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Design and preliminary characterizations of traveling wave parametric amplifiers for DARTWARS

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Nowadays, many experiments with very high energy resolution detectors rely on the faithful detection of low power microwave signals at cryogenic temperatures. This is especially true also in the field of the superconducting quantum computation, where quantum-limited noise microwave amplification is paramount to infer the qubit state with high fidelity.

For these applications, the goals are to maximize the signal to noise ratio of microwave signals extremely feeble while allowing a broad readout bandwidth.

The latter is also important, because both the quantum and the particle physics fields require to readout very large arrays of qubit and Low Temperature Detectors to achieve meaningful results in terms of computational power and acquired statistics respectively. To solve this problem, parametric amplification, a well known technique used for low noise amplifiers, will be exploited and developed to its technical limits.

DARTWARS (Detector Array Readout with Traveling Wave AmplifieRS) is a three years project that aims to develop high-performing innovative traveling wave parametric amplifiers (TWPAs). The practical development follows two different promising approaches, one based on the Josephson junctions (TWJPA) and the other one based on the kinetic inductance of a high-resistivity superconductor (KITWPA). The technical goal is to achieve a gain value around 20 dB, comparable to the currently used semiconductors low temperature amplifiers (HEMT), with a high saturation power (around -50 dBm), and a quantum limited or nearly quantum limited noise ($T_N < 600$ mK). These features will lead to the readout of large arrays of detectors or qubits with no noise degradation. In particular, this contribution will present the progress made so far in the design and development of a KITWPA as a weakly dispersive artificial transmission line by the DARTWARS collaboration.

Collaboration

DARTWARS

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