NEW 9MM 7-BEAM RECEIVER

This receiver will replace both correlation and polarization modules of the current 2x3 horn 9mm receiver. Figure 1 shows the new receiver during laboratory tests in October 2007 in Bonn.
The receiver will deliver 12 RF channels at 30-34GHz from totally 7 horns arranged elliptically as shown in Figure 2. This horn layout is the result of a redesign of the receiver in 2004. In comparison to the first layout, which had the horns arranged in a hexagonal grid, the latter satisfied the astronomers' request for larger horn spacing available in azimuth.

Figure 1 *9mm 7beam receiver during assembly and tests in the lab*

The receiver is a pseudo correlation design similar to those used for WMAP / PLANCK that offers suppression of the 1/f noise resulting from gain fluctuations which are inherent to cryogenic InP HEMTs. There will be three polarimetry pixels available, 2 circular, 1 linear polarized. Another two pixels will be total power LCP, each referenced to an internal cold waveguide load whose temperature is accurately measured synchronously with the data from the RF detectors. Finally there is beam switch implemented in hardware with two horns differenced by means of a waveguide magic tee. In Figure 3 a schematic sketch of the different types of RF channels that are implemented in the receiver is given. Since the receiver is laid out as a direct detection receiver, no mixing to an IF at a few GHz is carried out; all processing down to the final direct detection step is done at 30-34GHz.

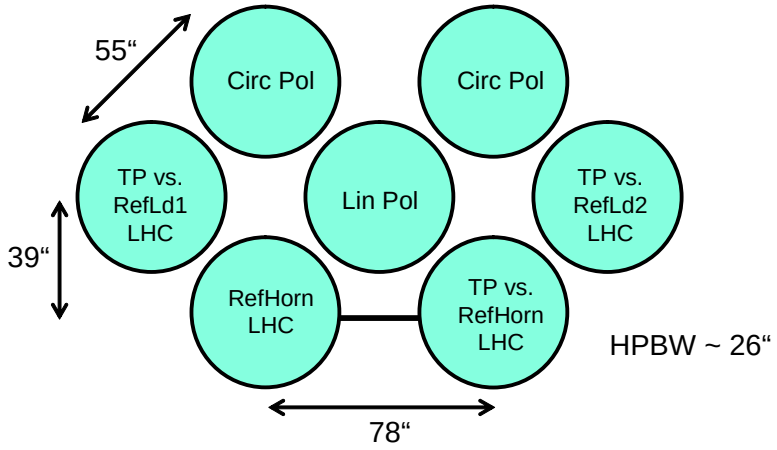

Figure 2 *Horn layout of the7 beam 9mm receiver with beam spacing on sky indicated*

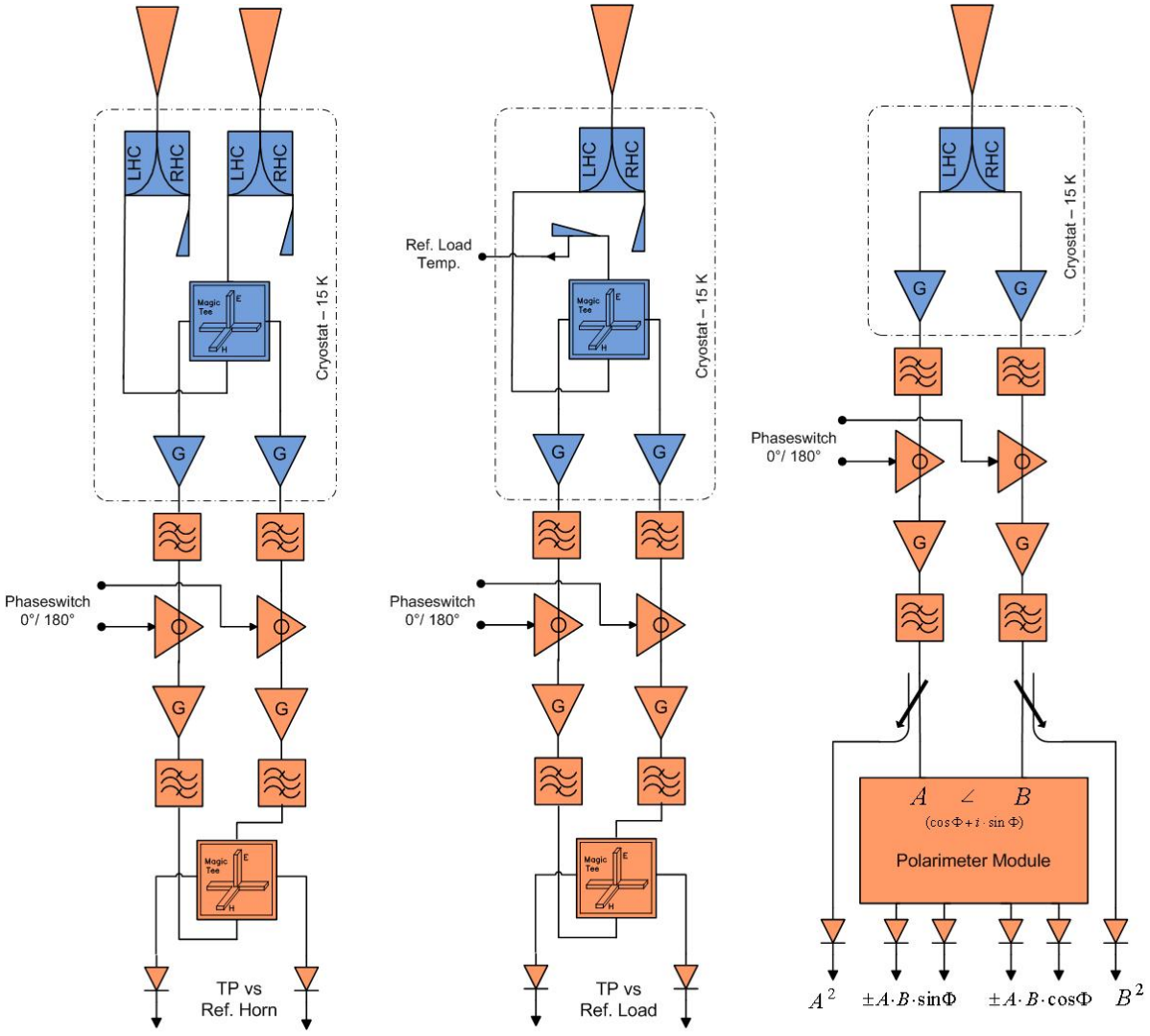

Figure 3 *Schematic diagram of the different types of RF channels for the7 beam 9mm receiver*

Also from the aspect of supporting electronics this receiver is completely different as compared to previous total power receivers designed for the Effelsberg telescope; therefore it largely required the development of new electronics:

- The receiver was meant to be a test vehicle for the development of large arrays. Its design is therefore entirely based on MMICs. A large number of InP / GaAs MMICs is employed: in total there are 24 cryogenic LNAs, 48 LNAs at ambient temperature and 12 phase switches. This resulted in the need for the design of a completely new, modular bias electronics that includes the capability for remote computer control in the future to ensure scalability.
- Injection of the calibration signal in the usual manner using multihole couplers in the input waveguide section of every channel didn't seem practical for larger numbers of horns. Hence the calibration signal will be injected via a transmitter horn located at the rim of the secondary mirror of the telescope. Feasibility of this scheme has already been verified with the old 9mm receiver.
- The standard Effelsberg continuum backends do not support fast switching at rates up to 4kHz which are necessary to properly operate a switched pseudo correlation receiver in order to suppress the 1/f noise. Therefore a new backend had to be developed that will integrate the new capabilities into the timeframes defined by the common Effelsberg data reduction system. This backend will be integrated with the receiver and therefore needs to be shielded very thoroughly. It will interface to the Effelsberg data system via an optical fiber link. A short technical description is given below in the section on "Backend Developments".
- Since this will be a completely new type of receiver at the 100-m telescope, its implementation will be done step for step. First tests will be carried out in unswitched mode using the standard Effelsberg backend with the phase switches in a fixed state. For this purpose 4 standard V to f converters are implemented in the receiver that interface to the telescope in the usual way. This enables a smooth transition to the switched mode of the receiver starting from a standard operating mode and thus will simplify debugging the new operating modes. This will also simplify the testing of the new digital backend for EMI problems that might arise due to the placement of the new backend in the receiver rack.
- Since only 4 V to f channels will be available for the first implementation of the receiver, a decision which horns should be selected are nescessary. From the astronomers side (Th. Krichbaum) the two horns with the largest spacing on sky (156") were requested which are TP vs. Ref.Load 1 / 2 LHC