

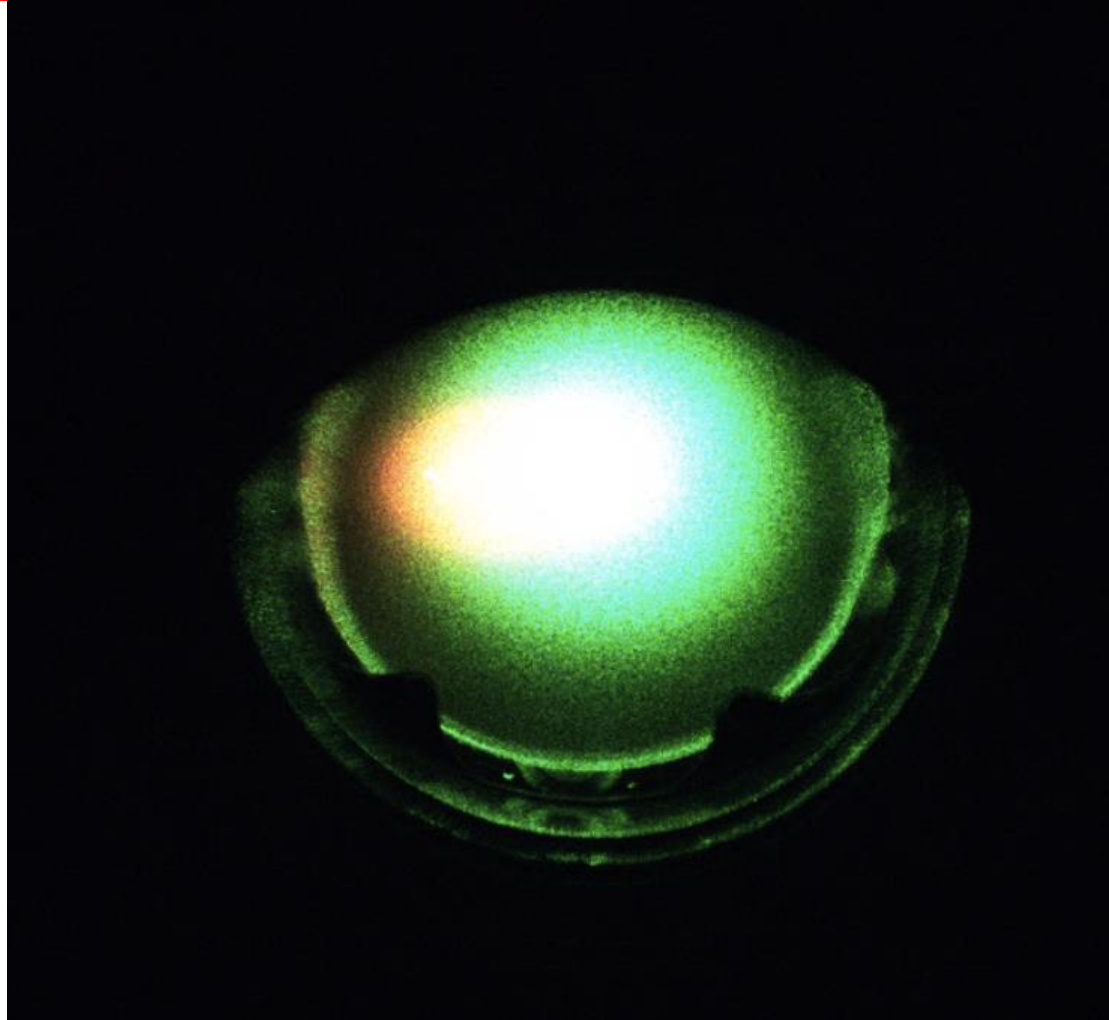
Optical loss of a molecular layer

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Abstract

- ✓ Molecular layer can be formed on the cryogenic mirror surface.
- ✓ Estimation of optical loss induced by a molecular layer on the cryogenic test mass.
- ✓ Scattering can be negligible.
- ✓ Absorption may become a problem.

Molecular layer

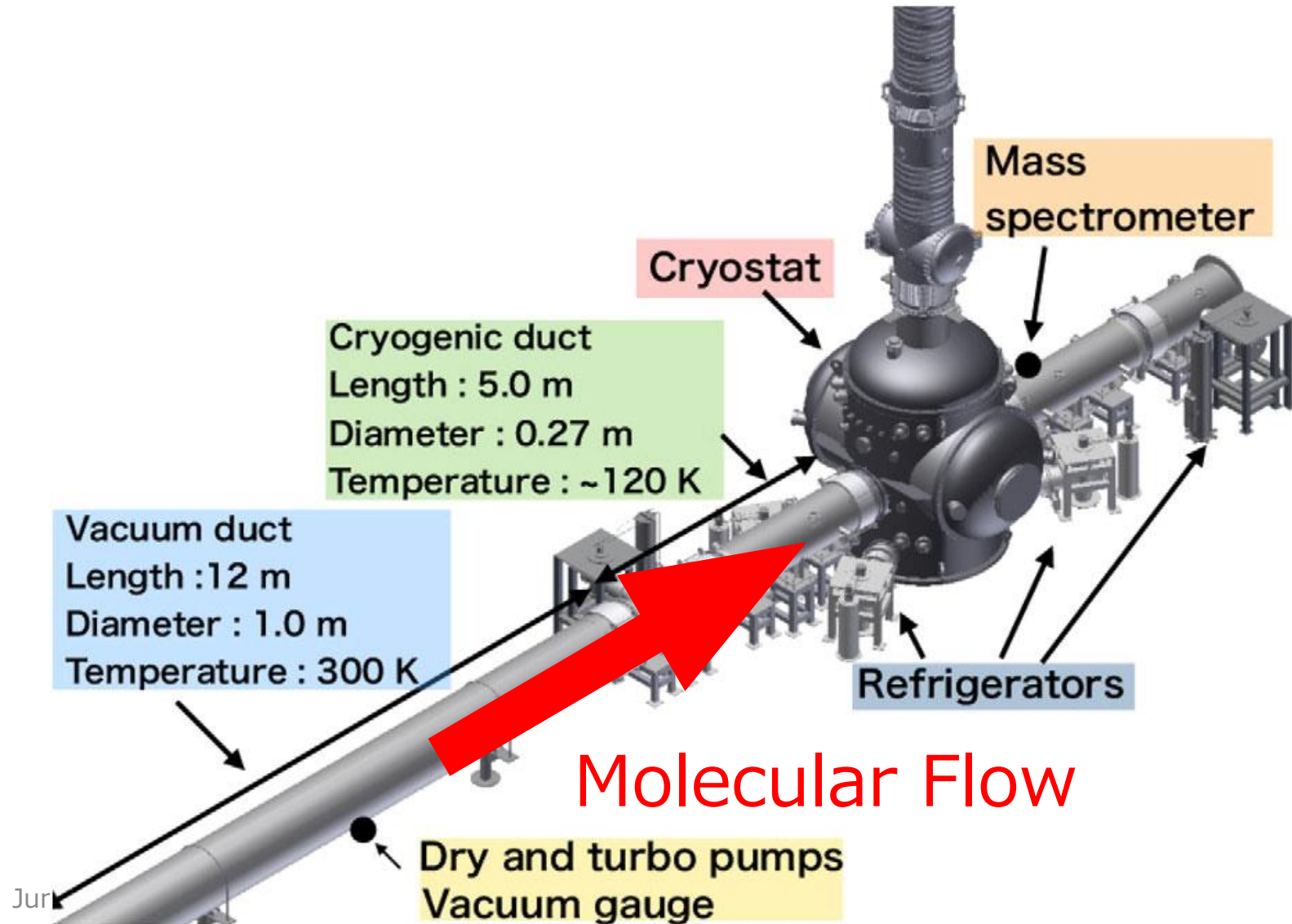


<http://klog.icrr.u-tokyo.ac.jp/osl/?r=9377>

June 9, 2020

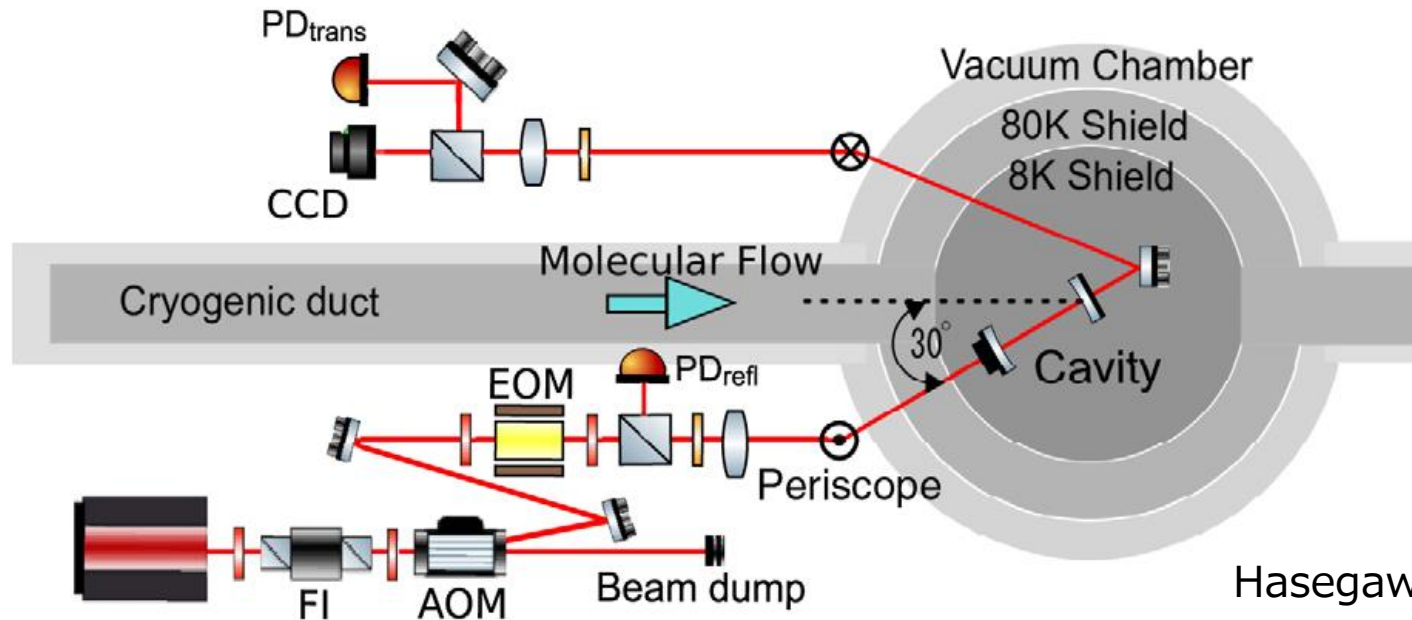
Voyager telecon

Molecular layer formation



Formation rate

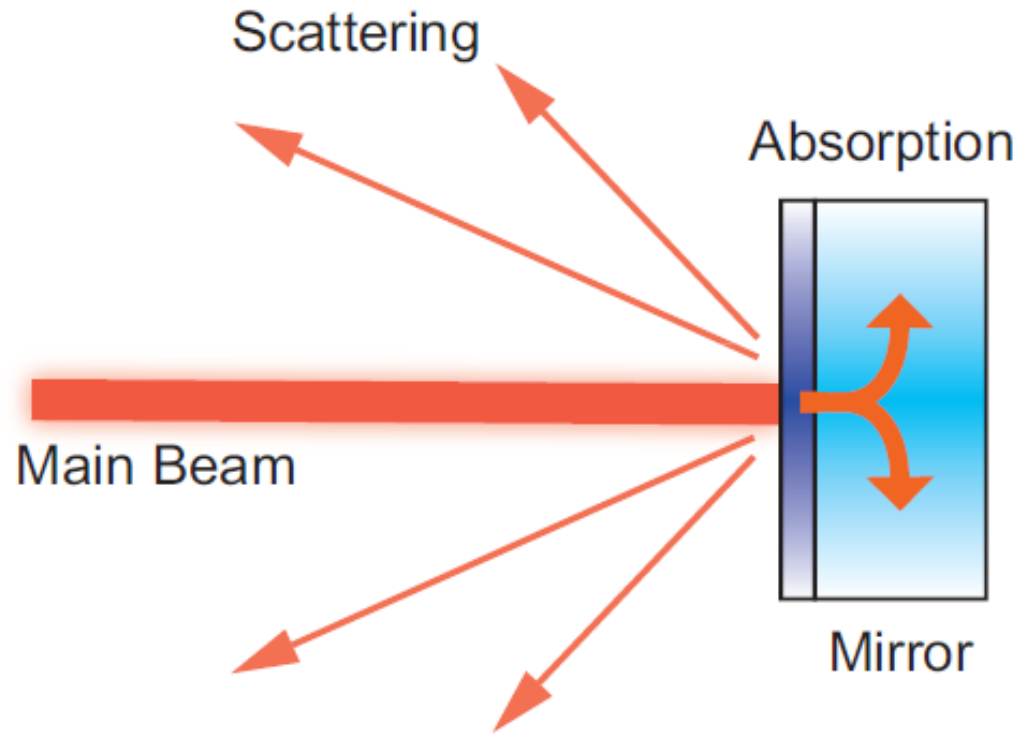
Measured in KAGRA



Forming Rate $\eta = 27 \text{ nm/day}$

It can be reduced by a factor of 50 by improving the vacuum system of KAGRA.

Optical loss

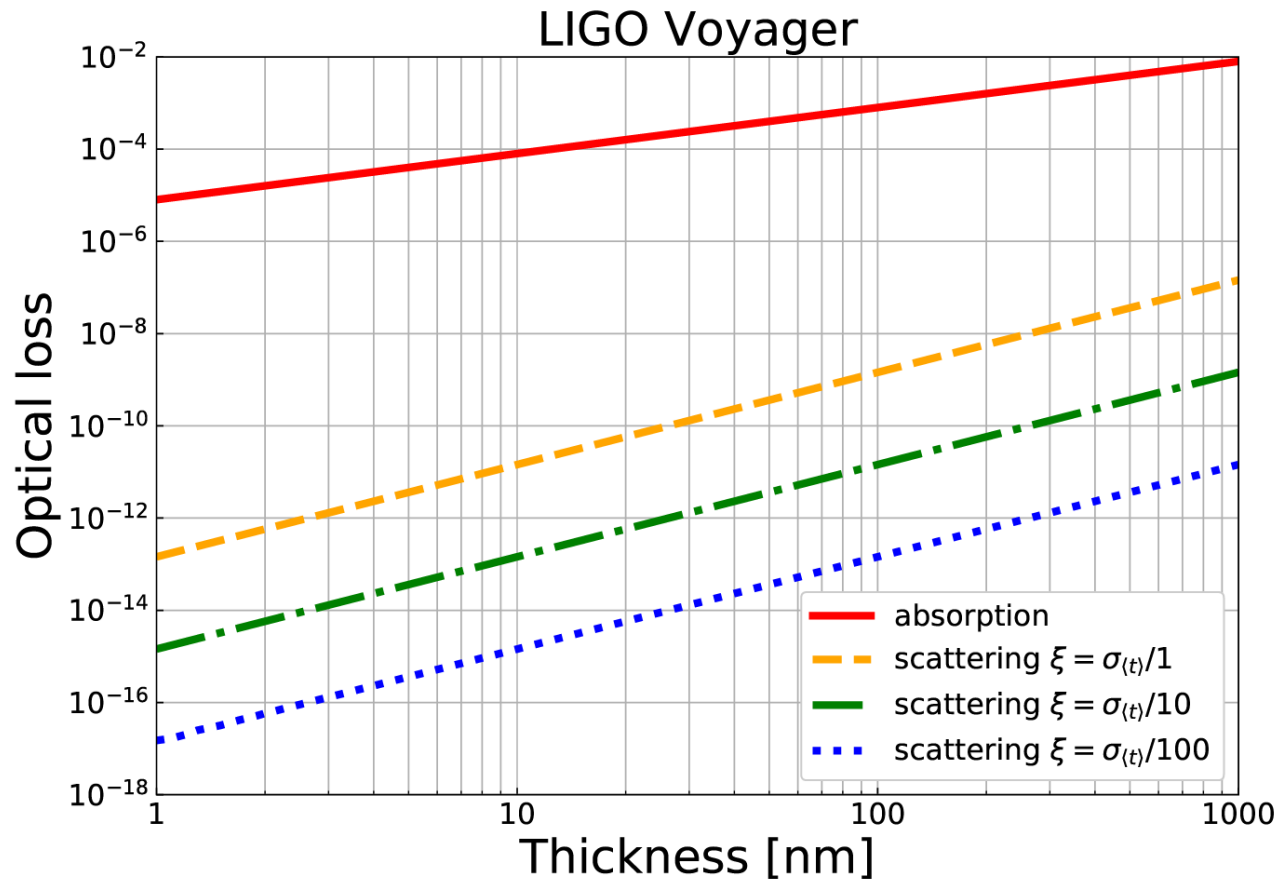


✓ Optical losses are induced by the molecular layer.

Assumption

- ✓ Uniform molecular layer formation
- ✓ Amorphous ice
- ✓ Lambert-Beer law -> absorption
- ✓ Literature value for the absorption coefficient of amorphous ice
 - https://ghosst.osug.fr/resources/PUBLI_Schmitt_1998/schmitt98-ASSL-SSI-227-199.pdf
 - thin film deposited

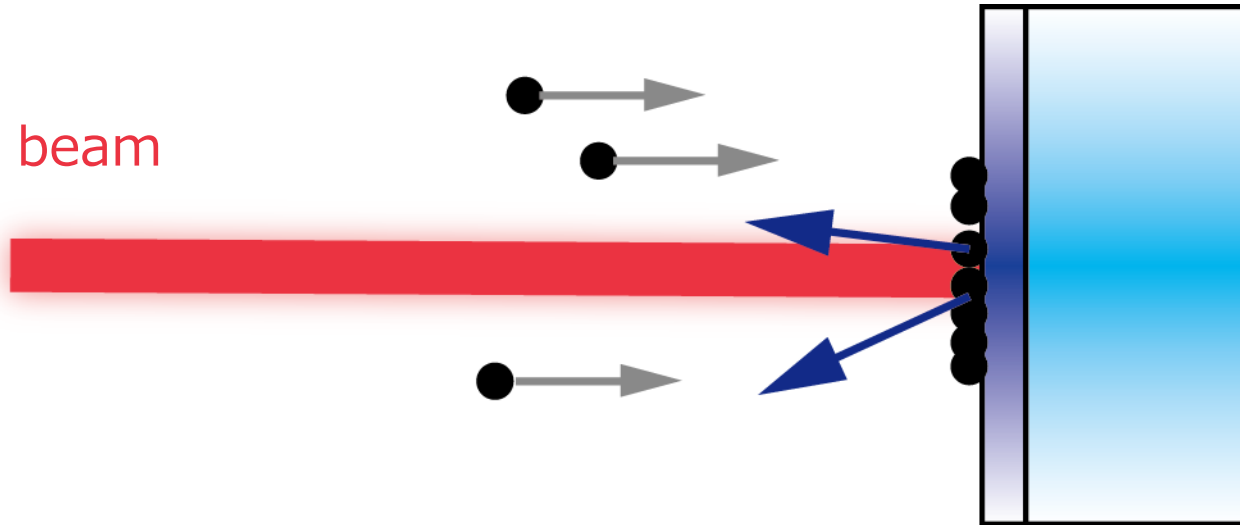
Absorption



ξ : the correlation length which characterizes the periodic length of the roughness along the surface.

σ : the standard deviation of thickness.

Desorption



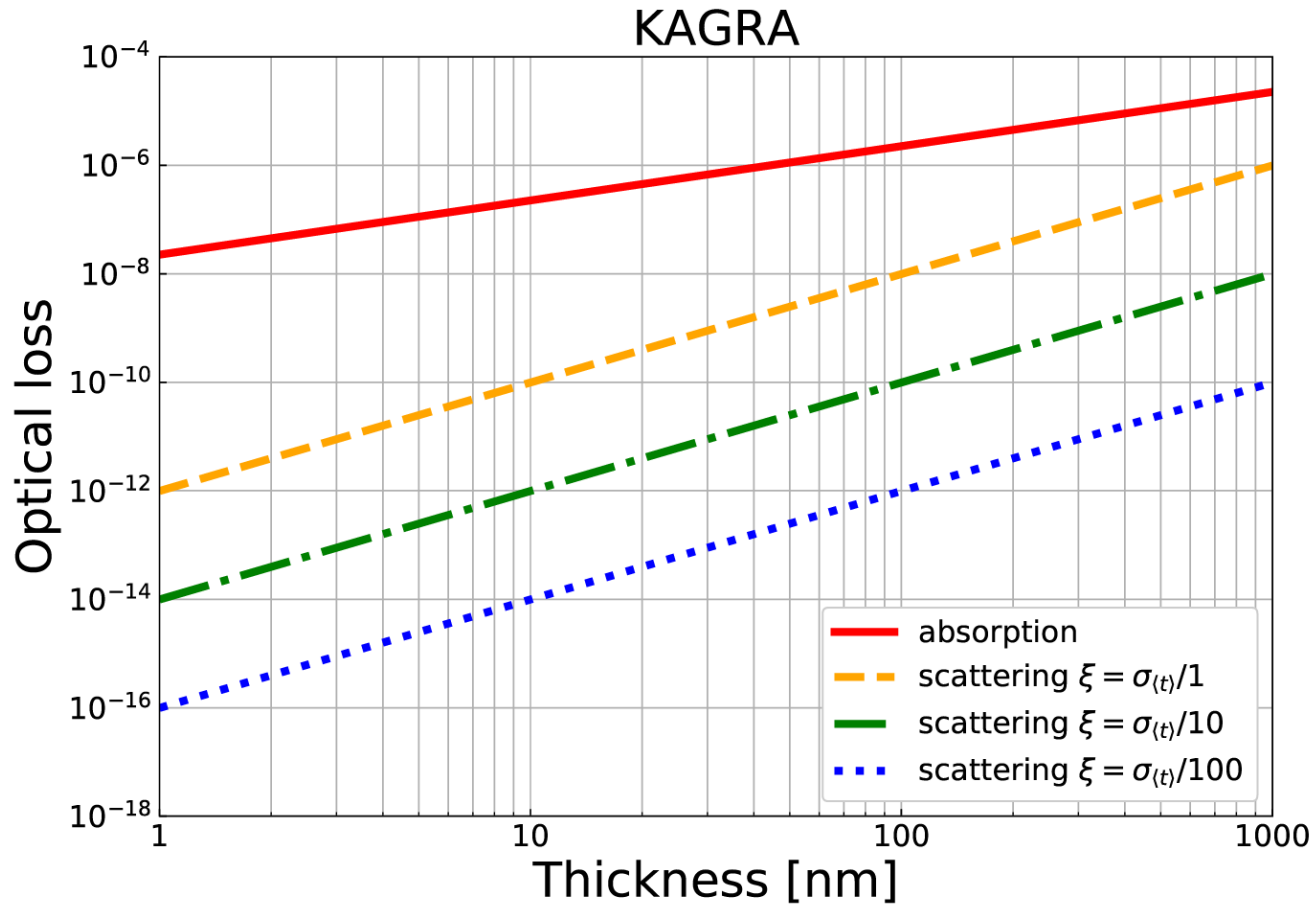
Large absorption can give energy to the molecules.
-> molecules may desorb from the surface

This effect is now under consideration.

Summary

- ✓ The molecular layer transportation from the beam duct introduces the molecular layer on the cryogenic mirror surface.
- ✓ Absorption by the cryogenic molecular layer can become a problem.
- ✓ Further investigations are needed.
 - absorption coefficient of molecular layer
 - whether the layer is formed or not for the case of LIGO Voyager

Backup



Backup

