Large Reflectometer for EUV Optics

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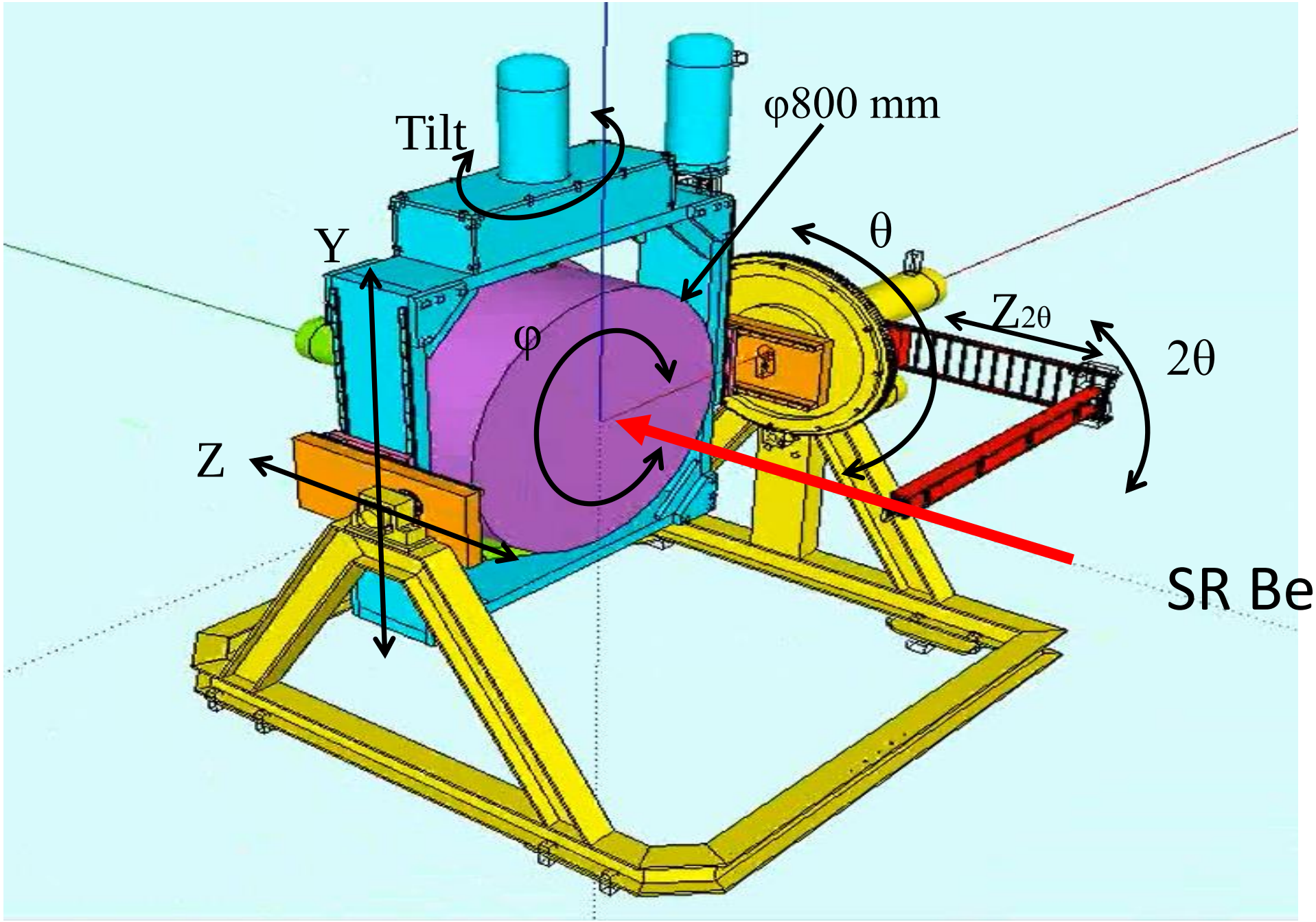
Background

- Large ellipsoidal mirror is required for condenser optics of LPP source.
- Fraunhofer Institute of Germany and Tinsley+ Rigaku IT can provide it.
- However, Only PTB of Germany has reflectometer of large optics (ϕ650).
- The largest reflectometer has developed in NewSUBARU, which can measure the optics larger than 800 mm in diameter.

Requirement of LPP collector mirror

- Figure: Ellipsoid
- Diameter: > 660 mm
- Sag: > 150 mm
- Weight: > 40kg
- Reflectivity: > 50% @13.50 ±0.03 nm
- Removal of infrared light
- Easy refurbishment

In Japan, Gigaphoton will deliver EUV source
and Rigaku IT will deliver collector mirror.


Tilt
φ800 mm
Y
θ
Z2θ
φ
2θ
Z
SR Beam

Specification

Items	Specification	Precision	Resolution
Mirror Size & Weight	＞Φ800 mm、t250 ＞W 50kg		
θ	-5° ～95°	±0.01°	0.00016°
2θ	-5° ～185°	±0.01°	0.00014°
Φ	360°	±0.01°	0.00014°
Y	-50～450 mm	±2.5 μm	0.1μm
Z	-140～100 mm	±2.5 μm	0.1μm
Tilt	±10°	±0.01°	0.00014°

Each axis with optical encoder is controlled by closed-loop.

Characteristics of Mechanism

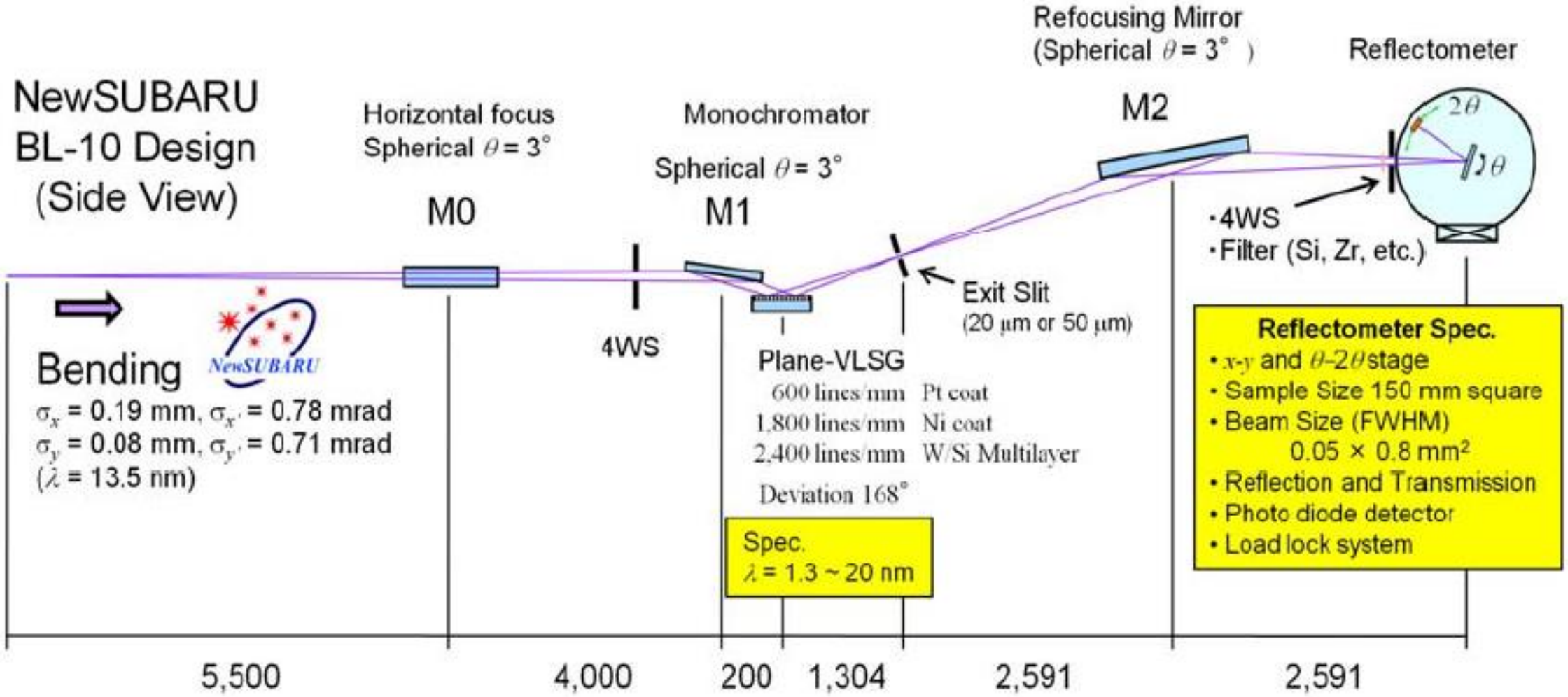
- In order to get high torque in vacuum, stepping motors in atmosphere are used.

- As the drive shaft and the chamber are completely separated, a high accuracy is obtained.

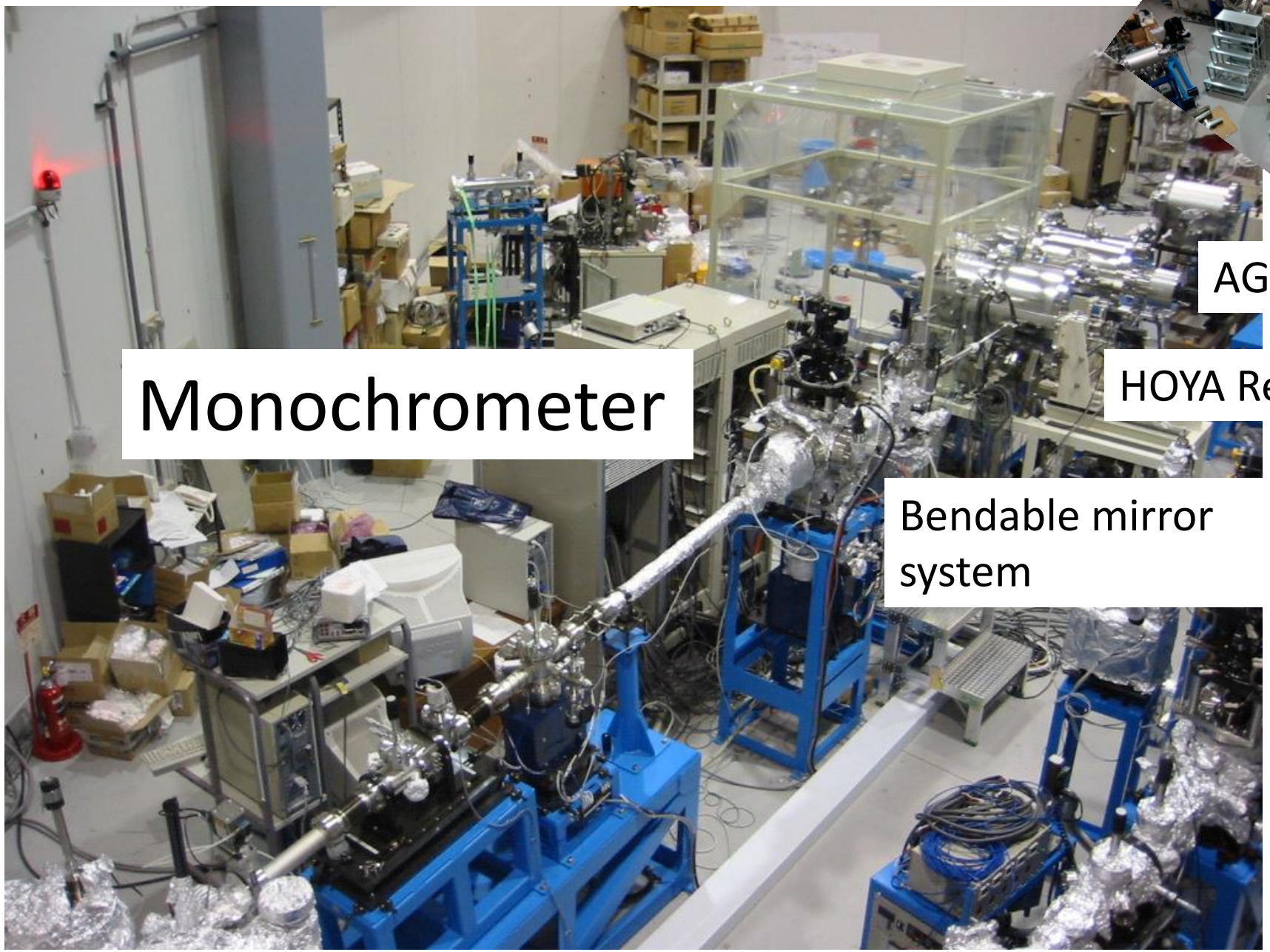
- Linear guide and ball screw are used in Y and Z axes.
  Harmonic gear and 5ϕ stepping motor are used in Φ, tilt, 2θ axes.
  For mounting heavy stages, Big gear of gear ratio 1:11 is used to θ stage.

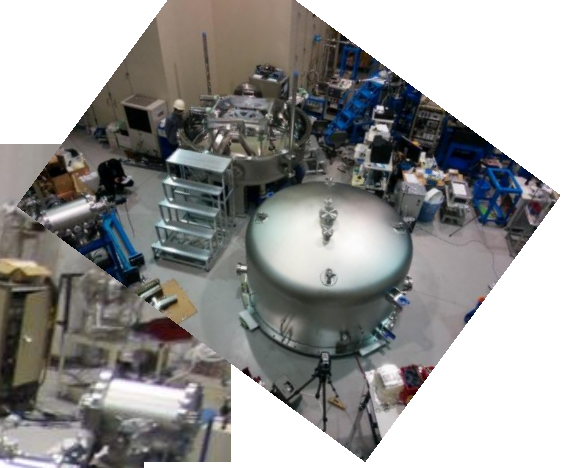
- Using ϕ and Y axis, the optics of 1000mm in diameter can be measured.

- Vacuum degree of 2.0x10-6 Pa was achieved.


NewSUBARU
BL-10 Design
(Side View)
Horizontal focus
Spherical θ = 3°
M0
Monochromator
Spherical θ = 3°
M1
Refocusing Mirror
(Spherical θ = 3°)
M2
Reflectometer
2θ
θ
•4WS
•Filter (Si, Zr, etc.)
Bending
σx = 0.19 mm, σx' = 0.78 mrad
σy = 0.08 mm, σy' = 0.71 mrad
(λ = 13.5 nm)
NewSUBARU
4WS
Plane-VLSG
600 lines/mm Pt coat
1,800 lines/mm Ni coat
2,400 lines/mm W/Si Multilayer
Deviation 168°
Exit Slit
(20 μm or 50 μm)
Spec.
λ = 1.3 ~ 20 nm
Reflectometer Spec.
• x-y and θ-2θ stage
• Sample Size 150 mm square
• Beam Size (FWHM)
0.05 × 0.8 mm²
• Reflection and Transmission
• Photo diode detector
• Load lock system
5,500
4,000
200
1,304
2,591
2,591

BL-10 Beamline

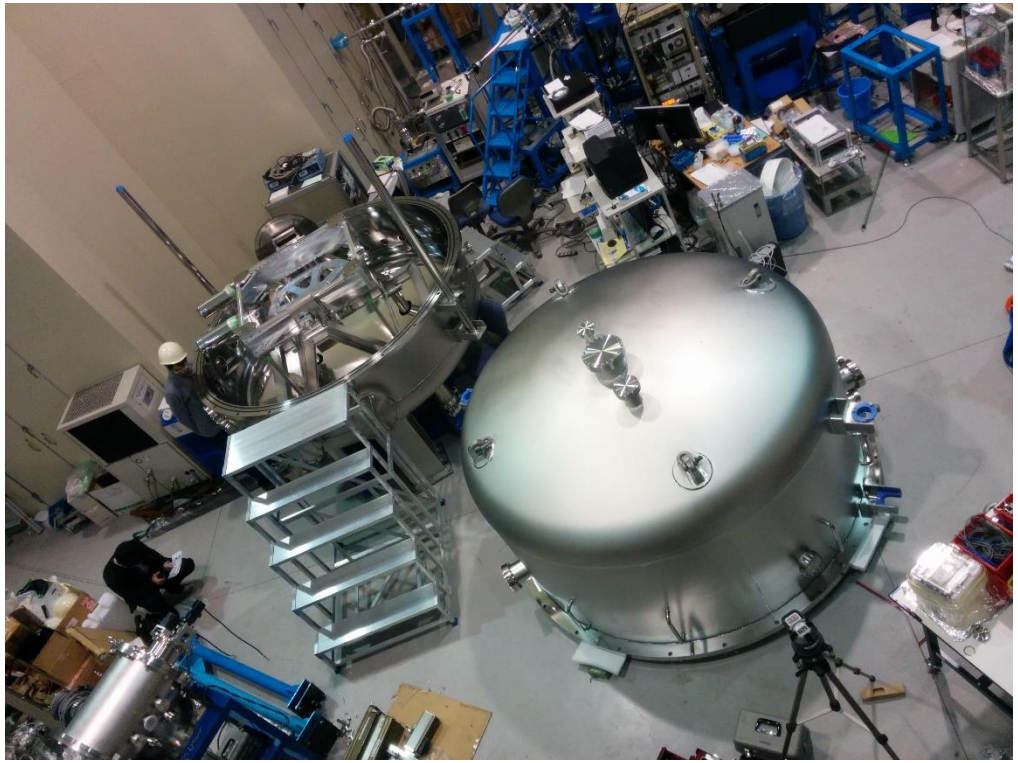


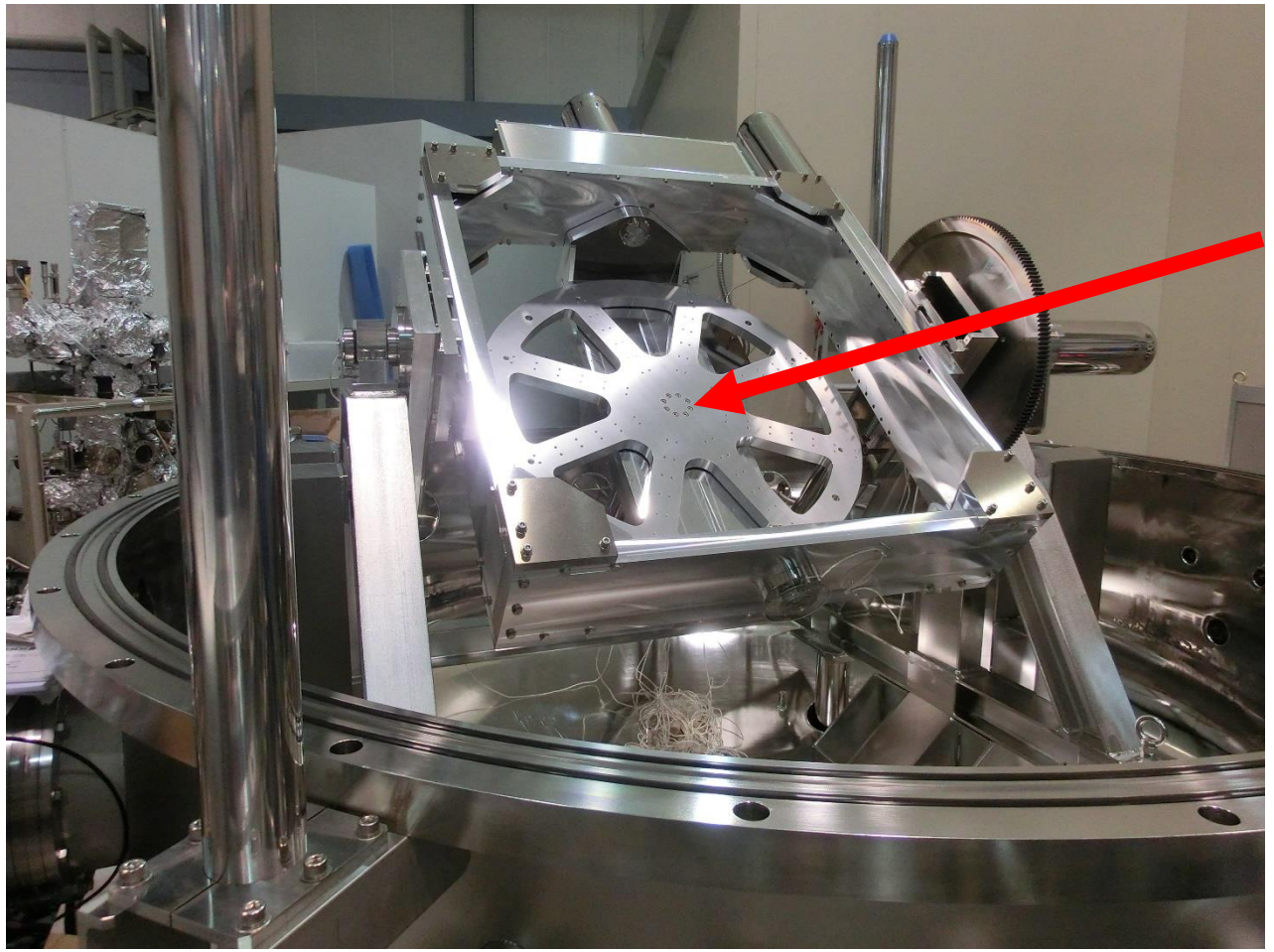


AGC Reflectometer

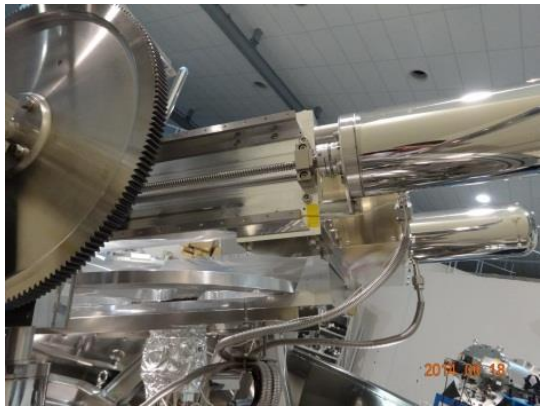
HOYA Reflectometer

NewSUBARU

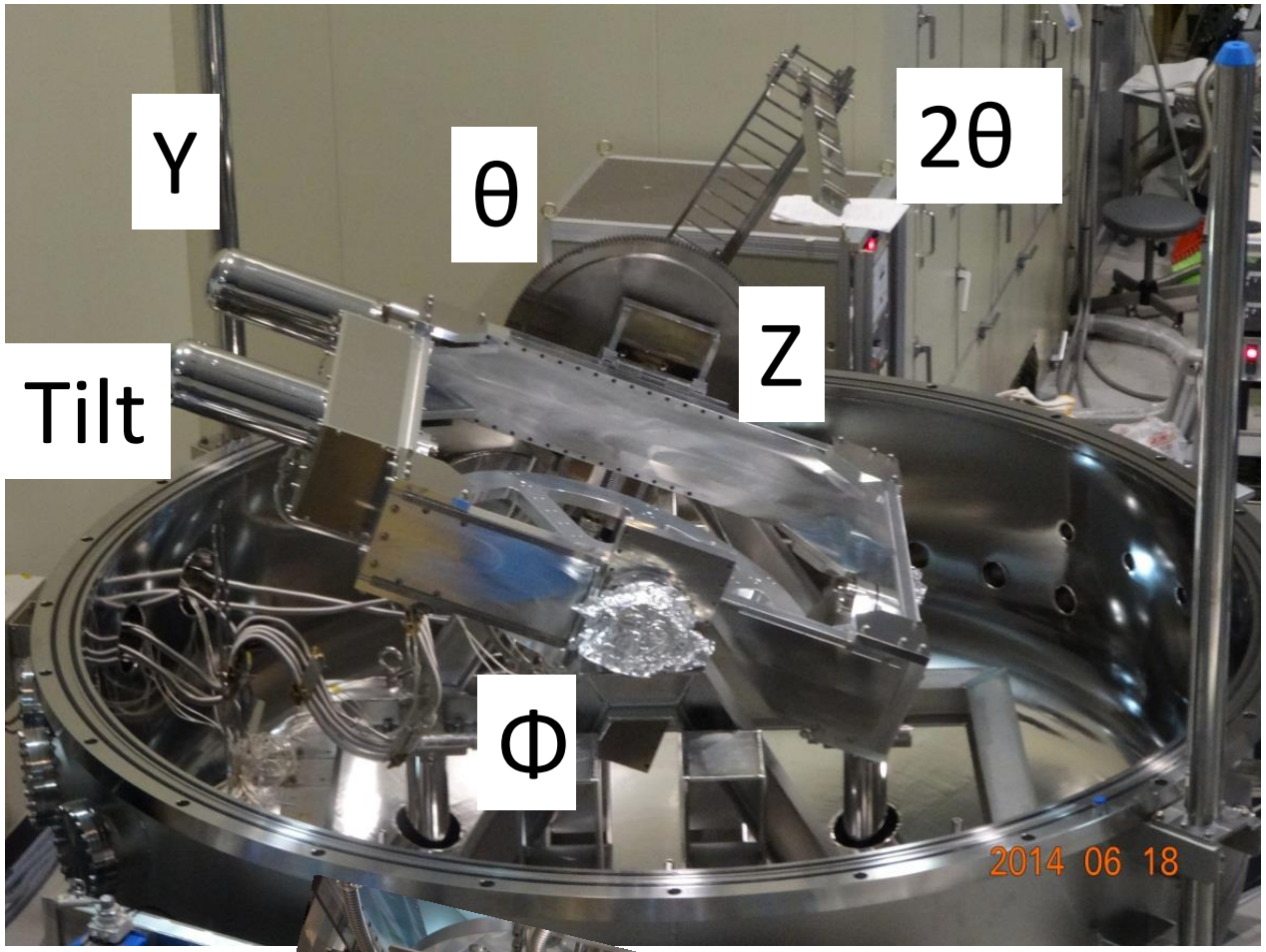


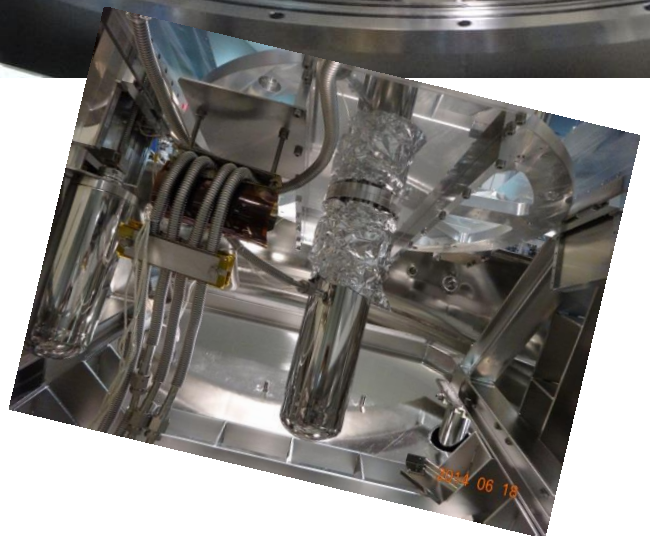

Mirror stage

Z axis



Y axis

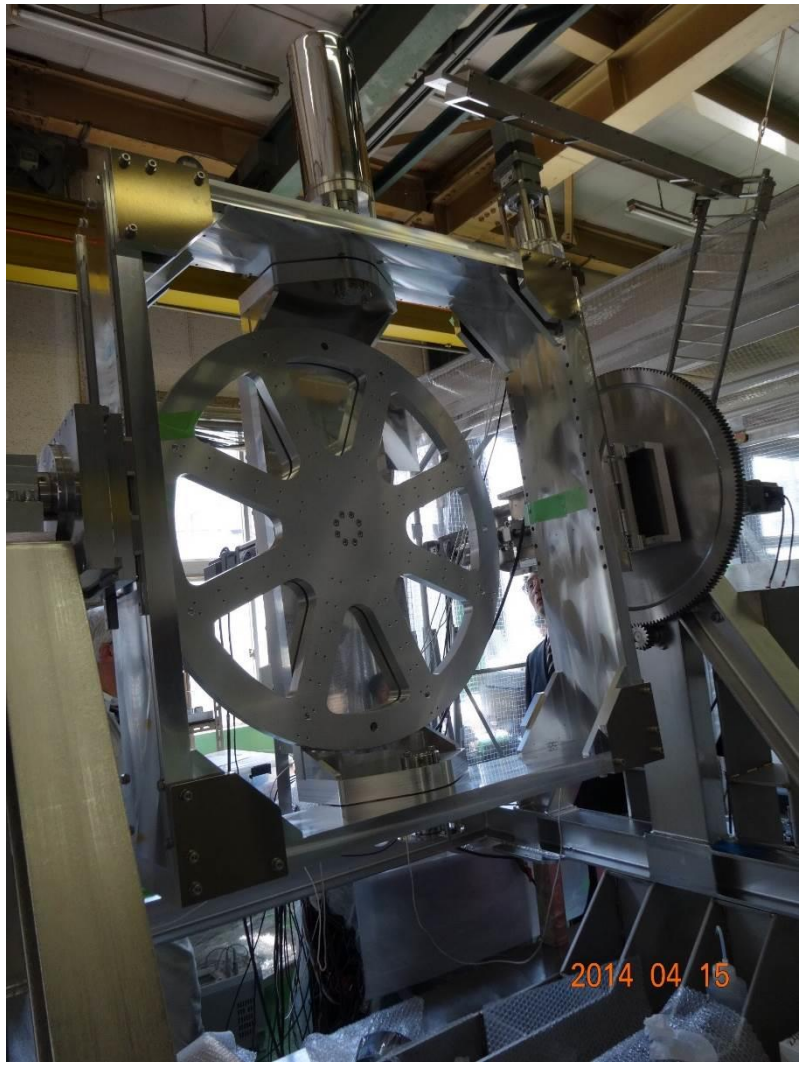




Φ axis

2θ axis

θ axis

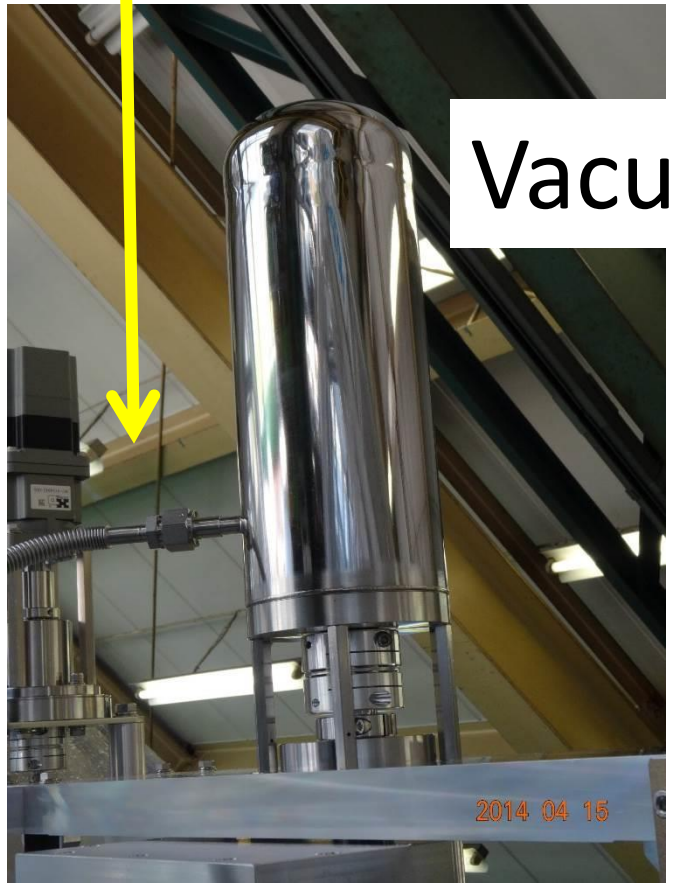


Θ stage

Gear ration of 1:11 is used

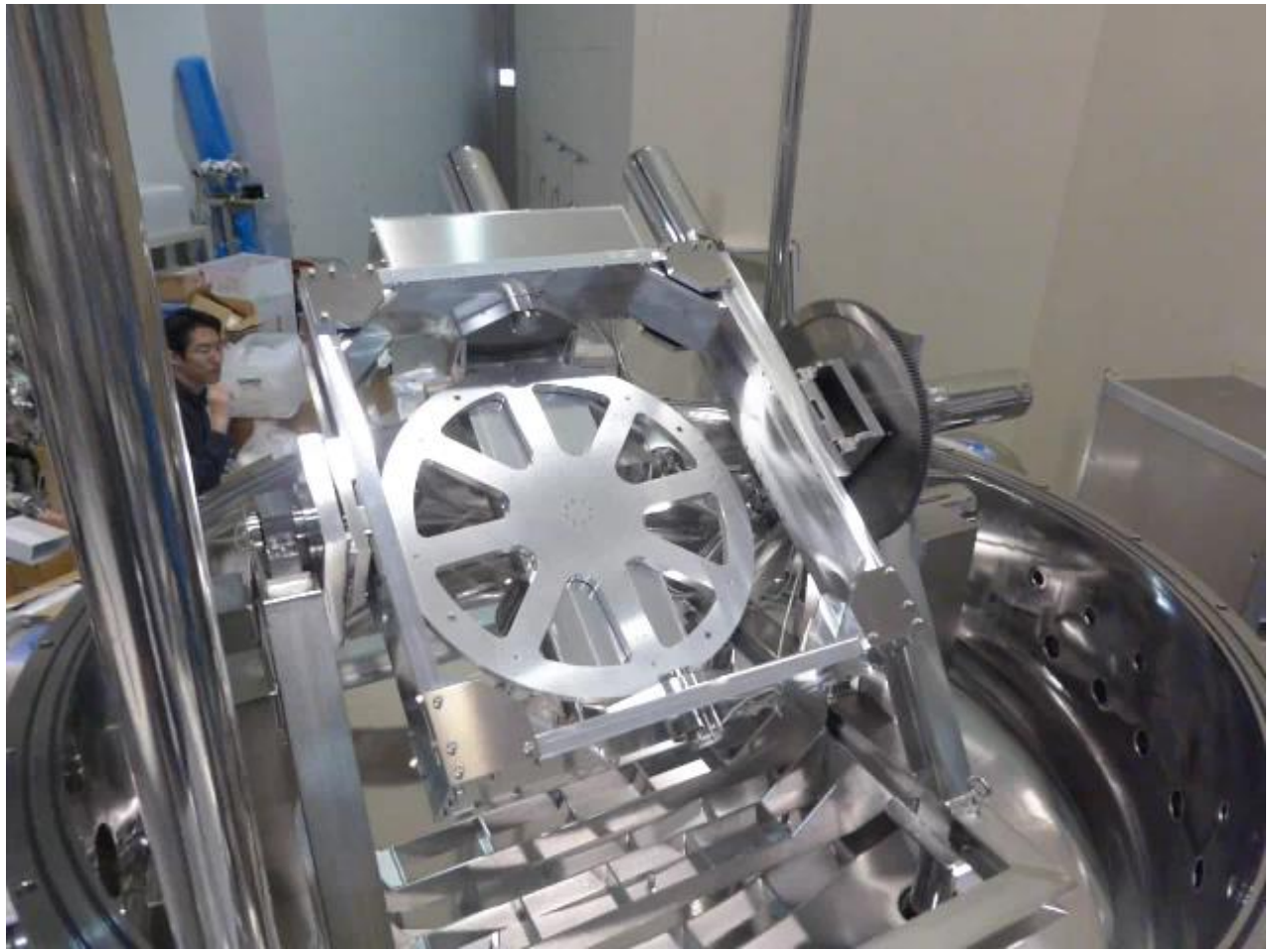
θ—2θ Stages

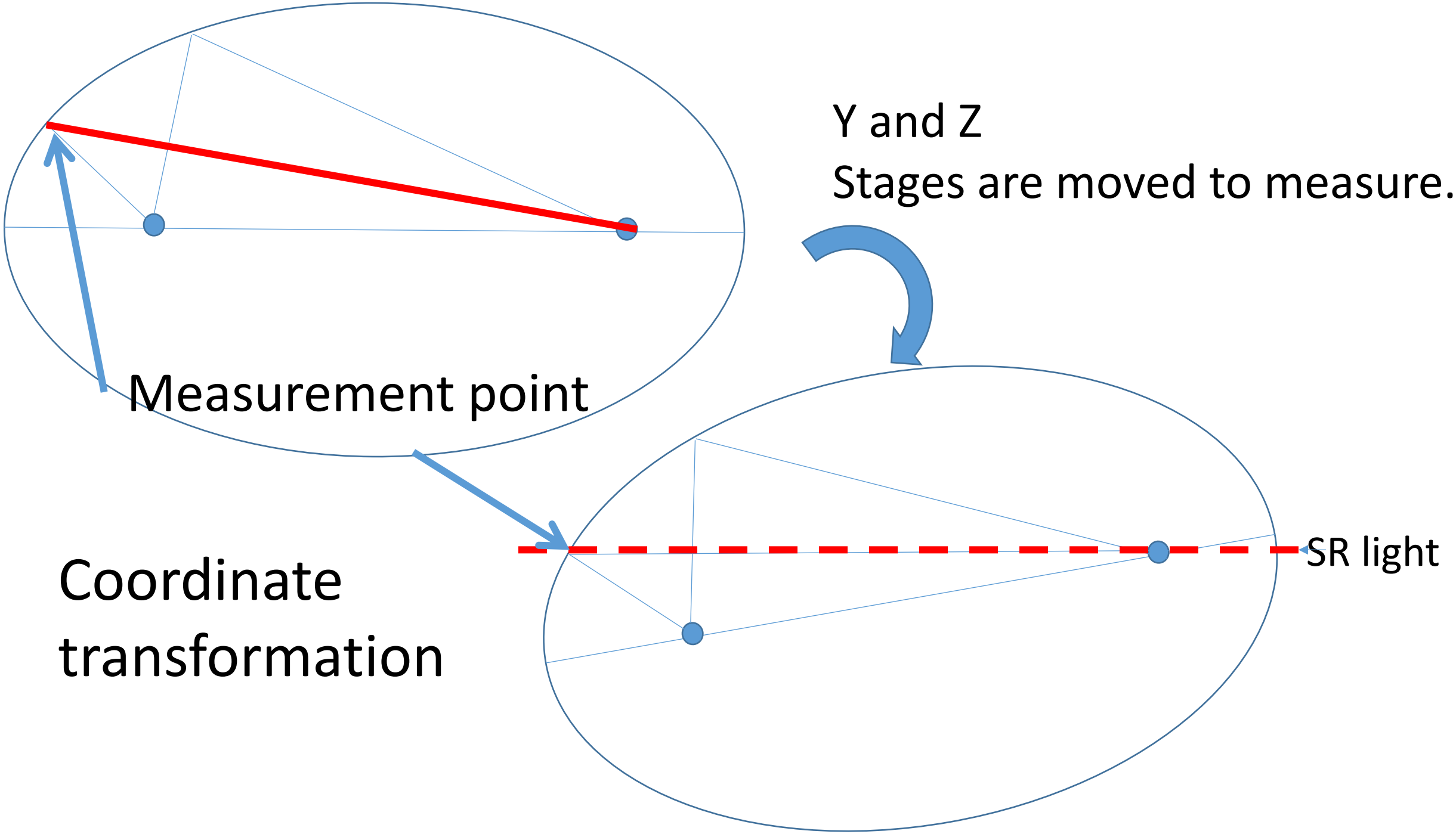
Flexible tube



Vacuum Vessel

Stepping motor in the atmosphere is used.




Y and Z
Stages are moved to measure.
Measurement point
Coordinate
transformation
SR light

Summary and Acknowledgement

- Dr. Yuriy Platonov of Rigaku Inovative technology gave me a specification of reflectometer in 2013.2 .
- We will measure LPP optics as soon as possible in collaboration with Rigaku Inovative Technologies.
- The development of this system was accomplished by financial support of Ministry of Education, Culture, Sports, Science and Technology