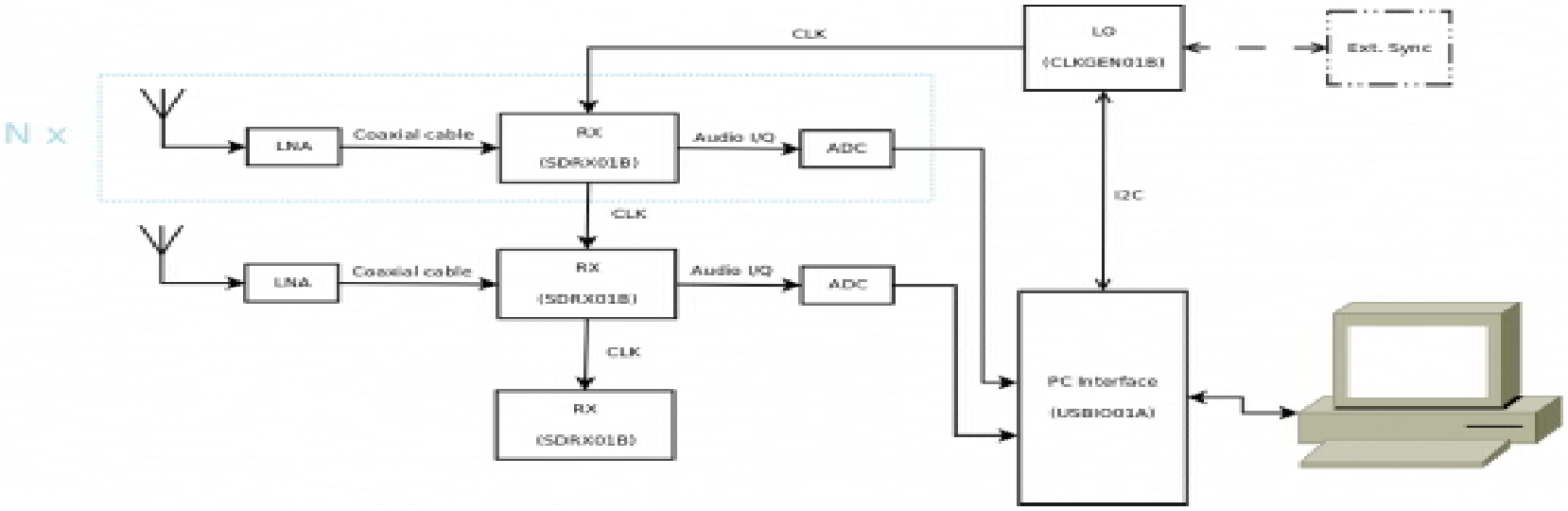
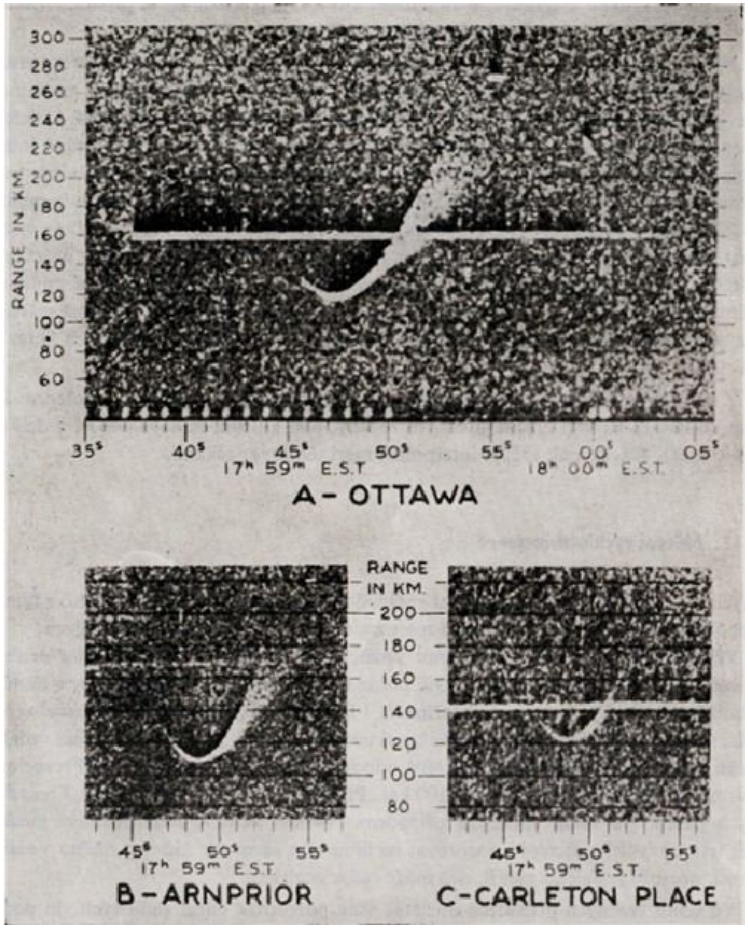
# Nové způsoby detekce meteorů

Detekce meteorů je jedna z možností použití univerzálního přijímacího systému pro radioastronomii SDRX01B.



# Použití klasického radaru



K detekci meteorů můžeme použít principu pasivního radaru.

Máme vhodný přijímač a tak si musíme hledat vhodný vysílač.

Co by měl splňovat vhodný vysílač. Použitelná frekvence je 30-200MHz.

Maximální vzdálenost od vysílače je volená podle parametrů vysílače a je 500-2000km.

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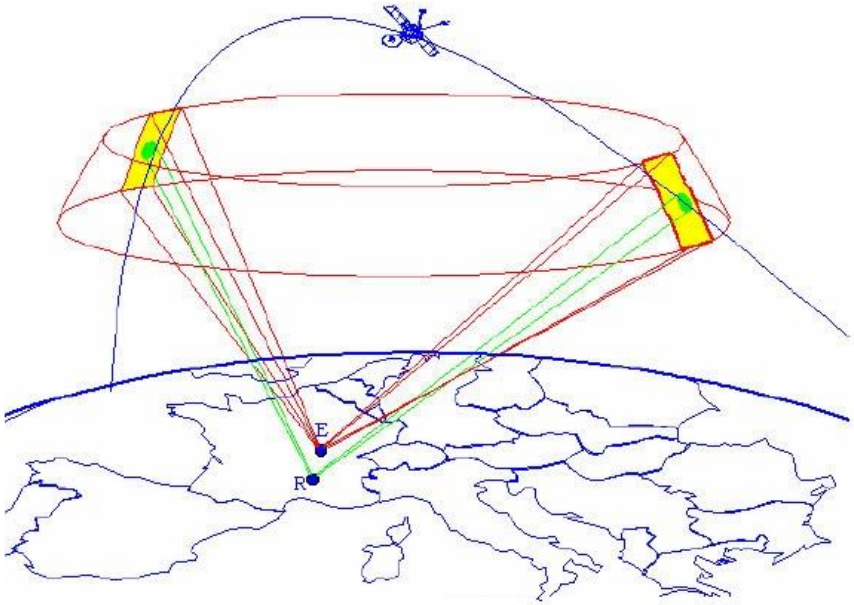
# GRAVES RADAR – Grand Réseau Adapté a la Veille Spaiale

Může být vhodným vysílačem pro pasivní radar. Je to vojenské zařízení a tak nejsou přístupné všechny informace o parametrech radaru i tak je GRAVES použitelný.

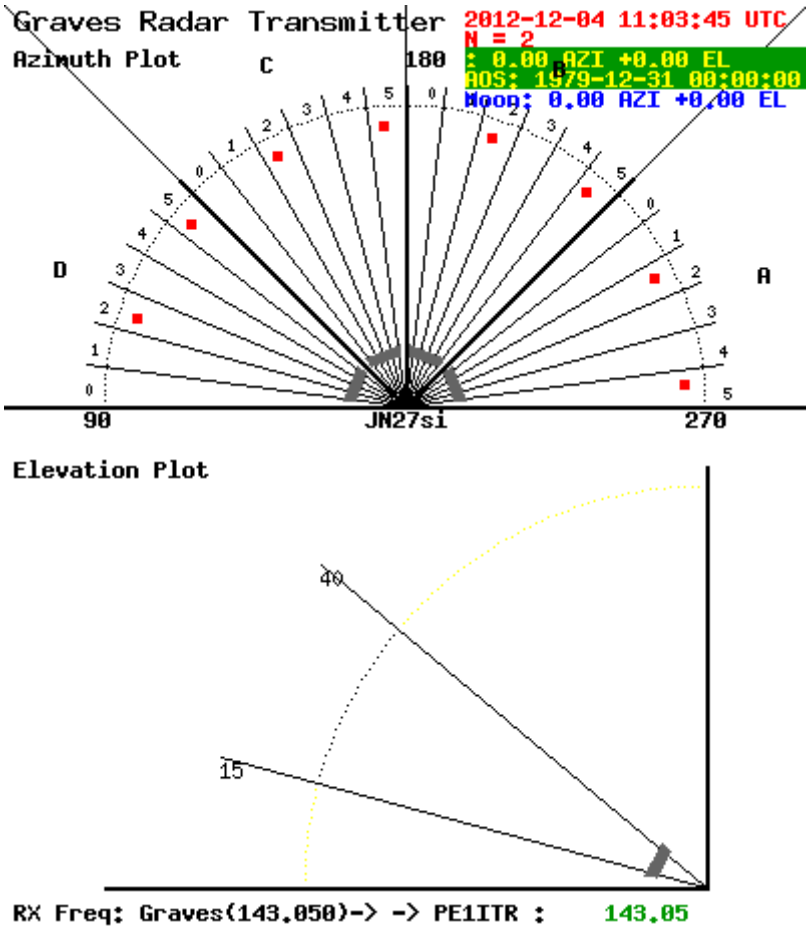
GRAVES byl spuštěn v roce 2005.




Většinou pracuje non-stop slouží k detekci objektů ve výškách od 400 do 1000km a zjišťování elementů drah těles, které přelétají nad územím Francie

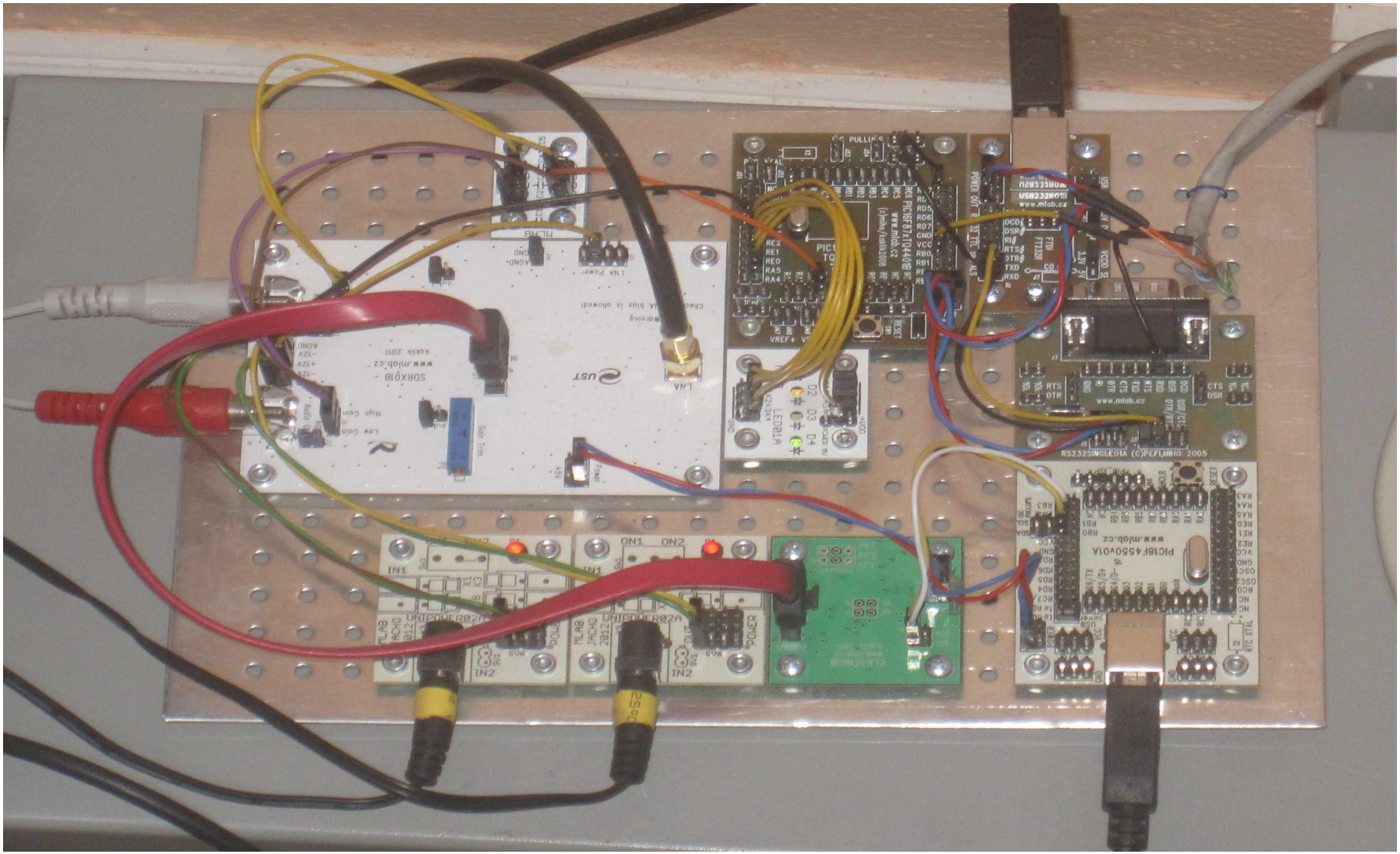
Pracovní frekvence je 143.050MHz

# Vysílací část radaru GRAVES



# Přijímací část radaru GRAVES

# Sestava přijímače SDRX01B a GPS modulu v Úpici



# Radarová pozorování meteorů v projektu EISCAT.

Jde o soustavu složenou z radarů a pasivních přijímacích antén, které využívají nekoherentního rozptylu rádiových vln na ionizovaných stopách meteorů k získání údajů o četnostech meteorů a jejich atmosférických trajektoriích. Radary vysílající impulsy vertikálně na frekvencích VHF a UHF byly instalovány v norském Tromsö, kdežto přijímací antény se nacházely ve švédské Kiruně a finském Sodankylä. V prosinci 2008 uskutečnilo během činnosti meteorického roje Geminid nepřetržité celodenní měření, během něhož získali v pásmu VHF téměř 23 tis. Ozvěn a v pásmu UHF jen něco přes 2 tis. ozvěn. 11 ozvěn VHF se vrátilo z výšky přes 150 km nad zemí; rekord drží ozvěna z výšky 247 km!

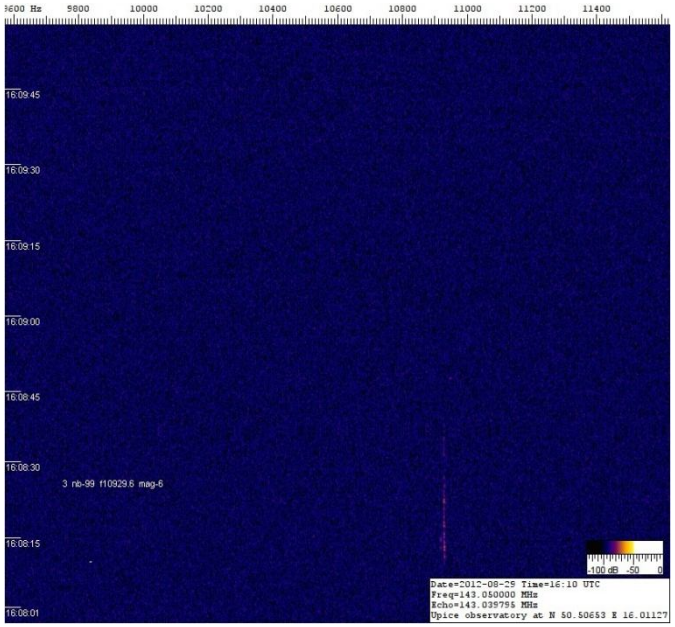
Během doby, kdy byl radiant Geminid nad obzorem, nepozorovali žádné zvýšení počtu ozvěn (z výšek nad 120 km), takže v souboru se vyskytují téměř výhradně sporadické meteory s geocentrickými rychlostmi <60 km/s. Průměrná četnost ozvěn v pásmu VHF se pohybovala kolem 16 met/min, což opticky odpovídá meteorům 13–14 mag

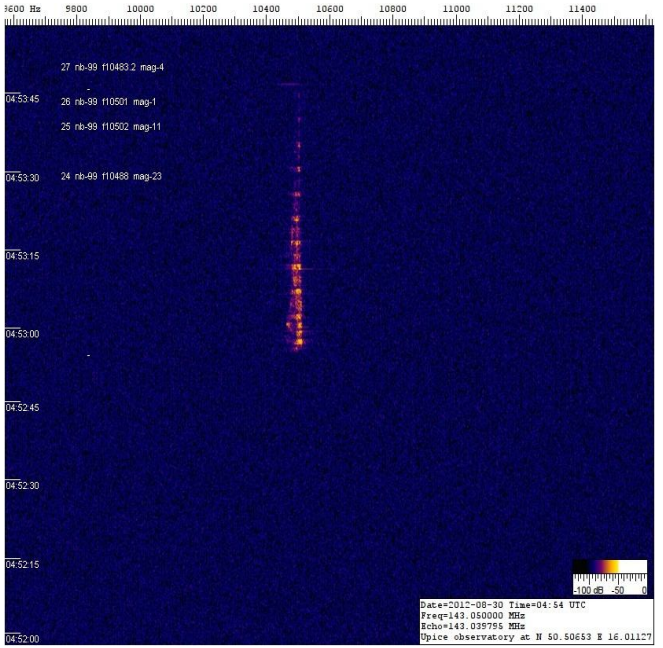
Pozorované meteory se štěpily na úlomky již při tlacích >0,5 Pa, to znamená že jsou o dva řády křehčí, než jasné kometární meteoroidy. V jednom dni pozorování tak byla objevena nová populace radarových meteorů s výškami zážehu v rozmezí 150 – 120 km nad zemským povrchem.

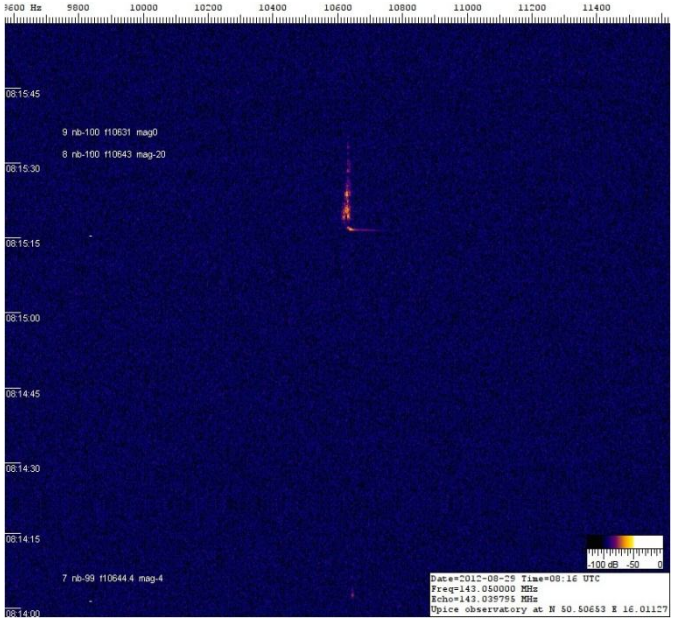
# Denní bolid z 29.8.2012

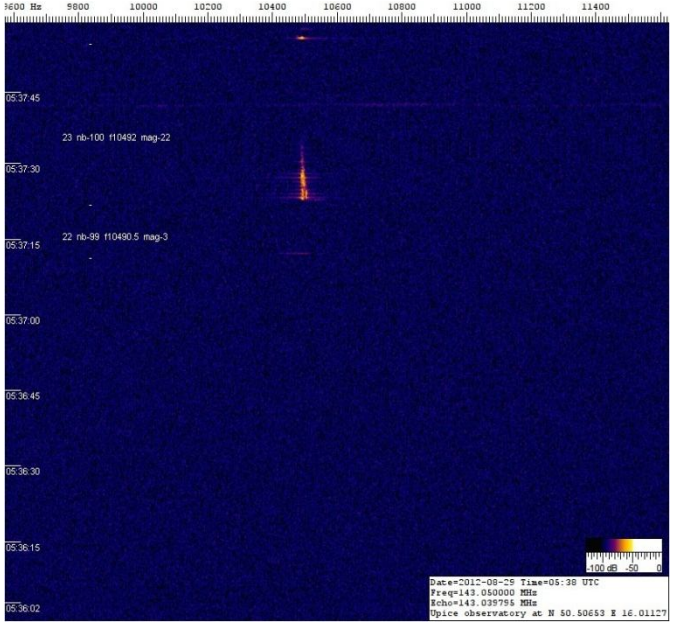
29 srpna po 18 hodině byl pozorován výjimečný jev denní bolid. Dle článku který si můžete přečíst na http://www.astro.cz/article/5484 autor Lukáš Shrbený popisuje z dostupných informací pravděpodobné parametry bolidu. Byla provedena  i přibližná rekonstrukce dráhy a velikosti bolidu. Bolid byl také zachycen na detektoru meteorů v Úpici. Čtvrt metru velký kus meziplanetární hmoty vstoupil asi rychlostí kolem 20km/s nad Doupovem a skončil u Jablonce nad Nisou kde z něj pravděpodobně zbylo řádově100 g hmoty která mohla dopadnout na zem. Bohužel bolidová sít není přes den použitelná a naše detektory meteorů ještě nedosahují plánovaných parametrů tak přesné místo dopadu není známo. Proč se o tomto jevu zmiňuji hned uvidíte.

# Který z nich je denní bolid?

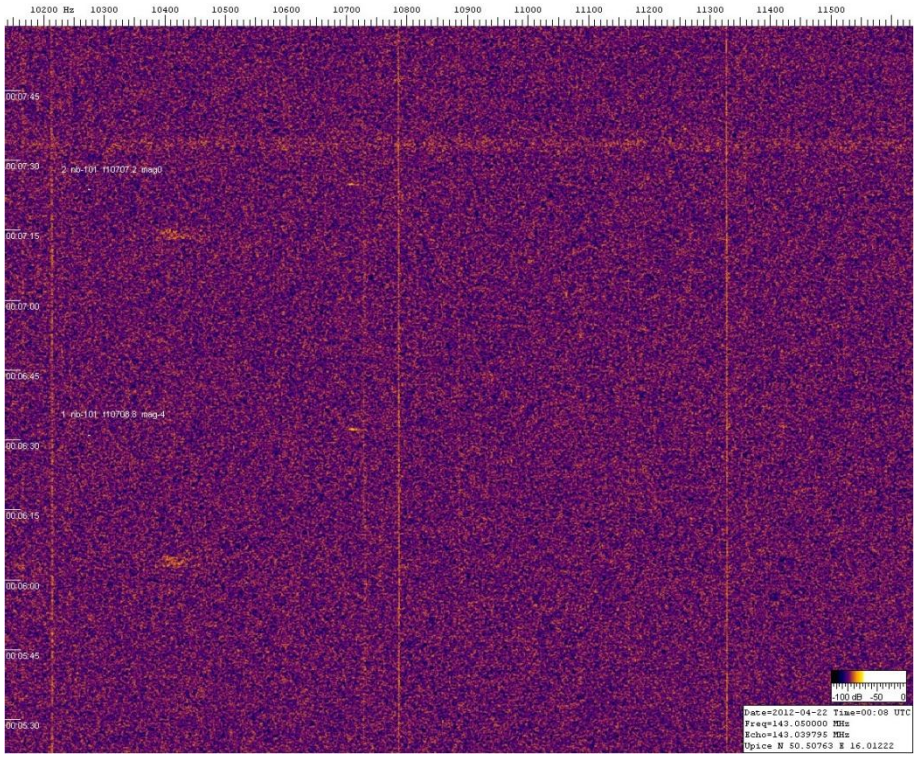


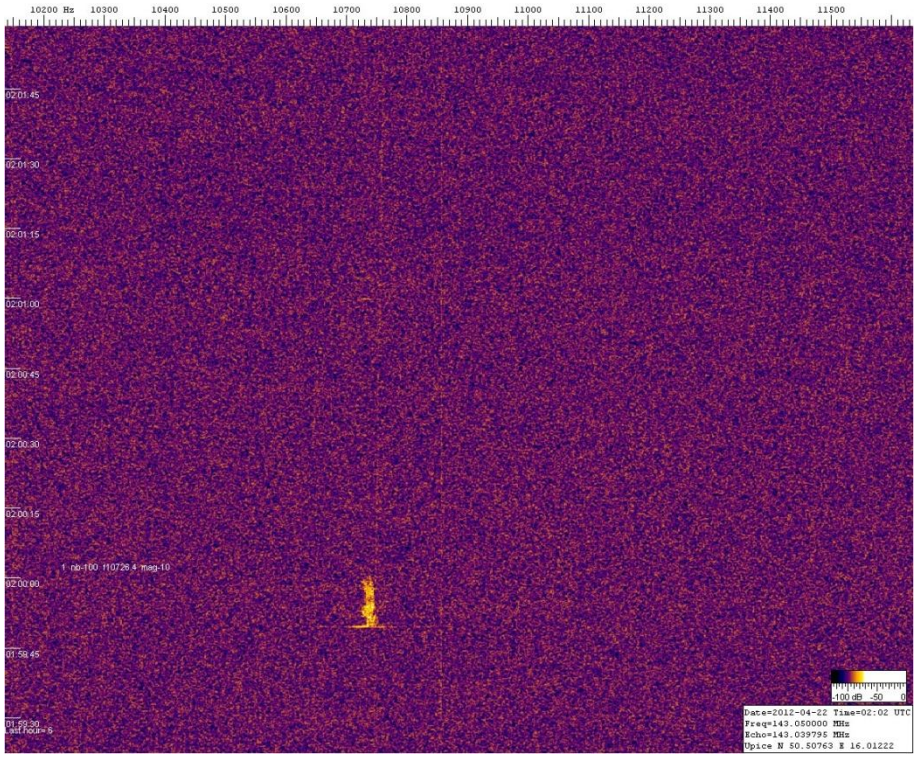



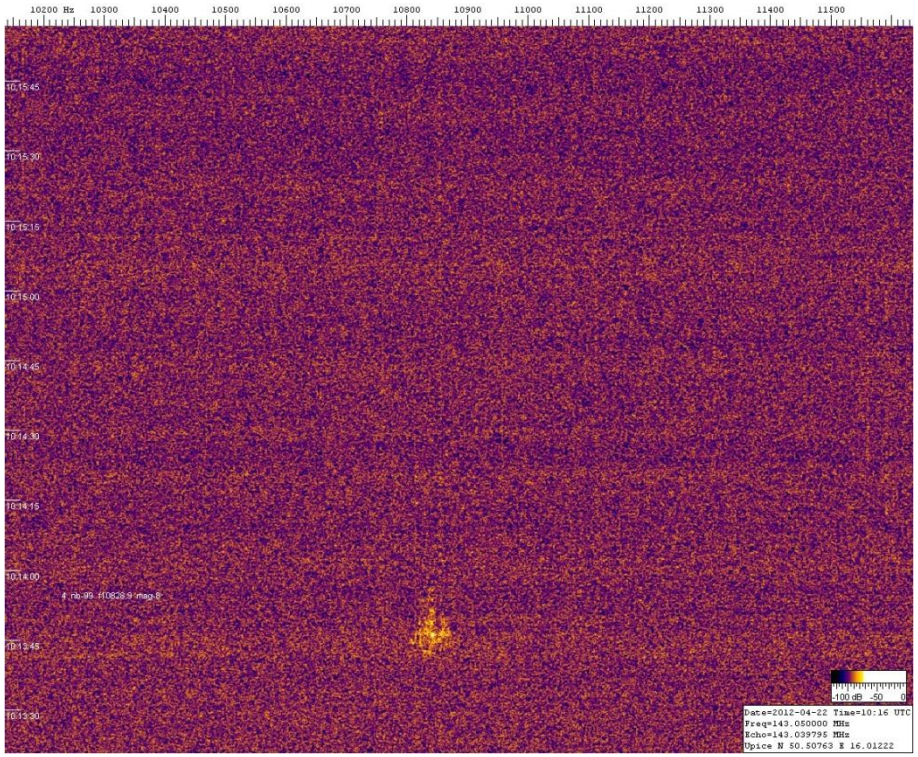



# Co vidíme na záznamech.

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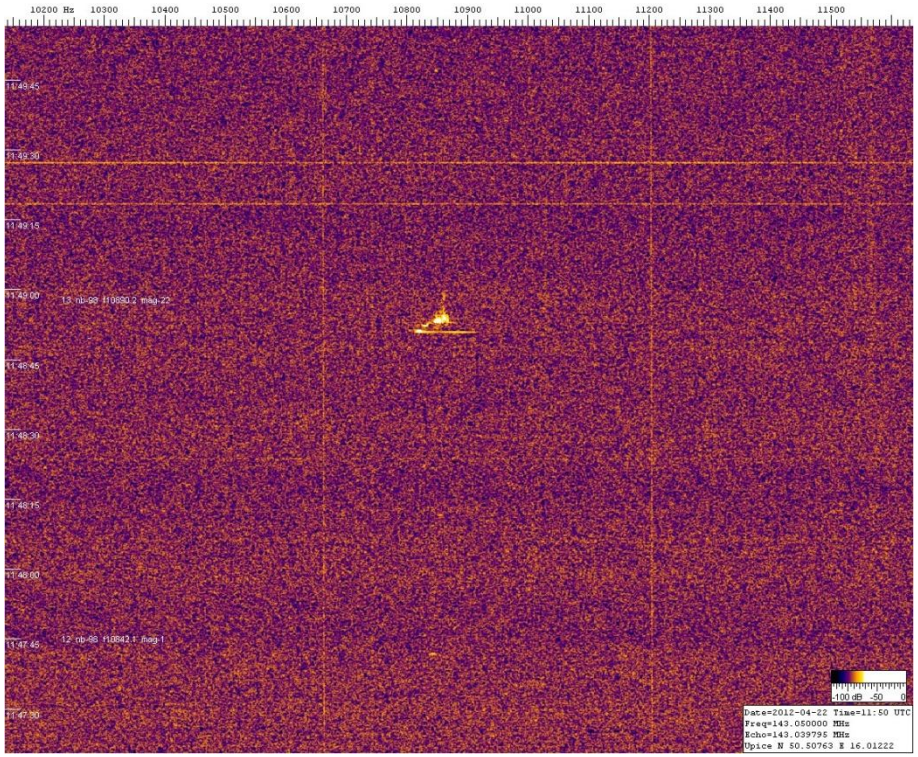
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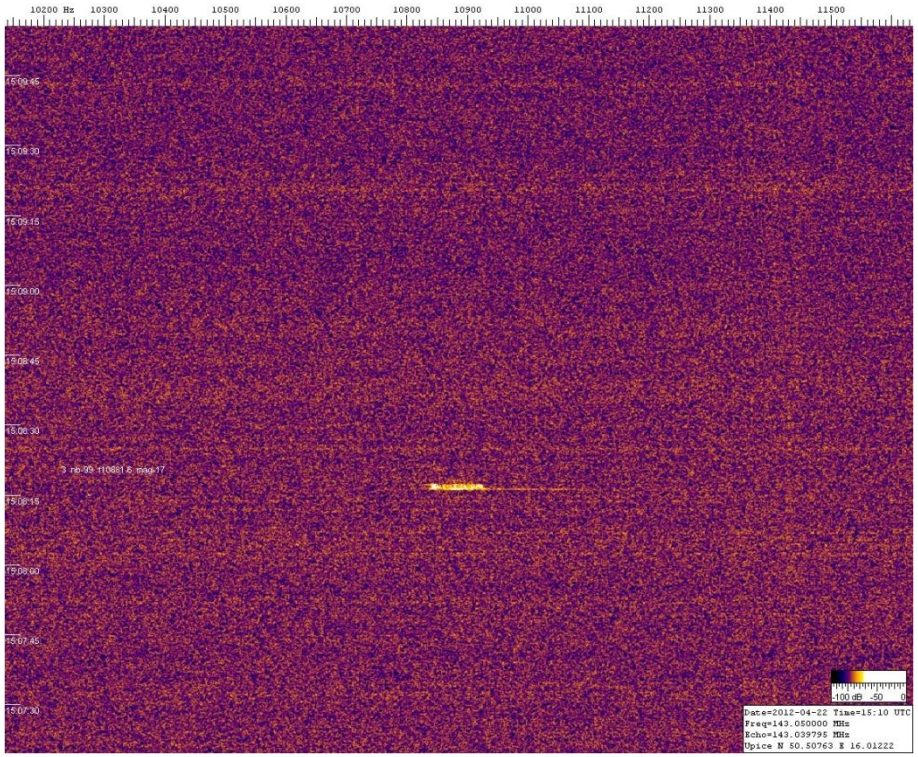
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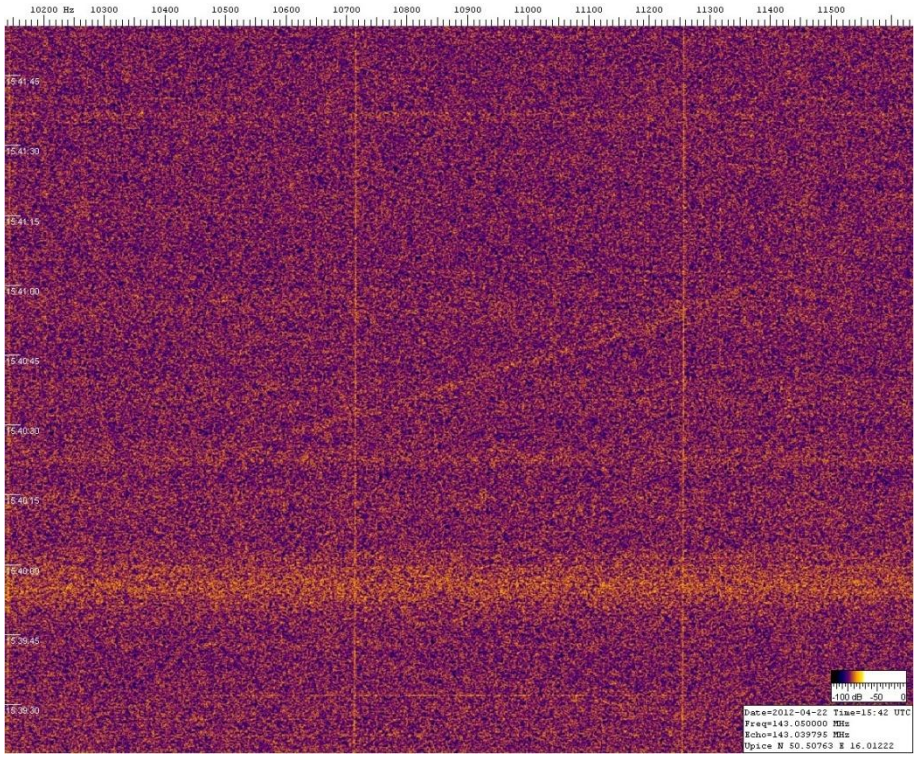
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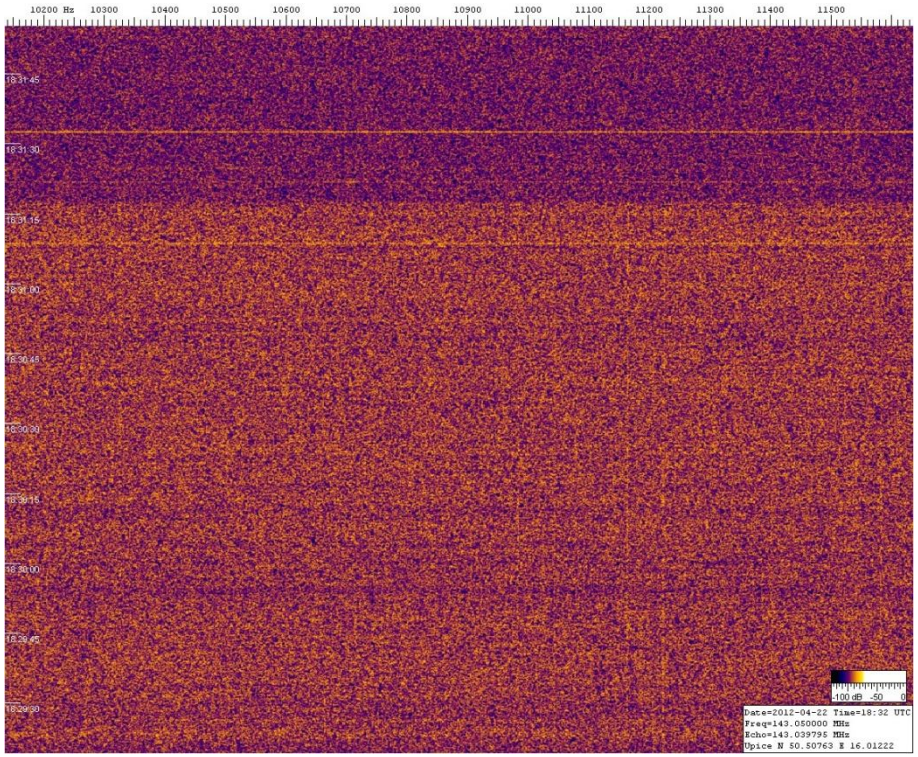
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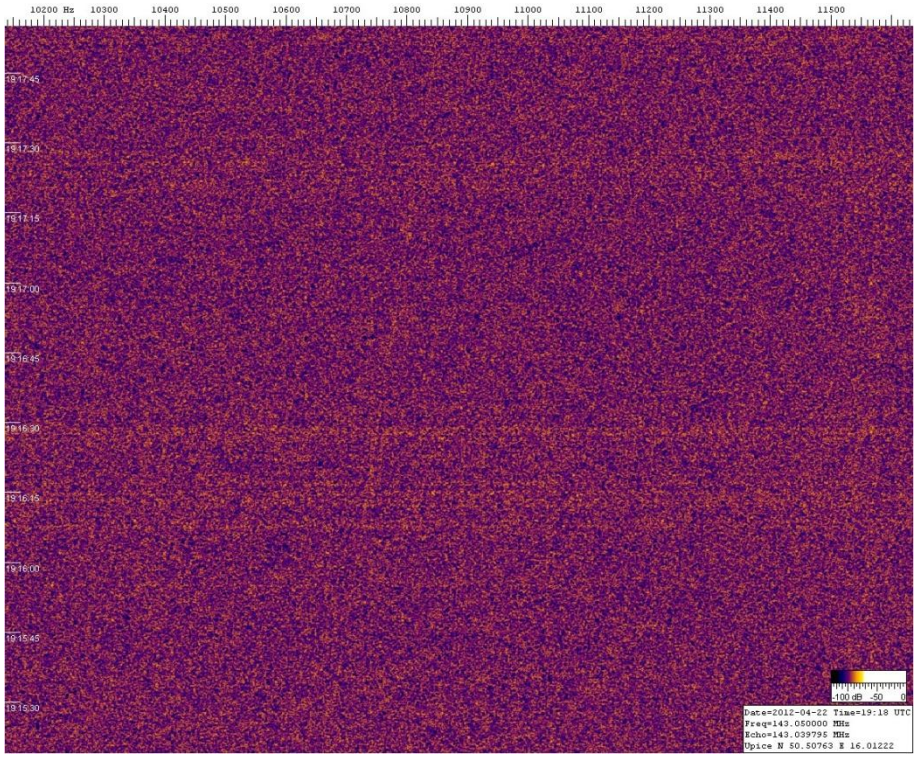
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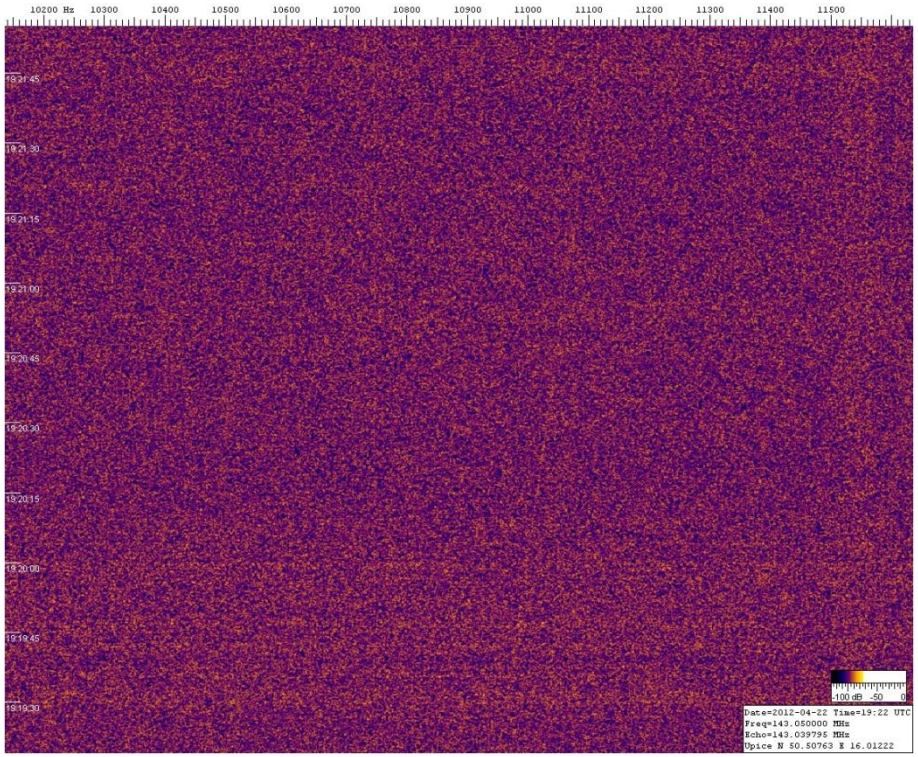
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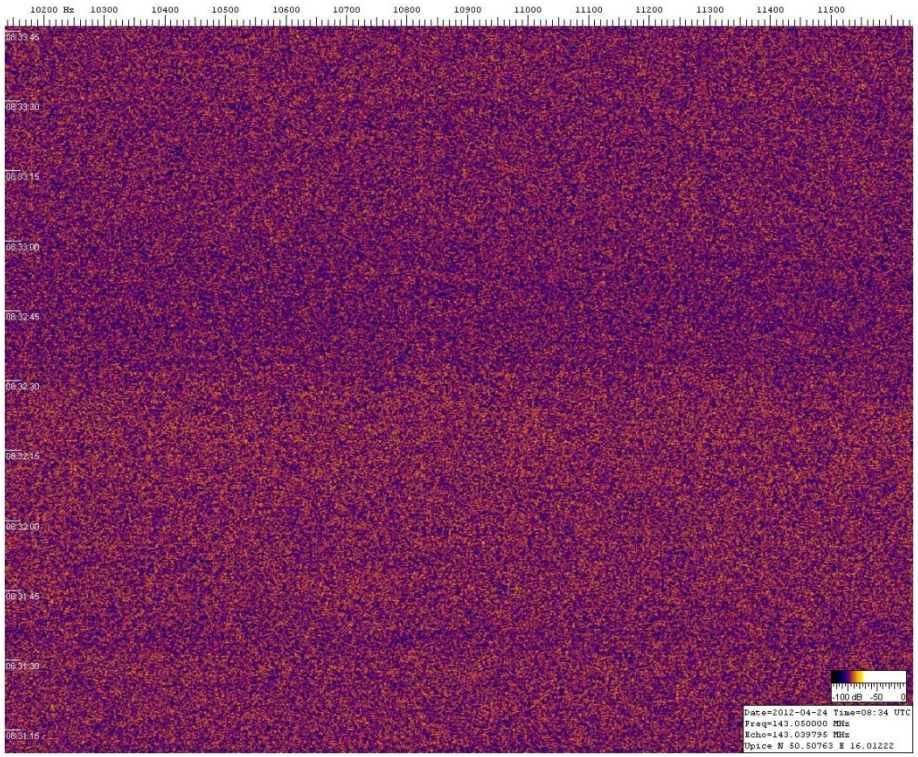
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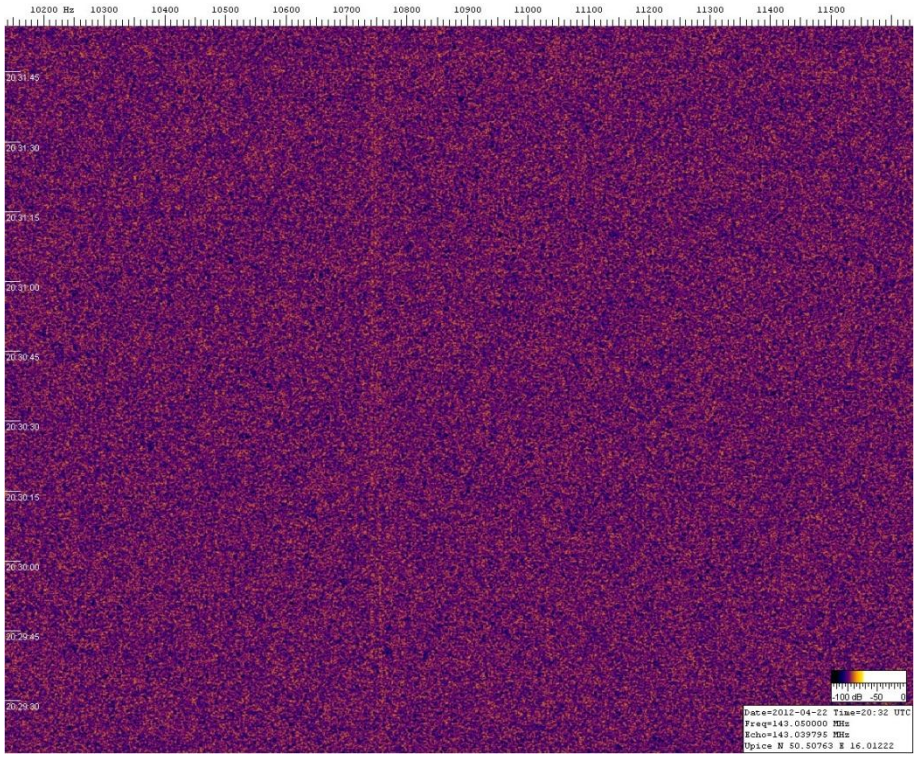
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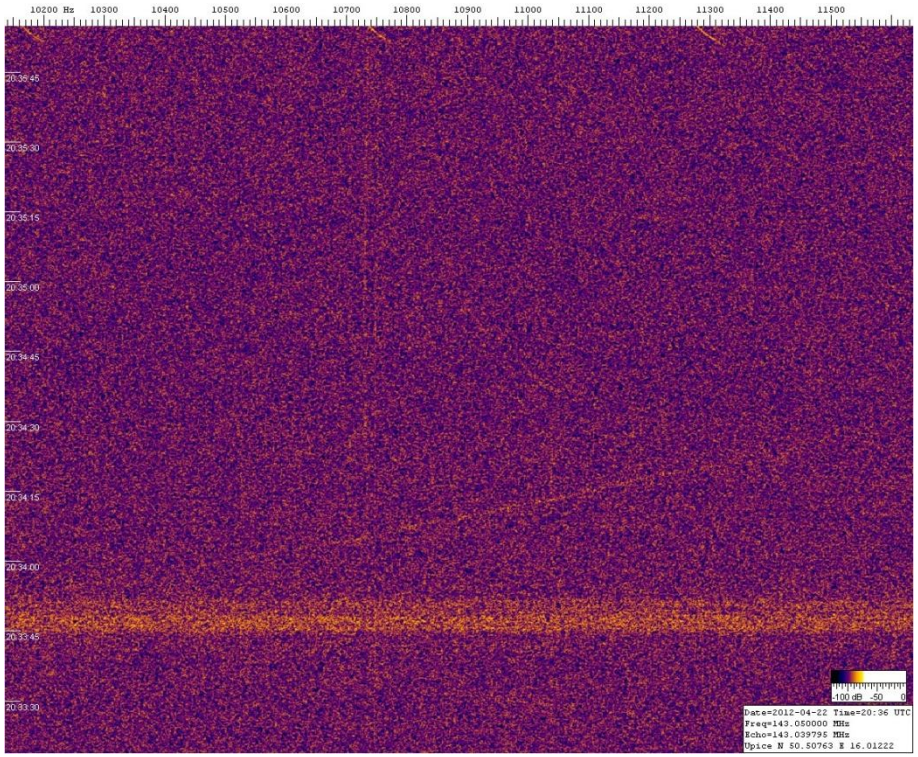
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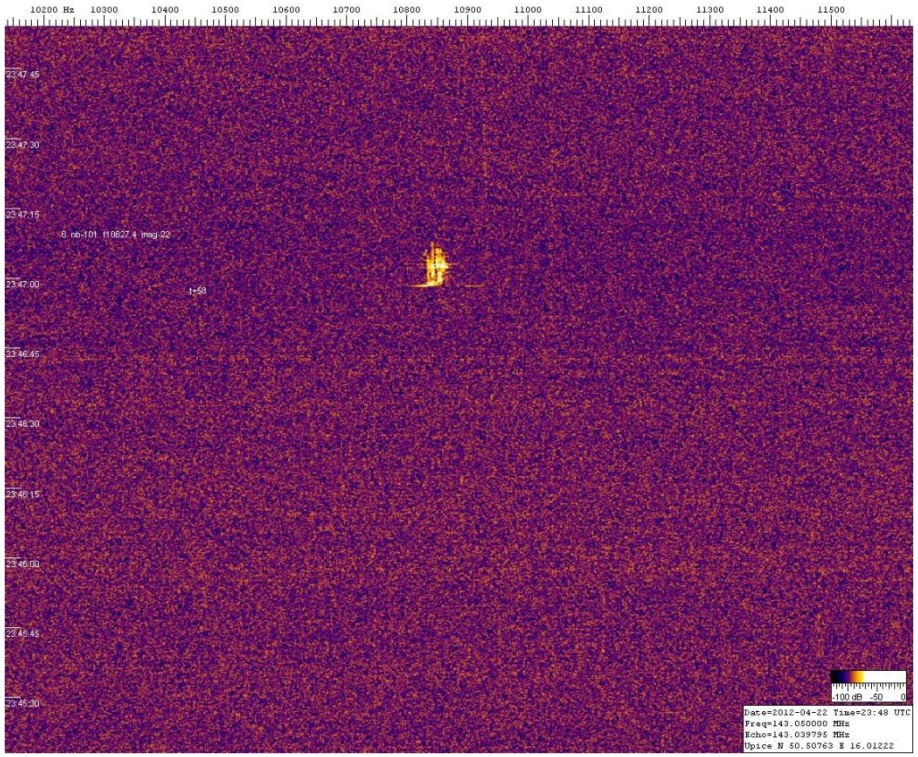
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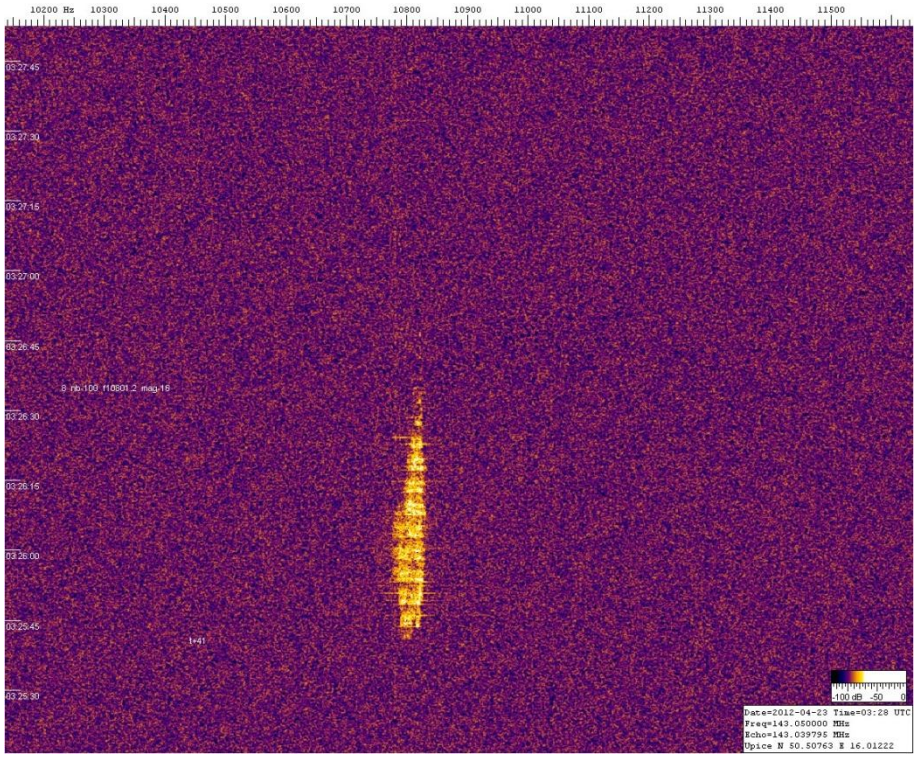
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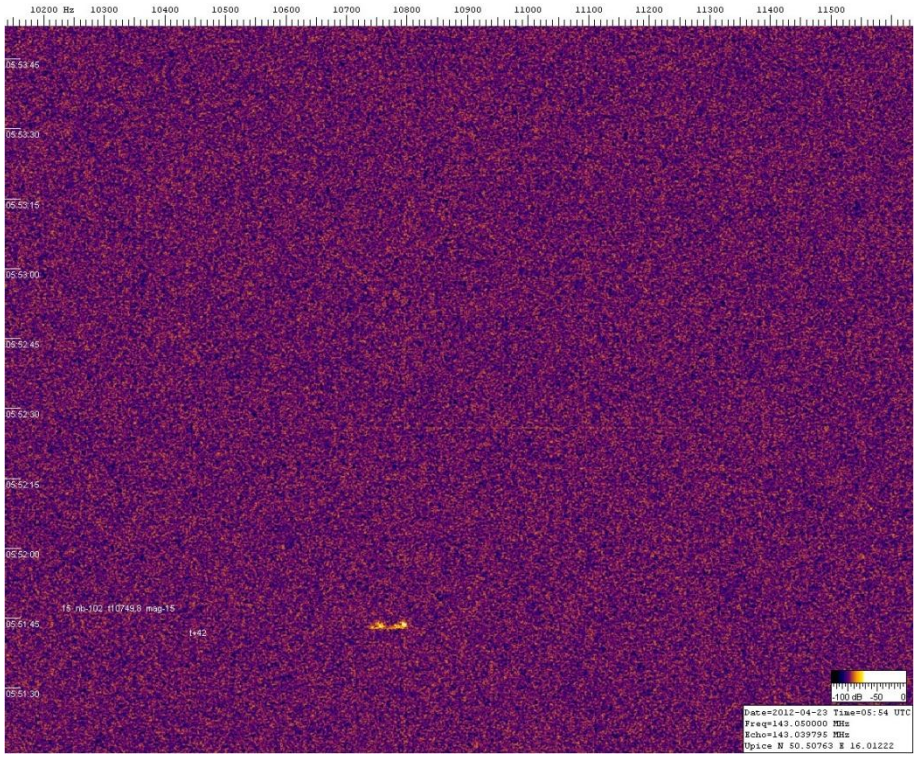
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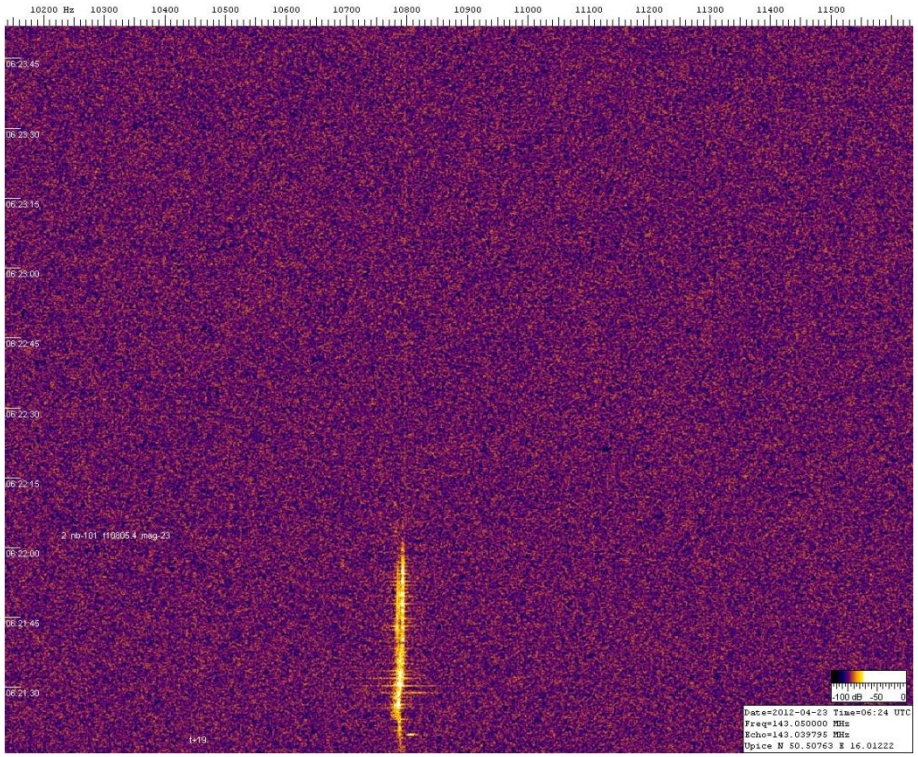
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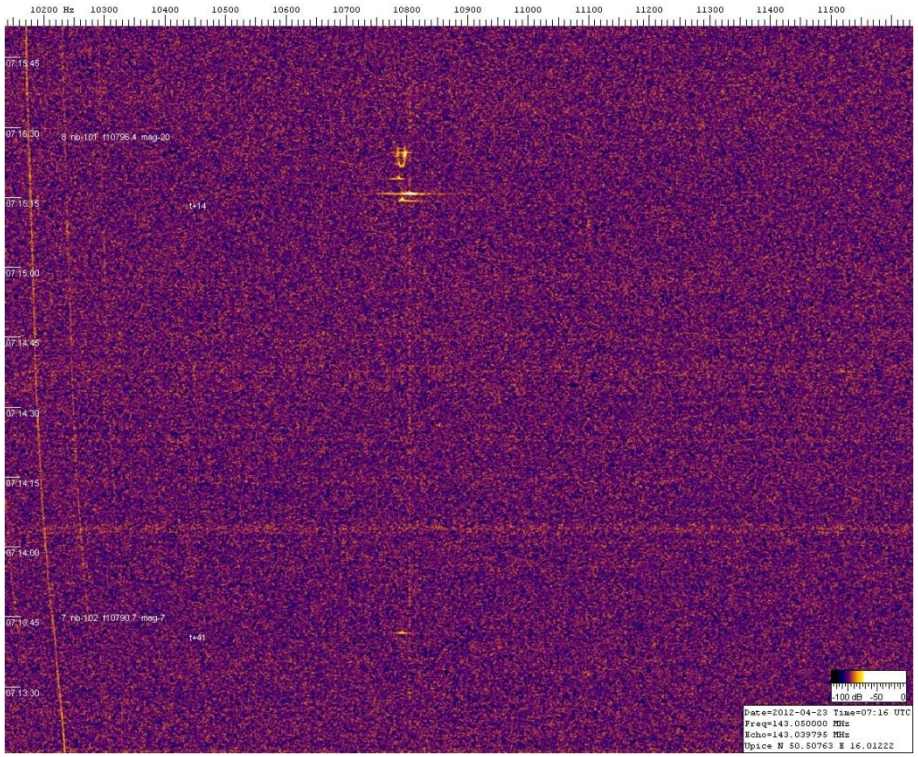
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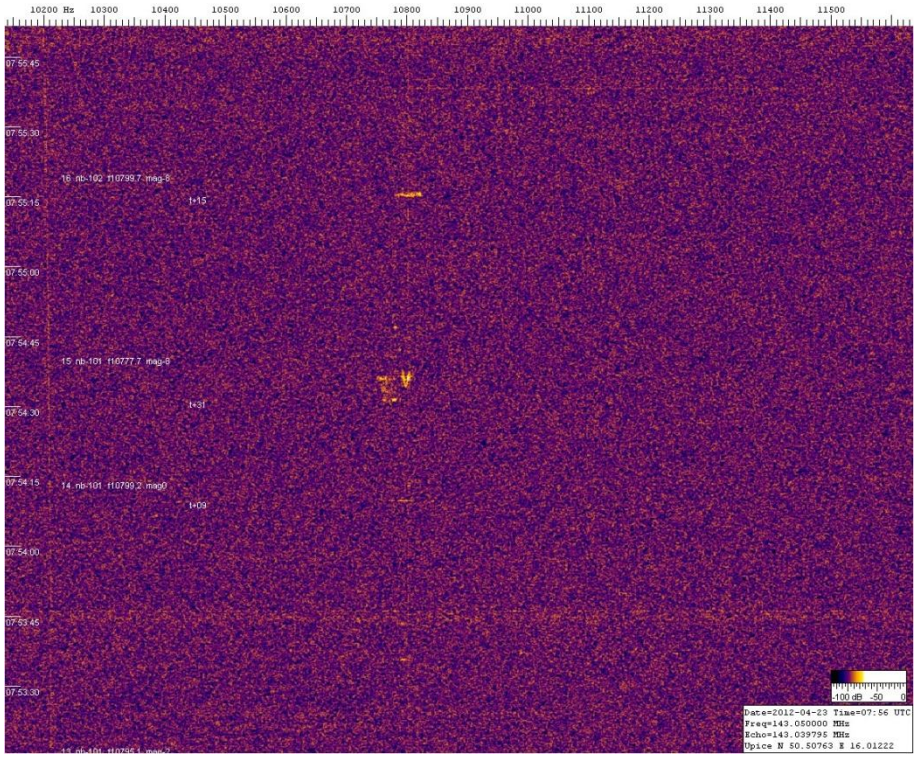
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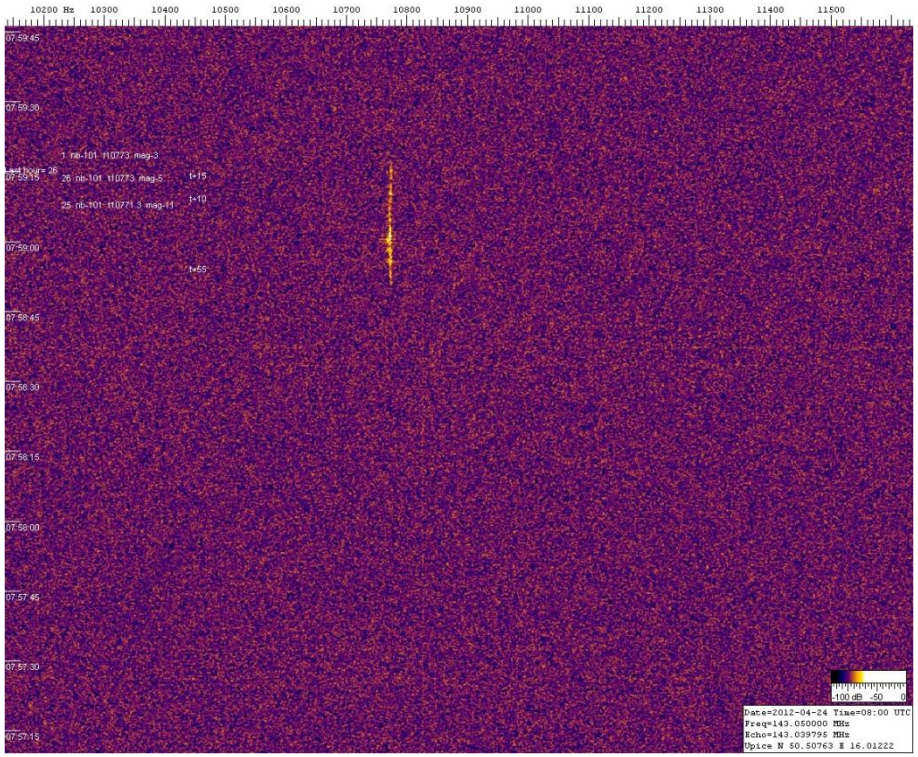
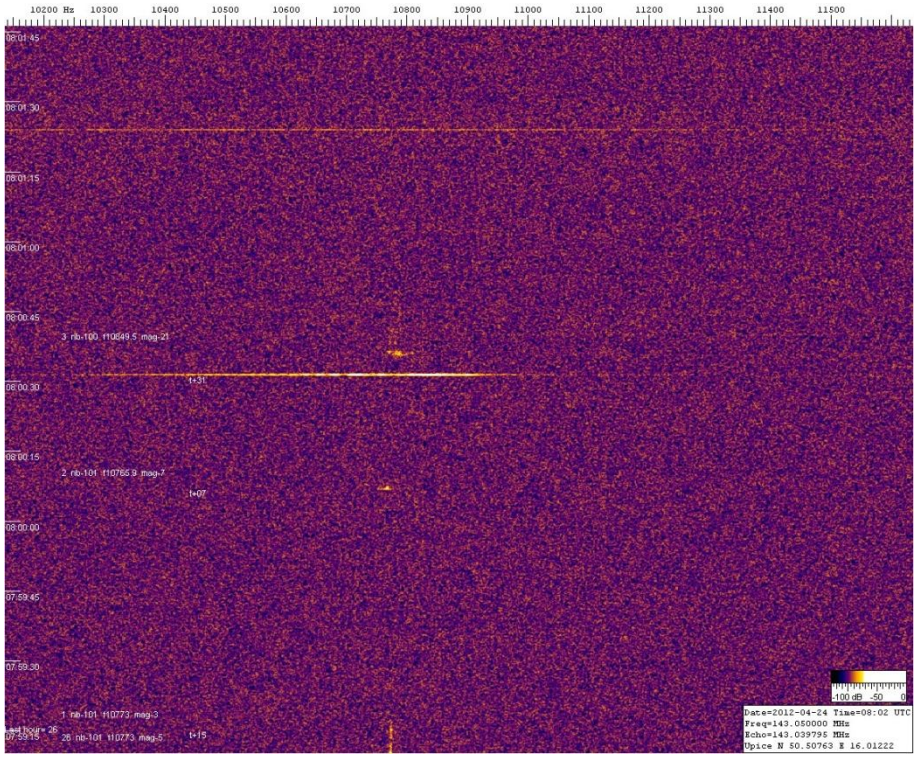
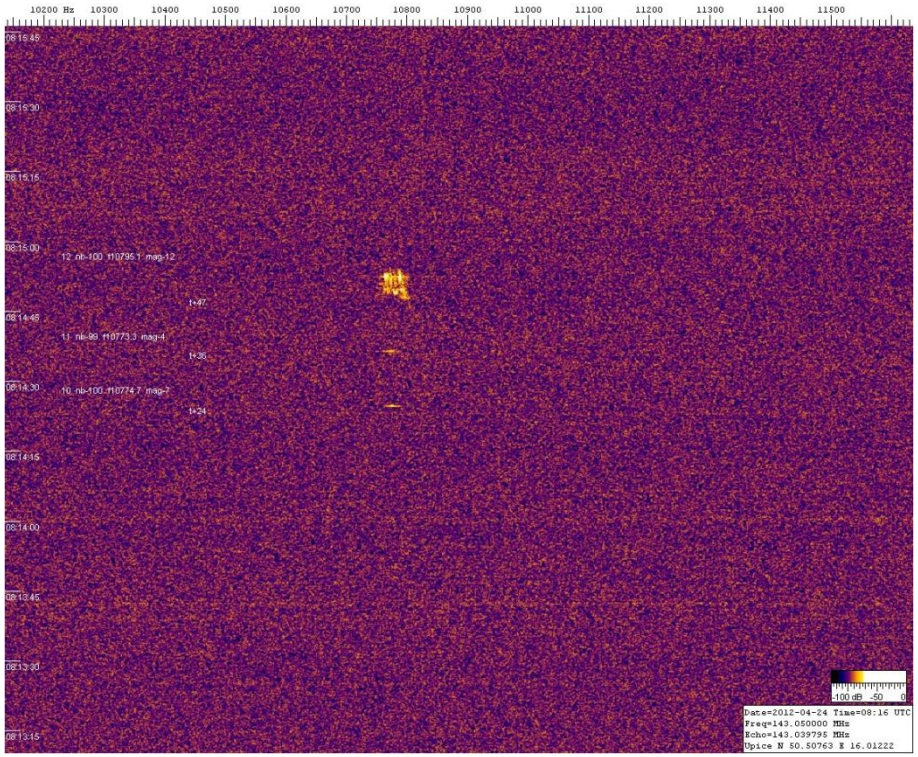

10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
07:59:45
07:59:30
07:59:15
07:59:00
07:58:45
07:58:30
07:58:15
07:58:00
07:57:45
07:57:30
07:57:15
1 nb-101 f10773 mag-3
last hour= 26
26 nb-101 f10773 mag-5
t+15
25 nb-101 f10771.3 mag-11
t+10
t+55
-100 dB -50 0
Date=2012-04-24 Time=08:00 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222


10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
08:01:45
08:01:30
08:01:15
08:01:00
08:00:45
08:00:30
08:00:15
08:00:00
07:59:45
07:59:30
07:59:15
3 nb-100 f10849.5 mag-21
t+31
2 nb-101 f10765.9 mag-7
t+07
1 nb-101 f10773 mag-3
last hour= 26
26 nb-101 f10773 mag-5
t+15
-100 dB -50 0
Date=2012-04-24 Time=08:02 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222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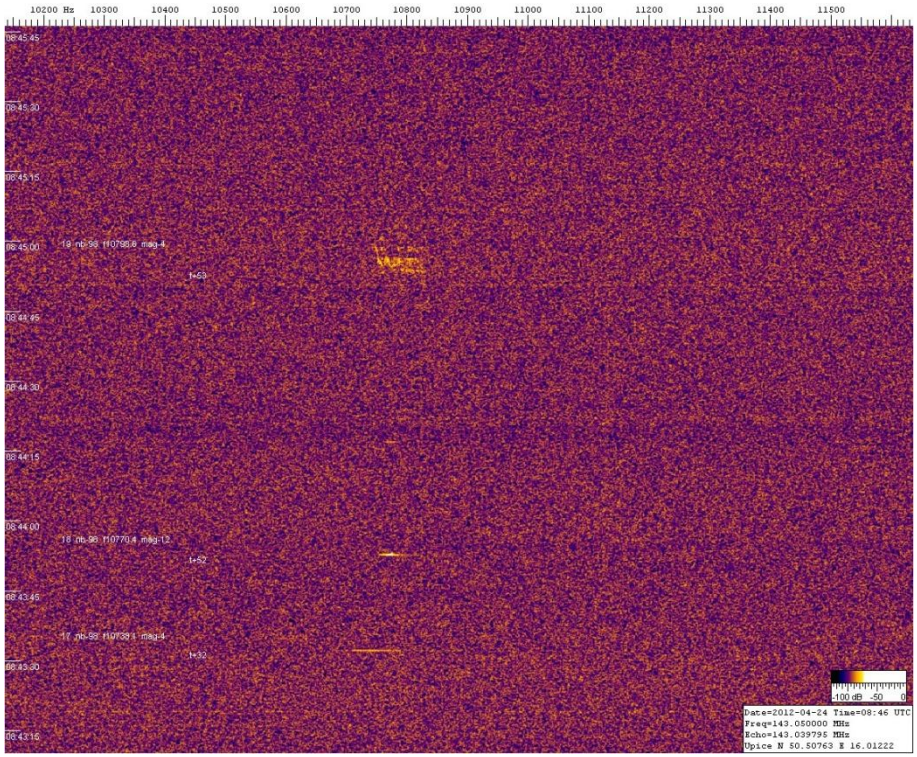
08:15:45
08:15:30
08:15:15
08:15:00
12 nb-100 f10795.1 mag-12
t+47
08:14:45
11 nb-99 f10773.3 mag-4
t+36
08:14:30
10 nb-100 f10774.7 mag-2
t+24
08:14:15
08:14:00
08:13:45
08:13:30
08:13:15
-100 dB -50 0
Date=2012-04-24 Time=08:16 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222


10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
08:45:45
08:45:30
08:45:15
08:45:00
19 nb-99 f10795.6 mag-4
t+53
08:44:45
08:44:30
08:44:15
08:44:00
18 nb-99 f10770.4 mag-12
t+52
08:43:45
17 nb-99 f10738.1 mag-4
t+32
08:43:30
08:43:15
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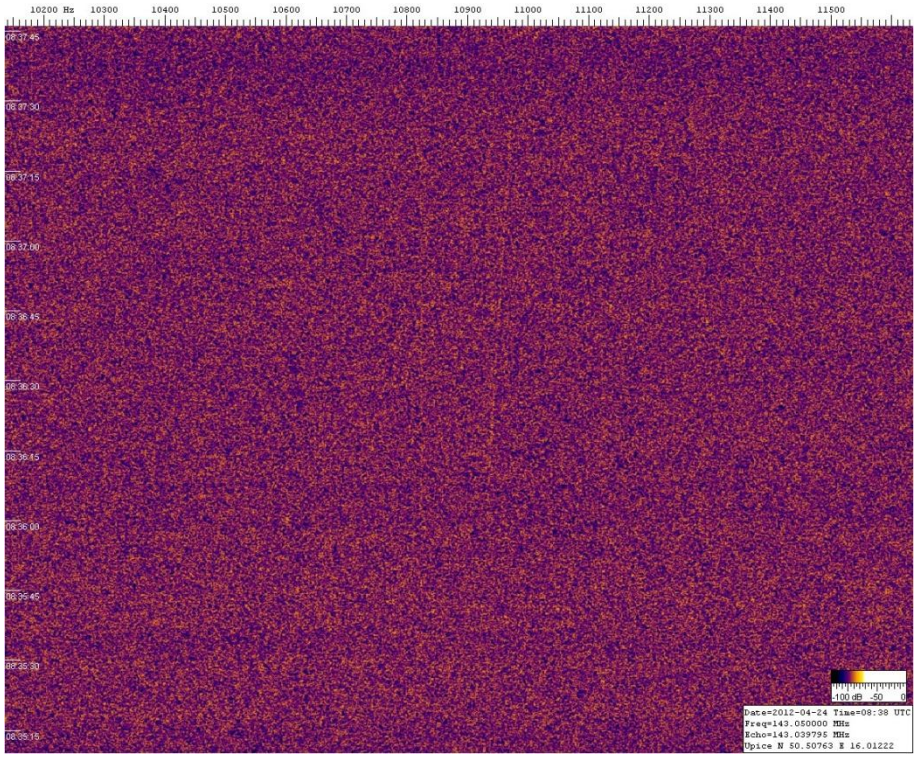
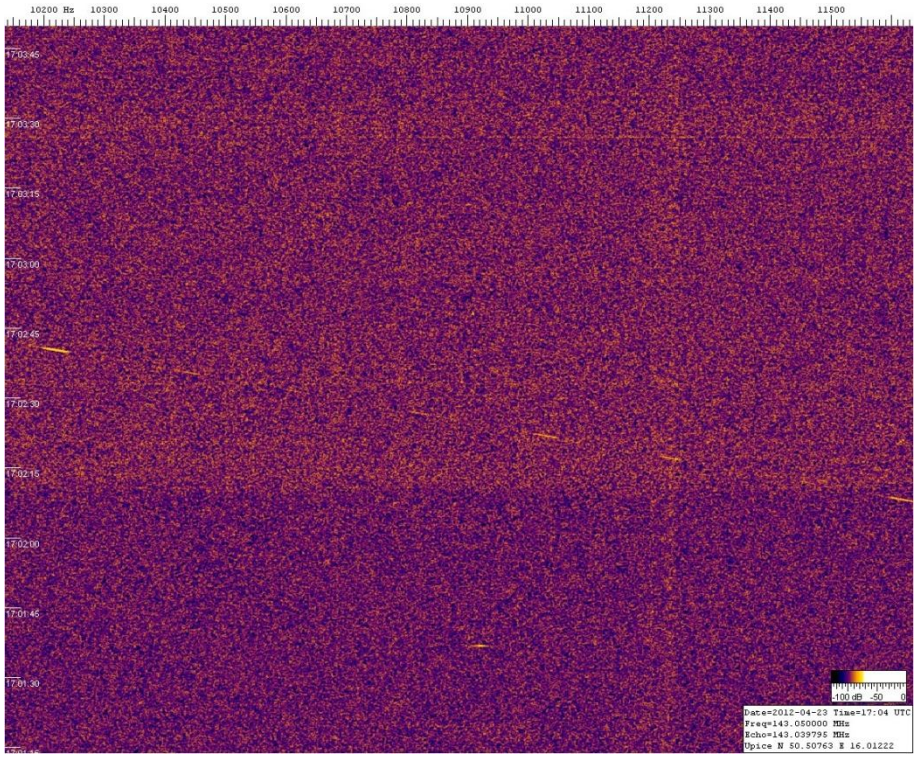
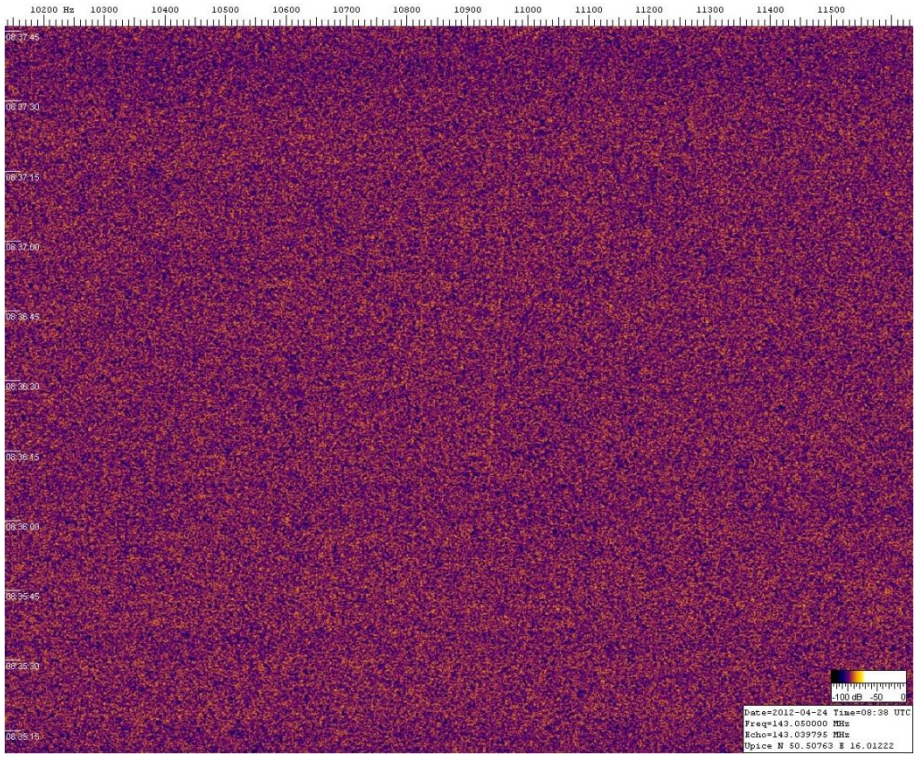
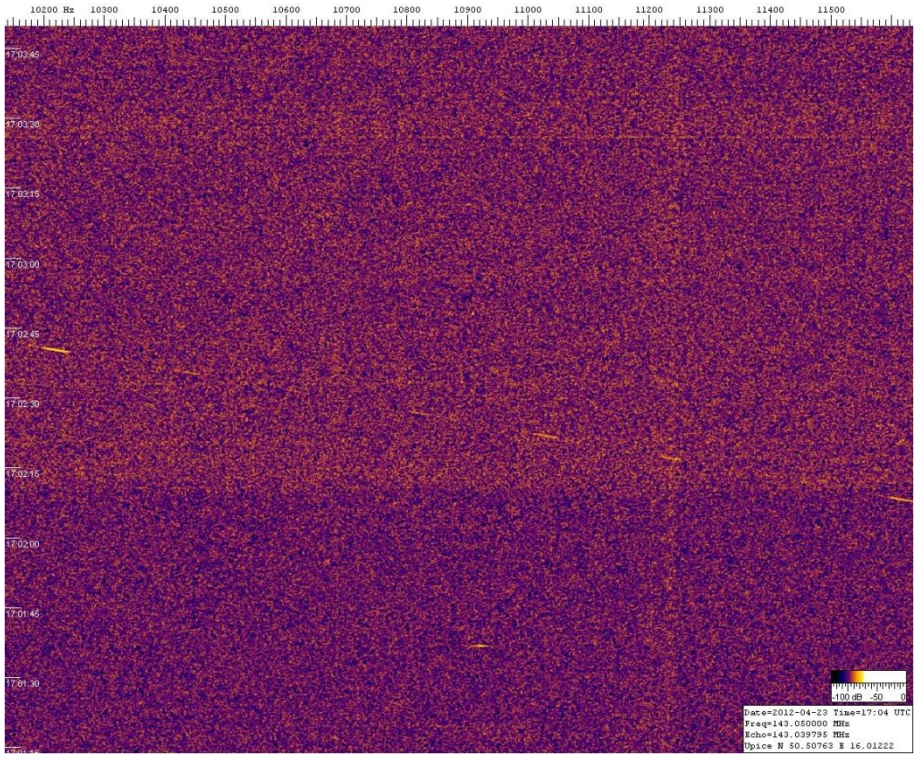
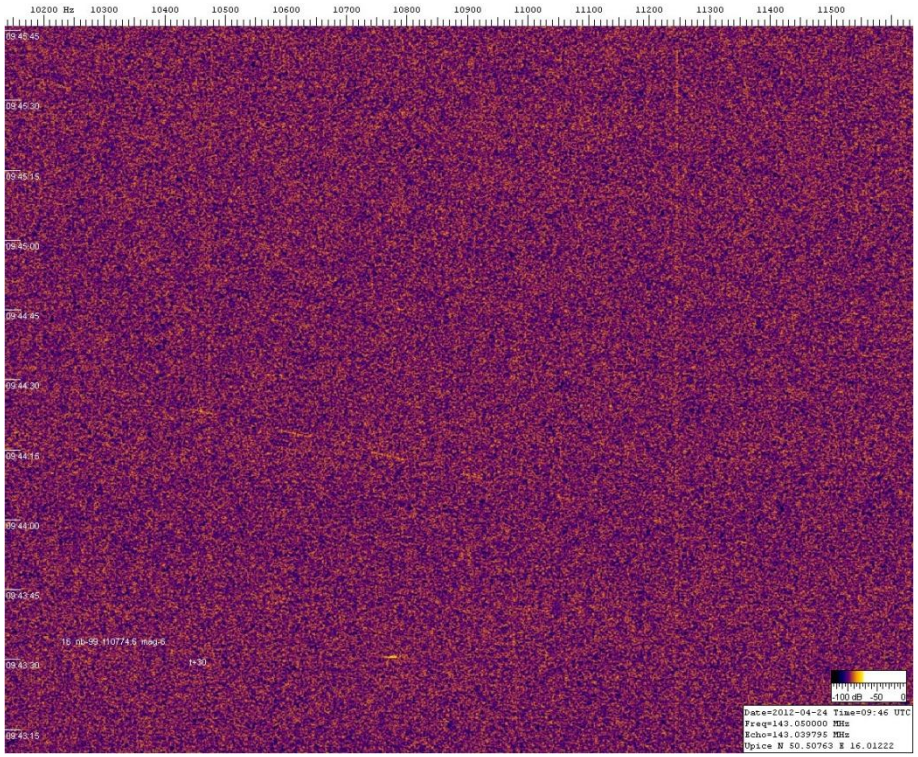
Date=2012-04-24 Time=08:46 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222

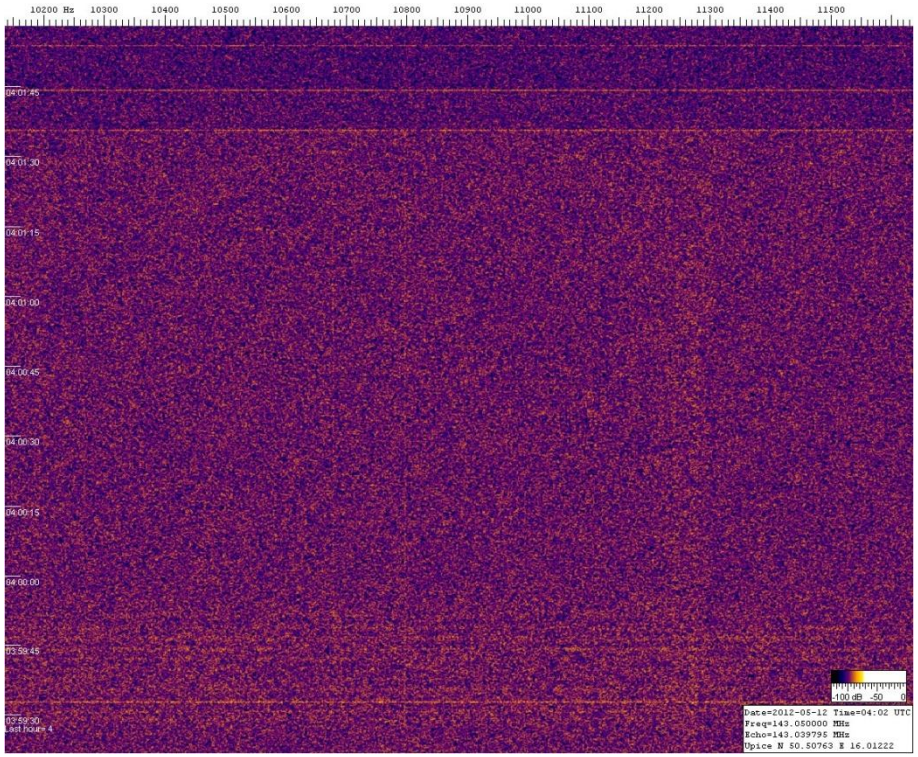

10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
08:37:45
08:37:30
08:37:15
08:37:00
08:36:45
08:36:30
08:36:15
08:36:00
08:35:45
08:35:30
08:35:15
-100 dB -50 0
Date=2012-04-24 Time=08:38 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222

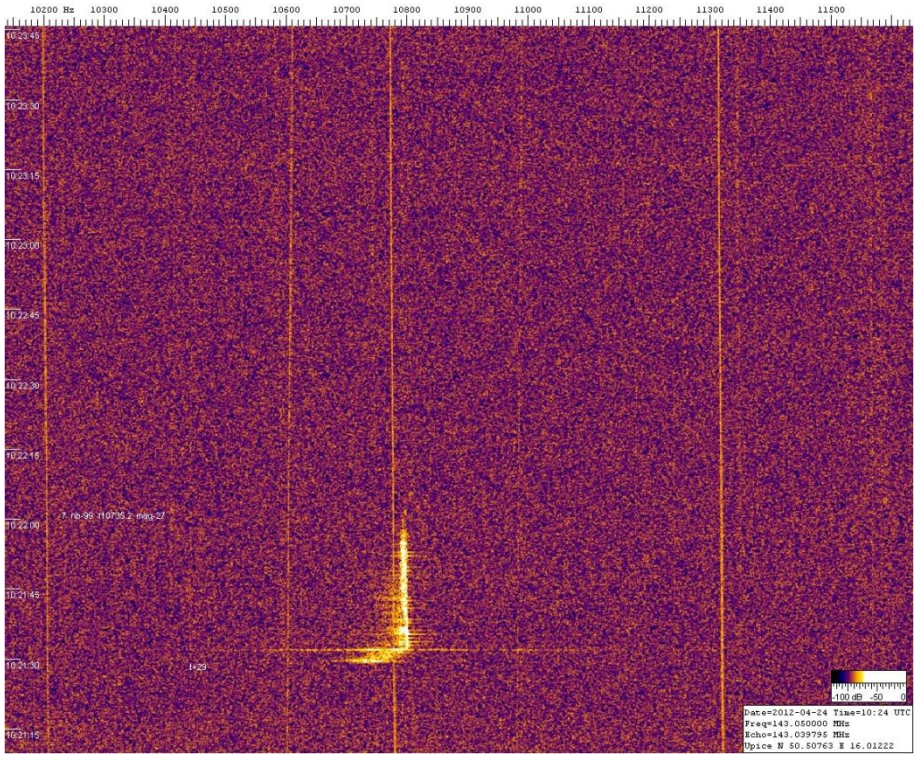

10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
17:03:45
17:03:30
17:03:15
17:03:00
17:02:45
17:02:30
17:02:15
17:02:00
17:01:45
17:01:30
-100 dB -50 0
Date=2012-04-23 Time=17:04 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222

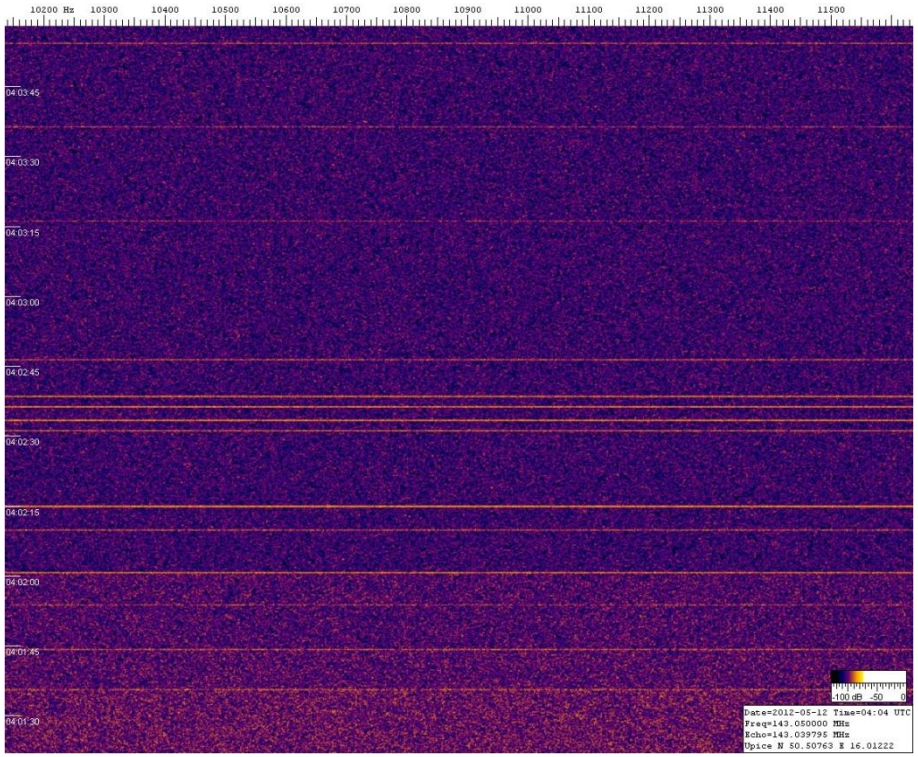

10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
08:37:45
08:37:30
08:37:15
08:37:00
08:36:45
08:36:30
08:36:15
08:36:00
08:35:45
08:35:30
08:35:15
-100 dB -50 0
Date=2012-04-24 Time=08:38 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222


10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
17:03:45
17:03:30
17:03:15
17:03:00
17:02:45
17:02:30
17:02:15
17:02:00
17:01:45
17:01:30
-100 dB -50 0
Date=2012-04-23 Time=17:04 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222

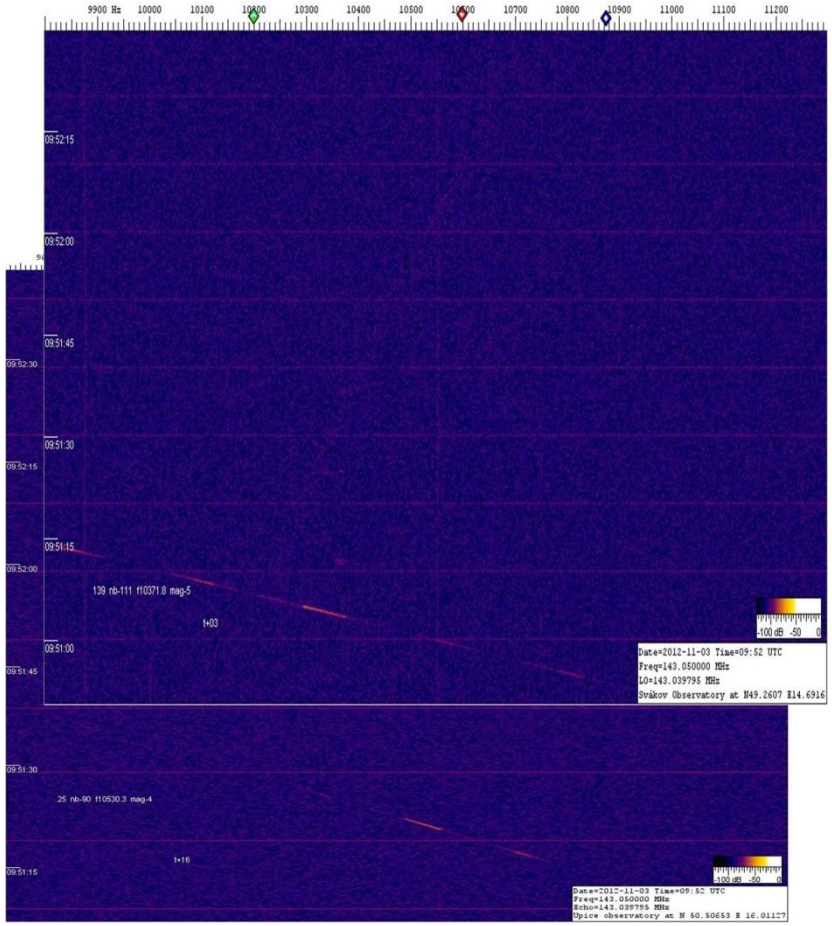

10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
09:46:45
09:46:30
09:46:15
09:46:00
09:45:45
09:45:30
09:45:15
09:45:00
09:44:45
09:44:30
09:44:15
09:44:00
09:43:45
18 dB -99 f10774.6 mag-6
t+30
09:43:30
09:43:15
-100 dB -50 0
Date=2012-04-24 Time=09:46 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222

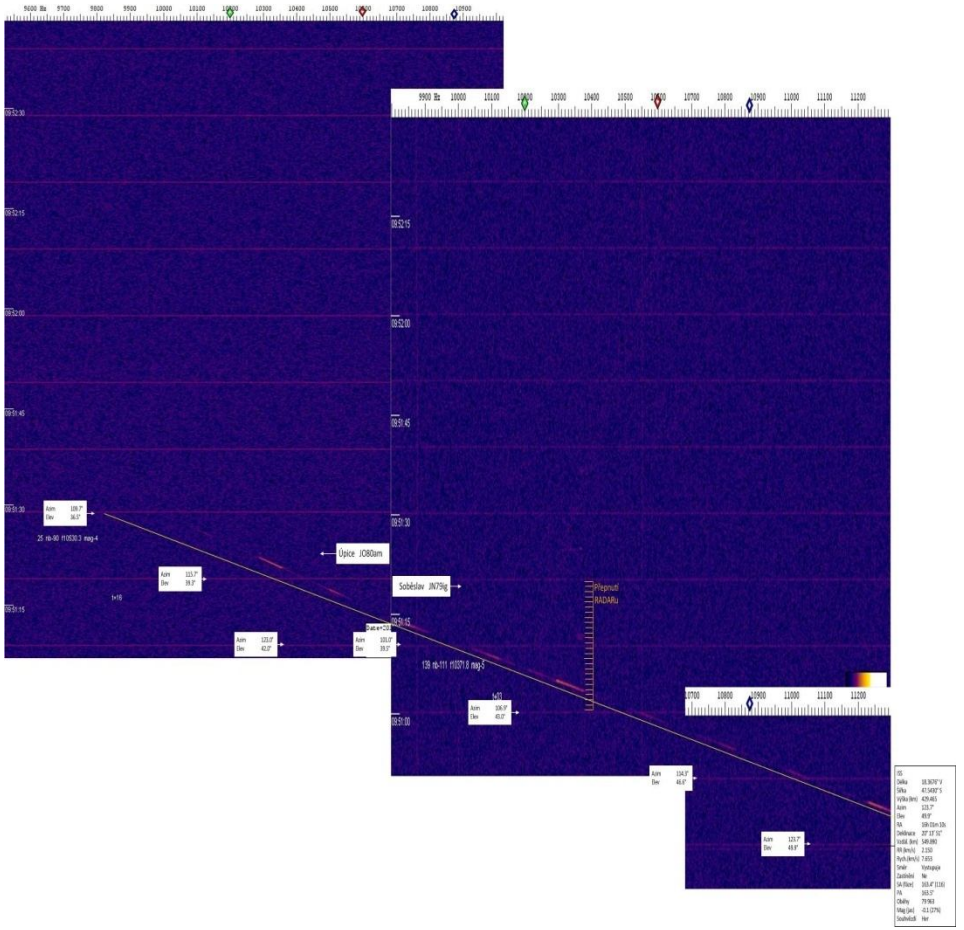

10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
04:01:45
04:01:30
04:01:15
04:01:00
04:00:45
04:00:30
04:00:15
04:00:00
03:59:45
03:59:30
Last hours 4
-100 dB -50 0
Date=2012-05-12 Time=04:02 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222

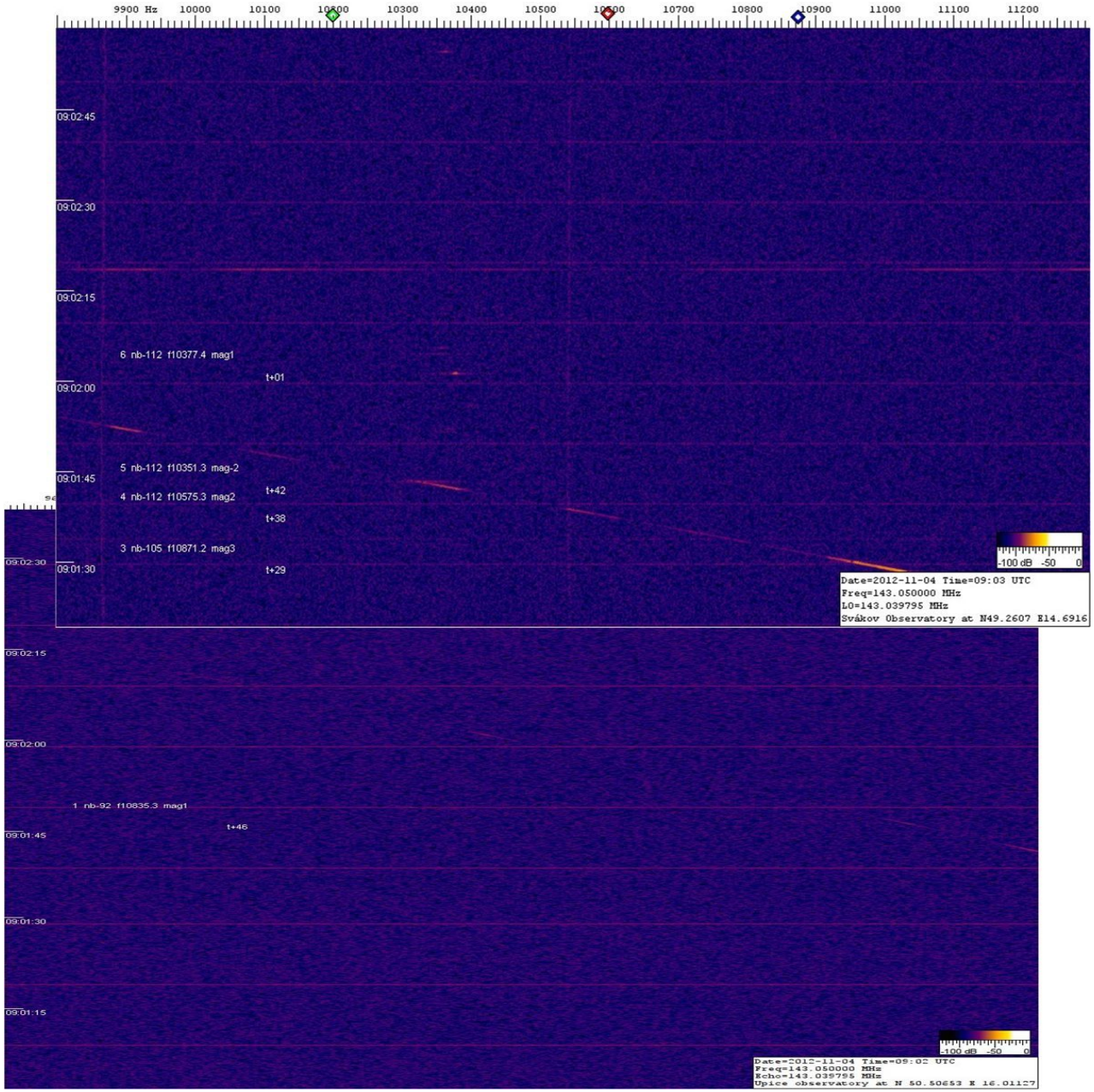

10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
10:23:45
10:23:30
10:23:15
10:23:00
10:22:45
10:22:30
10:22:15
10:22:00
10:21:45
10:21:30
10:21:15
-100 dB -50 0
Date=2012-04-24 Time=10:24 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222


10200 Hz 10300 10400 10500 10600 10700 10800 10900 11000 11100 11200 11300 11400 11500
04:03:45
04:03:30
04:03:15
04:03:00
04:02:45
04:02:30
04:02:15
04:02:00
04:01:45
04:01:30
-100 dB -50 0
Date=2012-05-12 Time=04:04 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice N 50.50763 E 16.01222

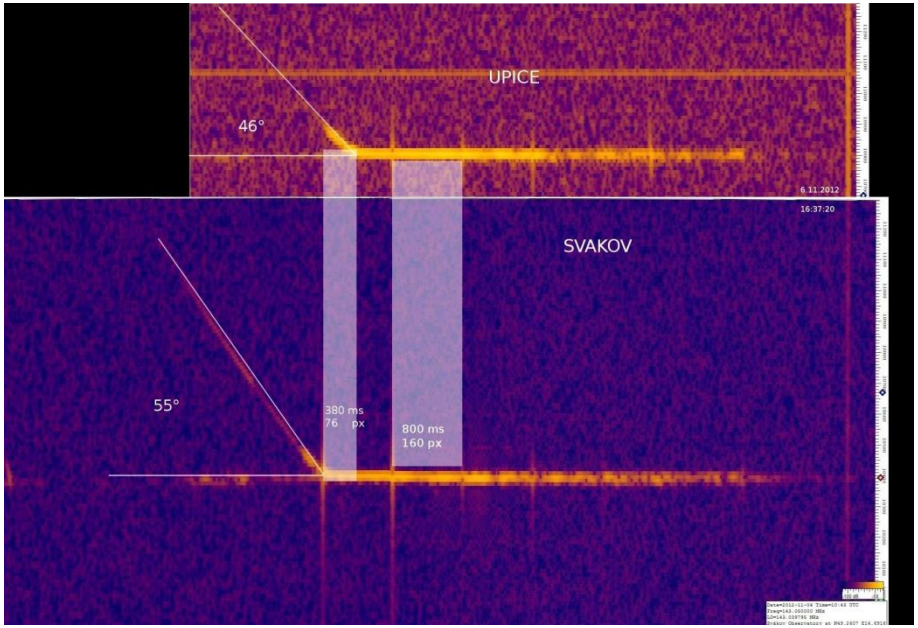
# Porovnání dat dvou stanic: přelet ISS

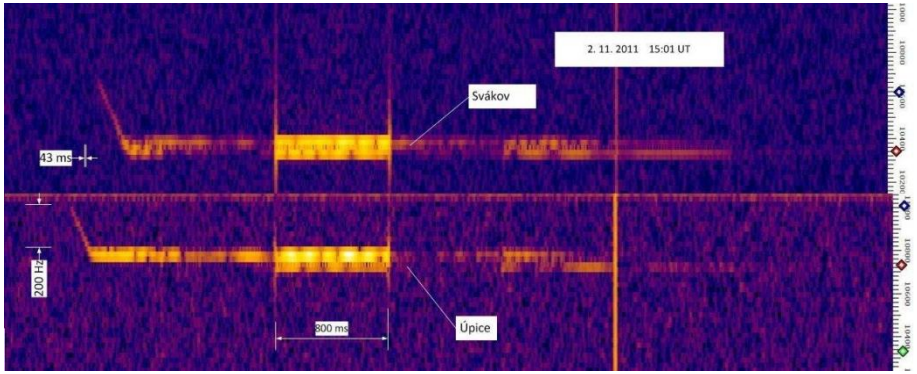


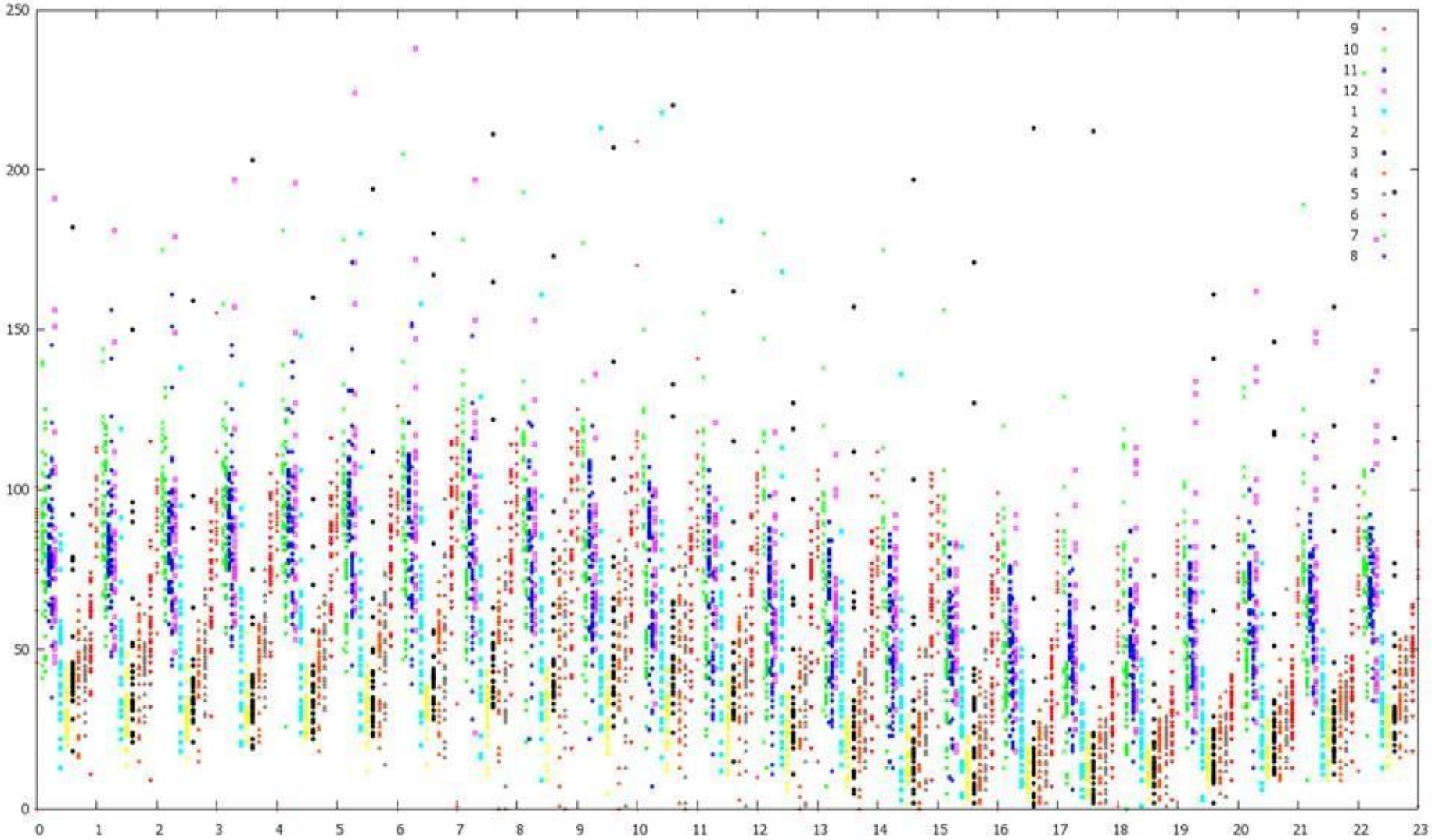

9900 Hz
10000
10100
10200
10300
10400
10500
10600
10700
10800
10900
11000
11100
11200
09:02:45
09:02:30
09:02:15
09:02:00
09:01:45
09:01:30
6 nb-112 f10377.4 mag1
t+01
5 nb-112 f10351.3 mag-2
4 nb-112 f10575.3 mag2
t+42
t+38
3 nb-105 f10871.2 mag3
t+29
-100 dB -50 0
Date=2012-11-04 Time=09:03 UTC
Freq=143.050000 MHz
LO=143.039795 MHz
Svákov Observatory at N49.2607 E14.6916
09:02:30
09:02:15
09:02:00
1 nb-92 f10835.3 mag1
t+46
09:01:45
09:01:30
09:01:15
-100 dB -50 0
Date=2012-11-04 Time=09:02 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127

# Porovnání vlastního letu meteoru a jeho stopy

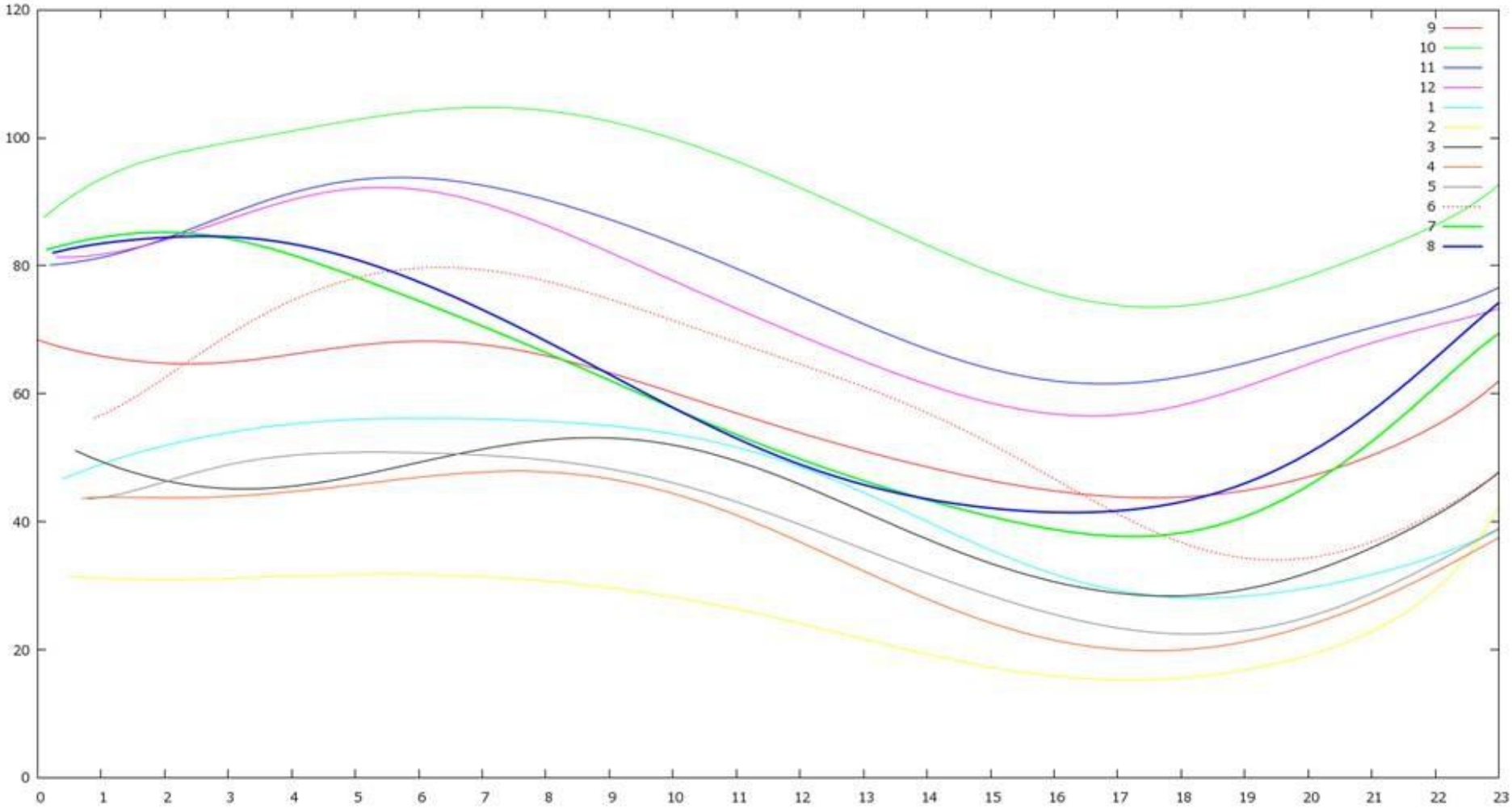


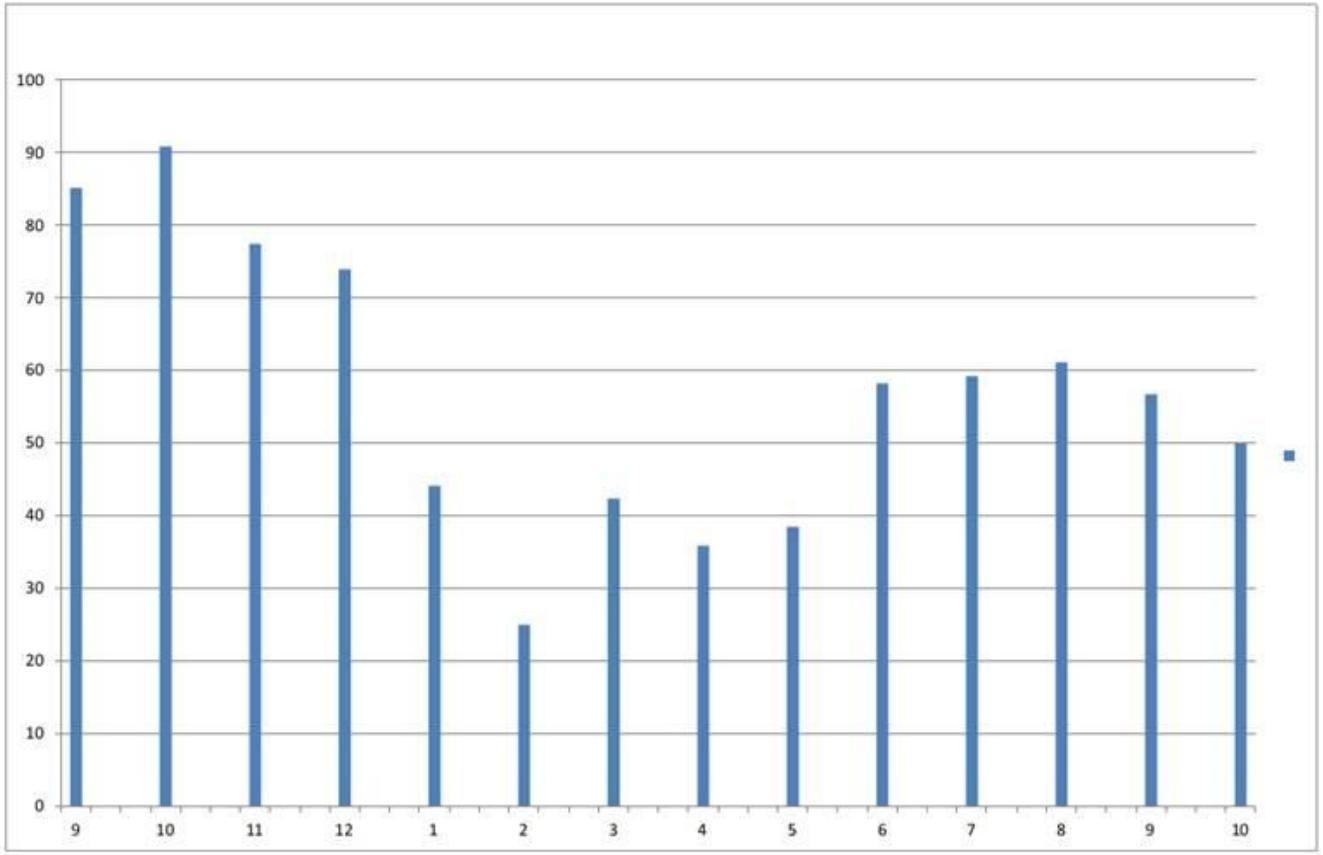
Hodinové četnosti, barvy odpovídají měsícům v roce.
Data jsou od září 2011 do září/října 2012.



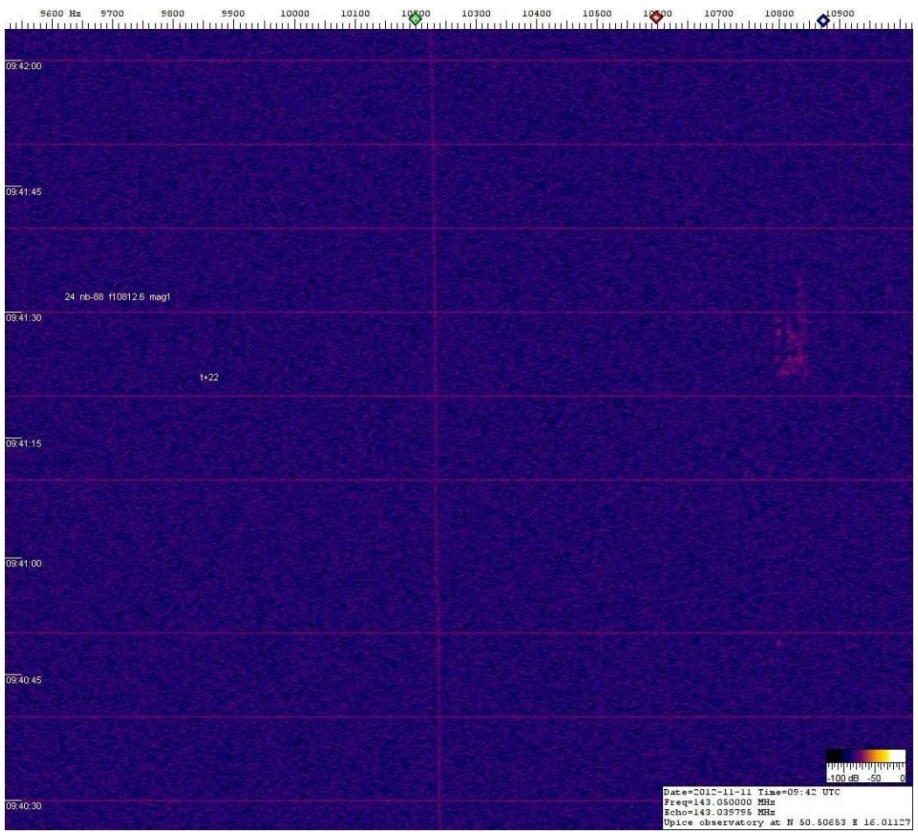
# Aritmetické průměry hodinových četností proložené Bézierovou křivkou, opět barvy odpovídají měsícům

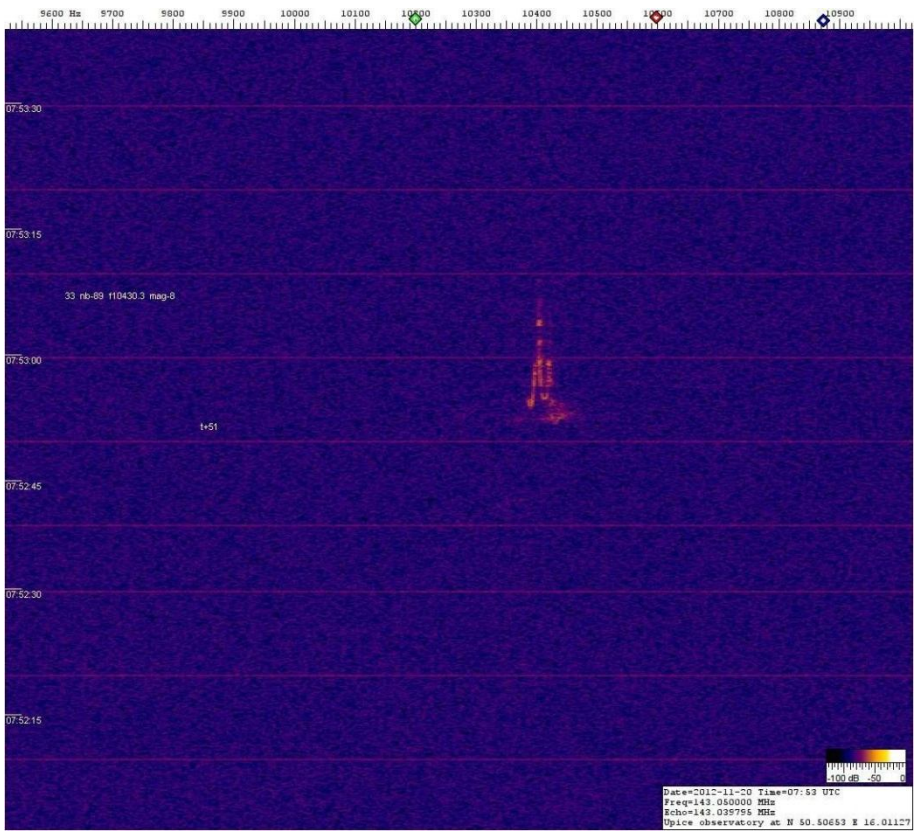


# Měsíční průměrné četnosti

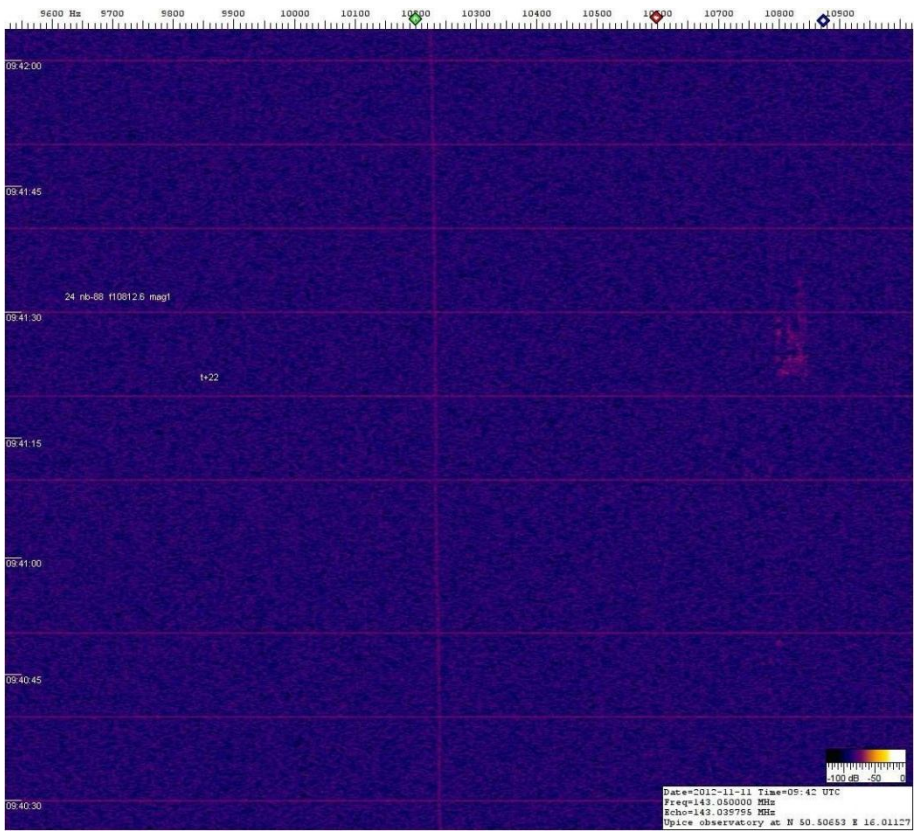


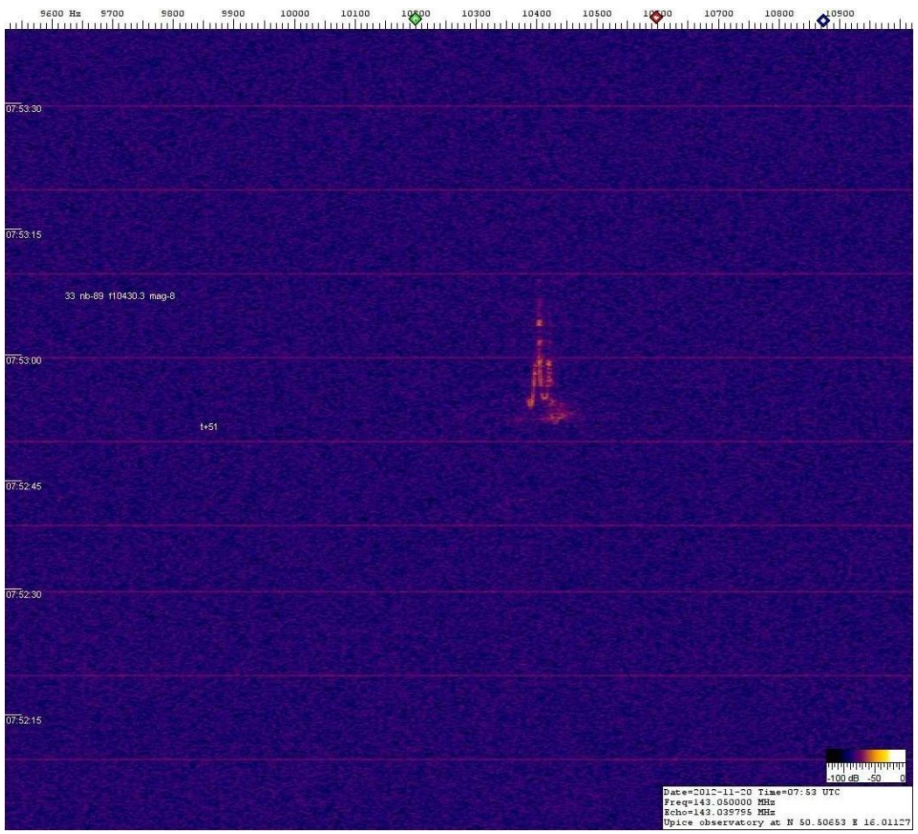
# Na závěr ještě několik  ukázek

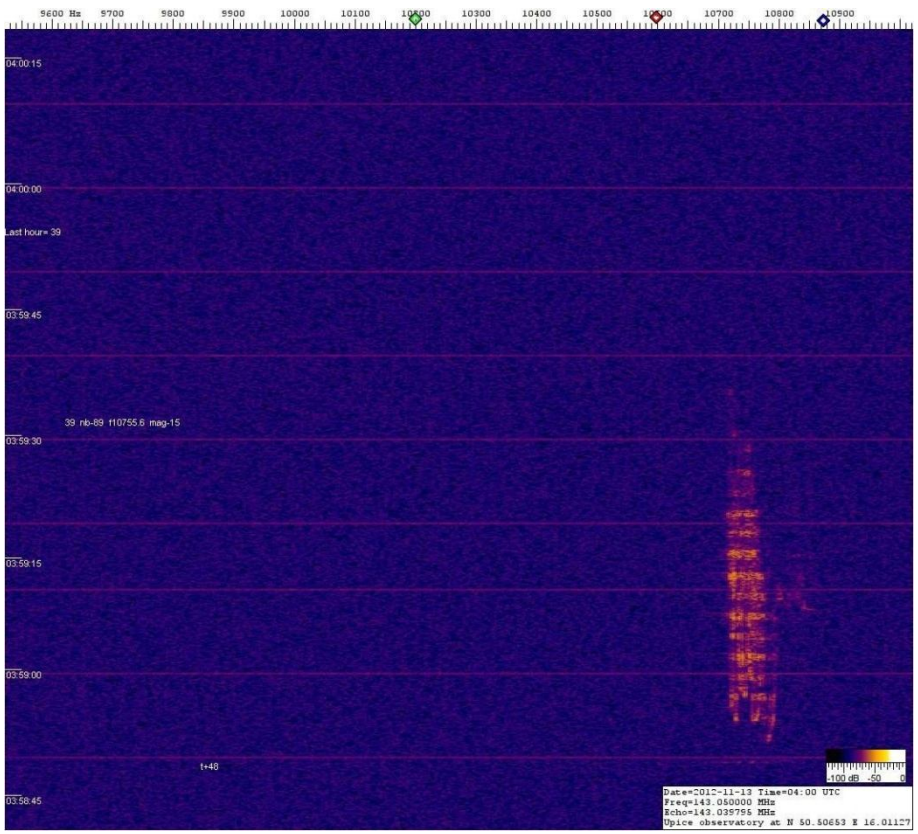


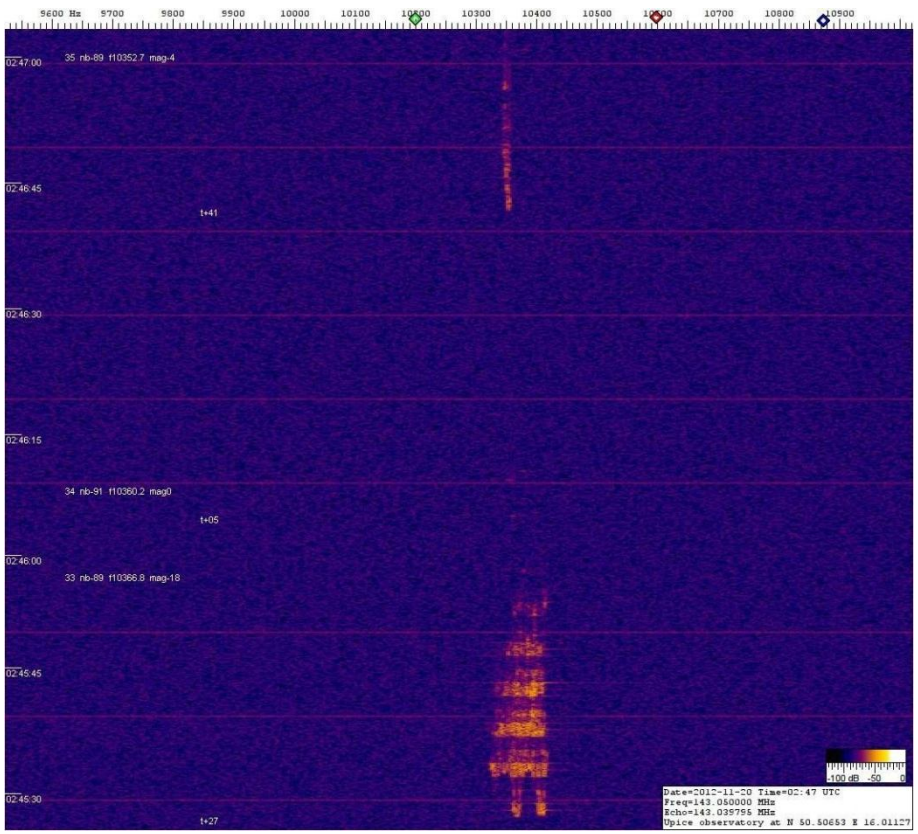



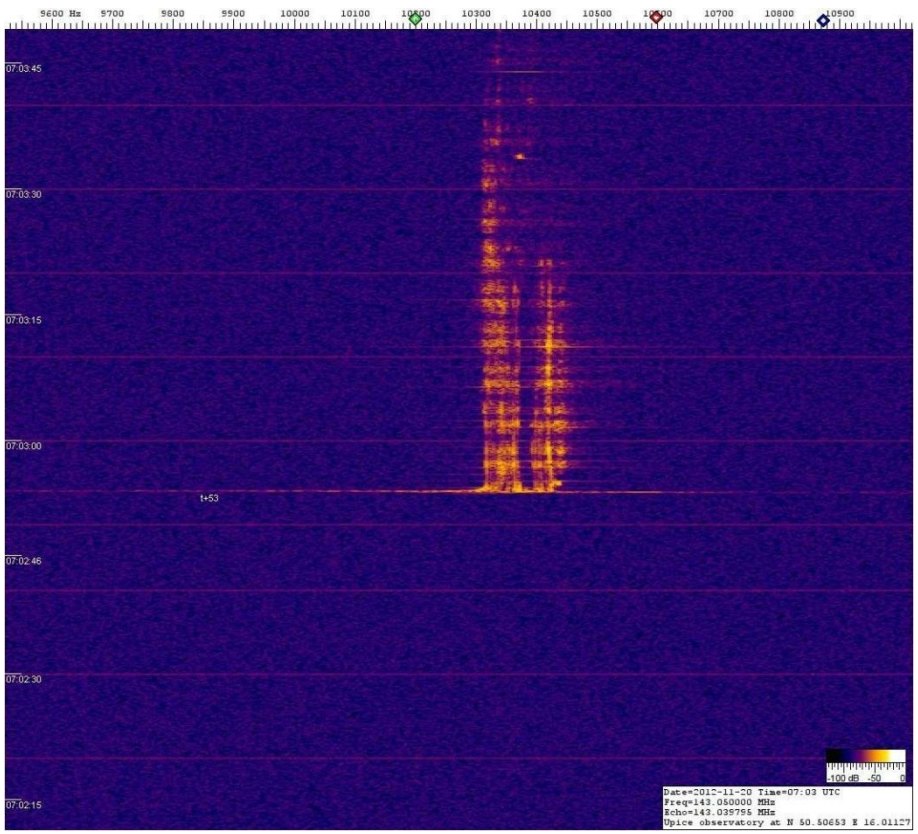
# Na závěr ještě několik  ukázek

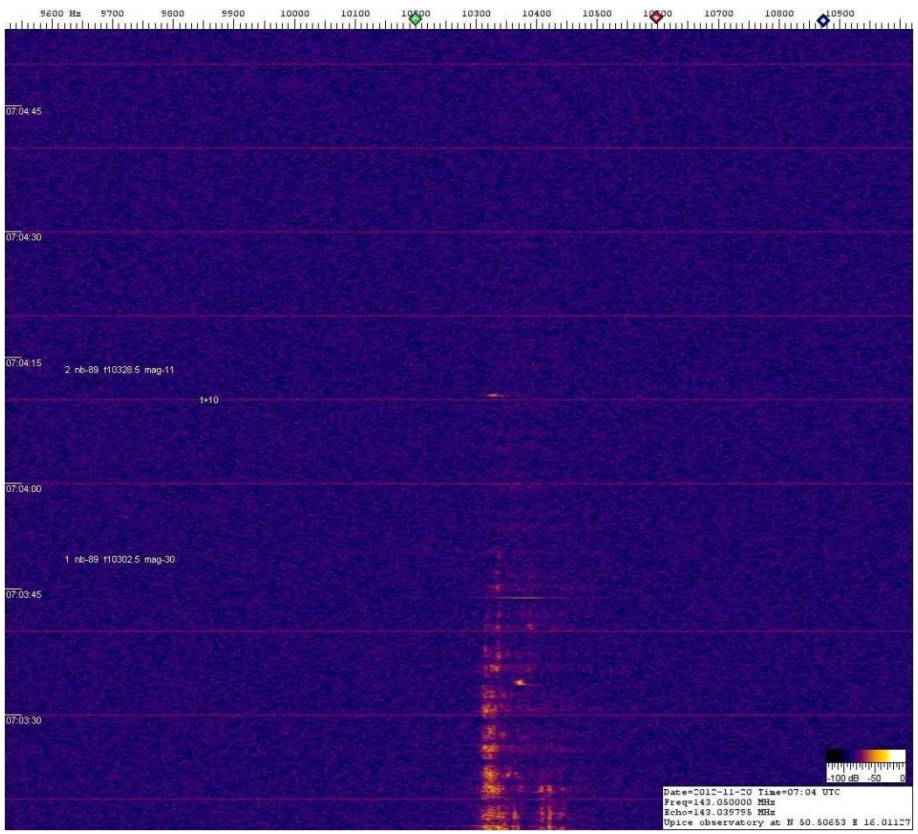


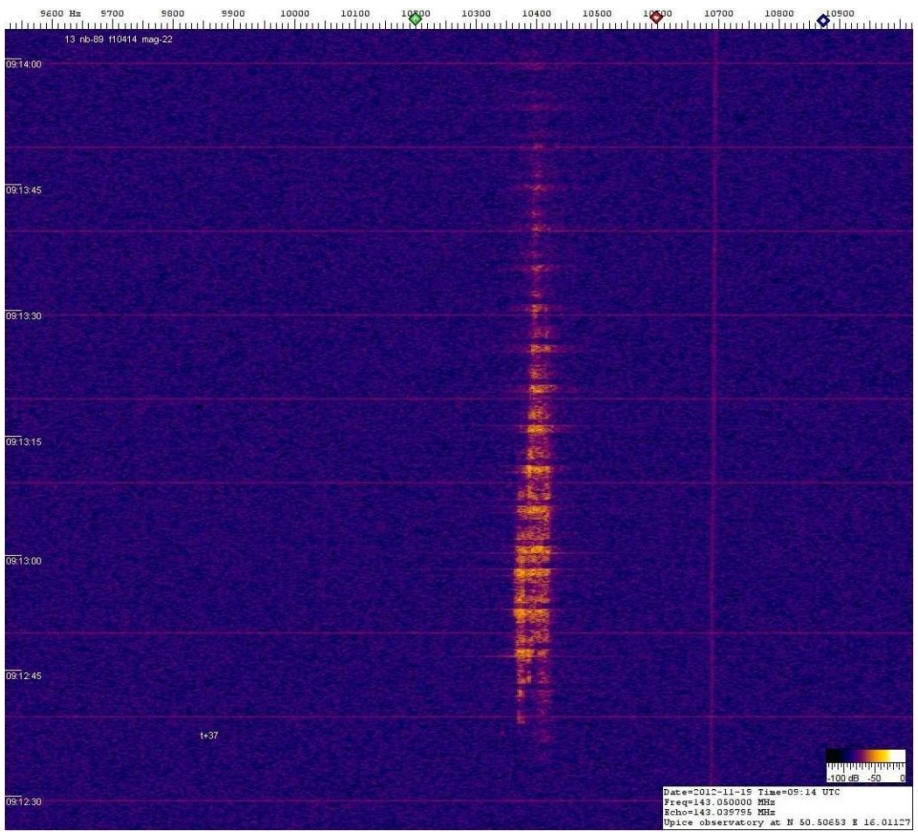



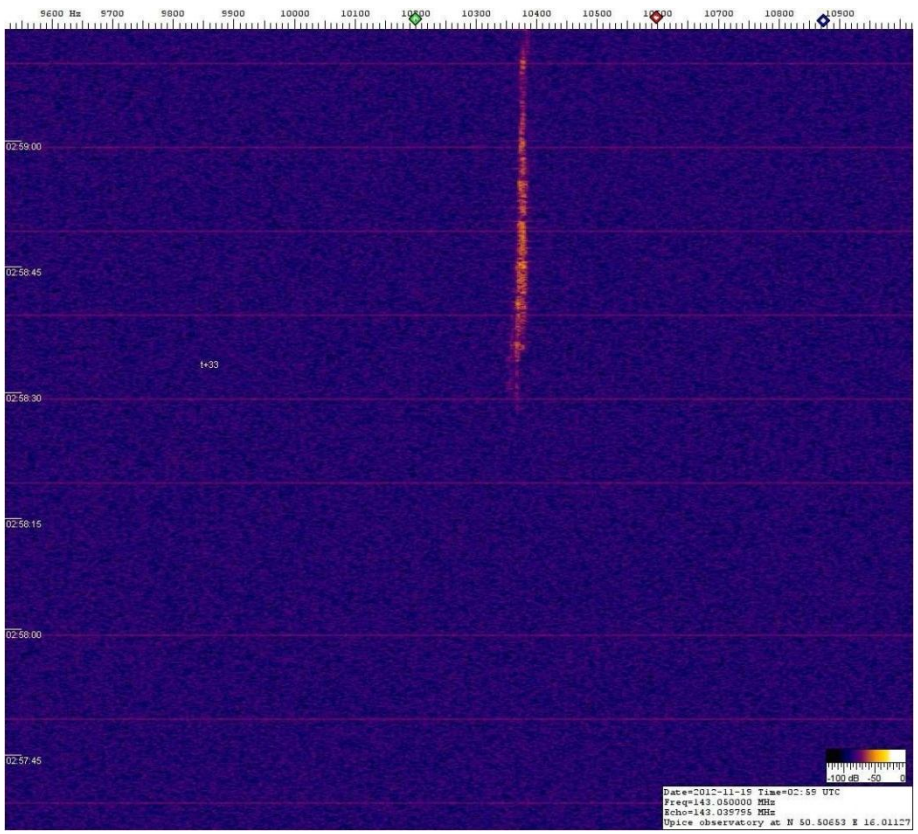

9600 Hz 9700 9800 9900 10000 10100 10200 10300 10400 10500 10600 10700 10800 10900
04:00:15
04:00:00
Last hour= 39
03:59:45
39 nb-89 f10755.6 mag-15
03:59:30
03:59:15
03:59:00
t+48
03:58:45
-100 dB -50 0
Date=2012-11-13 Time=04:00 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127

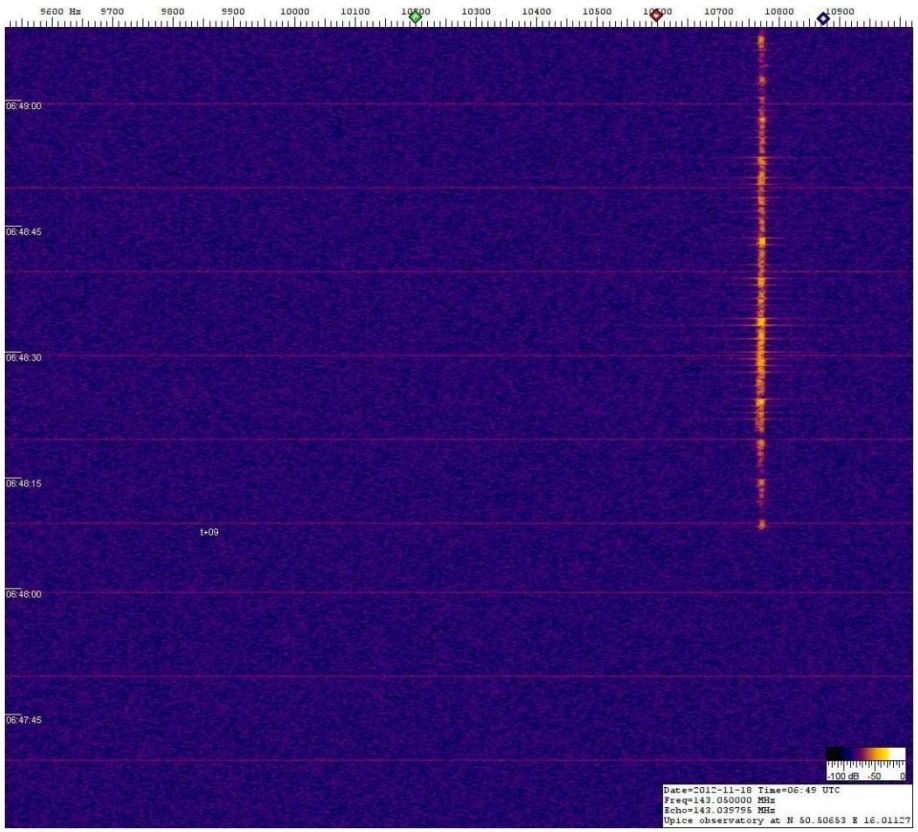

9600 Hz 9700 9800 9900 10000 10100 10200 10300 10400 10500 10600 10700 10800 10900
02:47:00
35 nb-89 f10352.7 mag-4
02:46:45
t+41
02:46:30
02:46:15
34 nb-91 f10360.2 mag0
t+05
02:46:00
33 nb-89 f10366.8 mag-18
02:45:45
02:45:30
t+27
-100 dB -50 0
Date=2012-11-20 Time=02:47 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127

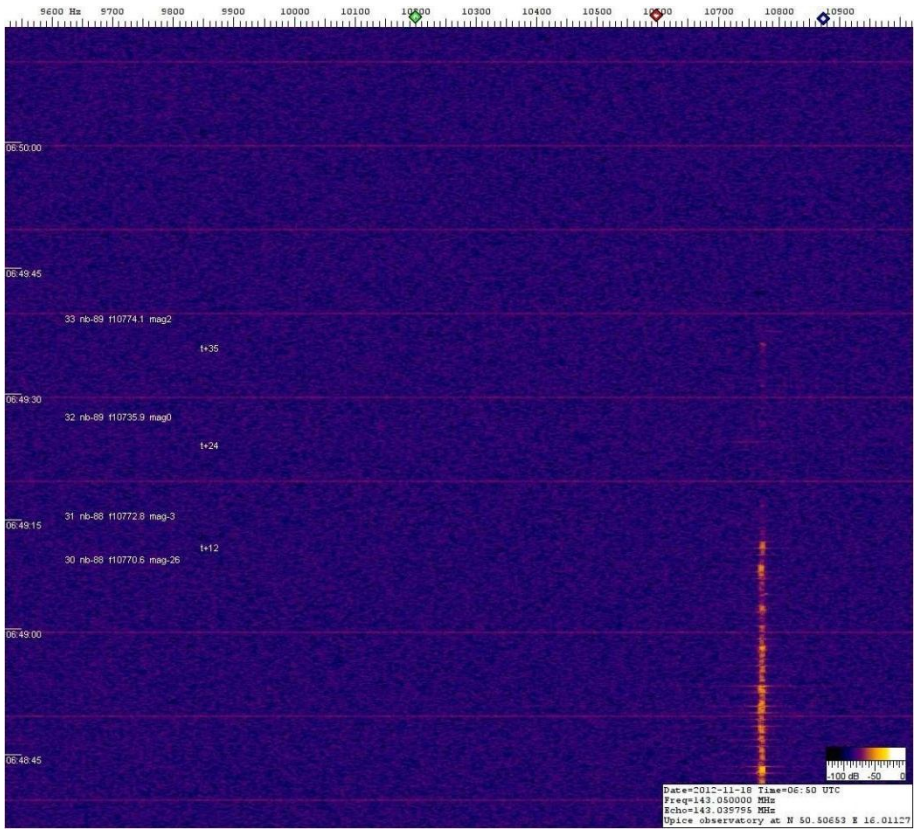

9600 Hz 9700 9800 9900 10000 10100 10200 10300 10400 10500 10600 10700 10800 10900
07:03:45
07:03:30
07:03:15
07:03:00
07:02:45
07:02:30
07:02:15
t+53
-100 dB -50 0
Date=2012-11-20 Time=07:03 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127

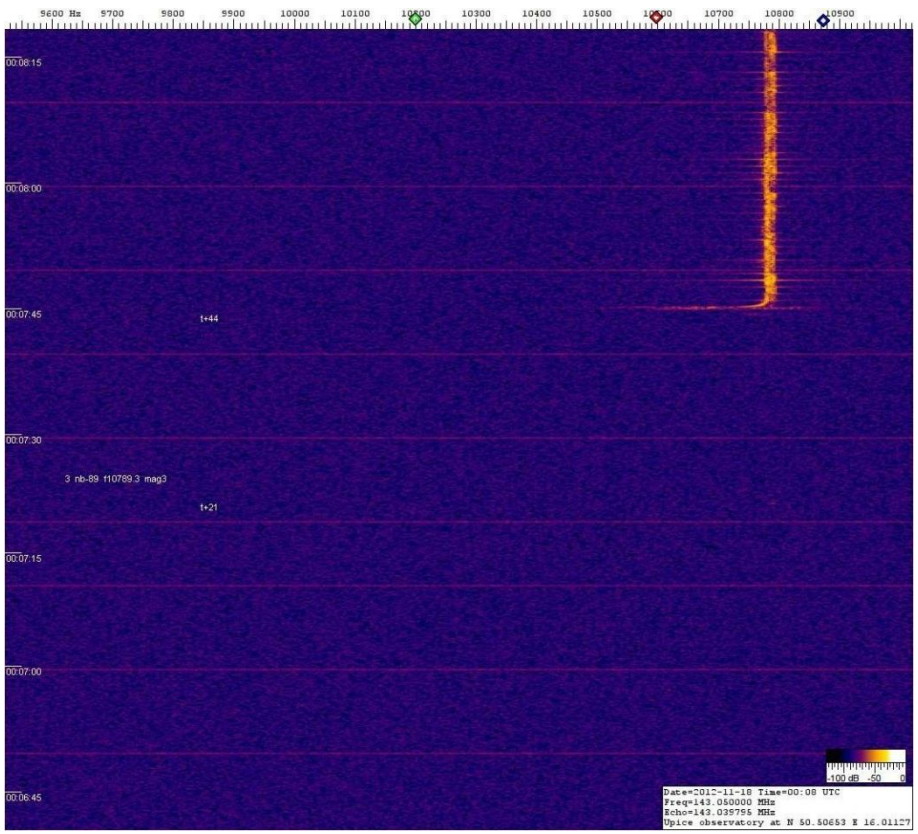

9600 Hz 9700 9800 9900 10000 10100 10200 10300 10400 10500 10600 10700 10800 10900
07:04:45
07:04:30
07:04:15
07:04:00
07:03:45
07:03:30
2 nb-89 f10328.5 mag-11
t+10
1 nb-89 f10302.5 mag-30
-100 dB -50 0
Date=2012-11-20 Time=07:04 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127

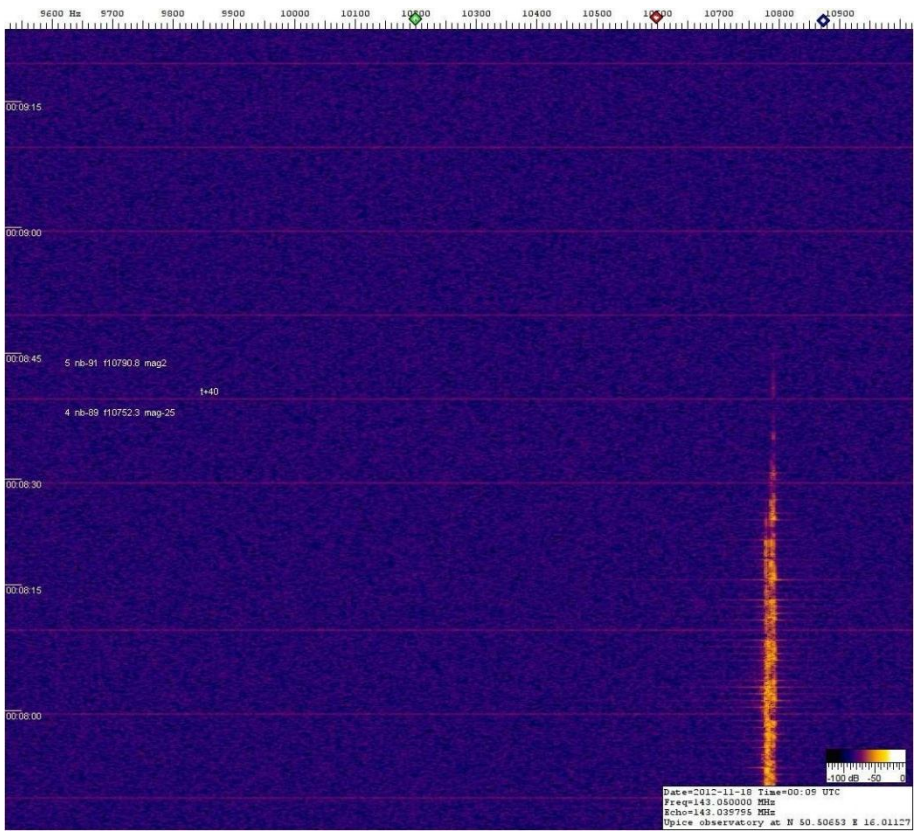

9600 Hz 9700 9800 9900 10000 10100 10200 10300 10400 10500 10600 10700 10800 10900
13 nb-89 f10414 mag-22
09:14:00
09:13:45
09:13:30
09:13:15
09:13:00
09:12:45
09:12:30
t+37
-100 dB -50 0
Date=2012-11-18 Time=05:14 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127

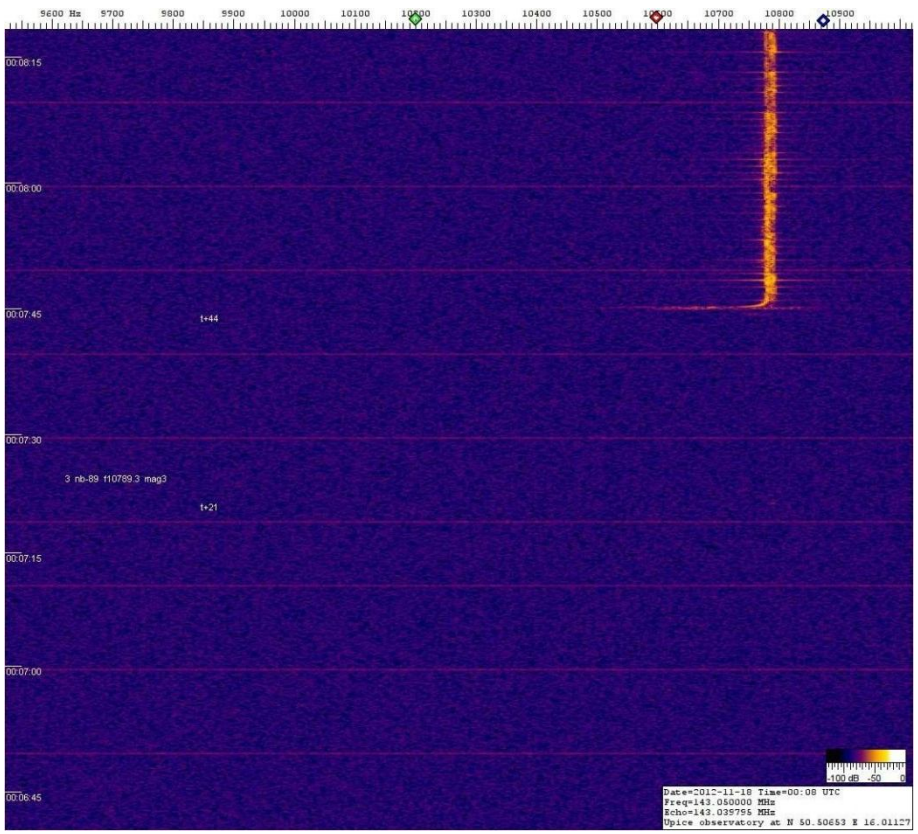

9600 Hz 9700 9800 9900 10000 10100 10200 10300 10400 10500 10600 10700 10800 10900
02:59:00
02:58:45
02:58:30
02:58:15
02:58:00
02:57:45
t+33
-100 dB -50 0
Date=2012-11-18 Time=02:59 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127

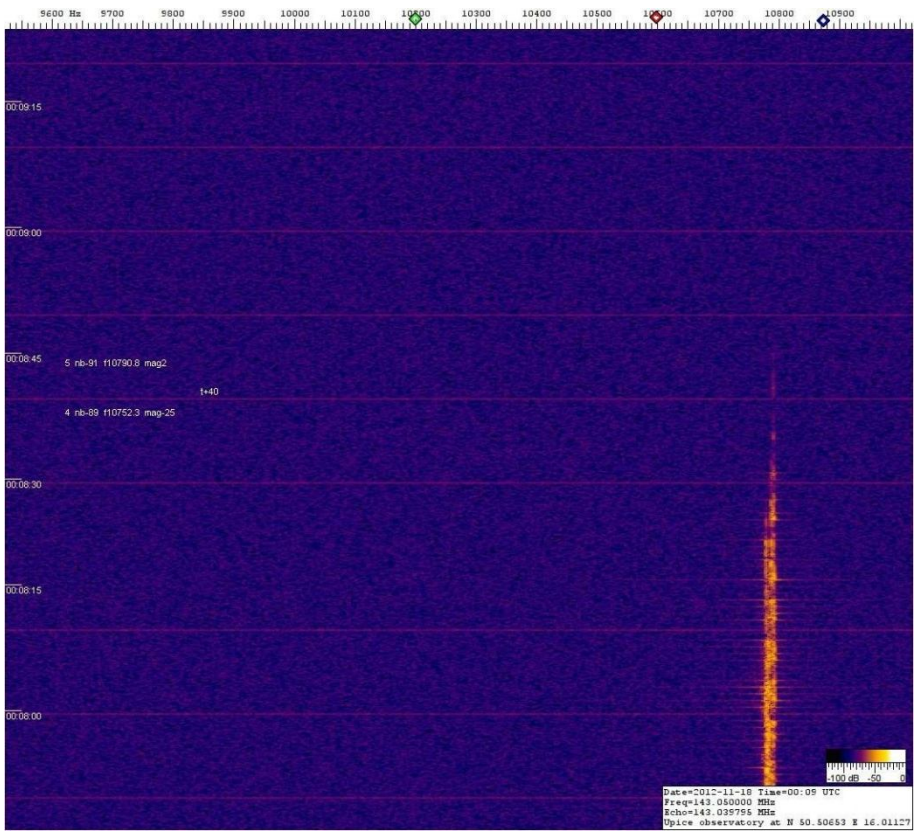

9600 Hz 9700 9800 9900 10000 10100 10200 10300 10400 10500 10600 10700 10800 10900
06:49:00
06:48:45
06:48:30
06:48:15
t+09
06:48:00
06:47:45
-100 dB -50 0
Date=2012-11-18 Time=06:49 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127


9600 Hz 9700 9800 9900 10000 10100 10200 10300 10400 10500 10600 10700 10800 10900
06:50:00
06:49:45
33 nb-89 f10774.1 mag2
t+35
06:49:30
32 nb-89 f10735.9 mag0
t+24
31 nb-88 f10772.8 mag-3
06:49:15
t+12
30 nb-88 f10770.6 mag-26
06:49:00
06:48:45
-100 dB -50 0
Date=2012-11-18 Time=06:50 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127


9600 Hz
9700
9800
9900
10000
10100
10200
10300
10400
10500
10600
10700
10800
10900
00:08:15
00:08:00
00:07:45
t+44
00:07:30
3 nb-89 f10789.3 mag3
t+21
00:07:15
00:07:00
00:06:45
-100 dB -50 0
Date=2012-11-18 Time=00:08 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127


9600 Hz
9700
9800
9900
10000
10100
10200
10300
10400
10500
10600
10700
10800
10900
00:09:15
00:09:00
00:08:45
5 nb-91 f10790.8 mag2
t+40
4 nb-89 f10752.3 mag-25
00:08:30
00:08:15
00:08:00
-100 dB -50 0
Date=2012-11-18 Time=00:09 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127


9600 Hz
9700
9800
9900
10000
10100
10200
10300
10400
10500
10600
10700
10800
10900
00:08:15
00:08:00
00:07:45
t+44
00:07:30
3 nb-89 f10789.3 mag3
t+21
00:07:15
00:07:00
00:06:45
-100 dB -50 0
Date=2012-11-18 Time=00:08 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127


9600 Hz
9700
9800
9900
10000
10100
10200
10300
10400
10500
10600
10700
10800
10900
00:09:15
00:09:00
00:08:45
5 nb-91 f10790.8 mag2
t+40
4 nb-89 f10752.3 mag-25
00:08:30
00:08:15
00:08:00
-100 dB -50 0
Date=2012-11-18 Time=00:09 UTC
Freq=143.050000 MHz
Echo=143.039795 MHz
Upice observatory at N 50.50653 E 16.01127

# Co plánujeme do budoucnosti?

V současné době máme přesnost času +- 1μs, pokud uděláme vzorkování A/D převodníku 1MHz dostaneme nepřesnost určení dráhy v prostoru do 300m.

Pokud použijeme lepší GPS modul s přesností +- 15ns a zvýšíme vzorkování A/D převodníku a dostaneme se na nepřesnost určení dráhy v prostoru do 5m.

Co potřebujeme: alespoň dvě dvojice vysílačů na kmitočtu kolem 50MHz a 150MHz a větší množství stanic po celém Česku a Slovensku.

Co ještě potřebujeme: Někoho kdo kdo napíše program na zpracování pořízených dat.

Co očekáváme : Doplnění bolidové sítě naše data budou nepřetržitá.

Co to přinese : Nové poznatky o kterých zatím nevíme.

Co na nás může čekat: Studium jevů při letu těles velmi vysokou rychlostí v plynech