

Dome flat illumination system at Kottamia Observatory

Toshiyuki Sasaki / 2010-03-24 (Ver0.1)

1. Dome Flat illumination system

Dome flat illumination system has been installed at Kottamia Observatory in Nov., 2010. Two illuminating lamps are installed at both sides of the tube top the 188cm telescope, as shown in Fig.1-1 and Fig.1-2.



Fig. 1-1 Two Dome-Flat lamps, installed both sides of the tube top of Kottamia 188 cm telescope, which are illuminating the wall inside the dome.

The dome flat illumination system consists of two Halogen lamps, one lamp power unit, and a remote control box (Table 1-1). Dome lamps are controlled locally with a local On-Off switch attached to the power unit and also remotely using a small control box (Fig.1-3) from the control room. Detail specifications of components of the dome flat illumination system are shown in Tables 1-2, 1-3, and 1-4.

Several spare Halogen lamps are already available at Kottamia. When a Halogen lamp is burned out, it should be replaced to new one with careful treatment WITHOUT direct touch of the lamp glass with bare human hands.



Fig. 1-2 Dome-Flat lamps are illuminating the dome slit when the telescope near the zenith. Shadows are of telescope structures lighting by interior lamps around the dome.



Fig.1-3 A remote control box for Dome-Flat illumination lamps, operated manually.

Table 1-1 Components of Dome-Flat lamp system		
Item	Product	Spec
Halogen Lamp	Ushio JC12V50WG/1.0	12V/50W, 2900K, 2000h
Halogen Lamp power unit	μ Tec HSV2-150-15	150W, Output:DC 3-15V
Fused-Silica window glass	Tokiwa-optical TS-0869G4	50 x 50mm x 2.00 mm
Cooling Fan	Sunon KD1204PFS2	PC fans DC12V, 0.9W
remote control box	(home-made)	On/Off switch, connected to the power unit with cables of 80m long.

Schematic diagram of the dome flat illumination system is shown in Fig. 1-4. As an output voltage of the Halogen lamp power unit is variable, current output voltage is set as 10VDC. Remote Control of Halogen Lamp Power Unit is carried manually with the

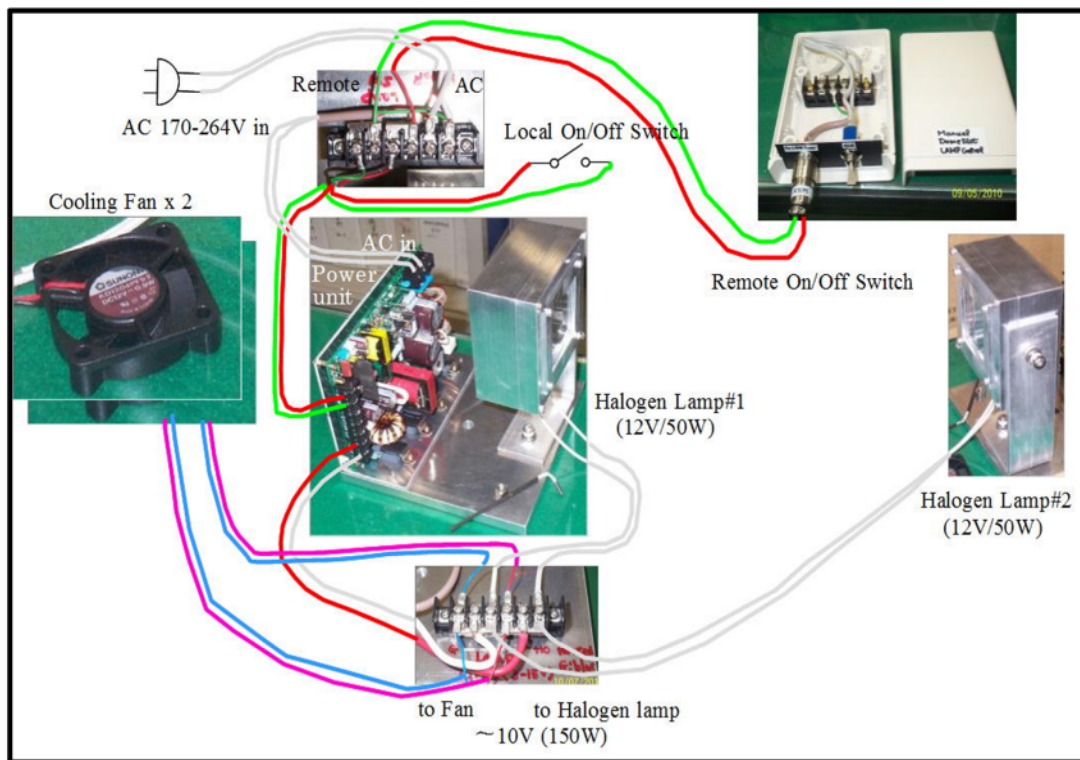


Fig. 1-4 Schematic diagram of the dome flat illumination system

On/Off switches attached locally on the lamp power unit and on the remote control box as shown in Fig.1-5.

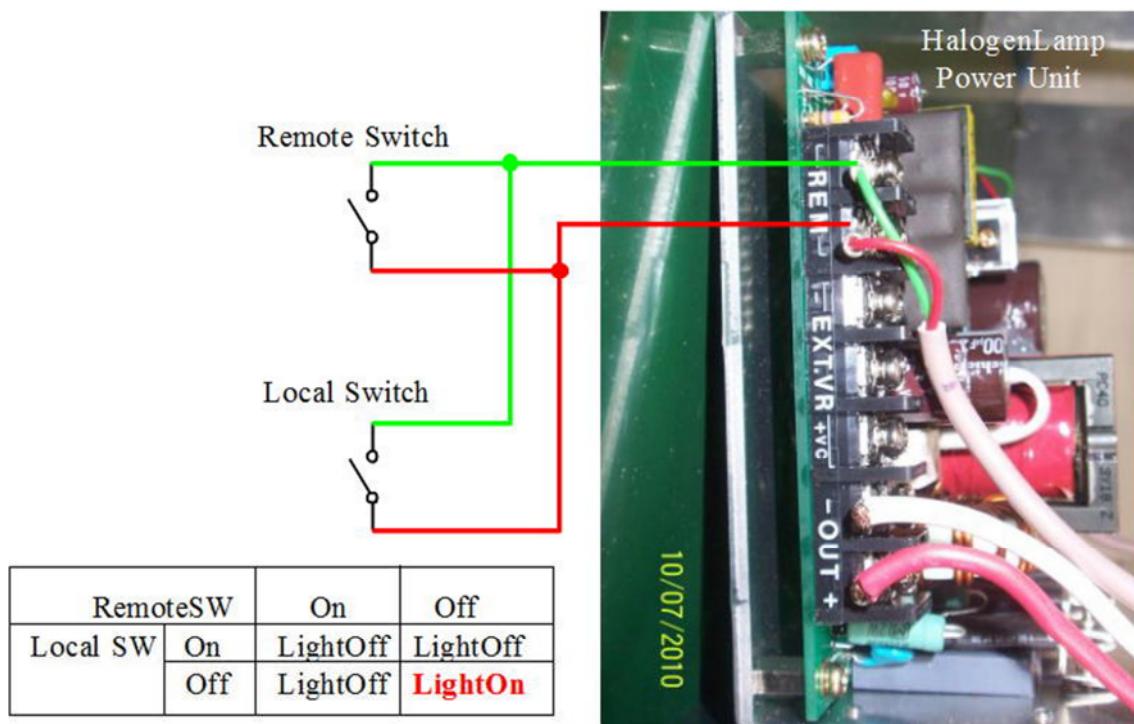
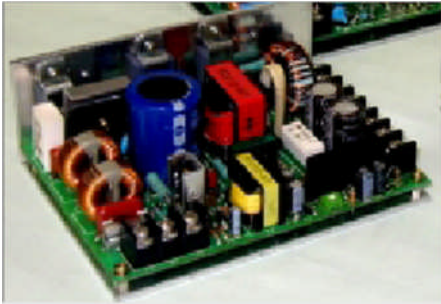


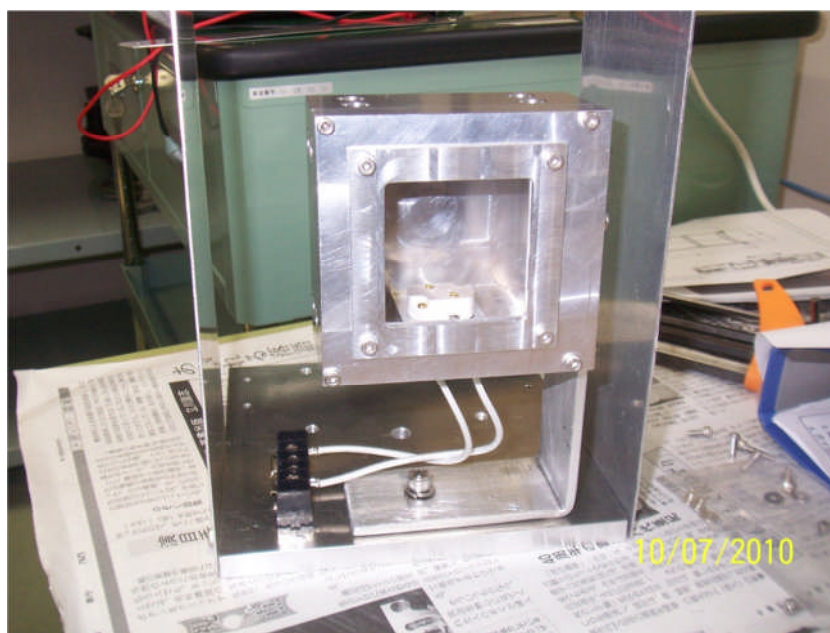
Fig.1-5 Remote Control of Halogen Lamp Power Unit

Table 1-2 Halogen Lamp power unit	
Product name	HSV2-150-15, 150W Halogen Lamp power unit
Input Votage	AC100V(85-132V) / 200V(170-264V) (switching with an internal connector)
Output Voltage	DC 3-15V (adjusted with an internal rotating switch), 10Amp(max)
Usage environment	Temp: 0 - +40℃ RH: 20 – 85% (w/o dew)
Storage environment	Temp -20 - +70℃ RH: 20 – 85% (w/o dew)
Remote Control	On/Off available by connecting two terminals
	

(Fig. 1-6)

Table 1-3 Halogen Lamp	
Halogen Lamp	Ushio JC12V50WG/1.0
Voltage	12V
power consumption	50 W,
flux	900 lm
color temperature	2900K,
lifetime	2000h
size	Length 44mm, Tube diameter 11mm
Filament type	C-6
Mount	G6.35
Socket	G6.35/L150
 (Fig. 1-7)	
Replacement	After burn out, replace the lamp carefully without touching the bulb by bare hands, (see note* how to replace the lamp).

*Note) How to replace the Halogen lamp



(Fig. 1-8)

1. Release/remove four screws, then remove the window glass.
2. Remove the burned lamp. Take care as it may be hot just after used.
3. Insert the new lamp carefully with hand globes. If some oil/human fingerprint on the lamp, the oil get hot during its lightening to break the lamp itself.
4. Put the window glass and tighten the screws

Table 1-4 Fused-Silica Window Glass

Synthetic Fused-Silica Window	Tokiwa-optical TS-0869G4
Parallelism Tolerance	3' ~5'
Surface Accuracy	$3\lambda \sim \lambda/2$ (effectiveness: inside central 85%)
Surface Quality	MIL 60-40
Design Wavelength	587.6nm
Reflective Index	1.45850
Chamfer	Whole edges (45°)
Size	50 x 50mm +0/-0.3mm t 2mm $\pm$ 0.2mm
http://www.tokiwa-optical.co.jp/catalog/c22.html	

Reflecting screen (additional item)

Three projector screens of size 1m x 3m each are prepared at Kottamia (Fig. 1-9), which is waited for usage if enough illumination brightness is not obtained using a dome inner wall. Info of the screen is available on the Web:

http://theaterhouse.co.jp/tp_shop.php



Fig. 1-9 A parcel of three projector screens

Contributors to make the dome flat illumination system

- Toshiyuki Sasaki, Subaru telescope, NAOJ (Hawaii)
- Hisashi Koyano, Okayama Astrophysical Observatory, NAOJ (Okayama)
- Takeshi Noguchi, National Astronomical Observatory (Mitaka)

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- Collaboration fund with Egypt at OAO (H. Koyano)
- Individual Research fund at NAOJ (T. Sasaki)

2. Accuracy of Dome-Flat calibration

We estimated an accuracy of flat-fielding using Dome Flat images, compared to blank Sky images. When we took blank sky area and Dome-Flat images, sheets of black screen were set on the telescope tube to block the ghost illumination through to CCD at Newtonian focus (shown in Fig. 1-1 and Fig. 1-2). Both Dome-Flat and blank Sky images are subtracted of their bias using IRAF CCDRED commands, and then the blank Sky images are divided with Dome Flat images (see a CCD frame list in appendix). Resultant images are shown in Fig. 2-1(a) and (b) in B-band, Fig. 2-2(a) and (b) in V-band, Fig. 2-3(a) and (b) in R-band, and Fig. 2-4(a) and (b) in I-band.

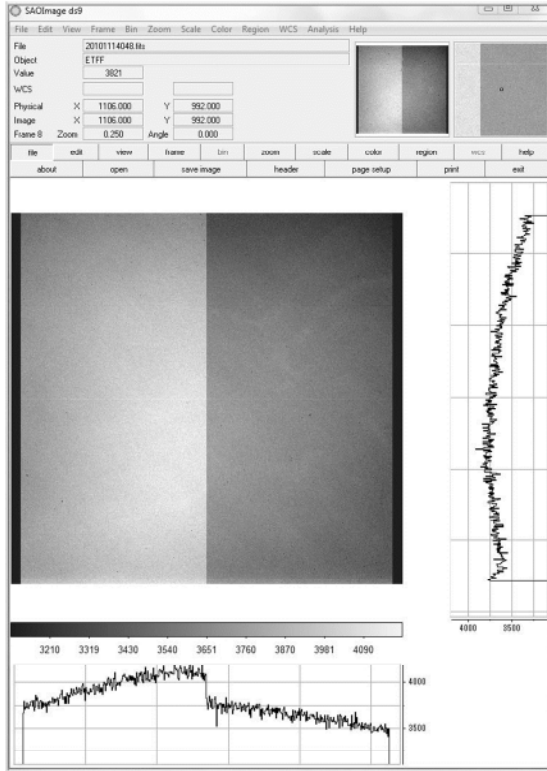


Fig. 2-1 (a) Raw Sky image, 20101114048.fits, of EXPT=300 sec with B-band filter.

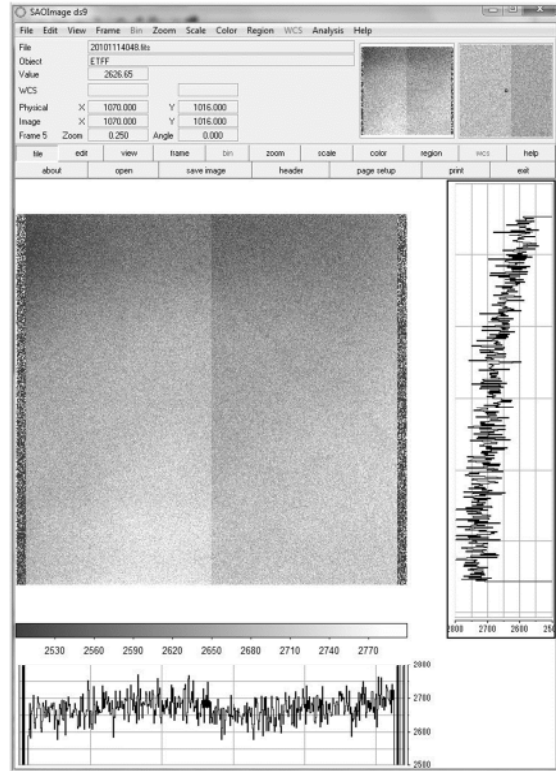


Fig. 2-1 (b) Processed Sky image of 20101114048.fits, by subtracting bias and flat-fielding with Dome-Flat image.

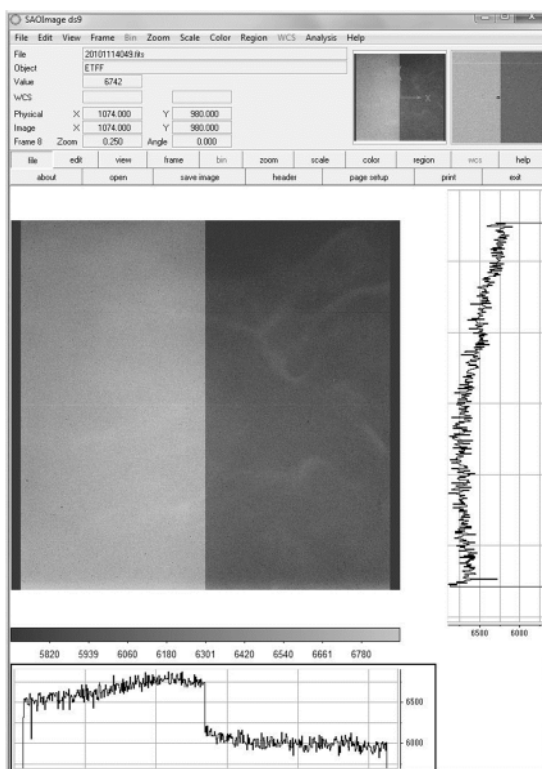


Fig. 2-2 (a) Raw Sky image, 20101114049.fits, of EXPT=300 sec with V-band filter.

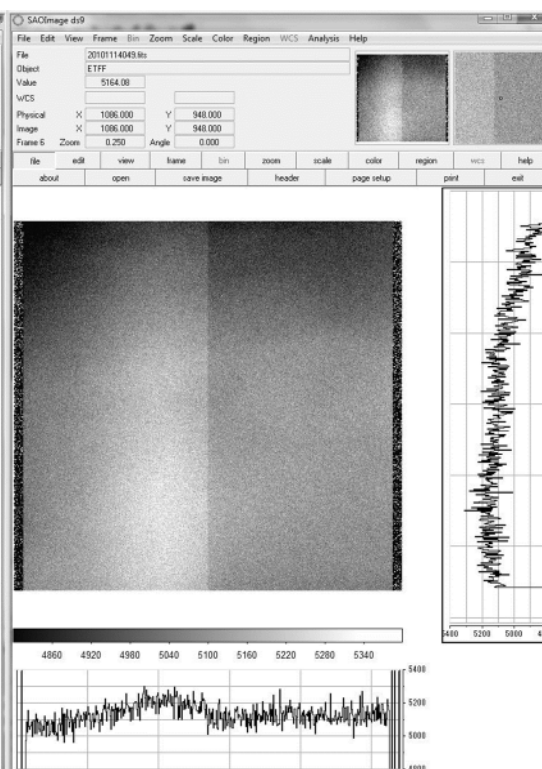


Fig. 2-2 (b) Processed Sky image of 20101114049.fits, by subtracting bias and flat-fielding with Dome-Flat.

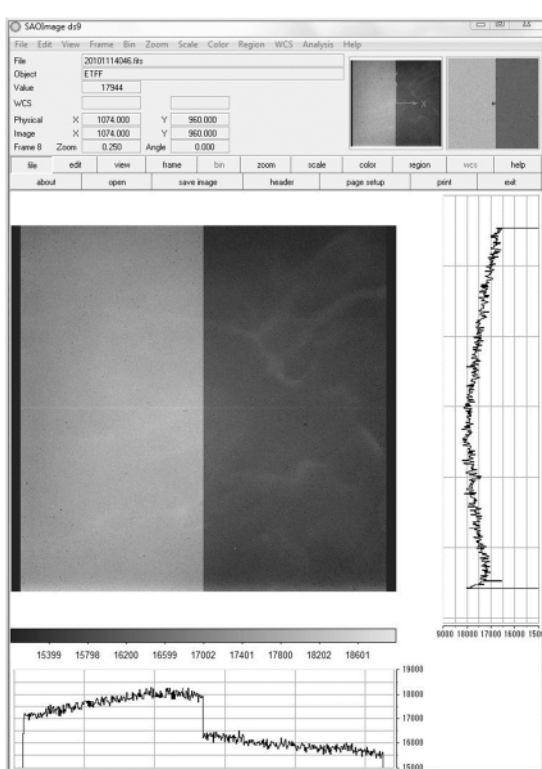


Fig. 2-3 (a) Raw Sky image, 20101114046.fits, of EXPT=240 sec with R-band filter.

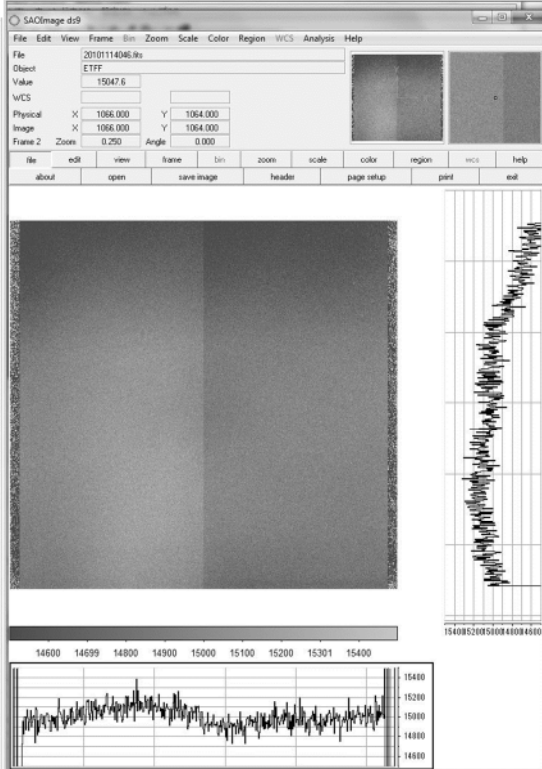


Fig. 2-3 (b) Processed Sky image of 20101114046.fits, by subtracting bias and flat-fielding with Dome-Flat.

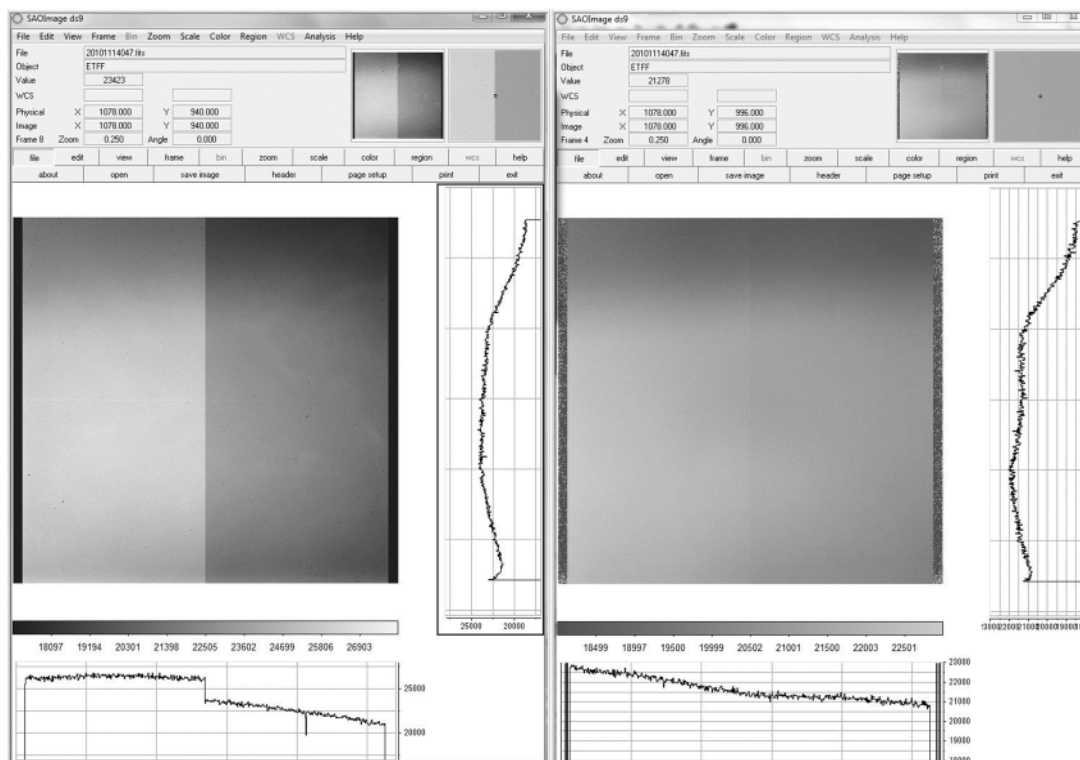


Fig. 2-4 (a) Raw Sky image, 20101114047.fits, of EXPT=300 sec with I-band filter.

Fig. 2-4 (b) Processed Sky image of 20101114047.fits, by subtracting bias and flat-fielding with Dome-Flat.

As central intensity jumps of CCD are notable for the CCD used at Kottamia, the jumps are reduced to 1% of processed images from 10% of raw frames, but some jumps still remain (Fig.2-12).

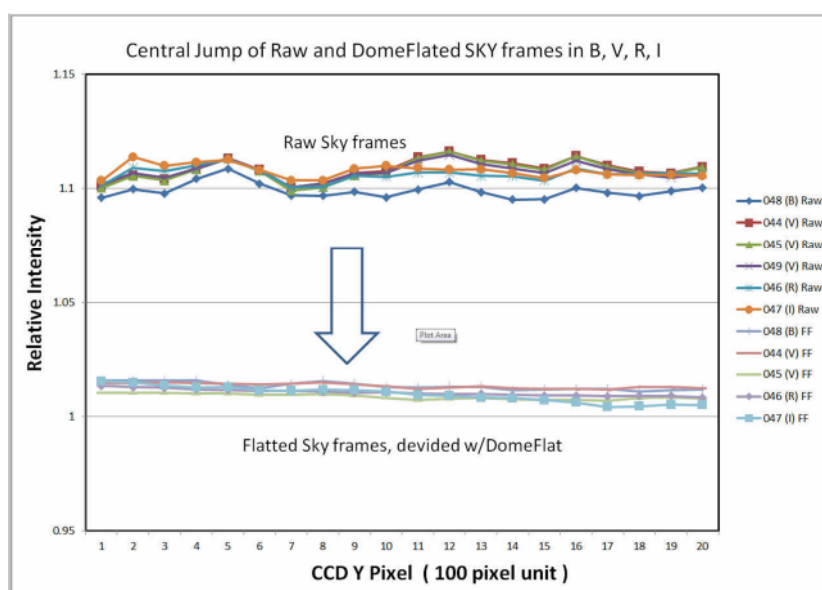


Fig.2-5 Reduction of central intensity jumps of blank sky images after subtracting with dome-flat images.

Global fluctuations over the entire field of CCD are observed even for the processed images, as shown in Fig.2-8 (b) to Fig.2-11(b). Vertical plots of processed Sky images show unflatness about a few percent of their average intensity (Fig.2-13).

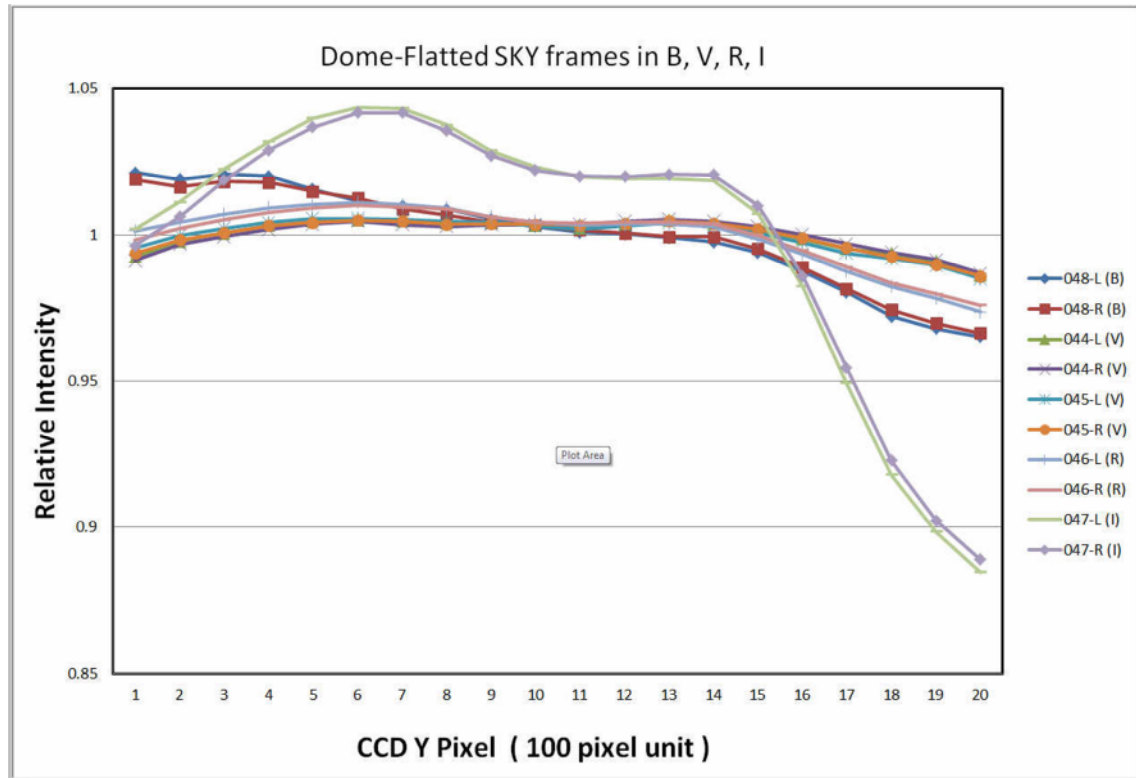
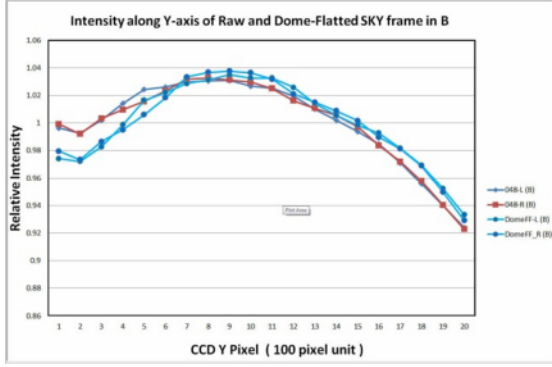
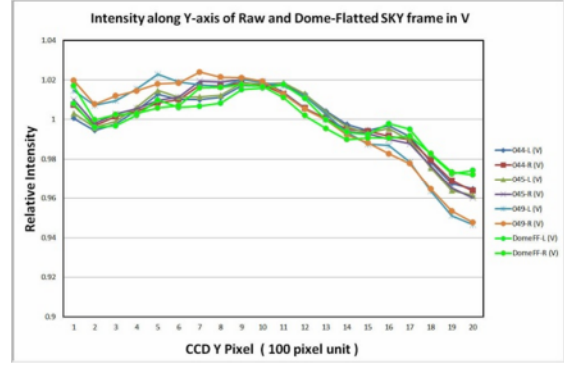


Fig.2-6 Vertical plots of processed Sky images of central portions of images[950:1050,*] and [1100:1200,*] along both sides of the central intensity jump. Abscissa is along CCD Y-axis in unit of 100 pixels. CCD format is of 2154(X) x 2048(Y).

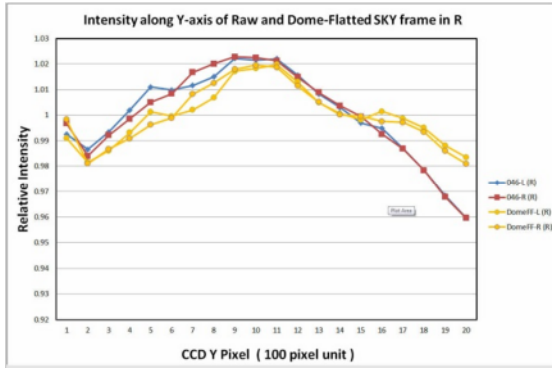
Systematic differences of blank sky images and dome-flat images are observed, shown in Fig.2-14. The differences are increased toward redder color bands. We must investigate the cause(s) of the remaining central intensity jumps and the global fluctuations/unflatness. Field-stopper(s) in optical path to Newtonian focus may be necessary to reduce the jumps and fluctuations.



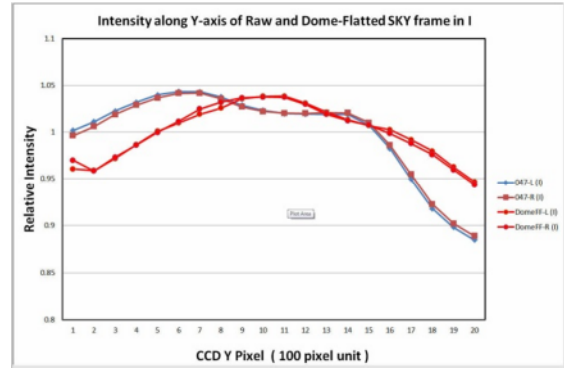
(a) B-band



(b) V-band



(c) R-band



(d) I band

Fig. 2-7 Vertical intensity plots of processed blank sky images and dome-flat images at the both sides of the central jumps in B, V, R, and I bands.

Appendix) A CCD frame list for Dome-Flat

--- Bias frames -----

FITS File, OBJECT, RA, DEC, EXPTIME, FILTER, DATE_OBS, DATE_OBS, HOURANG, Z, MAXPIX, MINPIX, BITPIX, NAXIS, NAXIS1, NAXIS2

20101114050.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:03:19, 0.0, 0.0, 984, 644, 16, 2, 2154, 2048
 20101114051.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:03:19, 0.0, 0.0, 1254, 644, 16, 2, 2154, 2048
 20101114052.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:03:33, 0.0, 0.0, 970, 644, 16, 2, 2154, 2048
 20101114053.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:03:44, 0.0, 0.0, 970, 645, 16, 2, 2154, 2048
 20101114054.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:03:55, 0.0, 0.0, 969, 645, 16, 2, 2154, 2048
 20101114055.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:04:06, 0.0, 0.0, 65527, 645, 16, 2, 2154, 2048
 20101114056.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:04:17, 0.0, 0.0, 971, 644, 16, 2, 2154, 2048
 20101114057.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:04:28, 0.0, 0.0, 971, 645, 16, 2, 2154, 2048
 20101114058.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:04:39, 0.0, 0.0, 65527, 645, 16, 2, 2154, 2048
 20101114059.fits, BIAS FRAME, , , 0.000, V, 2010/11/14, 16:04:50, 0.0, 0.0, 1301, 645, 16, 2, 2154, 2048

20101114103.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:31:10, 0.0, 0.0, 1064, 644, 16, 2, 2154, 2048
 20101114104.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:31:10, 0.0, 0.0, 2101, 645, 16, 2, 2154, 2048
 20101114105.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:31:25, 0.0, 0.0, 971, 645, 16, 2, 2154, 2048
 20101114106.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:31:36, 0.0, 0.0, 969, 645, 16, 2, 2154, 2048
 20101114107.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:31:47, 0.0, 0.0, 971, 645, 16, 2, 2154, 2048
 20101114108.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:31:58, 0.0, 0.0, 969, 645, 16, 2, 2154, 2048
 20101114109.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:32:09, 0.0, 0.0, 972, 645, 16, 2, 2154, 2048
 20101114110.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:32:20, 0.0, 0.0, 972, 645, 16, 2, 2154, 2048
 20101114111.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:32:31, 0.0, 0.0, 972, 645, 16, 2, 2154, 2048
 20101114112.fits, BIAS FRAME, , , 0.000, B, 2010/11/14, 16:32:42, 0.0, 0.0, 3219, 645, 16, 2, 2154, 2048

--- SkyFlat frames, taken around Eastern sky in the twilight -----

FITS File, OBJECT, RA, DEC, EXPTIME, FILTER, DATE_OBS, DATE_OBS, HOURANG, Z, MAXPIX, MINPIX, BITPIX, NAXIS, NAXIS1, NAXIS2

20101114042.fits, , , 120.000, V, 2010/11/14, 15:26:47, 0.0, 0.0, 65535, 647, 16, 2, 2154, 2048
 20101114044.fits, , , 60.000, V, 2010/11/14, 15:34:01, 0.0, 0.0, 13598, 645, 16, 2, 2154, 2048
 20101114045.fits, , , 240.000, V, 2010/11/14, 15:35:54, 0.0, 0.0, 22678, 645, 16, 2, 2154, 2048
 20101114046.fits, ETFF, , , 240.000, R, 2010/11/14, 15:40:59, 0.0, 0.0, 65535, 645, 16, 2, 2154, 2048
 20101114047.fits, ETFF, , , 300.000, I, 2010/11/14, 15:45:44, 0.0, 0.0, 28987, 645, 16, 2, 2154, 2048
 20101114048.fits, ETFF, , , 300.000, B, 2010/11/14, 15:51:24, 0.0, 0.0, 7896, 645, 16, 2, 2154, 2048
 20101114049.fits, ETFF, , , 300.000, V, 2010/11/14, 15:57:28, 0.0, 0.0, 9858, 645, 16, 2, 2154, 2048

--- DomeFlat frames -----

FITS File, OBJECT, RA, DEC, EXPTIME, FILTER, DATE_OBS, DATE_OBS, HOURANG, Z, MAXPIX, MINPIX, BITPIX, NAXIS, NAXIS1, NAXIS2

20101114060.fits, DomeFF, , , 5.000, R, 2010/11/14, 16:11:05, 0.0, 0.0, 65535, 647, 16, 2, 2154, 2048
 20101114061.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:12:34, 0.0, 0.0, 50253, 644, 16, 2, 2154, 2048
 20101114062.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:13:13, 0.0, 0.0, 50174, 644, 16, 2, 2154, 2048
 20101114063.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:13:13, 0.0, 0.0, 50103, 645, 16, 2, 2154, 2048
 20101114064.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:13:30, 0.0, 0.0, 50115, 645, 16, 2, 2154, 2048
 20101114065.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:13:43, 0.0, 0.0, 50121, 645, 16, 2, 2154, 2048
 20101114066.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:13:56, 0.0, 0.0, 50139, 645, 16, 2, 2154, 2048
 20101114067.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:14:09, 0.0, 0.0, 50051, 645, 16, 2, 2154, 2048
 20101114068.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:14:22, 0.0, 0.0, 65527, 645, 16, 2, 2154, 2048
 20101114069.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:14:35, 0.0, 0.0, 50004, 645, 16, 2, 2154, 2048
 20101114070.fits, DomeFF, , , 2.000, R, 2010/11/14, 16:14:48, 0.0, 0.0, 50315, 644, 16, 2, 2154, 2048

20101114073.fits, DomeFF, , , 0.700, I, 2010/11/14, 16:16:29, 0.0, 0.0, 49344, 644, 16, 2, 2154, 2048
 20101114074.fits, DomeFF, , , 0.700, I, 2010/11/14, 16:17:28, 0.0, 0.0, 49585, 644, 16, 2, 2154, 2048
 20101114075.fits, DomeFF, , , 0.700, I, 2010/11/14, 16:17:28, 0.0, 0.0, 49523, 644, 16, 2, 2154, 2048
 20101114076.fits, DomeFF, , , 0.700, I, 2010/11/14, 16:17:45, 0.0, 0.0, 49628, 645, 16, 2, 2154, 2048
 20101114077.fits, DomeFF, , , 0.700, I, 2010/11/14, 16:17:56, 0.0, 0.0, 49510, 644, 16, 2, 2154, 2048
 20101114078.fits, DomeFF, , , 0.700, I, 2010/11/14, 16:18:08, 0.0, 0.0, 49425, 644, 16, 2, 2154, 2048
 20101114079.fits, DomeFF, , , 0.700, I, 2010/11/14, 16:18:20, 0.0, 0.0, 49331, 645, 16, 2, 2154, 2048
 20101114080.fits, DomeFF, , , 0.700, I, 2010/11/14, 16:18:32, 0.0, 0.0, 49385, 644, 16, 2, 2154, 2048
 20101114081.fits, DomeFF, , , 0.700, I, 2010/11/14, 16:18:44, 0.0, 0.0, 49609, 644, 16, 2, 2154, 2048
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 20101114085.fits, DomeFF, , , 5.000, V, 2010/11/14, 16:20:24, 0.0, 0.0, 43305, 645, 16, 2, 2154, 2048
 20101114086.fits, DomeFF, , , 5.000, V, 2010/11/14, 16:20:43, 0.0, 0.0, 43415, 645, 16, 2, 2154, 2048
 20101114087.fits, DomeFF, , , 5.000, V, 2010/11/14, 16:20:59, 0.0, 0.0, 43608, 645, 16, 2, 2154, 2048
 20101114088.fits, DomeFF, , , 5.000, V, 2010/11/14, 16:21:15, 0.0, 0.0, 43543, 645, 16, 2, 2154, 2048
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 20101114090.fits, DomeFF, , , 5.000, V, 2010/11/14, 16:21:47, 0.0, 0.0, 43531, 645, 16, 2, 2154, 2048
 20101114091.fits, DomeFF, , , 5.000, V, 2010/11/14, 16:22:03, 0.0, 0.0, 43388, 645, 16, 2, 2154, 2048
 20101114092.fits, DomeFF, , , 5.000, V, 2010/11/14, 16:22:19, 0.0, 0.0, 43419, 645, 16, 2, 2154, 2048

20101114093.fits, DomeFF, , , 30.000, B, 2010/11/14, 16:23:14, 0.0, 0.0, 44398, 645, 16, 2, 2154, 2048
 20101114094.fits, DomeFF, , , 30.000, B, 2010/11/14, 16:24:37, 0.0, 0.0, 44479, 645, 16, 2, 2154, 2048
 20101114095.fits, DomeFF, , , 30.000, B, 2010/11/14, 16:24:37, 0.0, 0.0, 44503, 645, 16, 2, 2154, 2048
 20101114096.fits, DomeFF, , , 30.000, B, 2010/11/14, 16:25:21, 0.0, 0.0, 44480, 645, 16, 2, 2154, 2048
 20101114097.fits, DomeFF, , , 30.000, B, 2010/11/14, 16:26:02, 0.0, 0.0, 44536, 645, 16, 2, 2154, 2048
 20101114098.fits, DomeFF, , , 30.000, B, 2010/11/14, 16:26:43, 0.0, 0.0, 44437, 645, 16, 2, 2154, 2048
 20101114099.fits, DomeFF, , , 30.000, B, 2010/11/14, 16:27:24, 0.0, 0.0, 44596, 644, 16, 2, 2154, 2048
 20101114100.fits, DomeFF, , , 30.000, B, 2010/11/14, 16:28:05, 0.0, 0.0, 44523, 645, 16, 2, 2154, 2048
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 20101114102.fits, DomeFF, , , 30.000, B, 2010/11/14, 16:29:27, 0.0, 0.0, 44481, 645, 16, 2, 2154, 2048