

# Hyper Suprime-Cam

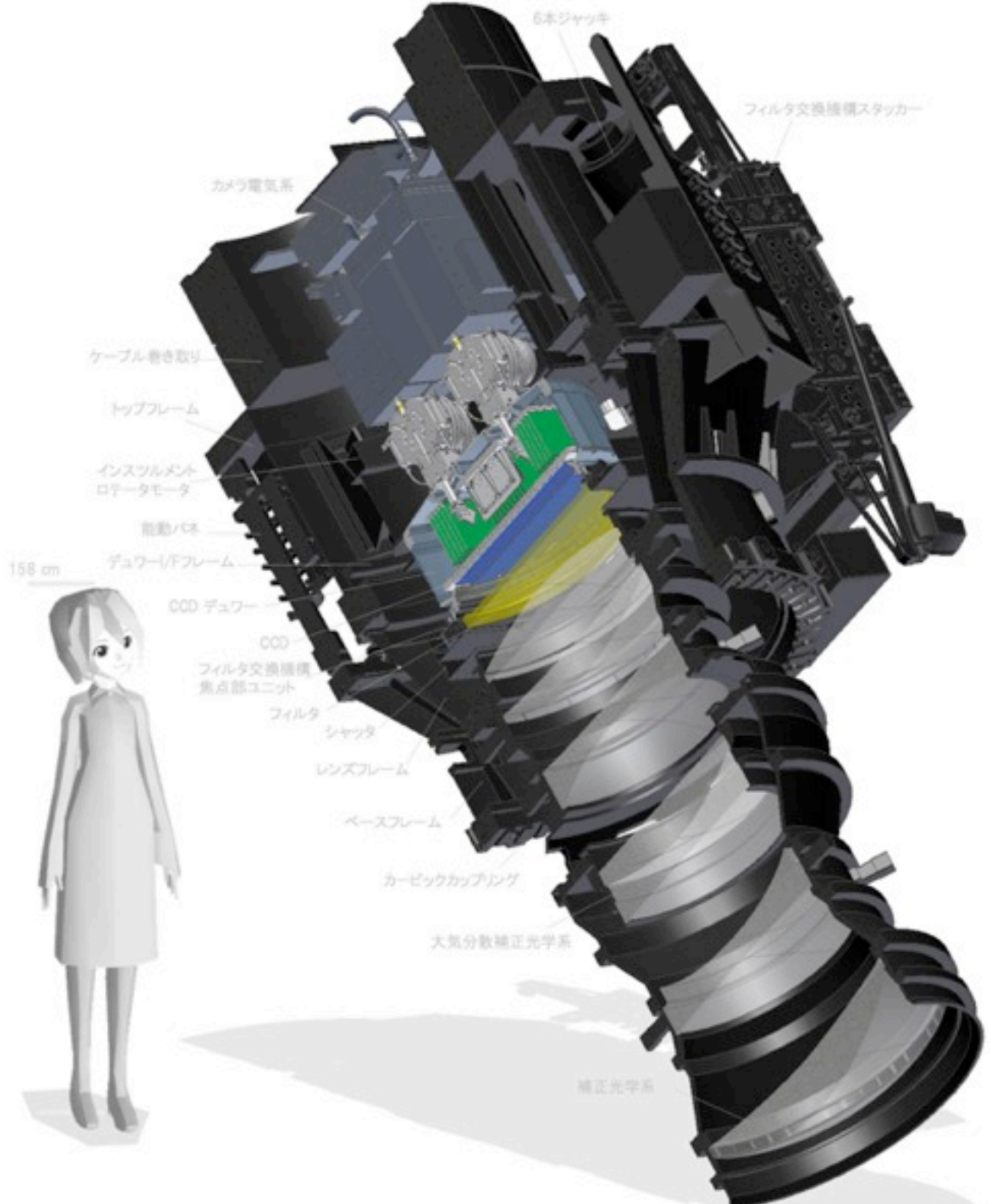
## 開発の現状と戦略枠観測





# Hyper Suprime-Cam

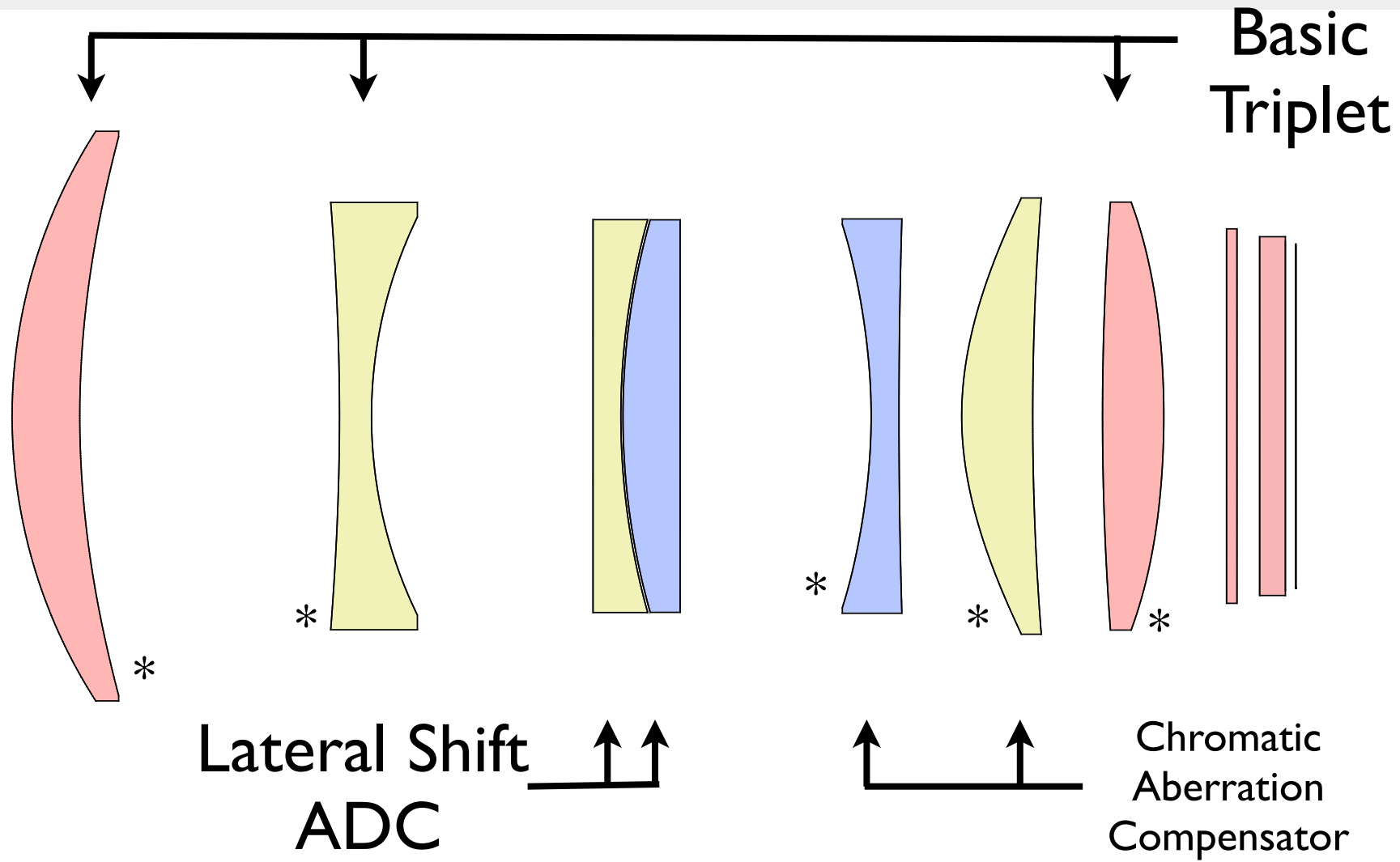
Larger Camera on 8.2 m  
Subaru Telescope



# Key Elements

- Sharp Lens:  $< 0''.2$  FWHM
- Large Number of CCDs  
: to pave  $\varnothing$  50 cm focal plane

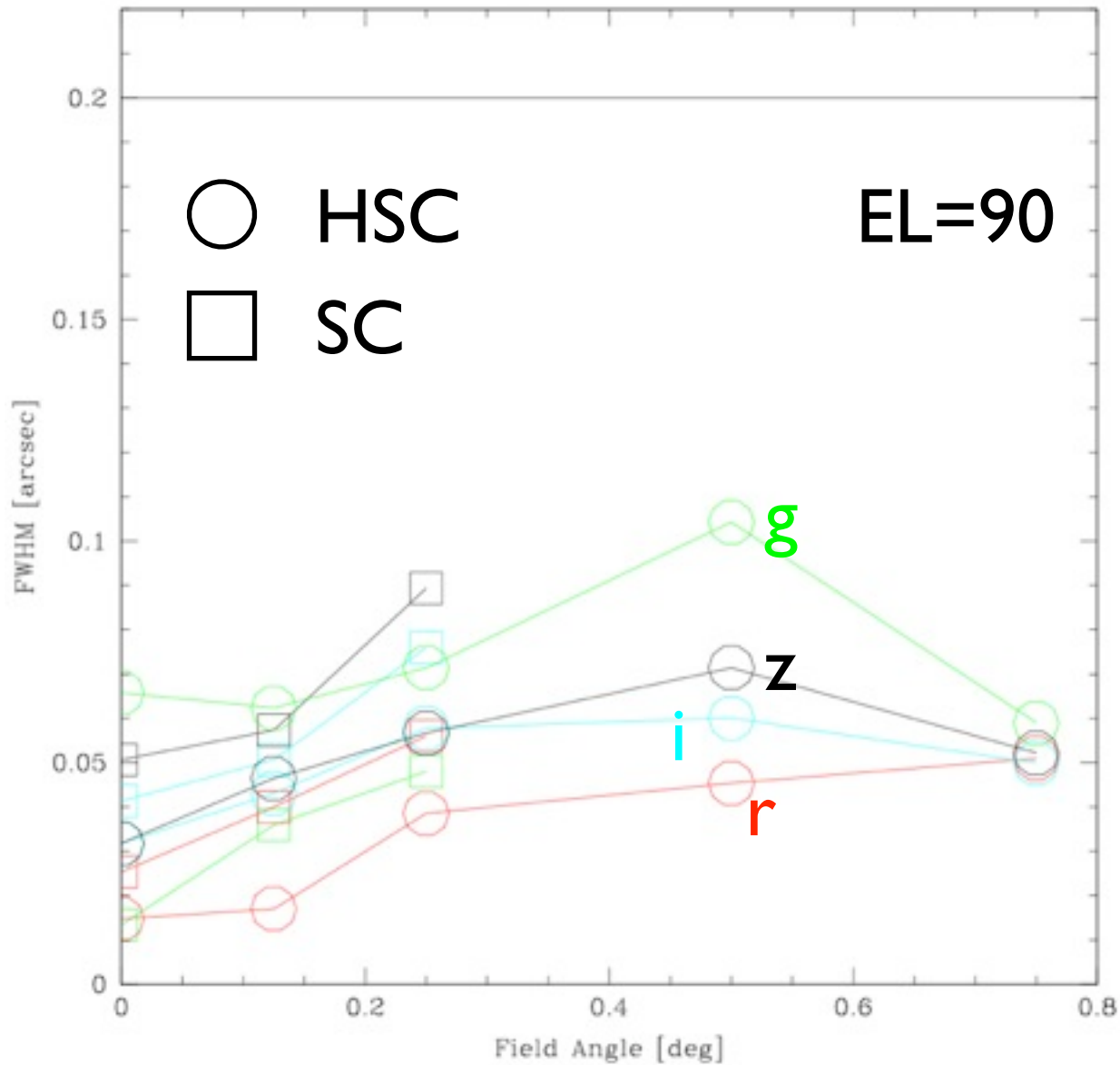
# New Wide Field Corrector



- Quartz
- BSL7Y
- PBLIY

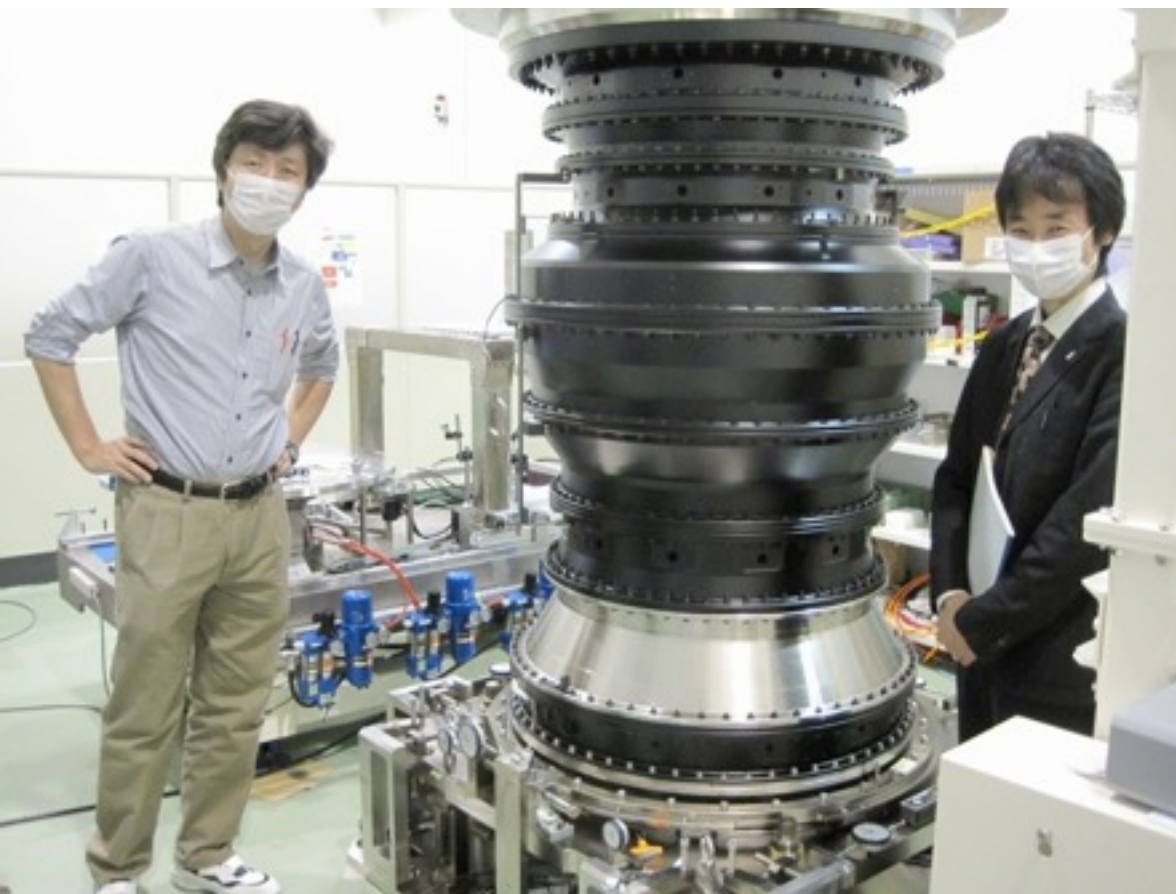


# WFC Designed Performance



0".2 (FWHM) is allocated including manufacturing error

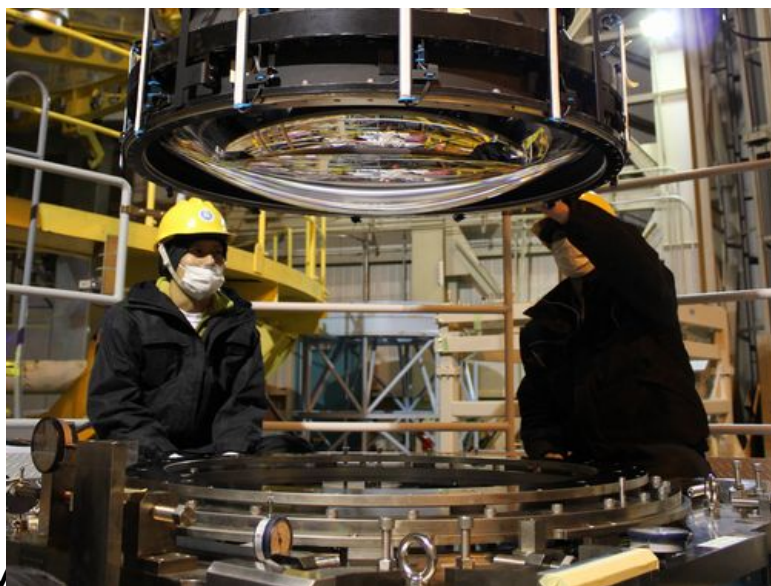
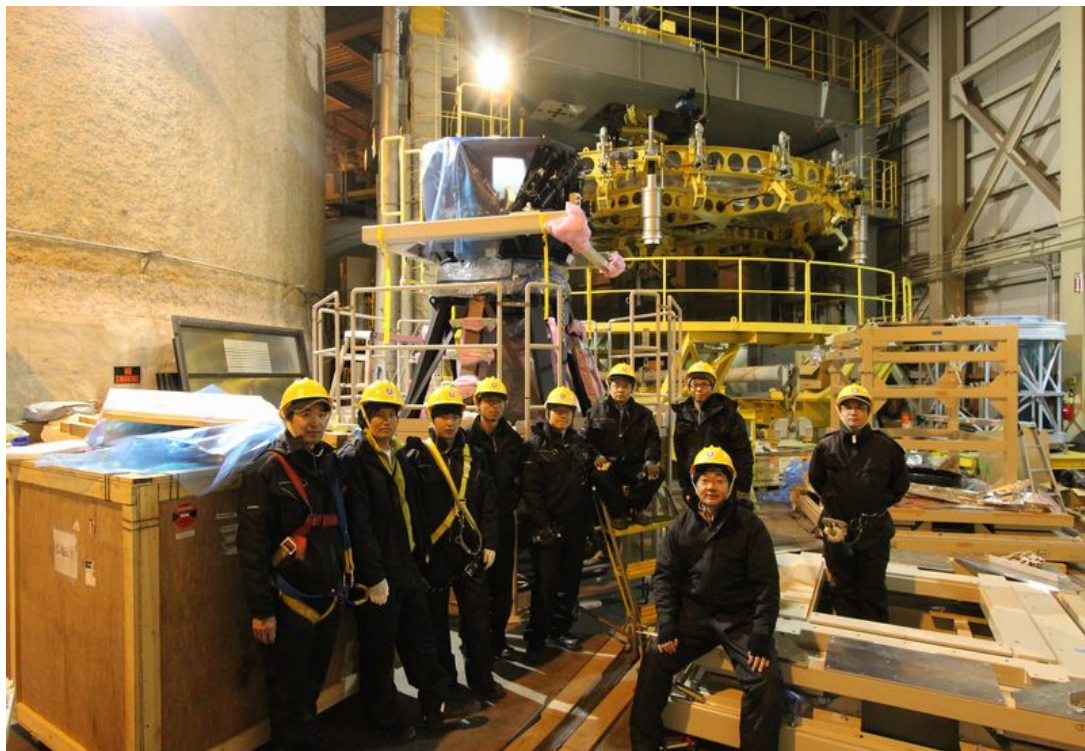
# Wide Field Corrector



Estimated Worst Performance over the field of view  $\leftarrow \sim 0''.18$  FWHM in  $r$  (spec:  $0''.2$ )



# WFC docking with PFU: June '12





# Structure and optics alignment

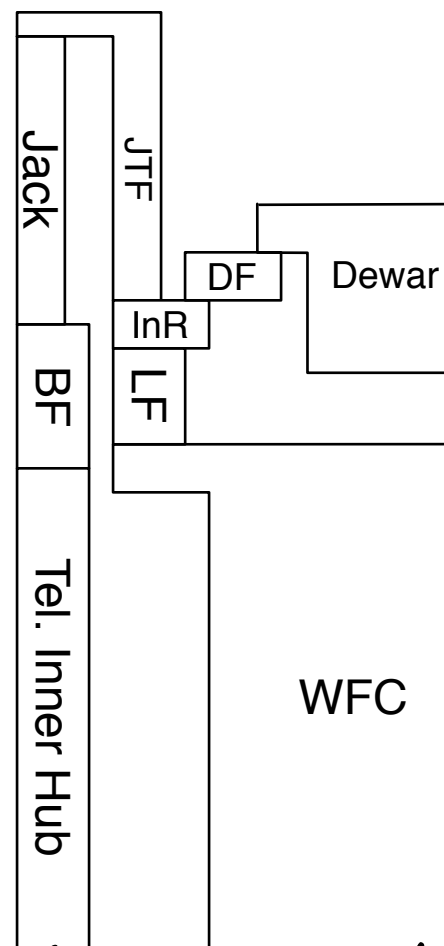
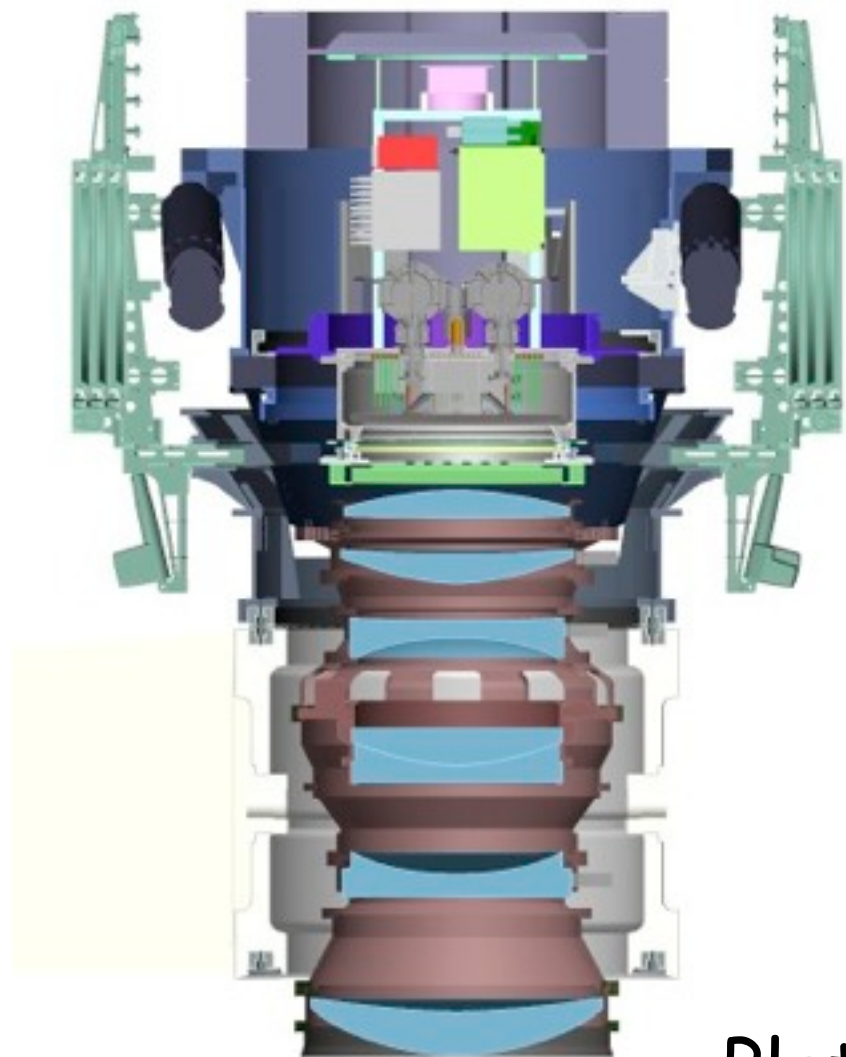
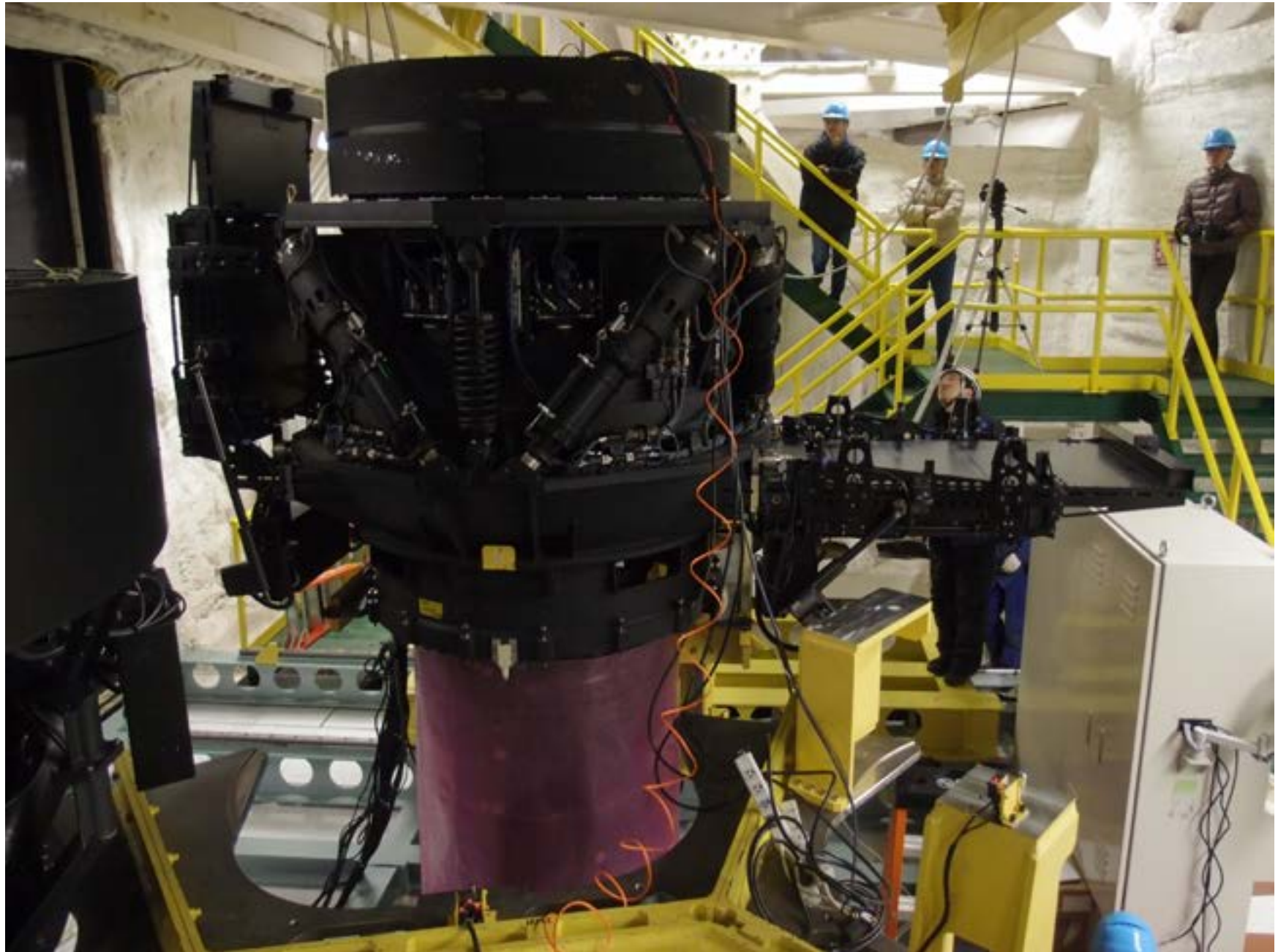


Plate scale  $0.18 \text{ arcsec}/15 \mu\text{m}$   
~ a few  $\mu\text{m}$  precision required for  
3 tons camera

# New Prime Focus Unit



## Collaboration with Hamamatsu

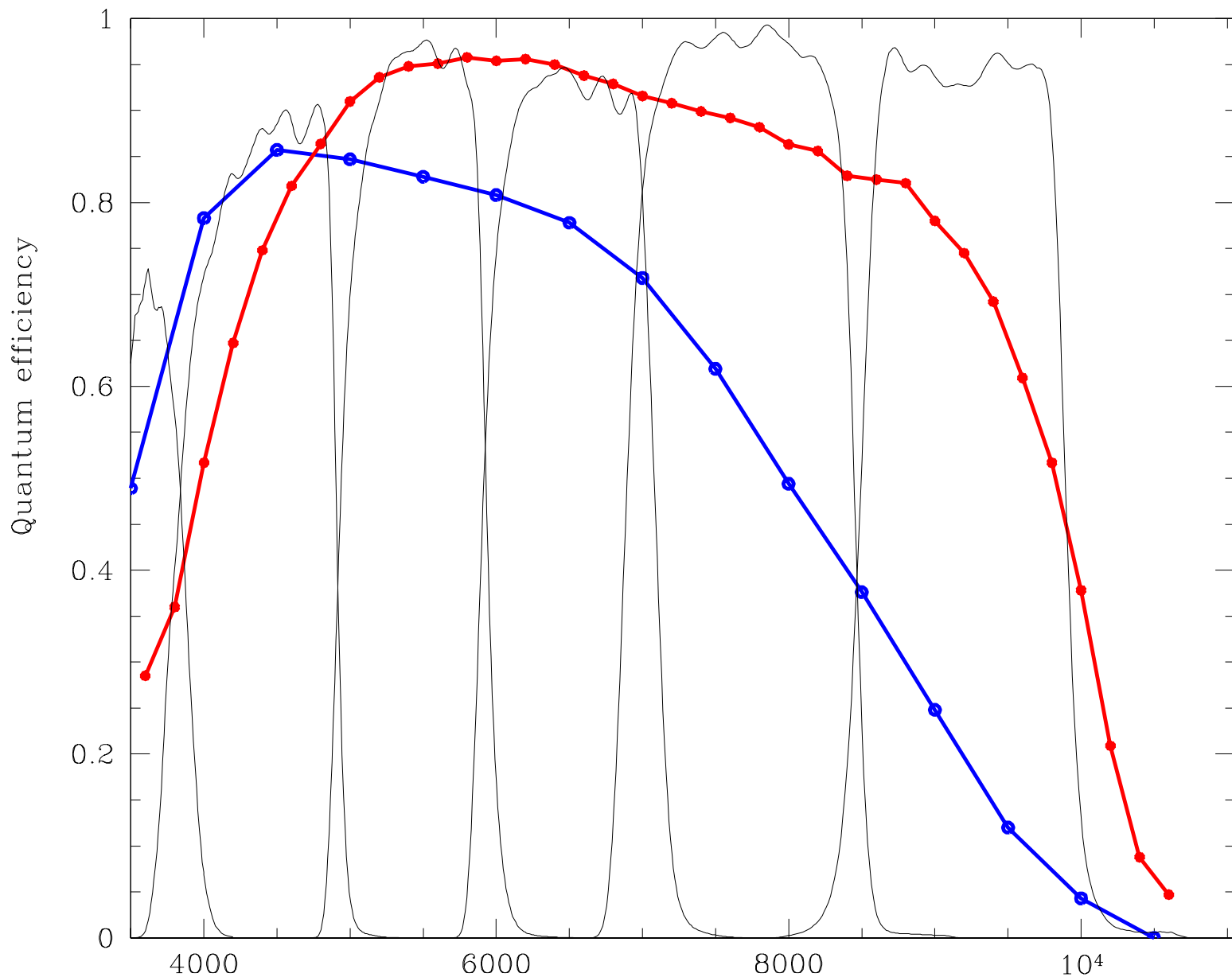


- 2k4k 15 $\mu\text{m}$
- Fully depleted CCD
- High resistivity Si
- 200  $\mu\text{m}$  thick

Kamata et al. SPIE 8453-69



# Optical Quantum Efficiency



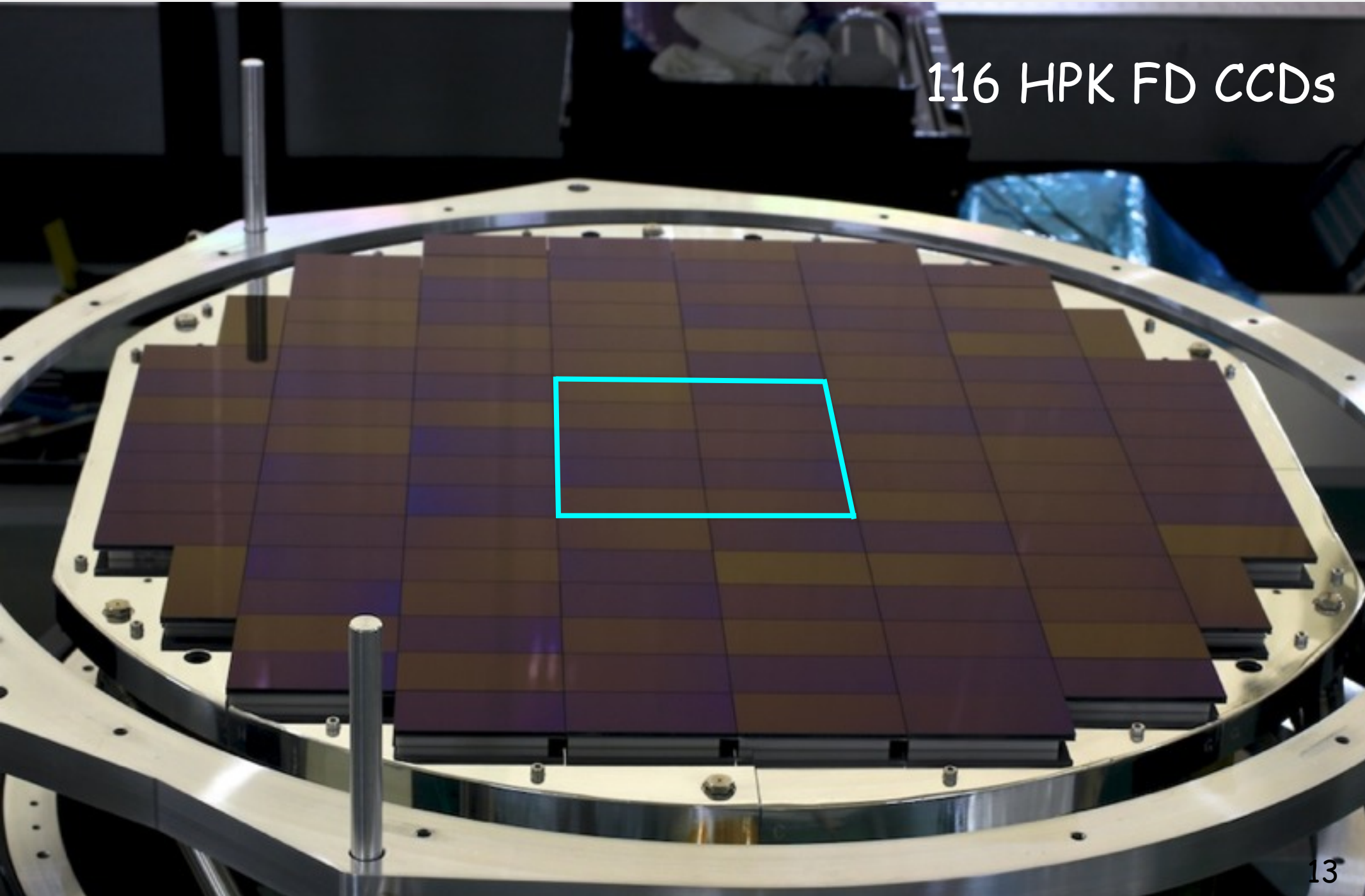
Hamamatsu  
FDCCD

(previous)  
e2v CCD



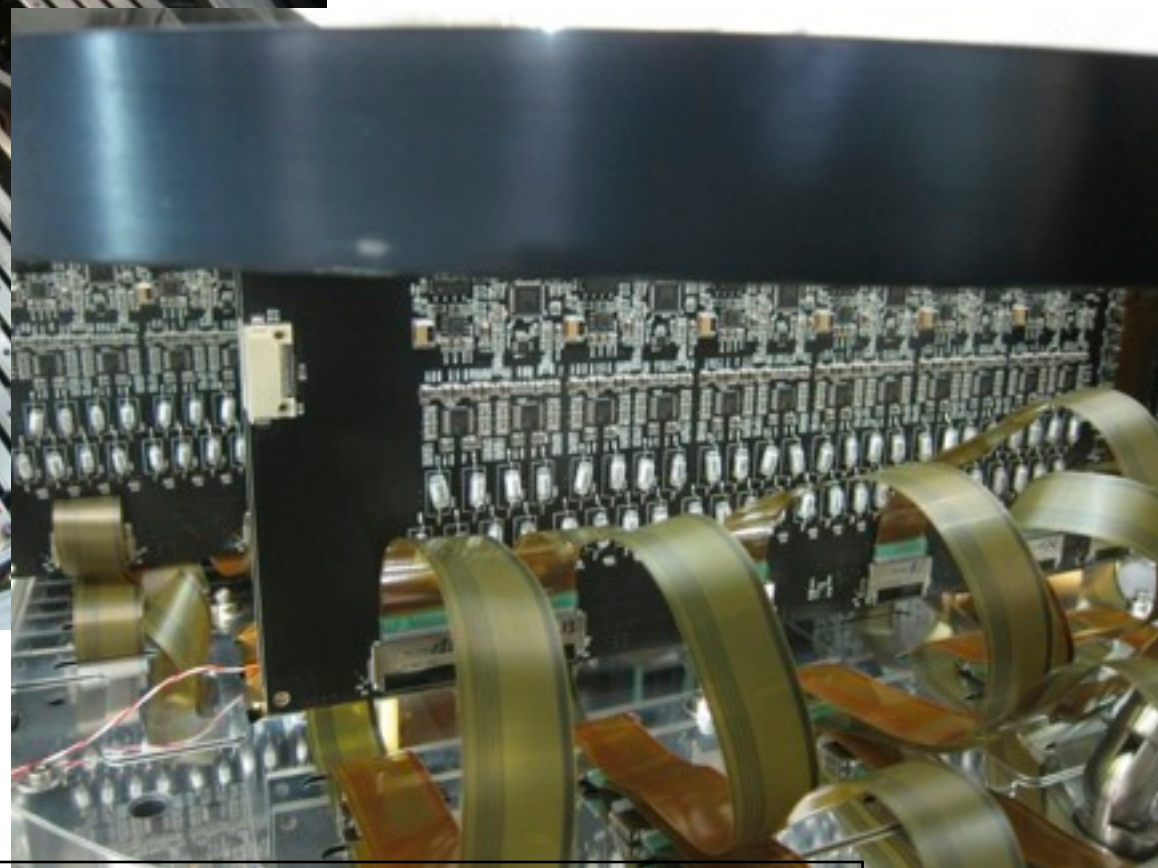
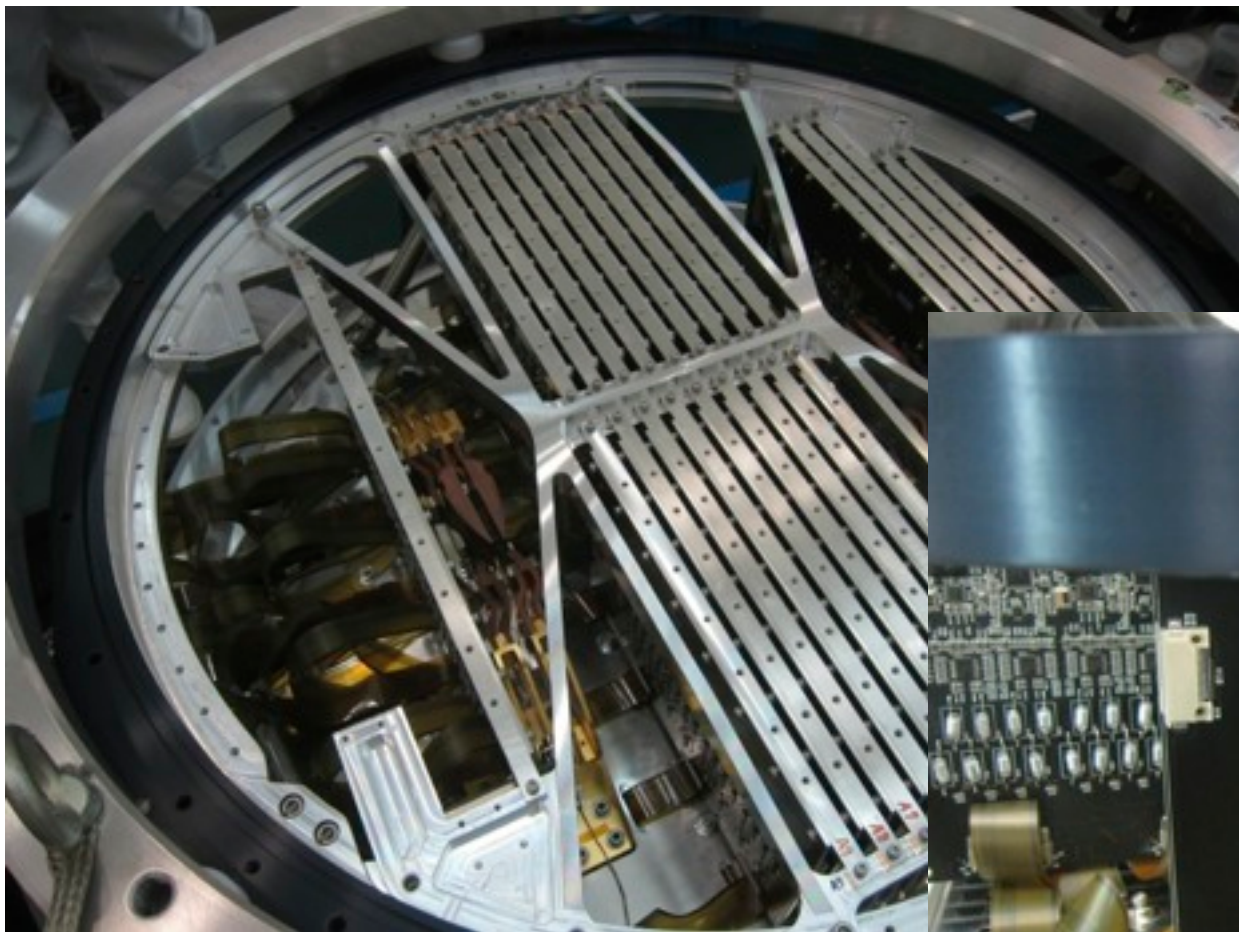
# HSC Focal Plane

116 HPK FD CCDs





# In-Dewar Electronics Assembly



Nakaya et al. SPIE 8453-101



# HSC Dewar

## Vacuum Maintenance

- Achieved Vacuum:  $P < \sim 1 \times 10^{-5}$  Torr
- With electronics powered on (outgas)
- Life time of the ion pump: 8,000 hours
  - (cf 80,000 hours @  $10^{-6}$  Torr)
  - Maint. cycle:  $\sim 2$  year (14 nights/month)

# Assembling Dewar



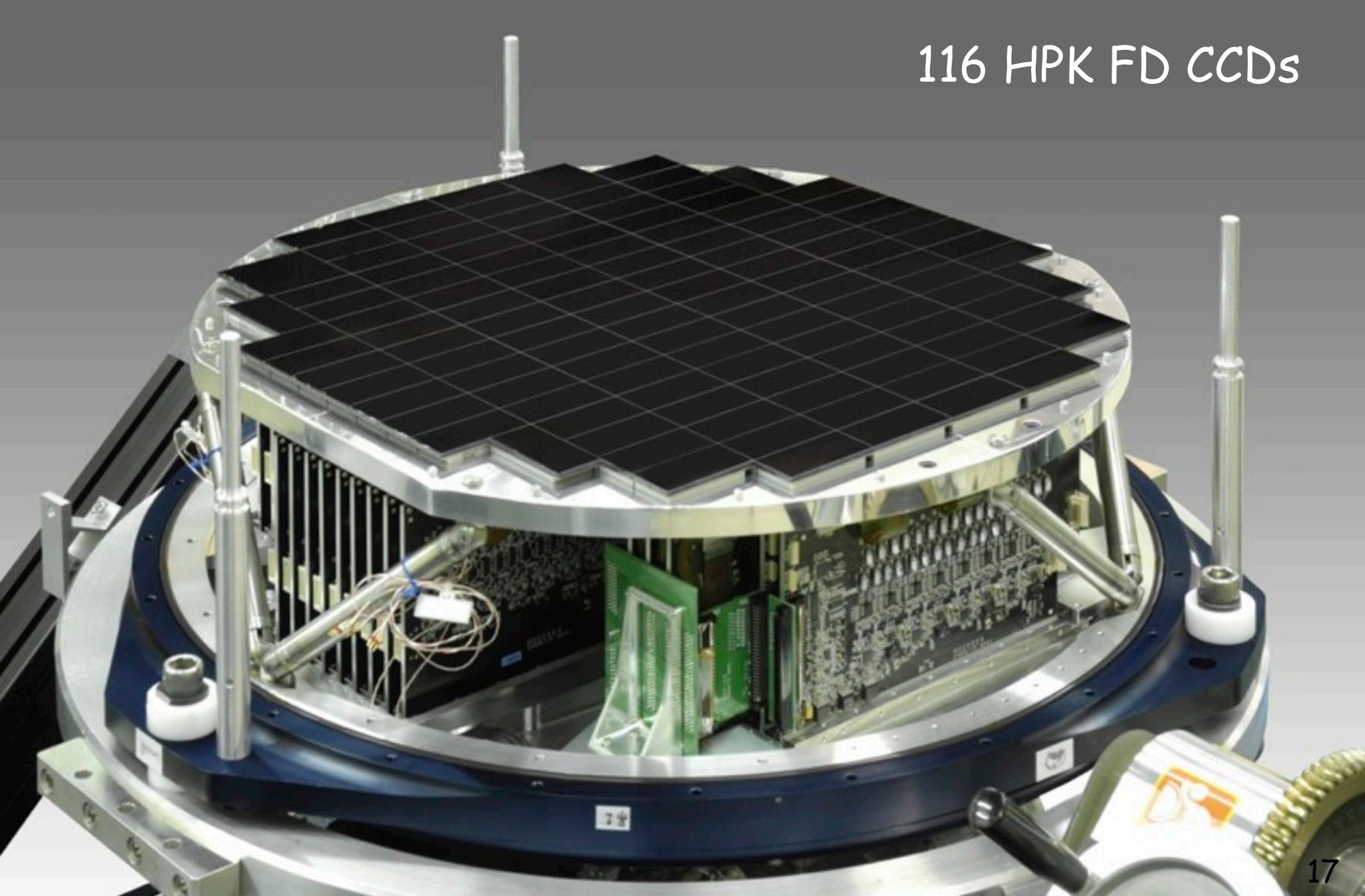
Komiyama et al. 2010  
Obuchi et al. 8446-256



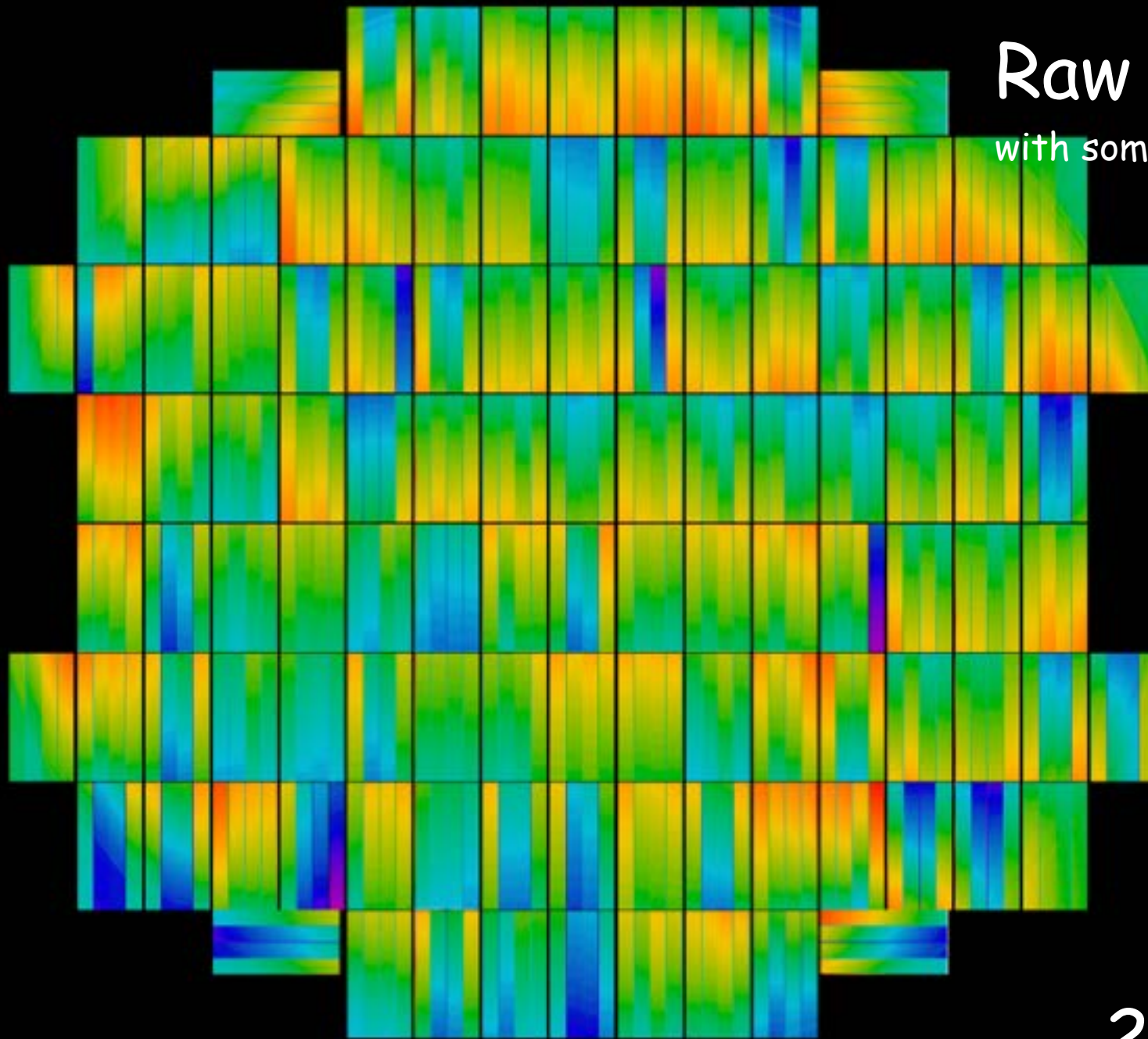


# HSC Focal Plane

116 HPK FD CCDs



Raw images  
with some light leak

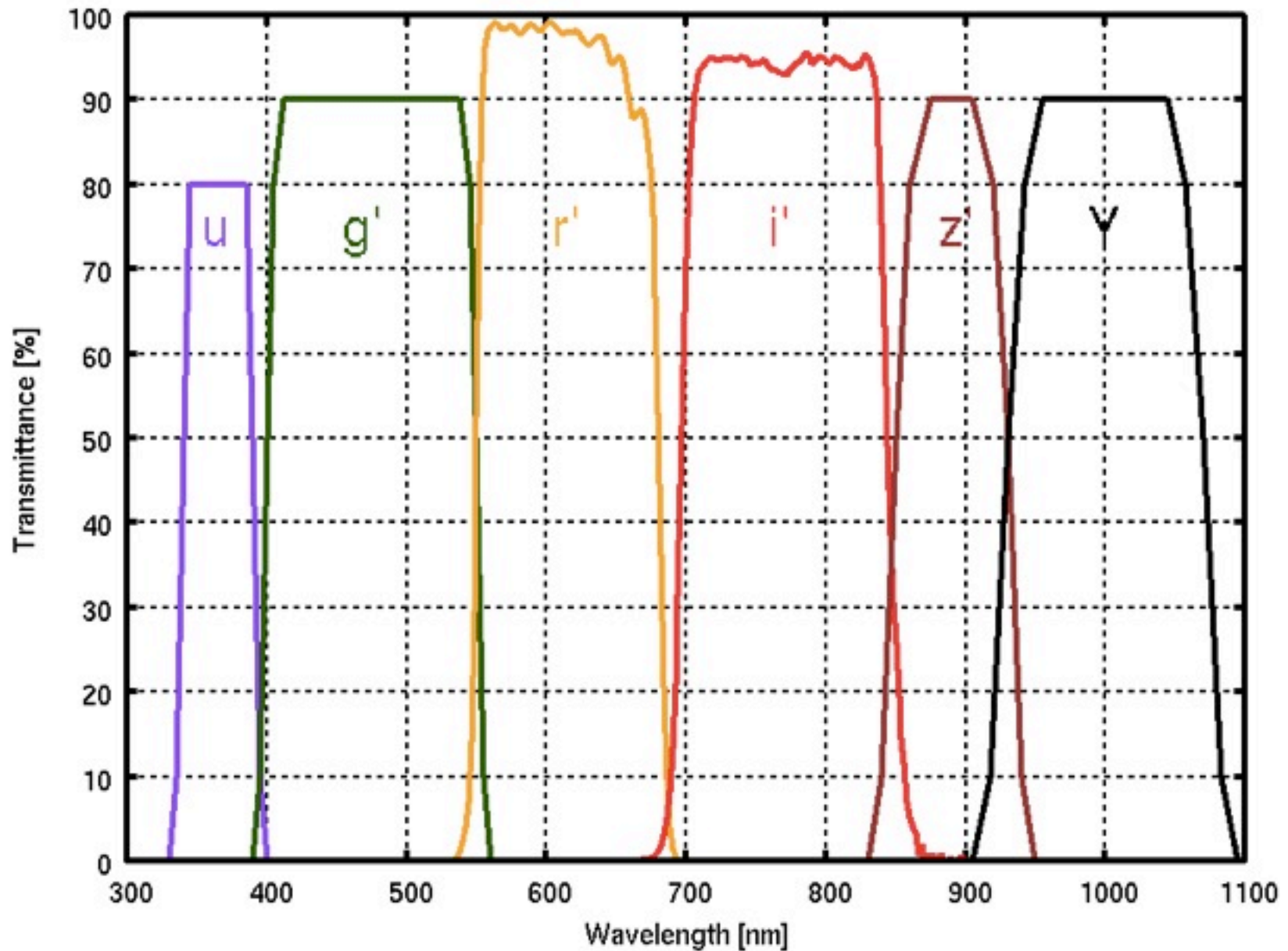


[500,

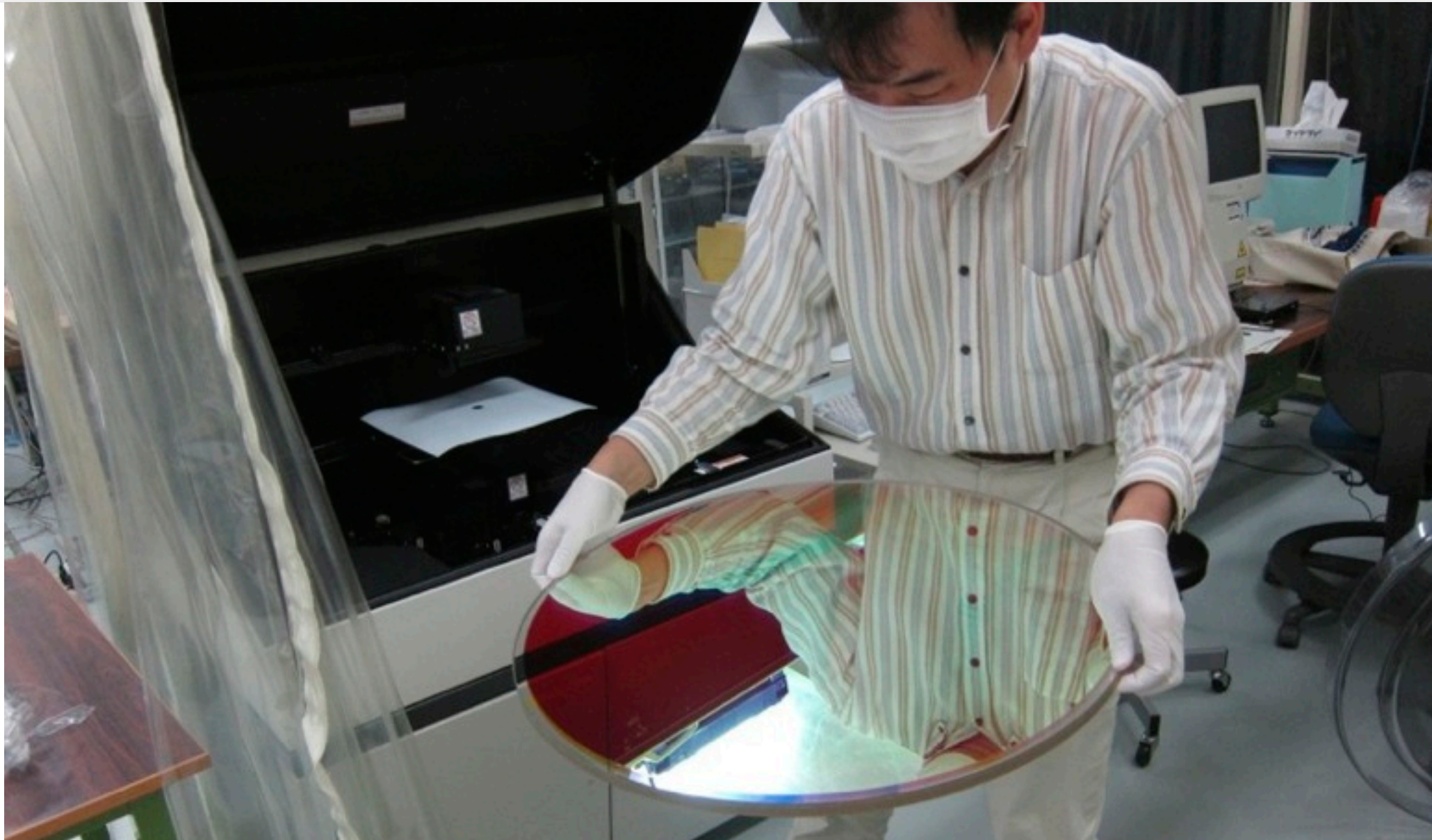
2500]



# Filter Plan



# Filter

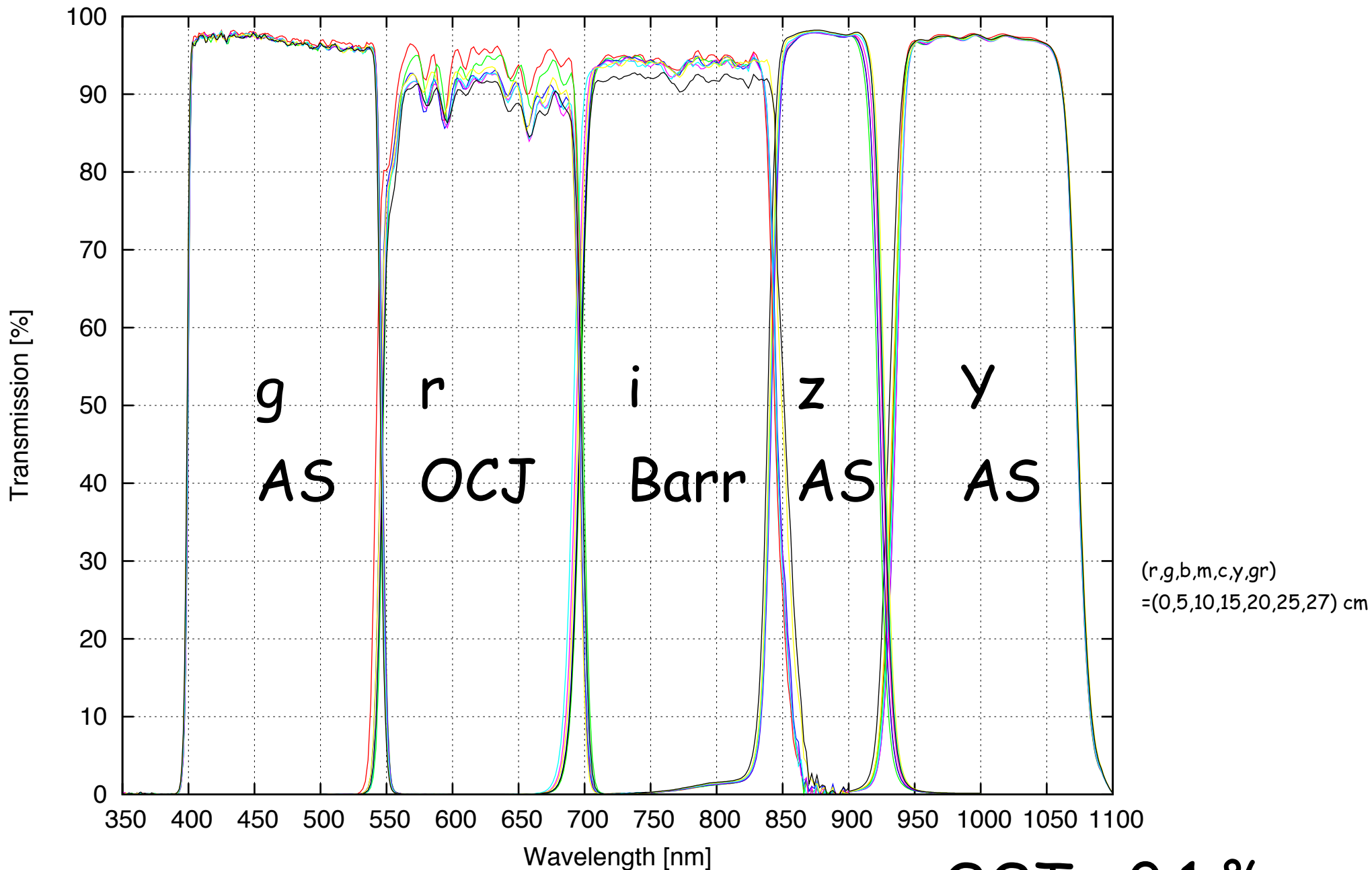


Kawanomoto et al. 2008

i - filter : Barr



# Filter in the Cabinet



# Narrow Band Filter Set

- ML(hscfilter@anela)における話し合いで製作フィルターを決め、観測所、SACに提案  
(Chair: 東大 嶋作)
- 技術サポートはHSC Project (川野元)
- 予算は各自獲得
- フィルターは観測所に寄付 誰でも使える

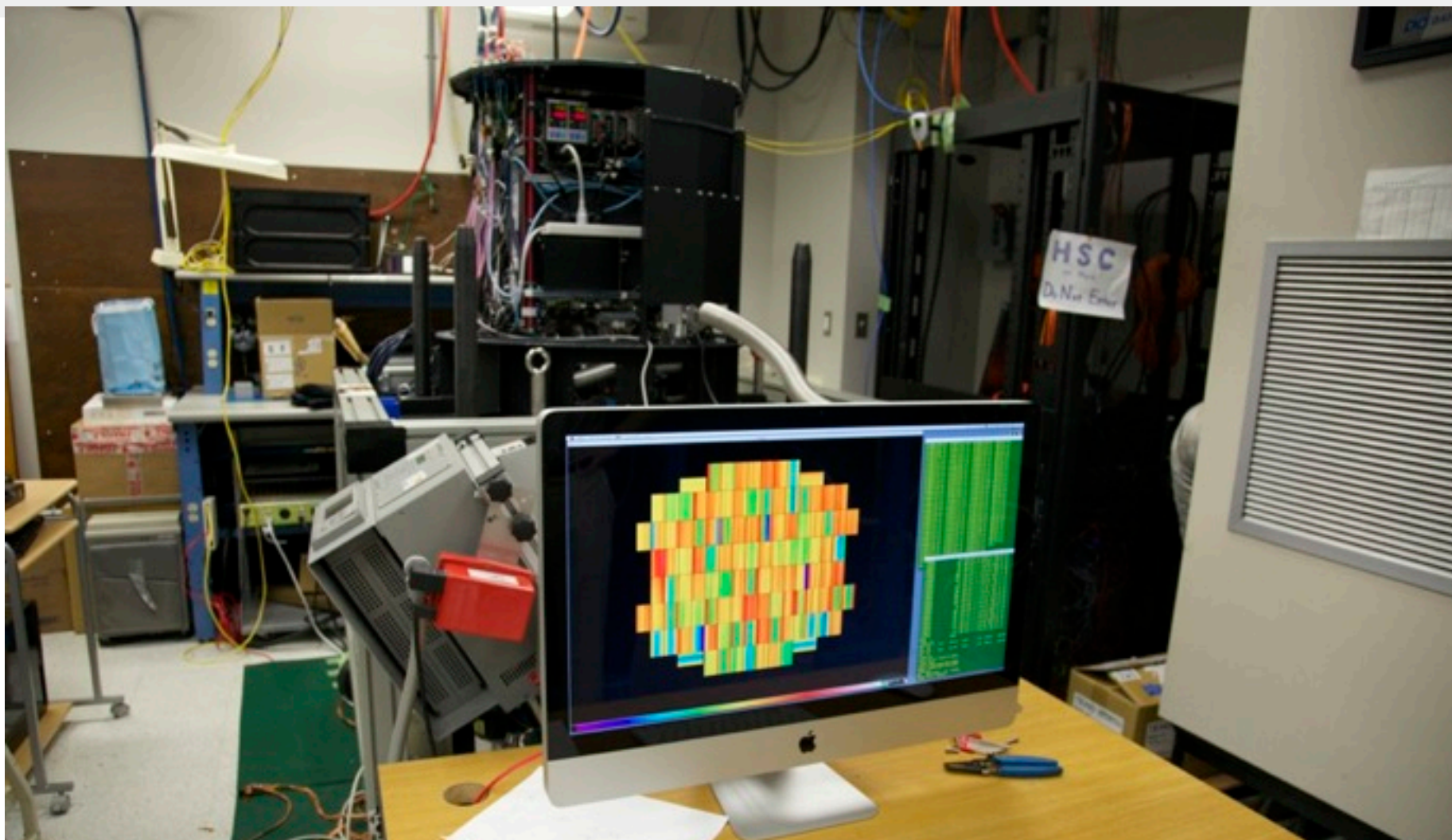
名前	発注者	CW [nm]	CW誤差 [±%]	FWHM [nm]	FWHM誤差 [±%]
NB515	東北大学	514.52	0.3	8.0	10.0
NB718	愛媛大学	718.0	0.3	10.2	10.0
NB816	愛媛大学	816.0	0.3	11.6	10.0
NB921	東京大学	921.0	0.3	13.1	10.0
NB101	東京大学	1009.5	0.3	9.0	10.0

NB387, NB527, NB946, NB973も手続き中



Uraguchi et al. SPIE 8453-232

# Camera Readout Test



Read & Save: ~ 30 sec(goal: ~ 20 sec )

Utsumi et al. SPIE 8453-231

HSC Workshop 2012/09/24





# Camera Unit Installation Done

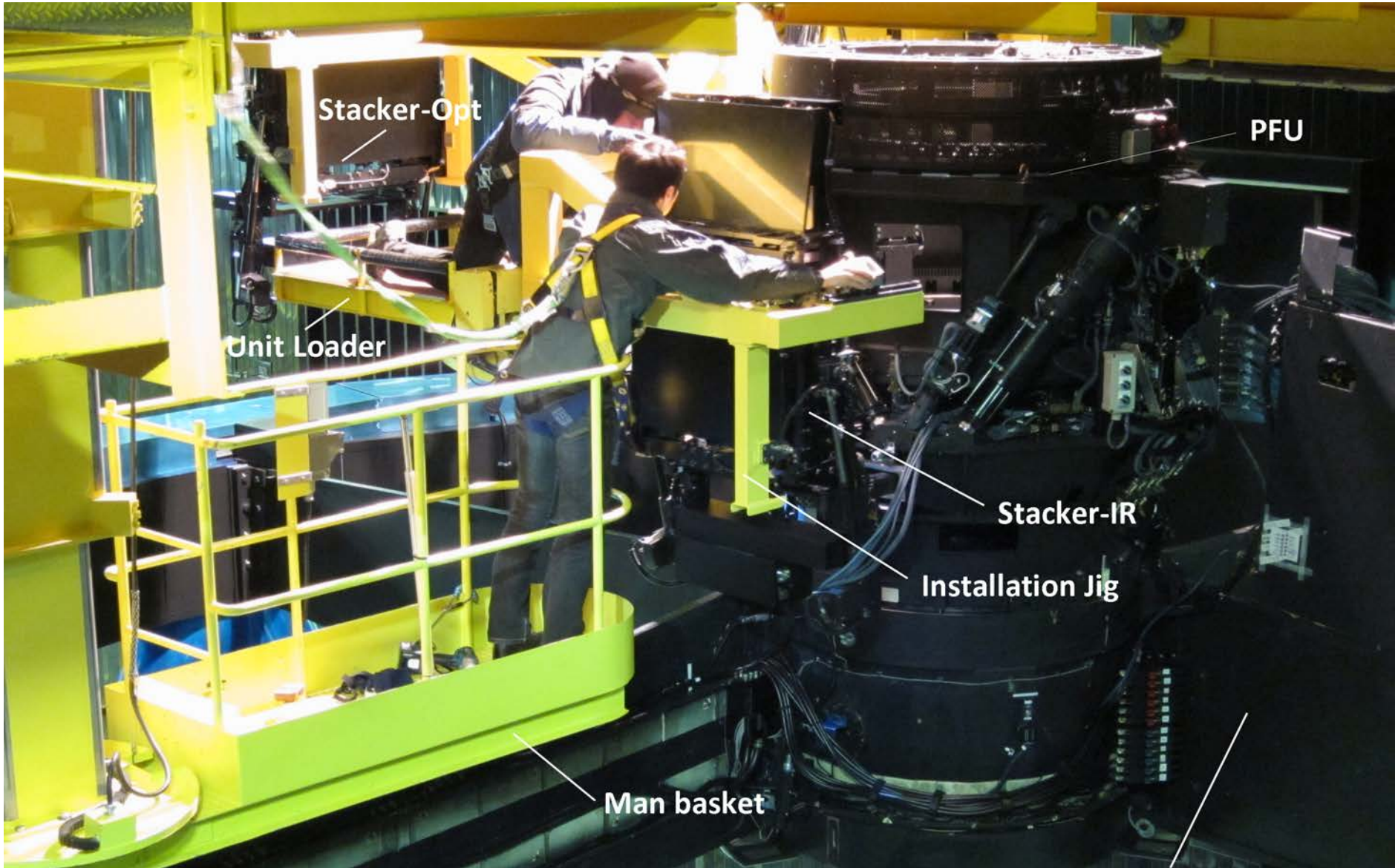




# Mounting on Subaru



# FEU Attachment



Uraguchi et al. SPIE 8453-232



# Engineering First Light

- 2012/08/28 ~
  - Auto Guider, Pointing Analysis System, Mirror Analysis Systemのsoftware/  
hardwareの機能確認
  - 新規HardwareはHSC project、Softwareは  
三菱電機、全体監修を観測所が分担



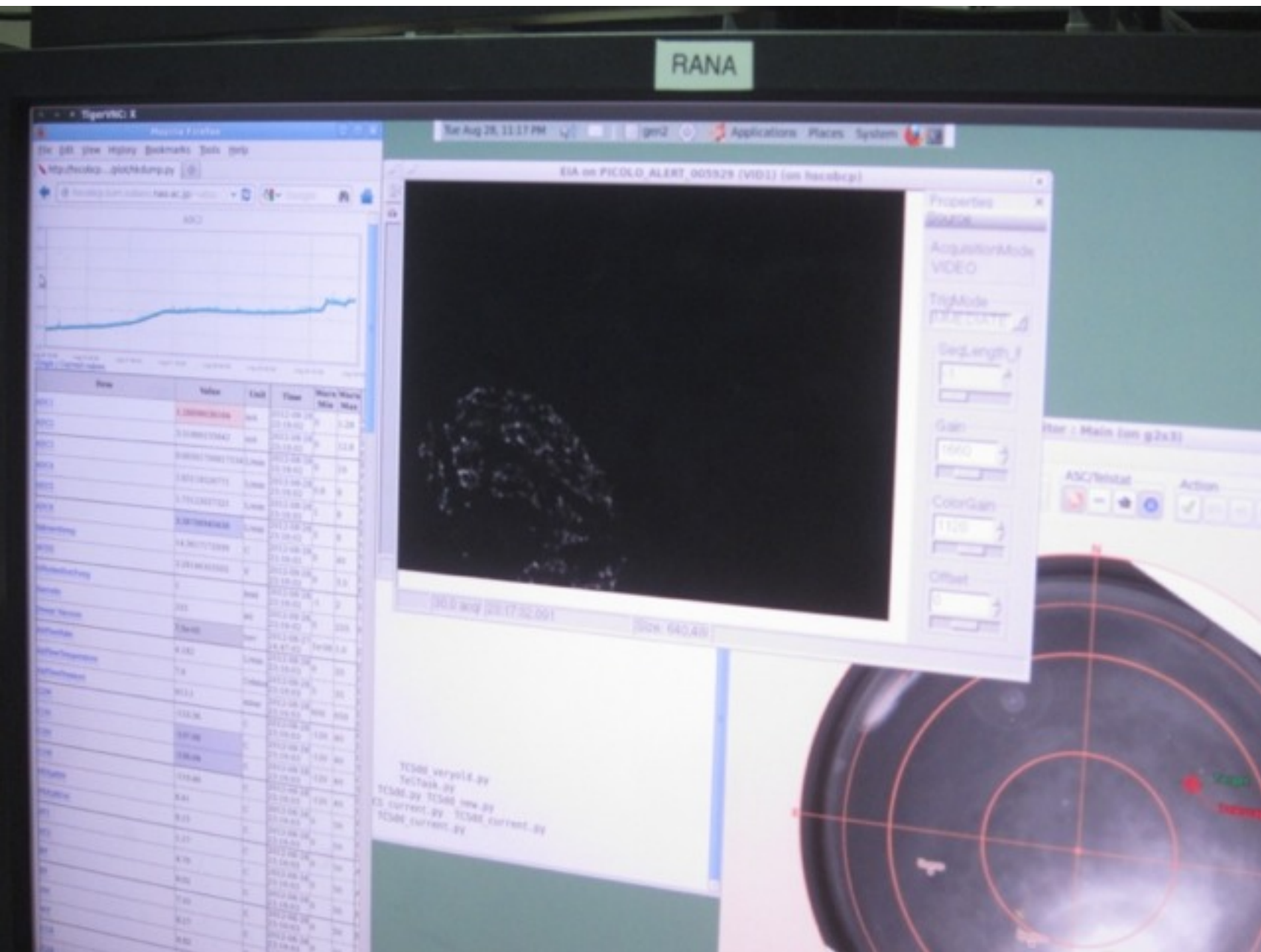
# HSC First Light

2012/08/28

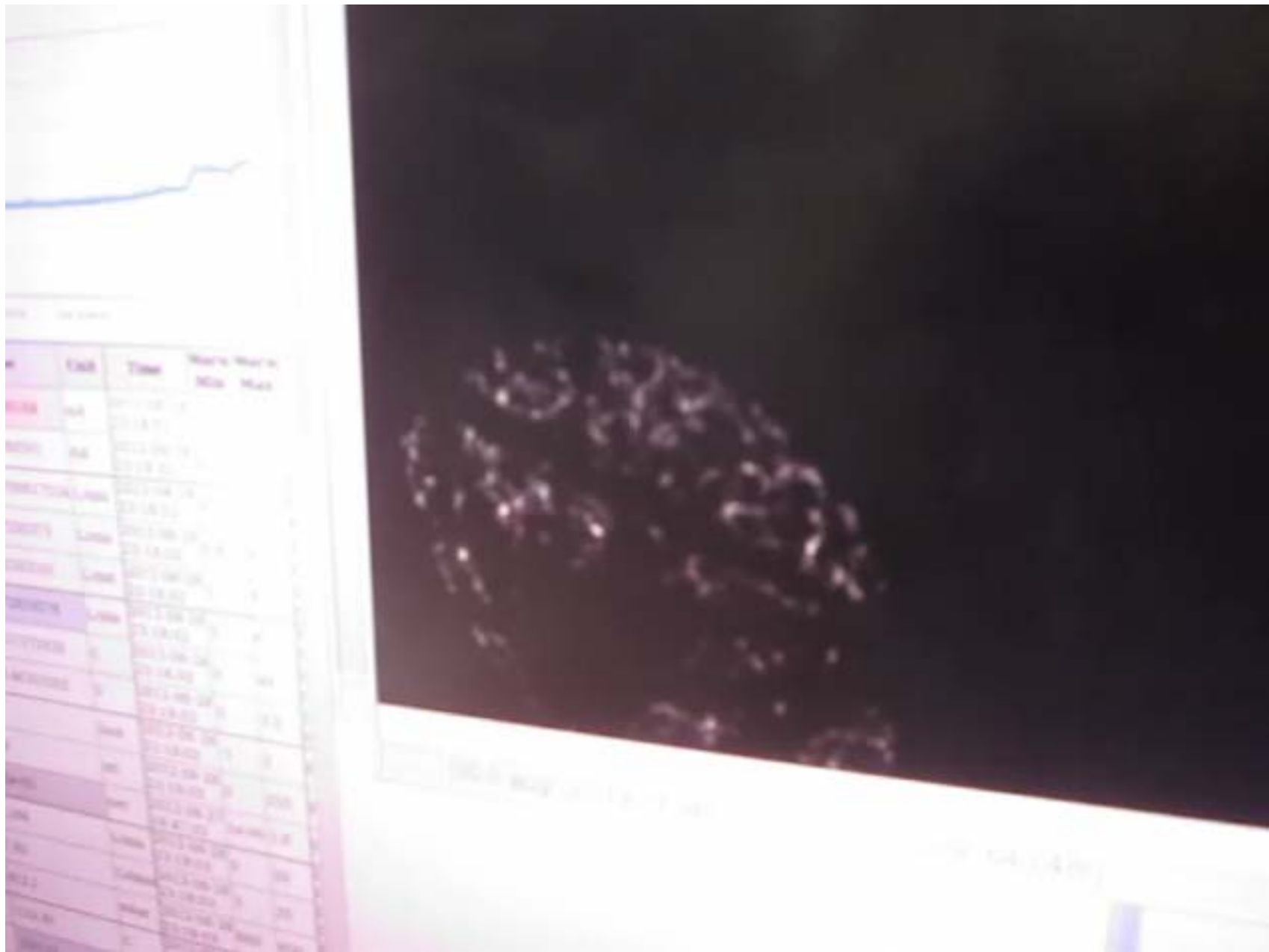
~ 23:17

Vega  
with Video  
Camera for  
SHAG

Perr  $\leftarrow \sim 20''$



# HSC First Light





# HSC First Light

LIBRA

Tue Aug 28, 11:33 PM gen2 Applications Places System

Ginga: HSCSHAG

File Channel

Info Header

QDAS\_VGW DSS SH HSCSCAG HSCSHAG HSCSH

Frame ID: Noname  
Object: #  
X: 553.000  
Y: 466.000  
Value: 0.0  
RA: BAD WCS  
DEC: BAD WCS  
Equinox: 2000.0  
Dimensions: 640x480  
Min: 0.0  
Max: 159.0  
Zoom: 1x  
Cut Low: 0.00  
Cut High: 82.02  
Auto Levels  
Cut New: on  
Zoom New: off  
Preferences

23:33:24.850

HSCSHAG Pick Start DSS: AgAutoSelect

Dialogs Thumbs Contents Help Debug

DSS: AgAutoSelect

Instructions

Manual mode selected:

Please select a guide star manually.

Image Server

Server: dss@base Get Image

width: 0.0  
dec: +01:25:06.77  
ra: 20:08:45.498  
height: 0.0

Catalog

Server: gsc@eso  
Limit stars  
Search

dec: +01:25:06.77  
ra: 20:08:45.498  
r2: 0.0  
m2:

Set parameters from entire image

Params Listing

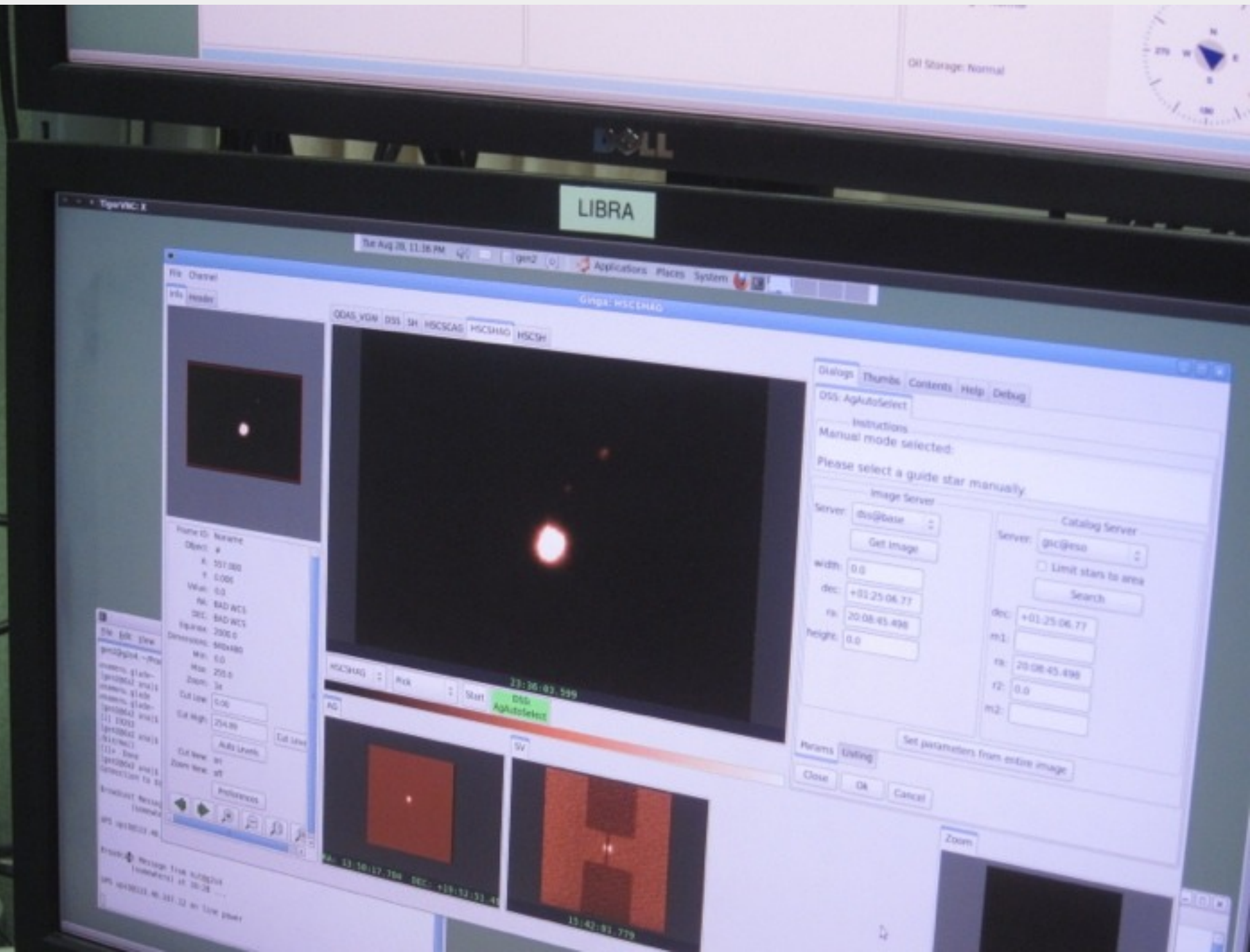
Close Ok Cancel

AG SV Zoom

The screenshot displays the LIBRA software interface. At the top, a green label reads 'LIBRA'. Below it, a system tray shows the date and time as 'Tue Aug 28, 11:33 PM' and the user as 'gen2'. The main window title is 'Ginga: HSCSHAG'. The interface is divided into several sections: a top menu bar with 'File' and 'Channel'; a central panel with tabs for 'QDAS\_VGW', 'DSS', 'SH', 'HSCSCAG', 'HSCSHAG', and 'HSCSH'; a left sidebar with 'Info' and 'Header' tabs; a large central image area showing a circular field of stars with a timestamp '23:33:24.850' at the bottom; a right sidebar with a 'DSS: AgAutoSelect' dialog box containing fields for 'Server', 'width', 'dec', 'ra', and 'height', along with a 'Get Image' button; and a bottom control area with buttons for 'Pick', 'Start', 'AG', 'SV', and 'Zoom'. A terminal window is visible in the bottom-left corner, showing a shell prompt and some system messages.

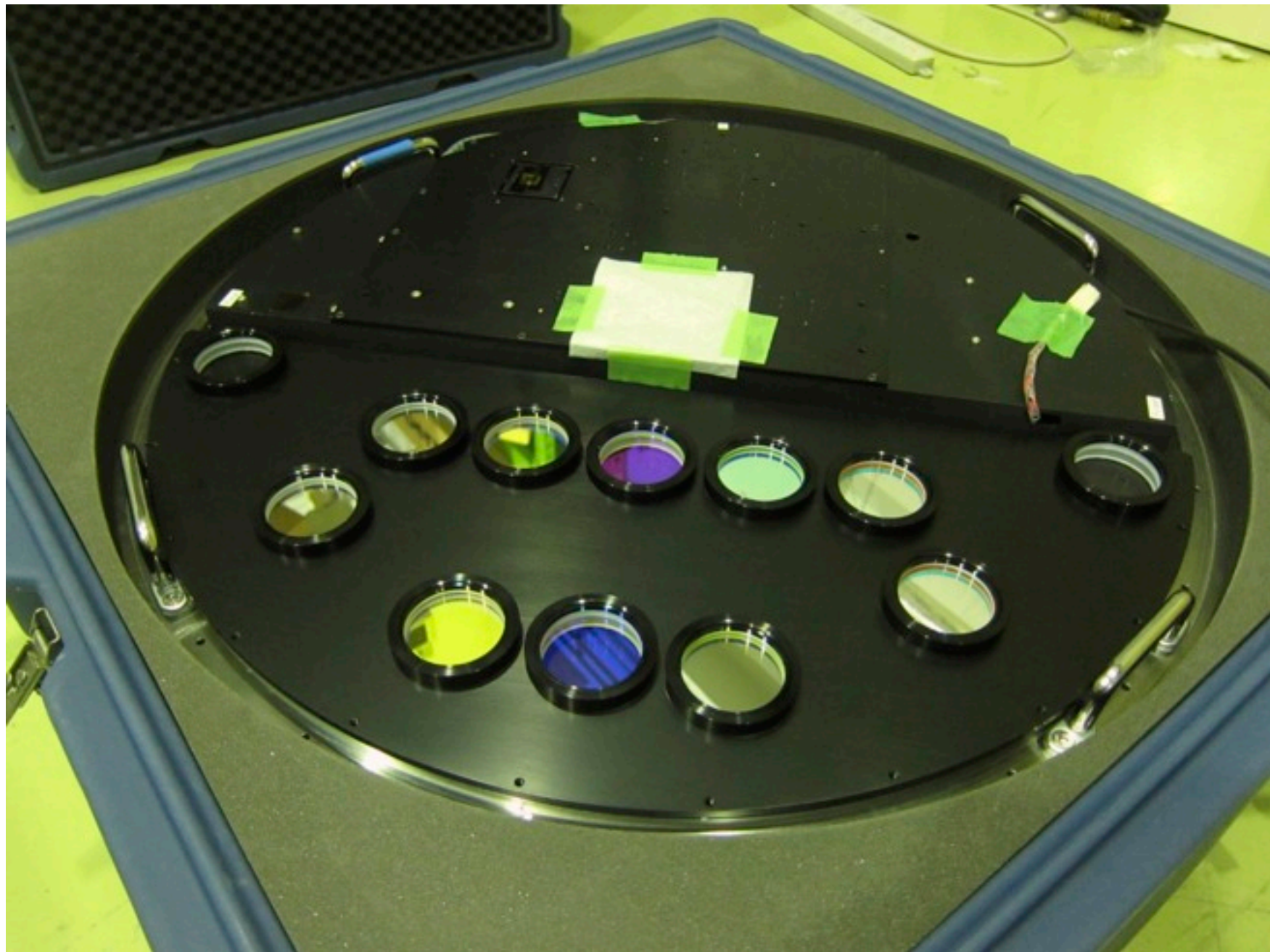


# HSC First Light



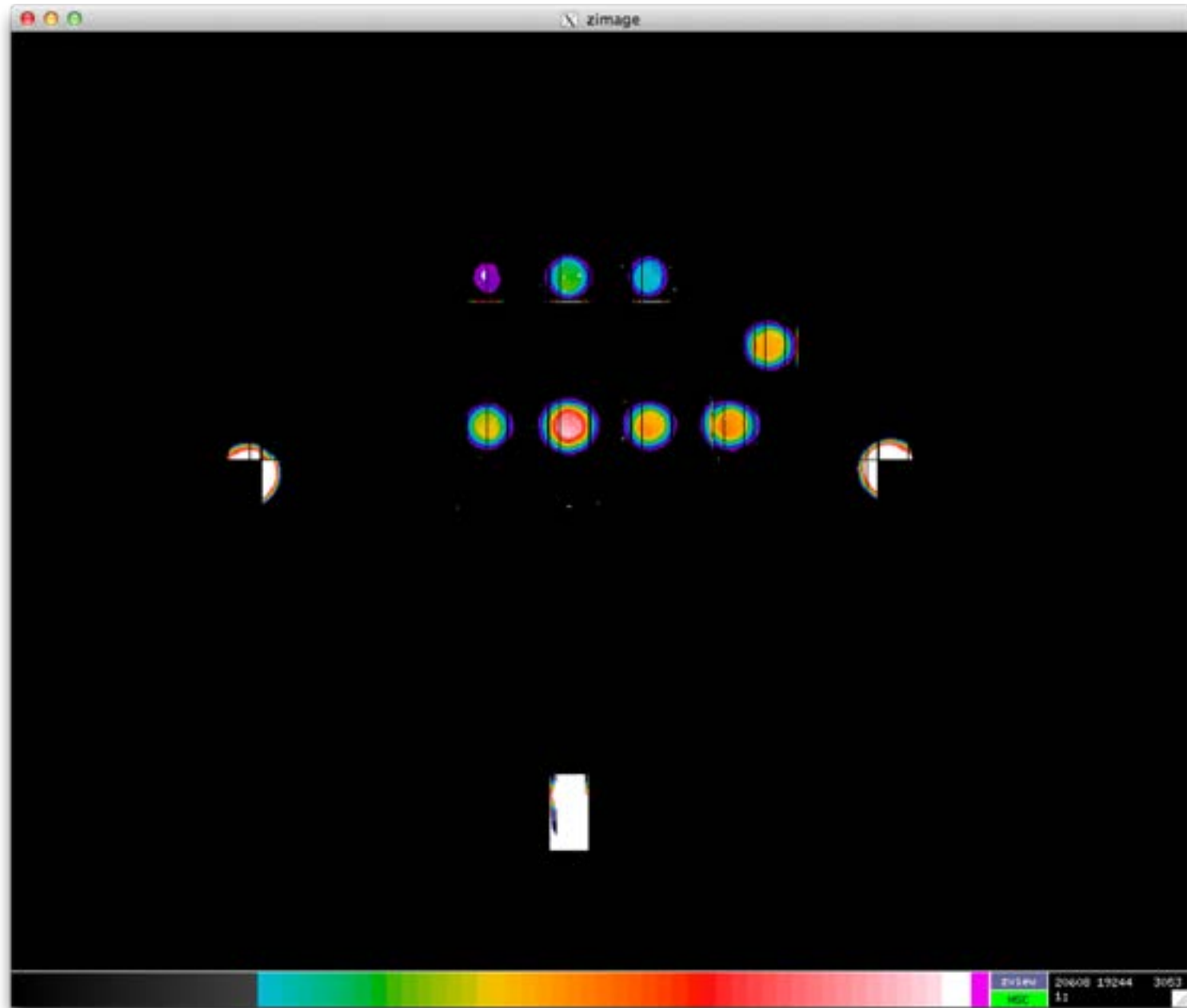


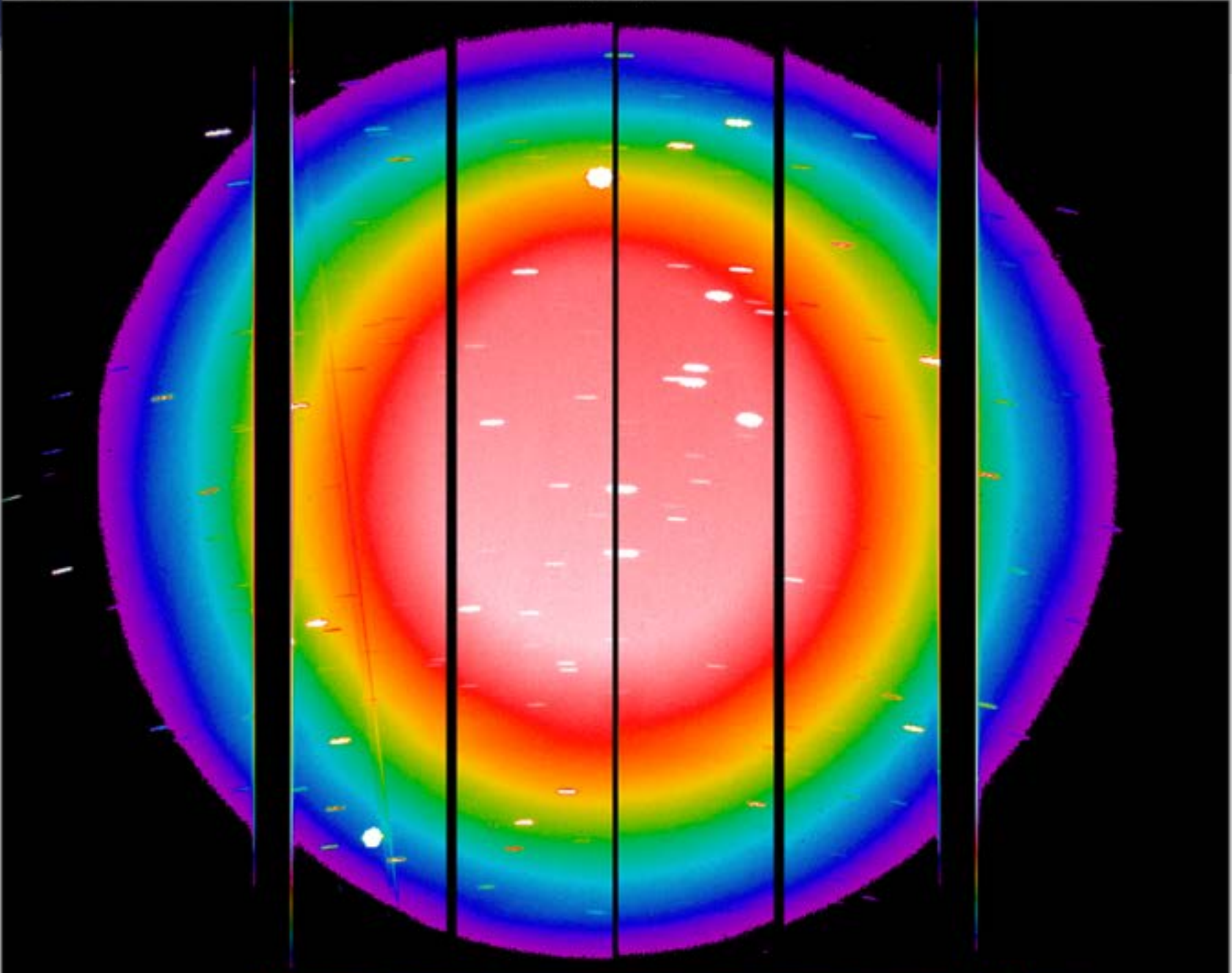
# SH Filter



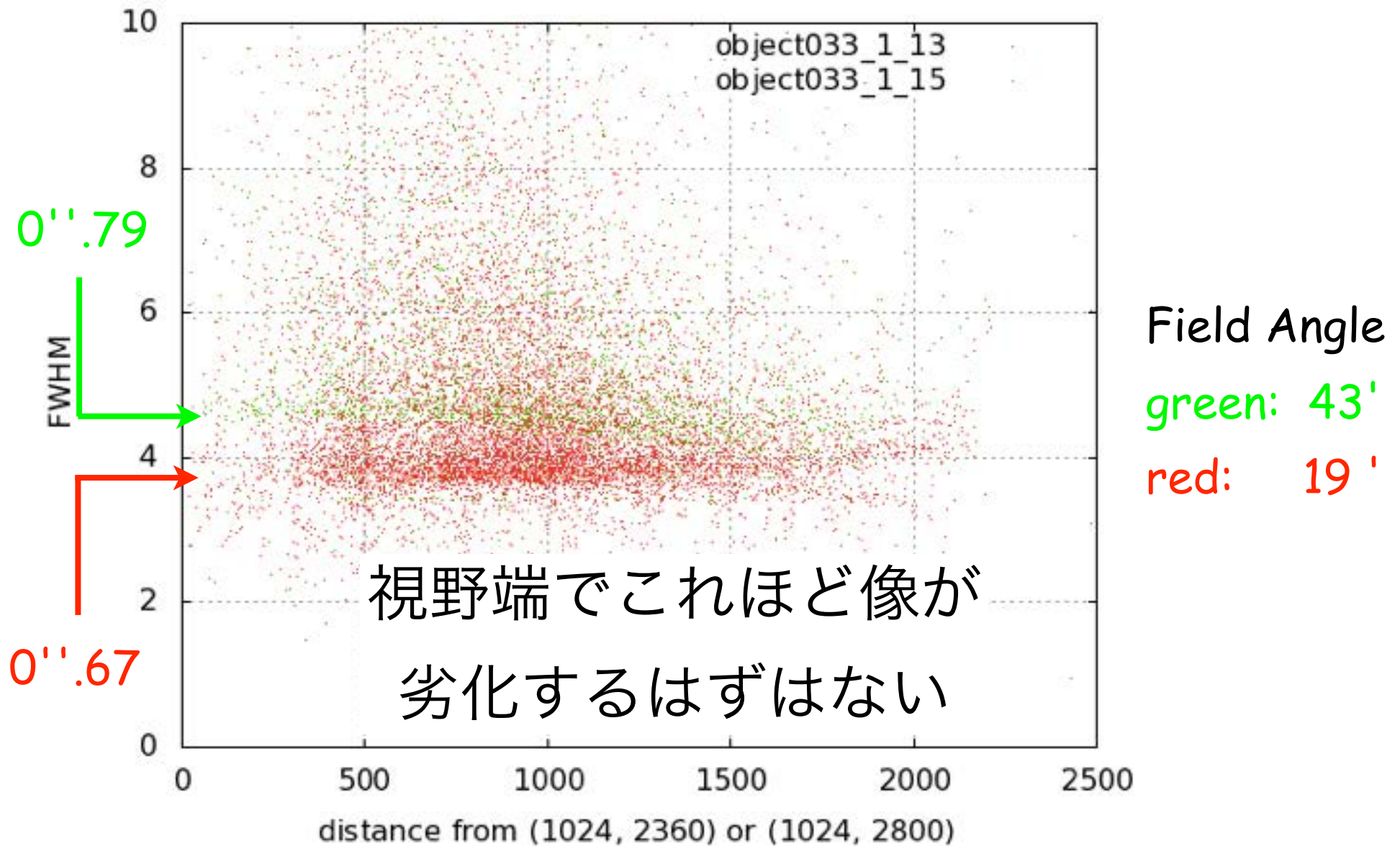


# HSC First Light





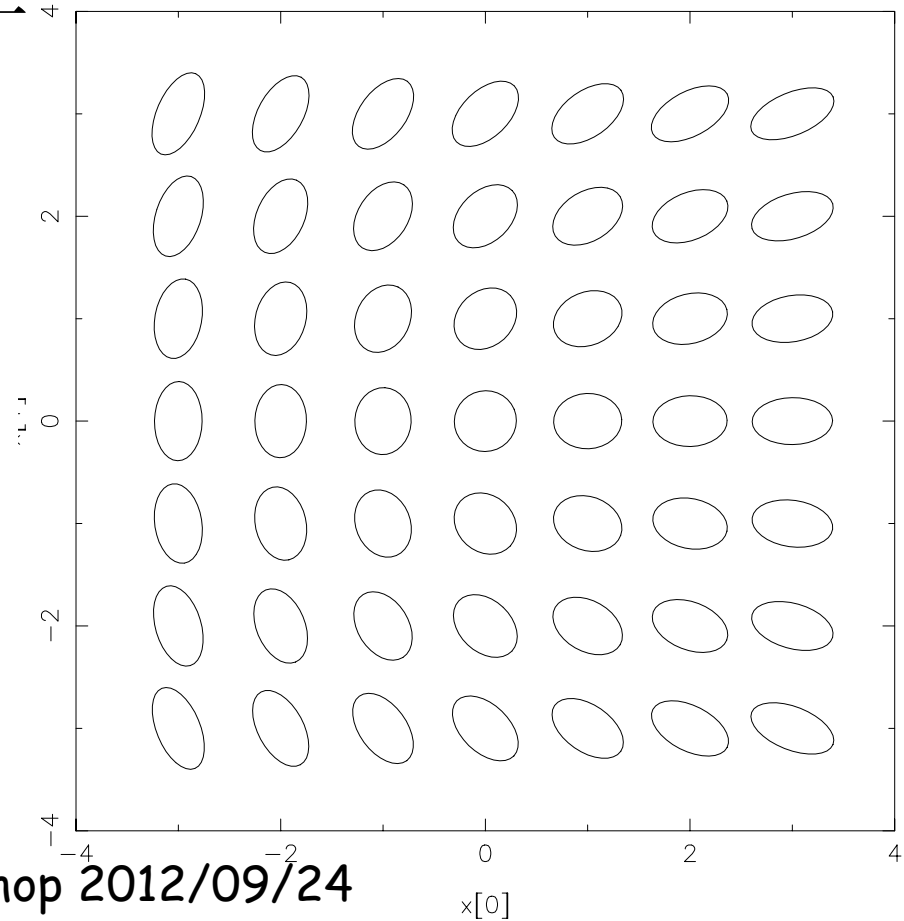
# Main Camera Image Analysis



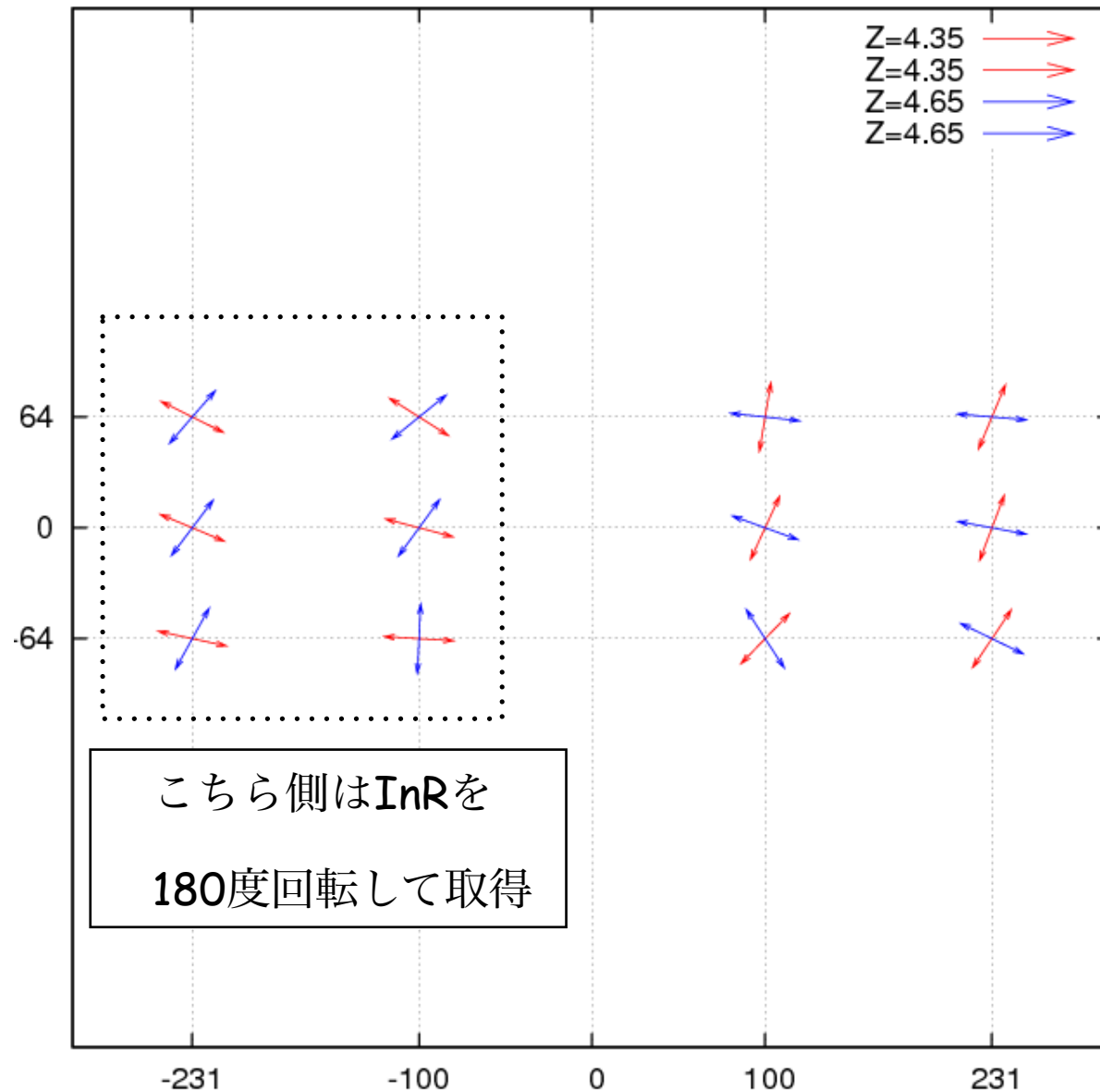
# Main Camera Image Analysis

- Distortionによるplate scaleの変化
  - 6%くらい
- (HSC Camera Unit + WFC)のM1光軸に対する傾きによる非点収差

Simple Astigmatism Model

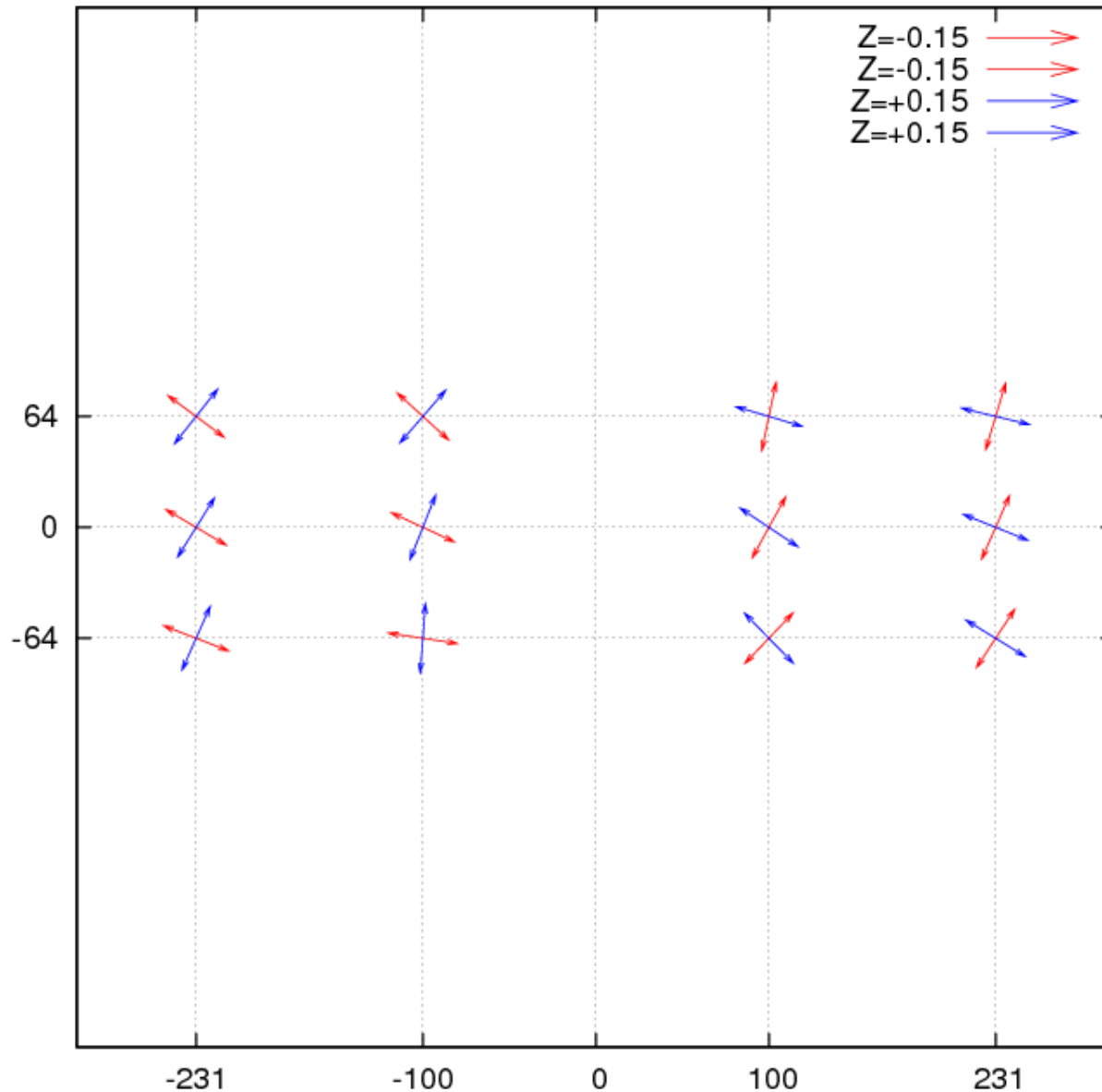


# Main Camera Image Analysis



150  $\mu\text{m}$  off-focus  
画像の星像の伸び  
直交  $\rightarrow$  非点収差

# Main Camera Image Analysis



zemaxで生成した星像  
を解析

$\theta_x = 2'.4$

$\theta_y = 1'.8$

回転させるとよくあう

像の大きさの変化も再現

次回試験観測で確認す

る予定



# Main Camera Image

M56 10 sec r-band  $\sim 0''.58$  FWHM

