CALLISTO status report/newsletter #85

CALLISTO station at ERAU Prescott Observatory Operational

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The CALLISTO solar radio spectrometer located at the Prescott Observatory of Embry-Riddle Aeronautical University (ERAU) has been reactivated using a VHF solar tracking antenna. Previously it was in a test phase using a tower mounted UHF Discone antenna.

The observatory's Callisto receiver (SN NA-029) had been activated several years ago (during solar max of Solar Cycle 24) using the observatories dual Jove dipole and an up-converter. The dual Jove dipole is east-west and has a beam directed at 45 degrees to the south. The receiver was used only locally to collect solar data. It was removed from service to make room in the observatories rf rack for additional radio astronomy equipment and receivers. Over the summer of 2019 the observatory reconfigured and expanded its Space Situational Awareness Demonstration Facility (SSA) and we were able to reconstitute the Callisto receiver system as part of the newly expanded facility.

A standard VHF nine element yagi had been modified with a large reflector screen to reduce the nominal low frequency to about 150 MHz and also reduce the front to back noise by about 6 dB. Frequency coverage and the front to back ratio has been enhanced on our Stellar Labs commercial antenna 2476. Testing also showed that it was useable from about 300 to 500 MHz. See table 1 below:

Table 1 Stellar Labs VHF Antenna Specifications (enhanced)

Antenna Specifications	Model 30-2476
Frequency	150 – 500 MHz
Impedance	75 ohm
Elements	9
Forward gain	10 – 14 dB
F-B Ratio	18 – 23 dB
Bean width horizontal	48 deg
Beam width – vertical	55 deg
Boom length	83 in

Tracking is accomplished with an azimuth rotator, a Channel Master CM-9521HD, mounted on a short stub pipe. See figure 1 which shows the complete antenna before being mounted on the roof. This configuration was used for testing the tracking and noise level over the sky. The antenna is mounted in

the vertical direction at a fixed angle of 45 degrees from the horizon. Tracking is accomplished using PST Rotator and the USB-UIRT interface (see usbuirt.com). We had to use the PST Rotator program for AZ and EL as the azimuth only program did not have sun tracking built in.
The original design had the rotator mounted at 55 degrees and the antenna mounted at the normal 90 degrees to create an equatorial mount for better solar tracking. Testing proved that the Channel Master rotator (CM-9521HD) cannot be operated in any alignment other than vertical. The rotator parts are not designed to be operated other than vertical as they begin to rub and destroy any calibration.


Figure 1: Antenna System and mount


Figure 2: Ray Fobes with antenna

Therefore the system was redesigned to point the antenna at the middle point of the ecliptic and rely on the 55 degree half power beam width to cover 90 percent of the solar path over the year. Even when the sun is outside the HPBW it will still be in the wider overall beam pattern of the antenna.
The yagi is mounted in the vertical direction in order to reduce terrestrial interference. The antenna is nominally connected directly to the rf input on the Callisto receiver; however it can be connected to an in-line low noise rf amplifier. The amplified has a FM band filter at the input to reduce saturation. The rf amplifier has a bandwidth of 10 to 500 MHz with 20 dB gain and a NF of less than 1 dB. Testing with the low noise amplifier has not been completed yet.
The Callisto receiver is mounted in a rack in the SSA room of the observatory along with its computer. The computer is a Dell Optiplex 7010 running Windows 7 Home Premium 64-bit. The PC is dedicated to the Callisto system and also operates the PST Rotator software and the UIRT interface. Figure 3 shows the nominal screen of the Callisto Computer.

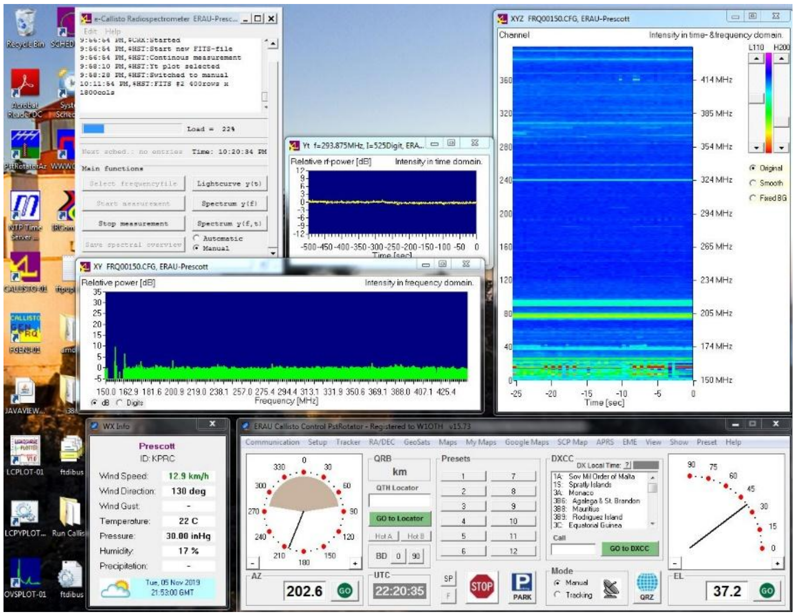


Figure 3: Nominal screen shot of Callisto computer

e-Callisto Station (NA-029) is located at longitude 112 West and latitude 34 North with an elevation of 1572 meters. The antenna is mounted on a flat part of the roof of the ERAU observatory building looking south and the observatory in on the north edge of the Prescott campus. Field of view is unrestricted to the east and to about 10 degrees to the west due to the roof of the building.

The station will nominally be operated in the VHF mode with a frequency spectrum from 150 to 500 MHz with the VHF vertical yagi. A second mode can be made available where the dual Jove dipole and an up converter can be employed allowing for a spectrum from 10 MHz to 50 MHz. The decision to use the in-line low noise amplifier will be made after suitable testing.

Files are transmitted daily via script (from e-Callisto) using the file header: USA-ARIZONA-ERAU.

Photos by Dan Elsea

Welcome ERAU on the e-Callisto network!

ART – Autonomous Radio Telescope
Callisto Solar Radio Spectrometer Development in Western New York State, USA

Pepe, Martin J, Jr. (KROC) mjpastro(at)gmail.com

Preface;

Over the years, I've read with great interest *(& some envy)* about the many radio telescope developments under the Callisto banner. I hope you find our work below, an acceptable, budding addition, to this excellent global collection.

Intro;

The School & Program;

Rochester Institute of Technology (RIT) is an internationally known Engineering and Technology college, based in Rochester, New York USA starting in 1829. In addition to traditional university departments, it is renowned for its cutting-edge technology development programs. The Multi-Disciplinary Senior Design (MSD) Program, part of the Kate Gleason College of Engineering, is meant to mimic real life (industrial environments) by exposing senior students to a team approach to project and process development. In doing so, student transition into the workforce is almost seamless. The project below has been developed under this umbrella.

Project ART;

Our development of a Solar Radio Telescope to study Sunspots *began* as an alternative to optical telescope observations, given the local WNY weather. We are in one of the cloudiest sections of the country due to the Great Lakes being just to our west (windward), so the number of clear observing days is very limited. The fact that clouds are transparent to radio waves, made a radio telescope, a natural observing solution.

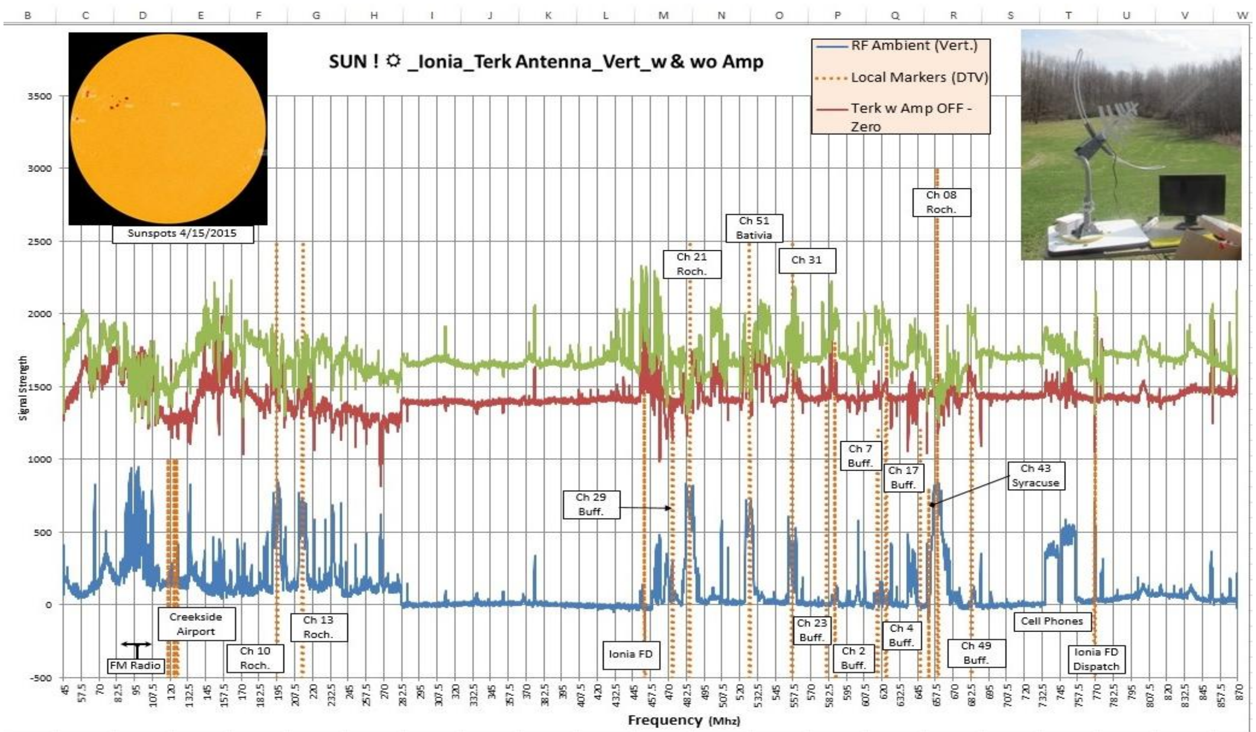
There was a desire to make a fully **A**utonomous **R**adio **T**elescope system to study the Sun, including pointing and tracking, data collection, analysis, and information upload to Switzerland. By anyone's standards, this is quite an undertaking in the professional world, let alone a student driven one. A means to breakdown critical functions into digestible pieces (modules) had to be developed, for a new student team to tackle every school year.

The first few years were spent in developing 'proof of concept' ideas for basic functions. This part was one of frequent frustration and dead ends. Ideas that seemed (theoretically) logical just didn't pan out with real world data. Example, most Callisto systems use a standard Log Periodic 'Yagi' like design. In our location, however, a strong local TV station swamped the rear lobe of our LP design. Thus, the development of a modified feed, 7' (2M) dish, for its superior front to back ratio. The next few years saw many system partitioning 'paper' concepts of basic functions. Finally, we settled on prioritizing the most difficult functions first.

By far, we viewed the autonomous tracking feature the most difficult function to automate. Waking the system up in the morning, pointing to the east and acquiring the Sun was the starting point. Tracking during the entire day, until Sunset was the goal, without needing any (local) human operator intervention. The location (Ionia, NY) is rather remote to the Rochester city center (away from noise & interference sources), and, almost an hour from the RIT campus. The logistics ruled out productive daily and weekly visits by the student teams to work on the system, especially since there are no appropriate labs, test equipment or model shops nearby. Further, imagine the challenge of having to dis-assemble the entire system and transporting it back to campus each new school year, for the incoming development team, a very time consuming and slow process.

The first senior development team P15571 was tasked with this mission critical, tracking function. An RA / Dec mount was designed, built on campus, and demonstrated. It was then installed in Ionia to enable basic (manual) operation. This accomplishment enabled some local data taking during the summer, to further our understanding of the local ambient noise, and allow taking basic Solar data. This effort, along with a totally manual 'proof of concept' portable bench set-up is shown below.

The bottom (**Blue**) trace shows the local interference (FM radio, TV stations, a cell phone tower, etc.). The two upper traces (**Red** wo an amplifier, **Green** w an amplifier) show the actual Sun signal with the bottom (blue) trace mathematically removed. Note the very large Ch 8 TV signal (@ ~ 658 MHz) removed from the two processed Sun data sets. It is possible to change the individual gain coefficients on each slice of the data to make the local noise essentially 'disappear'. A visual SOHO image of the Sun at the time (w sunspots), is shown in the upper left, and the portable test setup in the upper right.



The ‘local noise’ (blue) trace data, was taken with a vertical dipole.
The second design team P17571 concentrated on controls and software development. Our initial effort was to try to use Radio Eyes software to add the systems intelligence to our project. This software is like a (visual) Planetarium software program (Stellarium, etc.) but for what’s ‘visible’ in the **RF** radio sky.

The third design team P18571 consisted of fleshing out the controls, adding an uninterruptable power supply (UPS) to minimize system crashes and data corruption, improving software operability and looking into the possibility of nighttime operation by adding low noise amplifiers (LNAs). The UPS was not designed for continuous operation in the event of a power loss, but a means to provide a ‘soft landing’ so that ‘in process’ data files could be saved, systems could be orderly shutdown, etc., then restarted from a known good state (& position) when power re-appears. The LNAs are meant to try to acquire the top 40 brightest RF objects in the northern night sky, limited by the meager dish size of only 2 meters, (of **all** the tasks, this, is our lowest priority).

The next design team P19571 concentrated on designing a LabView like GUI (graphical interface) to look like a piece of test equipment, for operator input and controls. At this point, the system was operational enough to make preliminary data runs and to try sending preliminary data to Zurich.

The present team P20571 is concentrating on systems level integration, software, and functionality, including a web based interface ‘portal’ for remote operations. The hardware is being expanded to include dual receivers, one to collect the Sun signal, the other to collect the local interferers. The ‘local’ dipole is mounted right on the telescope mount, so it tracks with the dish and has its ‘null’ axis pointed directly at the Sun, thus minimizing the Sun signal, and maximizing the related ‘local’ RFI signal. The intent is to send the regular *.fits, *.csv files, etc. that have been the traditional Callisto formats. Maybe later the eCallisto network will be able to expand into corrected formats compensating for the each of their local interferences, at problem Callisto stations.

The photo (below), taken this last summer, between build blocks, shows the Rochester area (Ionia, NY) installation of our Callisto station called ‘**KROC**’ located at [**N 42.929826**, **W -77.500156**].
Our hope is that we will be ‘on the air’ by the end of this school year, May 2020.

Sincerely,
Martin Pepe

Do you know what your Sun is doing today ? **RT** does !

Credits;
Recognition and credit(s) have to be given to those supporting this effort. Funding & (remote) site location in Ionia, NY was provided under an ‘educational outreach grant’ by the Astronomy Section of the Rochester Academy of Science (**ASRAS**). Site selection and characterization was performed by students from the University of Rochester (U of R). Development and Lab facilities were provided by RIT Kate Gleason College of Engineering.
Besides the direct involvement of the mainline student teams, additional thanks, has to be given to the many students, professors and support personnel who have given us their continued support over the (many) years of its incubation, and development.

Cloudy Skies ? – *Switch to a longer wavelength* !

Welcome KROC on the e-Callisto network!

Solar Radio Spectrometer Commissioning in Algeria

During November 23-28, I visited Centre de Recherche en Astronomie Astrophysique et Géophysique (CRAAG) in Algiers, Algeria to perform final instrument commissioning of a Callisto solar radio spectrometer system which was delivered by Reeve [1]. The instrument is located about 40 km east of Algiers in a medium sized town Boumerdes where CRAAG is hosting a seismic observatory. The system is composed of a LPDA CLP-5130, a tower mounted amplifier (TMA) and among other rf-components based on a Mini Circuits low noise amplifier FX60-33LN and a Callisto NA-107 which is connected via a serial cable to a standard Windows 7 PC. Only minor changes were required in the software configuration to get the system operational as expected. Unfortunately, the situation regarding radio frequency interference (rfi) is quite severe. We were able to identify strong interference and cross-modulation from FM-transmitters, TETRA-system [2] and mobile phone transmitters above 850 MHz. Beside this stationary rfi we also got sporadic rfi which was wide-band over the whole spectrum which can be observed by Callisto. After intensive and time-consuming investigations, together with a specialist from communication industry we finally were able to identify the source. It was the controller of the photo-voltaic (PV) system, installed in the same building as the Callisto antenna. We found 12 periodic bursts after activating the PV which seems to test the charge level of the battery. These bursts were followed by strong, wideband several seconds duration burst due to charging the battery. After this the battery is kept charged by a short pulse about every 30 seconds all over the day. The only method to mitigate the situation is to move the antenna as far away as possible from this PV system. In addition, we found a wavy structure in the spectrum all over the day when people were around. After carefully taking protocol of all activities we found out, that the power adapters from a student's notebook was the source of rfi. By moving the antenna away from the office area it should be possible to reduce this rfi in the observed spectrum.

Currently the Callisto system is operational and is providing data on a daily basis to the e-Callisto network. Data can be found in the archive [3] under the keyword 'Algeria_CRAAG_date_time_59.fit.gz. Now we are all eager to see the 1st light from this instrument, any kind of solar radio burst.

The last day of my visit was used to train master-students, PhD-students and post-docs on how to read FIT-files from the e-Callisto archive and how to produce plots which are accepted by any publisher. In addition, spectral overview files were used to read and plot the level of rfi, compared to quiet Sun and Cygnus A, a radio source for calibration.

Fig. 1: Concrete shed, containing the seismometers, seismometer transmitter and PV-controller with battery. On the roof we see the antenna CLP-5130 in vertical polarization as well as the PV-panel oriented to the high noon transit of the Sun.

Fig. 2: 3-phase circuit breaker, PV-controller and power supply for seismometer.

Fig. 3: Team of CRAAG discussing on how to mitigate rfi. In the mean-time antenna polarization changed to horizontal polarization.

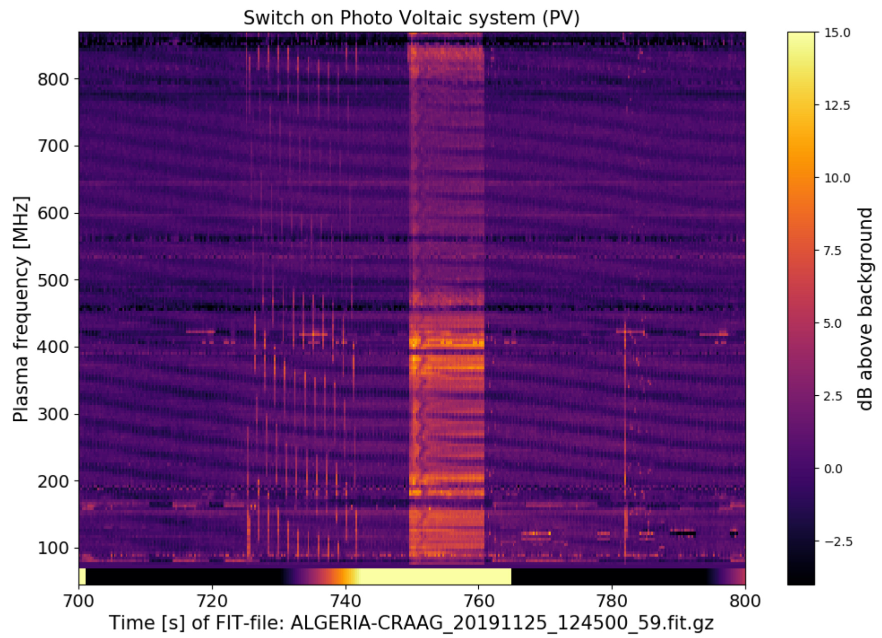


Fig. 4: Interference plot from PV-system, seen with Callisto (vertical structures). Seconds 725-740 testing battery charge. Seconds 750-760 fully charge of the battery. Second 782 either testing or re-charging the battery. We also see 'wavy' structure of the badly designed switched power supply of a student's notebook.

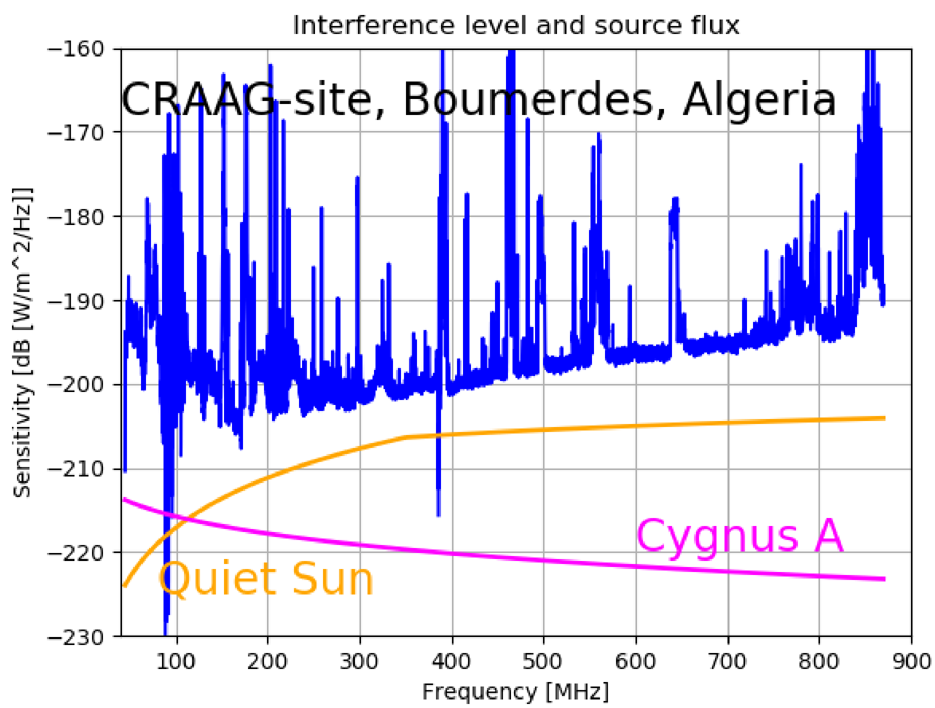


Fig. 5: Radio flux, observed with Callisto and LPDA CLP-5130. FM-radio is so strong that it saturates the spectrometer, therefore we get negative peaks. The same takes place at 395 MHZ (TETRA) which is stronger than the dynamic range of the spectrometer. Only very few channels are free from interference.

Fig. 6: Core-team Khalil Daiffallah from CRAAG (front) and radio-engineer Bachir Roméo Fox (back).

[1] Reeve: http://www.reeve.com/Solar/e-CALLISTO/e-callistoReeve.htm
[2] TETRA: Terrestrial Trunked Radio (TETRA) used for international police communication
[3] Archive: http://soleil.i4ds.ch/solarradio/callistoQuicklooks/

Welcome CRAAG on the e-Callisto network!

CESRA NEWS

Third harmonic electromagnetic radiation observed in Interplanetary Type III radio bursts
by M. Reiner et al.*
http://cesra.net/?p=2328

Solar chromospheric temperature diagnostics: A joint Ha - ALMA analysis
by K. Reardon et al
http://cesra.net/?p=2348

Imaging spectroscopy of fiber bursts
by C. Alissandrakis*
http://cesra.net/?p=2367

A microflare associated with periodic particle acceleration
by A. Mohan et al.*
http://www.astro.gla.ac.uk/users/eduard/cesra/?p=2385

Split-Band Feature of a Solar Flare Termination Shock
by Chen et al
http://cesra.net/?p=2412

Anisotropic radio-wave scattering in the solar corona
by Nicolina Chrysaphi et al.*
http://www.astro.gla.ac.uk/users/eduard/cesra/?p=2399

Malaysia maintenance

Asnor ANGKASA
Malaysia is trying to relocate the antenna closer to the receiver and they are doing some maintenance work in the carbine. Therefore, no data for Malaysia at this moment.

Receiver cabin for Callisto at ANGKASA, Malaysia.

PAPERS

Burst-Finder: burst recognition for E-CALLISTO spectra, Zulaikha Afandi et. al.
https://link.springer.com/article/10.1007/s12648-019-01551-2

AOB

- IRSOL is meant as the new core-station of the e-Callisto network, once the instruments at ETH Zurich will be shut down due to retirement of the PI.

- CALLISTO or Callisto denotes to the spectrometer itself while e-Callisto denotes to the worldwide network.
- General information and data access here: http://e-callisto.org/
- e-Callisto data are hosted at University of Applied Sciences, Institute for Data Science FHNW in Brugg/Windisch, Switzerland. Additionally, data are available at ESA site here:
SSA Space Weather Portal (http://swe.ssa.esa.int/).
- In case you (as the responsible person for operating and maintenance of Callisto) are leaving the institute or, if you are retiring, please send me name and email address of the successor.
- Daily light curves update: P-band included for satellite down links from geostationary satellites 243.05-318 MHz
- Problem solved at server level with stations which provide more than 5 ITU-frequencies

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