CHIBA UNIVERSITY

The 20th CEReS International Symposium

SOMIRES 2013

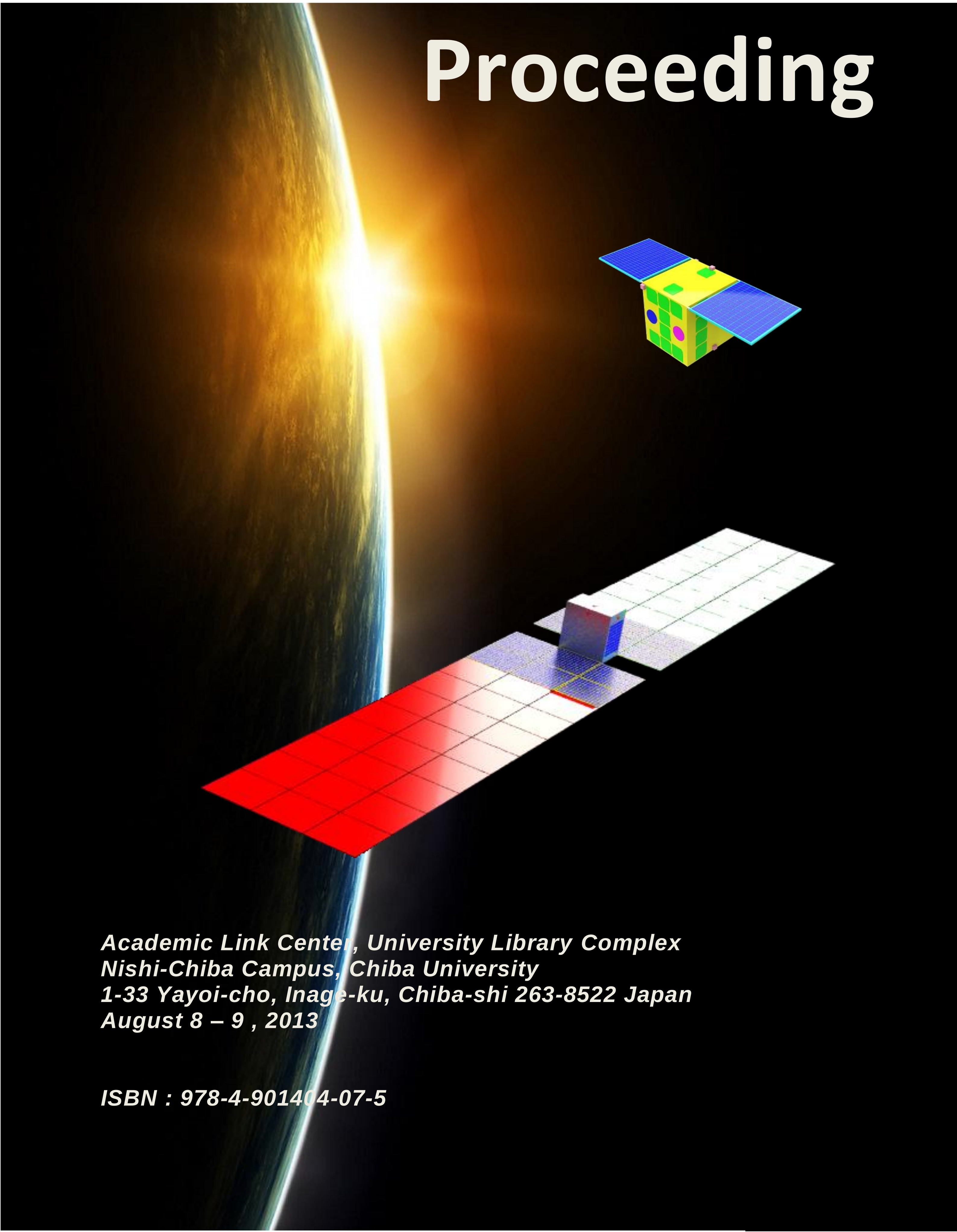
Symposium on Microsatellites for Remote Sensing

KYOTO UNIVERSITY FOUNDED 1897

The 231th RISH Symposium

The International Workshop on GPS Radio Occultation Mission with a Microsatellite

Proceeding



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Program

SOMIRES 2013 and 231th RISH

The 20th CEReS International Symposium or ***The Symposium on Microsatellites for Remote Sensing (SOMIRES 2013)*** is kick-off event of Chiba University microsatellite project and co-organized by Research Institute for Sustainable Humanosphere (RISH), Kyoto University (The 231th RISH Symposium): ***The International Workshop on GPS Radio Occultation Mission with a Microsatellite***. This symposium will provide an opportunity for researchers and system engineers to discuss new and viable technical topics of microsatellites, payload and spaceborne system, missions, analysis technique and applications for remote sensing.

Organized and Sponsored by

- Center for Environmental Remote Sensing (CEReS), Chiba University
- Research Institute for Sustainable Humanosphere (RISH), Kyoto University
- Department Electrical and Computer Engineering, Ajou University, Korea.

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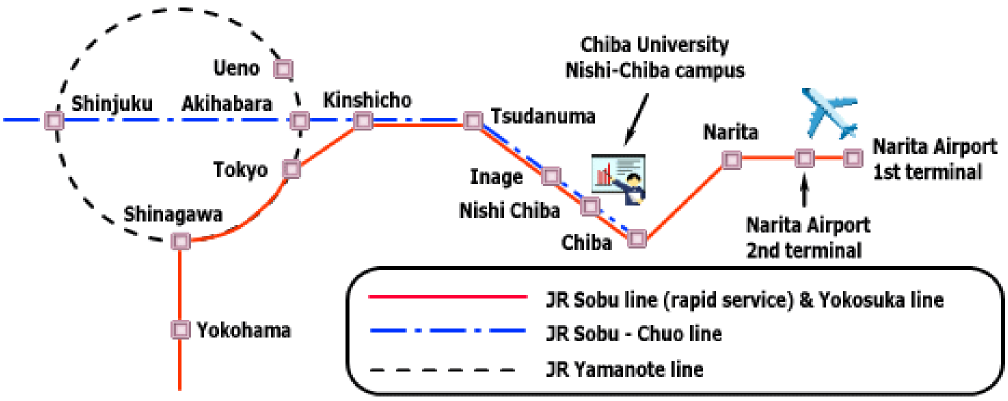
Symposium site

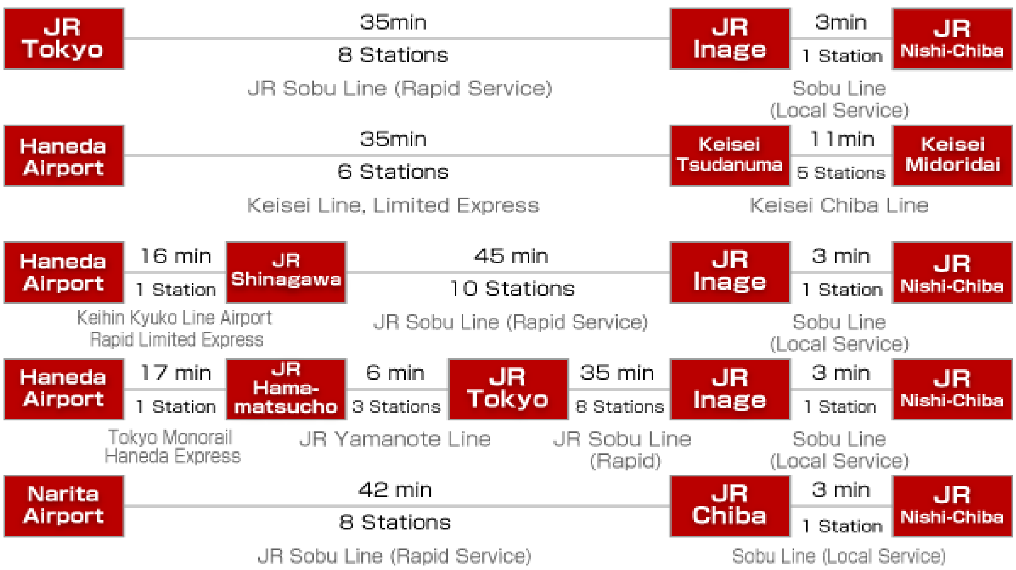
Venue

1F, Contents Studio “Hikari”, Academic Link Center, University Library Complex, Nishi Chiba Campus, Chiba University, 1-33 Yayoi, Inage, Chiba 263-8522 Japan.

Maps to access Symposium site:

- 3-min walk from JR Nishi-Chiba Station to the South Gate of Nishi-Chiba Campus
- 7-min walk from Keisei Midoridai Station to the Center Gate of Nishi-Chiba Campus





Chiba University Map
Nishi-Chiba Campus

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The International Workshop on GPS Radio Occultation Mission with a Microsatellite

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10:00 – 10:30	Development of UAV and Microsatellites for Remote Sensing *Josaphat Tetuko Sri Sumantyo (Chiba University), Koo Voon Chet (MMU Malaysia), and Robertus Heru Triharjanto (LAPAN Indonesia)*
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SAR Antenna Development in the UK

Steven Gao[1], Yohandri[2,3] and Josaphat Sumantyo[2]
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Abstract
Antenna sub-system is one of the most critical and expensive sub-systems for Synthetic Aperture Radar (SAR) onboard aircraft or satellites. This paper provides a brief overview of SAR antenna development in the UK. Some results will be shown. The conclusion and future development of SAR antenna and systems in the UK are given in the end.
Key words: SAR, phased array, space antenna

1. Introduction

Due to the capabilities of day-and-night operation and penetration through clouds and rain, SAR has become an important tool for earth observation and environmental monitoring worldwide. Space-borne SAR systems are usually very expensive and take many years from the development to launch. One of the recent trends is to develop low-cost SAR systems onboard small satellites. In Europe, one of the recent examples is the COSMO-SkyMed (Constellation Of Small Satellites for Mediterranean basin Observation) is a four-satellite constellation funded by ASI (Agenzia Spaziale Italy) and the Italian Ministry of Defense. The four satellites, from Thales Alenia Space, Italy, were launched during 2007 and 2010, and each satellite is equipped with a SAR operating at X band with multiple operation modes (Spotlight, Stripmap and ScanSAR) and multi-polarization capabilities. The multi-mode and multi-polarization capability of SAR is achieved by using an active phased array for the SAR antenna onboard. The COSMO-SkyMed allows both the wide-area mapping (at low resolution, ScanSAR mode, X band) and the high-resolution imaging (in Spotlight SAR mode, X band) of the Mediterranean latitudes with repetition time of a few hours. A brief review of SAR antenna development will be given in the following.

2. Brief Review of SAR Antenna in the UK and Some Results of Low-Cost SAR

In the UK, many SAR systems have been developed during recent decades. These SAR systems mainly operate at S band, C band, X band, both S/X band, etc, for air-borne or space-borne applications. Key players in SAR systems and related technologies include companies such as EADS Astrium UK Ltd, Surrey Satellite Technology Ltd (SSTL), Selex, BAE Systems, Qinetiq, as well as academic institutes such as the University of Kent, University College London, University of Sheffield, University of Surrey, etc. Some examples of recent space-borne SAR systems include ERS-1 (C band), ASAR on ENViSAT (C band), NovaSAR-S (S band), Sentinel-1 (C band), AstroSAR-Lite (X band), etc. A variety of antenna technologies have been developed for SAR systems, including printed microstrip patch arrays, slotted waveguides, deployable antennas, horn antennas, annular slot arrays, active phased arrays, etc [1]. As an example, the antenna sub-systems for NovaSAR-S are explained below.

NovaSAR-S is a low-cost radar imaging satellite, recently developed by SSTL and Astrium UK Ltd [2-3]. One key drive of NovaSAR-S development is to significantly reduce the cost of space-borne SAR systems while improving the performance of imaging. This is made possible by adopting the modern small-satellite platform technology, new antenna technology and new RF sub-system technologies. NovaSAR-S operates in S-band (3.1-3.3 GHz) and has a design life of 7 years. The total mass of the satellite including SAR system is below 400 kg. It can operate in single (e.g., HH or VV) or multiple polarizations (HH, VV, HV and/or VH). The modes of operations are highly flexible, including ScanSAR (narrow), Stripmap, ScanSAR (wide swath width), and a maritime surveillance mode. In single-polar operations (e.g., HH or VV), spatial resolutions in the range 6-30m are achieved with corresponding swath widths ranging from 15-

150 km. The maritime surveillance mode is unique and it has a surveillance swath of 750 km width for detecting the ships or other targets in the ocean. The optimum orbital altitude for NovaSAR-S is 580km. The highly flexible modes of NovaSAR-S are enabled by using an active phased array antenna.

Figure 1 show the antenna array which is a microstrip-patch active phased array consisting of 18 sub-arrays. The total size of the antenna array is 3 m×1 m. The antenna can achieve multi-polarizations (VV, HH, VH, HV). To achieve electronic beam steering, the antenna is integrated with microwave phase shifters which are controlled by DC voltages. To reduce the size and mass (and cost) of SAR antenna system, it is integrated with GaN power amplifiers. The use of GaN technology is important here for significantly reducing the size and mass of active phased array, due to the high power density capability of GaN devices in comparison to conventional GaAs technologies.

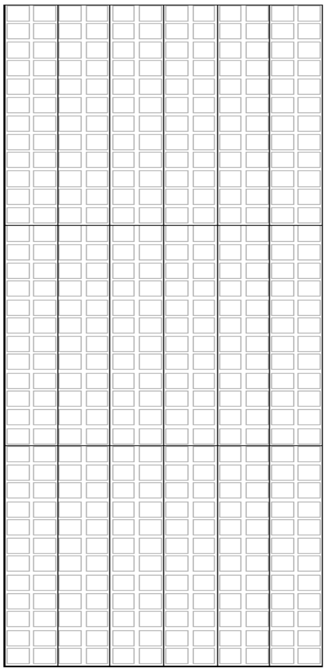

Figure 1 SAR antenna for NovaSAR-S [2,3]

One challenge of SAR antenna is to improve the polarization purity and increase the isolation between transmit and receive chains. This is achieved by using the “anti-phase technique”. Figure 2 shows the configuration of one sub-array. As shown in Figure 2, the radiating elements (square microstrip patch) in the 1^{st} row and the 2^{nd} row are fed at opposite positions. This will excite electric currents following in opposite directions on the elements in the 1^{st} and 2^{nd} row. To compensate this, these two rows will be fed with 180^{o} phase difference between them. Such an “anti-phase technique” enables the cancellation of high-order modes in the sub-array, leading to high polarization purity and high isolation between transmit and receive [1,4].

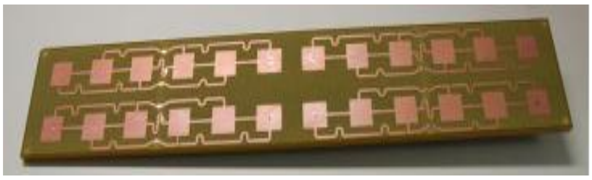

Figure 2 Sub-array of SAR antenna for NovaSAR-S [2,3]

3. Conclusion and Future

The above provides a brief overview of SAR antenna in the UK. One of important steps next is to develop digital beamforming (DBF) multi-static SAR. The University of Kent, teamed with DLR (Germany) and other European partners, is working on DBF multi-static SAR for a constellation of several micro-satellites in low earth orbits. Such a SAR system requires DBF array antennas and novel algorithms for antenna adaptive beamforming.

Acknowledgement

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