

# Calibration of a HTS Based LOX 400mm Level Sensor

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## Background

The measurement of cryogen level in cryostage of space crafts is very crucial. At the same time the weight of the sensor should be less as it affects the payload fraction of the space craft. An attempt to develop HTS based level sensor of 400 mm for LOX measurement was made. In the initial phase of testing, loss of superconductivity of HTS wire in LOX inside a cryostat was noticed. Thus, a new four wall cryostat was designed to have stable LOX level to provide thermal stability to HTS based LOX sensor. The calibration of developed sensor is carried against pre-calibrated capacitance type Triple Redundant Level Sensor (TRLS) to verify its linearity and performance for different current excitation levels. The automatic data logging was accomplished using a program developed in LabVIEW 11.0.

## Description

- The resistance of HTS wire varies inversely for changes in cryogen level and exhibits linearity. Hence, forms a reliable HTS cryo level sensor.
- Superconductivity loss was observed during initial calibration with LOX due to heat transfer, thus a 4-wall cryostat is fabricated to address the issue.
- The final calibration of HTS wire based 400mm level sensor was carried out against pre-calibrated triple redundant capacitance level sensor using LOX and LN<sub>2</sub> as cryogens.

## Conclusions

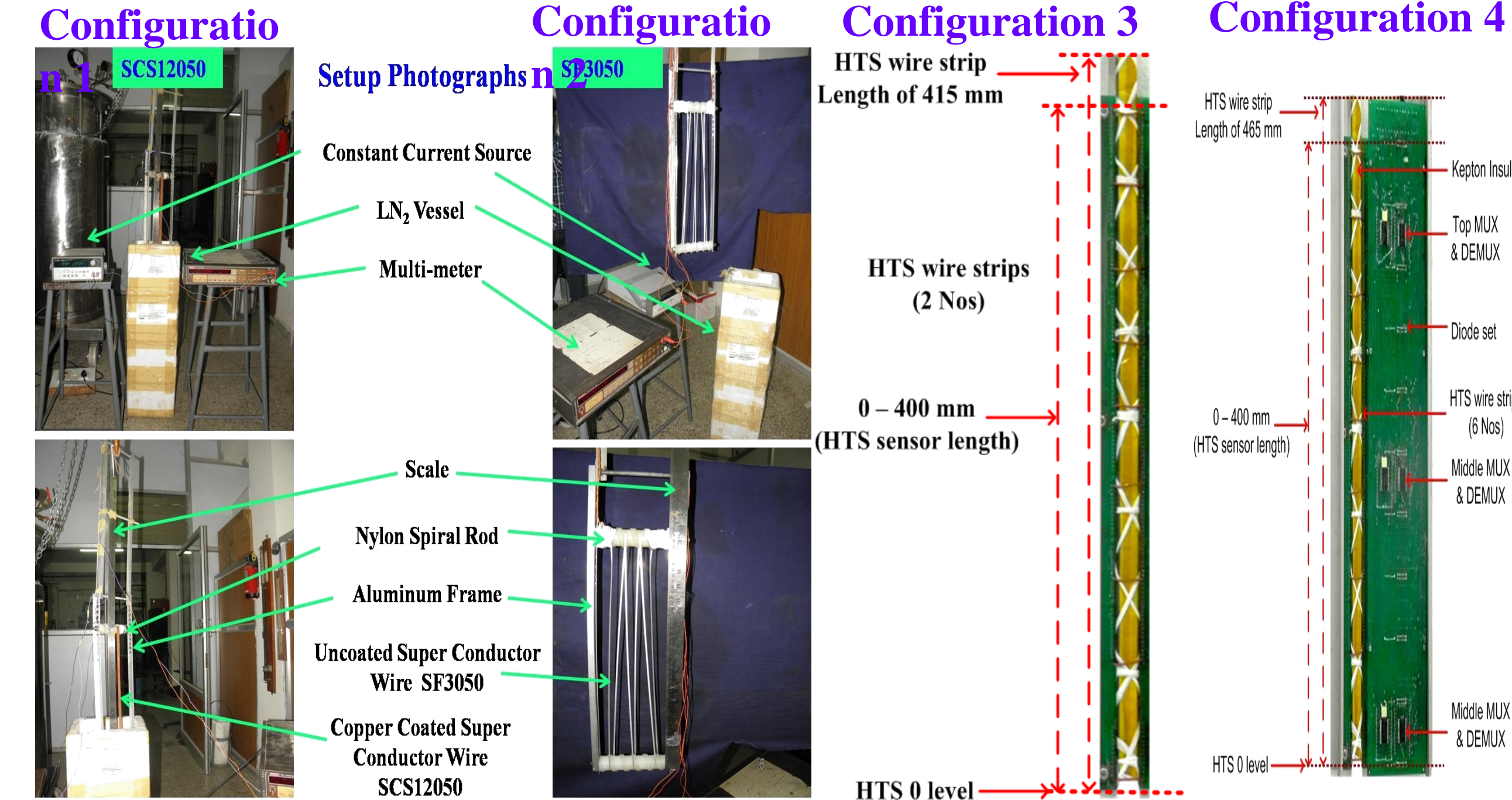
- The HTS based level sensor shows a linear response both in LOX and LN<sub>2</sub>.
- The calibration was carried for the entire length of 400mm.
- The weight of the sensor is less than 0.5 kg which is a major advantage.
- The behavior of sensor was found to be stable for 3A and 4A constant DC current for LOX and 5A for LN<sub>2</sub>.
- The capacitance has a sensitivity of 0.26pF/mm in LOX and 0.23pF/mm in LN<sub>2</sub>.
- The developed HTS level sensor has the sensitivity of 17.66 mV/pF (4.591 mV/mm) and 27.078 mV/pF (7.04 mV/mm) for 3 A and 4 A excitation current respectively in LOX whereas in LN<sub>2</sub> the sensitivity is 42 mV/pF (9.8mV/mm) for 5A.

## Acknowledgment

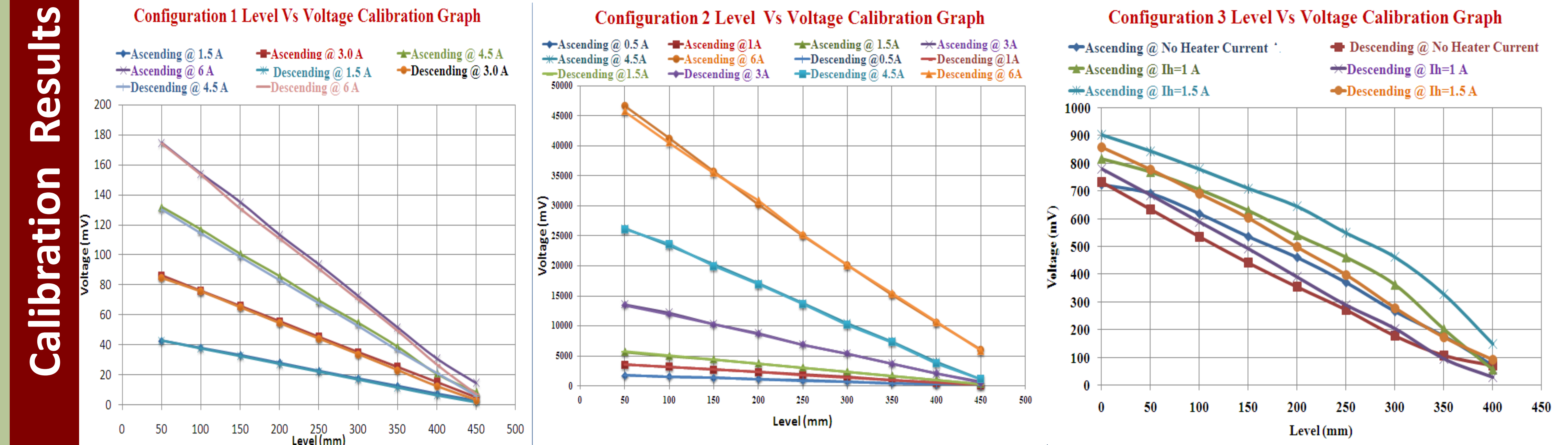
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## HTS Wire Specifications

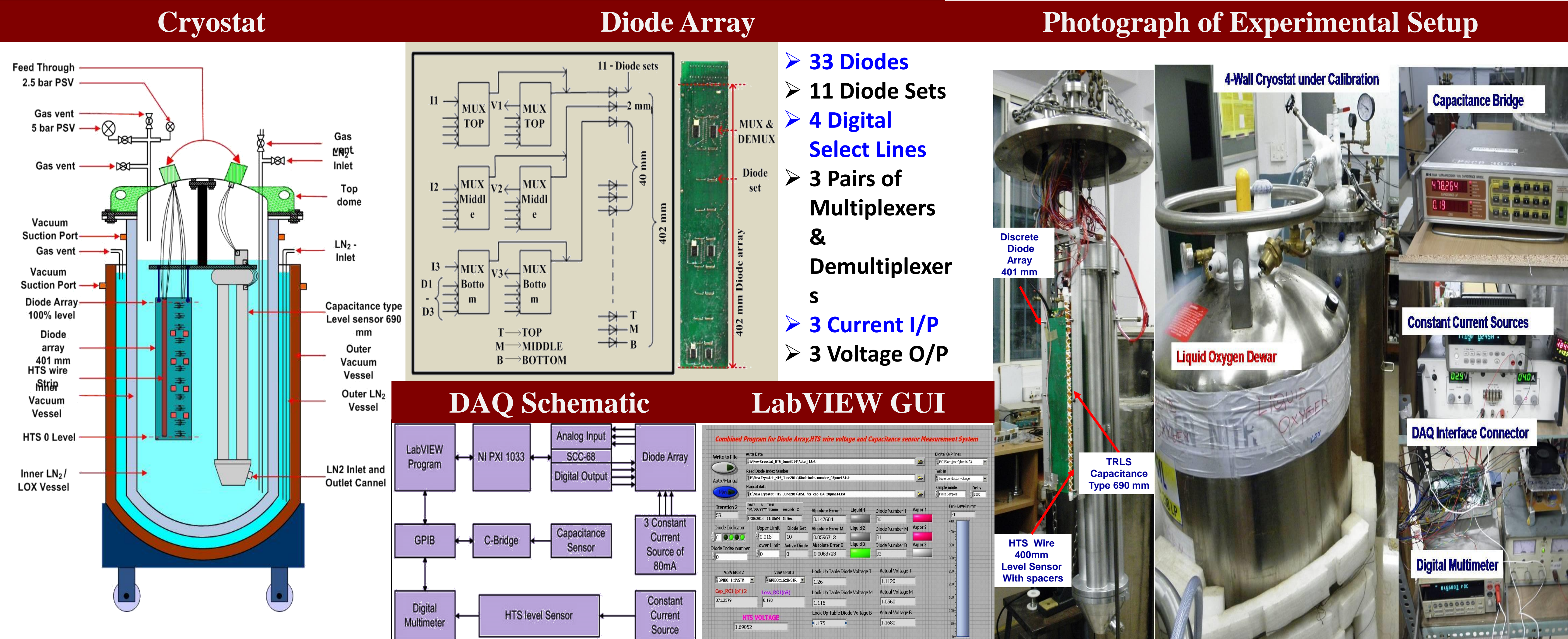
Parameters	Configuration 1	Configuration 2	Configuration 3	Configuration 4
Model Number	SCS12050	SF3050	SF12100	SF12100
Minimum Ic (A)	240	60	200	200
Width (mm)	12	3	12	12
Total Wire	0.055	0.055		
Thickness (mm)			0.105	0.105
Critical Bend Diameter (mm)	11	11	25	25
Stabilizer	Copper	None	None	None
Soldering Temperature (K)	<520	<520	<520	<520
Critical Temperature (K)	77	77	77	77
Length Used (m)	1	3	0.83	2.76



## HTS Wire Configuration in LN<sub>2</sub>



## Setup Description



## Calibration Procedure

- The ascending calibrations of HTS wire against pre-calibrated capacitance type level sensor have been carried out at constant flow rate of 1 lit/min and maintaining a constant inner pressure of 0.2 bar throughout the experiment.
- Changes in the capacitance and voltage values were recorded continuously for the full active length of capacitance sensor.
- The experiment was repeated for different excitation current ratings i.e. 3A and 4A for LOX and 5A for LN<sub>2</sub>.
- It has been observed that for different levels of LOX and LN<sub>2</sub>, the voltage across the HTS wire is changing linearly.
- A straight line has been fit to the obtained curves to arrive at standard mathematical equations for computational purposes.

## Calibration Graphs in LOX and LN<sub>2</sub>

Calibration graph of HTS level sensor voltage versus TRLS capacitance level sensor capacitance carried out using LOX and LN<sub>2</sub> as cryogens, with a filling rate of 1lit/min with a linear curve fit for 3Amps and 4Amps for LOX and 5Amps for LN<sub>2</sub>.

