CLARA – A Compact and Light-Weight Absolute Radiometer

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Abstract

PMOD/WRC is building the Compact and Light-weight Absolut RAdiometer (CLARA) to fly on the Norwegian Space Centre's (NSC) NORSAT-1 mission. The CLARA is based on a new design by PMOD/WRC which minimizes size and weight while improving the radiometric performance. The NORSAT-1 mission is planned to be launched to a polar LEO in Q4 2015. NSC intends to extend the inital three-years mission for as long as the platform and payload remain functional.

CLARA design and thermal concept

CLARA is designed as a successor to PMOD/WRC's PMO6-type space radiometer with the following design targets:

1. Reduced air-vacuum (non-equivalence) correction
2. Reduced stray light
3. Enhanced thermal symmetry
4. Digital controller
5. Compact and light weight

In order to reach the targets, novel technology and manufacturing methods are employed:

1. Conical cavities equalize the areas of electrical and radiative heating
2. Inverted aperture arrangement eliminates internal scattering
3. Reference block (heat sink) and thermal impedance are manufactured in one single piece (Al). Ultrasonic welding yields near-perfect thermal contact between cavities (Ag) and thermal impedance (Al)
4. µp-based control loop
5. Enhanced thermal symmetry allows for a reduced thermal capacity of the reference block, thus less weight and volume

CLARA thermal concept

The CLARA package is split in two units. The *control unit* is mechanically and thermally attached to the satellite structure. In order to thermally de-couple the *radiometer unit* from the satellite structure it is connected to the *control unit* by four titanium pillars. Thermal conductivity between both units is 8 mW/K. The temperature of the *radiometer unit* is passively controlled via the front shield, although a small compensation heater (~150 mW) can be switched on if needed. CLARA will point to the Earth during eclipses.

This concept drastically reduces the thermal requirements to the platform. NORSAT-1 temperature is allowed to change up to 30 K per orbit (peak-to-peak), whereas the *radiometer unit*of CLARA will change by only 1 K.

CLARA will have three cavities, each of which can serve as measuring, active or backup cavity as well as for degradation tracking.

Air-vacuum (non-equivalence) correction

In PMO6-type radiometers the air-vacuum difference can be up to 0.7% with large empirical uncertainty. The conical CLARA cavities reduce the air-vacuum difference about ten-fold with respect to the inverted cones of the PMO6.

DARA* air-vacuum	Cavity A	Cavity B	Cavity C
Correction factor	1.00046	1.00089	1.00043
1σ-uncertainty [ppm]	80	60	60

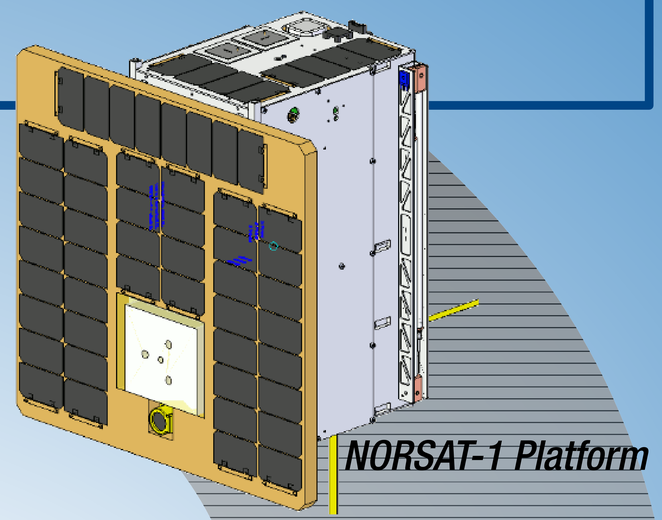
*DARA is a fully-characterized working prototype for CLARA. The large air-vacuum correction for cavity B can be explained with a slightly (0.3 mm) off-centered positioning of the electrical heater in that cavity.

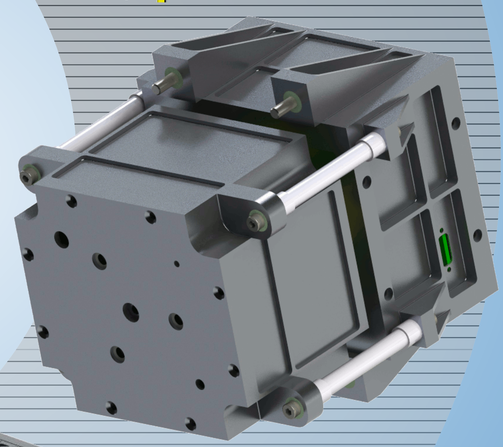
Enhanced thermal symmetry

The CLARA reference block, thermal impedance, and cavities are designed to equalize the thermal relaxation time constants of all cavities. The number of material junctions in the heat path from each cavity to the reference block is reduced to one. The planar fit of the cavities' edges and the thermal impedance eliminate uncertainties due to fabrication tolerances.

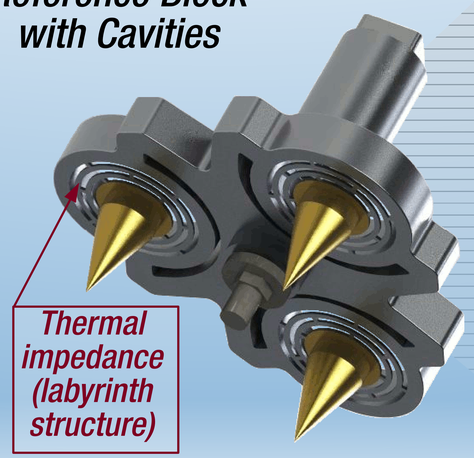
CLARA specs

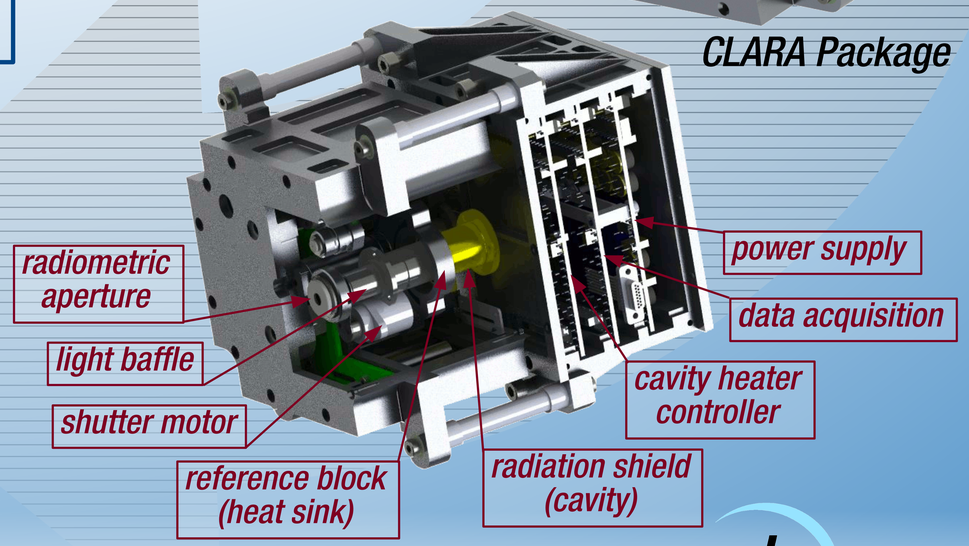
Dimensions	114 x 141 x 155 mm^3
Mass	2.63 kg
Power consumption	5.6 W
Measuring cadence	30 s





Reference Block with Cavities





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