
High Power Injection Lock 6kHz 60W Laser for ArF Dry/Wet Lithography

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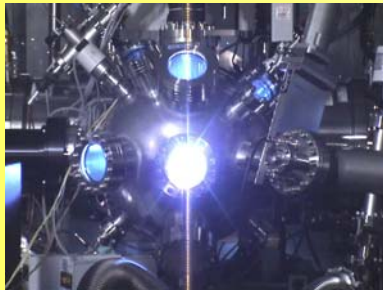
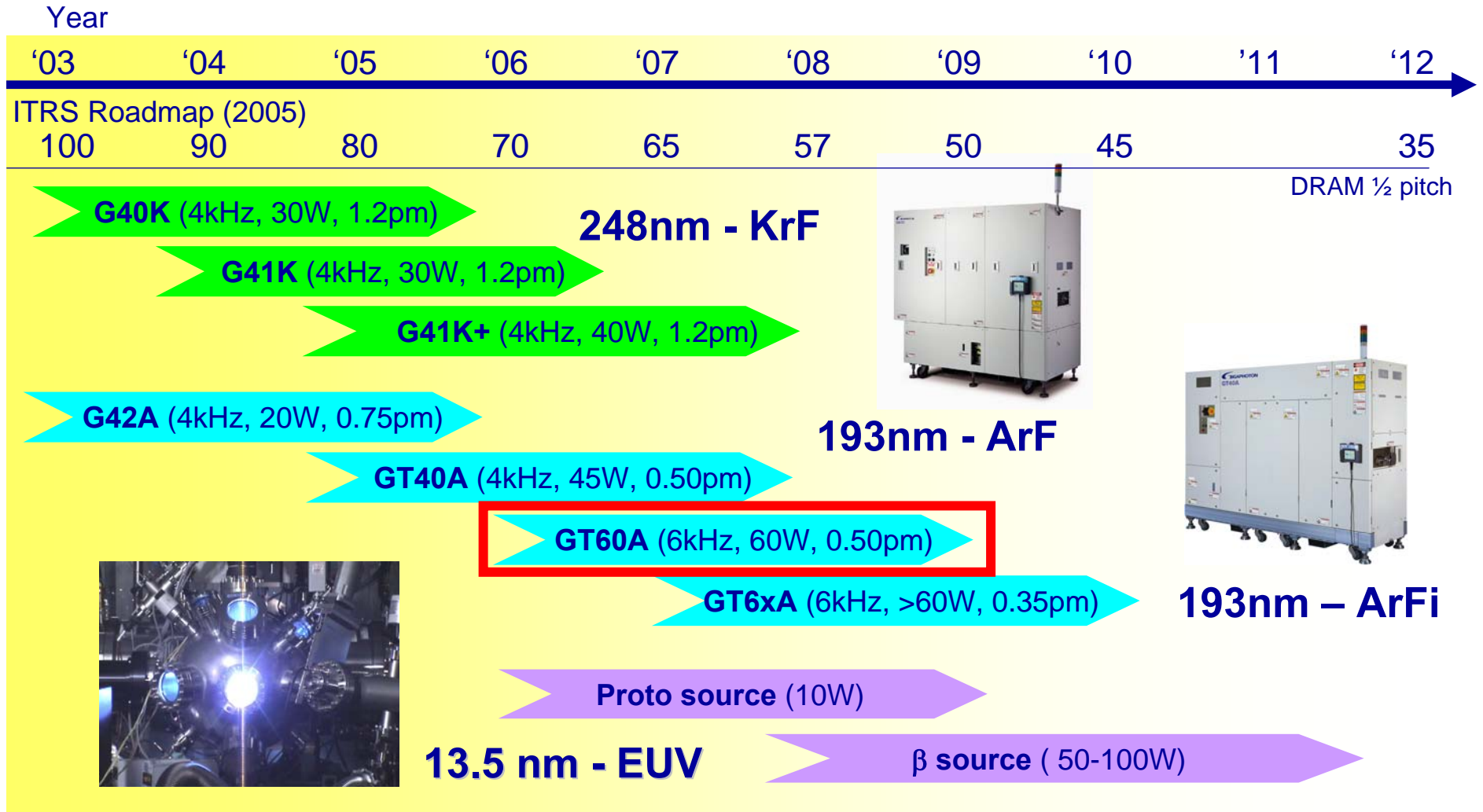
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Outline

- **Introduction**
- Architecture of High Power Injection Lock Laser GT60A
 - Advanced “Injection lock” system
 - Specification
 - Advanced design
- Performance data of GT60A
- Advanced Bandwidth Control Module
- Conclusion

Gigaphoton roadmap



ArF roadmap

Power	Model	2001	2002	2003	2004	2005	2006	2007	2008
60W	XT:1900i							GT6xA	
60W	XT:1700i XT:1400F, i S610[op] AS5[op], AS7						GT60A		
45W	XT:1400E, i XT:1400F,i[op] AT:1250D XT:1250D, i S308, S610 AS5					GT40A			
20W	AT:1200B XT:1250B			G42A					
20W	/11x0 AT:11x0 AS2, AS3	G41A							

ArF specifications

ArF model		G41A	G42A	GT40A	GT60A	GT6xA
Wavelength	nm	193	193	193	193	193
Power	W	20	20	45	60	60
Pulse energy	mJ	5	5	11.25	10	10
Max. rep rate	Hz	4000	4000	4000	6000	6000
FWHM	pm	0.35	0.3	0.2	0.2	TBD
E95	pm	0.85	0.75	0.5	0.5	0.35
Durability (Expected)						
MO Chamber	Bpls	7	8	13	13	TBD
PO Chamber	Bpls	-	-	19	19	TBD
LNM / MO LNM	Bpls	7	8	-	-	TBD
MM	Bpls	10	10	30	30	TBD
FM / PO FM	Bpls	10	10	12	12	TBD
PO RM	Bpls	-	-	12	12	TBD

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Injection Lock: Dual optical resonator

Merit coming from **Injection Lock** technology

- | | | |
|---------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------|
| 1. High Efficiency | Theoretical | Easy to get High Power
Long Chamber / LNM lifetime |
| 2. High Stability | Allowing
non-critical timing control | Stable energy / spectrum performance
Can use 2 charger system
=> Can replace chamber one by one |
| 3. Long pulse | Low load to optical modules | Long Life Optics
Low load to litho tool optics |

Merit comes from **design concept**

1. Short module exchange time by **high maintainability design**.
2. Short down time by **self check function**.
3. High stability of Spectrum by **BCM (Optional)**.

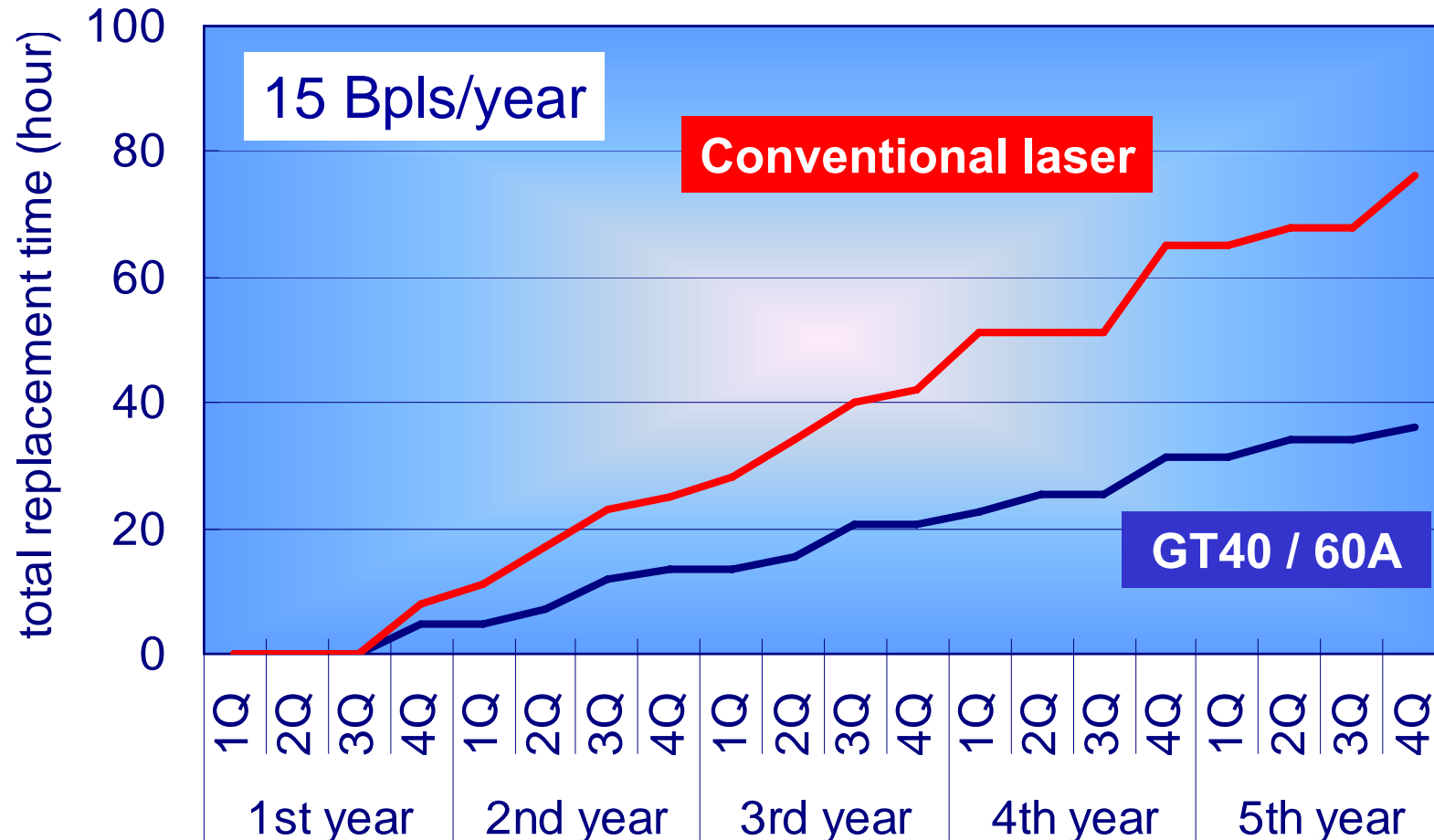
GT60A outlook

- GT60A and GT40A share a common platform
 - ✓ Physical size
 - ➔ Same as GT40A (2800x820x2100)
 - ✓ Maintenance space
 - ➔ Same as GT40A
 - ✓ Utilities
 - ➔ Electrical cable, breaker
 - ➔ Coolant water connection Same as GT40A
 - ➔ Ventilation connection
 - ✓ GT60A enables highest flexibility of customer floor plan by common platform and utility connections

Direction of low cost of downtime

- Reduce cost of downtime
 - ✓ Schedule downtime
 - ➡ Quick parts replacement
 - ✓ Un-schedule downtime
 - ➡ Self diagnostics function
 - ✓ Event downtime
 - ➡ Automatic background parameter tuning
 - ✓ Systematic downtime
 - ➡ Advance gas maintenance

Reduction of schedule downtime



➤ GT60A is designed to realize quick parts replacement

GT40/60A

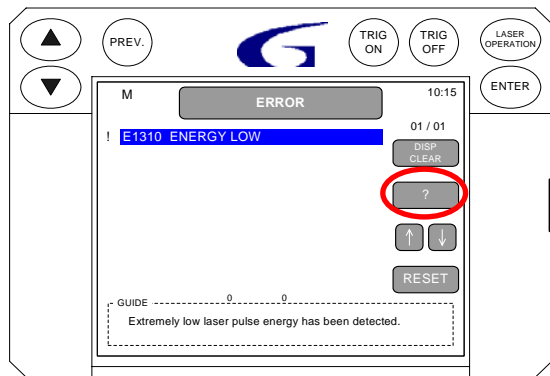
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Self diagnostics function

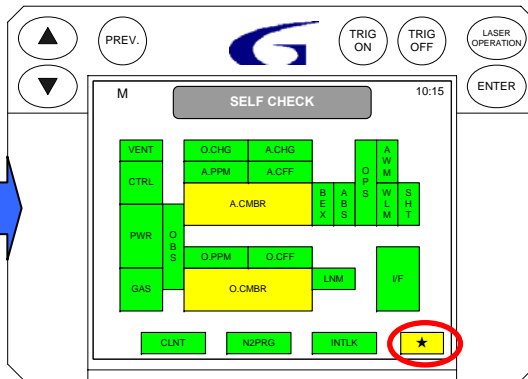
- ✓ Easily handling of data
- ✓ Quick troubleshooting
- ✓ Recovery time reduction at an error occurrence

Reduction of Unscheduled down

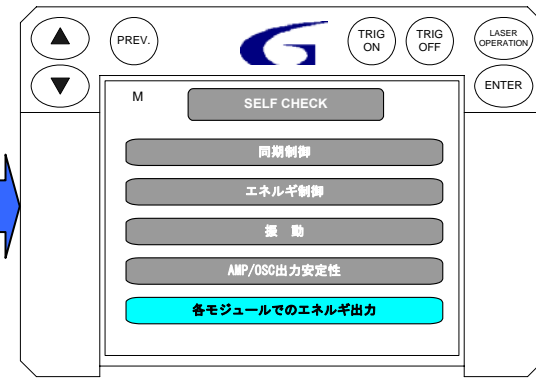
➤ An error occurs !



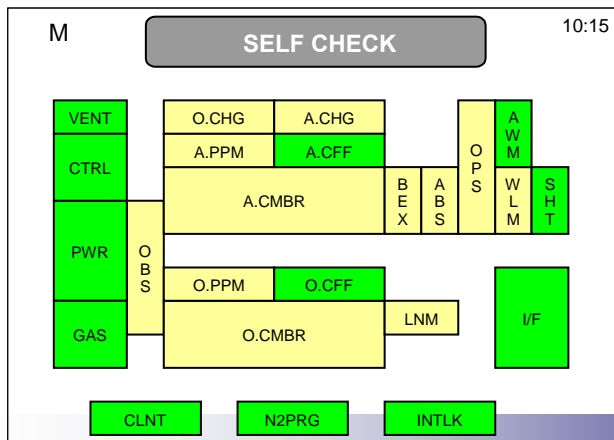
➤ Locate



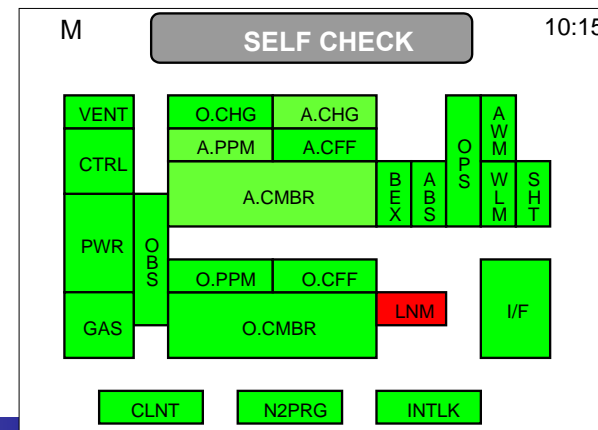
➤ Check



✓ Query internally



✓ Found

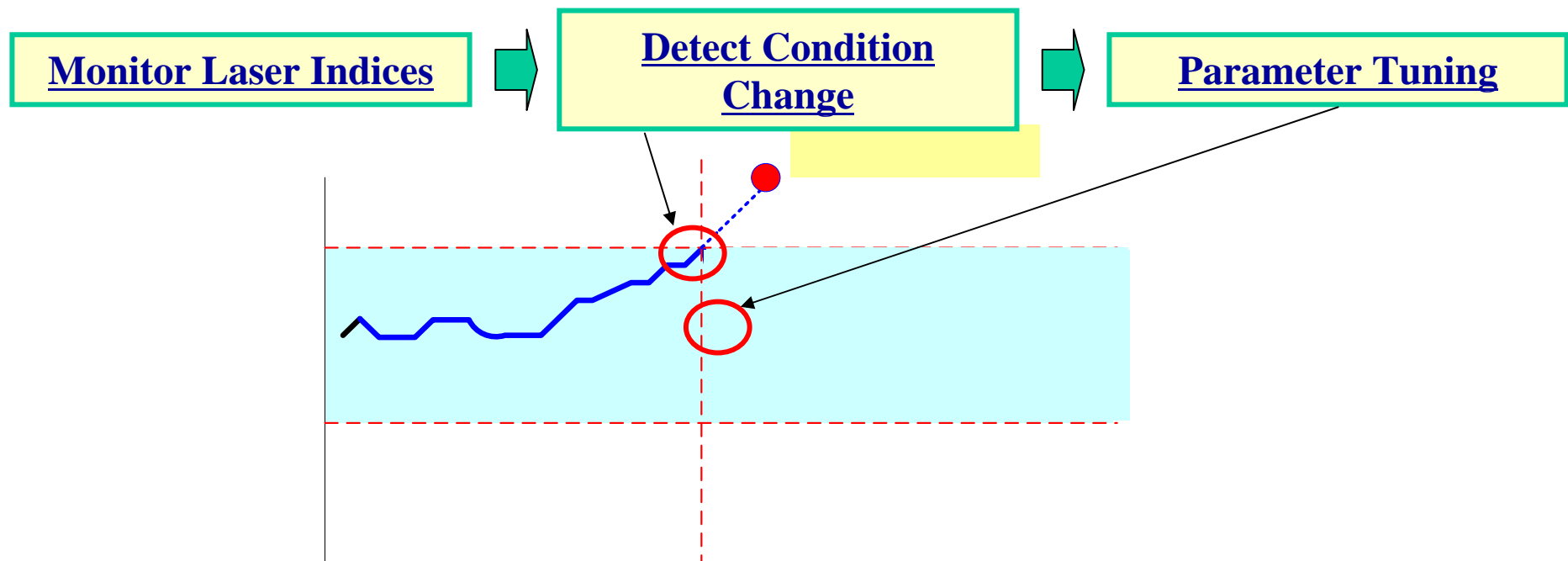


Reduction of event downtime

➤ "Automatic Background Parameter Tuning"

- ✓ Automatic operation parameter adjustment
- ✓ No interruption to scanner operations

Reduction of Event down and Scheduled down

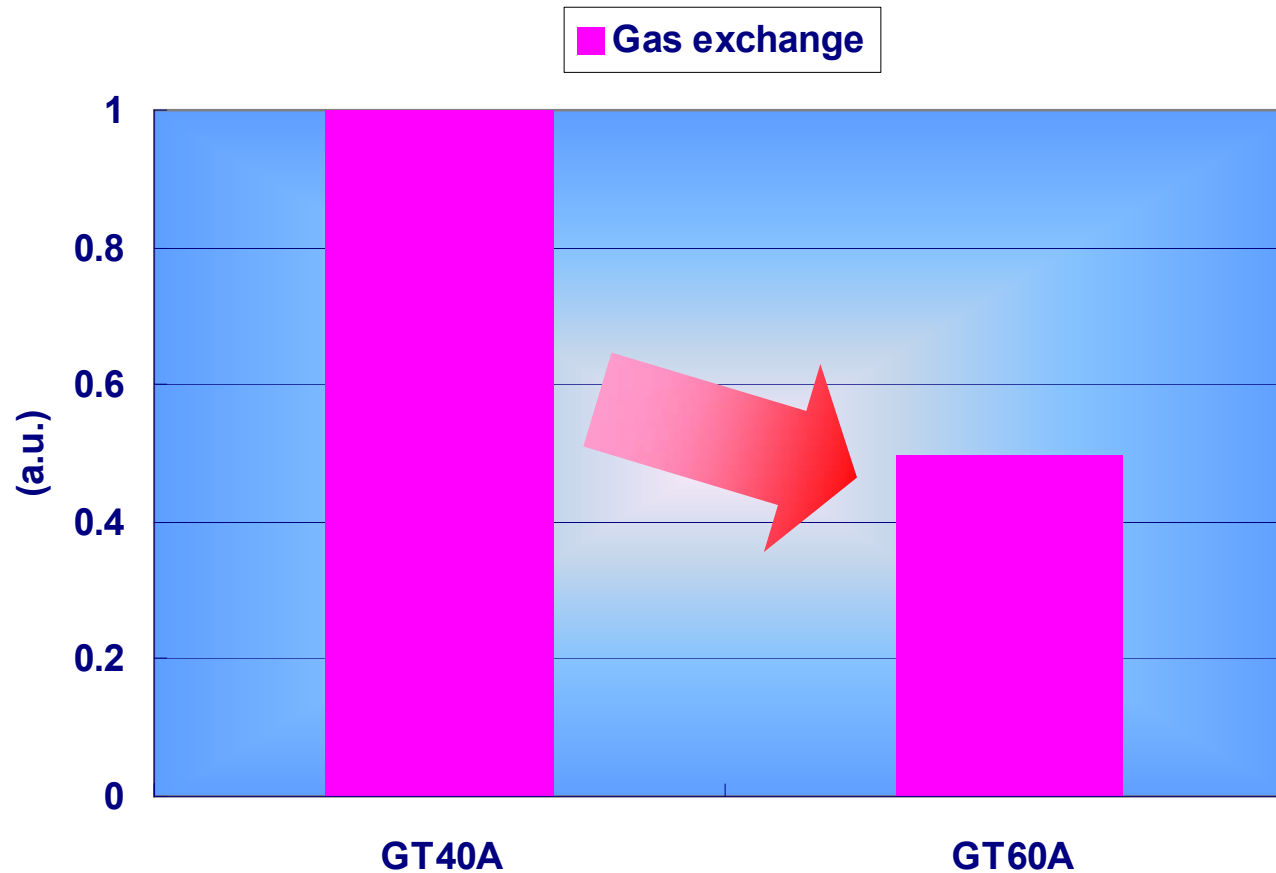


GPI direction for low cost of downtime

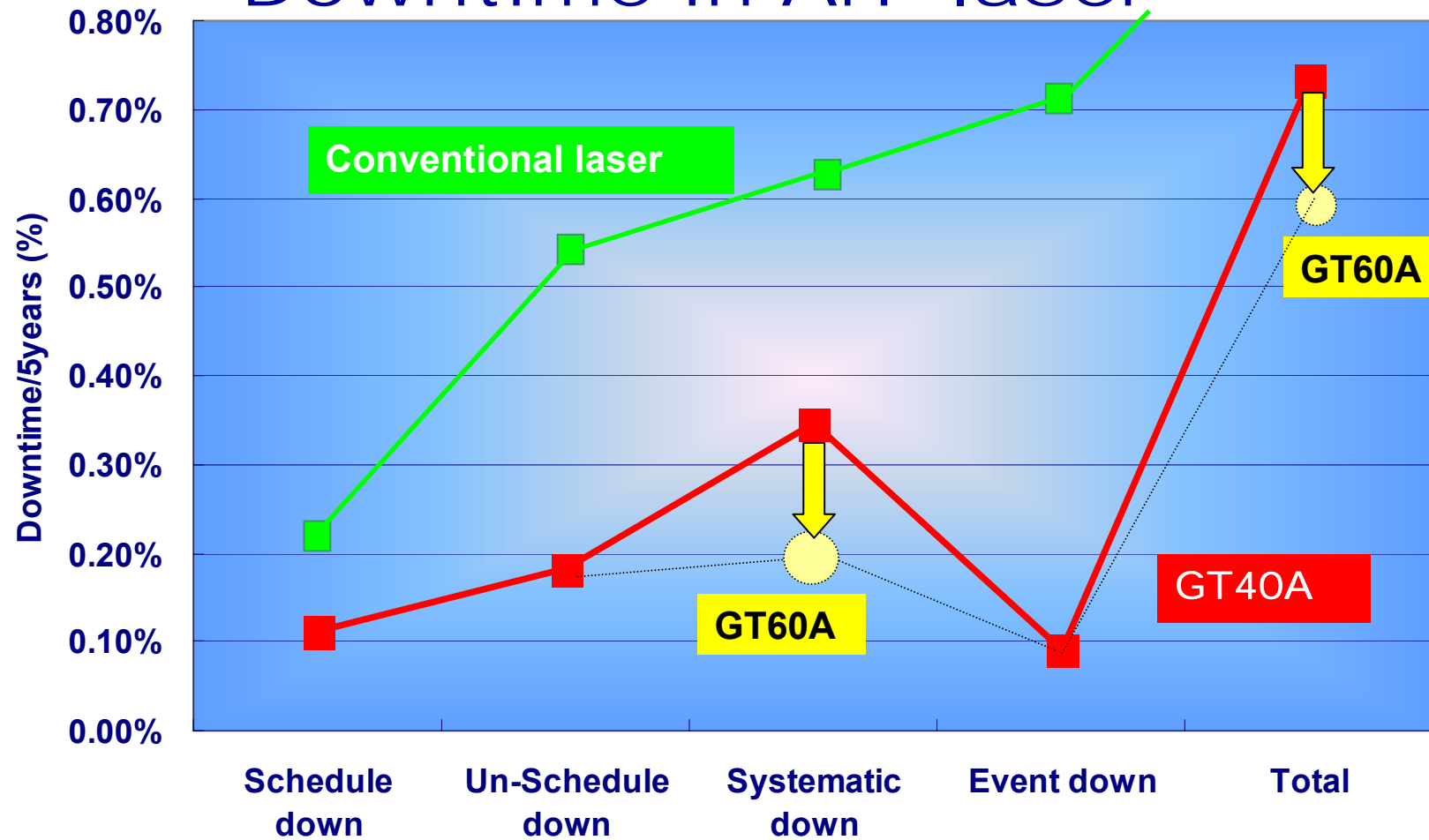
- Reduce cost of downtime
 - ✓ Schedule downtime
 - ➡ Quick parts replacement
 - ✓ Un-schedule downtime
 - ➡ Self diagnostics function
 - ✓ Event downtime
 - ➡ Automatic background parameter tuning
 - ✓ Systematic downtime
 - ➡ Advance gas maintenance

Reduction of systematic downtime

- GT60A aspire 50% reduction of gas replacement



Downtime in ArF laser



GT platform reduced downtime dramatically

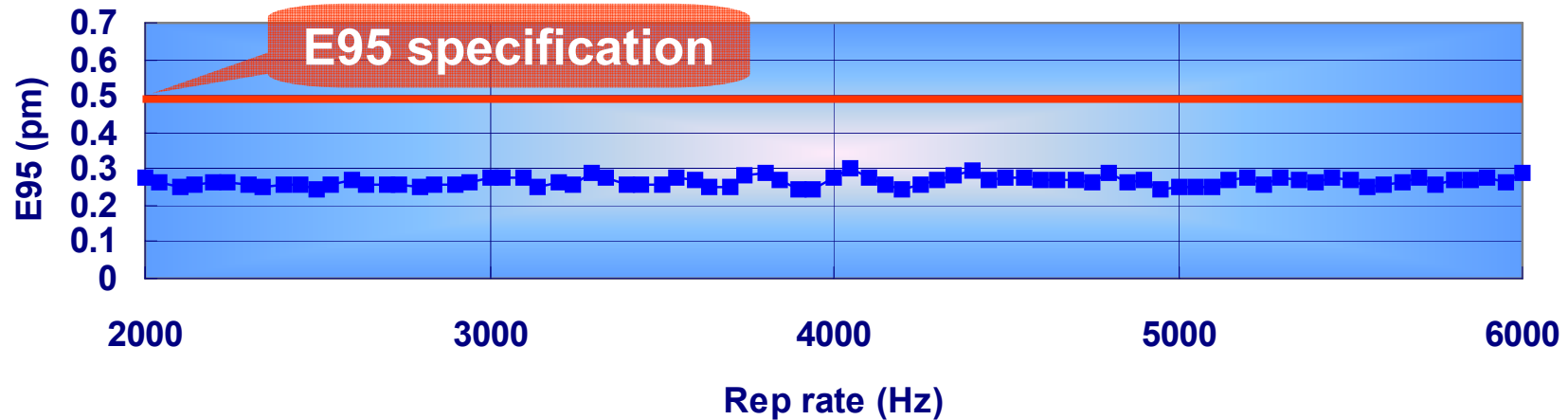
GT60A reduces systematic down from GT40A

Outline

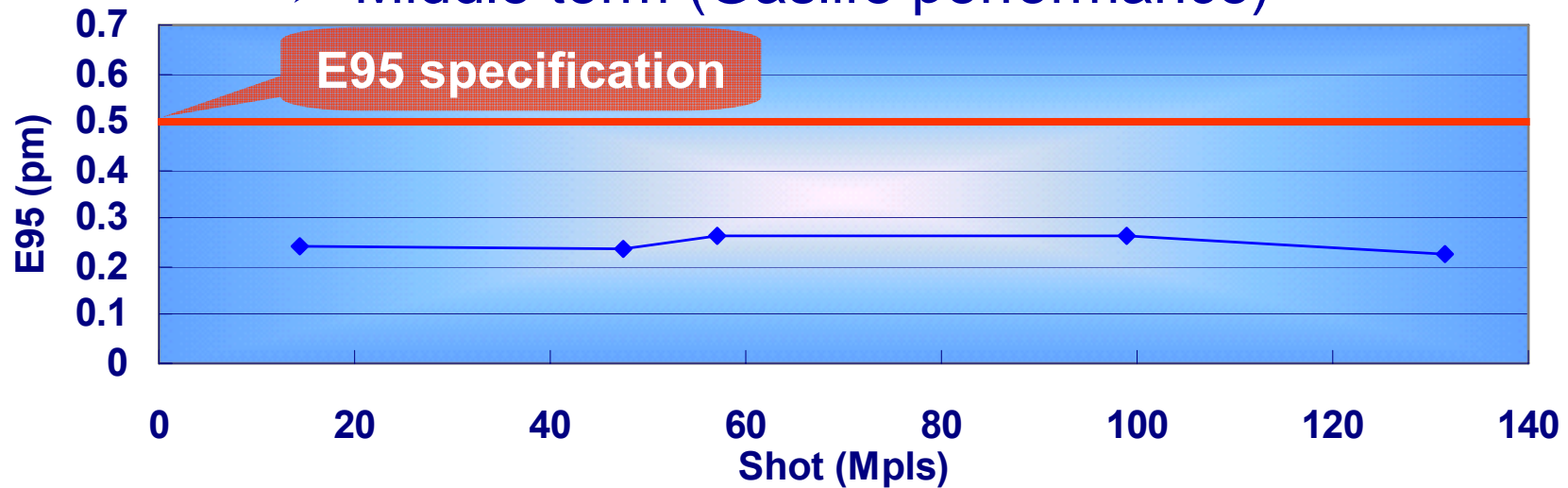
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GT60A Spectrum performance

➤ Short term (Rep rate performance)

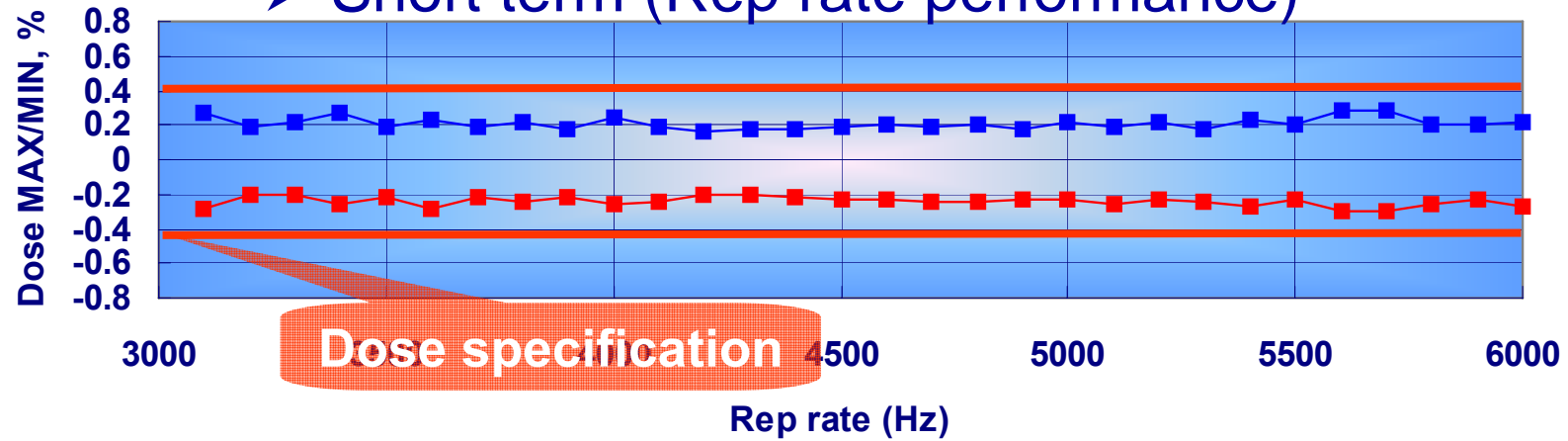


➤ Middle term (Gaslife performance)

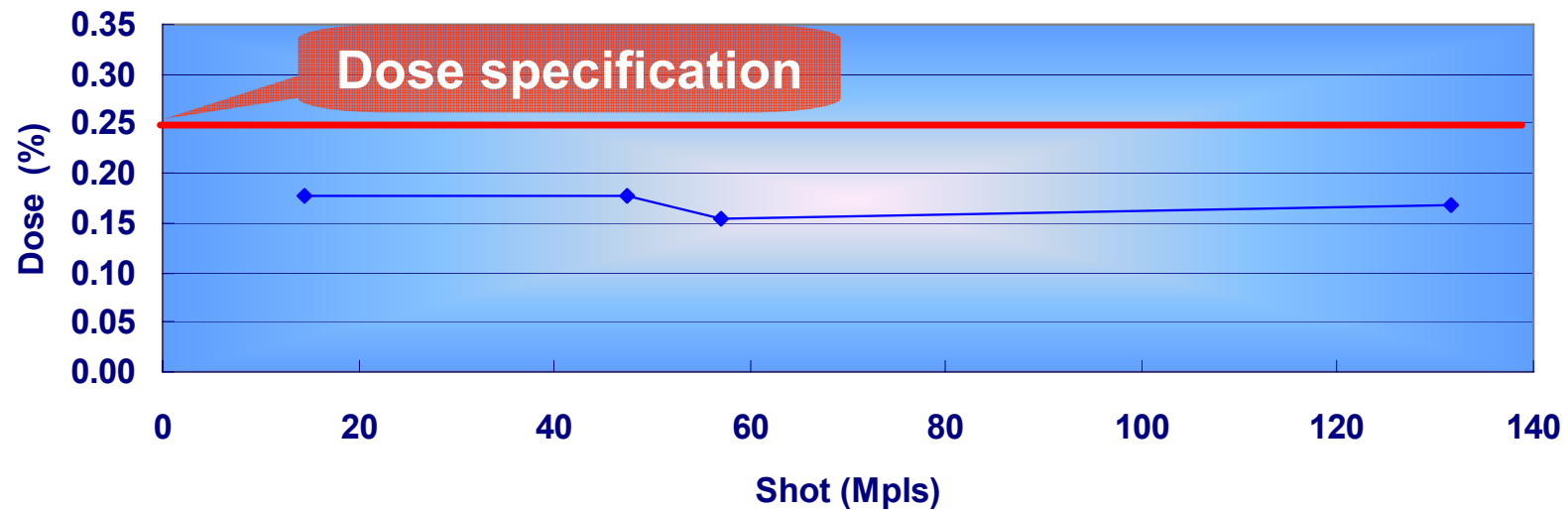


GT60A Dose stability performance

➤ Short term (Rep rate performance)

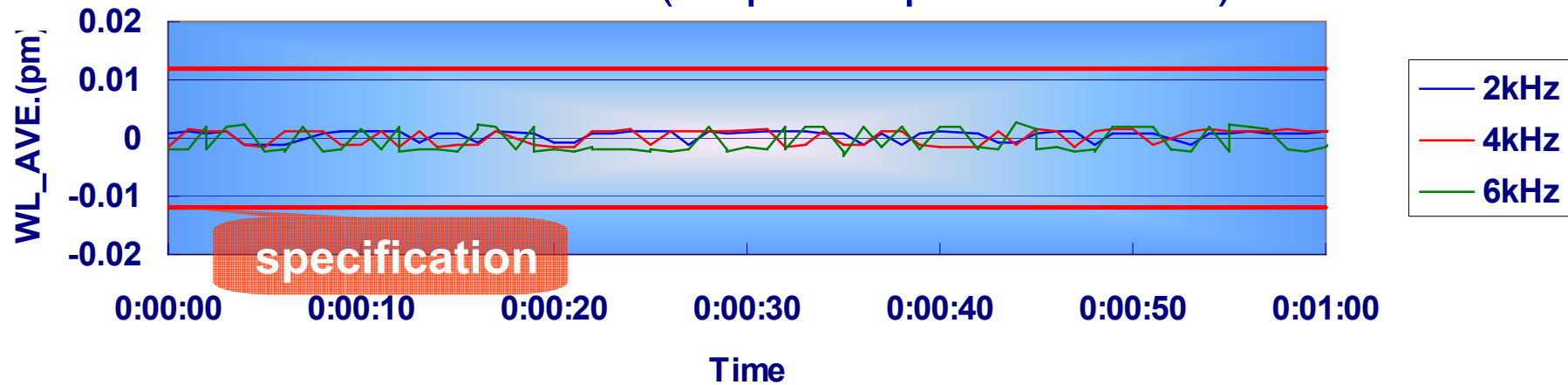


➤ Middle term (Gaslife performance)

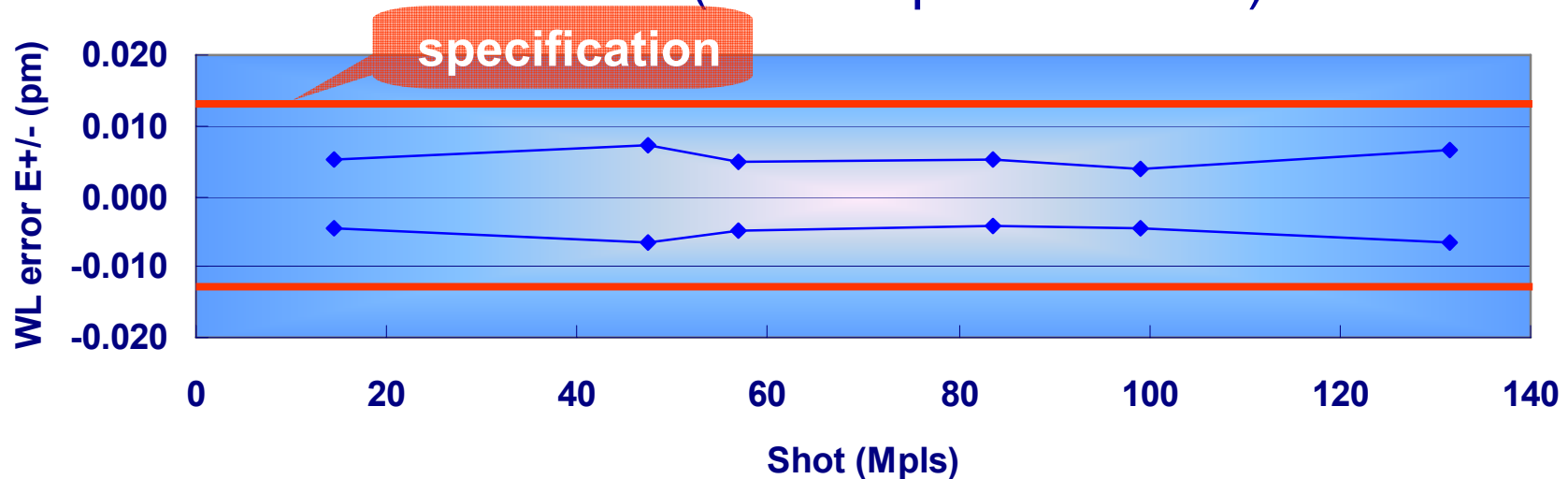


GT60A WL stability performance

➤ Short term (Rep rate performance)



➤ Middle term (Gaslife performance)

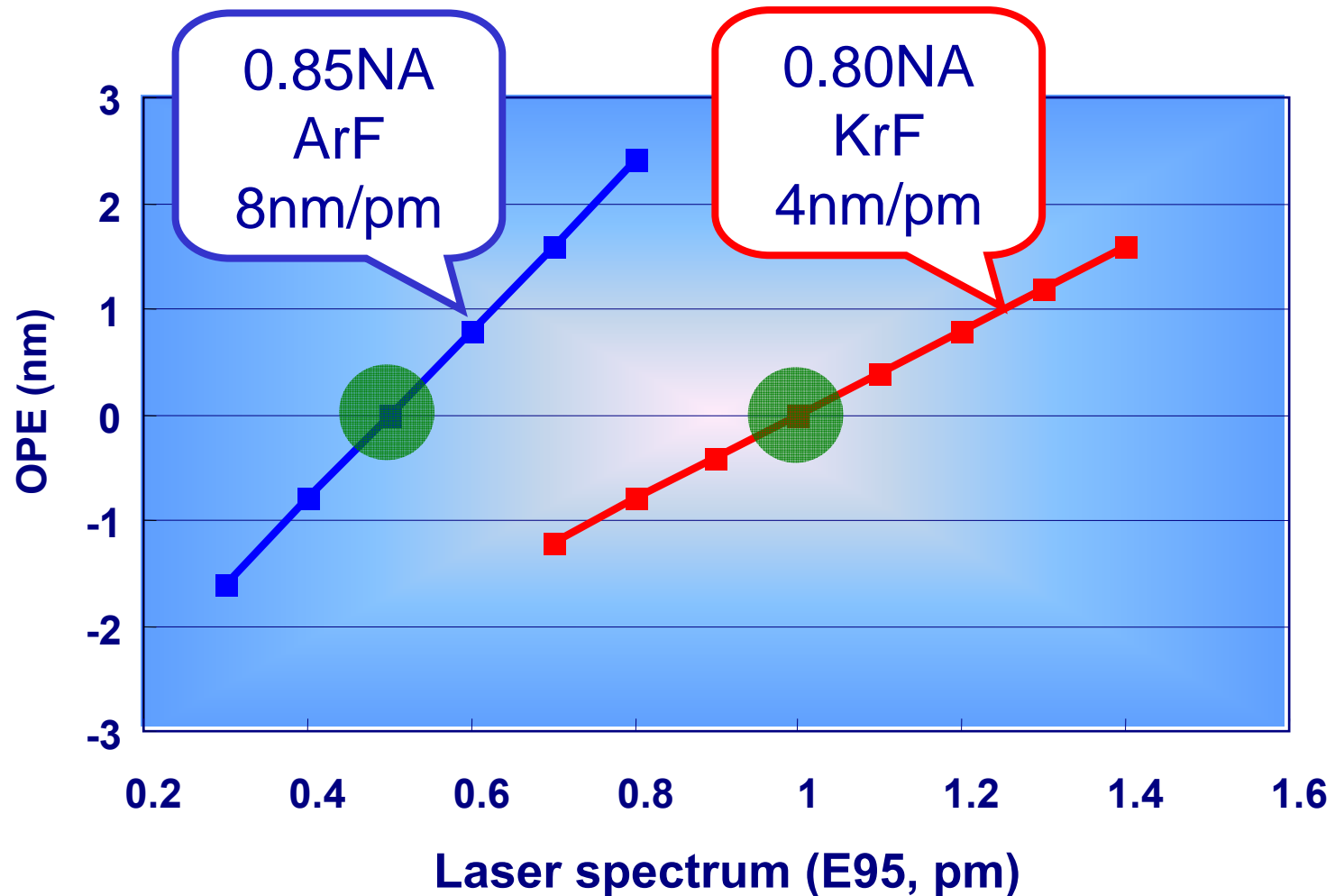


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- **Advanced Bandwidth Control Module**
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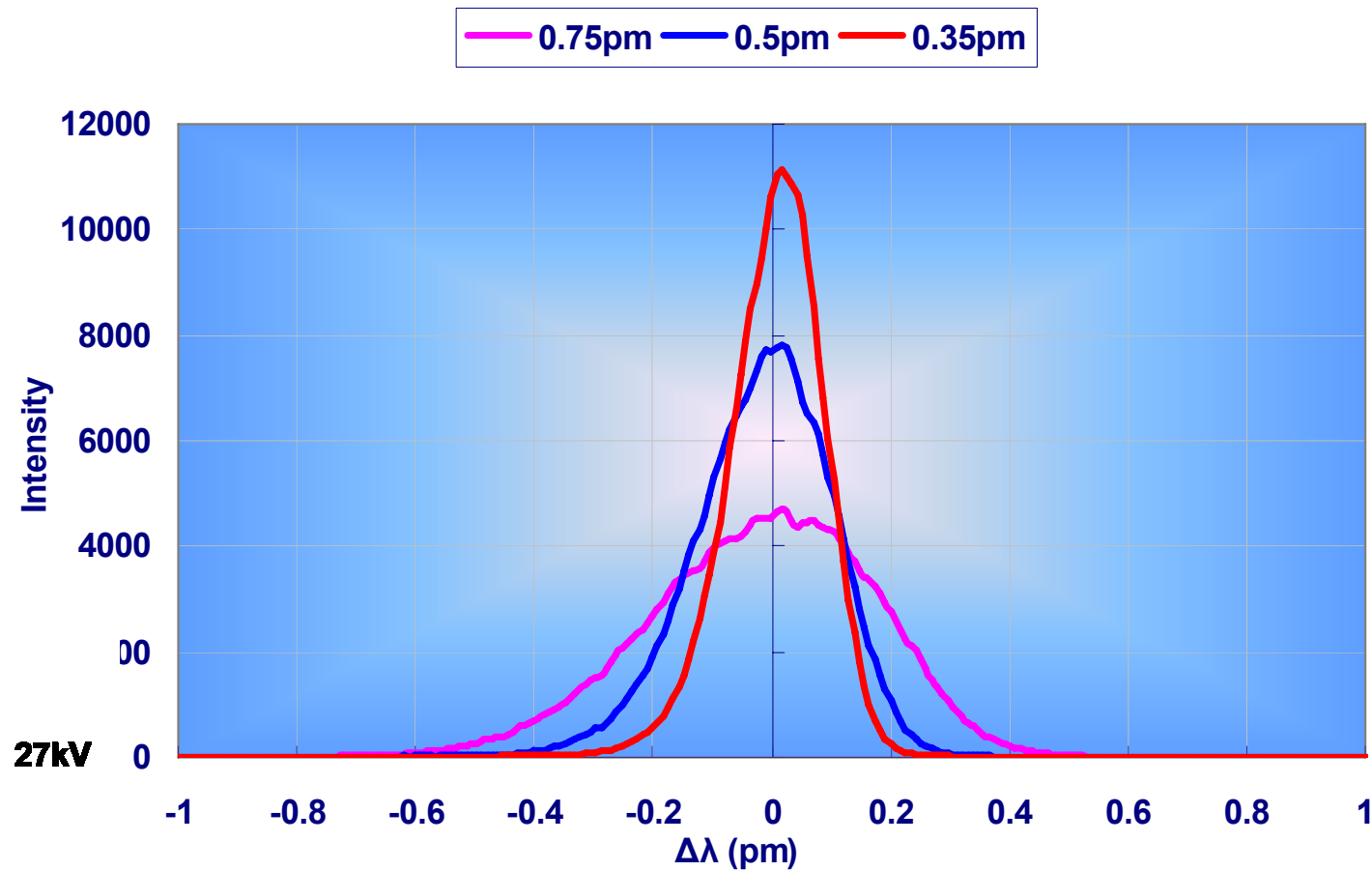
Estimation of OPE change by Spectrum

E95 influence on Optical Proximity Error stronger in ArF.



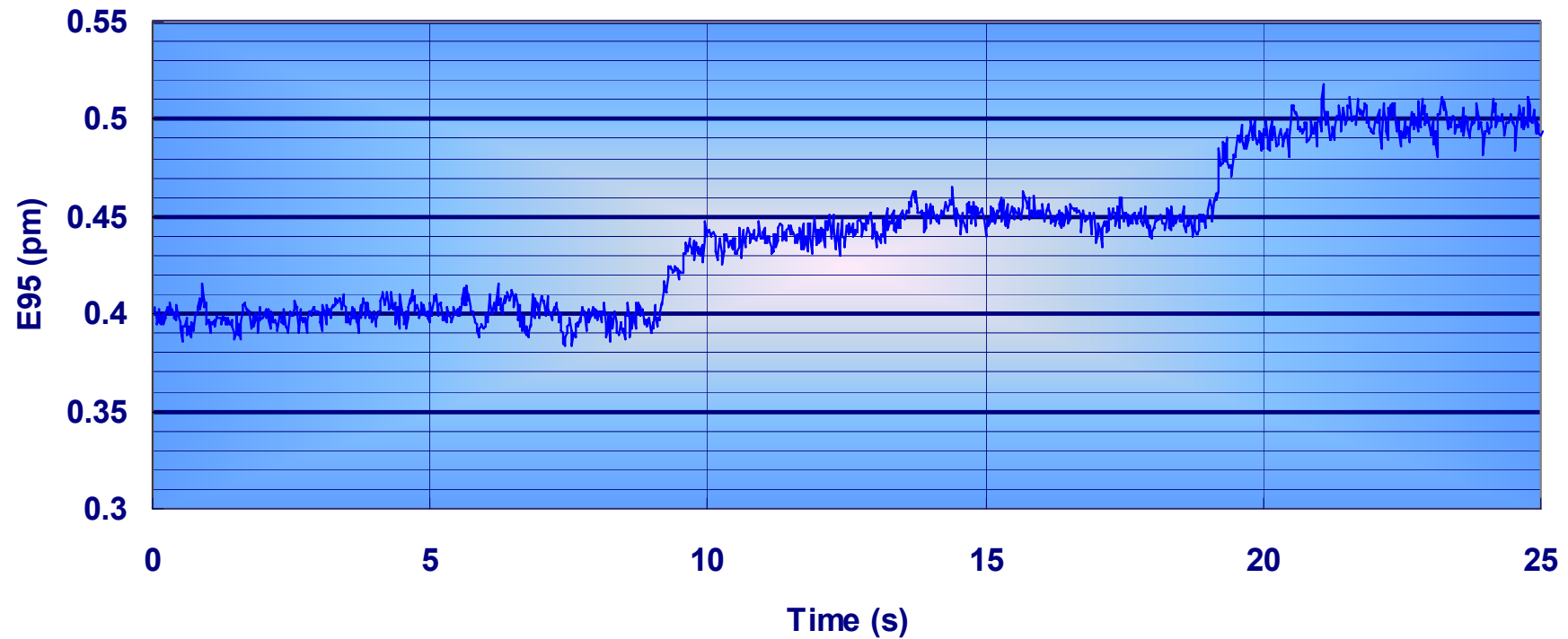
Active BCM (Bandwidth Control Module)

E95 spectral shape is actively controlled by active mechanism



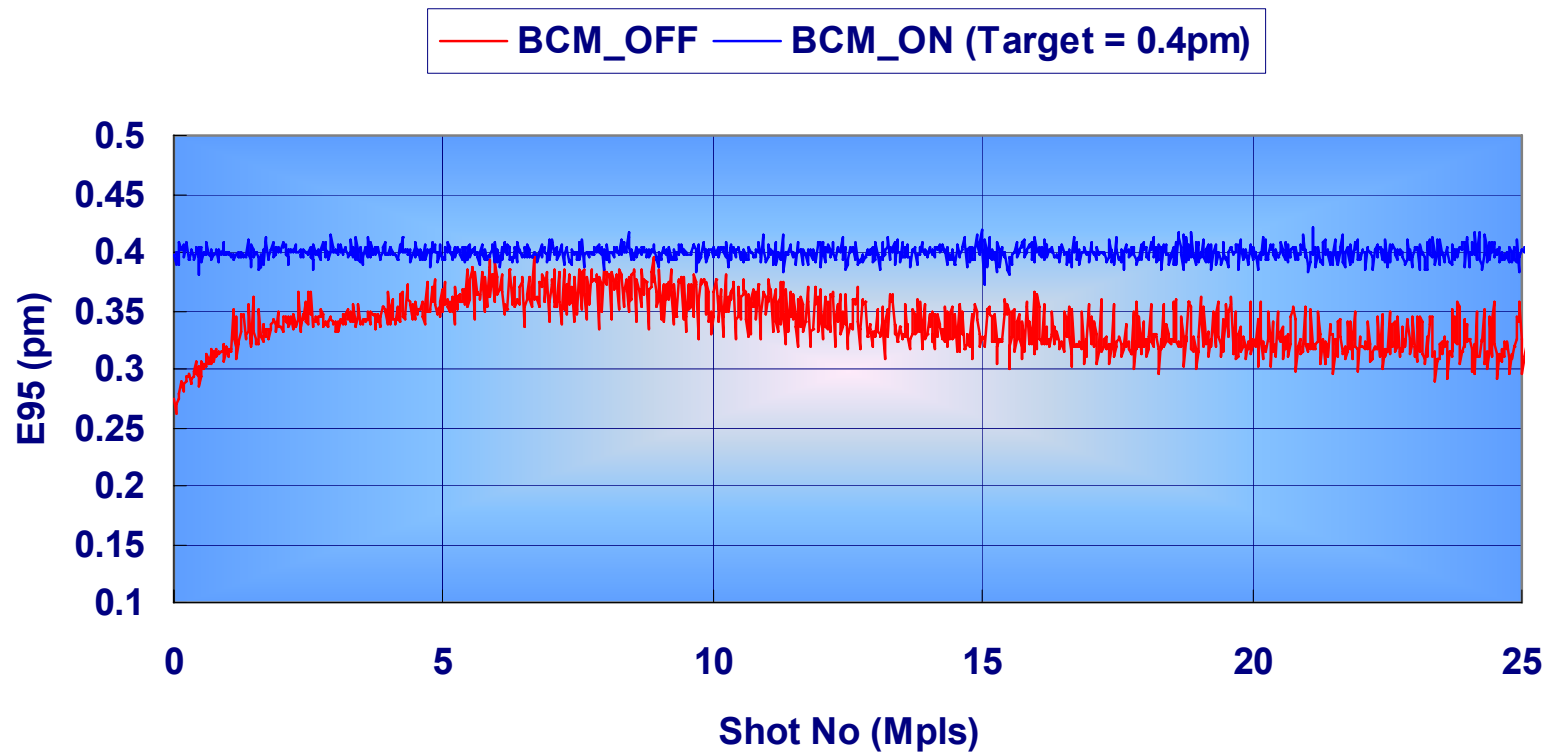
High speed active E95 control

- Very high speed E95 tuning by active E95 control (a few second range)
- Quick CD optimization / control is possible



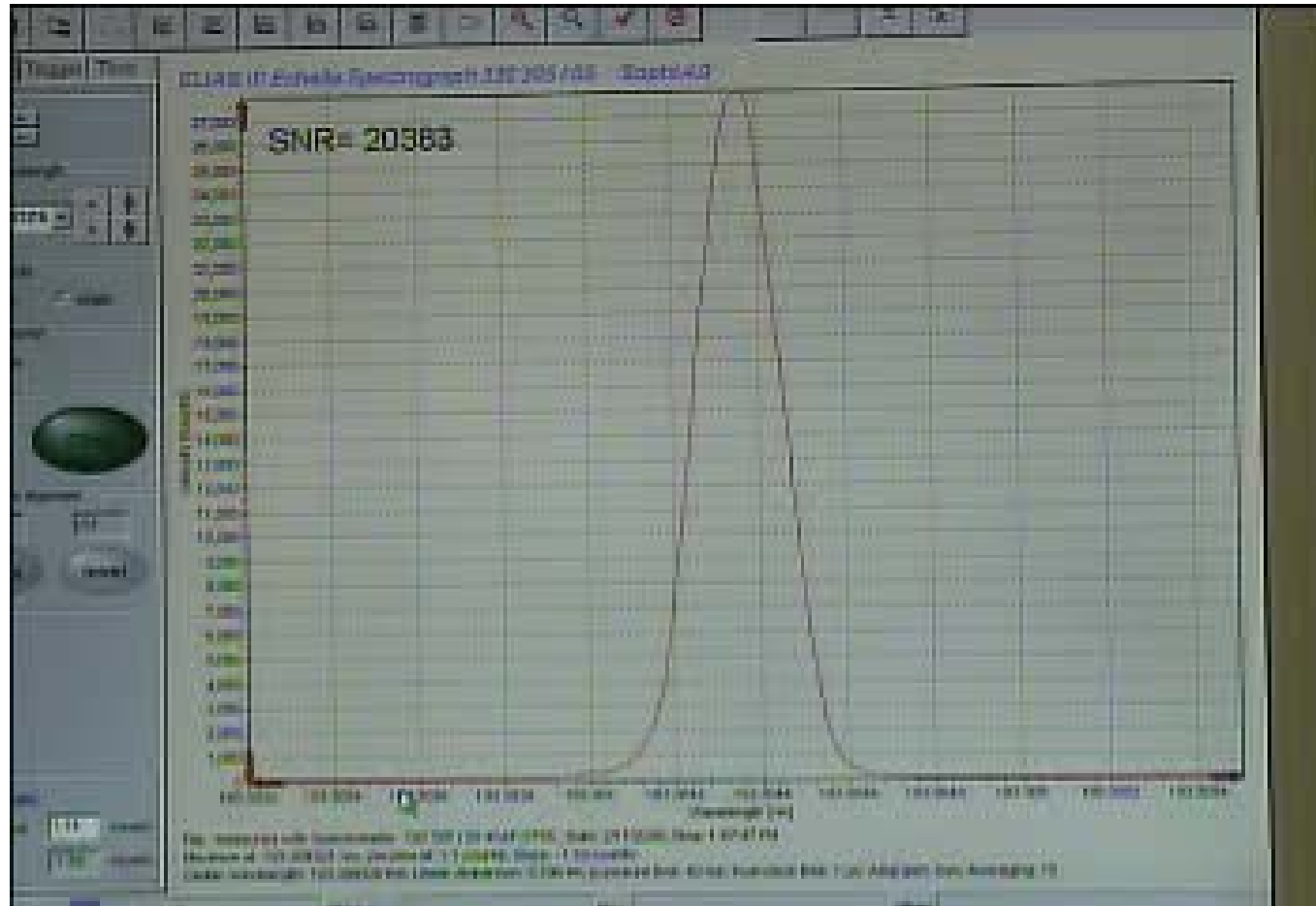
Middle term E95 control

- Active BCM stabilize E95 drift dramatically.
- Very fast instability (in a few second range) is stabilized (it was difficult to control by passive bandwidth control)



E95 control demonstration

- E95 changes from 0.3 to 0.5 pm (real time)



Active BCM (Bandwidth Control Module)

- Excellent proximity error stabilization (accurate and fast)
 - ✓ Stabilization accuracy < +/- 0.05 pm

- Tool to tool matching
 - ✓ Tuning E95 performance differences on tool to tool
 - ✓ E95 tuning range 0.4 – 0.5 pm*

- Active CD control toward more advanced CD control
 - ✓ Advanced active CD control by optional wider setting of E95
 - ✓ Advanced E95 optional value 0.4 – 0.70 pm*

* Detail specification is under investigation

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Conclusion

- “Giga Twin” high power laser platform was developed based on injection lock technology. We already succeeded to commercialized 60W 6kHz GT60A.
- The GT60A is designed to save cost of downtime by quick parts replacement, self diagnostics function, automatic background parameter tuning and less parts replacement. Long and short term performance of Gt60A are verified.
- Bandwidth control technology is developed for better CD control and proximity muching. Active BCM (Band width control Module) technology provides accurate and fast proximity stabilization, tool to tool matching and active CD control toward more advanced control.
- We are convinced “GigaTwin” series will lead the ArF light source for semiconductor industry below 45nm node era.

Acknowledgement

*This development is partially based on F_2 laser research performed under the management by **Association of Super-advanced Electronics Technologies (ASET)** in the **Ministry of Economy Trade and Industry (METI)** program of “ F_2 laser lithography technology” supported by **New Energy and industrial technology Development Organization (NEDO)** in JAPAN during 2000-2002.*



Finally, See you again at next Microliothography in 2007.

See you soon at your factory with our GT60A !



GT60A shipping from Gigaphoton