PHARS: A C-BAND AIRBORNE SAR.

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In The Netherlands a plan to design and build a polarimetric C-band aircraft SAR system of a novel design, called PHARUS (PHased Array Universal SAR) is carried out by three institutes. These institutes are the Physics and Electronics Laboratory TNO in The Hague (prime contractor and project management), the National Aerospace Laboratory NLR in Amsterdam and the Microwave Laboratory of the Delft University of Technology. The PHARUS project is being carried out under program management of NIVR (Netherlands Agency for Aerospace Programs) in Delft. The project is sponsored by the Ministry of Defense and by the National Remote Sensing Board.

The PHARUS project is divided into a definition phase and a realisation phase. The ultimate goal is the development of an airborne polarimetric SAR system in the C-band (same frequencyband as ERS-1), to be realised in the realisation phase (1991-1993).

In the currently running definition phase three preparatory studies are carried out. These studies are essential for a proper design of the PHARUS polarimetric SAR. A preparatory study on antenna technology is carried out to study the integrated antenna design (including power and low noise amplifiers). An antenna motion compensation study is necessary to build up the experience with corrections of aircraft or rather antenna movements. In the third preparatory study a SAR testbed will be realised. This paper focuses on the SAR testbed, called PHARS.

The PHARS is a simple SAR system, capable of imaging a 7 km strip at limited ranges under incidence angles between 20 and 60 degrees. It has no internal calibration. The image quality relies on autofocus methods and on motion compensation on basis of onboard accelerometers and gyro's, closely mounted to the antenna. The antenna itself is fixed to the aircraft. It is a one dimensional phased array. The beam can be steered in 1 ° steps to compensate for the average driftangle. The beamwidth of the antenna is wide enough to eliminate the influence of aircraft yaw. In table 1 the key parameters for the PHARS are given.

The testbed will be used to study general problems of aircraft SAR. The experience gained with it forms an important input for the choices to be made on the PHARUS high resolution polarimetric system. Of course the testbed will also be used to acquire images for remote sensing studies. Since the polarisation and the frequency correspond to those of the ERS-1, it may be a valuable tool for underflights.

The PHARS has an eight element patch antenna for transmit and receive mode. Each element consists of four serial fed patches. The total gain of the antenna is more than 20 dB. In the testbed the antenna can be easily replaced to adapt the system to different imaging modes (for instance steep versus shallow look).

-frequency	: 5.3 GHz (C-band)
-antenna	: 8-element patch antenna for transm. and rec. beamwidth 9 * 20 degr, VV pol. coarse step beamsteering (1 °)
-transmitted power	: 160 Watt peak by 8 transistors
-PRF	: 3500 Hz
-pulsewidth	: 32 ns (4.8 m) after compression 12.8 µs before compression
-digitisation	: 4096 samples, 8 bits @ 87.5 MHz (offset IF)
-range	: 6 - 13.7 km
-azimuth presumming	: 16 x
-aircraft	: Swaeringen Metro (NLR); used at an altitude of 6 km, and a speed of 100 m/s

Table 1: Properties of the SAR testbed PHARS.

Each element of the array antenna is equipped with its own module, consisting of a two stage GaAs FET 20 Watt power amplifier, a two stage GaAs FET LNA (low noise amplifier), two PIN diode switches and a four bit phase shifter. The modules are located on the backside of the antenna, with the drivers on top of it. The receive and transmit gain is 16 dB and the noise factor is about 1.7 dB.

The microwave generator is a phase locked dielectric resonator oscillator (PLL-DRO) working at 5.6 GHz with a SSB noise level less than -40 dB at 1 Hz and -70 dB at 10 Hz from the carrier. The phase lock is realized by using a GaAs divider. The active devices in the generator are bipolar transistors.

The technique used in the RF circuitry is thin film technology. Where possible MMIC's are used to increase integration and performance.

The pulse compression frequency chirp is generated by a digital circuit, realised in ECL technology operating at a 87.5 MHz clock rate. The circuit is built on a six layer pcb with ECL components mounted on both sides of the pcb to increase integration.

The digital data that remains after azimuth presumming with a factor of 16 will be recorded on a high density tape recording system. Apart from the azimuth presumming there is no on board processing for the testbed. By getting down as much data as possible, very flexible experiments are enabled with the system at the cost of long processing times.

The PHARS will probably make its first flight in May 1990. Hopefully some first results can be presented at the EARSeL symposium.

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