

# Adjustable Wave Tube Stand for Acoustic Reflection Technique

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## Abstract

Acoustic reflection technique is a non-invasive method of measuring vocal tract anatomy. It is useful in studying a number of conditions including sleep apnea and speech disorders. Current studies at the Vocal Tract Lab of the University of Wisconsin seek to compare acoustic reflection technique data with information from medical imaging studies. The current protocol calls for the wave tube device to be held in the hands of a researcher throughout the duration of the scans. This is inducing variability in the data. For this reason it has been proposed to design an adjustable stand for the acoustic reflection wave tube device. Several designs were considered and evaluated. The final design incorporates a miniature adjustable boom stand attached to a custom high density polyethylene base that is used to hold the wave tube device. This design also features rubber strapping and a silicone lining to firmly hold the wave tube in place.

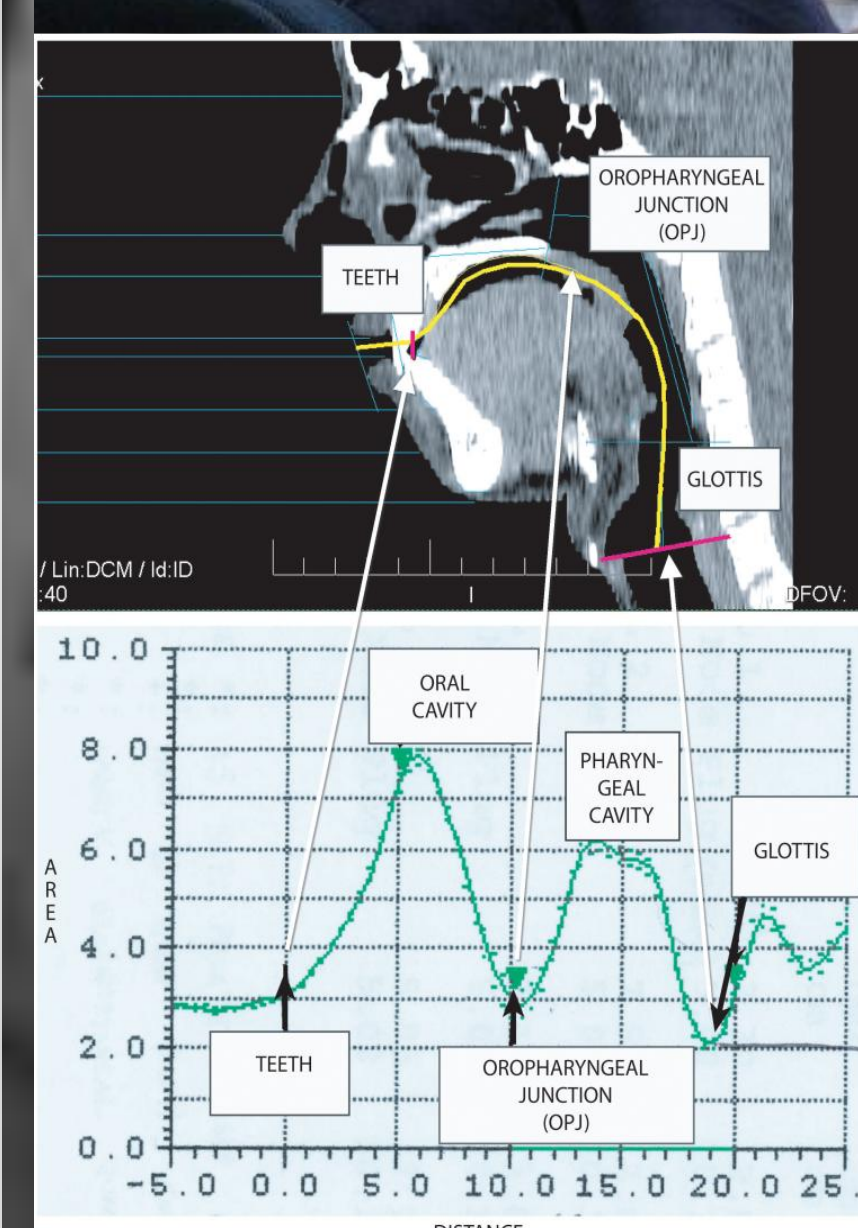
## Problem Statement

**Project Goal** – Design an adjustable wave tube stand that allows the device to remain in a fixed position promoting accuracy and repeatability between scans

**Background Information** – Acoustic Reflection Technique is a non-invasive method of studying the anatomy of the human vocal tract. Patients are required to exhale into the device, which calculates the amplitude of sound waves as well as their travel time to construct an airway echogram representative of the patient's vocal tract

**Current Problem** – The current research protocol calls for the researcher to hold the wave tube device in their hands throughout the duration of the scans. The wave tube does not remain fixed and data varies due to this inconsistency in wave tube position

**Client Motivation** – The researchers at the UW Vocal Tract Lab hope to improve the methods of Acoustic Reflection Technique and compare ART data with information from medical imaging studies. Eventually they hope to use Acoustic Reflection as a low cost alternative to medical imaging especially with disabled patients

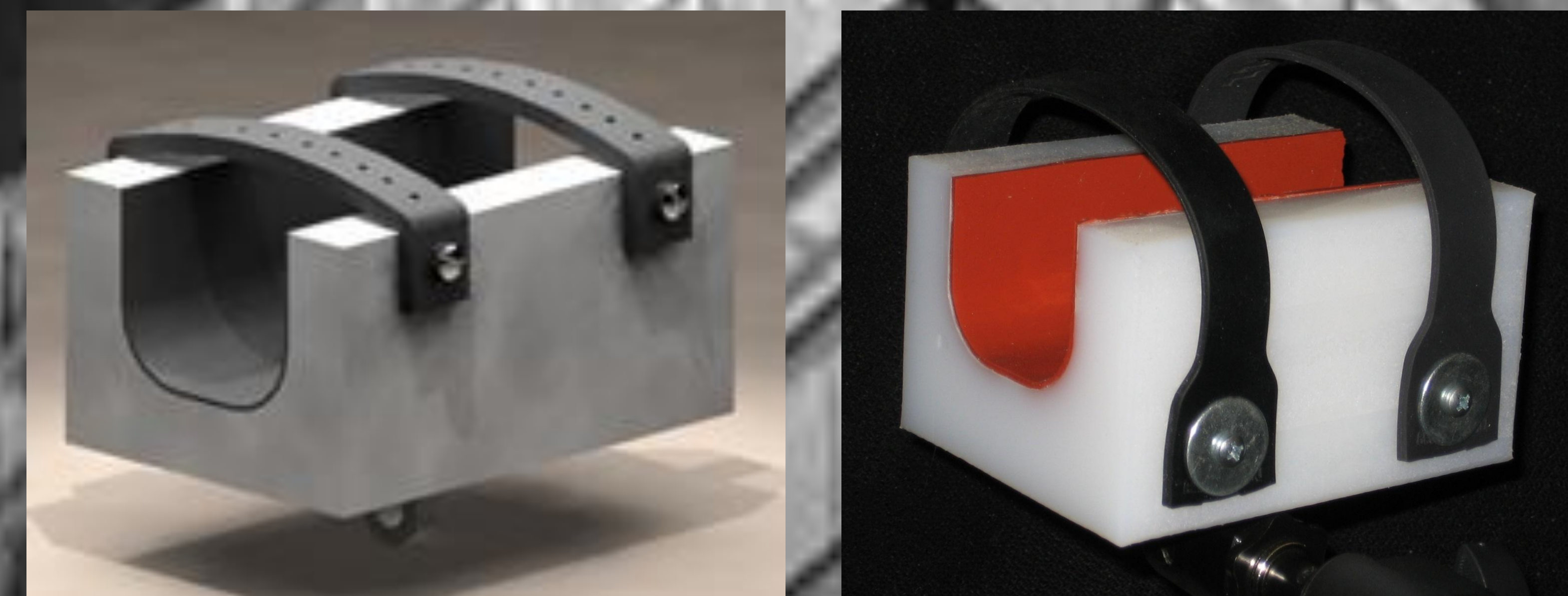


## Client Requirements

- To allow accurate measurements to be made, the wave tube should be held at a horizontal position when subjects are sitting upright and at a vertical position when subjects are in the supine position
- The stand should reflect the Vocal Tract lab's wide subject age range with a large range of adjustability. When the subject is seated at a table, the stand should allow measurements to be made on small children as well as grown adults
- The stand should allow for fine adjustments to achieve the exactness required by the Vocal Tract lab
- To keep with the protocol of the lab setting, the stand should be easily disinfected
- The stand should be non-invasive and pose no harm or discomfort to the patient

## Final Design

The final design for the adjustable wave tube stand consists of three major components



A comparison of design ideas at mid-semester with final prototype

### Samson MB1 Mini Boom Stand

- Adjustability in many directions including, horizontal extension to accommodate more broad subjects, vertical extension to accommodate taller subjects, and the ability to rotate about the horizontal long axis allowing the stand to be used in upright and supine positions
- Markings indicate settings for preferential test positions (upright/supine) as well as height and length settings to aide in repeatability between scans
- Collapsibility allows stand to be easily stored and transported if scans are to be made in settings outside of the lab

### Custom High Density Polyethylene Base

- Lightweight polymer minimizes moment arm reducing potential to tip
- Custom shape provides form fit between base and wave tube

### Silicone/Rubber Gripping Mechanisms

- Silicone lining improves fit and increases friction between base and wave tube
- Adjustable rubber straps hold wave tube in place and allow easy insertion and removal of the wave tube device



The adjustable wave tube stand in the laboratory setting at the University of Wisconsin Vocal Tract Lab

## Testing

Upon prototype completion the wave tube stand was brought to the Vocal Tract lab for usability testing. The stand proved to meet the majority of requirements set forth by the client in addition to eliminating the need for the wave tube to be held.

Qualitative tests were also carried out to determine whether the silicone lining would hold up to the disinfectant used



## Future Work

### Prototype Improvements

- Fix joints where motion is deemed unnecessary by the user
- Make adjustments to ensure accommodation of all possible subjects tested in the Vocal Tract Lab

### Future Testing

- Design and implement tests to determine whether or not device promotes repeatability between scans
- Compare Acoustic Reflection Technique data with medical imaging information to determine if device improves the accuracy of ART measurements

## Cost Analysis

### Price Breakdown:

UHMW Polyethylene Block	-	\$39.29
MB1 Boom Stand	-	\$34.98
Rubber Belt Straps	-	\$9.49
Screws, Mounting Brackets, Pins	-	\$8.00

**Total** **\$91.76**

## References

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