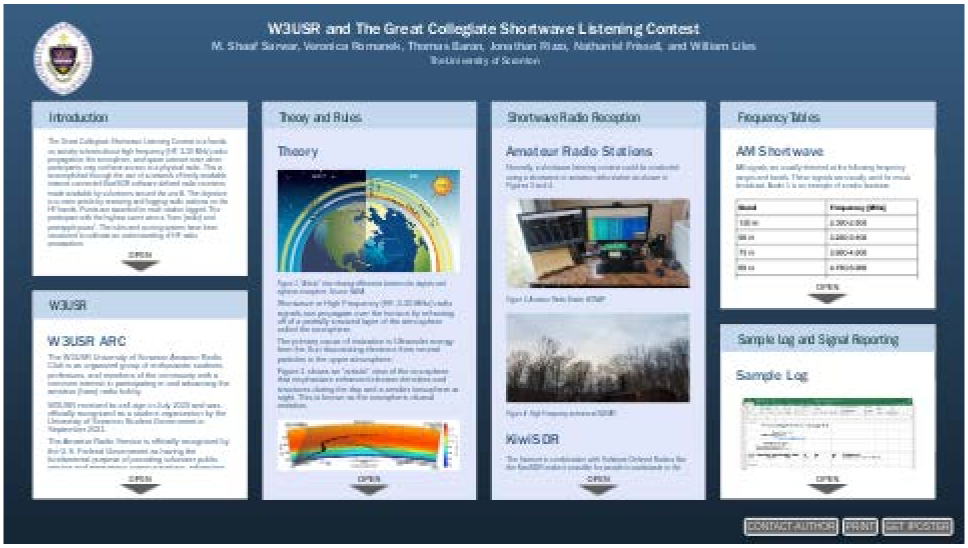
W3USR and The Great Collegiate Shortwave Listening Contest



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The University of Scranton

PRESENTED AT:

INTRODUCTION

The Great Collegiate Shortwave Listening Contest is a hands-on activity to learn about high frequency (HF, 3-30 MHz) radio propagation, the ionosphere, and space science even when participants may not have access to a physical radio. This is accomplished through the use of a network of freely available, internet connected KiwiSDR software defined radio receivers made available by volunteers around the world. The objective is to earn points by receiving and logging radio stations on the HF bands. Points are awarded for each station logged. The participant with the highest score wins a “ham (radio) and pineapple pizza”. The rules and scoring system have been structured to cultivate an understanding of HF radio propagation.

W3USR

W3USR ARC

The W3USR University of Scranton Amateur Radio Club is an organized group of enthusiastic students, professors, and members of the community with a common interest in participating in and advancing the amateur (ham) radio hobby.

W3USR received its call sign in July 2020 and was officially recognized as a student organization by the Univeristy of Scranton Student Government in September 2021.

The Amateur Radio Service is officially recognized by the U.S. Federal Government as having the fundamental purpose of providing volunteer public service and emergency communications, advancing the state-of-the-art of radio technologies, expanding the pool of trained radio operators, radio technicians, and electronics experts, and enhancing international goodwill.

The W3USR University of Scranton Amateur Radio Club aims to increase the number of involved members by spreading the word of the club on campus and around the community.

The goals of the club include

- Provide educational opportunities for members to learn about the ionosphere, radio propagation, and space science
- Increase general knowledge of radio engineering and science, communications practices, and the amateur radio service
- Provide service to the community using the skills and resources of the club and its members.
- Encourage amateur radio licensing of both club and community members

These goals are achieved through regular club meetings, special club activities, and the establishment and operation of an on-campus amateur radio station.

COVID-19 Operations

W3USR was formed during the unique period of the COVID-19 pandemic. This restricted the club members from meeting in-person. However, the club continued to meet on a regular basis over Zoom, and was even able to invite guest speakers from around the world to present at club meetings.

The Great Collegiate Shortwave Listening Contest using internet-based KiwiSDRs was developed out of a need to provide members with a hands-on activity to learn about the ionosphere and radio propagation even when they may not have access to a physical radio.

THEORY AND RULES

Theory

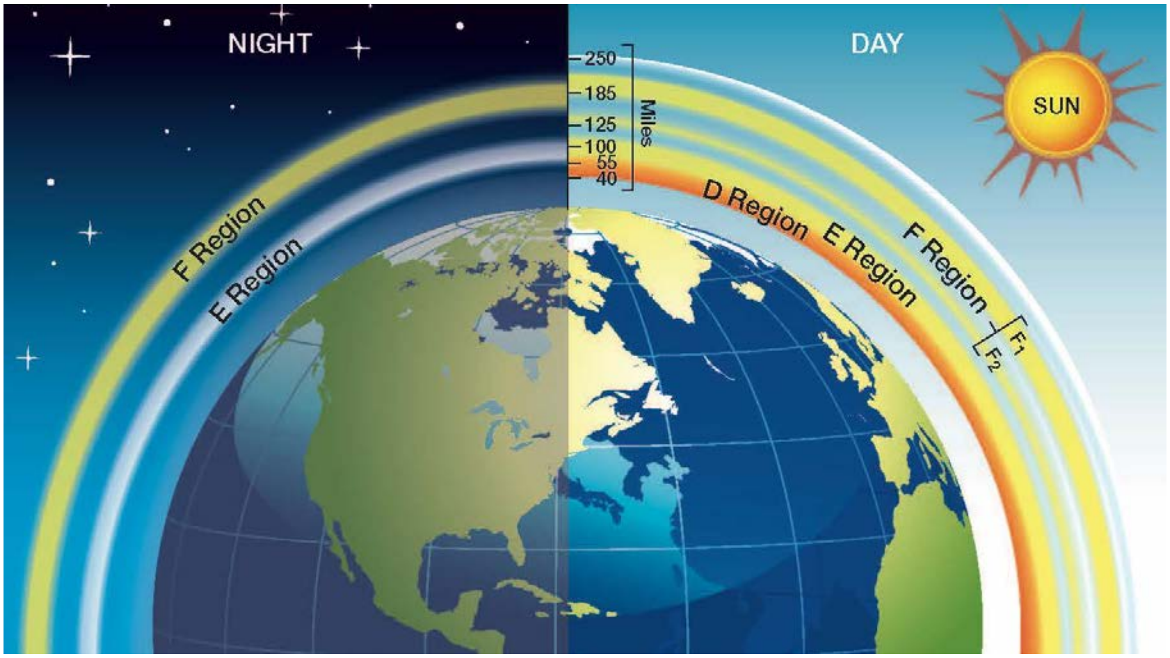


Figure 1: "Artistic" view showing differences between the daytime and nightime ionosphere. Source: NASA

Shortwave or High Frequency (HF, 3-30 MHz) radio signals can propagate over the horizon by refracting off of a partially ionoized layer of the atmosphere called the ionosphere.

The primary cause of ionization is Ultraviolet energy from the Sun dissociating electrons from neutral particles in the upper atmosphere.

Figure 1 shows an "artistic" view of the ionosphere that emphasizes enhanced electron densities and structures during the day and a weaker ionsophere at night. This is known as the ionospheric diurnal variation.

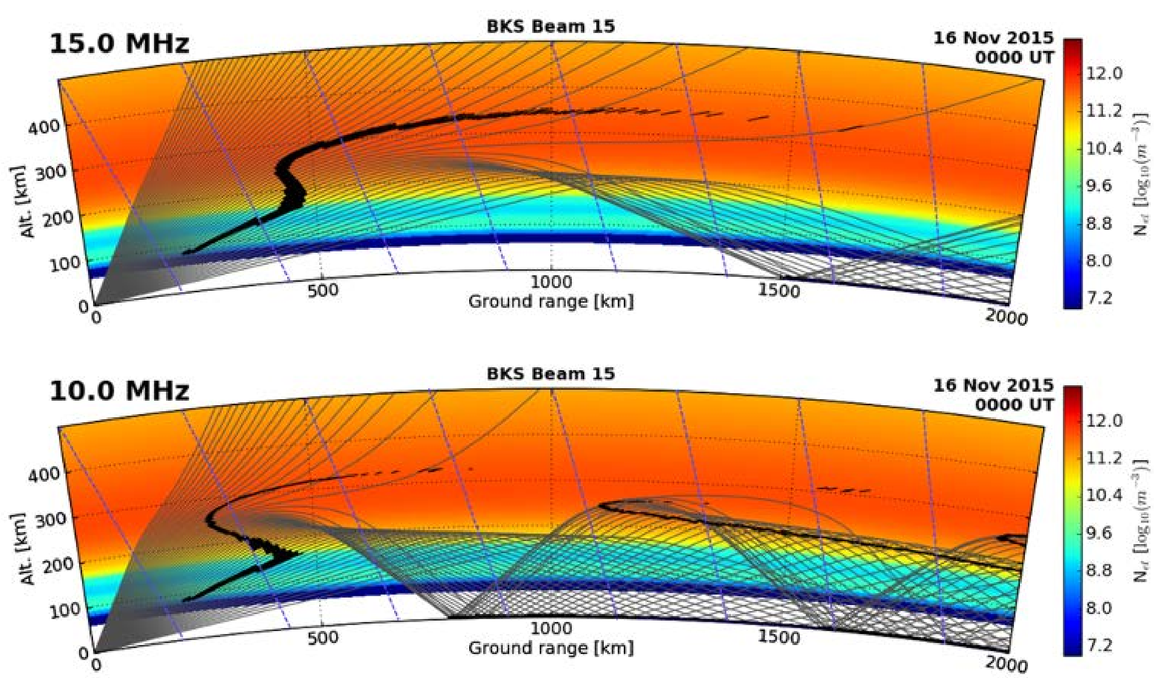


Figure 2: Raytrace diagram showing HF radio paths at 10 and 15 MHz through the International Reference Ionosphere (IRI) empirical model. Source: Frissell 2016

Figure 2 illustrates how HF radio signals are refracted (bent) by the ionosphere using a numerical ray trace through the empirical International Ionosphere Model. Note that higher frequency are refracted less by the ionosphere than lower frequencies. If either frequency or take-off angle exceeds a certain critical value, the radio wave will escape into space and not return to Earth.

At night when electron densities are decreased, frequencies in the lower portion of the HF band (3-15 MHz) tend to work better for long distance propagation. During the day, when electron densities are increased, frequencies in the higher portion of the HF band (15-30 MHz) tend to work better for long distance propagation.

Contest Rules

1. The contest duration: 7 April, 2021 0000z - 21 April 2021 0000z (2 weeks).
2. The participant should use a single radio receiver for the whole contest. It can be a physical radio or an SDR accessed through the KiwiSDR shortwave radios http://kiwisdr.com/ (http://kiwisdr.com/).
3. The participants must submit three daytime and three nighttime 30-second recordings of stations they hear.
4. Logging in one station earns 1 point which can be of any type e.g ham radio, shortwave broadcast, or standard stations.
5. For each station log the UT, Frequency [kHz], Mode, Signal Report, Call Sign, and QTH in the provided spreadsheet.
6. The final score is calculated by multiplying the number of stations heard and the number of unique DXCC entities (countries) or US States.
7. Email results to Dr. Frissell at nathaniel.frissell@scranton.edu (http://nathaniel.frissell@scranton.edu)
8. Final decisions to be made by the contest committee.

Scoring

- Base Score: Multiplying the number of stations heard with the number of unique DXCC entites or US States heard.
- Bonus Points:
  - 3 bonus points given for each waterfall screenshots submitted along with recordings from rule #3.
  - 10 bonus points given to the farthest away station (upto half way around Earth)

SHORTWAVE RADIO RECEPTION

Amateur Radio Stations

Normally, a shortwave listening contest could be conducted using a shortwave or amateur radio station as shown in Figures 3 and 4.

Figure 3: Amateur Radio Station W2NAF

Figure 4: High Frequency antenna at W2NAF.

KiwiSDR

The Internet in combination with Software Defined Radios like the KiwiSDR make it possible for people to participate in the SWL Contest even if they do not have a radio of their own at home.

Particpants can freely access the worldwide network of KiwiSDR shortwave radios at http://kiwisdr.com/ (http://kiwisdr.com/).

We can see a recorded conversation in Video 1 of an amateur radio operator from Lithuania trying to contact another ham in New York. He clearly states his Call Sign in Phonetic alphabets to avoid miscommunication due to interference and noise. The map in Figure 5 also illustrates the scale of the distances covered by the signals.

[VIDEO] https://www.youtube.com/embed/YLMKmcxR5jE?rel=0&fs=1&modestbranding=1&rel=0&showinfo=0

Video 1: Recording of a conversation from KiwiSDR

Figure 5: Map showing W2NAF and LY31A. Source: Google Earth

FREQUENCY TABLES

AM Shortwave

AM signals are usually detected at the following frequency ranges and bands. These signals are usually used for music broadcast. Audio 1 is an example of a radio bradcast.

Band	Frequency [MHz]
120 m	2.300-2.500
90 m	3.200-3.400
75 m	3.900-4.000
60 m	4.750-5.060
49 m	5.950-6.200
41 m	7.100-7.600
31 m	9.200-9.900
25 m	11.600-12.200
22 m	13.570-13.870
19 m	15.100-15.800
16 m	17.480-17.900
13 m	21.450-21.850
11 m	25.600-26.100

Figure 6: Shortwave Band Charts. Source: W3USR

Audio 1: Radio broadcast

Ham Radio

Ham radio signals can be detected at the following frequency ranges and bands. Depending on the bands, a lower side band (LSB) or upper side band (USB) mode may be needed. Below is an example of another Amateur Radio transmission.

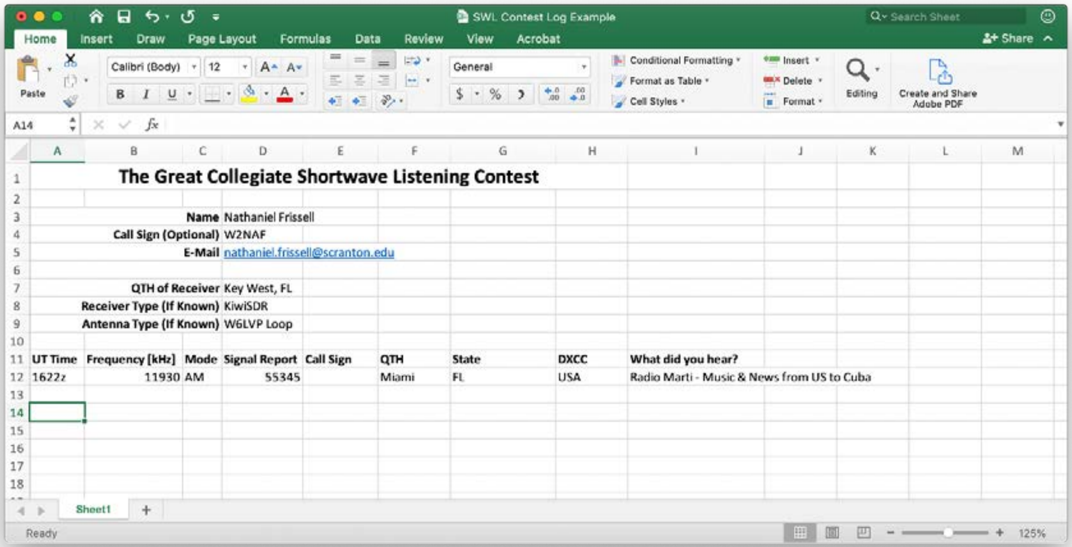
Band Name (Wavelength)	Phone Frequency Range [kHz]	Phone (Voice) Mode
160 m	1800 - 2000	LSB
80 m	3600 - 4000	LSB
40 m	7125 - 7300	LSB
20 m	14150 - 14350	USB
17 m	18110 - 18168	USB
15 m	21000 - 21450	USB
12 m	24930 - 24990	USB
10 m	28300 - 29700	USB

Figure: Ham Radio Bands. Source: W3USR.

Audio 2: Amateur Radio transmission

SAMPLE LOG AND SIGNAL REPORTING

Sample Log


The Great Collegiate Shortwave Listening Contest

Name: Nathaniel Frissell
Call Sign (Optional): W2NAF
E-Mail: nathaniel.frissell@scranton.edu

QTH of Receiver: Key West, FL
Receiver Type (If Known): KiwiSDR
Antenna Type (If Known): W6LVP Loop

UT Time	Frequency [kHz]	Mode	Signal Report	Call Sign	QTH	State	DXCC	What did you hear?
1622z	11930	AM	55345		Miami	FL	USA	Radio Marti - Music & News from US to Cuba

Figure: Sample Log Sheet

RST System

The RST system is used to score the strength of a Ham Radio signal. RST is an abbreviation for Readability, Signal Strength and Tone. Only CW and digital signals use Tone.

Readability (R)	Signal Strength (S)	Tone (T)
1. Unreadable	1. Faint, signals barely perceptible	1. Sixty cycle a.c or less, very rough and broad
2. Barely readable, occasional words distinguishable	2. Very weak signals	2. Very rough a.c., very harsh and broad
3. Readable with considerable difficulty	3. Weak signals	3. Rough a.c. tone, rectified but not filtered
4. Readable with practically no difficulty	4. Fair signals	4. Rough note, some trace of filtering
5. Perfectly readable	5. Fairly good signals	5. Filtered rectified a.c. but strongly ripple-modulated
	6. Good signals	6. Filtered tone, definite trace of ripple modulation
	7. Moderately strong signals	7. Near pure tone, trace of ripple modulation
	8. Strong signals	8. Near perfect tone, slight trace of modulation
	9. Extremely strong signals	9. Perfect tone, no trace of ripple or modulation of any kind

Figure: RST Sytem

SINPO Code

The SINPO code is used to quantify the reception conditions of an AM signal. SINPO is an abbreviation for Signal Strength, Interference, Noise, Propagation, and Overall which gives us us a very clear idea of how to measure the strength of the signal.

(S)ignal	(I)nterference	(N)oise	(P)ropagation	(O)verall
5 excellent	5 none	5 none	5 none	5 excellent
4 good	4 slight	4 slight	4 slight	4 good
3 fair	3 moderate	3 moderate	3 moderate	3 fair
2 poor	2 severe	2 severe	2 severe	2 poor
1 barely audible	1 extreme	1 extreme	1 extreme	1 unusable

Figure: SINPO Code