OH5KW
Timo Törö

OHDXF/CFF Cruise 2015

Software Defined Radio, the future?

Future

There is nothing new under the sun?

What is Radio?
How it was invented and developed

- The 1st milestone: Mathematics and Physics

Maxwell's Equations

1. $\frac{\nabla \times \underline{B}}{\mu} = \underline{j} + \frac{\partial}{\partial t}(\mathring{a}\underline{E})$

2. $\nabla \times \underline{E} = -\frac{\partial \underline{B}}{\partial t}$

3. $\nabla \underline{B} = 0$

4. $\nabla \underline{E} = \frac{\ell_c}{\mathring{a}}$

where $\underline{D} = \mathring{a}\underline{E}$ and $\underline{B} = \mu \underline{H}$

$\underline{B}$ is the magnetic induction. $\underline{E}$ is the electric field.

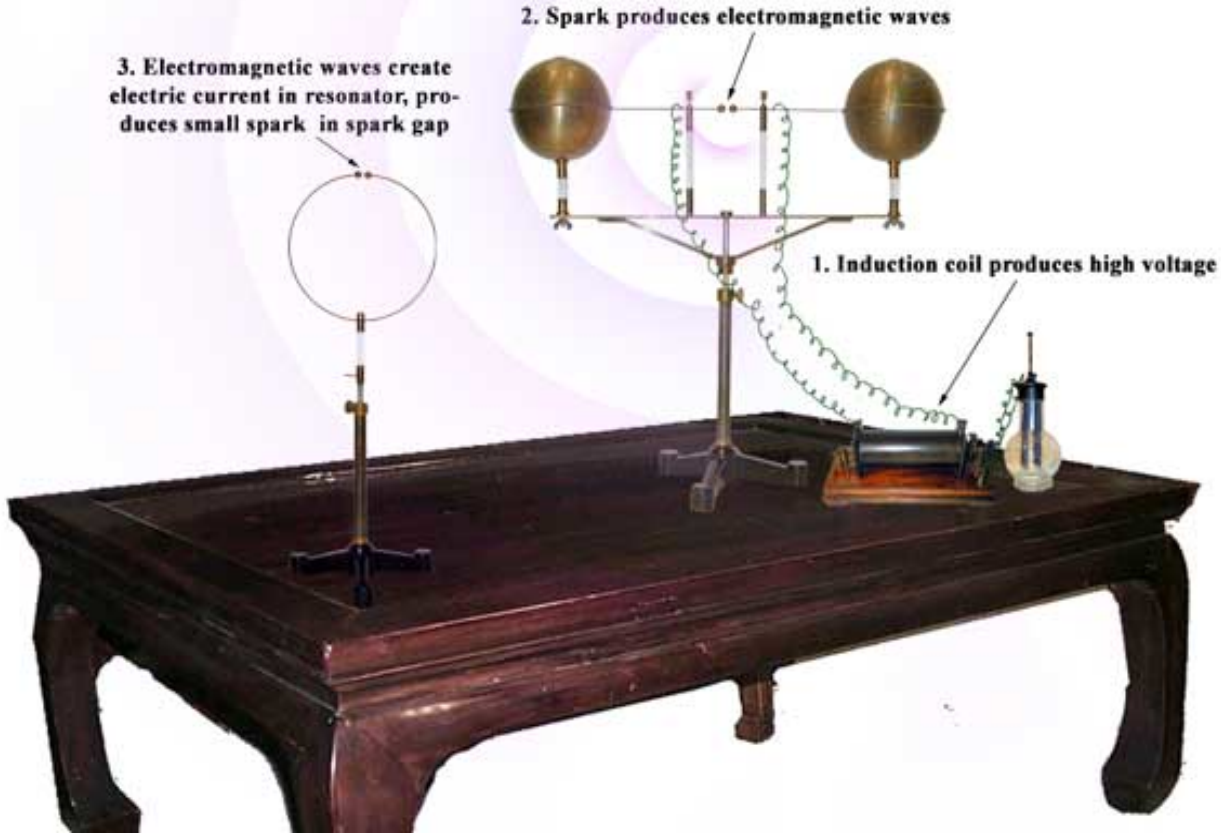
$\underline{D}$ is the electric displacement. $\underline{H}$ is the magnetic field.

$\underline{j}$ is the electric current. ℓ_c is the charge density.

μ and a are constants.

What is Radio?

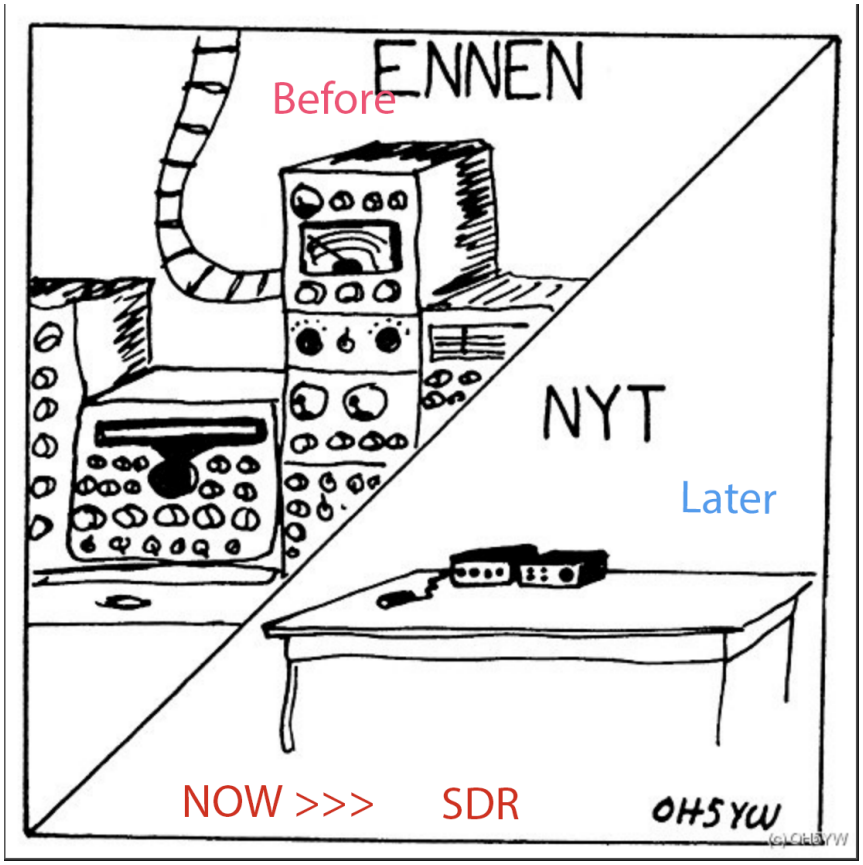
- The 2nd milestone: The theory proved by experiments. Hardware development starts.



What is Radio?

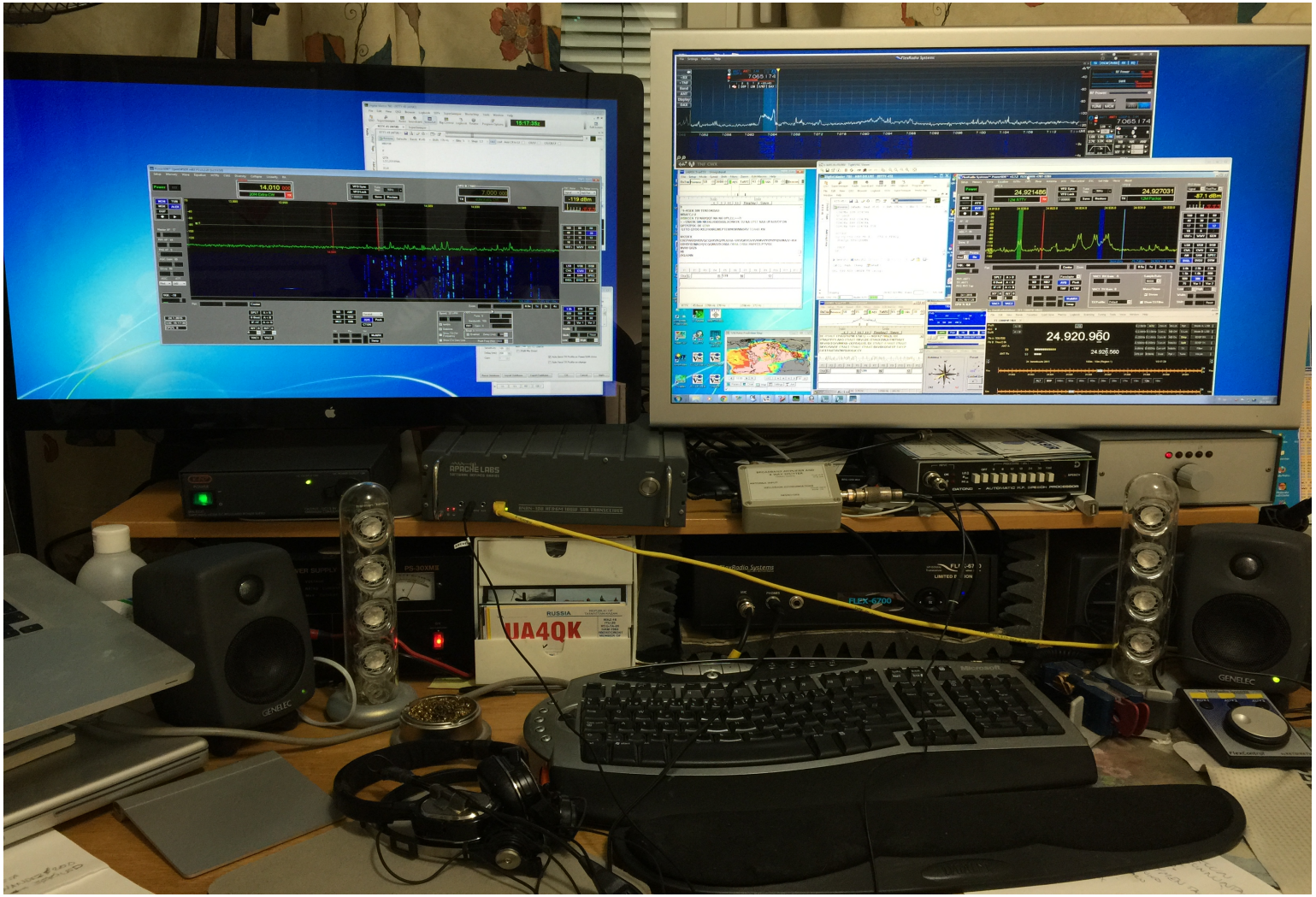
- The 3rd: Making Business. Radio for everyone.

My HAM Radio History



My HAM radio History

Testing ANAN 100 vs. Flex6700 & remote controlling OH5



History of Computers!

- Not really today

Computing Power Summary

Name	Year	Cost	# GFLOPS	Cost/GFLOP
Cray-1	1976	$5M	0.08 GFLOPS	$62m/GFLOP
Cray-2	1985	$17M	3.9 GFLOPS	$4.3M/GFLOP
Cray X1	2002	$2.5M	205 GFLOPS	$12K/GFLOP
Flex-6700	2012	$7K	121 GFLOPS	$57.84/GFLOP

Source: http://w8zpf.cboh.org/talks/2013-10+K8NQ+SDR+Flex.pdf

SDR radios, how good are they?

Receiver Test Data

Sorted by Third-Order Dynamic Range Narrow Spaced - or- ARRL RMDR (Reciprocal Mixing Dynamic Range) if Phase Noise Limited

Updated 9 December 2014 with Kenwood TS-590SG

Device Under Test	Noise Floor (dBm)	AGC Thrshld (uV)	dB	100kHz Blocking (dB)	Sensitivity (uV)	LO Noise (dBc/Hz)	Spacing kHz	Front End Selectivity	Filter Ultimate (dB)	Dynamic Range Wide Spaced (dB)	kHz
Added 9/29/14 FlexRadio Systems 6700 Hardware Updated	-118 -135[b2]	3.0 1.0[b2]	Var	A/D Limit	2.0 0.25[b2]	145 155	10 50	B Band Pass	115	99	20&
Added 10/02/12 Hilberling PT-8000A Hardware Rev 2.00	-128 -141[b]	5.4 1.0[b]	3	142	0.45 0.11[b]	144 149	10 50	A Trk Presel	100	105	20
Added 08/10/12 Elecraft KX3	-123 -138[b2]	12 1.3[b2]	3	138	0.9 0.09[b2]	144	10	B Band Pass	110	105	20
Added 12/01/10 Yaesu FTdx-5000D	-123 -135[b] -141[b1]	4.6 1.2[b] 0.33[b1]	3	127[s]	1.1 0.27[b] 0.13[b1]	135	10	B Band Pass	90[f]	104	20
Added 2/15/08 Elecraft K3	-130 -138[b]	2.1 0.6[b]	3	140[s]	0.33 0.19[b]	138	10	B Band Pass	105	104	20

Source: http://www.sherweng.com/table.html

WHY SDR?

- Multi-conversion a.k.a. Superhetrodyne 1928 – Legacy
  - Your car radio, your TV, any older scanner you have
  - Most every Kenwood, Icom, Ten-Tec, Elecraft and Yaesu on the market today

- Direct Conversion 2000 – Modern
  - FLEX-5000, FLEX-3000, FLEX1500, Elecraft KX3, Elad FDM-Duo

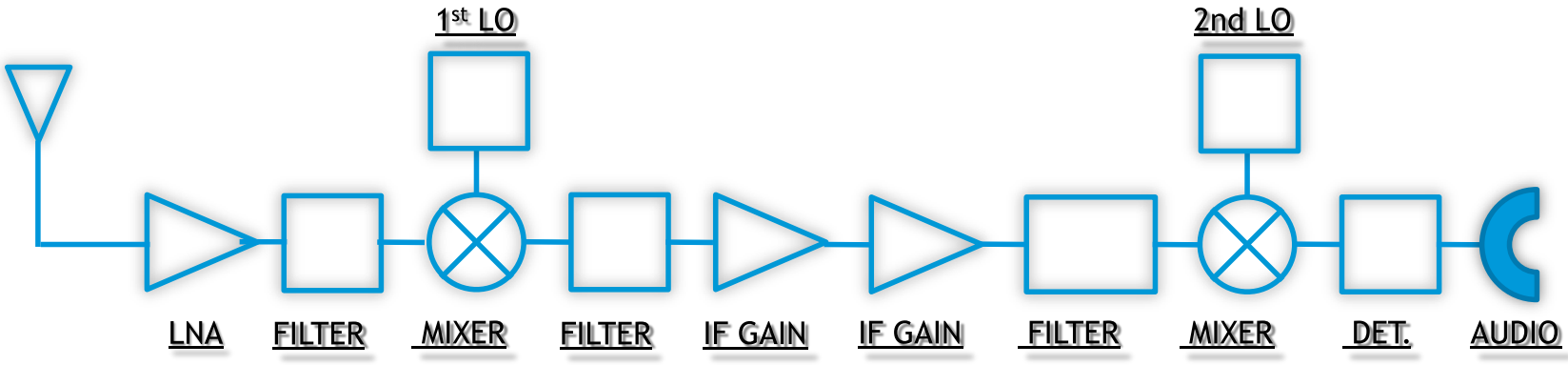
- Direct Sampling a.k.a wideband 2009 – Modern
  - FLEX-6000, HPSDR, ANAN-100, SUNSDR-2

Source:

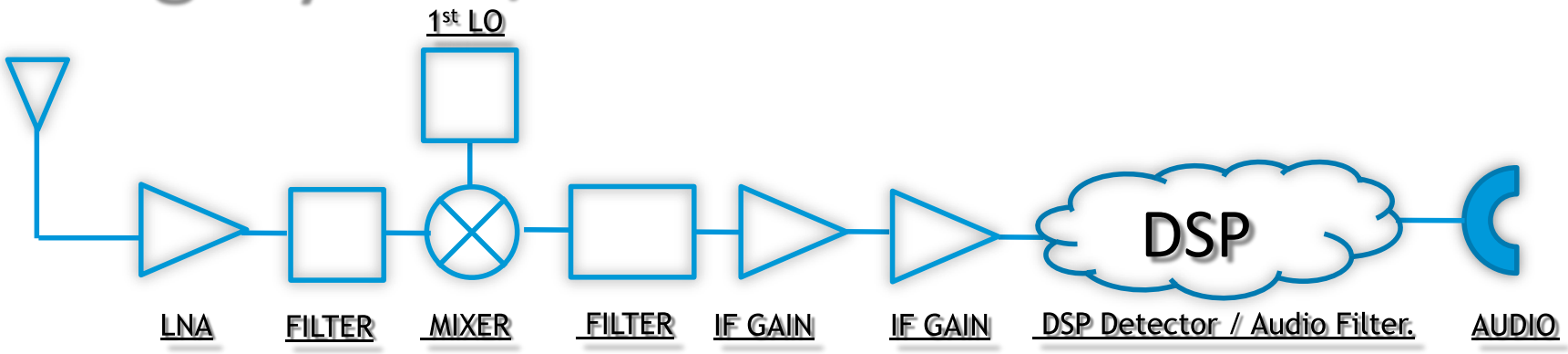
https://www.dropbox.com/s/d2yturid60npgdm/How%20to%20Build%20a%20Quiet%20Station%20V2.

Radio RF/IF Architecture

Multi-Stage HW Receiver Chain - 1928



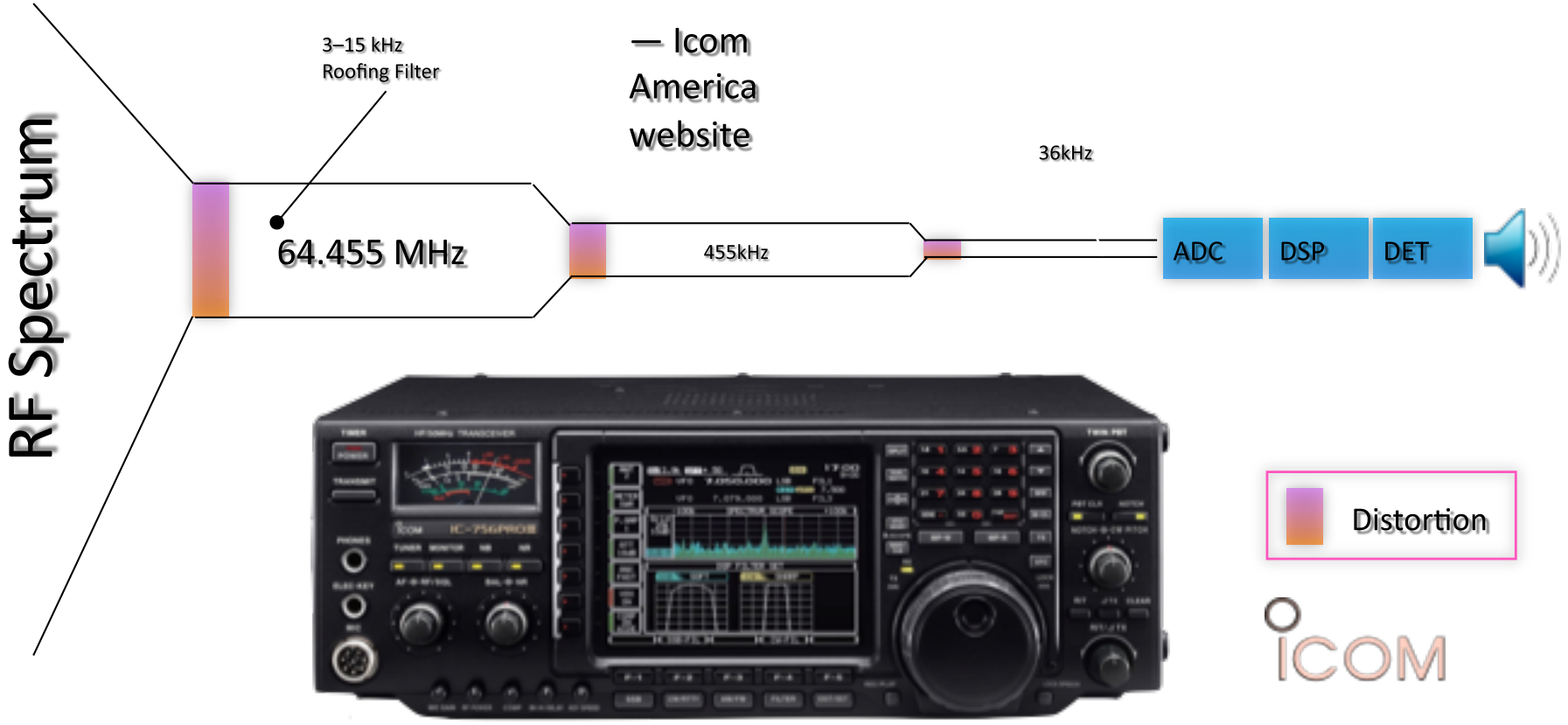
Legacy HW/DSP Receiver Chain - 1980



* Multi-Conversion

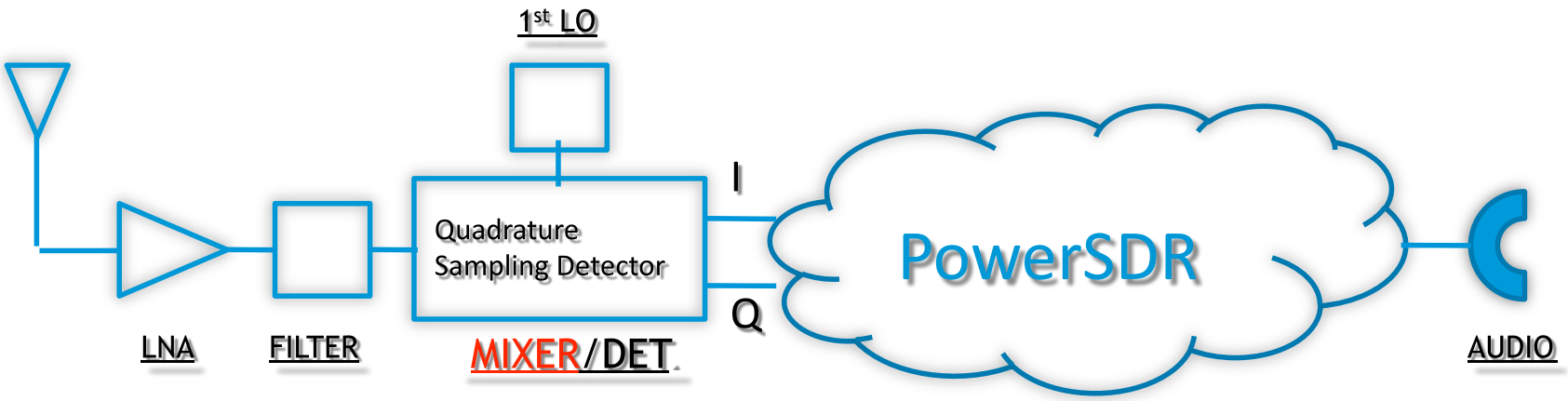
On the IC-7600:

"When compared to a typical triple-conversion system, the double conversion system is more difficult to implement but it dramatically reduces signal distortion and provides a high-fidelity RF signal to the DSP processor."



— Icom America website

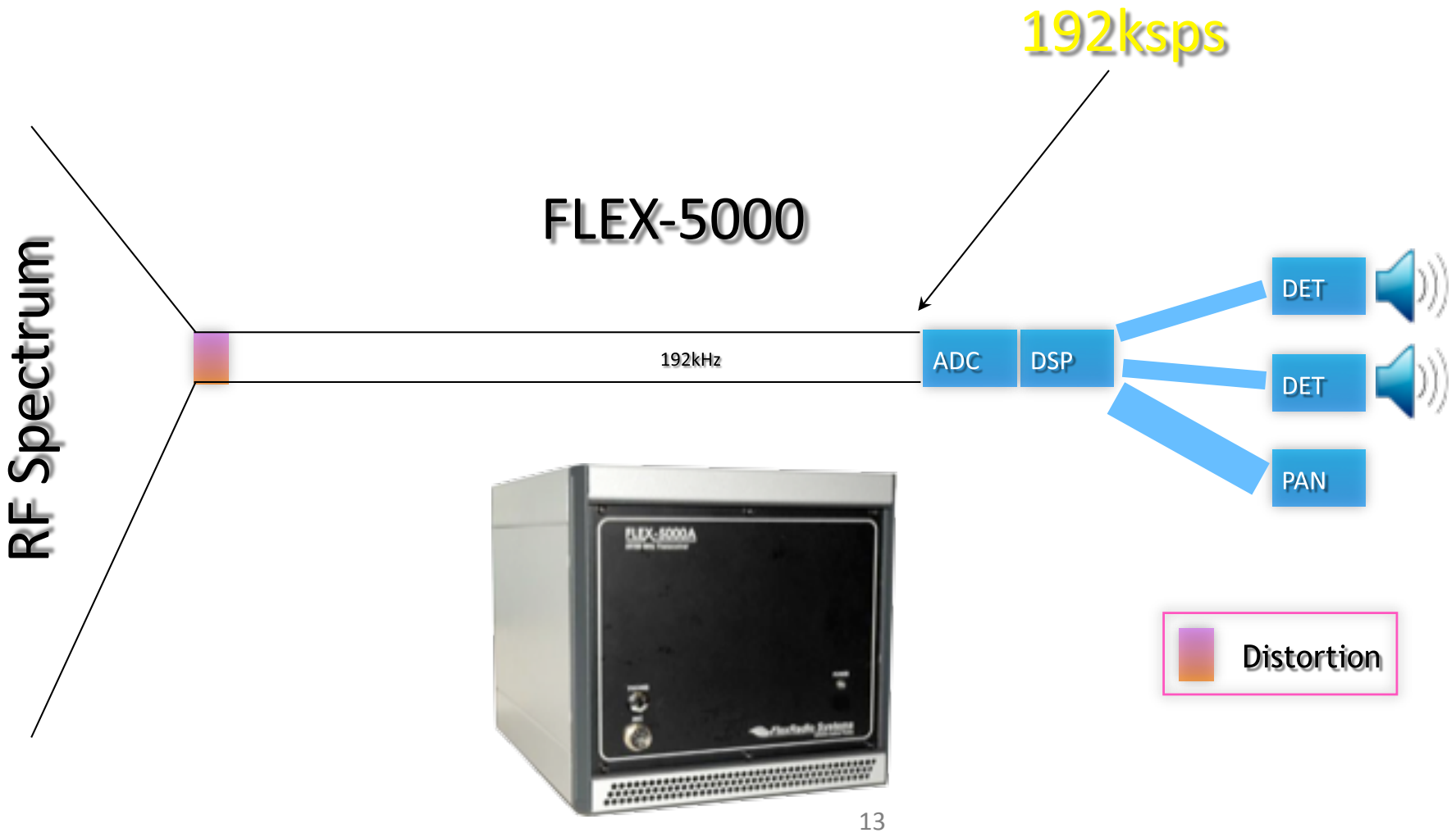
MODERN RADIO - 2000 TECHNOLOGY - 2nd Generation SDR



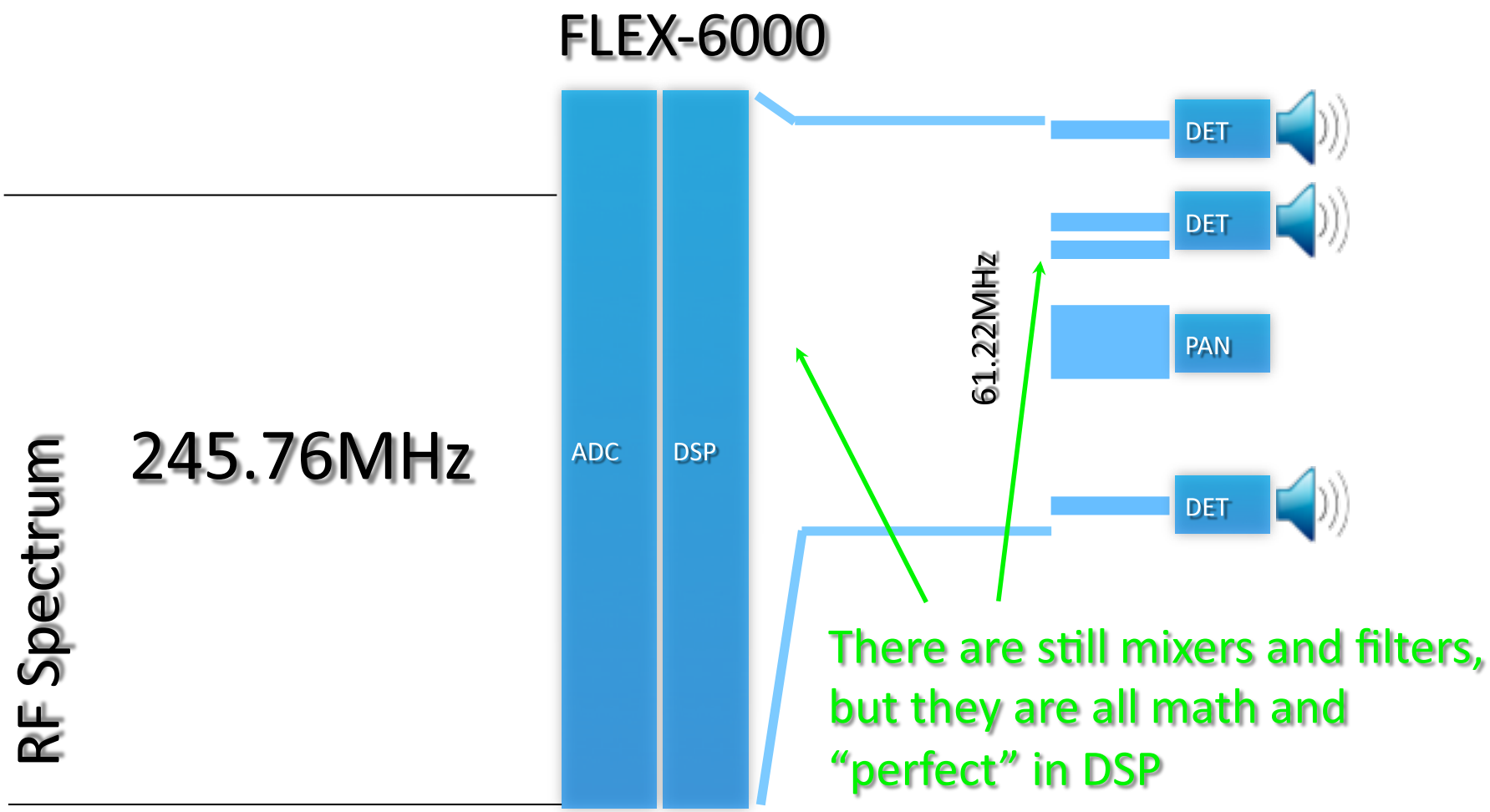
"QSD" Direct Conversion Chain

SDR-1000

* Direct Conversion



* Direct Sampling



+ Distortion minimized (ADC @ antenna):
best signal clarity

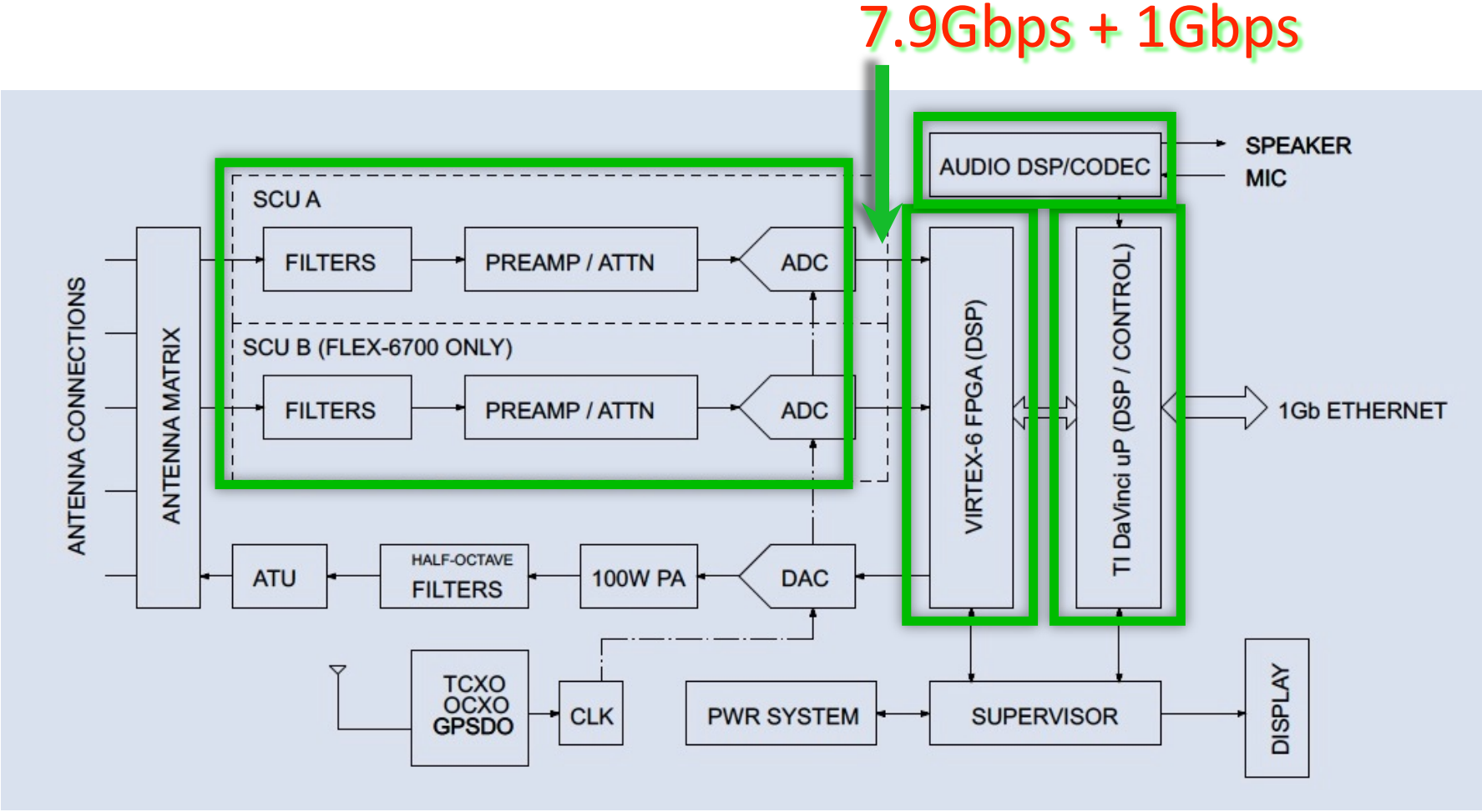
+ n-Receivers, n-Panadapters and varying widths see more bands, more receivers

+ Extremely high dynamic range: operate in worst conditions - IP3 +50db +125db Dynamic Range or better

+ Extreme flexibility through reprogrammability (***ultimate*** SDR): future benefits

– Technically challenging to design and write software

Direct Sampling Benefits



* 3rd Generation SDR Architecture

FLEX-6000 Series

ANAN-200

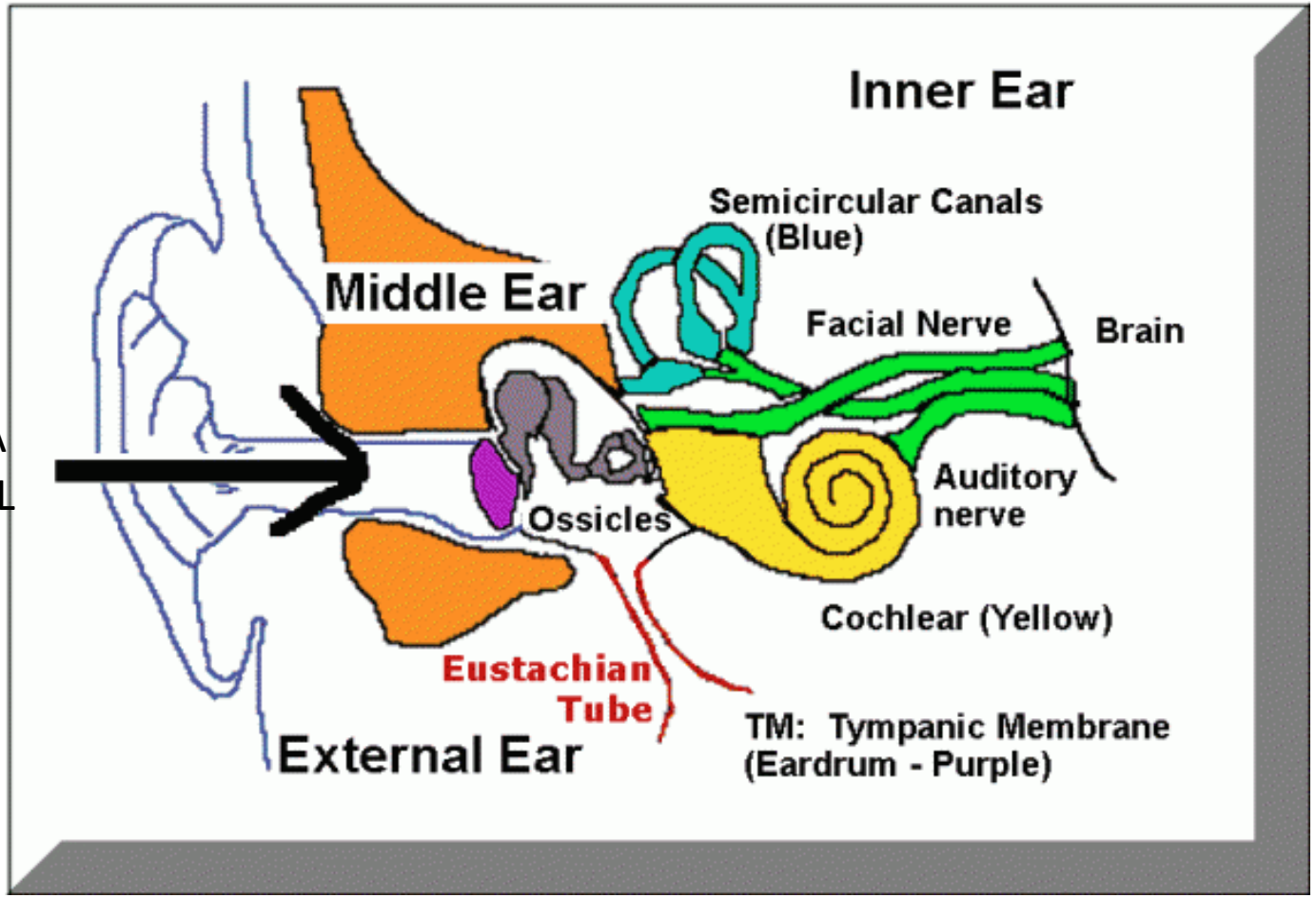
SUNSDR-2

3rd Generation Direct Sampled SDR

Summa summarum

SDR radio is like ear

OSSICLES = FRONT END, IMPEDANCE MATHING, ATTENUATOR



ANTENNA + COAXIAL

FPGA=BRAIN

COCHLEAR = ADC

AUDITORY NERVE = ETHERNET

Voice of America Monitoring

- 1. Ahti OH2RZ and Sami OH2BFO from Attocon were SDR1000 pioneers from 1998-
- My own SDR tests with SDR1000 to find new receiver for Remote Monitoring System 2006
- New RMS system with Sami's software and SDR radio
- 70 systems online at the moment
- VOA/BBG + FlexRadio systems + Attocon Oy

RMS Web
Listen to Sounds

Sound Query Results

Bcstrs	Langs	Locs	Time Range	Dates	Freqs	Sort
- All -	- All -	HELS	0000 to 2400	2015-01-28	- All -	by Time

66 sound files matched your query.

Click a sound file link below to listen to it on the right.
Click the Graph link to view the sound data while listening.

1. 150128 0001@HELS_3965RFIFREN.MP4 Graph DRM
2. 150128 0031@HELS_3965RFIFREN.MP4 Graph DRM
3. 150128 0101@HELS_3965RFIFREN.MP4 Graph DRM
4. 150128 0131@HELS_3965RFIFREN.MP4 Graph DRM
5. 150128 0201@HELS_3965RFIFREN.MP4 Graph DRM
6. 150128 0203@HELS_1386RFERU_.MP4 Graph
7. 150128 0231@HELS_3965RFIFREN.MP4 Graph DRM
8. 150128 0233@HELS_1386RFERU_.MP4 Graph
9. 150128 0301@HELS_3965RFIFREN.MP4 Graph DRM
10. 150128 0303@HELS_1386RFERU_.MP4 Graph
11. 150128 0331@HELS_3965RFIFREN.MP4 Graph DRM
12. 150128 0401@HELS_3965RFIFREN.MP4 Graph DRM
13. 150128 0403@HELS_6105RFEBR_.MP4 Graph
14. 150128 0403@HELS_6075RFEBR_.MP4 Graph

Sound File Data

View Graphs Use Java

00:36 00:00

Recorded:	2015-01-28 05:31	**Broadcaster:**	RRO
Location:	HELS	**Language:**	RUSS
Frequency:	5940	**Relay Stn:**	TIG

VOA/BBG RMS installed in Islamabad

PC is needed

- Modern win7 PC
- With many pan adapters and receivers in use, PC and graphic power need will increase
- 1GB ethernet connection preferred between radio and PC
- Display area is needed. It is normal to have 2-3 big displays
- Ergonomics is important

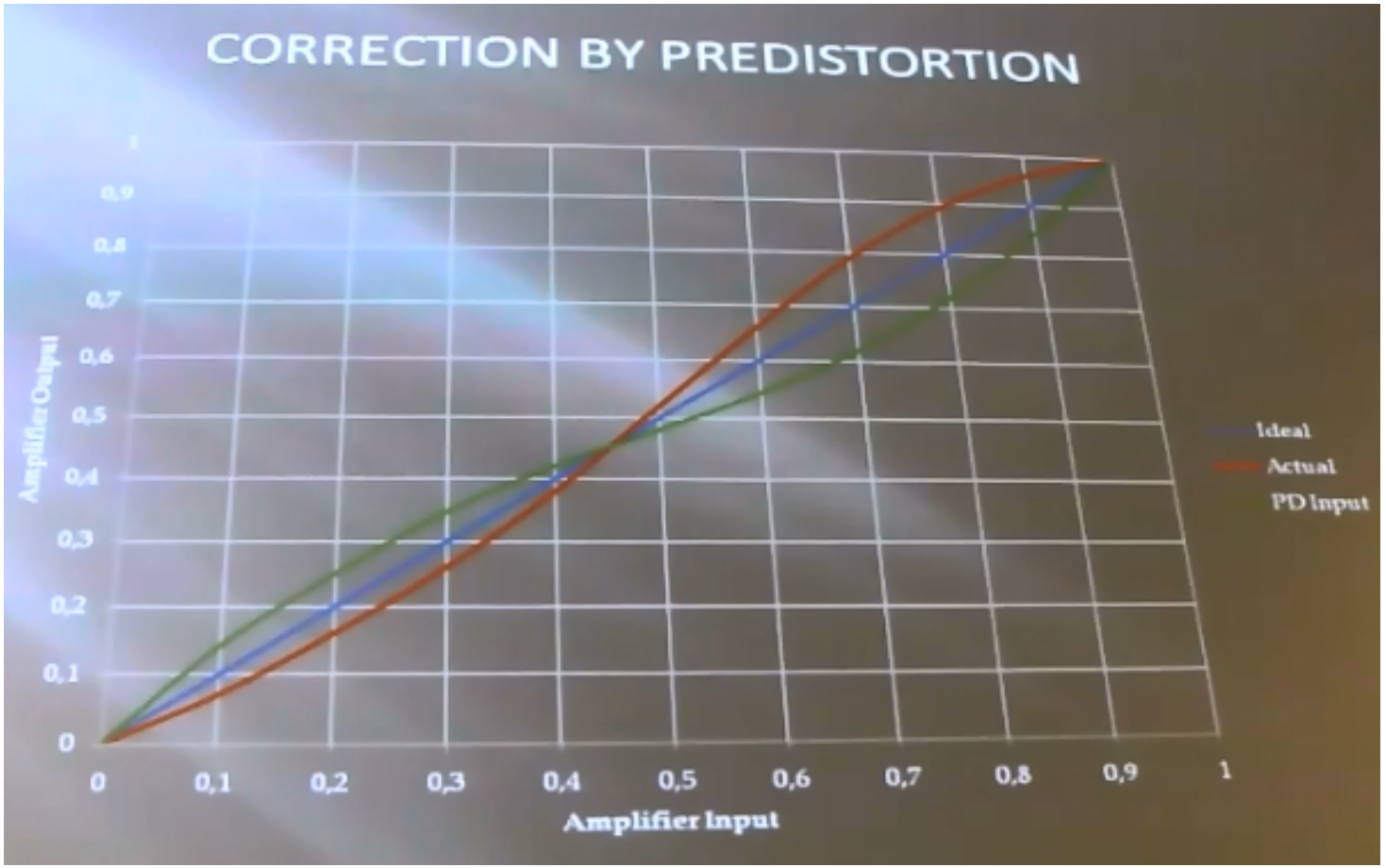
SDR benefits

- Good, quiet reception, less fatique
- Best weak signal reception, best strong signal reception
- Panadapter, you can see the band
- Digimodes, winner in the pile up
- Diversity and adaptive noise cancelling
- Tracking notch, auto notch
- Pure signal a.k.a predistortion, cleans TX

SDR benefits

- *Native* remote will be supported soon
- Great learning opportunity
- More that one client can connect to a *radio-server* (Flex6000)

- THINK DIGITAL(, sooner or later you have to)



Correction by Predistortion

Source Dr Warren Pratt NR0V
Friedrichshafen, June 2014

Flex-Radio vs. HPSDR

- PowerSDR is software for many SDR radios, started by FlexRadio
- Open source project mostly

- When FlexRadio went to closed software for new 6xxx radios, many former PowerSDR contributors moved to HPSDR development (ANAN)

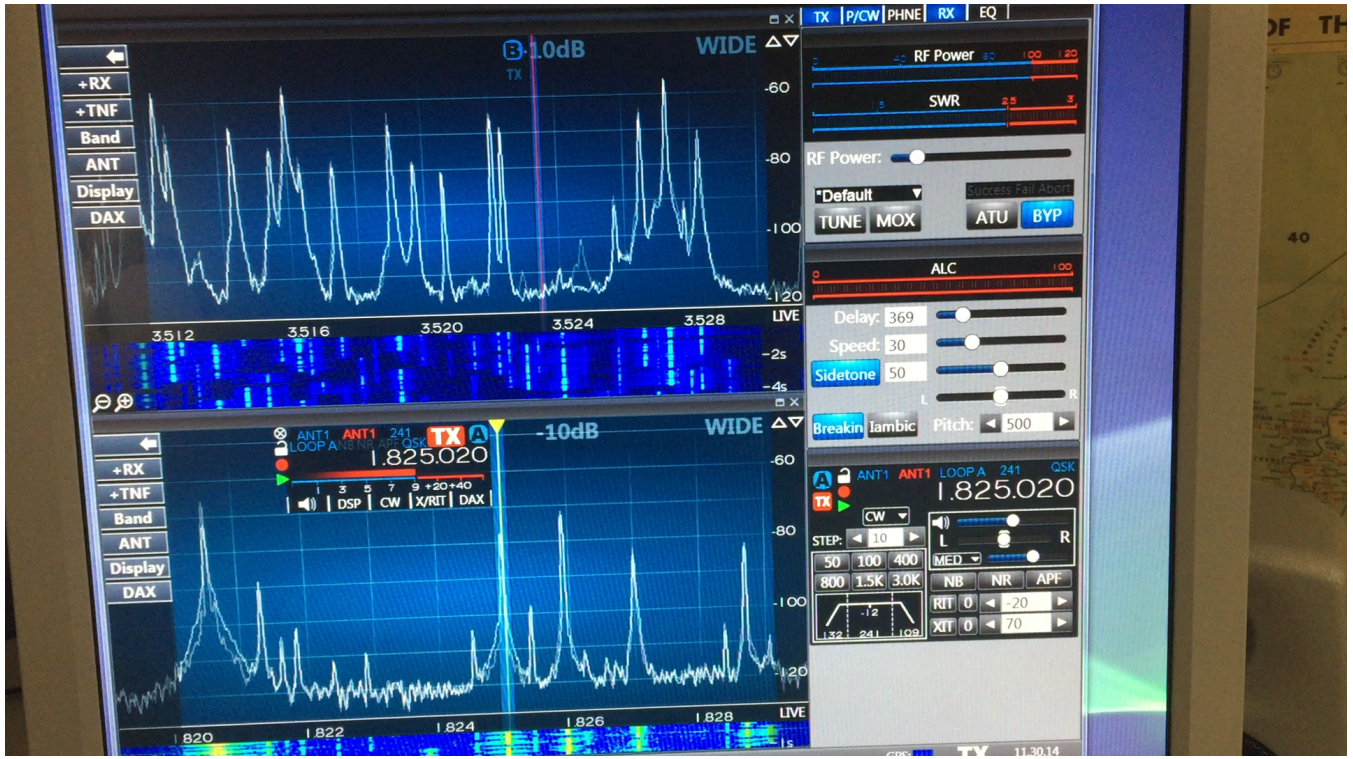
Multimedia, Flex6700 in action

- CQ WW CW 2015

  -Two local CW-skimmers + cluster spots, feeding N1MM+ , 160m low noise copy

  - 720 *test* QSOs made

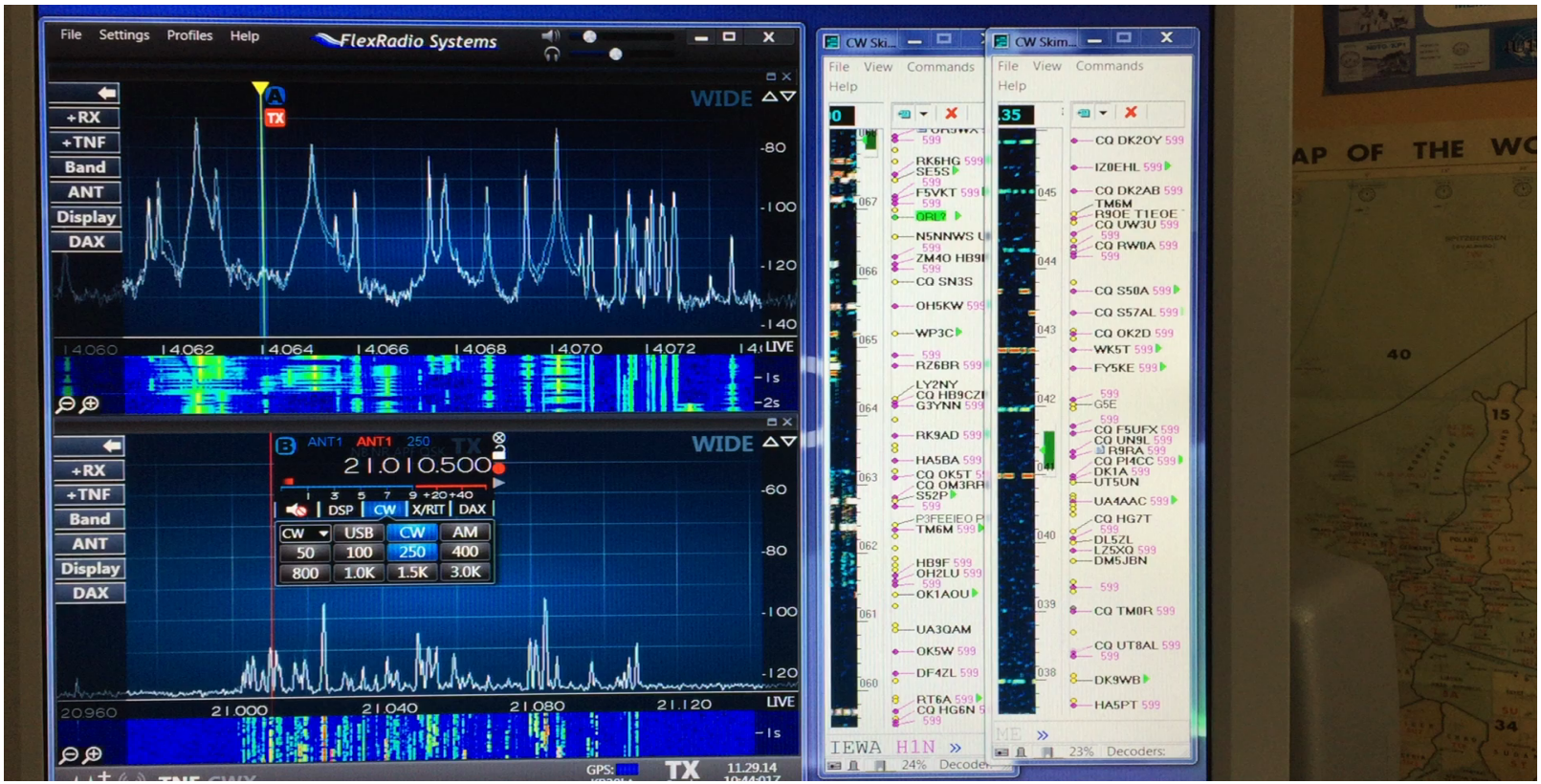
http://youtu.be/zQaqQUDCu9U



Multimedia, Flex6700 in action

- Click on the panadapter and have one more QSO, no keyboad needed, easy contesting

http://youtu.be/-3BKA0cmZeM



SDR radio is ALREADY here

- Sami OH2BFO: Software Makes the Radio
- Ahti OH2RZ: Work in Progress
- Gerald Youngblood K5SDR: Re-discover Radio
- Timo OH5KW: Best Way to Work More DX’es and Have Fun!

- Thank You