Commissioning Cornell OSTs for SRF cavity testing at JLab

G. Eremeev, TJNAF, Newport News, U.S.A.

ABSTRACT: Understanding the current quench limitations in SRF cavities is a topic essential for any SRF accelerator that requires high fields. This understanding crucially depends on quench localization. Second sound quench detection in superfluid liquid helium with oscillating superleak transducers is a technique recently applied at Cornell University as a fast and versatile method for quench localization in SRF cavities. Having adopted Cornell design, we report in this contribution on our experience with OST for quench localization in different cavities at JLab.

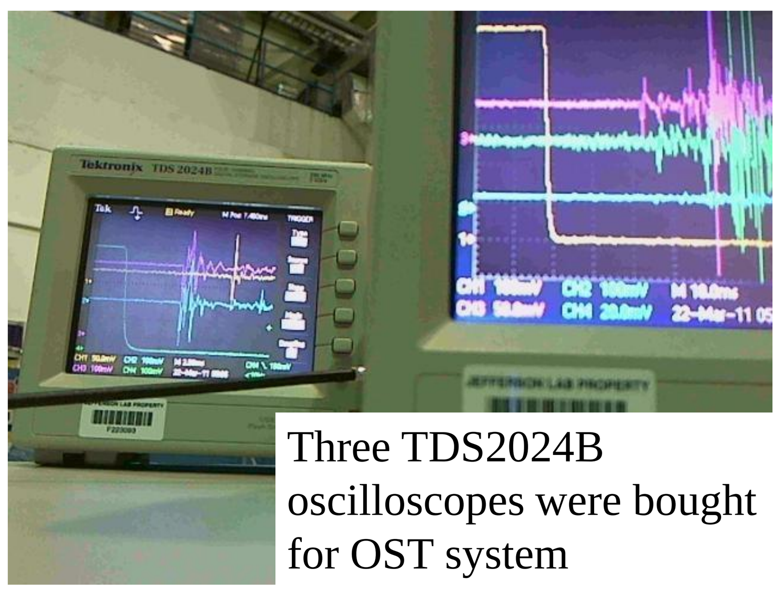
ILC cavity testing

9-cell cavity with OST sensors attached to the cage.

Second sound quench detection system in superfluid helium has been duplicated at Jlab from Cornell design. At Jlab we have 16 oscillating superleak transducers (OST) sensors kindly provided to us by Dr. Zachary Conway. JLab cavity cage provides an excellent fixture for OSTs attachment.

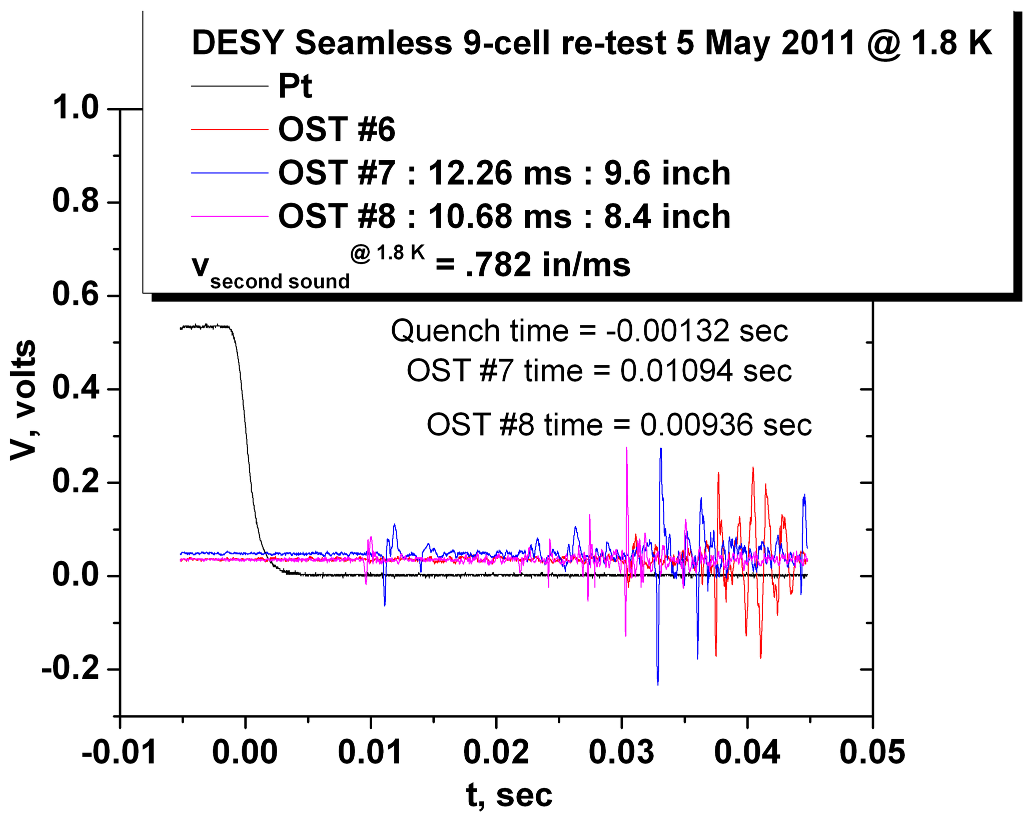
OST amplifier

Web camera screenshot of TDS2024B oscilloscopes

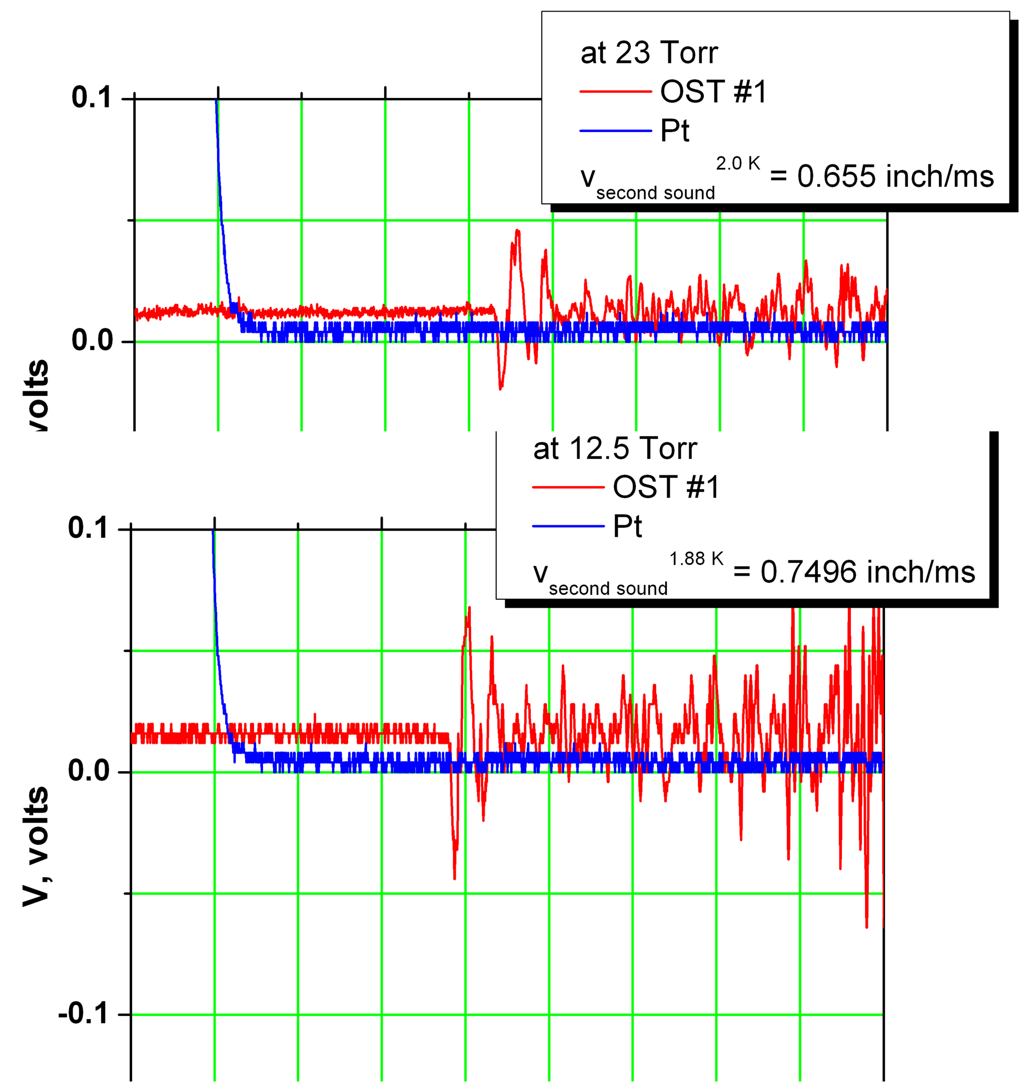


Three TDS2024B oscilloscopes were bought for OST system

DESY Seamless 9-cell π mode



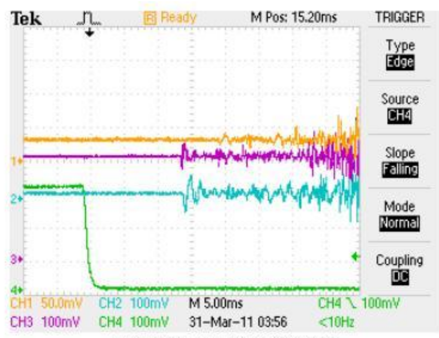
Second sound system was routinely used for SRF testing of 9-cell cavities since September 2010. In several cases we found and marked all limiting defects for all pass-bands in a single RF test. In general , OST signals converge to an area of about 1 inch in diameter.

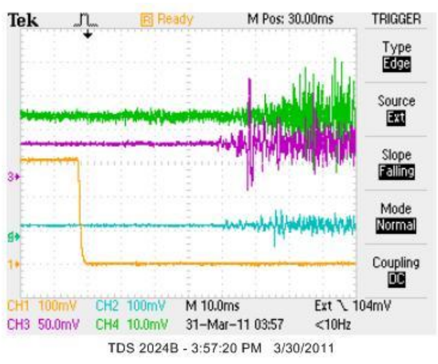


Typically, second sound measurement is done with 8 sensors attached to the cage around the cavity. Although the standard ILC RF testing is done at 2.0 K, we found that we get better resolution with OSTs at 1.8 K, so we often cool down to 1.8 K to do second sound quench detection.

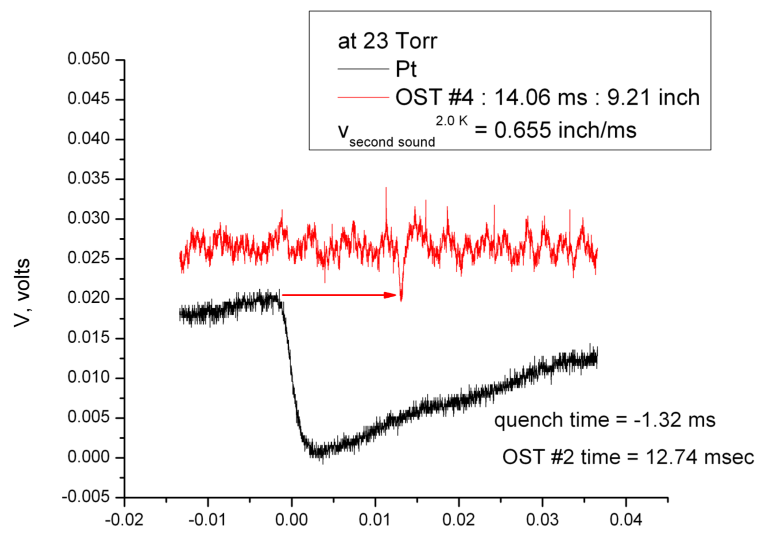
Experience with other cavity shapes

We have located π mode quench in MHI #8 and ICHIRO #7. In the picture below we show OST traces for π mode quench in MHI #8 and location of the quench on the cavity surface.

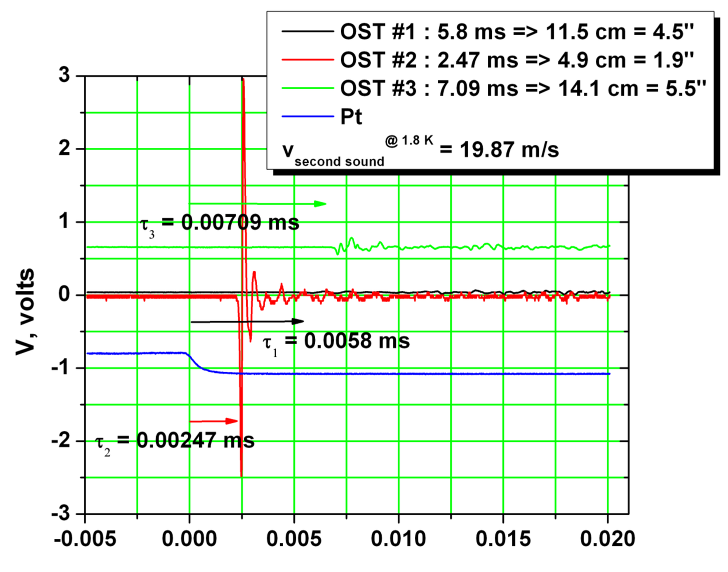




OST signal during Crab cavity repetitive quench. We could not triangulate quench location, because only one sensor showed reproducible signal.



OST signals during π mode quench in 3 ½ gun cavity



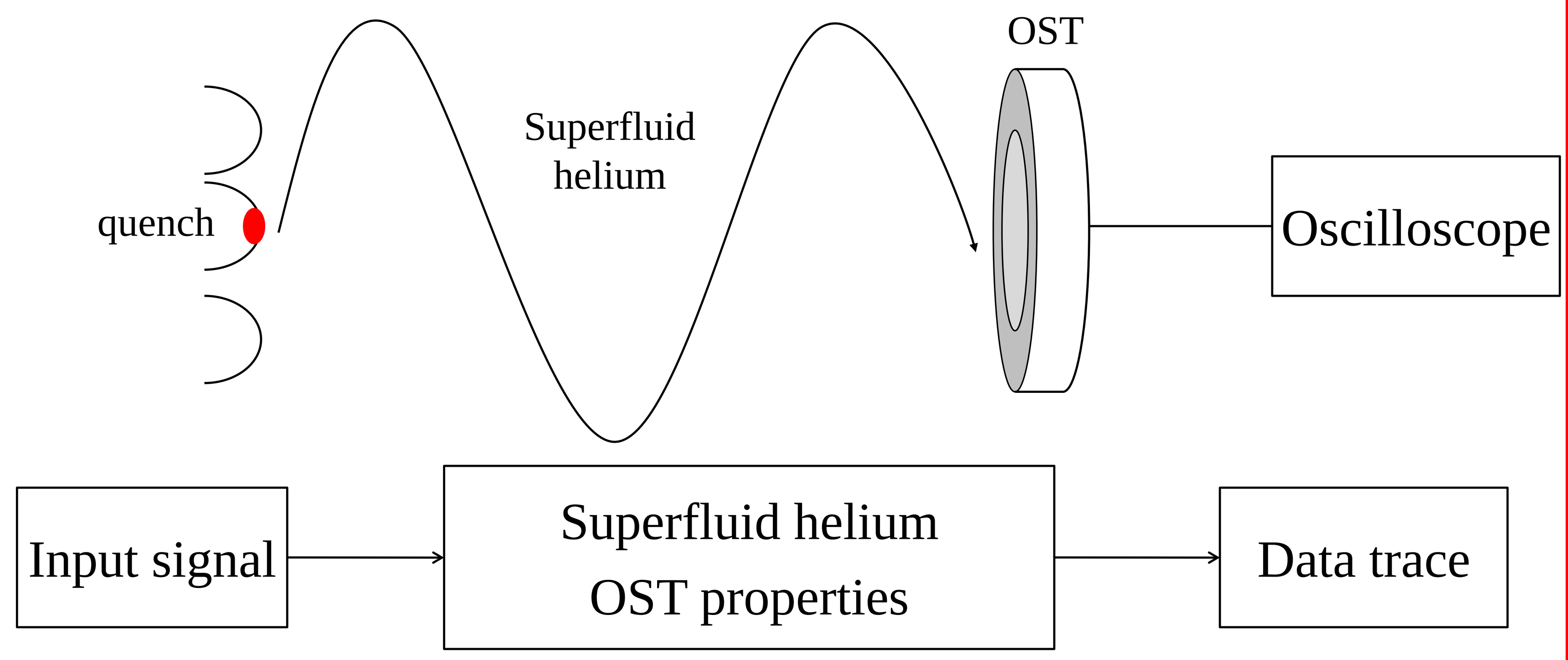
In order to be able to resolve low energy quenches, sensor sensitivity need to be improved and sensor response need to be better understood.

Future plans

We are considering two possible future developments at JLab. One possible direction is to build OST sensors in house and to modify design of OST sensors to improve sensitivity. The other direction is analysis and simulation of OST response.

We have made several oscillating superleak transducers following Cornell design

We have observed that second sound signals on oscilloscopes are very reproducible, which suggest that noise plays little role in OST traces, and that the signal is a function of quench, superfluid helium, and OSTs properties. Via simulation we may be able to go beyond time of flight measurements and deduce quench properties to obtain better location resolution.



Conclusions

Understanding the current quench limitations in SRF cavities is a topic essential for any SRF accelerator that requires high fields. This understanding crucially depends on quench localization. Second sound quench detection in superfluid liquid helium with oscillating superleak transducers is a technique recently applied at Cornell University as a fast and versatile method for quench localization in SRF cavities. Having adopted the Cornell design, we routinely use OSTs for quench localization in different cavities at JLab. Usually, with the standard-shape ILC cavities OST signals converge to an area of about 1 inch in diameter. Possible future directions are modifications of the Cornell design to improve sensitivity and analysis and simulation of the data to improve resolution.

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Jefferson Lab
Thomas Jefferson National Accelerator Facility