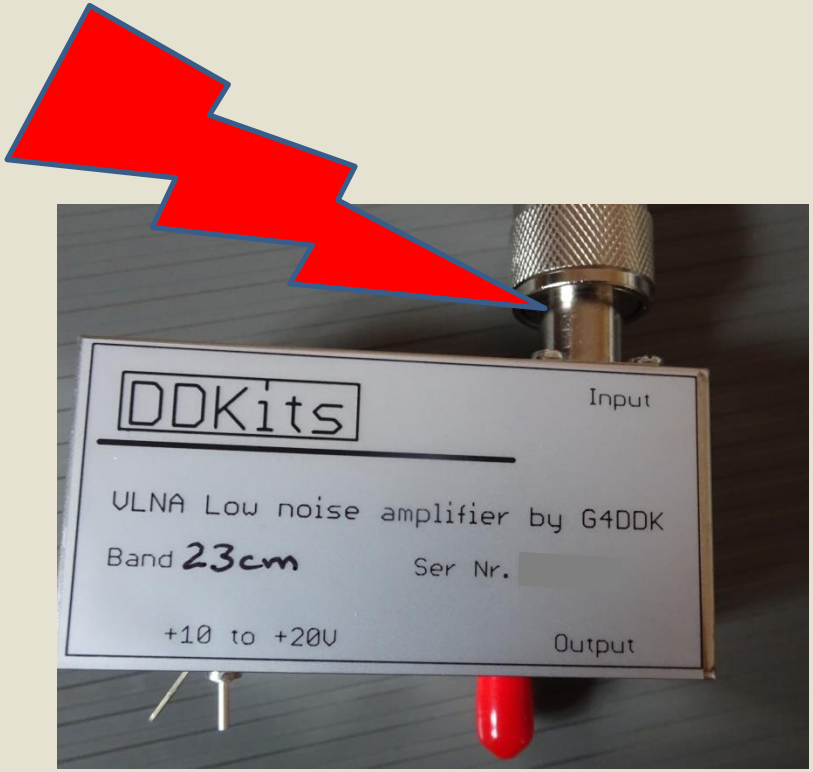
Failure levels in LNAs



Sam Jewell, G4DDK

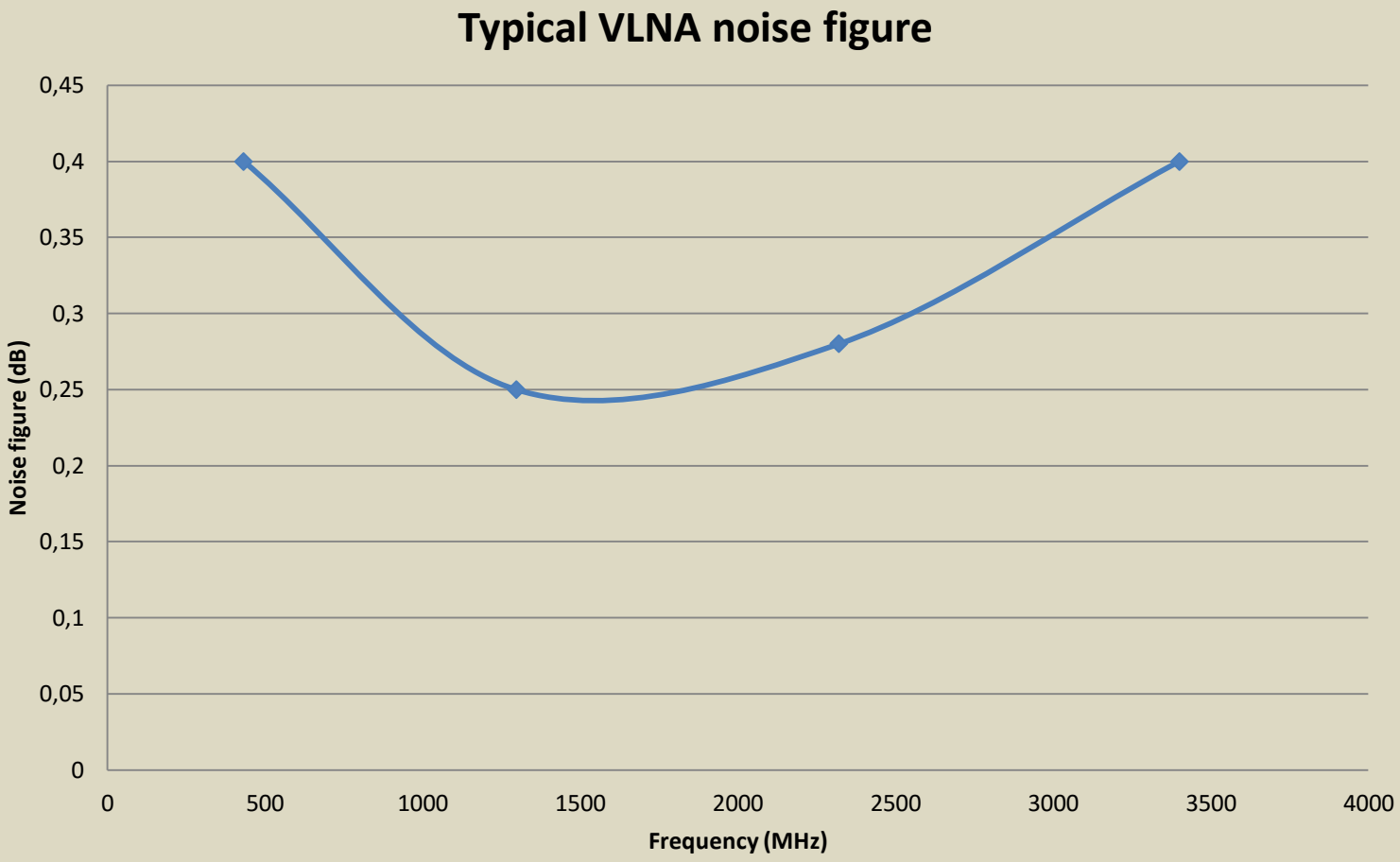
EME 2016

Venice, August 2016

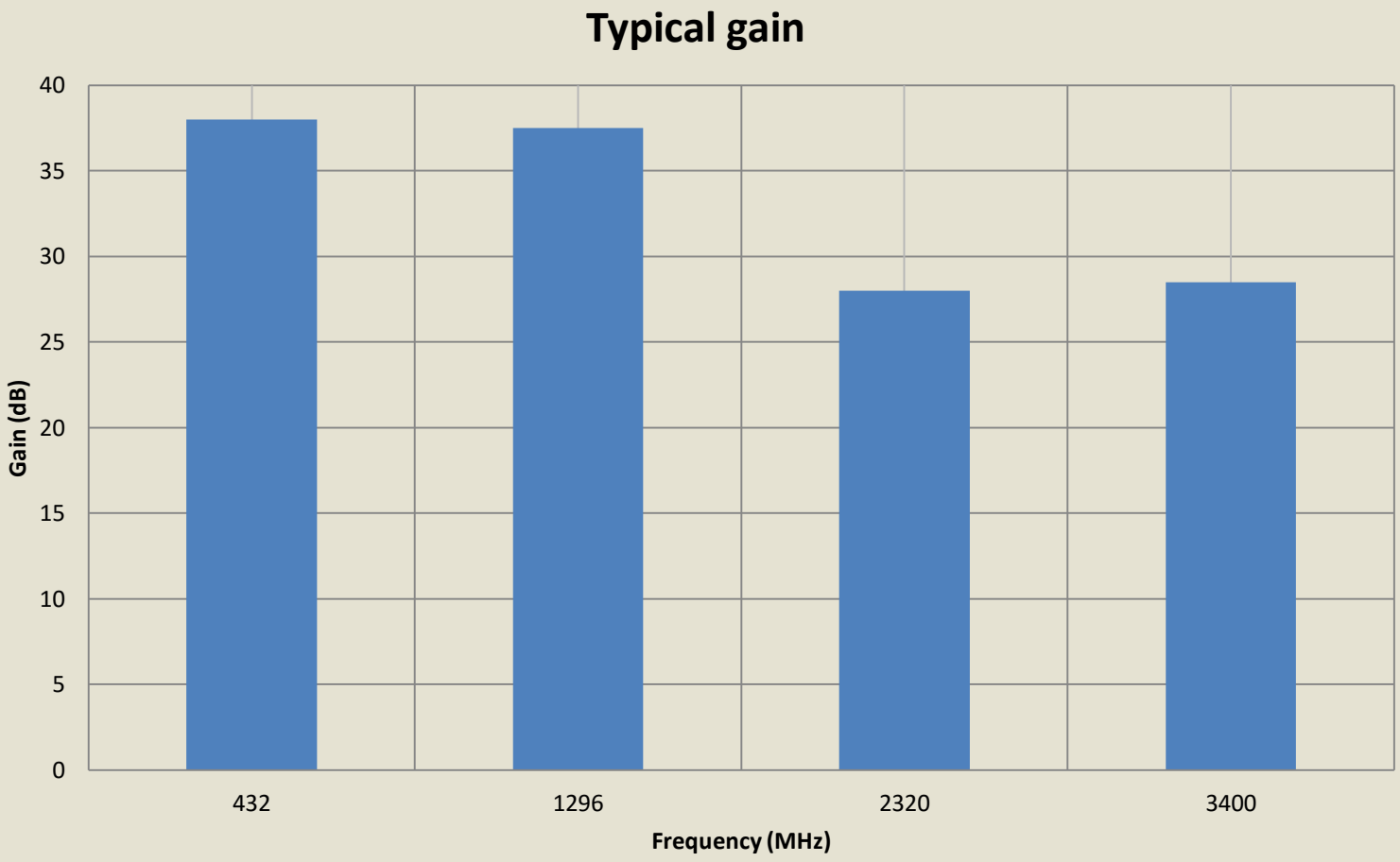
Failure levels in LNAs

- Update on the VLNA
- Investigation of the failures seen in the VLNA
  - Nature of the failures
  - Method of the investigation
  - Results
  - Conclusions
- Over-coax power feeding

VLNA Update

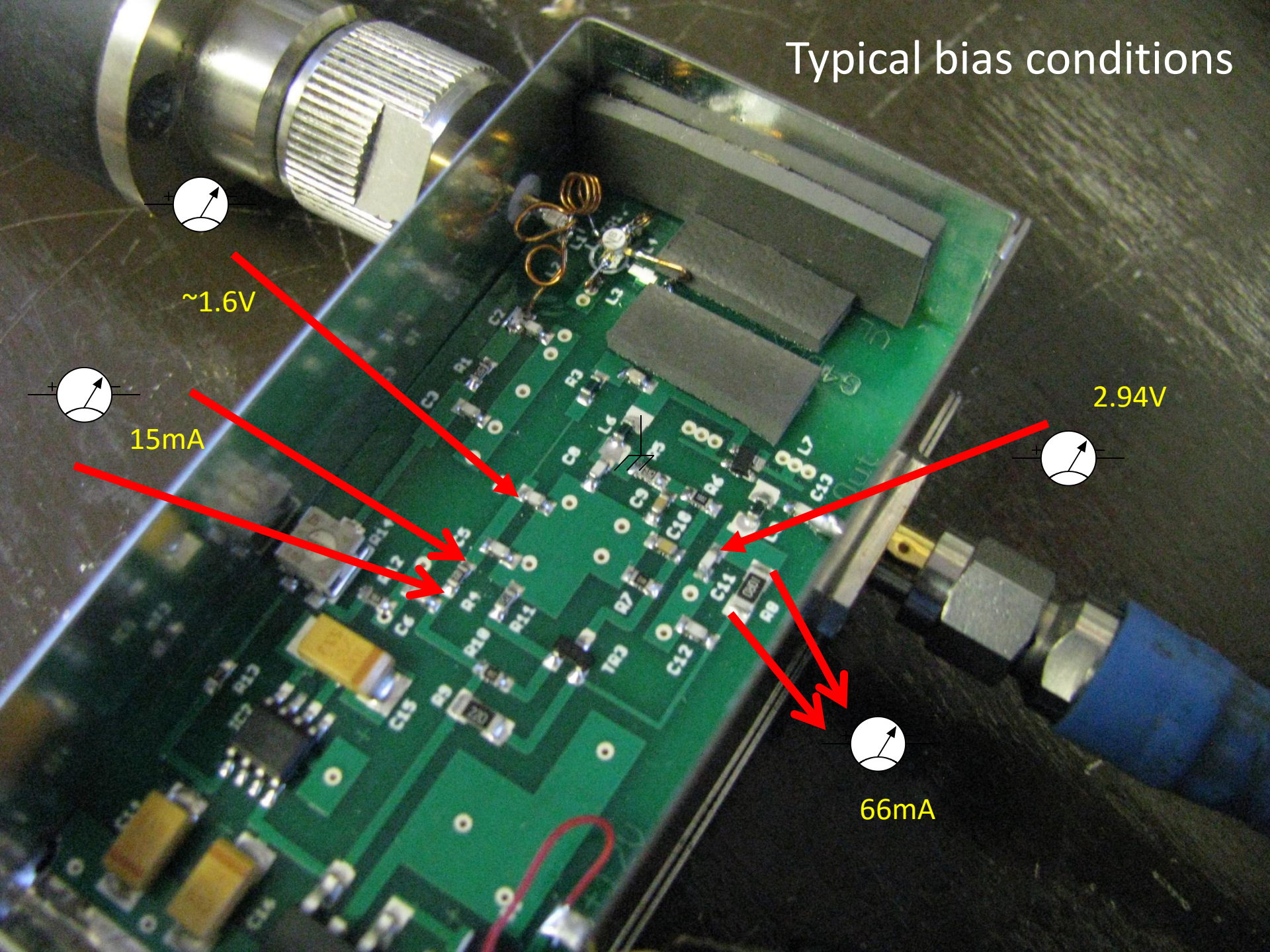

Typical VLNA noise figure
Noise figure (dB)
0,45
0,4
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
0
500
1000
1500
2000
2500
3000
3500
4000
Frequency (MHz)

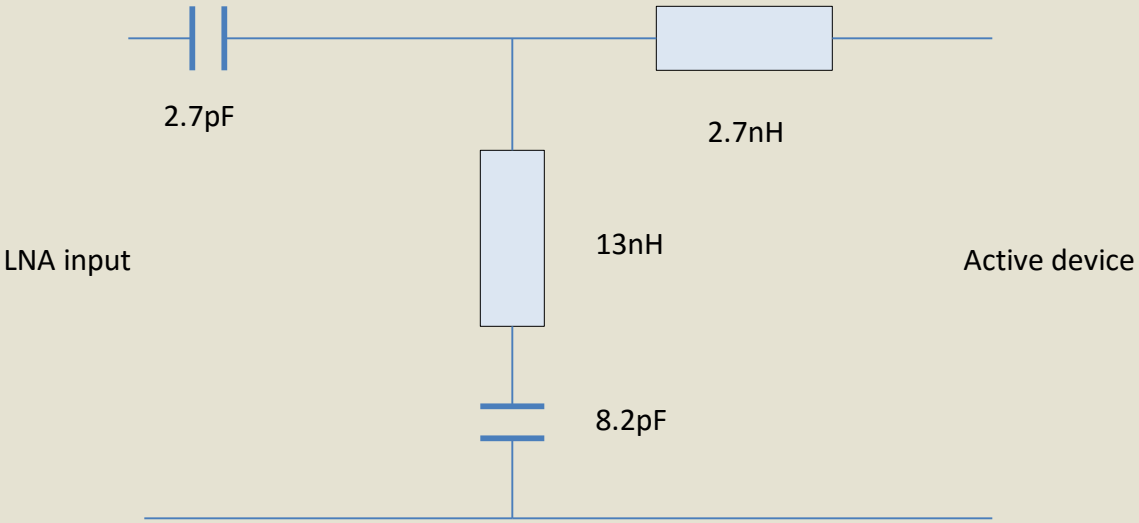
VLNA typical gain



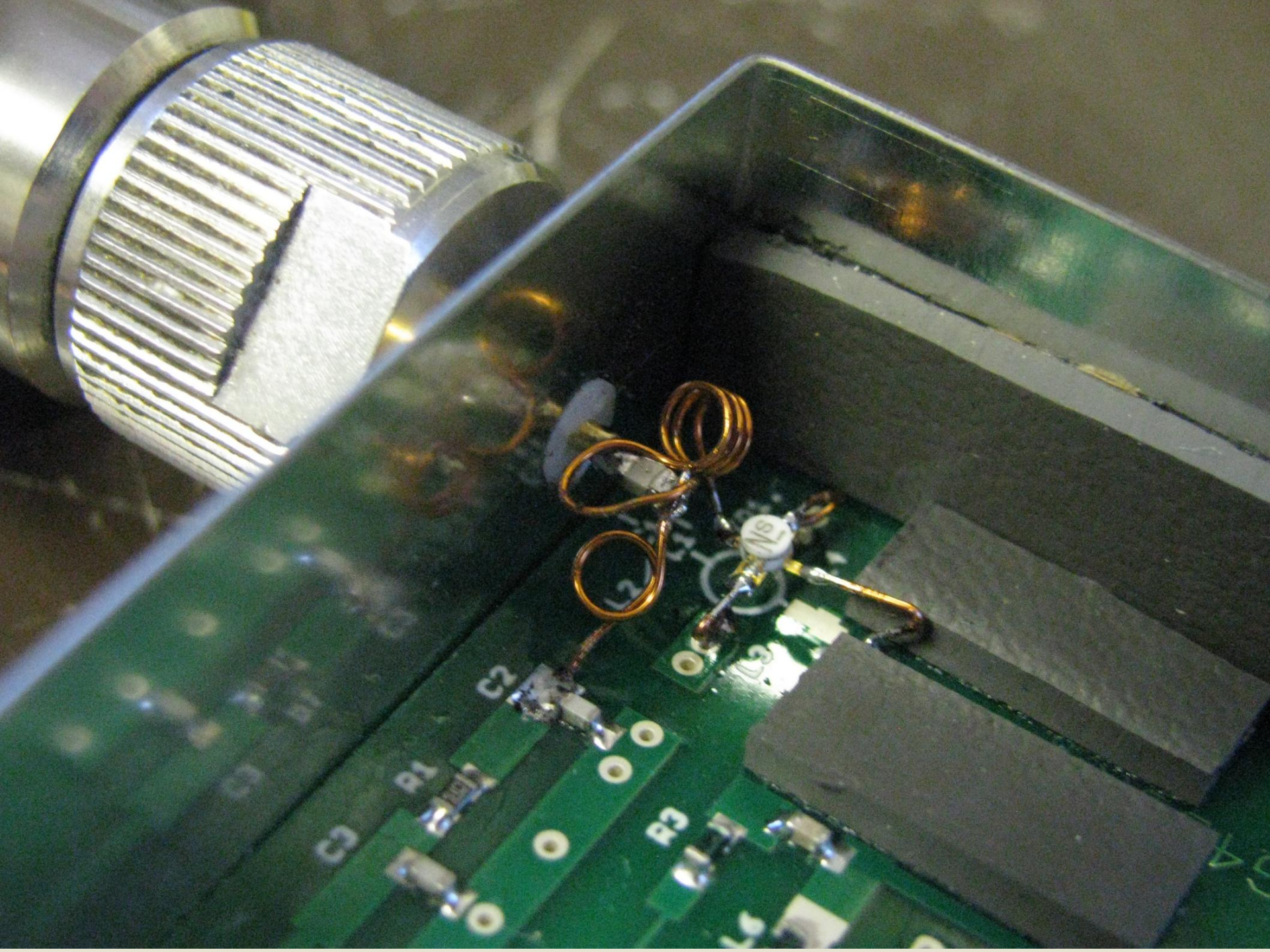
Bias conditions for 23cm

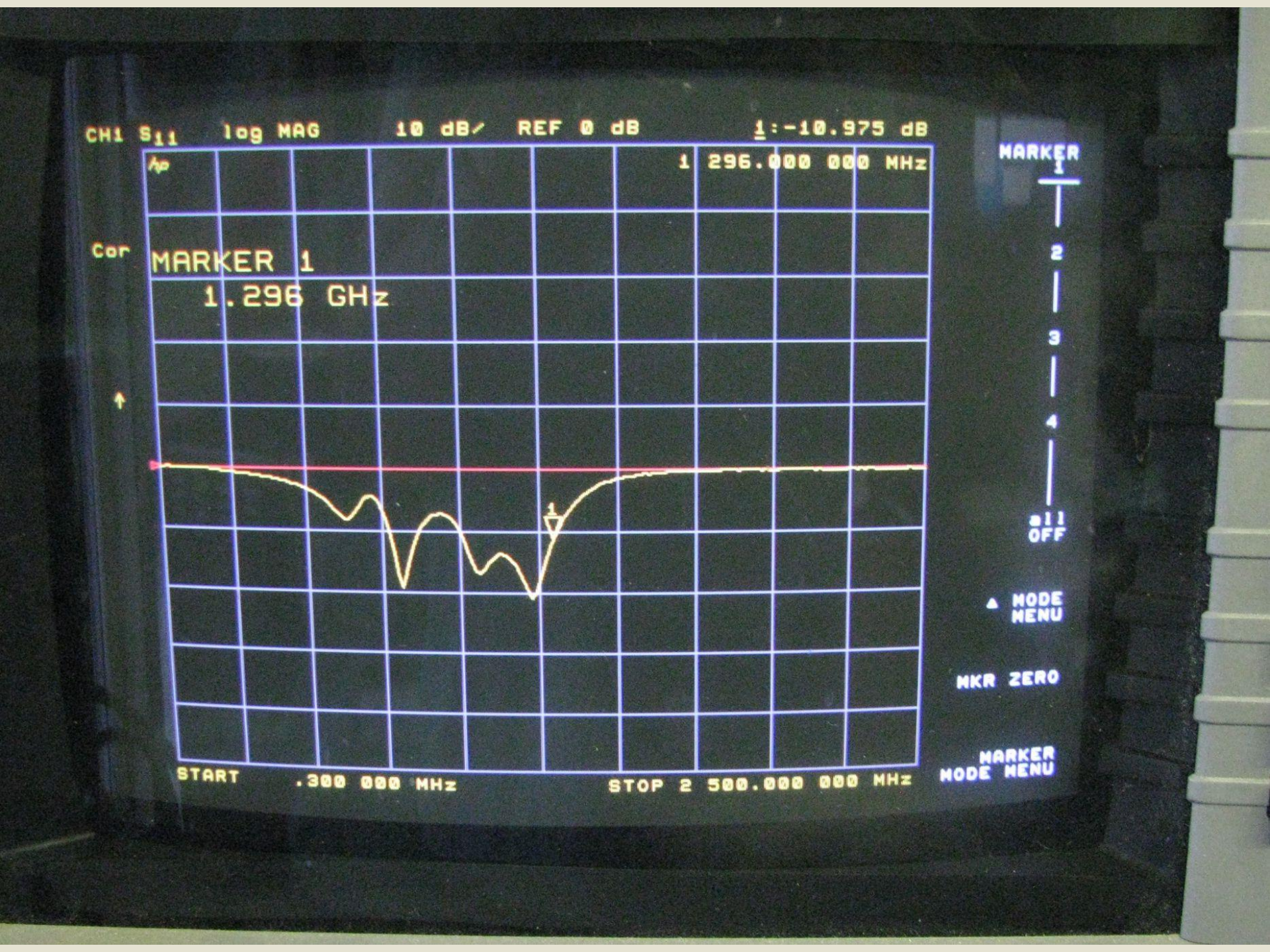
- TR1
  - Vds = 1.5-1.8 volts
  - Id = 14.8 – 16mA
- TR2
  - Vds = 2.94 volts
  - Id = 66mA


Typical bias conditions
~1.6V
15mA
2.94V
66mA



Input noise matching circuit for the VLNA23


C2
R1
C3
R3


CH1 S11 log MAG 10 dB/ REF 0 dB 1:-10.975 dB
1 296.000 000 MHz
Cor
MARKER 1
1.296 GHz
START .300 000 MHz
STOP 2 500.000 000 MHz
MARKER 1
2
3
4
all OFF
MODE MENU
MKR ZERO
MARKER MODE MENU

Nature of the failures

I wanted to investigate two areas in particular

1. Gain/noise figure anomaly
2. Is it better to keep power on during transmit?

Gain/noise figure anomaly

- Reports that gain appears normal.
- Noise figure has increased

Manifestation

- Preamps appeared to be working normally but signal reports were ‘asymmetric’. Receiving better reports that able to give previously.
- Observed in several different preamps, not just the VLNA
  - ATF53189 PHEMT has been shown to exhibit the same effect at 2m

Power on or off?

To test claims that the preamp can ‘survive’ higher levels of input signal if the power is left on during transmit

Failure tests

Testing for the gain/noise figure anomaly and power on/off survival can be tested as a single set of measurements

Power on

Increase the power into the preamp in steps, soak for a set amount of time, measure noise figure, gain and input return loss at each step. Repeat until preamp fails. Note level at which failure occurs and any changes.

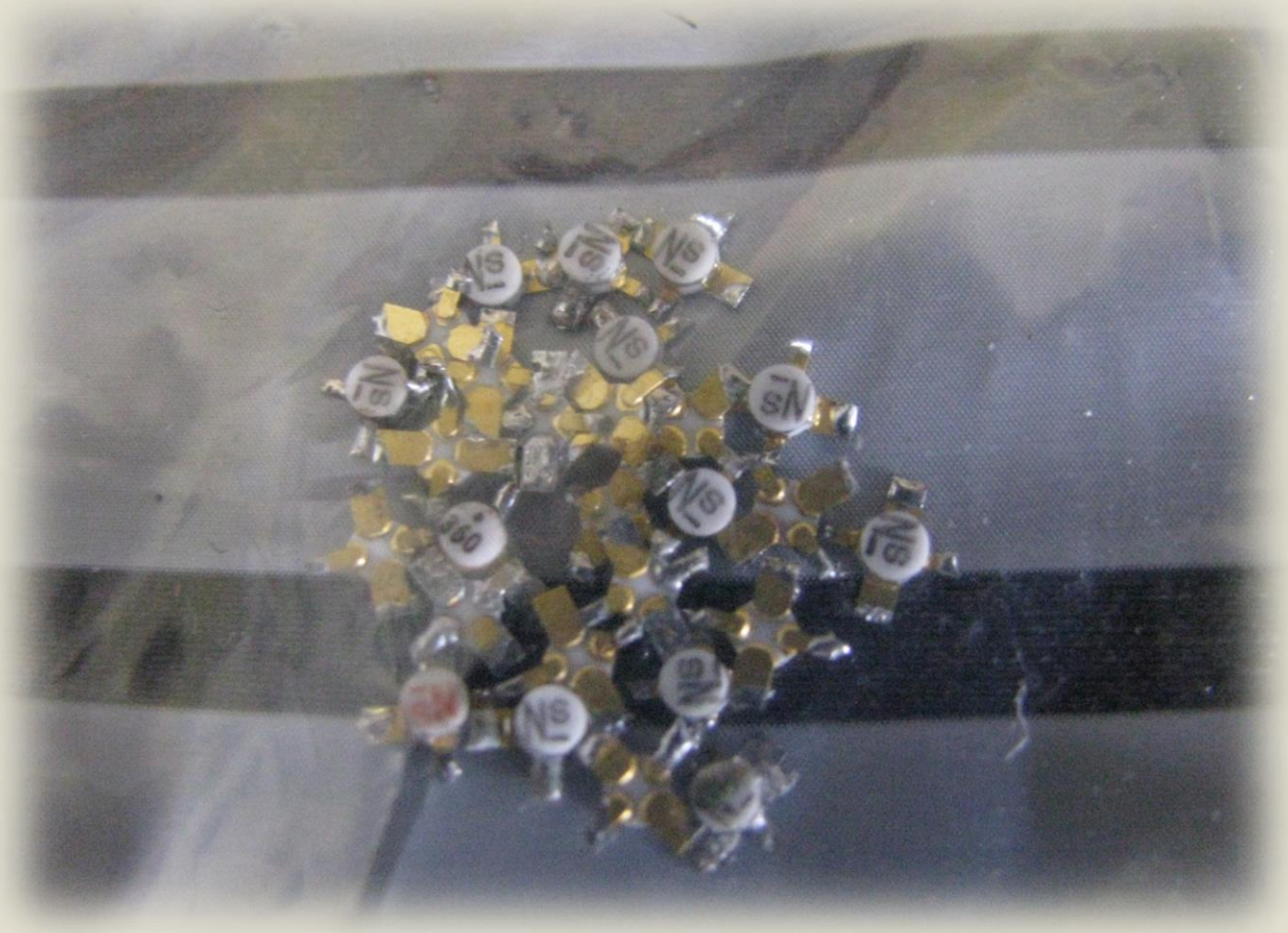
Change FETs

Power off

Repeat above tests until failure.

Note level at which failure occurs and any changes.

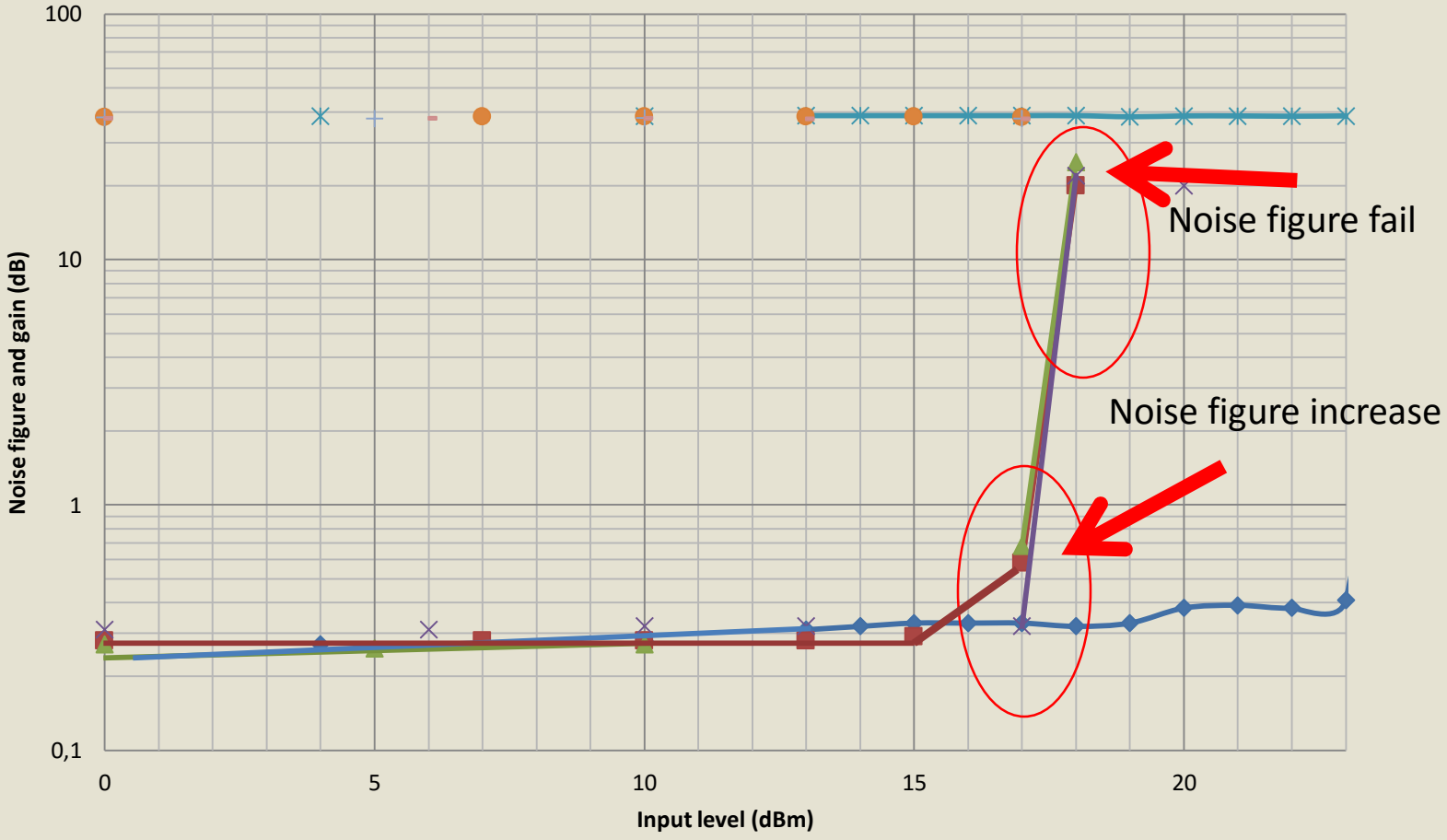
No one wants to deliberately blow up their favourite preamps, do they?



Failure tests

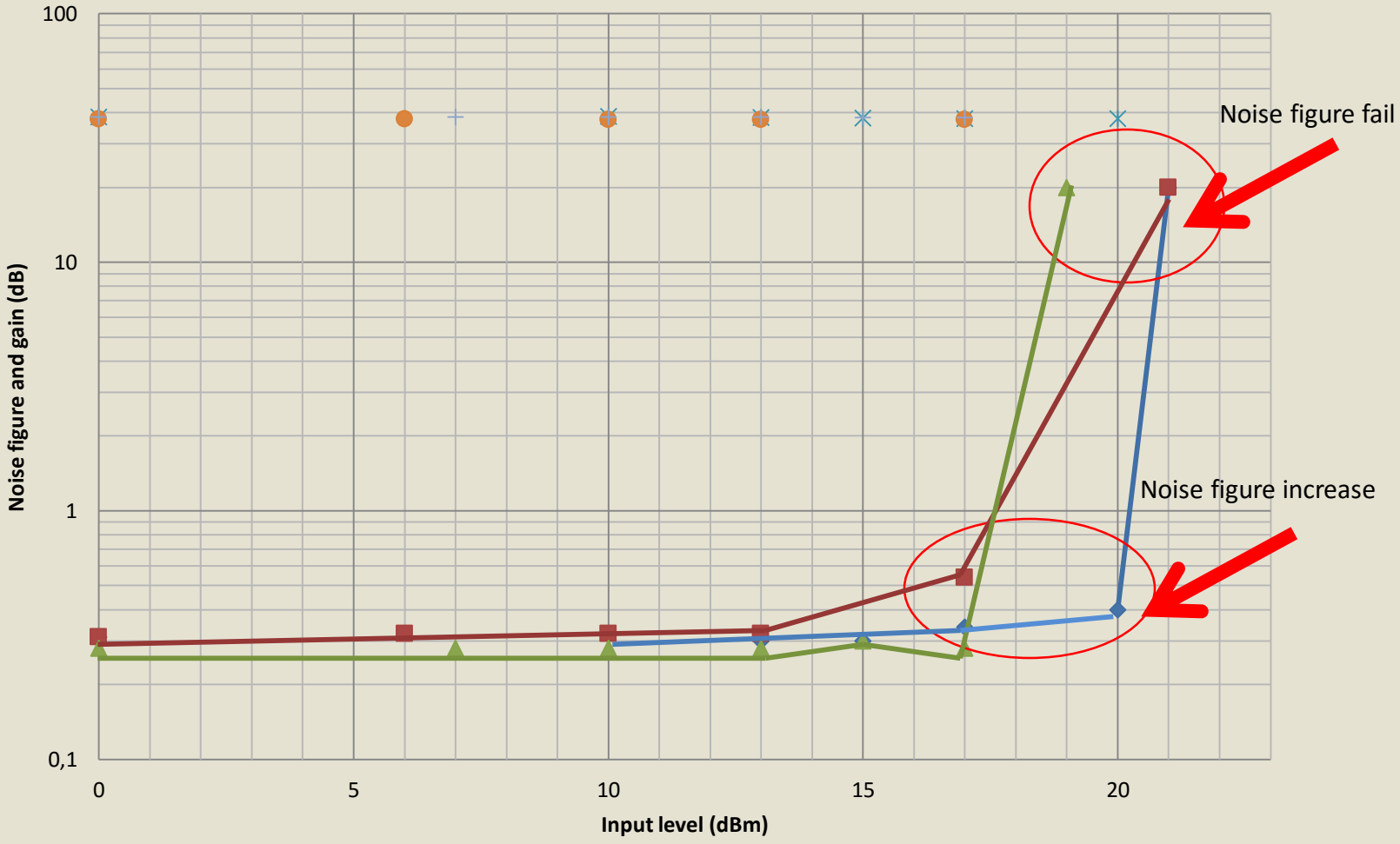
- ‘Soak period’ varied from 3 minutes to 1 hour at each of the input levels
- Noise figure, insertion gain and input return loss measured after each period

Early results - Power on
Table 1,2,3,&4

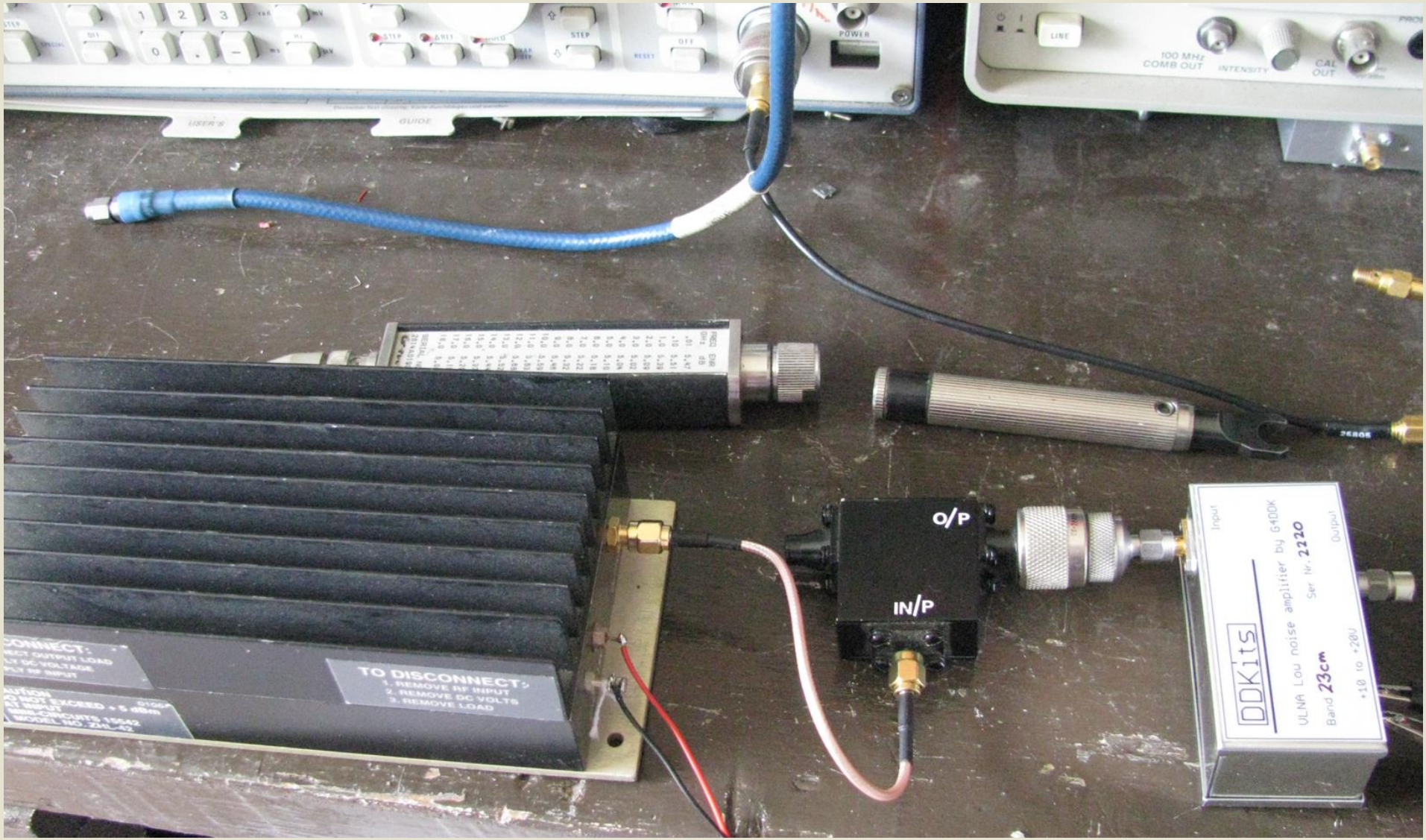


Early results - power off
Table 4*,5 and 6

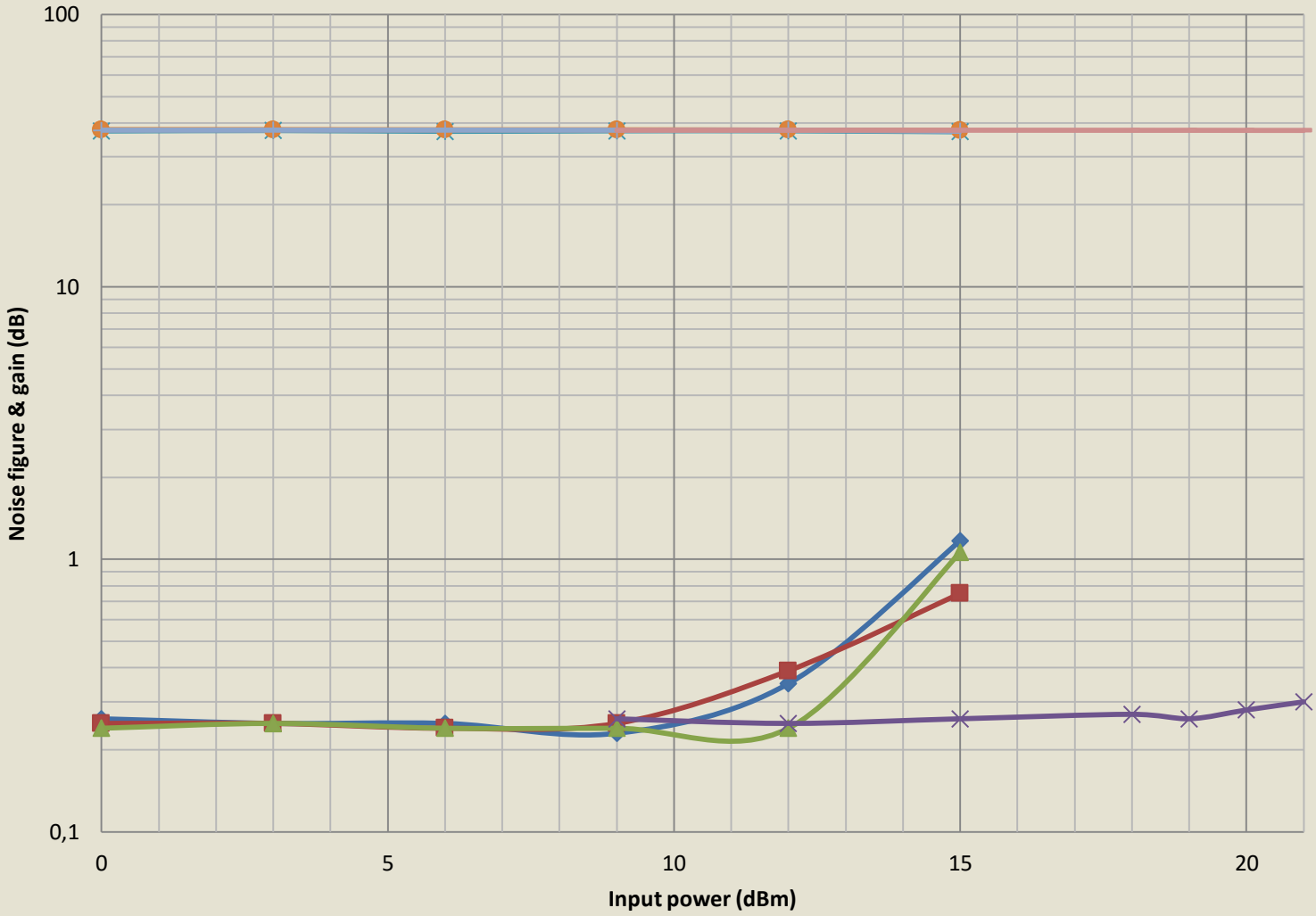
*Two table 4!



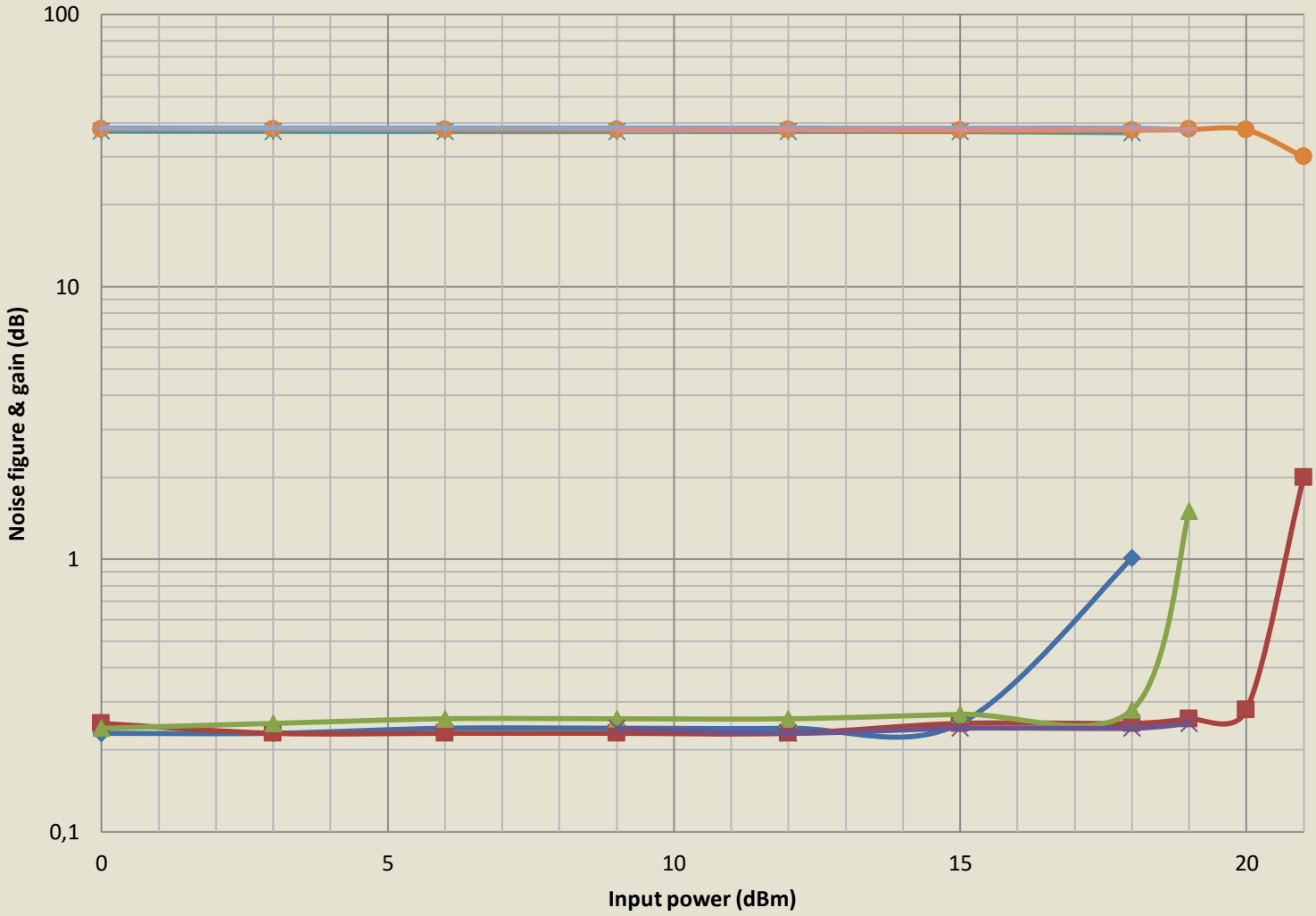
Later test results with isolator



Latest results - Power ON



Latest results - Power OFF



Conclusions 1

- The noise figure/gain anomaly has been observed in testing and usually occurs in a limited input range before complete failure
- Does not happen every time.

Conclusions 2

- Occurs mainly between +12dBm and +17dBm input
  - Anomaly due to gate puncturing?
- It seems to be due to the onset of gate current
  - Too low to be measured (maybe picoamps?)
  - At this level of gate current the gain is largely unaffected
- Most devices fail completely between +20dBm and +23dBm input

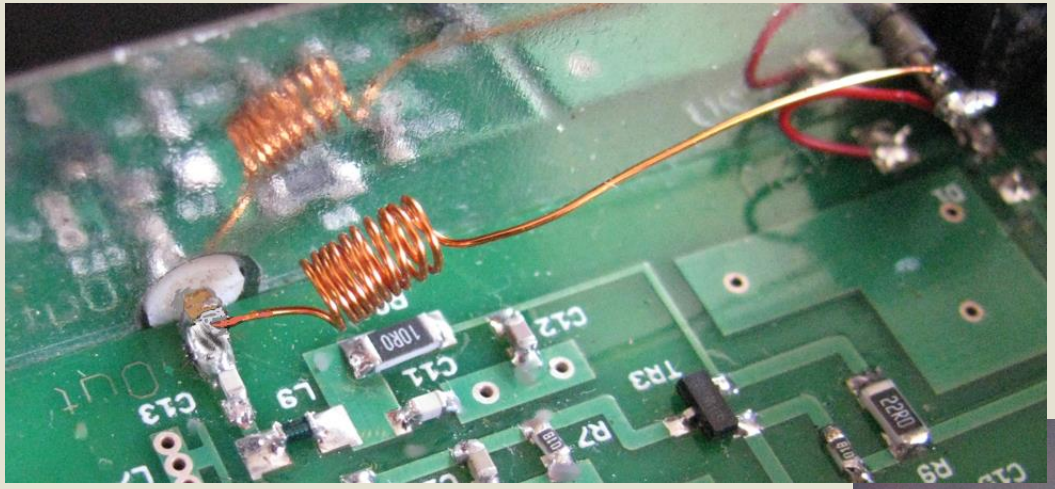
Conclusions 3

- Doesn’t seem to be due to RF heating, directly
- It has been observed in both HEMT and PHEMT devices
- Second stage (ATF54143 PHEMT) unaffected as first stage limits input signal level

Conclusions 4

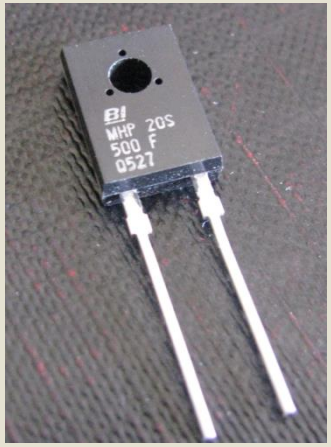
- Keeping power on during transmit does not confer any advantages – see next slide
- VLNA23 is able to withstand a larger input signal than previously recommended
  - If I can afford the FETs I will check the other bands!
- Failure suspicion falls on relay isolation
  - Need for dynamic rather than static testing - Spikes

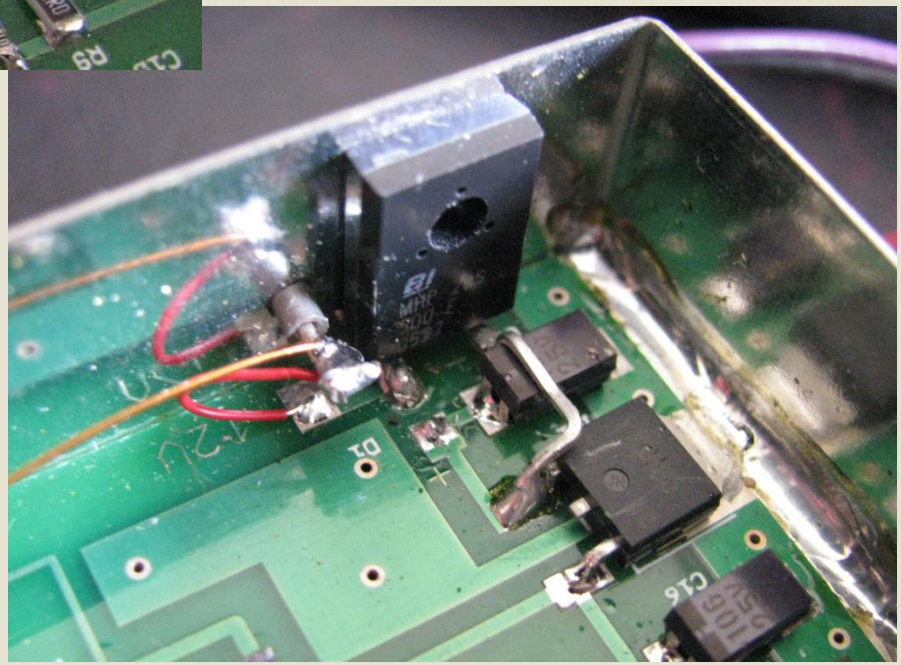
Power feed over coax



Preamp and isolation relay
Powered in parallel
Option to use 20-24V

120R =
10V
@85mA





Thank you

More details will appear on my web page
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Blog: G4DDK.BLOGSPOT.COM
Twitter: DXING

Basic HEMT structure