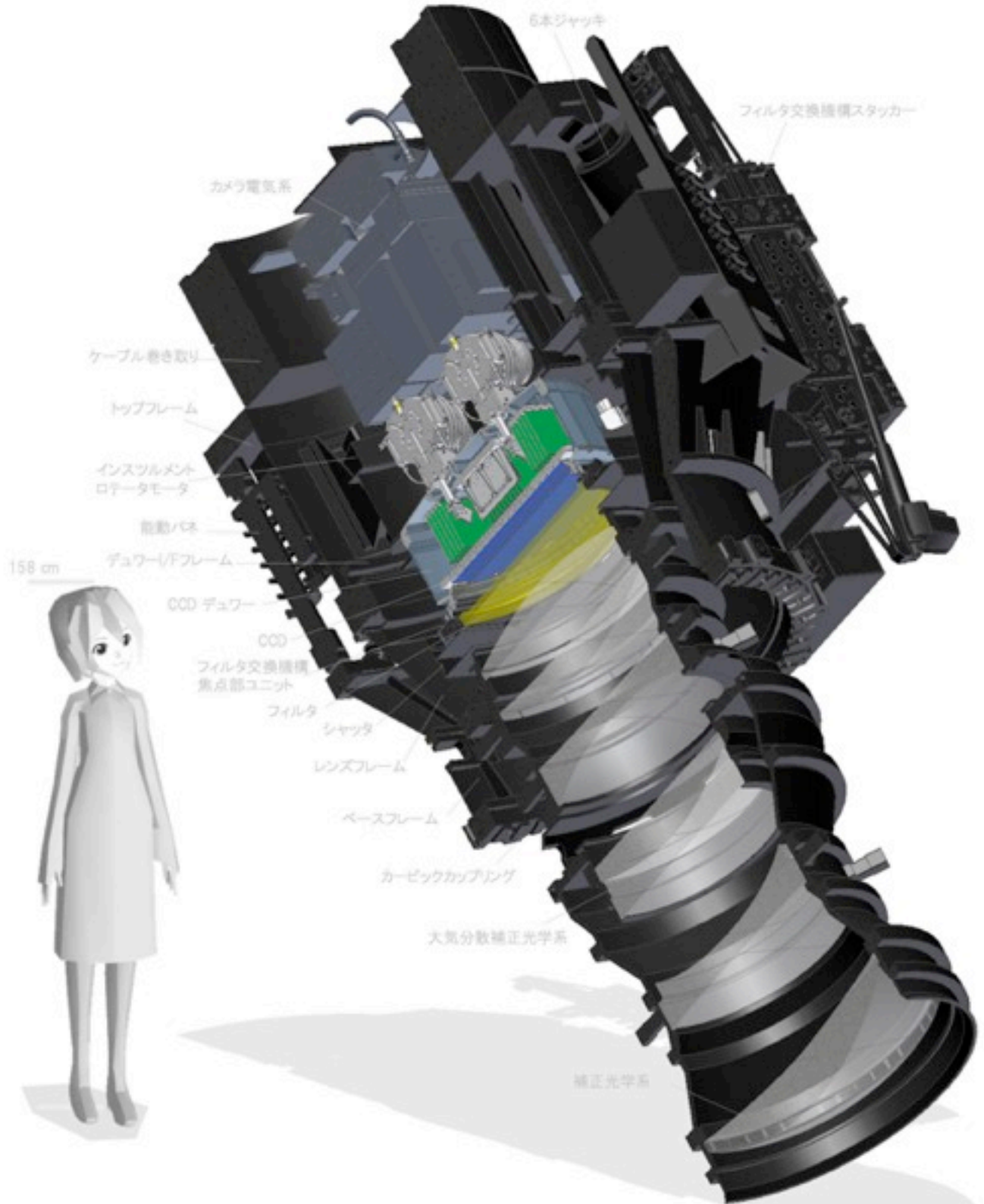
# Hyper Suprime-Cam

## 開発の現状と戦略枠観測

# Hyper Suprime-Cam

Larger Camera on 8.2 m Subaru Telescope

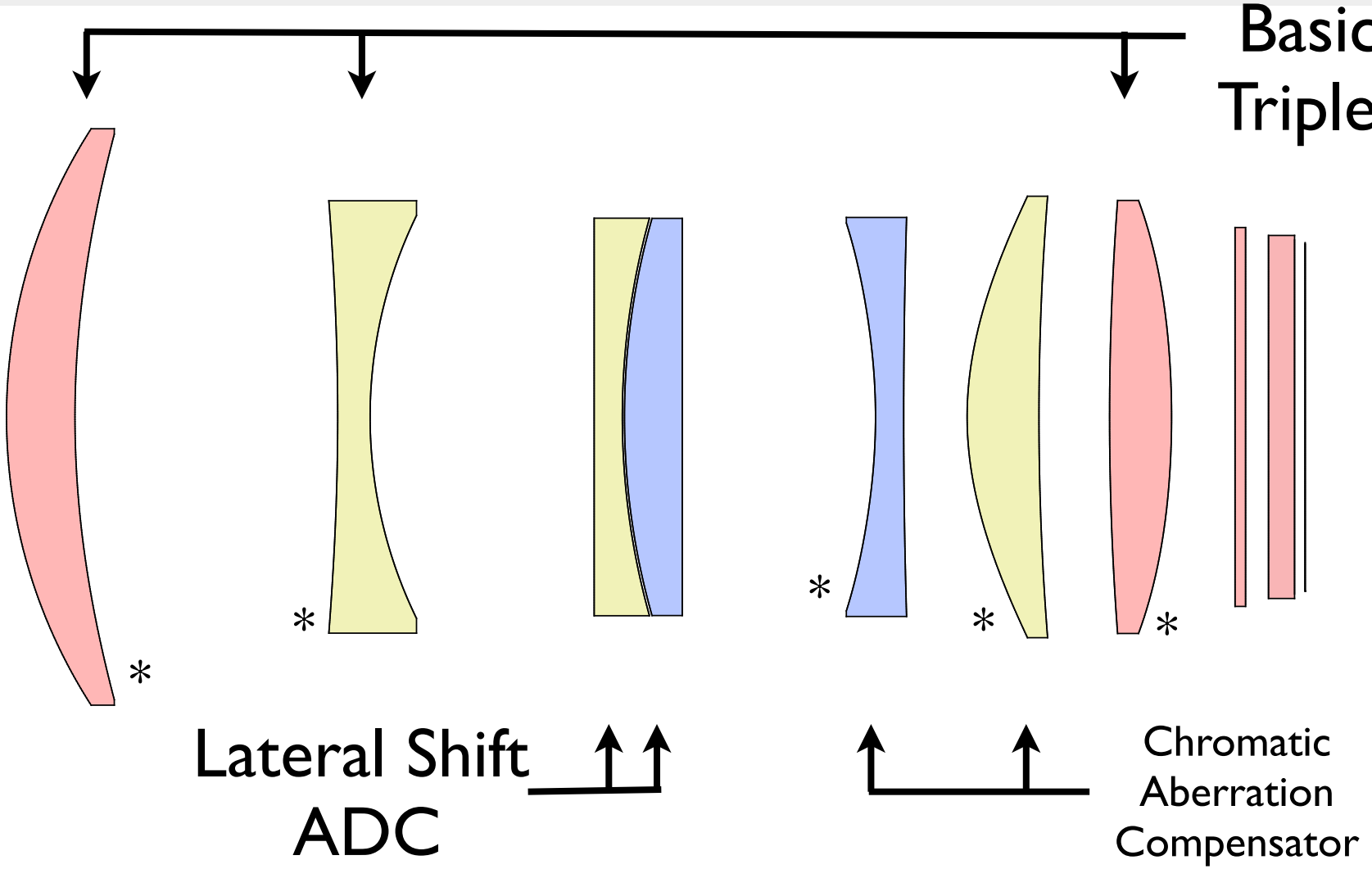

6本ジャッキ
フィルタ交換機構スタッカー
カメラ電気系
ケーブル巻き取り
トップフレーム
インスツルメント
ロテータモータ
駆動バネ
デュワーI/Fフレーム
158 cm
CCD デュワー
CCD
フィルタ交換機構
焦点部ユニット
フィルタ
シャッタ
レンズフレーム
ベースフレーム
カービックカップリング
大気分散補正光学系
補正光学系

# Key Elements

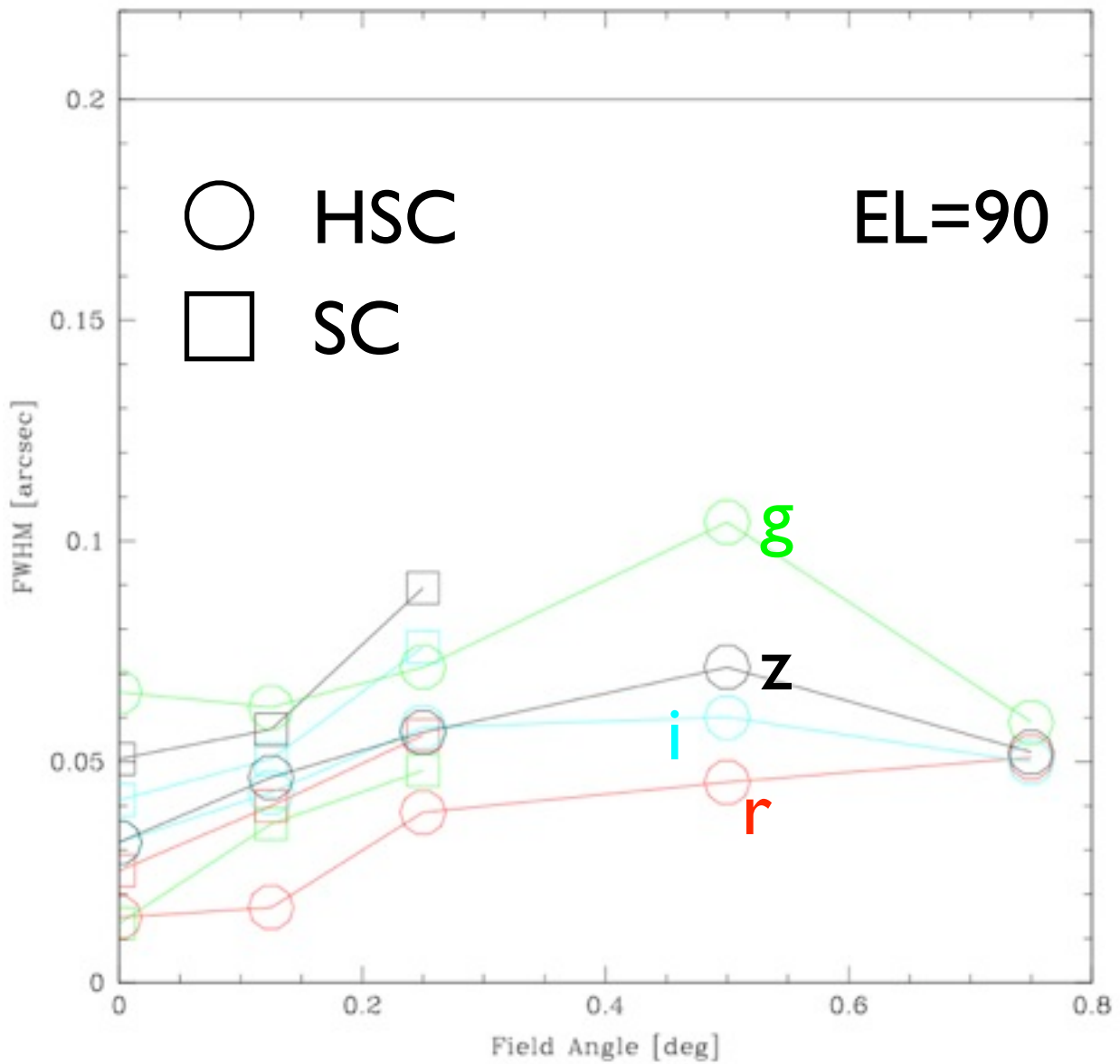
- Sharp Lens: < 0''.2 FWHM

- Large Number of CCDs
  : to pave ø 50 cm focal plane

# New Wide Field Corrector

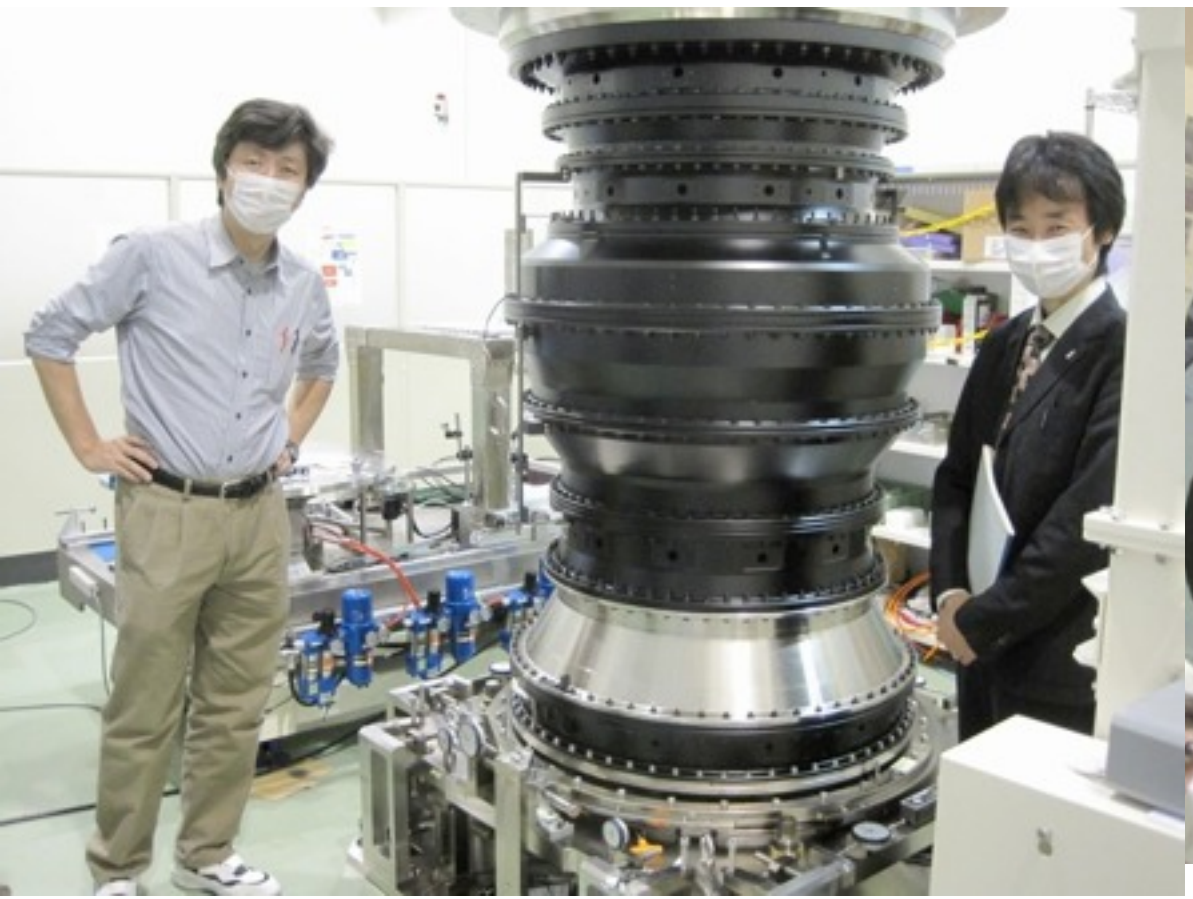


# WFC Designed Performance



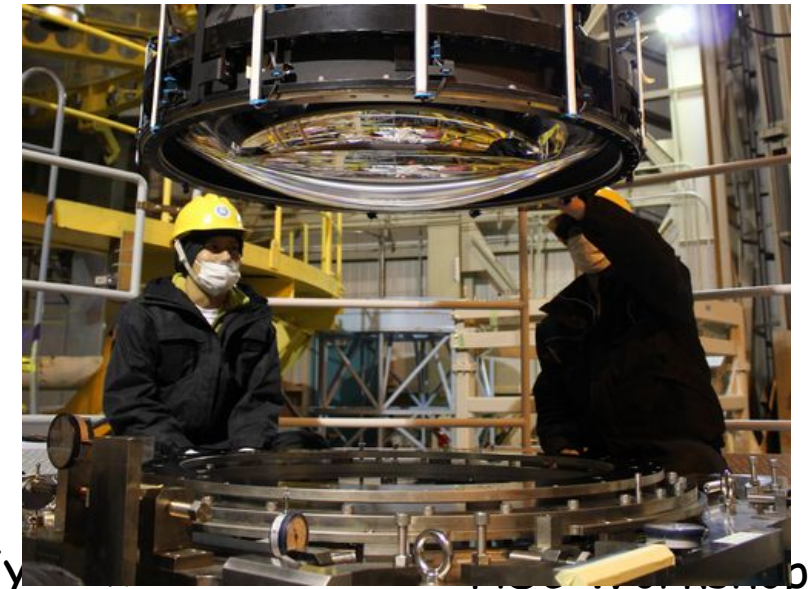

0".2 (FWHM) is allocated including manufacturing error

# Wide Field Corrector

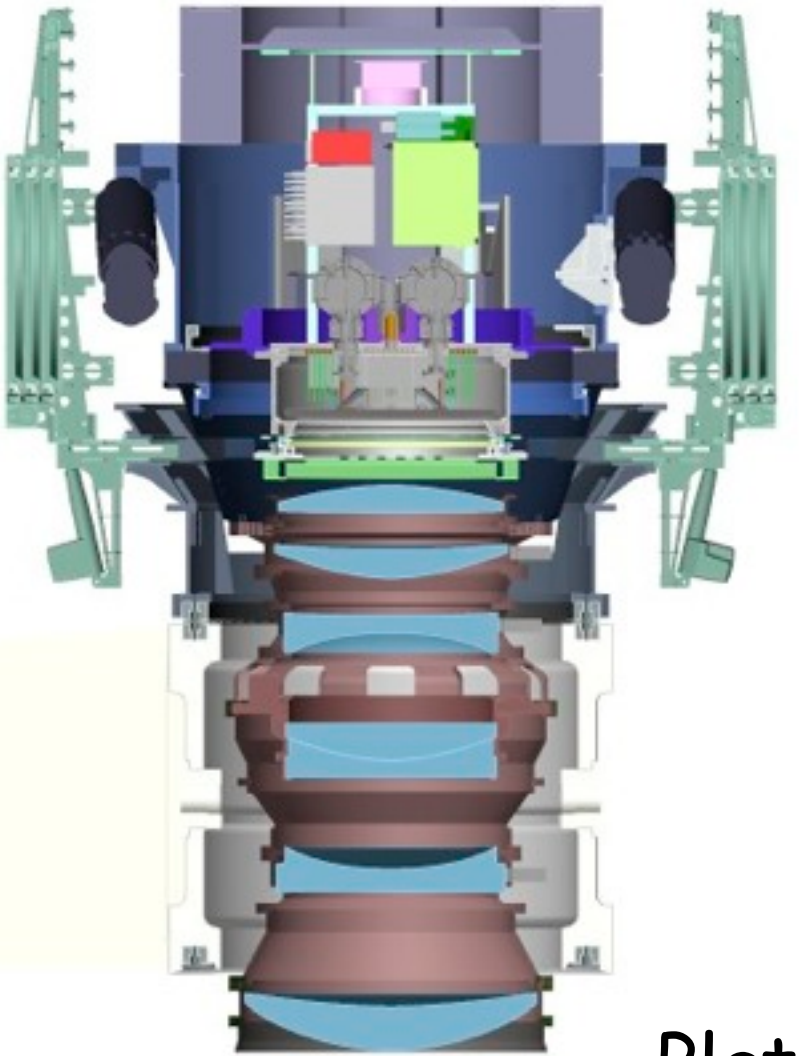


Estimated <u>Worst</u> Performance over the field of view <~ 0".18 FWHM in r (spec: 0''.2)

# WFC docking with PFU:June '12



# Structure and optics alignment



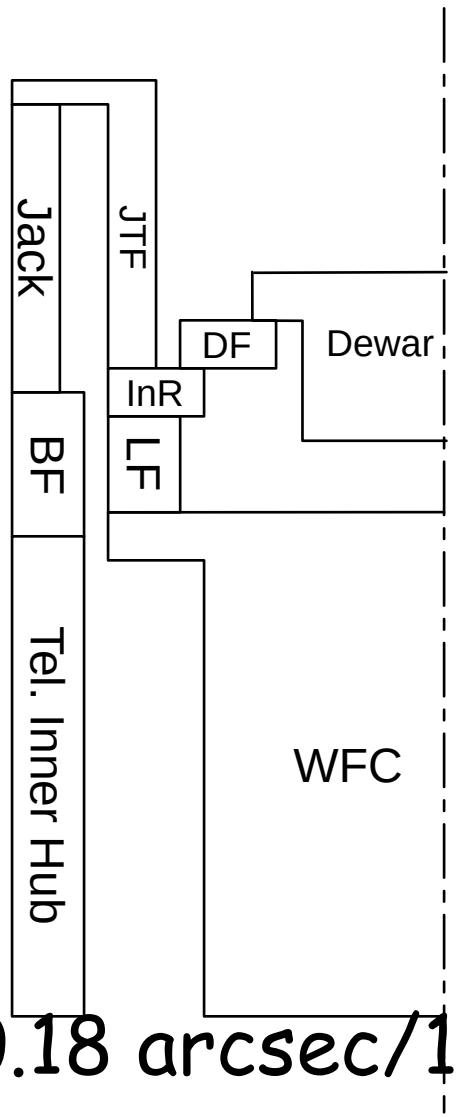
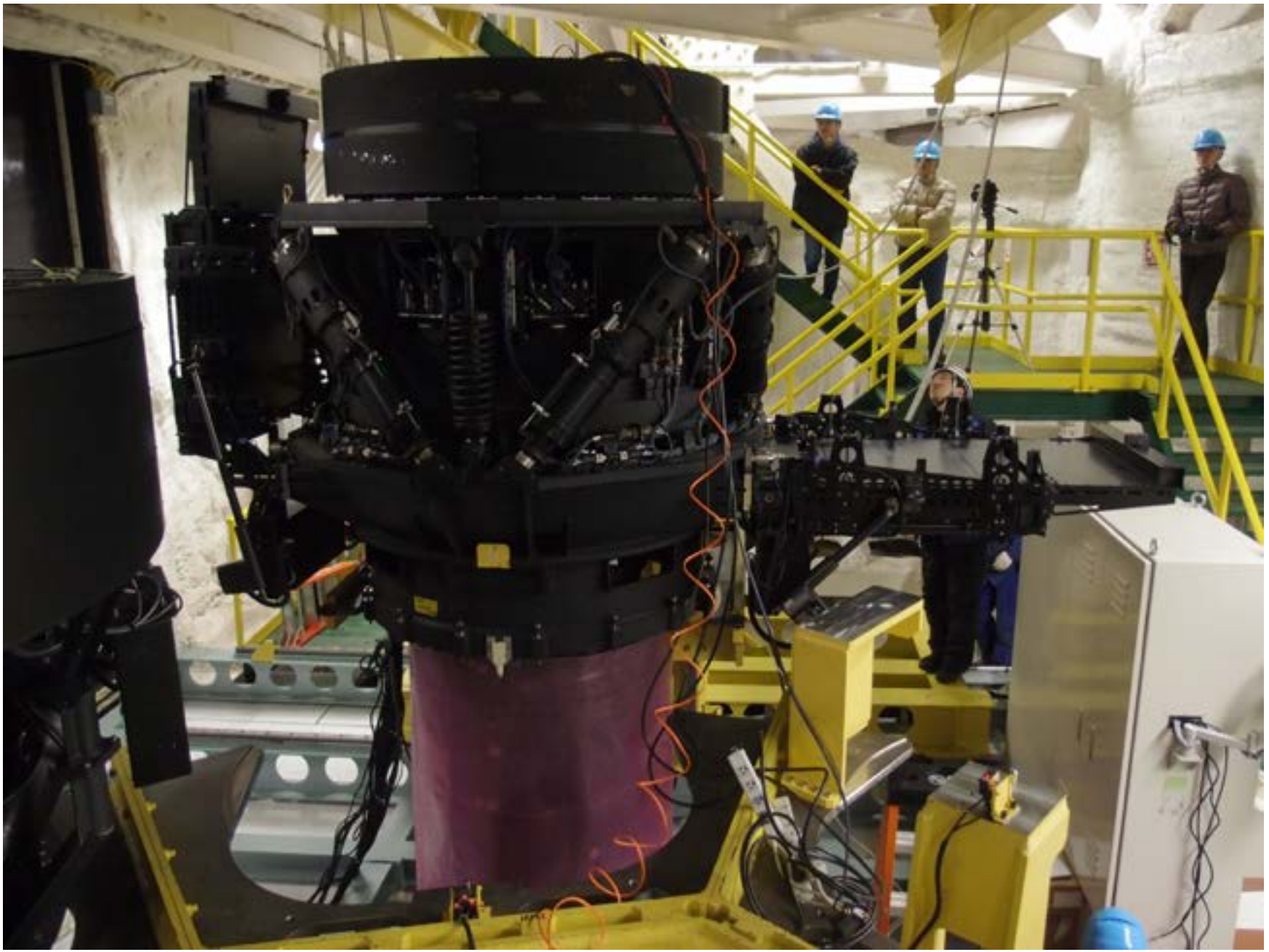



Plate scale 0.18 arcsec/15 μm

~ a few μm precision required for 3 tons camera

# New Prime Focus Unit



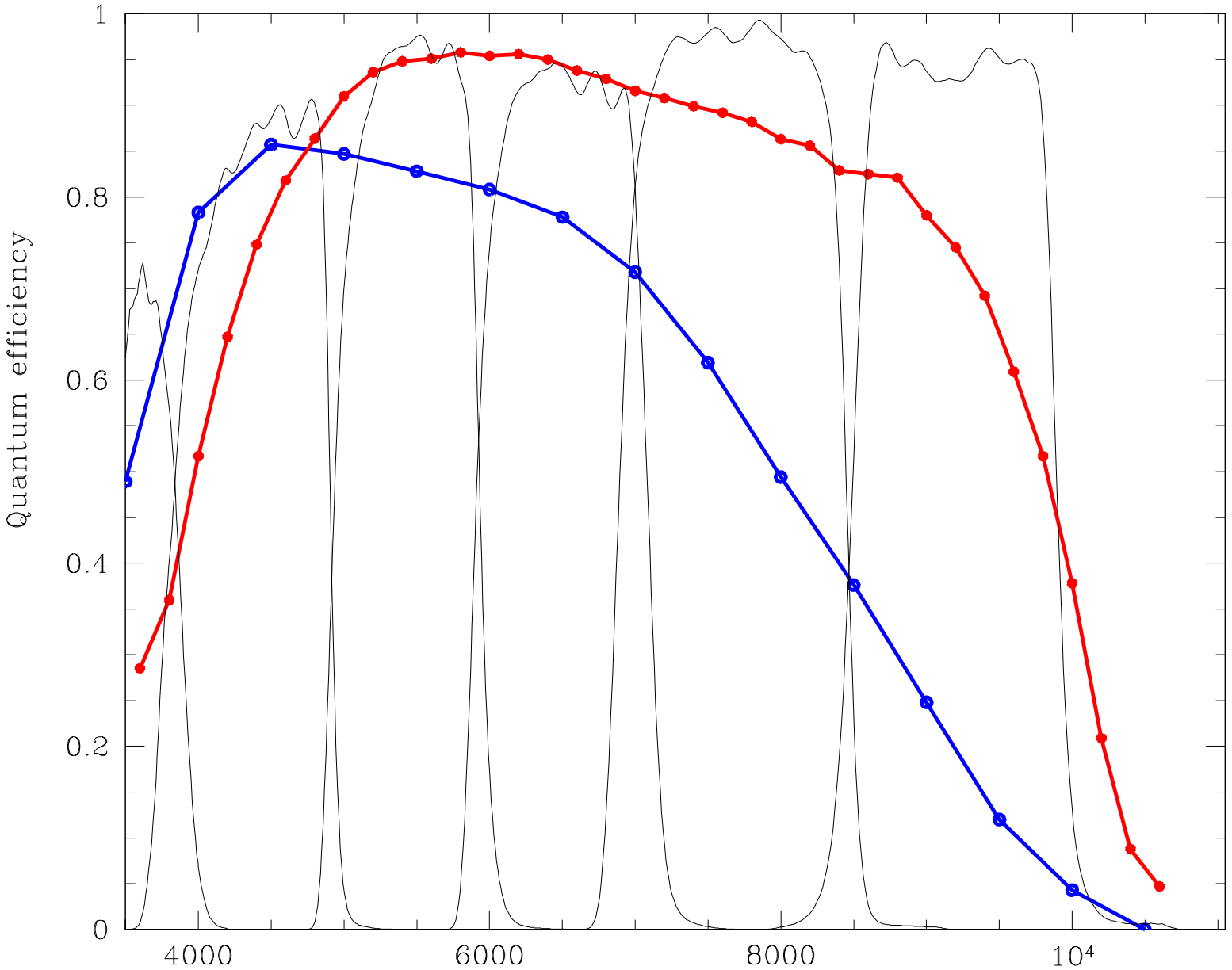
# Detector

## Collaboration with Hamamatsu

- 2k4k 15μm
- Fully depleted CCD
- High resistivity Si
- 200 μm thick

Kamata et al. SPIE 8453-69

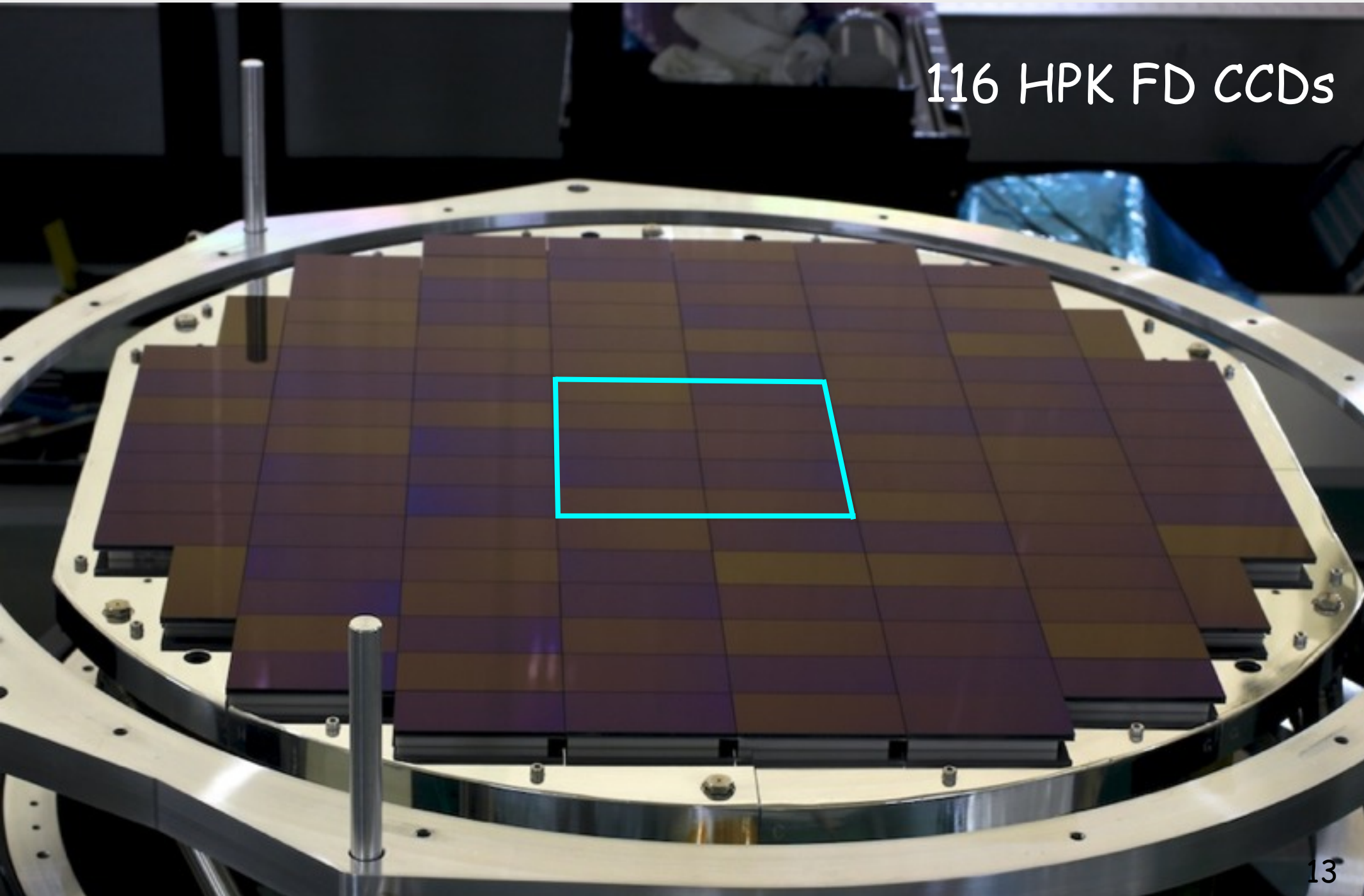
# Optical Quantum Efficiency



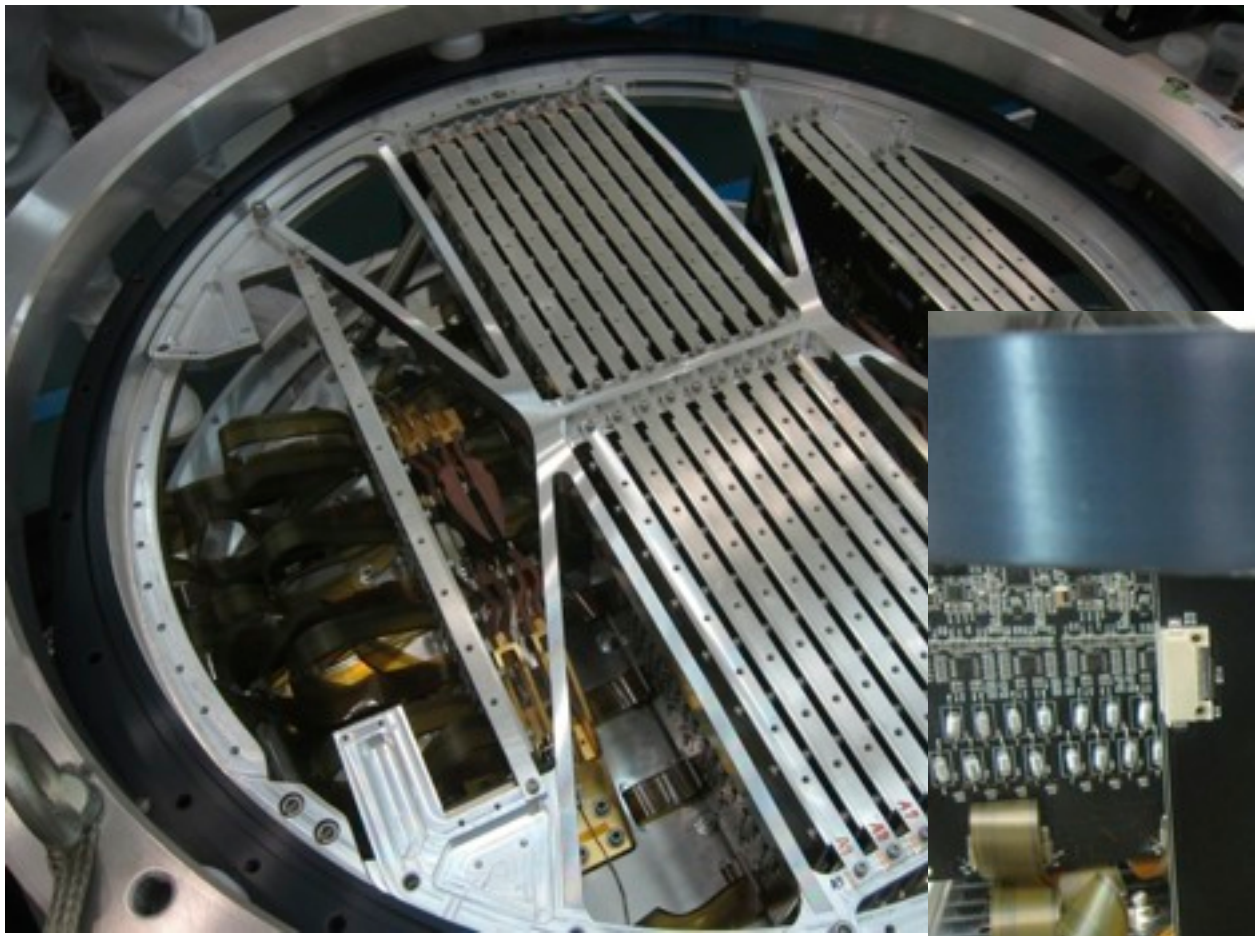

Hamamatsu FDCCD

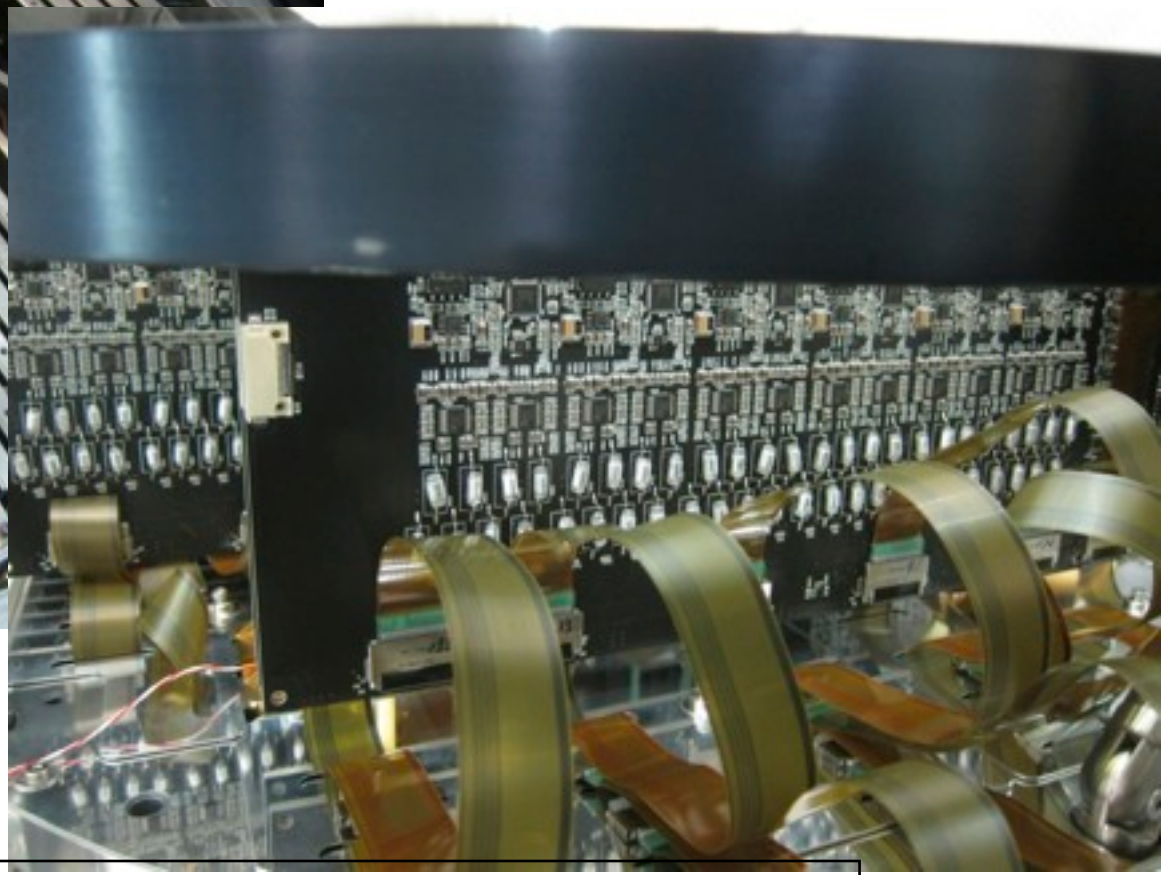
(previous) e2v CCD

# HSC Focal Plane



# In-Dewar Electronics Assembly





Nakaya et al. SPIE 8453-101

# HSC Dewar

## Vacuum Maintenance

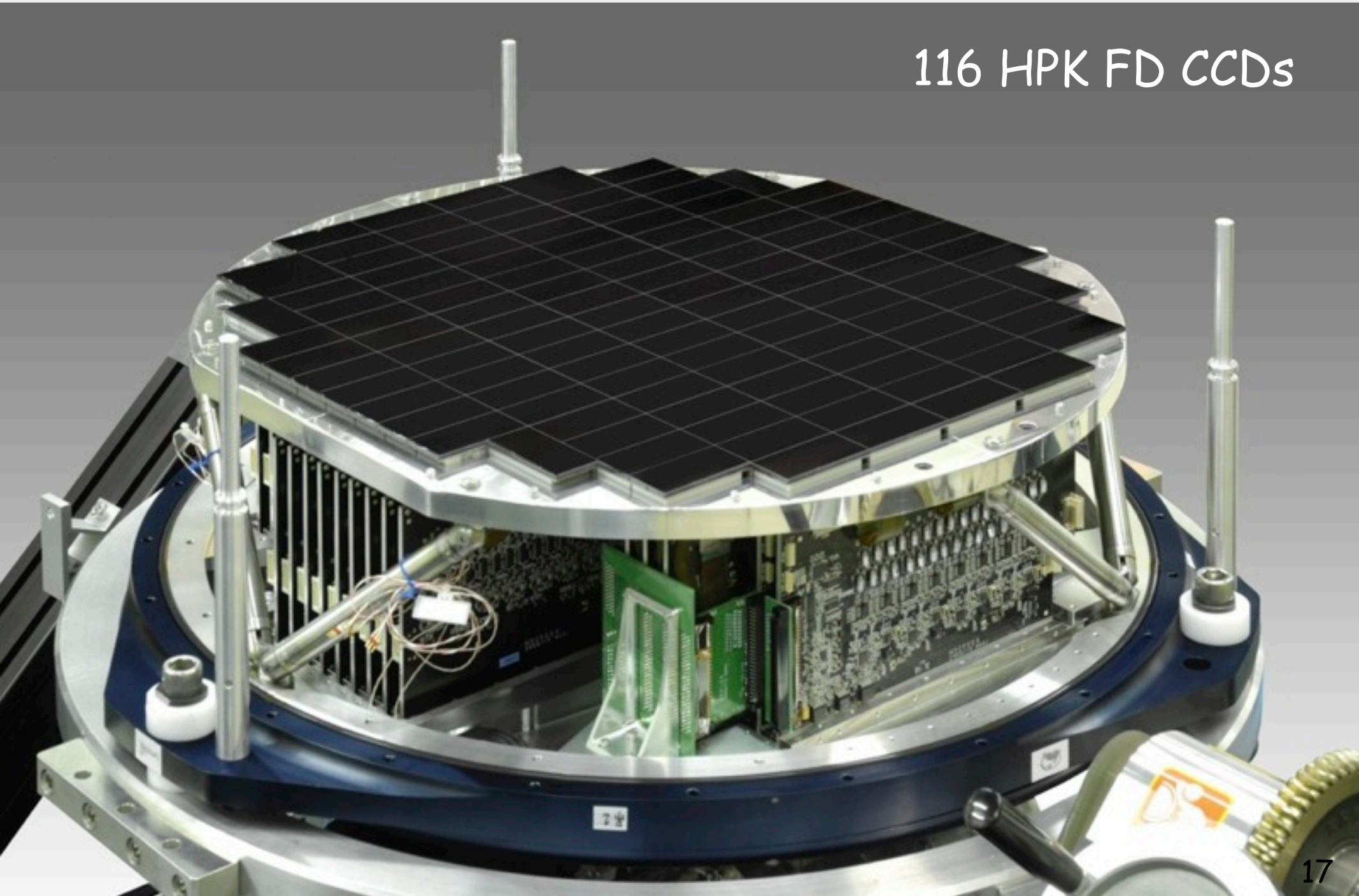
- Achieved Vacuum: P <~ 1 x 10^-5 Torr
- With electronics powered on (outgas)
- Life time of the ion pump: 8,000 hours
  - (cf 80,000 hours @ 10^-6 Torr)
  - Maint. cycle: ~ 2 year  (14 nights/month)

cf. VacuumTemp20110927.pdf

# Assembling Dewar

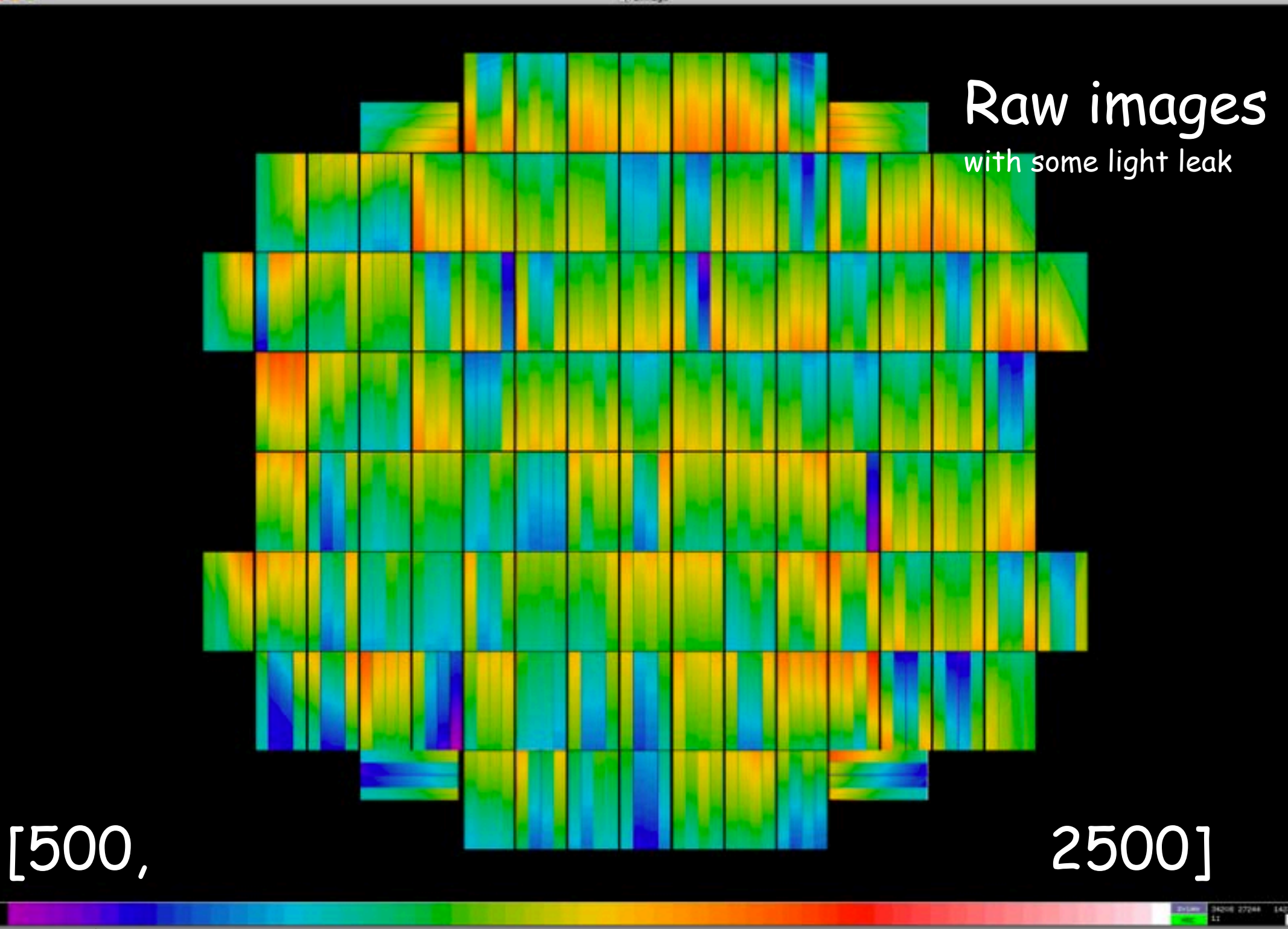
Komiyama et al. 2010
Obuchi et al. 8446-256

# HSC Focal Plane

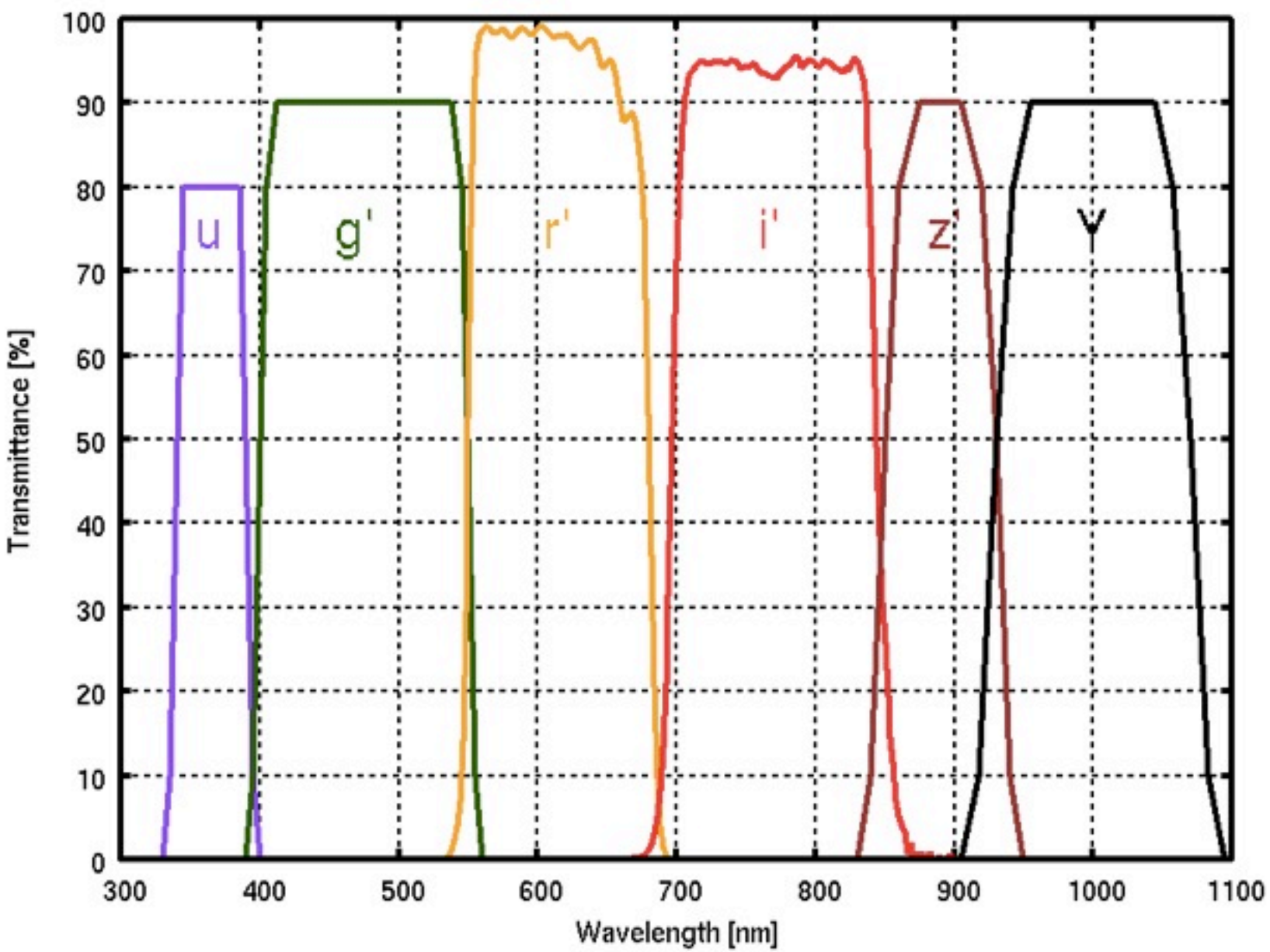


# Raw images

with some light leak

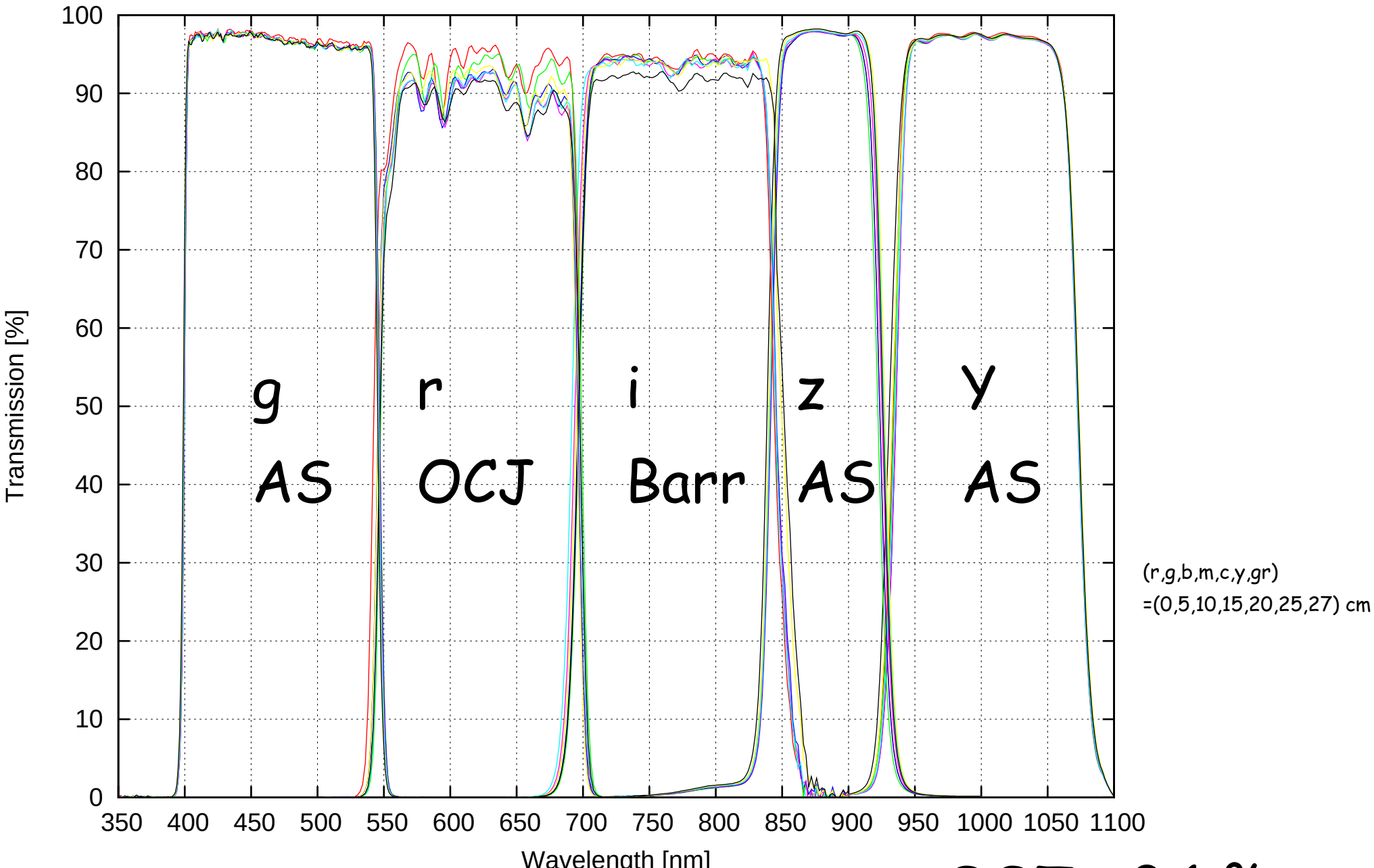


# Filter Plan


Transmittance [%]
Wavelength [nm]
u
g'
r'
i'
z'
Y
0
10
20
30
40
50
60
70
80
90
100
300
400
500
600
700
800
900
1000
1100

# Filter

# Filter in the Cabinet




OOT < 0.1 %

# Narrow Band Filter Set

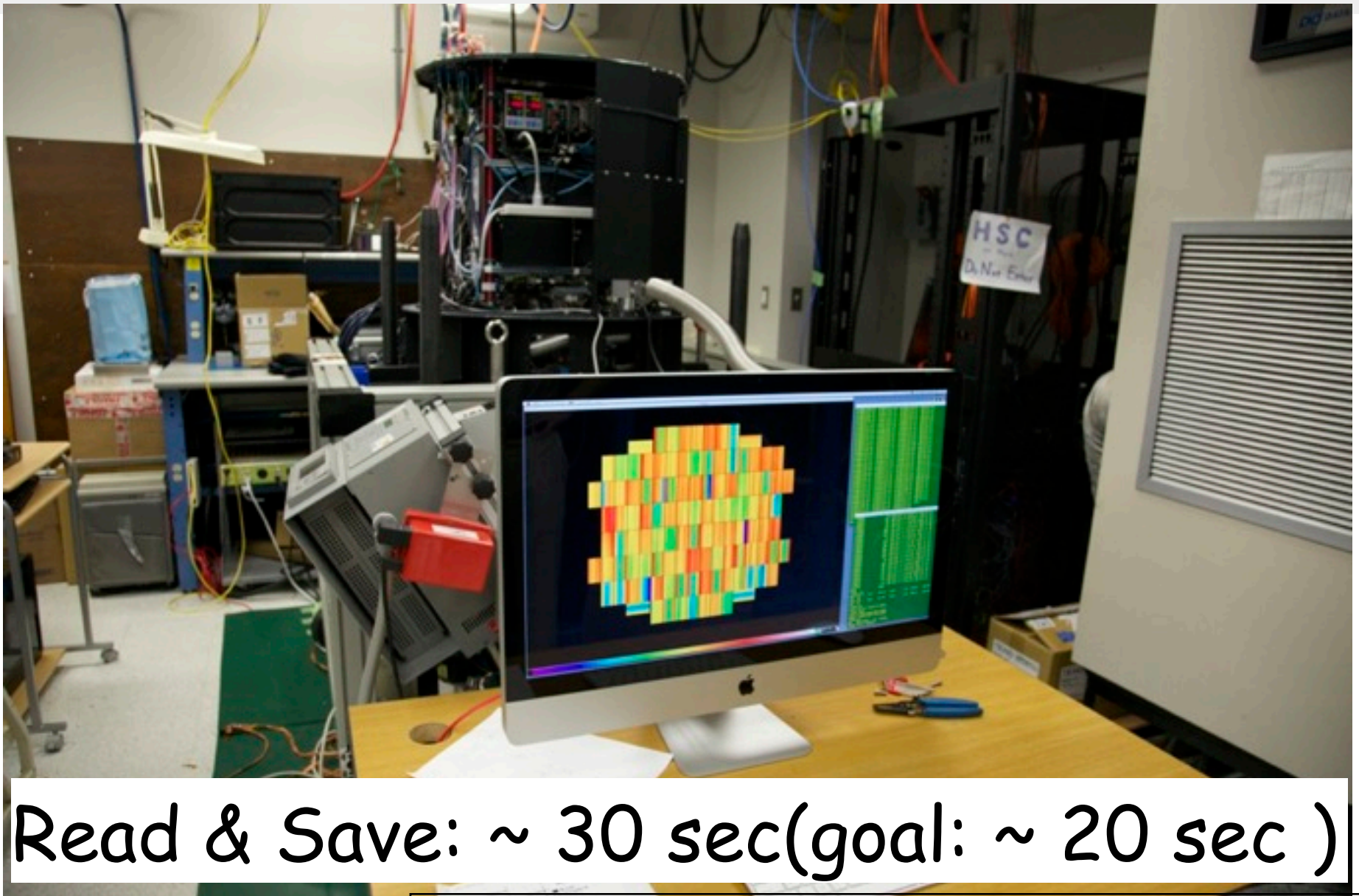
- ML(hscfilter@anela)における話し合いで製作フィルターを決め、観測所、SACに提案
  （Chair: 東大 嶋作）
- 技術サポートはHSC Project (川野元)
- 予算は各自獲得
- フィルターは観測所に寄付　誰でも使える

| 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



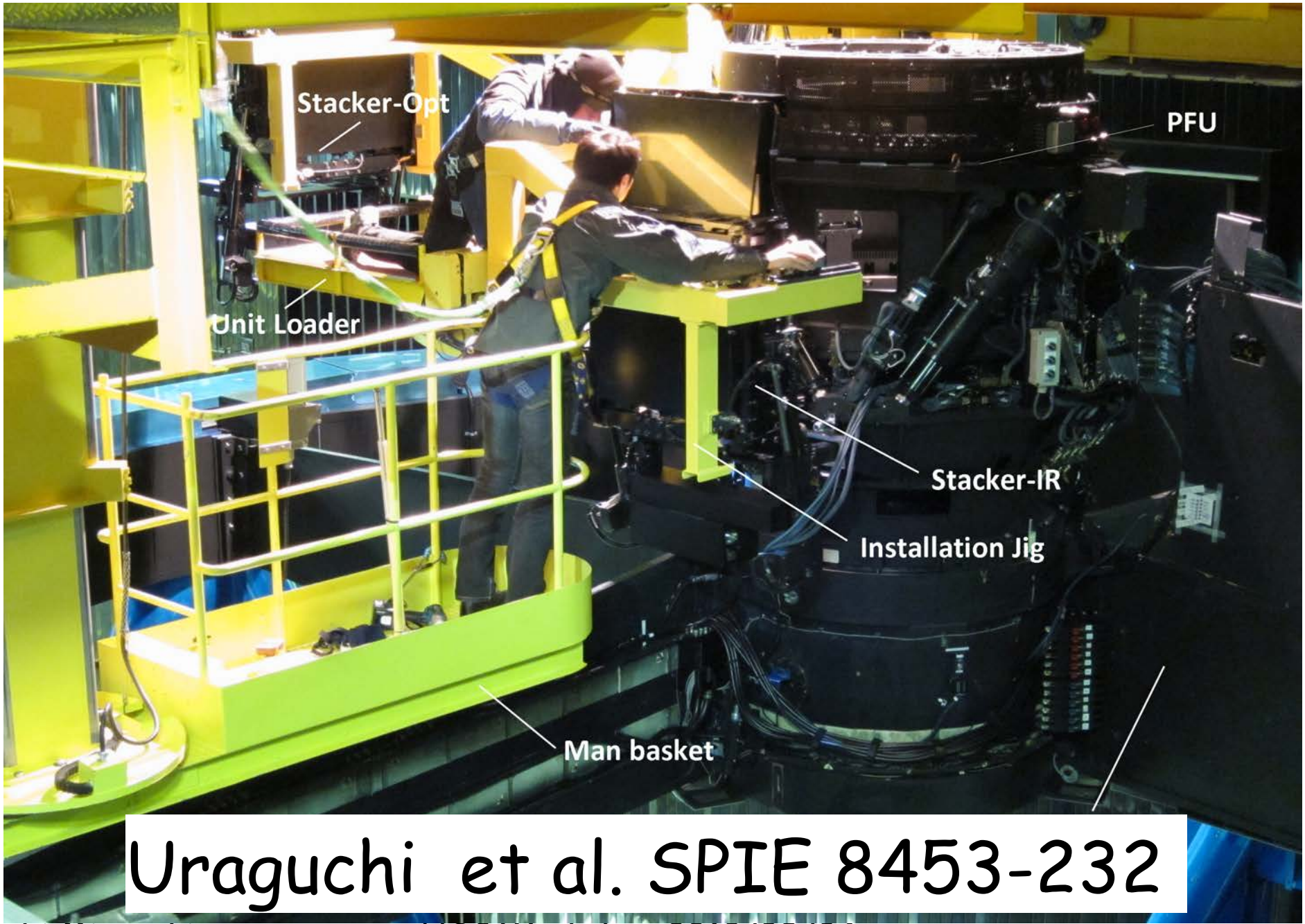

Read & Save: ~ 30 sec(goal: ~ 20 sec )

Utsumi et al. SPIE 8453-231

# Camera Unit Installation Done

# Mounting on Subaru

# FEU Attachment

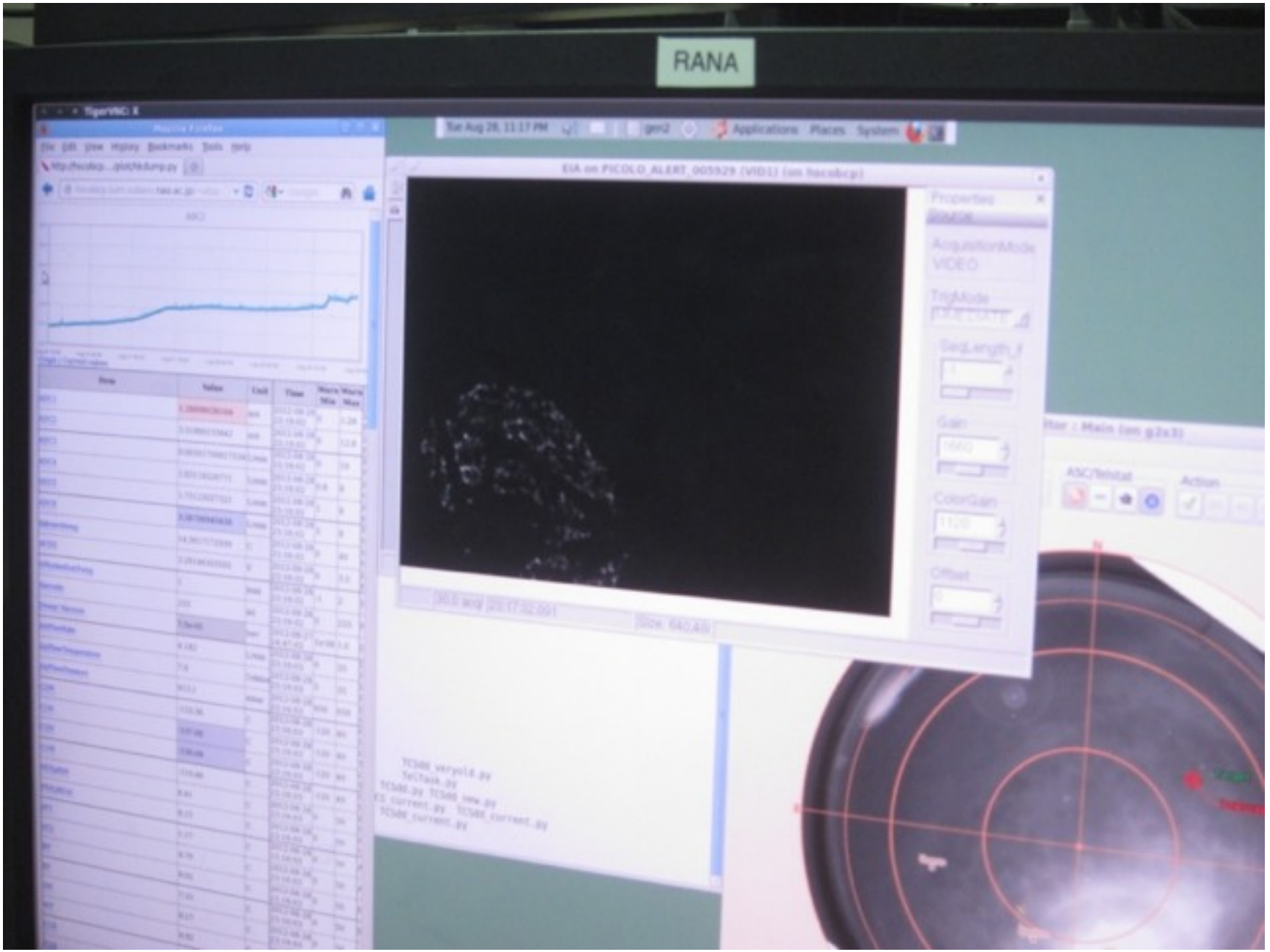



Uraguchi et al. SPIE 8453-232

# 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

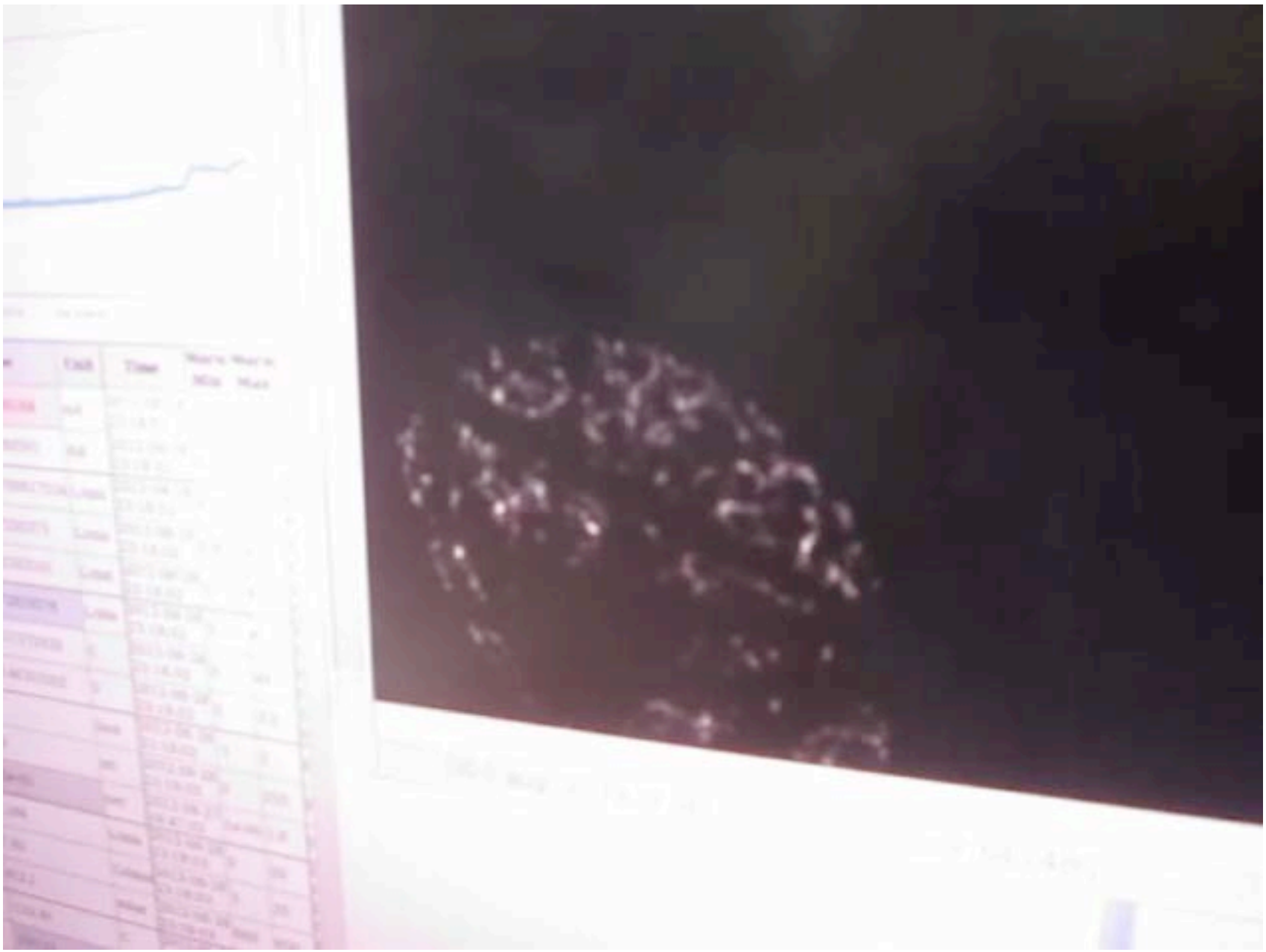
# HSC First Light




2012/08/28
~ 23:17
Vega
with Video
Camera for
SHAG

Perr <~ 20''

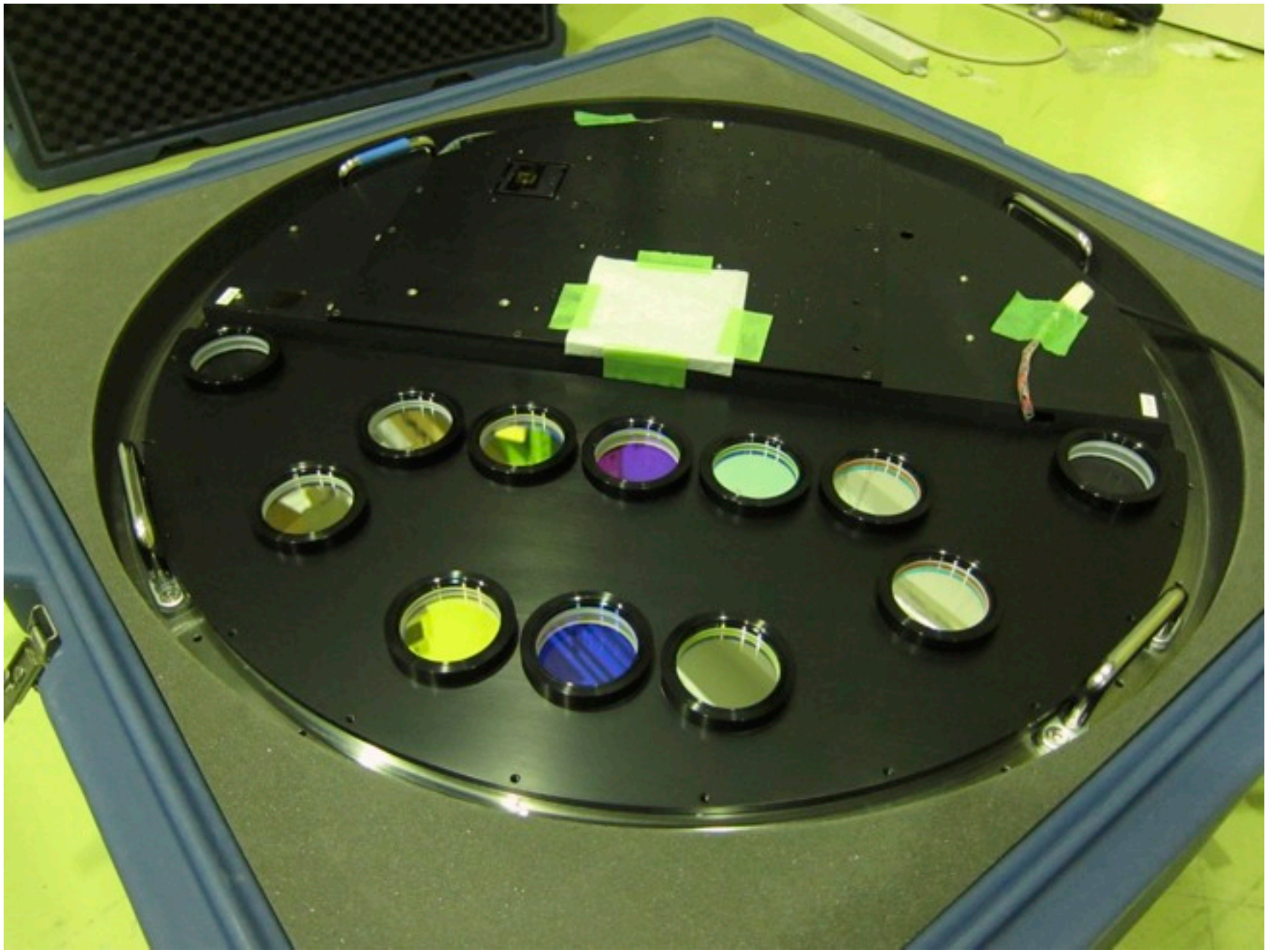
# HSC First Light



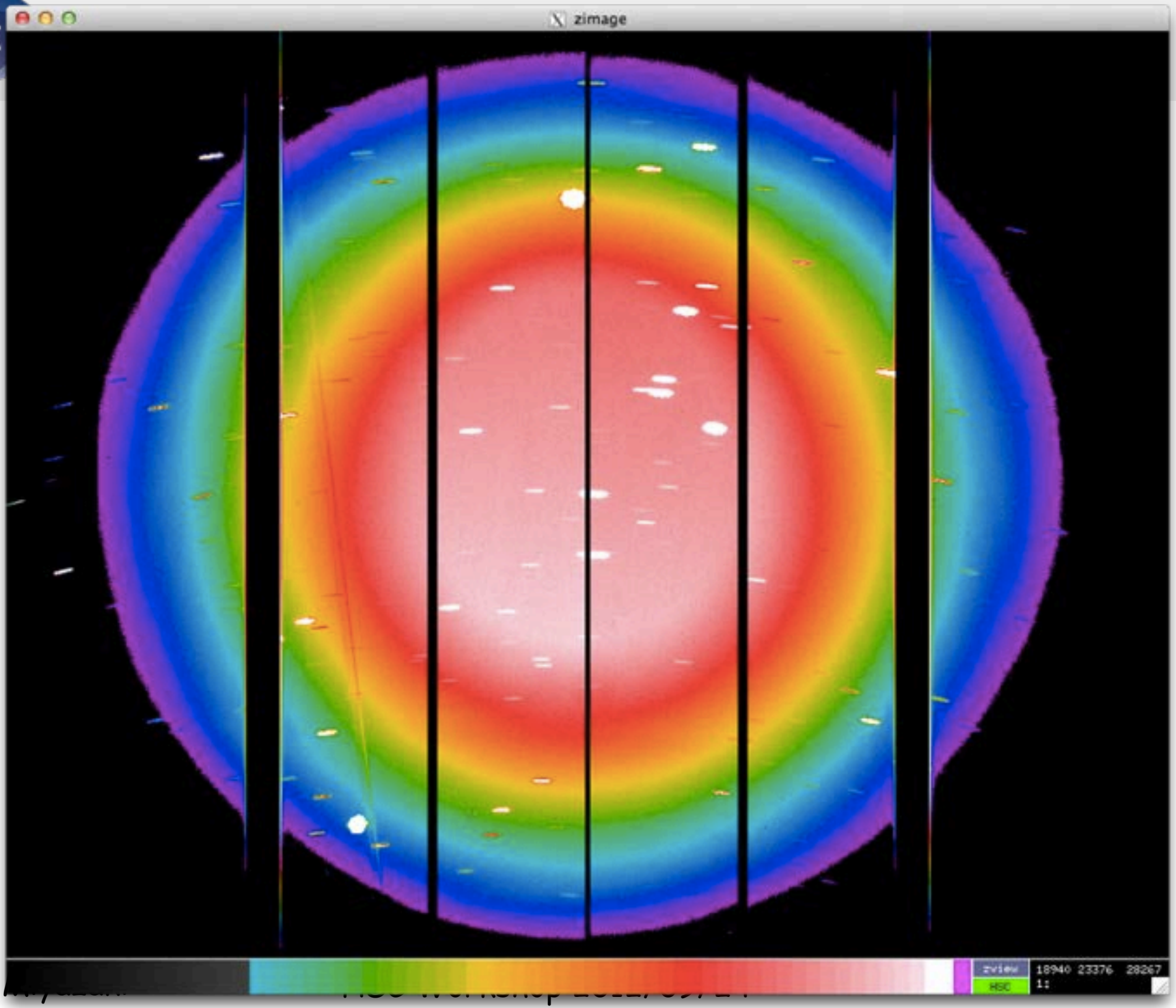
# HSC First Light

# HSC First Light

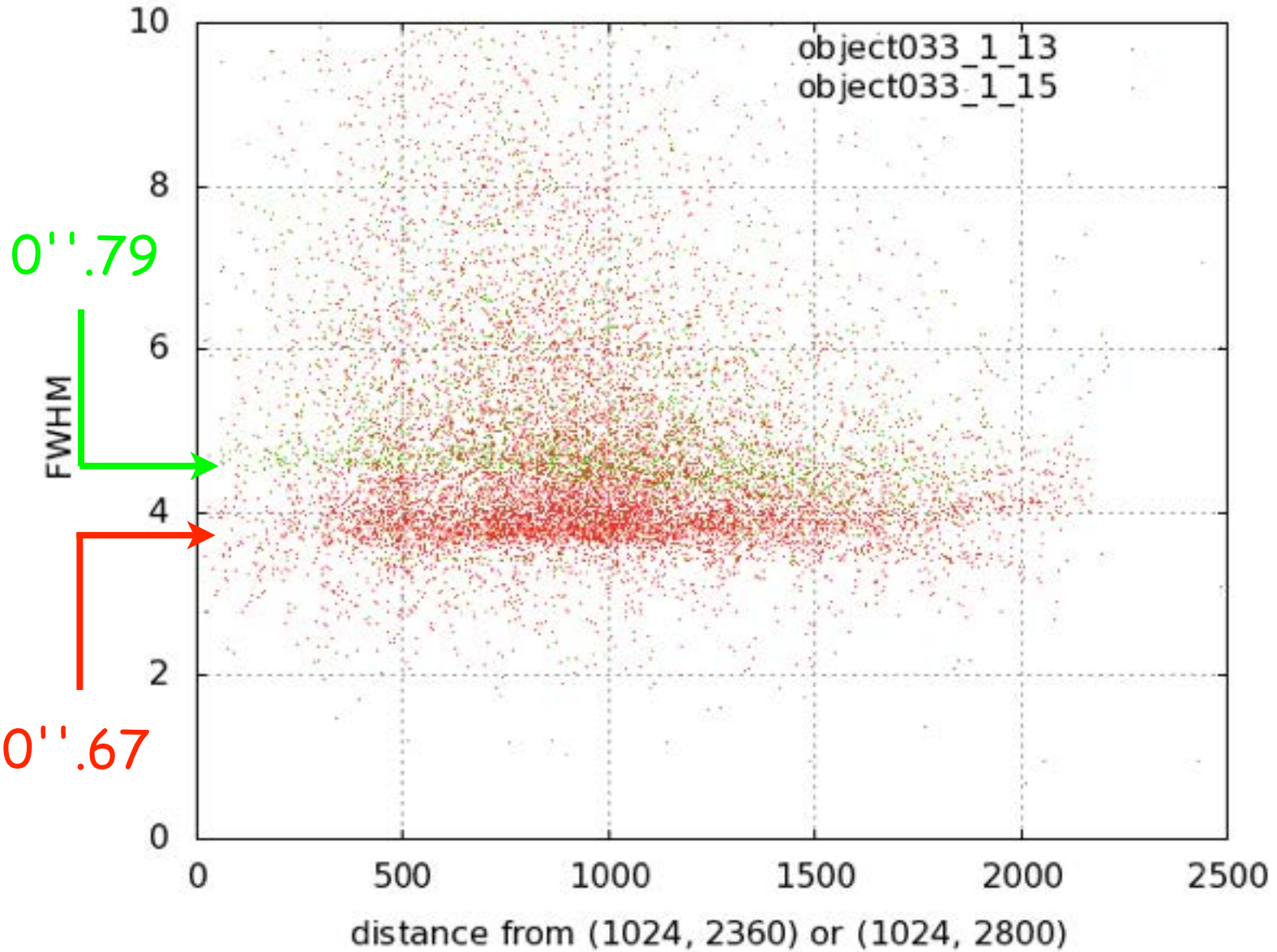
# SH Filter



# HSC First Light


zimage
zview
HSC
18940 23376 28267
1:

# Main Camera Image Analysis

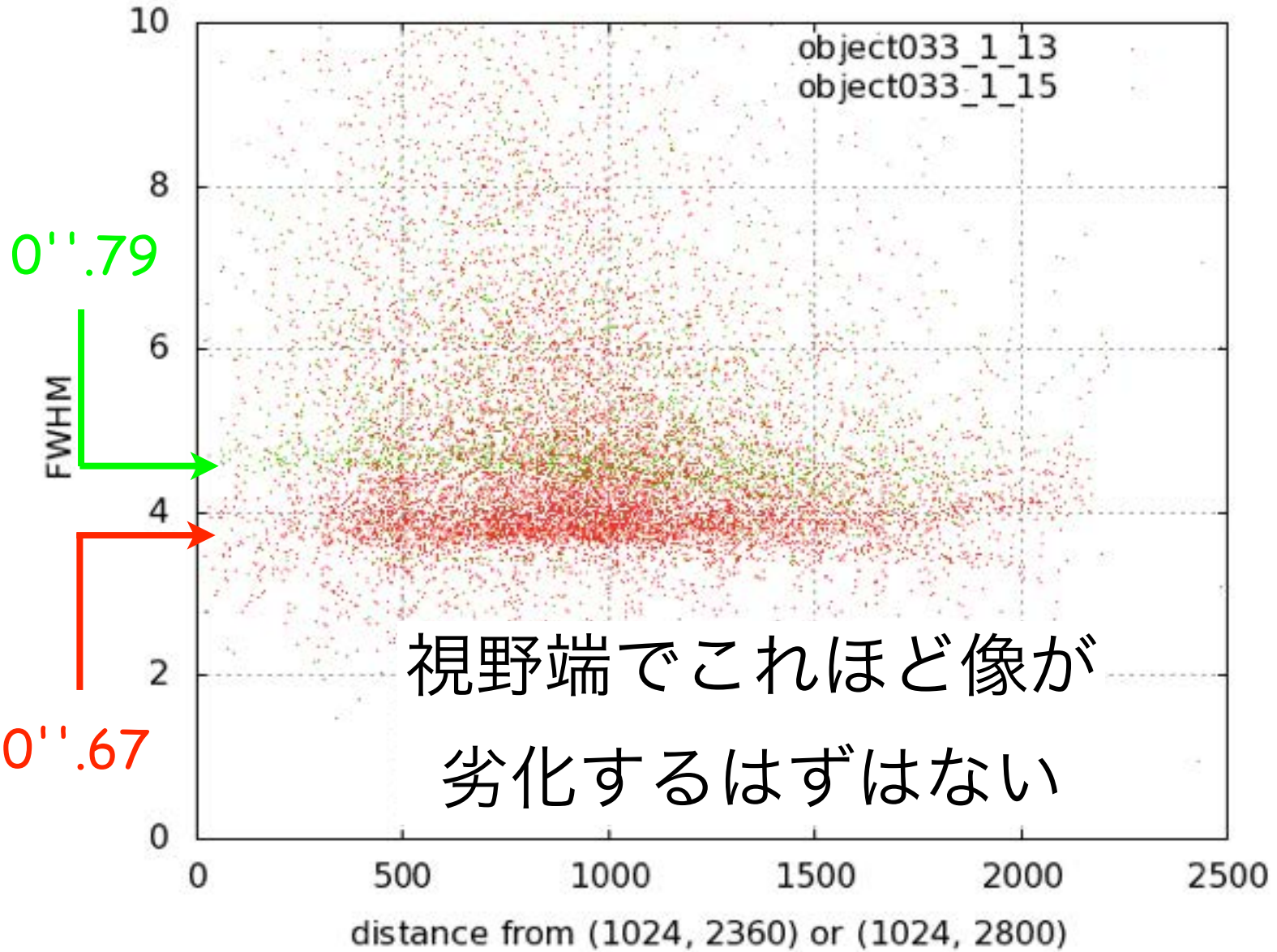



Field Angle

green: 43'

red: 19 '

# Main Camera Image Analysis




Field Angle

green: 43'

red: 19 '

# 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

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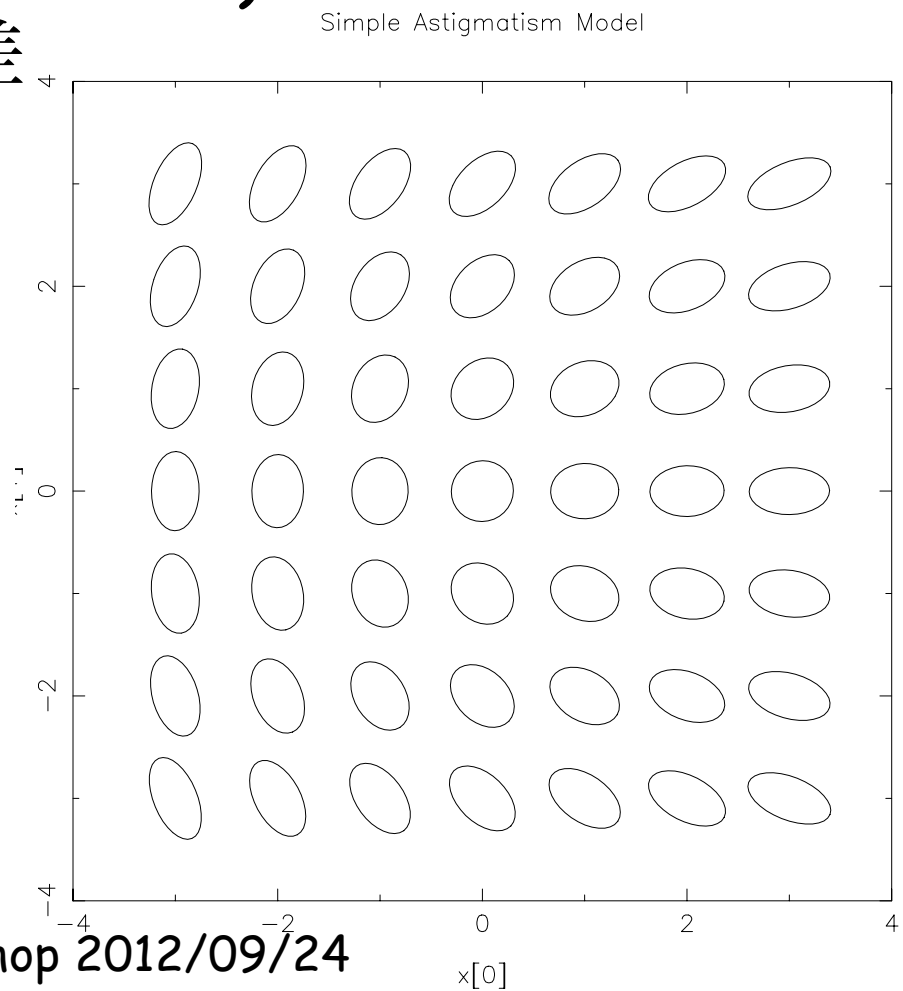

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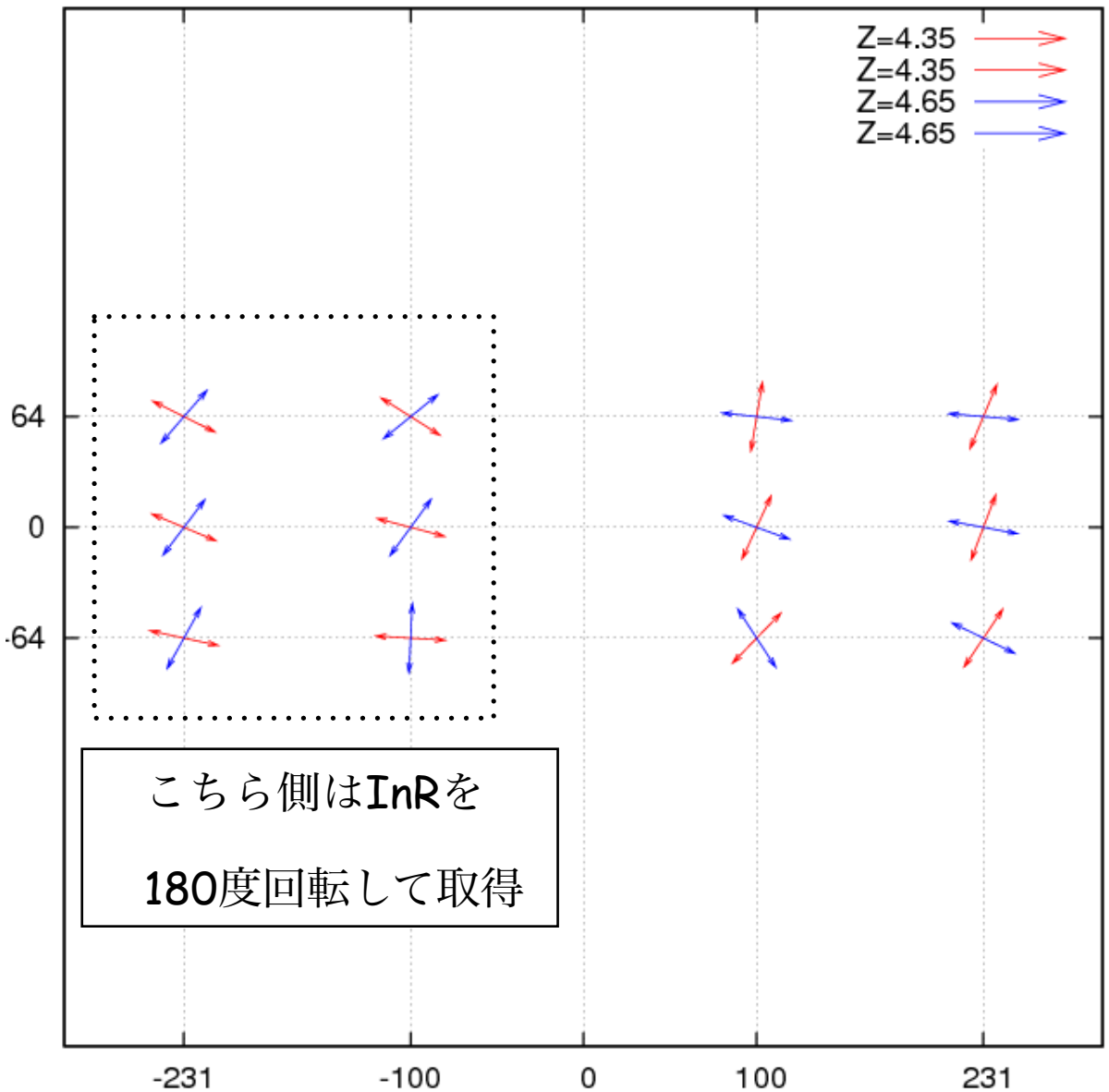
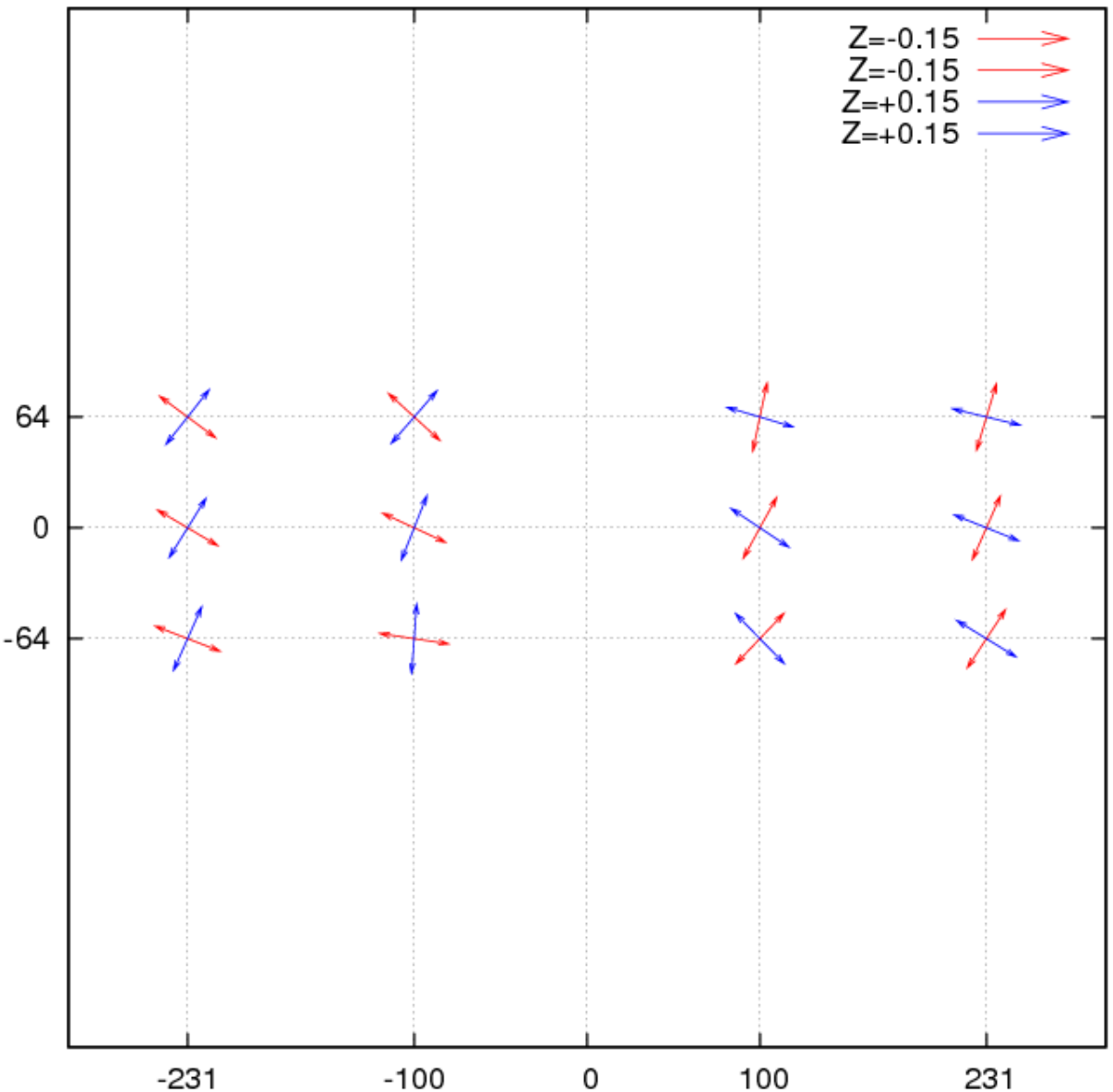



150 μm off-focus

画像の星像の伸び

直交 -> 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 ~0''.58 FWHM

~ 2000 pix

~ 4000 pix (10 arcmin)

# Legacy Survey

Model: CFHTLS (410 nights over 5 years)

| | | |
|---|---|---|
| Very Wide | 410 | Solar System |
| Wide | 170 | Cosmology |
| Deep | 4 | Galaxy |

Community efforts well organized

Survey plan, data analysis, catalog generation

---> A lot of results, publications from the CFHTLS astronomers

# HSC Strength

Sharp Image: Lensing and SNIa

-> Wide and Deep

High QE in red: High z galaxies

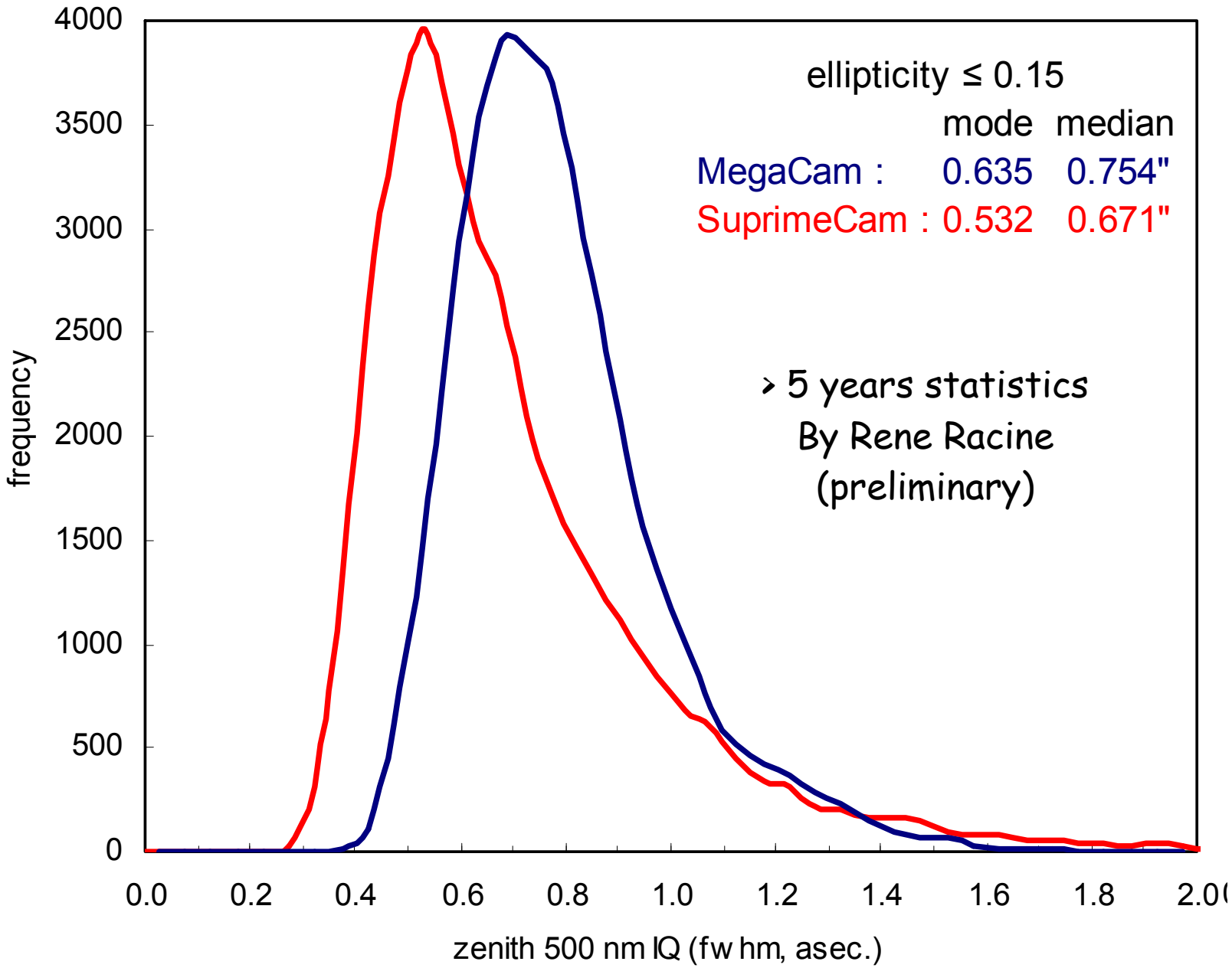
-> Deep and Ultra-Deep

Hardware & Software in unified group

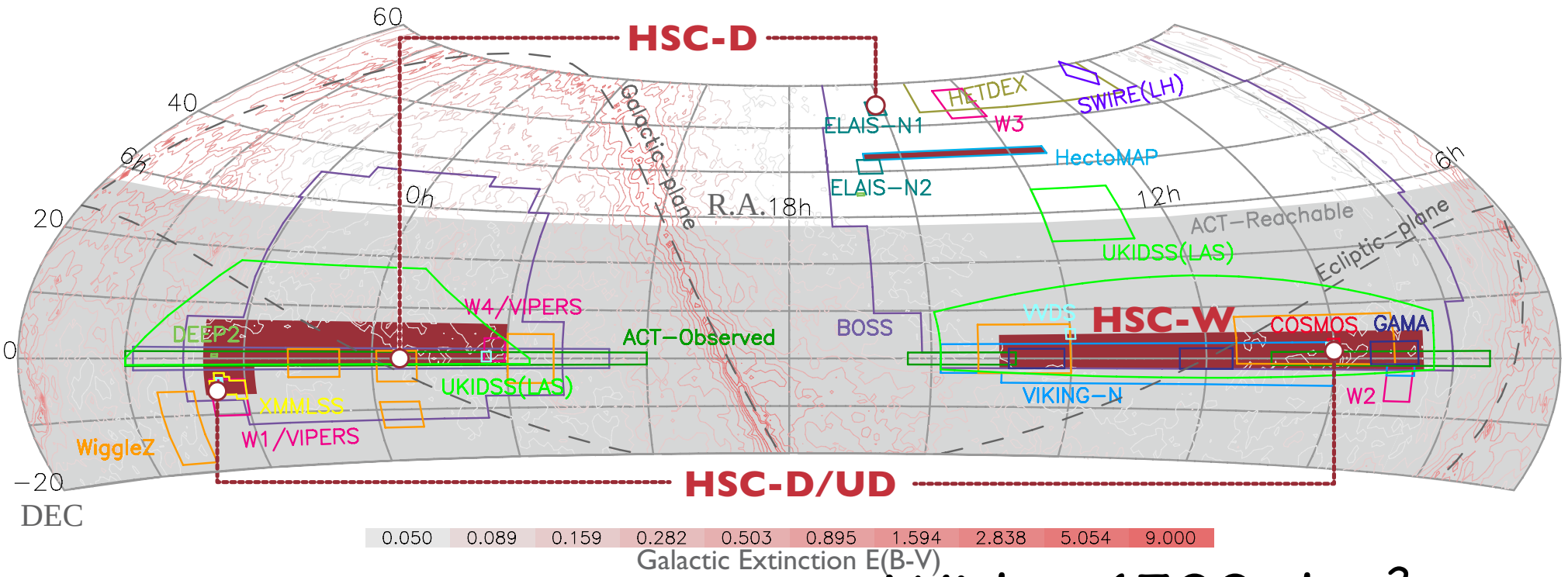
-> Less systematics,

reliable catalog

# Image Quality: vs CFHT



# Survey Field




Wide 1500 deg$^2$

Deep 28 deg$^2$

UDeep 4 deg$^2$

~ 300 nights over 5 years (S13B ~ )

# Wide Survey Projects

| | | Depth | Width ($deg^2$) | IQ (arcsec) |
|---|---|---|---|---|
| CFHLS | Completed | 25.0 | 170 | 0.75 |
| Pan-STARRS | on-going | 25.4 | 70 | ~ 1.1 |
| DES | soon | 25.2 | 5,000 | ~ 0.9 |
| HSC | soon | 26.2 | 1,500 | 0.67 |

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| DES | soon | 25.2 | 5,000 | ~ 0.9 |
| HSC | soon | 26.2 | 1,500 | 0.67 |
| Euclid (space) | 2020's | 24.5 | 15,000 | (~ 0.1) |
| LSST | 2020's | > 26.5 | 30,000 | (~ 0.7) |

# HSC General Observer Support

- Provides user with data analysis package : a subset of hscana pipeline
  - based on lsst-stack
- Basic package is only for blank field data
  - Efforts made by user (in collaboration with HSC project) will be added in the future release

# Data Analysis

解析ソフトはHSC Projectより公開（予定）

インストール

- 初回時 (<~ 1 hour)
- 更新　make rev=origin/1.6.0c_hsc 一行コマンド

解析

- 各素子解析 (bias, flat, cross-talk, PSF決定, Astrometry, SDSSカタログとのマッチ ・・・)
- Mosaic Parametersを解き、Stackして最終画像

# Data Analysis

Suprime-Cam用の解析ソフトを

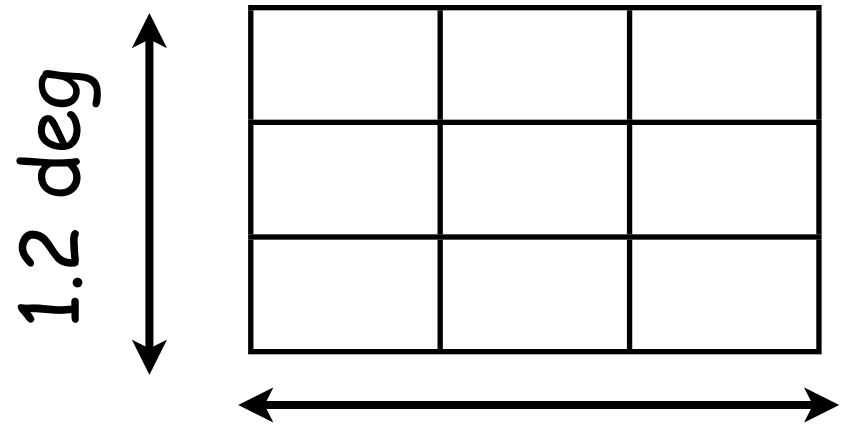
ベータテスターに公開（予定）

- 従来の解析ソフトと比較してもらい、フィードバックを受ける
- SC各世代に対応
  - 2001/04 ~ 2002/07 MIT/Messia4
  - 2002/08 ~ 2008/07 MIT/Messia5
  - 2008/08 ~ Hamamatsu

# Data Analysis

ベータテストの一例

- 2002/09取得
- R-band 450 sec exp.
- 1 Visit: 4 dithered exp. (計30分積分)
- 3 x 3 Visits
- CCD画像 10 x 4 x 3 x 3 = 360 枚



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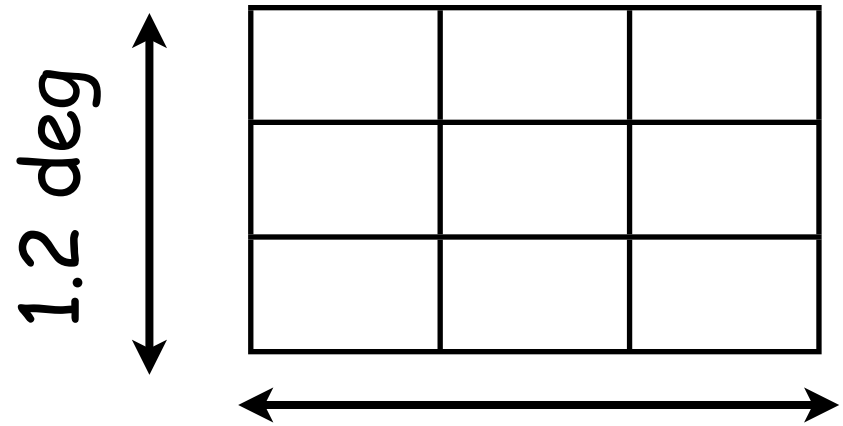


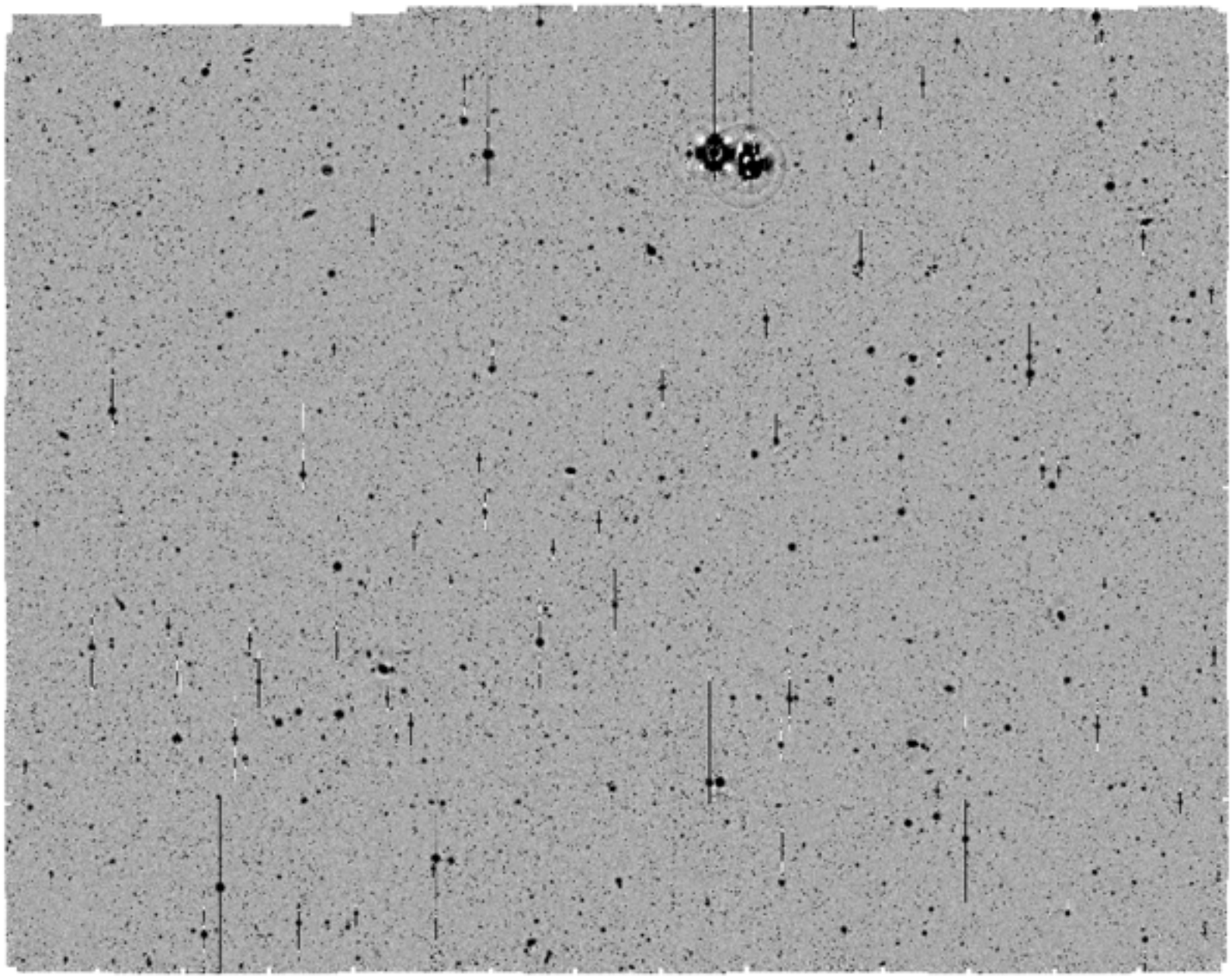

おおよそHSC 1 視野の大きさ

# Data Analysis

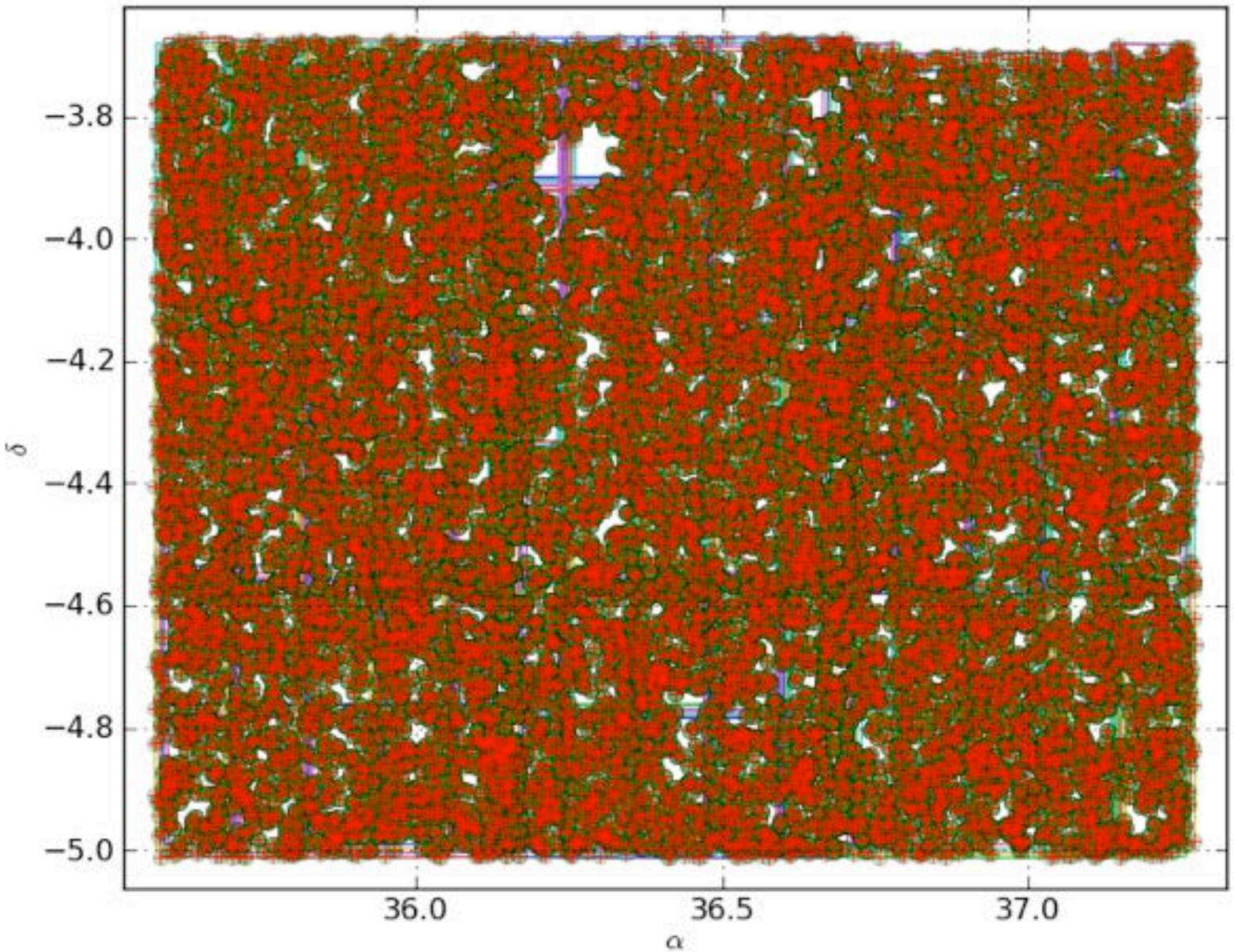
ベータテストに要した時間

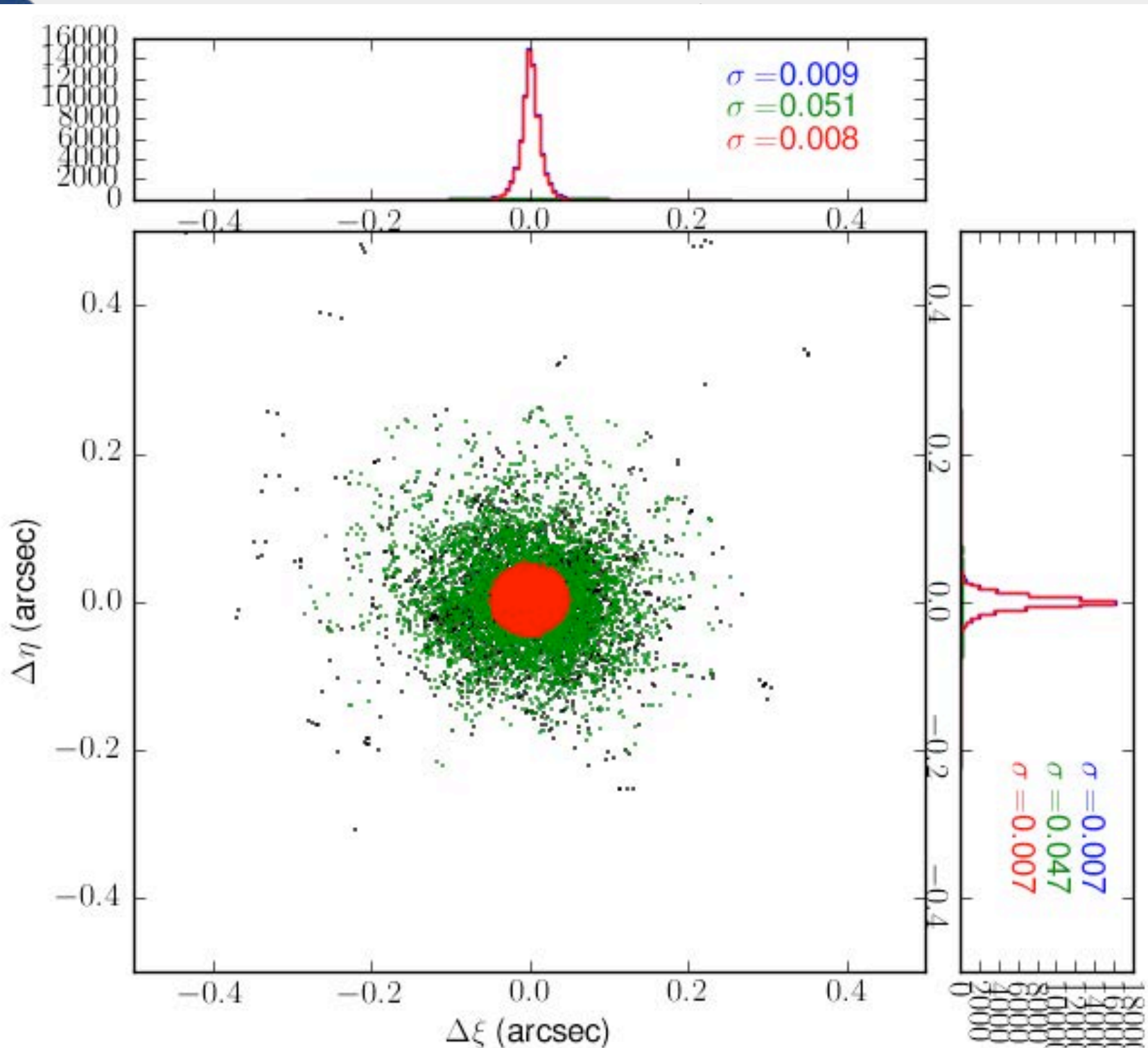
- 各素子解析：　10時間30分
  - かかりすぎ？解析項目を選択制にすべきか？
- mosaic 解を求める：40分　（速い！）
- stack: 45分

# Data Analysis



# Data Analysis




σ =0.009
σ =0.051
σ =0.008
Δη (arcsec)
Δξ (arcsec)
σ =0.007
σ =0.047
σ =0.007

# Data Analysis

計算機ハードウェアー

- CPU: Intel Xeon  6 core (2.6 GHz)  X 2
- Memory: 24 GB
- Hard Drive: 3 TB
- OS: CentOS 5.8 以降

# Data Analysis

SYSTEM WORKS

製品 サポート コンタクト

ホーム » ショッピングカート

## ショッピングカート
Shopping cart

**POWER MASTER Vision S9620**

システム詳細ページへ　カートから削除する

※標準構成のケースの写真です

| | |
|---|---|
| 数量 | 1 |
| 税込単価 | ￥353,640 |
| 税込金額 | ￥353,640 |

カート内でパーツの選択に迷った場合や、その他ご希望の仕様がある場合など、下の「ご要望の入力」欄にご入力下さい。ご提案させて頂きます。

搭載パーツを隠す

# Data Analysis

System Works PC for Suprime-Cam Analysis in 2000

- CPU: Pentium III 733 MHz
- Memory: ~ 512 MB (256 MB?)
- Disk: ~ 100 GB (RAID)

APOD: 2001 September 17 - Southwest Andromeda

http://apod.nasa.gov/apod/ap010917.html

# Astronomy Picture of the Day

Discover the cosmos! Each day a different image or photograph of our fascinating universe is featured, along with a brief explanation written by a professional astronomer.

2001 September 17

**Southwest Andromeda**

**Credit & Copyright:** Satoshi Miyazaki (NAOJ) et al., Suprime-Cam, Subaru Telescope, NOAJ

**Explanation:** This new image composite of the southwest region of M31 from the Subaru Telescope shows many stars, nebulae, and star clusters never before resolved. An older population of stars near Andromeda's center causes the yellow hue visible on the upper right. Young blue stars stand out in the spiral arms on the lower left. Red emission nebula, blue open clusters of stars, and sweeping lanes of dark dust punctuate the swirling giant. Andromeda, at about 2.5 million light years distant, and our Milky Way are the largest galaxies in the Local Group of Galaxies. Understanding M31 helps astronomers to understand our own Milky Way Galaxy, since the two are so similar.

# HSC Data Release Policy (draft)

- Raw data automatically release for public in 18 mo.
- Reduced image and Catalog release within the HSC collaboration
  - 1 st release 18 mo. from the beginning of the survey: every 12 mo. from the 2 nd
  - 18 mo. after the survey completion open globally
- Part of the catalog items release globally from the beginning ? (Position & BB mag ...)

# Schedule

- 2012/08 First Light
- ~ 2013/07 Commissioning Run
- (2013/08~ Legacy Survey (5 yr) and Open Use)