

EUV Source Metrology Roadmap

Source Development

α -Tool

β -Tool

γ - Tool

• Methods standardized
 ==>
 Tools which follow procedure and have evaluation procedures that lead to commonly accepted values.

- Integrate Metrology in Tool
- Monitor Source Performance
- Correlate Source - Tool Performance
- Find Reasons for Potential Malfunction
- Identify Critical Parameters
- Develop Tool Metrology System
-

Intermediate Focus !!
 Clean Photons

 + Monitors for relevant component features

 (e.g.
 Source Spectrum,
 Source Position)

- Stability
- Reproducibility
- Lifetime
-

- Test Tool M
- Develop Clo

2003

2004

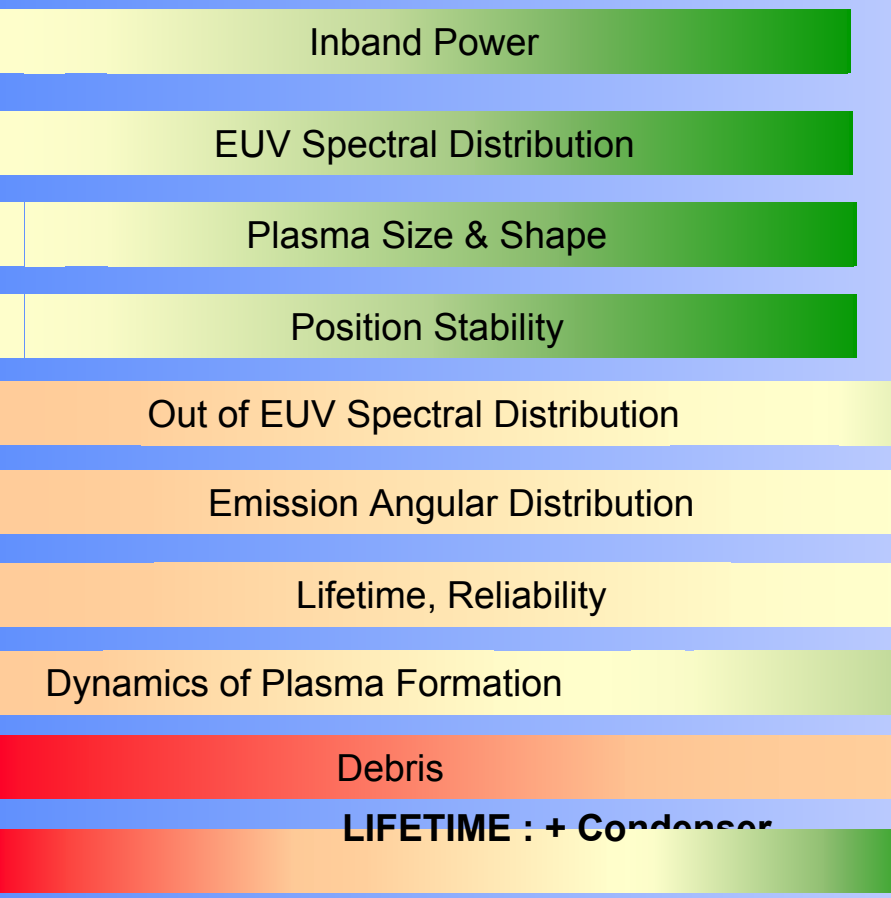
2005

2006

2007

EUV Source Metrology Roadmap

Source Development



Fair Order of Priorities:

Calibration !!!

Validity for longer lifetime !!

Recalibration of tools !!!

Secondary Calibration necessary !!
(Become available at Lab Sources)

Where : At interface vessel !

DEFINE : Tolerance Budget

TASK OF SOURCE SUPPLIERS !

AS USEFUL AS POSSIBLE !

DEFINE STANDARD MEASUREMENT PROCEDURES.

2003

2004

2005

Tasks / Items / Projects

Absolute Calibrated metrology (Standards)

- Reference to National Lab
- Studies on non linear effects
- Off-Synchrotron secondary calibration
- Standardized measurement procedures
- Cross calibrations of suppliers

Lifetime of optics at high power sources

Quantification of "debris"

- Ion / Electron analysis
- Detection of neutrals
- Direct optics lifetime measurement
- Scalable quantities
- Secondary processes (chemistry)

Lifetime of metrology at high power sources

- Calibration lifetime studies
- Studies on debris effects
- Concepts for long calibration lifetime

Out-of band measurements

- Out of band measurement procedure
- Out of band calibration
- Stability of ratios in / out of band

Characterization of IMF

- Absolute power
- Spectral distribution
- Beam quality

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EUV Source Metrology Roadmap

Working Group E

Metrology Suppliers

AIXUV
 JENOPTIK Mikrotechnik
 Phystex
 Scientec Engineering
 ...

National Labs

CXRO
 N
 P

Metrology Research

CXRO
 FOM
 ISAN
 National Labs
 Phystex
CREOL, USF

Procedure:
 Jointly with SEMATECH will make a suggestion of how to start such a working group

White Paper Version I :
 Draft on Source Metrology

Issues
 Procedures
 Tools
 Feedback request

rs / Developers

UV
 ER
 EMI
 EUV
 EX
 ase
 V
 hnnologies
 ...

ors / End users

ML
 on
 ECH
 on
 SS
 :ON

Goal:

The EUV Source Metrology Roadmap will allow outlining development needs and ensure that developers and end-users needs are met in time.

Definition of the EUV Source Metrology Roadmap

Vivek Bakshi, International SEMATECH



Fred Bijkerk, FOM Institute of Plasma Physics



Rainer Lebert, AIXUV GmbH



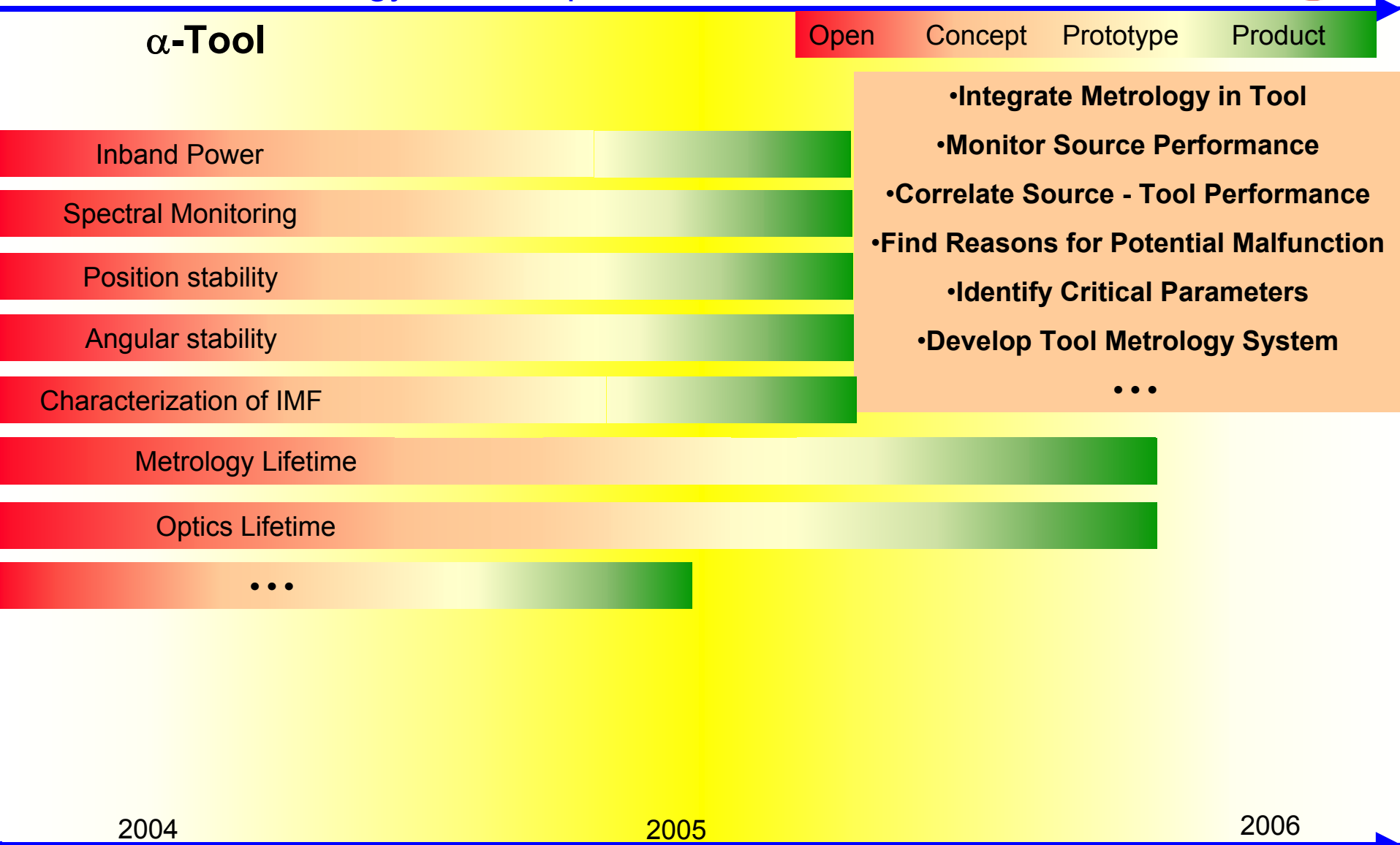
Max C. Schürmann, JENOPTIK Mikrotechnik



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EUV Source Metrology Roadmap



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-

EUV Source Metrology Roadmap

β -Tool

Open Concept Prototype Product

- Test Tool Metrology System
- Develop Closed Loop Control
-

Characterization of IMF

Tool Metrology System

Software

•••

2005

2006

2007

EUV Source Metrology Roadmap

γ -Tool

Open Concept Prototype Product

•Metrological Data into
Fab Automation

...

...

2006

2007

2008

Example: Inband Power (Source Development)

Quantity	Definition	Comment
Inband:	13.5nm 2% BW	depending on emitter
Collectable solid angle:	1.8 sr	depending on collector optics
Solid angle accepted by power monitor:	not defined	angular power distribution
Location of accepted solid angle:	not defined	angular power distribution
Max. source size (FWHM)	1,3 mm(rad) x 1,6 mm(ax)	Etendue limitation of collector optic
Source size accepted by power monitor:	not defined	plasma size / shape
Re-absorption of EUV / beam path length	not defined	residual gas
Transfer procedure of calibration	not defined	non linear effects
Lifetime of calibration	not defined	debris
Data accumulation / analysis	not defined	repetition rate, pulse energy, stability
Acceptable signal values	not defined	pulse energy
Time resolution	not defined	pulse structure
Accuracy of power measurement:	not defined	

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Example: Measurement of Debris (Source Development)

<u>Quantity</u>	<u>Definition</u>	<u>Comment</u>
Debris	not defined	collective term for various effects
Emitted particles		ions / electrons / neutrals / clusters...
Kinetic energy of emitted particles		
Flux of emitted particles		
Combined effects with residual gas		e.g. photo chemistry
Secondary produced debris		debris mitigation tool
Angular distribution of debris		
Prospected optics lifetime		scalable quantities
Accuracy of debris measurement:		pre-estimate optics / components lifetime
• • •		

Example: Characterization of Intermediate Focus (α -Tool)

Quantity	Definition	Comment
Usable power	Inband	
Inband beam quality	not defined	depends on quality (collector x source)
related: max. source size	1,3 mm(rad) x 1,6 mm(ax)	
Angular power distribution		
Wavefront		
Focus position stability	not defined	
related: source position stability	< 60 μm (rad); < 150 μm (ax)	
Out of band power		
...		

...input for the Source Metrology Roadmap is welcome!

Acknowledgement

Thomas Mißalla, JENOPTIK Mikrotechnik



Harald Sakowski, Carl Zeiss SMT



For the time being:

- inband power flux (2 % bandwidth,

- Spectral distribution
 - “Wavefront” ?
- Angular distribution

γ -Tool:

- System - Integrators : Source Characterization at intermediate focus
- Power Flux
 - Spectral distribution
 - “Wavefront” ?
 - Angular distribution

System - Integrators : Source Characterization at Intermediate Focus