Current status of evaluation of the Kösters prism on HiZ-GUNDAM/MONSTER

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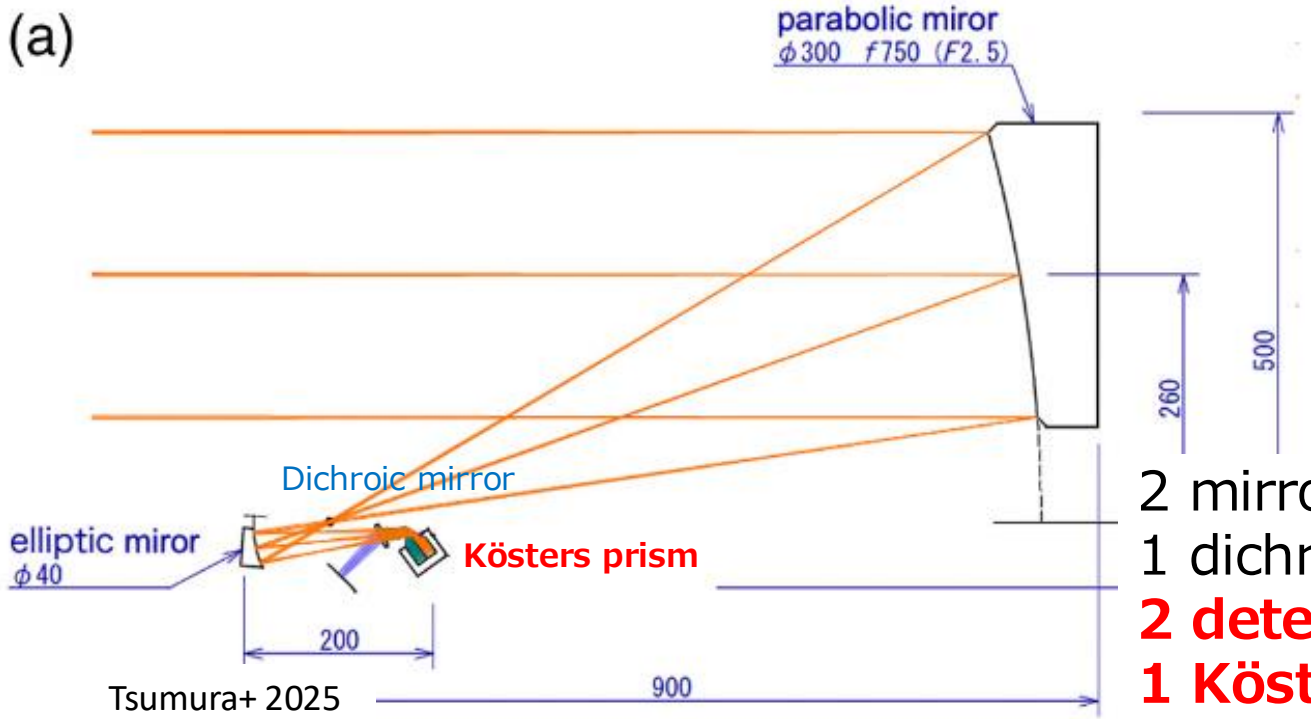
MONSTER (Optical/NIR Telescope)

Multiband **O**ptical and **N**ear-infrared **S**imultaneous **T**elescope for **E**fficient **R**esponse

The adoption of a Köster prism enables simultaneous imaging observation of the 0.9-2.5μm range with a single H1RG detector



Tsumura+ 2025

Aperture	30cm				
FOV	12arcmin × 12arcmin				
Pixel scale	2arcsec × 2arcsec				
Integration time	10min (2 min × 5 frames)				
Observation band (μm)	**0.5**-0.9	0.9-1.3	1.3-1.7	1.7-2.1	2.1-**2.5**
Limit mag (S/N=10)	21.3	20.9	20.6	20.5	20.4

2 mirrors
1 dichroic mirror
2 detectors
1 Kösters prism

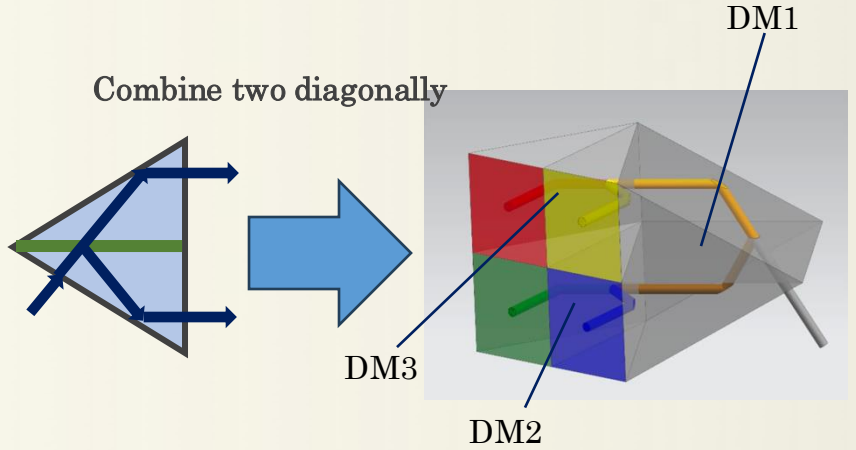
Kösters Prism

An optical element that splits light and emits it so that the optical axes are aligned in the same direction

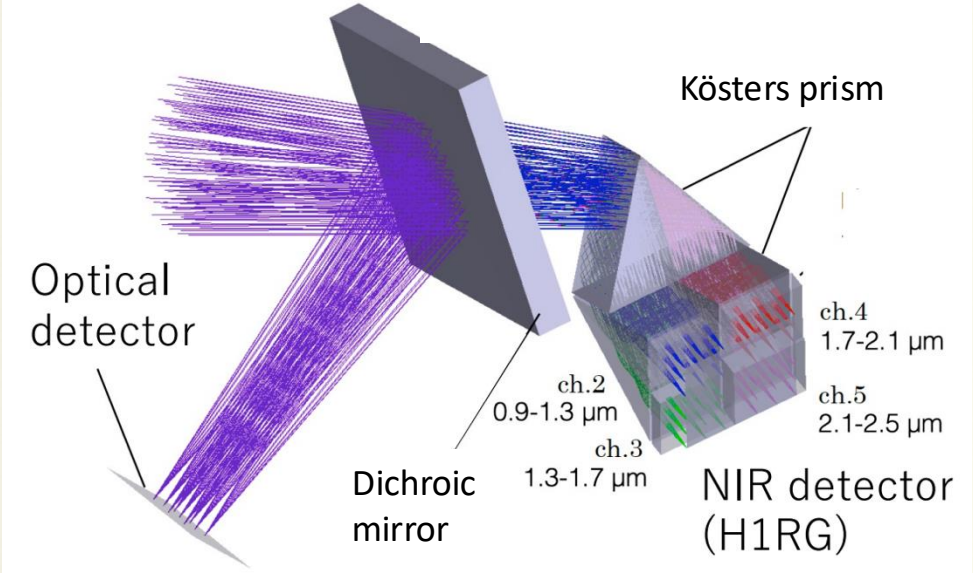
→ Reduce the number of detectors required, enabling space and cost savings

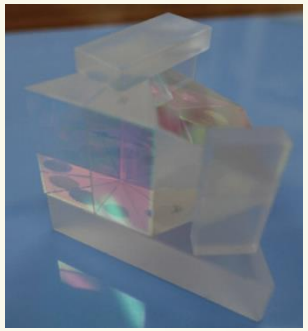
There is currently no track record of use in space

→ Performance evaluation will be implementated to verify its suitability for space use



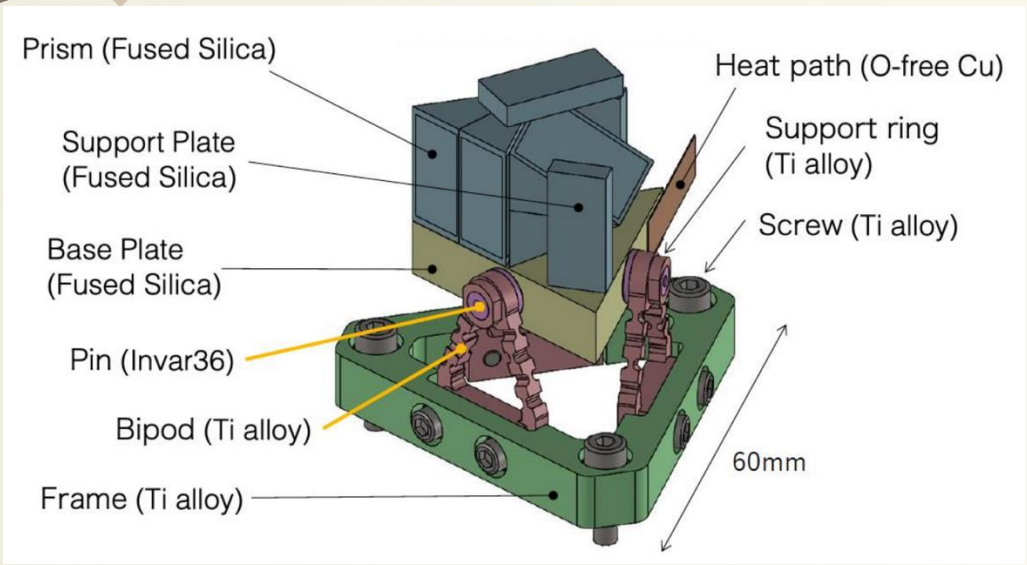
Double Kösters prism
J. Greiner & U. Laux 2022



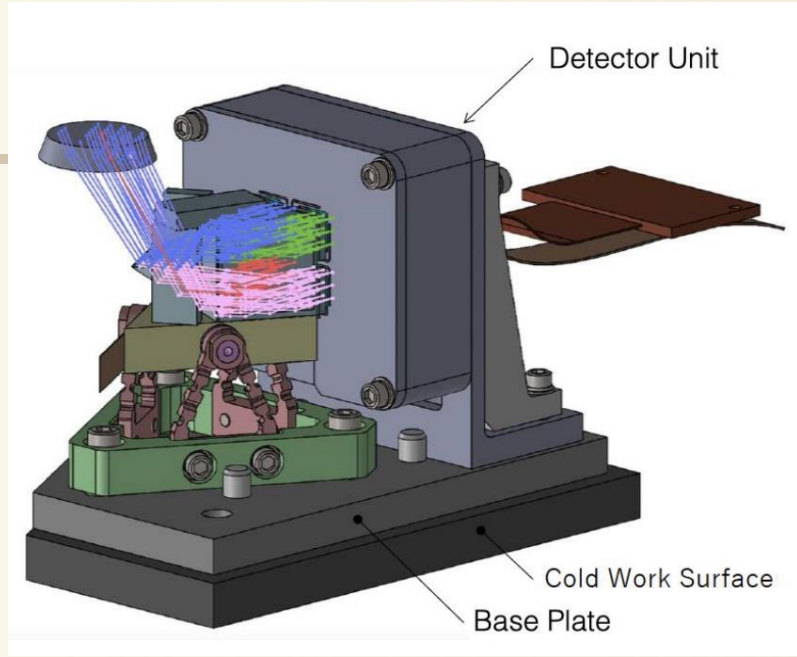


matterial	Anhydrous Fused silica
DM1	$T = 92.3\%$ @ 0.9-1.7μm、$T = 1.7\%$ @ 1.7-2.5μm Effective area 19.4mm × 17.8mm
DM2	$T = 92.2\%$ @ 0.9-1.3μm、$T = 4.1\%$ @ 1.3-1.7μm Effective area 9.2mm × 17.8mm
DM3	$T = 93.7\%$ @ 1.7-2.1μm、$T = 8.3\%$ @ 2.1-2.5μm Effective area 9.2mm × 17.8mm

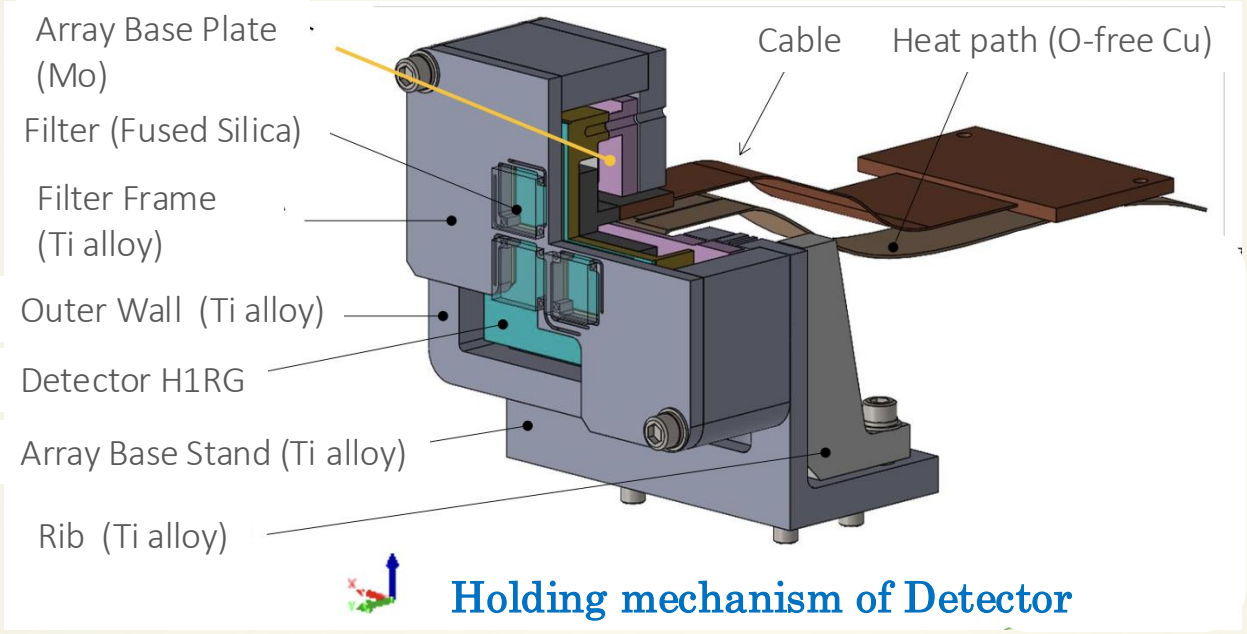
Holding Mechanism



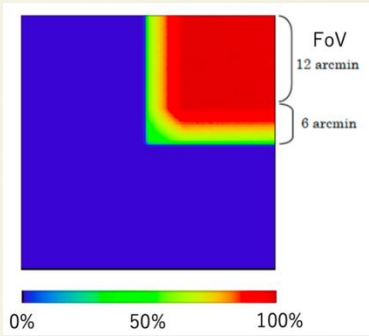
Holding mechanism of Kösters prism (ref: Rothhard+ 2022)



Unit part



Holding mechanism of Detector



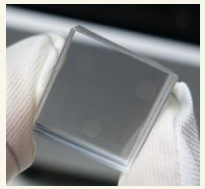
Transmittance distribution of FOV at detector

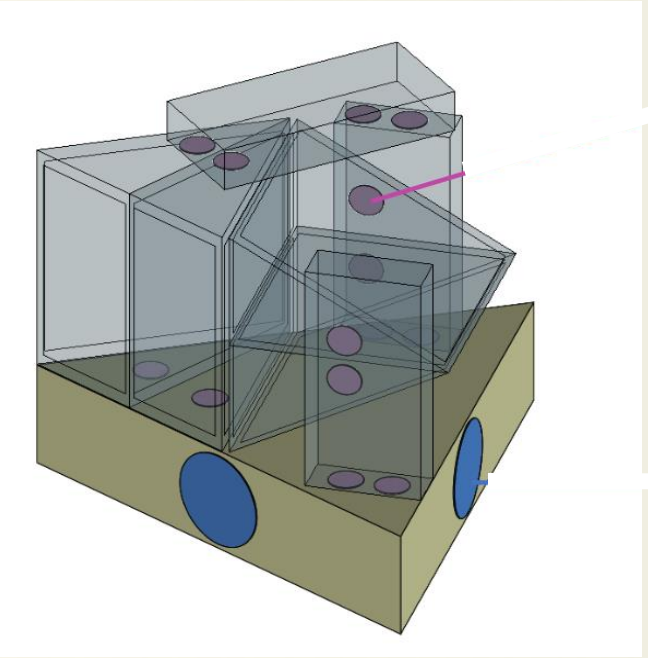
Performance test (Adhesion)

Evaluation of adhesive

- Adhere to prism, base plate and support plate (●14points)
- Adhere to base plate and pins (●3points)

Use 3 types of adhesive bonding 2 fused silica plates, and their transmittance was measured after undergoing radiation and cooling resistance tests



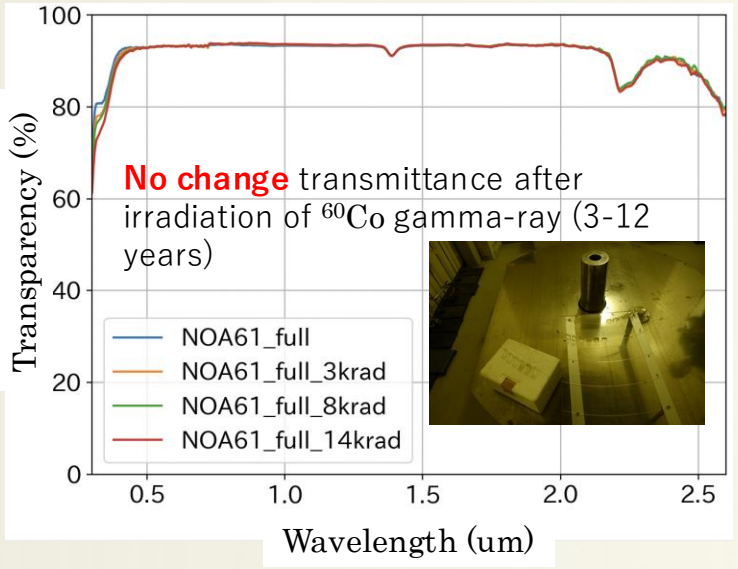


Adhesive	Radiation resistance (^{60}Co gamma-ray)	Cooling resistance (130K)	Optical transmittance
Norland NOA61	good	good	○
Scotch Weld EC 2216 B/A	good	good	△
Masterbond EP21TCHT-1	good	good	--- (cloudy)

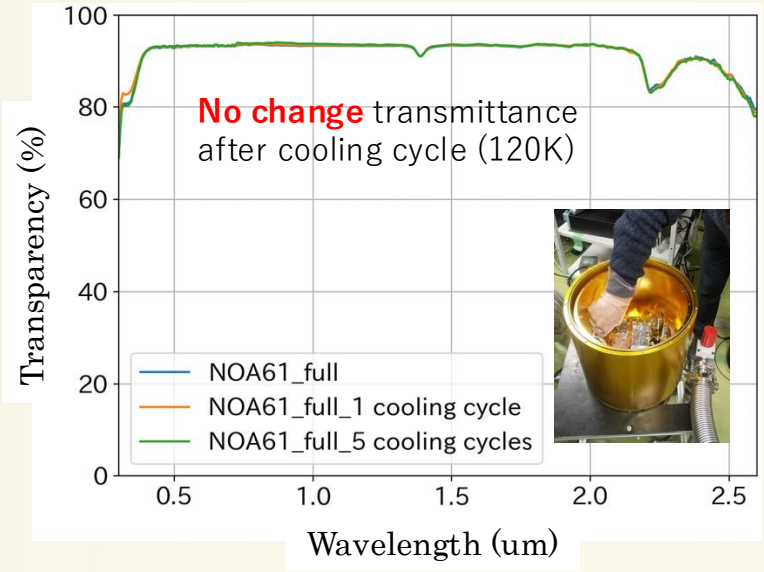
Comparison of which is more suitable for the ● points

evaluation for suitability as ● points

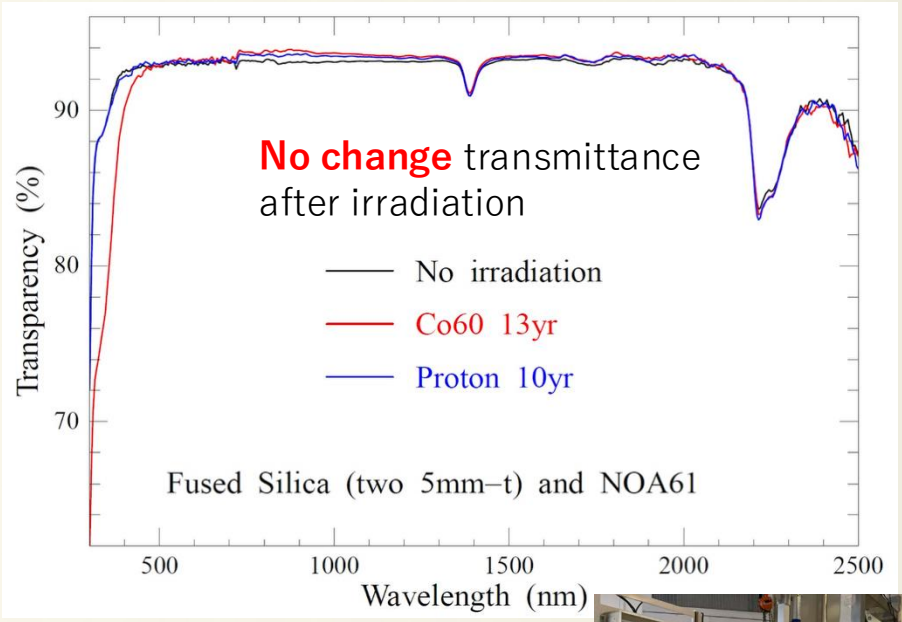
Performance test (Adhesion)



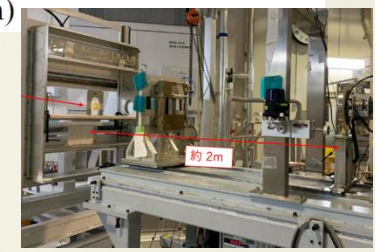
Irradiation test of ^{60}Co



Cooling test



Irradiation test of Proton

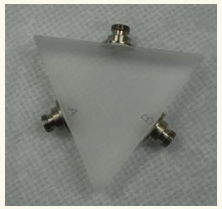


Applying 80G static load after irradiation or cooling test

→**No damage**

Decided to use Norland NOA61 for bonding within the prism

Performance test (Adhesion)

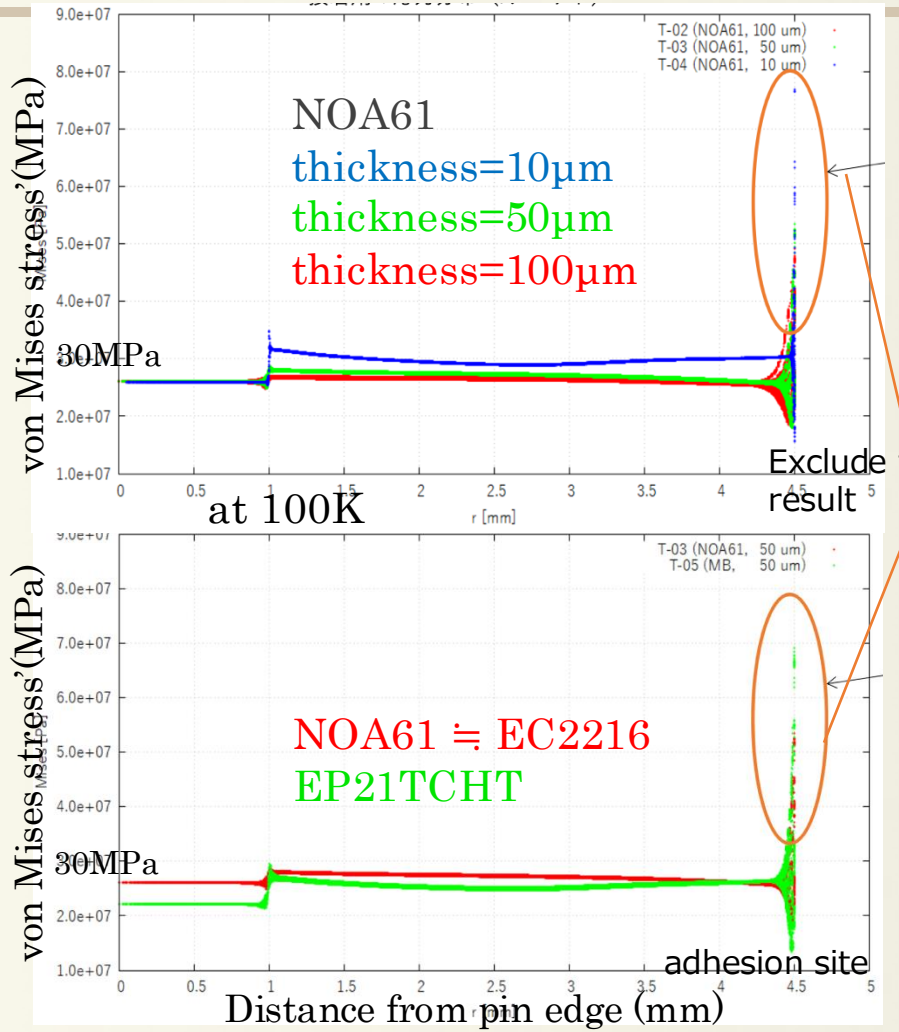


Pin adhesion

About adhesion of base-plate and pins
Vary the thickness and type of adhesive to investigate stress on the pins

- NOA61, EC2216's internal stress values at the adhesion site exceeds the strength limit
- In case of EP21TCHT, when the thickness of adhesive is less than 50μm, stress increases sharply

→Use EP21TCHT for pin adhesion, with a thickness of 50μm



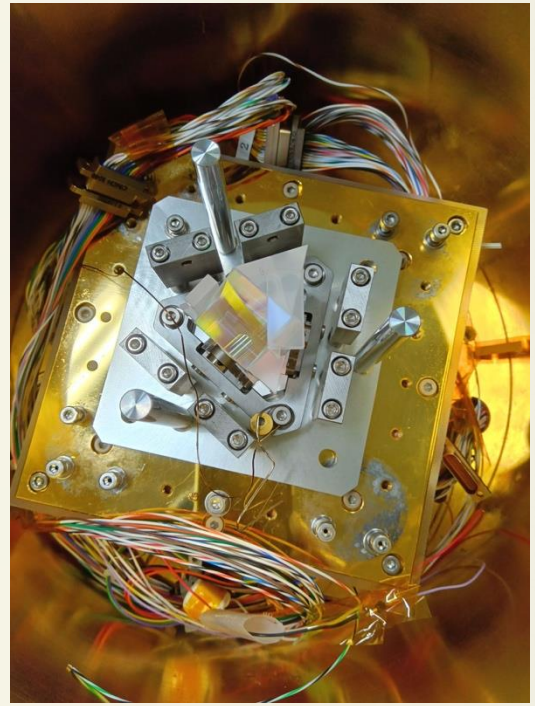
Distribution of von Mises stress by thickness (above) and type (below) of adhesive
Tensile strength of NOA61 and EP21TCHT are 21MPa, 55MPa

Cooling test (Prism + Holding mechanism)

Cooling test

Cool the Kösters prism and its holding mechanism along with the base plate

Leave for 2days with 115K temperature of stage in the dewar
→There were no visual changes, defects, or other issues

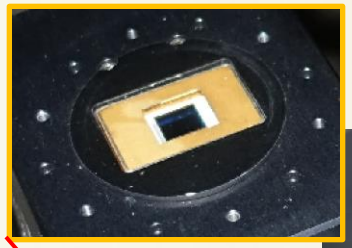


We plan to conduct strength tests and other procedures this winter along with samples subjected to proton irradiation

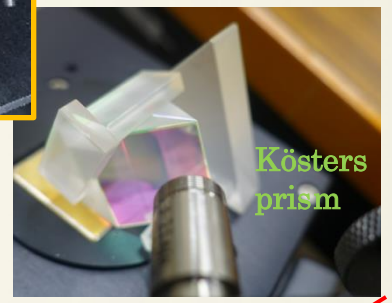
Performance test (Transmittance)

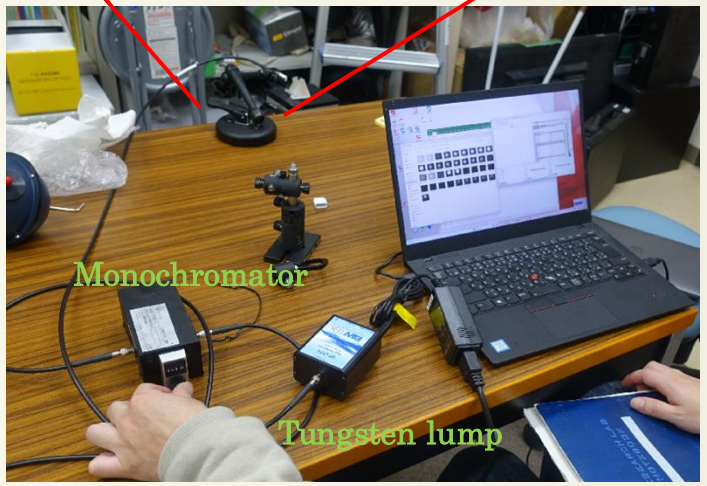
Simple measurement of Kösters prism

Measure the transmittance of Kösters prism ch2 and 3 using an InGaAs array with sensitivity 0.8-1.7 μm



InGaAs array





Tungsten lump

EO 56171
350-2600nm

Monochro mator

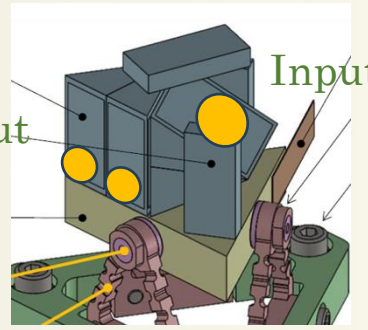
MINI-CHROM model 6
EO 56254 850-2200nm

Fiber collimator
EO 47223 0,25NA 1310nm

InGaAs array

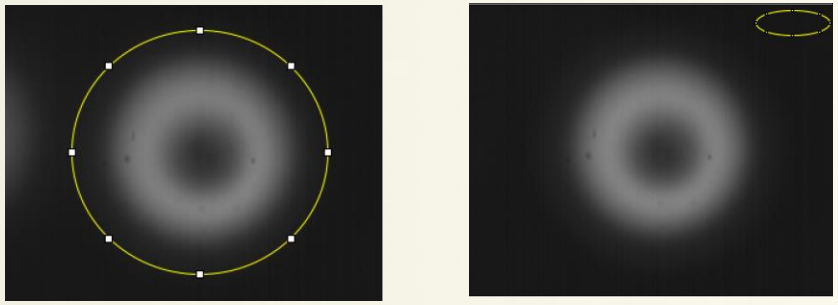
PC

Save as BMP file



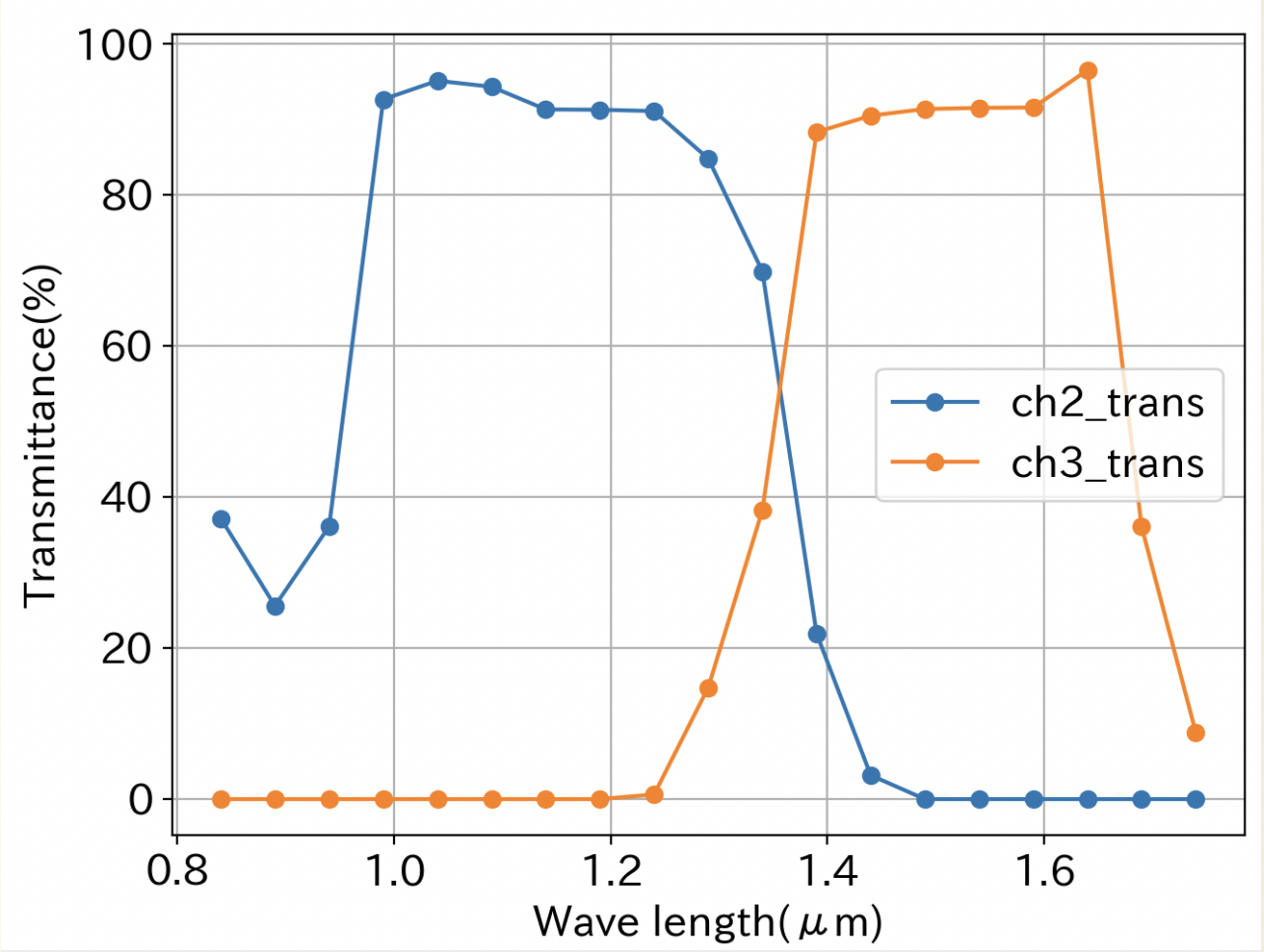
Performance test (Transmittance)

Measurement of transmittance



Region of measurement of light intensity(left) and background(right)

It has a transmittance of approximately 90% in the observation wavelength range of ch2 and ch3
Typical error : a few%@above 60%



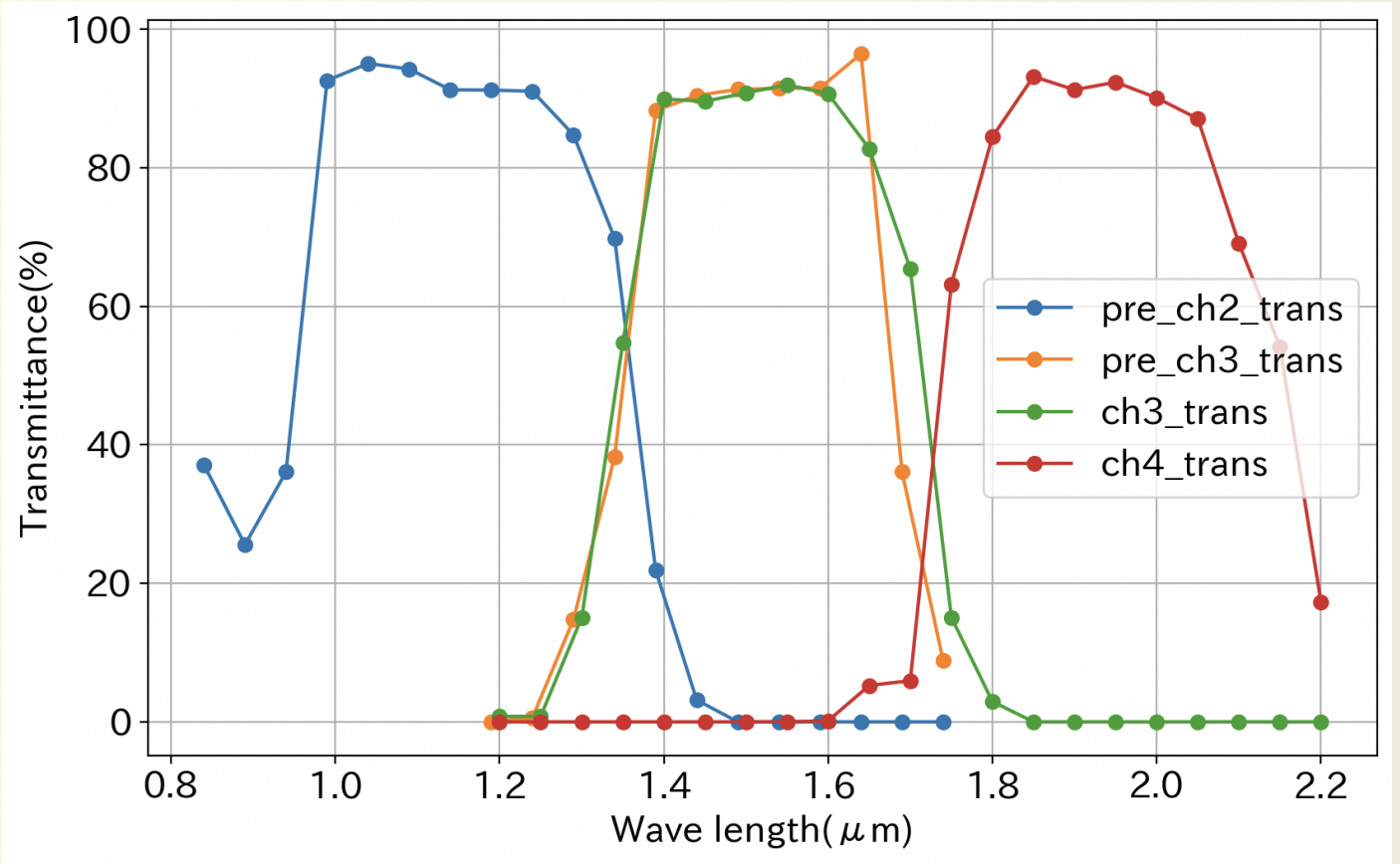
Performance test (Transmittance)

Measurement of transmittance

Use other NIR camera with sensitivity 1.3-2.15μm and measure ch3 and 4 transmittance

ABA-001MIR
Credit : AVAL DATA

Calculate the transmittance from the scaling of previous result and this time's result of ch3's transmittance
→ ch4 also has a transmittance of about 90%



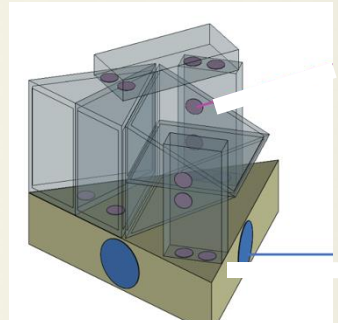
Summary

- Kösters prism : An optical element that splits light and emits it so that the optical axes are aligned in the same direction

  → **Reduce the number of detectors required, enabling space and cost savings**

- There is currently no track record of use in space

→ A BBM was developed and its capability to withstand space conditions was successfully validated



- About prism's adhesion

  NOA61 14points : prism, base plate and support plate

  EP21TCHT 3points : base plate and pin

- A simplified transmittance measurement revealed that the BBM exhibit a transmittance of about 90% in the observed wavelength of ch2,ch3 and ch4