



Mask maintenance cycle for EUV masks with pellicle

Cleaning tool supplier perspective

EUV Mask Pellicle TWG
Maastricht, The Netherlands, 4th October 2015

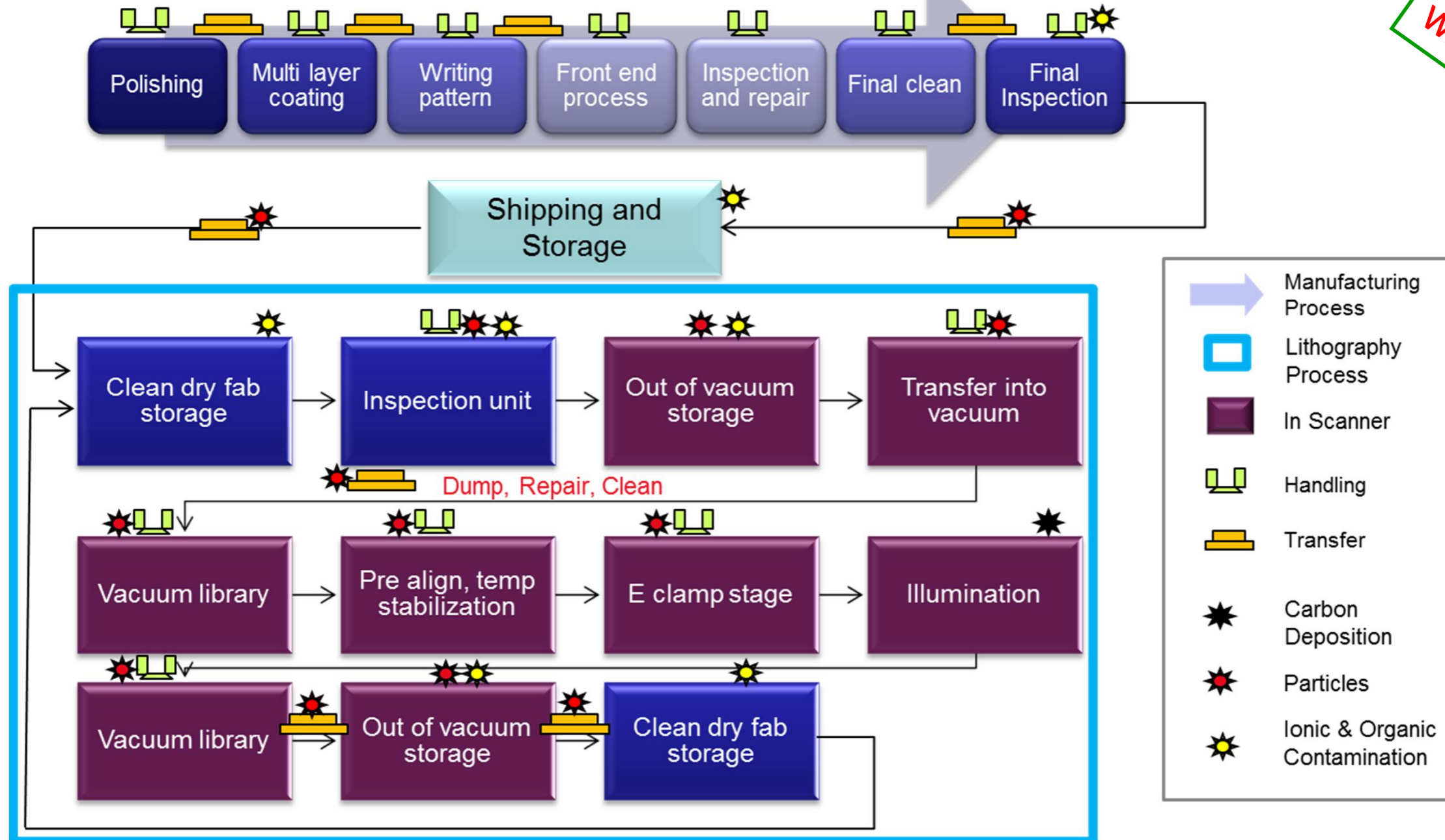
Jens Krümborg, Oliver Brux, Peter Dress, Uwe Dietze

- + Introduction
- + Pellicle related mask maintenance challenges
- + Summary

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- + From 2009 to 2012, SÜSS, in close cooperation with other industry partners, developed solutions for pellicle less EUVL mask maintenance. Project names were EXEPT and SEAL

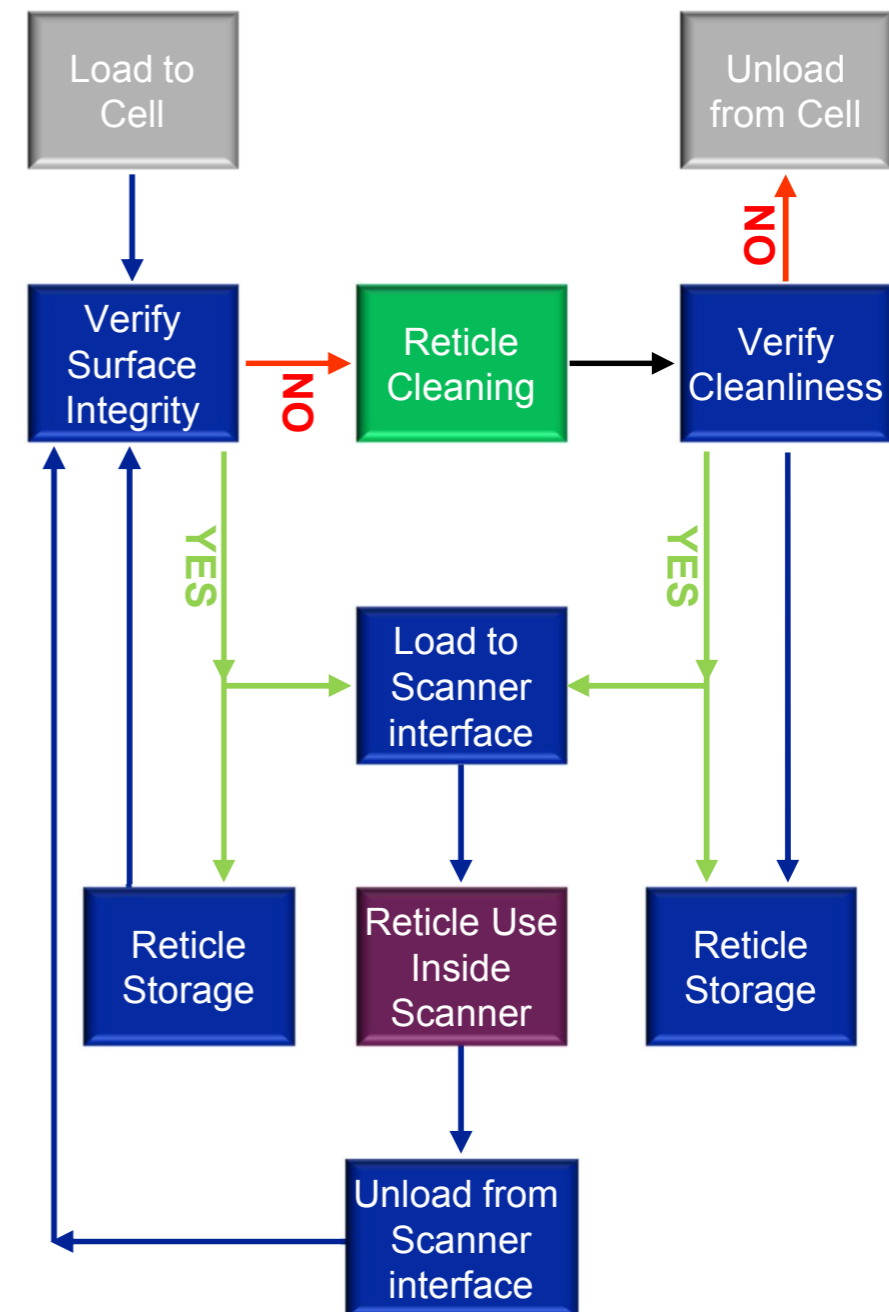
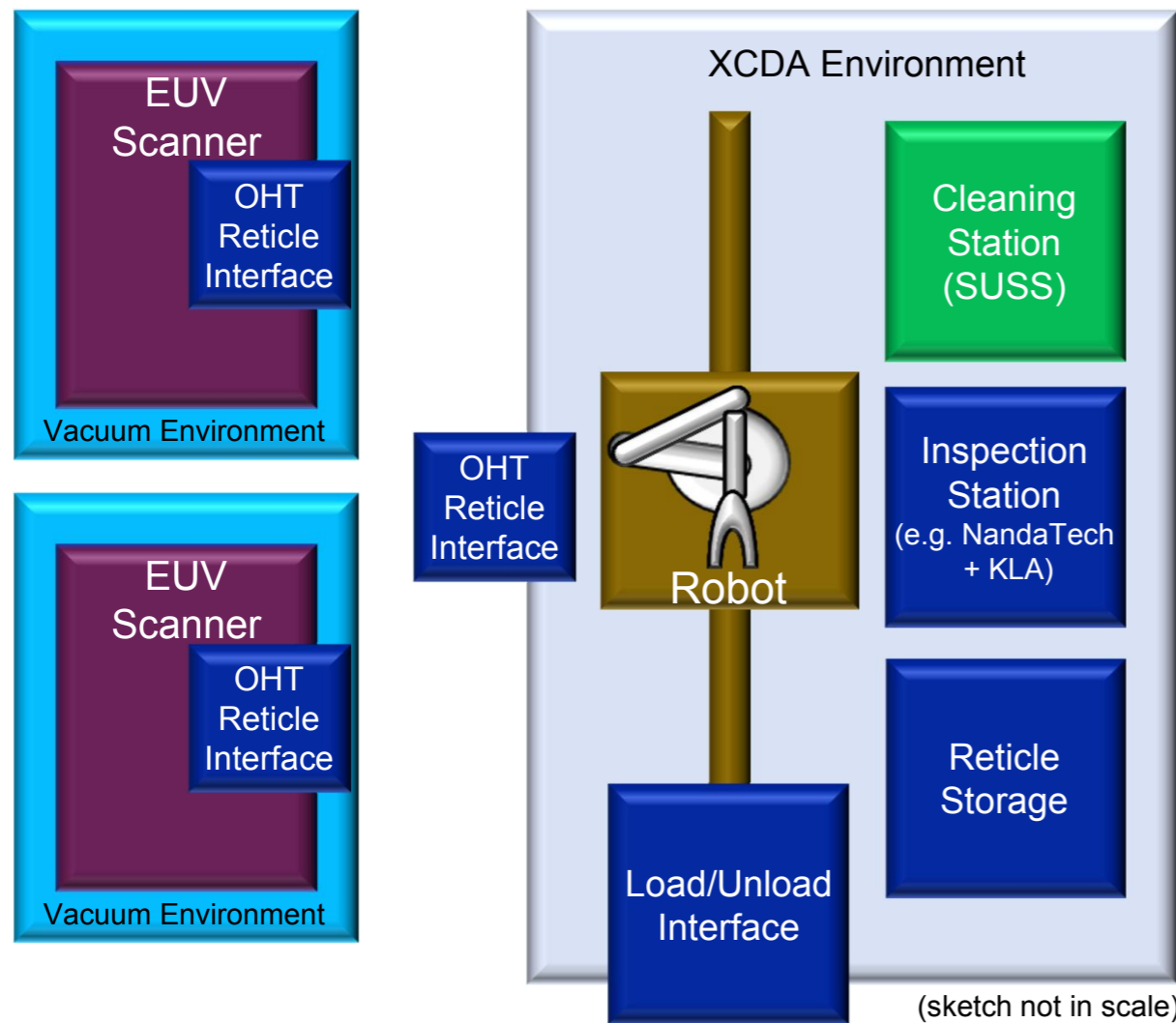
EUV Reticle Life Cycle



EUV mask
w/o pellicle

"In-fab EUV Reticle Maintenance: Needs – Challenges – Solutions" : P. Dress, S. Singh, U. Dietze
EUVL Conference, Lake Tahoe, September 2008

+ Integrated inspection, cleaning and storage maintenance cell for EUV masks **w/o pellicle**



Advantages

- + Fast turn-around
- + Decreased risk of particle adders
- + No environmental trace deposition
- + In-line data collection, analysis and use

Maximized MTBC & Increased Reticle Life → Reduced Cost

+ Mask cleaning challenges for EUV masks **without** pellicle

- + EUV mask front-side cleaning process (100x) without influencing the mask printing quality (→ EXEPT)
- + EUV mask back-side cleaning (→ SEAL)

EUV mask backside cleaning

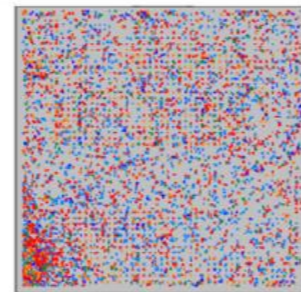
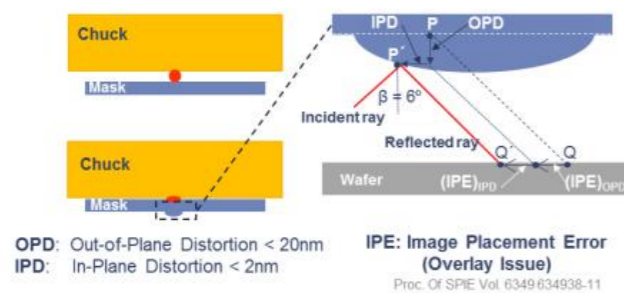


EUV mask front side cleaning



- + Maintenance cell

RISK OF BACKSIDE PARTICLE CONTAMINATION



Defect map of the mask backside after reticle clamp

- + Backside particles cause mask distortion and image placement errors (IPE)
- + Backside Inspection is necessary to eliminate scanner contamination
- + Particle size detection of < 500nm @ a dynamic capture rate > 95% is critical
- + Inspection of entire backside (152mm x 152mm) is a prerogative

EUVL MASK MAINTENANCE INFRASTRUCTURE



UNIQUE INFRASTRUCTURE REALIZED INTEGRATING CLEANING, BACK-SIDE INSPECTION AND AUTOMATED HANDLING OF NXE3100 RETICLES



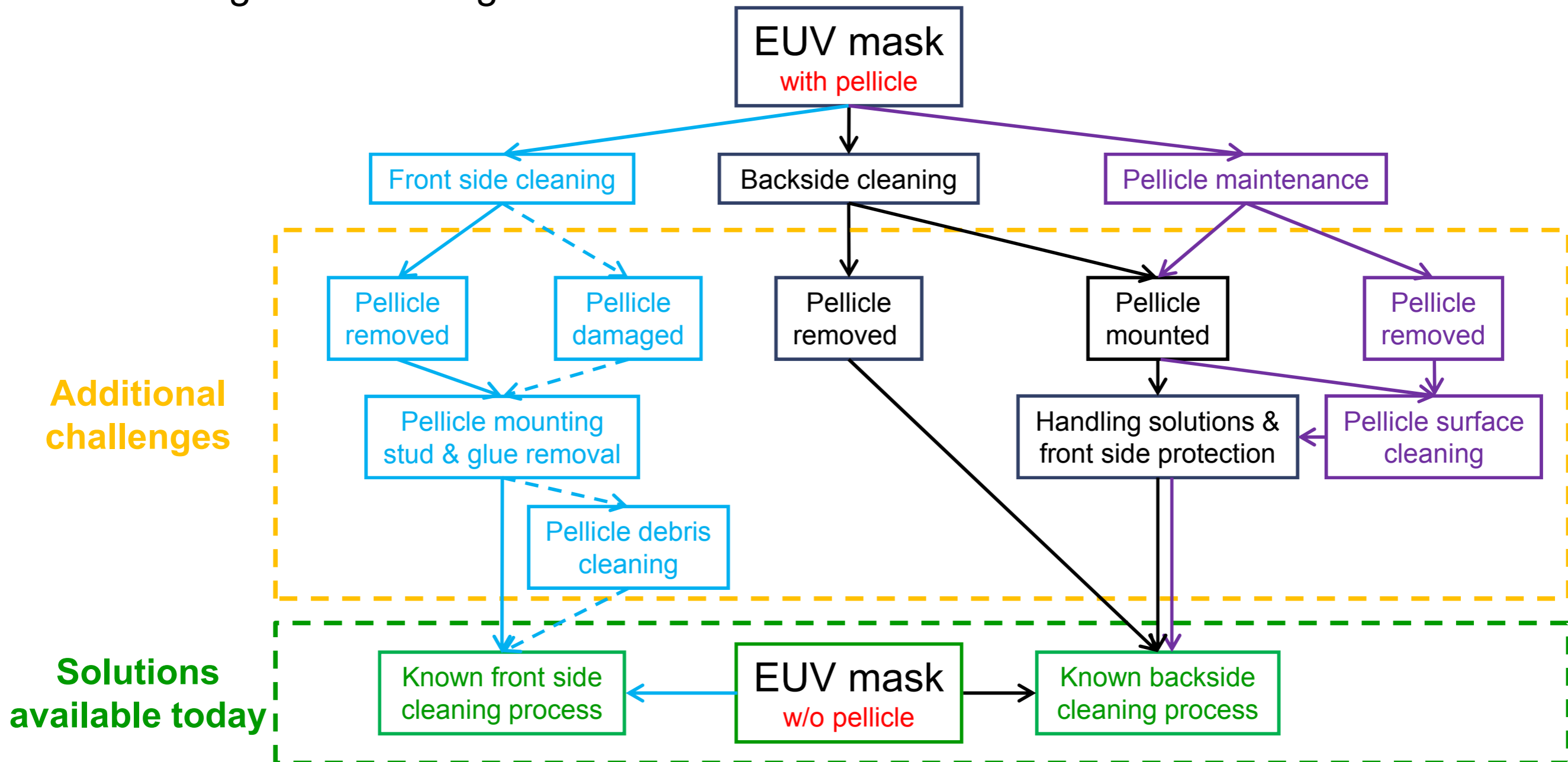
R. JONCKHEERE @ EUVL SYMPOSIUM 2012, BRUSSELS

“Challenges and solution ensuring EUVL mask integrity”
O. Brux, P. Dress, H. Schmalfluss, R. Jonckheere, W. Koolen-Hermkens
Photomask Japan, 19th April 2012

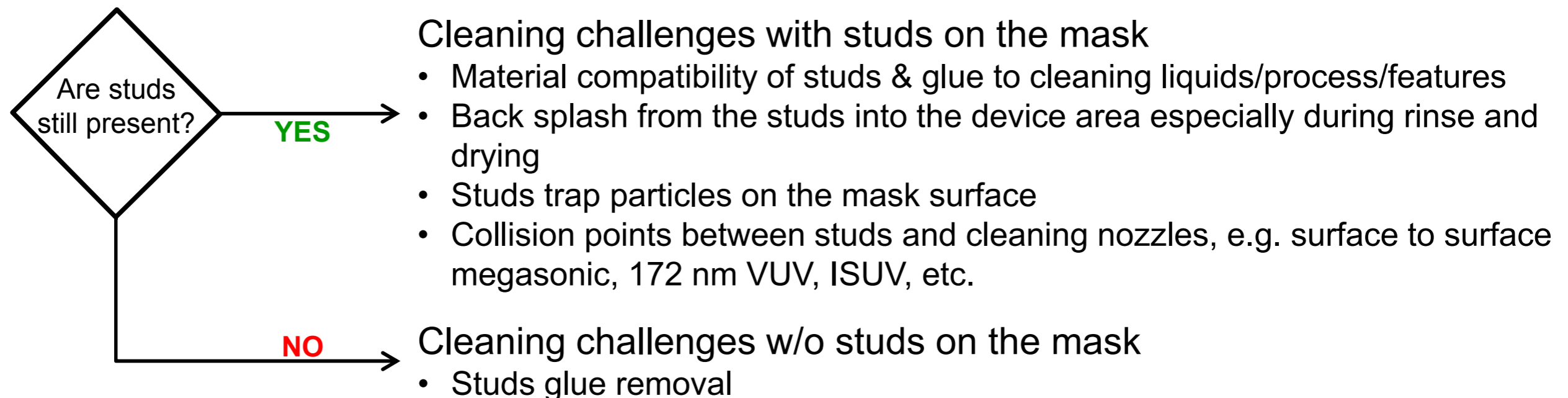
“Remaining EUVL mask cleaning challenges”
S. Singh, P. Dress, O. Brux, U. Dietze
IEUVI Mask TWG, San Jose, CA, 24th Feb. 2013

- + Introduction
- + Pellicle related mask maintenance challenges
- + Summary

- + Pellicle on EUV mask introduce additional challenges for mask cleaning
- + Cleaning of EUV masks without pellicle is solid background and prerequisite for addressing new challenges



- + Pellicle design (material, layout) introduces further cleaning challenges
 - + In one dimension the pellicle size equals the mask size
 - New mask handling solutions required
 - + Material of the pellicle is Si: in case of pellicle is damaged → debris is deposited onto the mask surface
 - Mask and debris have chemical similar properties → physical cleaning methods only
 - + Connection of the pellicle to the mask surface by four studs
 - After demounting the pellicle a mask front side cleaning process is required
- + New challenges for **front side cleaning** of EUV mask after removing the pellicle



+ Pellicle on EUV masks introduces additional challenges

+ SÜSS PE is addressing those challenges on equipment and process side: e.g. as participant of the European SeNaTe consortia (2015 – 2018)



+ Equipment compatibility for handling EUV masks with pellicle

+ Backside cleaning of EUV masks with pellicle

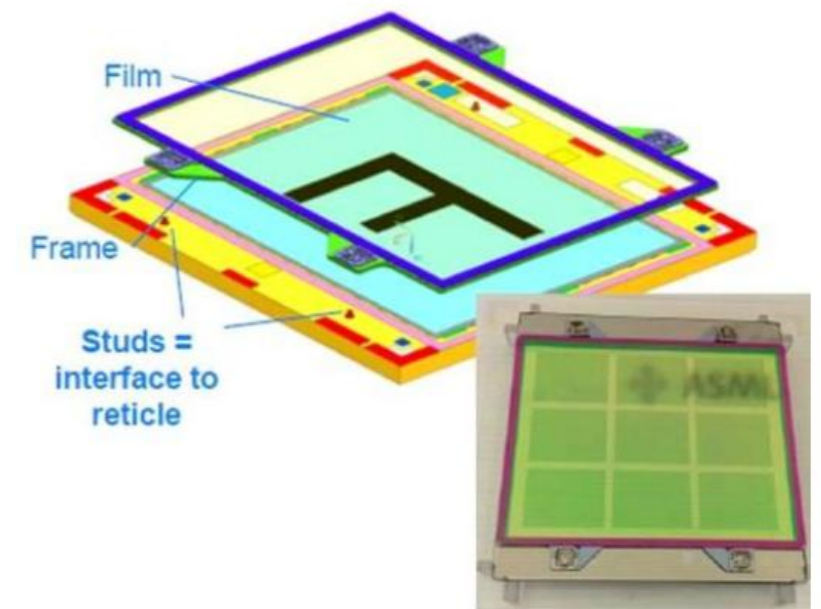
+ EUV mask front side processing

+ Debris cleaning after the pellicle was damaged

+ Cleaning of the front side with studs after pellicle removal

+ Glue removal

Prototype for EUV pellicle



R. Merritt: It's crunch time (again) for EUV lithography; *EETimes*, 7/6/2015

+ Pellicle maintenance

- + Introduction
- + Pellicle related mask maintenance challenges
- + **Summary**

- + The maintenance of EUV masks with pellicle introduces new challenges in EUV mask cleaning
- + EUV mask cleaning processes need specific solutions for mask front side and backside
- + EUV mask cleaning equipment need handling adaptations
- + SÜSS is addressing these challenges, e.g. by joining the SeNaTe consortia
- + The SÜSS mask cleaning platform will address all specific solutions and infrastructure in order to enable full EUVL pellicle compatibility
- + EUVL pellicle related solutions provided by SÜSS will be well aligned with worldwide key player in EUVL arena



Thank you!

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