Special Projects in Radiometry (SPIR) is a division dedicated to providing turnkey systems in spectral radiometry and optical remote-sensing instrumentation. Our team includes over 80 highly qualified engineers, scientists and technicians.

Expanding ABB Bomem's excellence in building state-of-the-art instruments:

- Optical instruments for use on aircrafts, balloons or satellites
- Hyperspectral imagers
- Optical calibration systems
- Software for data processing and instrument modeling

Fourier Transform Spectroradiometer Modeling Tools Parameters

NESR

The NESR of the instrument is calculated using a set of validated empirical relations that accurately represent the instrumental sources of noise from:

1. *Detector and Electronics*
2. *Photon shot noise*
3. *Quantization noise*
4. *Aliasing*
5. *Sampling jitter*
6. *Interferometer*

The last source of noise, labeled interferometer noise, pertains to a form of instrument noise specific to Fourier Transform interferometers. This type of noise arises from the coupling of optical path difference rate variations to electrical response characteristics. An example of simulated NESR for a solar occultation instrument is shown in Figure 1. In this case the interferometer noise due to optical path difference rate variations and electrical filter delay mismatch is the fourth dominant source of noise making up the NESR.

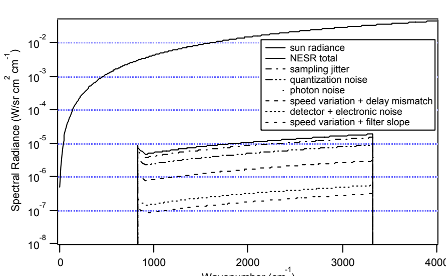

Figure 1 Simulated NESR of a solar occultation FTS.

The photon flux at the detector is calculated by summing up the signal from the scene, but also the contribution from each optical component. An optical component matrix is set up by specifying the transmittance, reflectance, emissivity and temperature of every component.

ILS

The ILS of the instrument is calculated by integrating the phase of the recombining wavefronts in the field of view of the interferometer. The effects modeled include:

1. *Finite Optical Path Difference*
2. *Interferometer divergence (circular or rectangular)*
3. *Shear/Tilt vs. Optical Path Difference*
4. *IR and laser misalignment*
5. *Optics Blur*
6. *Speed and Sampling perturbations*

Examples of ILS simulated various pixels of an imaging FTS at 1000 and 3500 cm^{-1} are shown in Figure 2.

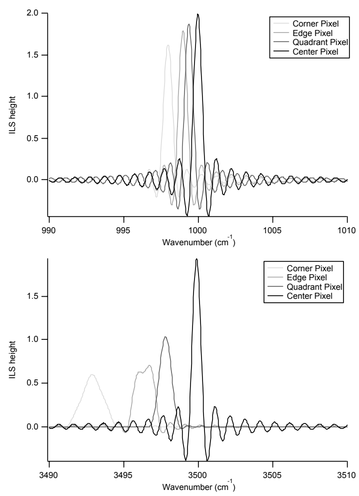

Figure 2 Simulated ILS of an imaging FTS.

The ILS simulation tool also allows to model the effect of vibrations (position or angle) of each optical components of the interferometer. This is performed by tracking the effect of misalignment of each component on the relative shear/tilt of the recombining wavefronts. For example a sinusoidal vibration on a component will give rise to an amplitude. modulation which translates in ghosts in the ILS.

Figure 3 shows an example of a FTS equipped with a beamsplitter affected by a sinusoidal displacement normal to its surface. Parasitic sidebands on each side of the main peak are clearly visible.

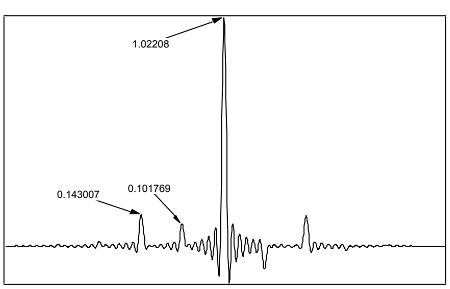

Figure 3 Simulated ILS with a vibrating beamsplitter.

Radiometric Accuracy

The modeling tool is also useful in compiling a detailed Radiometric Uncertainty budget. The calculation of the relative radiometric uncertainty (part of the radiometric errors which are proportional to the signal) include:

1. *Calibration source errors (temperature and emissivity)*
2. *Detector non-linearity*
3. *Variation of detector responsivity (thermal)*
4. *Variation of optical alignment*
5. *Variation of properties of optical components*
6. *Variation of OPD rate*
7. *Variation in properties of sampling system*
8. *Variation of phase*
9. *SNR of calibration measurements*

The calculation of the absolute radiometric uncertainty (part of the radiometric errors which are independent the signal) include:

1. *Variation in stray light*
2. *Aliasing of signal*
3. *Detector non-linearity*

Every source of radiometric uncertainty is grouped in a way to represent the coupling of errors:

A. **Coherent Errors** Errors that interact in a coherent fashion are added together in absolute value in "coherence groups". This represents a worse case since some errors could cancel out.

B. **Incoherent Errors** The coherence groups are added together in a root mean square manner to reflect the fact that they are incoherent one with respect to another.

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