

K. Liao*, D. Brunner, E. Ciapala, T. Junginger, W. Weingarten, CERN, Geneva, Switzerland

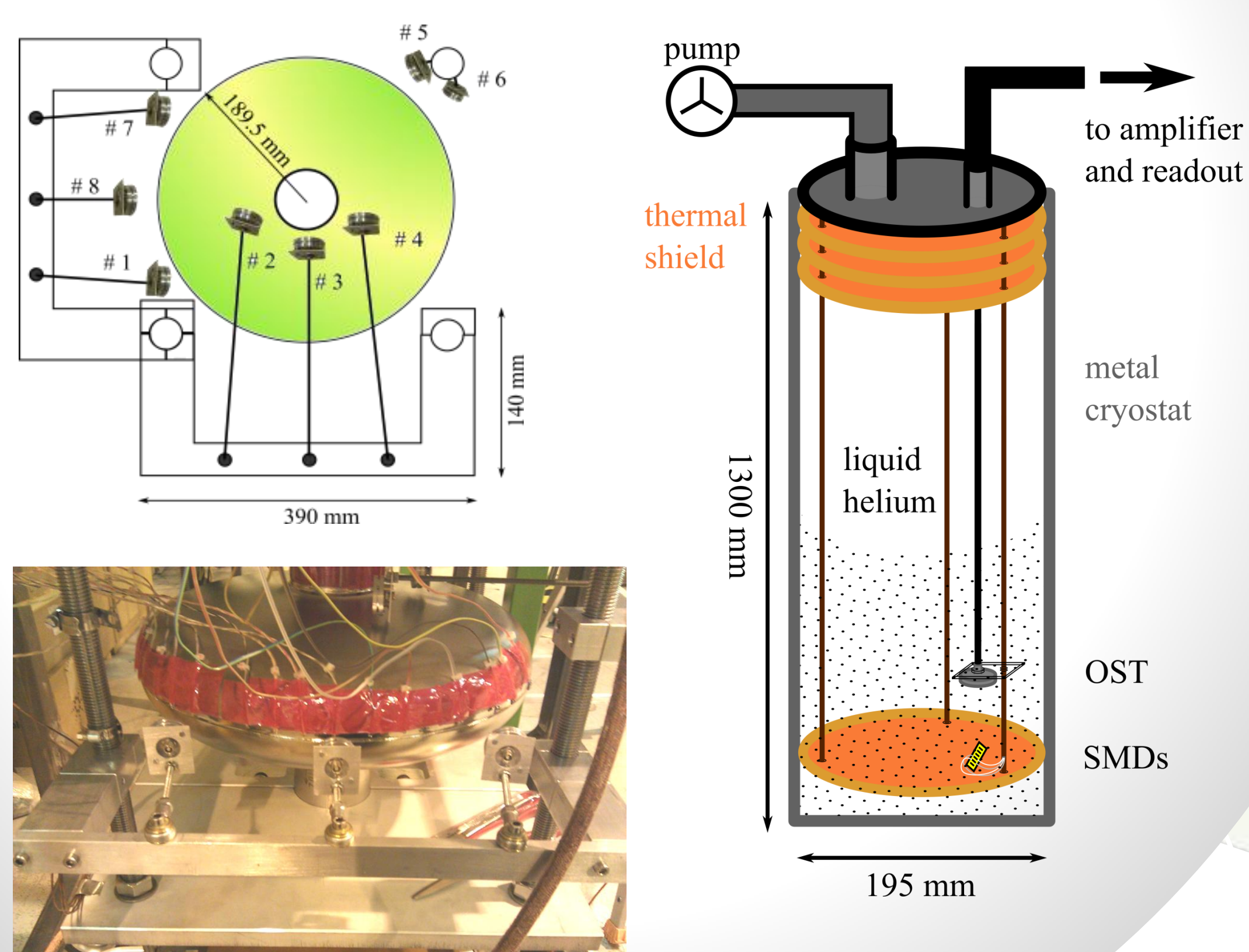
I. INTRODUCTION

- ❖ Second sound behaviour 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 localisation.
- ❖ 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 $V \sim 20$ m/s in superfluid Helium at ~ 1.8 K.
- ❖ In principle, triangulation method can be used to localise a quench by constructing circles using the constant second sound speed and measured time-of-flight to each OST.

OST 1

II. EXPERIMENTAL SETUPS

- ❖ 27 quench locations on the cavity using Surface Mount Device (SMD) – thick film resistors,
- ❖ 8 OSTs

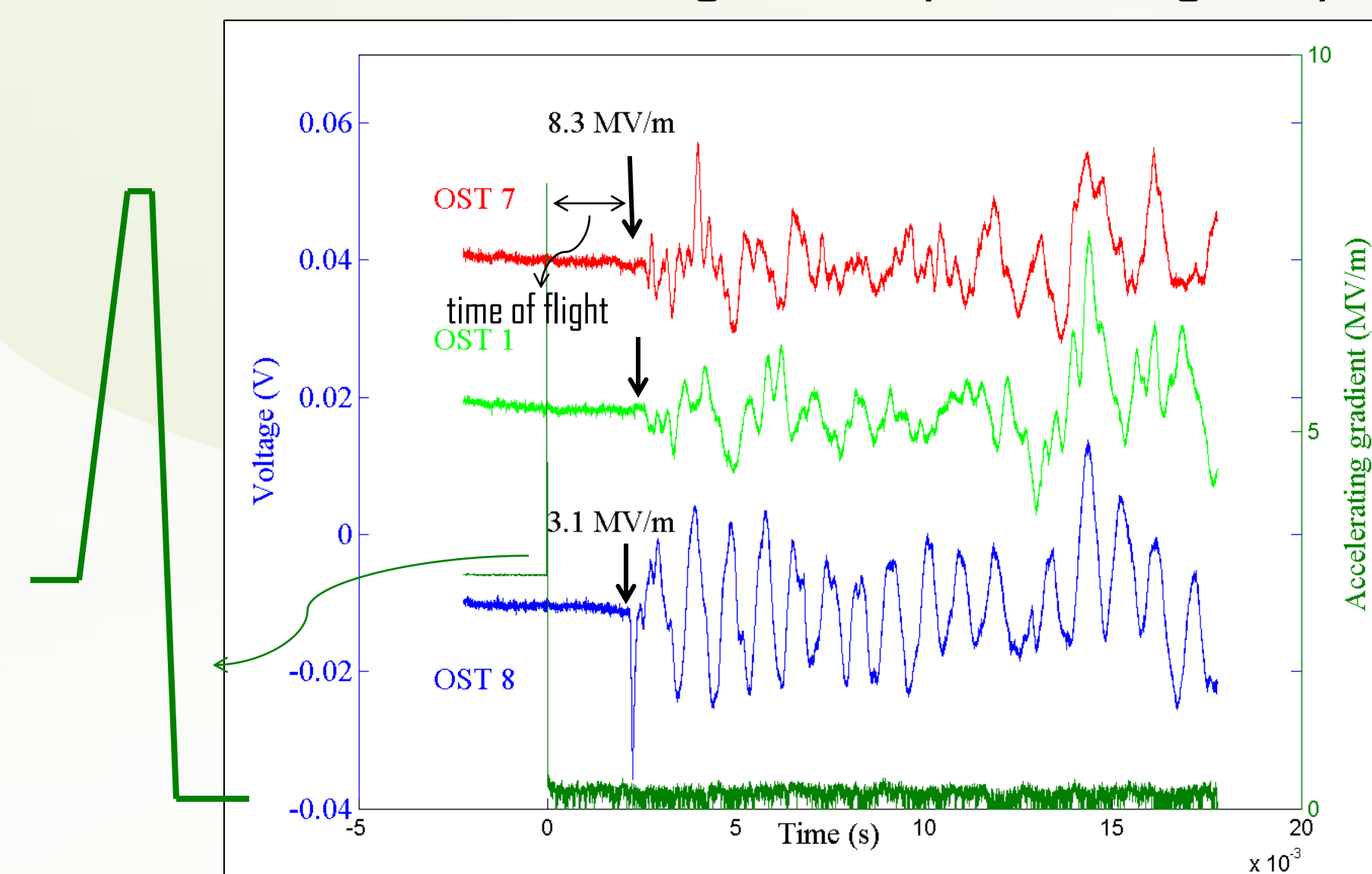


OST 2

SPL Cavity

III. QUENCH LOCALISATION

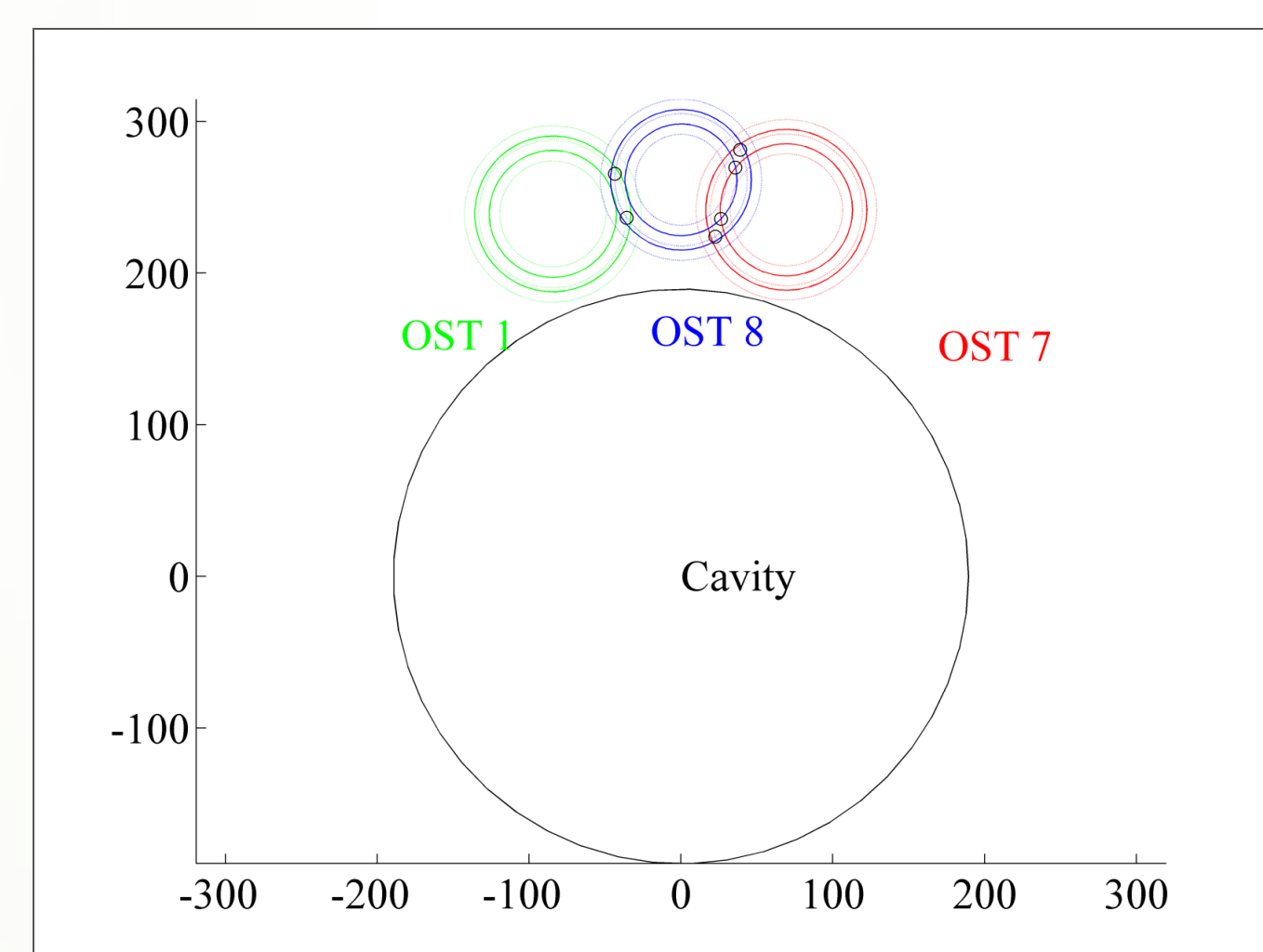
- ❖ First Quench Event on the SPL test cavity
– at 3.1 MV/m, 2 K during helium processing, 28 μ s breakdown time



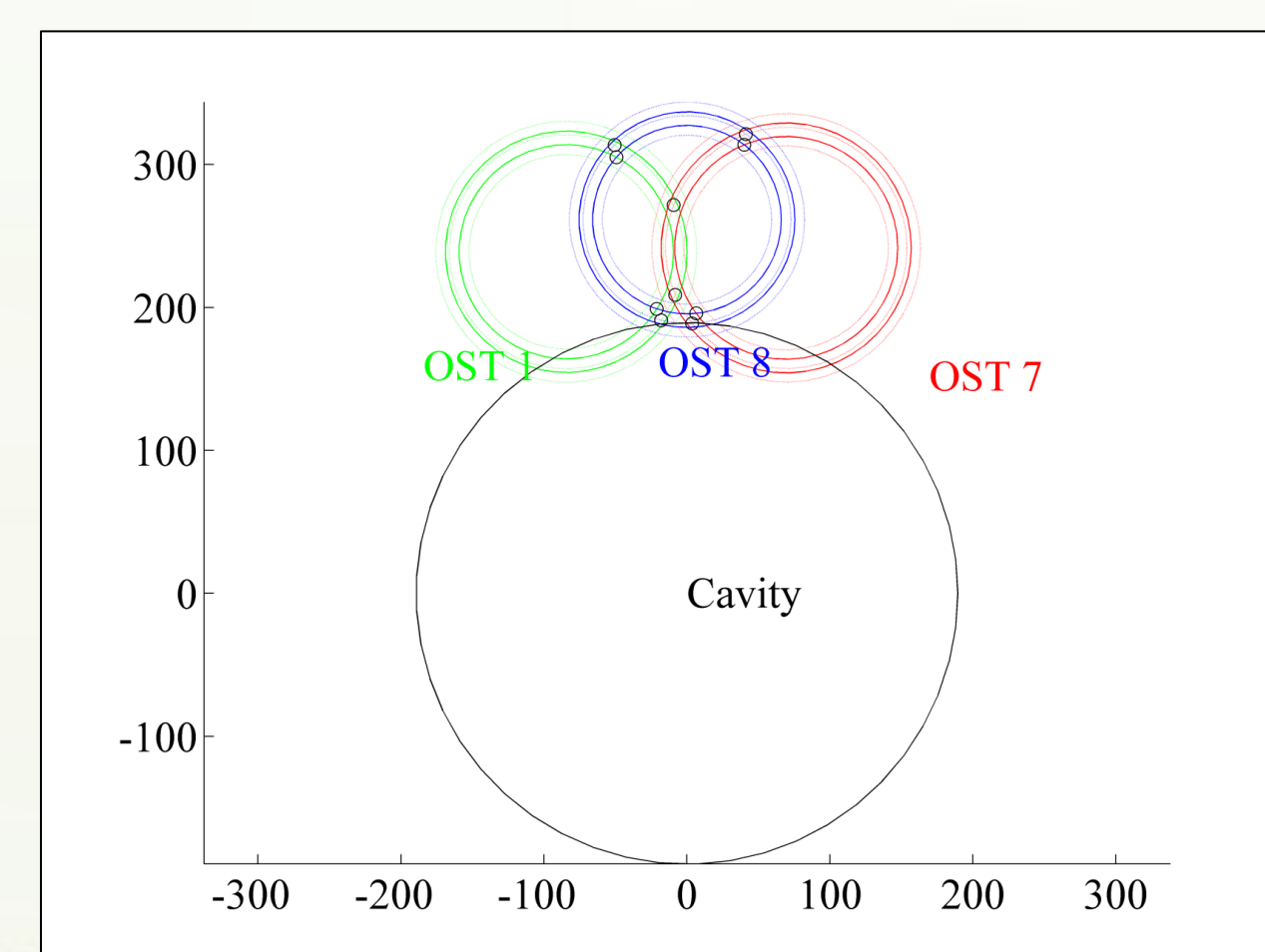
- ❖ Triangulation

$$S = V \cdot \text{time-of-flight}$$

(S: diameter of the sphere)



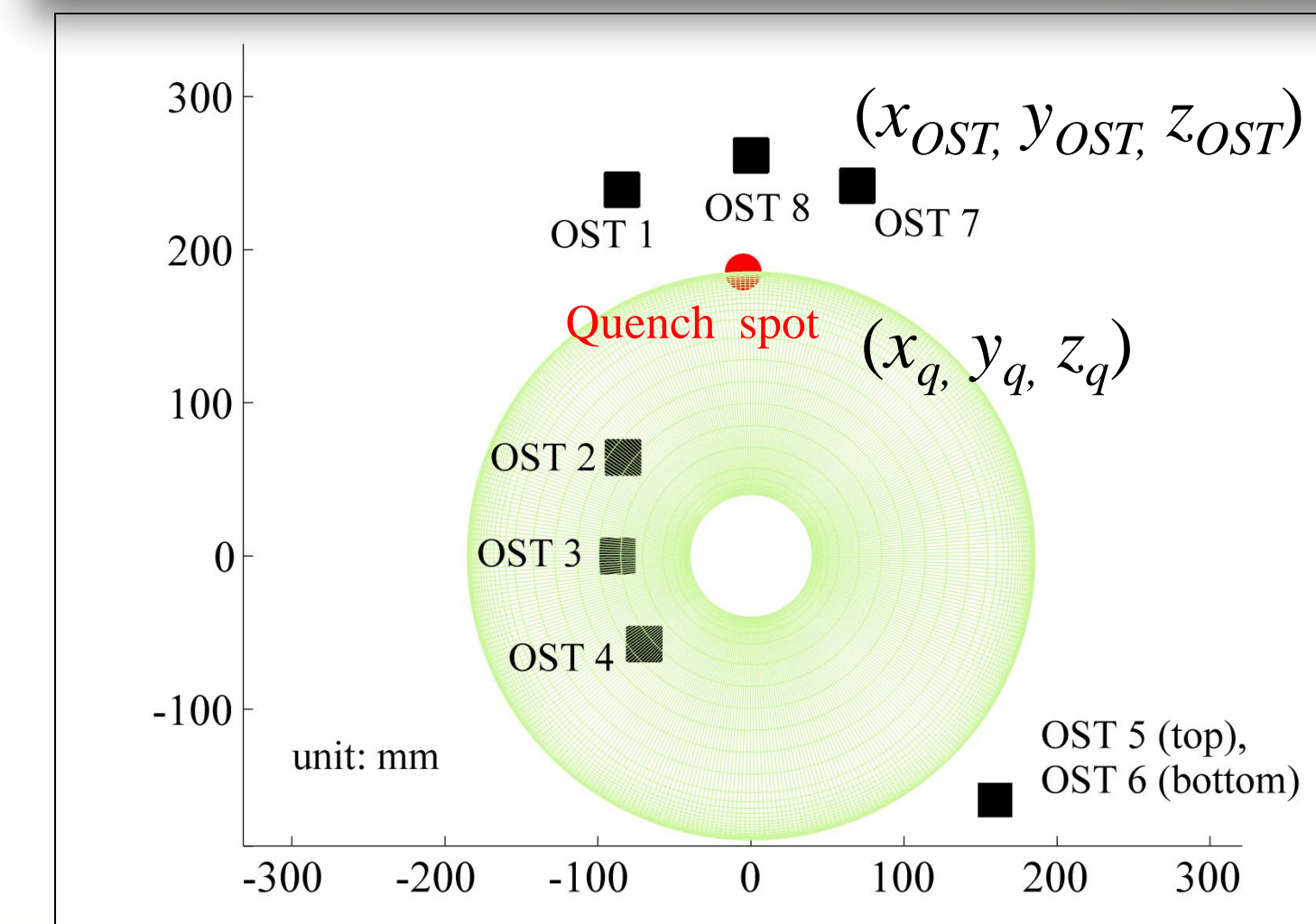
- ❖ $V \sim 30$ m/s Triangulation
– derived from the minimisation method
– an intersection area instead of a point



- ❖ Minimisation Method¹

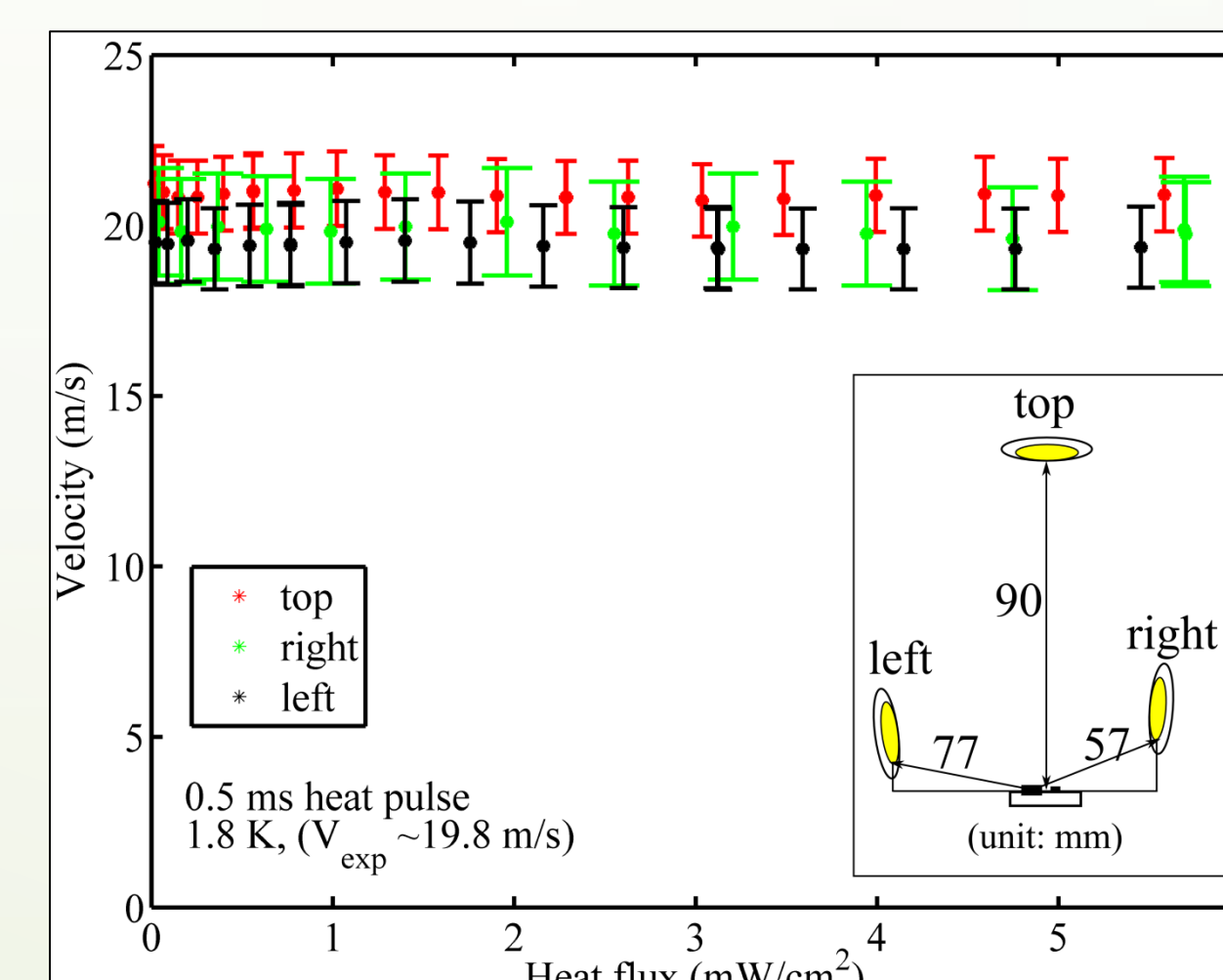
$$v^2 \cdot t^2 = (x_q - x_{OST})^2 + (y_q - y_{OST})^2 + (z_q - z_{OST})^2$$

$$\sum_{i=1}^n [(x_q - x_{OST_i})^2 + (y_q - y_{OST_i})^2 + (z_q - z_{OST_i})^2 - v^2 \cdot t_i^2] = f(x_q, y_q, z_q)$$



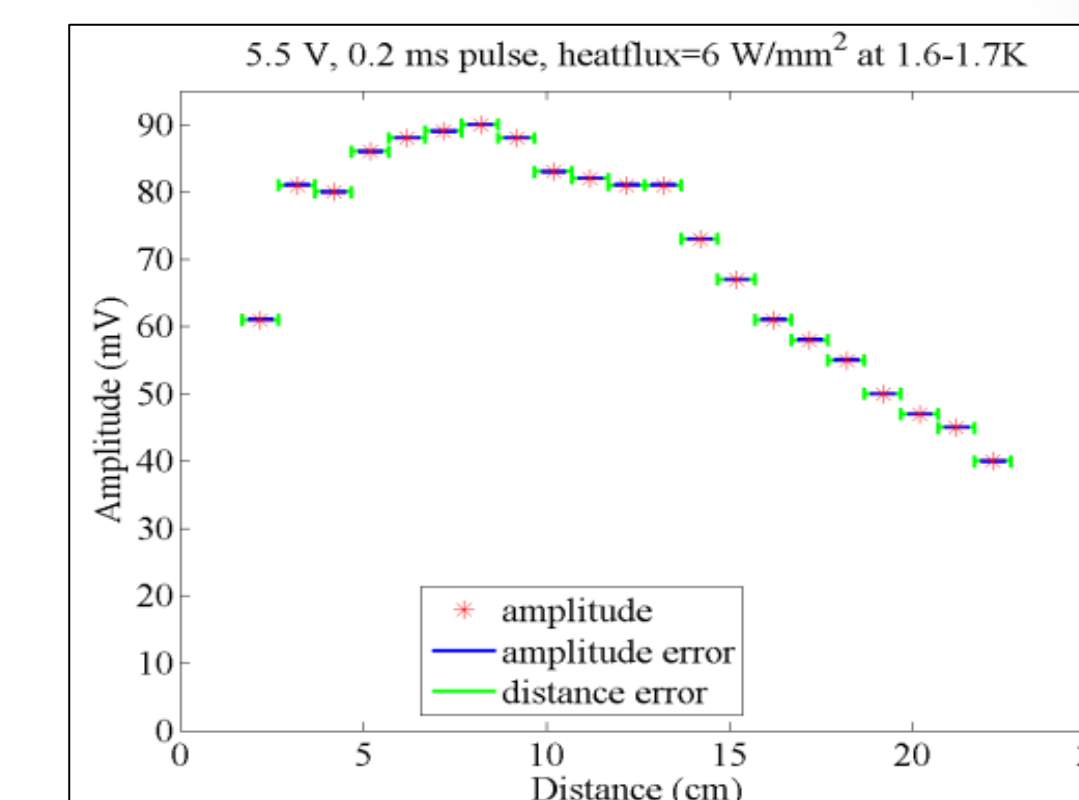
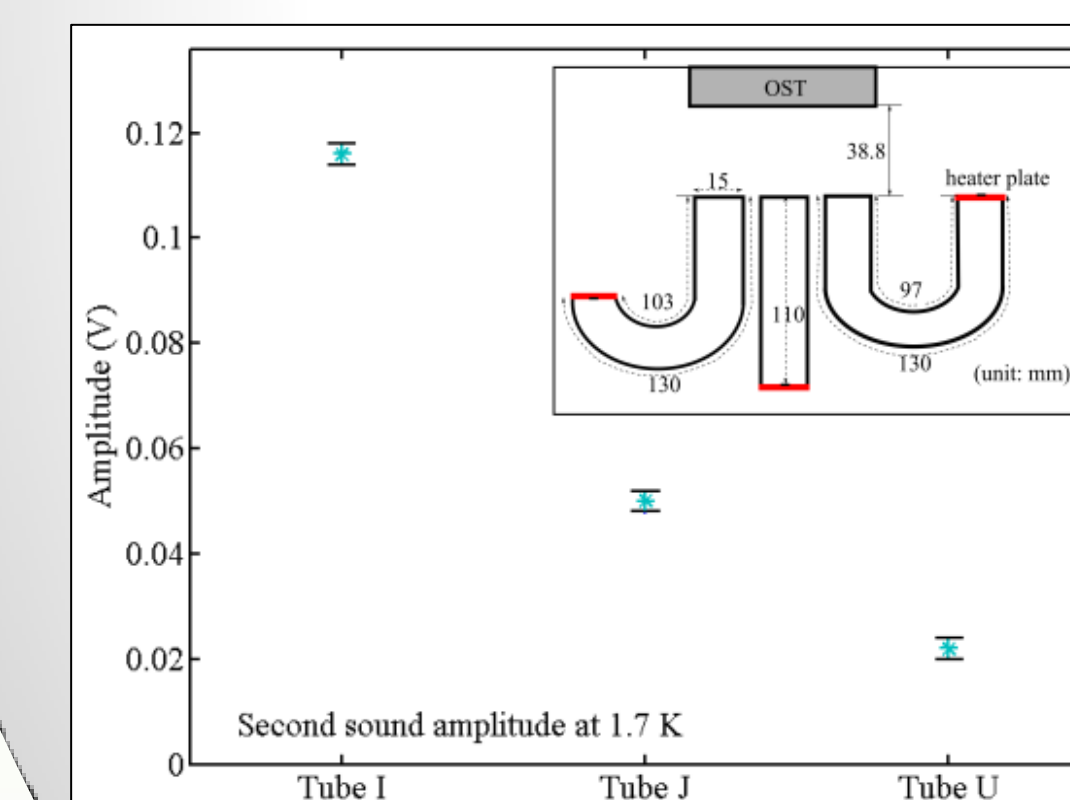
- ❖ Search for 'Fast Second Sound'

- 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 $d_{heater-OST} \sim 9$ cm
- ❖ OST Blind Spots – heater source not within OST membrane's coverage angle, no signal is detected.



- ❖ Second Sound Reflection – bent tubes receives signals with attenuated amplitudes compared with the straight tube.
- ❖ This can be applicable to complicated cavity structures.



- ❖ OST protection caps made of silicone prevent damage and pollution to the membrane during system installation.

OST 3

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.

OST 4

*Kitty.Liao @ CERN.CH

¹Y. Maximenko, et al., Fermilab tech. report TD-II-152 (2011)