SILENT WAVES

THE CARTHAGO

Reversed-Kerr
Traveling Wave
Parametric amplifier

Specification sheet

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The CARTHAGO is our second traveling-wave parametric amplifier. Designed with user-friendliness in mind, first-class performance, and high tunability, it is the perfect fit for **ultra-low noise amplification** over a **high bandwidth**.
It can thus fit a wide variety of setups.

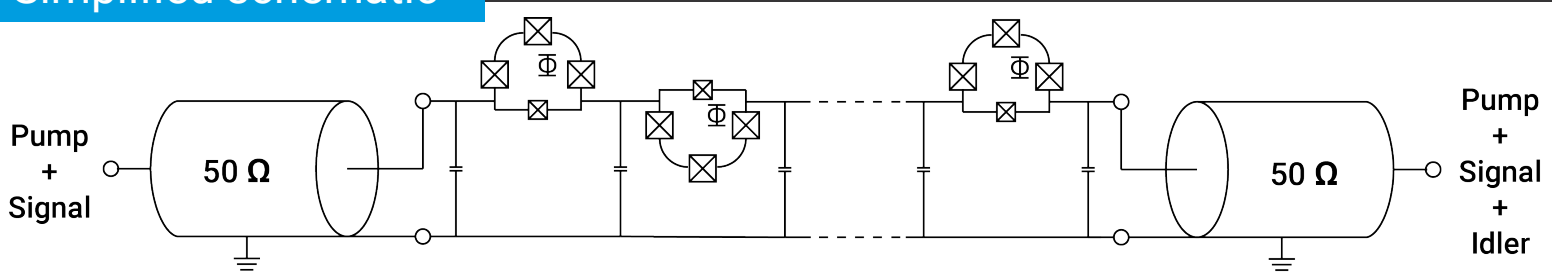
FEATURES

- Ultra-low noise
- 50 Ω matched
- Wideband
- Low pump power
- Highly tunable

The CARTHAGO is an array of Josephson junction asymmetric loops. The amplifier is powered by a microwave pump* enabling a four-wave mixing process and leading to very low noise parametric amplification. To fully exploit the potential of the CARTHAGO, every loop must be threaded with a DC magnetic flux, generated by a small magnetic coil included with the device.

* not provided with the amplifier

Simplified schematic



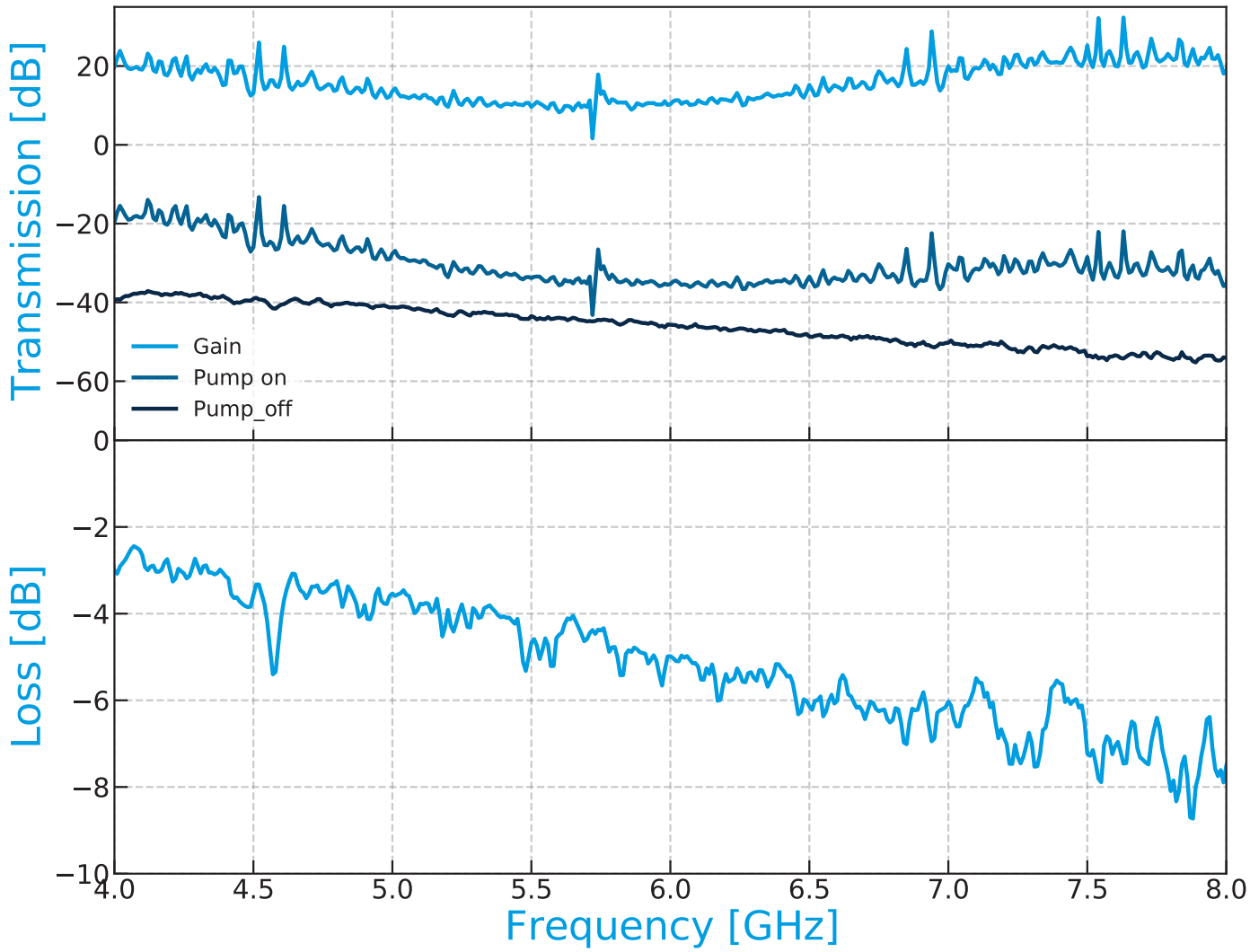
THE CARTHAGO

Electrical specifications at 20 mK

Parameter	Frequency (GHz)	Pump power: -70 dBm Pump frequency: 5.15 GHz Min.	Typ.	Max.	Units
Frequency		4		8	GHz
Gain	4.0		18		dB
	5.0		12.5		
	5.5		12.5		
	6.75		18		
	7.25		18		
Loss	5.0		5		dB
	6.0		6		
	7.0		7		
	7.5		7.5		
SNR improvement*	6.5		7.0		dB
	7.5		7.0		
Input power at 1 dB compression	5.5		-102		dBm
	7.0		-105		

* compared to HEMT only (see p.7)

Transmission



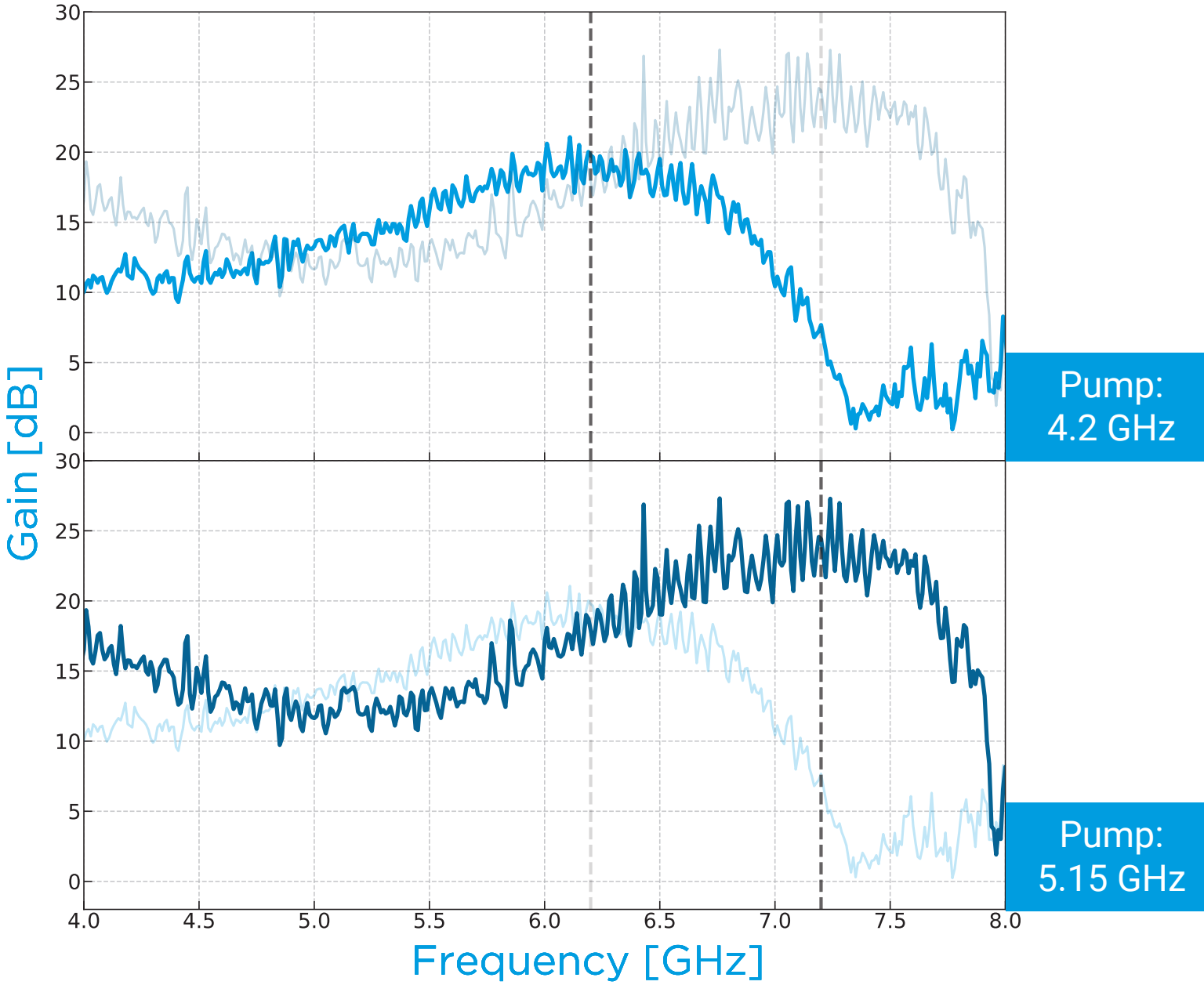
To achieve high-gain over a band exceeding 3 GHz, phase-matching between the pump, the signal and the idler is required.

In order to satisfy the phase-matching condition, we make use of alternately oriented SNAILs (Superconducting Nonlinear Assymetric Inductive Loop), effectively circumventing the need for dispersion engineering by directly acting on the nonlinearity of the metamaterial.

This architecture enables the CARTHAGO to exhibit no stop-band in the gain profile, and in-situ tunability.

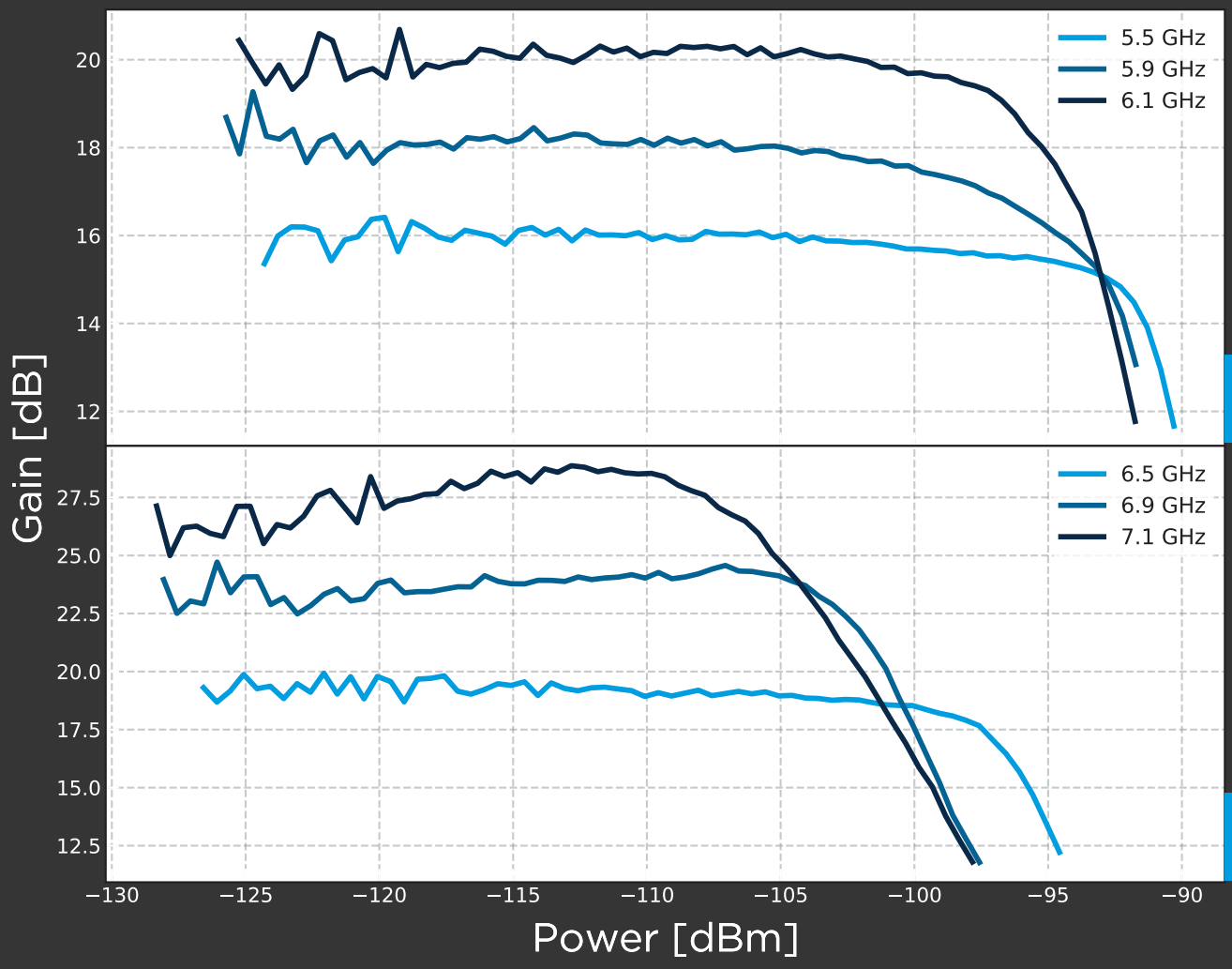
Tunability

The pump frequency can be tuned to systematically ensure the highest gain for your targeted readout frequencies.



The above plots show the gain profile of a single device measured for two different pump frequencies. By tuning the pump, one can measure devices in the 4-8 GHz band within a single cooldown.

Power saturation

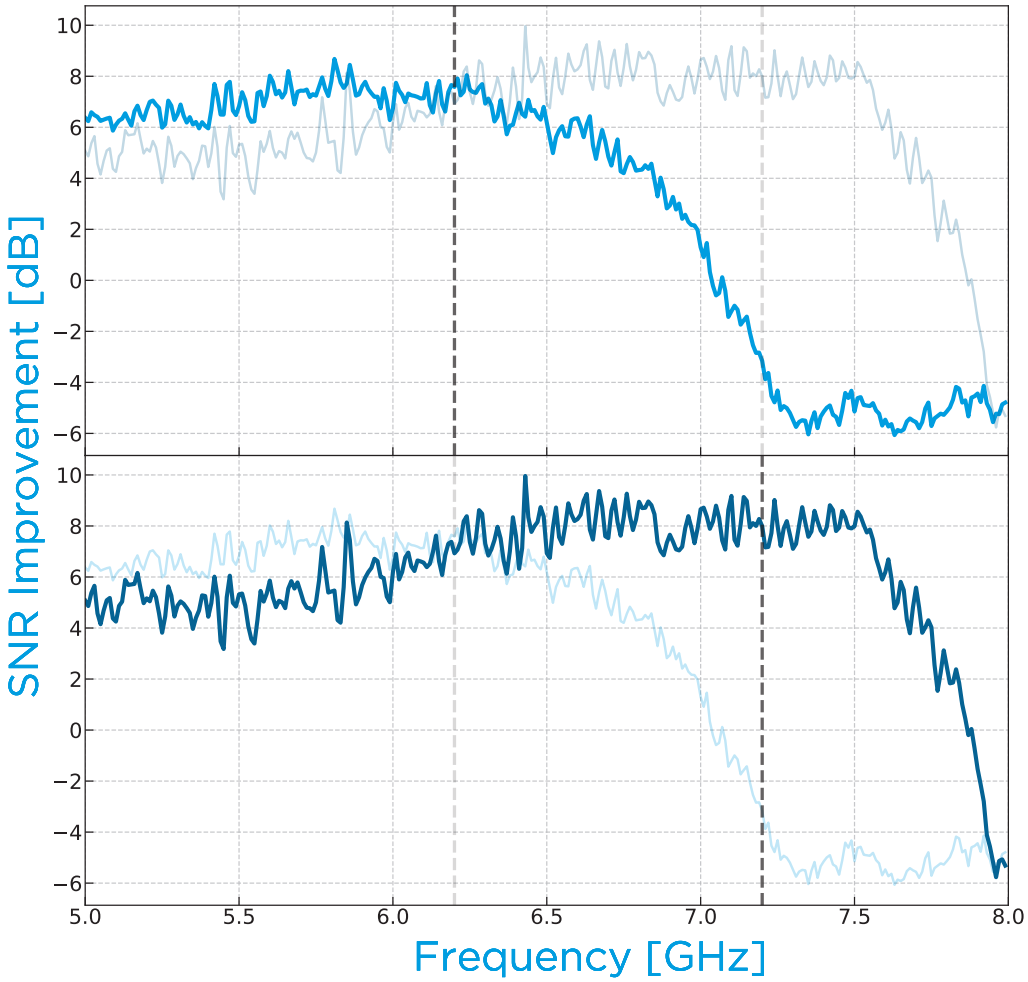


Pump: 4.2 GHz

Pump: 5.15 GHz

In addition, the CARTHAGO shows a high dynamic range.

Signal-to-noise ratio

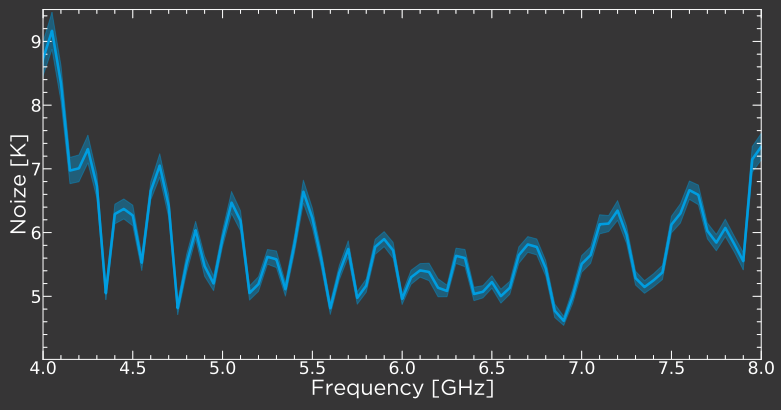


Pump: 4.2.GHz

Pump: 5.15 GHz

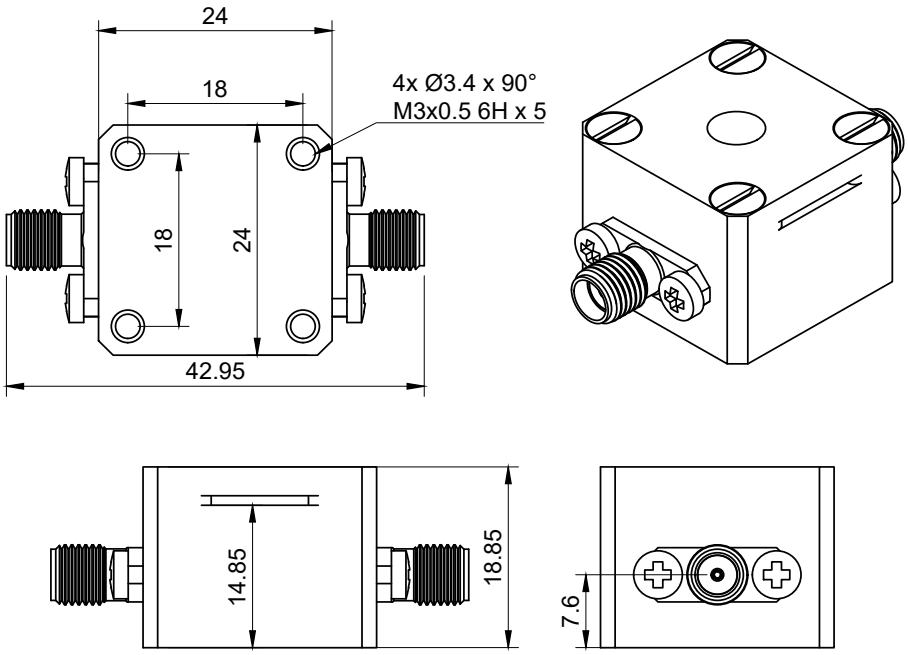
The figure above shows the SNR improvement when the TWPA is on compared to when it is bypassed. Bypassing the TWPA alows to get the SNR with the HEMT only. It results in the genuine improvement offered by the TWPA, as it includes its internal losses.

Noise



Typical noise of the setup used to characterize the devices (**WITHOUT TWPA, HEMT ONLY**).

Box schematic



The magnetic coil is embedded in the sample holder for a reduced footprint

Characterization circuit