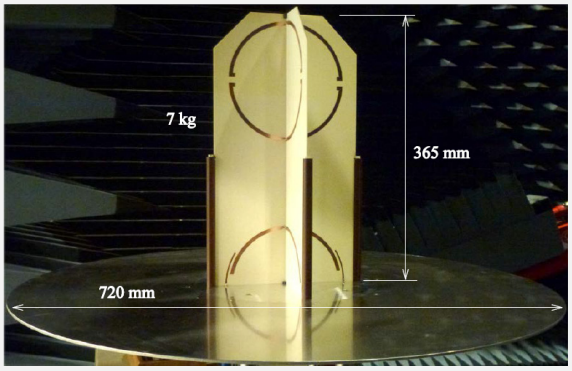
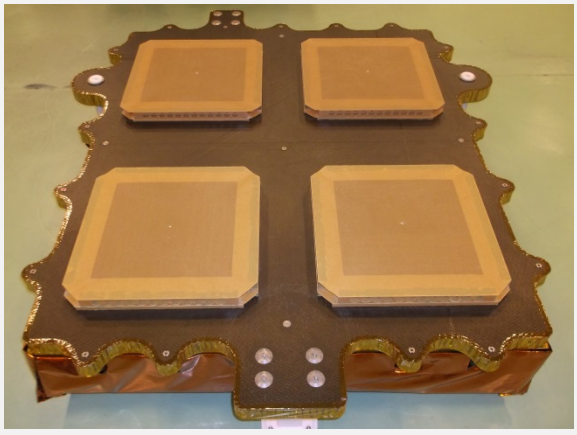
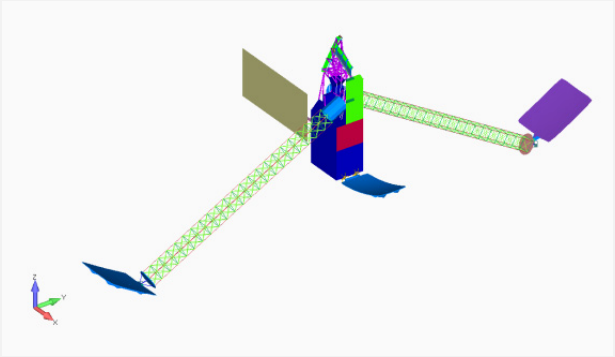
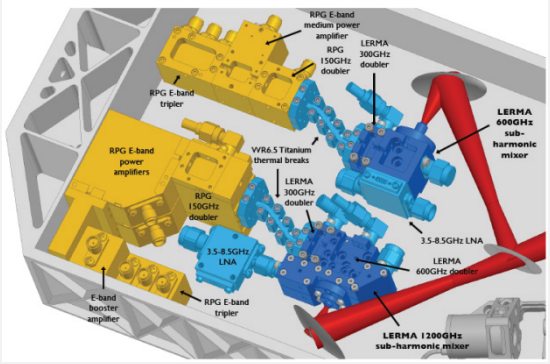
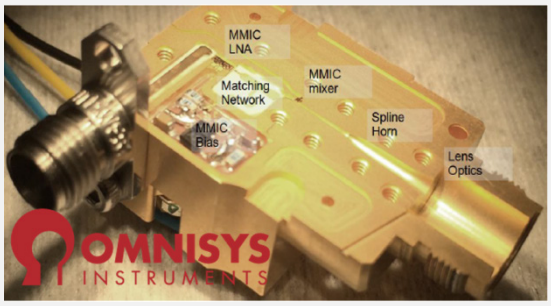
Final Presentation Day – 14 November 2016 (Newton meeting room)

Recent Antennas and Front-End Developments

9:15	**Introduction**
9:30	**Dual-polarized P-band spherical near field probe (TRP, 150 k€)** *DTU (DK)*
	 The objective of the project is to develop a compact light-weight (< 10 kg) dual-polarized first-order probe Near-Field measurements at 435±3 MHz frequency range (BIOMASS). Existing probes for Spherical Near-Field (SNF) antenna measurements are either classical first-order probes based on conical horns and open-ended circular waveguides excited by the fundamental TE11-mode, or wide-band higher-order mode probes. In either case, these probes become excessively bulky and heavy at frequencies below 1 GHz. In this project, a compact dual-polarized first-order P-band probe has been developed (Figure 1). The height of the probe is just 365 mm over a 720-mm circular ground plane and it weighs 7 kg. The probe covers the bandwidth 419-445 MHz with more than 9 dBi directivity and parasitic $\|\mu\| \neq 1$ spherical modes suppressed below −35 dB. The probe has been designed, manufactured and tested by the Technical University of Denmark (DTU).
10:30	**Large reflector P-band critical breadboarding (TRP, 750 k€)** *Thales Alenia Space (IT)*
	 Thales Alenia Space – Italia (TAS-I), in the frame of "Large Antennas for P-Band SAR- Critical Breadboarding" study, has successfully conducted RF, thermo-mechanical and technological validation of P-band Feed Array (FA) breadboard for Biomass mission. The FA breadboard is made of flight proven technology, based on a structural panel (sandwich CRFP-AL) supporting on one face the radiating elements (4 patches) and on the other face the Beam Forming Network (BFN) in microstrip. The BFN is designed to compensate the cross-polar intrinsic contribution of main optics based on short F/D (~0.65). The selected BFN scheme avoids using of large hybrids and extra-HW (e.g. loads) still providing the needed cross-cancellation at secondary level. The FA design is modular and allows customization to cope with final optics geometry and mission required beams by tuning few FA parameters (e.g. inter-element spacing, coupling level for cross-cancellation). Furthermore the FA can withstand the required input power (140W) at P-band frequency with adequate margin provided by test (> +6 dB) selecting proper BFN thickness. The P-band Feed Array critical breadboarding study has evidenced that the feed array flight technology is suitable for the BIOMASS mission and that the TRL 6 is achieved.
11:30	**Coffee break**

11:45	**Ka-band interferometric SAR antenna system (TRP, 600 k€)** *HPS GmbH (DE), RST AG (DE), OHB (DE), LuxSpace (LU)*
	 The objective of the activity is to study the Ka-band antenna subsystem for an interferometric SAR instrument utilising scan-on-receive technique. The activity includes the review and selection of a SAR instrument concept, design and analysis (RF, accommodation, mechanical, thermal, thermo-elastic) of the antenna subsystem, including the radiating apertures for both the Tx and Rx operations of the instrument, the corresponding passive RF feeding systems of the antennas, the antenna structures/supports, the deployment arms interconnecting the antenna to the host S/C, the HDRMs, the deployment and pointing mechanisms. A breadboard of the identified most critical component of the subsystem, identified in the RX feed array and the relative scan on receive BFN, provides the proof-of-concept.
12:45	**Lunch break**
14:00	**Terahertz receiver technology for future missions (CTP, 1 M€)** *Omnisys Instruments AB (SE), Observatoire Paris (FR), ACST (DE)*
	 Driven by the requirements of astronomy (e.g., HERSCHEL HIFI and ALMA) and aeronomy instruments (e.g., EOS MLS, STEAM-R), sub-millimetre heterodyne radiometer technology has markedly improved in the last few years. Heterodyne mixers using planar Schottky diode technology have been demonstrated at all frequencies up to at least 2,500 GHz in a laboratory environment. The advantage of Schottky diodes is the fact that they can work at temperatures that can readily be achieved by passive cooling. At frequencies above 150 GHz, Schottky diodes are a common choice for non-cryogenic detectors (mixers) and sources (frequency multipliers). In addition, Schottky diodes are robust enough to work in hostile environments and have been space qualified. These factors make Schottky diodes the preferred choice for several applications. A drawback of Schottky based sub-systems is that they traditionally require relatively high local oscillator (LO) power. The conventional way of generating LO power at sub-mm wave frequencies consists of a multiplier chain of 2 or 3 frequency multipliers in cascade driven by a Gunn oscillator. The amount of LO power generated is determined by the output power available from the Gunn oscillator and the frequency conversion efficiency of the multipliers, i.e. by the performance of the varactor devices at their respective operating frequencies. State of the art performance of the complete front-end can therefore only be achieved if both the mixer and multiplier chain elements are optimized together (either as separate units or even intimately integrated in a single block). The operational frequency bands for Science missions carrying planetary atmosphere characterisation instruments are moving towards higher frequencies (1 to a few THz), the technology for which was not readily available in Europe at the start of the activity. The activity focused efforts on ensuring European State of the Art capability at frequencies close to 1 THz and demonstrate that the performance meets the requirements for future missions. The activity also had to demonstrate appropriate TRL level for potential inclusion on JUICE.

15:00	**875 GHz receiver front-end for an airborne ice cloud imager demonstrator (TRP, 650 k€)** *Omnisys Instruments AB (SE)*
	 Omnisys Instruments has developed a new high performance MMIC based dual polarization receiver operating at 875 GHz, for the International Sub-Millimetre Airborne Ice Cloud Imager Demonstrator ISMAR instrument operated by UK MetOffice. The activity has included development of critical front-end THz components based on MMIC technology from Chalmers, integrated antenna and lens-optics, and complete LO system and bias support electronics. For the heterodyne receiver architecture subharmonic diode mixers, varactor diode multipliers and IF LNA's have been developed based on GaAs Schottky diode membrane MMIC and InP HEMT MMIC technology. The tested receivers had a typical double sideband noise temperature around 3000 K, applying only 2 mW of LO power operating at an efficiency of 6% for the last X4 multiplier stage. For the first high power multiplier stage a W-band tripler from Wasa Millimetre Wave AB based on Chalmers HBV MMIC was used. The HBV MMIC tripler had over 200 mW of peak output power, operating at over 25% efficiency.
16:00	**Flexible antenna sprayhood (GSTP, 225 k€)** *Spinlock (UK), Antrum (UK)*
	 According to the International Life Saving Federation around 1.2 million people around the world die by drowning every year, that is more than two persons per minute and 50 percent are children. The majority of these drownings occur in open water and many could be prevented through the adoption of appropriate life saving equipment. Certain professions carry an additional risk of drowning: fishing, oil and gas off shore workers, merchant navy, cruise operators, armed forces and leisure boat industry participants. One of the most effective ways to reduce this number of drowning fatalities is to ensure that victims are rescued promptly and that they are able to keep their 'heads above water' whilst the rescue is executed. This is achieved through utilising life jackets and locator beacons. Currently life jackets and locator beacons are two distinct units. Whilst life jacket technology has undergone dramatic evolution in recent years, locator beacons remain relatively bulky devices with inherent difficulties around effective deployment. To elaborate, current locator beacons run the risk of simply being forgotten or left behind, they are still relatively large and cumbersome, many rely on manual deployment of the antenna which can be difficult in an emergency situation or where the wearer is a child or has suffered an injury and beacon antennas are not always effective in harsh environments such as stormy seas. A collaboration between Spinlock and Antrum has resulted in a integration and improvement of these two vital life saving technologies: the life jacket and the beacon antenna. Spinlock's sophisticated life jackets incorporate a spray hood which, under normal circumstances, is folded back into the collar of the jacket. In an emergency situation, the hood is pulled forward to cover the head and face thus protecting the wearer's face from being buffeted by the water and the wearer suffering so called 'secondary drowning' from inadvertently swallowing water. In this project a beacon antenna is integrated into the protective spray hood of the life jacket and which is connectable to a designated PLB. This PLB may either be carried by the wearer or embedded into the body of the lifejacket in miniaturised form.
17:00	**Closure**