第9回 可視赤外線観測装置ワークショップ
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MOIRCSに搭載された LightSmyth製新グリズムの性能評価

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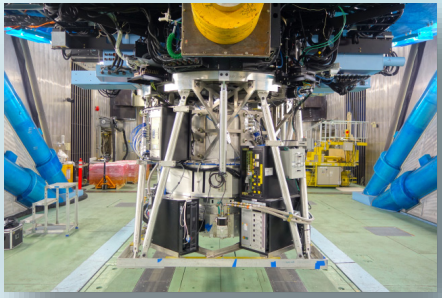
Introduction



- **MOIRCS … Multi-Object Near-Infrared Camera and Spectrograph for Subaru 8.2-m Telescope.**
- **Its Medium-Resolution VPH Grisms have Issues.**
  - **Peaky Transmission Curve**
  - **Large Dependence to the Angle of Incidence (AoI).**

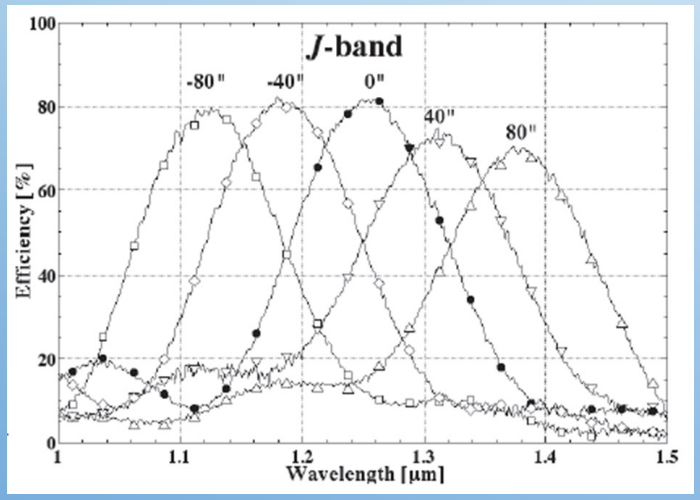
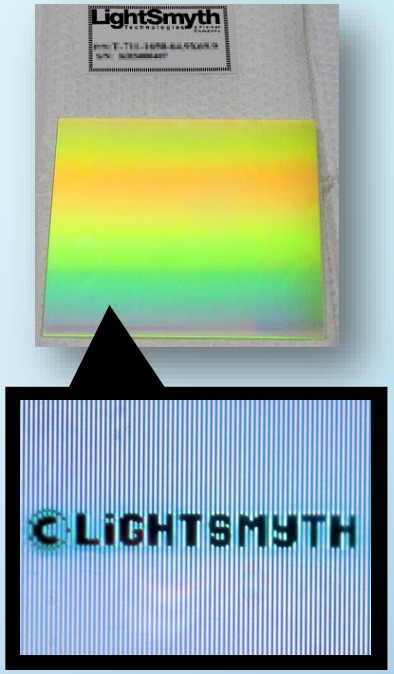


Fig.1: An example of the VPH grism transmission curve for MOIRCS (Ebizuka et al. 2011).

Introduction

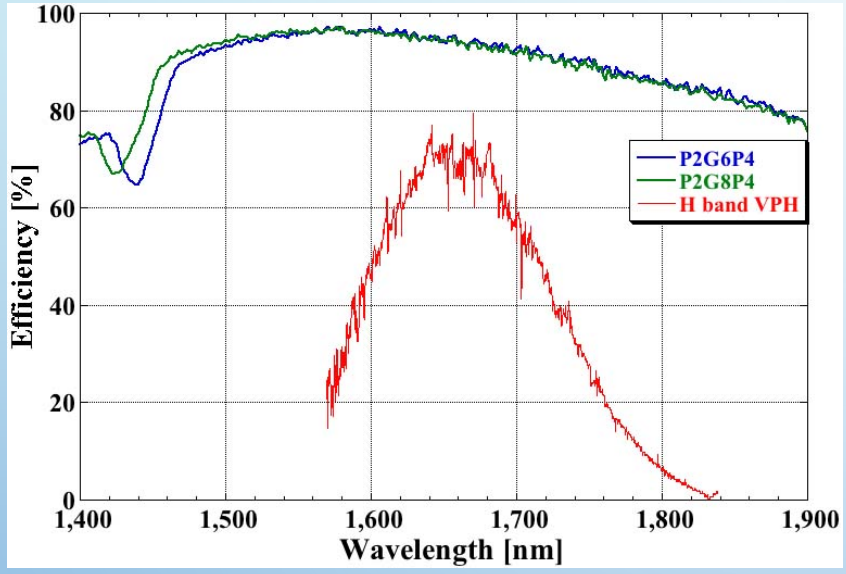
- **LightSmyth Technologies/Finisar has made a great grating.**
  - ✓ **Very High Peak Efficiency**
  - ✓ **Wide Spectral Coverage**
  - ✓ **Minimum Dependence to the AoI and Polarization**
  - ✓ **Tough (up to ~500℃).**

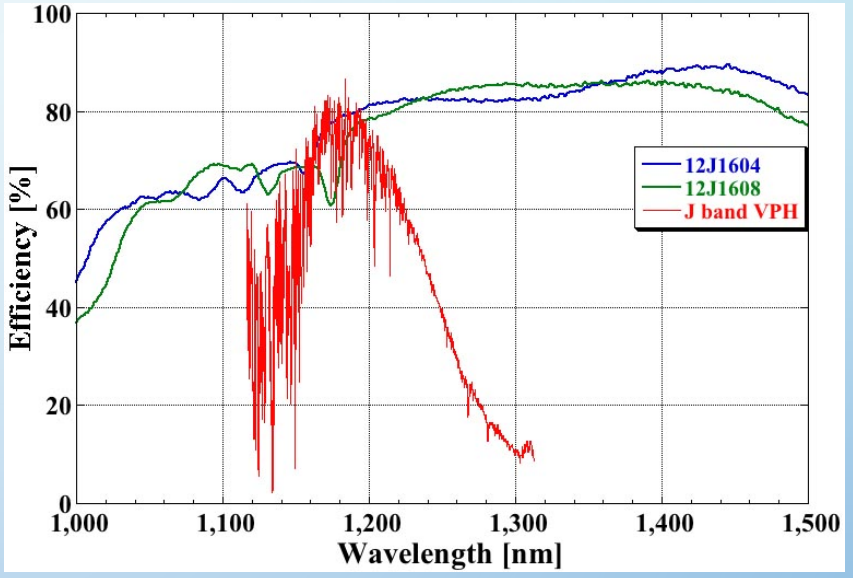


No astronomical application has ever made.

We decided to make grisms using the LightSmyth Grating.

Grating Design

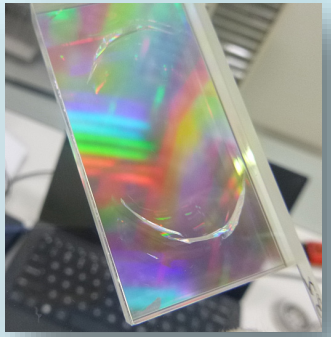




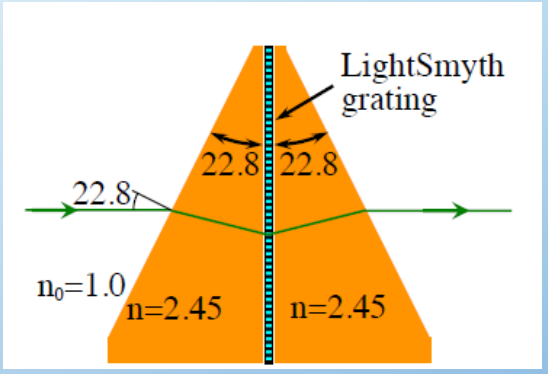
- **H-band Grating…Custom Made, with Peak Efficiency ~98%.**
- **Covers most H-band window with >90% as a grism.**

- **J-band Grating…Catalog (T940C) with Peak Efficiency ~93%.**
- **Covers most J-band window with 80% as a grism.**

Assembly



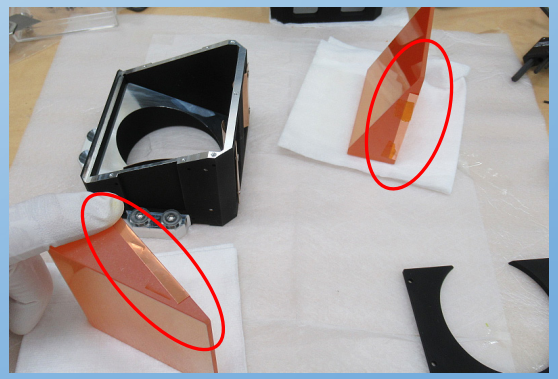
- **Thinness of the Grating Substrate is the Issue.**
  - **Only 0.65 mm for J, 0.9 mm for H.**
- **Order-of-Magnitude Difference in the Thermal Expansion Rate among Prisms (ZnSe) and Grating (FS).**



→We gave up gluing Grating and Prism.

→ "Sandwich Design" without Glue.

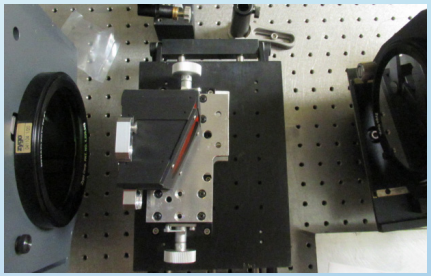
But ghosts are then a Concern … We put Shims on one-side of Prisms.

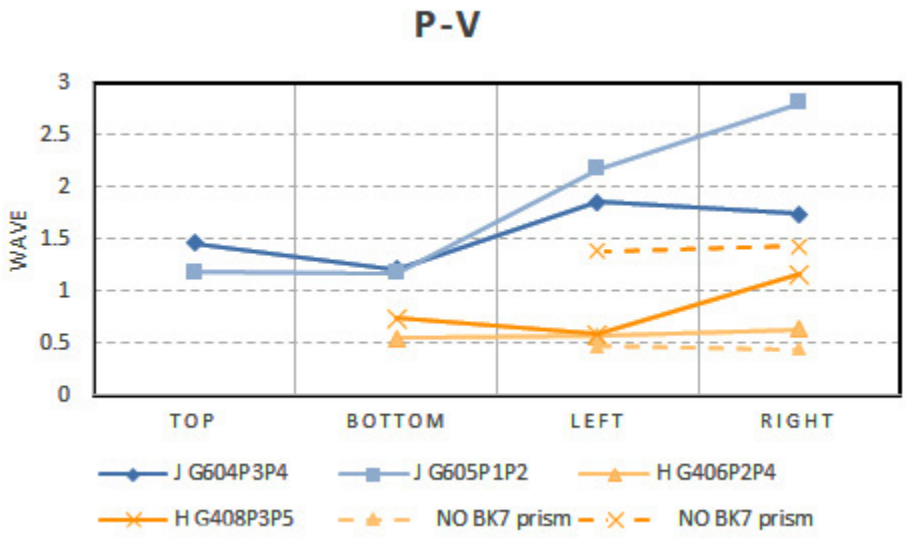


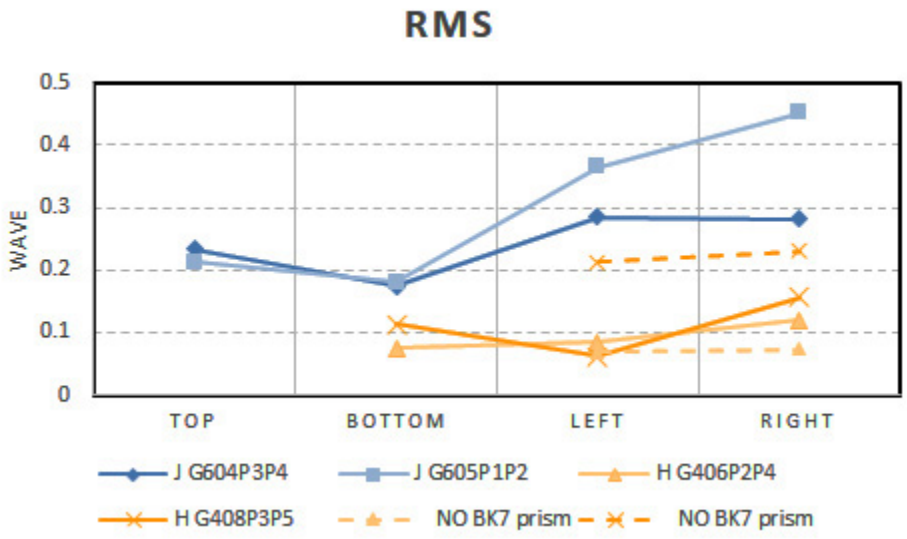
Assembly

Stability Tests

- **Change of the Wavefront Error with Gravity Direction is Evaluated.**
- **LS_J is Worse than LS_H Due to Its Thinness.**

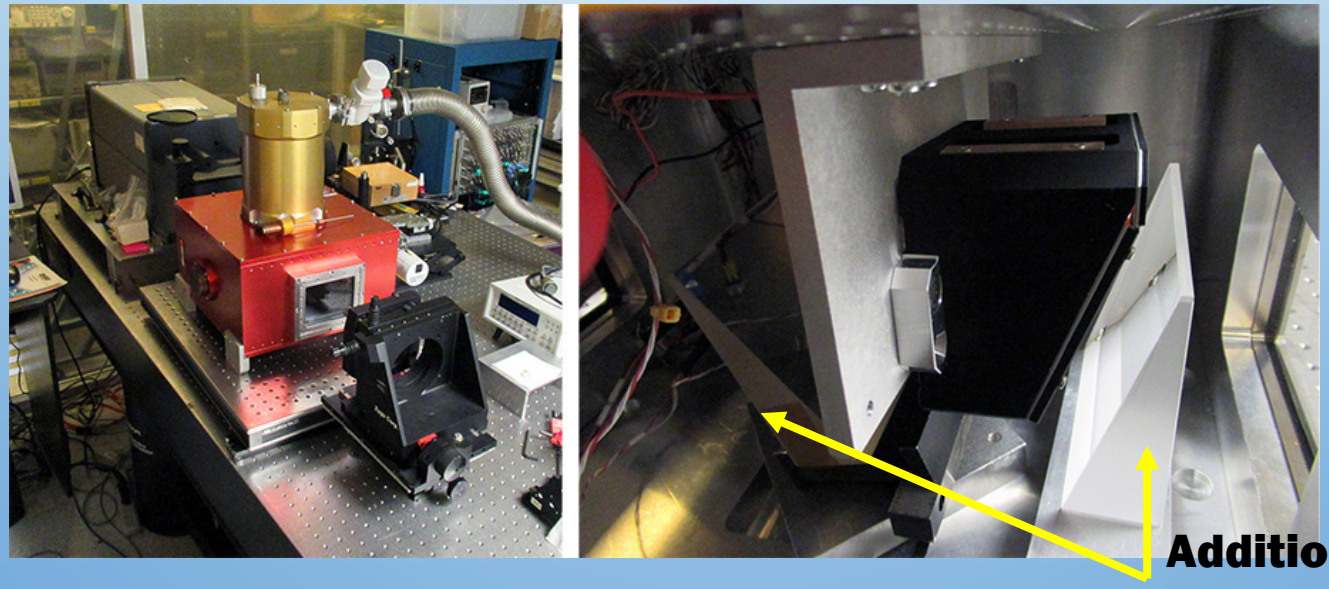






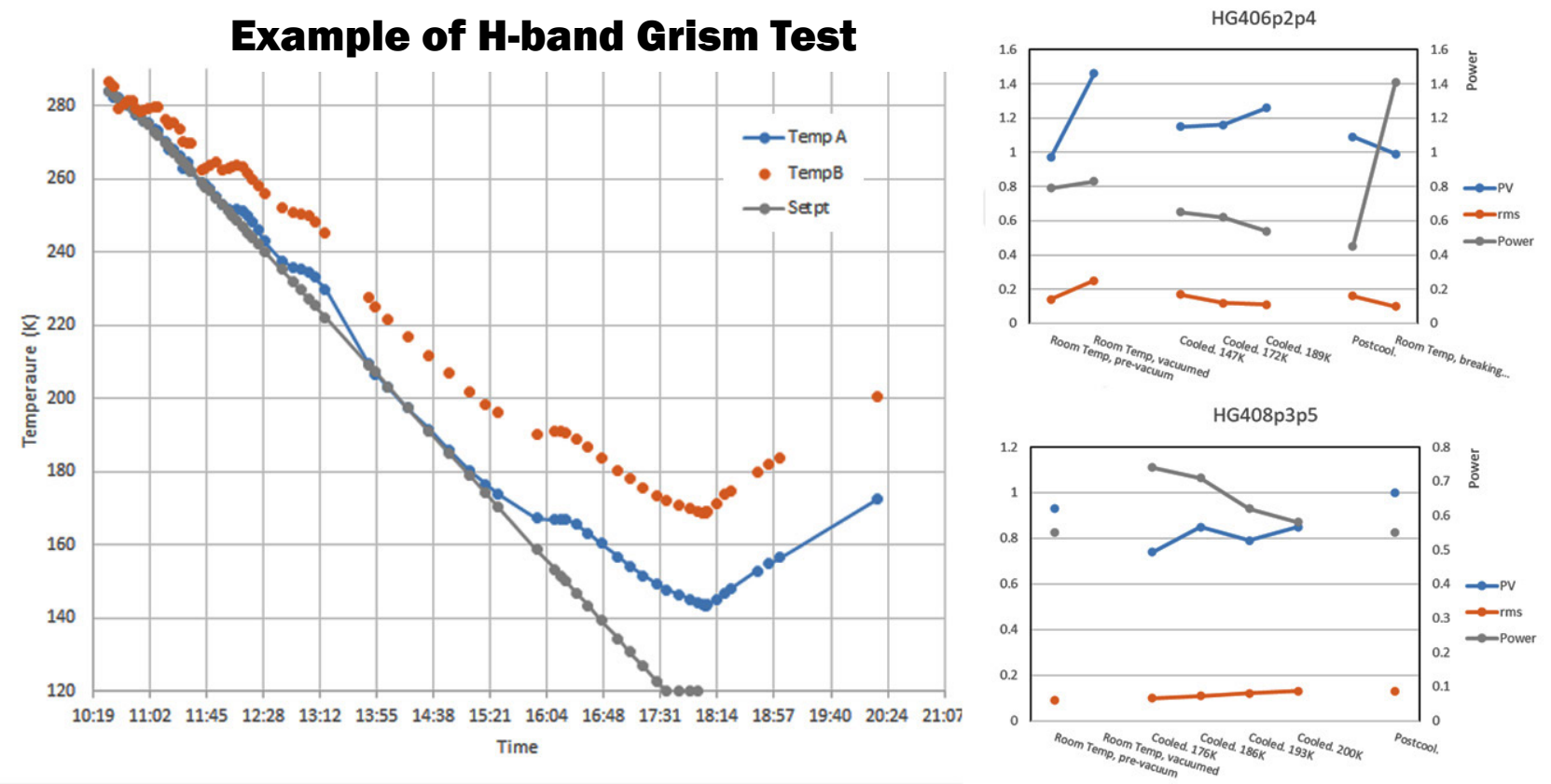
Cooling Test

- Checking Stability over the Thermal Cycle.
- Wavefront Error Measurements with Cooling.

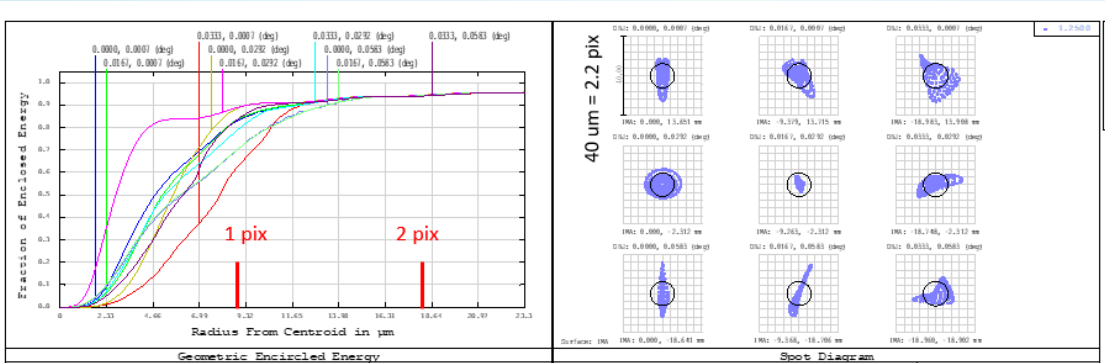


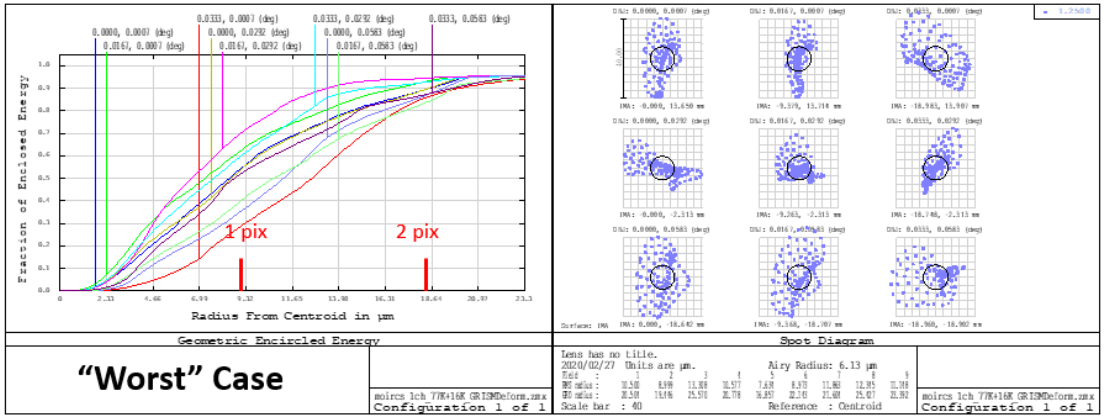
Cooling Test Results

- **Relatively Stable Across Thermal Cycle.**
- **LightSmyth-J is Worse Due to Its Thinness.**



Checking Degradation with EE80.

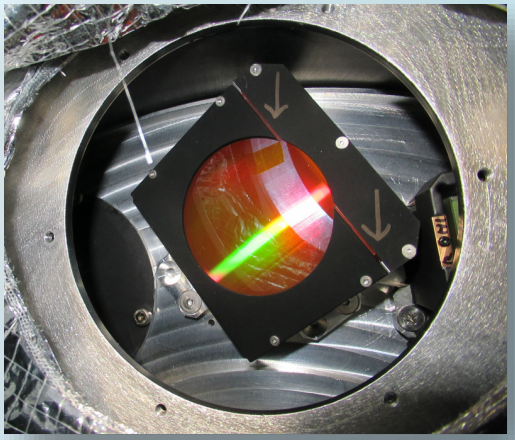


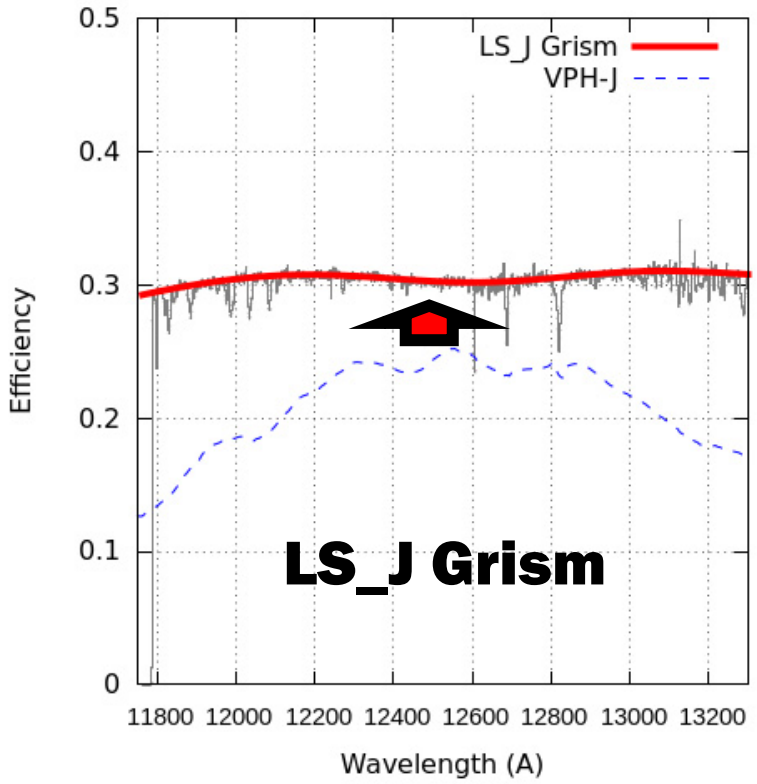


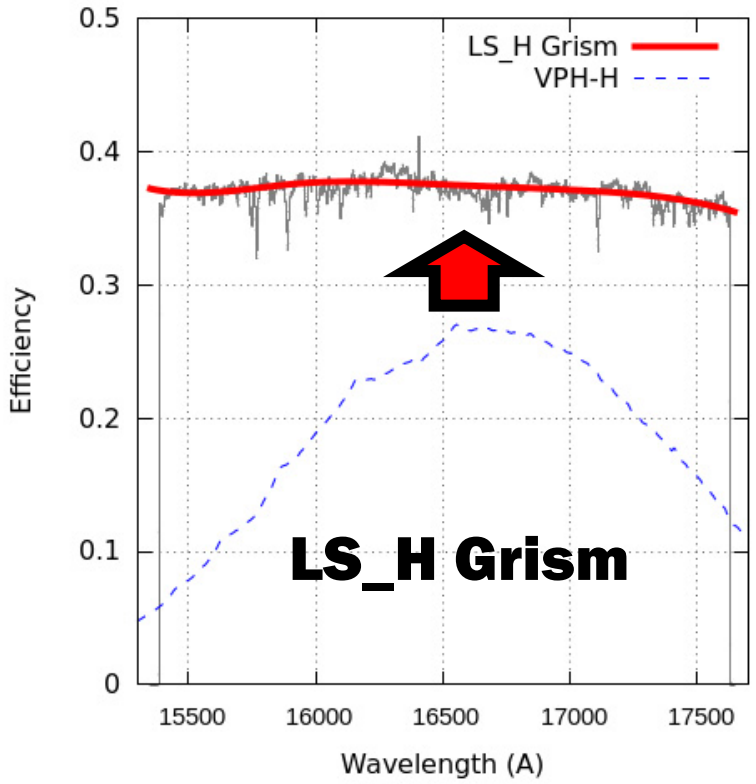
- **Degradation is at most ~1 pix for Worst Case for LS_J.**
- **It does not affect to the data in Natural Seeing Condition.**

On-Sky TEST (July 2020)!

- **Beautiful and Great Sensitivity!**
- **Ghosts…but found to be negligible to the Data.**

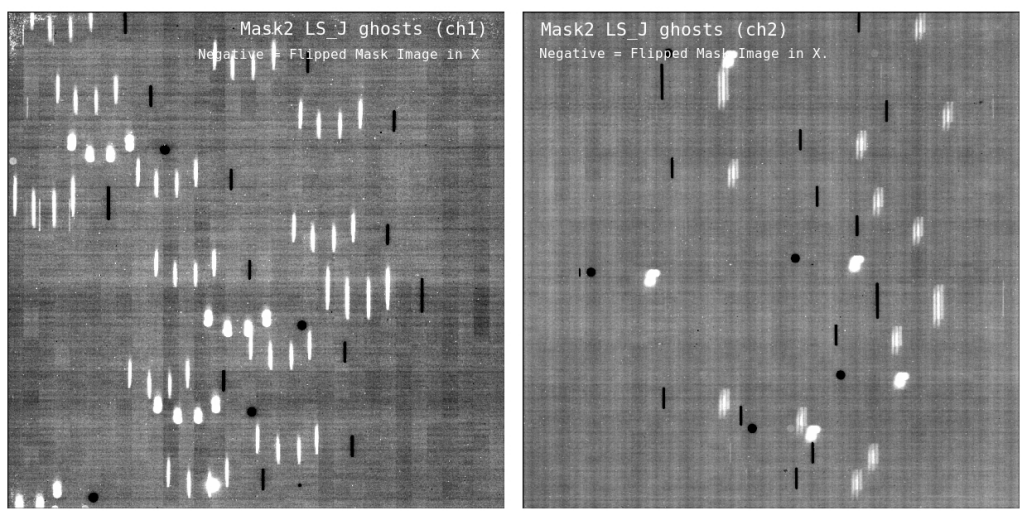


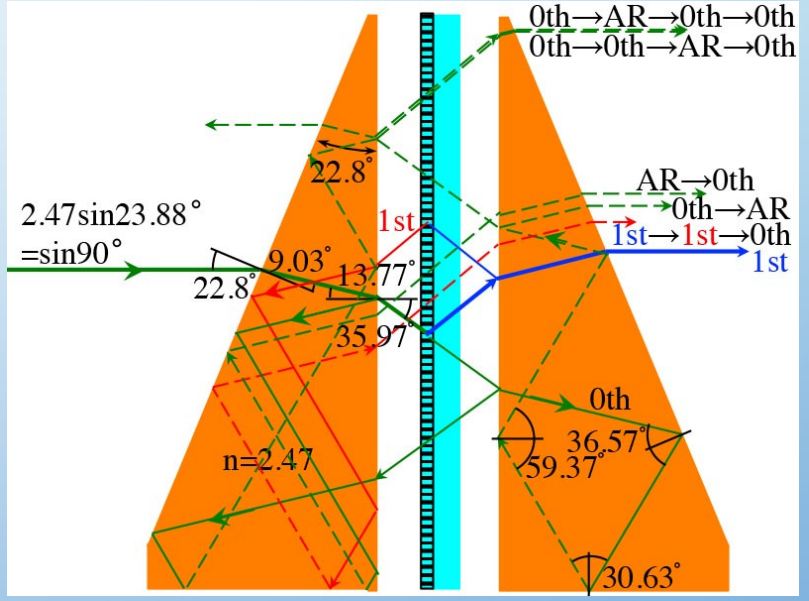




On-Sky TEST !

- **Ghosts… internal reflection of the 0-th-order light.**
- **But found to be totally negligible to the Data.**



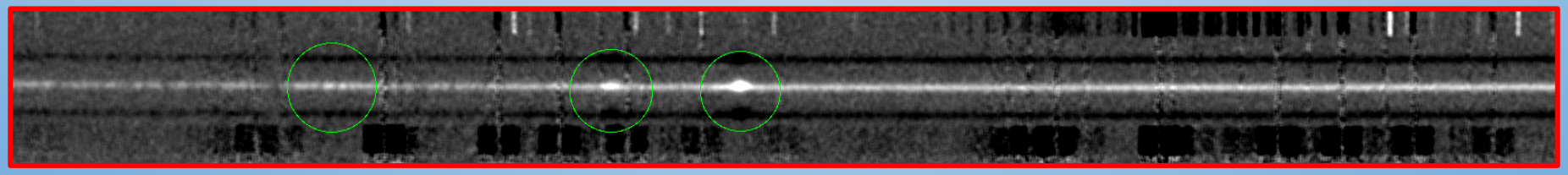


Ghost Image for LS_J grism.

- Position is predictable.
- Stable and disappeared by A-B subtraction.

Conclusion

1. **Application of the LightSmyth Grating to Astronomical Use was Successfully Done!**
2. **Amazing Flatness and Great Total Efficiency are Achieved!**
3. **Effect of Ghosts are Found to be Negligible.**
4. **LS_J is Somewhat Unstable than LS_H, though Will Not Affect the Observation.**
5. **We Will Remake LS_J Grism in the Future for ULTIMATE-Subaru.**
6. **Open-Use Obs Has Started from S20B. A Paper is Submitted Already.**



Hβ & [OIII] in QuickLook Spectra from LS_J grism (30 min).
Image by courtesy of Dr. M. Schuramm (Rakshit et al. ApJL, submitted).