

# 26th National Symposium on Cryogenics and Superconductivity

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## Design and characterization of a low noise amplifier operating at cryogenic temperature

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### Content :

Low noise amplifier (LNA) with a very high input impedance operating at cryogenic temperature is extensively used for the detection of weak RF signal in several real time physics experiments such as particle detector, NMR spectroscopy, scanning tunneling microscopy, high accuracy mass spectrometry (Penning/Paul trap) and beam instrumentation. At Variable Energy Cyclotron Centre (VECC) Kolkata, a cryogenic Penning ion trap facility, operating at 4K, is being developed [1]. This facility is mainly aimed to accelerate research in basic physics study using trapped charged particles. As per design of the VECC Penning ion trap facility, trapped electrons will be in dynamic equilibrium with its axial oscillation frequency  $\sim 63$  MHz and it will be measured by observing the weak image current ( $\sim 100$  fA) induced on trap electrodes. As the Penning ion trap assembly will be placed at 4K and the image signal is extremely weak, the LNA should be kept very close to the ion trap electrodes within the 4K cryostat. For this purpose an LNA has been indigenously developed at VECC [2] using GaAs pHEMT (ATF34143 from Avago Technologies), which is found to be compatible with cryogenic environment. A voltage gain  $\sim 4.3$  and an input noise voltage density  $\sim 2.3$  nV/Sqrt(Hz) are obtained at room temperature. For cryogenic testing we have developed a 77 K test set up before going for a 4K performance test. The test setup consists of a vacuum chamber placed within a cryogenic dewar filled with LN<sub>2</sub>. The LNA board is mounted on a metallic circular disc within the vacuum chamber and the required DC and RF signal are routed through vacuum feed throughs mounted on ISO-KF 40 flange. Simple RTD temperature sensor has been used to monitor the temperature of LNA circuit board. Measurement of voltage gain and input voltage noise density of the LNA at cryogenic temperature is in progress

### References:

- [1] P. Das et.al., "VECC Cryogenic Penning Ion Trap: A status report," in Proc. of the DAE Symp. on Nucl. Phys., 57, pp. 876-877, 2012.
- [2] Ashif Reza, Anuraag Misra and Parnika Das, "An improved model to predict bandwidth enhancement in an inductively tuned common source amplifier," Rev. Sci.

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