

# Long Wave Radio



A Presentation to  
the Mount Diablo  
Amateur Radio Club  
by Bart Lee, K6VK

From the California Historical Radio Society



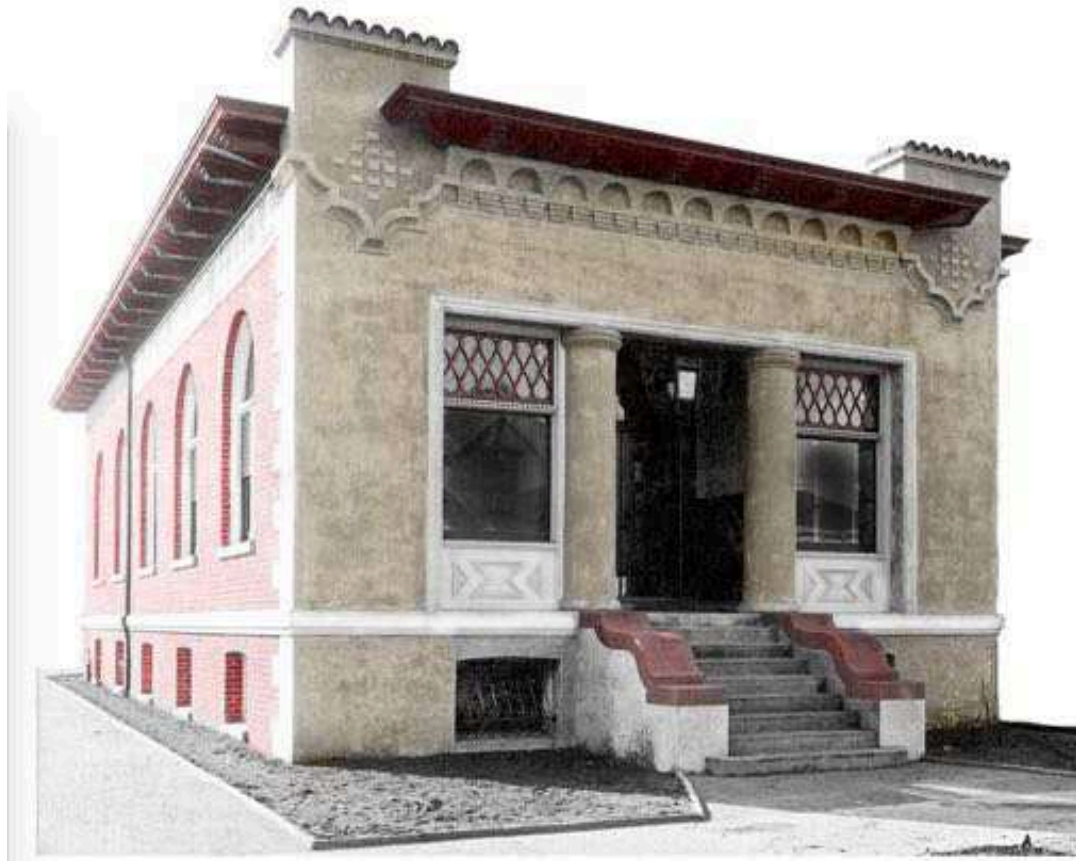
**Bart Lee**

**K6VK**

**LIFE MEMBER**

# The CHRS Museum as it will be Restored as of 1901

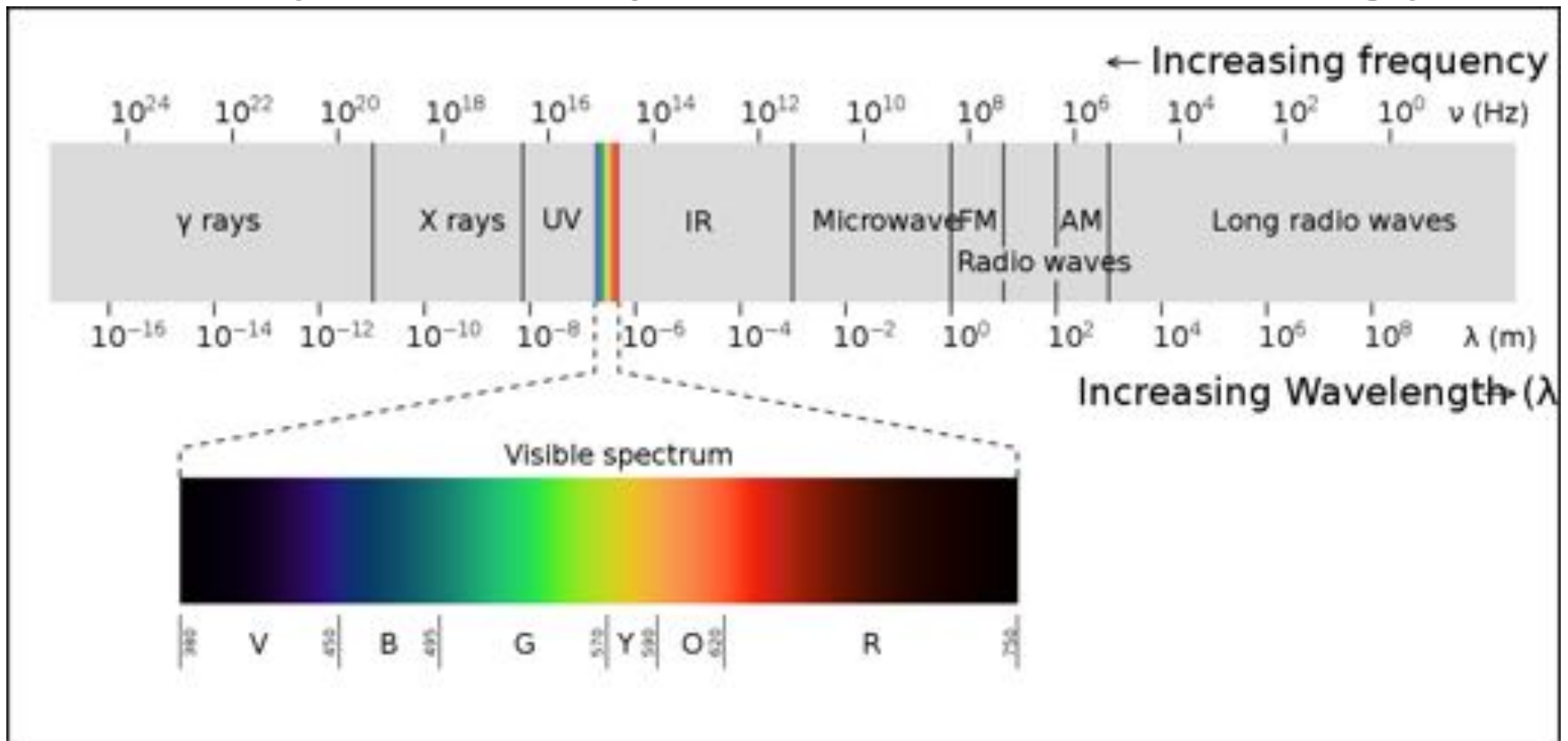
---



Light is a tiny sliver of the electromagnetic spectrum, from zero to gamma rays (see **Maxwell**, etc.)

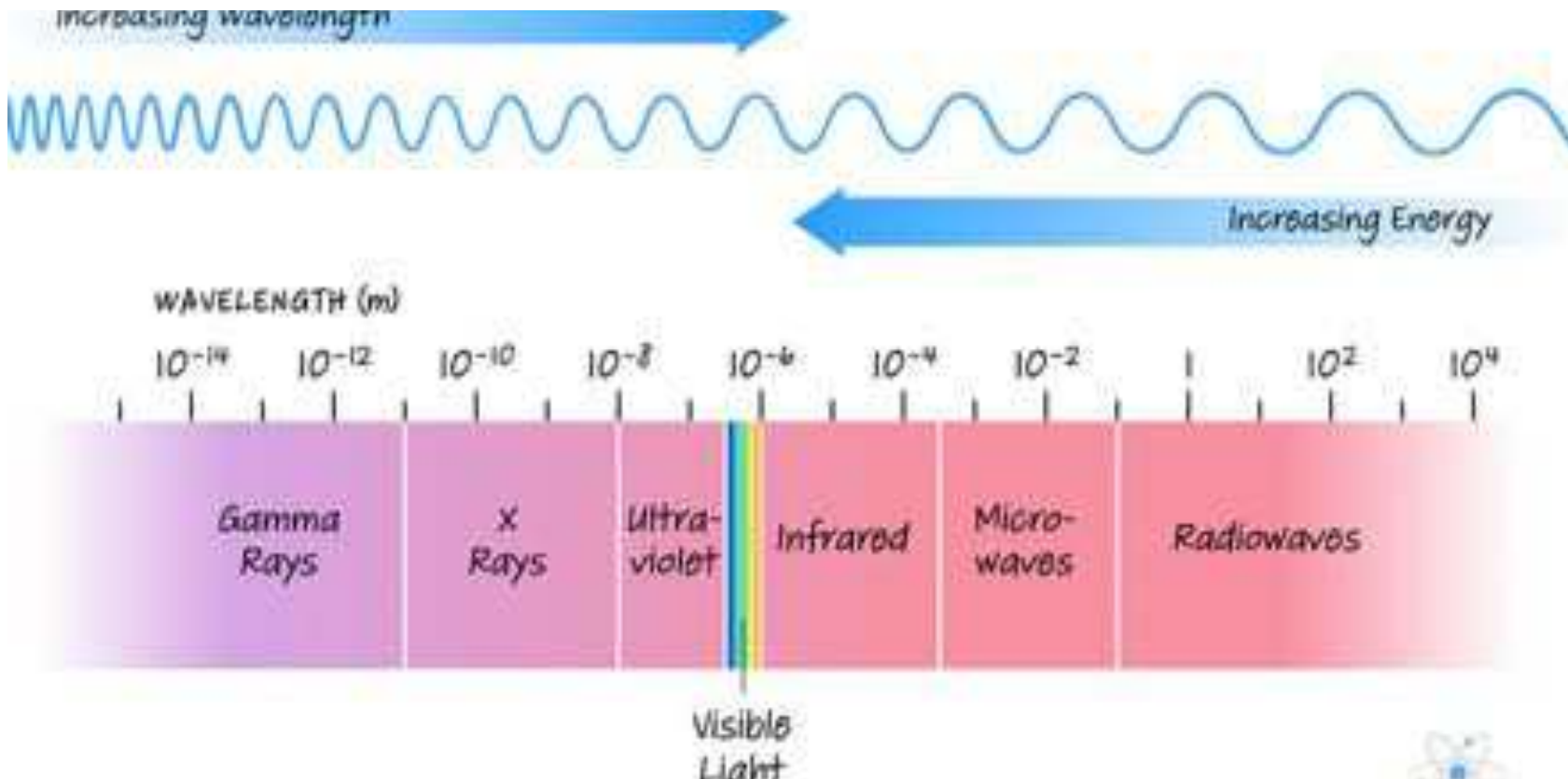


Radio Waves are longer than light waves, WAY longer (see **Hertz**, etc.); their photons just have less energy\*



\* So... they “vibrate” less frequently ...

Radio works from 8 KHz or less to 300 Gigahertz or more; “Long Wave Radio” means those frequencies below the AM broadcast band, 0.540 KHz down to ten KHz or less. The lower the frequency, the longer the radio wave, i.e., the longer the distance between wave peaks, as the wave travels at the speed of light, measured in meters (e.g., 20 meters).

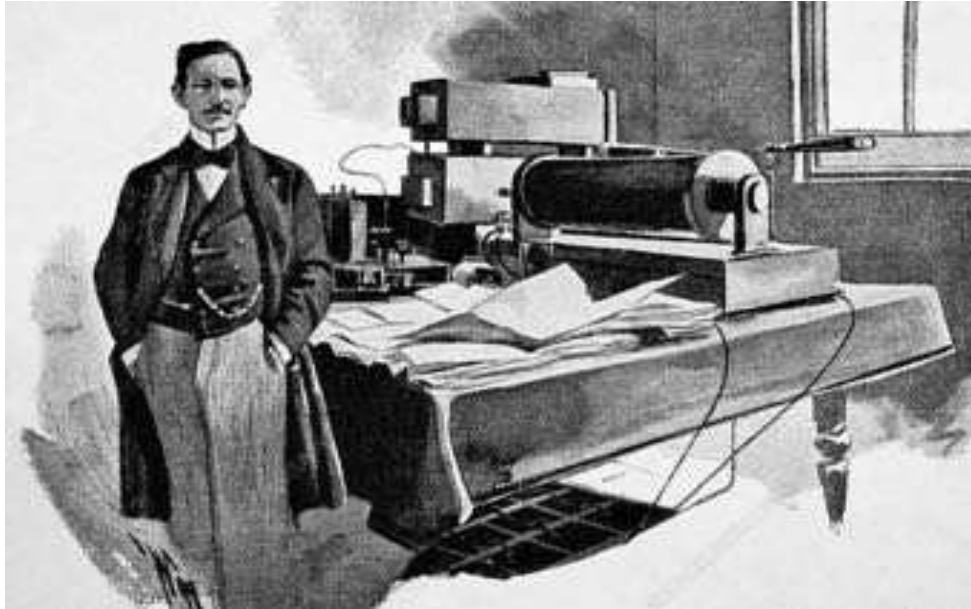


# Long Wave Amateur Radio

- Two New (world-wide) bands:
  - 630 Meters = 472 KHz
  - 2200 Meters = 137 KHz
- Mostly digital transmissions (e.g., WSPR), but some CW and in Los Angeles, on 630 m,
  - single side band QSOs.



# We owe it all to Bill Marconi and Jameson's Irish Whiskey



Marconi's mother, Annie Jameson, seems to have arranged Jameson money to fund the "start-up" Marconi company in the 1890s in London.



# 200 Meters and Down – Oh! Oh !

- Before 1912, amateur radio enthusiasts could operate anywhere in the then-available radio spectrum, almost always below 1500 KHz or 200 meters wavelength, “Long Wave” as we think of it now. Spark Gap transmitters reigned.
- The 1912 Radio Law outlawed amateur radio below 1500 KHz, 200 meters or only “200 Meters and Down.”
- I made a replica pre-1912 spark gap transmitter for the California Historical Radio Society, using period-appropriate parts >>>

# A Replica Spark Transmitter with Leyden Jars, too!



# And the First Spark!!!



# CHRS Holds Much Long Wave Gear

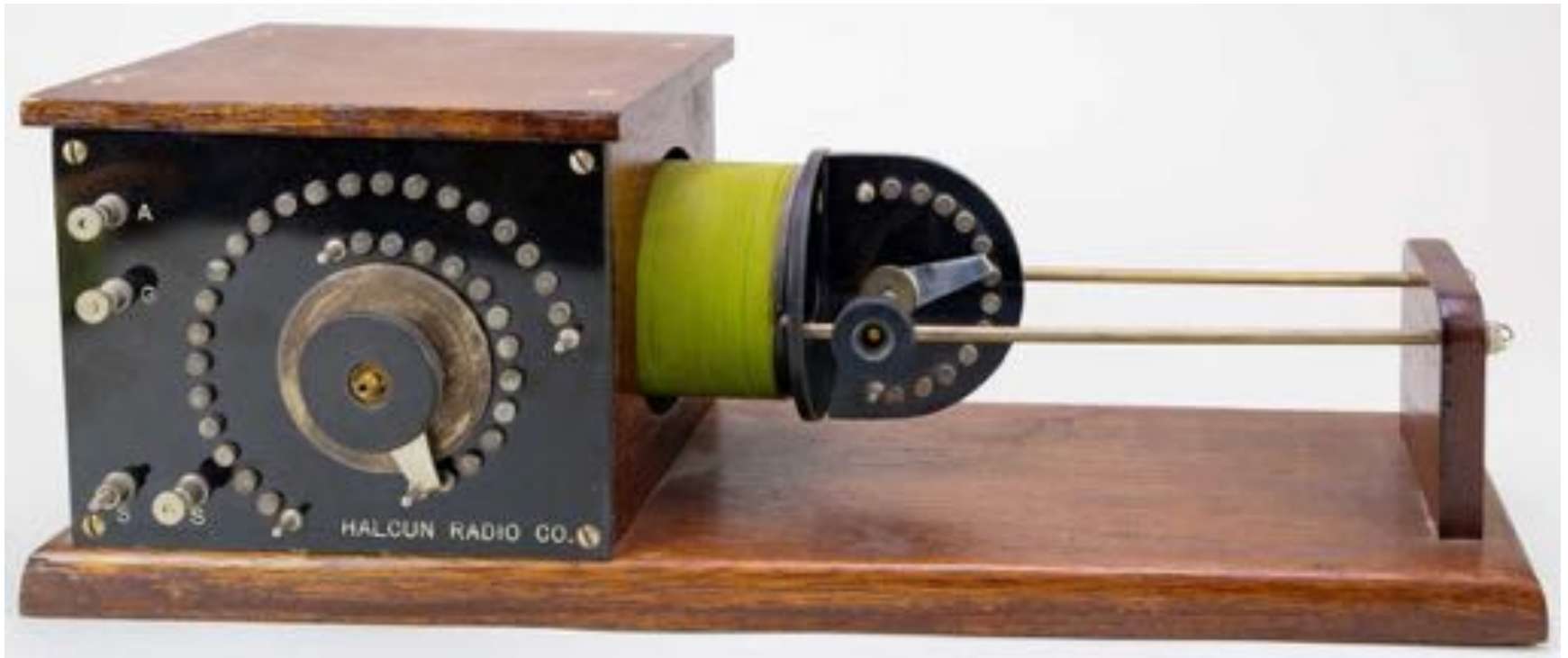
-- Photos by Walt Hayden and Cynthia Reinholtz



Marconi (Canada) Long Wave Receiver



# HalCun Loose Coupler, c. 1916



Haller-Cunningham, San Francisco, Selling Marine Radio Equipment

# Spark Gap Transceiver WW-1 era



# Mackay Marine Long Wave Receiver





# WW-II ARC-5 Long Wave Aircraft Radio

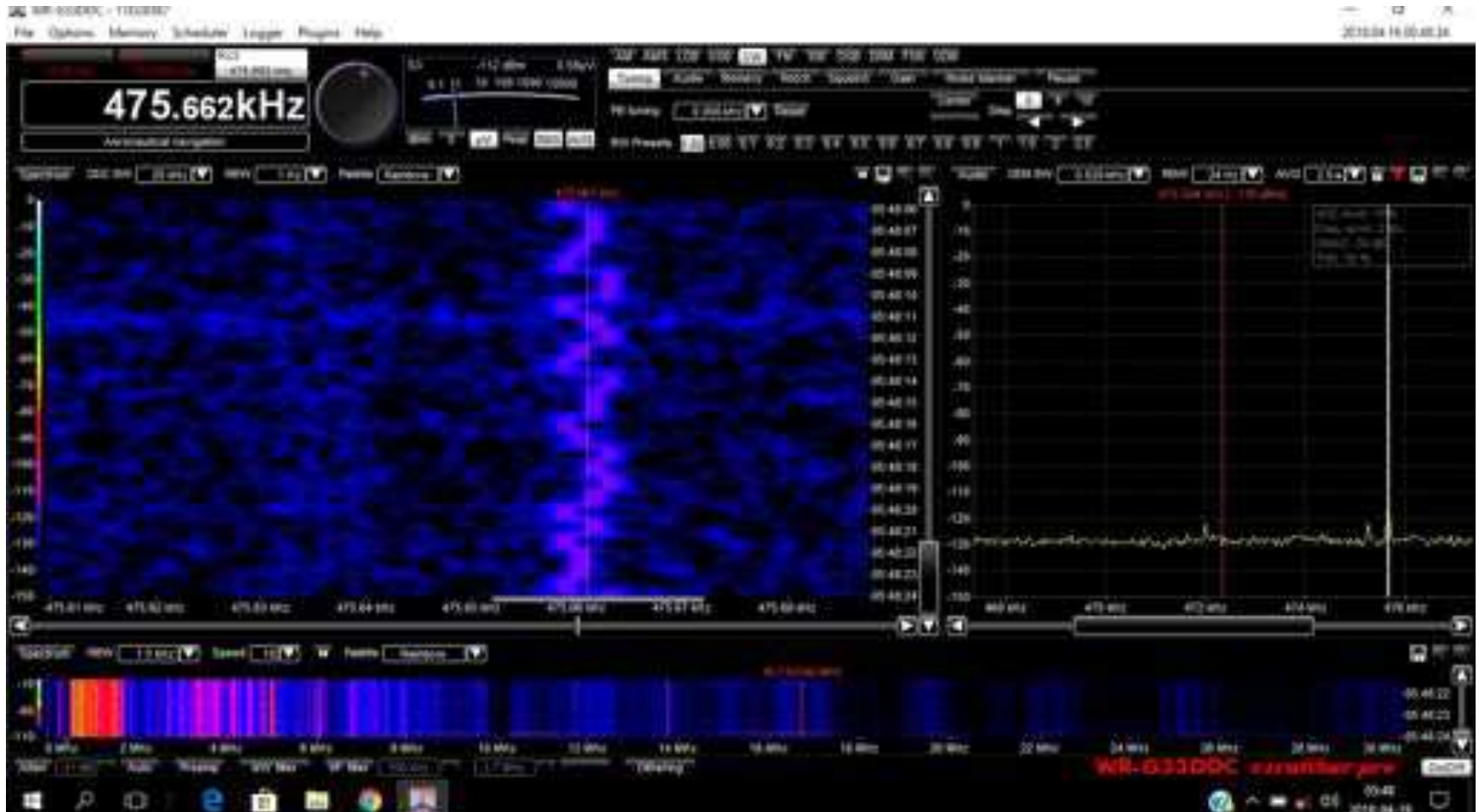


# AMELIA EARHART'S LONG WAVE RADIO AND LOOP

PHOTO: BART LEE



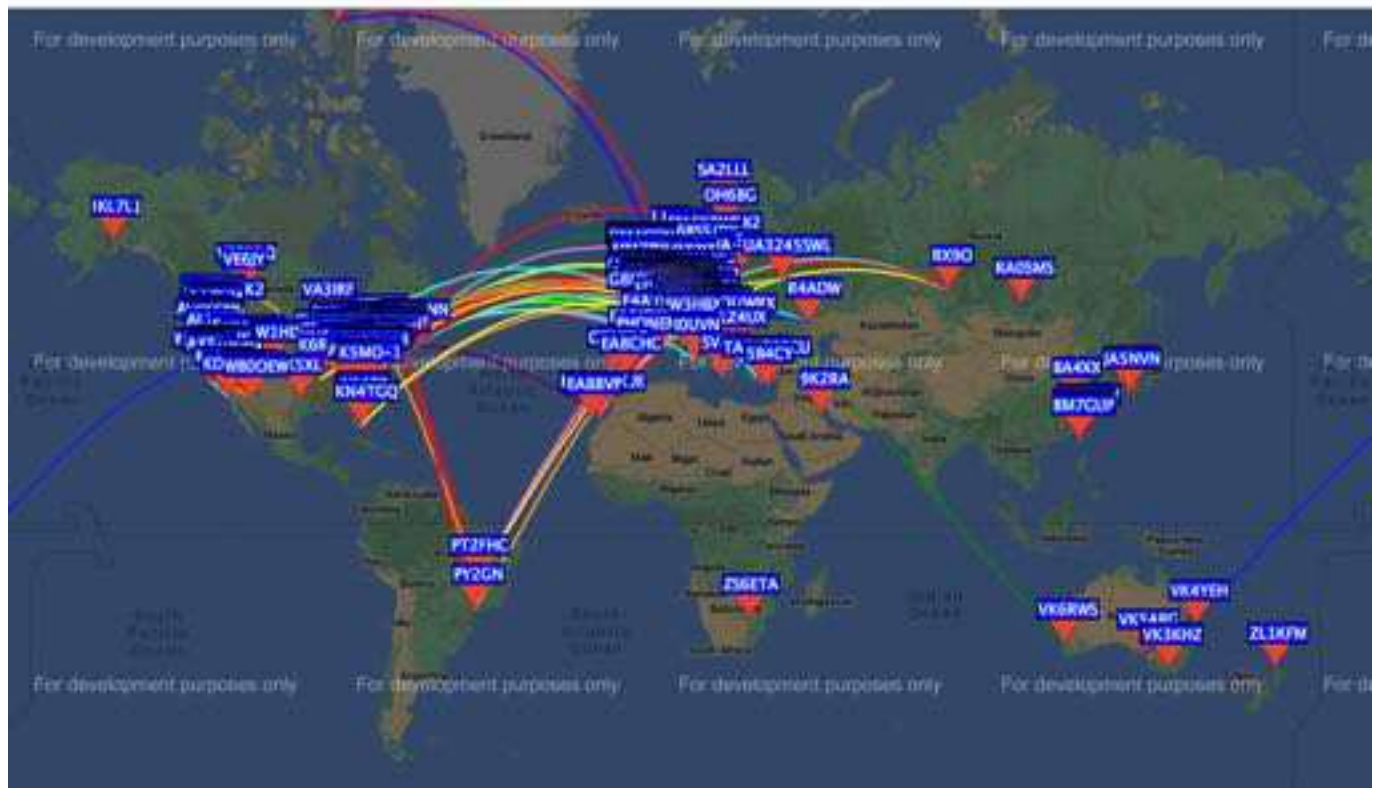
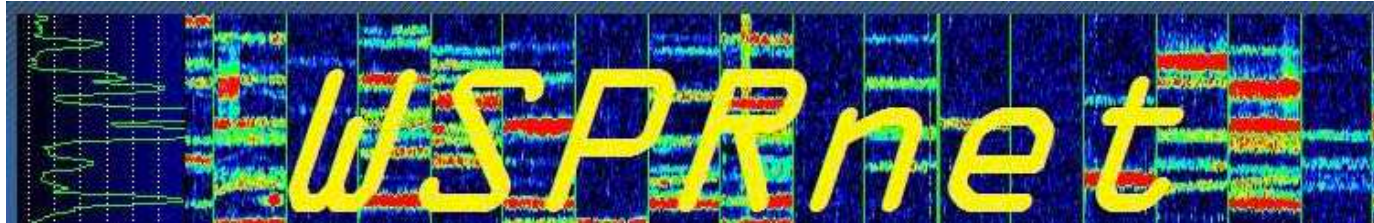
# Resurrected Long Wave (Digital) Amateur Radio, Today



630 m 19 IV 18 0549 UTC 475.662 KHz WSPR Capture @ K6VK

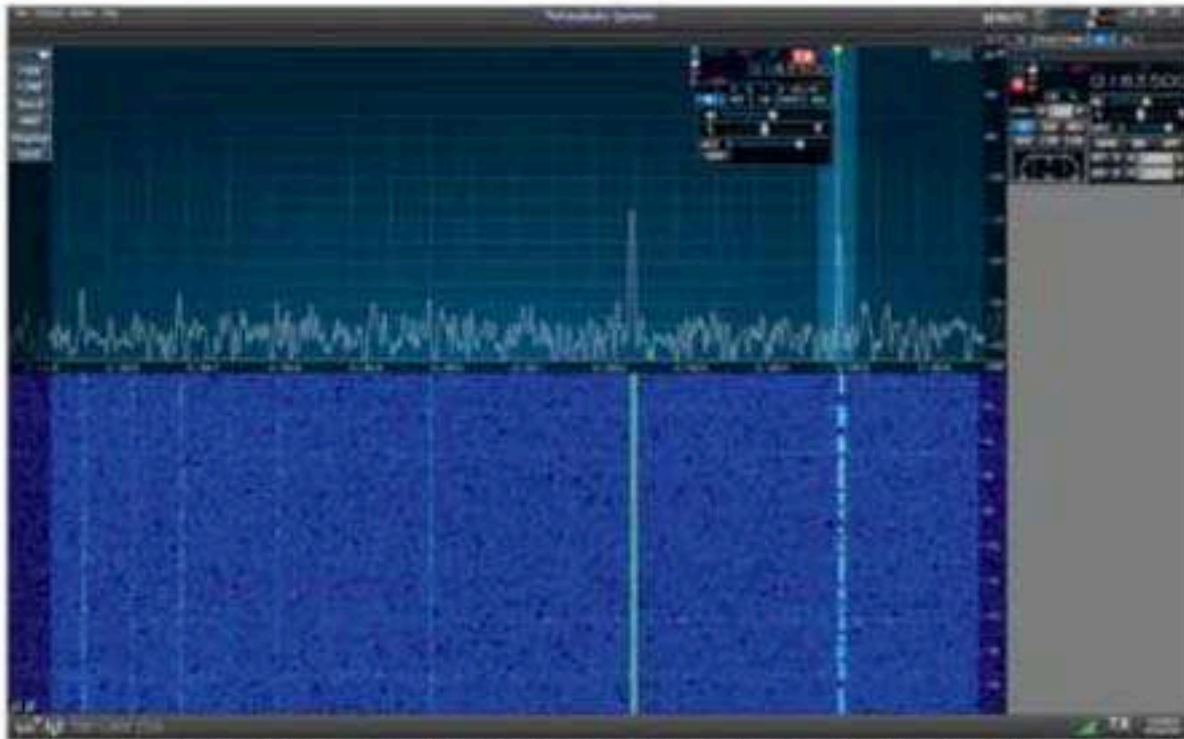


# Weak Signal Propagation Reporter



# LONG WAVE EXPERIMENTERS

## LoFer Beacon WH2XVN



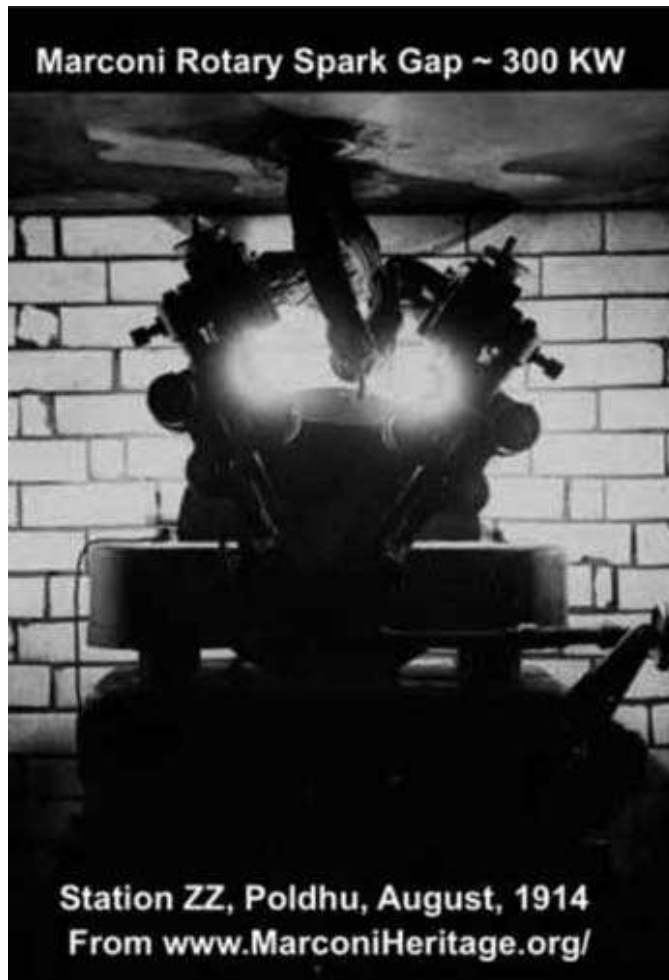
183.5  
KHz

John Stuart, KM6QX, CHRS, Mt Diablo ARC;  
Pixel Loop and Flex Radio, Lafayette, CA (first heard at K6VK)

Fig. 35. A record of receiving the Part 5 LoFer beacon WH2XVN on 183.5 kHz. (John Stuart)

# LONG WAVE RADIO, THEN...

- PRIMARILY SPARK SYSTEMS, THE FIRST...



“BOLINAS HIGH POWER”  
NOW KPH, EMPLOYED  
THIS MARCONI NEARLY  
300 KW ROTARY SPARK –  
“THE ROCK CRUSHER”  
ABOUT 1916

# ARC SYSTEMS (CW)

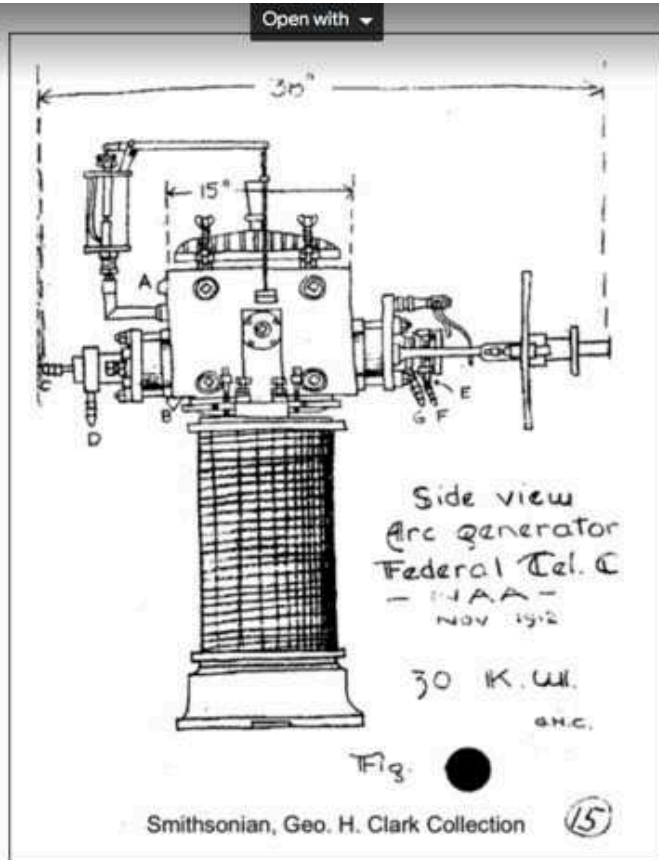


Fig. 13. A drawing by radio historian George H. Clark of a navy 30 kW arc as of 1912. (Smithsonian, Clark Collection, Bart Lee copy)

**FEDERAL IN SAN FRANCISCO  
PIONEERED ARC SYSTEMS, 1910**

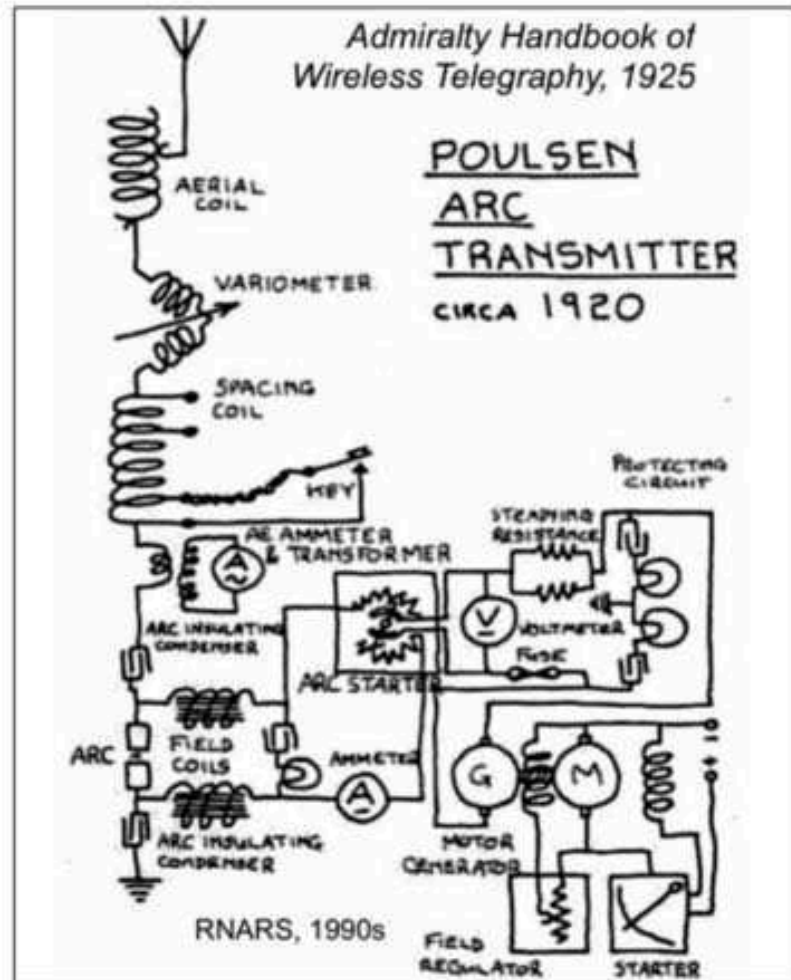


Fig. 12. A schematic diagram of Poulsen arc transmitter, circa 1920. (Cover of a 1994 Royal Navy Amateur Radio Society (RNARS) Communicator, 1994; schematic from the Admiralty Handbook of Wireless Telegraphy, 1925).



# A MEGAWATT ARC – WW-I

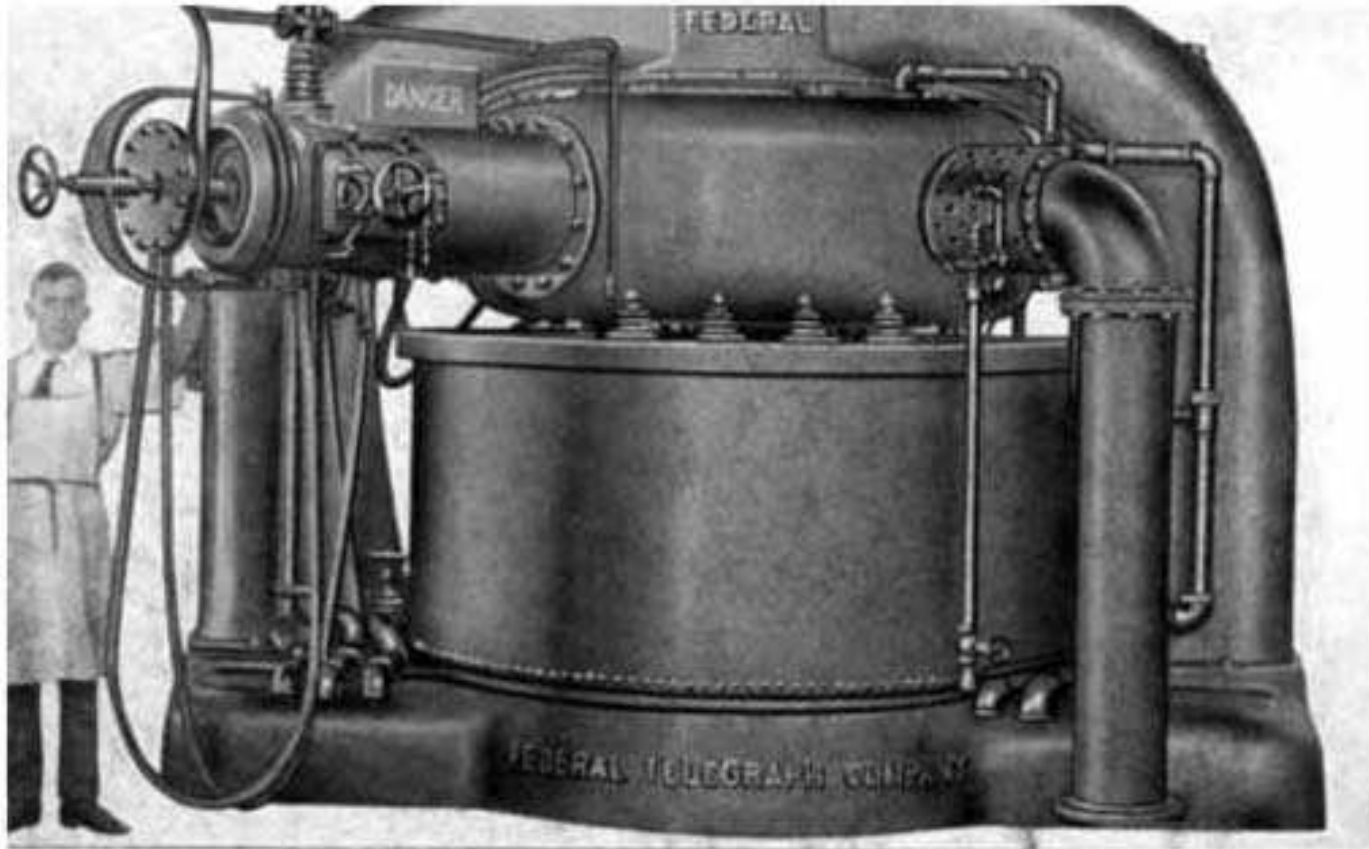
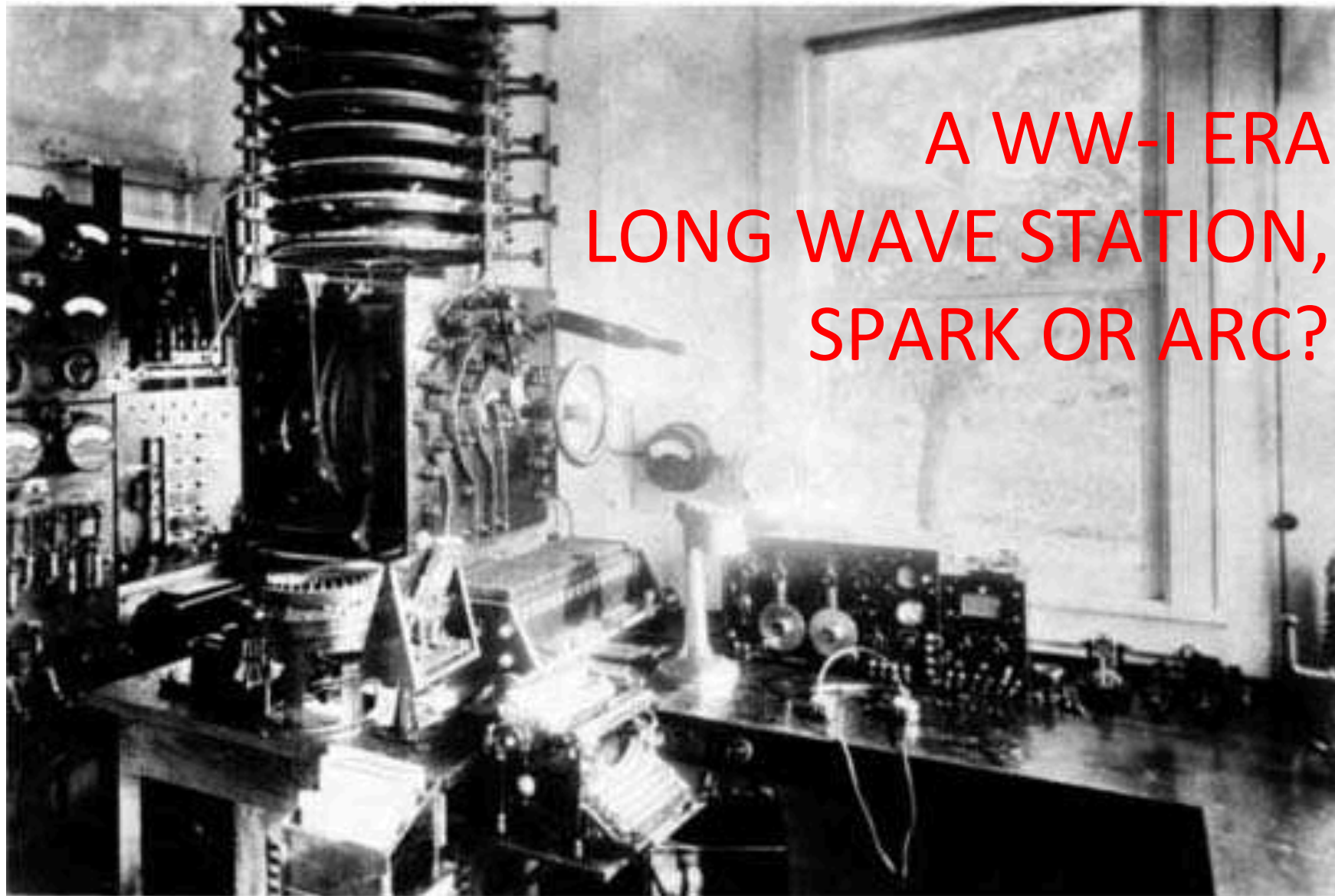


Fig. 14. A one megawatt large Federal arc, circa 1918, which operated in France circa 1920.



A WW-I ERA  
LONG WAVE STATION,  
SPARK OR ARC?

Fig. 7. A spark station, Navy or commercial dating from around WWI. This photo comes from the family of John Staples, and is known only as "Uncle Adrian's Radio Station." (John Staples)

# THE ALTERNATOR (CW)



THE SURVIVING SWEDISH RCA ALTERNATOR TRANSMITTER, SAQ (BART LEE PHOTO, 2018)

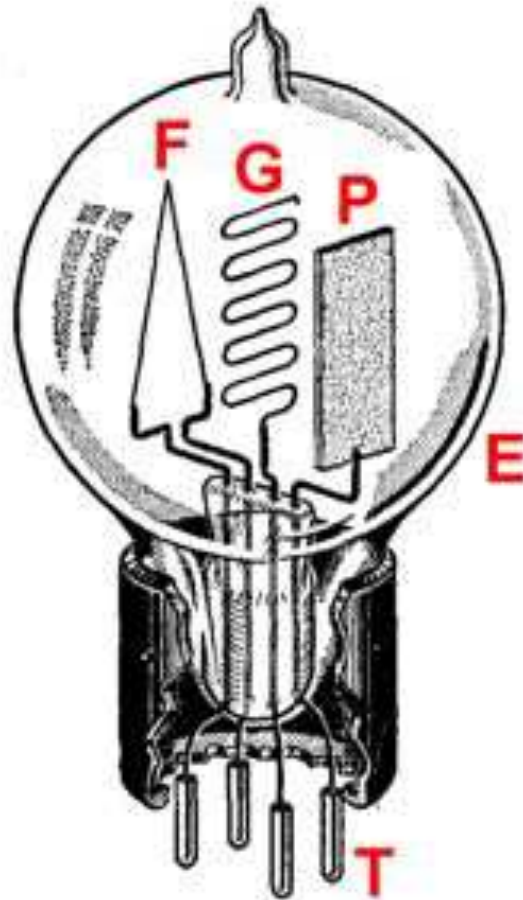
# 1930s USN LONG WAVE RADIO



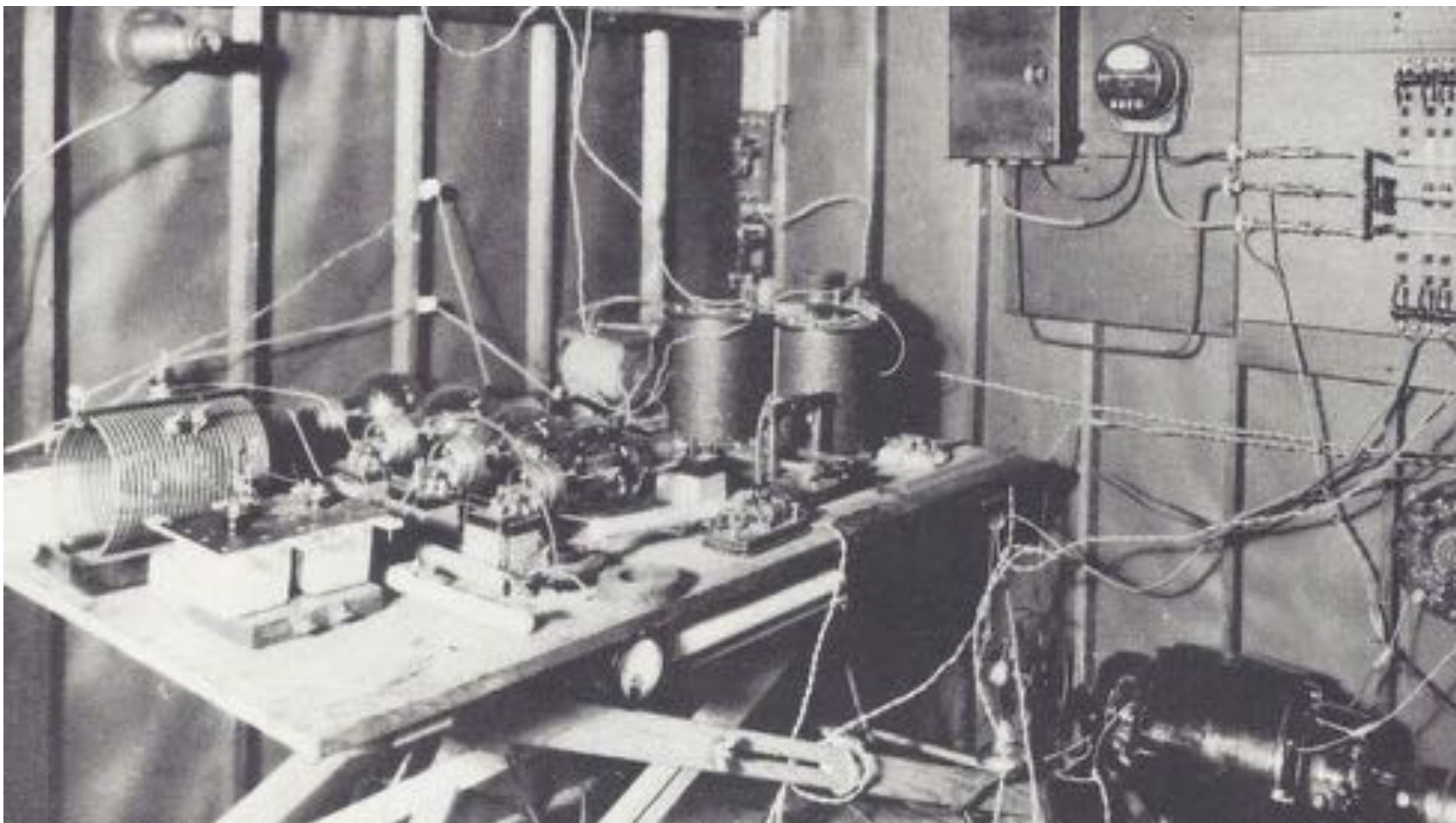
Washington, DC area: Navy Receiving Center, 1930s



# THE VACUUM TUBE COMETH, LONG WAVE DIE-ETH (or not?)



# HAMS KILL LONG WAVE !!



N1BCG GETS ACROSS THE ATLANTIC, 1921 – WITH VACUUM TUBES! ON SHORT WAVE! MARCONI FOLLOWS – AND THAT'S THE END OF LONG WAVE (OR NOT?)

# Long Wave after Short Wave...

- Radio Navigation, Marine and Aviation (“PNT”)



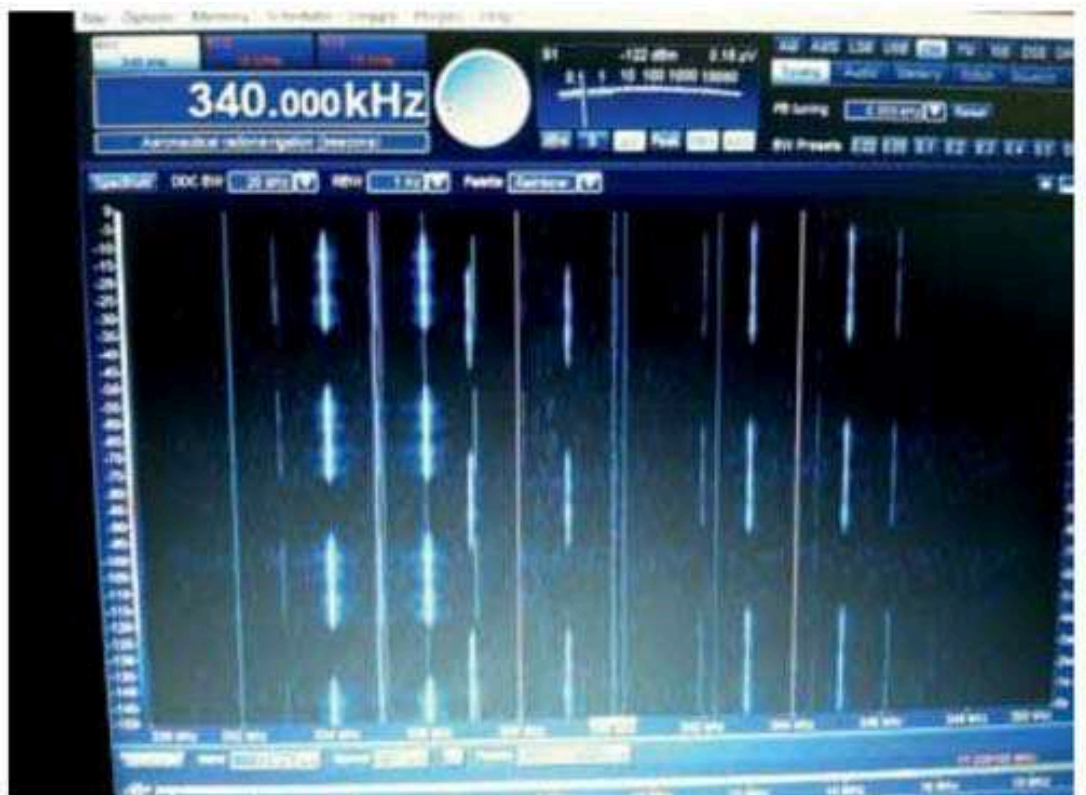
Aviation  
Weather  
1920s  
to 1970s

Fig. 25. The dial showing the “Weather Band” around 250 kHz, on a 1936 RCA 10K console radio. (Author’s collection)



# Persisting Long Wave Radio

- Aviation Beacons (to this day... but... dying fast)



335 KHz “CC”  
Concord, CA  
Off the Air...

Fig. 24. Station CC in Contra Costa County, CA at 335 kHz, a typical LF beacon for an airfield. (Author's screen cap)

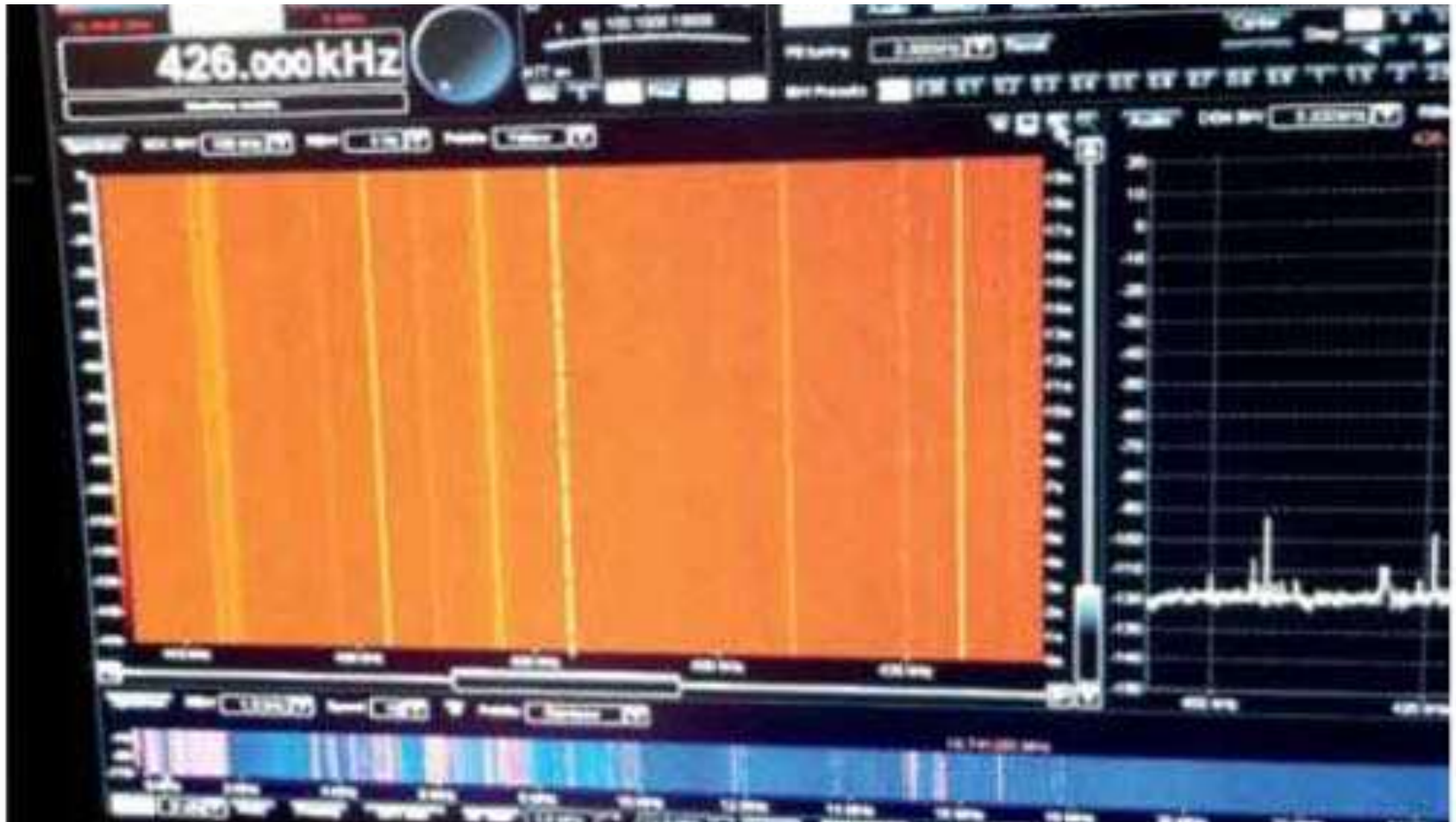
# Long Wave Broadcasting ...

- Radio Broadcasting in Europe, etc. (still ... but... maybe as few as eight still on the air)



A long-gone long wave radio station that was on 252 KHz

# Avocational Long Wave: KPH, KSM



Morse code from KSM (=KPH) Bolinas, CA, on 426 KHz



# Maritime Radio Historical Society

O, 700 MARITIME BLVD. SUITE B, LINTH  
ICUM HEIGHTS, MD 21090-1953. PHONE:  
410-850-8700\_ FAX: 410-850-0973. ALL  
RIGHTS RESERVED. THE MM AND P WHEEL  
HOUSE WEEKLY \_014. ARTICLES CAN BE >  
EPRINTED WITHOUT PRIOR PERMISSION IF  
CREDIT IS GIVEN TO THE MM AND P WHE  
ELHOUSE WEEKLY. FOR NEW SUBSCRIPTION  
S OR ADDRESS CHANGES, SEND AN I-MAIL  
TO WHEELHOUSE AT BRIDGEDECK.ORG (MA  
ILTO:WHEELHOUSE AT BRIDGEDECK.ORG).  
BACK ISSUES OF THE WEEKLY ARE POSTED  
ON WWW.BRIDGEDECK.ORG (HTTP://WWW.B  
RIDGEDECK.ORG). = EEETHIS CONCLUDES  
MASTERS MATERS AND PILOTS FREE PRESS  
BROADCAST. ES+ EE+Q CQ CQ DE KSM KS  
M KSM = EEIMASTERS MATES AND PILOTS  
FREE PRESS BROADCAST IS PROVIDED AS  
A SERVICE TO THE MARITIME COMMUNITY  
BY SAN FRANCISCO RADIO/KSM, M STATIO  
N OF THE MARITIME RADIO HISTORICAL S  
OCIETY. COMMENTS MAY BE SENT TO KSM  
AT RADIOMARINE DOT ORG, OR TO EMARIT  
IME RADIO HISTORICAL SOCIETY, C/O RI  
CHARD DILLMAN, PO BOX 392, T ■



# Yet Long Wave Radio Thrives...

- PNT (Position, Navigation and Time)
- NAVTEX Coastal Radio warning and weather texts – and distress traffic
- Naval and Military Communications

# PNT: WWVB 60 KHz



Fig. 17. Day range, WWVB, 60 kHz. (NIST)

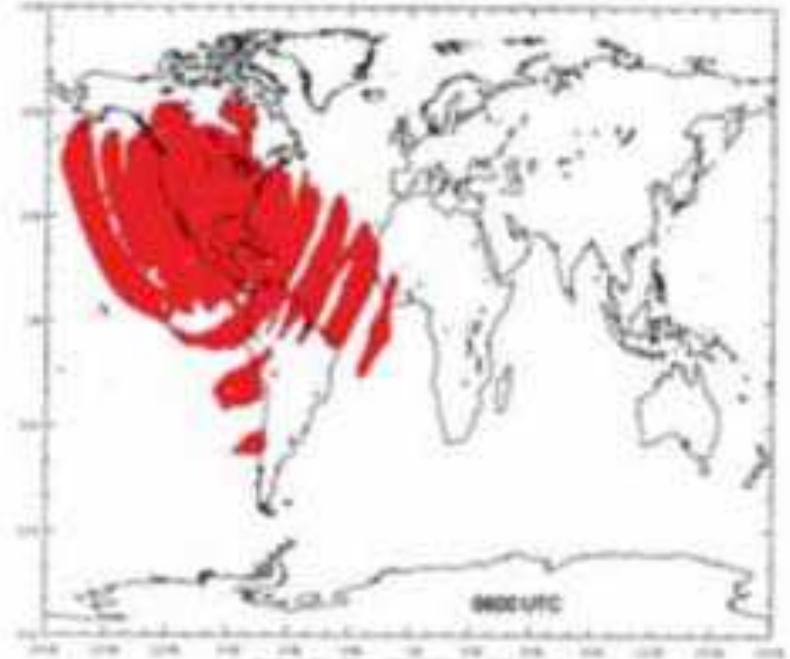


Fig. 18. Night range, WWVB, 60 kHz. (NIST)

The Basis for our “Atomic Clocks”; China, Japan, UK, Russia, France *etc.* also transmit PNT data on long wave.

# PNT: RUSSIAN ALPHA STATION for Submarine Navigation

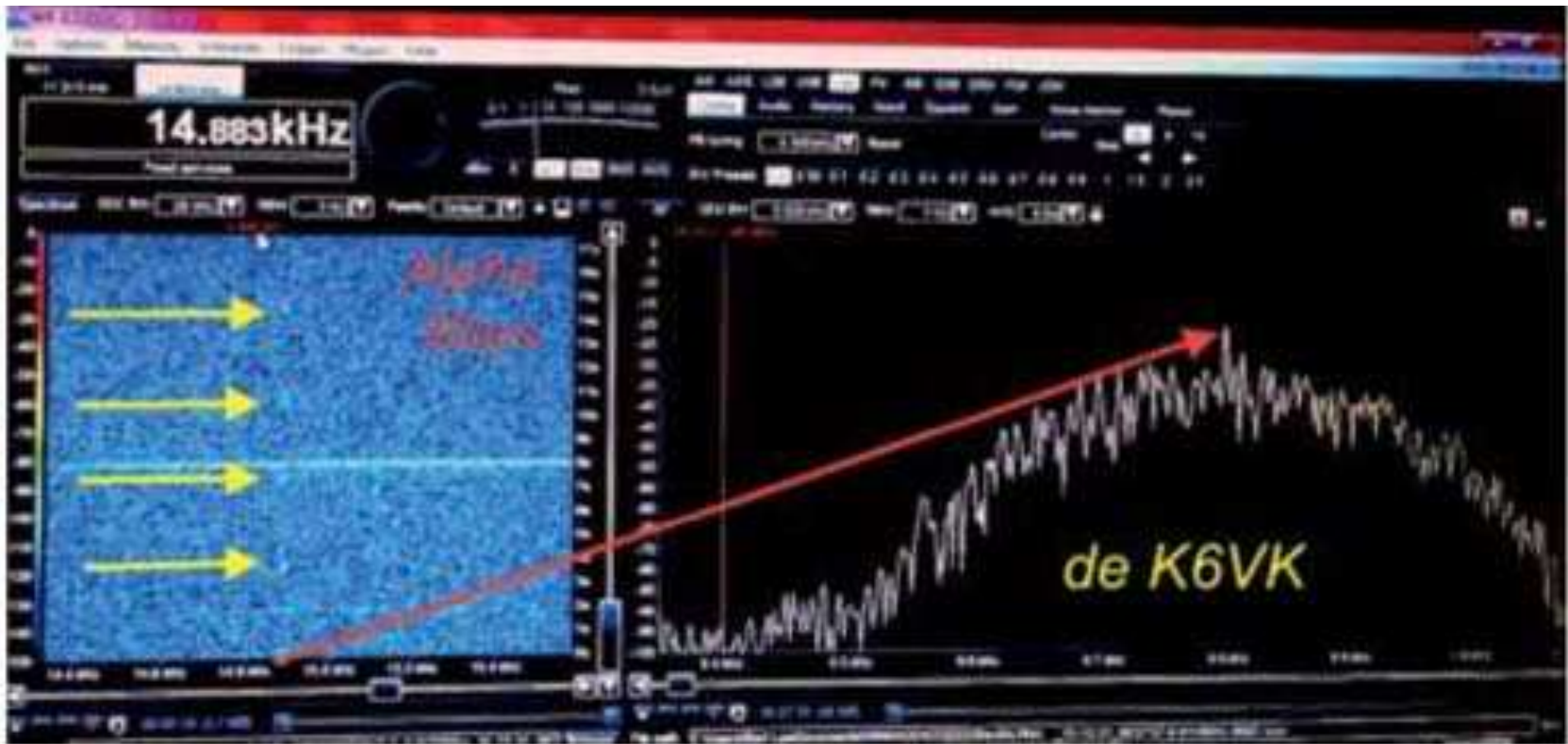


Fig. 22. Audio analysis of the Russian Alpha VLF station at 14.881 kHz on December 31, 2015, at 14:57 UTC at K6VK. (Author's annotated screen cap photo)

**ALPHA STATION (ONE OF SEVERAL) 14.883 KHZ**

# NavTex – International @ 518 KHz





# Naval *Long* Long Wave -- VLF

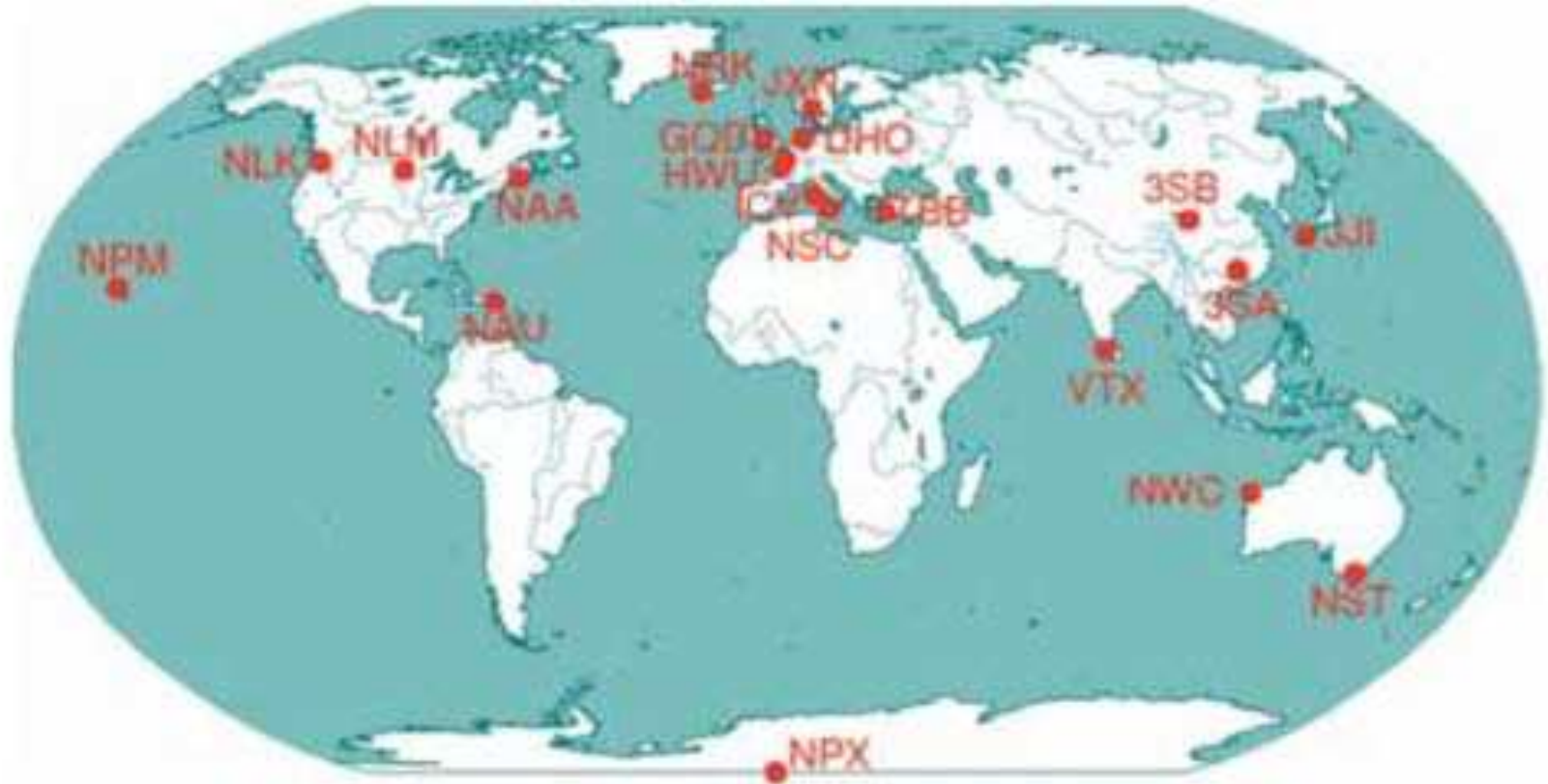


Fig. 20. Most of the VLF stations of the world appear on this map; NPX in Antarctica is perhaps notional.

TEN KHZ TO ABOUT 80 KHZ,  
MOSTLY AROUND 25 KHZ  
– MOSTLY FOR SUBMARINES

# US NAVY VLF STATIONS

Station	Frequency (kHz)	Location
NPM	21.4	Lualualei, Hawaii
NAA	24.0	Cutler, Maine
NLK	24.8	Seattle, Washington
NML	25.2	LaMoure, N. Dakota

# FOUR NAVY VLF 200 HZ STATIONS – AND A MYSTERY 800 HZ SIGNAL!

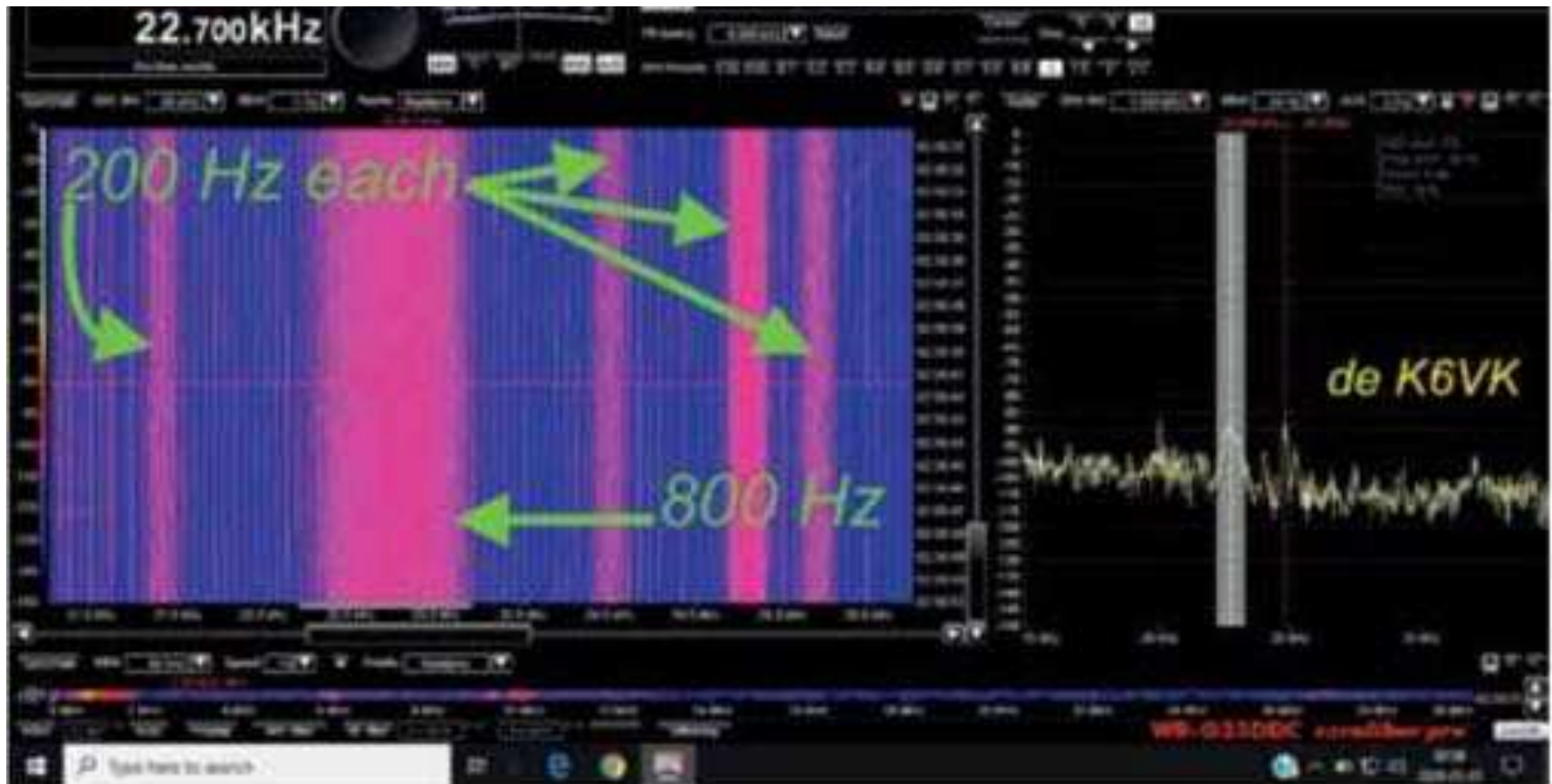


Fig. 38. A strong (32 microvolt), 800 Hz bandwidth MFSK VLF signal appeared at 22.7 kHz on May

# A NAVY AIRCRAFT VLF TRANSMITTER

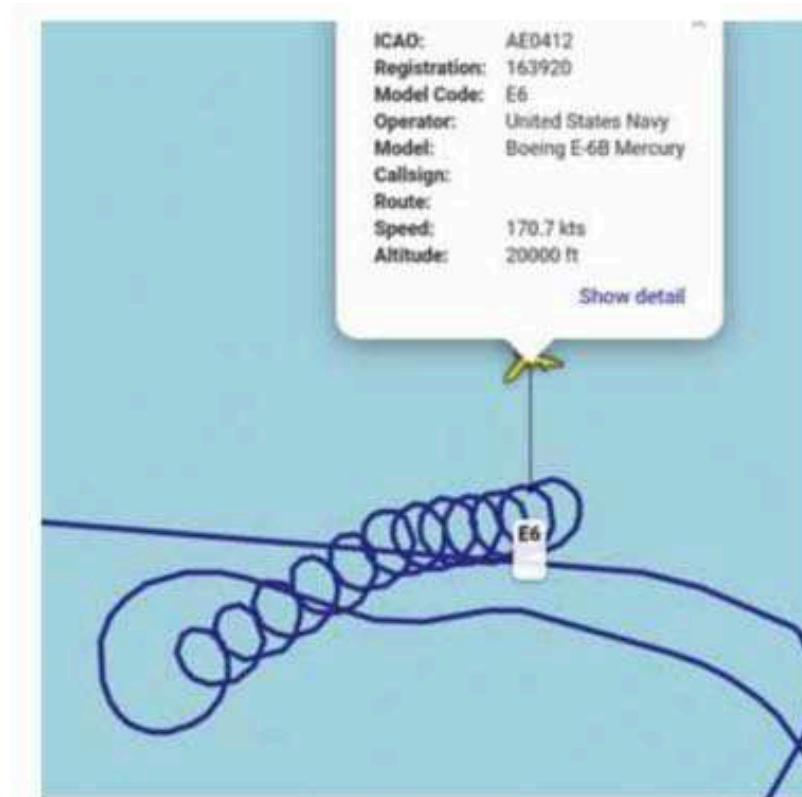


Fig. 39. As plane-spotting goes, this is as good as it gets; this diagram with data was posted by "Evergreen Intel @vcdgf555" on Twitter on December 12, 2019. The note reads "ICAO: AE0412, Registration: 163920, Model Code: E6, Operator: United States Navy, Model: Boeing E-6B Mercury, Callsign: (blank), Route: (blank), Speed: 170.7 kts, Altitude: 20000 ft. (Evergreen Intel @vcdgf555)"



# A NAVY “TACAMO” VLF AIRCRAFT



THIS PLANE SENDS THE 800 HZ VLF SIGNALS  
TO SUBMARINES BELOW – TARGET UPDATES?

# ECLIPSE VLF – CITIZEN SCIENCE



VLF (AND OTHER) SIGNALS CAN CROSS AN  
ECLIPSE PATH – HERE 2017

# 25.2 KHZ NML SIGNAL STRENGTH BEFORE, DURING AND AFTER THE ECLIPSE



Fig. 46. Graph of increase in VLF station NML (ND) signal strength in California during the eclipse, 6dB+. (Author)

# SDR IMAGE OF ECLIPSE MAX SIGNAL

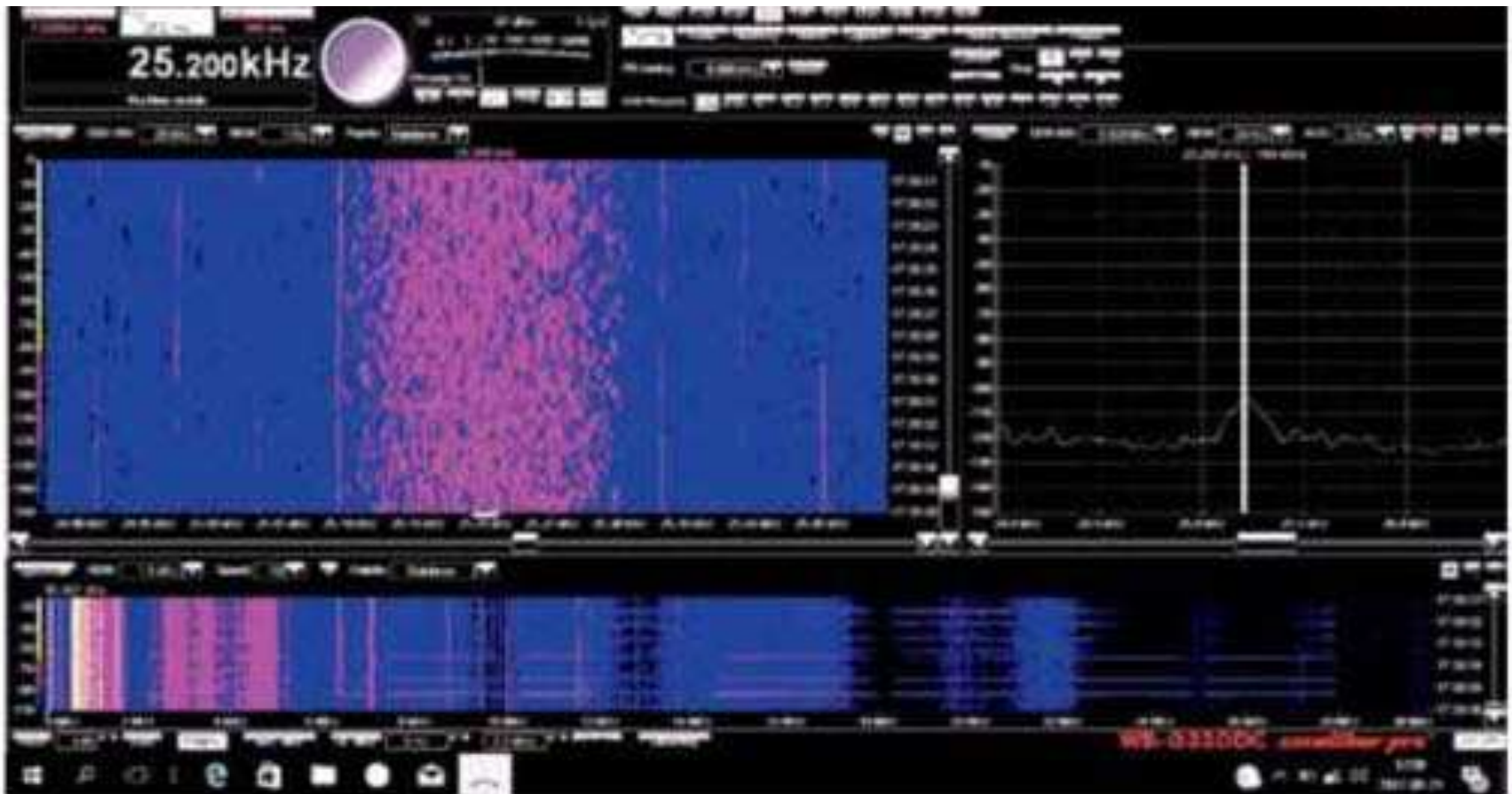
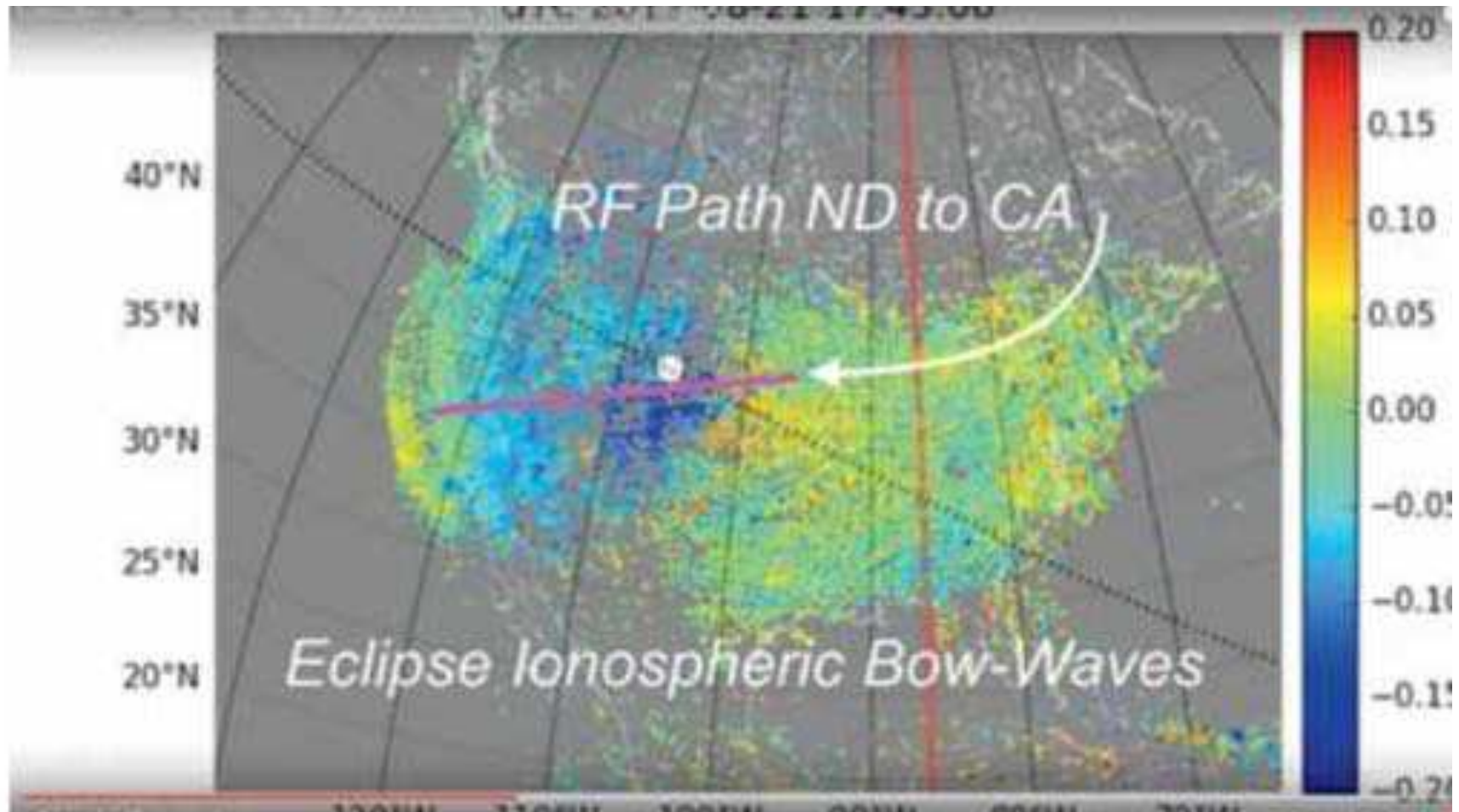


Fig. 47. Maximum signal strength at K6VK at maximum umbra intersection, 3.1 microvolts.



# ECLIPSE IONOSPHERIC 'BOW-WAVE' STRENGTHENS VLF PROAGATION



<https://skyandtelescope.org/astronomy-news/solar-eclipse-made-bow-waves-earths-atmosphere/>

# RADIO SCIENCE, 2024

- “...the next total solar eclipse ... will pass over the United States on April 8, 2024. While the Moon’s shadow will not go coast-to-coast, its 3,400-km- long path, nearly 80 km wider than 2017’s path of totality, will pass over the central and eastern U.S., from Texas to Maine.”
- A less-than-total annular eclipse will pass over the US in October, 2023.
- Time to get out those SDRs!

# CHRS Appreciates Mt Diablo ARC's Contribution to the Museum



And thanks for looking at this presentation and listening!

73 de Bart, K6VK (19 V '23) ##