

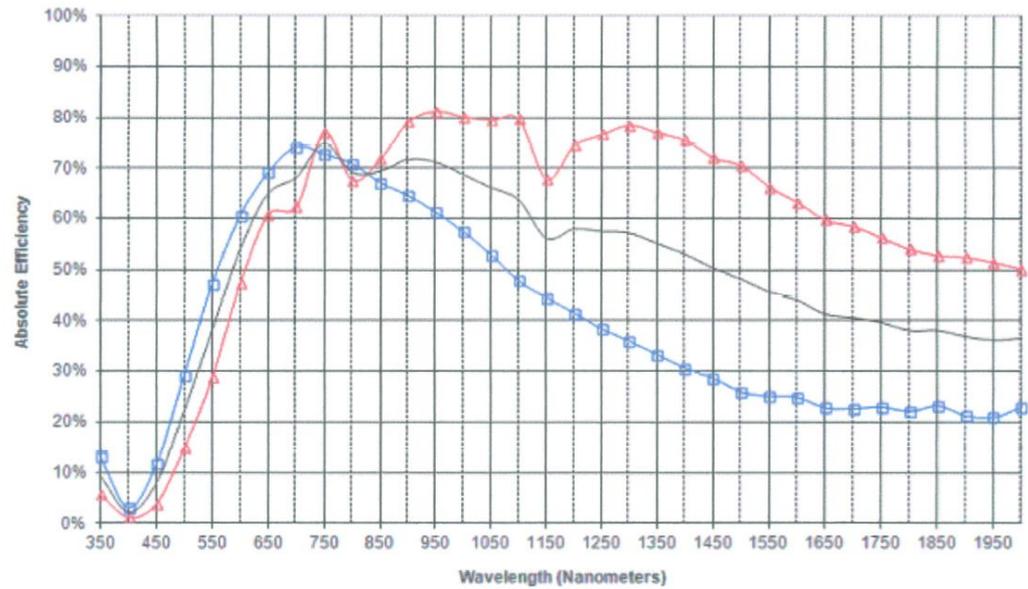
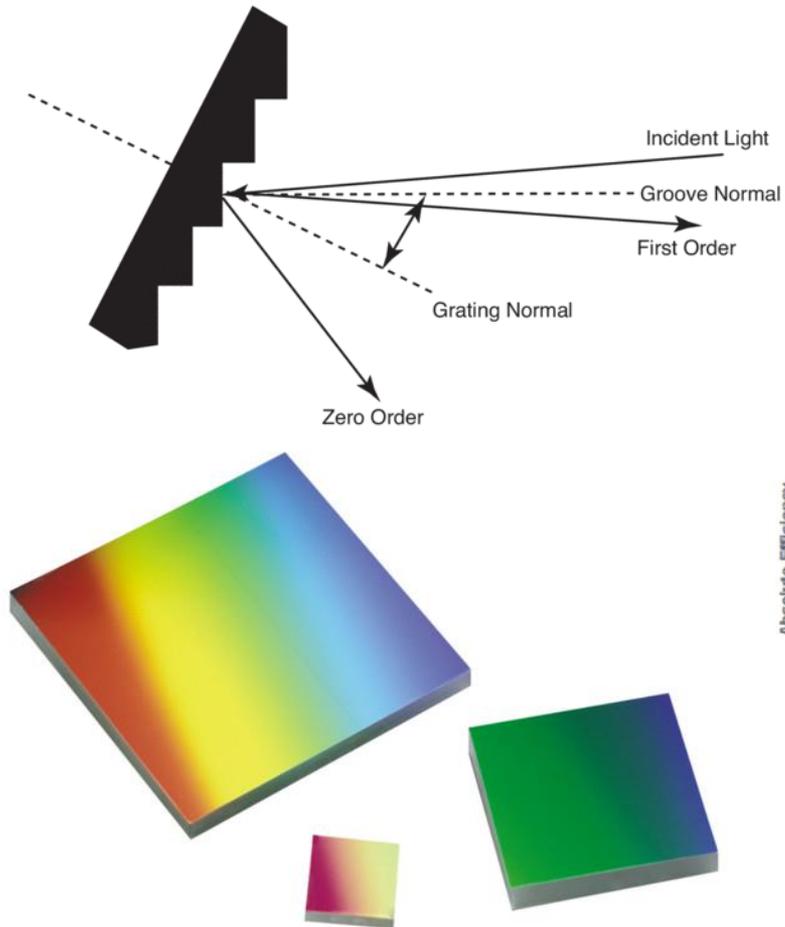
天体計測学特論 I

Observational Astronomy I

Lecture 08:
Designing systems
for spectroscopic observations

Dispersing element (1)

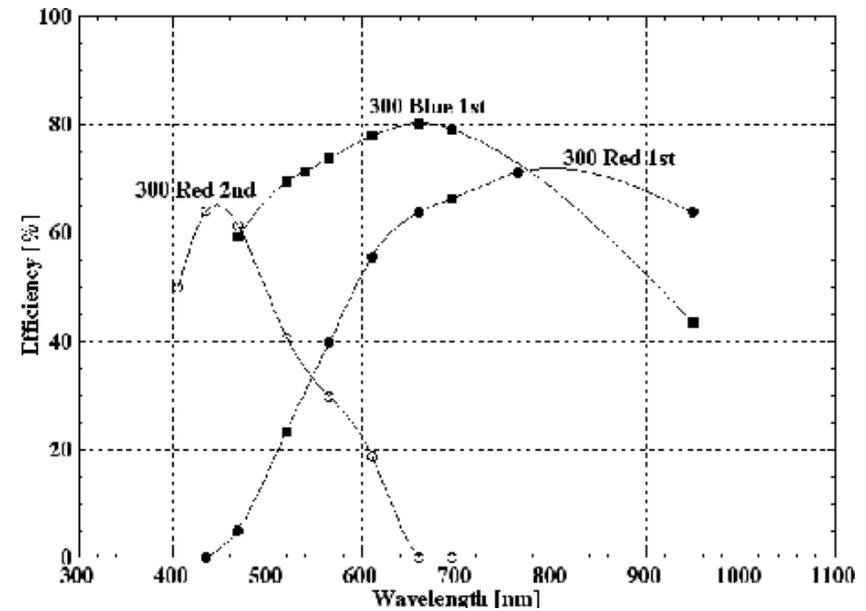
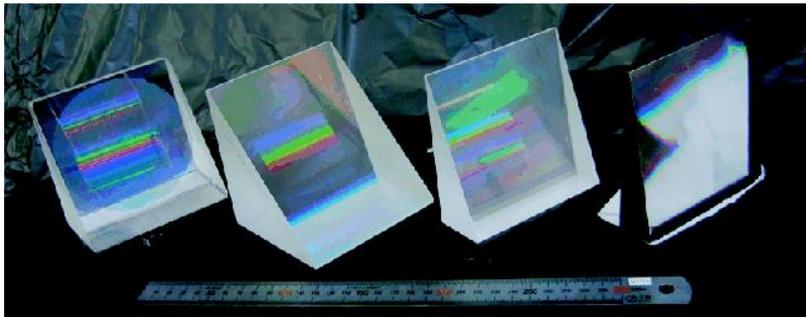
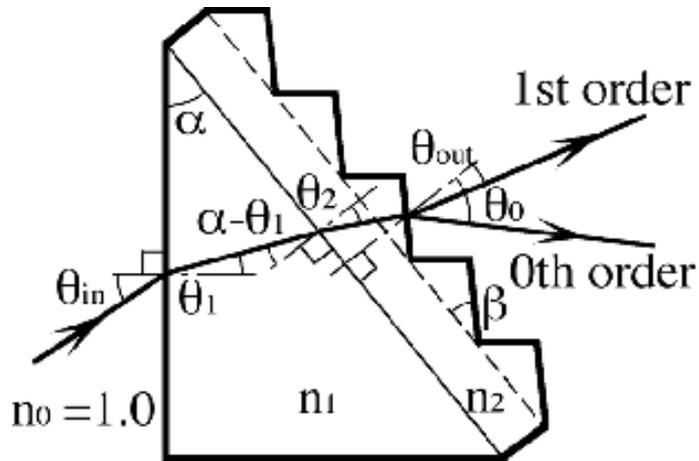
- Reflection grating



From Newport

Dispersing element (2)

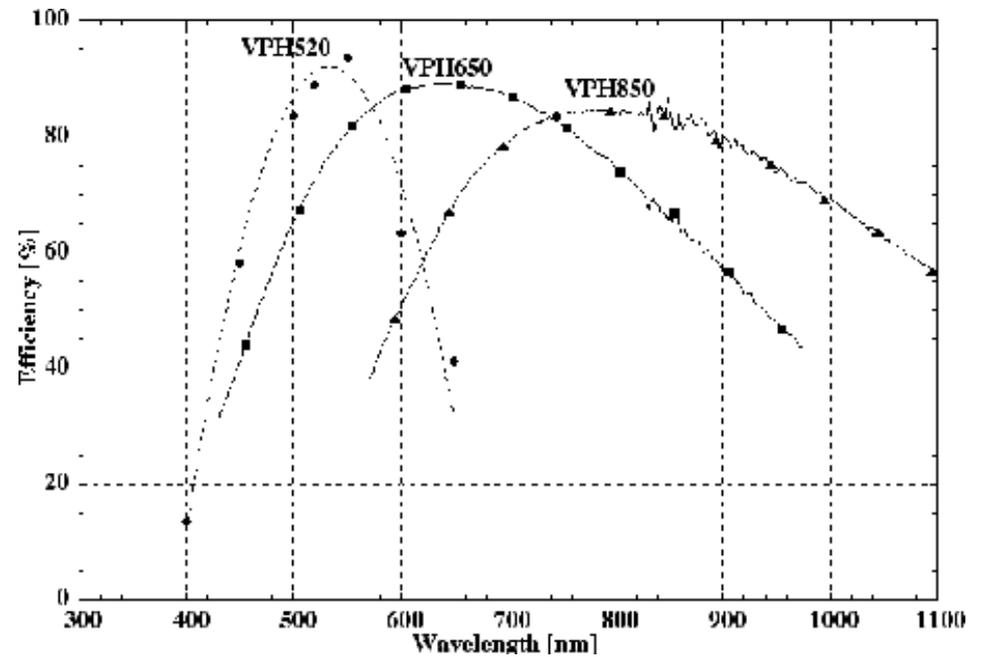
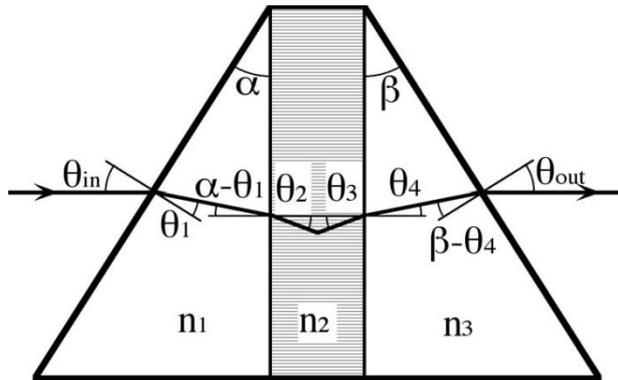
- Grism (for FOCAS)



Ebizuka et al. 2011

Dispersing element (3)

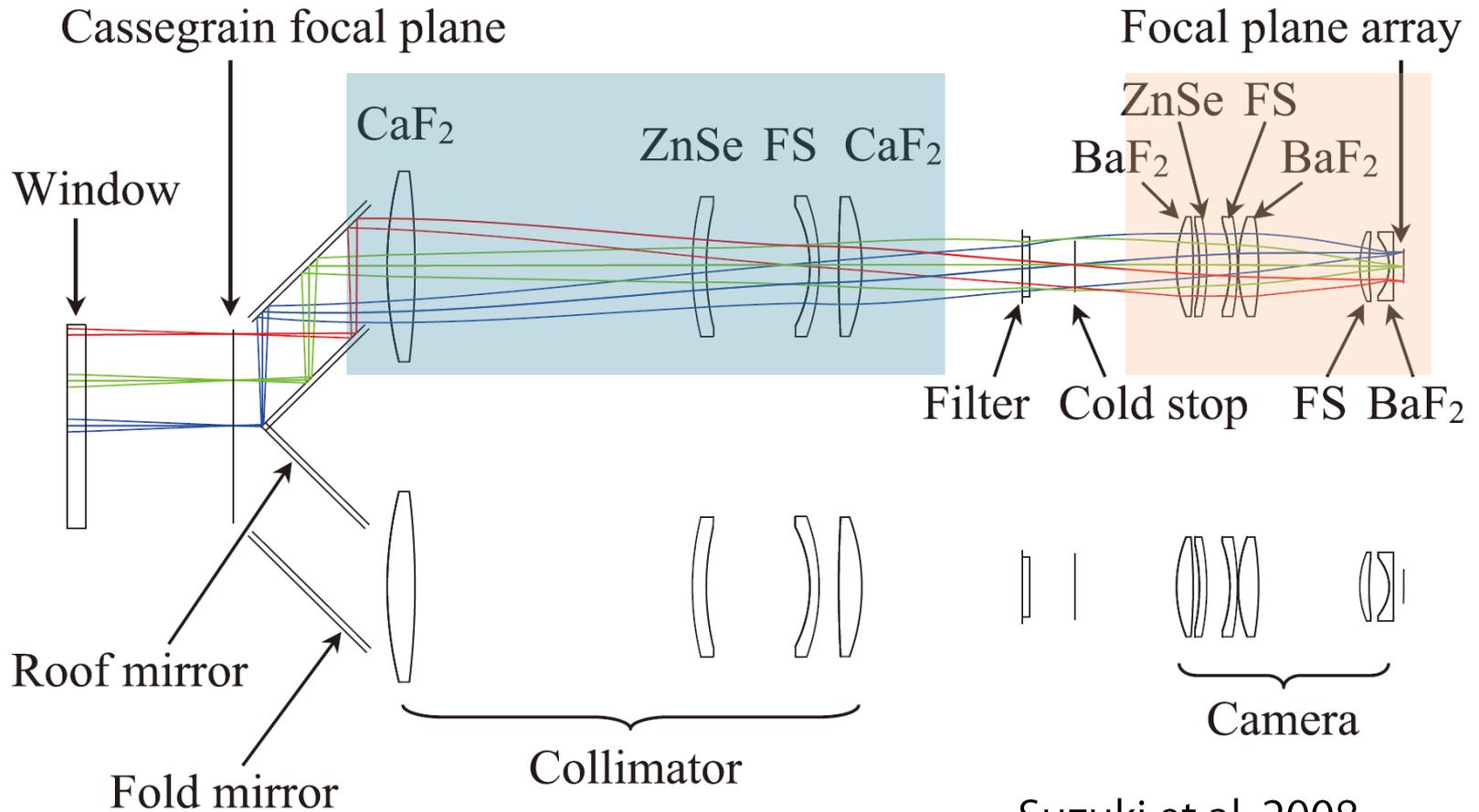
- VPH grating (for FOCAS) : High-throughput



Ebizuka et al. 2011

Optical system for a spectrograph MOIRCS

- Grism (Grating, Prism) as a dispersion element.



Suzuki et al. 2008

Optical system for a spectrograph

- Reflectin grating as a dispersion element.

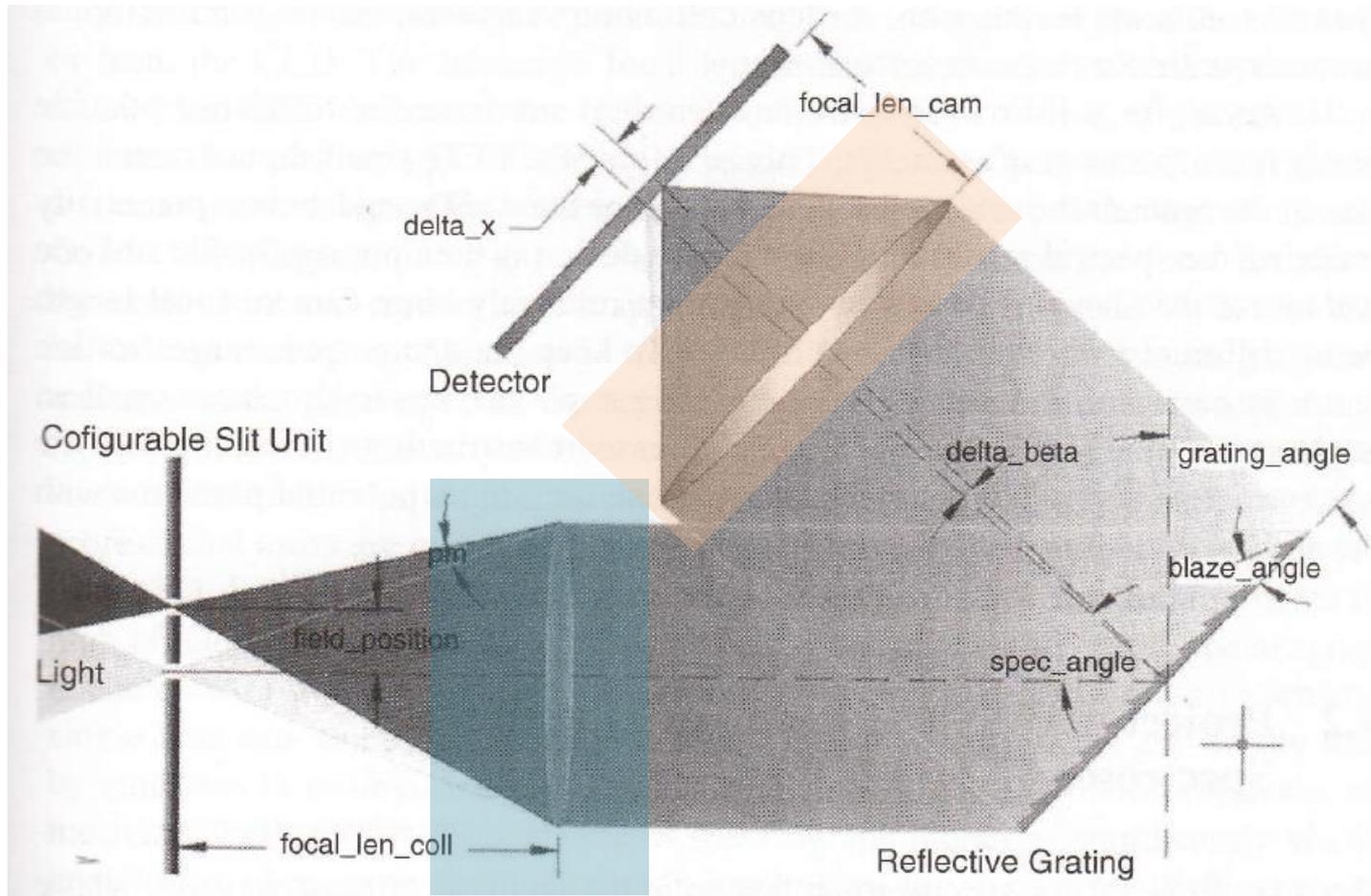
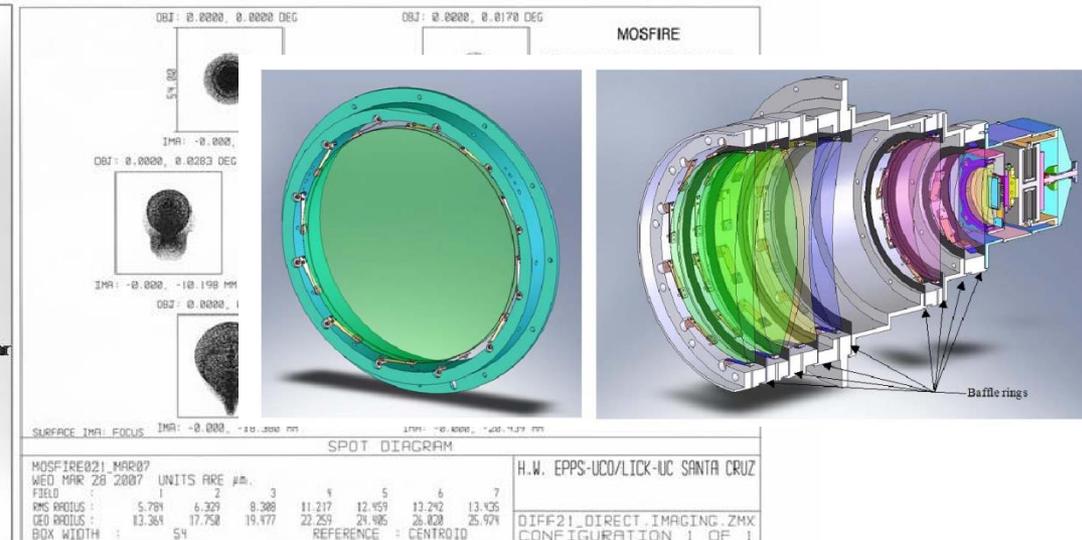
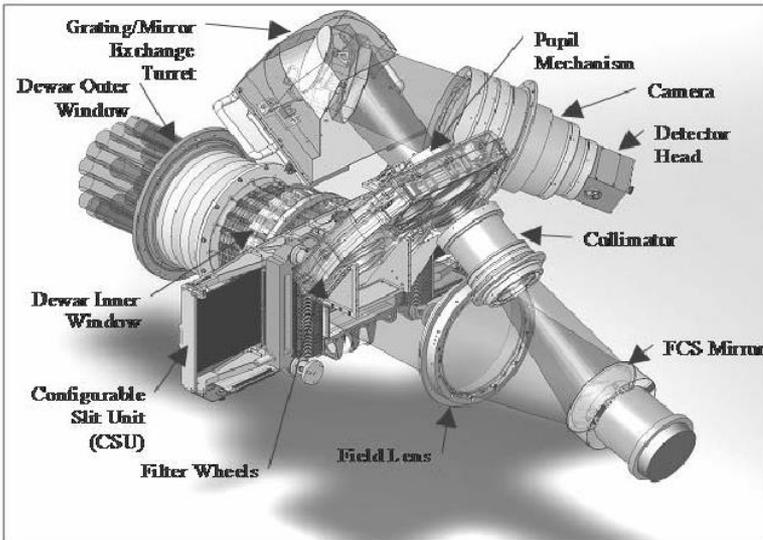
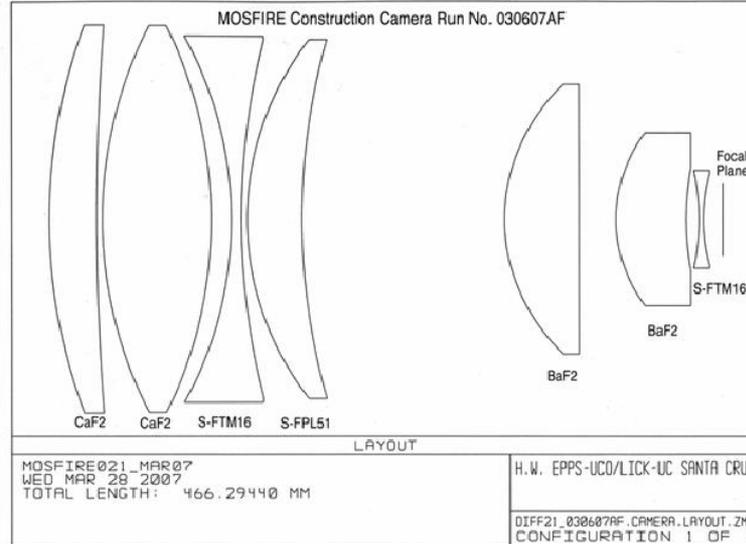
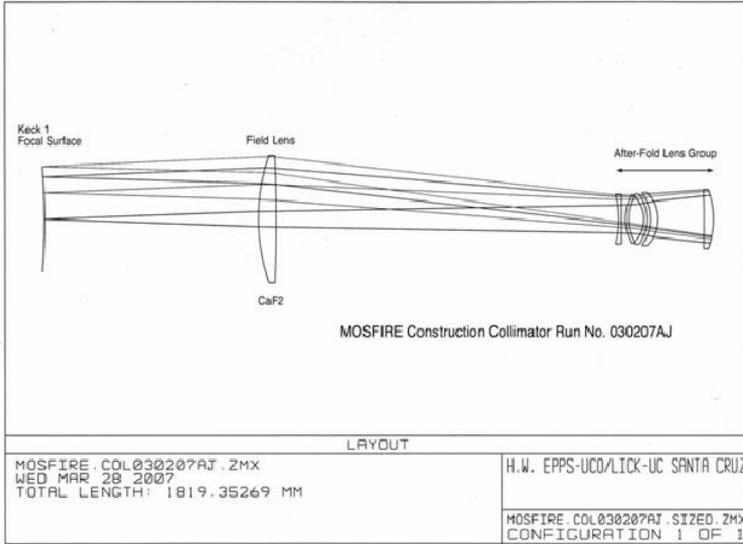


Fig. 4.12 Angles in a classical spectrograph

Optical system for a spectrograph MOSFIRE

- Reflectin grating as a dispersion element.



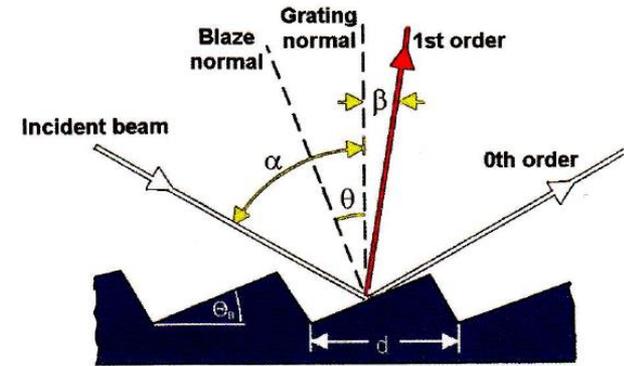
Spectral resolution and sampling

- Spectral resolution, R :

- Grating equation and dispersion (n: order)

$$n \cdot \lambda = d(\sin \alpha + \sin \beta)$$

$$\frac{d\beta}{d\lambda} = \frac{n}{\cos \beta \cdot d}$$



Eversberg 2015

- Spectrograph diffraction-limited condition (size $B = d \times N$)

- Note: diffraction of the spectrograph optics : not telescope. (This is usually not the case.)

$$\Delta\beta = \frac{\lambda}{B} \quad R = \frac{\lambda}{\Delta\lambda} = \frac{N \cdot n}{\cos \beta}$$

- Image-size (“Seeing”/“Telescope-diffraction”)-limited condition

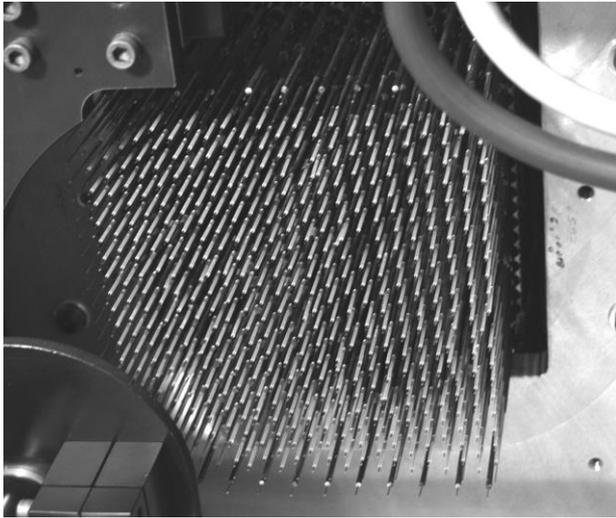
- image size d_{image} on the spectrograph detector,
- spectrograph camera focal length f_{camera}

$$\Delta\beta = \frac{d_{\text{image}}}{f_{\text{camera}}} \quad R = \frac{\lambda}{\Delta\lambda} = \frac{f_{\text{camera}}}{d_{\text{image}}} \cdot \frac{\lambda n}{d} \cdot \frac{1}{\cos \beta}$$

- Sampling (nm/pix, A/pix)

Multi-object spectrograph

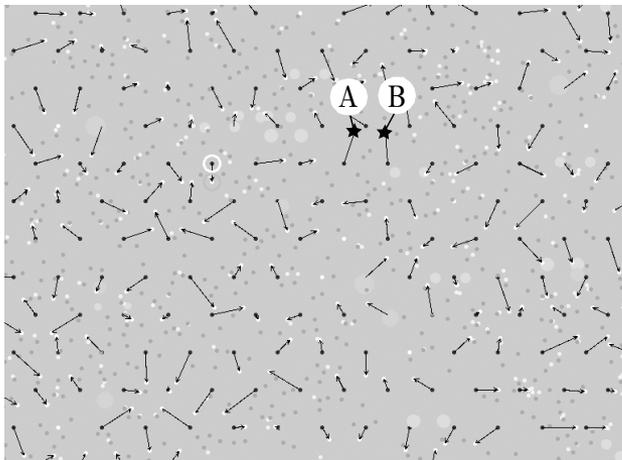
- Fiber (Subaru FMOS) vs. Slit masks (Subaru MOIRCS)



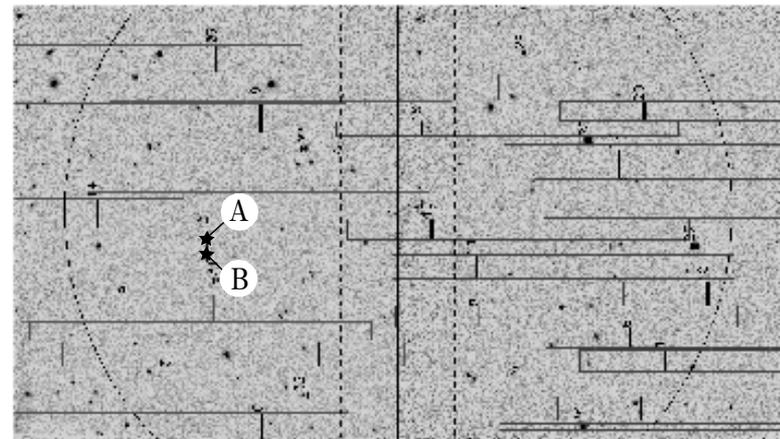
焦点面に取り付けられるファイバー配置機構



焦点面に取り付けられるスリットマスク



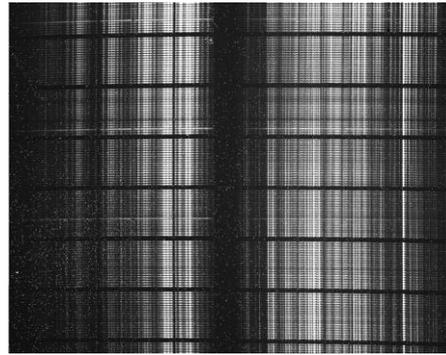
専用ソフトウェアによるファイバー配置(一部拡大)
ファイバー多天体分光器 FMOS の観測例



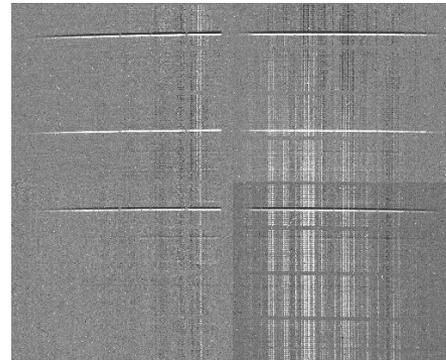
専用ソフトウェアによるスリット配置
多スリット多天体分光器 MOIRCS の観測例

Out put from MOS

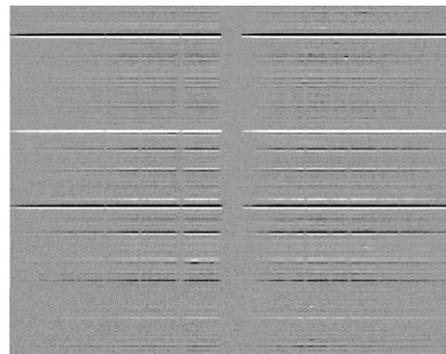
- Fiber (Subaru FMOS) vs. Slit masks (Subaru MOIRCS)



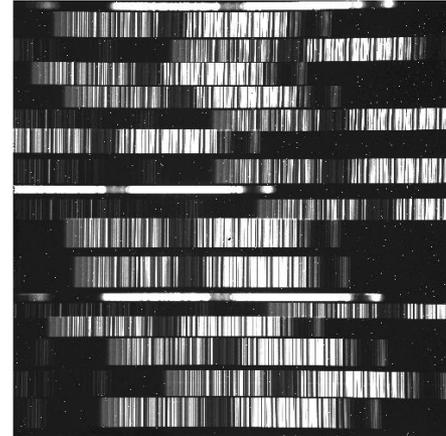
得られたスペクトル画像
1分光器分一部拡大 15分間の積分



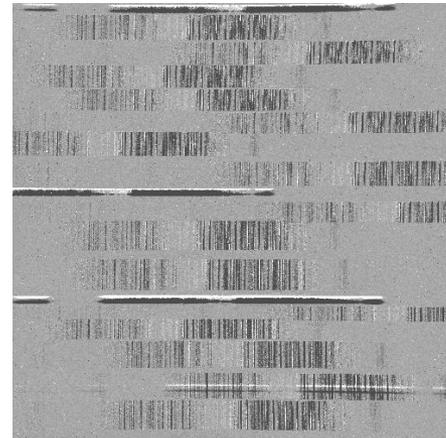
A-B の引き算画像



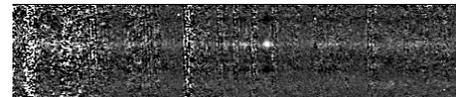
解析されたスペクトル 10時間の積分
多スリット分光器 FMOS のデータ例



得られたスペクトル画像
1チャンネル分 15分間の積分



A-B の引き算画像

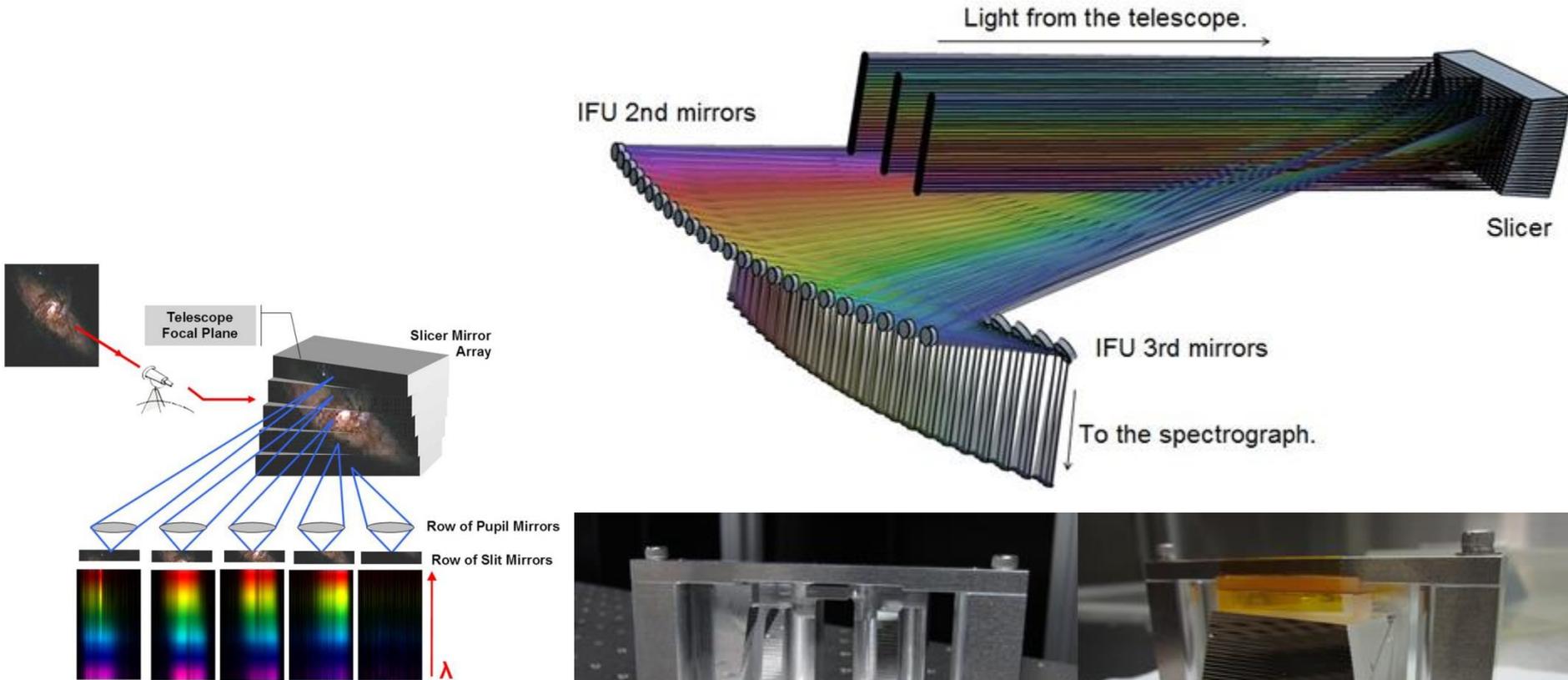


解析されたスペクトル(1天体分)

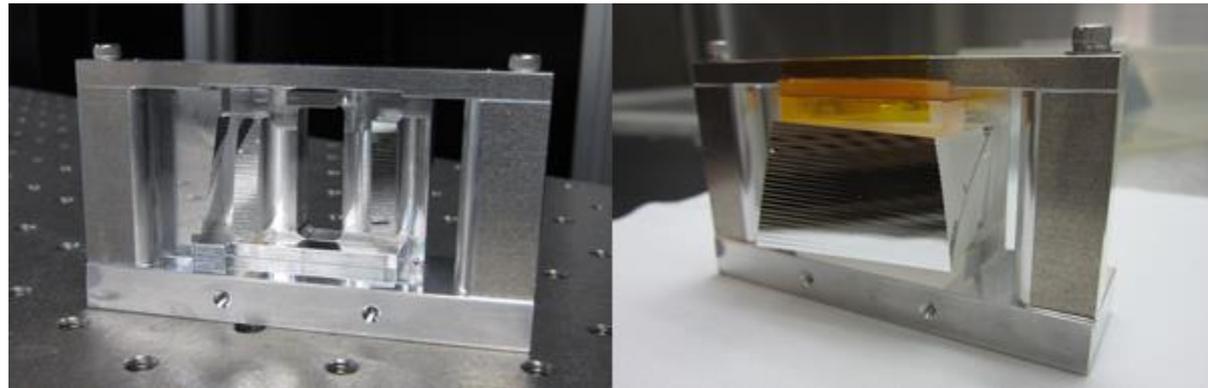
多スリット分光器 MOIRCS のデータ例

Integral Field Spectroscopy

- Image slicer (for FOCAS)



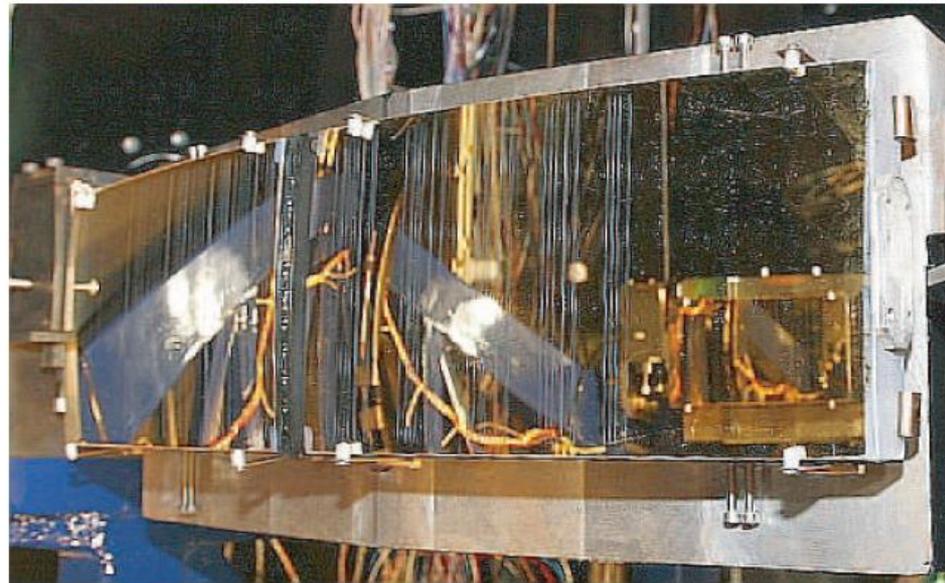
From SPIE



From ATC website

Night sky OH line suppression

- Optically masks the wavelength range affected by strong OH sky lines.



Kimura et al. 2010