Sn film and ignition control for performance enhancement of laser-triggered DPP source

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Laser-triggered Sn DPP source provides clean EUV to IF

Neutral debris
(Macro/microscopic particles, gaseous debris)
- Completely stopped by debris shield

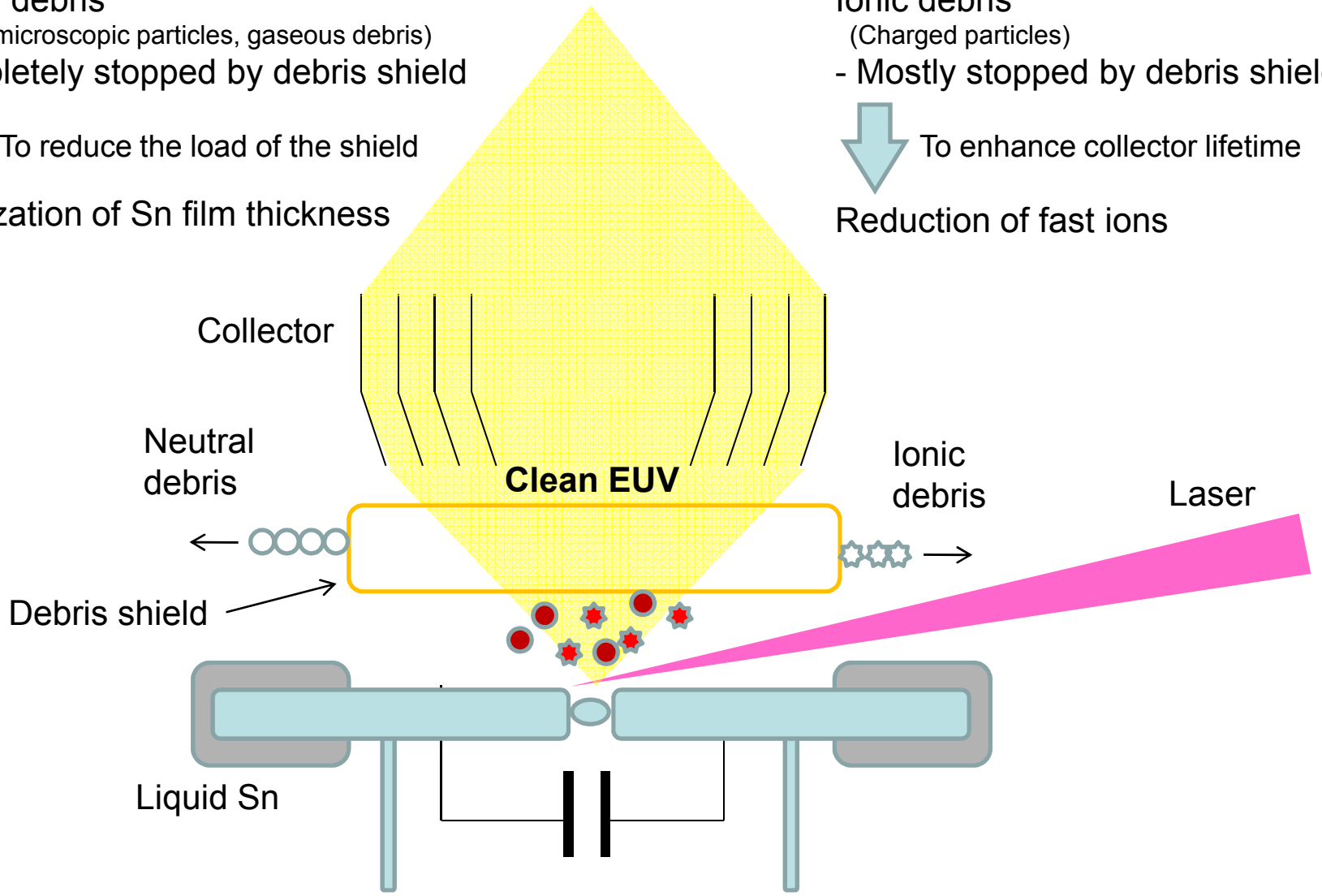
To reduce the load of the shield

Minimization of Sn film thickness

Ionic debris
(Charged particles)
- Mostly stopped by debris shield

To enhance collector lifetime

Reduction of fast ions



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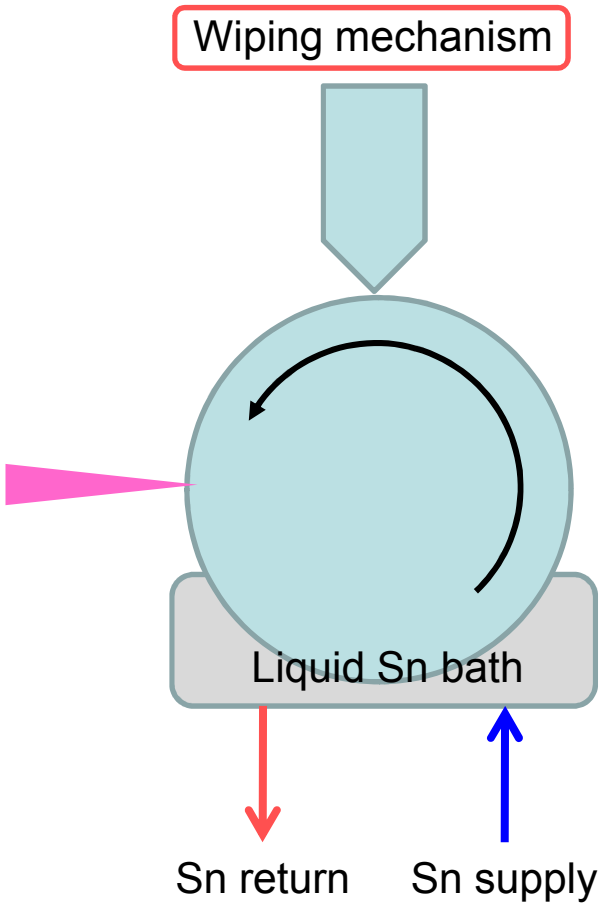
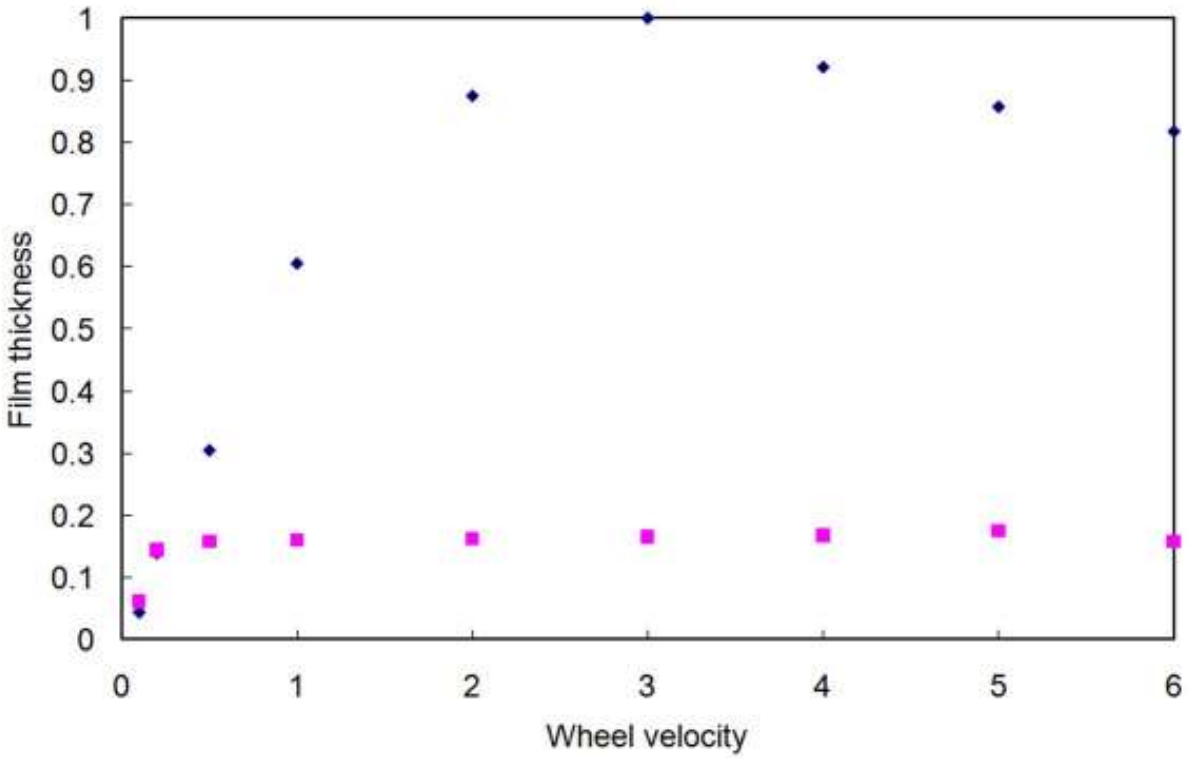
Sn film thickness control: Active surface control



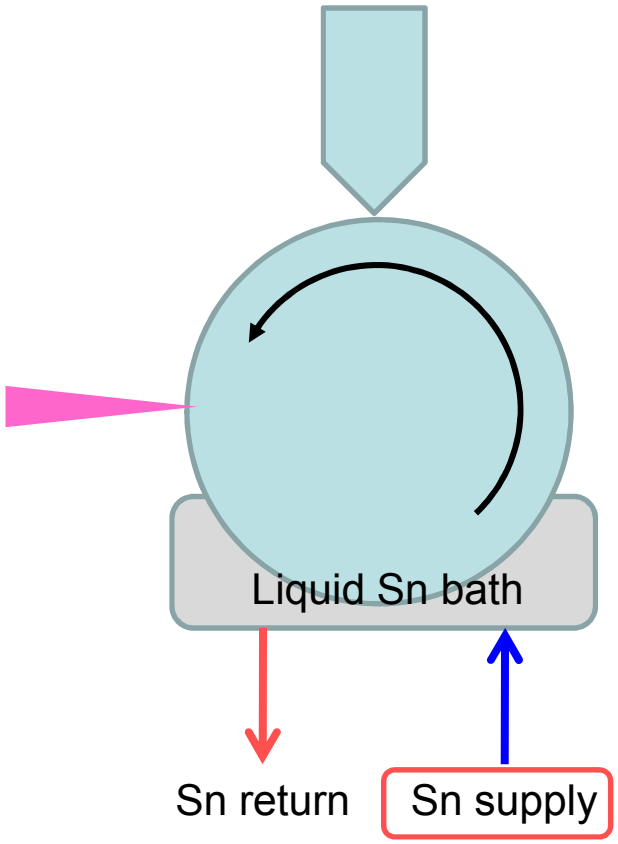
Sn film thickness on the electrode wheel is reduced by a factor of 5 resulting in less particle debris emission (see other slide). In addition, film thickness can be kept over wide range of the wheel rotational speed.



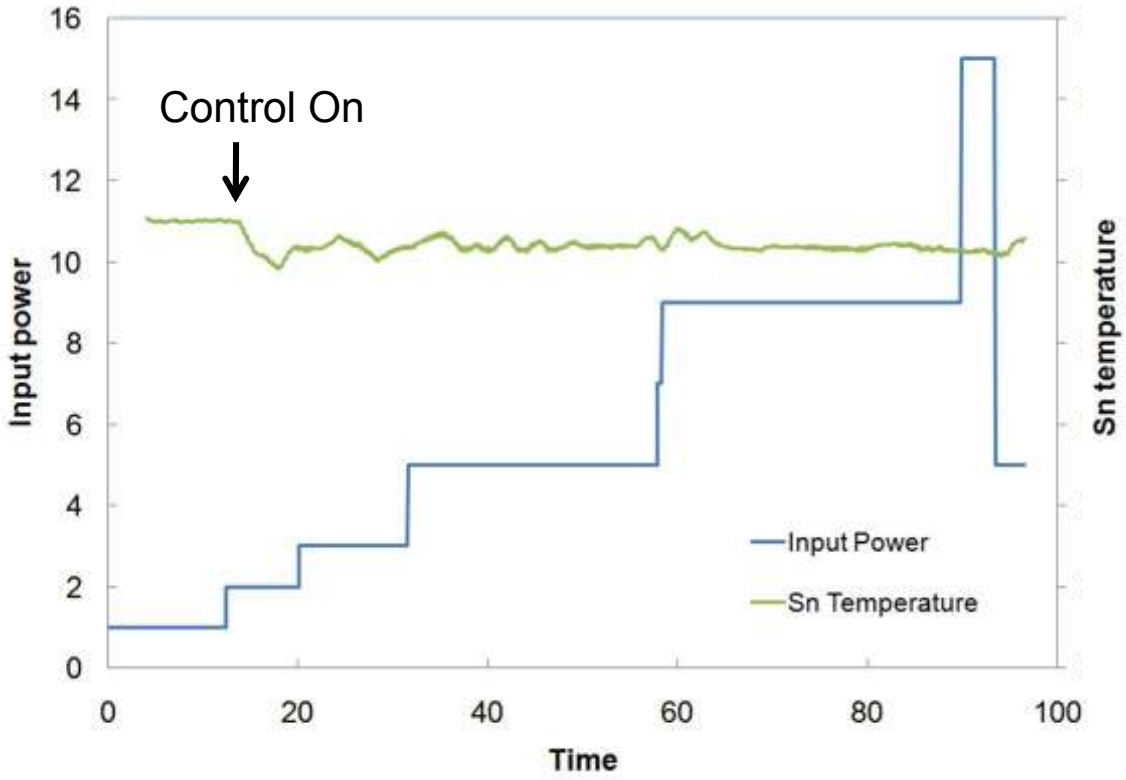
An example of Sn film thickness control

Sn film thickness control: Temperature control

Wiping mechanism

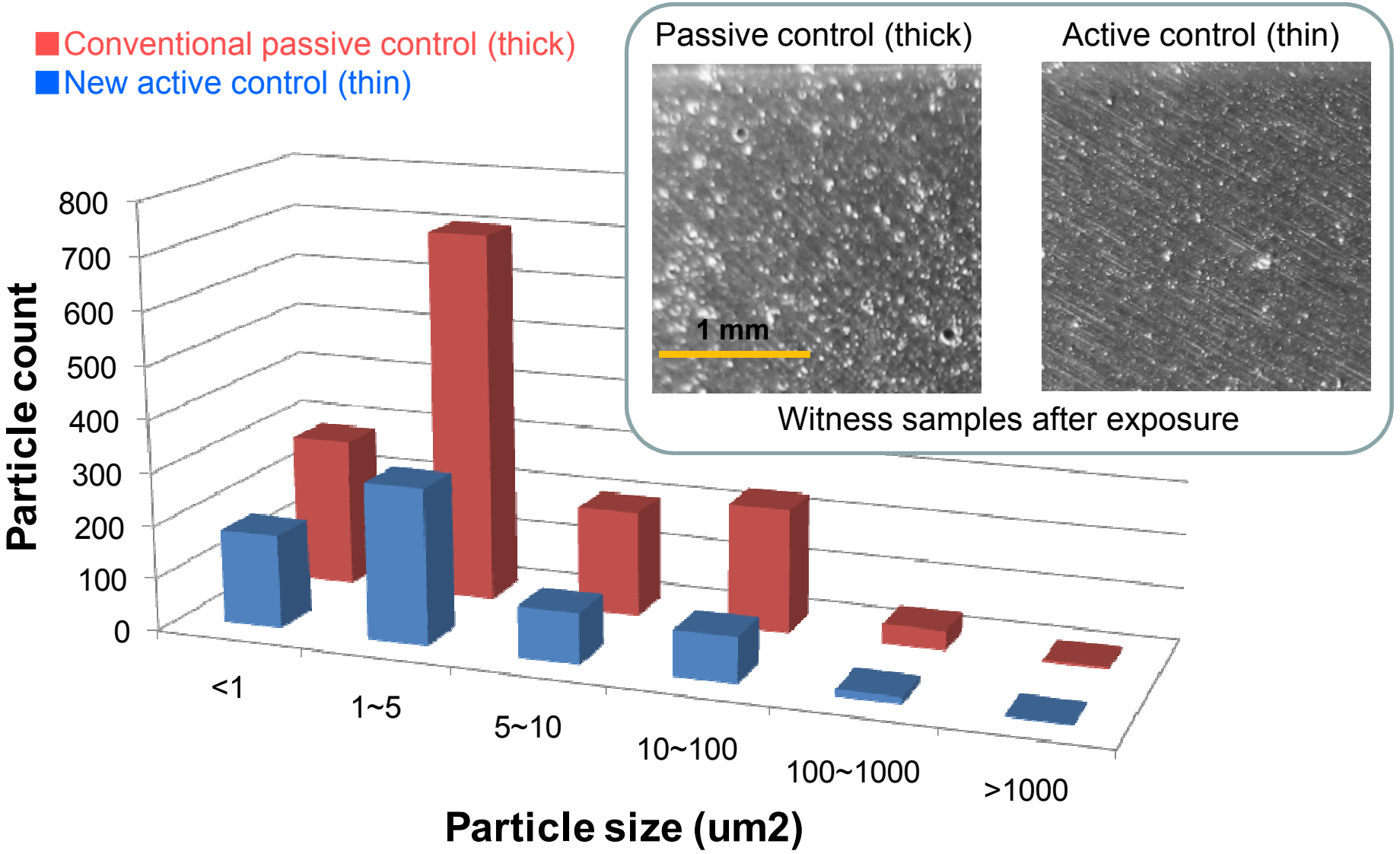


Even though input power is increased, liquid Sn temperature supplied to the bath is kept at the constant level by controlling cooling power.



An example of Sn temperature control

Sn film thickness control: Particle debris reduced by a factor of 3



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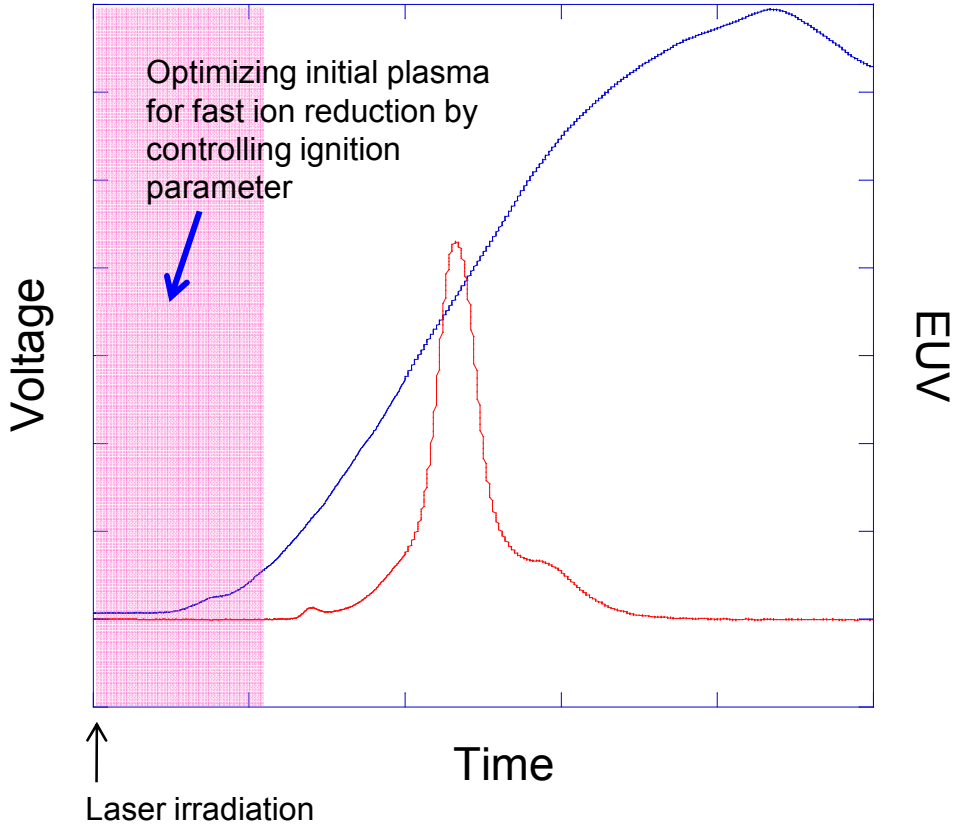
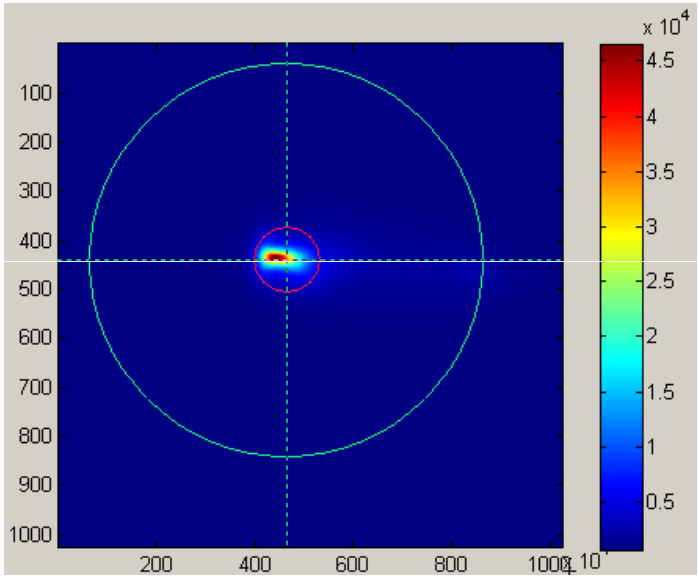
Ignition control: CE enhancement and fast ion reduction

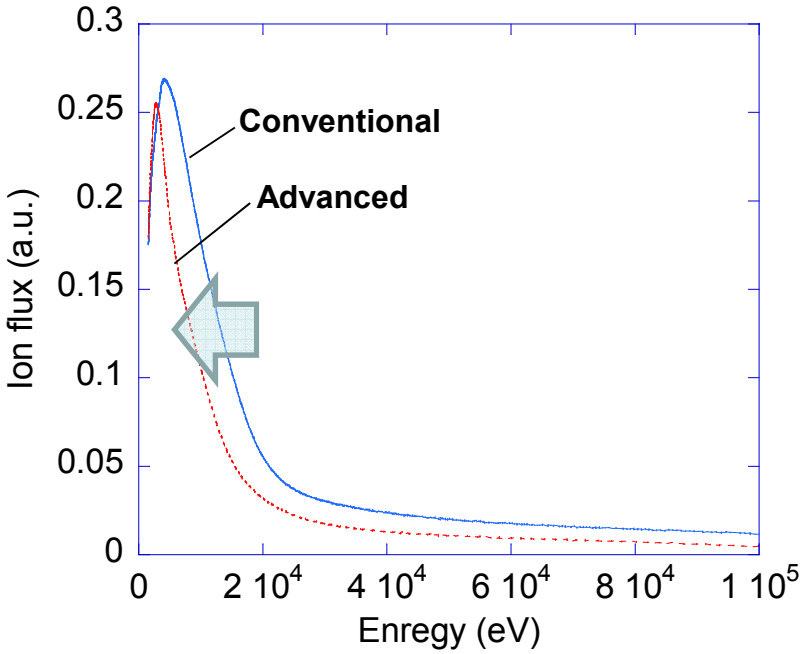
Initial plasma produced by a trigger laser is one of the essential parameters of laser-triggered DPP. Advanced ignition control which increases CE and decreases fast ion has been developed.



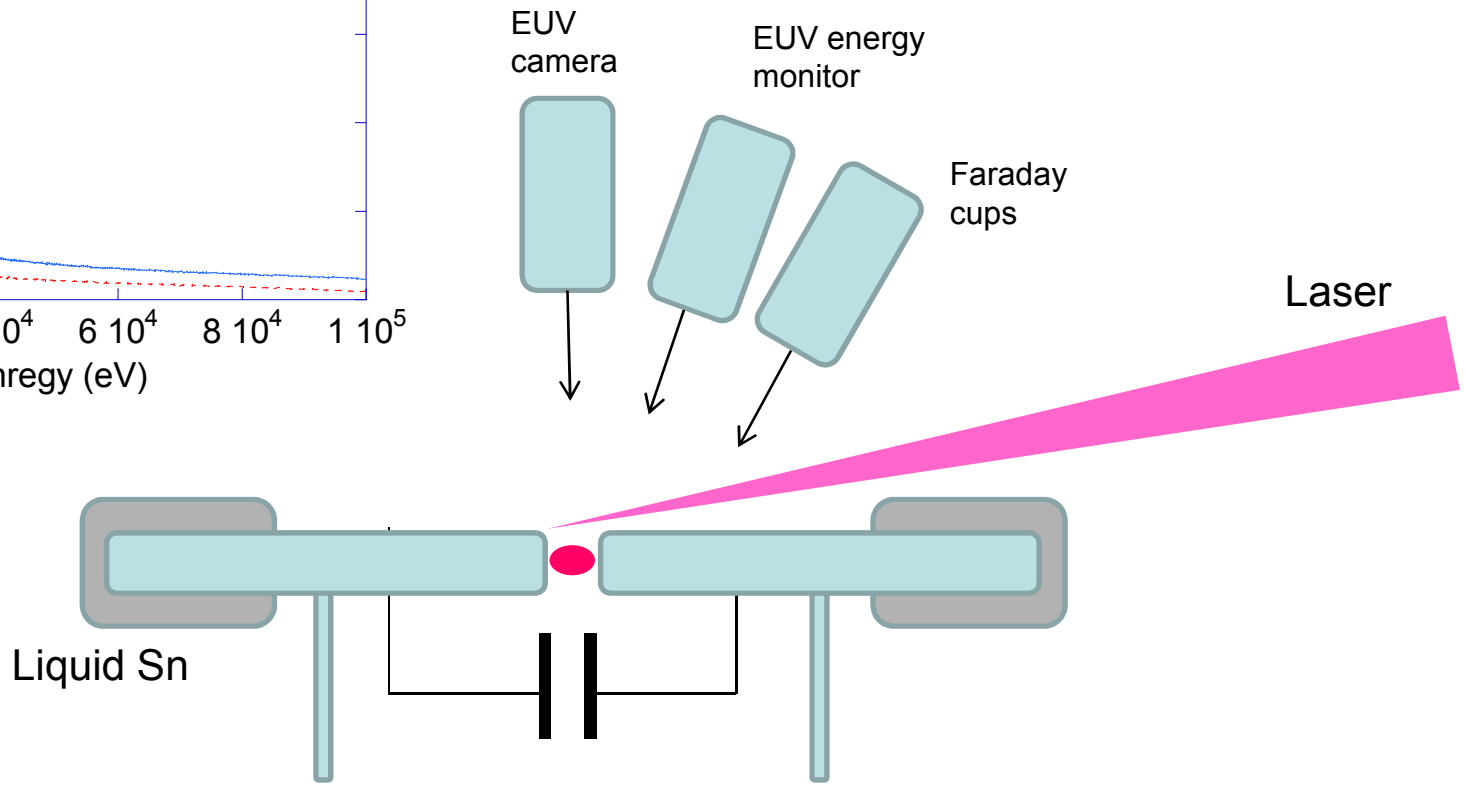


Plasma shape does not change or even improve.

Fast ion reduction: Experimental setup

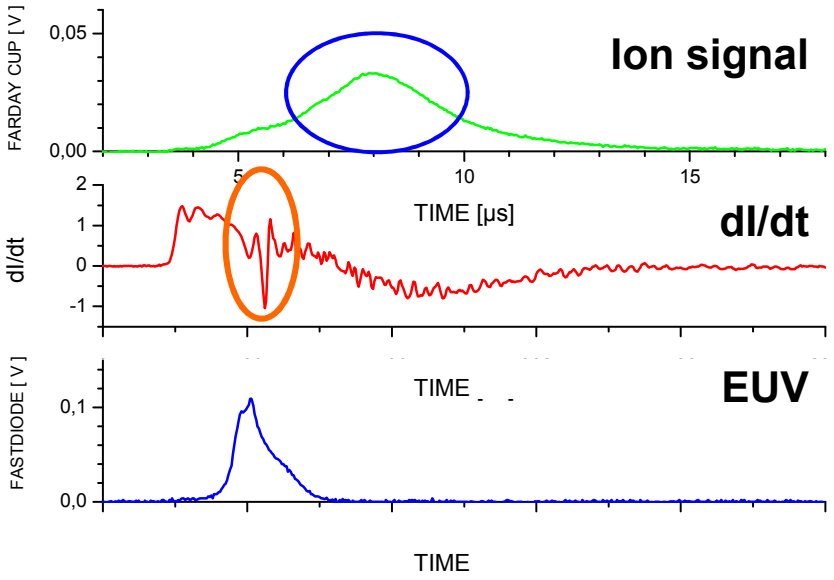


Ion flux was measured using faraday cups by means of time of flight method. Total amount of fast ion flux which can cause collector sputtering was calculated changing ignition parameter.

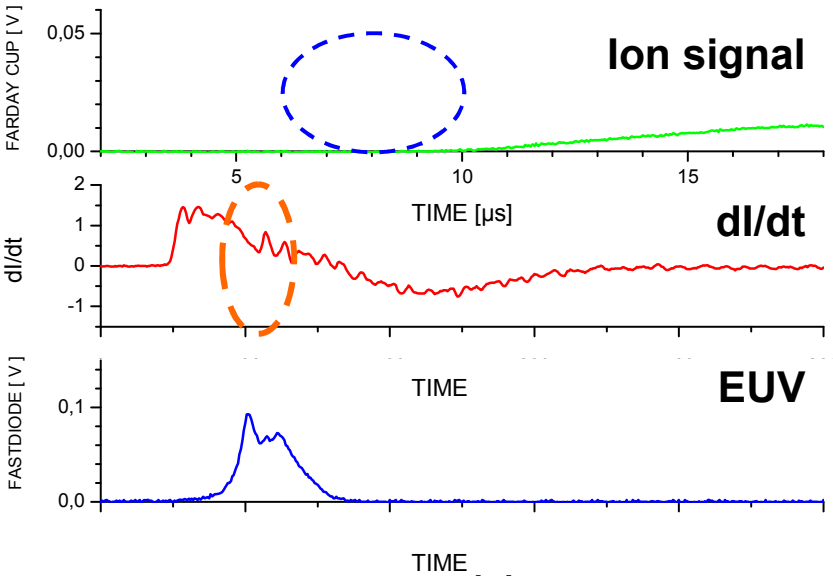


Fast ion reduction: Example of waveforms

Voltage across the plasma induced at the time of plasma implosion (pinch) is reduced by the advanced ignition. Energy and amount of fast ion flux are significantly reduced as well.

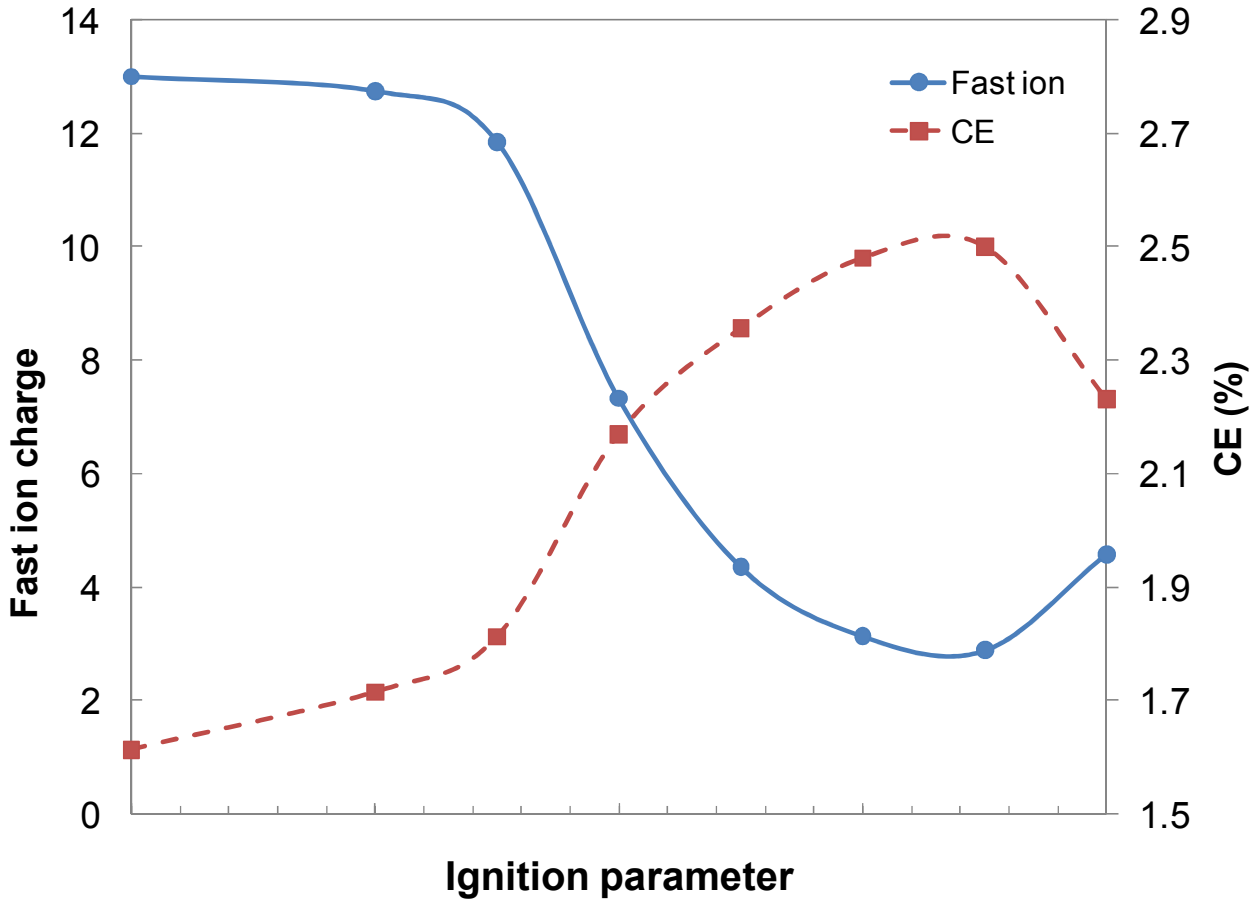


Conventional ignition control



Advanced ignition control

Fast ion reduction: Fast ions reduced by a factor of 5



•Fast ion charge of which the energy range causes collector sputtering was reduced by a factor of 5 compared.

•CE was also 50-60 % increased at the same condition.

Summary

Particle debris reduction

Film control reduces Sn layer thickness on the electrode and keeps it at wide range of electrode rotational speed.
Particle debris is reduced by a factor of 3 compared to the conventional one (less load of debris shield).

Fast ion reduction

Advanced discharge ignition control improves initial plasma parameter creased by a trigger laser.
It increases CE and reduces amount of fast ions by a factor of 5 simultaneously.

These technologies are capable of enhancing performance of our laser-triggered DPP source and support beta and HVM source readiness.

Acknowledgment

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