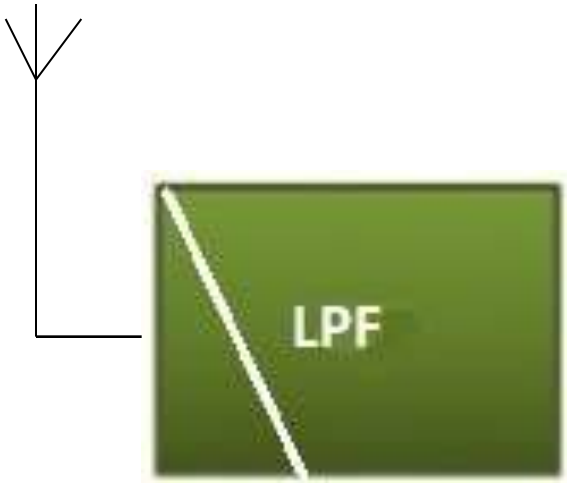
Conventional receiver dynamic range is mainly limited by RECIPROCAL MIXING and 3rd ORDER INTERMODULATION.
The outcome is not the average of these two parameters, but simply the worst of the two (I4SBX)

Think Different III

A chain is only as strong as its weakest link

I4LEC - Claudio

Then, which is the weakest point?

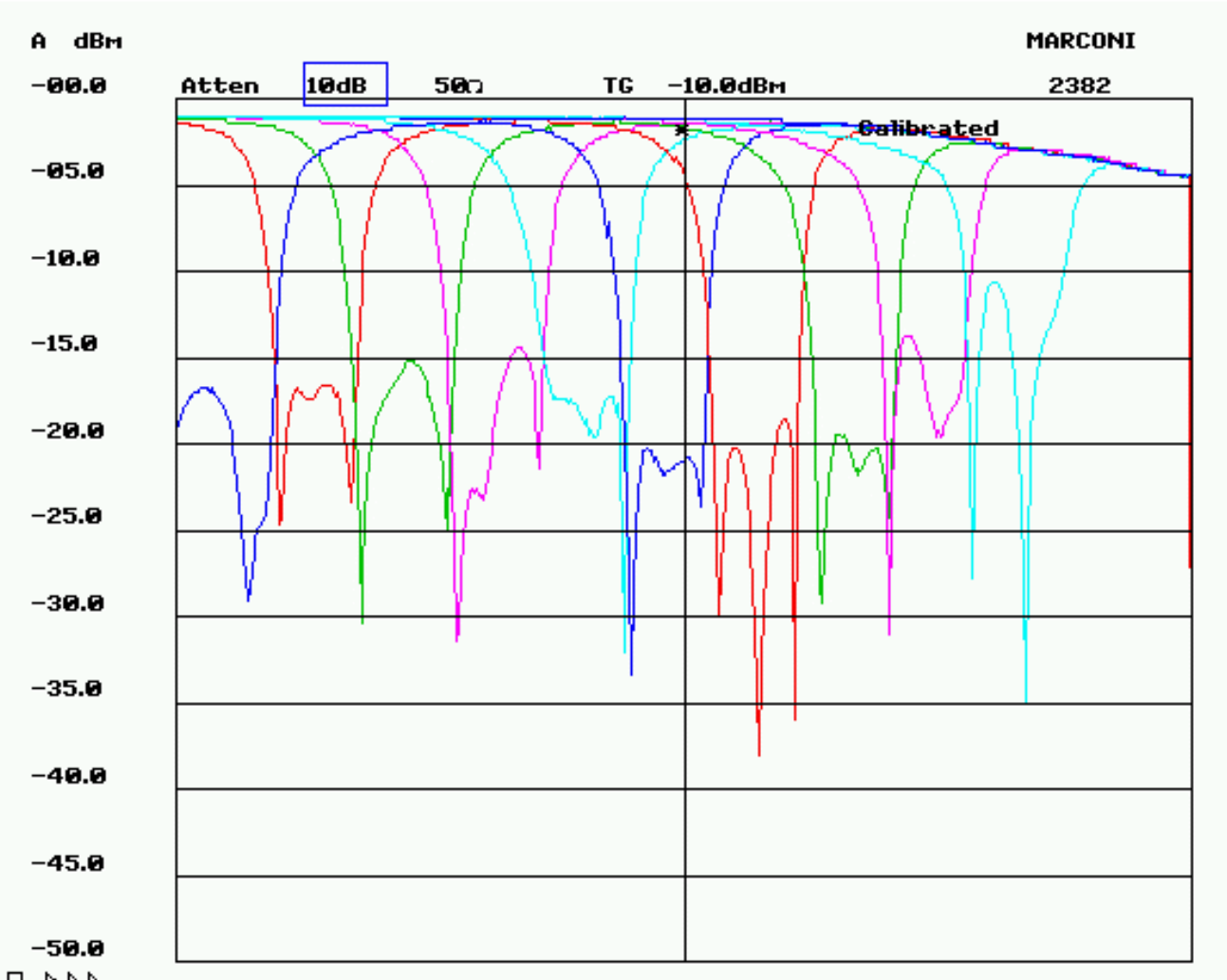


High end BRAND	Band Selectivity
Yaesu	B – Band Pass
Elecraft	B – Band Pass
Flex (SDR)	B – Band Pass
Ten Tec	B – Band Pass
Kenwood	A – Trk Preselec
Icom	A – Trk Preselec

Mid end BRAND	Band Selectivity
Flex (SDR)	B – Band Pass
Ten Tec	B – Band Pass
Elecraft	B – Band Pass
Kenwood	B – Band Pass
Icom	A – Trk Preselec
Yaesu	B – 0.5 Octave

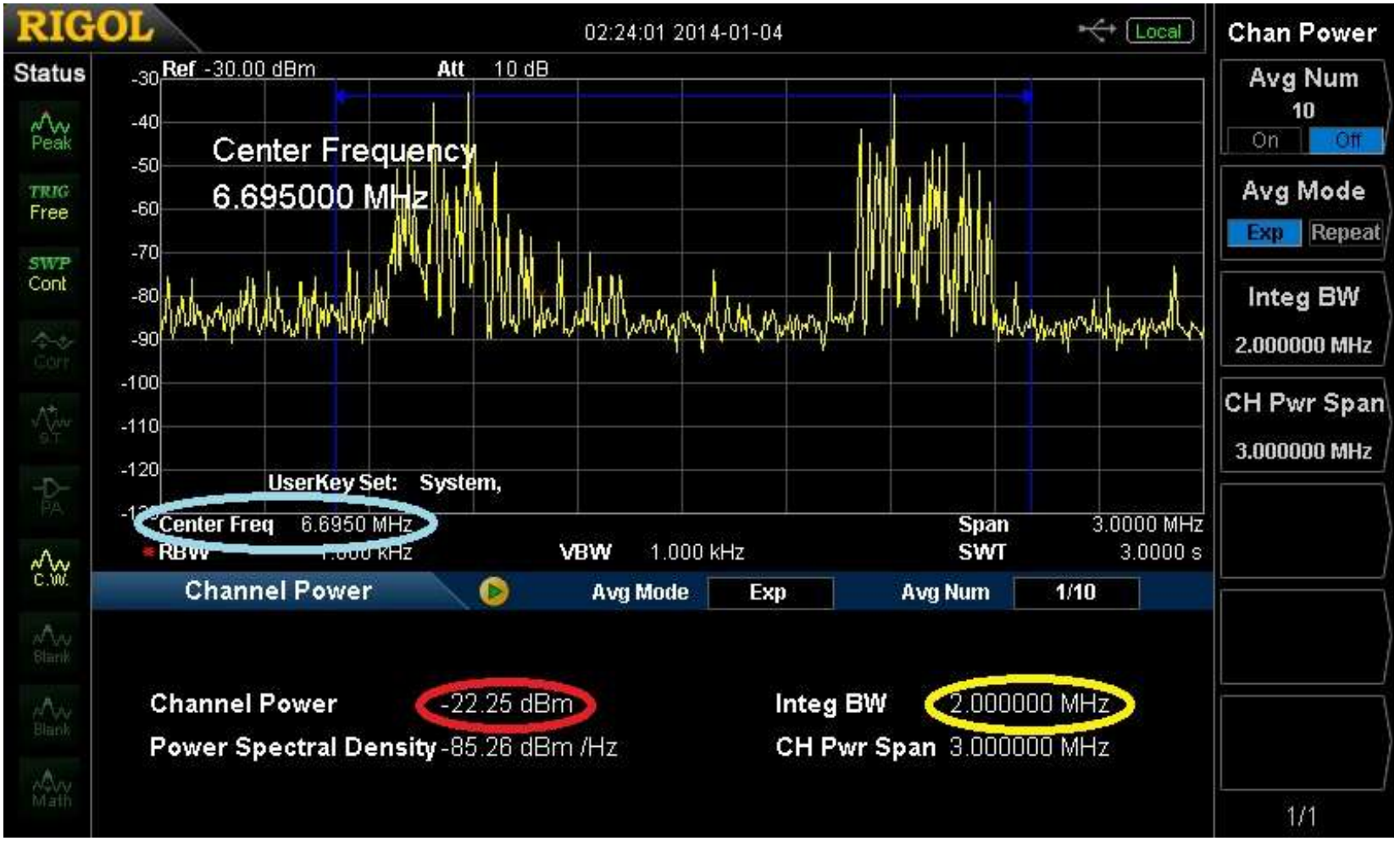
Courtesy of Sherwood lab.

First RX stage is the filter banks which determines the front-end selectivity (ability to reject out of band signals). Rating from A, for a tracking pre-selector to F for no input selectivity.
Large majority of today's radios use a Band Pass (B), few a Trk Pre-selector (A) which assure a better rejection.



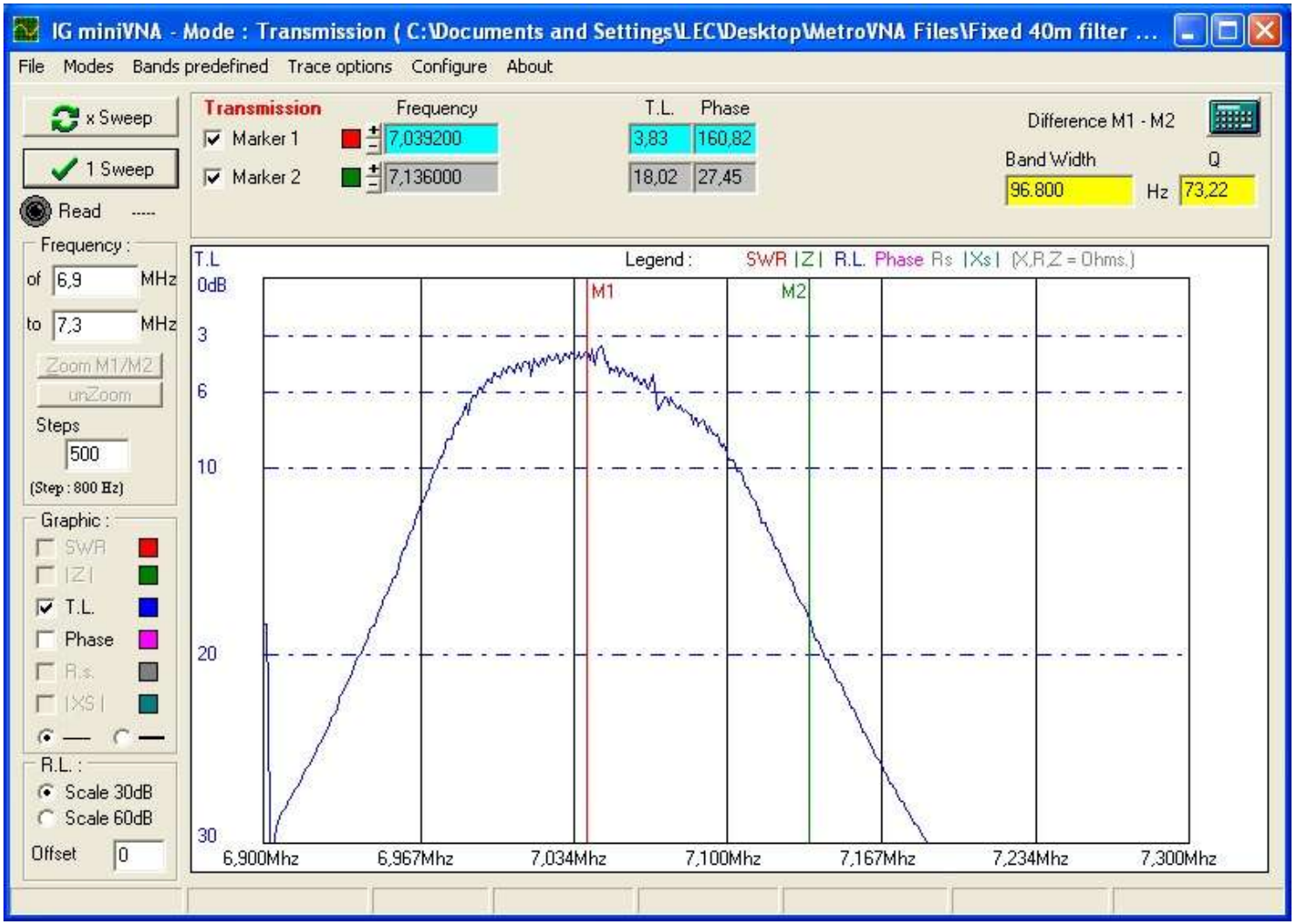
A typical Band Pass front end (Flex 1500), the first filter is a low pass with a roll off at 2MHz, the others are band pass filters with a band width around 2MHz (10 banks total)

See 2MHz (typical front end width) channel power on 40m = -22 dBm going into the Mixer



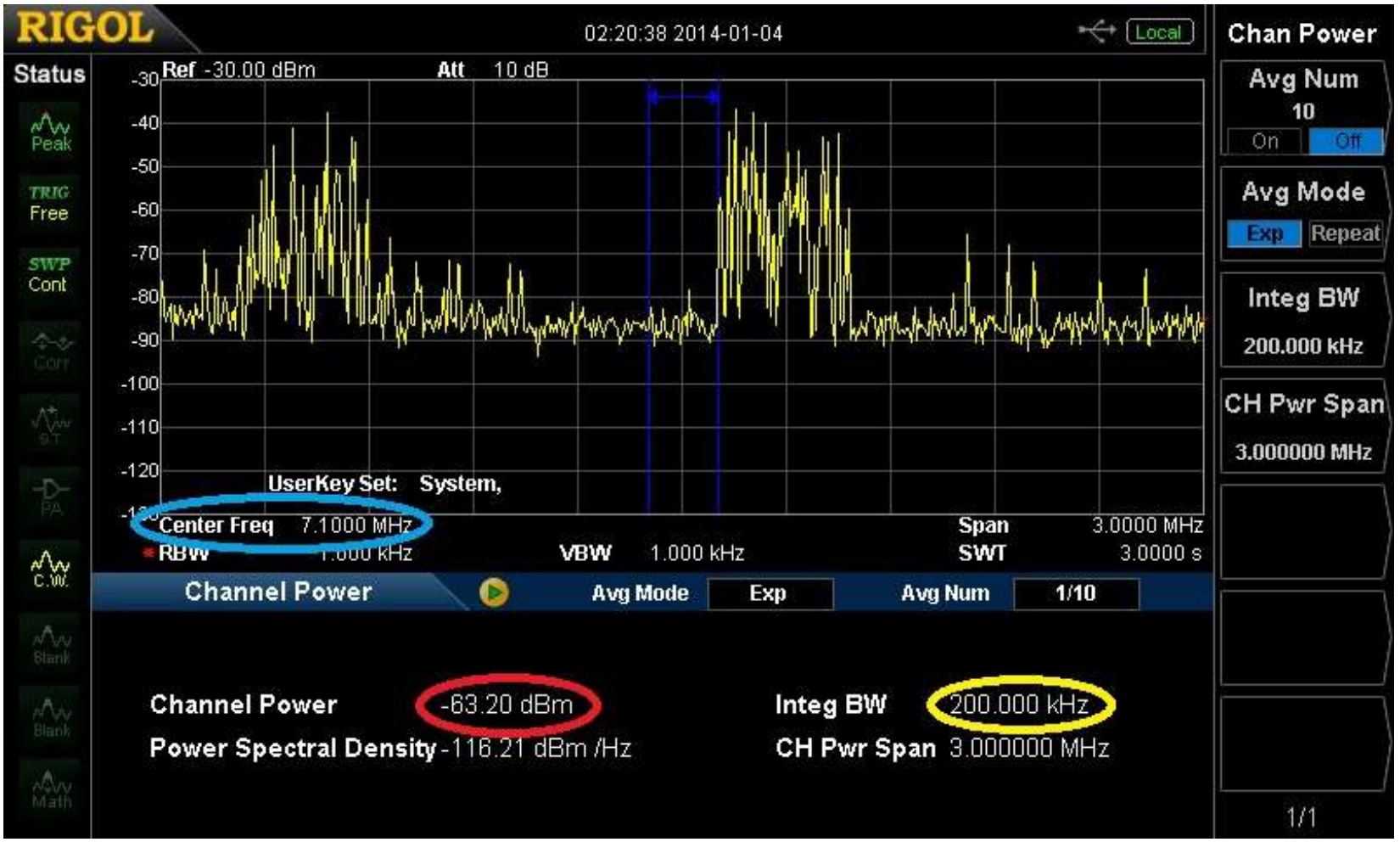
A good front end lowers the signal level reaching the first mixer

See a 40m 100kHz bandwidth home made filter



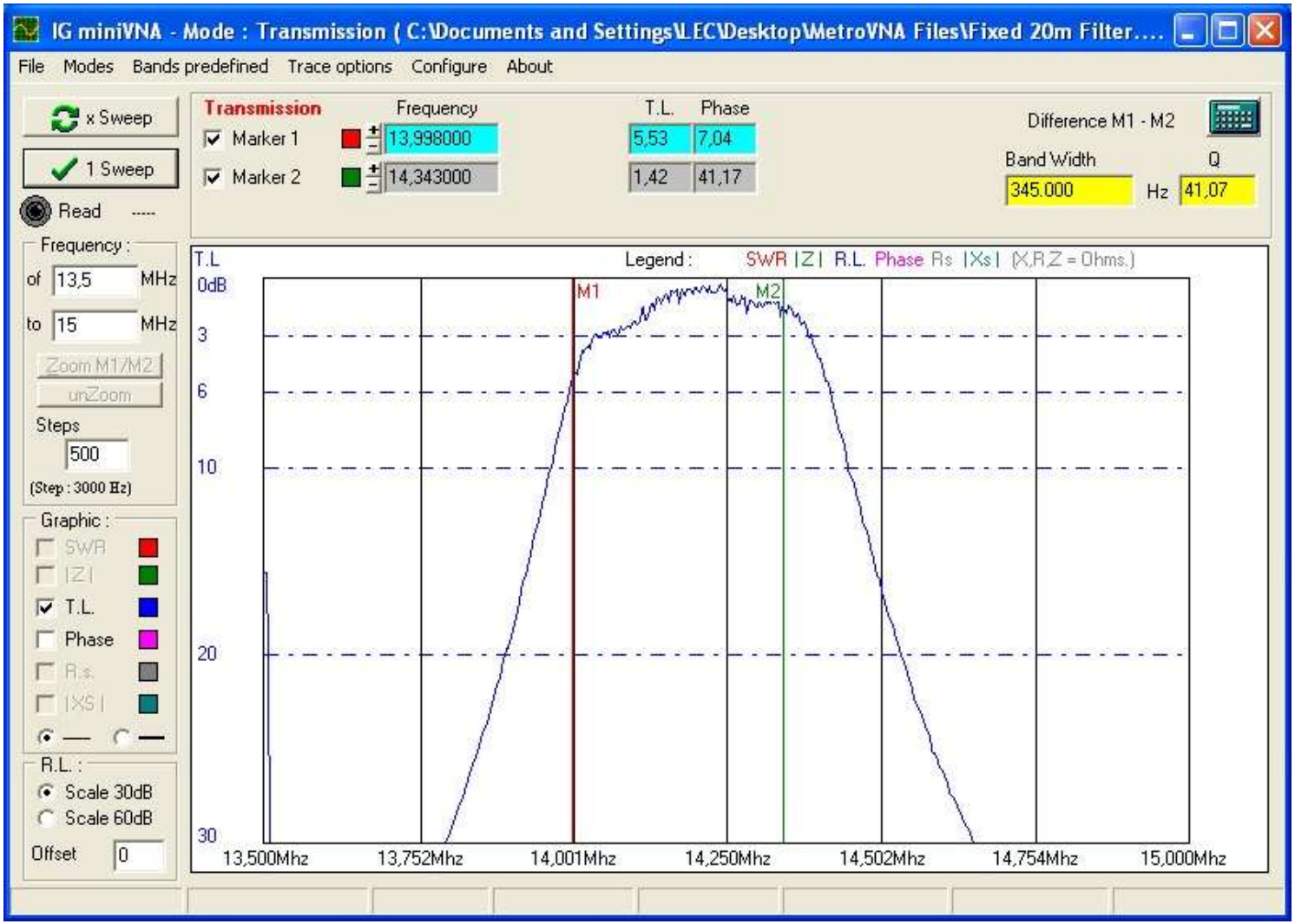
This placed in front of your receiver can help a lot reducing the power reaching your mixer, by how much?

200kHz channel power on 40m = -63 dBm going into the Mixer



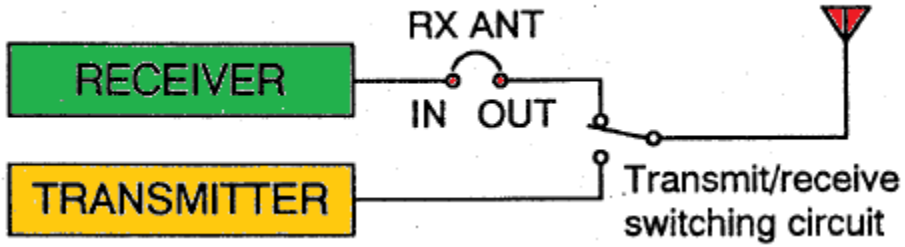
On some bands, as 40m, an added narrow band pass filter (as per the old days pre-selector) can lower the level to the mixer by as much as ……40 dB

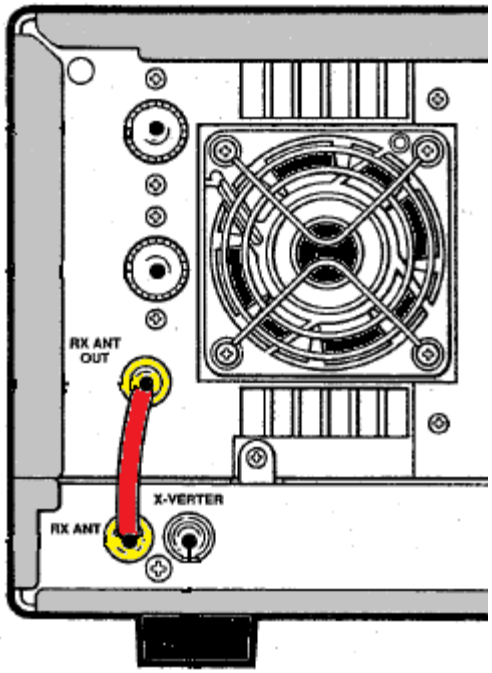
See a 20m 350kHz band width home made filter



As soon as you place a narrower filter in front of it, the band will sounds back as it is suppose to be, with gaps in between signals etc.

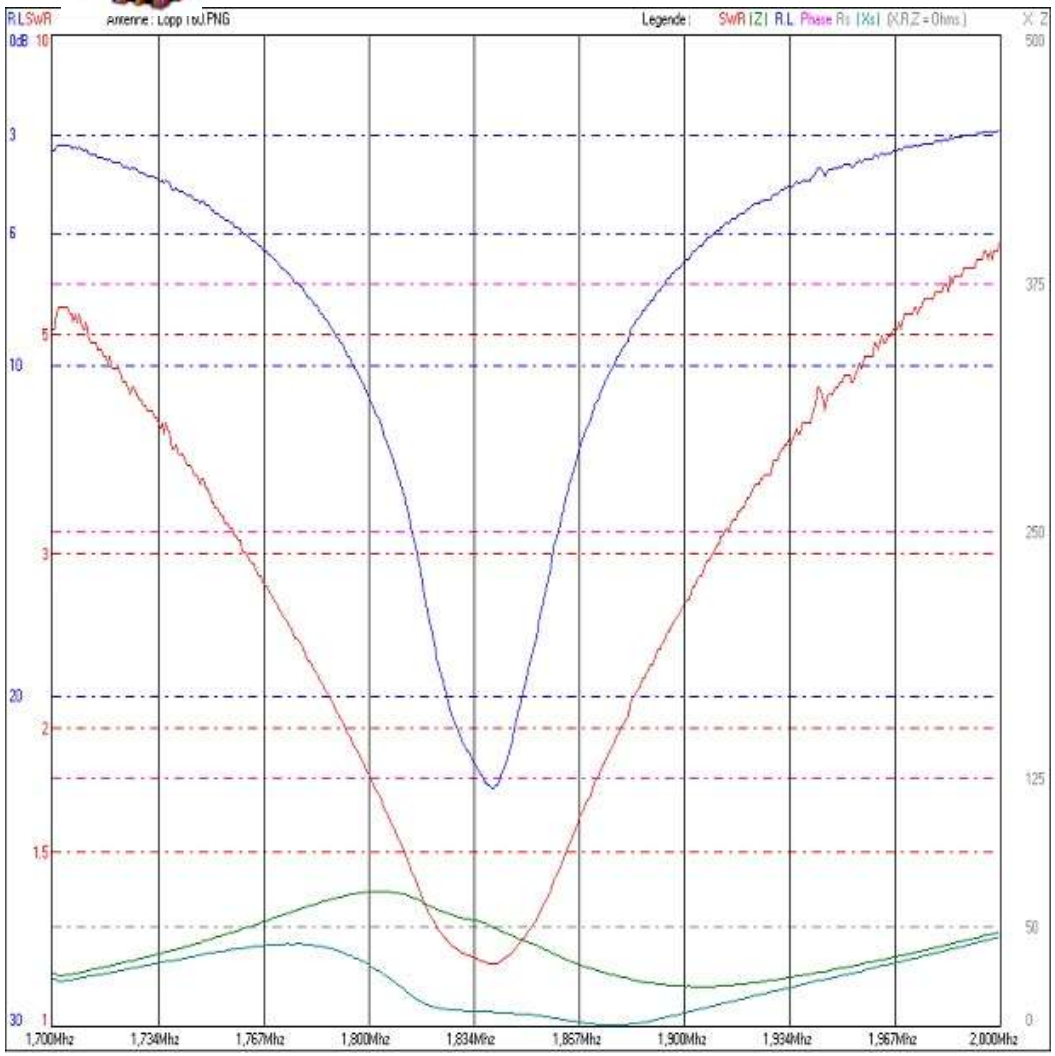
My filter bank box from 10m to 40m

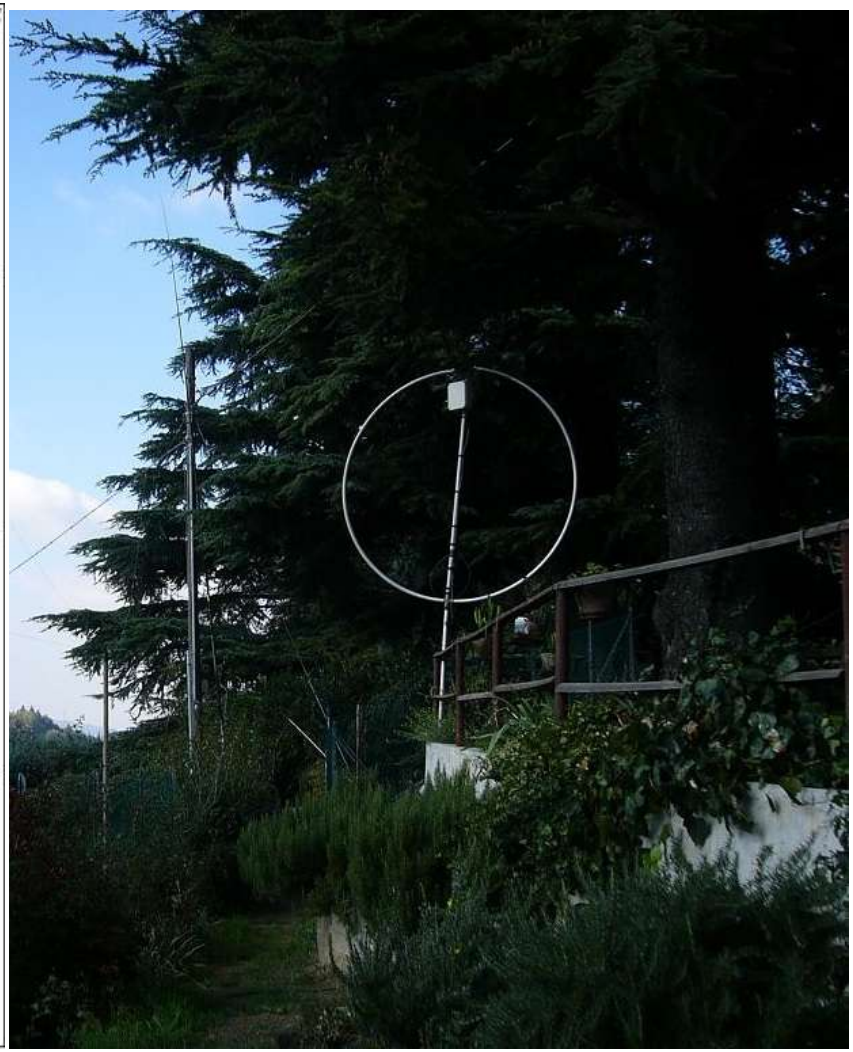




If your RX has a poor out of band rejection (Rate C-D), I would first place an external narrow BPF, as per the one above, actually even if it does have a fairly good out of band rejection (rate B). Is any thing missing?

The missing bands, 80m and 160m

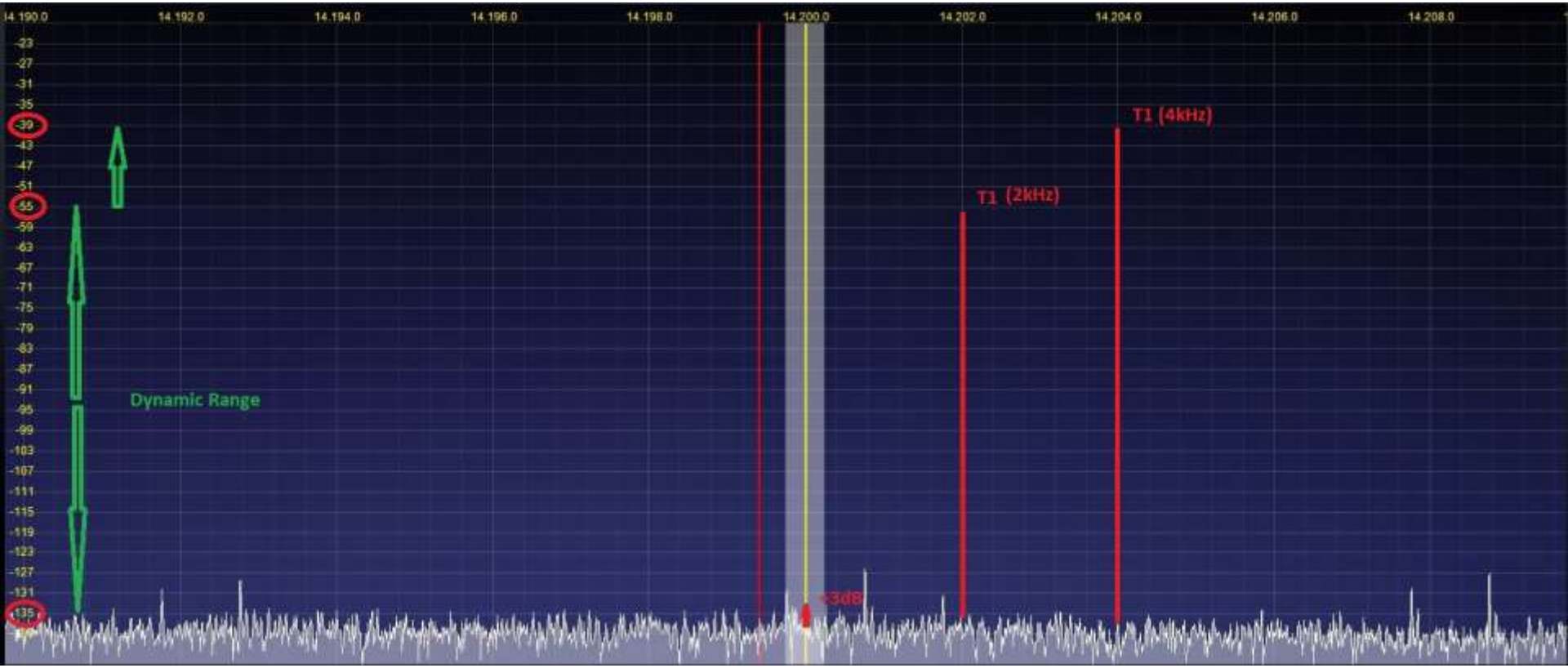




First front-end selectivity is determined by the antenna, a 2m diameter loop covering the low bands is sharper than a band pass filter, see the above graph showing 160m Return Loss

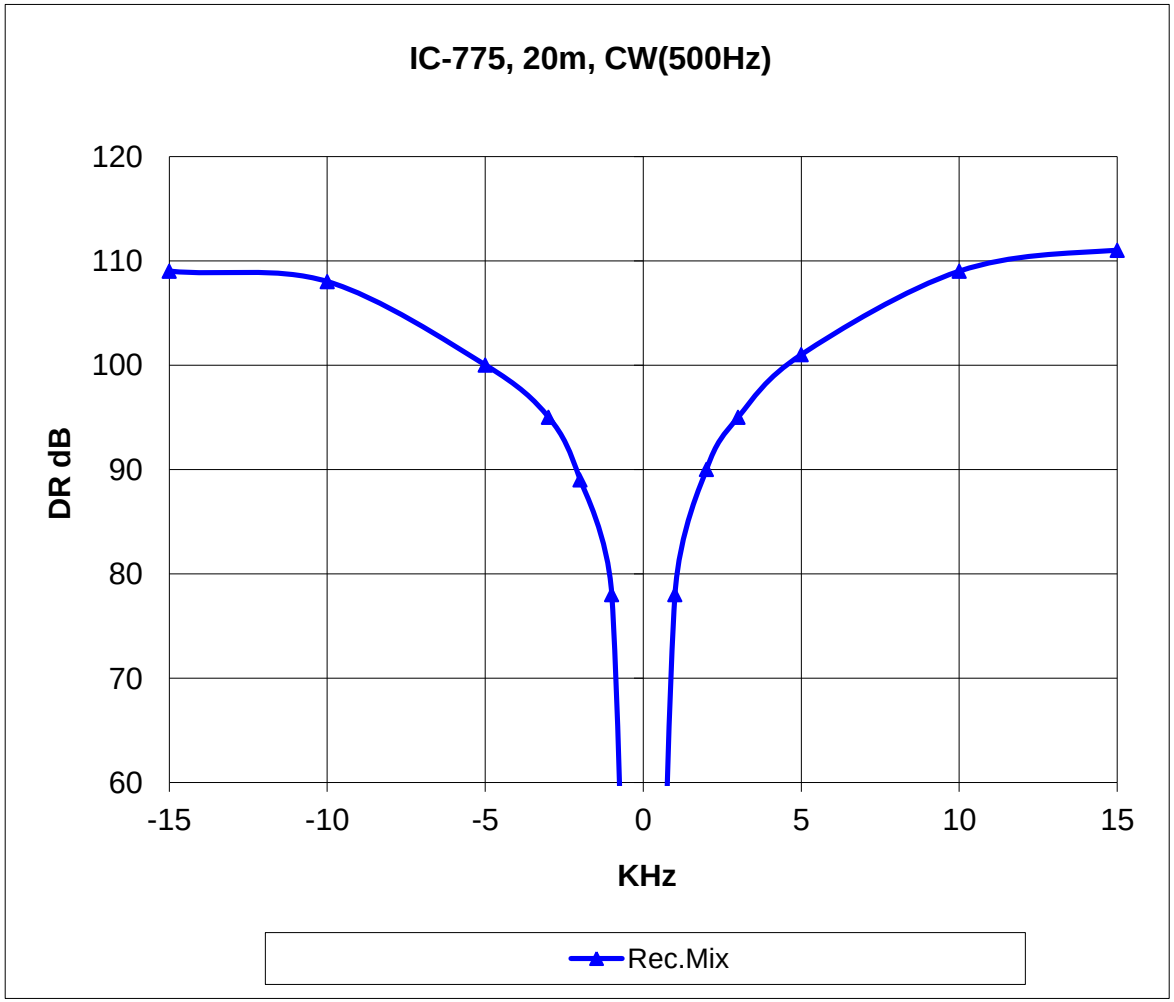
RM = T (-57dBm) - NF (-135dBm) = 78dB @2kHz

RM = T (-40dBm) - NF (-135dBm) = 95dB @4kHz



Dynamic range is the range in dB of very strong signals to very weak signals that the receiver can handle at the same time.

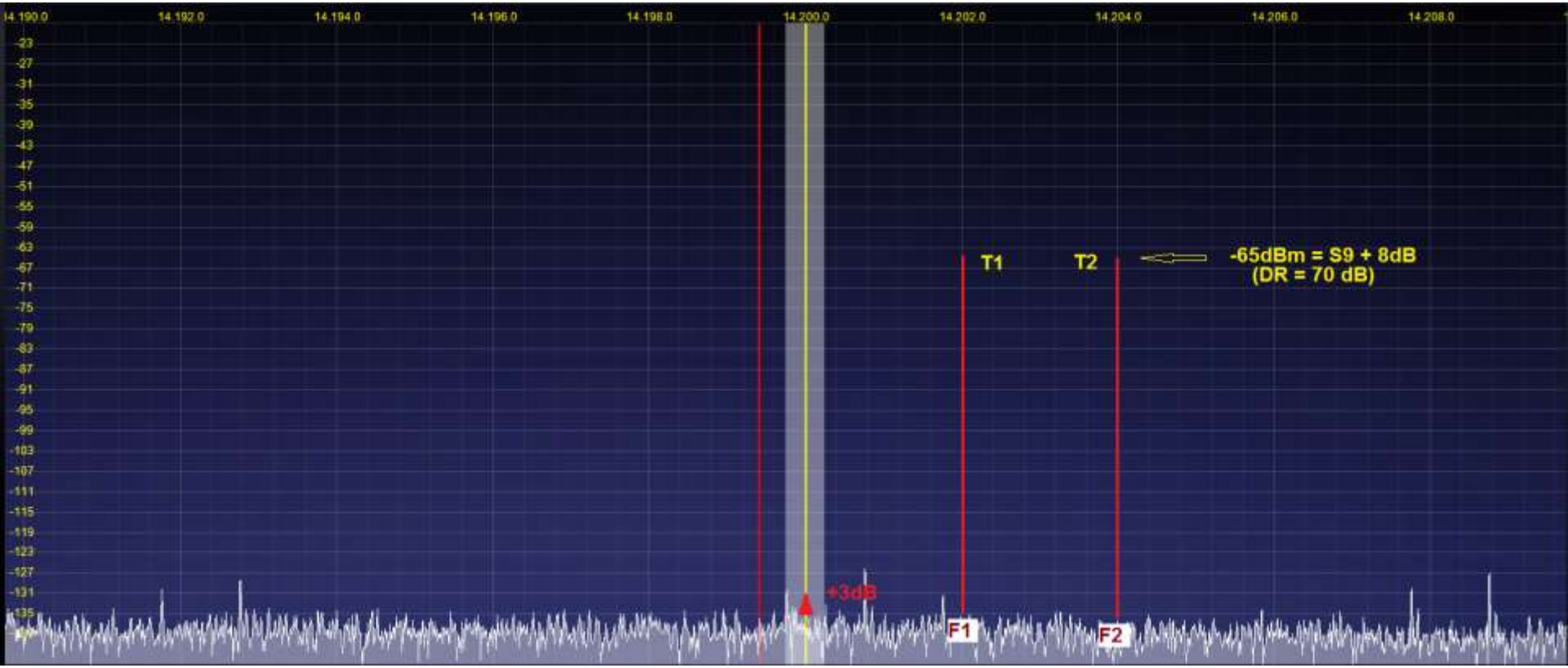
Dynamic range is constant if you enable an attenuator and nearly constant with a preamp enabled.



Useless and some time counter-productive improve a good stage, the weakest one should be pinpointed and act on this instead.
Above the Reciprocal-Mixing taken at several single tone spacing

DR3 = T (-65dBm) - NF (-135dBm) 70dB @ 2kHz

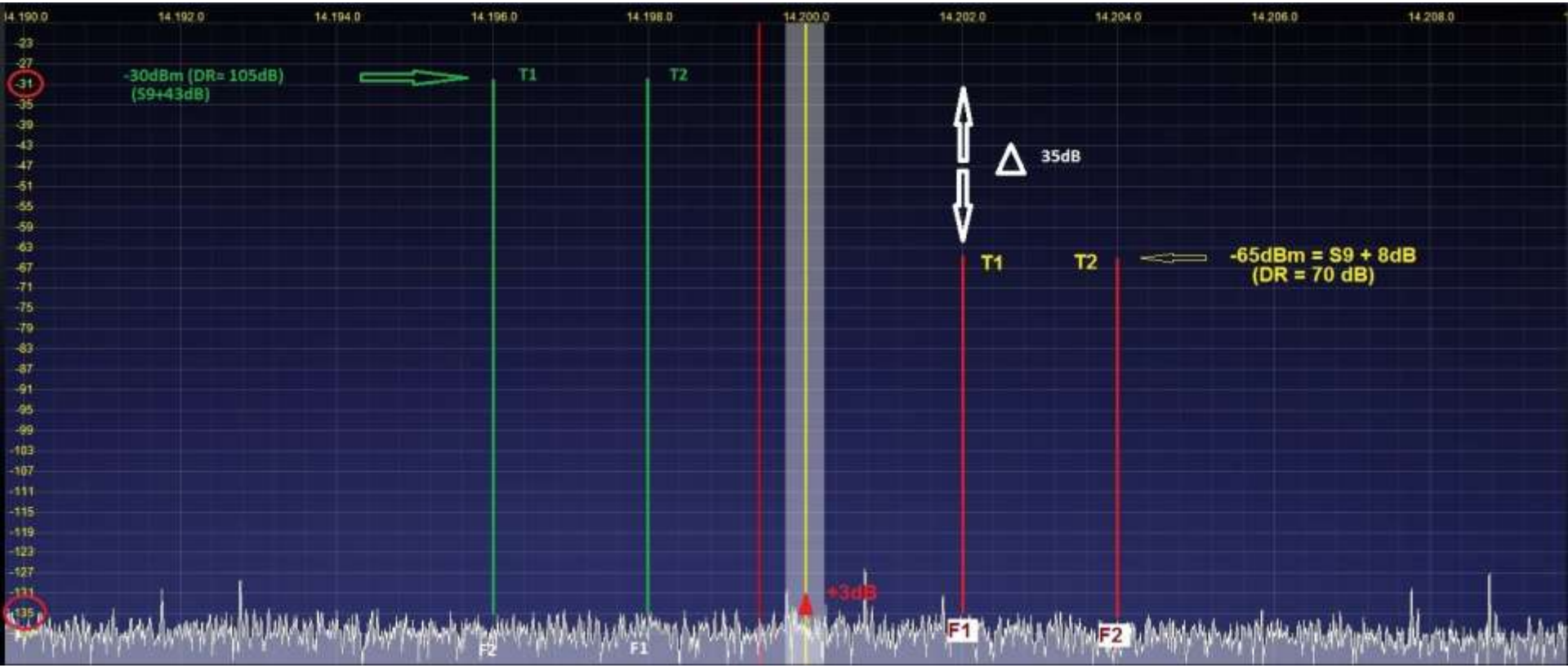
(2F1-F2, 2F2-F1)



The range in dB of very strong signals to very weak signals that the receiver can handle At the same time.

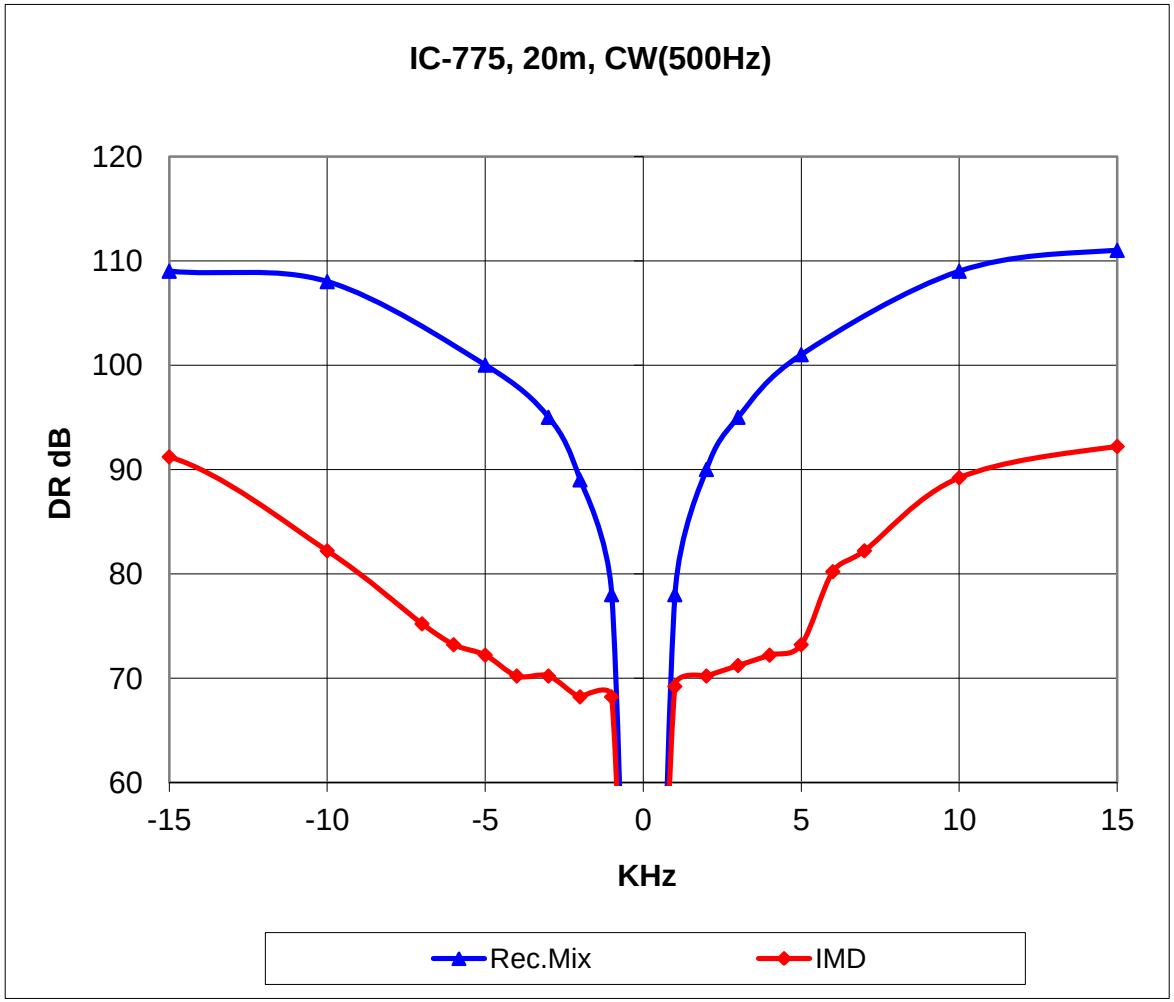
Dynamic range is constant if you enable an attenuator and nearly constant with a preamp enabled.

DR3 = T (-65dBm) - NF (-135dBm) 70dB @ 2kHz
DR3 = T (-30dBm) - NF (-135dBm) 105dB @ 2kHz

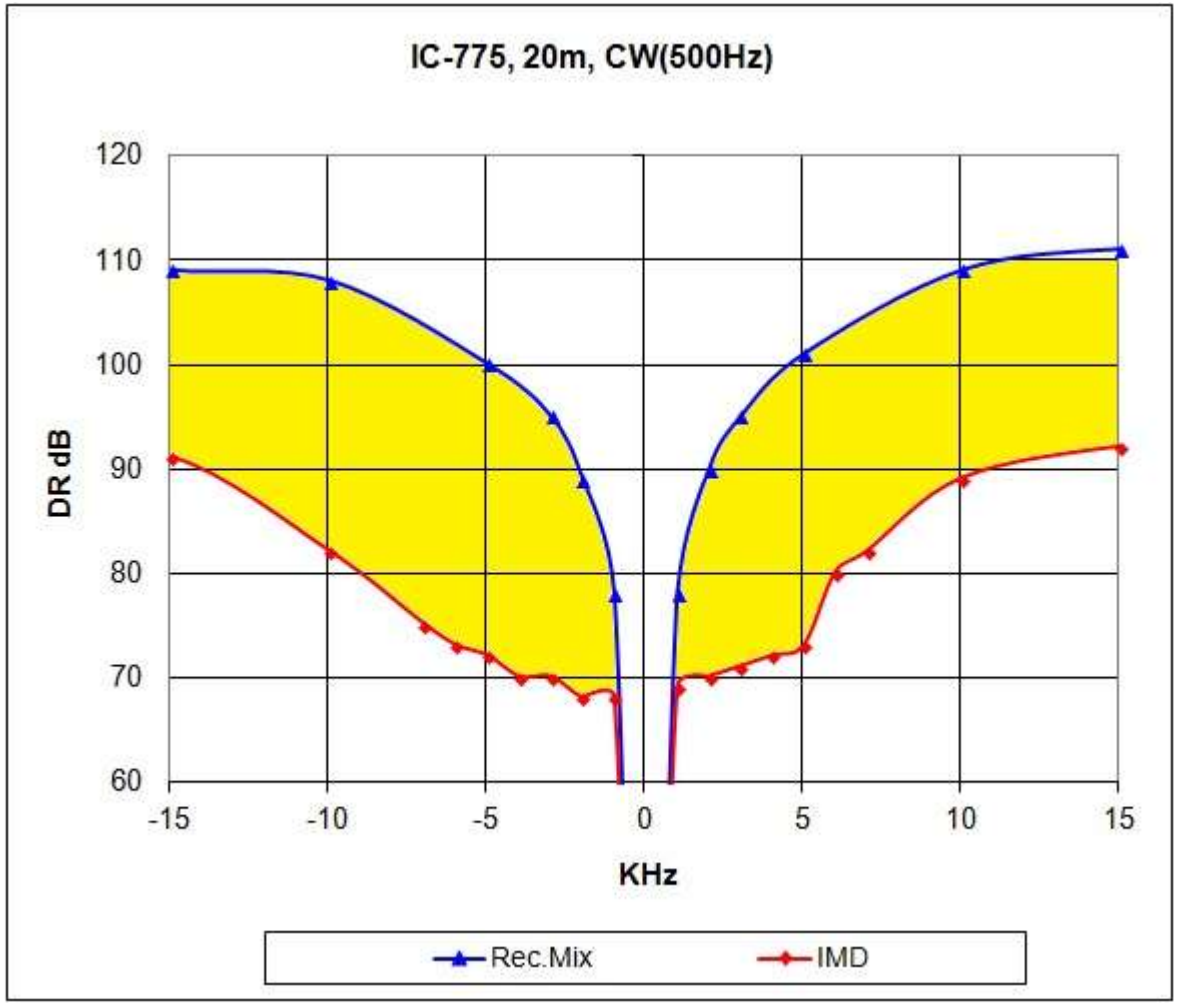


The range in dB of very strong signals to very weak signals that the receiver can handle at the same time

The difference in performance is typically determined by the front-end roofing filter selectivity, 25kHz vs few hundred Hz bandwidth.

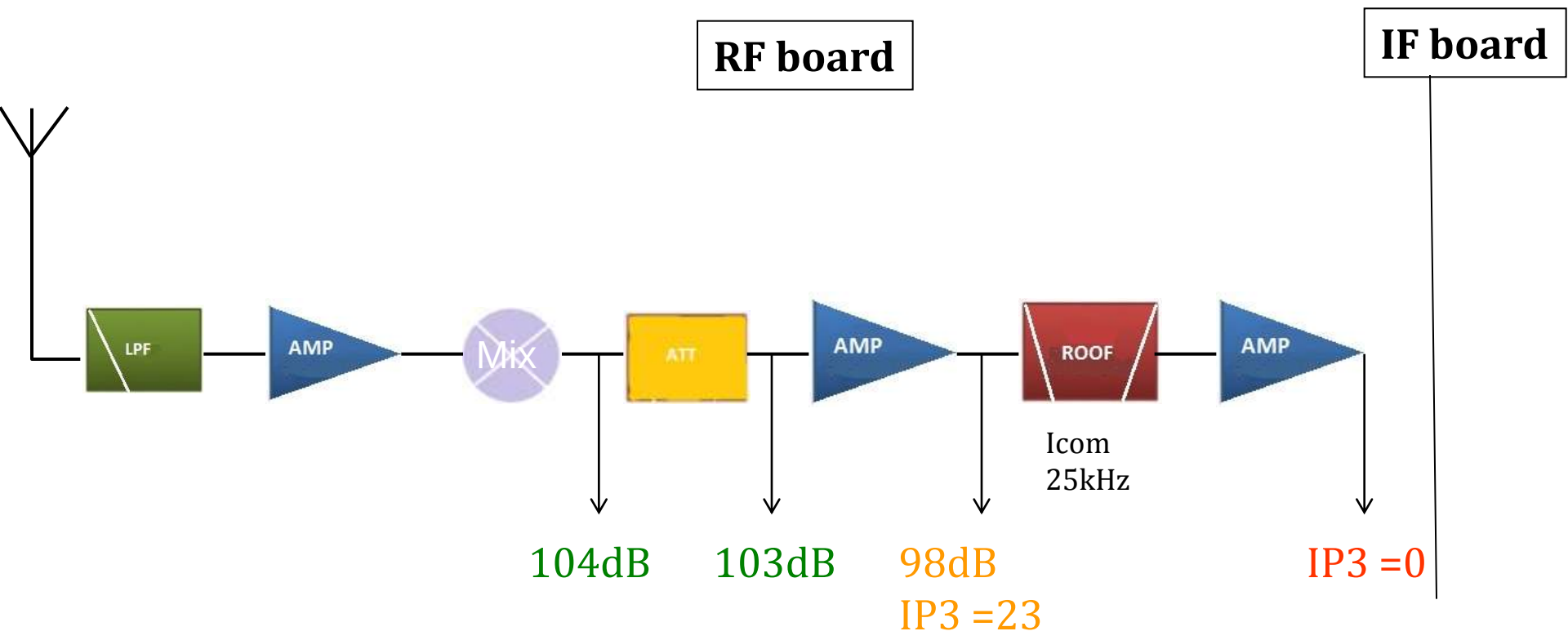


Given the Reciprocal-Mixing and the 3rd order of IMD as the most limiting Dynamic Range parameters, these should be measured at several 2 tones spacing.



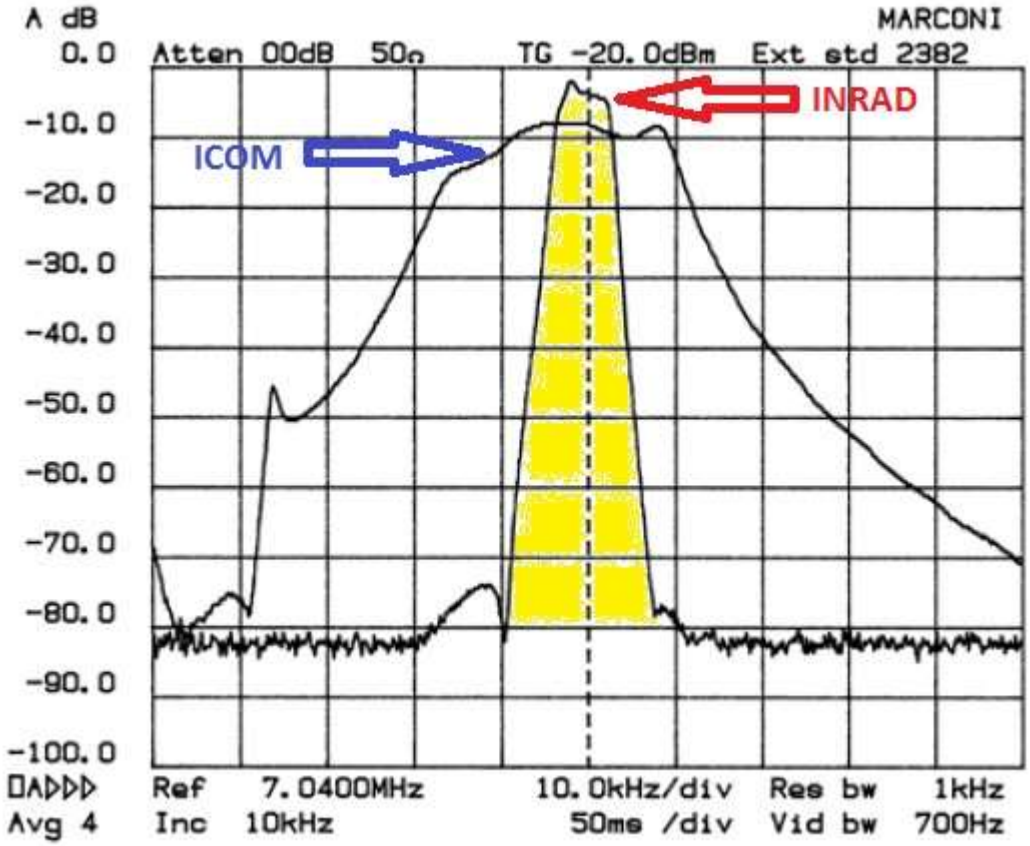
See overall RM and DR3 at the various spacing, the limiting parameter here is the DR3 (worst of the two), if not happy with RM we should have put our hands on the Local Oscillator, this value was deemed good enough, thus focus went to the DR3, where there was certainly room for improvements (specially at the close spacing)

I C 775 simplified block diagram



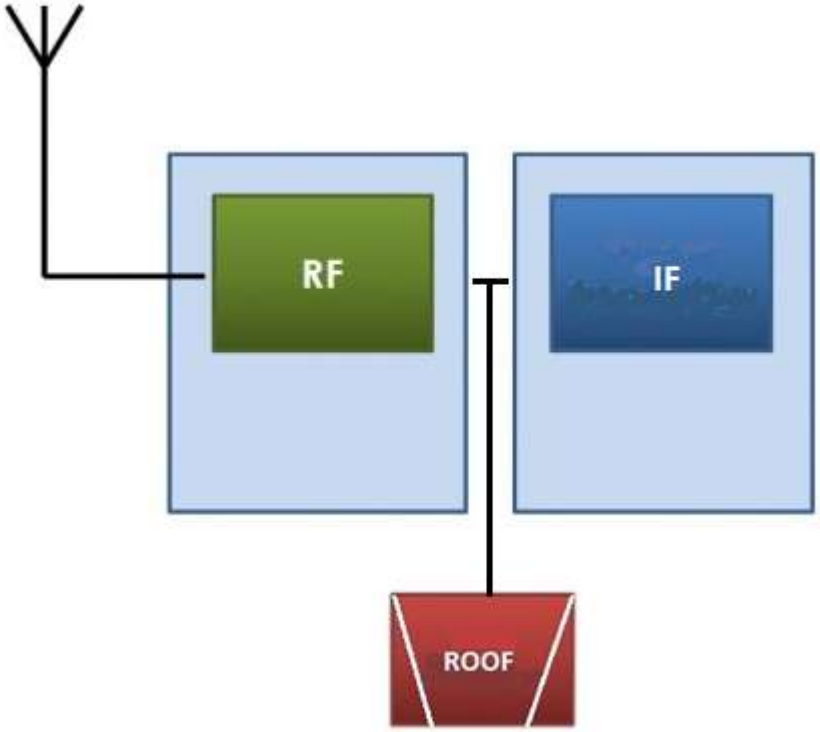
For each stage, IMD3, MDS have been measured, the very week point turned out to be the last RF boad amplifier, just prior to the IF board

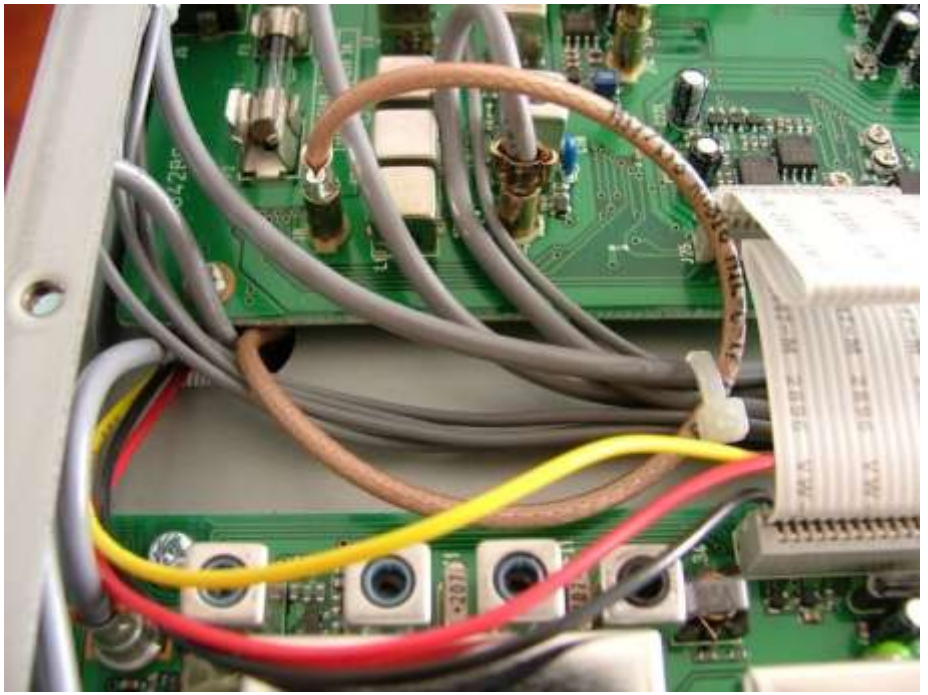
Standard Icom roofing vs Inrad



So, why not buying an already available commercial filter?, possibly without open it, as we did to retrive two of the six crystals

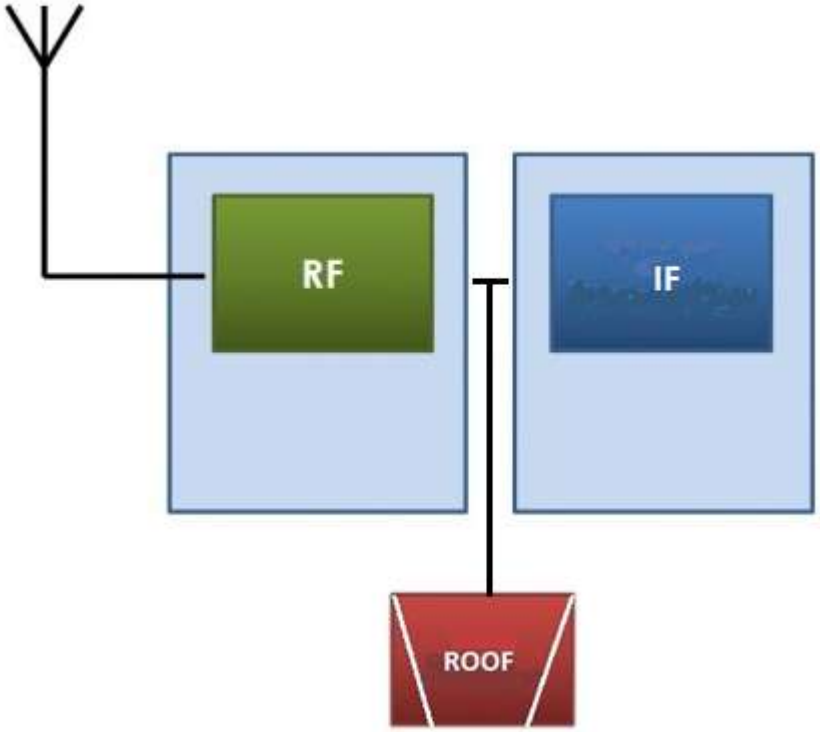
I C 775 Inrad roofing filter modification

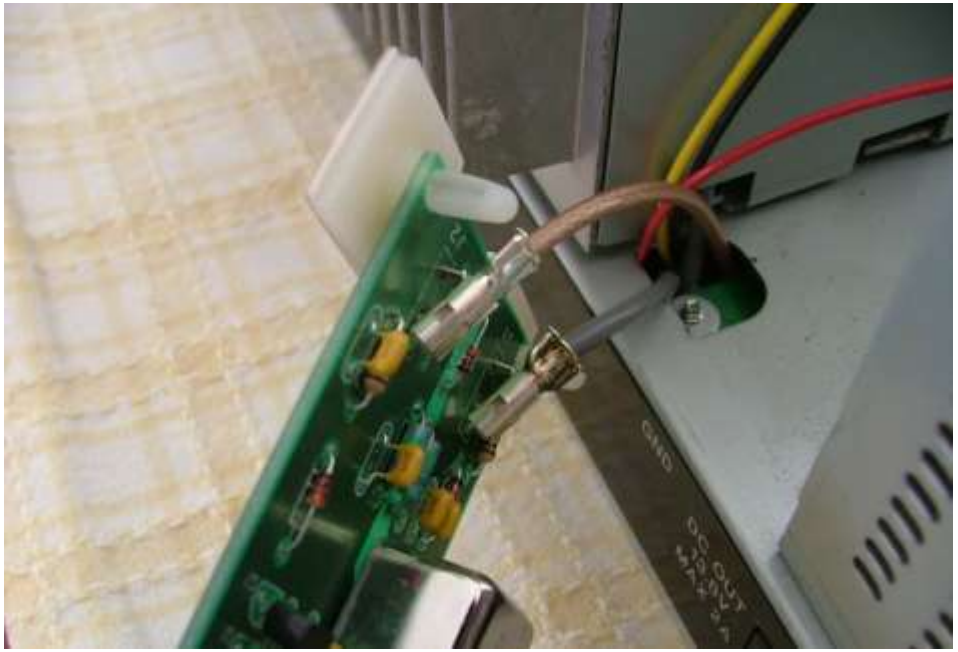




The filter installation at the end of the RF chain (as per the original vendor instructions), is most likely driven by the availability of a connector between the two stages, thus allowing an easy plug & play, but not necessarily the most suitable place

I C 775 Inrad roofing filter modification





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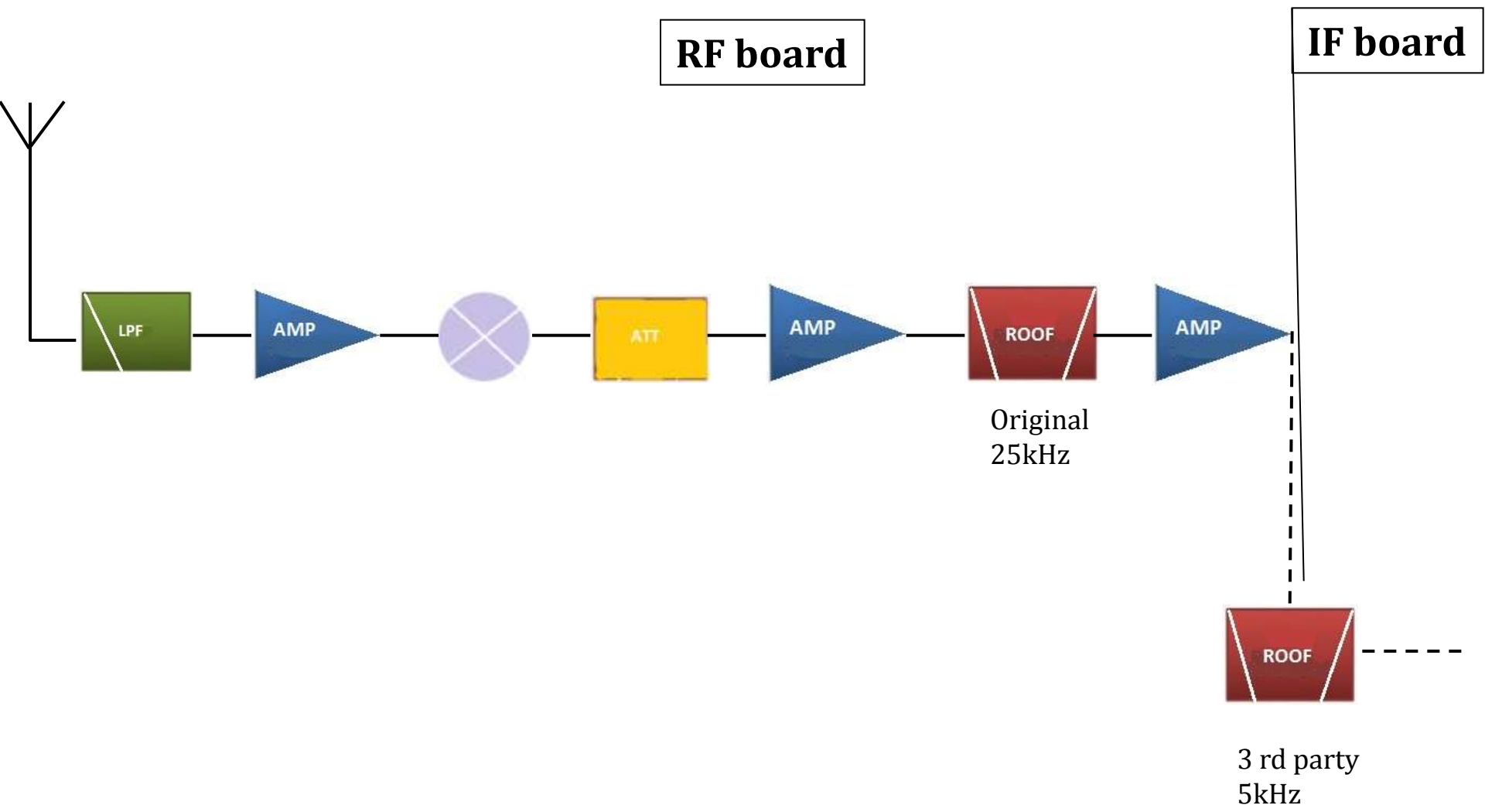
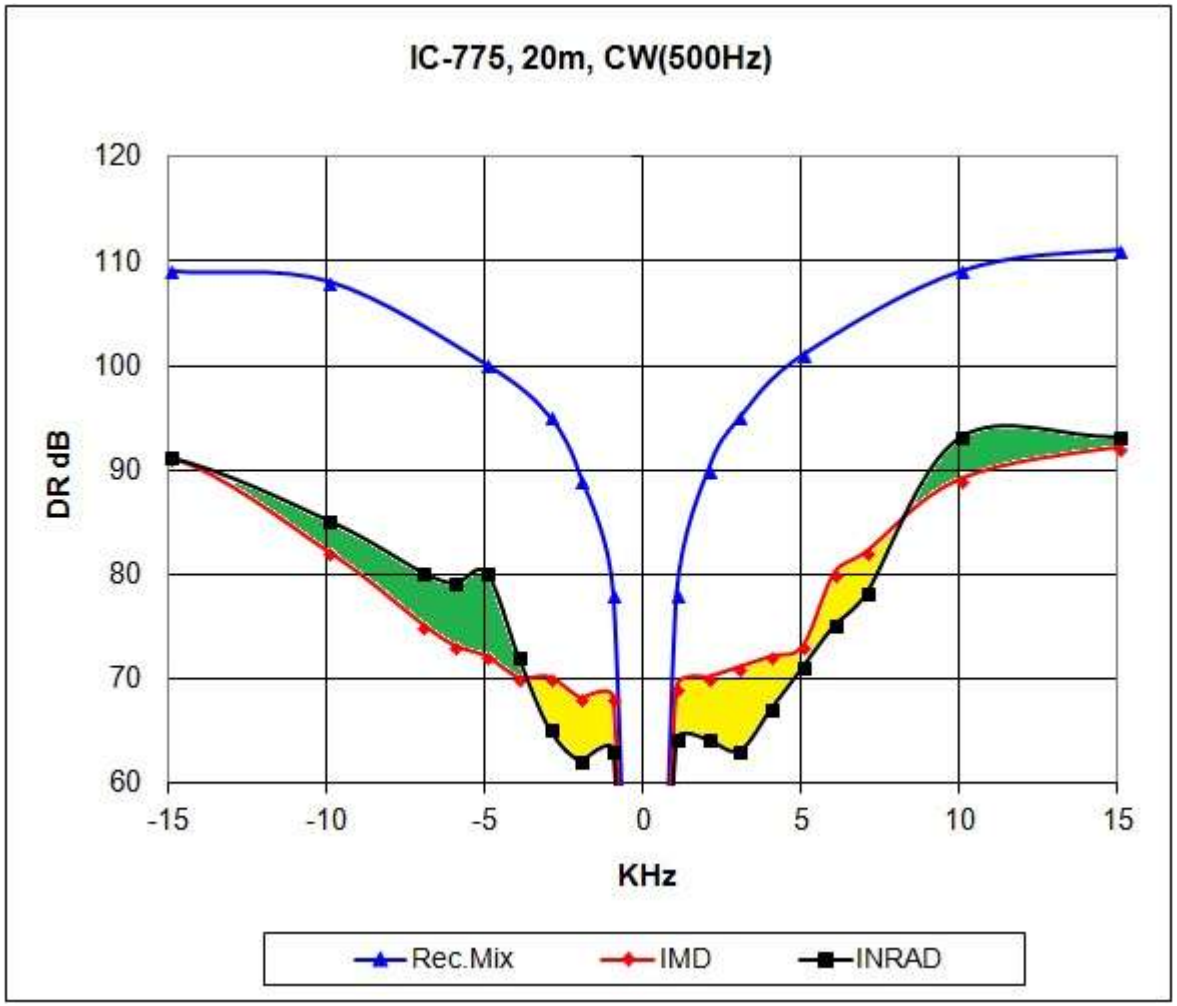
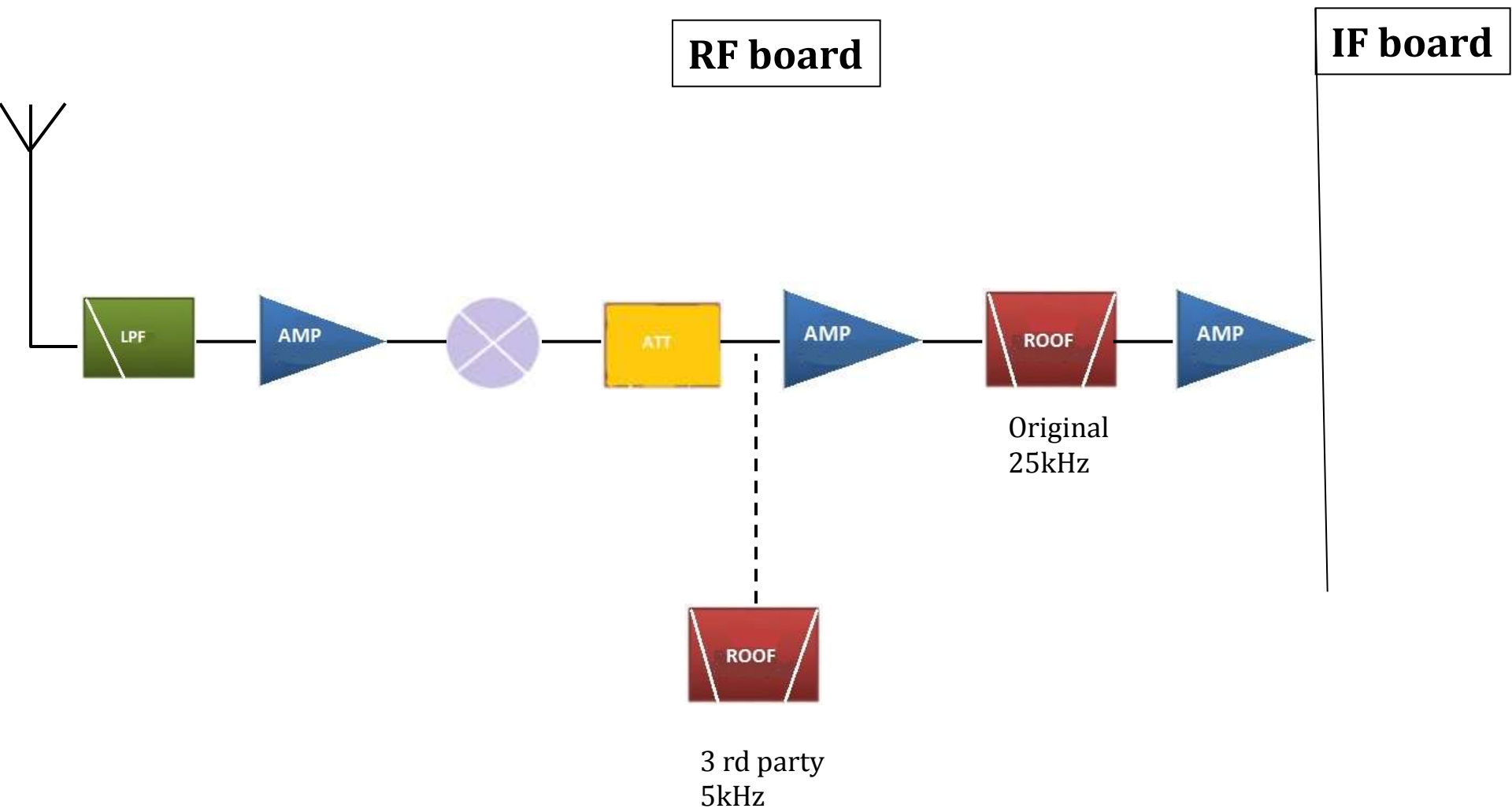
I C 775 simplified block diagram



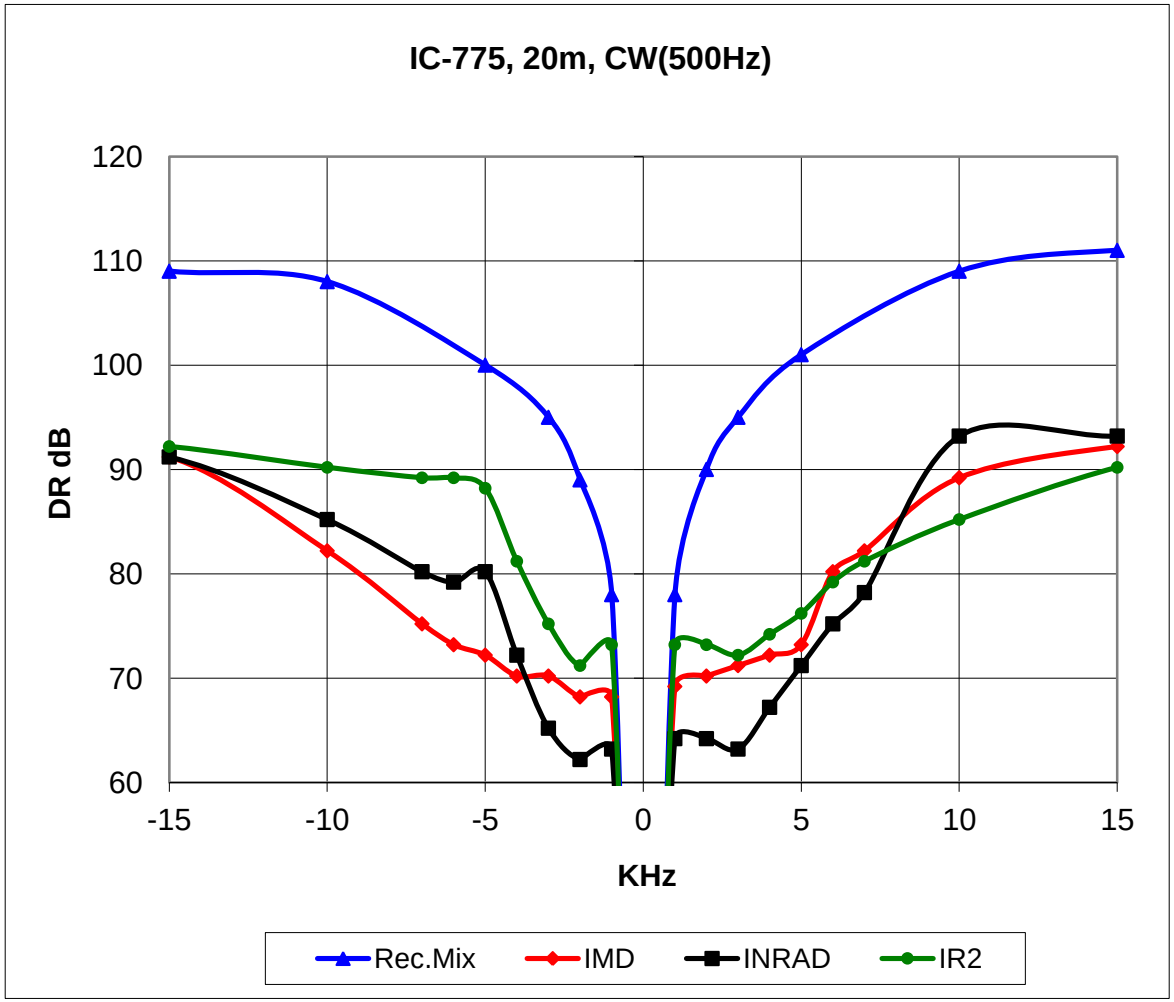


This installed at the end of the RF chain (as per the original vendor instructions), improves the DR3 at some frequency intervals only, while get worst at others (closest spacing)

I C 775 simplified block diagram

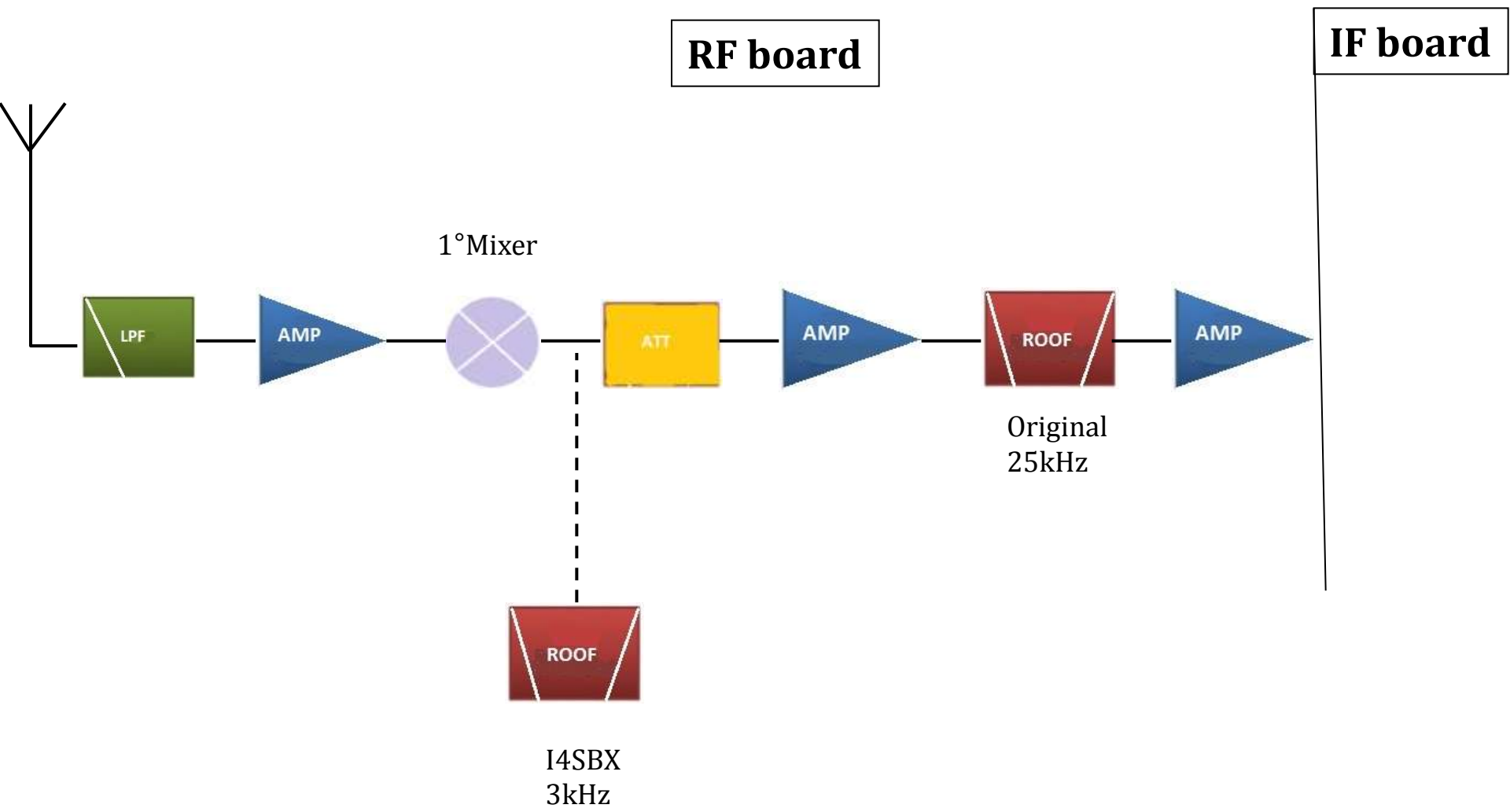


What about a relocation right after the attenuator following the mixer, this 6 poles filter about 5kHz wide, has a very deep attenuation and looks very nice.



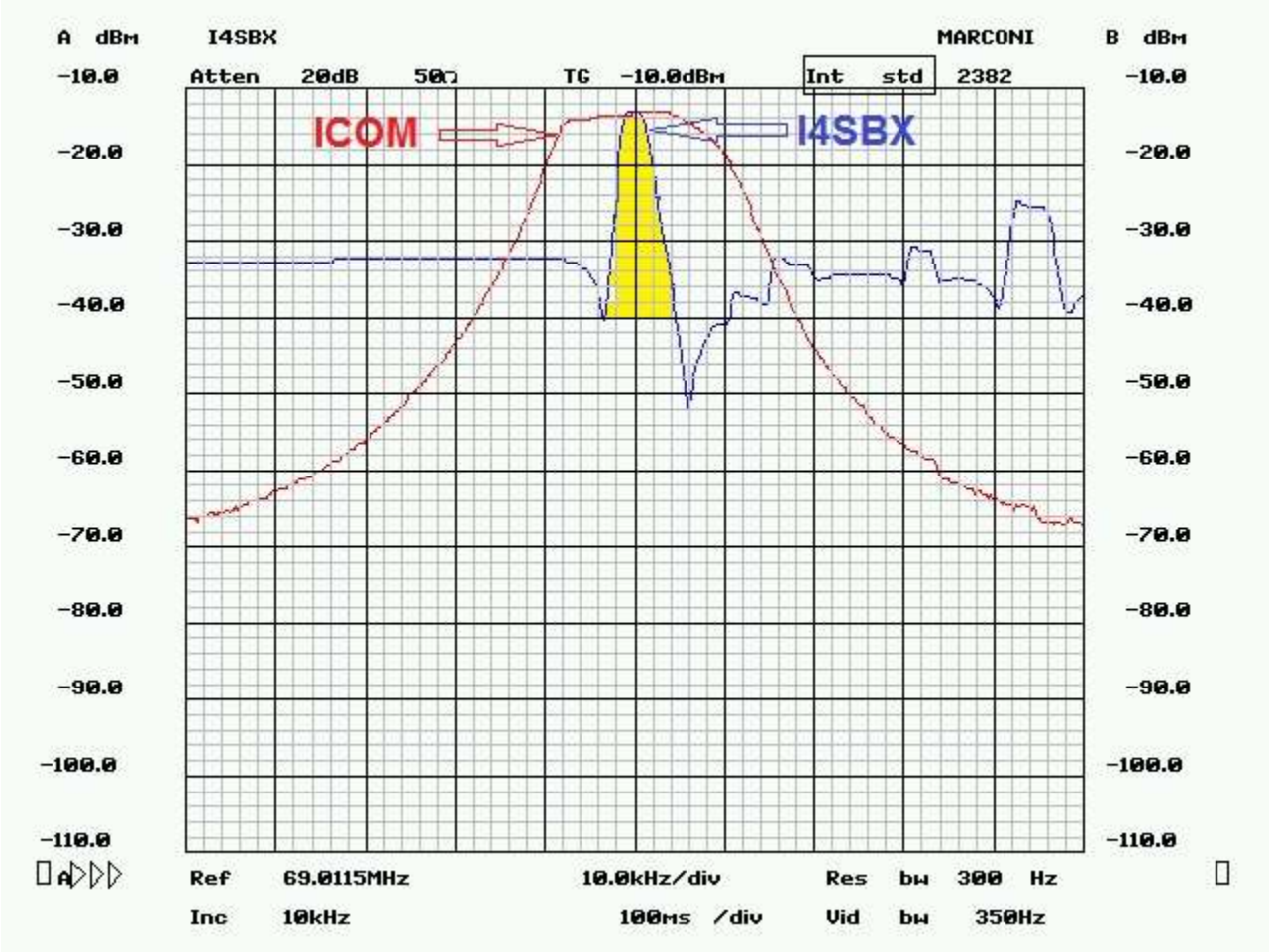
The improvement is noticeable, especially from 5kHz above, still not satisfactory at lower spacing

I C 775 simplified block diagram

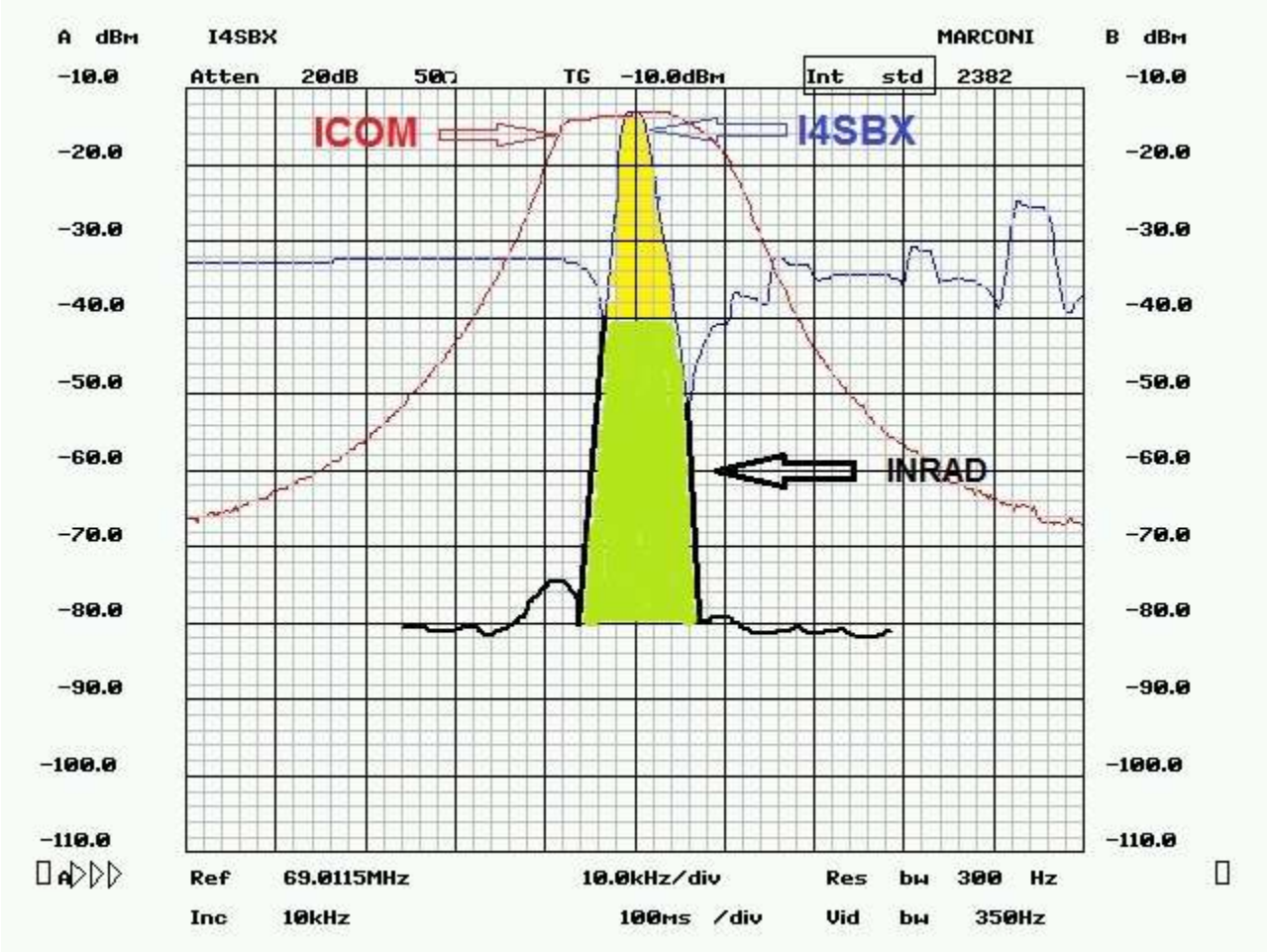


What about a relocation right after the mixer, using a narrower home made 2 poles only filter about 3kHz wide, with no so deep attenuation.

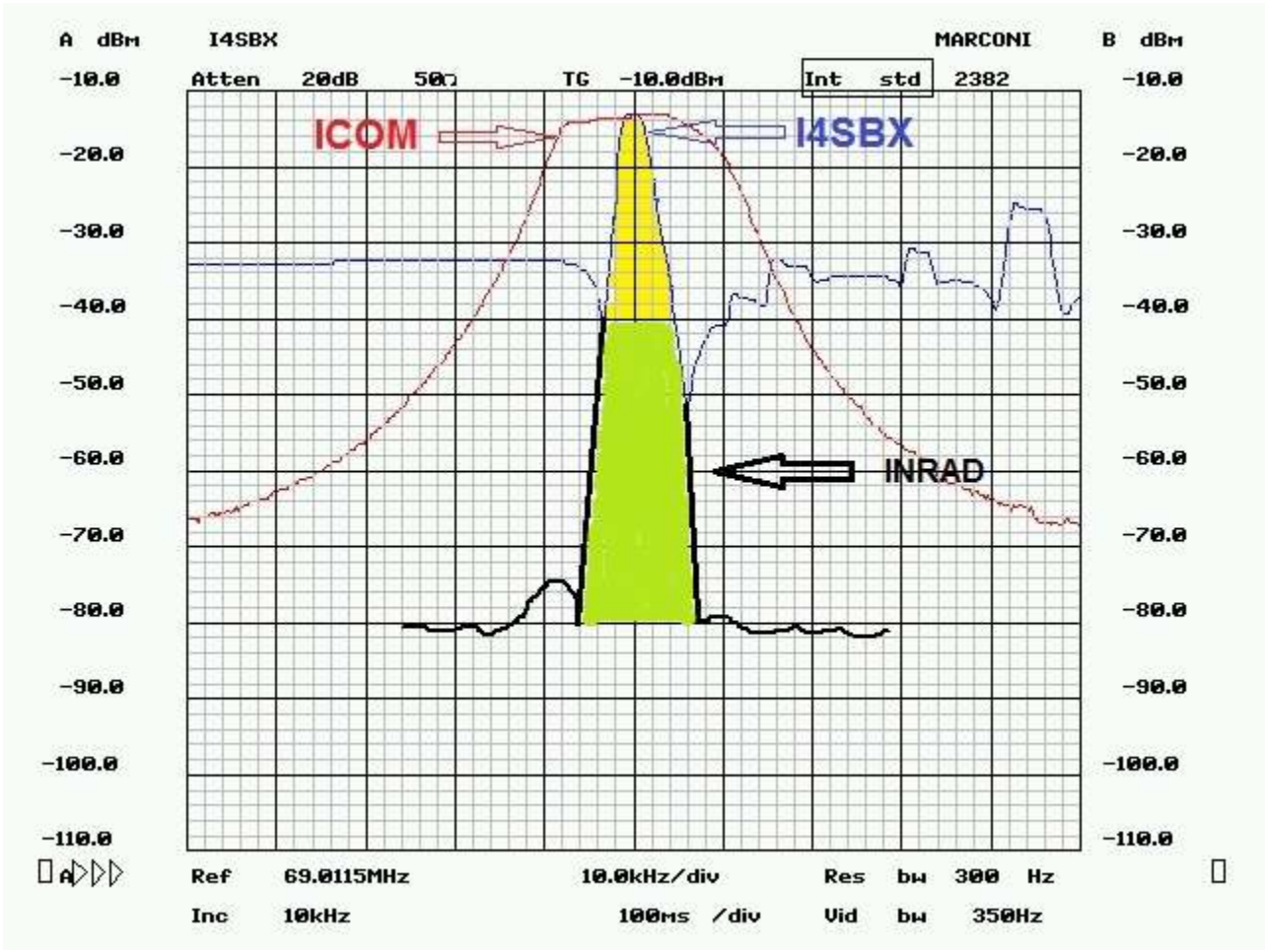
Standard Icom roofing vs SBX filter



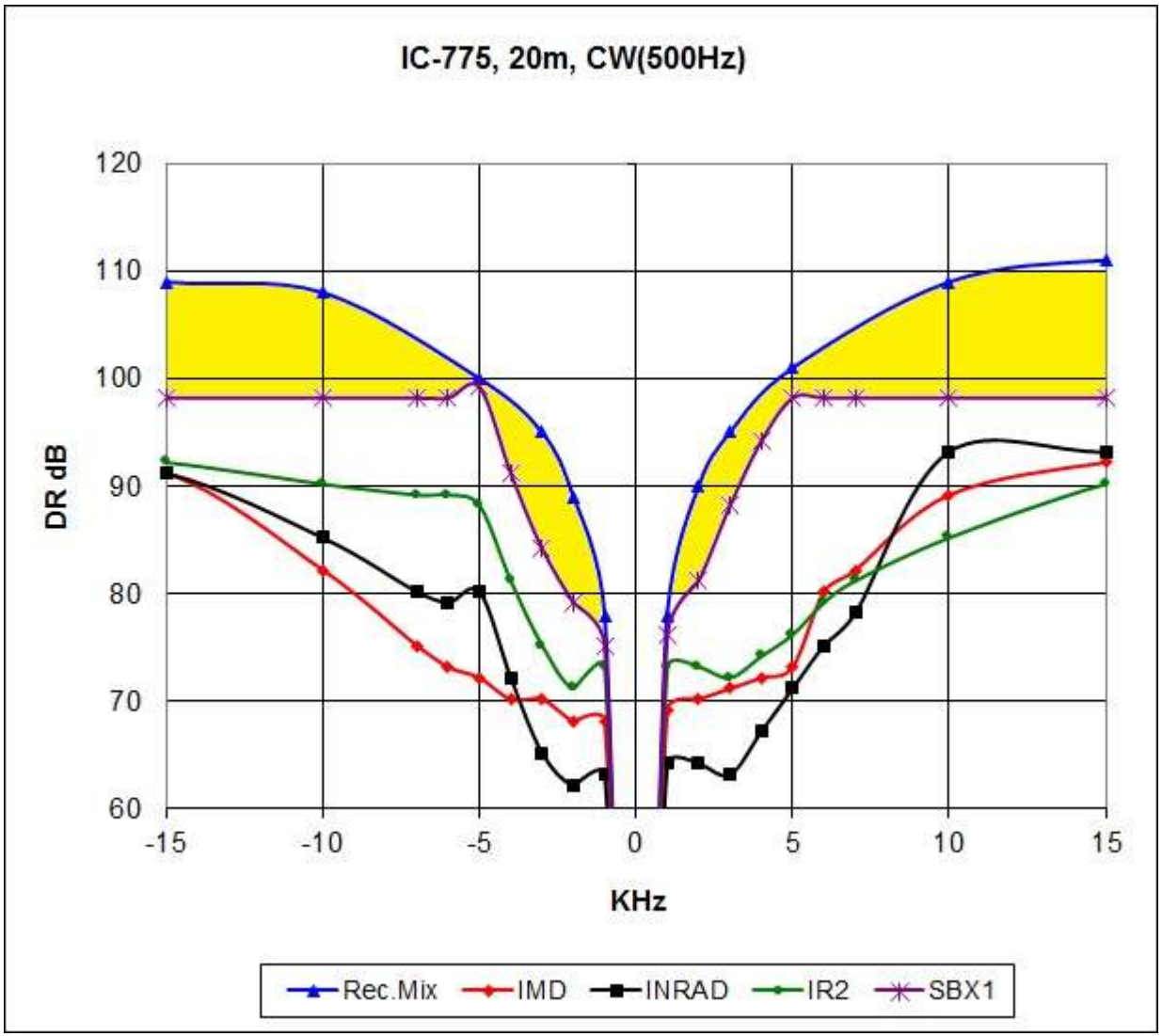
As can be seen the attenuation is not so much, the aim was to make it as narrow as possible, using a very low noise pre-amp in front of it with very high gain followed by an attenuator, in such a way the mixer could be matched at 50 ohm over a wide freq. range



3rd order product amplitude has a slope equal to one third compared to the input signals amplitude, this means that if the interfering signals varies in amplitude by 1 dB, the 3rd order IMD products will vary by 3 db in the same direction. Which means that in order to reach an improvement of 36dB (104dB-68dB), it takes only 12dB (36/12) of attenuation of the possible interfering signals.



Thus, a narrower filter with an out of band rejection of only 12dB is enough to reach the target, that's why the original commercial filter was stripped out to retrieve 2 of the 6 crystals necessary to build a 3kHz one (instead of the existing 5kHz), with much less attenuation out of band.
The original ICOM roofing filter will continue to take care of the imagine frequency and spurs



The improvement is much noticeable even at lower spacing, there is still room for improvement, matter of fact, work is still in progress with the latest filter/pre-amp design around 86 dB @ 2kHz

L'articolo completo a cura di Eraldo, I4SBX
Su Rke di Ottobre

IC-775DSP Mods.
Alcuni tentativi per migliorarne la dinamica.

Premessa.

Proporre l'ennesima modifica di apparati commerciali, certamente non è una cosa originale.
Tuttavia tenterò di raccontare questa mia esperienza con la speranza (o illusione) di poter essere propedeutico per altre modifiche o miglioramenti.

Misure.

All'uscita del Mixer (Q12 e Q13), abbiamo misurato una OIP3 (Output Intercept Point) di almeno 21 dBm e nel altro verso una MDS di -135 dBm, corrispondente ad una dinamica di **104 dB**.
Il Mixer ha un ottima chiusura a larga banda sugli stadi successivi, Ret-Loss -15 dB.

This was I4SBX's idea, which may sounds upstream, no wonder why I agreed with it, remember, MORE WITH LESS, a simple well designed 2 poles filter fitted in the right place can do the job as well.

MAKE IT SIMPLE AND THINK DIFFERENT

THANK YOU

FT1000 Noise Blanker issue, another very weak point

The INRAD filter improves IMD @2kHz from 69dB to 71dB, whereas Tom's mod.

The IM problem is created because the FT1000 heavily forward-biases the noise-blanker's first FET whenever the blanker is turned ***OFF.*** This causes the FET hanging on the IF system to have high gain. Strong signals within roofing filter BW saturate the FET's drain, causing mixing products (IM).

The NB mod is a simple effective mod. It improves close-spaced IM3 dynamic range about 10dB on average. In rare cases I have seen as much as 20dB change! ***Moving just one foil trace, a very simple manufacturing change, would have made the MK V receiver noticeably better in close-spaced performance. Fortunately this mod is fairly easy for owners.***

http://www.w8ji.com/ft-1000_noise_blanker_mod.htm