assure success
NIKON CORPORATION

3rd EUVL Symposium

EUV Exposure System Development Plan in Nikon

Nov-4.2004

Nikon Corporation
Takeshi Asami

Outline

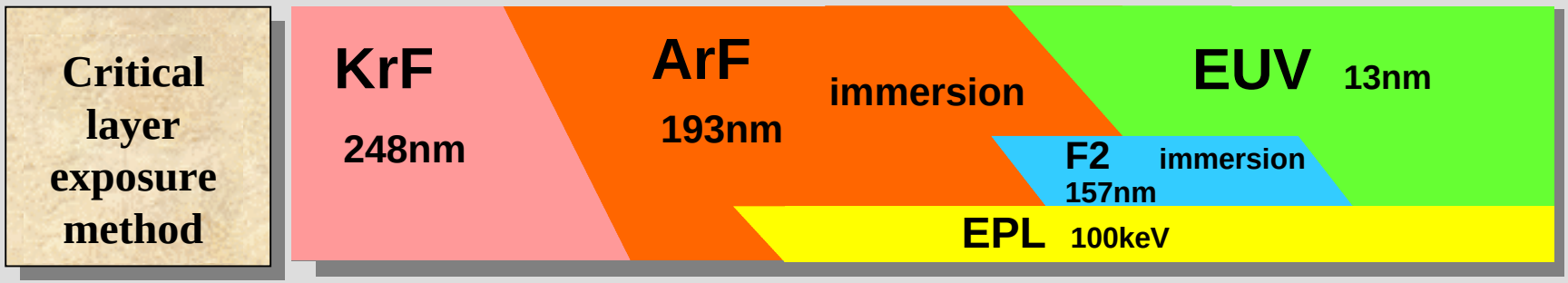
- Introduction
- Current Status
  - Source
  - Optics
  - Coating
  - Contamination
  - Body, Stages
- Development Plan
- Summary

assure success
NIKON CORPORATION

Nikon Lithography Roadmap

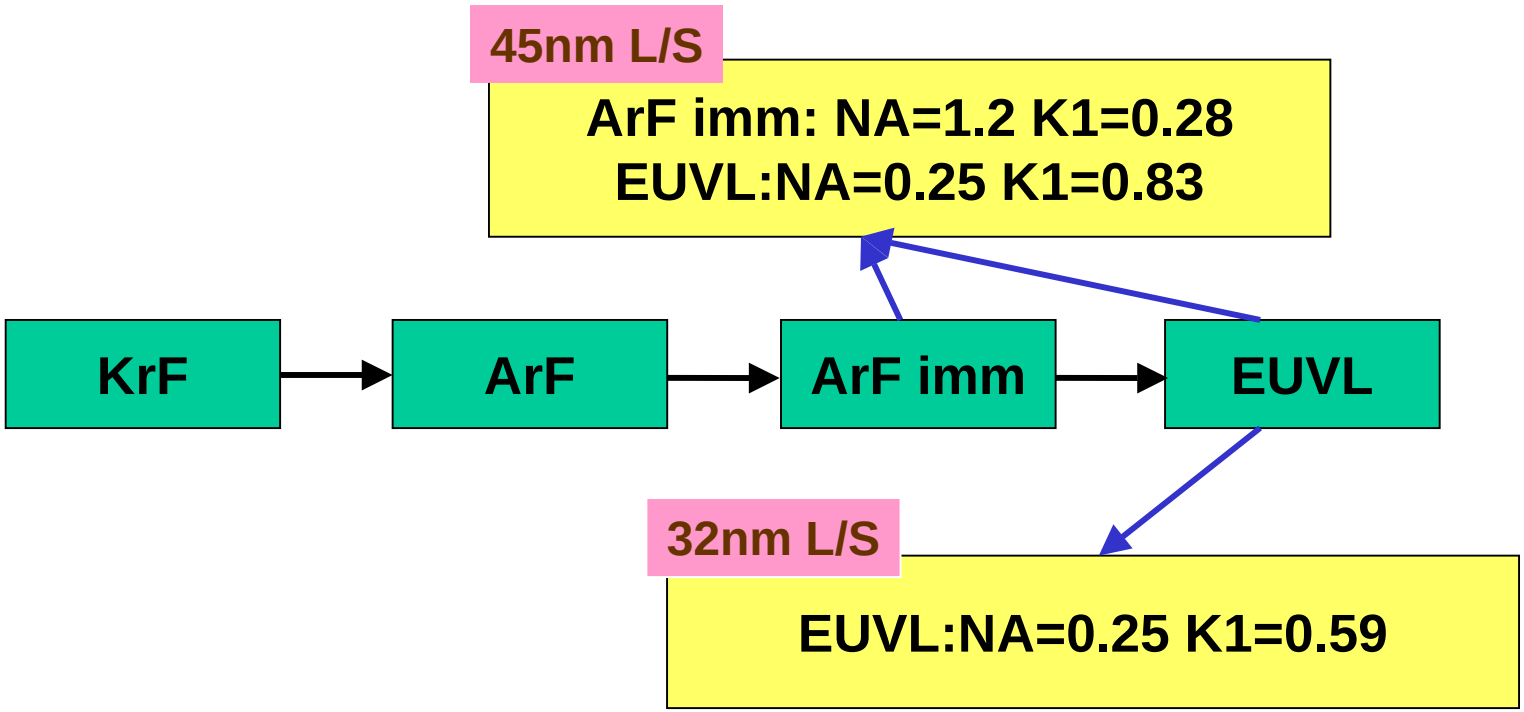
ITRS 2003

CY	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Technology Node	hp130			hp90			hp65			hp45			hp32			hp22
DRAM Half Pitch	130	115	100	90	80	70	65	57	50	45		35	32		25	22
MPU Gate in resist	90		65	53	45	40	35	32	28	25		20	18		15	13
post-etch	65		45	37	32	28	25	22	20	18		14	13		10	9



January, 2004

Nikon Strategy for Future Lithography



EUVL for 45nm technology node

EUV1 (Process Development Tool) E/2006

EUV2 (HVM) (E/2008)

- Introduction
- Current Status
  - Source
  - Optics
  - Coating
  - Contamination
  - Body, Stages
- Development Plan
- Summary

Source

Basic requirements for EUV1 are

Power at IF :	≧10W
Repetition Rate :	≧5KHz
Etendue :	≦5.5mm2sr

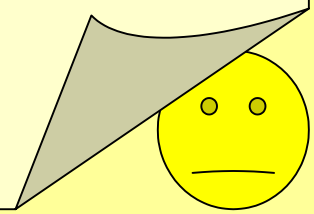
Status

Current status of the source suppliers are close to our basic requirements.

Challenges

Collector mirror life time

Reasonable CoO



IU and PL Design

Illumination Optics

The illumination optics using 2 reflective optical integrators (fly-eye mirrors) were designed.

Projection Optics

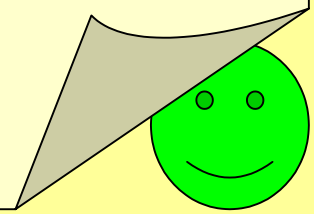
EUV1 PO design was completed.

NA=0.25 Magnification=4X Field size=26X33mm

High stiffness multi-barrel structure

Stress free mounting mechanism

6DOF fine adjustment mechanism



Aspheric mirror for the PO

Polishing Technologies

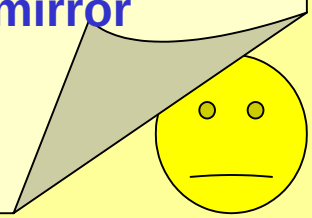
- Computer controlled small tool polishing (STPM)
- Magneto Rheological Figuring (MRF)
- Ion Beam Figuring (IBF)
- Elastic Emission Machining (EEM) (Tool not available)

Metrologies

- High repeatability Interferometer

Challenges

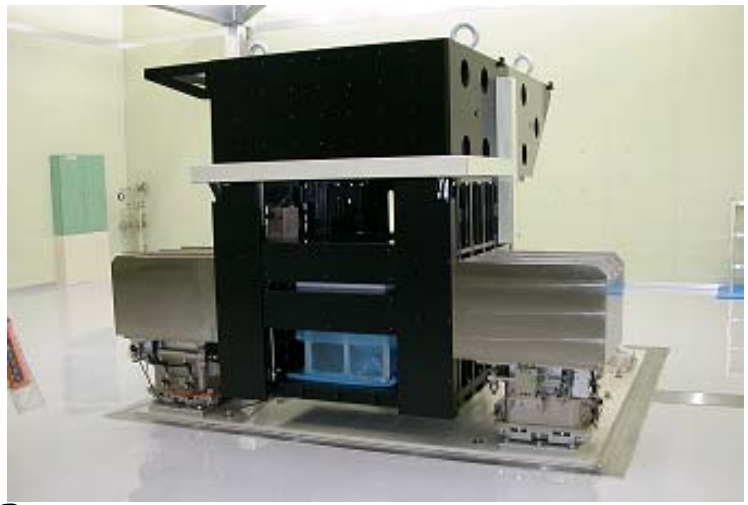
- Improve LSFR,MSFR, and HSFR simultaneously
- Polishing and metrology of the peculiar shape mirror



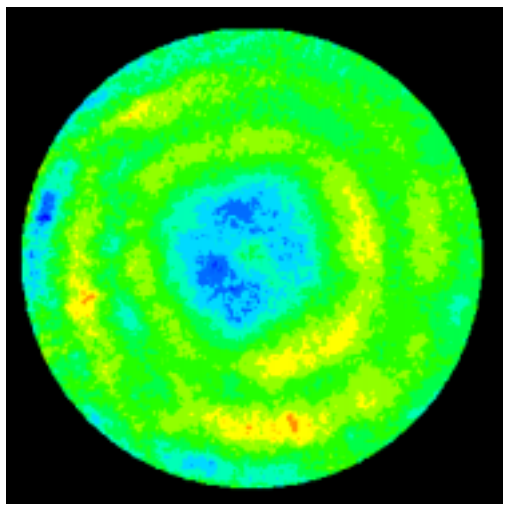
Polishing and Metrology are inseparable

Polishing tool

Interferometer

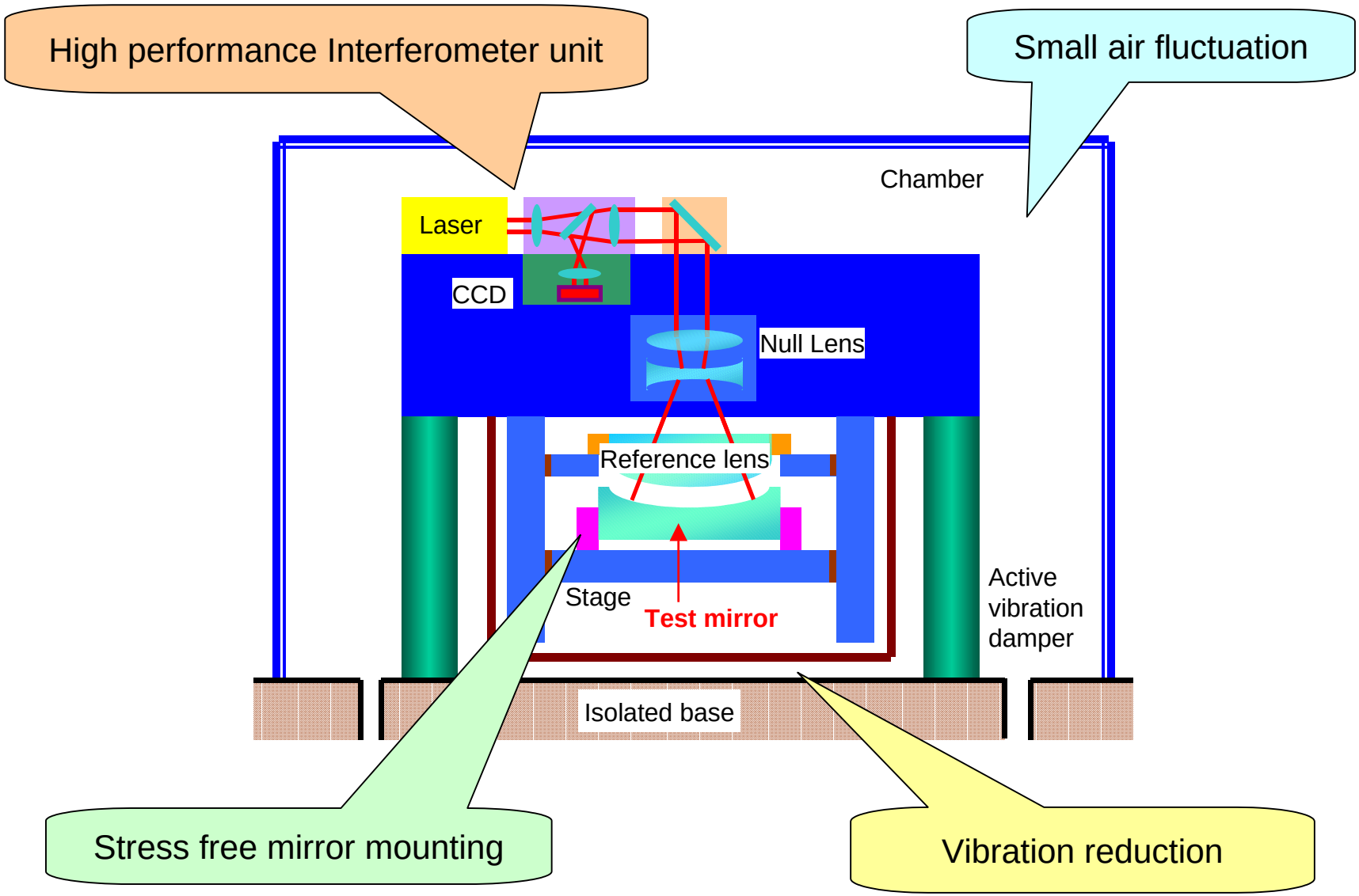


Surface error data



High Repeatability Interferometer

Supported by NEDO



History of the optics for EUV tools

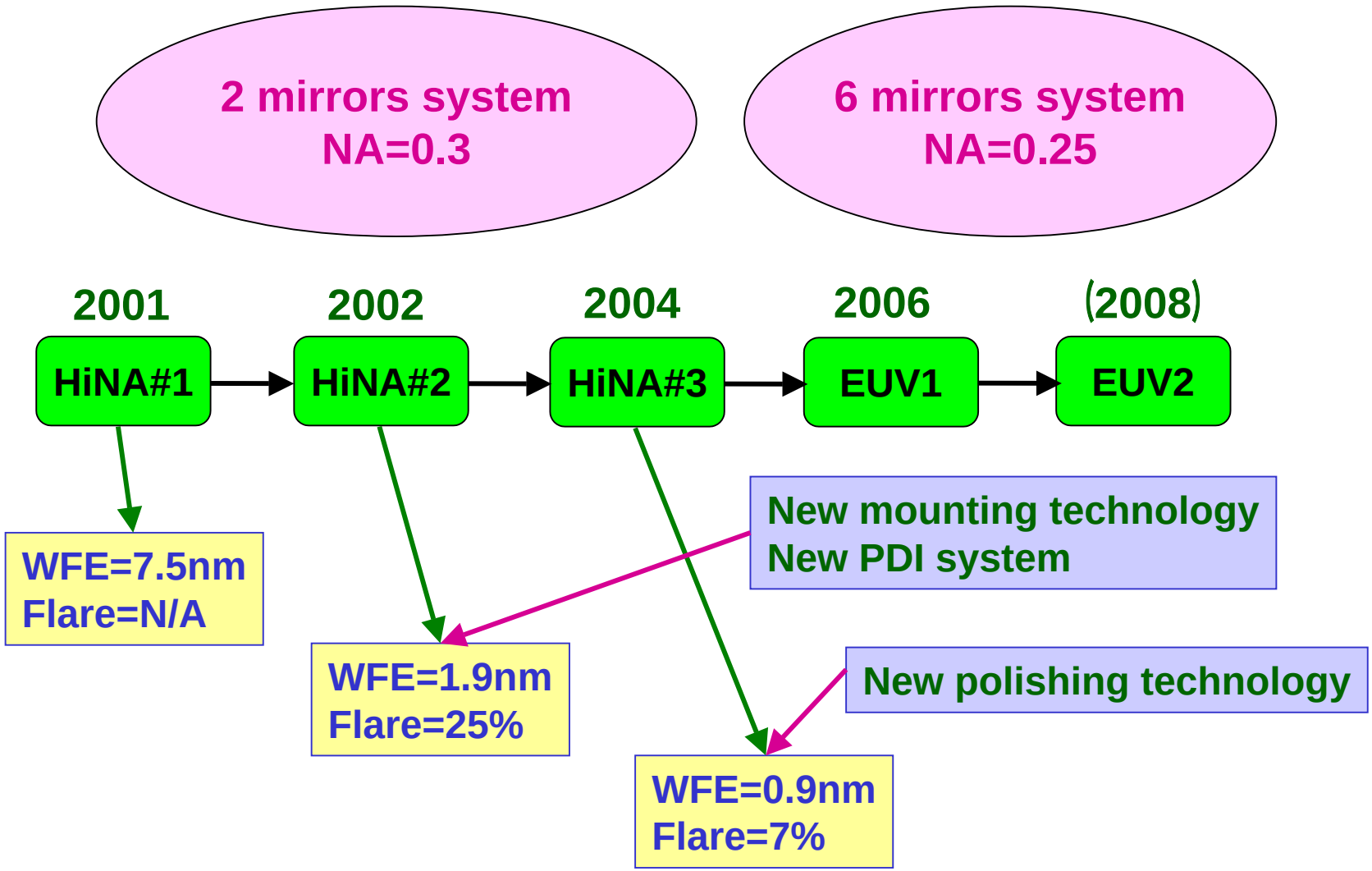


Figure error data of the HiNA set-3 optics

		LSFR			MSFR			HSFR		
			Raw	Z36		ϕ1mm	0.1mm		10μm	1μm
Set-2	M1	0.52	0.55	0.22	0.34	0.34	0.25		0.13	
	M2	0.66	0.66	0.40	0.32	0.33	0.23			
Set-3	M1	0.25	0.28	0.14	0.17	0.17	0.13	0.10	0.10	0.09
	M2	0.25	0.25	0.20	0.20	0.18	0.11	N/A	N/A	N/A

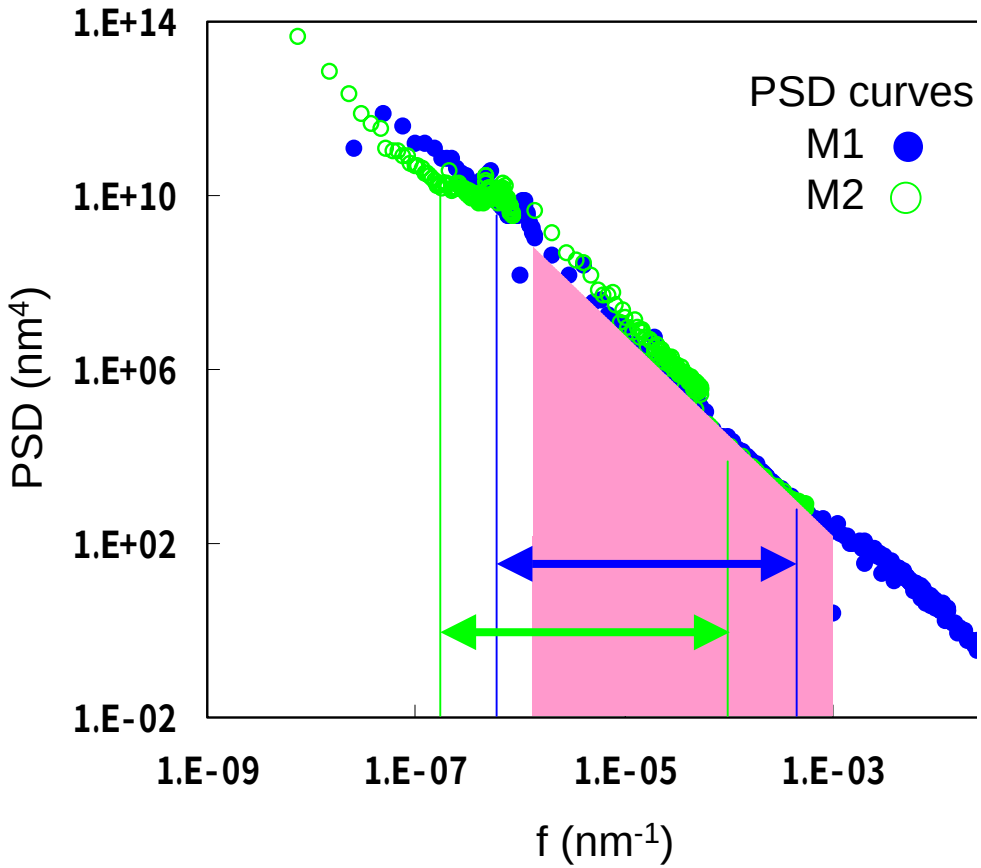
Unit: nm rms

We successfully reduced LSFR, MSFR and HSFR compared with set-2.

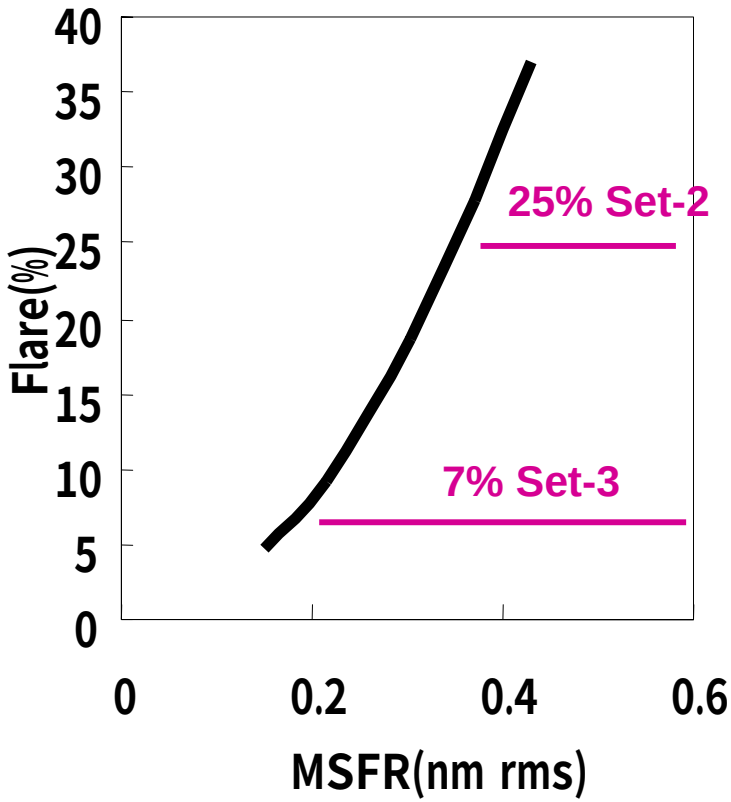
MSFR, which strongly affects the flare, was substantially reduced.

PSD curve and calculated flare of Set-3 optics

PSD curve

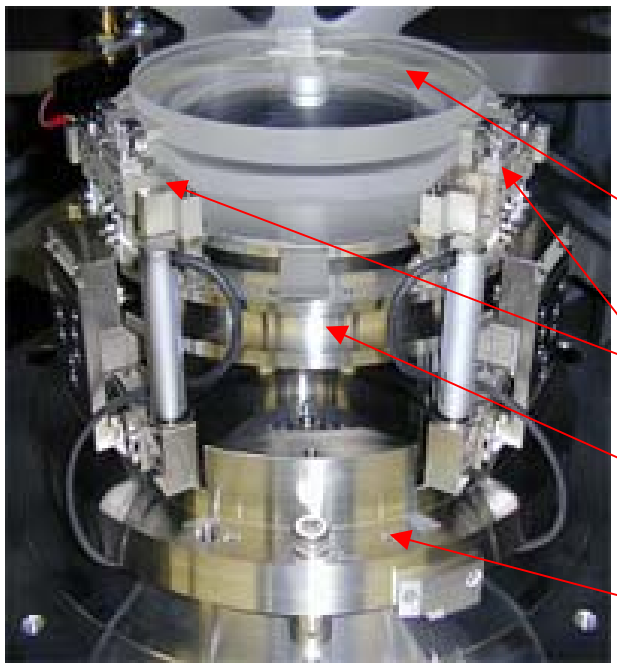


Calculated flare



HiNA set3 PO Apparatus and WFE map

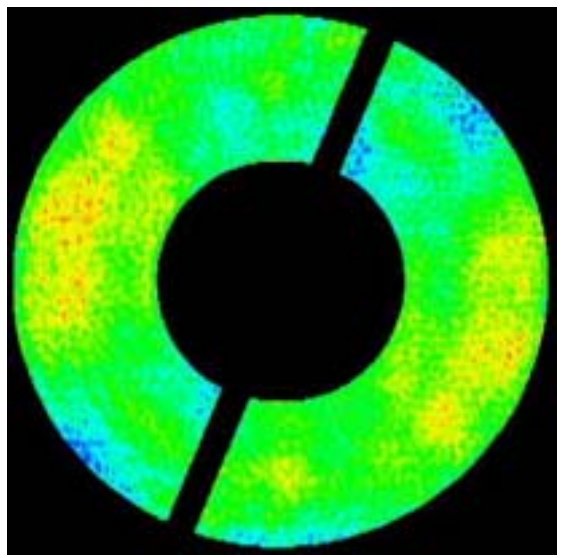
PO apparatus



Measured wavefront error

	Raw data	Zernike 36-fit
Set-2	**1.9**	**1.2**
Set-3	**0.90**	**0.74**

Unit: nm rms



Coating

Tools and Technologies

Ion Beam Sputtering system (IBS)

DC magnetron sputtering system (RMC)

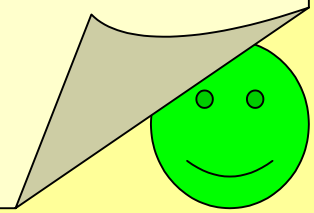
Status

High Reflectivity over 70% has been achieved

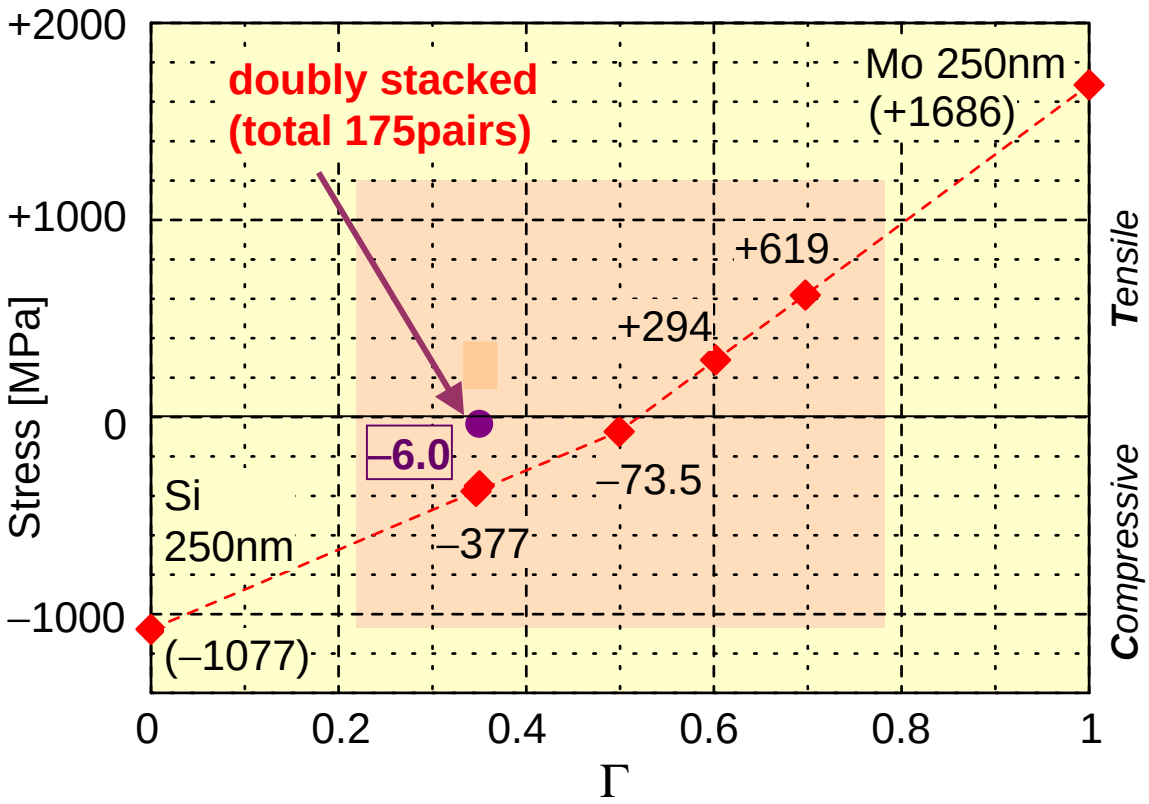
Precise stress control has been developed

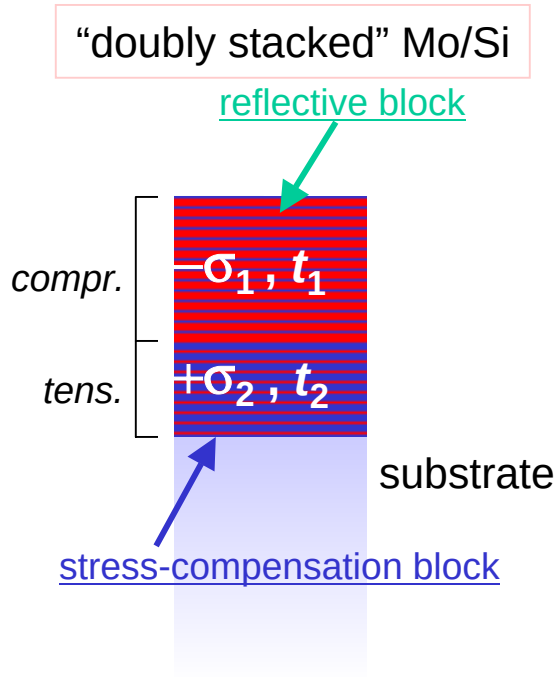
Challenge

Precise thickness distribution control for large mirror



Doubly stacked Multi-layer

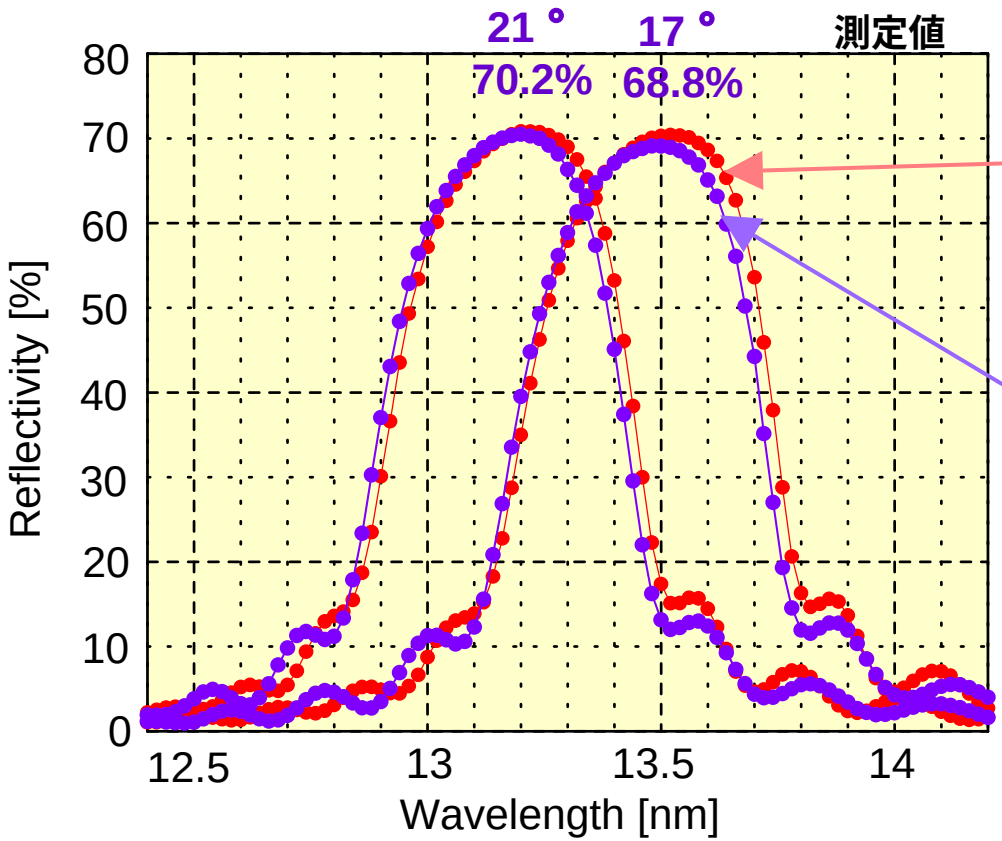




The doubly stacked multilayer exhibited a small stress of –6.0MPa.

Doubly stacked Multi-layer

High reflectivity 67% was achieved.



Mo/Si Multi-layer
(50 pairs with large stress of –377MPa)

Doubly stacked Mo/Si Multi-Layer
(175 pairs with low stress of –6MPa)

Wave Front Sensor

UV-VIS Wave Front sensor

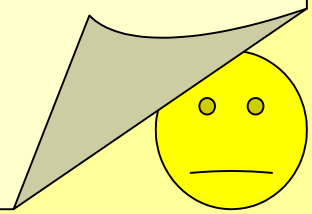
- Interferometer system is under manufacture

Actinic Wave Front Sensor

- POC testing has been done using EEI at Subaru-factory
- Both PDI and LSI concepts are verified
- Tool for 6 mirror PO is under manufacture

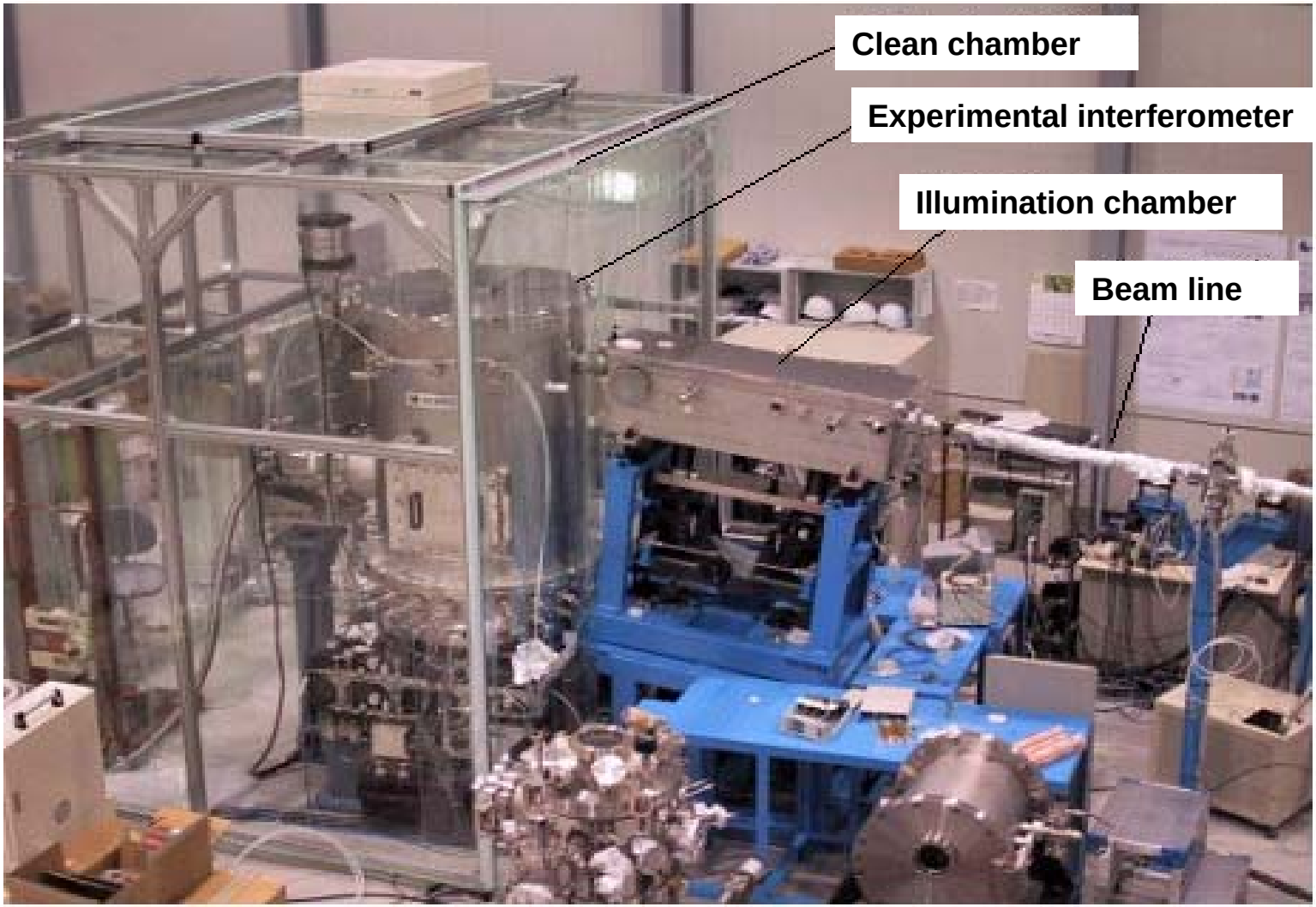
Challenges

- Improve accuracy
- Astigmatism measurement of LSI

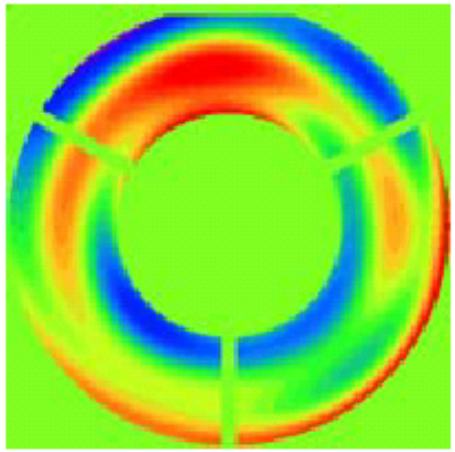


EUV Experimental Interferometer (EEI)

Supported by NEDO

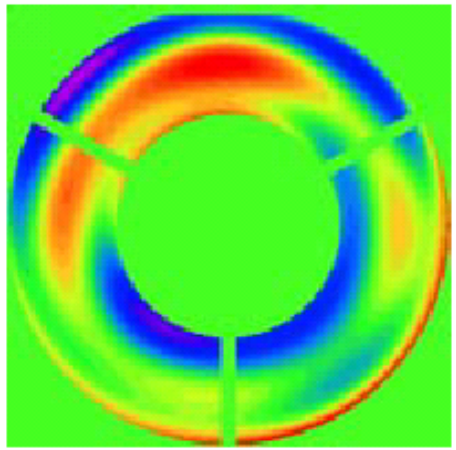


Comparison between PDI and LSI acquired by EEI

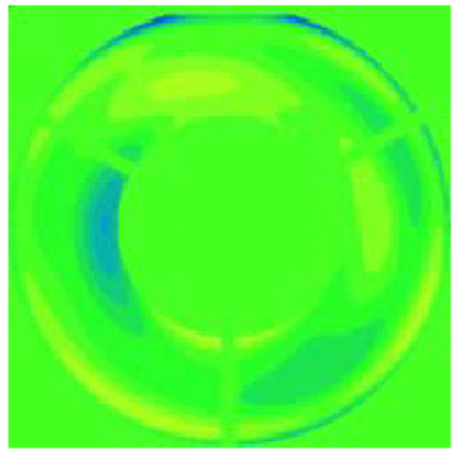


LSI(x2y2) 0.999 nmrms

⇔



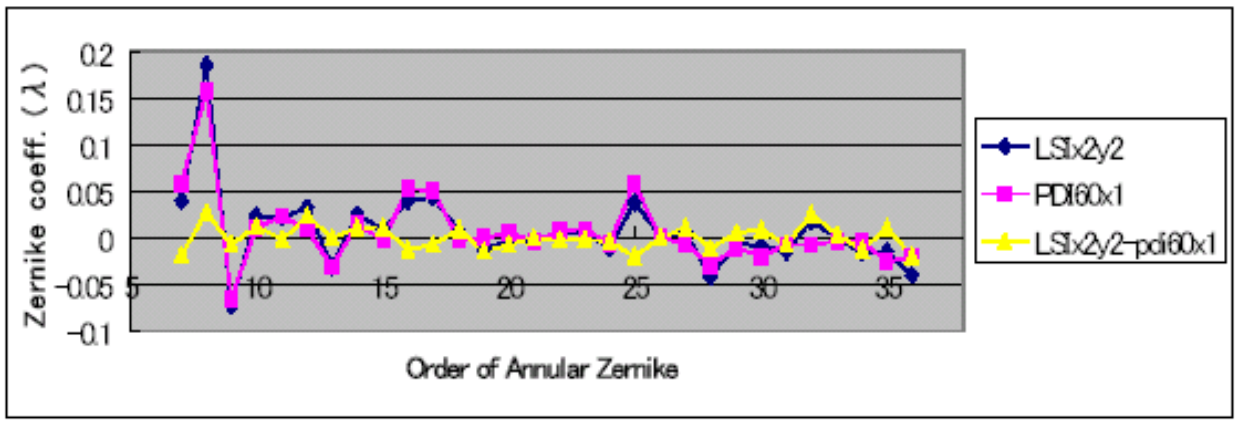
PDI(60x1) 0.954 nmrms



LSI-PDI 0.295 nmrms

Both data are well matched.

Supported by NEDO



Contamination Control

Mitigation

Supported by NEDO

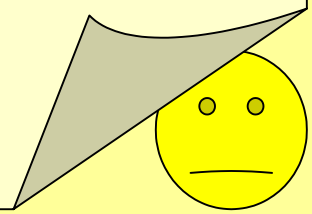
- **Oxidation : Capping layer**
- **Carbon deposition : EUV+O2 or UV+O2 cleaning**

Status

- **Complete installation of contamination test tool in Super-ALIS (NTT)**
- **Start study for H2O dependence on carbon/oxidation in New Subaru (UoH)**
- **Start UV+O2 cleaning test**

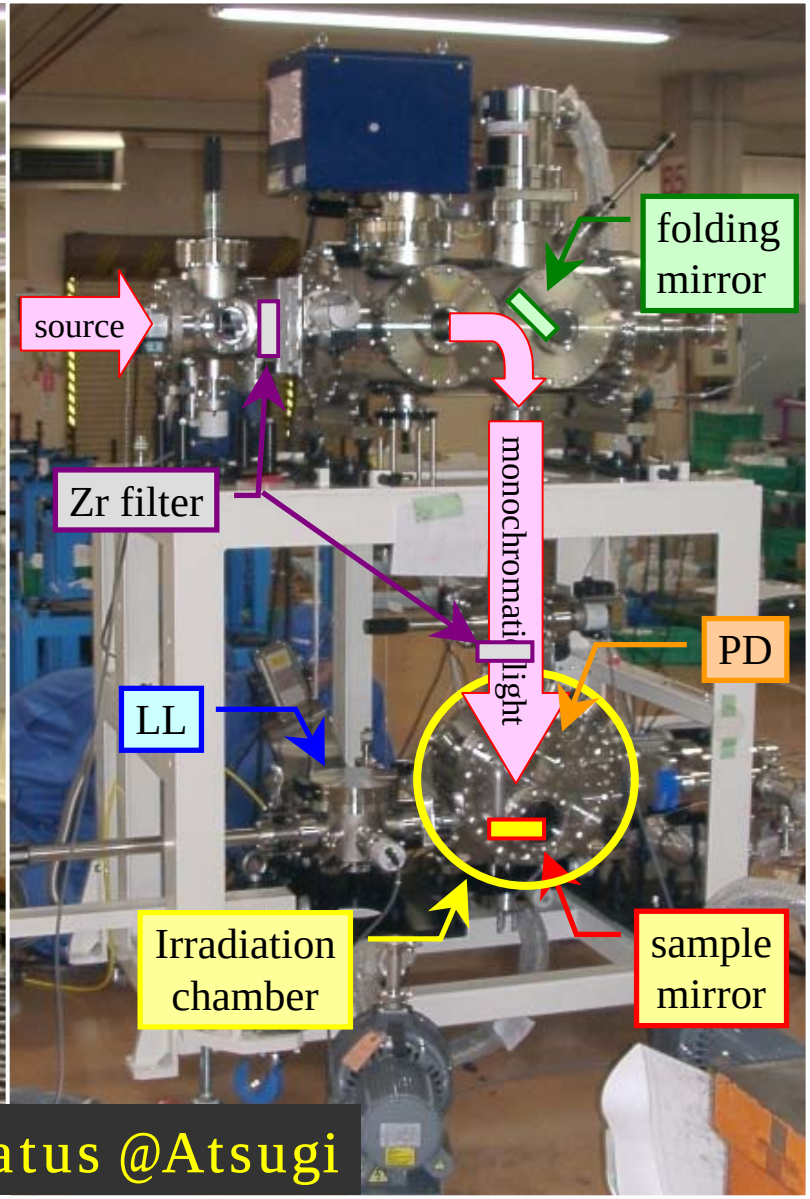
Challenges

- **Further understanding for the contamination mechanism**
- **Systemization**



Apparatus

Supported by NEDO



Super-ALIS beam-line & Apparatus @Atsugi

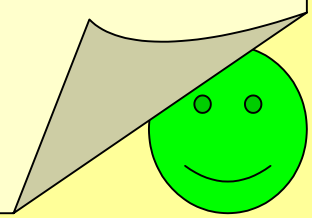
Body,Stages and Sensors

Vacuum compatible subsystems of the EPL, and novel control system of the Optical Lithography system can be used for the EUVL exposure system.

- **Vacuum body technology**
- **Scanning stage technology.**
- **Reticle and wafer loading system**
- **Vacuum environmental system.**
- **Wafer alignment system.**
- **Wafer auto-focus system.**

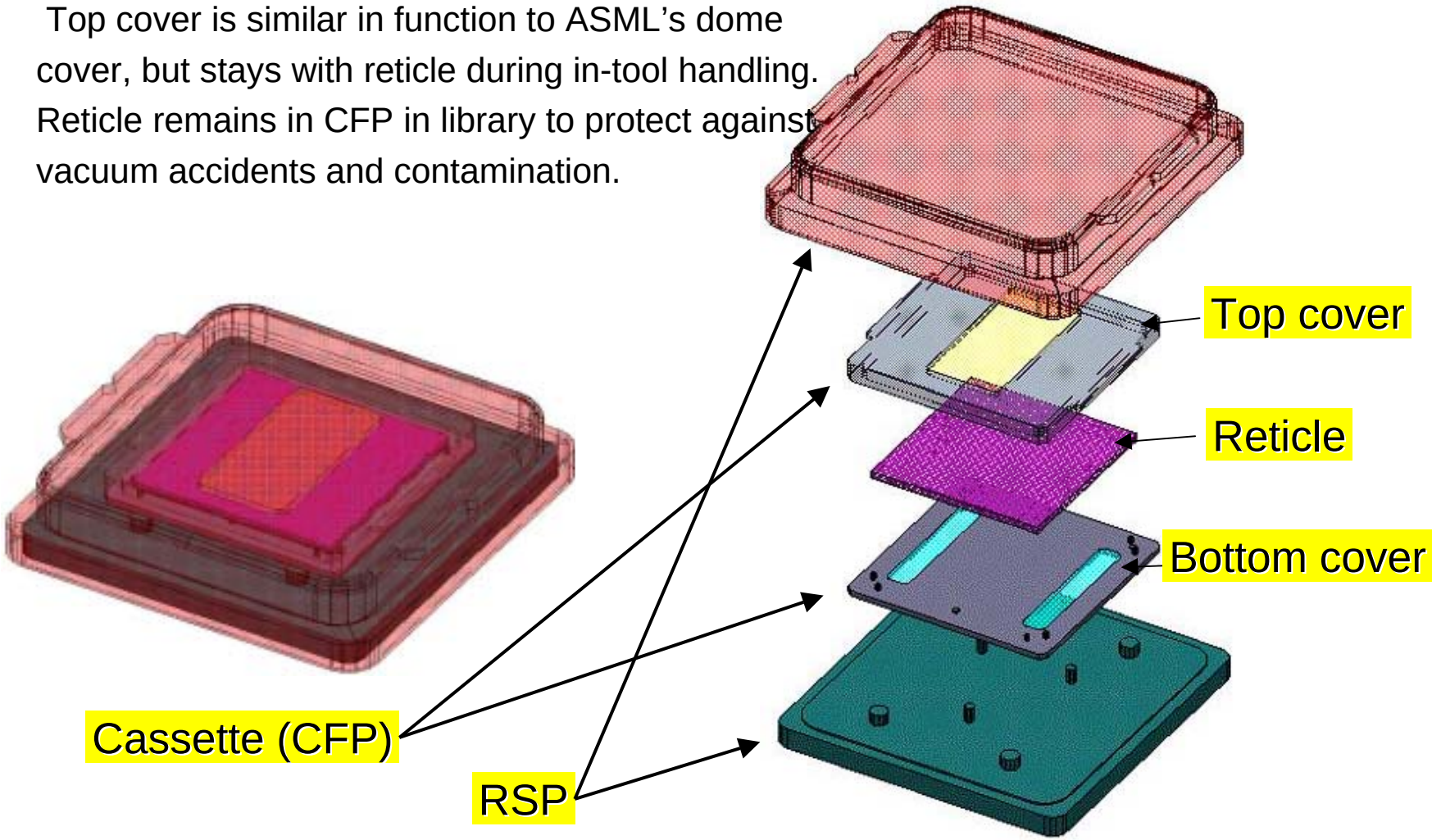
Status

- **These subsystems are under design.**



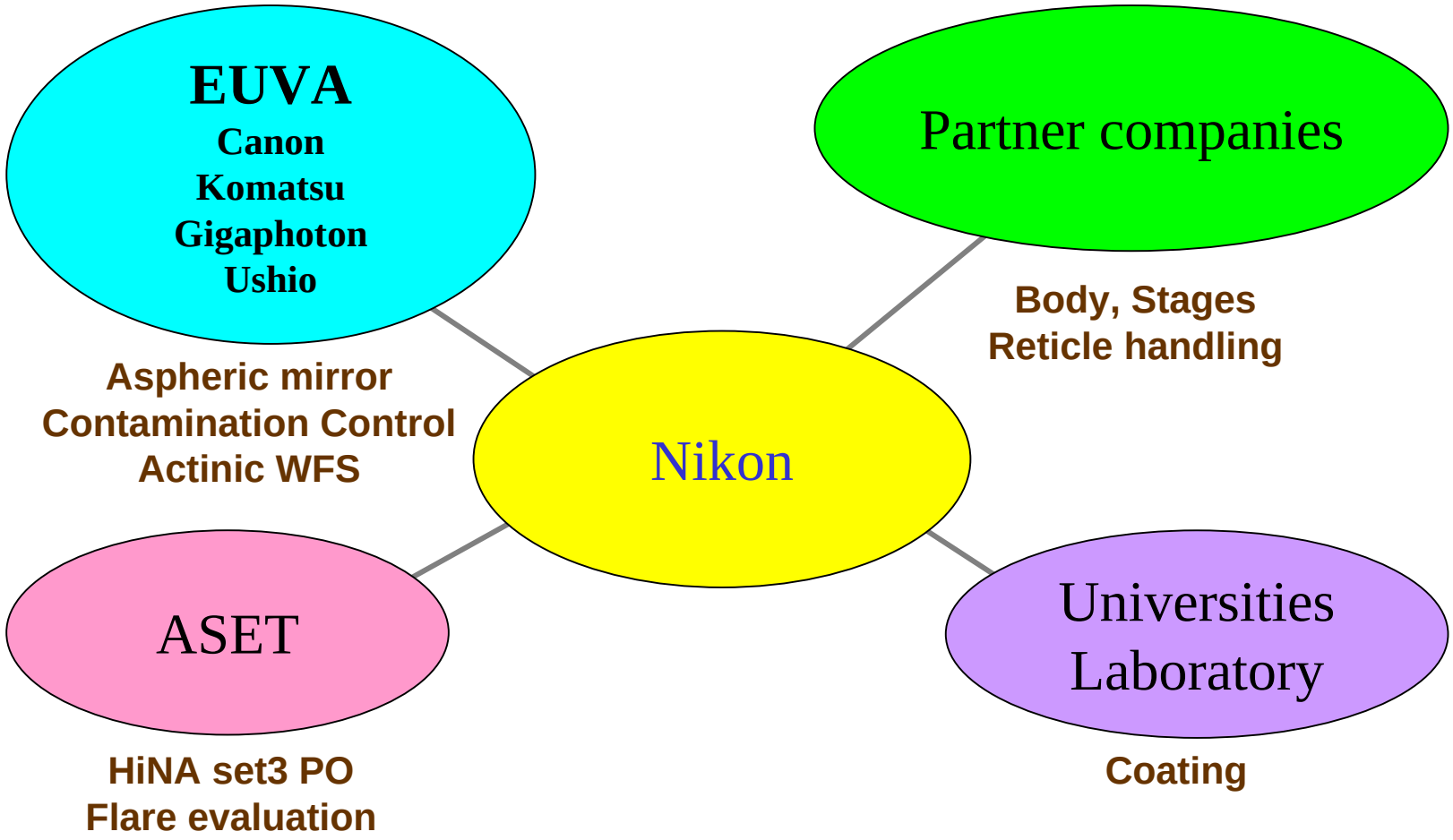
Dual Pod Concept by Canon and Nikon

- Reticle in Cassette(CFP) in Carrier(RSP).
- Cassette protects the reticle in loadlocks.
- Top cover is similar in function to ASML's dome cover, but stays with reticle during in-tool handling.
- Reticle remains in CFP in library to protect against vacuum accidents and contamination.



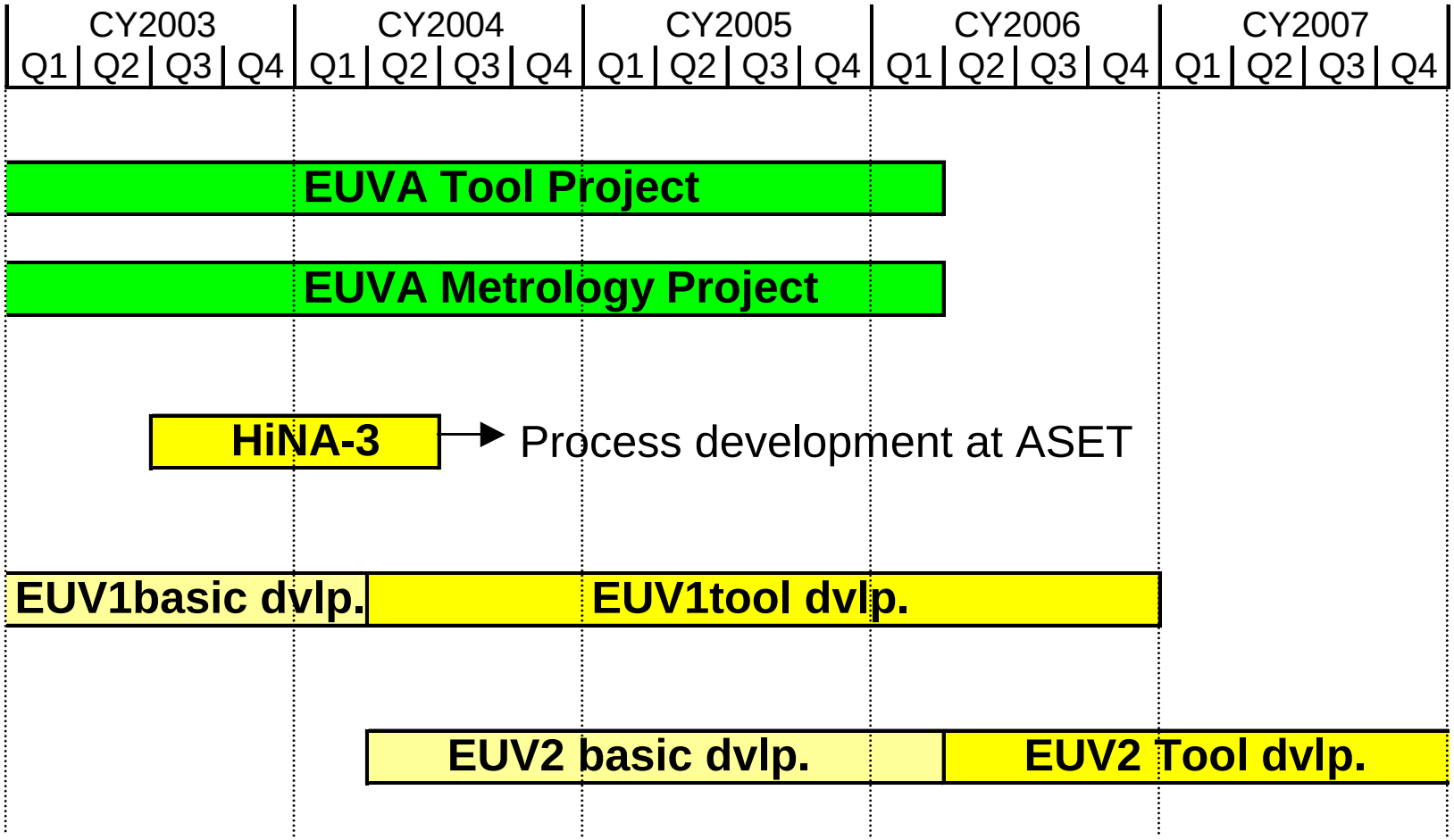
- Introduction
- Current Status
  - Source
  - Optics
  - Coating
  - Contamination
  - Body, Stages
- **Development Plan**
- **Summary**

Collaboration



Nikon develops EUVL with more than ten companies and organizations.
Nikon gratefully acknowledges METI and NEDO for their support.

EUVL Development Plan



Risks

	Technical	Timing
Source		
IU & PO Design		
Aspheric mirror		
Coating		
WFS		
Contamination		
Body,Stages		

There is no high risk item () on the table.

Summary

- Source for EUV1 will be available by our required date.
- Expected power at IF is 10W and TP is around 5-10WPH.
- IU and PO optics have been designed.
  - NA=0.25 Magnification=1/4 Field=26x33mm
- HiNA set3 PO was successfully completed as the path finder to the EUV1 PO.
- Metrology tools are under manufacture.
- High reflective Mo/Si coating with low stress was achieved.
- Irradiation tests using SR will be started.
- Body and stages are under design.

We plan to develop the EUV1 by the end of 2006.

Developments are on going, and there are no major technical issues so far.

END

Business adjourn
Enjoy beautiful autumn in Japan