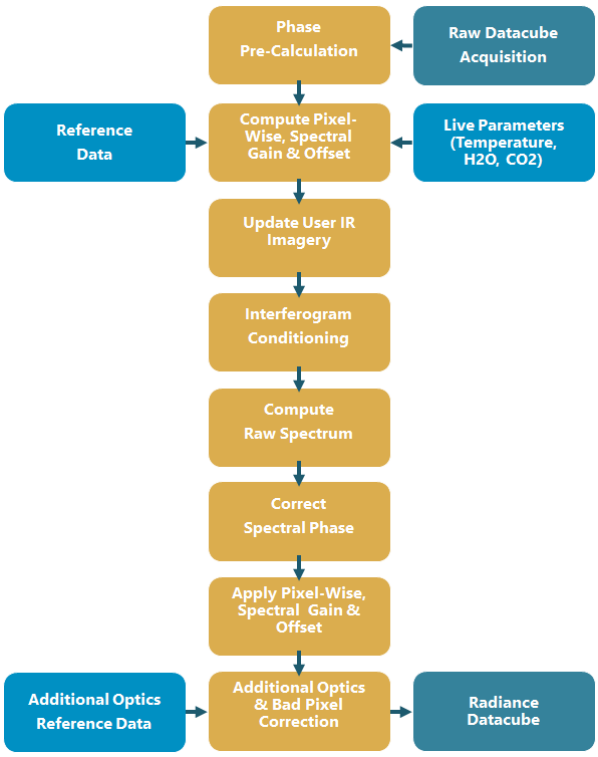


Figure 1 : High-level flowchart of the permanent calibration process.

The resulting benefits extend beyond operational convenience. Removing calibration hardware reduces system complexity, weight, power consumption, and manufacturing costs while increasing overall reliability. More importantly, users spend considerably less time performing calibration sequences and significantly more time collecting scientifically valuable hyperspectral data. For airborne surveys, drone-based mapping, and field campaigns where acquisition opportunities are limited, continuous operation translates directly into increased spatial coverage and improved mission efficiency.

Implementing permanent calibration in an FTIR hyperspectral imager presents several technical challenges. Unlike conventional imaging systems, FTIR instruments require accurate compensation of interferometric processing effects while preserving the high radiometric and spectral performance expected from scientific instruments. The proposed calibration framework addresses several key aspects, including robust phase correction, compensation of channel spectra, preservation of spectral fidelity at high spectral resolutions, accommodation of variable integration times, compensation for instrument temperature variations, support for multiple optical configurations, and maintenance of radiometric accuracy throughout the instrument operating envelope.

This work will discuss the calibration methodology adopted for these compact hyperspectral imagers and the engineering trade-offs encountered during its development. Experimental results demonstrate that permanent calibration can maintain scientific-grade performance while substantially improving operational efficiency. The presented approach enables a new generation of compact FTIR hyperspectral imaging systems that deliver the measurement quality expected from laboratory-grade instruments together with the simplicity and availability required for demanding field and airborne applications.

The implementation represents a significant step toward reducing the operational burden associated with high-performance infrared hyperspectral imaging, allowing users to maximize productive acquisition time without sacrificing measurement quality or instrument flexibility.

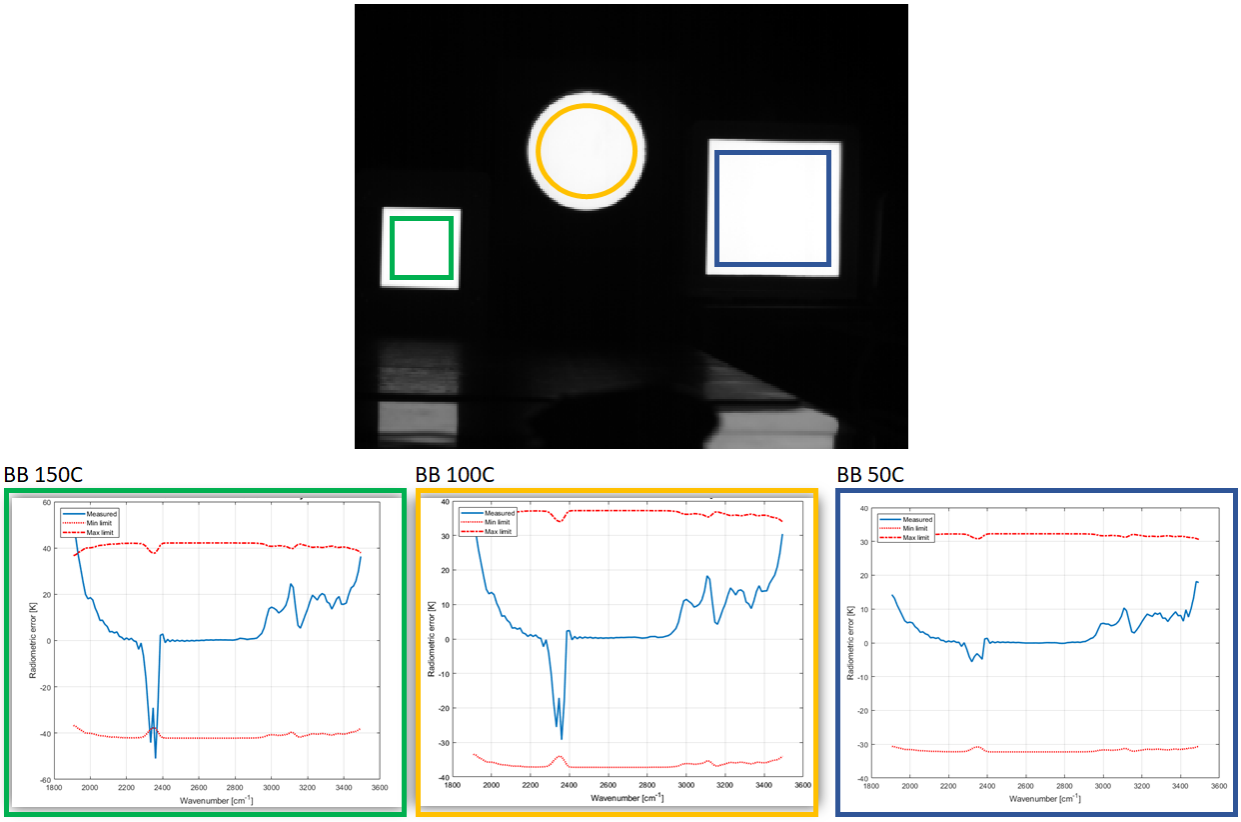


Figure 2 : Preliminary results showing the radiometric accuracies (blue curves, mean of all pixels within the selected region of interest) obtained from 3 blackbody sources at 3 different temperatures: 50, 100 and 150°C. Red curves indicate the upper and lower specifications. All three measurements are within specifications. The large downward feature between 2300 and 2400 cm^{-1} is the absorption region from the atmospheric CO_2.