Observation of a type II burst with the e-Callisto network

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On November 5th there was a strong solar burst of type M7.9 reported by NOAA as event 8440 popping up between 09:26 and 10:02 UT. Connected to that x-ray event, there was a CME accelerated into interplanetary space, producing an interesting type II radio burst. This burst was observed by at least 13 out of 69 Callisto spectrometers as part of the worldwide network e-Callisto. This type II burst is a special one, we can clearly see first harmonic beside the fundamental radiation. Both spectra also show split band structure, a measure for the magnetic configuration in the corona of the sun. For comparison with a more elaborated fast Fourier-transform spectrometer (FFT) there is also shown a plot at the bottom with high resolution in time and frequency. Quite some locations are terribly suffering from local radio interference (rfi). I hope that this image gallery may help to convince some locations to search for a better location with less rfi or to mitigate self produced rfi nearby their observatory. The plots are sorted in alphabetical order, corresponding to their filenames in the data archive at Fachhochschule Nordwestschweiz (FHNW). Every plot has some comment regarding image quality given by the instrumental configuration. Every plot got an average background subtracted. Only the 'nice' part of the individual spectrum was plotted, so the different plots show different frequency ranges given by the rfi-situation. But all spectra cover identical time range from 09:41 to 10:00 UT.

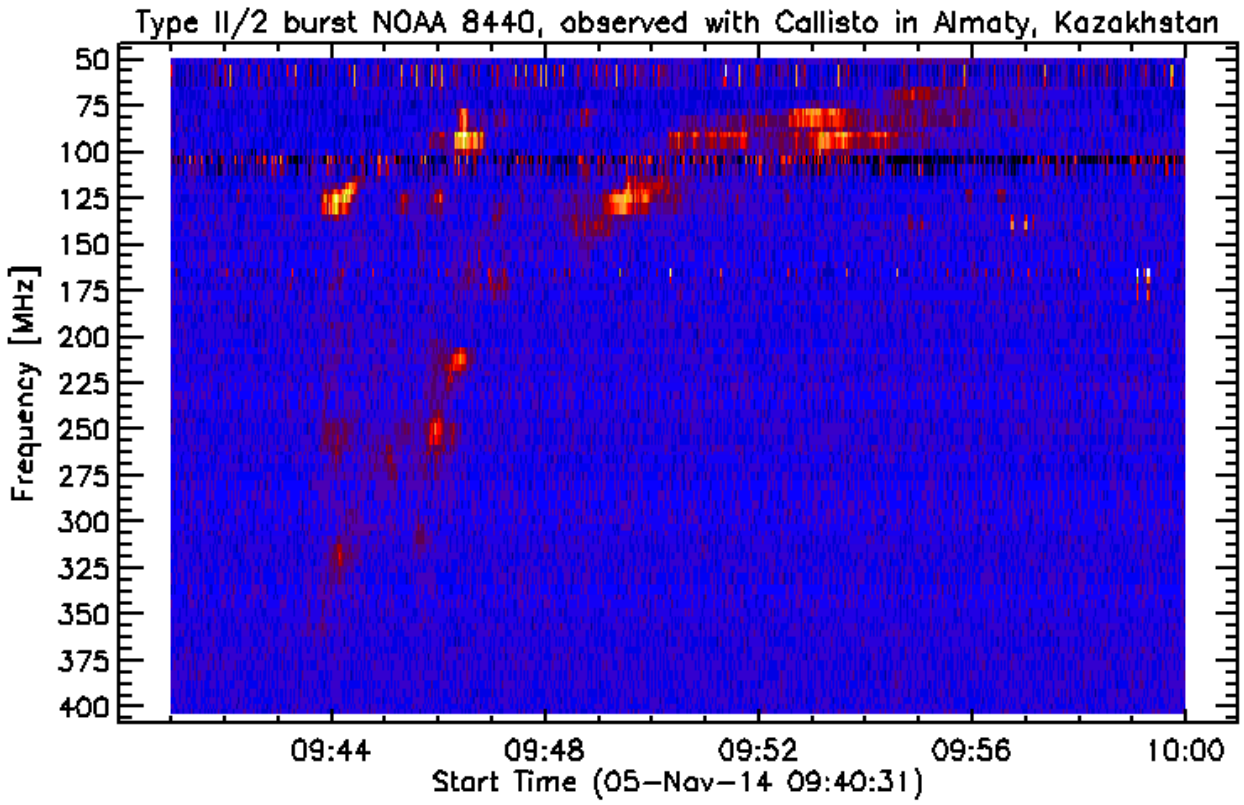

Figure 1 ~ Observation Institute of Ionosphere in Tian Shan mountains near Almaty in Kazakhstan. Quite clean spectrum with very low rfi.

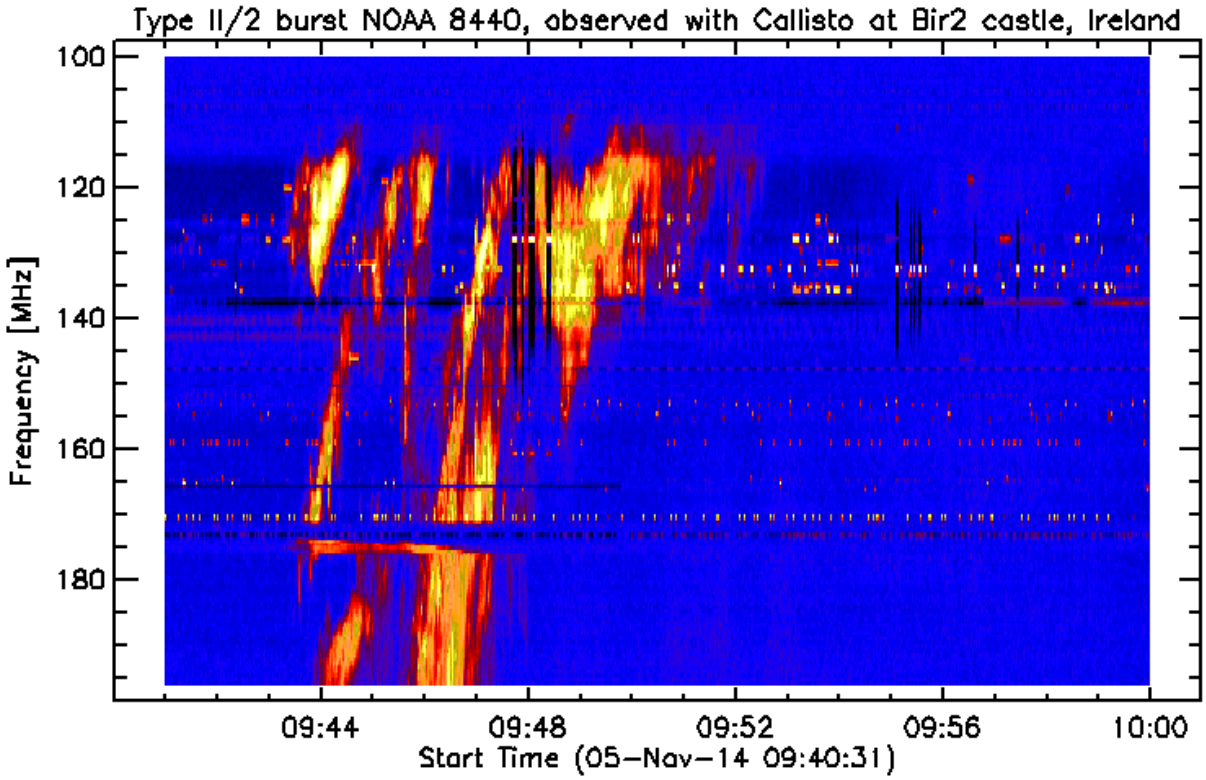

Figure 2 ~ Observation of Trinity College at Bir castle in Ireland. Quite clean spectrum with very low rfi. Instrumental artifact between 175 MHz and 180 MHz (receiver band switching).

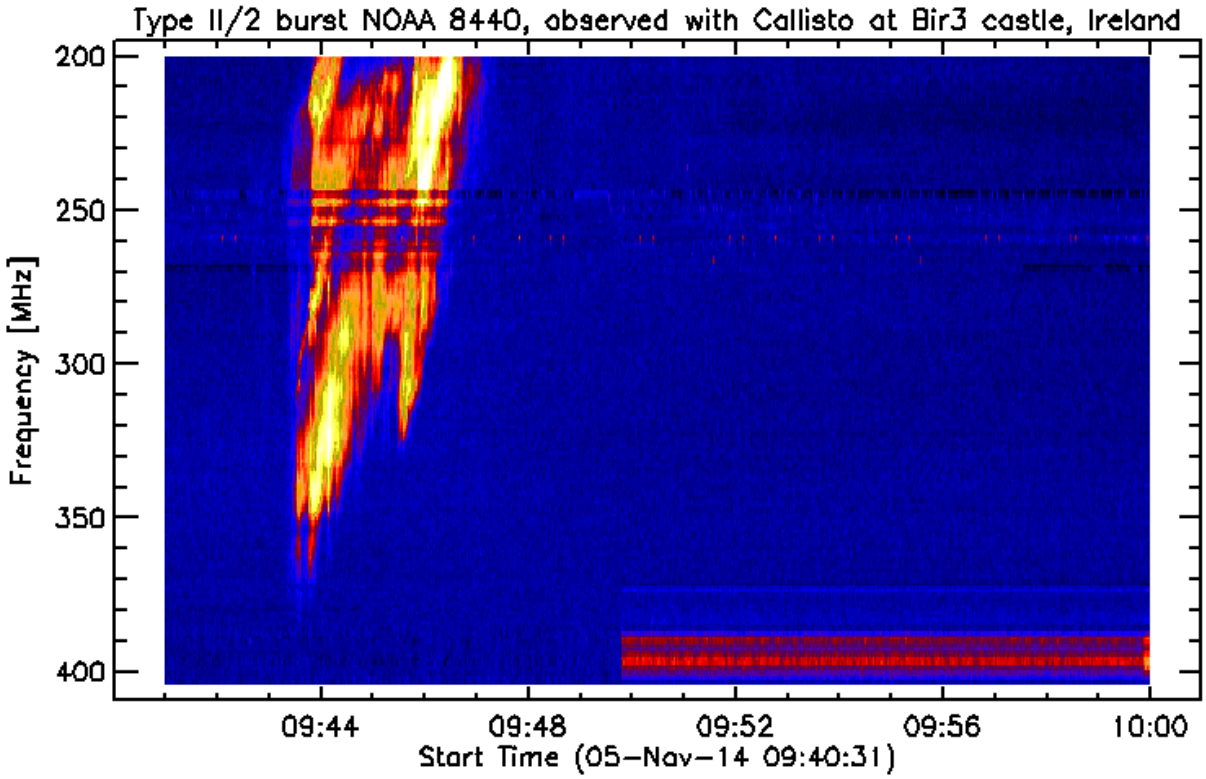

Figure 3 ~ Observation of Trinity College at Bir castle in Ireland. Quite clean spectrum with very low rfi.

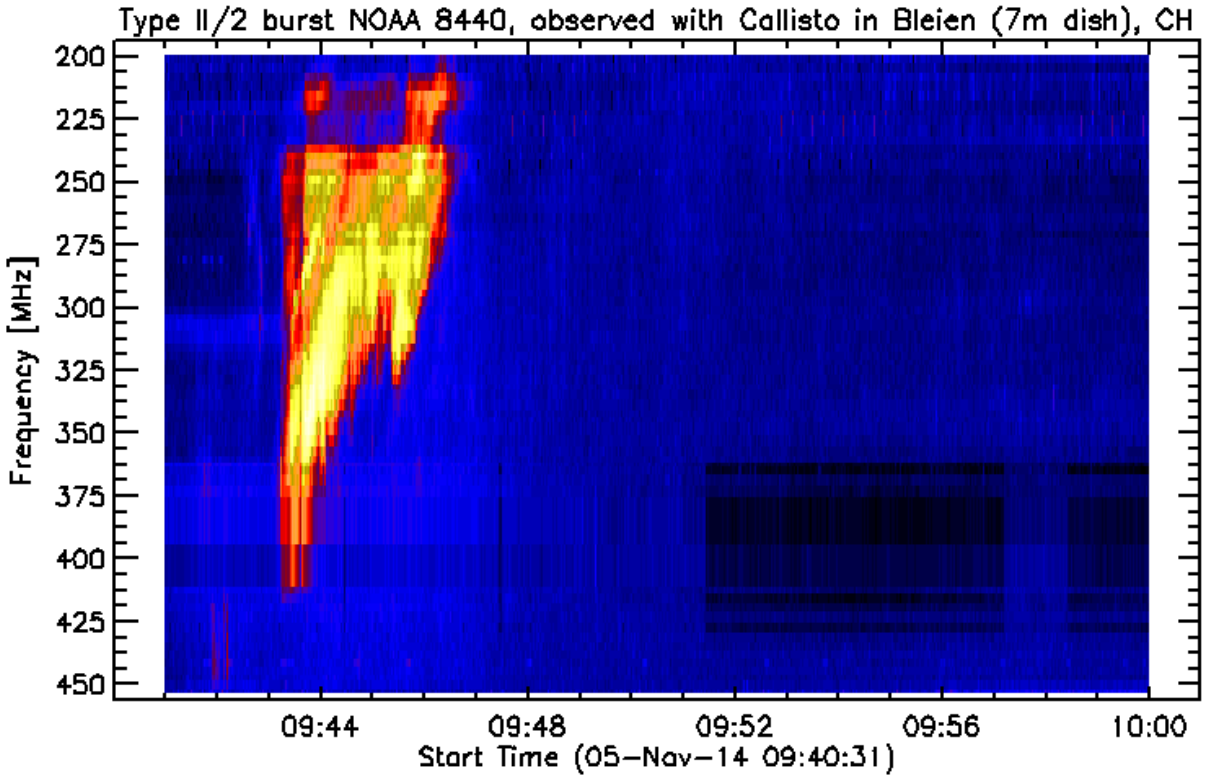

Figure 4 ~ Observation of ETH Zurich at Bleien in Switzerland with a 7m dish in circular polarization. Quite clean spectrum with very low rfi.

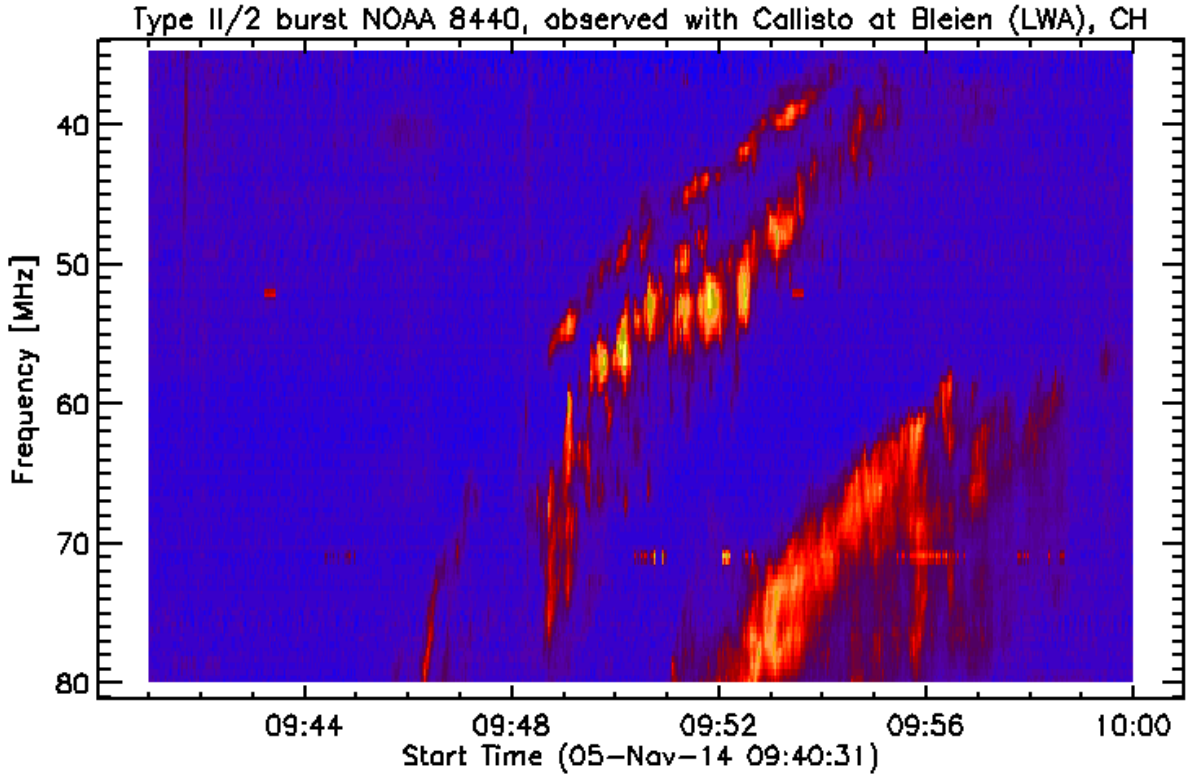

Figure 5 ~ Observation of ETH Zurich at Bleien in Switzerland with a new long wavelength antenna (LWA). Quite clean spectrum with very low rfi.

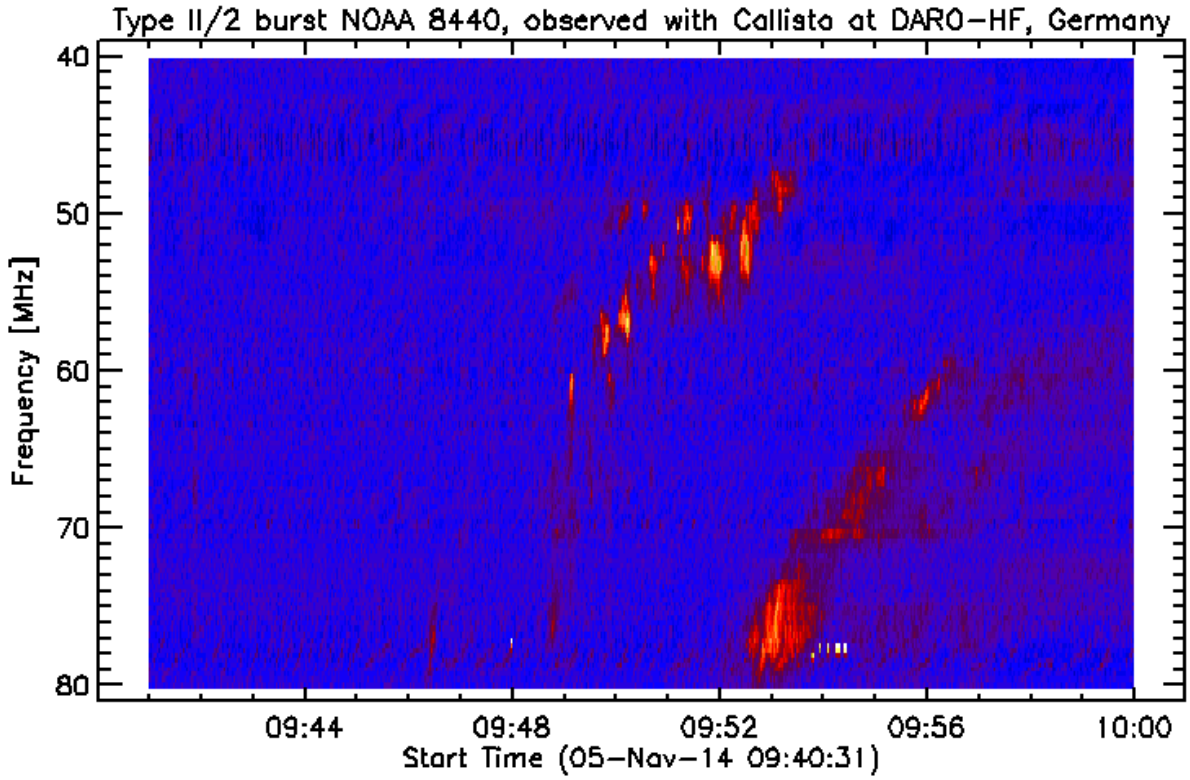

Figure 6 ~ Observation at short wave of Karl-Heinz Gansel in Germany. Quite clean spectrum with low rfi.

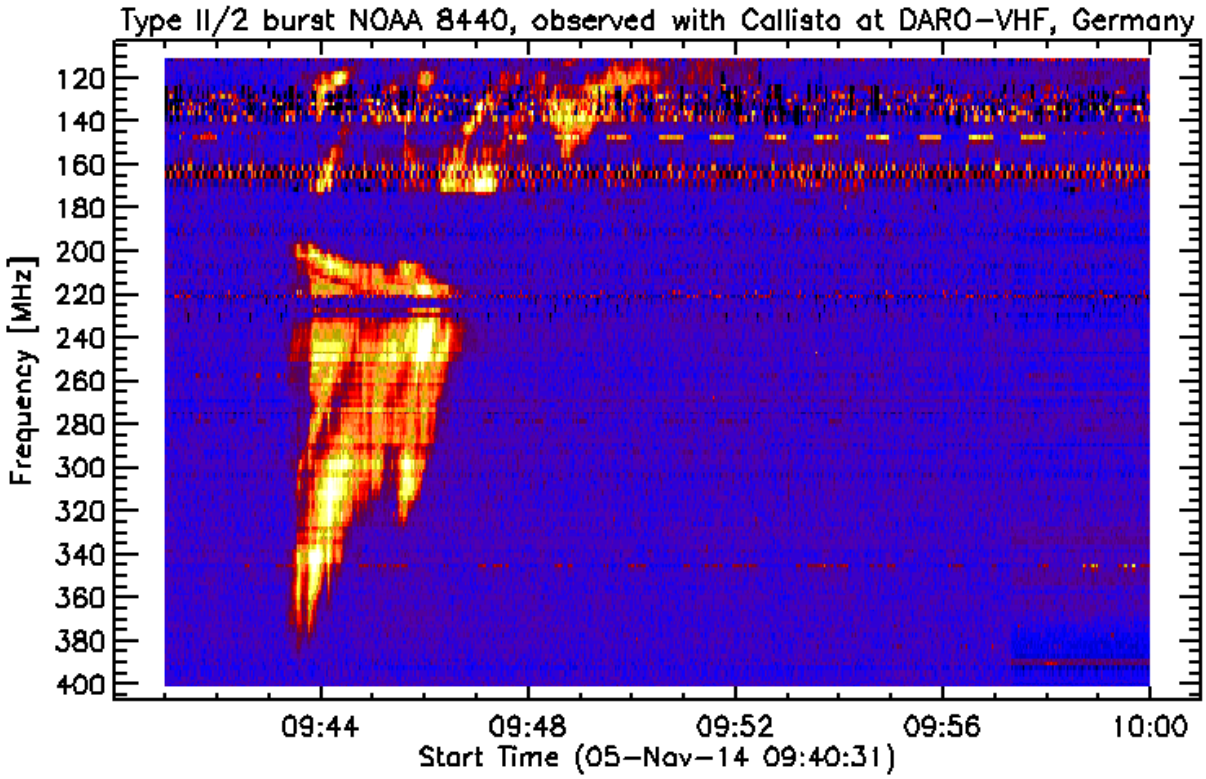

Figure 7 ~ Observation at VHF of Karl-Heinz Gansel in Germany. Quite clean spectrum with low rfi above 170 MHz. Instrumental artifact above 175 MHz (band switching).

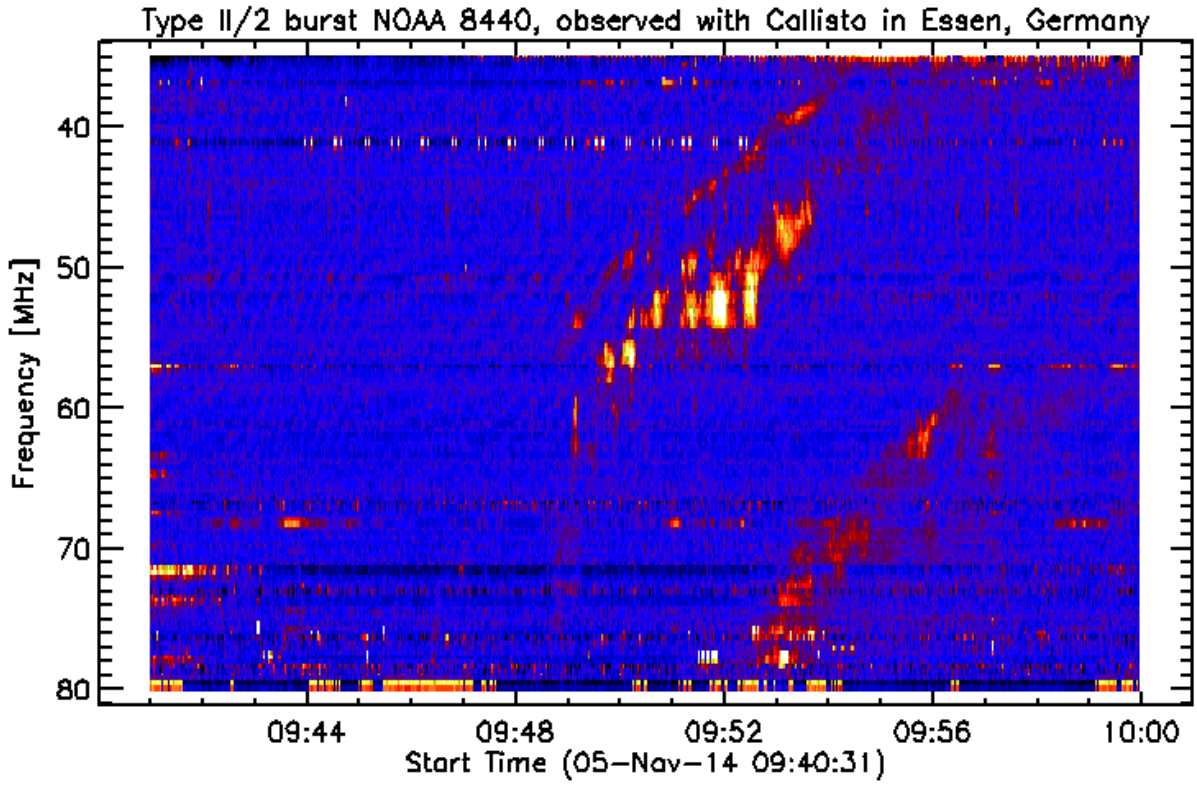

Figure 8 ~ Observation at Sternwarte Essen in Germany. Relatively clean spectrum with low rfi.

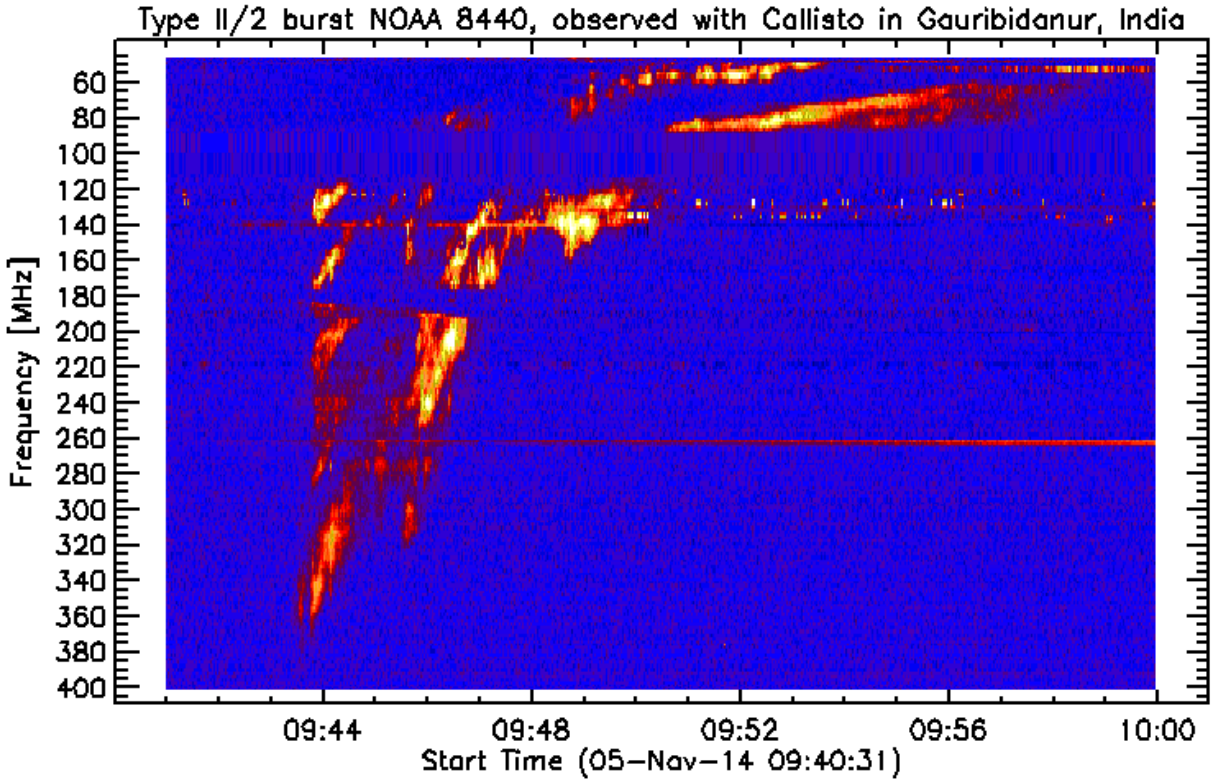

Figure 9 ~ Observation Gauribidanur observatory, India. Very clean spectrum with low rfi. Instrumental artifact above 175 MHz (band switching). FM-notch filter helped to get mitigate rfi due to strong FM-transmitters.

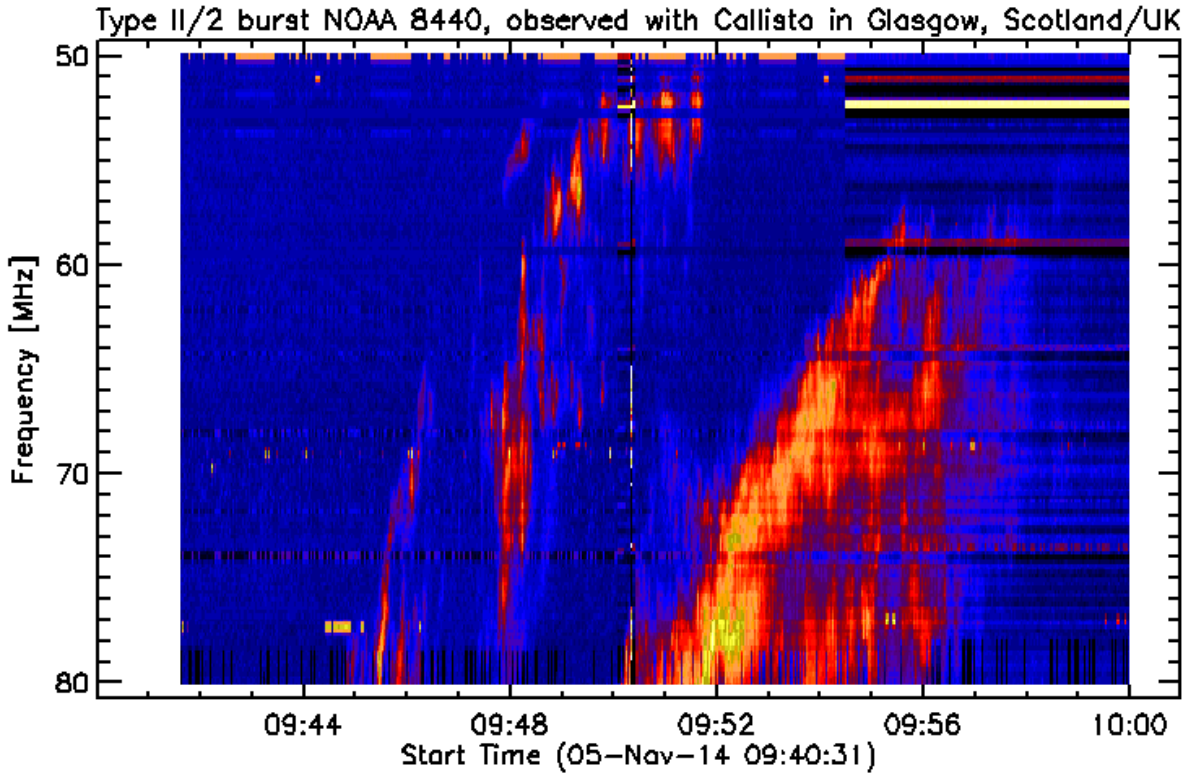

Figure 10 ~ Observation University of Glasgow, Scotland UK. Quite clean spectrum with low rfi. But data loss due to overloaded PC and/or a bad USB-interface at 09:55 UT.

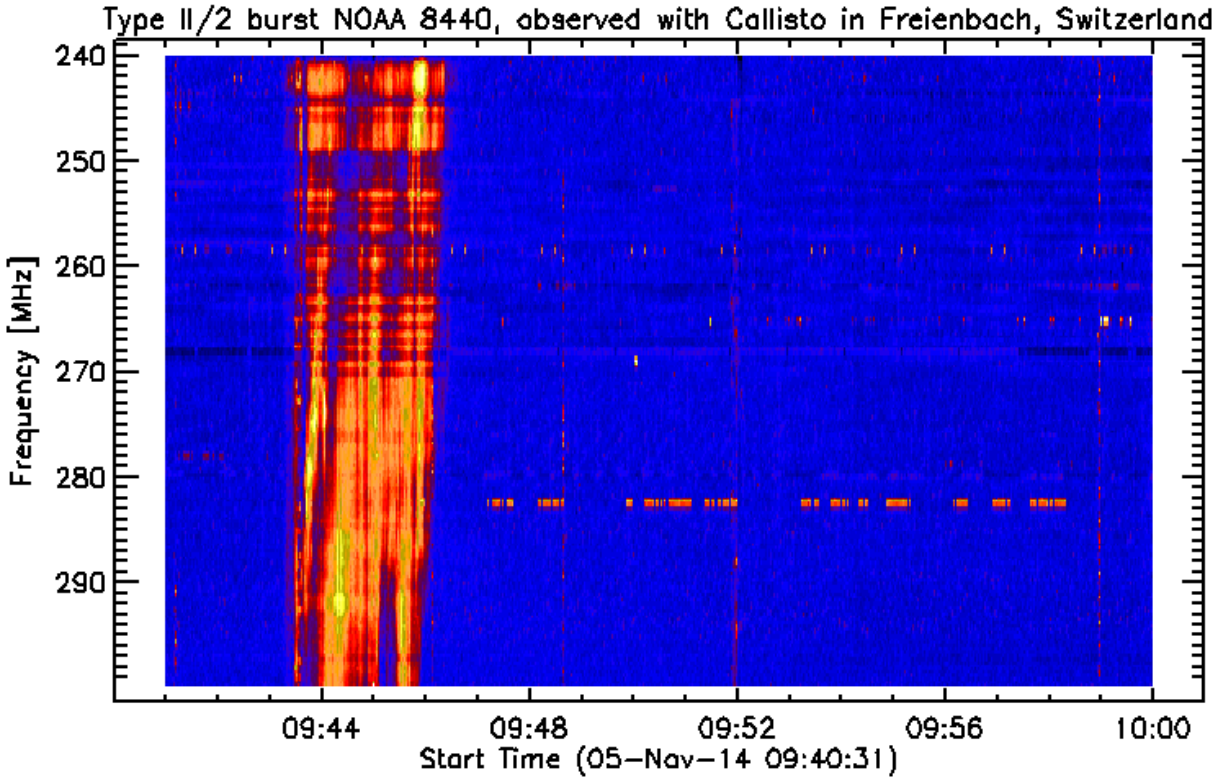

Figure 11 ~ My own observation at VHF in Freienbach, Switzerland. Lot of rfi outside of this band due to electric train.

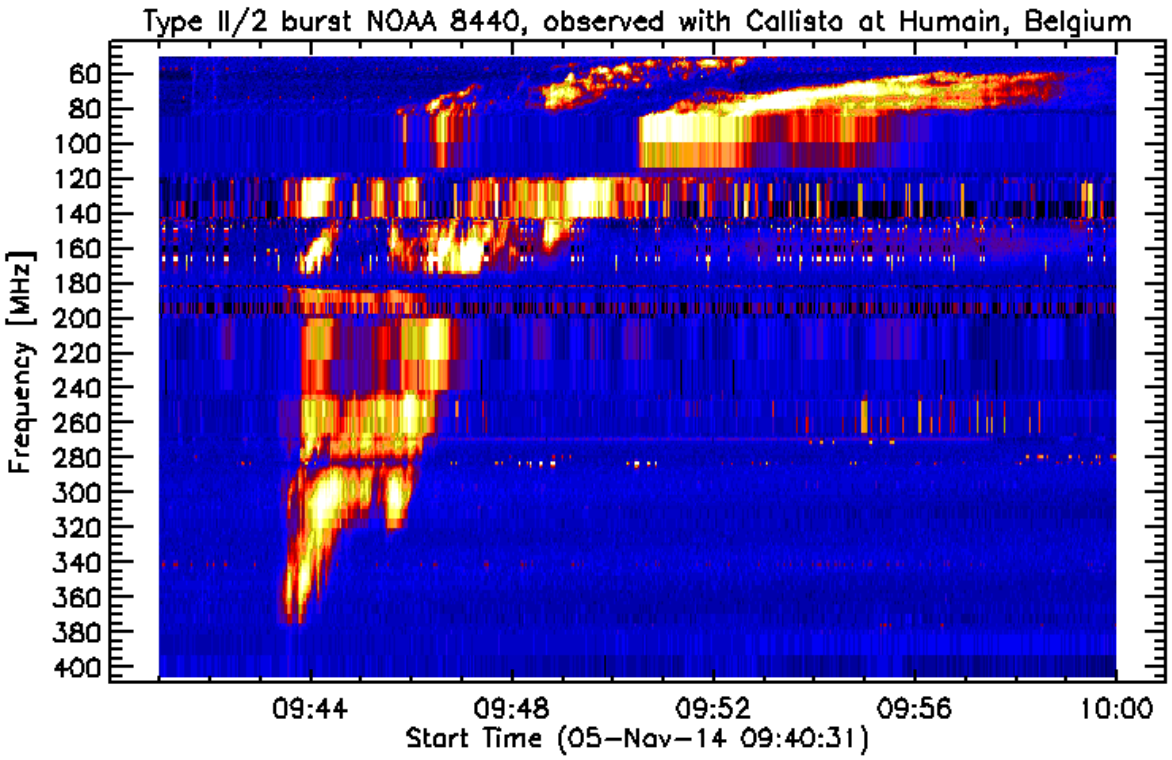

Figure 12 ~ Observation Royal Observatory of Belgium in Humain. Large gap due to strong FM-band. It would be better to use 2 Callisto, one from 45 MHz to 85 MHz and a second one above from 140 MHz to 870 MHz. Instrumental artifact above 175 MHz (band switching).

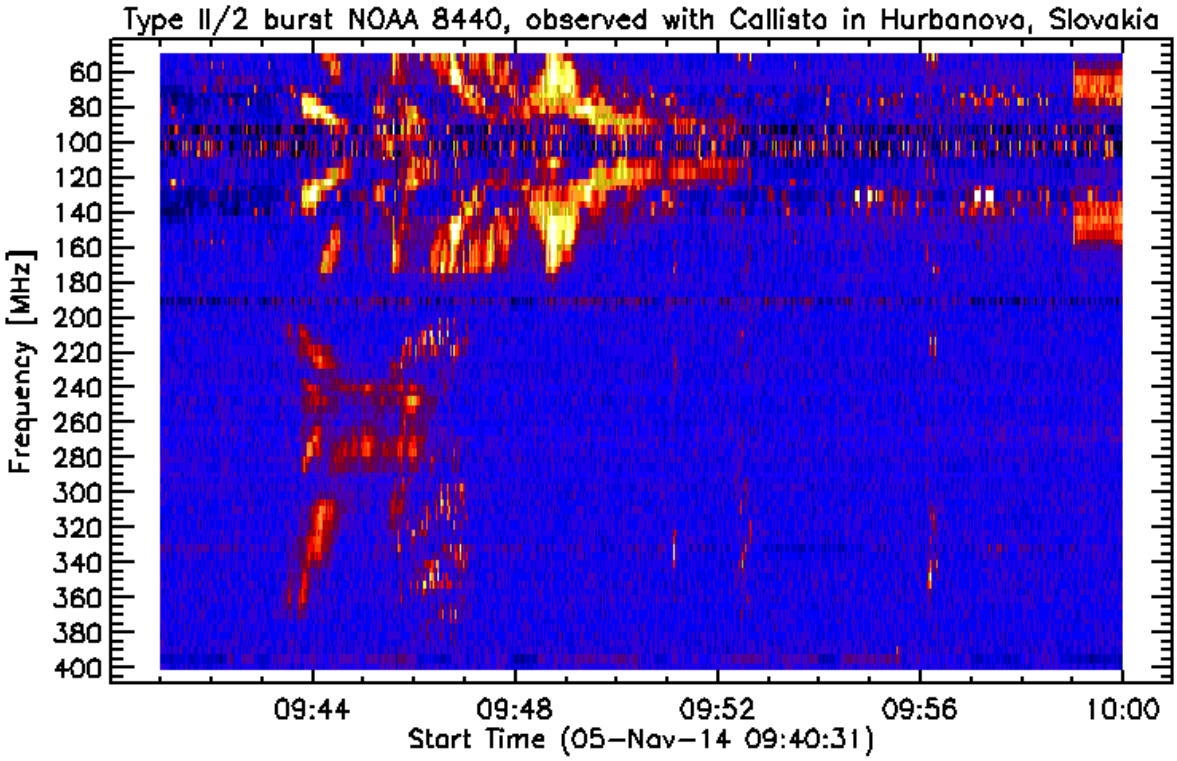

Figure 13 ~ Observation observatory Hurbanovo in Slovakia. Cross modulation due to strong rfi. Suggest to observe either below 85 MHz or above 120 MHz but not in FM-range. Instrumental artifact above 175 MHz (band switching).

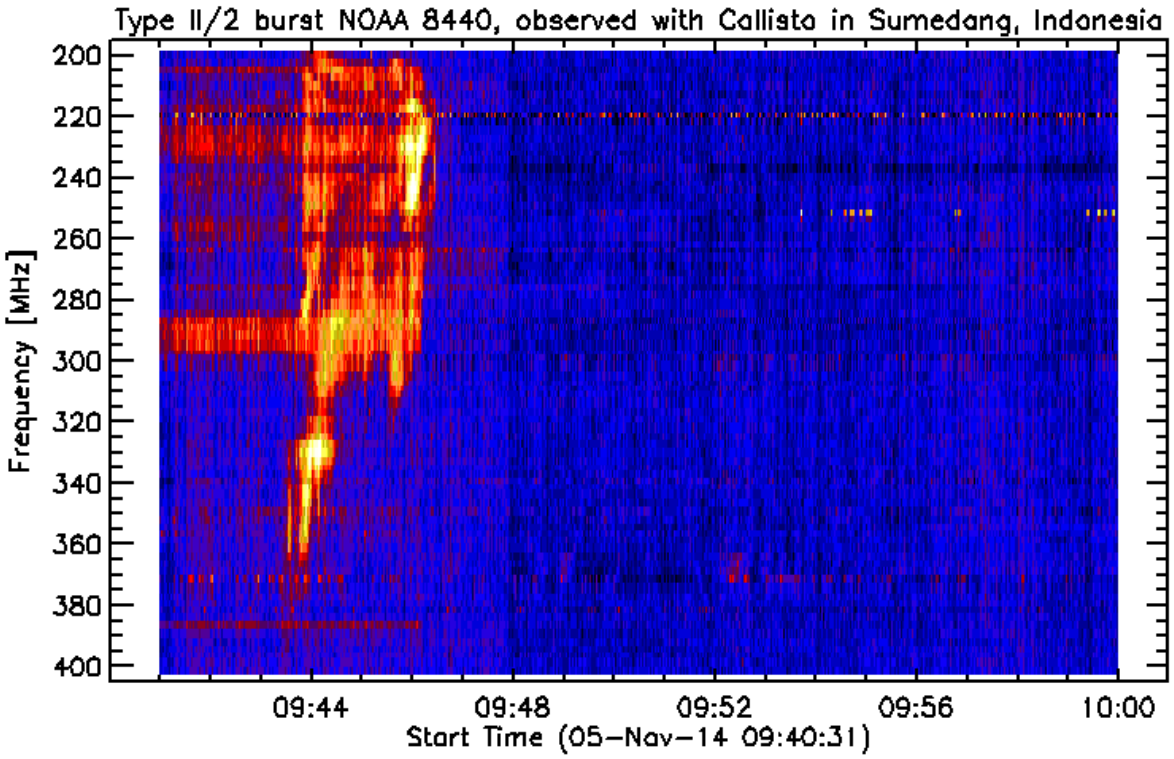

Figure 13 ~ Observation observatory Sumedong, West Java, Indonesia. Quite some strong rfi. May be it's worth to reduce frequency range of observation into a band which is 'cleaner'.

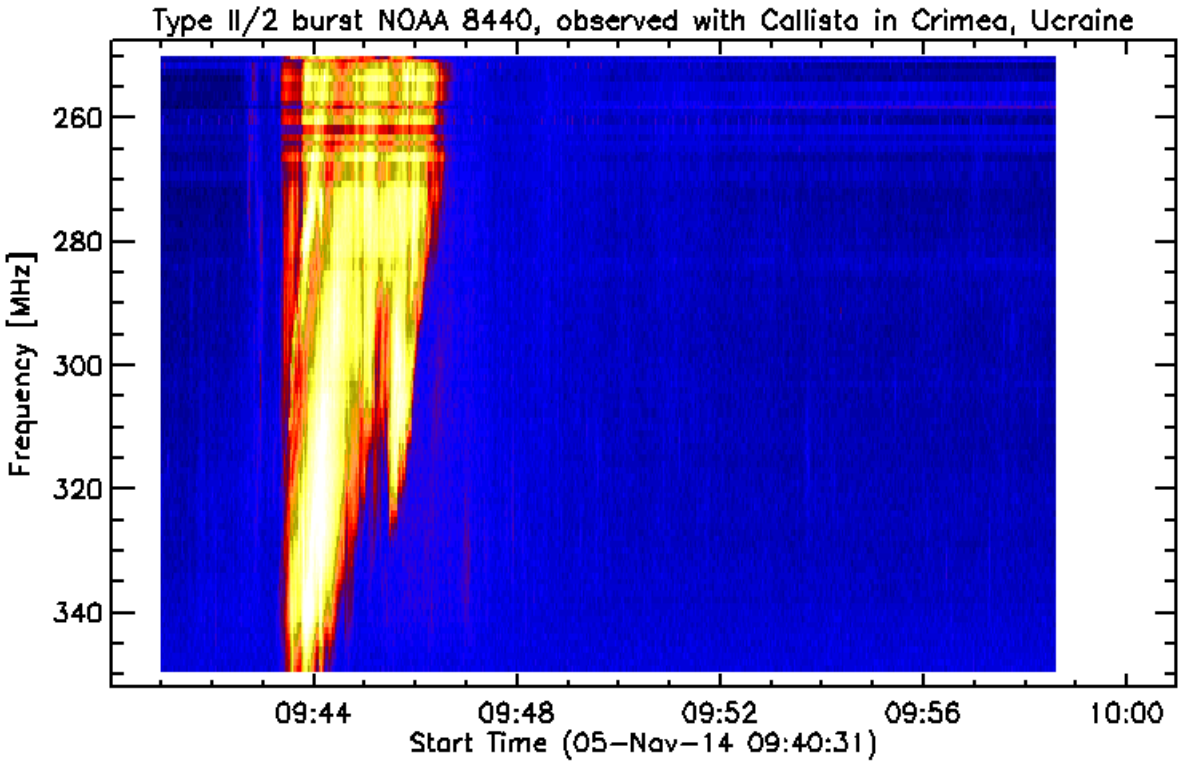

Figure 14 ~ Observation with 16 Yagi-array at Crimea, Ukraine. Very low level of rfi in a limited frequency range (Deuterium line).

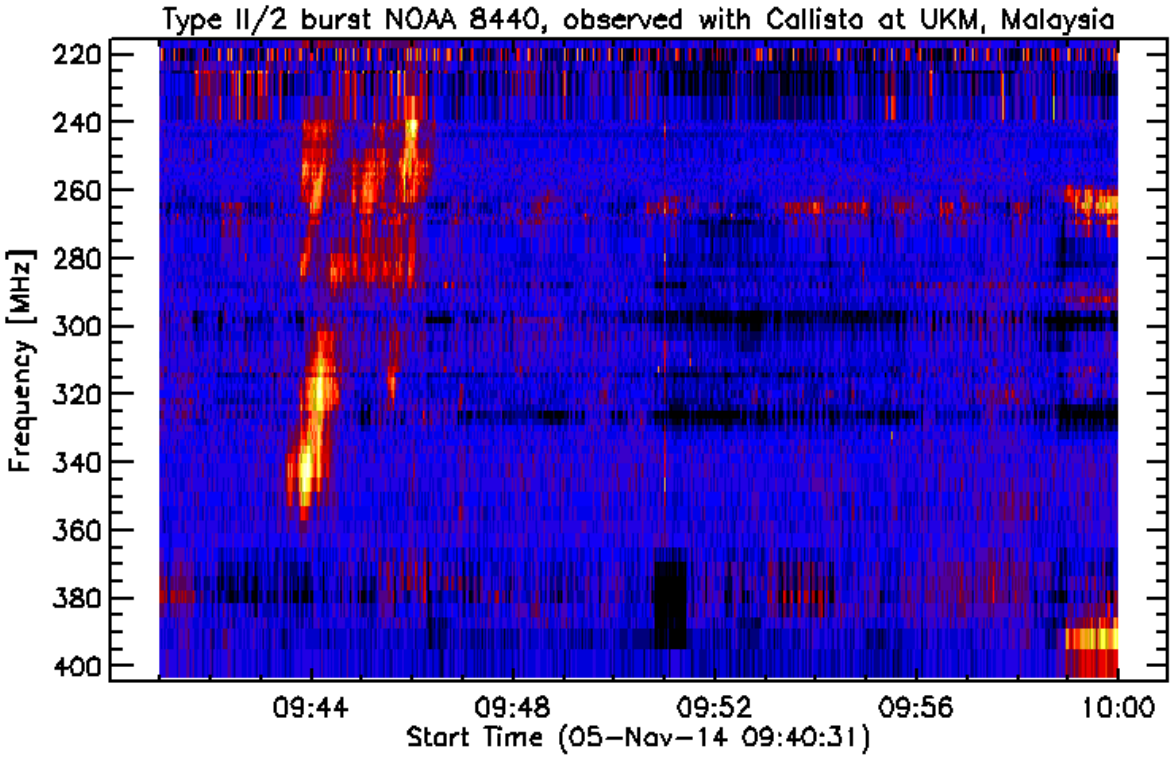

Figure 15 ~ Observation at UKM in Malaysia. Very strong level of rfi, suggest to search for a better location.

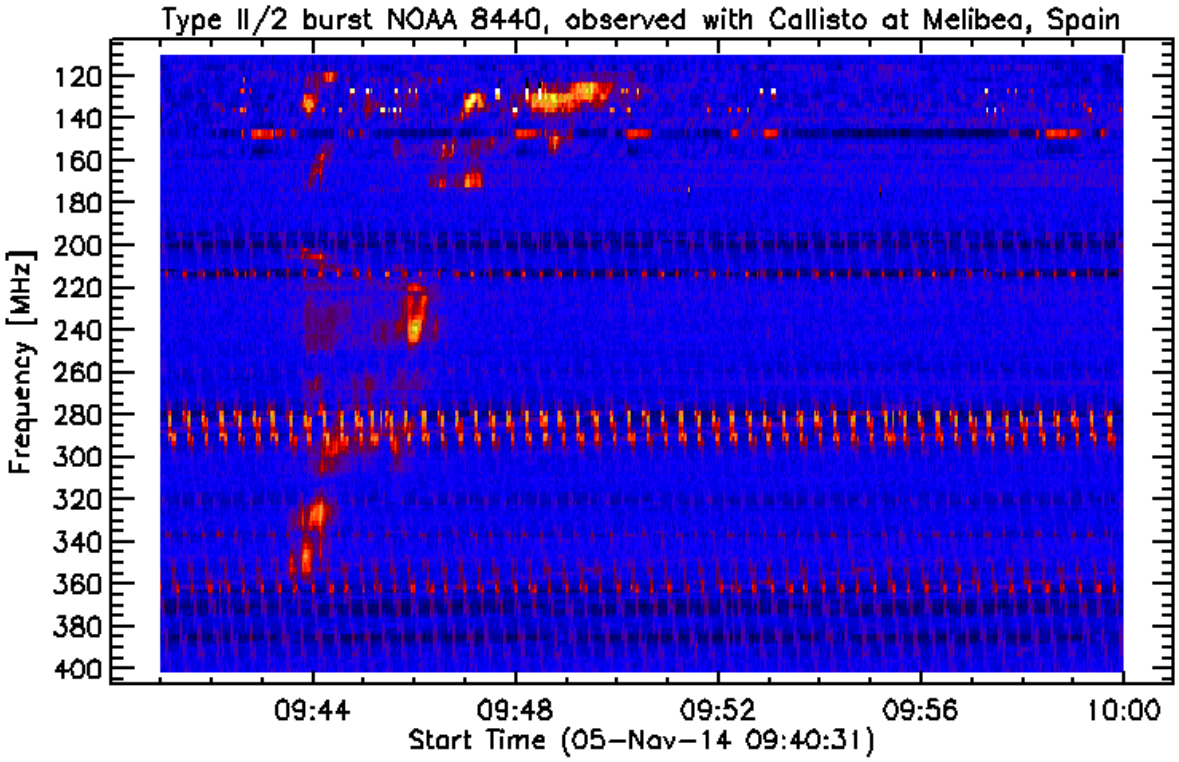

Figure 15 ~ Observation of Melibea, Spain. Quite strong level of rfi, it might be useful to reduce frequency range of observation. Instrumental artifact above 175 MHz (band switching).

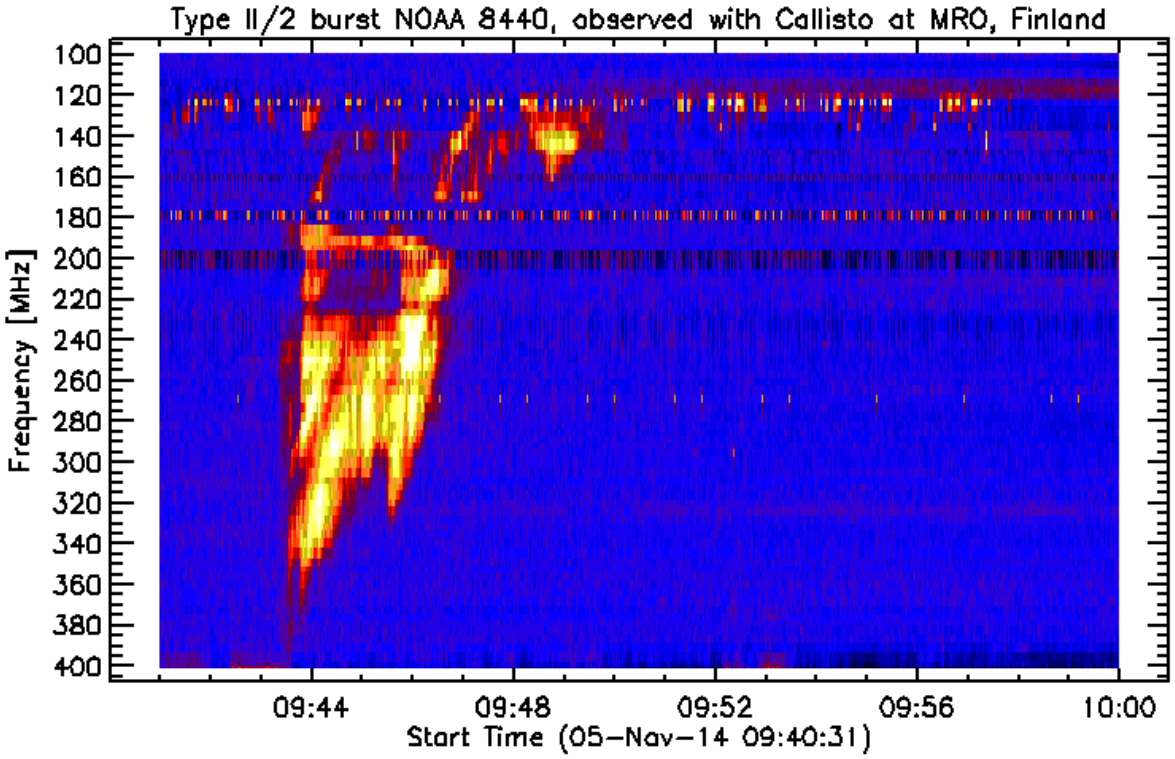

Figure 16 ~ Observation at MRO in Finland. Quite strong level of rfi. Instrumental artifact above 175 MHz (band switching).

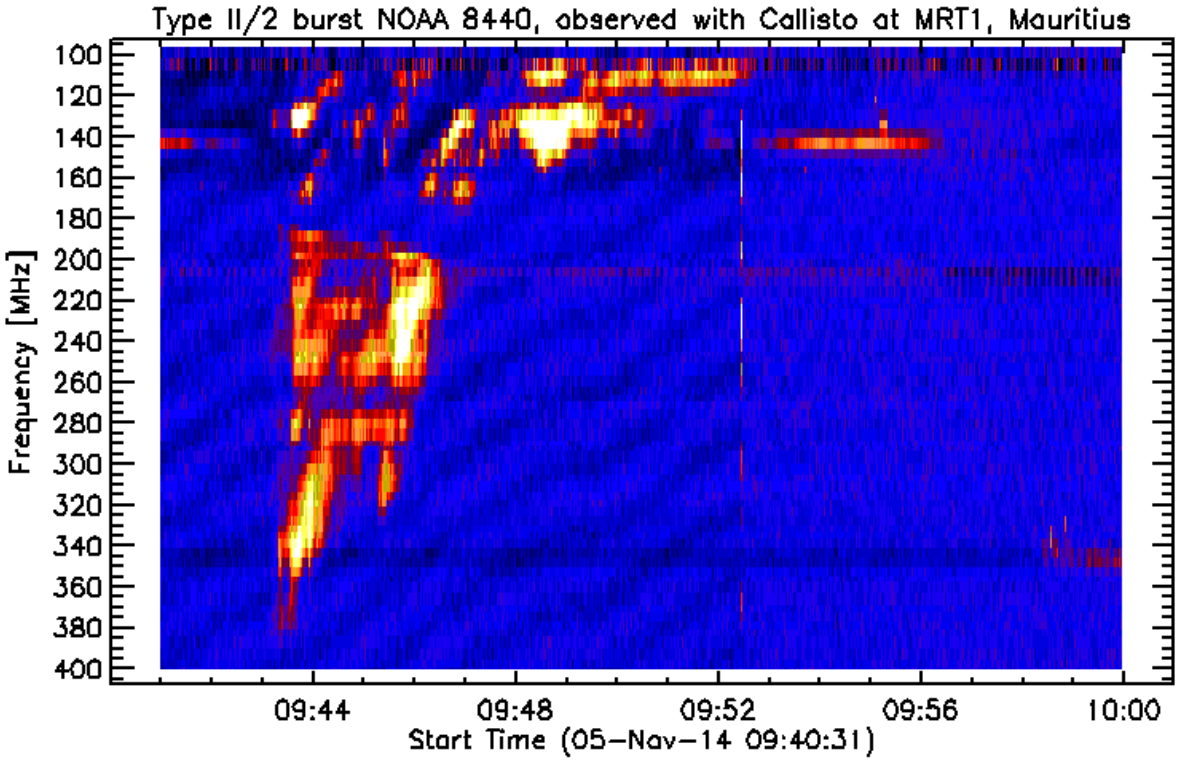

Figure 17 ~ Observation at MRT antenna 1 in Mauritius. Local rfi from electronic equipment. Instrumental artifact above 175 MHz (band switching).

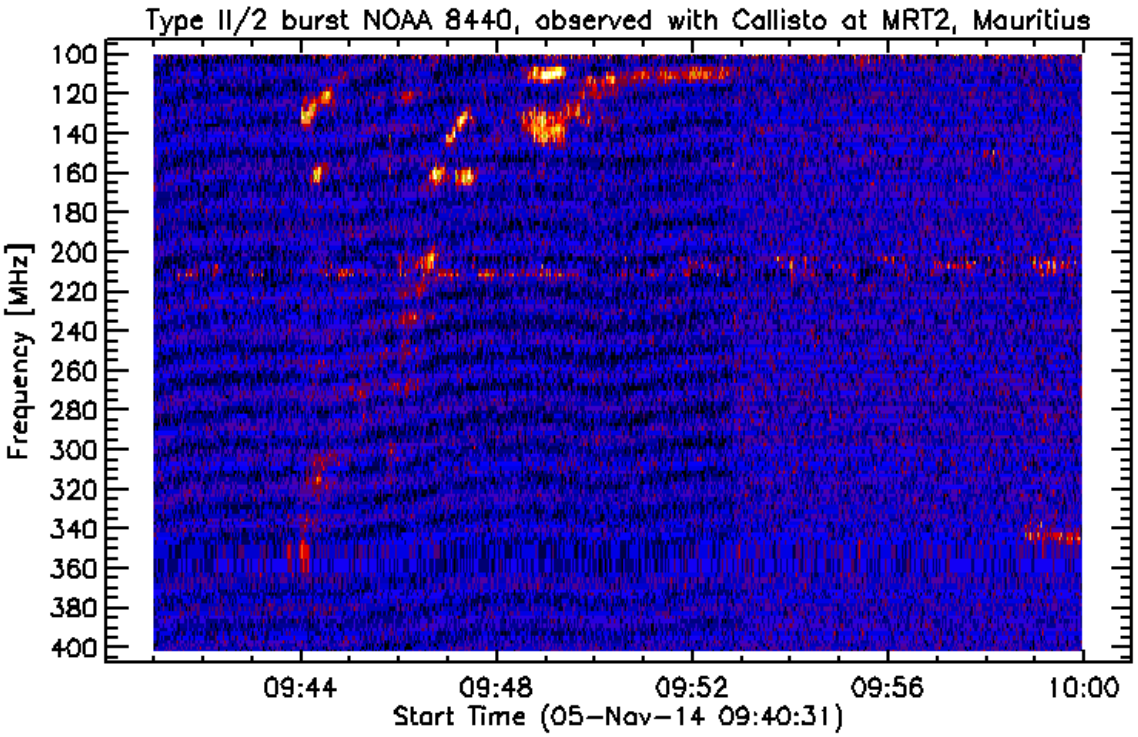

Figure 18 ~ Observation at MRT antenna 2 in Mauritius. Local rfi from electronic equipment. Low sensitivity of the whole system.

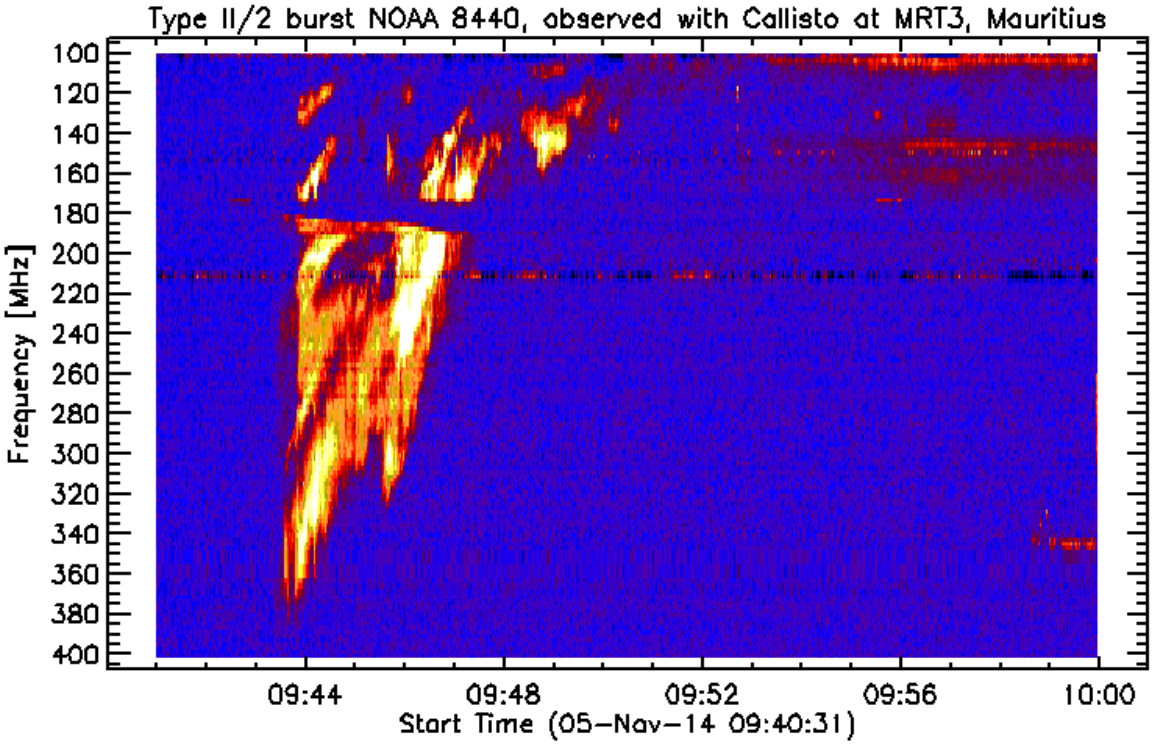

Figure 19 ~ Observation at MRT antenna 3 in Mauritius. Low rfi and good sensitivity of the system. Instrumental artifact above 175 MHz (band switching).

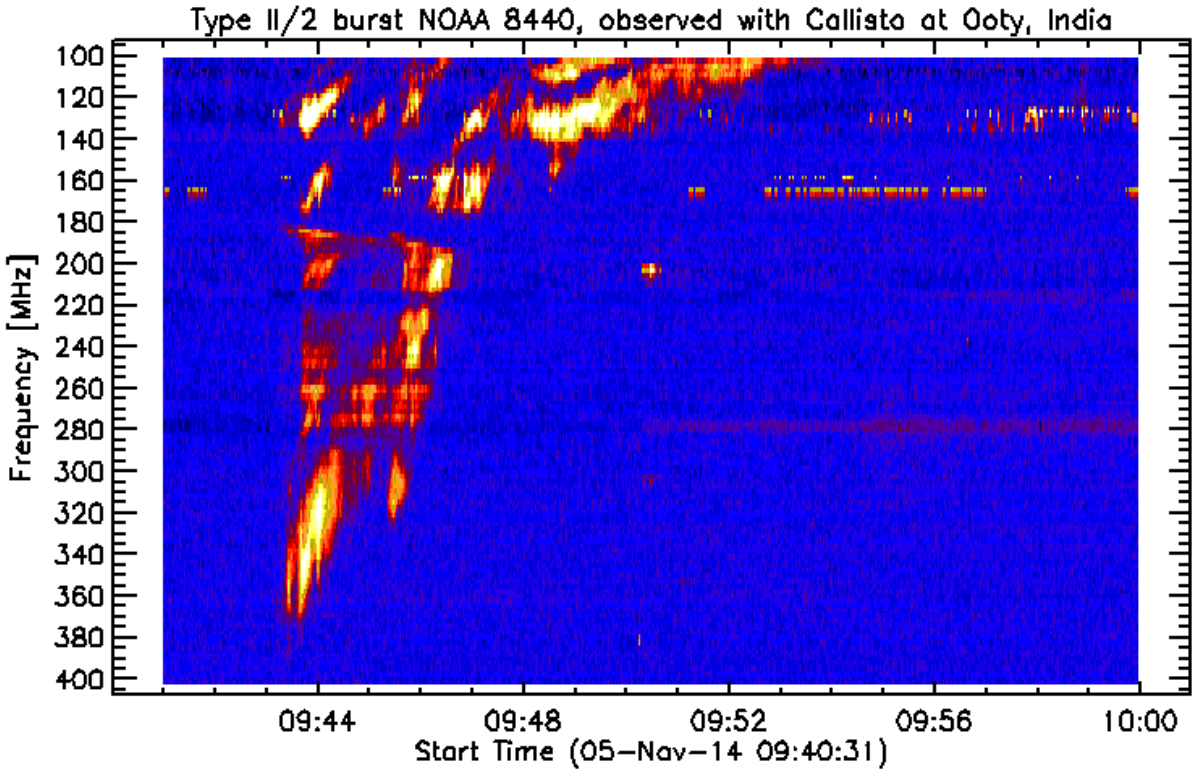

Figure 20 ~ Observation from Ooty, India with very good sensitivity and low rfi. The second polarization (not shown here) is suffering from local rfi. Instrumental artifact above 175 MHz (band switching).

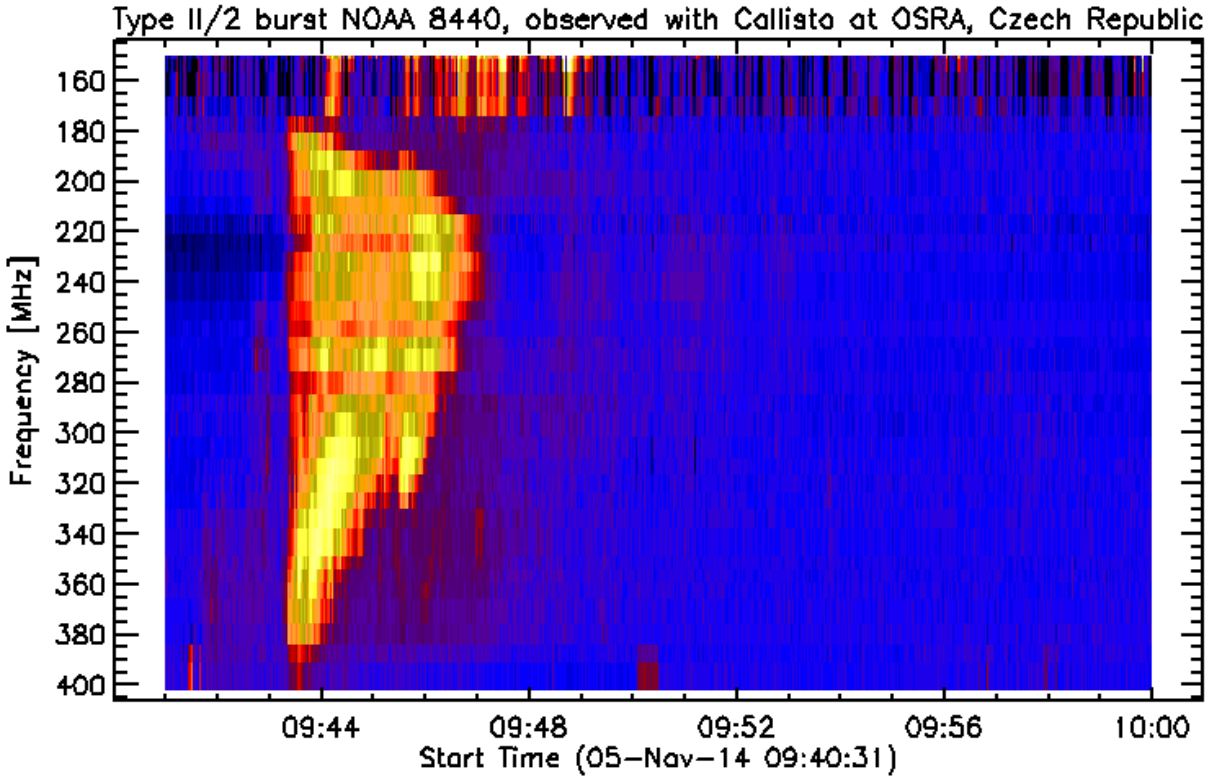

Figure 21 ~ Observation from OSRA in Czech Republic with a 7m dish (old German Würzburg Riese). High level of rfi from Prag town. Instrumental artifact above 175 MHz (band switching).

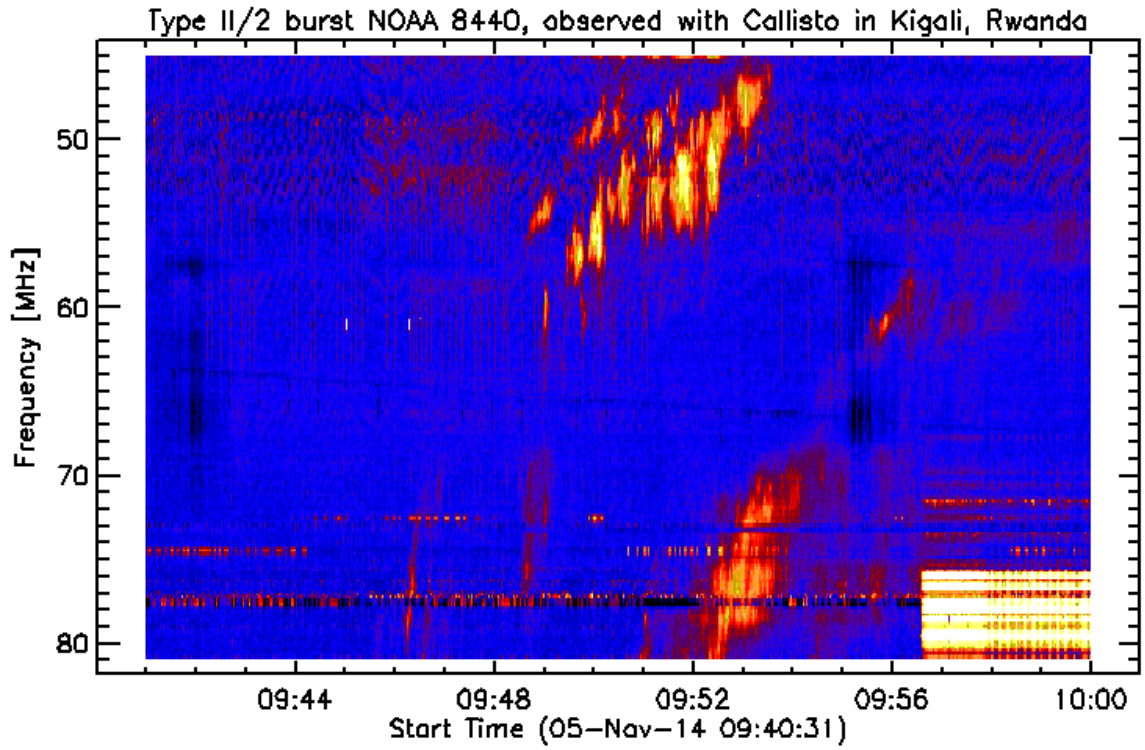

Figure 22 ~ Observation from Kigali University in Rwanda. Frequencies above 76 MHz show strong rfi from local transmitters.

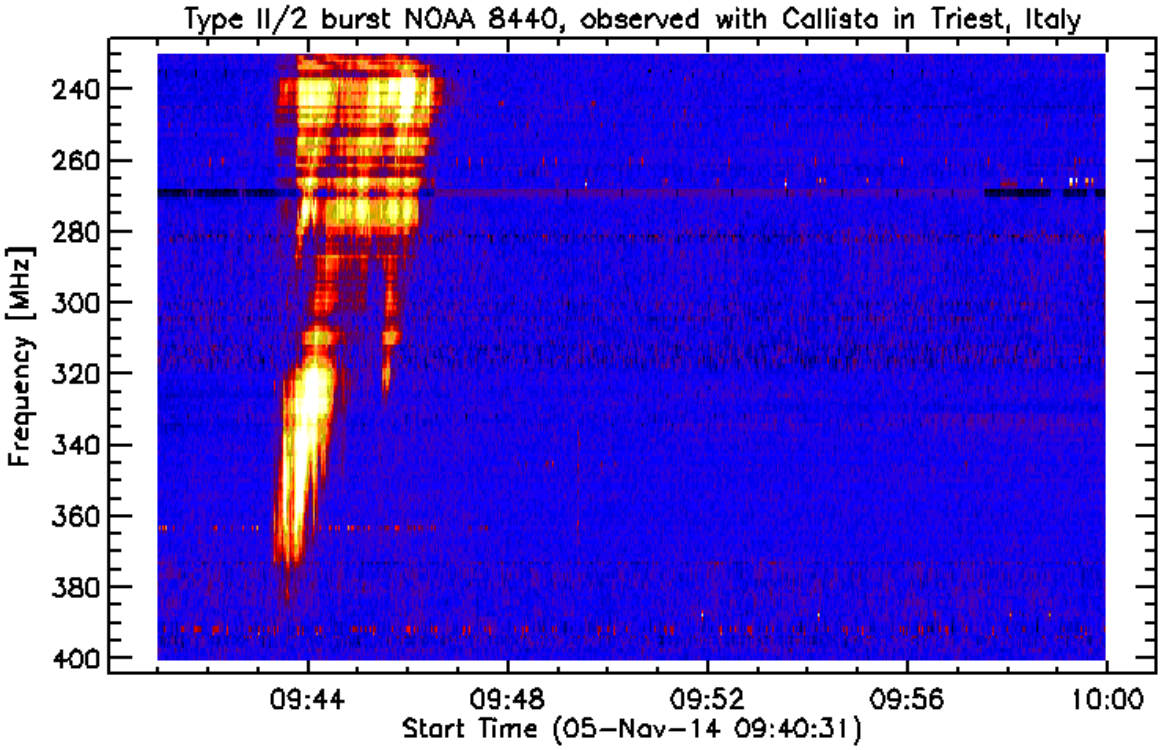

Figure 23 ~ Observation from Trieste, Italy. Quite low level of rfi and good sensitivity.

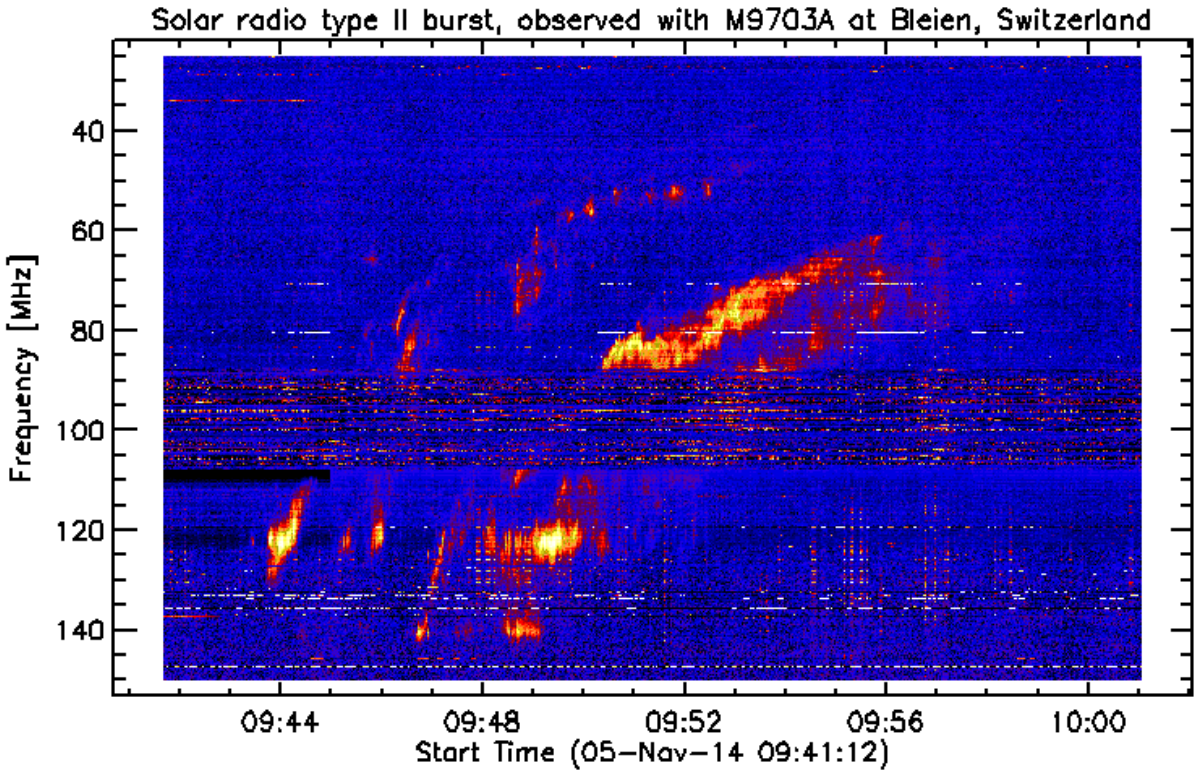

Figure 24 ~ For reference, an observation from Bleien observatory, Switzerland with a long wavelength antenna (LWA) and a new FFT spectrometer M9703A from Keysight (ex Agilent). Resolution in frequency 48.8 KHz, resolution in time 38 ms and a high dynamic range allows even to observe in the FM-range with strong transmitters.

Conclusion

Observations of the same burst at different locations would allow to conduct cross-correlation to improve image quality, a nice students project. The burst with fundamental and harmonic would also allow to derive the radial velocity of the CME in interstellar space, another nice students-project to study Newkirk models. Comparison of spectra from different locations allows to identify potential improvements regarding rfi-mitigations. Timing uncertainty seems to be quite good, there is no big difference in start-time of the type II burst. Some stations suffer from strong FM signals. Here, I suggest either to insert an FM-notch filter or to concentrate on frequency ranges either below 85 MHz or above 110 MHz. If you want to observe the whole frequency range you may use two Callisto covering individual frequency ranges.

Further information about NOAA event:

http://www.swpc.noaa.gov/ftpdir/indices/events/20141105events.txt

More information about the instrument Callisto and the network e-Callisto can be found here:
http://e-callisto.org/