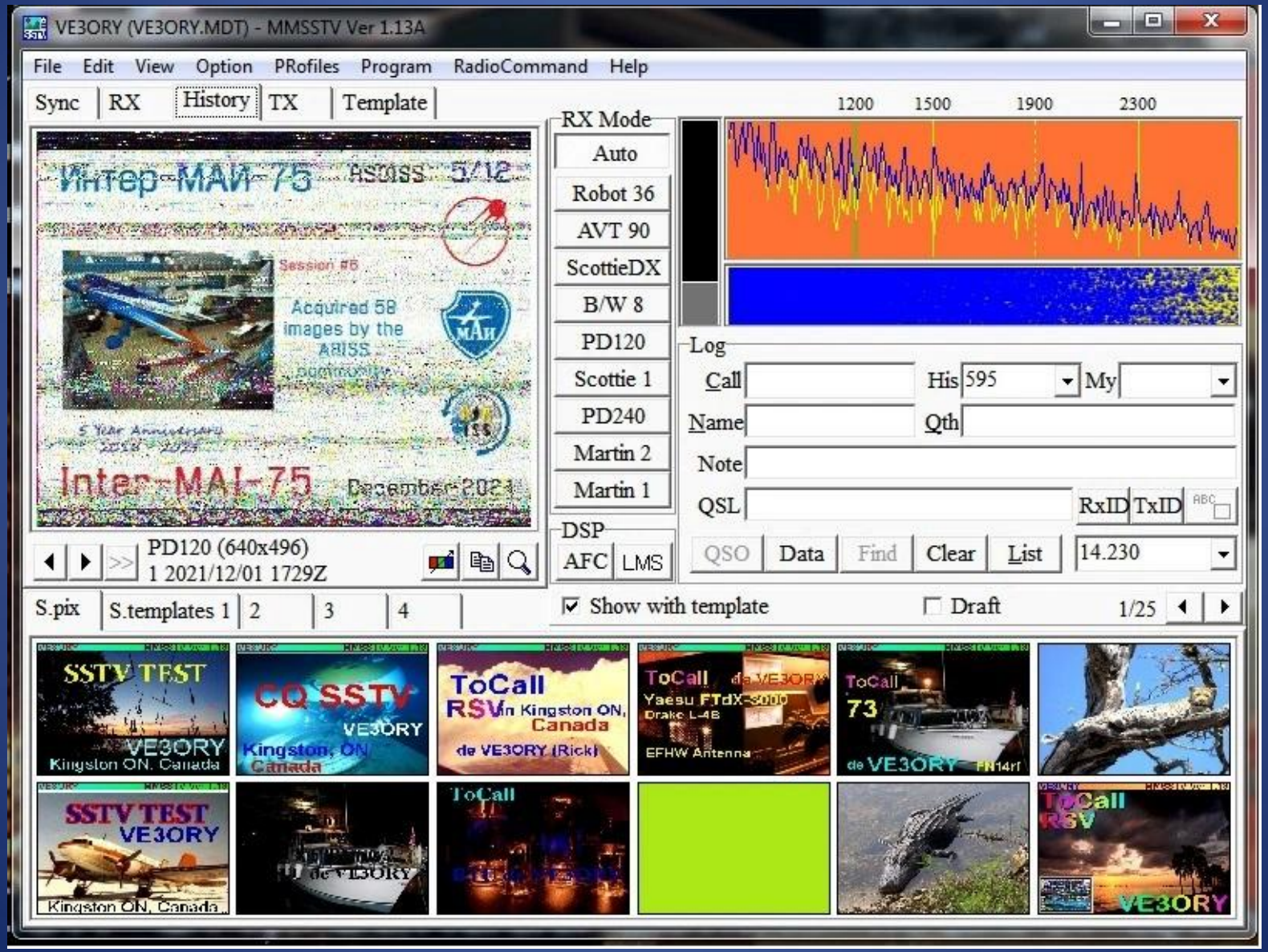
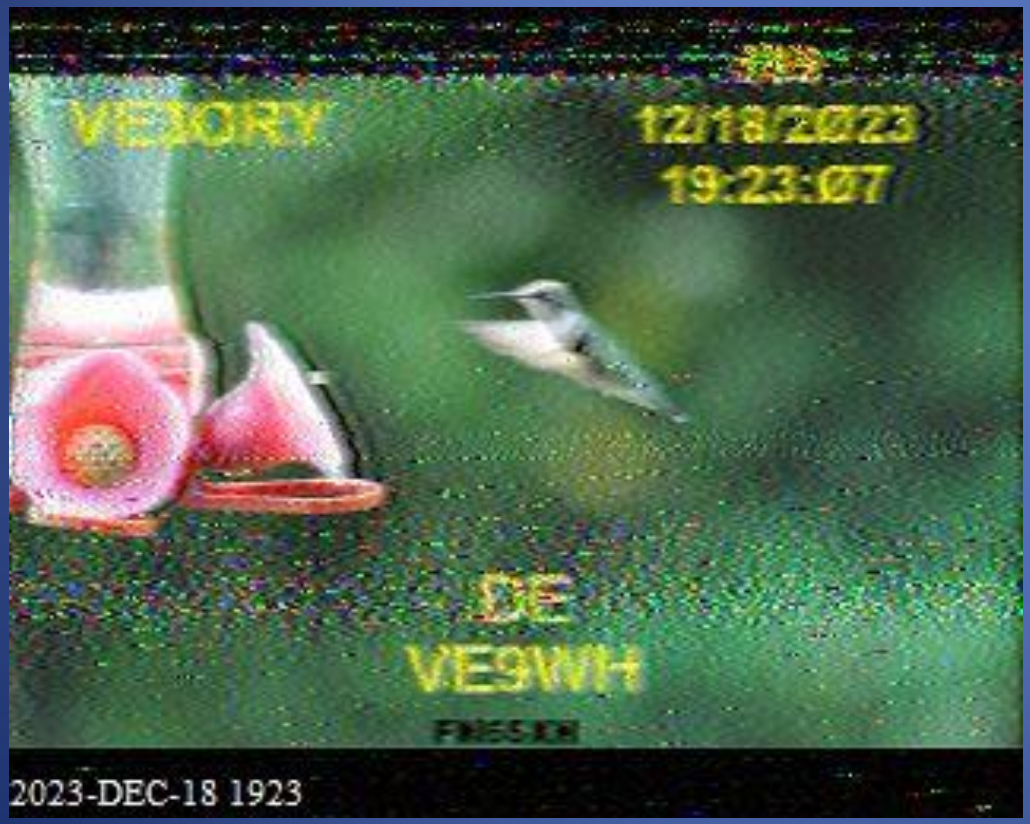
Amateur Radio – Slow Scan Television (SSTV)

- Not really television as such, but rather an Amateur Radio method of communication by transmitting images via radio



Although this page highlights images received from the ISS using VHF radio, I often exchange these SSTV images with distant stations using HF Radio frequencies.

Here is an example of a contact between my station (VE3ORY) and VE9WH in Saint John, NB. This contact was completed on the 14 MHz HF amateur band, on 18 Dec 2023.



Transmitting these images over long distances using HF radio frequencies requires that the signal be reflected several times between the ground and earth's ionosphere.

In travelling along this path, signals can be disturbed by atmospheric noise / signal interference and / signal fading…all of which will degrade the image at the receiving end of the transmission. You can see examples signal noise in this image

The challenge is to find a frequency that will support strong / clear signals between stations…always part of the fun for amateur operations on the HF bands.

Another example of an SSTV image exchange between my station in Kingston ON, and G4VRT in Sheffield, England...this one also on the 14 MHz amateur band. This frequency often favors communication over very long distances, with multiple hops between earth and the ionosphere, before the signal reaches its' destination.

Most often on this band, signals cannot be received by stations near-by…the radio signals will skip over near stations and will then be heard by stations at much greater distances, after being reflected off the ionosphere back to earth. For me, this has always been one of the most fascinating aspects of amateur radio communications on the HF bands.

Communication using this SSTV mode is accomplished by starting with a small computer image, and then superimposing brief text messages over the image.

A special computer software program then converts the image to audio tones in a computer sound card. The tones are then fed into the radio's microphone input circuit to modulate the transmitted signal.

At the receiving station those audio tones from the radio receiver are fed into that station's computer where the same software program demodulates those audio tones, converting them back into the originating image

This is the primary base station radio that I use for all of my HF band communications. Yes I still occasionally do Morse code (CW) with it.

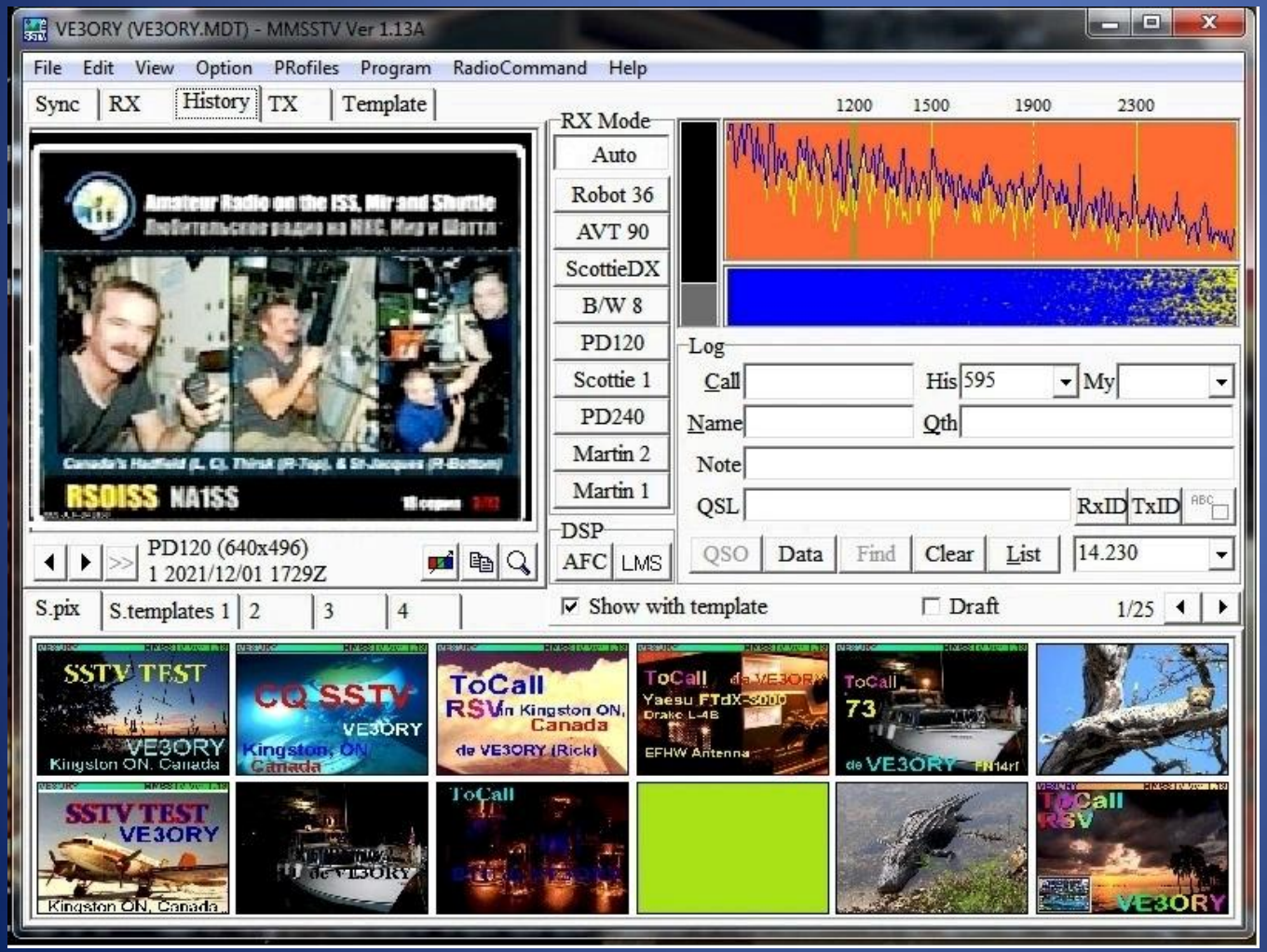
This radio also provides Single Sideband (SSB) / AM / and FM voice communication, and a computer interface to accommodate all of the data communication modes in amateur radio use today, with a maximum RF power output of 100 watts

Yaesu FTdX-3000

100 watt transceiver covering all HF band frequencies from 1.6 MHz to 50 MHz

MMSSTV Ver 1.13A by: Makoto Mori JE3HHT… Shown here the main program interface screen for sending and receiving SSTV images. Multiple other screens and menus for configuring the interface between the computer on which this program is installed and the radio transceiver to he used.

All modern amateur transceivers provide capability of providing serial communication between the radio and computer…normally by means of a serial interconnecting cable, or often a USB-Serial adapter. This feature is referred to as 'Computer Aided Tuning' or CAT control and provides ability for the computer to be able to control most all of the radio functions from the computer screen and keyboard.



As previously mentioned, radio signals at HF frequencies are for the most part reflected by earth's ionosphere. HF radio signals are also absorbed and attenuated as they pass through layers of the ionosphere. For these reasons, HF radio signals cannot be used for communicating between earth and satellite stations which are orbiting well above the ionosphere.

All communication between earth and orbiting satellites is done at much higher frequencies using VHF and UHF transmission. These higher frequency signals suffer much less absorption and very little refraction while passing through the ionosphere, making them well suited for satellite communication.

One of the greatest privileges afforded Amateur Radio, is that we are given authorized use of portions of the radio spectrum from Very Low Frequency right up to and including Microwave.

Amateur operators, are therefore able to select frequencies in portions of the radio spectrum that will support the type and mode of communication desired.

Many amateurs experiment with communication via Orbiting Satellites Carrying Amateur Radio (OSCAR satellites).

Most astronauts aboard the ISS are also licensed Amateur Radio operators.

For transmitting and receiving VHF and UHF frequencies on the amateur bands I am using this 1992 vintage Icom IC-970H transceiver. Not state of the art by today's standards, however this rugged radio designed by Icom specifically for satellite communication still provides the necessary features to meet that intended function.

This radio also provides the necessary serial interface for computer control, allowing it to function in data communication modes with software such as the MMSSTV program for transmitting and receiving Slow Scan TV images at VHF and UHF frequencies…

ARISS

Amateur Radio on the International Space Station

The ARISS agency (Amateur Radio on the International Space Station) coordinates pre-arranged Amateur Radio communication sessions between astronauts aboard the ISS and students at selected educational facilities for the purpose “inspiring them to pursue interests and careers in science, technology, engineering, and math (STEM) and engaging them with science technology through amateur radio.”

Astronaut Doug Wheeling KF5BOC, operating the NA1SS amateur radio station , onboard the International Space Station

The ISS has two amateur radio stations installed…one in the Columbus Module and one in the Service Module. These stations operate various modes on the VHF and UHF amateur bands, under calls signs NA1SS, RS0ISS, and OR4ISS

Amateur activities take place as operational workload permits. At times the stations may be configured to support Packet Radio, SSTV, or Voice Repeater operations.

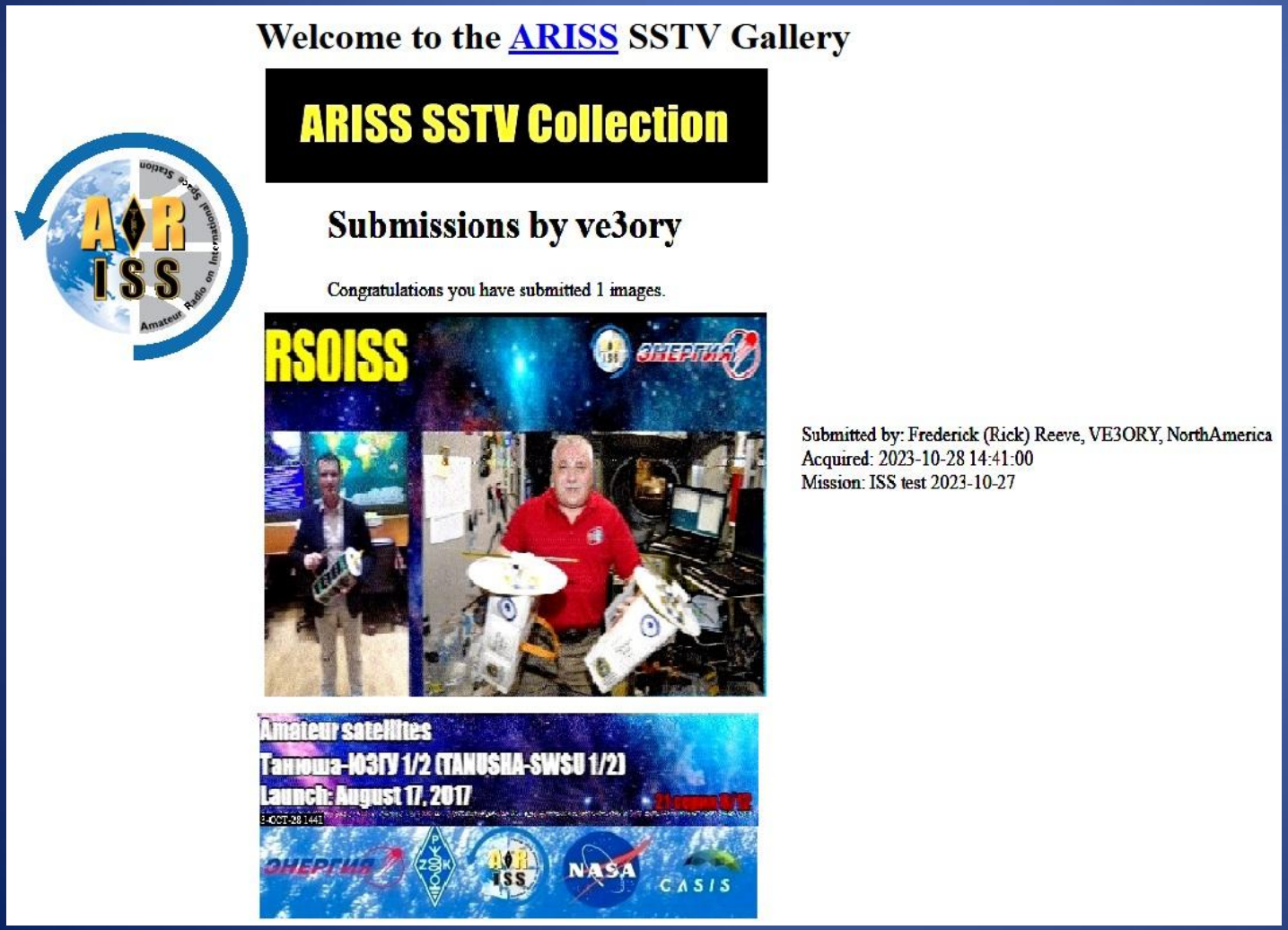
Antenna efficiency is a key factor for all radio communication, especially when it is intended that the antenna is to be used for both transmitting purposes., as well as receiving. Antenna construction must be designed to suit the frequency and mode of transmission for which it is intended.

These two antennas are home built specifically for my VHF satellite communications. On the left is a 144 MHz 'Eggbeater' antenna used for satellite communication on the 2-meter amateur band. On the right is a 137 MHz Quadrafilar Helical antenna that I built for reception of weather satellite transmissions.

Both of these designs are optimized for omni-directional reception of VHF radio signals from high (overhead) angles, and therefore well suited to signals from orbiting satellites while they are above the horizon.

A few times each year, astronauts aboard the ISS will attempt to execute campaigns to transmit SSTV images continuously over a period of up to 5 days. The images transmitted usually commemorate significant events from the space programs history.

For these campaigns the dates / frequency / and SSTV transmission mode are normally announced in advance. Usually a series of 12 images are randomly transmitted at 2 minute intervals



Stations receiving these images are invited to submit them to the ARISS organization for recognition and posting online in their SSTV gallery.

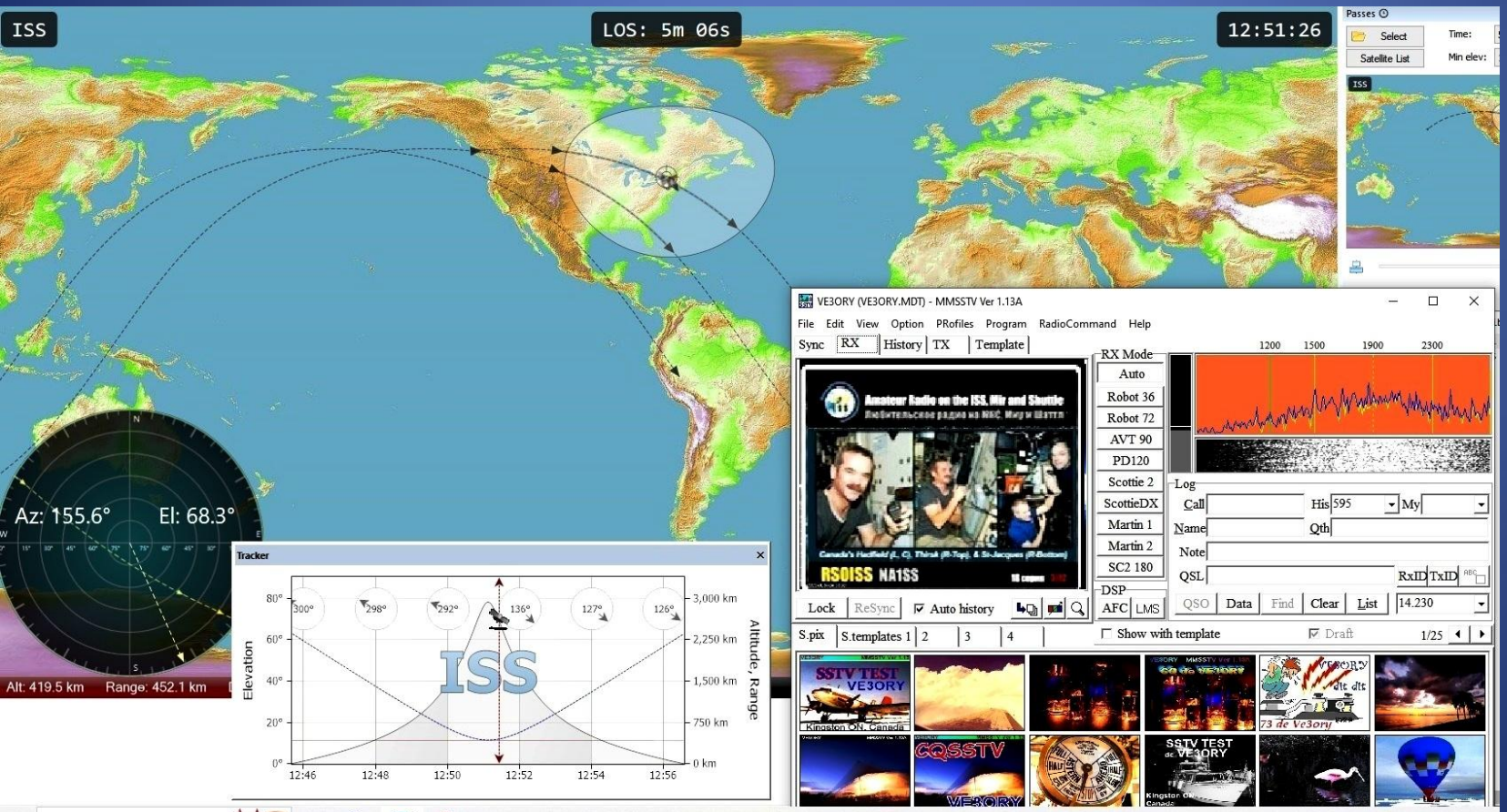
The challenge during one of these campaigns is to try to receive as many of the 12 images as possible, over the duration of the exercise, and to see how clearly you are able to decode the images.

And there are some challenges in trying to achieve that goal…

SSTV images from the ISS are normally transmitted on the 2 meter amateur band at a frequency of 144.800MHz. Radio signals at this VHF frequency are only able to be received via line-of-sight transmission. So in order to be able to receive these transmissions, the ISS must be above the horizon and ‘visible’ at the receiving station location.

Tracking the position of the ISS is complicated given that it follows a Low Earth Orbit, travelling at ~27,600 km/h at an altitude of `400 km. Taking into account earth’s rotation means that, for any given position on earth, the ISS is only visible during several of its’ orbits in any 24 hour period. And, during each of those passes the space station is only above the horizon for up to a maximum of about 9 minutes.

Taking into account all of these factors means that in order to know when to listen for signals from the ISS requires a means of tracking the space station’s location. Fortunately there are computer programs that use Keplerian data for each satellite to track its’ orbital position. With this information and knowing the location of a ground based receiving station, the computer software is able to display a model that can predict the satellites relative position. At my station, I am using a software program called ‘SDR Console’



‘SDR Console’ tracking position of the ISS during one of its orbits… passing almost directly over our location on this particular pass.

And the MMSSTV software decoding the received image transmission in real time as the ISS passes over-head.

During the space station's SSTV campaign in June 2021, I managed to receive pretty nice images for 11 of the 12 images sent. The number 10 image (lower left corner) was only partially received… just before the ISS descended below the horizon, making it no longer possible to receive the remainder of the image…a little frustrating, but emphasizing the difficulty in tracking and being able to decode the received signals in real time, while the satellite is visible at the receiving location. None the less, I was pretty pleased with these results.

This groundbreaking method of amateur radio communication by transmitting small images was first developed in 1957 by Canadian amateur Copthorne Macdonald VE1BFL , using modified television equipment to transmit small black and white / analogue / still images on HF frequencies within the amateur bands.

Transition to digital technologies in the 1990's made it much easier to generate SSTV images with computer based systems, and this mode of communication is still in popular use today amongst amateur operators.

An Amateur Radio operators license is <u>not required, for *receiving* only</u>. So all that is needed is a radio capable of receiving Single Sideband Voice transmissions at the desired frequency / an appropriate antenna / and the necessary software (MMSSTV or YONIQ) to allow decoding of the received signals.

The most commonly used frequency for HF transmission of SSTV is on the 20 meter amateur band at 14.230 MHz, using Upper Sideband (USB).

SSTV images from the ISS are usually transmitted on 144.800 MHz also using Upper Sideband (USB)

https://airspy.com/airspy-hf-plus

Adding one of today's modern Software Defined Receivers (SDR) to a computer system provides a relatively inexpensive way to create a high performance radio receiver which covers a wide range of signal modes and frequencies.

https://www.rtl-sdr.com

Just remember that with all radio receivers (including SDR), you need to connect an appropriate antenna to its' input, in order to receive the desired signals. Amateur operators have long known that the antenna is the most critical part of any radio system.

Rick VE3ORY