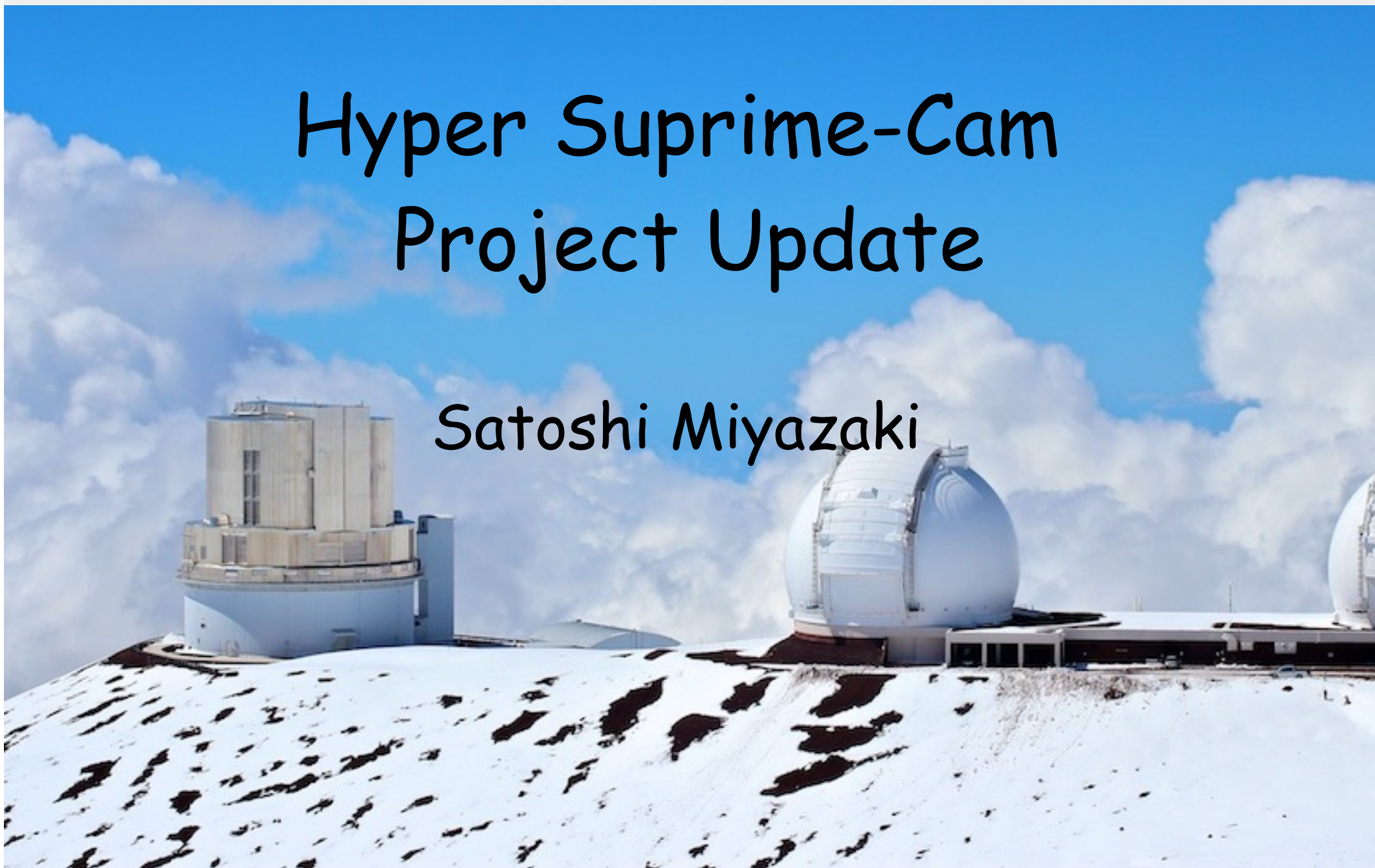


Hyper Suprime-Cam Project Update

Satoshi Miyazaki



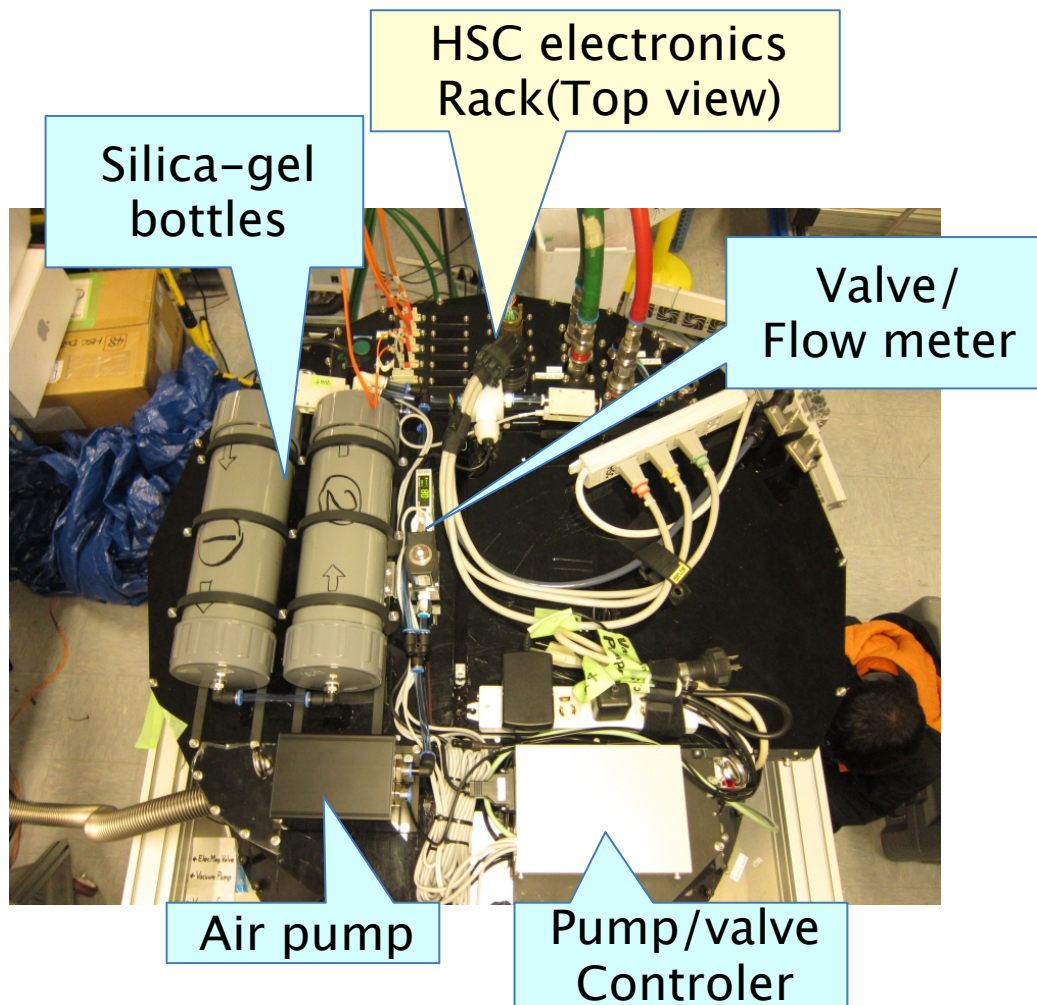


Summary@2013/08

- HSC camera development completed
- Data management software being matured
- In the middle of the commissioning
- 300 nights proposal accepted
- Survey from 2013/02 over 5 years

- Ceasing vacuum leak only occurred under low humidity environment
- Throughput
- Stray Light
- Fat PSF
- Long exposure test(~ 300 sec)

Vacuum Leak Update



November works by Komi&Kawa

Plastic seal implemented

Test at summit dry booth
(RH 2 %)

(1) 650 g water in the bottles

(2) $T=21.6^{\circ}\text{C}$ RH = 34.6% Air
→ 6.6 g/m^3

(3) the rate 3.75 L/min
(1 atm equiv.)
→ $8.8 \text{ m}^3/\text{day}$

(4) Water lasts for 10.4 days

$$6.6 \times 8.8 \times 10.4 = 600 \text{ g}$$

Calculation consistent



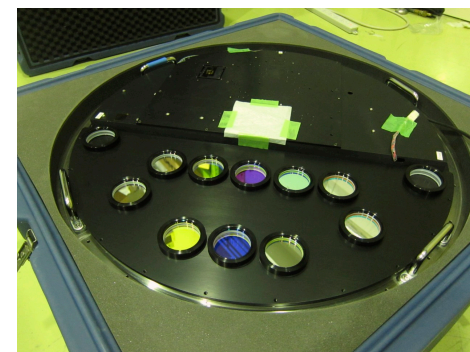
Necessary Maintenance

- Charge the bottles using the IG humidifier at laboratory (Location: Base of Summit).
- Takes 10 days to fill 1000 g (max)
- Swap the bottles on the ceiling of HSC every two months
 - < 30 minutes works.

Accepted by the observatory on Dec. 12, 2013

System Throughput

Measured by small filters on the SH filter
on the (hopefully) photometric night
(2011-11-01 UT)



Measured Throughput/Expected Throughput

g : ~ 0.9

$r, i \sim 1.0$

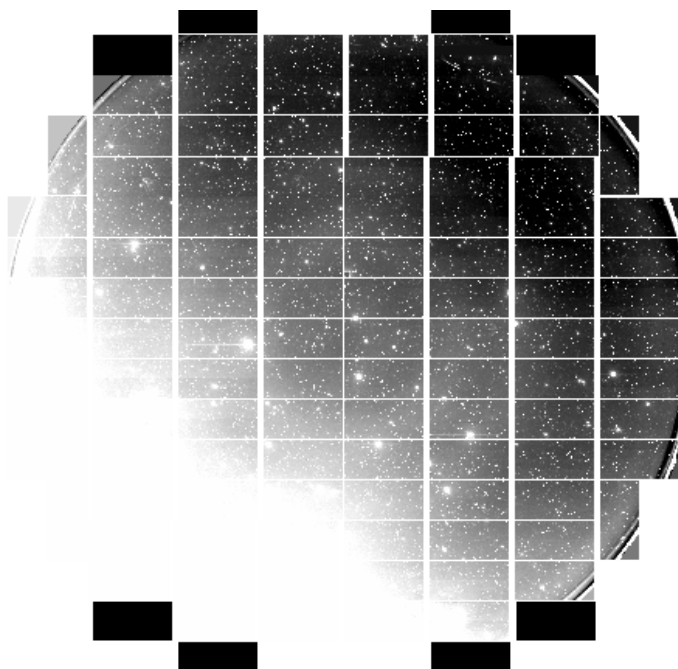
$z \sim 0.975-0.98$

Throughput except filter
is mostly verified.

- Need to verify the actual throughput using the real filter in the future
- There is no Y on the SH filter

Dome Flat

Global slope seen (on all g,r,i)



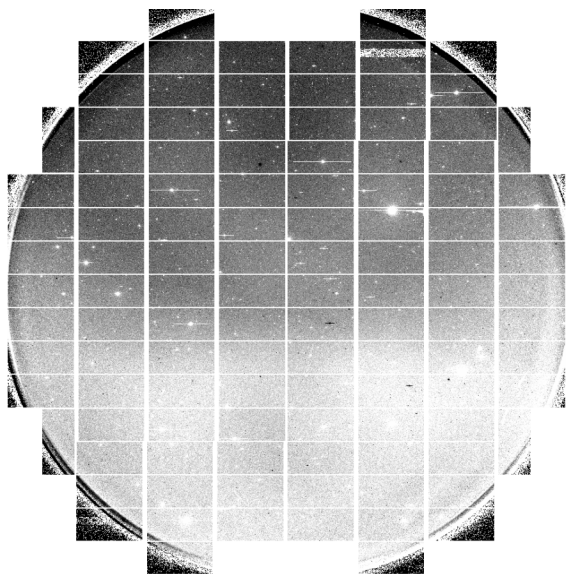
Reached up to 20 %

This dome flat
cannot be
used for
calibration.

IR-Rear lamp dying... Non uniform
illumination pattern coupled with HSC
vignetting caused the slope
Single light source preferred.

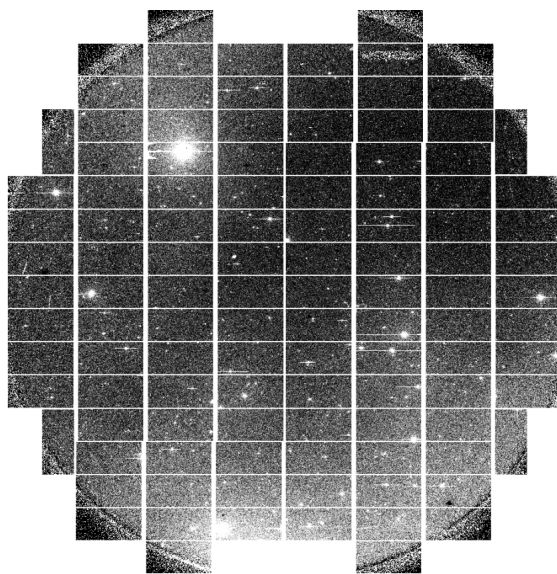
Stray Light

Ring: $\sim 1.5 \text{ e/s}$



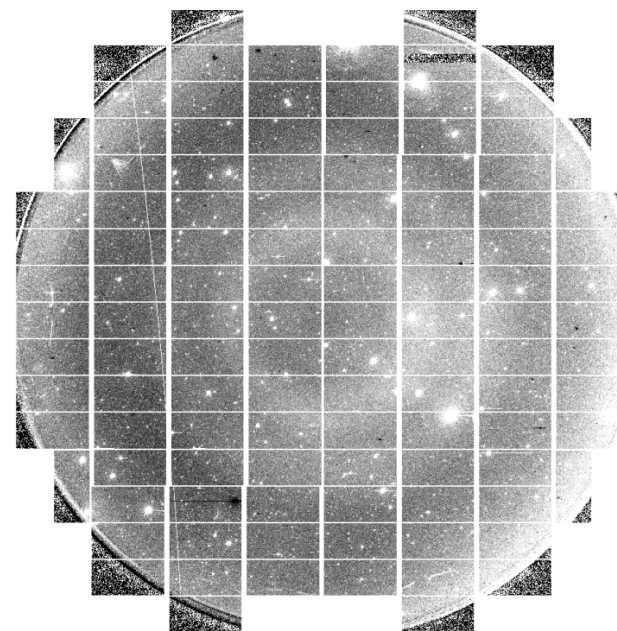
$g (5 \sim 6 \%)$

$\text{TW}(T=180)/\text{TW}(T=8)$



$r (2 \%)$

$\text{TW}(T=150)/\text{TW}(T=5)$



$i (\sim 2 \%)$

$\text{TW}(T=120)/\text{TW}(T=8)$

These are apparently not aperture ghost
but stray light.

Stray Light

- Ring structure analysis from the twilight

imnno5 (HSC20130325_KawagomotoS_FlatShape.pdf)

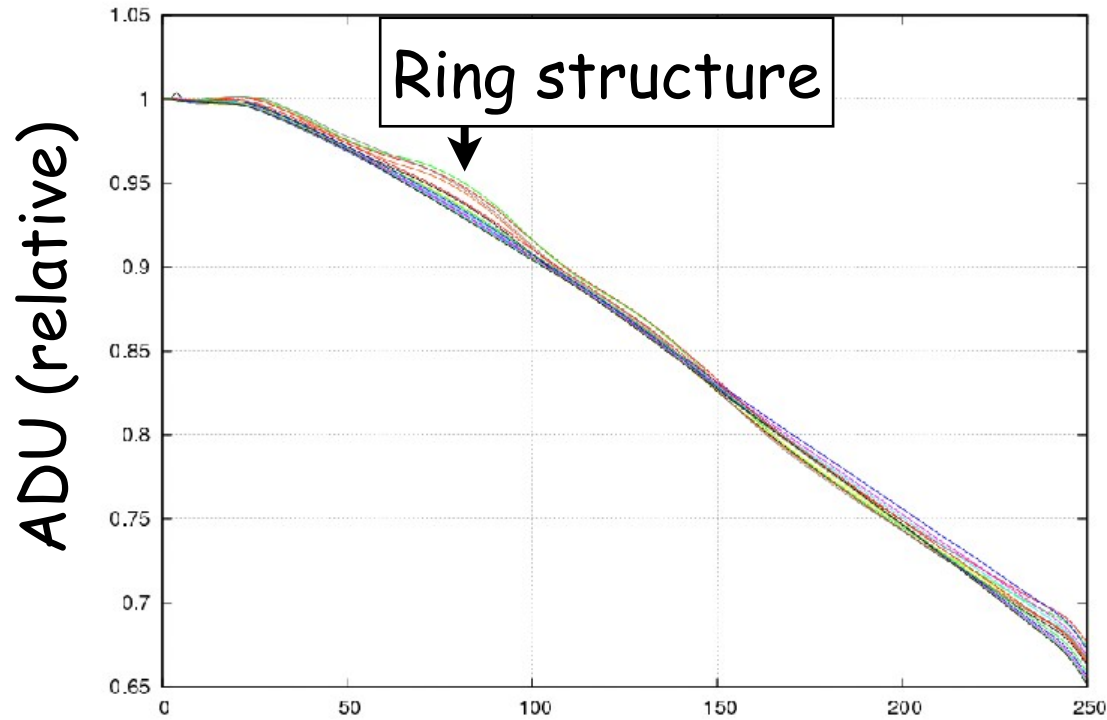


図 9: 16 ショット分のフラット形状データ。横軸は半径、縦軸は相対強度。

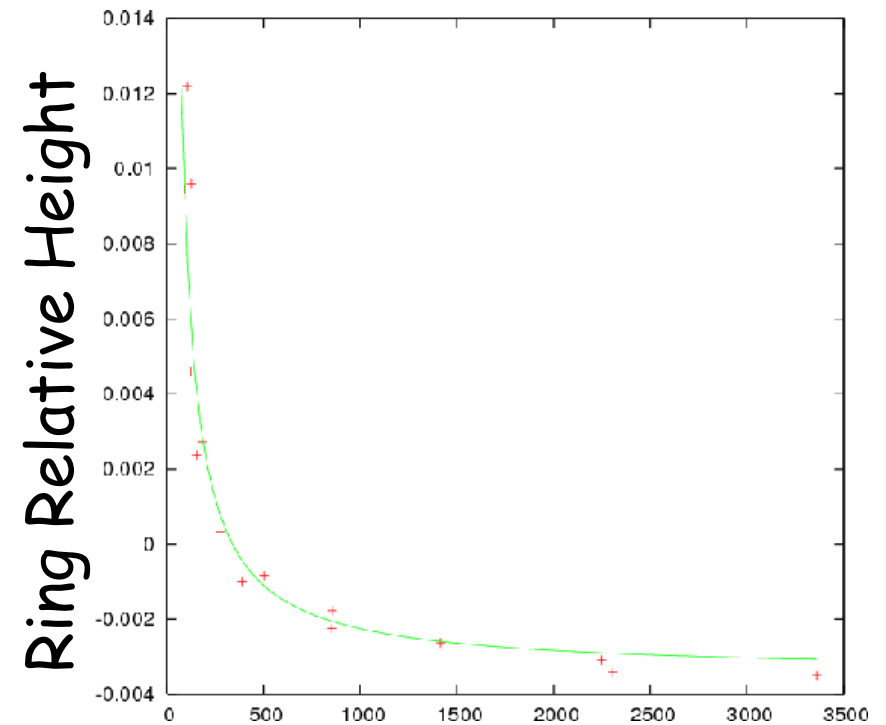


図 10: $r=80\text{mm}$ の構造の高さとスカイの明るさの関係

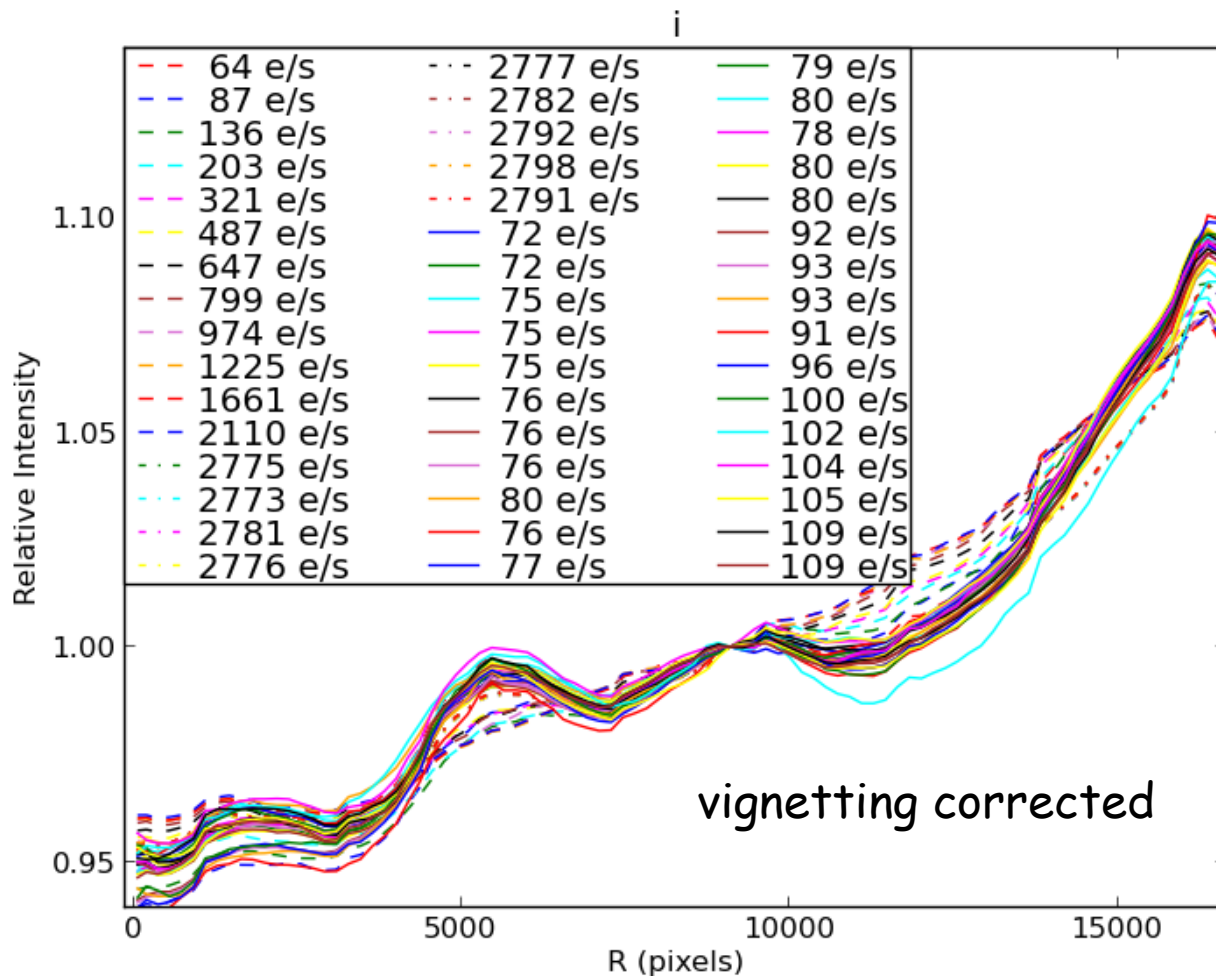
distance from the center

sky brightness (ADU/sec)

Suggest the existence of the light source somewhere

Not a simple scattered light caused by sky

- Similar Analysis by Princeton (RHL hsc_report_november.pdf)



long dash: twilight
dash-dot: dome
straight: science
dome is somewhere
between twilight
and science
although the
brightness is
highest ... Weird

迷光・散乱光

- バンドによって異なる
- リング構造はスカイレベルに反比例して目立つようになる([science/twilight](#))。ただし、**Dome**ではこの関係が成り立たないことが分かった。

Scattered Light Analysis

Unpainted parts inside the lens barrel can be the light source ?

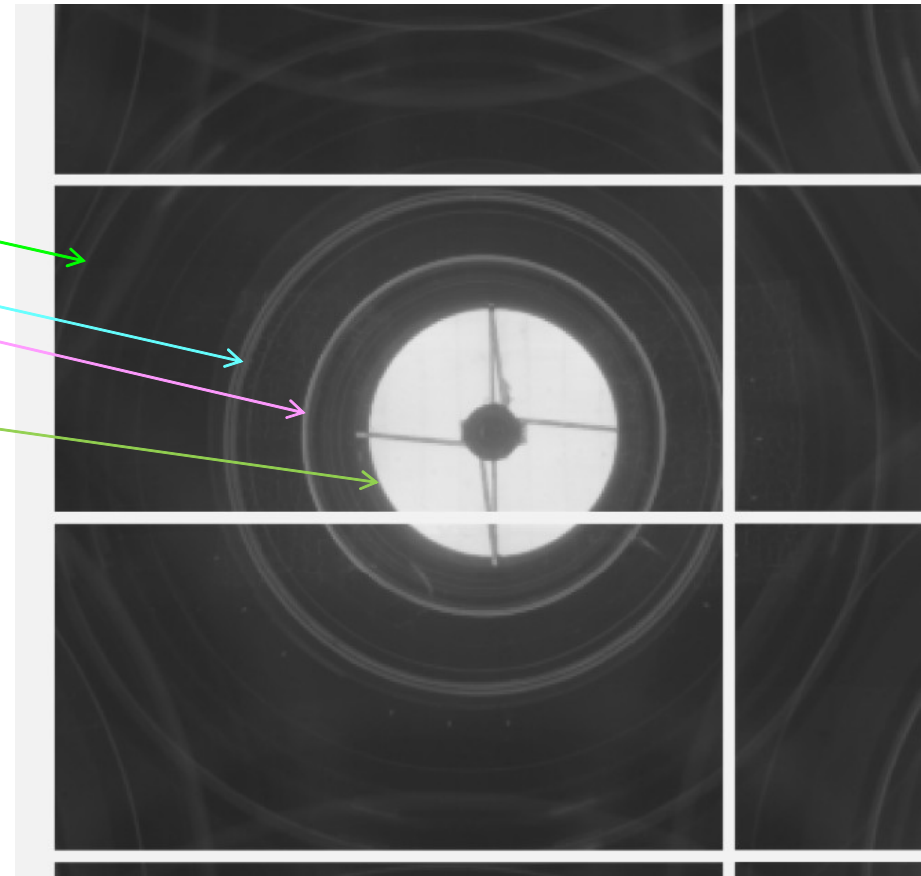
	直径(mm)	CCD面上像直径 (中心光線の計算値)	CCD面上像直径 (Centerピンホール 画像で定規で計測)
G5R2外周エッジ	661.0	149.96	
G4R2外周エッジ	674.0	132.34	
G3R2外周エッジ	616.0	82.38	
G3R1外周エッジ	616.0	75.26	76.9
ADC2R2外周エッジ	636.0	49.18	
ADC1R2研磨面エッジ	618.0	46.30	47.5
G2R2研磨面エッジ	609.3	33.06	33.1
G1R2研磨面エッジ	821.3	25.06	
フード内端	900.0	24.32	
主鏡外端	8300.0	23.26	23.1

④

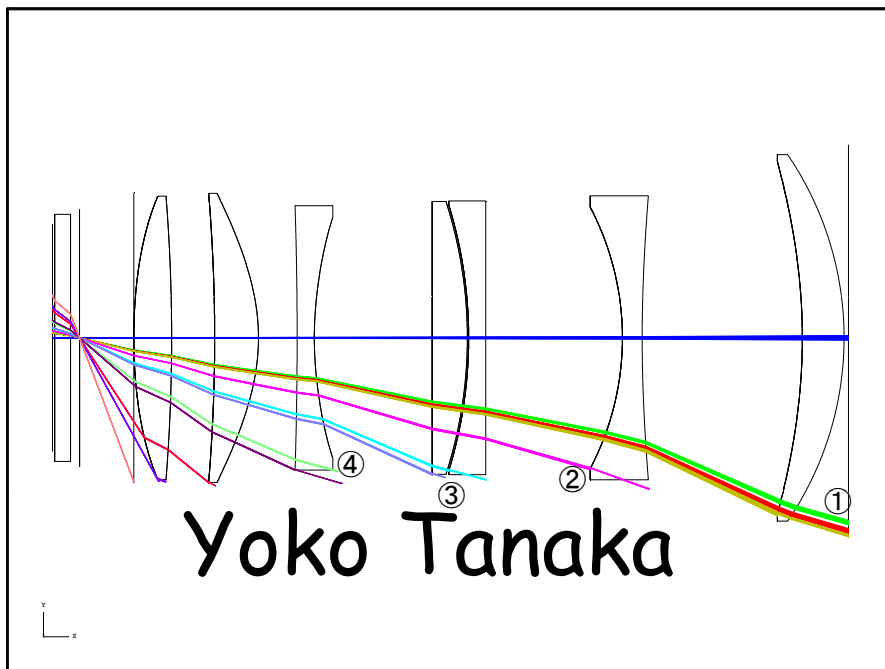
③

②

①

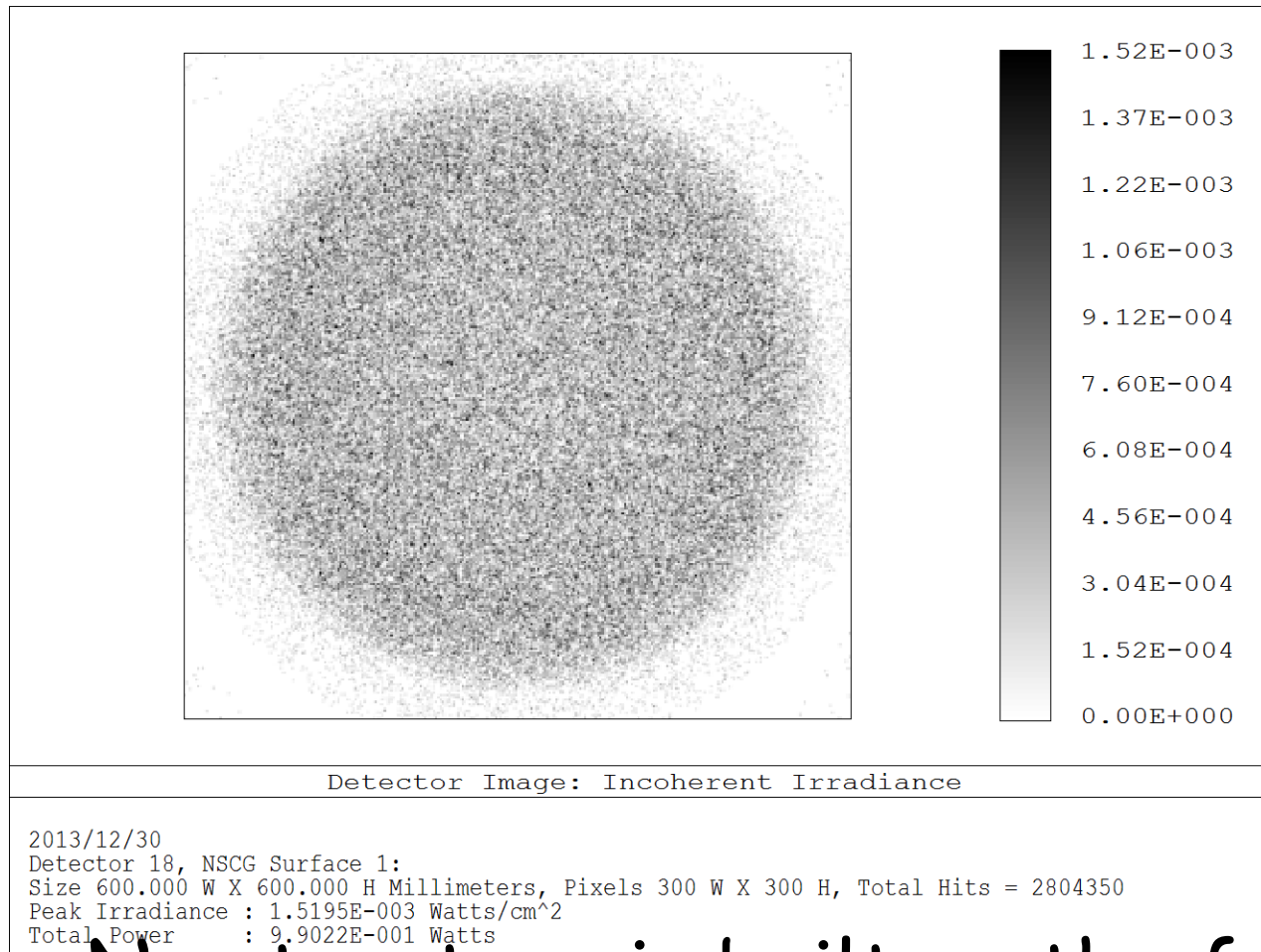


Pin hole image



Yoko Tanaka

Result of the scattered Light

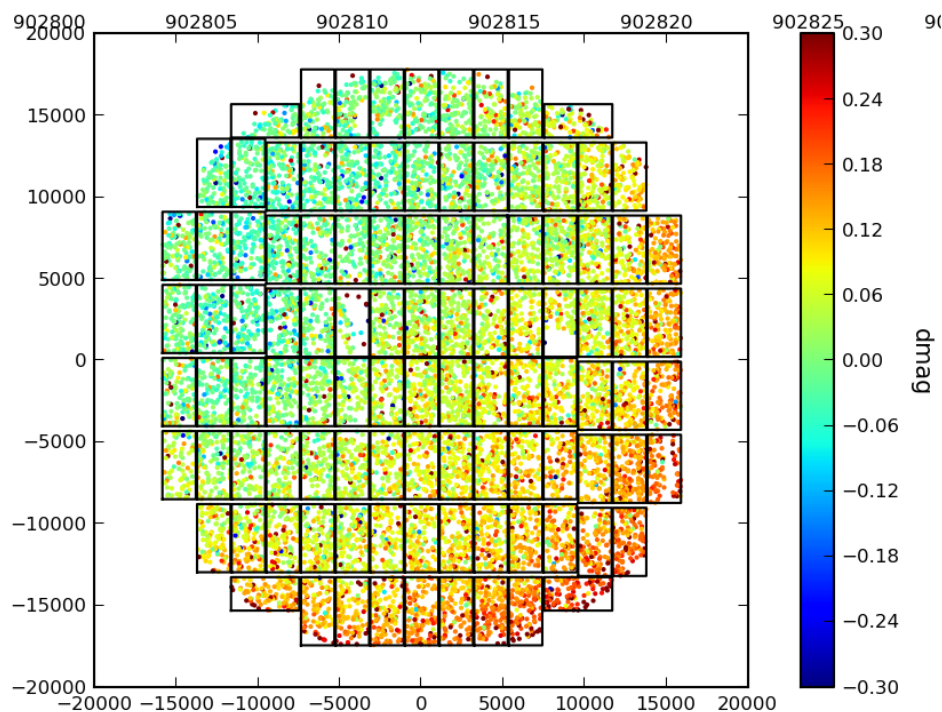


No structure is built on the focal
plane

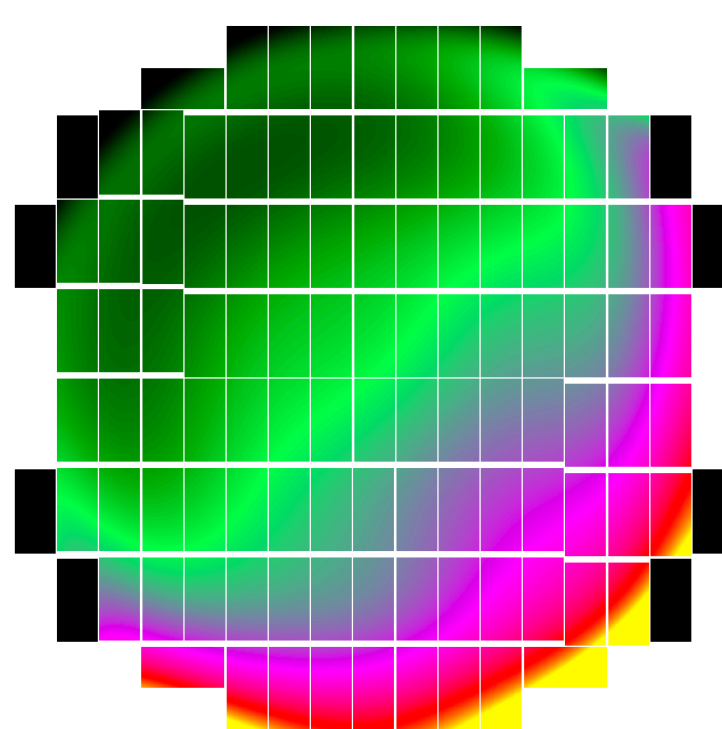
We would include telescope structure
(baffle, Center section)

Photometric Calibration

- Using stars observed at many different location on the dithered exposures (Sort of 'Uber-Calibration')



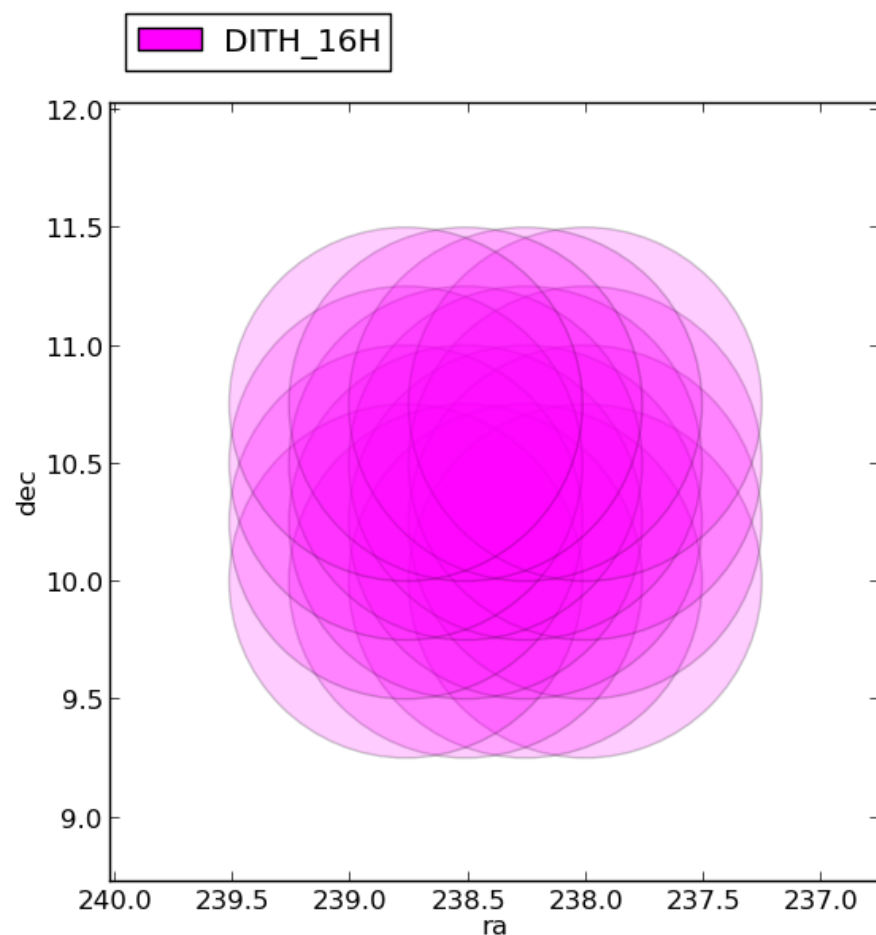
measured



model

~ 2 % error already achieved in every band

- Dithered Pattern



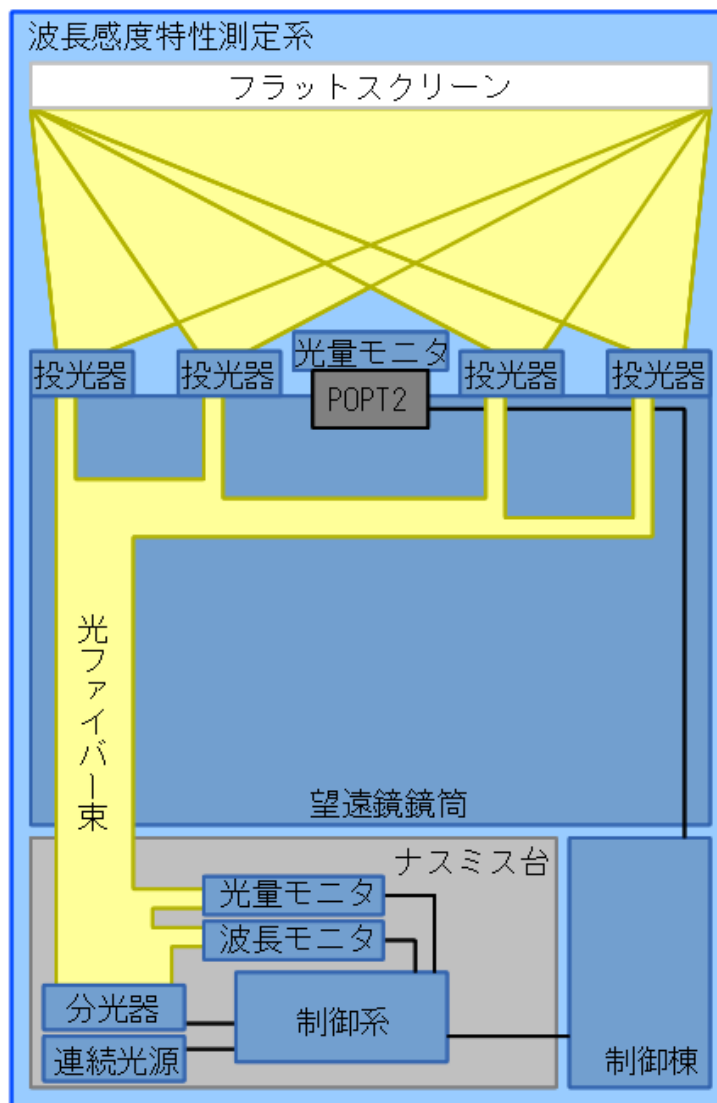
Offsets of 0, 15, 30, 45 arcmin
4 x 4

Stray/Scattered Light

- Will not be a critical show stopper for SSP program where large dithered pattern are used and the object size is smaller than the spacial variation.
- But HSC is also used for general purpose. We are making every effort to understand the phenomena.
- Scattered light analysis continues.

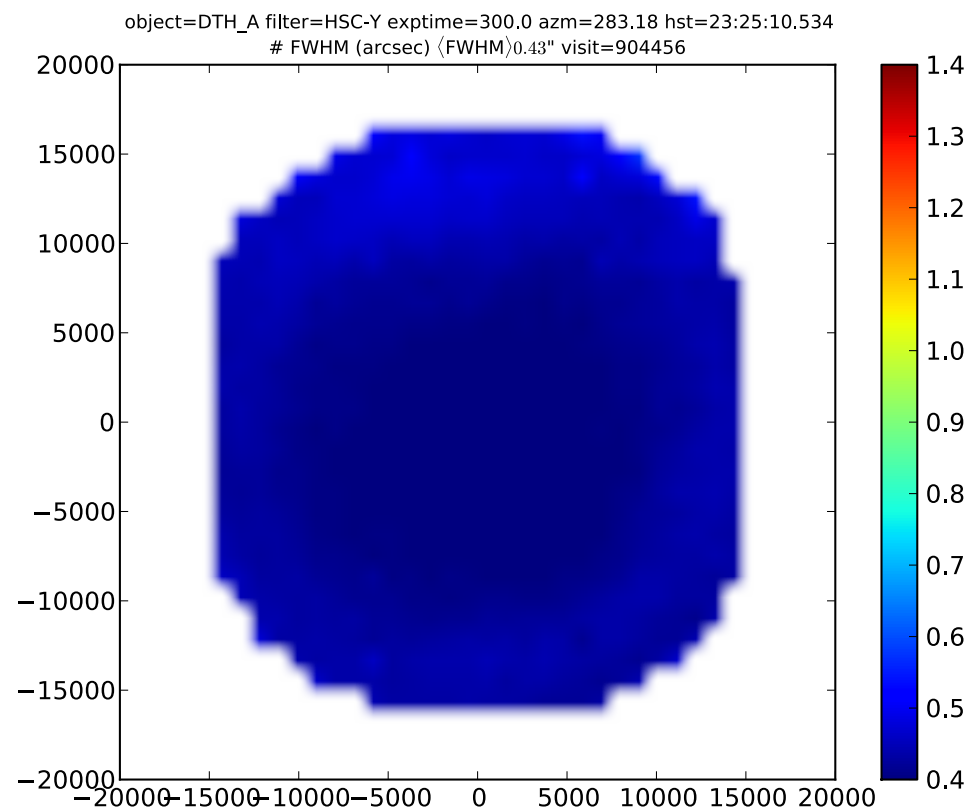
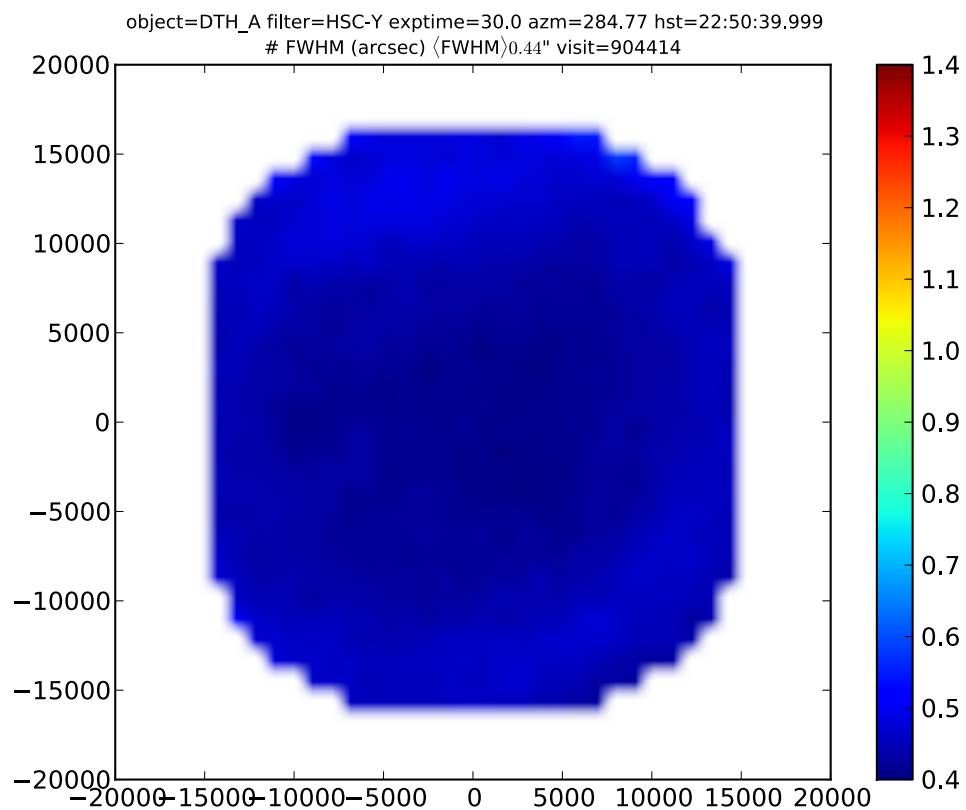
New Dome flat & Calibrator

- Will be implemented by late 2014





HSC Best Seeing Record



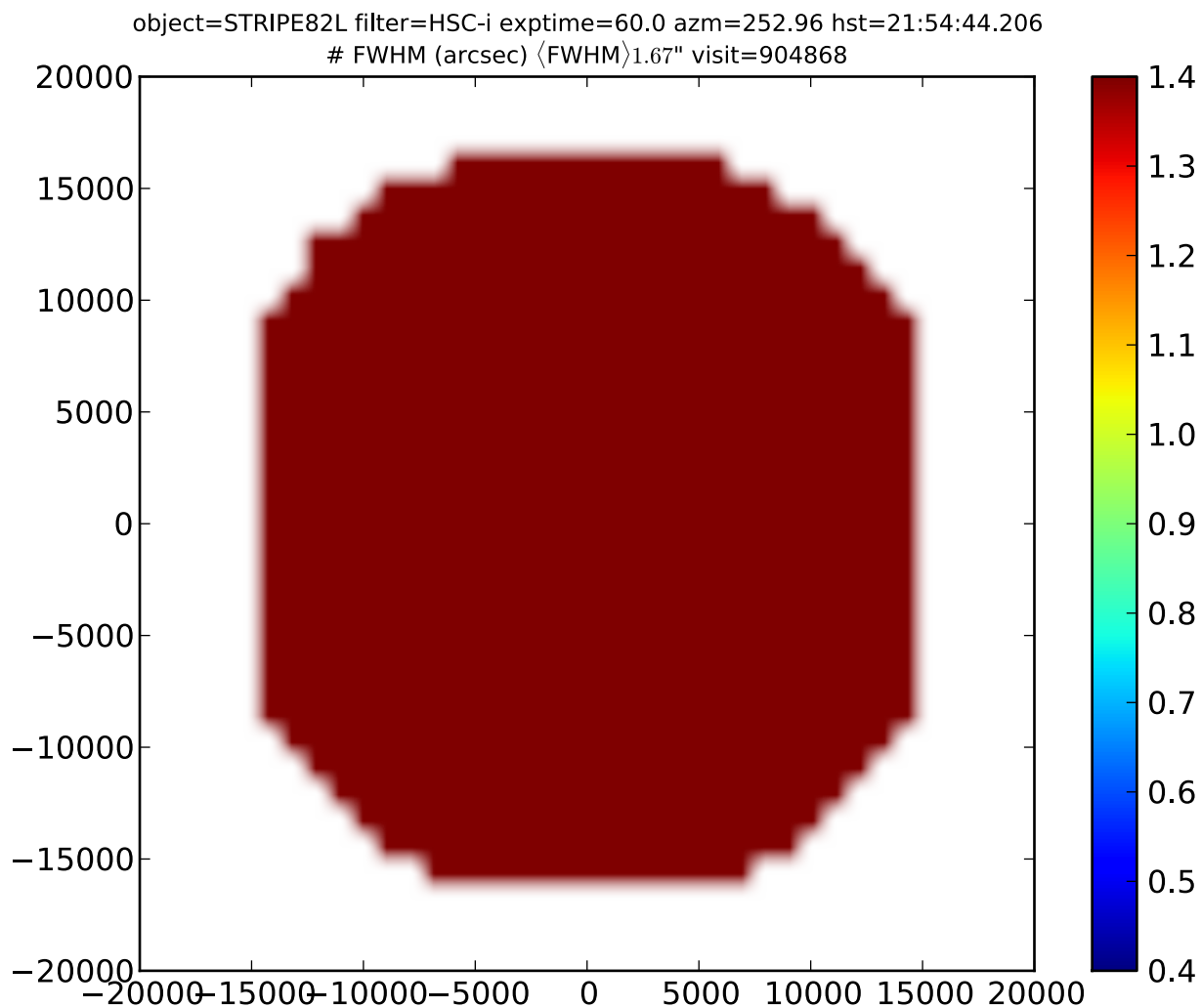
←→ 1.5 deg

Nov. 2 2013 22:49
object059
EL=70
Texp = 30
 $\langle \text{FWHM} \rangle \sim 0''.42$
Y-band

Nov. 2 2013 23:25
object081
EL=62
Texp = 300 (no guide)
 $\langle \text{FWHM} \rangle \sim 0''.43$
Y-band



Natural Seeing Limited



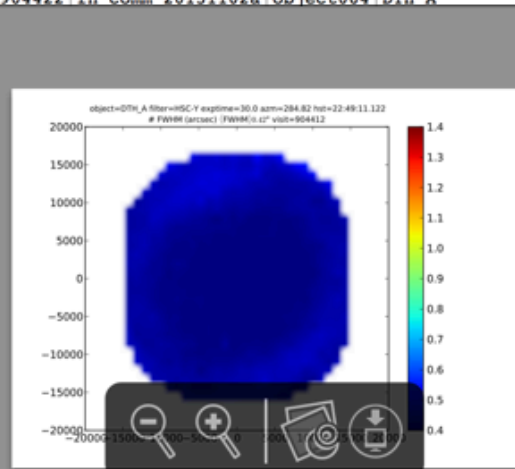
共同利用者向け情報

- 山頂では、**Suprime-Cam**とほぼ同じように観測を遂行できる。
- **SSP**用に用意された**DM software**を使った解析結果はスタック画像・カタログ共に観測者に提供される予定。将来的には観測中に観測者が解析するのが基本。ただし、保証できる誤差は大きい(評価中)
- **DM software**は提供予定なので、**Home institute**でパラメーターを変えながら**try and error**をしてもらう。

On Line Data Evaluation

- by Hilo On Site PC Cluster System

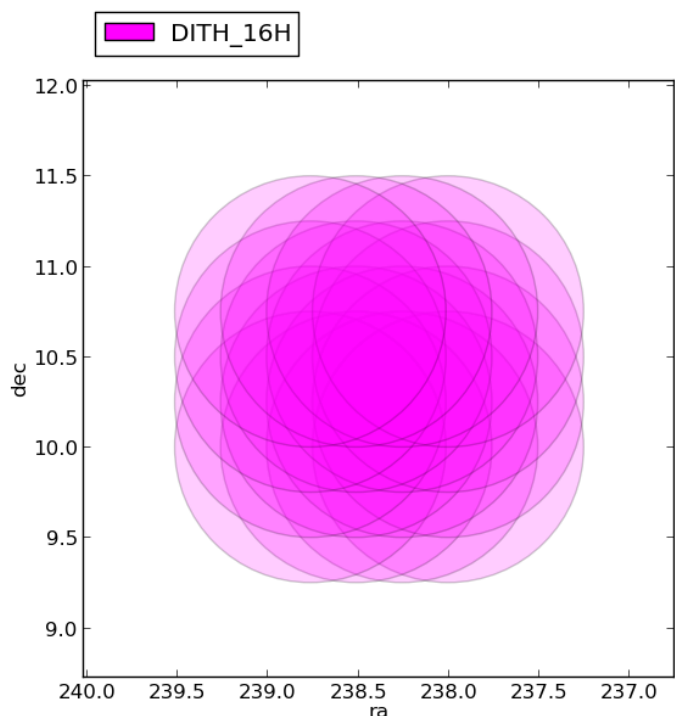
904450	fh_comm_20131102a	object078	DTH_A	HSC-Y	23:16:09.225	30	65.0023874	94.53958	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904448	fh_comm_20131102a	object077	DTH_A	HSC-Y	23:14:44.702	30	65.07542111	94.5848	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904446	fh_comm_20131102a	object076	DTH_A	HSC-Y	23:13:19.168	30	65.1522577	94.632663	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904444	fh_comm_20131102a	object075	DTH_A	HSC-Y	23:11:49.437	30	65.29506554	94.722065	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904442	fh_comm_20131102a	object074	DTH_A	HSC-Y	23:10:29.540	30	65.549148	94.88267	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904440	fh_comm_20131102a	object073	DTH_A	HSC-Y	23:09:01.703	30	66.64941881	95.012293	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904438	fh_comm_20131102a	object072	DTH_A	HSC-Y	23:07:42.122	30	66.70389096	95.047709	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904436	fh_comm_20131102a	object071	DTH_A	HSC-Y	23:06:13.082	30	66.79490479	95.10685	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904434	fh_comm_20131102a	object070	DTH_A	HSC-Y	23:04:47.328	30	66.92229954	95.190177	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2 # row2 2nd pointing		
904432	fh_comm_20131102a	object069	DTH_A	HSC-Y	23:03:19.202	30	67.2300461	94.786558	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2 # (0,0)		
904430	fh_comm_20131102a	object068	DTH_A	HSC-Y	23:01:53.888	30	67.53238394	95.598073	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2 # row2 1st pointing		
904428	fh_comm_20131102a	object067	DTH_A	HSC-Y	23:00:27.356	30	68.62737347	95.846145	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904426	fh_comm_20131102a	object066	DTH_A	HSC-Y	22:59:03.156	30	68.69896036	95.896247	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904424	fh_comm_20131102a	object065	DTH_A	HSC-Y	22:57:46.765	30	68.74161594	95.926613	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
904422	fh_comm_20131102a	object064	DTH_A	HSC-Y	22:56:14.924	30	68.89225591	96.033696	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
				HSC-Y	22:54:46.562	30	69.17899352	96.240211	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
				HSC-Y	22:53:16.425	30	70.2723241	96.923756	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
				HSC-Y	22:51:57.930	30	70.32252737	96.962935	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
				HSC-Y	22:50:39.951	30	70.37082123	97.0007	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2		
				HSC-Y	22:49:11.094	30	70.50978063	97.110328	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2 <FWHM> = 0''.42		
				HSC-Y	22:47:51.708	30	70.76178511	97.311718	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	H2 I skipping the final 5 shots of H2		
				TIVE	22:44:38.053	10	71.49830985	97.894267	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	Z_best = 3.70 - 0.10		
				TIVE	22:43:35.343	10	71.73608437	98.099677	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	Z_best = 3.70 + 0.10		
				HSC-Y	22:42:25.702	10	71.99987874	98.331885	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	Z_best = 3.70 + 0.00 <FWHM> = 0''.44 !!! Also for J		
				HSC-Y	22:39:55.997	10	72.56668419	98.849669	0.000	tile	ellip (*)	[#]	fwhm	[#]	header	QA	change field to DTH A Z_best = 3.70		



2-3分で評価完了・表示 ログとして活用

Photometric Error

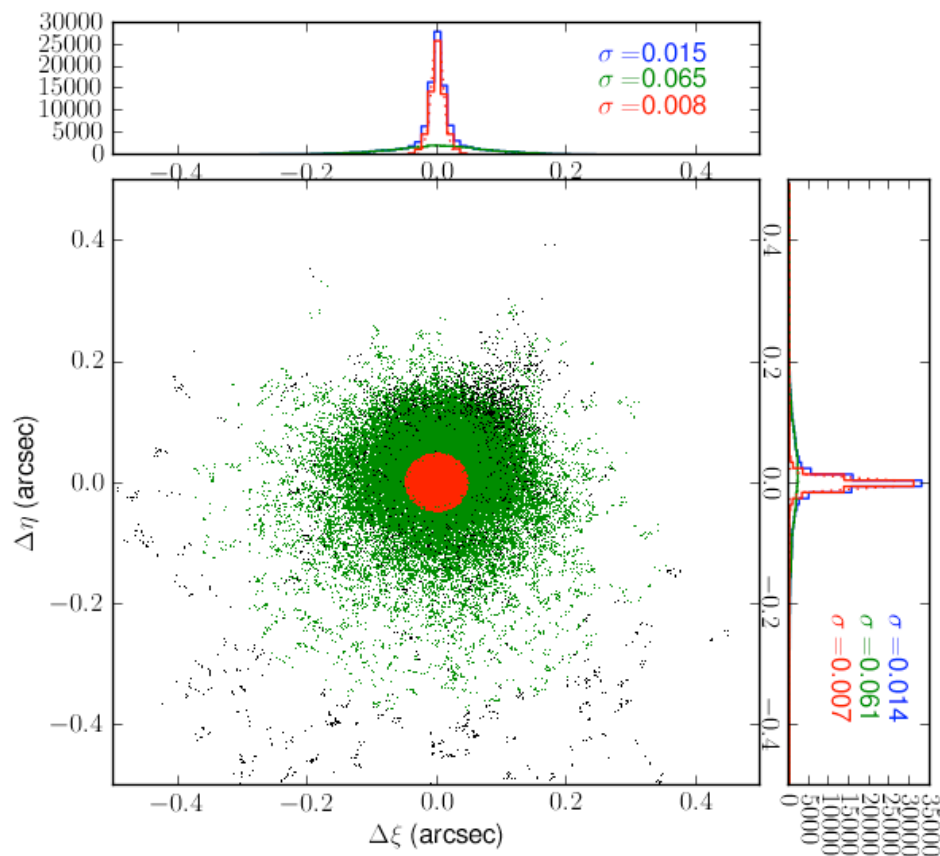
- SSP Wideの様な大きなDither patternで
SDSSデータがある領域を観測すると、 g : 3 %
 r, i : 2 %程度の誤差におさまる（実績値）



- より小さいDither
patternでの誤差は次
回エンジニアリングで
評価予定

Astrometric Error

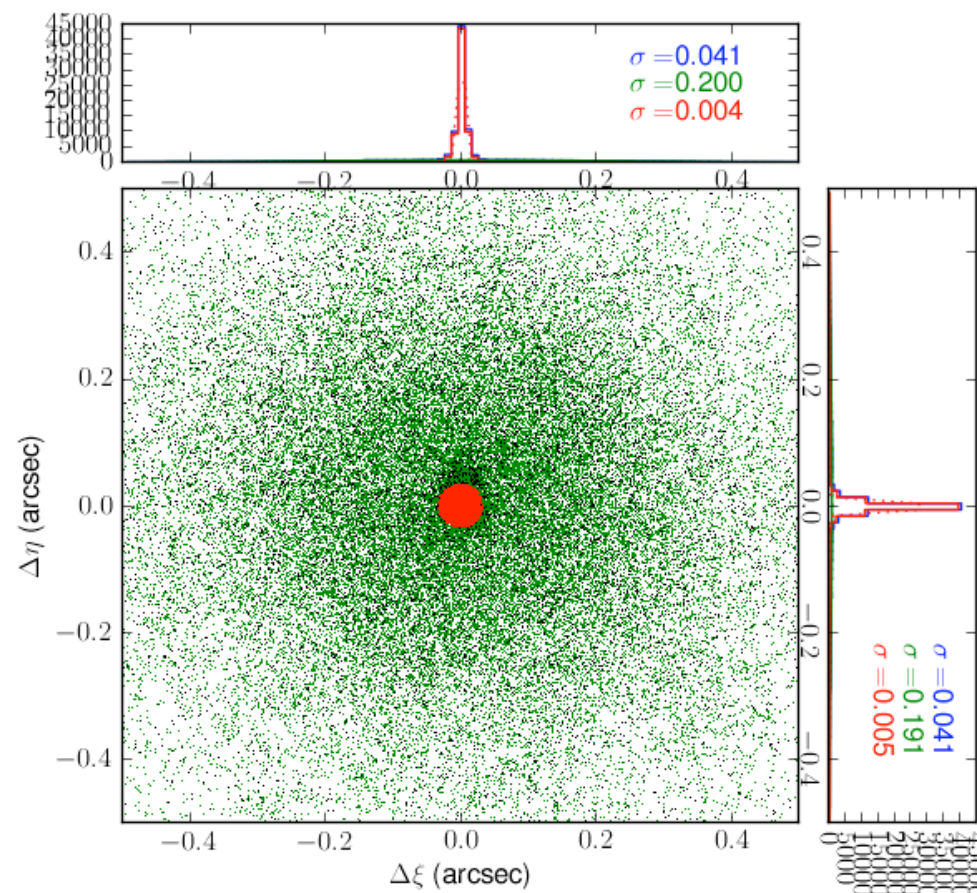
SDSS Field



Internal: 7 mas

X External: 61 mas

non-SDSS Field



2MASSを使用

どちらも問題なさそう

- **SC**が退役する**S16A**までに、共同利用者にコミットできる項目を増やしたい
- **SDSS Field**外での等級誤差
- 大きく広がった天体の解析
- 共同利用者が観測後に受け取るデータと解析ツール
- 解析のサポート

- Narrow Band Filter
 - まだ一枚も空を見ていない 1月末の観測で NB921を試験したい
- S14Bの夜数制限
 - Suprime-Camとの交代になるので、二ヶ月に1回

まとめ

- カメラのハードは安定運用に耐えうるものに仕上がりがつつある。
- データ解析も SDSS Field に関しては、**Robust**に行うことができるようになってきた。
- SDSS 外、小さい dithering pattern の場合のデータ精度については、次の試験観測データで評価(迷光、散乱光りの影響)
- 新ドームフラット (Efficiency monitor つき) を来年度設置したい

人員募集中

- SSPの観測を実施する (ハワイ)
- SSPのデータ解析 (三鷹)
- 興味のある方は 内**3871** 宮崎まで

