The Challenge of LNA`s for 10 GHz

HB9BBD

Introduction

- Much has been written on the value of NoiseFigure at EME conferences, in Dubus etc.
- Still, it‘s the difference between Noise and Signal which really matters
- It‘s not what‘s printed on the box, but what‘s inside which makes the challenge
- The benchmark for HM LNA is clearly DB6NT
- Hypothesis: It should be possible to build a Band LNA, unconditionally stable, NF<0,8dB (averaged!), G>20dB

Agenda

- Don‘t trust the box, measure!
- The Benchmark LNA by DB6NT
- The Gang challenging the Leader
- Building the LNA
- Selecting the Device
- Measuring Noise and Gain
- The Results
- Appendix
- Zugabe!!

What the Market keeps telling us..

0,1 dB ?

Bargain!

The Components alone cost more!

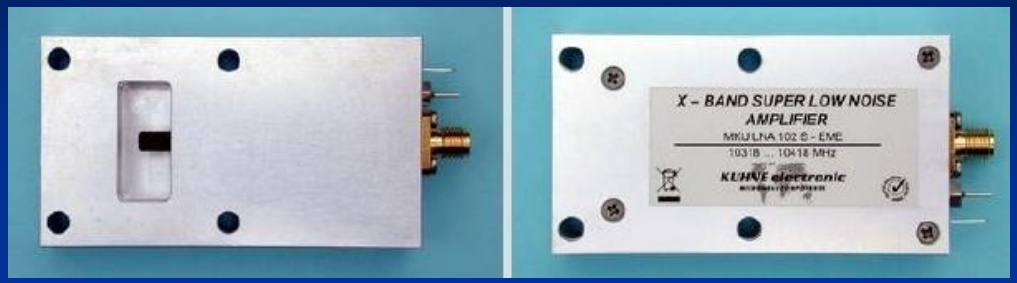
The Benchmark LNA

DB6NT, Michael Kuhne

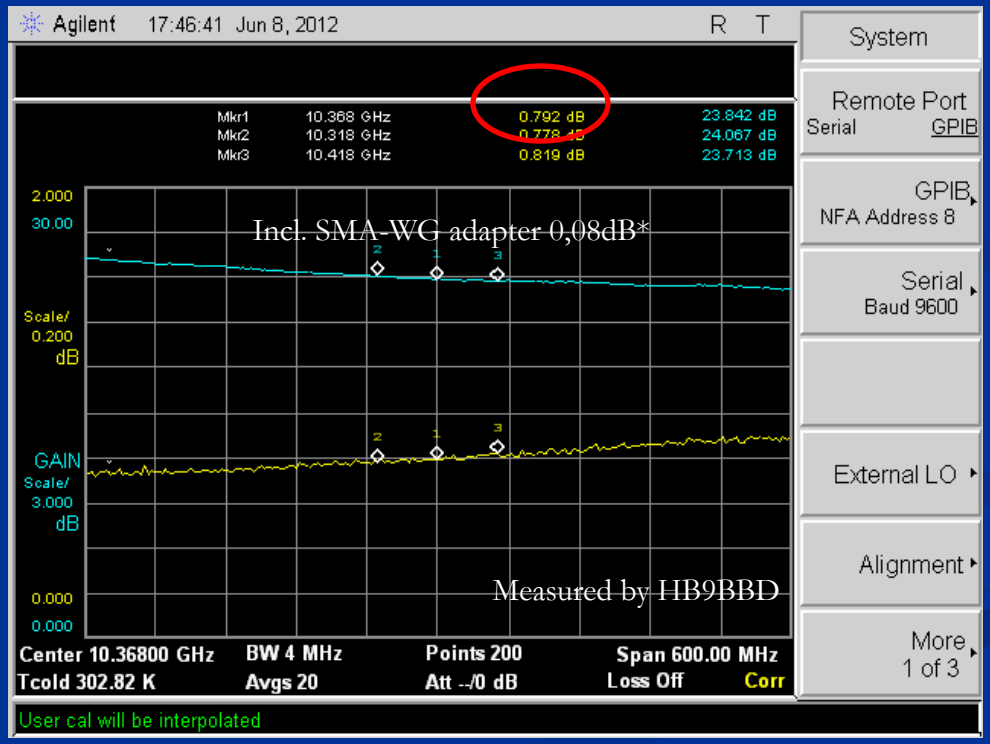
The Benchmark LNA

DB6NT

F = 0,7 dB&18C
G = 22 dB
R100
239 €



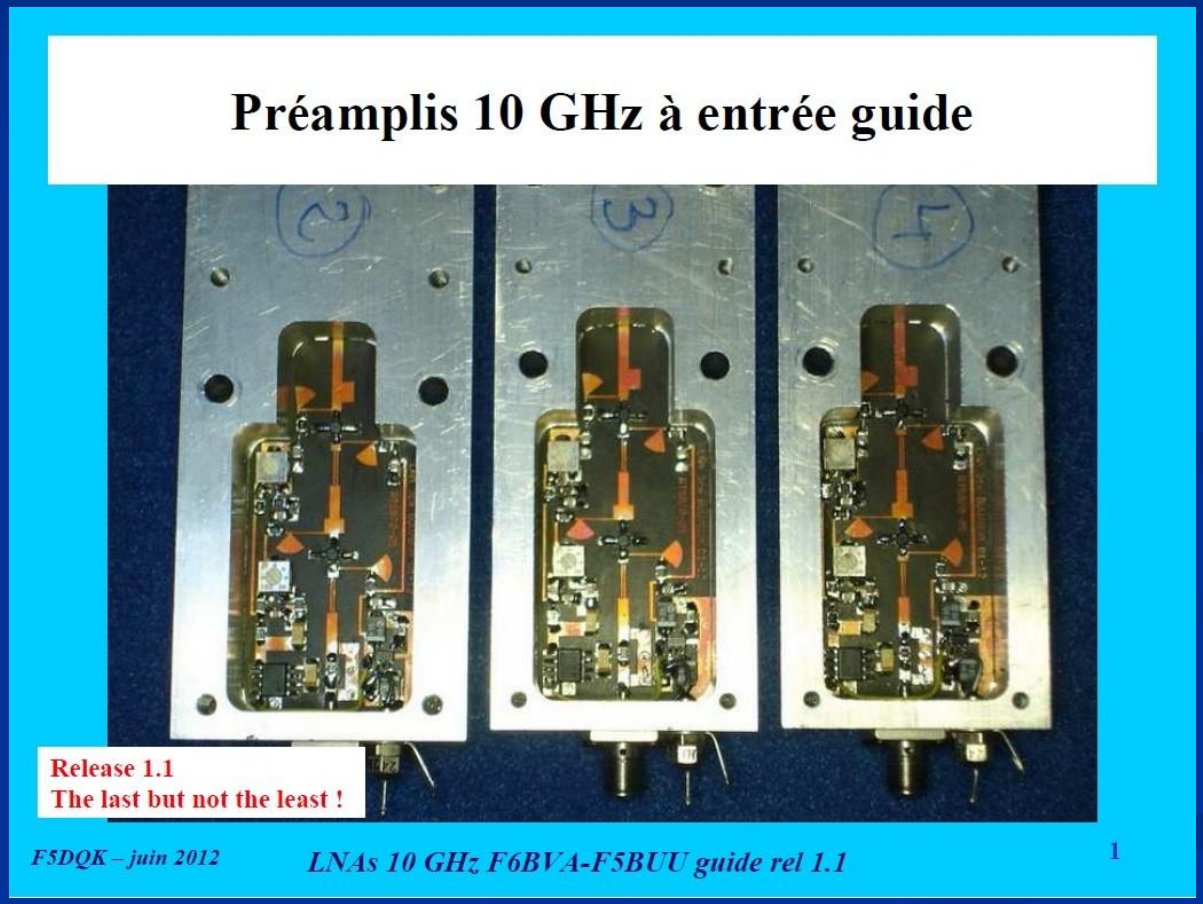
Agilent 8975A
N4000A



* Loss of adapter measured on p.50

F5BUU + F6BVA challenging DB6NT

http://f1chf.free.fr/F5DQK/3_Preamplis_LNAs/Preamplis_10_GHz_DB6NT.pdf



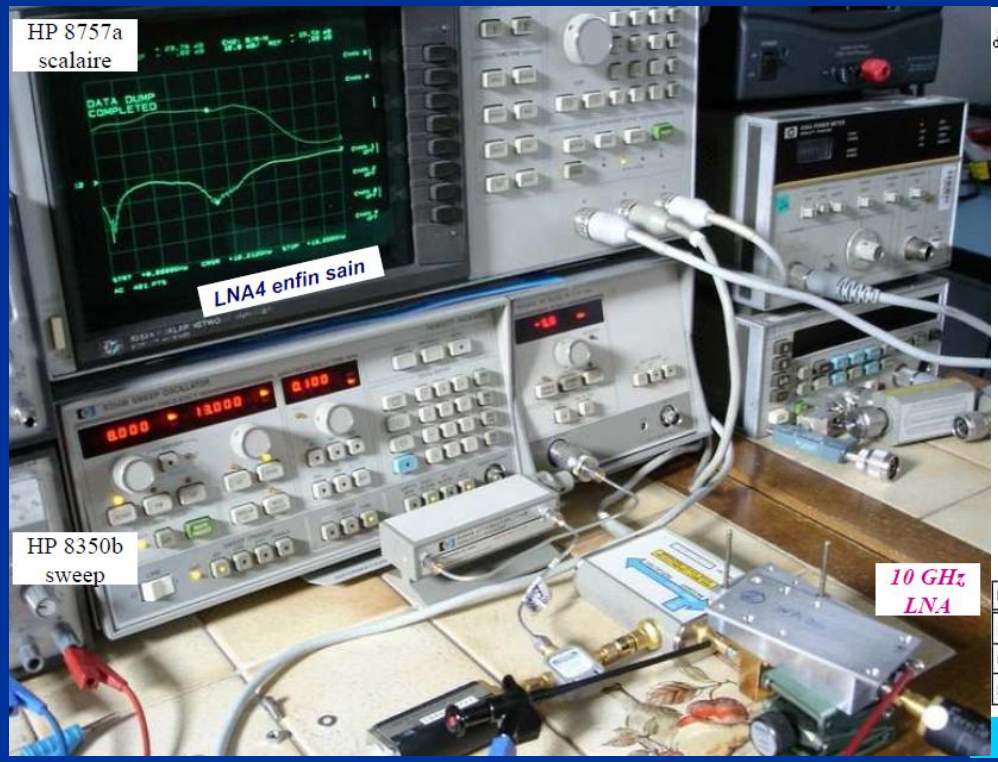
F5BUU, Jean Claude F6BVA, Michel

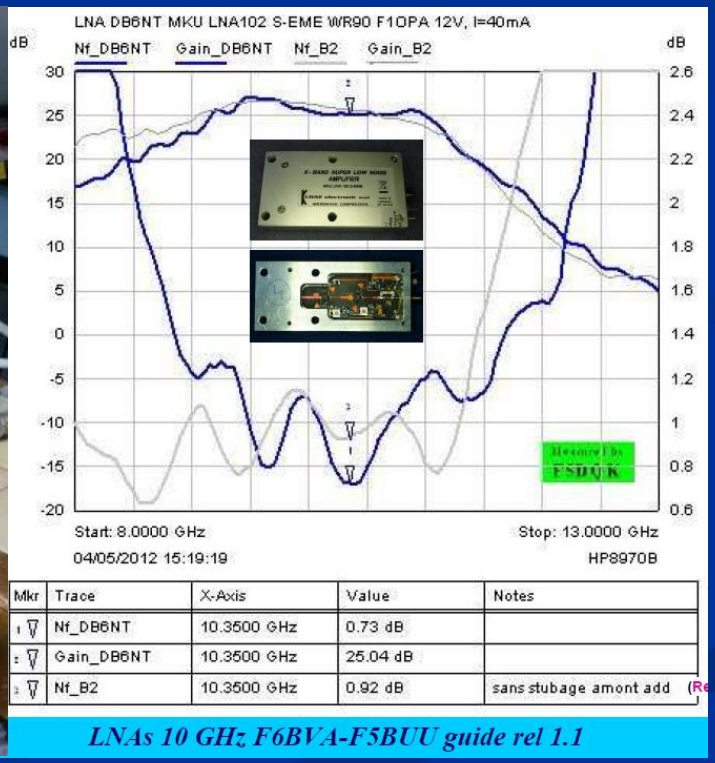
http://f1chf.free.fr/F5DQK/3_Preamplis_LNAs/Preamplis_10_GHz_DB6NT.pdf

F5BUU + F6BVA challenging DB6NT

(F5DQK Publisher, LNA's built by F5BUU and F6BVA)

http://f1chf.free.fr/F5DQK/3_Preamplis_LNAs/Preamplis_10_GHz_DB6NT.pdf





Mkr	Trace	X-Axis	Value	Notes
1	Nf_DB6NT	10.3500 GHz	0.73 dB	
2	Gain_DB6NT	10.3500 GHz	25.04 dB	
3	Nf_B2	10.3500 GHz	0.92 dB	sans stubage amont add

LNAs 10 GHz F6BVA-F5BUU guide rel 1.1

OK2AQ challenging DB6NT

http://www.vhf.cz/soubory/dokumenty/lna-10ghz.pdf

OK2AQ challenging DB6NT

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or
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PGP Public Key

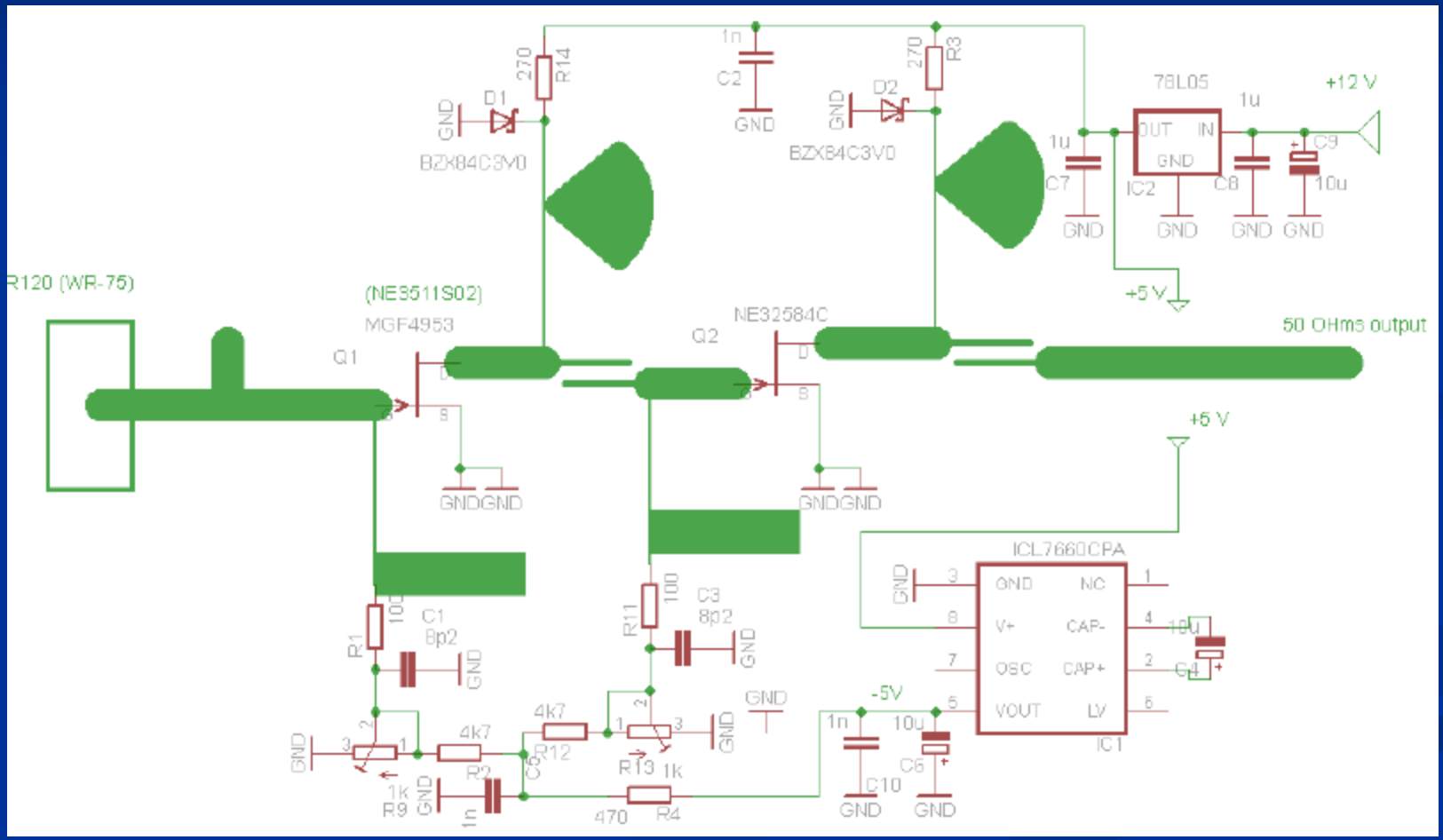
Dept. of Radio Electronics
Faculty of Electrical Engineering
and Communication
Brno University of Technology

Miroslav Kasal (* 1947 in Litomysl, Czech Republic) graduated in communication engineering from the Faculty of Electrical Engineering, Brno University of Technology, in 1970. In 1984 he obtained his Ph.D. degree in metering engineering. He was the head of the NMR Department and Electronics Laboratory of the Institute of Scientific Instruments, Academy of Science of the Czech Republic (1991-2002). Since 2002 he has been with the Department of Radio Engineering, Faculty of Electrical Engineering and Communication, Brno University of Technology, initially as associate professor and since 2006, as professor. He is a senior member of the IEEE. He has authored or coauthored a number of papers in scientific journals and conference proceedings. Dr. Kasal received the Award of the Rector of the Brno University of Technology and together with his doctor students the SIEMENS Prize for research (2004). In 2007 prof. Kasal received the Prize for research of the Minister of Education of the Czech Republic.

Professional orientation
Microwave techniques, satellite communication, signal processing, scientific instruments.

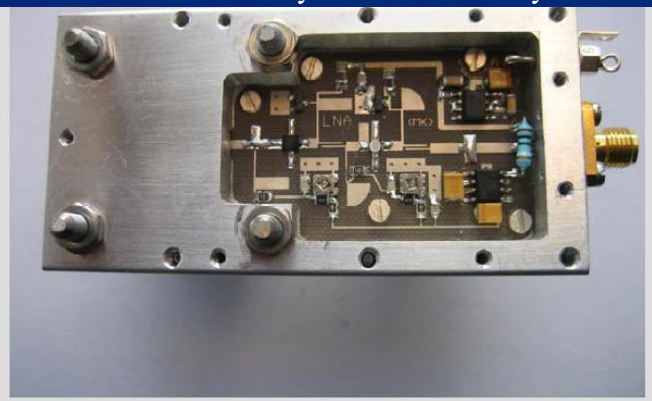
OK2AQ challenging DB6NT

http://www.vhf.cz/soubory/dokumenty/lna-10ghz.pdf

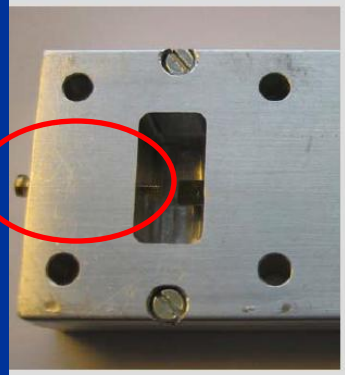


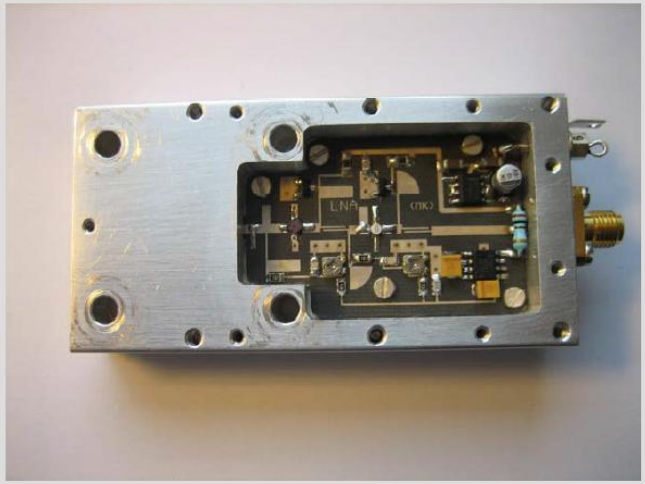
OK2AQ challenging DB6NT

http://www.vhf.cz/soubory/dokumenty/lna-10ghz.pdf



NE3511S02
DiCLAD 870



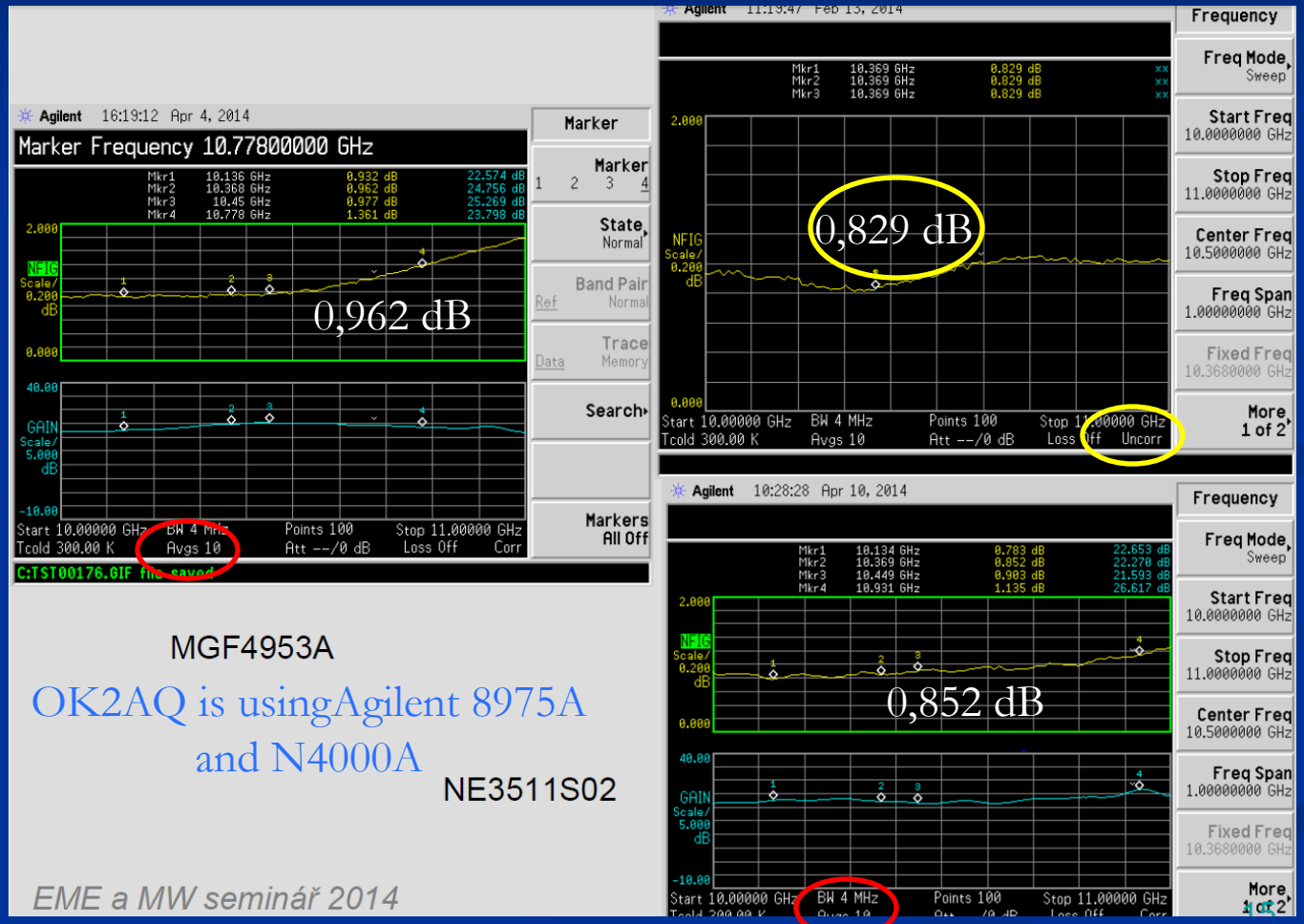


MGF4953A
Duroid 5880

EME a MW seminář 2014
Tři Studně, Duben 11- 13, 2014

OK2AQ challenging DB6NT

http://www.vhf.cz/soubory/dokumenty/lna-10ghz.pdf



MGF4953A

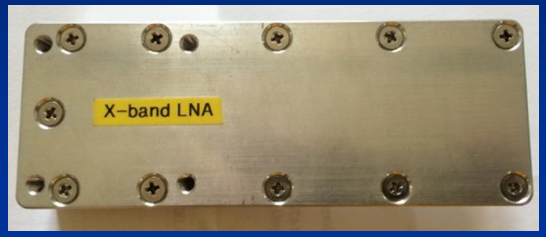
OK2AQ is usingAgilent 8975A and N4000A

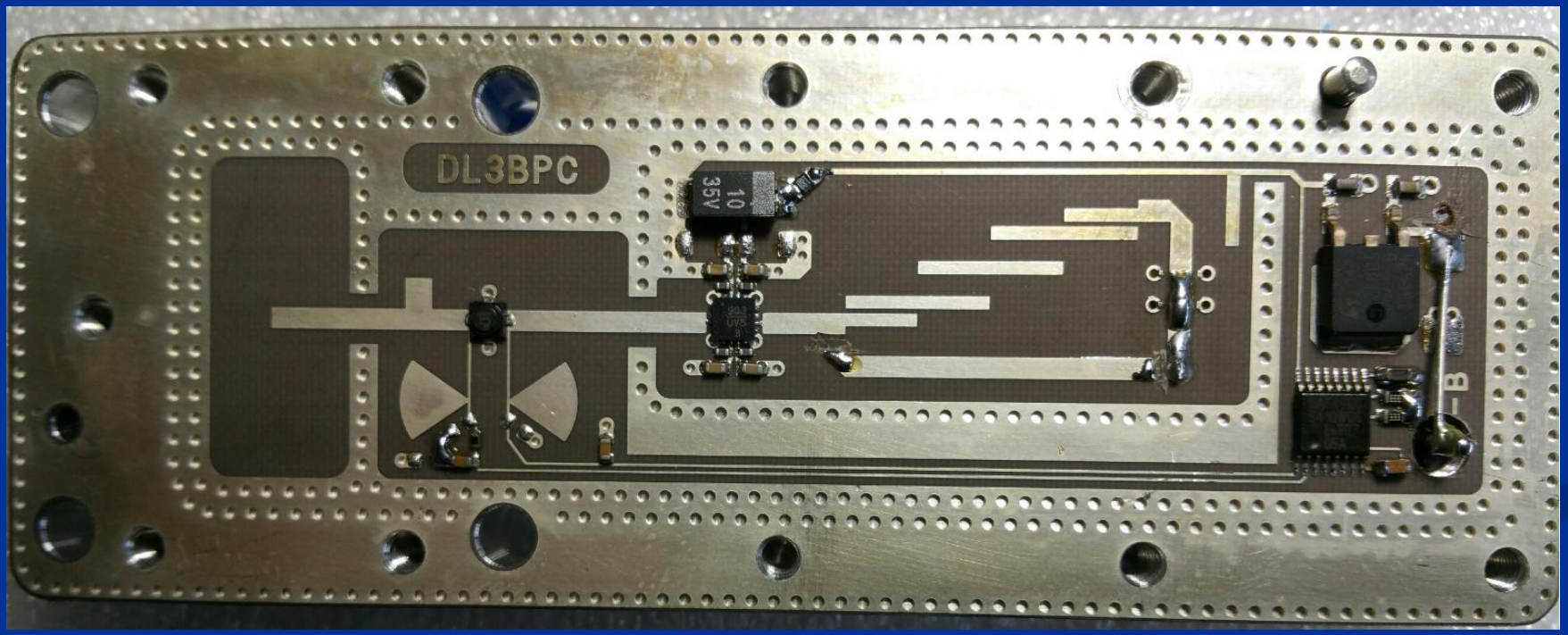
NE3511S02

EME a MW seminář 2014

Sat-Technology challenging DB6NT

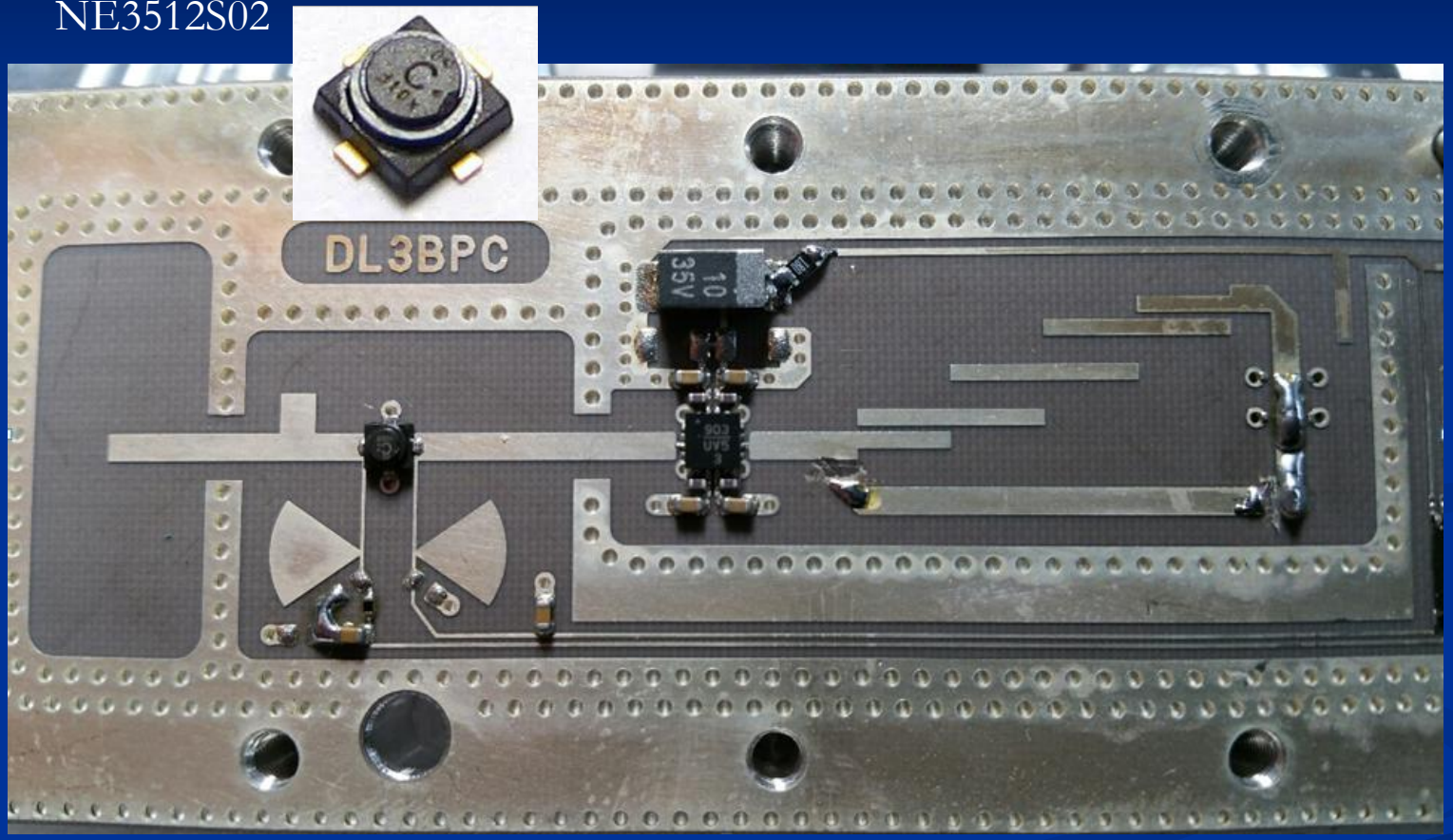
„Sandwich-design“





Sat-Technology challenging DB6NT

NE3512S02

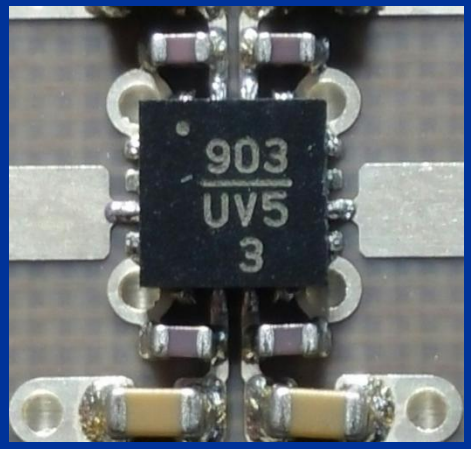


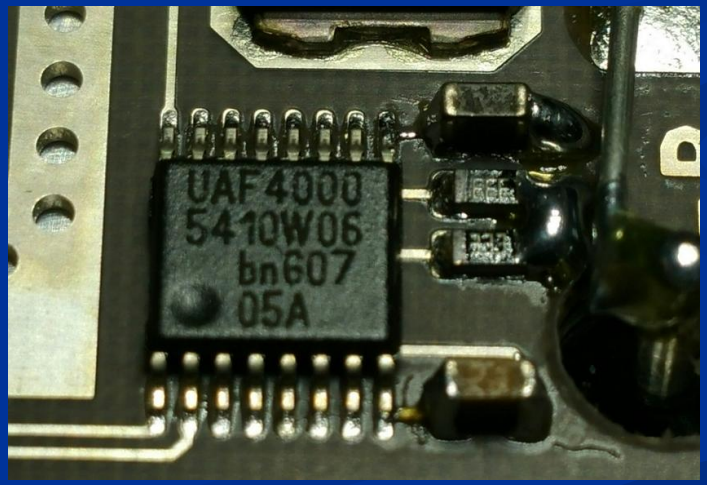
Sat-Technology challenging DB6NT

„Sandwich-design“

Characteristics:

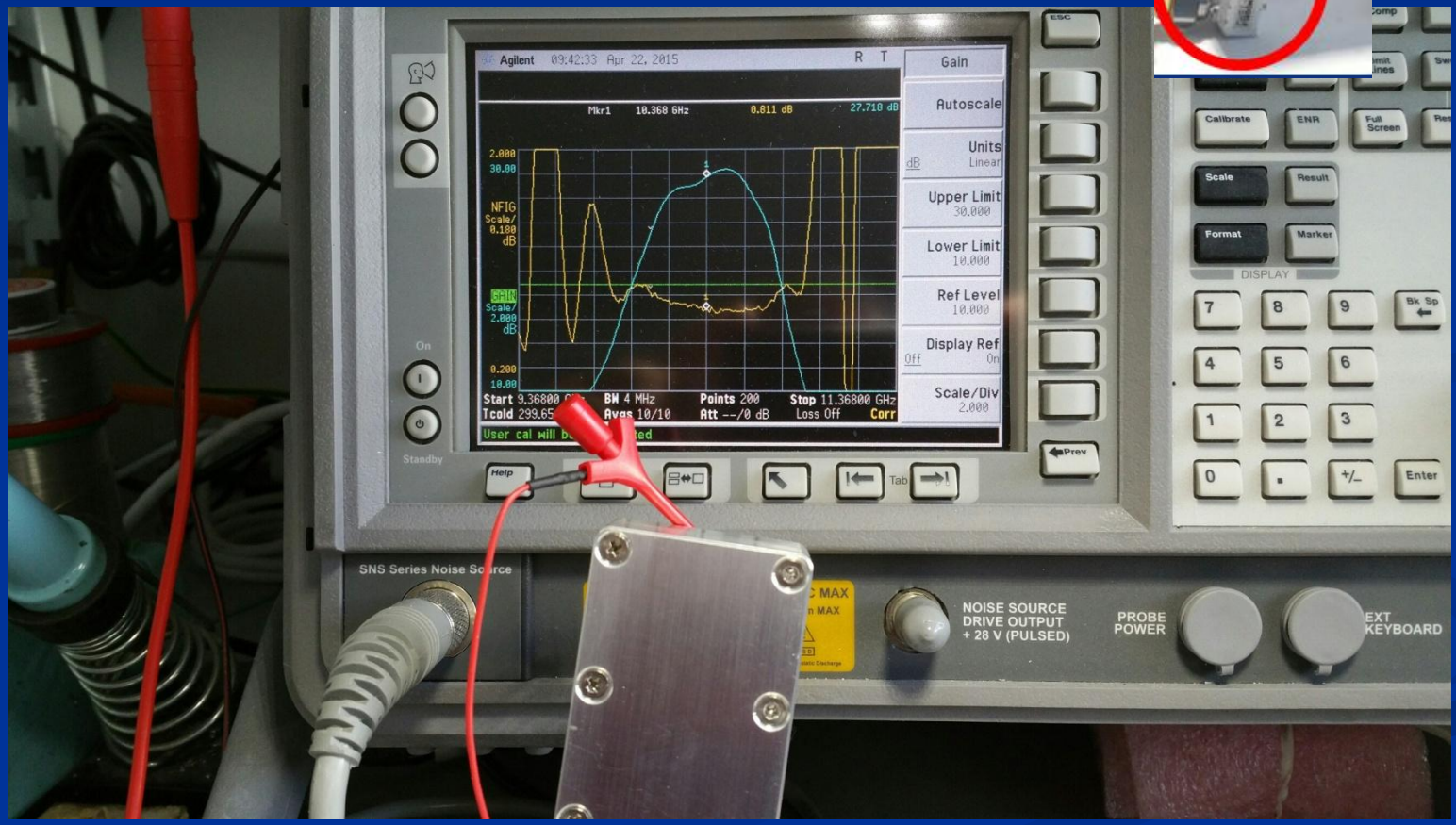
- Made in Asia by a Sat/LNB company
- Interdigital Filter
- No tuning at all, no flaps, no variable gate-supply-regulator
- Perfectly repeatable industrial design
  (I measured 4 pieces, all within 3/100 of a dB in NF, same Gain)



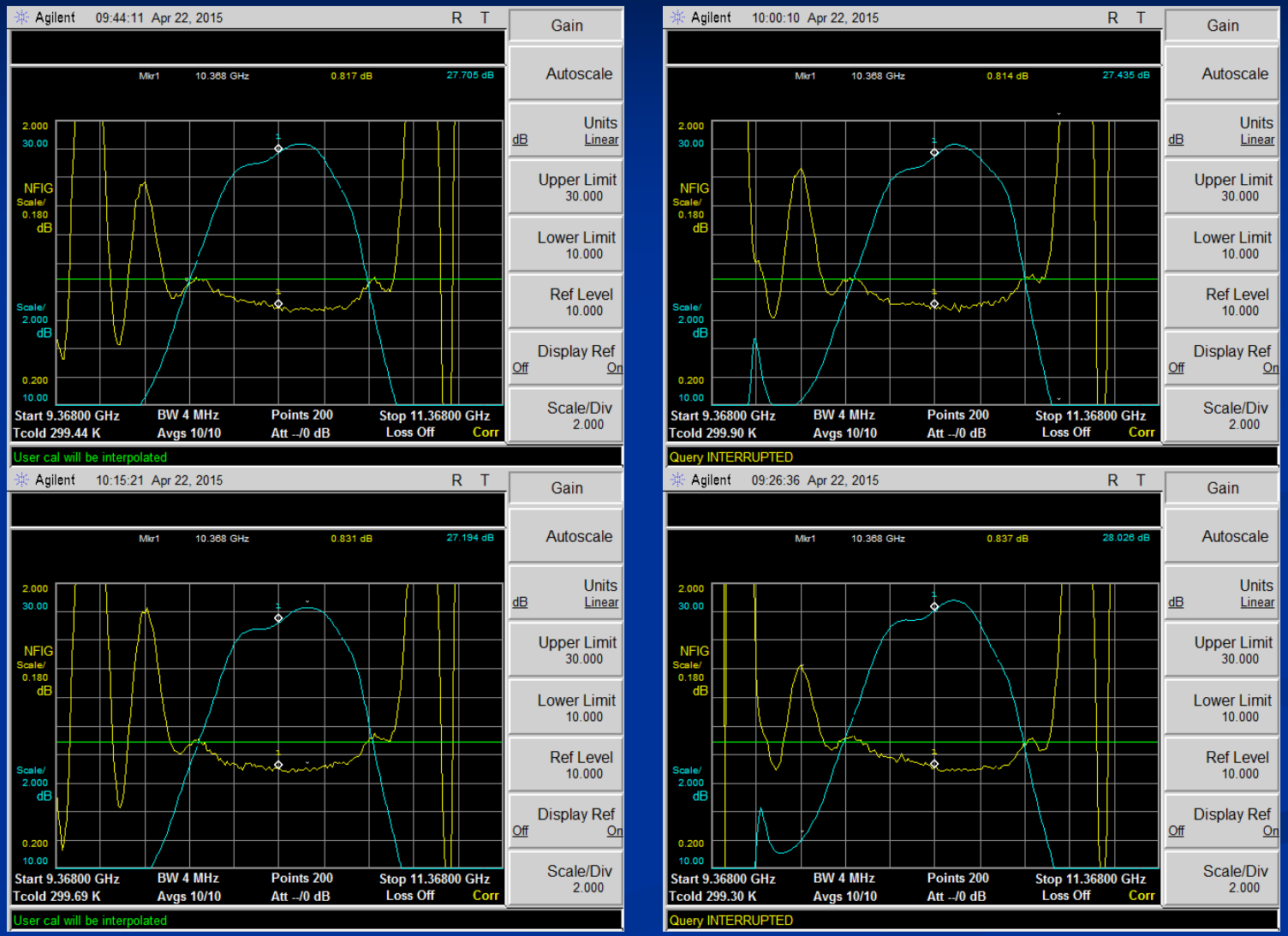


Sat-Technology challenging DB6NT

NE3512S02  NF 0,81dB; G 27,7dB

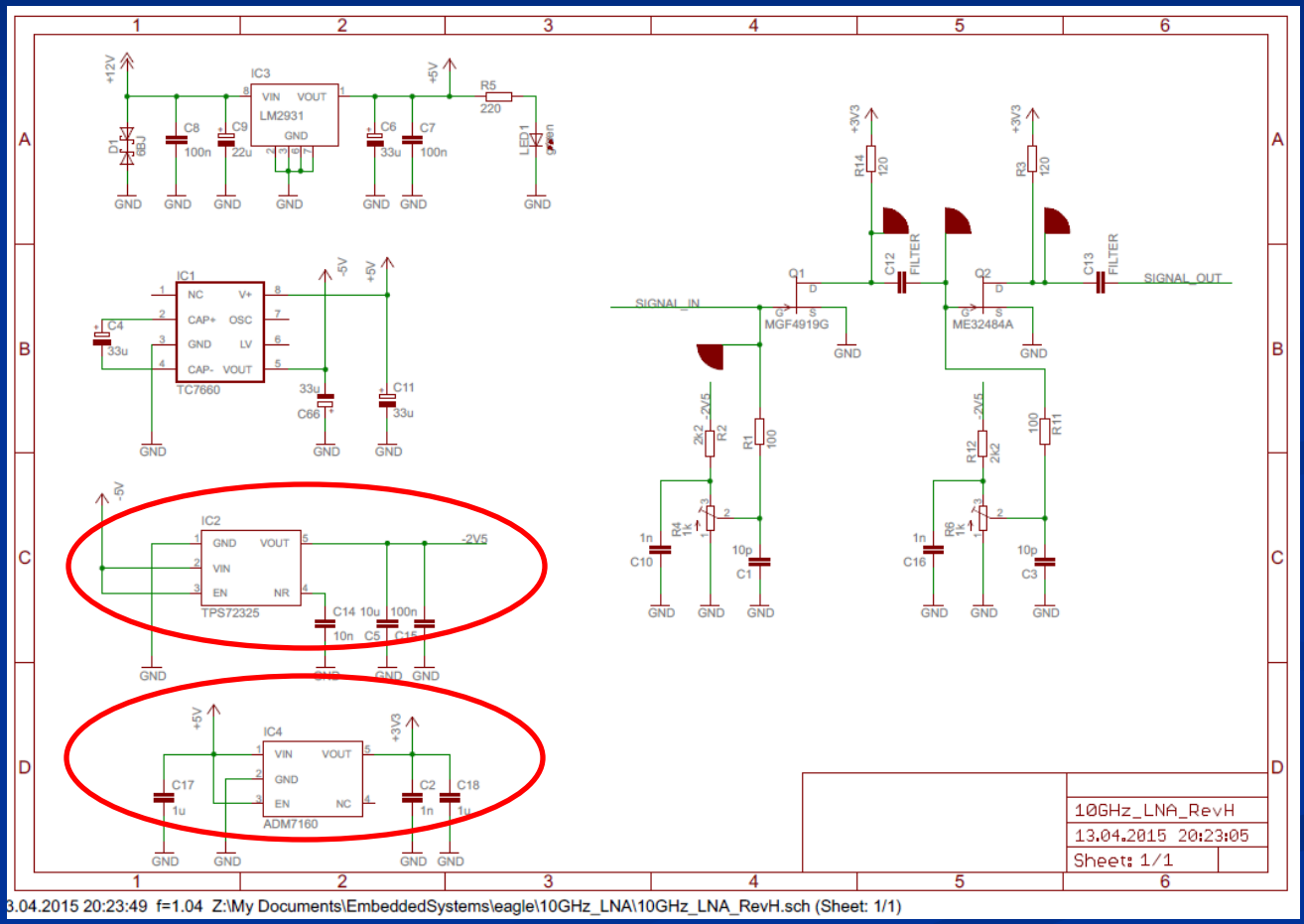


Sat-Technology challenging DB6NT



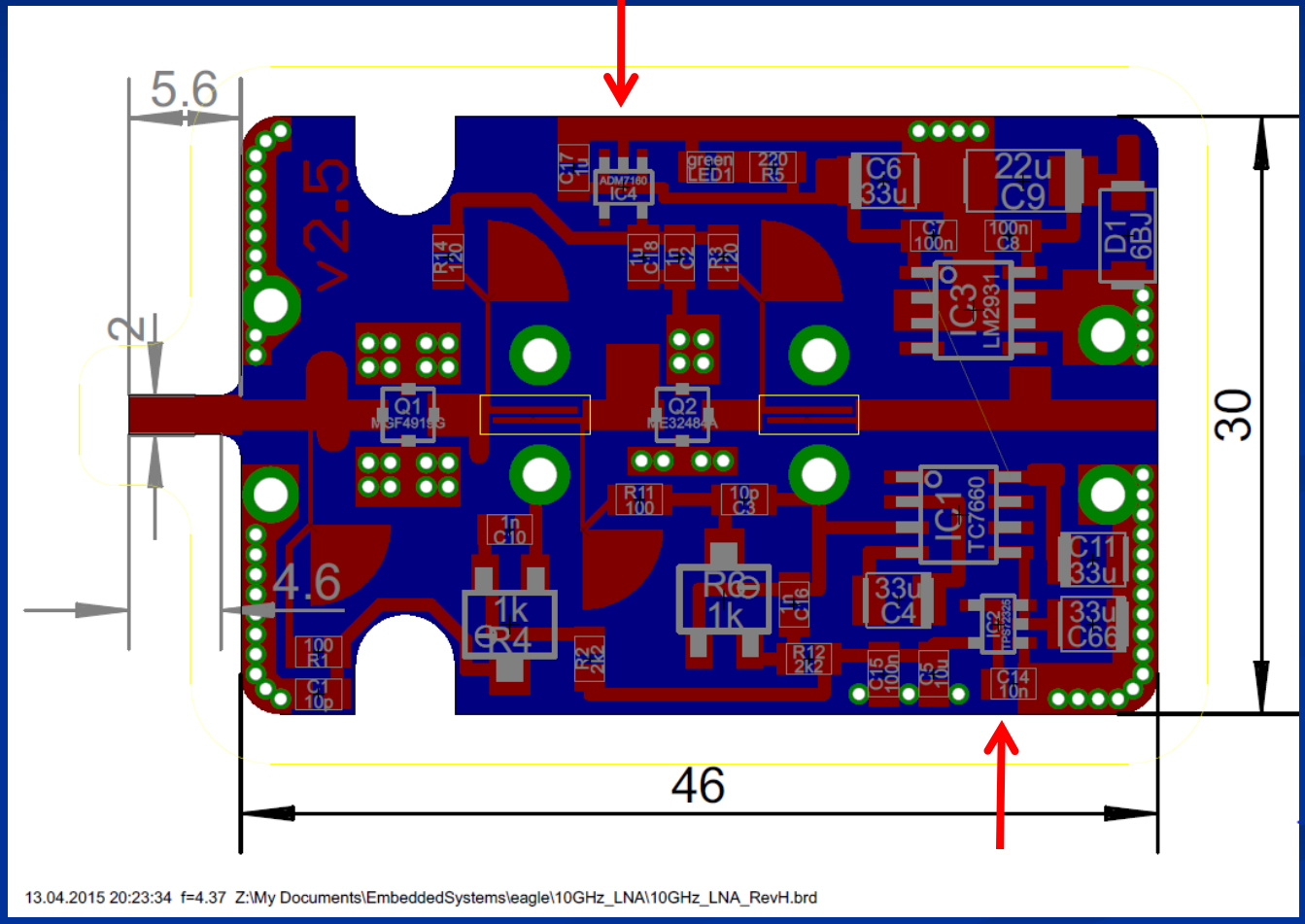
So let‘s challenge them all!

Designing a low noise LNA



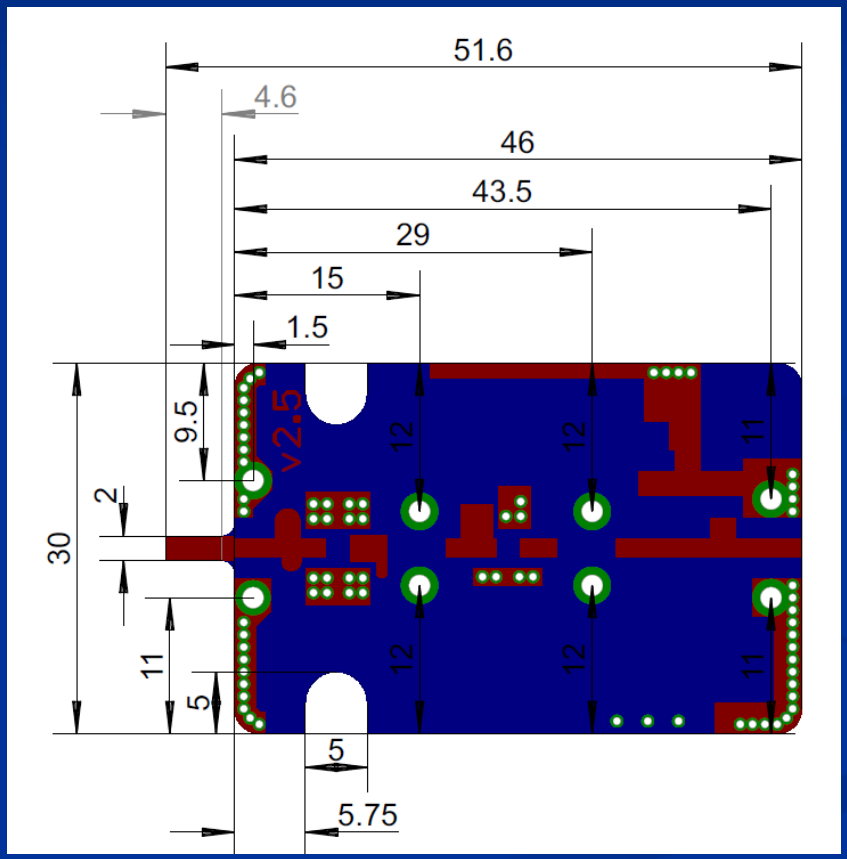
So let‘s challenge them all!

Designing a low noise LNA



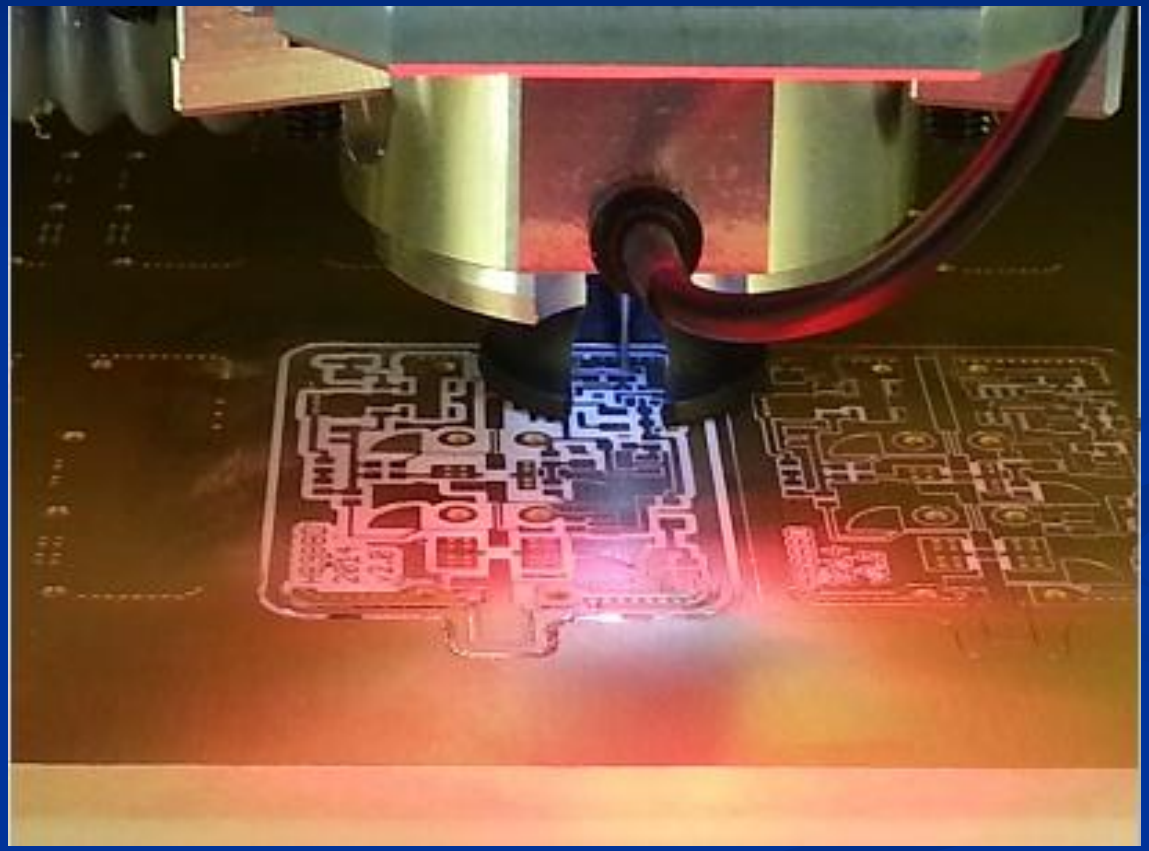
So let‘s challenge them all!

Mechanical Dimensions in mm



Building the LNA

Making the PCB (Rogers 4003C 0,508mm)



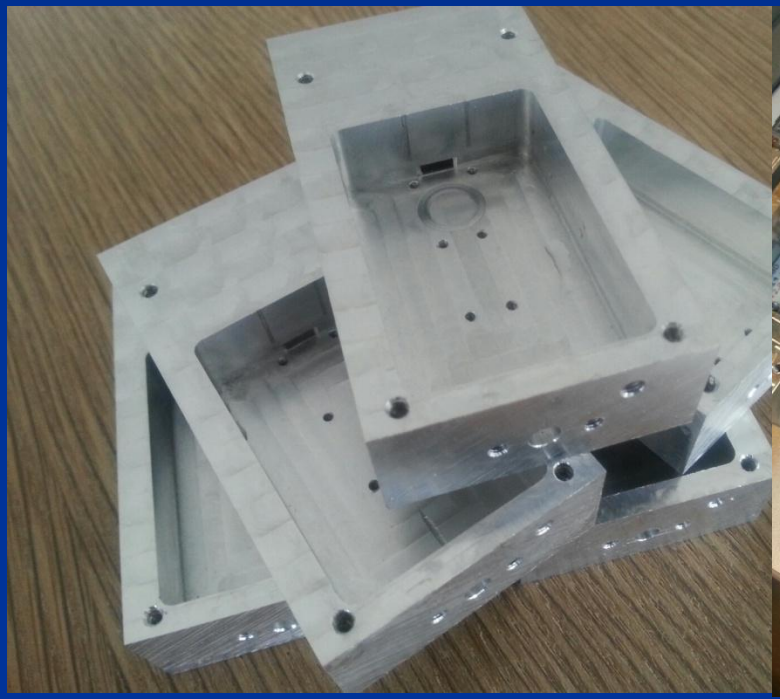
20141004_151100 (2).mp4

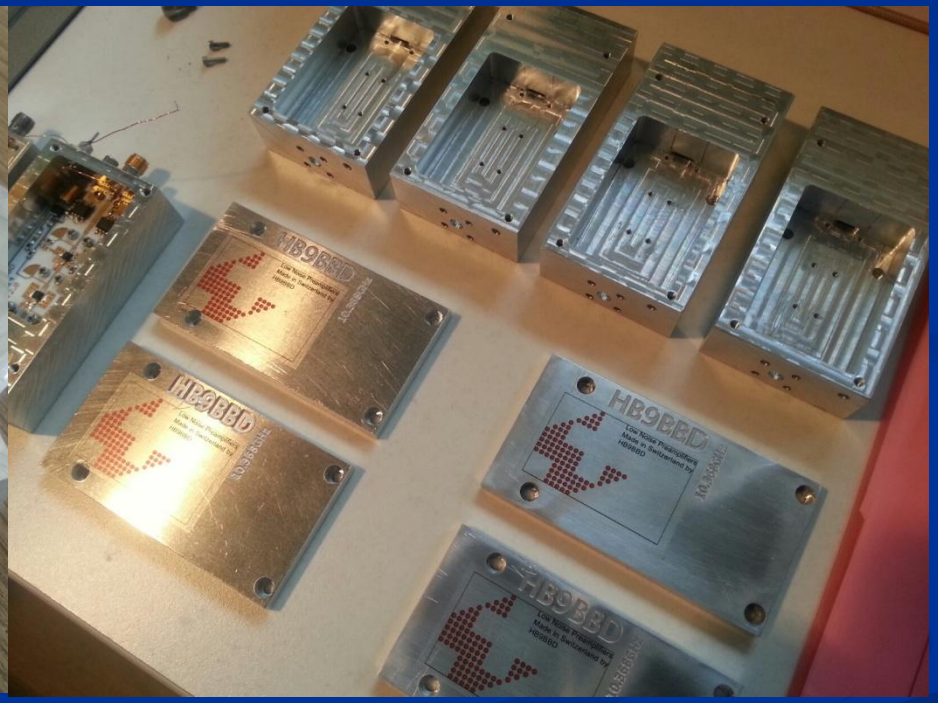
Building the LNA

Making the body

Building the LNA

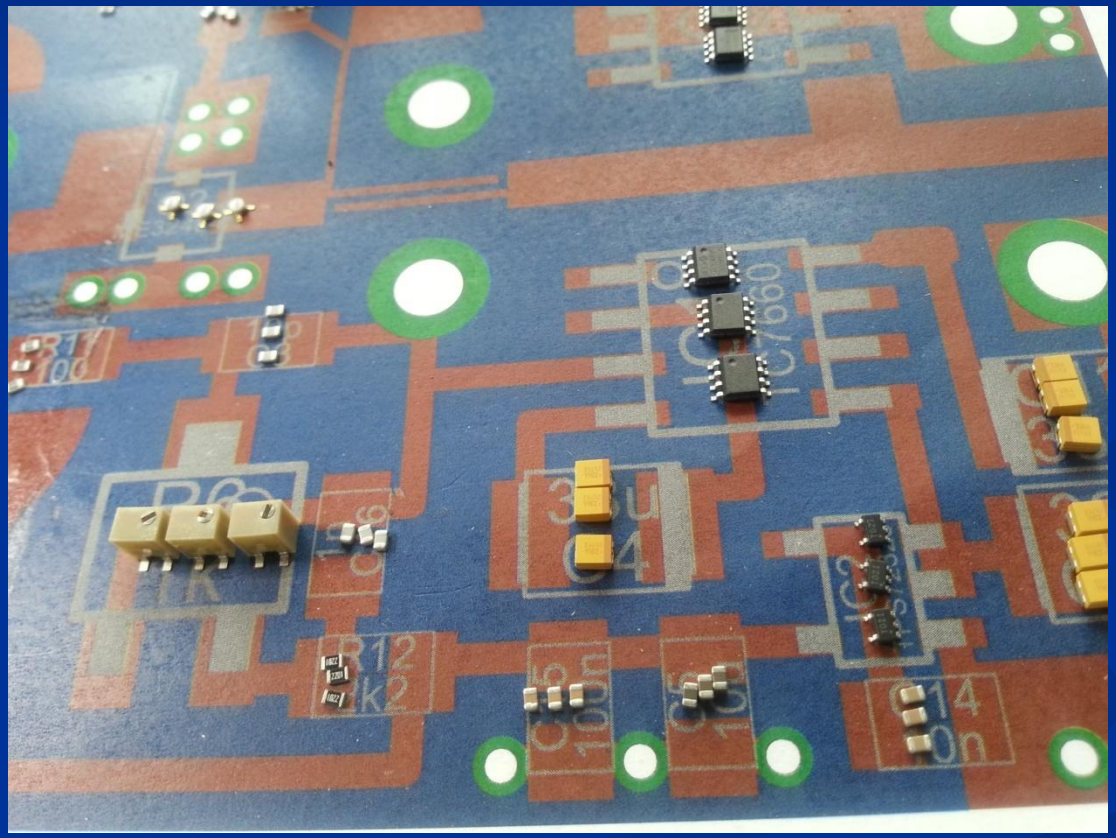
Making the body





Building the LNA

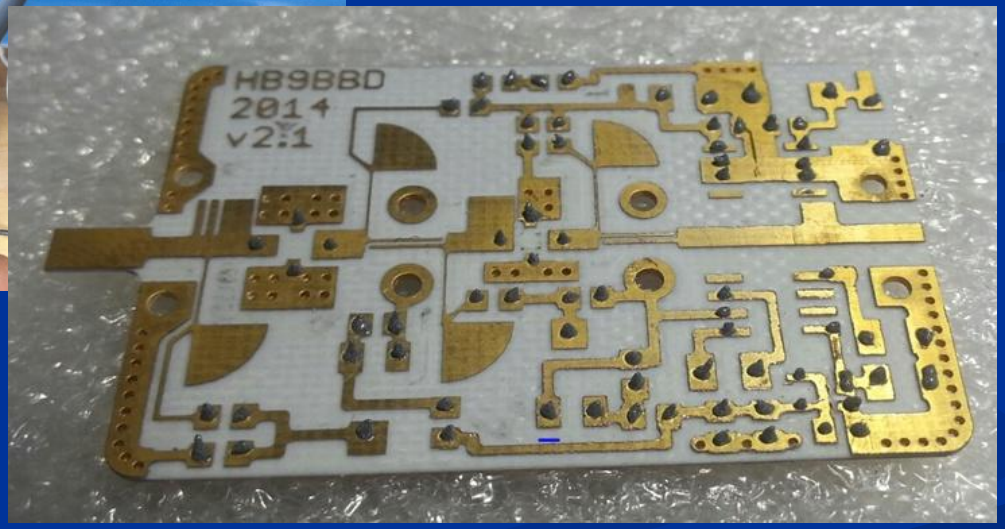
Assembling the PCB: Components are ready



Building the LNA

Assembling the PCB: Applying Solder Paste

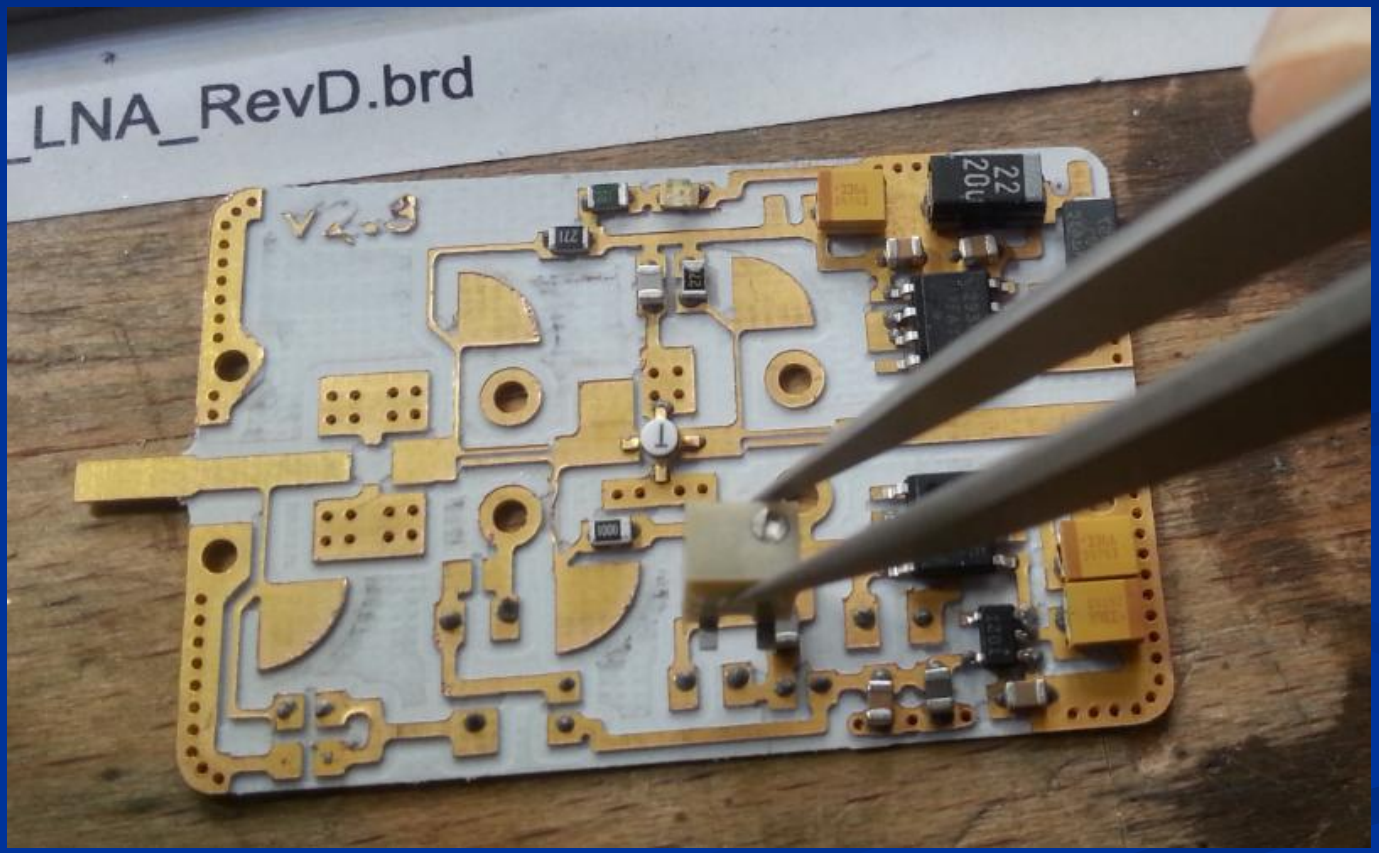
Hightech „Footswitch“



Solder Paste (with Pb!) melting point at **179** deg. C

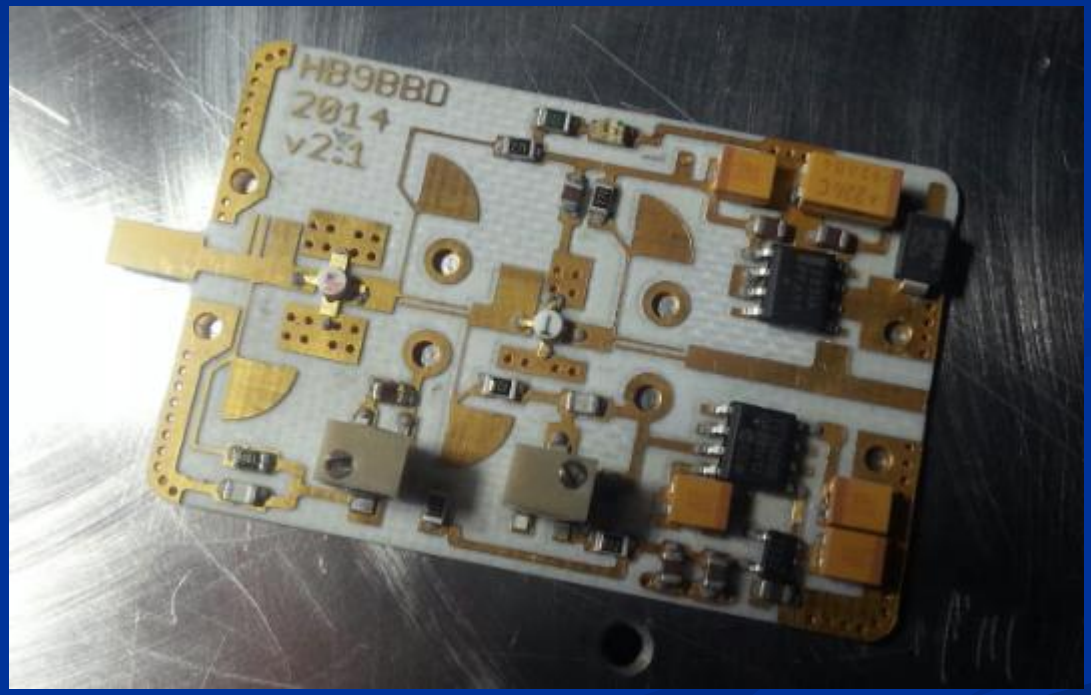
Building the LNA

Assembling the PCB: Placing the Components



Building the LNA

Pre-Heating the PCB



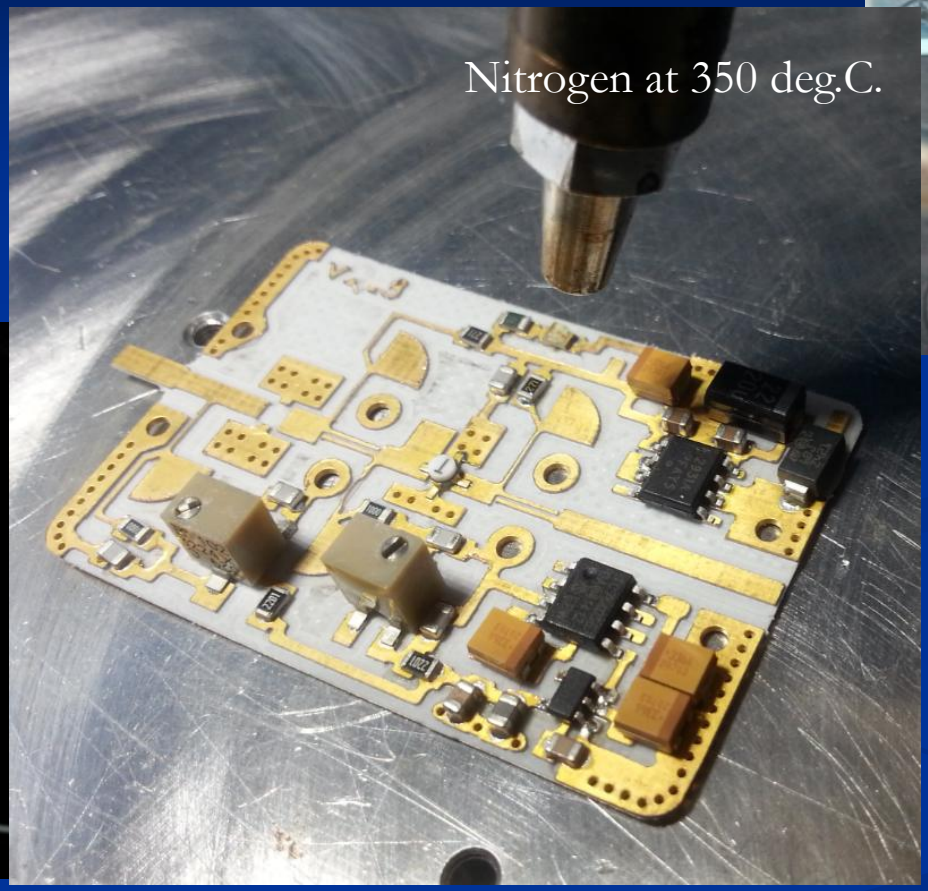
Heating plate at 164 deg. C for preheating the board

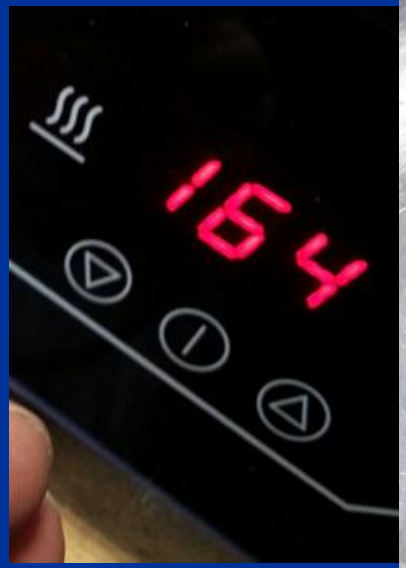
Building the LNA

„Reflow oven“ substituted by hand..

Hot Nitrogen at 350 deg. C

Building the LNA

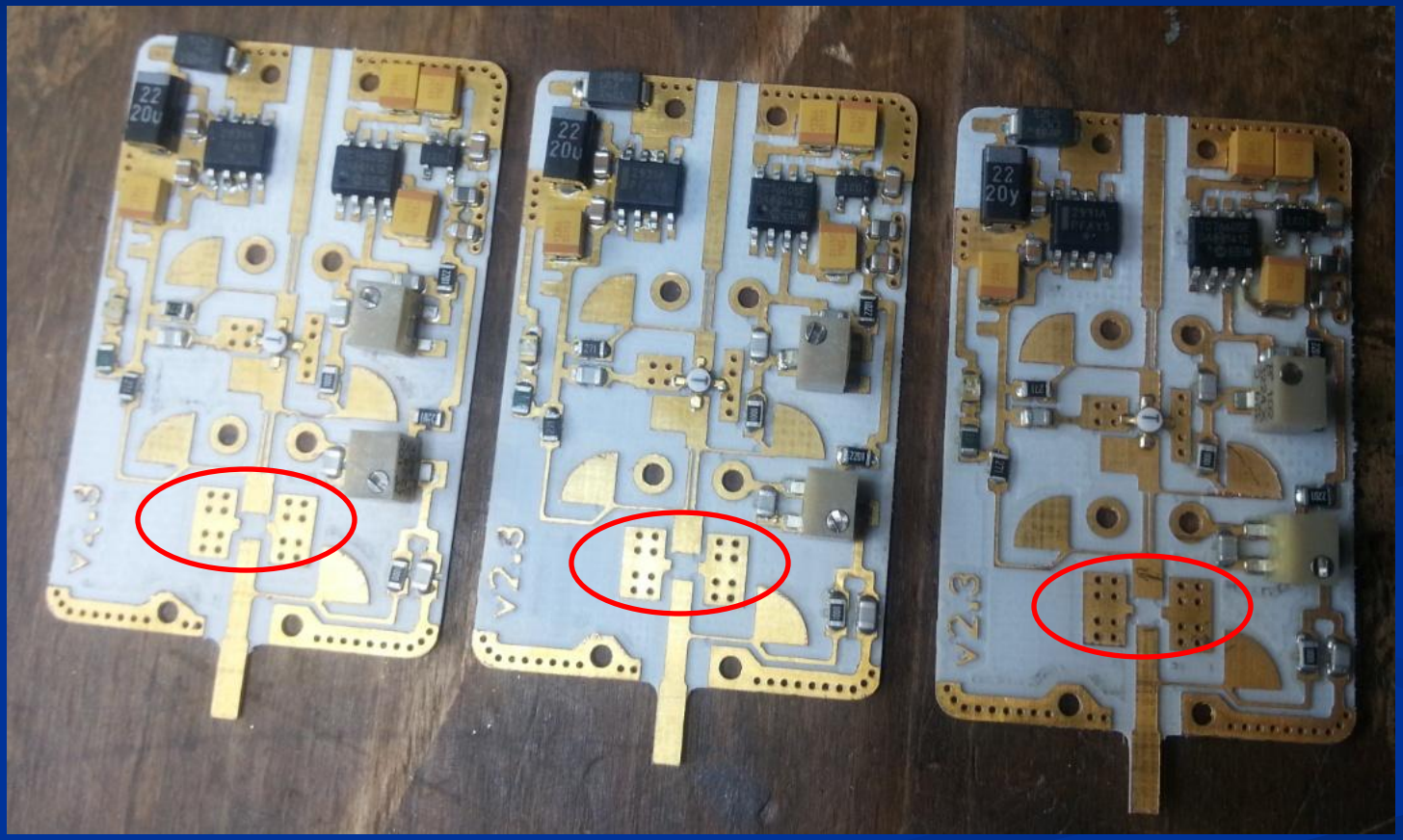




Heating plate at 164 deg. C for preheating the board

Building the LNA

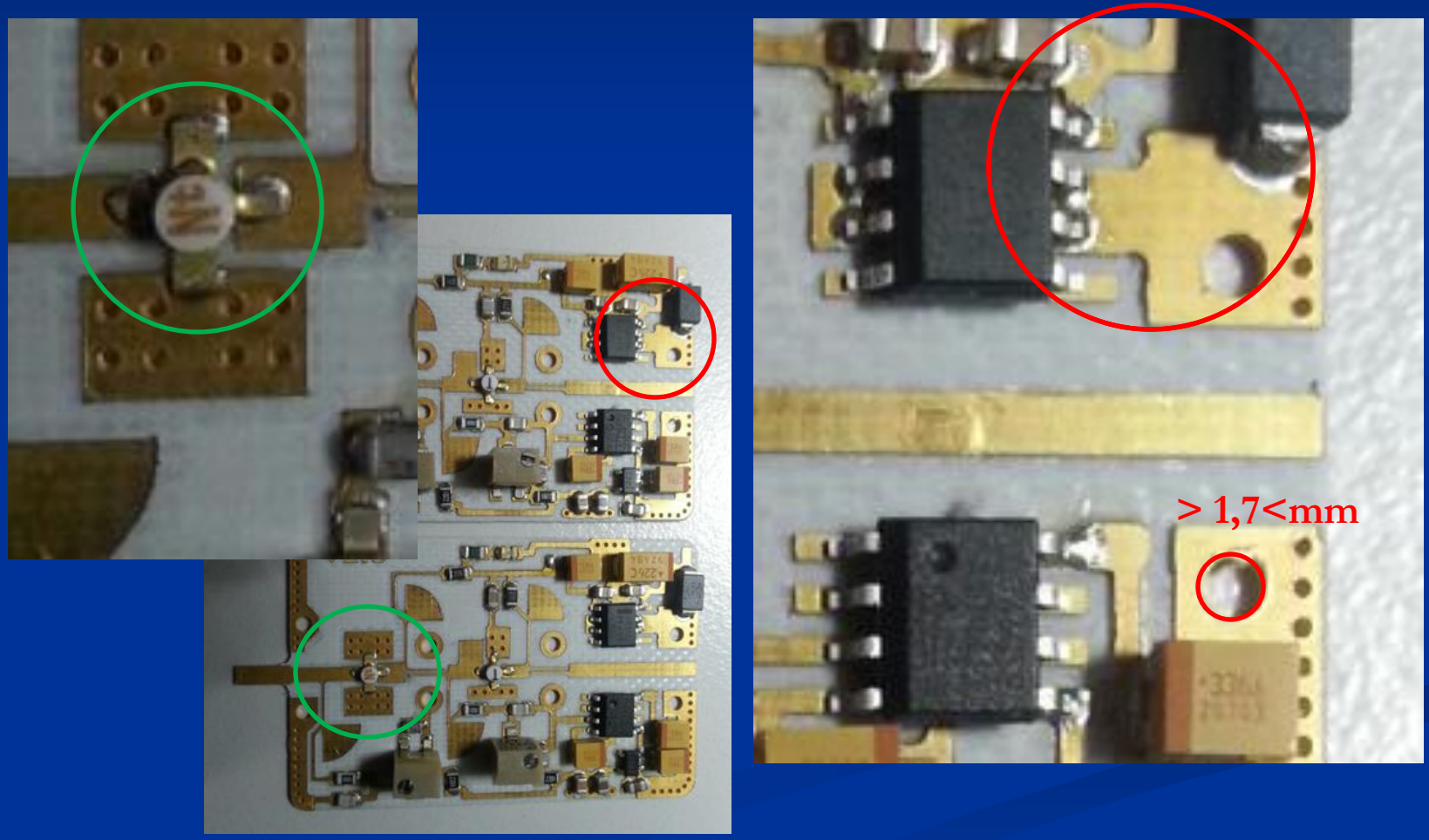
Some boards (almost) ready



The first Fet still to be selected

Building the LNA

Manual „Reflow Oven“ of the poor man



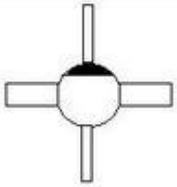
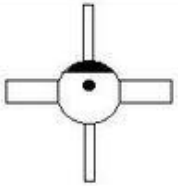
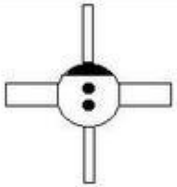
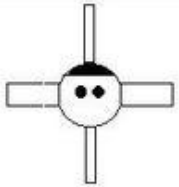
Selecting the best device

Various GaAsFet tested

Obsolete and discontinued GaAs-Fets of the 90ies..

Fujitsu Type Markings

Fujitsu Low Noise HEMT Identification

COLOUR				
PURPLE	FHX13LG/LP	FHX14LG/LP	FMM5701LG	
RED	FHX04LG/LP	FHX05LG/LP	FHX06LG/LP	
BROWN	FHX35LG/LP			
BLACK	FHX40LG	FSX56LP		FSX017LG
GREY			FHX67LP	
BLUE				FSU01LG
GREEN				FSU02LG

The gate lead is always the one with the sloping end

0,45 dB@12 GHz

0,75 dB@12 GHz

Selecting the best device

Later GaAsFet s (already discontinued **)

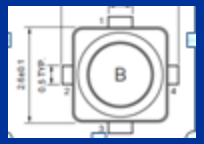
NE32484A ** 0,6 dB@12 GHz

NE32584C 0,45 dB@12 GHz



MGF4919G ** 0,45 dB@12 GHz


NE3210S01 ** 0,35 dB@12 GHz



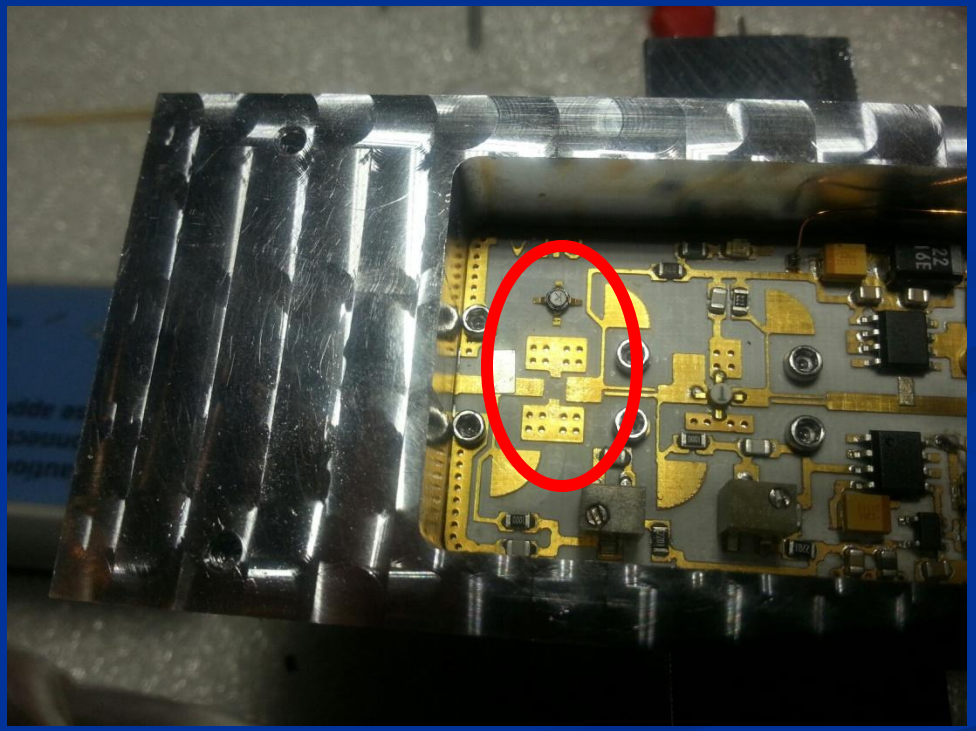

NE3511S02 0,30 dB@12 GHz

NE3512S02 0,35 dB@12 GHz

Selecting the best device

A simple way to qickly selct a device
Various GaAs-Fet tested

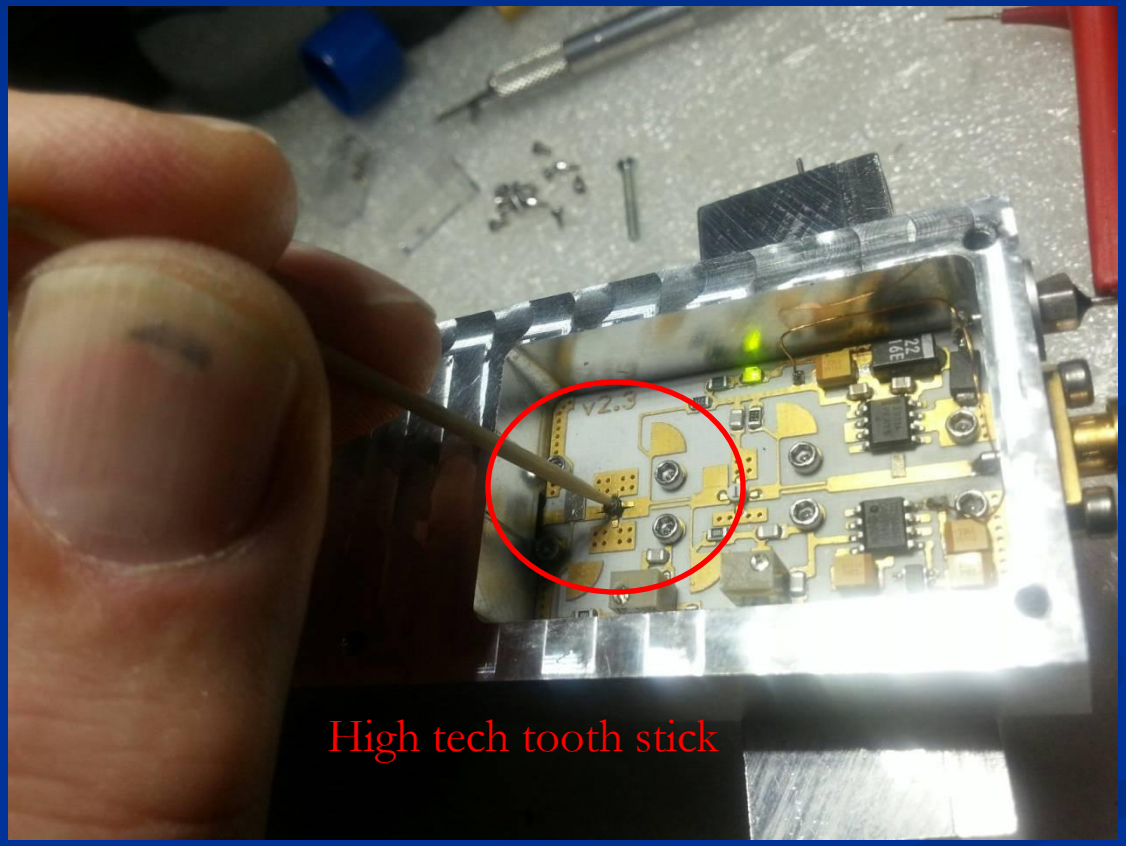
Again, don‘t believe,
MEASURE!



Selecting the best device

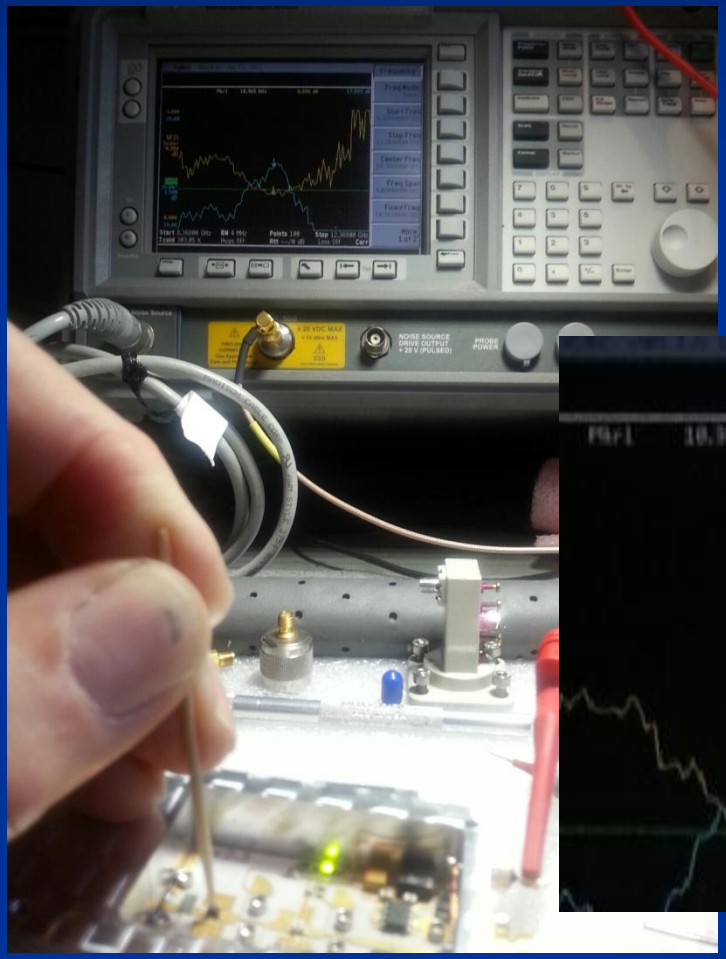
A NE3210S01 at work

The latest Test Fixture!



Selecting the best device

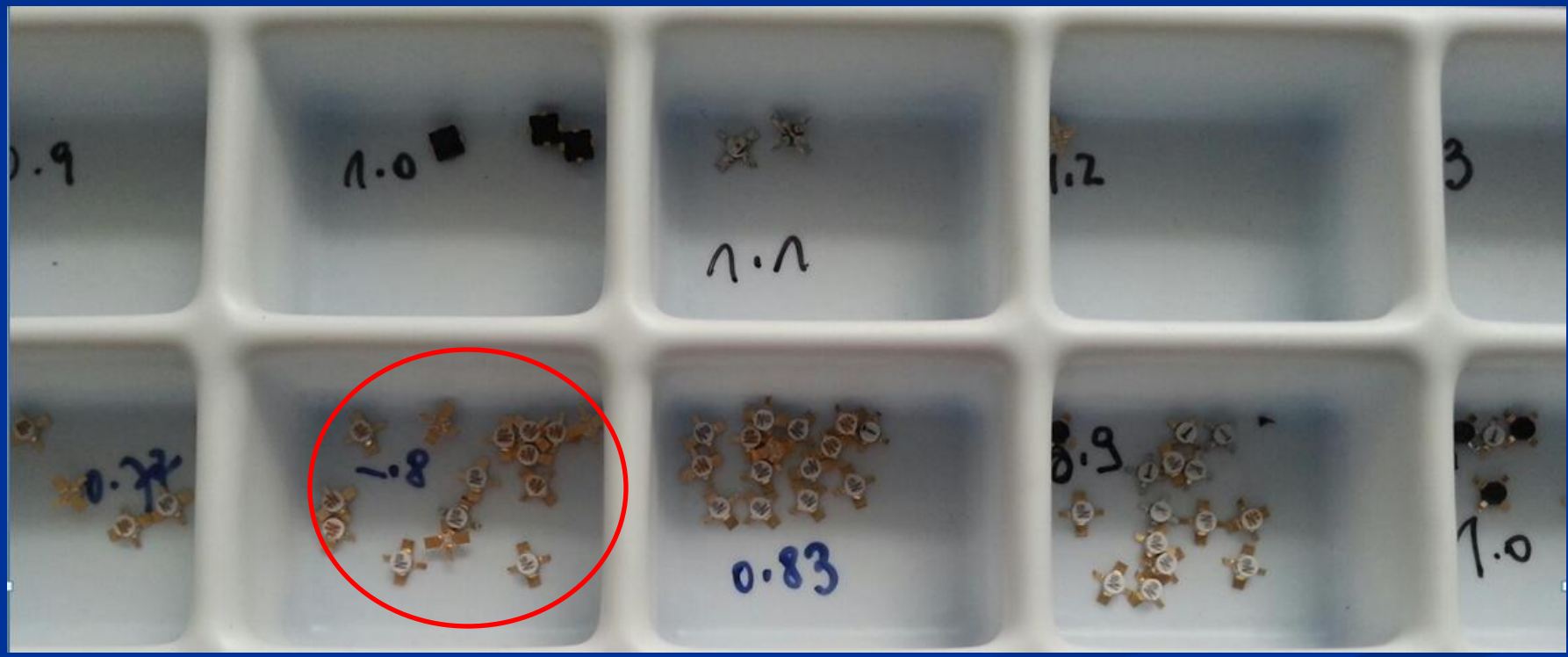
A NE3210S01 looks good!



Agilent 8975A
N4000A

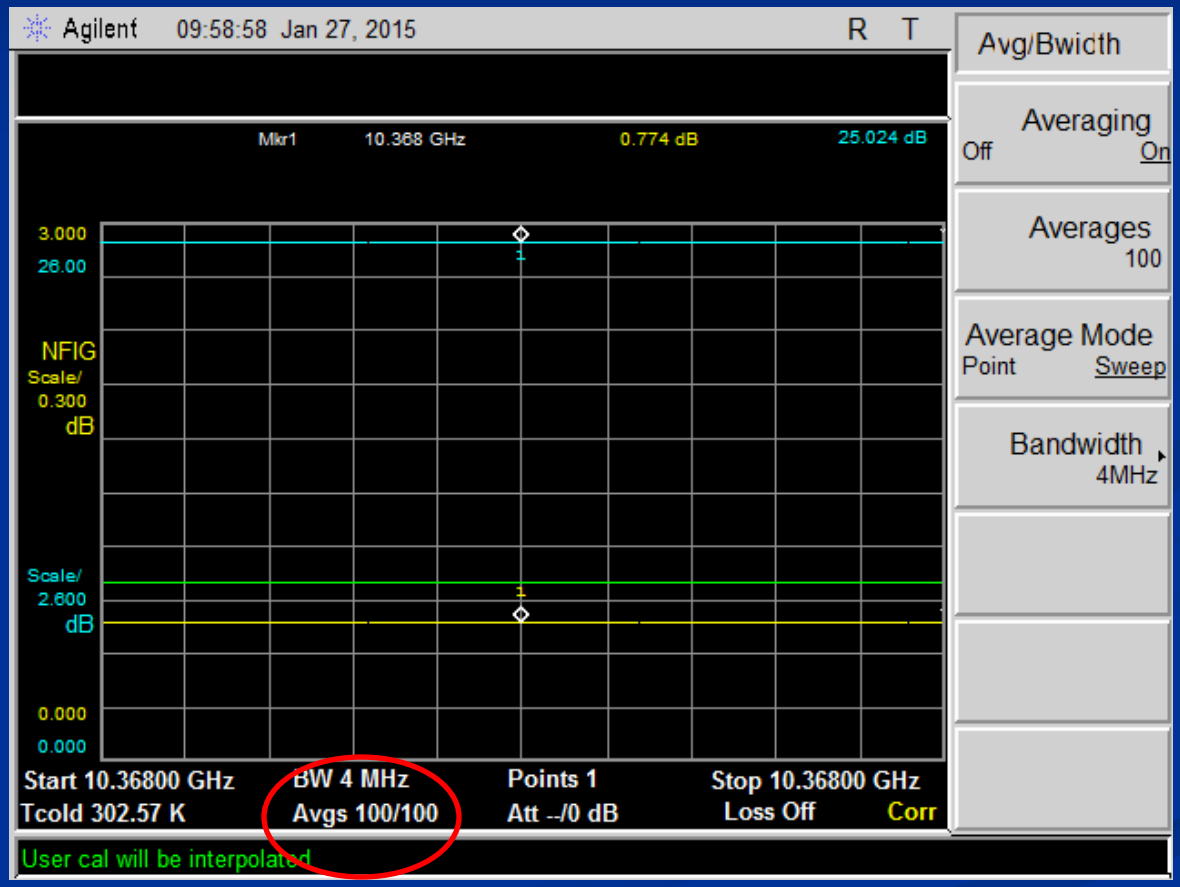
Selecting the best device

After the measurment things become obvious..



Measuring Noise and Gain

For reliable NF measurment averaging matters!

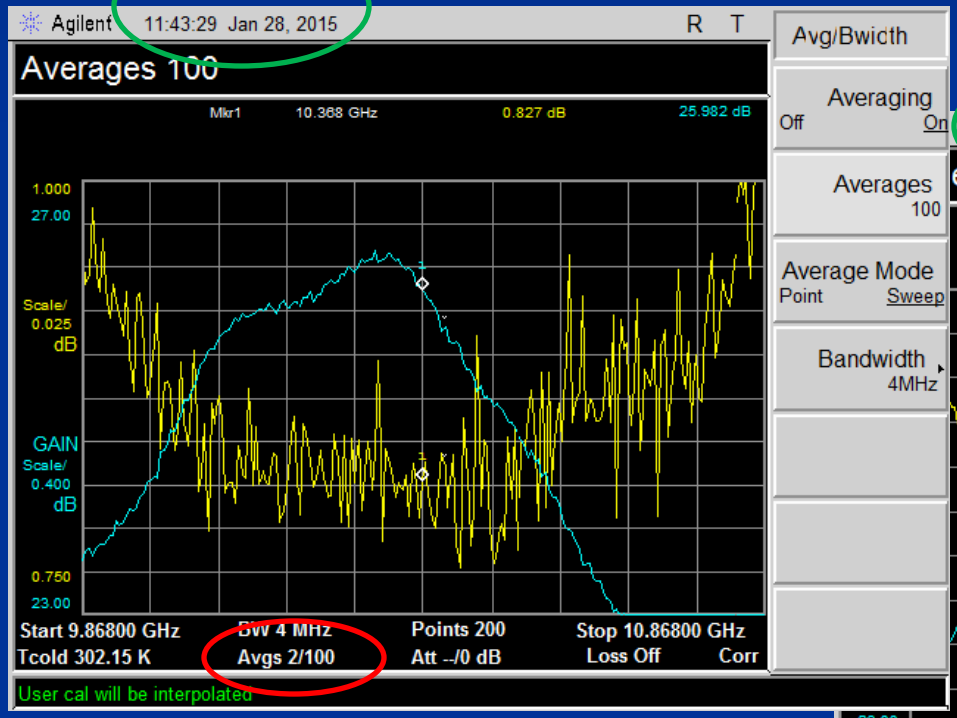


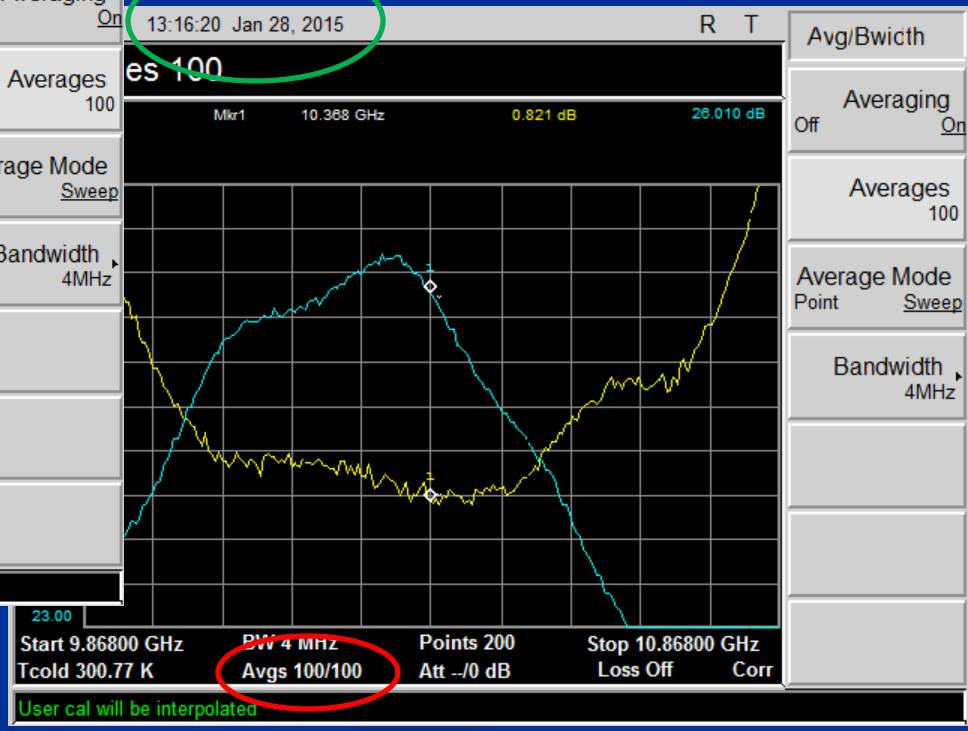
Measuring Noise and Gain

The Relevance of Measurment Results

Work done. While I was at lunch with my wife

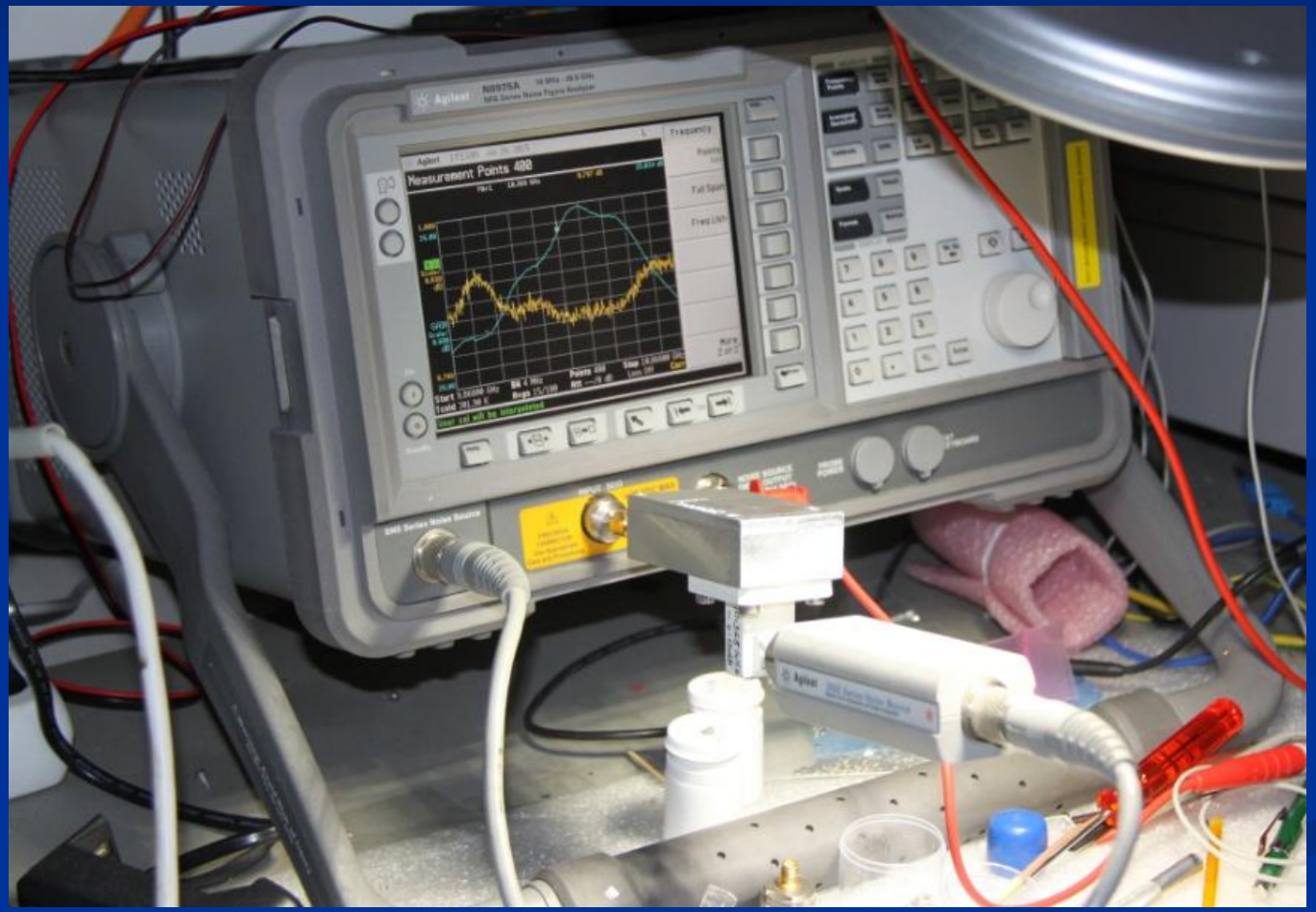
20‘000 measurments were taken



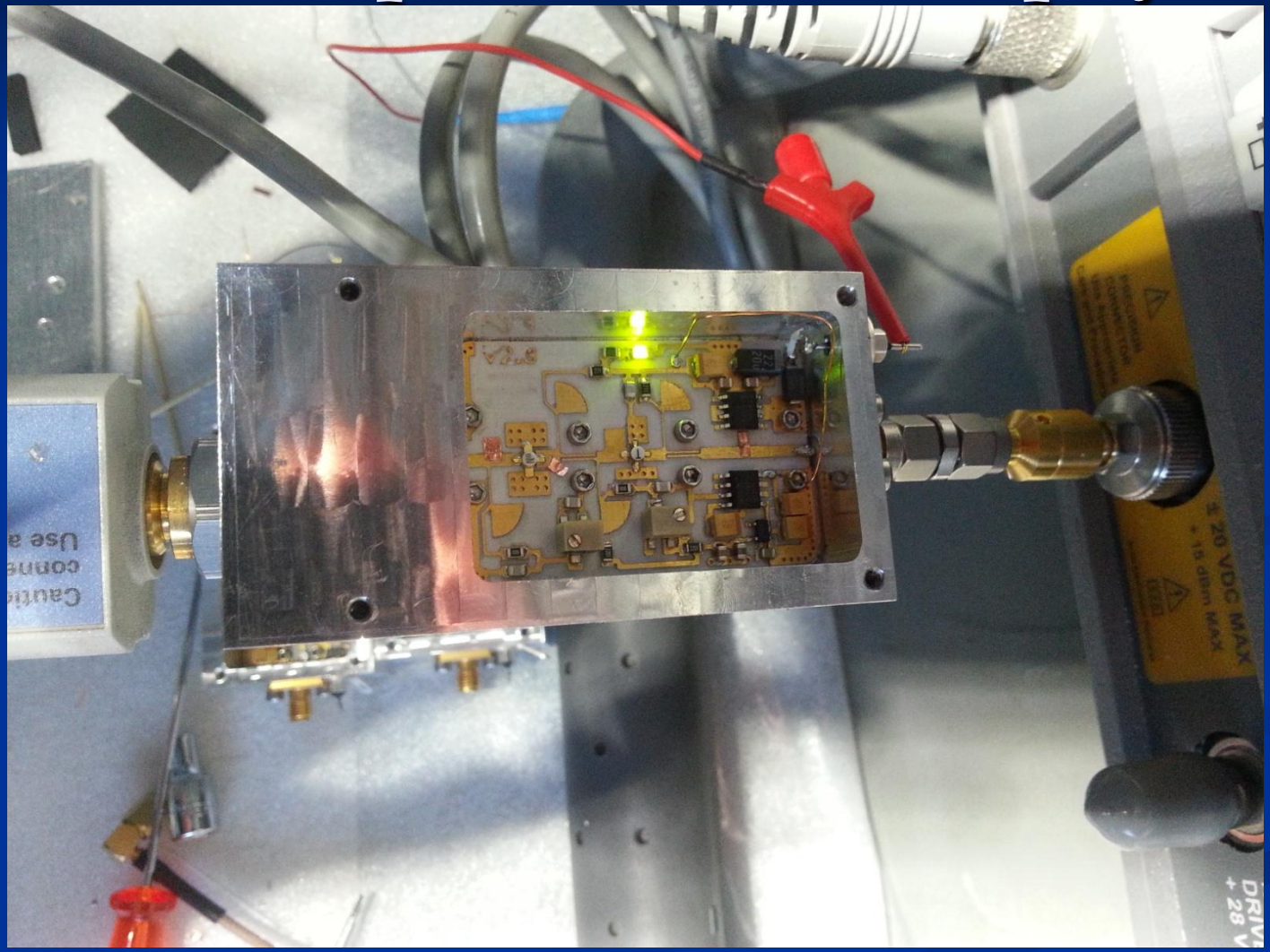


Where is the minimum Noise?

The Results pull us down to physics..

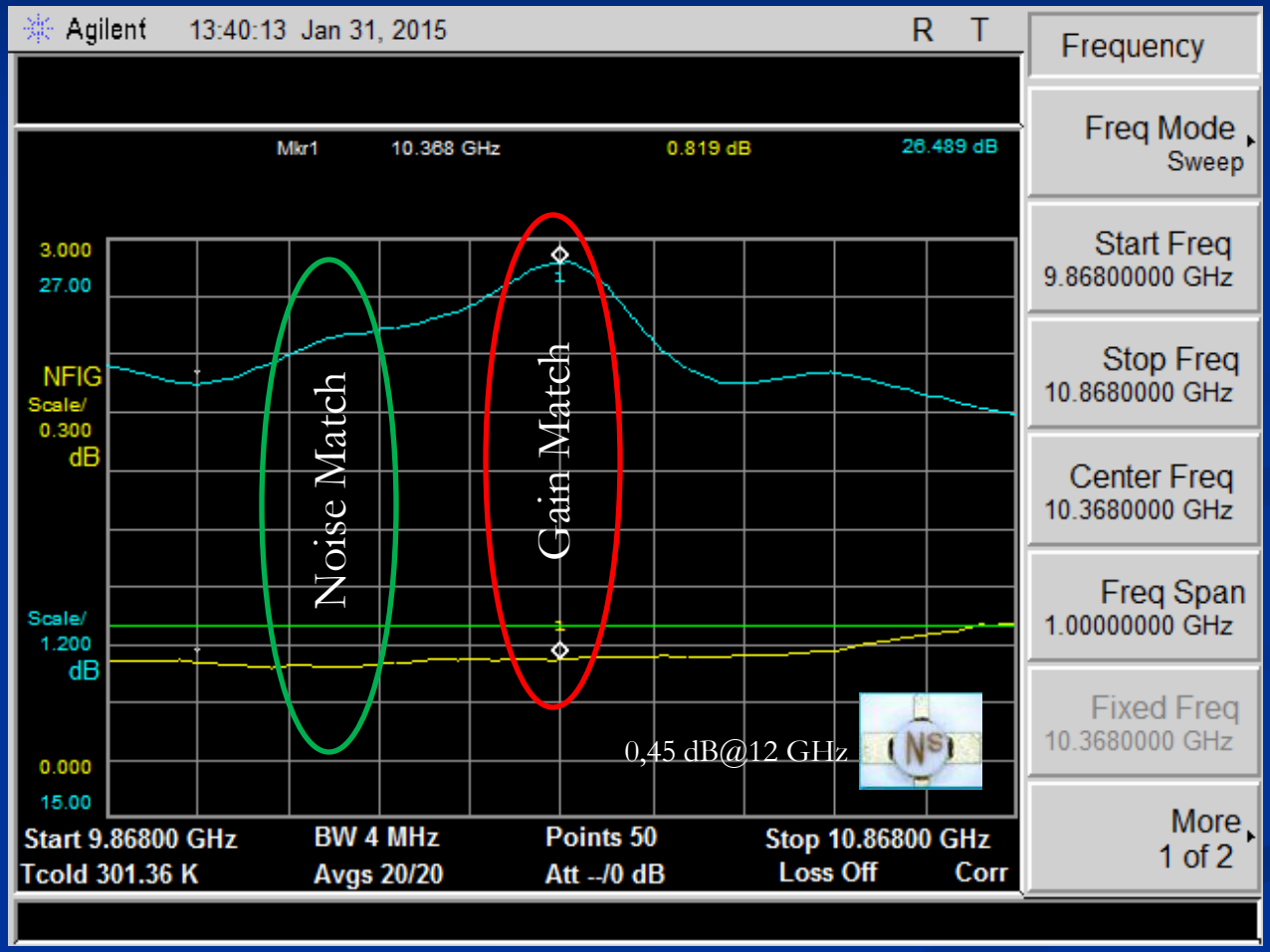


The Results pull us down to physics..



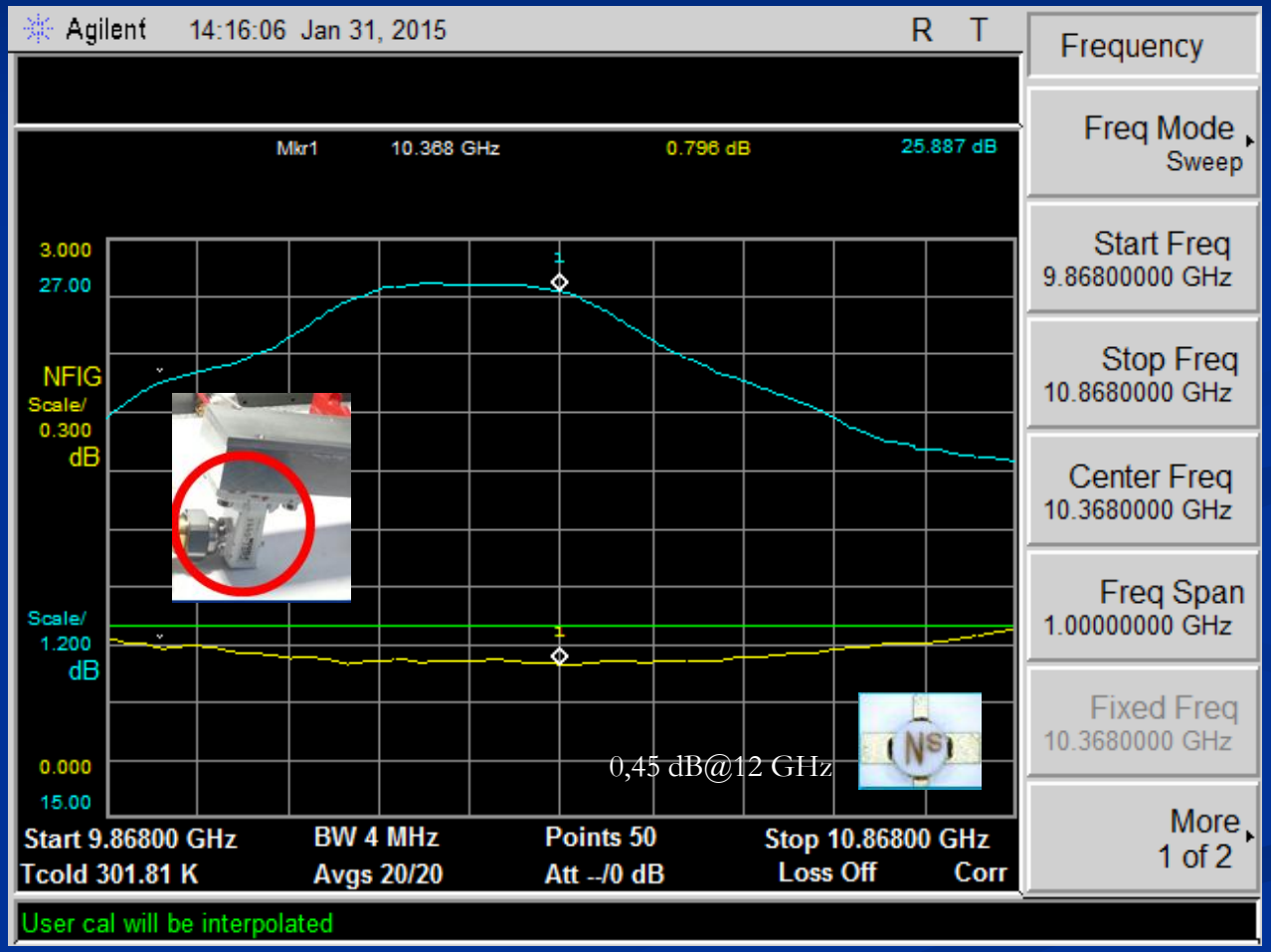
Measuring Noise and Gain

HB9BBD # 1-V2.3



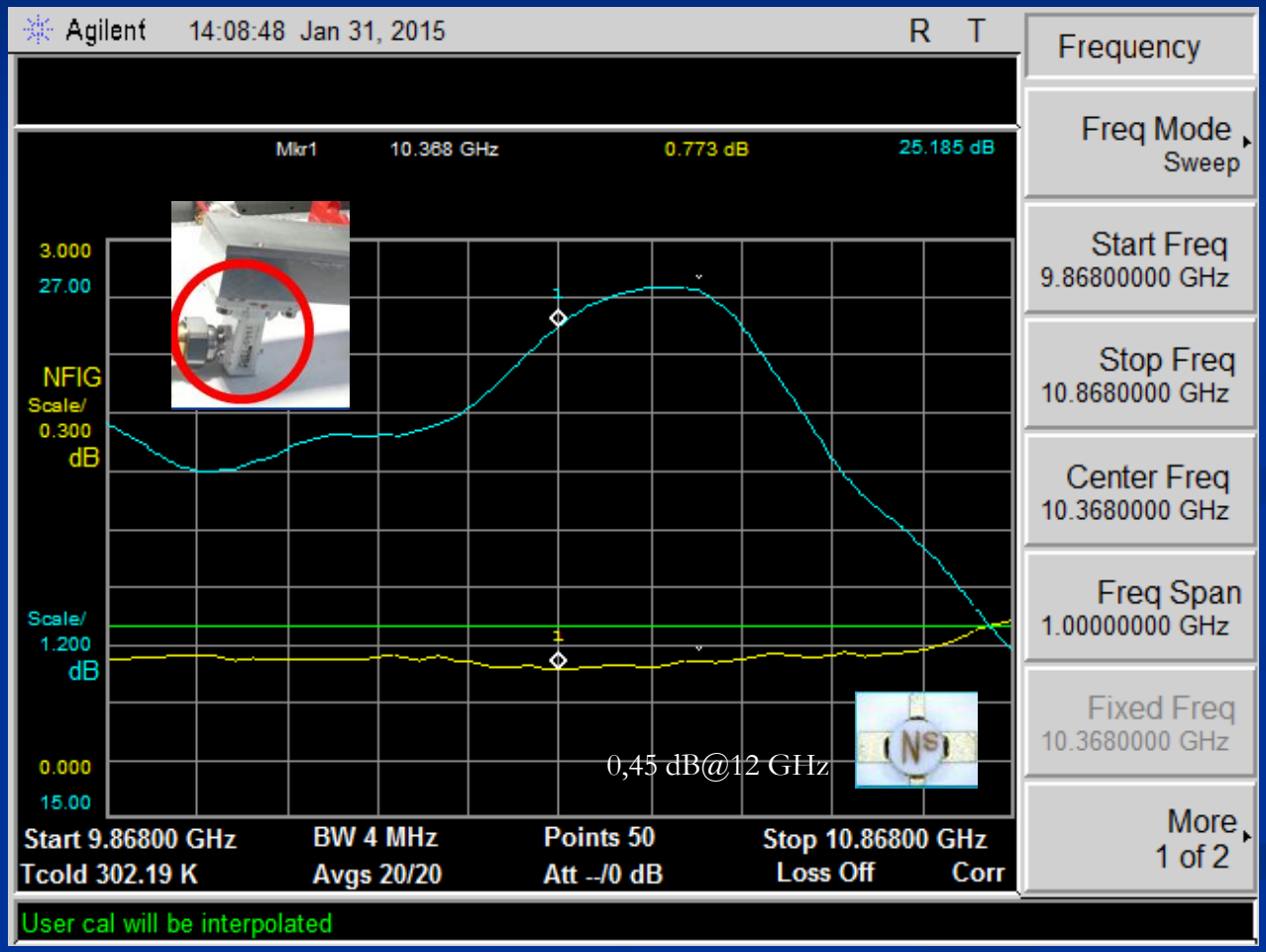
Measuring Noise and Gain

HB9BBD # 1-V2.0



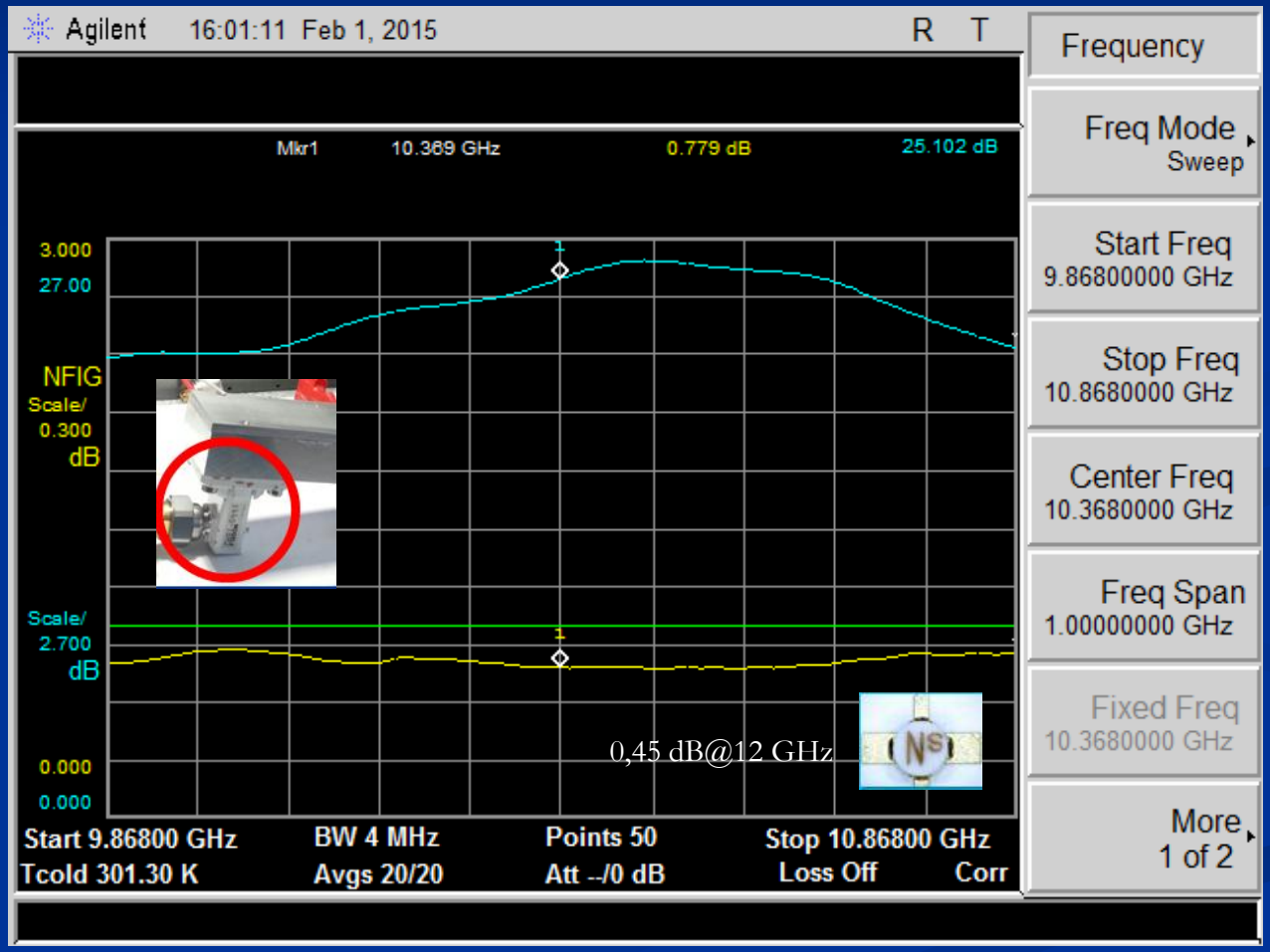
Measuring Noise and Gain

HB9BBD # 1-V2.2



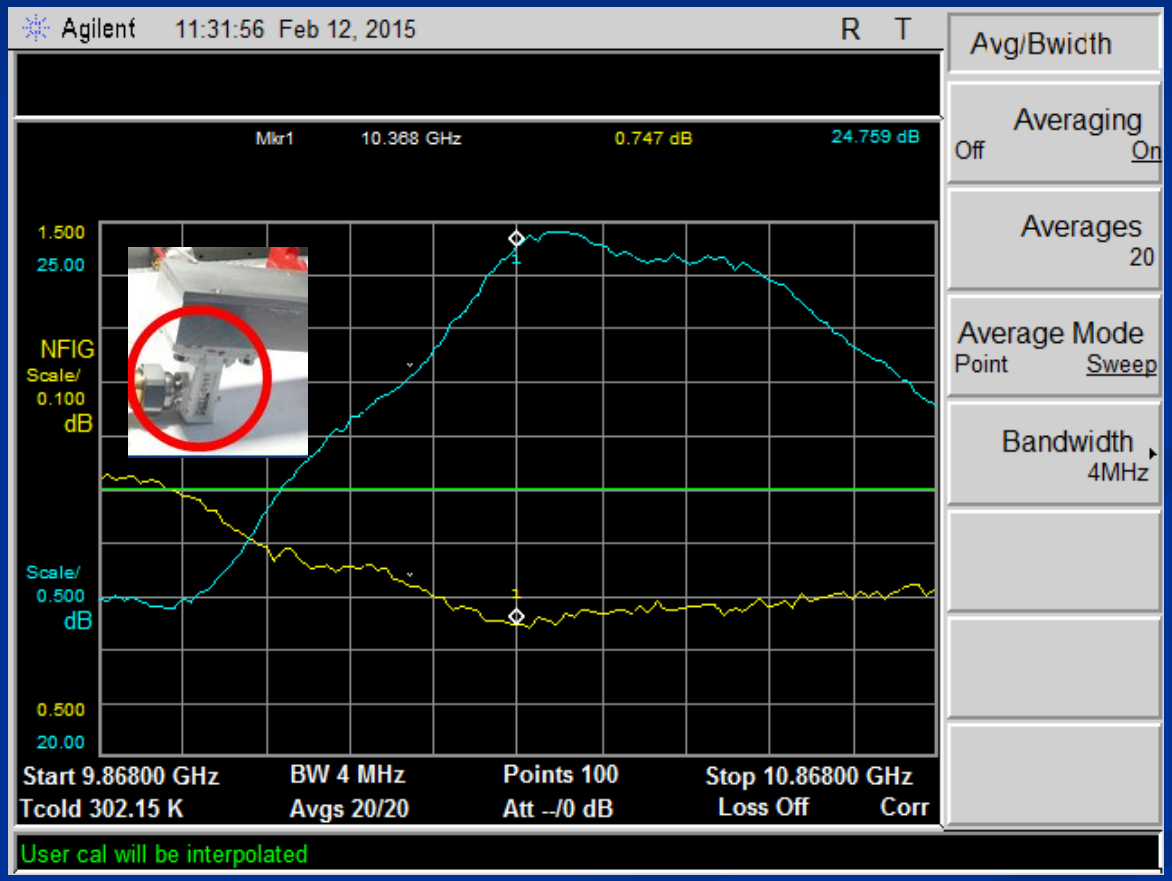
Measuring Noise and Gain

HB9BBD # 2-V2.3



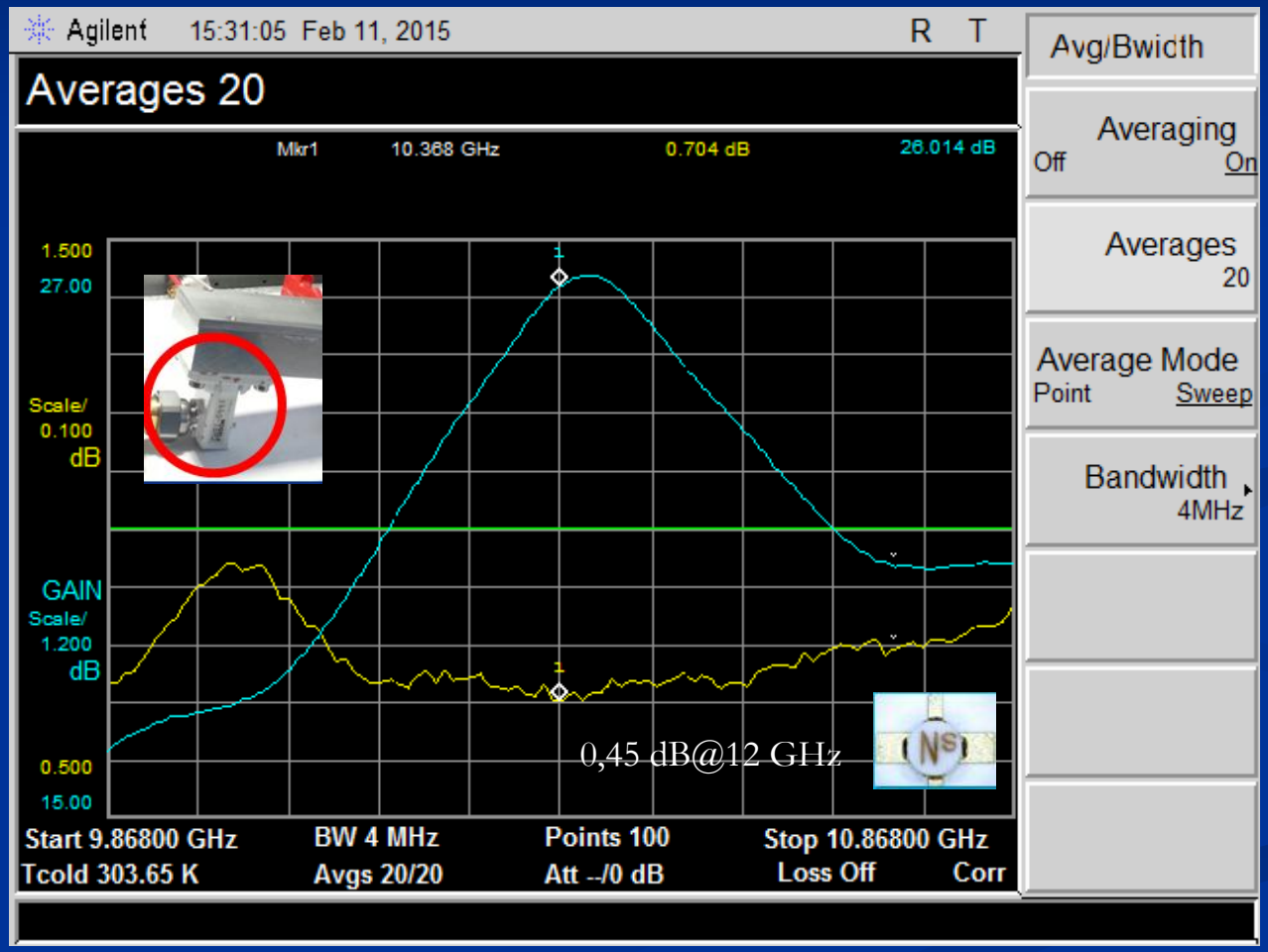
Measuring Noise and Gain

HB9BBD # 4-V2.3



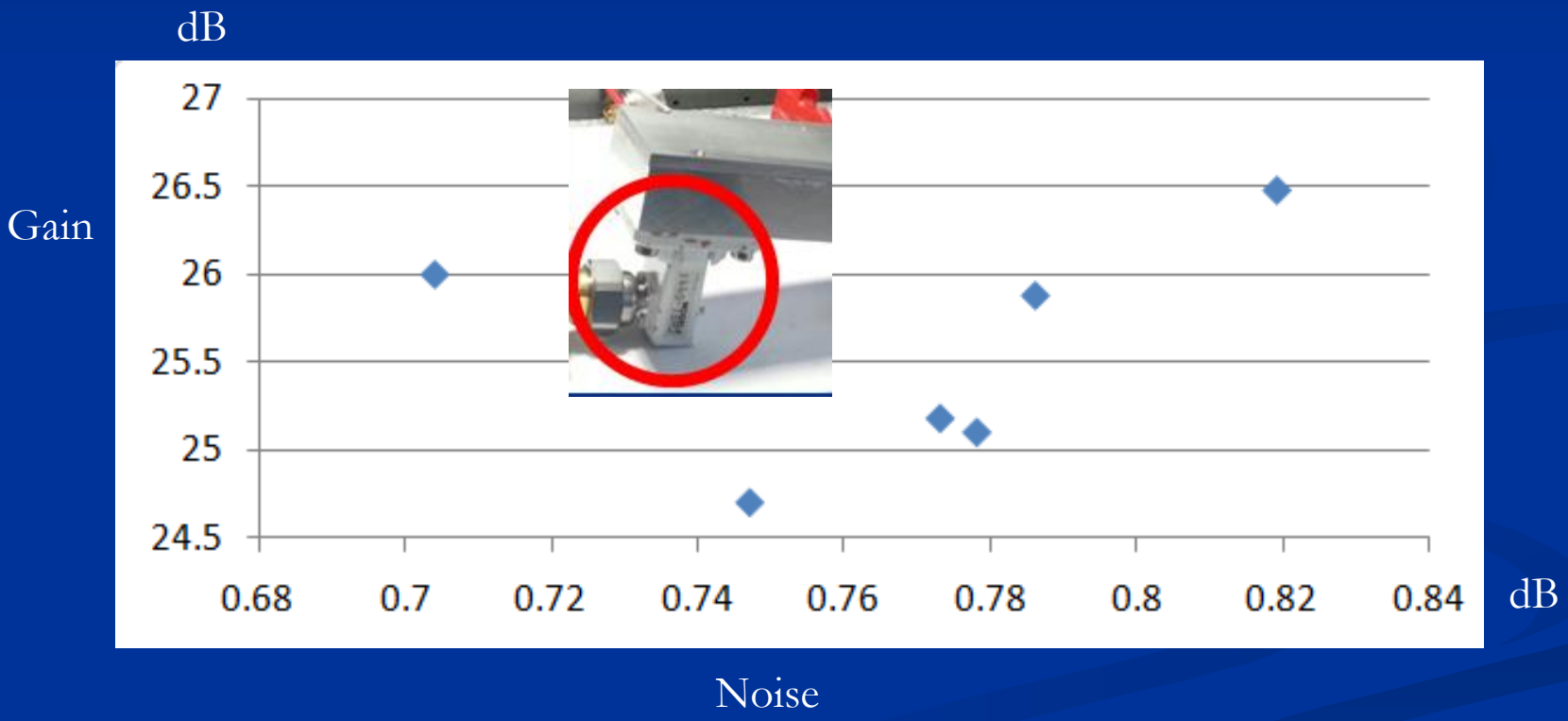
Measuring Noise and Gain

HB9BBD # 3-V2.3



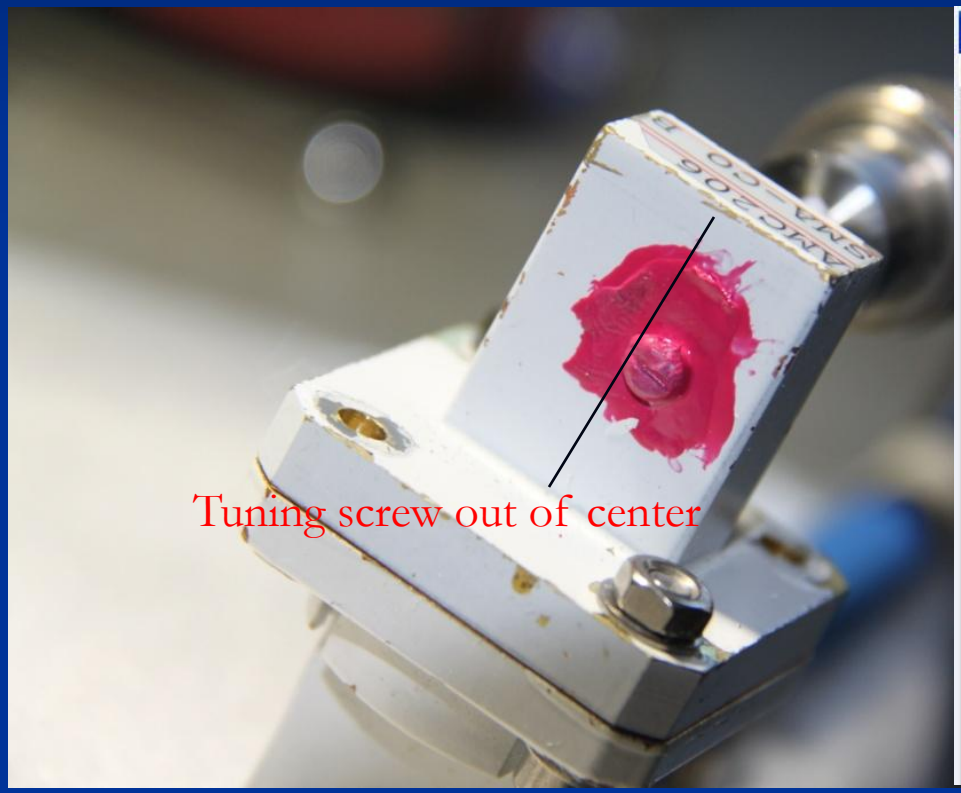
The Results bring us down to reality..

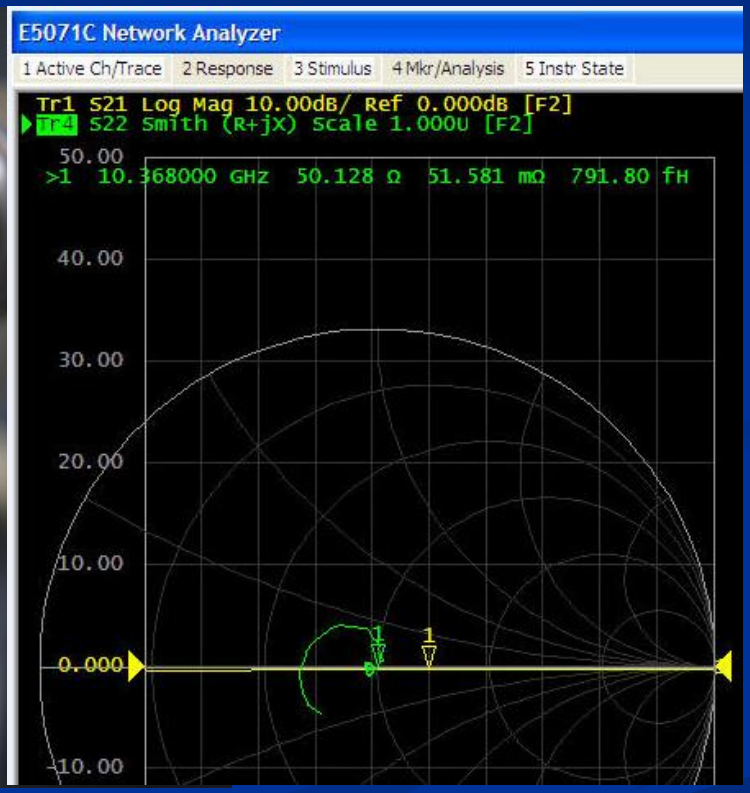
HB9BBD 10 GHz LNA‘s including WG/SMA Adaptor



SMA-WR75 adaptor considerations

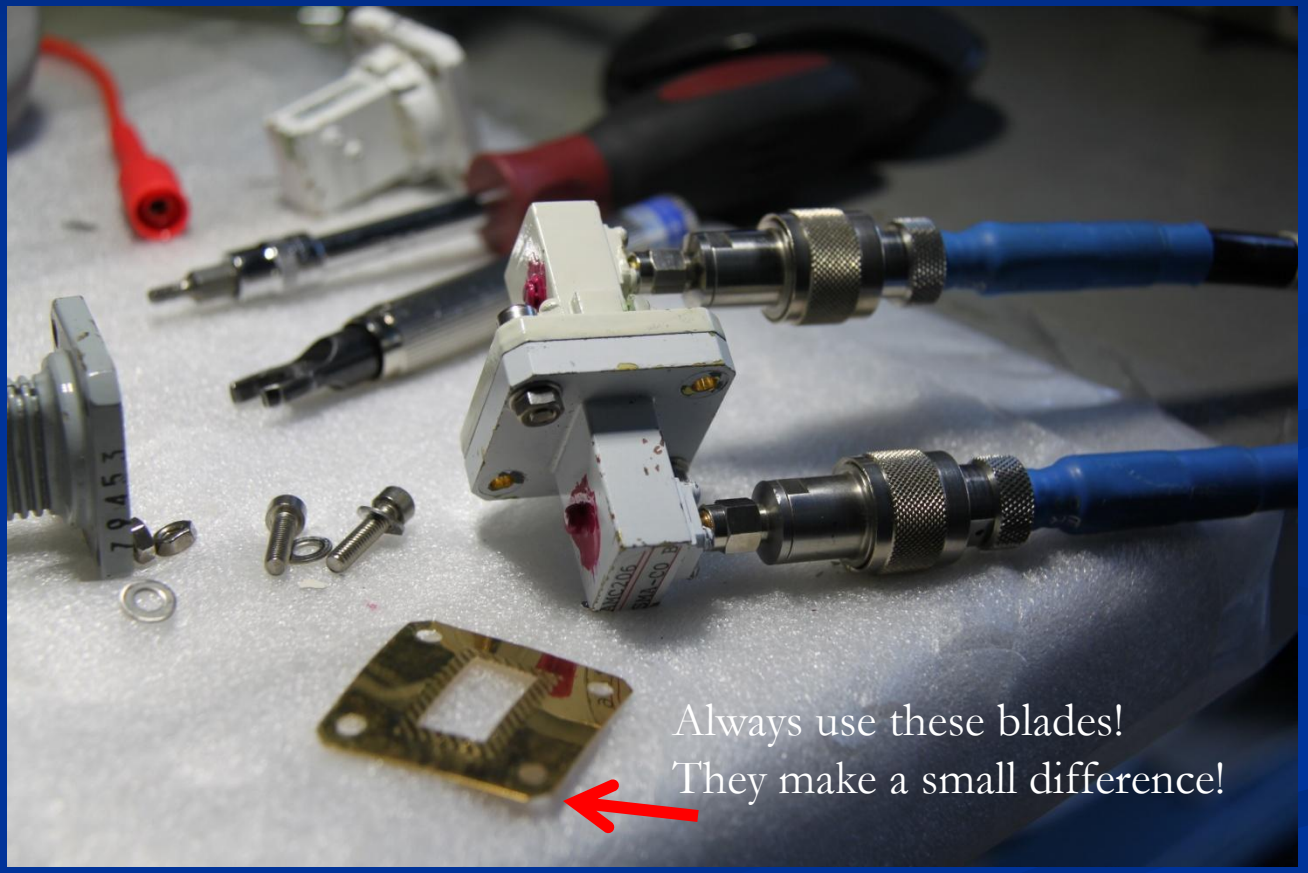
Some Adaptors are perfect





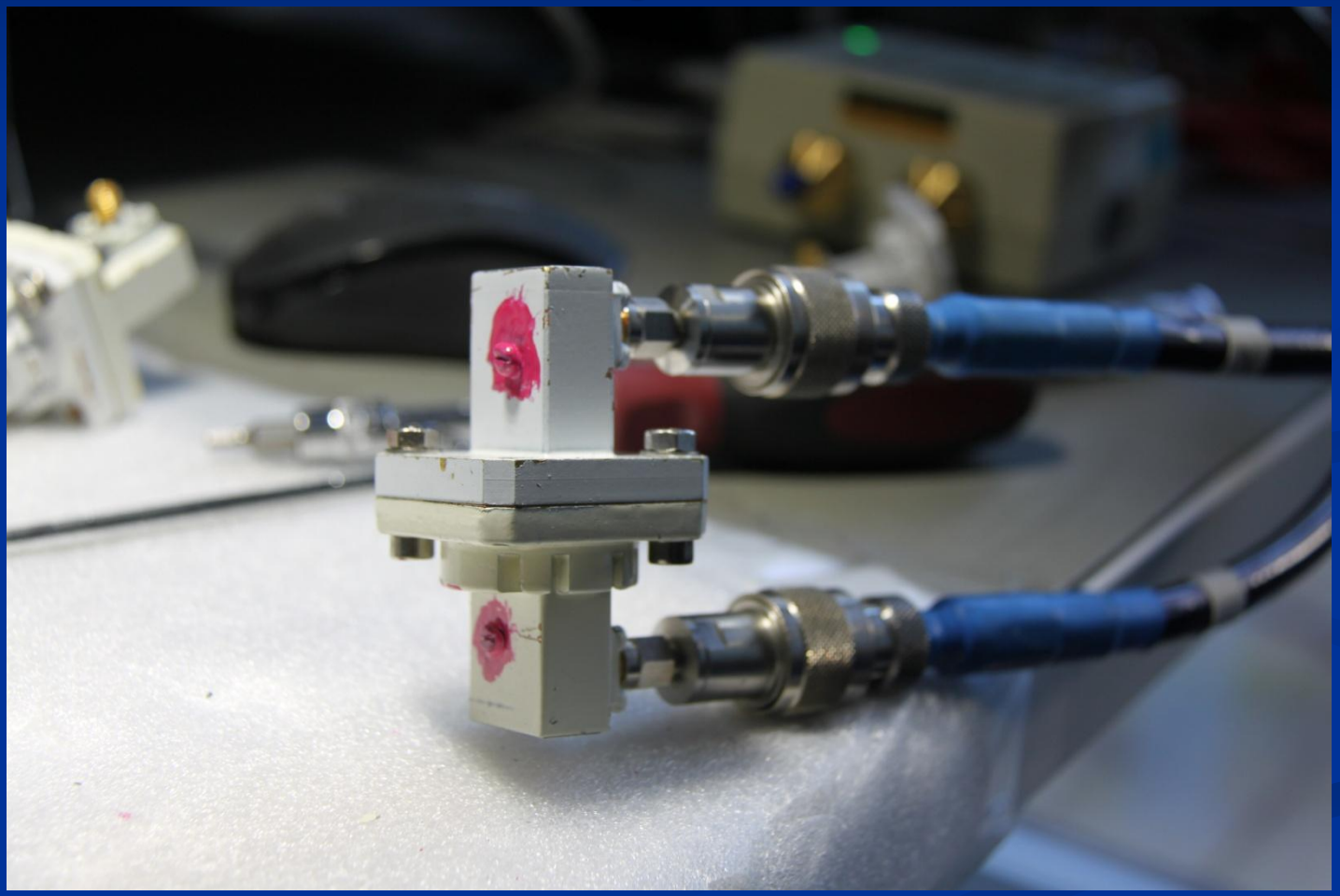
SMA-WR75 adaptor considerations

Measuring the loss



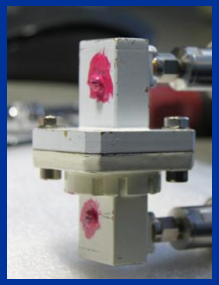
SMA-WR75 adaptor considerations

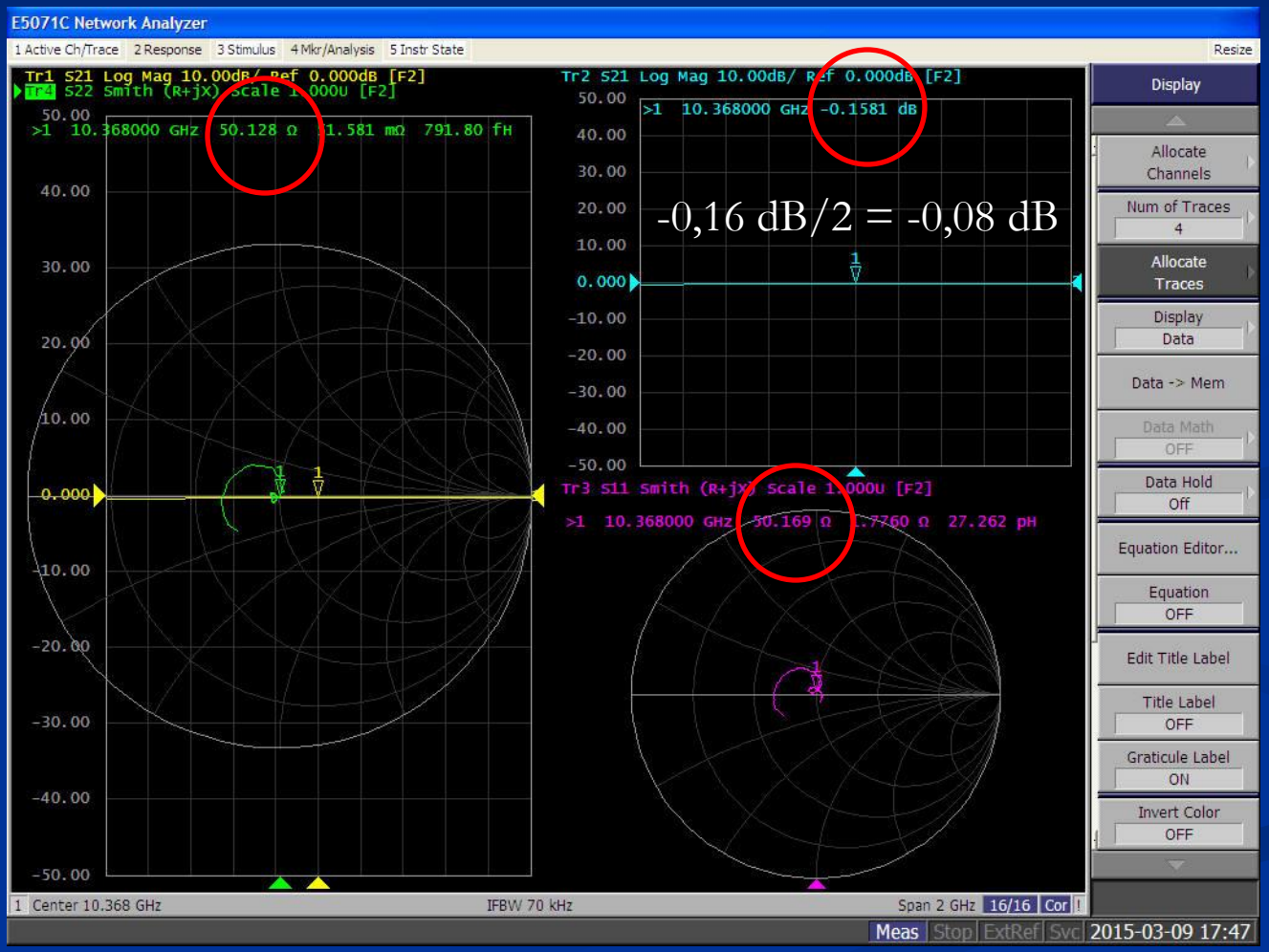
Measuring the loss



SMA-WR75 adaptor considerations

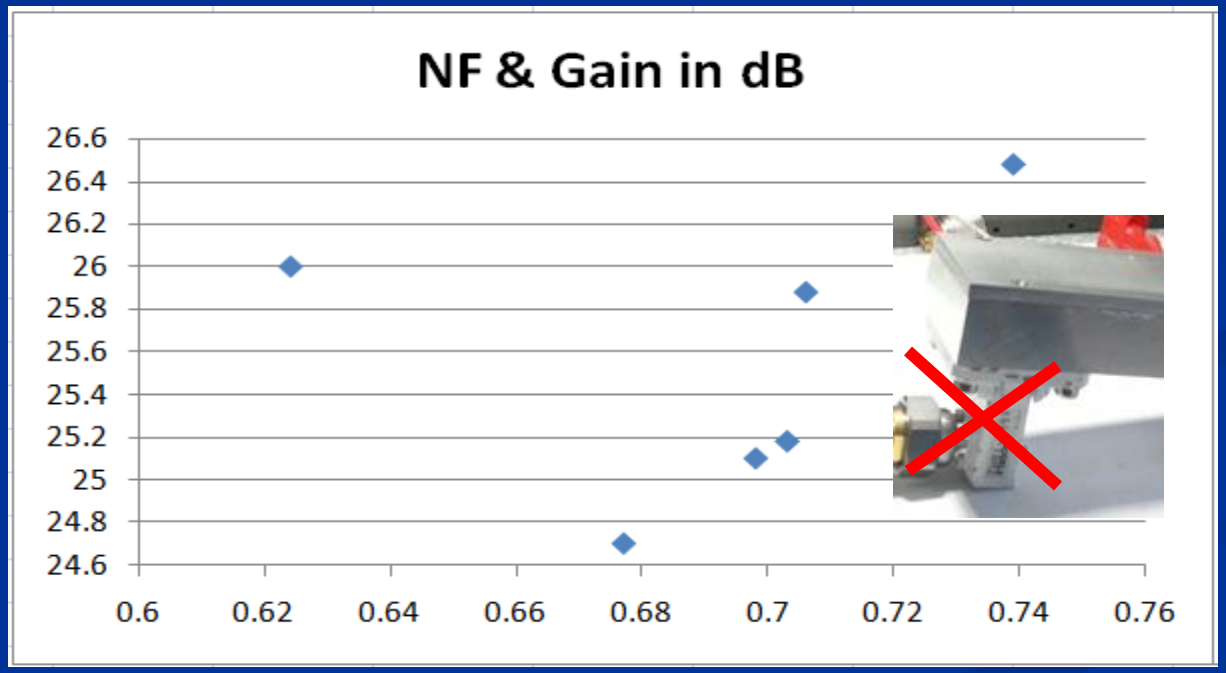
S-Parameters S11, S22, S21 at a glance





The Results bring us down to reality..

HB9BBD 10 GHz LNA's without WG/SMA Adaptor



Wrap-up

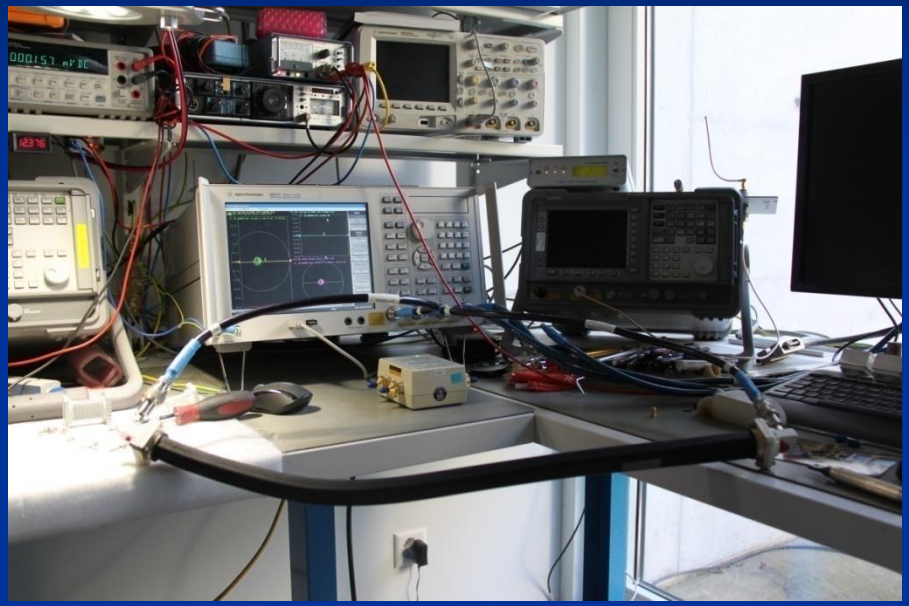
- On 10 GHz the State-of-the-Art NF is in the order of
  Noise@Device + 0,2 dB at ambient temperature
- The adapter SMA-WG adds some 0.08 dB ~
- There is no WG NoiseHead available anymore!

- Therefore at best NF can be expected 0,60 dB (WG/SMA loss)
  This is because all components including PCB are lossy and generate Noise.
- You can build your own LNA, if you are not much impressed by the time you invest and if your XYL is very tolerant.
- Do not expect wonders (from LNA!).

Questions? Comments?

SMA-WR75 and 60cm Flexible WG

S21 -0,2 dB net without Adaptors



-0,2 dB

-0,36 - 0,16 = -0,2 dB

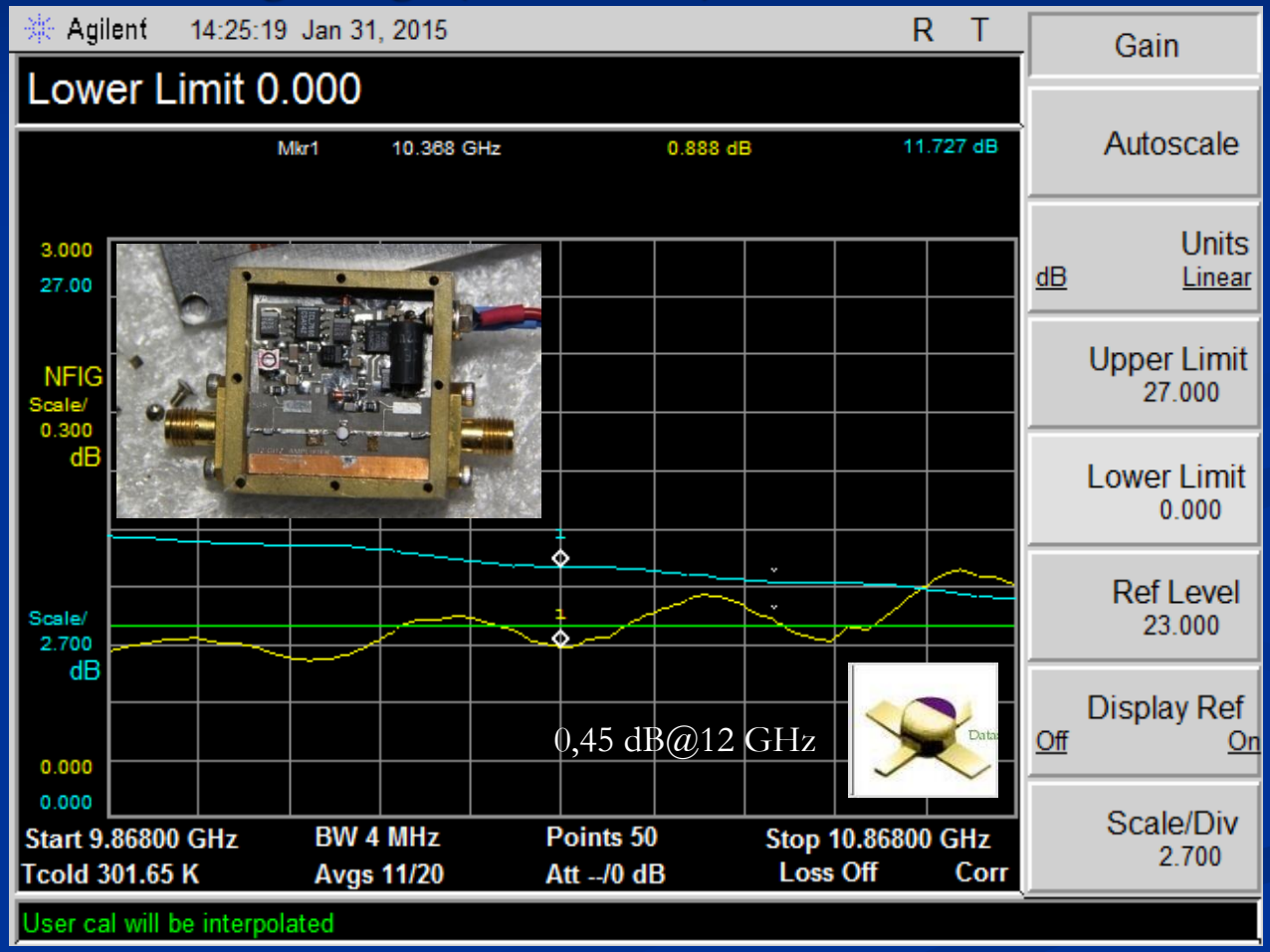
Appendix

HP X347A Waveguide Noise Source

ENR 15,2 dB, not ideal for LNA
(obsolete)

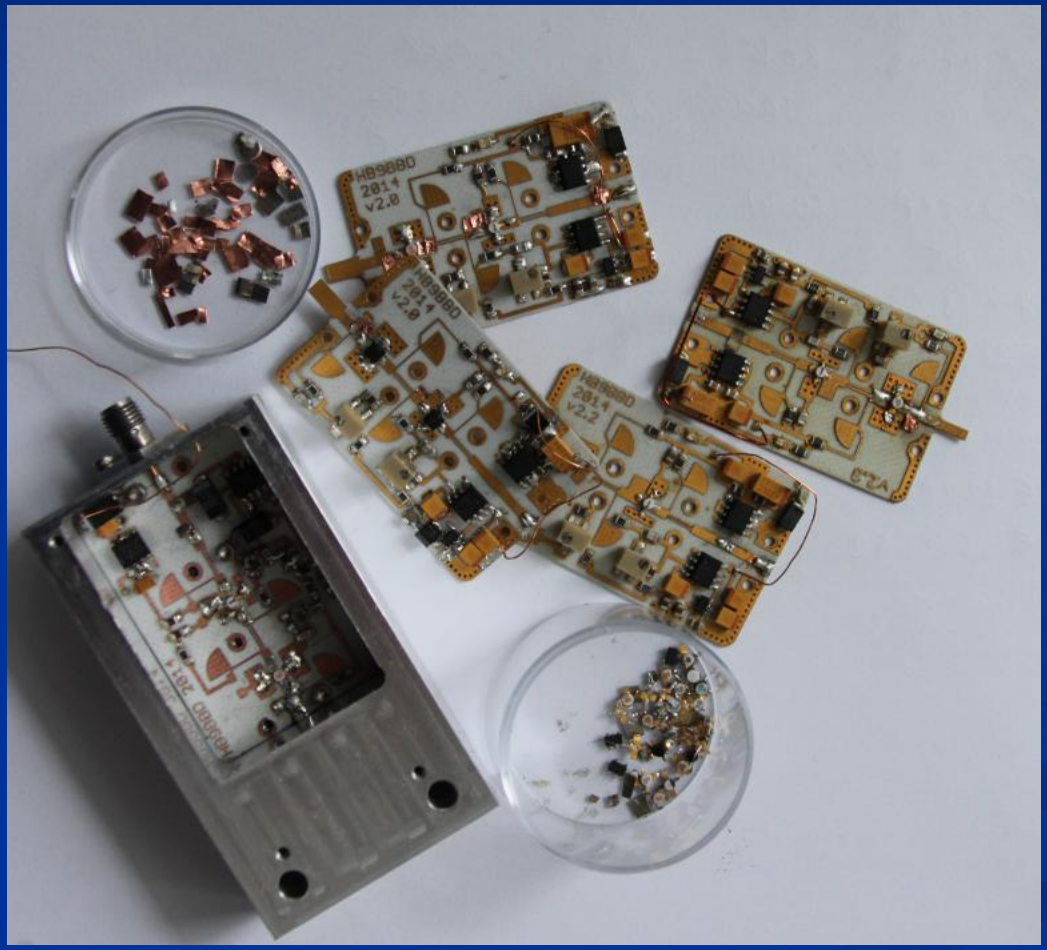
Measuring Noise and Gain

Single stage (SMA/SMA) FHX13LG



Appendix

Some scrap…



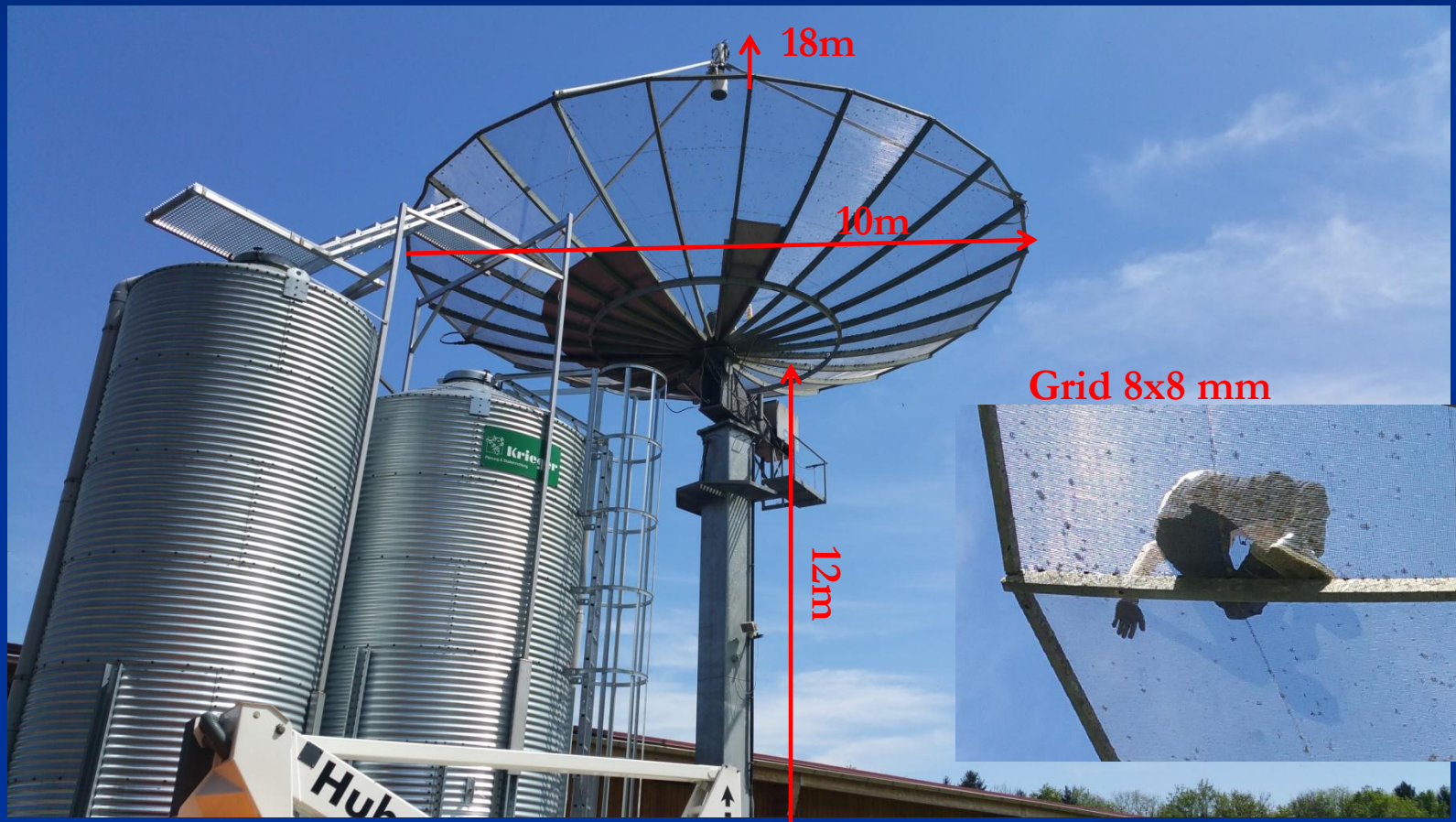
Antenna upgrade

Mai 2015 upgrade of 10 m parabolic antenna for 10 GHz

1mm stainless steel
280 Kg ..

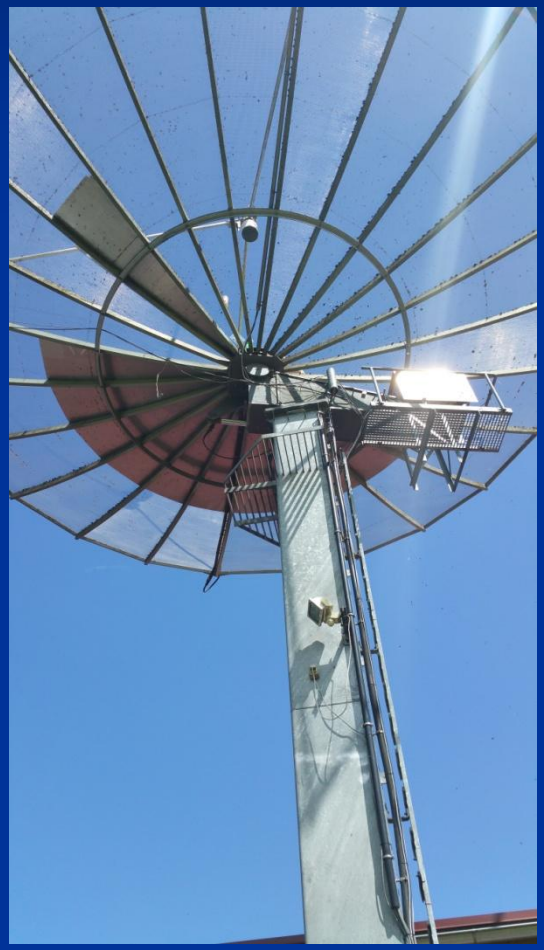
Antenna upgrade

Mai 2015 upgrade of 10 m parabolic antenna for 10 GHz



Antenna upgrade

Mai 2015 upgrade of 10 m parabolic antenna for 10 GHz



finished.

5,86 m/203 Lambda > f/D 0,85 > Gain dBi 52@3cm 3dB/0,35 Deg.