# JTSIM-DARA Pointing Measurements

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**The pointing of the JTSIM-DARA radiometer was measured four times during its construction in the optic laboratory of PMOD/WRC. The final offset of the pointing before shipping relative to the optical axis, defined by a removable alignment cube, is 1.07°/0.67° (β/γ-axis) for the four-quadrant sensor and 0.095°/-0.017° for the radiometer cavity A.**

## JTSIM-DARA

Continuous and precise TSI measurements are indispensable to evaluate the influence of short and long-term solar radiative emission variations on the Earth's climate. PMOD/WRC has constructed the JTSIM-DARA (DARA for the Joint Total Solar Irradiance Monitor) absolute radiometer for the Chinese FY-3E mission. JTSIM-DARA is one of PMOD/WRC's contributions to the almost seamless series of spaceborne TSI measurements since 1978. It will be mounted on the FY-3E satellite, which is the 5$^{th}$ flight unit of the Fengyun-3 (FY-3) series. Key aspects of the FY-3 satellite series include collecting atmospheric data for intermediate and long-term weather forecasting and global climate research.

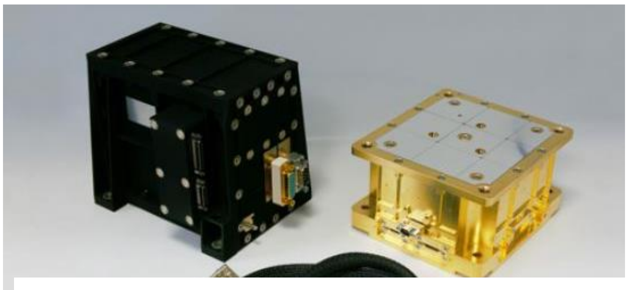

**Figure 1.** The JTSIM-DARA is composed of a senor case with 3 radiometer cavities (right) and the control unit.

The JTSIM-DARA instrument (Fig. 1) is a cooperation with CIOMP (Changchun Institute of Optics, Fine Mechanics and Physics of the Chinese Academy of Sciences), and the China Meteorological Administration (CMA). Next to the JTSIM-DARA a solar irradiance absolute radiometer (SIAR) radiometer was designed by CIOMP. The JTSIM-DARA design is based on the Digital Absolute Radiometer (DARA/PROBA-3) and the Compact

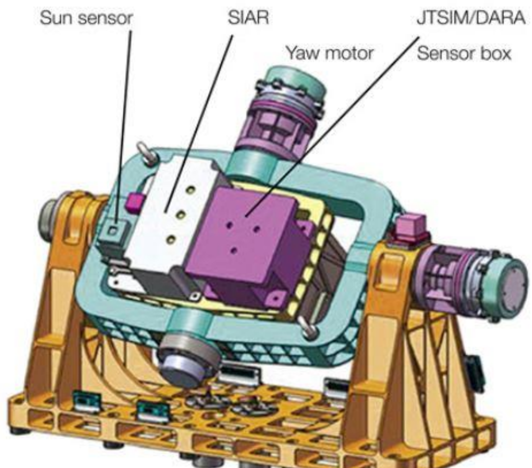


**Figure 2.** FY-3 sun tracker with the JTSIM radiometers.

Lightweight Absolute Radiometer (CLARA/NorSat-1) instruments.

The two JTSIM radiometers are mounted on the sun tracker (Fig. 2) of the satellite enabling independent pointing toward the sun whereas the other instruments point toward the earth. As two devices are mounted on the sun tracker, the pointing of JTSIM-DARA is a critical parameter of the mission. The instrument is currently integrated into the Chinese FY-3E weather satellite and is made ready for launch in 2020 [1].

## MEASUREMENTS

Measurements of the pointing of the three JTSIM-DARA cavities relative to each other were performed on the WSG sun tracker. The pointing relative to a cube alignment mirror was measured at the angular response facility in the optic laboratory of the WRC. This setup (Fig. 3) consists of a 1 kW Xe-Lamp

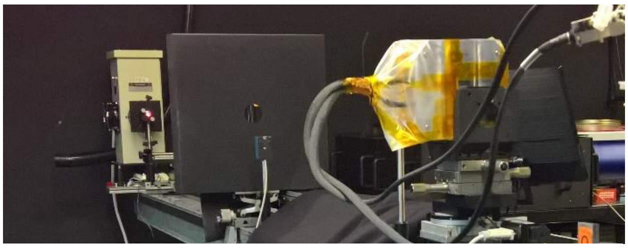

**Figure 3.** The angular response setup showing the Xe-Lamp in the back, a WG305 filter and a baffle in the middle and the JTSIM-DARA mounted on the goniometer.

emitting a collimated light beam towards the test device which is mounted on a goniometer about 3 m away from the light source [2]. The variability of the light intensity of a 50 mm$^3$ cube around the optical axis was characterized prior to the measurements. The homogeneity within this entire cube is 3% and inside a 10 mm$^3$ below 0.5 % (Fig. 4).

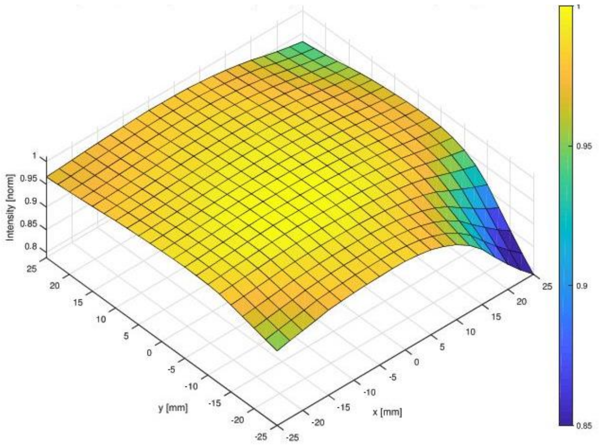


**Figure 4.** Homogeneity of the light intensity in the plane of rotation.

Figure 5 shows the alignment relative to the optical axis using a laser. First JTSIM-DARA was orientated using the removable alignment cube. Thereafter one selected cavity and the four-quadrant sensor (4Q) was moved into the centre. The measurements where performed by rotation around the β-axis of JTSIM-DARA and after a 90° rotation of the device around the γ-axis. The experiment was repeated four times: Before the end assembly (1), before (2) and after (3) the vibration tests and before shipping (4).

## RESULTS

Figure 6 and 7 shows results of the pointing measurements of the 4Q and the cavity A. Table 1 the results of the 4 measurements as numbered above.

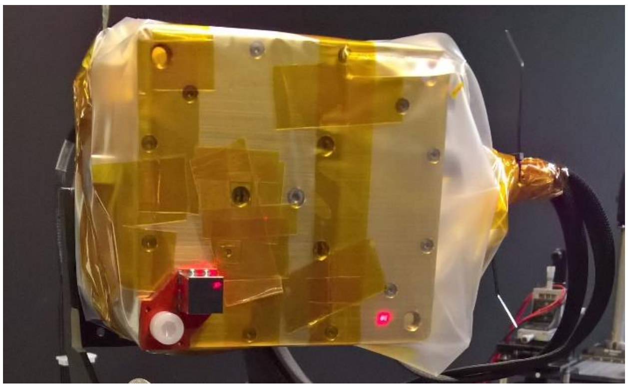

**Figure 5.** Pointing measurement of the JTSIM-DARA showing the alignment cube in the lower left corner, the 3 holes of the radiometer cavities in the centre and the four-quadrant sensor next to the cube.

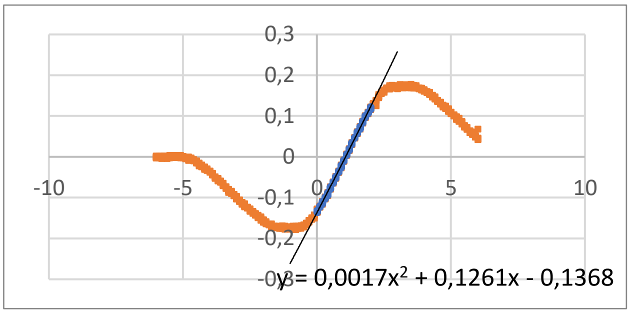


**Figure 6.** Pointing of the 4Q sensor around the β-axis. Plotted is the 4Q signal vs. the angle of rotation.

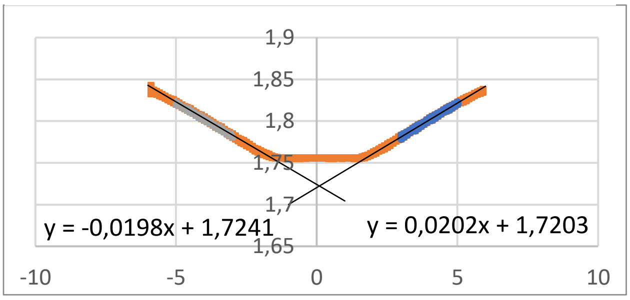


**Figure 7.** Pointing of the cavity A around the β-axis. Plotted is the intensity of the sensor vs. the angle of rotation.

The assembling has a major influence on the optical axis of the sun sensor and the cavity. The β-angle measurements changed after the vibration test. All other measurements are consistent within the estimated uncertainty of ±0.1°. The vibration test didn't show any shift on the optical axis defined by the alignment cube.

**Table 1.** Summary of the offsets for the 4 pointing tests as defined in the text.

| **Test** | **β-4Q** | **β-Cavity A** | **γ-4Q** | **γ-Cavity A** |
|---|---|---|---|---|
| **1** | 0.91° | -0.45° | 0.76° | 0.16° |
| **2** | 0.98° | 0.025° | 0.62° | -0.026° |
| **3** | 0.71° | 0.25° | 0.67° | -0.00° |
| **4** | 1.07° | 0.095° | 0.67° | -0.017° |

## OUTLOOK

The setup used for the pointing measurements is limited to about 20 Nm load on the goniometer. A new mechanic was constructed to enable loads up to 200 Nm.

## REFERENCES


1. http://www.nsmc.org.cn/en/NSMC/Channels/FY_3E.html
2. G. Hülsen et al., Characterization and calibration of ultraviolet broadband radiometers measuring erythemally weighted irradiance, Appl. Optics, 46, 5877- 5886, 2007.