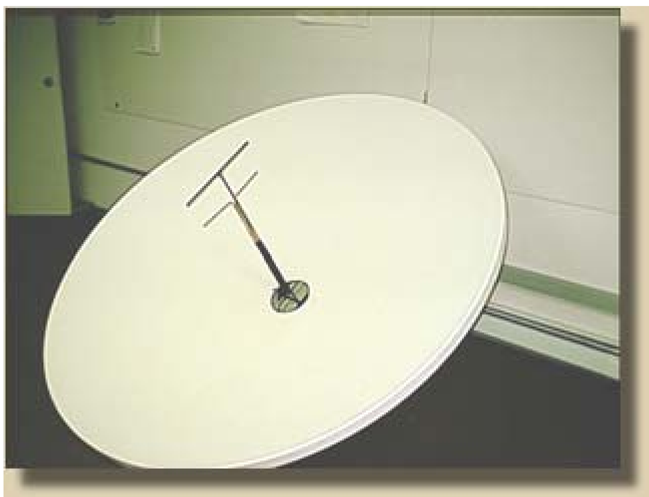
HIPAS Observatory

HIgh Power Auroral Stimulation

HIPAS Observatory Communication Studies in an Active Arctic Ionosphere



One of 48 6' diameter parabolic transmit antennas

Monitoring of electron plasma waves and ionospheric scatterers using a bistatic UHF radar utilizing an 88? dish at NOAA Gilmore Creek station.

The most important parameter governing HF scattering is the electron plasma waves (EPW) excited by the high power heater. With the availability of a large dish at the nearby NOAA Gilmore Creek tracking station we can now complete this diagnostic by acquiring UHF transmitters. Most recently we have installed a sensitive receiver on the 88? dish and its sensitivity has been tested.

The transmitter array:

The 6x8 element array of parabolic reflectors has been modeled using Numeric Electric Code (NEC), and the resulting pattern yields a main lobe gain of approximately 34dB over isotropic (dBi). These figures include an actual measured gain of a single 6-foot diameter dish fed with a two-element dipole array of 16.5dBi.

Electronics Research, Inc., the company that responded to our request for a one megawatt 48:1 power divider, was consulted again about the possibility of building four separate

megawatt 12:1 power splitters, with each power splitter being driven by a 1.25 MW klystron amplifier. The individual output of each would also be balanced (push?pull) to properly drive the dipole antennas on the individual dishes. ERI expressed interest in supplying the 48 two-element antenna feed assemblies. ERI has sophisticated antenna-modeling software, several generations more advanced than the NEC code. The newer software is capable of optimizing
the array configuration (e.g. adjusting the dimensions for maximum gain, or minimum side-lobes, or whatever parameter we ultimately deem most important). Conventional NEC cannot optimize an antenna array, but merely display the pattern of a given configuration. ERI indicated that they could model our proposed array for a nominal fee. We will ask them to bid on the whole job of furnishing antenna drives, power splitters, and connections to the wave-guide output of the klystrons.

We are considering having ERI build a 12:1 splitter and twelve antenna feeds that will be driven from the one-MW surplus UHF-RF package from Radio Research (described in August report, pages 5 & 6). Successful operation of this subsection would be reason to give ERI the rest of the package.

The receiving instrument:

The receive site at Gilmore Creek tracking station (NOAA) consists of a 426 MHz crossed dipole mounted at the focal point of an 88? diameter parabolic dish, with approximately 38 dB of gain. The dish is fixed at a near-zenith position. Separate low noise GaAs Fet pre-amplifiers are used for the crossed dipoles. Separate low-loss transmission lines feed from the preamplifiers to the main tracking center control room, where the received signals are fed to a down-converter, receiver and detector.

The modulation scheme, currently under design, will consist of a BPSK (bipolar phase-shift keyed) digitally encoded signal stream, with a matching coherent detector at the NOAA Gilmore Creek site. This coding scheme will greatly simplify the measurement of phase shift without the need for an external time reference.

Digital signal processing using a coding scheme will be used for the bistatic system. The gain and noise figure of the receiving antenna and preamplifiers currently in existence are at the limits of the state-of-the-art for this frequency range.

Nonlinear effects depend on the peak amplitude rather than average power. Since HIPAS transmitters can be pulsed to high power with shorter duty cycle, it is efficient to upgrade the HIPAS transmitters with higher voltage supplies to enable such pulses to be emitted. We are planning to upgrade the voltage by a factor of two first to test the limit of the highest voltage that can be impressed on the transmitter tube.

The objective of this task is to measure the effect of electron plasma waves (EPW) on the scattering of HF radiation from the ionosphere. The task includes several design and fabrication elements, as well as the measurements program. Some of the required hardware exists on-site. Some additional electronics components need to be purchased or fabricated, as noted below. Our implementation procedure is based on experience with existing prototype equipment, which includes a very low power the 430 MHz UHF transmitter at HIPAS, the large dish at the Gilmore Creek (NOAA) station, a sensitive 426 MHz UHF receiver for the
dish, and the HF transmitter at HIPAS.

This task is to design, build and demonstrate the generation of a very high power RF pulse at 2.85 MHz using the existing array at HIPAS. The task involves the modification of an existing amplifier to produce a shorter, higher power pulse from the existing power supply. The current system produces 84 MW ERP at 2.85 MHz, CW. The goal of the modified system is to demonstrate the capability to produce on the order of 1 GW at 2.85 MHz. This will be achieved by modifying one of the 8 amplifiers to produce the short pulse length required for the higher peak power, while maintaining the same average power as for the existing system.

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