Second Sound Measurement using SMD Resistors as Simulated Quench Locations on the 704 MHz Single-cell SPL Cavity at CERN

I. INTRODUCTION
- Second sound behavior has been studied through different surface mount (SMD) resistors setups on a Superconducting Proton Linac (SPL) test cavity, to help understanding the underlying physics and improve quench localization.
- Oscillating Superleak Transducer (OST) contains a flexible porous membrane for transmitting and blocking the movement of the superfluid and normal fluid component of the second sound wave.
- Theoretically, second sound travels at V~ 20 m/s in superfluid Helium at ~1.8 K.
- In principle, triangulation method can be used to localize a quench by constructing circles using the constant second sound speed and measured time-of-flight to each OST.

III. QUENCH LOCALISATION
- First Quench Event on the SPL test cavity - at 3.1 MV/m, 2 K during helium processing, 28 µs breakdown time
- Triangulation
  \[ S = V \times \text{time-of-flight} \]
  (S: diameter of the sphere)
- Minimisation Method
  \[ f = \sum_i \left( \left( x_i - x_{\text{OST}} \right)^2 + \left( y_i - y_{\text{OST}} \right)^2 + \left( z_i - z_{\text{OST}} \right)^2 \right) \]
- Search for ‘Fast Second Sound’
  - increase power that goes into the SMD heater (max only 6 W)
  - an appropriate source to simulate a quench is needed

IV. SECOND SOUND DETECTION IMPROVEMENT
- OST Arrangement – second sound amplitude is at its maximum when \( d_{\text{heater-OST}} \approx 9 \text{ cm} \)
- OST Blind Spots – heater source not within OST membrane’s coverage angle, no signal is detected
- Second Sound Reflection – bent tubes receive signals with attenuated amplitudes compared with the straight tube.
- This can be applicable to complicated cavity structures

V. FUTURE WORK
- The OSTs have observed second sound reflection. This makes them applicable for complicated cavity structures.
- It is crucial to search for possible sources as simulated quench locations for understanding the heat transfer mechanisms.
- Cavity quench tests on the SPL test cavity will be continued after an electropolishing process. Furthermore, new SPL cavity prototypes are awaited to be examined.