

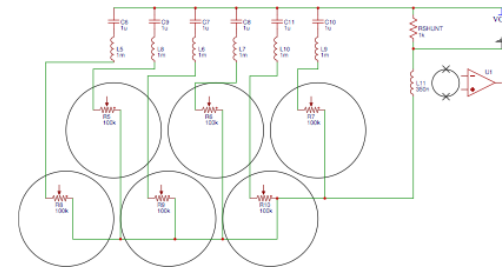
# A 16 channel frequency domain modulation readout system with custom superconducting LC filters for the SWIPE instrument of the balloon-borne LSPE experiment

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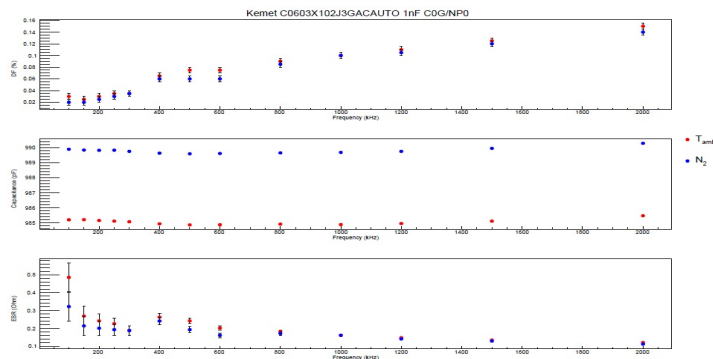


We present the design, implementation and first tests of the superconducting LC filters for the frequency domain readout of spiderweb TES bolometers of the SWIPE experiment on the balloon-borne LSPE mission. LSPE aims at measuring the linear polarization of the CMB at large angular scales to find the imprint of inflation on the B-mode CMB polarization.

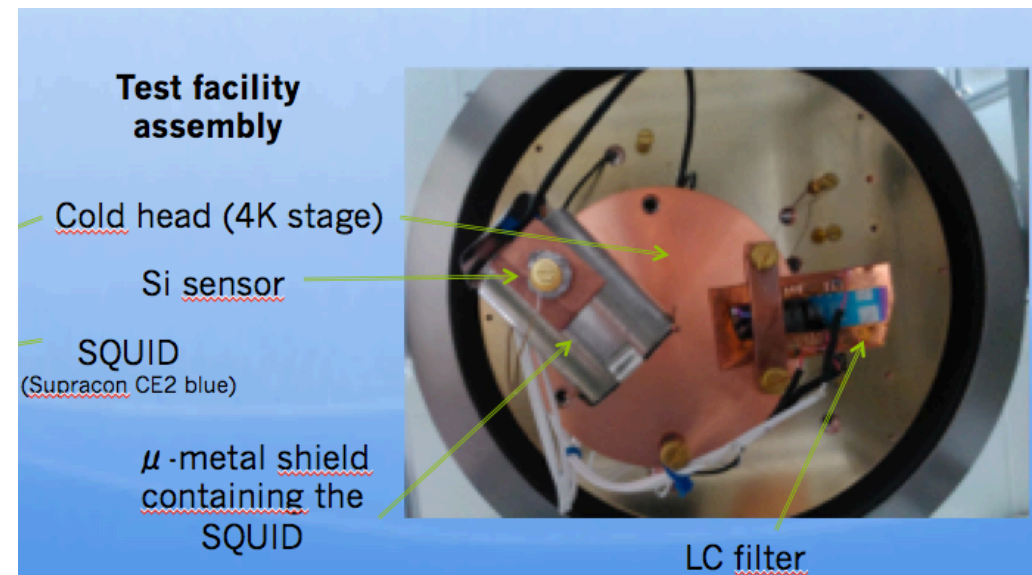
In SWIPE we will use a 16-channel multiplexing in the range 200 KHz–1.8 MHz. To guarantee a constant filter bandwidth,  $L \approx 20\div40 \mu\text{H}$  are designed. NP0/COG capacitors of  $220 \text{ pF} \div 30 \text{ nF}$  are being tested at cryogenic temperatures for final design.



Schematics of the bolometers readout scheme

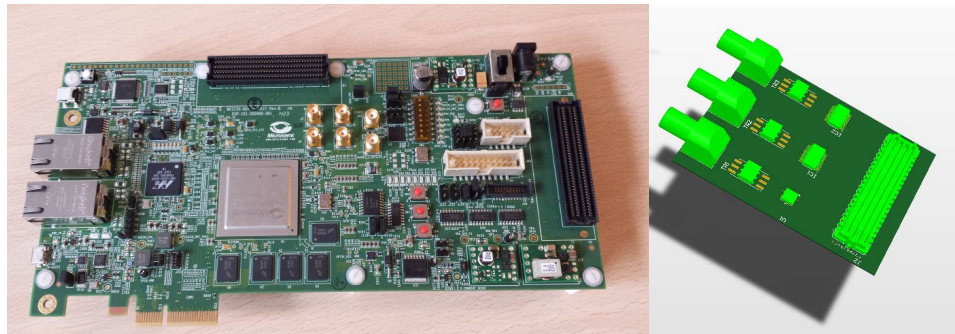
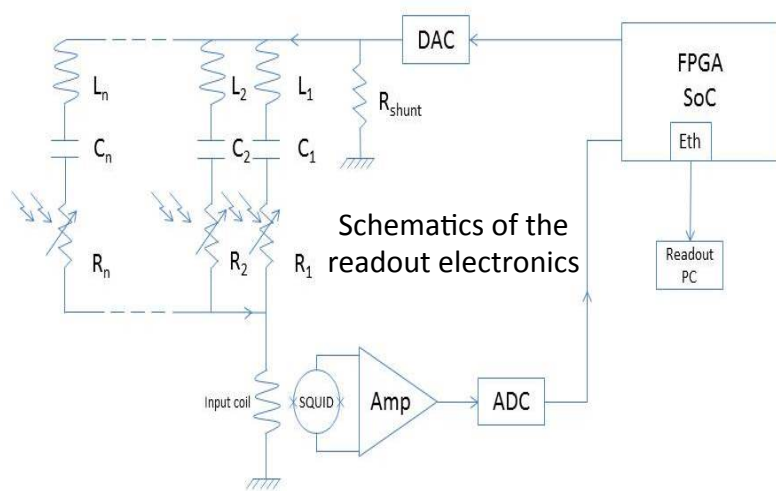


Test of a capacitor at room and cryogenic temperature. The first plot shows the dissipation factor, the second the capacitance, the third the equivalent series resistance as a function of the frequency



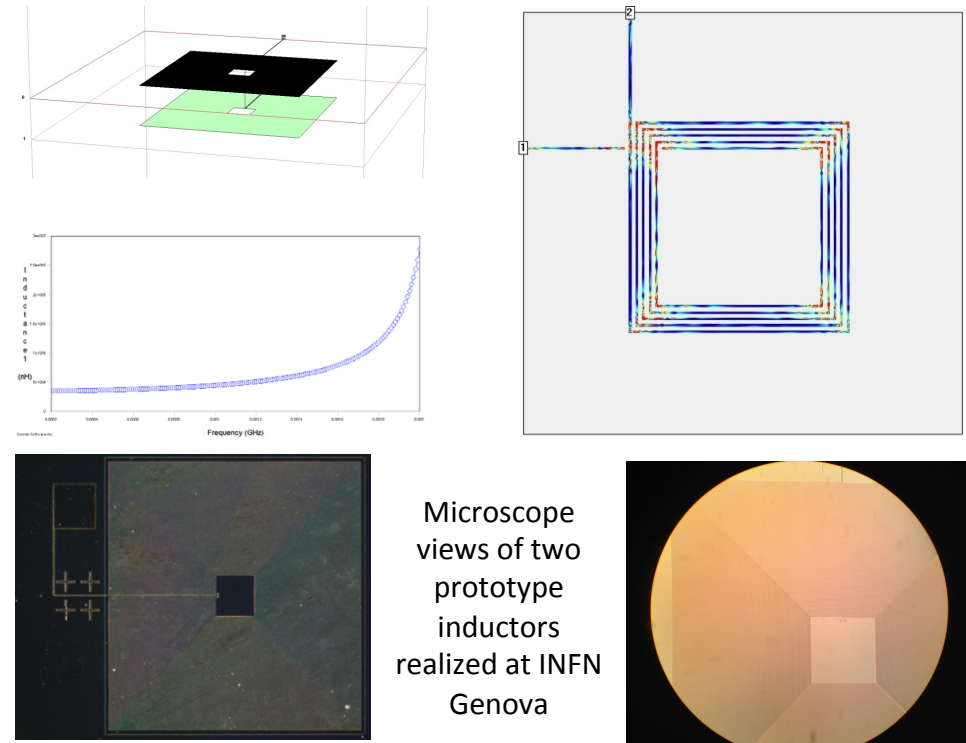
## Readout electronics

Bolometer bias carriers are synthesized on a FPGA, which performs demodulation and digitization of the bolometer outputs. The core of the system is a MicroSemi SmartFusion2 SoC, model M2S150. It includes a powerful FPGA core with 150K LUT and an ARM processor with 167 MHz speed. The chosen DAC (LTC1668) was selected for its low noise and low power properties, while the ADC will be an AD9266 with a sampling speed of 20 MHz.



SmartFusion2 demo board and design of the FDM interface mezzanine

SONNET simulation of a  $5\mu\text{m}$  niobium coil over a slit square washer showing the frequency dependent inductance and the maximum supercurrent



## LC filters

We designed and realized inductors consisting of a superconducting (Nb) coil deposited on and insulated from a slit square washer.

Detailed SONNET [4] simulations of spiral inductors showed that this design is suitable for our purpose.

Prototype Nb/SiO<sub>2</sub>/Nb inductors have been produced and are under test in our cryogenic facilities, where a complete readout chain (LC filter + SQUID amplification) is being set up.