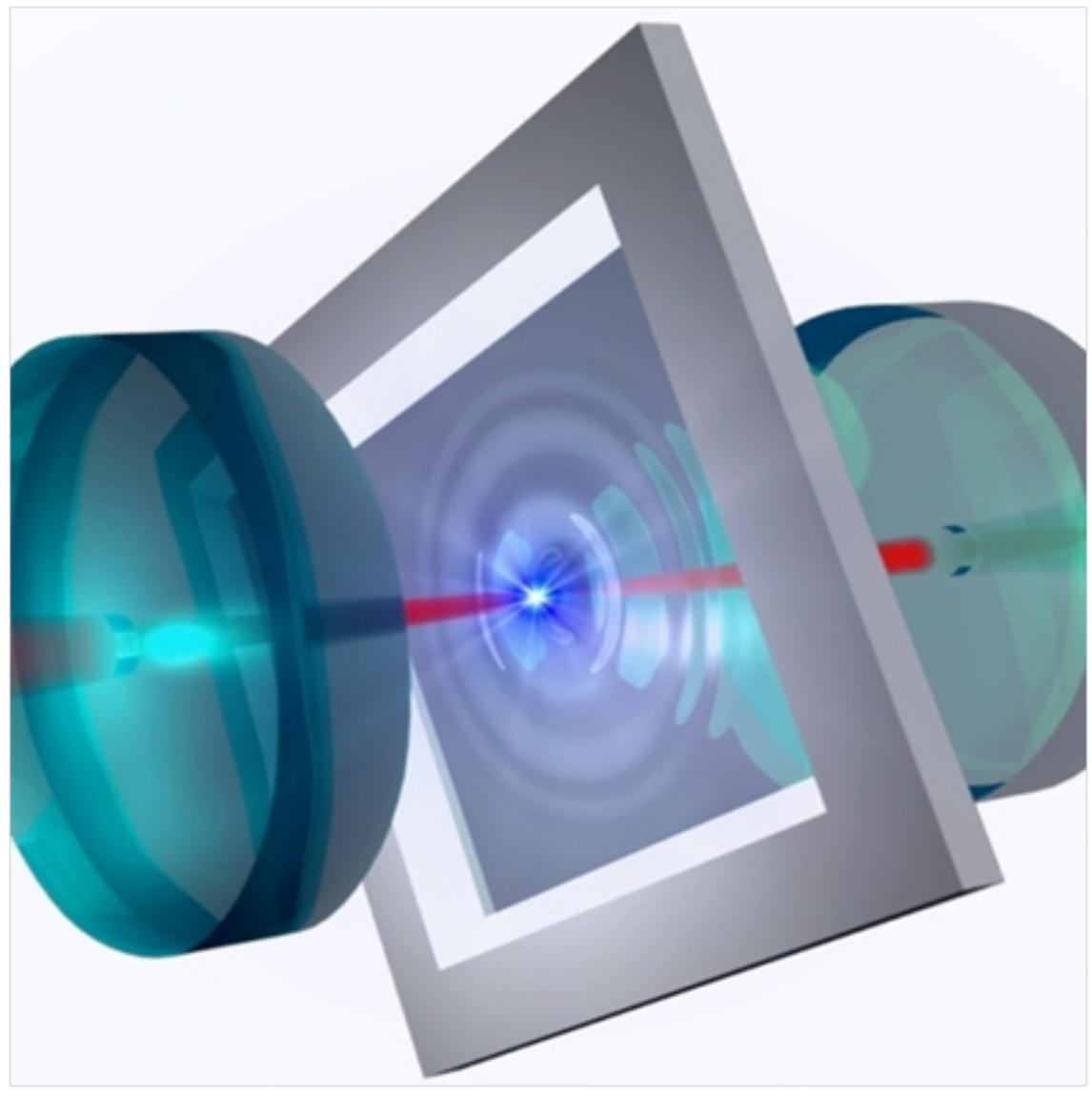
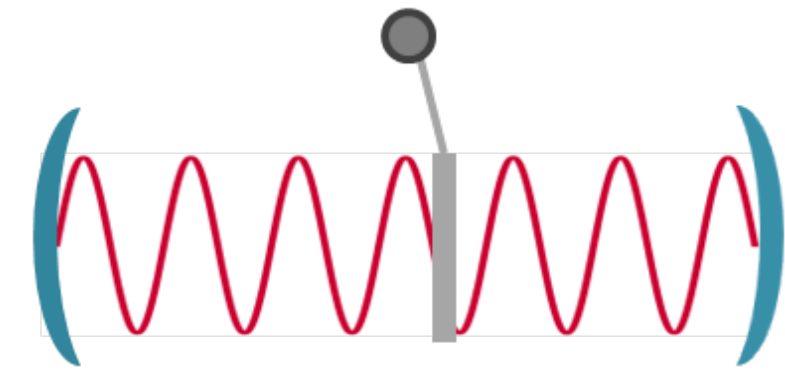


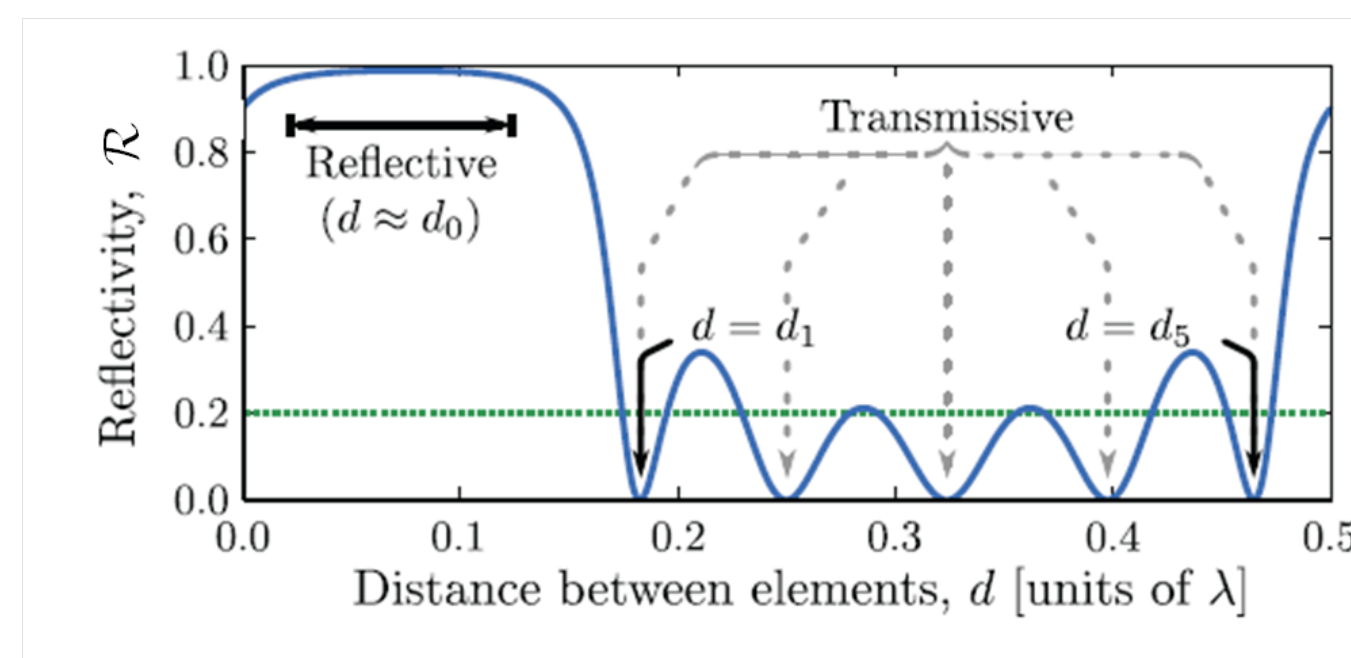
## Cavity optomechanics



**Radiation pressure force** prop. to intensity and dependent on membrane position in cavity



⇒ displacement measurement  
⇒ laser cooling



**Bad mirrors are good!**

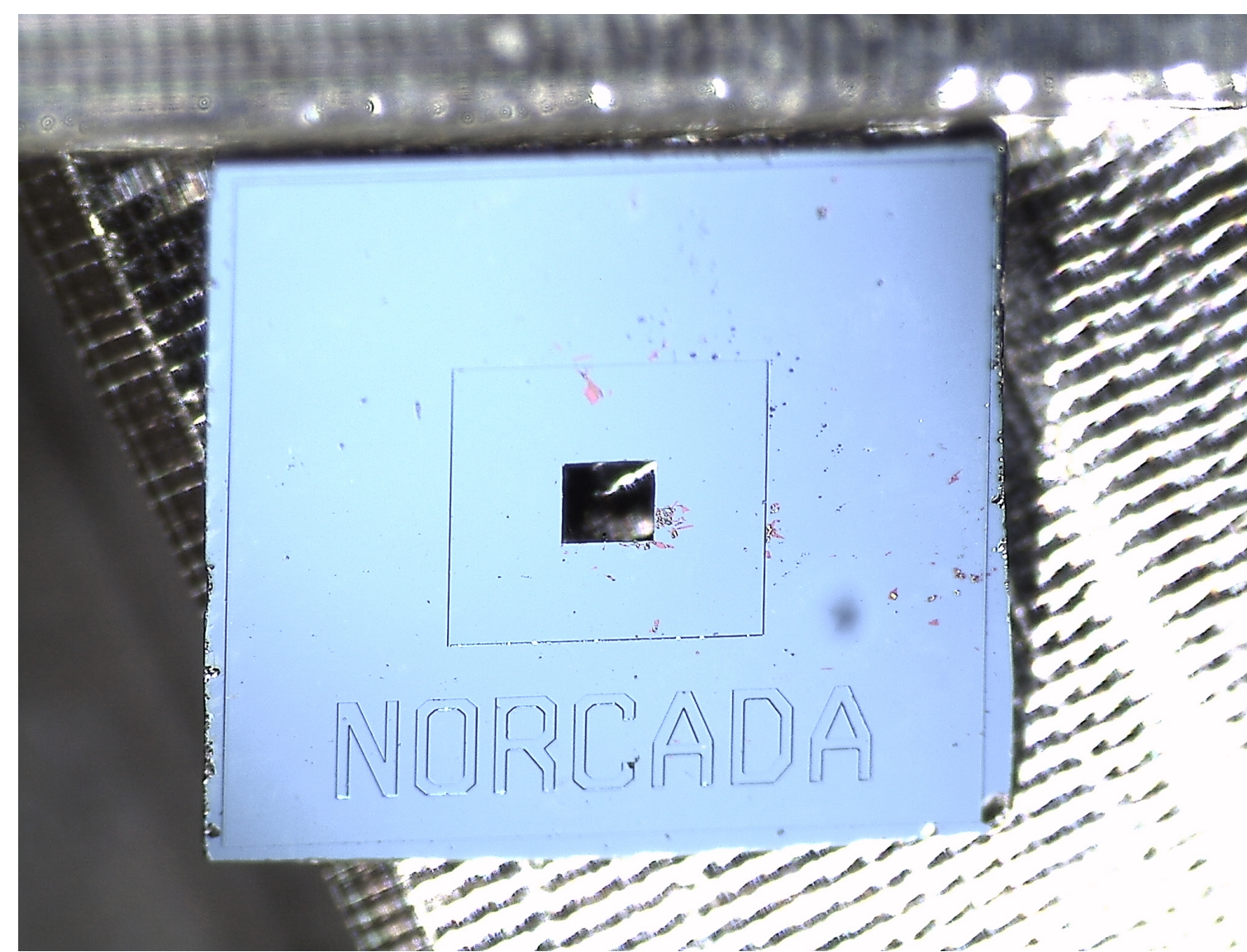
- Enhanced radiation pressure forces [1] ⇒ quantum optomechanics
- Collective optomechanical effects [2] ⇒ long-range phonon-phonon interactions, thermodynamics, synchronization, etc.



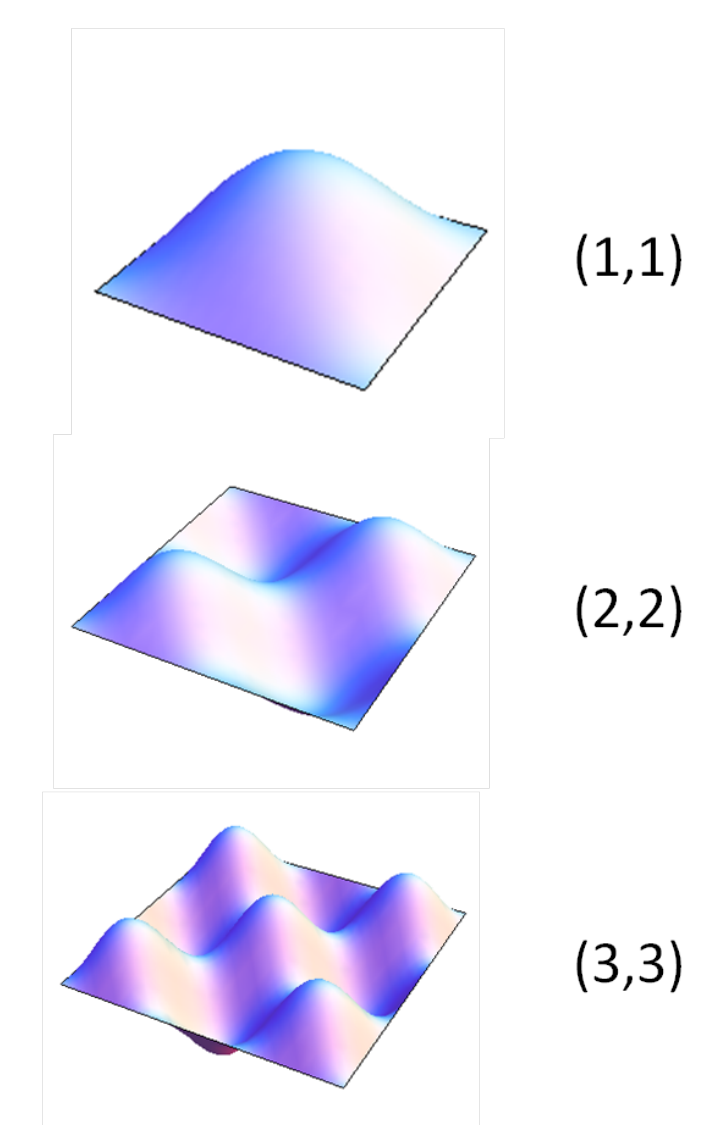
## SiN membranes

### Si<sub>3</sub>N<sub>4</sub> membranes

- area ~ mm<sup>2</sup>, thickness 50-100 nm
- vib. modes freq. ~ MHz
- high tensile stress (1 GPa)
- $Q \sim 10^6 - 10^7$
- low absorption

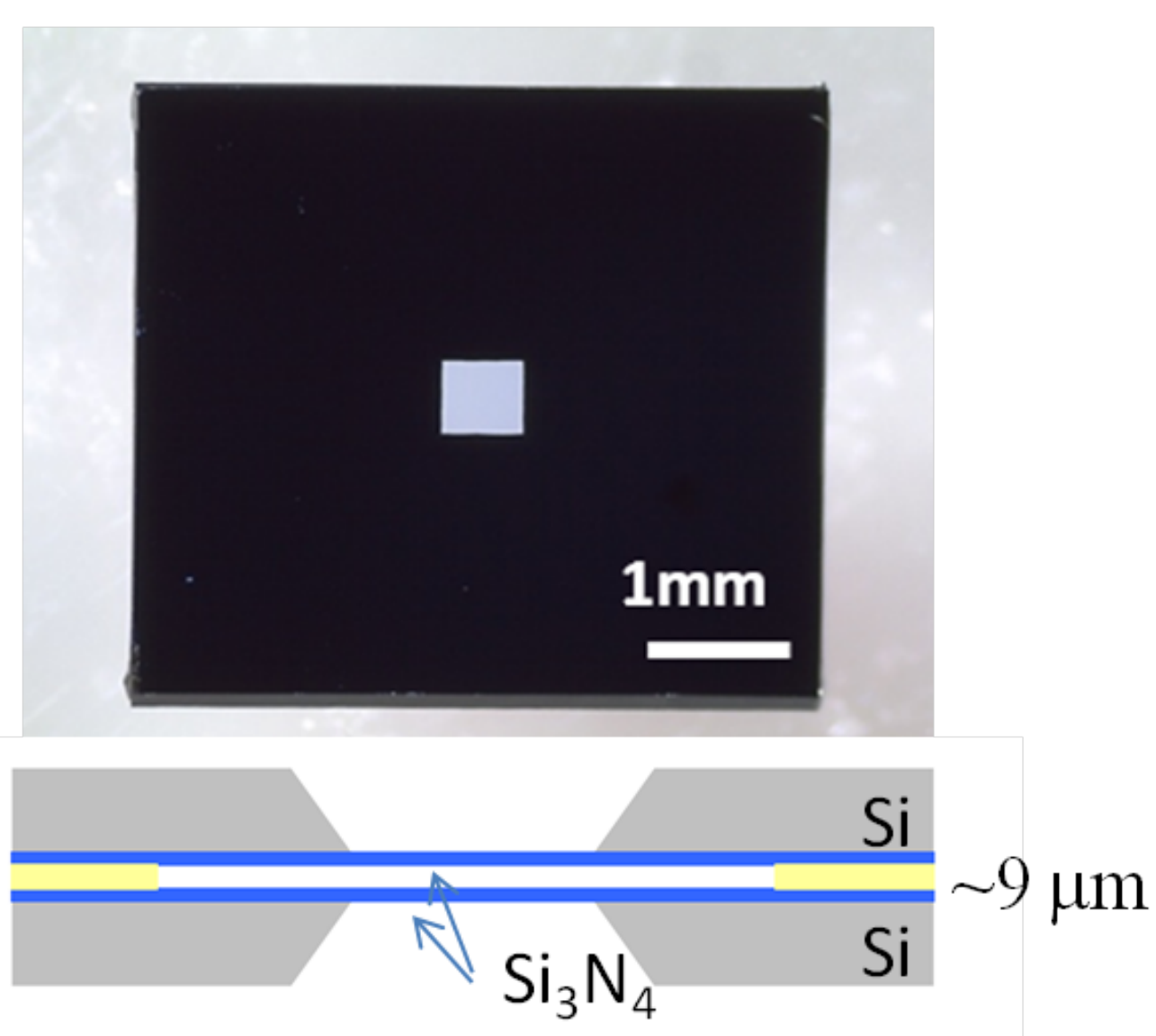


### Square drum modes

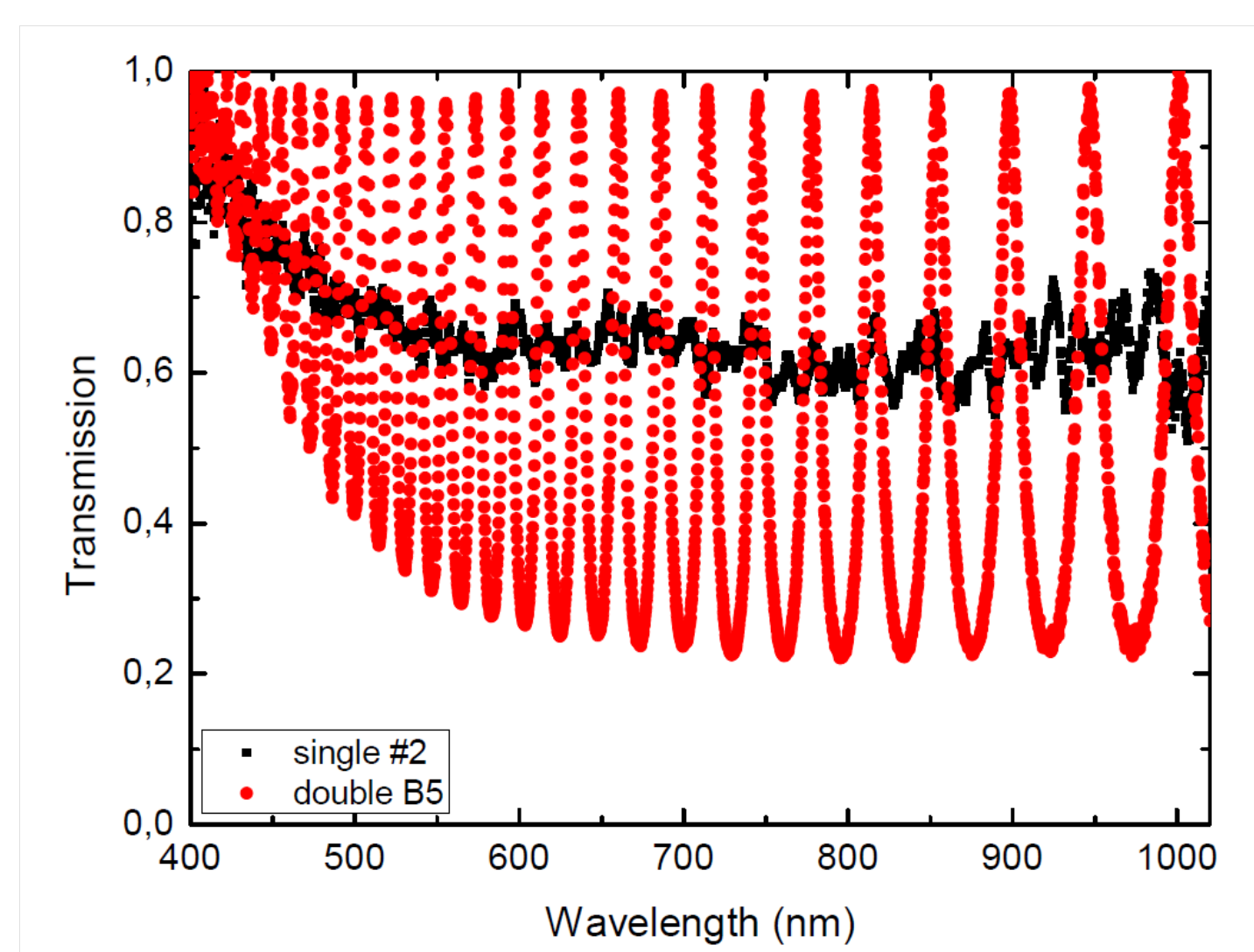


## SiN membrane arrays

### Periodic membrane arrays

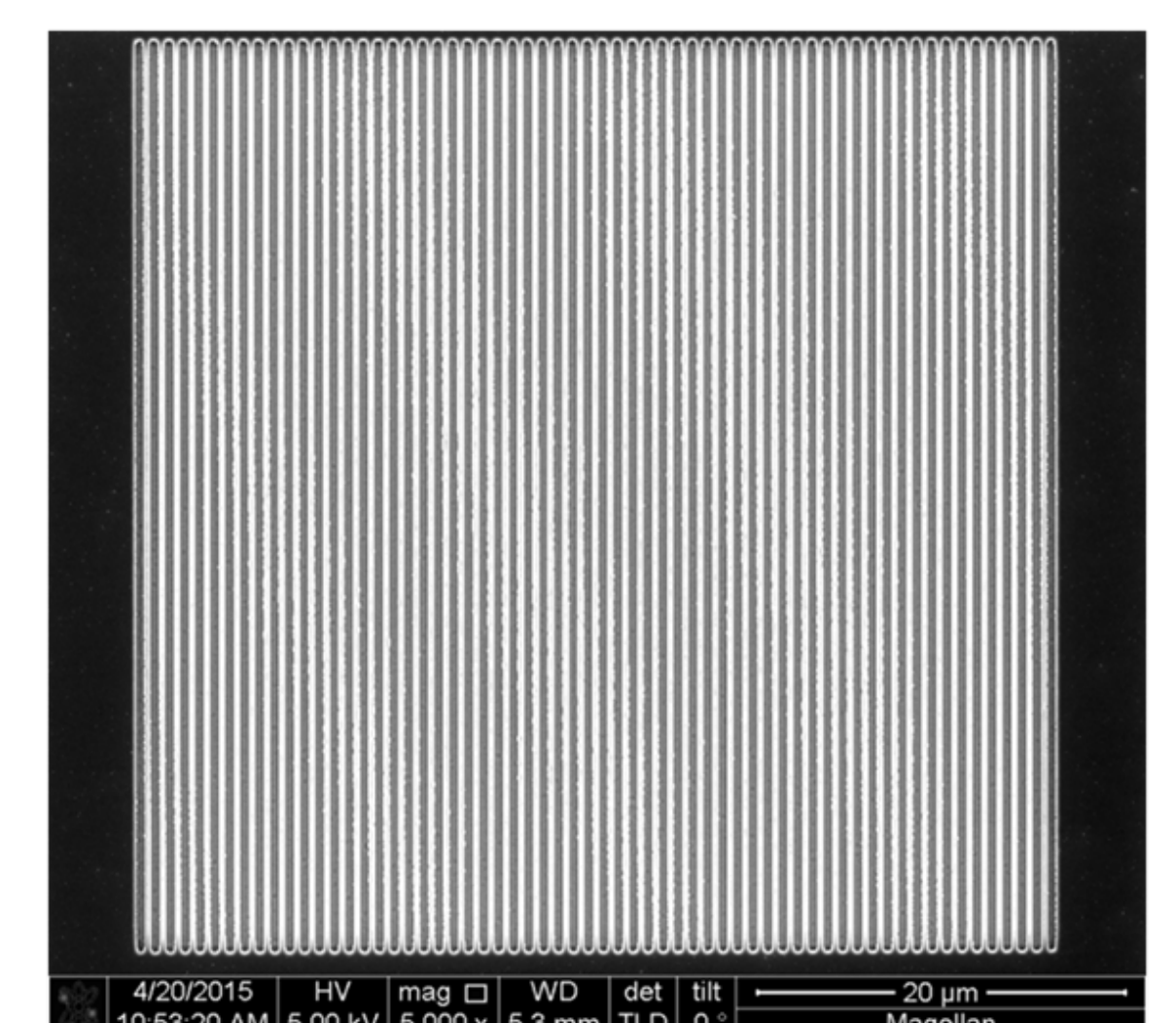
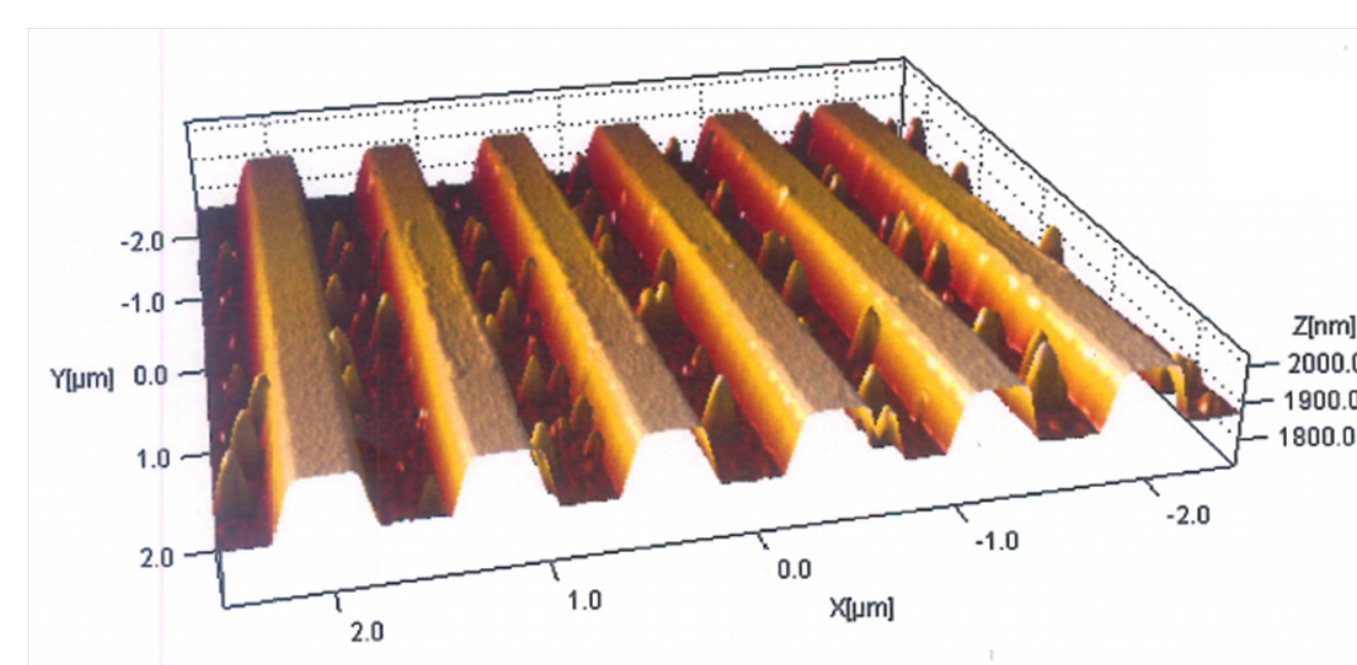


Two-membrane array



Transmission spectrum of single membrane (black) and two-membrane array (red)

### High-reflectivity membranes



Membrane "patterned" with 0<sup>th</sup>-order diffraction grating (left: AFM, right: SEM)

### Possible experimental projects:

- Fabrication & measurements of optical/mechanical properties of membrane arrays
- Alignment & characterization of high-finesse optical cavity
- Simulation & characterization of grating-patterned membranes (theory projects also possible)

## References

- [1] A. Xuereb, C. Genes, and A. Dantan, Phys. Rev. Lett. **109**, 223601 (2012).  
[2] A. Xuereb, C. Genes, G. Pupillo, M. Paternostro, and A. Dantan, Phys. Rev. Lett. **112**, 133604 (2014).