



Astro 500



Techniques of Modern Observational Astrophysics

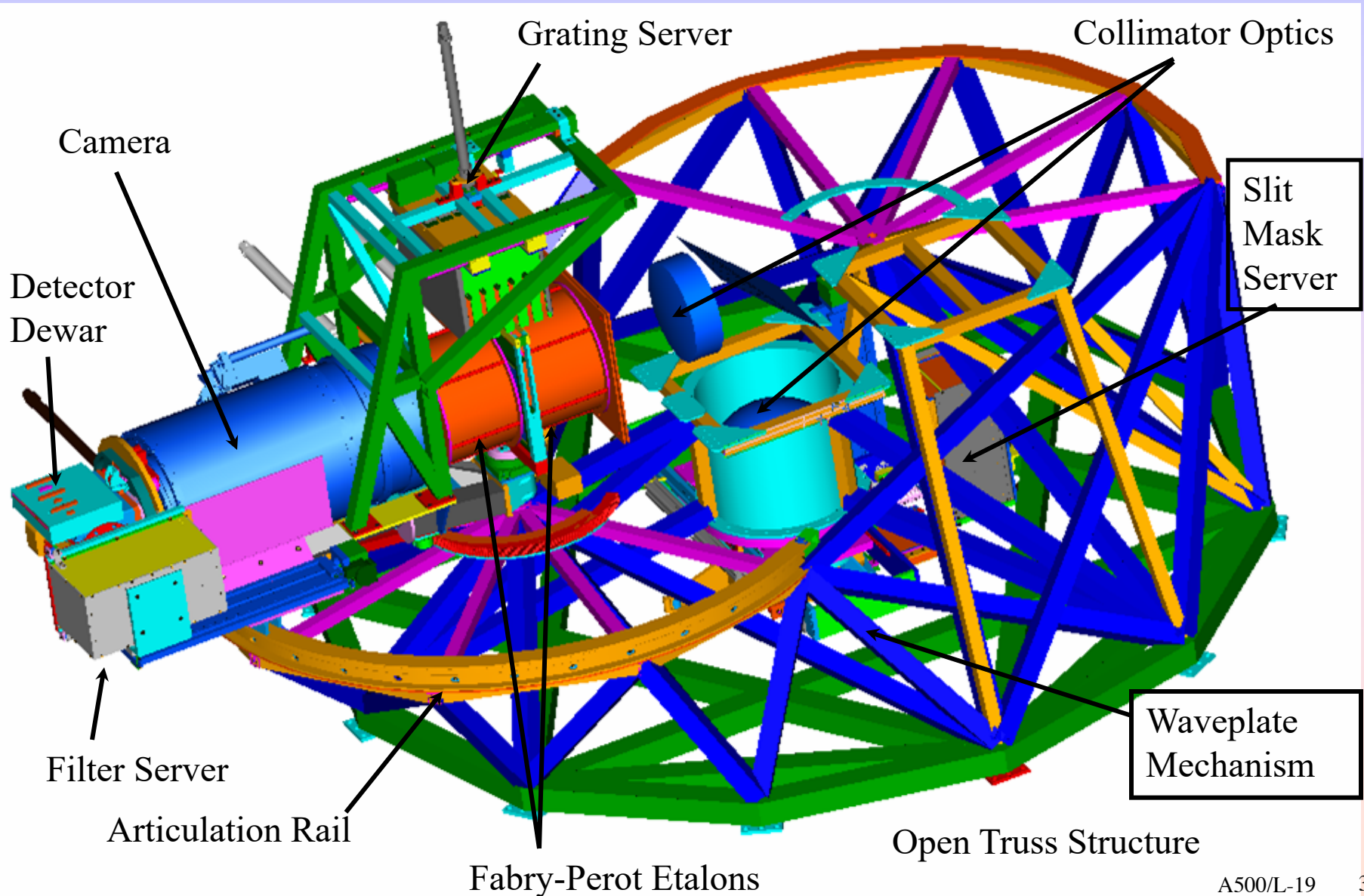
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University of Wisconsin

Lecture Outline

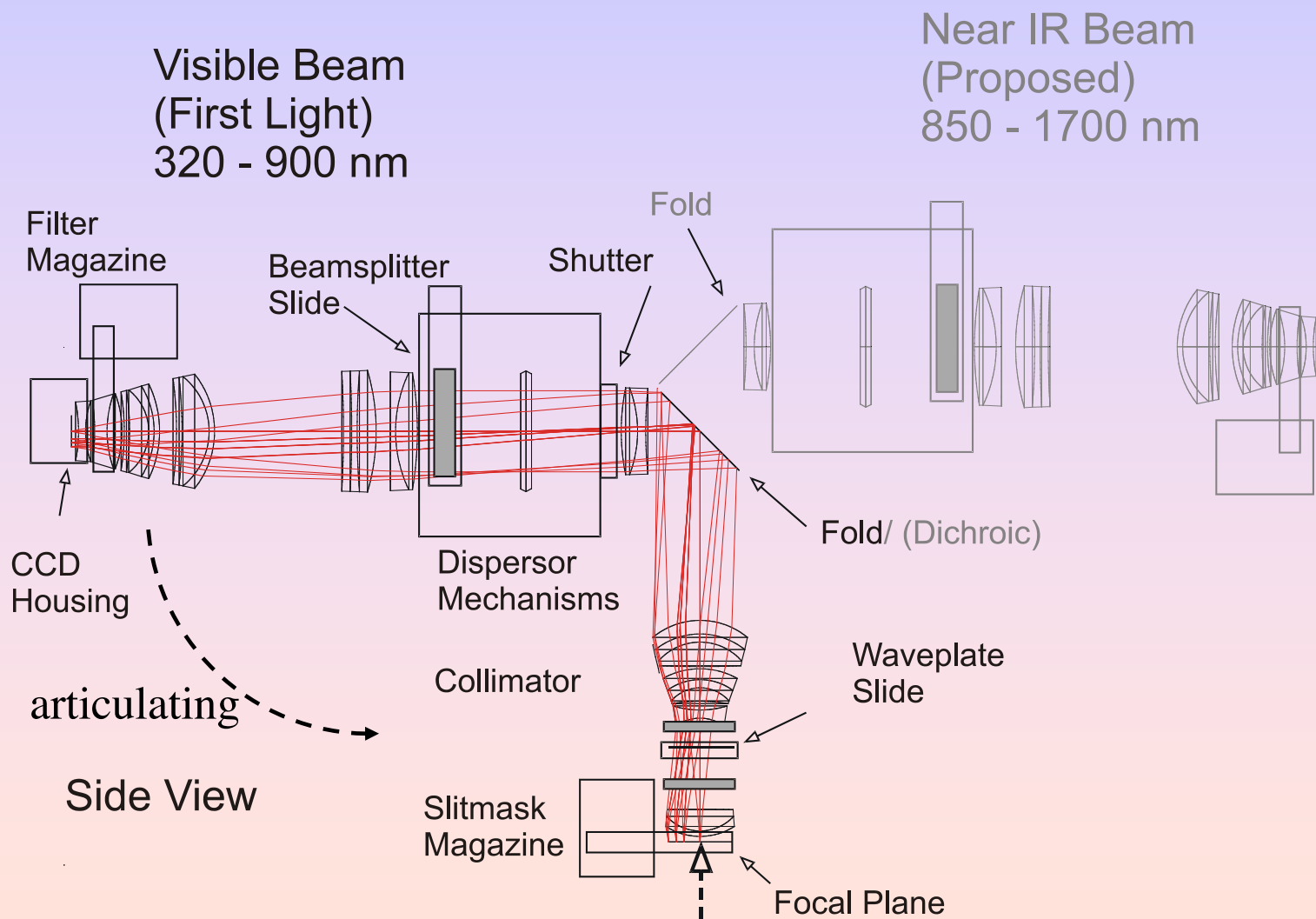
Spectroscopy from a 3D Perspective

- ✓ Basics of spectroscopy and spectrographs
- ✓ Fundamental challenges of sampling the data cube
- Approaches and example of available instruments
 - I: Grating-dispersed spectrographs
 - Echelles
 - Bench Spectrograph (WIYN 3.5m)
 - Robert Stobie Spectrograph (SALT 11m)
 - II: Fabry-Perot interferometry
 - III: Spatial heterodyne spectroscopy

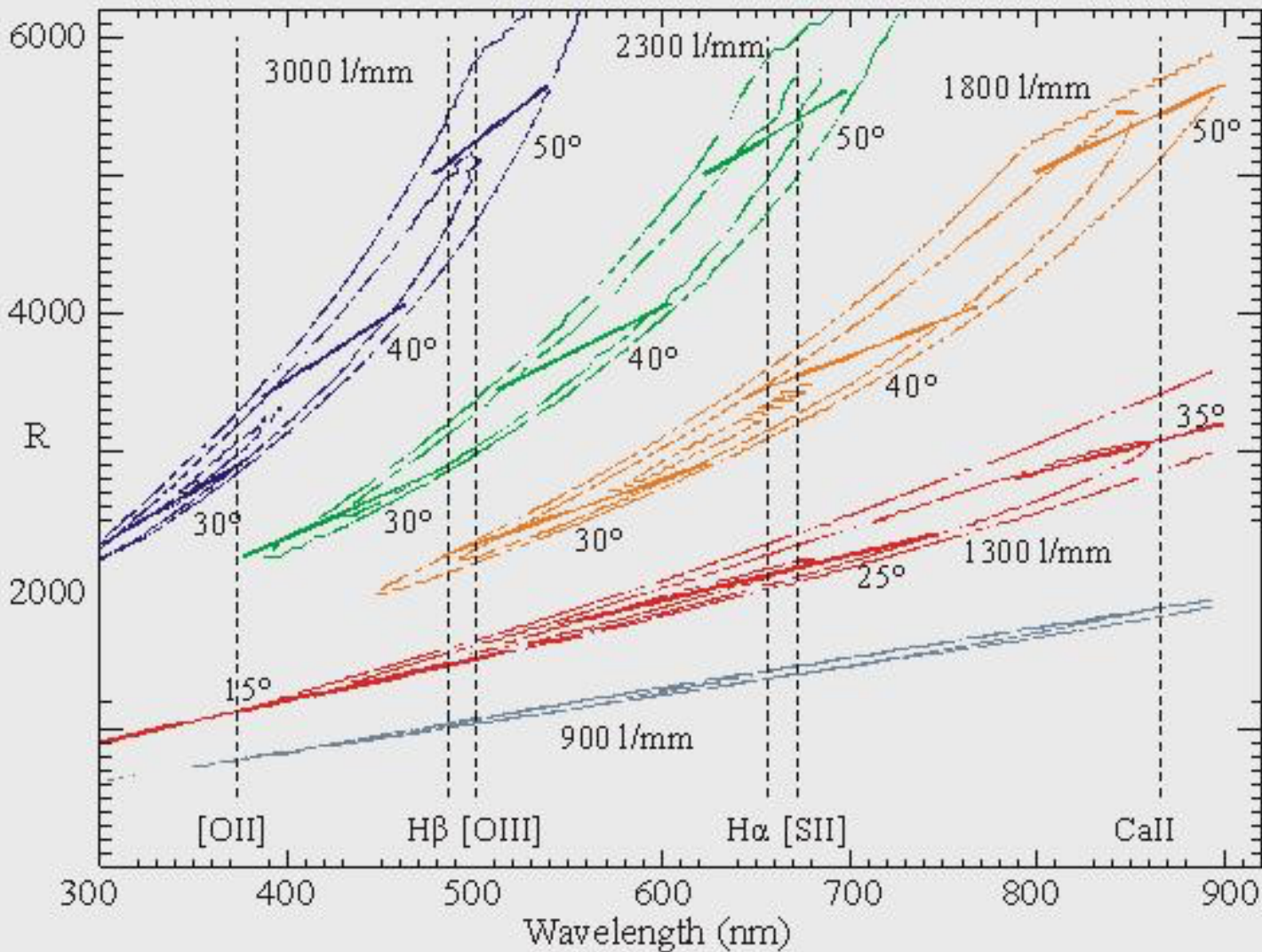
RSS: Schematic (vis only)



Southern African Large Telescope (SALT) Robert Stobie Spectrograph (RSS) layout:



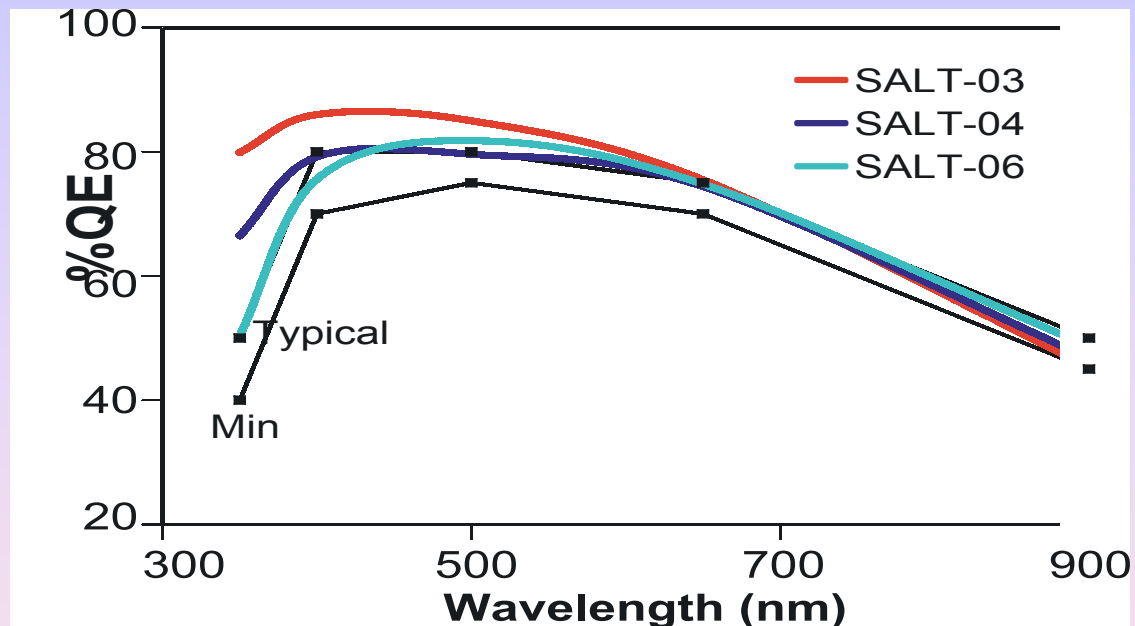
RSS complement of VPH gratings



RSS CCDs

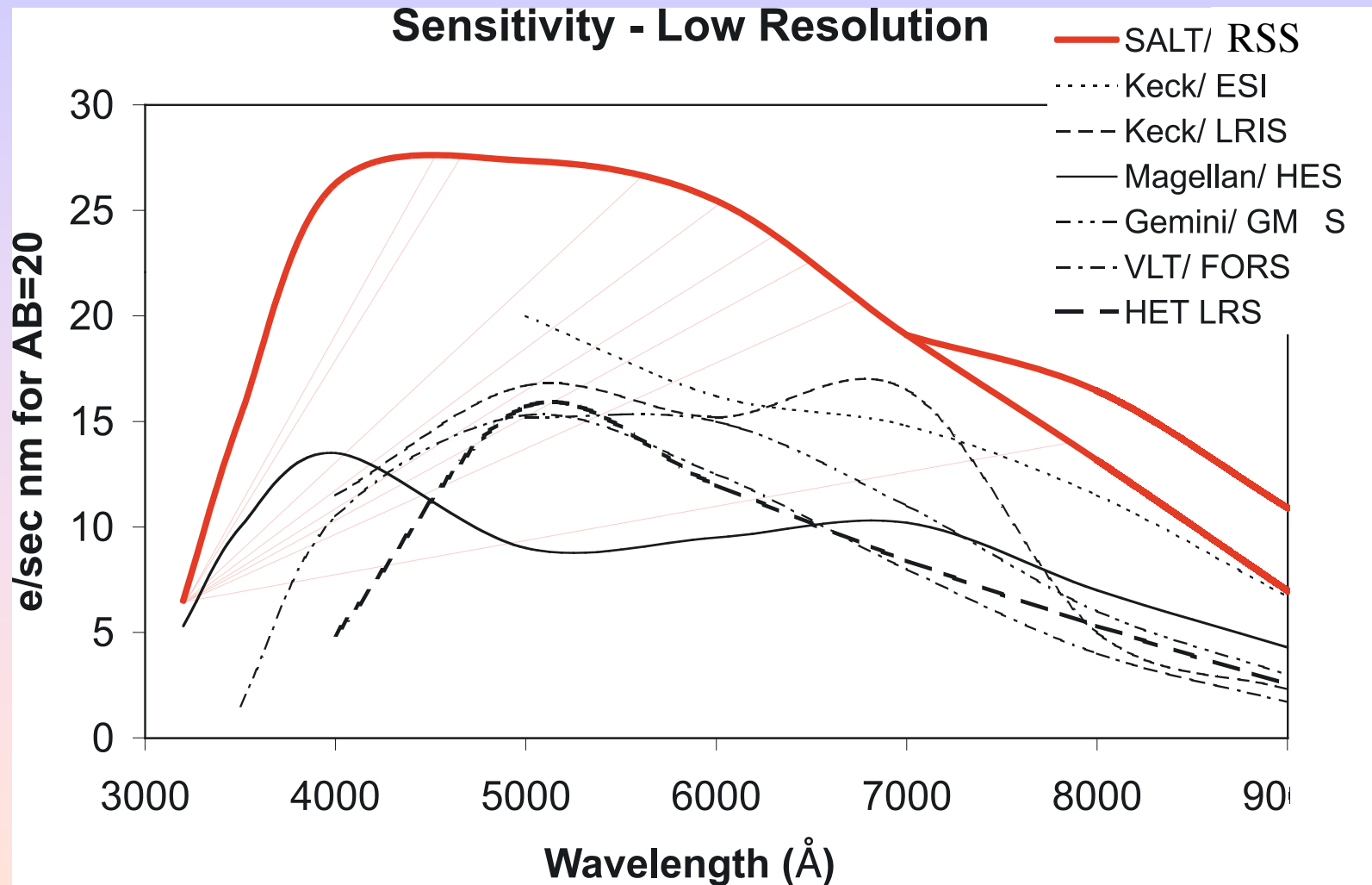
SALT CCDs for SALTICAM and RSS delivered Feb 2003.

- E2V 2k x 4k deep depletion Grade 0 devices
- custom frame-transfer chips
- thinned & astro-bb coating (good in blue)
- readout noise < 2.4e-

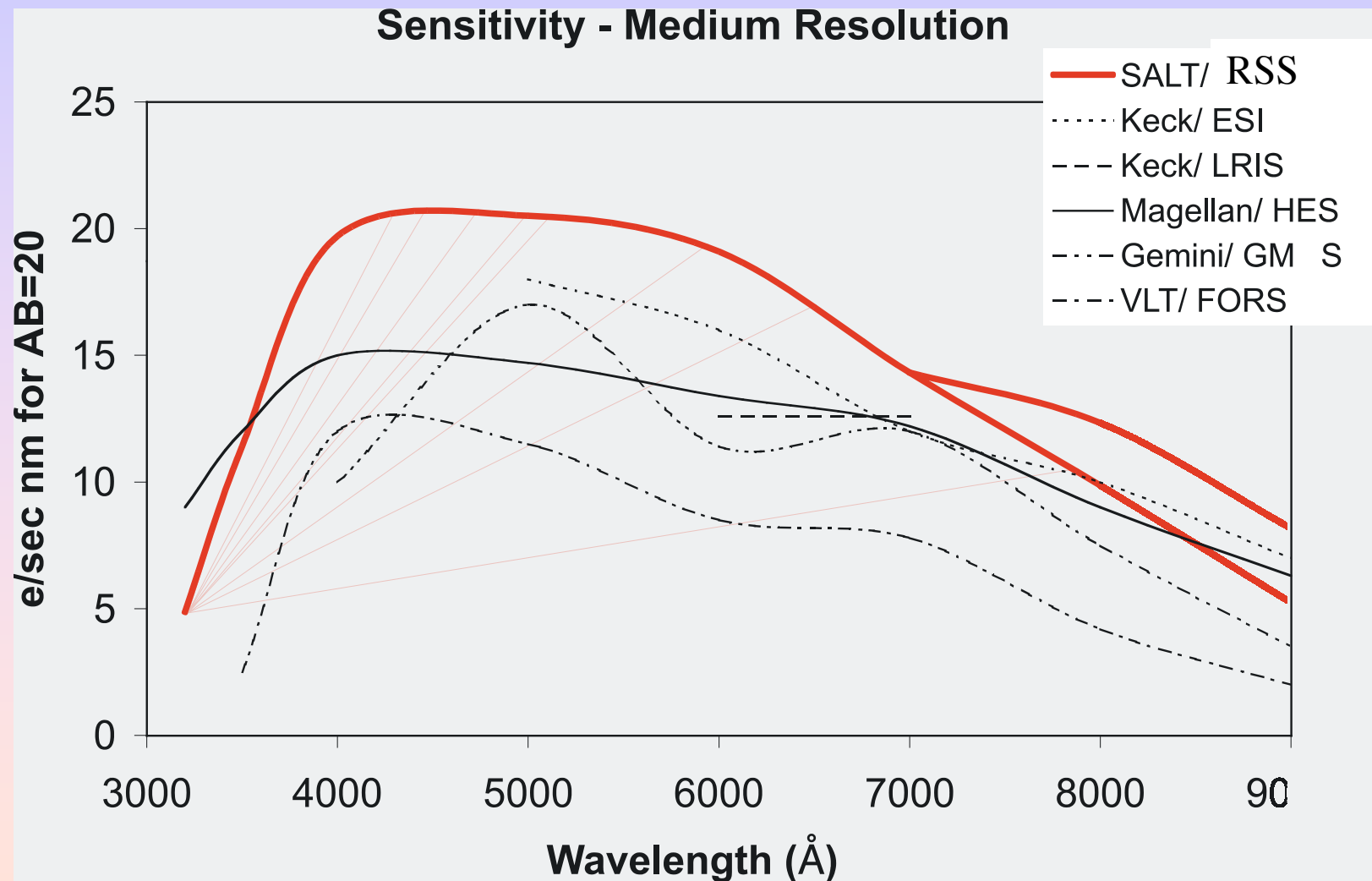


λ (nm)	Min QE (%)	Typical QE (%)	01 SALTICAM (%)	02 SALTICAM (%)	03 RSS (%)	04 RSS (%)	05 spare (%)	06 RSS (%)
350	>40	50	40.5	48.8	79.9	66.5	50.6	50.4
400	>70	80	79.6	71.2	86.0	79.2	71.7	75.6
500	>75	80	81.4	75.5	85.0	79.6	77.7	81.8
650	>70	75	78.0	72.7	75.5	74.4	70.1	74.8
900	>45	50	47.6	45.3	45.4	46.8	45.1	48.7
1000	No spec	No spec	11.2	10.7	10.8	10.7	10.0	10.6

Comparison with other Spectrographs

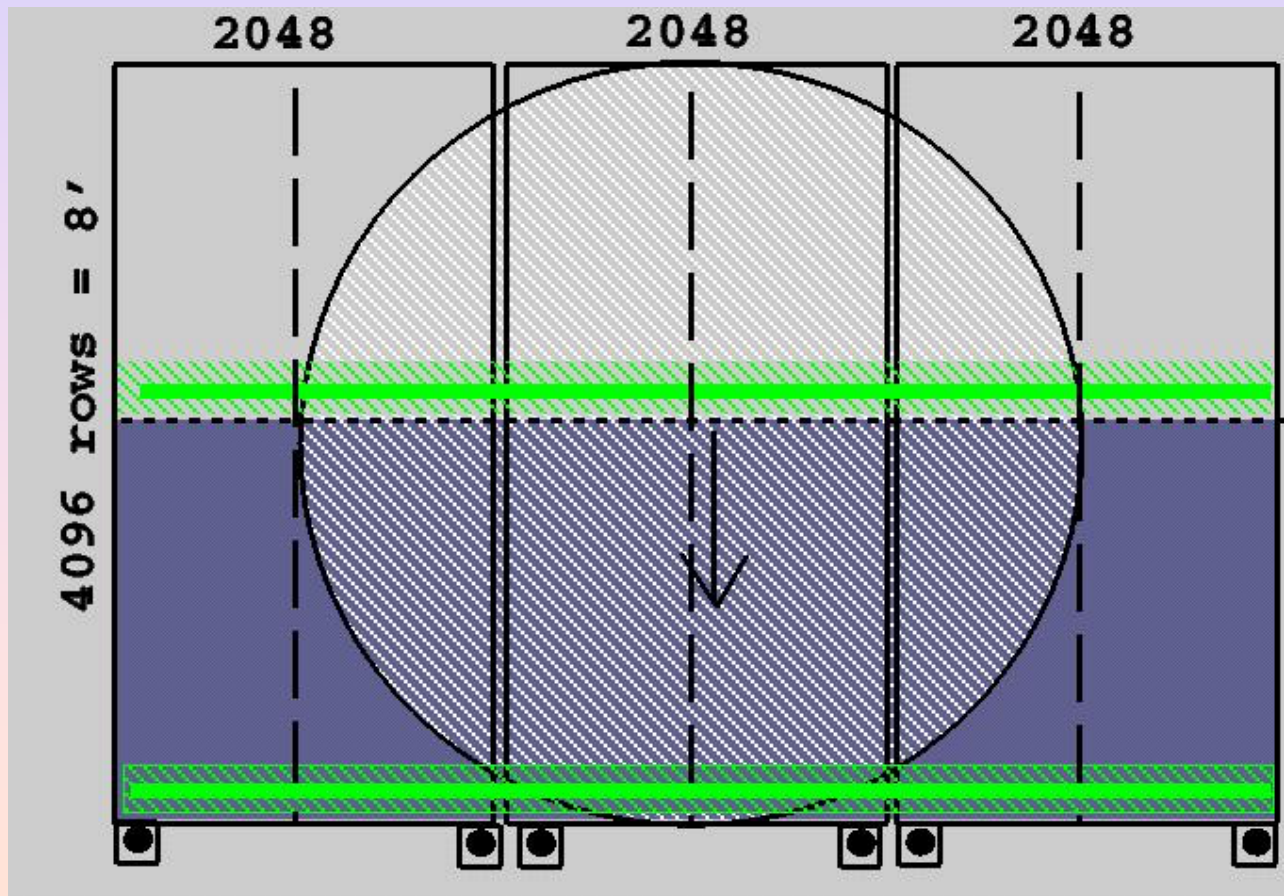


Comparison with other Spectrographs



CCD subsystem readout modes

High time resolution with frame-transfer in operation; max 4' spatial field with lower half masked, and possibility for upper portions masked as well (slot mode).



Bin	RN	Read
1x2	3e-	11.0 s
2x2	3e-	5.5 s
1x2	5e-	3.2 s
2x2	5e-	1.6 s

RSS: fast imaging or spectroscopy

‘Slot’ mode

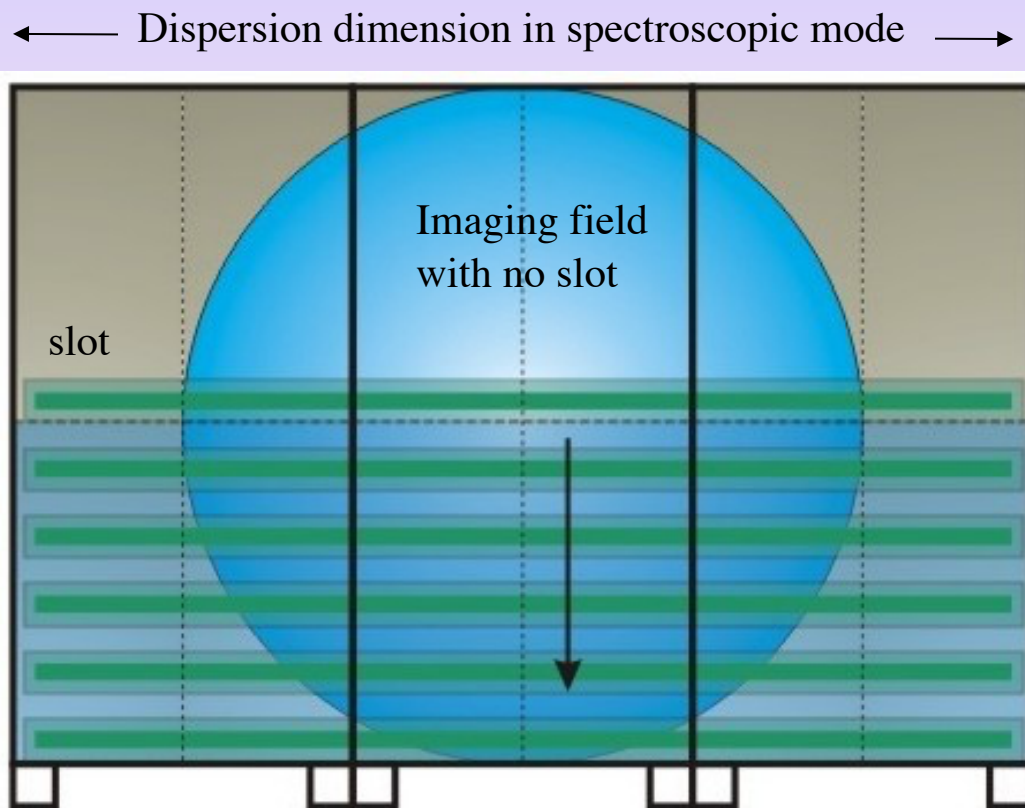
Slot in telescope focal plane placed just above frame transfer boundary

Do 2 x slot width row transfers
(discard smeared rows)

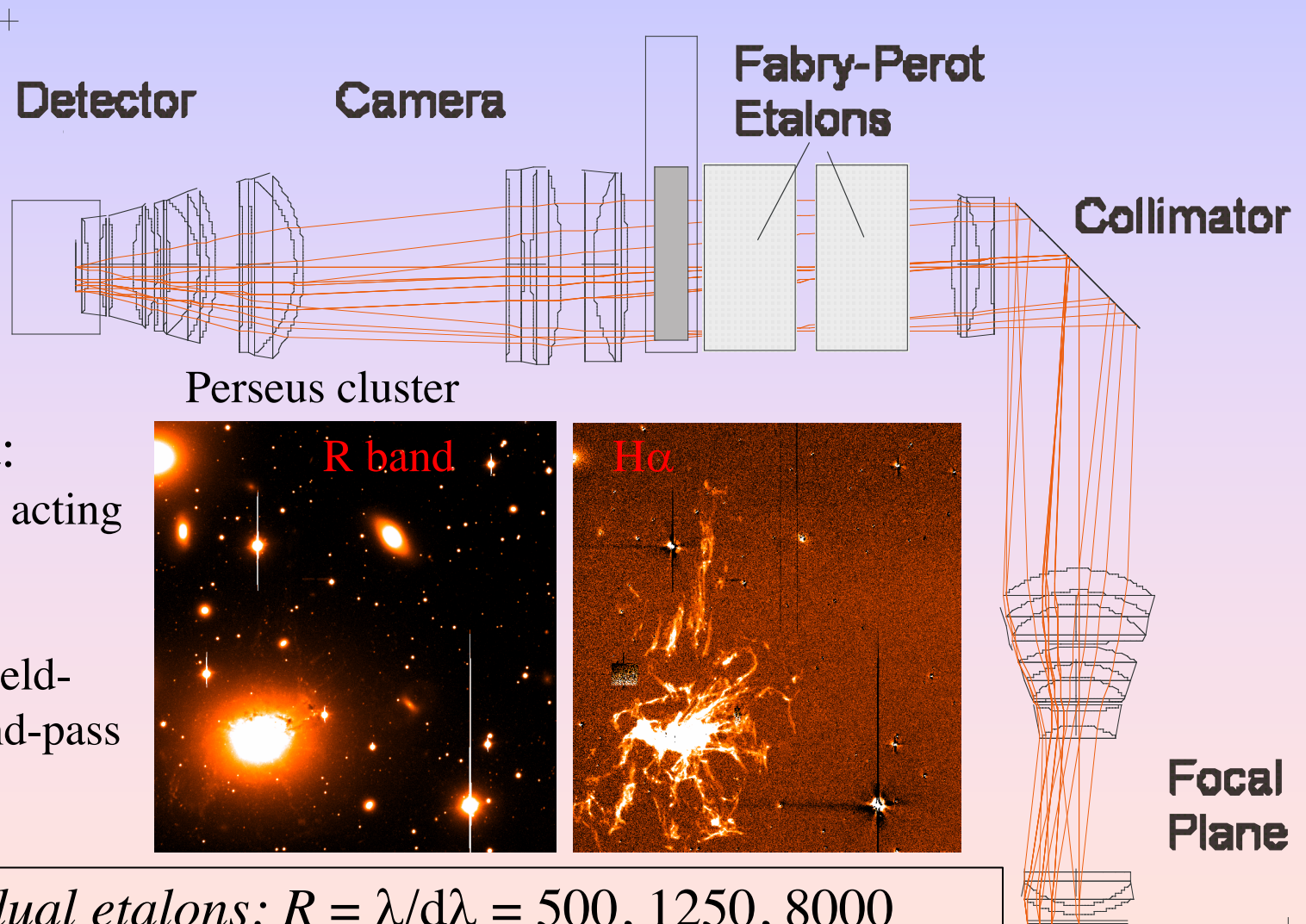
This example has 204 pix slot
(~ 27 arcsec), each shifted 408
rows at a time.

Expect to run at

- >76 msec integrations
- ~ 6 msec deadtime (row transfers)
 - fast spectroscopy
 - fast spectropolarimetry



RSS Fabry-Perot Imaging Mode



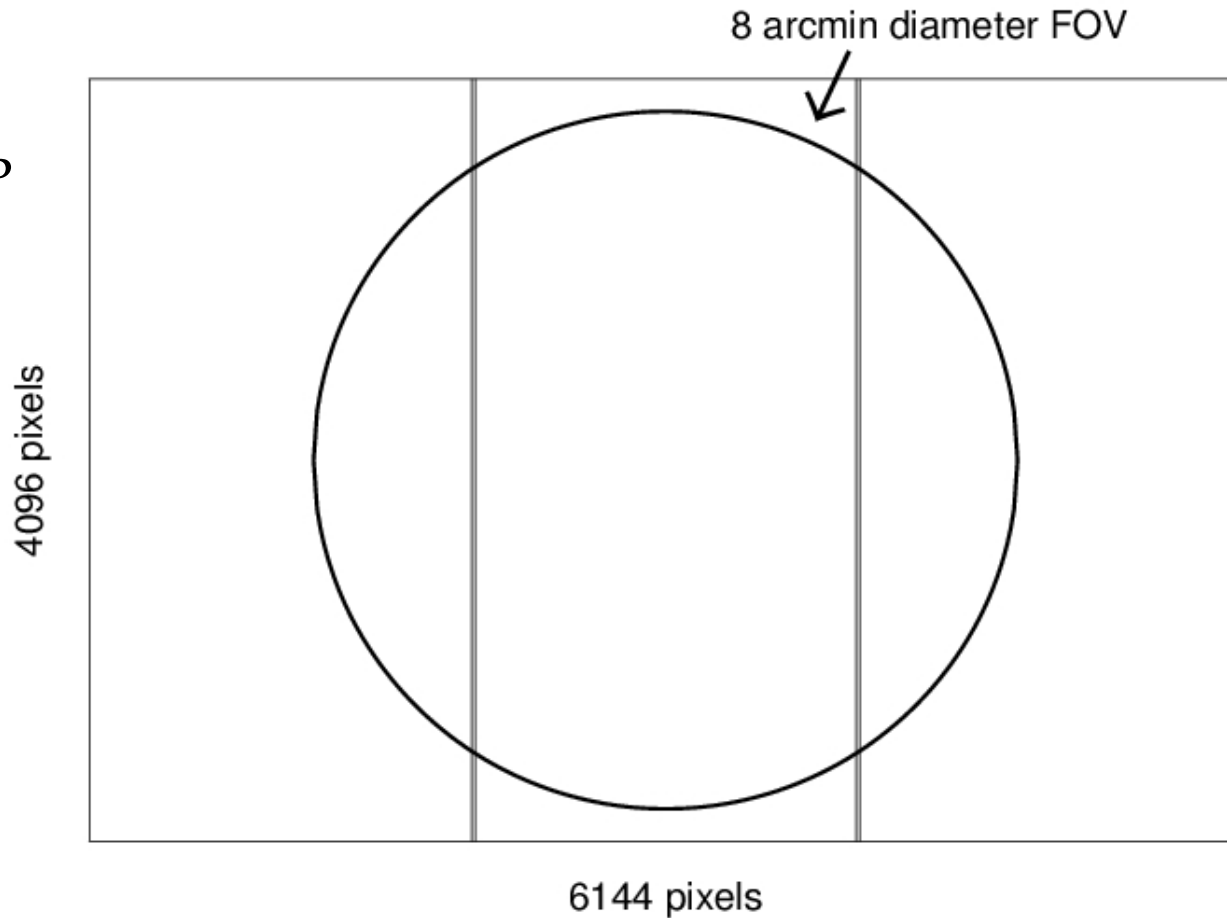
Fabry-Perot:
interferometer acting
like a tunable,
narrow-band
filter, with a field-
dependent band-pass

*Single or dual etalons: $R = \lambda/d\lambda = 500, 1250, 8000$
+ order-block filters covering 450-900nm at $R = 50$*

New Modes for using RSS

Tuning the trade-off between spatial and spectral multiplex

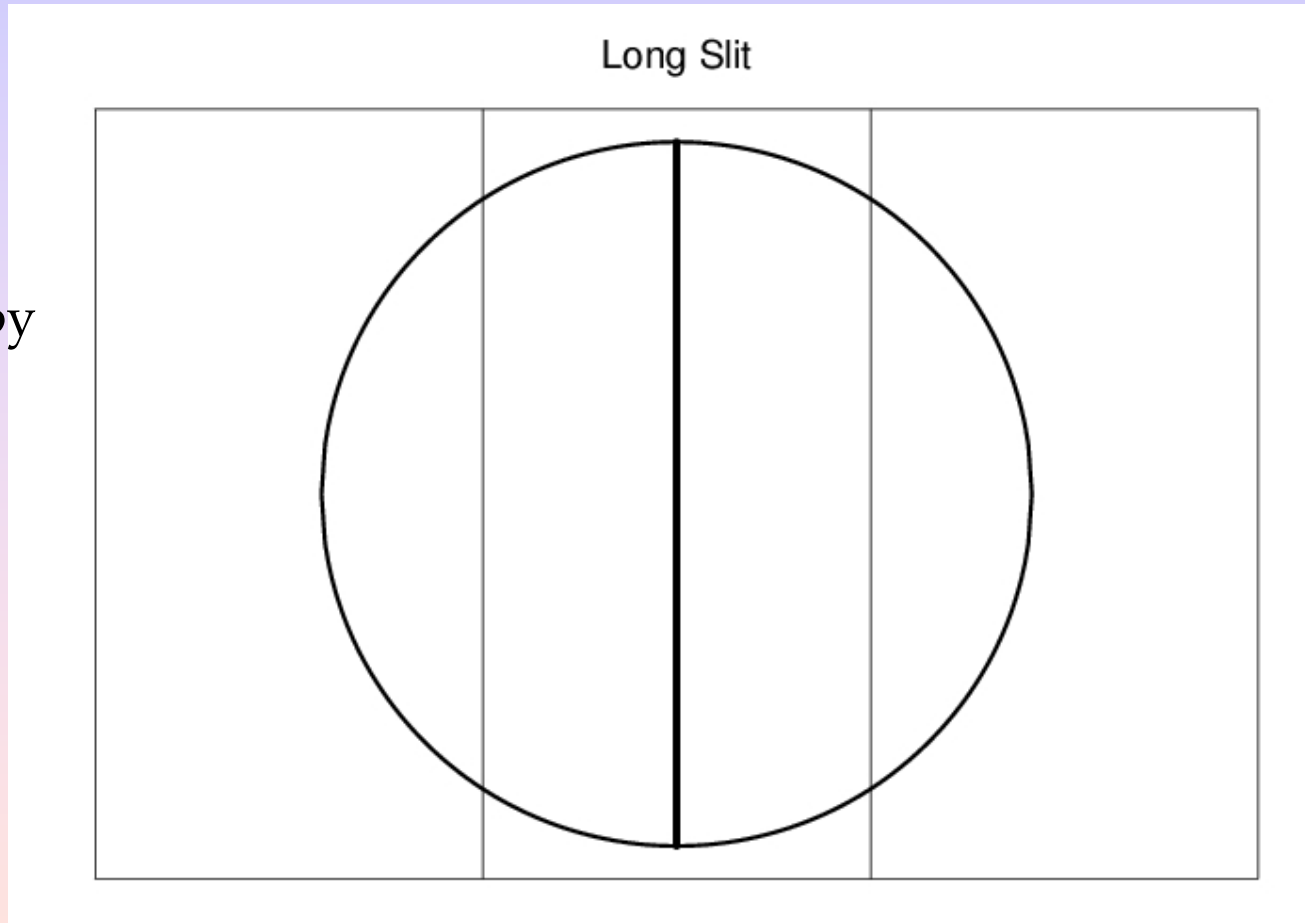
Imaging/FP



New Modes for using RSS

Tuning the trade-off between spatial and spectral multiplex

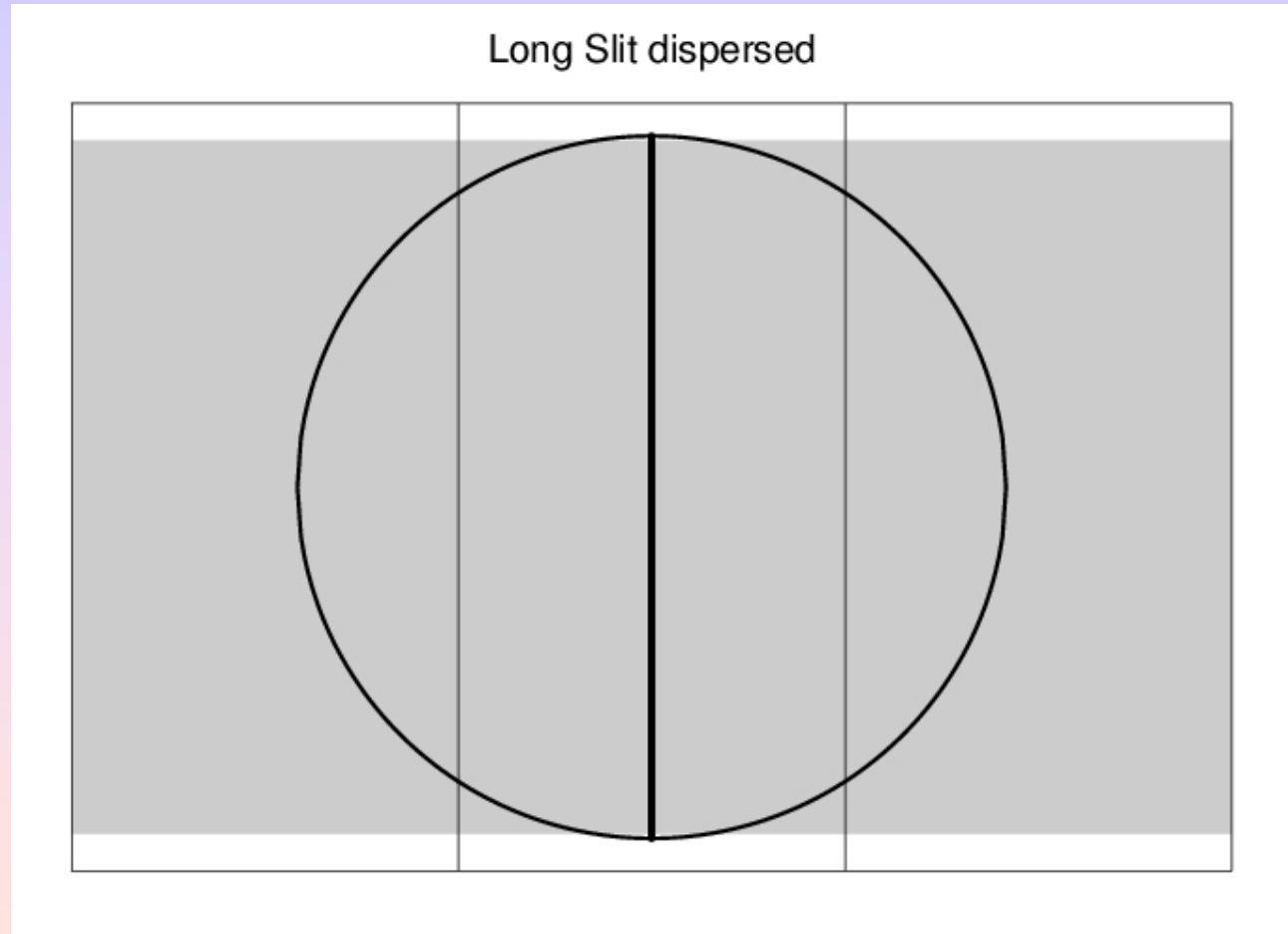
Spectroscopy



New Modes for using RSS

Tuning the trade-off between spatial and spectral multiplex

Spectroscopy

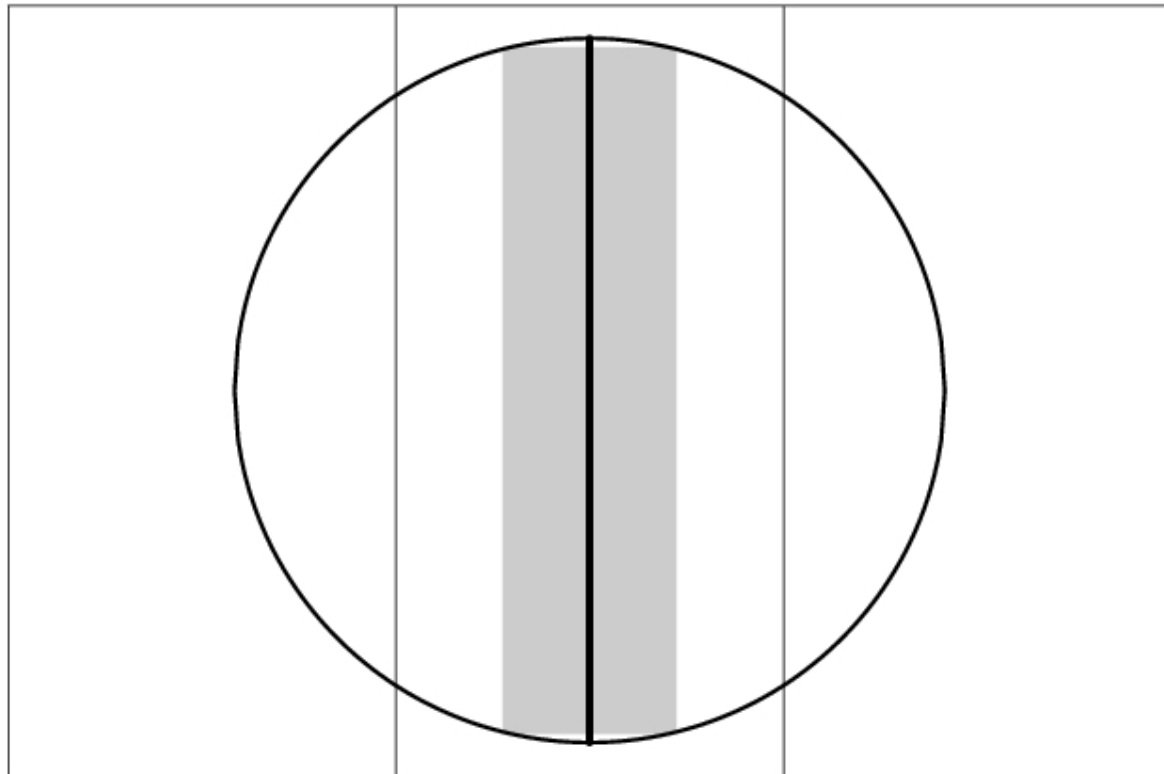


New Modes for using RSS

Tuning the trade-off between spatial and spectral multiplex

Spectroscopy

Long Slit dispersed + NB filter

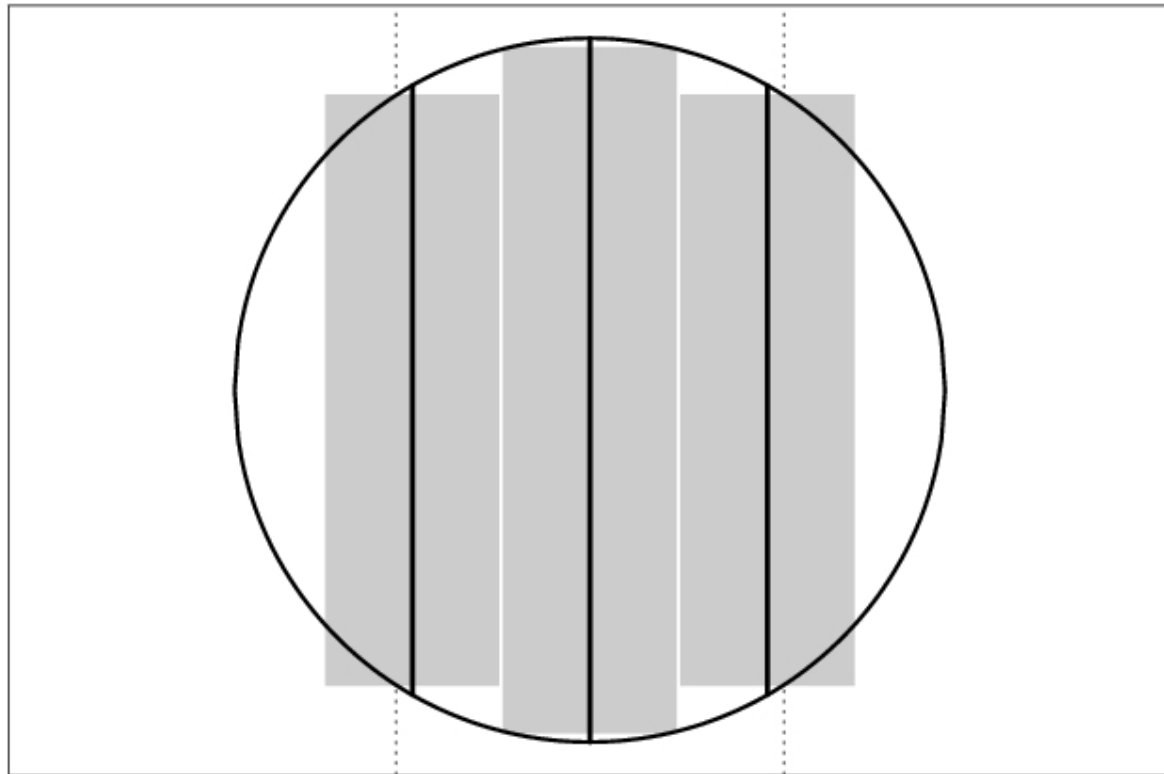


New Modes for using RSS

Tuning the trade-off between spatial and spectral multiplex

Spectroscopy

Massively Multi Slit dispersed + NB filter



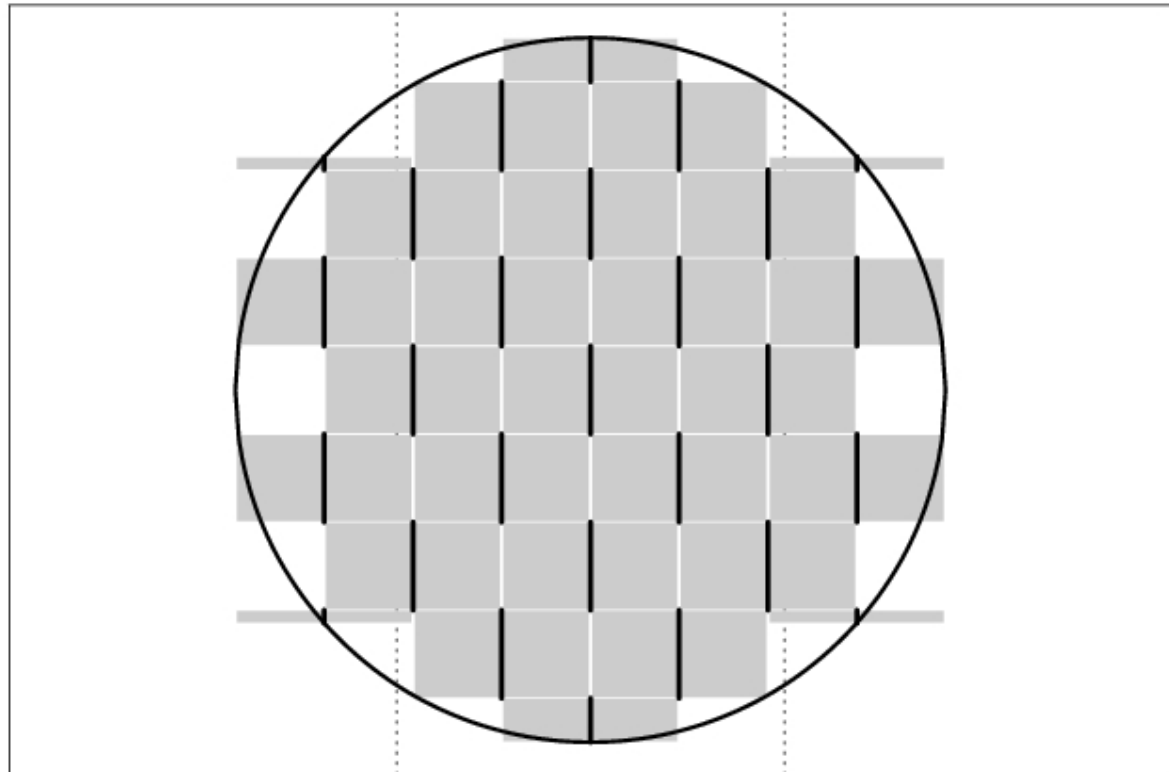
4' slitlets
2' spacing

New Modes for using RSS

Tuning the trade-off between spatial and spectral multiplex

Spectroscopy

Massively Multi Slit dispersed + NB filter



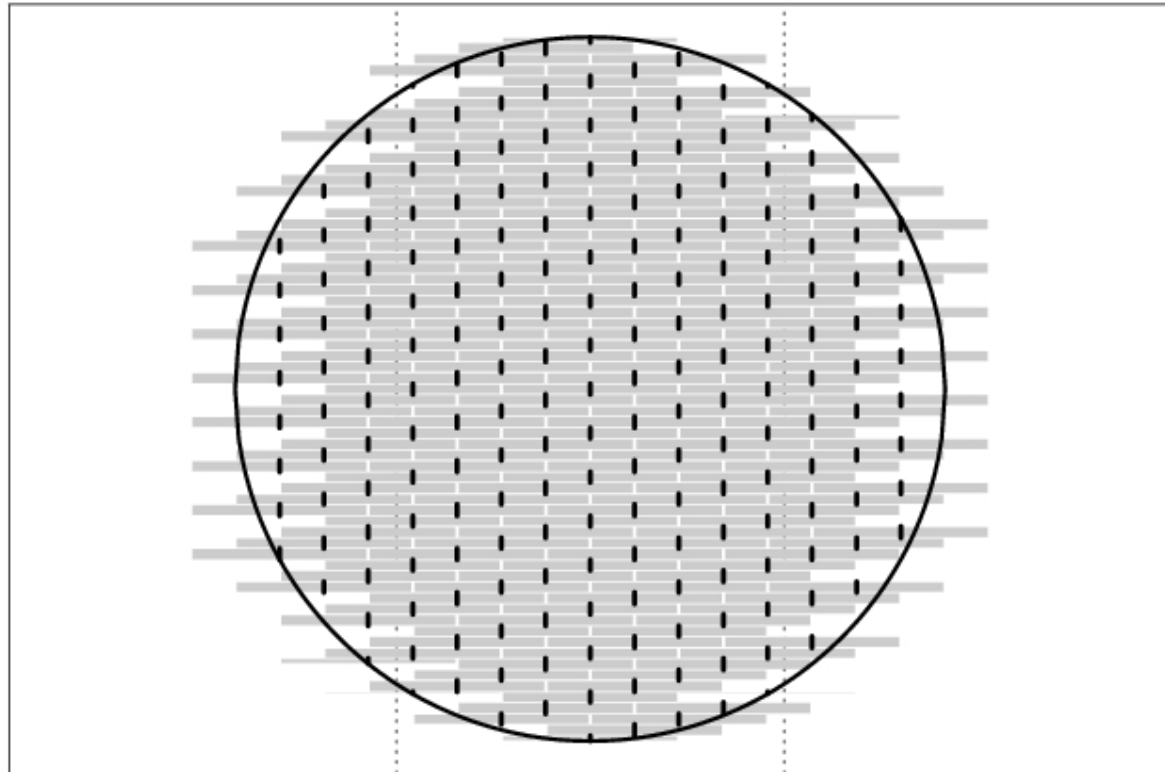
1' slitlets
1.4' spacing

New Modes for using RSS

Tuning the trade-off between spatial and spectral multiplex

Spectroscopy

Massively Multi Slit dispersed + NB filter



7.5" slitlets
17" spacing

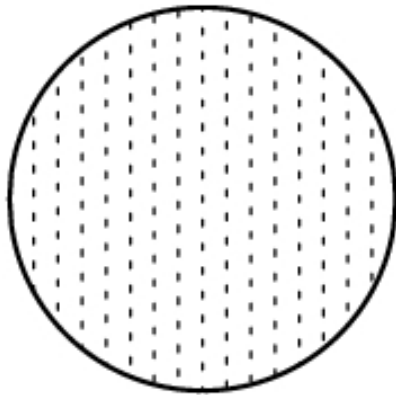
Massively Multiplexed Slitlets

PFIS:

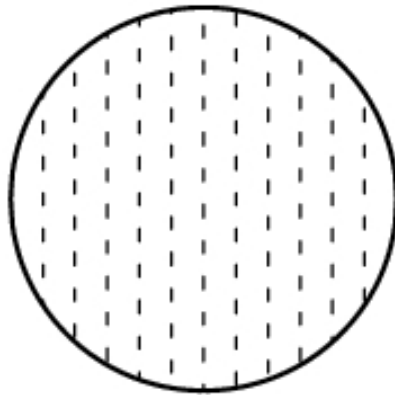
3000 l/mm VPH grating + 0.6" slit: $R = 10,000$

+ NB filter: $R = 50$

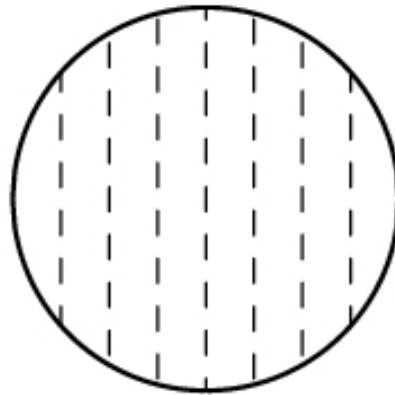
→ 10 nm at 510 nm A: $N_{\Delta\lambda} = 1000$



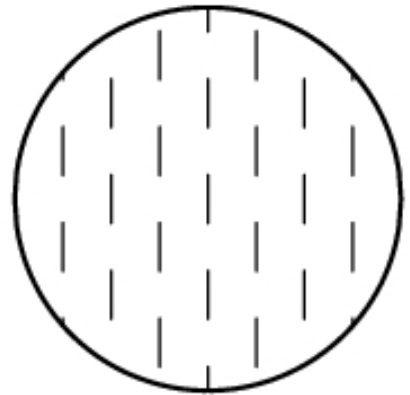
7.5" slitlets
17" spacing



15" slitlets
25" spacing

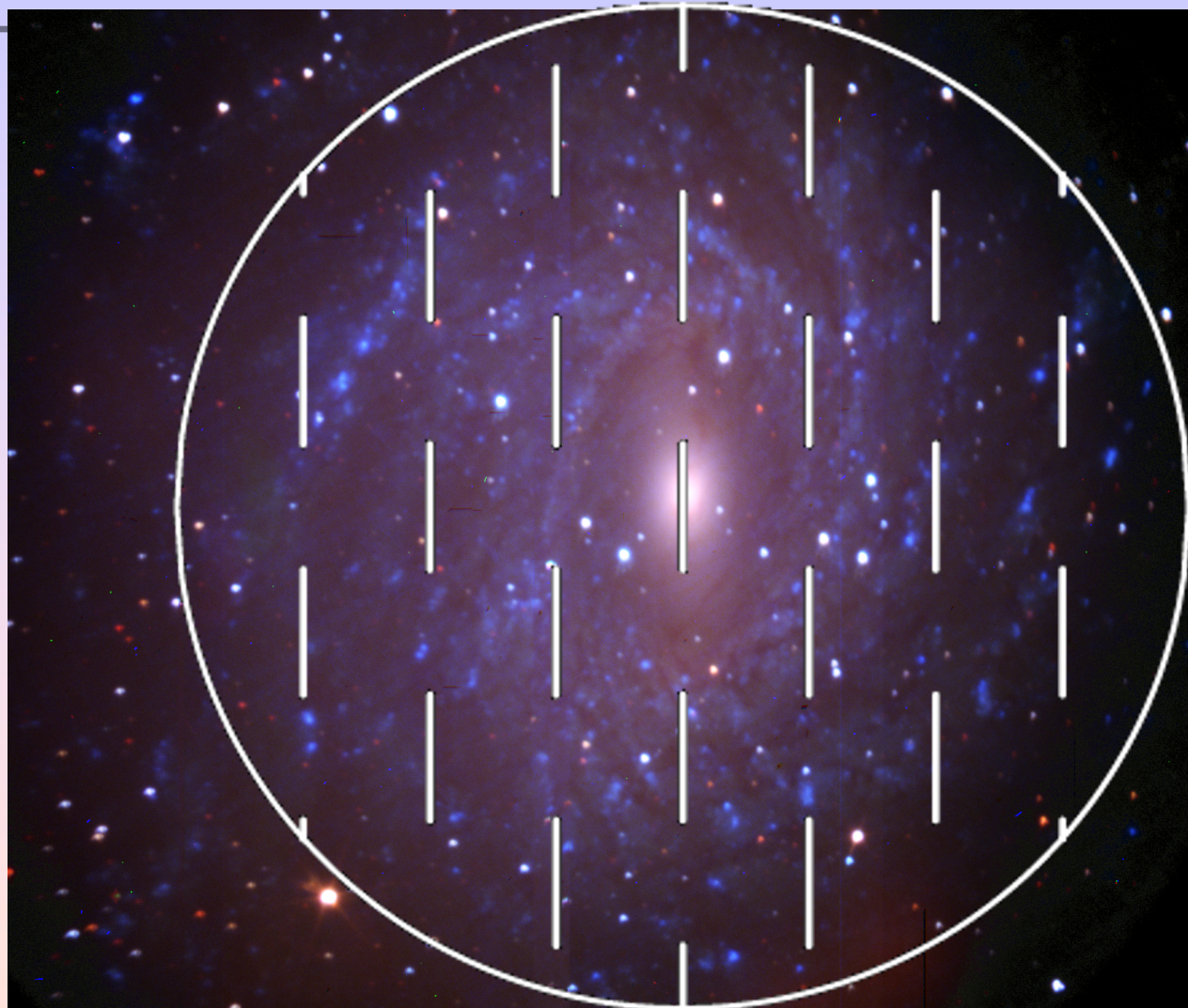


30" slitlets
1.1' spacing



1' slitlets
1.4' spacing

NGC 6744 and RSS: MMS-1'



NGC 6744 and RSS MMS-7.5''

