

ZERO Gravity
ZERO Stress



Acceleration of liquid surface in capillary action in microgravity

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Last year ATZ-G experiment



Comparison of the result from the orbit and the ground

Material	Contact angle		Result in orbit	Result on the ground At 27 Celsius degree
Acrylic tube (Inner diameter: 6 mm)	79.7°	1	-	-
Polycarbonate tube (Inner diameter: 0.3 and 0.8 mm)	95.9°	1	-	-
Silicone tube (PDMS) (Inner diameter: 1 mm)	99.9°	2	-	N/A
Nylon 12 (Inner diameter: 0.65 mm)	70.0°	3	N/A	+
Glass capillary (Inner diameter: 1 mm)	26.6°	2	N/A	+

Details N/A : Not Available Data

+ : The water was risen up

- : The water was not risen up

Contact angle

<90°



>90°

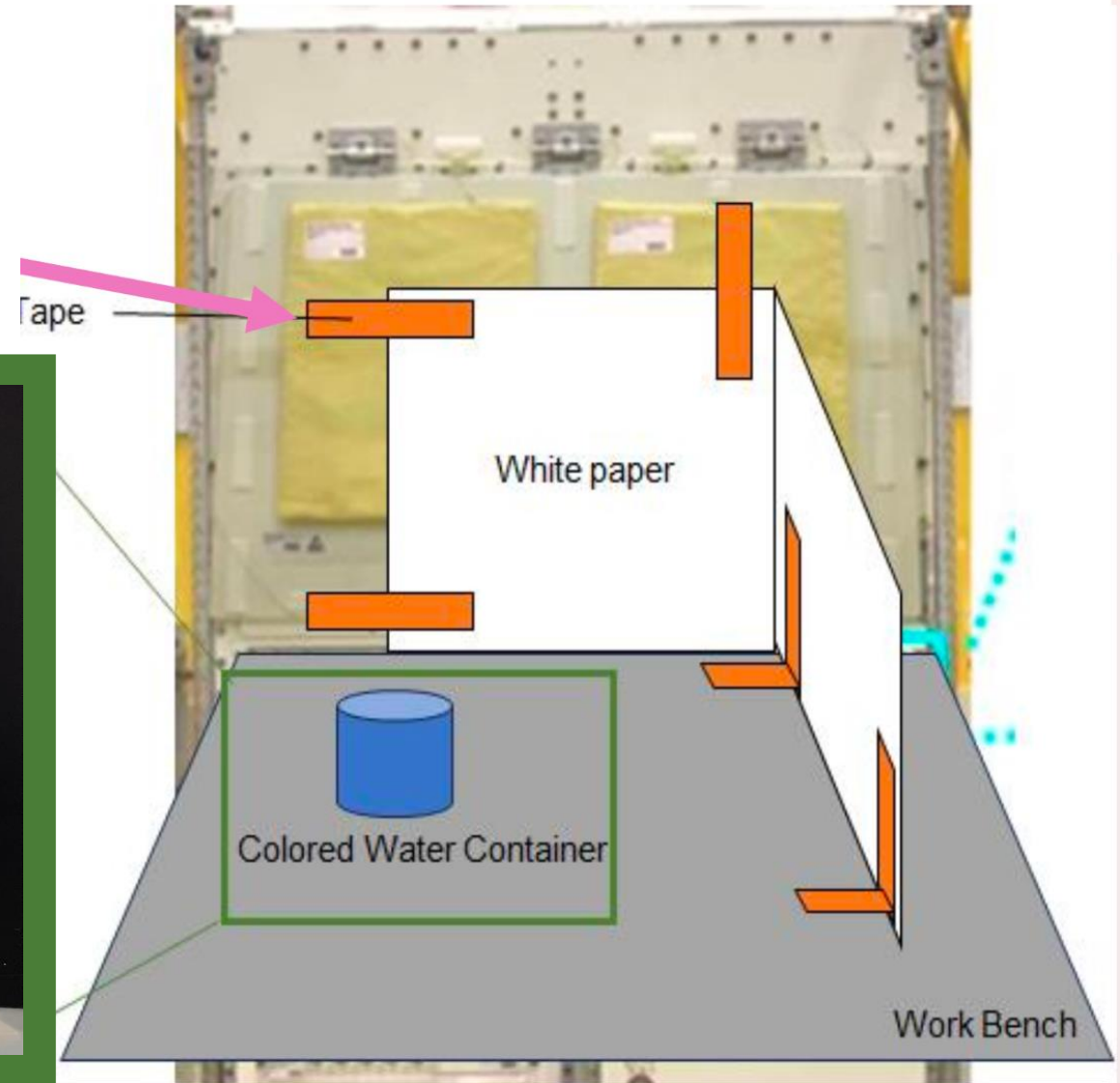
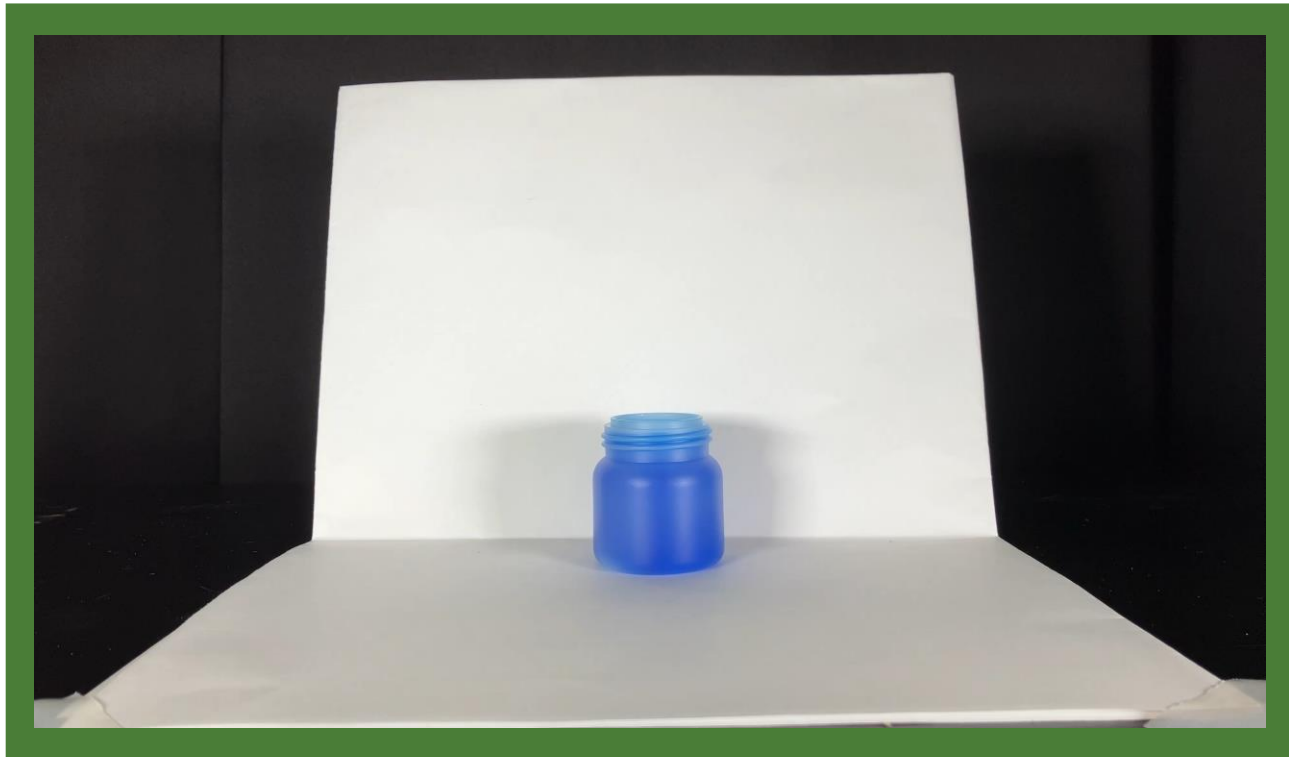


References

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2. Phaechamud T, Savedkairop C. Contact angle and surface tension of some solvents used in pharmaceuticals. *RJPBCS* [Internet]. 2012;3(4):628. Available from: <http://mis.pharm.su.ac.th/web/sites/default/files/contact%20angle%20and%20surface%20tension%20of%20some%20solvents.pdf>
3. Ellison AH, Zisman WA. Wettability studies on nylon, polyethylene terephthalate and polystyrene. *J Phys Chem* [Internet]. 1954;58(6):503–6. Available from: <http://doi.org/10.1021/j150516a013>

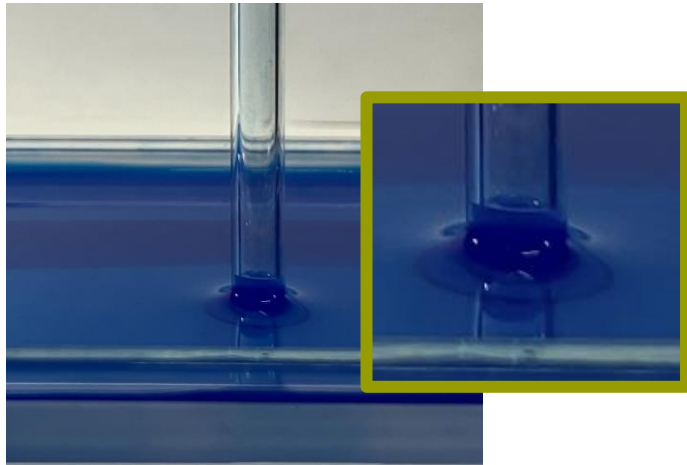
Our experimental method

- Three sizes of capillaries



Our experimental method

Glass is danger in ISS \Rightarrow We need to find another material



Glass contact angle



Plastic(PC) contact angle

\rightarrow Need to solution

- 4 Capillary materials : acrylic(PMMA) , polycarbonate(PC) , ABS , fluororesin .
- 4 Coatings : polishing with abrasives (7.0 μ m, 1.0 μ m, 0.2 μ m) , glass coating

\rightarrow Acrylic capillary and polishing with 1 μ m

Hypothesis

$$\frac{2\sigma \cos \theta}{R} = \frac{d}{dt}(\rho h \dot{h}) + \frac{8\mu h}{R^2} \dot{h} + \rho g h(1)$$

Where ,

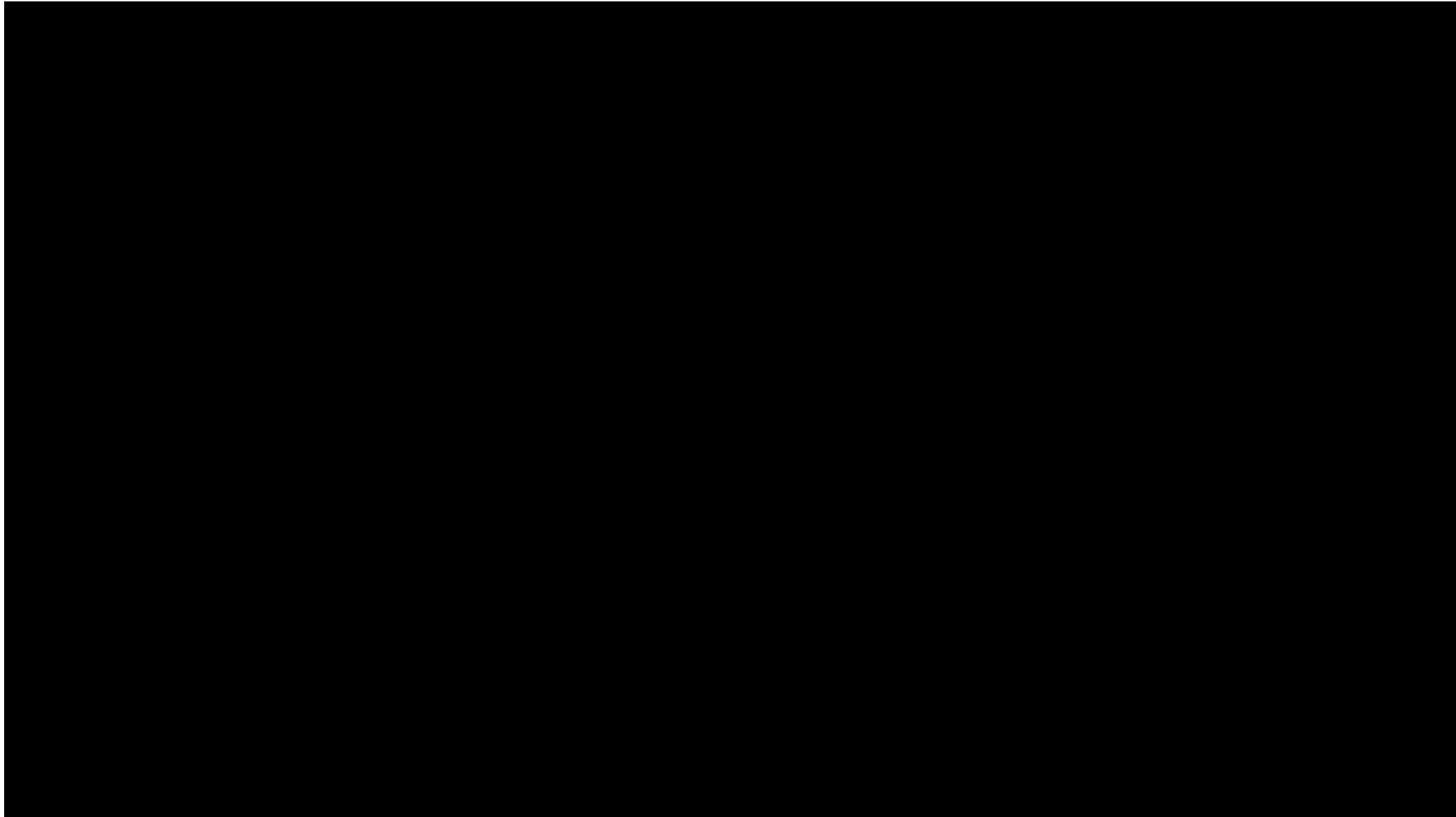
σ : surface tension , ρ : fluid density , θ : contact angle , g : gravity

R : inner tube radius , h : fluid height , μ : fluid viscosity

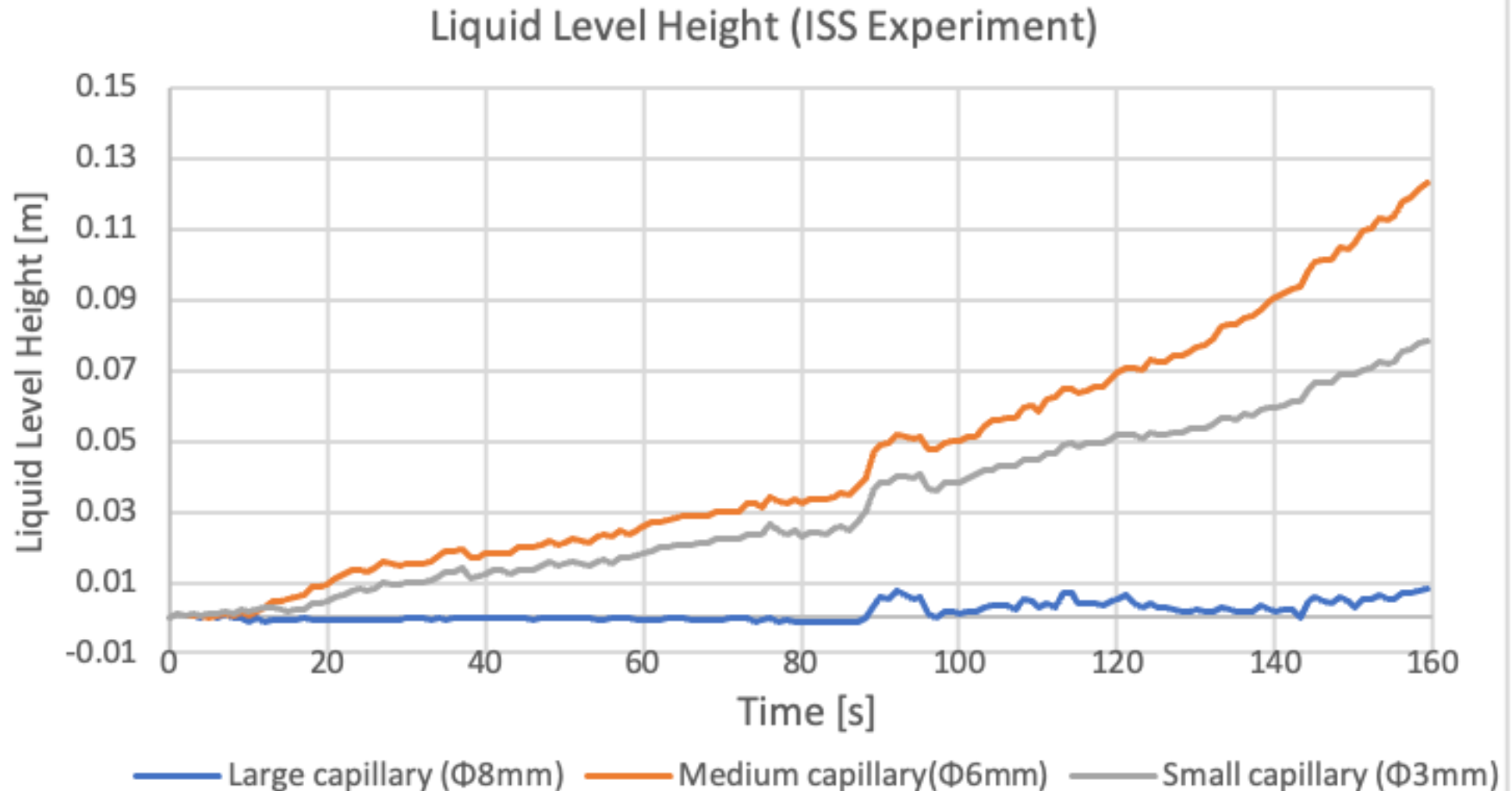
Solution by *Bosanquet*

$$h = \sqrt{\frac{\sigma R \cos \theta}{2\mu} \left[t - \frac{R^2 \rho}{8\mu} \left(1 - e^{-\frac{8\mu}{R^2 \rho} t} \right) \right]} (2)$$

Result Video



Analysis



Analysis

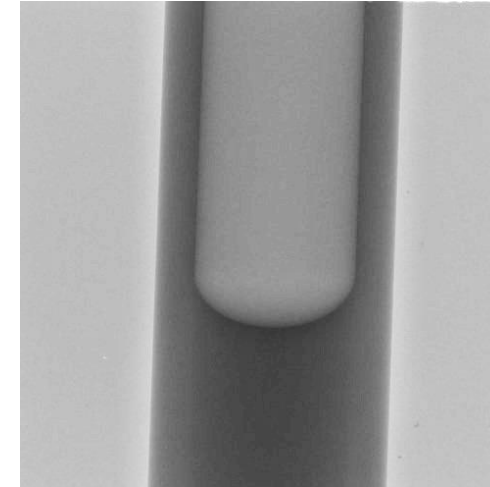
Water sample measurement

surface tension → **86.12[mN/m]**

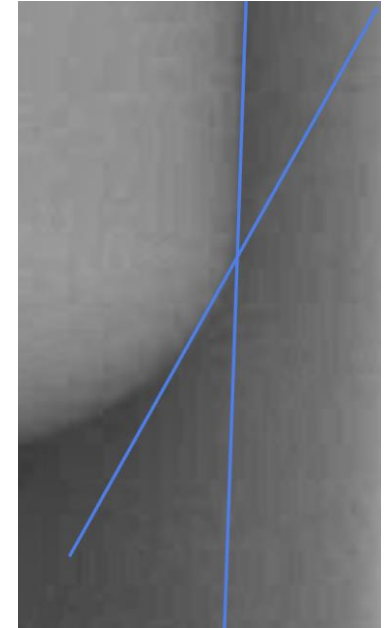
viscosity → **1.32[mPa · s]**

contact angle → **29°**

density → **981.2kg/m³**



CT picture



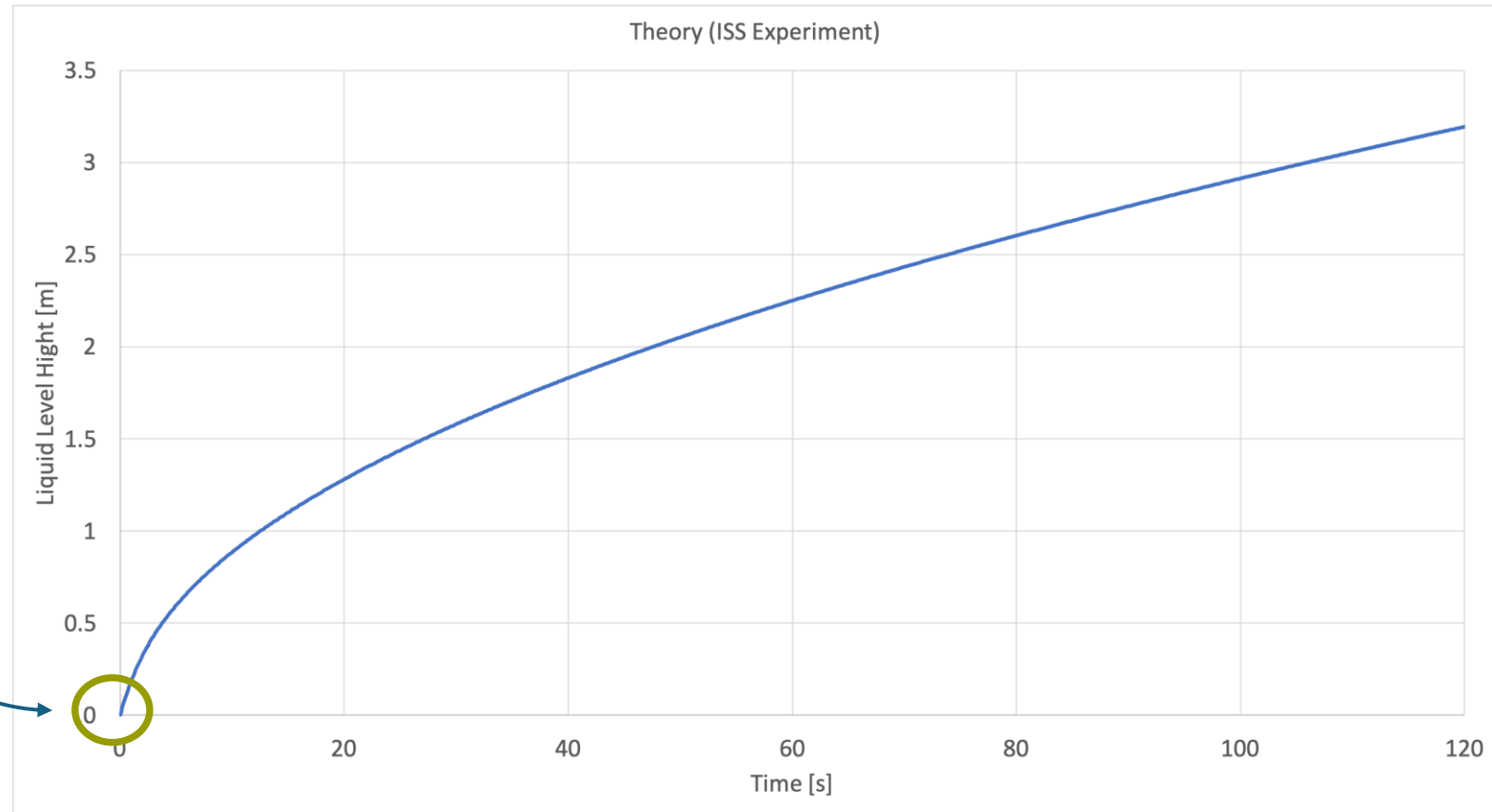
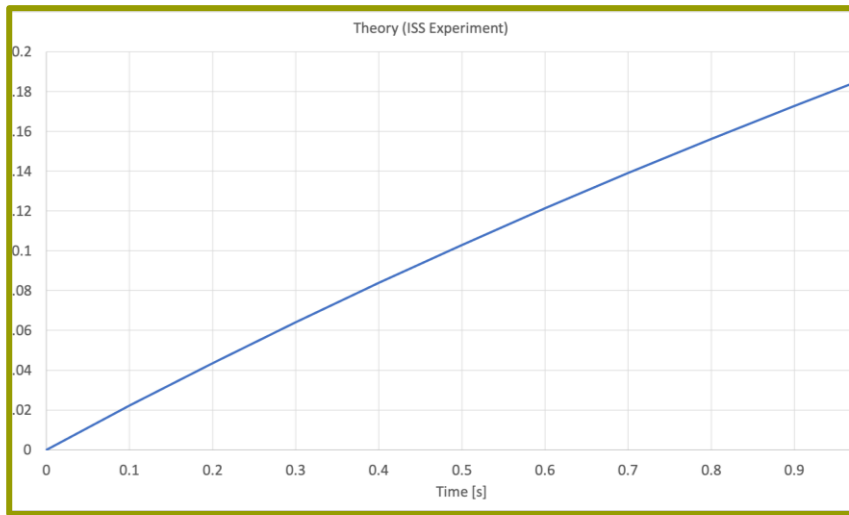
Contact angle

	1st Time	2nd Time	3rd Time	Average
Surface Tension [mN/m]	84.91	85.42	88.03	<u>86.12</u>

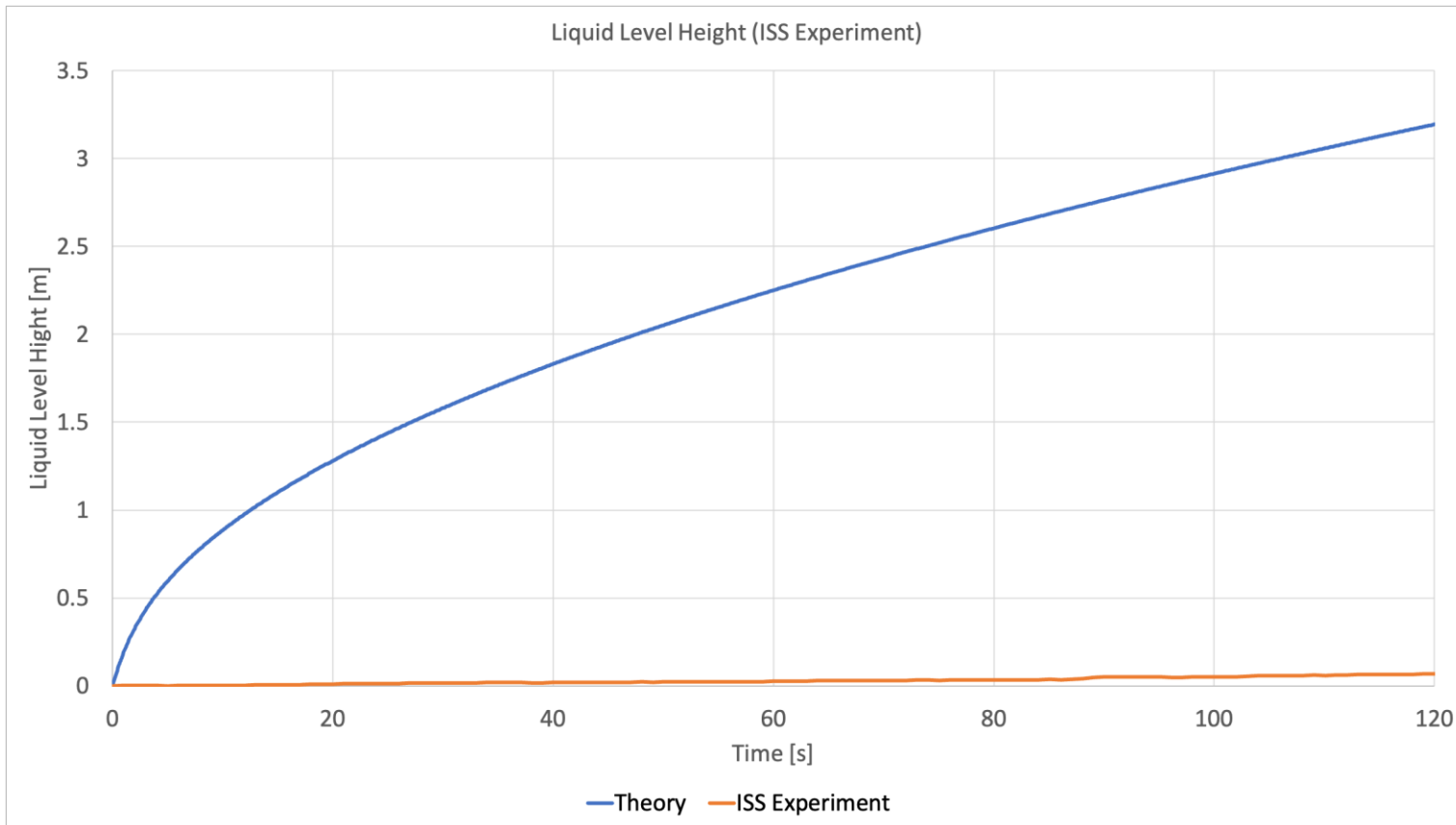
	1st Time	2nd Time	3rd Time	Average
Temperature [°C]	25.0	24.7	24.5	24.7
Viscosity [mPs · s]	1.35	1.30	1.30	<u>1.32</u>

Analysis

$$t \cong 0 \rightarrow h \propto t$$
$$t \gg 0 \rightarrow h \propto \sqrt{t}$$



Consideration

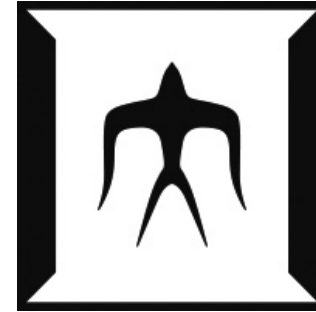


- Difference between theory and measurement
- High quality method is necessary
- Difference of G at the contact between ISS and Freefall

Acknowledgement



Photron



EXPLOROUND

もりのこぼれ。

JASMA

日本マイクロ重力応用学会

The Japan Society of Microgravity Application



Parabolic Flight
Management



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NIHON UNIVERSITY

MRI

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ZERO Gravity
ZERO Stress



Thank you for listening

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