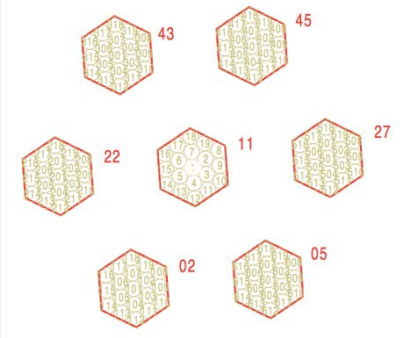
Final Presentation Day – 10 June 2015 (Einstein Aj033)

Recent Antenna and Test Facilities Developments

<table>
<tr><td>9:15</td><td>Introduction</td></tr>
<tr><td>9:30</td><td>Single-Feed-Per-Beam Multiple-Spot-Beam Reflector Antenna System for Broadband Communications (TRP-TAS, 35 k€)
Antenna Systems Consulting ApS (DK)</td></tr>
<tr><td></td><td> 

This work extends a previous activity under ESA/ESTEC Contract No. 19075/05/NL/NH that derived the RF performance achievable if the four-reflector single-feed-per-beam multibeam antenna system often used on Ka-band high-throughput satellites is replaced by one oversized shaped reflector antenna. The previous activity demonstrated the feasibility of the oversized reflector, but also identified limitations due to degradations of scanned beams caused by the offset-reflector astigmatism. Similar but smaller scan degradations occur in the four-reflector system. Multiple-feed-per-beam reflector systems provide some scan-degradation compensation but many feeds are required in severe cases. This activity aims at overcoming the scan limitations of the oversized shaped reflector by modifying each single-feed-per-beam feed horn depending on scan angle and scan direction. We use an array to represent each single-feed-per-beam feed horn. The figure illustrates one of the three array approaches considered.
The presentation will discuss merits and demerits of various approaches and results obtained for optimised array phase excitations - assumed to vary linearly with frequency – for various amplitude distributions. One objective is to reduce the complexity by minimising the number of designs required. Another objective is to combine receive and transmit operation.</td></tr>
<tr><td>10:30</td><td>Compact C-Band Feed Assembly for Single and Multi-Beam Missions (ARTES 5.1, 750 k€)
Rymsa Espacio (ES)</td></tr>
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This activity investigated suitable multiple beam antenna configurations for C-band applications. A trade-off between single-feed-per-beam (SFB) and multiple-feed-per-beam (MFB) reflector antenna configurations was performed on continental and sub-continental coverage. Considering the large reflector apertures required for proper gain and beam-to-beam isolation, the MFB configuration was preferred as only two reflector antenna are required to produce the full coverage in transmit and receive. A novel feed array design for periodic MFB feed systems has been developed. This feed array uses 6 radiating elements per beam and each radiating element is shared with 6 surrounding arrays. The radiating elements are shared only in polarization leading to fully decoupled Beam Forming Networks (BFNs). Furthermore all BFNs can be constructed in a single layer without crossings. The proposed feed array is associated with four colour re-use scheme different from the standard hexagonal one. The use of this feed array and associated re-use scheme in combination with square-rim or super-elliptical reflectors provides some improvement on the Carrier over Interferers ratio (C/I) when compared to standard circular-rim reflectors.
The feasibility of the novel approach has been demonstrated by the manufacturing and testing an MFB feed array leading to extreme feed system height reduction when compared to a feed array in comparison respect to SFB approach. This is due to the use of bar-line technology and to the use of a small and efficient radiating element. The model has no issues in PIM. The array losses are better than 0.5dB in worse case.</td></tr>
<tr><td>11:30</td><td>Coffee break</td></tr>
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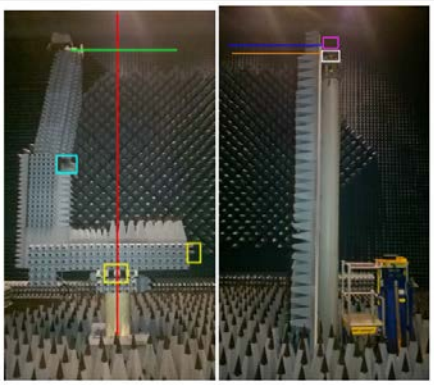
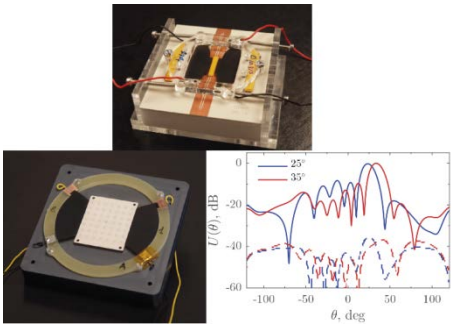
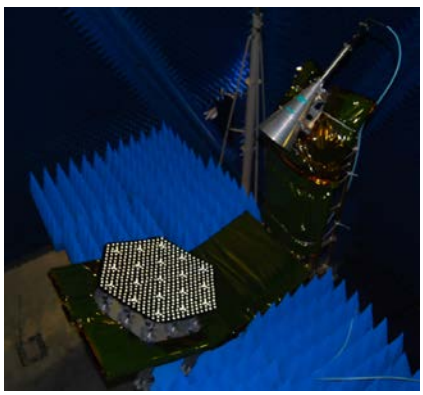
11:45	**Alignment of Antenna Measurement Facilities with Machine Vision Technology (TRP-TAS, 40 k€)** *Technical University of Denmark (DK)*
	 This presentation reviews the project "Alignment of Antenna Measurement Facilities with Machine Vision Technology". Different approaches for using a machine vision tool in performing antenna and probe positioner mechanical alignment are presented and compared. A machine vision alignment system for aligning a spherical roll-over-azimuth setup, based on fitting coordinate data to a geometrical model, is presented. A detailed description of the alignment steps and derivation of the model equations for this alignment system are given. Procurement and maintenance complexity and costs are assessed for different solutions. Obtainable accuracy and its influence on antenna measurement uncertainty are also estimated and compared for different approaches. The picture shows the AUT positioner and probe tower of the DTU-ESA Spherical Nearfield Antenna Test Facility and the adjustment tools for mechanical alignment of vertical axis, horizontal axis on AUT positioner as well as probe positioning and pointing on probe tower. One or more of such mechanical alignments are generic and can be found in most antenna measurement facilities.
12:45	**Lunch break**
14:00	**Reconfigurable millimetre-wave antennas based on micro fabricated actuators (NPI, 81 k€)** *Ecole Polytechnique Fédérale de Lausanne (CH)*
	 Dynamic reconfiguration of microwave and millimetre-wave (MMW) antenna devices is becoming a prime need in space-related applications, among others for updating in real time antenna, as needed both in ground terminals and spacecraft antennas. In this context, we propose the implementation of mechanically reconfigurable MMW devices using Dielectric Elastomer Actuators (DEAs), which possess appealing properties for antenna reconfiguration: low cost materials and fabrication, analogue control, low power consumption and large strain outputs. Within the scope of DEA-based reconfiguration, we have successfully demonstrated the application of planar DEAs for the realization of a tunable Ka-band phase shifter providing analog-controlled true-time-delay. The experimental characterization of the fabricated prototype demonstrated state-of-the-art phase shift to loss performance, achieving 235°/dB at 35 GHz. A similar reconfiguration approach has been applied for the implementation of a beam-scanning reflectarray (RA) operating at Ka-band. The proposed device is based on rectangular resonant patches whose length can be adaptively modified using the in-plane expansion provided by DEAs. This principle was validated implementing a uniform reflective surface, which was characterized using free-space monostatic measurements highlighting a very good agreement with simulated data. The design of a 1-D beam-scanning RA based on the same actuation principle has been also proposed and preliminary performance have been evaluated.
15:00	**Reconfigurable Antenna Optics (ARTES 5.1, 940 k€ + CCN 116 k€)** *Thalès Alénia Space – France (FR) and Technische Universität of München (DE)*
	 This study enabled the design of a new Ku band antenna compatible of in orbit reconfiguration of the radiation pattern. The reconfiguration of the pattern is achieved by means of a number of mechanical actuators acting on a flexible reflecting surface. The challenge of the project was the definition of a flexible shell compatible with RF and mechanical needs. The antenna design is based on a multidomain optimization (technology, mechanical, RF). An antenna architecture implementing a reconfigurable reflector has been defined and several analysis have been done to evaluate the achievable RF performances. A demonstration model of the reconfigurable reflector has been developed, surface shape measurement as well as electrical testing have been performed for 3 different target shapes. Nonlinear mechanical analysis has been required to predict surface shape. The demonstration model development and testing allowed to demonstrate the feasibility of this promising solution to provide in orbit reconfiguration of the antenna pattern. Further activities are still required to improve the TRL of the solution.
16:00	**Closure**