



www.gigaphoton.com

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

H. Tanaka, H. Tsushima, M. Yoshino, T. Kumazaki, H. Watanabe, S. Matsumoto, H. Umeda,
Y. Kawasuji, T. Suzuki, S. Tanaka, A. Kurosu, T. Matsunaga, J. Fujimoto, and H. Mizoguchi

Gigaphoton Inc.



Contents

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



Contents

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

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.**

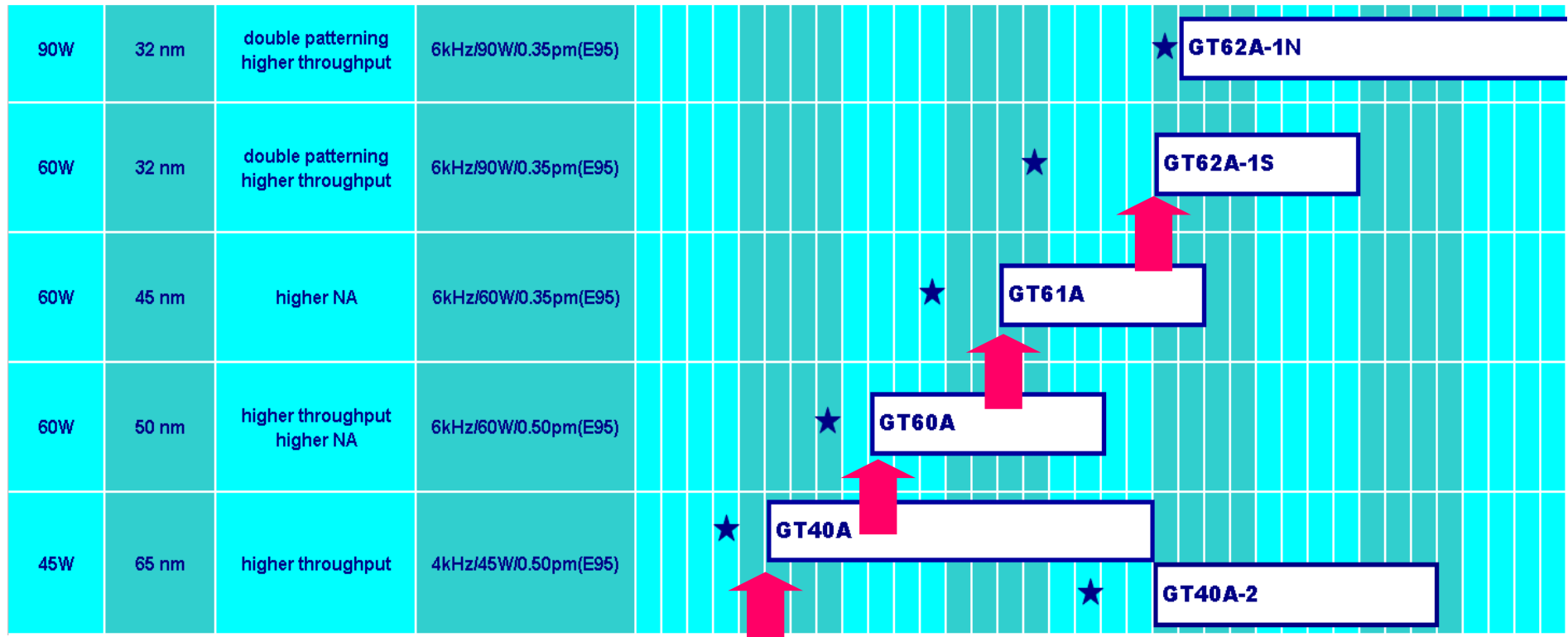
For Example:

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
-------	-----------------	-------------	---------------------------	-------	------	------	------	------	------	------	------



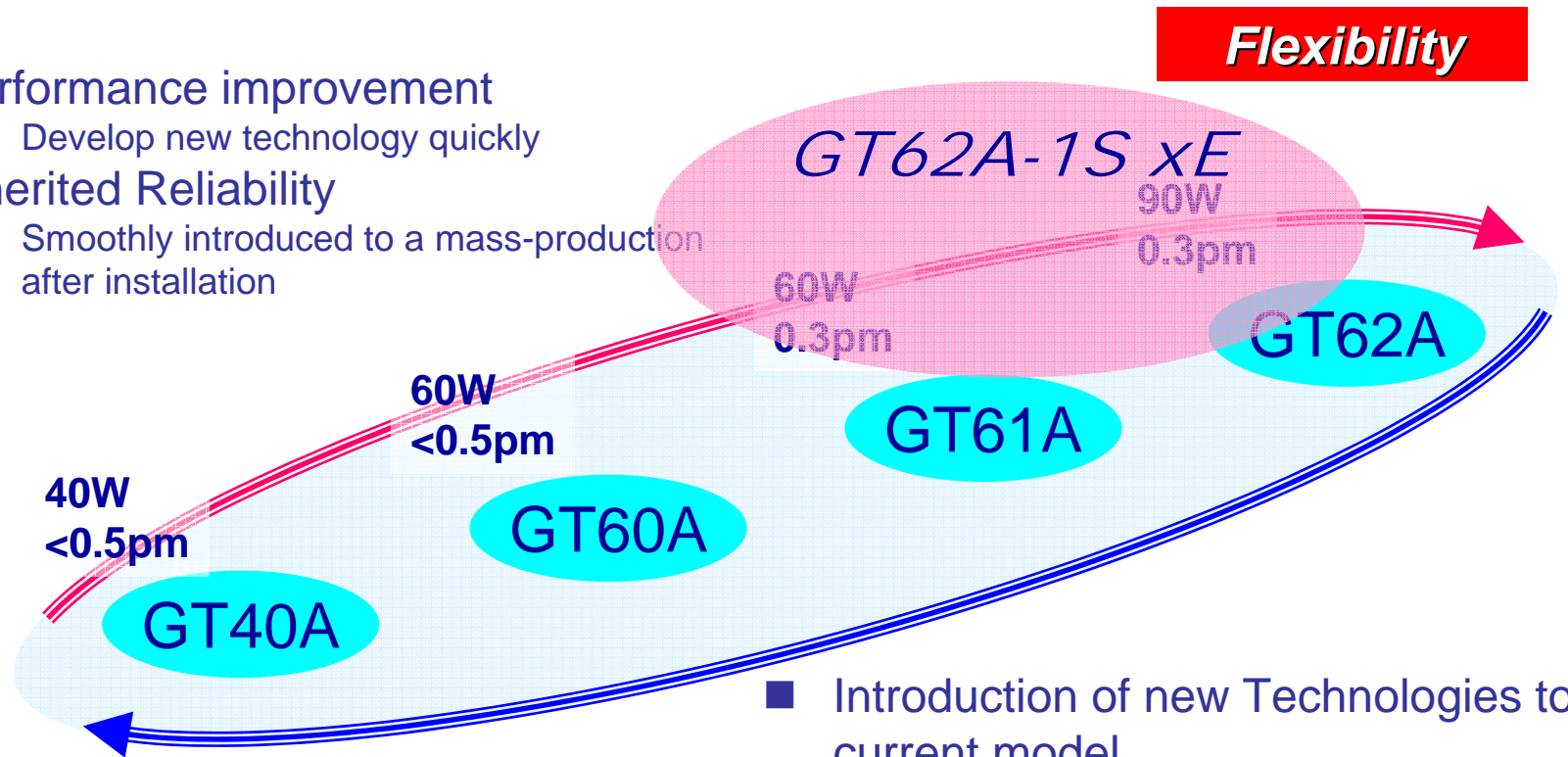
★ 1st laser delivery timing to scanner manufacture

* 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



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



GRYCOS



MPL



TGM

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*
LNLM / MO LNLM	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 LNLM)
 *** 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.



Contents

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

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**

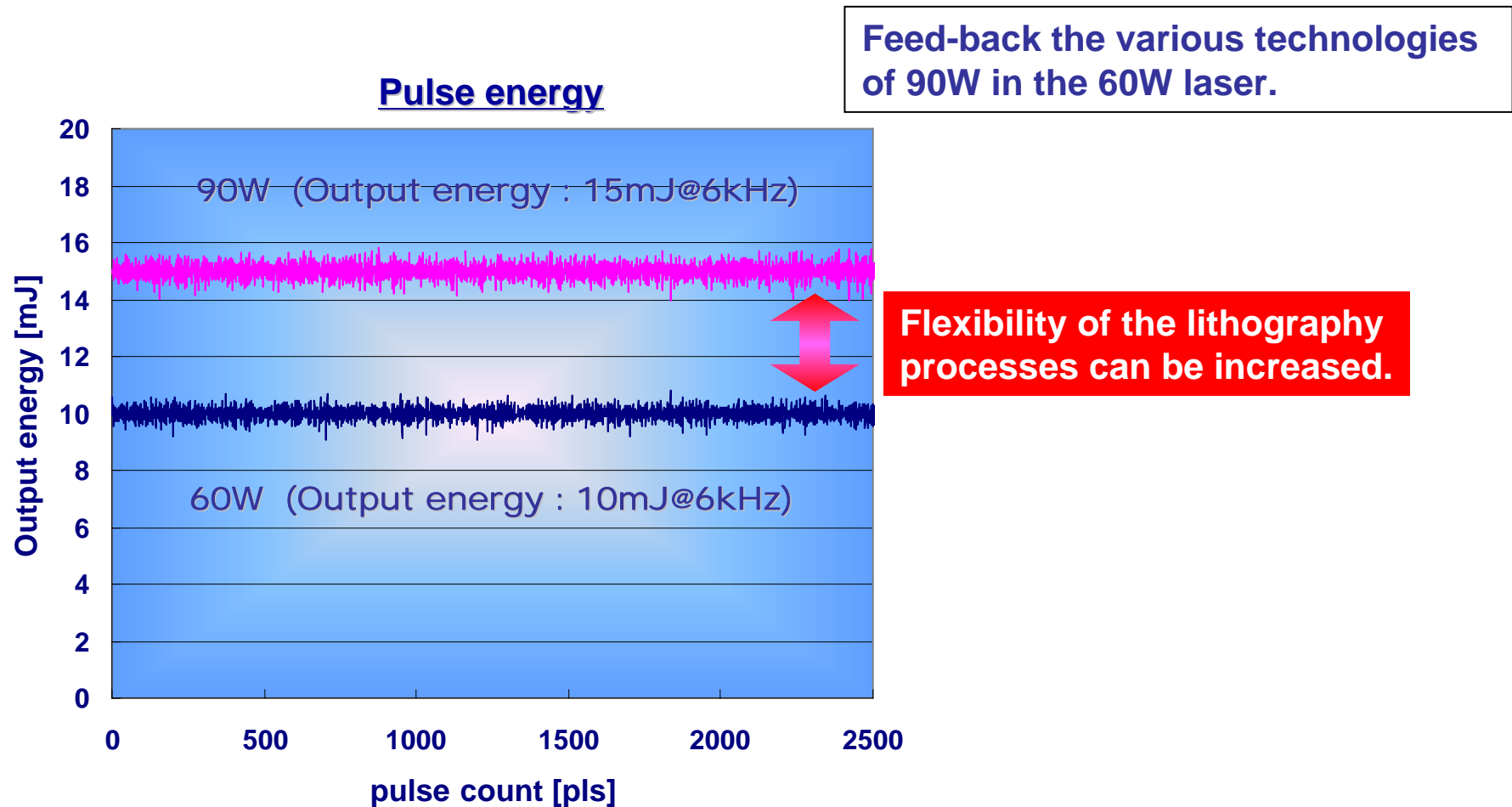
- ✓ **Extendable Power**
- ✓ **Long pulse duration**

➤ **Other Features**

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

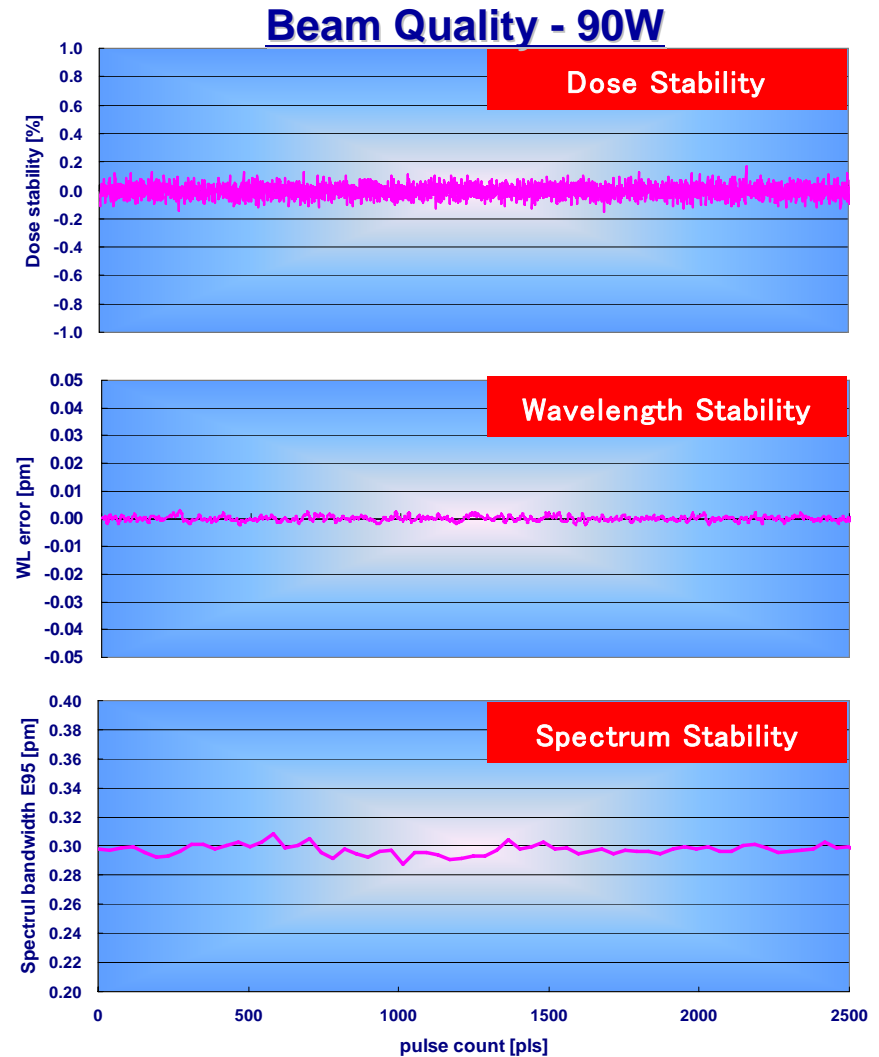
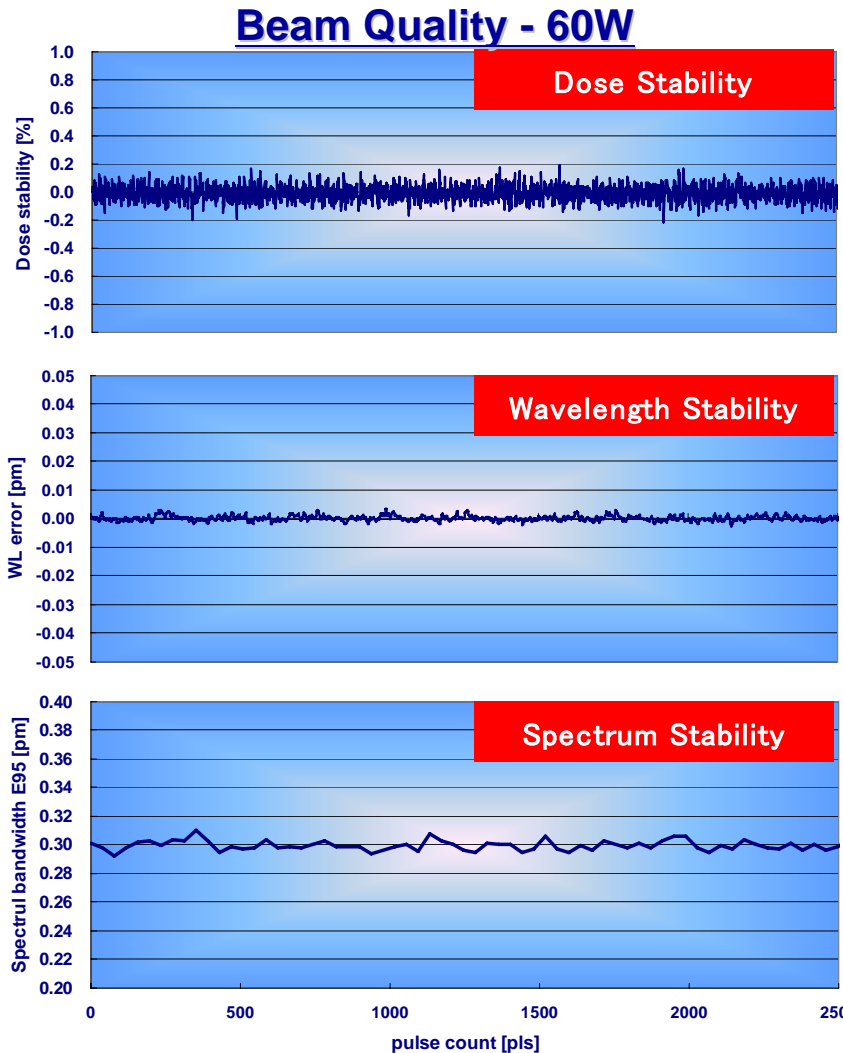
Extendable Power

- **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.**

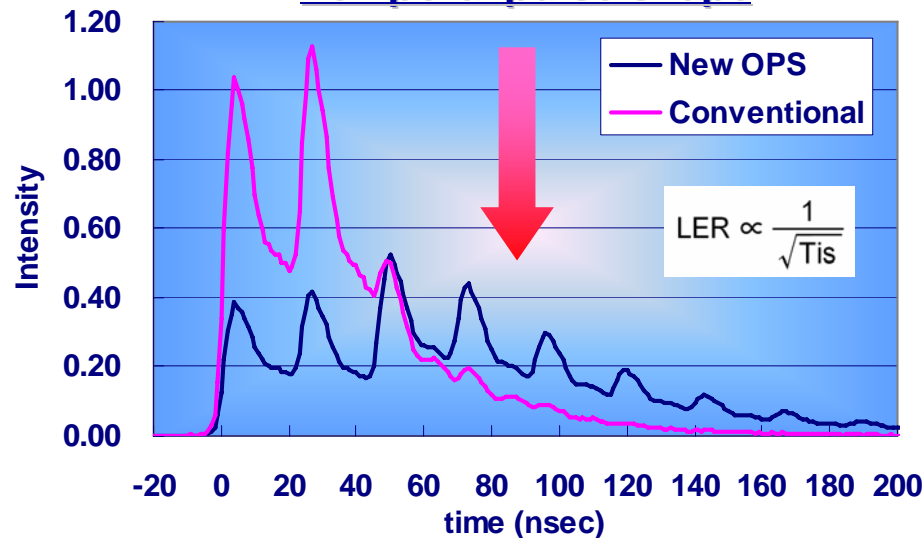


Long pulse duration

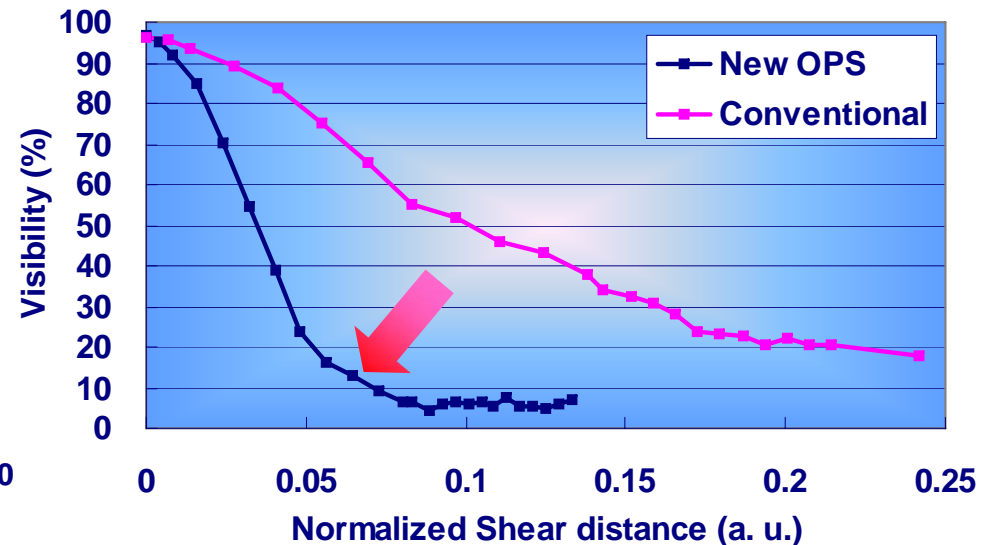
- **GT62A-1S xE contributes optics durability and is able to reduce LER.**

- **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)



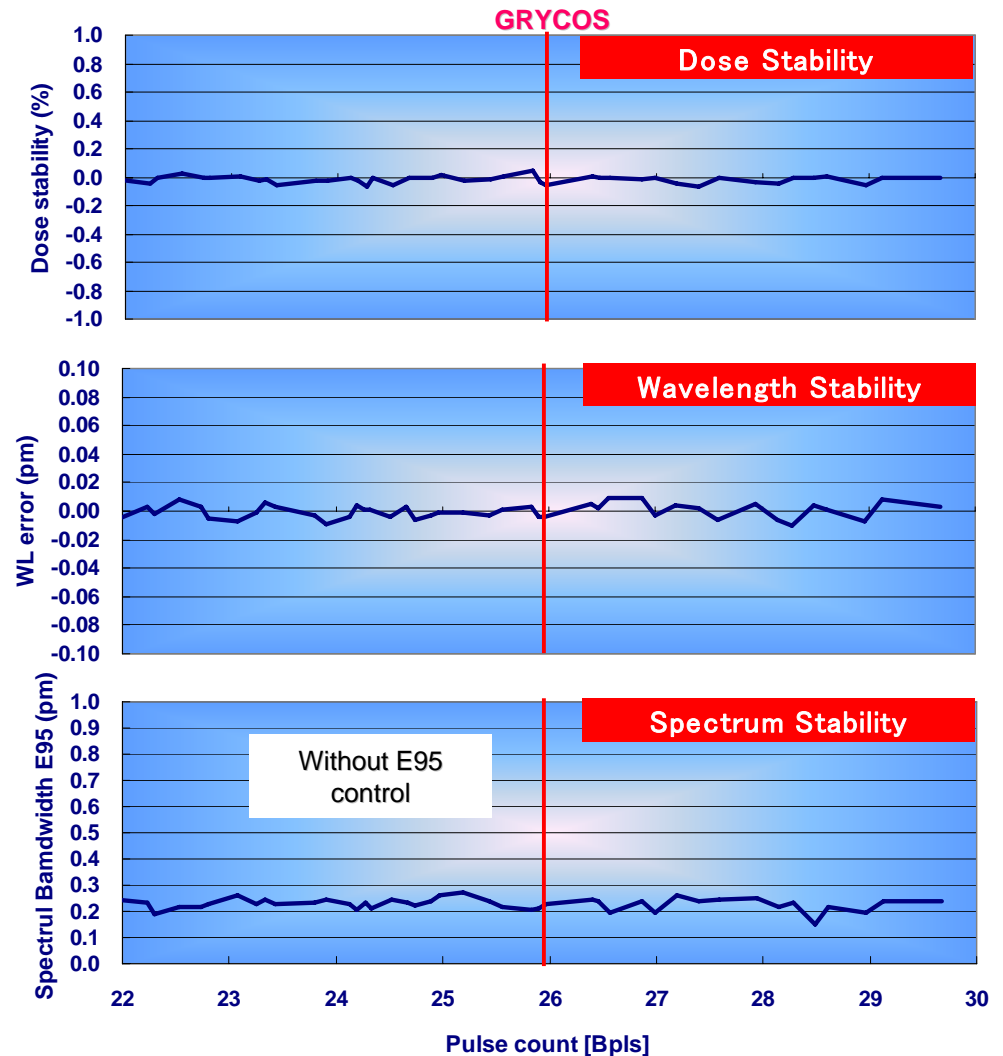
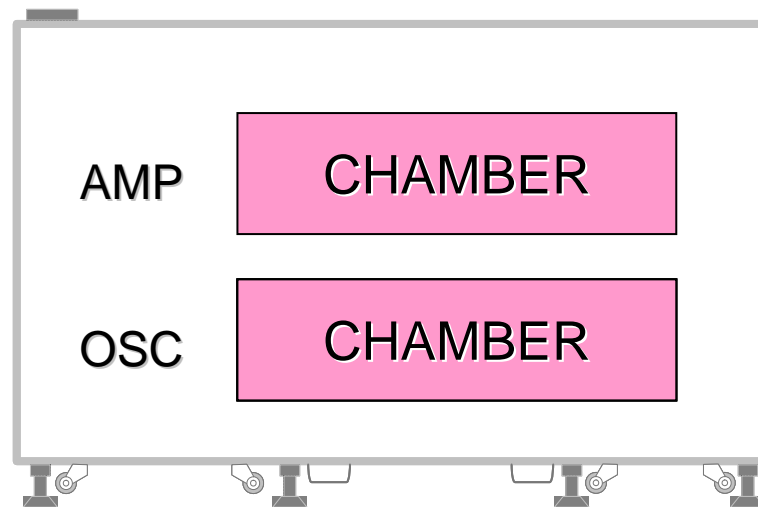
Chamber lifetime extension (GRYCOS) :

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

No impact to Beam Quality

Beam Quality

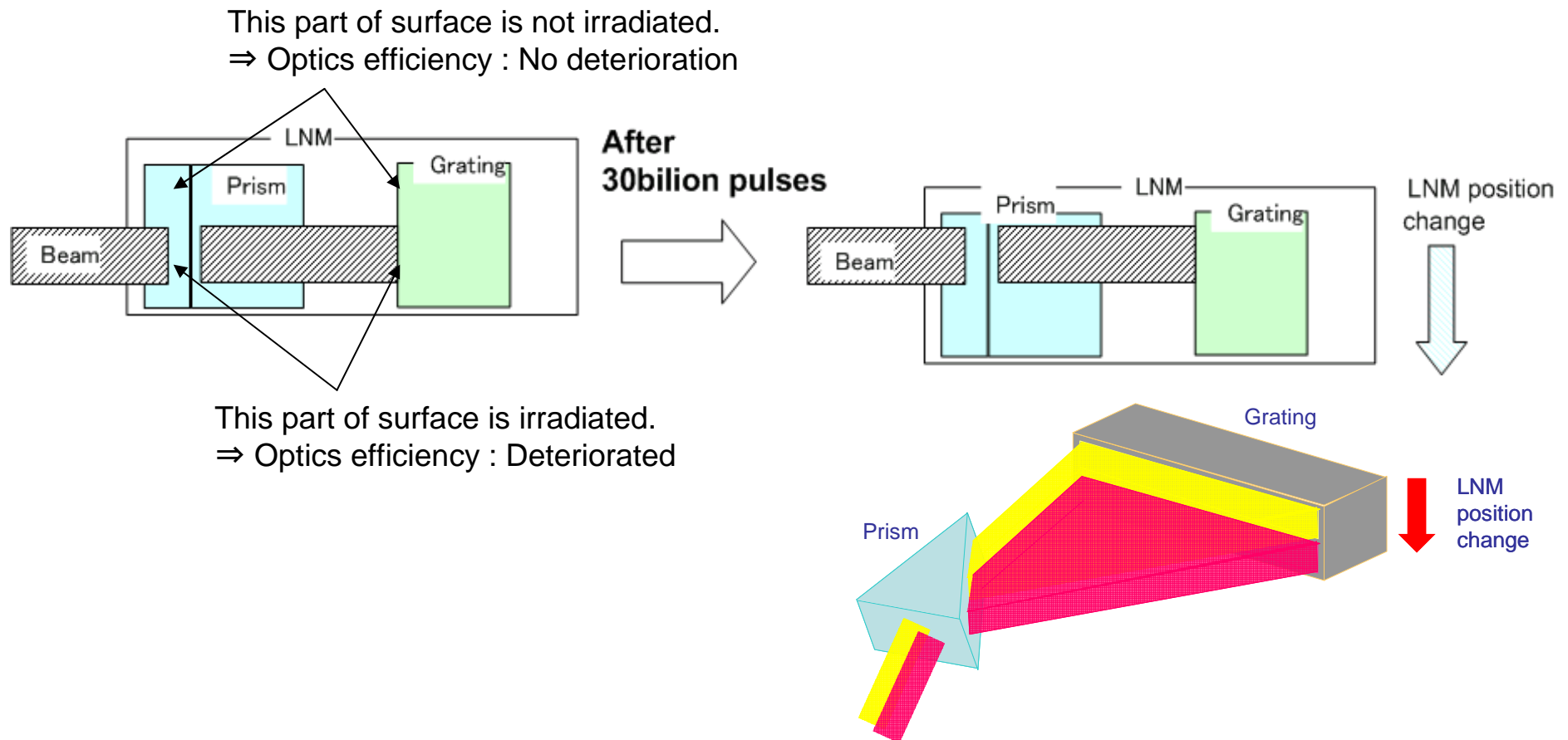
By using a chamber as an oscillator and then an amplifier



LNM lifetime extension (MPL) :

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

By changing optical path efficiently



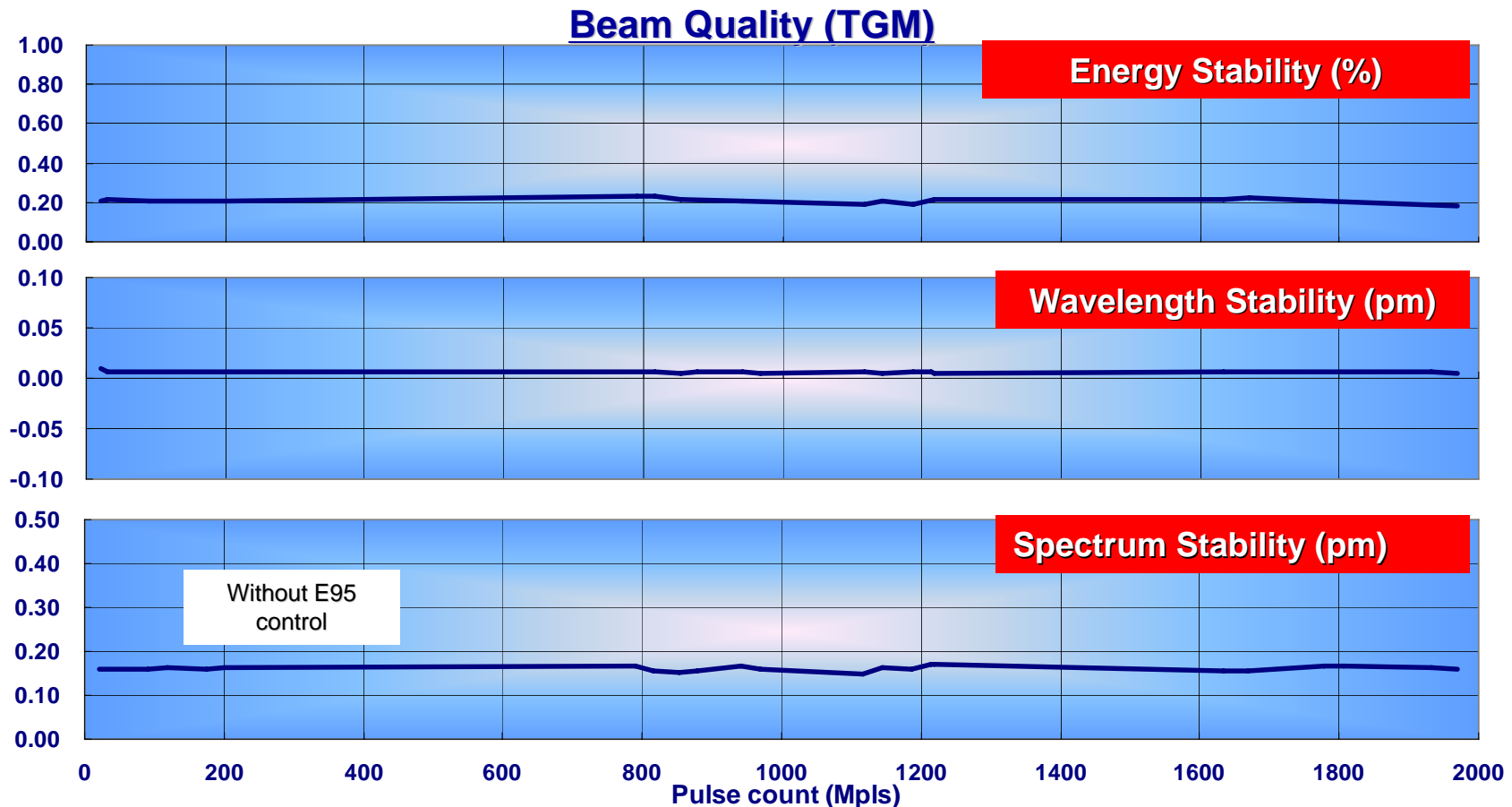
Gas lifetime extension (TGM) :

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

By Improving Gas Control

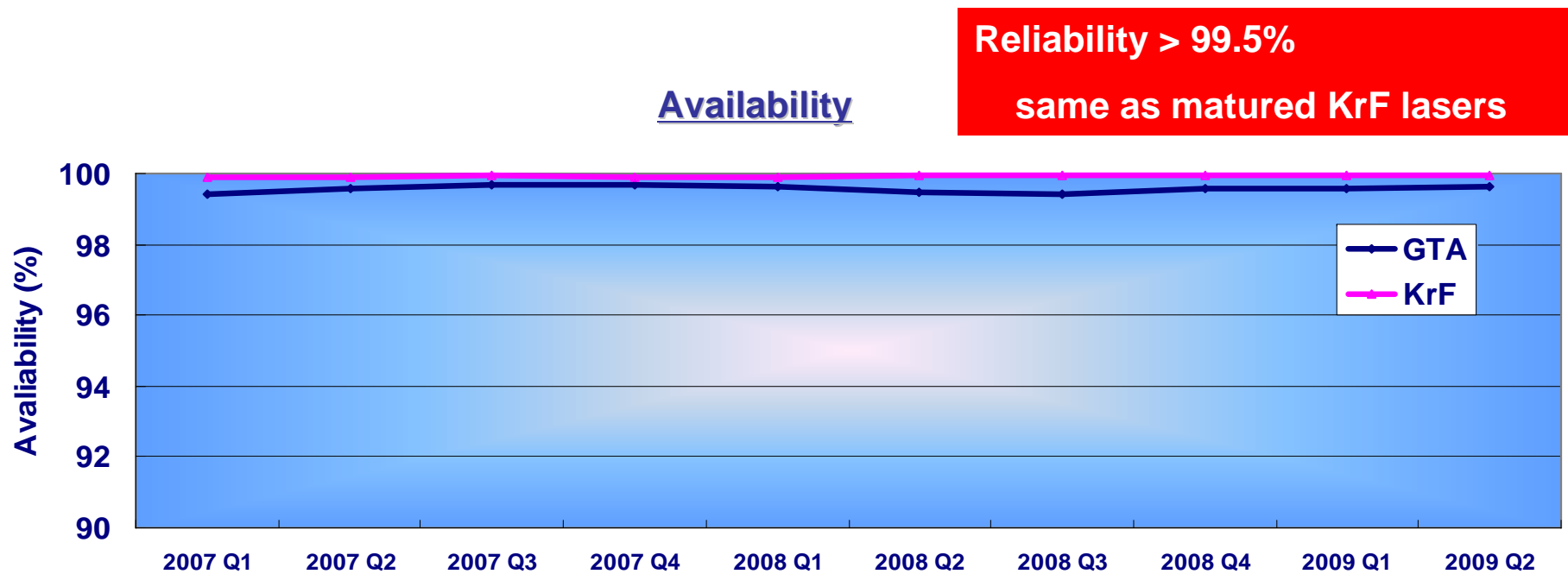
- ✓Stabilization of fluorine partial pressure
- ✓Reduction of the amount of impurity

Beam Quality is stable during extended gas lifetime.



Reliability

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





Contents

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

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.

 **GIGAPHOTON**
<http://www.gigaphoton.com>