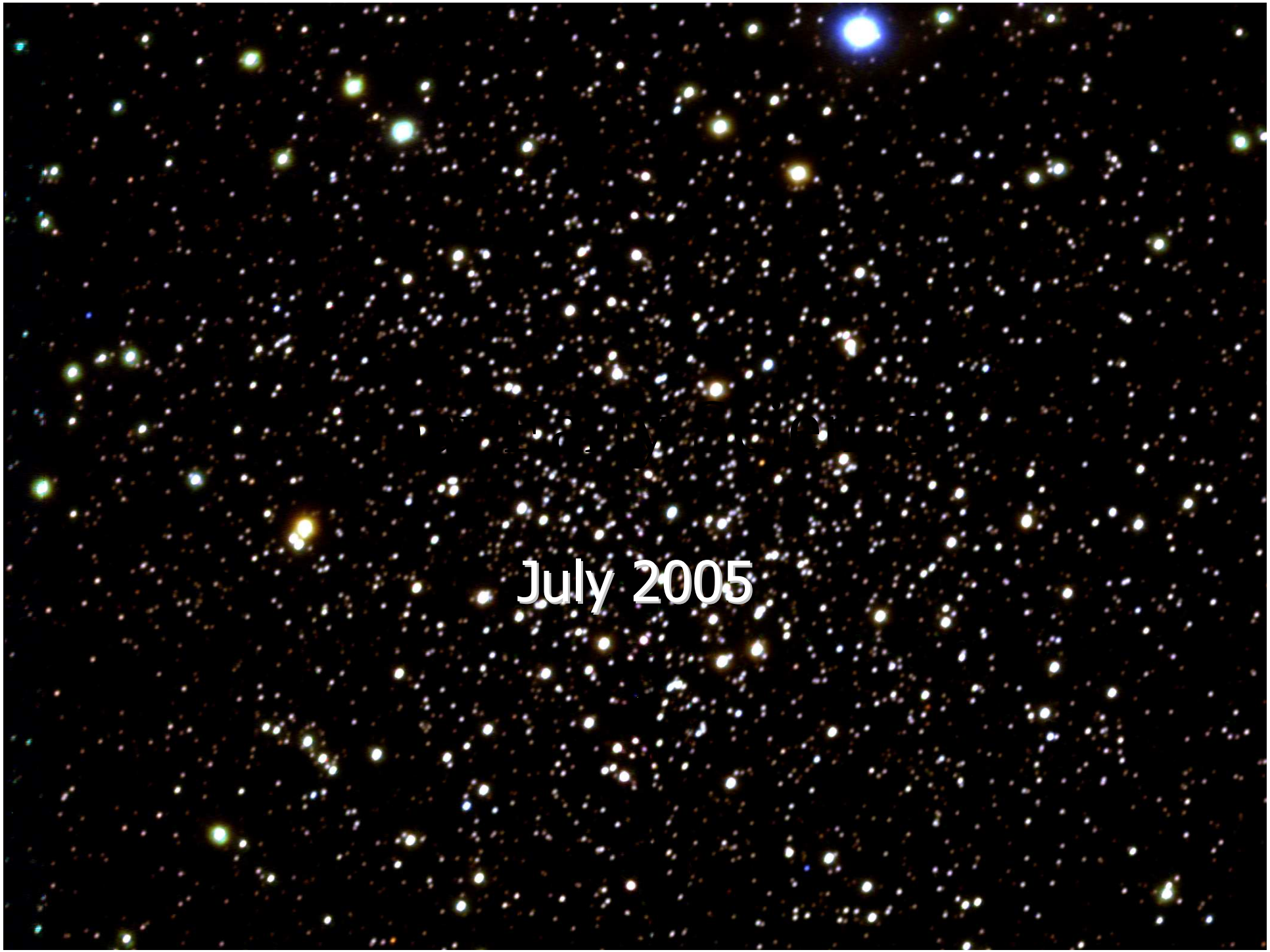
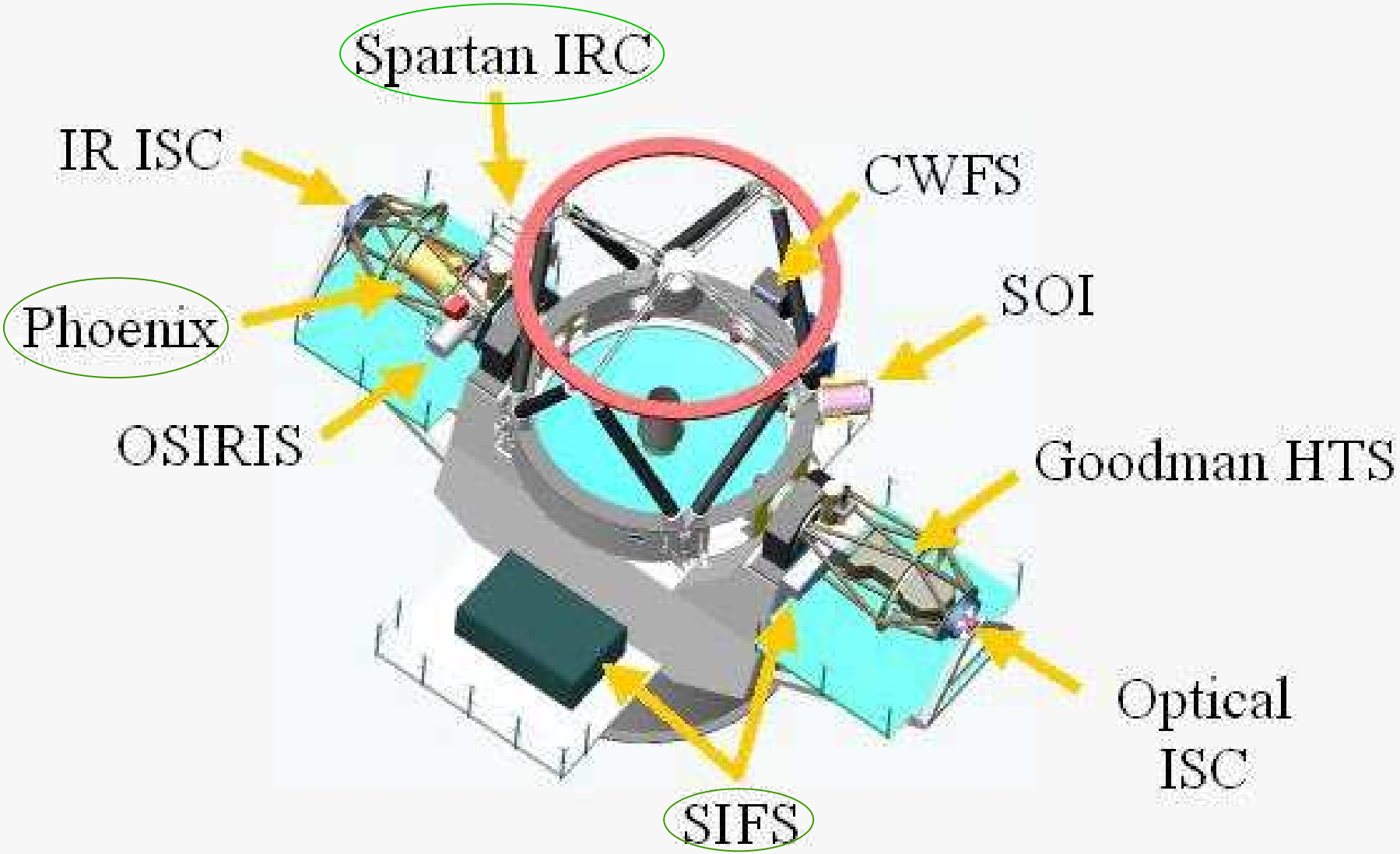

July 2005

Instruments



SOAR

- **SOAR** (SOuthern Observatory for Astrophysical Research) **Telescope** is a 4.1 m diameter alt-az optical telescope constructed by a consortium of the razilian Ministry of Science, the ational Optical Observatories, the niversity of North Carolina and ichigan State University.
- It is located at Cerro Pachon, in Chile, and was designed to work from the atmospheric cut-off in the blue (320 nm) to the near infrared, to have excellent image quality (0.22 arcseconds), fast slewing and to have up to nine instruments mounted ready for use.
- Its primary mirror is only 10 cm thick and is supported by 120 eletro-mechanical actuators, to set and hold its optimum shape. The tertiary mirror will partially correct the atmospheric turbulence by tip-tilting at 50 Hz.

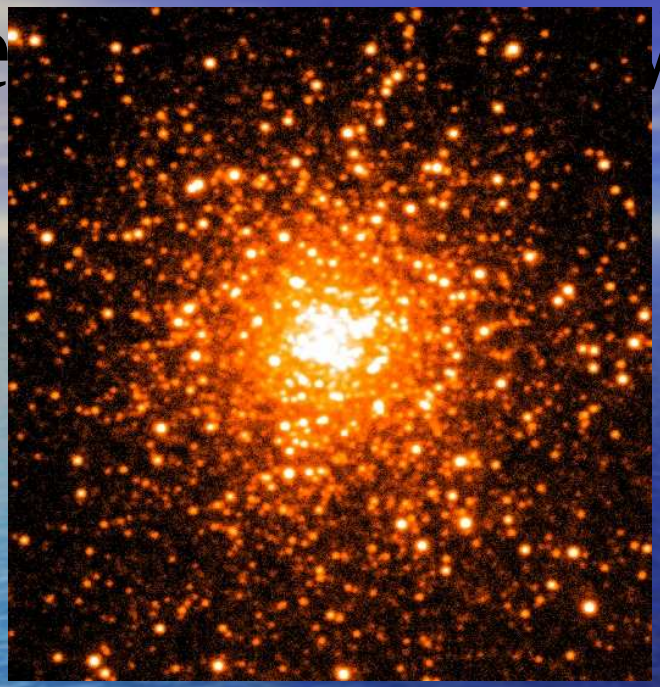
SOAR Instrumentation

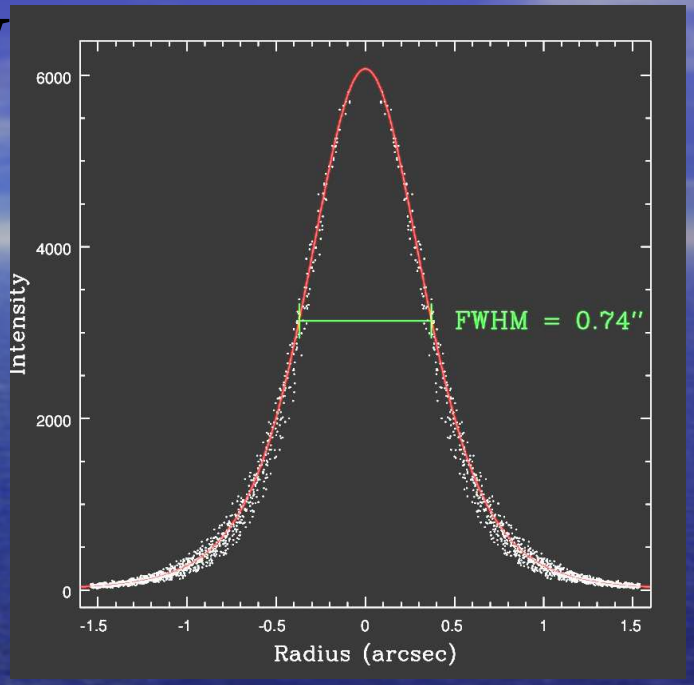
Imagers		FOV (arcmin)	Scale (arcsec/pixel)	Detector	Wavelength Range (micron)
Optical	SOAR Optical Imager	5.25 x 5.25	0.077	E2V CCD mini-mosaic 2 x 4096x2048	0.31-1.05
	Goodman HTS	5.0 x 5.0	0.15	UH/LL CCD mini-mosaic 2 x 4096x2048	0.32-0.85
IR	Spartan IR Camera	2.5 x 5.0 1.5 x 3.0	0.073 0.043	HgCdTe mosaic 2 x 2048 x2048	1.0-2.2
	OSIRIS	3.3 x 3.3 1.3 x 1.3	0.32 0.13	HgCdTe 1024 x 1024	1.0-2.2

Spectrographs		FOV	Resolving Power	Detector	Wavelength Range (micron)
Optical	Goodman HTS	Multislit 5.0 x 2.5 arcmin	VPH gratings 1,400-6000	UH/LL CCD mini-mosaic 2 x 4096x2048	0.32-0.85
	SIFS	IFU 7.8x15 @ 0.3" 3.9x7.5 @ 0.15"	VPH gratings 1,000-40,000	CCD mini-mosaic 2 x 4096x2048	0.32-0.85
IR	OSIRIS	175" x 0.98" 66" x 0.41" 24" x 0.98"	1,200 J, H or K 3,000 J, H or K 1,400 X-disp	HgCdTe 1024 x 1024	1.0-2.2
	Phoenix		Echelle Single order 90,000	InSb 1024 x 1024	1.0-5.0

- The interest in building the telescope started around 1985, by UNC. Its site preparation started in September 1998, The SOAR agreement between the partners for construction was signed in Jan 1999, the mirrors were installed in February 2004, and it was dedicated 17 April 2004.

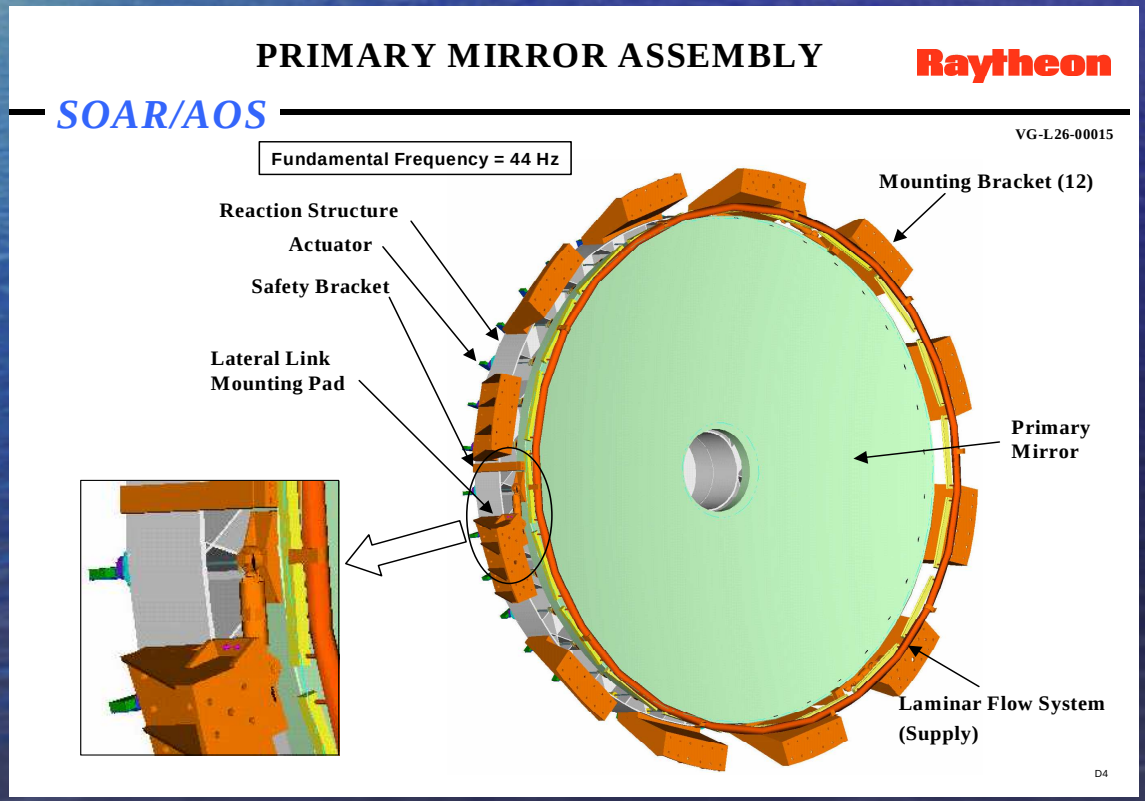
The





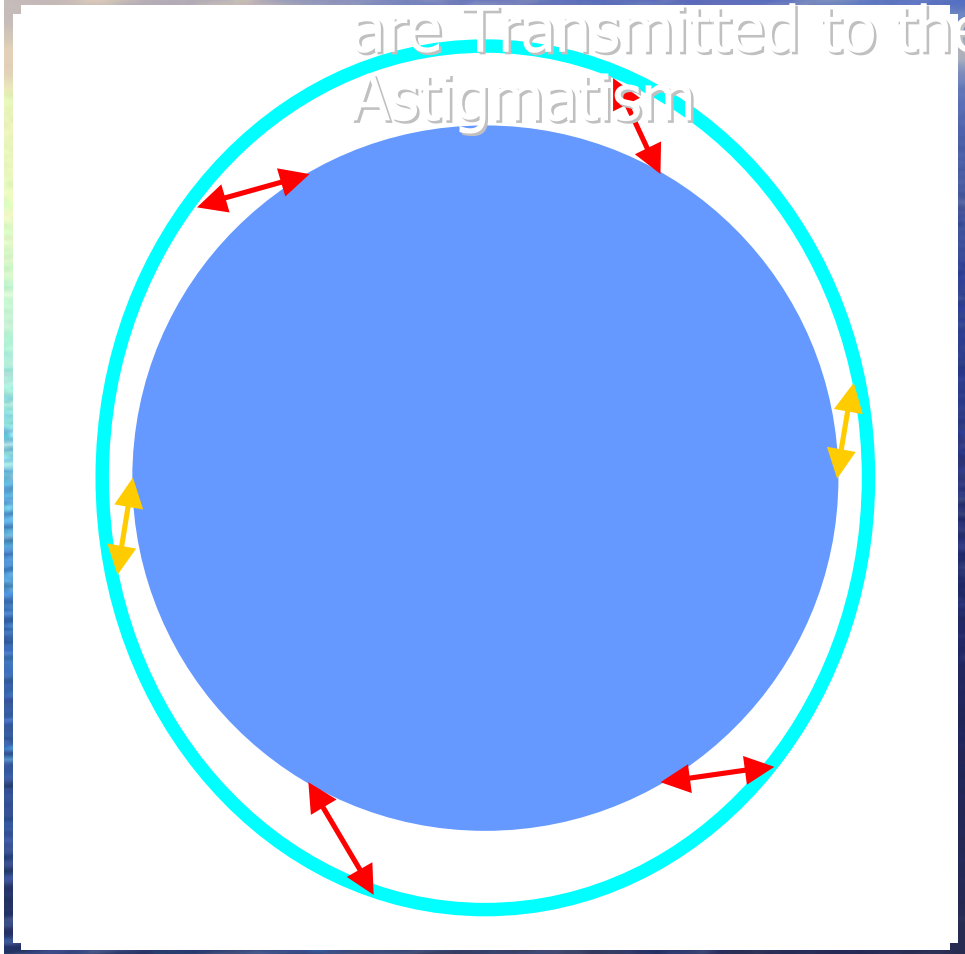
- M1 figure can be optimized to produce seeing limited images of a given object
  - M1 actuators work well and have enough range to correct the measured aberrations anywhere on the sky
  - Residual wave front errors after optimization ~ 0.1 μm RMS

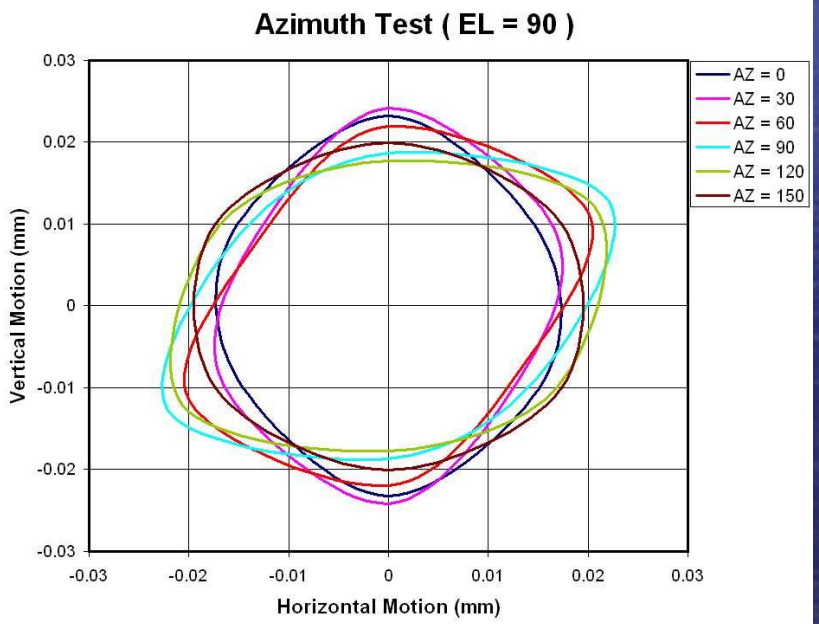
- Design incorporates 6 passive lateral links
  - Carry an increasing fraction of M1 weight as telescope moves off zenith
- Recognized as an area of technical Risk



The Problem

- Six Rigid Links Over Constrain the System
  - Forces due to Asymmetric distortions of the cell are Transmitted to the Glass Producing Astigmatism



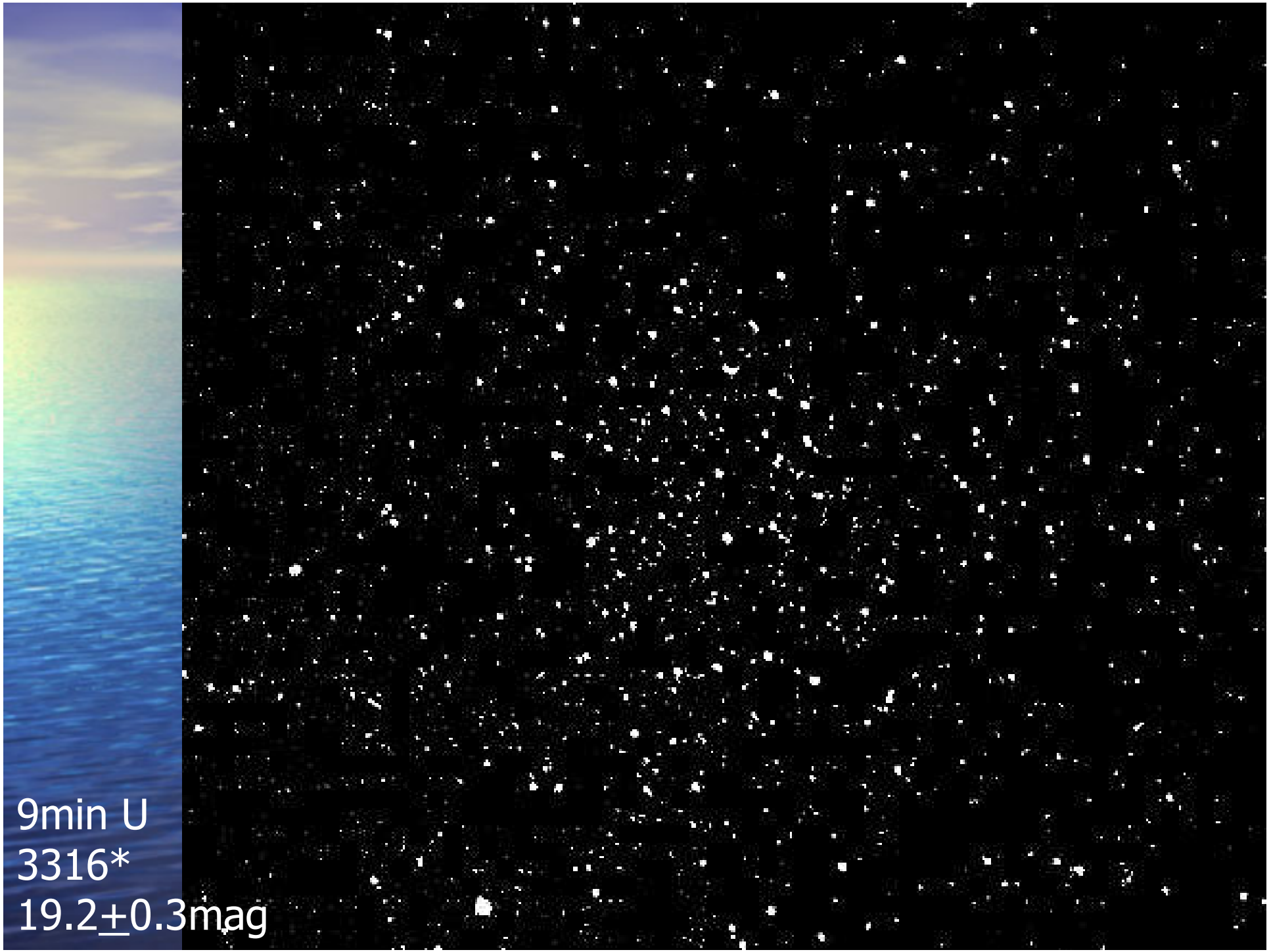


Measured Distortion of cell as Telescope moves in Azimuth

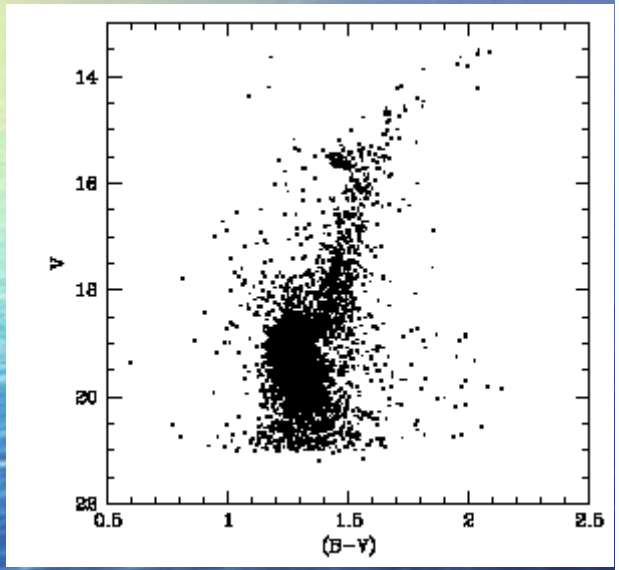
after

- Installation of baffle on M3 31st May
- Wash tertiary and tape secondary 6th Jun
- Wash primary 8th Jun
- Installation of external baffle on SOI 6th Jul

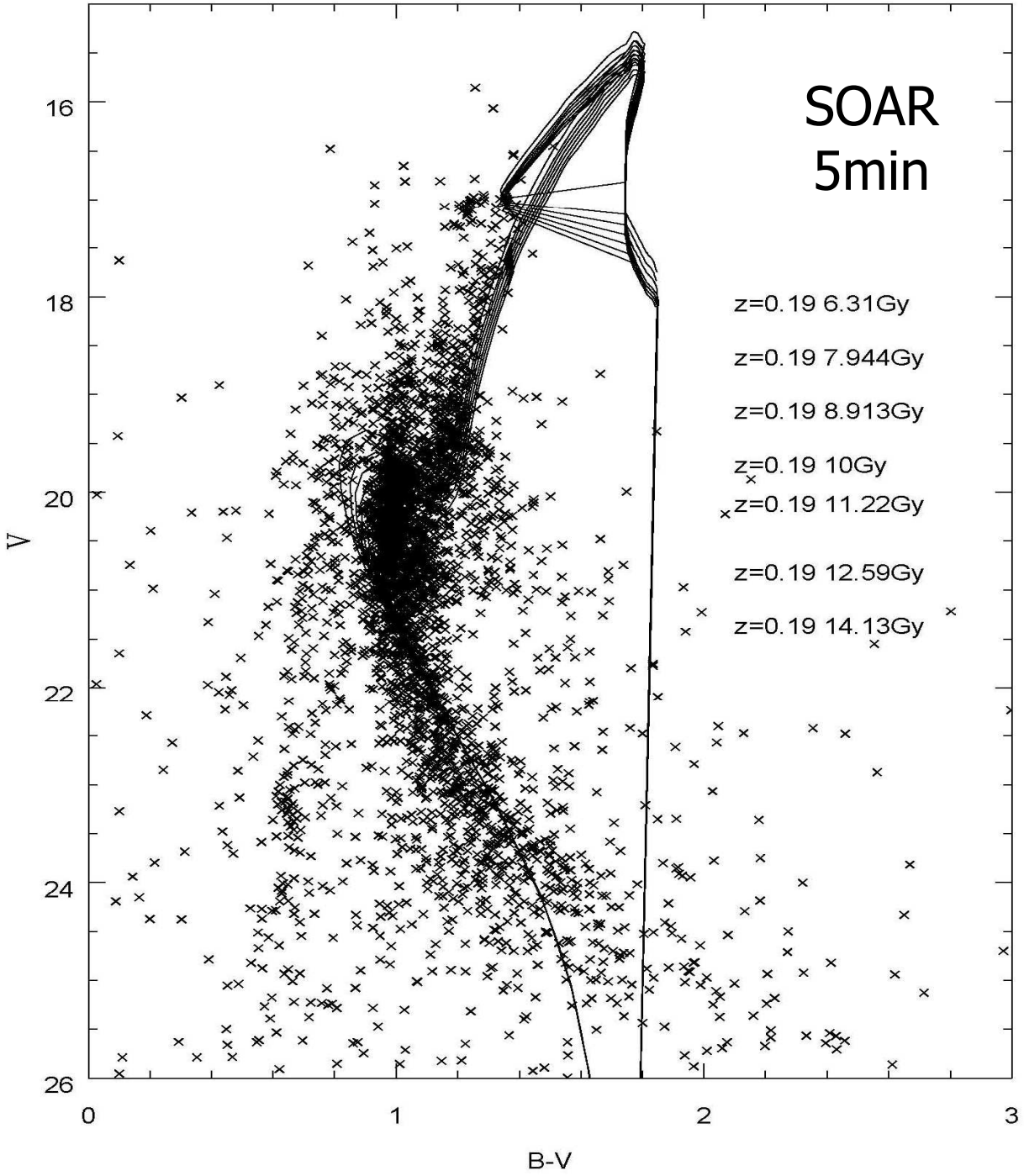
NGC6366
1800s
Brazil SOI3
1”


9min U
3316*
19.2±0.3mag

NGC6366

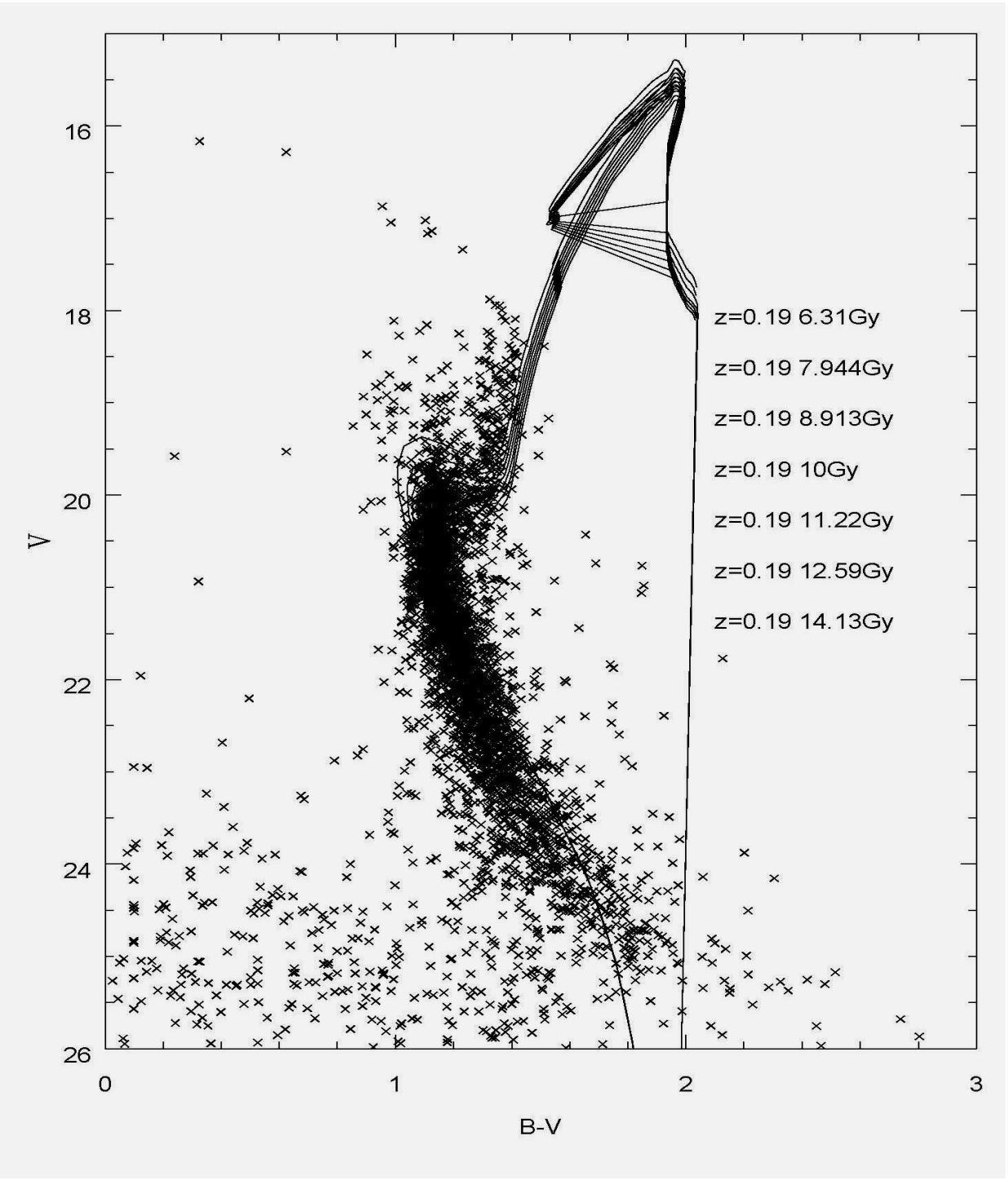


Isaac Newton 2.5m 3x600s

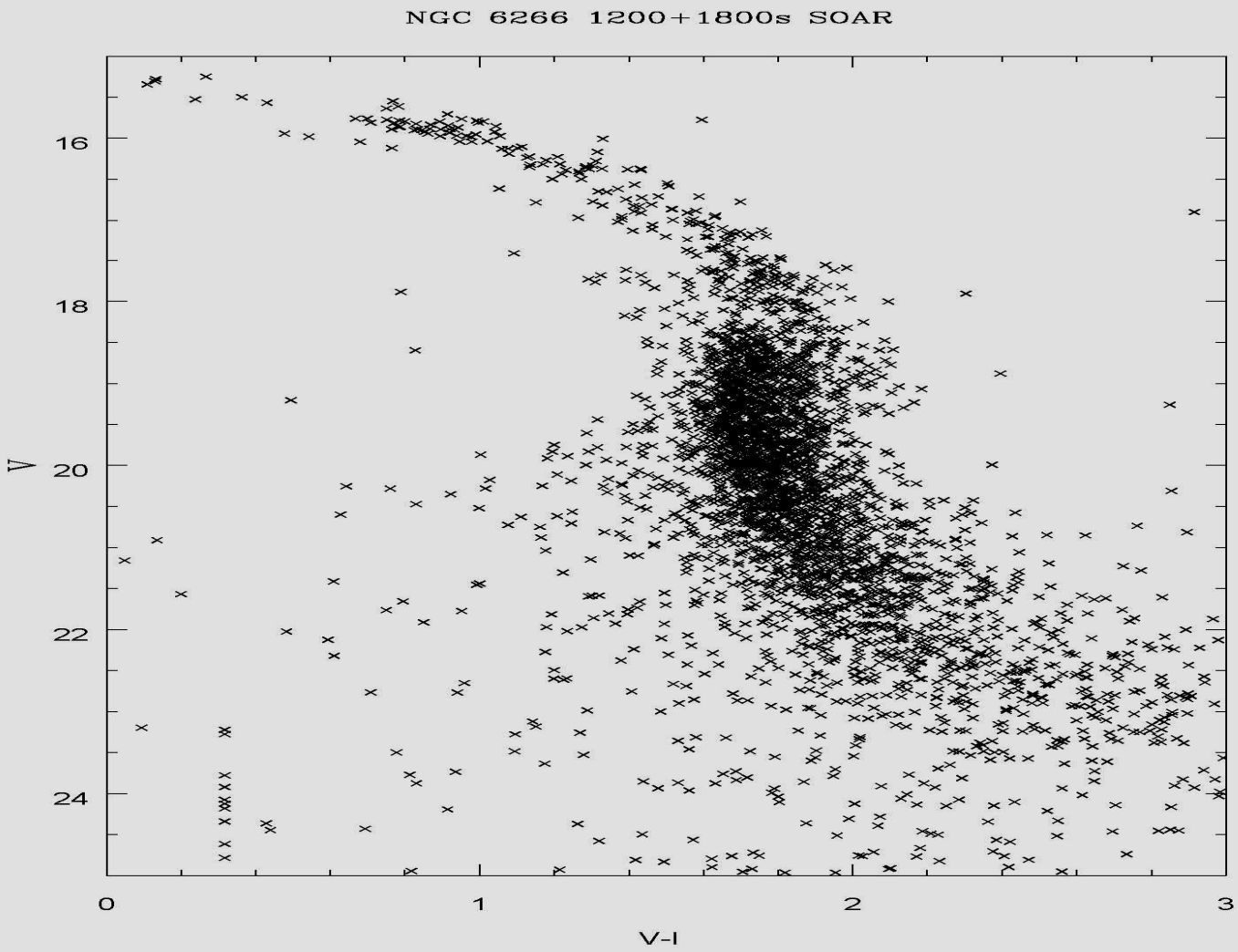


NGC6366

20m

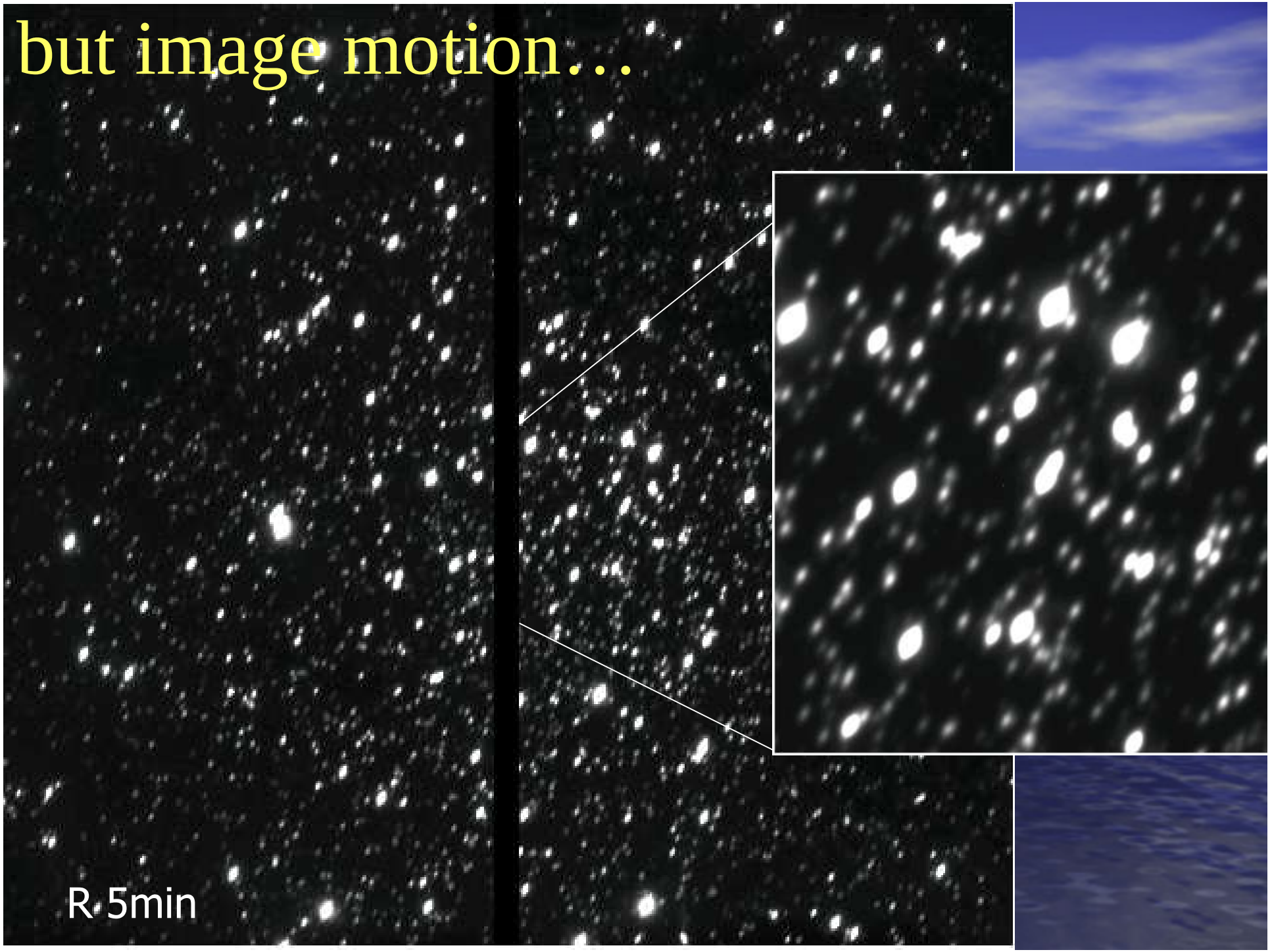

16
18
20
22
24
26
V
0
1
2
3
B-V
z=0.19 6.31Gy
z=0.19 7.944Gy
z=0.19 8.913Gy
z=0.19 10Gy
z=0.19 11.22Gy
z=0.19 12.59Gy
z=0.19 14.13Gy

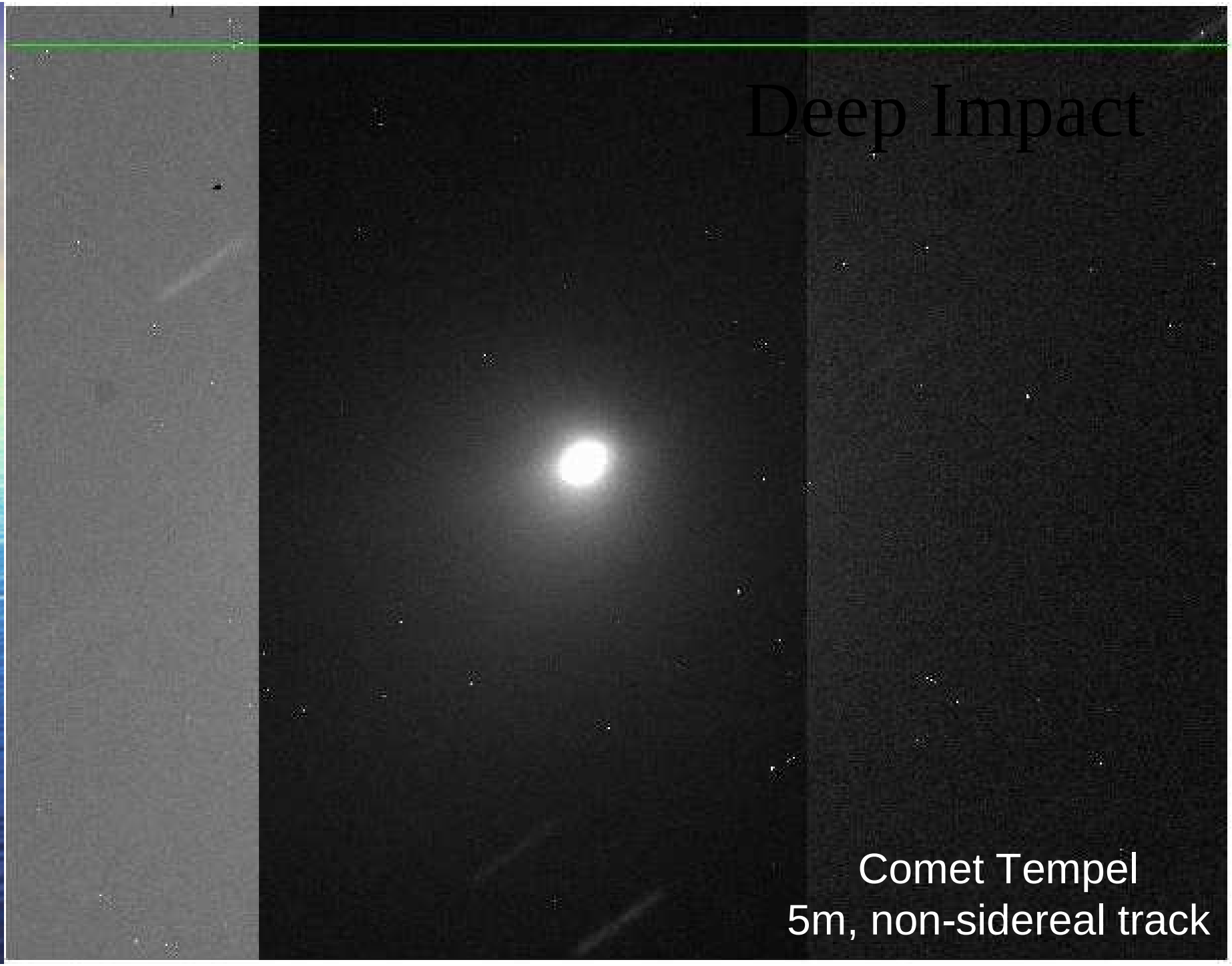
NGC6366 V-I

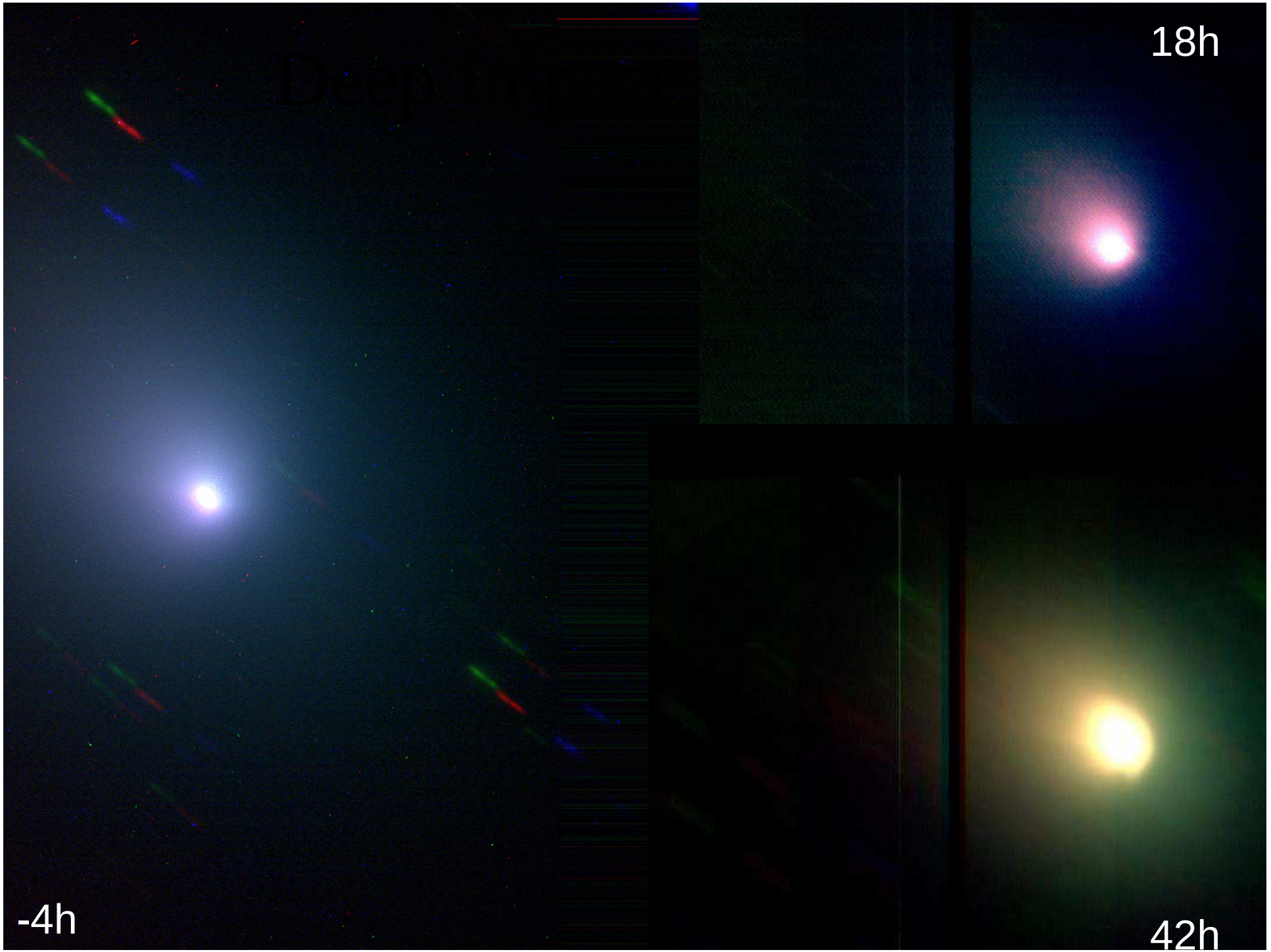


Extinction and color terms still to be determined

but image motion…

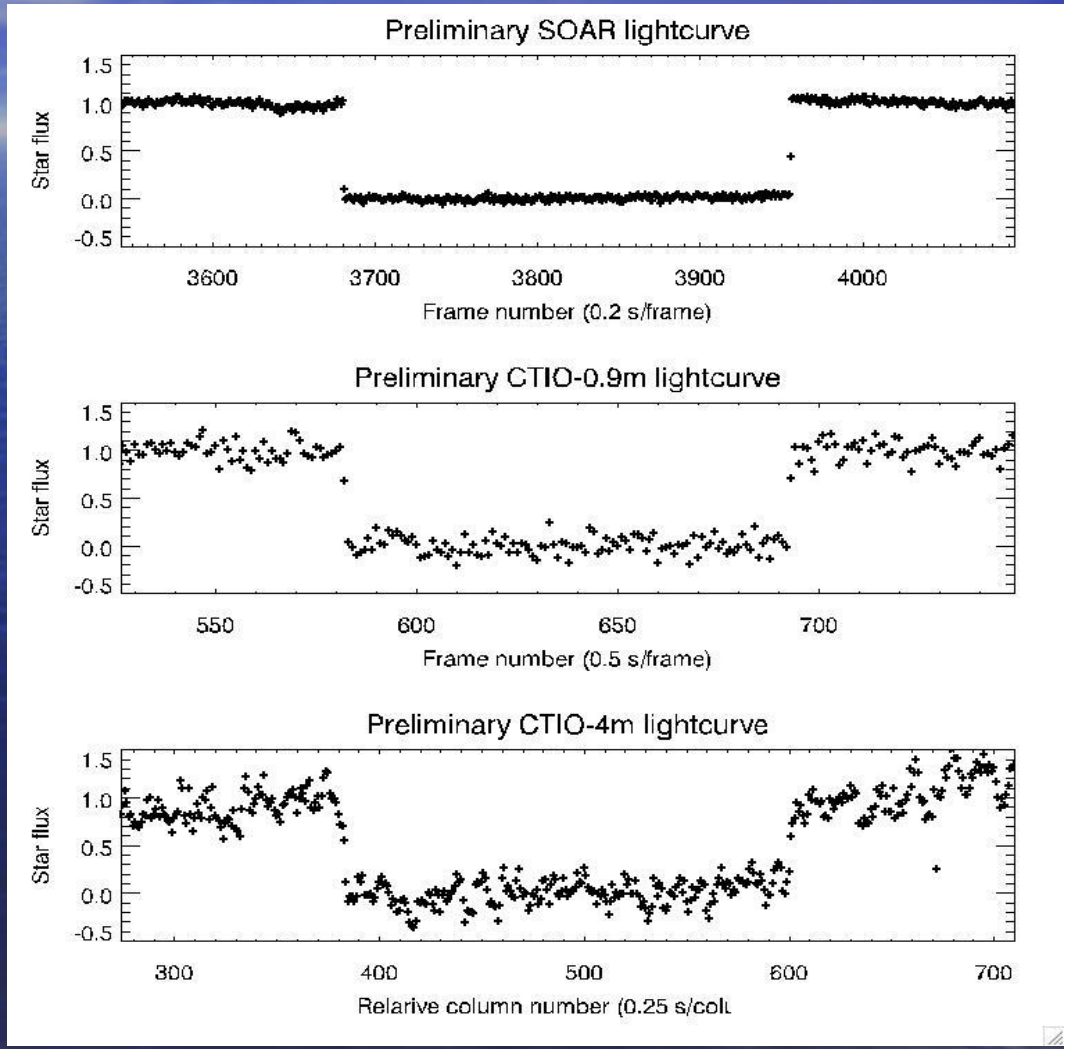



Deep Impact
Comet Tempel
5m, non-sidereal track


Deep Impact
18h
-4h
42h

Charon Pluto Occultation

Pluto Charon+C313.2



0.2s/frame

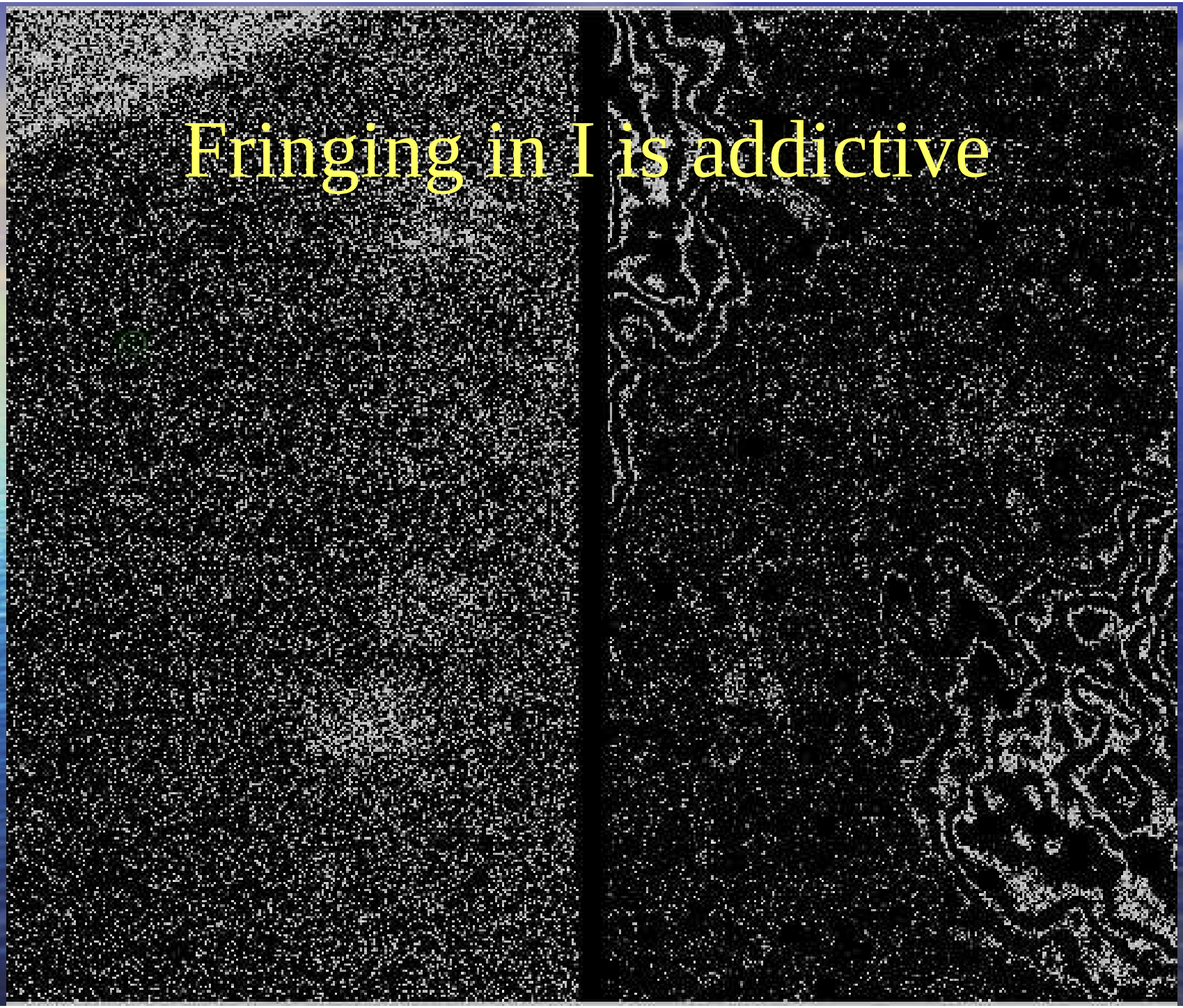
11 Jul Leslie Young

A. Ribeiro's Brazil Soi1

- Galaxy distribution in medium/high z clusters
- 2h total UBVRI imaging
- Failed due to seeing > 1", mount oscillation, insufficient flat correction, background gradient and arcs, and fringing on I band

20m B

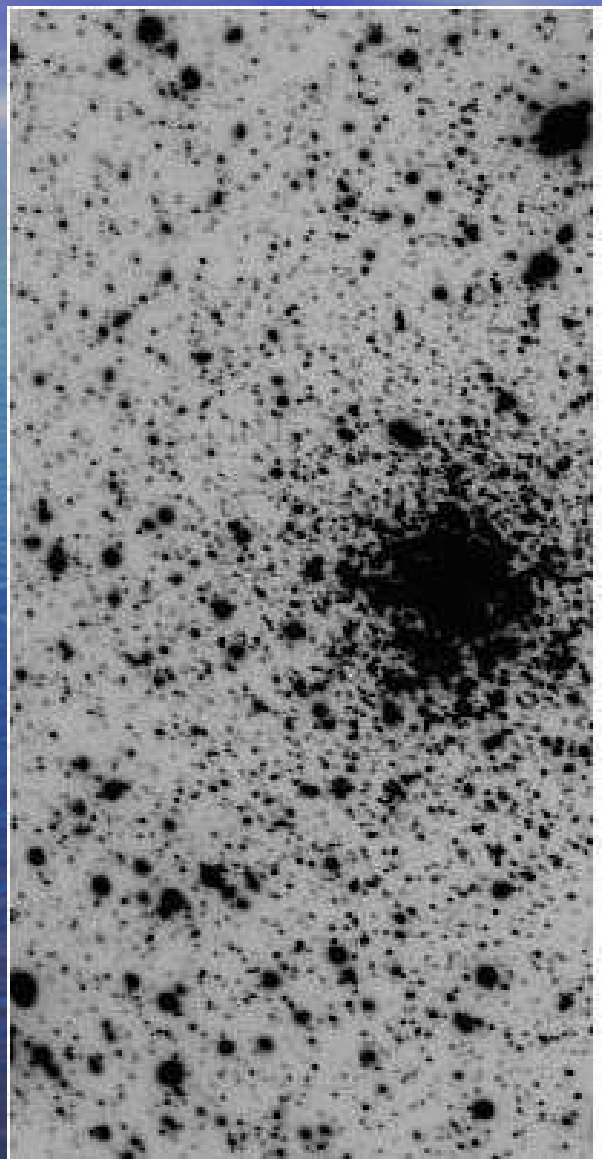
Fringing in I is addictive

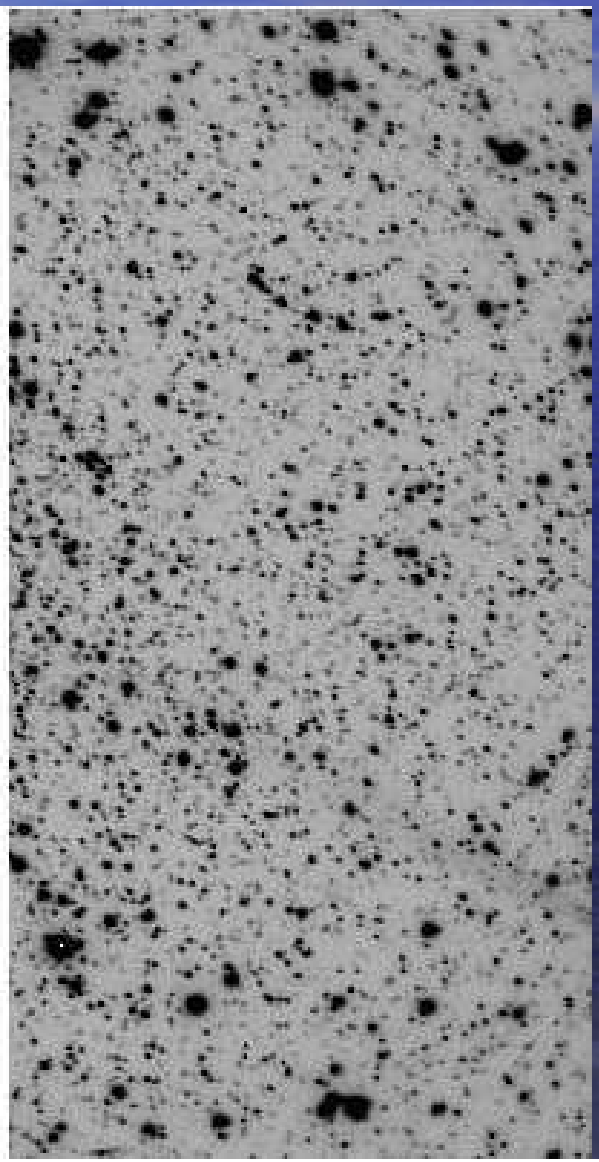


NOAO 2005A/136 Dale Kocevisk

- Clusters of galaxies in the Zone of Avoidance (mapping galaxies behind the Milk Way)
- 98x1m images in R: open loop 2.4m/image all sky (42% efficiency)

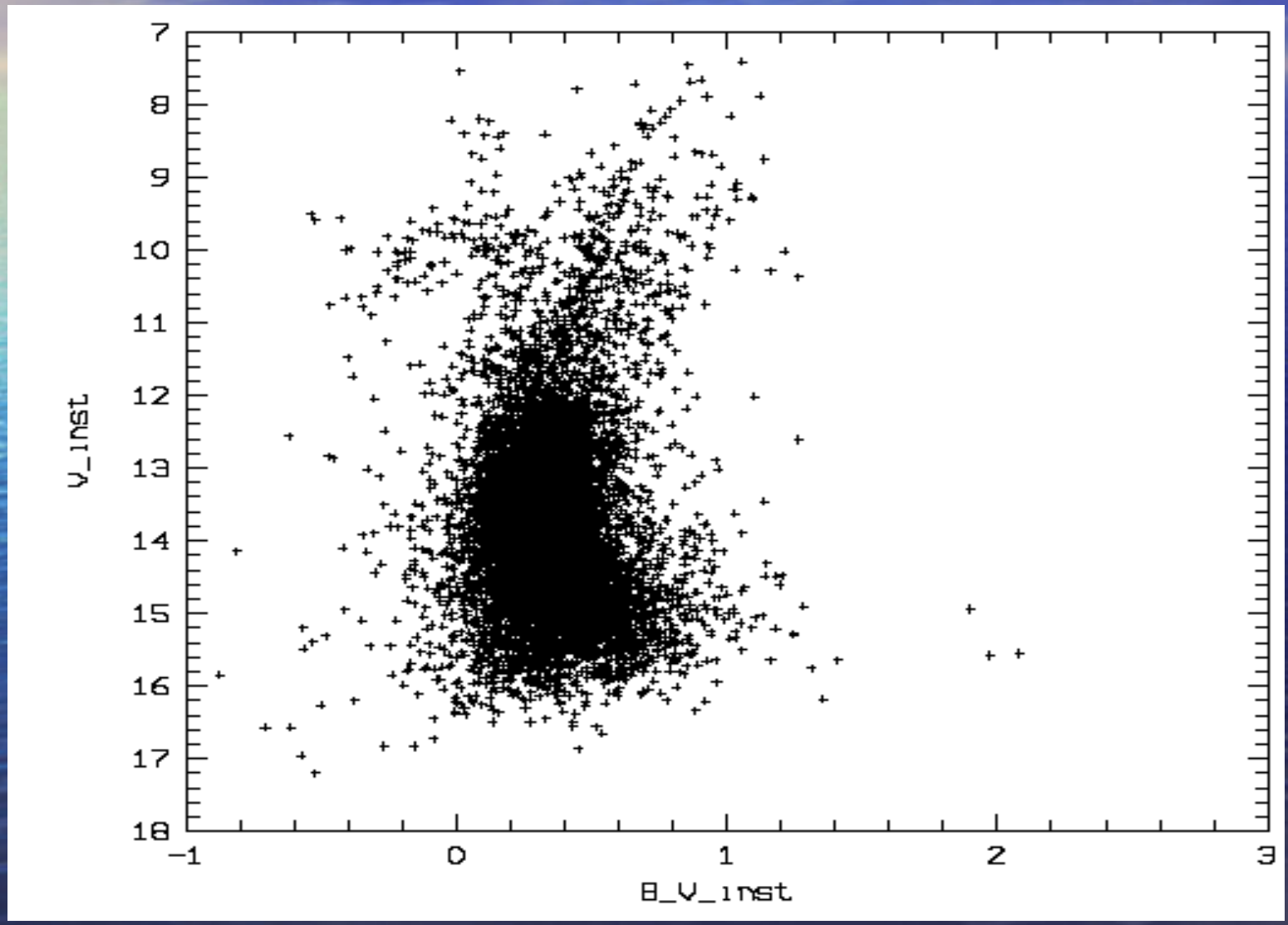
NGC 6642

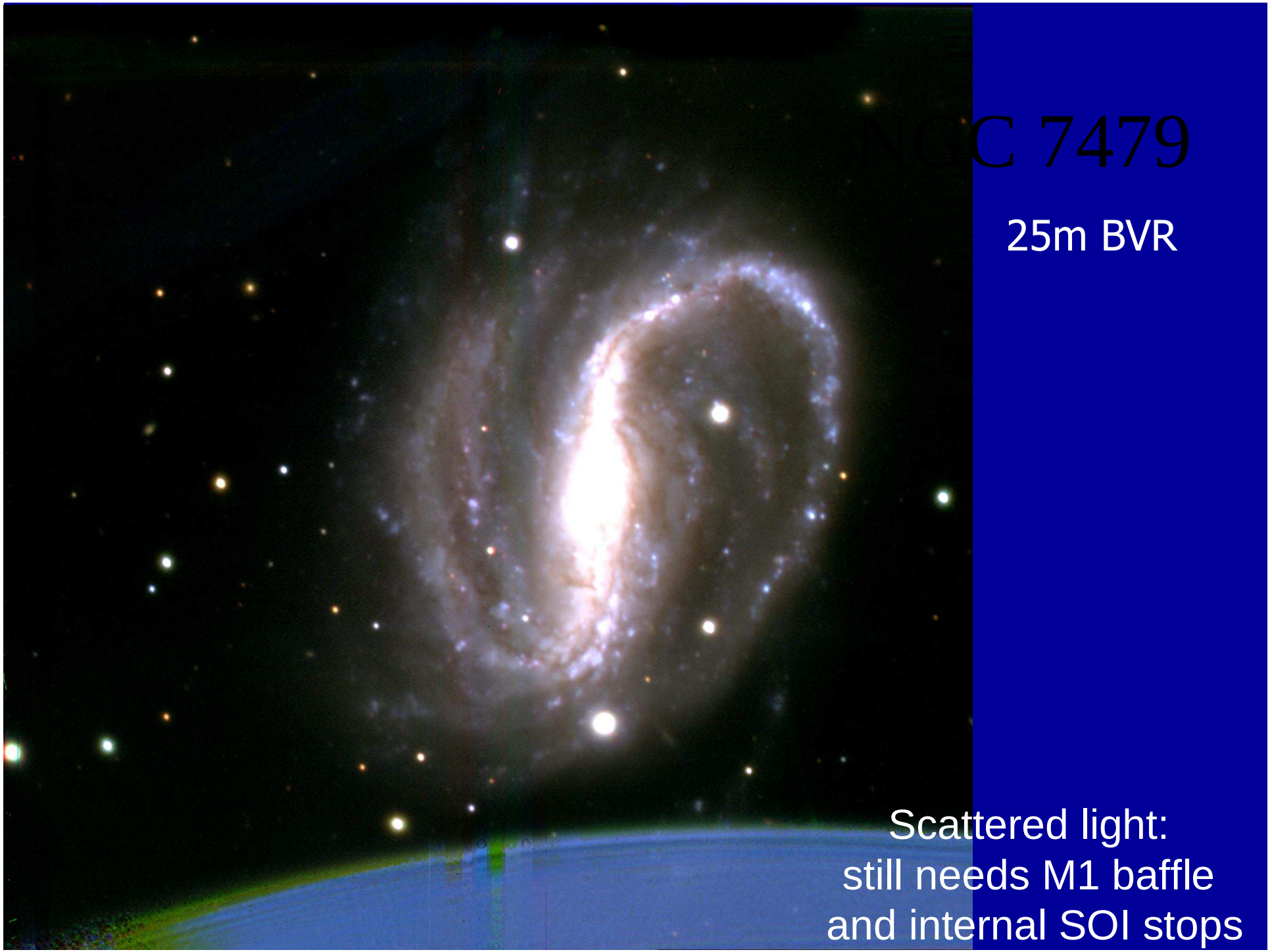




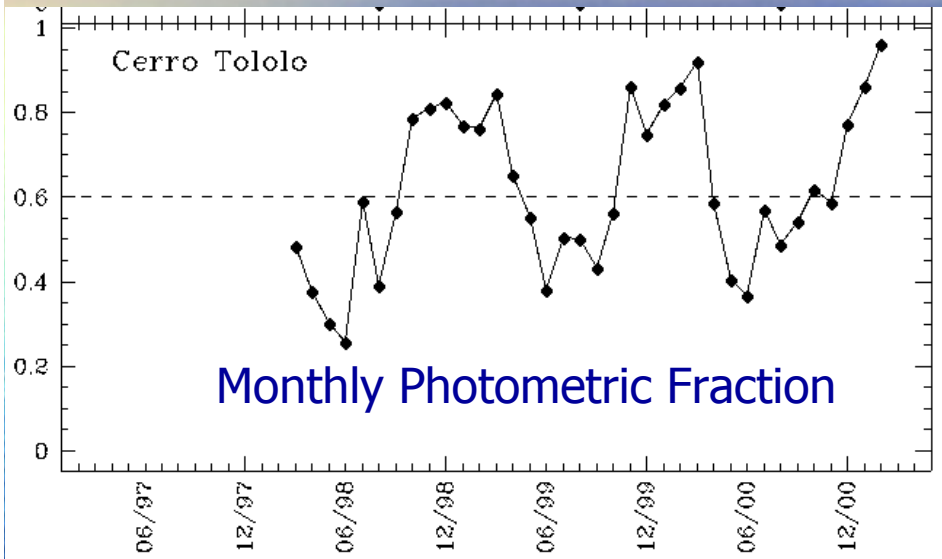
Brazil SOI2
1”
1h total,
10m V

NGC 6642

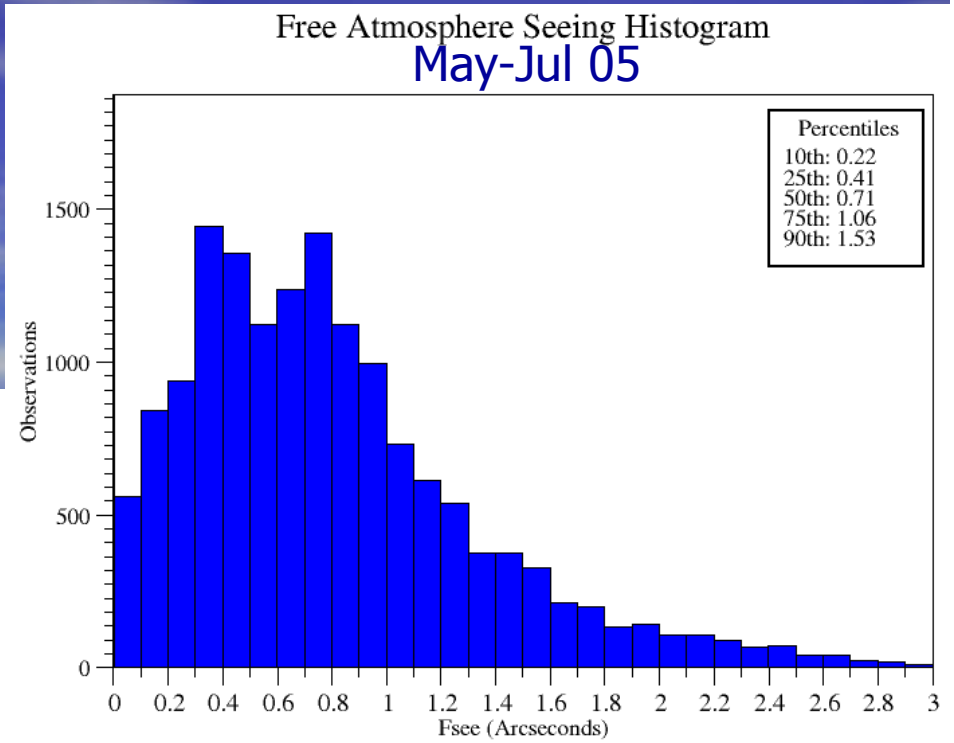


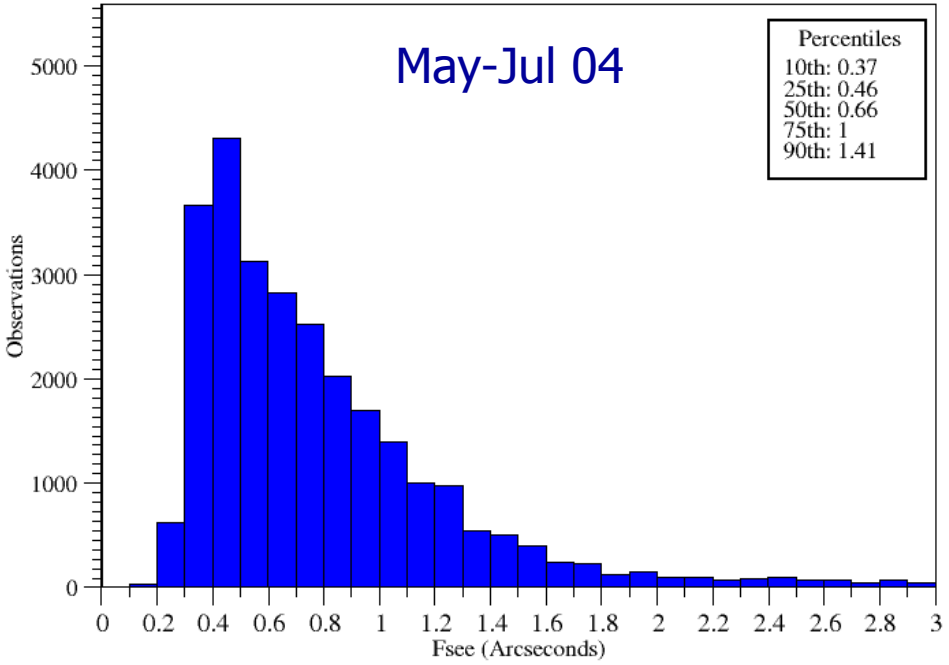

NGC 7479
25m BVR
Scattered light:
still needs M1 baffle
and internal SOI stops

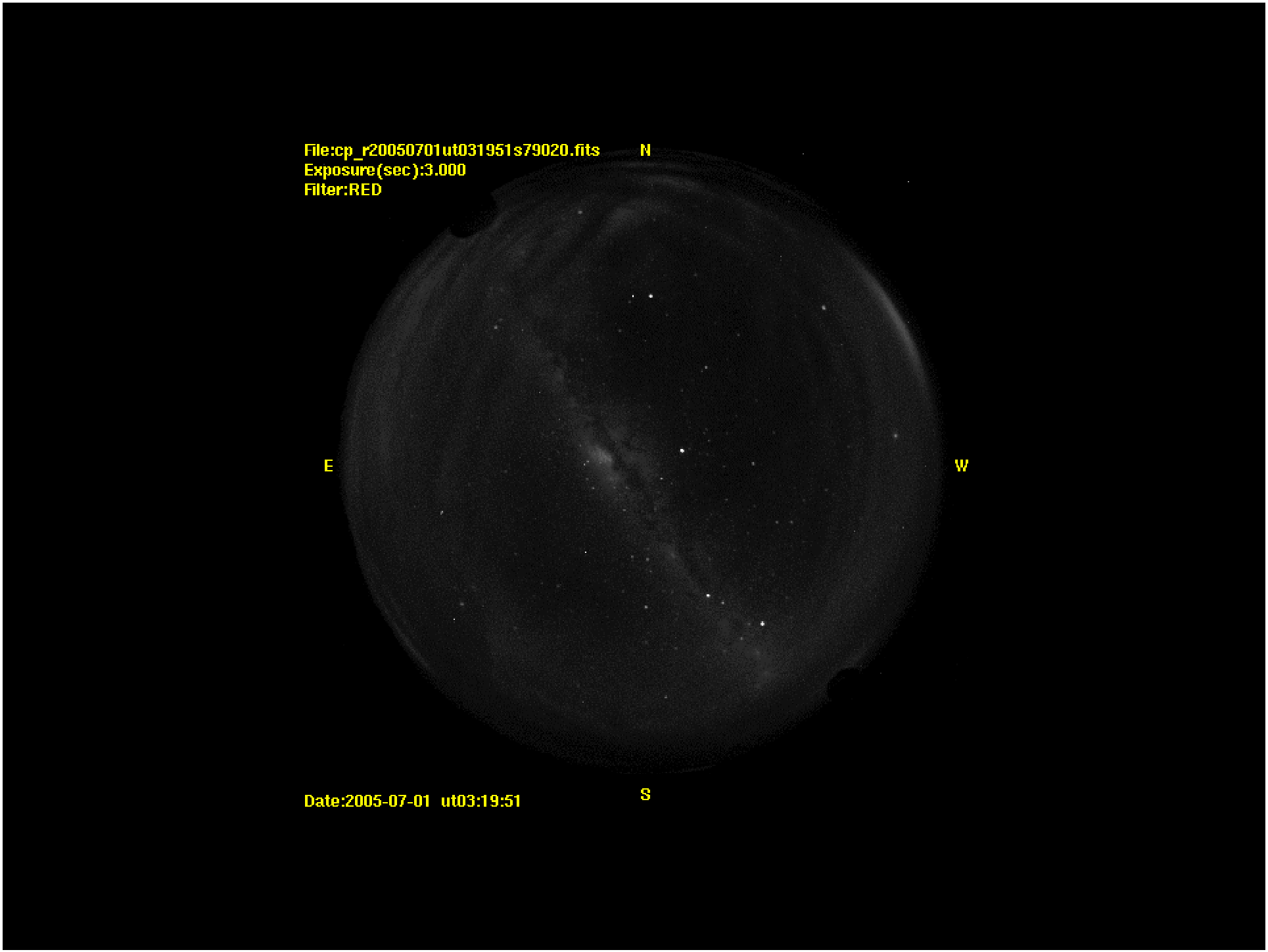
Weather



Monthly Photometric Fraction



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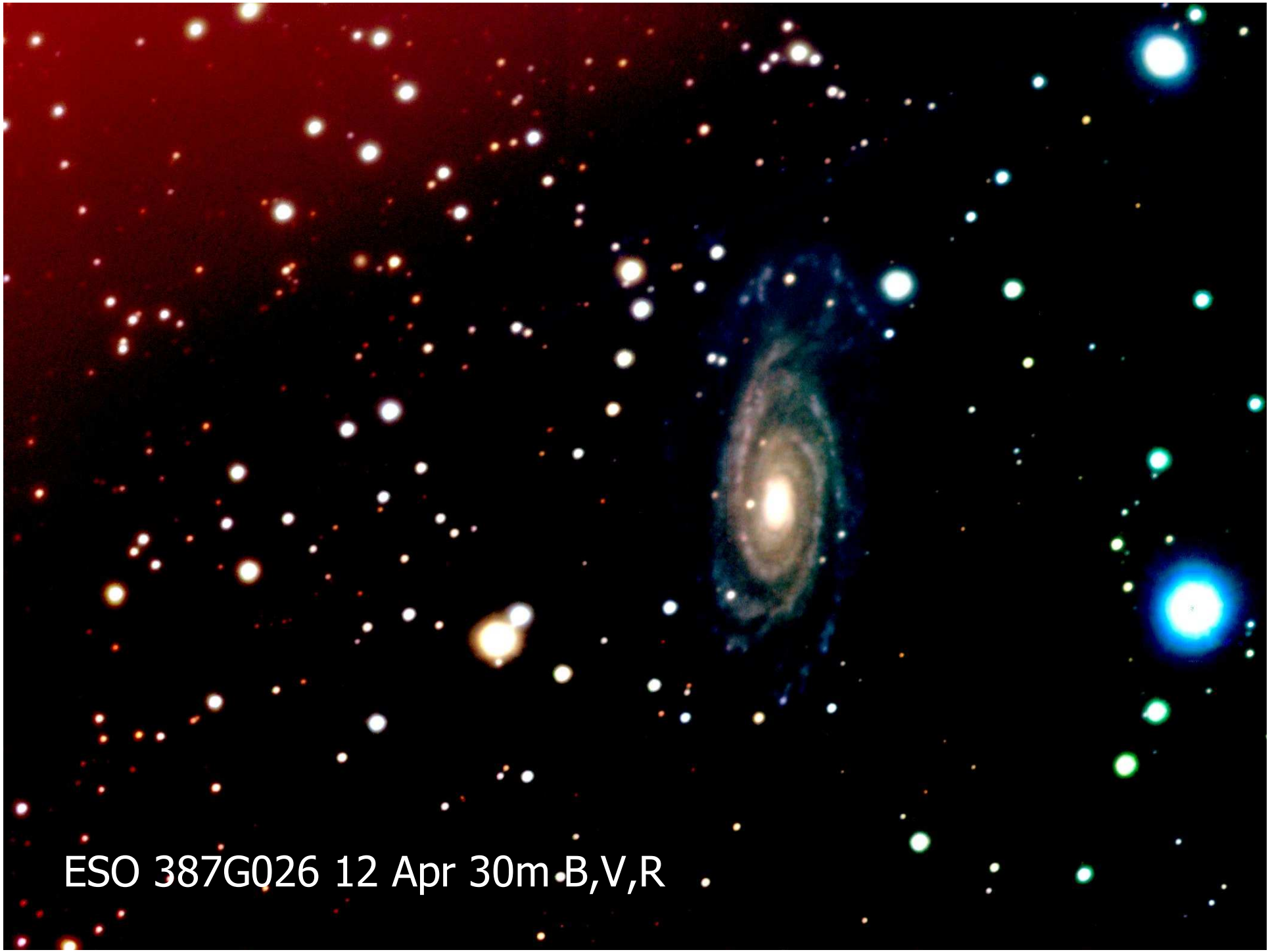
Exposure(sec):3.000
Filter:RED
N
E
W
S
Date:2005-07-01 ut03:19:51

Before June

- Jack Baldwin's MSU – Giant HII region
- Daniel Reichart's UNC – ToO: GRB

- H. Dottori's Brazil Soi5 – Double Nuclei Galaxies
- M. Maia's Brazil Soi9 – Bright Galaxies
- B. Castanheira's Brazil Soi3 – Variable WDs


ESO 387G026 12 Apr 30m B,V,R

Optical and Near-Infrared imaging of Disk Galaxies with Double Nucleus

Horacio Alberto Dottori (UFRGS- Brasil)

Germán Gimeno (OAC,UNC, Córdoba, Argentina)

Irapuan Rodrigues (IF-UFRGS)

Rubén Díaz (OAC,UNC, Córdoba, Argentina)

Gustavo Carranza (OAC,UNC, Córdoba, Argentina)

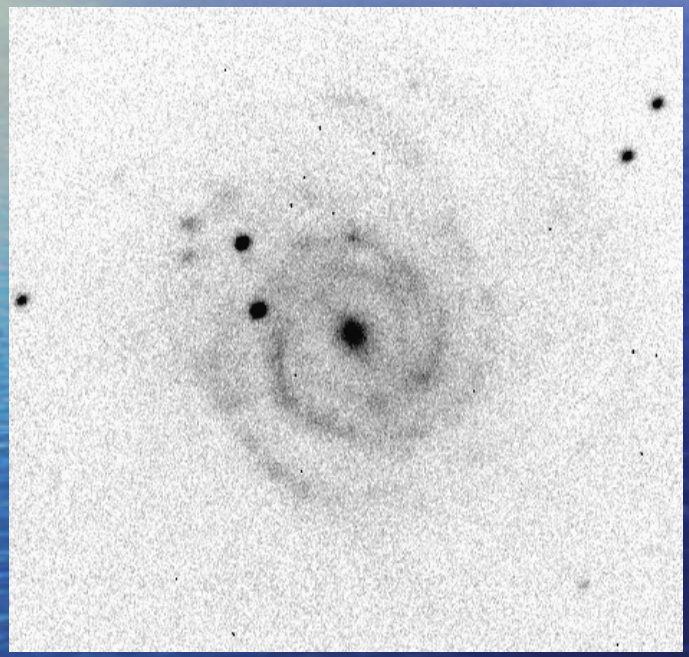
The main objectives of the program are to obtain the luminosities, colors and detailed information about the morphological structure af the nuclei (such as size, mutual separation) as well as of the host galaxies. These galaxies are from a sample under investigation (Gimeno et al. 2004a) in order to determine interaction signatures, stellar populations, morphology and structure. Optical and Near-Infrared images will allow to study such morphological details of the nuclei pair as well as those of the host galaxy with SOAR superb spatial resolution. Surface photometry will help to determine stellar populations and constraints to the M/L ratio (e.g. Bell & de Jong, 2001) of the nuclei. These new results will together with our kinematic ones (Gimeno et al 2004b, 2005) allow us to build dynamical models of these systems.

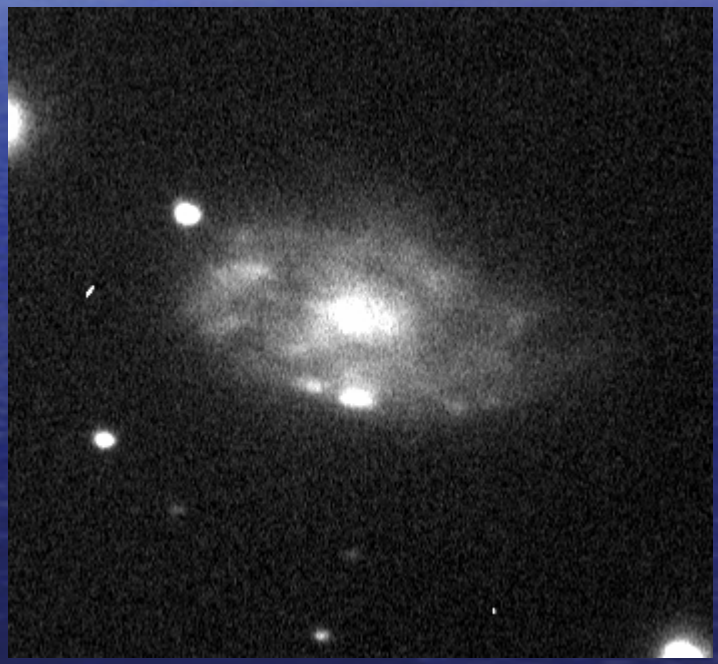
Optical and Near-Infrared imaging of Disk Galaxies with Double Nucleus

Horacio Alberto Dottori (UFRGS- Brasil)

	B	Sep(“)
NGC 3663	13.03	9
ESO 381-IG23	14.60	7
MCG -4-31-031	15.10	9
MCG -05-32-062	15.0	9
MCG -3-35-014	14.9	15
ESO 384-G57	15.0	4
Fairall 58	13.8	10

The quality and resolution of the images is good. The two best images are shown here: Fairall 58 (B) and ESO 381-G24 (V)





Some preliminary quantitative results in the B-band

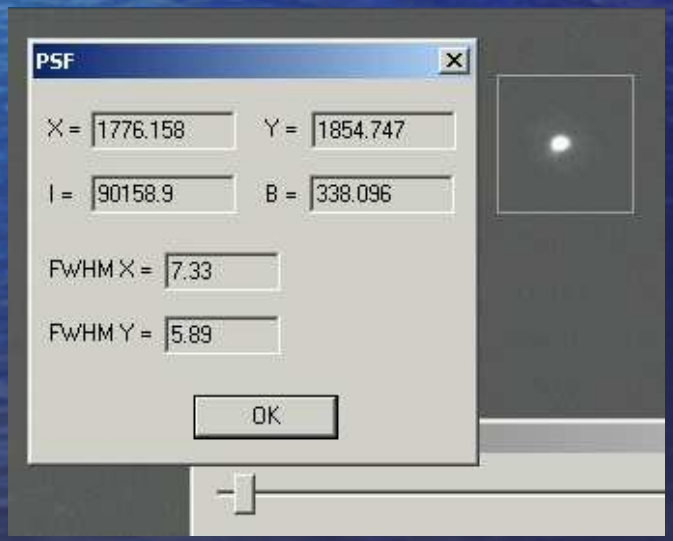
Based on the analysis of Fairall 58 - B frame:

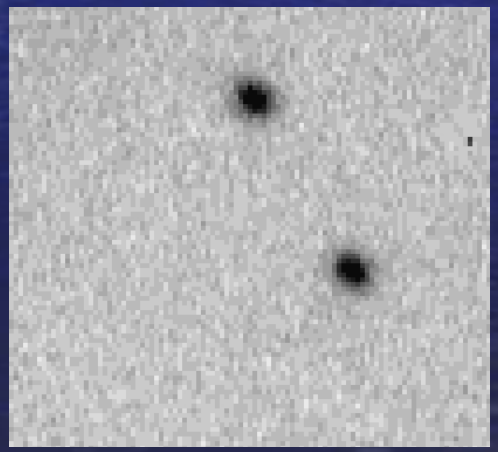
Sky brightness: ***21.9 Bmag***

Limiting surface brightness: ***24.8 Bmag/sqr".***

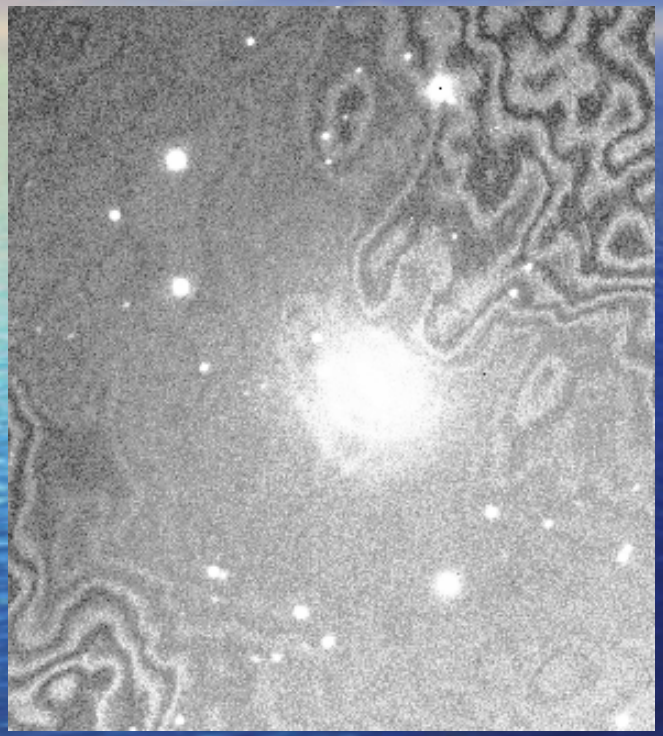
PSF mean FWHM: ***1".1***

non axisymmetric stellar images: in the majority of the frames, stellar images are elongated



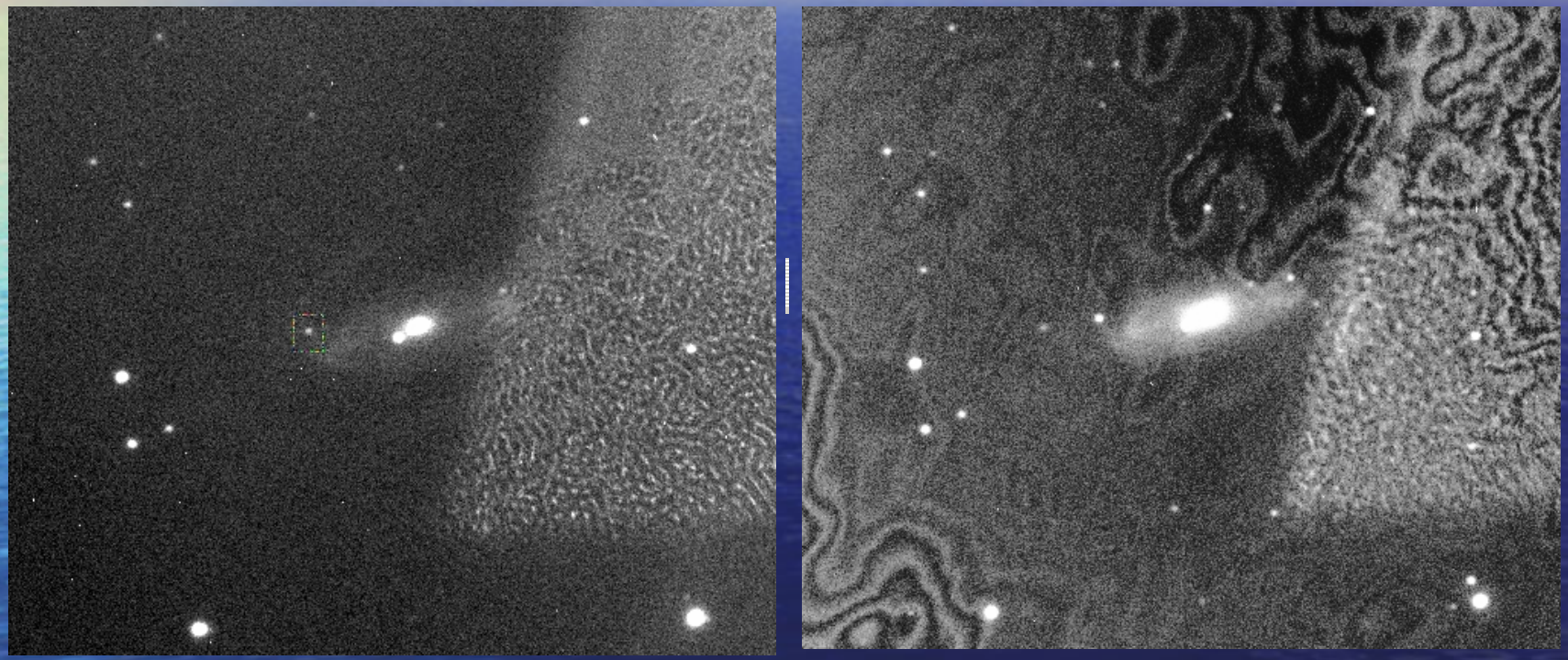


- fringes: this is quite serious, and most notably in the I-band, for example these are from Fairall 58-I:



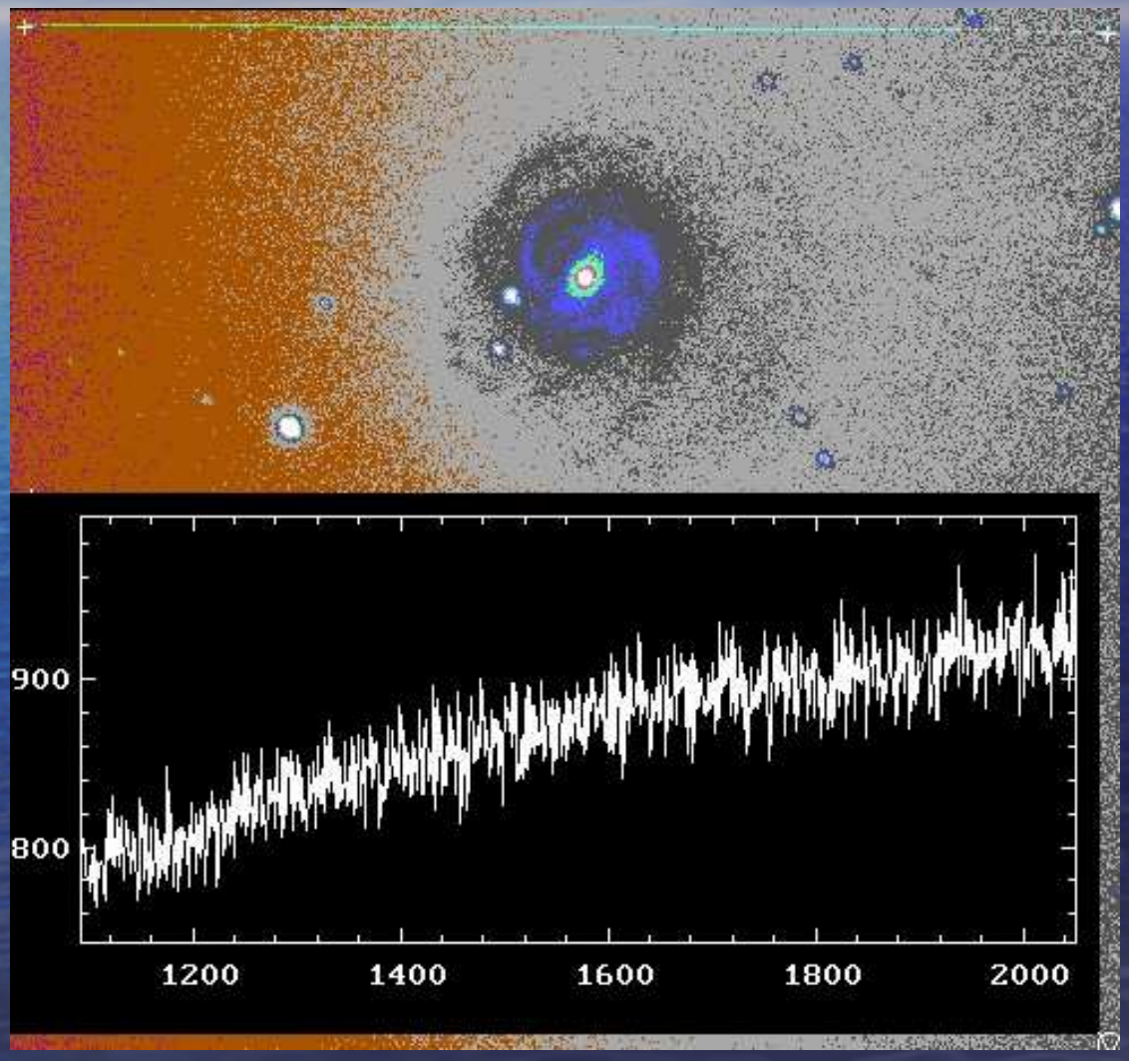
These frames are practically useless for surface photometry

- Scattered light: in some frames, due to the presence of a nearby bright star, as for ESO 384-57



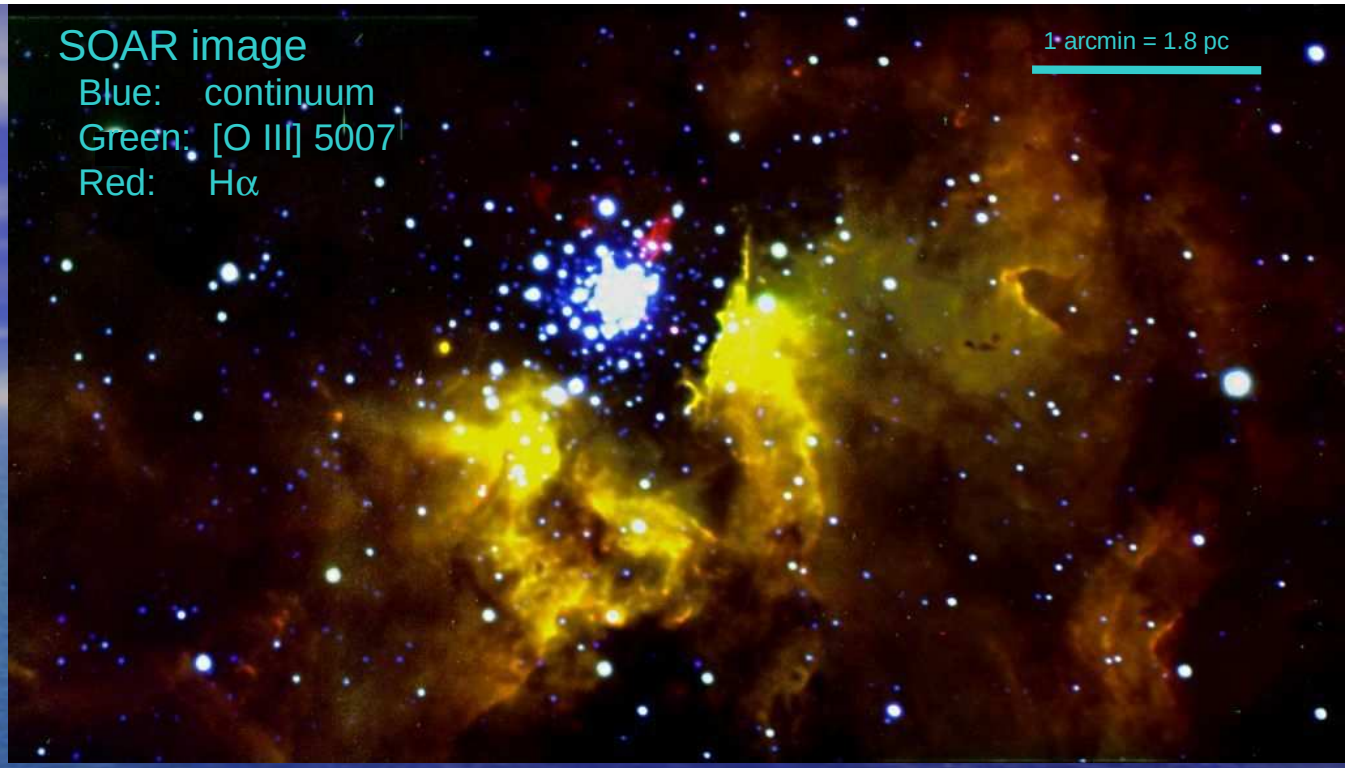
Left: B- image with scattered light. Right: I-image with scattered light + fringes (brightness comparable to or greater than that of the galaxy disk)

- Background gradient: quite important and present in almost all frames, though easily removable



Structure of the Ionization Front in NGC 3603

PI: Jack Baldwin



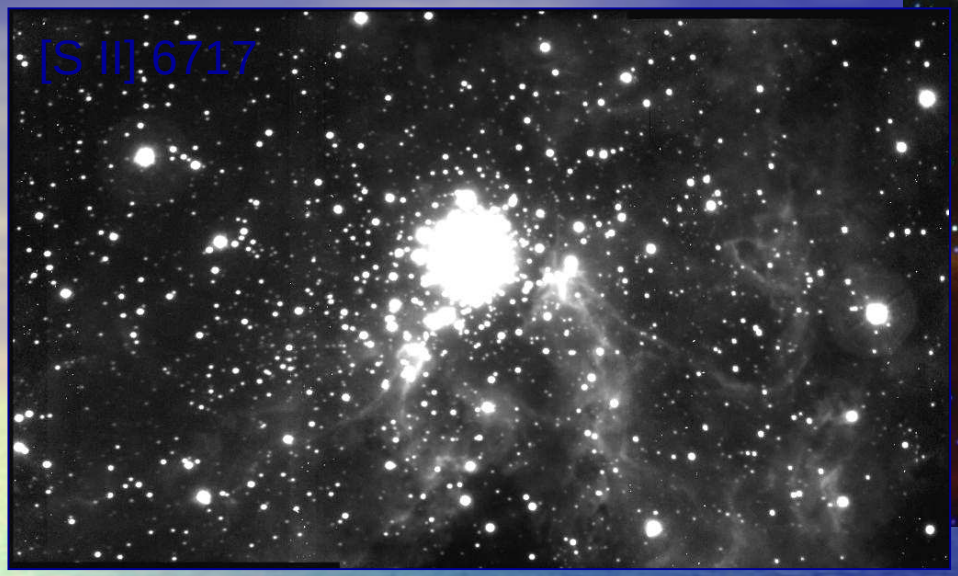
NGC 3603

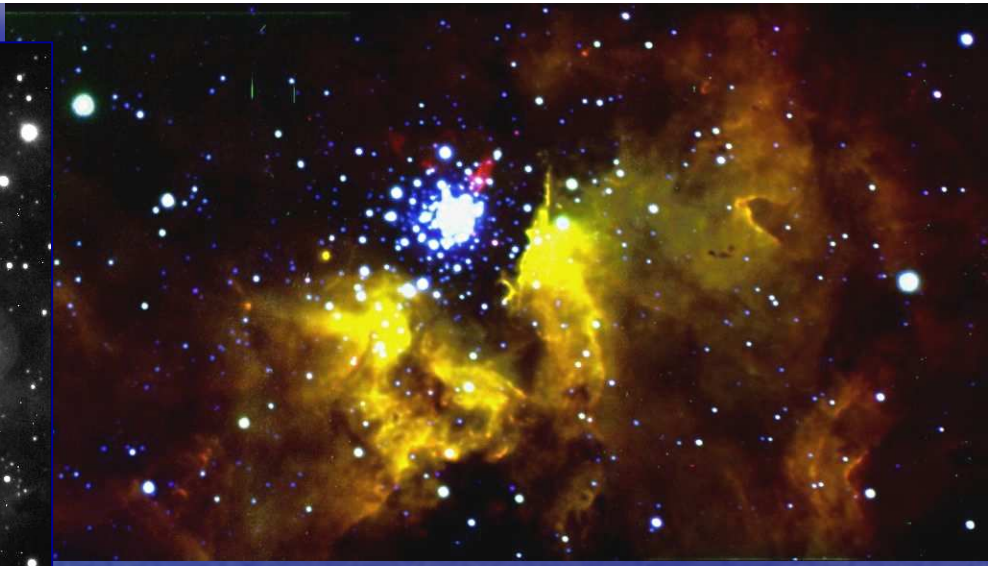
- Largest star-forming region in our Galaxy.
- Nearby prototype of distant Giant Extragalactic H II Regions.
- Line-emitting gas is illuminated edge of dense molecular cloud.

General Questions

- What are the details of star-gas interaction?
- Do the emission lines come from:
  - a well-stratified Photo-Dissociation Region? Champagne flow?
  - or maybe a messy mix of dense neutral clumps embedded in highly ionized gas?
- Affects interpretation of distant GEHRs.

SOAR has good FOV and spatial scale for a detailed study.

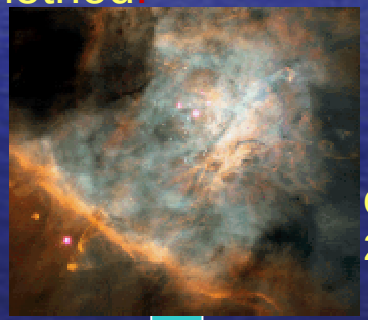




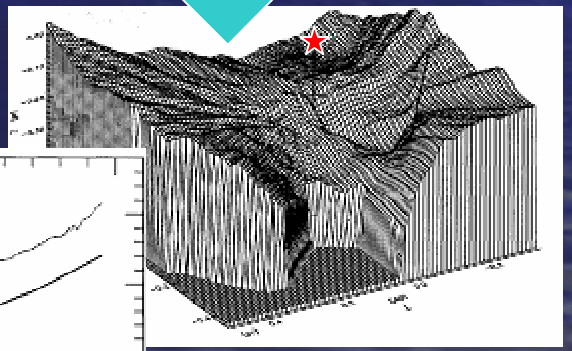
Pilot study

- Attempt to map 3D structure of ionization front.
- Using method applied to Orion Nebula by Wen & O'Dell, 1995, ApJ 438, 784
- Need gas density from [S II] 6717/6731 ratio, + Hα surface brightness.
- Calibrate with HST Hα image of central region, and [S II] line ratios from published slit spectroscopy.
- So far: unable to remove scattered light to required accuracy.

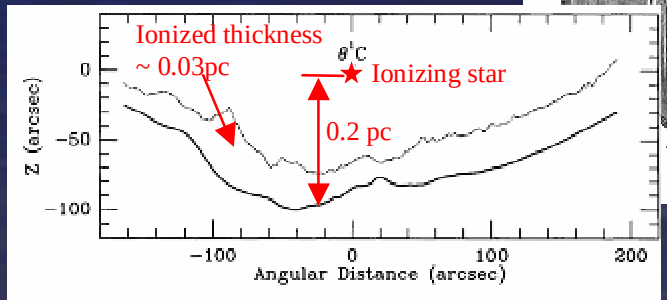
Method:



Orion
2D image

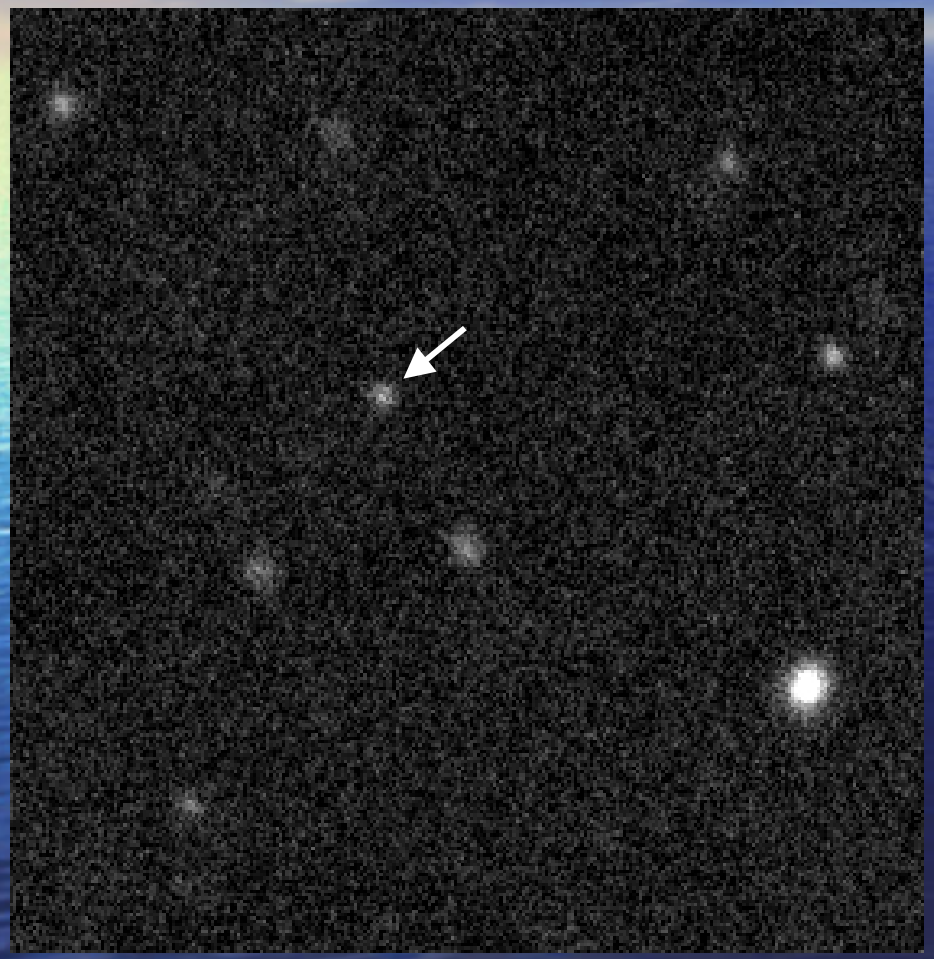


3D reconstruction

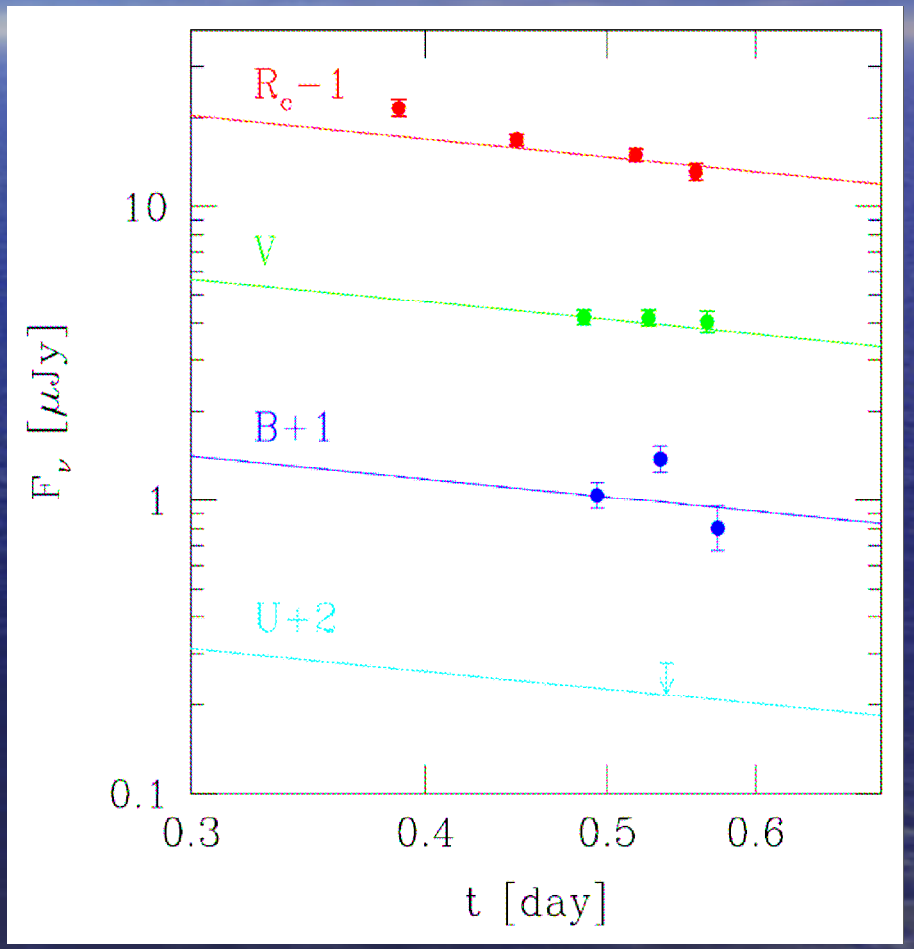


GRB 050408

SOAR Image (R_c)



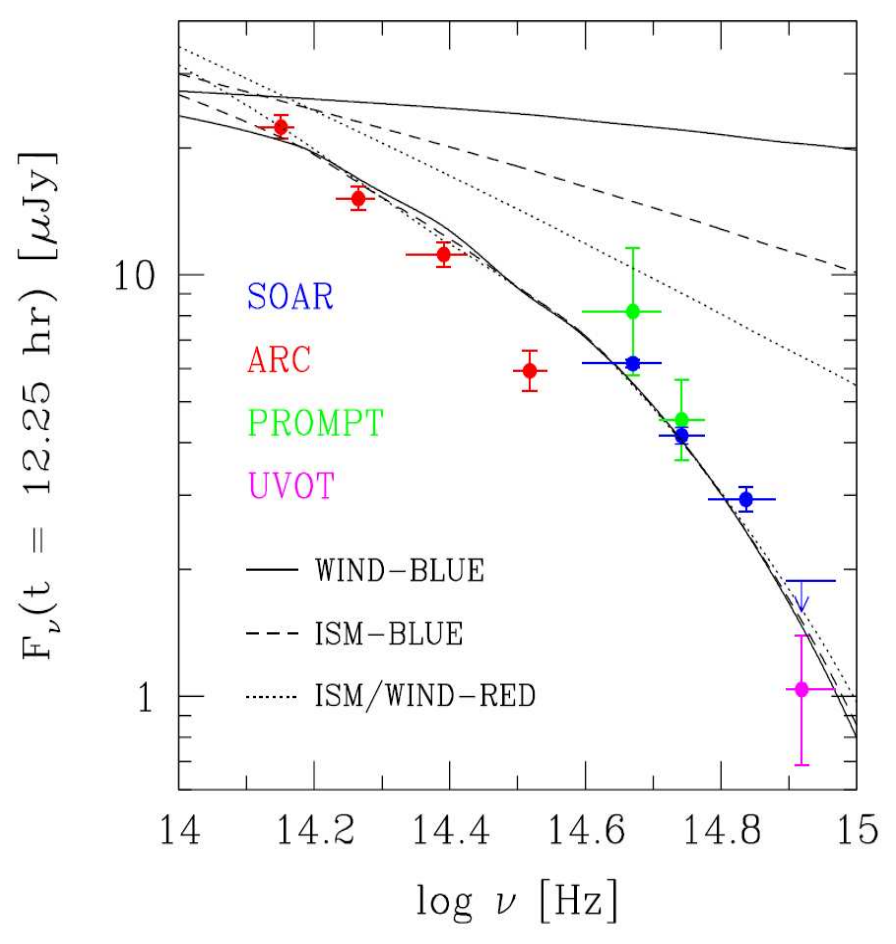
SOAR Light Curve



Nysewander et al. 2005, in prep.

GRB 050408

FUN GRB SFD



UBVR$_c$ZJHK$_s$ SFD of the afterglow of GRB 050408 scaled to 12.25 hours after the burst and best-fit WIND-BLUE (solid curves), ISM-BLUE (dashed curves), and ISM/WIND-RED (dotted curves) models. Data are from FUN GRB Collaboration telescopes SOAR, ARC, and PROMPT, and from Swift's UVOT. We plot each fit twice, once with source-frame extinction turned off. We find that source-frame $A_V \approx 0.7$, 0.5, and 0.4 mag, respectively. Existing Swift XRT data will help distinguish between these models.

Nysewander et al. 2005, in prep.

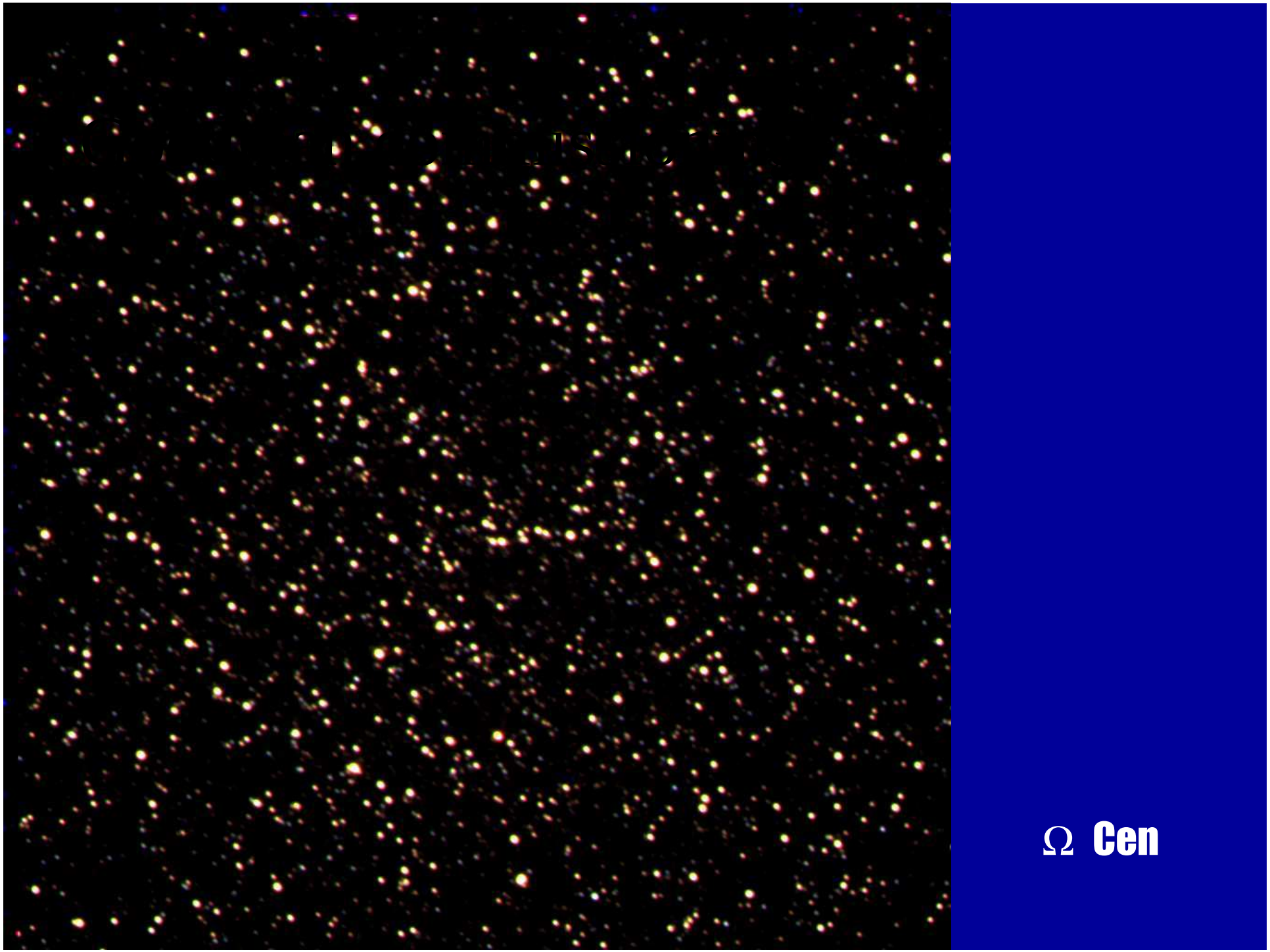
- 13fev05 - E3 region - Z.P. (B) = 25.332 +/-0.4 Sky (B) = 137 e/s.as2 = 1.7 adu/pix
- Internal LEDs shut down
- 11apr05 - stars E5 e E6 - Z.P. (B) = 25.319 +/- 0.8 - Sky (B) = 126 e/s.as2 = 20.8 mag/as2
- 11apr05 - stars E5 e E6 - Z.P. (V) = 25.080 +/- 0.01 - Sky (V) =244 e/s.as2 =19.866 mag/as2
- 11apr05 - stars E5 e E6 - Z.P. (R) = 25.205 +/- 0.01 - Sky (R) = 505 e/s.as2 =19.2 mag/as2 (with dark correction)
- M3 baffle and wash M2 and M3
- 04jun05 - stars sdssdr3 and E8 - sky(B) = 20.8 mag/as2
- 06jun05 - stars E5 e E6 - Z.P.(B) = 25.577 +/- 0.0008 - sky(B)* = 0.532adu/pix =
- 22.20 mag/as2 (obs: for the 1200s image 0.8adu/pix -> 21.75 mag/as2)
- Z.P.(V) = 25.478 +/- 0.0003 - sky(V) = 1.1adu/pix= 21.30mag/as2
- Z.P.(R) = 25.502 +/- 0.0009 - sky(R) = 2.96adu/pix = 20.263+/-0.05
- Z.P.(I) = 25.161 +/- 0.0009 - sky(I) = 6.08adu/pix = 19.14+/-0.04
- Z.P.(U) = 23.262 +/- 0.08 - sky(U) = 0.12adu/pix = 21.44+/-0.08
- 08jun05 -stars E7 - Z.P.(B) = 25.368+/-0.002 - sky(B) = 1.14adu/pix +/- 0.097= 21.15 mag/as2
- ZP(V)= 25.368+/-0.0018 - sky(V) = (1.94+/-0.096)adu/pix = 20.58 mag/as2
- ZP(R)= 25.448+/-0.0006 - sky(R) = (3.48+/-0.12)adu/pix = 20.03 mag/as2
- ZP(I)= 25.114+/-0.0013 - sky(V) = (6.54+/-0.07)adu/pix = 18.993 mag/as2
- 02jul05 -stars sa109 e pg1323- Z.P.(B) = 25.502+/-0.0004 - sky(B) = 0.6adu/pix= 21.88mag/as2
- ZP(V)= 25.467+/-0.0003 - sky(V) =(1.3)adu/pix = 21.12 mag/as2
- ZP(R)= 25.514+/-0.0002- sky(R) =(2.9)adu/pix = 20.30 mag/as2
- ZP(I)= 25.133+/-0.0006 -sky(V)=(10.)adu/pix = 18.6 mag/as2
- 06jul05 -pg1323-ZP(B) = 25.681+/-0.0006 - sky(B) = 0.67adu/pix =22.05 mag/as2
- ZP(V)= 25.603+/-0.002 - sky(V) =(1.15)adu/pix = 21.39 mag/as2
- ZP(R)= 25.613+/-0.0007- sky(R) =(2.44)adu/pix = 20.58 mag/as2
- ZP(I)= 25.216+/-0.001 -sky(V)=(6)adu/pix = 19.37 mag/as2

SOI Photometry

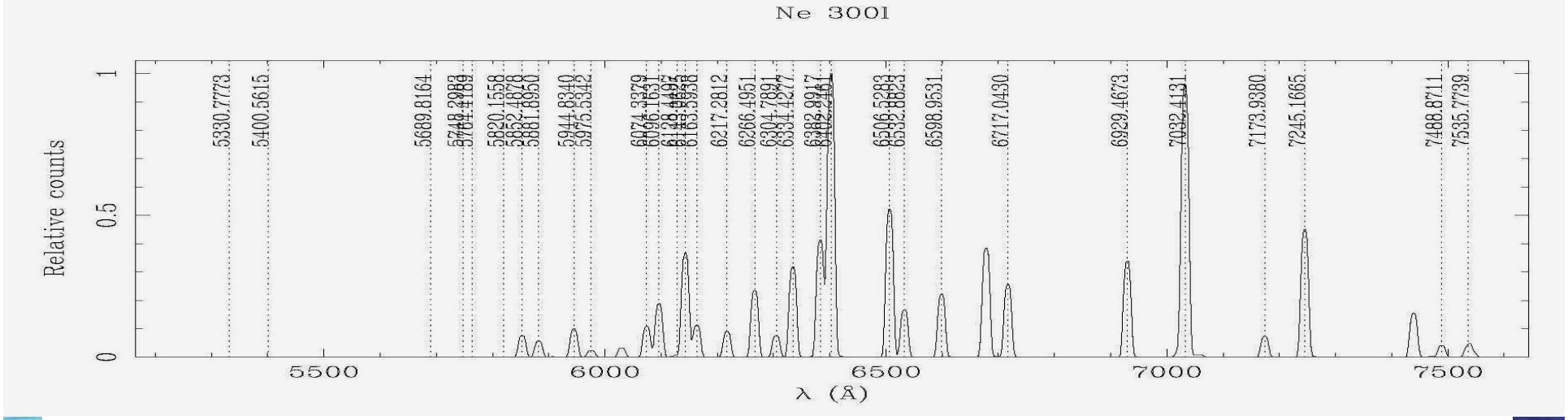
- 13fev05 - Z.P. (B) = 25.332 +/-0.4 sky (B) = 20.74 mag/as2
- Internal LEDs shut down
- 11apr05 - Z.P. (B) = 25.319 +/- 0.8 sky (B) = 20.80 mag/as2
- M3 baffle
- 04jun05 – Z.P.(B) = 24.73 +/-0.3? sky (B) = 20.80 mag/as2
- wash M1, M2 and M3
- 06jun05 - Z.P.(B) = 25.577+/-0.0008 sky (B) = 22.20 mag/as2
- 08jun05 - Z.P.(B) = 25.368+/-0.002 sky (B) = 21.15 mag/as2
- 02jul05 - Z.P.(B) = 25.502+/-0.0004 sky (B) = 21.88 mag/as2
- 06jul05 – Z.P. B) = 25.681+/-0.0006 sky (B) = 22.05 mag/as2
- I background still 0.5mag brighter

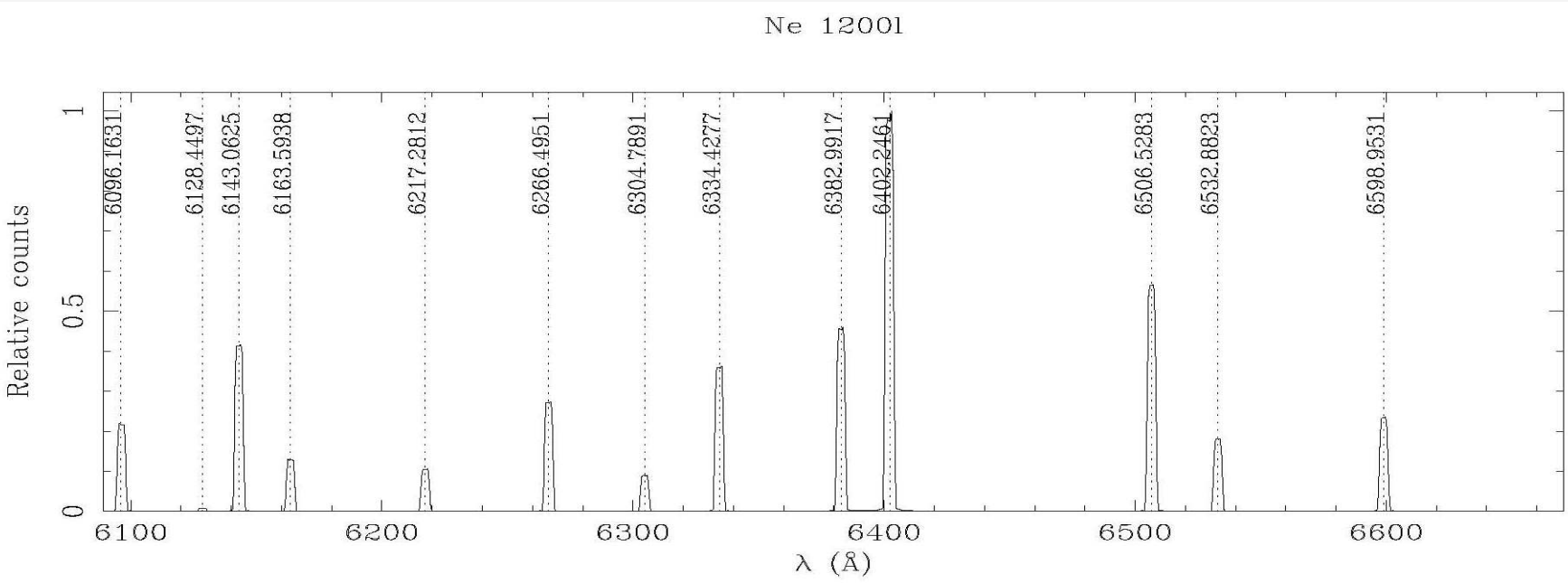
SOI Filters

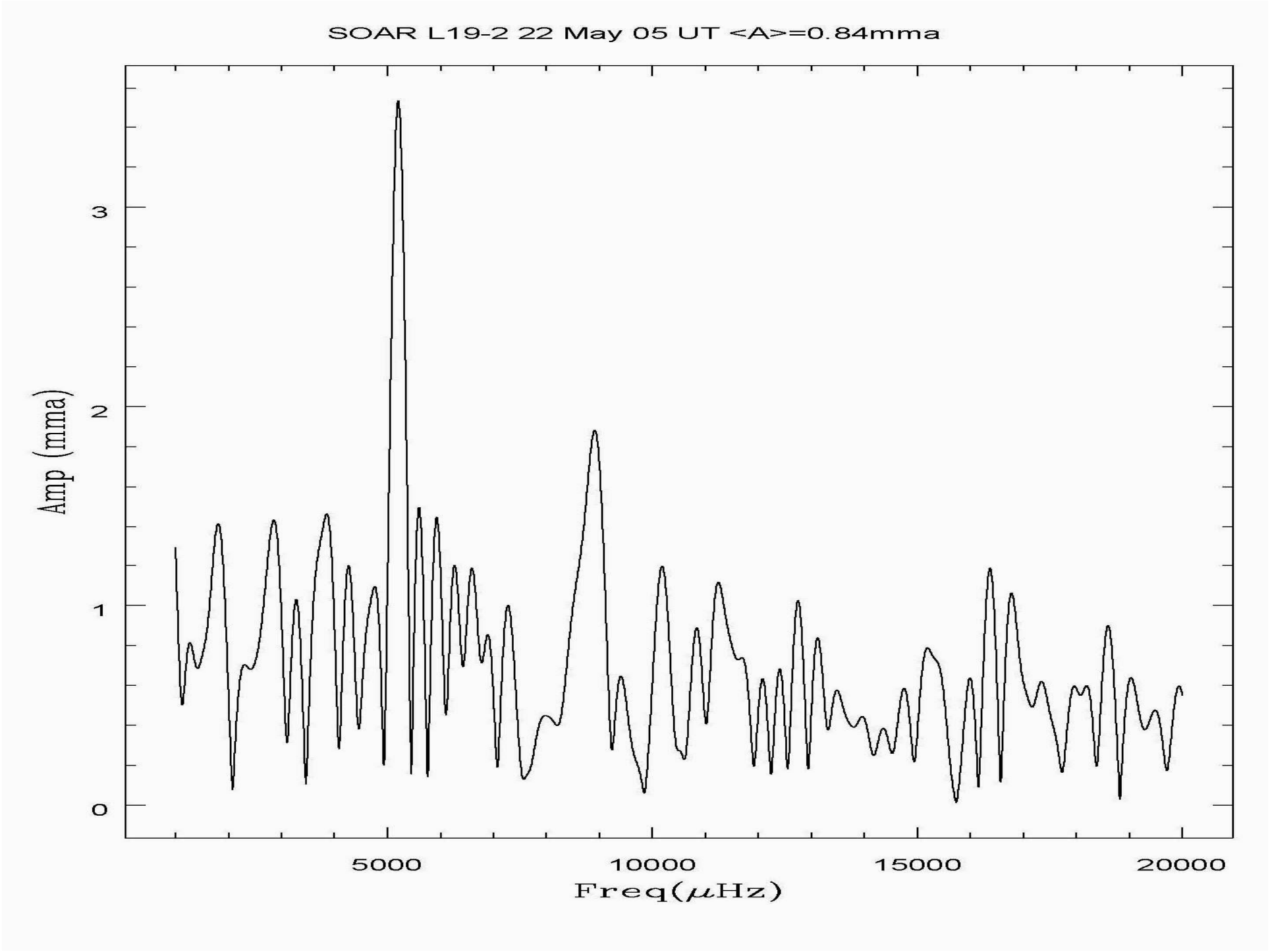
Filter name	Filter set	Central wavelength/FWHM (Angstroms)
u	Stromgren	3460/441
u'	SDSS	3529/719
U	Bessell	3624/784
v	Stromgren	4084/207
B	Bessell	4326/1269
b	Stromgren	4694/229
g'	SDSS	4737/1734
V	Bessell	5332/1073
y	Stromgren	5455/285
r'	SDSS	6271/1779
R	Bessell	6289/1922
Halpha	narrow	6571/93
S II	narrow	6743/67
i'	SDSS	7731/2006
TiO	Wing	7779/125
CN	Wing	8123/116
I	Bessell	8665/3914
z'	SDSS	10094/4842


Ω Cen

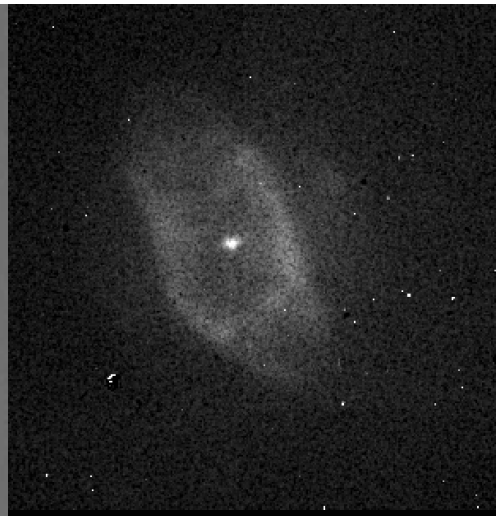
Goodman spectrum






SOAR L19-2 22 May 05 UT <A>=0.84mma
Amp (mma)
0
1
2
3
5000
10000
15000
20000
Freq(μHz)

Osiris

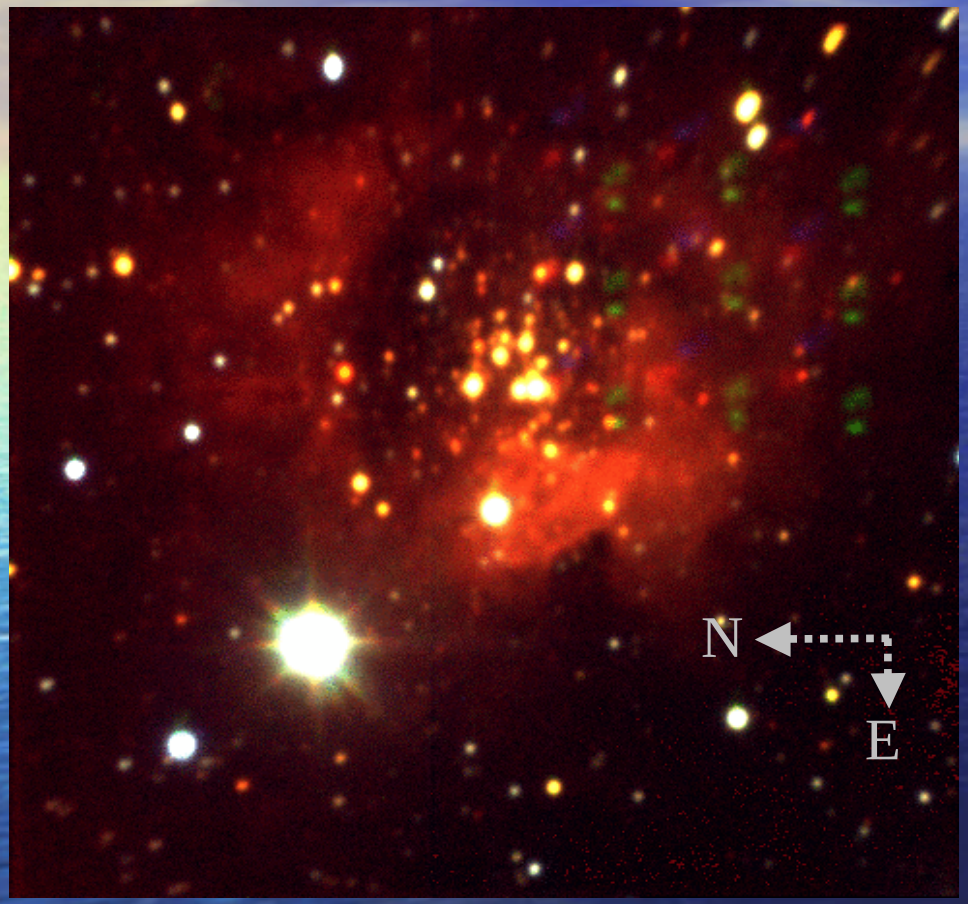


- Denise Gonçalves Brazil: PN NGC7009 observed (imaging mode) with filters 2.12μm (1000s), 2.17μm and Ks (24Jul)

(Before Alignment)

HII region G282.0-1.18

Obs. Date: 2005 June 03-04 (Sky Clear, High wind 53 km/s, SM > 1")



OSIRIS at SOAR

Plate Scale: 0.331"/pixel (f/2.8)

Filters: J (1.276 microns) - blue
H (1.632 microns) - green
K (2.188 microns) – red

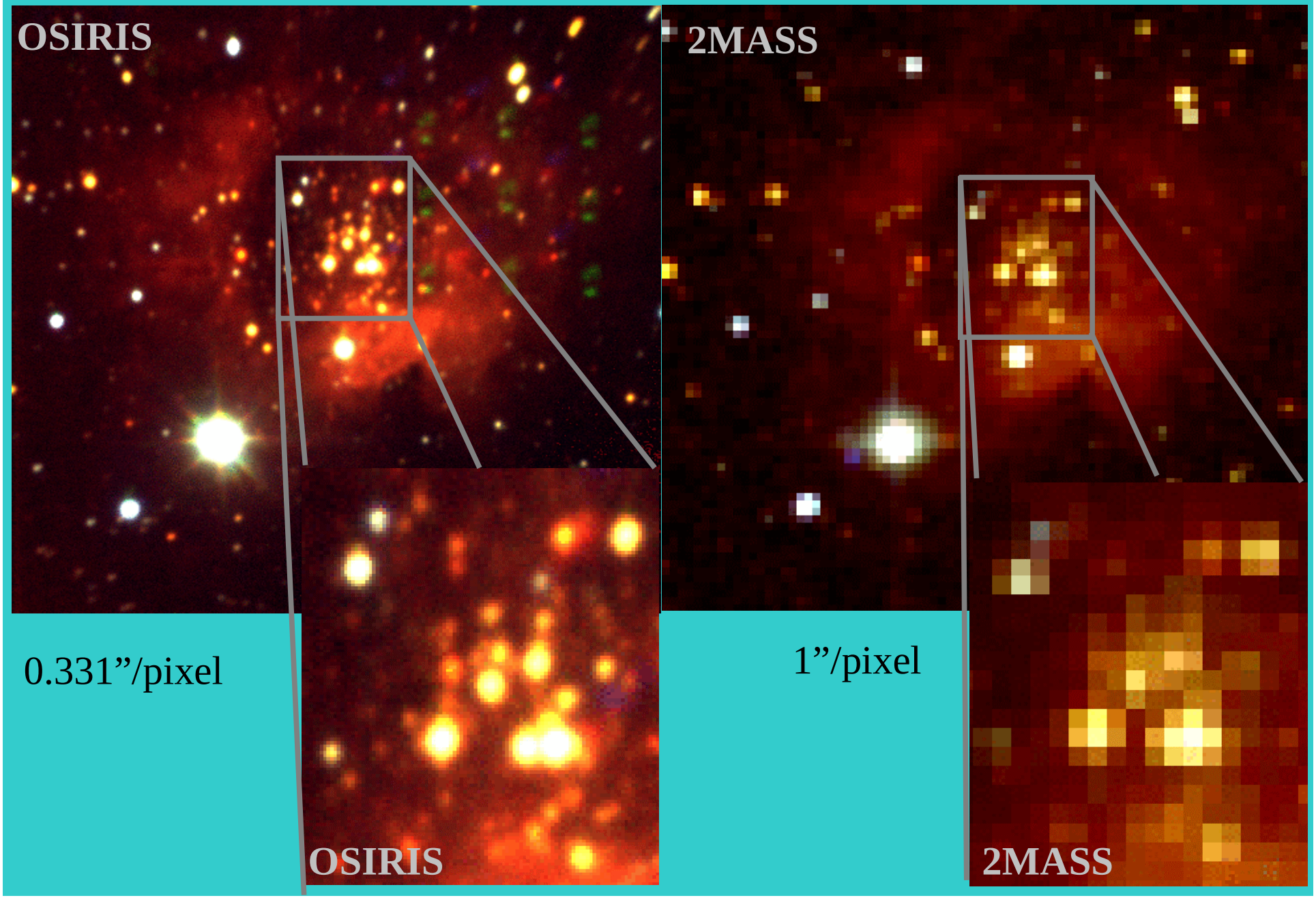
Exp. Time: 1.45 min. each filter

Dittering pattern: 3.24" x 3 (coadds)x 9 (points 10" sep.)

- Size of final Image – 2.7 x 2.7 arcmin
- Final FWHM – 1.60" (J), 1.44" (H) and 1.45" (K)

OSIRIS *x* 2MASS

(Before Alignment)



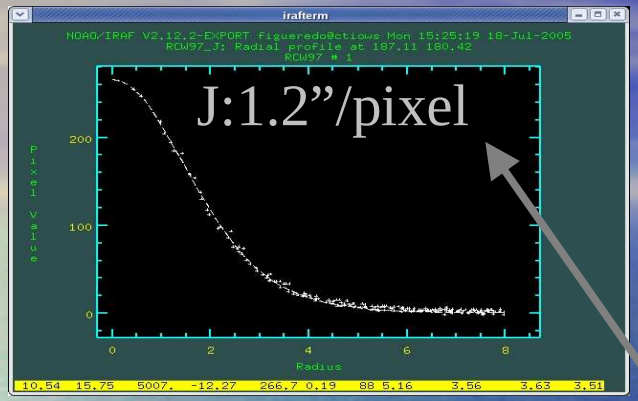
0.331”/pixel

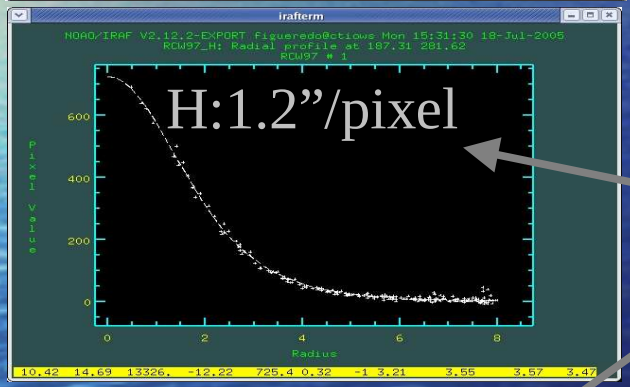
1”/pixel

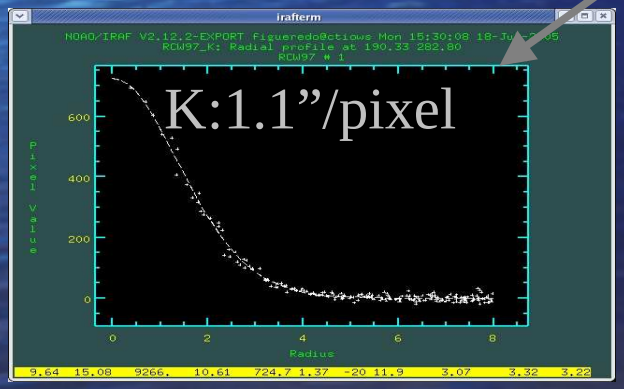
(Before Alignment)

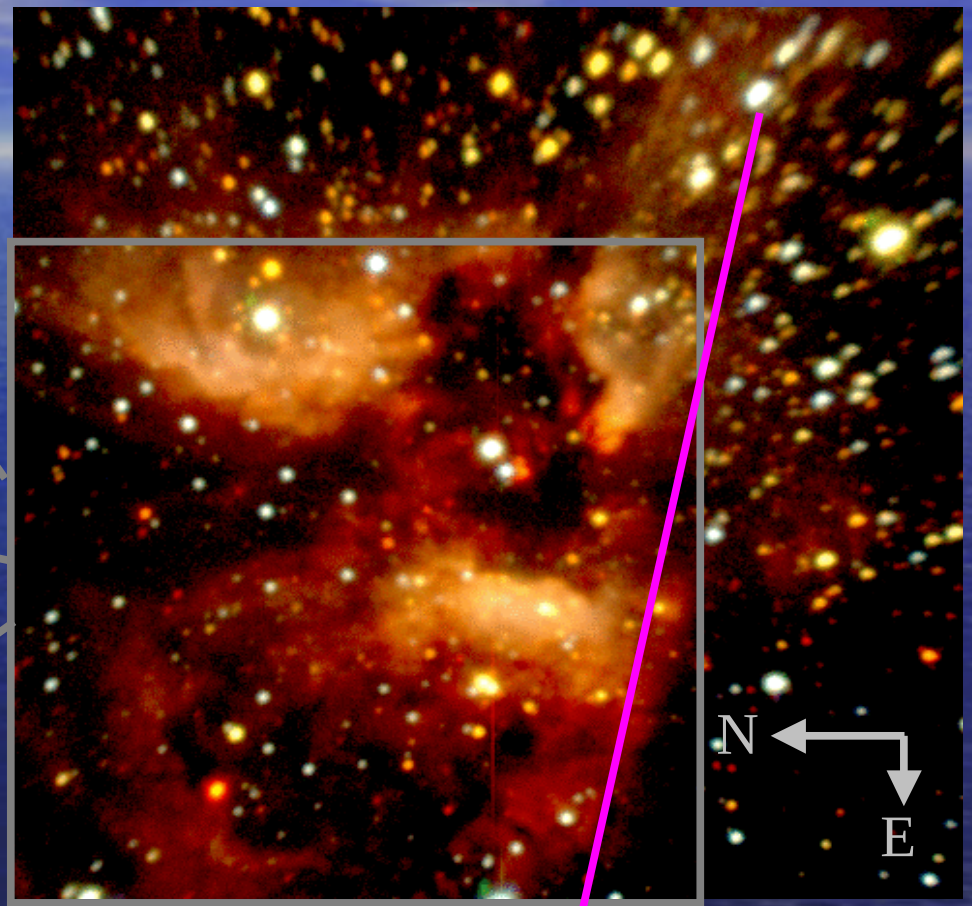
HII region RCW97

Obs. Date: 2005 June 03-04 (Sky Clear, High wind 53 km/s, SM > 1”)





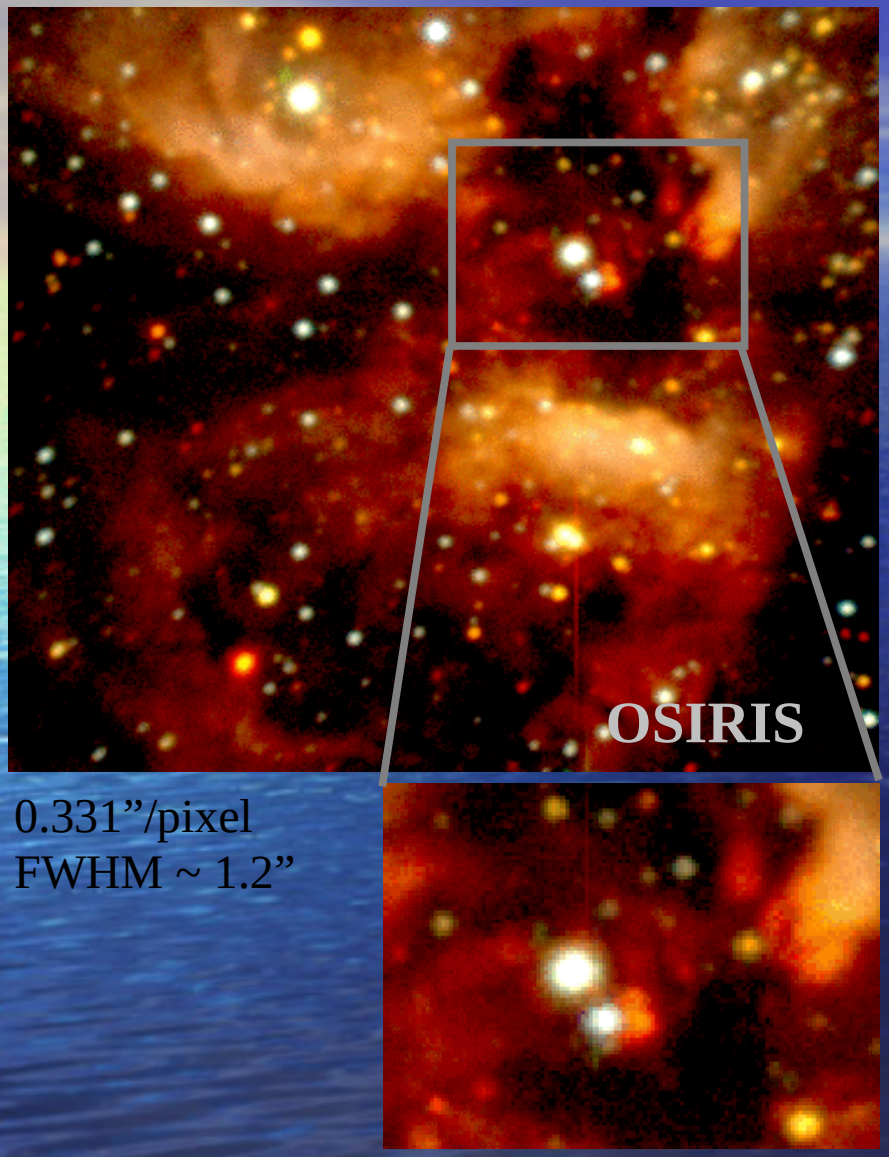




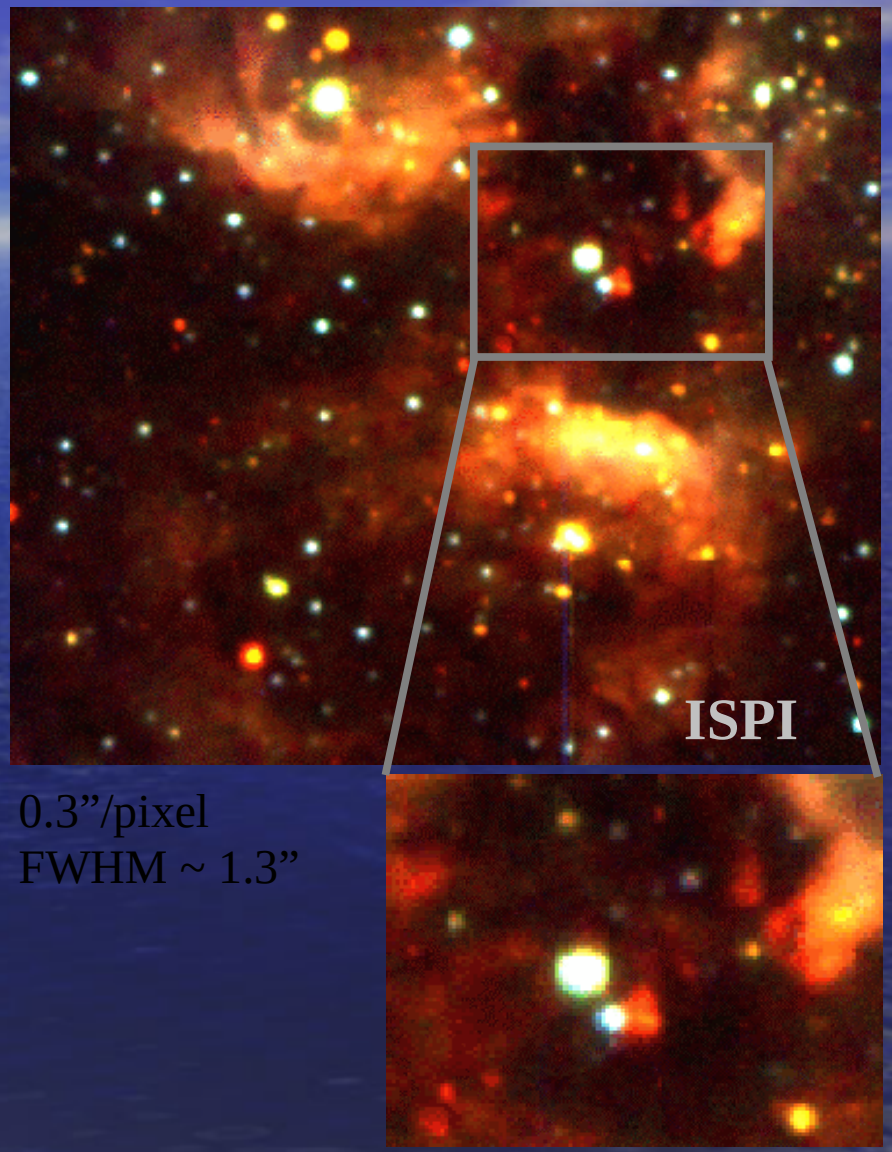
This effect maybe because the instrument was mis-aligned or we have a differential focus (?)

(Before Alignment)

OSIRIS *x* ISPI



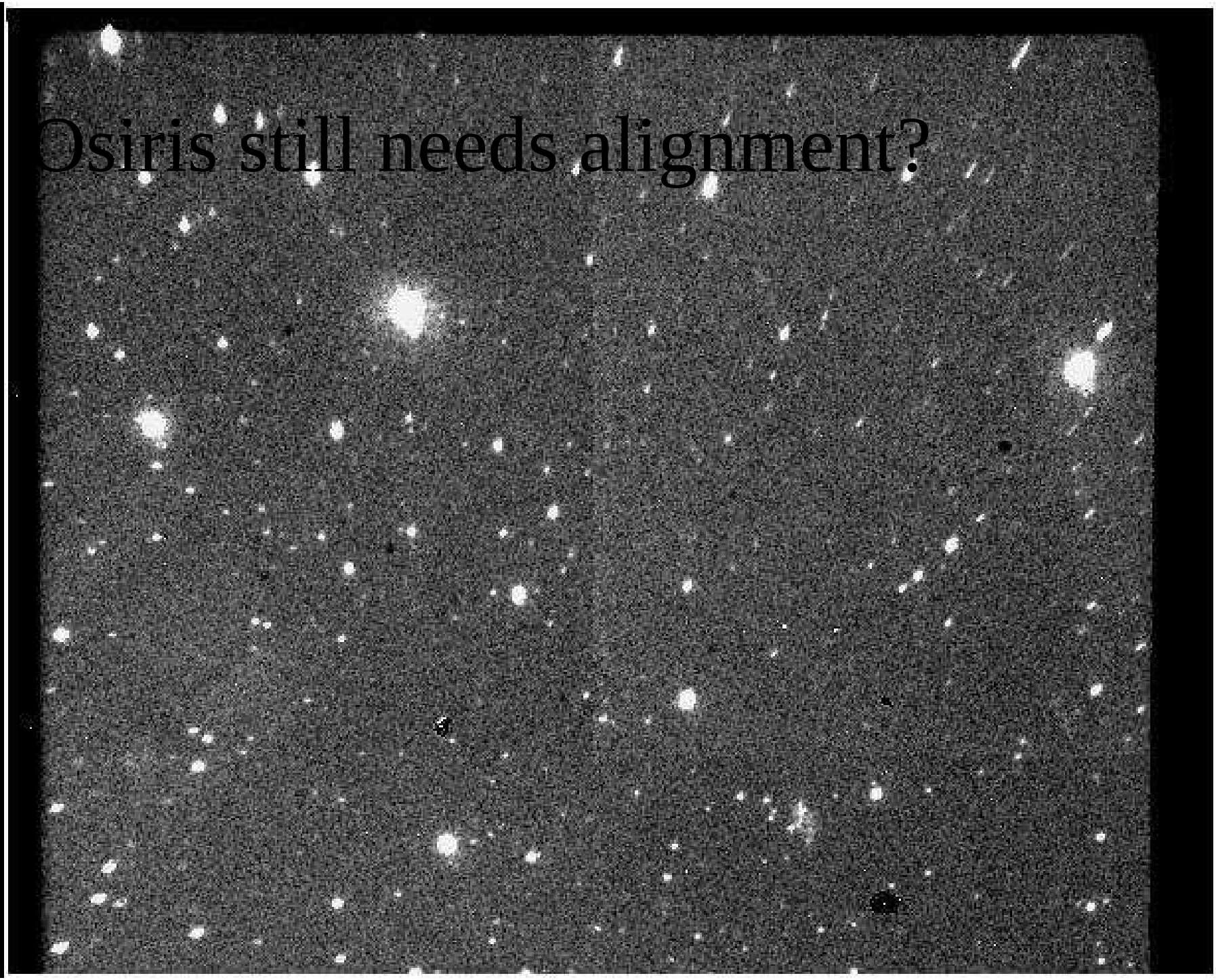
0.331”/pixel
FWHM ~ 1.2”



0.3”/pixel
FWHM ~ 1.3”

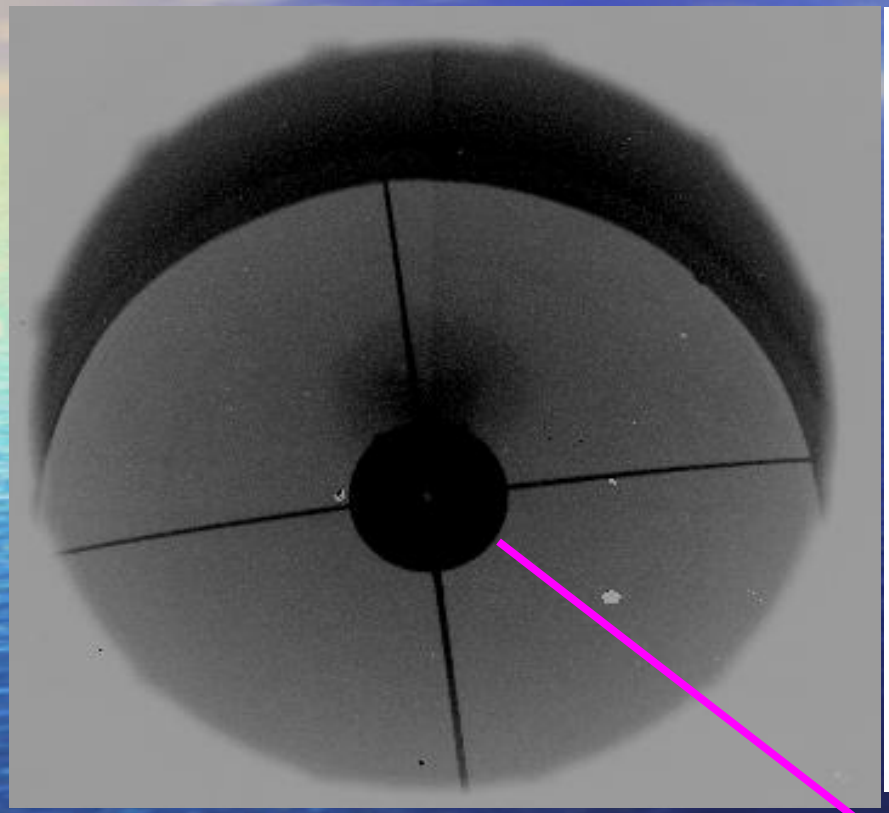
Exp Time OSIRIS < Exp Time ISPI

Osiris still needs alignment?

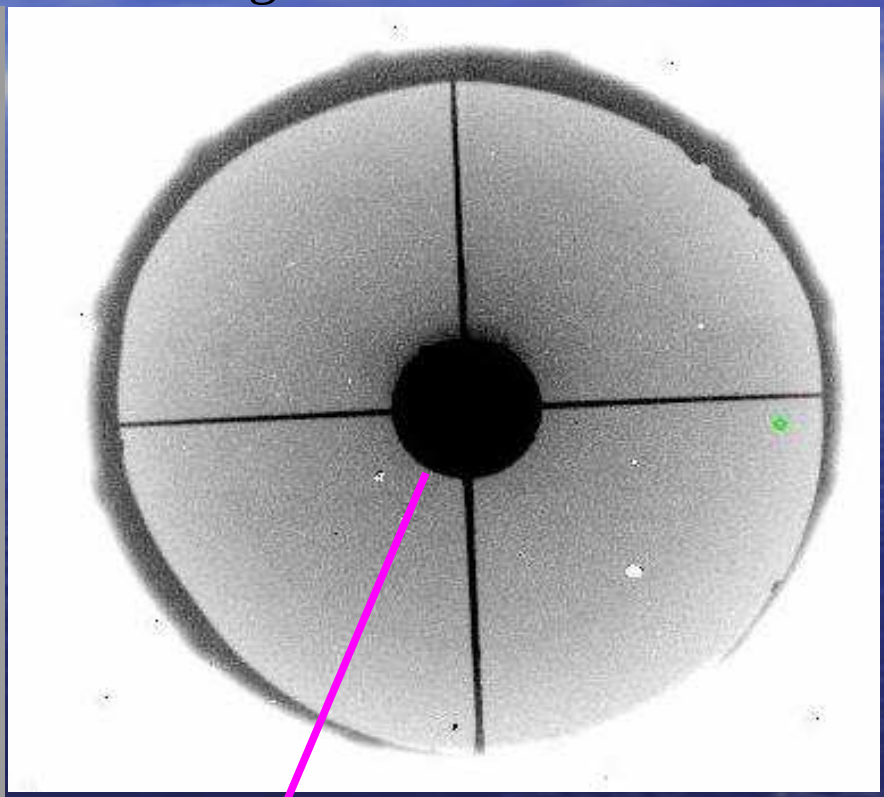


Instrument Aligned (2005 June 16):

Before Alignment:



After Alignment:

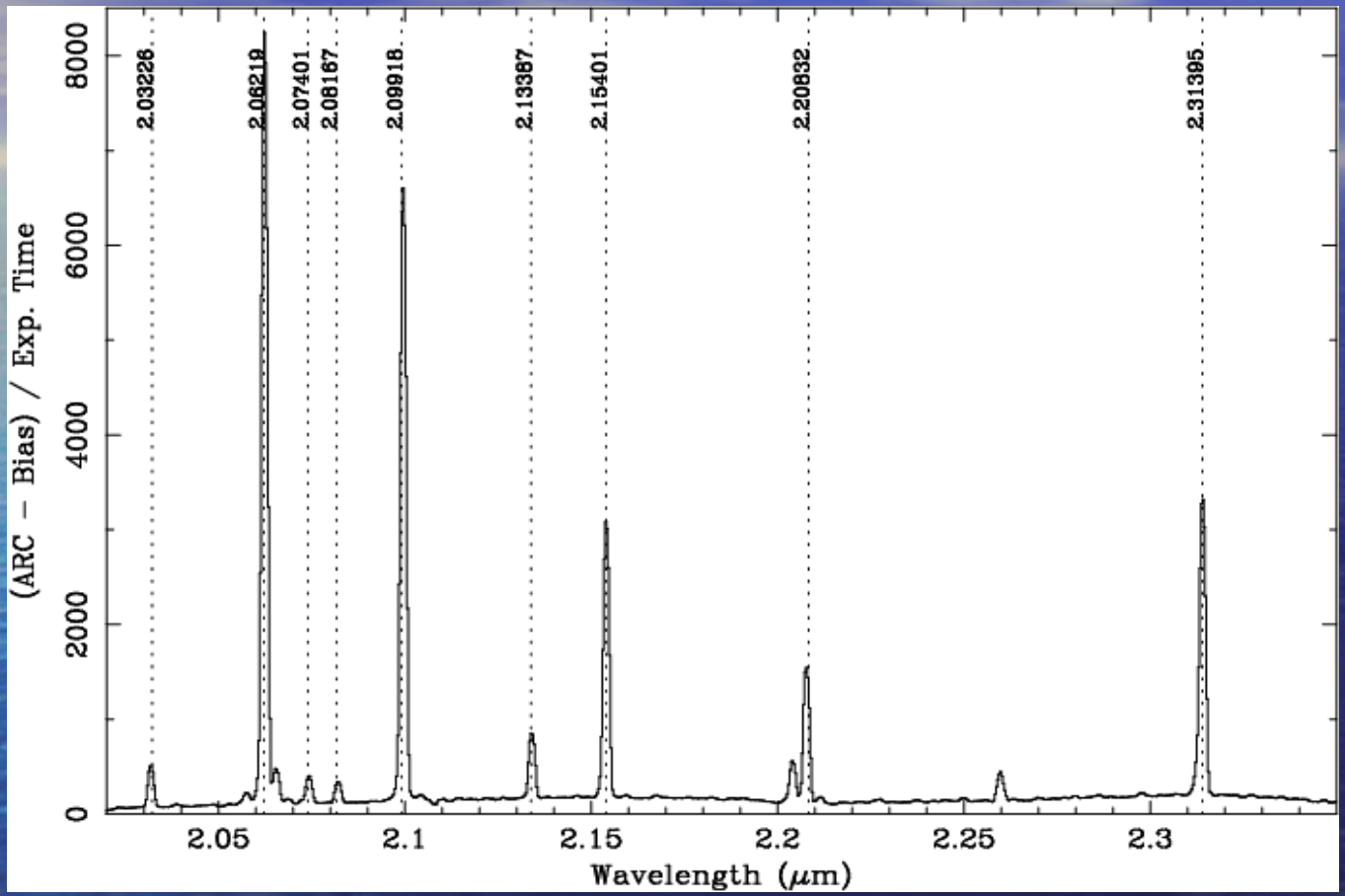


Lyot Mask

(After Alignment)

Lamps:

Argon – HiRes - K band

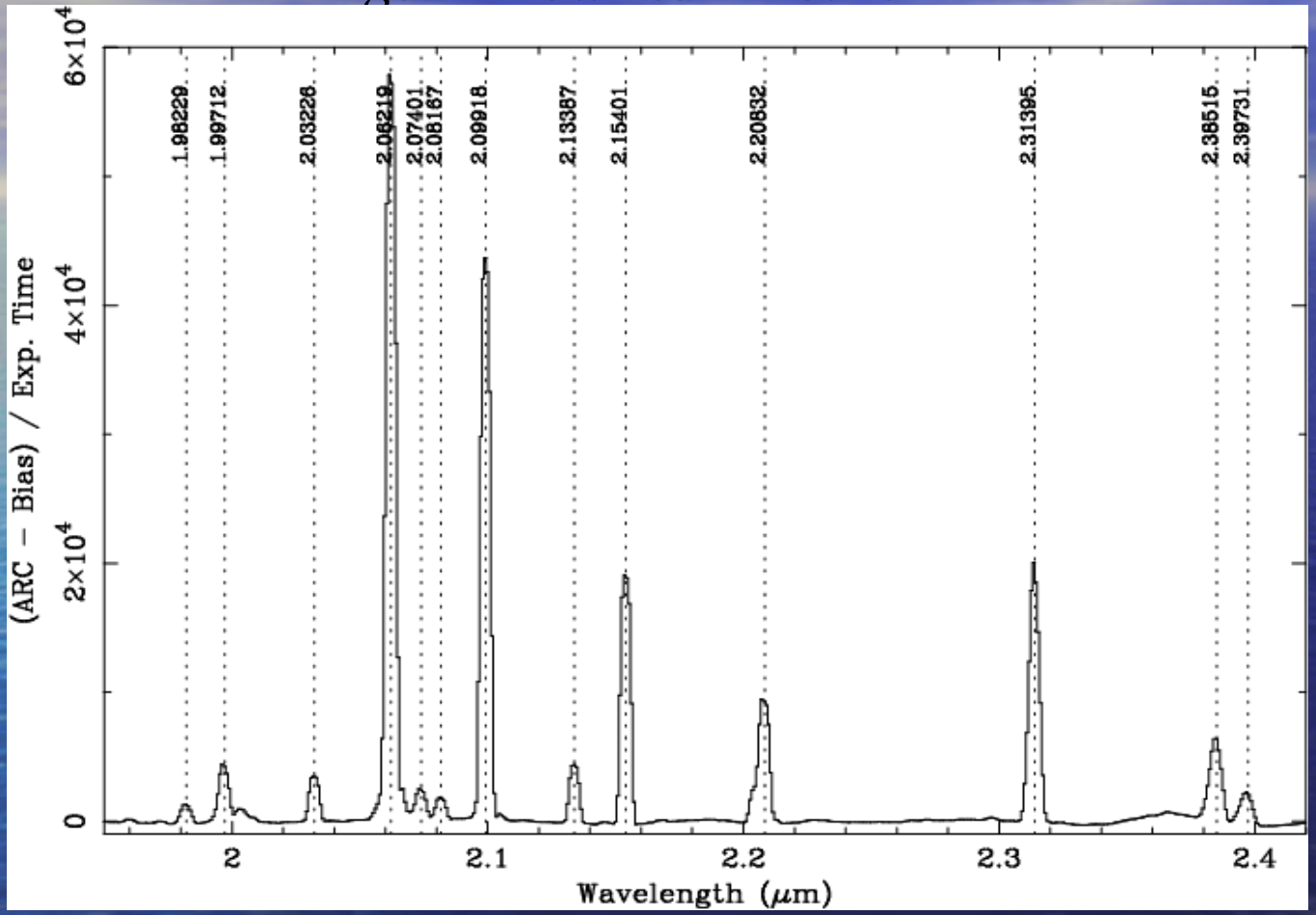


High-Res Long (f/7) - 0.42”
Wavelength range ~ 3600 Angs.
Linear Dispersion = 3.691 Angs. /pixel
FWHM = 9.53 Angs.

(After Alignment)

Lamps:

Argon – LowRes - K band



Low-Res Long (f/3) - 1.0”
Wavelength range ~ 4700 Angs.
Linear Dispersion = 8.939 Angs. /pixel
FWHM = 19.66 Angs.

Discovery of fourteen new ZZ Cetis with SOAR

astro-ph/0507490 accepted on A&A

S. O. Kepler, B. G. Castanheira, M. F. O. Saraiva, A. Nitta, S. J. Kleinman, F. Mullally, D. E. Winget & D. J. Eisenstein