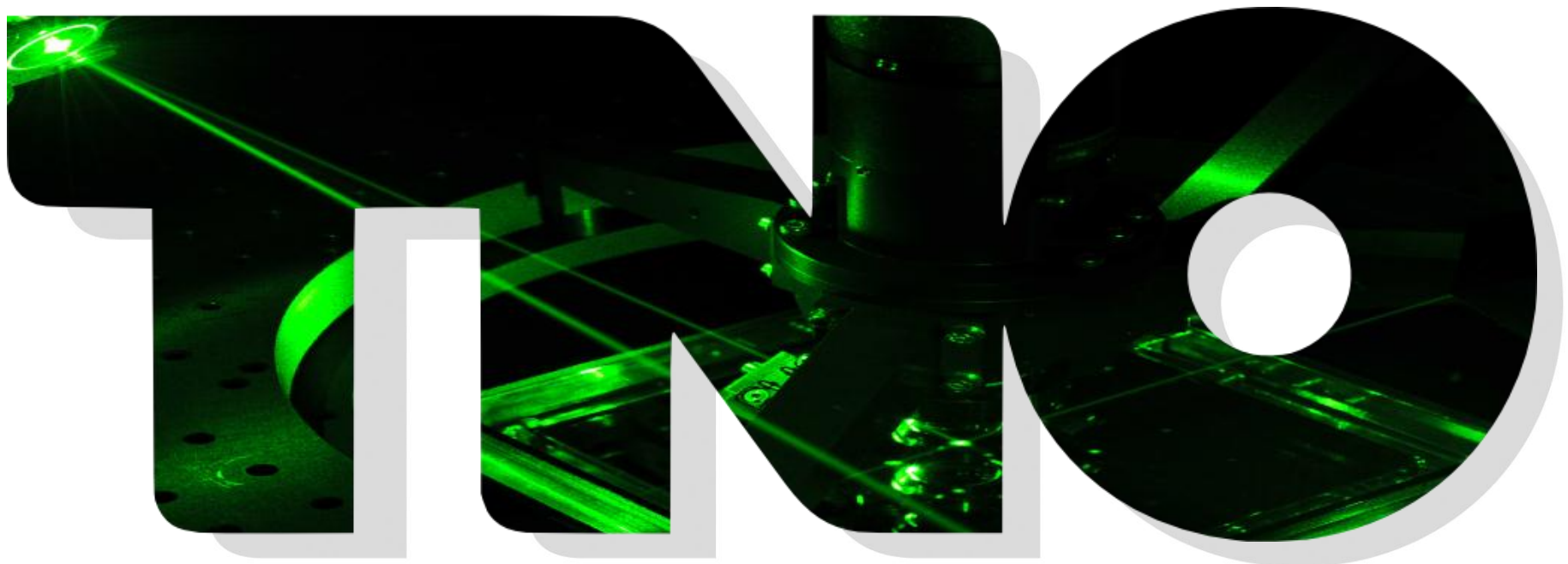




# Qualification of particle free EUV equipment

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Miami, Sunday October 16, 2011.

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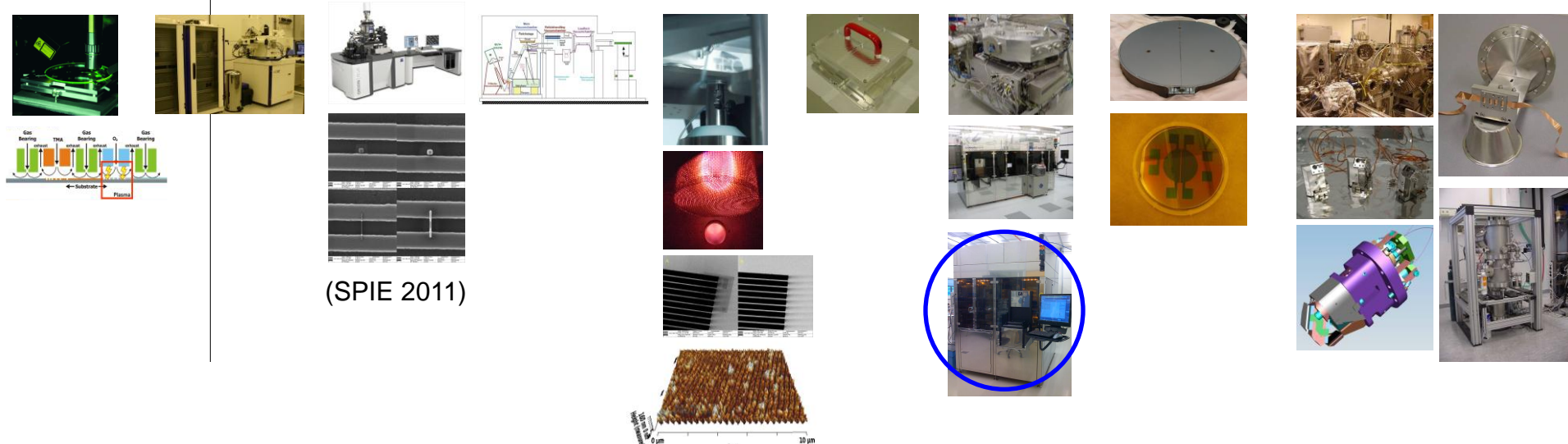
# Contents

- › Background
- › Qualification set-up
- › Root Cause Analysis
- › Summary



# The life cycle of an EUVL reticle: TNO contributions

blank production  
 patterning  
 pattern repair  
 pattern inspection  
 cleaning  
 transport  
 handling  
 clamping  
 conditioning in stepper





## Examples from HamaTech InSync tool

- › Examples will be shown from the qualification procedure of the HamaTech InSync tool.
- › Several stages of development
- › Data are not representative for final performance



See also: O. Brux, P. van der Walle, J.C.J. van der Donck, P. Dress, “Investigating the intrinsic cleanliness of automated handling designed for EUV mask pod-in-pod systems”, SPIE Vol.8166-95, 2011



# Background

Particles have a high impact on EUV reticle functionality (yield/overlay) and scanner uptime.

Equipment for handling of EUV reticles must meet strict requirements on cleanliness.

The equipment must be qualified and monitored to guarantee performance.



# Qualification procedure

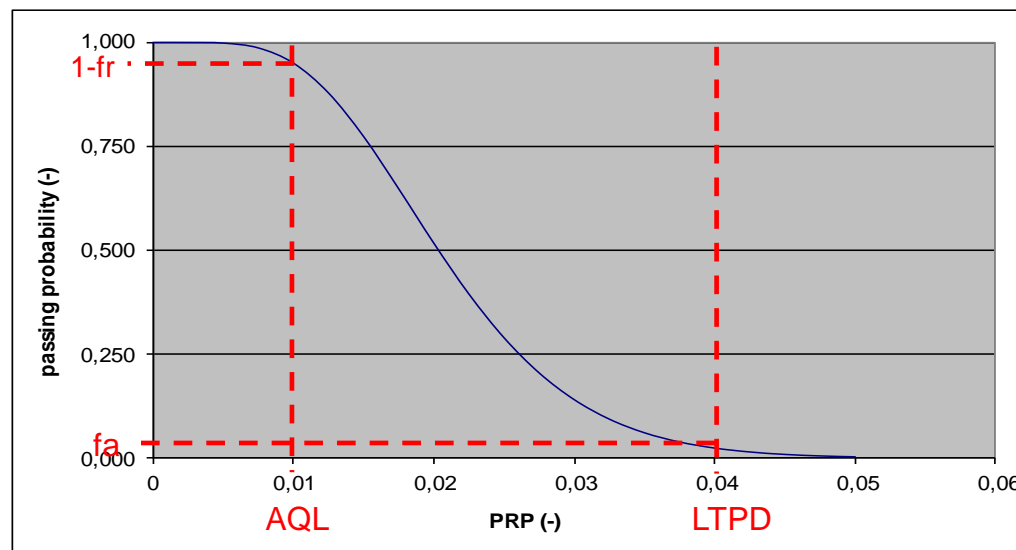
The following items should be covered before actual testing commences:

1. Set requirements
2. Arrange equipment
3. Map routing & identify critical steps
4. Measure environment contribution
  - Transport and handling between inspection equipment and tool to be qualified
5. Determine test plan from routing



# Set Requirements

- › Define max PRP number, particle size
- › Average PRP level, define uncertainty levels



**HamaTech InSync** < 2 particles / 25 cycles  
→  $PRP_{max} < 0.08$ ,  $PRP_{average} = 0.01$



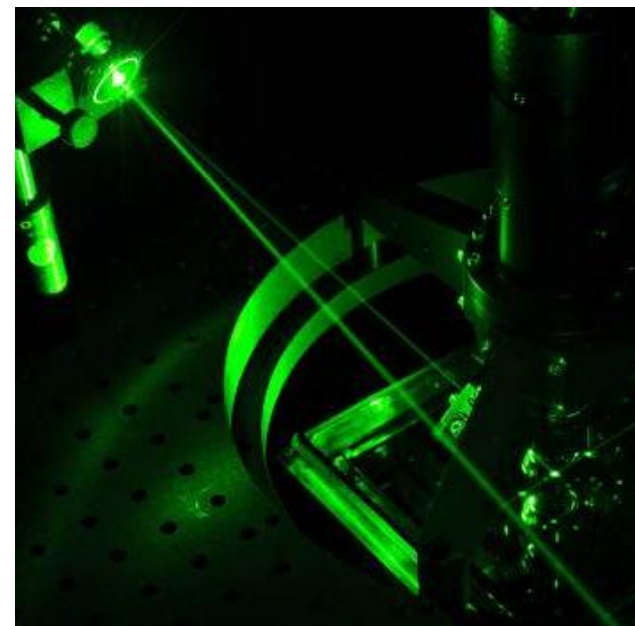
# Arrange equipment

All qualified on cleanliness

- Cleanroom
- Particle measurement equipment
- Dual Pod carrier
- Reticle substrate

## Hamatech InSync tool

- RapidNano1
- DualPod type A
- ML blank (courtesy Rik Jonkheere, IMEC)



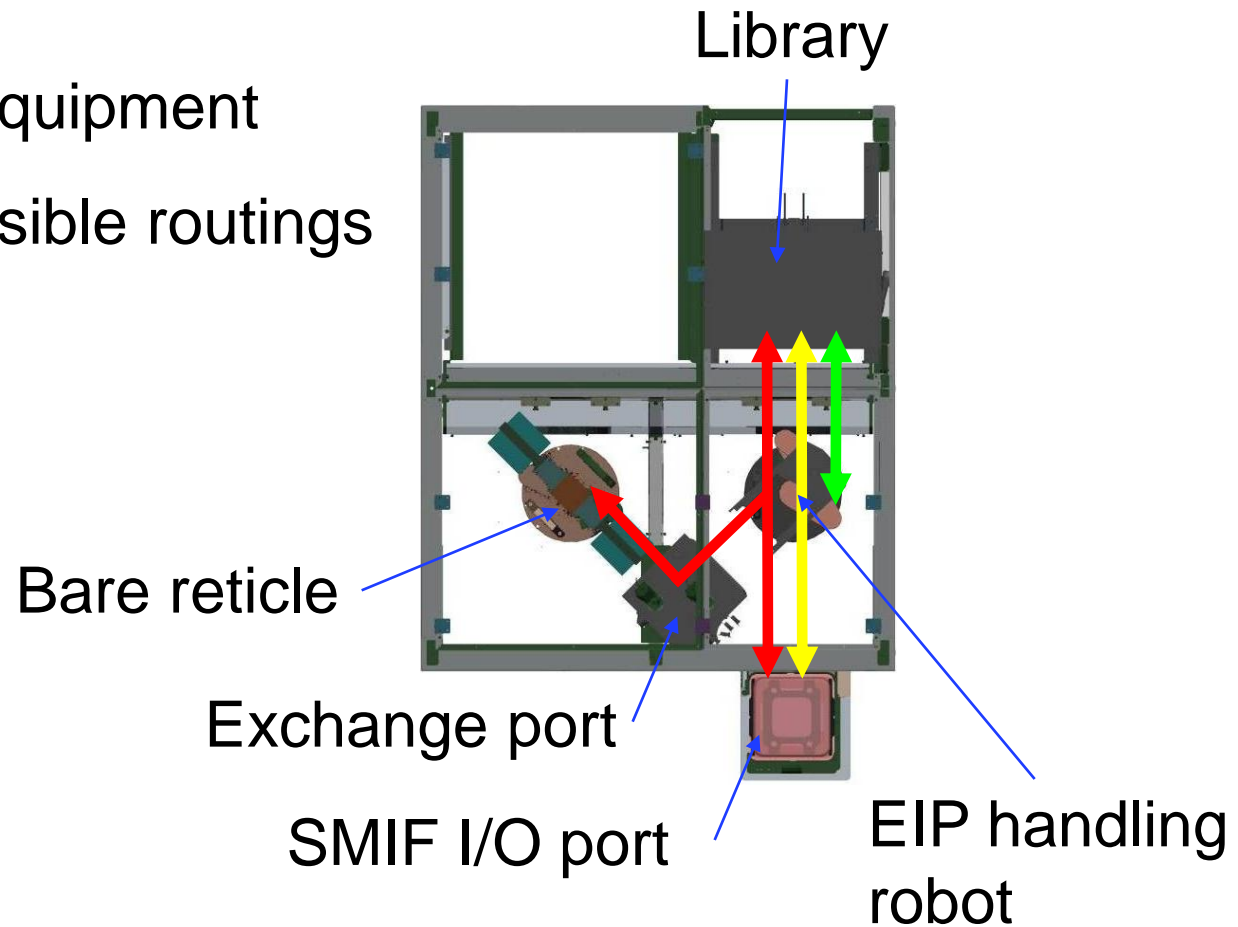




# Map Routing

- Describe equipment
- Define possible routings

## HamaTech InSync

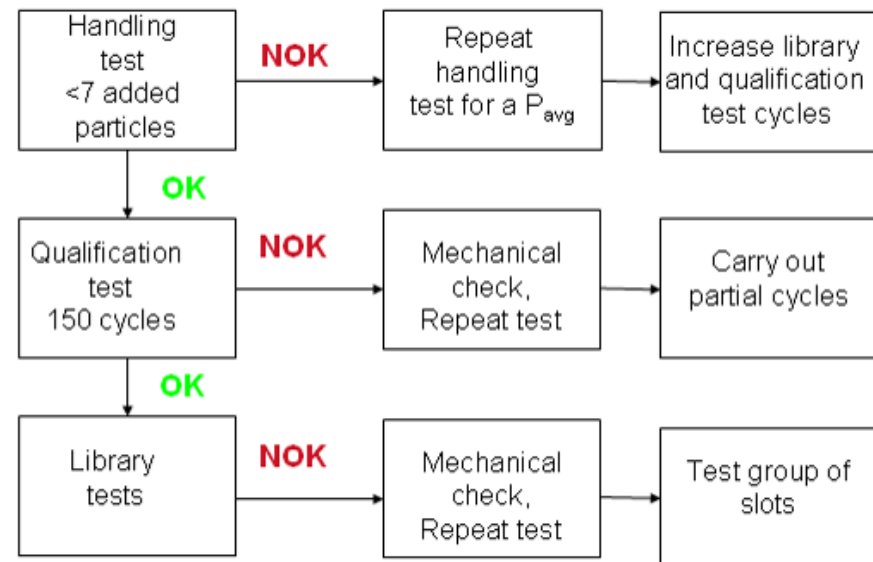




# Test plan

- Select most relevant routings and determine test sequences
- Make a decision tree

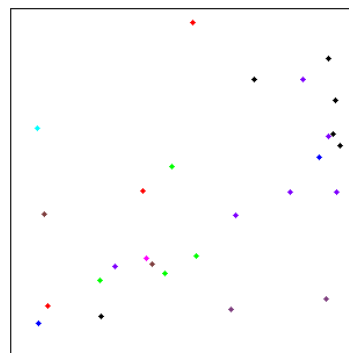
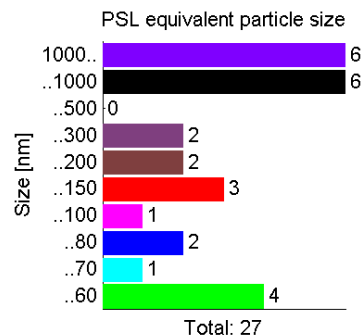
HamaTech InSync





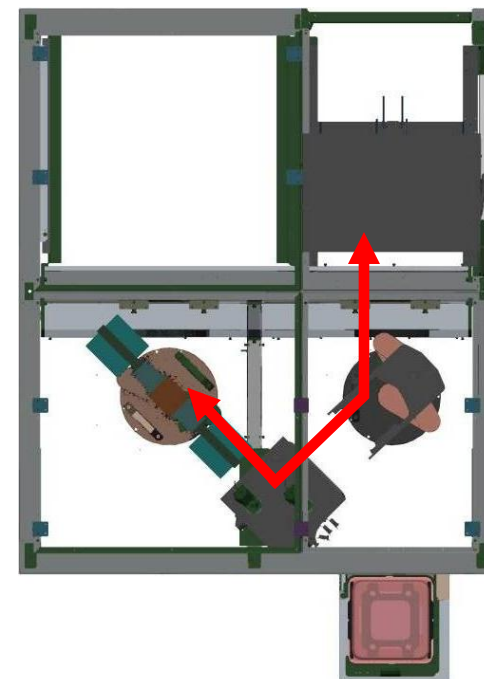
# Root Cause Analysis

- Goal: identify particle sources
- Methods:
  1. Visual inspection
  2. Isolation tests
  3. Particle analysis



Added particles  
after 144 cycles

## HamaTech InSync





## Root Cause Analysis (2)

### 1. Visual inspection of units and alignments

Observation:

Exchange port door closed too fast.

Cause:

Defect locking pin caused release of a nut and misalignment of exchange port door.

Solution:

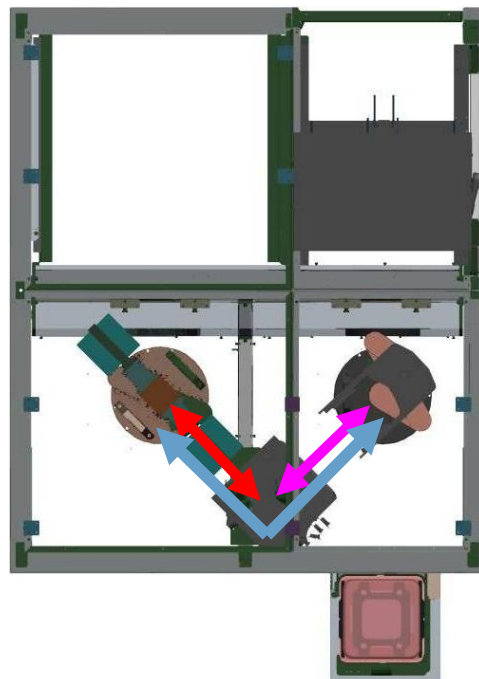
Mechanical fix of locking pin and realignment of exchange port door.



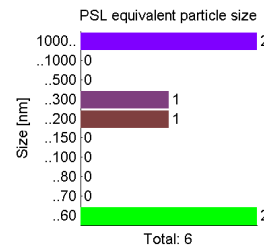
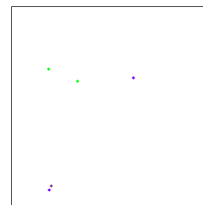
# Root Cause Analysis (3)

## 2. Isolation tests

# Issue solved

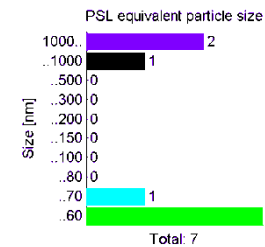
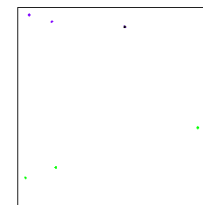


**Run. A**



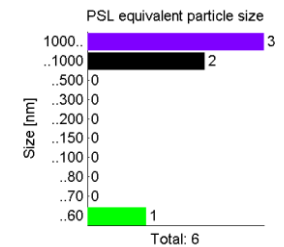
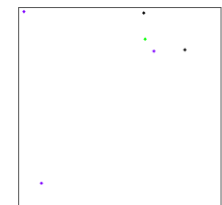
Cycle # = 641

**Run. B**



Cycle # = 575

**Run. C**



Cycle # = 296

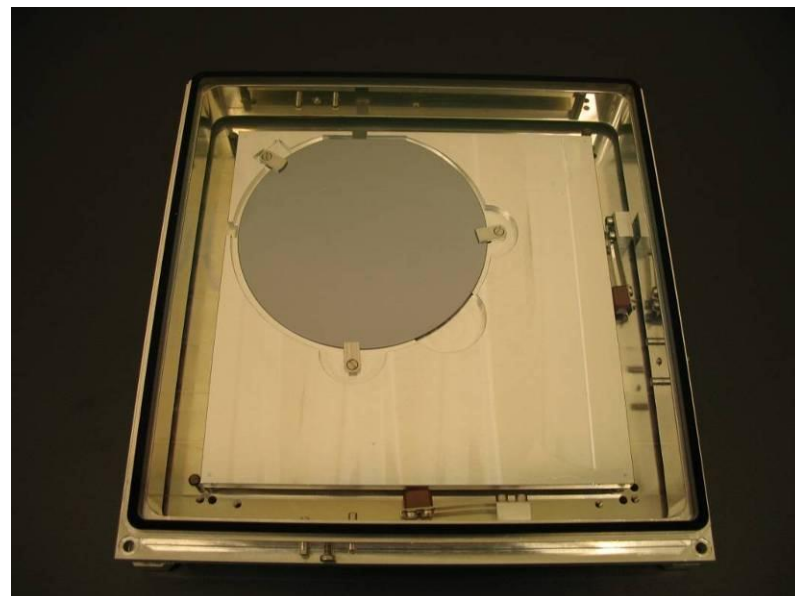


# Root Cause Analysis (4)

## 3. Particle analysis

Dummy reticle with wafer was used to collect particle adders during cycling

- Material analysis of added particles by SEM-EDX





# Root Cause Analysis (5) HamaTech InSync

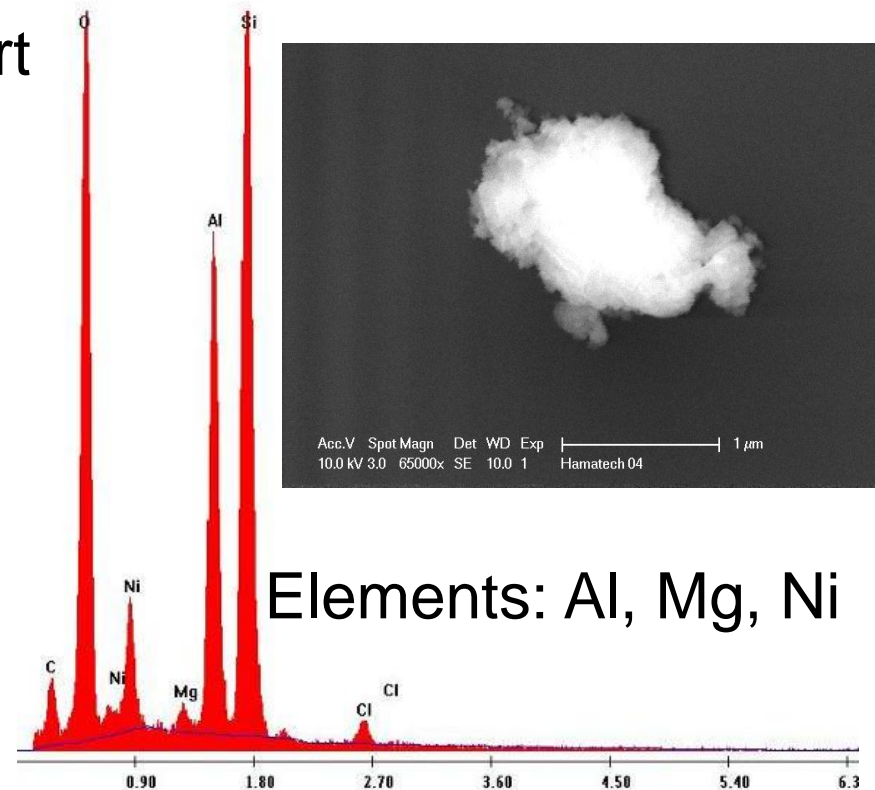
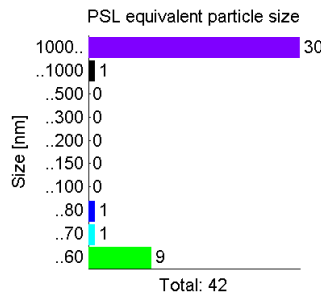
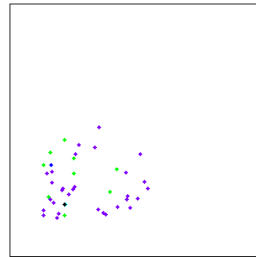
Observations:

- Particles added on backside
- Added in Exchange Port

## SEM-EDX

Collect particles:

- dummy reticle
- face up
- 605 cycles

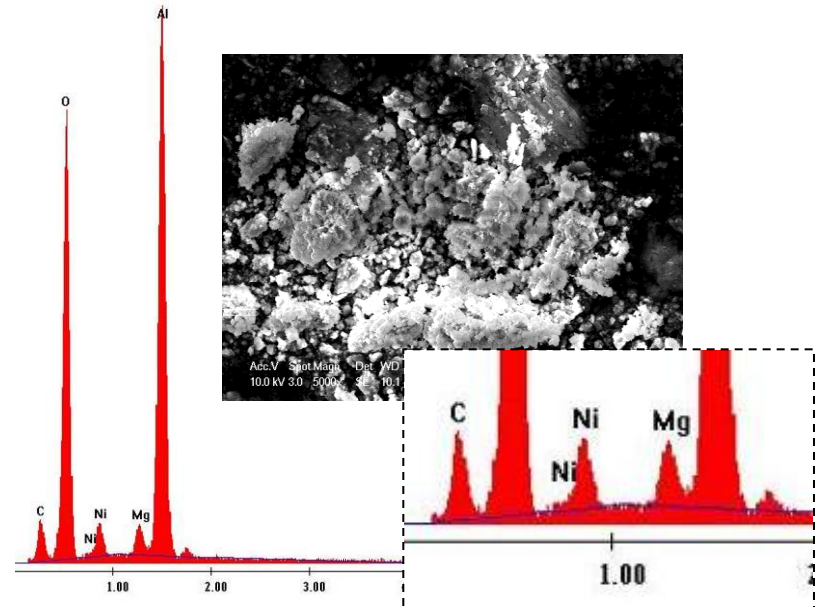
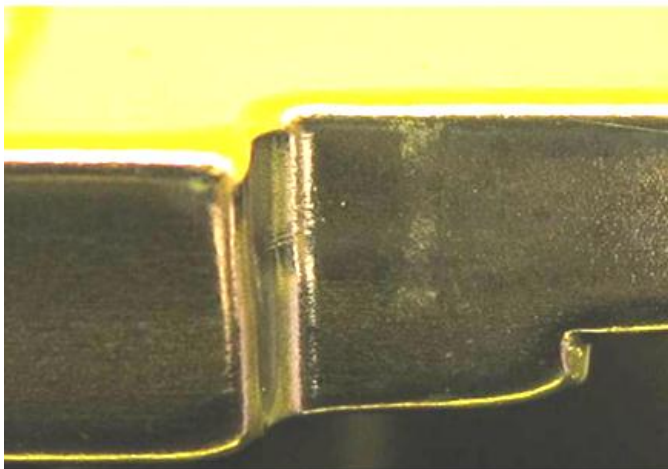




# Root Cause Analysis (6) HamaTech InSync

## NO Ni-containing components in InSync Exchange Port

Wear marks on EIP bottom Particles from wear marks



- Same Al/Mg ratio and Ni
- Match between particles and material of EIP
  - Wear of Inner Pod causes particle deposition on reticle backside





# Summary

Method for particle qualification has been presented

1. Set requirements
2. Arrange equipment
3. Map routing & identify critical steps
4. Measure environment contribution
5. Determine test plan from routing
6. Run tests

Have a strategy and (access to) required tools for  
root cause analysis / particle source analysis



# Acknowledgement

Süss HamaTech is thanked for releasing data which were used as examples.

Thank you for your attention