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Reliability report of high power injection lock laser light source for double exposure and double patterning ArF immersion lithography

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Gigaphoton Inc.



Contents

- INTRODUCTION
 - ✓ ArF Roadmap
 - ✓ GigaTwin advantage
 - ✓ ArF Specifications
- FEATURES OF GT62A-1S xE
 - ✓ Approach to the advanced exposure technology
 - ✓ Other Features
- CONCLUSION



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INTRODUCTION

- **193nm ArF light sources are widely used in semiconductor mass production from the 90 nm node and beyond.**
- **The ArF immersion technology is even spotlighted as the enabling technology for the 45nm node and beyond.**
- **Beyond that, double patterning is considered to be most promising technology to meet the requirement of the next generation 32nm node.**
- **To achieve this, market demands for ArF light source are getting more severe.**

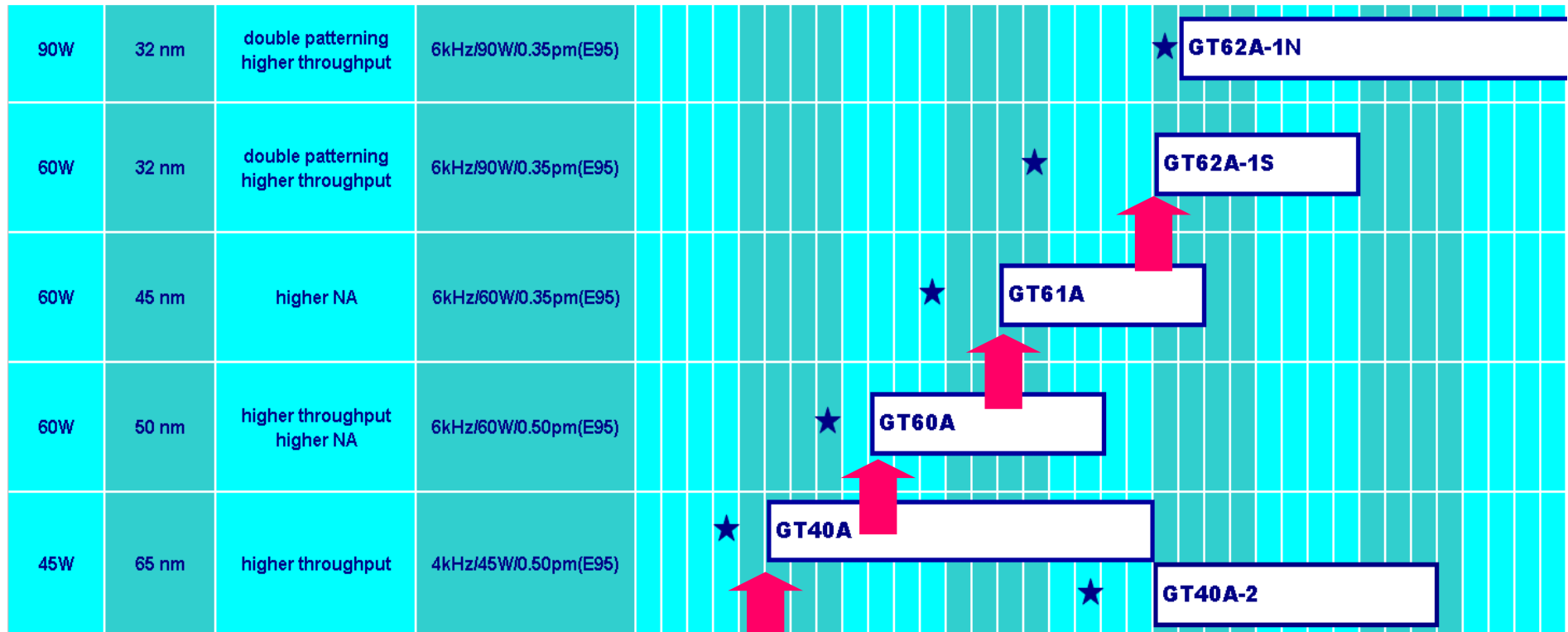
For Example:

Higher throughput / Higher reliability / Less running cost

ArF Roadmap

Release timing : Q3.2010*

Power	Technology Node	Main driver	Requirement for ArF Laser	~2004	2005	2006	2007	2008	2009	2010	2011
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★ 1st laser delivery timing to scanner manufacture

* TBD



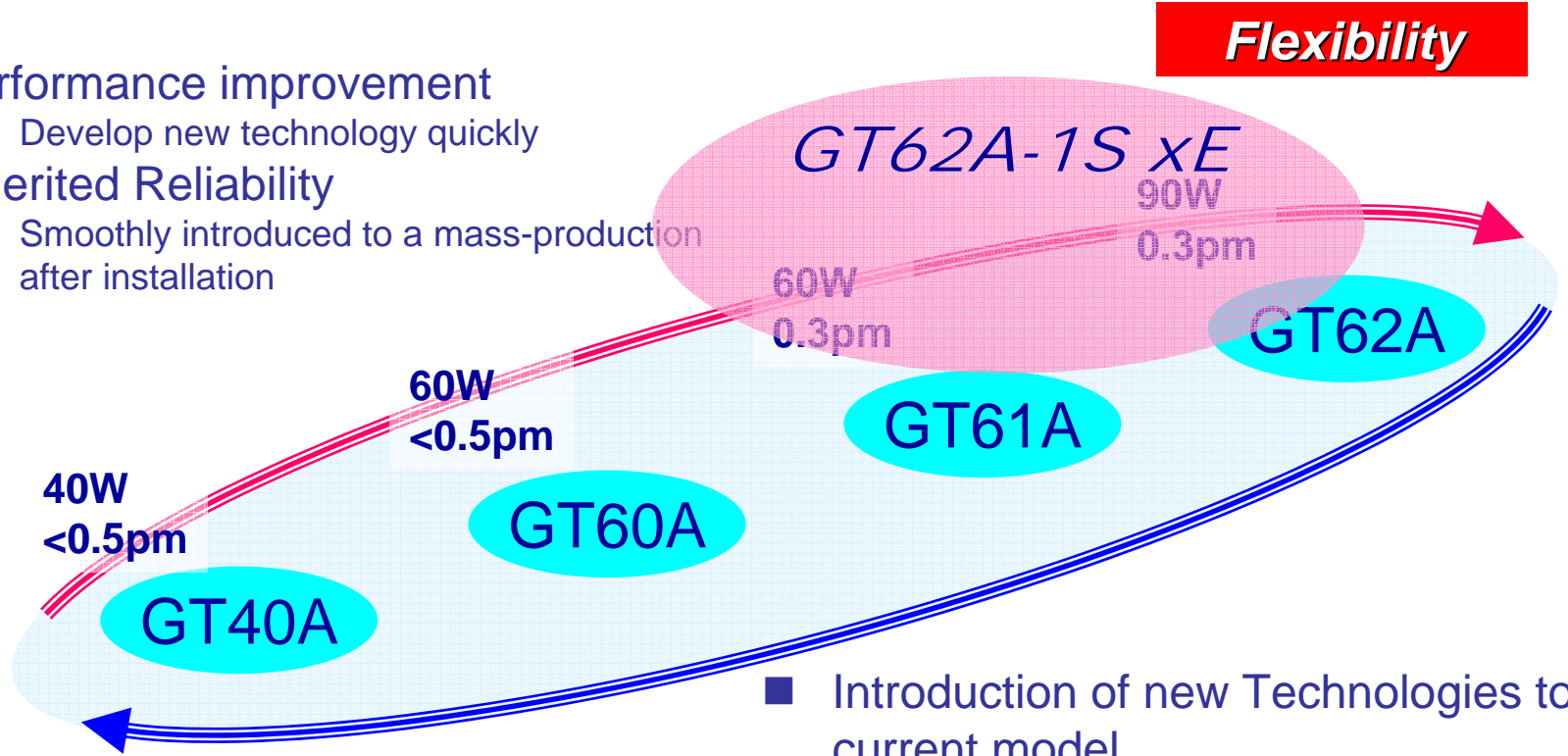
GTxxA

End customer installation timing (Estimation)

GigaTwin advantage

- Performance improvement
 - ✓ Develop new technology quickly
- Inherited Reliability
 - ✓ Smoothly introduced to a mass-production after installation

Flexibility



- Introduction of new Technologies to current model
 - ✓ EcoPhoton roadmap
 - ✓ BCM



ArF Specifications

Flexibility

ArF model		GT40A	GT60A	GT61A	GT62A-1S	GT62A-1N
Wavelength	nm	193	193	193	193	193
Power	W	45	60	60	60	90
Pulse energy	mJ	11.25	10	10	10	15
Max. rep rate	Hz	4000	6000	6000	6000	6000
FWHM	pm	0.2	0.2	N.A	N.A	N.A
E95	pm	<0.5	<0.5	0.3	0.3	0.3
Durability (Expected)						
MO Chamber	Bpls	40*	40*	40*	40*	40*
PO Chamber	Bpls	40*	40*	40*	40*	40*
LNM / MO LNM	Bpls	60**	60**	60**	60**	60**
MM	Bpls	30	30	30	30	30
FM / PO FM	Bpls	30	30	30	30	30
PO RM	Bpls	30	30	30	30	30

* GRYCOS technology
 ** MPL (Multi Positioning LNM)
 *** Durability extension @ <90W

GT62A-1S xE is the laser matching the enhancement technology of advanced Exposure Systems. It has the capability of power extension from 60W to 90W.



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FEATURES OF GT62A-1S xE



- **Approach to the advanced exposure technology**
 - ✓ **Extendable Power**
 - ✓ **Long pulse duration**
- **Other Features**
 - ✓ **Running cost reduction**
 - **Chamber lifetime extension (GRYCOS)**
 - **LNM lifetime extension (MPL)**
 - **Gas lifetime extension (TGM)**
 - ✓ **Reliability**

FEATURES OF GT62A-1S xE



➤ **Approach to the advanced exposure technology**

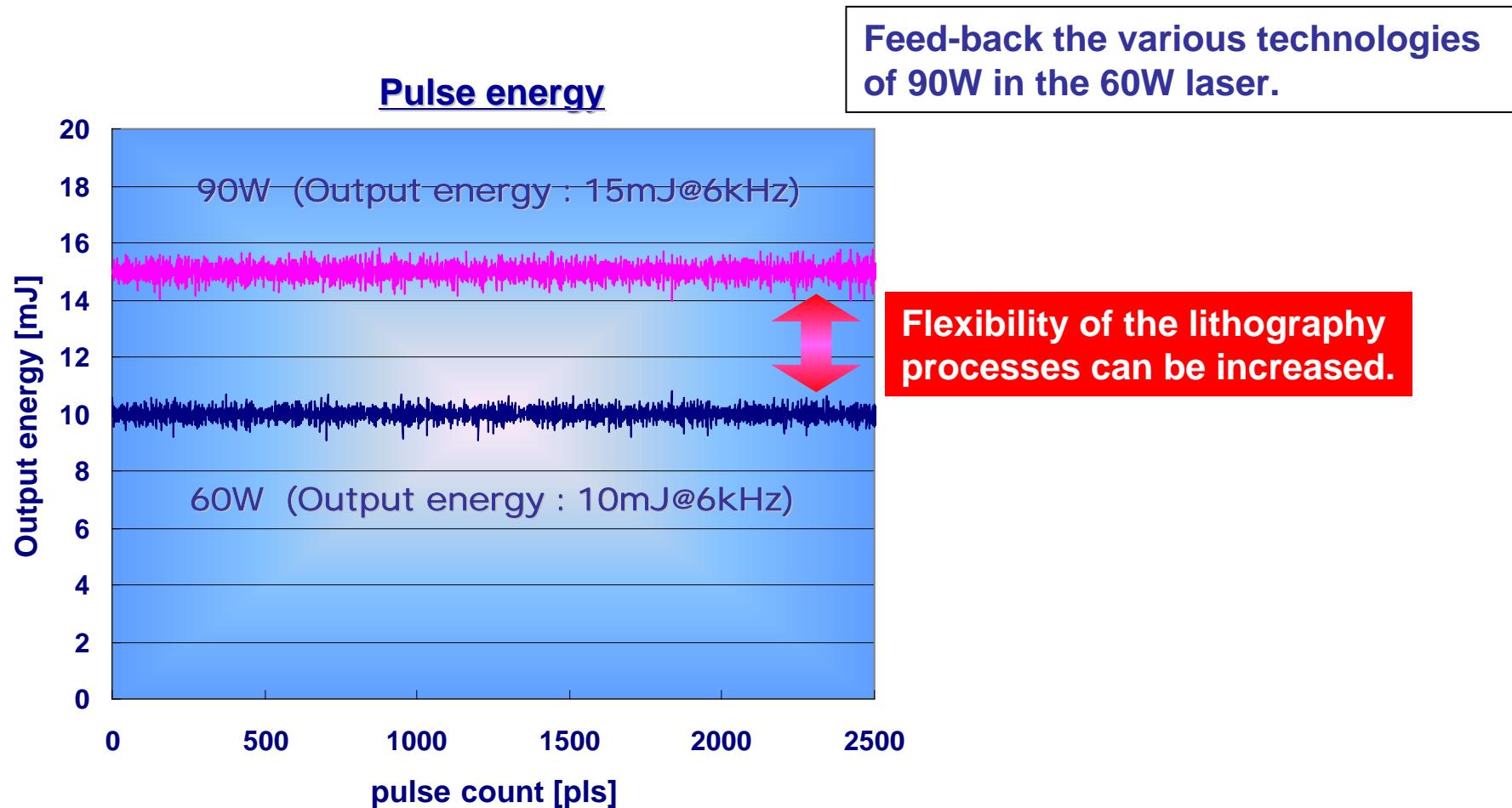
- ✓ **Extendable Power**
- ✓ **Long pulse duration**

➤ **Other Features**

- ✓ **Running cost reduction**
 - Chamber lifetime extension (GRYCOS)
 - LNM lifetime extension (MPL)
 - Gas lifetime extension (TGM)
- ✓ **Reliability**

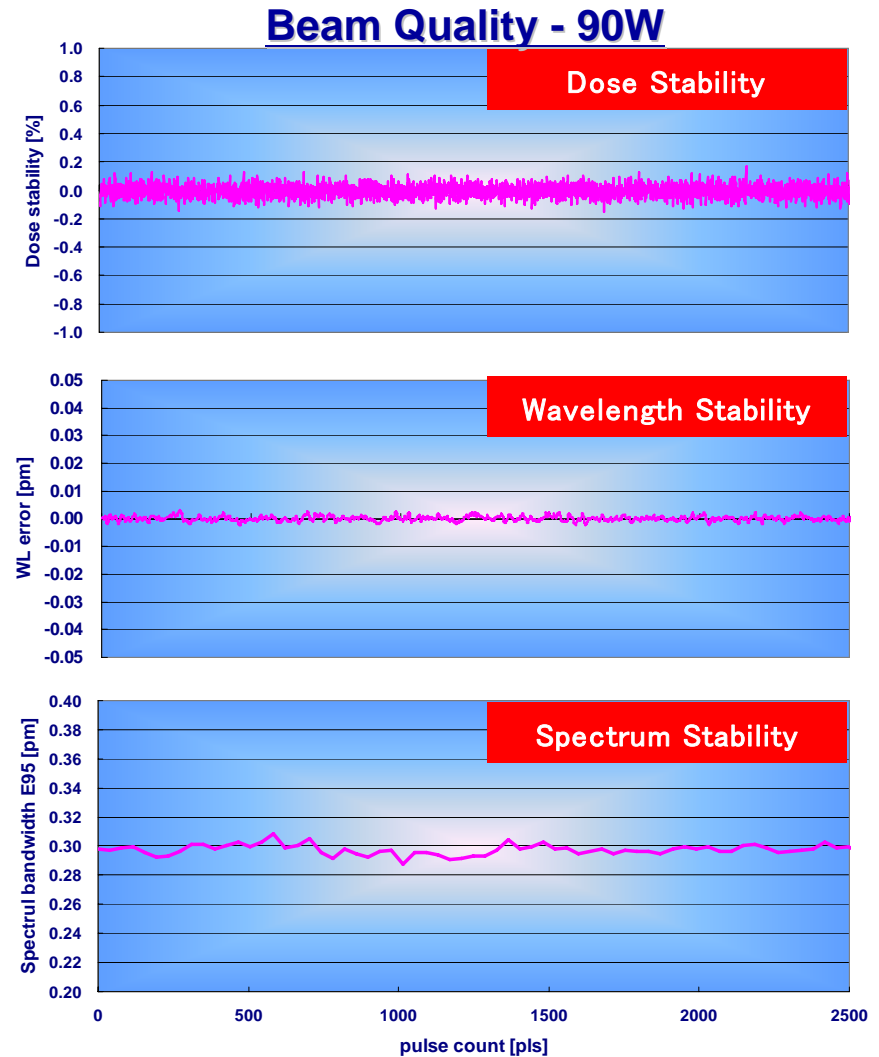
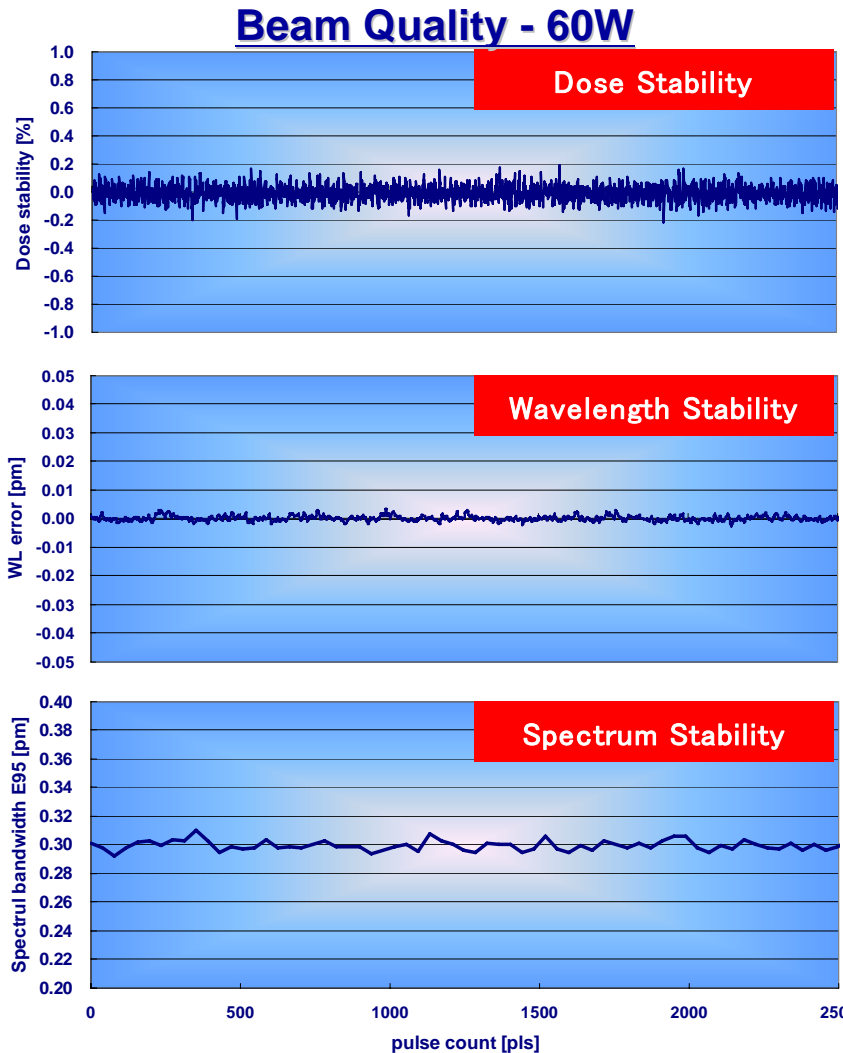
Extendable Power

- **Illumination Power optimum for Resist Sensitivity is provided.**
 - ✓ **Power extension from 60W to 90W**



Extendable Power

- **Beam Quality related to CD variation is kept stable in Power extension.**

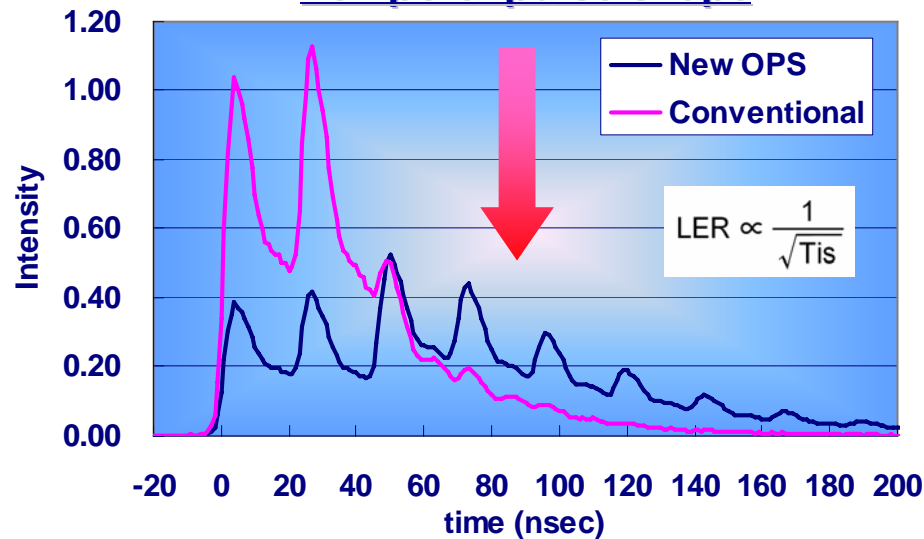


Long pulse duration

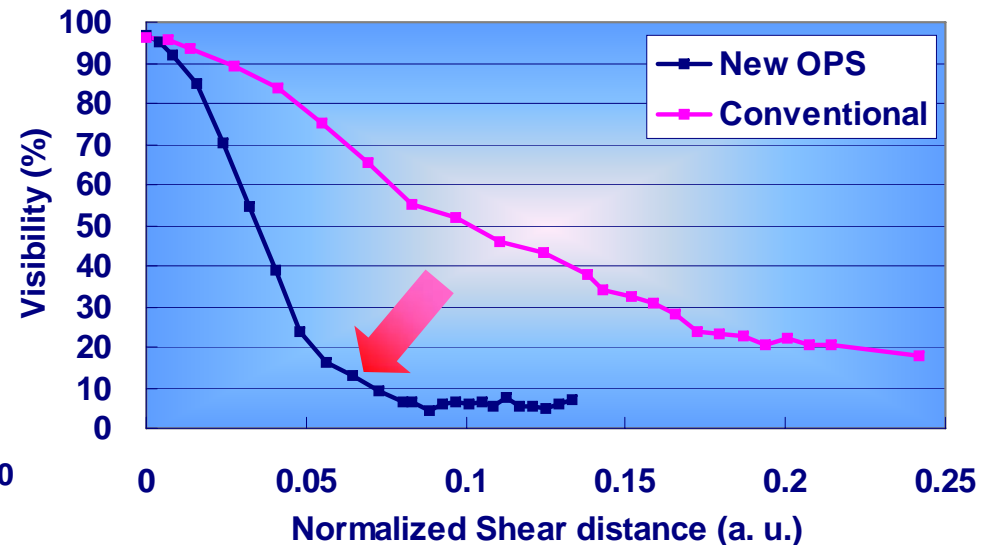
- **GT62A-1S xE contributes optics durability and is able to reduce LER.**

- **New OPS (Optical Pulse Stretcher) developed for >60W operation**
 - 2 stage pulse stretch : $T_{is} = 130\text{ns}$
- **Advantage of New OPS**
 - Lower peak power slows down optics deterioration
 - Reduce Spatial / Temporal coherence

Temporal pulse shape



Spatial coherence



* Measured by Shearing interferometer

Immersion Symposium 2009 P13

FEATURES OF GT62A-1S xE



- Approach to the advanced exposure technology
 - ✓ Extendable Power
 - ✓ Long pulse duration
- Other Features
 - ✓ Running cost reduction
 - Chamber lifetime extension (GRYCOS)
 - LNM lifetime extension (MPL)
 - Gas lifetime extension (TGM)
 - ✓ Reliability

Running cost reduction

➤ Inheriting the GigaTwin platform, GT62A-1S xE features the reduced running costs.

✓ Three technologies for running cost reduction are equipped.

Technologies for running cost reduction :

Chamber lifetime extension (Gigaphoton Recycled Chamber Operation System)

LNM lifetime extension (Multi Positioning LNM technology)

Gas lifetime extension (Total Gas Manager)



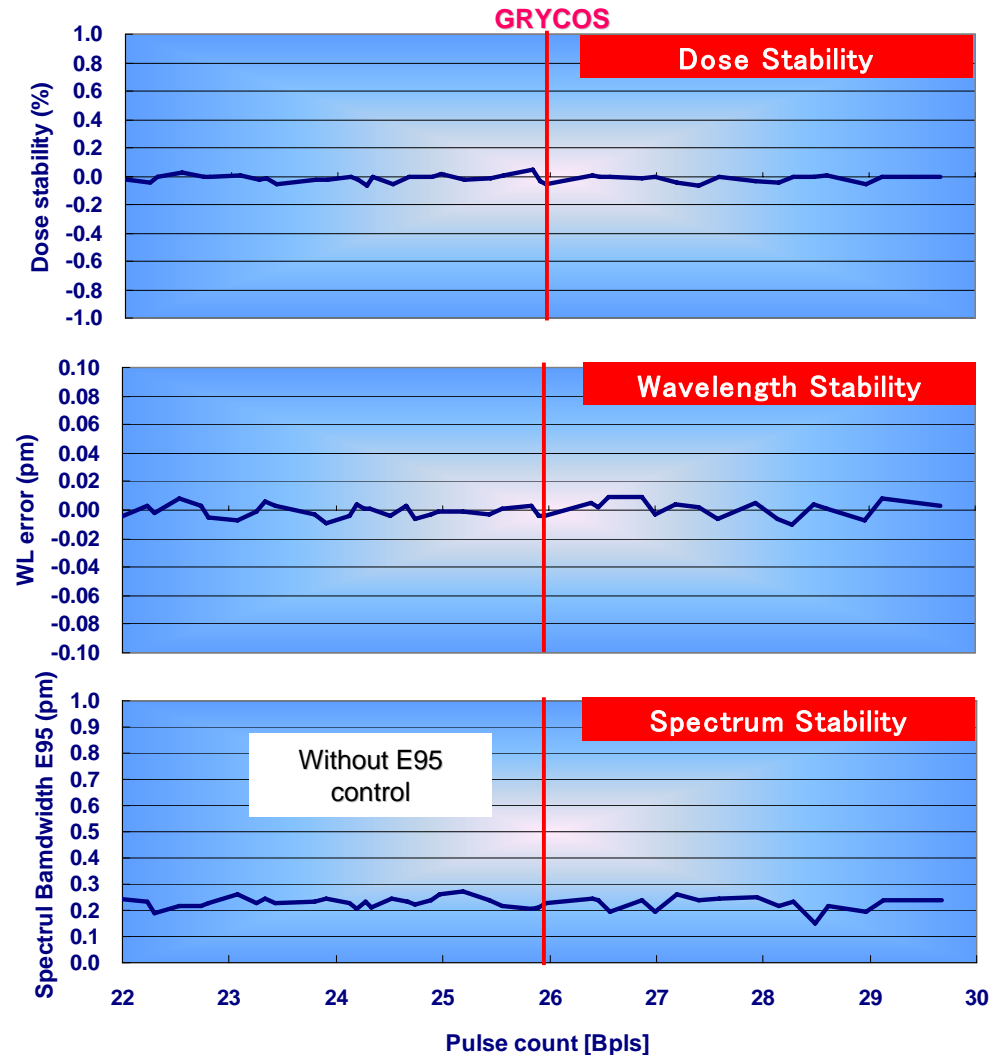
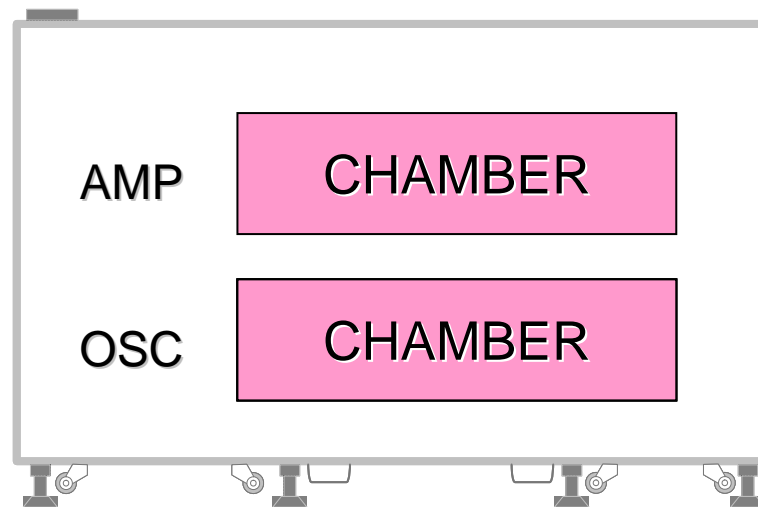
Chamber lifetime extension (GRYCOS) :

➤ Each laser chamber can be used up to 40Bpls.

No impact to Beam Quality

Beam Quality

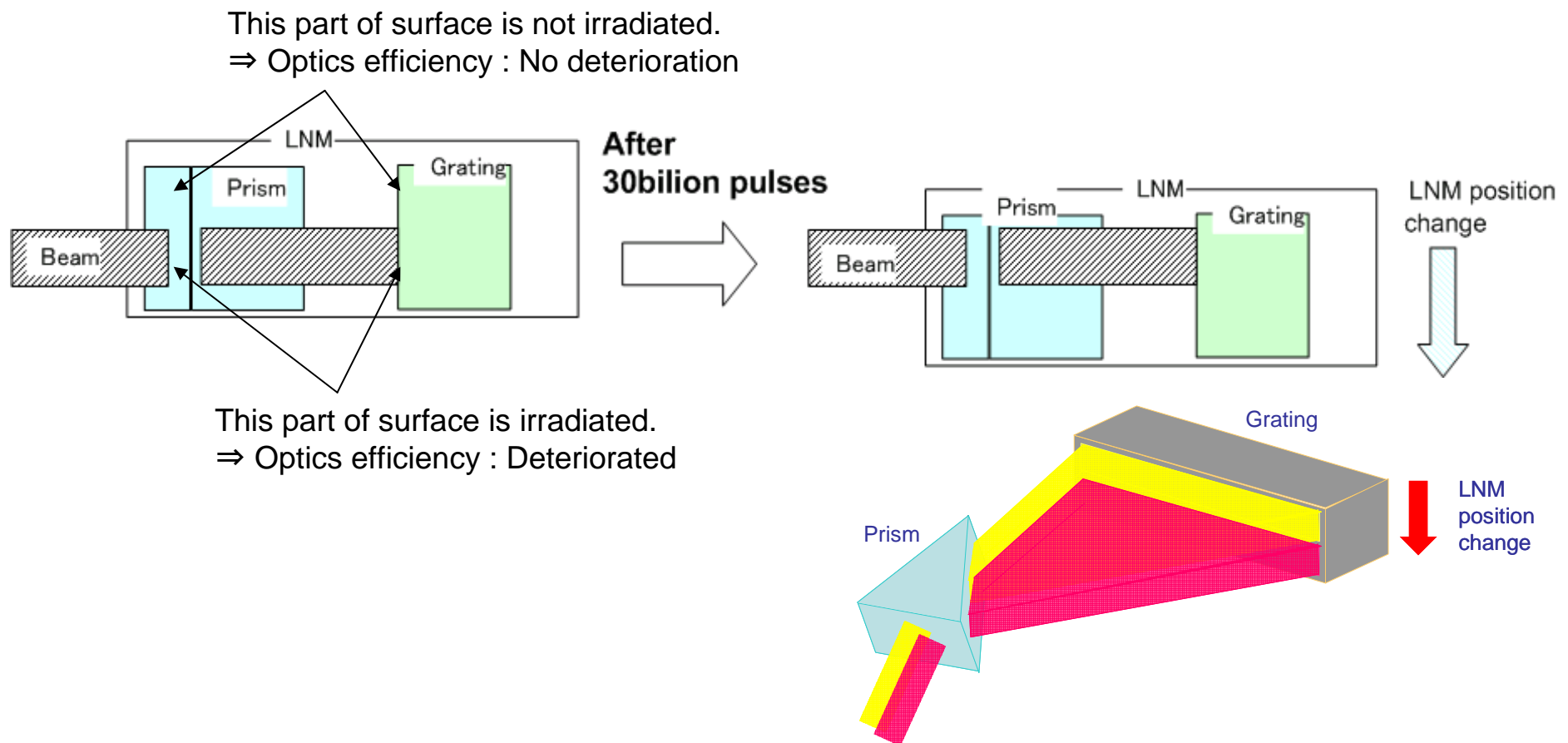
By using a chamber as an oscillator and then an amplifier



LNM lifetime extension (MPL) :

- LNM lifetime extends to double (30Bpls ⇒ 60Bpls).

By changing optical path efficiently



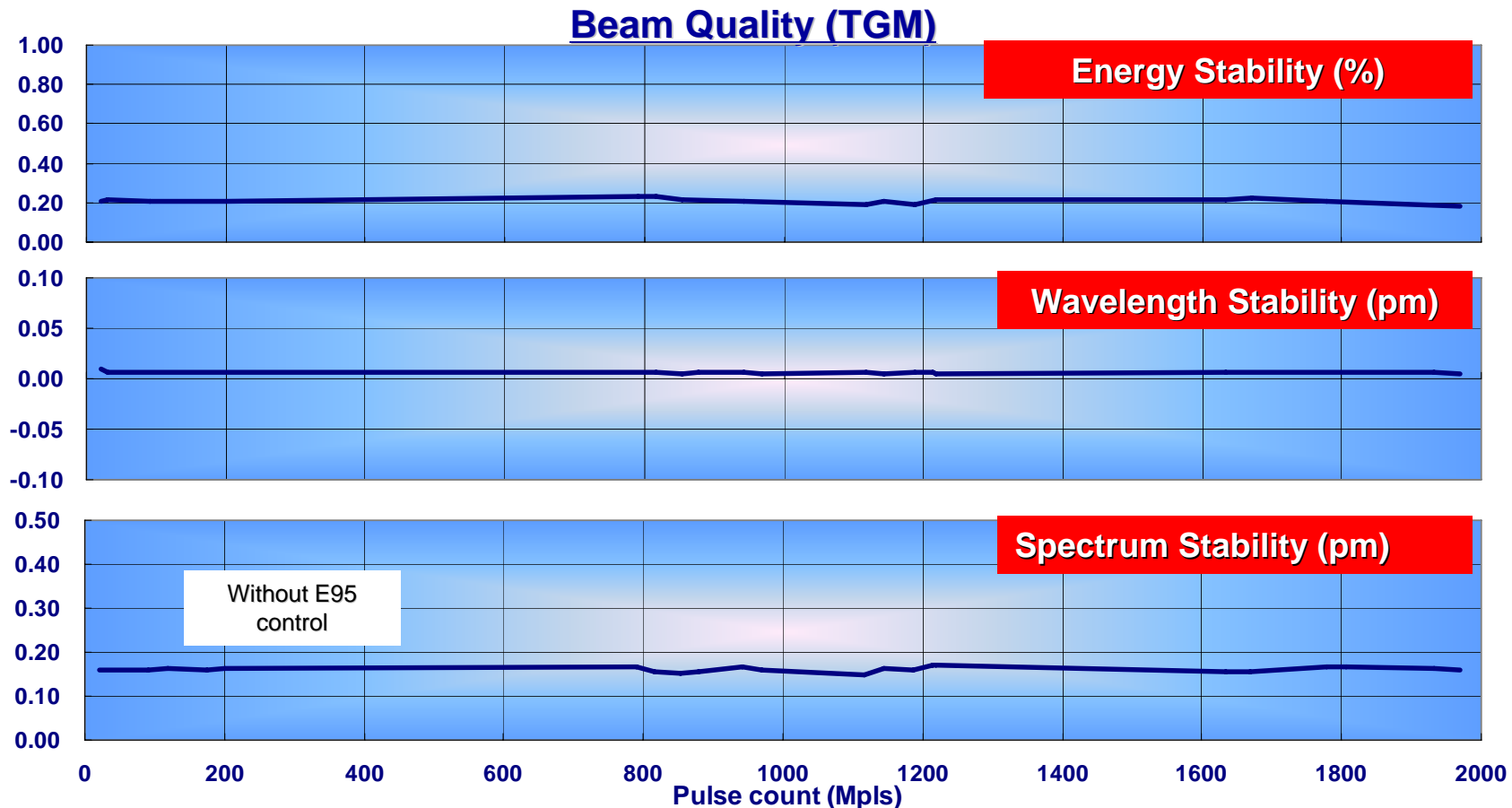
Gas lifetime extension (TGM) :

➤ Gas refill interval extends remarkably (3days ⇒15days : 24times/year).

By Improving Gas Control

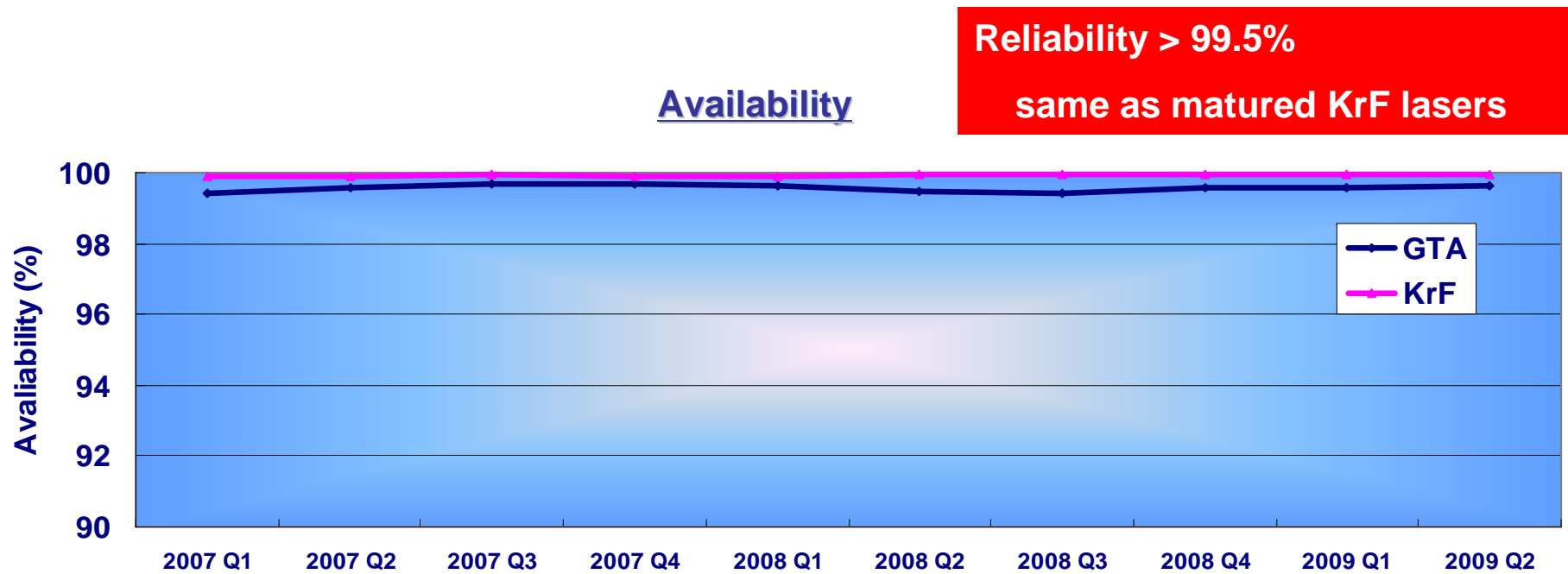
- ✓Stabilization of fluorine partial pressure
- ✓Reduction of the amount of impurity

Beam Quality is stable during extended gas lifetime.



Reliability

➤ Inheriting the GigaTwin platform, GT62A-1S xE features proven reliability.





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CONCLUSION

- **GT62A-1S xE designed to support the requirement of process parameter flexibility of exposure tool and end customer.**
 - ✓ **Fit to Advanced Exposure Systems like a new illumination system.**
 - ✓ **Provide Illumination Power optimum for Resist Sensitivity**
 - ✓ **Maintain CD variation well in Power extension**
 - ✓ **Contribute to optics durability and is able to reduce LER.**

- **Inheriting the GigaTwin platform, it features the reduced running costs and proven reliability by GRYCOS, MPL, TGM.**

Gigaphoton's mission is to be the No. 1 provider of advanced technology and quality products, and to contribute to society as the industry leader.
We at Gigaphoton aim at being a team of professionals who can build a strong relationship of mutual trust, both within and outside of the company.

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