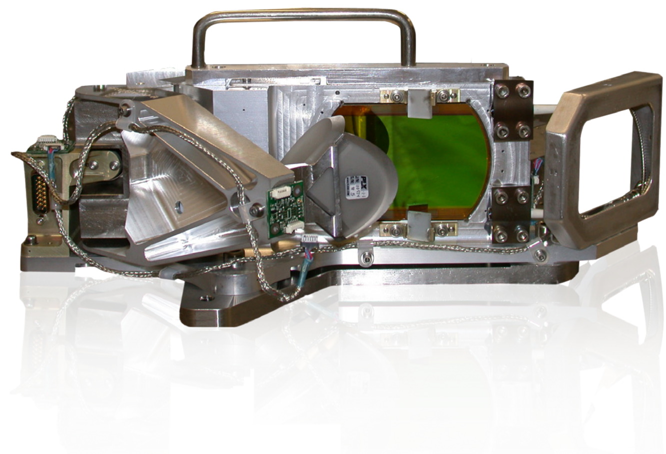
GFI
Generic Flight Interferometer

Since the 90's ABB Analytical Measurement is involved in the development of hyperspectral Fourier Transform Spectrometer (FTS) instruments for atmospheric sounding from Geostationary Earth Orbit (GEO) and Low Earth Orbit (LEO) satellites.



The development of GFI is based on private sets of generic parameters inspired by the Hyperspectral Environmental Suite (HES) and Meteosat Third Generation (MTG) requirements. The level of maturity of the GFI concept is very high due to substantial investments already spent on TRL improvement. The fine tuning of the GFI module for a specific missions is minimal as most of the parameters are already compatible with many of the previous mission. The fundamental parameters present low variability between meteorological missions as they are driven by the end-user needs and the limitation of satellite technologies.

The Opto-Mechanical Assembly (OMA) is an electronic free assembly, except for the scanning actuator and for the passive temperature sensors. This approach has the combined advantages of grouping in one shielded location (the Interferometer Control Electronics or ICE) all electronic components sensitive to the high radiation levels of goestationary orbits as well as solving issues associated with operating the OMA at colder temperature than the ICE. The structure of the interferometer combines simplicity and functionality in a two part assembly: a moving part, the scan arm, holding both retro reflector mirrors and a fixed part, the beamsplitter wall, holding the beamsplitter/compensator plates and the metrology optics. These two main elements are linked via flexure blades which offer a rigid pivot without any backlash for rotating the scan arm. This mechanism is frictionless and does not wear out. There is no need for lubricant often associated with lifetime issues. Using well established design rules that respect the endurance stress of selected blade material, it is possible to ensure flexure lifetime exceeding the mission duration.

This has been validated by successful accelerated life testing of the mechanism. With the double pendulum configuration created by the V-shaped scan arm, both retro reflector mirrors move in opposite directions thus doubling the Optical Path Difference (OPD) for a given mechanical displacement. The actuator and the flexure blade based scanning mechanism only have to offer half the displacement compared to an equivalent single mirror system and this offers interesting margins for increasing the global stiffness.

The GFI design, inherited from sucessfull commercial systems deployed since 1984 (more than 6000 units in the field), appeals by its compactness, simplicity and robustness. Other characteristics are:
- Wide spectral range limited only by the choice of beamsplitter (0.7- 15 mm with ZnSe)

- Electronic free OMA (scanning actuator excluded) for minimal thermal gradient
- OPD up to 2.5 cm
- Frictionless scanning mechanism with lifetime over 60 Millions cycles (from accelerated life testing and MTBF on commercial legacy)
- No active launch lock mechanism required
- Operating temperature ranging from 200 K to 300 K
- Fully redundant electronics and referencing system (metrology)
- Asynchronous infrared array detection possible that greatly simplifies the detection scheme of the science signals
- OMA mass of 11 kg (with contingency) and ICE mass of 1.9 kg including cables
- Maximum power consumption of 21 W (OMA + ICE)

Uniform Time Sampling

The GFI is designed to be compatible with both a triggered acquisition mode and the Uniform Time Sampling (UTS) approach that allows for asynchronous IR array detector sampling instead of classical triggered sampling mode. ABB has developed a series of algorithms (patent pending) that allowed implementing the UTS in recent ABB commercial spectrometers (2007), and that have shown enhanced instrument performances over legacy approaches. These algorithms make use of additional metrology information that can be sent to the ground along with the detector data in order to correct interferogram for non-equidistant OPD sampling intervals. This technique offers many advantages in the context of a space based imaging FTS instrument.

The main advantages of the UTS are:

- Simplification of detector sampling electronics
- Maximisation of duty cycle during scan (no dead time between frames required)
- Numerical definition of delay matching parameter between laser signal sampling pulse and true detector acquisition that allows for greater insensitivity to speed instability
- Possibility for post-launch updates of delay matching parameters
- Sampling rates that can differ from metrology laser wavelength

GFI is ideally swuited for several new space mission applications. Many feasibility studies have shown that the design fulfills the need of future geostationary weather sounding instruments as well as new FTS based atmospheric missions for climate, greenhouse gas monitoring and atmospheric chemistry applications.

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