

The Value of Collaborations between National Facilities and Universities for Instrumentation Development Programs

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One item which has been often noted in the astronomy community over the last 10-20 years is the decline in expertise in astronomical instrumentation. As astronomers move from being wavelength experts to being phenomenological experts, their in-depth understanding of astronomical instrumentation and the inherent limitations of those instruments is also waning. As a result, the expertise needed to accurately understand astronomical data and its restrictions is also in decline. The result of this is felt in a number of ways. First, as the pool of astronomers with detailed instrumentation knowledge decreases, the probability of a given astronomer knowing an instrument expert in a given field also decreases. As a result, astronomers become extremely dependent on the quality and accuracy of canned data reduction routines and pre-reduced data which is supplied by the national (and university) telescope facilities. If flaws exist in the routines or data, or if the instrumentation limits are reached within the data, there is an increasing probability that fact will not be realized prior to the data's publication, resulting in the publication of potentially erroneous results. A second, and equally important, consequence is that the national facilities will have an increasing difficulty finding knowledgeable staff to create the required data reduction routines and data products.

A number of excellent programs exist to try and fill the need for training in astronomical instrumentation; however their reach is necessarily limited, often because their outreach is limited only to the universities in which a program is already in place and which has direct affiliation to a research-quality telescope. One means for increasing the training for students and other professionals which does not have such restrictions is through collaborations between university groups and national facilities. The advantages to such collaborations are many-fold, including the ability of university groups to take advantage of both the knowledge and facilities which otherwise may not be available to them and the opportunity for other researchers to use the newly developed instruments once they are released for use by the primary development team. The advantage of these programs should not be overlooked, nor should their numerous past successes. (See appendix for an example listing of all recent programs with the NRAO's Green Bank Observatory). In an era wherein expertise in astronomical instrumentation is in decline, these programs should be both lauded and encouraged throughout the coming decades.

Appendix – Listing of all Recent University Collaborations with the National Radio Astronomy Observatory’s Green Bank Observatory and the Robert C. Byrd Green Bank Telescope

- **Pulsar Spigot:** The GBT pulsar spigot takes the output from the GBT spectrometer and provides it in a format useful for astronomers interested in high time resolution data.
 - *University Collaborators:* California Institute of Technology
 - *Current Status:* In use as of 2005
- **Caltech Continuum Backend (CCB):** The CCB is a sensitive, wideband backend which provides carefully optimized RF detector circuits and the capability to beam switch the receiver rapidly to suppress instrumental gain fluctuations.
 - *University Collaborators:* California Institute of Technology
 - *Current Status:* In use as of 2006
- **Multiplexed Squid TES Array at Ninety GHz (MUSTANG):** MUSTANG is a 64 pixel bolometer array which is being commissioned on the GBT for use at 90 GHz.
 - *University Collaborators:* University of Pennsylvania, National Institute of Standards
 - *Current Status:* Shared risk release for 2009
- **Zpectrometer:** Zpectrometer is an analog signal processor which has 14 GHz of instantaneous bandwidth that cover 26–40 GHz with moderate resolution and with superb baselines, due to its correlation design.
 - *University Collaborators:* University of Maryland
 - *Current Status:* Shared risk release for 2009
- **Green Bank Ultimate Pulsar Processing Instrument (GUPPI):** GUPPI is a pulsar search and timing backend built with off-the-shelf hardware designs, and custom FPGA gateware.
 - *University Collaborators:* University of Cincinnati, West Virginia University
 - *Current Status:* Incoherent filter bank modes released; De-dispersion modes in development
- **Phased Array Research:** A 19-element beam forming array and data acquisition system with radio frequency interference mitigation components is being developed and tested on the 20m radio telescope on the Green Bank Site
 - *University Collaborators:* Brigham Young University
 - *Current Status:* Ongoing development project
- **Bistatic Radar Observations of the Ionosphere:** The 43m telescope on the Green Bank site is being used both study turbulent properties of Earth's Ionosphere as well as for a development program for FPGA-based backends and a cryogenic feed and data monitoring system project.
 - *University Collaborators:* Massachusetts Institute of Technology
 - *Current Status:* Ongoing observation and development project

- **Pulsar Tomography Instrument:** This is a self-contained receiver system, consisting of a dual-polarization feed with wide-span spectral response (100-1500 MHz), to be used at the prime focus of the GBT.
 - o *University Collaborators:* Ramen Research Institute
 - o *Current Status:* Planned deployment on telescope in June, 2009
- **Radio Frequency Propagation Study:** The RF propagation study is to test and enhance the capabilities and accuracy of the terrain modeling program to understand the propagation of radio waves.
 - o *University Collaborators:* Virginia Polytechnic Institute
 - o *Current Status:* Ongoing testing and development