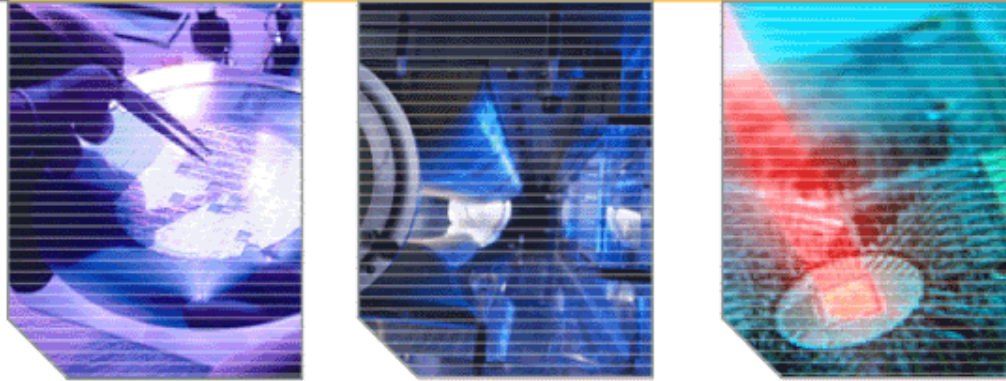


# High Power Lasers for HVM EUV Source



Igor Fomenkov  
November 10, 2005

# Conversion Efficiency Summary (peak values)

	Xe	Sn	Li
Excimer (351nm)	TBD	0.5-1.0%	2.0-2.5%
Solid State (1064nm)	0.5-1.0%	2.0-2.5%	2.0-2.5%
CO <sub>2</sub> (10.6μm)	0.5-1.0%	3.5-4.0%	1.0-1.5%*

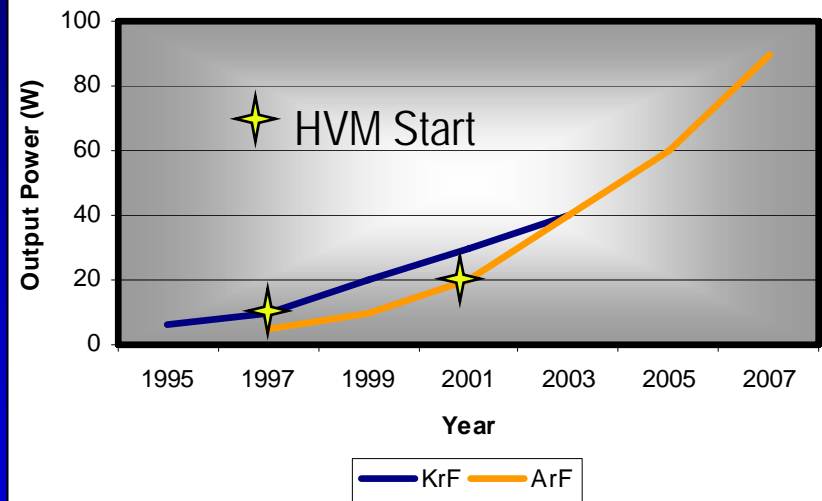
\* As suggested by modeling

# Source Performance Roadmap to HVM and Beyond

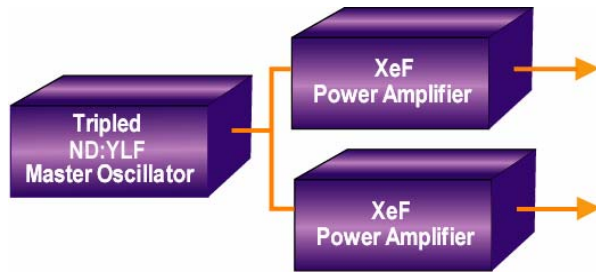
LPP EUV Source Performance Roadmap			
	Gen 1	Gen 2	Gen 3
Total Rep Rate (kHz)	48	60	72
<b>Laser power (kW)</b>	<b>9.6</b>	<b>12.0</b>	<b>14.4</b>
In-band CE	3.5%	4.0%	4.5%
Geometric collection effy (sr)	5	5	5.5
Collector average reflectivity	50%	50%	50%
Optical transmission	80%	82%	84%
<b>Total power at IF (W)</b>	<b>110</b>	<b>155</b>	<b>230</b>

- Cymer is committed to commercializing an HVM EUV light source
- Laser Produced Plasma (LPP) technology is the most viable HVM EUV source solution
  - Due to flexibility and scalability of power
- Cymer is targeting the most feasible and cost effective LPP technology solutions
  - Excimer & Li, Solid State & Sn or Li, or CO<sub>2</sub> & Sn

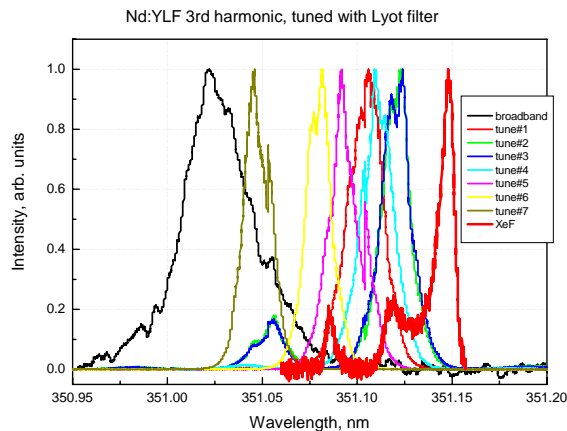
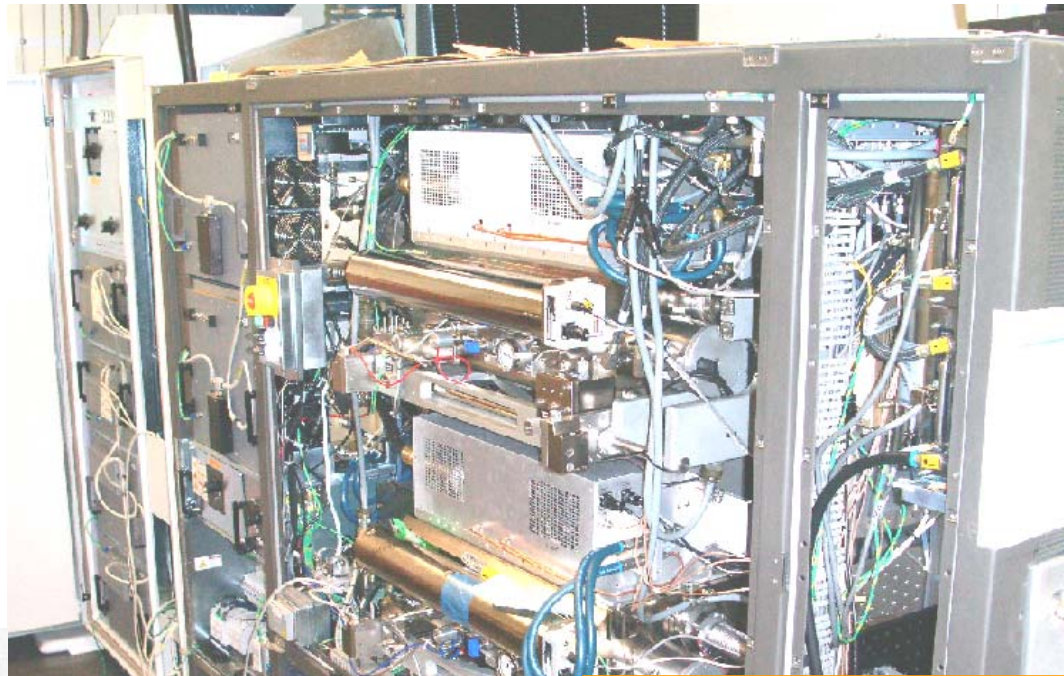
DUV Power Trend



# Excimer Drive Laser Development



- Solid State MO provides required high beam quality
- XeF power amplifiers provide reliable pulse energy

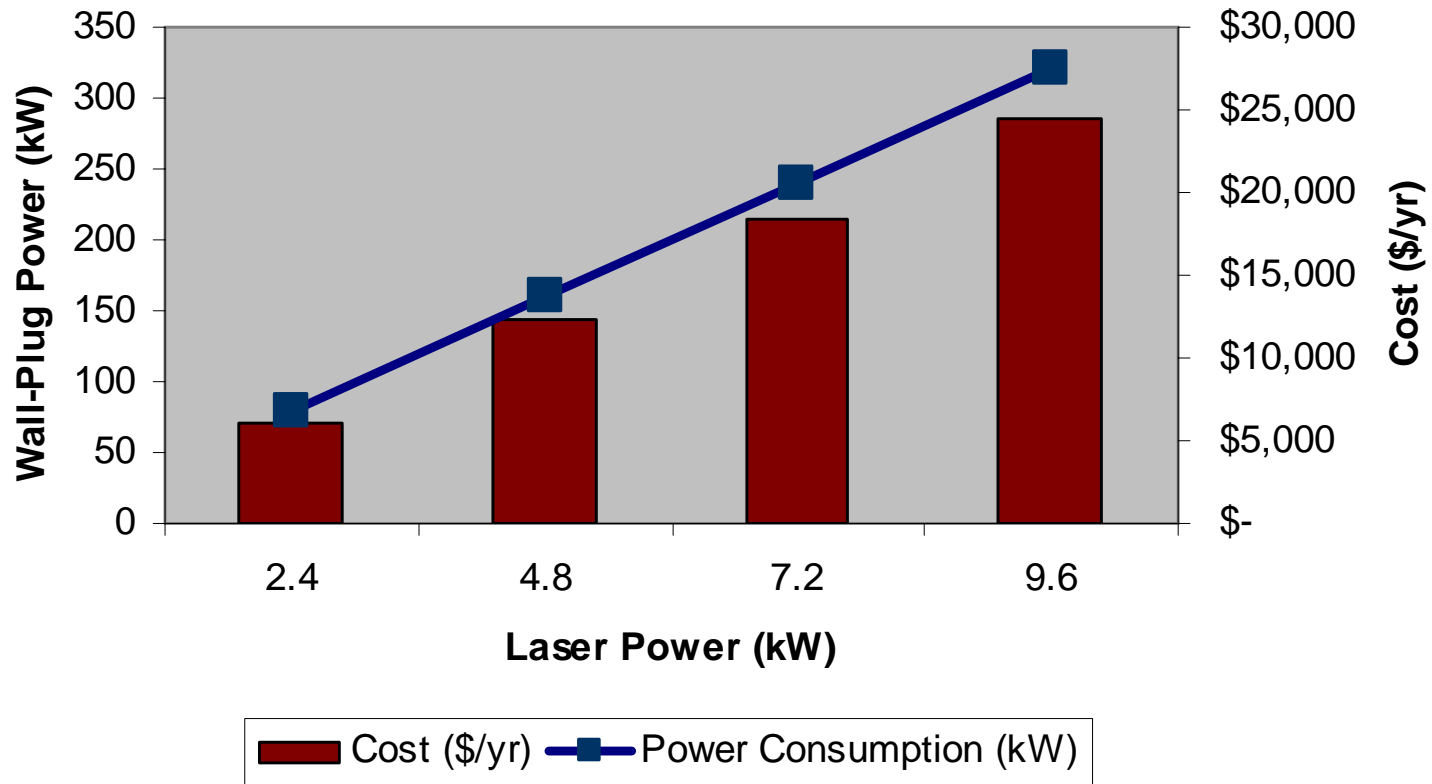


XeF Power Amplifier	
Energy/pulse	150-200mJ
Beam Divergence	<150 uRad
Energy Stability (30pulse)	1%
Repetition Rate	6000 Hz
Efficiency	3.5%
Pulse Length	<16ns
Pointing Stability	<25uRad

# 351nm Excimer Laser Capability

Parameter	XeF Limit
Pulse Energy	200 mJ
Repetition Rate	8 kHz (per amp)
Power	1600 watt
Pulse Width	16 ns
Energy Stability	1%
Pointing Stability	25 $\mu$ Rad
Beam Divergence	150 $\mu$ Rad
Wall-plug Efficiency	3.5%

# Electricity Cost Estimate for Excimer Laser



Power Consumption (kW)	80	160	240	320
Duty cycle	25%	25%	25%	25%
Utilization	70%	70%	70%	70%
Electricity Cost (\$/kWhr)*	0.05	0.05	0.05	0.05
<b>Cost (\$/yr)</b>	<b>\$ 6,132</b>	<b>\$ 12,264</b>	<b>\$ 18,396</b>	<b>\$ 24,528</b>

\* conservative estimate



# High Power Laser Technology Capability

	XeF	CO <sub>2</sub> - TEA	CO <sub>2</sub> – Low Pr.	DPSS
Laser Efficiency	3.5%	10-20%	10-20%	10-50%
Repetition rate (Max)	8 kHz	~10 kHz	30 - 100 kHz	30 - 100 kHz
Pulse Width	~ 15 ns	50 - 150 ns	15 – 150 ns	5 – 50 ns
Beam Quality	M <sup>2</sup> ~10	M <sup>2</sup> ~ 2-5	M <sup>2</sup> ~1.5	M <sup>2</sup> ~ 1 - 15
Power kW	1.6	1.5	10	0.1 – 0.6
10kW Cost CoO	medium - high medium	medium medium	medium low	high high

DPSS : Slab, Rod, Fiber, Disk



# High Power Laser Summary

Laser Type	$\lambda$ (nm)	Power & effcy	Beam Quality	Optical Matls	Polar-ization	Pulse width	Fab Exp.	System Cost	CoO	Resist sens.
XeF	351	☹️	😊	☹️	😊	😊	☹️	☹️	☹️	☹️
DPSS	1064	😊	😊	☹️	😊	😊	☹️	☹️	☹️	☹️
CO <sub>2</sub>	10.6 $\mu$	😊	☹️	☹️	😊	☹️	☹️	☹️	😊	☹️

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