PROPULSION EVERYWHERE!

WATER EVERYWHERE!

SUSTAINABLE PROPULSION SOLUTIONS

10-May-2023

EPIC 2023 | Naples, IT

Alberto Garbayo

CEO

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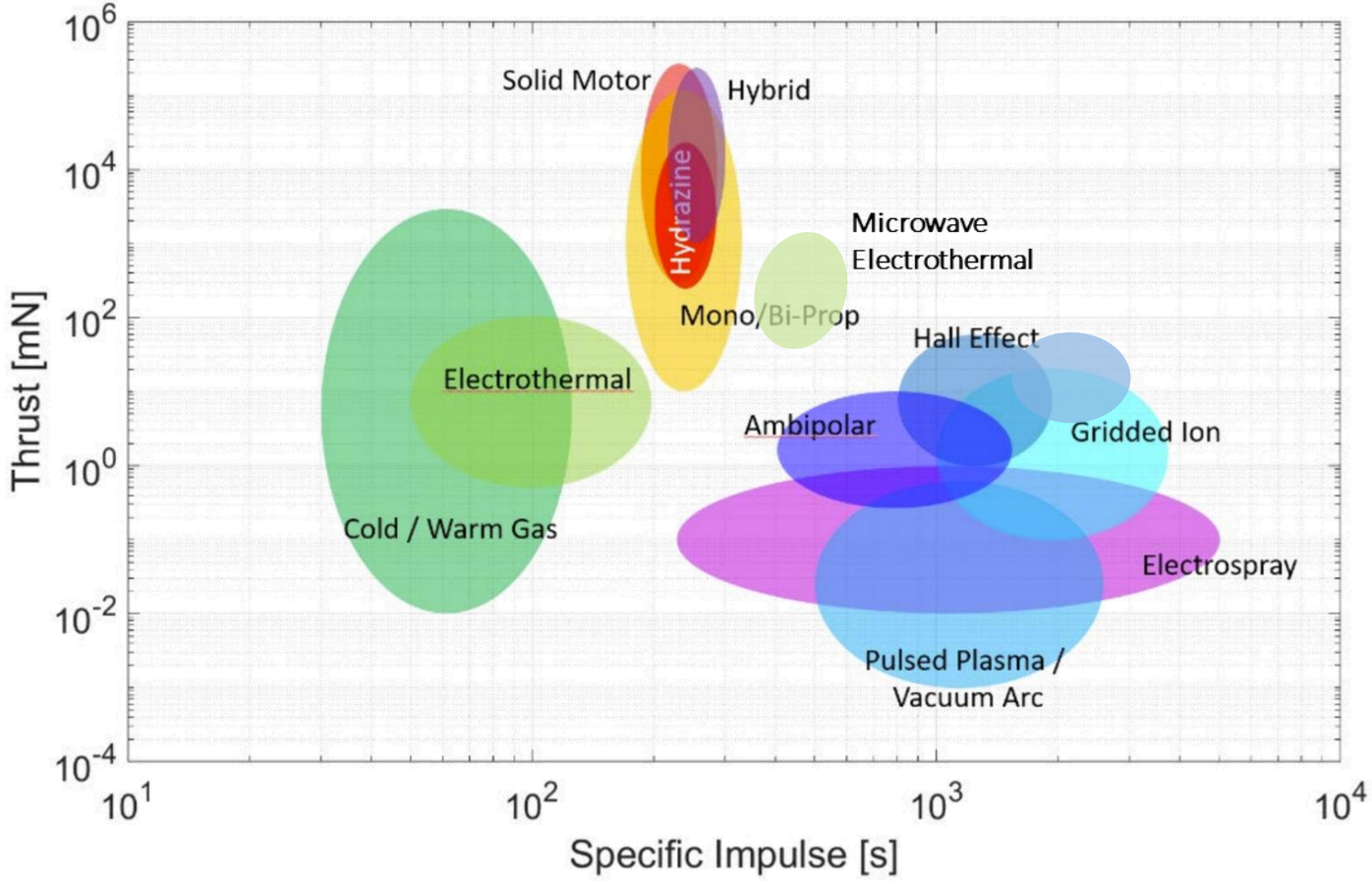
PROPULSION EVERYWHERE!

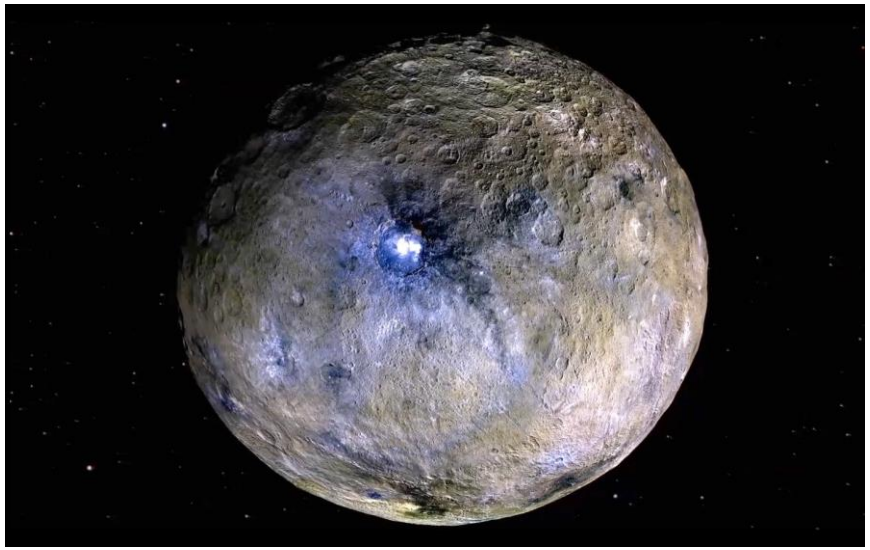
PROPULSION IS (BECOMING) A COMMODITY

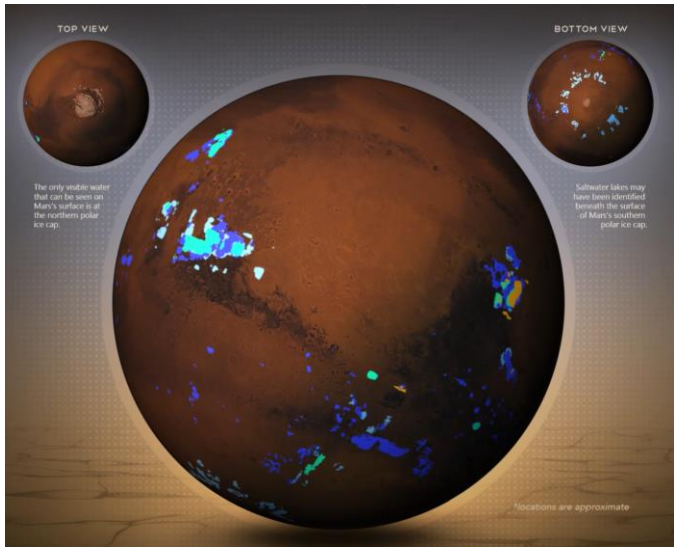
BUT IS EP (BECOMING) A COMMODITY?

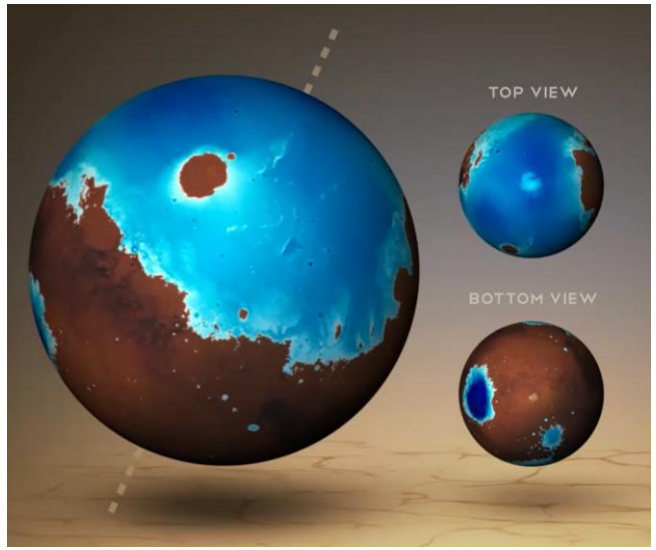
- IS FUTURE ELECTRIC?
- IS THERE AN ULTIMATE EP SYSTEM?
  - Power vs. Thrust
  - Thrust vs. ISP
  - TTPR vs. ISP
- IS THERE AN ULTIMATE EP PROPELLANT?

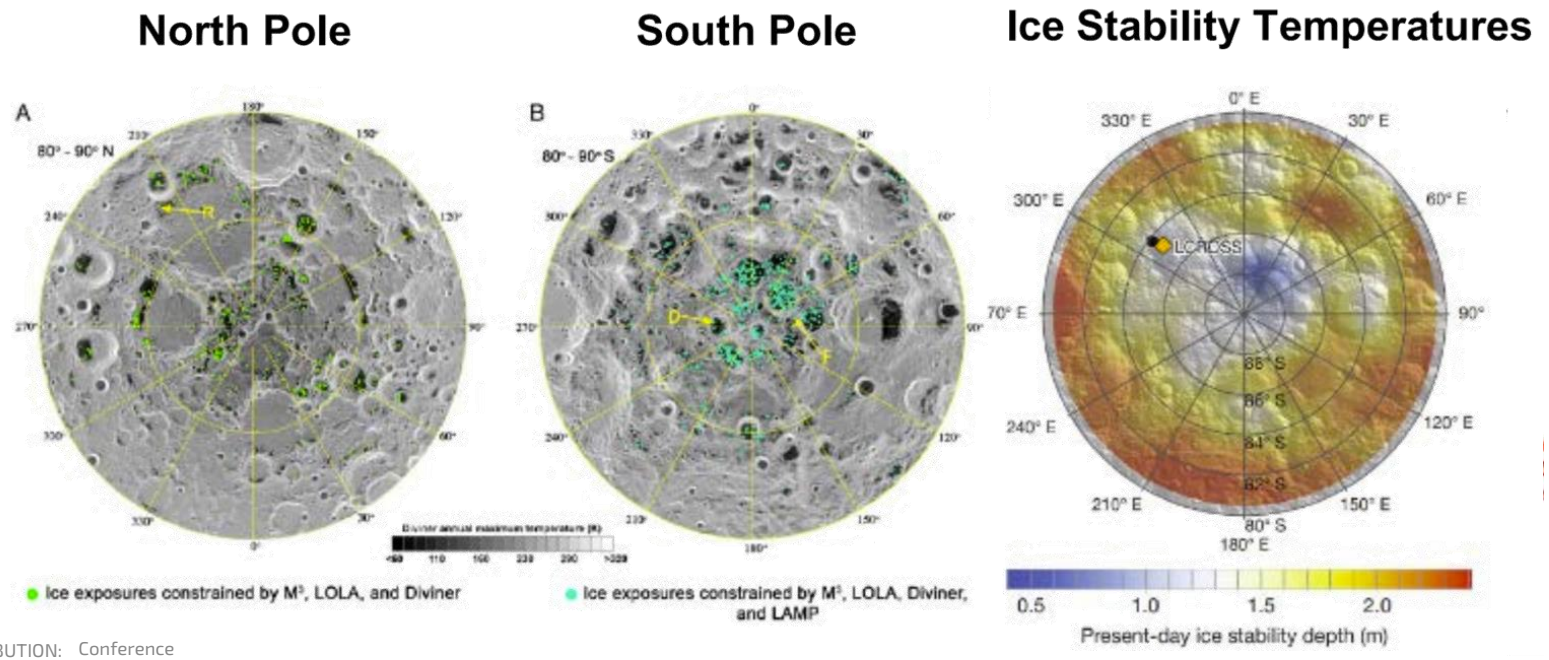


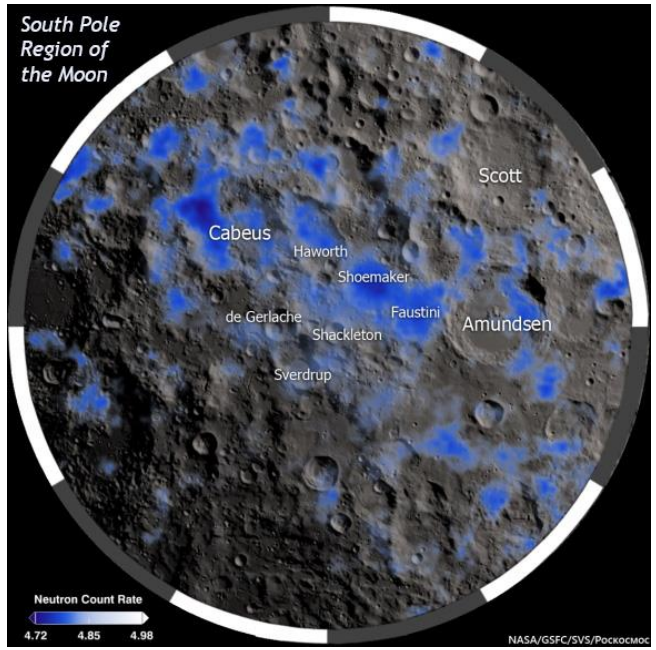
WATER EVERYWHERE!











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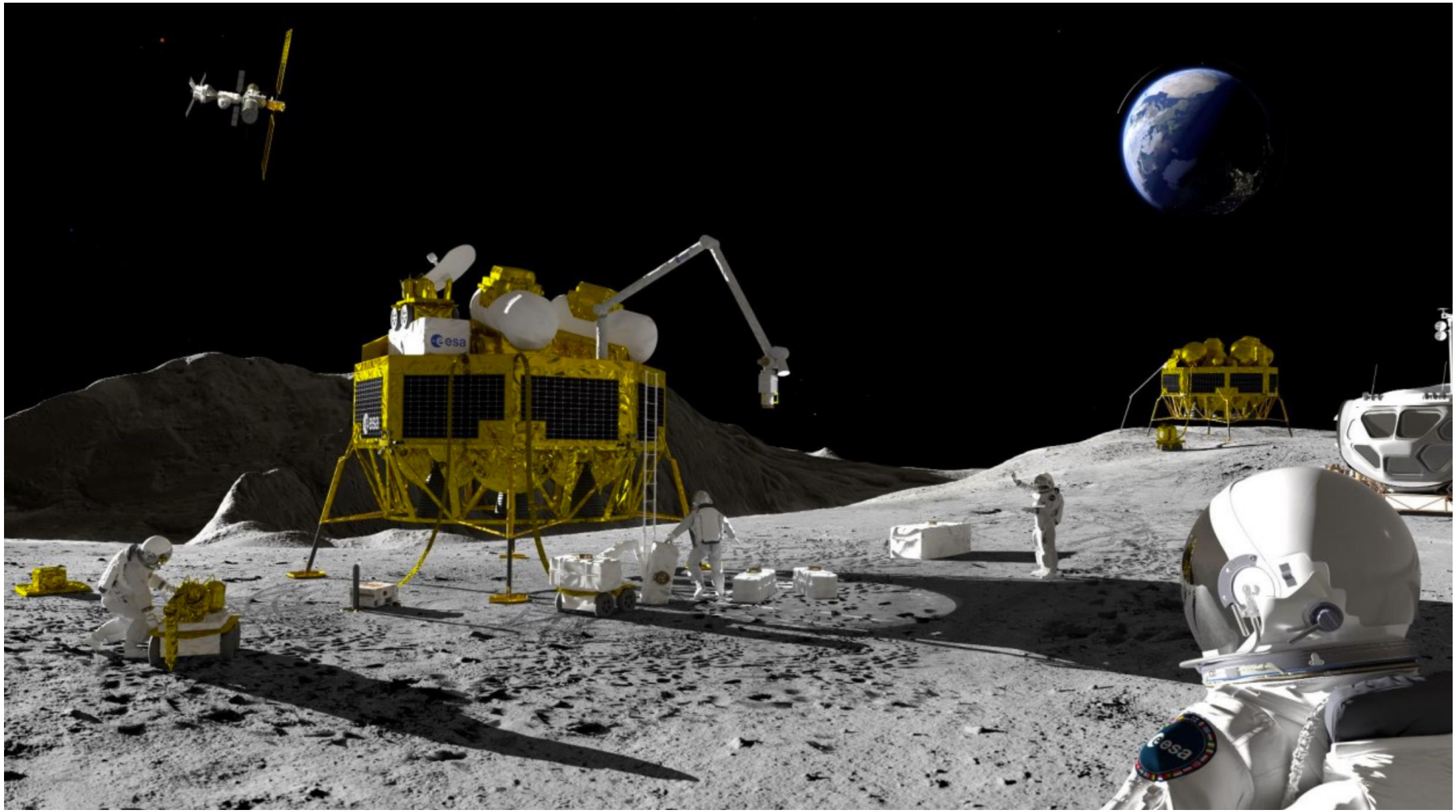

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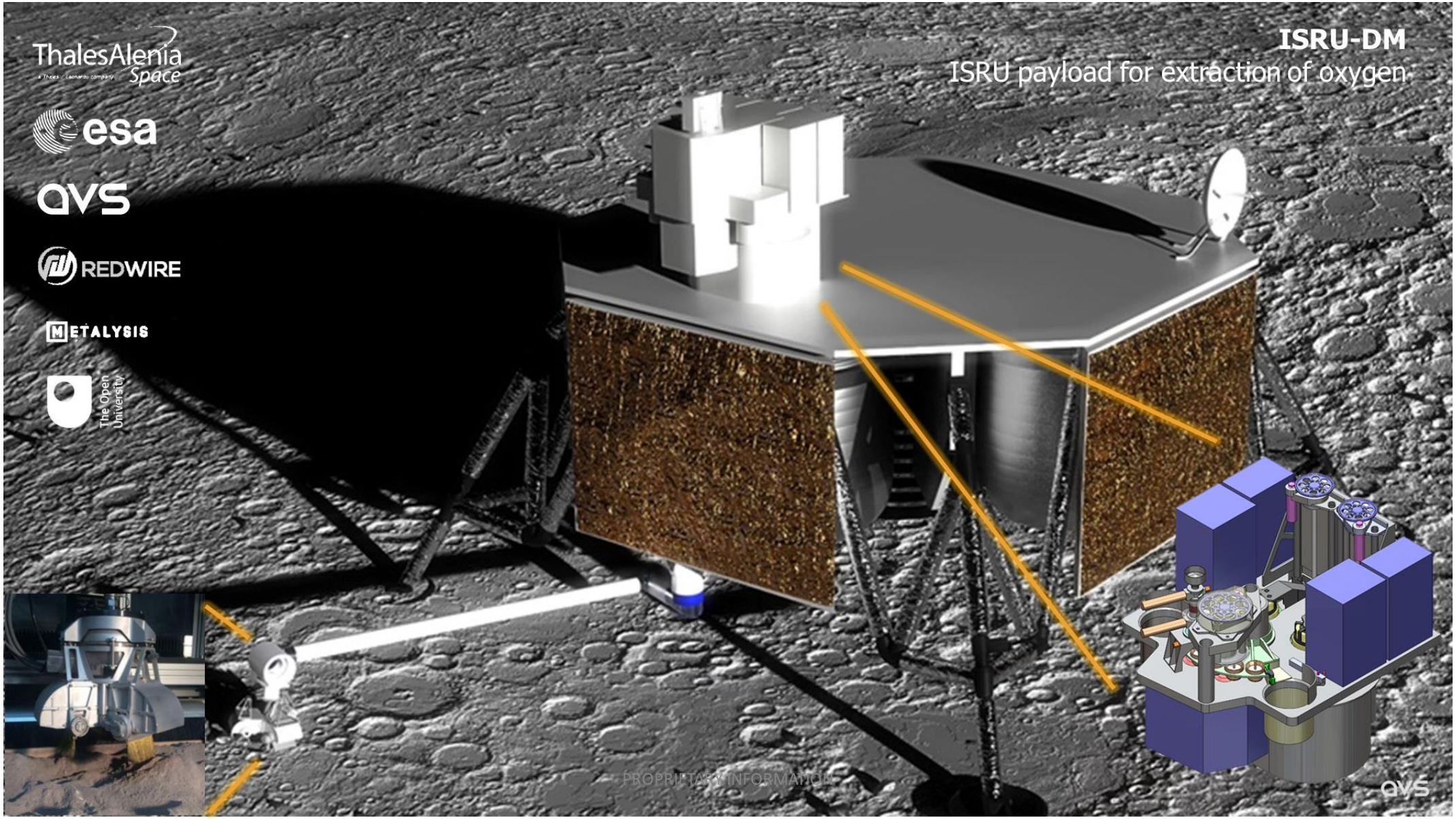


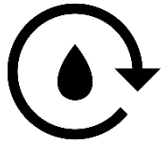
ABOUT US

WHY WATER ?

URA

means water in the Basque language, the oldest living language in Europe and, perhaps, the seed of all articulate language.

At URA we will transform not communication, but in-space transportation by providing green, low-cost and high-performance propulsion solutions.



THE MOST SUSTAINABLE

Water is an enduring propellant choice: it is essential to our species and will follow humans wherever we may explore.

Water is the propellant of the future, avaiable NOW!

MOST SCALABLE

And only option produced in sufficient quantities to match the space market growth requirements.

And the only cost-effective option for high-power Nuclear Electric Propulsion (NEP) developments.

MOST COST-EFFECTIVE

By several orders of magnitude.

URA' thrusters allow to load the propellant at the spacecraft instead of the launch site.

Large GEO spacecrafts will be able to reduce $100K-500K cost only during integration.

THE ULTIMATE GREEN PROPELLANT

Available across our Solar System to support the future of Lunar and Interplanetary exploration missions!

ABOUT AVS

GLOBAL SME
SET-UP IN 2006

in 2022

>200 PEOPLE
HIGHLY QUALIFIED PERSONNEL
(80% MSc, MEngs and PhDs)

€23M REVENUE
€60M BACKLOG

worldwide

9 locations
5 main sites
+30,000 m² FACILITIES
ISO 9001 & EN 9100

MODELLING DETAILED-DESIGN ANALYSIS PROCUREMENT MANUFACTURING ASSEMBLY INTEGRATION TEST

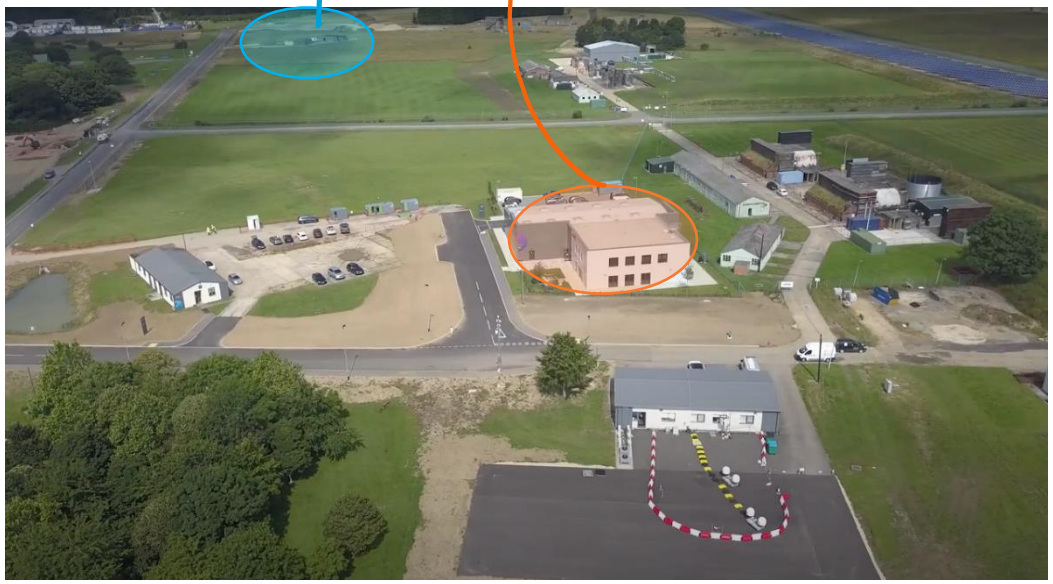
ABOUT US

FACILITIES | WESTCOTT

TESTA

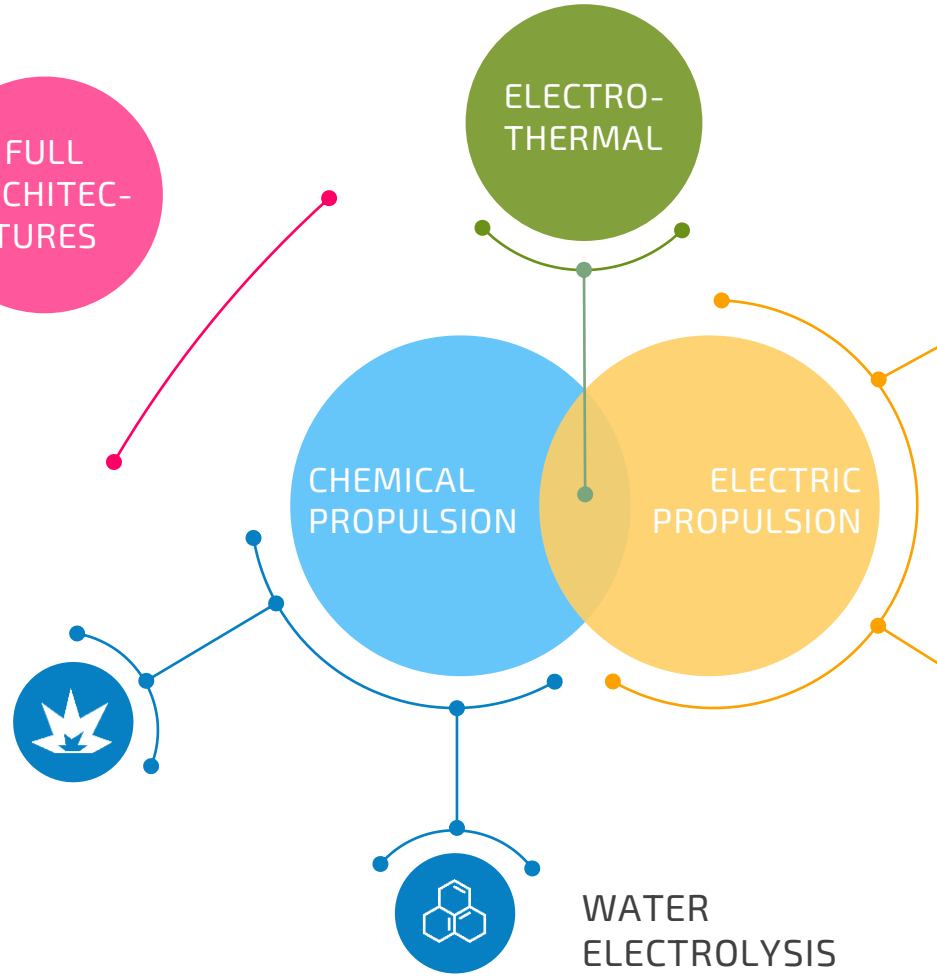
OFFICES &
EN9100 WORKSHOP

Westcott, the UK hub for space propulsion
The home of URA Thrusters | the home of the National Space Propulsion Test Facility (NSPTF)



ABOUT US

PRODUCTS



Microwave electrothermal

AQUAMET (H_2O | NH_3)
XMET (CO_2 | Kr)

CP + EP
AND
FULLY-ALL-ELECTRIC

HYDRA
IMPULSE

Ion engines

Water-based Hall-effect thrusters
AQUAHET

CHEMICAL BI-PROP

ICE-R (H_2 + O_2)
AQUAMAG (H_2O + Mg)

Electrospray

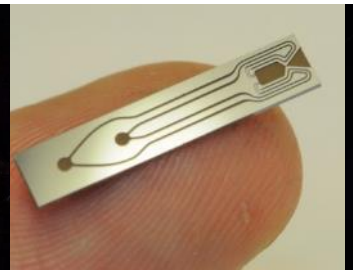
PET (Porous Electrospray)
EMI-BF4

WATER
ELECTROLYSIS

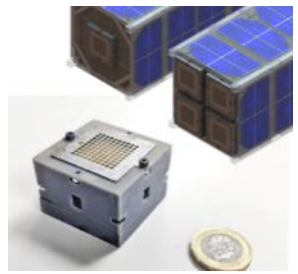
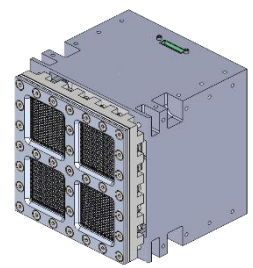
ICE (H_2O)

PRODUCTS | WATER & ELECTROSPRAY








ICE

Water electrolysis

ICE-10 | ICE-50 | ICE-100
ICE-1000 | ICE-5000

$H_2 + O_2$

The first EU water electrolysis solution
IOD in Q2 2024

P [W]	10 - 60 | 150 - 500
I_{sp} [s]	310
TTPR [mN/kW]	n/a

MET

Microwave electrothermal

AQUAMET
XMET | COMET

H_2O | NH_3 | CO_2 | Kr

Chemical thrust in an electric thruster
Available 2025

P [W]	1,000
I_{sp}[s]	500 - 600
TTPR	90 - 100

PET

Electrospray

PET-50
PET-200 | 400 | 800

EMI-BF4

Plug-and-play | Safe and inert
IOD in Q2 2024

P [W]	50 - 800
I_{sp}[s]	>2,000
TTPR	1 - 30

AQUAHET

Hall-effect

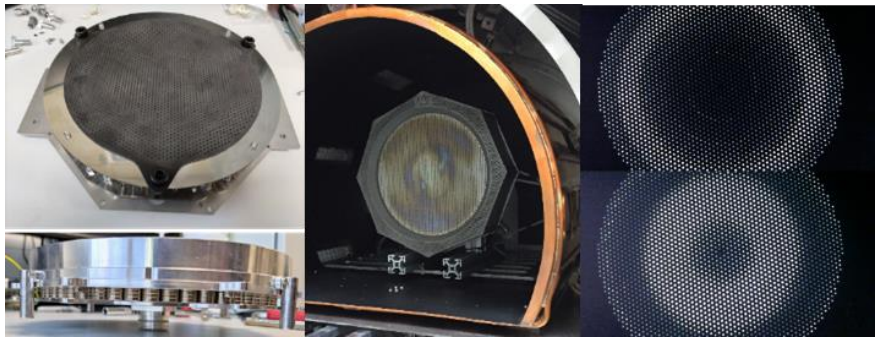
AQUAHET-2000
AQUAHET-5000

H_2O | $H_2 + O_2$

Our water version of the HET
Available 2026-27

P [W]	1,500 - 7,000
I_{sp}[s]	>2,800
TTPR	>20

PRODUCTS | FULL ARCHITECTURES



IMPULSE

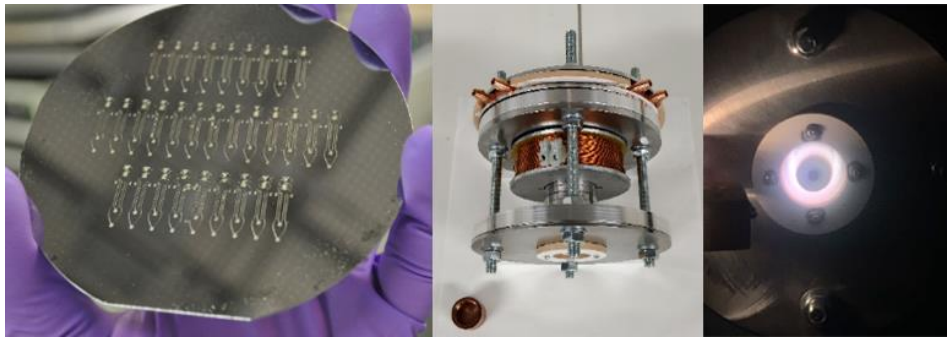
Dual mode (fully-all-electric)

XMET: BoL + RACS
XEPT: SK + OR + EoL

Microwave PSU: 250 W | 500 W
High-voltage PSU: 2,000 W | 5,000 W

Integrated Microwave Propulsion Architecture

P [W]	2,000 | 5,000
I_{sp} [s]	XMET: >150 XEPT: >3,500
TTPR [mN/kW]	n/a



HYDRA

Dual mode (CP + EP)

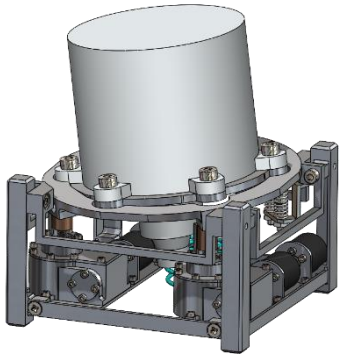
ICE: BoL + RACS
AQUAHET: SK + OR + EoL

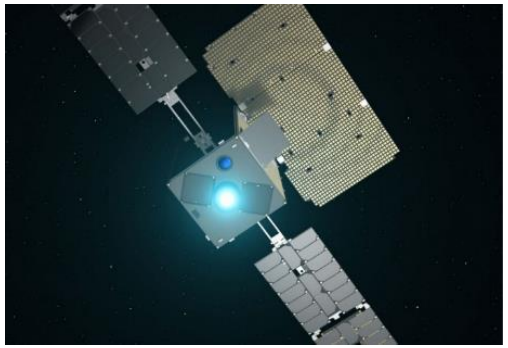
HYDRA-2000
HYDRA-5000

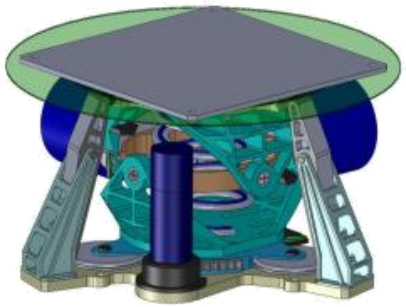
A dual-mode hybrid water propulsion architecture

P [W]	2,000 | 5,000
I_{sp} [s]	ICE: 310 (H20) AQUAHET: >2,200 (O2)
TTPR [mN/kW]	n/a

PRODUCTS | MECHANISMS







POINTING

EP Thruster pointing mechanisms

TPM-250 | TPM-5000
50 – 300 W | 3,000 – 7,000 W

M-ARGO (2025)
Available in 2024

	TPM-250	TPM-5000
Volume	0.5 - 1 U	~5 U
Payload	500 - 1,200 g	<13 kg
Thruster power	100 – 300 W	3 – 7 kW
Angular range	± 5 - 7.5 deg	± 5 - 8 deg

BALANCES

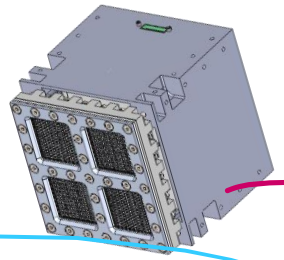
High-precision thrust balances

HTB-20 | HTB-100
TVB-100 | PTB-1500

Available now | EN9100 certified
Lead time: 6 months | 3 currently sold (EU & Asia)

	HTB-20	HTB-100 **TVB	PTB-1500
Thruster mass	< 10 kg	< 12 kg	< 2 kg
Thrust range	0.05 - 600 mN	5 - 100 mN	0.3 - 1.5 N
Accuracy	≤1%	≤0.2% **≤0.1°	≤0.5%

IOD IN Q2 2024 | LUR | HYBRID (CP + EP)



THE FIRST EU WATER ELECTROLYSIS (ICE-1000) PROPULSION SYSTEM
THE FIRST LOW-POWER (>20 W) ELECTROSPRAY (PET-50) PROPULSION SYSTEM

ICE

Water electrolysis

ICE-10 | ICE-50 | ICE-100
ICE-1000 | ICE-5000

$H_2 + O_2$

The first EU water electrolysis solution
IOD in Q2 2024

P [W]	10 - 60 | 150 - 500
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Electrospray

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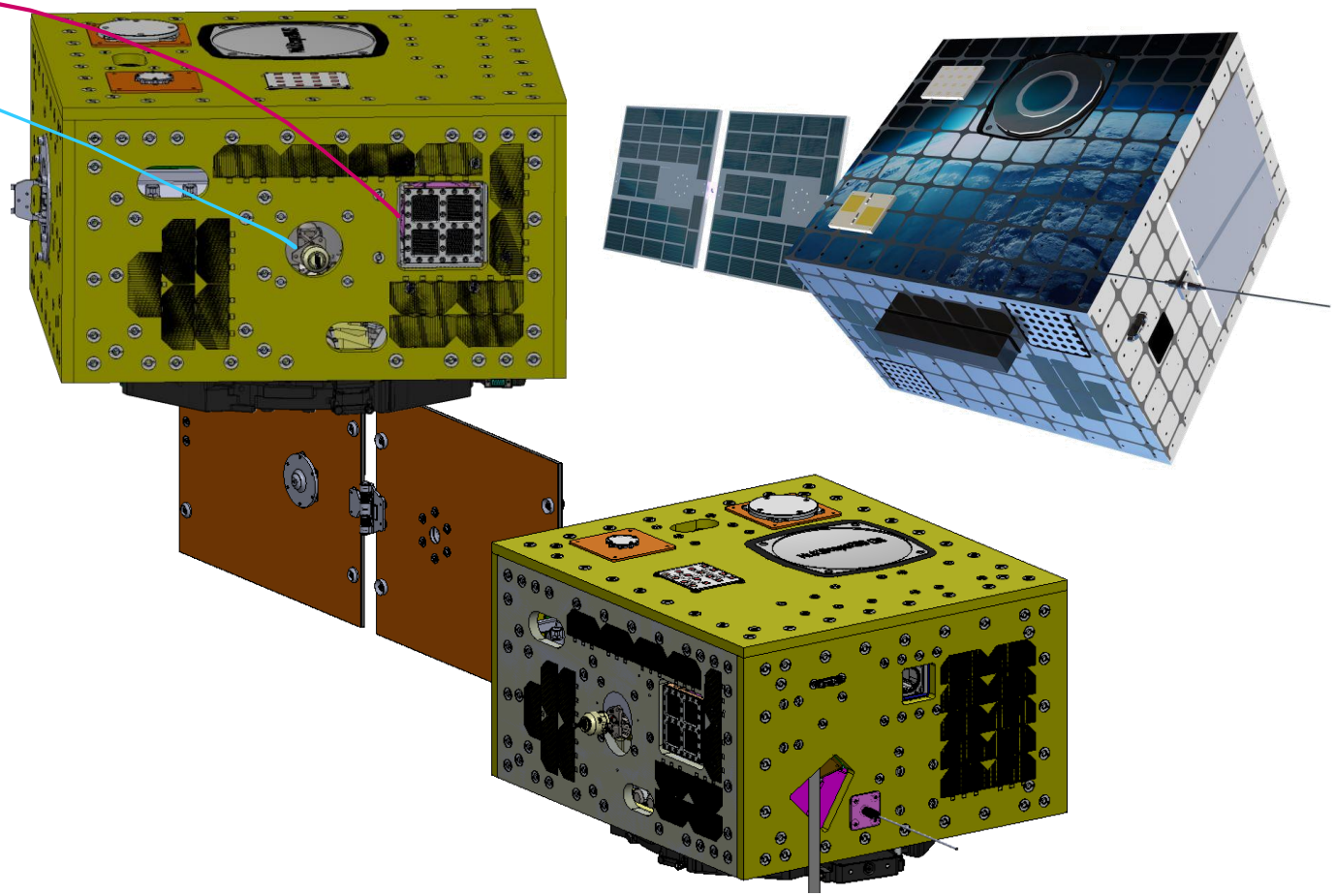
IOD in Q2 2024

P [W]	50 - 400
I_{sp}[s]	>2,000
TTPR	1 - 30



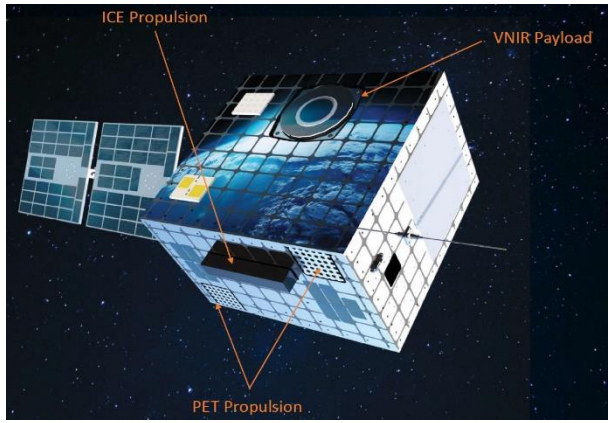
ICE | Water electrolysis

ICE | s/s

Propellant Management Assembly (PMA)
Electrolyser and Pressure Management Assembly (EPMA)
Thruster Mount Assembly (TMA)
Power Processing Unit (PPU)

ICE,
the first EU water electrolysis propulsion solution

LAUNCH Q2 2024



HIGH PERFORMANCE

Typ. chemical thrust at much higher ISP than existing techs. High thrust | min. power input.

The ultimate green CP system

MODULAR AND SCALABLE

Different thruster variants can be chosen independently of the EPMA.

Ideal for any type of missions.

BATCH PRODUCED

All hardware components have been design for mass manufacturing.

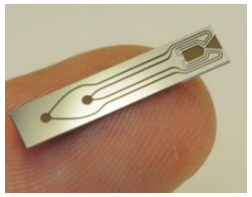
Ideal for constellation use.

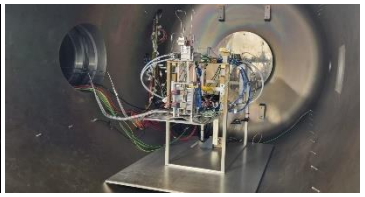
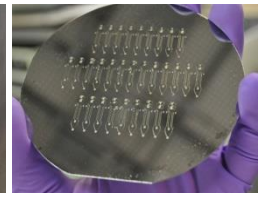
MEMS PRODUCED

Thruster chips and rest of miniaturised components make ICE systems lightweight and compact.

Ideal for any type of spacecraft.

	ICE-10	ICE-1000
Nominal thrust	10 mN	1000 mN
ISP	310 s	310 s
Min. IBIT	20 x 10^{-6} Ns	0.05 Ns
Power EPMA	10 - 60 W	150 - 500 W
Power TMA	10 W	20 - 40 W
TTPR **in case of continous thrust*	150 - 170 mN/kW	150 - 170 mN/kW
Thruster size	20 x 4 x 1.2 mm	32 x 12 x 3.4 mm
Total impulse	<10 kNs	<300 kNs
Wet mass	<6.2 kg	<60 kg
Impulse per burn	5 - 10 Ns	1000 - 2000 Ns
Firing duration	15 mins.	60 mins.
Lifetime	>100,000 pulses >5 years	>120,000 pulses >15 years
Applications	Smallsats *Available in 2025*	Large S/C typ. GEO *LUR-1 -50 kg microsat- (2024)*



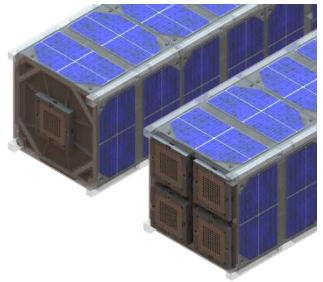
DISTRIBUTION: Conference
RATING: Public

PET | Electrospray

PET | s/s

Processing Unit (PPU)
Propellant Management Assembly (PMA)
Thruster Mount Assembly (TMA)

PET,
the first EU low-power (>20 W) electrospray propulsion solution



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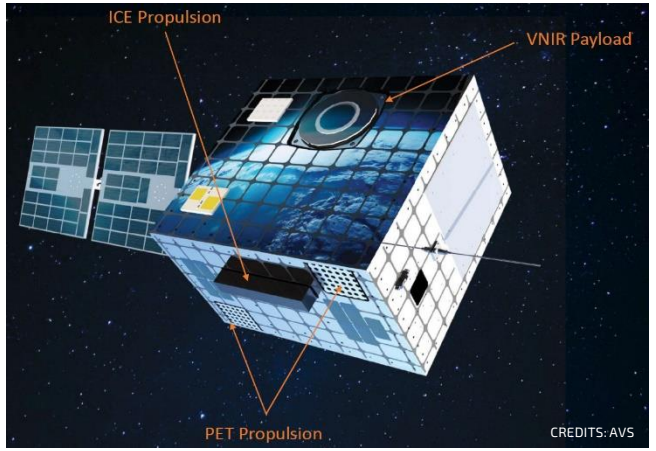


SAFE AND INERT

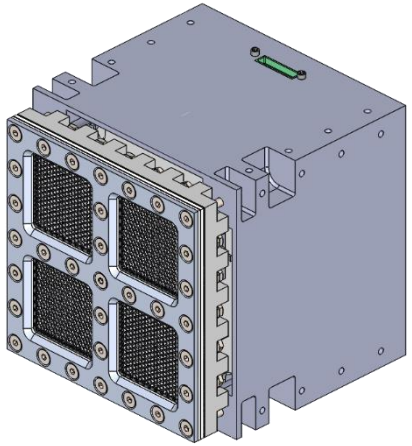
Ionic liquids are inert and non-toxic propellants that can be handled with normal care.

Ideal for ride-share

MODULAR AND SCALABLE

Amount of liquid and emitter arrays can be modify to suit all mission needs.

Even 4 x PET-50 modules are competitive in 100-200 W apps.



BATCH PRODUCED

Emitter tips, and main critical components are batch produced, providing a low-cost and low lead-time system.

Ideal for constellation use.

THROTTEABLE

Thrust and impulse can be changed by varying the applied voltage.

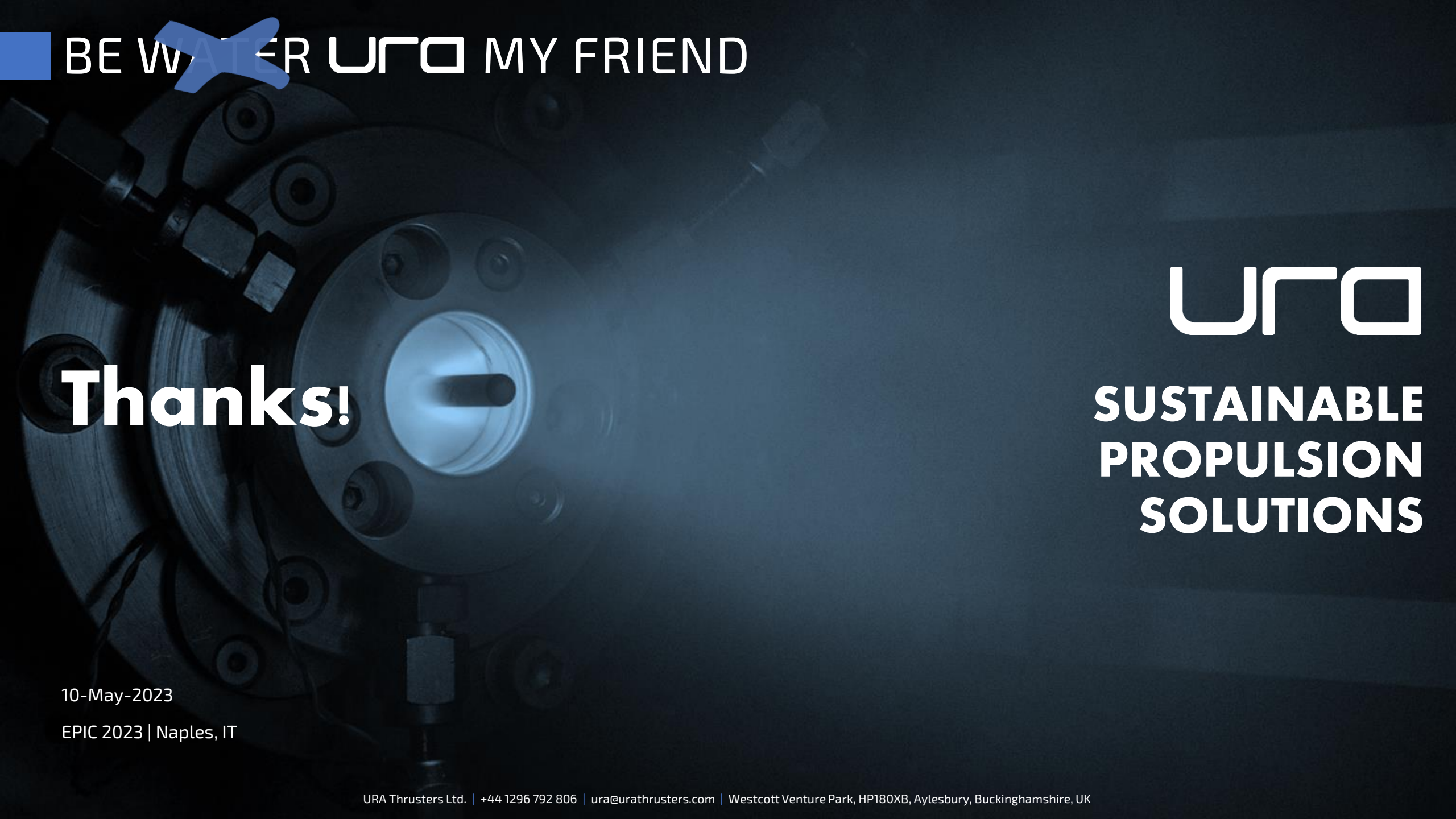
Large range of dynamic thrust.

PLUG-AND-PLAY

Preloaded. No pressurised tanks. Bolt-on. It includes PPU.

No need for launch or integration activities.

	PET-50
Nominal thrust	1 - 1.2 mN
Dynamic thrust	0.05 – 1.5 mN
Power	<50 W
ISP	>2,000 s
Total impulse	>4,000 Ns
Wet mass	<1.5 kg
Volume	1 U *(~100 x ~100 x ~100 mm)*
Temperature range	-10 to + 70 degC
Power bus input	12 V 24 to 32 V 50 V
Lifetime	>5 years
Applications	Smallsats *LUR-1 microsat (2024)* *Available in 2023*



Thanks!

URA

SUSTAINABLE PROPULSION SOLUTIONS

10-May-2023

EPIC 2023 | Naples, IT

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LEAD / CHIEF EP ENGINEER

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