# ASML Approach to Euv Reticle Handling

Mask Workshop Antwerp

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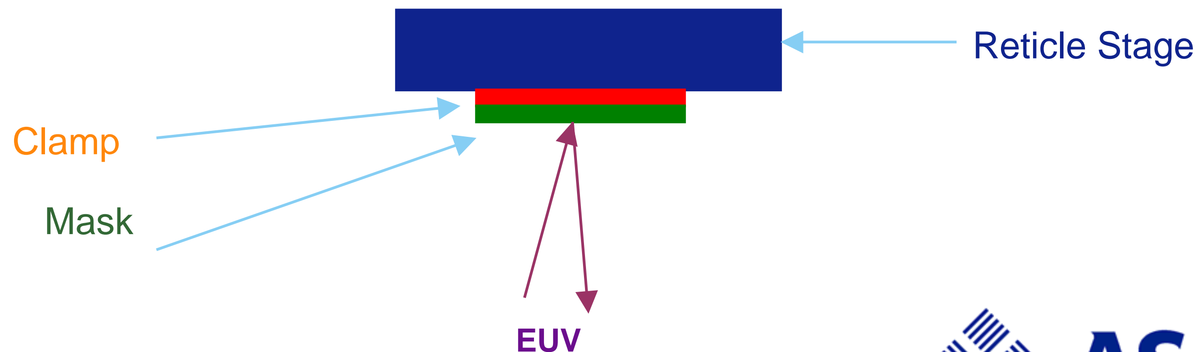
# Presentation Agenda

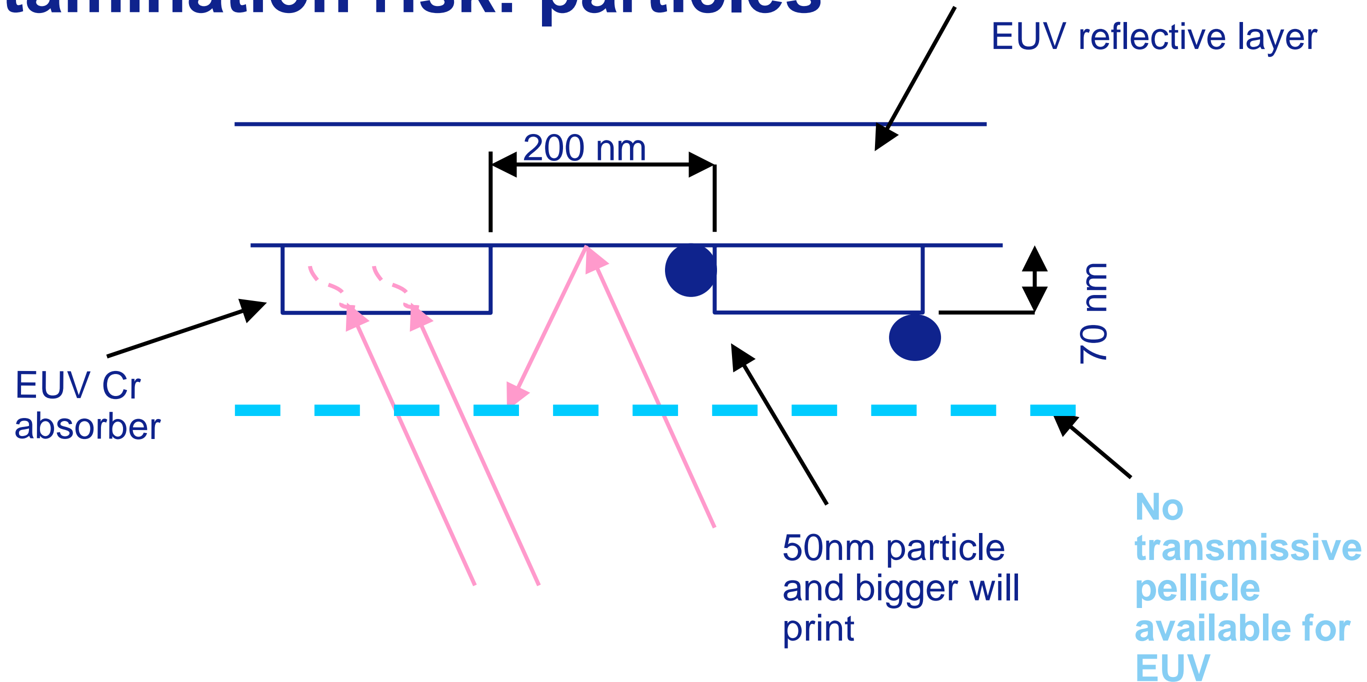
- Unique features of EUV reticles
- Contamination Risk: the problem we are attempting to solve
- Life of an EUV Reticle
- Alternate Concepts / Potential Solutions
- ASML current approach

# Unique Features of EUV reticles

- No physical protective transmissive pellicle
- Reticle is reflective with multi-layer coating & a patterned absorber
- Operating environment is high vacuum with very low partial pressures $H_2O$ $10^{-7}$ mbar and $C_xH_y$ $10^{-9}$ mbar
- Reticle will be Clamped electrostatically using the full back side area
- Reticle substrate is a low thermal expansion material



# Contamination risk: particles




- 50 nm particle in in 200 nm line/space field will print (shown in EUV-LLC publications)
- No repeatable errors allowed
- Requirement: allowable number of 50 nm (or larger) particles = 0 in patterned area

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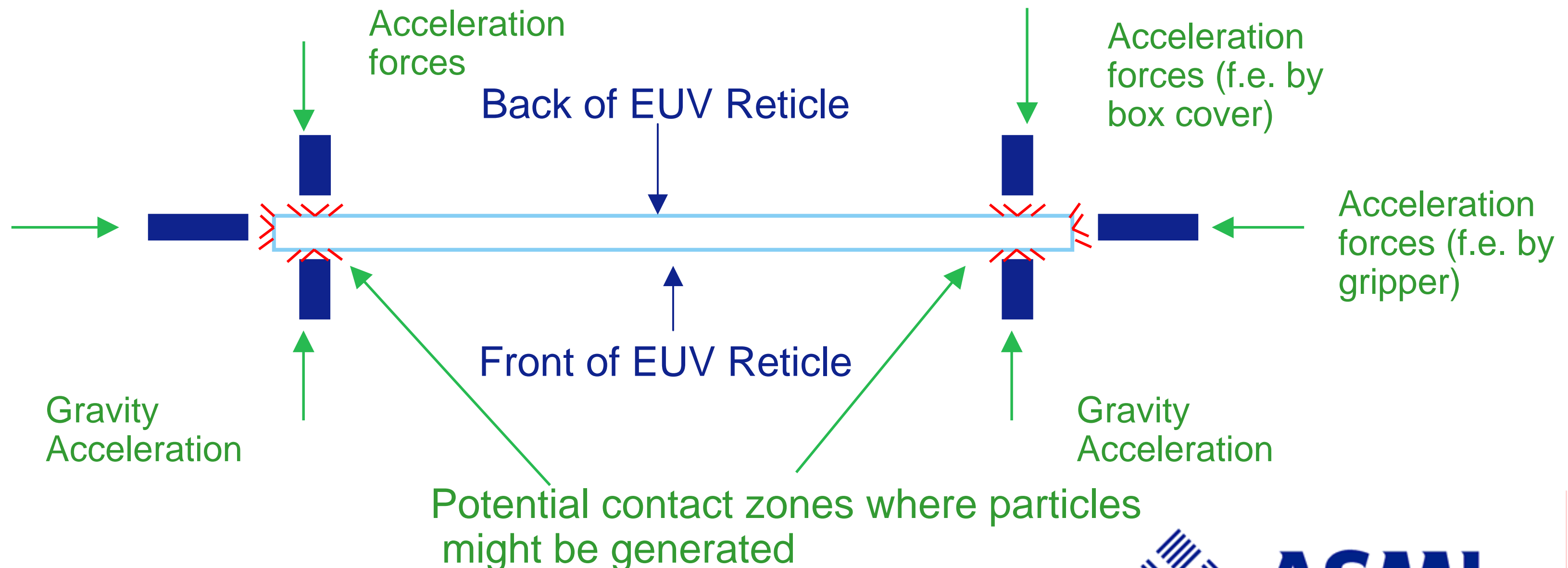
# Particle generation risk during handling

- Every make/break contact with the reticle generates particles; front side contact is risk to pattern area, backside contact is risk to clamped area
- Experiments show that in general particles stay close to the contact area, even in vacuum

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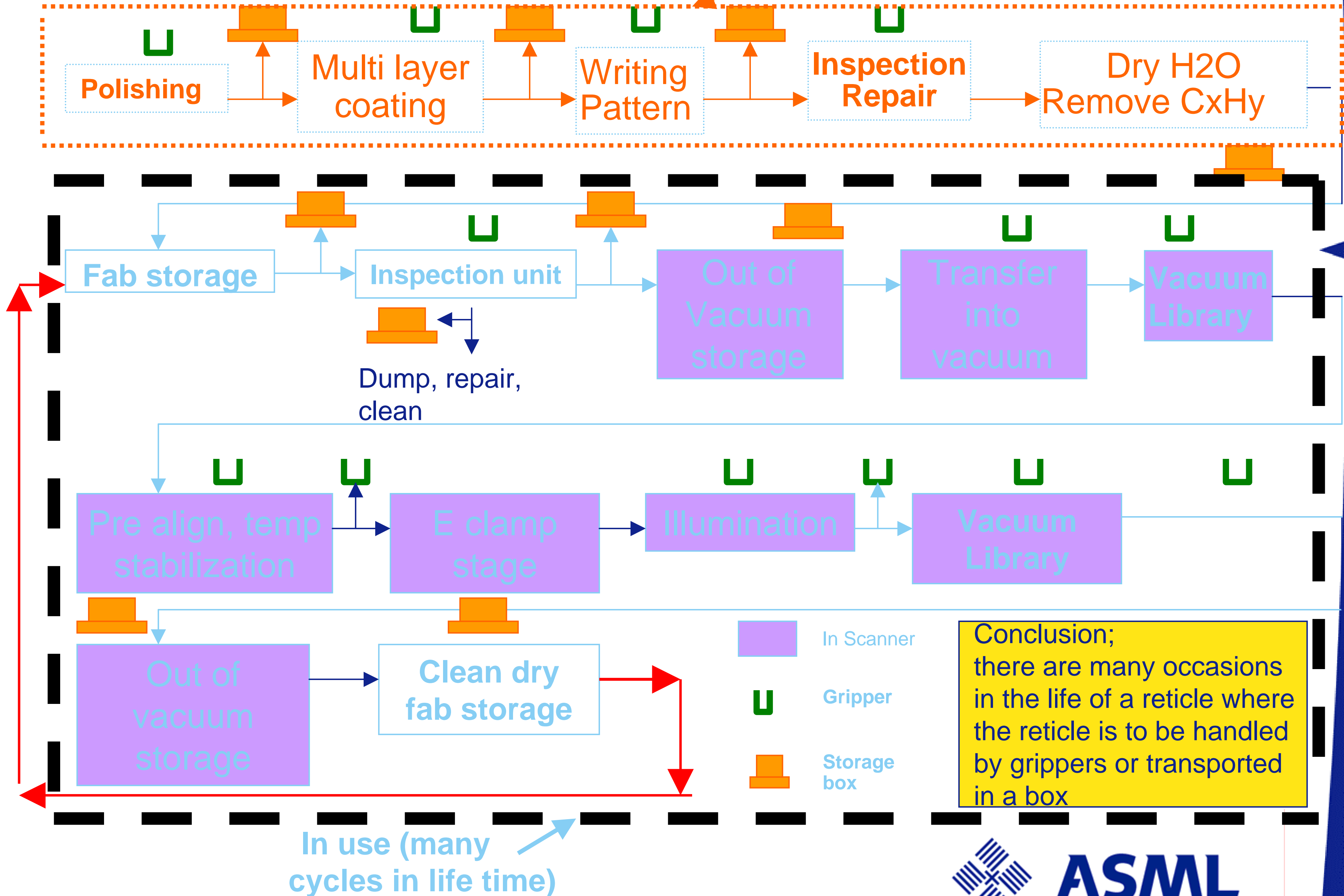
# Objectives/Challenges

- ASML Approach for exposure tool:
  - Optimize material choices used for direct contacts to reduce particle generation
  - Place contact area far away from patterned area to reduce migration risk
  - Minimize the number of direct make/break contacts with the reticle
  - Only direct contact with reticle is on the exposure stage by the electrostatic clamp

# Life of an EUV reticle (typical)



# ASML Handling Concept

## Use a frame to grip instead of directly handling the mask

- Permanent handling brackets (“ears”)

- Removable handling frames

## Advantages:

- Eliminate/Reduce contact with Reticle frontside
- Eliminate/Reduce sliding contact with Reticle frontside
- Expand choice of materials (minimize particle generation)
- Move contact area further away from pattern

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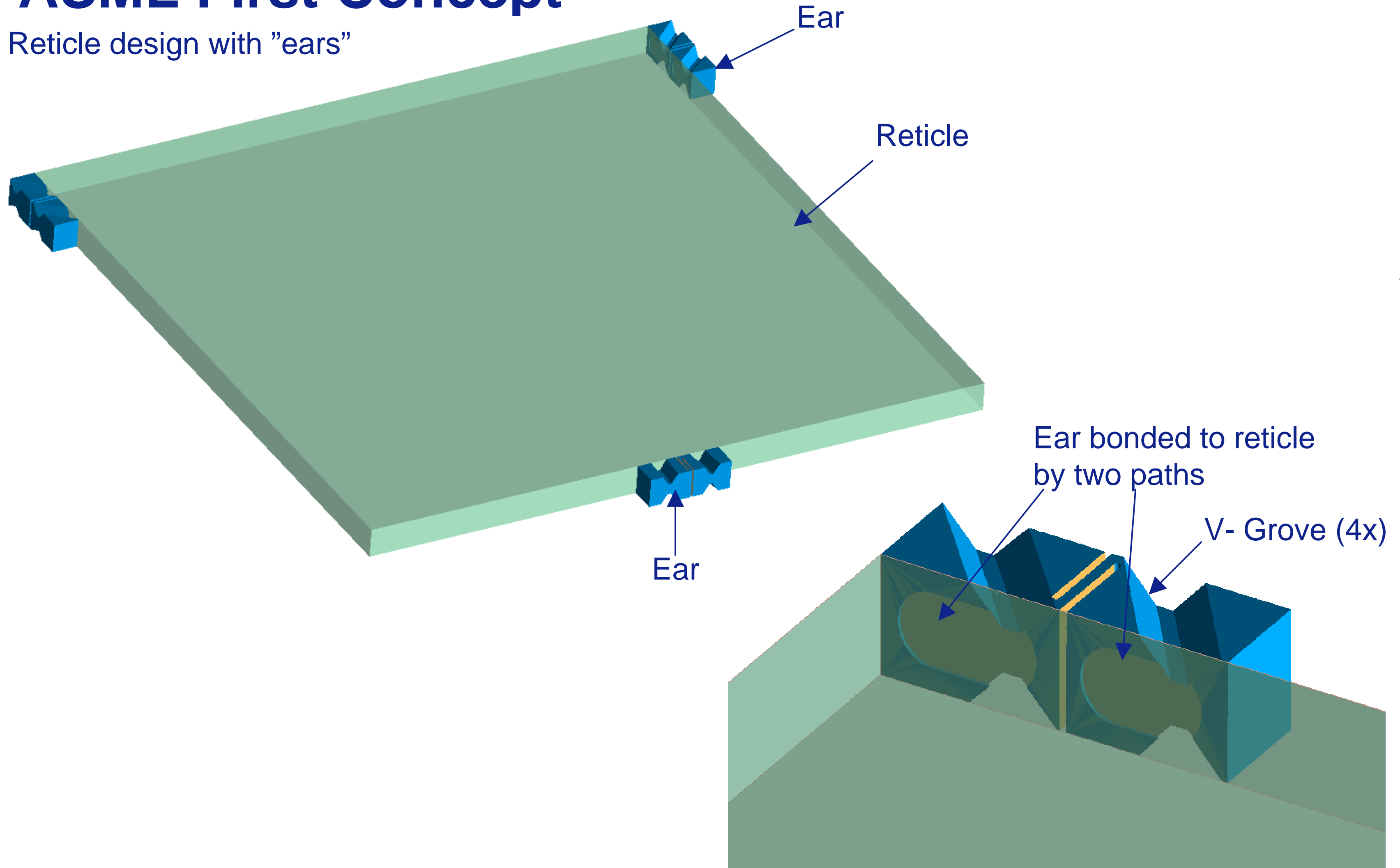
# ASML First Concept

Reticle design with ”ears”

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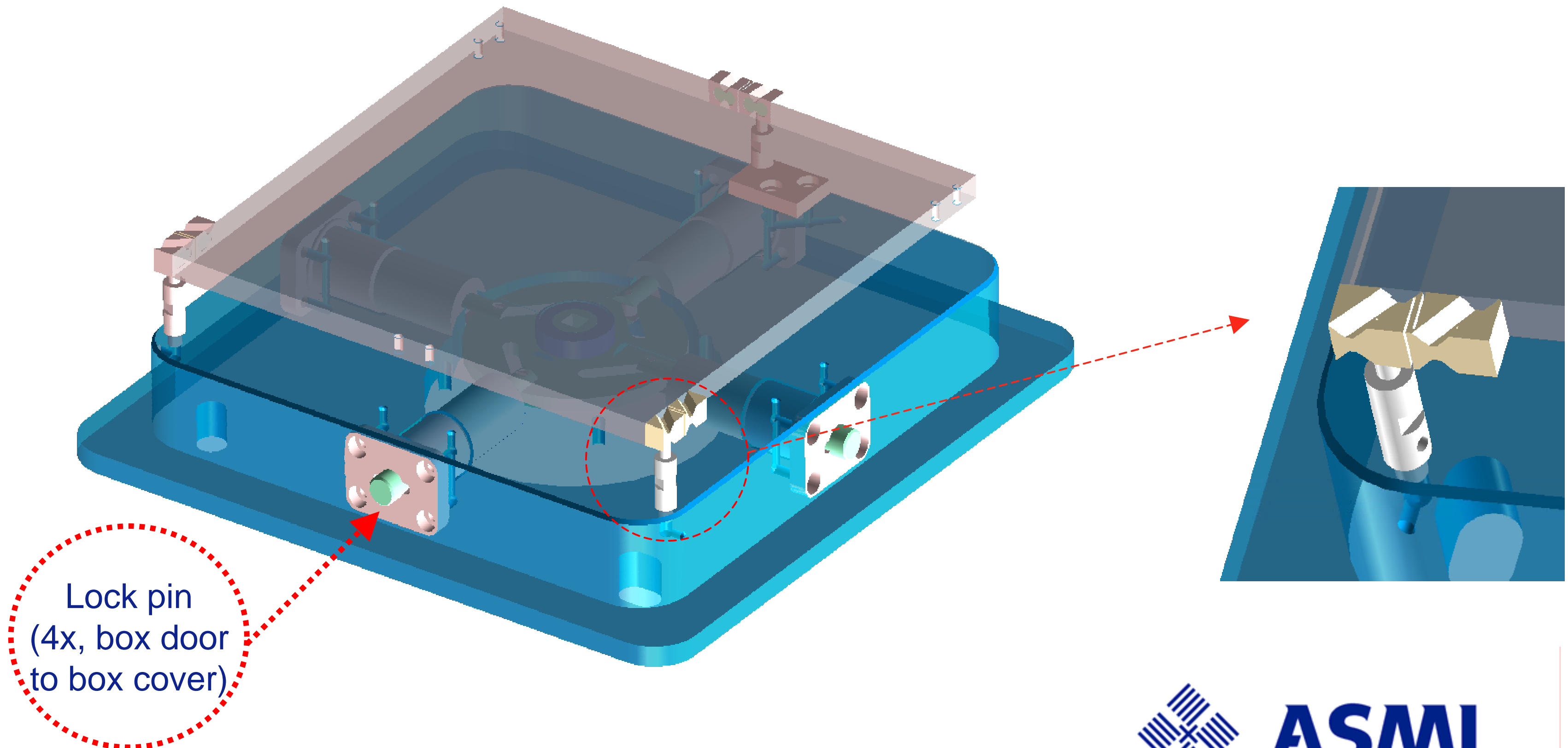
# ASML First Concept

- Add Brackets or “ears” to reticle edges that act as kinematic mounts
- Reticle storage box with inert gas

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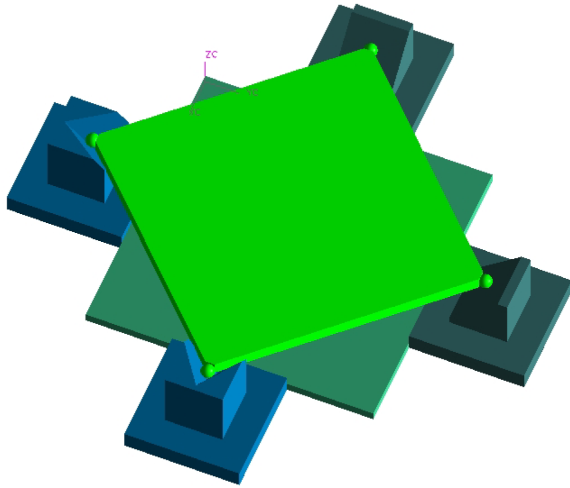
# Industry Response

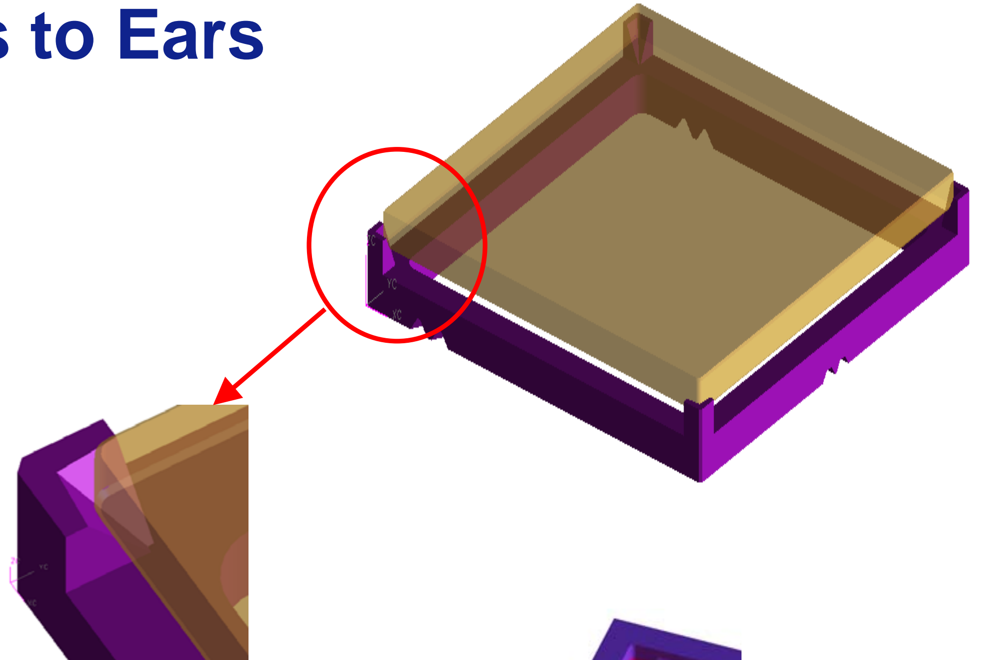
- Substrate Suppliers,Blank Suppliers,Mask Makers,Metrology Tool Makers,E-beam writer makers
- Concerns:
  - reticle form change: compatibility with material handling tools, polishing tools, coating tools
  - backwards compatibility with their DUV tools
  - requires EUV-specific mask fab line
  - impact on chemical processes of bracket material and bonding material
  - past problems with bonding techniques

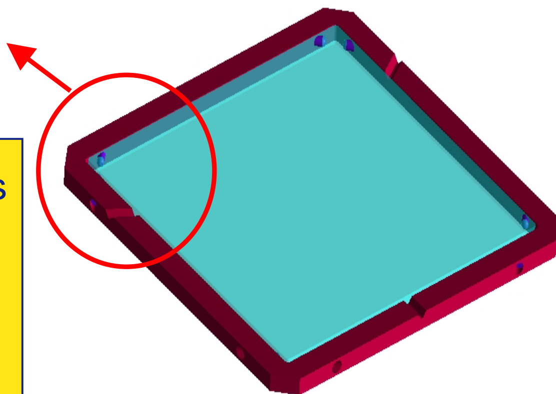
# ASML Plan - Version #1

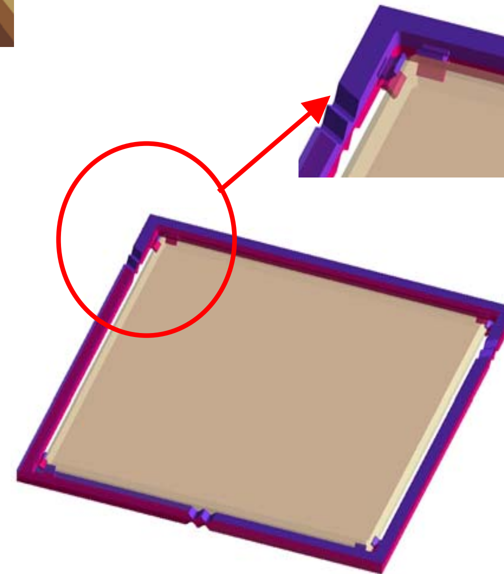
- Use brackets for Alpha tool only
- Develop alternative for Production Tools
  - Precise handling without intrusive features/reticle form change
    - Preserve present reticle geometry as much as possible
    - Compatibility with all processes with minimum equipment impact
    - Minimum complexity (hardware)
    - Develop solution for whole life of reticle, not just that just for the exposure tool if possible
  - Contamination prevention
    - Develop handling frame and permanent or removable cover
    - Minimize contact with front and rear faces
    - Investigate materials for direct contact areas

# Potential Alternatives to Ears









All these solutions would require modifications to the shape of the reticle

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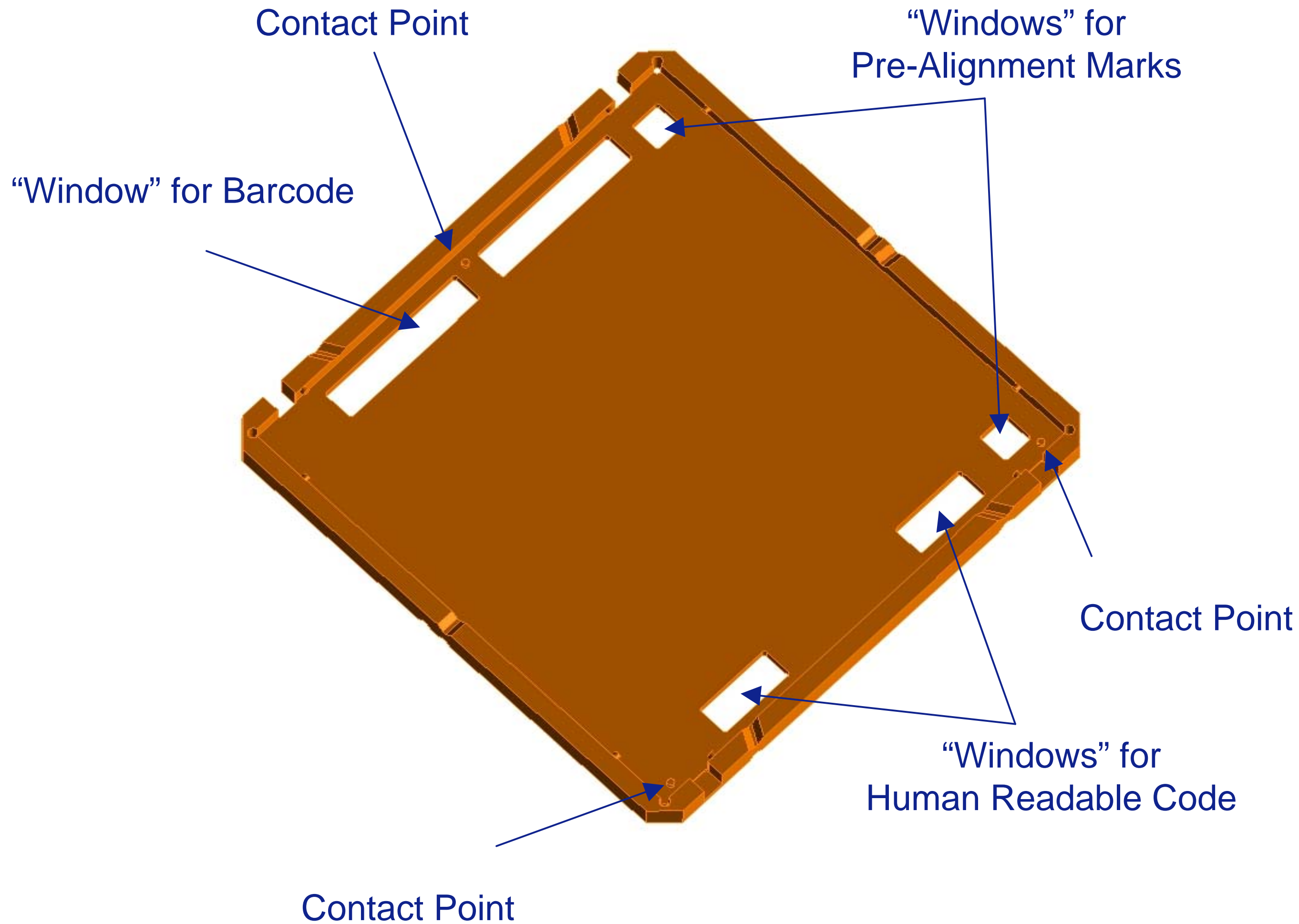
# ASML Selected Concept: Removable cover/frame

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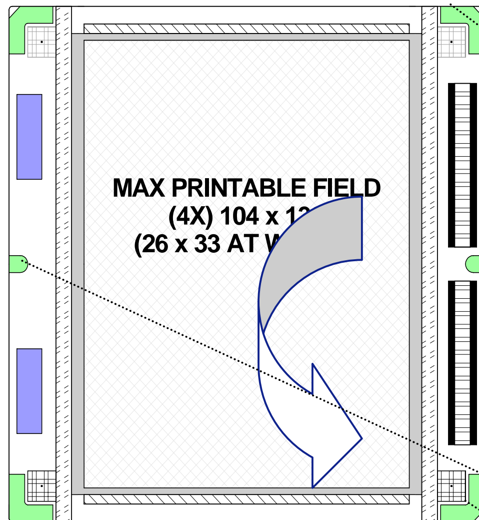
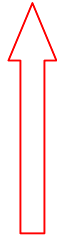
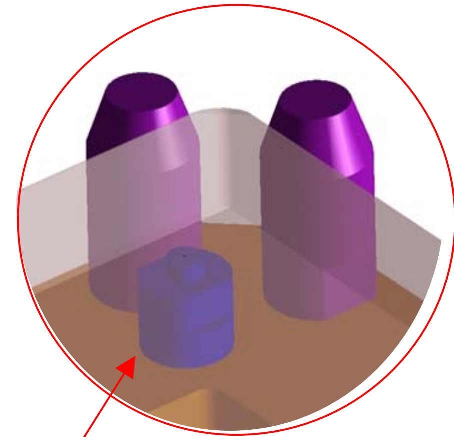
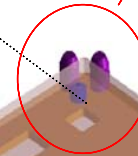
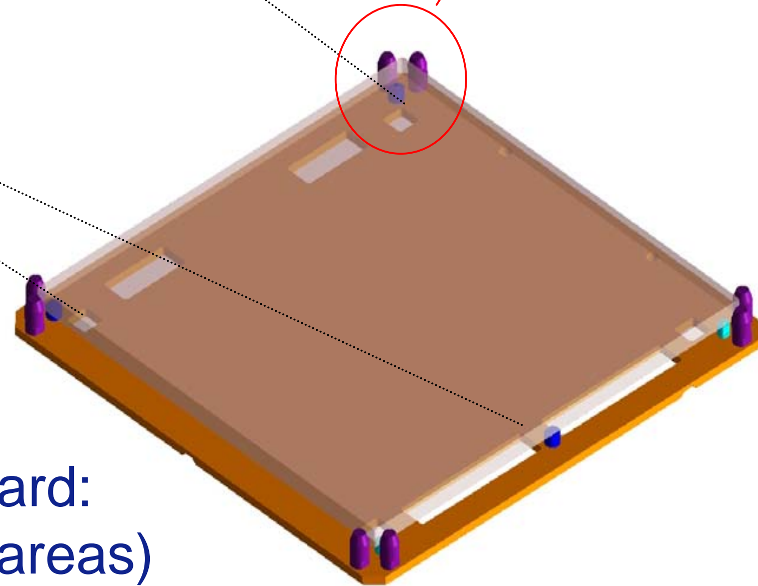
# ASML Selected Concept:
## Removable Cover/frame









ASML proposal for Layout Standard:
proposed handling areas (green areas)

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# ASML Selected Concept:
## Approach to meeting requirements

- Optimizes material choices used for direct contacts to reduce particle generation
  - Material Contact tests have identified several candidate materials for use in contact areas
- Place contact area far away from patterned area to reduce migration risk
  - reticle cover/frame contacts reticle as far away form patterned area as possible,without affecting reticle form factor
- Minimize the number of direct make/break contacts with the reticle
  - reticle frame is used for all but one direct contact event - when clamped on the exposure stage
  - cover/frame shields reticle from migrating particles during most handling in the exposure tool

# ASML Plan - Current Version

- Modify Alpha Demo Tool reticle Handler:
  - replace “ears” with removable cover/frame
    - modify storage box, loadlock, robot/gripper, reticle stage
  - validate basic concept using test rigs and FuMos
  - refine concept for Alpha Demo Reticle Handler
  - validate final version during Alpha Demo Tool actual use