

# A Nanosatellite Optoelectronic Payload Dedicated to Radiation-Induced Degradation Measurement in Erbium-Doped Fiber

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Radio over optical fiber (RoF) technologies appears as good candidates to address flexible payload requirements of the next generation of telecommunication satellites operating in Ku and Ka bands. In this context we have started the assembly of a 3U nanosatellite dedicated to the qualification of several erbium-doped fibers by using an optoelectronic metrology technique. The objective is hence to quantify the gain and noise figure degradation of the erbium-doped fiber amplifier (EDFA) due to cosmic ray exposure during a two years mission at a low earth orbit (LEO). This educational project is called NIMPH for “Nanosatellite to Investigate Microwave Photonics Hardware”. It started in 2013 and involves students from the University of Toulouse with the support of Thales Alenia Space and CNES, the French national space agency.

The main challenge of NIMPH mission is to fit the photonic payload (Figure 1) and all the associated electronic (Figure 2) into a two cubesat units. These constraints have guided us in the choice of the measurement architectures, both on the photonic and electronic sides of the payload.

The EDFA Gain measurement is accomplished by using a thermally stabilized 1550 nm laser source modulated by a 10MHz signal in conjunction with a frequency-selective receiver acting as a narrow-band powermeter for the photo-detected signal (Figure 1: Photodiode PD2; Figure 2). The advantage of this straightforward method is that the measured signal is separated from amplified spontaneous emission (ASE) thanks to the laser modulation. Also, this modulation frequency is set to a frequency higher than the inverse of erbium recovery time so as not to modulate the ASE.

Noise figure measurement is made according two different but complementary approaches both based on the properties of a shot-noise-limited laser. The optical method measures the total noise spectral density generated by the erbium-doped fiber 5 nm away from the laser wavelength thanks to a narrow band fiber Bragg grating filter (Figure 1: FBG1 and 2). The electrical one extracts the optical amplifier excess noise from the total electrical noise spectrum at the photodiode output (Figure 1: Photodiode PD2). This total noise includes the shot, thermal and 1/f noise contributions. However, shot noise and thermal noise can be minimized by a proper choice of the optical power on the photodiode and 1/f noise is suppressed thanks to a high pass filter. With this second method, the noise is integrated over a bandwidth of 10-100MHz by an RF amplifier and applied to the same power detector as for the gain measurement to limit measurements uncertainties (Figure 2). The corresponding amplification coefficient is calibrated prior each measurement thanks to an on-board electronic noise source.

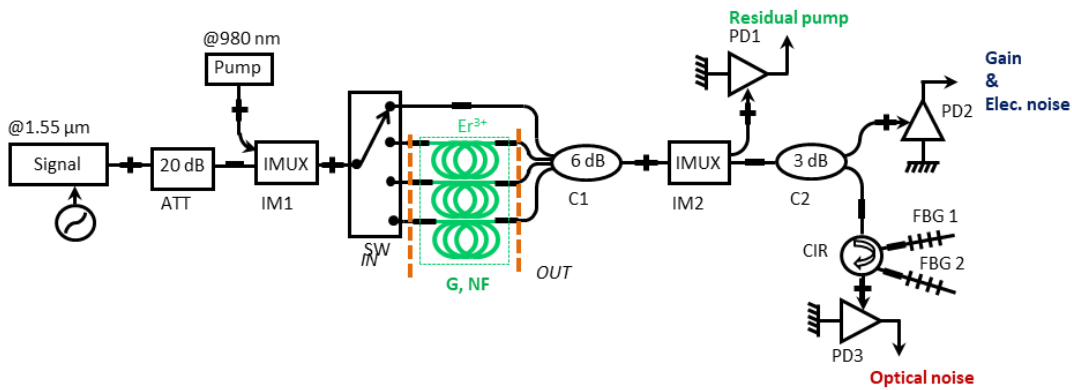


Figure 1: NIMPH photonic payload

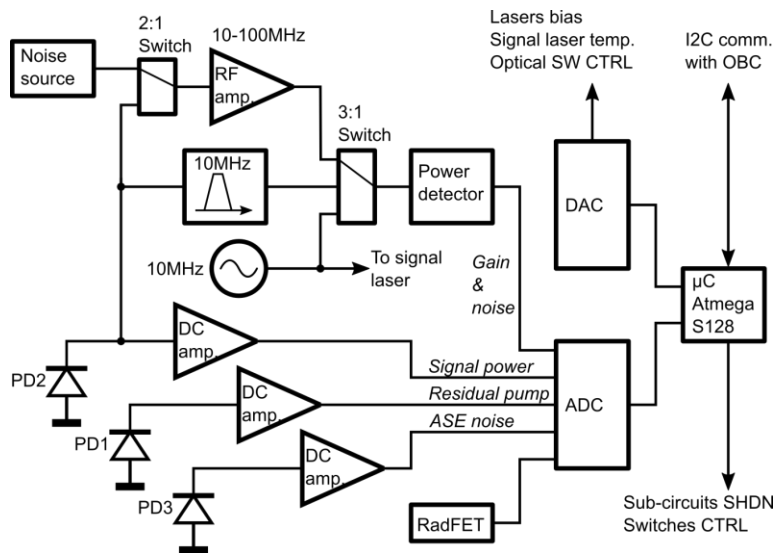


Figure 2: Synoptic of the electronic part of the payload

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New Scientific Instruments / Sensors / Subsystems Concepts and Technologies

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