

Current Status of development of the Kösters prism on HiZ-GUNDAM

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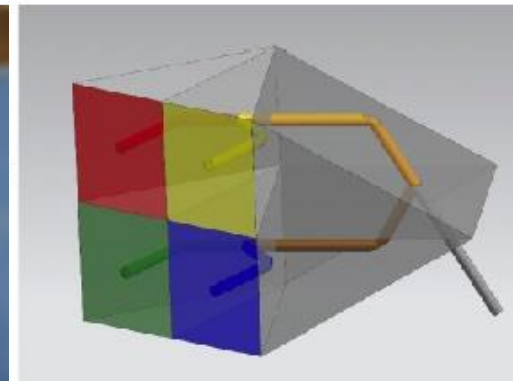
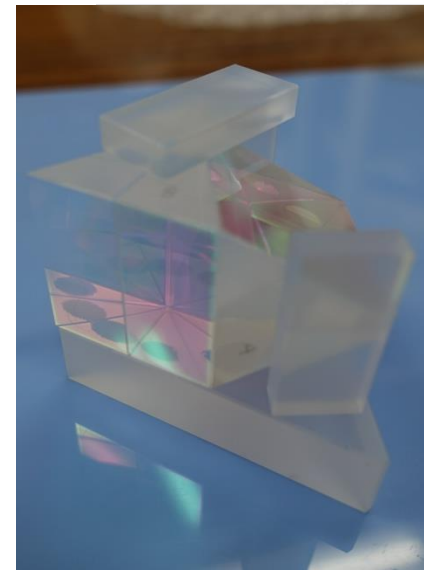
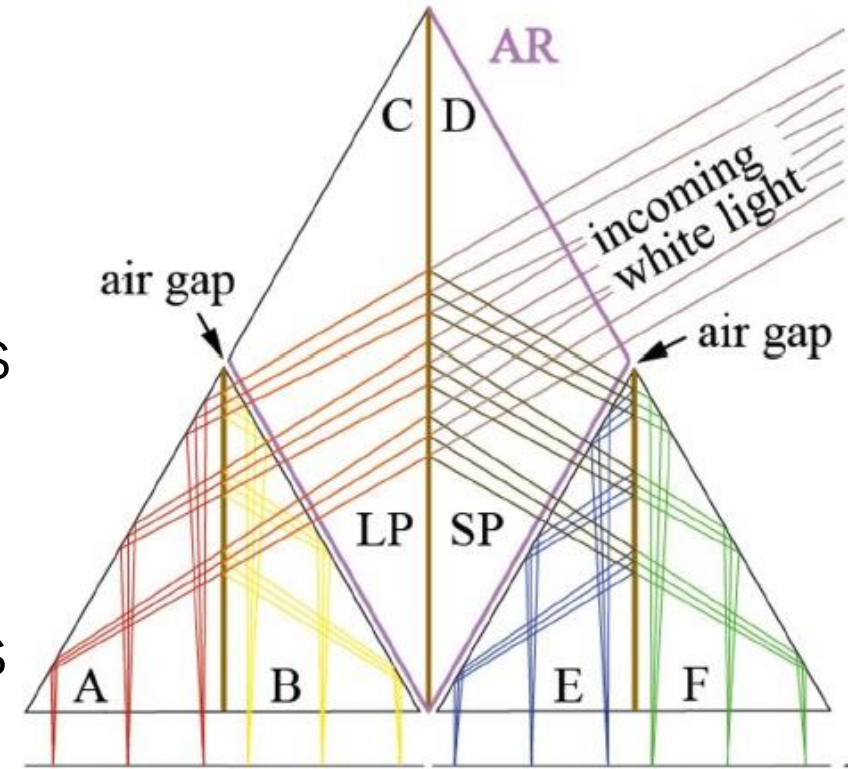
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HiZ-GUNDAM collaboration

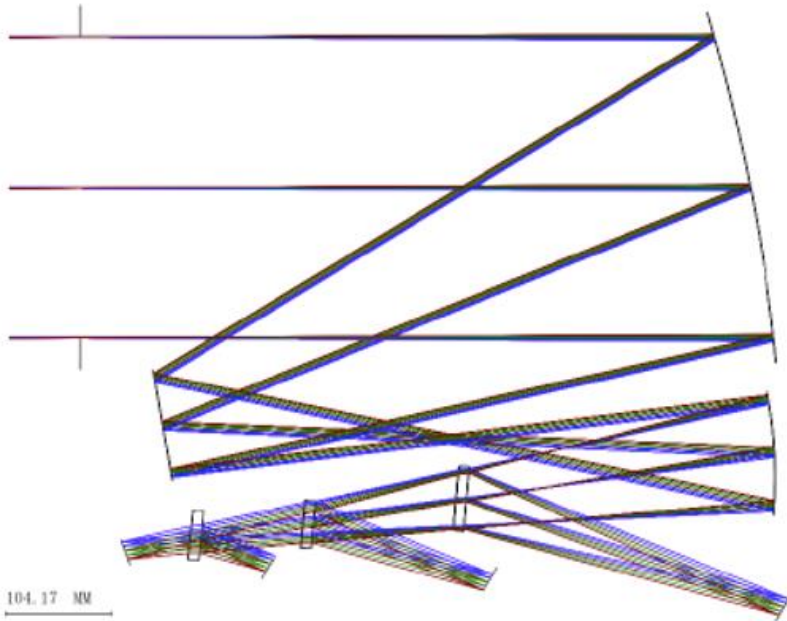
Special thanks to Koji Kawabata (Hiroshima U.)

Kösters prism

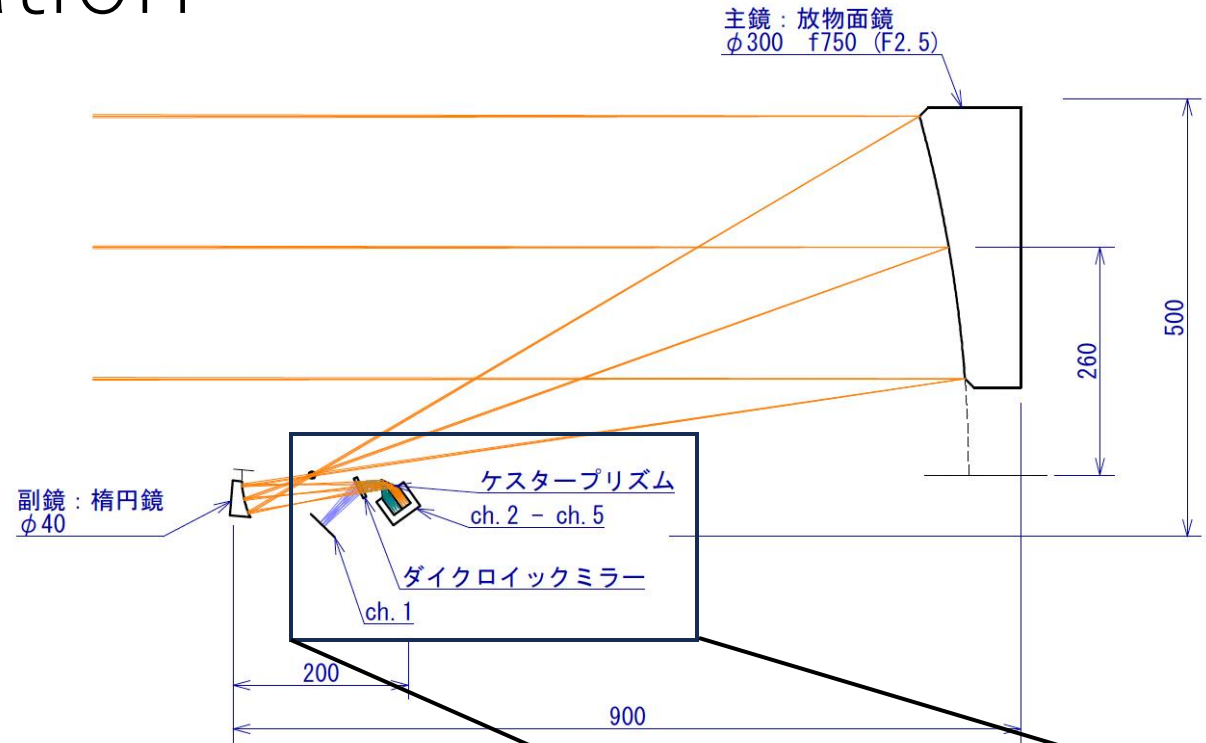
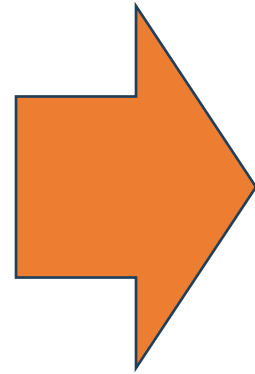
- Splitting incident light into multiple wavelengths
- Double Kösters prism with two prisms stacked at perpendicular angles to achieve a 2 x 2 split
- Utilizing the knowledge of German collaborators who were developing Kösters prisms for nano-satellites (Greiner and Laux, 2022)
- Kösters prism for HiZ-GUNDAM is under development by 公募研究(24H01818).



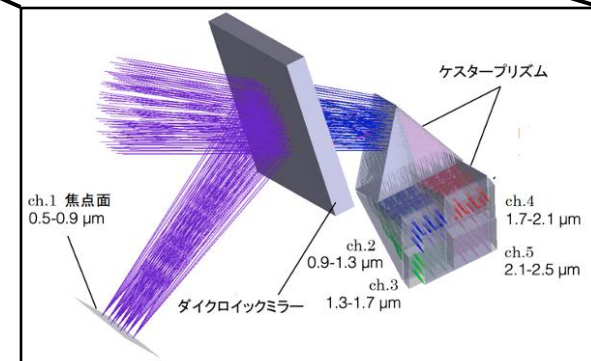
Optical Design Modification



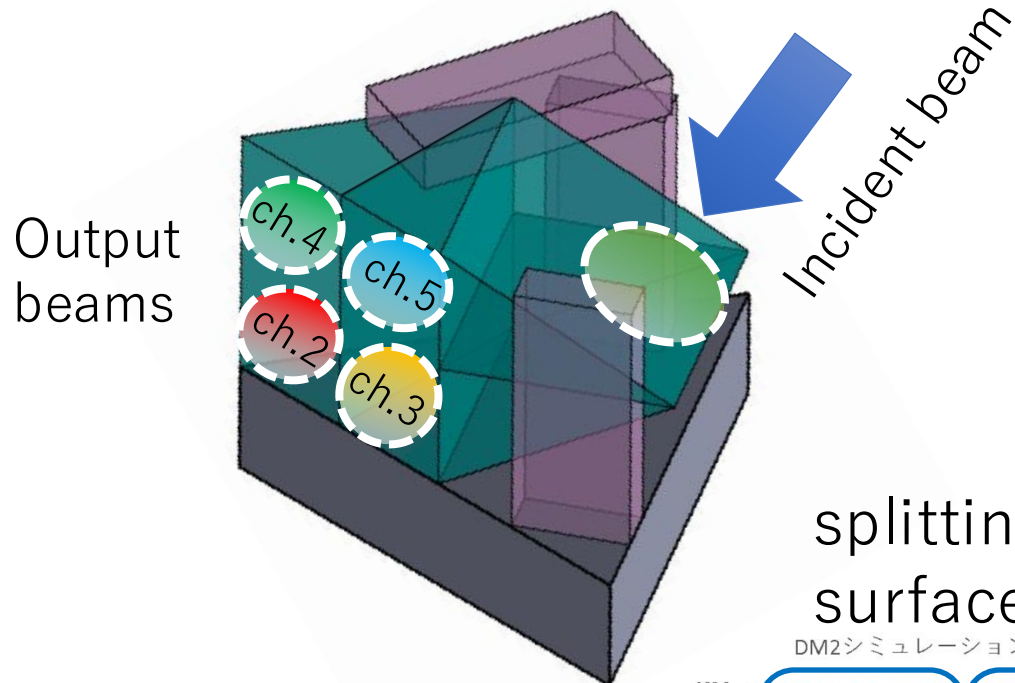
3 telescope mirrors,
3 dichroic mirrors,
4 detectors



2 telescope mirrors,
1 dichroic mirror
1 Kösters prism,
2 detectors



Design of the Kösters prism



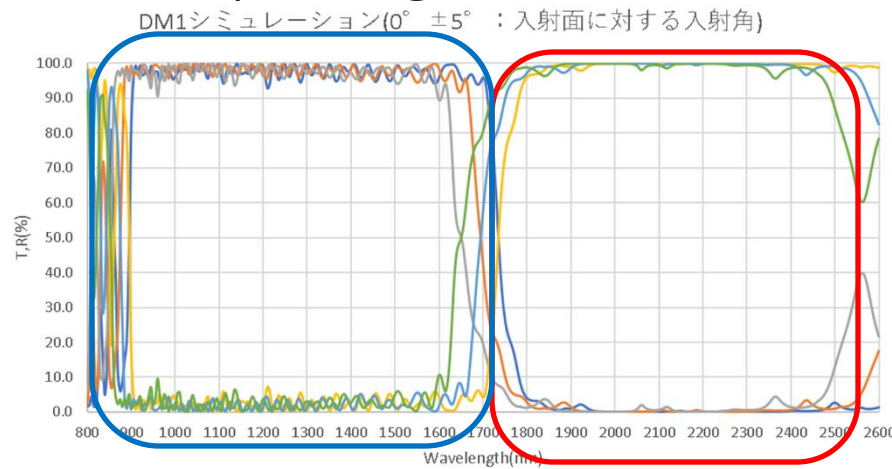
Prism (green)
anhydrous fused silica

Base plate (gray)
fused silica

Supporters (purple)
fused silica

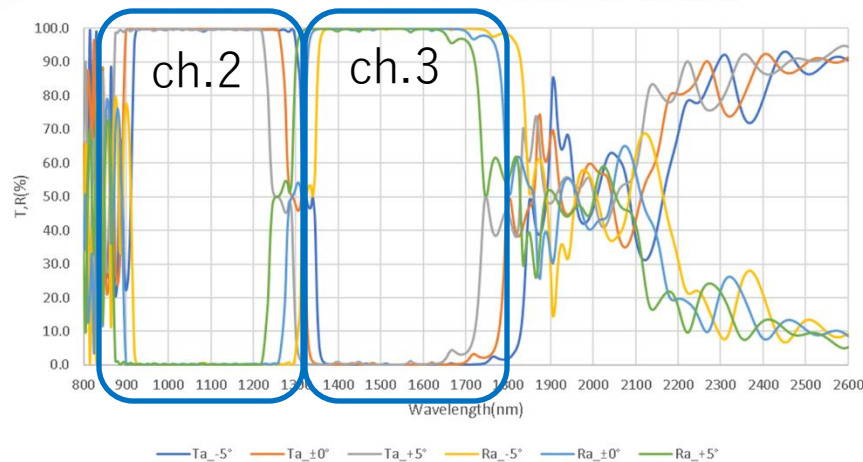
splitting surface 1

Transmittance



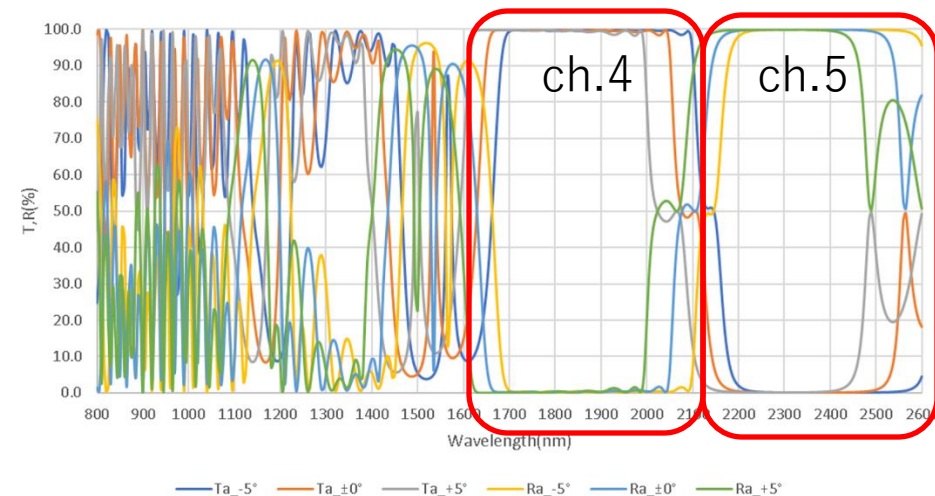
splitting surface 2

DM2シミュレーション(0° ±5° : 入射面に対する入射角)



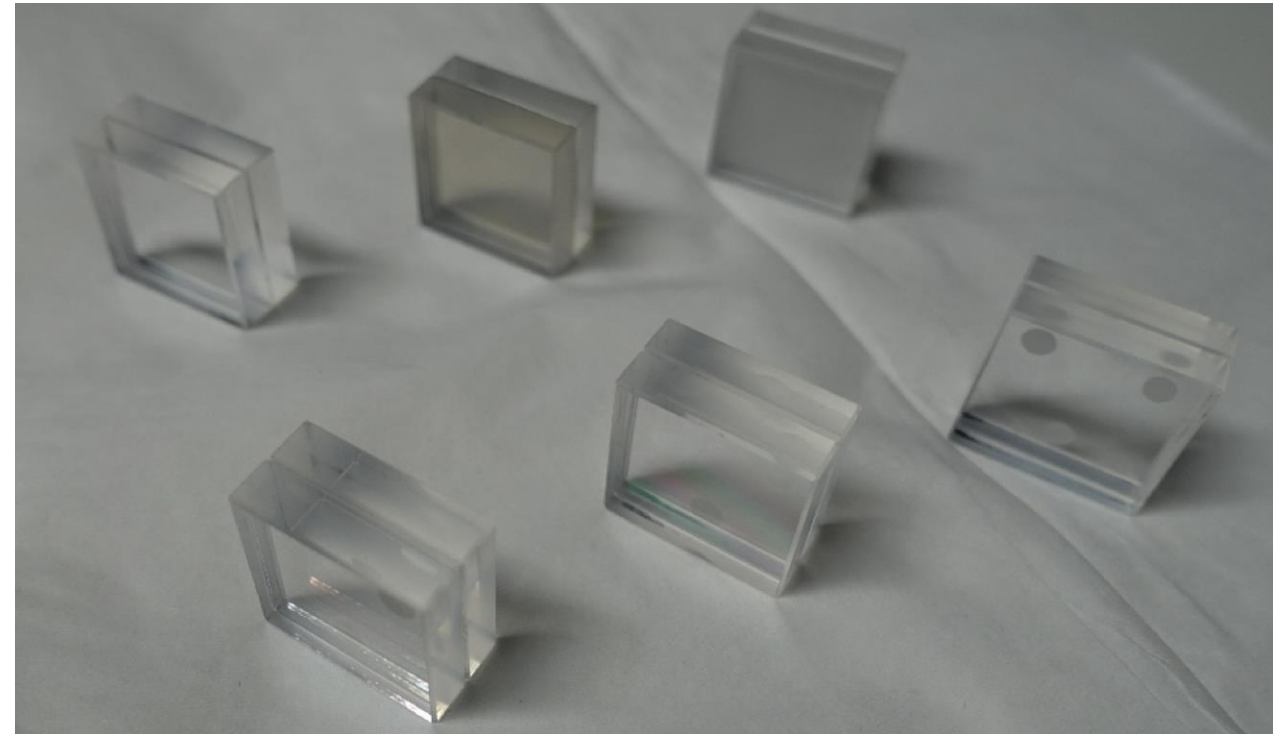
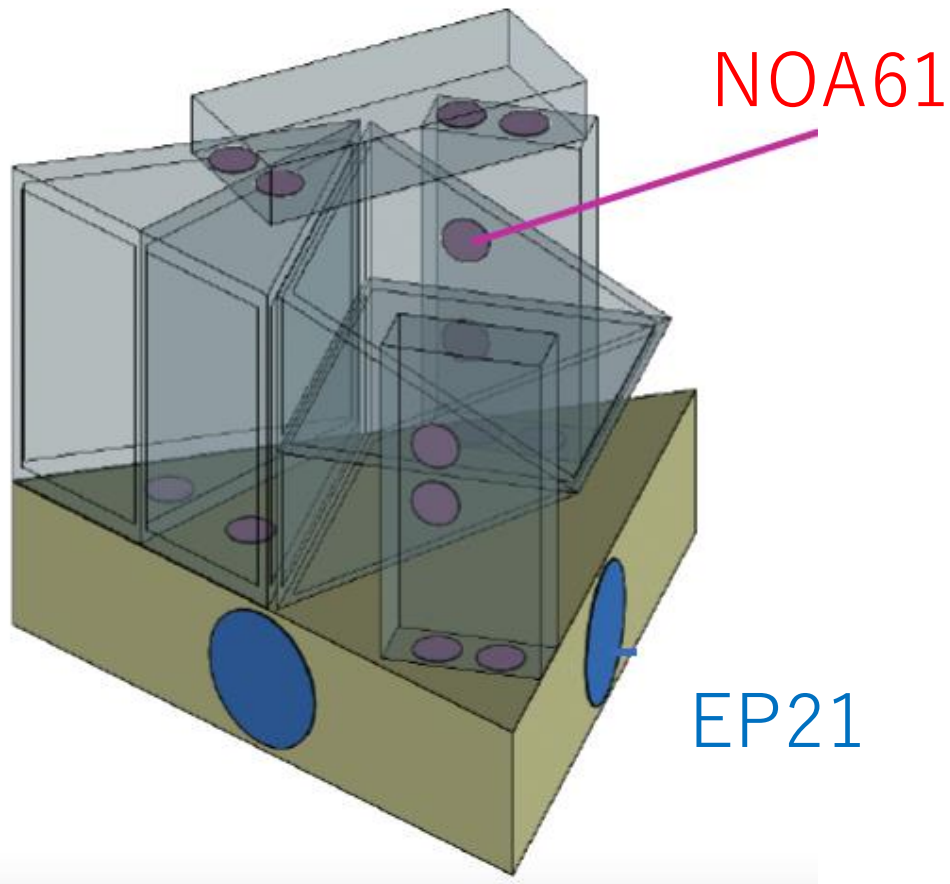
splitting surface 3

DM3シミュレーション(0° ±5° : 入射面に対する入射角)



Bonding Samples

- Adhesion bond is used in the Kösters prism
- Some tests were conducted to adhesion bond samples.
- Three Adhesion bond candidates.
 - NOA61, EC2216, EP21

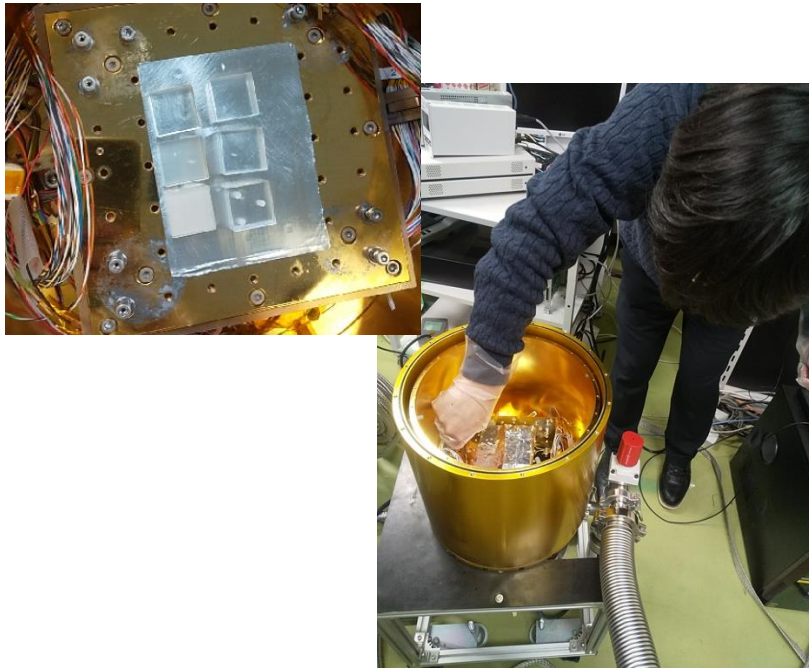


Tests for bonding samples

Thermal cycles

- <130 K for 4 hours
- 5 cycles

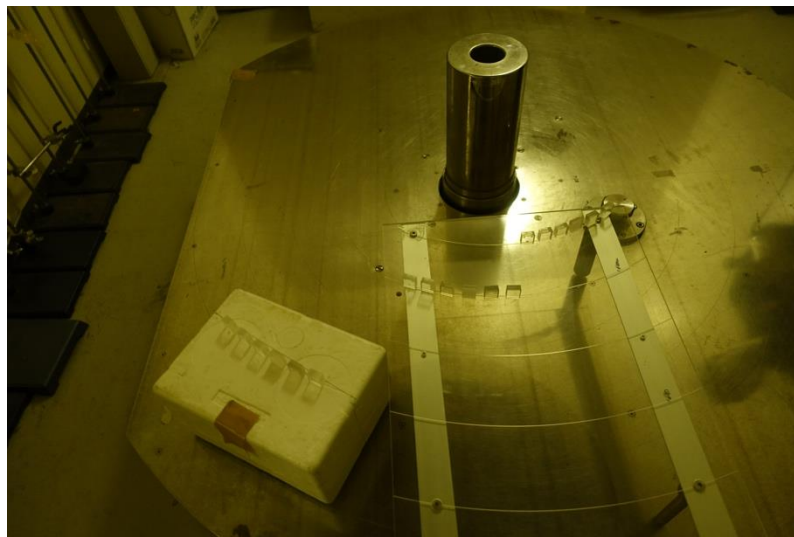
→ **No Damage**



γ -ray irradiation

- 3.4, 7.7, 13.8 krad γ -ray by ^{60}Co
- Equivalent to 3, 6, 13 years on orbit.

→ **No Damage**



Load test

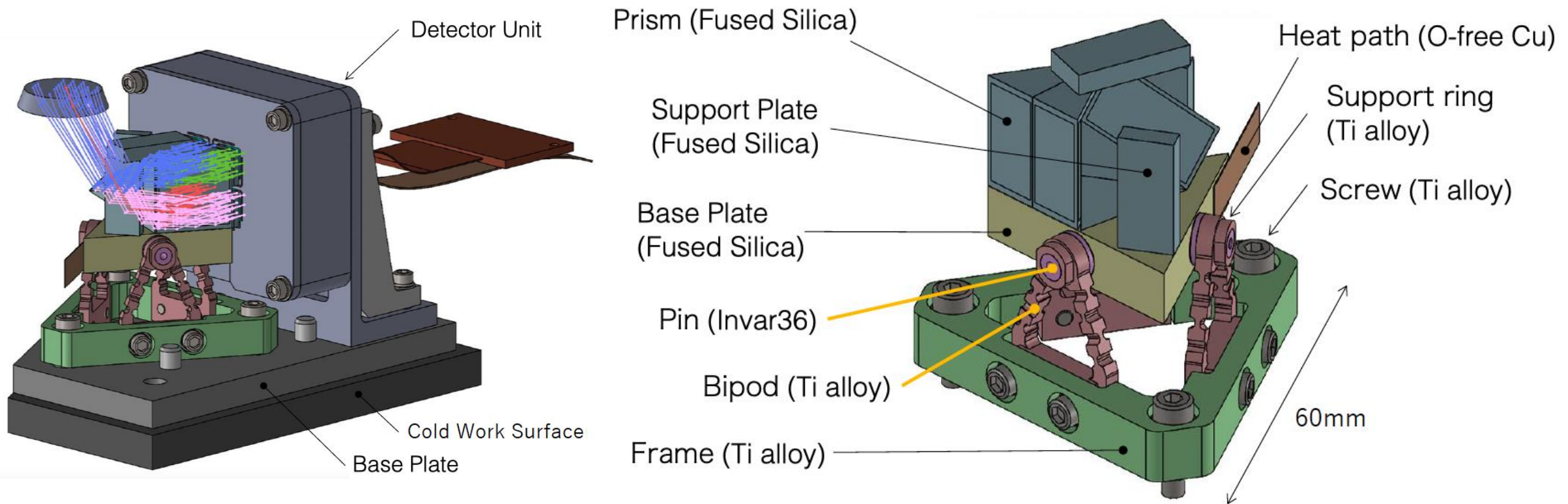
- Applying 80G static load to samples after thermal cycles/ γ -ray irradiation

→ **No Damage**



Support Structure Design

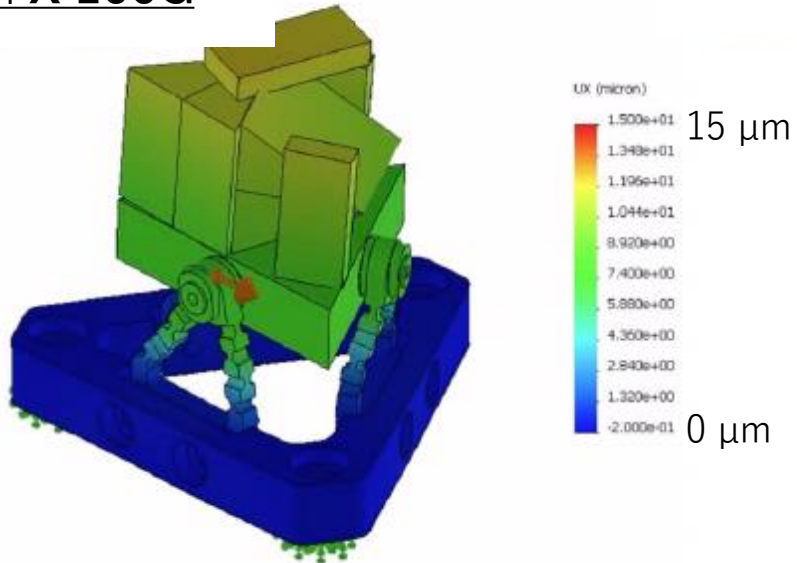
- A support structure was designed regarding a previous study (Rothhardt et al. 2022) by Photocross Co. Ltd.
- Structure analysis was conducted to this design.



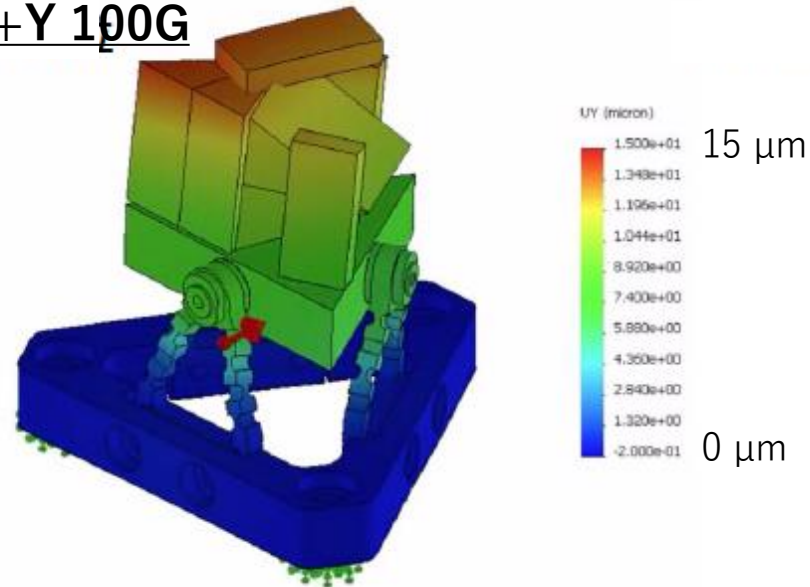
Load analysis

- Safety factor >2.8 for 100G load in each axis.

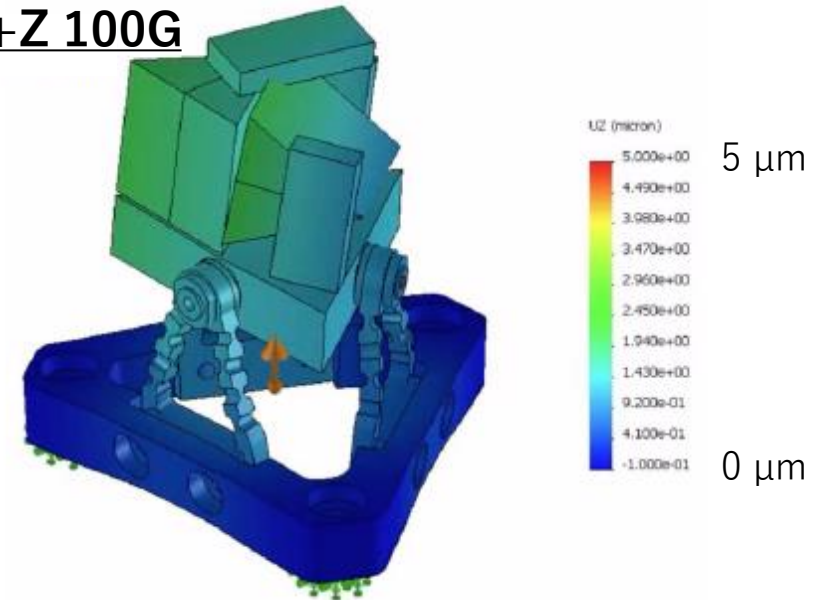
+X 100G



+Y 100G



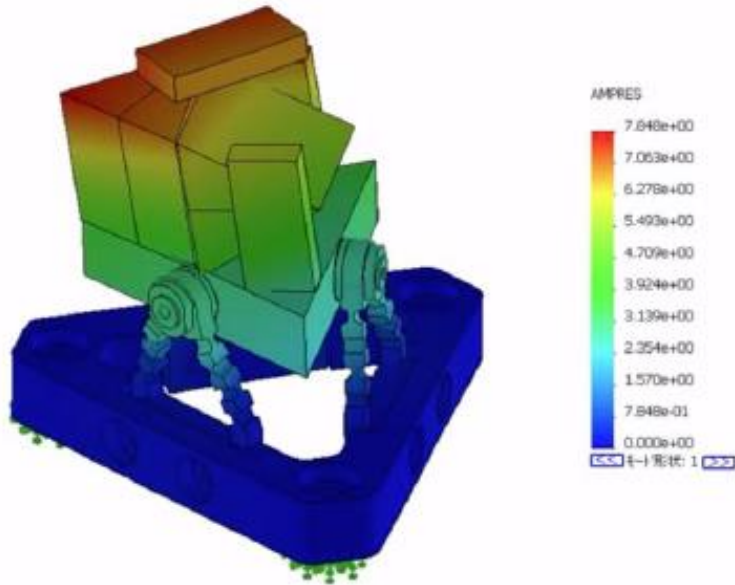
+Z 100G



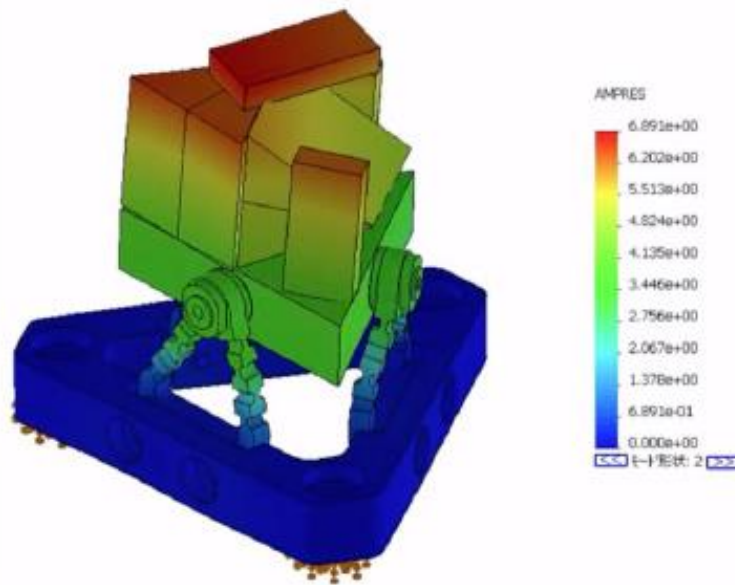
Characteristic vibration mode

- This design Fulfilled the >1000 Hz requirement from the rocket.
- Mises stress associated with vibration at bipod and bond do not exceed yield stress.

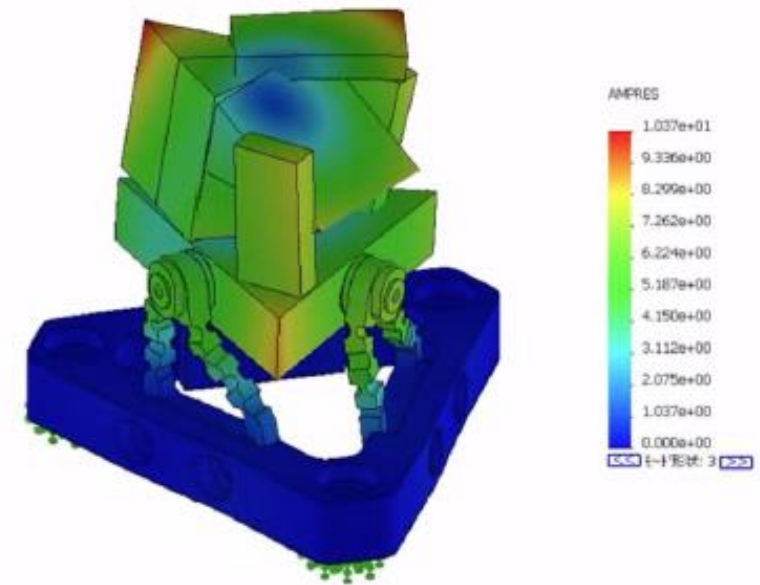
1次 : 1591Hz



2次 : 1678Hz

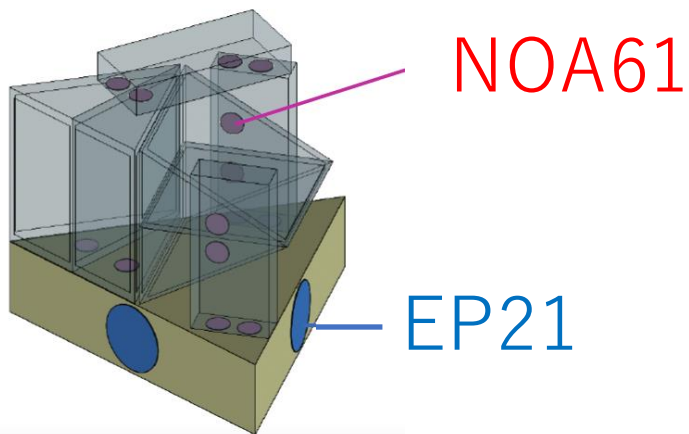
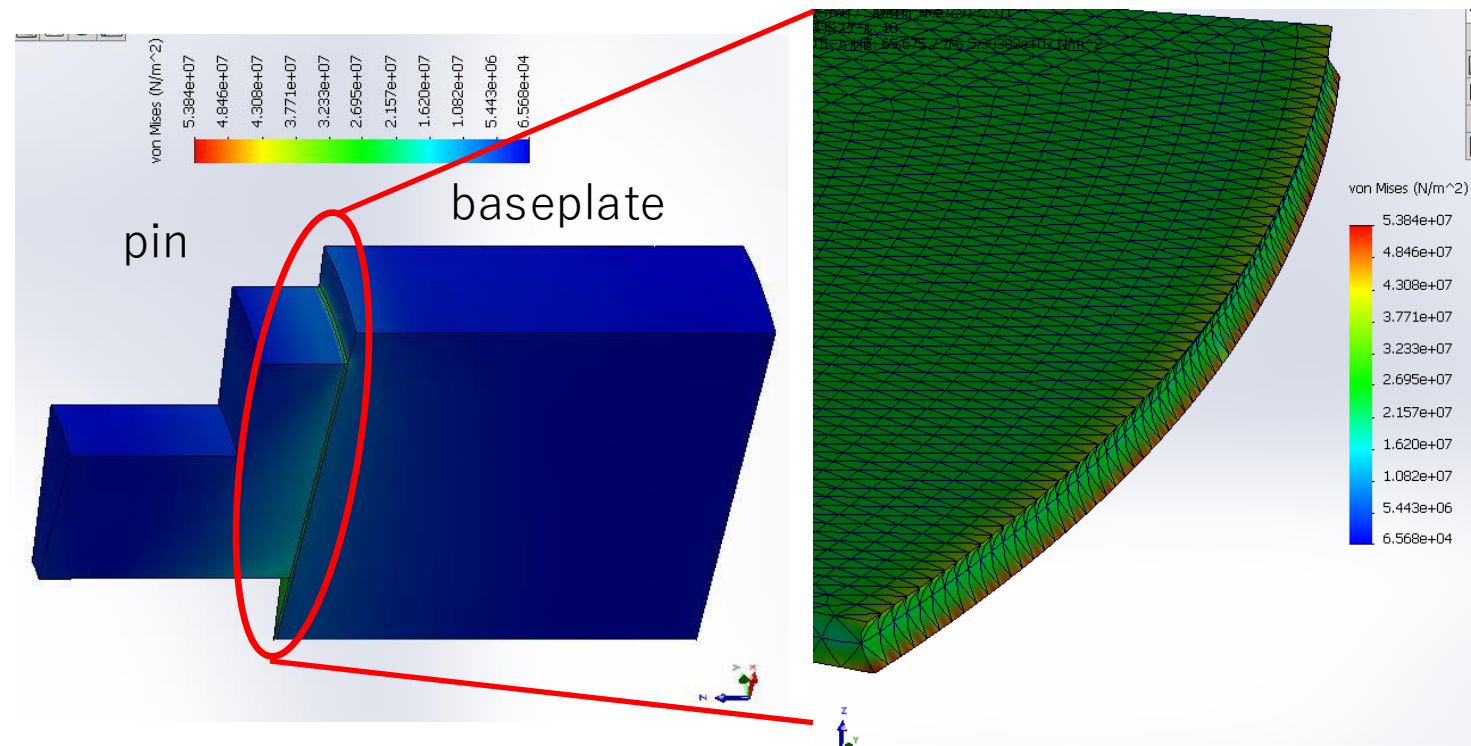
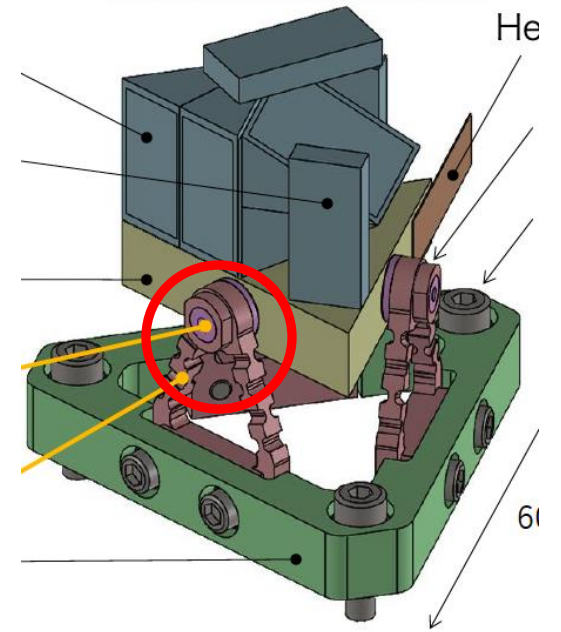


3次 : 2717Hz



Thermal stress analysis

- Kösters prism and its support structure is cooled down to <160 K
- Mises stress of some adhesion bond between base plate (fused silica) and pin (Ti alloy) exceed yield stress at <160 K.
 - Only the case of EP21 with >50 μm thickness meets the requirement.



Summary

- The Kösters prism is a key optical component in the HiZ-GUNDAM telescope.
- Many analysis required for the fabrication of the Kösters prism are performed
 - Adhesion bond selection
 - Design of support structure
 - Load analysis
 - Vibration mode analysis
 - Thermal stress analysis
- A prototype Kösters prism has been completed and the support structure is under fabrication.

