

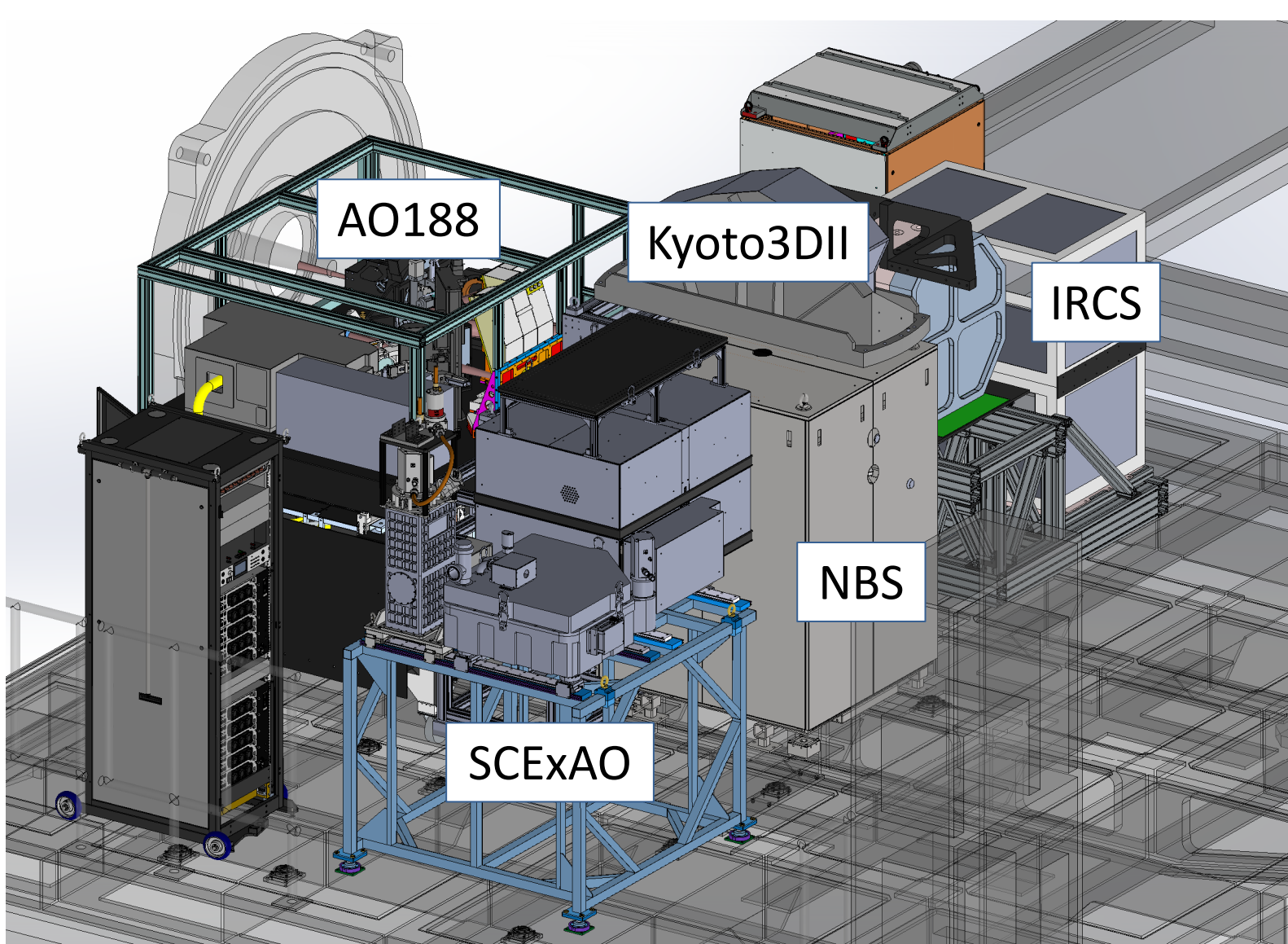
Subaru Nasmyth Beam Switcher

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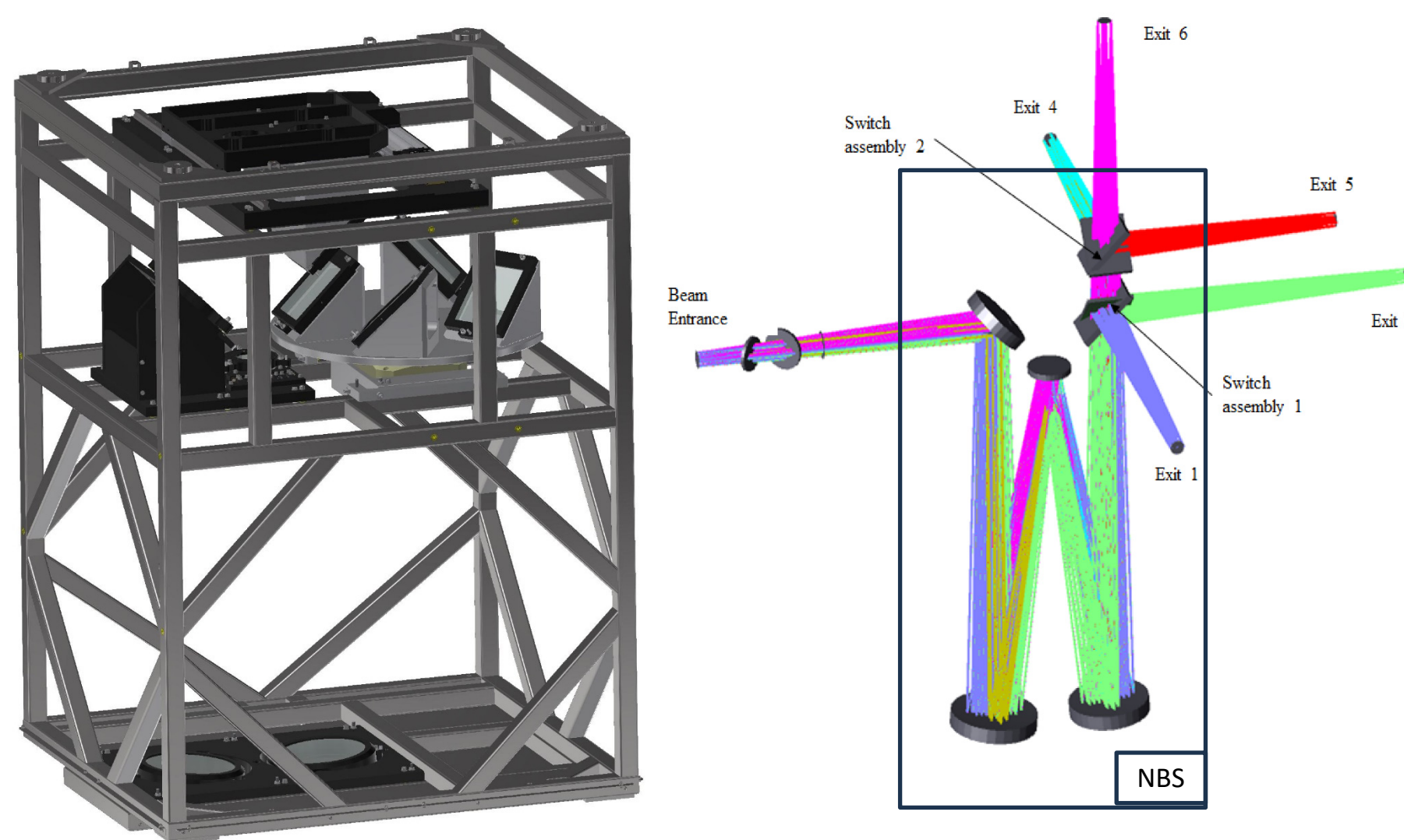
Abstract

Nasmyth Beam Switcher (NBS) is a device for redirecting the beam from the facility AO system (AO188) to the backend science instruments at Subaru's Nasmyth IR (NslR). The NBS is a key device to realize the flexible instrument switch among the AO188 fed science instruments, which significantly reduces the workload of the daytime instrument exchange and, more importantly, allows a new queue mode operation for improving the observing efficiency of AO observations. The NBS also enables us to accommodate the Laser tomography AO system, ULTIMATE-START. The design of the NBS was conducted in collaboration with Australian Astronomical Optics - Macquarie University in 2017-2021. The fabrication of the mechanical and optical parts were done in 2022. We are now working on the assembly of the mechanical parts and also the design of the common platform, which is necessary to mount the NBS, LTAO-WFS, and IRCS. We present the design, expected performance, and current status of the NBS.

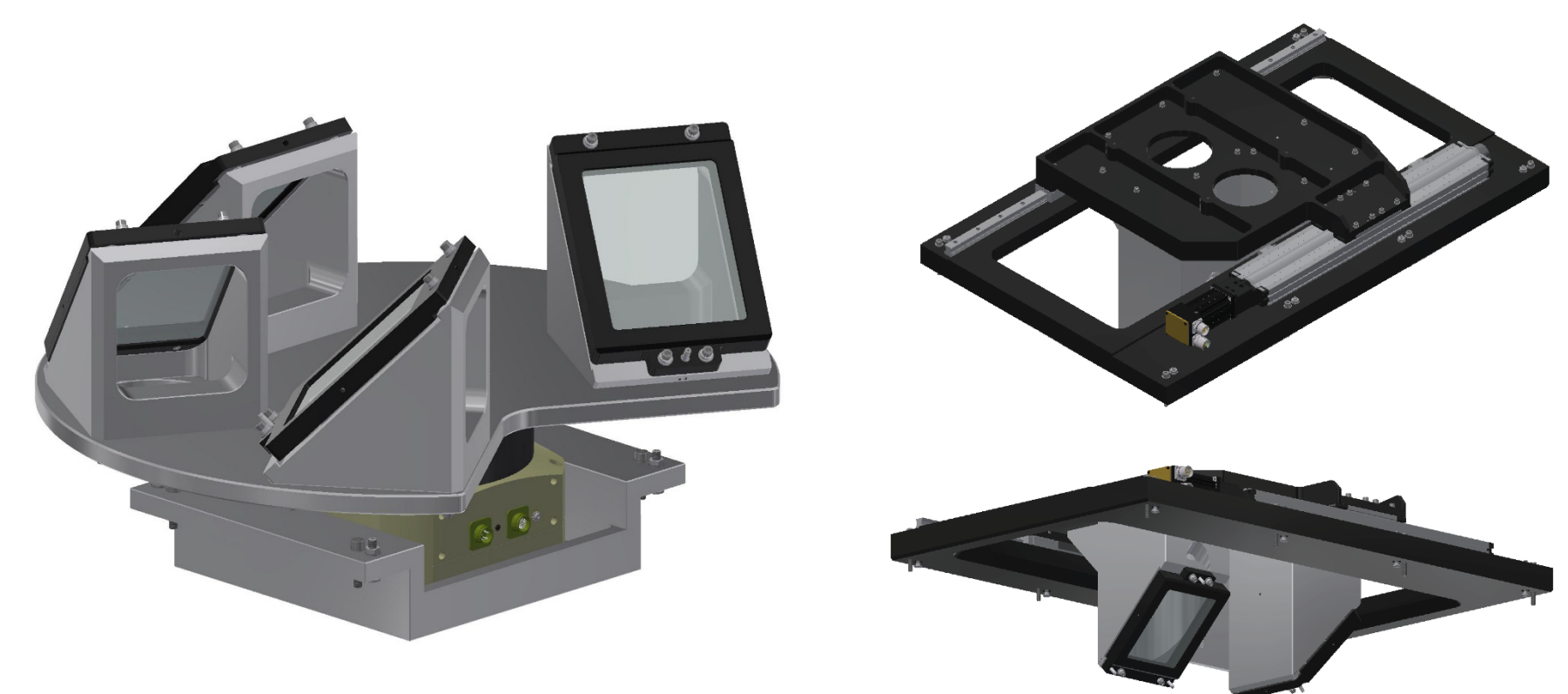
Design



This figure shows 3D CAD model of the Nasmyth IR platform when the NBS is installed. It redirects the light from AO188 to IRCS, SCEXAO, or Kyoto3DII.



The overview of the mechanical design (left) and optical layout (right). It is composed of an Offner relay and two switching mechanisms.

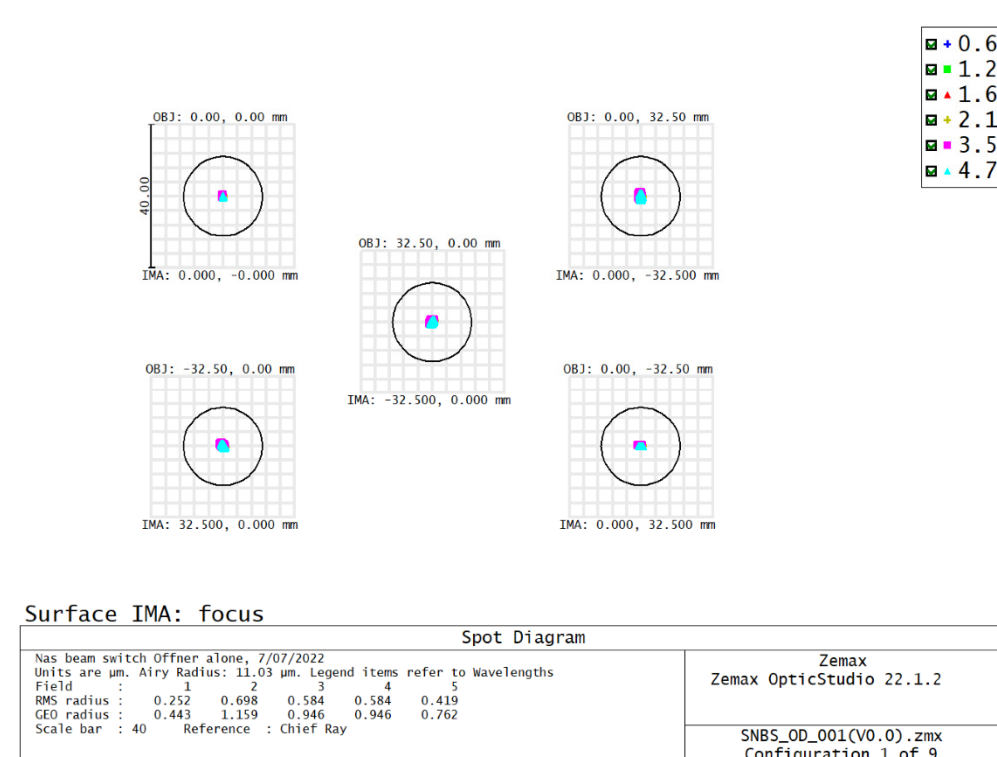


The detailed views of the switching mechanisms. (Left) The switching mechanism 1 is a rotation stage and can have 4 mirrors, dichroic-mirrors, or through-plate. (Right) The switching mechanism 2 is a linear stage and has 2 mirrors. Both mechanisms have an open-slot.

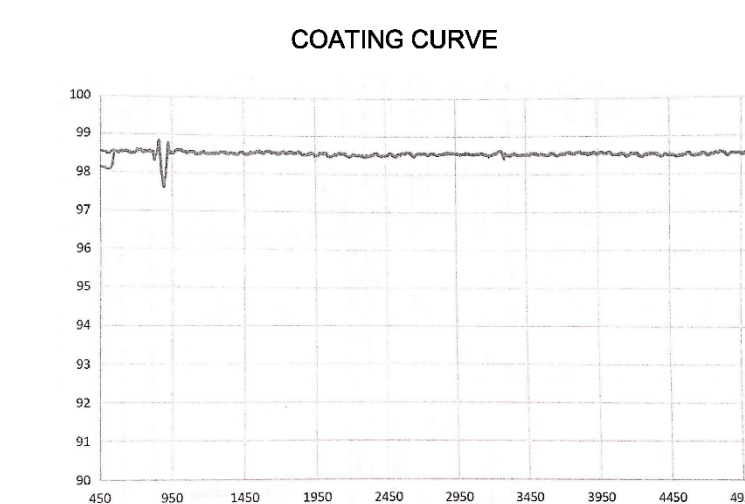
References

- Subaru Nasmyth Beam Switcher final design report (2021)
- Minowa et al. (2020), Proc. SPIE **11450**, 1145000

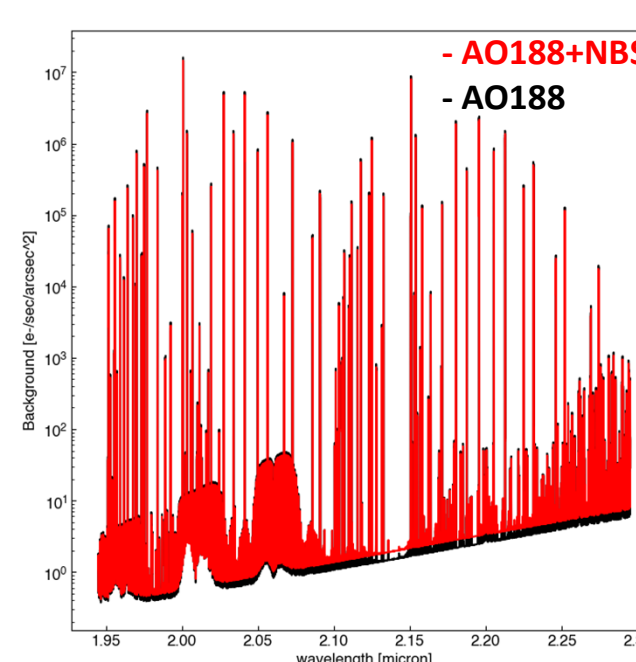
Expected Performance



This is a spot diagram when point sources are located at the input of the NBS within the field-of-view. Their Strehl ratios are almost 100% across the full wavelength range and the field-of-view. This means the degradation of the Strehl ratio by the NBS is expected to be small.



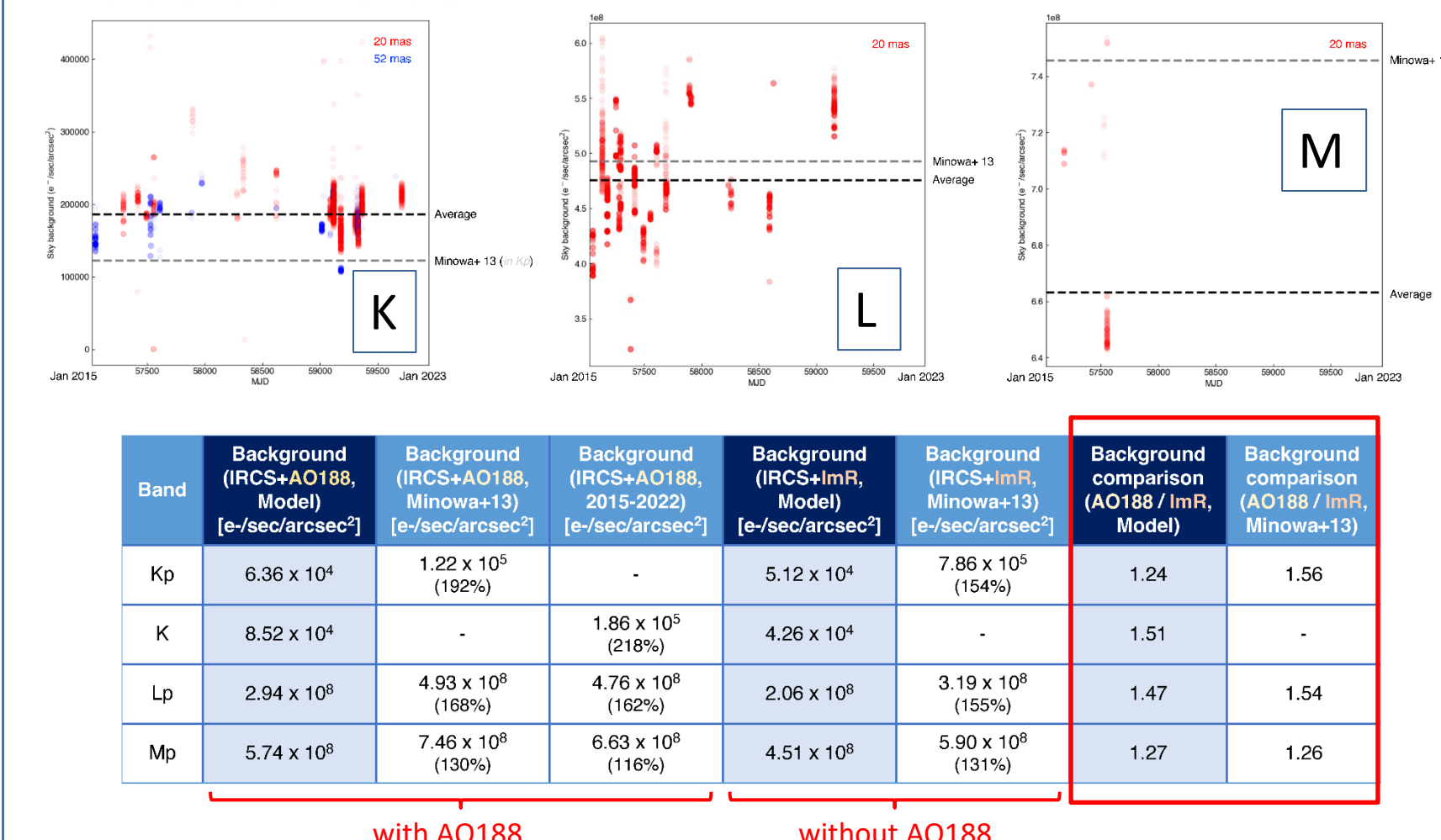
The measured reflectivity of one of the fabricated NBS mirrors. With the reflectivity of >98% at 0.45-5.0um for the five mirrors of NBS, we expect the through-put of NBS to be >90%.



Band	Background comparison by model (AO188+NBS / AO188)
Kp	1.10
K	1.18
Lp	1.17
Mp	1.12

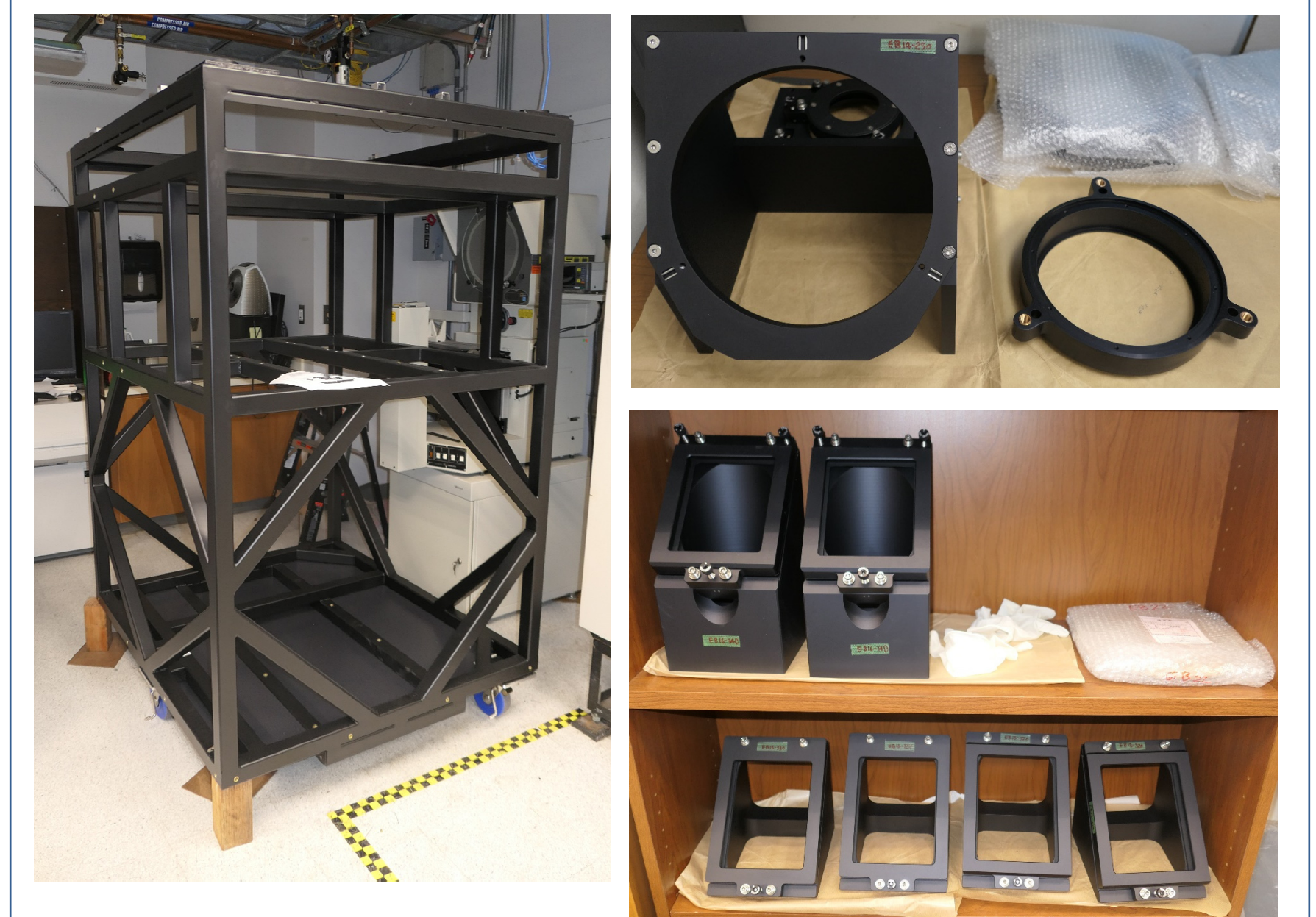
We calculated the expected background emission for IRCS with (red) and without (black) NBS using the model by Minowa et al. (2020). The increase of the background emission is estimated to be 10-20% in K- to M-band.

The figures below show background measurements with IRCS imaging mode in 2015-2023, and comparison with the model predictions. The model underestimates the background level, but predicted increase of the background by AO188 is similar to the actual value.

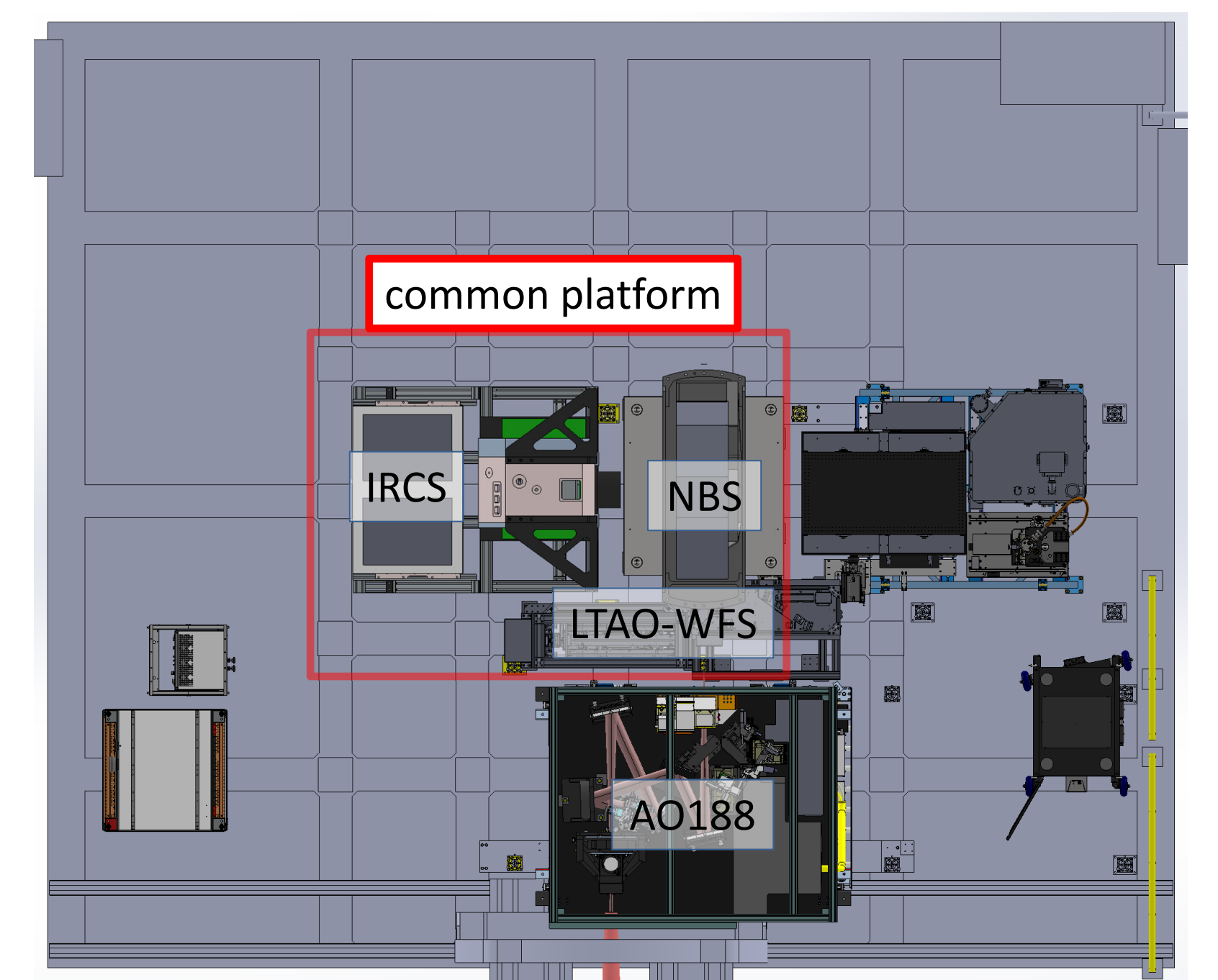


Current Status

The procurement of the mechanical and optical parts were completed in 2022. The assembly of the mechanical parts are now ongoing.



In addition, the design for the common platform is underway. It is the mounting base for the NBS, LTAO-WFS, and IRCS, and is necessary for the installation of the NBS.



The procurements of the rotation and linear stages for the switching mechanisms 1 and 2 are ongoing, and they are expected to arrive by the end of this fiscal year. The mechanical assembly of the NBS will be completed after integrating those stages.

Remaining Tasks

- Integration of the mirrors and optical alignment (after the mechanical parts assembly)
- Fabrication of the common platform (after the design, in FY2024)
- Planning and scheduling of the installation process at the summit