Analysis of uneven EUV mask structure

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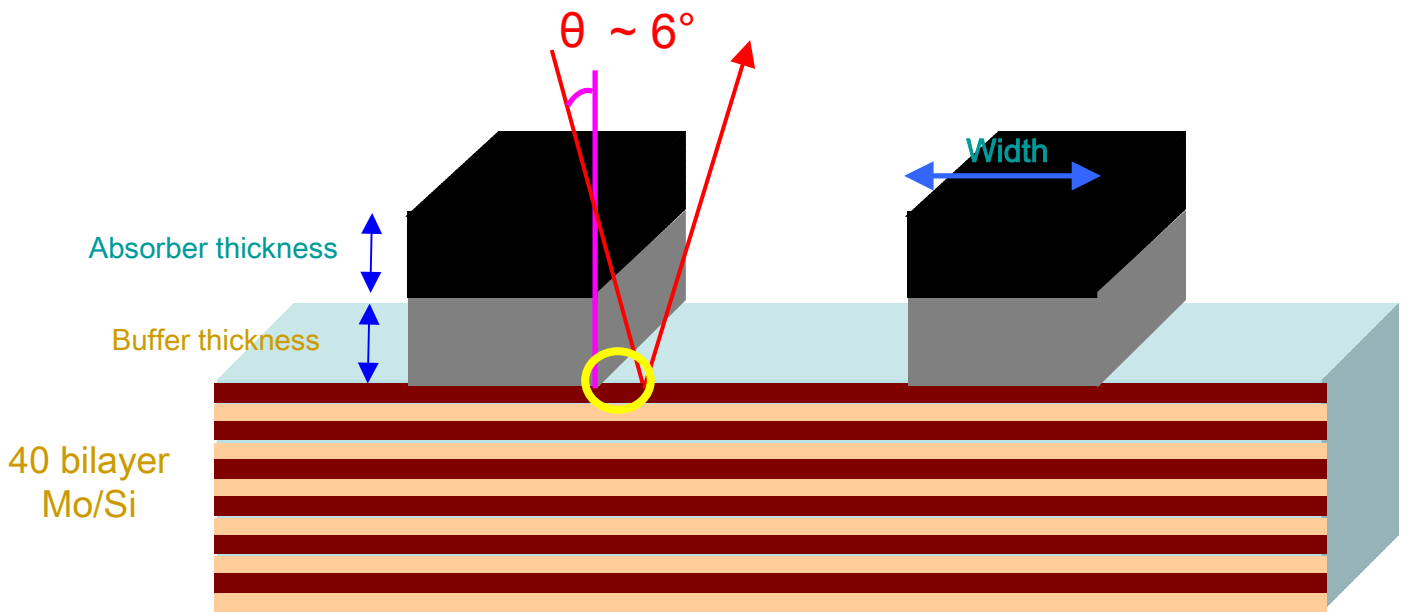
- Aerial image formation with uneven side wall

The 3D geometry of EUV mask



- **Cr/SiO_2 and TaN/SiO2 absorber stack in the top of planar multilayer**

EUVL mask simulation conditions

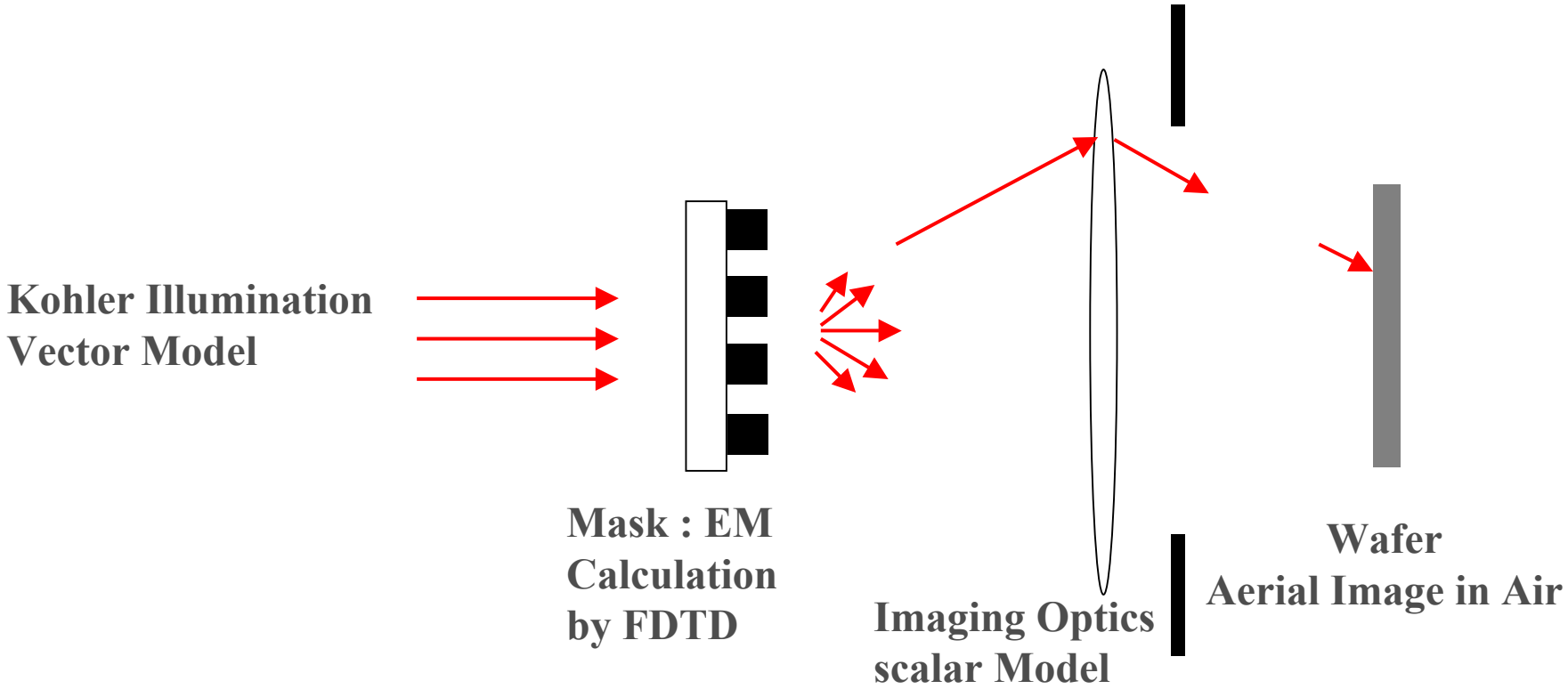
Wavelength (nm)	13.5
NA	0.25
Partial coherence	0.7
Reduction	0.25
Incident angle	6°

Table 1. EUV exposure condition

	Material	Thickness(nm)	n	k
Substrate	SiO_2	70	0.978601	0.010610
Absorber	Cr	70	0.933156	0.038332
buffer	SiO2	70	0.978601	0.010610
Mo/Si stack	Mo	4.2	0.924161	0.006255
	Si	2.8	0.999810	0.000182

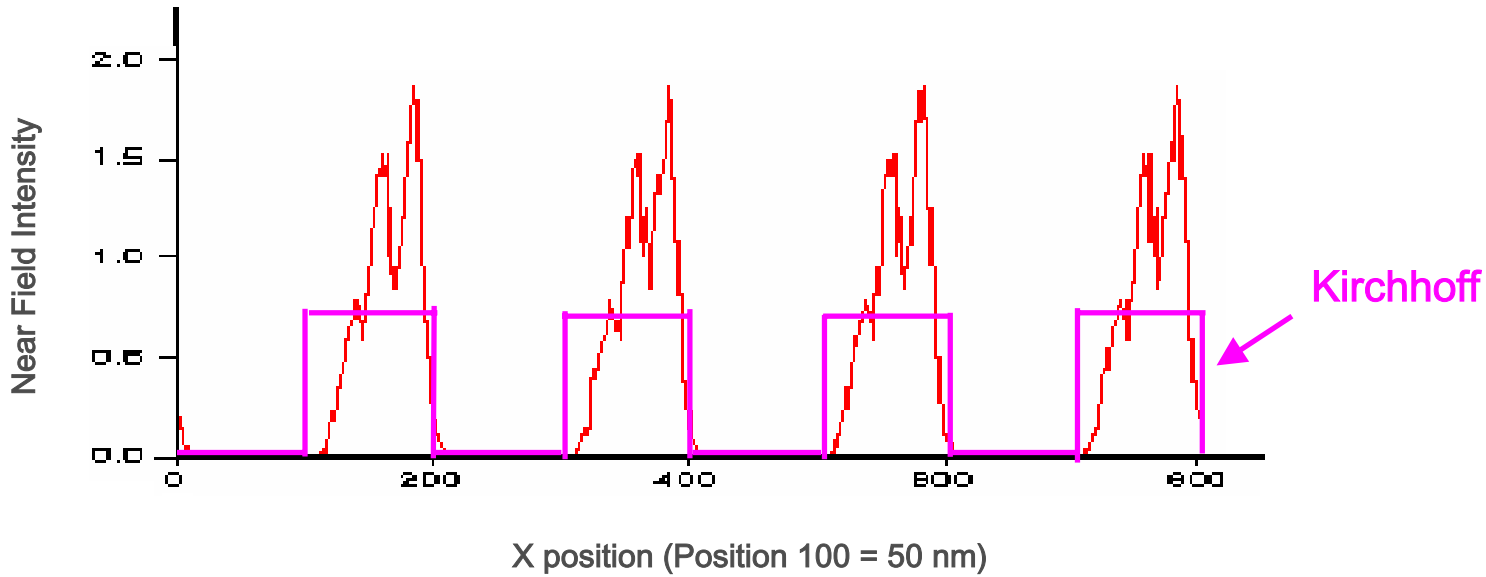
Table 2. Mask material parameters used in the simulation

Simulation method



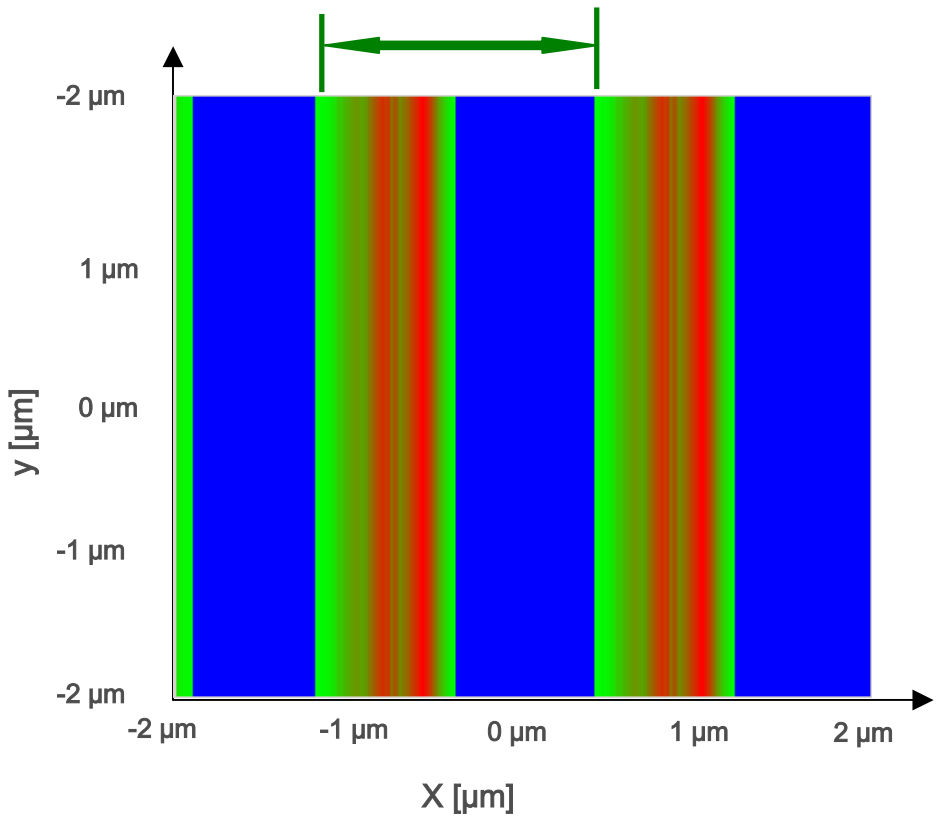
• The image simulation model

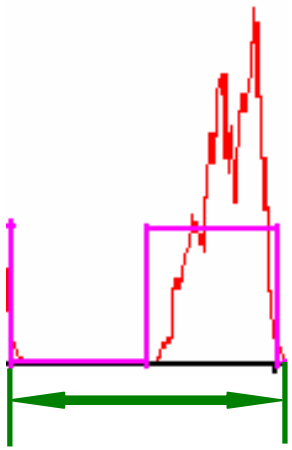
Simulated EUV mask structure



- Near field intensity through the domain

Simulation result

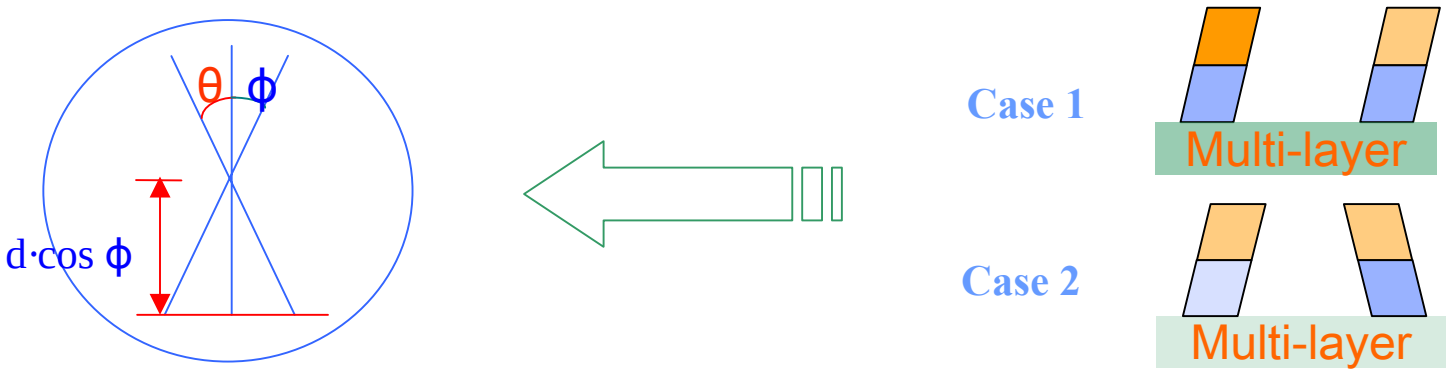




→ 200 nm pitch

- Intensity distribution of top view through the mask

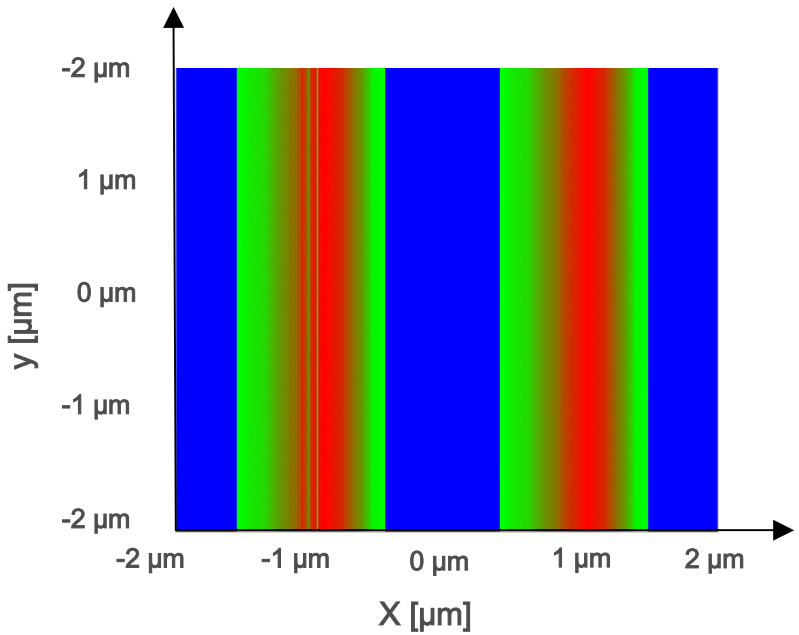
Uneven structure (Non-vertical)



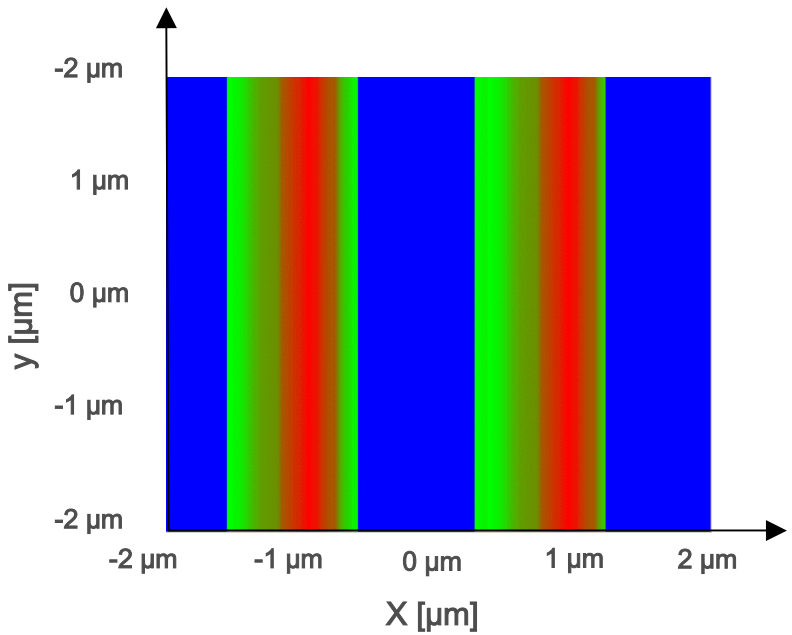
Space CD (printed) = CD (designed) – (2d cos ϕ × tan (θ + ϕ)·M
Line CD (printed) = CD (designed) + (2d cos ϕ × tan (θ + ϕ)·M

θ : incident angle M : Reduction factor
ϕ : oblique buffer and absorber angle

Simulation results

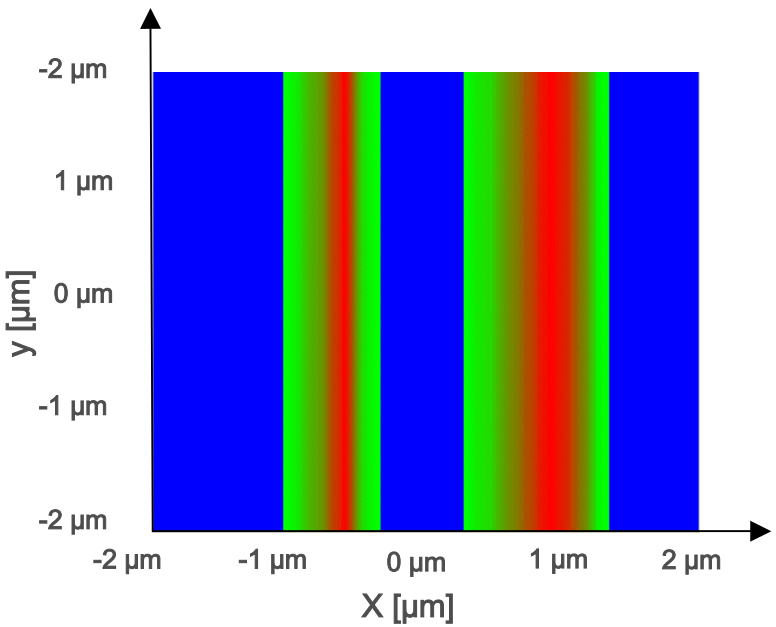


Case 1, Φ =1

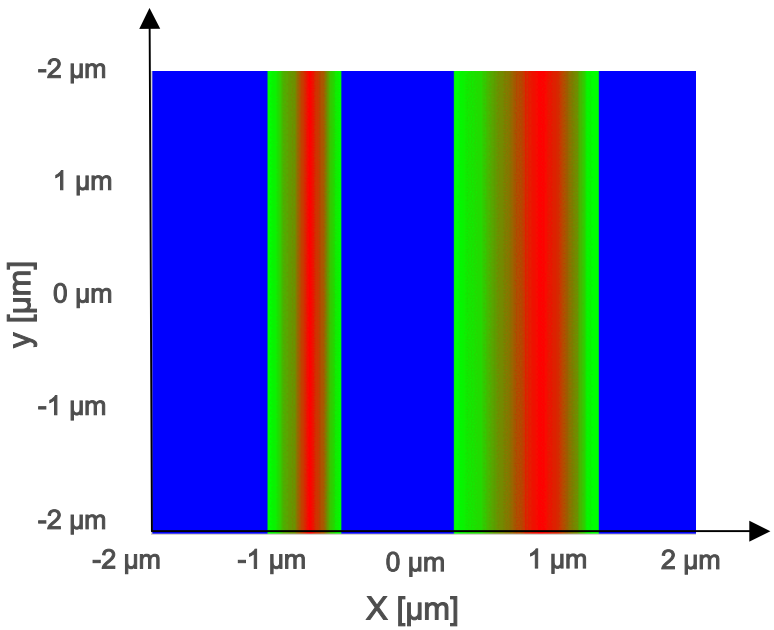


Case 1, Φ =2

- **Uneven mask structure with parallel oblique absorber (periodic)**



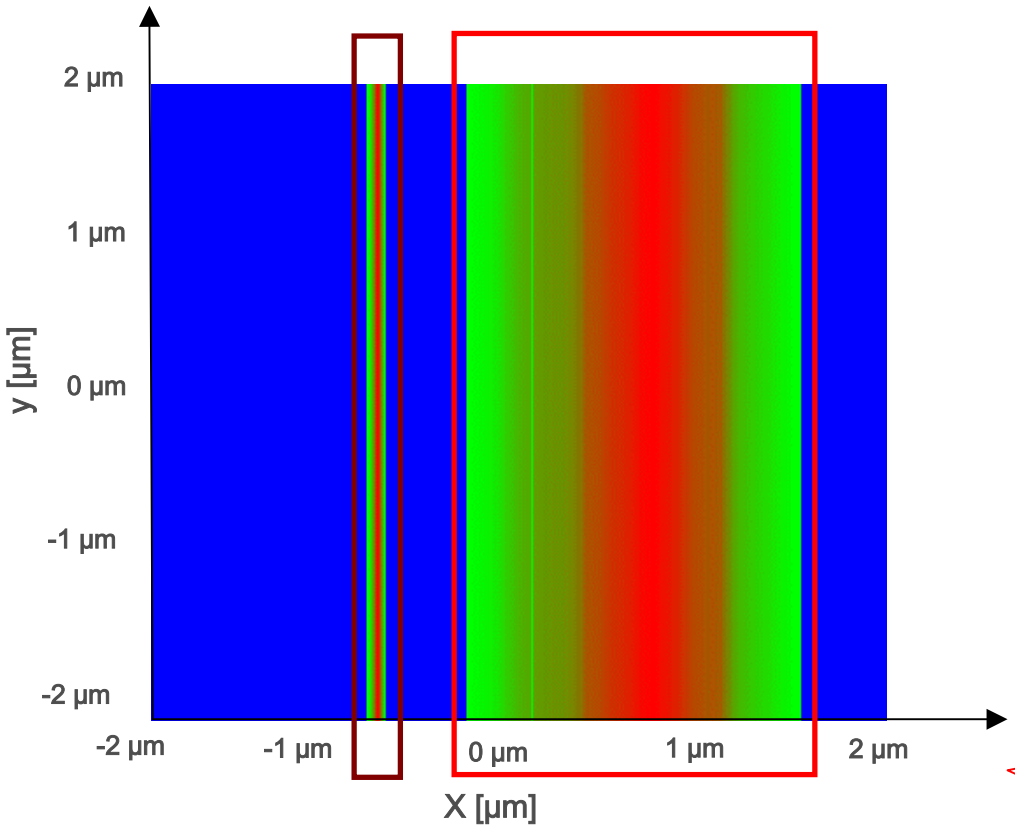
Case 2, Φ =1

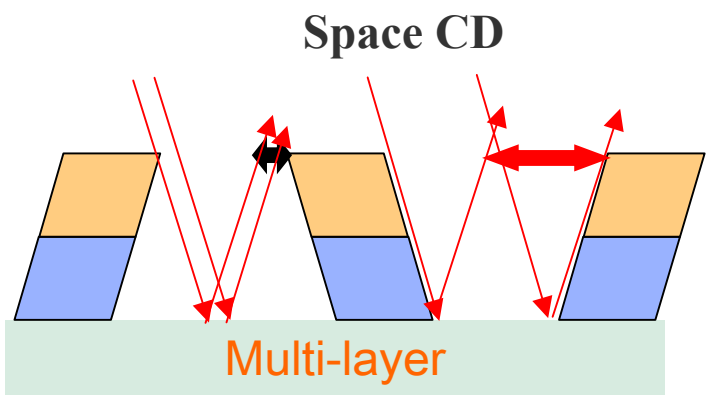


Case 2, Φ =2

- **Uneven mask structure with anti-parallel oblique absorber (periodic)**

No aerial image formation





- Φ =6, same incident angle

No aerial image formation

Conclusion

- Difficulty of aerial image formation due to non-vertical phenomenon of buffer and absorber
- Comparison of changing aerial image with oblique geometry and with vertical geometry
- The aerial image heavily depends on uneven mask structure and absorber thickness