5A.5 DEVELOPMENT STATUS OF THE EARTHCARE/CPR

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1. INTRODUCTION

The Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) mission has been jointly proposed by European and Japanese scientists and has been developed by European Space Agency (ESA) and Japanese agencies, that is, Japan Aerospace Exploration Agency (JAXA) and National Institute of Information and Communications Technology (NICT) (Kimura 2008 and Ohno 2007). The mission objective of the EarthCARE is to improve the understanding of cloud-aerosol-radiation interactions so as to include them correctly and reliably in climate and numerical weather prediction models. For that purpose, EarthCARE spacecraft (Figure 1) have been defined with four sensors, such as backscatter lidar (ATLID), cloud profiling radar (CPR), multi-spectral imager (MSI) and broadband radiometer (BBR), and they will make synergy observation to understand aerosol and cloud vertical profiles and their interactions on a global scale. In EarthCARE mission, JAXA and NICT are to provide Cloud Profiling Radar (CPR), which is one of the core sensors of the EarthCARE satellite and the first space-borne W-band radar with Doppler measurement mode.

JAXA and NICT have developed the CPR so far, and preliminary design review was finished in September 2009. This report shows the preliminary design result of the EarthCARE/CPR.

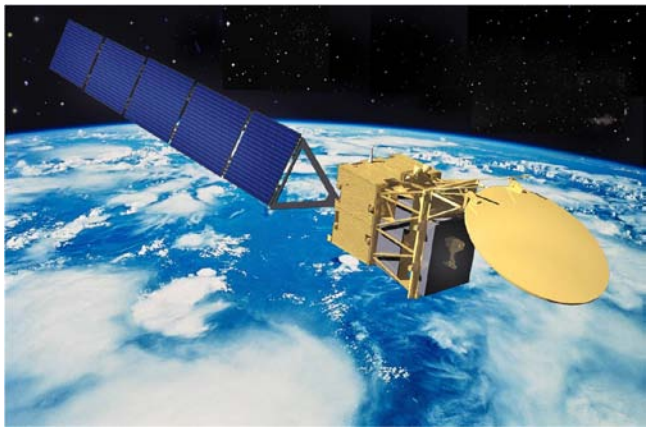

Figure 1 EarthCARE Spacecraft Overview (ESA)

2. SPECIFICATIONS OF EARTHCARE/CPR

Major specifications of the EarthCARE/CPR are shown in Table 1.

Table 1 CPR Major Specifications

Term	Value
Frequency	94.050GHz
Peak power	1.5kW (EOL)
PRF	6100Hz to 7500Hz (during nominal observation)
Antenna diameter	2.5m
Beam width (Beam foot print)	0.095deg (800m)
Vertical resolution (Pulse width)	500m (3.3us)
Horizontal resolution	500m
Minimum sensitivity	-35dBZ (10km integration, uniform cloud)
Doppler measurement accuracy	1m/s (10km integration, -19dBZ clouds)

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3. PRELIMINARY DESIGN RESULTS OF THE EARTHCARE/CPR

3.1 System design

Figure 2 shows the block diagram of the EarthCARE/CPR. The CPR consists of signal processing units, transmitters with high power source (HPT), a transmit/receive duplexer (quasi-optical feed), a 2.5m Φ main reflector and Receivers. Transmitting power will be monitored for compensation of the measurement level and leakage signal from the transmit/receive duplexer will be used as the Doppler reference.

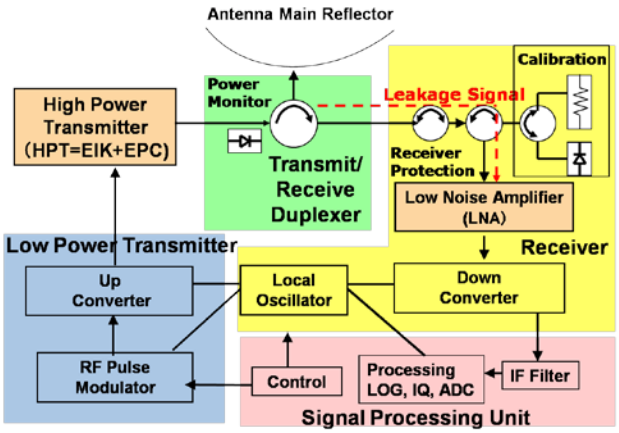

Figure 2 CPR Block Diagram

In the CPR preliminary design, several technical efforts were taken. A large reflector was employed to get higher antenna gain, CFRP material was used as a reflector and structure of the CPR to minimize thermal distortion, main reflector protection cover was attached to protect the CPR against for Sun illumination, quasi-optics was selected to minimize system loss, and transmission and receiver subsystems also designed to assure high power transmission, long life time and small loss. As the results of those efforts, the CPR is currently evaluated to be compliant with the required specifications (Doppler velocity requirement will be compliant when we could sufficiently eliminate spacecraft attitude uncertainty).

3.2 Operation

This chapter introduces the CPR nominal operation. In the nominal operational phase, the CPR will performs nominal observation with variable PRF and appropriate observation window, and calibration operations which includes calibration using sea surface or ground based active calibrators,

Figure 3 shows the operation image of the CPR nominal operation. The CPR will change the observation window (basically 12km in high latitude area and 20km in middle and low latitude area) and change the PRF to make effective cloud observation. There are three calibrations considered for the CPR. One is the internal calibration for signal processing unit which will be processed electrically and this calibration need to stop the observation. One is the sea surface calibration which will be performed to calibrate RF performance and to get normalized radar cross section. This calibration shall be performed wide sea area like those shown in Figure 3. The third one is the external calibration which will be performed using ground based radar calibrator. Antenna pattern measurement, RF performance measurement and Doppler velocity measurement will be verified by this calibration. This calibration is currently planed when the EarthCARE spacecraft flies over Japan (shown in Figure 3).

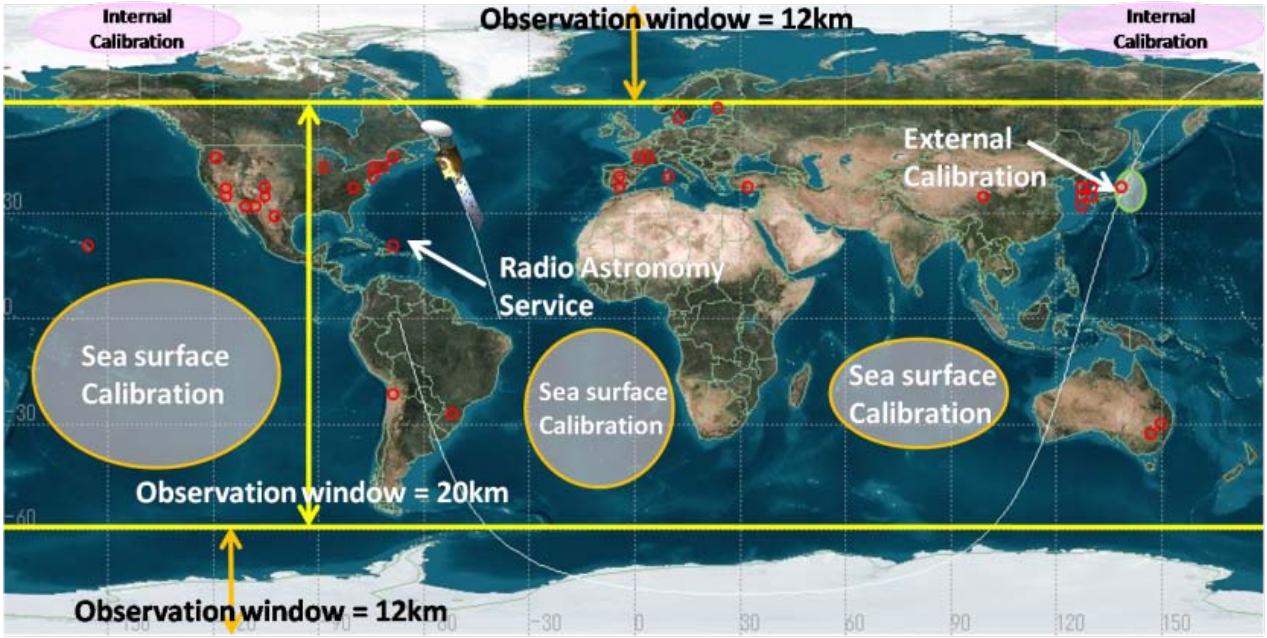

Figure 3 CPR Operation Image

Red circles show the radio astronomy services

4. BBM TESTING

In the preliminary design phase, we made a lot of test peace of the sample materials, test models, and BBMs and even test facility was established. I will show such a BBMs and test results in my presentation. Here, the large reflector BBM and RF test facility are shown in Figure 4.and Figure 5.

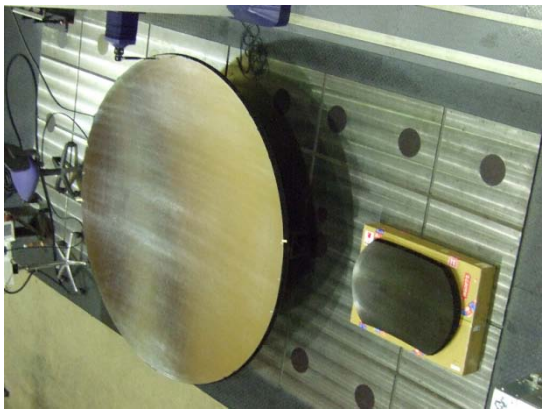

Figure 4 2.5mΦ BBM reflector

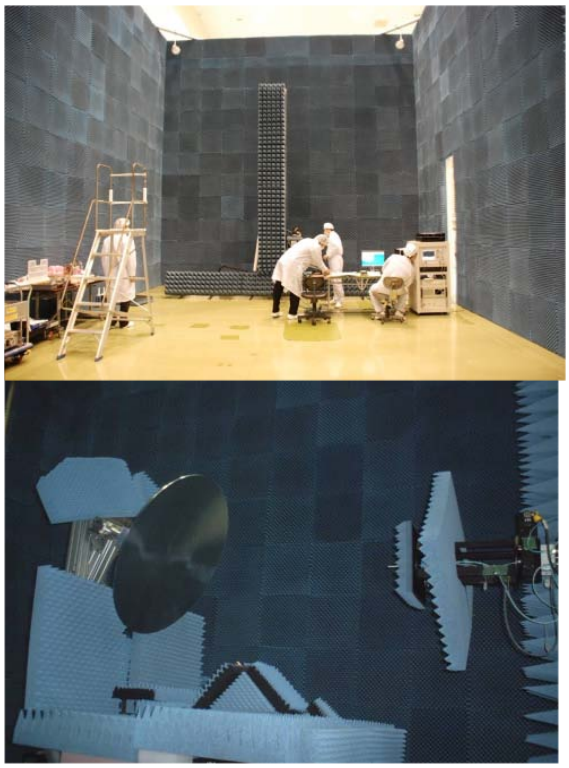

Figure 5. Near-Field Measurement Facility (Upper) and Scale Antenna Test Configuration (Bottom)

5. CONCLUSION

The EarthCARE mission has been developed by ESA, JAXA and NICT. The cloud profiling radar is one of the core sensors and jointly developed by JAXA and NICT. Preliminary design phase is just finished and most of requirement specifications were evaluated to be compliant. This report presented overview of the CPR preliminary design result including BBM testing.

References

1) T. Kimura, H. Kumagai: Japanese Cloud Profiling RADAR for EarthCARE, The 27th International Symposium on Space Technology and Science. July, 2008.

2) Y. Ohno, H. Horie, K. Sato, H. Kumagai, T. Kimura, K. Okada, Y. Iida, M. Kojima: Development of Cloud Profiling Radar for EarthCARE, 33rd Conference on Radar Meteorology, August 6, 2007