SILENT WAVES

THE CARTHAGO

REVERSED-KERR TRAVELING WAVE PARAMETRIC AMPLIFIER

SPECIFICATION SHEET

THE CARTHAGO

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.

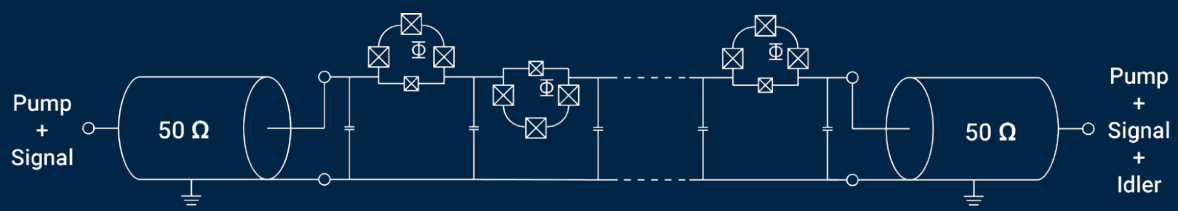
FEATURES

- SMA compatible connectors
- 50 Ω matched
- In-situ tunability
- Low pump power
- Very wide bandwidth
- DC magnetic flux required

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



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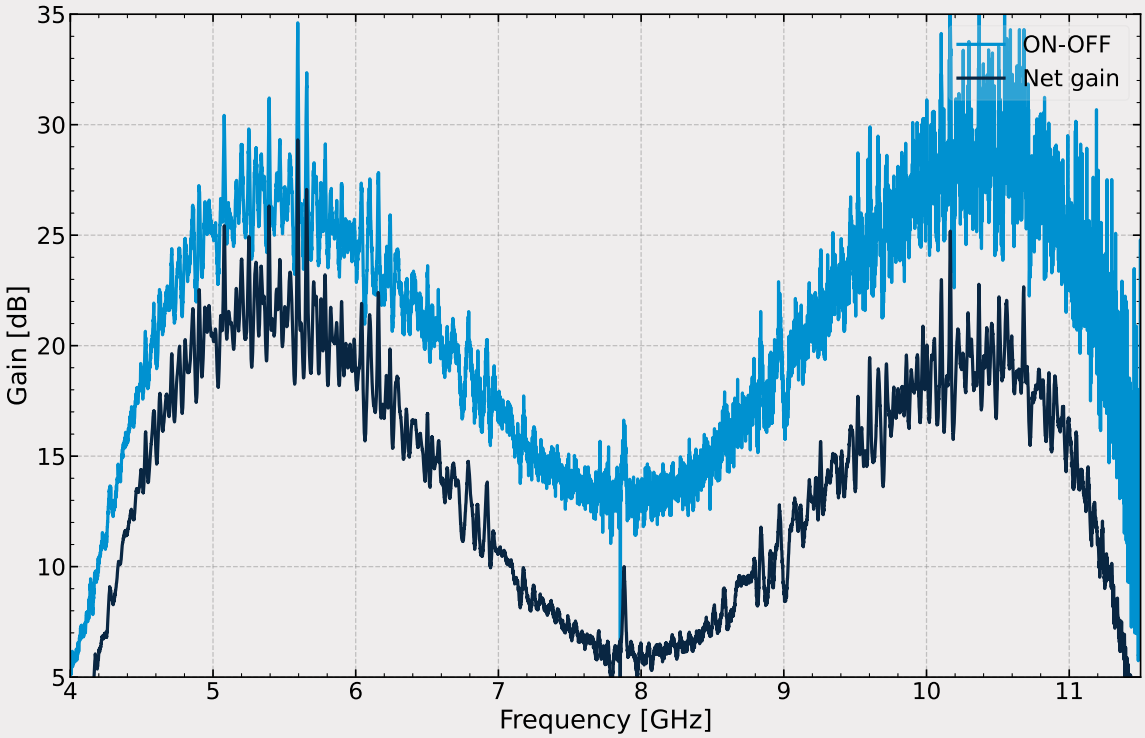
THE CARTHAGO

GAIN PROFILE



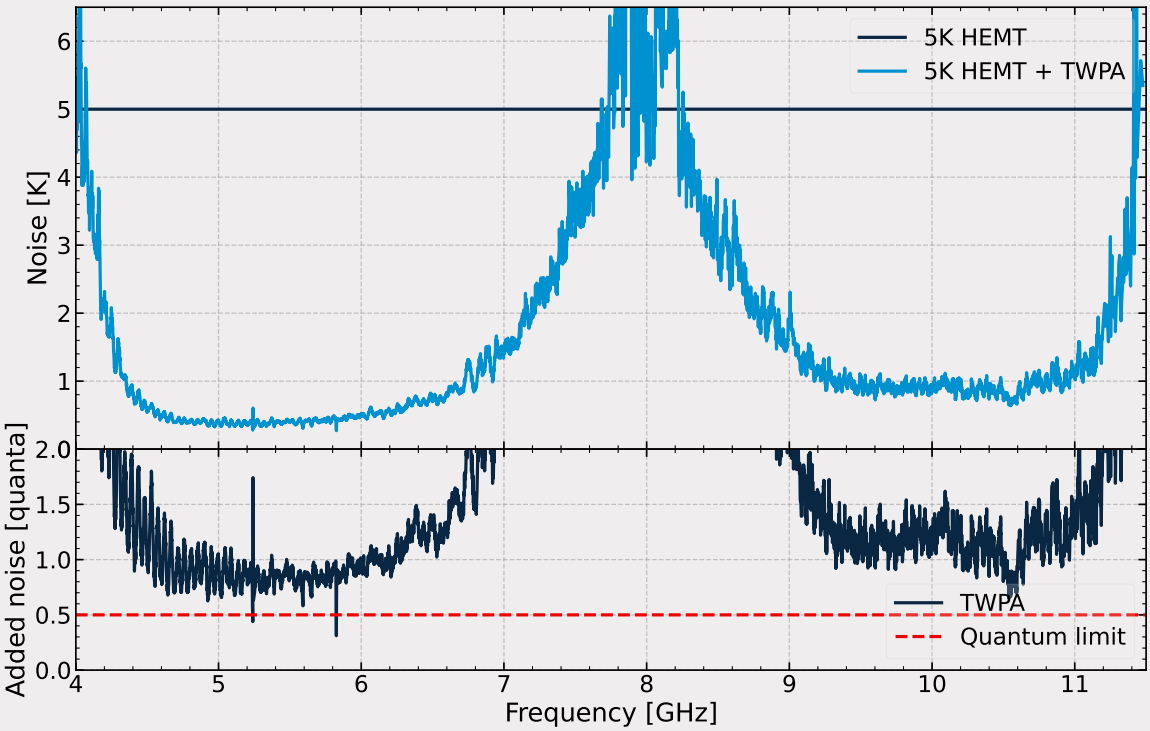
To achieve high-gain over a band exceeding 3 GHz, phase-matching between the pump, the signal and the idler is required.

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.

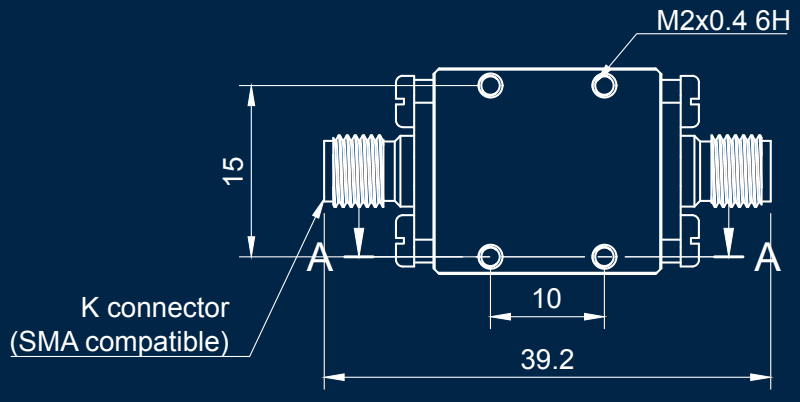
This architecture enables the CARTHAGO to exhibit no stop-band in the gain profile, and in-situ tunability.

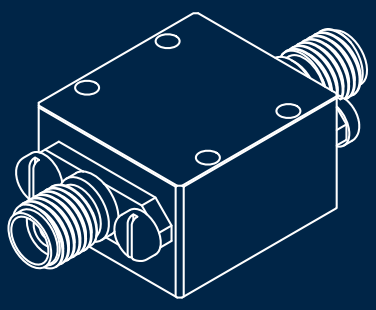
THE CARTHAGO

SYSTEM NOISE AND ADDED NOISE



The figure above shows the total system noise (top panel, in kelvin) and the TWPA added noise (bottom panel, in quanta). The total system noise when the TWPA is on (light blue) has been measured with an effective HEMT noise of 5K (accounting for loss between the TWPA and the HEMT).





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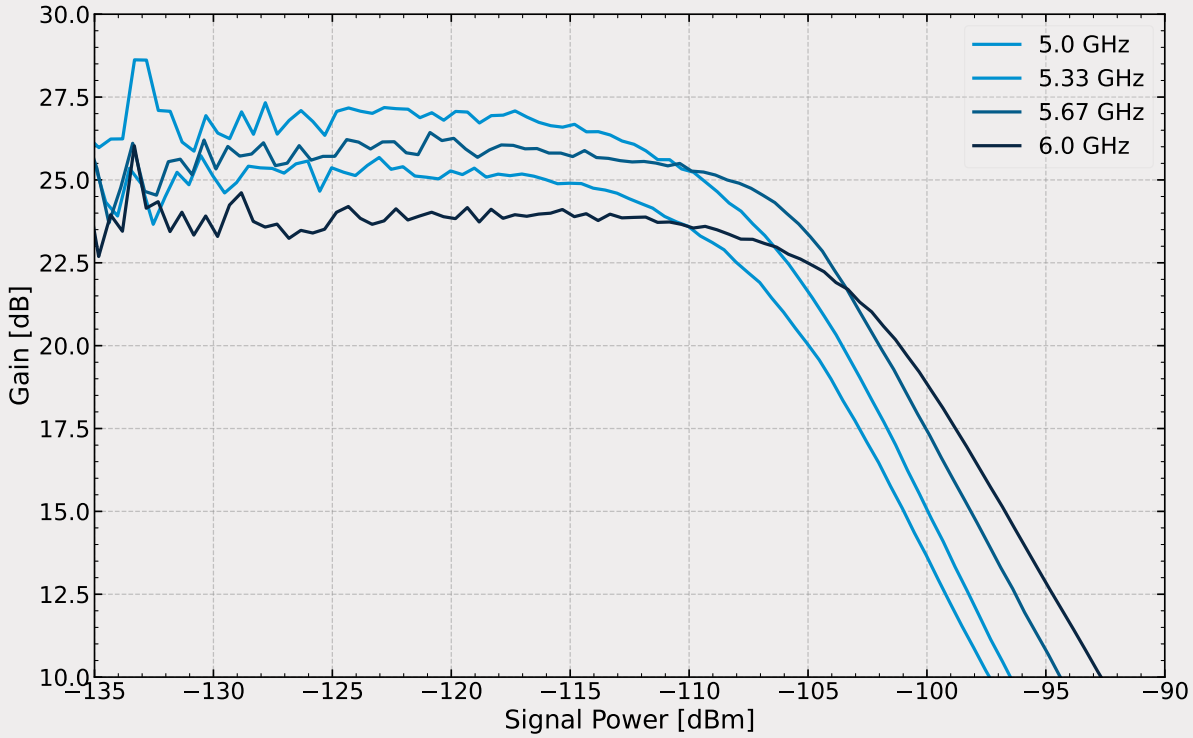
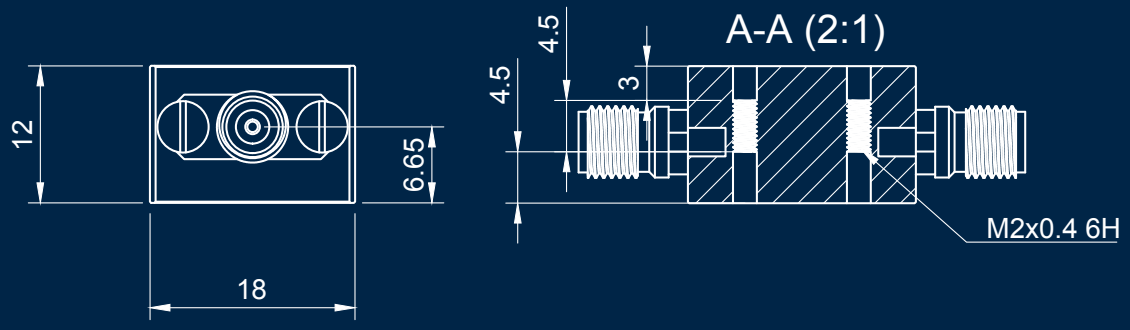
POWER SATURATION

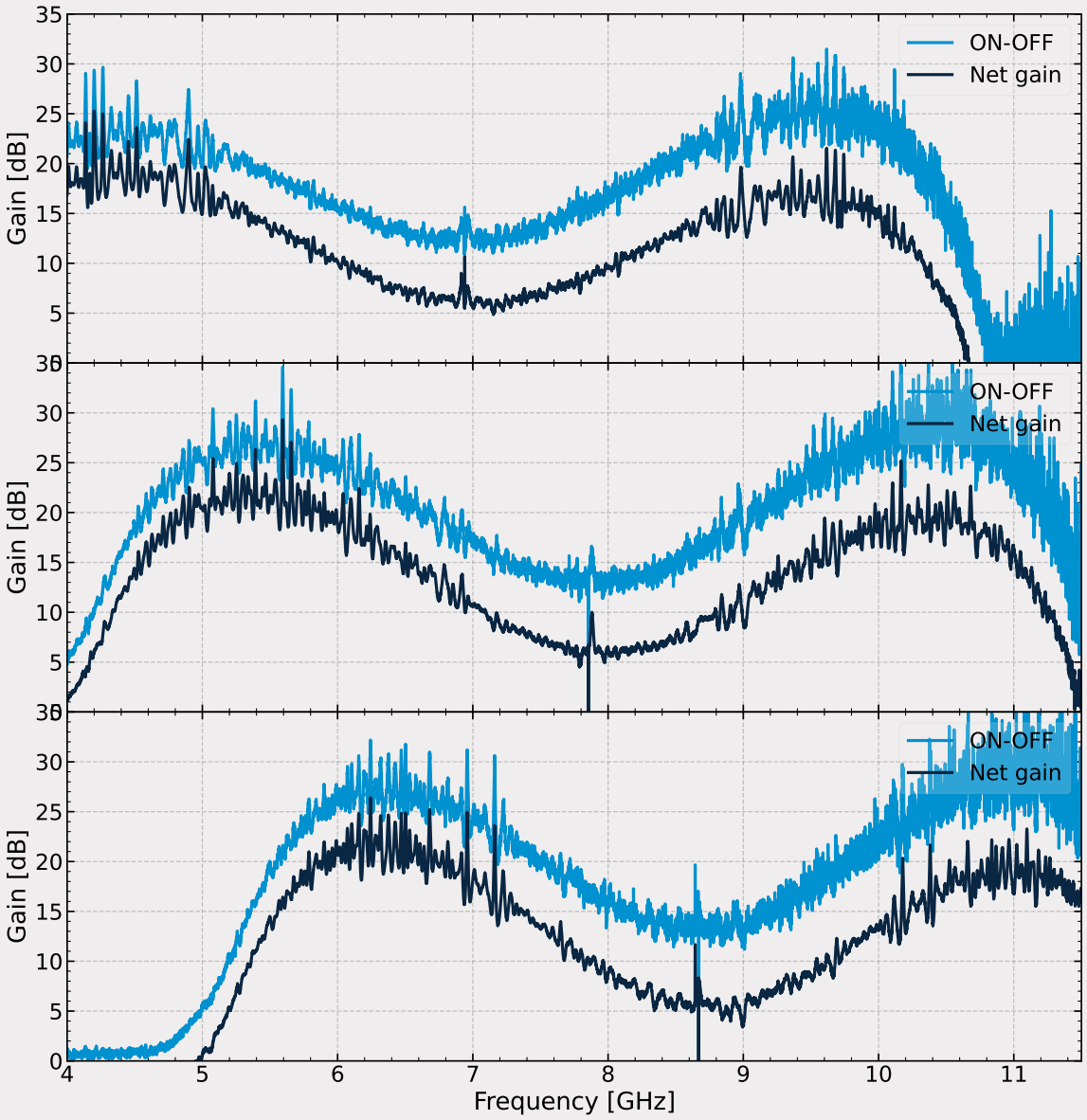


BOX SCHEMATIC



THE CARTHAGO

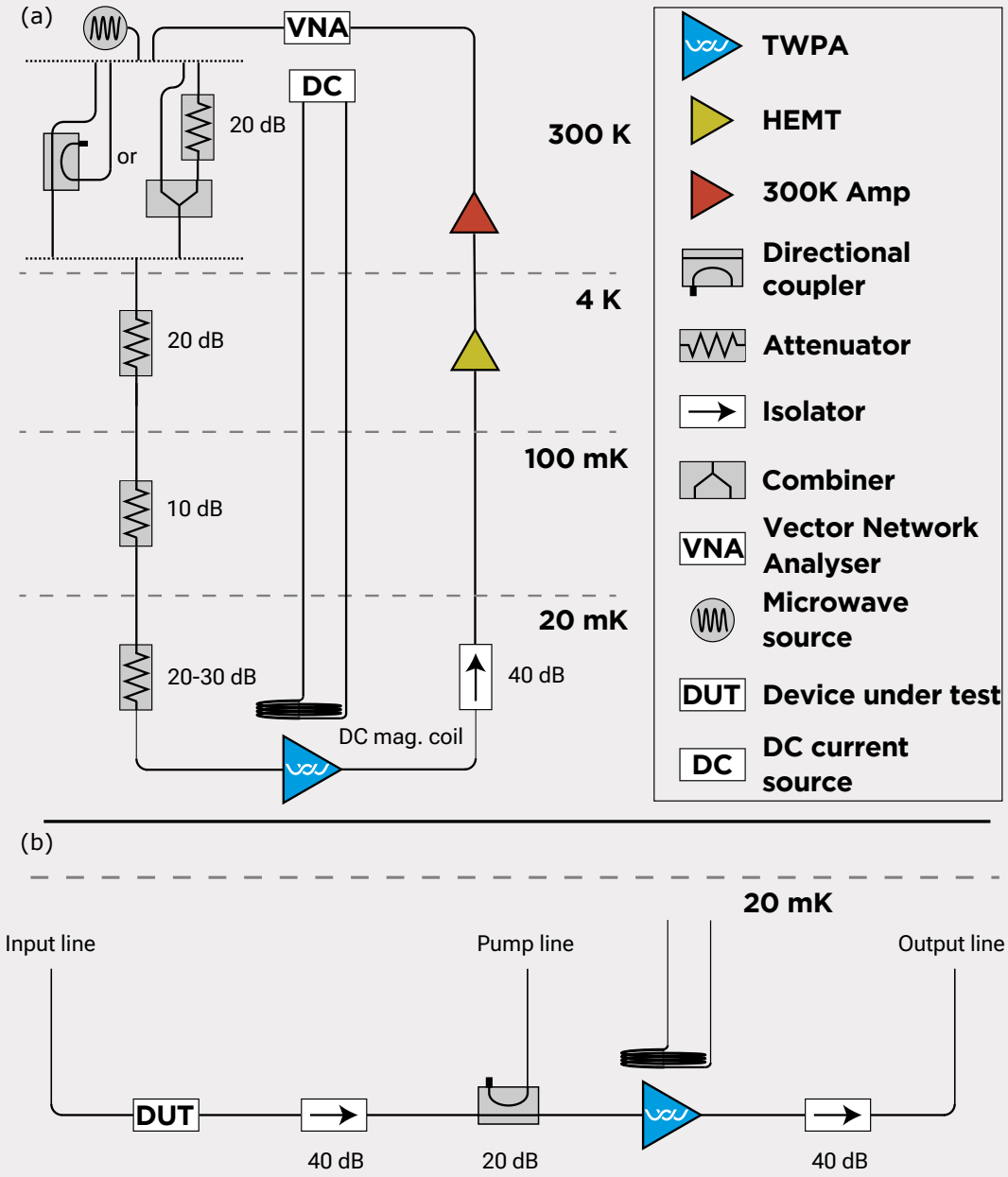
IN-SITU TUNABILITY



The plots above show the gain profile of the same device measured for three different pump frequencies. By tuning the pump frequency, one can have high-fidelity readout in the 4-8 GHz band within the same cooldown.

THE CARTHAGO

CHARACTERIZATION CIRCUIT



Typical setups for testing/using the TWPA. (a) Ideal setup for testing the TWPA. (b) TWPA in a readout line (at the mixing chamber stage).

A NEW GENERATION OF AMPLIFIERS ENABLING ULTRA-LOW NOISE MICROWAVE READOUT

We specialize in developing and manufacturing state-of-the-art quantum hardware using superconducting circuits for readout applications. Our products are the result of years of intensive research. Currently, we focus on the development of Josephson Traveling-Wave Parametric Amplifiers (JTWPA) for high-fidelity multiplexed qubit readout.

SALES@SILENT-WAVES.COM
+33 (0)4 58 00 88 35

SILENT WAVES

69-73, RUE FÉLIX ESCLANGON
38000 GRENOBLE - FRANCE
WWW.SILENT-WAVES.COM