Second Sound As Diagnostic For Quenches In Super Conducting RF Cavities

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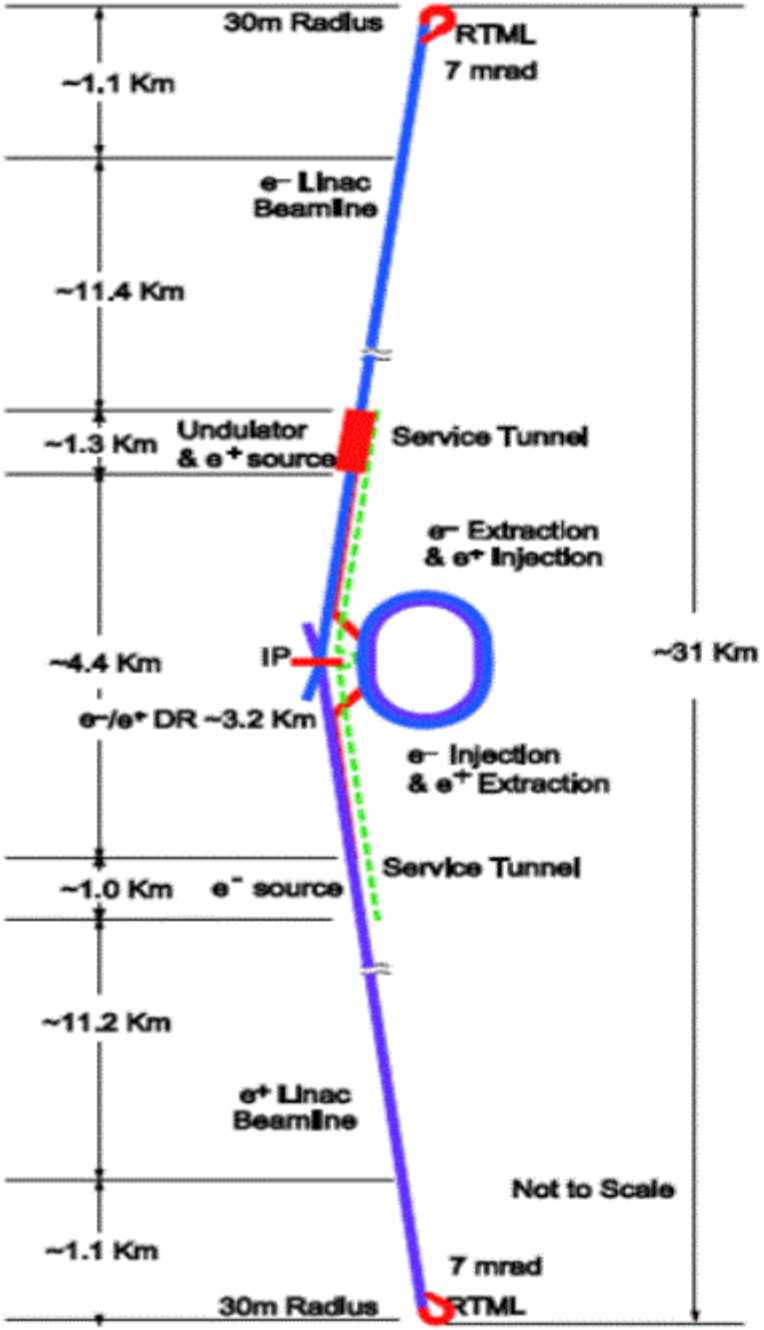


THE INTERNATIONAL LINEAR COLLIDER

→ MAJOR FUTURE APPLICATIONS OF SUPERCONDUCTING RADIO FREQUENCY CAVITIES.

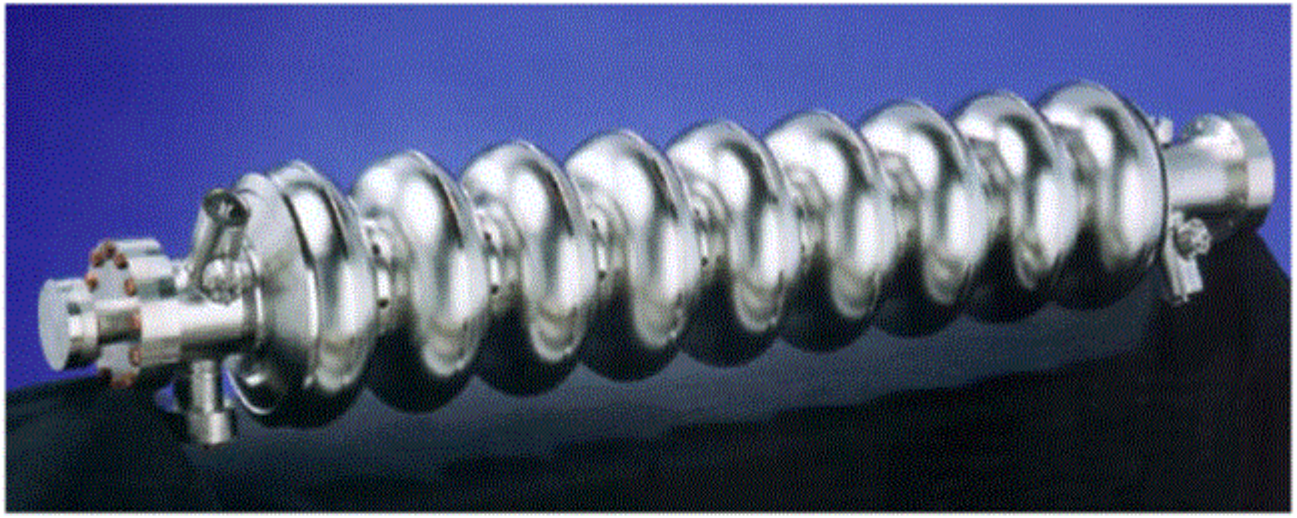
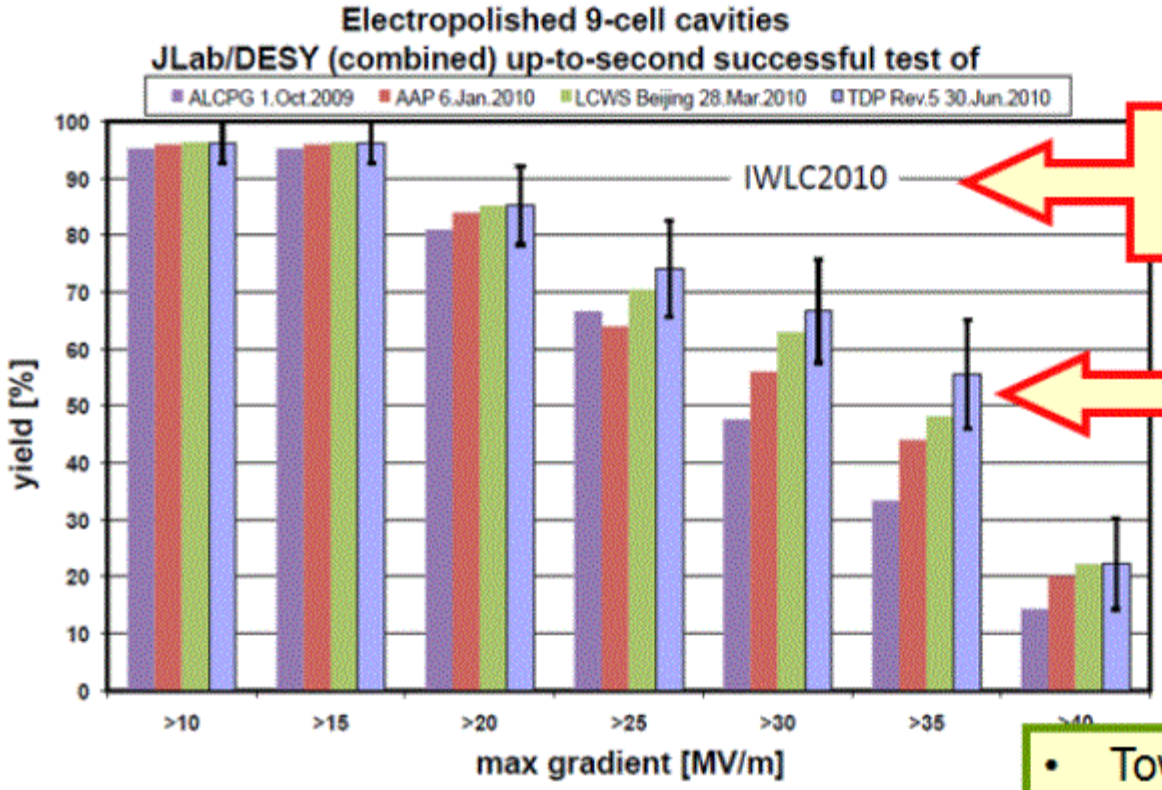


Figure 1.2-1: A TESLA nine-cell 1.3 GHz superconducting niobium cavity.

- SRF TECHNOLOGY ENABLES
  - ILC
  - XFEL

→ HIGH ACCELERATING GRADIENT ~ 40 MV/m
→ HIGH Q_0 VALUES $> 10^{10}$
→ LOW POWER DISSIPATION

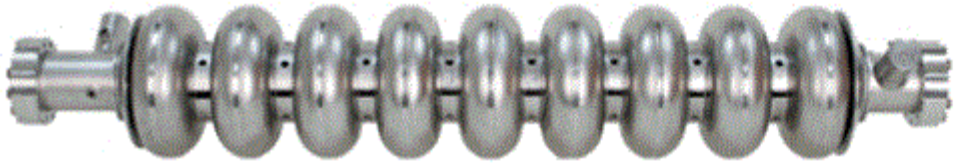
Cavity Gradient Milestone Achieved



TDR Goal

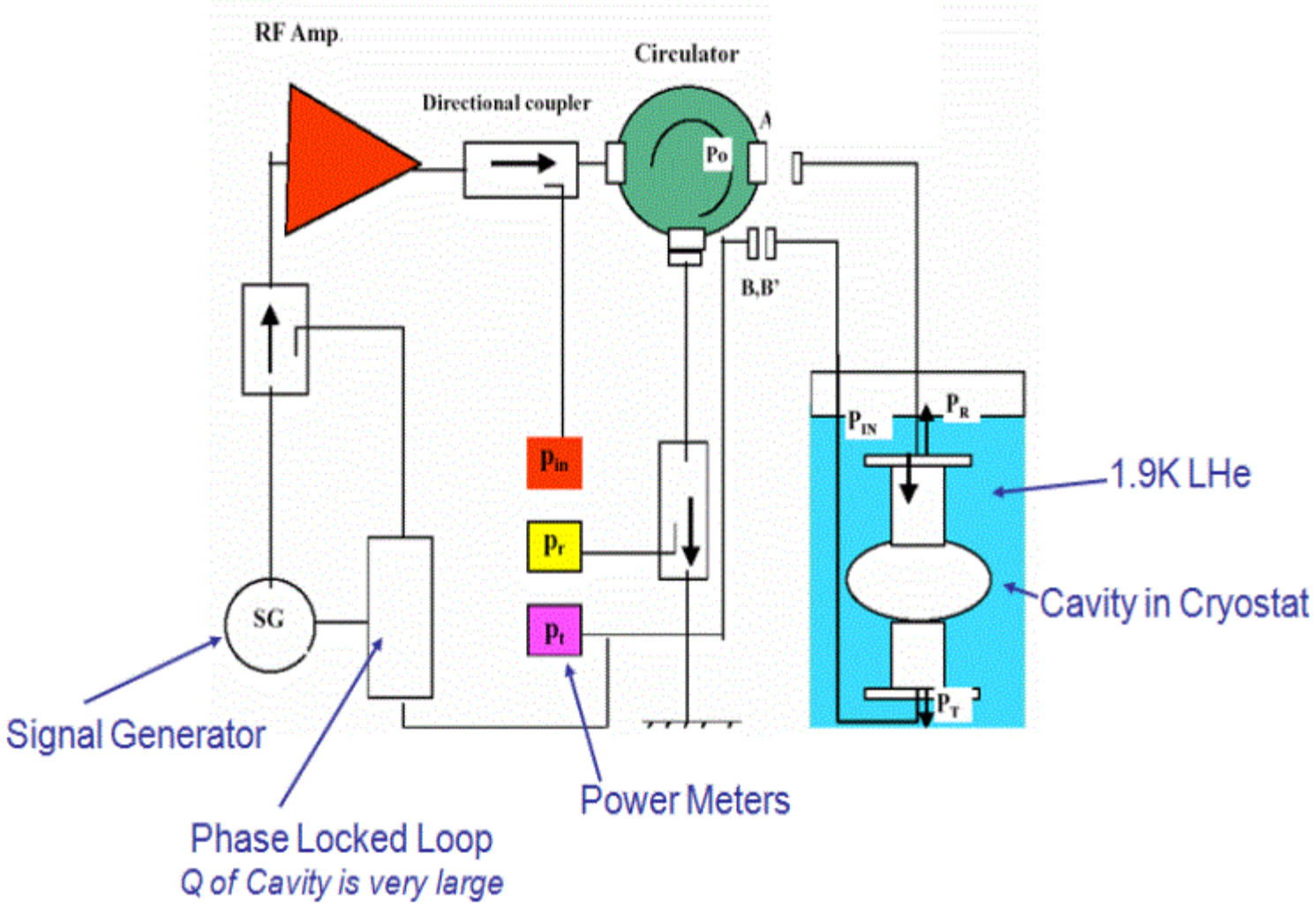
2010 Milestone

See Geng

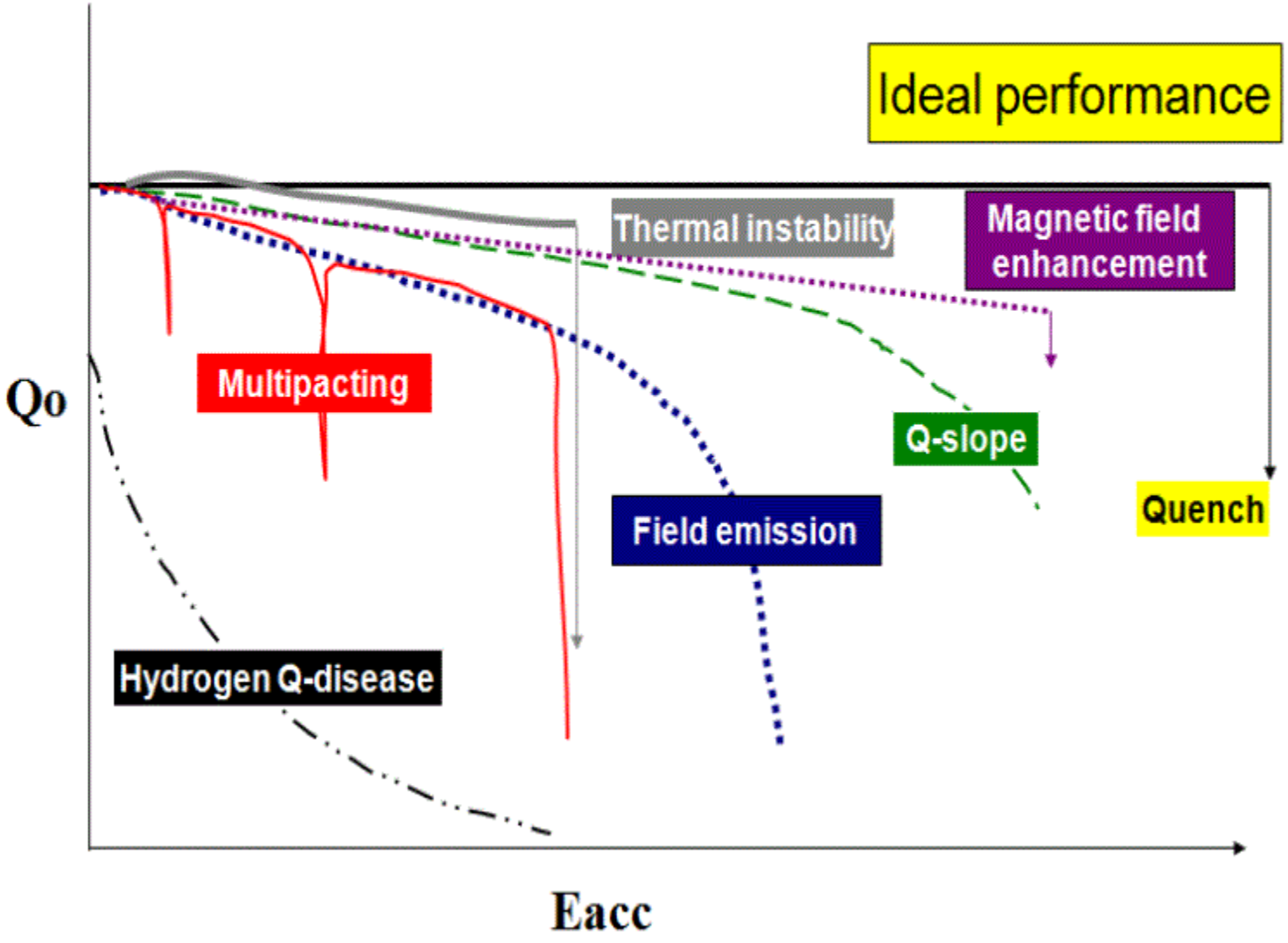


- Toward TDR goal
- Field emission; mechanical polishing
- Other progress

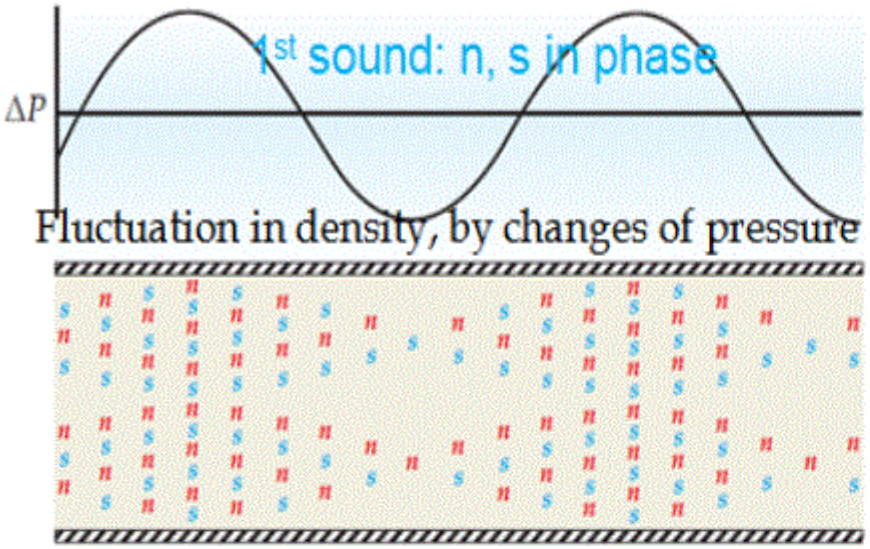
Schematic of Experimental Setup

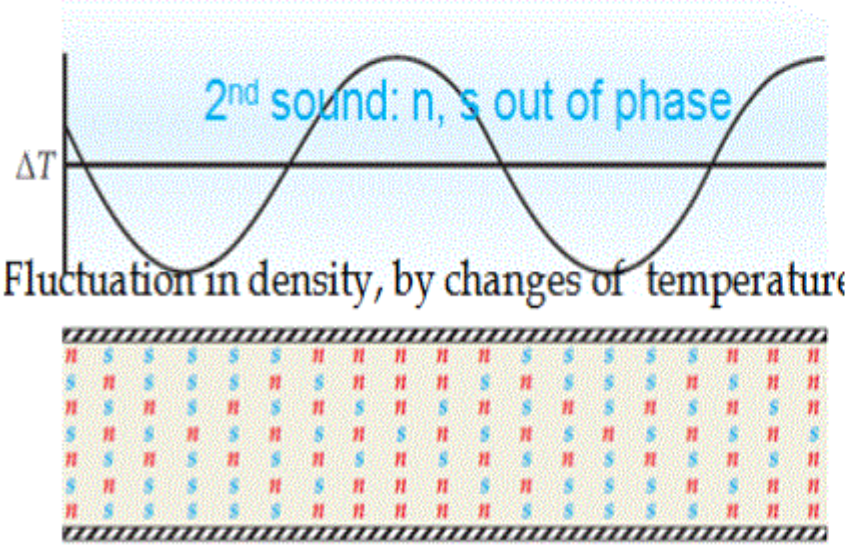


Various Performance Limitations in SRF Cavity



SECOND SOUND





BELOW λ POINT - 2.17K

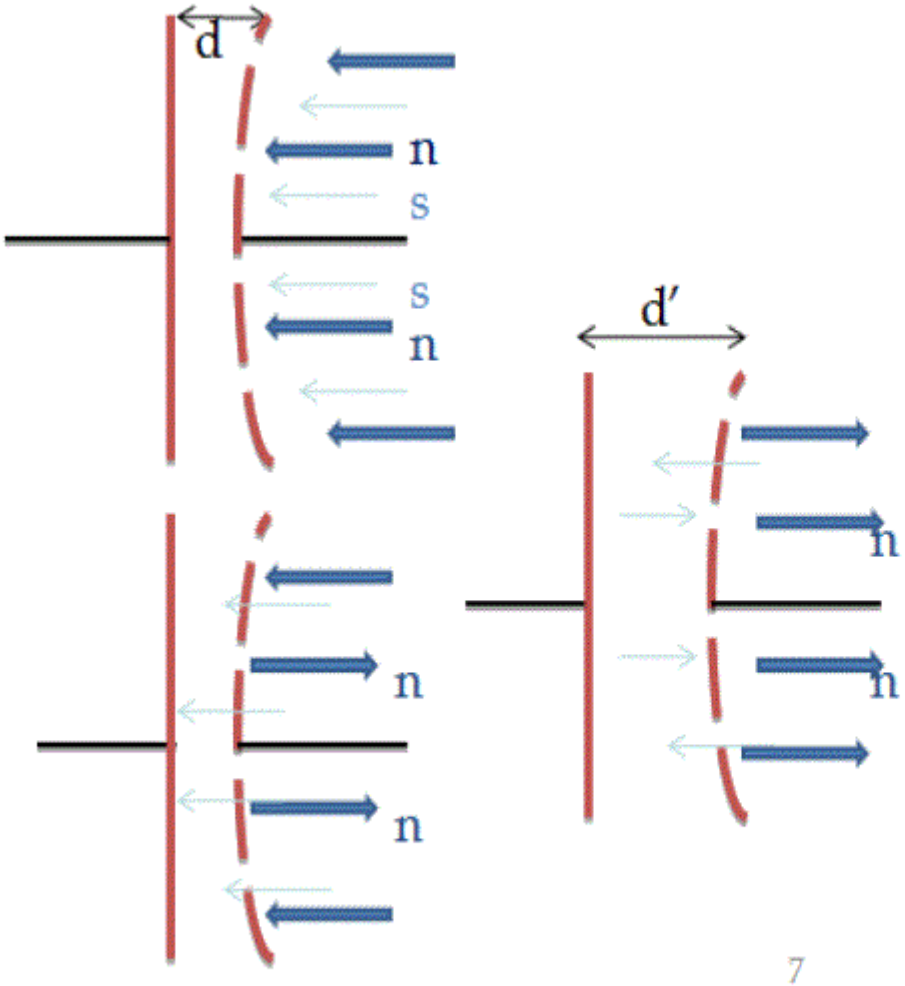
→ 2 FLUID MODEL OF LIQUID He

→ NORMAL FLUID
- VISCOSITY
- 1ST SOUND 200 m s^{-1}

→ SUPER FLUID
- NO VISCOSITY
- ENTROPY → HEAT WAVE

2ND SOUND - 20 m s^{-1}

OSCILLATING SUPER LEAK TRANSDUCER

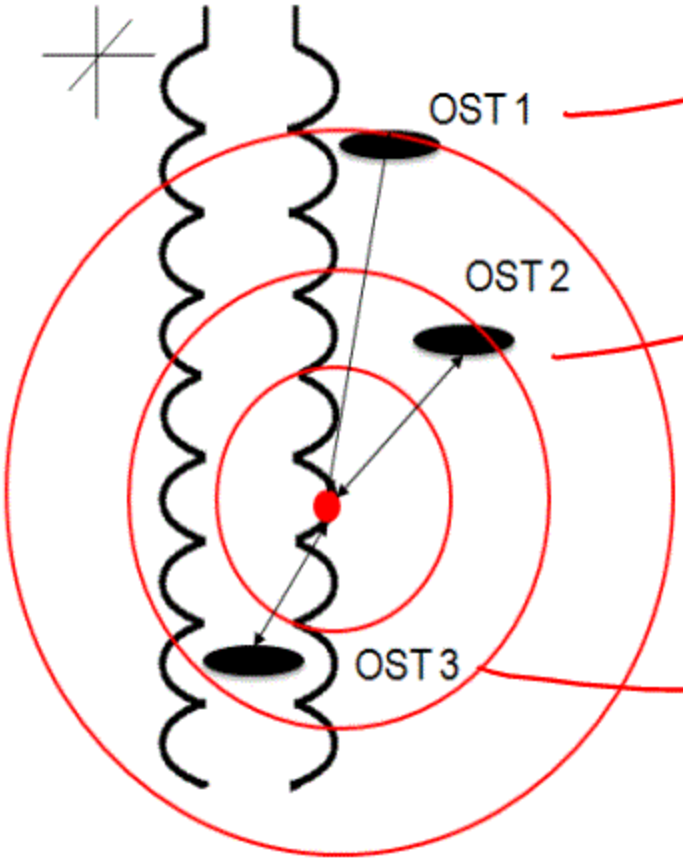


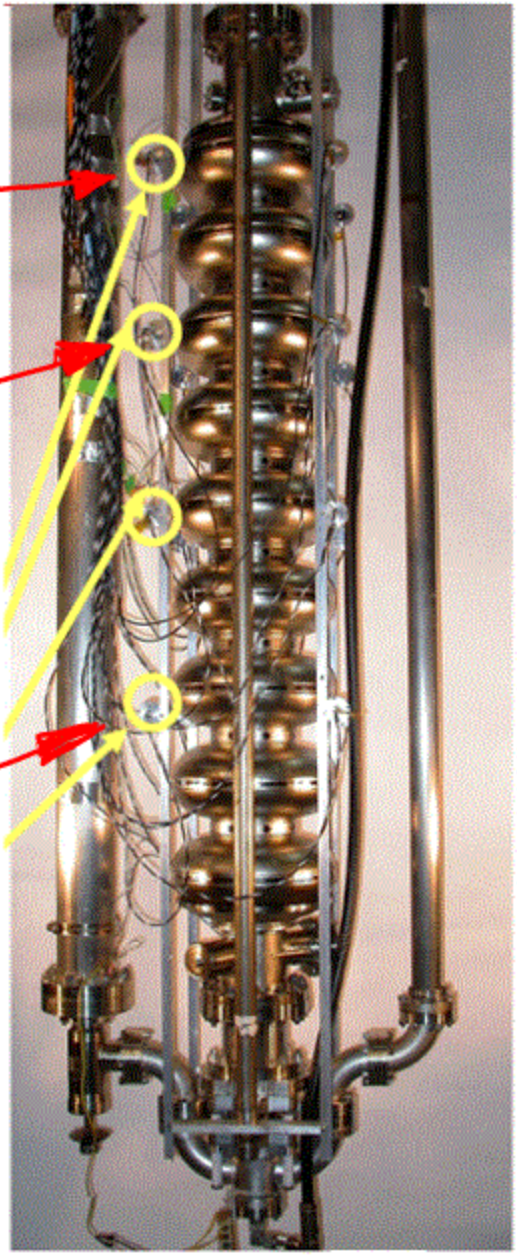
- OSCILLATING POROUS MEMBRANE $\sim 1\mu$
- CHANGES RELATIVE CONCENTRATION OF FLUID SUPER FLUID

⇓

SECOND SOUND

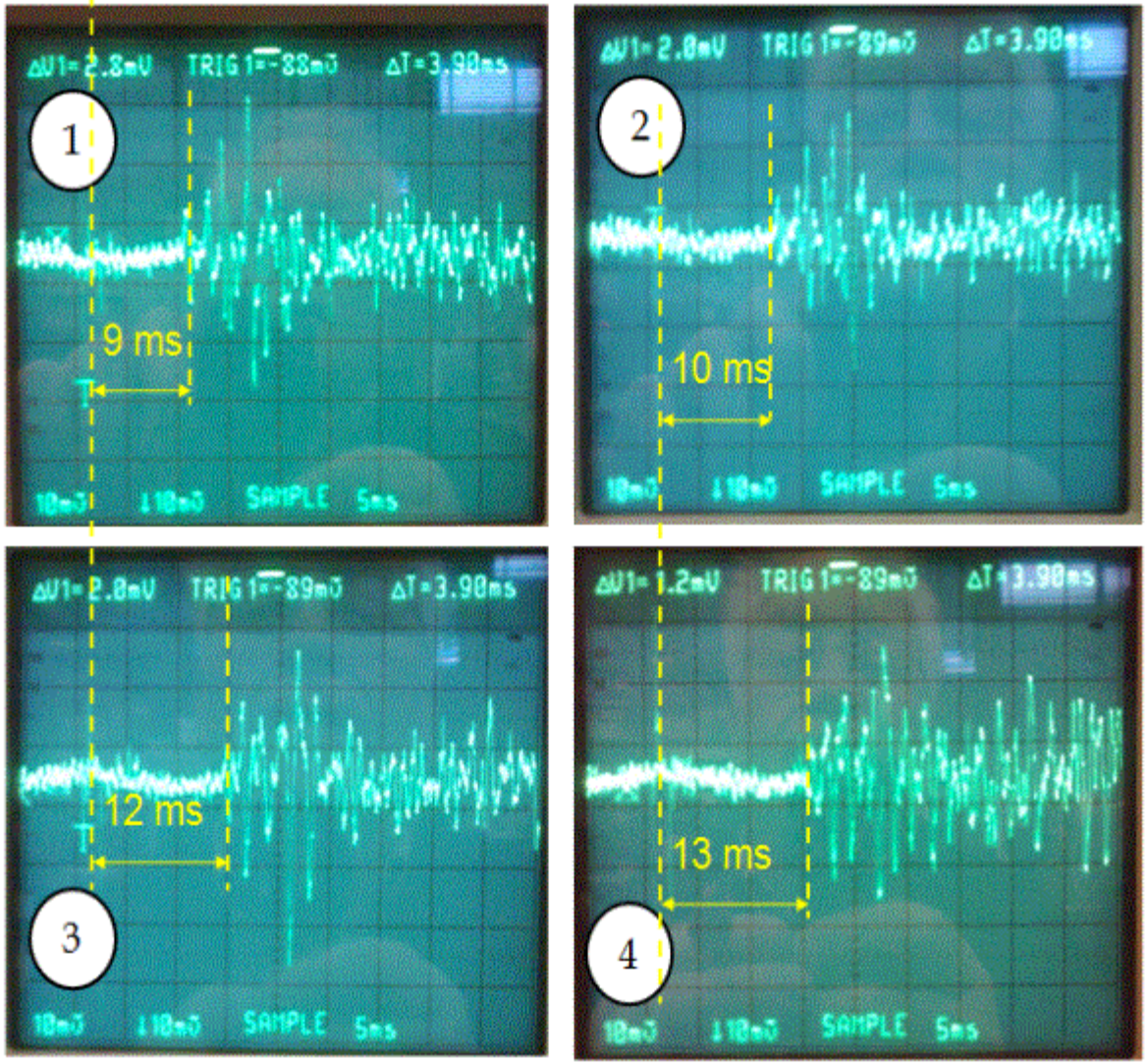
- CAN PRODUCE OR DETECT



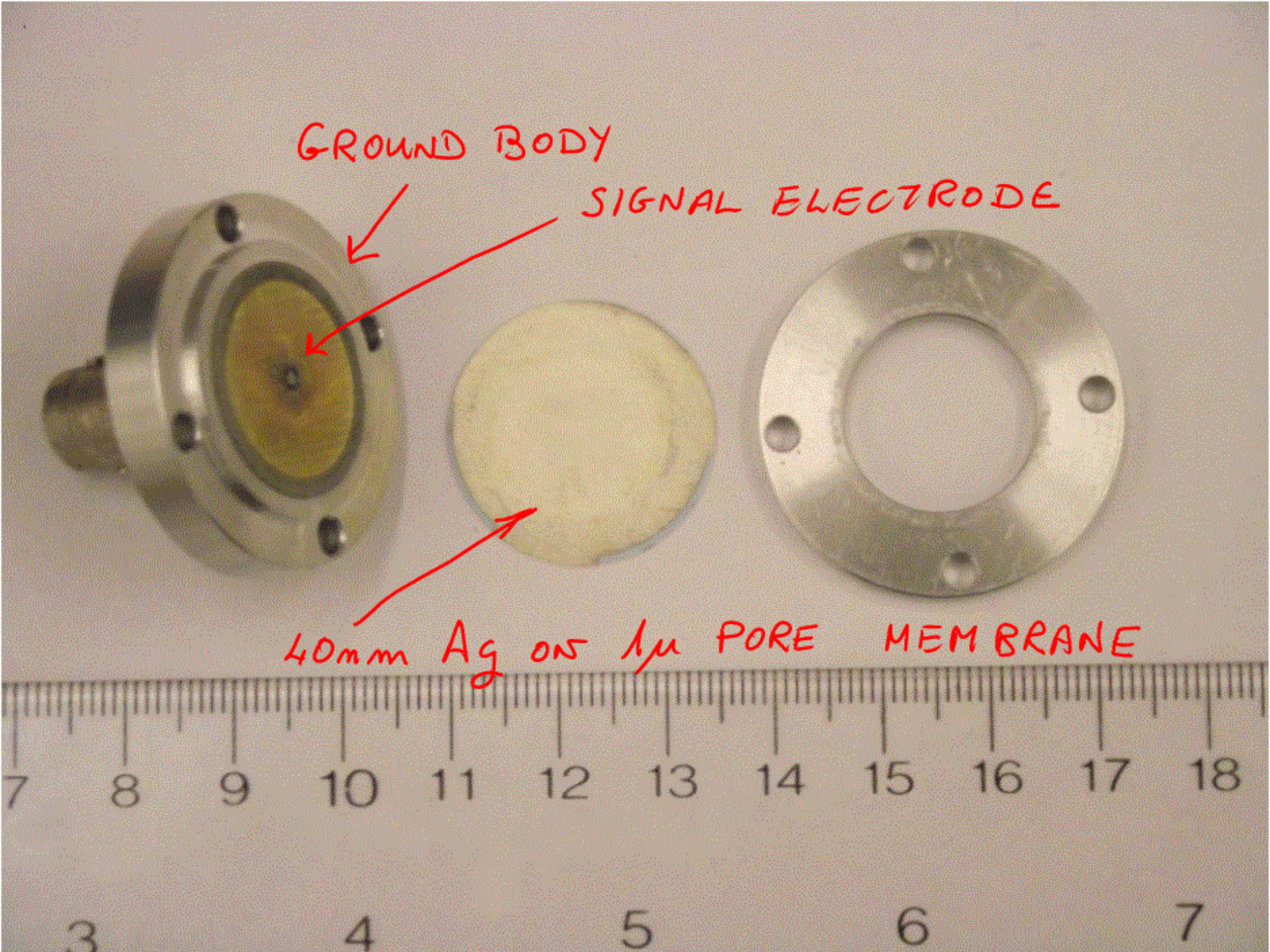


TRIANGULATION USING SECOND SOUND ARRIVAL TIME

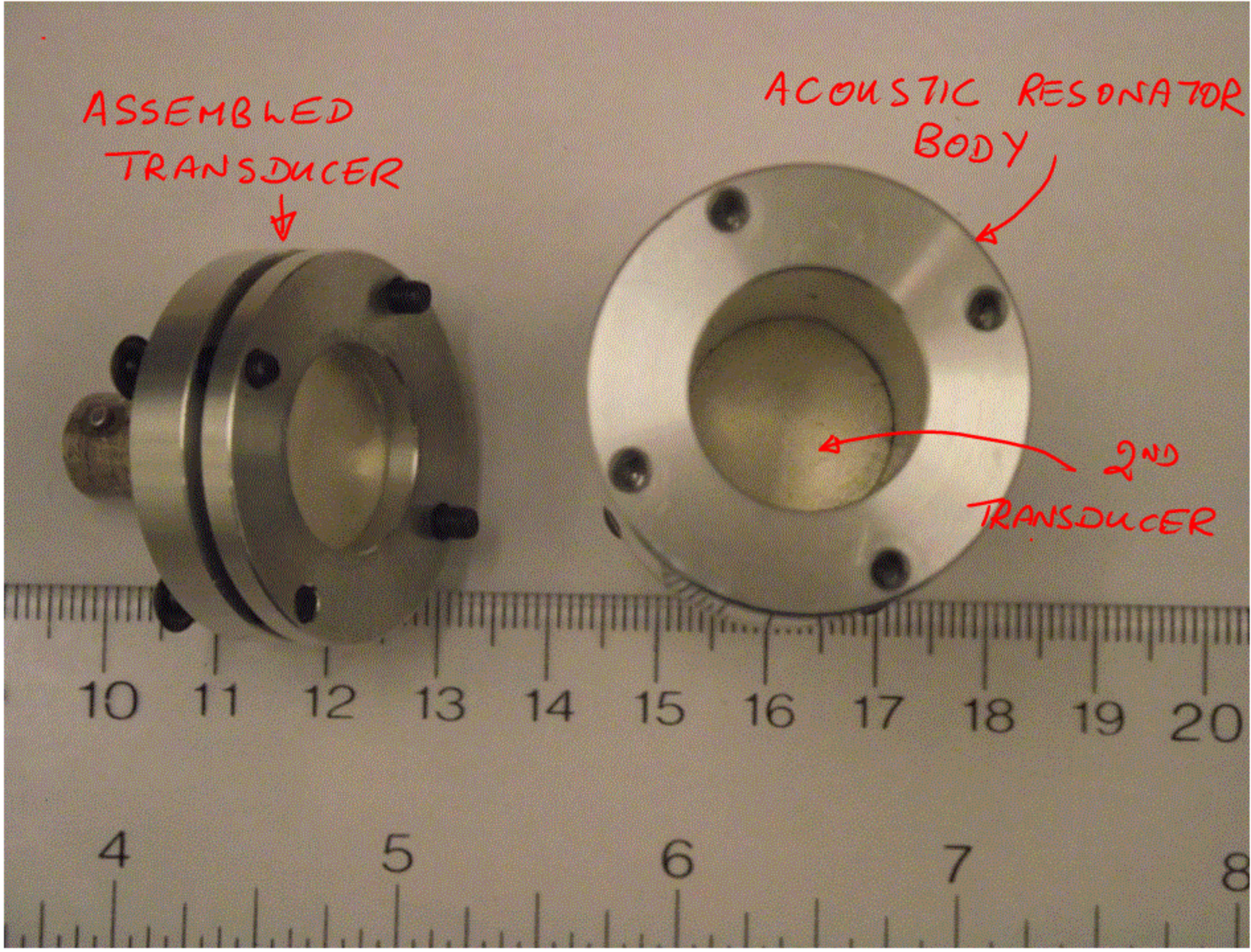
→ LOCATE CAVITY DEFECT AT QUENCH

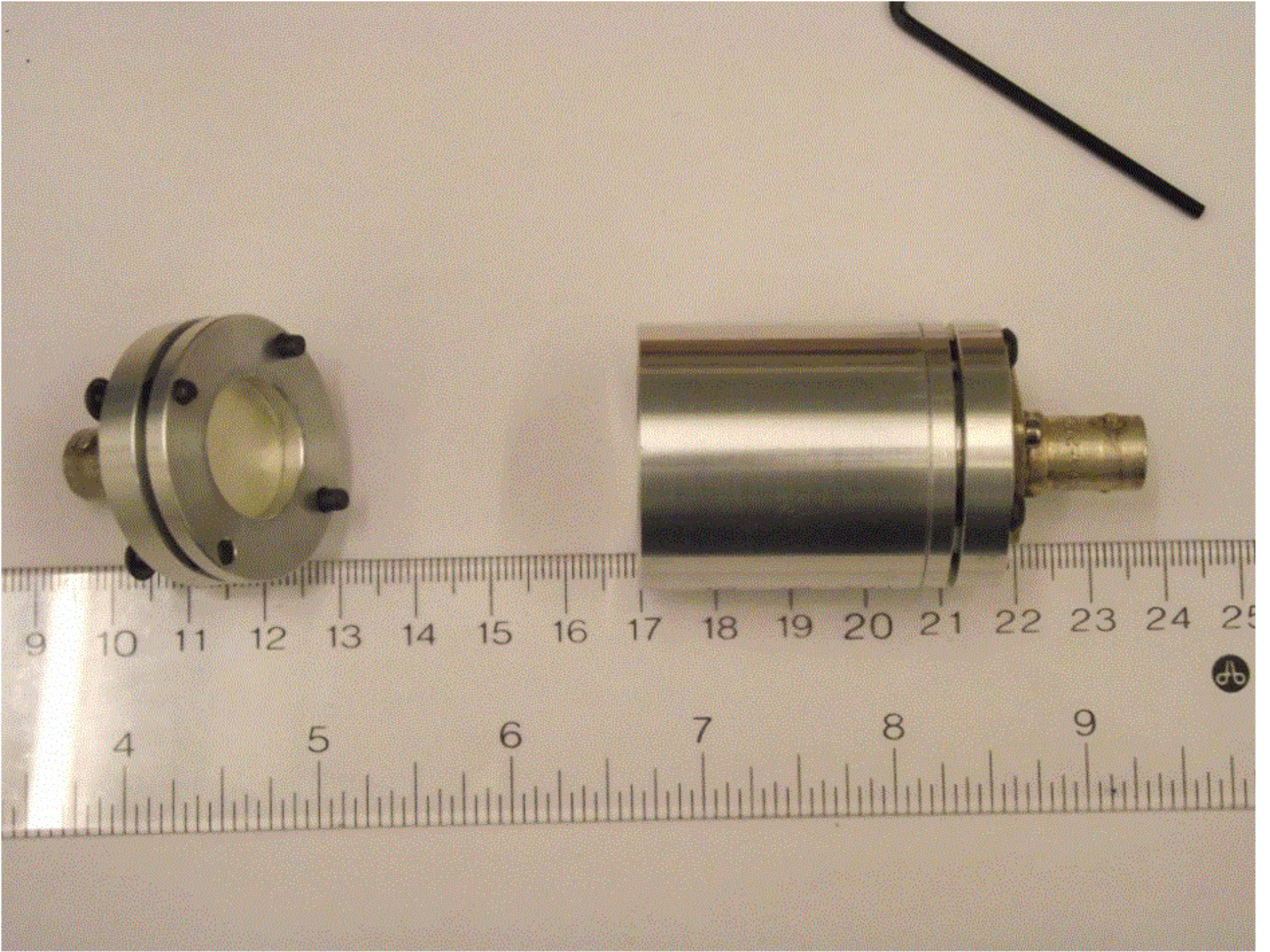


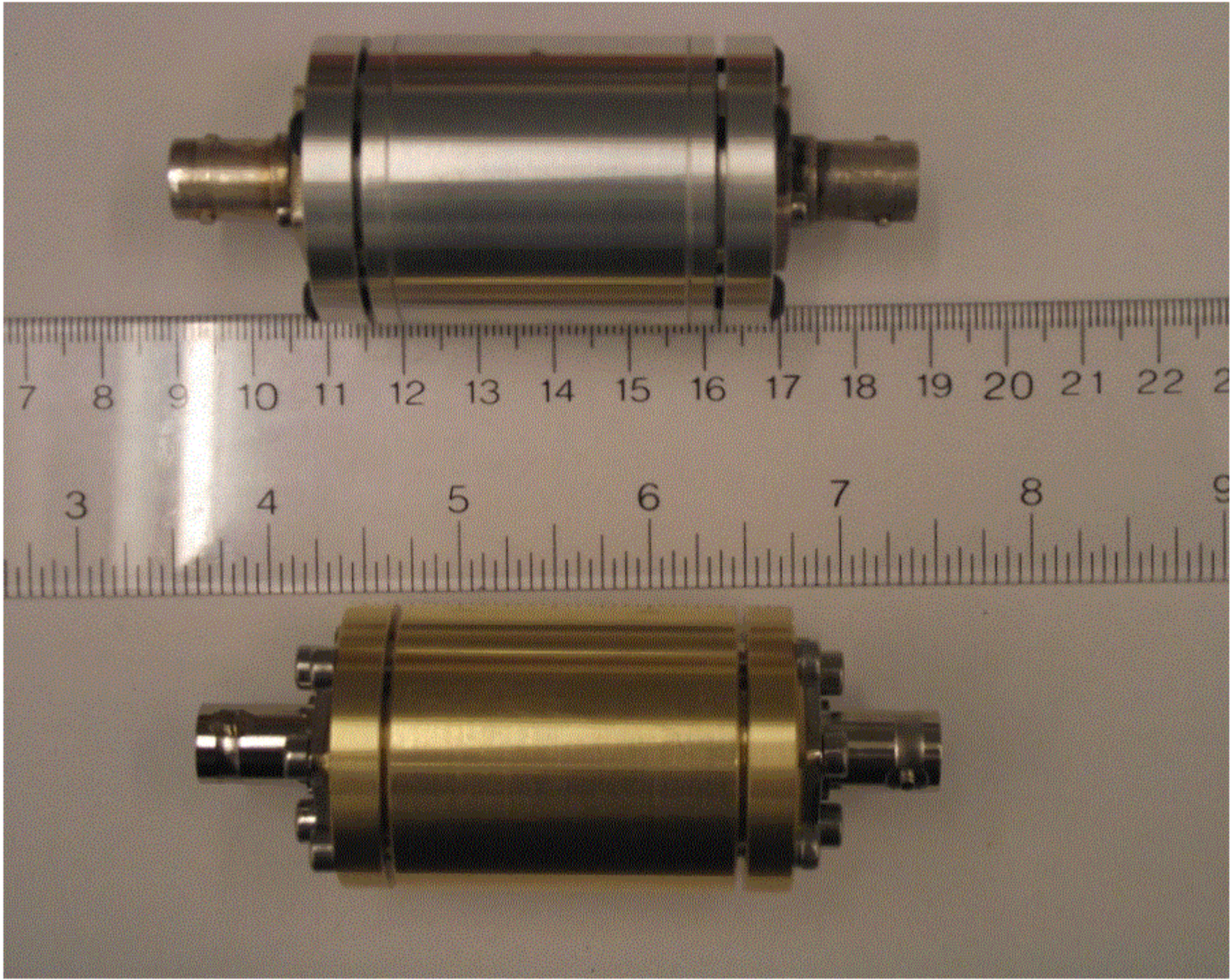
SECOND SOUND ARRIVAL TIME AFTER QUENCH

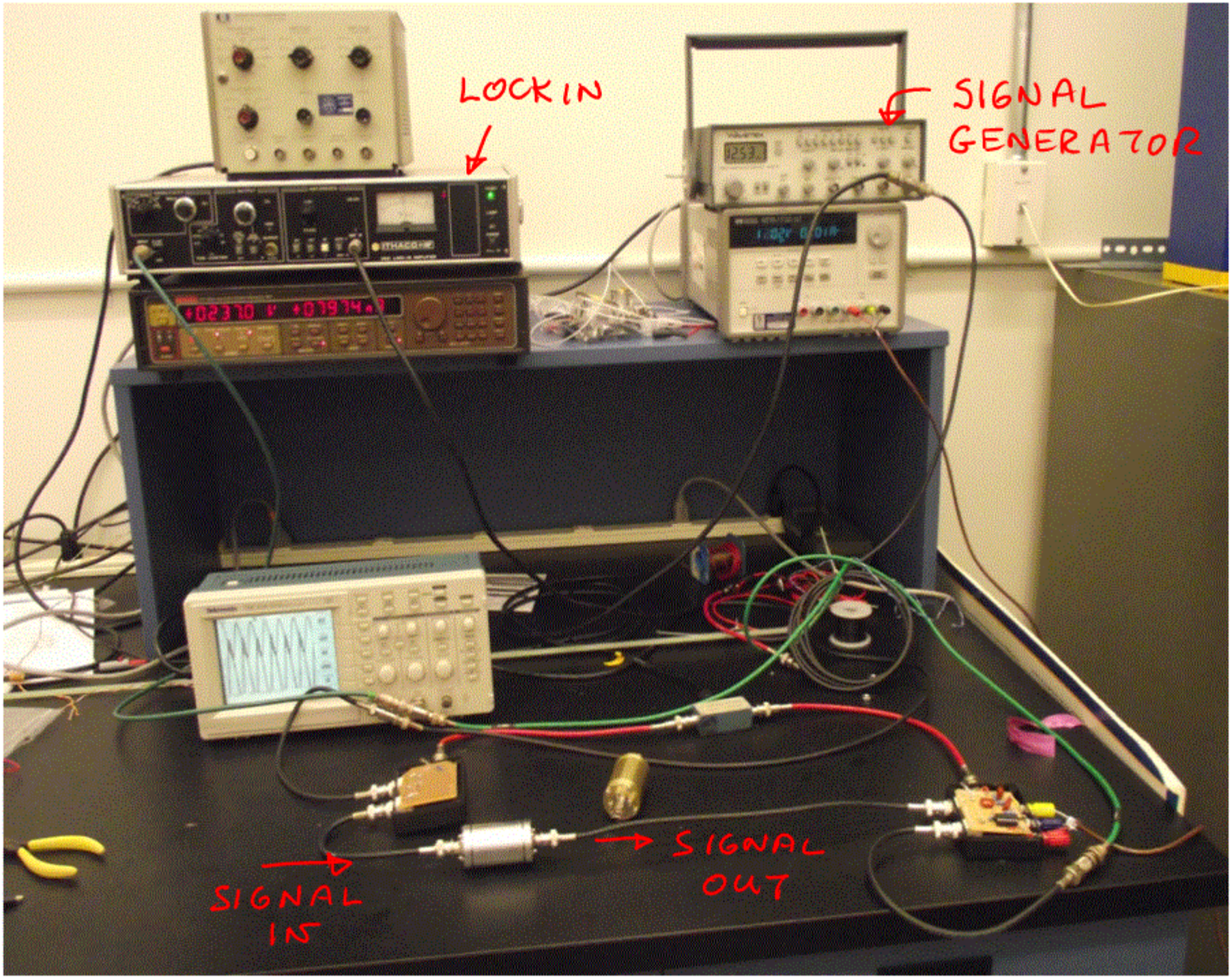

GROUND BODY
SIGNAL ELECTRODE
40mm Ag on 1µ PORE MEMBRANE
7
8
9
10
11
12
13
14
15
16
17
18
3
4
5
6
7

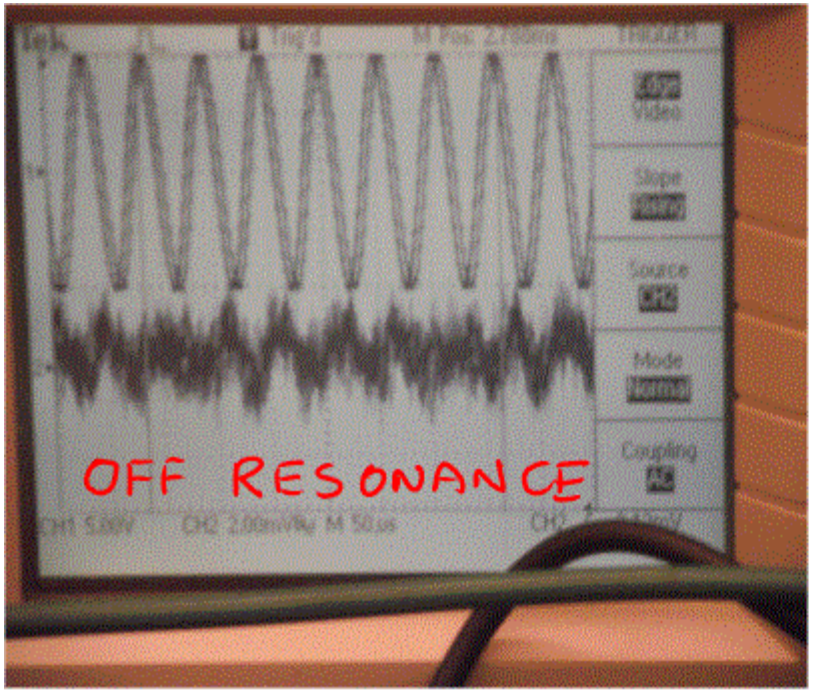
- WE DO NOT HAVE CAVITIES AT TORONTO
- USE OST TO BOTH PRODUCE AND DETECT 2ND SOUND
- USE STANDING WAVES IN ACOUSTIC RESONATOR TO MEASURE "SOUND" VELOCITY

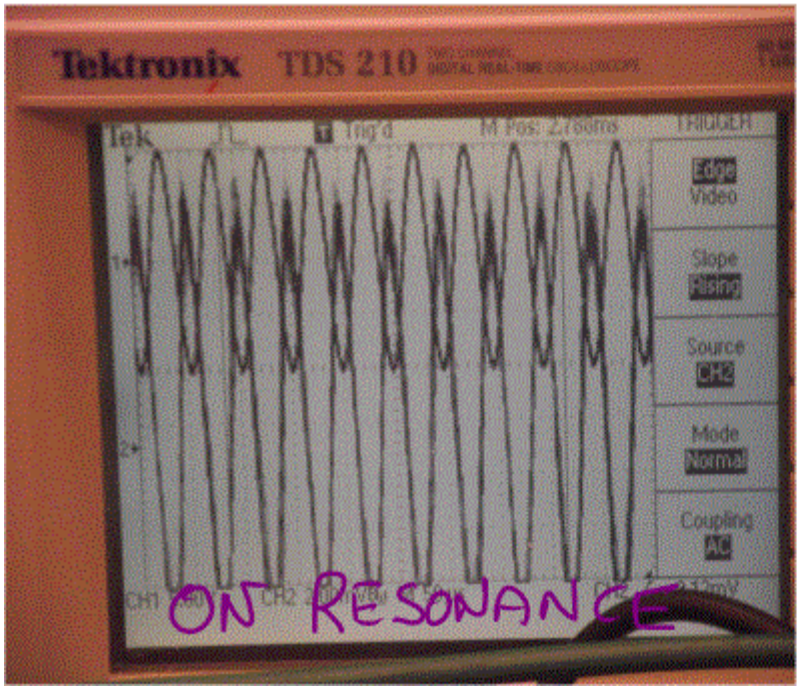

ASSEMBLED TRANSDUCER
ACOUSTIC RESONATOR BODY
2ND TRANSDUCER
10 11 12 13 14 15 16 17 18 19 20
4 5 6 7 8


9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
4 5 6 7 8 9


7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
3 4 5 6 7 8


LOCK IN
SIGNAL GENERATOR
SIGNAL IN
SIGNAL OUT



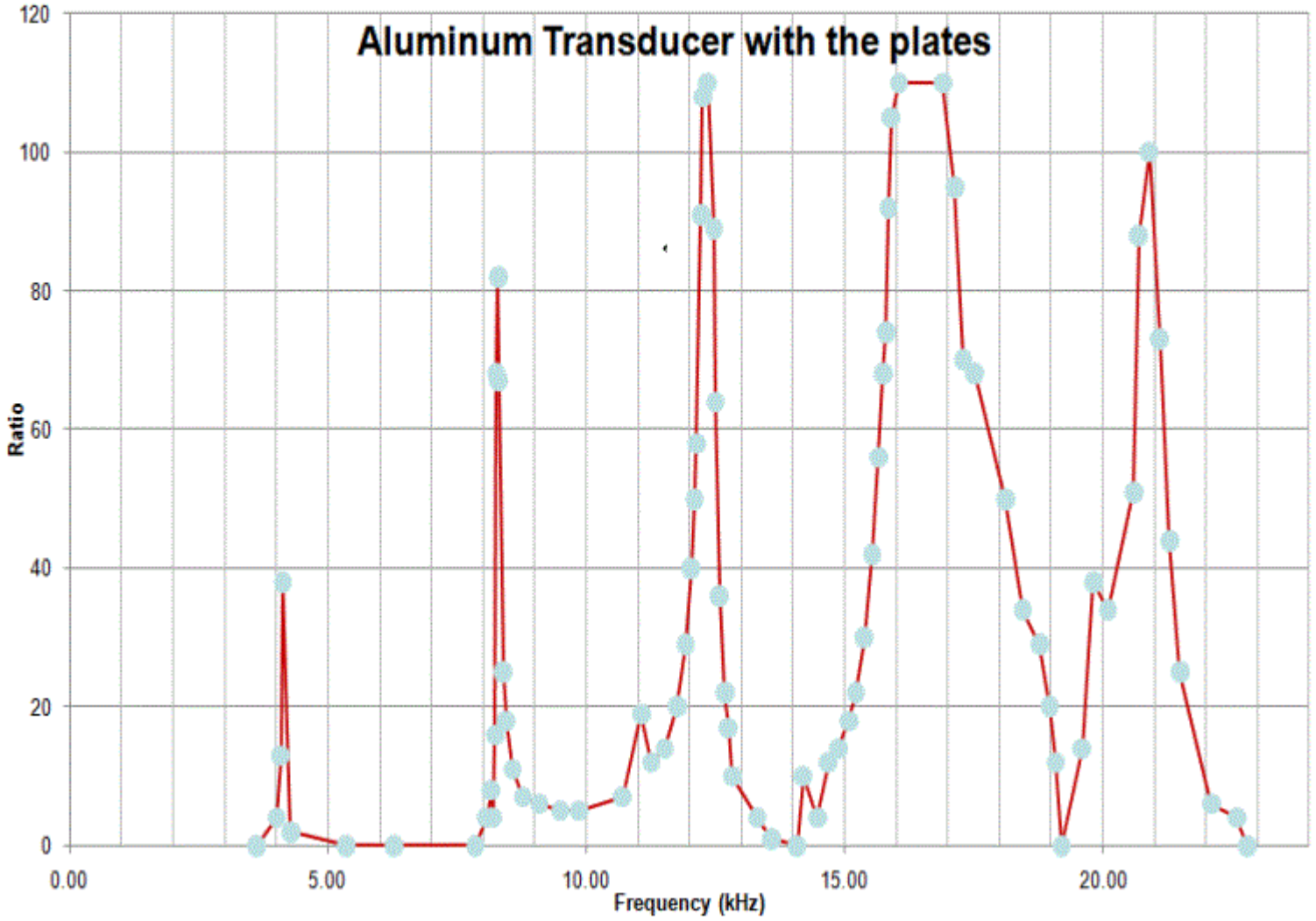


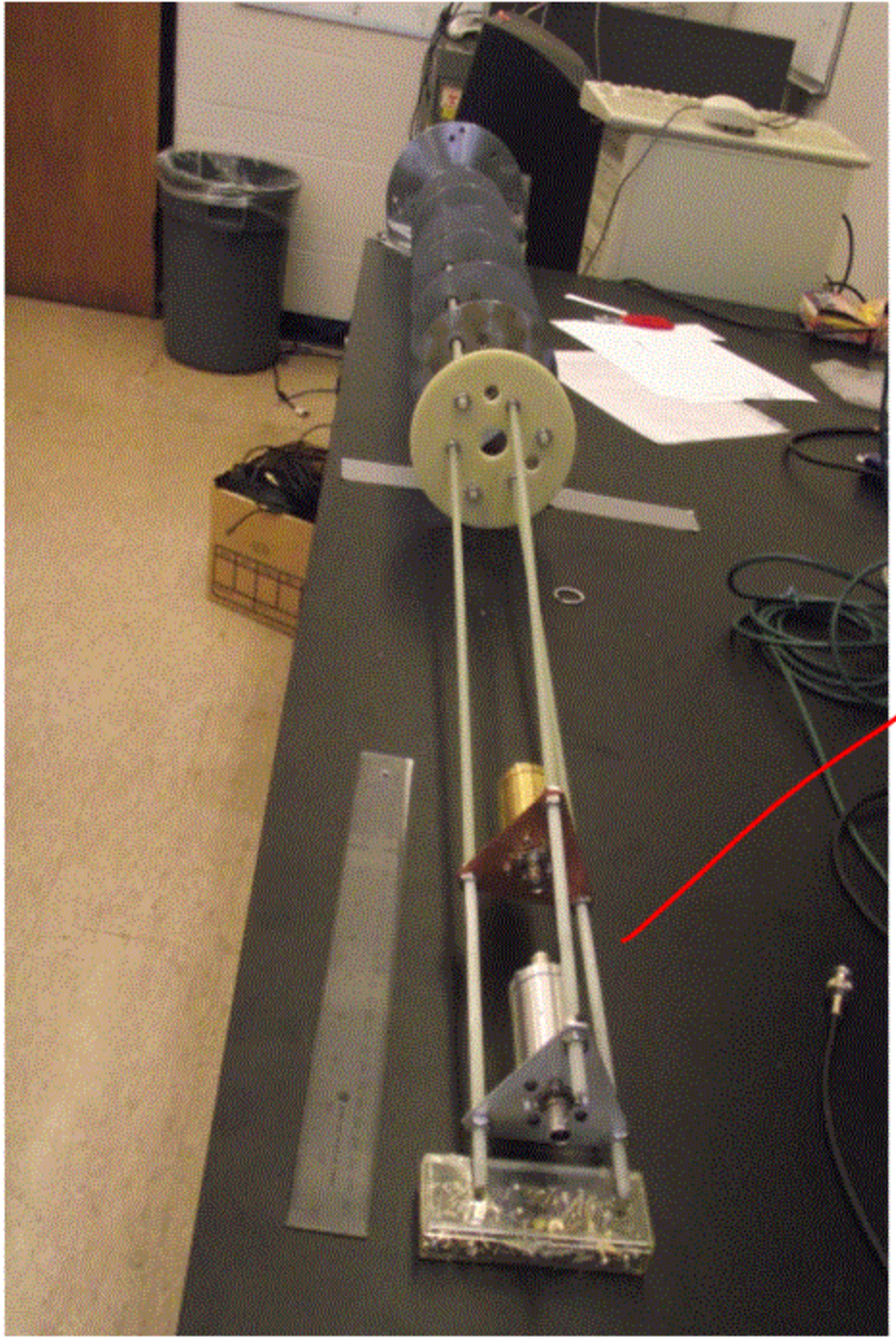
FREQUENCY SPACING OF STANDING WAVES IN ACOUSTIC RESONATOR

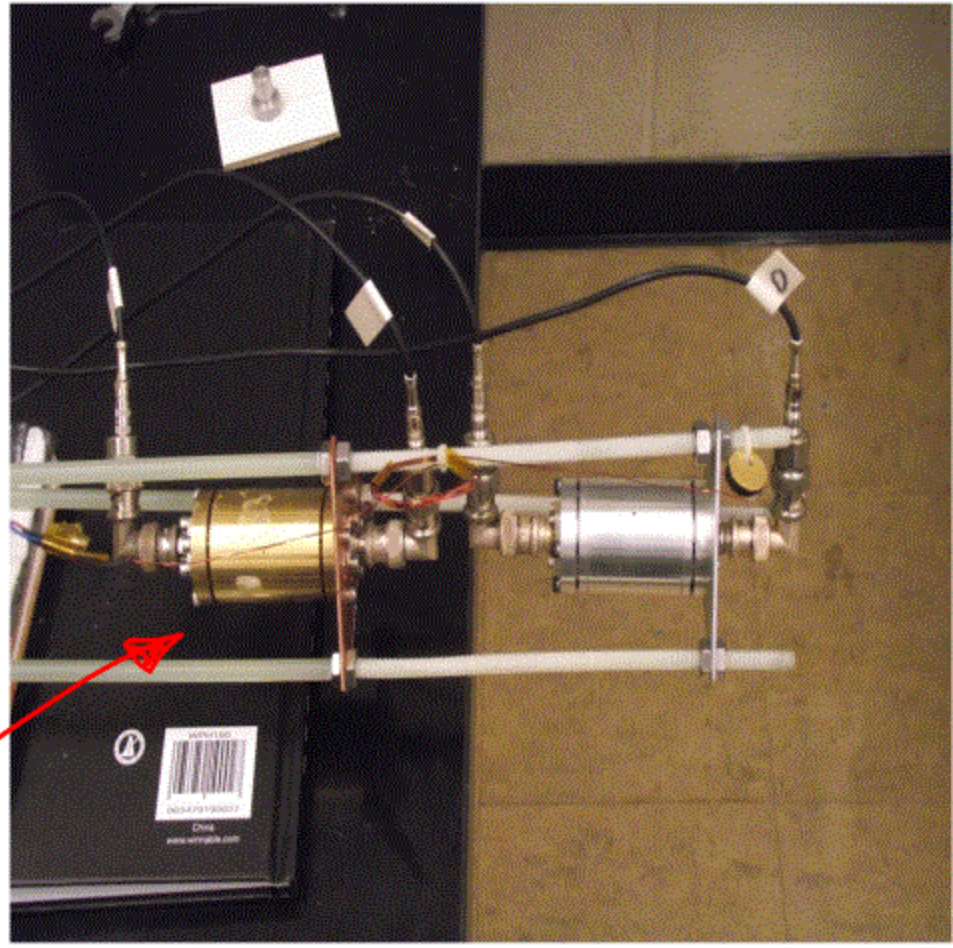
→ VELOCITY OF "SOUND"

→ DISTINGUISH 1ST & 2ND SOUND

RESONANCES AT ROOM TEMPERATURE



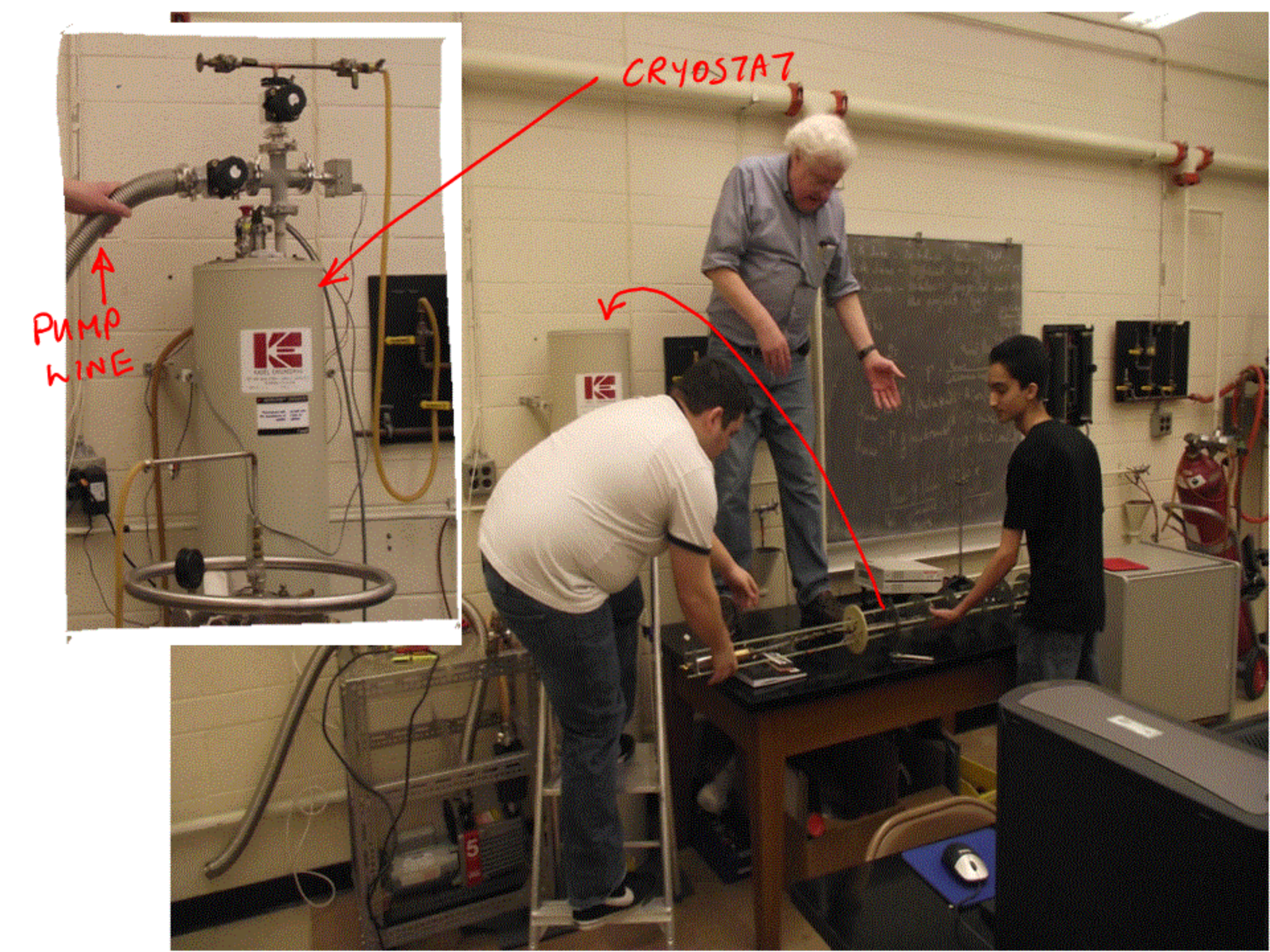


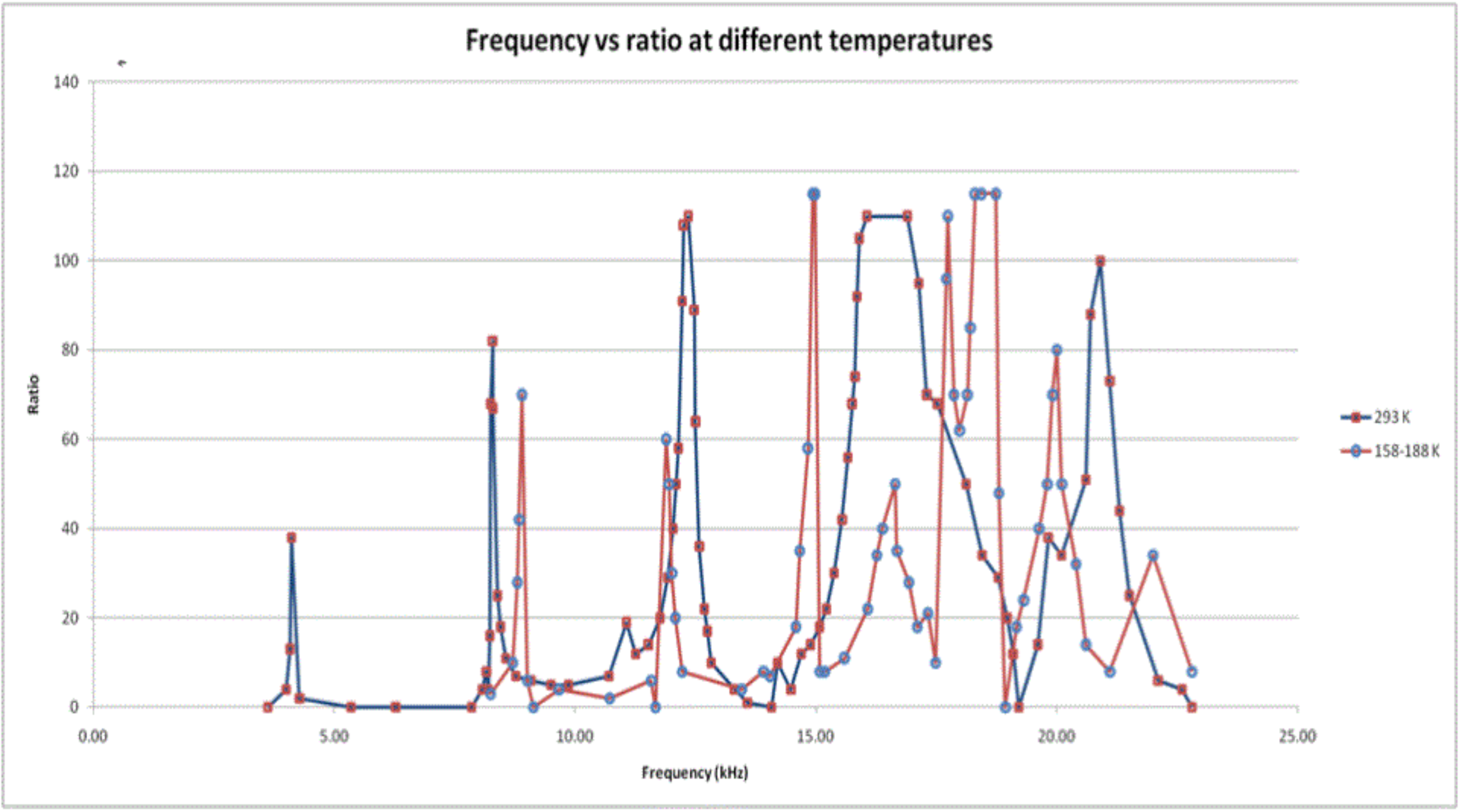


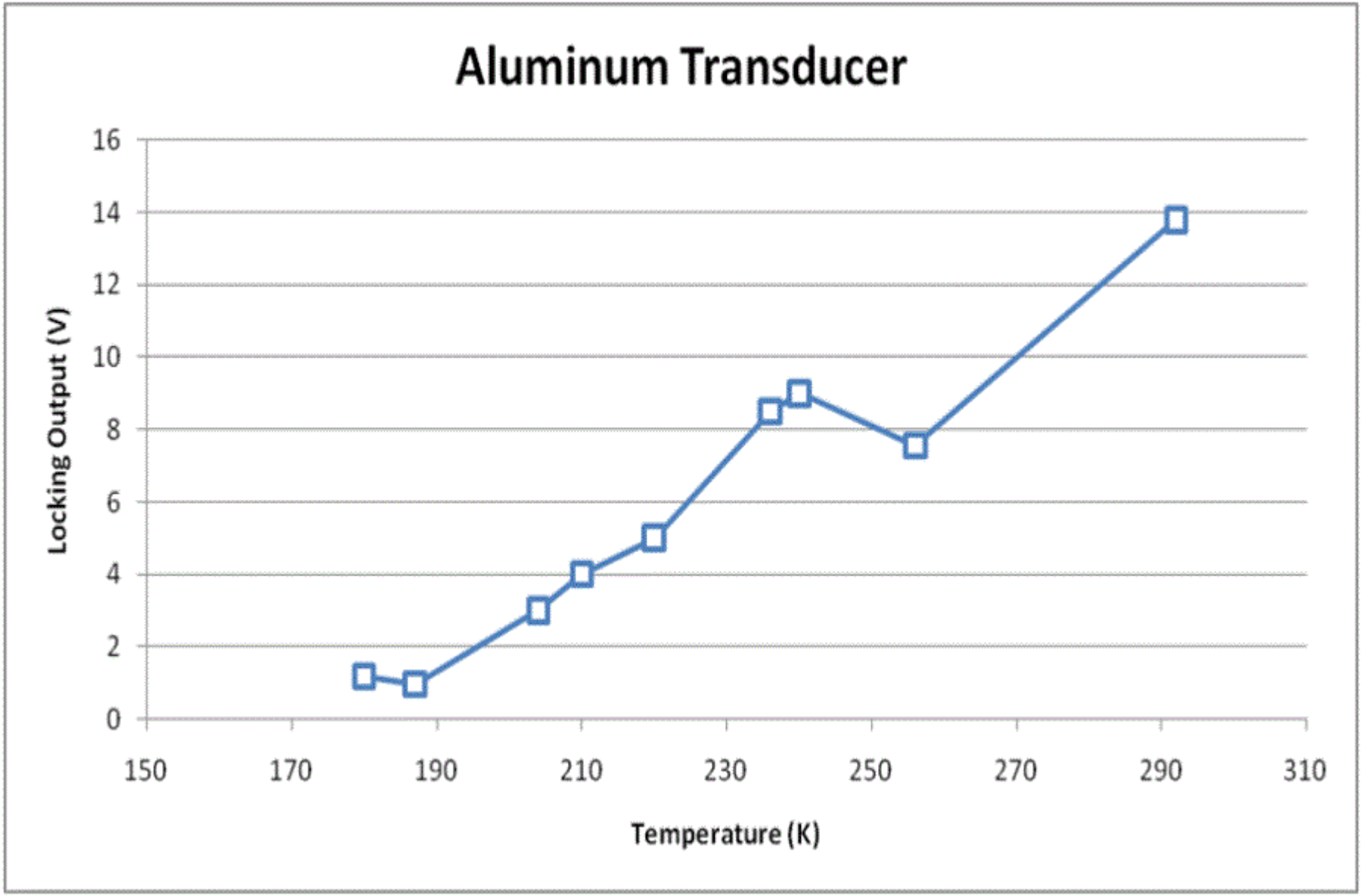
COLD TEST

SUSPEND IN He CRYOSTAT

→ PUMP.


CRYOSTAT
PUMP
LINE


Frequency vs ratio at different temperatures
Ratio
140
120
100
80
60
40
20
0
0.00
5.00
10.00
15.00
20.00
25.00
Frequency (kHz)
293 K
158-188 K


Aluminum Transducer
Locking Output (V)
16
14
12
10
8
6
4
2
0
150
170
190
210
230
250
270
290
310
Temperature (K)

FUTURE WORK

- OPTIMIZE METALIZATION OF MEMBRANE
- OPTIMIZ MEMBRANE PORE SIZE
- WHEN HAVE 2ND SOUND SIGNAL

↓

- INSTAL TRANSDUCERS IN TRIUMF 9-CELL CAVITY CRYOSTAT.