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Multiple Water Propulsion Systems: All Propulsive Capabilities for CubeSats from LEO to Deep Space

Pale Blue

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What is Pale Blue Inc.?

- Start-up company from University of Tokyo
- Established in April 2020
- Focusing on
  - Propulsion system for nano-/micro- satellite
  - Propulsion system using **water as a propellant**

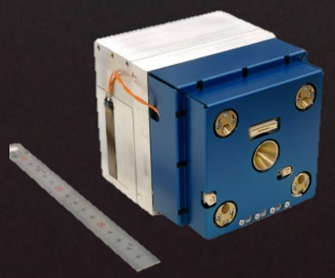
Water propellant

Safety / No toxic
Liquid in 1 atm
Easy to handle
Low cost

- Reducing cost on safety requirement
- Low-cost / short-term development
- Scalable total impulse
- ISRU: In-Situ Resource Utilization

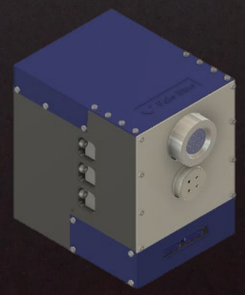
Water resistojet thruster

- 1U module / 5-20 W
- 5 Nozzles
- Thrust: 200 mN/kW
- Specific impulse: 70 s
- 400 g water propellant
- Launched in 2019 / TRL 7-8



Water ion thruster

- 1U+ module / 30 W
- Ion source & Neutralizer
- Thrust: 140 μN
- Specific impulse: 500 s
- 300 g water propellant
- TRL: 6-7



Proposal: Multiple Water Propulsion System

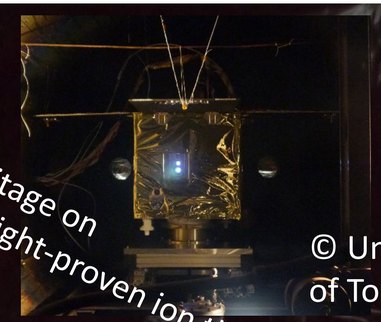
- Combine **water resistojet** and **water ion thruster**
  - Resistojet: High thrust and reaction control
  - Ion thruster: High specific impulse and large delta-V

Designed based on the same concept

✓ Safety requirement for ISS
✓ Vibration / radiation test
✓ Reproducibility

Applied to the system

Heritage on the flight-proven ion thrusters



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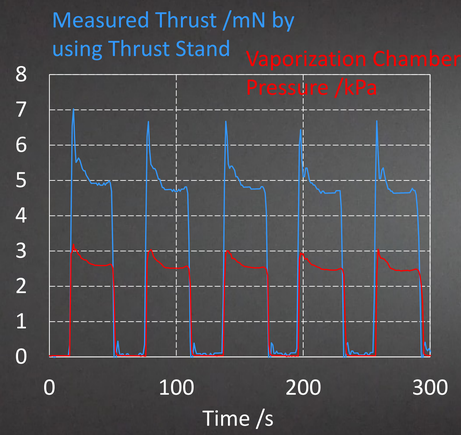
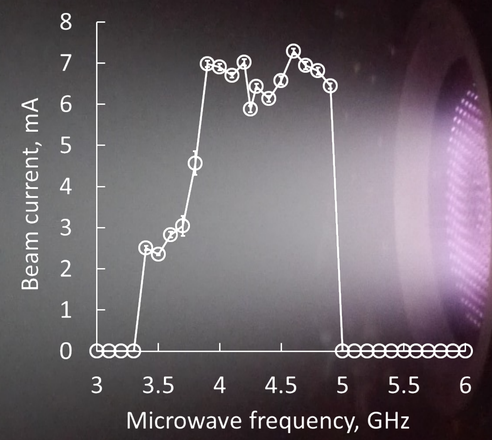
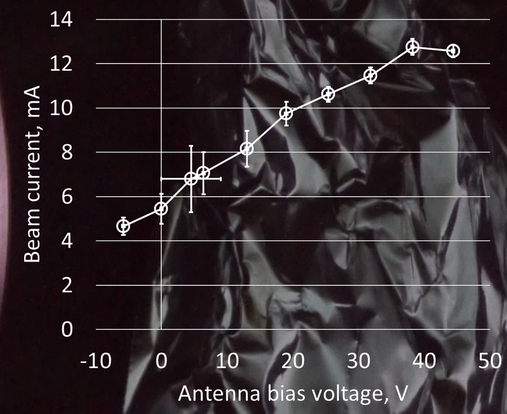


Improvement on ion thruster collaborating with U Tokyo





Conclusion / Future works

- Multiple Water Propulsion System is proposed
- Resistojet thruster passed all tests and was launched
- Ion thruster was developed and is being improved
- Integrated model is designed and under construction

	Designed*	Future target
Thrust	310 μN	180 / 550 μN
Specific Impulse	970 s	940 / 2000 s
Power	60 W	25/ 60 W
Size	1U+	1U+
Propellant	350 g	350 g
Total Impulse	3.3 kNs	3.2 / 6.8 kNs

* Based on experimental data of components

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