

WKU Sisterhood Grant 110222: Big Red Radio Telescope

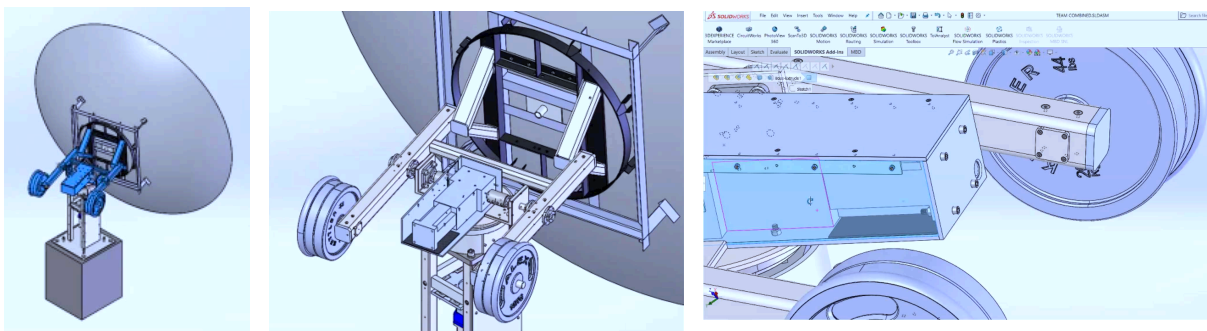
Mid-Year Status Report

Steven Gibson, April 30, 2020

Activities and Progress to Date

We are pleased to report that the Big Red Radio Telescope (BRRT) project has made considerable progress toward its goals in the past six months. A few highlights:

- A team of mechanical engineering students, as part of their ENGR 490 Senior Design course, have completed their design of the upper half of the radio telescope mount and motor drive system (**see figures below**). This critical subsystem includes the “horizontal axis” about which the telescope pivots to aim at a desired angle above the horizon (often called altitude or elevation). It sits on top of the “vertical axis” system that turns the telescope to a particular compass direction (often called azimuth); with motion about these two axes, the telescope can aim at any point in the sky as needed. The original donated satellite dish had much less pointing ability, which would have greatly reduced its functionality as a radio telescope.
- The engineering team also designed several important systems to enable safe operation of the telescope. These include: (1) mechanisms to stop the telescope from turning too far about its vertical axis, to avoid damaging it; (2) cable pathways and suspension systems to ensure that the data and power lines are fully protected during mechanical motions; (3) a mounting frame connecting the reflector dish to the horizontal axis subsystem, which has been stress tested in numerical simulations of storm wind loading; and (4) an external cover to shield the mechanical and electrical systems from weather, insect life, and other intrusions of nature.
- At the same time, physics students in the PHYS 318 Data Acquisition course have proceeded with several related efforts: (1) a special encoder system that will allow the telescope to “know” its absolute position along each axis was researched and is being purchased and integrated into the larger mechanical design; (2) new and more versatile software-designed radio receivers have been acquired, and a new control interface is being designed to use them; (3) improvements to the motor control interface are in development, with plans to test them on a small working model of the mechanical system; and (4) lightning mitigation systems are being researched to protect the working telescope in the field.



Left to right: Full model of redesigned mechanical system; altitude assembly; motor enclosure and counterweights.

An institutional goal of this project is to foster and encourage hands-on student education and career training in diverse fields of astronomy, physics, engineering, and computer interfacing while also promoting interdisciplinary collaboration. Our efforts in these area are already paying dividends, and we wish to recognize the WKU undergraduate students who have been working so hard on the project in recent months in support of the activities described above. They include Mahran Al-Mahri, Brianna Rech, Parker Stewart, and Tanner Whatley in engineering, and Jared Parker, Micah Thornton, and Caleb Dillingham in physics. Guiding and assisting their efforts are WKU faculty members Gordon Smith and Joel Lenoir in the School of Engineering and Applied Sciences and Douglas Harper and Steven Gibson in the Department of Physics and Astronomy, with additional technical advice provided by Henry Cantrell in the Kentucky Colonels Amateur Radio Club. For a full list of all people involved in the project, please see physics.wku.edu/~gibson/radio/dish/dish_credits.html.

Plans for the Remainder of the Grant

Despite the progress made, significant work remains on the project. With the mechanical design now essentially done (the ENGR 490 students present their work for review next week), the next major tasks are to build the horizontal axis assembly, complete the motor control and radio hardware interfacing, deploy the telescope in the field, and start using it for education and outreach as intended. However, the exact timing of this work is now in question due to COVID-19 social distancing restrictions, which severely constrained PHYS 318 projects this spring and have caused this summer's planned ENGR 491 build course to be deferred until fall, when a new PHYS 318 course will also be running. Although we are eager to complete the project, we were gratified to learn just today that the WKU Sisterhood has extended the original end date until June 30, 2021, which will allow us much greater flexibility in these somewhat uncertain times.

Financial Accounting

Many grant expenditures are planned for the build and deploy phases (e.g., site preparation, foundation, laying cables, etc.). However, we have made a few purchases already for some reference books for students, new radio receivers, and the first of two special axis position encoders. These are listed below, with orders separated by horizontal lines (books are in *italics*).

Product or Service	Vendor	Cost	Qty	Ship	Tax	Total	Date
<i>Understanding Basic Electronics</i>	ARRL	\$29.95	1	\$12.50	\$5.39	\$107.74	2020 Feb 7
<i>Understanding Basic Radio</i>	ARRL	\$29.95	1	–	–	–	–
<i>Understanding Basic Antennas</i>	ARRL	\$29.95	1	–	–	–	–
<i>Grounding and Bonding</i>	ARRL	\$22.95	1	\$10.50	\$2.21	\$49.61	2020 Mar 14
<i>Elimination of Electrical Noise</i>	ARRL	\$13.95	1	–	–	–	–
RSPdx software-defined radio	SDRPlay	\$179.95	3	\$21.71	\$0.00	\$561.56	2020 Mar 18
IncOder Inductive Angle Encoder*	Zettlex	\$540.20	1	\$6.48	\$47.74	\$594.42	2020 Mar 18
All purchases as of 2020 Apr 30						\$1313.33	

*Encoder purchased but grant expense claim awaiting delayed shipment from United Kingdom

Some additional purchases are anticipated prior to full assembly, including a second encoder, interfacing hardware, and possibly other mechanical parts. The grant budget also includes funds for student wages. So far, students have only worked on the project for credit as part of a course, but we may hire a student over the summer for interfacing work, and additional paid labor is anticipated for the telescope assembly and deployment.