"LNA cooling for EME on 77GHz"

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Swedish EME Meeting

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The first succesful 77 GHz EME echo test took place in 2013.

I'm still on this band, and I hope for a two-way EME QSO.

What has been done in the past four years?

I tried to improve all parts of my station.

The greatest progress has been made in improving the sensitivity of the RX.

The sensitivity of the receiver was increased by 15 times.

I was lucky enough to get samples of CGY2190UH,
MMIC manufactured by OMMIC.

This is a low-noise amplifier with NF better than 3 dB and 25 dB gain.

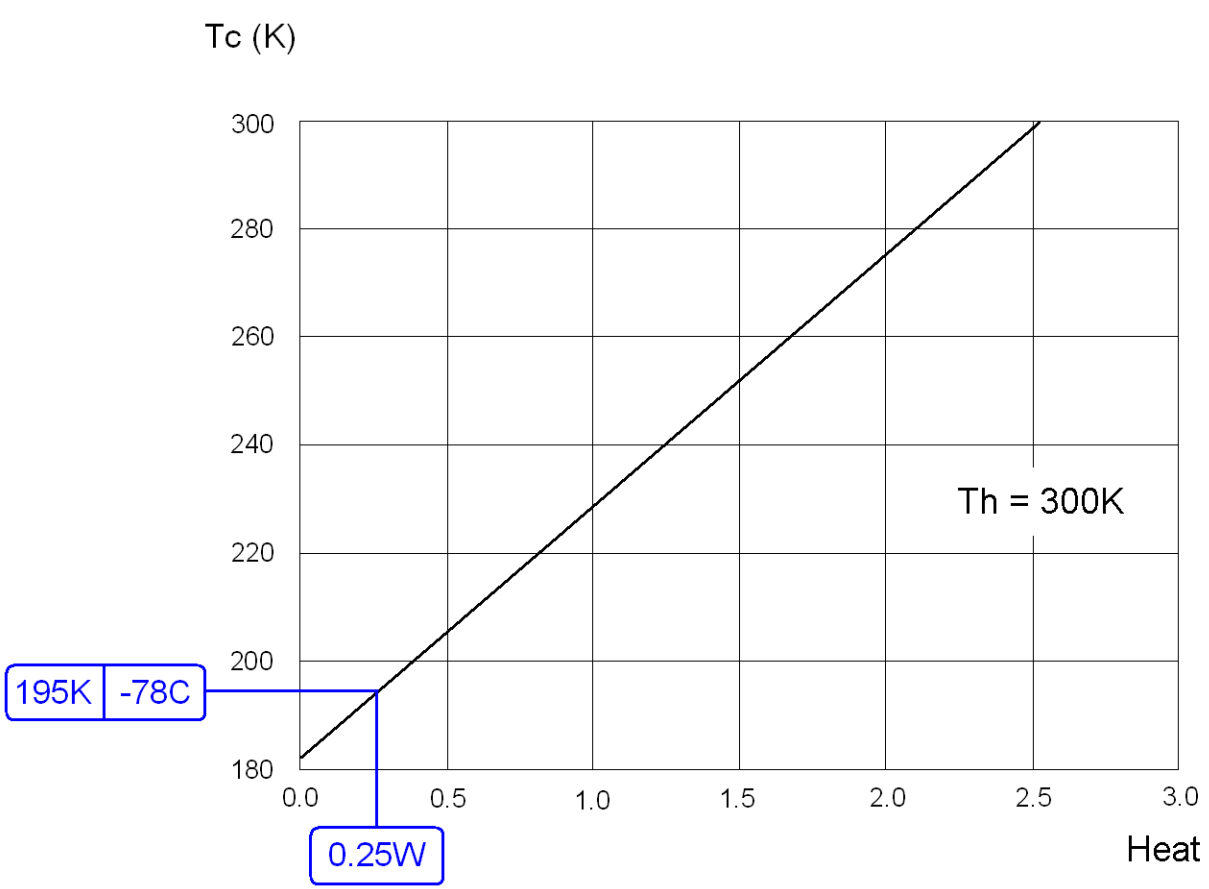
Very low power consumption 33 mW!
Easy to cool it!

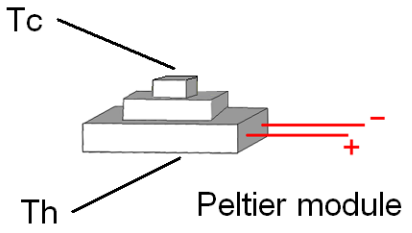
The first plan was to cool it to the temperature of dry ice (-78 ° C),
and get 2 dB NF.

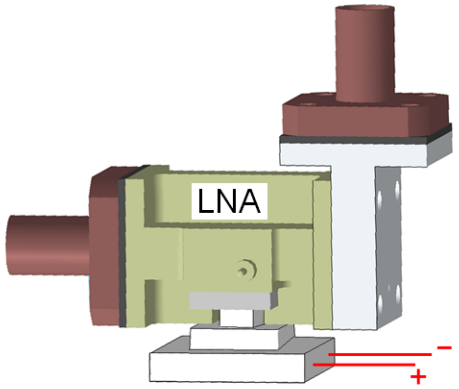
And I started this work.

Three stage Peltier module TB-3-(83-18-4)

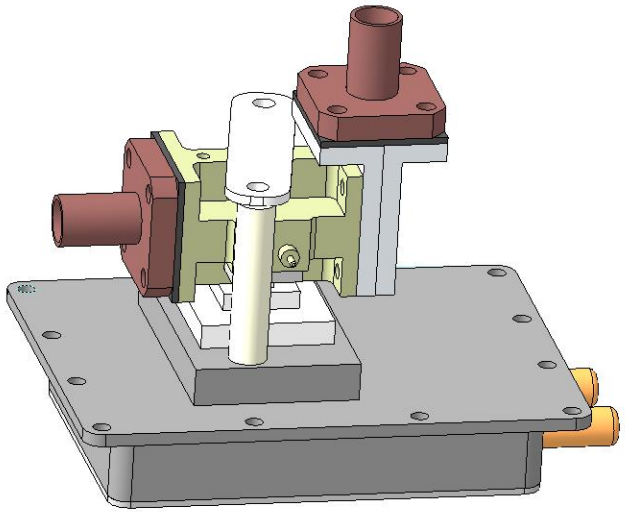
T cold side of the module (K) vs Heat influx (W)



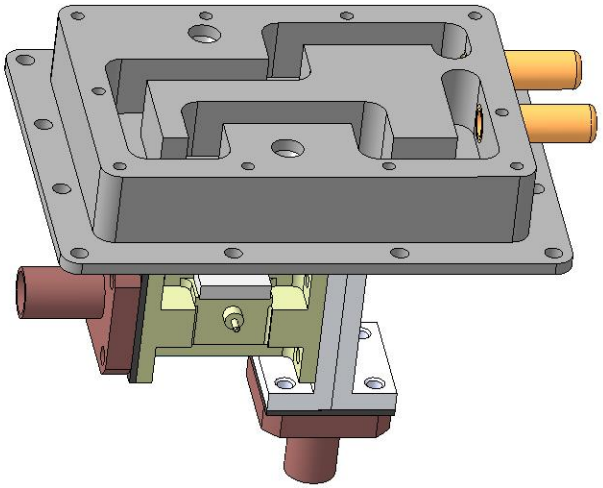


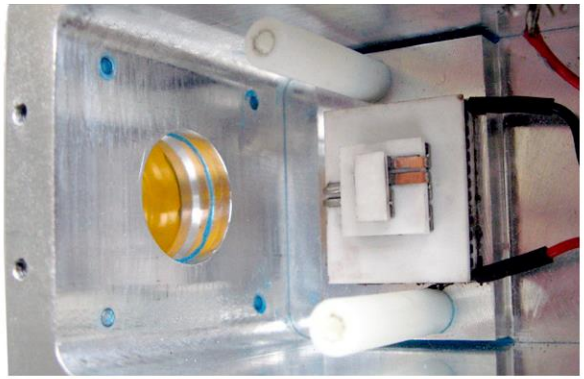


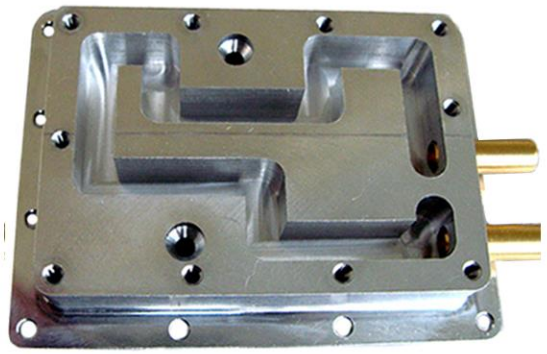
Water cooling of hot side of Peltier module



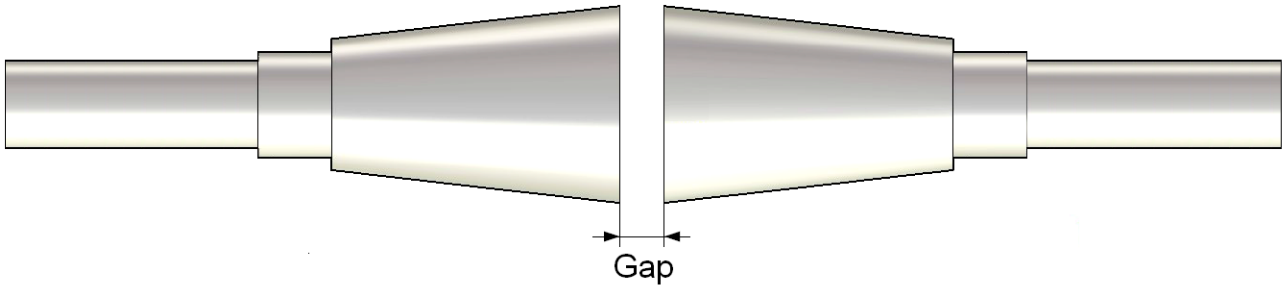
Bottom view

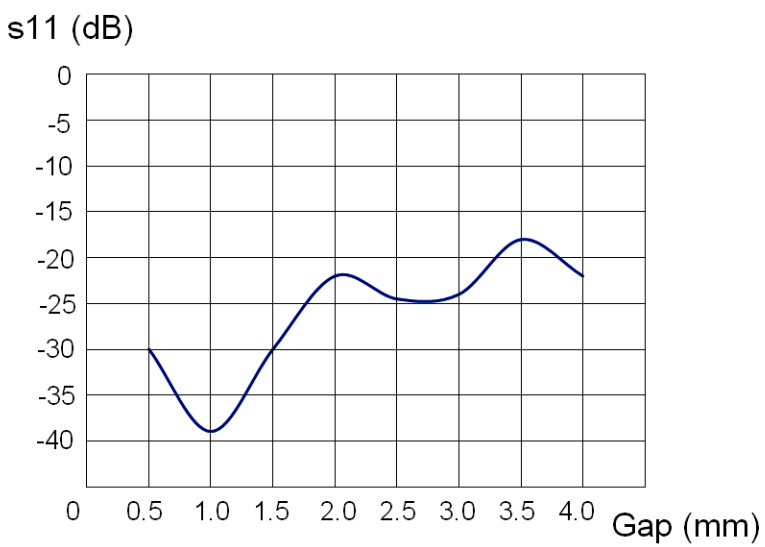


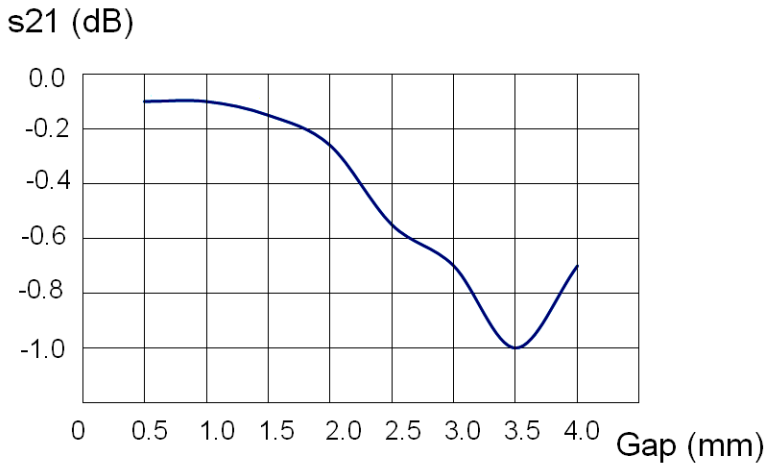




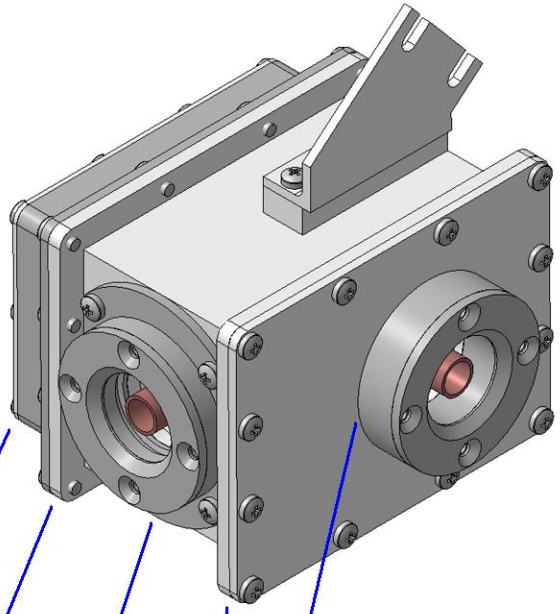
77 GHz horn to horn transition. Two RA3AQ horns.

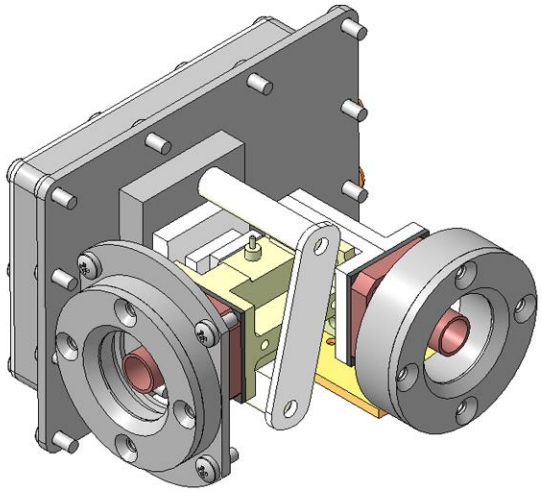




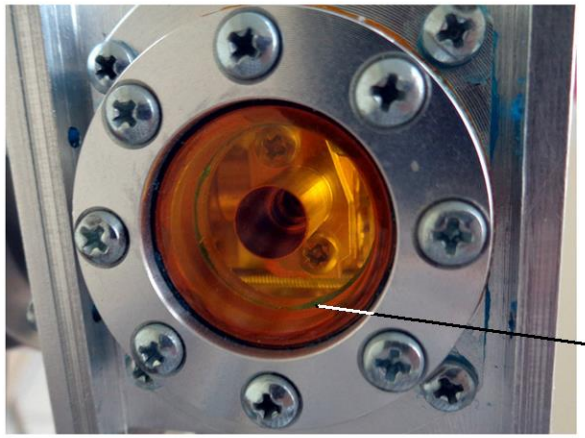


Vacuum box and radiation windows



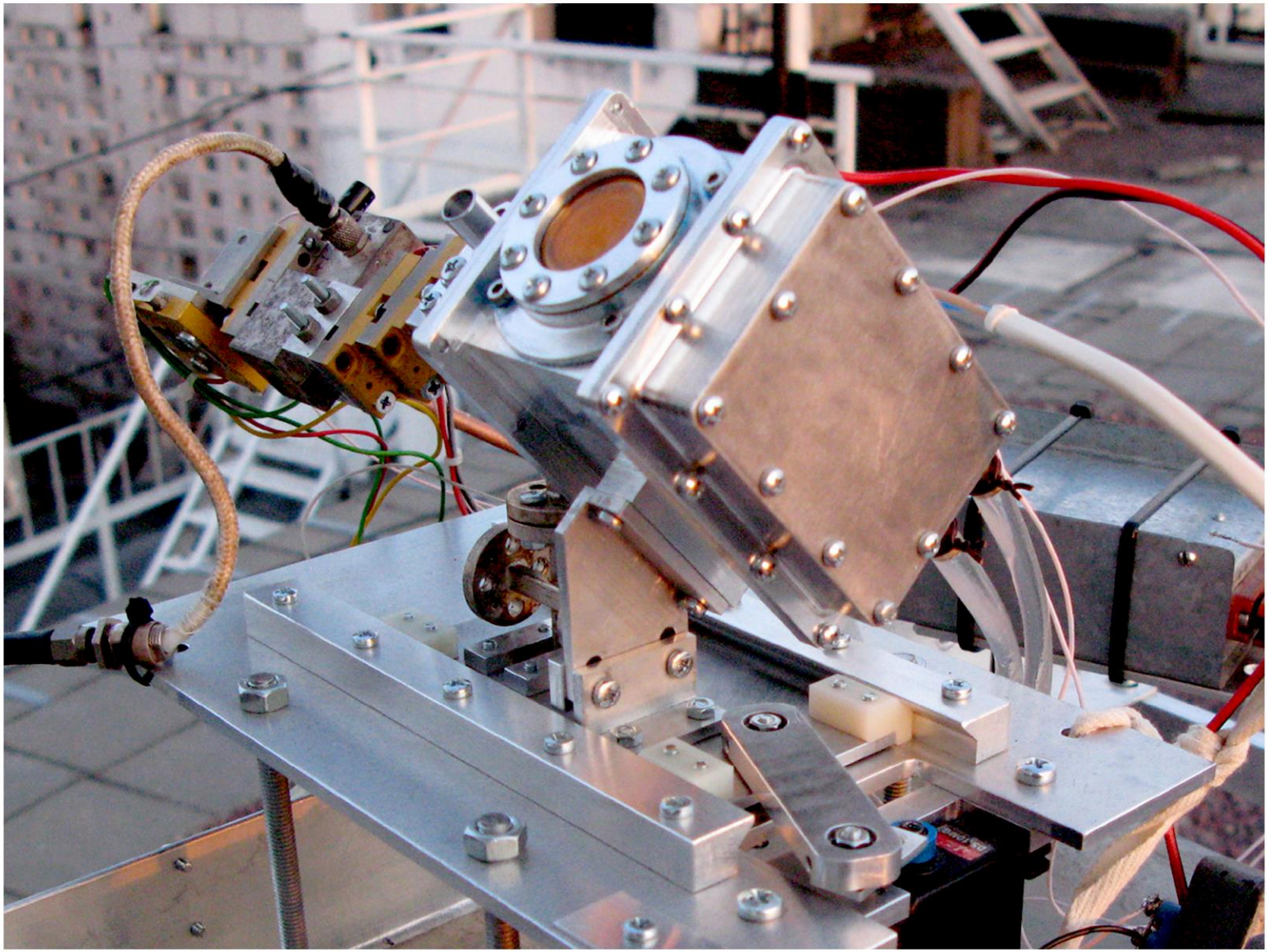


Automotive silicon sealant

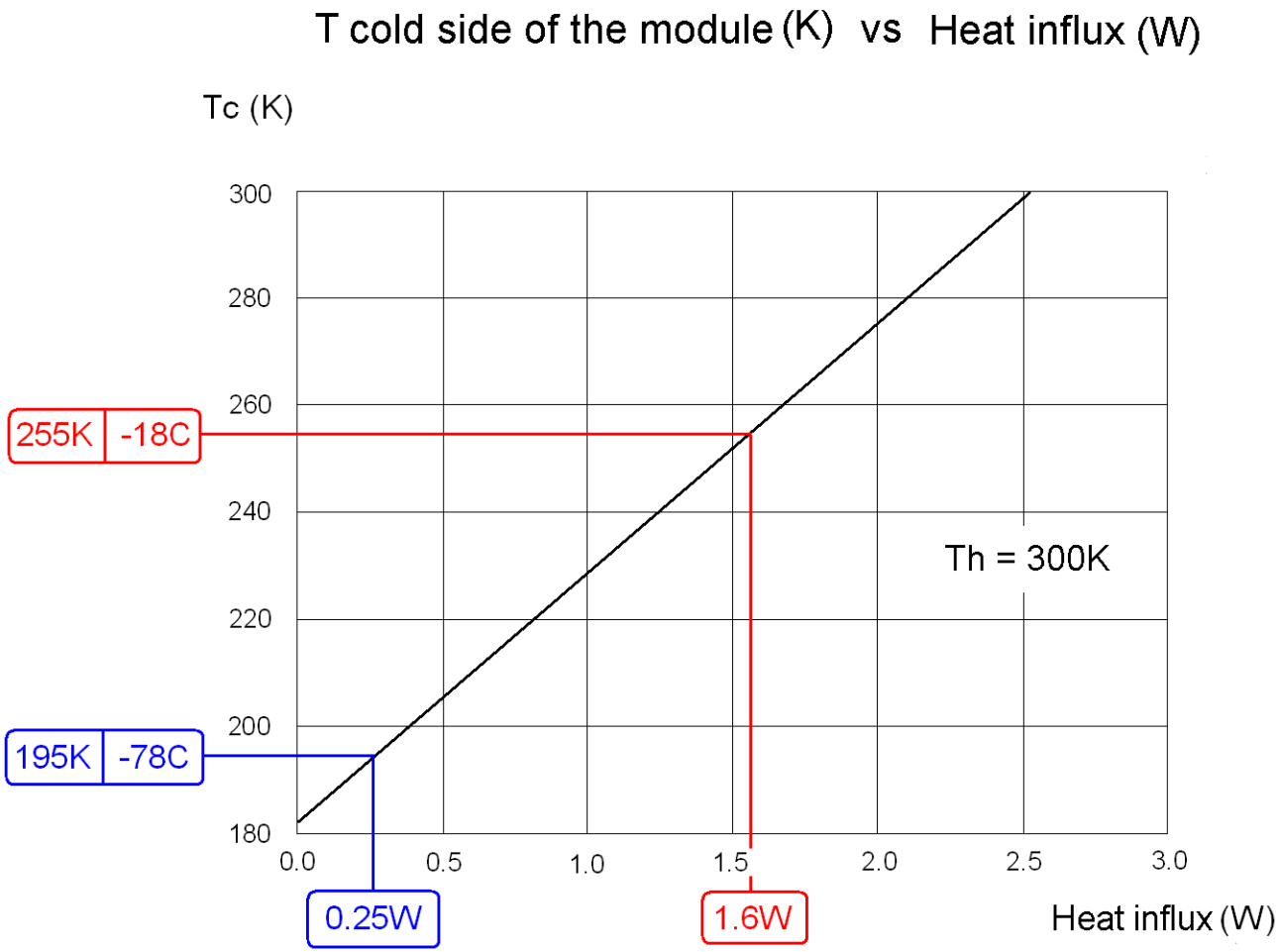


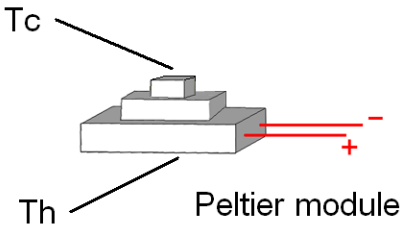
0.05 mm Capton film

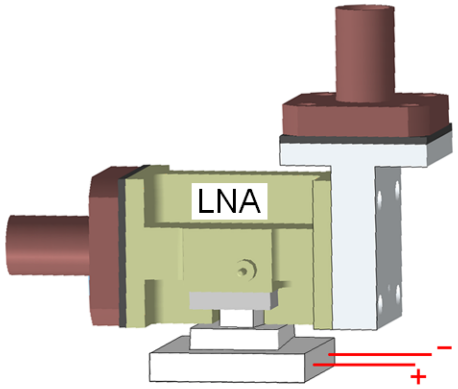
Peltier cooled LNA mounted on Antenna



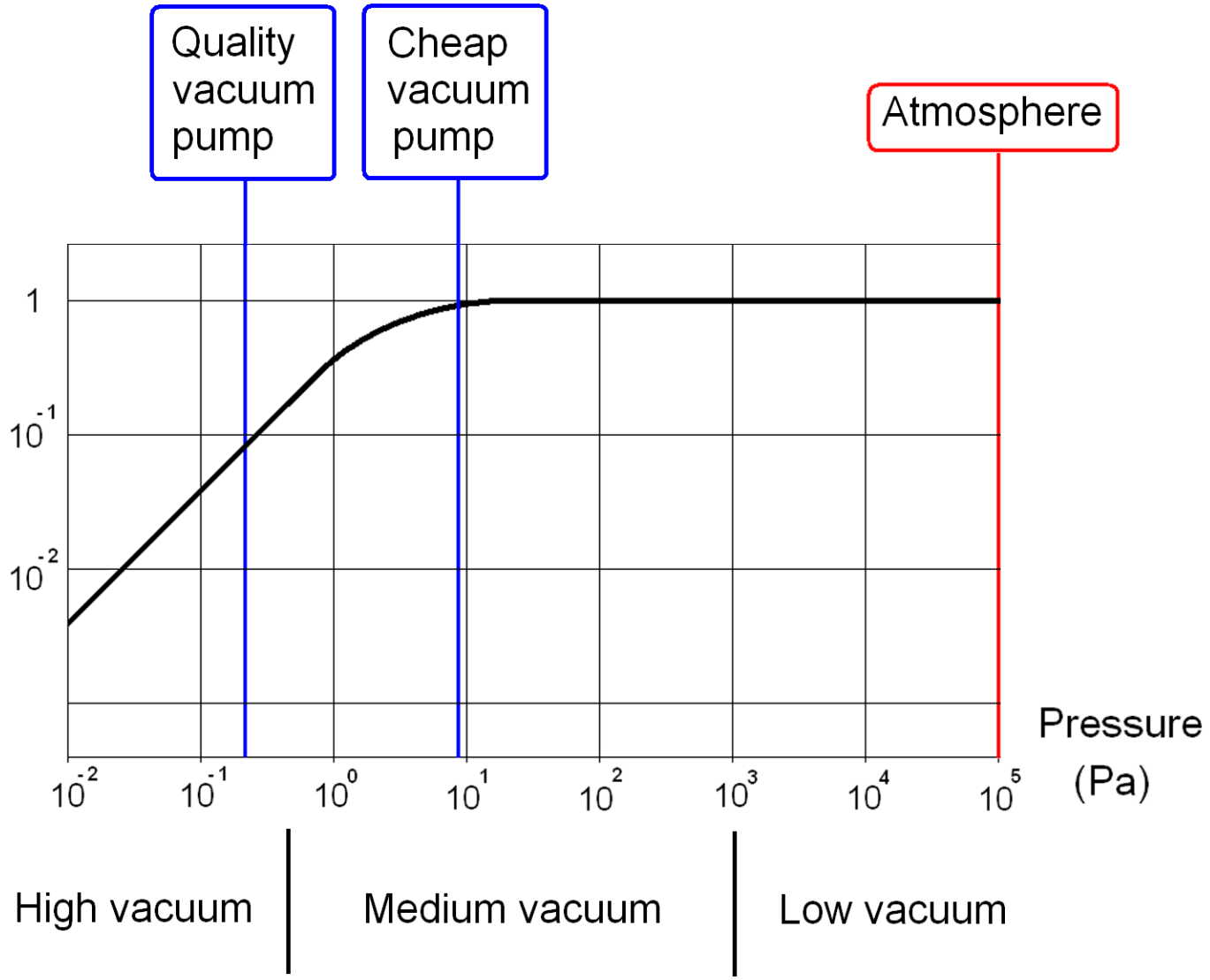
Three stage Peltier module TB-3-(83-18-4)



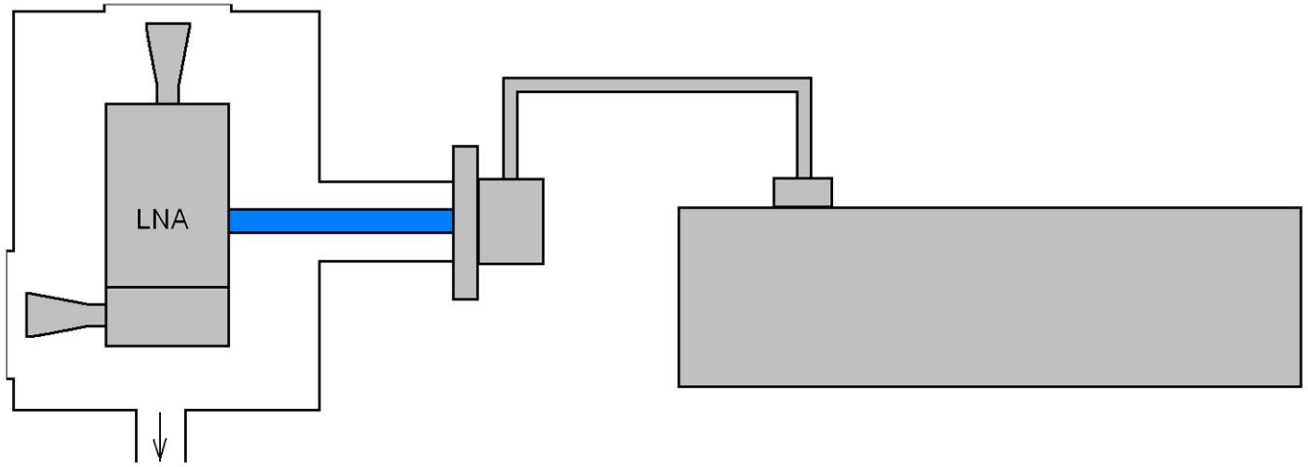


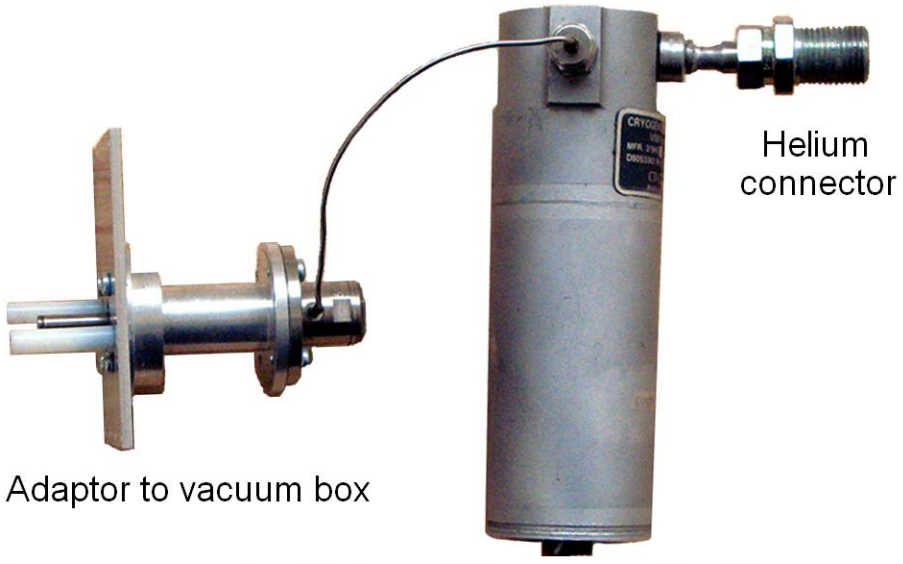


Thermal conductivity of air vs air pressure



Stirling split cooler





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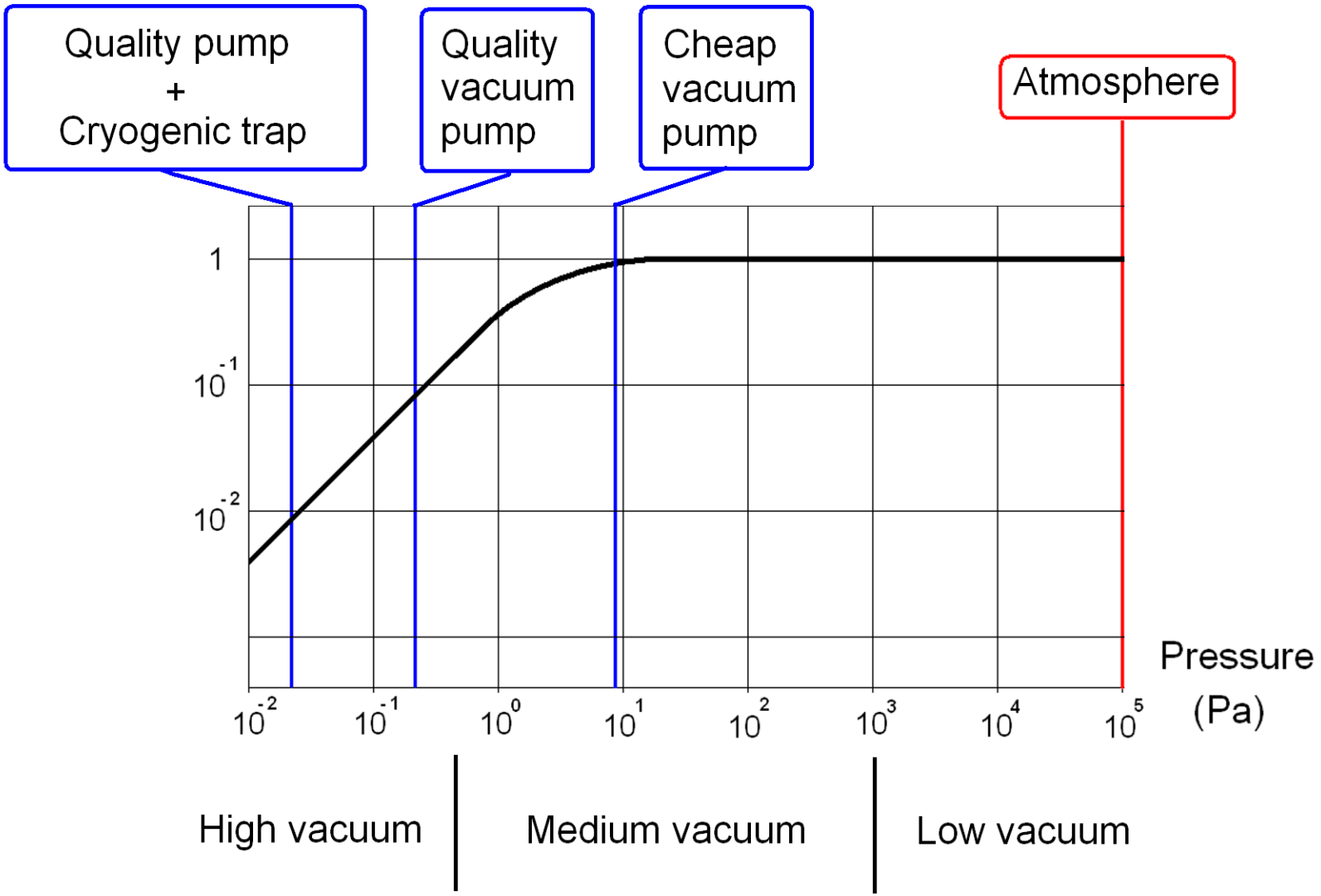
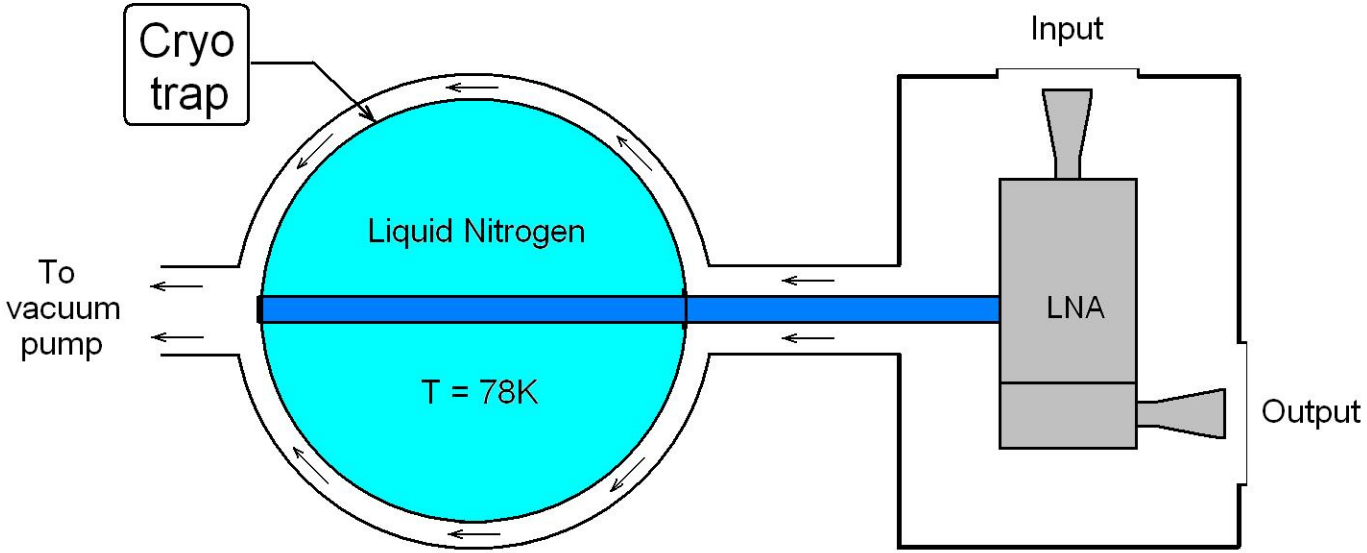
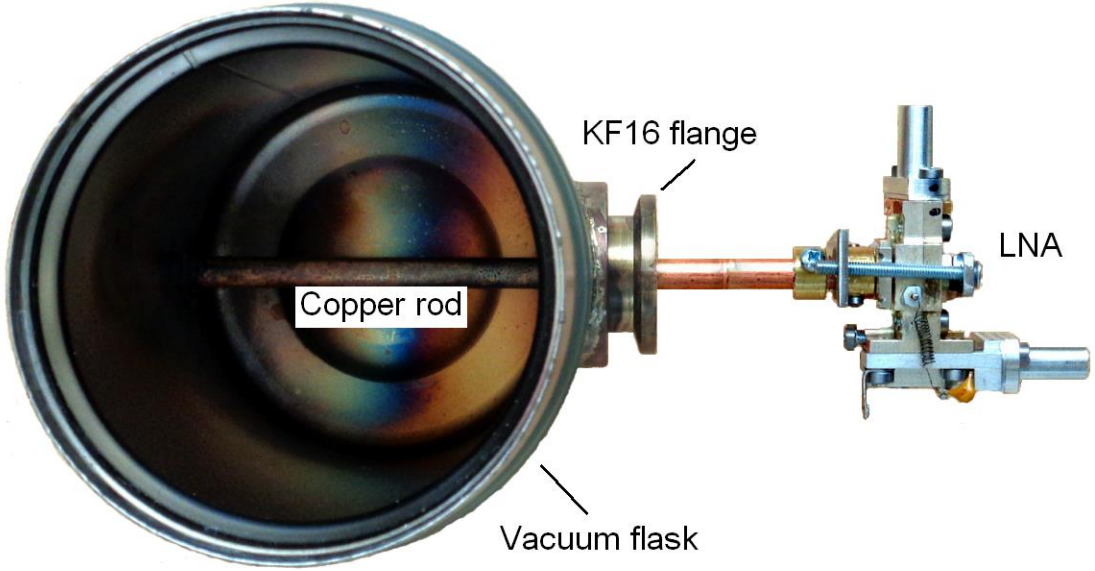
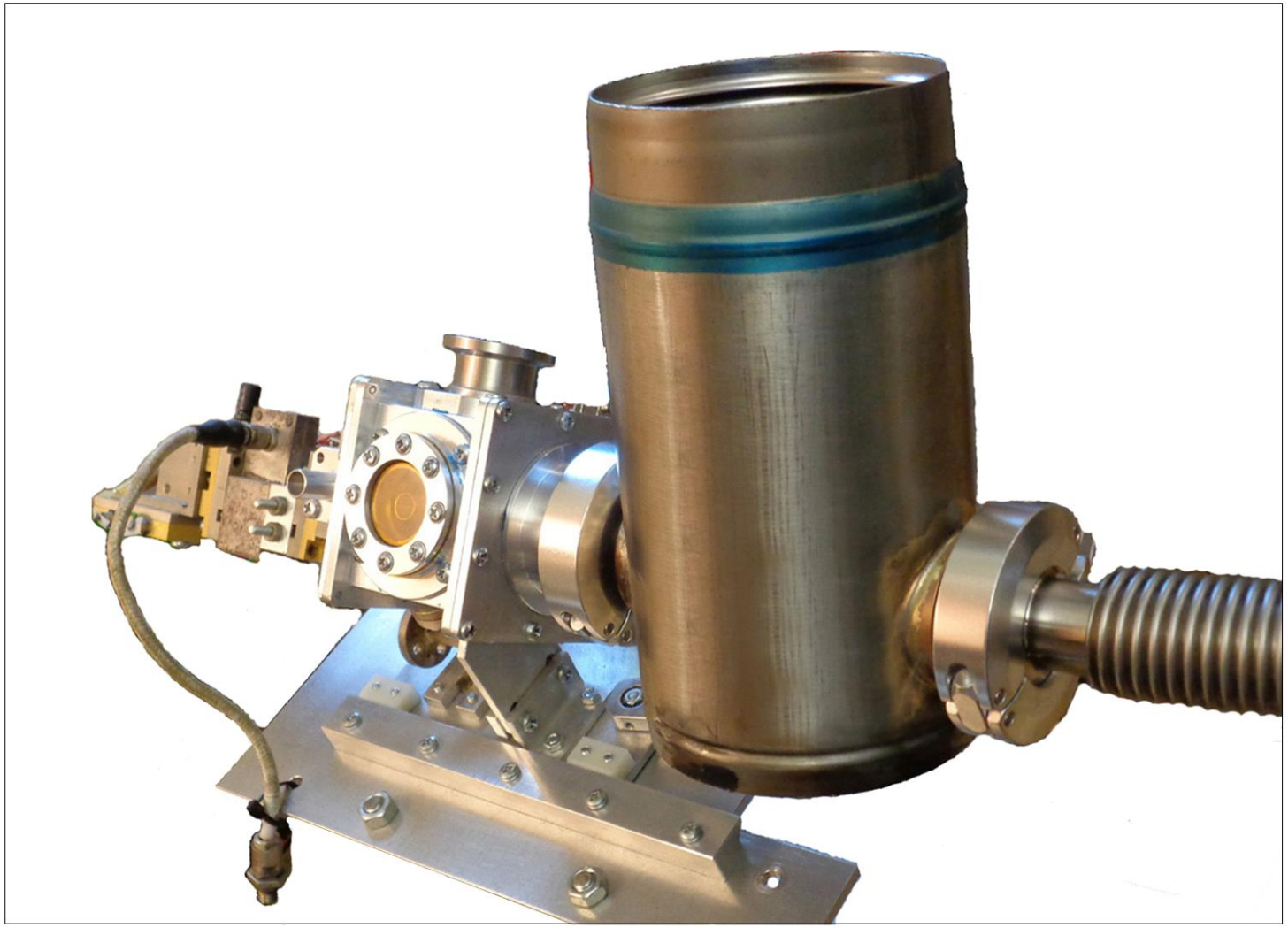


Liquid Nitrogen cooling (1)

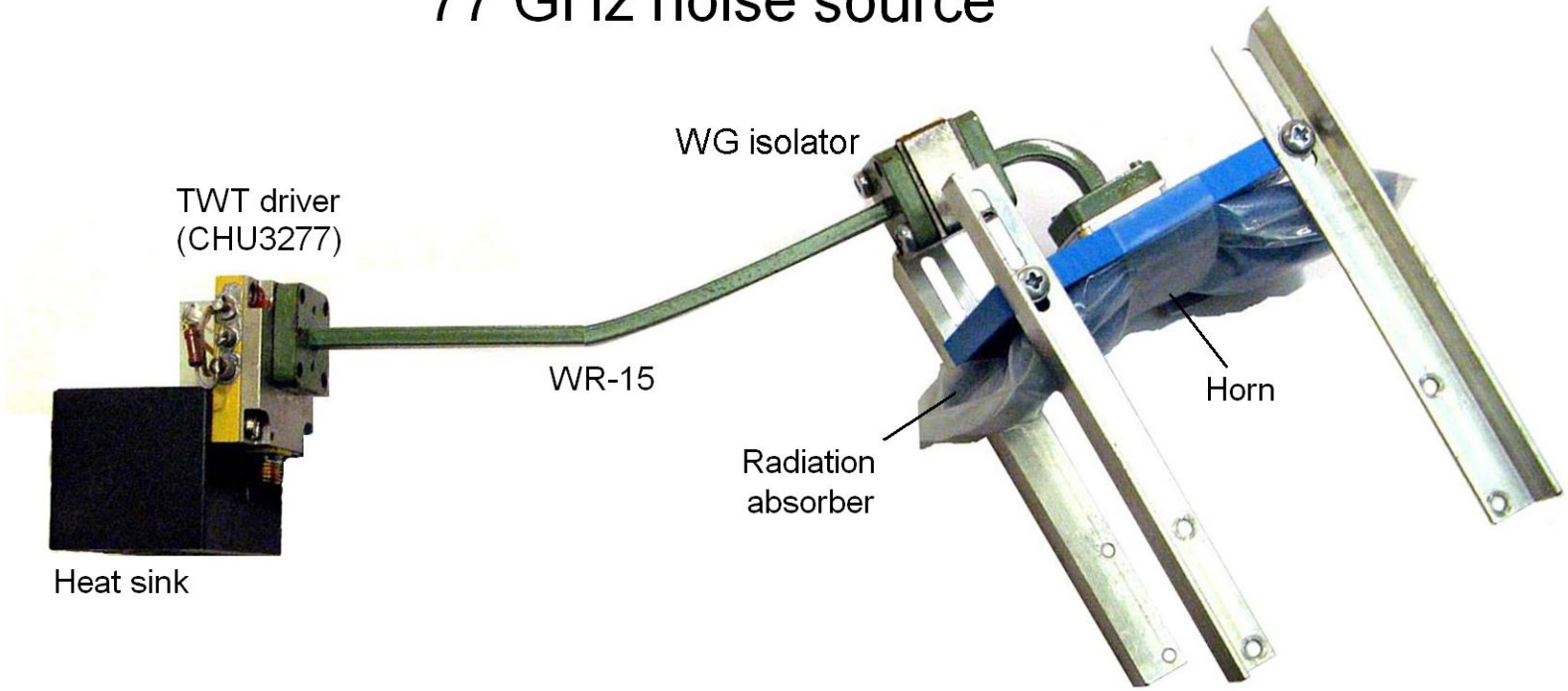


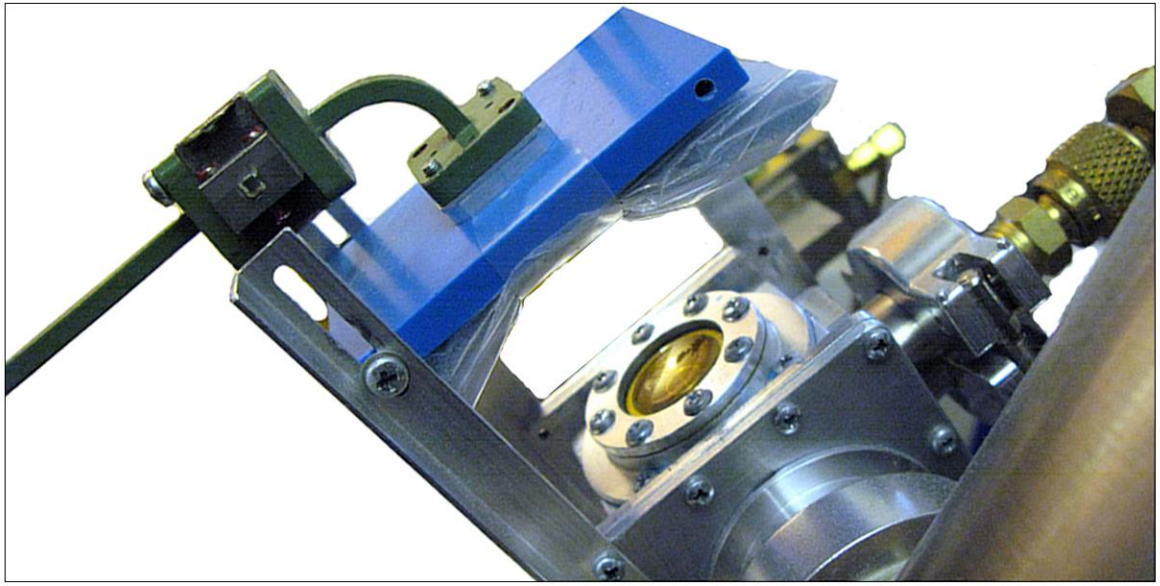


Liquid Nitrogen cooling (2)

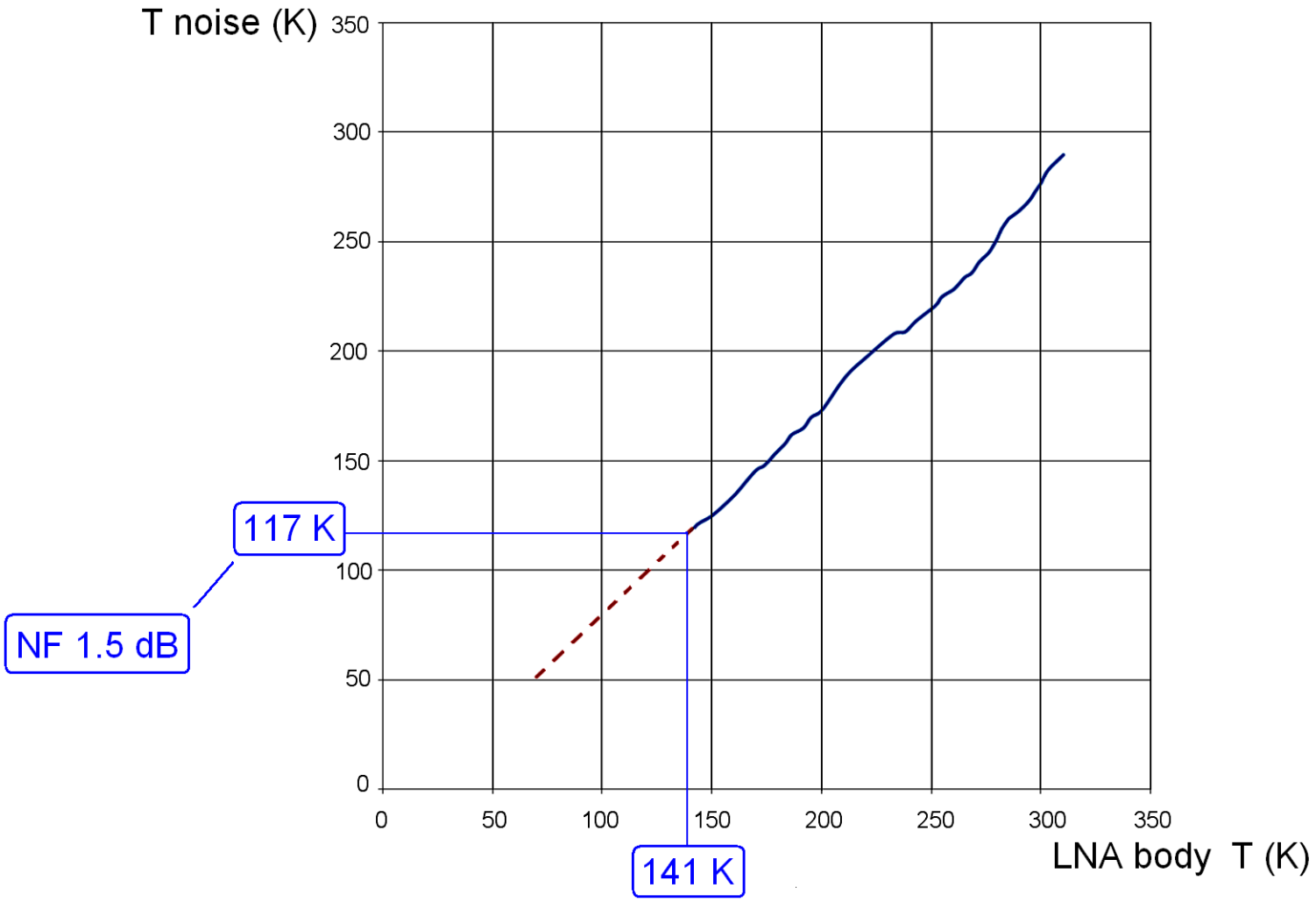


77 GHz noise source

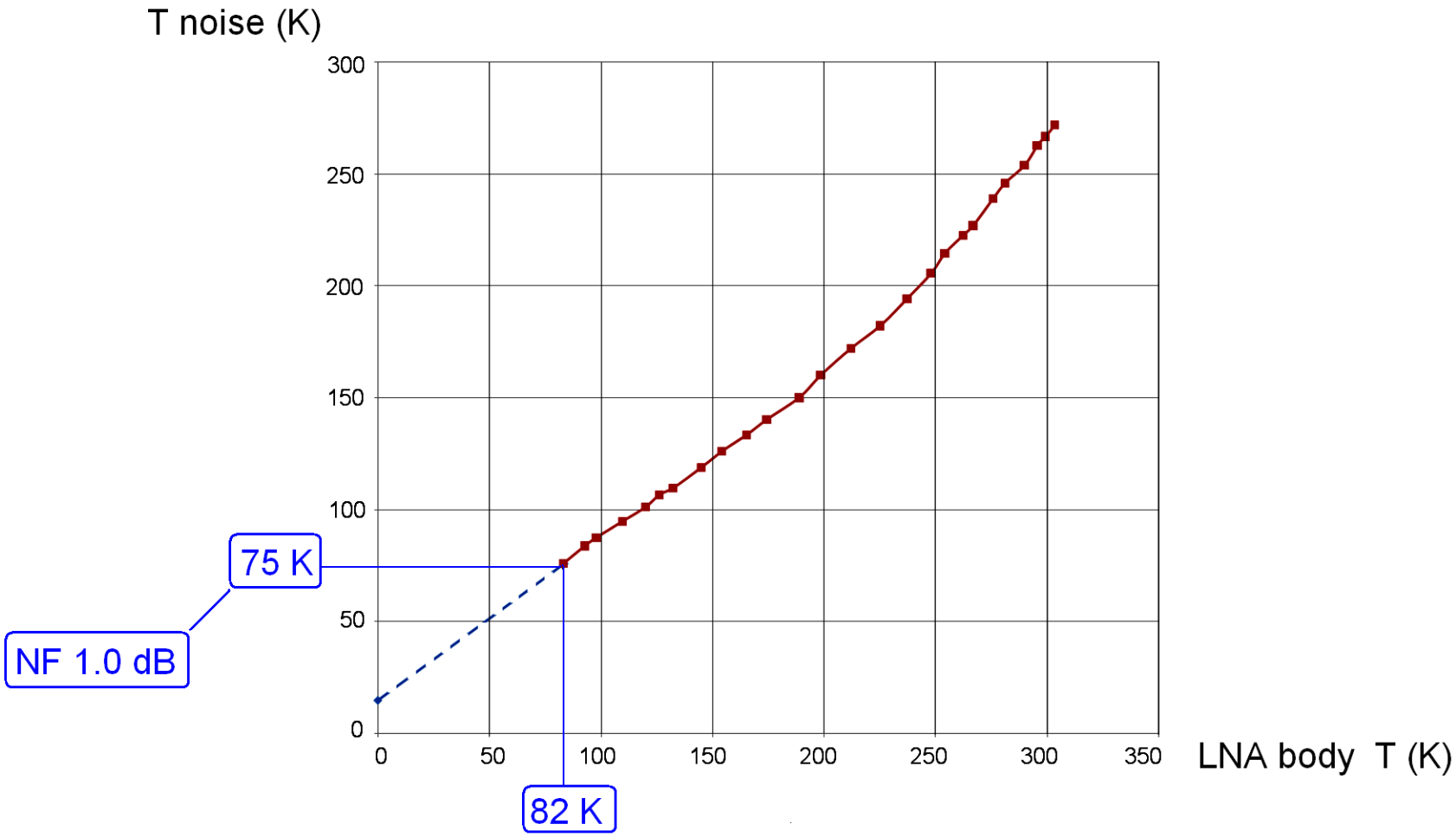




77 GHz LNA cooled by Stirling split cooler



77 GHz LNA cooled by Liquid Nitrogen

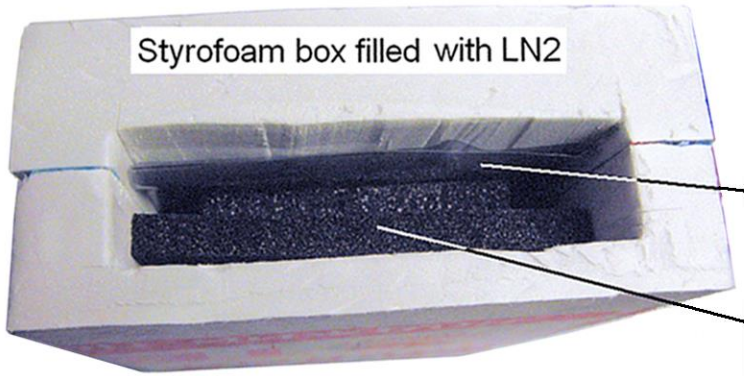


Noise temperature measurement by using Cryo load

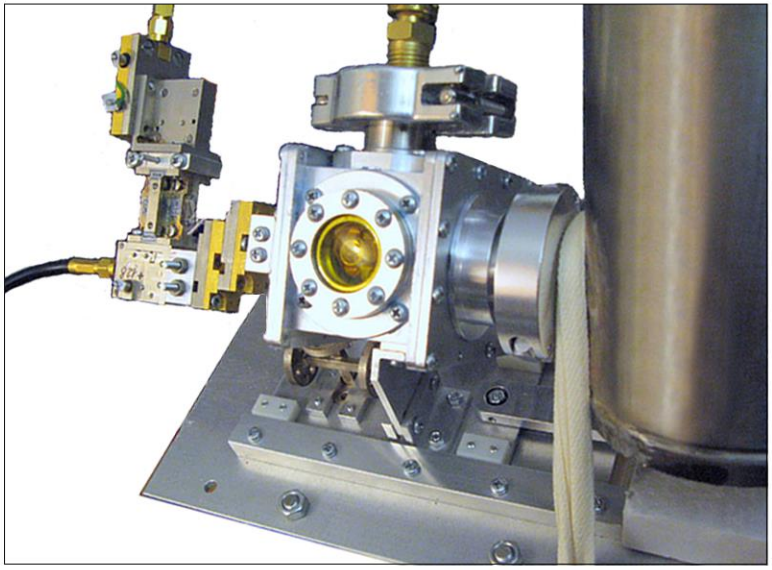
$$Y = \frac{Trx + Troom}{Trx + 78K}$$

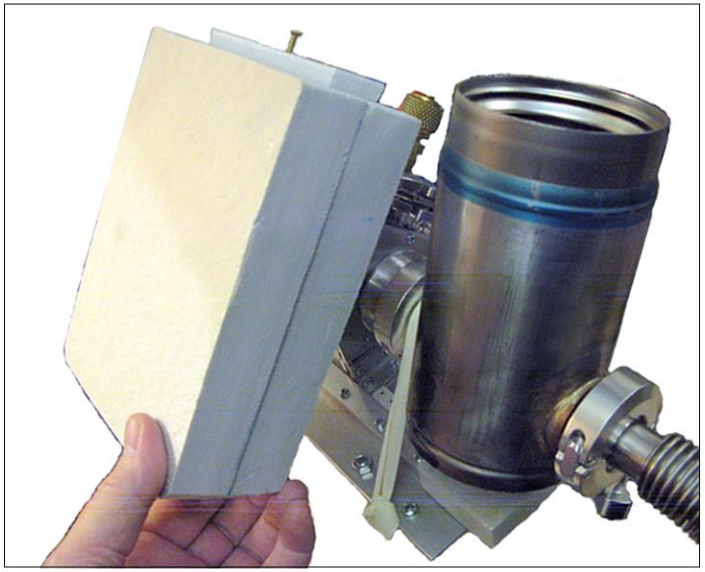
$$Trx = \frac{Troom - Y * 78}{Y - 1}$$

$$NF = 10 \log \frac{Trx + 298}{298}$$



Through attenuation > 40 dB
Return attenuation > 25 dB





The results

	2013 Old RX used for echo test	2017 New RX with LN2 cooling
T noise	1000 K	64 K
NF	6.5 dB	0.85 dB

Improvement 15.6 times (12 dB)

or

5 times (7 dB)

If to take into account the moon noise and atmosphere noise and loss

The results

Liquid Nitrogen cooled LNA tested on antenna

Ground to sky noise ratio	4.25 dB			ant elevation 56 deg
Moon noise	3.9 dB	air temp -12 C	humidity 90%	ant elevation 45 deg
Sun noise	14.6 dB	air temp +5 C	humidity 36%	ant elevation 35 deg
Venus	0.037 dB	air temp +5 C	humidity 36%	ant elevation 35 deg

CONCLUSION

Summary improvement of antenna and the receiver parts of the station can be more than 10 dB.

It helps to reduce transmitter power from 60 W to 5 W level.

There is hope for using of SSPA for EME QSO on 77 GHz.

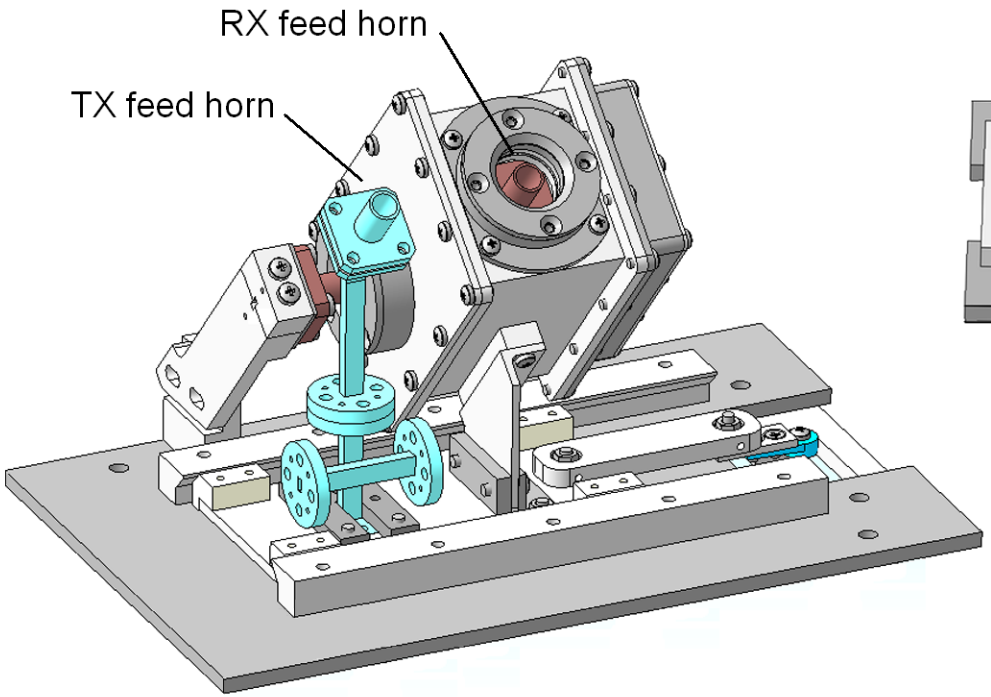
THANK YOU !

Many thanks to Dmitry RA3AQ for horns calculations.

Many thanks to Georgy, my grand-nephew, for milled components.

TX / RX feed horns changer

RX feed horn in focus point of Antenna



TX feed horn in focus point of Antenna