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Biomedical Photoacoustic Imaging Using Gas-coupled Laser Acoustic Detection

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SRI Graduate Seminar

Jami Johnson

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Acknowledgements

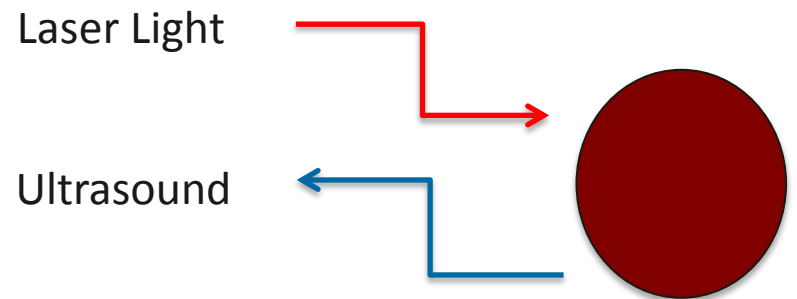
- Advisor: Michelle Sabick
 - Mechanical and Biomedical Engineering
- Physical Acoustics Lab: Kasper van Wijk
 - Geoscience

Motivation

- Importance of vascular imaging
 - Diagnosis of disease
 - Cardiovascular disease: #1 cause of death globally
 - Peripheral vascular disease
 - Cancer characterization
 - Treatment planning
 - Clinical and surgical aid
 - Viewing difficult-to-access structures
- Imaging unavailable in many settings
 - Expense, harmful radiation, impractical design

Photoacoustic Imaging

- Safe radiation (light and sound)
- Multiple centimeters deep
- High contrast
- High spatial resolution
- ‘Speckle free’



Dual Photoacoustic/Laser-Ultrasound Imaging

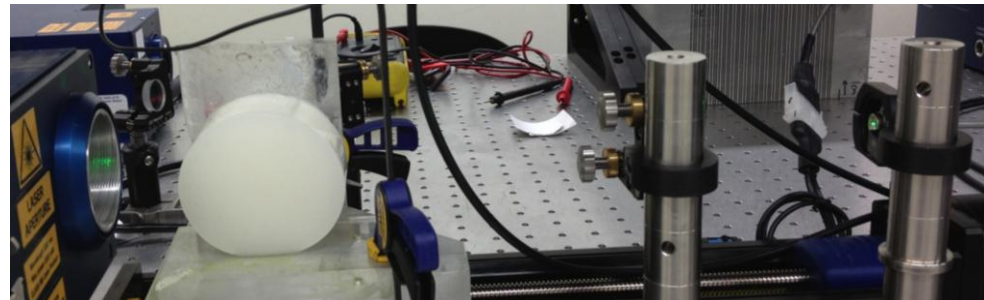
- **PA** : uses light to detect light absorbing molecules in the body
 - Lipids, hemoglobin, inflammation, etc.
- **LU**: uses ultrasound to detect changes in acoustic properties
 - Calcification, stiffening of arteries

Goals of Project

- Noncontact detector
- Low cost
- Comparable performance to high cost, state-of-the-art system

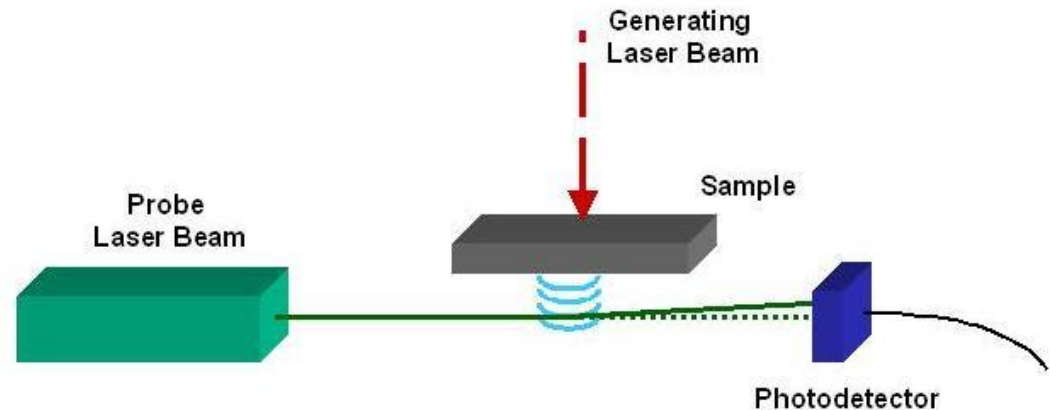
State-of-the Art ~\$350,000

GCLAD <\$2,000
plus computer for data acquisition

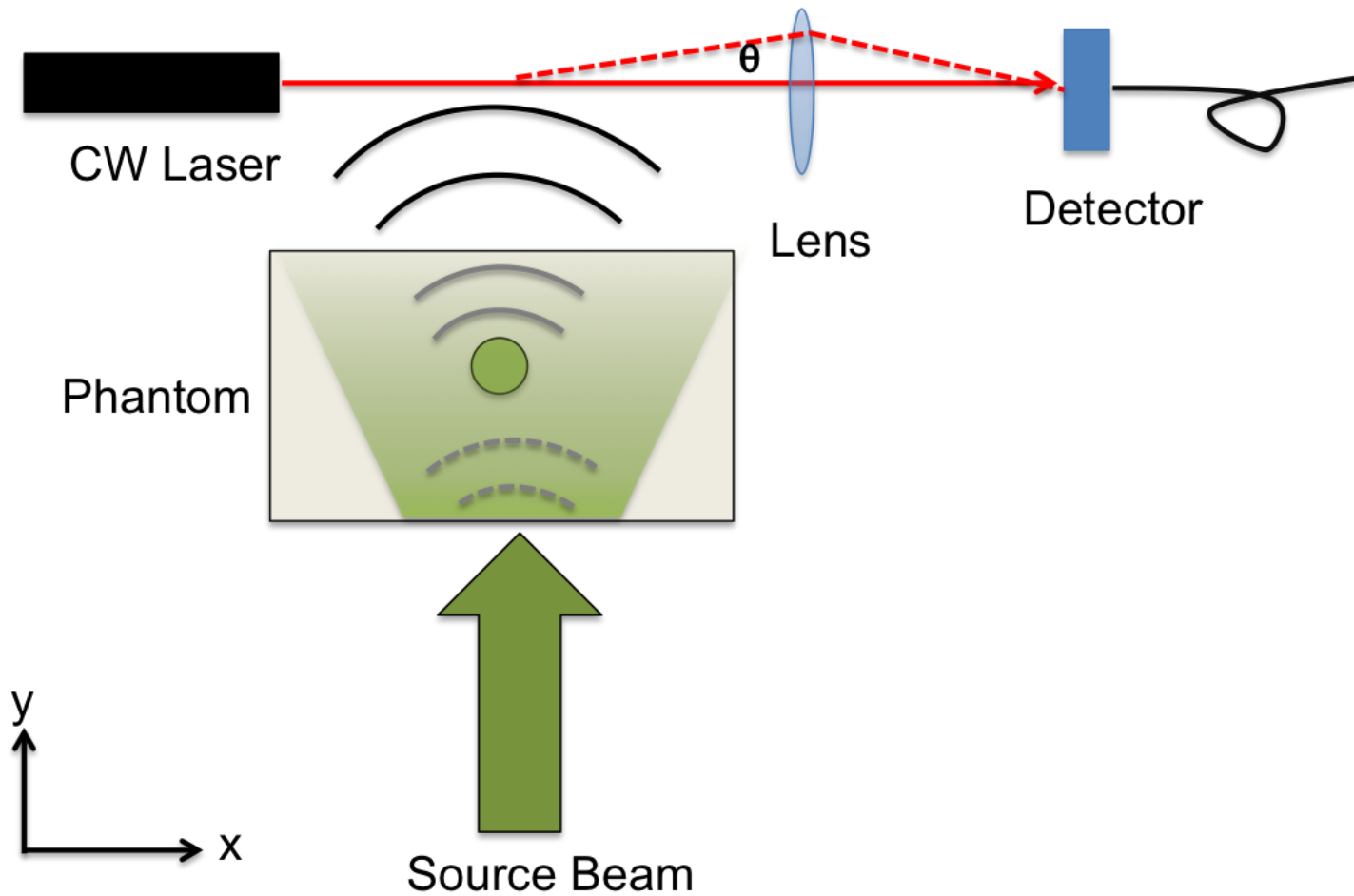


Gas-coupled Laser Acoustic Detector

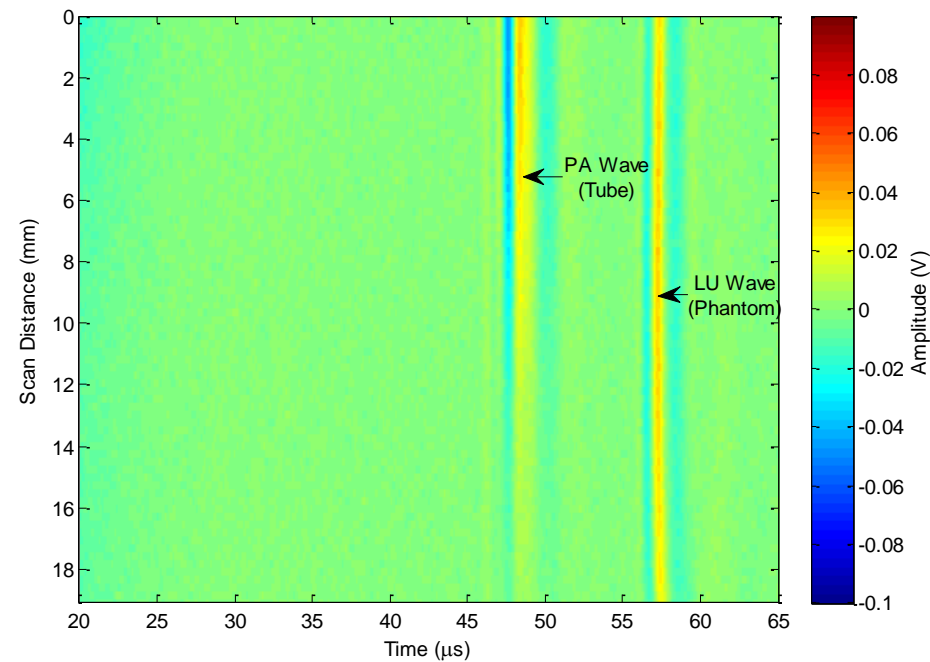
- ✓ Point-like spot size
- ✓ Noncontact
- ✓ Reflectivity doesn't matter
- ✓ Simple alignment
- ✓ Low cost and maintenance



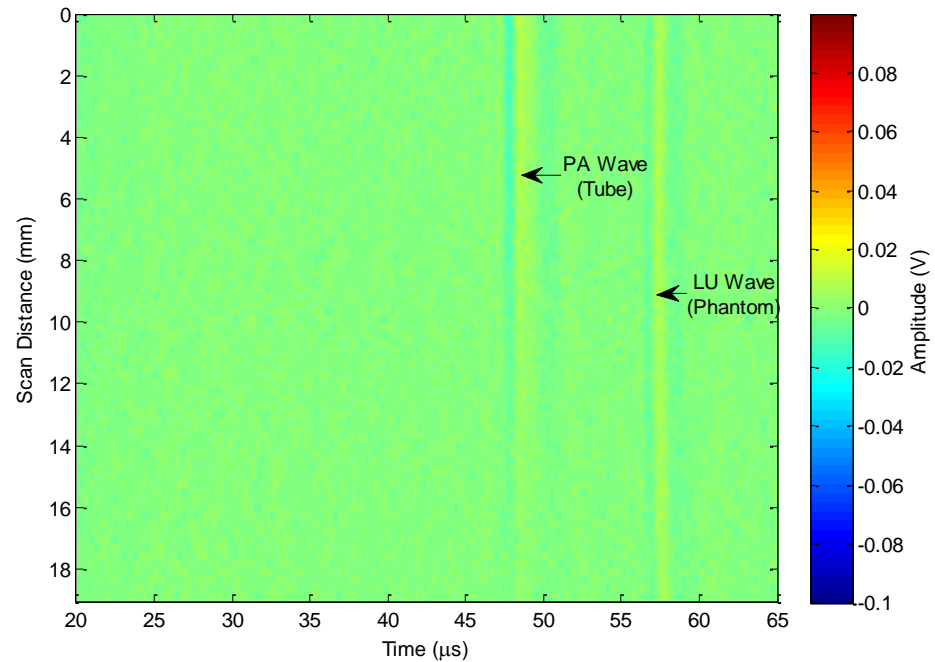
Setup



Preliminary Images with GCLAD

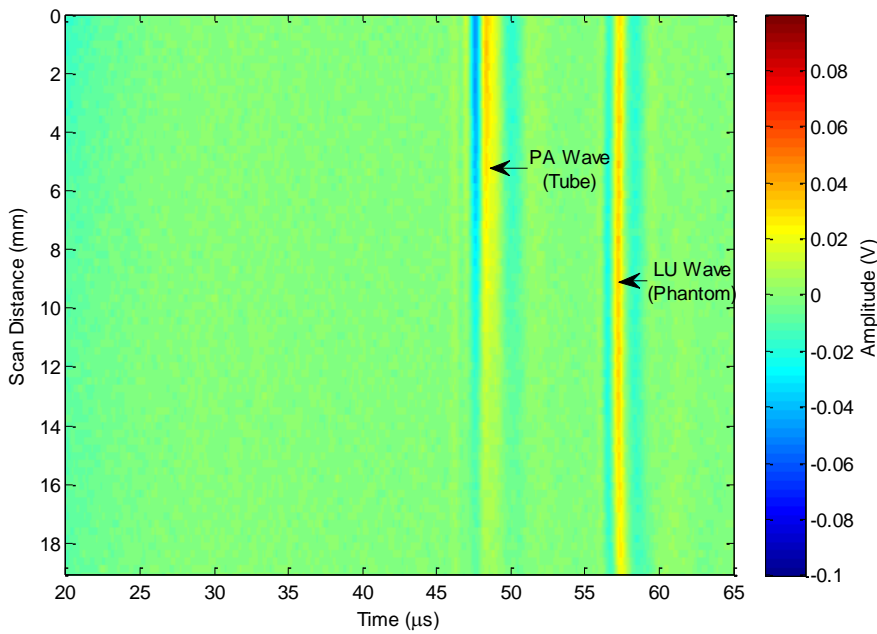


High Energy

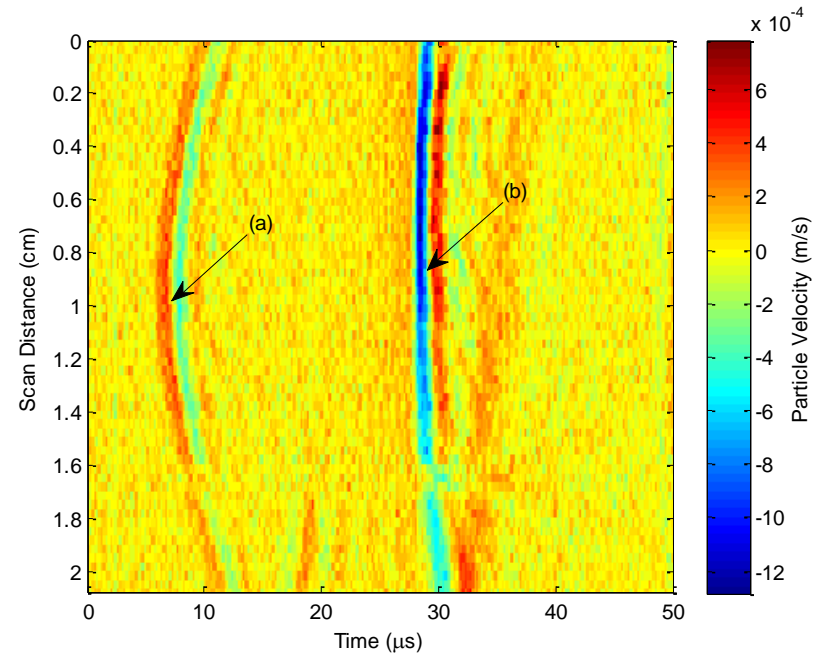


Low Energy

Comparison of Detectors



Low Cost GCLAD



High End Detector

Conclusions

- Designed and built GCLAD system for photoacoustic/laser-ultrasound imaging
- Feasibility of GCLAD detection in tissue phantoms shown
- Comparable sensitivity to state-of-the art vibrometer

Future Work

- Using the detector!
 - Optimize
- Phantom studies of artery surrogates with different characteristics of disease
- Geophysical image processing
- Try different configurations
 - Reflection mode
 - Curved surfaces



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THANK YOU