EUV Source Evaluation at the Intermediate Focus

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Canon

Outline

Speed&Quality

-Canon's Requirements for EUV Source

-Necessity of evaluation at IF

-Evaluation tools

-Evaluation of an EUV source

-Summary

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Definition of clean photon spot at intermediate focus (IF)

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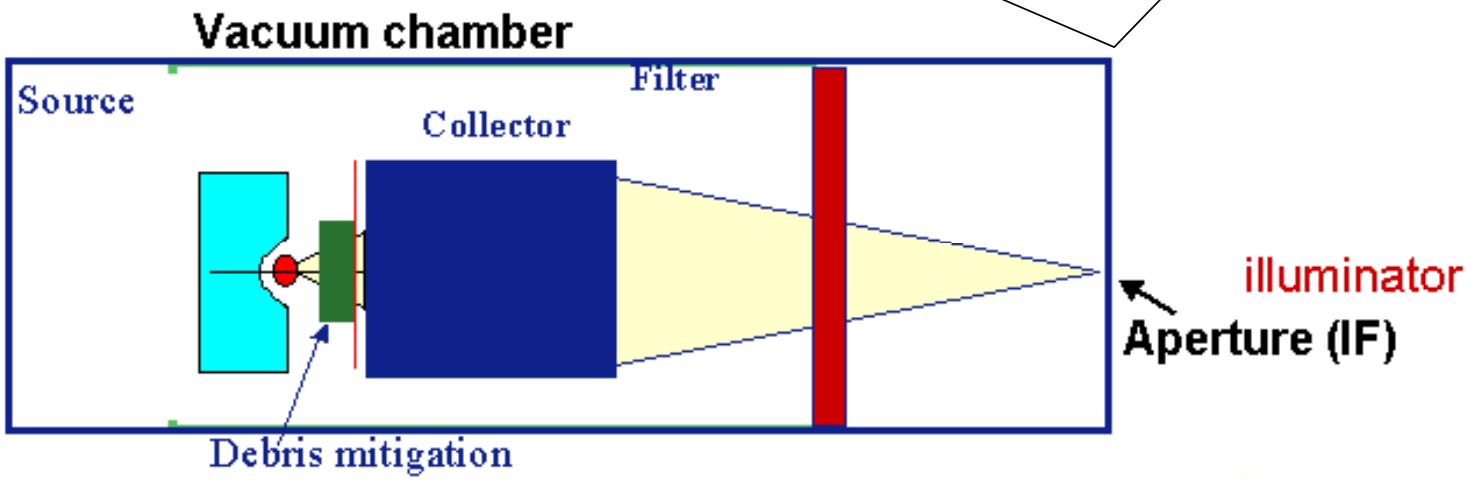
Source specifications are defined at intermediate focus (IF) which is illuminator entrance



Nikon ASML Canon

Joint Requirements for EUV Source

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SOURCE CHARACTERISTIC	REQUIREMENT
•Wavelength	13.5 [nm]
•EUV Power (in-band)	115 [W] *
•Repetition Frequency	> 7-10 kHz ***
•Integrated Energy Stability	±0.3%, 3σ over 50 pulses
•Source Cleanliness	≥ 30,000 hours **
•Etendue of Source Output	max 3.3 mm^2sr ***
•Max. solid angle input to illuminator	0.03 - 0.2 [sr] ***
•Spectral Purity:	
130-400 [nm] (DUV/UV)	≤ 3 - 7% ***
≥ 400 [nm] (IRVis) at Wafer	TBD ***

*** At IF**
**** After IF**
***** Design dependent**

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Canon's Requirements for EUV Source

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Other requirements

Following items are specified at IF.

Source Characteristics	Requirement
Pulse-to-pulse positional stability	< 10% (3s) of source size
Angular distribution of power	TBD (must be axially symmetrical with respect to the optical axis.)
Rotational symmetry of power	TBD
Long term power drift	< +/-2% / optical monitor module lifetime
Stability of repetition rate	+/- 0.1% (long term)
Spatial distribution of power	TBD
Spectral purity	
< 130 nm	< 100%
130-400 nm	< 3%
400-800nm	< 10%
>800nm	< 0.2%
Vacuum before intermediate focus	TBD

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Evaluation at IF

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Source specifications are defined at IF.
Evaluation of EUV sources at IF is needed.

Necessity of the evaluation for exposure tool maker

-Reflection of information at IF to illuminator designs
-Acceptance check of EUV sources to a factory
-Feedback of information at IF to control an EUV source in an exposure tool

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Evaluation tools

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Canon has developed seven evaluation tools to measure the characteristics of an EUV source at IF.

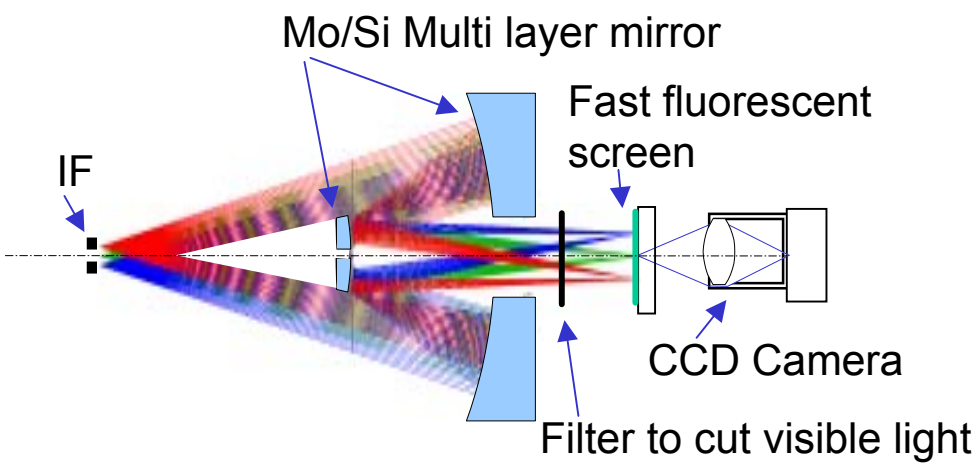
-Spatial distribution
-Angular distribution
-Fine spectrum
-Rough spectrum
-Total power
-Debris and contamination
-Gas flow

Etendue is obtained both by spatial distribution and angular distribution.
In-band EUV power is obtained both by angular distribution and fine spectrum.

Spatial distribution

Measurement of spatial distribution and pulse-to-pulse positional stability of power at IF.

This tool is comprised of
- Schwartzchild optics to project in-band EUV over all solid angle input into illuminator. (Pinhole camera is not suitable for this purpose.)
- a fast fluorescent screen to measure an image profile of the average spatial distribution over a few pulses.



Angular distribution

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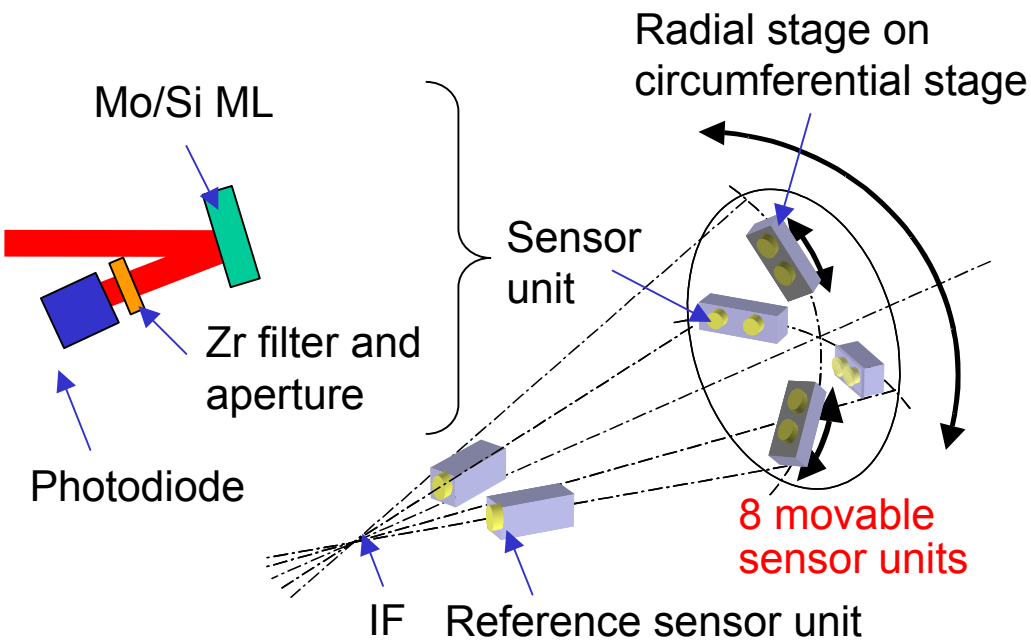
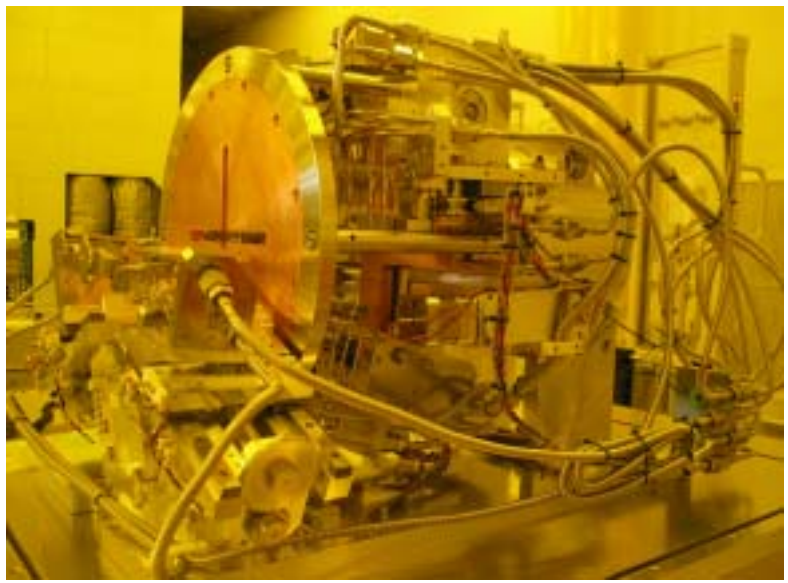
Measurement of angular distribution, rotational symmetry of power, pulse-to-pulse angular distribution and rotational symmetry stabilities.

Each sensor unit is comprised of a Mo/Si ML, a Zr filter and a photodiode.
There are eight movable sensor units in this measurement tool.
This tool is utilized to obtain in-band EUV power.





Fine spectrum

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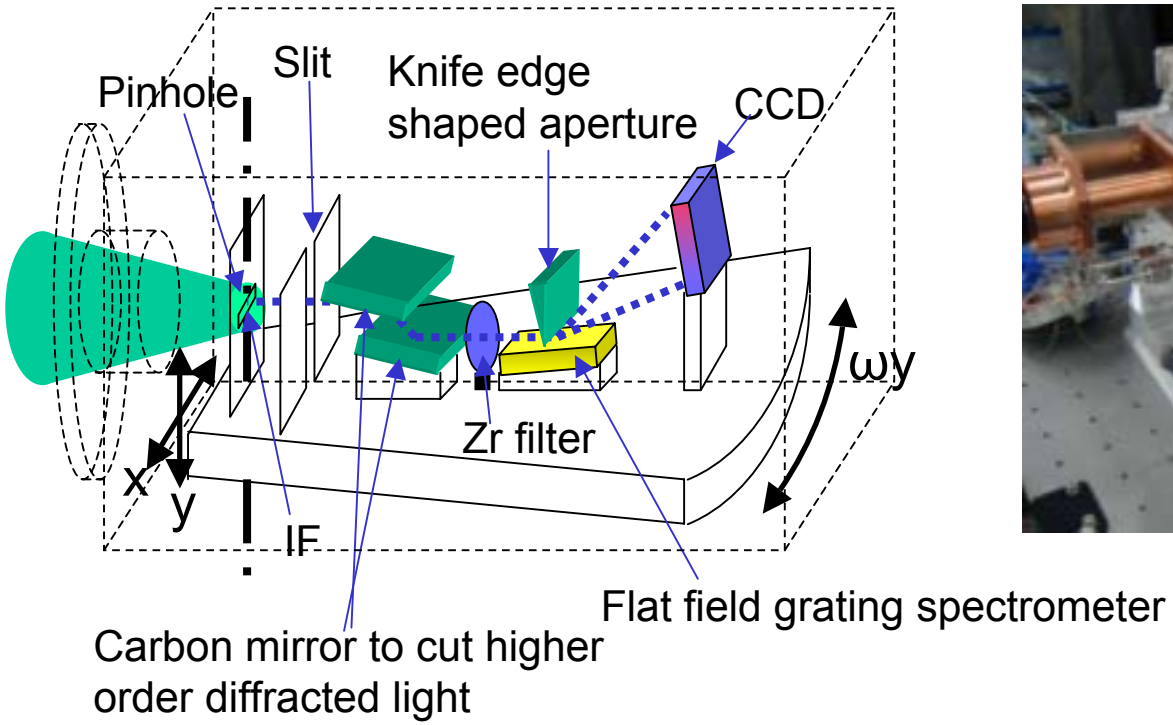
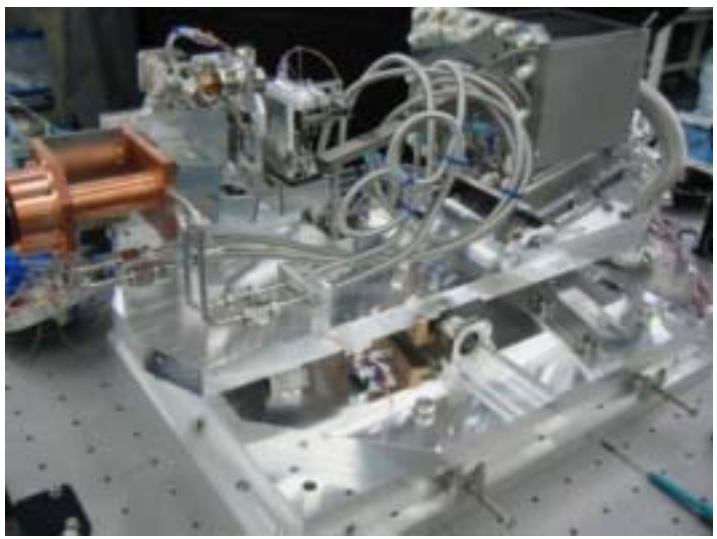
Measurement of fine spectrum of 12-17 nm.

Fine spectrum is measured to obtain in-band EUV power. The spectrometer is placed on x, y and ωy stages because angular dependence of in-band EUV has to be measured.





Chamber for evaluation tools

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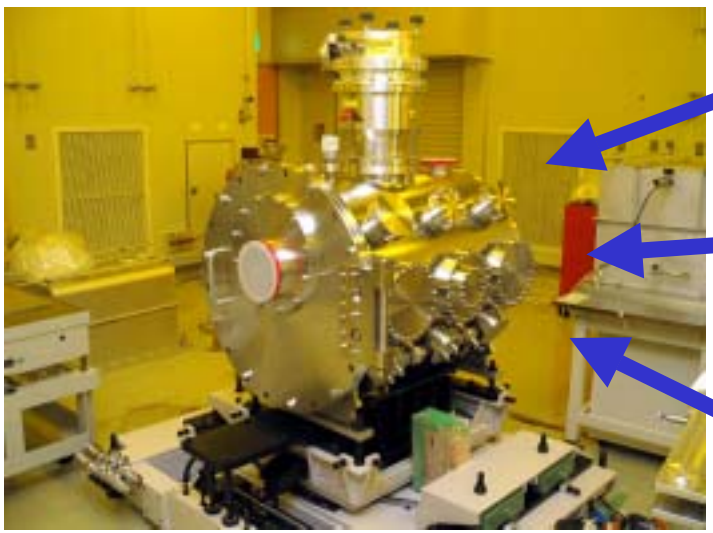
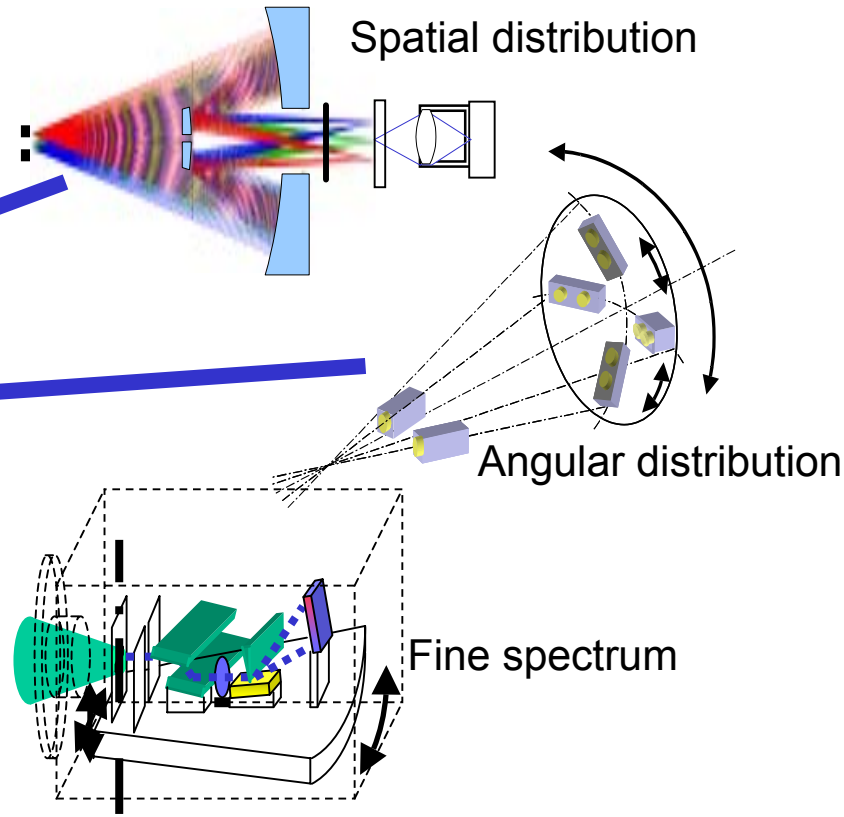
A vacuum chamber is shared for measurements of spatial distribution, angular distribution and fine spectrum measurements.

Each measurement tool is positioned to the same datum in the chamber.





Total power and Rough spectrum

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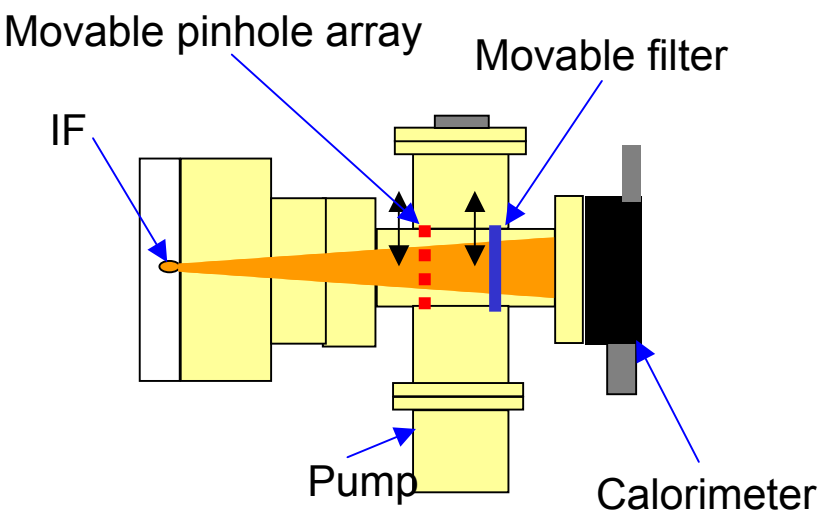
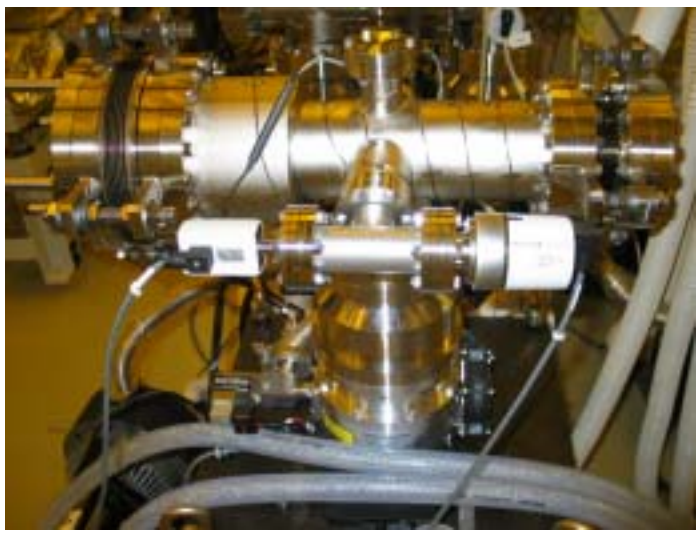
Measurement of total power and spectral purity with a calorimeter and filters.

Pinhole array is used as an ND filter.
Several pinhole arrays can apply to a wide range of input power.





Debris and contamination

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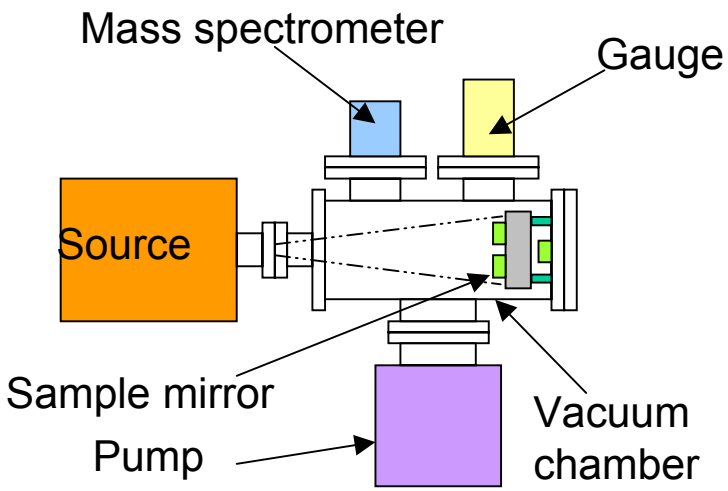
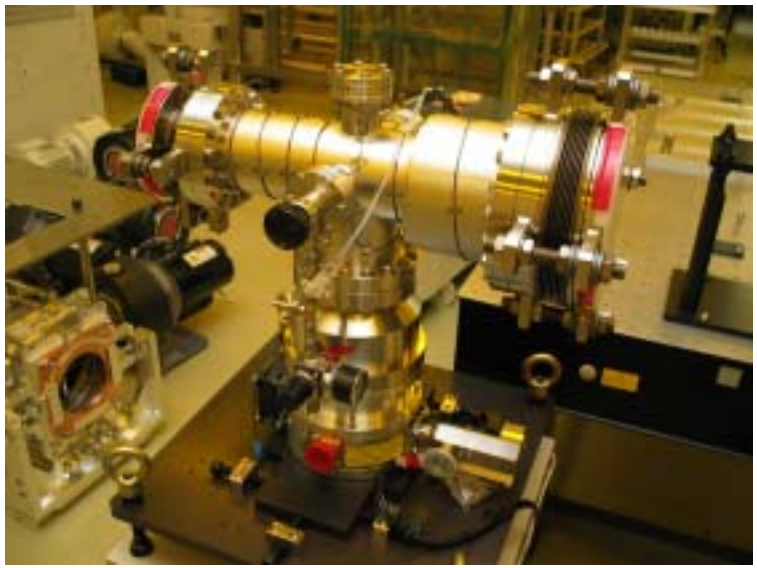
Measurement of deposited debris and contamination onto multilayer mirrors to measure an optics lifetime after IF.





Gas flow

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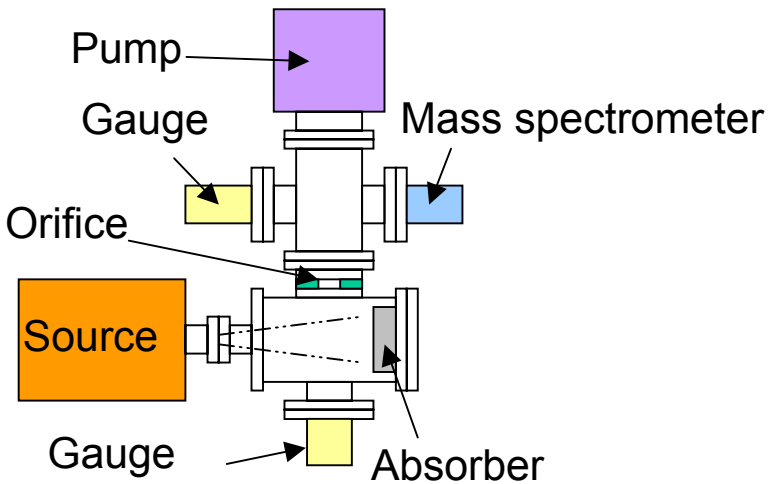
Measurement of gas flow rate and partial pressure by differential pressure between two chambers with known gas conductance of an orifice between the chambers.



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Evaluation of a Xe source

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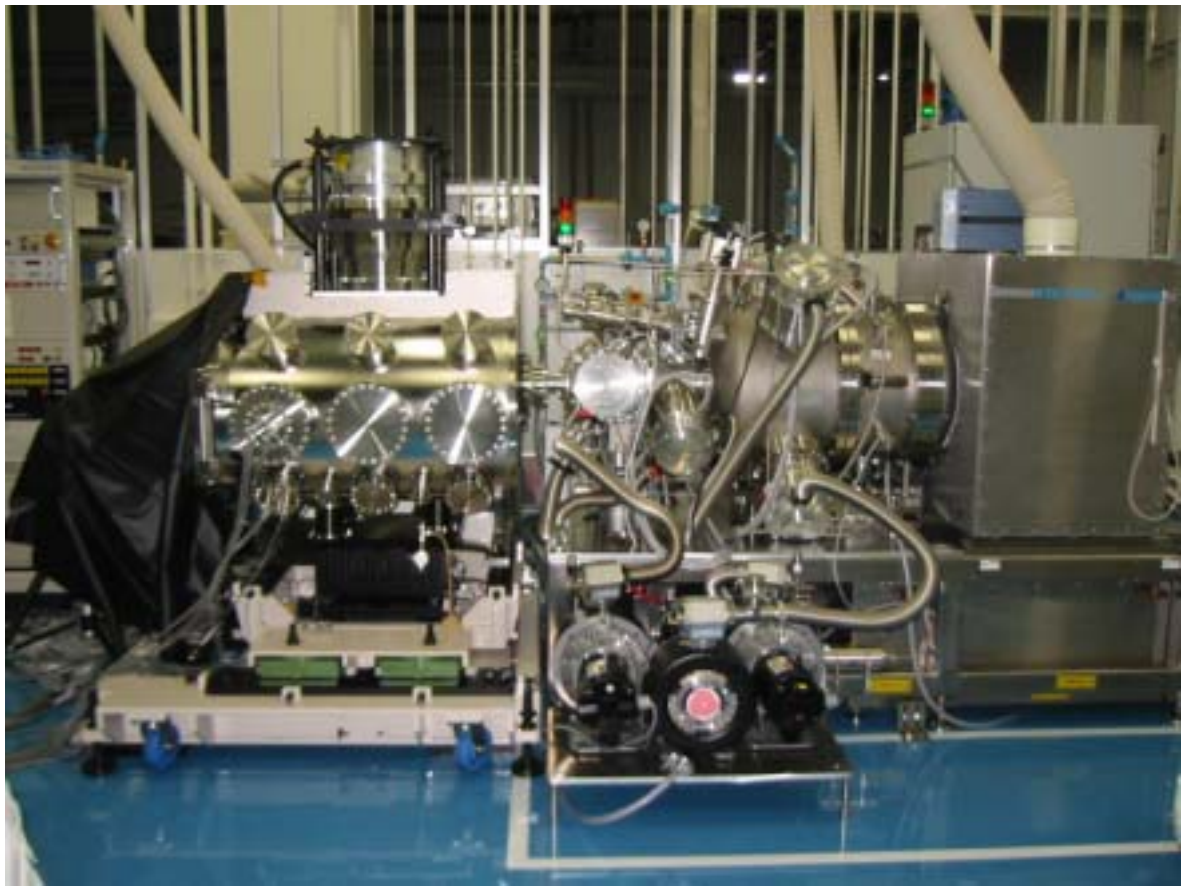
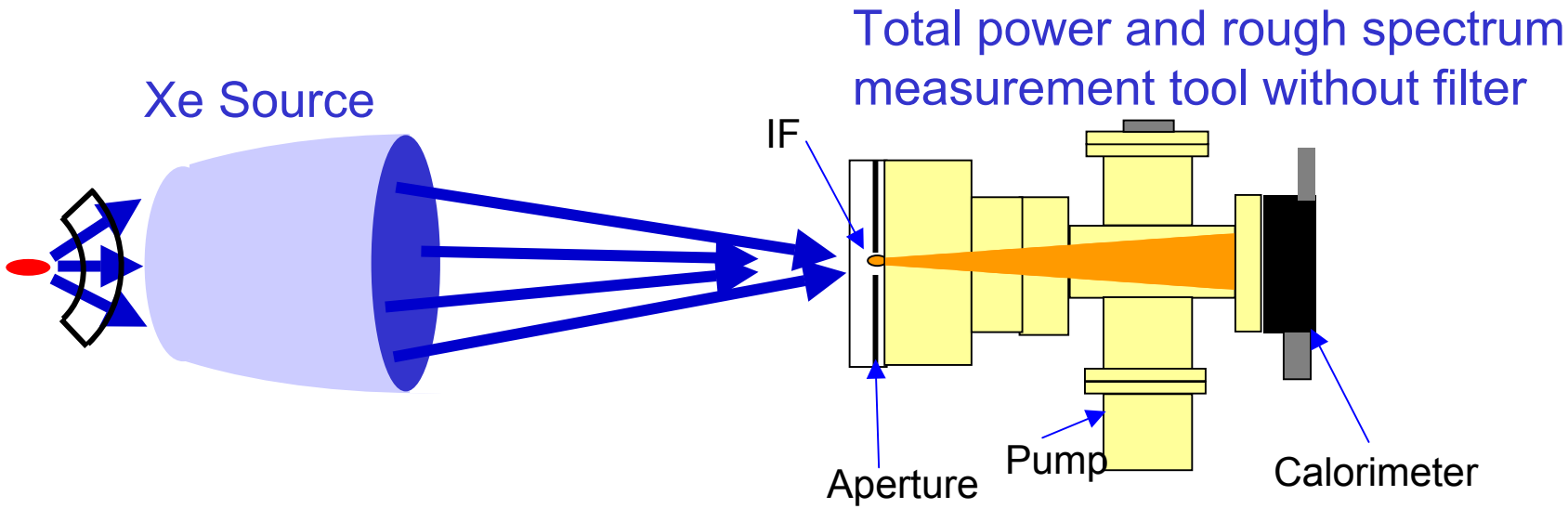
An EUV source was connected to the evaluation tools and the evaluation of the source just started.



Experimental data of Total power



Total power was obtained to be 6.6W when in-band EUV power is 0.6W.
Ratio of Total Power to In-band EUV Power is 1100% at IF.

Experimental data of Fine Spectrum

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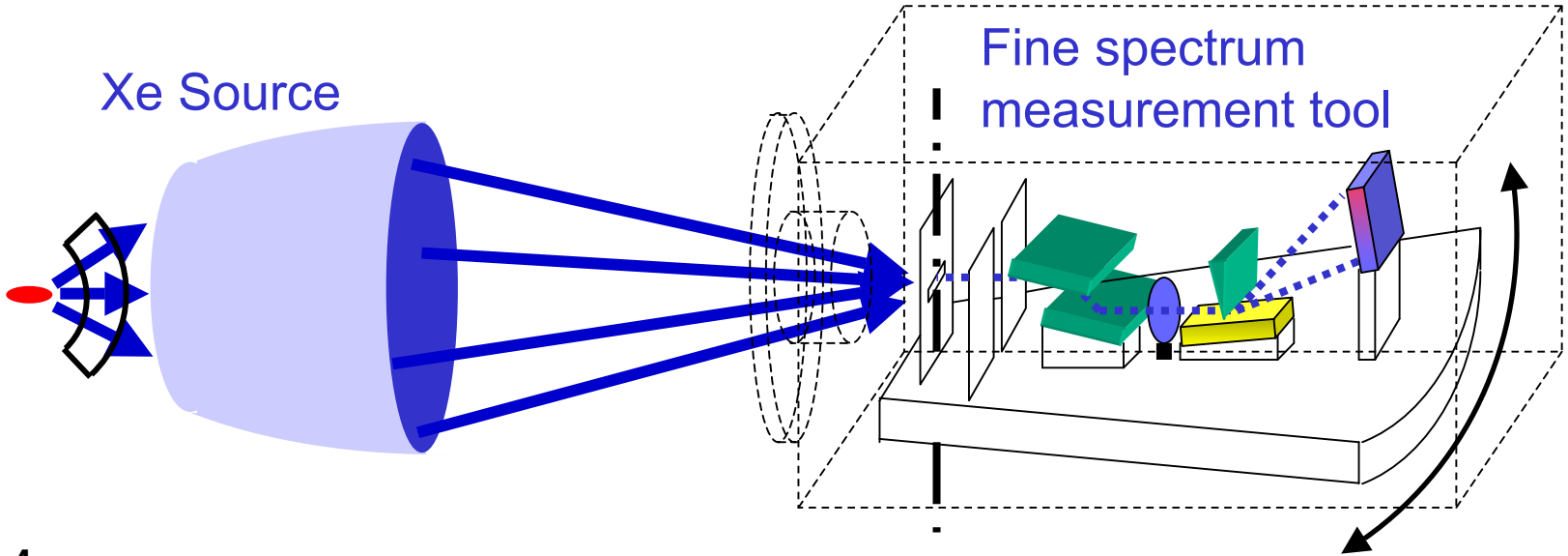

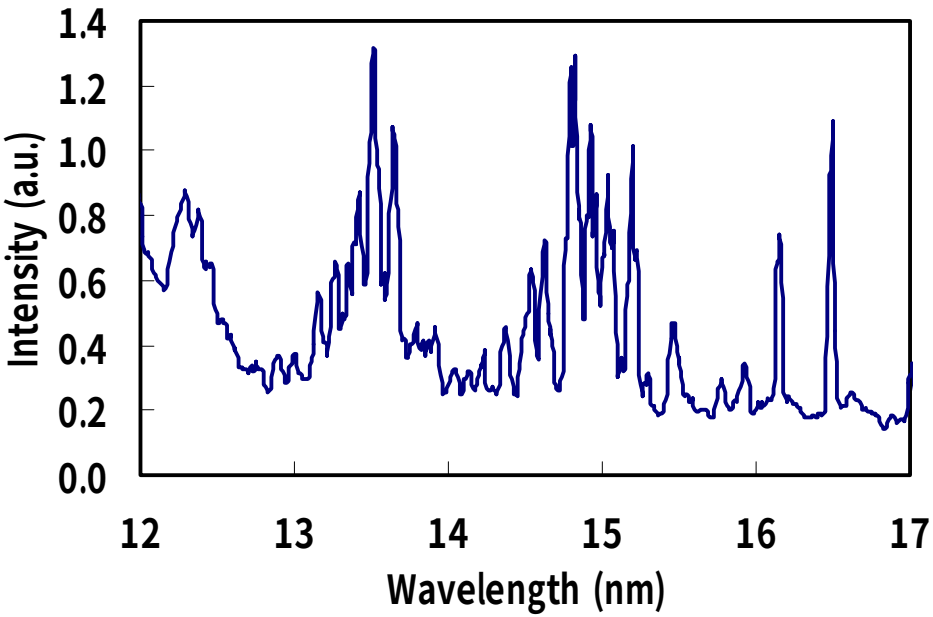

Canon has already prepared EUV source evaluation system at IF.

Canon just started to measure the characteristic of an EUV source.

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1. Canon has prepared EUV source evaluation system at IF.

2. The evaluation system which is comprised of seven measurement tools which make possible to measure the characteristics of all items in Canon's requirements.

3. Canon started to measure the characteristics of an EUV source.

END