

VPH grism development in NAOJ

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Hattori, Masanori Iye

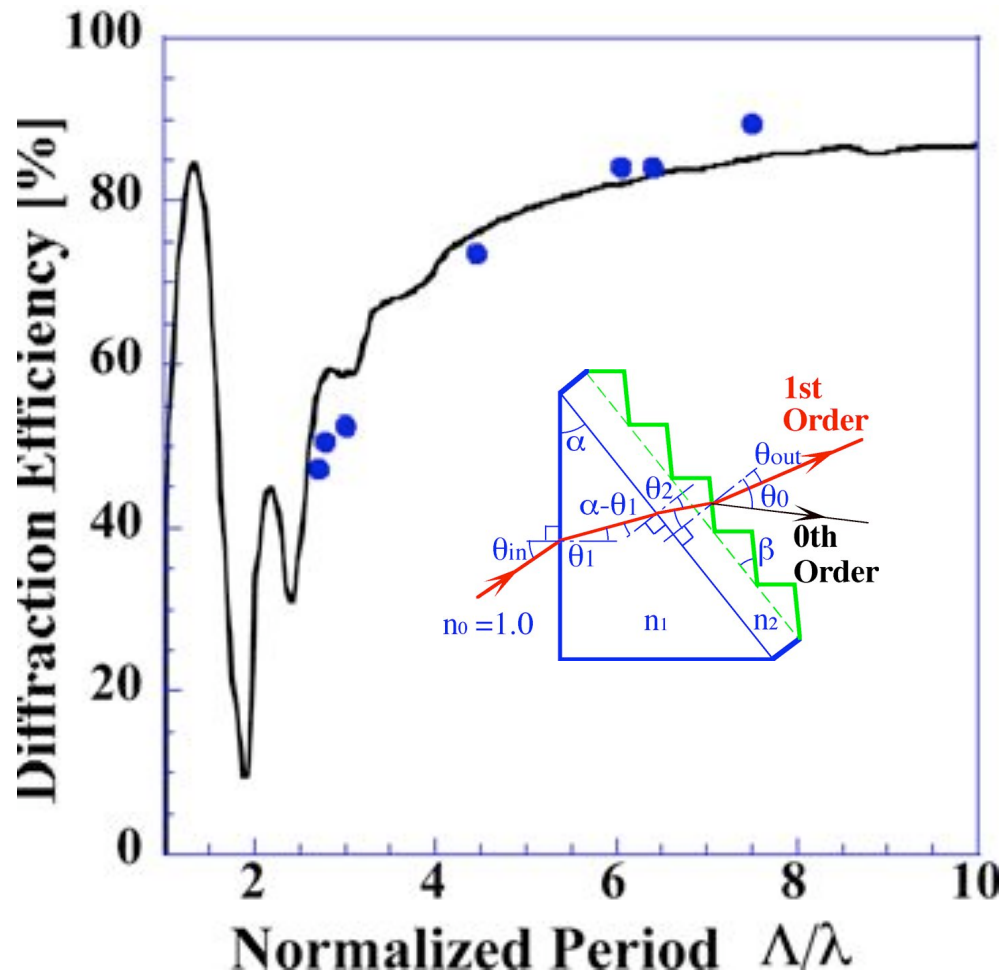
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Hiroshima University, Nagoya University, Tohoku University,
National Astronomical Observatory of Japan

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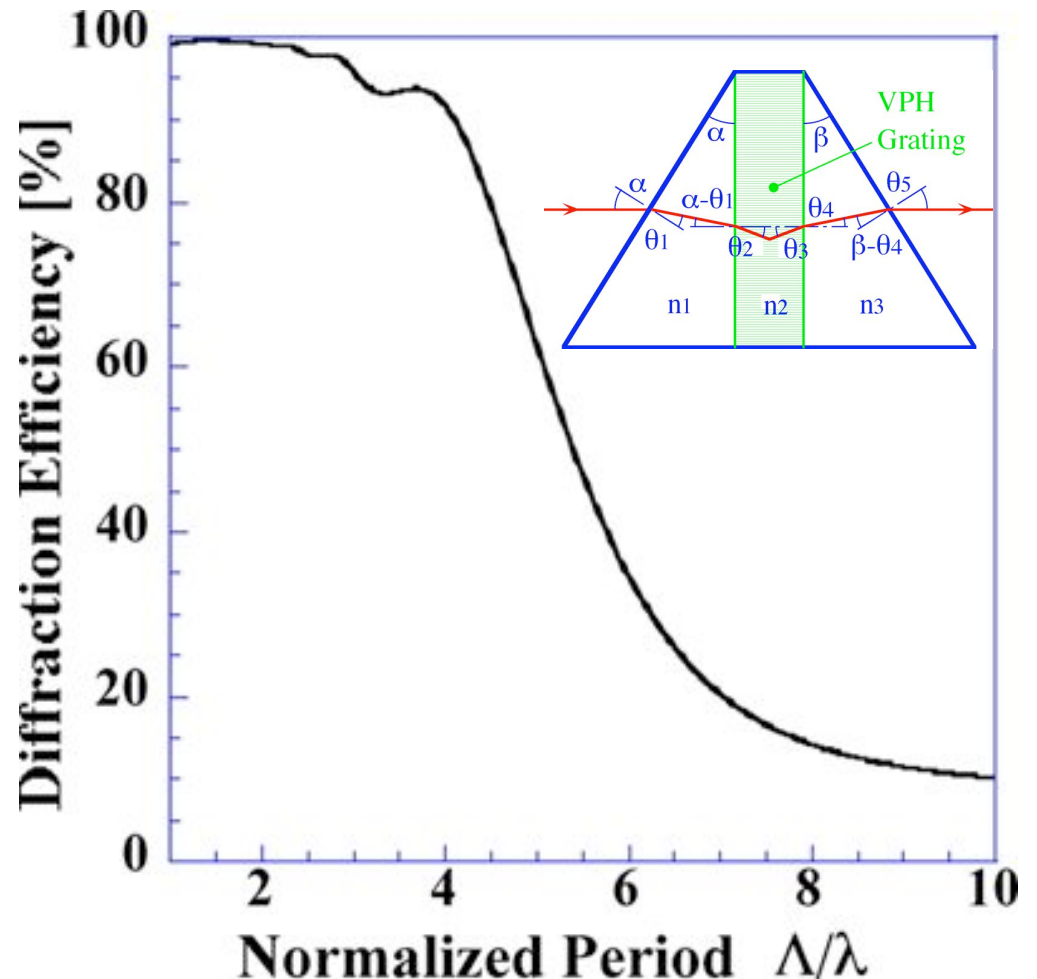
Subaru Telescope UM



Diffraction Efficiency of Transmission Gratings



Surface relief grating



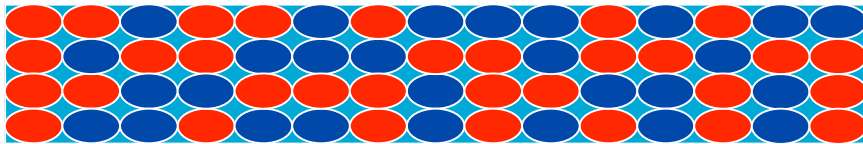
VPH grating

[K. Oka et. al., SPIE 5005, 2003]

Resin for Volume Hologram

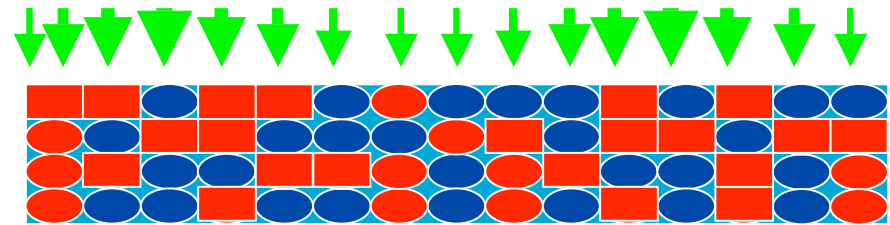
- Radical polymerization monomer (RPM) Polymerized by UV and 460 - 600 nm
- Cation polymerization monomer (CPM) Polymerized by UV
- Radical polymerization polymer (RPP)
- Cation polymerization polymer (CPP)

①



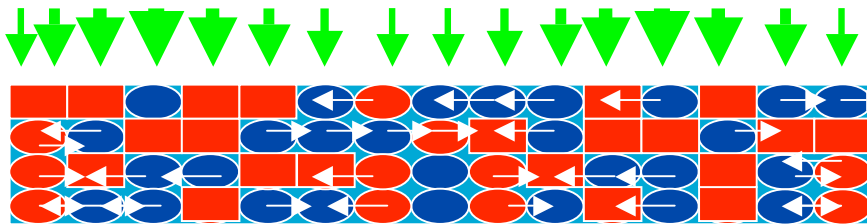
②

Laser Exposure



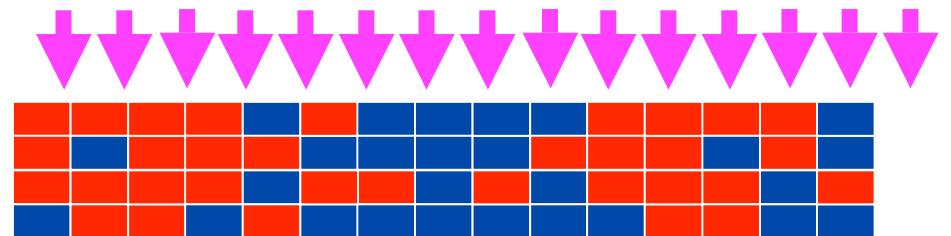
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Laser Exposure

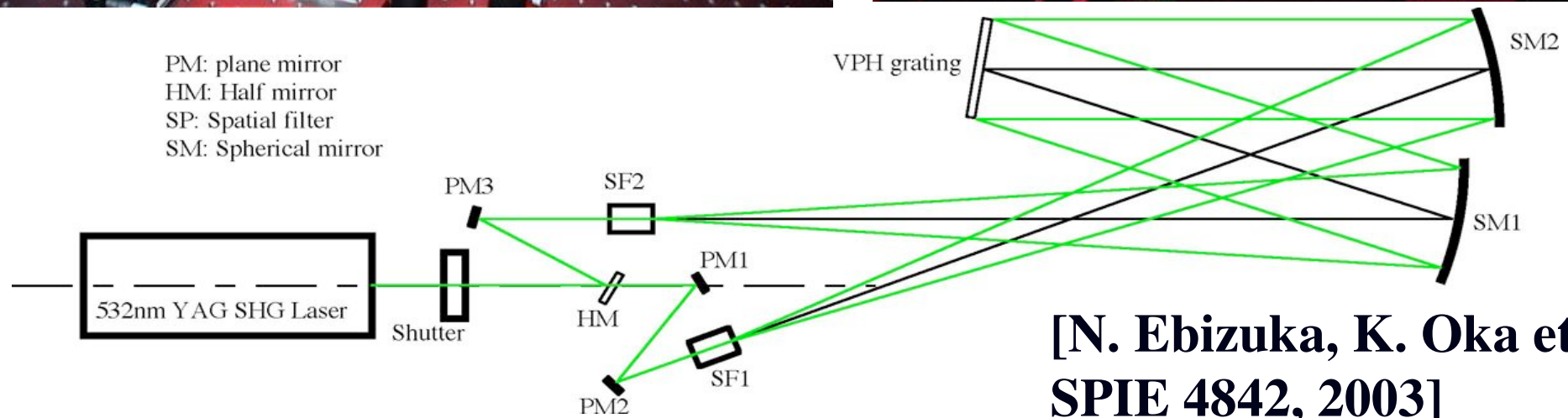


④

UV exposure

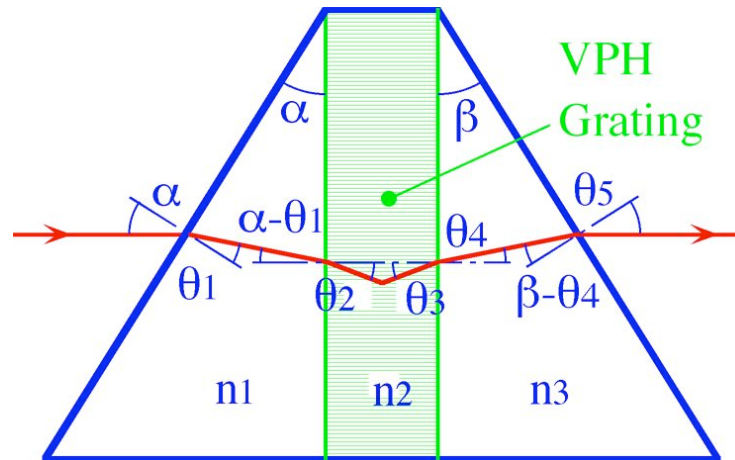
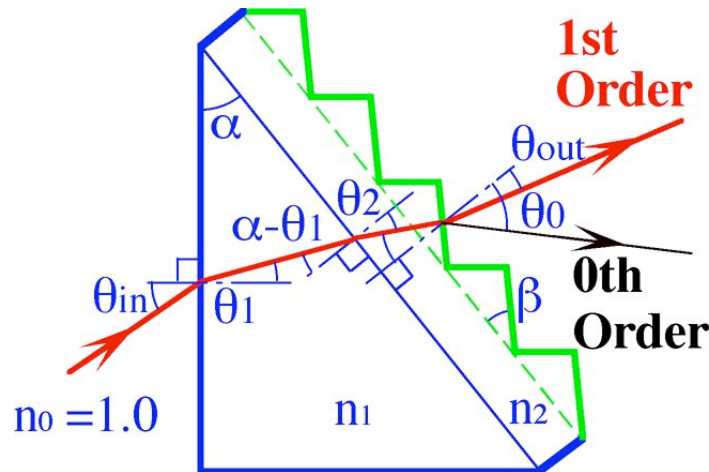


Optical System for VPH Fabrication



[N. Ebizuka, K. Oka et. al.,
SPIE 4842, 2003]

Grism with High Index Prisms



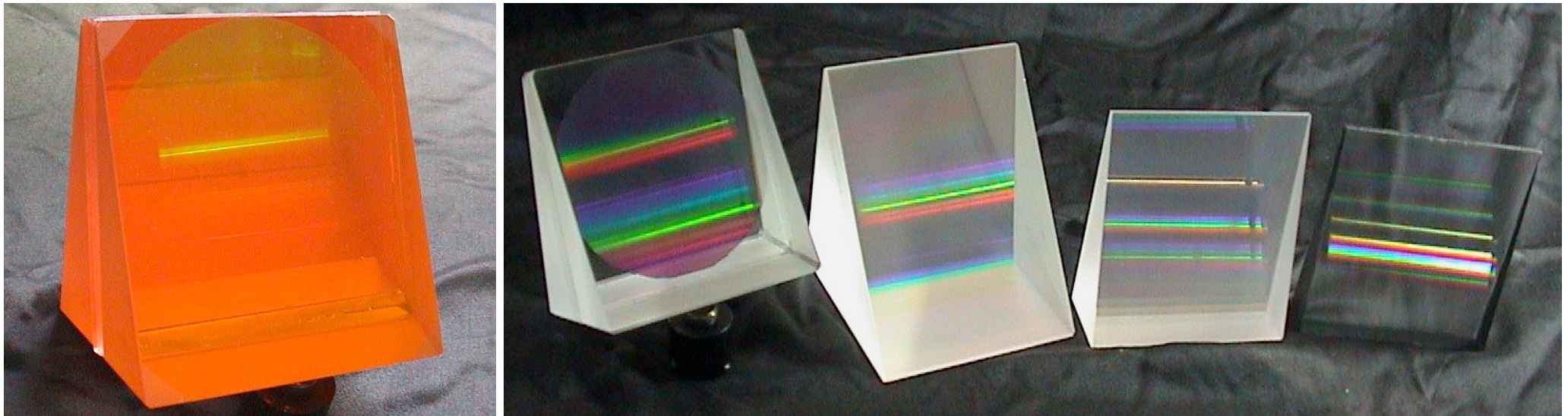
Critical angle of refractive indices **2.6** and **1.5** is **35.2 degree** ($\theta_{in} = 0$, $\alpha = 35.2$).

Refractive indices of the **prisms** and **VPH grating / quasi-Bragg grating** are **2.6** and **1.5** respectively, the largest **vertex angle** α is **63.6 degree**.

Grisms for FOCAS

FOCAS (Faint object camera and spectrograph) grisms are complete, commissioned and in regular use

4 replicated grisms ($R=280\sim1,400$ @ $0.4''$ slit),
1 Echelle grism (replica, $R\sim2,800$, 2nd~5th order),
3 VPH grisms with optical glass prisms ($R\sim3,300$),
3 VPH grisms with ZnSe prisms ($R\sim7,000$).



Size: 110 x 106 x 106 mm (max)

[M. Kashiwagi et. al., SPIE 5494, 2004;

K.S. Kawabata et. al. SPIE 4841, 2003]

Grisms for WFGS 2 and KOOLS

WFGS 2: Wide Field Grism Spectrograph for the 2.2m Telescope of Univ. Hawaii

	Blaze [nm]	Range [nm]	R (Slit width)
Replica	697	500 – 900?	1,010 (0.7'')
Replica	405	360 – 600?	1,250 (0.7'')
VPH(ZnSe)691		580 – 700?	4,680 (0.7'')

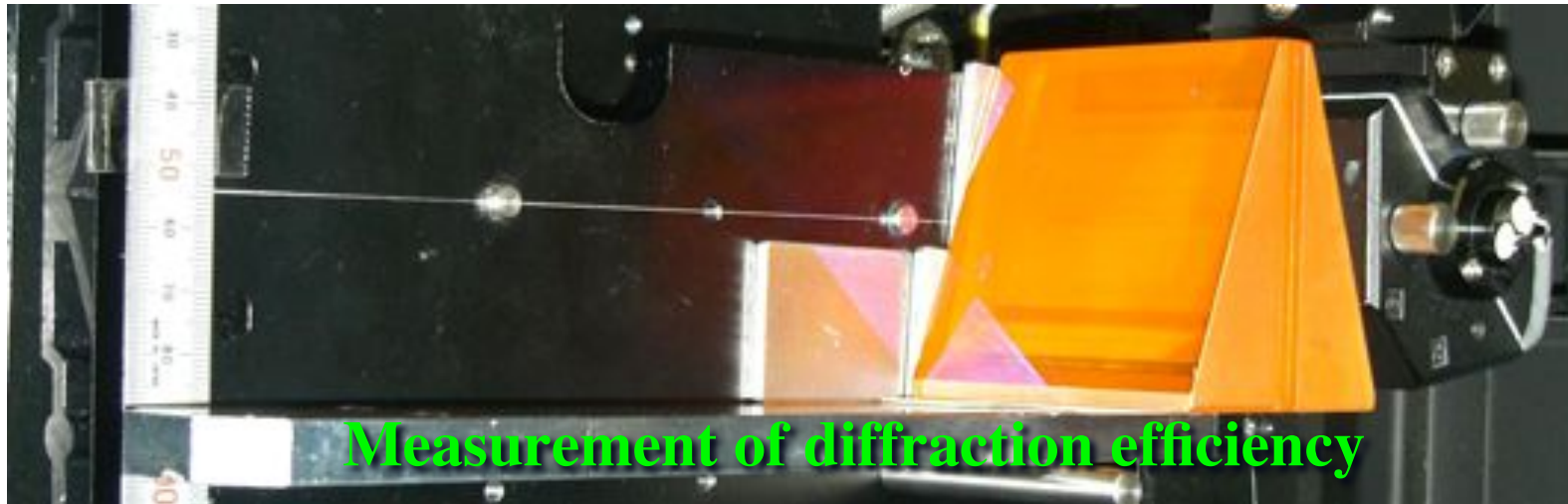
[M. Uehara et. al., SPIE 5492, 2003]

KOOLS: Kyoto Okayama Optical Low dispersion Spectrograph for the 1.88 m Telescope of Okayama

	Blaze [nm]	Range [nm]	R (Slit width)
VPH683	683	600 – 720	2,000 (1.0'')
VPH495	496	450 – 540	2,000 (1.0'')

Grisms for MOIRCS

MOIRCS: Multi-Object InfraRed Camera and Spectrograph for the Subaru Telescope



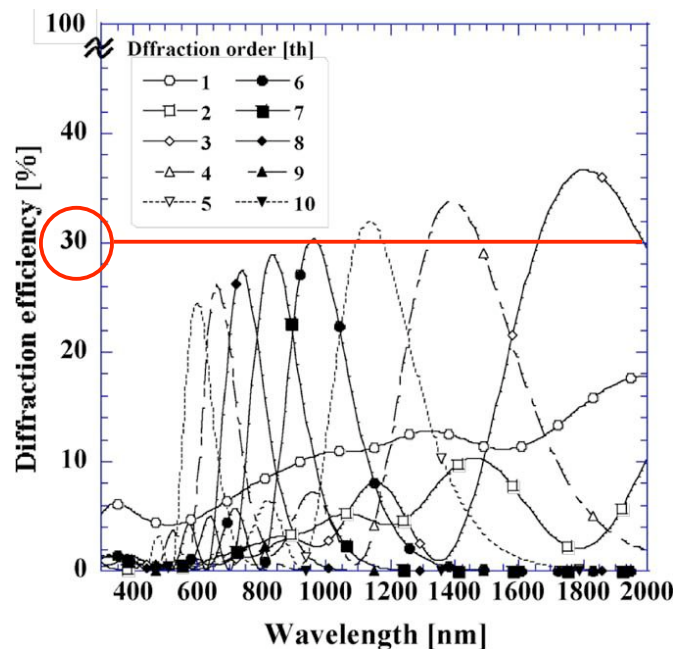
	Blaze [μm]	Range [μm]	R (Slit width)
J Band	1.25	1.13 – 1.32	3,050 (0.5'')
H Band	1.65	1.52 – 1.78	2,940 (0.5'')
z band	1.00	0.90 – 1.10	3,000 (0.5'')
K band	2.25	2.10 – 2.40	3,000 (0.5'')

[T. Ichikawa et. al., SPIE 6269-43]

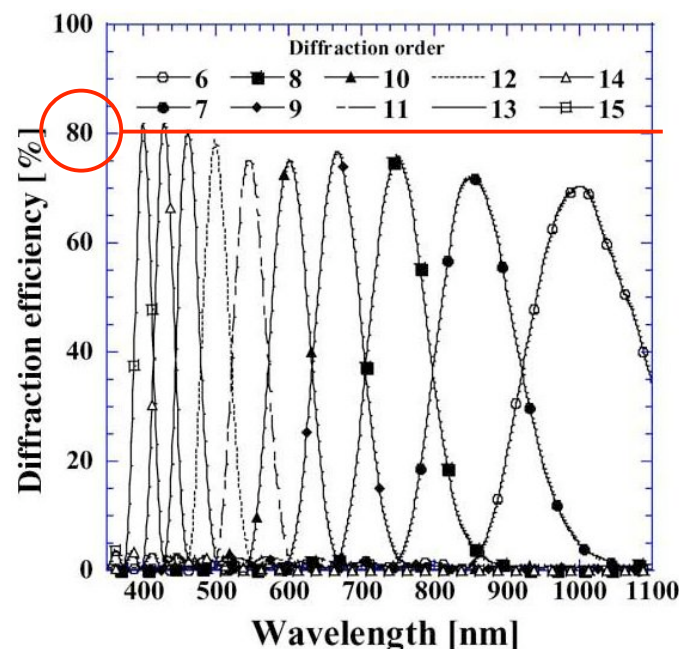
Quasi-Bragg grating



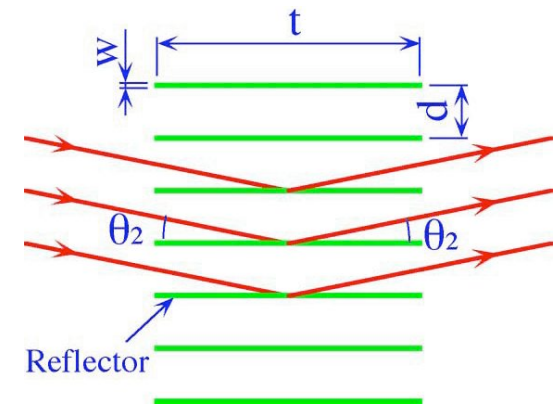
- 2 dimensional detector is effectively used by a higher order grating with a cross disperser.
- Diffraction efficiency of a surface relief grating changes slightly.
- Diffraction efficiency of a VPH grating decreases at higher orders.



Diffraction efficiency of VPH grating of higher order

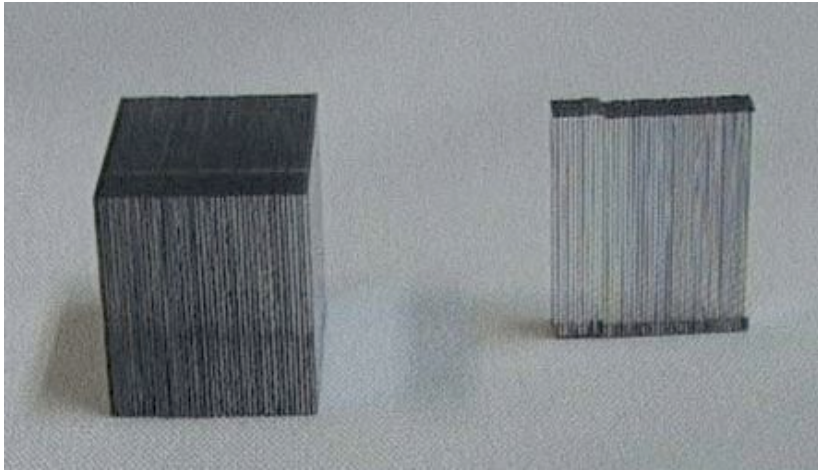


Diffraction efficiency of Quasi-Bragg

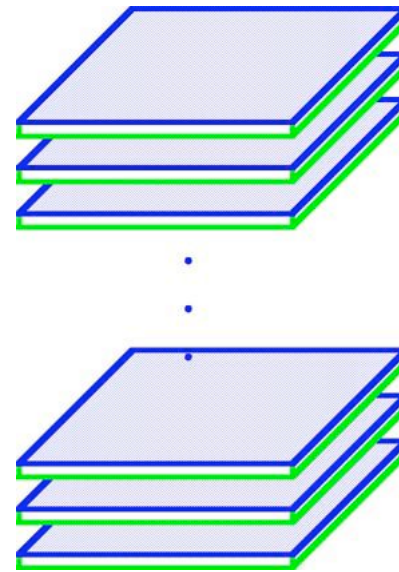
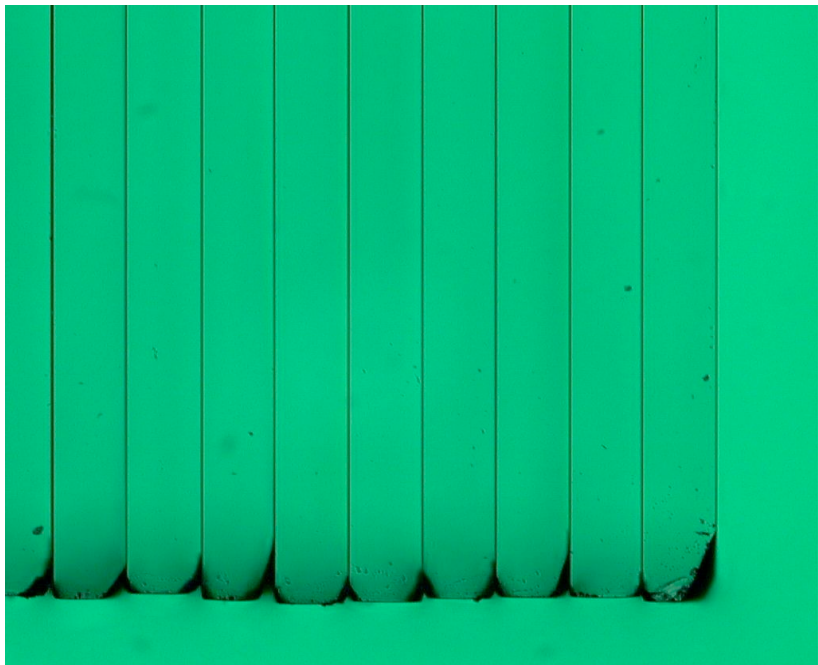


[K. Oka, N. Ebizuka et. al., SPIE 5290, 2004]

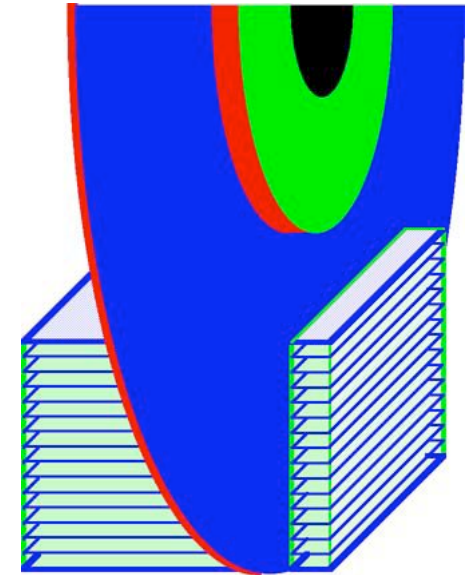
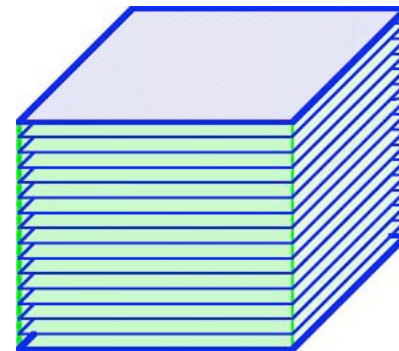
Trial Fabrication of Quasi-Bragg Grating



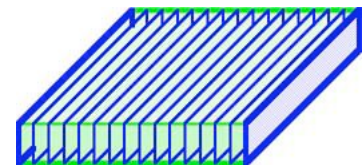
**A: 10 x 10 x 0.2 x 40 pcs (left),
B: 1.5 x 10 x 0.2 x 40 pcs (right)**



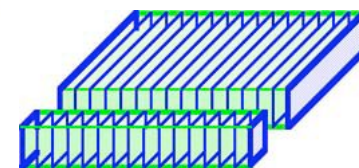
**Laminating
of Mirror
Plate**



Cutting

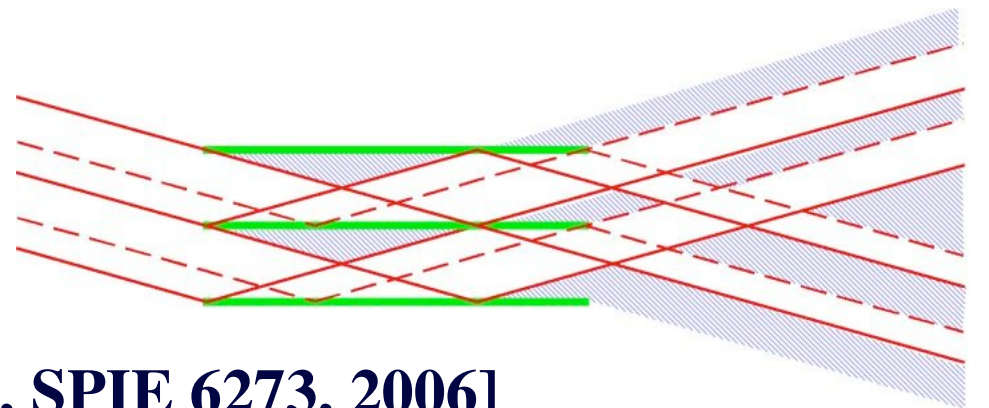
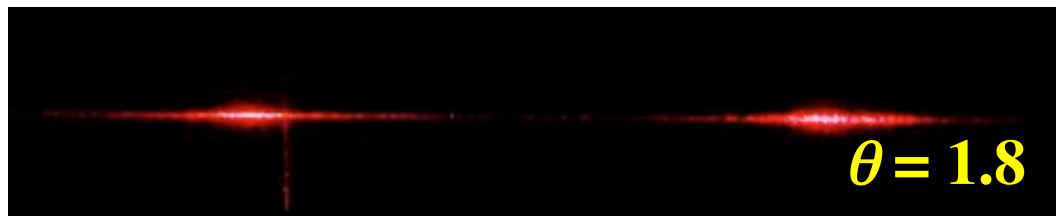
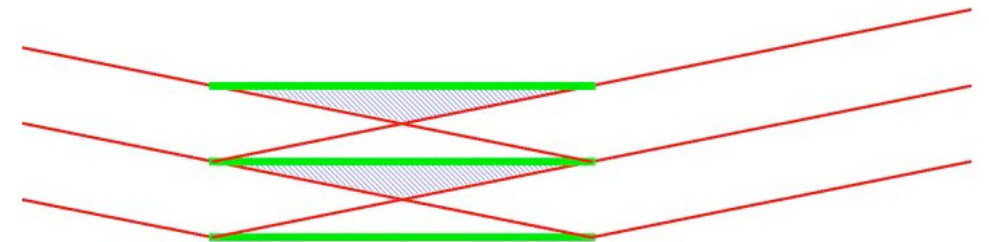
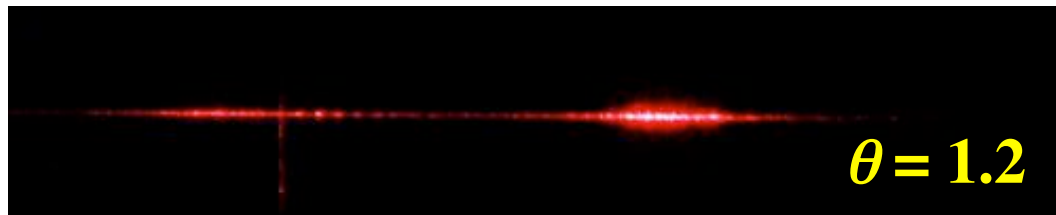
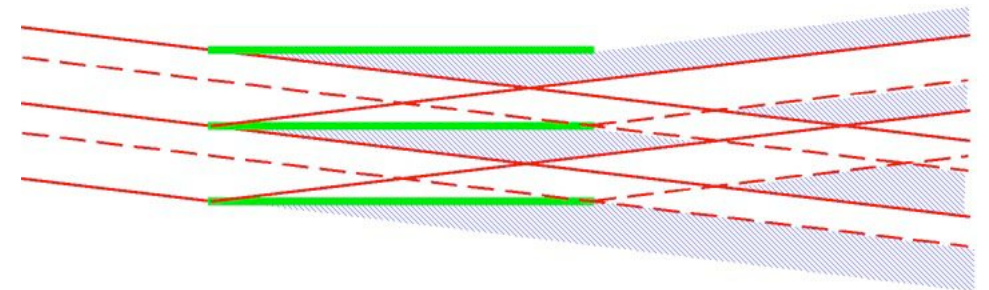
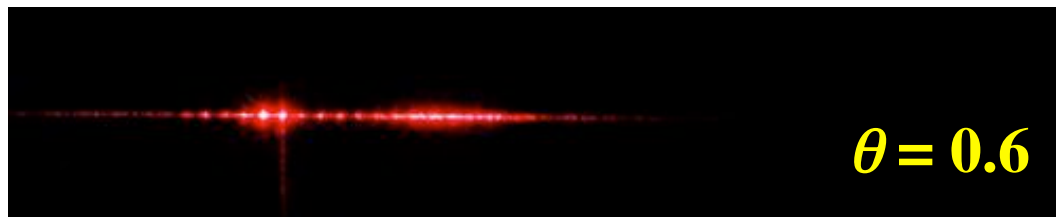
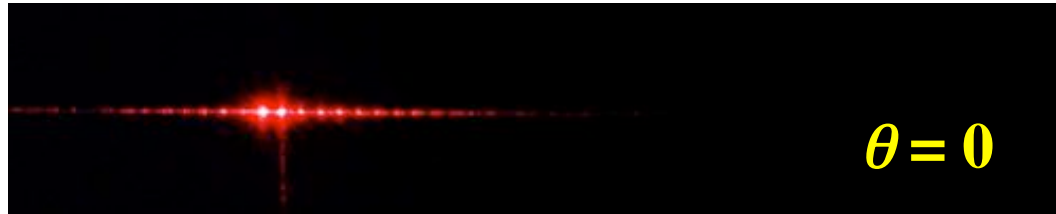


**Lapping and
Polishing**



**for Wave
Guide**

Diffraction of Quasi-Bragg Grating



[N. Ebizuka et. al., SPIE 6273, 2006]

Current and future works

- **z band VPH grism for MOIRCS** is under developing.
- **K band VPH grism for MOIRCS** and **z band VPH grism for FOCAS** are planed for development.
- Trial fabrications of **Quasi-Bragg grating**.

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