

CHORUS. I.

Cosmic HydrOgen Reionization Unveiled with Subaru:  
Overview

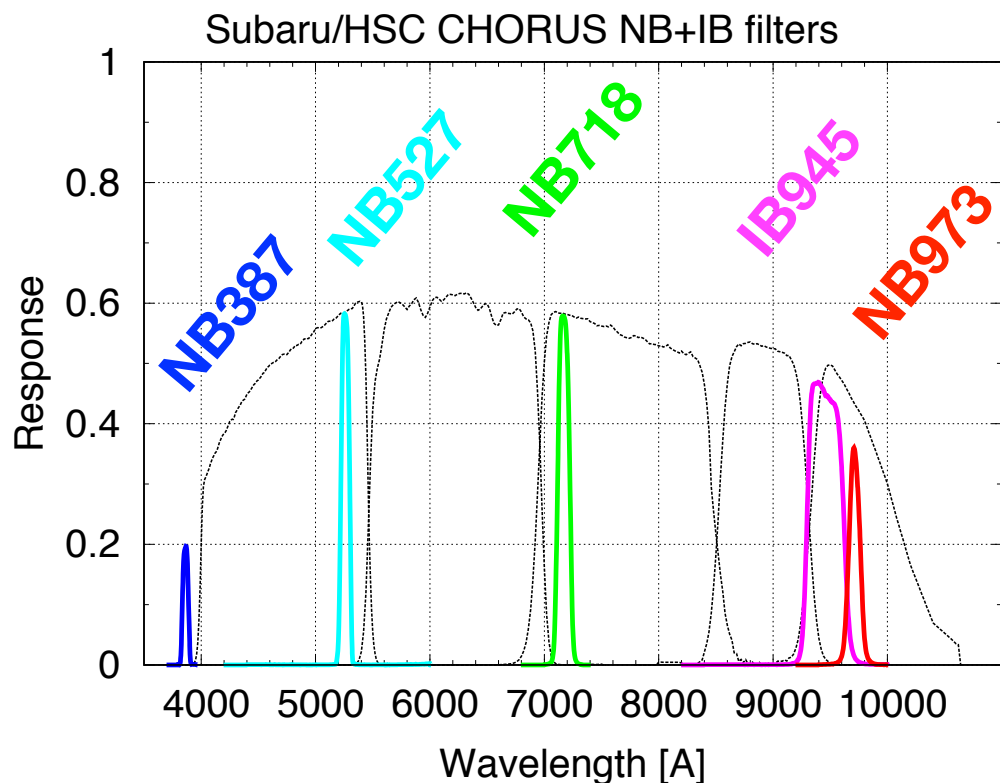
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山中郷史 (早稲田大学)

井上昭雄 (PI; 早稲田大学), CHORUS members, HSC collaborators  
On behalf of CHORUS project (HSC project 147)

# CHORUS

Cosmic HydrOgen Reionization Unveiled with Subaru  
(PI: Akio K. Inoue)



- ✓ 宇宙再電離の解明を目指した  
HSC プロジェクト (HSC project 147)
- ✓ 5フィルターによる撮像サーベイ
  - 4 Narrow-band (NB) filters  
( NB387, NB527, NB718, NB973 )
  - 1 Intermediate-band (IB) filter  
( IB945 )
- ✓ ターゲットは COSMOS 領域

## Publication list

- [1] CHORUS. I. Cosmic HydrOgen Reionization Unveiled with Subaru: Overview,  
by [Akio, K. Inoue, S.Y., et al. submitted to PASJ](#)
- [2] CHORUS. II. Subaru/HSC Determination of the Ly $\alpha$  Luminosity Function at  $z = 7.0$ : Constraints on  
Cosmic Reionization Model Parameter, by [Itoh et al. 2018, ApJ, 867, 46](#)
- [3] CHORUS. III. Photometric and Spectroscopic Properties of Ly $\alpha$  Blobs at  $z = 4.9-7.0$ ,  
by [Zhang et al. 2020, ApJ, 891, 177](#)

# CHORUS Public Data Release (PDR) 1

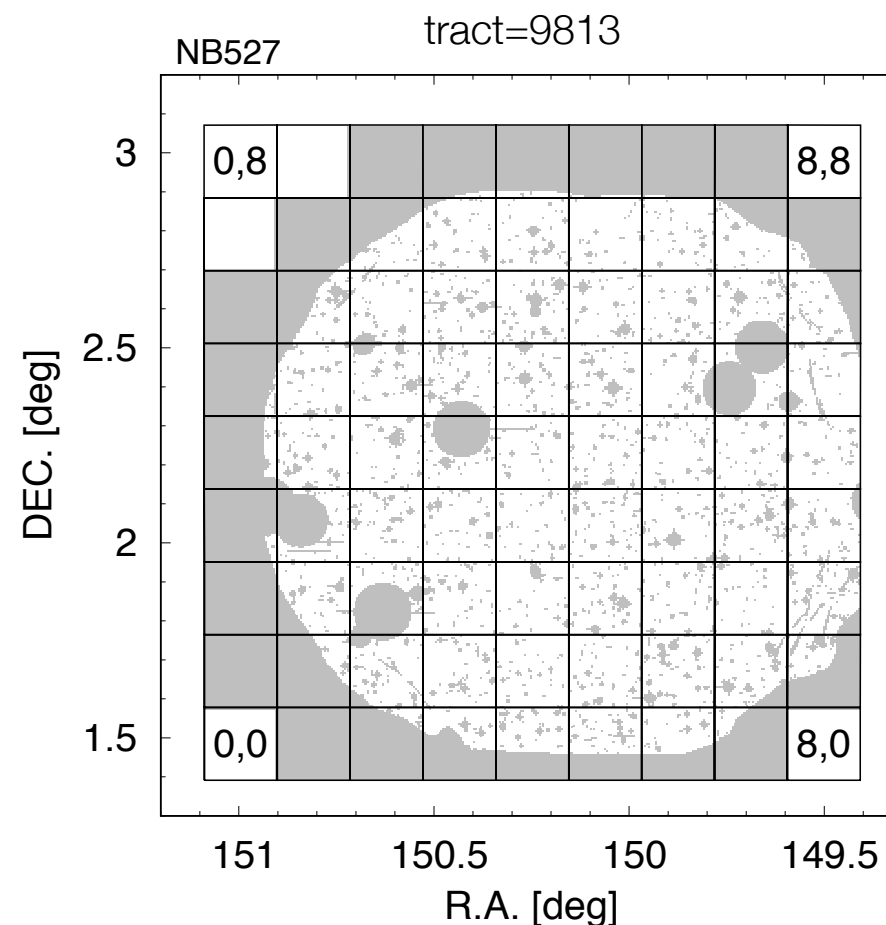
## CHORUS 観測情報まとめ

Filters	Exposure [h]	観測日	PSF FWHM	限界等級 [ $5\sigma$ , $1.5''\phi$ ]
NB387	17.3	Jan. 17, 18, 19 (2018)	0.99"	26.07* <sup>1</sup>
NB527	8.9	Dec. 16, 17, 18 (2017) Mar. 15, 16, 18 (2018)	0.82"	26.87
NB718	7.7	Feb. 25, Mar. 23, 25 (2017)	0.68"	26.47
IB945	10.2	Dec. 1, 2, 3, 12 (2018)	0.61"	25.92
NB973	14.7	Jan. 26, 28 (2017)	0.64"	25.37

\*1 : NB387 のゼロ点 offset (-0.45 mag) を補正した後の数字

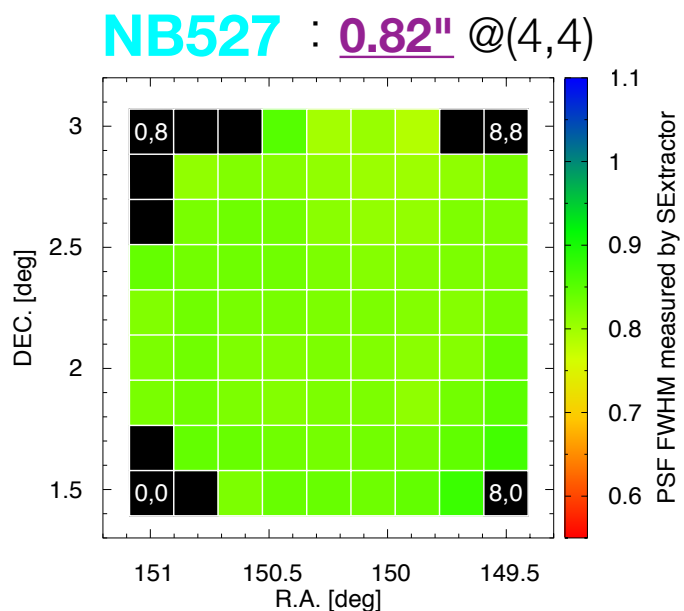
# CHORUS Public Data Release (PDR) 1

- ✓ 観測は COSMOS 領域
  - SSP の Ultra-deep と重複 (tract=9813)
- ✓ データ解析は hscPipe version 6.7
  - PDR1 データは SSP チームに行なっていた
- ✓ PDR1 は内部に向けて公開済み
  - 論文出版と同時に public となる予定
- ✓ "CHORUS Official Mask" を作成
  - 目で見て作成し FITS 画像を公開

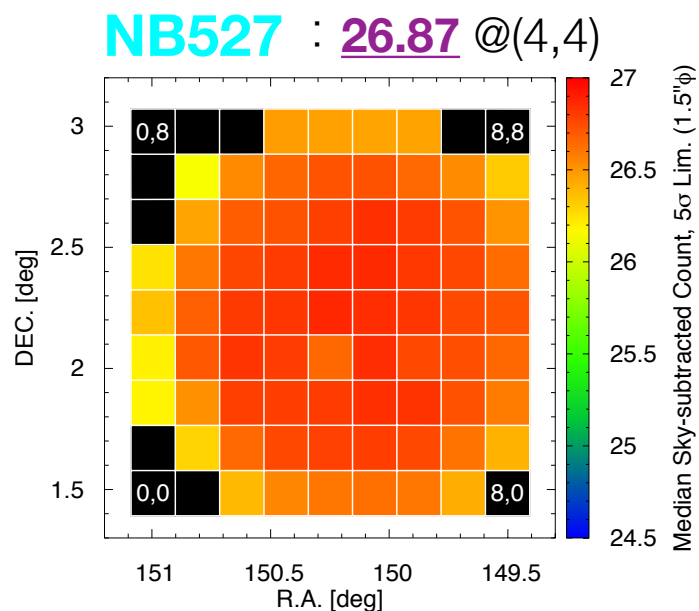


Ex.) NB527 マスク画像

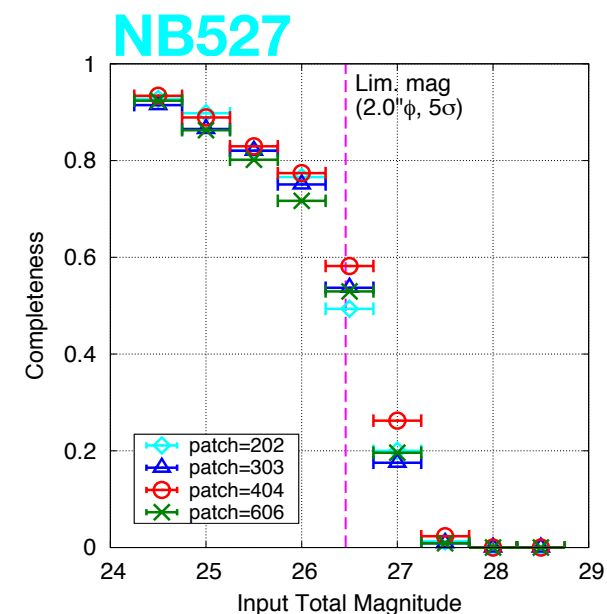
# CHORUS PDR1 のデータチェック



**PSF  
FWHM**



**限界等級**

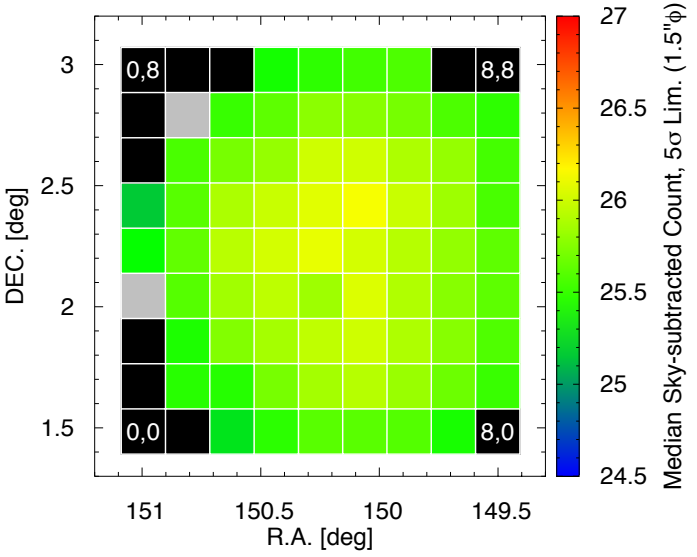


**Detection  
Completeness**

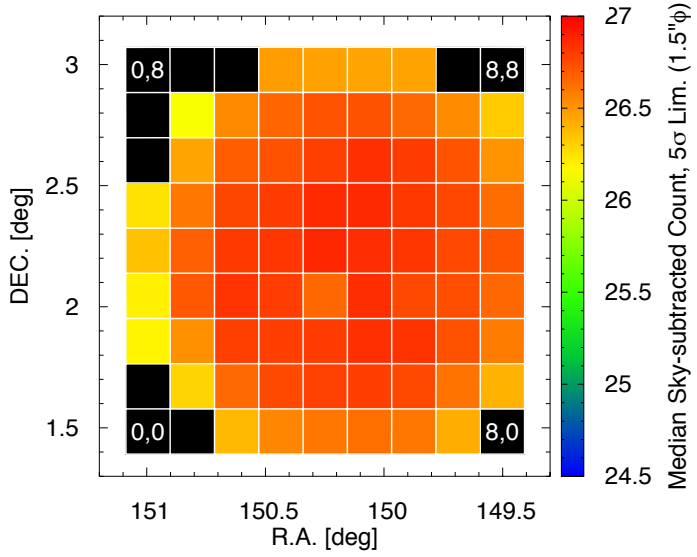
- ✓ 各フィルターごとに各patch or 選択した patch ごとに見積もり
- ✓ 非常に質の高いデータが得られたことを確認
- ✓ 詳細は Inoue, SY, et al.2020 submitted to PASJ に記載

# Data quality - Limiting mag. ( $5\sigma, 1.5''\phi$ ) -

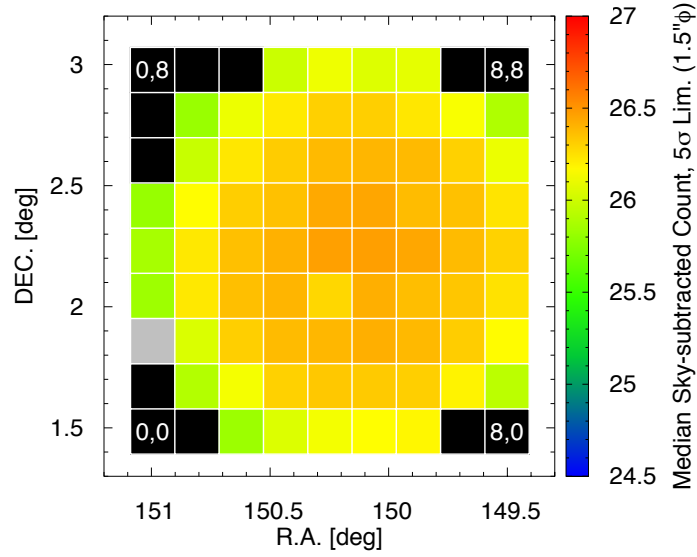
**NB387** : 26.07 @ (4,4)



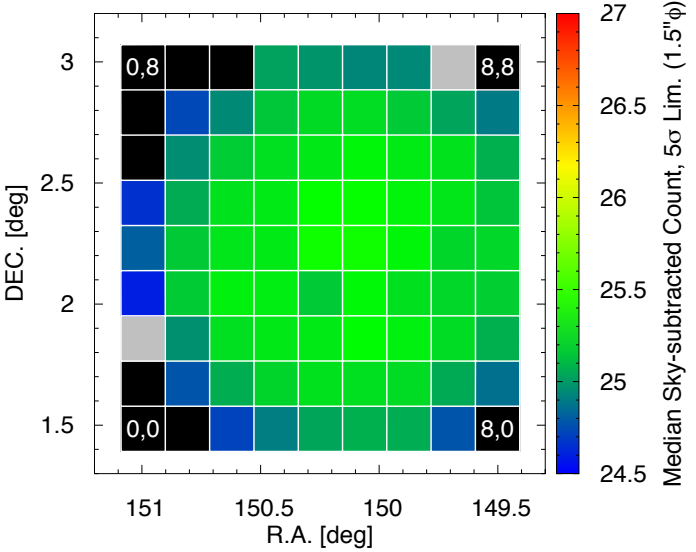
**NB527** : 26.87 @ (4,4)



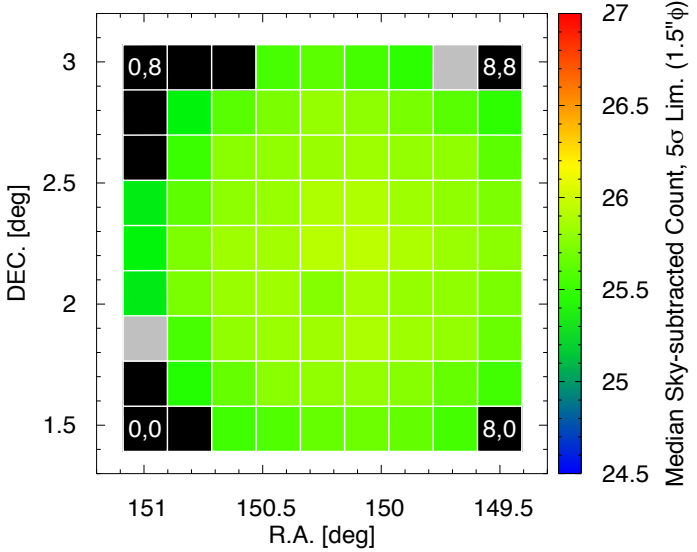
**NB718** : 26.47 @ (4,4)



**NB973** : 25.37 @ (4,4)



**IB945** : 25.92 @ (4,4)



# 天体の個数密度

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## 1. CHORUS PDR1 NB/IB 検出カタログを用意

- SSP Catalog Archive Server (CAS) からダウンロード

*nchild = 0*

*detect\_ispatchinner IS True*

*merge\_peak\_{n387|n527|n718|n973|i945} IS True*

*{n387|n527|n718|n973|i945}\_pixelflags\_saturatedcenter IS False*

*{n387|n527|n718|n973|i945}\_pixelflags\_bright\_object IS False*

## 2. CHORUS Official Mask を用いて天体の取捨選択

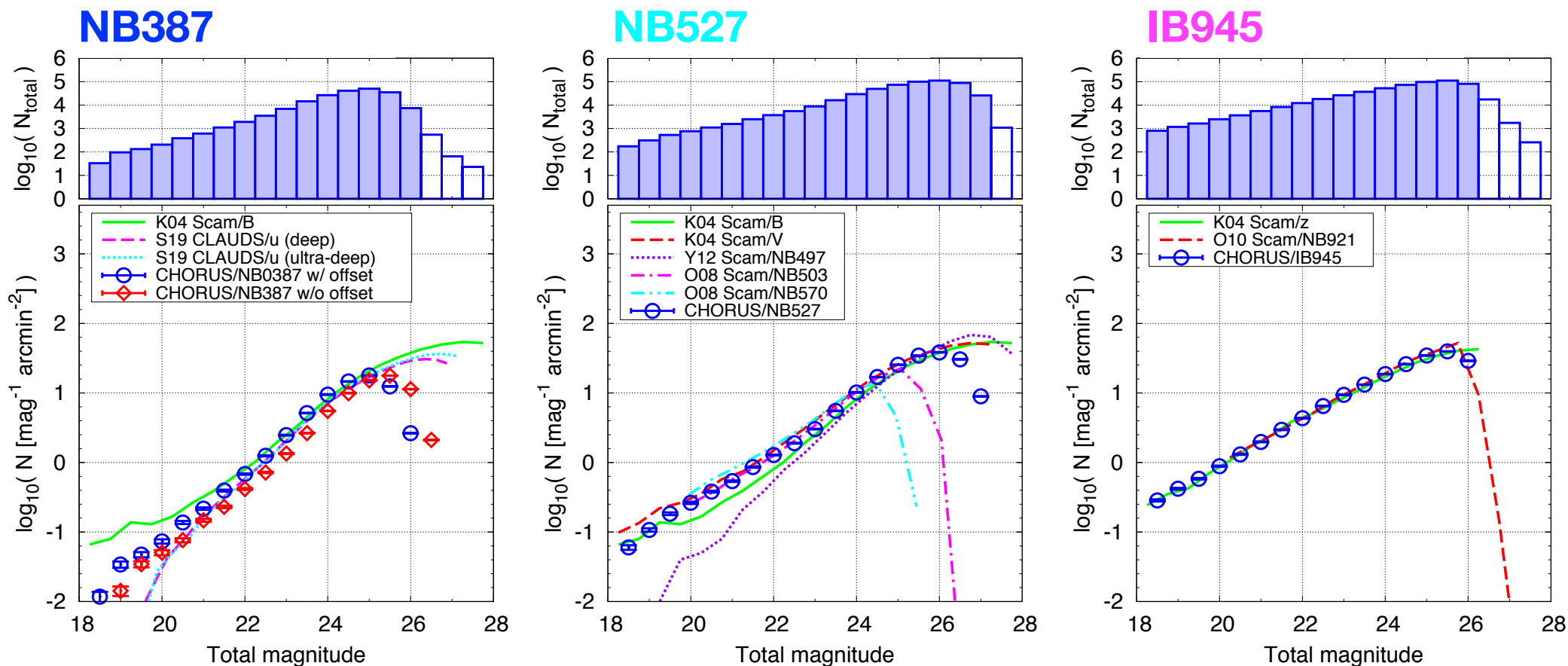
- マスクされた領域の天体を除外
- 有効面積の計算 (CHORUS mask + hscPipe flags)

## 3. 天体個数を各等級ごとに数え、有効面積で割って個数密度を計算

- 以下の先行研究と比較

Kashikawa et al.2004 (K04); Ouchi et al. 2008 (O08), 2010 (O10);  
Yamada et al. 2012 (Y12); Sawicki et al.2019 (S19)

# 天体の個数密度



- ✓ 天体の個数密度は先行研究と非常によく一致し、カタログの検出/測光は妥当であると思われる
- ✓ NB387 のゼロ点 offset 値も適切に見える



# データ公開について

## Additional Products

In addition to the pipeline products, we also provide a collection of public spectroscopic redshifts, random points, and the bright star masks in our database. Photometric redshifts are not yet available and will be released in the future.

### Bright Star Masks (Updated!)

Objects around bright stars likely have bad photometry and these objects are flagged during the processing. Although this is a useful database flag, the size of the current mask is known to be too small and some stars are missing the mask. Refer to the [Known Problem](#) page details.

**Incremental Release 1:** revised masks are now available at the database!

### Random Points

For clustering analysis, a set of random points across the survey area will be useful. Such a collection of random points can be found in the database.

### Emission-line Object Catalog

**Incremental Release 3:** The Deep and UltraDeep fields are observed in a few narrow-band filters in addition to the broad-band filters. These narrow-band filters allow us to detect emission line objects at some specific redshifts and the emission-line object catalog from Hayashi et al. 2020 is now publicly available.

## COSMOS stacks

The COSMOS field is one of the key extragalactic fields and is a valuable calibration field. Using subsample of the UltraDeep COSMOS data, we have generated three sets of Wide-depth stacks at 25, 50, and 75th percentile seeing for each band in the Wide layer. These

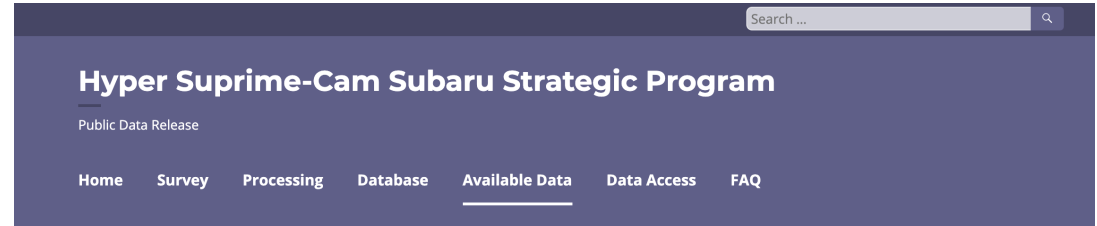
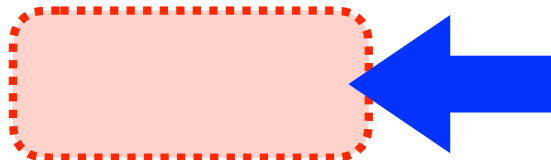
### Public Spectroscopic Redshifts

Partly for the purpose of photo-z calibrations, we have collected public spectroscopic redshifts from the literature and the collection is matched to the HSC objects by position. Each spectroscopic survey has its own flagging scheme to indicate the redshift confidence and we have a homogenized flag for each object for easy selection of objects with reliable redshifts. *It is important to emphasize that users should acknowledge the original data source(s) when using this table.*

Weak-lesing data products from some of our papers ([Oguri et al. 2018](#); [Hikage et al. 2019](#); [Shirasaki et al. 2019](#)) are made publicly available as part of the incremental release 1.

### Photometric Redshifts

**Incremental Release 2:** Photometric redshifts for PDR2 are now available!



## Available Data (PDR2)

HSC PDR2 includes over 300 square degrees of multi-band data at the nominal survey depth. See the figures below for the survey footprints. The blue and green areas show the Wide and Deep+UltraDeep layers, respectively. The darker blue regions are covered in more filters (max. 5).

- マスク画像は FITS 形式
- PSF FWHM、限界等級、  
detection completeness、天体個数密度  
は全てテキストファイル形式  
で公開される予定

# データ公開について

The screenshot shows a GitHub repository page for 'satoshi-ymnk / cats-tail'. The repository has 1 pull request, 0 stars, and 0 forks. The commit history shows a commit by 'syamanaka\_aoni' titled 'Upload meas\_limmag package' on 7 Aug. The commit message is 'Upload meas\_limmag package'. The commit includes files: LM.ipynb, README.md, limit.param, and limit.sex. The README.md file is displayed below, with the title 'meas\_limitmag' and the section '目的' (Purpose). The text in the README states: '画像の限界等級を測るためのノートブックです。ランダムなスカイポジションに対してアパーチャー測光した結果から限界等級を推定します。'

meas\_limitmag

## 目的

画像の限界等級を測るためのノートブックです。  
ランダムなスカイポジションに対してアパーチャー測光した結果から限界等級を推定します。

データ解析に用いたコードは山中の  
GitHub (satoshi-ymnk) で公開しています  
(すみません、一部はまだ準備中です)

# Summary

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- CHORUS は宇宙再電離の解明を目指した HSC プロジェクトの一つ
- CHORUS PDR1 データ (画像とカタログ) はすでに内部に向けて公開済みで、論文出版に合わせて public になる予定
- ターゲットは COSMOS 領域 (およそ 1.6 平方度) で SSP の Ultra-deep 領域 (tract=9813) と重複
- PSF FWHM、限界等級、detection completeness を各フィルター毎に調べ、質の高いデータが得られていることを確認
- CHORUS PDR1 catalog の天体個数密度も調査し、先行研究と一致することを確認

**CHORUS PDR1 をぜひご活用ください！！**