Current Status of SPOL-Blue

2017-09-25

Korea Astronomy and Space Science Institute

Manufacture Result

Outlook

Figure 2 Lens Unit

Figure 4 Outlook of lens assembly(= lens unit + focusing ring)

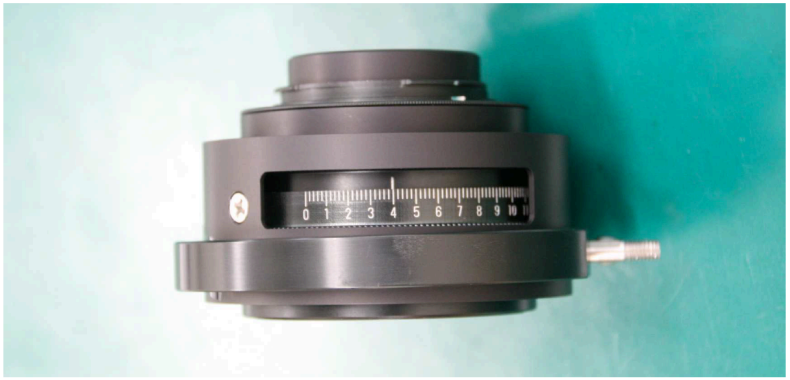
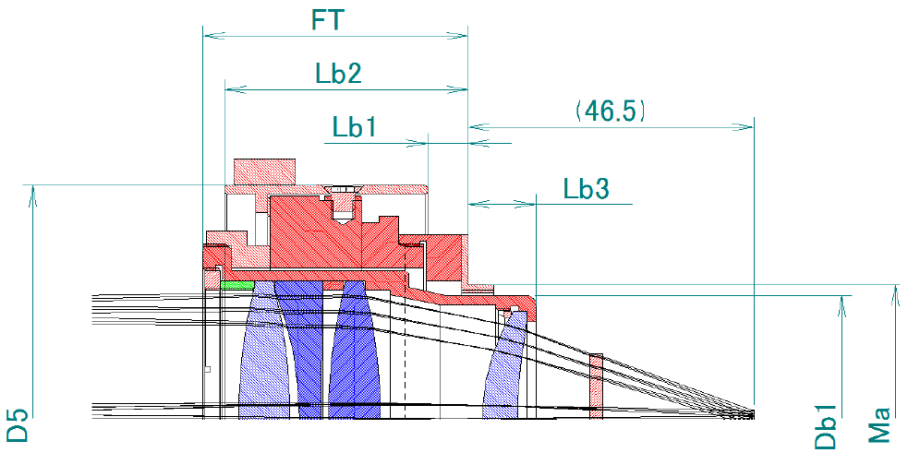
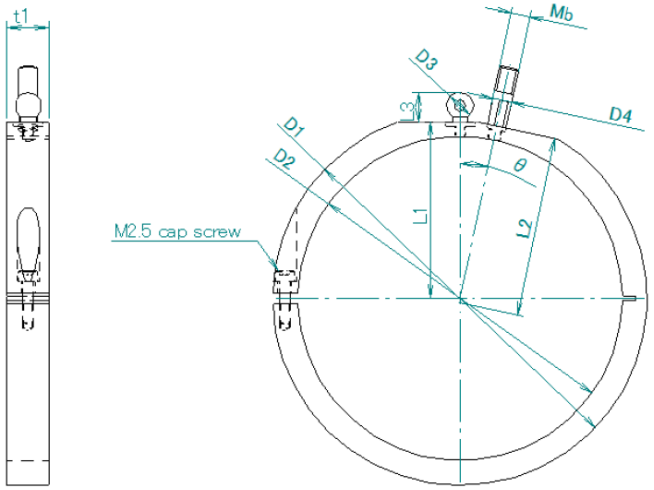


Figure 5 Side view of lens assembly
(Indicator read of helicoid is set to be “4” in the photo)

Optical Performances



DWG #1 / Dwg of the lens unit to specify symbols for dimensions atTable3.



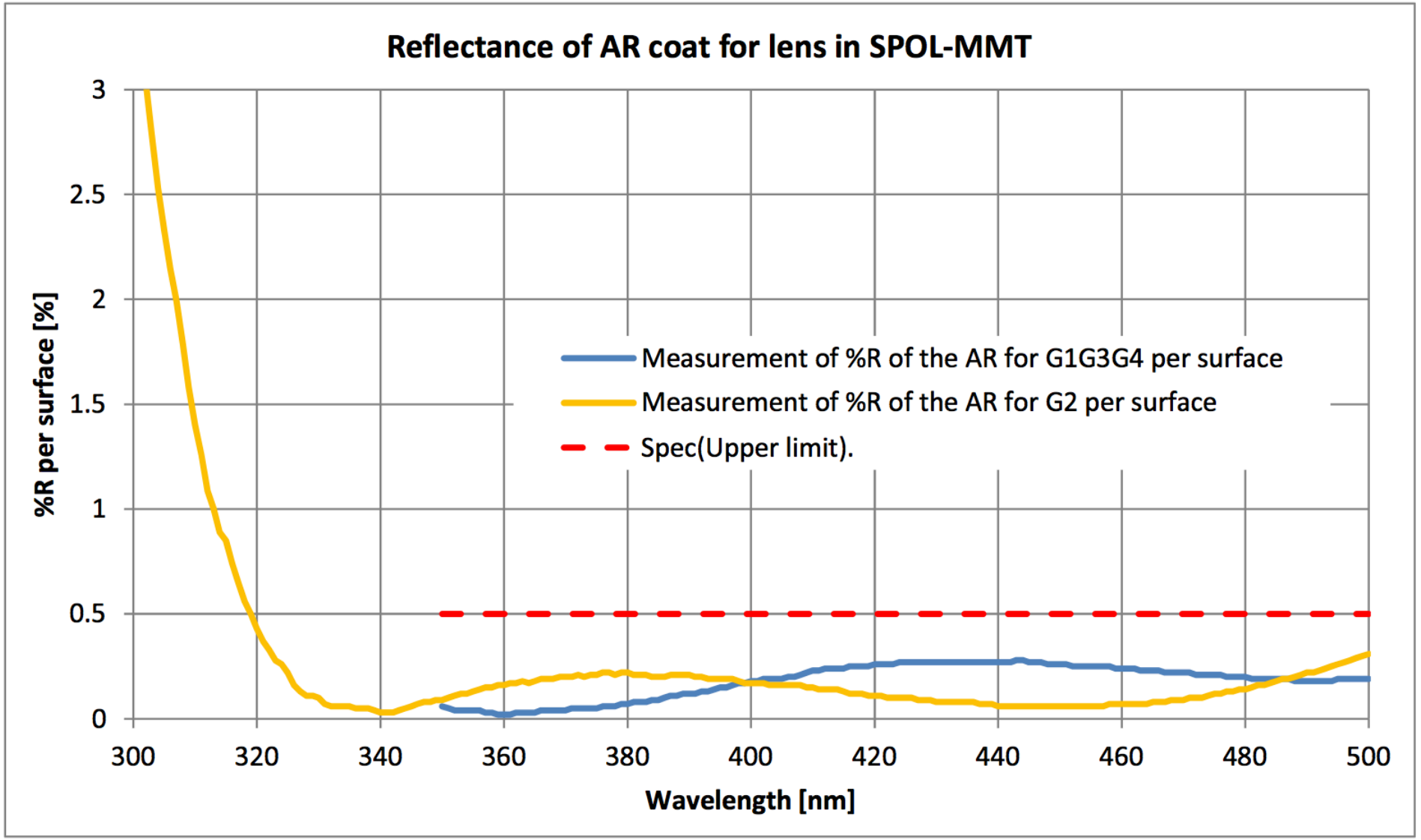
WG #2 / Dwg of the focusing ring to specify symbols for dimensions atTable3.

Table 3 Test results of lens assembly

#		Tolerance	Result		Judge		
			#1	#2	#1	#2	
Optical Specs.							
01	focal length at 546nm *see note 1 below*	55.716mm < f < 56.842mm	56.240 mm (-0.07%)	56.273mm (-0.01%)	OK	OK	The design value is 56.279mm.
02	metal back at 546nm *see note 1 below*	33.896mm < mb < 34.580mm	34.228 mm (-0.03%)	34.263mm (+0.07%)	OK	OK	The distance btween best focus plane and the tail end surface of the lens barrel
03	image quality	No defect	No defect	No defect	OK	OK	Pinhole at infinity looks rotationaly symmetric and has diffraction ring.
Mechanical Specs. *see note 2 below*							
#1	Ma	Attaching to /detaching from Nikon Fmonut without problem	Attaching to /detaching from Nikon Fmonut without problem	Attaching to /detaching from Nikon Fmonut without problem	OK	OK	see DWG#1 Nikon F-mount compatibility has been tested with a Nikon D810 camera body.
#2	Indicator read of helicoid to realize flange back = 46.5mm	1~7	4.0	1.4	OK	OK	
#3	FT *see note 3 below*	43.15	43.13	43.16	OK	OK	
#4	max of FT *see note 4 below*	-	55.24	55.50	-	-	
#5	Db1	40.2	40.11	40.15	OK	OK	
#6	Lb1	6.6	6.32	6.55	OK	OK	
#7	Lb2	39.6	39.37	39.70	OK	OK	
#8	Lb3 *see note 3 below*	11.05	11.01	11.05	OK	OK	
#9	max of Lb3 *see note 4 below*	-	12.73	12.74	-	-	
#10	t1	10	10.04	10.23	OK	OK	see DWG#2
#11	D1	88	87.75	87.85	OK	OK	
#12	D2	76.6	76.06	76.09	OK	OK	
#13	D3	6.35	6.32	6.34	OK	OK	
#14	D4	4.5	4.48	4.47	OK	OK	
#15	D5	<76.0	75.90	75.92	OK	OK	
#16	L1	41.5	41.6	41.6	OK	OK	
#17	L2	41.5	41.6	41.6	OK	OK	
#18	L3	7.0	7.45	7.29	OK	OK	
#19	Mb	M4.5	M4.5	M4.5	OK	OK	
#20	θ	12°	12.1°	12.1°	OK	OK	

note 1) Evaluated/measured without a silica plate of the 2mm thickness.
note 2) All the measure value are that when the indicator of helicoid is set to "4"
note 3) Measured value when the indicator read of helicoid is set to the value shown in #2.
note 4) Measured maximum dimension when you adjust the helicoid all through the range.

Optical Throughput



Test List (brainstorm)

- Mechanical Test & Focus
  - Test if the new lens works well with the existing focusing knob.
  - Record the optimal focus values for each lens (with pinhole masks and calibration lamp?).

- PSF & Image quality
  - In the imaging-pol mode, put polarization standard stars on different locations (e.g. four corners) on FOV.
  - Measure the PSF shapes and check the image quality.
  - Determine which one of the two new lens has better PSF shape.
  - Measure P, theta for a polarization standard, see if new lens introduces any spurious signal (although I doubt).
  - Check if dPA remain same [dPA = PA(real) - PA(obs) - Rotator - 90].

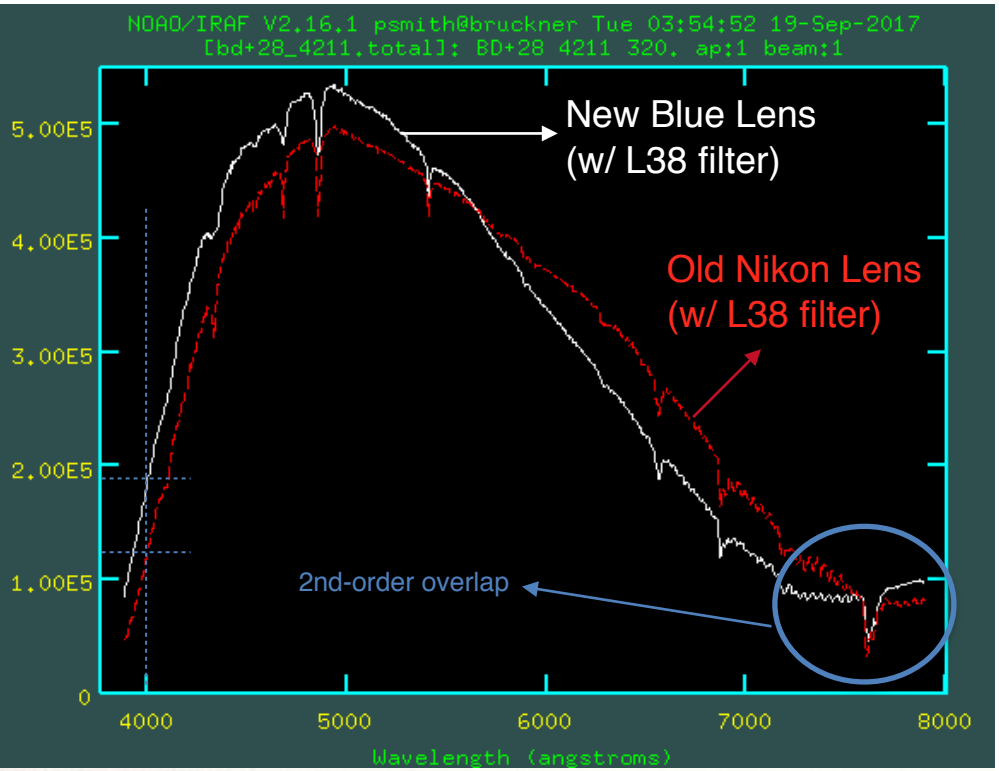
- Throughput Test
  - Take spectro-photometric standard stars in the spec-pol mode.
  - Compare throughput as a function of wavelength for the old and new lenses.
  - Determine which one of the two new lens has better throughput.

- Extended Source

First Light Observation

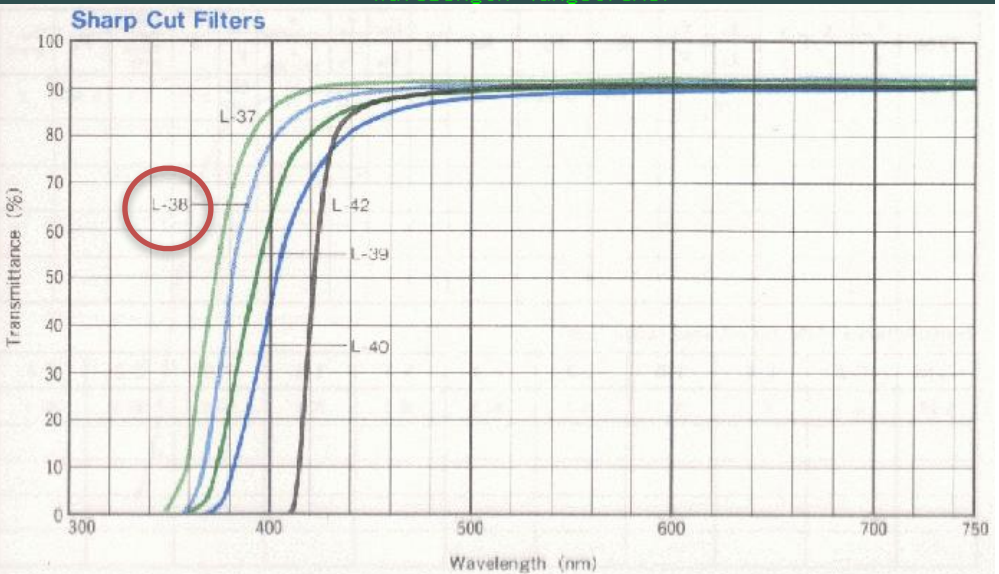
9/18 - 9/21, 2017
@Steward Observatory 61-inch Telescope

First Light - Lens #1 (2017-09-18 @61-inch)

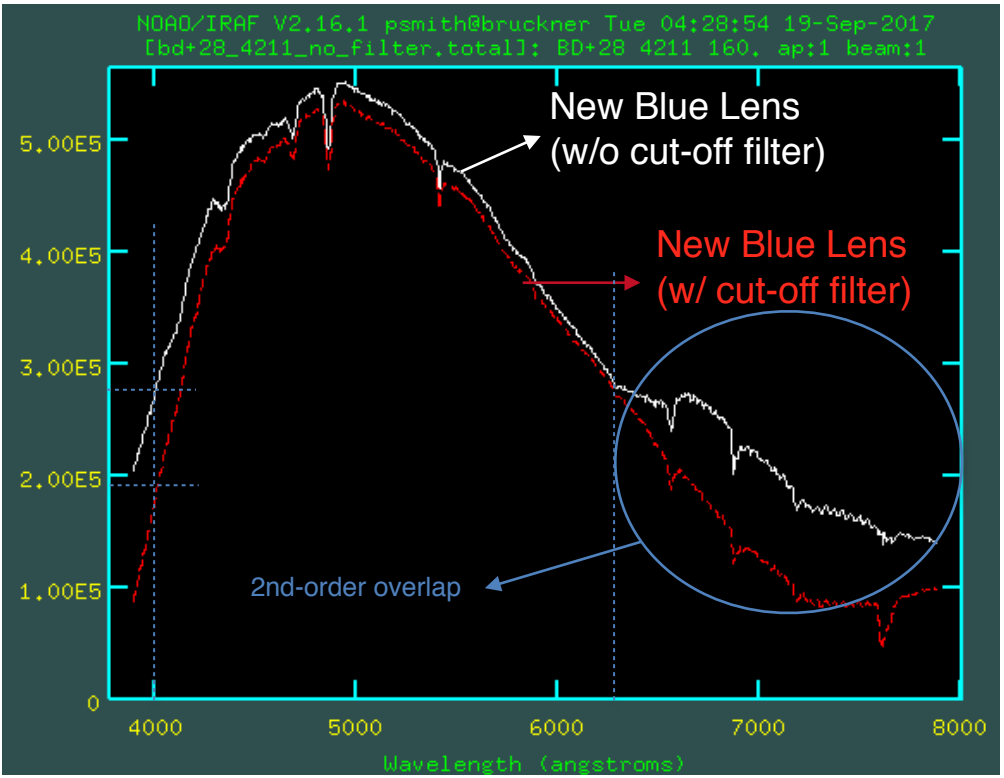


< Blue Sensitivity Comparison >

- Object: BD+28 4211 (standard star)
- Spectro-polarimetric mode
  - grating: 600 l/mm
  - blocking filter: L38
- **Note the 2nd-order overlap at λ > 7200Å for the new lens, indicating that much more λ > 3600Å light is making it through the new lens compared to the old.**



First Light - Lens #1 (2017-09-18 @61-inch)



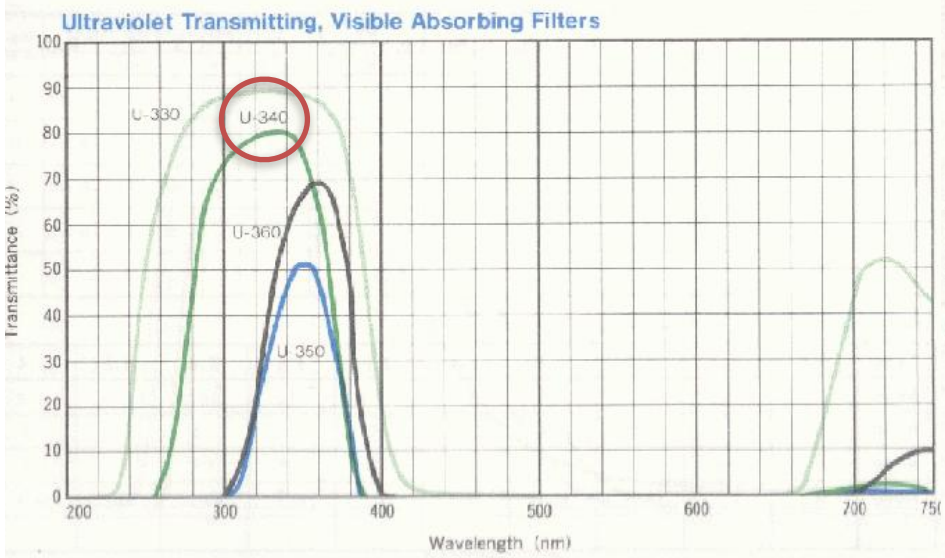
< Blue Sensitivity Comparison >

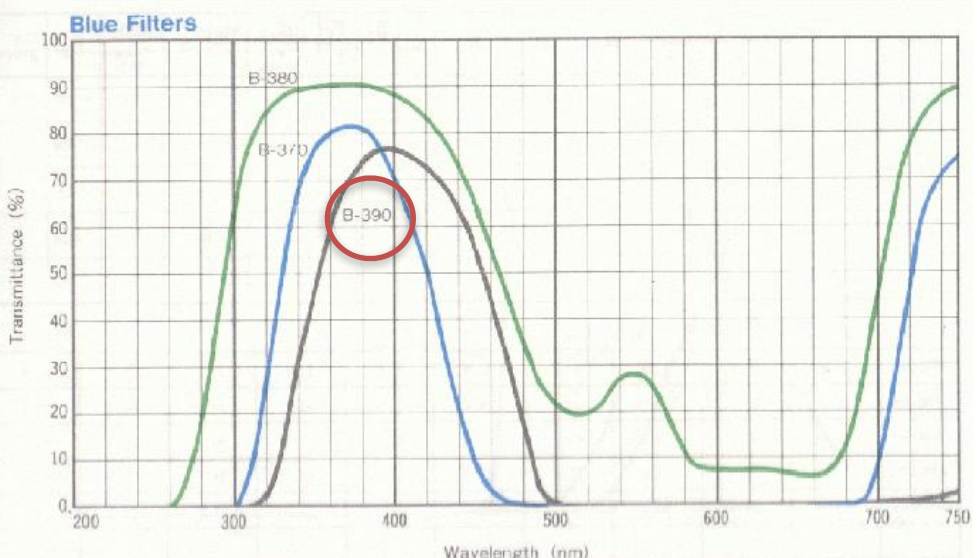
- Object: BD+28 4211 (standard star)
- Spectro-polarimetric mode
  - grating: 600 l/mm
  - blocking filter: (red curve): w/ L38 & (white curve): w/o L38
- **Notice the ADU number at the blue end of the spectrum. Also, note that the 2nd-order overlap begins at λ ~ 6400Å, indicating the instrument is detecting photons right down to the atmospheric UV cutoff of λ ~ 3200Å.**

Blue Sensitivity Comparison (2017-09-19 @61-inch)

< Blue Sensitivity Comparison (Blue Lens #1 vs. Nikon) >

- Object: BD+28 4211 (standard star)
- Spectro-polarimetric mode
  - grating: 600 l/mm (not blue grating)
- With U340 filter, the blue lens sensitivity is ~40 times higher than the Nikon.
- With B390 filter, the blue lens sensitivity is ~1.04 times higher than the Nikon (4% higher).
- **In λ < 4000Å, the new blue lens is much higher sensitive than the original Nikon lens. However, in λ > 4000Å, two lenses show similar amounts.**
  - **Even if the grating used is not optimal at blue region and the wavelength of two filters are partially overlapped, it is interesting to see the 40x sensitive!**

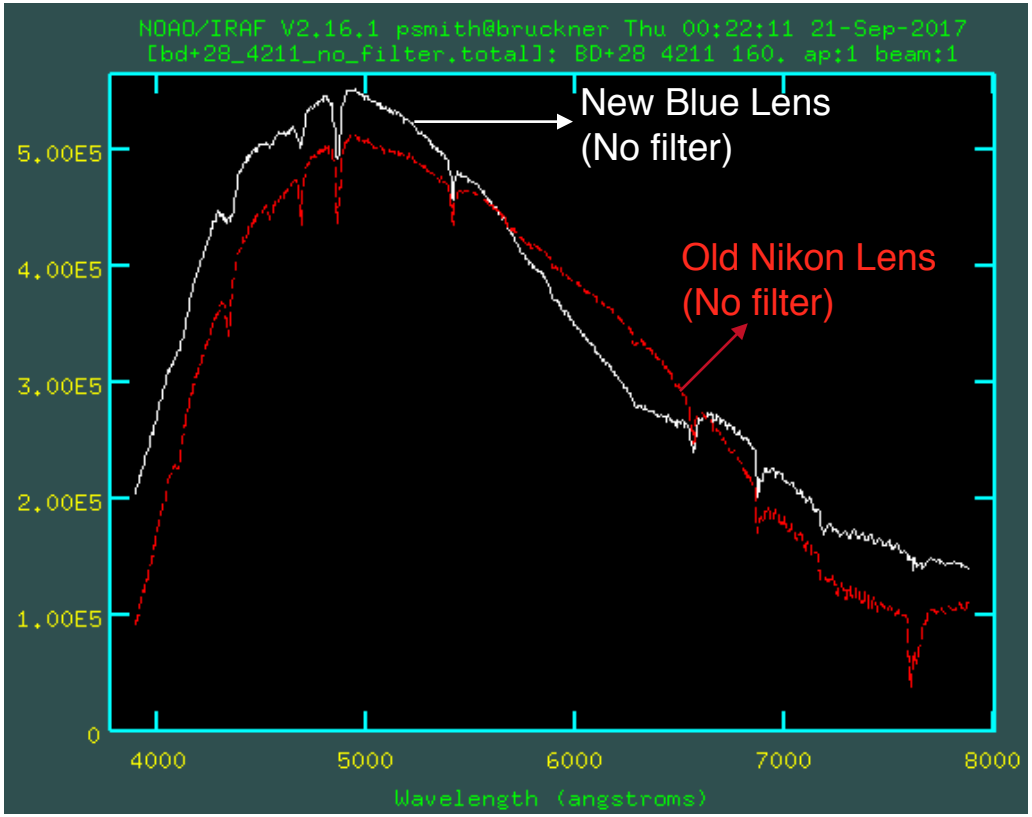




Blue Sensitivity Comparison (2017-09-19 @61-inch)

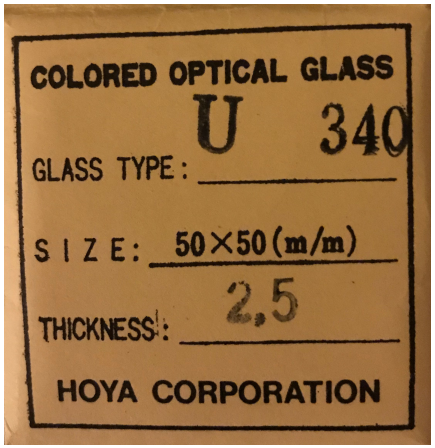
< Blue Sensitivity Comparison (Blue Lens #1 vs. Nikon) >

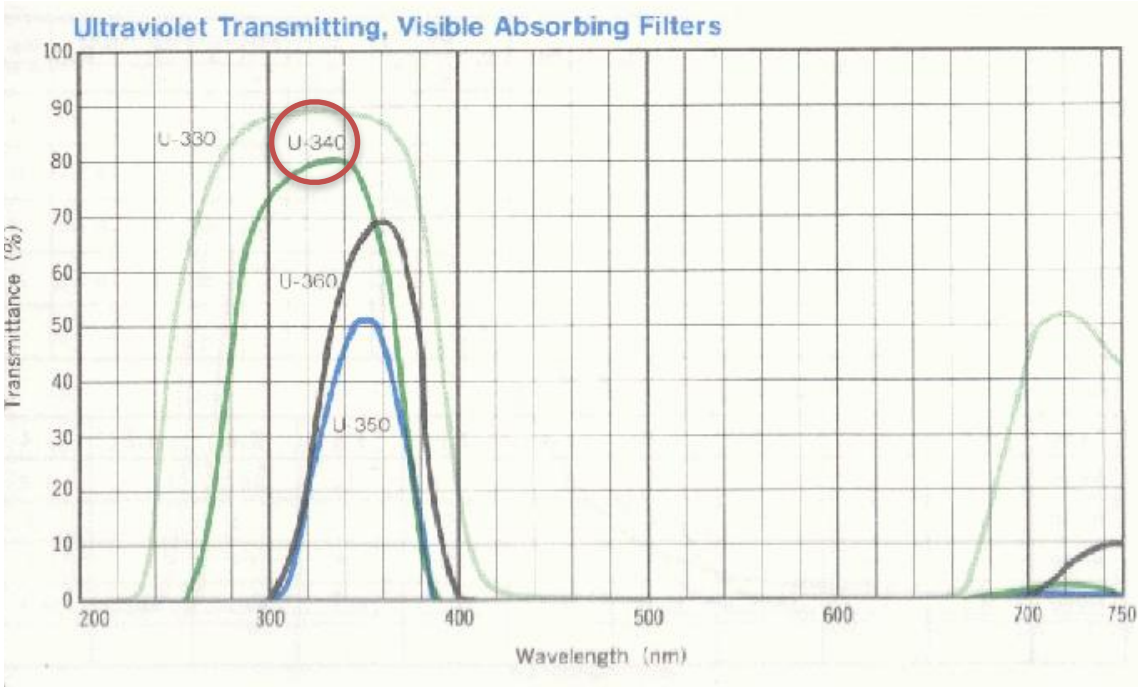
- Object: BD+28 4211 (standard star)
- Spectro-polarimetric mode
  - grating: 600 l/mm (not blue grating)
  - No filters used for both lenses



PSF Measurement (2017-09-20 @61-inch)

- With U340 filter

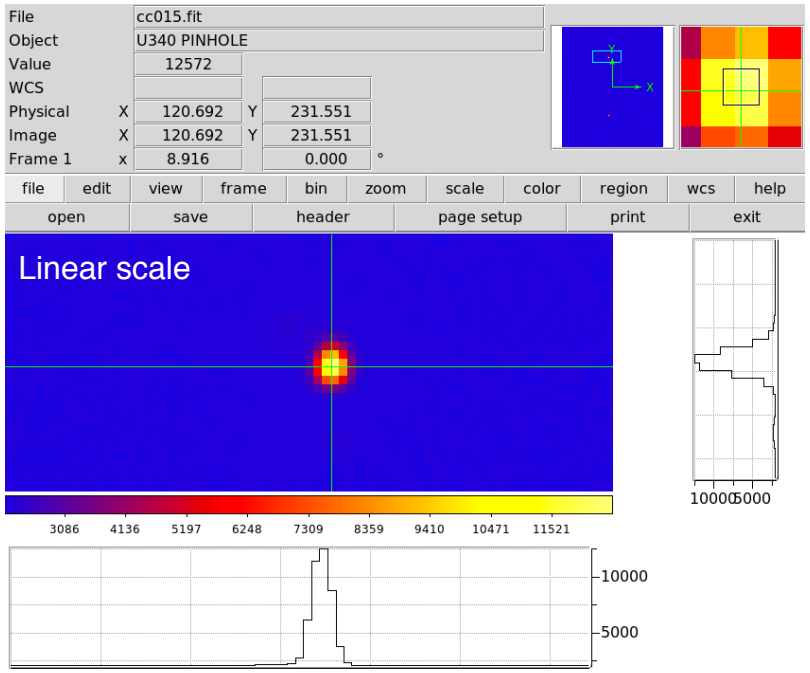


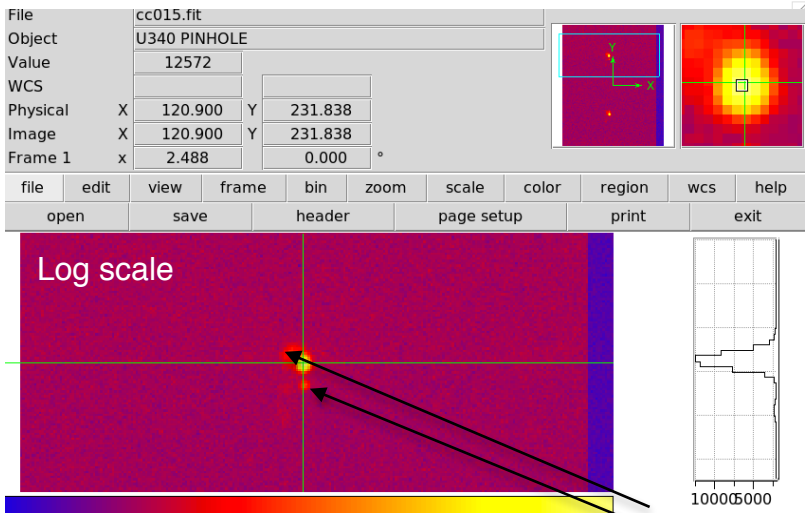


PSF Measurement (2017-09-20 @61-inch)

< PSF Profile (Blue Lens #1) >

- Filter: U340
- Object
  - “blue light projected on the dome” with pinhole located at the Cassegrain focus
- Raw data: “cc015.fit”

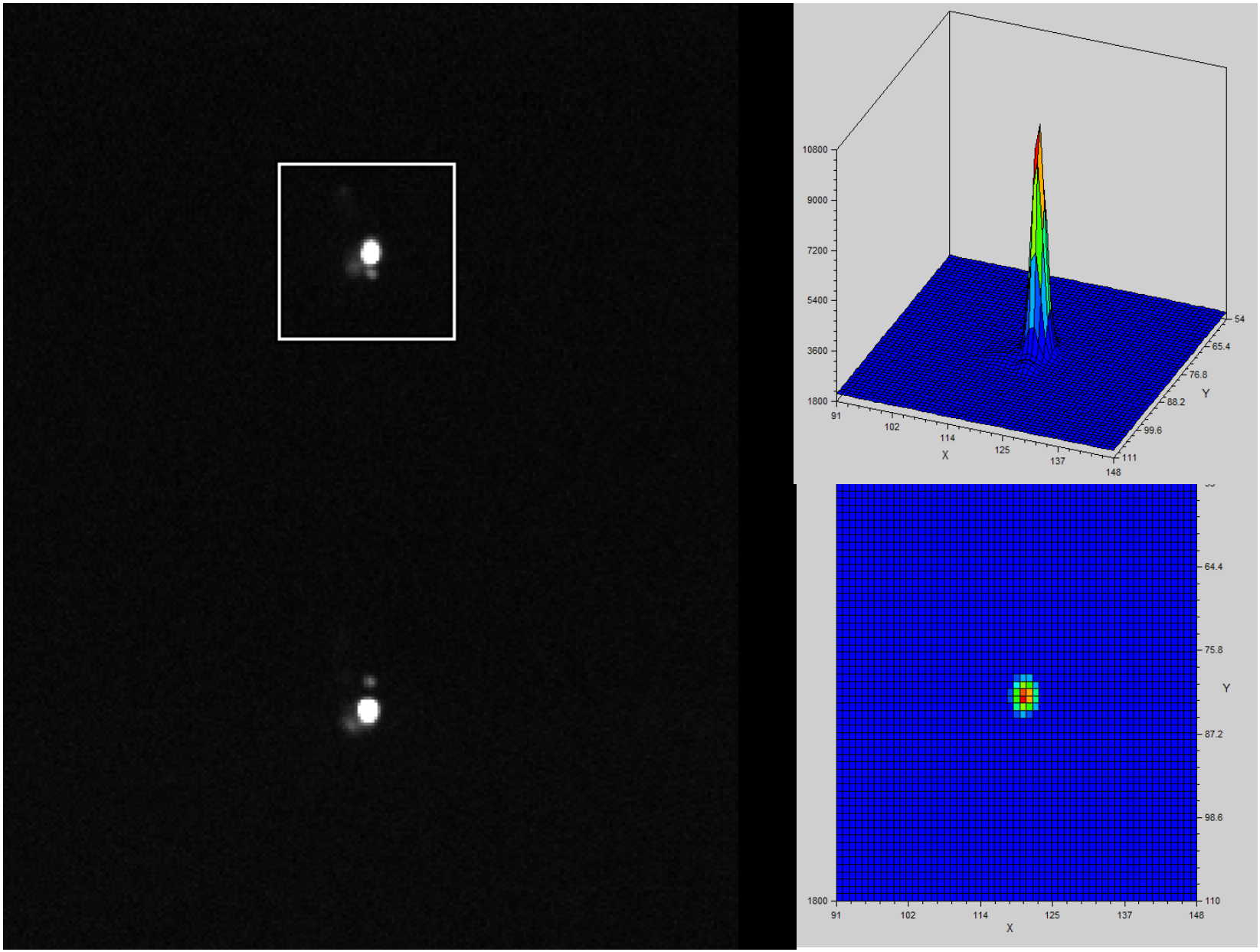




Internal reflection (weak)?
- ~5 times less than main peak and ~1.1 times higher than background

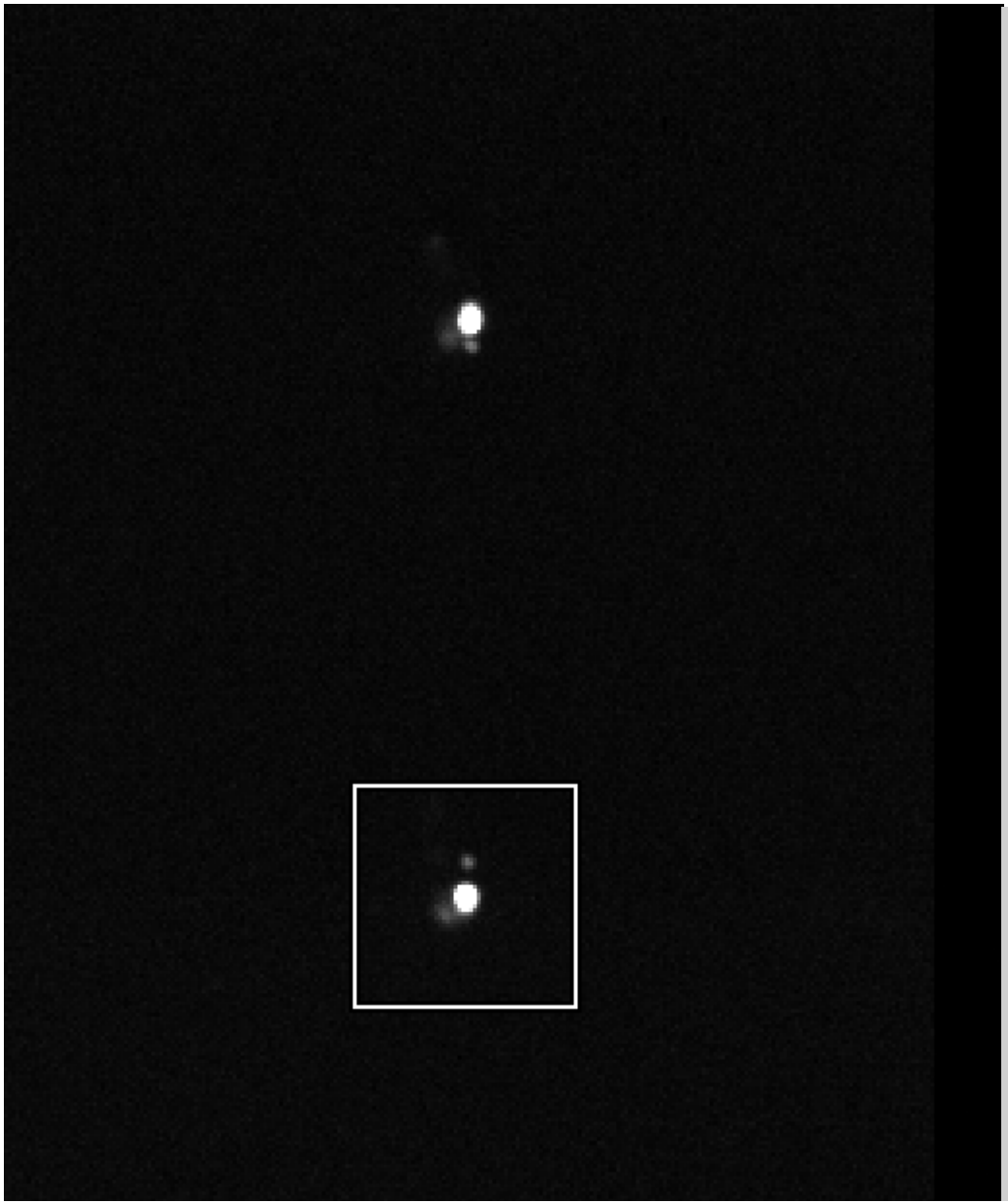
PSF Measurement (2017-09-20 @61-inch)

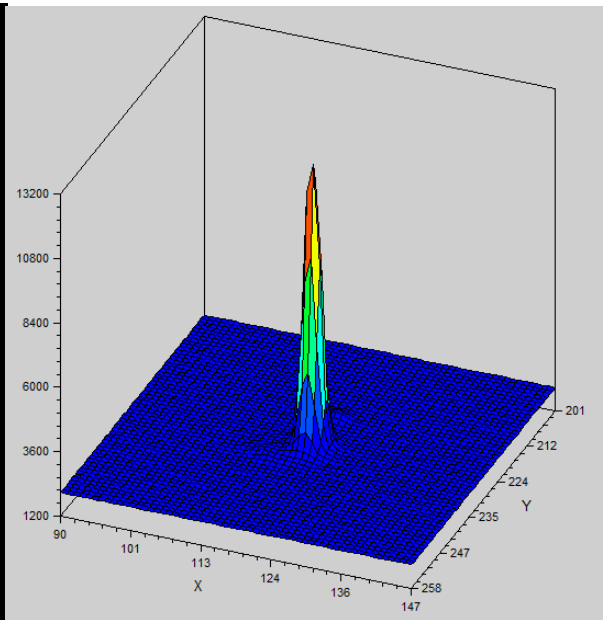
< Pinhole@Cassegrain Focus (Blue Lens #1) >

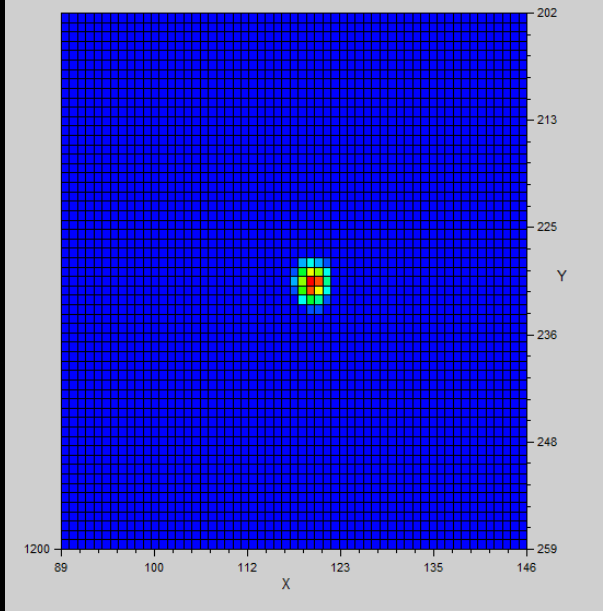


PSF Measurement (2017-09-20 @61-inch)

< Pinhole@Cassegrain Focus (Blue Lens #1) >



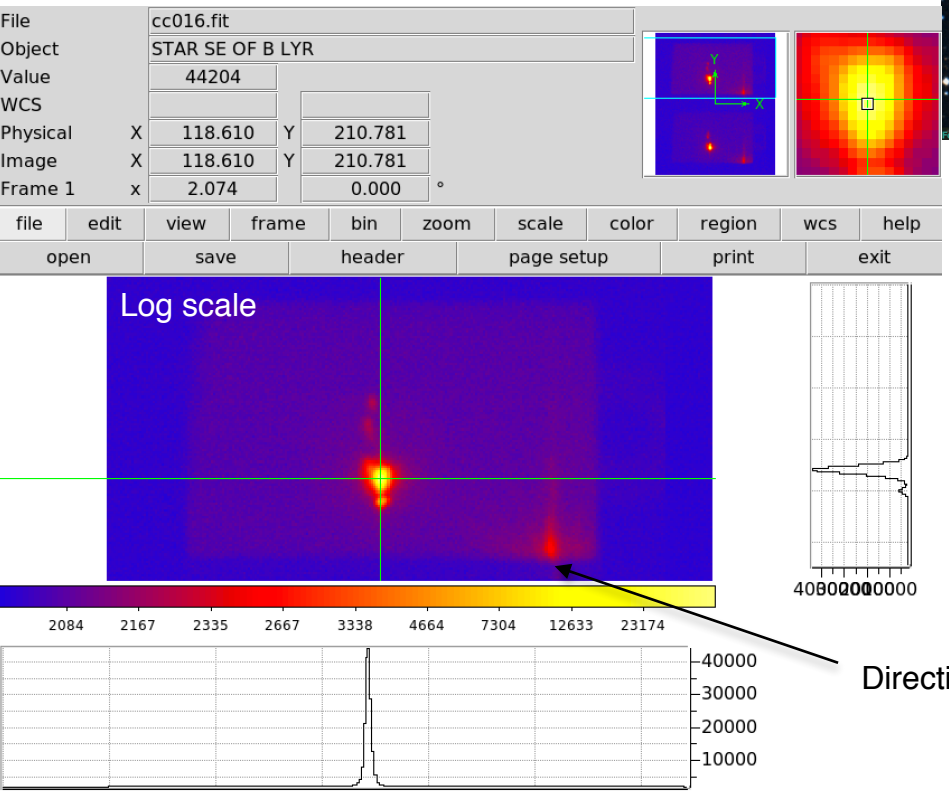




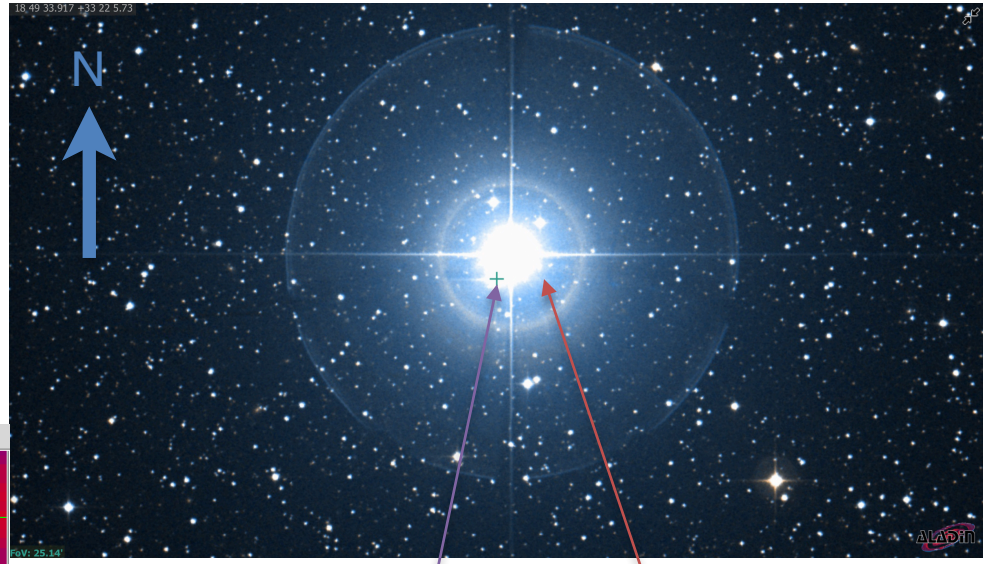
PSF Measurement (2017-09-20 @61-inch)

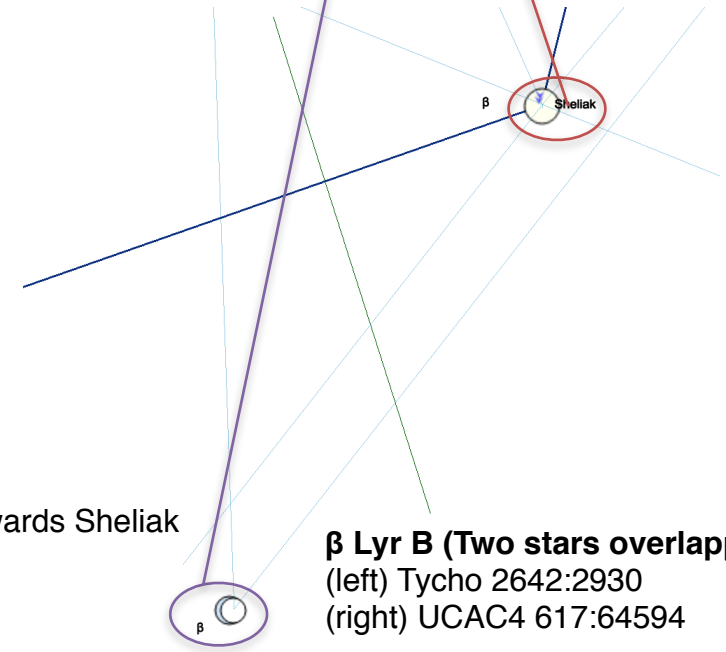
< PSF Profile (Blue Lens #1) >

- Filter: U340
- Object: β Lyr B
- Seeing: 1.6 ~ 1.7 arcsec (measured at red)
- Raw data: “cc016.fit” ~ “cc030.fit” (at various fields)



Direction towards Sheliak



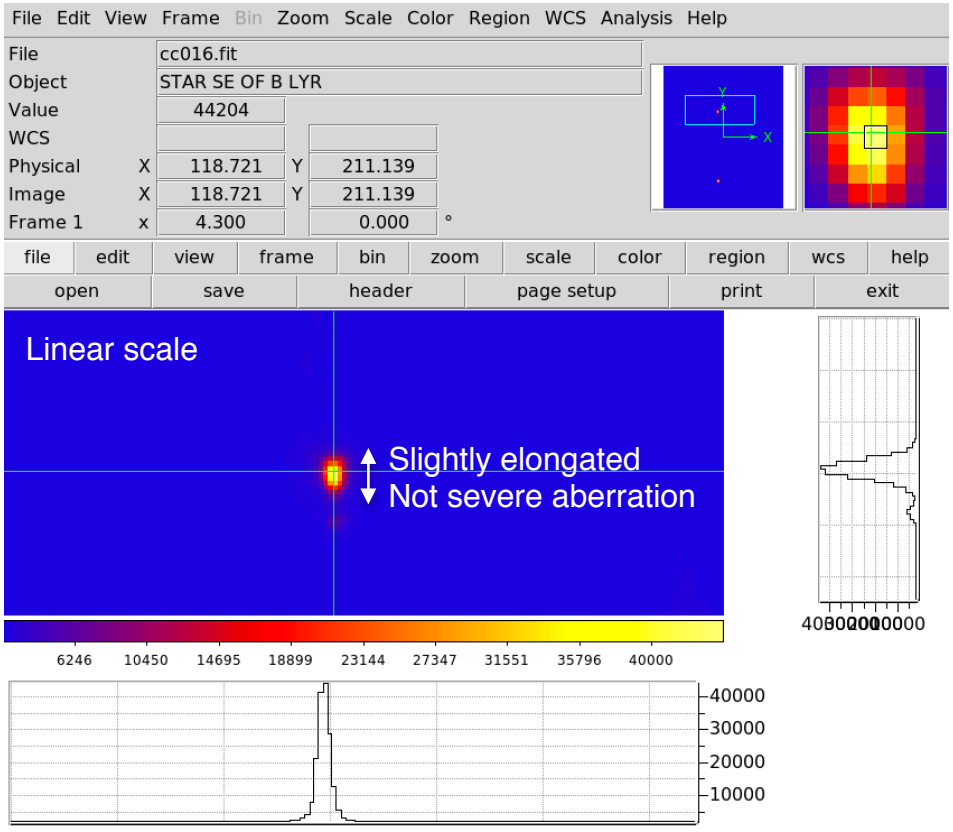


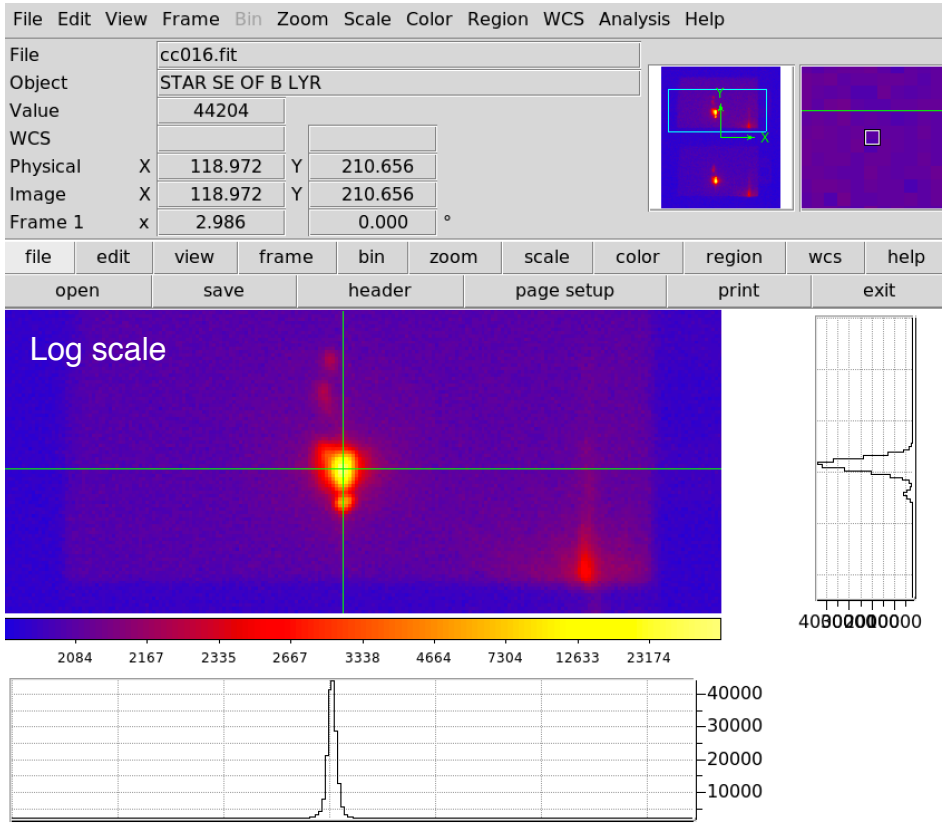
β Lyr B (Two stars overlapped???)
(left) Tycho 2642:2930
(right) UCAC4 617:64594

PSF Measurement (2017-09-20 @61-inch)

< PSF Profile (Blue Lens #1) >

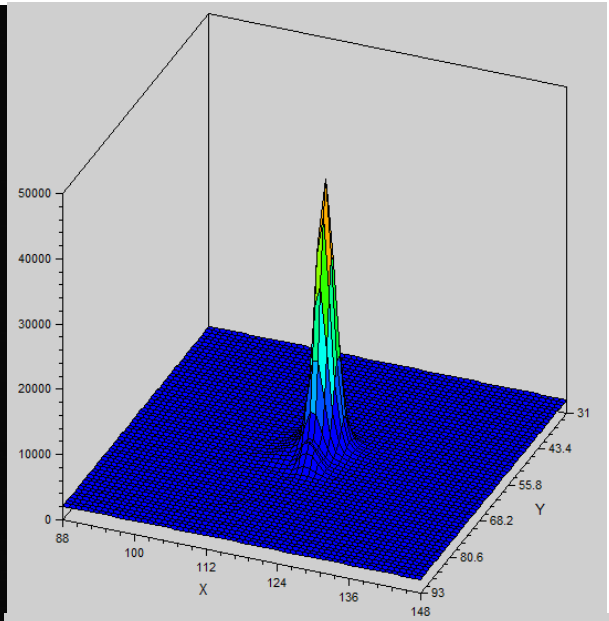
- Filter: U340
- Object: β Lyr B
- Seeing: 1.6 ~ 1.7 arcsec (measured at red)
- Raw data: “cc016.fit” (near center & slightly lower)

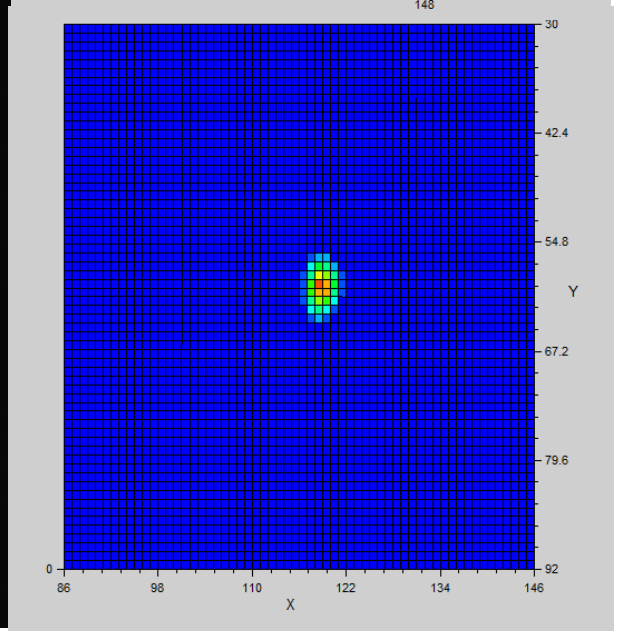




PSF Measurement (2017-09-20 @61-inch)

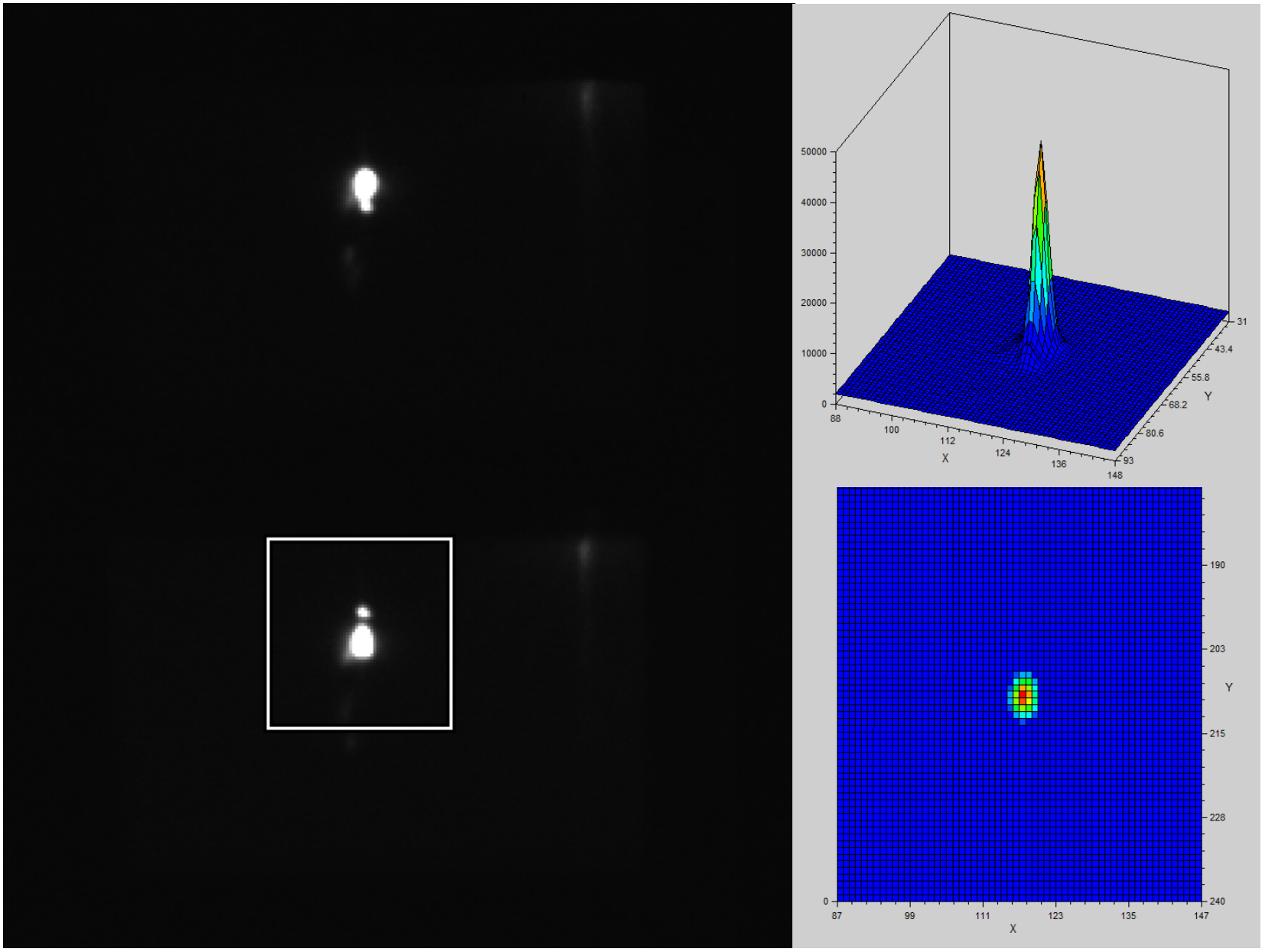
< β Lyr B near center FoV (Blue Lens #1) >





PSF Measurement (2017-09-20 @61-inch)

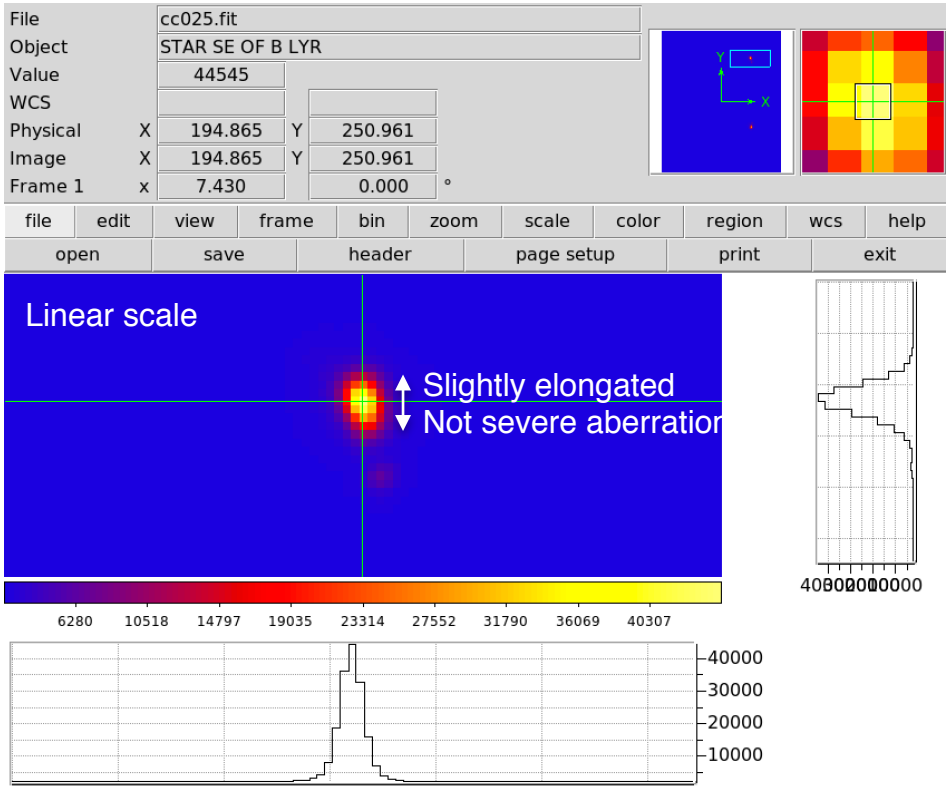
< β Lyr B near center FoV (Blue Lens #1) >

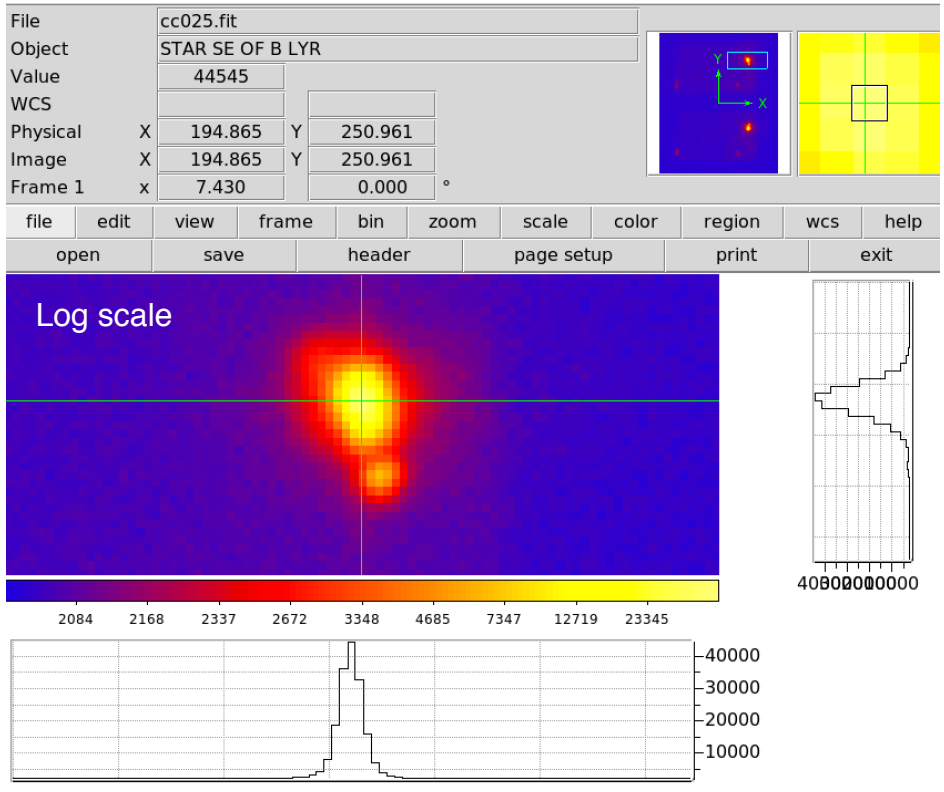


PSF Measurement (2017-09-20 @61-inch)

< PSF Profile (Blue Lens #1) >

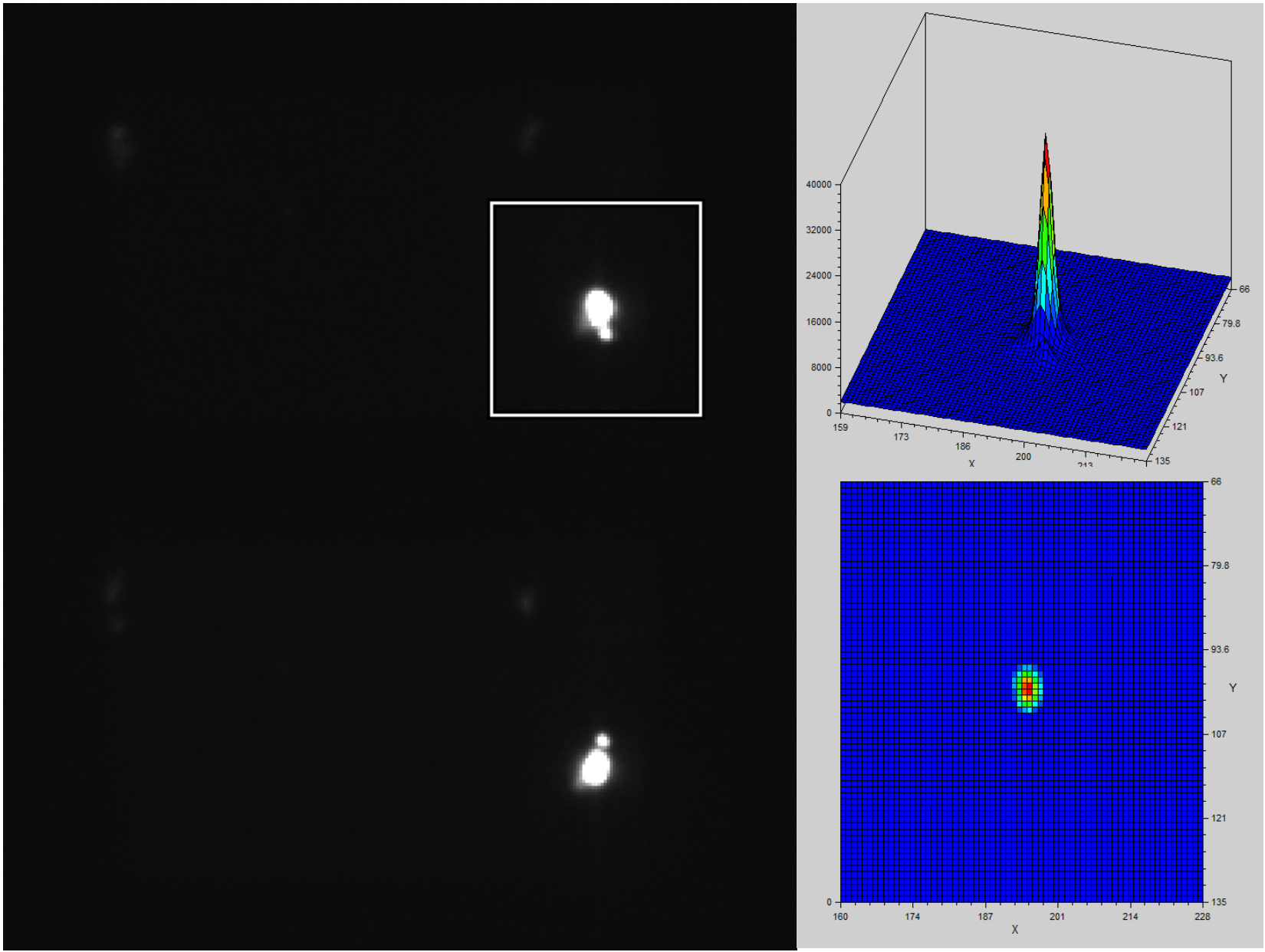
- Filter: U340
- Object: β Lyr B
- Seeing: 1.6 ~ 1.7 arcsec (measured at red)
- Raw data: “cc025.fit” (upper right)





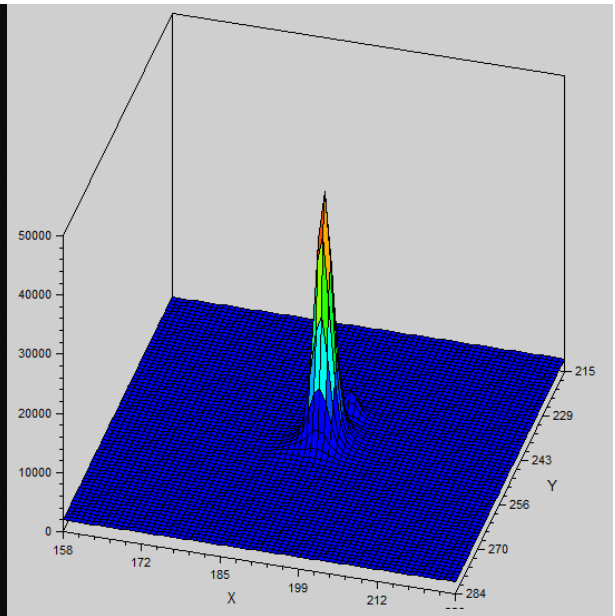
PSF Measurement (2017-09-20 @61-inch)

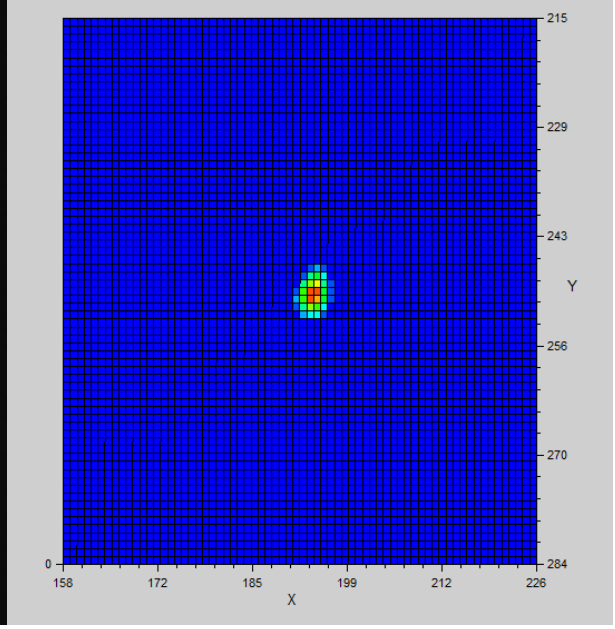
< β Lyr B at corner FoV (Blue Lens #1) >



PSF Measurement (2017-09-20 @61-inch)

< β Lyr B at corner FoV (Blue Lens #1) >





Mechanical Issues Found (1)

< Focus Ring issue >

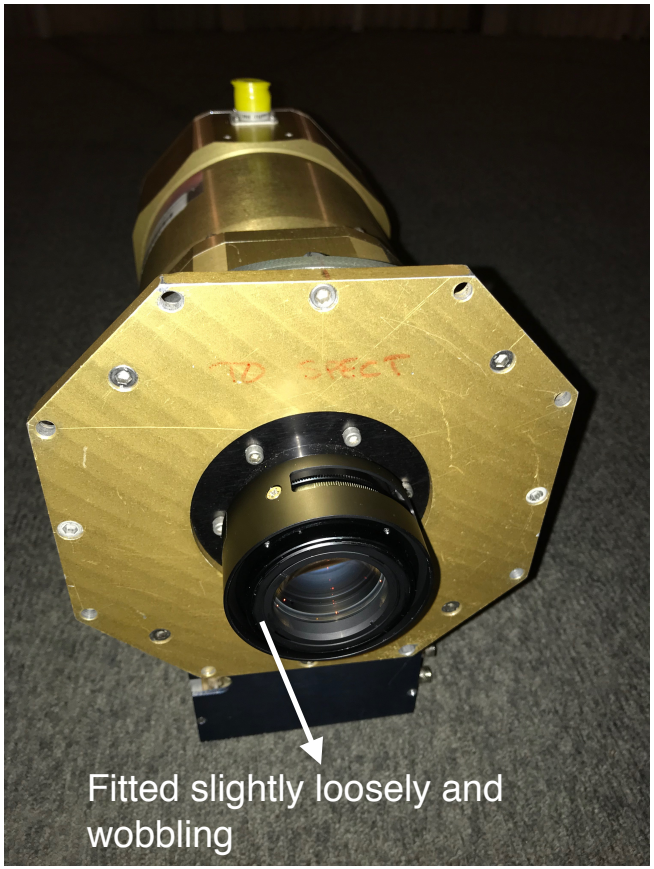
- Focusing ring is not compatible with the structure. Outer diameter of the ring is a litter larger, which can be easily fixed.
  - **This will be fixed until December (may be easy work).**

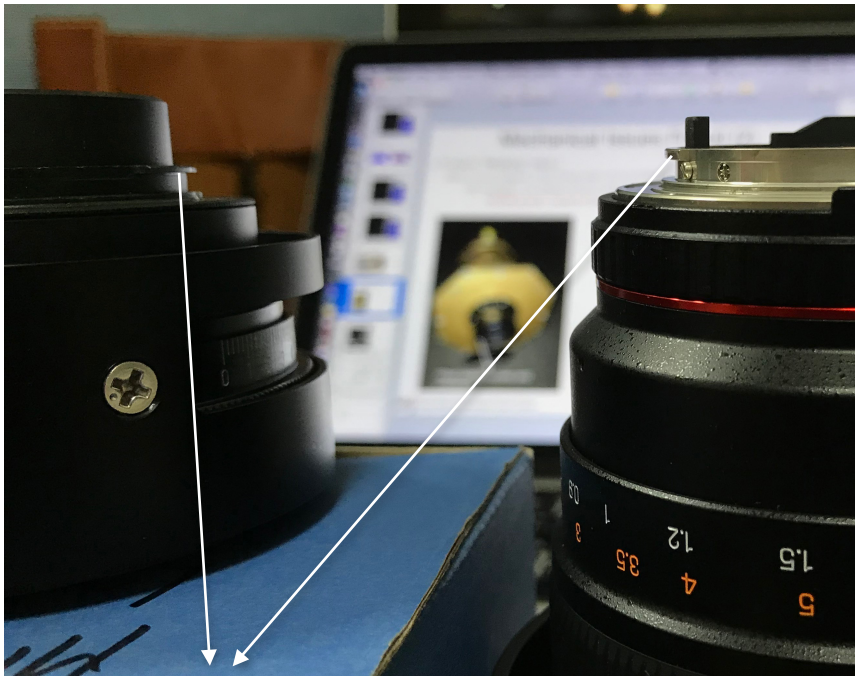
- **New Focus Ring Modification**
  - ✓ Inner size: OK
  - ✓ Outer size should be same as the size of original ring (~82.25mm).

Mechanical Issues Found (2)

< F-mount “Wobbling” issue >

- Nikon F-mount adapters of both lenses seems not to be attached firmly.
  - Will investigate more detailed tomorrow afternoon.
    - ✓ **“Wobbling issue” found at F-mount adapter (9/19)**

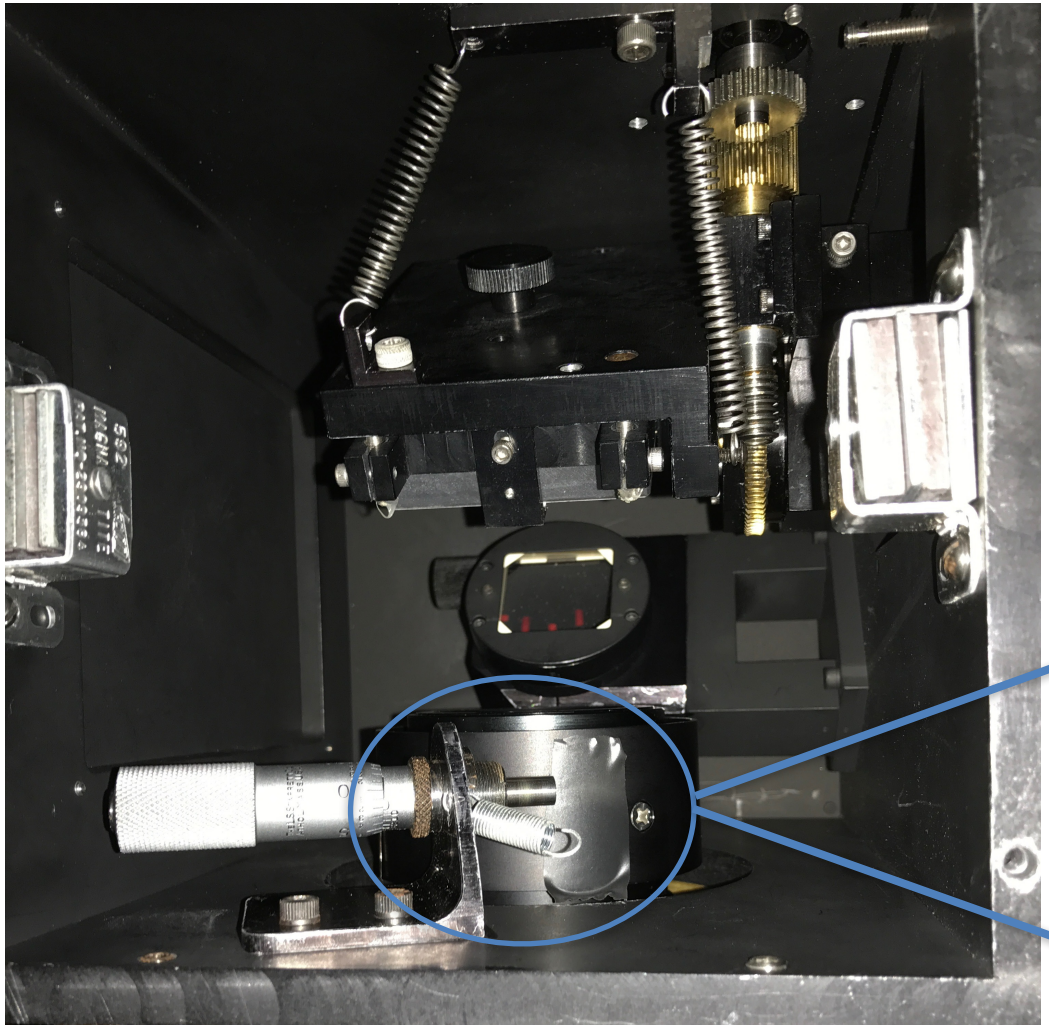


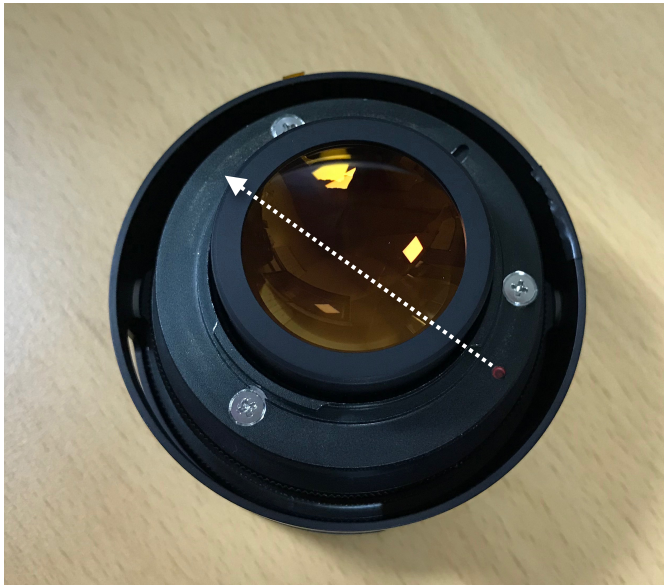


We suspect that three blades of F-mount in new lenses are slightly thinner than the commercial lenses. This may be one of the candidates of the “wobbling” issue.

Mechanical Issues Found (3)

< F-mount “direction” issue >





Hopefully, this issue can be easily resolved by moving “red spot” to the 180° opposite.

It is recommended that the F-mount adapter is rotated to see the “focusing scale”.

Test Result Summary [TBD]

Items		Lens #1	Lens #2	Remark
Mechanical issue	Interference at Dewar	No	No	
	Focusing ring	Outer diameter should be reduced referring to the redundant ring.		Lens#1: best focus @2mm Lens#2: best focus@ [TBD]
	F-Mount	Mounting is not so good - “some wobbling”.		See the movie attached.
		Scaling number should be opposite direction by rotating F-mount.		See the picture attached.
Imaging-pol mode	PSF profile (pinhole)	• Circular shape • Internal reflection (?)		
	PSF profile (star, center)	• Slightly elongated • No severe aberration • Internal reflection (?)		β Lyr B (double?)
	PSF profile (star, field)	• Slightly elongated • No severe aberration • Internal reflection (?)		β Lyr B (double?)
	measure P and θ			
	dPA check			
Spec-pol mode	Throughput1			calibration source
	Throughput2	10x enhanced [TBD]		Pol. standard stars
Extended object		[TBD]	[TBD]	[TBD]

Observed Data Summary (9/18~9/20)

- Data
  - Raw data
    - ✓ Note that “aa***.fit, bb***.fit, cc***.fit, dd***.fit” test data
  - Reduced data

- Observation Log
  - only for 2017/09/18~19 (when blue lens was fully used all night)