PROJECT 2.625
PULSAR SIGNAL PROCESSOR
MEMO NO. 4

Recommended Hardware Improvements/ Acquisitions for NRAO

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Short Term:

1. Accurate Time at the 300' telescope; ability to record time to within 1 μs (necessary for pulse timing measurements; dual observatory observations requiring the identification of the same pulse).

2. Ability to fire noise calibration sources for specified durations at specified intervals (e.g. synchronously with a pulsar). Cals for different receiver channels should be separately controllable. Necessary for calibration of an adding polarimeter in pulsar work.

3. Retrofitting of the Fabritek signal averager in burst sampling mode; at present it can sample only 64 or 128 samples per pulse period when 4 channels are averaged. For many pulsars this is an insufficient duty cycle and it would be desirable to average 256 or even, if hardware permits, 1024 samples per period (corresponding to continuous, or 100% duty cycle, sampling.

Long Term:

Self-contained Stand Alone Data Acquisition System

Ideally, a stand-alone system which accomplishes the following is desirable:

1. variable-bandwidth filter bank plus post-detection dedispersion capability for 4 channels (e.g., polarimeter outputs).

   e.g., pipeline FFT (2x32 points complex) + microprocessor dedisperser; digital time constant (via voltage-to-frequency converters)

2. ability to record single pulses or synchronously-averaged pulses or continuous sampling.

3. ability to construct the Stokes parameters.

4. can record timing information.

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5. can easily be moved to any telescope; requires as inputs a clock tick (for GMT or local solar time), a synthetizer clock (for driving FFT, etc.), and IF signal.

Approximate cost (in parts): approximately $100K

Justification:

1. Specific projects in the foreseeable future include pulsar polarimetry of single pulses and arrival-time measurements. Timing measurements require two channels (to get the total intensity).

   Many pulsars outside of Arecibo's declination range could be studied. Scientific output: propagation effects in pulsar magnetospheres and internal dynamics of neutron stars.

2. Pulsar searches would be optimized by maximizing the bandwidth while also accomplishing post-detection de-dispersion. An "all sky" survey along the lines of the recent Damashek/Taylor search can be re-done using the smaller system-temperature upconverter receivers.

   Also, the 300' will be useful for pulsar searches in specific fields as dictated by future x-ray and γ-ray studies (if any).

3. A stand-alone system would be useful on both the 140' and 300' telescopes and also at Arecibo, Bonn, and Goldstone. NRAO is the best organization to construct such a device because Arecibo has neither the labor force nor the funds and NASA will not fund ground-based astronomy at such a level (nor is JPL s hardware FFT device flexible enough to accomplish the abovementioned tasks). Bonn's current de-disperser is inflexible in bandwidth so the number of pulsars is limited.

4. A digital approach is desirable over an analog one because stability (of bandpass shapes, time delays, etc.) is necessary in order to compare pulse shapes from difference epochs. This is important in pulse timing measurements (in which a pulse shape is convolved with a template) and in any searches for precession of the pulsar beam.