CO_2 amplifiers to generate > 20kW laser power for stable > 250W extreme ultraviolet (EUV) power

Koji Yasui[1], Naoyuki Nakamura[2], Jun-ichi Nishimae[2], Masashi Naruse[3], and Masato Matsubara[3]

[1]Mitsubishi Electric Corporation, Head quarter, Tokyo, Japan
[2]Mitsubishi Electric Corporation, Advanced technology R&D center, Hyogo, Japan
[3]Mitsubishi Electric Corporation, Nagoya works, Nagoya, Japan

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1. Why we need EUVL and for what
2. CO_2 amplifiers for HVM
3. Lasers for > 500W EUV power

Summary

1. Why we need EUVL and for what

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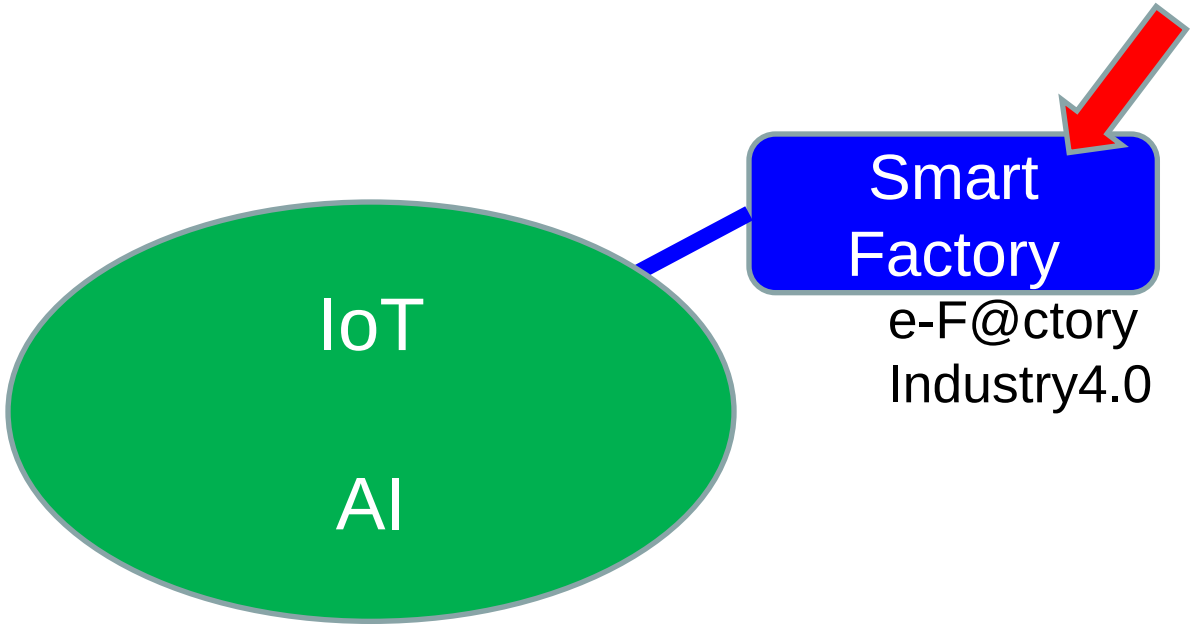
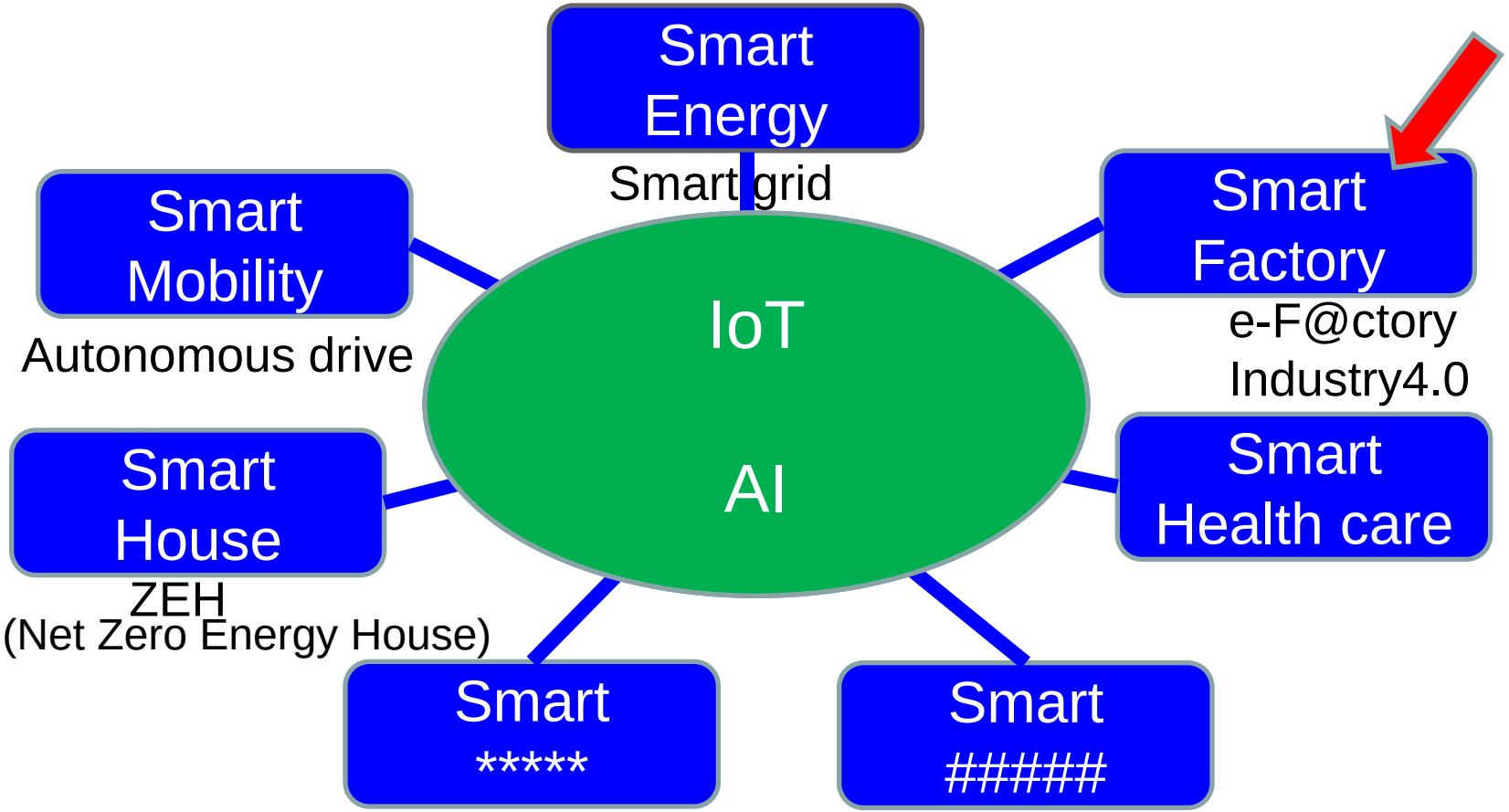


IoT: Internet of Things, AI : Artificial Intelligence

1. Why we need EUVL and for what



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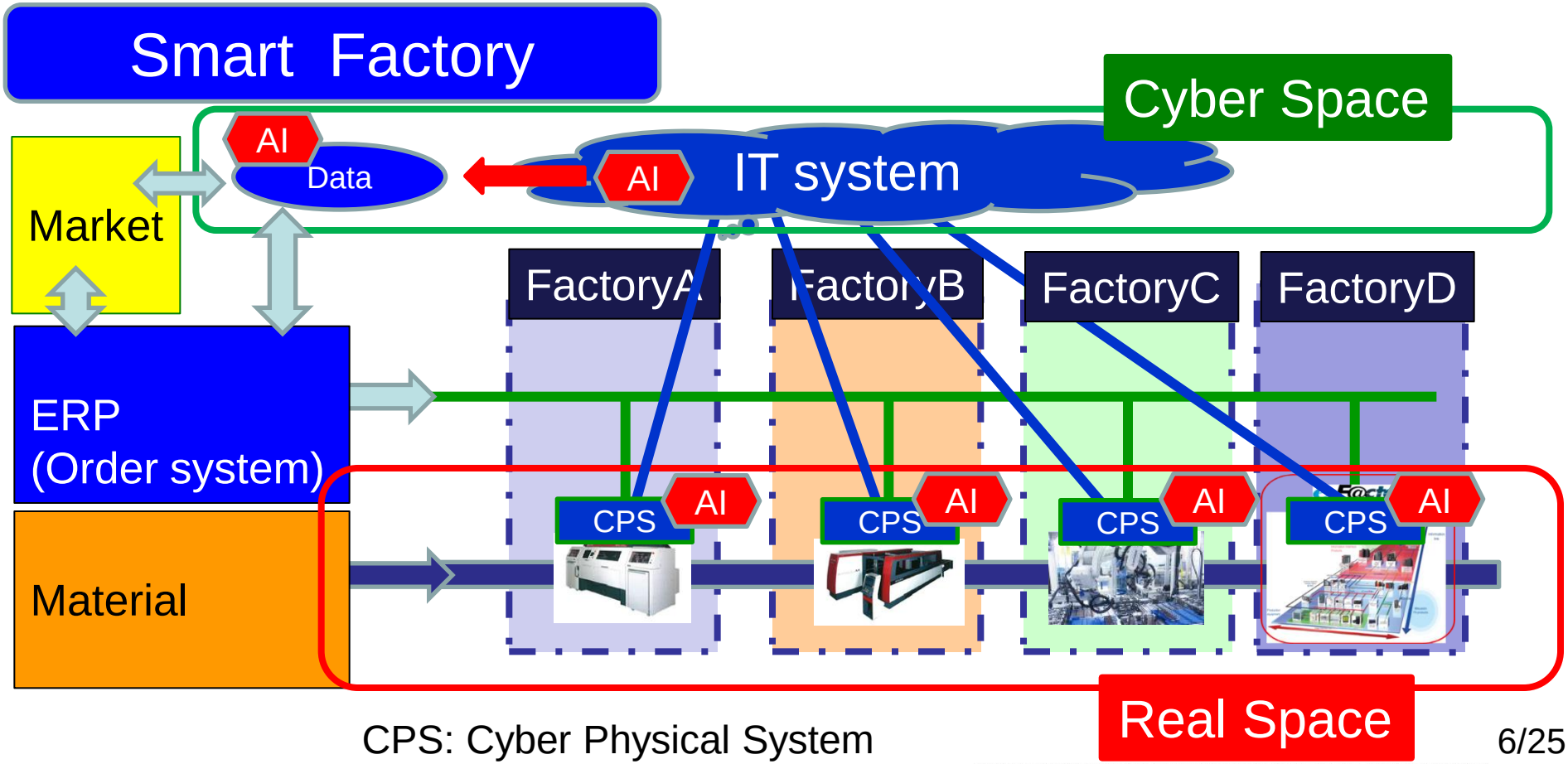
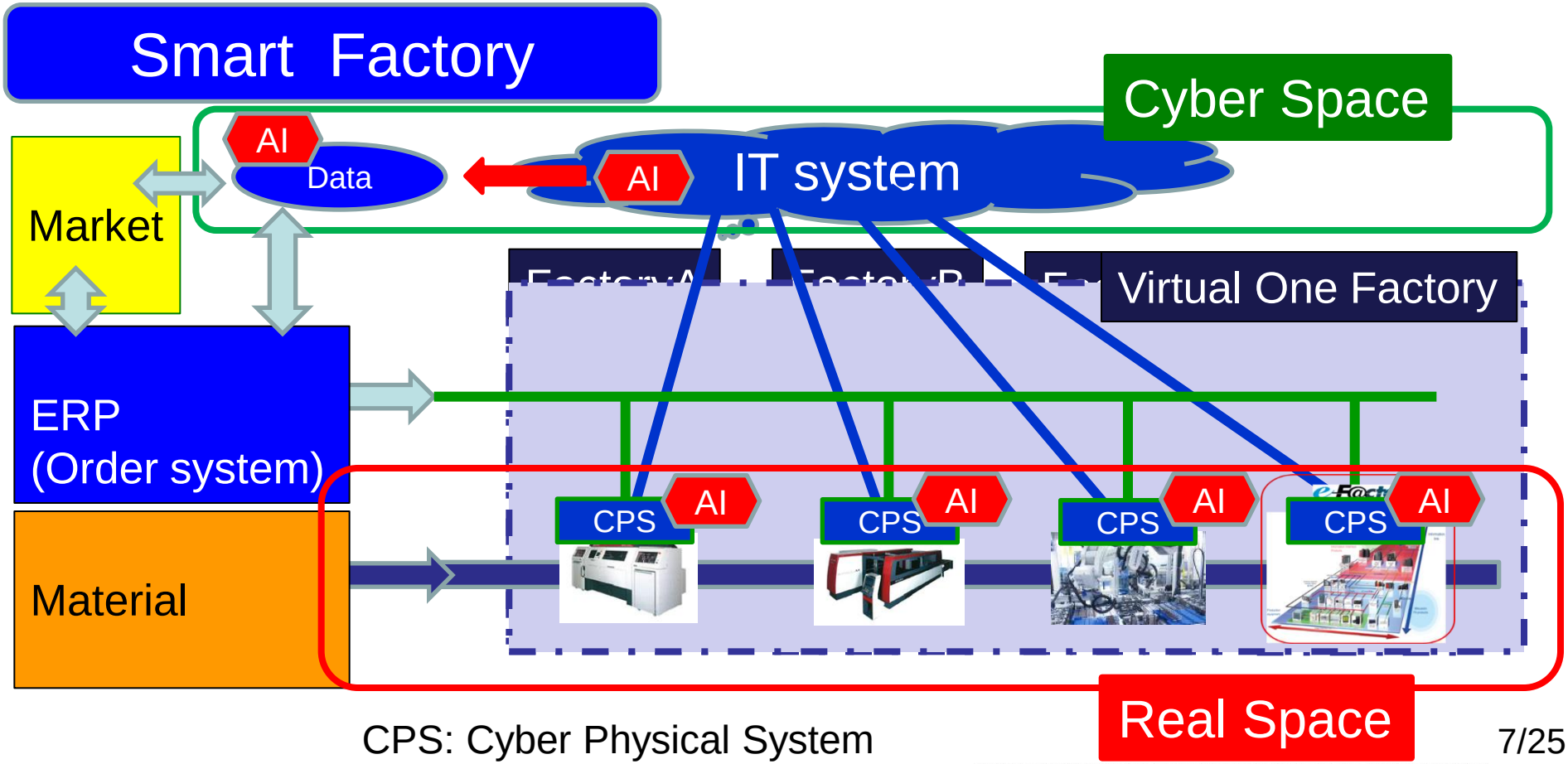


CPS: Cyber Physical System

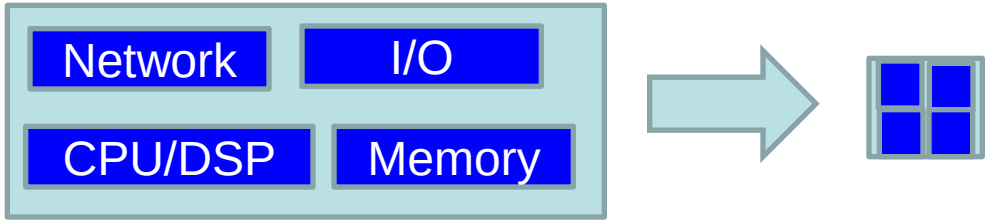
1. Why we need EUVL and for what



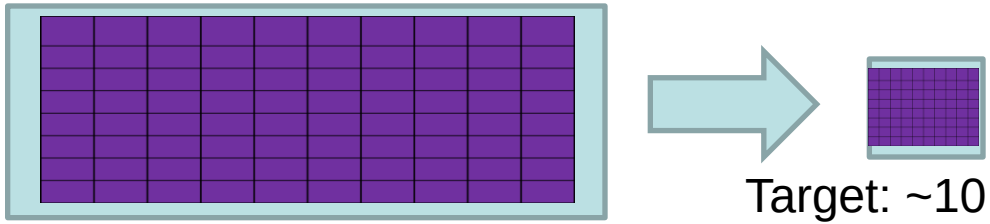
CPS: Cyber Physical System

1. Why we need EUVL and for what

IoT Applications → We need low-cost CPS modules



AI Applications → We need high density AI chips



Today: ~10 millions neurons

Target: ~10 billions neurons

2. CO_2 amplifiers for HVM

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Our roll for high-power EUV generations

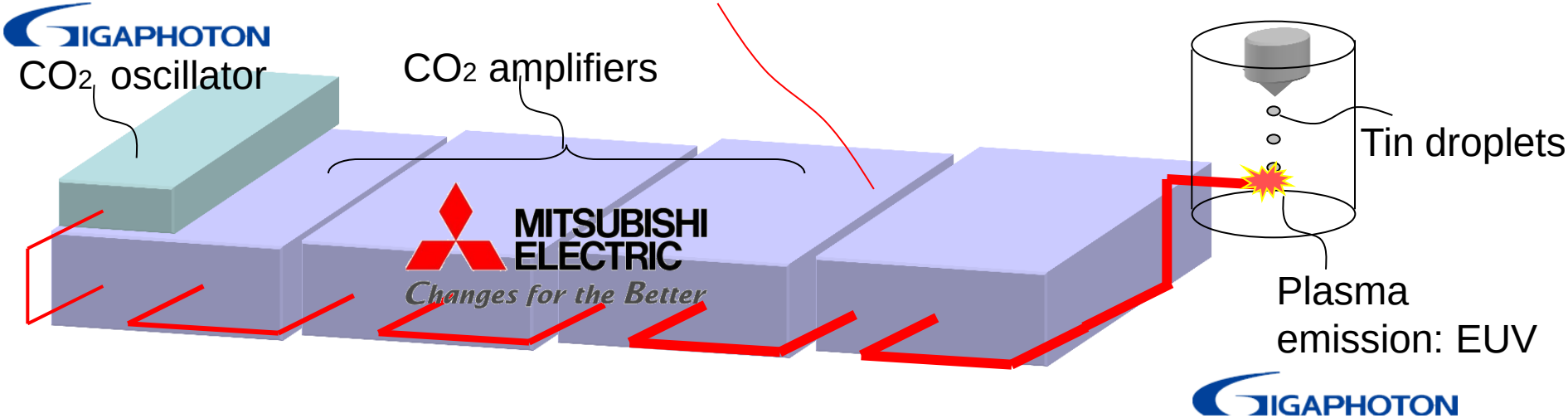
Electrical power
0.5-1 MW

→

CO_2 laser
> 20kW

→

EUV
>250W



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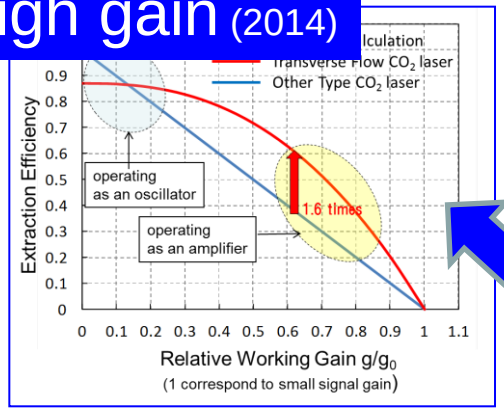
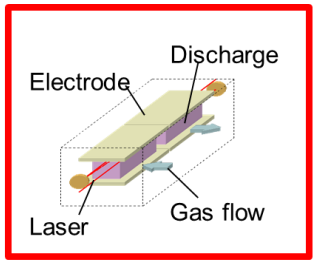
2. CO_2 amplifiers for HVM

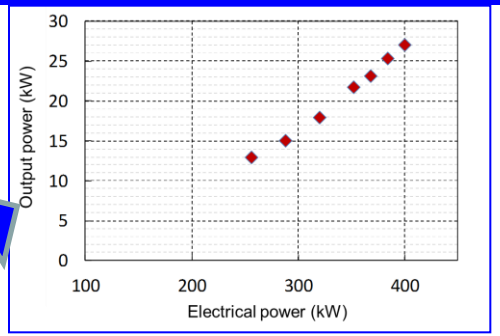
High gain (2014)

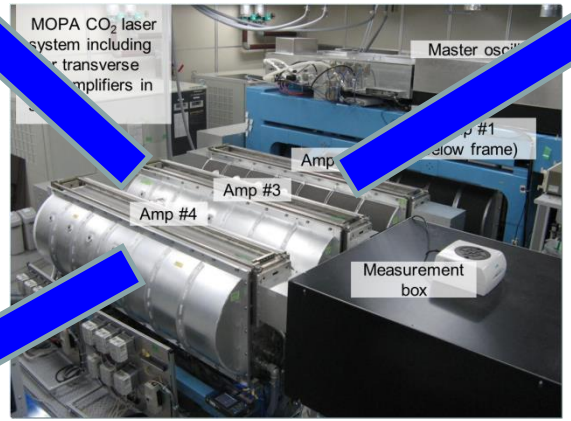




1. Transverse-gas-flow

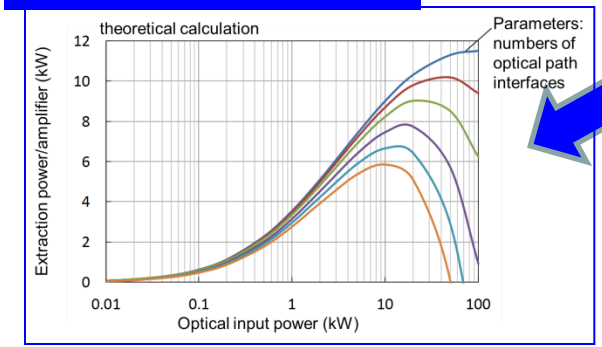
High power>25kW(2015)





Experimental setup

Low loss (2015)



2. CO_2 amplifiers for HVM

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Pilot #1: System outlook

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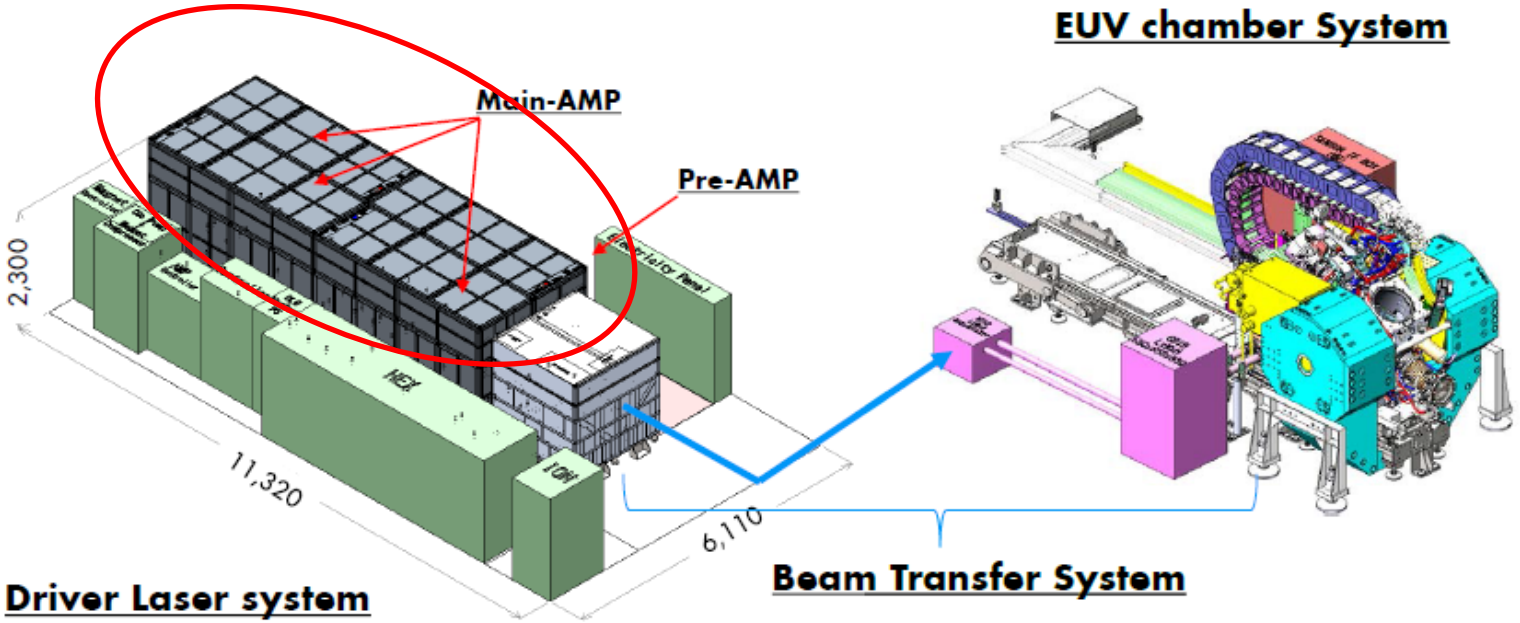
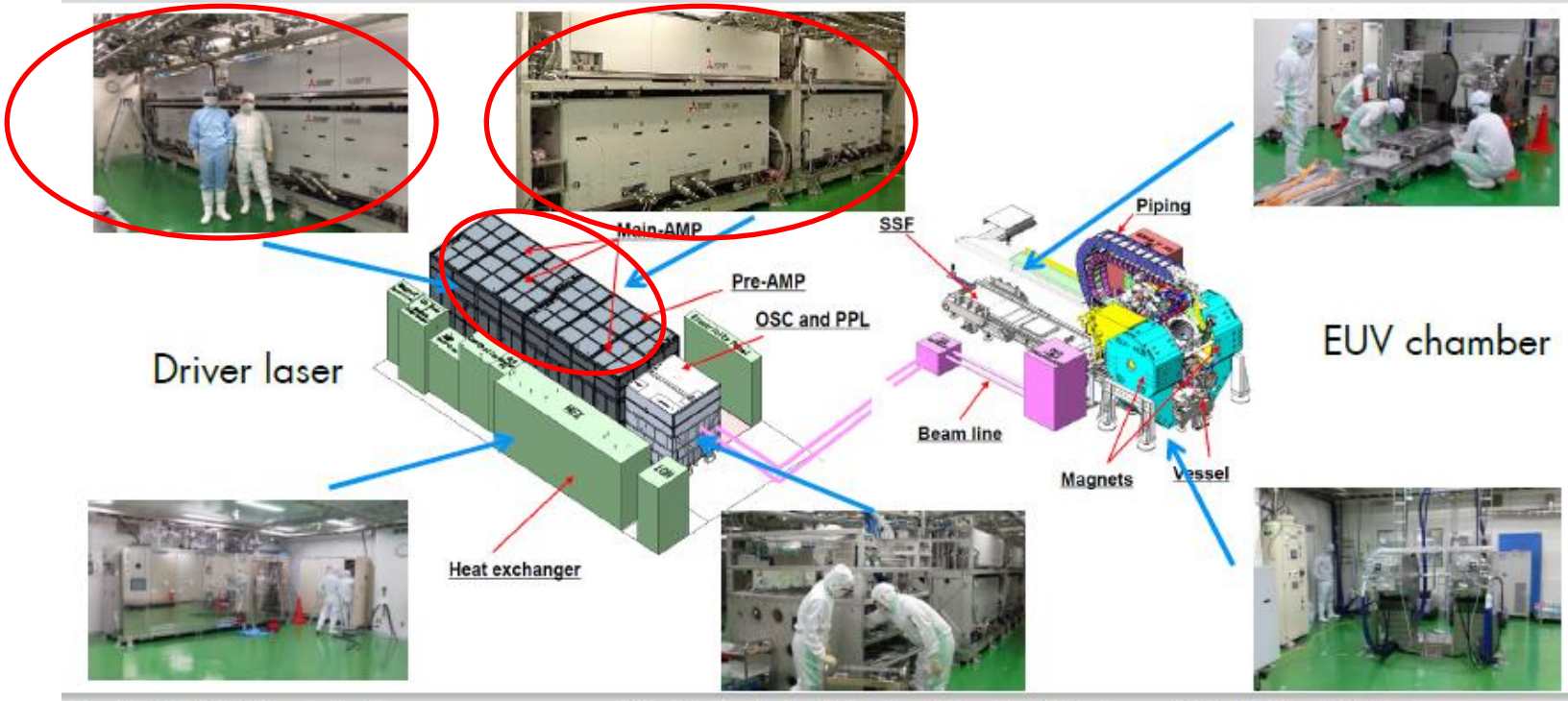


2. CO_2 amplifiers for HVM

Pilot #1: Picture of construction (2015.6 – 2016.1)



2. CO_2 amplifiers for HVM

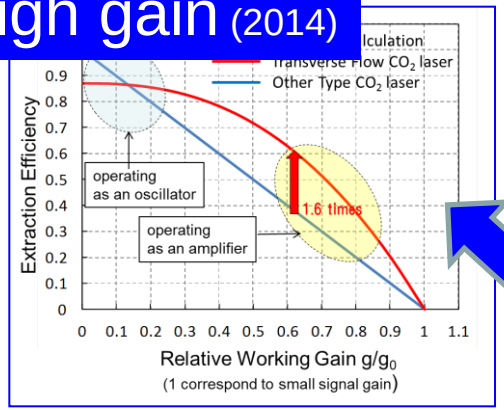
Pilot #1: *Construction is completed !* *(2016.02)*

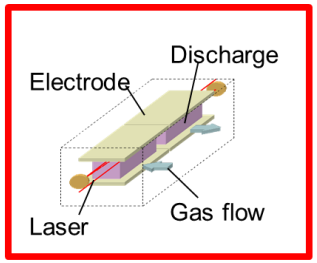
EUV chamber and Magnet

CO_2 driver laser system

2. CO_2 amplifiers for HVM

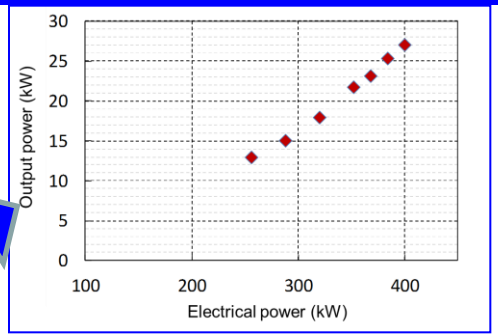
High gain (2014)

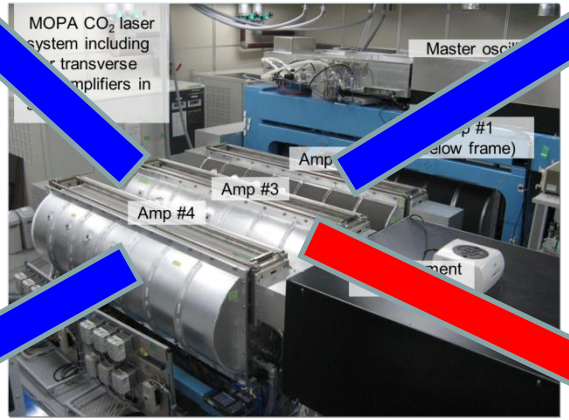




1. Transverse-gas-flow

High power>25kW(2015)





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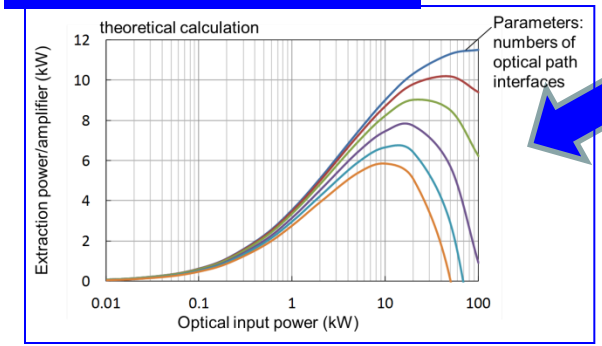
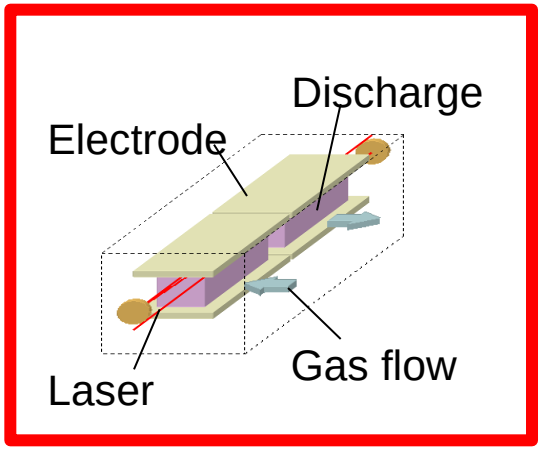


1. Stable operations
2. Ideal beam shapes for efficient EUV generation

2. CO_2 amplifiers for HVM

Transverse-gas-flow CO_2 lasers vs. other CO_2 lasers



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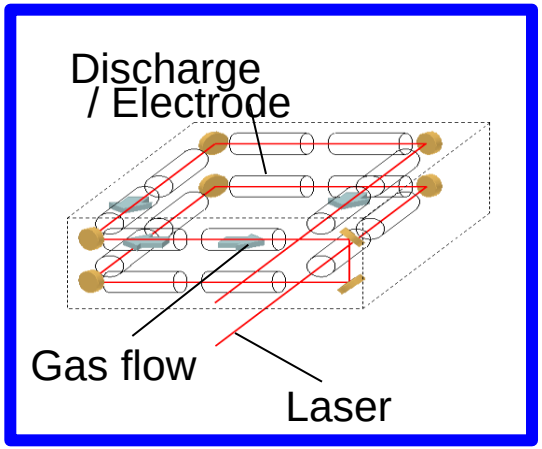
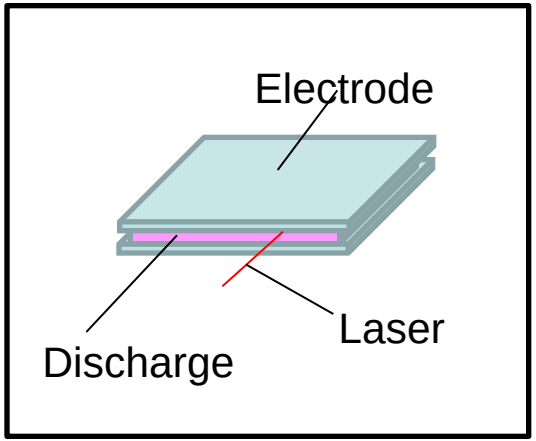


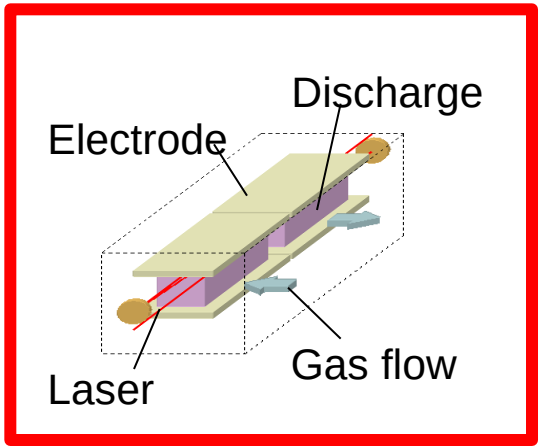
2. Fast-axial-flow



3. Wall cooling

2. CO_2 amplifiers for HVM

Advantage of our amplifiers : 1. Low-loss



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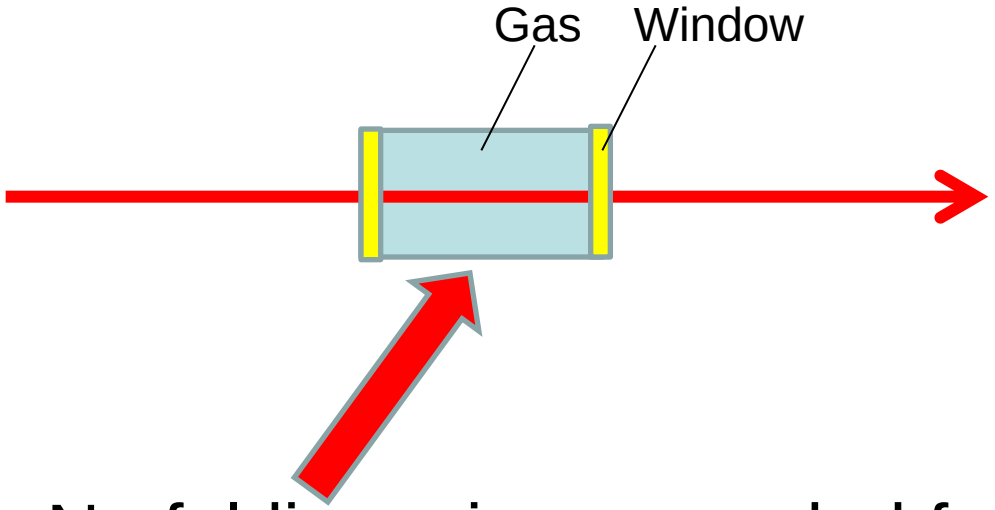
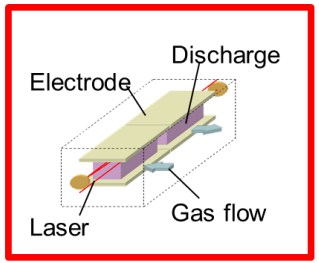


No folding mirrors needed for each amplifier

2. CO_2 amplifiers for 250W EUV

Advantage of our amplifiers : 2. Stable-Operation



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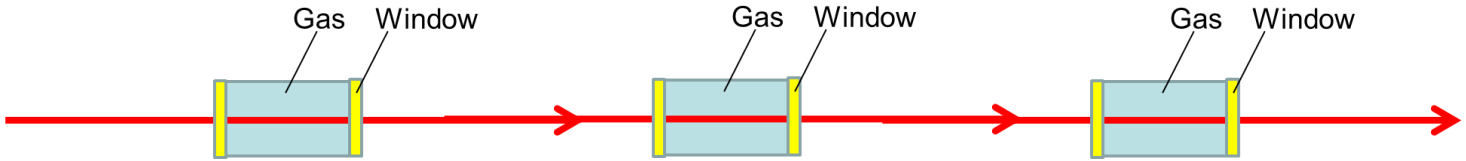

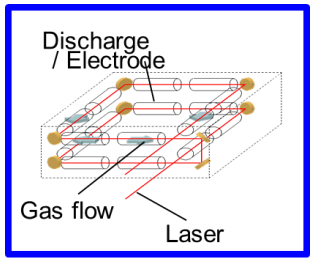

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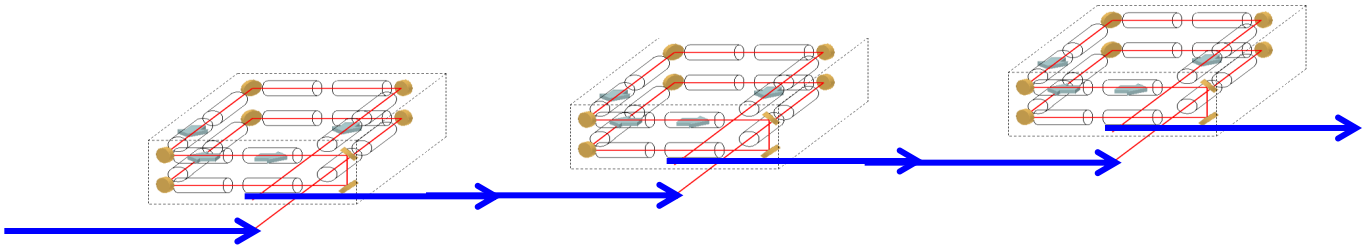

3. Lasers for > 500W EUV power

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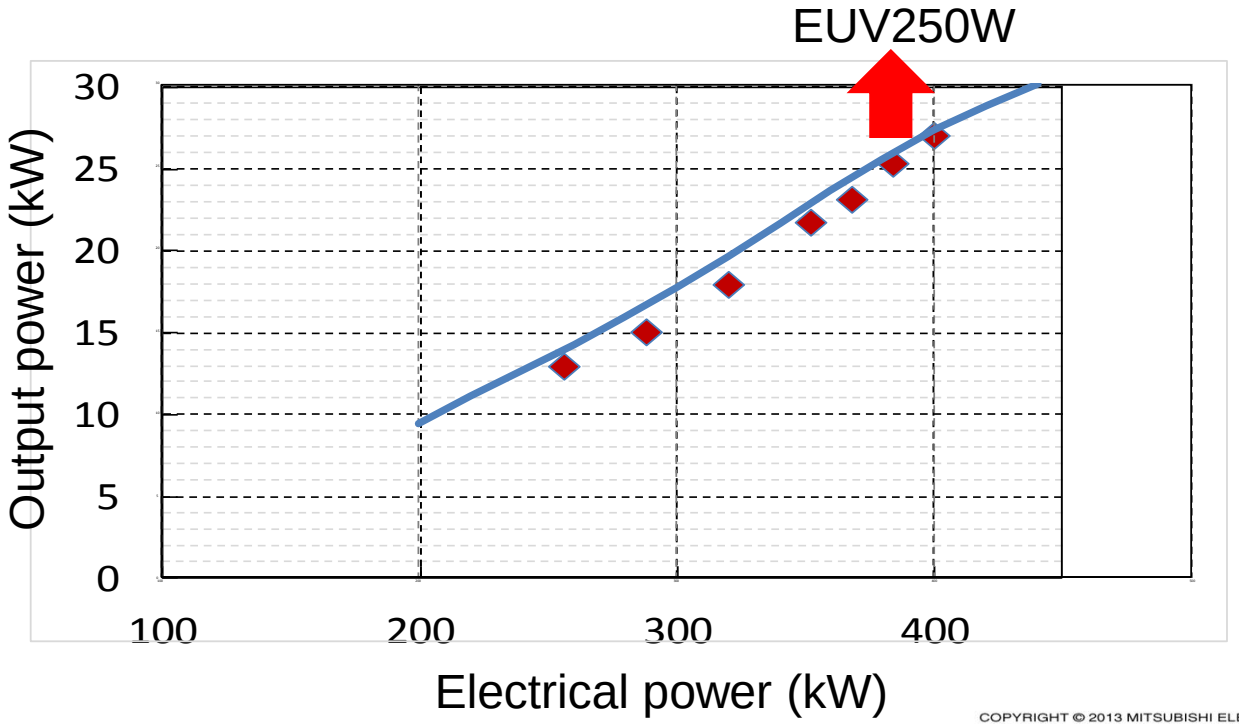
Calculations to explain base data

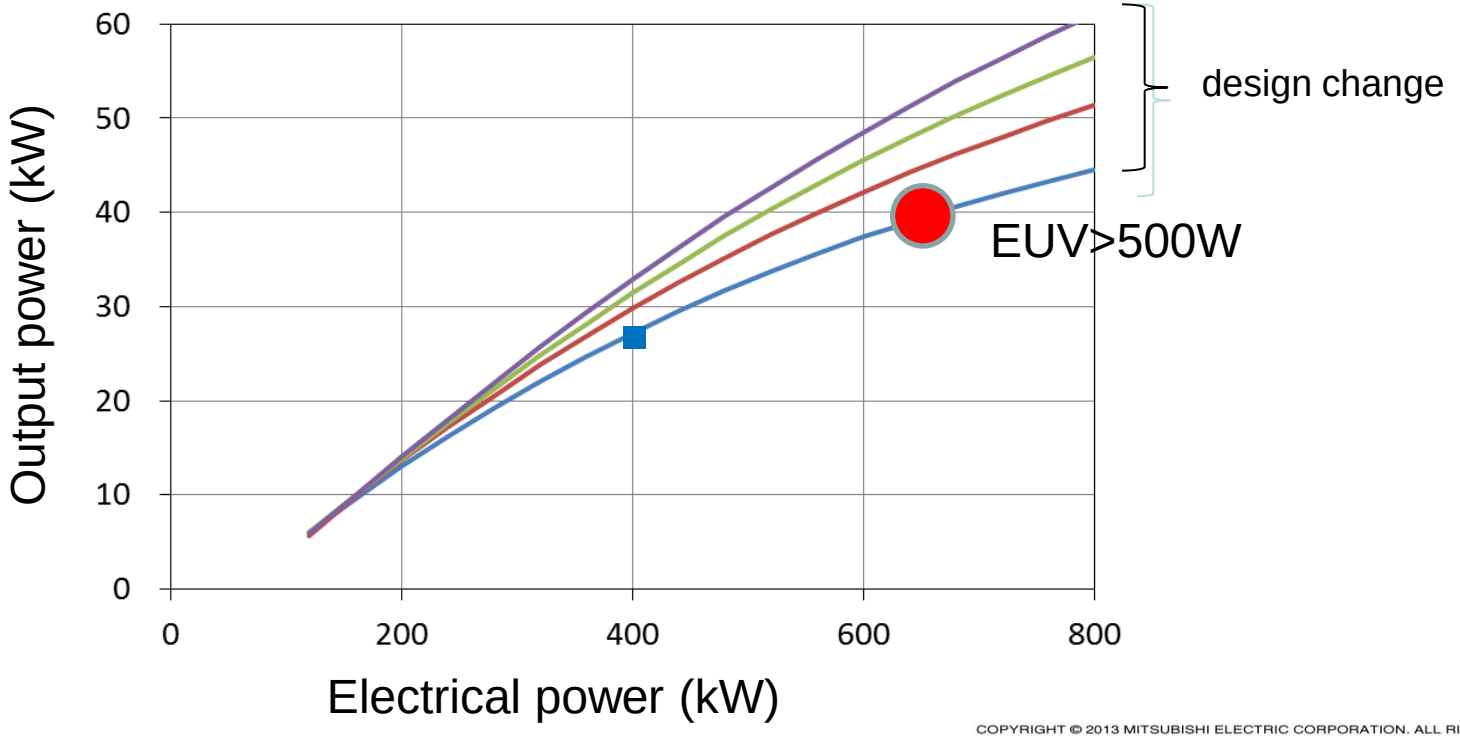
Output power of 27 kW was demonstrated（duty 100%）



3. Lasers for > 500W EUV power

Calculations for minimum target: 500W EUV power

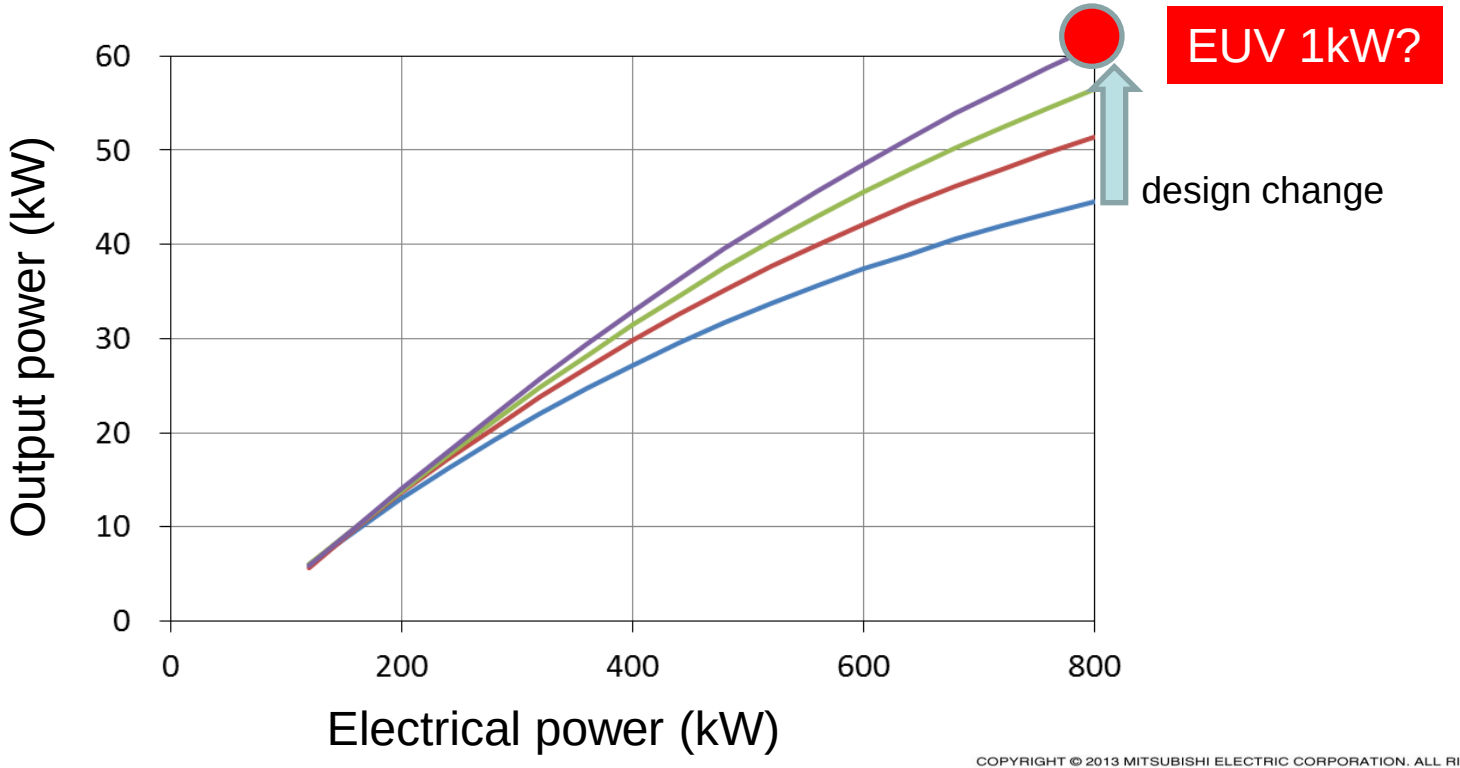
Output power of 40 kW is expected by 1.6 times input



3. Lasers for > 500W EUV power

Calculations for maximum target: 1kW EUV power

Output power of >60 kW is expected by 2 times input



Summary

1. We will strongly assist the developments of EUVL by supplying laser drivers to initiate applications of smart factory, then, smart mobility, smart energy, and so on.

2. CO_2 lasers for HVM are developed to generate > 250W EUV power at better efficiency, better stability and easy maintenance.

3. CO_2 lasers for higher EUV power generations are also designed based on experimental results and calculations.

Acknowledgements

- The experiments were performed by research members of Mitsubishi Electric corp. and Gigaphoton Inc.

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- A part of this work was supported by The New Energy and Industrial Technology Development Organization (NEDO, Japan)

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