C09

デブリ除去衛星への搭載を目指したホールスラスタの開発

Development of 200 W class Hal thruster for ADR main propulsion

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デブリ除去衛星のメイン推進として、小型ホールスラスタシステムの開発を行っている。システム全体の小型化のために、ボルテラエンジンを採用すると共に、長寿命化のために、マグネチックシールディングに似た磁場形状を採用している。中和器としては、従来型のホローカソードの他に、マイクロ波放電型中和器での作動も成功した。推進性能としては、消費電力 150W において、推力 7mN、推進効率 16%と改善の余地があり、アノードの形状などの最適化を行っている。

We have been developing 200 W class Hall thruster system for a main propulsion system of active debris remover. We use a Volterra engine for reduction of power consumption. A microwave discharge electron emitter is used as a neutralizer. the thrust is 7 mN at input power of 150 W was obtained with thrust efficiency of 16%.

1

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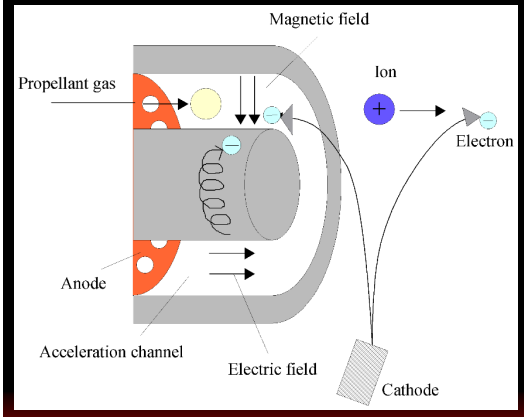
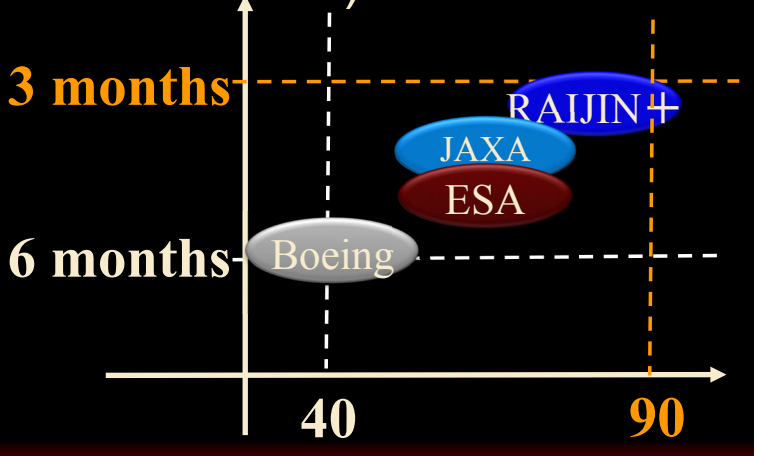
2

Hall thruster

1. High efficiency (>50%) with I_{sp} of 1,000-3,000 sec
2. High Thrust density
3. High thrust to power ratio(T/P)





3

Debris altitude: 800 km→400km

status	ΔV m/s
approach	165
De-orbit	217
De-orbit(non-contact)*	458

* momentum transfer efficiency of 0.9

ADR	Debris	Xenon mass	Xenon mass *
200 kg	1,500 kg	40 kg /120L	81 kg

P:250 W, I_{sp} :1,000 sec, F: 13 mN

8500 hours

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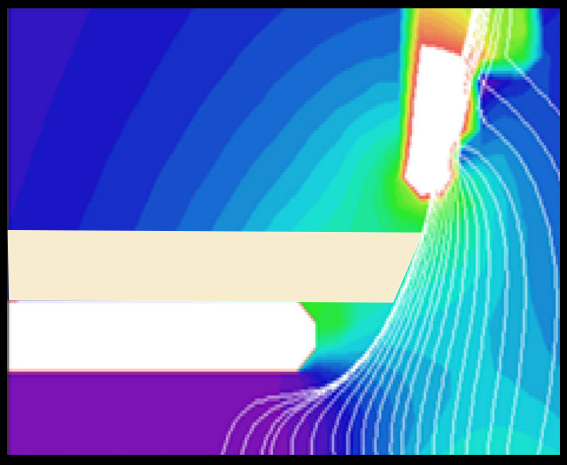
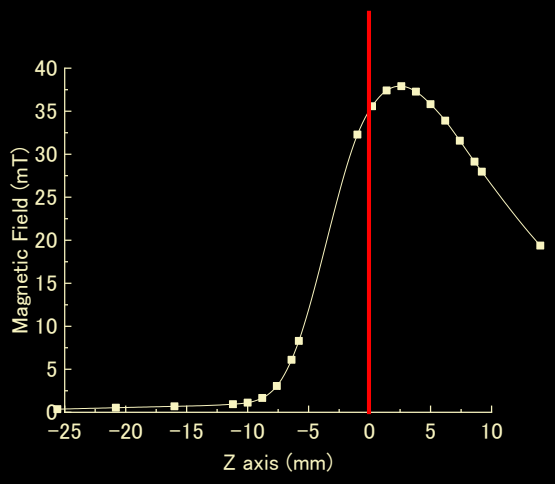
Magnetic field configuration





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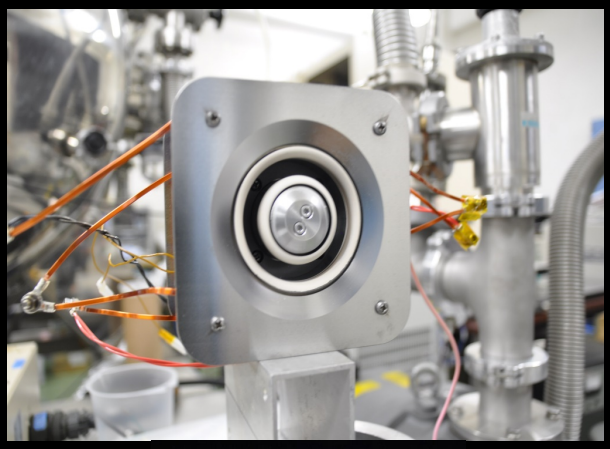
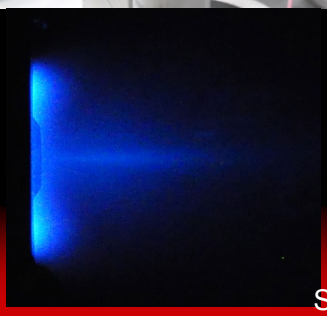
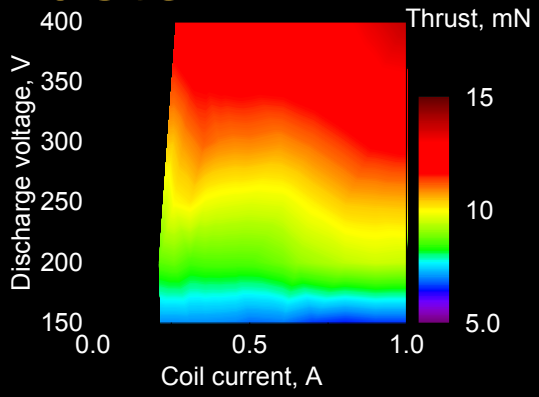
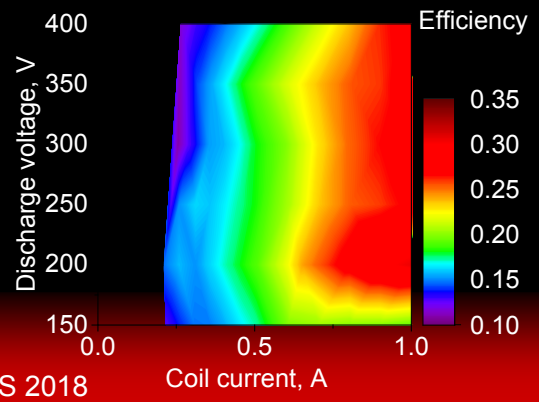
5

200 W class Hall thruster



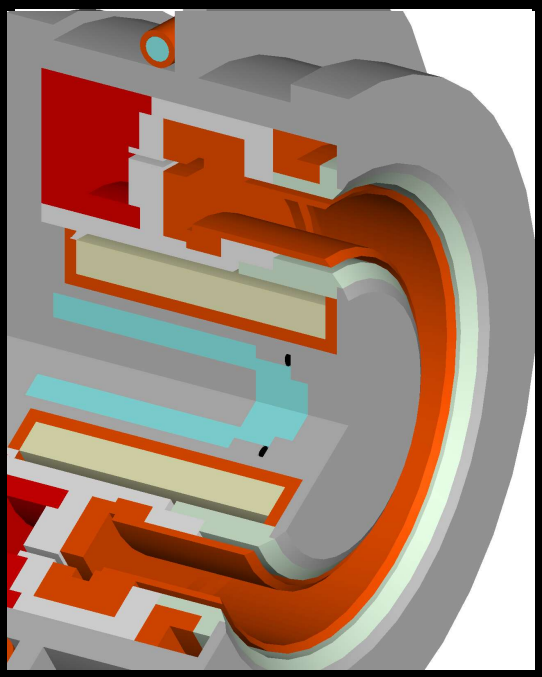






6

What is a life-limiter for Hall thrusters?



Acceleration channel change

Magnetic field profile

wall was sputtered

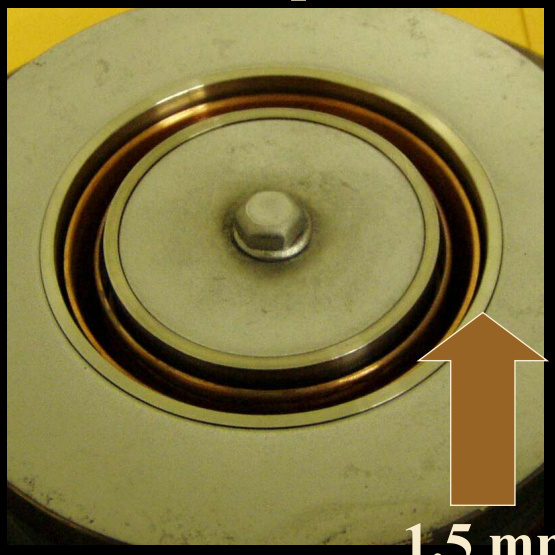
When ion collides wall,

- **Operation becomes unstable**
- **Thrust performance decreases**
- **Redeposit and form coatings on spacecraft surfaces**

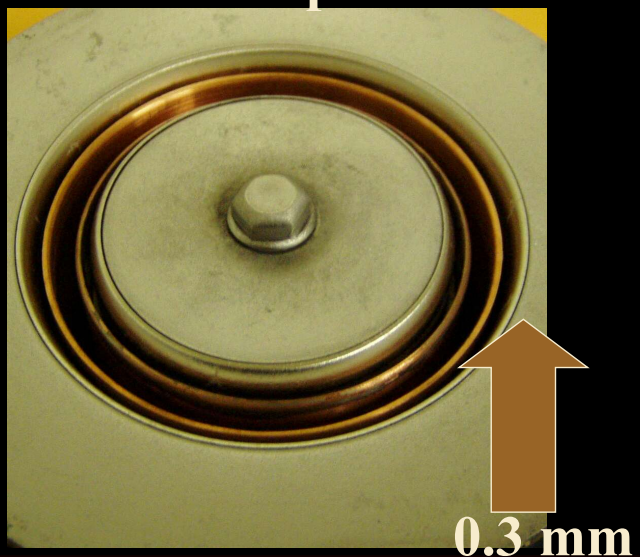
7

Lifetime of Hall thrusters

Before Operation



After Operation



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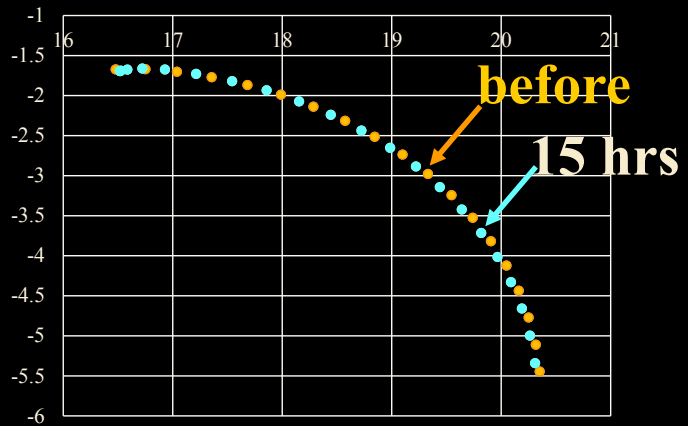
8

lifetime



No difference was observed before and after

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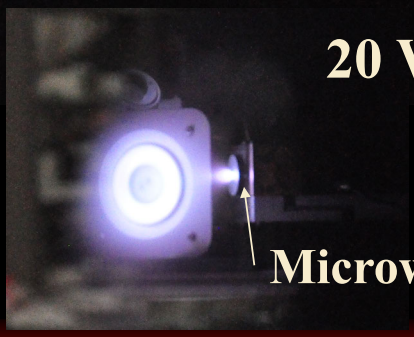
9

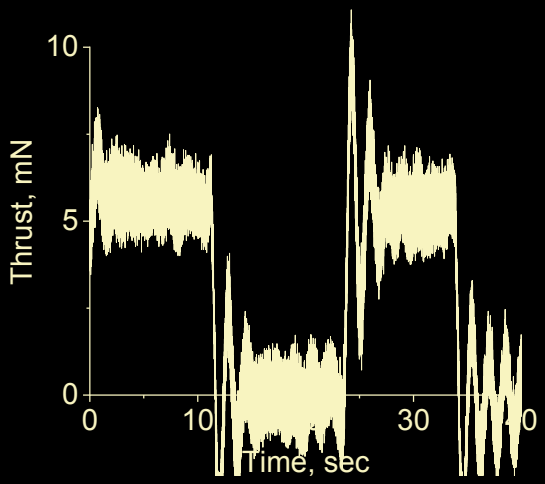
Microwave discharge cathode

Hollow cathode **10 W**

Mass flow 2.8 sccm

20 W





Mass flow 1.5 sccm ⇨ I_{sp}:1,100s

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10

Subsystem

- 300 W class Power Processing Unit

  600 cc 500 g, 93%

  Space transportation symposium 2019

- Mass flow control system

  Shape memory alloy valve , less than 0.3 W

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Acknowledgement

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