

Motivation

• “Capsule-cameras” – currently the gold standard for small intestine diagnosis; extending their reach into the esophagus and colon.

• **Commercial Capsules – passive diagnostic tools**



• **Research Capsules – active therapeutic devices**



Anchoring Capsule [1]

Clip Deployment Capsule [1]

Legged Capsule [1]

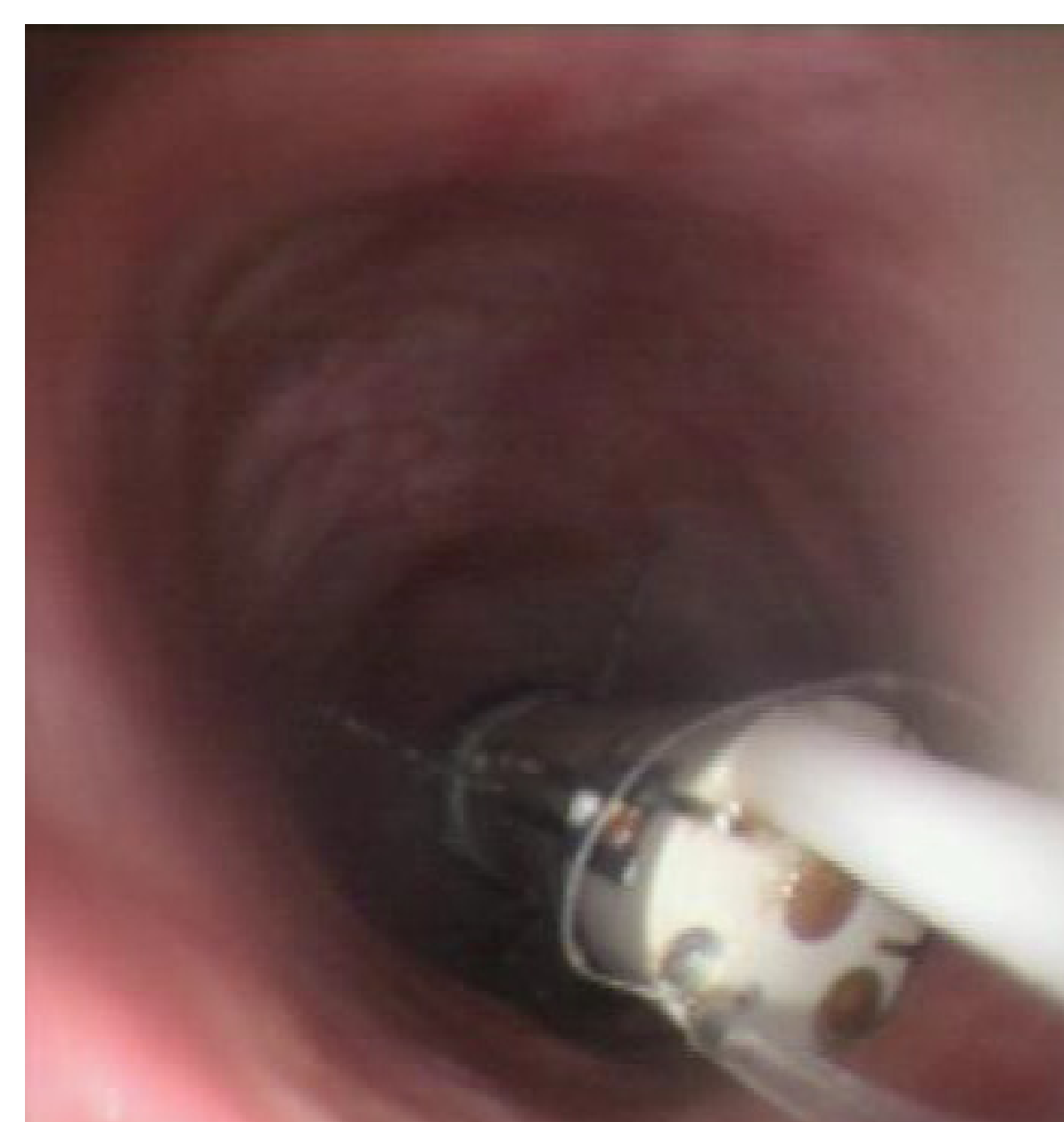
Problem: Tissue Distention



• Traditional colonoscopy relies heavily on insufflation.

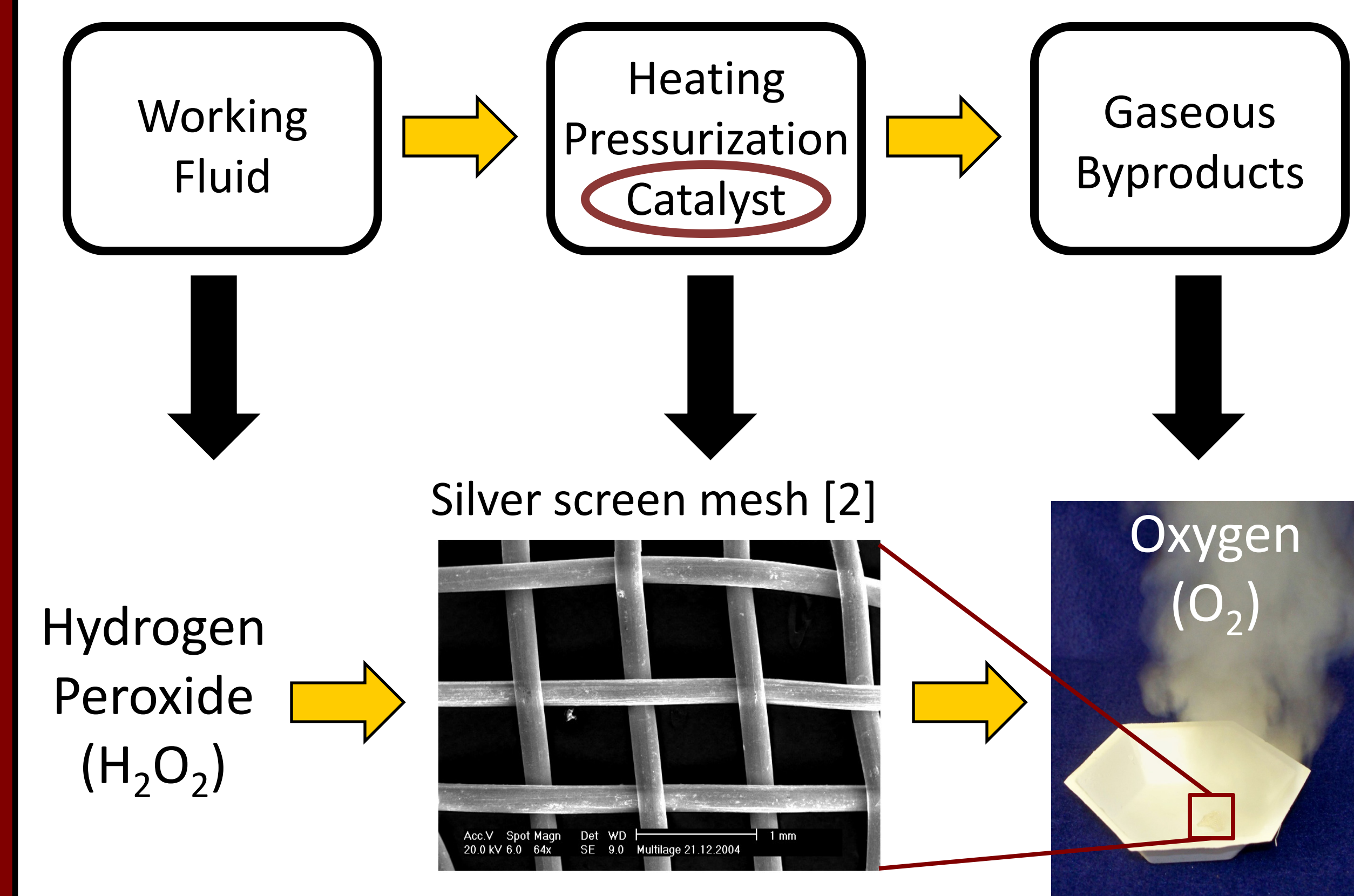
• Intestinal folds make it difficult to view the internal surface of the lumen as shown in the image to the left taken from a colonoscope prior to insufflation.

• The image to the right is taken after insufflation is provided, showing much more of the intestinal surface that would be viewable from onboard a capsule. Also pictured is a legged capsule prototype.



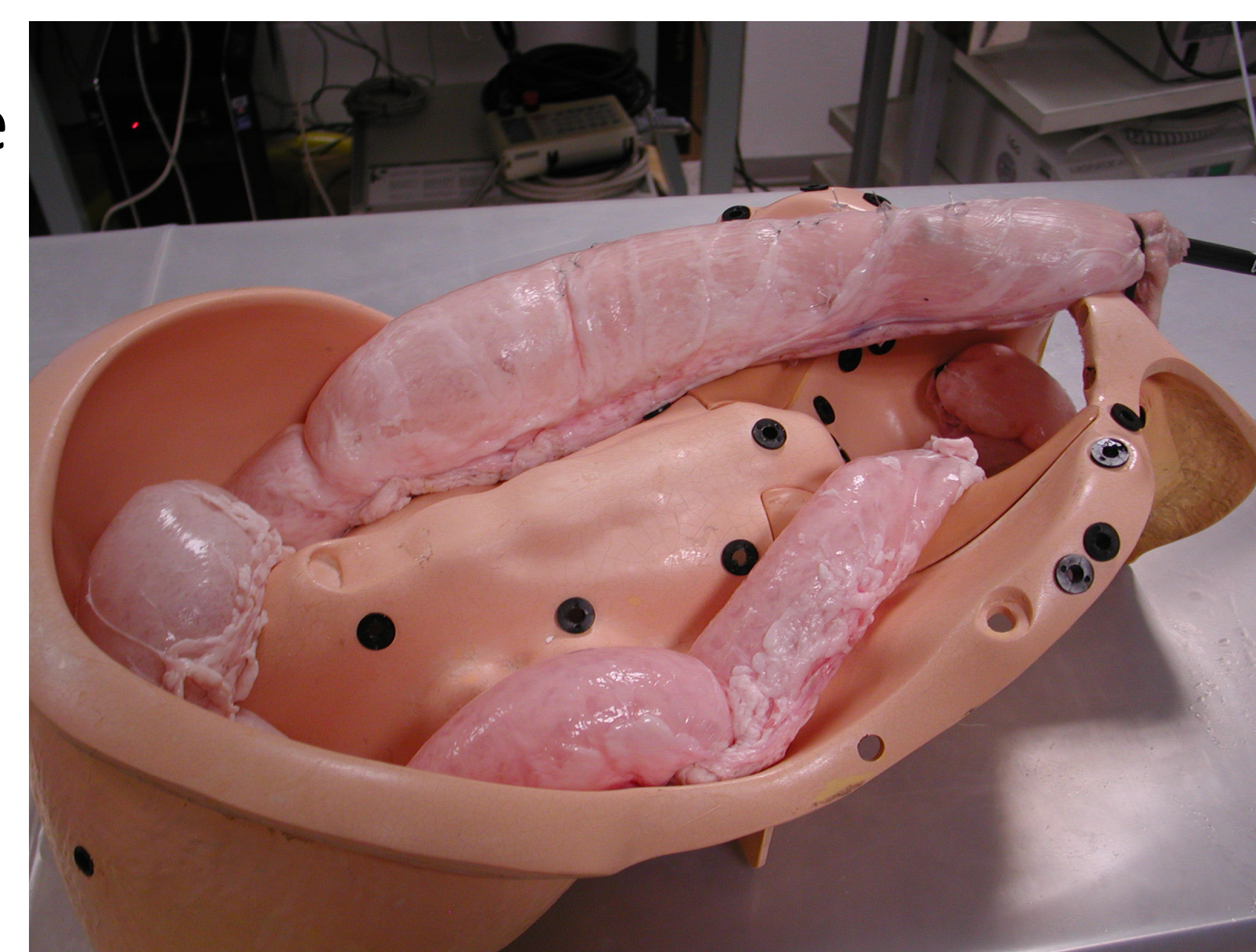
Insufflation via Fluid Power

• Fluid Power – Harnessing pneumatic pressure generated from the state transition of a liquid to a gas.

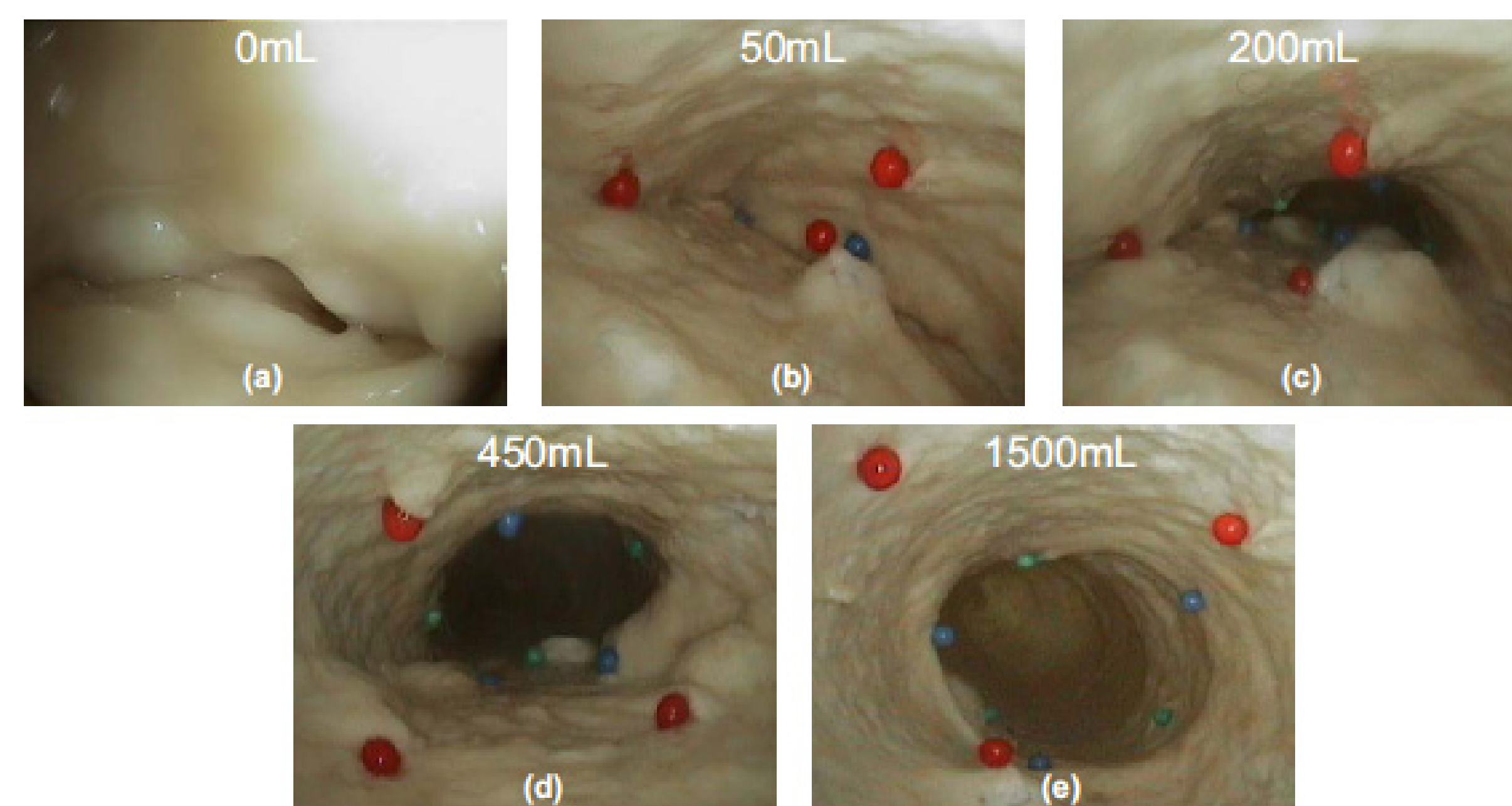


Colon Inflation Experiment

• Determined the amount of insufflation required to enhance visualization within porcine large intestine.



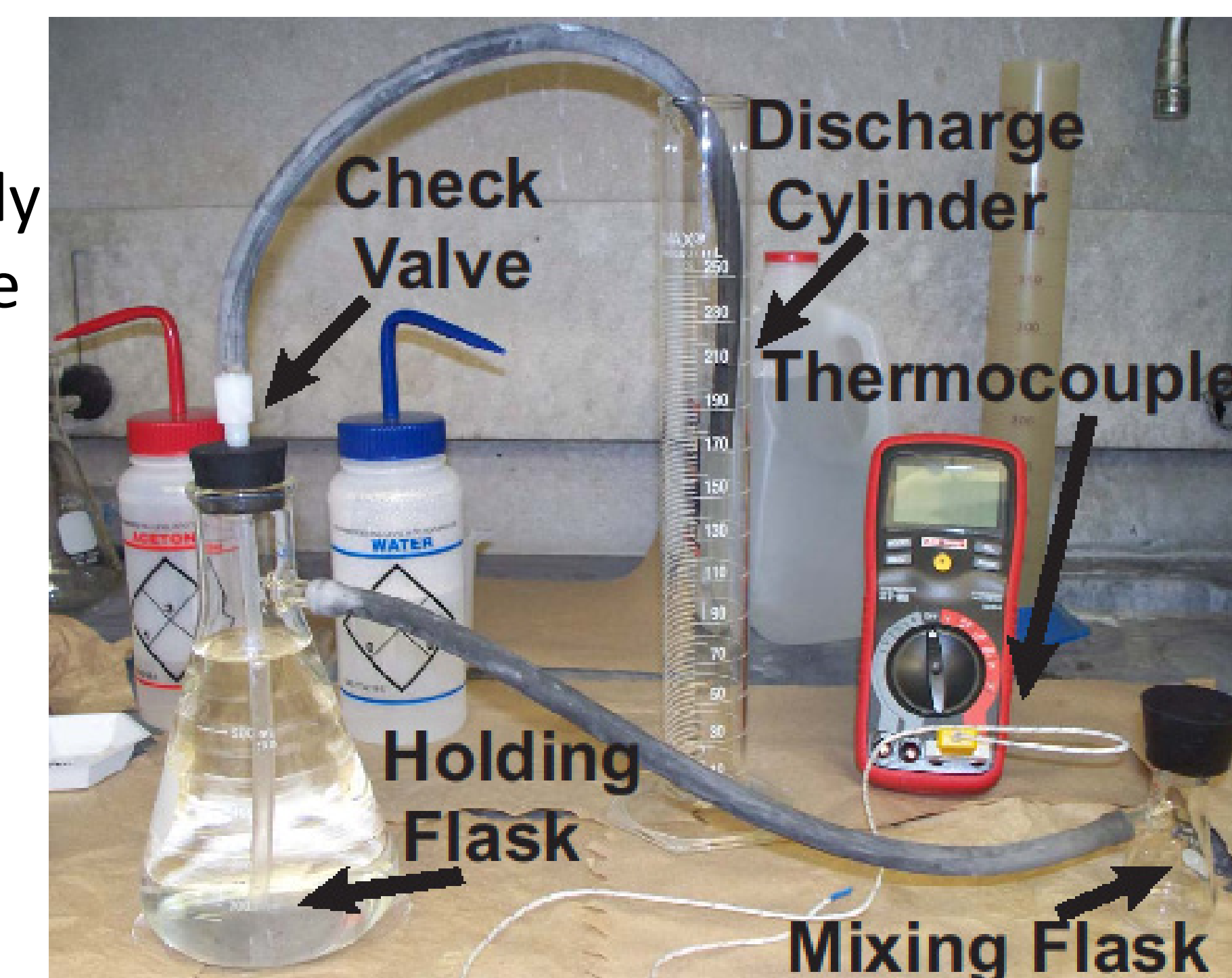
• Attached 9 markers on the internal intestinal wall and inflated the intestine incrementally.



• Visualization was significantly improved with just 50mL of insufflation. 450mL was the threshold of consistent visibility of all 9 markers.

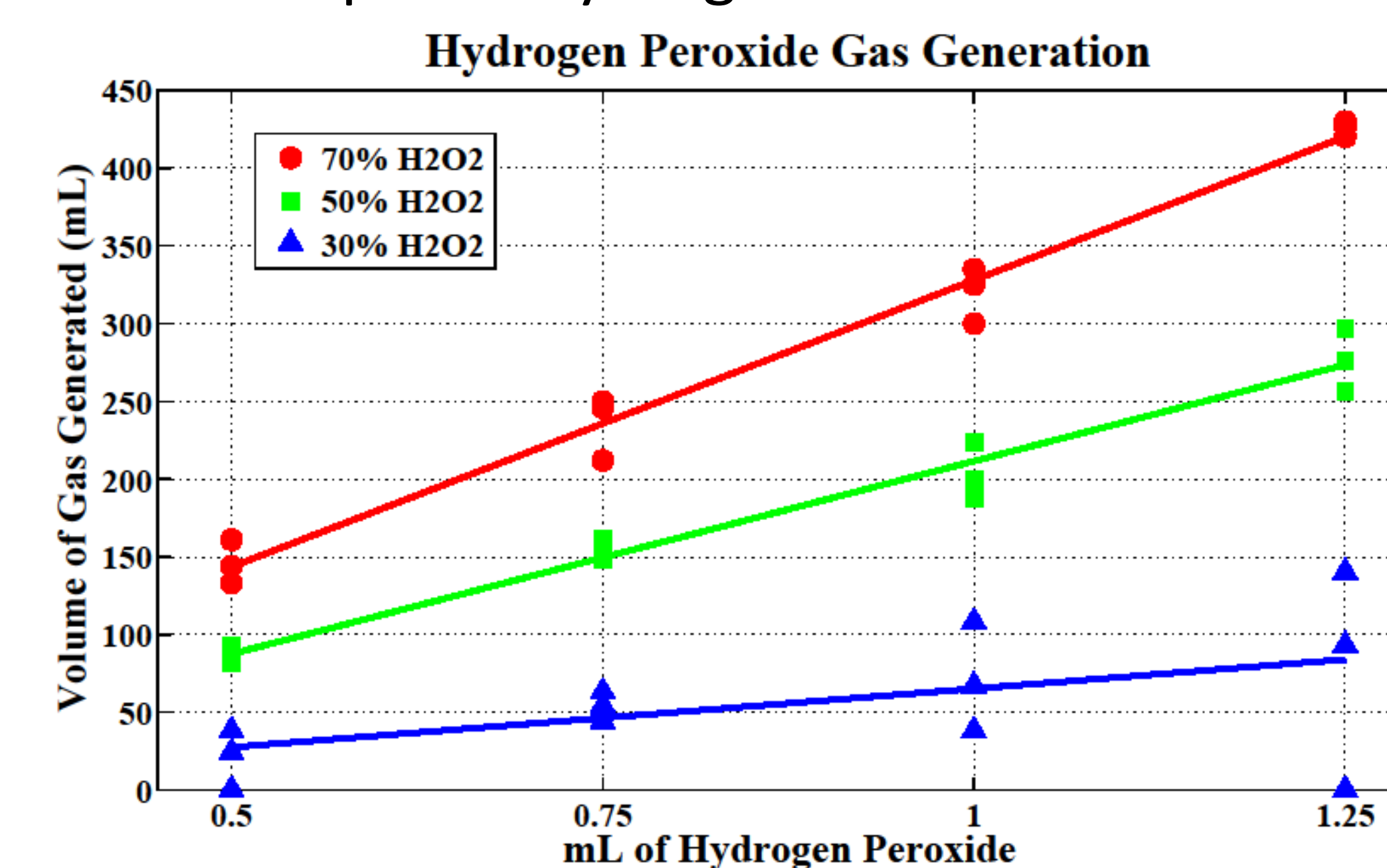
Hydrogen Peroxide Experiment

• Experimentally determined the volume of gaseous byproducts produced from small amounts of H₂O₂.



Results

• Gaseous output of Hydrogen Peroxide

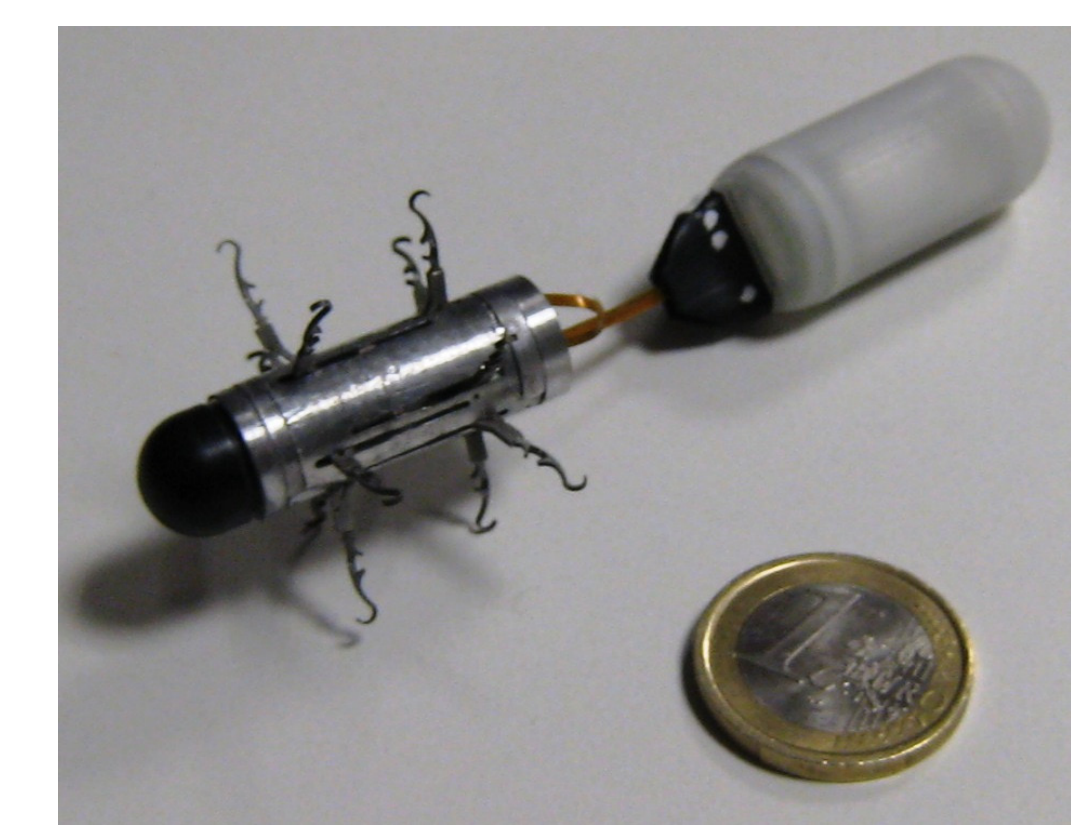


• Initial fluid volumes of H₂O₂ at different concentrations. All volumes in mL.

Air Volume	H ₂ O ₂ (30%)	H ₂ O ₂ (50%)	H ₂ O ₂ (70%)
50.00	0.71	0.35	0.26
150.00	1.62	0.75	0.52
250.00	2.54	1.16	0.79
350.00	3.45	1.56	1.06
450.00	4.36	1.96	1.33
1500.00	13.95	6.20	4.14

Future Work

• Fluid power could power miniature pneumatic actuators and serve as the energy-dense power source that current capsules lack.



References

- [1] Toennies, J. L., Tortora, G., Simi, M., Valdastrì, P., and Webster III, R. J., 2010, "Swallowable medical devices for diagnosis and surgery: The state of the art," *Journal of Mechanical Engineering Science*, (In Press).
- [2] www.peroxidepropulsion.com