LNA`s for 10 GHz

What did change in LNA design?

HB9BBD

Introduction

- In the past LNA‘s were designed, built, tested, redesigned, tested, modified, tested...
- Beginning 2015 EME LNA‘s came on the market without any tuning elements
- Repeatability and thus industrial production became a fact
- The well-known TV LNB design has reached Ham gear

Agenda

- The Past 
- Traditional LNA development and design 
- Time consuming LNA work 
- The Future: NO-Tune Sandwich Design
- About measuring Noise and Gain
- Comparison of various LNA's
- Conclusions

Appendix: The EME beacon DL0SHF with 1m dish

Step-Transformer circ.feed to Antenna

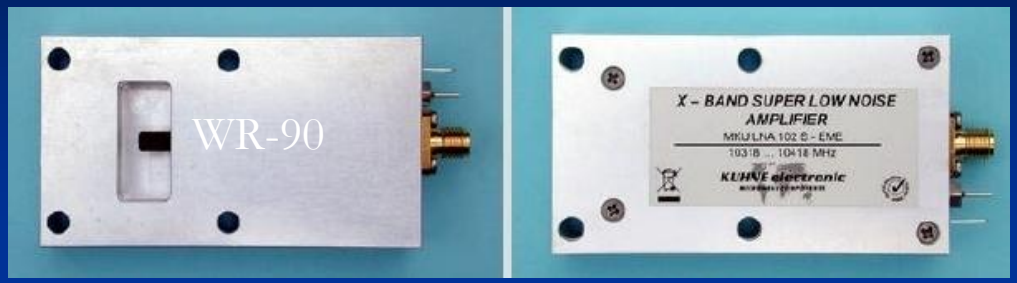
The Benchmark LNA

DB6NT, Michael Kuhne

Gajow 2017 Dominique Fässler
HB9BBD

The Benchmark LNA

The first commercial 10 GHz LNA mit WG input for HAMs

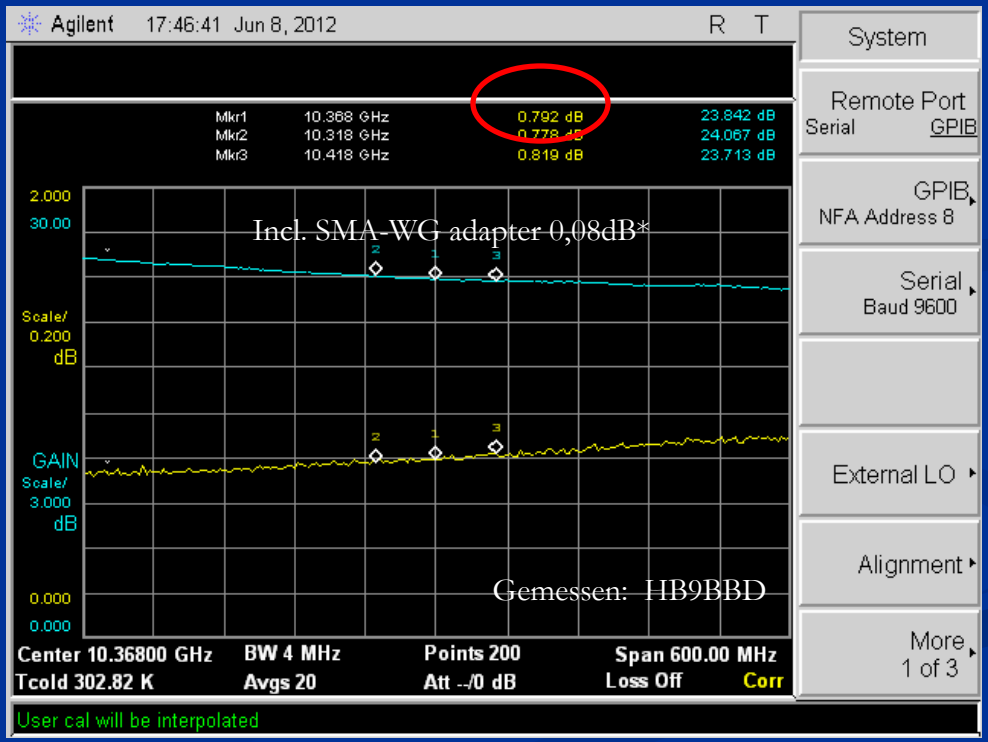


Testgear of DB6NT

DB6NT

F = 0,7 dB&18C
G = 22 dB
R100

Agilent 8975A
N4000A



* Insertion Loss by SMA/WG adapter p.

What if no DB6NT ?

- Homebrewing – phantastic!
- The microwave community would be very small
- Newcomer would have a difficult access to microwave communication
- Inspiration by DB6NT
- It is just fair to thank DB6NT for his exploring work

The Dinosaur Method

„DB6NT – inspired“ Projects:

„*Design, construction, measurments, endless tuning*“

F5BUU und F6BVA

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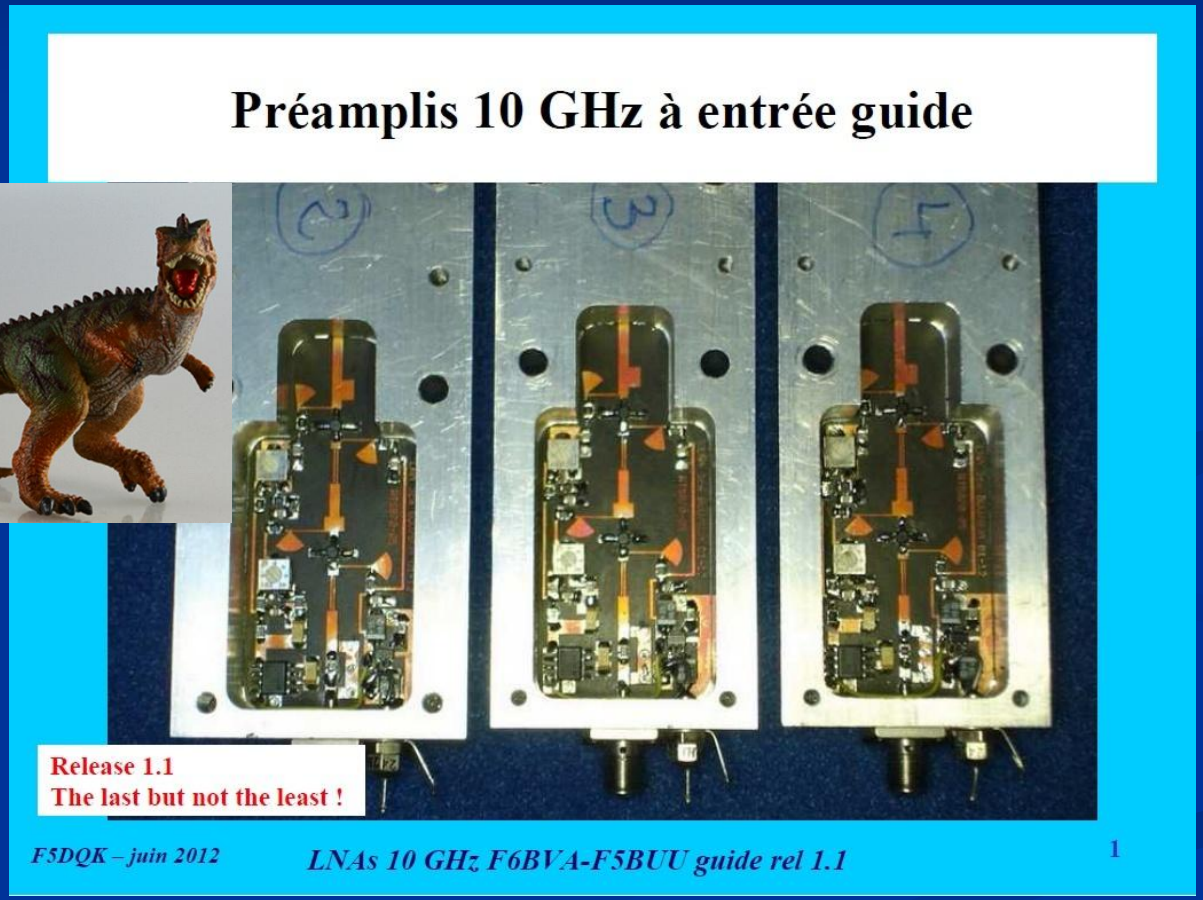
F5BUU + F6BVA tried to outperform DB6NT

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



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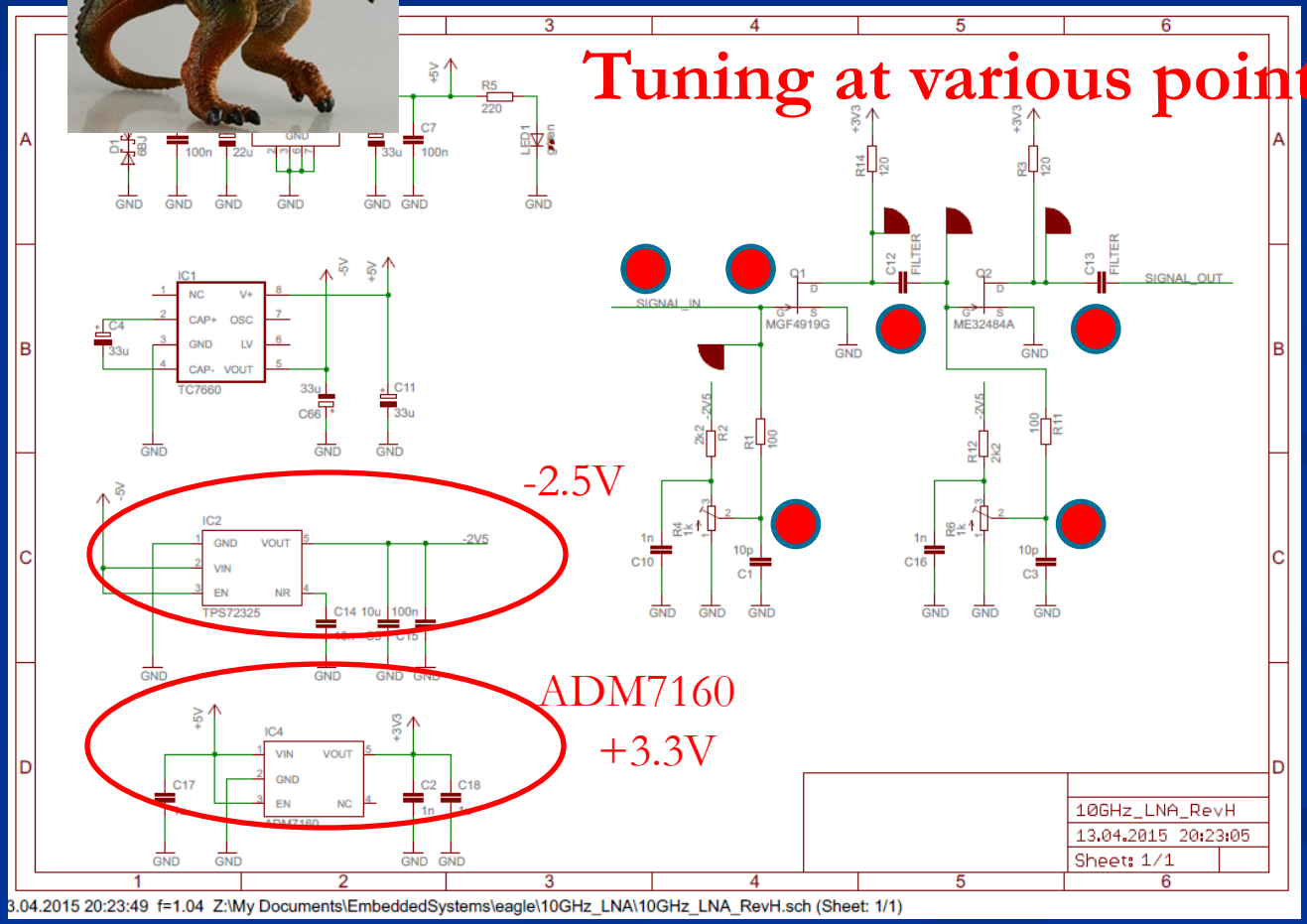
Even more tuning ..



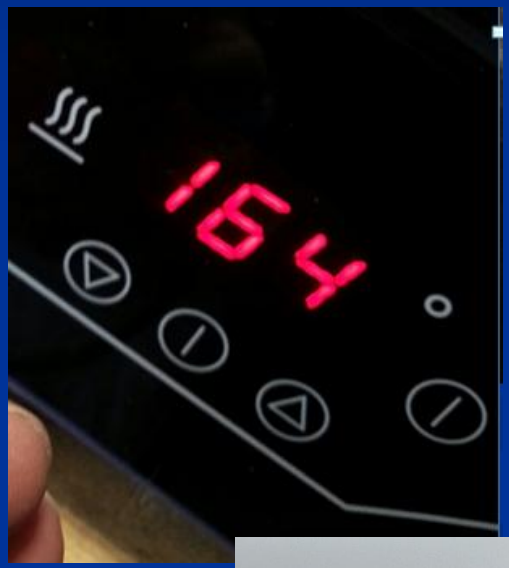
Tuning work at PCB in body..

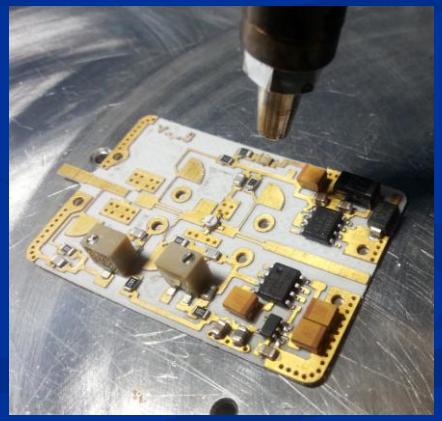
We all know the heat dissipating when soldering in LNA..

Stickstoff bei 350 Grad C

I heat the whole LNA without removing the PCB

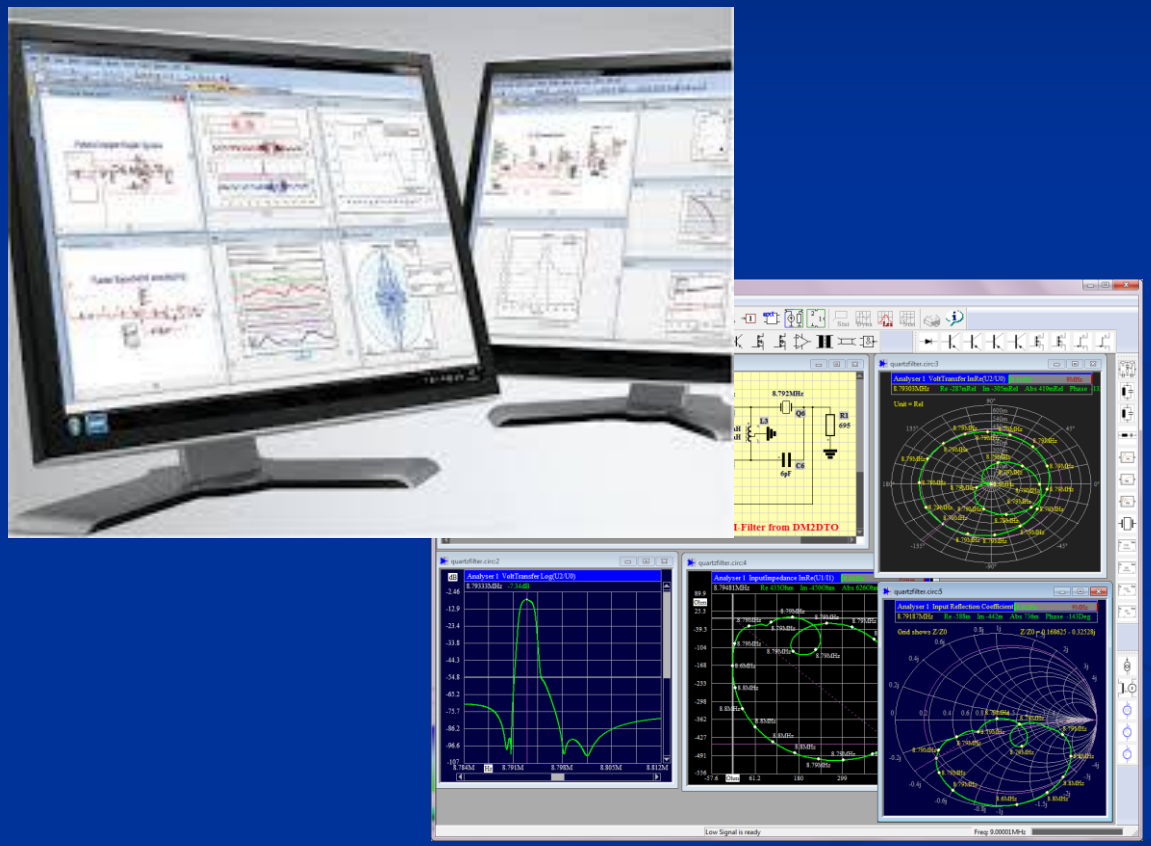
Nitrogen at 350 degrees C





Too much work and time..

There is a more efficient way to achieve good results

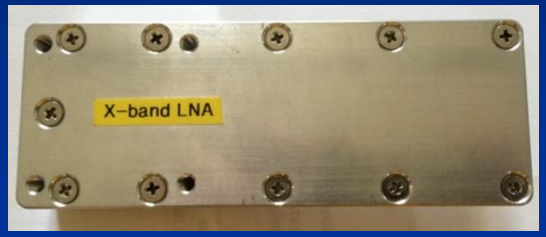


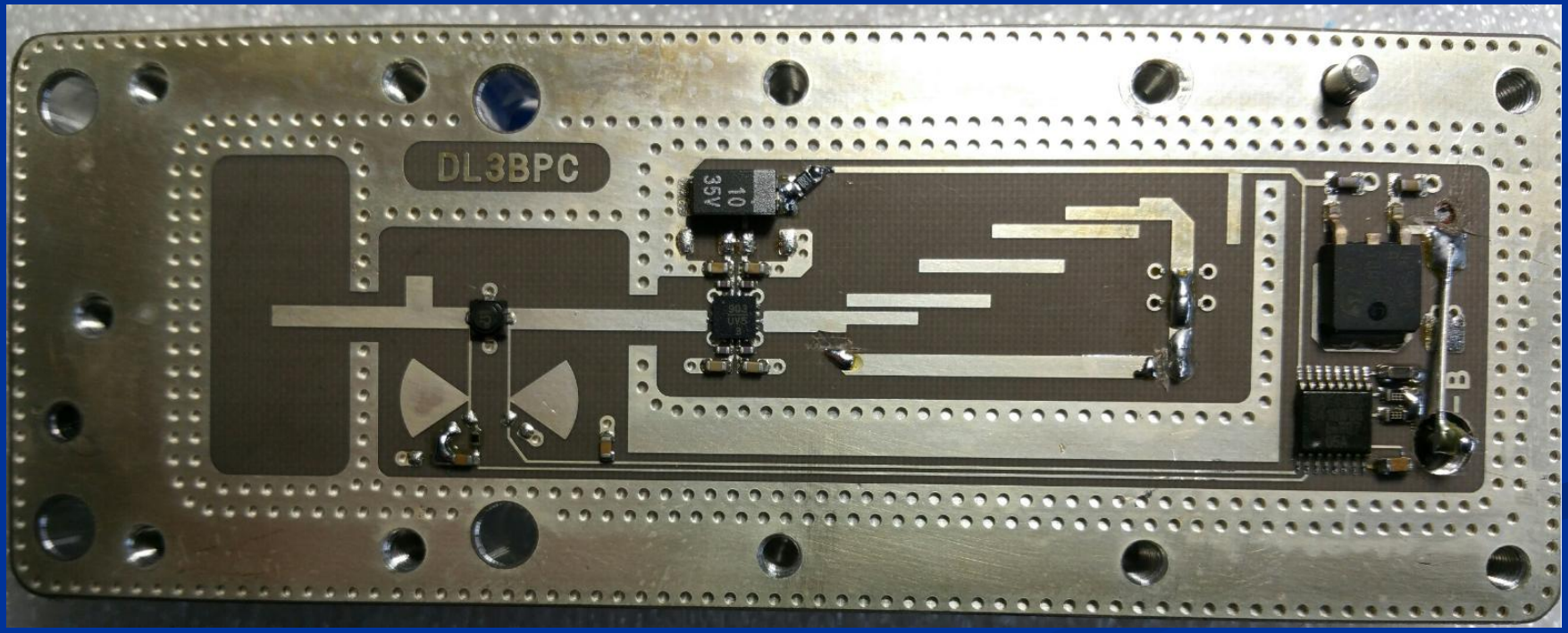
Some of us have studied TV LNBs..

Very cheap, reasonable qualities

„*Simulation – industrial manufacturing, NO tuning* “

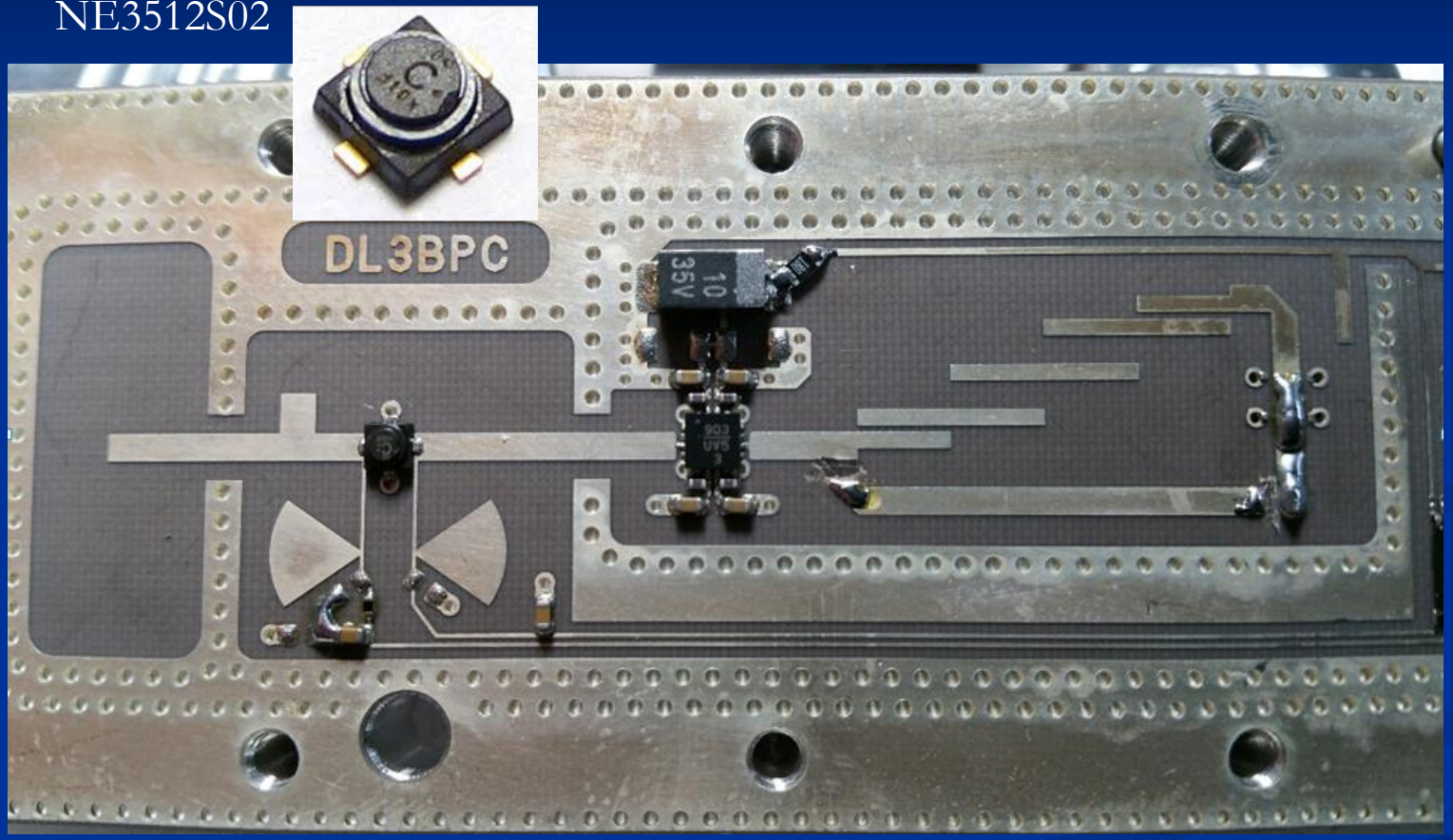
Sandwich LNA by DL3BPC





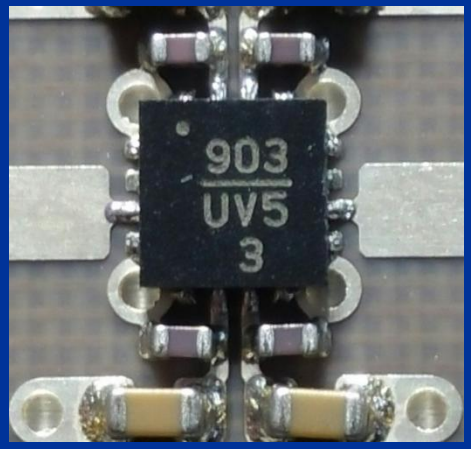
DL3BPC

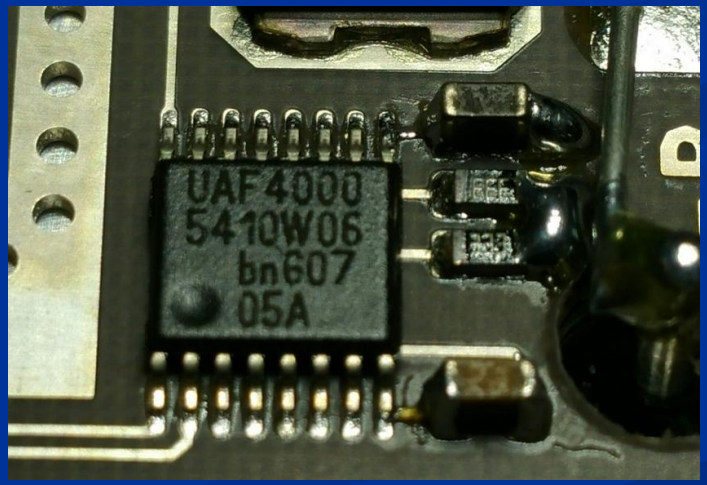
NE3512S02



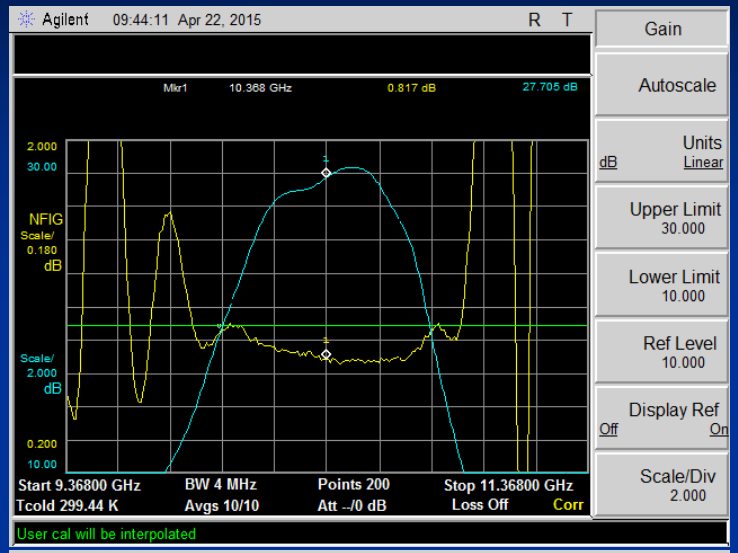
DL3BPC Charakteristics:

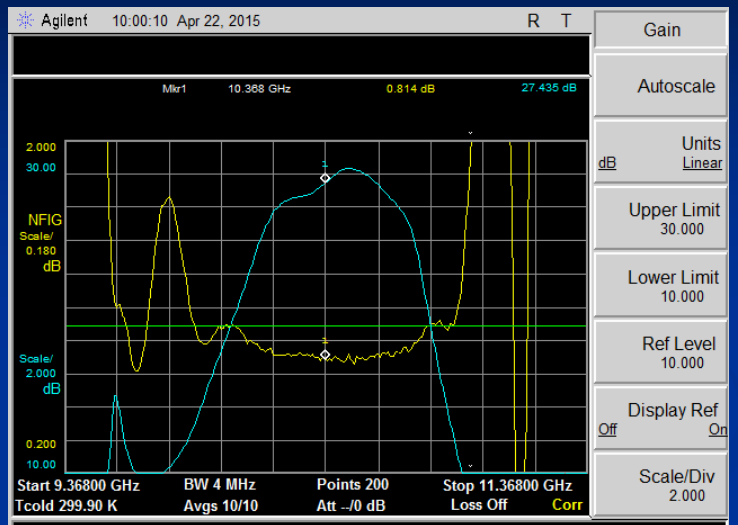
- Industrial design
- Interdigital Filter *after* 2-stage amplifier
- No Tuning, no flaps, no tunable Gate supply
- some components are not standards
- perfectly repeatable specifications. NF within 3/100 dB, identical Gain)

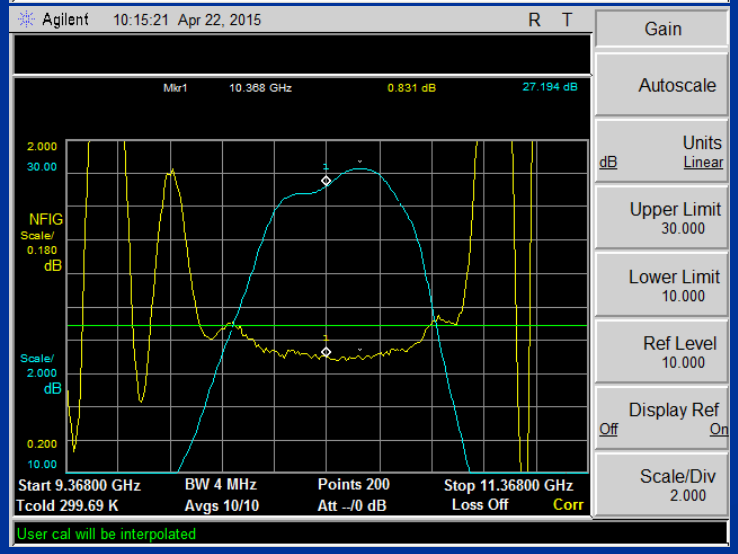


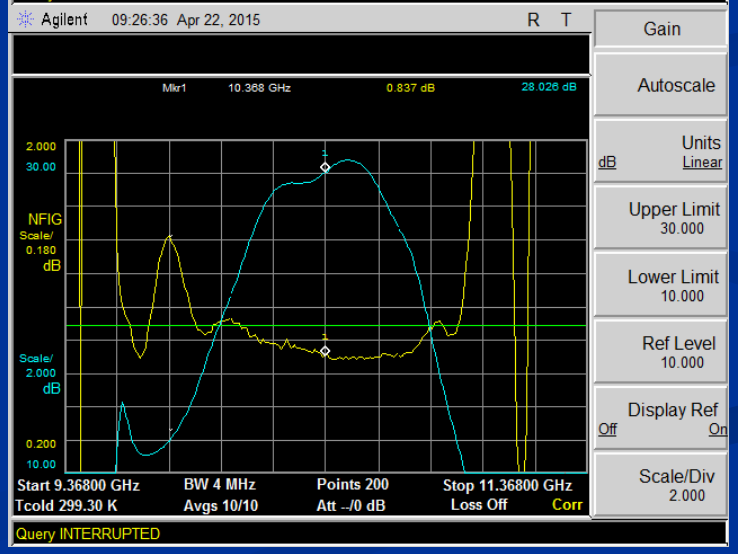


4 measured LNAs, all identical





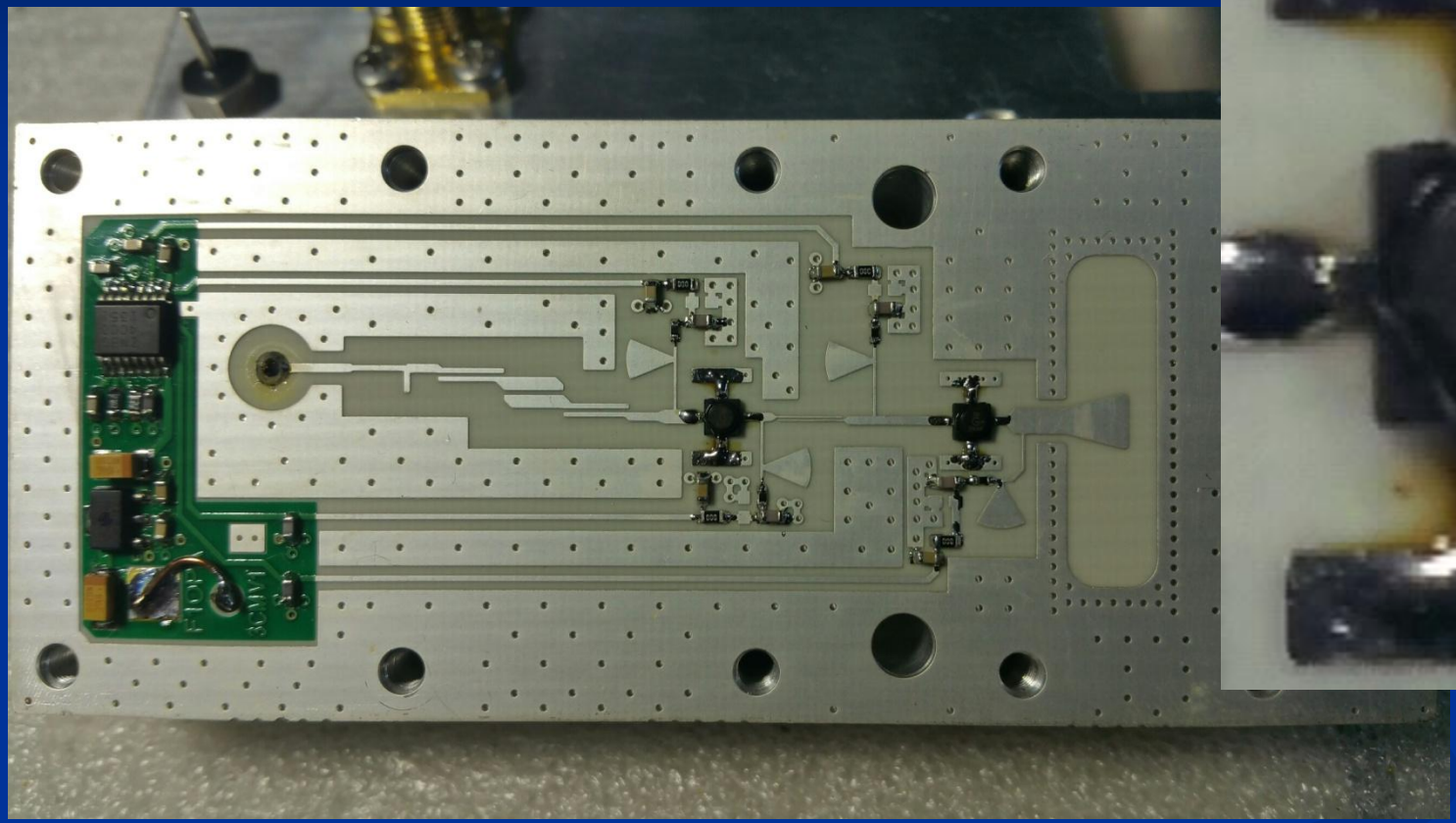


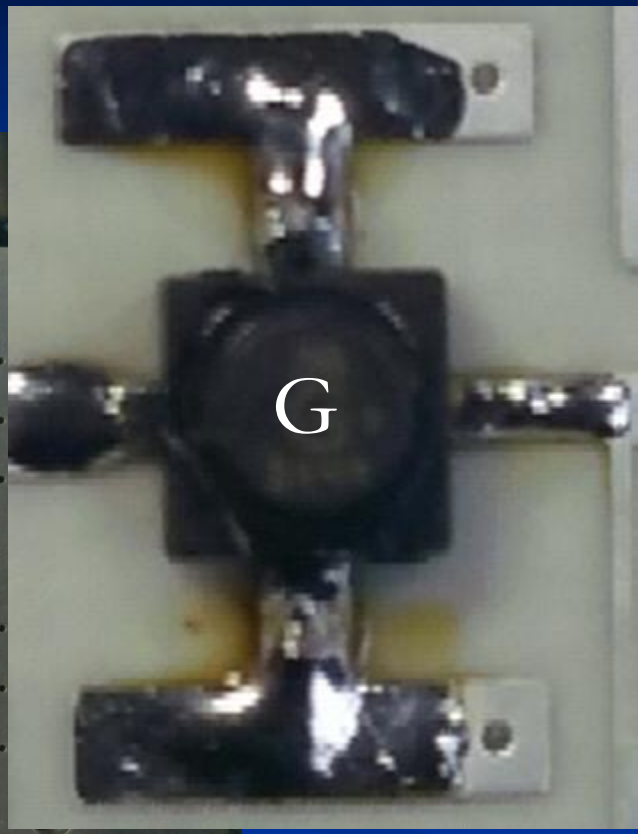


F1OPA


X BAND - LOW NOISE AMPLIFIER
10.2 - - - 10.5 GHz
PN : WGLNA10G
F1OPA Design
SN : 1615

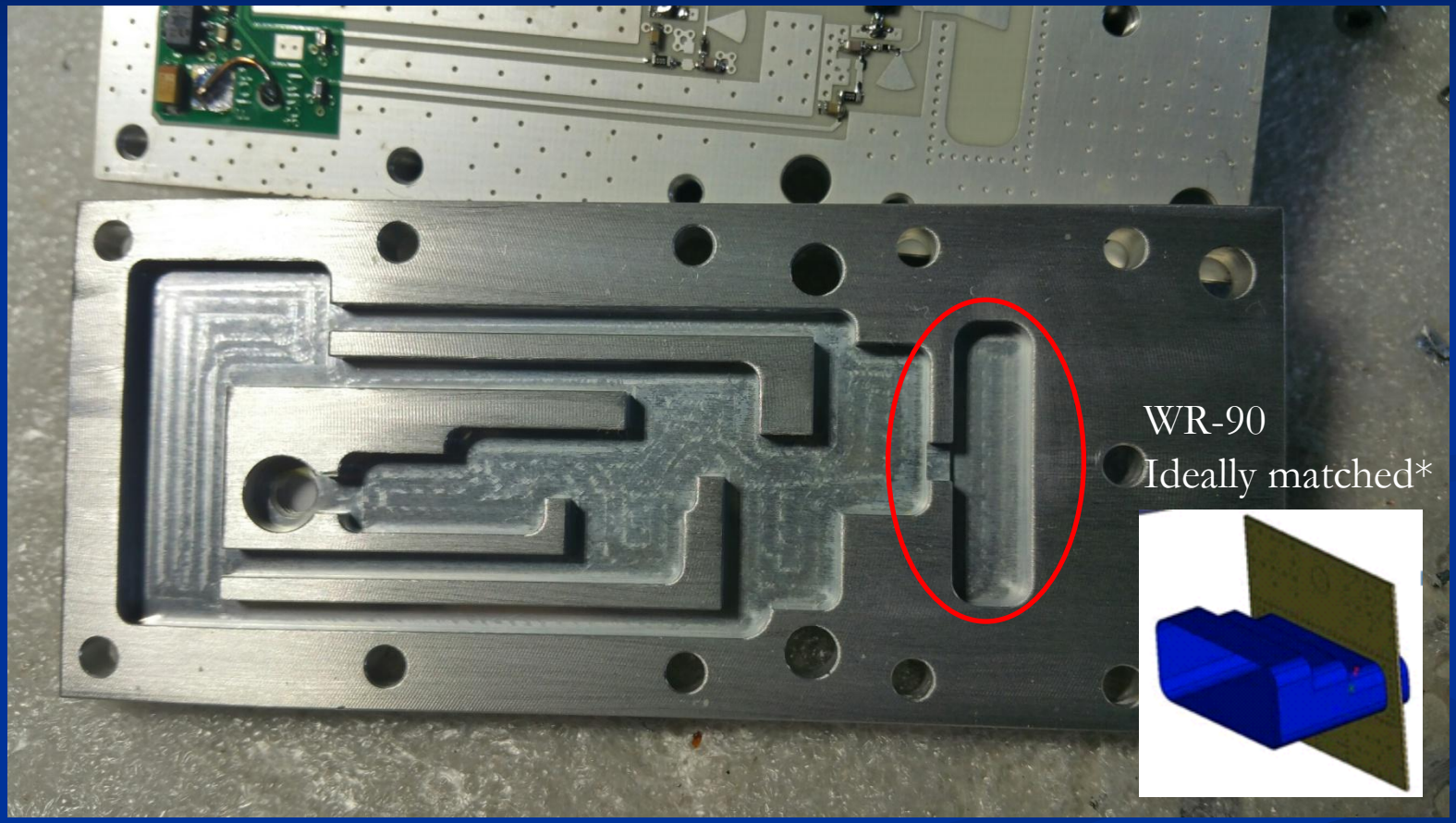
F1OPA





NE 3515S02

F1OPA



*ref. Dubus 3/2016

F1OPA Charakteristics

- Matched WG-Input stage
- Interdigital Filter following 2 stage amplifier
- No tuning, no flaps, no adjustable Gate supply
- Industrial make
- Standard components
- Reference: Dubus 3/2016 description

https://sites.google.com/site/vincentf1opa/STORE_F1OPA

Currently used Hemts by:

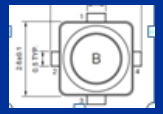
** discontinued types

NE32484A ** „T“ 0,6 dB@12 GHz

NE32584C** „ D“ 0,45 dB@12 GHz

MGF4919G ** 0,45 dB@12 GHz **HB9BBD**

NE3210S01 ** „K“ 0,35 dB@12 GHz



NE3511S02 „B“ 0,30 dB@12 GHz **DB6NT OK2AQ**

NE3512S02 „C“ 0,35 dB@12 GHz **DL3BPC**

NE3515S02 „G“ 0,30 dB@12 GHz **F1OPA**

Measuring Noise

- Noise is very volatile – It is therefore that averaging many measurments only can characterize an LNA
- WG LNA need an adapter to measure Noise.

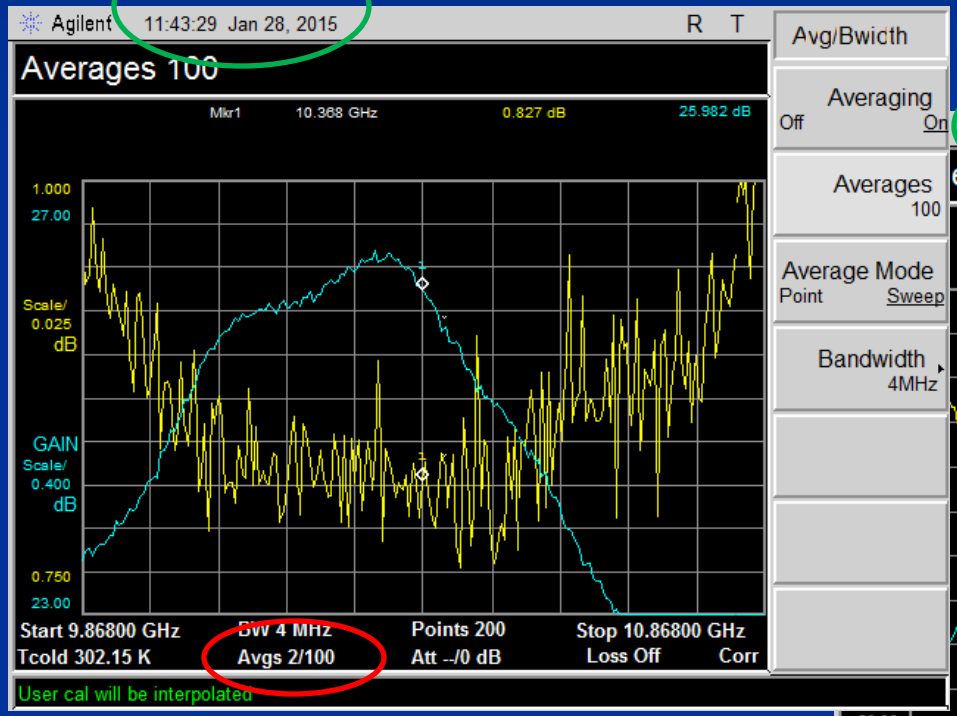
  We have to know the loss of WG-coaxial adapters to quantify the LNA‘s Noise Figure
- Temperature matters. 290K (17 deg.C.) is specified for Agilent 8975A/N4000A. Usually, our Lab temp. is much higher! So NF measured may be close to, but not correct

- Calibration of the testequipment is significant

Averaging

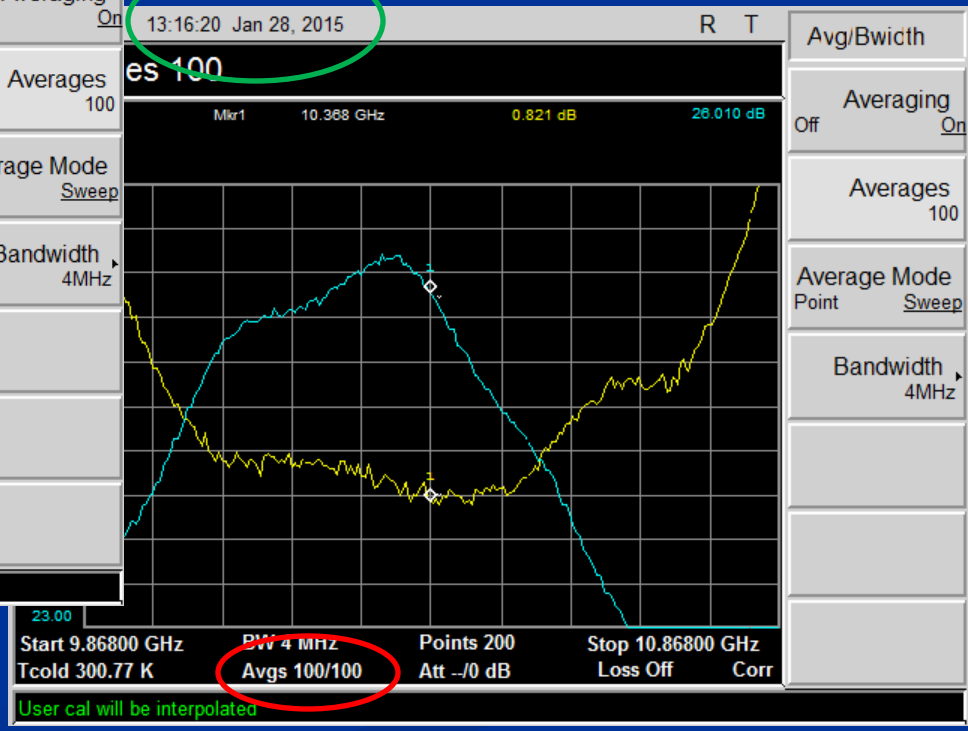
2 averages

Time required fo 20‘000 Measurings: >1h..



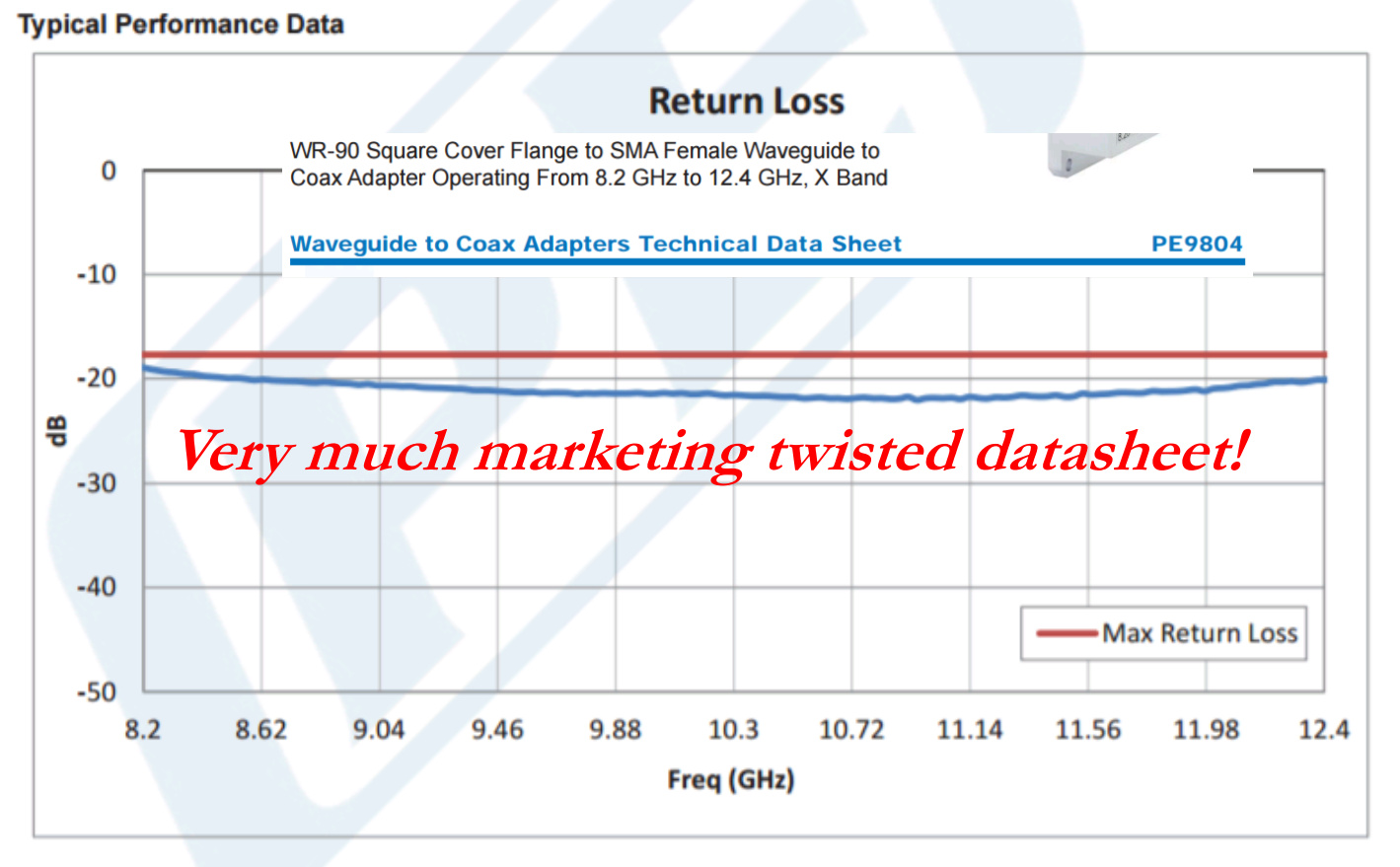
Where is the minimum noise ?

100 averages



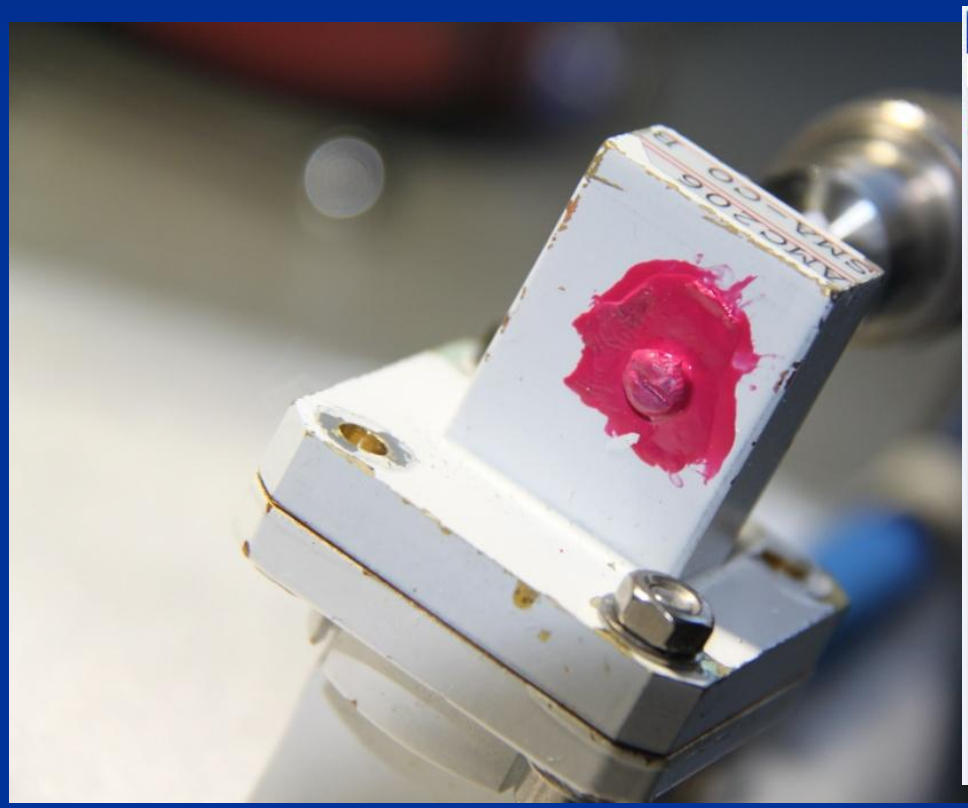
SMA-WG Adapter

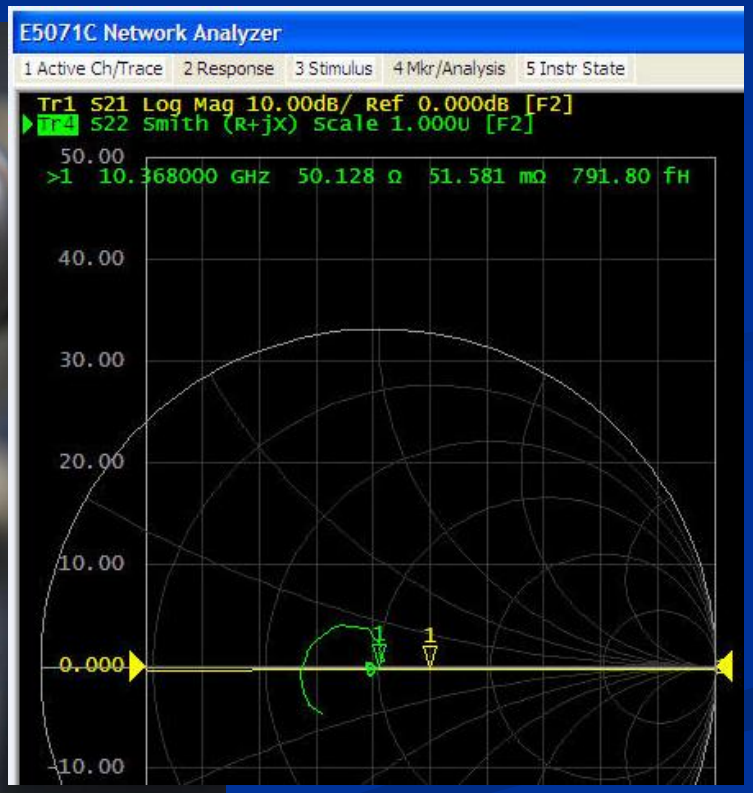
Commercial WG adapters are broadband and not good enough for Noise measurments



Match of SMA-WG Adapter

WR90	RG52 (b) RG67 (a)	WG16	R100	8.20-12.40	6.56	0.900	0.400
WR75	RG346 (c) RG347 (a)	WG17		10.0-15.0	7.87	0.750	0.375





SMA-WG Adapters

Some home made WG-coaxial adapters

It is very much a question of testequipment and cost!

WR75

WR90

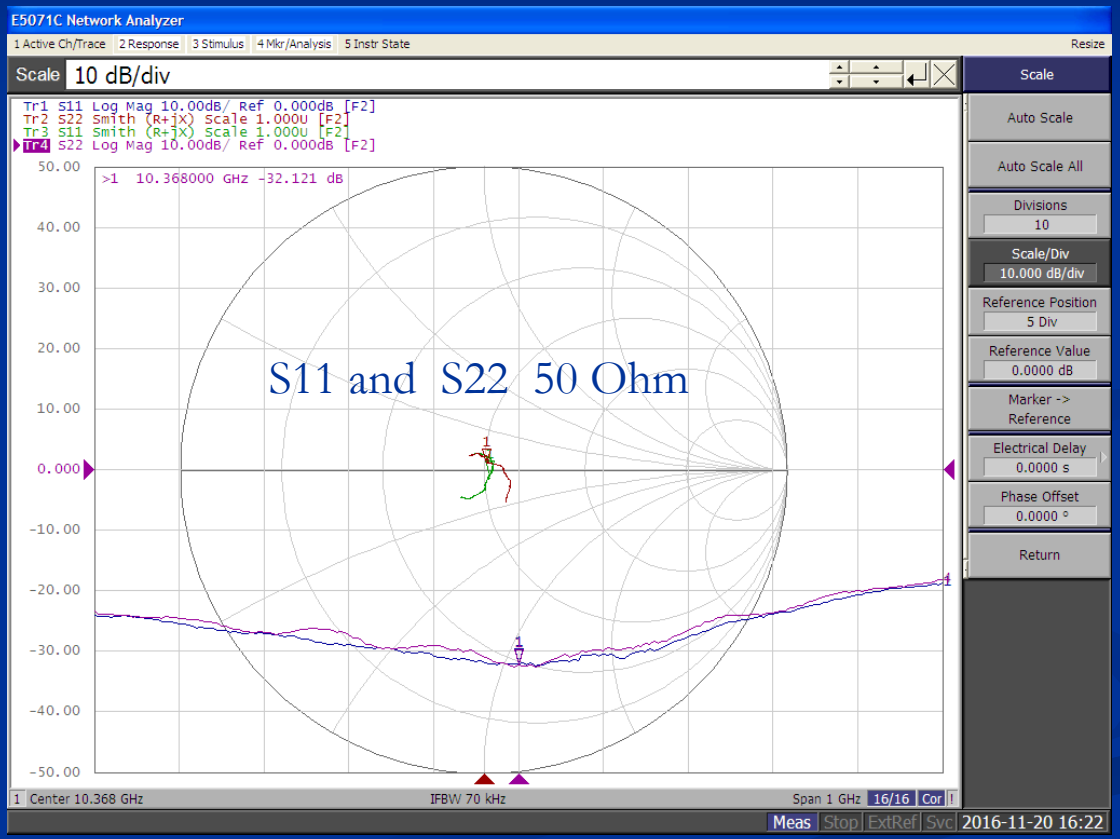
SMA-WR75 for 10‘368 MHz

Near to perfect match can reduce the insertion loss and reduce reflections and thus is reducing measurment uncertainty

Match of WR-75 for 10‘368 MHz

Match at 10‘368 MHz

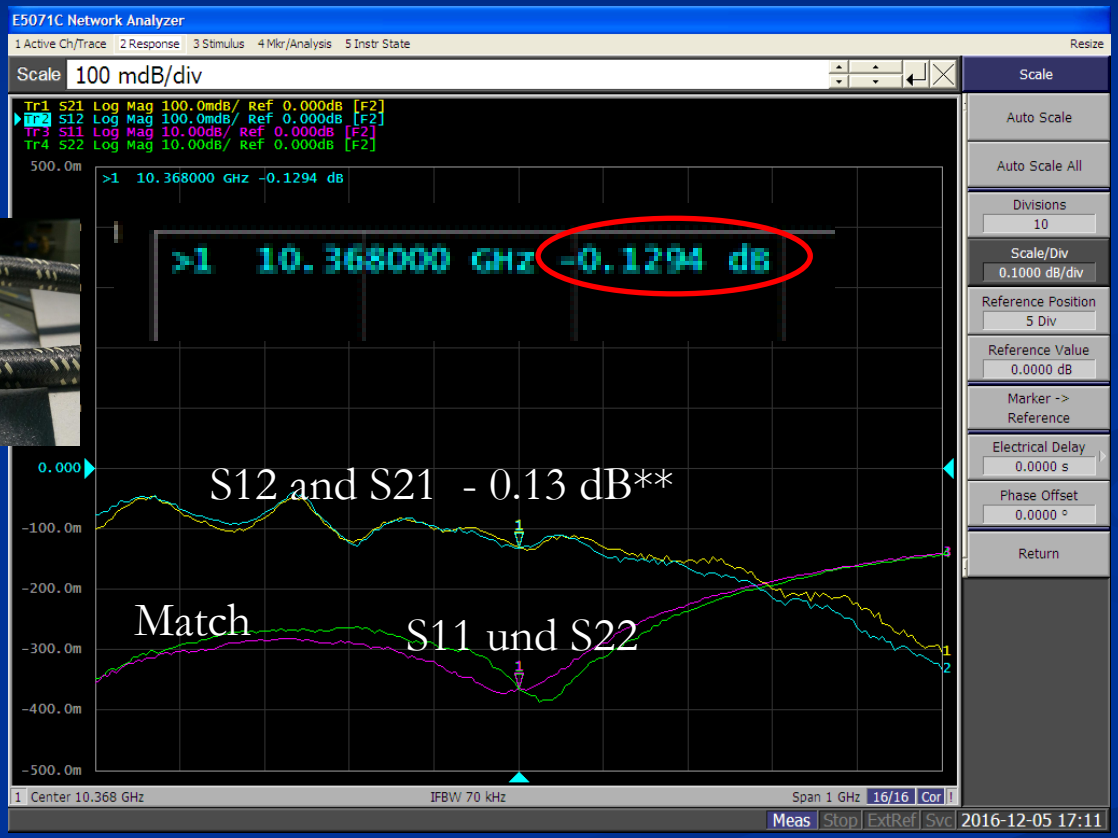
S11 and S22 -32 dB



WR-75 for 10‘368 MHz

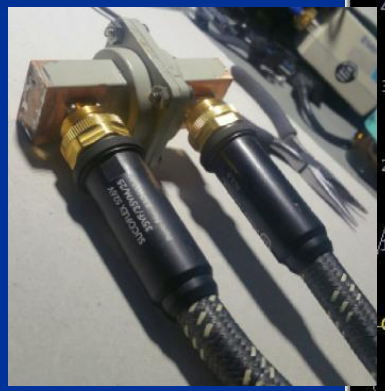
Insertion loss for two adaptors is -0,13 dB, > 1 Adapter 0.07 dB

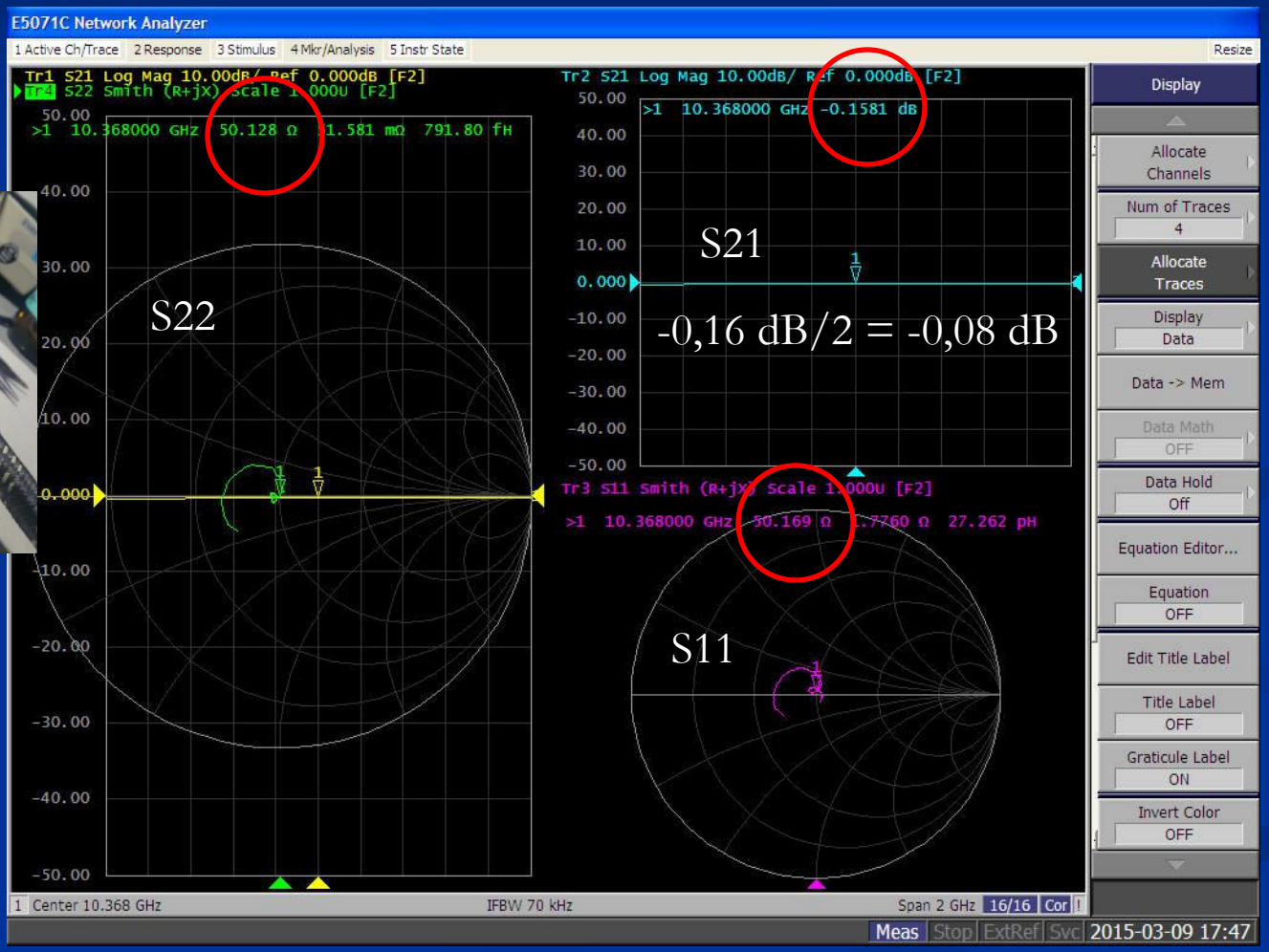
Insertion loss



SMA-WR90 für 10‘368 MHz

S-Parameters S11, S22, S21 an overview





Calibration of Testequipment

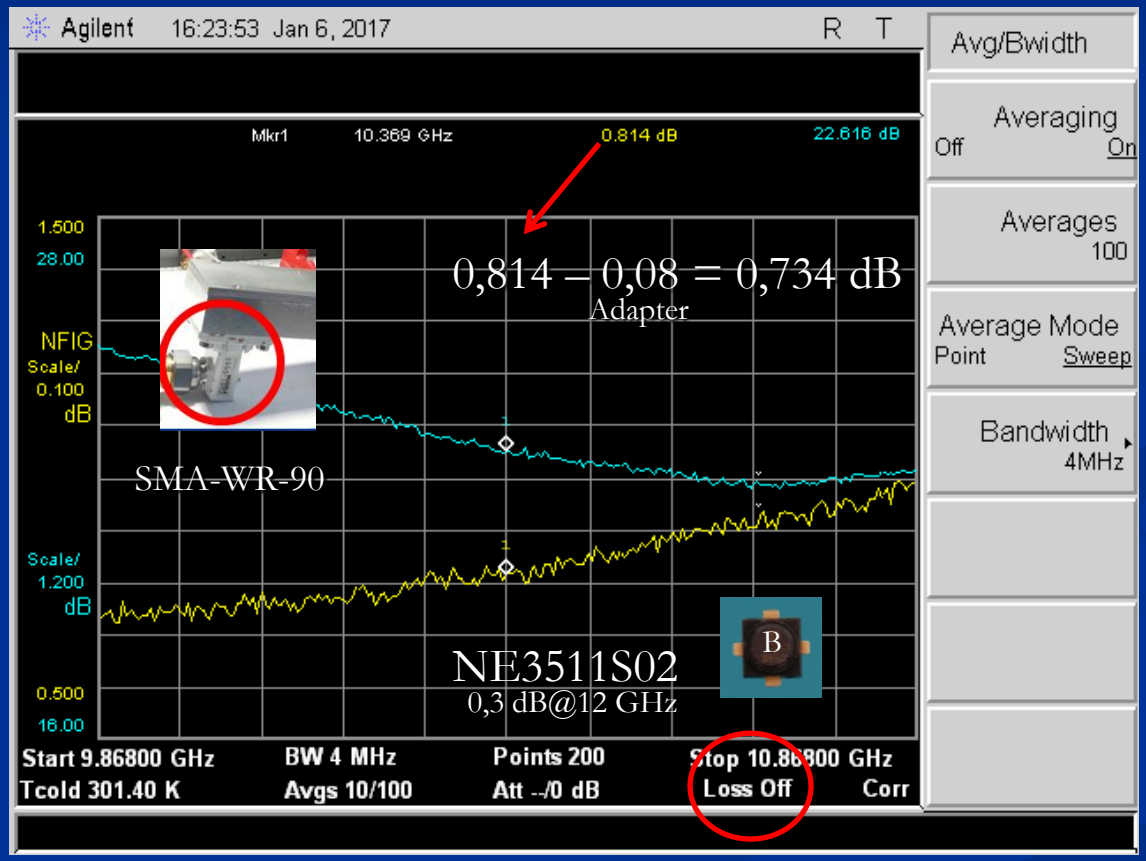
Calibration is essential for reliable results

Temperature matters for testequipment
And DUT

Amateurs are by 1 decade more critical Than professionals (*but sometimes dont calibrate carefully !!*)

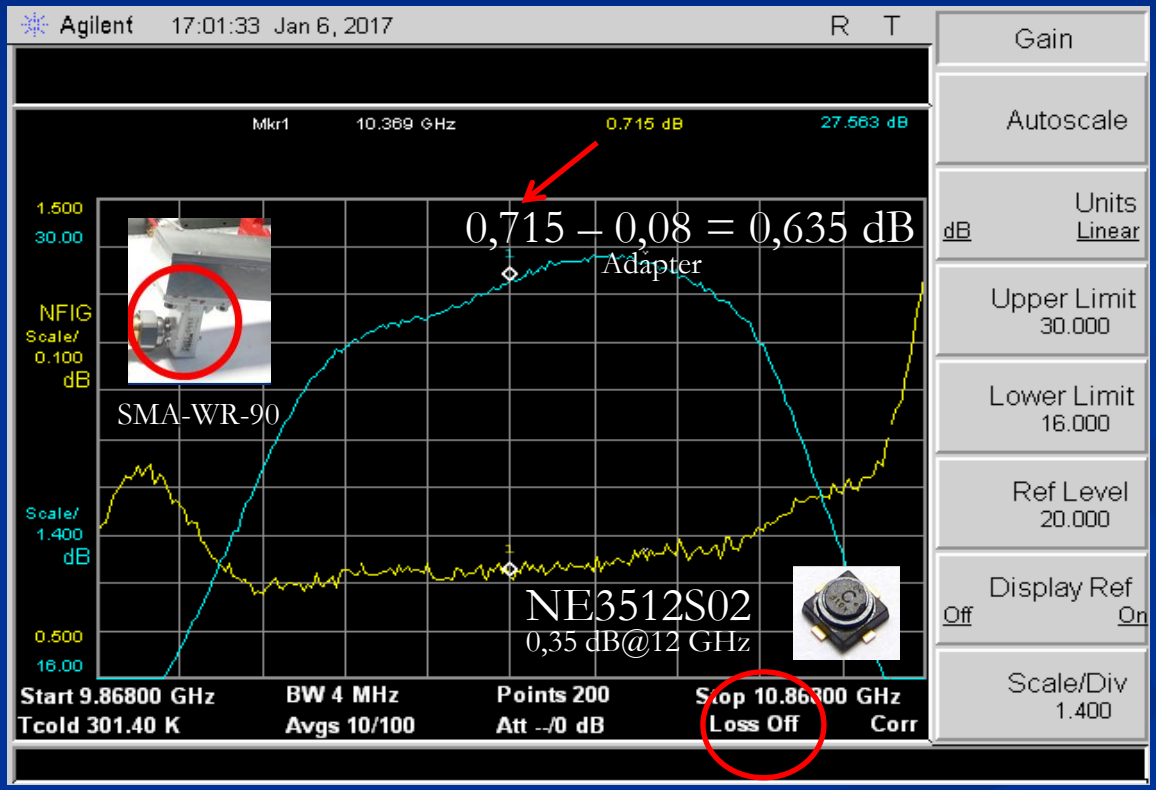
Summary

DB6NT (Seal undestroyed..)



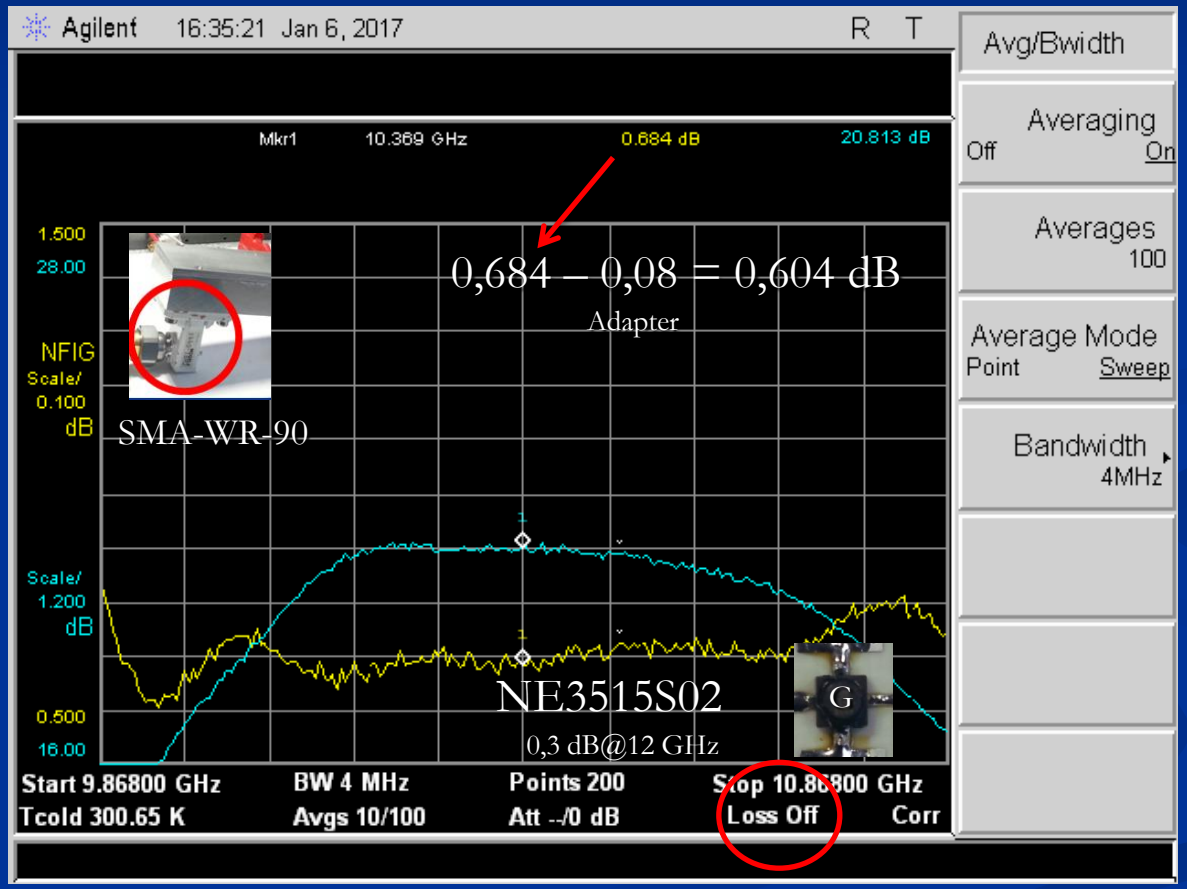
Summary

DL3BPC #10



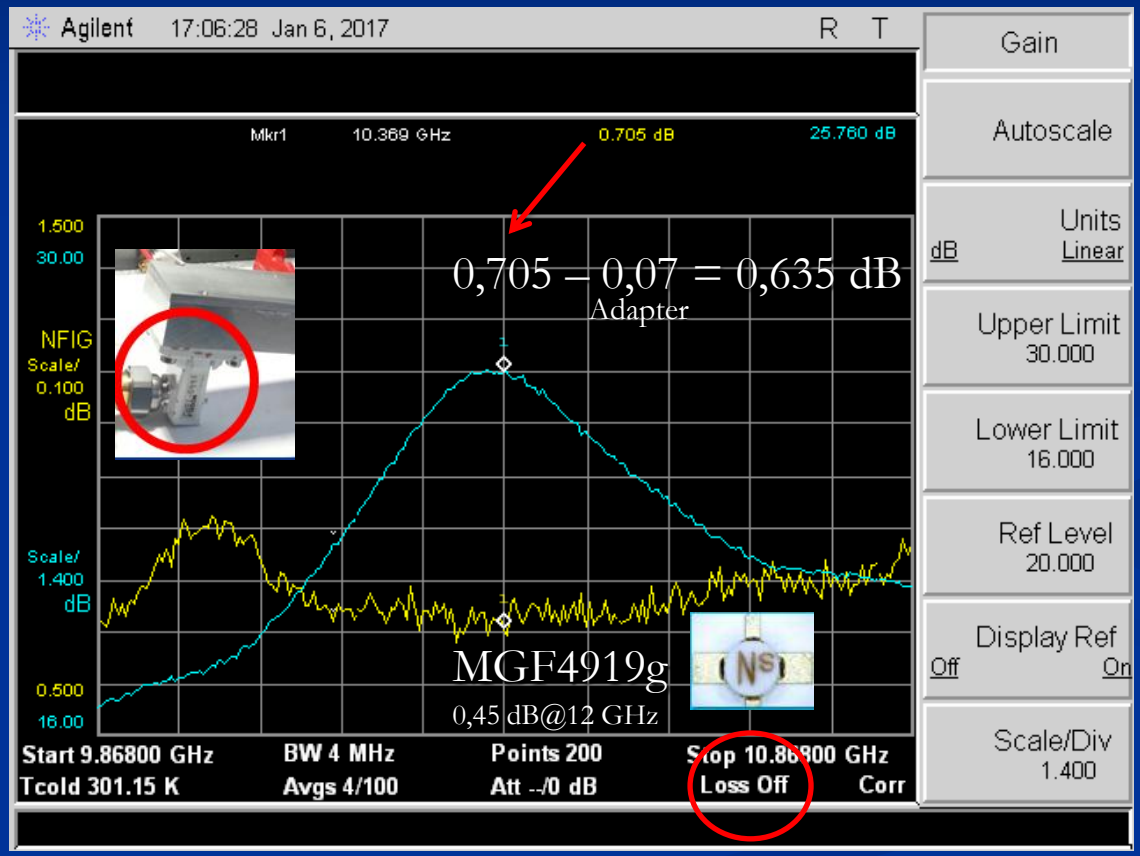
Summary

F1OPA #1628



Summary

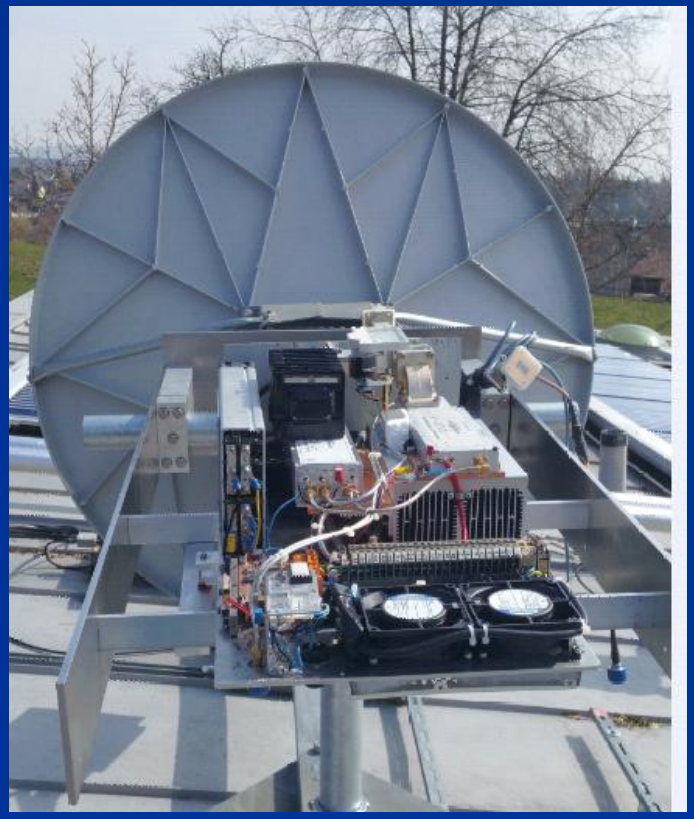
HB9BBD # 3-V2.3

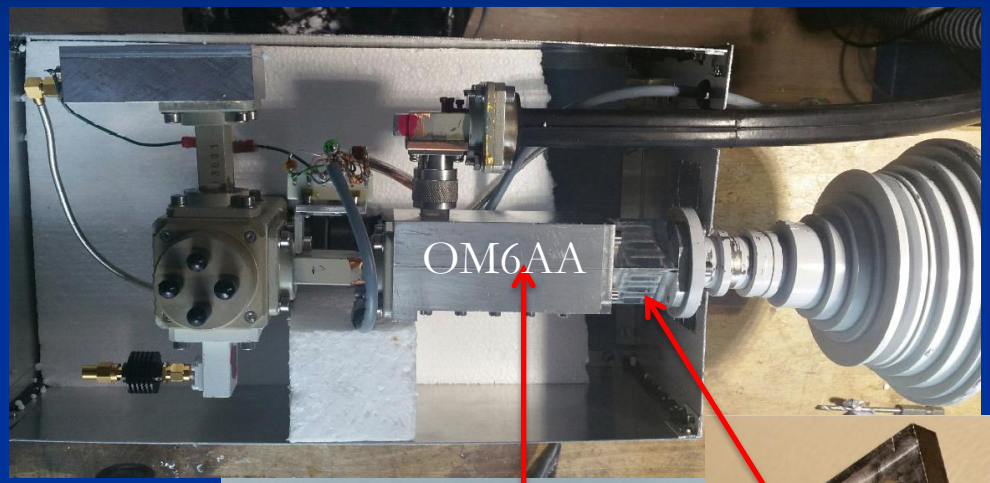


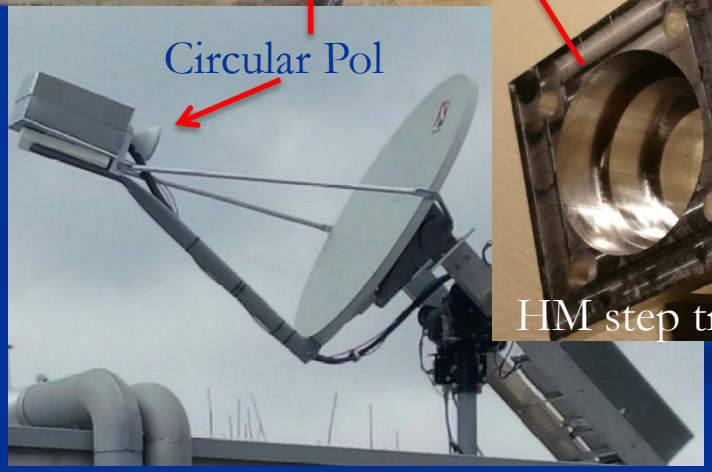
Conclusions

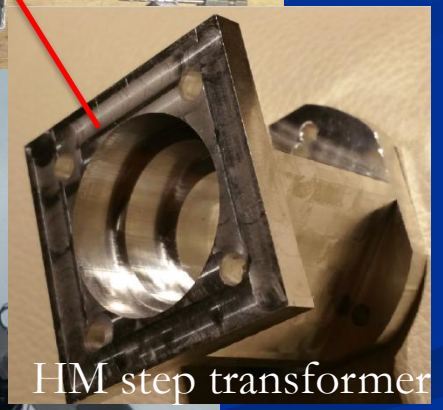
- Traditional LNA construction clearly suffers disadvantages in design. It requires more time and efforts to work as desired 
- Broadband WG-Coaxial Adaptors do not fit for measurment purposes without manual retuning on the specified frequency. No passive device is linear over a span of >4 GHz at 10‘368 MHz
- Much emphasis is needed to match WG to LNA at Gate of first stage
- Best achievable NF on 3cm band today is probably 0,5 dB at ambient temperature Losses occur by all components, by radiation, by mismatch and by components at temperature above absolute Zero
- Measurment of NF is meaningless without averaging several sweeps and still, we have to accept uncertainty by temperature and NF of testequipment etc
- The future belongs to LNAs designed by simulation and built in „sandwich format“

EME Beacon DL0SHF with 1m off-set dish

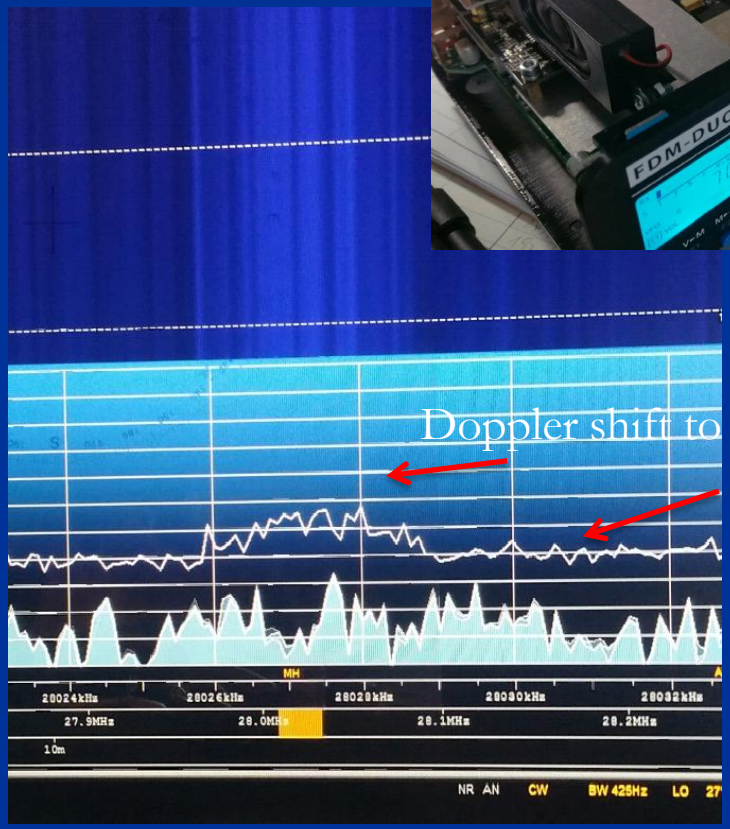






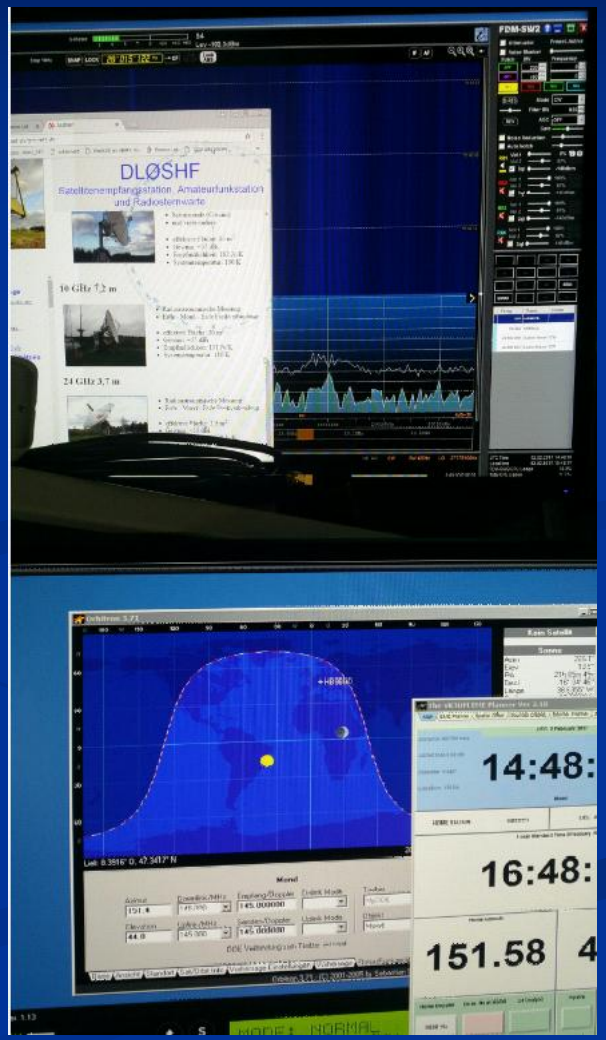


EME Beacon DL0SHF with 1m off-set dish



Doppler shift to moonset

peak values

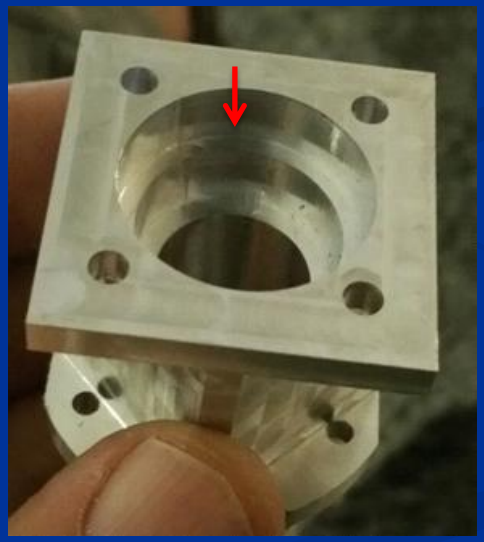


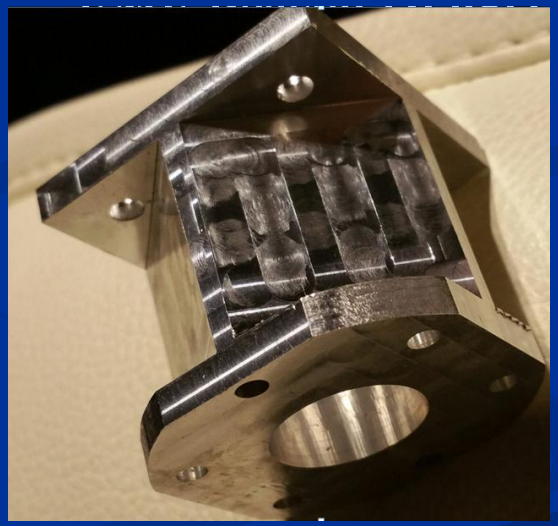
Step Transformer from circular feed to feedhorn

The OM6AA feed has a square mouth, while the adapter to the antenna is circular.
How to match these two mechanical pieces`?
HB9MPU, former head of microwave lab at STR, and a good friend, suggested this:

This side to
OM6AA feed

Step 8.0mm



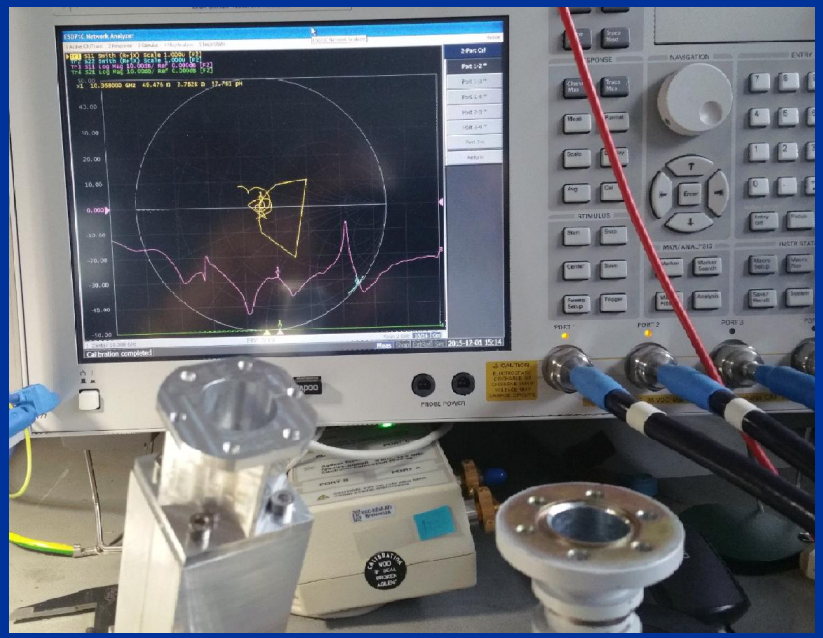


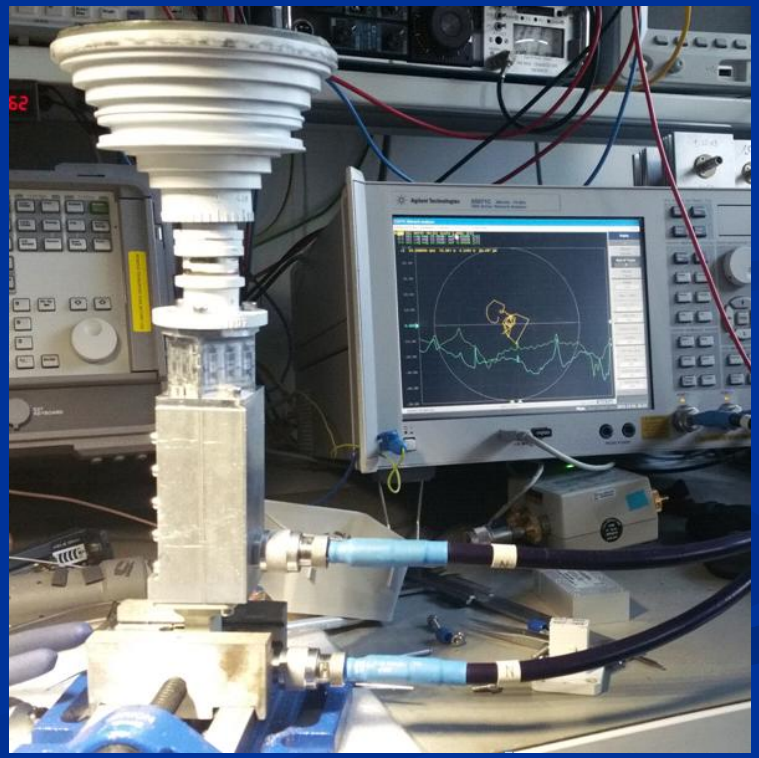
This side to
Antenna

Step Transformer from circular feed to feedhorn

S11 = -25,1dB / 53,9 Ohm (with antenna)

S11 = -27dB / 49,4 Ohm (open feed)





Questions ?