

# RELIABILITY IMPROVEMENT MEASURE AND ITS AVAILABILITY IMPACT ANALYSIS FOR CUTTING- EDGE ArFi LIGHT SOURCE



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# Agenda

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- Motivation
- RAM Enhancement Classification
- Approach
  - Reliability Improvement
  - Availability Improvement
  - Maintainability Improvement
- Value Analysis
- Summary

# Gigaphoton's Motivation for Providing Tool Time Enhancement

- Utilization improvement on ArF immersion tools for chip is the most important key parameter.
- In line with this, maximizing utilization requires “long-term stable operation” and “minimized maintenance time.”
- In order to contribute from light source, Gigaphoton provides the key solution names “**RAM Enhancement**”, targets on enhancing the Reliability, Availability, and Maintainability of an ArF immersion light source.

# RAM ENHANCEMENT

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# RAM Enhancement Clarification

## Reliability

Improved optimized design for reliability improvement.

## Availability

Reduce touch frequency, and enhance **Mean Time Between Service (MTBS)** for main modules.

## Maintainability

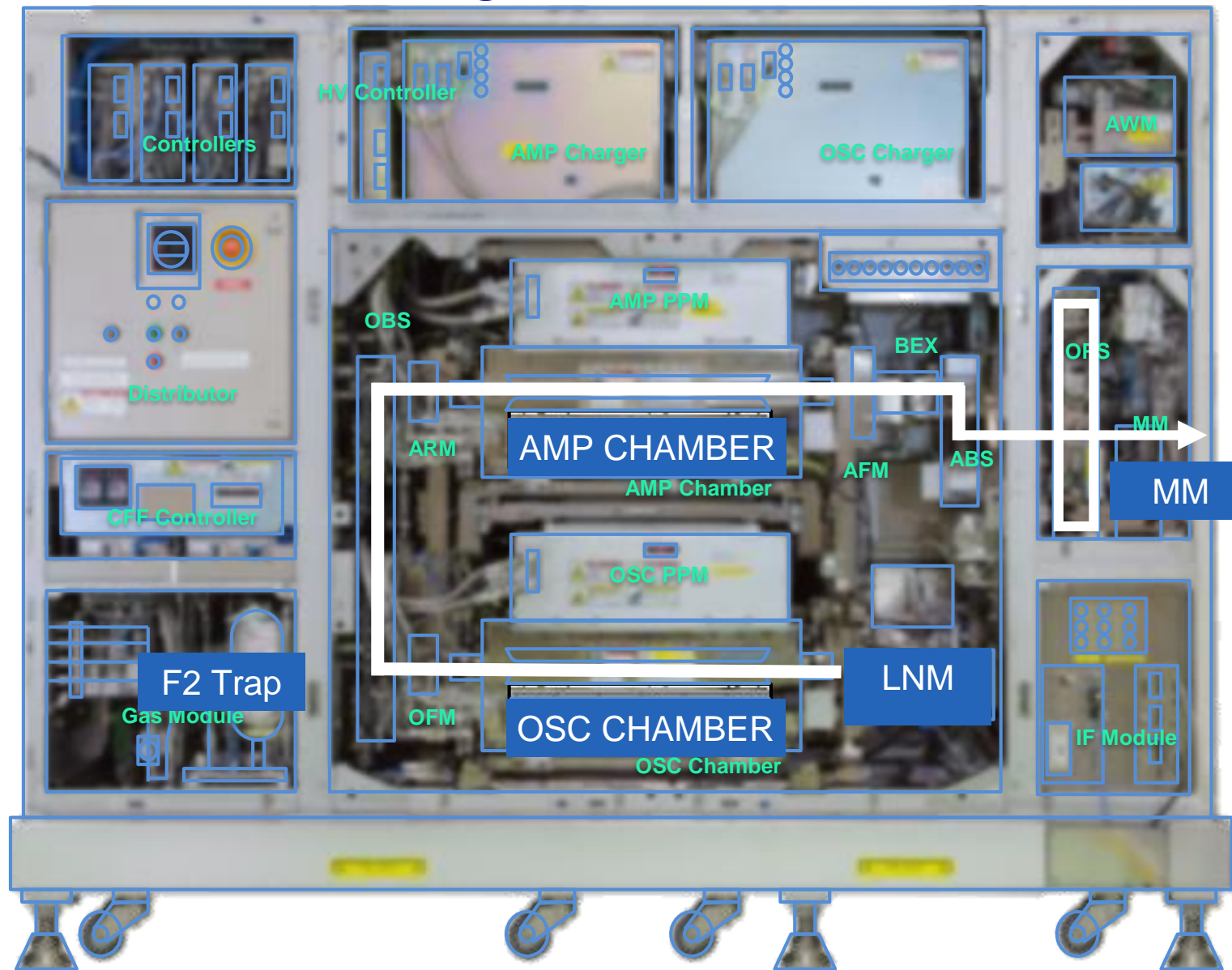
Reduce **Mean Time To Service (MTTS)**, by reducing parts exchange time.



## Enhanced Tool Utilization

Overcome the “99.8%-availability” barrier

# Radiation Mechanism of Lightsource

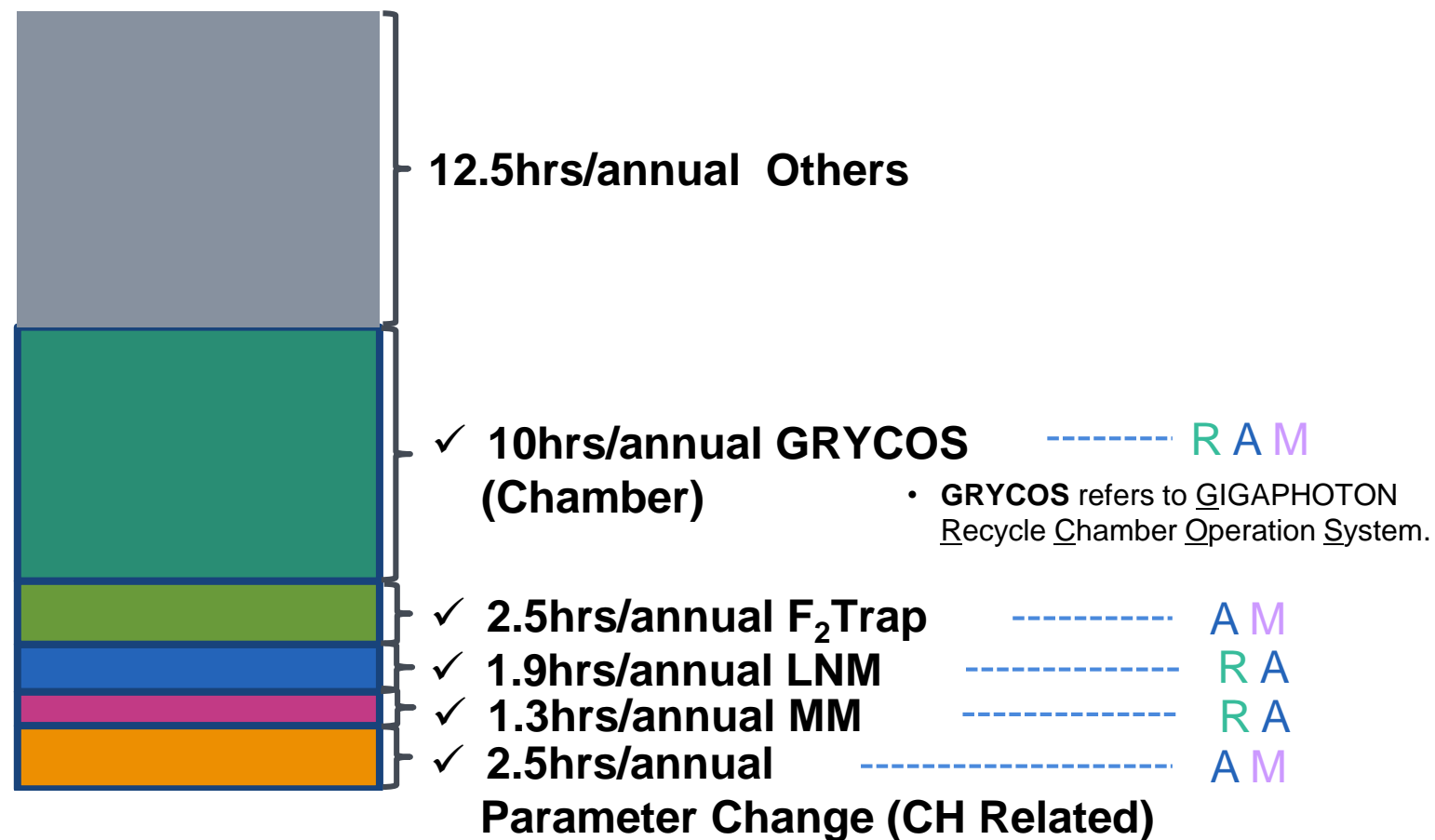


# RAM Enhancement Matrix

Feature	Reliability	Availability	Maintainability
Optimized New Electrode Design for chamber	✓	✓	
Optimized Heat Absorption by LNM optical designing	✓	✓	
Synchronized Main Modules' replacement		✓	✓
New software "Touch Mitigator" used for reducing Parameter Change Time		✓	✓
Reducing MTTS by GRYCOS Time Improvement		✓	✓

# Classify of Annual Maintenance in ArF Immersion Light Source

- Top 4 modules service frequency is related with GRYCOS (Chamber), F<sub>2</sub>Trap, LNM and MM.
- Service time taken on Parameter Change is especially related with chamber.



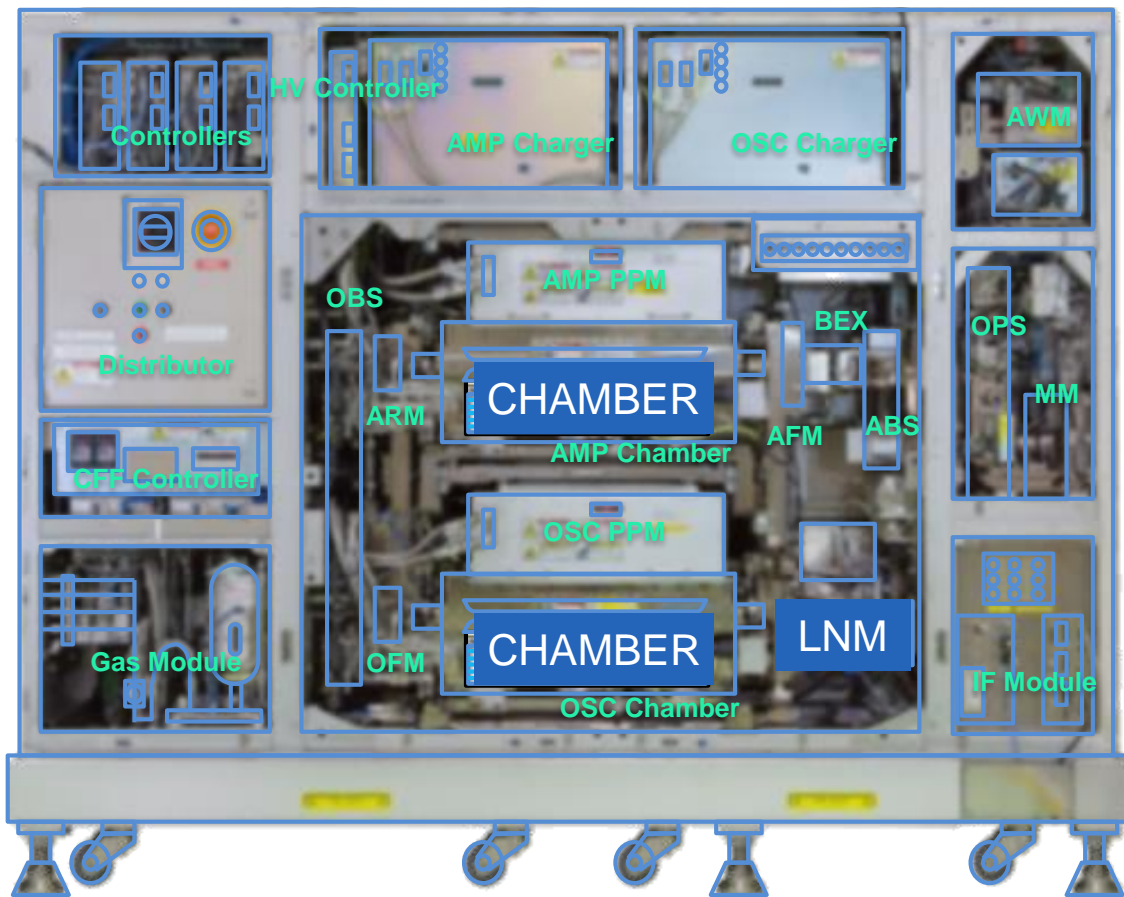
■ Parammeter Change (CH Related) 
 ■ MM 
 ■ LNM 
 ■ F2 Trap 
 ■ GRYCOS 
 ■ Others



# RELIABILITY IMPROVEMENT

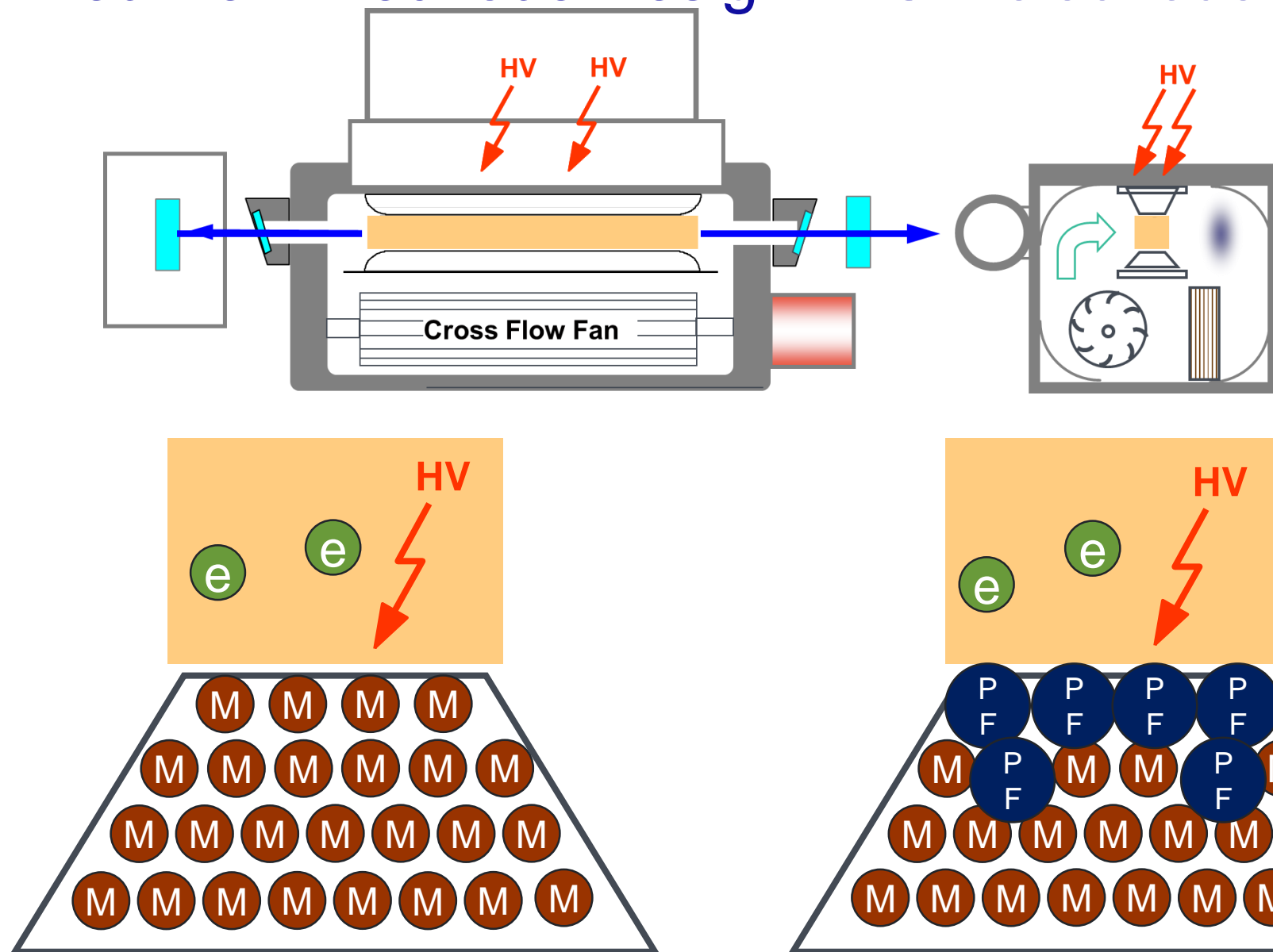
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# Key Technology for Reliability Improvement



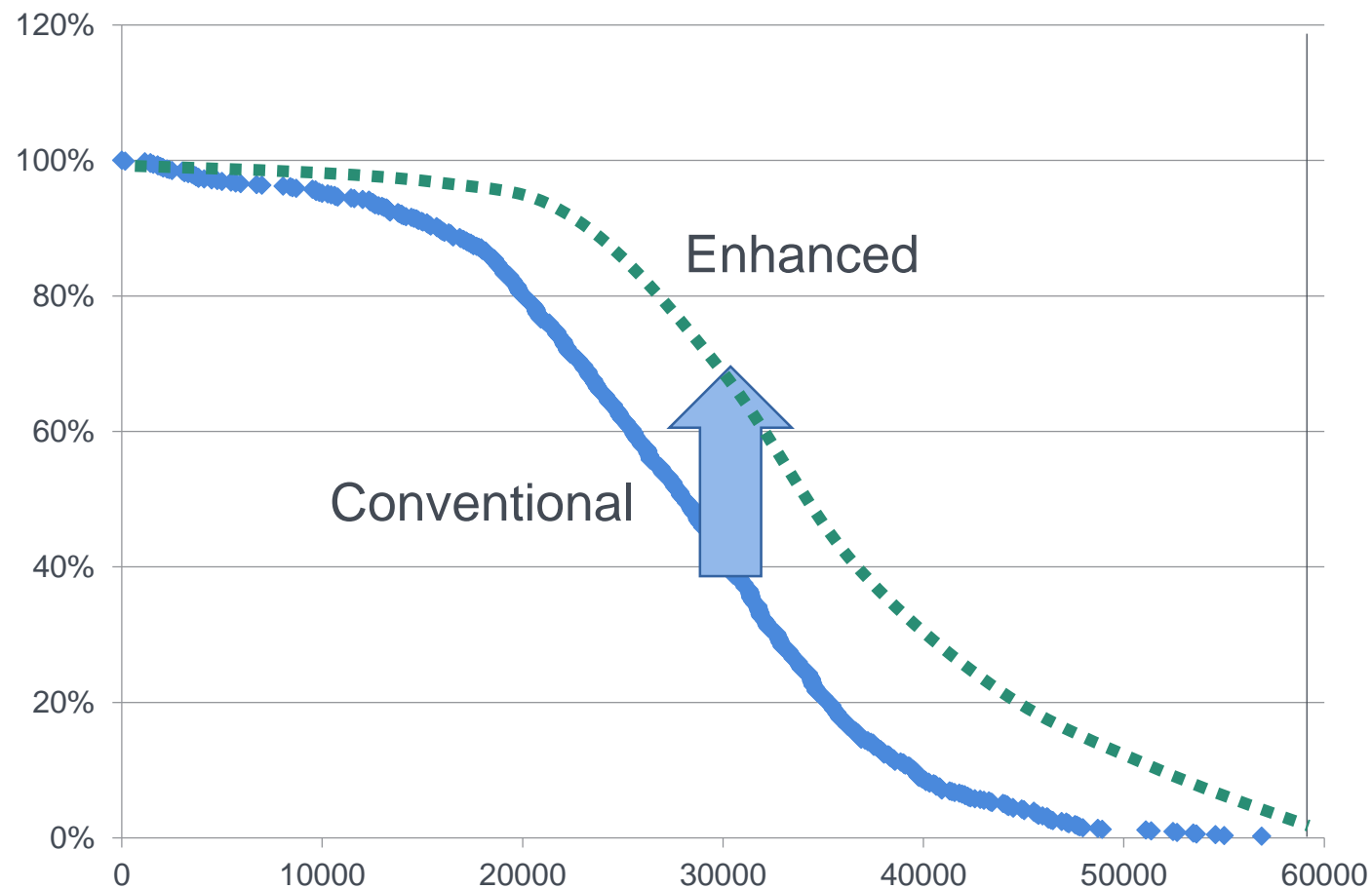
- Optimized module design on reducing life time's variations among specific module, is crucial to improve reliability.
- As a spin-off, it is expected to extend module's lifetime, reduce annual downtime, by reducing the frequency of **PM (Periodical Maintenance)** to one time a year on each system.
  - Chamber
    - Introduces durable “G-electrode”
  - Line Narrowing Module (LNM)
    - Optimized Heat Absorption by LNM optical designing

# Optimized New Electrode Design – “G – electrode”



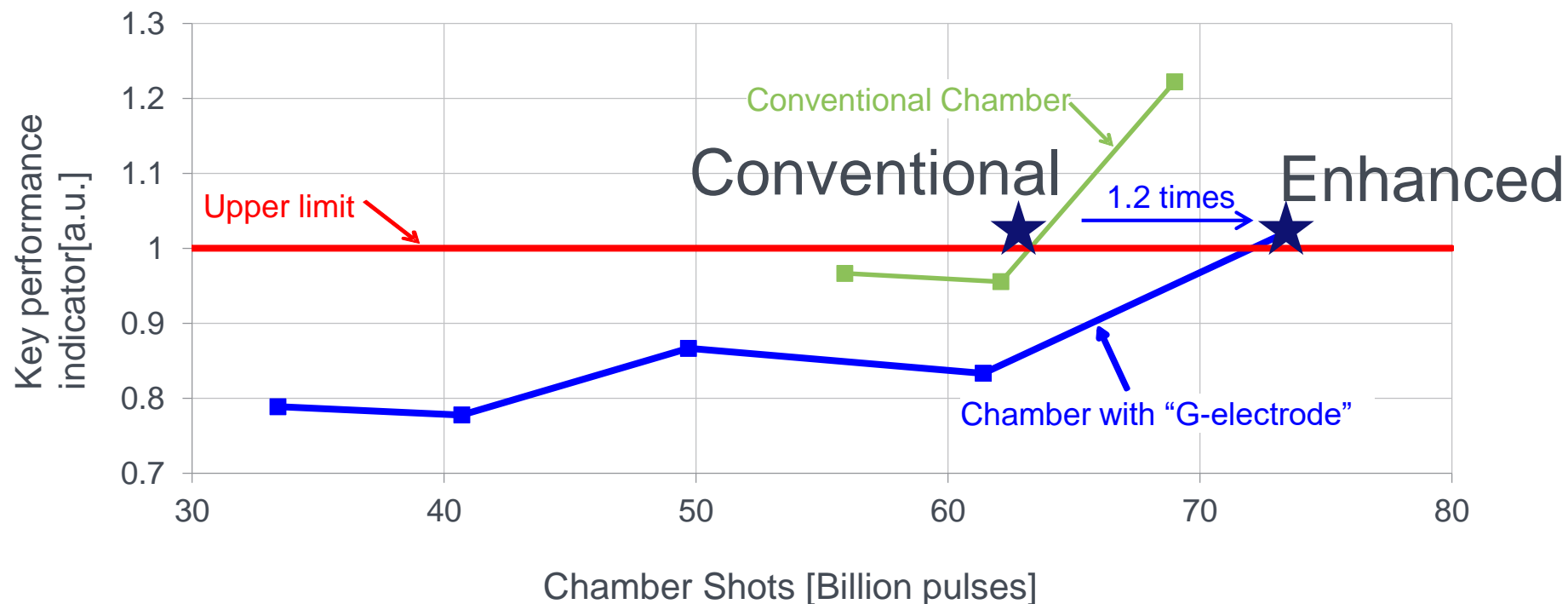
# Reliability Improvement for Conventional Chamber

## Chamber Survival Curve



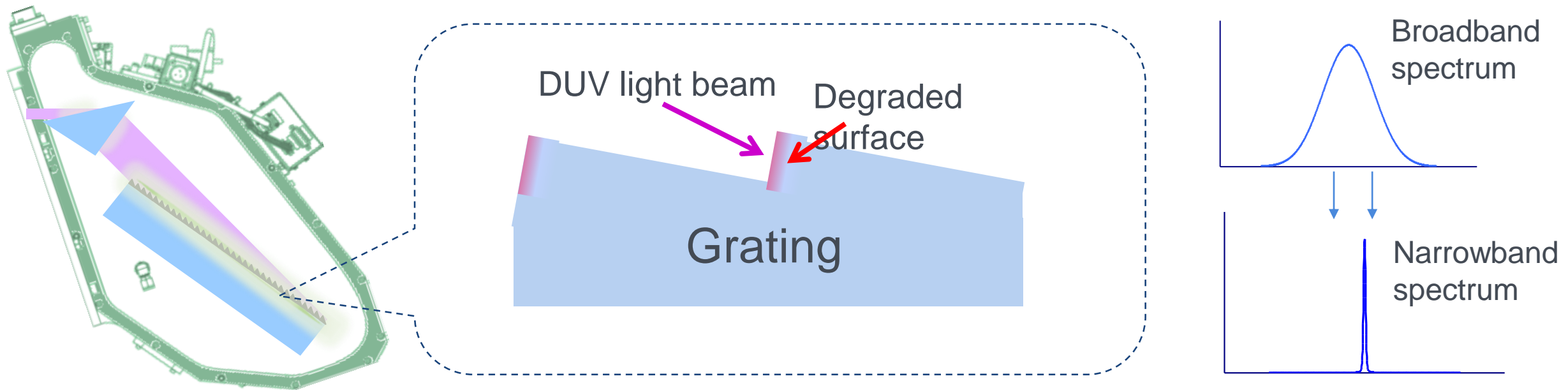
Reliability improvement made at 30% by G-electrode

# Demonstrated Chamber Lifetime



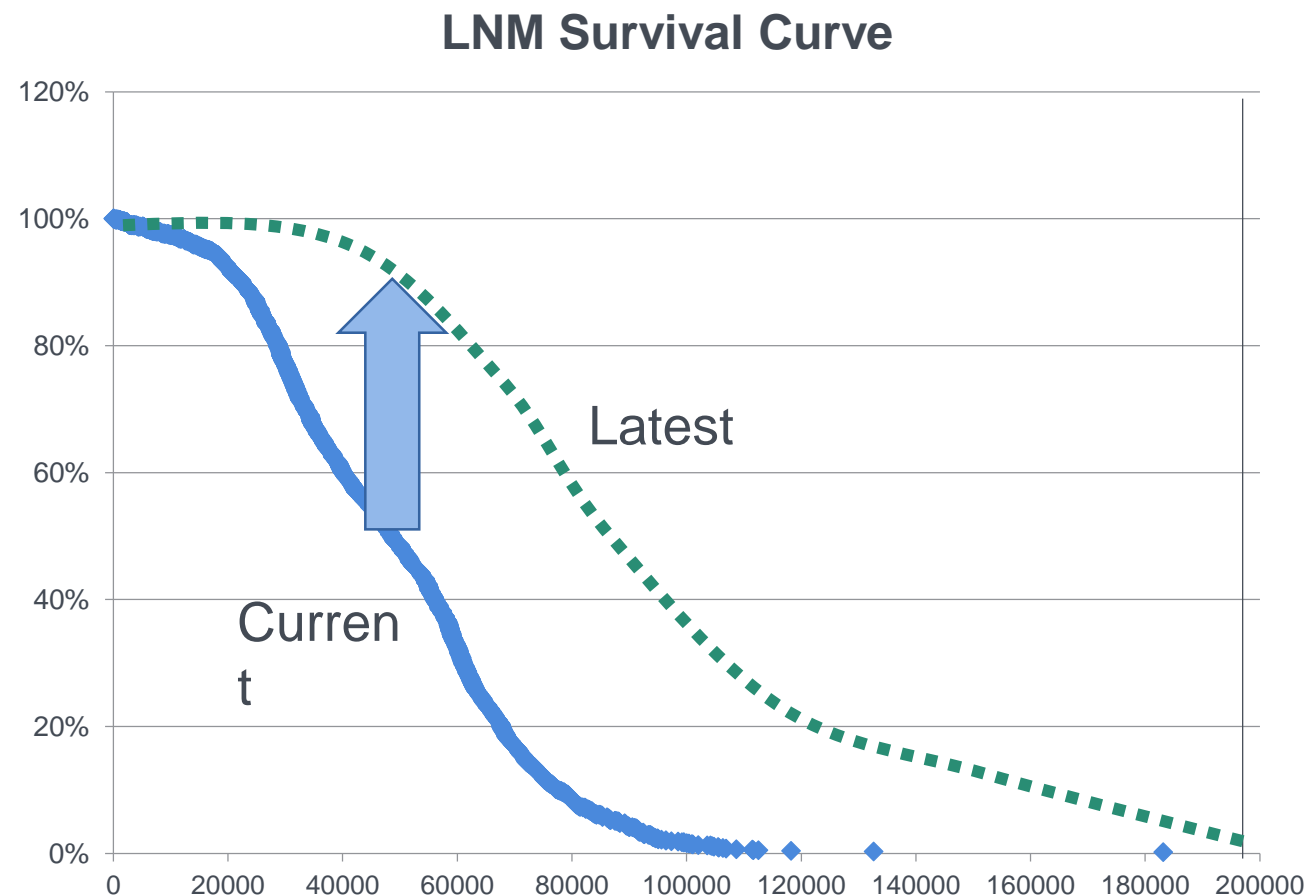
- Chamber lifetime is able to be extended by 1.2 times compared with conventional chamber.
- Realize **1.7hrs** reduction towards total events.

# Optimized Heat Absorption by LNM optical designing



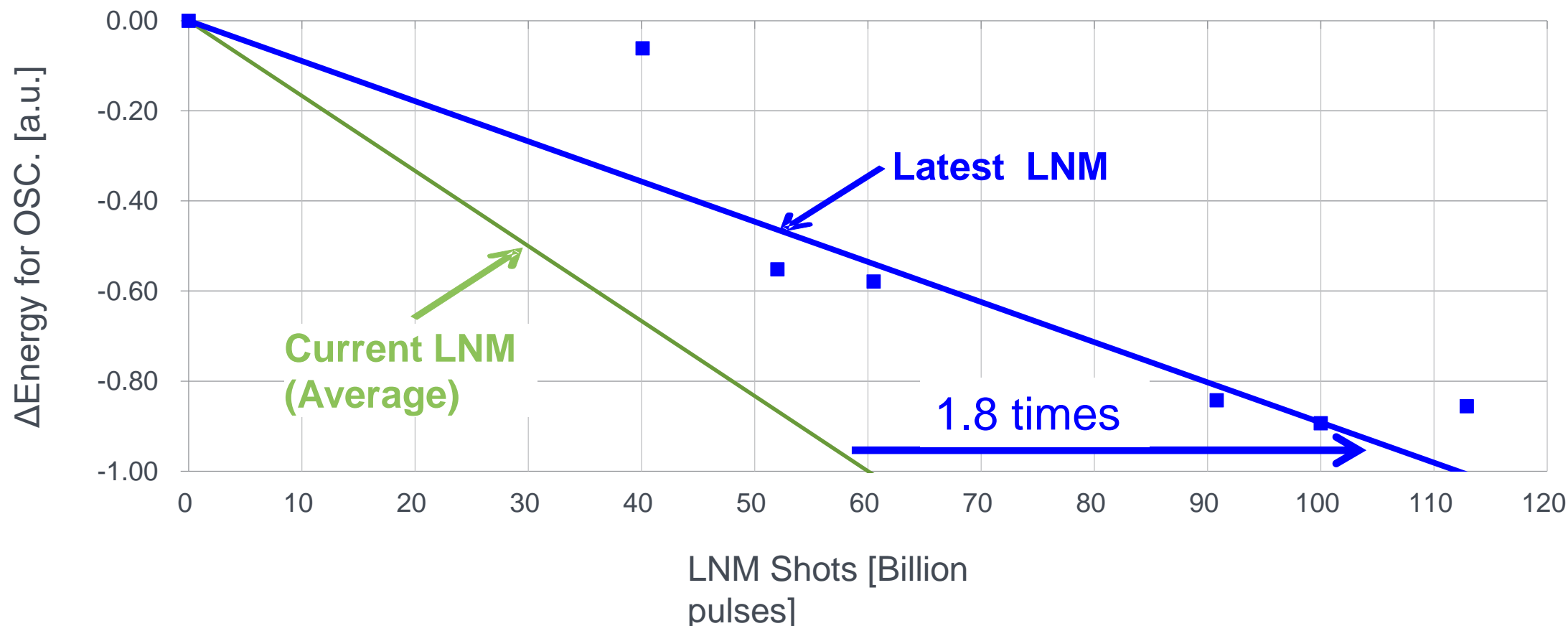
- LNM lifetime mostly depends on **diffraction efficiency** of grating and other optical elements.
- Lightsource's output energy decreases due to diffraction efficiency decreasing.
- Optimized Heat absorption by LNM optical designing

# Reliability Improvement for Current LNM



Reliability improvement made at 40% by Optimized Optical Design

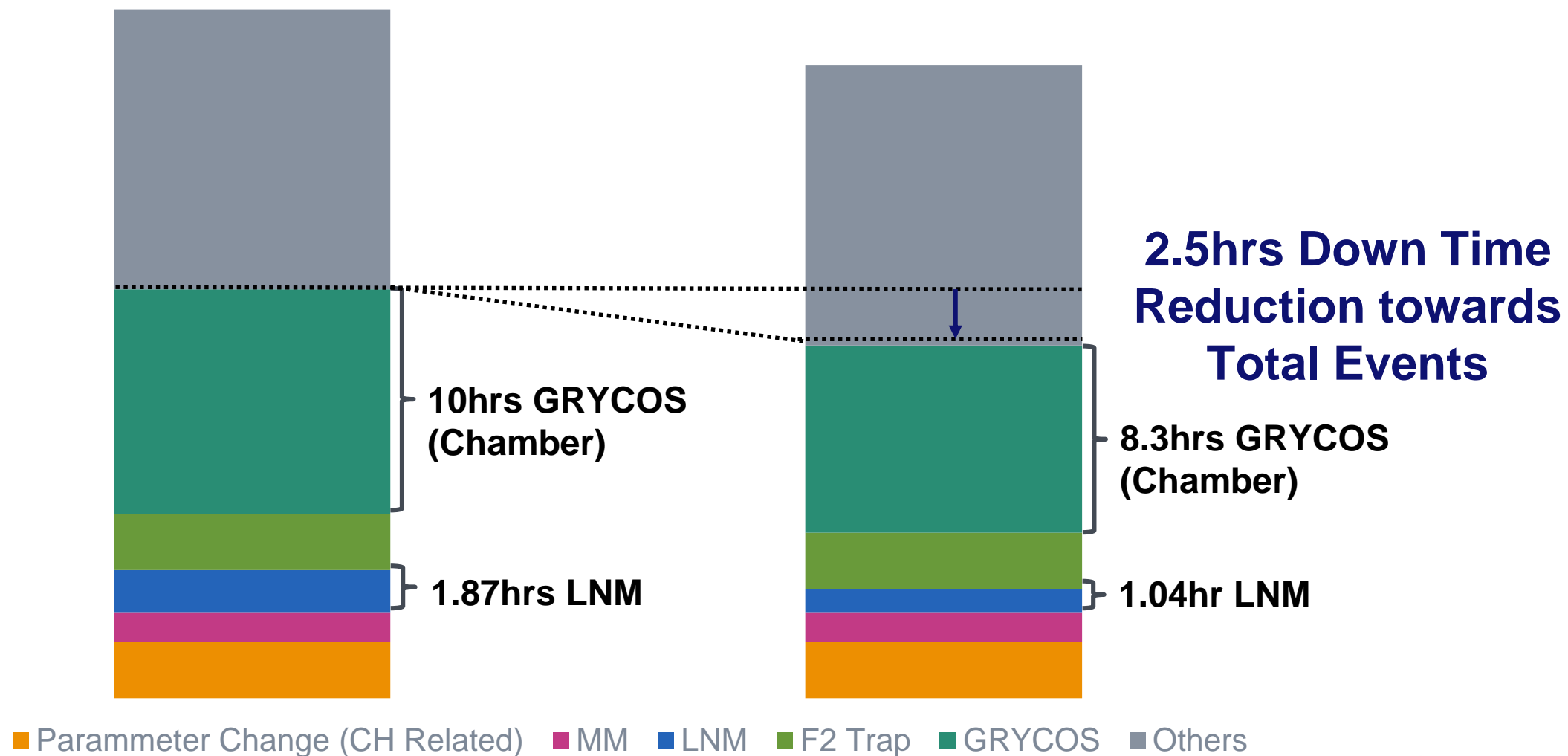
# Reduces Optical Damage on Grating by Design Change



- Improves energy efficiency on latest LNM compared with current type.
- Realize **0.83hrs** reduction towards total events.



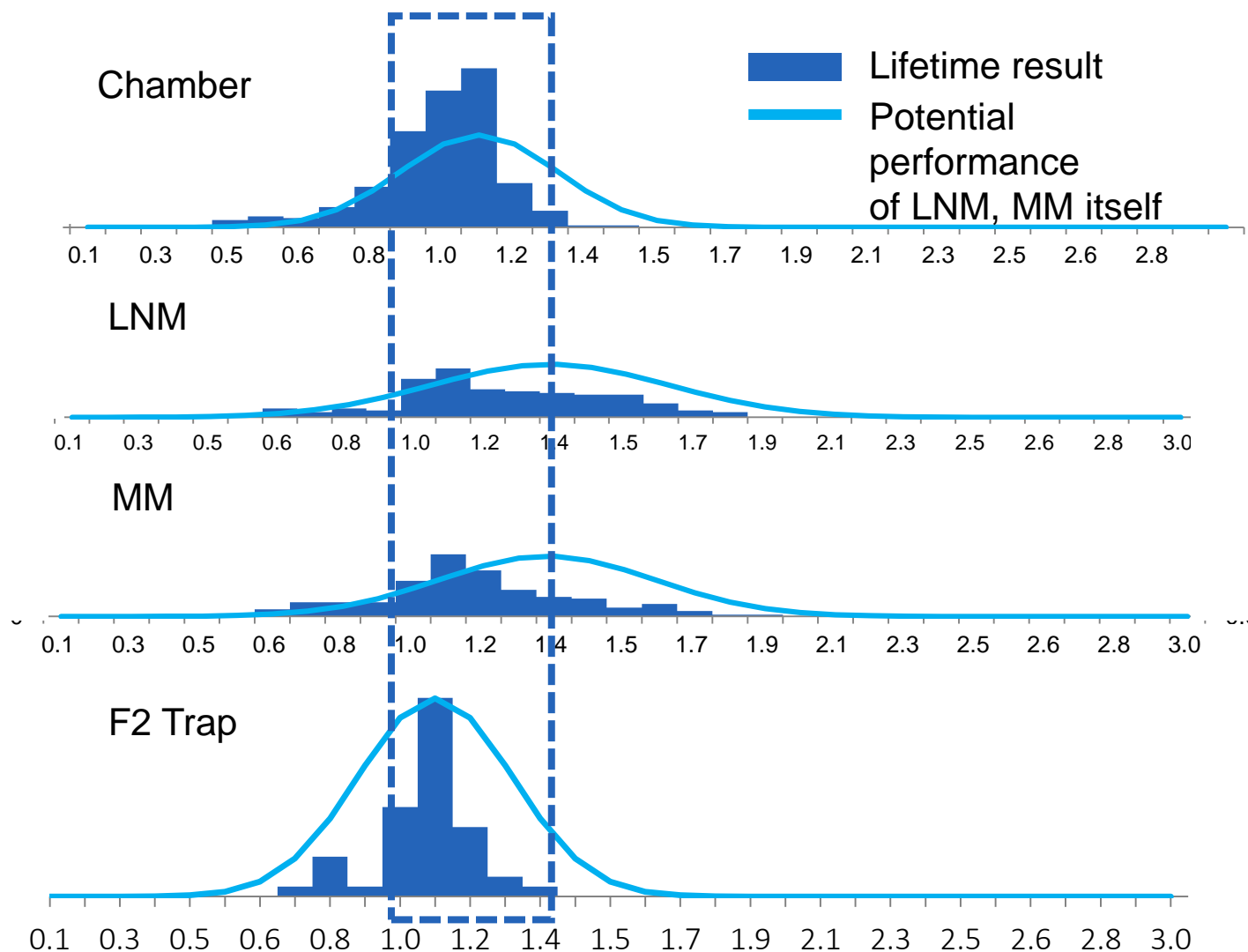
# Contribution to Tool Time by Chamber & LNM Lifetime Extension



# AVALABILITY IMPROVEMENT

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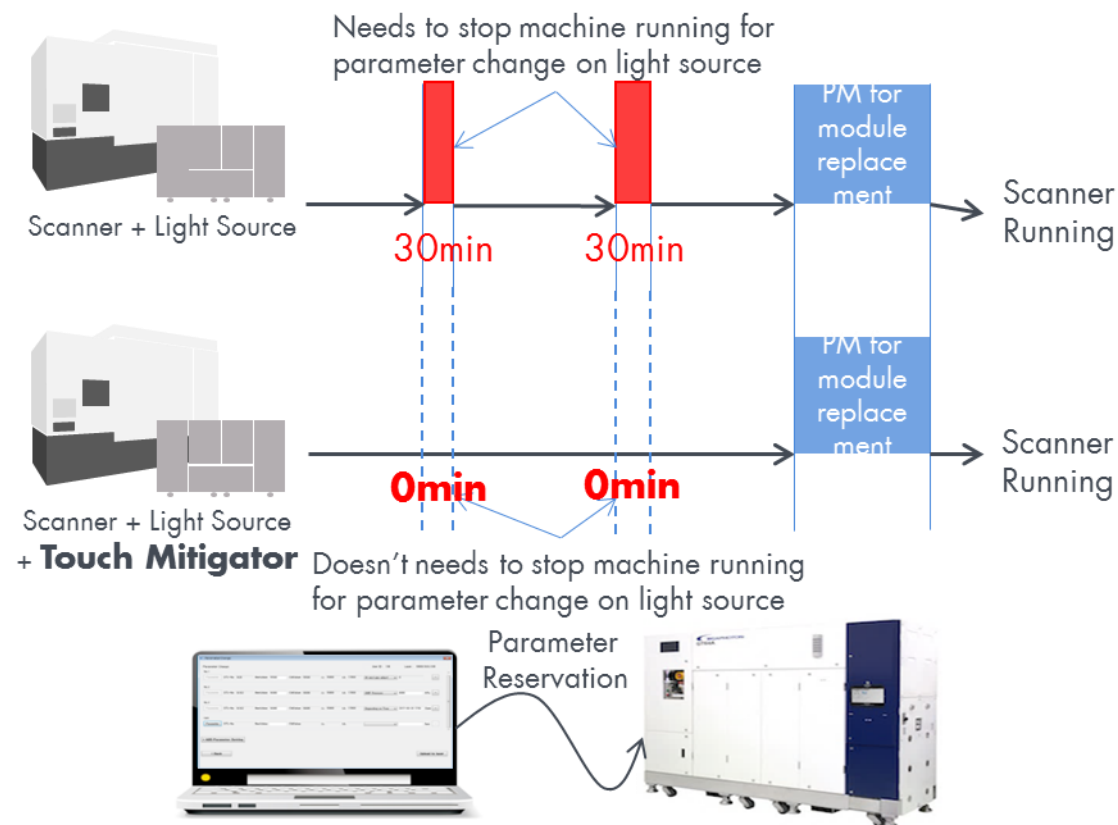
# Synchronized Replace for Main Modules



- Synchronized parts exchange successfully reduce the exchange frequency from **4 times** to **1 time** in one year.
- In this way, down time can be reduced to **10hrs**, from **15.7hrs**.

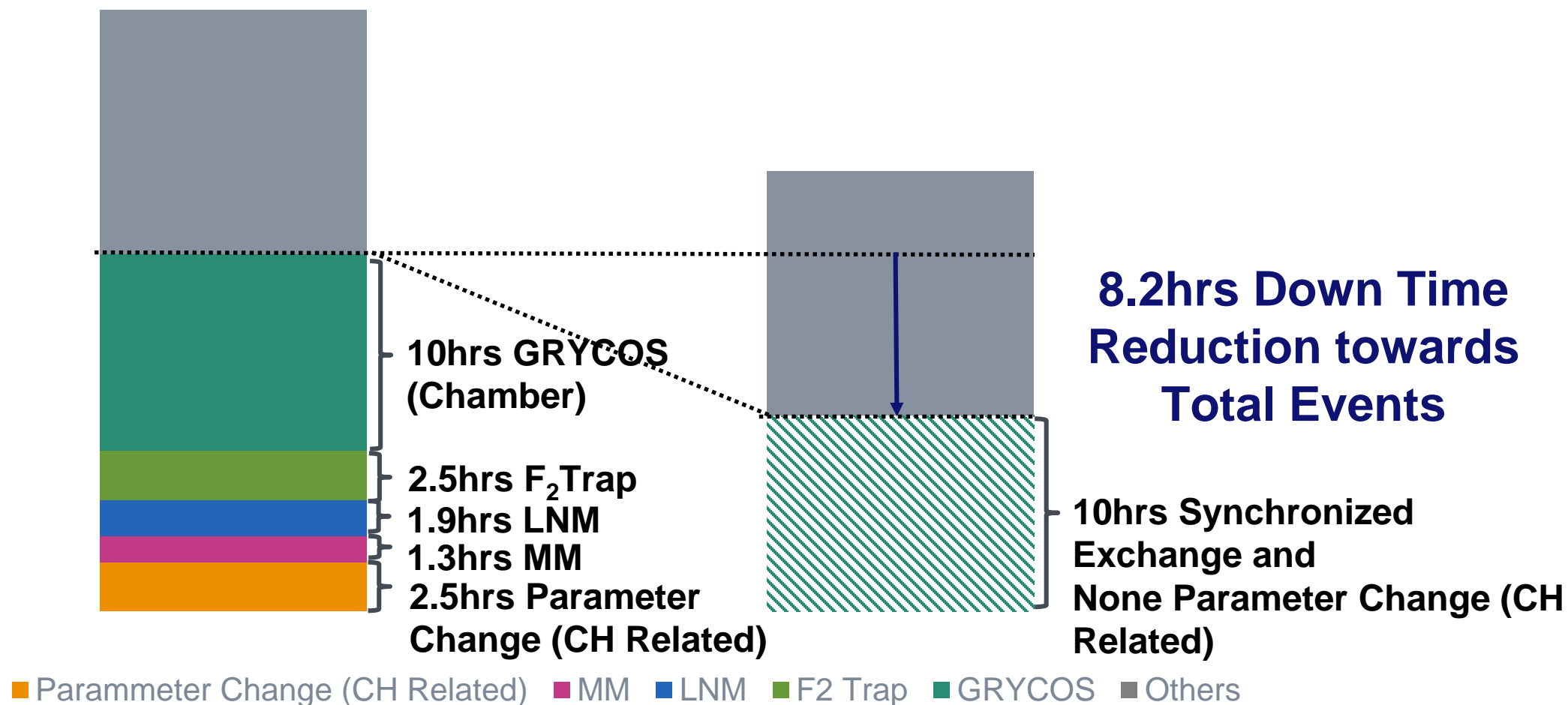
# Parameter Change Time Reduction - Touch Mitigator

Annual Reduction of **2.5hrs** on parameter change for chamber related is demonstrated.



- 30min to 0min for parameter change
- Parameter change is executed during “Gas adjustment” during scanner idle time.
- No influence on chip maker’s productivity.

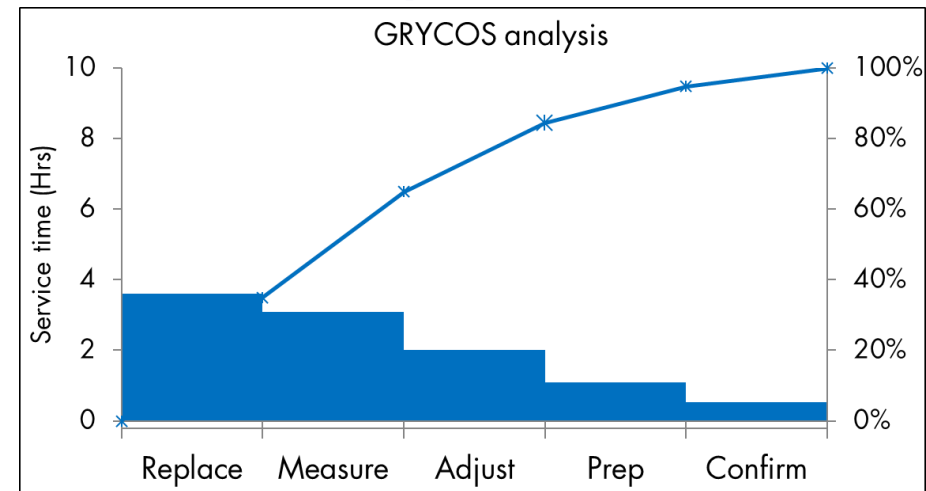
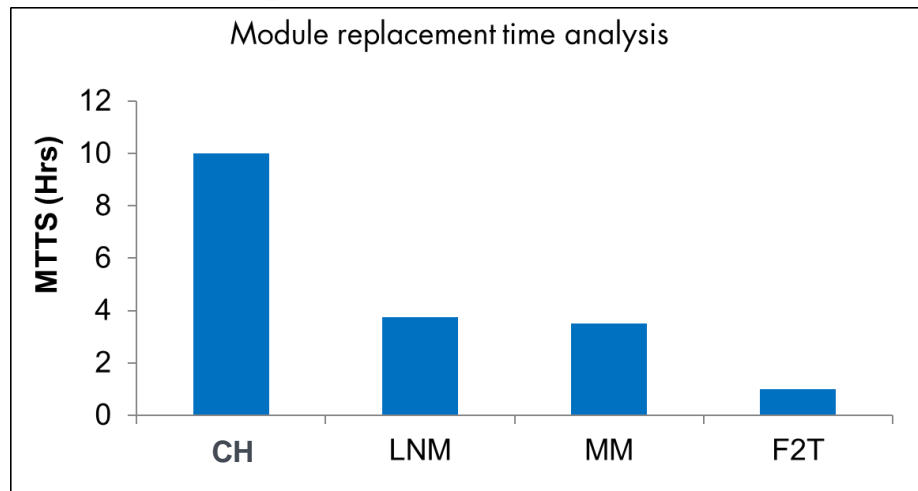
# Contribution to Tool Time by Synchronized Exchange and Touch Mitigator



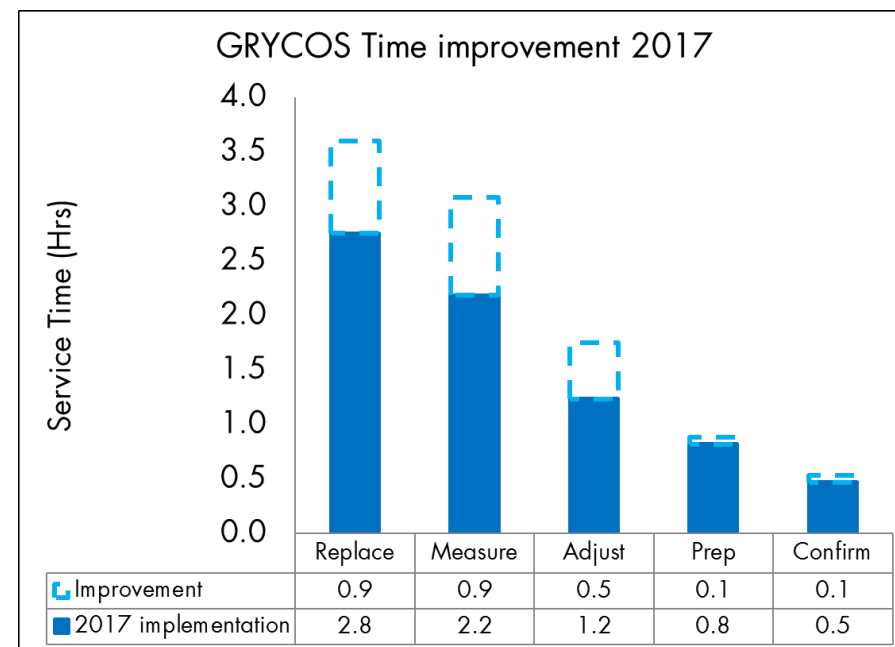
# MAINTAINABILITY IMPROVEMENT

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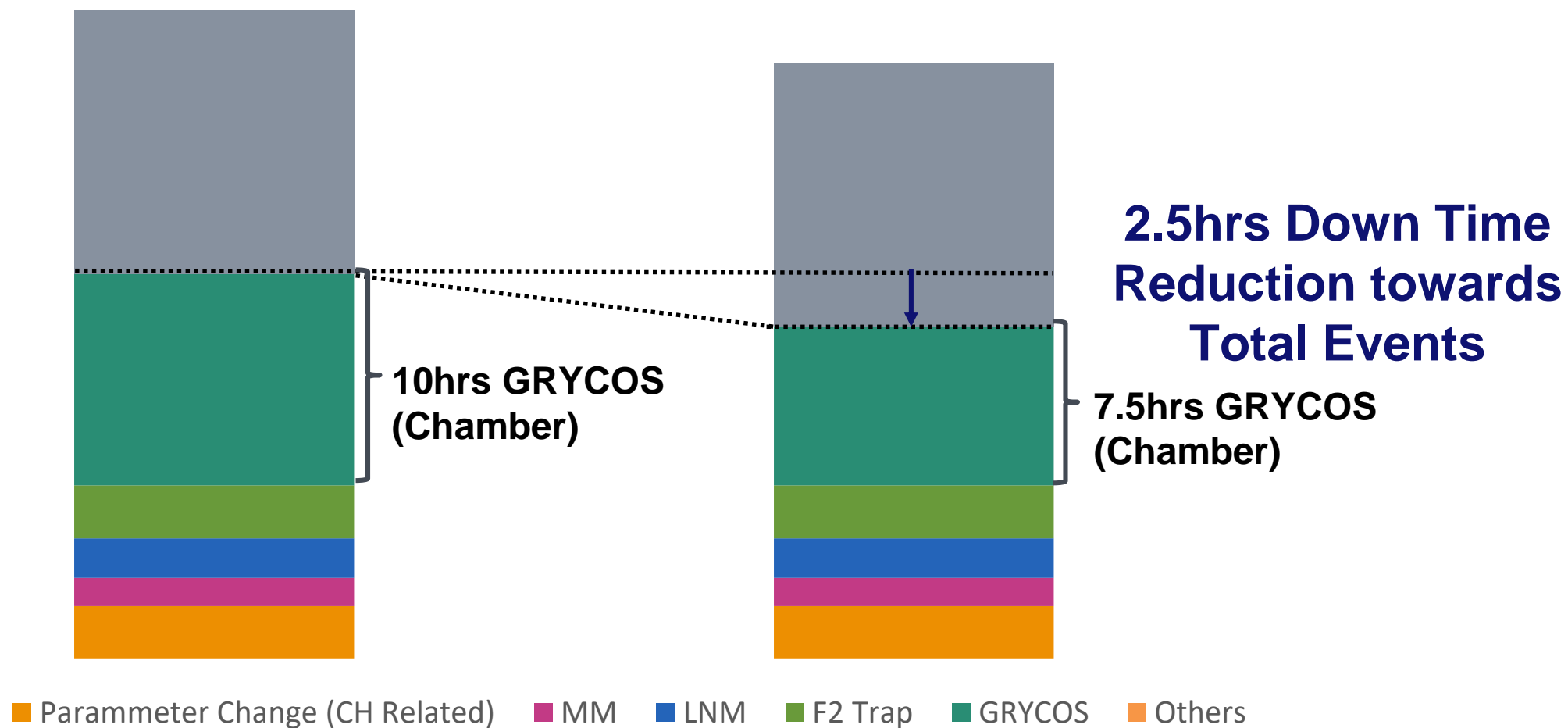
# MTTS Improvement – GRYCOS Time Improvement



- Key challenge is to reduce chamber maintenance time among top 4 modules.
- Service time taken on **GRYCOS** is crucial to reduce MTTS.
- Gigaphoton realized **2.5 hrs** reduction by GRYCOS Time improvement.

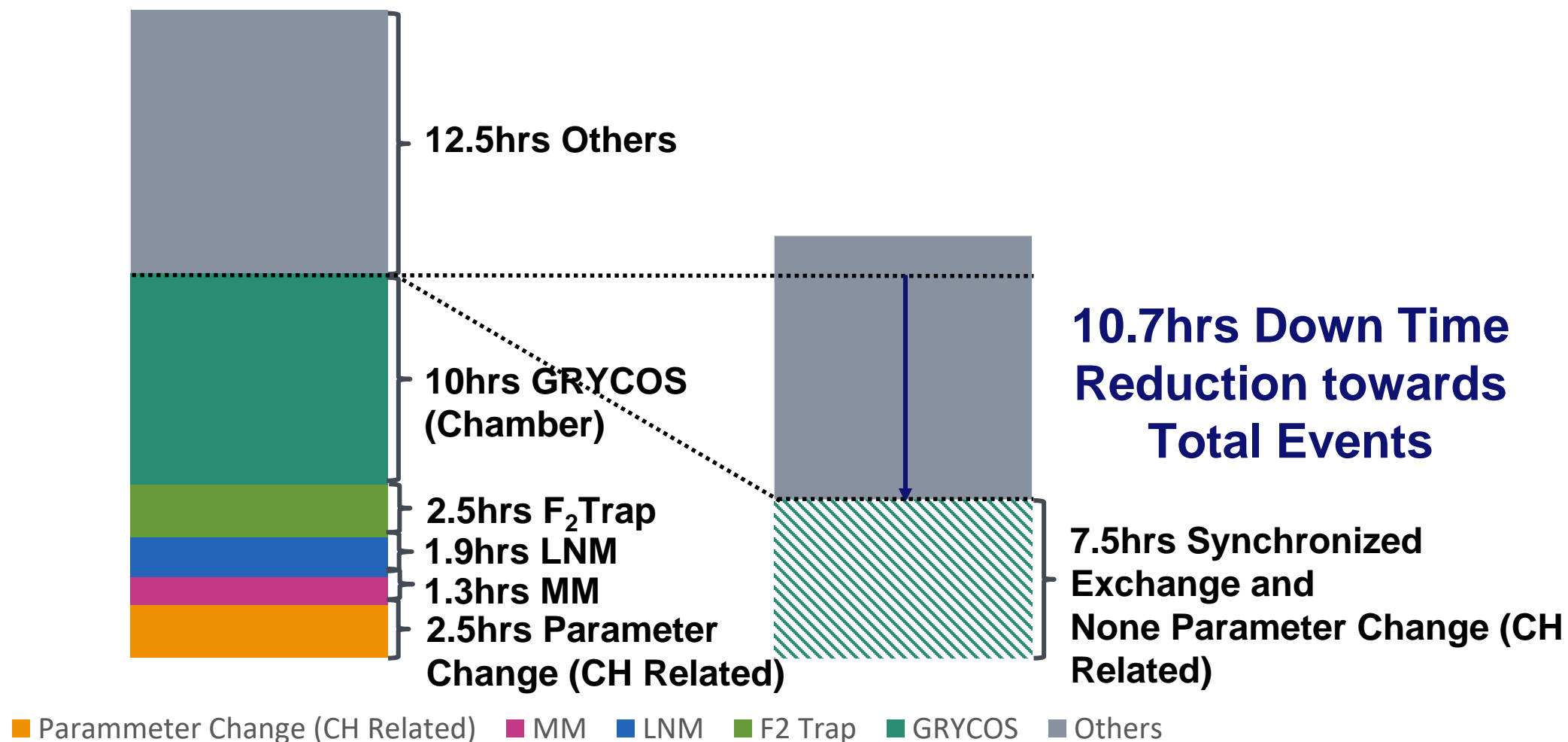


# Contribution to Tool Time by GRYCOS Time Improvement





# 0.12% Utilization Up Towards Total Event



# Down Time Reduction by RAM Enhancement

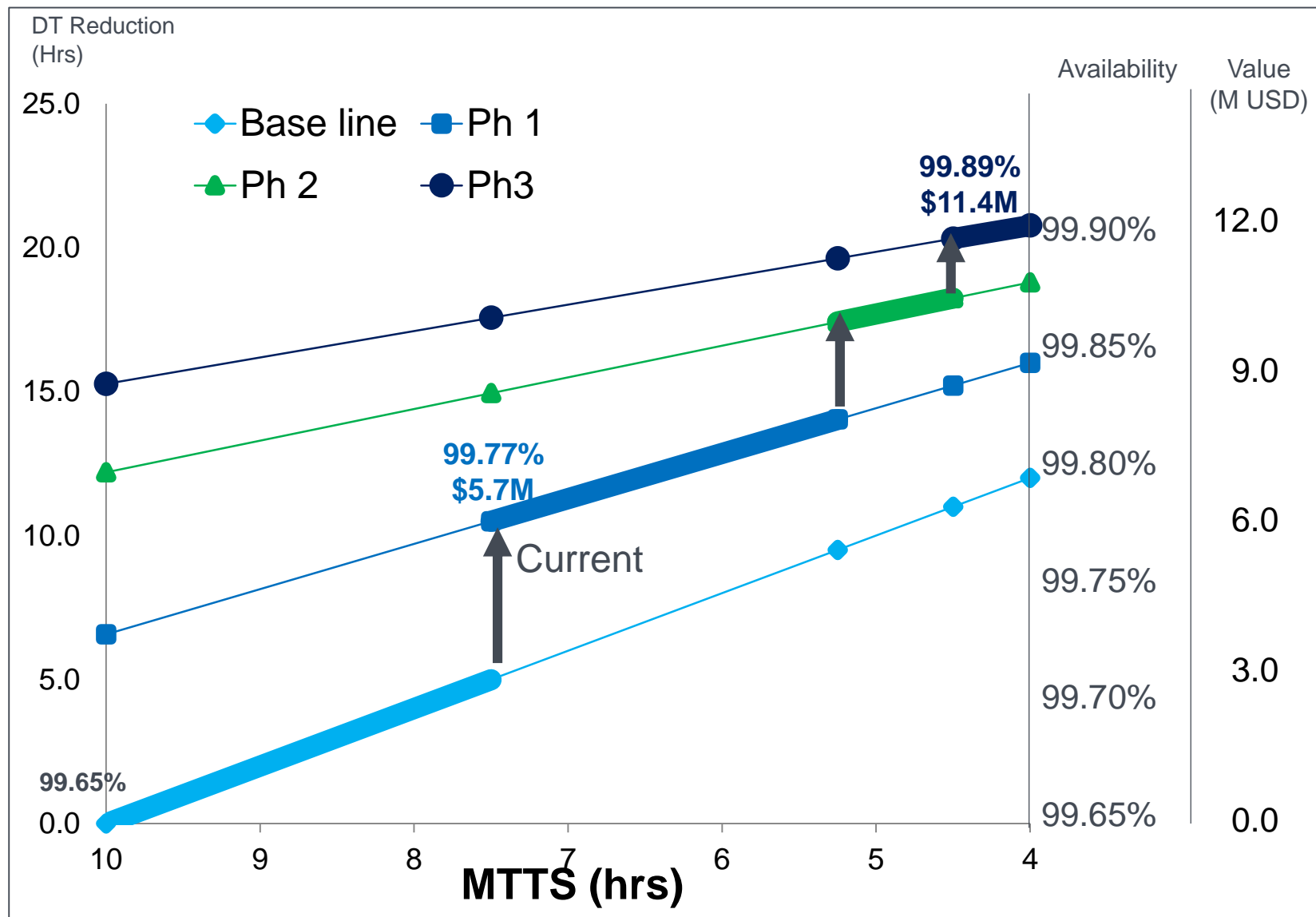
Feature	Reliability	Availability	Maintainability	Annual Time Reduction
Optimized New Electrode Design for chamber	✓	✓		1.7hrs* <sup>1</sup>
Optimized Heat Absorption by LNM optical designing	✓	✓		0.8hrs* <sup>1</sup>
Synchronized Main Modules' replacement		✓	✓	5.7hrs* <sup>2</sup>
New software "Touch Mitigator" used for reducing Parameter Change Time		✓	✓	2.5hrs
Reducing MTTS by GRYCOS Time Improvement		✓	✓	2.5hrs

Because reduction performance of \*<sup>2</sup> is bigger than \*<sup>1</sup>,  
when executing both \*<sup>1</sup> and \*<sup>2</sup>, value of \*<sup>1</sup> can't be reflected.

# VALUE

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# RAM Value Analysis



- Ph1 module transition implementation is on going.
- 99.77% \$5.7M is demonstrated as of today.
- Ph2 and Ph3 are planned.
- By 2020, 99.89% and \$11.4M value creation is realized.

# Summary

- RAM enhancement improve downtime reduction of PM through increasing baseline of tool utilization.
- Gigaphoton introduced durable “G-electrode” for chamber, and reduced optical damage on grating for enhance LNM lifetime.
- Top 4 modules service frequency reduction should be Chamber(GRYCOS), F2T, LNM and MM, and Parameter Change especially for chamber related.
- Gigaphoton introduced Touch Mitigator to reduce time for parameter change related with chamber.
- Gigaphoton synchronized modules exchange in order to support higher utilization.
- Gigaphoton’s RAM goal >52wk MTBS and 4hr MTTS contribute to achieve 99.9% light source utilization and **\$11.4M** chipmaker’s value could be provided.

# Acknowledge

## Special Thanks to,

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THANK YOU