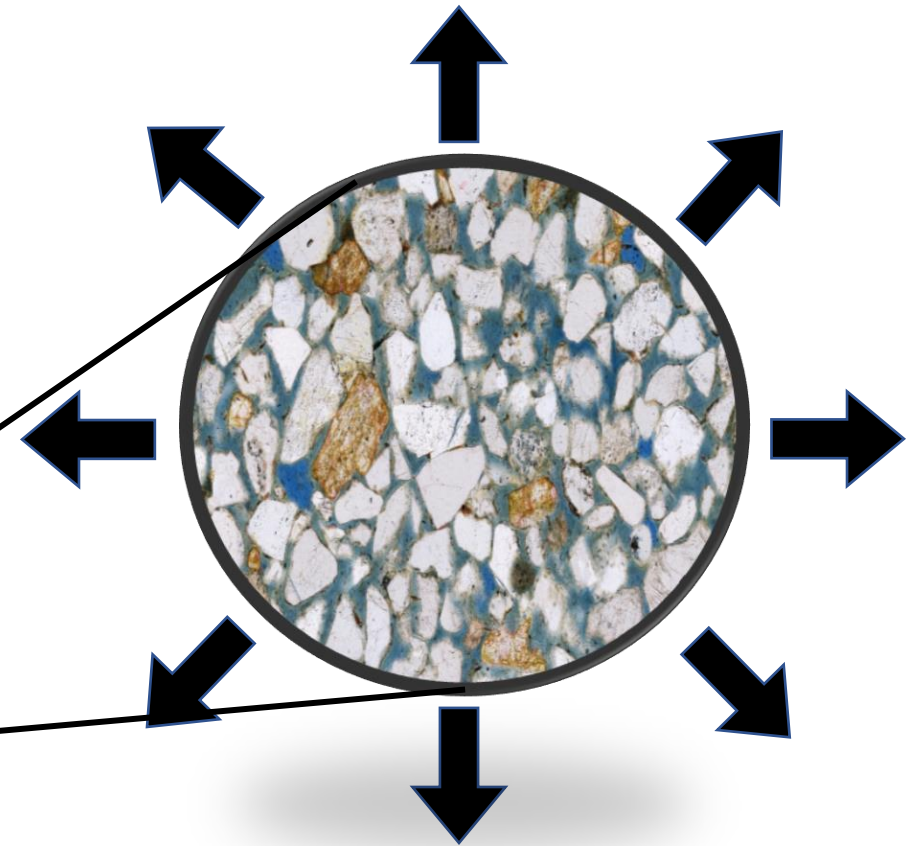# On the Deformation of Porous Medium by Pressurized Flow
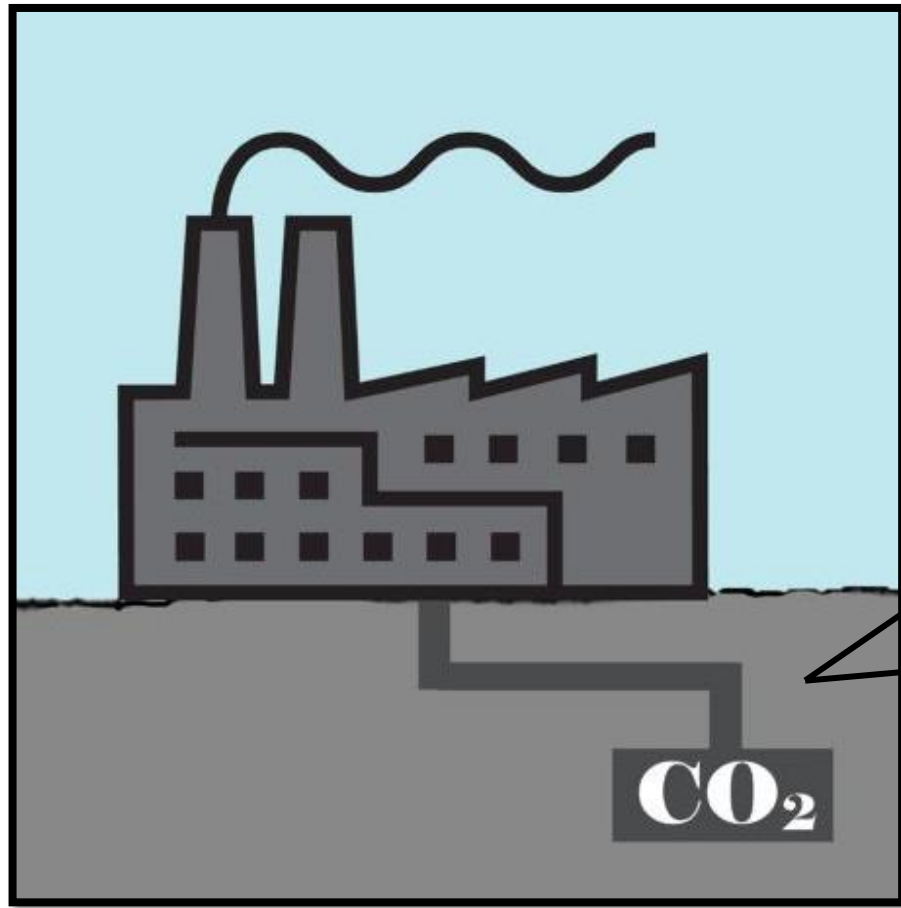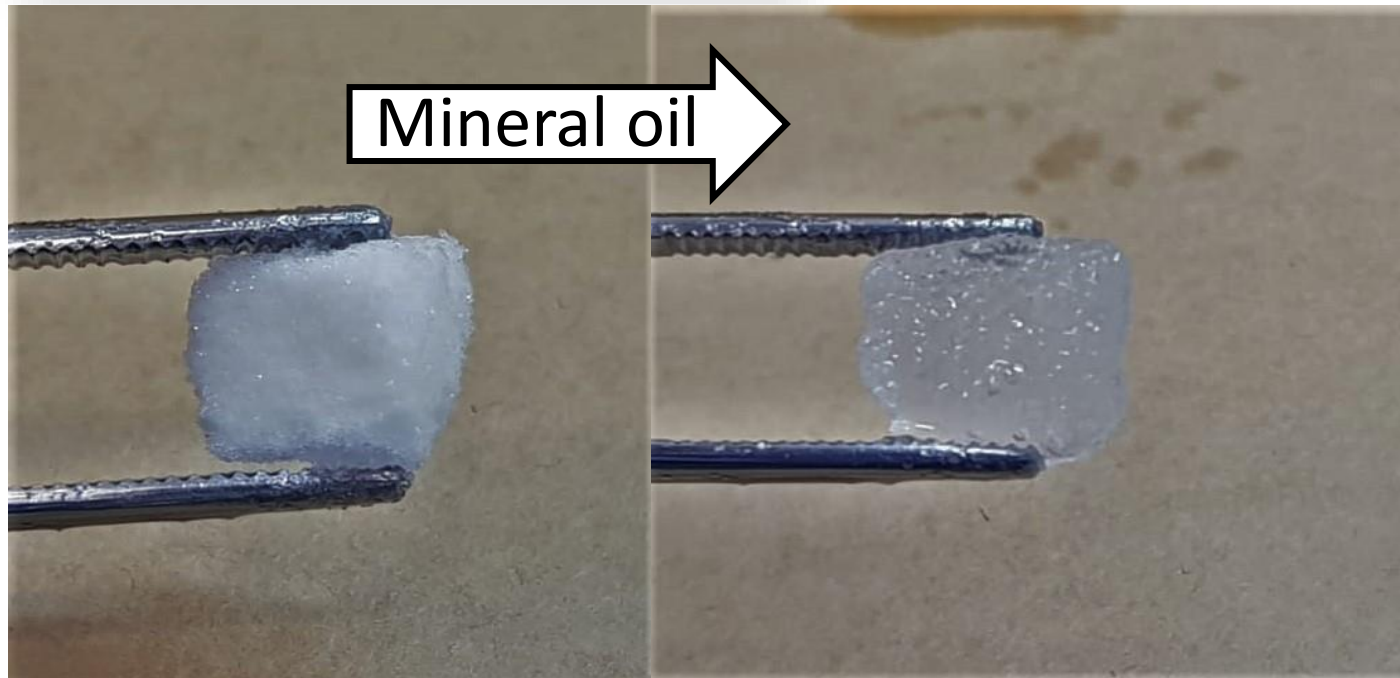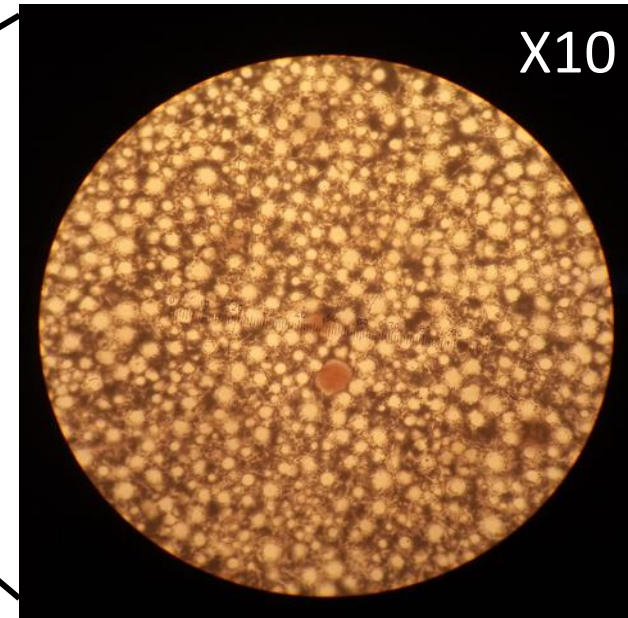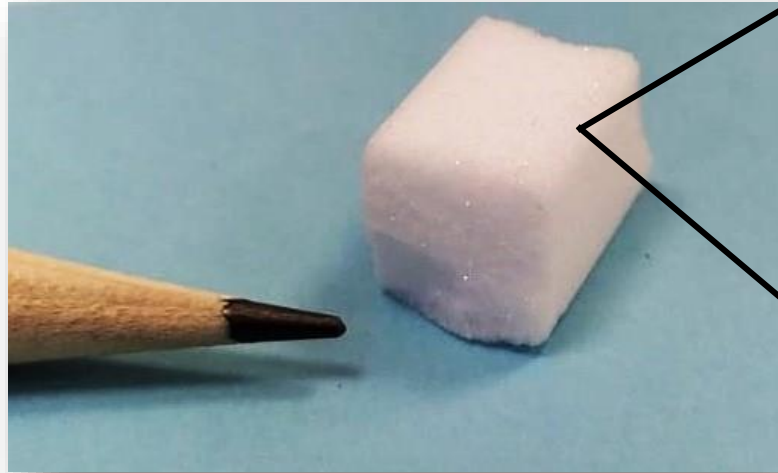
Arnold Bachrach

Yaniv Edery

The Deformation of Rocks Due to Fluid Injection
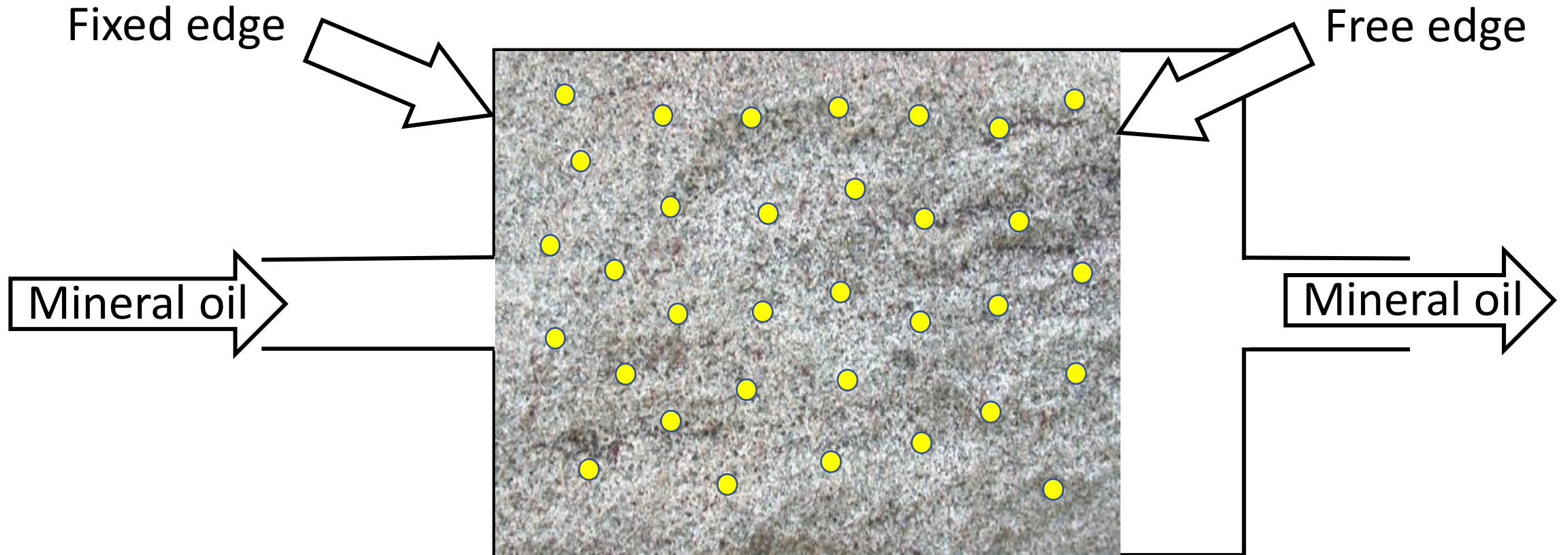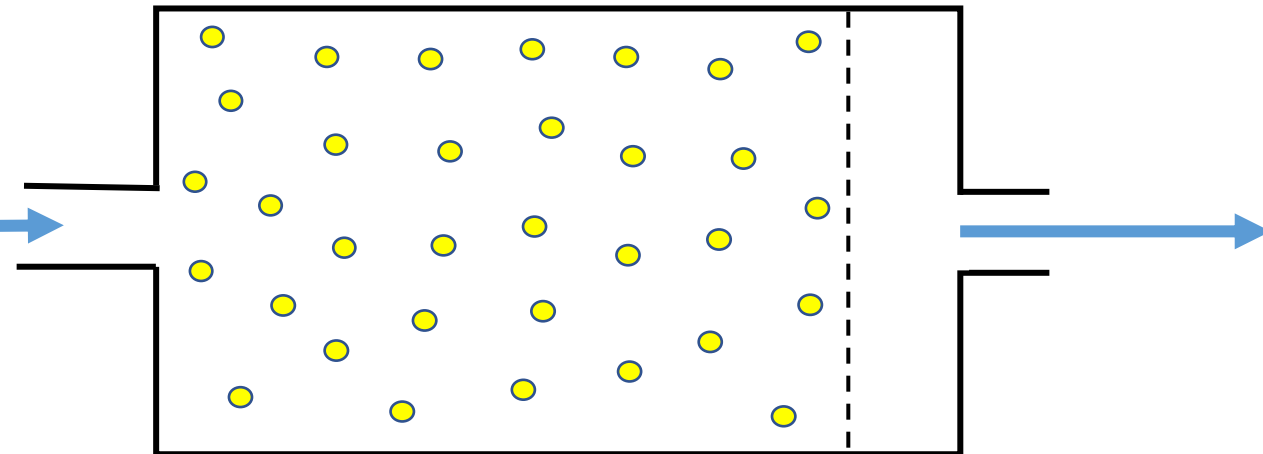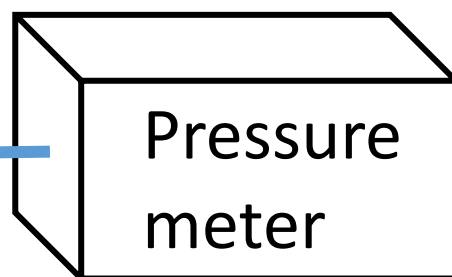
Carbon Capture & Storage (CCS)

Sandstone thin section (Digital Rocks Portal)

Artificial Rocks

Set-Up

Fixed edge

Free edge

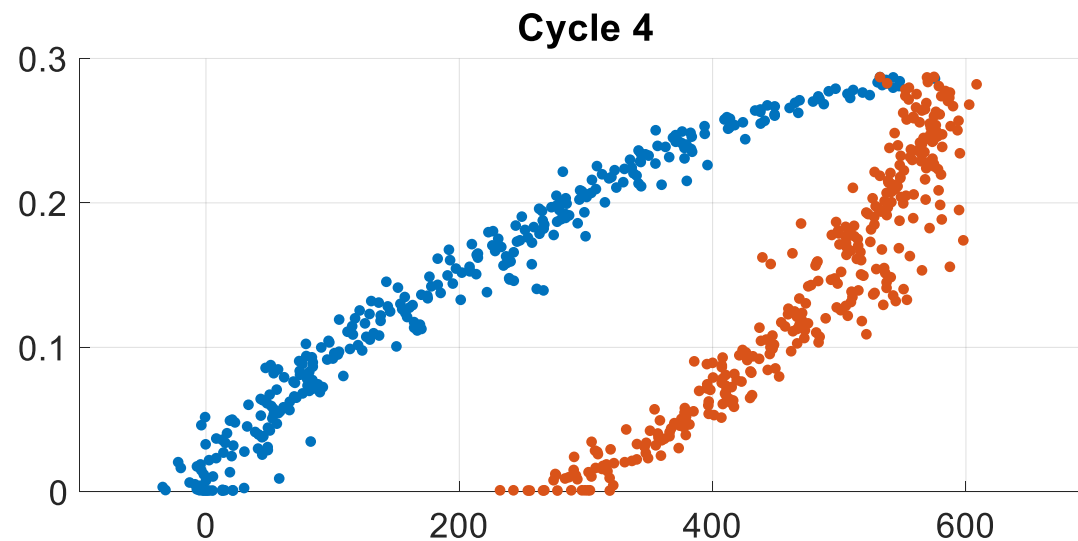Mineral oil

Mineral oil

~2 cm

Flow

Flow meter

Pressure meter
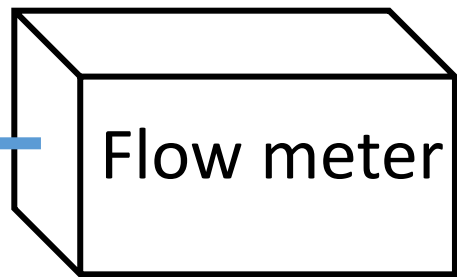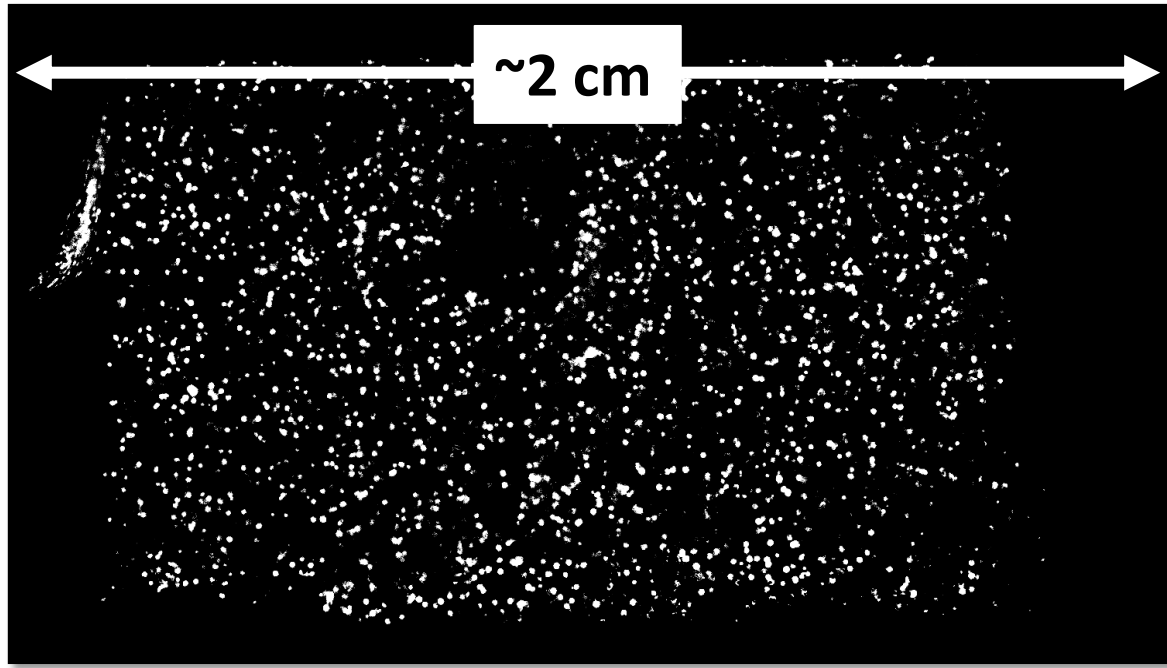
MATLAB PIV

Flow

Pseudo Stress-Strain

Inlet pressure[MPa] vs Total extension/sample's length [micron/meter]

Elastic

Elasto-plastic

Stoxreiter et al.(2020)

Stress [Mpa] vs Strain [micron/m]
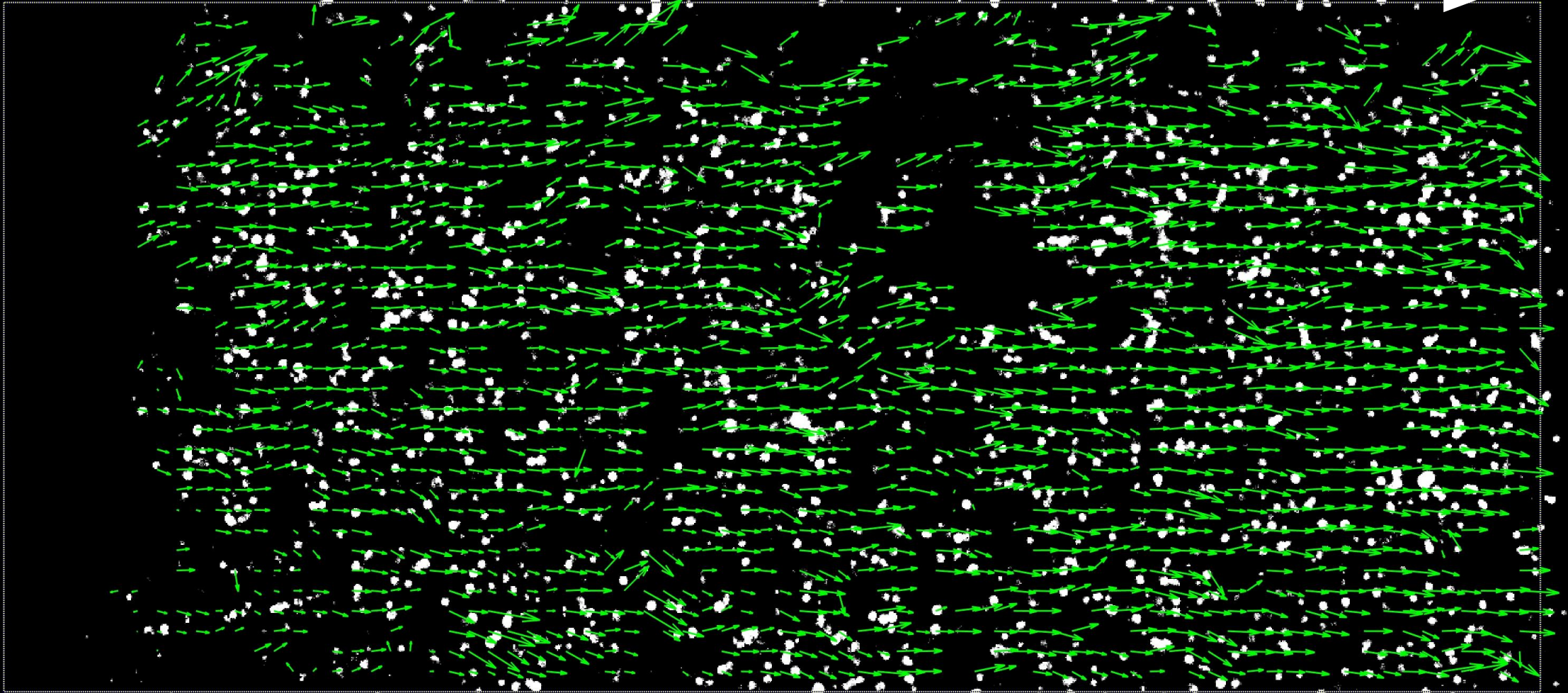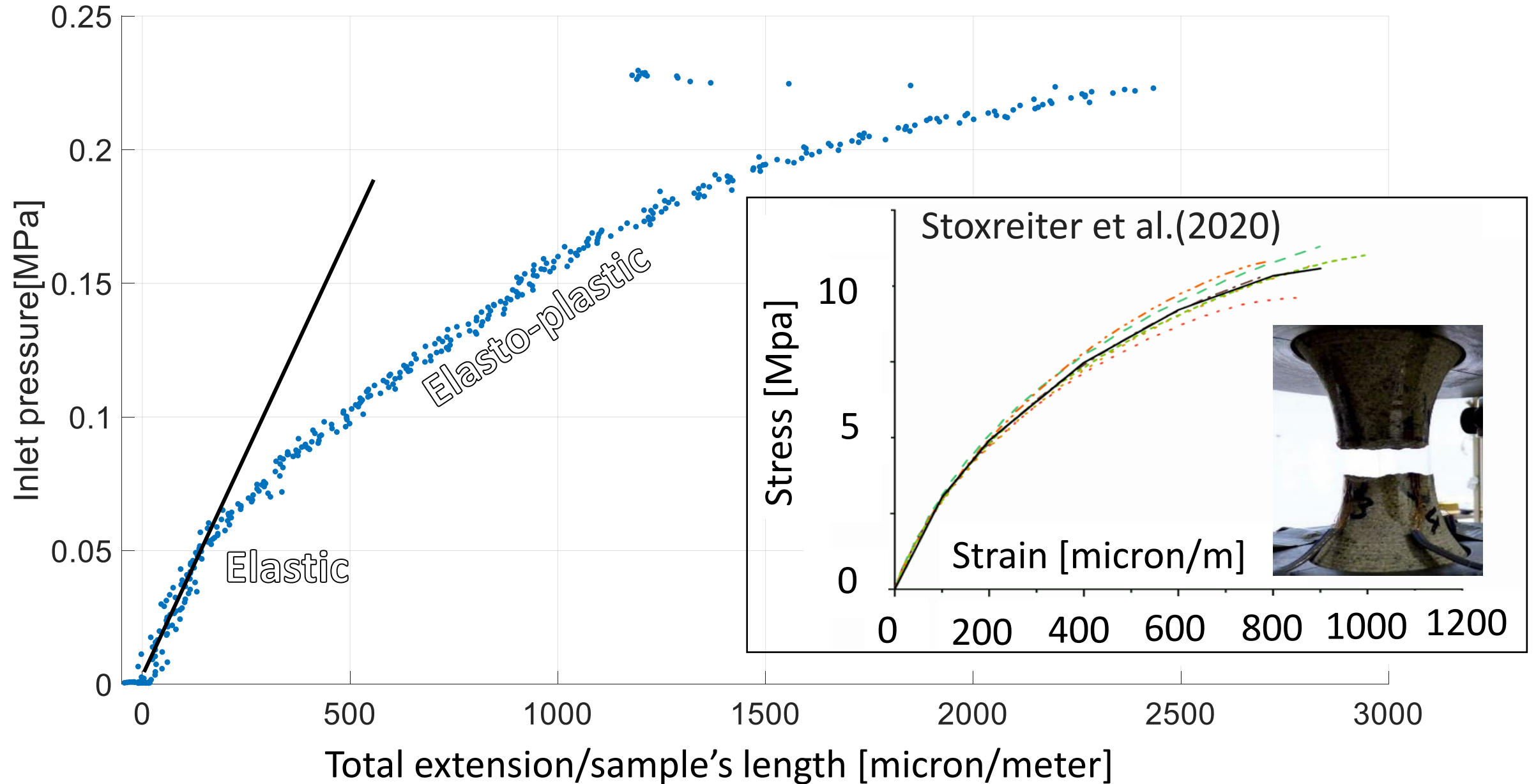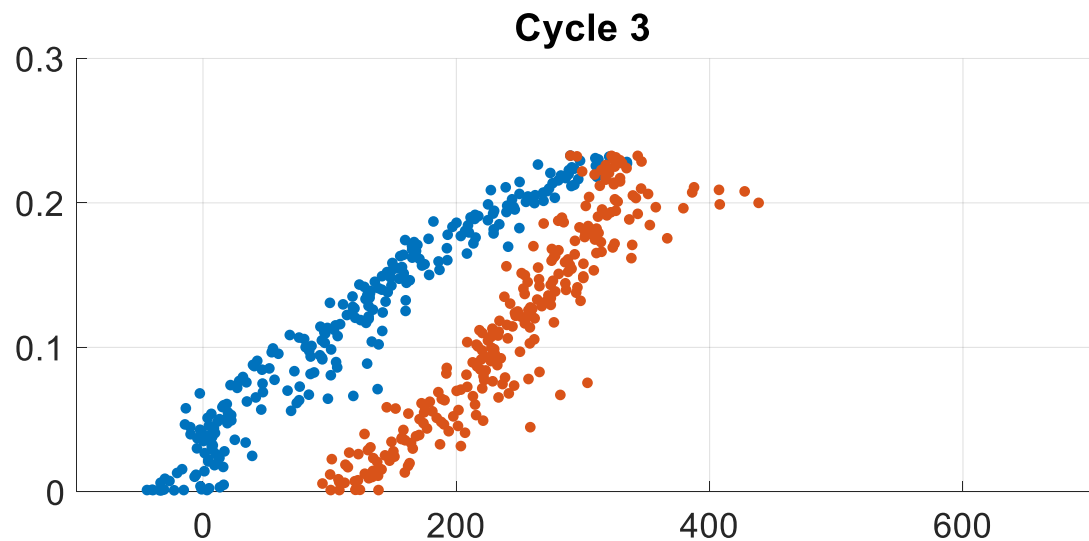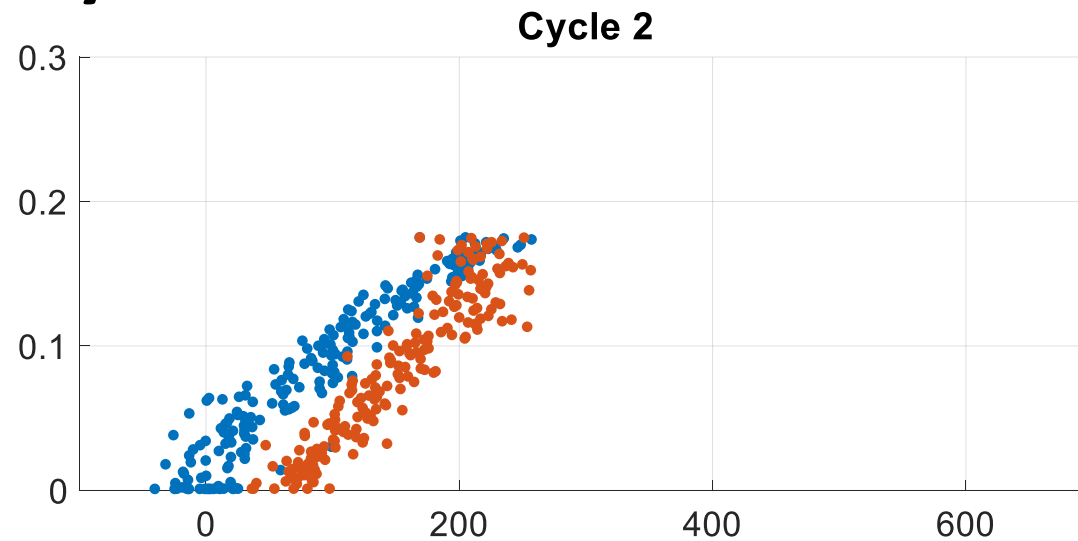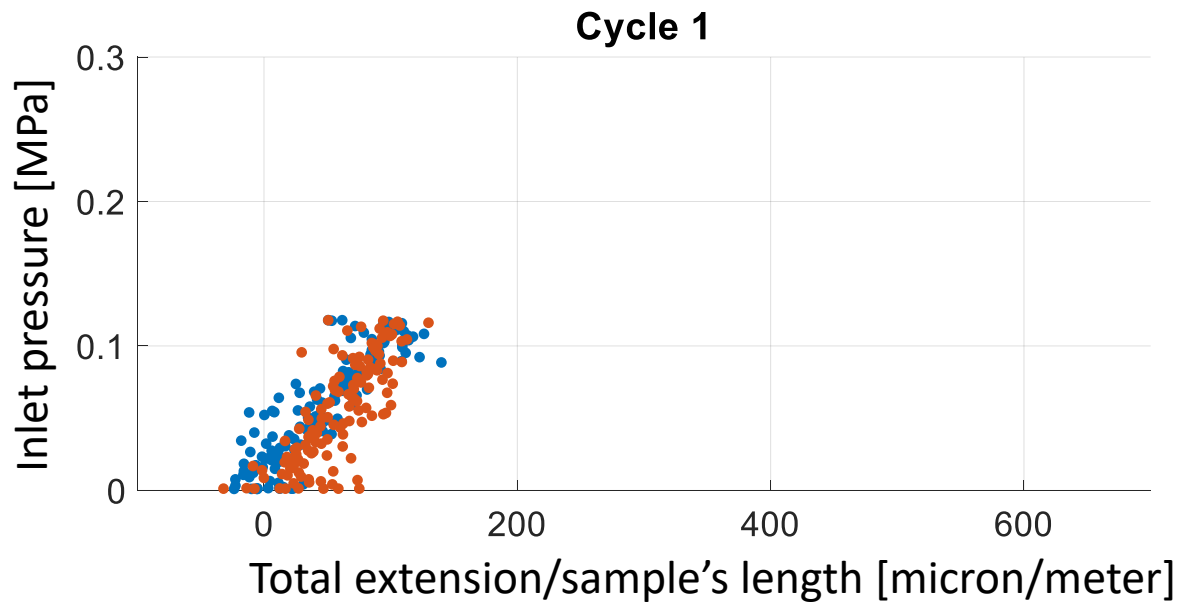
Pressure Cycles

Internal Deformation
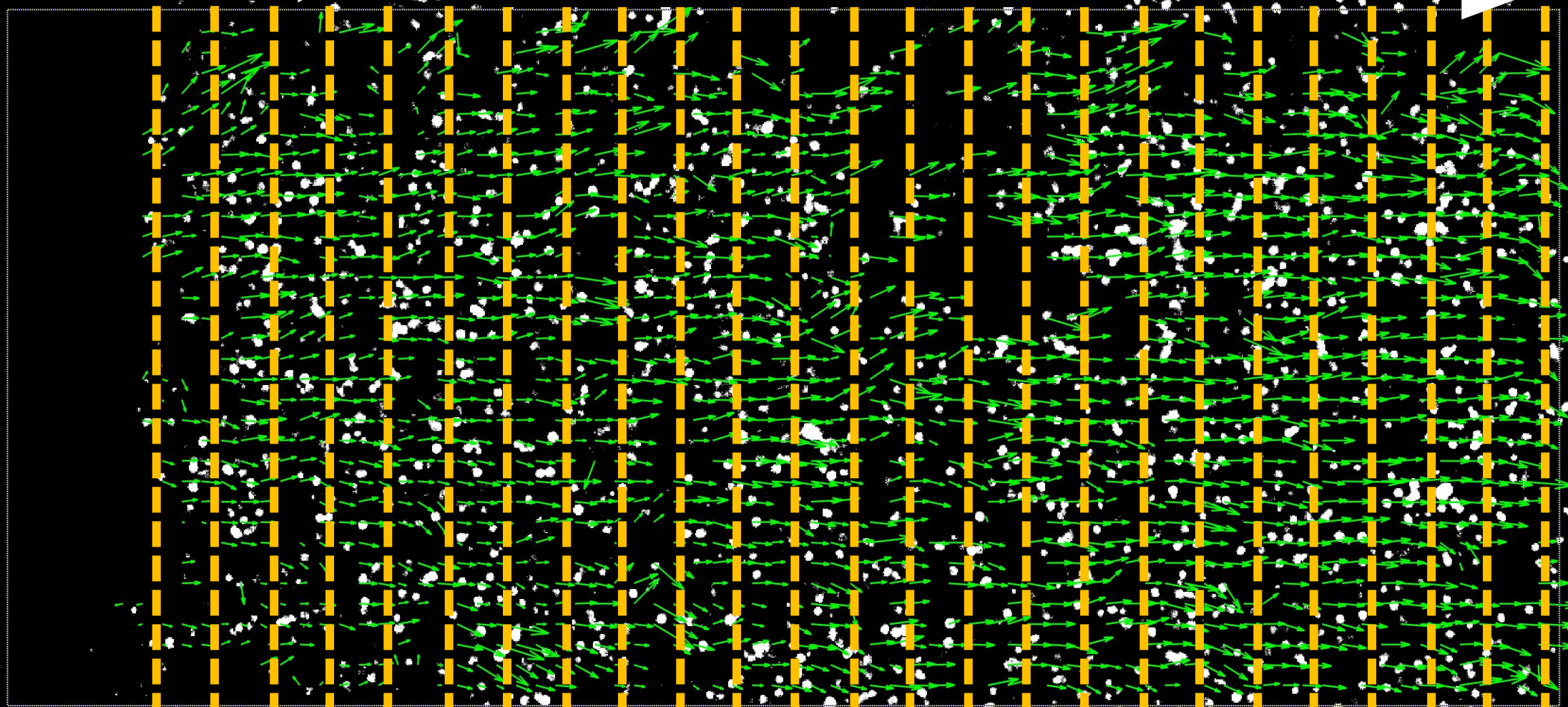
Modeling Internal <u>Elastic</u> Deformation

$$\varepsilon(x) = \frac{du}{dx} = H^{-1}P_p(x)$$ **Biot**	$$\frac{1}{\gamma}\left(\frac{dP_p}{dx}\right) = -qK^{-1} - C\left(\frac{du}{dx}\right)$$ **Modified Darcy**

$$\begin{cases} P_p(x) \\ u(x) \end{cases}$$

$P_{in}=0.039MPa$ $P_{in}=0.046MPa$ $P_{in}=0.062MPa$

Displacement [micron]

X along sample [mm]

Inlet pressure increase

Pressure & Displacement

$$\varepsilon(x) = \frac{du}{dx} = H^{-1}P_p(x)$$

Biot

$$\frac{1}{\gamma}\left(\frac{dP_p}{dx}\right) = -qK^{-1} - C\left(\frac{du}{dx}\right)$$

Modified Darcy

$P_p(x)$

$u(x)$

$P_{in} = 0.039MPa$

$P_{in} = 0.046MPa$

$P_{in} = 0.062MPa$

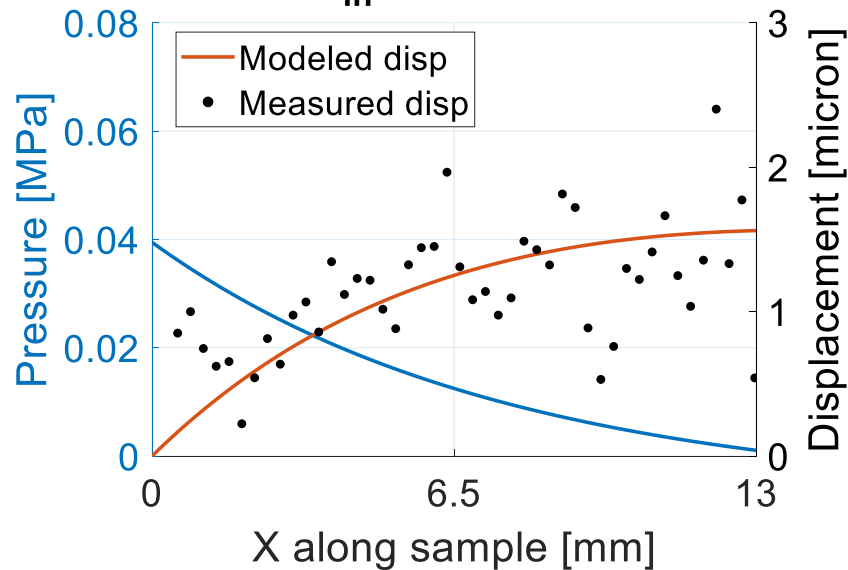*Inlet pressure increase*

11

Strain & Displacement

$$\varepsilon(x) = \frac{du}{dx} = H^{-1}P_p(x)$$

Biot

$$\frac{1}{\gamma}\left(\frac{dP_p}{dx}\right) = -qK^{-1} - C\left(\frac{du}{dx}\right)$$

Modified Darcy

$$\begin{cases} P_p(x) \\ u(x) \end{cases}$$

P$_{in}$=0.039MPa

P$_{in}$=0.046MPa

P$_{in}$=0.062MPa

Inlet pressure increase
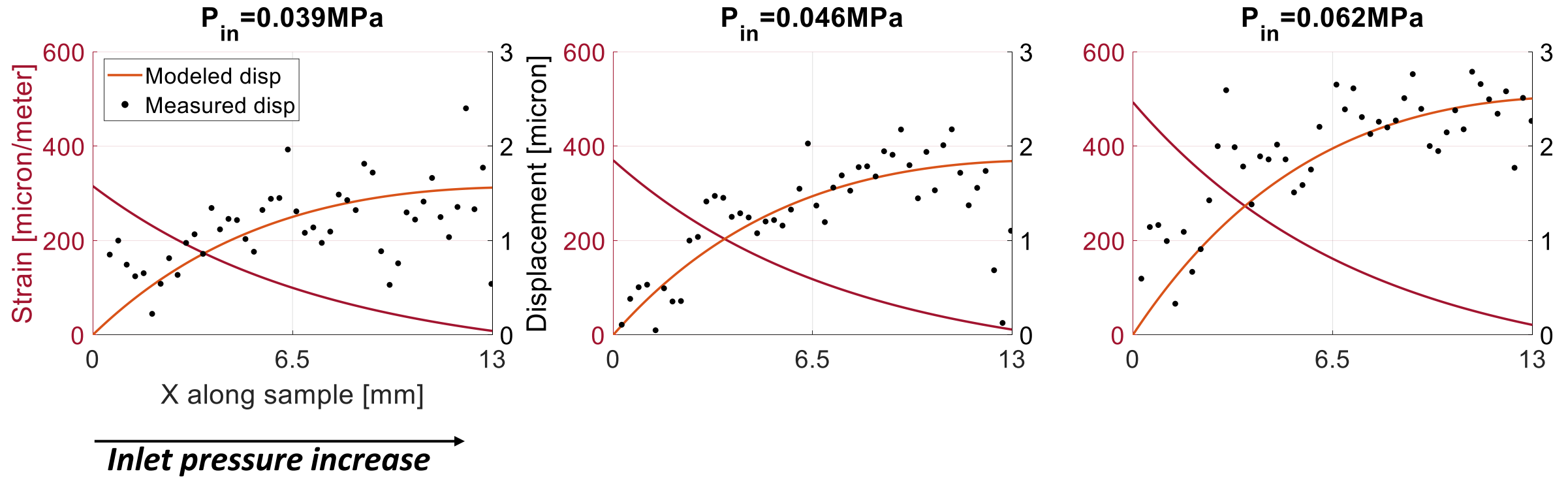
Head-Loss Fractions

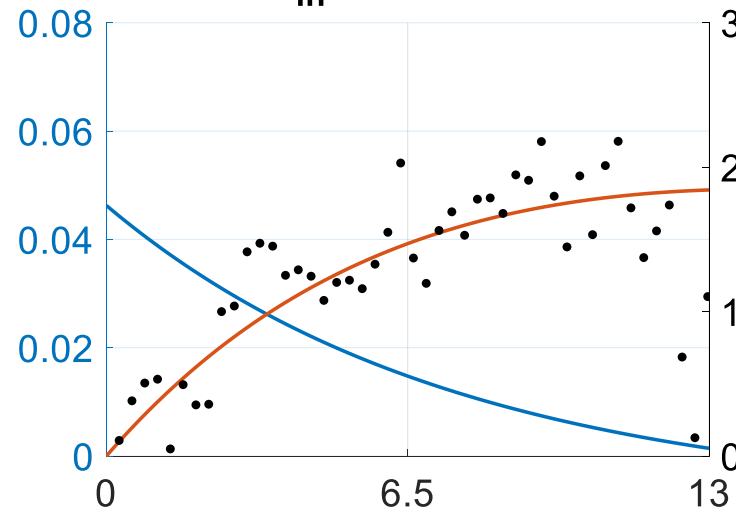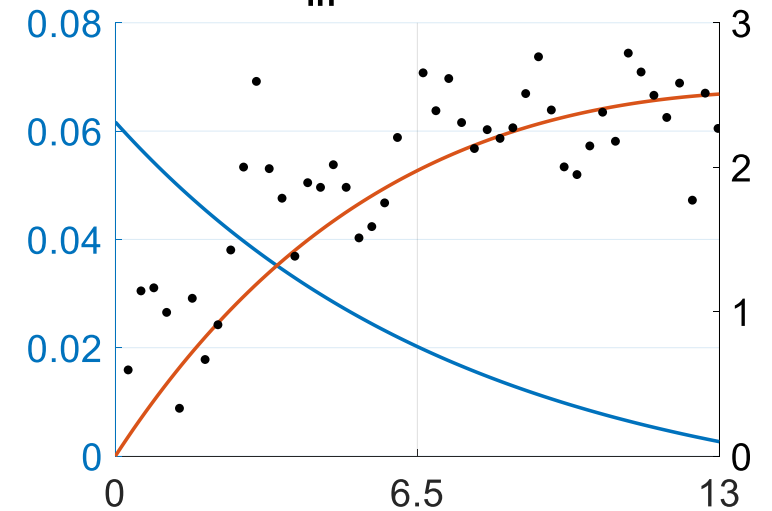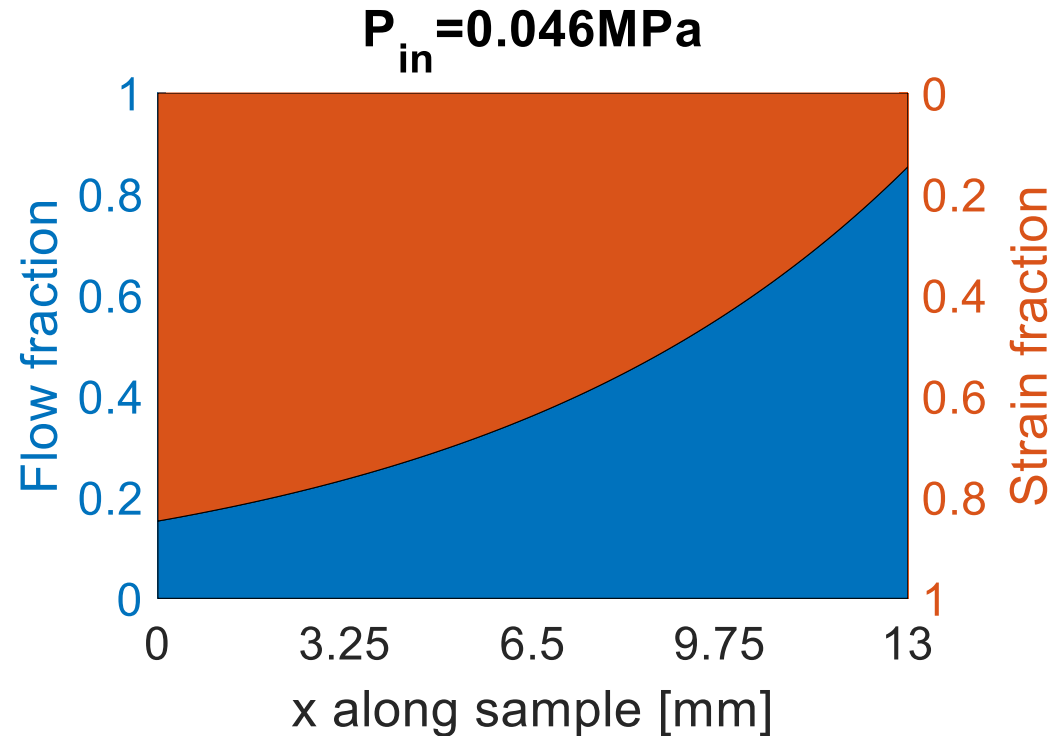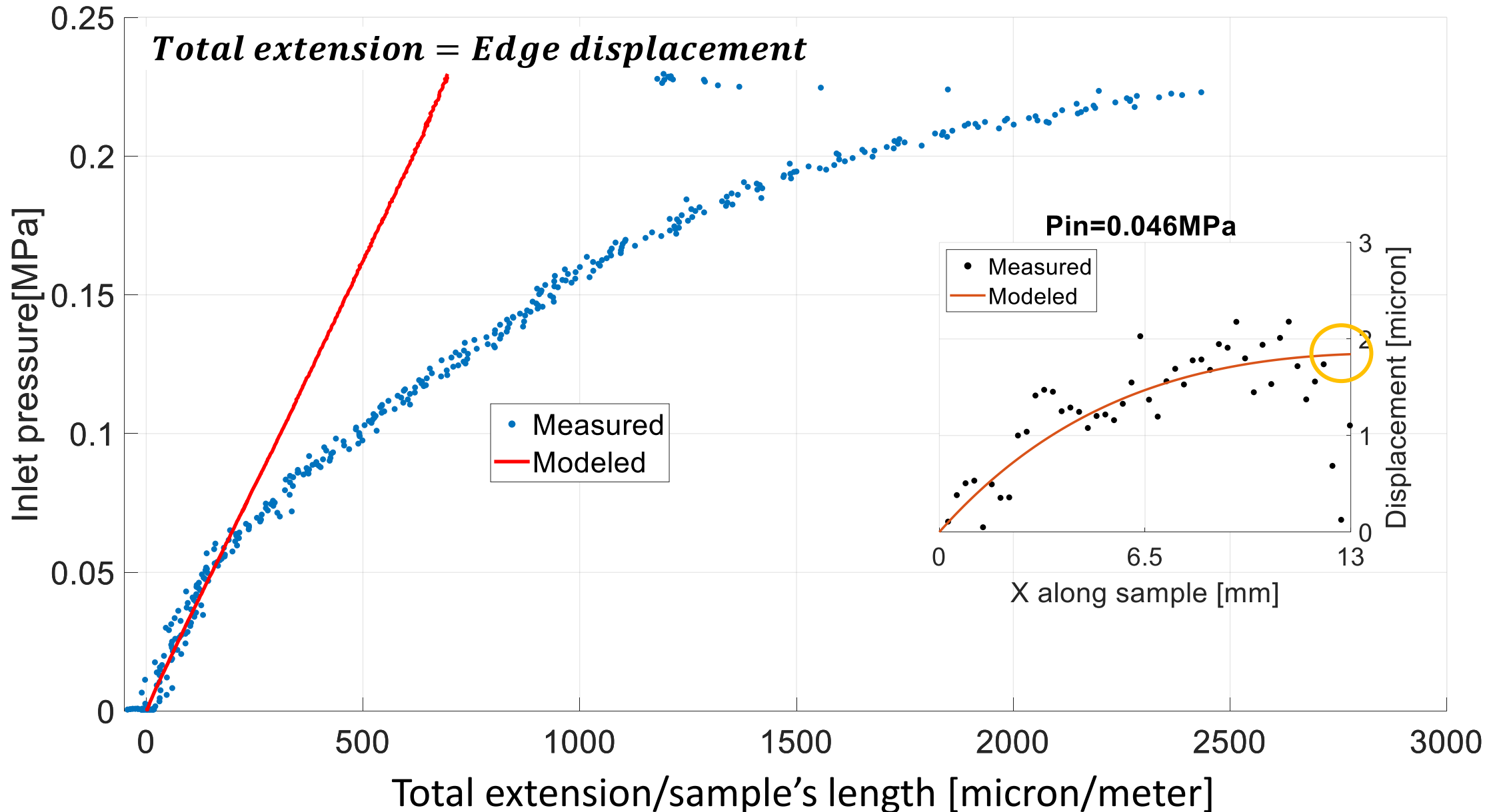|	
$\varepsilon(x) = \dfrac{du}{dx} = H^{-1}P_p(x)$ **Biot**	$\dfrac{1}{\gamma}\left(\dfrac{dP_p}{dx}\right) = -qK^{-1} - C\left(\dfrac{du}{dx}\right)$ **Modified Darcy**

$$\begin{cases} P_p(x) \\ u(x) \end{cases}$$

P_{in}=0.046MPa

Reconstructing the Curve

Total extension = Edge displacement
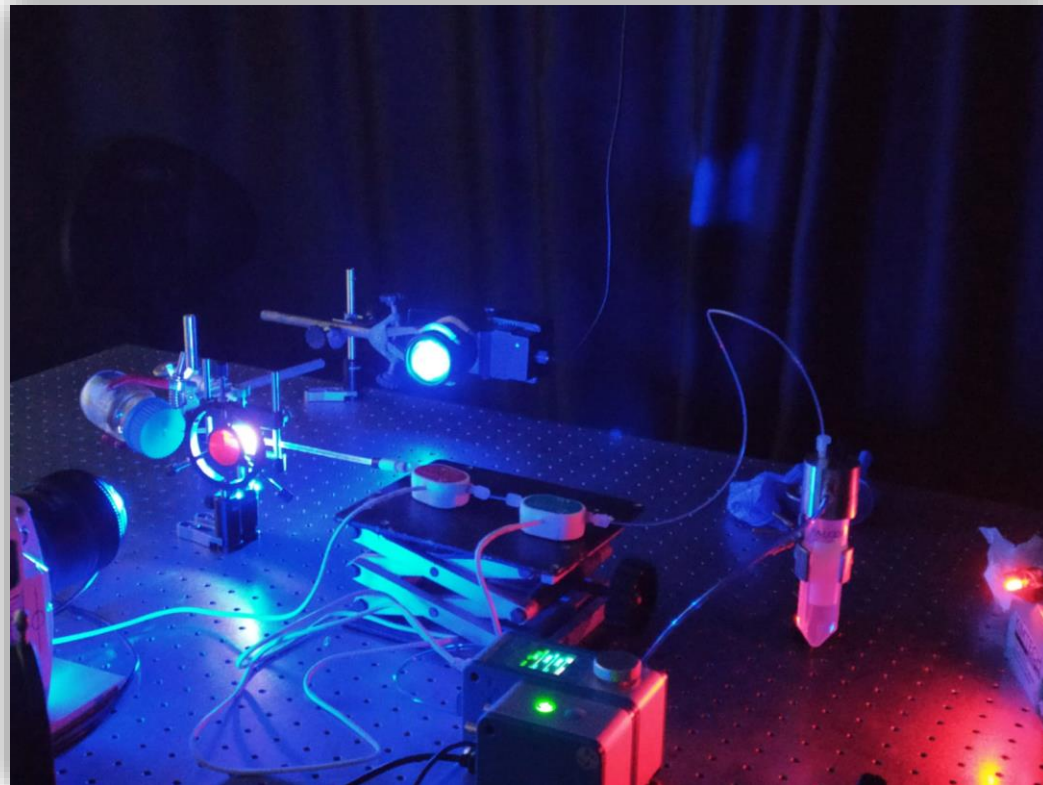
To Conclude

- Experimentally backed up analytical model for injection induced elastic deformation in brittle materials.

- Exponential drop of the pressure and the strain.

Acknowledgments

Yaniv Edery

Ludmila Abezgauz

PMV lab members

Merav Miller

The Nancy and Stephen Grand Technion Energy Program (GTEP)

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