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DVC Challenge: Project Update

Brendan Croom
Mechanical and Aerospace Engineering
University of Virginia

Helena Jin
Sandia National Laboratories

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DVC Challenge Objectives

- Characterize DVC error modes with different laboratory XCT equipment
- Establish XCT and DVC “best practices”- what are key experimental parameters that influence DVC accuracy?
- Build DVC research community through collaborative experiments

DVC Challenge Overview

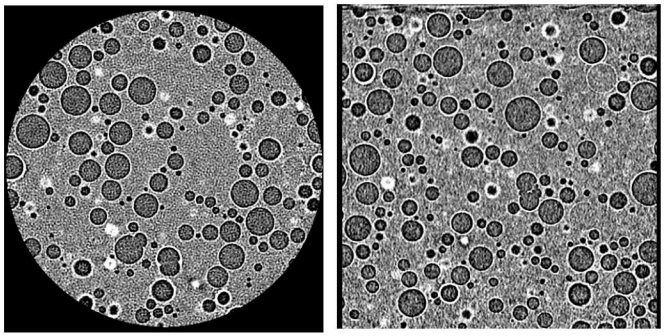
- Four participants with laboratory (cone-beam) XCT equipment
- At each lab:
  - Receive GMB/Sylgard syntactic foam specimens (from SNL-CA)
  - Perform *uniform set* of rigid body motion experiments
  - Each lab determines appropriate set of XCT parameters

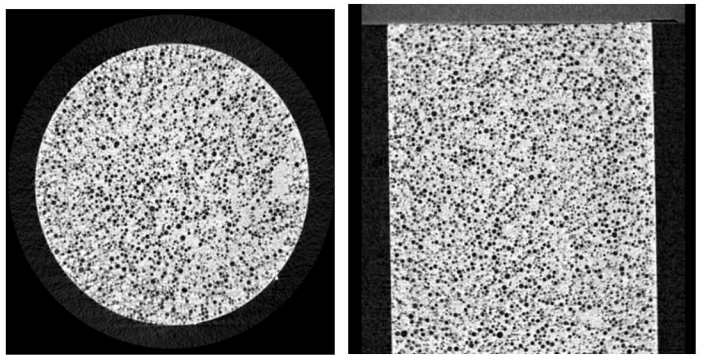
Material: Sylgard® 184 Impregnated with A16 Glass Micro-Balloons (GMBs)

Sylgard 184 Impregnated with A16 GMBs:

- GMBs randomly mixed with Sylgard resin
- GMBs with average size 70 μm and 10%~90% distribution at 35~ 115 μm
- Syringe-molded cylinder specimens with different diameters and volume fractions
- Hollow GMBs and Sylgard resin provide nice contrast and pattern in XCT image

Syringe molded Sylgard specimens





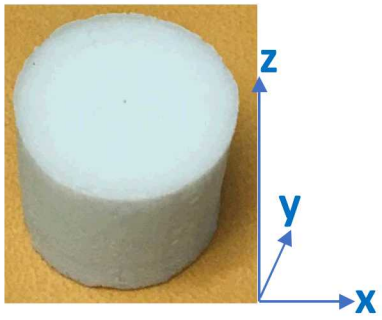
XCT image of Sylgard with GMBs

Designed Scans

Specimens:

Cylinder Sylgard specimen

- diameter 5 mm
- height 5 mm
- 30%vol GMB
- GMB 70 μm



Scan parameters:

- Scan size : 8x8 mm
- Image size: 500 x 500 voxels
- Speckle size varies mostly from 5~15 voxels in diameter

Test scans:

(1) Sample centered on the rotation stage and collect three consecutive scans without any change; (sample axis and rotation axis aligned)

(2) Offset specimen in Z direction by 1.0mm and take two repeatable scans.

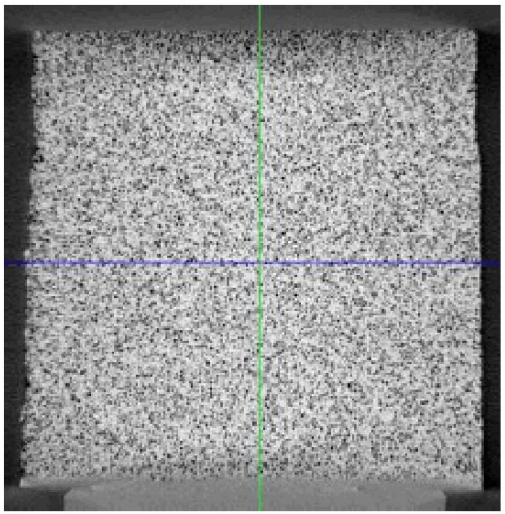
(3) Back to original Z and offset specimen 1mm in X axis (specimen and rotation axis offset 1mm) and take two repeatable scans.

- Total of 7 scans, 3 for consecutive scans without any change and 4 for rigid body motion.

Experiment Overview

Materials:

- Syntactic foam with ~37% GMBs
- Repeatable manufacturing process – controlled GMB size and porosity
- Previously demonstrated to produce high-quality DVC results [1,2]



Procedure:

- Reference scan
- Repeat motion scans
- Axial motion scans
- Radial motion scans

Scan coordinates (mm):

Scan ID	XCT 1	XCT 2	XCT 3a	XCT 3b
Scan 0 (reference)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)
Repeat 1	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)
Repeat 2	(0, 0, 0)	(0, 0, 0)	-	-
Axial 1	(0, 0, 1)	(0, 0, 1)	(0, 0, 1)	(0, 0, 0.2)
Axial 2	(0, 0, 1)	(0, 0, 1)	-	-
Radial 1	(1, 0, 0)	-	-	-
Radial 2	(1, 0, 0)	-	-	-

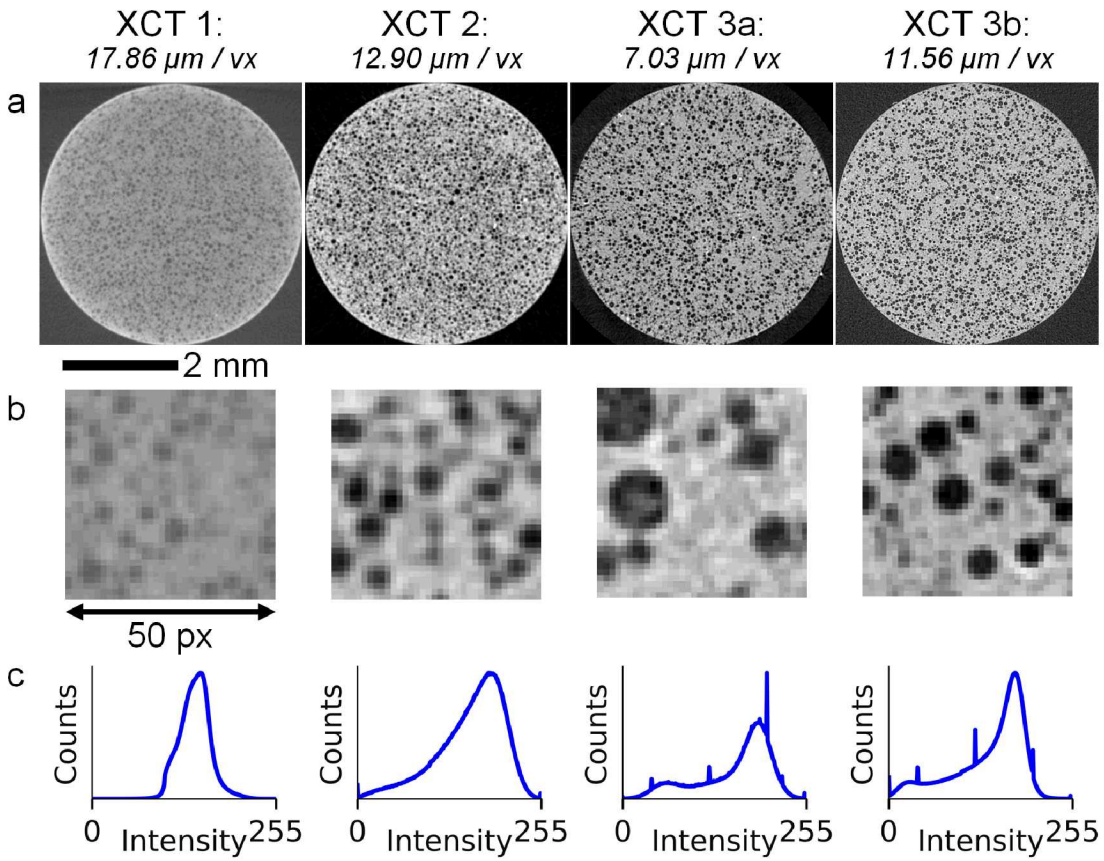
[1] Croom, *Composites Science and Technology*, 2019

[2] Croom, *Experimental Mechanics*, in press

DVC analysis parameters

- “Local” DVC implementation (Vic Volume)
- All analyses are normalized based on voxel size
  - Subset size, step size, strain filter are scaled based on voxel size

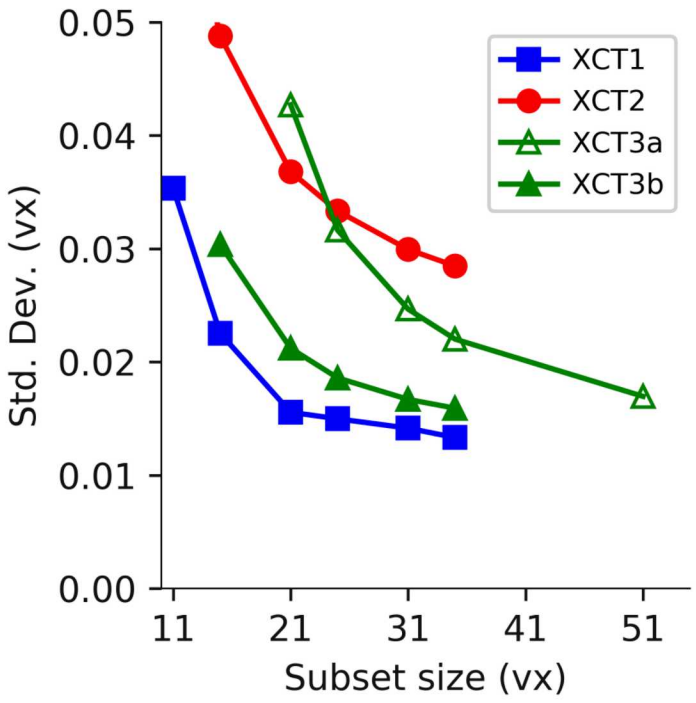
Preliminary Results



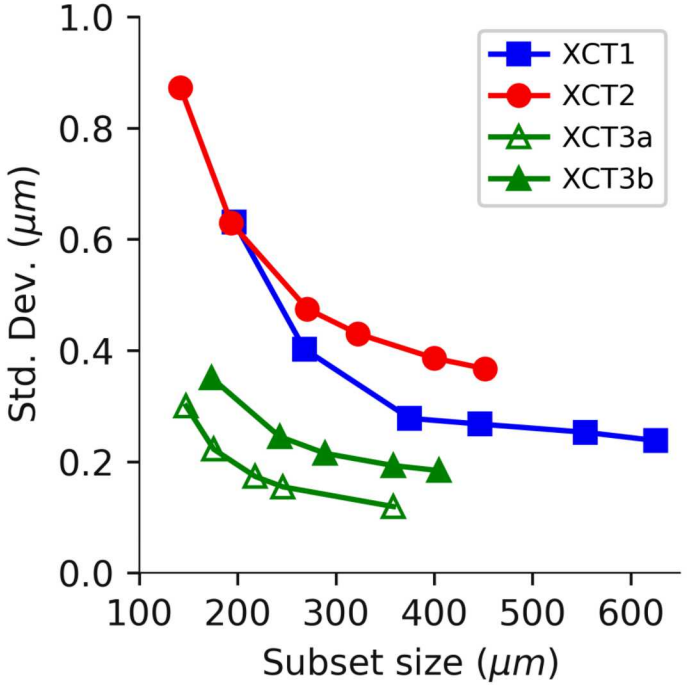
Preliminary Results

Repeat scans:
Y-direction displacement *noise*
(noise = St. Dev. of artificial displacements)

Noise in voxels:



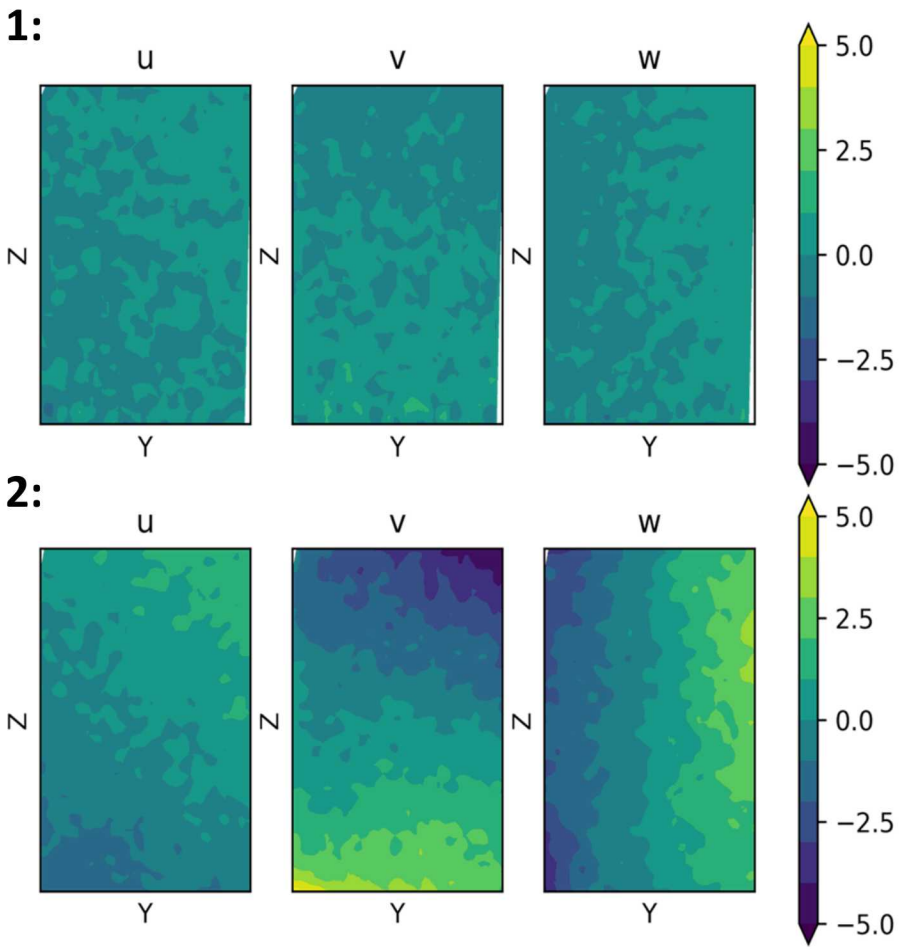
Noise in µm:



Preliminary Results

XCT systems have unique systematic error profiles

Displacement after repeat scan



Artificial displacement (µm, rigid translation subtracted)

Artificial displacement (µm, rigid translation subtracted)

Z (Axial)

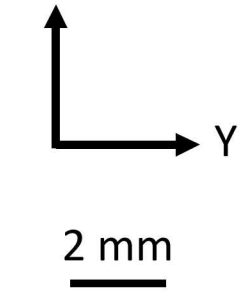
Y

2 mm

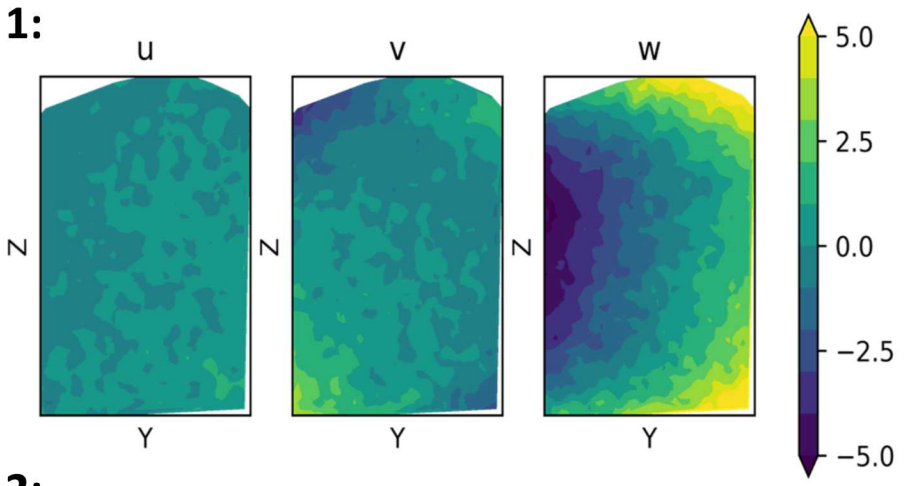
Preliminary Results

XCT systems have unique systematic error profiles

Displacement after 1 mm axial motion

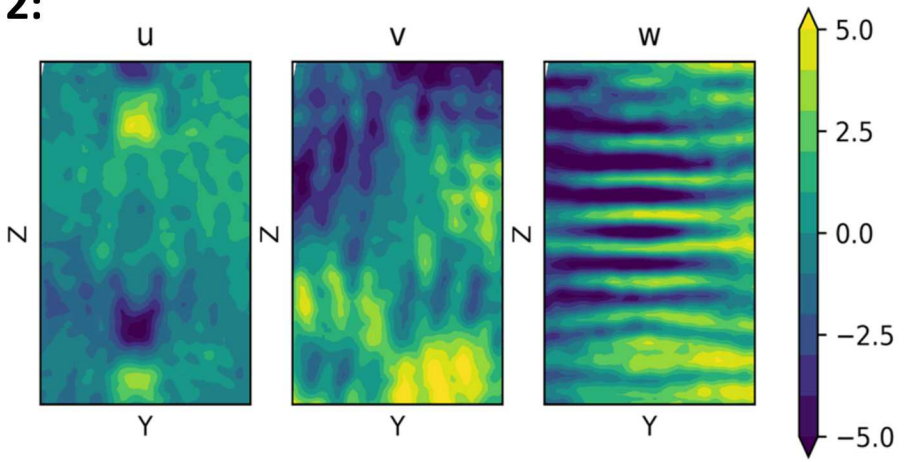


XCT 1:



Artificial displacement (µm, rigid translation subtracted)

XCT 2:

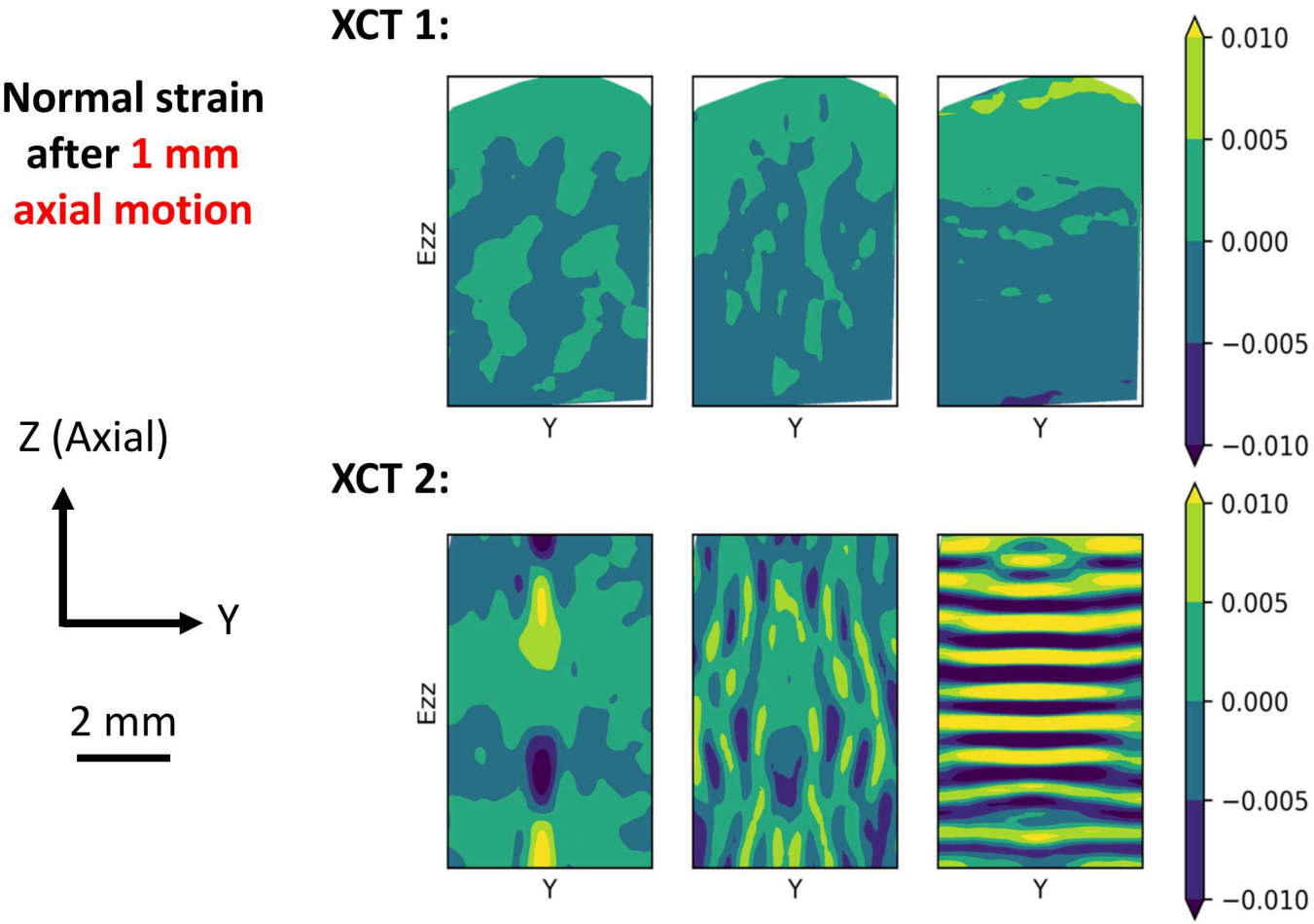


Artificial displacement (µm, rigid translation subtracted)

Preliminary Results

XCT systems have unique systematic error profiles

Normal strain after 1 mm axial motion



Ongoing work

- Hoping to collect more datasets from different micro XCT.
- Summarize results for journal publication?