## Introduction

- Johnson–Nyquist noise (thermal noise) is the electronic noise generated by the thermal agitation of the charge carriers inside an electrical conductor at equilibrium,
- which happens regardless of any applied voltage.
- Johnson noise for a resistor depends on temperature as predicted by the equation $\langle v^2_J(t)\rangle = 4k_BRT\Delta f$ also called the Johnson-Nyquist equation.
- Thermal noise is of great importance within receiver circuits where this form of noise along with other forms of noise limits the sensitivity of the receiver.
- This setup can be successfully used to calculate the Boltzmann constant which is related as $\langle v^2_J(t)\rangle = 4k_BRT\Delta f$.

## Methodology

- We studied the effect of temperature on Johnson noise by managing the temperature of the resistor at 77K, 126K, 212K and 298K with the help of liquid nitrogen and a heater.
- Measurement of temperature was assured with the help of a thermal probe which uses a 'Transdiode' as a transducer for thermal energy to electrical energy conversion.
- We also calibrated the thermal probe using the two-point calibration method.
- we plotted a graph between Johnson voltage and absolute temperature.

## Set up for the experiment

Left picture: Dewar flask containing liquid nitrogen along with Thermal Probe dipped inside it. The thermal probe is then connected to Low-level electronics as shown on the right side. Below is the image of high-level electronics which provides The final gain in signal as well as it contains a bandpass filter for our experiment.