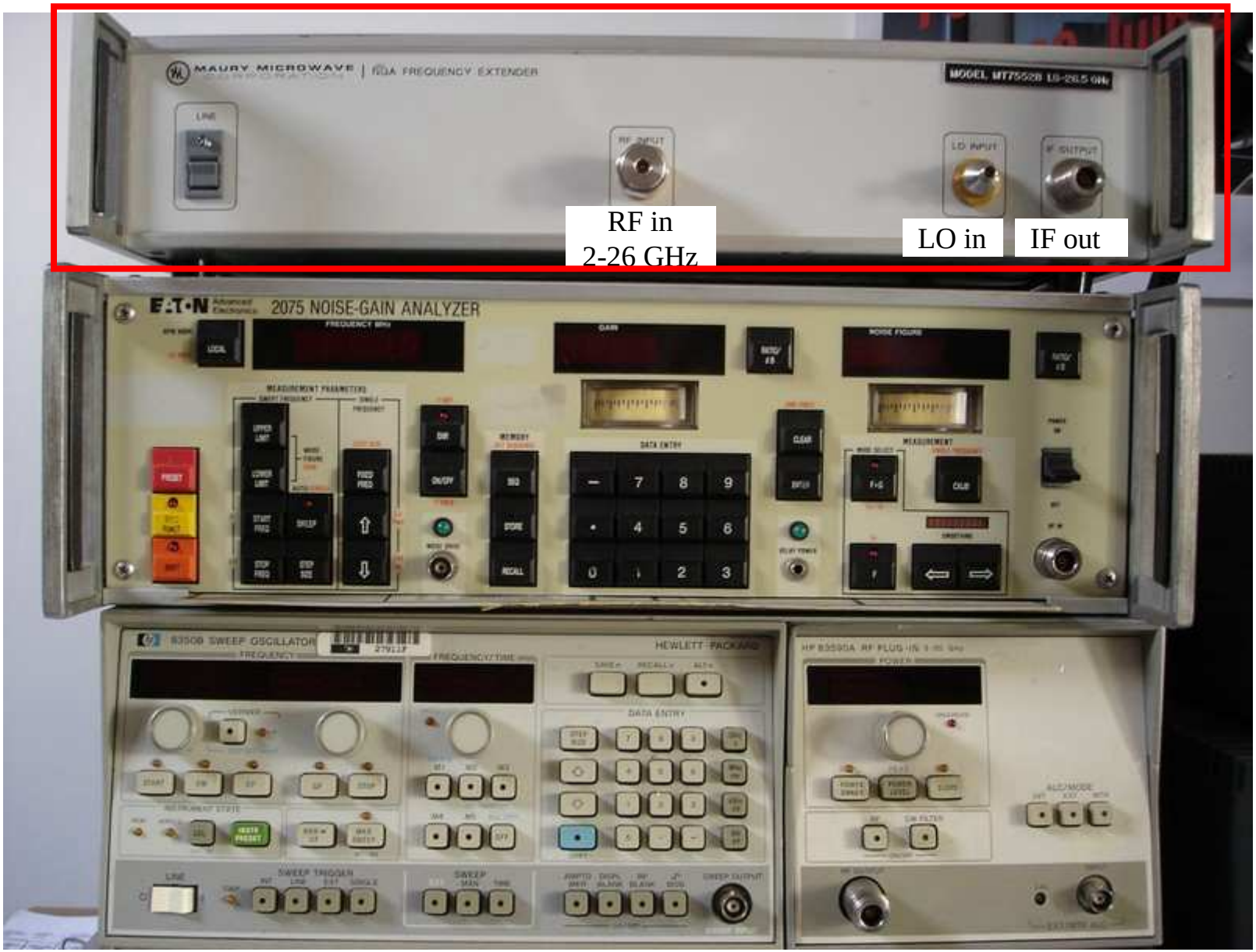
Measures over 2 GHz with Eaton MT7552b 26 GHz extension

Eaton MT7552b extension set



Overview

AGILENT / HP 8970a or EATON 2075 gain/noise analysers are limited to frequencies respectively up to 1.6 or 2 GHz. In order to extend their possibilities over 2 GHz the only way is to use these extensions :

- The HP 8971(b or c) NF test set extension (18 or 26.5 GHz) is only dedicated to the HP 8971b (not « a ») analyser ! Either SSB and DSB measures can be done.
- If an HP 8350 sweep is choosen, the b version is obligatory.

- The Eaton MT7550 extender family has a more simple construction and a more universal use (whole Eaton 2075 family or HP/Agilent 8970a and b analysers) - - But measures can only be done in DSB mode !
- The local oscillator choice is only restricted by the GPIB calble obligation

The chance was just given to me to do reverse engineering, make a few restricted measures and understand how it is working !
And great thanks to F5ICN - - without him these investigation would not been possible!!!

Abstract

1- Reverse engineering - internal hardware

2- Broadband gain / NF calibration problems

3- 8 to12 GHz broadband measures on a 10 GHz DB6NT preamp

4- 2 to 15 GHz broadband measures

- **Broadband calibration problems ?**
- **Measures from 5 to 15 GHz ?**
- **Measures from 2 to 7 GHz**

5- Conclusions

1- Internal hardware

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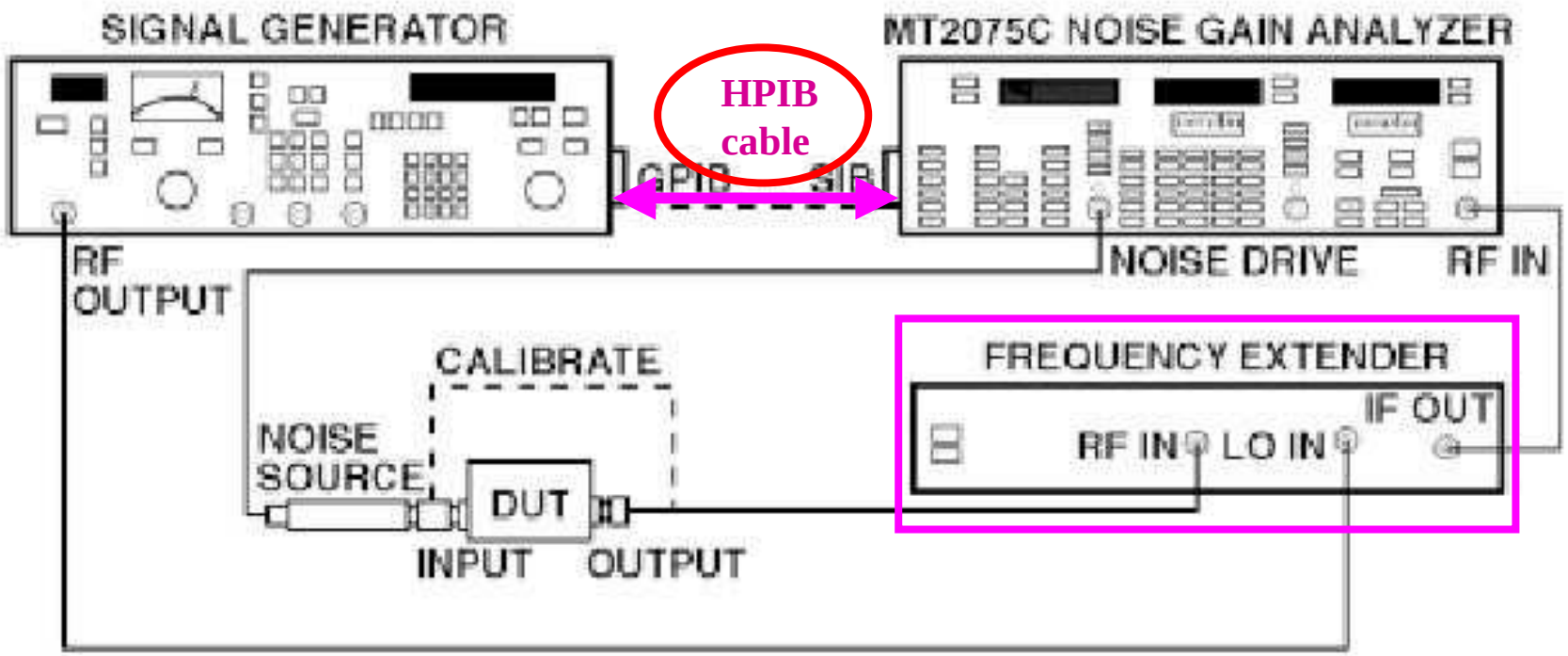
Eaton (Maury) MT 7550 series noise gain analyser frequency extender, up to 26 GHz

The choice of only **DSB mode** measurements possibility gives a design with :
- no internal tracking filter
- no HPIB tracking requirement, only between analyser and sweep generator
- only a 20 dB broadband preamplifier, a mixer and a 500 MHz LPF !!
- fixed IF of 30 MHz (up to 500 MHz)



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Eaton (Maury) MT 7550 series noise gain analyser frequency extender

3 models choice according to the frequency domain

Model	Frequency Range GHz	Conversion Mode
MT7550A	1.6 — 4.2	Single Sideband
MT7551B	1.8 — 18.0	Double Sideband
MT7552B	1.8 — 26.5	Double Sideband

→ **no inside filter !**

Great advantage : full compatibility with :
- all Agilent/HP sweeps 9350a or b series - - or sweep synthesiser
- all Maury/Eaton or Agilent/HP noise/gain analyser

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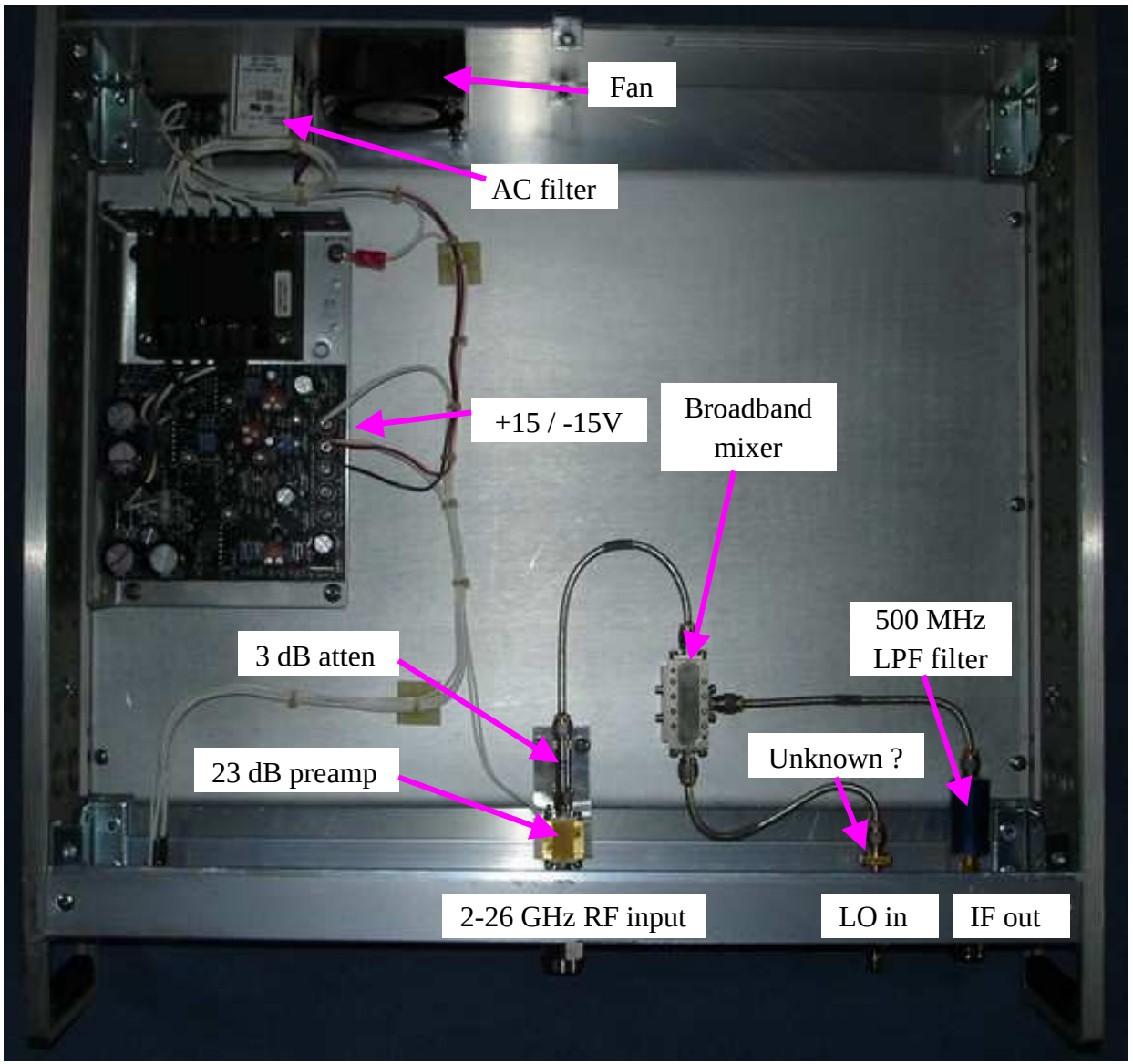
MT 7552 extender from 2 to 26.5 GHz – a very empty box !



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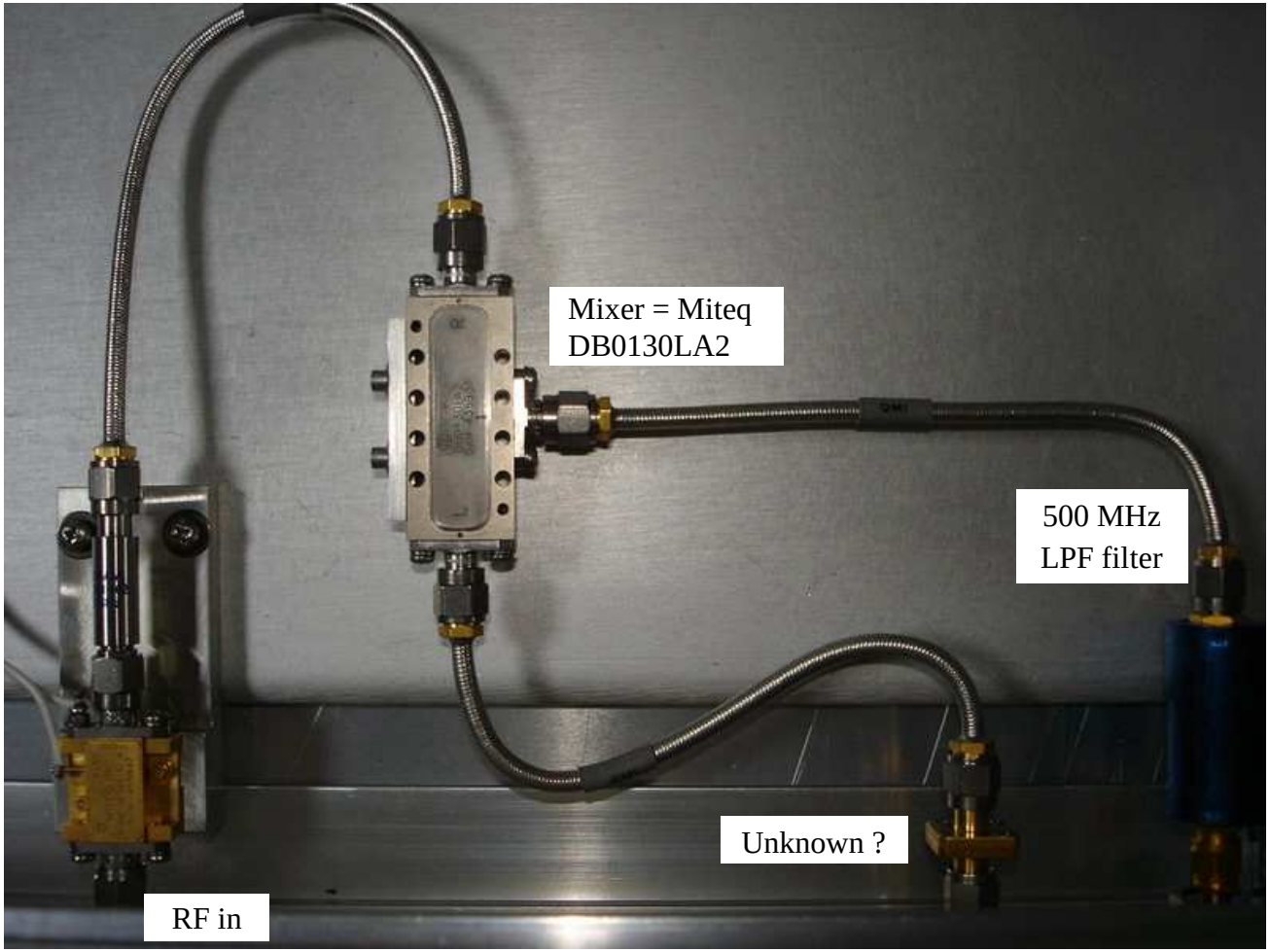
The RF mixer assembly



Zoom on Rf input assembly

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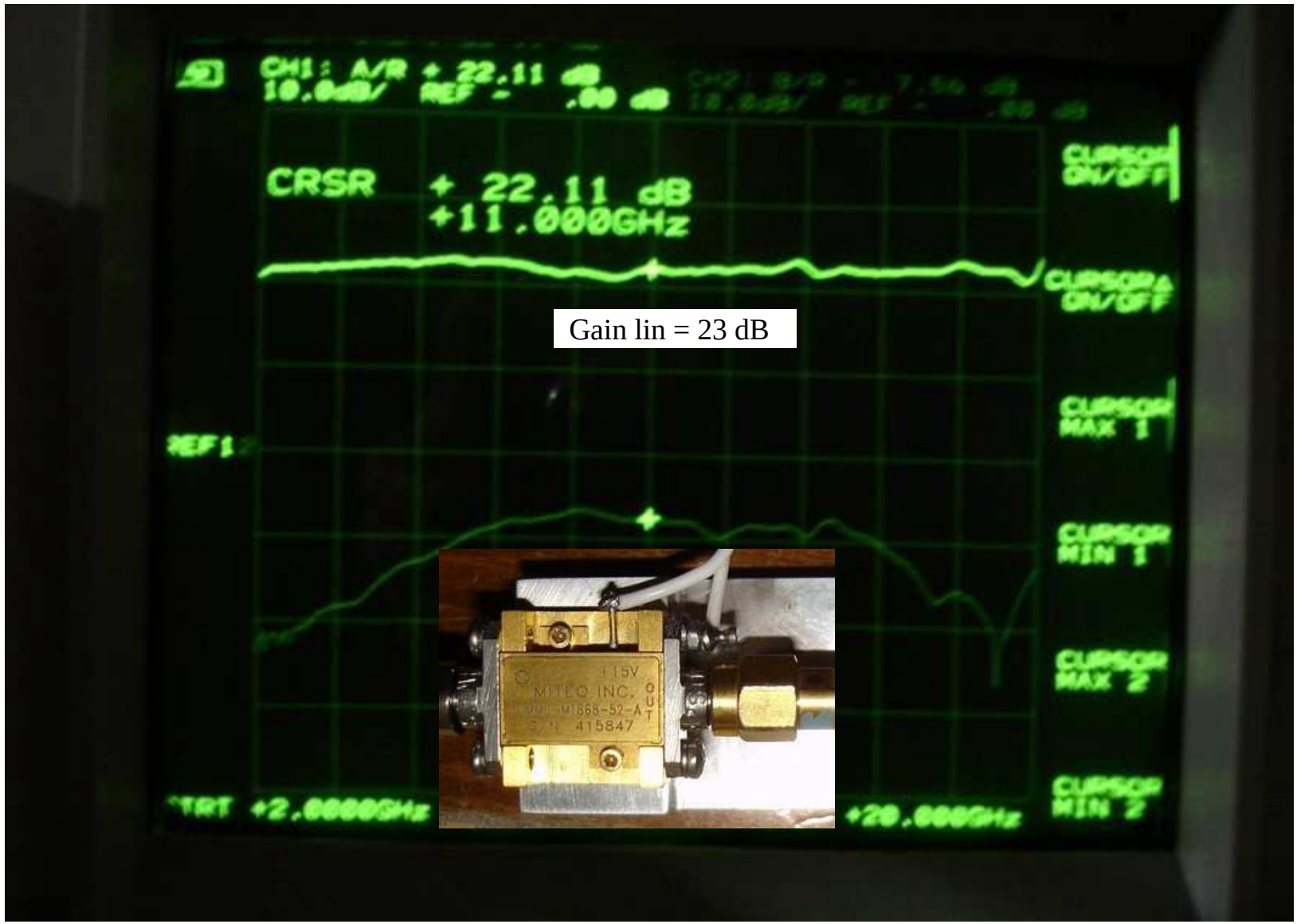
Miteq MT869-52-A 26 GHz broadband amplifier meas



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Mini-Circuits SPL-550 low pass filter

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Meas of « unknown » serial SMA/SMA in LO line

2- Broadband gain / NF calibration → problems

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HPIB commands examples using either the HP or Eaton analyser

Gain/Nf measures in DSB with outside LO at frequencies > 2 GHz

With HP 8970a analyser					**HPIB analyser menu to enter**		*With Eaton 2075 analyser*		
	HP 8970a master							Eaton 2075 master	
	HPIB cable							HPIB cable	
	HP 8350a ou b slave sweep default address 8							HP 8350a ou b slave sweep default address 8	
page 3-70	1,1	**SP**	LED Local Talk "on"		**Var RF, ext LO, fixed IF**		**SP**	1,2	**Enter**
Start	6000	**Enter**			**Start 6 GHz**		**Start**	6000	**Enter**
Stop	12000	**Enter**			**Stop 12 GHz**		**Stop**	12000	**Enter**
Step size	100	**Enter**			**Step size**		**Step size**	100	**Enter**
					= DSB		**SP**	2,0	**Enter**
	41,0	**SP**			**Drives the HP 8350a or b sweep**		**SP**	47,3	**Enter**
	4,1	**SP**			**Takes the HP 8350a control**		**SP**	40,2	**Enter**
	3,0	**SP**	70	**Enter**	**Fixed IF of 70 MHz**	**Shift**	**Start**	70	**Enter**
Sweep HP 8350		**Pwr lvl**	6	**dBm**	**P LO = +6 dBm**		**Shift**	↑ 6	**Enter**
	19,1	**SP**			**IF cal**		**SP**	33,0	**Enter**

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First broadband gain / NF calibration tryings up to 15 GHz – a *GREAT DECEPTION* ! *Why ?*

With its internal Miteq broadband preamp, it's **absolutely impossible** to get a correct **broadband NF cal**
The beginning of calibrating immediately gives **ERROR 118** (input overloading)

Tests were previously tried as followings (**WITHOUT ANY SUCCES**) :
- SP 16.2 or 16.3 instead of 16.1 (other calibration attenuator setting)
- LO power injection from +10 dbm, down to -2 dBm
- Subsidiary 10 or 20 dB N attenuator in the IF line
- IF frequency change from 30 to 150 MHz
- Tryings with Eaton 2075a and b models or HP 8970a analysers give same results

- It can work at some dot or spot frequencies but is **absolutely unable to make broadband measures**
- Sure that this Eaton extension wasn't only thought for this restricted purpose or ???

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Only solution : putting a 20 dB attenuator AFTER the internal Miteq broadband amp

A 20 dB attenuator between broadband amp output and mixer input (initial 3 dB attenuator replacement) cures immediately the problem
- Trying a 10 dB attenuator isn't sufficient (Error 118)
- Sorry I didn't try with values between 13 and 19 dB
- The same 10 or 20 dB put at its front-end doesn't solve the problem (error 118)

So the total gain before mixer input is now roughly 0 dB - - as it is with an outside passive mixer

So I suppose that:
- A 10 to 13 dB broadband amplifier instead of the actual 25 dB one is largely sufficient (compensating the mixer losses irregularities).

3- First restricted 8 to 12 GHz broadband measures on a 10 GHz DB6NT preamp

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Following measures and comparaisons were done

a- Direct RF input to mixer (no Miteq broadband amp) → internal passive mixer
b- 20 dB attenuator between Miteq amp and mixer instead of the 3 dB original one → active mixer
c- Factory build Extender without any mods
d- Comparaison with an external Watkins-Johnson M52C broadband mixer

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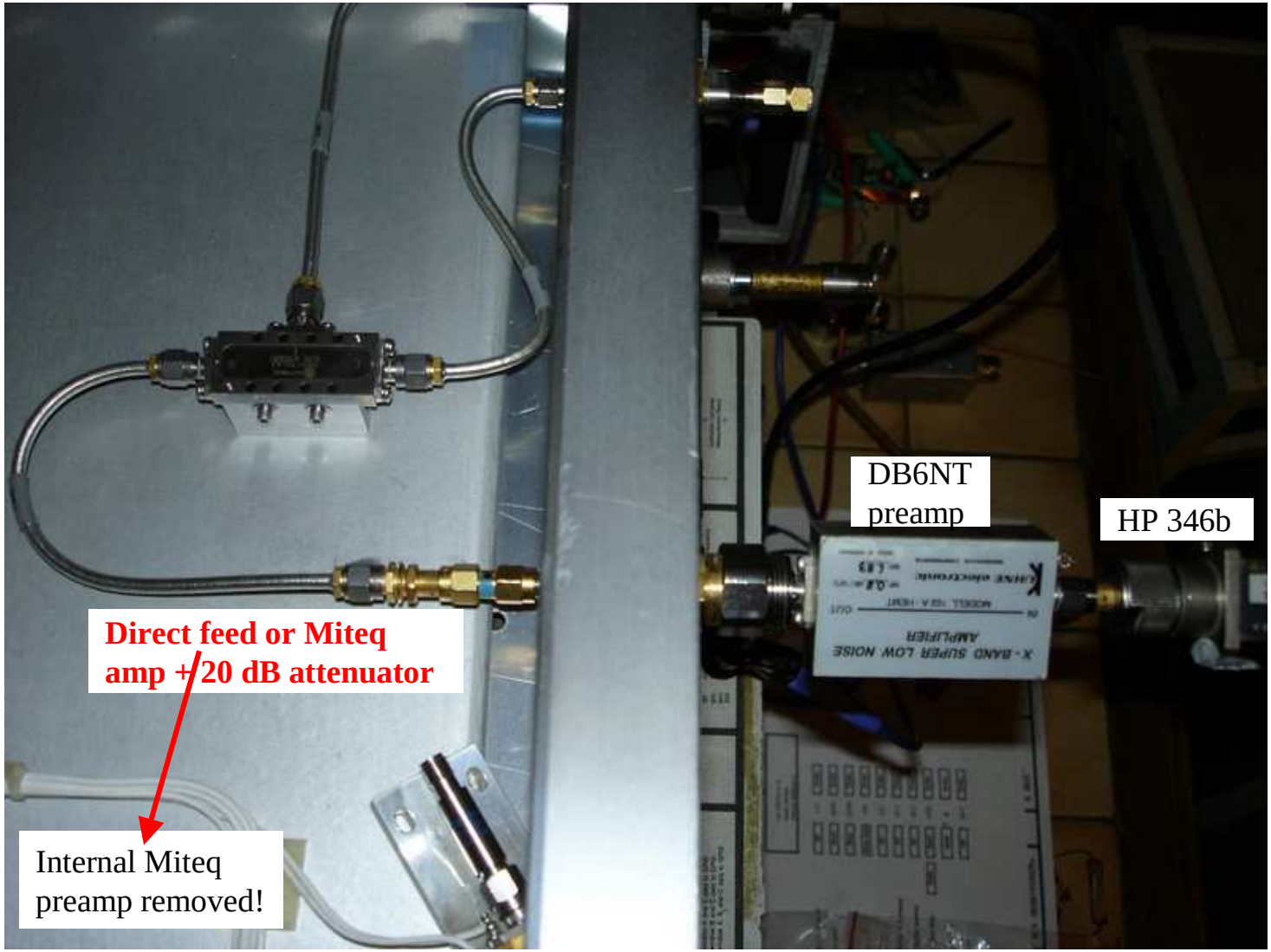
Broadband meas of a DB6NT 10 GHz preamplifier

Hardware needed



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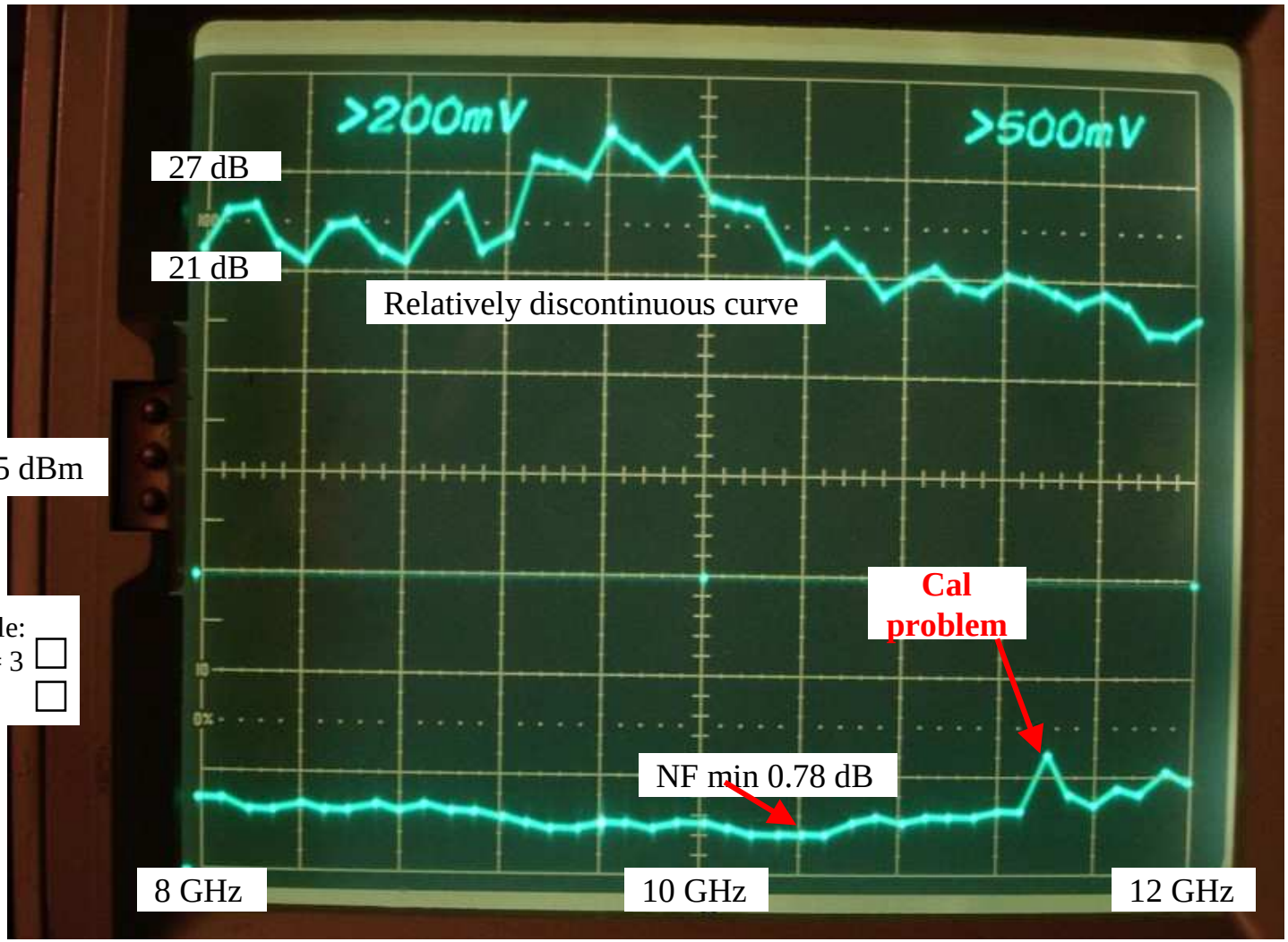
Meas of a DB6NT 10 GHz preamplifier

a- Direct RF input to mixer (no Miteq broadband amp) → **internal passive mixer**



Impossible to make a correct cal especially à F > 12 GHz (broadband mixer losses uncontinuous and too high)

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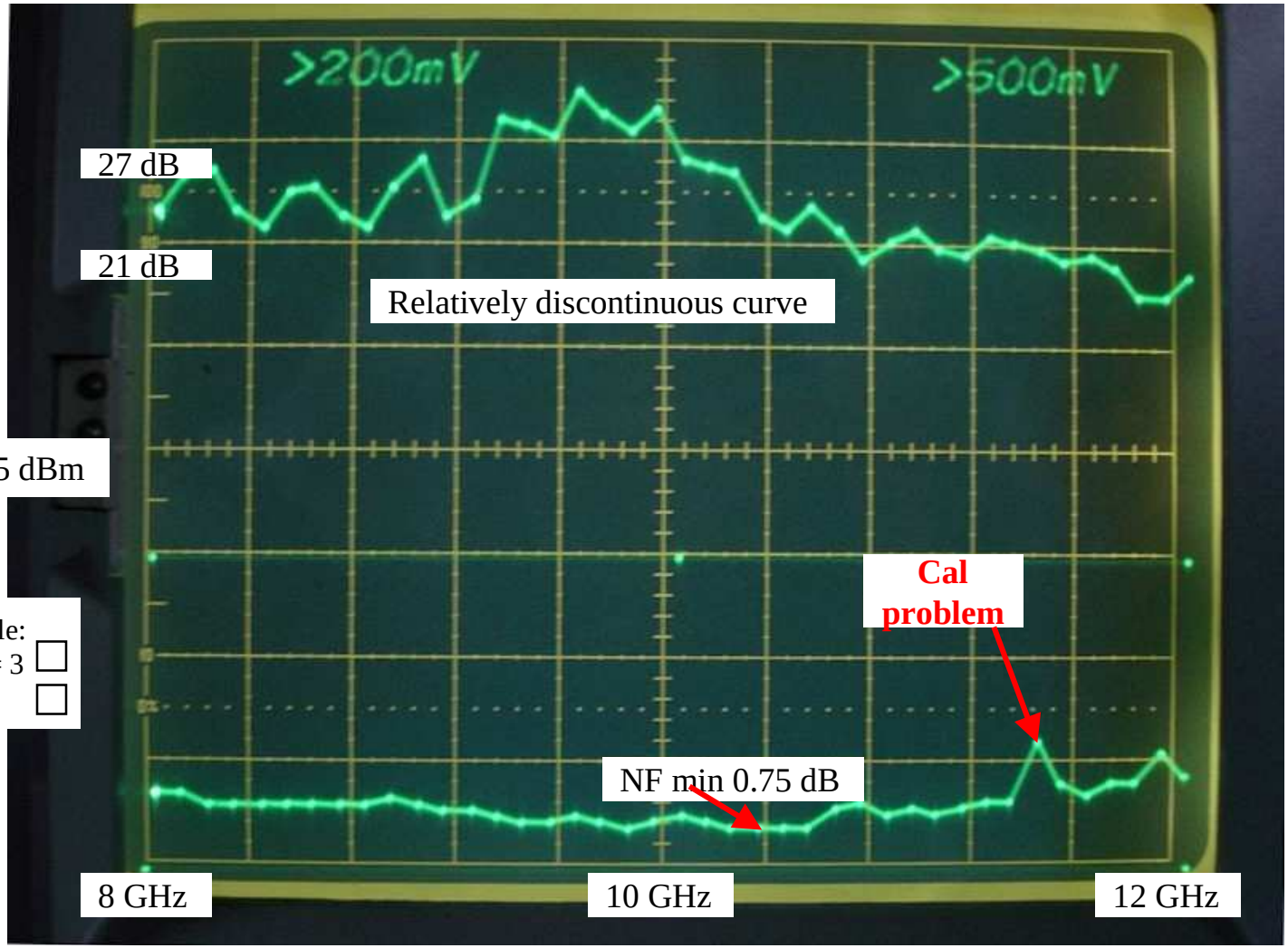
Meas of a DB6NT 10 GHz preamplifier

b- 20 dB attenuator between Miteq amp and mixer instead of the 3 dB original one → **internal active mixer**



It gives exactly the same results as before but could be measured !!

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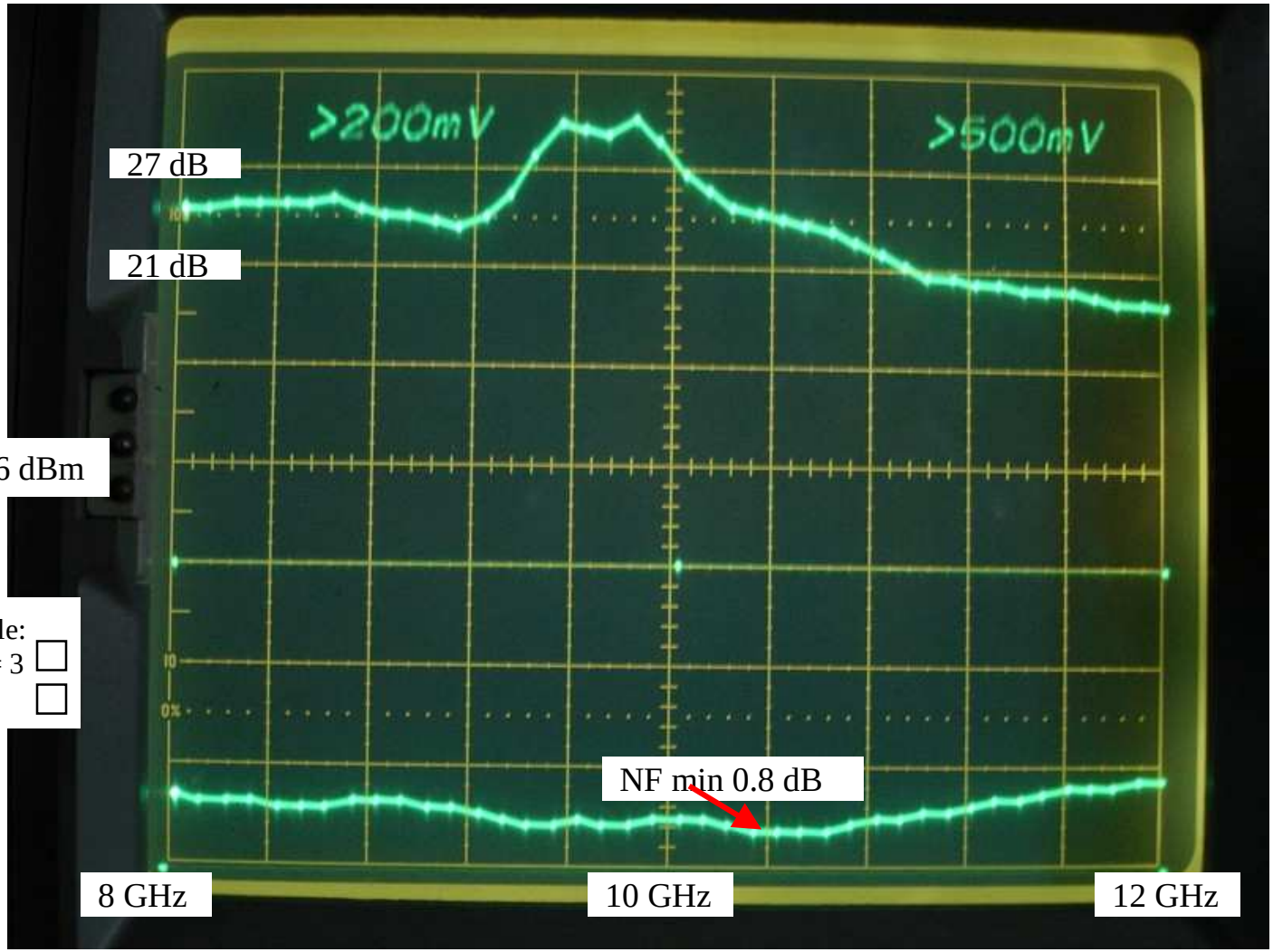
Meas of a DB6NT 10 GHz preamplifier

c- **Factory build** Eaton **extender** without any modifications - - but Eaton analyser with SP 16.3 function



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Meas of a DB6NT 10 GHz preamplifier

d- **External** Watkins-Johnson M52C **passive mixer** as « gold » comparaison

4- 2 to 15 GHz broadband measures

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2 to 15 GHz calibration problems with factory build Eaton extension

- **Impossibility** to get correct **NF calibration** at frequencies **ABOVE 12.4 GHz**
- Correct calibration restricted from 2 to 12 GHz but with:
  - Gain/NF analyser max internal attenuator setting with SP 16.3
  - Sweep with P LO restricted to +7 dBm max and 500 MHz step size (error 118 if more power injection)
  - With a 100 MHz step size or less, P LO must be again restricted to +6 dBm (again error 118)

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Measure of a Miteq AMF-8S-109127-5 broadband amp (5 to 15 GHz, gain 50 dB Nfmin=2 dB)

Absolutely impossible to achieve with SP 16.3 and also a 20 dB attenuator at its output (error 118 and relays fluttering)

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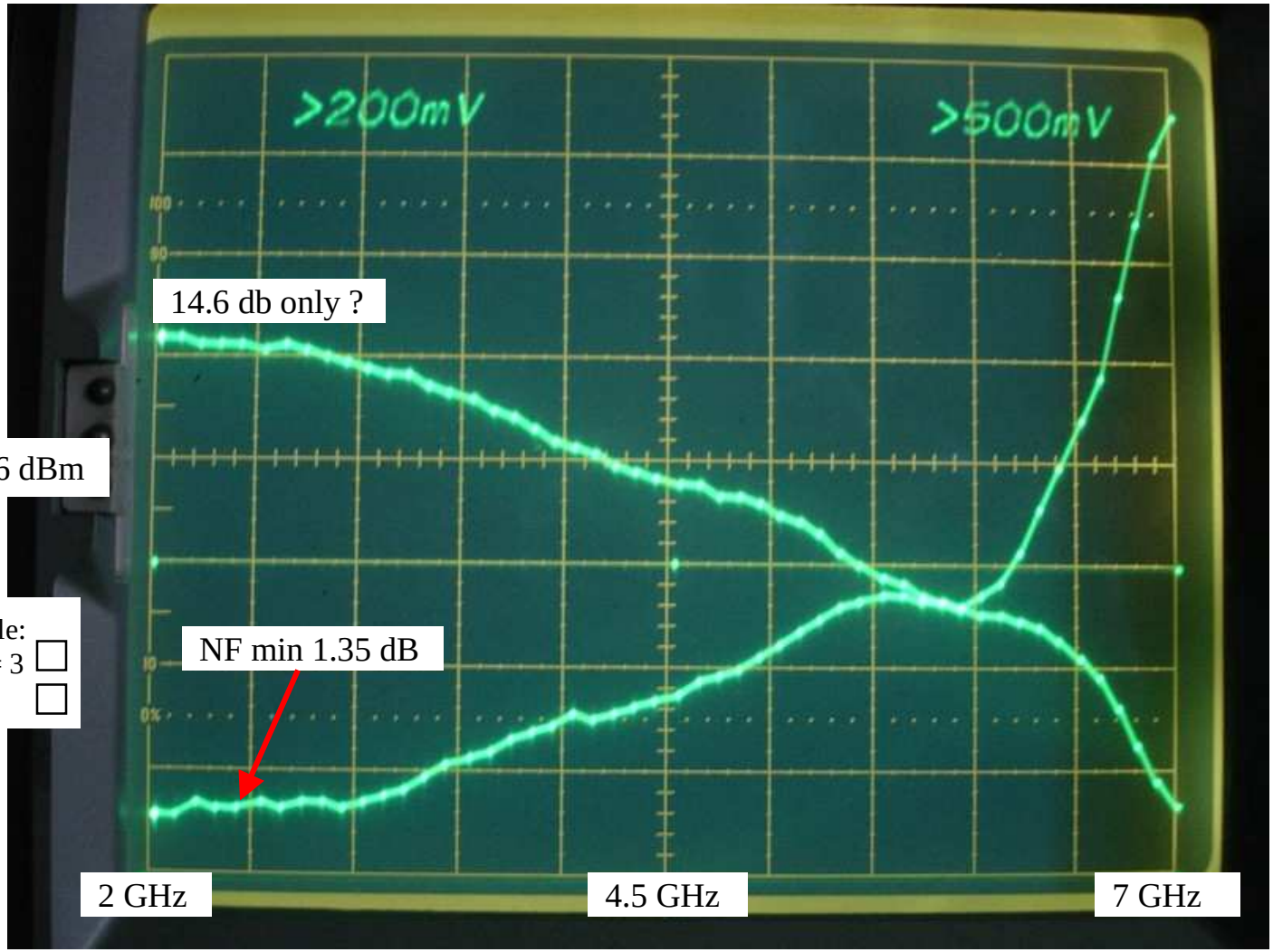
Measure of a 10 MHz – 3 GHz LNA 3000a broadband amplifier (15 dB Nfmin=1.3 dB à 2.8 GHz)

a- **Factory build** Eaton **extender** without any modifications - - but Eaton analyser with SP 16.3 function



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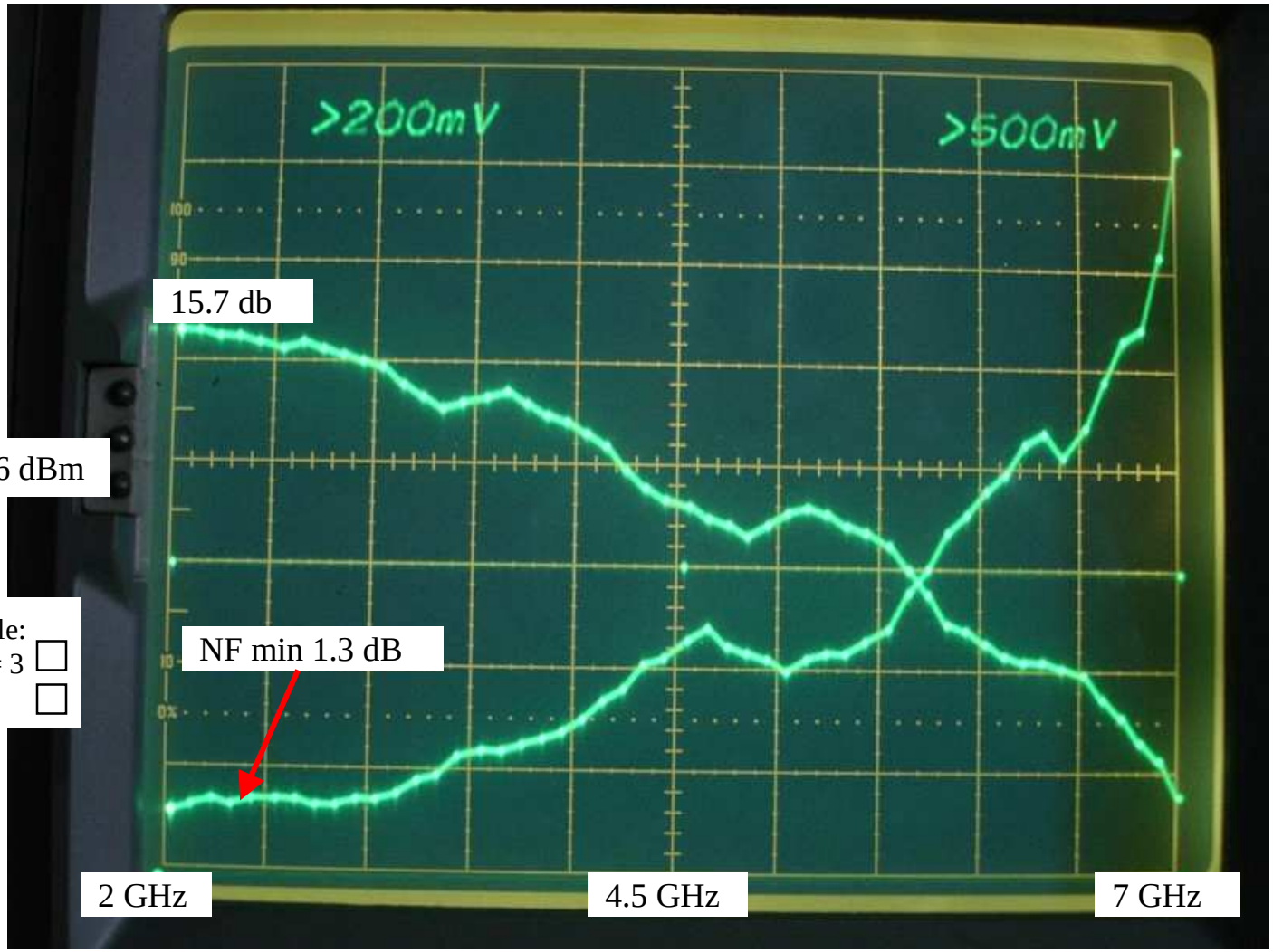
Measure of LNA 3000a 10 MHz – 3 GHz broadband amplifier (15 dB Nfmin=1.3 dB à 2.8 GHz)

b- **External** Watkins-Johnson M52C **passive mixer** as comparaison (normal SP 16.1)



5- Conclusion

Conclusion

- As manufactured it's **impossible to calibrate the NF correctly over 12.4 GHz** !!!!
- Correct calibation only from 2 to 12 GHz - - but with taking care of the LO injection
- Optimal measure parameters are difficult to find - - also obligation to use the SP 16.2 function
- **Overloading the analyser input** is its most drawback (error 118, also with relay fluttering) !
- The internal broadband mixer don't have a continuous loss versus frequency, especially à F>12 GHz. Sure that it's internal Miteq broadband front-end hardware is helping to compensate this drawback

Measures (principally NF) are roughly the same as with an external broadband mixer but this last way is the far cheapest and simpliest one !

Special thanks to F5ICN for his extension lending possibility, and also F6AJW and F5BQP for their unconditional help