



Scattering of the ITM and ETM mirrors and constraints for the Wide-Angle Baffles in bKAGRA

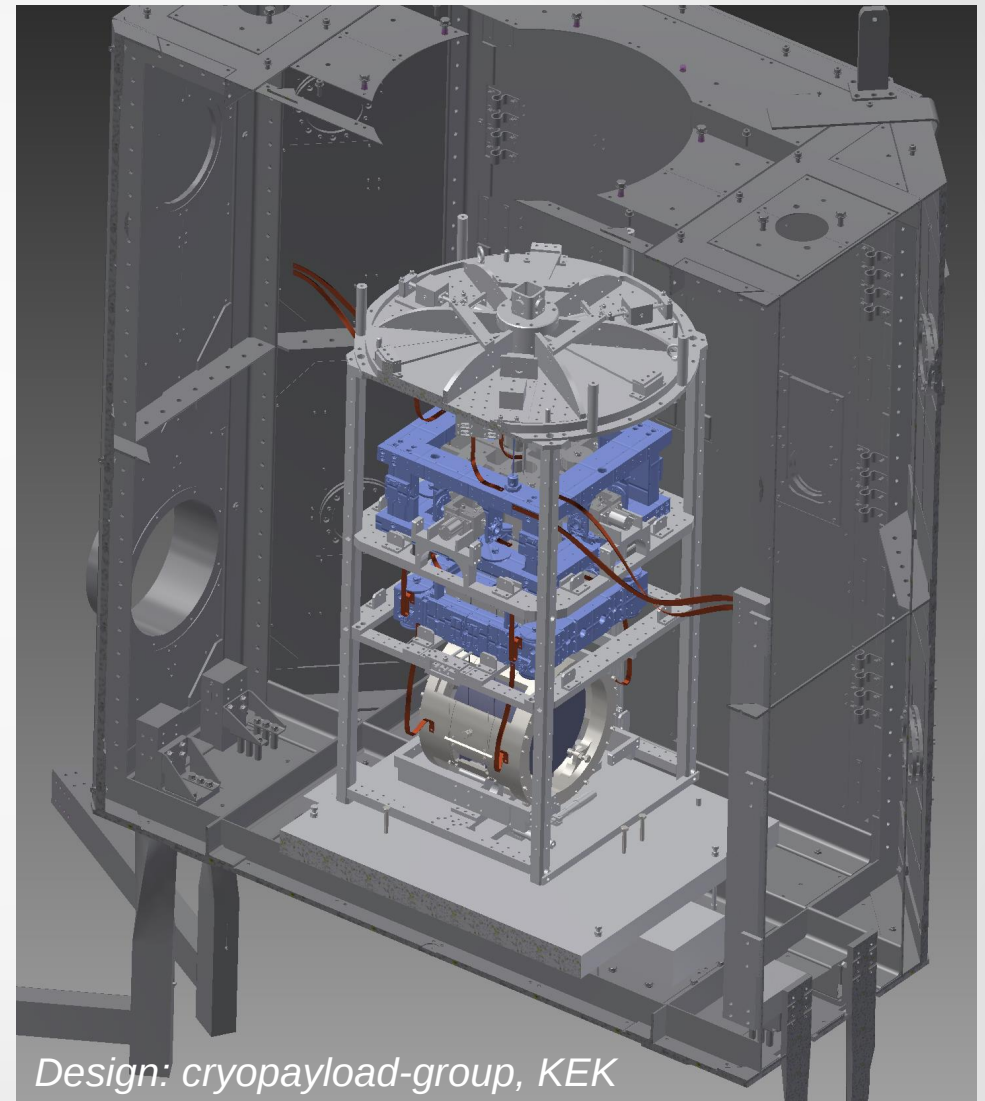
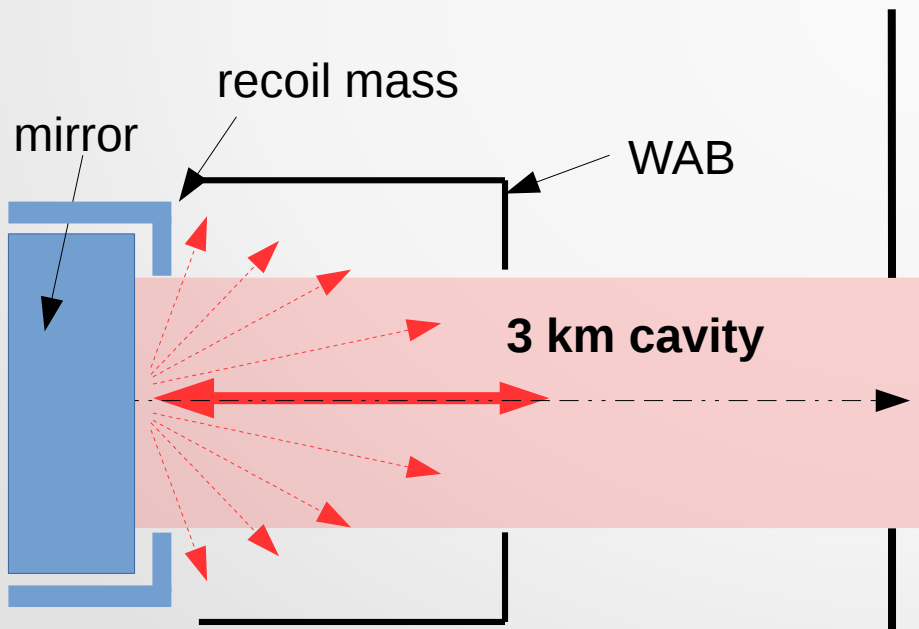
Simon ZEIDLER*, Tomotada AKUTSU

NAOJ, AOS

f2f KAGRA meeting at the University of Niigata, March 2017

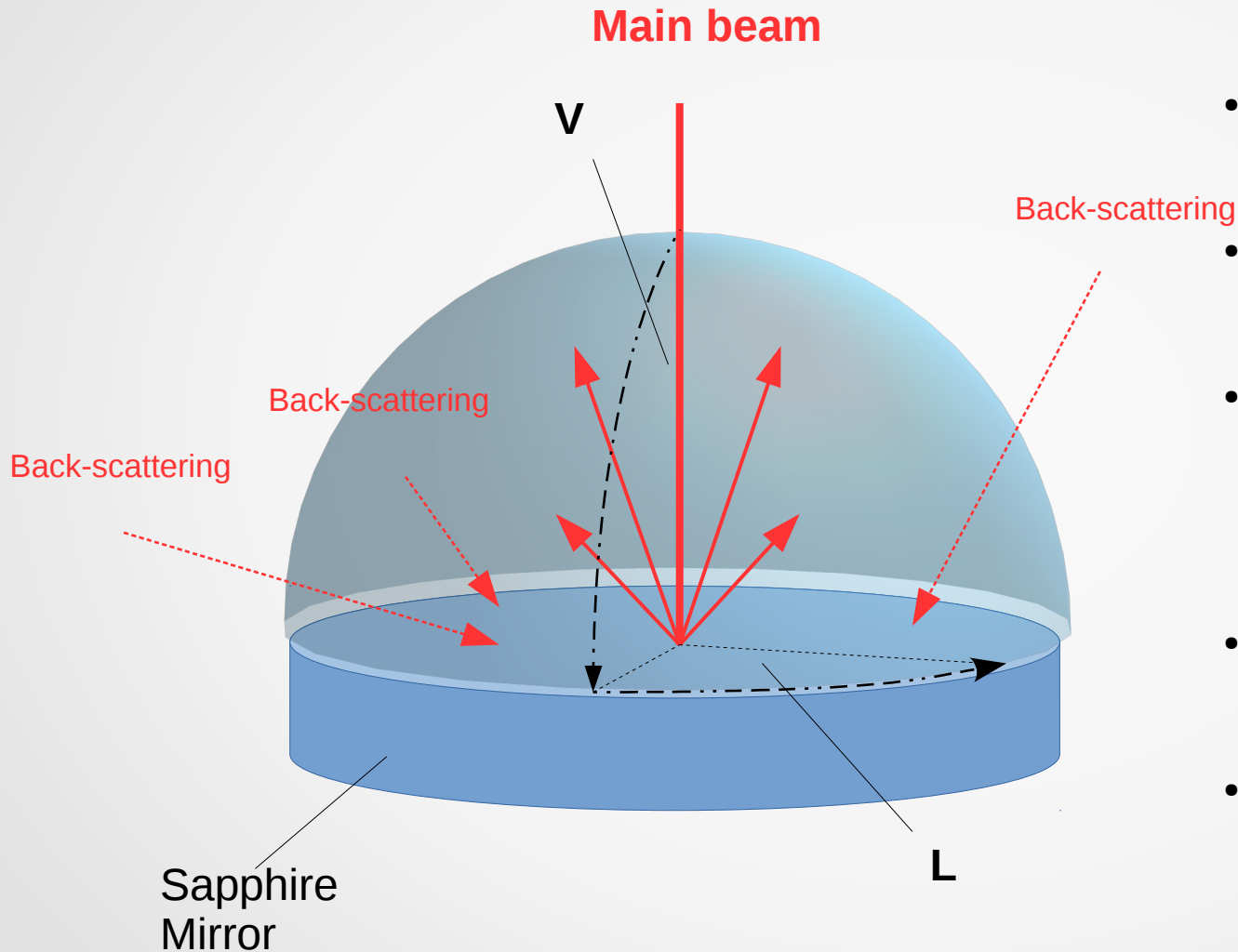
Wide-Angle Baffles (WAB)

- Baffles to be installed close to the ITM and ETM mirrors
- Inside the cryostats
- To block scattering at wide angles ($\sim 30^\circ - 85^\circ$)
- Simulations to find most effective design



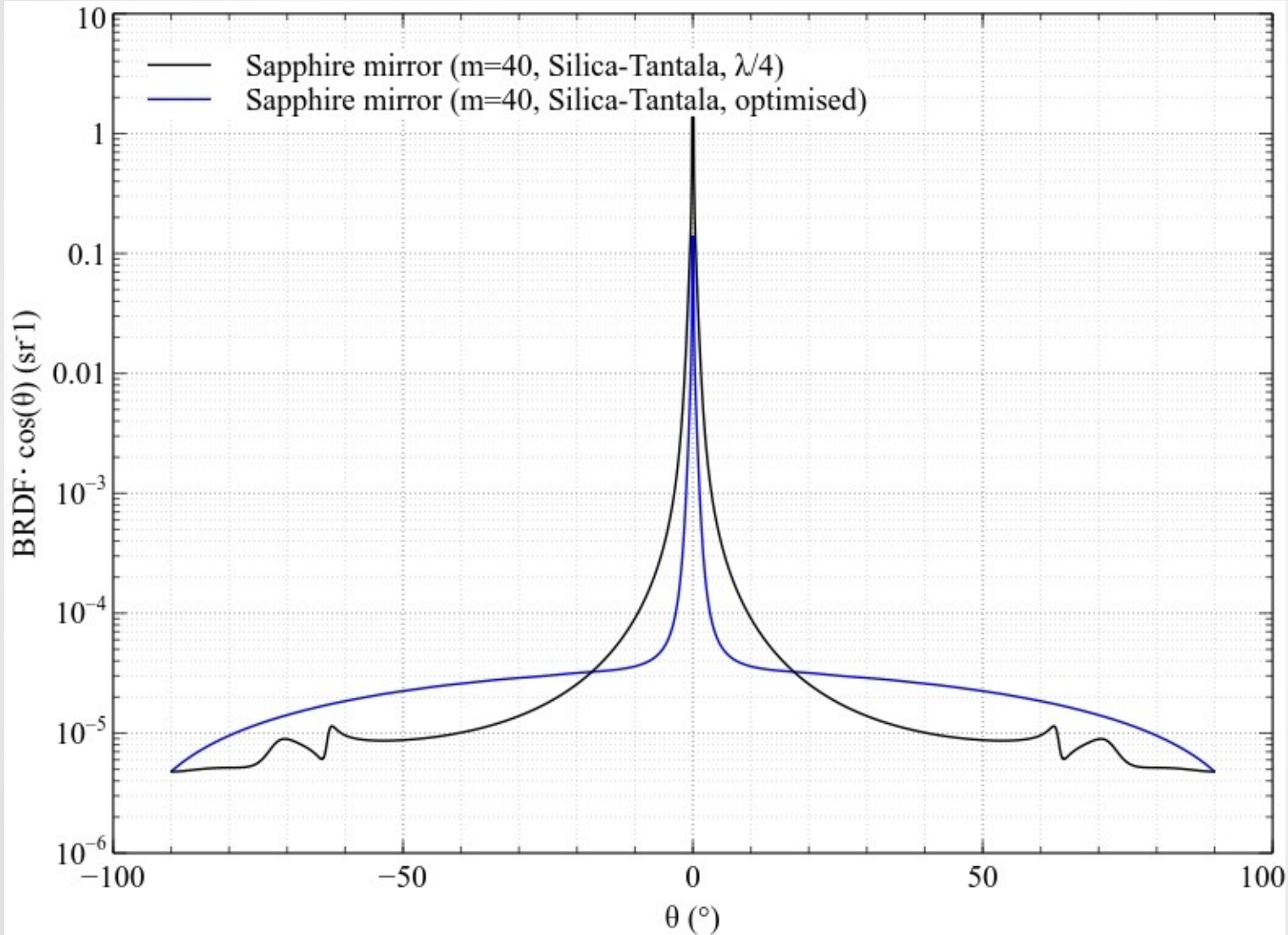
Design: cryopayload-group, KEK

Simulating back-scattering from the interior of the cryostat



- Simulation tool: "LightTools"
- 10^8 rays per simulation run
- Mirror's scattering distribution calculated with multi-layer scattering theories
- Specular reflection not included
- Result: scattering map as a function of **L** (longitude) and **V** (latitude)

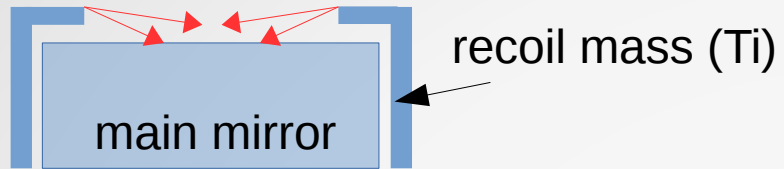
Scattering distribution on coated sapphire mirror



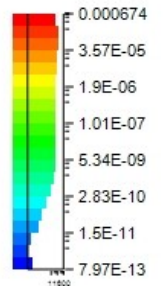
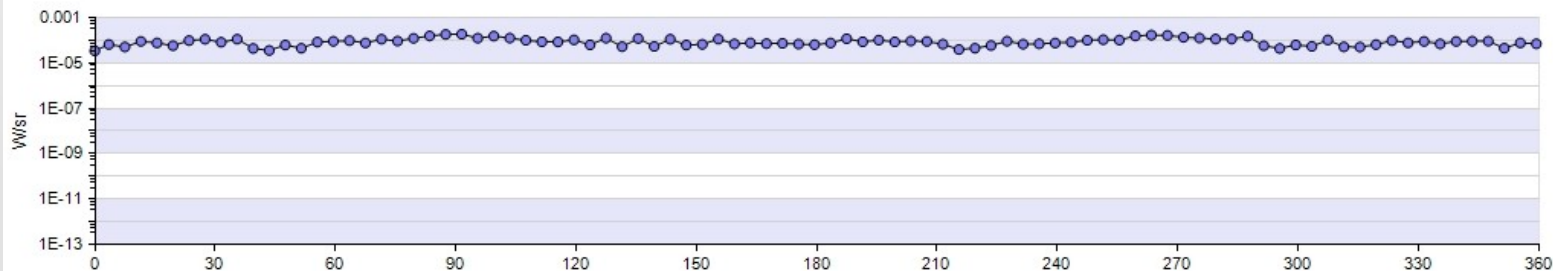
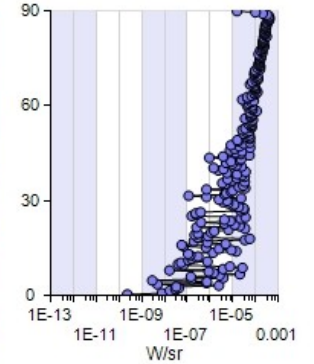
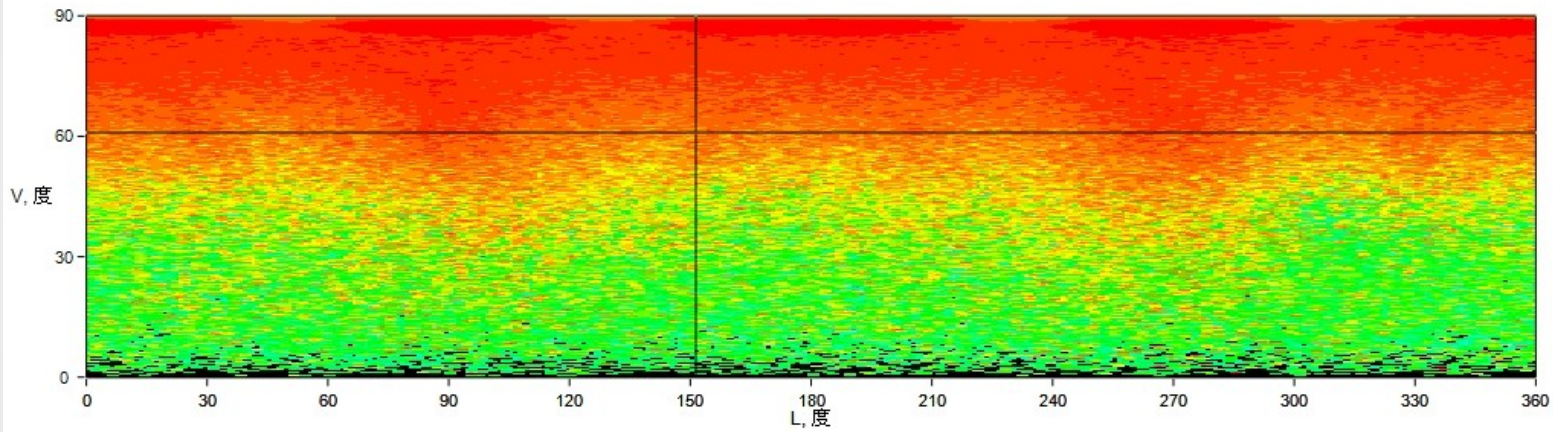
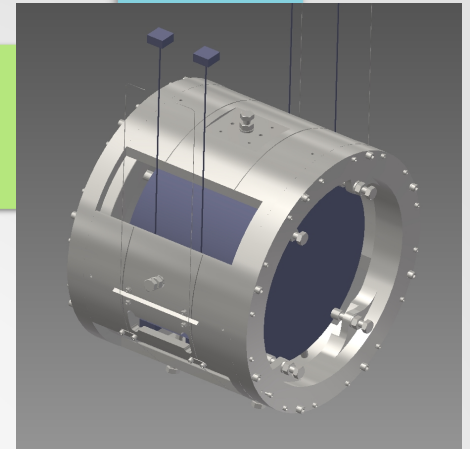
→ surface roughness (100ppm) + point defects (30ppm)

coating design:
Hirose-san

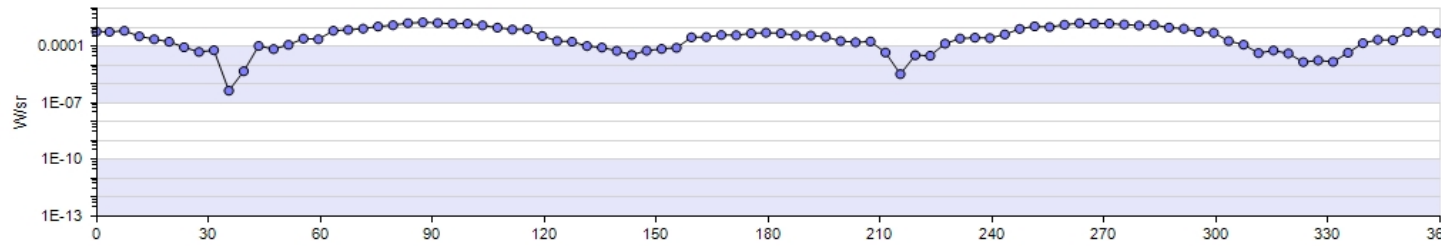
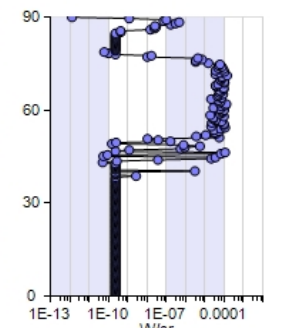
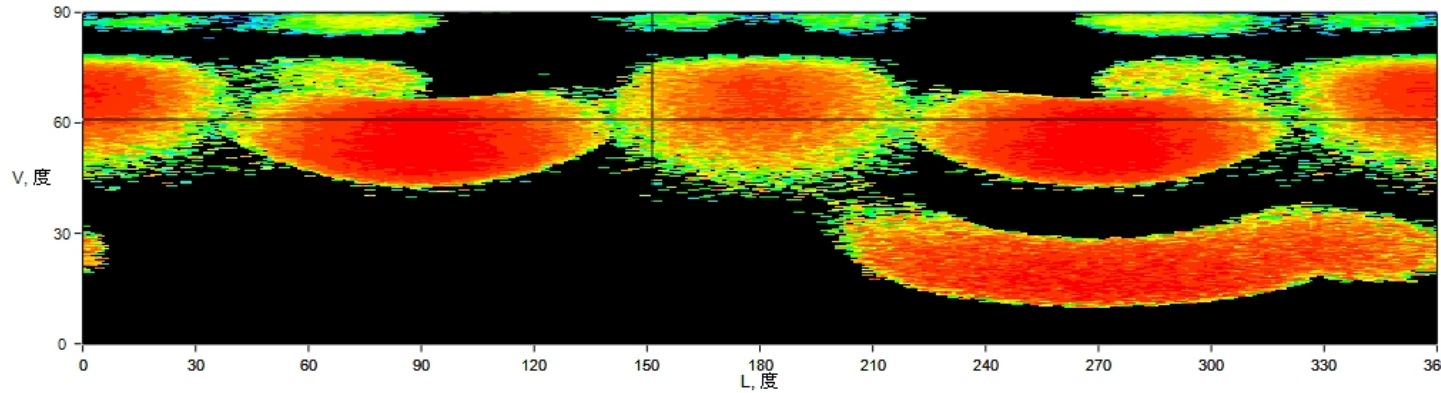
Simulation results of recoil-mass scattering



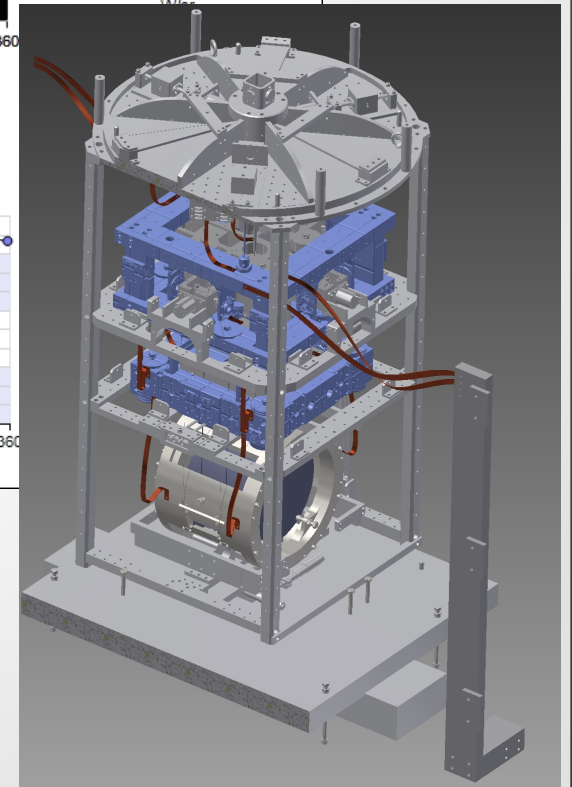
$$P_{\text{bsc}} / P_{\text{scat}} \sim 0.027 \%$$



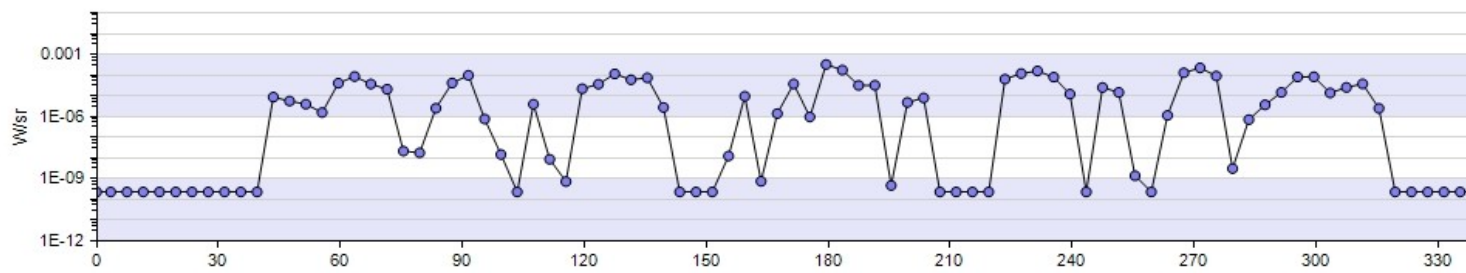
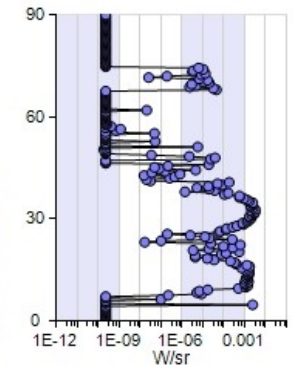
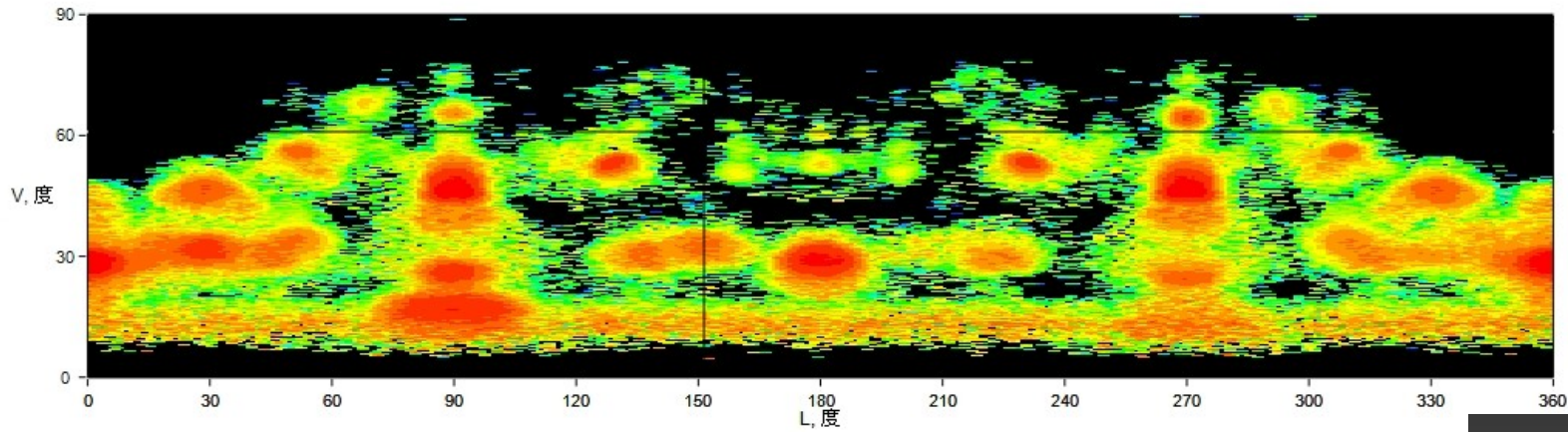
Simulation results of assembly-frame scattering



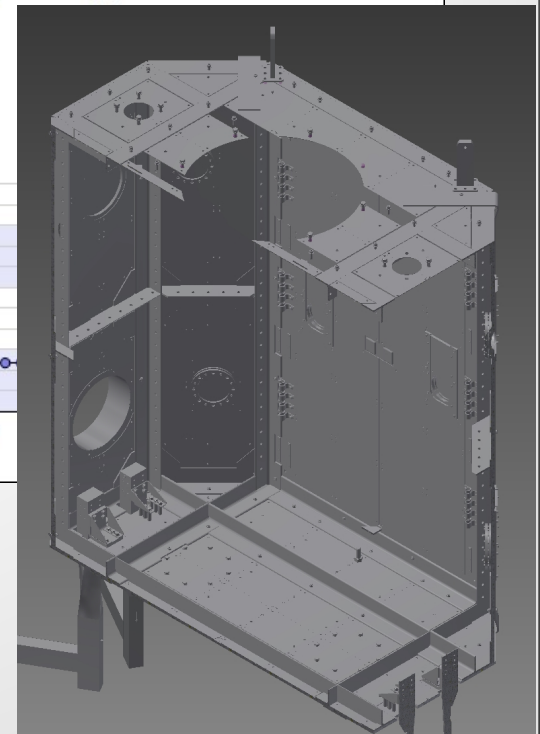
$$P_{\text{bsc}} / P_{\text{scat}} \sim 0.043 \%$$



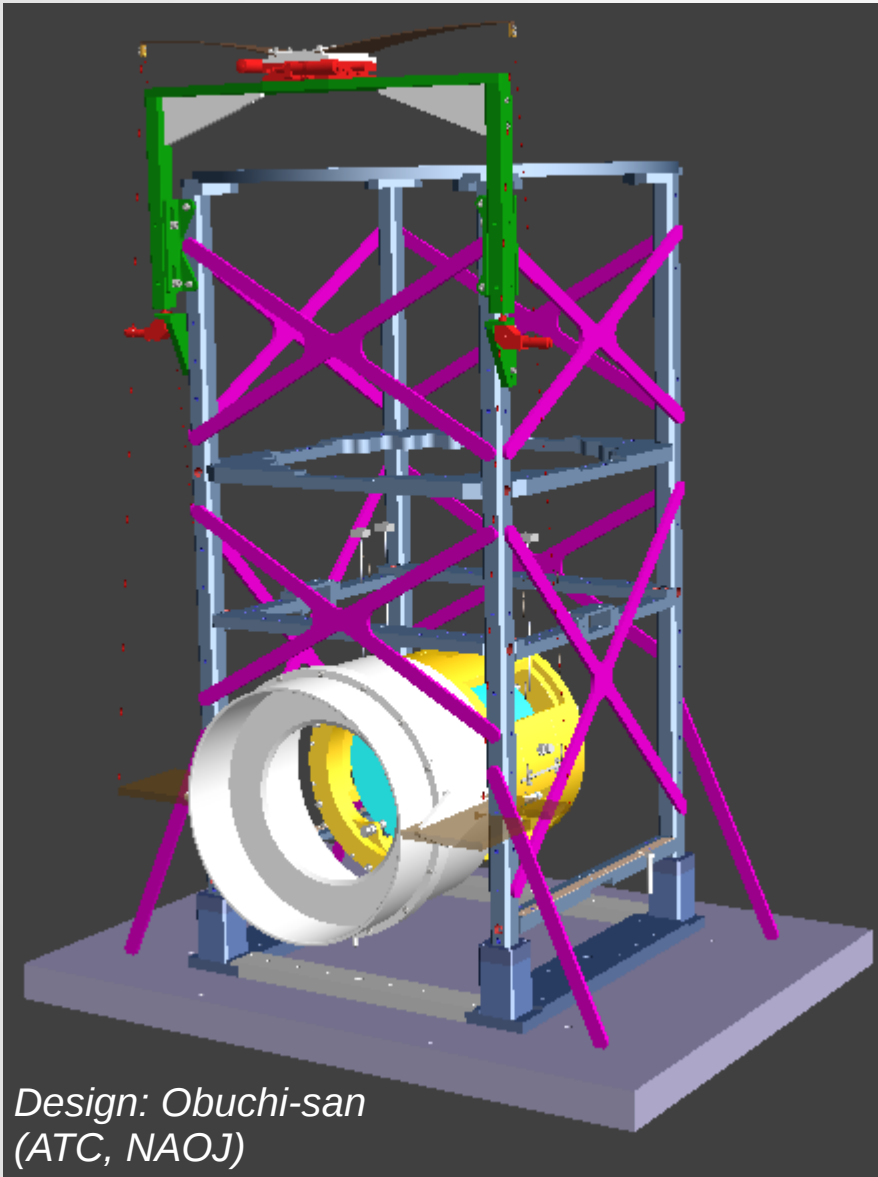
Simulation results of inner-shield scattering



$$P_{\text{bsc}} / P_{\text{scat}} \sim 0.1 \%$$



Change of back-scattered power with WAB



$$P_{\text{bsc}}/P_{\text{scat}} \sim 0.1 \%$$

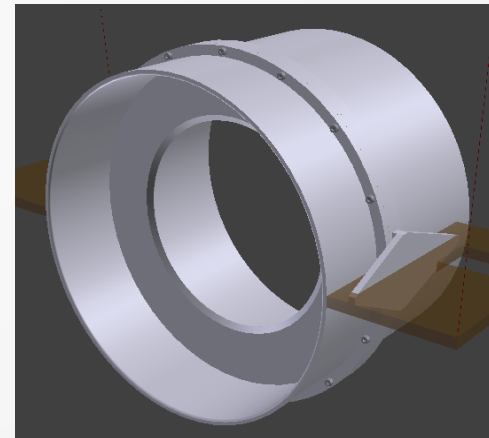
→

$$\sim 0.013 \%$$

$$P_{\text{bsc}}/P_{\text{scat}} \sim 0.043 \%$$

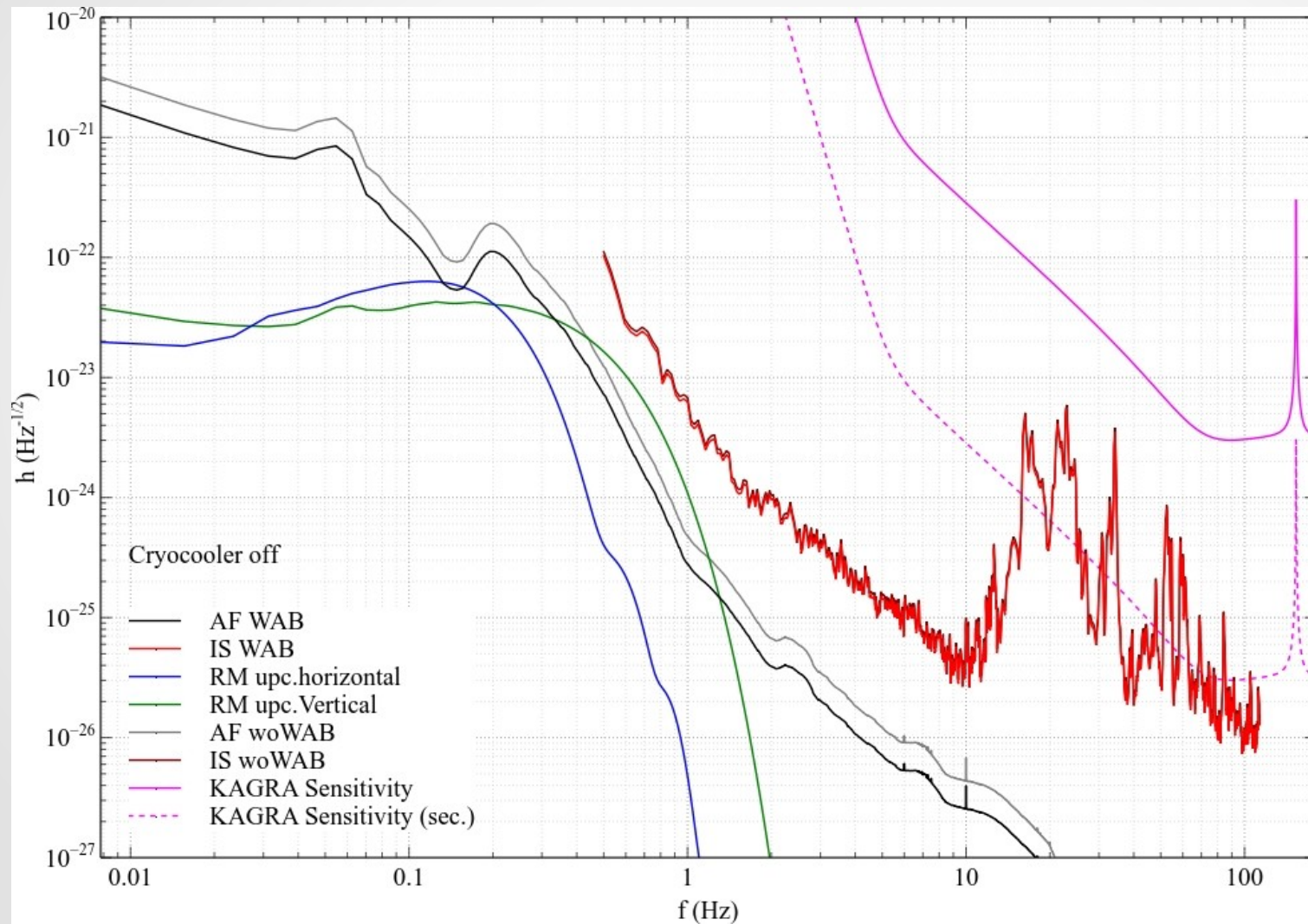
→

$$\sim 0.003 \%$$

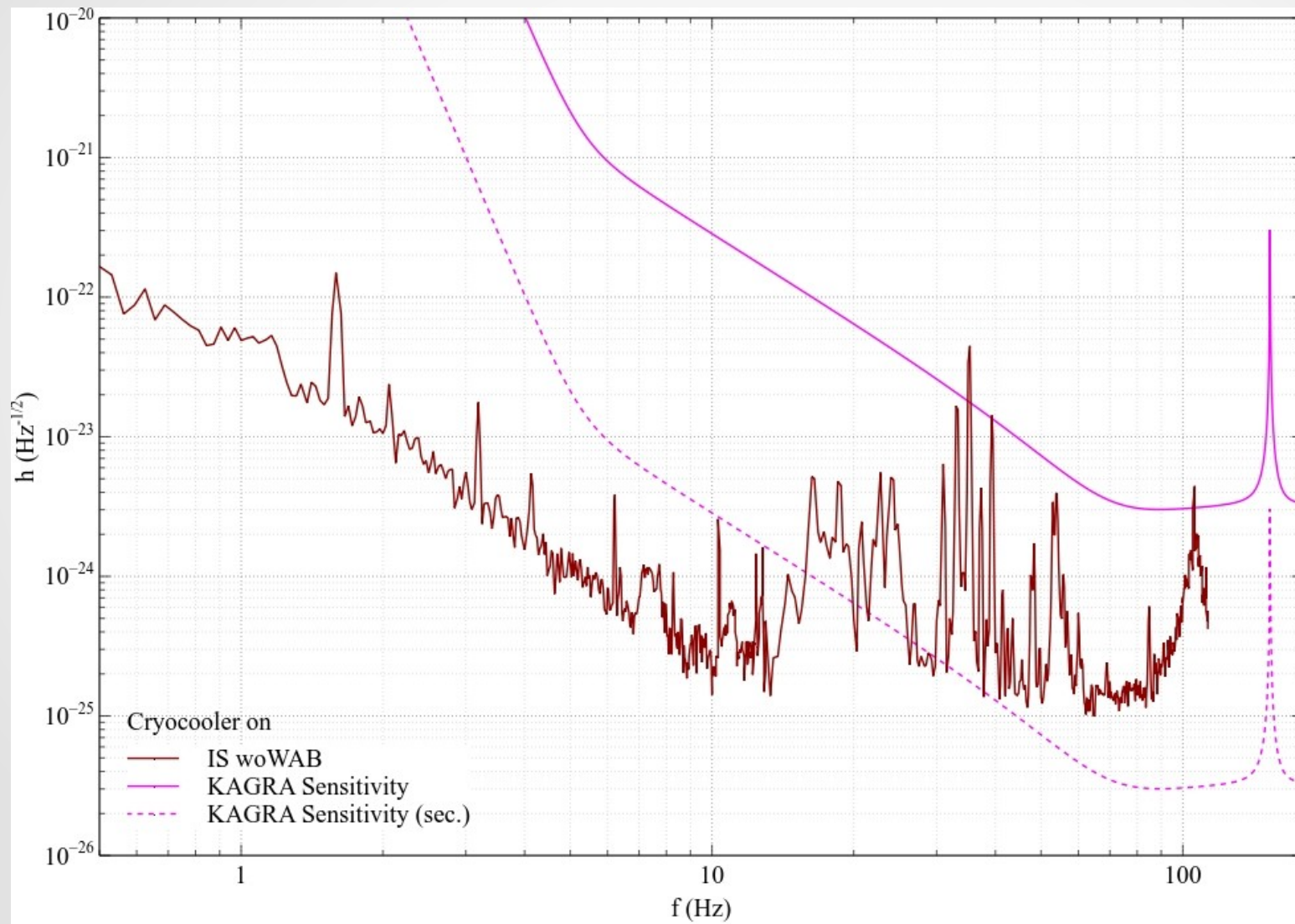


WAB: length – 300 mm
diameter – 280 mm
radiation disk – 210 mm from mirror

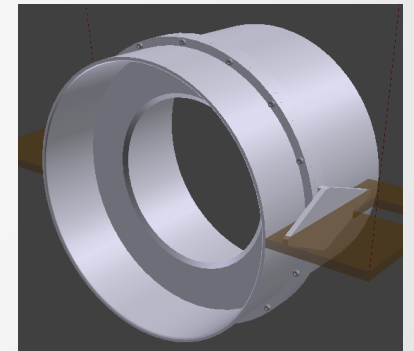
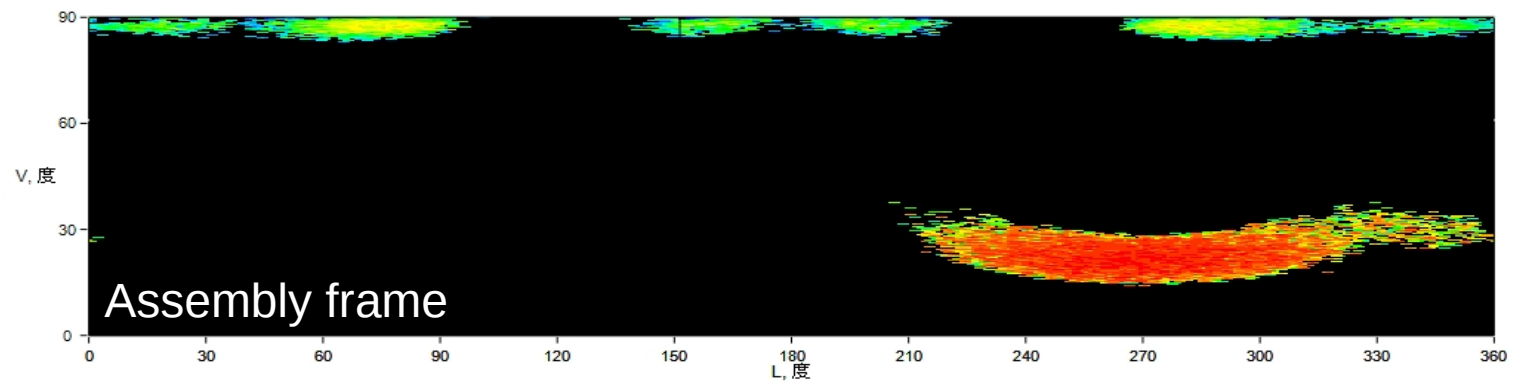
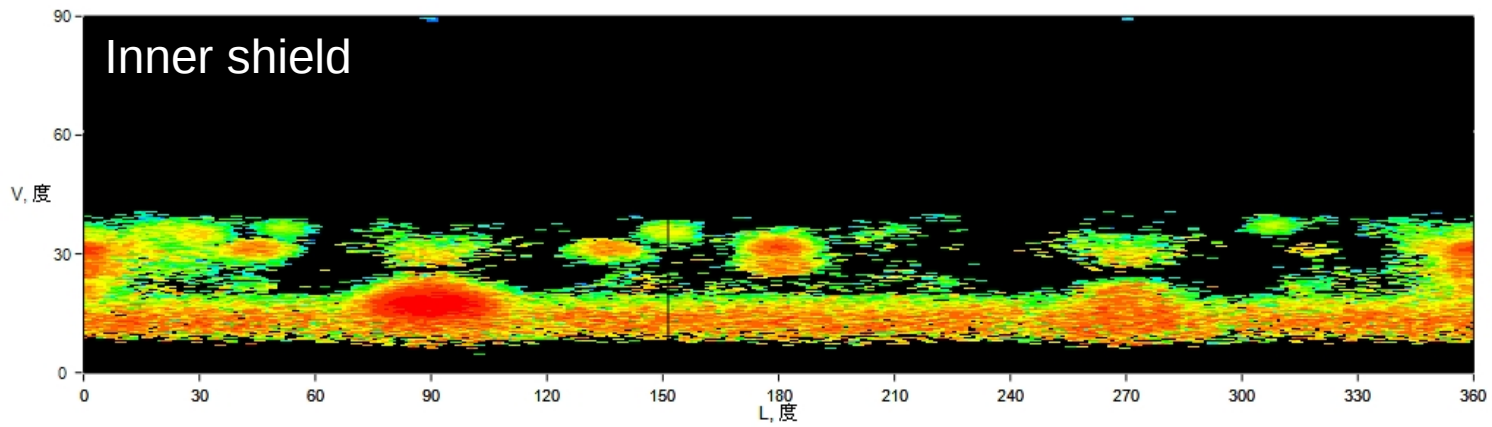
Impact on strain-noise of KAGRA



Impact on strain-noise of KAGRA

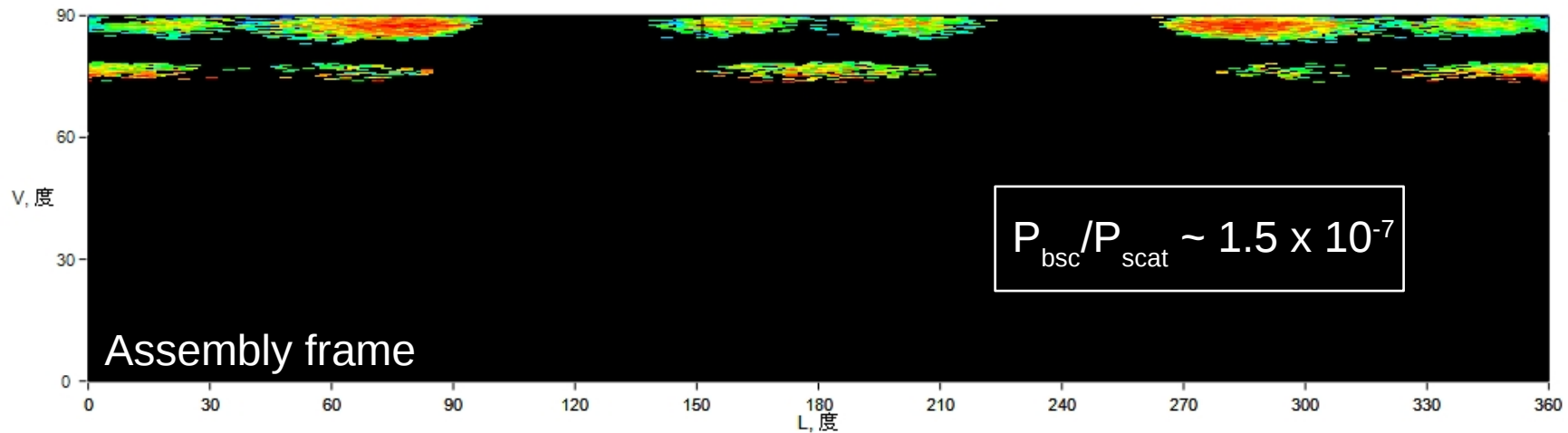
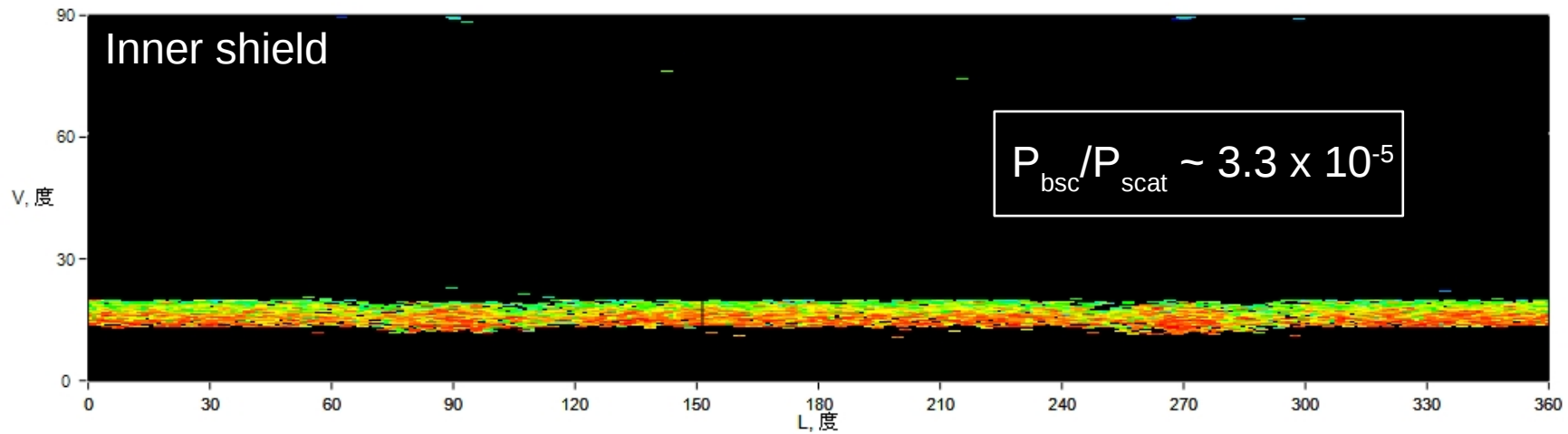


Simulation results with WAB



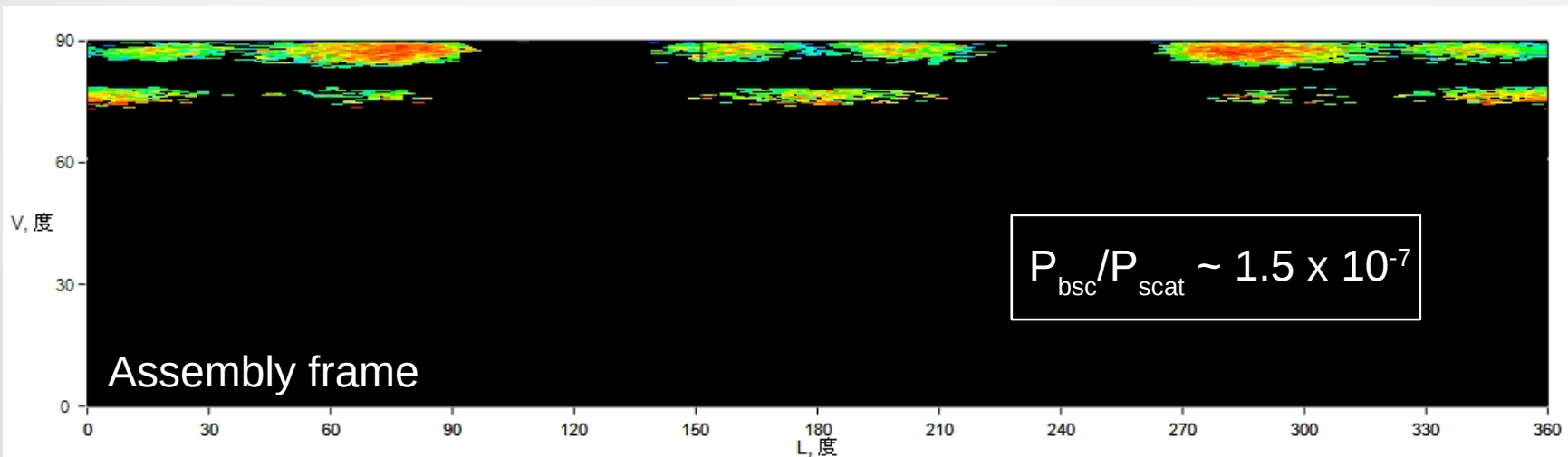
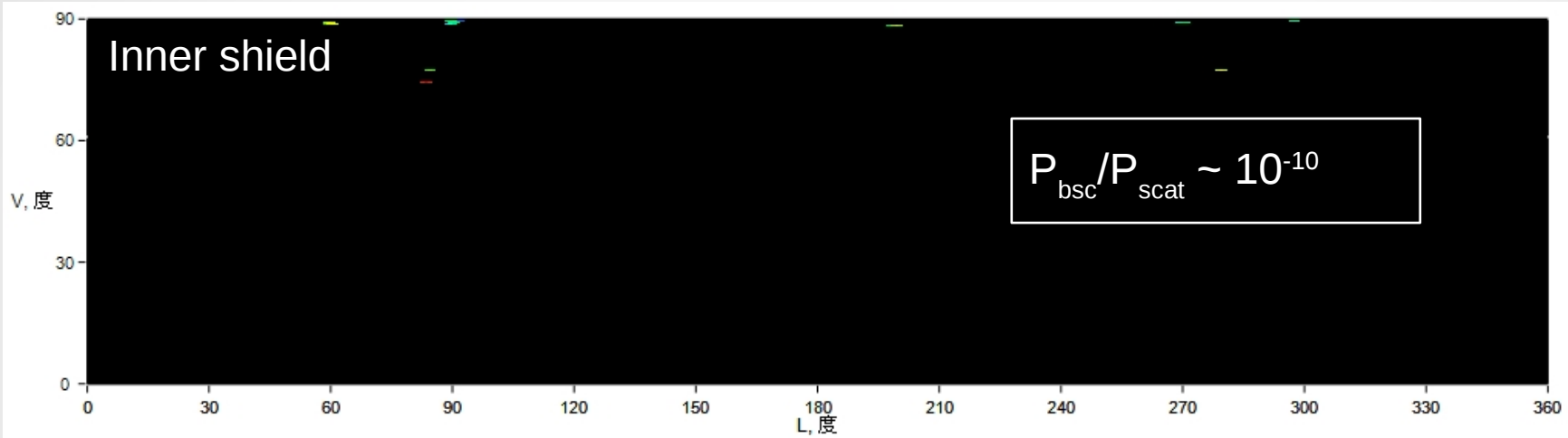
Elongation of WAB brings better results

300 mm → 400 mm

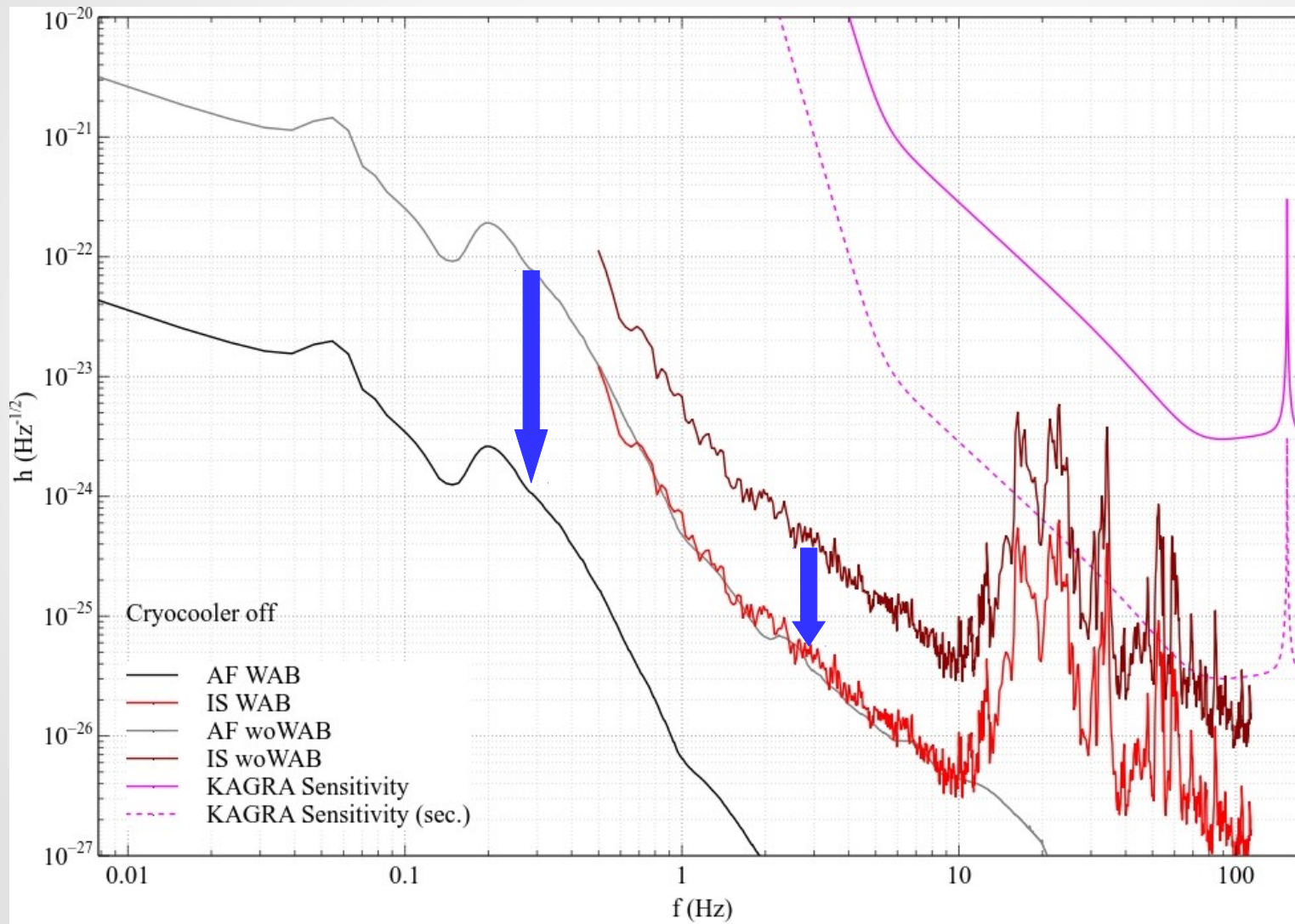


Elongation of WAB brings better results

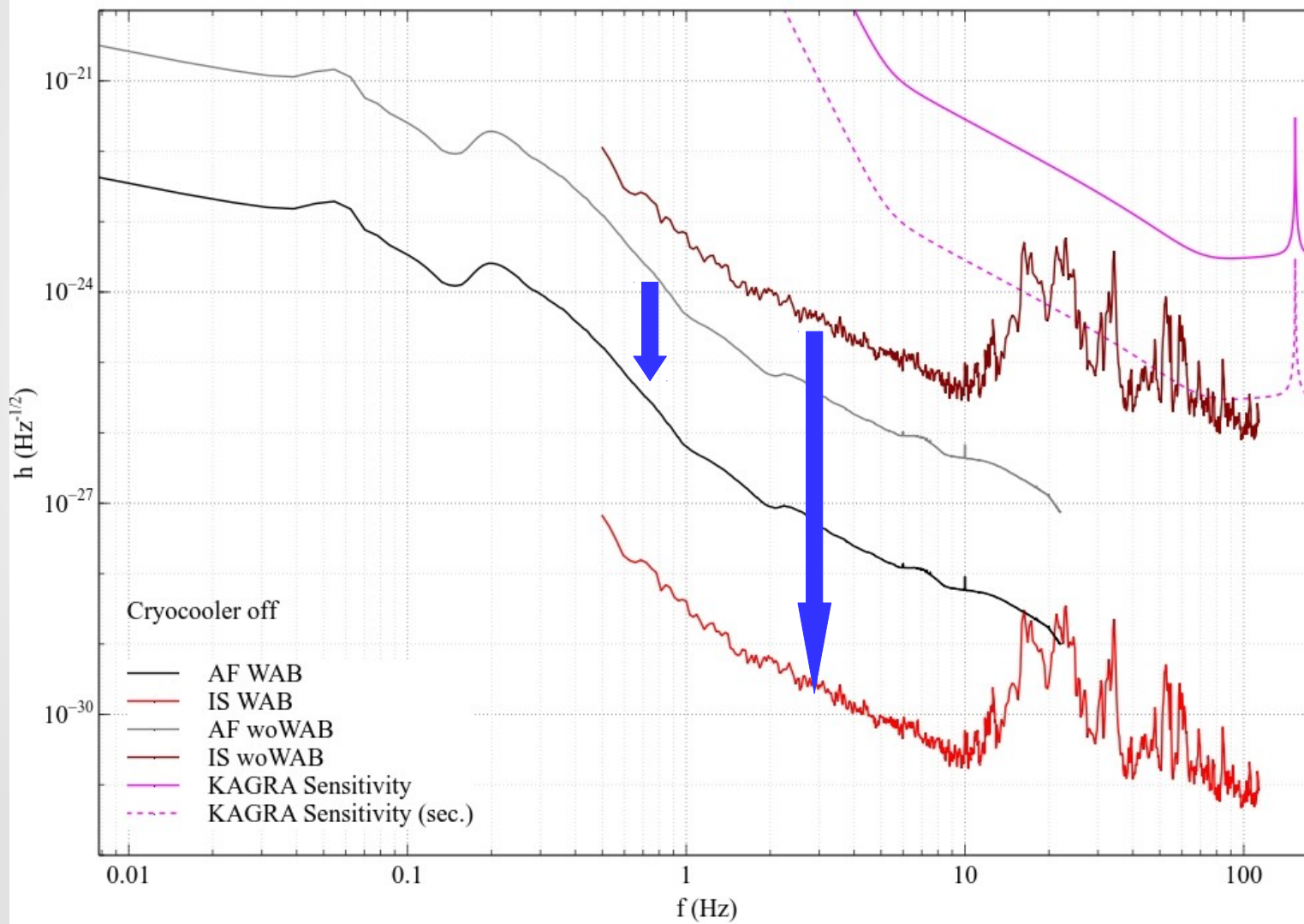
400 mm → 546 mm (maximum elongation)



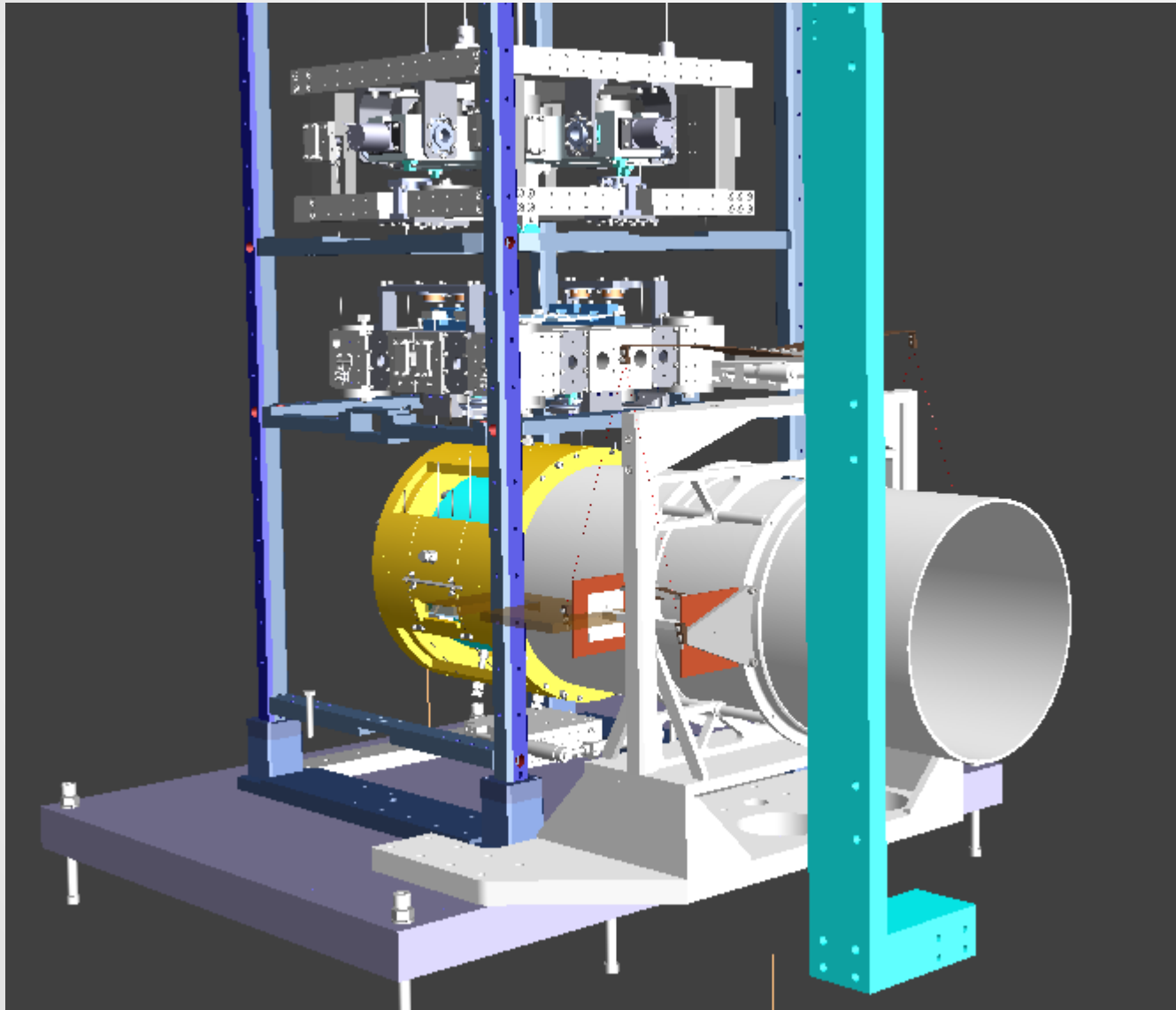
Strain-noise change for 400 mm WAB



Strain-noise change for 546 mm WAB



Elongated WAB in the cryostat



- Separated assembly frame for baffle suspension
- Issue: installation alongside the payload installation

*Design: Obuchi-san
(ATC, NAOJ)*

Summary

- Simulations on scattering inside the cryostats done under real conditions (scattering distribution, interior, etc.)
- Influence of back-scattering on the strain noise highest for “inner shield” and lowest for recoil mass
- Need motion-noise data for assembly frame (ongoing)
- Decreasing of strain noise possible but WAB needs to be longer than initial design
- Coating of baffle (Solblack) not included in simulations
- Influence from Solblack-coating: $P_{\text{bsc}}/P_{\text{scat}} \sim 1.7 \times 10^{-9}$