

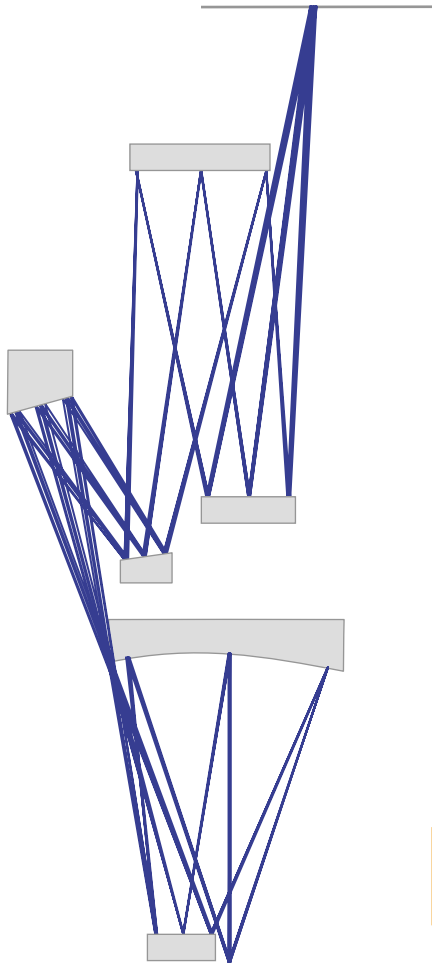


ASML

Illumination angle change – why and when

John Zimmerman
Mask TWG, EUVL 2008 Symposium
October 2, 2008

EUV 6-mirror design is extendable to 0.32 NA

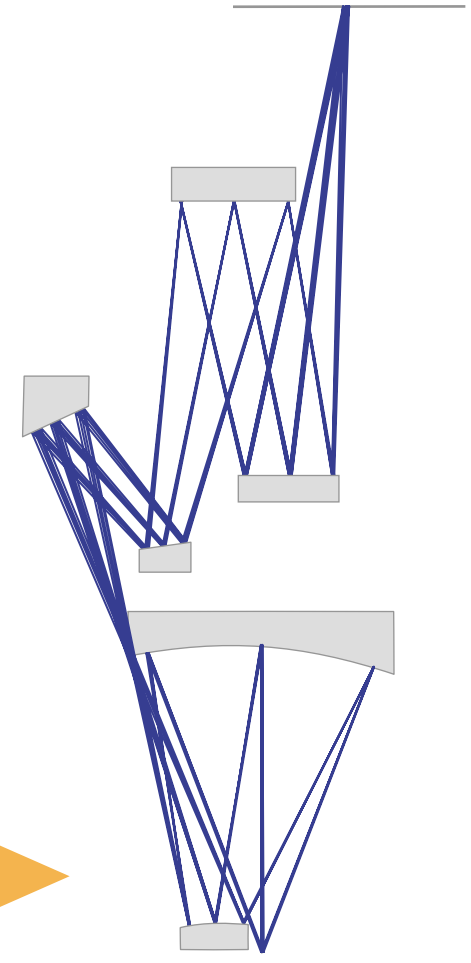


Design example

- Field size 26 mm
- Chief ray at mask 6°
- Design complexity increases
 - Larger mirrors
 - Steeper aspheres
 - High angles of incidence

0.25 NA

0.32 NA



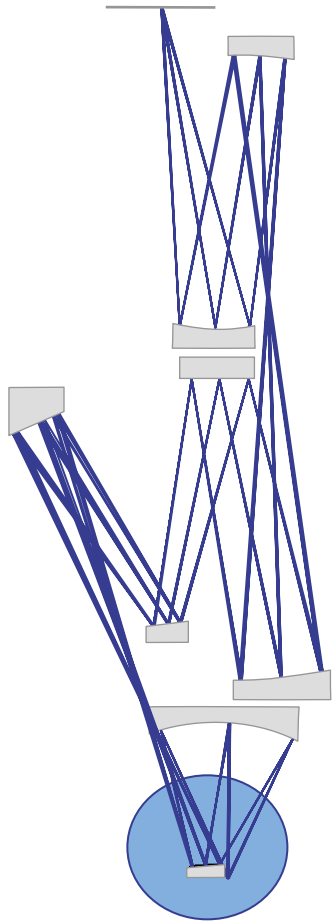
Design example



EUV apertures >0.4 NA feasible

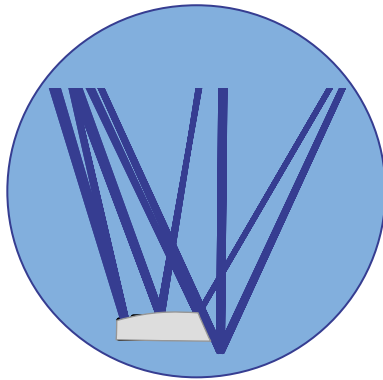
enabling EUV down to below 10 nm

NA > 0.4, no obscuration



Incidence angles limit aperture

Need ~8° illum. angle

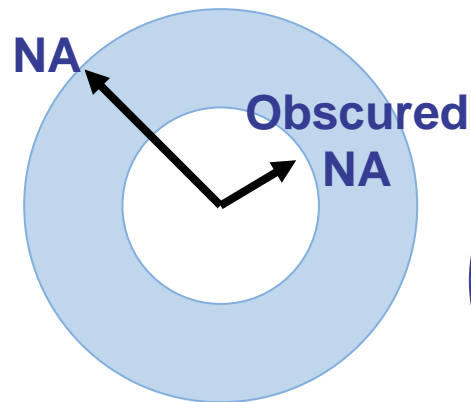


US 6,710,917 B2

NA ~ 0.4, obscured

Obscuration reduces angle of incidence

Could stay at 6° illum. angle



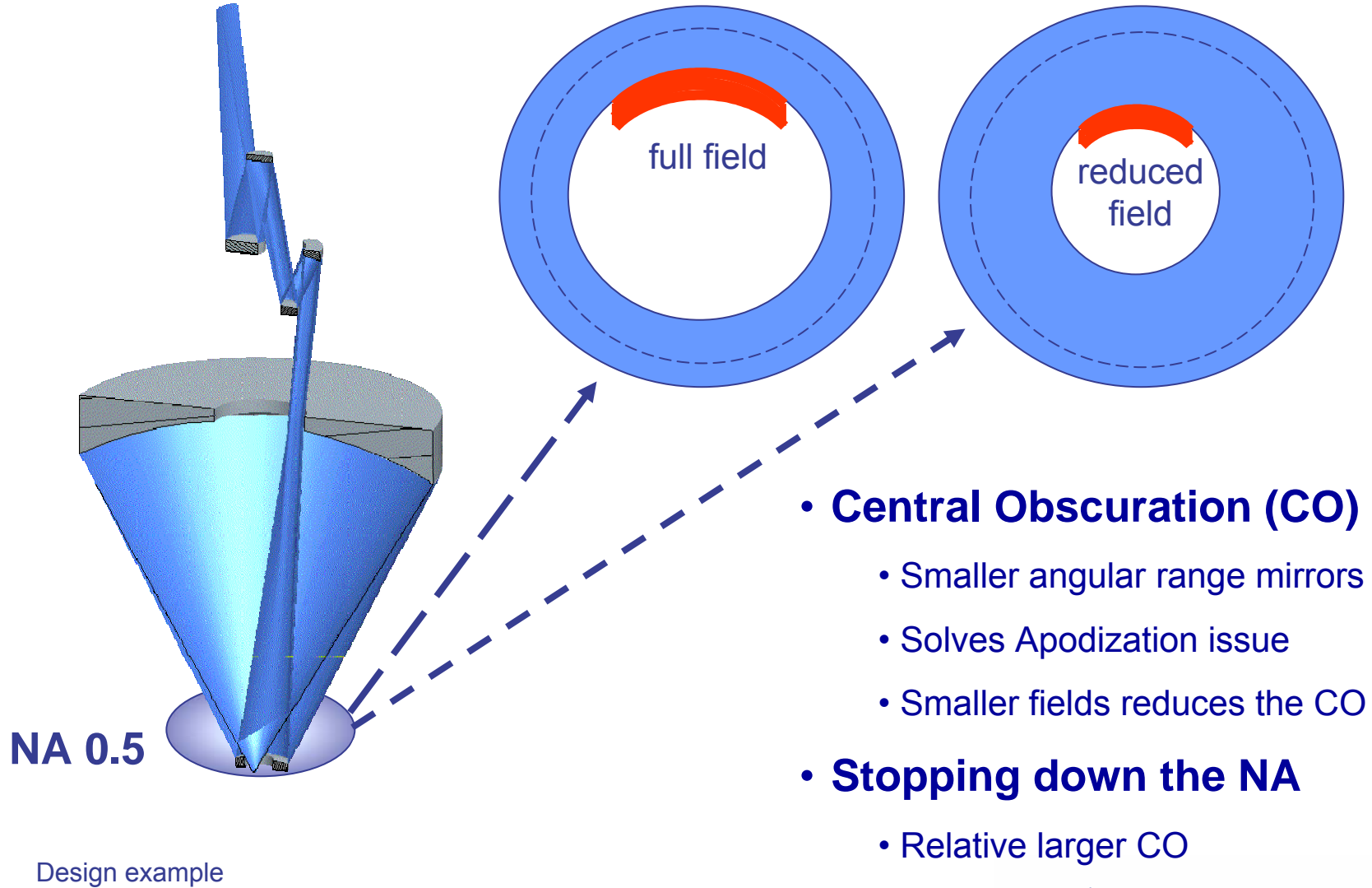
WO 2006/069725

Design examples

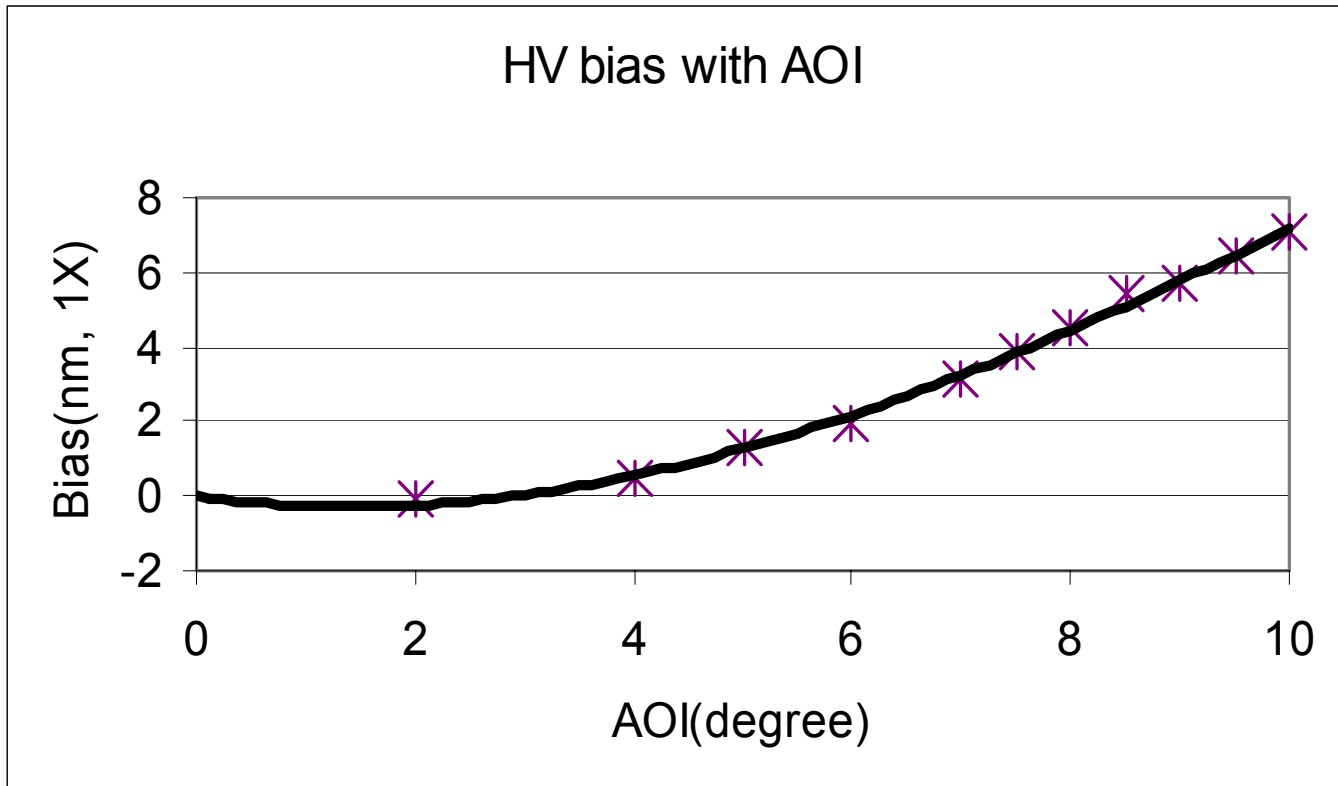


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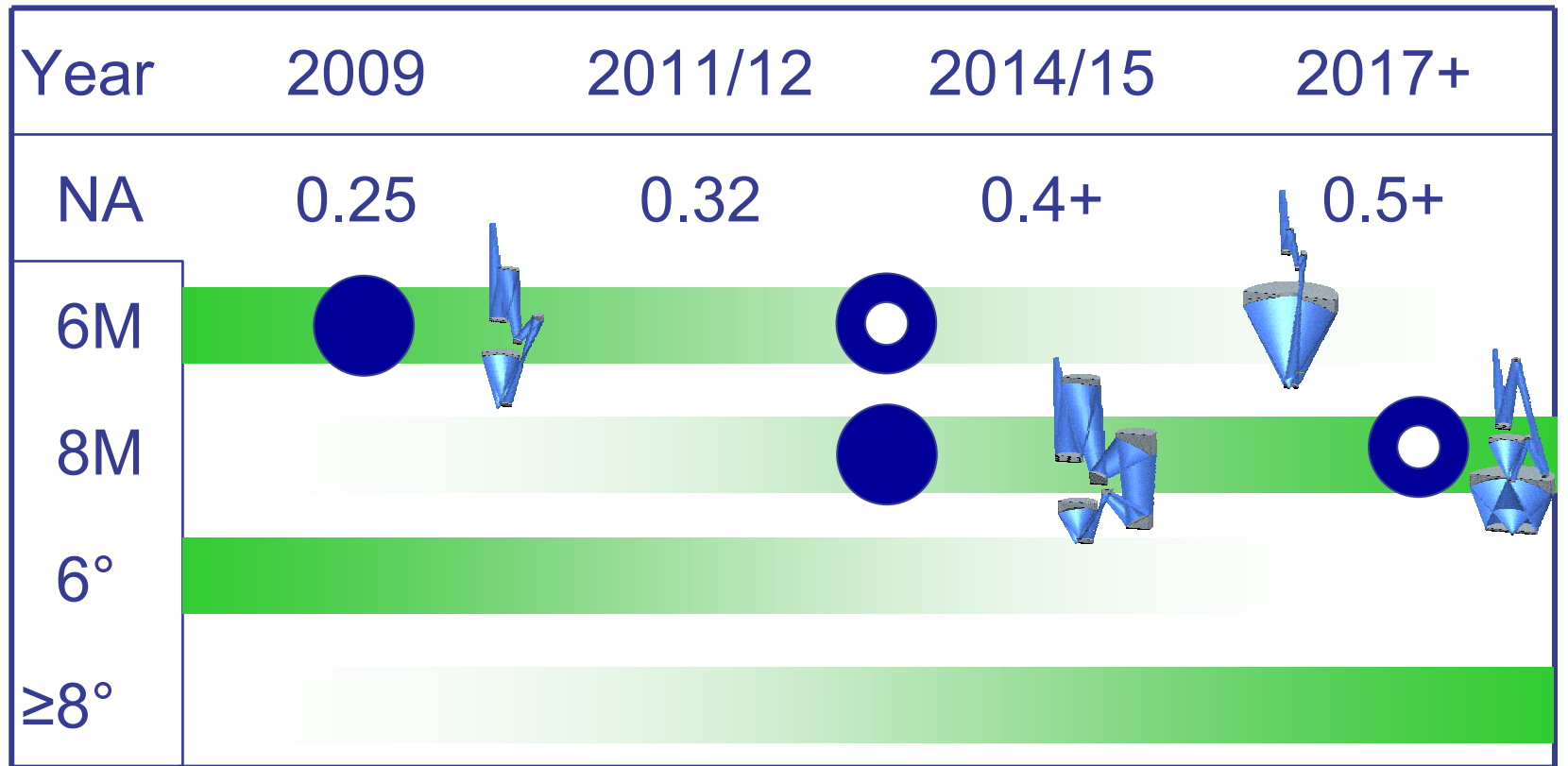
Central obscuration maintains 6-mirror POB but has limitations



HV bias increases with increasing illumination incidence angle



Incidence angle and NA overview and roadmap



- unobscured
- central obscured (smaller fields)

Design examples



Summary

- High NA EUV systems will be needed below 16nm (and maybe sooner)
- Increasing NA has two design options, each with drawbacks:
 - 8 mirror – productivity decreased 50%; needs higher illumination incidence angle
 - 6 mirror with central obscuration – CO impacts imaging; NA growth is limited unless 4x mag is increased (which either impacts productivity or calls for larger reticles)
- Larger illumination incidence angle has impact on performance