



UNIVERSITY OF  
**ILLINOIS**  
URBANA-CHAMPAIGN

# Predicting Sorptivity via Surface Wettability: A Computer Vision Approach

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Committee 135: Challenges in ML/AI for the Concrete Industry

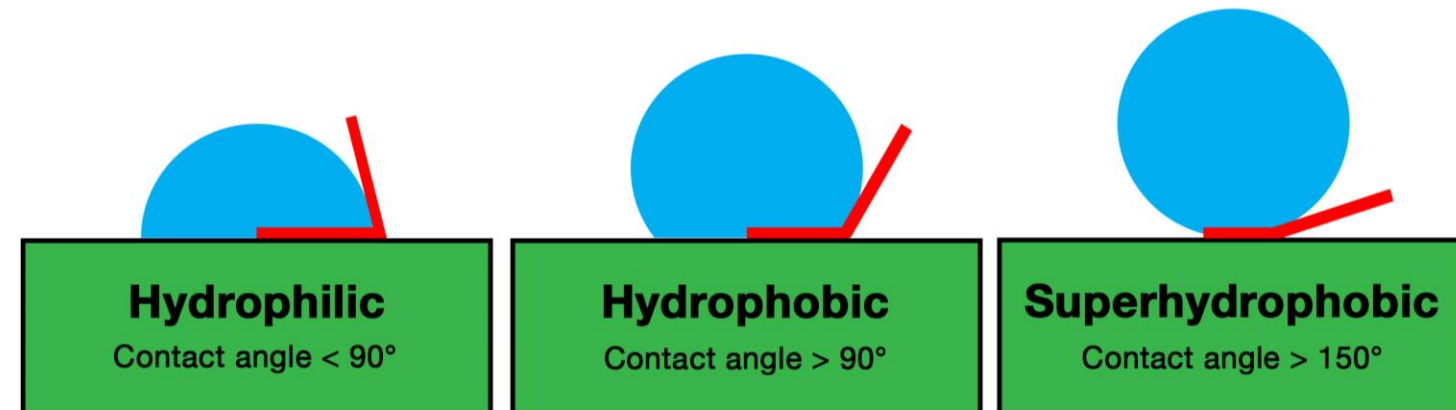
ACI Spring Convention, New Orleans

March 25<sup>th</sup>, 2024

# Introduction

## What is Contact Angle (CA)?

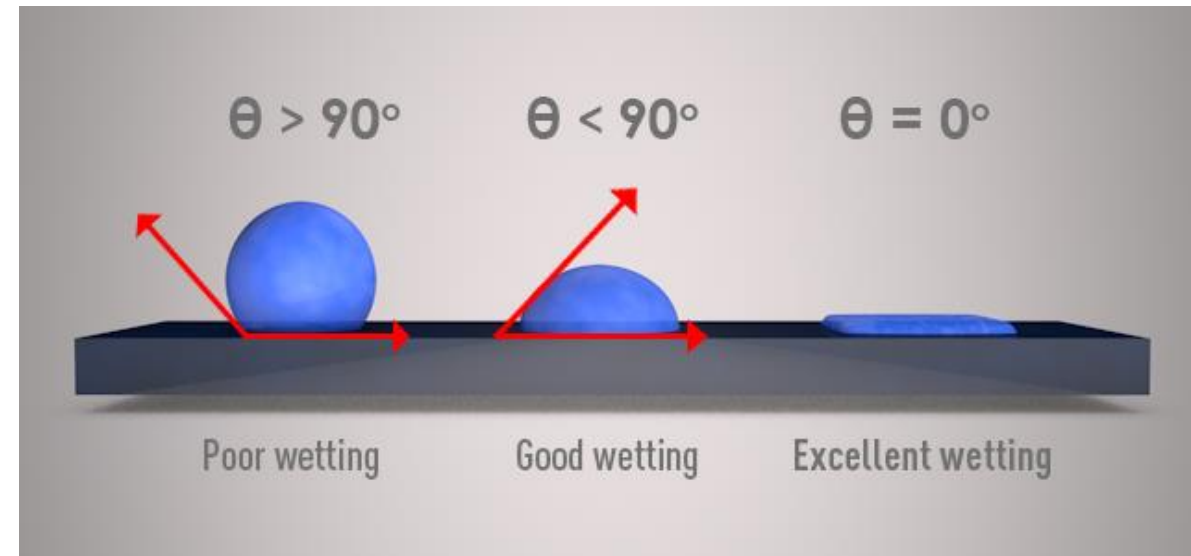
Contact Angle refers to the angle formed between a liquid droplet and a solid surface at the point of contact. It is a measure of how much the droplet **spreads or beads up** on the surface.



# Introduction

## What is Surface Wettability?

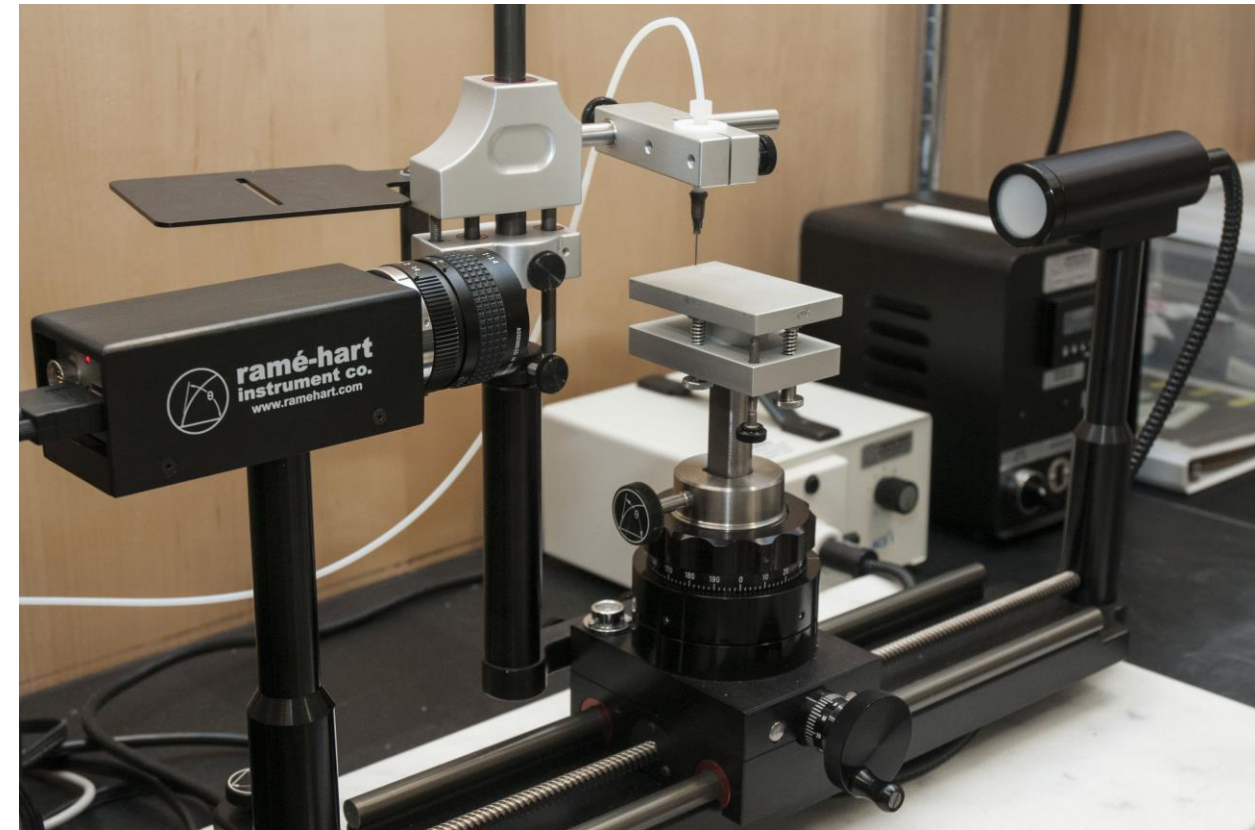
Wettability refers to the **ability of a liquid to spread or adhere** to a solid surface, determined by the balance between adhesive and cohesive forces.



# CA Goniometer

## Commercial CA Goniometer?

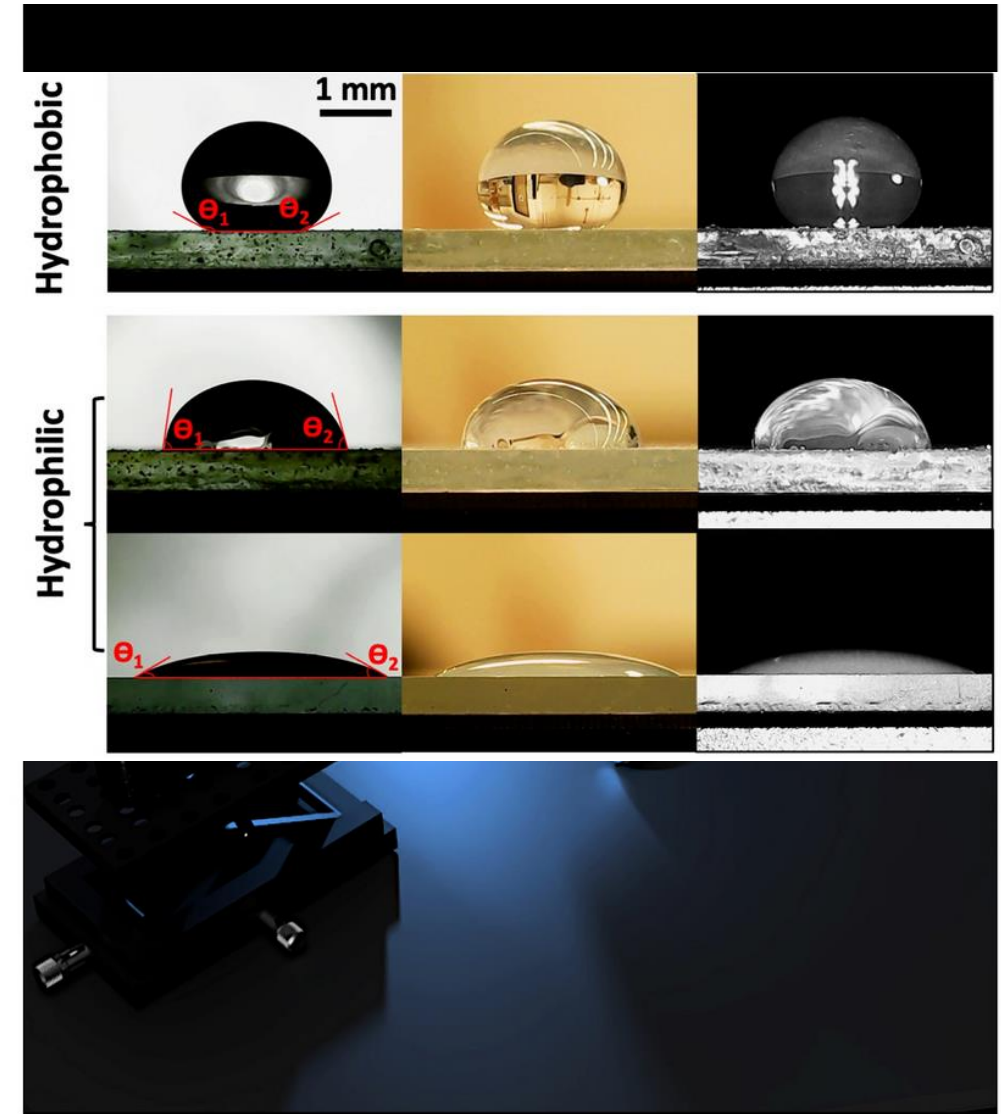
Commercial goniometers require **licensed** software and typically have a price tag of approximately **~ \$40-60k.**



# CA Goniometer

## A Cheaper CA Goniometer?

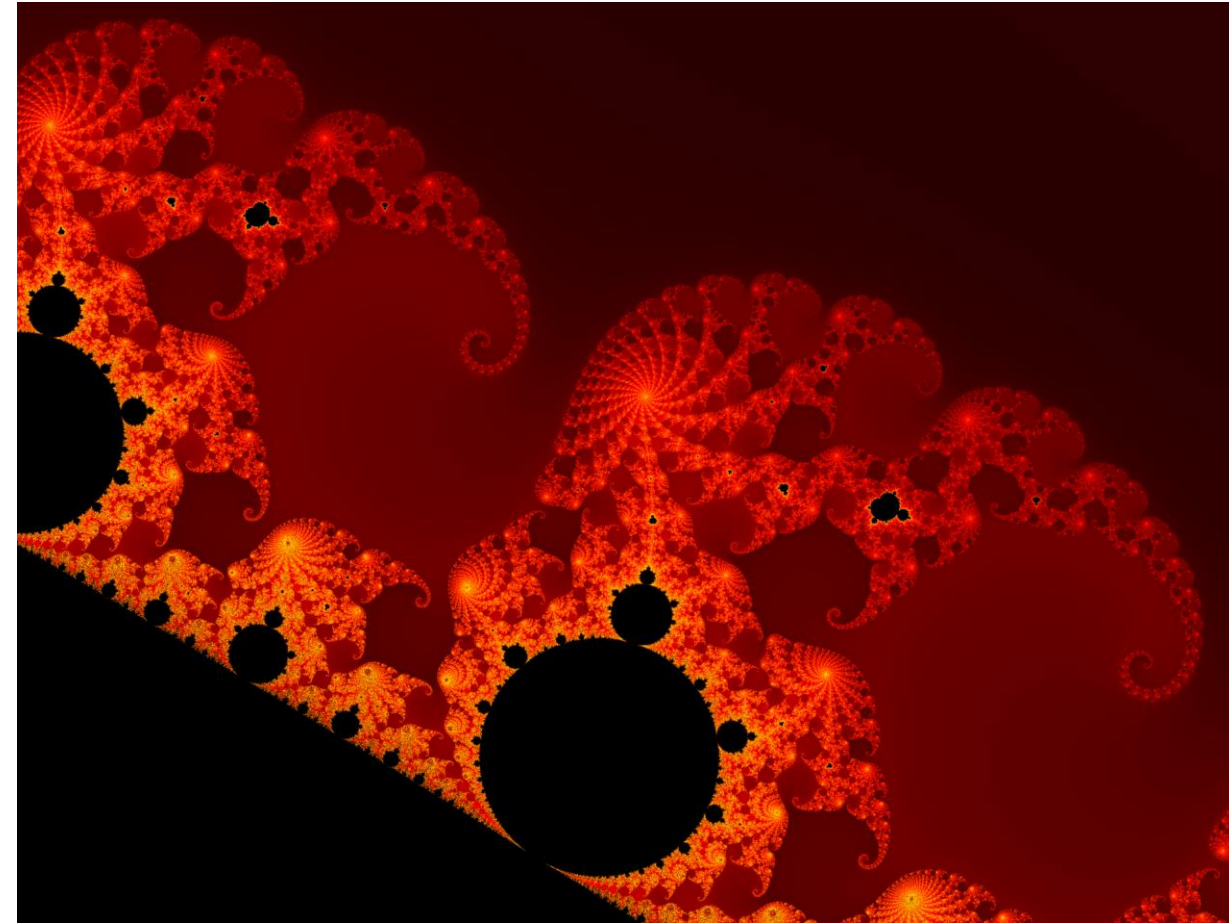
We have developed an affordable two-camera setup costing **\$175**, utilizing **machine learning**, to provide free accessibility and distribution for this purpose.



# CA Goniometer

## How to Train the ML Model?

## Kolmogorov Complexity

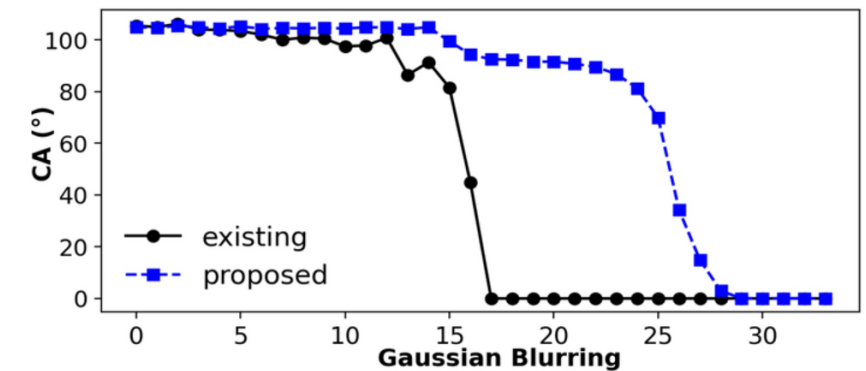
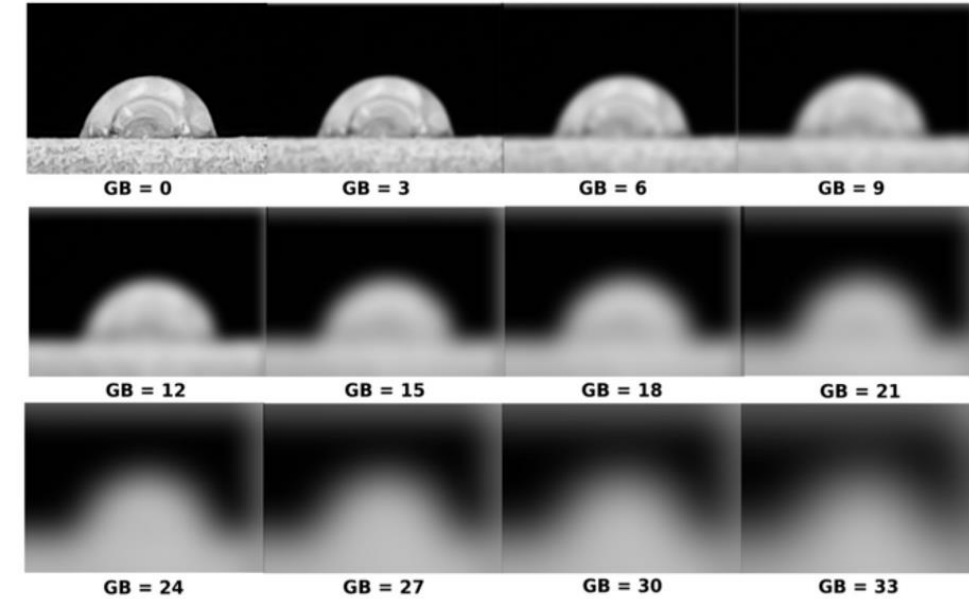
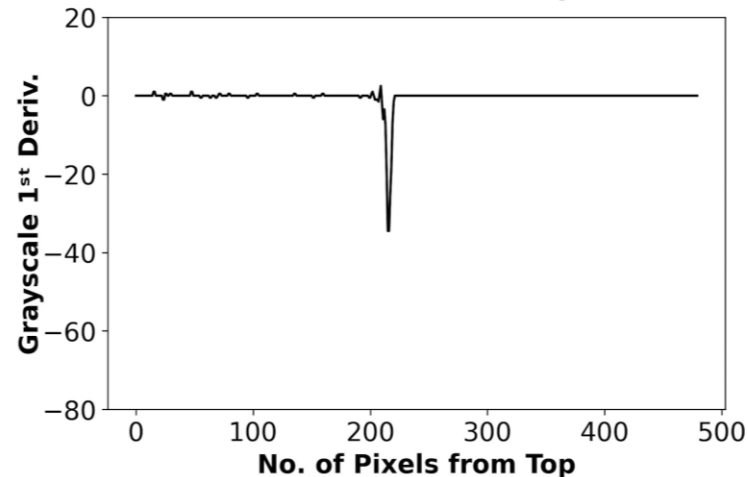
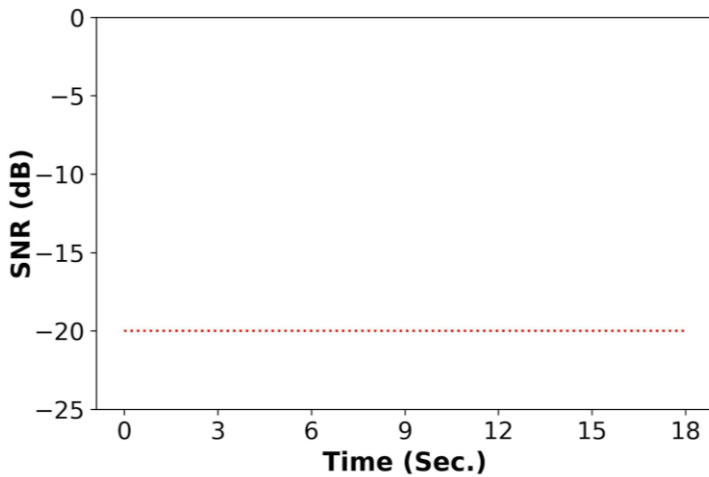
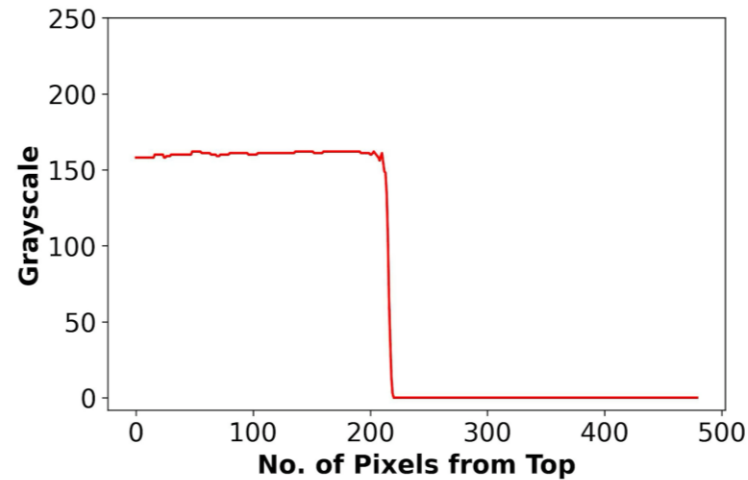


the length of the **shortest** computer program that produces the object as output

# CA Goniometer

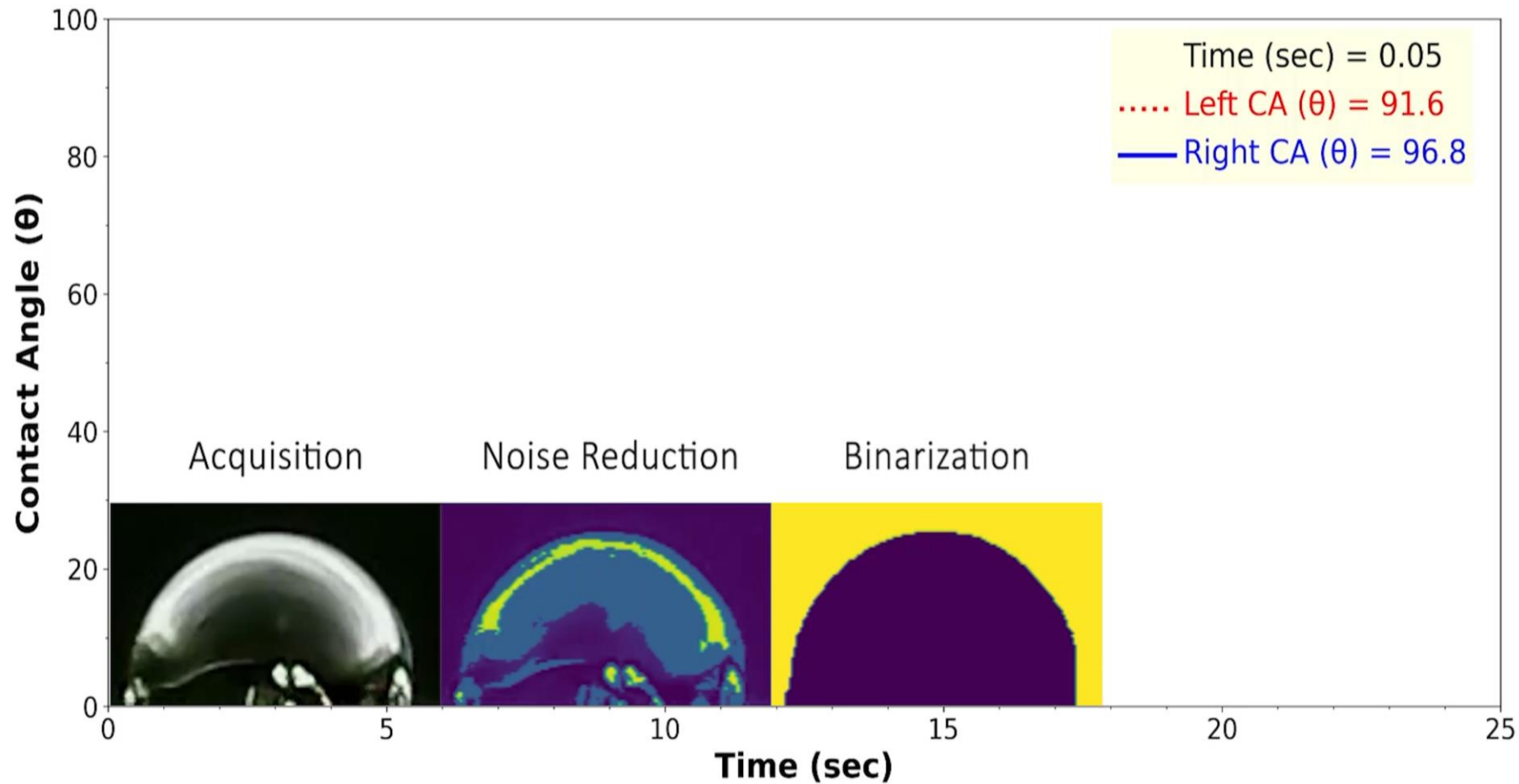
## Acutance Requirement of Drops?

SNR = -18.74 dB



# CA Goniometer

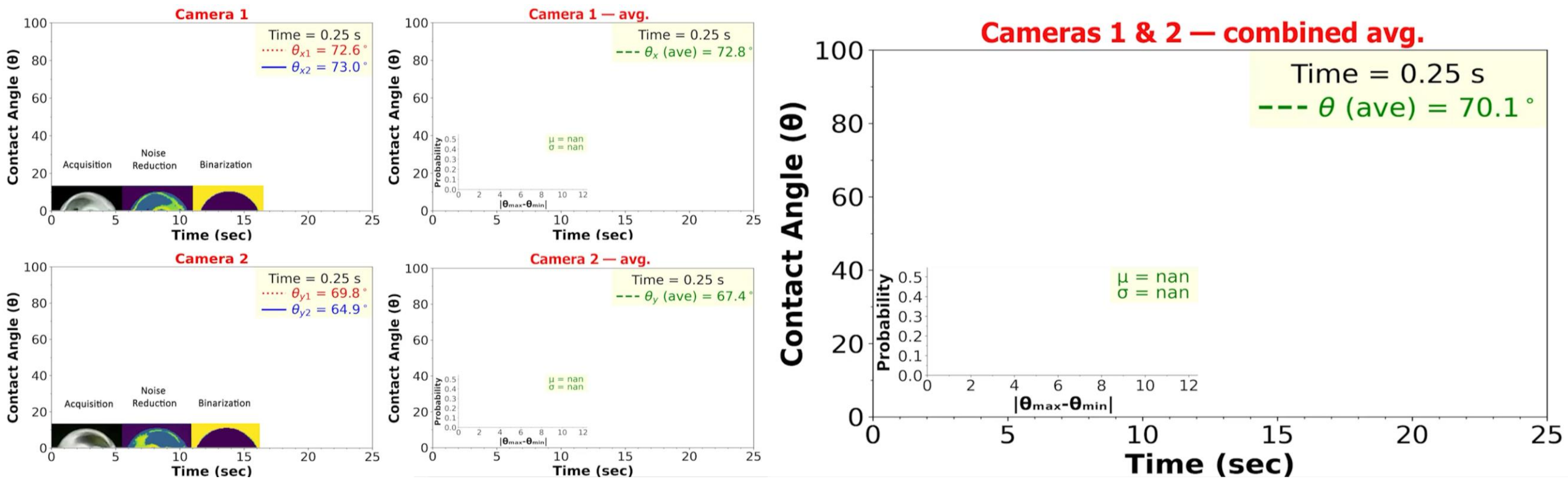
## Analysis of a Moving Drop (single view)?





# CA Goniometer

## Analysis of a Moving Drop (dual view)?



# Sorptivity Analysis

## What is Sorptivity?

Sorptivity refers to the ability of cement-based materials to absorb and transport water through **capillary** action.

Sorptivity measurements (ASTM C1585) can be **time-consuming** and **labor-intensive**, requiring monitoring over extended periods.

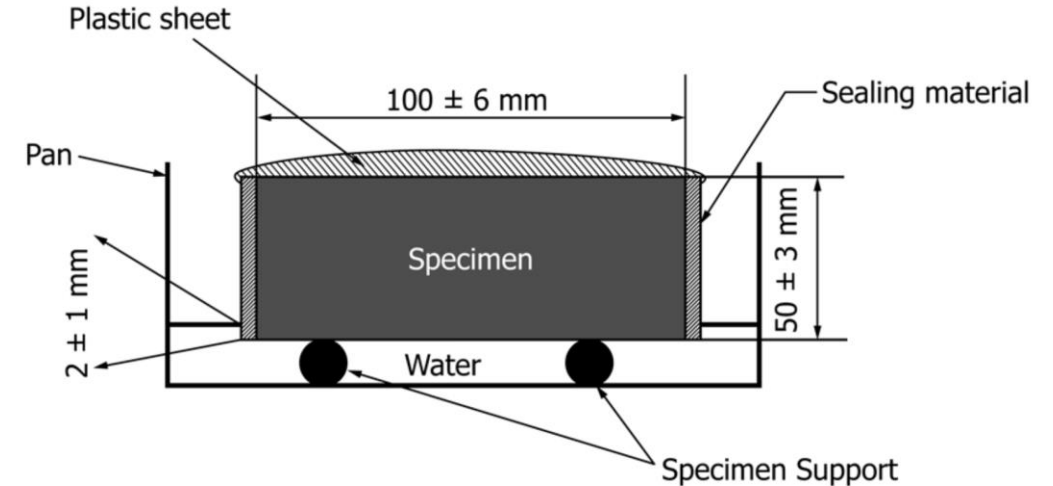
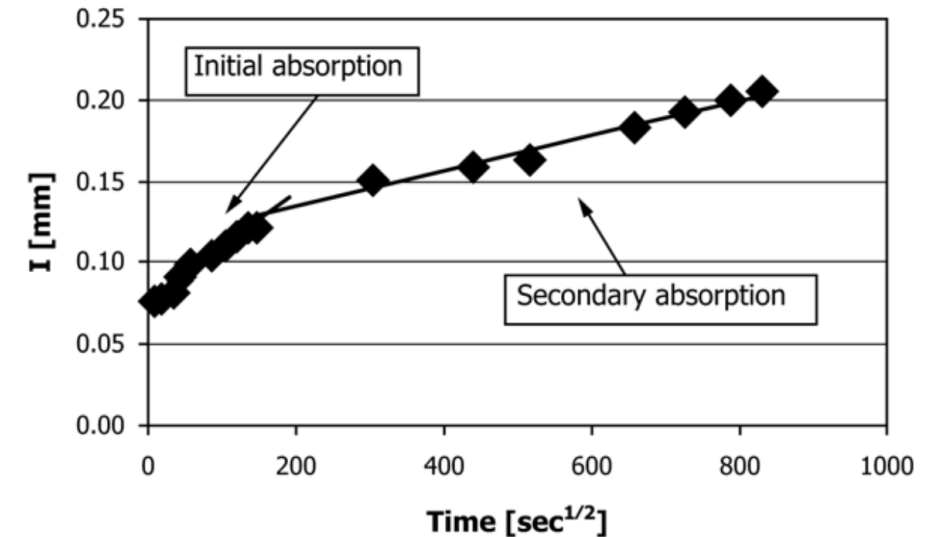
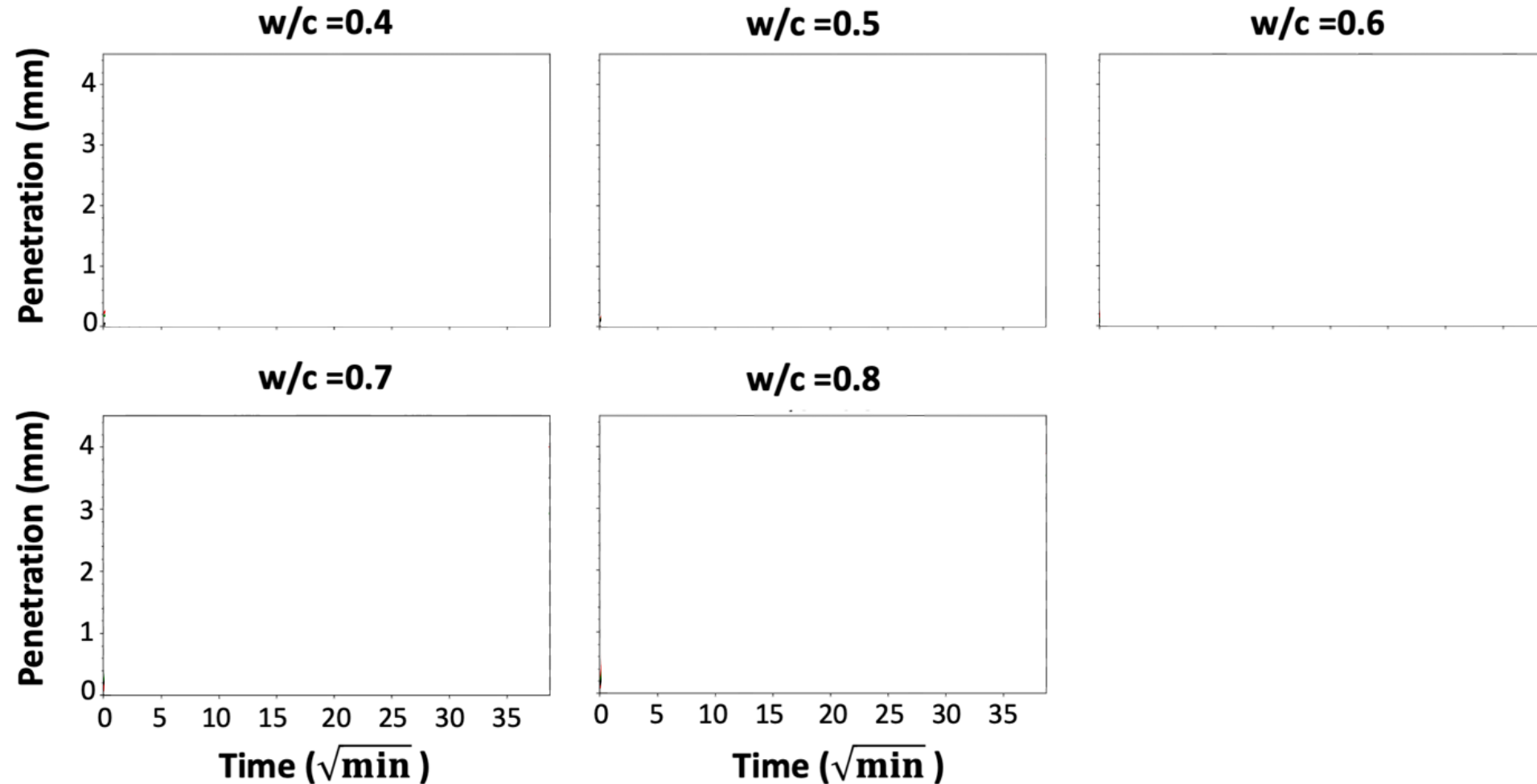


FIG. 1 Schematic of the Procedure



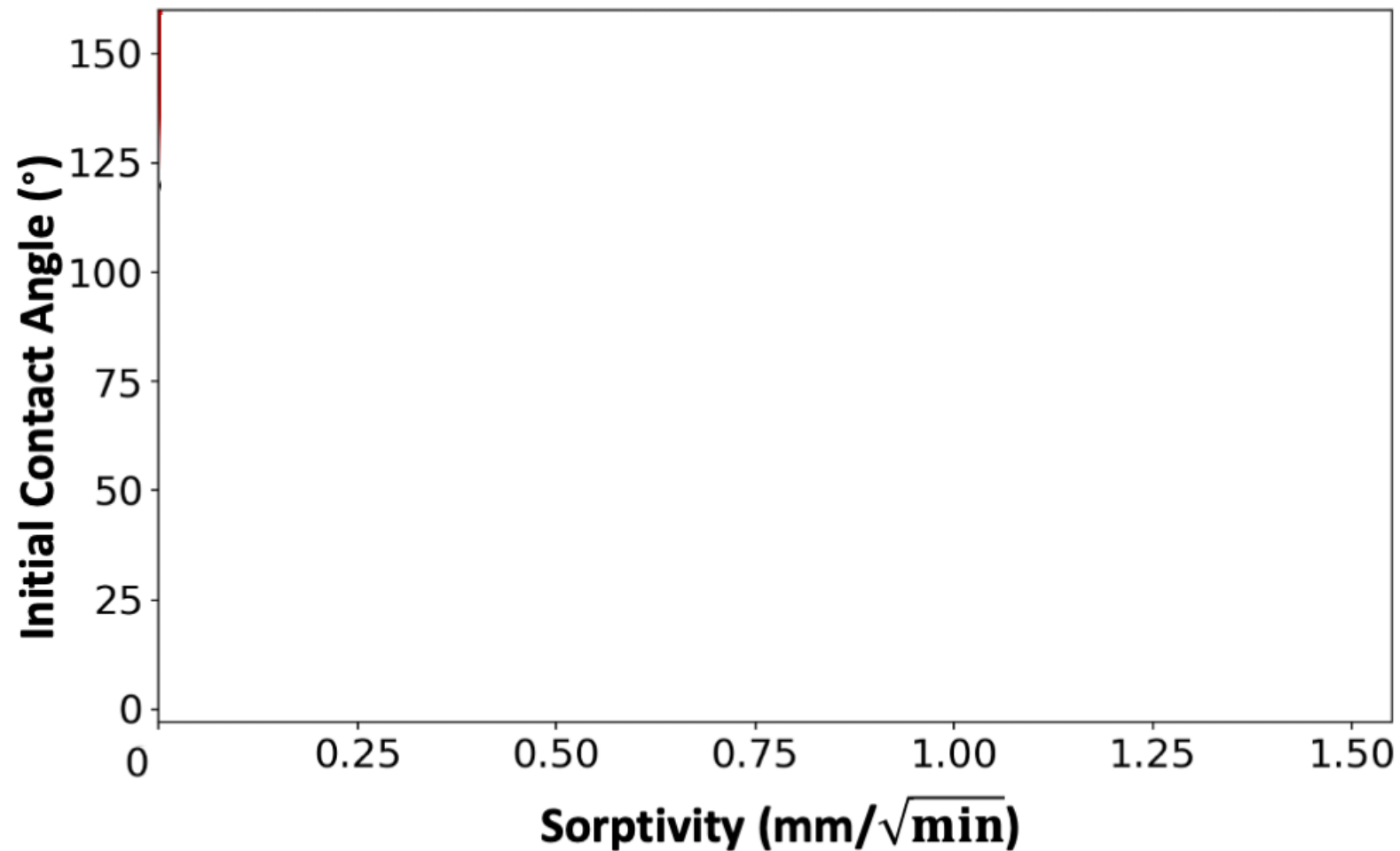
# Sorptivity Analysis

## Traditional Sorptivity Measurements?



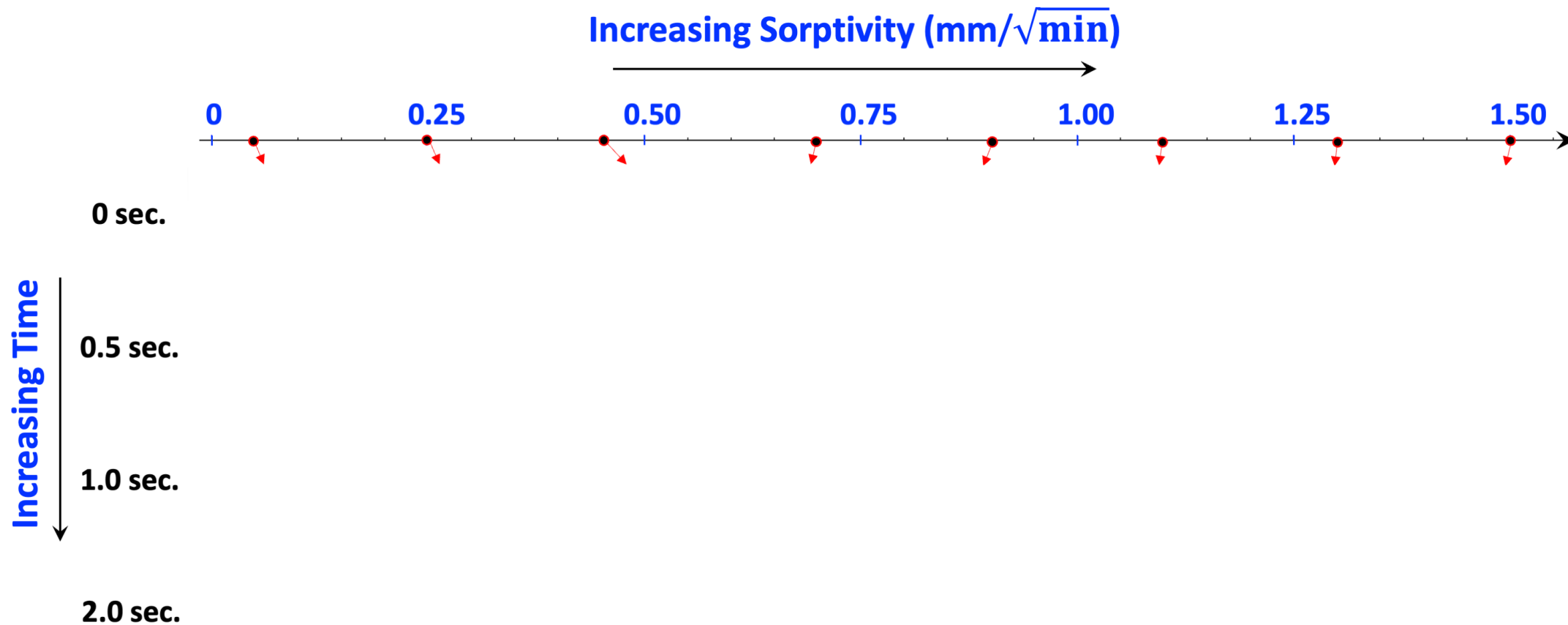
# Sorptivity Analysis

## Estimation of Initial Sorptivity?



# Sorptivity Analysis

## Surface Wettability vs Sorptivity?



# Sorptivity Analysis

## Surface Wettability vs Sorptivity?

### **Evolving Drop Volume as a Function of Sorptivity**

by

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Kabir & Garg, *npj Materials Degradation*, 2023

# Outlook

- Our developed orthogonally aligned goniometer outperforms commercial models by being more **cost-effective**, highly precise with **unfocused drops**, obviating the need for licensed software, and capable of **capturing surface heterogeneity**.
- We have discovered a rapid method to estimate the initial sorptivity of cementitious systems via dynamics of drop spreading (in just **a few minutes**), establishing **strong correlations** with traditional labor-intensive measurements.

Kabir, H., & Garg, N. (2023). Machine Learning Enabled Orthogonal Camera Goniometry for Accurate and Robust Contact Angle Measurements. *Scientific Reports*, 13(1), 1497.

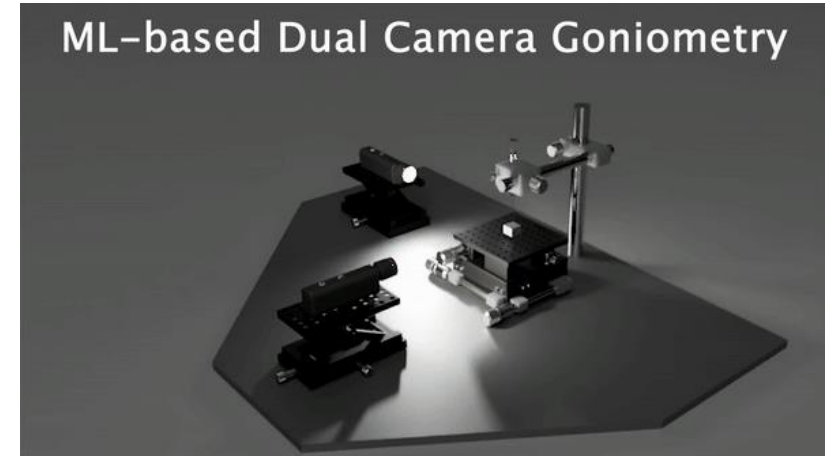
Kabir, H., & Garg, N. (2023). Rapid Prediction of Cementitious Initial Sorptivity via Surface Wettability. *npj Materials Degradation*, 7(1), 52.

# Acknowledgements



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ML-based Dual Camera Goniometry



Garg Group  
[garg.cee.illinois.edu](http://garg.cee.illinois.edu)