

Definition of the EUV Source Metrology Roadmap

Vivek Bakshi, International SEMATECH



Fred Bijkerk, FOM Institute of Plasma Physics



Rainer Lebert, AIXUV GmbH



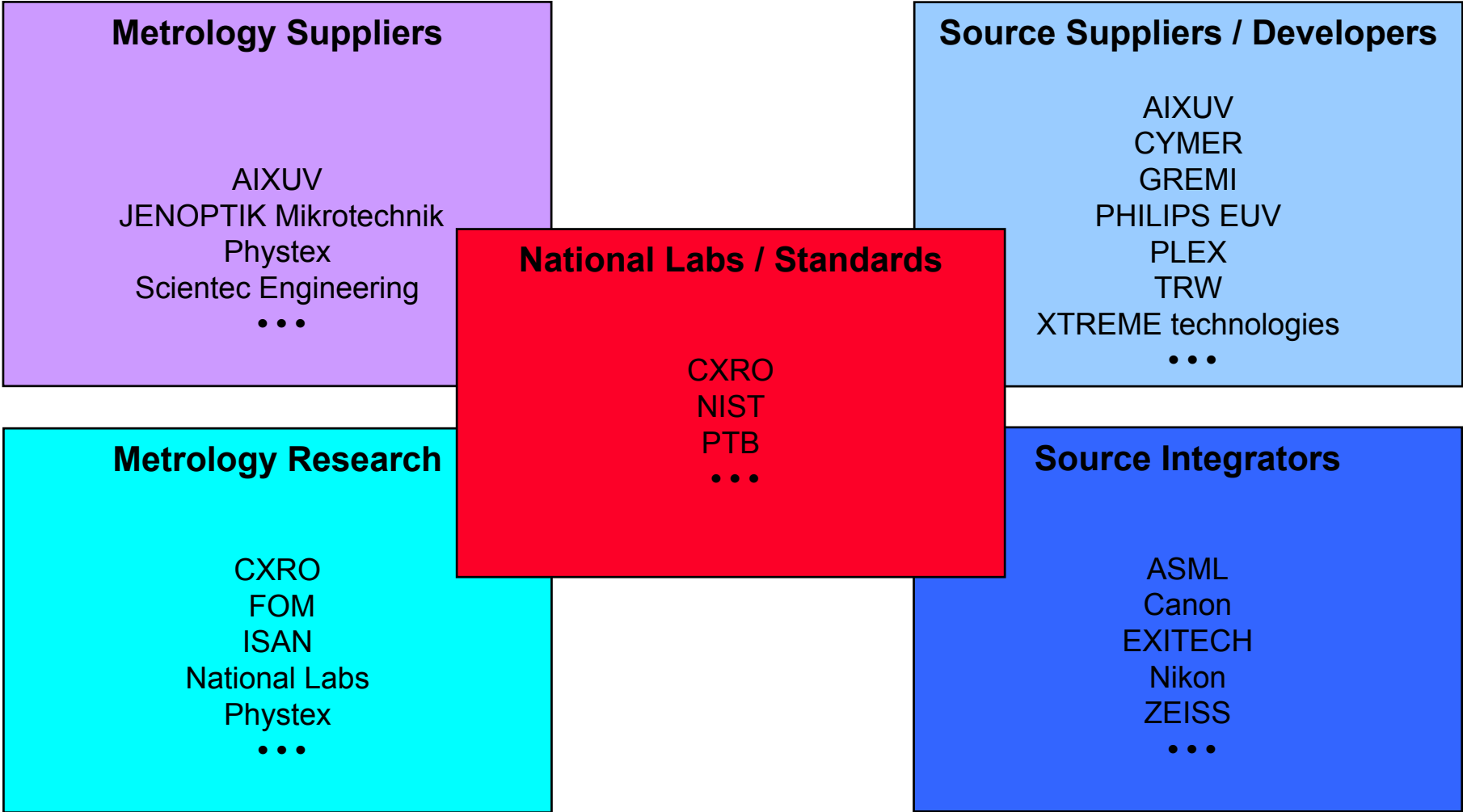
Max C. Schürmann, JENOPTIK Mikrotechnik



Goal:

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

Working Group EUV-Source Metrology



EUV Source Metrology Roadmap

Source Development

α -Tool

β -Tool

γ - Tool

- Understand the Emitting Plasmas
 - Search for Best CE
- Power Scaling of Sources
- Give System Integrators Data on Source Performance
 - • •

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

- Metrological Data into Fab Automation
 - • •

- Stability
- Reproducibility
- Lifetime
 - • •

- Test Tool Metrology System
- Develop Closed Loop Control
 - • •

2003

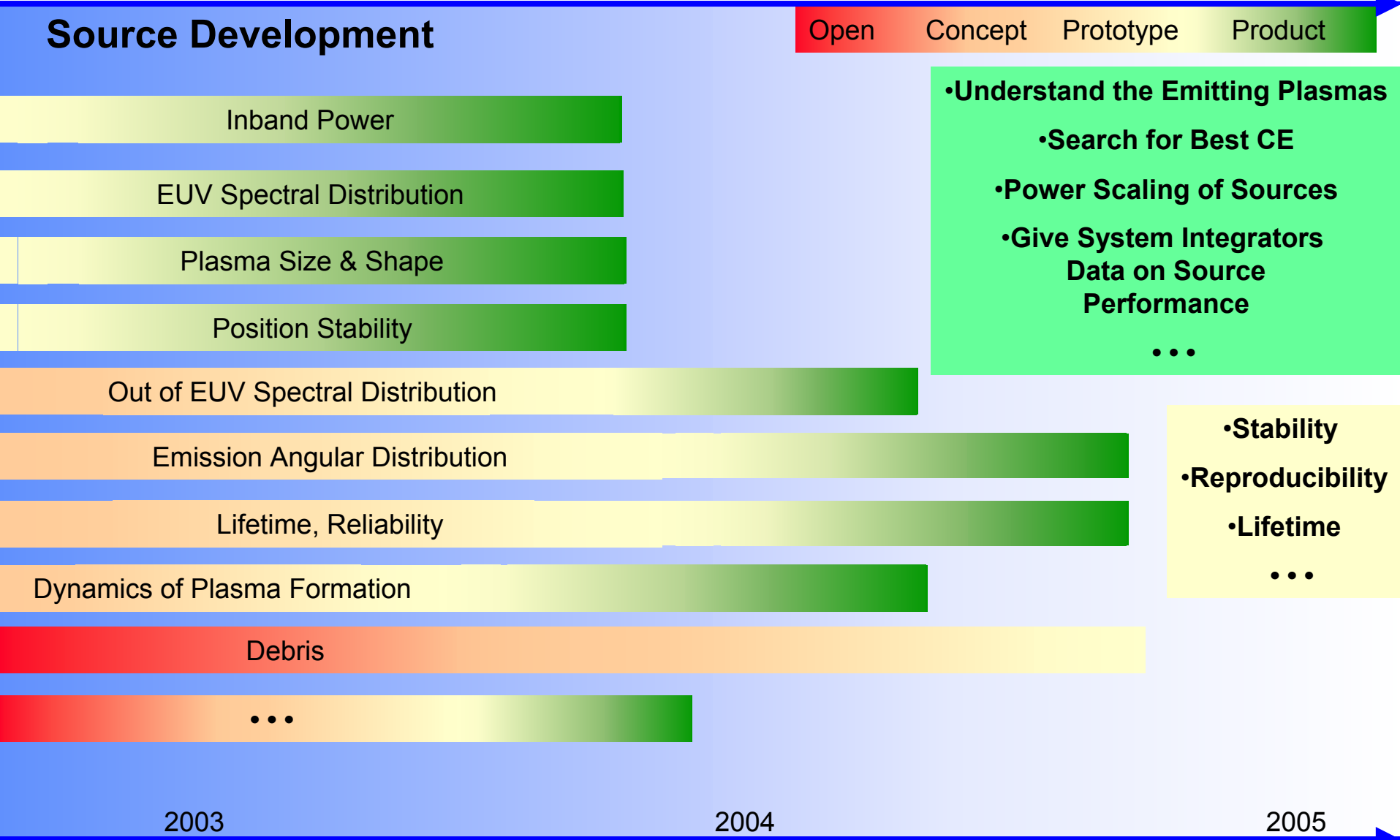
2004

2005

2006

2007

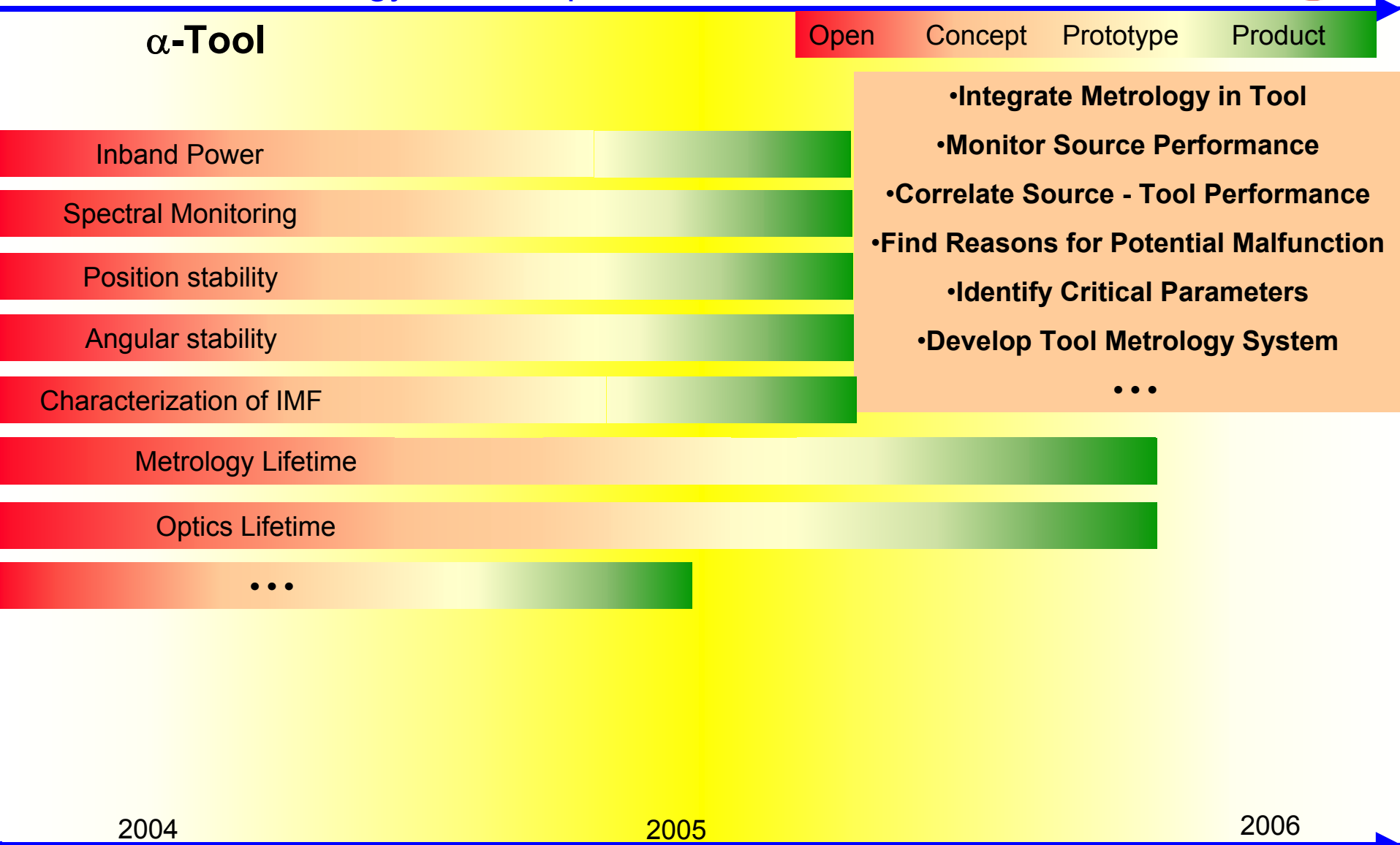
EUV Source Metrology Roadmap



- Understand the Emitting Plasmas
- Search for Best CE
- Power Scaling of Sources
- Give System Integrators Data on Source Performance
-

- Stability
- Reproducibility
- Lifetime
-

EUV Source Metrology Roadmap



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

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

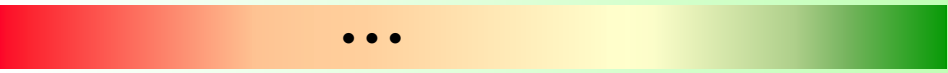
2006

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	

• • •

Example: Measurement of Debris (Source Development)

Quantity	Definition	Comment
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)

<u>Quantity</u>	<u>Definition</u>	<u>Comment</u>
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		
...		

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

...

- ...

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

Acknowledgement

Thomas Mißalla, JENOPTIK Mikrotechnik



Harald Sakowski, Carl Zeiss SMT

