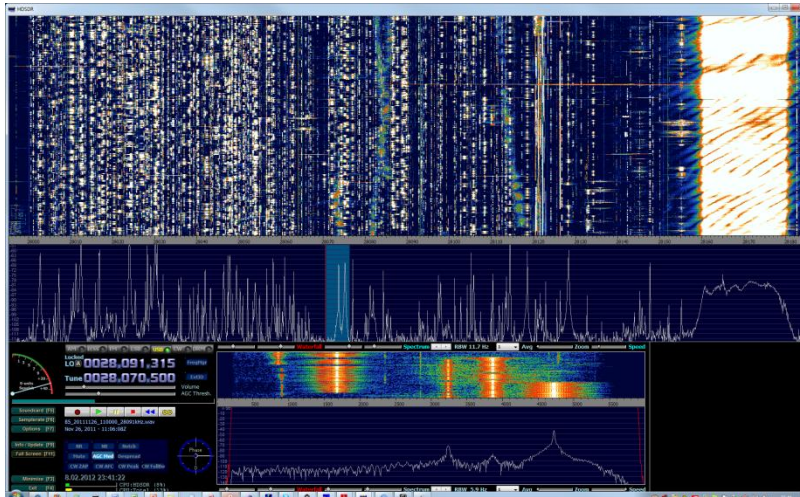


# SDR raadioamatööri praktikas - olevik ja tulevik



Viljo Allik  
ES5PC

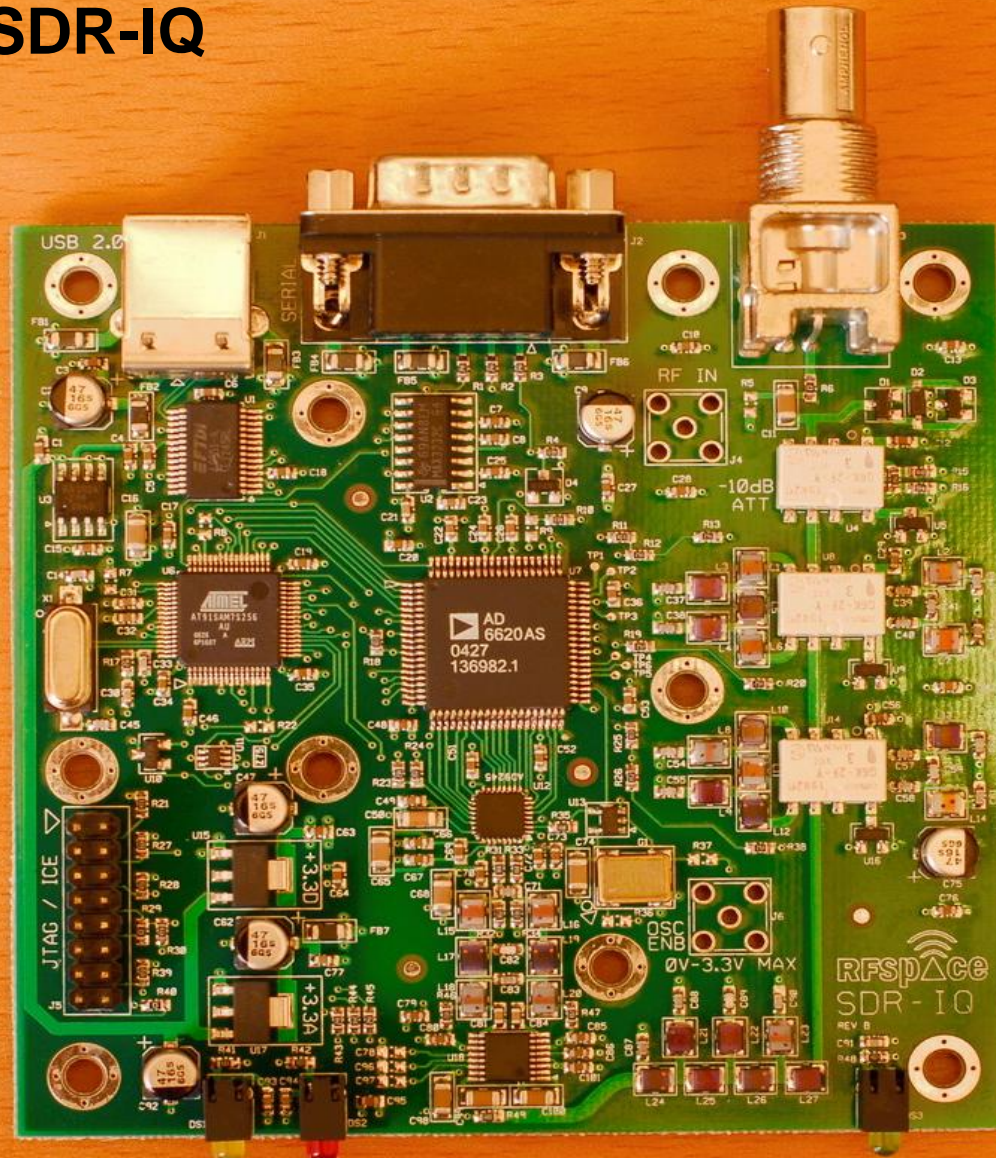
ERAÜ  
Talvepäev  
2012

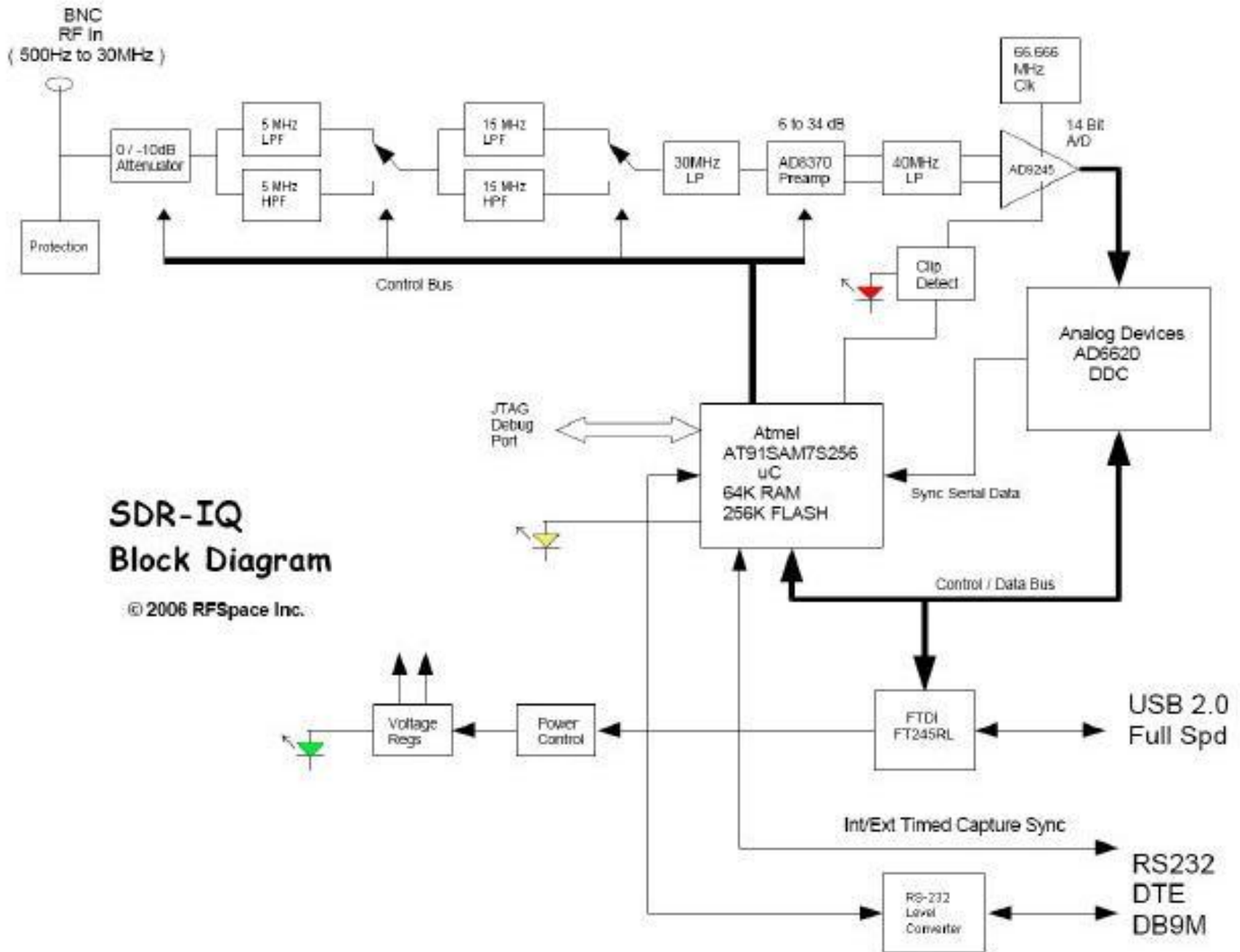


# History

- SDR-IQ direct sampling SDR was made available by RFSPace Inc. in 2006
- Relatively cheap, but still high performance SDR (14 bits, 500Hz-30MHz)
- A separate downconverter was built for VHF/UHF/SHF operation (144 to 27 MHz)
- Good software support (wideband recording, CW skimmer, MAP65-IQ)
- Used as a very efficient tool for wideband spectrum monitoring in my remote operated station over several years
- Still in use for terrestrial and EME on VHF/UHF/and MW bands

# SDR-IQ







# QS1R

- QS1R RevD 10kHz to 62.5 MHz receiver with up to 2 MHz bandwidth, designed by Philip Covington, N8VB
- Direct sampling at 125 MHz, 16 bits -> 96 dB input dynamic range, no input bandpass filters
- Initial signal processing done by powerful FPGA
- DAC Audio output for minimum latency
- Windows/OSX/Linux software available, very good software support
- Skim up to 7 Ham bands at once with [CW Skimmer Server!](#)
- Save I/Q baseband data on up to 7 bands simultaneously using Skimmer server + CWSL software!



SRL QS1R REVD  
DIRECT SAMPLING RECEIVER

PWR CLIP  
[Yellow LED] [Red LED]

RF IN  
[SMA Connector]

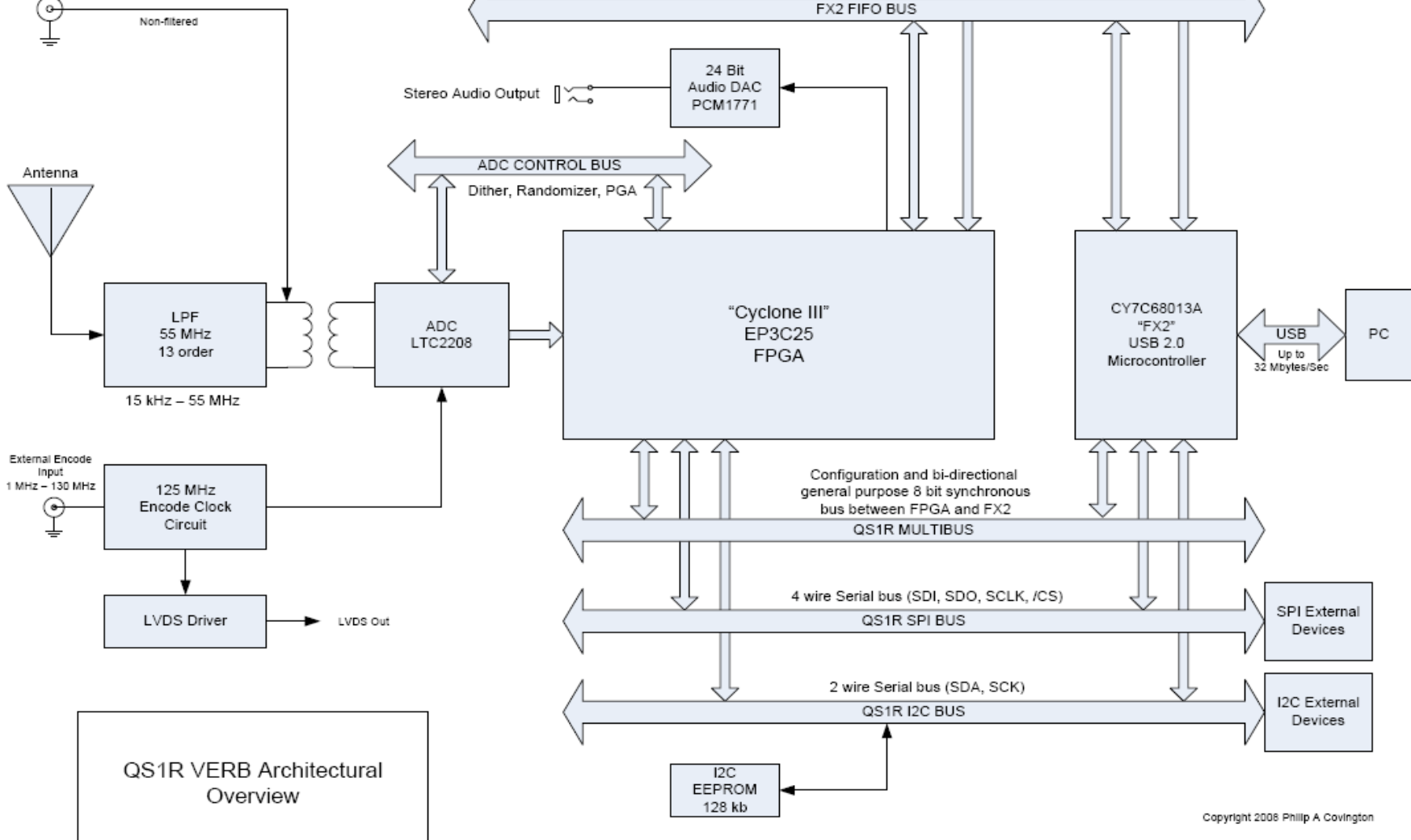
CLK IN  
[SMA Connector]

# QS1R Specifications

- Frequency Coverage: 10 kHz – 62 MHz
- Modes: LSB, USB, CW, AM, SAM, FMN, FMW
- Sensitivity: 0.56  $\mu$ V SSB (S+N)/N= 10 dB
- Selectivity: > 120 dB
- Image Rejection: 90 dB
- Input IP3 >42 dBm
- Dynamic Range: 101 dB (SSB, 2.4 kHz BW) 104 dB (CW, 500 Hz BW)
- SFDR: 112 dB BDR: 126 dB (CW, 500 Hz BW)
- MDS: -121 dBm (500 Hz BW)
- Input ADC Clipping Level: +9 dBm ( 8 mW )
- Audio DAC: TI 24 bit stereo, 50 kSPS
- Interface: USB 2.0 High Speed ( typ. 32 MB/S Max )
- Sampling Rates (kSPS): 25, 50, 125, 250, 500, 625, 1250, 1562, 2500
- Output Bandwidth (kHz): 20, 40, 100, 200, 400, 500, 1000, 1250, 2000
- Output Signal: 32 bit/sample I-Q pair



15 kHz – 300 MHz  
Direct Input





# Typical applications for amateur radio

- Local or remote wideband receiver using SDRMAX, Winrad, HDSDR, etc... CAT control of ordinary transceivers available
- CW skimmer server for local use or feeding the Reverse Beacon Network (RBN) via RBN Aggregator software
- Recording up to 7 amateur bands simultaneously during major SW contests using CW Skimmer and CWSL software
- Monitoring and recording other signals (satellites, VLF, digital modes etc...)
- Measurements

# RBN

- RBN stands for **R**everse **B**eacon **N**etwork
- Instead of beacons actively transmitting signals, the RBN is a network of stations listening to the bands and reporting what stations they hear, when and how well
- RBN can be reached as a web page at:  
<http://www.reversebeacon.net>
- RBN can also be reached via telnet as a regular packet cluster node: telnet.reversebeacon.net:7000
- RBN design is based on the [www.dxwatch.com](http://www.dxwatch.com) web DX-cluster

# REVERSE BEACON NETWORK

welcome main dx spots skimmers downloads about contact us



160m / 80m / 40m / 30m / 20m / 17m / 15m / 12m / 10m / 6m / 2m /  
 world wide / zoom to US / zoom to Europe / zoom to North Atlantic

show/hide my last filters

no filter selected, showing all spots

rows to show: 100

search spot by callsign

de	dx	freq	cq/dx	snr	speed	time
ES5PC	UA4YA/P	14013.0	CQ	52 dB	25 wpm	1039z 10 Feb
LA5EKA	UA4YA/P	14013.1	CQ	32 dB	25 wpm	1039z 10 Feb
TF3Y	UA4YA/P	14013.0	CQ	14 dB	24 wpm	1039z 10 Feb
HA6PX	UA4YA/P	14013.0	CQ	23 dB	25 wpm	1039z 10 Feb
DL8LAS	UA4YA/P	14013.1	CQ	36 dB	25 wpm	1039z 10 Feb
OL5Q	UA4YA/P	14013.0	CQ	24 dB	24 wpm	1039z 10 Feb

options:

[show/hide](#)

news

[RBN blog: stay tuned!](#)

we have 67 skimmers online

we have 134 visitors online

skimmers online:

- 7Z1SJ - 20m
- AB1HL - 40m
- DJ3AK - 2m
- DJ4DI - 40m
- DJ9IE - 40m
- DK8NE - 6m
- DK8NE-1 -
- DK9IP - 20m,30m,40m,15m
- DL0LBS -
- DL2CC -
- 10m,20m,30m,40m,17m,12m,15m
- DL8LAS -
- 40m,12m,10m,20m,15m,30m
- EK6IZ - 20m,30m,40m,17m,15m
- ES5PC - 10m,20m,40m,15m
- G4HSO -
- 10m,20m,30m,40m,17m,12m,15m
- G4HYG - 40m
- GW8IZR -
- 10m,20m,30m,40m,17m,15m
- HA6PX -
- 10m,20m,30m,40m,17m,15m
- IK0XBX -
- IK3STG - 10m,20m,30m,40m,15m
- JA4ZRK - 20m,80m,40m
- JG1VGX - 80m,40m

# ES5PC CW Skimmer setup in KO38hj

- Antenna: 80 m horizontal delta-loop

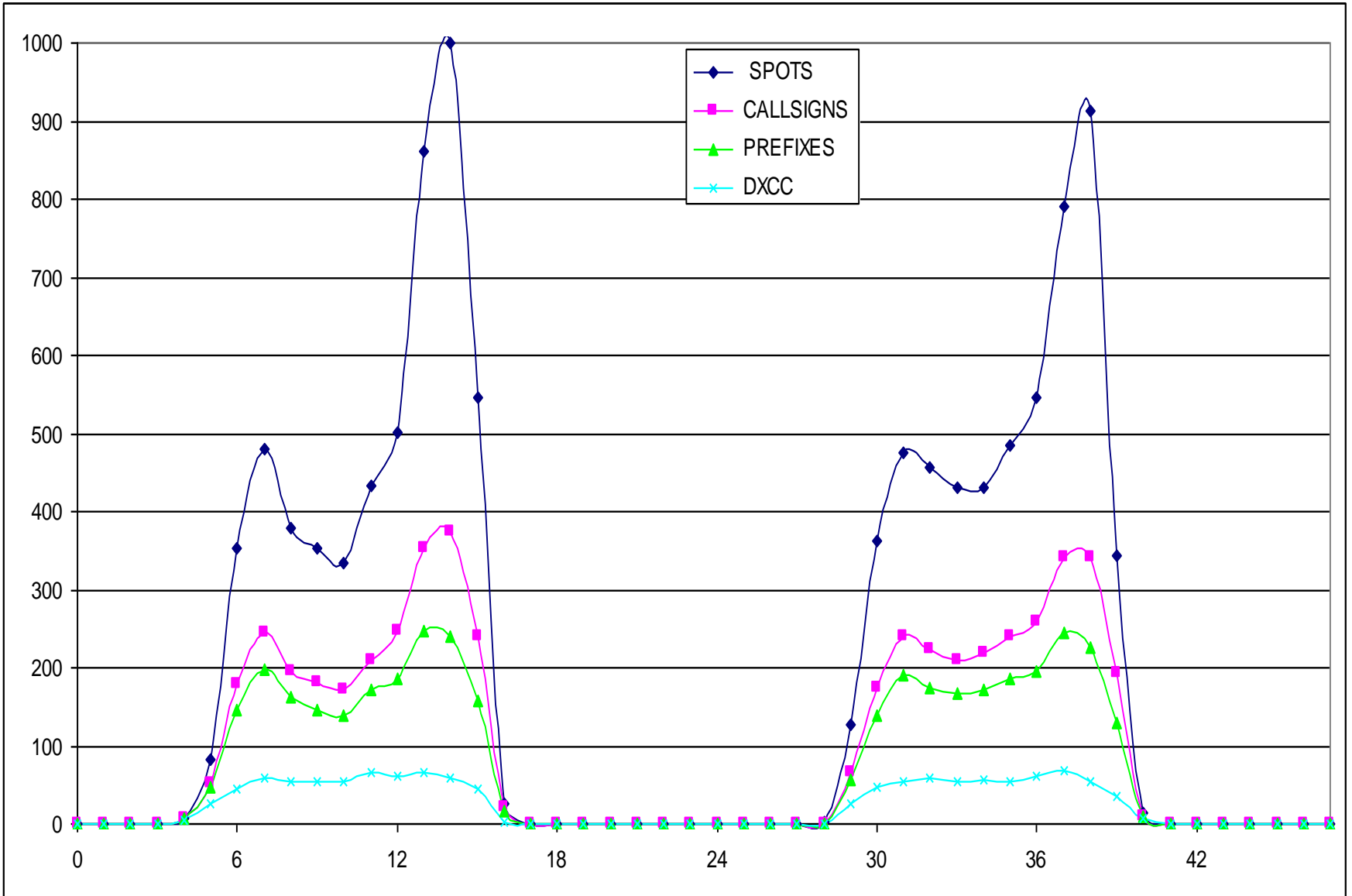


- Receiver: QS1R with preamplifier (sometimes)
- PC: Intel Core i5 750 @ 2.66 GHz, 8GB RAM

# Skimmer statistics from ES5PC skimmer during CQWW CW 2011

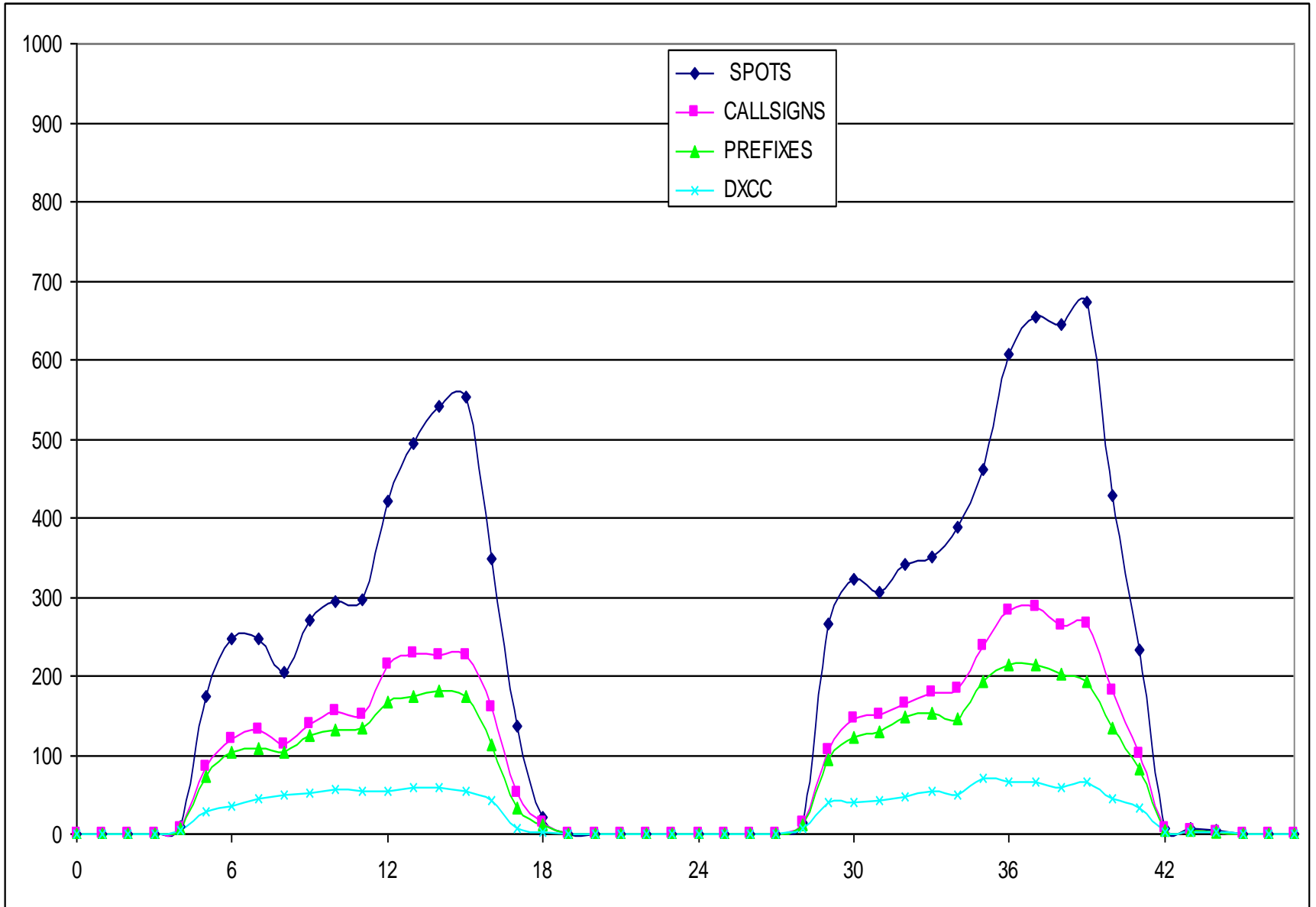
WHOLE LOG	SPOTS	CALLSIGNS	PREFIXES	DXCC
160m	5915	507	309	51
80m	10184	1025	511	78
40m	17371	1306	628	103
20m	9781	1187	619	102
15m	9973	1204	618	118
10m	10733	1288	655	124
TOTAL	63957	3047	1012	151

# 10 m

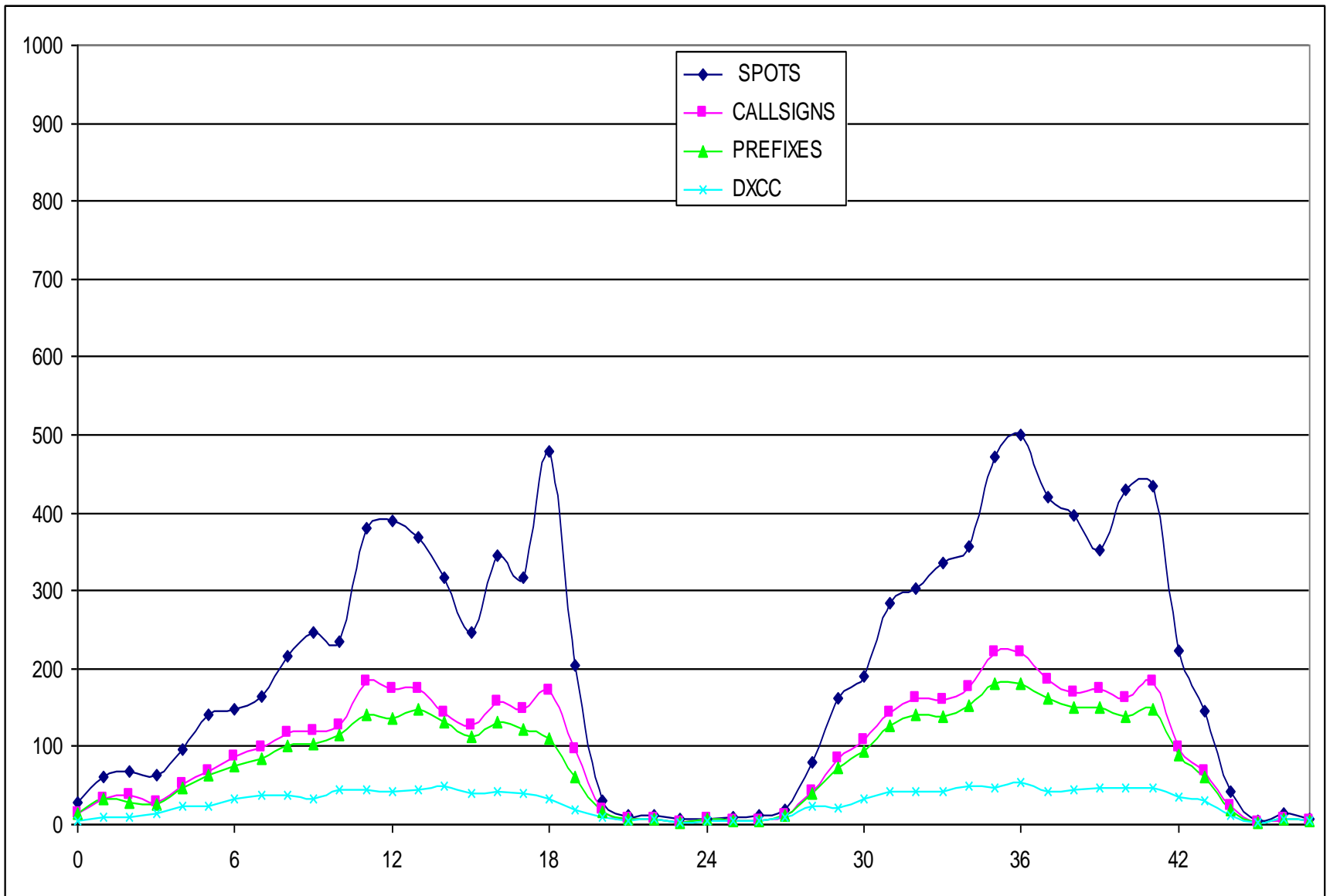




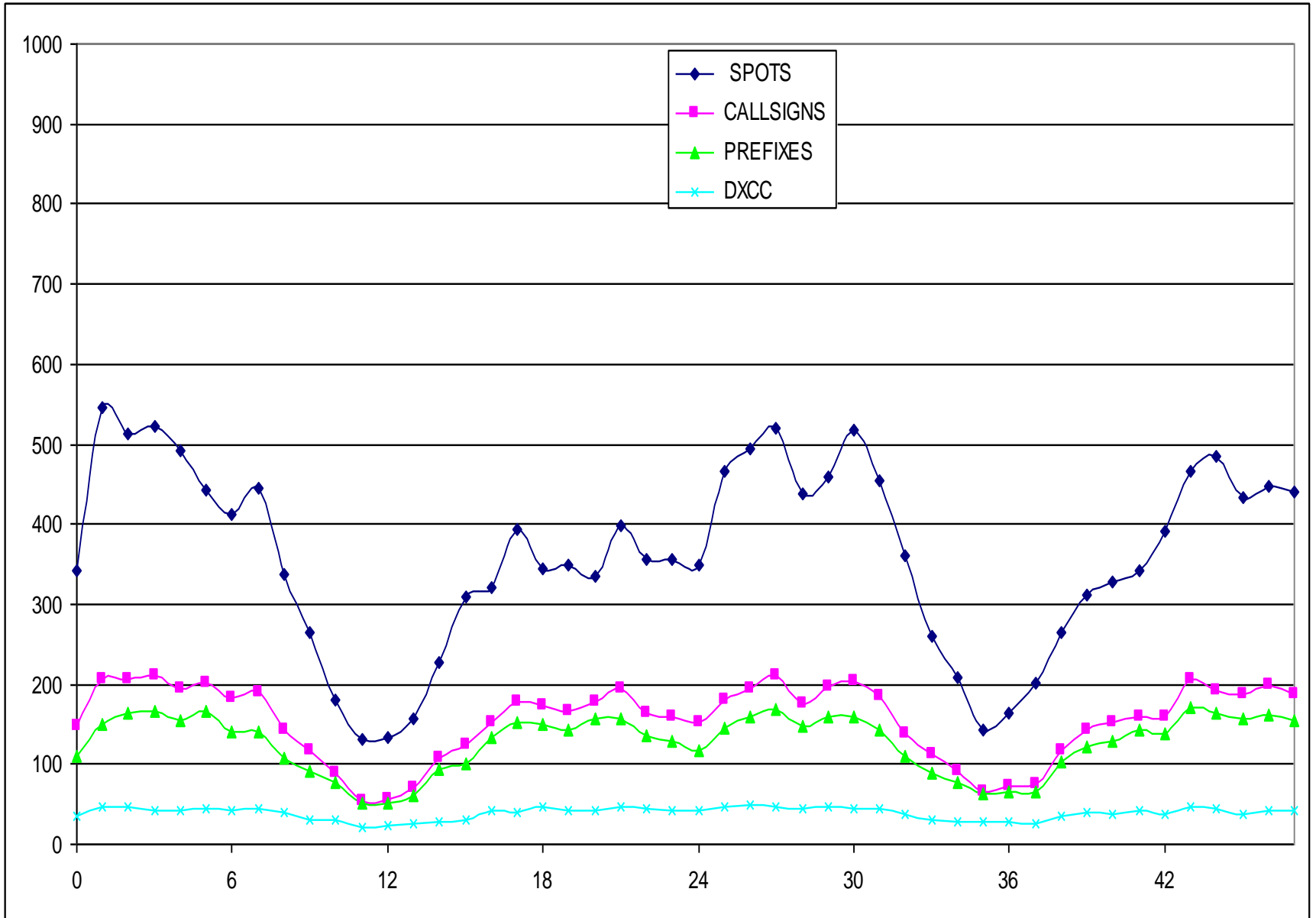
# 15 m



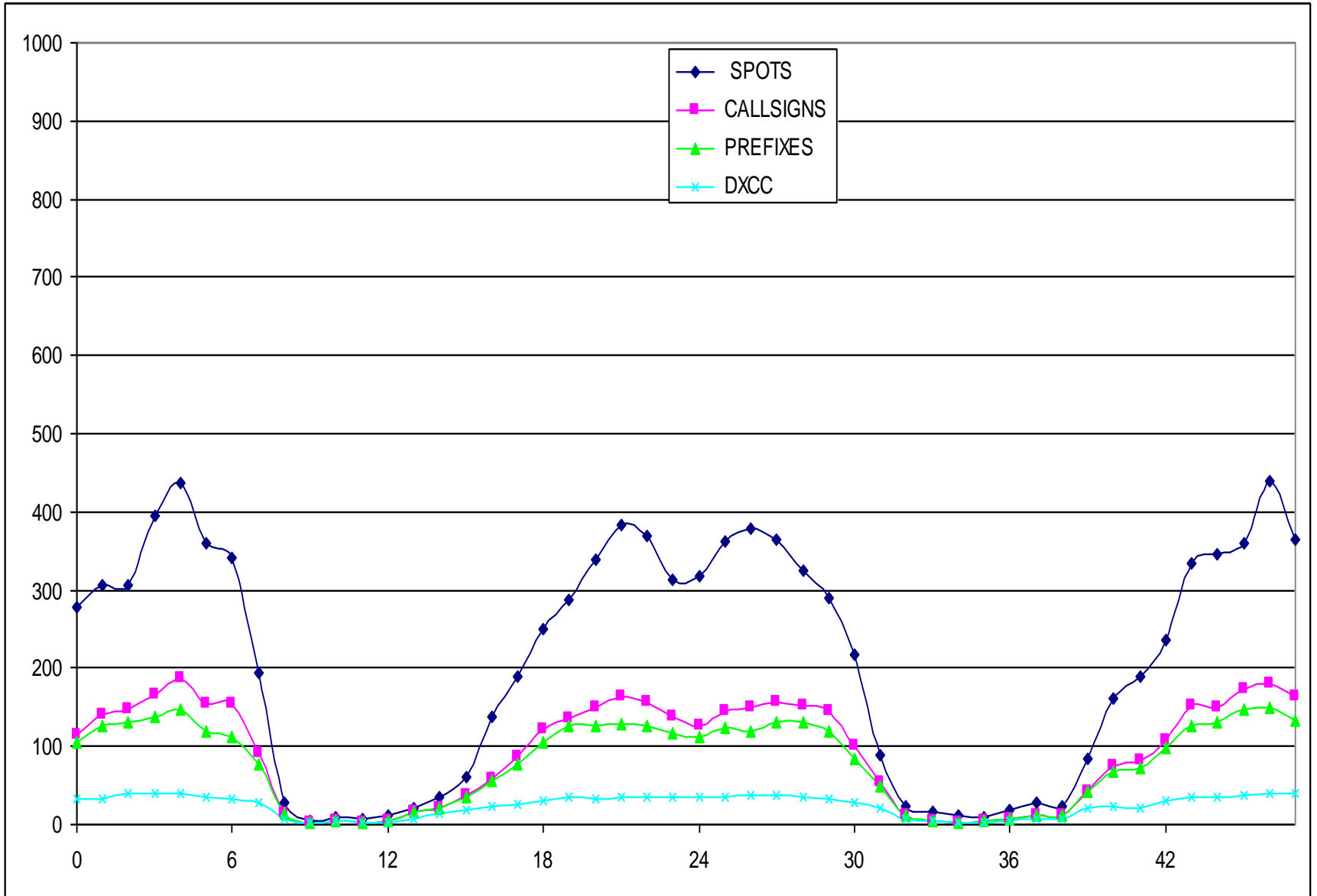
# 20 m



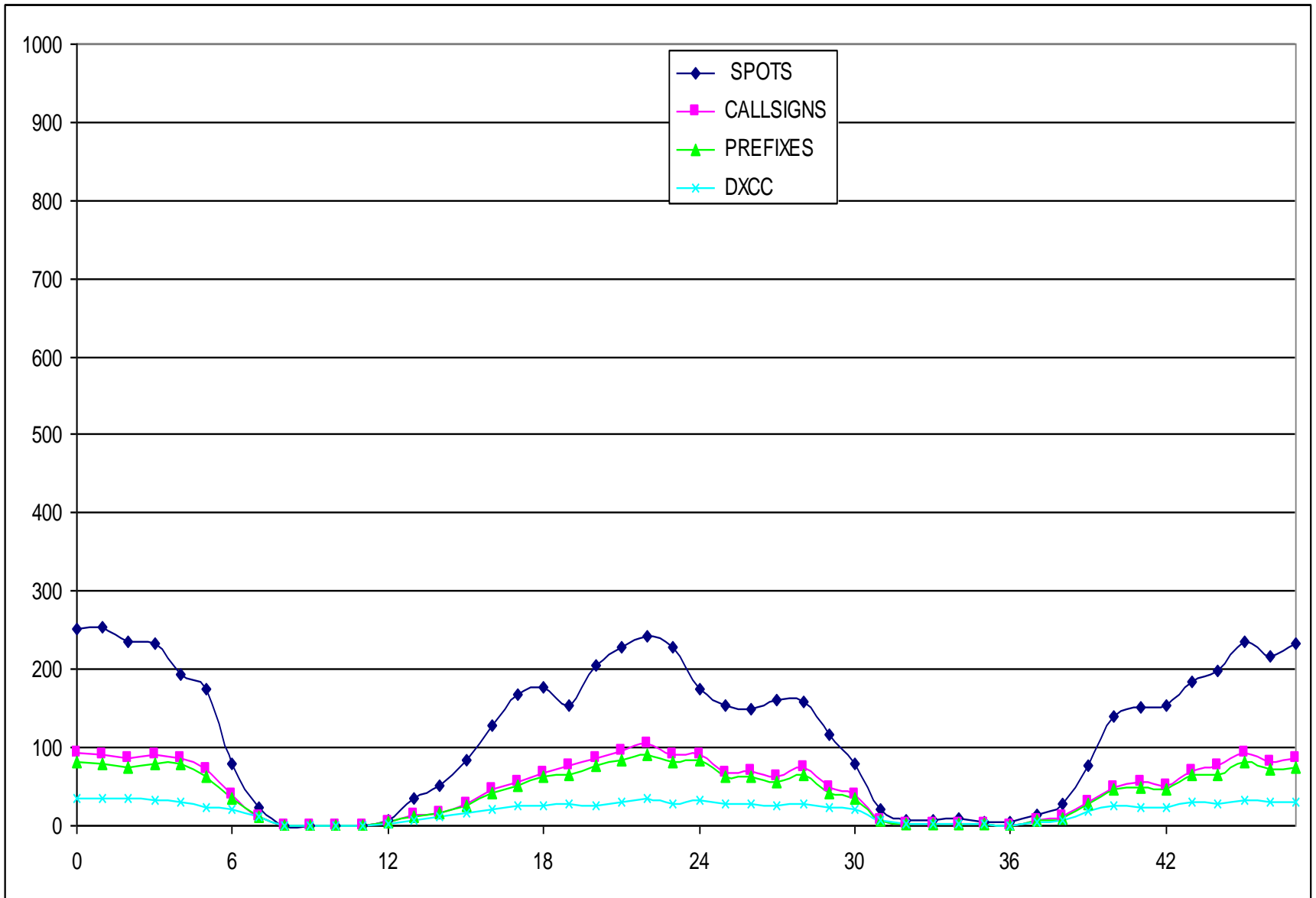
# 40 m



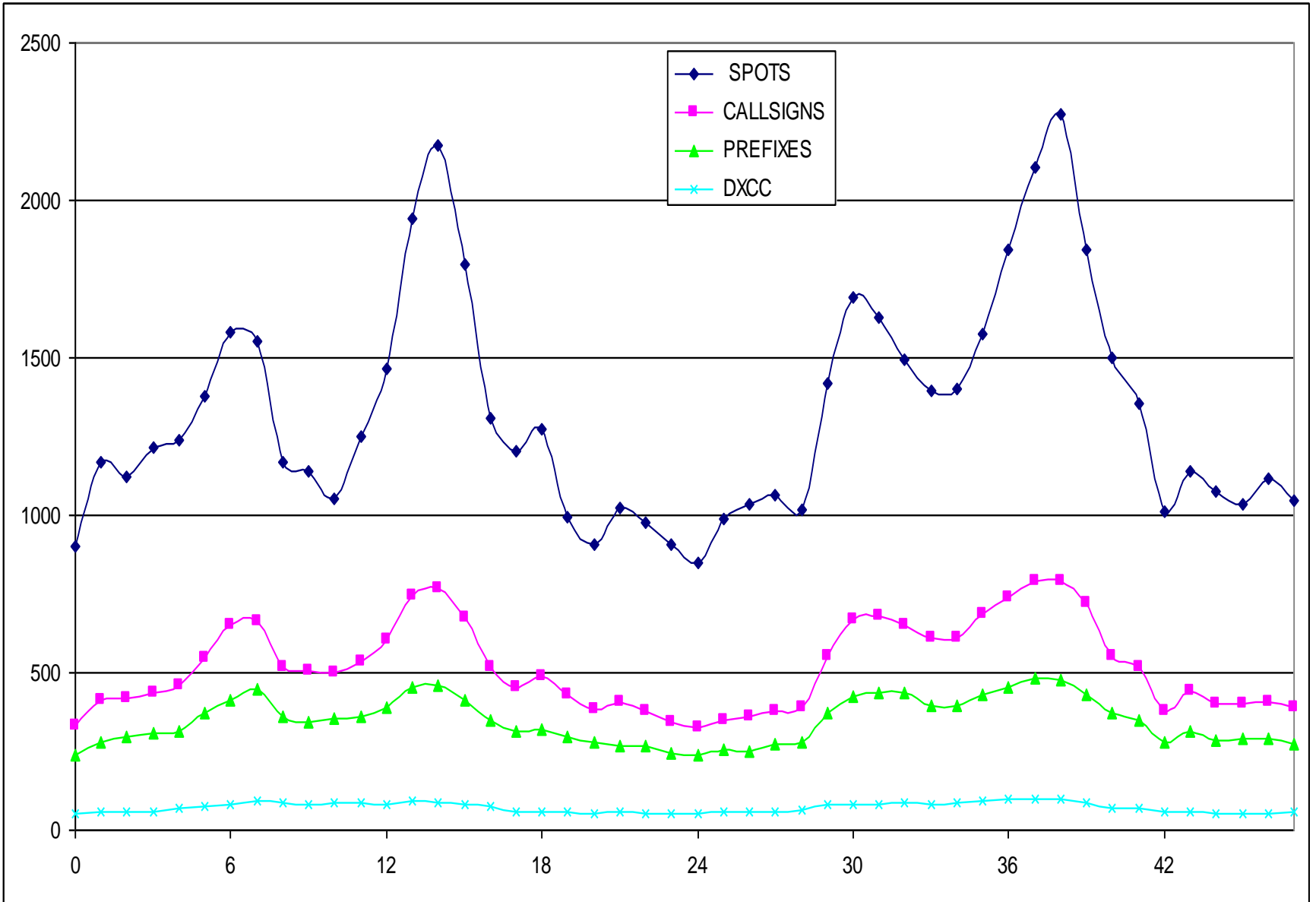
# 80 m



# 160 m

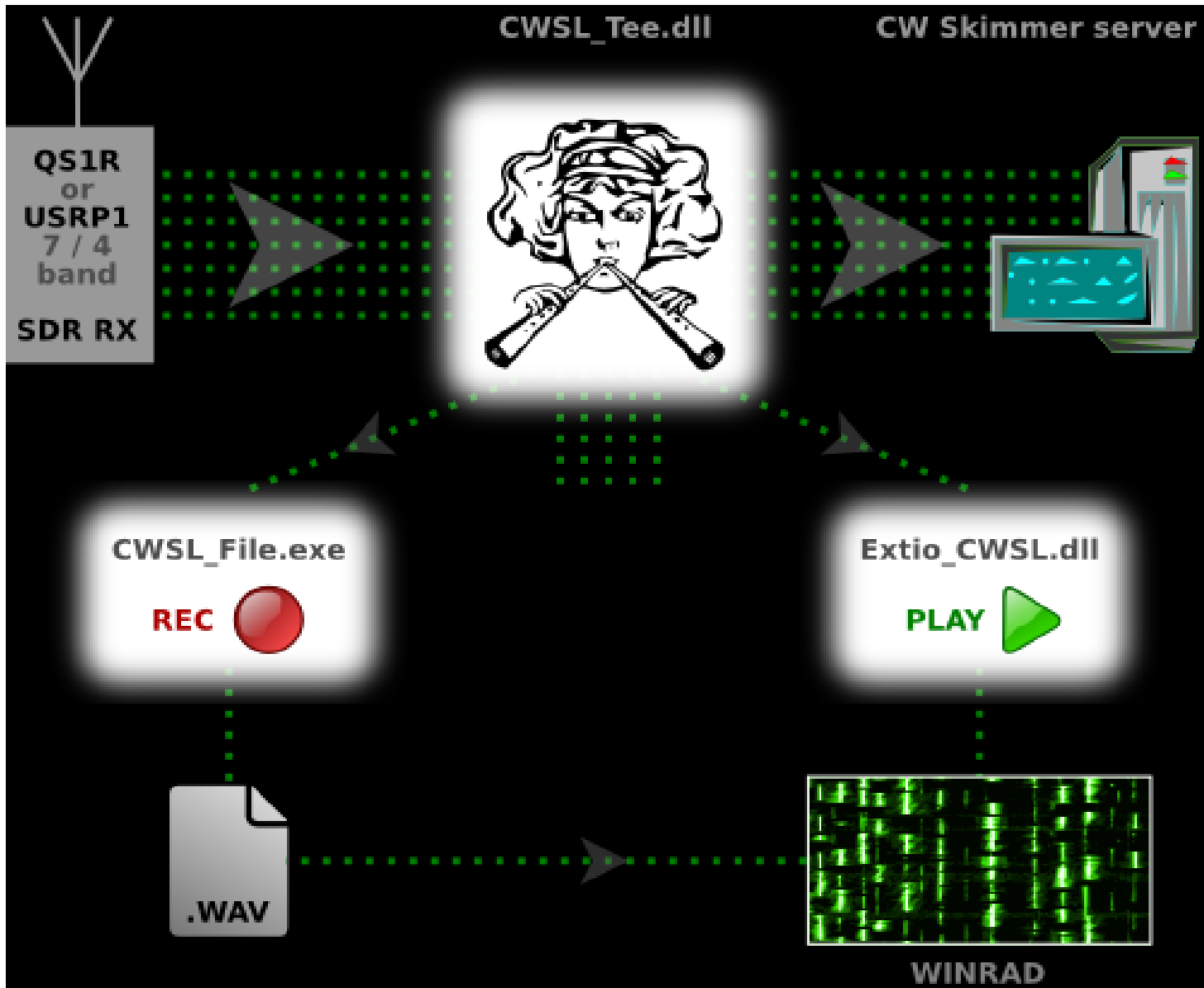


# Total





# CW Skimmer listener (CWSL)



# CW Skimmer listener (CWSL)

- Replicates the data stream between SDR and CW skimmer and makes it available for other applications
- Has a separate recording utility for automatic recording of all active bands from CW Skimmer
- Has a driver DLL for Winrad and HDSDR software for real-time monitoring of individual bands from CW Skimmer
- Recording and real time monitoring can be active at the same time
- Requires a lot of HDD space for continuous recording on 6 bands:  $6 \times 2.7 \times 48 = 777.6$  GBytes!
- Recordings used by ES5TV for checking the contest logs

# SDR in Moonbounce (EME) operation

- For weak signal operation SDR waterfall display is a very useful tool to detect active stations and determine their operating frequencies
- It is often possible to distinguish if the station is calling CQ or if the QSO is in progress
- Easy to see if a new station shows up and starts to call
- Easy to find an empty frequency for calling CQ
- Very good measurement instrument for measuring receiver performance (Sun noise, Moon noise, ground noise)
- Signal recording tool

27.010

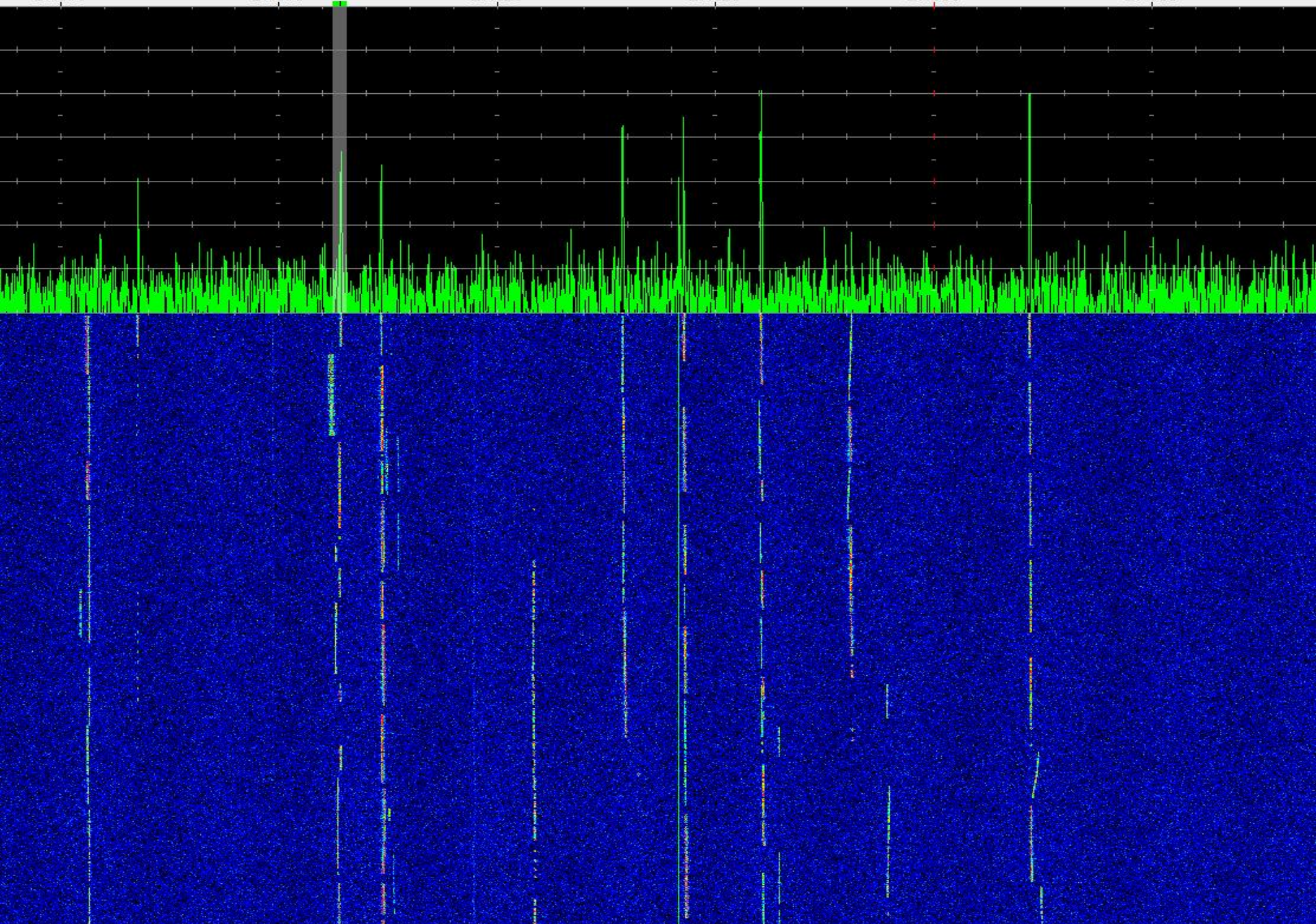
27.015

27.020

27.025

27.030

27.035





# SDR and JT65 EME

- MAP65 = Skimmer for JT65 EME
- MAP65-IQ software supports now SDR-IQ receiver via Linrad software
- Implements simultaneous decoding of all JT65 EME signals in one band
- Made by K1JT
- With dual polarization antenna and dual SDR setup it is possible to see the polarization angle for all decoded signals
- A list of stations received can be automatically uploaded to a web page: <http://www.livecq.eu>
- Very good possibility to check your EME station performance and EME propagation

# MAP65-IQ typical output

UTC Date: 2010 Jul 14

-----

144.123	211	-2	0	0	0.2	0	3	-20	1533	DF5BN OH4LA KP20	1	0	6
144.123	211	0	0	0	-0.1	0	2	-20	1535	DF5BN OH4LA KP20	1	0	7
144.111	-92	0	0	0	1.4	0	1	-22	1539	73	0	0	0
144.134	485	0	0	0	1.4	0	2	-13	1539	R0	0	0	0
144.148	250	1	0	-1	-4.1	0	1	-27	1540	WJ2EXB 4G7APN PE12	1	0	4
144.125	16	0	-1	0	2.4	0	1	-25	1541	CQ PY2SRB GG48	1	10	3
144.134	482	0	0	0	1.4	0	1	-14	1541	73	0	0	0
144.125	16	-1	-1	0	2.4	0	1	-23	1543	CQ PY2SRB GG48	1	10	4
144.123	45	-2	0	0	2.2	0	4	-15	1547	DF5BN OH4LA KP20	1	0	6
144.123	42	1	0	0	2.5	0	1	-18	1549	DF5BN OH4LA KP20 000	1	0	6
144.132	-99	-1	-1	0	2.4	0	1	-25	1549	W1ICW K5DNL EM15	1	0	4
144.111	-182	-1	1	-1	2.7	0	1	-16	1551	SP4K PA3DOL JO22	1	0	3
144.123	42	0	0	0	1.4	0	3	-15	1551	RRR	0	0	0
144.132	-105	1	-1	0	2.3	0	2	-22	1551	W1ICW K5DNL EM15	1	0	4
144.111	-200	0	0	0	1.6	0	3	-16	1553	R0	0	0	0
144.113	90	0	1	1	2.0	0	3	-21	1553	F4EGA WA4EWV EM70	1	0	11
144.117	-64	1	-5	1	2.3	0	1	-22	1553	ES5PC AE3T FN20	1	0	5
144.123	45	0	0	0	1.6	0	1	-17	1553	73	0	0	0
144.123	222	0	0	0	2.1	0	1	-21	1553	73	0	0	0
144.132	-105	-1	0	0	2.3	0	2	-22	1553	W1ICW K5DNL EM15	1	0	4



# LiveCQ 144 432 1296

22:48

## All spots

Menu

- All spots
- Latest spots
- Who is online
- Add your CQ spot here
- User config
- Contest style
- Simple design all spots
- Mobile

Search

→

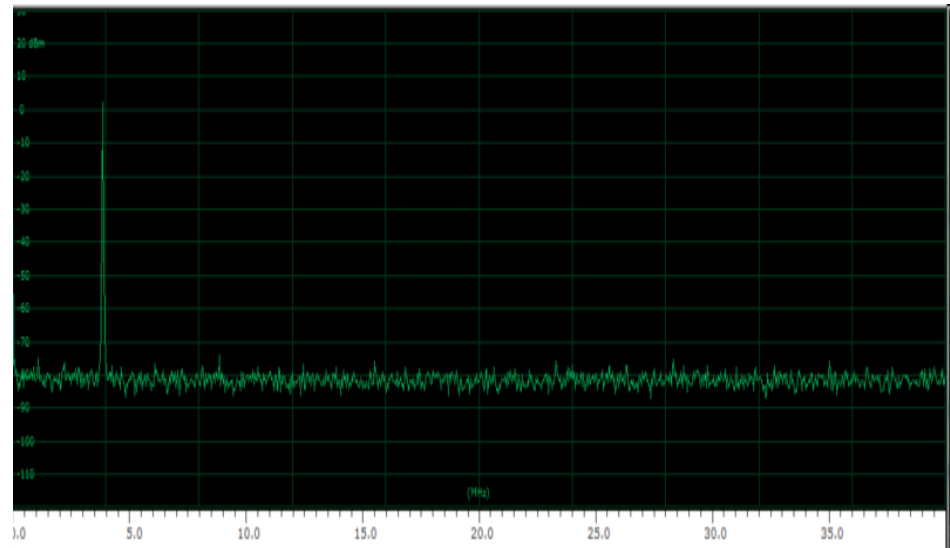
Spotters

- DK0KK
- DM1CG
- DP5G
- PA3FPQ
- PE1L

Freq	Time	Signal	DF	DT		Call	Loc	Pol	Spotter
144.110	2242	-25	+013			CQ HL5QO	PM45	0	DM1CG
144.115	2240	-19	- 253	2.6		CQ UA4LCF	LO44	172	DK0KK
144.115	2240	-19	+042	2.2		CQ UA4LCF	LO44	6	PE1L
144.115	2240	-23	+019	2.2		CQ UA4LCF	LO44	6	PA3FPQ
144.115	2238	-20	- 057			CQ UA4LCF	LO44	0	DM1CG
144.116	2247	-19	- 154	2.2		CQ DK1CO	JO63	126	DK0KK
144.116	2247	-19	+072			CQ DK1CO	JO63	90	DP5G
144.116	2247	-22	+117	1.9		CQ DK1CO	JO63	58	PA3FPQ
144.116	2247	-23	+041			CQ DK1CO	JO63	0	DM1CG
144.116	2247	-23	+143	1.9		CQ DK1CO	JO63	88	PE1L
144.120	2247	-18	+157	2.2		CQ OE3FVU	JN78	86	PE1L
144.120	2247	-22	- 138	2.4		CQ OE3FVU	JN78	77	DK0KK
144.120	2247	-23	+088			CQ OE3FVU	JN78	90	DP5G
144.120	2247	-24	+134	2.1		CQ OE3FVU	JN78	101	PA3FPQ
144.120	2245	-21	+058			CQ OE3FVU	JN78	0	DM1CG
144.122	2243	-25	- 198			CQ M0IKB	IO94	0	DM1CG
144.122	2243	-26	- 391	0.1		CQ M0IKB	IO94	18	DK0KK
144.142	2236	-18	+402	1.7		CQ IK2DDR	JN55	4	PE1L
144.142	2236	-19	+376	1.7		CQ IK2DDR	JN55	177	PA3FPQ

# Future

- SDR performance improvements
  - Better ADC-s & DAC-s
  - Dedicated digital downconverters (DDC-s)
  - FPGA-s with more processing power
  - Advanced interfaces (Thunderbolt, Gigabit+ LAN, Fiber optics)
- Transmit capability
  - (QS1E sub-module will be available soon for QS1R)



# QS1E

## Preliminary Information:

- Fits in the existing QS1R receiver enclosure.
- Interfaces to the QS1R through the J6, J8, and J25 expansion buses.
- Power output adjustable from -60 dBm to +3 dBm.
- All modes and bandwidth up to 20 kHz.
- CW, CW sidetone, and CW keyer generated locally on QS1E (no PC processing involved) for minimal latency.

# Role of the SDR in the ham shack in the future?

- Currently the SDR serves still as a complementary equipment in the shack
- Soon it will transform to the primary equipment in the shack
- Most of the SDR based systems will be remote operation ready

# Typical ham station of the future

