Daytona Section Small Radio Telescope (SRT) Program

Small Radio Telescope Program's Mission Statement

The objective of the Small Radio Telescope Program is to acquire and operate a small radio telescope in support of a comprehensive educational and research program. This program will be directed at increasing the understanding of science and electrical engineering in the local schools and universities of the greater Daytona Area.

History of Program

In early 2007 a grant application was submitted by the Daytona IEEE Section to the IEEE Life Member Committee (LMC) to provide funding for a Small Radio Telescope (SRT) Program. The purpose of the SRT Program was to acquire, assemble and calibrate a small radio telescope to be used for teaching radio astronomy, electronics, communications, antenna theory, and data processing. The device will be used to support the teaching of these technologies at the University Level, High School and Middle School Level, and provide workshops to home schooled students.

In January of 2008 we received confirmation that the grant for the SRT Project was approved by the IEEE LMC, and that funding had been made available.

SRT Program Development Effort

On November 20th 2008 the components for the small radio telescope were delivered to Embry-Riddle University (ERAU) in Daytona Beach, Florida. Embry-Riddle Aeronautical University permitted the use one of their developmental laboratories to assemble and test the telescope system. A picture of the radio telescope components as delivered from Custom Astronautical Support Services, Inc. (cassicorp) is shown in Figure 1.

Figure 1 - SRT Components Delivered to the Development Lab at ERAU

In order to support the Antenna System a custom SRT pedestal was designed and built by Dr. Hugh Ward and William Wallace. The original design was stiffened and equipped with casters for mobility. These casters permit the telescope to be rolled outside for testing. To provide antenna leveling during testing a set of four small automotive scissors jacks were obtained. A photograph of the SRT pedestal with the AZ/EL CASSI main motor gearbox assembly installed is shown in Figure 2.

Figure 2 - SRT Pedestal with AZ/EL Gearbox Attached in the Development Lab at ERAU

Not to exclude the human element the personnel who worked on the development of the SRT as of the 1st of December 2008 is shown in Figure 3.

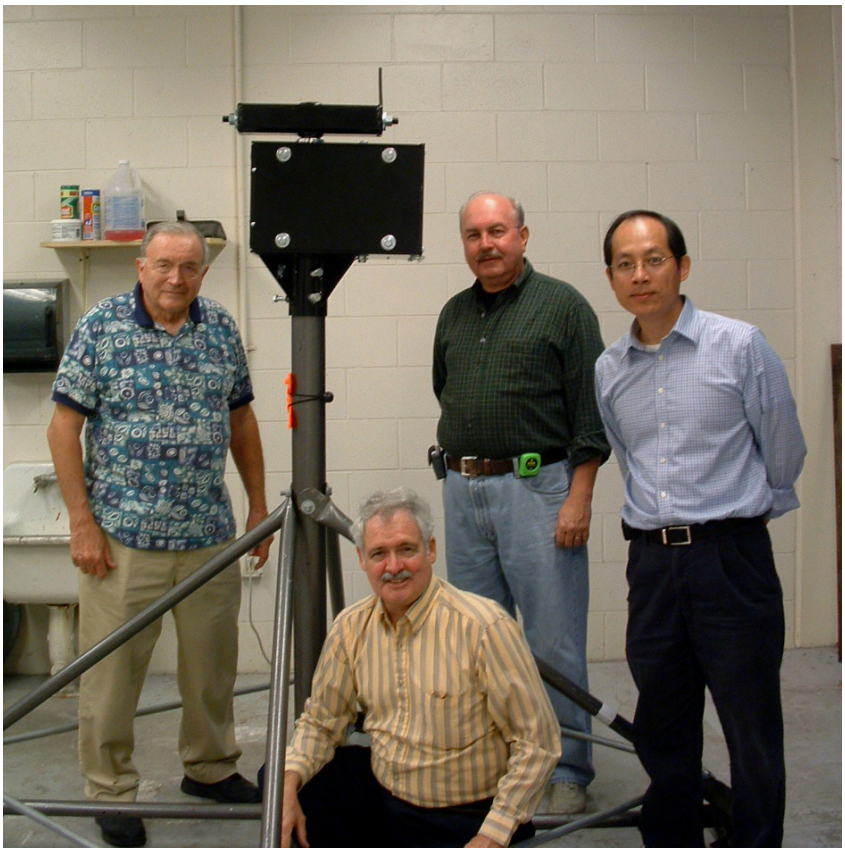

Figure 3 - The Support Team as of December 1, 2008 are shown (L to R) Charlie Husbands, Dr. Hugh Ward, Allen Jusko, and Dr. Jianhau Liu

With the pedestal and AZ/EL drive mounts completed, the parabolic reflector was assembled. The RF receiver front end was then attached, with standoffs, to the parabolic reflector at the calculated focal point. The completed reflector assembly with the receiver front end is shown in figure 4.

Figure 4 - Ron Gedney holds the assembled parabolic reflector assembly with the RF receiver ready for installation on the antenna pedestal

On December 5th, final mechanical portion of the assembly process was completed when the parabolic reflector assembly was mounted on the antenna pedestal. The AZ and EL drive assemblies were mechanically placed in the zenith position and the antenna reflector and RF front end were secured to the pedestal assembly. This final mechanical assembly stage is shown in figure 5.

Figure 5 - Dr. Ward and Dr. Liu securing the parabolic antenna assembly to the pedestal structure

With the, final mechanical portion of the assembly process completed it was necessary to interconnect the Azimuth drive and Elevation drive motors within the system gearbox control box. A 9 wire cable, carrying the calibration, control signals and power necessary to remote the antenna system from the system control box was also installed. The installation of the control cable to the antenna motor gear box is shown in Figure 6.

Figure 6 - Dr. Liu installs the remote cabling in the AZ/EL gearbox while Ron Gedney looks on

With the remote control box interconnected to the antenna structure the laptop computer was integrated into the system. One of the functions of the laptop computer is to permit the operator to aim the antenna system to a unique set of coordinates remotely. On 9 December, 2009 the system installation reached the point where the antenna system was functioning as designed while the receiver portion of the system still operated in the simulated mode. An illustration of the remote operation of the antenna system from the laptop computer station is shown in Figure 7.

Figure 7 - Charlie Husbands is shown remotely positioning the antenna system
through the laptop control computer in the development laboratory

On December 11th, the calibration unit was installed at the apex of the parabolic antenna and the digital receiver was interfaced to the system controller. With these devices in place an initial attempt was made to measure the temperature of system. A group of interested observers, shown in figure 8, are discussing the resulting laptop display data with both of the software simulators remove. This initial measurements of system temperature created many more questions than anticipated..

Figure 8 - The Dream Team Discuss the Initial Receiver Data
(L to R) Dr. Jianhau Liu, Dr. Hugh Ward, Ron Gedney, Charlie Husbands, and Roger Grubic

With the approach the Universities Holiday Break it was necessary to shut down the SRT's development effort until the beginning of the New Year. The system was rolled from the development laboratory to a near by storage facility. Figure 9 shows several members of the team placing the system in the storage facility for a well deserved rest.

Figure 9 - Placing the SRT System into Storage for the Holiday Season

On January 7th 2009 the SRT was removed from storage and disassembled in the Embry-Riddle University development laboratory. The disassembled SRT was moved from ERAU to a private aircraft hanger at the Spruce Creek Fly-In Community in Port Orange Florida. This move was made due to a space commitment at the University and the lack of good sky visibility at the development laboratory location. The new private hanger facility has excellent sky visibility and is an ideal location for completing the calibration and testing of the SRT. The radio telescope reassembled in the Hanger Test Facility is shown in Figure 10.

Figure 10 - SRT System Reassembled in the Hanger Test Facility

In mid February an arrangement was made to relocate the SRT from the hanger facility at Spruce Creek to the Museum of Arts and Sciences in Daytona, Florida. As this will be the permanent home for the telescope for some time it was decided to brand the device with the IEEE logo. The logo was made large enough to be seen

from the ground with the antenna section mounted on top of a twenty foot mast in the museum's courtyard. Figure 11, shows the Section Secretary Al Jusko applying the logo to the azimuth gearbox.

Figure 11 - Branding the Daytona IEEE Section's Radio Telescope

With the improved sky visibility at the new hanger test facility complete testing of the radio telescopes receiver could take place. Figure 12 shows the SRT on the hanger apron during receiver tracking testing. It should be noted that height of the antenna pedestal was shortened so that the SRT could be more easily moved in and out of the hanger space.

Figure 12 - SRT System on the Apron of the Test Facility Hanger during Initial Receiver Testing

On February 17th the SRT was disassembled and loaded into a rental truck for the trip from the aircraft hanger facility at Spruce Creek to the Daytona Museum of Arts and Sciences. Figure 13 shows the Dayton IEEE Section moving team unloading the disassembled small radio telescope into the courtyard behind the planetarium at the Daytona Museum of Arts and Sciences (MOAS). Dr Liu and Tracy Wichmann lift the parabolic reflector from the truck while John Harris and Roger Grubic balance the dish above their heads.

Figure 13 - Unloading the Disassembled SRT at the Daytona Museum of Arts and Sciences

The Small Radio Telescope was then reassembled in the courtyard at the Daytona Museum of Arts and Sciences. Figure 14 shows Dr. Liu reattaching the parabolic reflector to the azimuth drive assembly after its truck journey from the Spruce Creek Hanger Facility. Roger Grubic operates in the foreground with John Harris observing in the background.

Figure 14 - Shows the Reassemble of the SRO at the Daytona Museum of Arts and Sciences

The reassembled SRT was tested and found to have made the journey from Spruce Creek with no ill effects. Figure 15 shows the SRT reassembled in the Courtyard at the Daytona Museum of Arts and Sciences. Note the unused L Band satellite Dish also shown in this photograph. After additional testing of the SRO the L Band Satellite Dish is scheduled to be removed from its 20 foot mast and the SRT will be lifted into its place.

Figure 15 - The Small Radio Telescope Reassembled in the Courtyard at the Daytona Museum of Arts and Sciences

On February 21st, 2009 a reception was held at the Halifax River Yacht Club in Daytona Beach for a representative group of the IEEE Life Members Committee. These members, from throughout the United States and a number of foreign countries, had been holding their meeting in Orlando Florida. As this group was responsible for funding the SRT project they took time from their meetings in Orlando to visit the Daytona Section to see the the radio telescope. Figure 16 shows the gathering of the Life Members Committee at the Halifax River Yacht Club prior to the technical presentations on the SRT and luncheon.

Figure 16 - A gathering of Life Members Committee at the Halifax River Yacht Club
to discuss the Small Radio Telescope Program

The first item on the agenda was a welcome to the Dayton Section from Roger Grubby current Section Chairman. A presentation by Charlie Husbands, the SRT Project Leader, consisted of a brief lecture on Radio Astronomy, the development and characteristics of the SRT system, and a history of the acquisition and construction of the Daytona's SRT device. Tracy Whitman, the Section Treasurer, then gave an accounting of the funds spent on the project to date. Dr. Hugh Ward the Education Director on the project then explained the proposed steps necessary to integrate the SRT into the museum's planetarium program and in the future to permit remote access to the telescope for education and research applications.

Figure 16 - A Presentation on the SRT given to the Life Members Committee at the Halifax River Yacht Club

After the series of presentations, a luncheon buffet was set up at the Halifax River Yacht Club for the attending Life Members. During the luncheon a simulation of the operation of the SRT was presented, demonstrating the displays and controls necessary to select a radio sources, calibrate the telescope, track an object, record the received data and reduce the data into useable form.

Figure 16 - Luncheon Buffet for the Life Members Committee at the Halifax River Yacht Club

After the luncheon the Life Members Committee group was transported to the Daytona Museum of Arts and Sciences. Figure 17 shows the Life Members gathering in the courtyard behind the museum where the SRT is temporarily housed.

Figure 17 - Gathering of the Life Members Committee in the courtyard behind the Daytona Museum of Arts and Sciences

As a demonstration the operation of the SRT, the Sun was selected as the object to be tracked. Figure 18 shows the Life Members Committee gathered in the courtyard of the Daytona Museum of Arts and Sciences watching the radio telescope track the Sun.

Figure 17 - The Life Members Committee in the courtyard behind the Daytona Museum of Arts and Sciences watching the SRT track the Sun

At the conclusion of the demonstration a number of the members had specific questions on the construction and operation of the Small Radio Telescope. Figure 18 shows Dr. Ward in the dark hat, who is the Educational Director, on the SRT Project answer specific questions about the telescope.

Figure 18 - Dr. Ward answering questions on the operation and construction of the SRT with a group of visiting Life Members

On March 19th, 2009 a work party was put together to change out the parabolic reflector on the SRT. Dr. Hugh Ward had provided the Daytona Section with a 10 foot parabolic dish, in wonderful condition, to allow us to improve the sensitivity of the existing SRT. Figure 19 shows Al Jusko assembling, in the background, the four segments of the new 10 foot dish. The existing 7.5 foot dish, with the subreflector electronics still attached, is

shown in the foreground. The change out of the parabolic reflectors was done in the courtyard of the Daytona Museum of Arts and Sciences.

Figure 19 - The Removal of the 7.5 Foot Parabolic Reflector and the Assembly of the 10 Foot Parabolic Reflector

The 10 foot parabolic reflector was assembled and then lifted into the halo assembly ring on the SRT. The new reflector fit exactly into the the brackets on the halo ring and all of the bolt holes used to hold the 7.5 foot reflector could be used without any modifications. Figure 20 shows the SRT with the new 10 foot parabolic reflector securely mounted in the halo assembly of the SRT. The 7.5 foot parabolic dish with the subreflector still attached is shown in the background.

Figure 20 - The SRT with the new 10 foot parabolic dish bolted into the halo ring.

After securing the new 10 foot parabolic dish onto the SRT the subreflector assembly was removed from the old configuration and mounted, with new stand-off rods to the new parabolic reflector. Figure 21 shows Dr. Liu and Al Jusko adjusting the subreflector assembly on the new SRT configuration. Part of the alignment process requires carefully adjusting the subreflector focus point for the new reflector configuration.

Figure 21 - Al Jusko and Dr. Liu adjusting the focal distance from the subreflector to the main reflector in the new configuration

With the installation of the new 10 foot parabolic reflector completed the SRT was run through as series of test to determine its operational capability. Figure 22 shows the initial Sun tracking test required to adjust for antenna alignment and determine the systems mechanical performance. The installation of the new reflector will markedly increase the sensitivity of the SRT system.

Figure 22 - The SRT shown during Initial Sun Tracking Tests with the newly installed 10 foot Parabolic Reflector

On 1 April 2009 the SRT was moved from the courtyard of the Daytona Museum of Art and Science to a 20 foot mast. The mast was currently occupied by a 10 foot "L" band satellite dish. Figure 23 shows two workman from Advanced Cable removing the "L" band parabolic dish from the antenna mast.

Figure 23 - Removing the "L" Band Satellite Dish from the Antenna Mast

A bucket truck, provided by Advanced Cable, was used to move the SRT from the ground to the mast. Figure 24 shows the lifting arm of the bucket truck positioned over the center of gravity of the SRT. In this photo it can be seen that the bucket truck has just lifted the SRT free of the ground pedestal.

Figure 24 - Lifting the SRT free of the Ground Pedestal

The SRT was then moved from the courtyard toward the mast. Figure 25 shows the SRT being transported to the antenna mast end of the courtyard using the bucket truck.

Figure 25 - Moving the SRT from the Pedestal toward the Roof Mast

With the help of the bucket truck the SRT is lifted to the roof the the Daytona Museum of Arts and Sciences. Figure 26 shows the SRT being guided onto the satellite mast.

Figure 26 - The SRT is being guided to the mast on the roof of the Daytona Museum of Arts and Sciences

With the Small Radio Telescope on the mast, it was aligned and secured. The cables were then dressed and strapped down to permit proper operation from the ground. Figure 27 shows the SRT after the installation process on the roof had been completed.

Figure 27 - The Small Radio Telescope Installed on the roof of the Daytona Museum of Arts and Sciences.

With the SRT Antenna Installed on the roof the Daytona Museum of Arts and Sciences it was necessary to connect it to the SRT controller and control computer in the Planetarium. Figure 28 shows Al Jusko installing PVC conduit in the overhang between the SRT antenna and the Planetarium at the Daytona Museum of Arts and Sciences.

Figure 28 - Installing Conduit to carry the SRT Control and Data Cables under the Overhang at the Daytona Museum of Arts and Science

Figure 29 shows Al Jusko connecting the final segments of the conduit on the rear wall of the Daytona Museum of Arts and Sciences. The nine conductor control cable and the coaxial cable required to interface with the SRT is shown extending for the conduit under construction.

Figure 29 - Al Jusko working on the final segment of the Outside Conduit and SRT Control and Data Cables

The final segments of the control conduit are shown in Figure 30. At this point the control cable and coaxial cable pass through the exterior wall of the planetarium at the Daytona Museum of Arts and Sciences.

Figure 30 - The Control Cable Conduits where they enter the wall of the Planetarium

Because of limitations on the length of the cabling between the SRT Antenna and SRT Control Box it was necessary to install the Control Box at site just inside the rear wall of the planetarium. Figure 31 shows the SRT Control Box on the extreme right of the hardware on the shelf. In this configuration the laptop computer is connected to the SRT Control Box with a short piece of RS 232 cable. With this configuration we were able to run a series of test with the radio telescope to confirm that the installation to this point was working correctly.

Figure 31 - Final Position of the SRT Controller and Temporary Laptop Computer Test Station

In the final configuration a desktop computer will be used to control the SRT system from the Control Console position of the Planetarium. To interconnect the Control Box to the Control Console position it was necessary to run approximately 100 feet of RS 232 cabling through the access space in the ceiling of the planetarium. Figure 32 shows Al Jusko and Dr. Hugh Ward working the cable through the ceiling access space around the planetarium's projection equipment.

Figure 32 - Installing the final cabling in the ceiling of the MOAS Planetarium
from the SRT Controller to the Computer Control Station

With the RS 232 link connecting the SRT controller to the SRT Computer Facility the Planetarium installation was completed. Figure 33 shows the SRT Computer System integrated into the Planetariums display racks. From this point the computer can control the SRT antenna system and display the graphical results on the planetariums overhead projection system.

Figure 33 - The SRT Control Facility integrated into the Planetariums display facility

In Mid May 2009 a tropical depression dumped up to 24 inches of rain on the Daytona Area. One of wings of the museum of the Daytona Museum of Arts and Science suffered flooding which resulted in extensive water damage. The entire museum was closed for a month and 60 percent of the facility was able to reopen on 15 June 2009. The wing of the museum that was not able to reopen was the one containing the planetarium. Figure 34 shows the state of planetarium following the flooding. The seats have been removed and the planetarium machine stands watch in the empty wing of the museum.

Figure 34 - The Planetarium Machine stands in an empty Planetarium after the May flooding destroyed that wing of the Museum

When the museum reopened a decision was made to operate a version of the planetarium show in the auditorium. until the planetarium could be restored to its former condition. The Daytona IEEE Section decided to approach the museum about installing a wireless Ethernet Link between the SRT Control Computer in the the planetarium and a remote computer in the projection booth of the auditorium. To remotely control the SRT computer in the planetarium UVNC software was obtained, installed and tested in a pair of computers to demonstrate this remote control and display capability. Figure 35 shows Dr. Liu running a series of test on the remote software system, chosen for this application, using two computers interconnected over an Ethernet link.

Figure 35 - Dr. Liu testing the remote control computer software for remoting control of the SRT from the Museum's Auditorium

To interconnect the SRT Computer and the Remote Control Computer in the MOAS Auditorium required the installation of a special wireless Ethernet link. A Memorandum of Understanding was formulated and signed by the responsible MOAS and Daytona IEEE personnel to permit the installation of this link. The first portion of the link's installation involved pulling a 100 foot terminated CAT5 Ethernet cable from the control console position in the planetarium to a wiring closet in the office space of the damaged museum wing. Figure 36 shows Al Jusko examining the Ethernet cable at the wiring closet end of the cabled portion of the link.

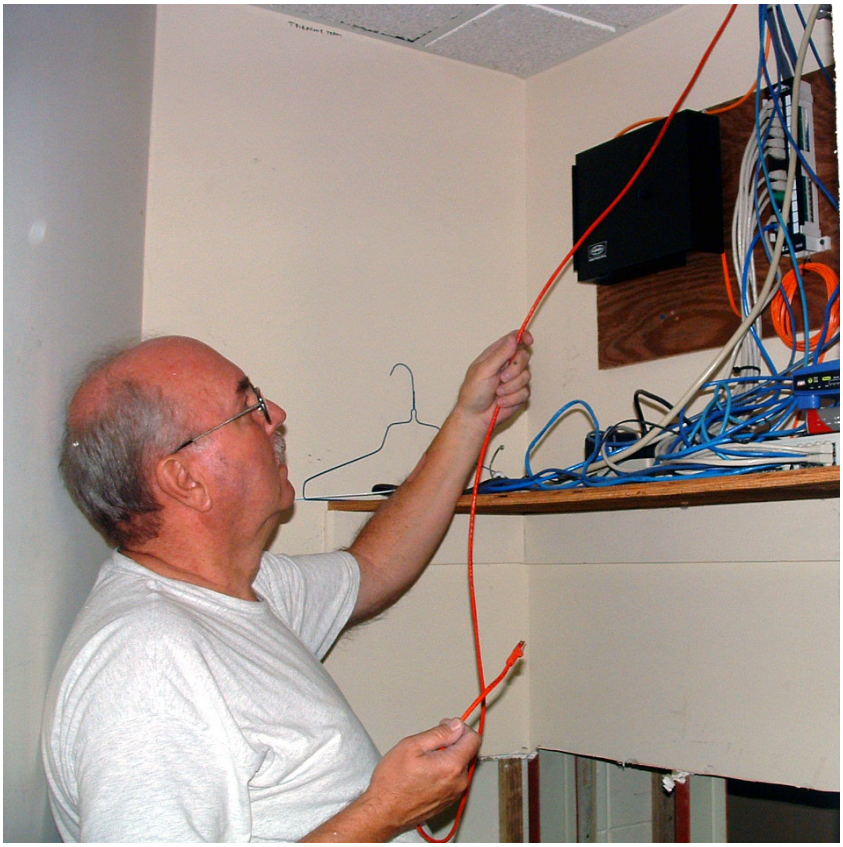

Figure 36 - Al Jusko examining the Ethernet Link from the Planetarium Console Position to the wiring closet in the damaged museum wing.

A high gain router was then installed in the wiring closet and connected to the SRT Control Computer through the cabled portion of Ethernet link. Because of the thickness of the walls and the number of galleries in the Planetarium Wing of the museum the output power of the selected router was unable to reach the Museum Auditorium without signal regeneration.

Figure 37 - The Hawkings 300N Router installed in the wiring closet in the damaged wing of the museum

To close the wireless Ethernet link from the planetarium to the auditorium required a regeneration facility. Figure 38 shows a portion of the information desk in the mail lobby of the Daytona Museum of Arts and Sciences. Installed under this desk is a 16 dB gain corner reflector to communicate with the router in the wiring closet in the planetarium wing. The high gain antenna is interfaced to a wireless Ethernet range extender unit. This unit increased the signal gain sufficiently to close the wireless link between the planetarium's wiring closet and the auditorium's projection booth.

Figure 38 - A portion of the Information Desk in the Daytona Museum of Arts and Science containing the range extender unit and corner reflector necessary to close the wireless Ethernet link

The auditorium end of the wireless Ethernet link was installed in the auditorium's projection booth. This end of the link is supported by a desktop computer operating with UVNC software. With this software the operator can view the display on the SRT control computer in the planetarium and remotely operate the SRT hardware and software. From this station the computer display can be patched into the auditorium's digital projector

system. Figure 39 shows the SRT remote computer hardware installed in the auditorium's projection booth.

Figure 39 - The remote control station in the Museum's Auditorium's projection booth for operating the SRT in the Planetarium.

In early 2010 the Executive Committee of the Daytona Section requested that work begin on providing remote connectivity so that the SRT can be operated over the World Wide Web. This capability would allow the SRT to made available to a number of schools and educational institutions for instructional and research purposes. The diagram in Figure 40 shows the components and connectivity required to implement the remoting capability.

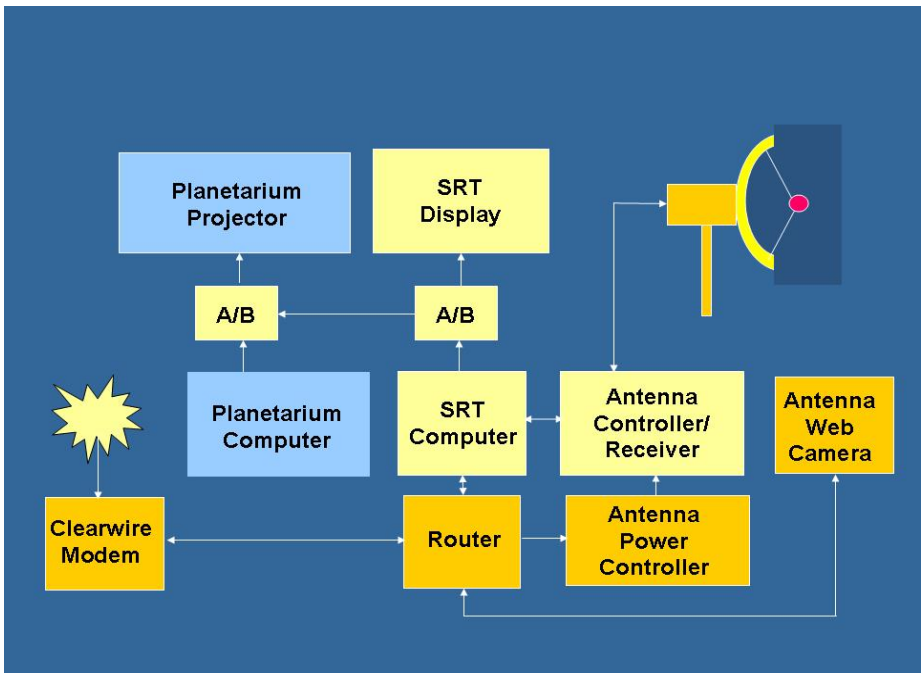

Figure 39 - A diagram of the components and connectivity required

to provide remote connectivity to the SRT

In Figure 40 the dark yellow boxes are components that were added to the Planetarium configuration of the SRT to allow remote operation. It was decided to set up a Wireless Ethernet Link to the SRT system as an alternative to using the museum's existing internet network. This was done to isolate the two system for administrative purposes and provide a designated Static IP for the exclusive use of the SRT system. We chose to use the Clearwire provider for this purpose. The SRT system does not require high uplink and downlink data rate connectivity for remoting purposes. Figure 41 shows the Clearwire modem mounted in a transparent frame installed high in a window of the office area of the Planetarium Wing of the museum.

Figure 41 - The Clearwire Ethernet Modem installed in a window of the Planetarium Wing of the museum

The Clearwire modem is interconnected to the SRT computer through an ethernet router. The router acts as a major node in the network configuration allowing the SRT computer to communicate with the outside world by way of the wireless modem, provide remote control power control to the SRT's receiver and antenna controller, and provides connectivity to the Ethernet webcam mounted on the roof of the planetarium. Figure 42 shows the router used in the SRT system layout.

Figure 42 - The network router installed in the SRT equipment rack

In order to provide remote power control an "iboot" remote power controller was procured. The "iboot" operates under computer control from the SRT computer by way of the router, through Cat5 cabling. The power controllers task is to power on or off the SRT receiver and antenna control motors under computer control. When the remote viewer gains control of the SRT computer he uses an icon on the desktop to switch "on" power to the SRT receiver and antenna electronics. At the end of the remote session the user returns to the desktop and turns "off" power to the SRT receiver and antenna electronics. Figure 43 shows the "iboot" interfaced to the SRT receiver.

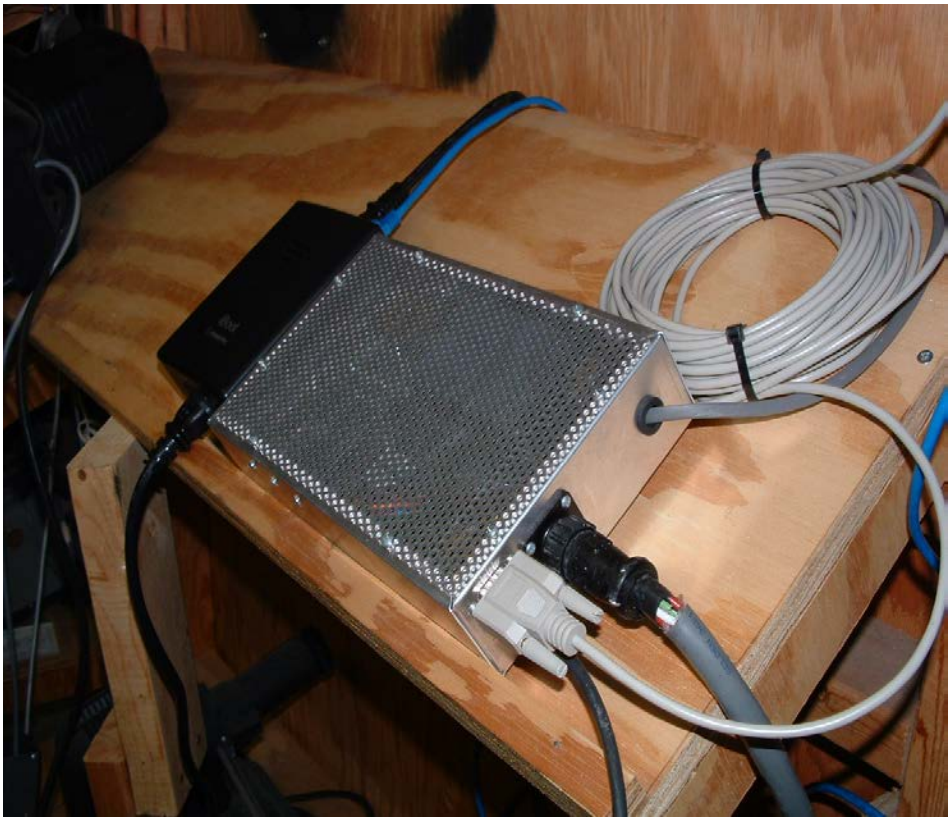

Figure 43 - The "iboot" Remote Power Controller supporting the SRT Antenna Driver System and Receiver.

The last piece of hardware controlled by the SRT computer via the router is the web cam mounted on the roof of the Planetarium building. The Webcam is used to monitor the movements of the antenna structure during movements of the SRT antenna structure. The Webcam is mounted on the outside wall of the Planetarium and receives control signal and transmits digitized video over a Cat5 cable that interconnects it to the SRT router. Power is furnished to the Webcam through the Cat5 cable. Because the SRT antenna structure can not been seen from the Control Rack in the Planetarium or by a remote operator over the internet the Webcam permits the user to visually verify the commanded movements of the SRT dish. Figure 44 shows the camera in its protected shield mounted on the exterior wall of the Planetarium.

Figure 44 - Webcam Mounted on the Exterior to Monitor Physical Position of the SRT Antenna Structure

To support the SRT operations during periods of darkness it became necessary to light the SRT antenna structure. Adequate lighting is necessary to monitor the movements of the antenna structure through the web camera to avoid potential mechanical problems. With the antenna structure illuminated the SRT can be operated remotely around the clock. To accomplish this task a 400 watt halide floodlight was installed on the exterior wall of the planetarium. Figure 45 shows the electrical contractor boring a hole in the exterior wall of the planetarium prior to installing the flood lamp.

Figure 45 - The Electrical Contractor boring the hole for the floodlight wiring through the exterior wall of the Planetarium

Cabling was run from the newly installed electrical box on the roof , through the exterior wall of the planetarium, to an electrical control box in the planetarium. Figure 46 shows the electrical contractors mounting the halide floodlight fixture on the exterior wall of the planetarium aimed, across the roof, at the SRT antenna structure.

Figure 46 - Mounting the Floodlight fixture on the Exterior Wall of the Planetarium

A picture of the halide flood lamp installed to light the SRT structure, during hours of darkness, is shown in Figure 47. The flood lamp installation is shown on the left, connected through the electrical box in the center,

to the lighting control position in the planetarium. Also shown, to the right, on this photograph is webcam in its associated rain shield.

Figure 47 - The completed Halide Flood lamp installation on the exterior wall of the Planetarium

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Minutes of SRT Program Committee Meetings

Minutes of February 12th, 2008 Meeting SRT Program Committee
Halifax River Yacht Club, Daytona Beach, Florida

Attendees: Ron Gedney, Roger Grubic, Charlie Husbands, Allen Jusko, Jane Owen, Hugh Ward, Tracy Wichmann

The Daytona Section received the funds from the Life Member Committee on 21 January 2008. Once the funds were received we called the kit suppliers and re-confirmed prices and ordering procedures. The executive board met on Tuesday, February 12 to:
(1) Appoint Dr. Hugh Ward project leader, and appoint a support team to work with him,
(2) Review the final purchase orders for the kit. The purchase order for the SRT was mailed on February 16. Delivery is expected in 8 months.

It was decided to mount the SRT on a Trailer for easy transport to various audiences. The trailer requirements are being defined and negotiations with a local trailer company for build is underway.

A Press release has been prepared and sent to the local press concerning the grant.

While waiting for the SRT to be delivered, the Daytona Section Subcommittee plans to focus on strategy and plans for making best use of the telescope. For example, we will start to define what radio astronomy experiments should be performed once the SRT is operational, and define courses, lectures, projects, etc. that can be implemented using the SRT as a focus (such as navigation, earth geography, microwave antennas and receivers, quantum physics, radiation, physics and many others).

The next meeting of the SRT team is scheduled for Thursday February 28, 2008.

Ron Gedney
Life Member Chairman
Daytona Section

Minutes of February 28th, 2008 Meeting SRT Program Committee
Halifax River Yacht Club, Daytona Beach, Florida

Attendees: Ron Gedney, Roger Grubic, Charlie Husbands, Allen Jusko, Jane Owen, Hugh Ward, Tracy Wichmann

The SRT Committee met at 6:00 PM in the Daytona Yacht Club to review progress and status on the SRT. Hugh Ward reported that the SRT has been ordered. He would like to name Diane Sartori as assistant project manager to help with employing the SRT, and working on the educational development side of the program. Ms. Sartori is an astronomy teacher and has agreed to participate in the SRT Program. Ms. Satori is currently participating in the Goldstone Apple Valley Radio Telescope (GAVRT) program and using it as a teaching tool.

Hugh Ward indicated that we might seriously consider participating in this program at some time in the future. The GAVRT program is a partnership involving NASA, the Jet Propulsion Laboratory (JPL), and the Lewis Center for Educational Research (LCER) in Apple Valley, California. The program provides an opportunity for students, teachers, scientists and educators, by means of the internet, to control and collect data from the Goldstone 34-meter radio telescope. Until recently the Goldstone Radio Telescope was part of NASA's Deep Space Network.

The group discussed some of the details associated with placing the SRT on a trailer. Because of its physical size the antenna mount must be capable of folding for transport and storage. Hugh Ward has been in contact with both the SRT manufacture CASSI and MIT's Haystack Hill facility concerning this problem. It was decided that the storage configuration of the

trailer and antenna system must be able to
fit into a standard one car garage with an overhead door, and should be able to be set up and stowed by one person. The new CASSI antenna with both azimuth and elevation motors requires a different trailer design then the one available on the Haystack Hill website, or the trailer design being produced by Stetson University for their SRT.

Charlie Husbands has taken on the responsibility of acquiring and testing the software developed for the SRT. He will download the simulator off of the Haystack Hill website and modify it to meet our location and antenna design requirements. The simulator which uses the same control console as the SRT will enable the group to become comfortable with the control of the antenna and the presentation of the collected data before the hardware is delivered.

The next meeting of the entire SRT team is scheduled for Thursday March 27, 2008.

Ron Gedney
Life Member Chairman
Daytona Section

Minutes of March 27th, 2008 Meeting SRT Program Committee
Halifax River Yacht Club, Daytona Beach, Florida

Attendees: Ron Gedney, Roger Grubic, Charlie Husbands, Jane Owen, Hugh Ward, Tracy Wichmann

The SRT Committee met at 6:00 PM in the Daytona Yacht Club to review progress and status on the SRT. Hugh Ward provided a letter and purchase order for a cavity filter for the SRT under construction. The cavity filter, designed to reduce out-of-band interference, must be placed between the antenna receiving element and the low noise amplifier. The cavity filter requires modifications to the antenna's electronics section so it is necessary to acquire and install the filter prior to the completion of the antenna construction phase of the SRT. At the meeting the committee voted to acquire the filter and the letter and purchase orders were signed and sent to CASSI.

A letter was received from Diane Satori indicating that she would like to make of presentation on the GAVRT workshop she recently attended. Ms. Sartori is an astronomy teacher at Pine Hills High School in Deltona, Florida. Ms. Satori is currently participating in the Goldstone Apple Valley Radio Telescope (GAVRT) program and using the Goldstone telescope as a teaching tool. Her presentation will be made at Emery-Riddle Aeronautical University, in Daytona Beach Florida, on April 9th at 5:00 PM.

At the present time Charlie Husbands is familiarizing himself with the control software

necessary to operate the SRT. This software available from MIT's Haystack Hill Site provides a simulation capability to permit the user to become familiar with the operation of the SRT before the antenna and digital receiver hardware is delivered. Charlie agreed to hold a short workshop in May 2008 to familiarize the members of the Section with some of the capabilities and limitations associated with the software developed for the SRT system.

The SRT committee previously approved the placement of the SRT antenna structure on a trailer for transportability and storage. Hugh Ward has agreed to assign Al Jusko of the SRT committee to work with the trailer manufacture to develop and implement a mechanical design to meet our transportation and storage requirements.

Hugh Ward indicated that he has a satellite dish and transceiver in storage at the school which might be converted to provide a secondary receiver for the SRT project. If the stored system is to be used it must be removed from the school and relocated to another storage location before 1 June 2008.

The next meeting of the entire SRT team is scheduled for Thursday April 24th, 2008 at 6:00 PM.

Ron Gedney
Life Member Chairman
Daytona Section

Minutes of April 24th, 2008 Meeting SRT Program Committee
Halifax River Yacht Club, Daytona Beach, Florida

Attendees: Ron Gedney, Roger Grubic, Charlie Husbands, Jane Owen, Hugh Ward, Tracy Wichmann

The SRT committee previously approved the placement of the SRT antenna structure on a trailer for transportability and storage. Hugh Ward has agreed to assign Al Jusko of the SRT committee to work with the trailer manufacture to develop and implement a mechanical design to meet our transportation and storage requirements. After some consideration the original trailer manufacture in Deland has been dropped from our list of possible suppliers and we are conferring with a trailer supplier in New Symrna Beach. One of the principle design problems associated with mounting the antenna on a trailer, is to provide a technique to lower the antenna structure to permit easier movement over the road and reduced overhead clearance for storage. Over the next several months the trailer design team will compare several designs for ease of implementation.

Hugh Ward indicated that we should soon choice a construction site to put the SRT

components together when they are delivered from the manufacture. It is hoped that we can find a clean and dry facility for this purpose with adequate lighting, power and assembly space. Charlie Husbands indicated that he would start searching for such a facility.

On April 9th, 2008 Diane Satori, made a presentation at Embry-Riddle Aeronautical University on the GAVRT workshop she attended in California. Graduates of the GAVRT program are permitted observation time on the Goldstone Apple Valley Radio Telescope. Ms. Sartori is an astronomy teacher at Pine Hills High School in Deltona, Florida, and she described how she uses the real time collected data from the radio telescope as a teaching tool in her high school classes. Ms. Satori indicated that she would like to help us integrate the SRT into high school astronomy classes in the Daytona area.

Charlie Husbands has been familiarizing himself with the control software for simulating and operating the SRT. This software provided from MIT's Haystack Hill Site permits the user to become familiar with the operation of the SRT before the antenna and digital receiver hardware is delivered. Charlie has put together a Power Point presentation demonstrating the software controls provided for SRT operation and the available data collection capability. This presentation will be given to the Section toward the end of summer.

As the SRT was provided by funding by the Life Member Committee it is necessary to periodically report to that body on the status of the program. We expect to generate a Progress Report to the LM Committee toward the end of June 2008.

Dr. Jane Owens asked about not-in-kind contributions. In the original proposal we had indicated that the Section would try to find additional support for the project beyond that provided by the LM Committee. Due to delays in obtaining principal funding and difficulties in the economy we lost some of the original sources. We are currently well within the budget provided by the LM committee and we will re-examine this problem in the fall when the Section's Executive Committee meets on a regular basis.

The next meeting of the SRT Program Committee will take place in July 2008.

Charles Husbands for Ron Gedney
Life Member Chairman
Daytona Section

Minutes of July 31th, 2008 Meeting SRT Program Committee
Halifax River Yacht Club, Daytona Beach, Florida

Attendees: Roger Grubic, Charlie Husbands, Jane Owen, Hugh Ward, Tracy Wichmann

A discussion on the use of a trailer as opposed to the mounting of the SRT in a permanent

location took place. The original concept was to place the SRO on a trailer to allow it to be towed to school sites and local events to fill our commitments to the Life Members Foundation to use the system for engineering educational purposes. The installation of the system on a trailer has several considerations: storage, cost of insurance, development cost, vehicle capable of transporting it, and the effects of road vibration on the instrument. If is is taken to schools, it must be set up in a location where the objects to be tracked are visible then the signals must be transmitted from the antenna system to the classroom. Also physical access to the schools after 9/11 has become increasing harder to achieve.

At this meeting Dr. Hugh Ward asked to be relieved of his duties as Program Manager. His contract with his employer will be continued for an additional year and this will reduce the time he has available to work on the development of the SRT. However, he wants to remain active in the SRT committee and involved with educational planning and implementation of the system. The committee unanimously acknowledged his resignation as Program Manager and voted to make him the SRT's Director of Education. Charlie Husbands agreed to replace Dr. Ward as the Program Manager. We want to take this opportunity to thank Dr. Ward for all of this service in helping to proposing and acquiring the SRT, he has done a wonderful job in focusing on what must be done and helping to achieve those goals.

It was proposed that we examine possible fixed sites for the installation of the SRT. Because of its design the system can be operated from any school or location with ethernet connectivity. This allows us to maintain the system in one place and still fulfill our educational goals. Several possible locations were considered. One of the facilities considered was the Daytona Museum of Arts and Science. This facility has always had great connections with the Volusia County School System and most 1st, 3rd, and 5th grade classes as well as middle and senior high school students pass through the museum each year. The museum also has an active planetarium program which logically fits with the radio telescope for teaching planetary science. A committee of Charlie Husbands, Dr. Ward and Tracy Wichman were chosen to go to the Museum of Arts and Science and examine its suitability as a fixed location for the SRT.

Charles Husbands for Ron Gedney
Life Member Chairman
Daytona Section

* After meeting update. After the meeting the selected committee went to the Museum of Arts and Sciences to talk to the Director of Education James Z, Zacharias. The committee examined the location of the new Children's Wing of the museum and the site lines available from the roof of that facilities. The Children's Wing is in the final stages of construction and will be opened in late November 2008. Mr. Zacharias was delighted with the idea of installing the SRT and indicated he thought it would fit in well with the planetarium program and the new emphasis on science education at the museum. He proposed that the IEEE generate a one page proposal to the Museum Director indicating what we planned to do, and its impact on the teaching of science at the museum. This proposal would act as vehicle for

opening a dialog between the Daytona IEEE and the MOAS on concerns of mutual interest. On August 4th, a proposal was written and emailed to the Mr. Zacharais. It consisted of a one page proposal, and an additional white paper explaining the science behind Radio Astronomy and attempted to answer some of the question about the size of the effort being proposing.

Minutes of October 23rd, 2008 Meeting SRT Program Committee
Halifax River Yacht Club, Daytona Beach, Florida

Attendees: Ron Gedney, Roger Grubic, Charlie Husbands, Jane Owen, Hugh Ward, Tracy Wichmann

A short meeting of the SRT Committee was held prior to the Daytona IEEE dinner/speaker events.
Charlie Husbands reported on a recent discussion with Dr. Al Helfrick about the assembly and testing of the SRT at Embry-Riddle Aeronautical University. Dr. Helfrick indicated that he thought he might be able to allow us the use one of the development laboratories in Lehman Building if it was available. We discussed possible roof top locations for testing the SRT at ERAU. Dr. Helfrick thought that was probably not a good idea, because the Universities proximity to the Daytona Beach Airport. The Airport's navigation aids would probably introduce a lot of electromagnetic interference to degrade the system operation. He offered the use of the backyard facilities of his home in Deland for testing. At his home he currently has a large array of antennas in his backyard and the electromagnetic interference is minimal. Dr. Helfrick indicated that if we use the ERAU facilities, we should consider that final exams start on 3 December and the school closes down on 15 December. It will be almost impossible to work in the laboratory between the 15th of December and the end of the year.

Charlie also discussed with Dr. Helfrick the remoting of the SRT antenna to the control console if the system is placed on the roof of the Museum of Arts and Sciences. The roof of the Children's Wing appears to be corrugated steel and would probably block spread spectrum or ethernet wi-fi transmissions. Dr. Helfrick indicated if we have to run a conduit to the roof to provide power we might consider installing a second parallel conduit for either RS-232 or ethernet cable for remoting purposes.

We are still looking for a possible laptop computer to dedicate to the SRT program.

Charles Husbands for Ron Gedney
Life Member Chairman
Daytona Section

Minutes of November 12th, 2008 Meeting SRT Program Committee
(Part of Daytona IEEE Section Executive Committee Meeting)
Embry-Riddle Aeronautical University Room LB235

Attendees: Ron Gedney, Roger Grubic, Charlie Husbands, Jane Owen, Hugh Ward, Tracy Wichmann, Dr. Thomas Yang, Dr. Al Helfrick, and Dr. Jianhau Liu.

The SRT vendor CASSI has indicated that the hardware is scheduled to be delivered during the week of 17 November 2008. The hardware will be delivered to Allen Jusko who will then transport it to Embry-Riddle Aeronautical University for assembly and test. ERAU has been kind in permitting us to use Room 186 in the Lehman Building for assembly and test of the SRT. This facility has a 12 foot roll-up steel door which will permit us to wheel the telescope outside for testing and then back inside for additional alignment. Dr. Liu has been appointed as ERAU point of contact for this effort.

In order to build the SRT a pedestal mount must be designed and build. Dr. Ward has volunteered to spearhead this effort. He has recently built a mount for a "C Band" dish which he is using for experimental work. He will build the stand and then be reimbursed by the Treasurer for actual expenses. Dr. Ward indicated that he will have the stand ready by the last week in November so that it will coincide with the delivery of the antenna and receiver hardware.

One component necessary for the development and operation of the SRT is a lap top computer. This computer, in the development stage, acts as a control console providing positioning information to the telescope drive. As it is necessary to change stored data bases in the computer, the operating system must be able to access the tables through the notebook function. To achieve this we need a computer capable of running Windows XP. Ron Gadney kindly offered to provide a laptop to be dedicated to this telescope project that will meet the necessary requirements.

At a past meeting the committee had discussed placing the SRT on the roof of the new Children's Wing at the Daytona Museum of Arts and Science (MOAS). We had prepared a short proposal to the museum to open discussions on this action. However, the new Children's Wing is scheduled for its grand opening on 20 November 2008. In discussion with the Director of Education at the museum it was decided to put off any discussions until the new wing is open and in operation. We will probably put off discussions until the 1st of the year while we build and test the system at ERAU.

Charles Husbands for Ron Gedney
Life Member Chairman
Daytona Section

Notes on Memoradum of Understanding with the Daytona Museum of Arts and Science
18 February 2009

In late January 2009 as series of discussions were held with the Curator of Education at the Daytona Museum of Arts and Sciences on possible placement of the SRT at their facility. It was apparent from these discussions that Museum management did not want any load bearing harware placed on the roof sructure of their facilities. In examining alteratives it was found that the Museum currently had an unused "L Band" Satellite Dish mounted on a 20 foot mast installed adjacent to the courtyard area behind the Planetarium. The Satellite Dish has not been unused for years. It was decided that if the Satellite Dish was removed the SRT could be placed on the same mast, eliminating the need to place it on roof. The SRT cabling could follow the same path as the existing "L Band" satellite wiring between the outside mast and planetarium. The inital planning was to operate the SRT remotely from the planetarium so that its education use could be easily integrated with the existing planetarium programs.

With this deployment in mind a Letter of Understanding between the Daytona Section of the IEEE and the Daytona Museum of Arts and Sciences (MOAS) was prepared. It was presented to Museum management on 2 February 2009, and was approved by the Museum's management on February 12th.

On February 17th the SRT was disassembled at the Hanger Facility in Spruce Creek Fly-In and trucked to the Museum. It was reassembled on its arrival at the Museum and is presently available for the demonstration to the LM Council Meeting on the afternoon of 21 Febuary.

Charlie Husbands
Project Manager for the Daytona SRT

Progress Report for the Small Radio Telescope (SRT) Project

June 2010

We have made remarkable progress over the last few months, overcome a few problems, and added significant capabilities to the SRT program. The Museum of Arts and Science (MOAS), where the SRT antenna is housed, is currently in the planning stages to expand their planetarium capabilities and make architectural changes necessary to repair problems associated with the flood damage of May 2009. Currently they are looking into the possibility of replacing the building wing that supports the SRT. As this work is still in the

planning stage and no timetable for its implementation is known, we do not know what kind of impact it will have on our schedule for completion.

With the SRT securely installed and operational on the roof of the planetarium at MOAS, we are concentrating on making the SRT more accessible to MOAS visitors and local educational facilities. Early in 2010, the Executive Committee of the Daytona Section requested that the SRT facility be improved to allow remote access of the small radio telescope system for educational and research projects. This can be accomplished by Internet access.

In order to provide continuous, reliable external Ethernet service, our IT experts suggested that we acquire a data network service with a static IP address. As the museum's Internet service was provided by a third party with little support, it was decided not to interfere with their configuration and instead use a separate Ethernet provider. We chose to go with a local over-the-air provider (Clearwire) that is a metropolitan wireless Internet data service. Clearwire could supply us with the required data bandwidth, a static IP, and their system could be implemented with no modification or interference with the museum's facility. We were very pleased to have the museum provide us with a grant to cover the cost of the first year of data service and the static IP.

The SRT computer was removed from the museum's planetarium and moved to an engineering laboratory at Embry-Riddle Aeronautical University (ERAU), so that we could upgrade the software and integrate the system components to achieve external remote access. A remote Ethernet controlled switch called an "iboot" was acquired and integrated through a router to the SRT computer. With the "iboot" the remote operator can control the power status of the SRT's antenna controller. The Clearwire wireless modem was then integrated, through the router, into the computer and tested using the static IP address.

When a new coordinate setting is inserted to move the antenna, it normally takes 2-3 minutes for the antenna to reach the new position. We decided that a

digital video camera was needed that would allow the operators and audience to remotely monitor the real time antenna position. A camera was obtained, mounted on the roof of the planetarium and integrated into the SRT system through the router. Ultra Virtual Network Computing (UVNC) server software was loaded into the SRT computer and the UVNC viewer software was installed in a remote computer to demonstrate remote operation of the SRT system.

The necessary cabling was installed in the planetarium and the SRT hardware was transferred from the ERAU laboratory to the museum. On 16 April all the hardware was installed and remote operation with the exception of the digital camera was demonstrated. Dr William Barott at ERAU was notified and he started to systematically evaluate the SRT and celestial targets of opportunity. At an ExCon Meeting on 17 April , Dr. Barott presented an amazing set of plotted data that he had gathered overnight with the SRT.

Later in the week, during data collection of some high elevation sources, the SRT antenna system ran into a mechanical problem. With no operating video available the antenna was raised to a very high elevation angle and the elevation actuator mechanically frozen in place. A replacement elevation actuator (with safety stops) was acquired and installed. The antenna system was recalibrated and is again operational.

Work is progressing well on developing software and the lesson plans necessary to permit the SRT to be applied to a variety of educational applications. A presentation on Radio Astronomy was prepared for the museum's staff. This presentation will be given as part of the Planetarium's Educational Program for students and visitors to the museum.

Work has begun on a new web page https://daytonasrt.org designed to provide public access to the SRT. This page will contain data about the SRT, and the proposed education programs. The web site will also support the scheduling of the telescope, control authorized access to the telescope, and act as a storage facility for data acquired from testing and the processed results of these tests.

Submitted by:

Charlie Husbands
SRT Program Manager