New Grisms for MOIRCS

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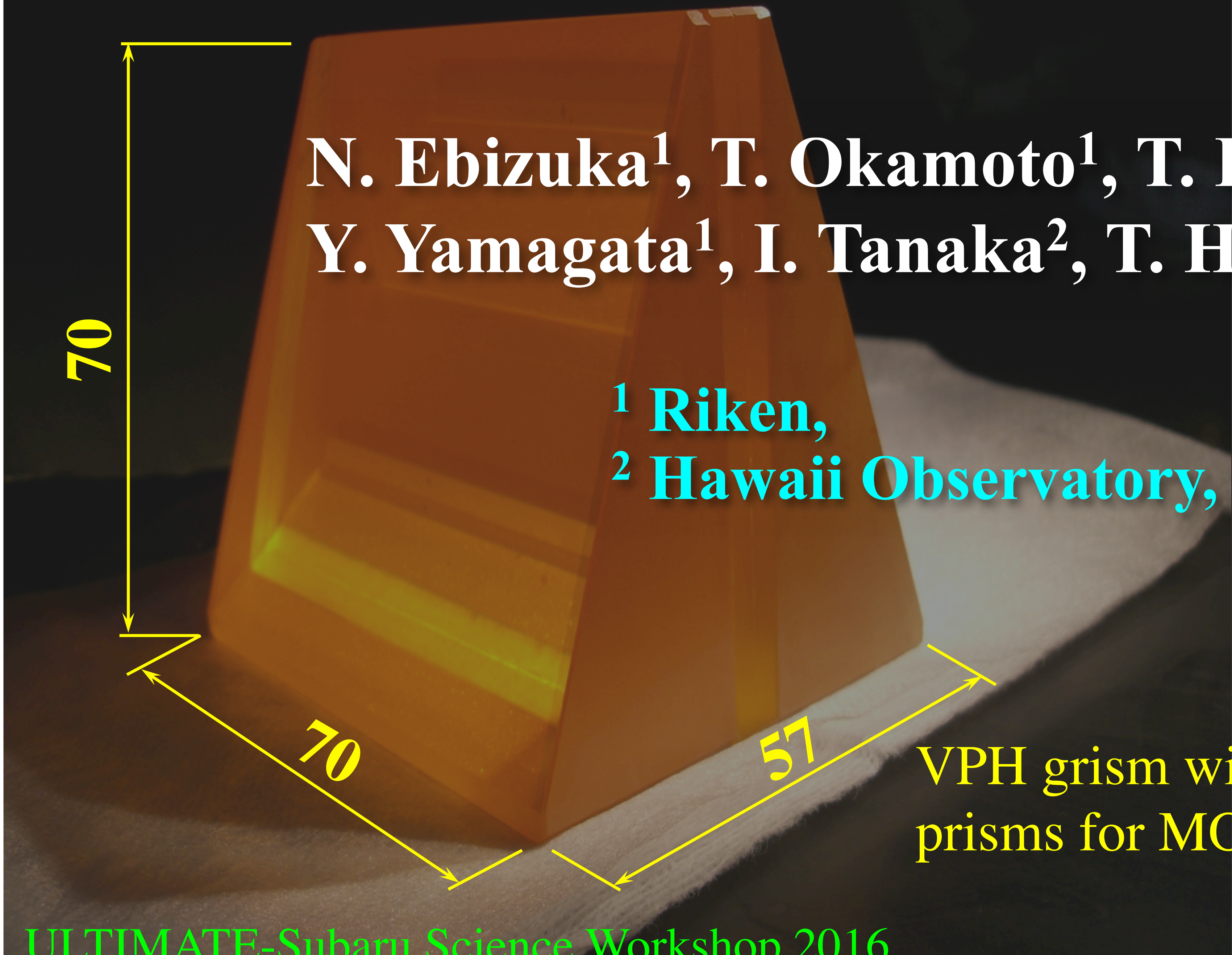
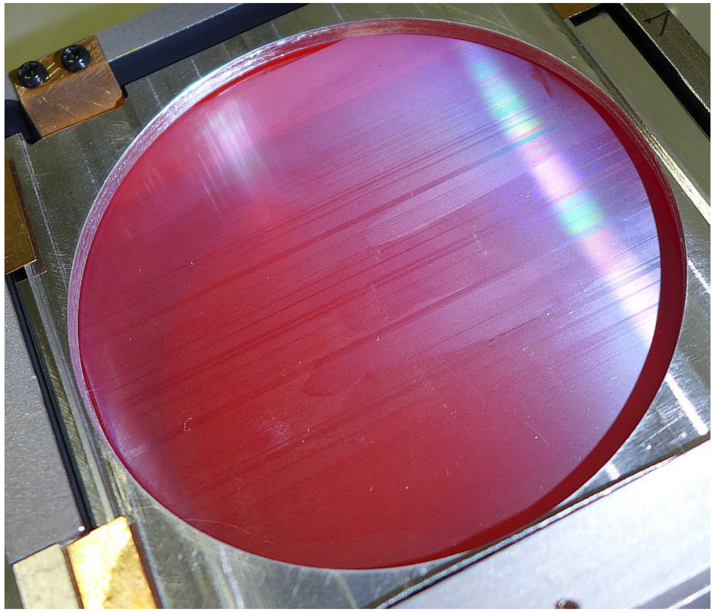
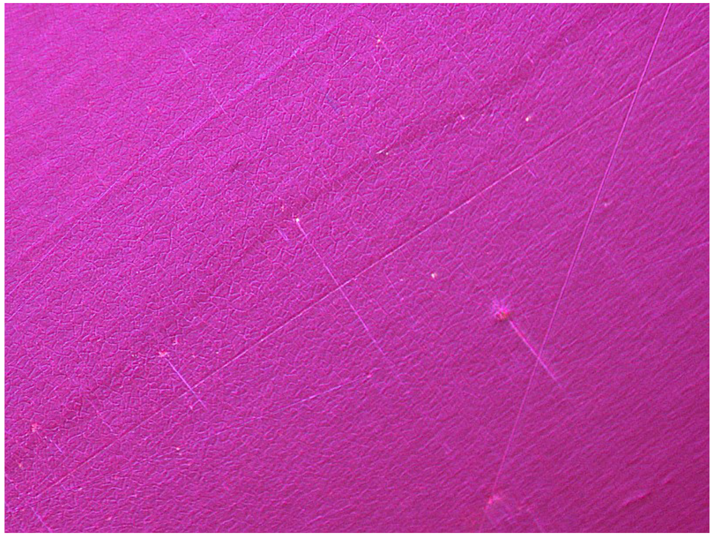


VPH grism with ZnSe prisms for MOIRS

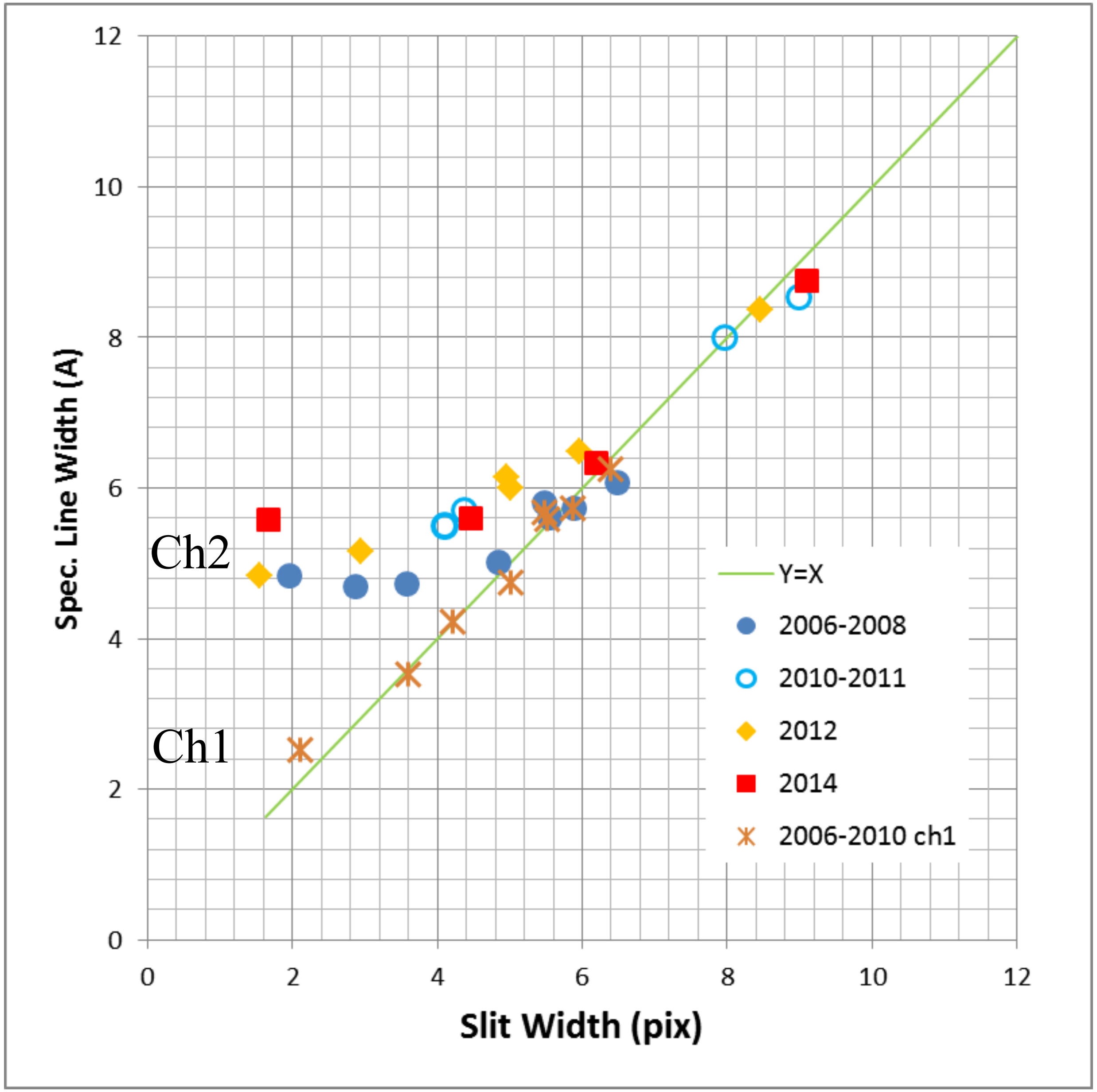
Deteriorations of R1300 (KRS-5) Grism



Ruling surface of Ch2



Back side of Ch2 (×200)

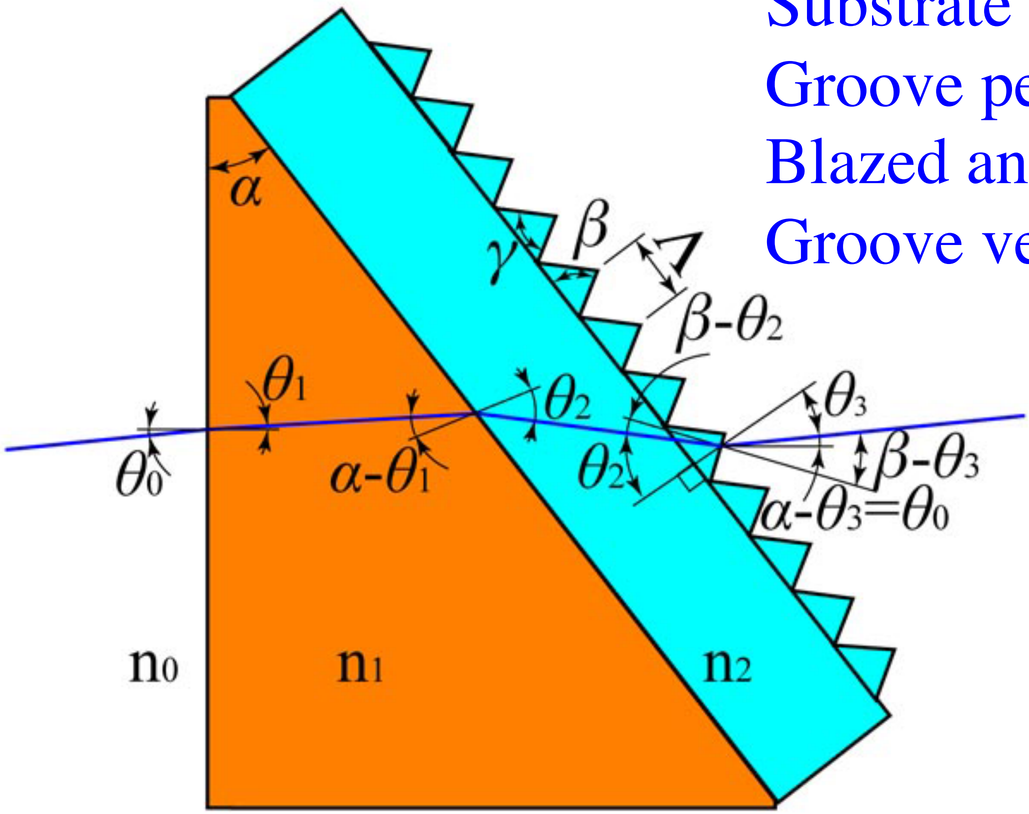


Expansion of line-spectrum width

Hybrid grism for MOIRCS

Refractive index of optical glass (n < 1.8) is not sufficinet for R1300 grism.

Size	: 70×70×54 [mm]
Prism material	: ZnSe (n_1= 2.4529@1.65 μm)
Prism vertex	: α = 23.8°
Incident angle	: θ_0= 5°
Substrate	: S-FPM3 (n_2= 1.5240@1.65 μm)
Groove period	: Λ= 10.79μm (92.68 grooves/mm)
Blazed angle	: β = 64.8°
Groove vertex	: γ = 61.8°



Slit width: 0.585”→ 0.3”

R= 1,487→2,900@0.88 μm (z band)

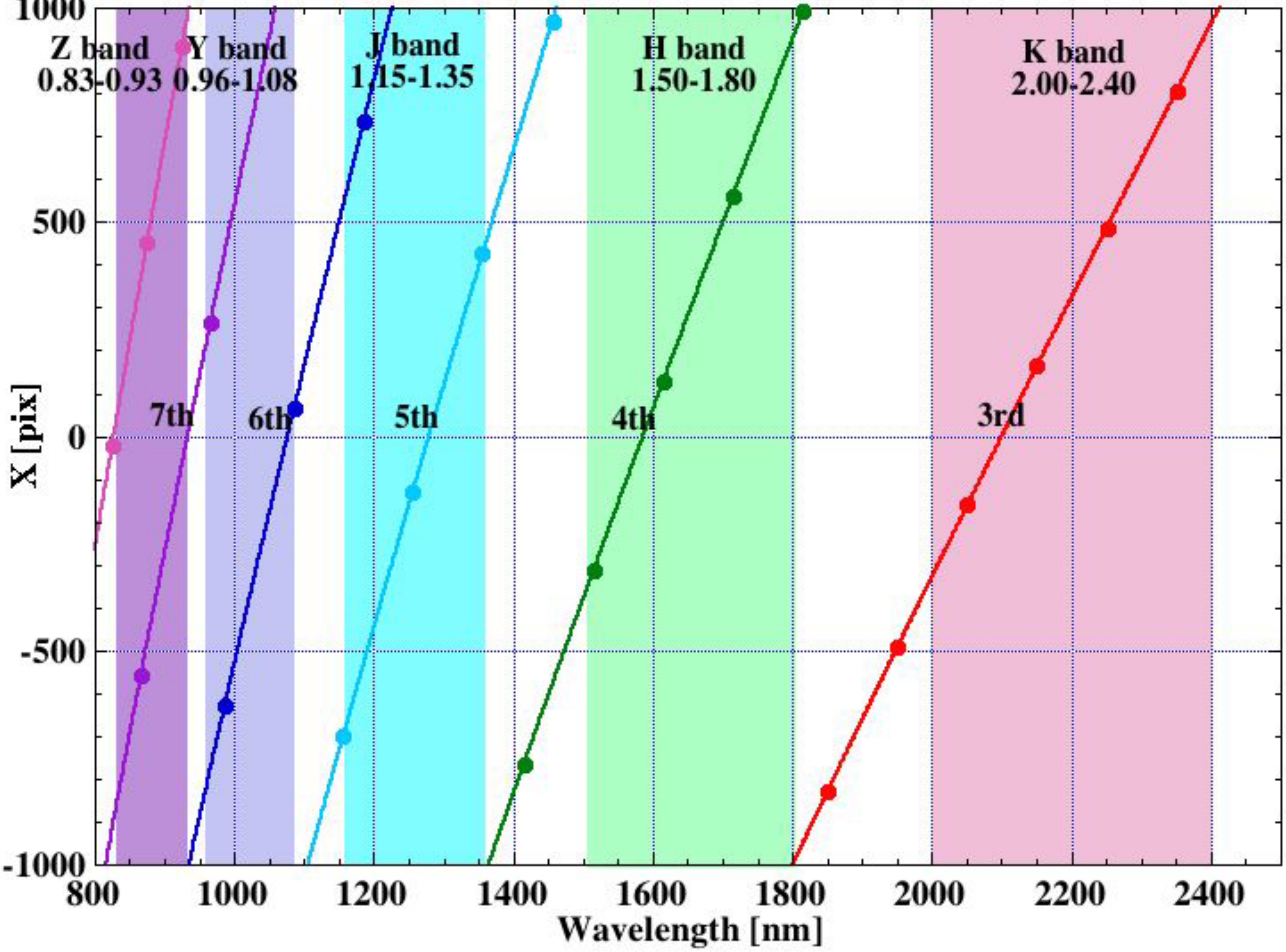
R= 1,431→2,790@1.02 μm (Y band)

R= 1,408→2,750@1.25 μm (J band)

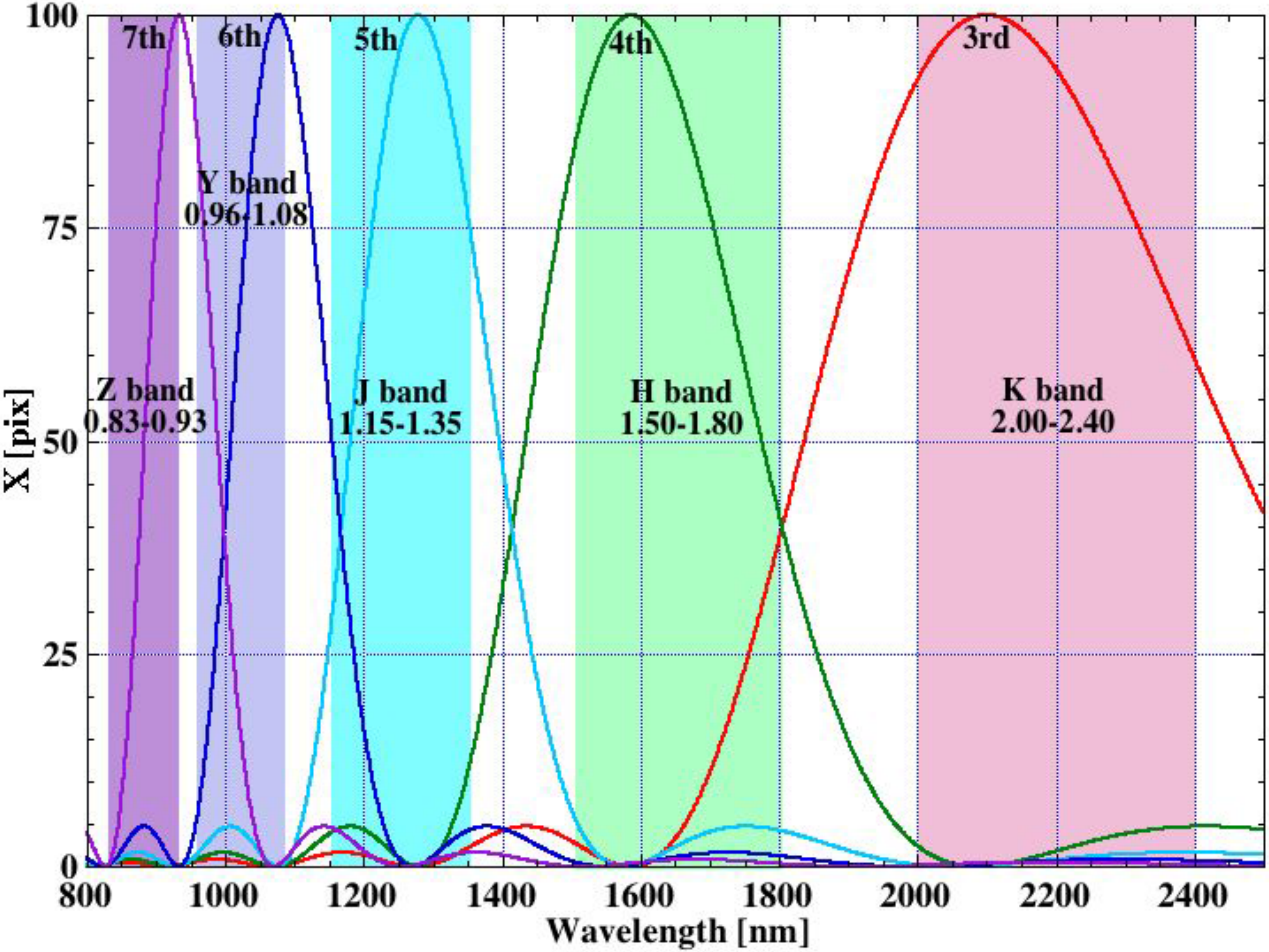
R= 1,434→2,800@1.65 μm (H band)

R= 1,419→2,770@2.20 μm (K band)

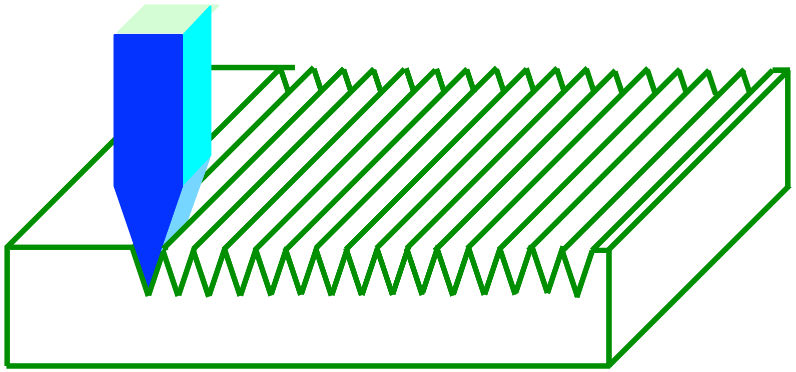
Observation Wavelength Range of Hybrid Grism



Diffraction Efficiency of Hybrid Grating (Scholar Calculation)

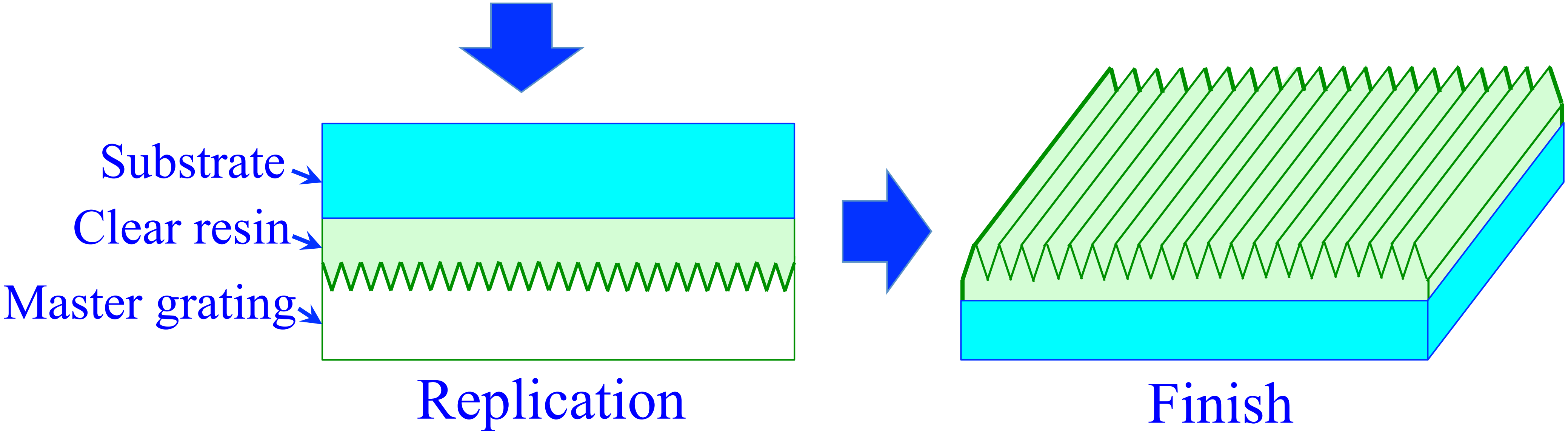


Fabrication Method of Master Grating for Hybrid Grism

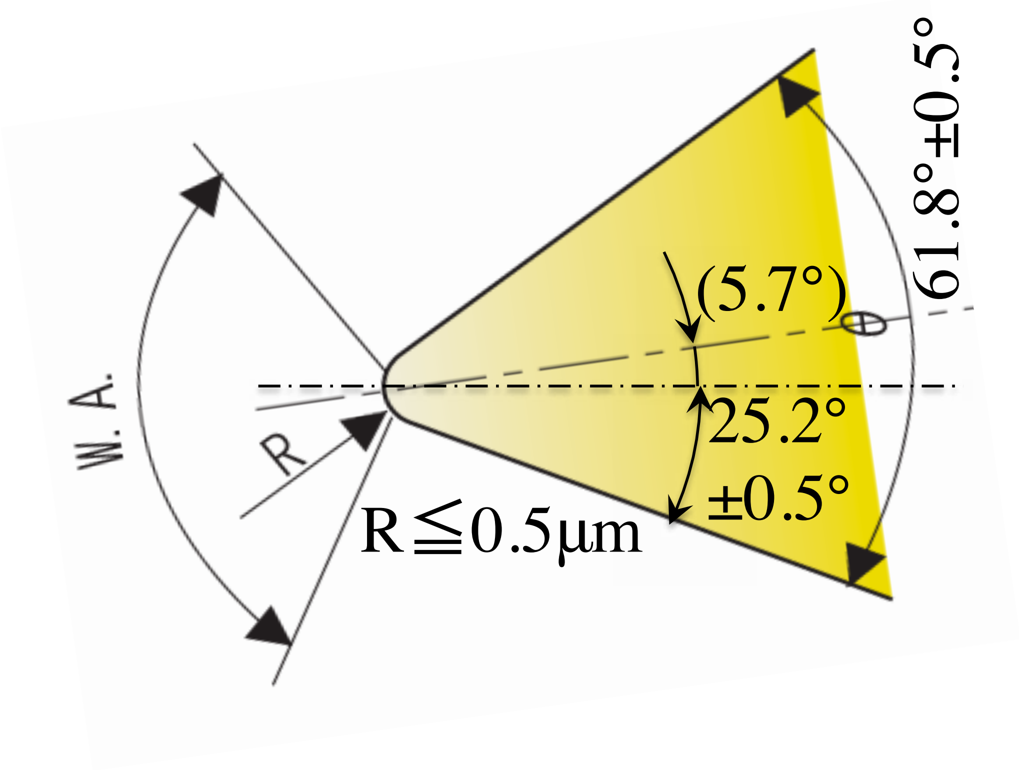


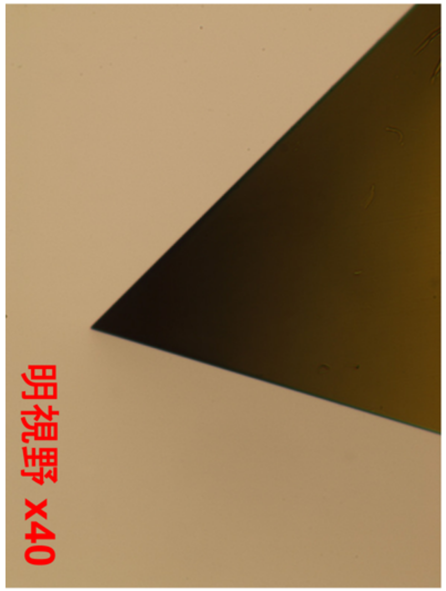
Shaper cutting of master grating

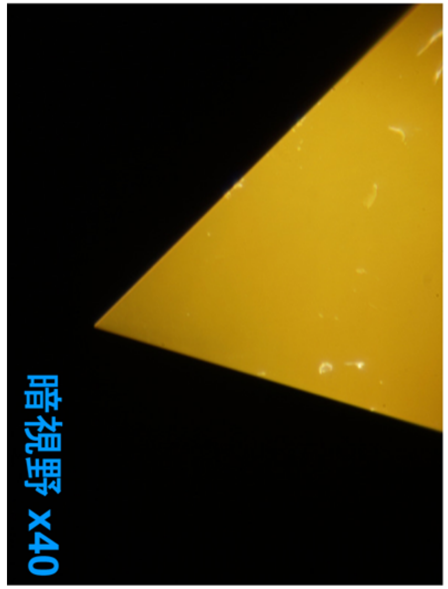
Work piece : Ni-P alloy
Blazed angle : $\beta = 64.8°$
Grooves vertex : $\gamma = 61.8°$
Grating period : $\Lambda = 10.79 \mu m$

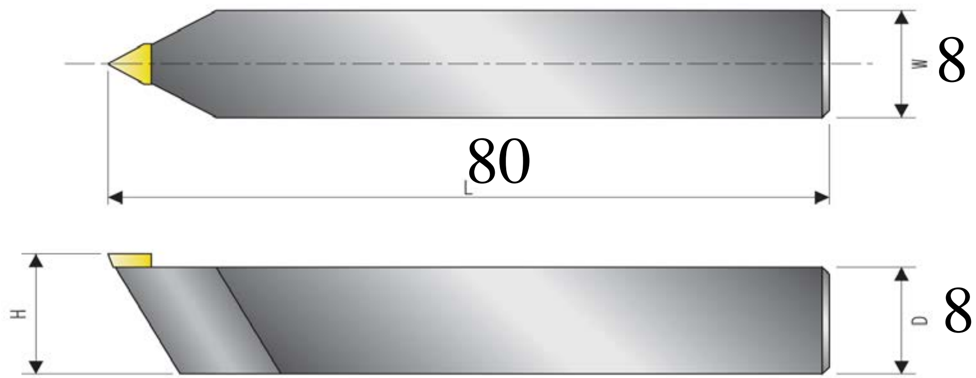


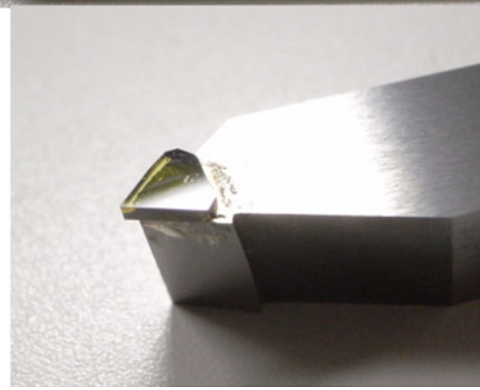
Diamond Bit for Master Grating Cutting



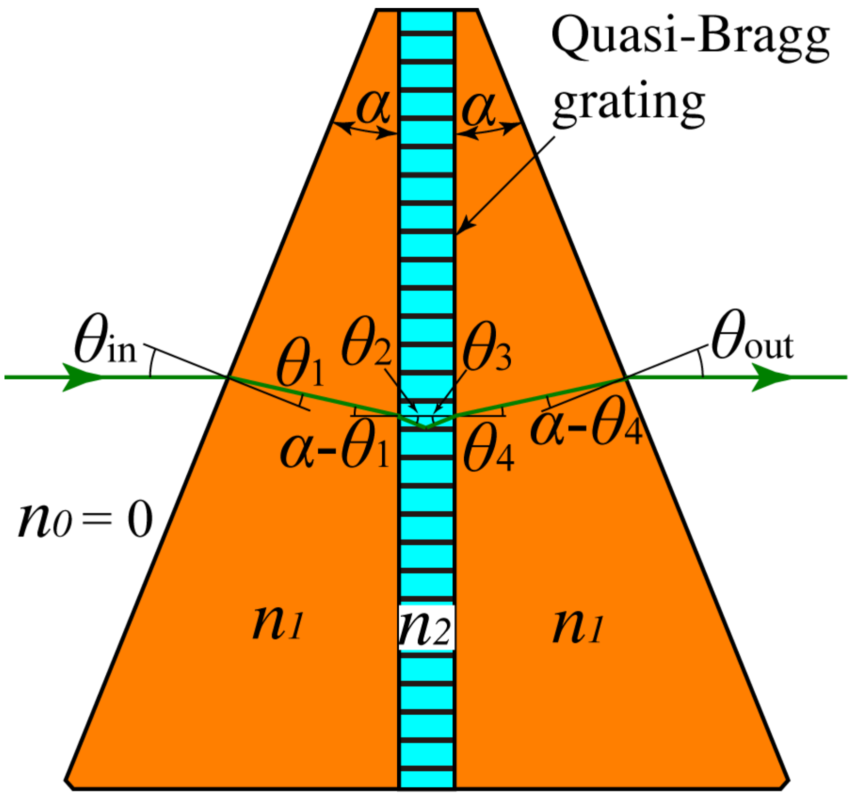


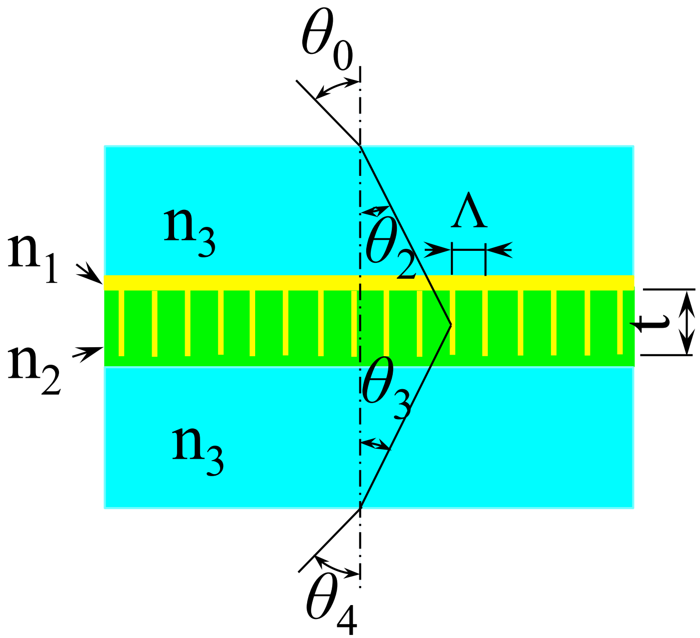






High-dispersion Ecelle Grism for MOIRCS





Volume binary grating

$L \gg S$, $90-\sin^{-1}(n_2 \sin\theta_2) > \sin^{-1}(n_1/n_2)$,

functions as a quasi-Bragg grating

Size : 70×70×54 [mm]

Prism material : ZnSe

Prism vertex : α= 18.5°

Grating period : Λ= 5.1μm (196g/mm)

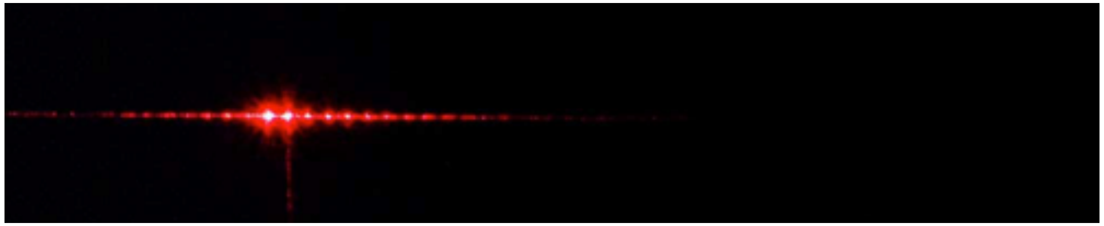
Slit width: 0.3”

R= 4,630@1.02 μm (Y band, 5次)

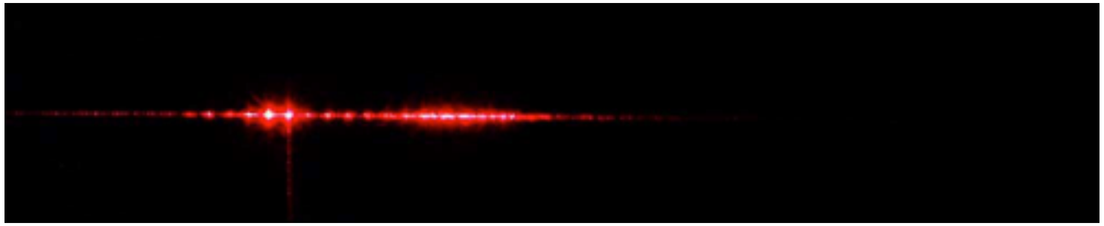
R= 4,420@1.25 μm (J band, 4次)

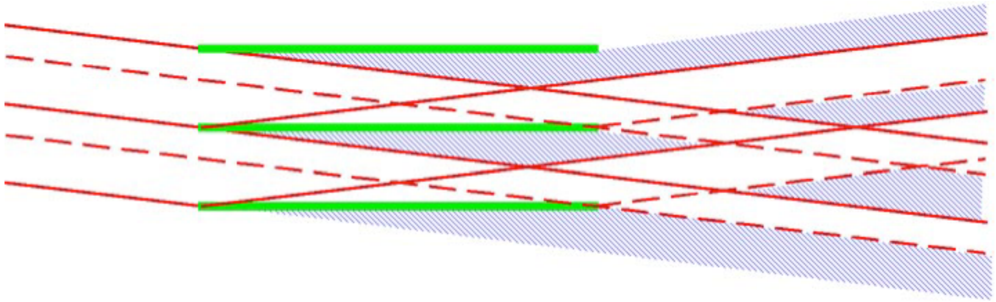
R= 4,270@1.65 μm (H band, 5次)

Beam Propagation in Quasi-Bragg Grating

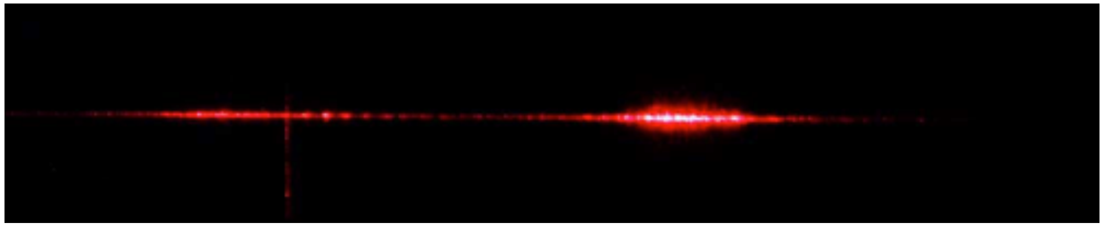


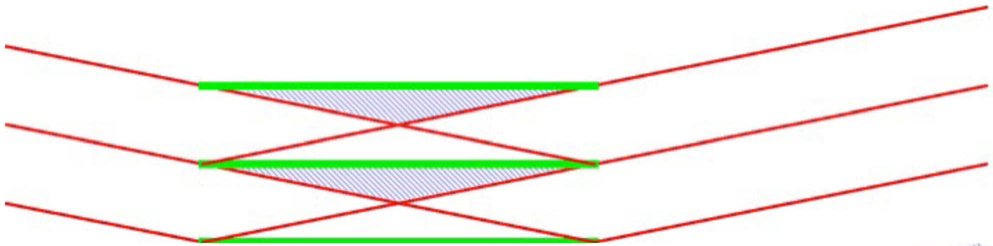
Normal incidence



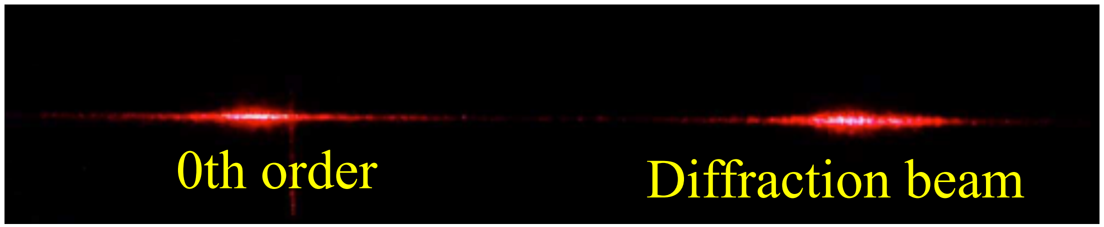


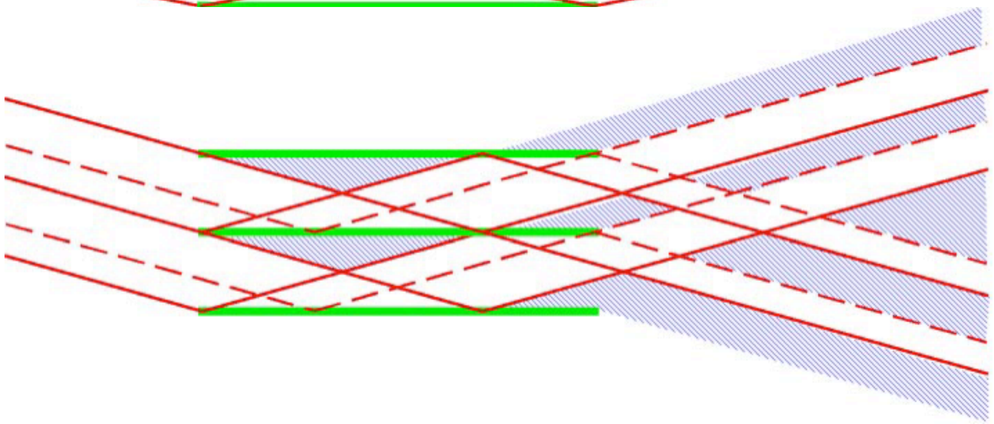
Small incident angle





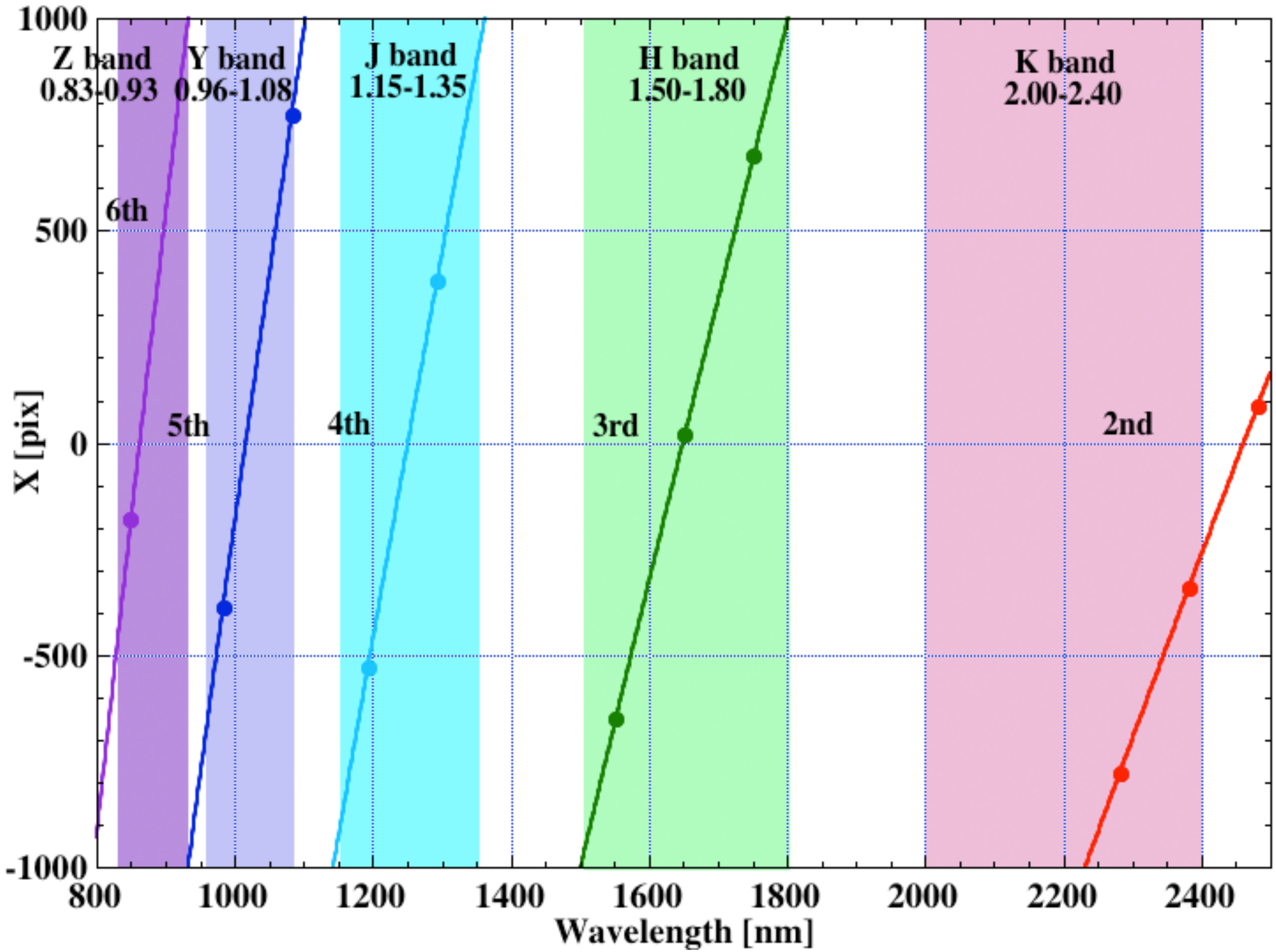
Ideal incident angle



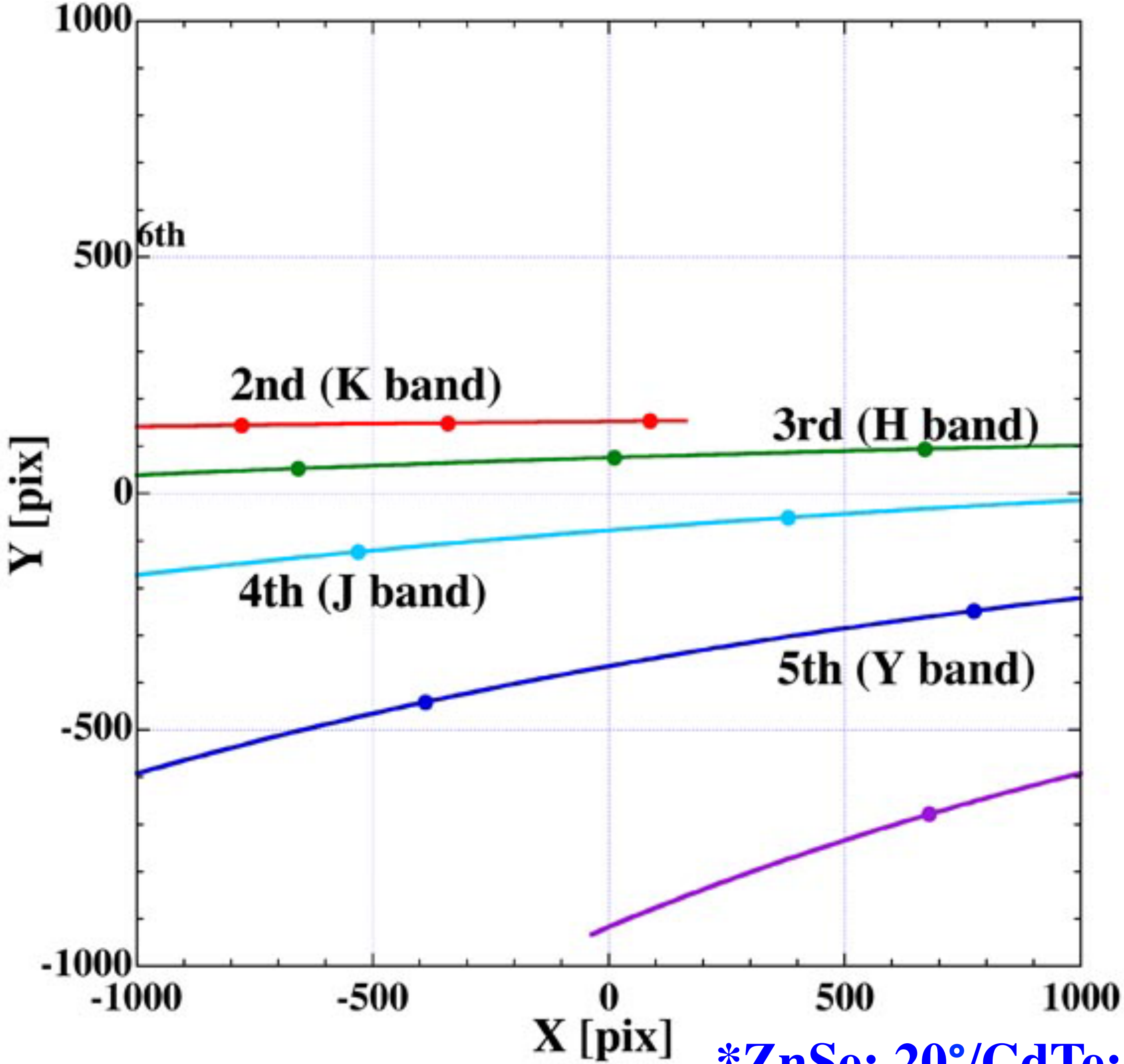


Large incident angle

Observation Wavelength Range of High Dispersion Grism

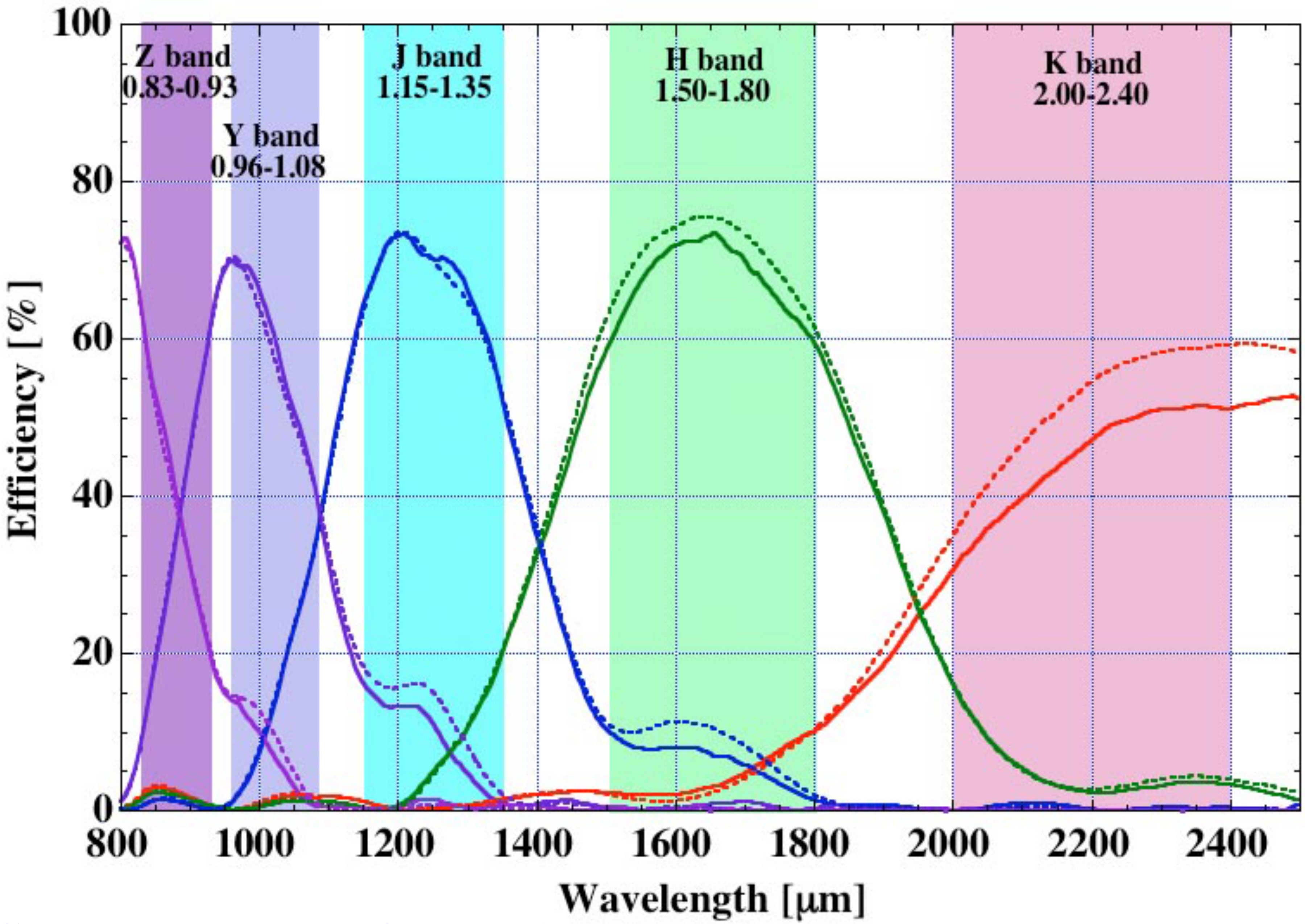


Echellegram with High Dispersion Grism and Direct Vision Prism*



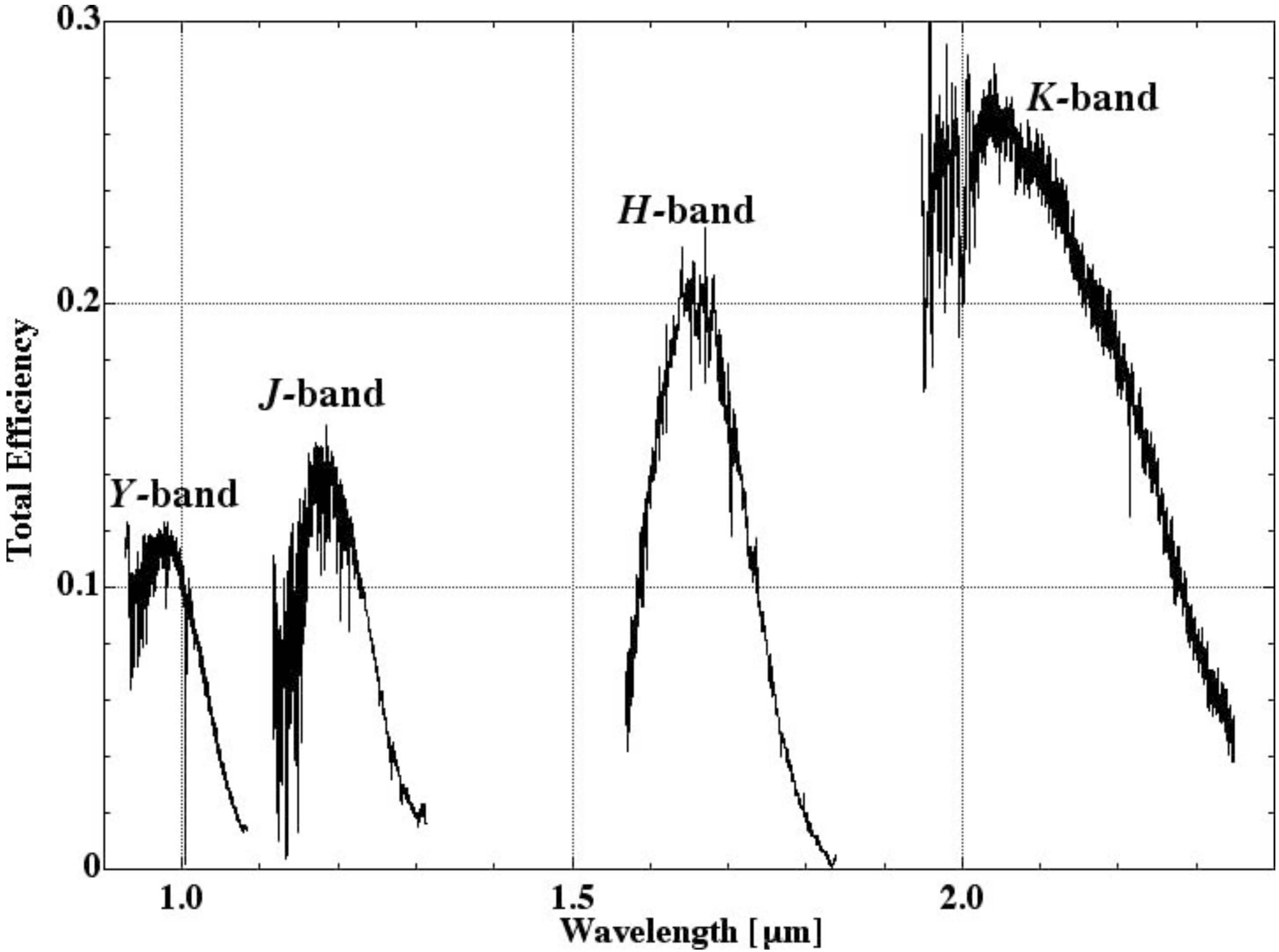
*ZnSe: 20°/CdTe: 16.6°×2 pieces

Diffraction Efficiency of High Dispersion Grism (RCWA)

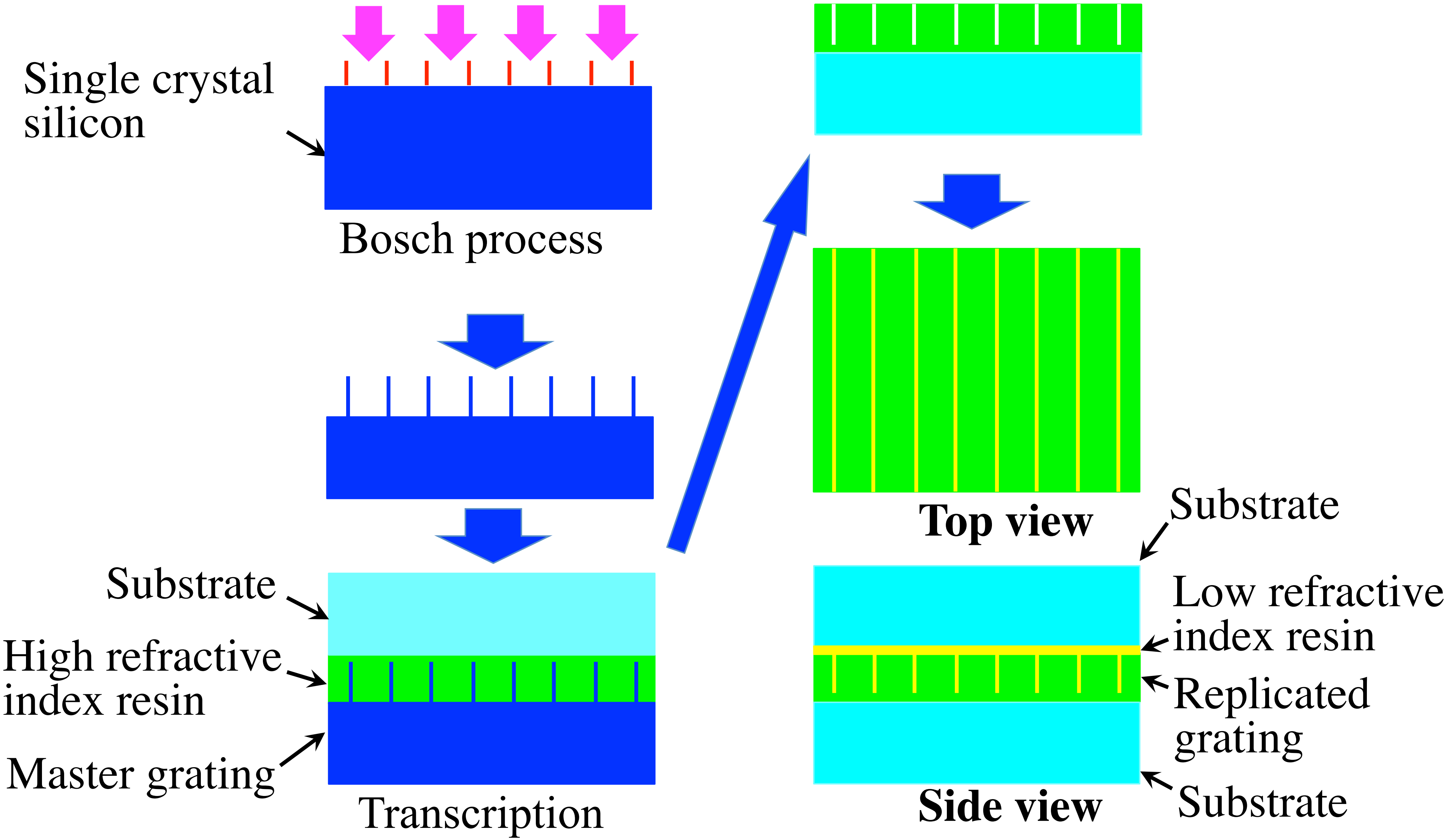


L&S=4.6:0.5 [μm], θ_0=28.4°, n_1=1.33, n_2=1.6, n_3=1.6, t = 16 μm

Total Efficiency of VPH Grisms



Fabrication Method of Volume Binary Grating



Summary

New R1300 (Hybrid) Grism

- The hybrid grism which is composed by a replicated grating with acute vertex angle and high refractive index prisms is under developing.
- R~2800 (0.3"slit)@830~2500nm.

High Dispersion Echelle Grism

- We evaluated the spectral diffraction efficiency and fabrication methods for the volume binary grating of which functions as a quasi-Bragg grating.
- Cross disperser: ZnSe: 20°/CdTe: 16.6° × 2 pieces.
- R=4,300~4,600 (0.3"slit)@960~1,800nm.

ハイブリッド･グリズム

n_1のプリズム界面における屈折の式はそれぞれ、

$$\sin\theta_0 = n_1 \sin\theta_1 \qquad \cdots(1)$$

$$n_1 \sin(\alpha - \theta_1) = n_2 \sin\theta_2 \qquad \cdots(2)$$

である。また、格子による屈折の式は、

$$n_2 \sin(\beta - \theta_2) = \sin(\beta - \theta_3)$$

$$n_2 (\sin\beta\cos\theta_2 - \cos\beta\sin\theta_2)$$

$$= \sin\beta\cos\theta_3 - \cos\beta\sin\theta_3$$

$$\tan\beta = \frac{n_2 \sin\theta_2 - \sin\theta_3}{n_2 \cos\theta_2 - \cos\theta_3} \qquad \cdots(3)$$

である。一方、回折の式は、

$$m\lambda = \Lambda (n_2 \sin\theta_2 - \sin\theta_3)$$

$$\sin\theta_3 = n_2 \sin\theta_2 - \frac{m\lambda}{\Lambda} \qquad \cdots(4)$$

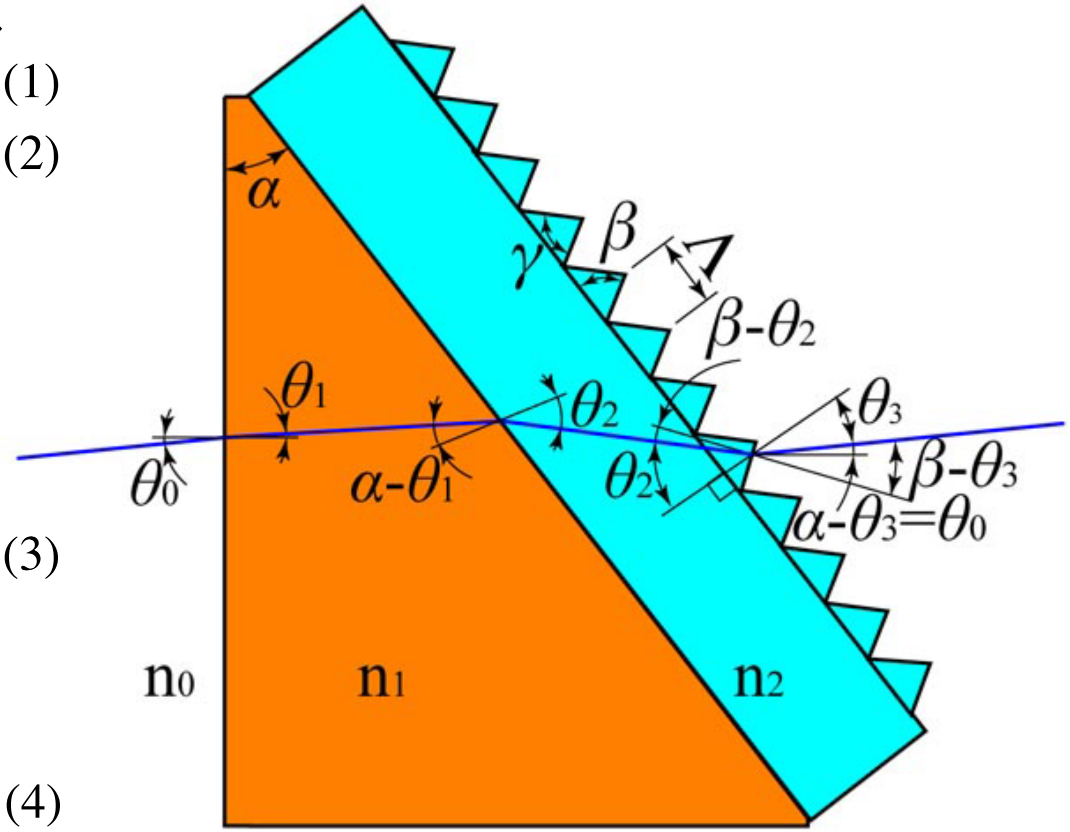
である。直進（ブレーズ）波長をλ_0、$\theta_3 = \alpha - \theta_0$として3式に4式を代入すると、

$$\tan\beta = \frac{m\lambda_0}{\Lambda\{n_2 \cos\theta_2 - \cos(\alpha - \theta_0)\}} \qquad \cdots(5)$$

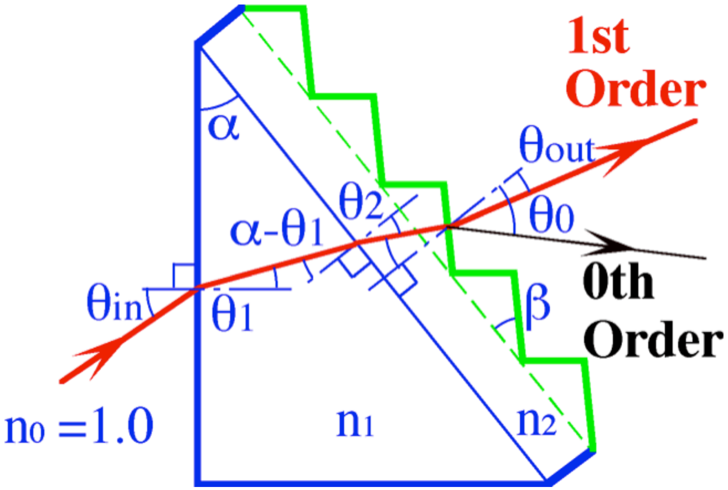
が得られる。なお、格子の頂角γは、

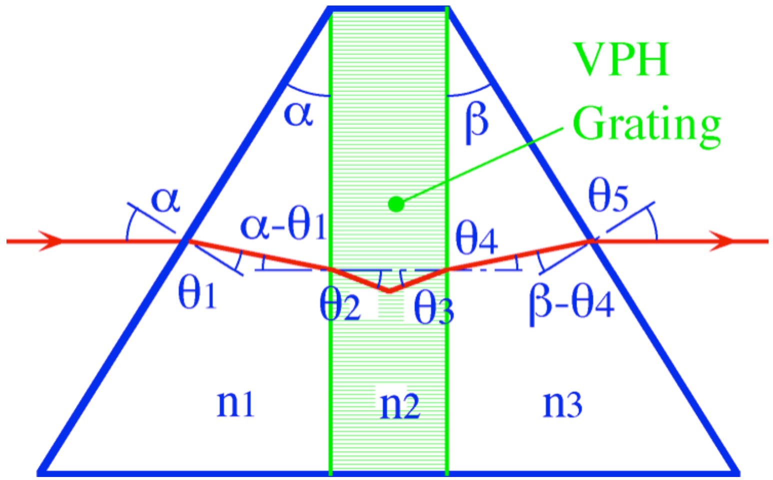
$$\gamma = 90 - \beta + \theta_2 \qquad \cdots(6)$$

である。



高分散グリズム





左図にて屈折率が 2.6と1.5の界面における臨界角は35.2°(θ_{in} = 0, $\alpha < 35.2$)。

中央の図においてプリズムとVPH gratingの屈折率がそれぞれ2.6と1.5 の場合、$\alpha > 63.6$。