HamSCI Workshop 2021:

Midlatitude Ionospheric Science

Friday, March 19 – Saturday, March 20, 2021

The University of Scranton

Scranton, PA

nathaniel.frissell@scranton.edu

A Word From Our Provost

Dr. Jeffrey Gingerich, Provost
The University of Scranton

A Word From Our Dean

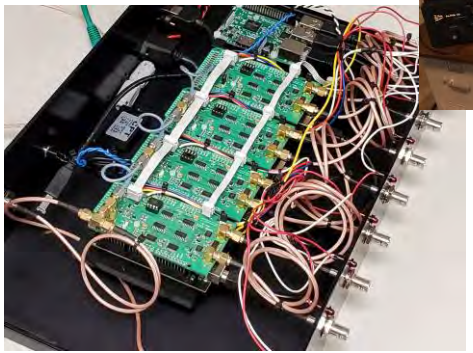
Dr. Michelle Maldonado, Dean of the College of Arts and Sciences
The University of Scranton

What is Ham Radio?

- **Hobby for Radio Enthusiasts**
  - Communicators
  - Builders
  - Experimenters
- **Wide-reaching Demographic**
  - All ages & walks of life
  - Over 760,000 US hams; ~3 million Worldwide
- **Licensed by the Federal Government**
  - Basic RF Electrical Engineering Knowledge
  - Provides a path to learning
  - Licensing ensures a basic interest and knowledge level from each participant
  - Each ham has a government-issued “call sign”

KD2JAO & WB2JSV at NJIT Station K2MFF

AB4EJ Home Station



N8UR multi-TICC: Precision Time Interval Counter

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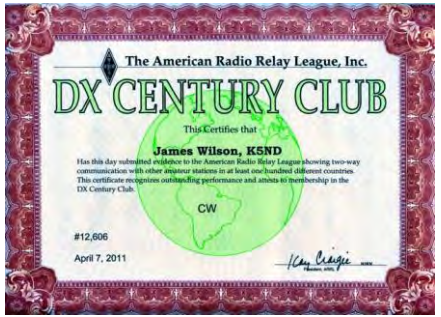
Examples of Ham Radio Communications

- **Emergency & Public Service**
- **Contesting / Radio Sport**
- **DXing / Distance Awards**



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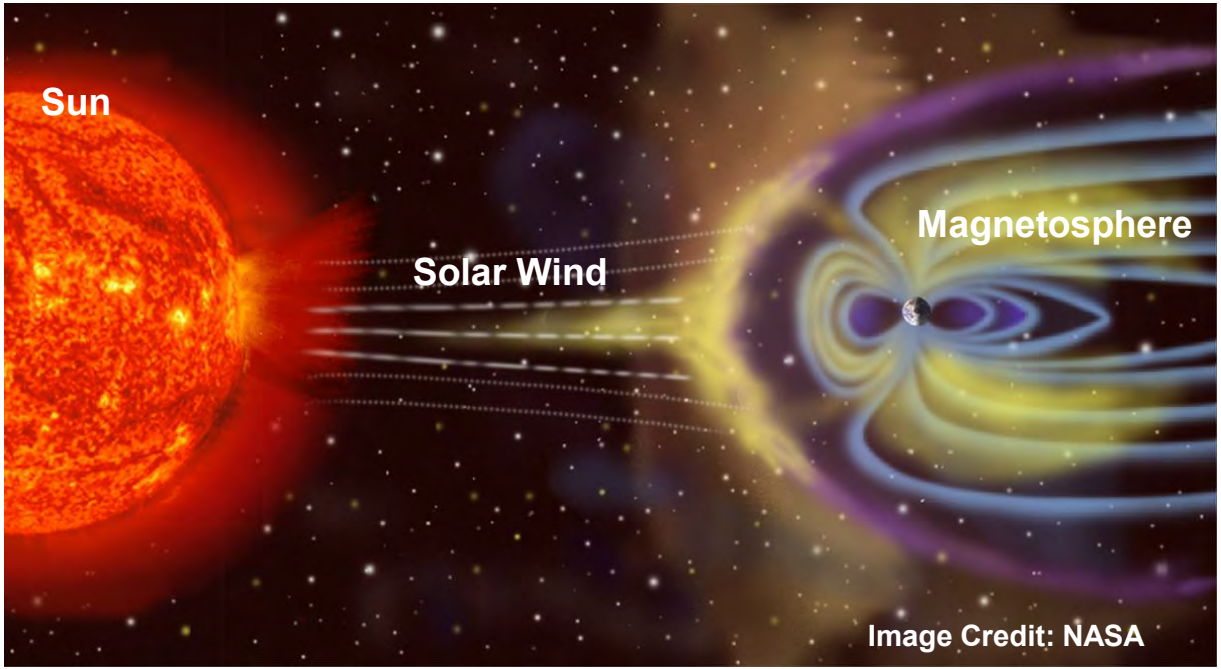
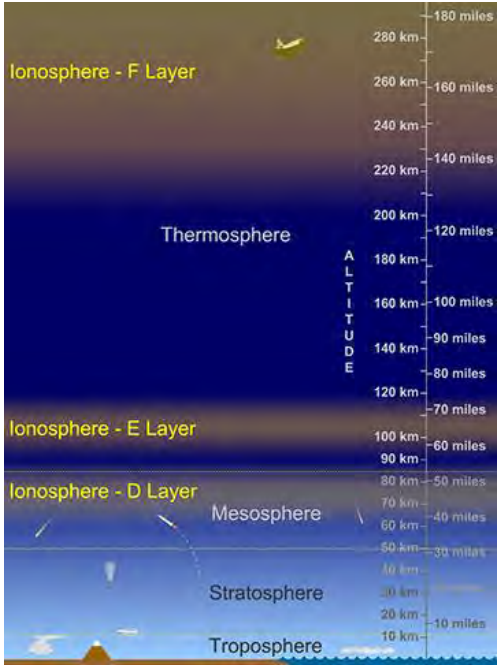
What is Space Weather & Space Science?

Geospace System



Atmosphere



Credit: Randy Russell, UCAR
https://scied.ucar.edu/ionosphere

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Space Weather Station Goals

In building a Personal SW Station, what do we want to do?

Operations

Hams

- Know the best frequencies for working DX
- Understand the RFI Environment
- Communicate better during emergencies

Research

Scientists

- Better sample the environment
- Better understand near-Earth Space

*Note: We have a good understanding of space **climate**, but not space **weather**…*

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HamSCI Ham radio Science Citizen Investigation

hamsci.org/dayton2017

Founder/Lead HamSCI Organizer:
Dr. Nathaniel A. Frissell, W2NAF
The University of Scranton

A collective that allows university researchers to collaborate with the amateur radio community in scientific investigations.

Objectives:

1. **Advance** scientific research and understanding through amateur radio activities.
2. **Encourage** the development of new technologies to support this research.
3. **Provide** educational opportunities for the amateur community and the general public.

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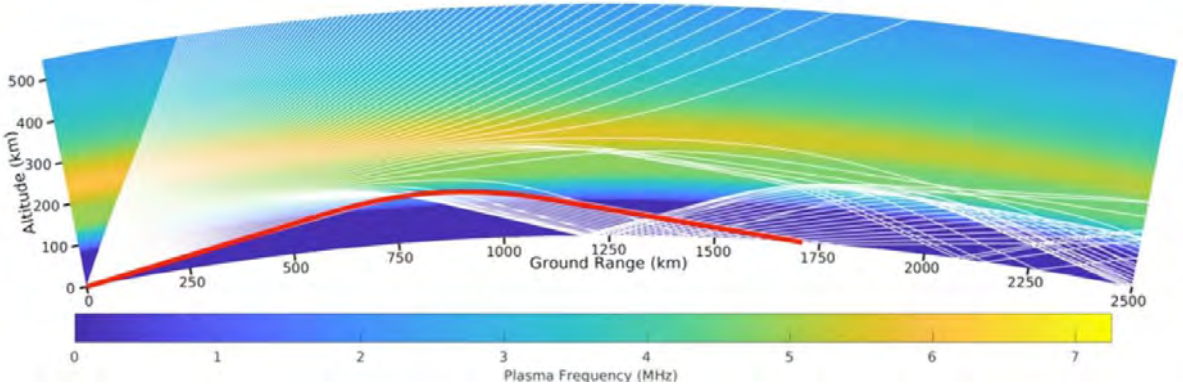
Ham Radio Frequencies and Modes

	Frequency	Wavelength
LF	135 kHz	2,200 m
MF	473 kHz	630 m
	1.8 MHz	160 m
HF	3.5 MHz	80 m
	7 MHz	40 m
	10 MHz	30 m
	14 MHz	20 m
	18 MHz	17 m
	21 MHz	15 m
	24 MHz	12 m
	28 MHz	10 m
VHF+	50 MHz	6 m
	And more…	

PHaRLAP Raytrace

1600 UT 21 Aug 2017 14.03 MHz - Eclipsed SAMI3

TX: AA2MF (Florida) RX: WE9V (Wisconsin)



- Hams routinely use HF-VHF transionospheric links.
- Often ~100 W into dipole antennas.
- Common HF Modes
  - Digital: FT8, PSK31, WSPRNet, RTTY
  - Morse Code / Continuous Wave (CW)
  - Phone: Single Side Band (SSB)

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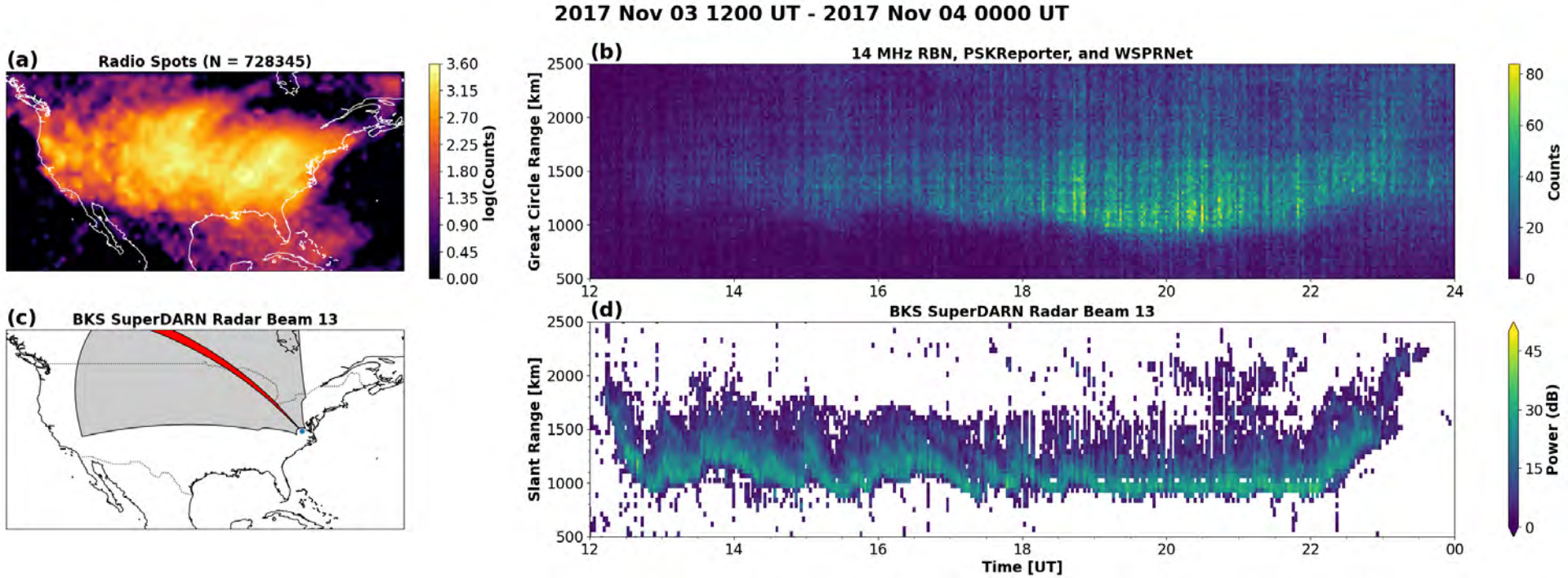
HamSCI 2021: Midlatitude Ionospheric Science



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Invited Speakers

Keynote Address

Dr. Liz Bruton
Science Museum
London
The History of Radio

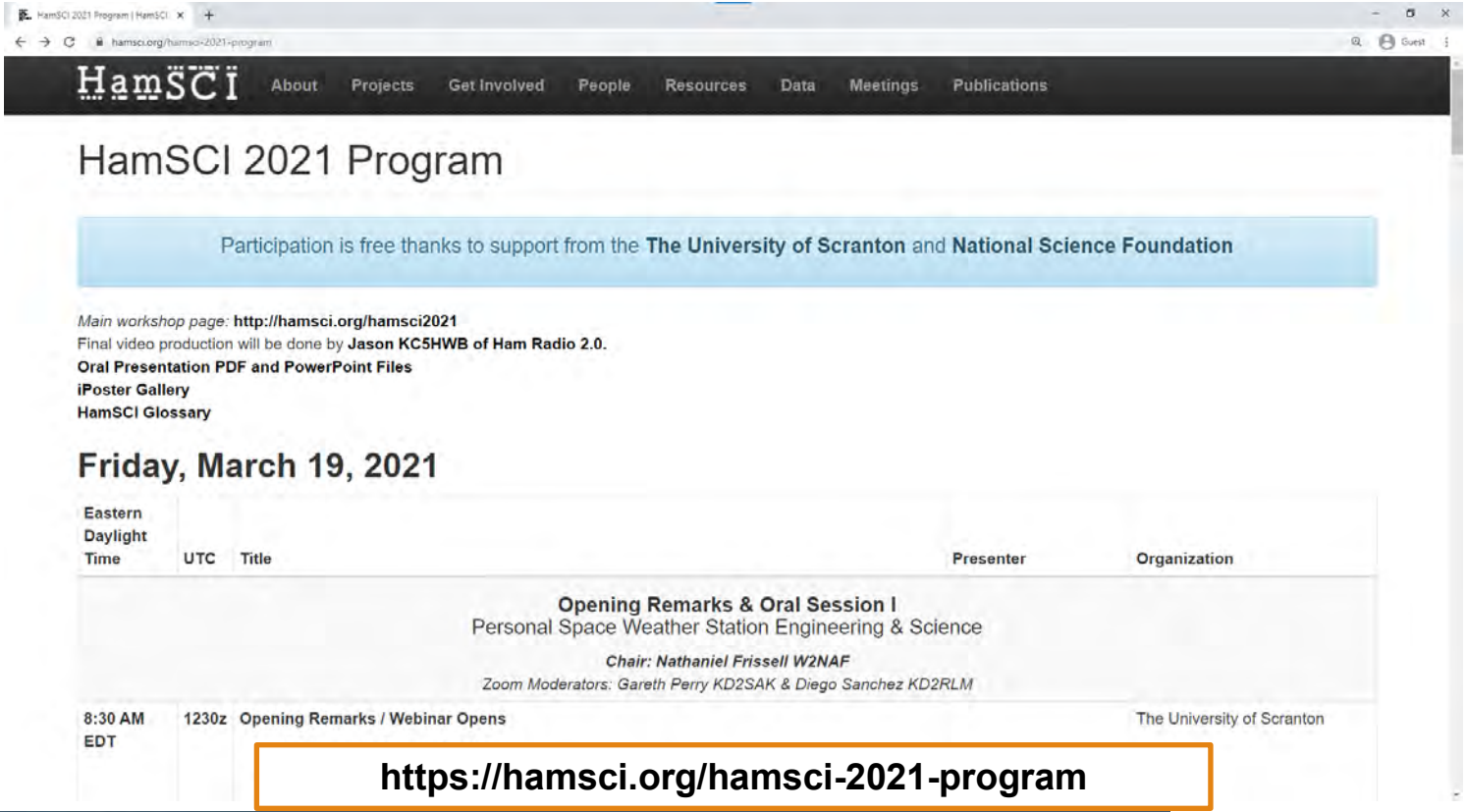
Scientist Tutorial

Dr. Mike Ruohoniemi
Virginia Tech
Midlatitude Ionospheric Physics

Amateur Radio Tutorial

Joe Dzekevich
K1YOW
Amateur Radio Observations of Midlatitude Sporadic E

Online Workshop Schedule

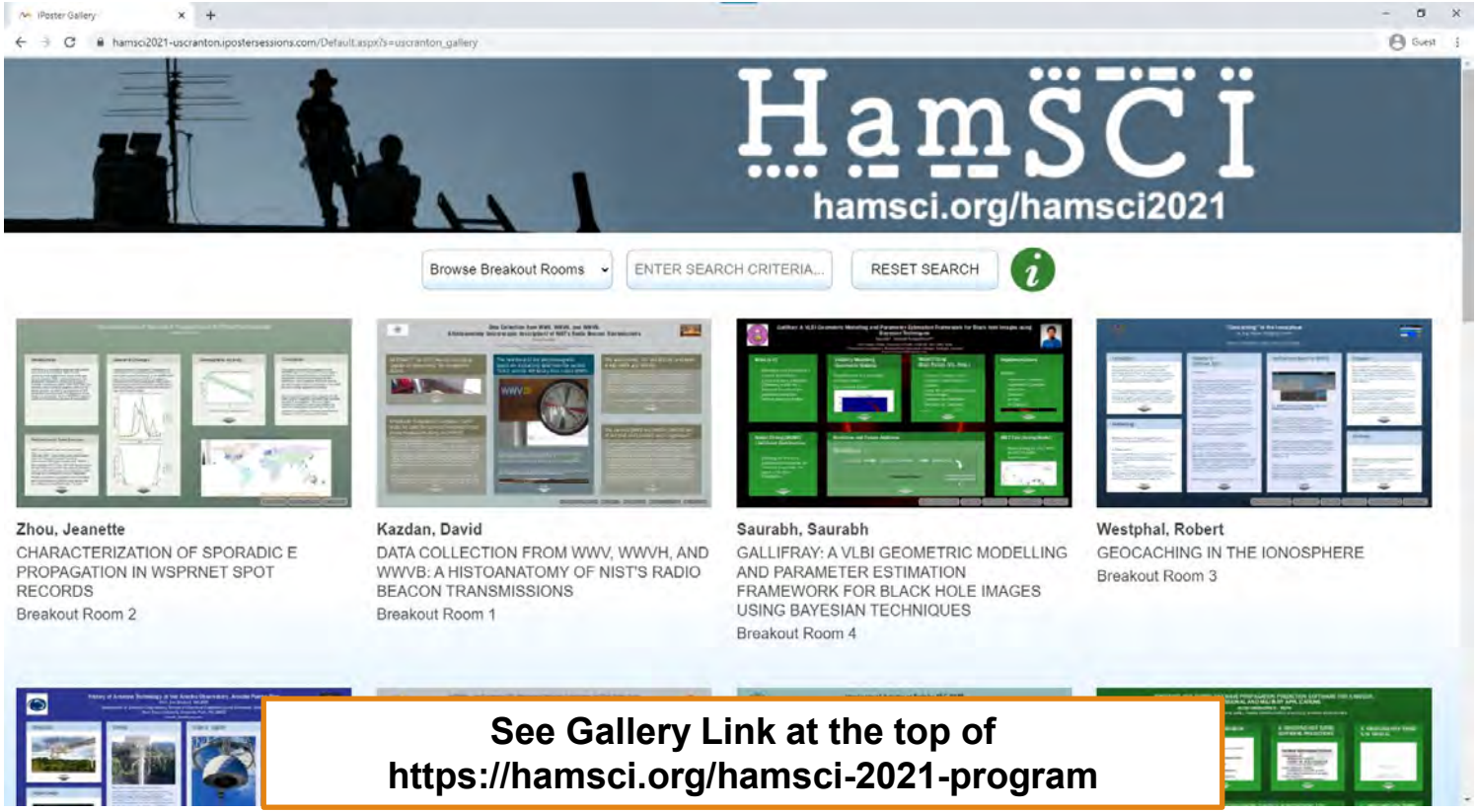


https://hamsci.org/hamsci-2021-program

This Year, We're Virtual!

- **Session Chair:** Person responsible for introducing talks, controlling flow of questions, and keeping track of time.
- **Zoom Moderator:** Panelists who are assigned to monitor the Zoom Chat window and interact with attendees.
- **Presenter:** The person giving the presentation.
- **Panelist:** Includes presenters and invited participants. Presenters can share video, talk, and ask questions directly.
- **Attendees:** People who can watch and listen to the workshop, but cannot directly talk or share video.
  - Attendees can ask questions and make comments through the Zoom Chat window.
  - Moderators will be watching the chat window and can ask questions on your behalf.
  - You can "raise your hand" to get the attention of a moderator.

Saturday iPosters



See Gallery Link at the top of https://hamsci.org/hamsci-2021-program

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Saturday iPosters

- **Saturday morning** will use this webinar link.
- **Saturday afternoon** iPoster session will be on a **different** Zoom link.
- Link will be posted at the top of the schedule page on Saturday.
- The goal of the iPoster session is to make the meeting more interactive.
- We will use breakout rooms and you will have a chance to socialize more casually with other people in the meeting.
- Make sure you are using the latest Zoom client.
- This is experimental! Please be patient and help to make this a good experience for everyone!

Live Streaming and Video Recording

- **We have live YouTube Stream!**
  - Address is posted on hamsci.org/hamsci2020
  - No live chat in YouTube stream… you need to log into Zoom for that!
- Meeting is being recorded and will be post-processed by Jason Johnston KC5HWB of [Ham Radio 2.0]

Questions?

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HamSCI Personal Space Weather Station: Overview and Project Update

Nathaniel A. Frissell W2NAF[1]

[1]The University of Scranton

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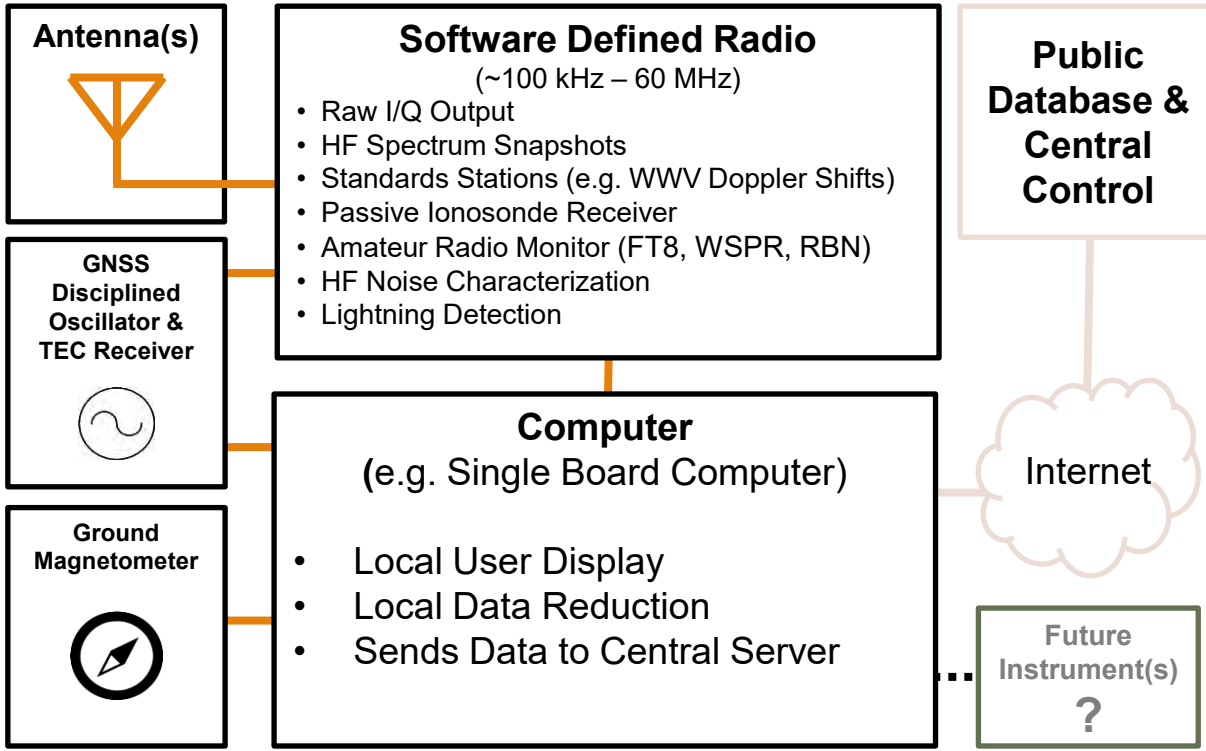
HamSCI Personal Space Weather Station

- **The PSWS is a multi-instrument, ground-based device designed to observe space weather effects** both as a single-point measurement and as part of a larger, distributed network.
- It is “Personal” because it is being designed such that an individual should be able to purchase one and operate it in their own backyard.
- The PSWS design also works to take into account the needs of both amateur radio operators and professional researchers.



For more information, visit http://hamsci.org/psws

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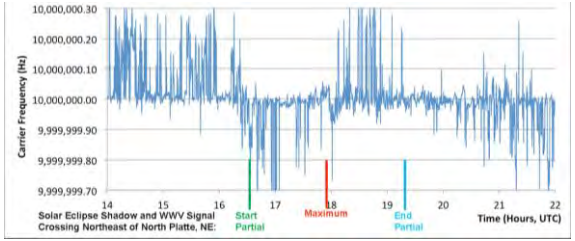
Low-Cost “Grape” PSWS

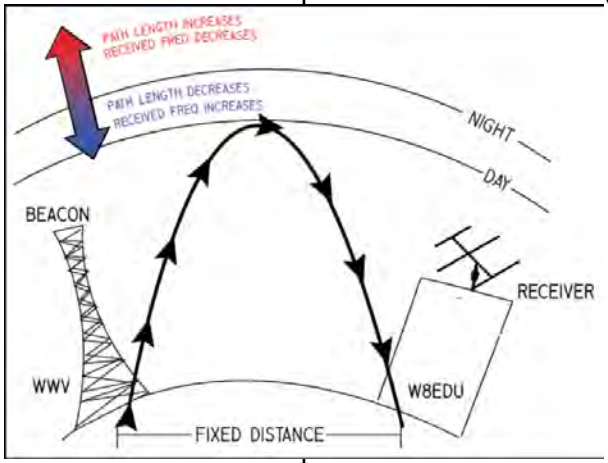
- HF “Doppler Shift” Monitoring
- Main components: Raspberry PI, GPSDO, Custom Direct-conversion receiver board
- Cost: ~$100 to $200
- Developed by Case Western

10 MHz Doppler During 2017 Eclipse
TX: WWV RX: WA9VNJ (Milwaukee)



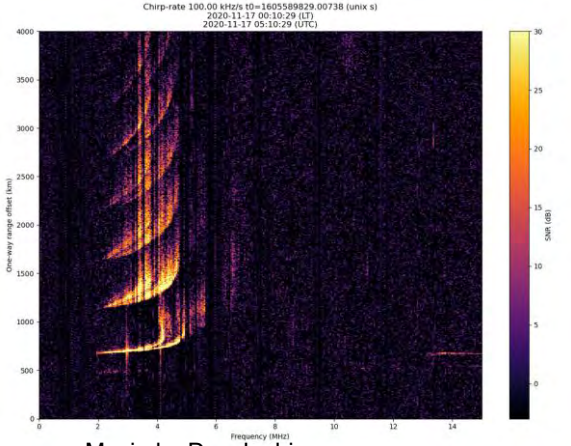
SDR-Based “Tangerine”

- HF FPGA-based Software Defined Radio
- Precision timing and frequency measurement
- 2 to 4 coherent, phase-locked receive channels
- Cost ~$500 to $1000
- Developed by Amateur Radio Group TAPR



[Collins et al., 2021]

Oblique Ionograms
(Currently on Ettus N200 but will be ported to Tangerine)



Movie by Dev Joshi
GNUChirpsounder2 by Juha Vierinen

PSWS Teams

University of Scranton
- **Nathaniel Frissell W2NAF (PI)**
- Dev Joshi KC3PVE(Post-Doc)
- Jonathan Rizzo KC3EEY
- Veronica Romanek KD2UHN

Responsibilities
- Lead Institution
- HamSCI Lead
- Radio Science Lead

TAPR & Zephyr Engineering
- **Scotty Cowling WA2DFI (Chief Architect)**
- Tom McDermott (RF Board)
- John Ackerman N8UR (Clock Module)
- David Witten KD0EAG (Magnetometer)
- Jules Madey K2KGJ (Magnetometer)
- David Larsen KV0S (Website)

Responsibilities
- TangerineSDR (High Performance)
- Data Engine
- Ground Magnetometer

University of Alabama
- **Bill Engelke AB4EJ (Chief Architect)**
- Travis Atkison (PI)

Responsibilities
- Central Database
- Central Control Software
- Local Control Software

Case Western Reserve University
Case Amateur Radio Club W8EDU
- **David Kazdan AD8Y (Lead)**
- Kristina Collins KD8OXT
- John Gibbons N8OBJ
- Rob Wiesler AC8YV
- Chris Zorman (PI)
- Matt McConnell KC8AWM
- Skylar Dannhoff KD9JPX
- Aidan Montare KB3UMD

Responsibilities
- Low Cost PSWS System

MIT Haystack Observatory
- **Phil Erickson W1PJE**

Responsibilities
- Science Collaborator

New Jersey Institute of Technology
- **Hyomin Kim KD2MCR (PI)**
- Gareth Perry KD2SAK
- Andy Gerrard KD2MCQ
- Diego Sanchez KD2RLM

Responsibilities
- Ground Mag Oversight & Testing
- Science Collaborators

PSWS Current Engineering Status

- **Tangerine Data Engine (MAX10)**
  - Schematic capture: 100% complete
  - BOM: 100% complete
  - Component placement: 100% complete
  - Next step: routing & pin swap
- **Tangerine RF Module (dual-channel 0.1-54MHz)**
  - Schematic capture: 100% complete
  - BOM: 100% complete
  - Component placement and routing: 100% complete
  - Update will be required for DE compatibility
- **Tangerine Clock Module (ZED-F9T SynthDO)**
  - Schematic capture: 100% complete
  - BOM: 100% complete
  - Component Placement: 100% complete
  - Routing and pin swap: 50% complete
- **MagnetoPi Hat**
  - Schematic capture: 100% complete
  - BOM: 100% complete
  - PC Board placement and layout: 100% complete
  - Compatibility review with LC-PSWS: 100% complete
  - Prototype build of 50 units: 100% complete

- **Low Cost PSWS (Grape)**
  - Grape Generation 1 consists of a Leo Bodnar GPSDO frequency standard, a low IF receiver and a USB based A/D converter running a modified version of FLDIGI executing on a Raspberry Pi.
  - ~15 Grape Generation 1 stations operational
  - Grape v2 Design in Progress
- **Control Software and Database**
  - Prototype of local control software exists
  - Runs on Odroid N2 Single Board Computer
  - Uses data from a TangerineSDR Simulator (FlexRadio with GPSDO + DAX IQ output)
  - Can monitor up to 16 band segments at a time
  - 4 types of data collection: Snapshotter, Ring Buffer, Firehose(L+R), and FT8/WSPR Propagation Monitoring
  - Proof of concept code working for all modes except WSPR and Firehose L (supercomputer interface)

Thank You!

This project is supported by NSF Grants AGS-2002278, AGS-1932997, and AGS-1932972, and many volunteers in the amateur radio community. We also thank the ARDC for their support of the TangerineSDR prototype build.

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