# Interventional Photoacoustic Registration

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# Paper Review

- S. Sethuraman, S. R. Aglyamov, J. H. Amirian, R. W. Smalling and S. Y. Emelianov, "Development of a combined intravascular ultrasound and photoacoustic imaging system", Proc. SPIE 6086, 60860F (2006); doi:10.1117/12.646372

# Project Update

- Currently working on
  - 532 nm three point experiment (Milestone 3)
  - Integration of a stereo camera (Milestone 4)
  - Registration between camera and US (Milestone 4)
  - BMEStart competition (Mile stone 5)
- Overall Status: **Project is On Time**

# Outline

- Introduction
- Methods
- Results
- Motivation
- Criticisms
- Possible Improvements

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# Introduction

- Imaging blood vessels and identifying vulnerable plaques
- Intravascular ultrasound (IVUS) combined with intravascular photoacoustic (IVPA) imaging system
- Other imaging techniques:
  - MRI
  - Electron-beam CT

# Introduction: IVUS

- Intravascular Ultrasound (IVUS) System
  - Two types of catheter

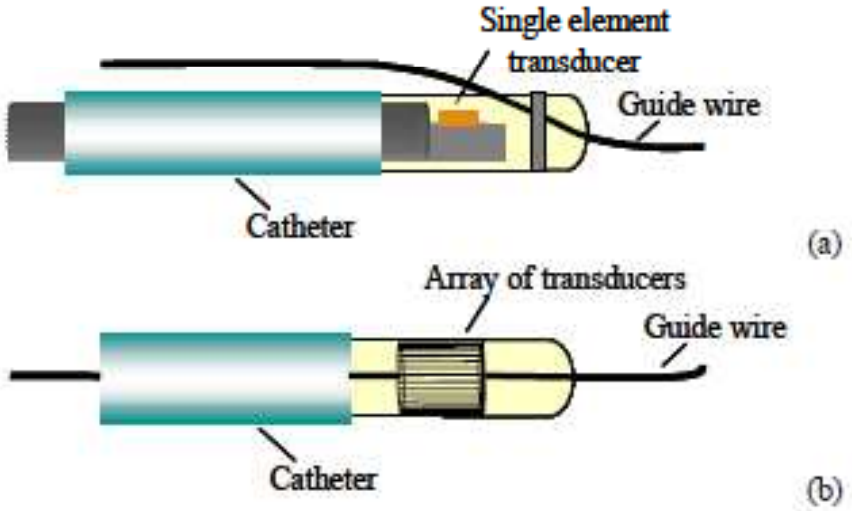


Image from S. Sethuraman, S. R. Aglyamov, J. H. Amirian, R. W. Smalling and S. Y. Emelianov, "Development of a combined intravascular ultrasound and photoacoustic imaging system", Proc. SPIE 6086, 60860F (2006); doi:10.1117/12.646372

# Introduction: IVPA

- Optical absorption wavelength
  - Red blood cells
  - Collagen
  - Plaques
- By varying the wavelength of the laser pulses, it is possible to identify different components

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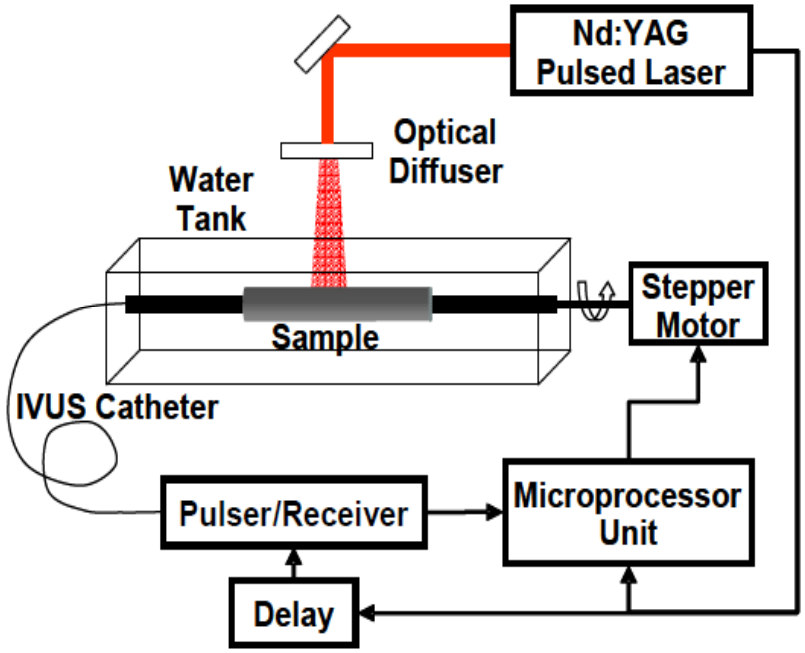
# Methods: Experimental Setup

- A motor was required to rotate the sample
- 532 nm or 1064 nm laser
- A ground glass optical diffuser to provide 1 mJ/cm$^2$ energy

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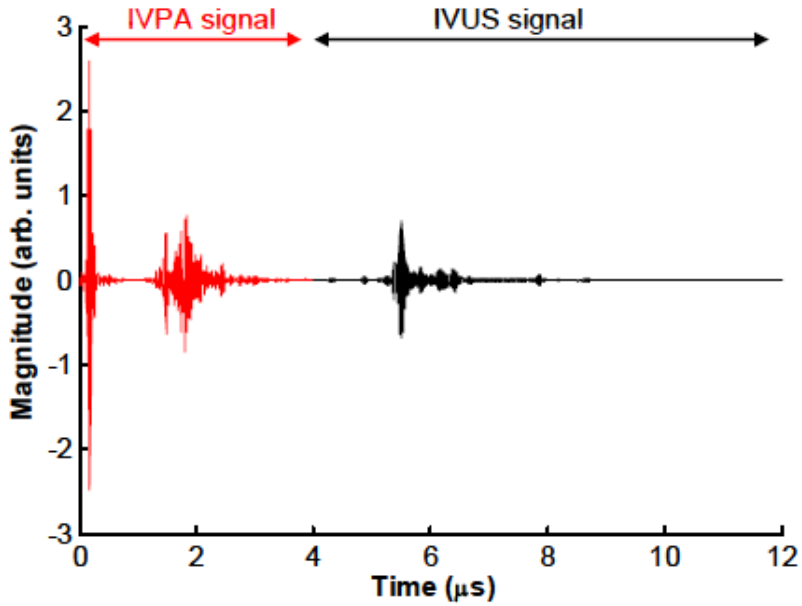
# Methods: Image Acquisition Scheme

- The laser system was fixed
- The sample had to be mechanically rotated
- IVPA system was initiated first, then IVUS was initiated
- Signal averaging, digital filters, and scan-conversion

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# Methods: Tissue-mimicking Vessel Phantoms

- Phantoms modeling arterial vessel wall and plaques
  - Poly vinyl alcohol (PVA)
  - Two optically absorbing inclusions

- Ex-vivo sample of a rabbit artery

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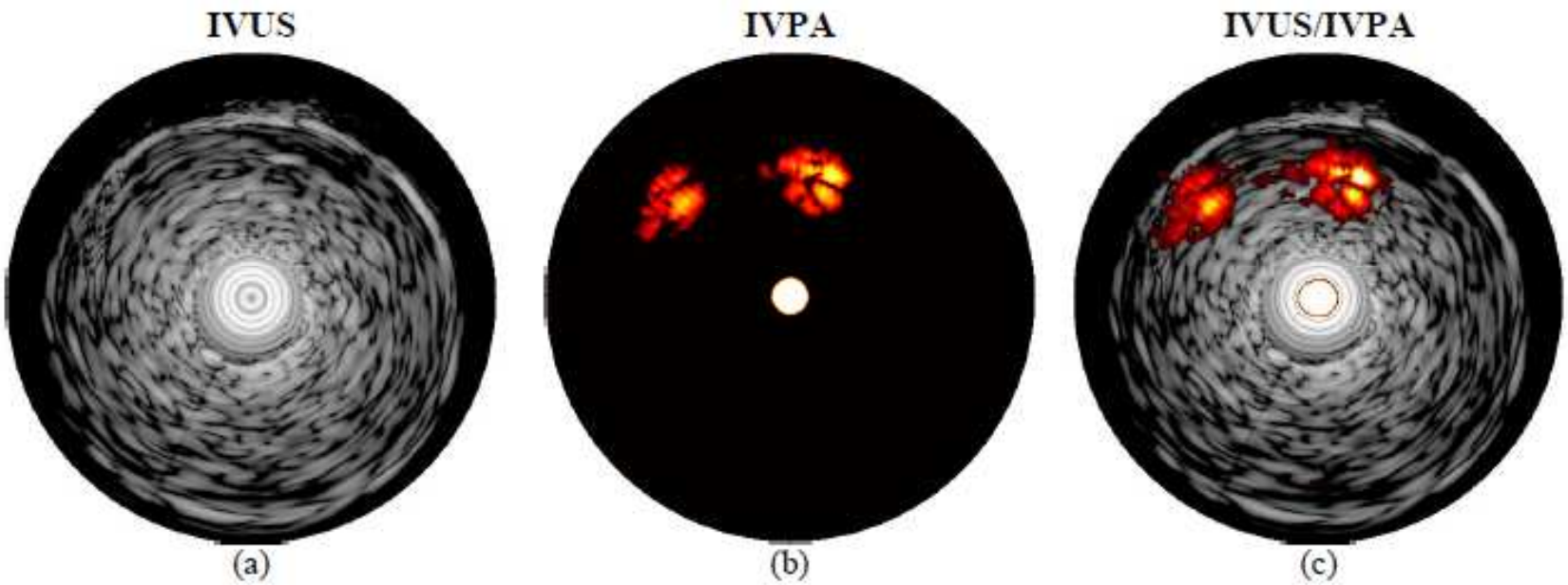
# Results: Phantom with Two Inclusions

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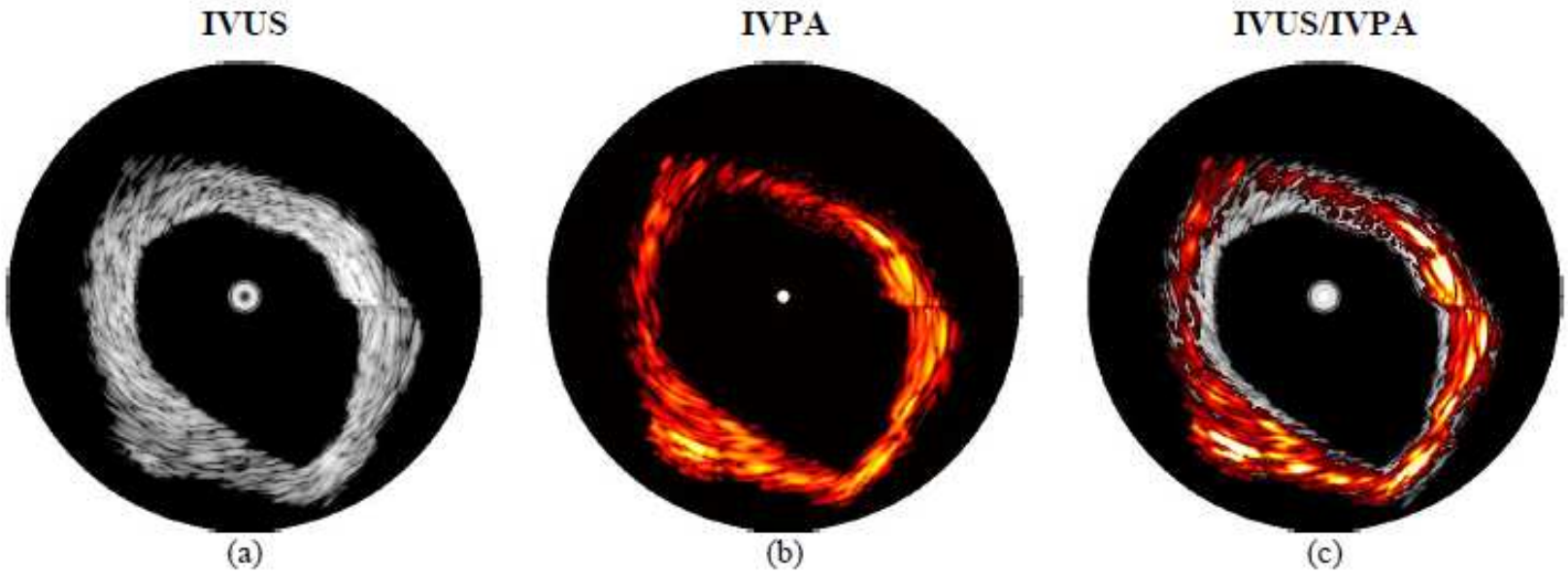
# Results: Ex-vivo Rabbit Artery

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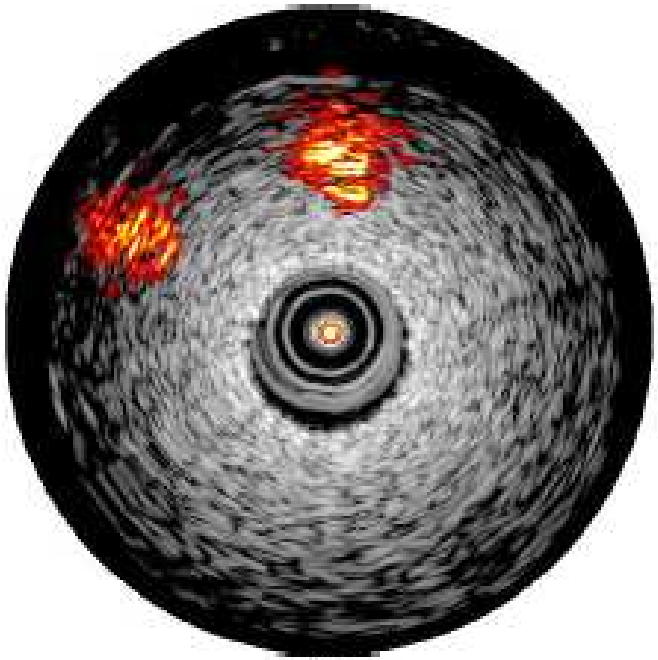
# Motivation

- Similarity
  - Photoacoustic imaging system combined with ultrasound system
  - Experimental setup
- Difference
  - Application of the combined imaging system
  - Integration of a stereo camera

# Motivation

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# Criticisms

- Why single-element IVUS transducer?
- Clinically feasible?
- What about identifying different components of plaques?

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# Possible Improvement

- Intravascular laser optic fiber
  - Optic fiber will be integrated with the IVUS single-element catheter
  - Rotation of the catheter (not the entire sample)
- Rotating intravascular laser optic fiber
  - IVUS catheter with an array of transducers
  - Rotation of the laser fiber

Thank you!