

B03

Cosmology with Galaxy Redshift Survey

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東京大学
THE UNIVERSITY OF TOKYO



B03 team & Goals



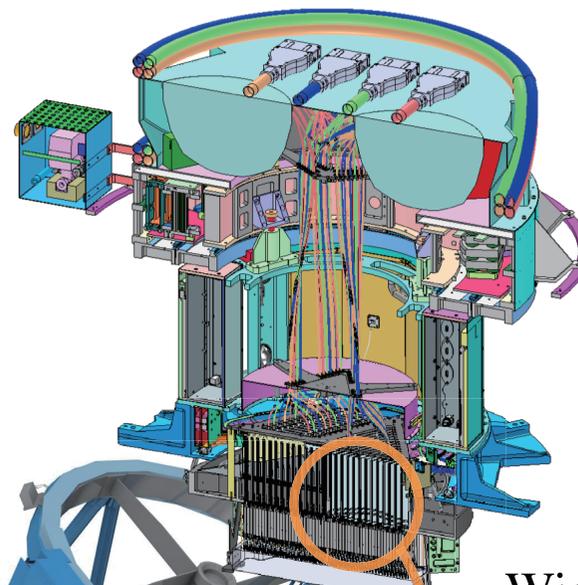
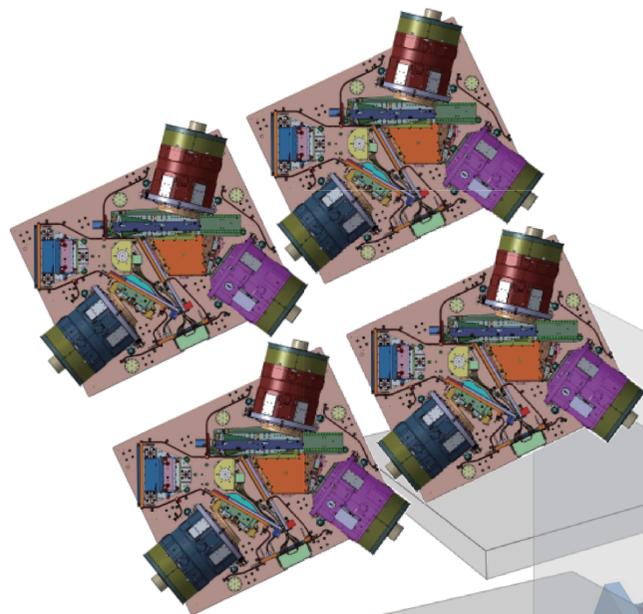
Naoyuki Tamura
(apology; now at Taipei)

- Team members:
 - Naoyuki Tamura (PM; Kavli IPMU)
 - Kiyoto Yabe, Yuki Moritani (KIPMU)
 - Ikuru Iwata (NAOJ)
 - Ryuichi Takahashi (Hirosaki U.)
 - Tomomi Sunayama (Kavli IPMU, next speaker)
+ students at U. Tokyo
- Goals
 - Build NIR spectrographs for the Subaru Prime Focus Spectrograph (PFS)
 - Develop methodology/strategy for carrying out high-precision cosmology with Subaru PFS+HSC

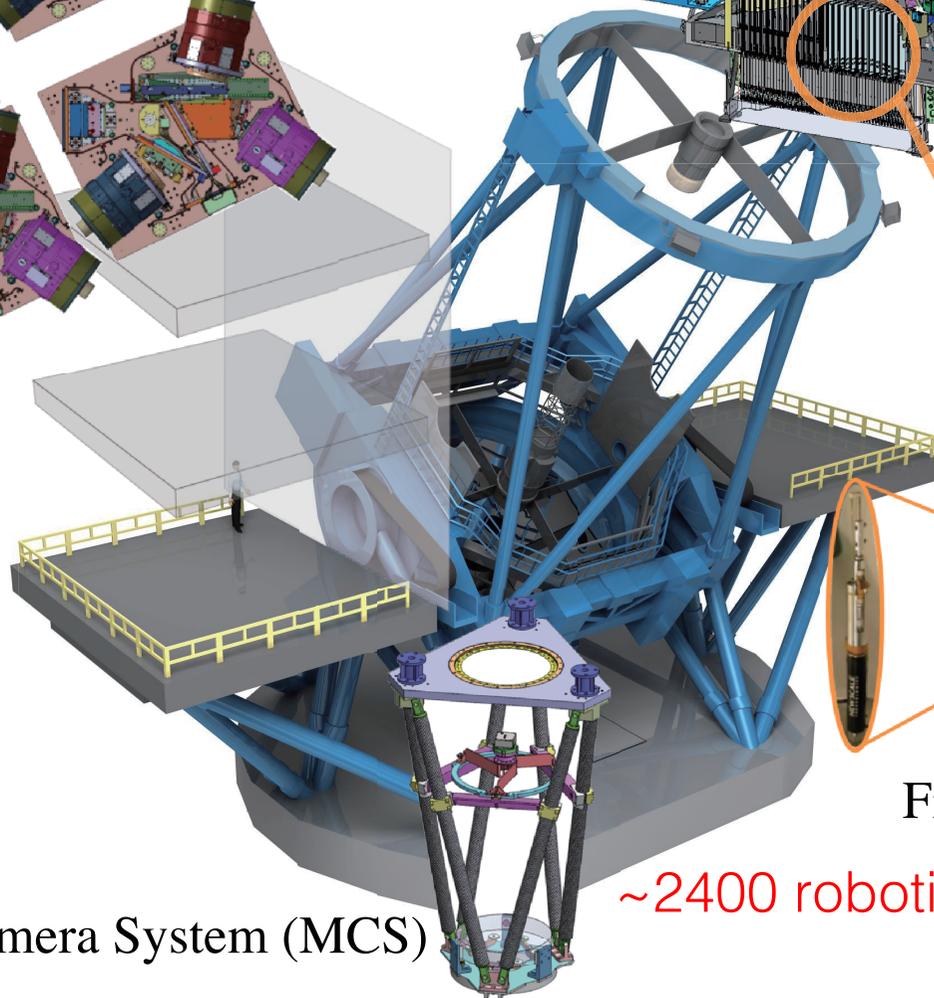
Prime Focus Spectrograph (PFS)

Prime Focus Instrument (PFI)

Spectrograph System (SpS)



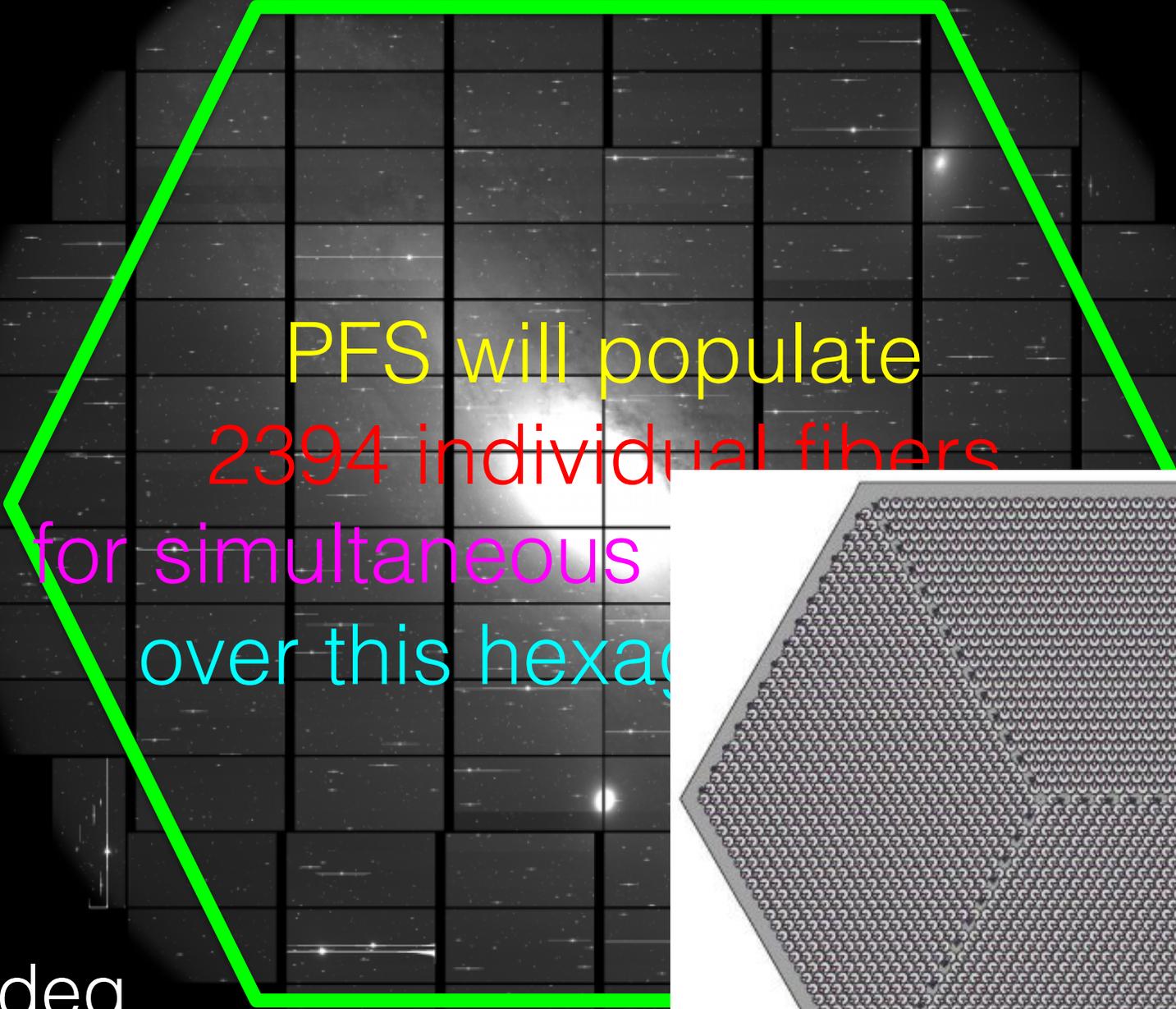
Wide Field Corrector



Fiber positioner "Cobra"

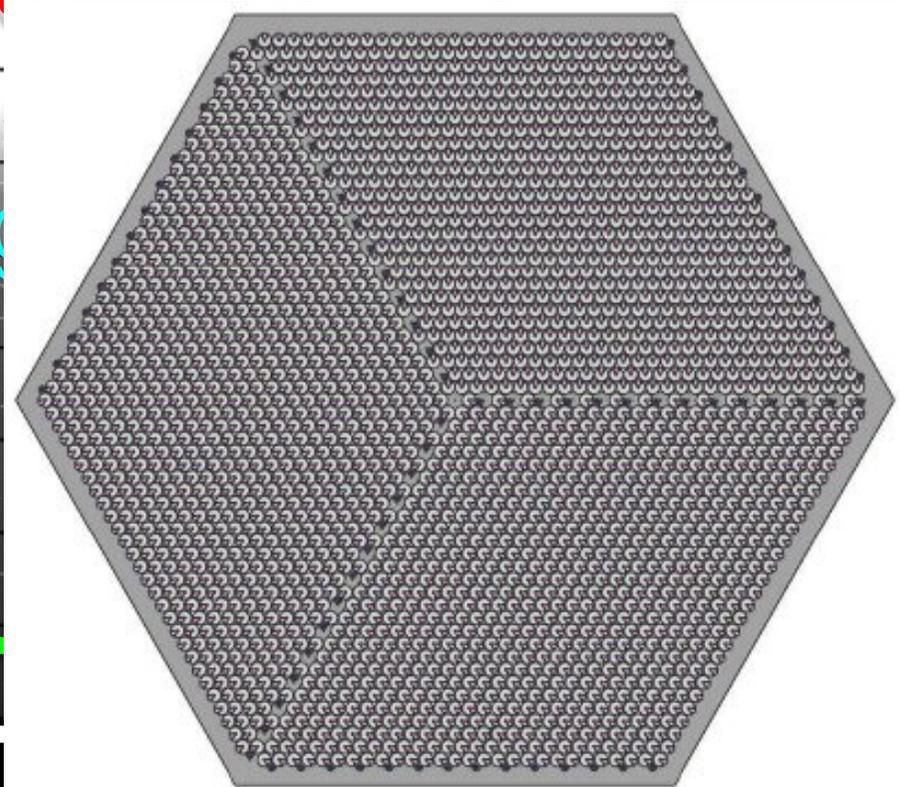
~2400 robotic positioners (fibers)

Metrology Camera System (MCS)



PFS will populate
2394 individual fibers
for simultaneous
over this hexag

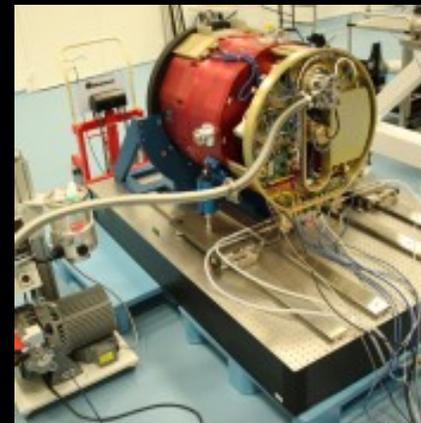
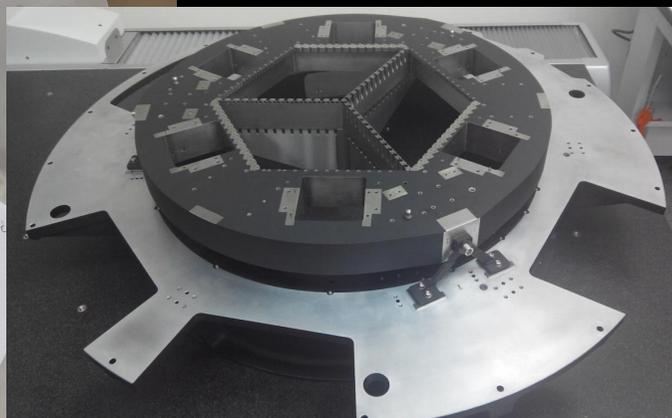
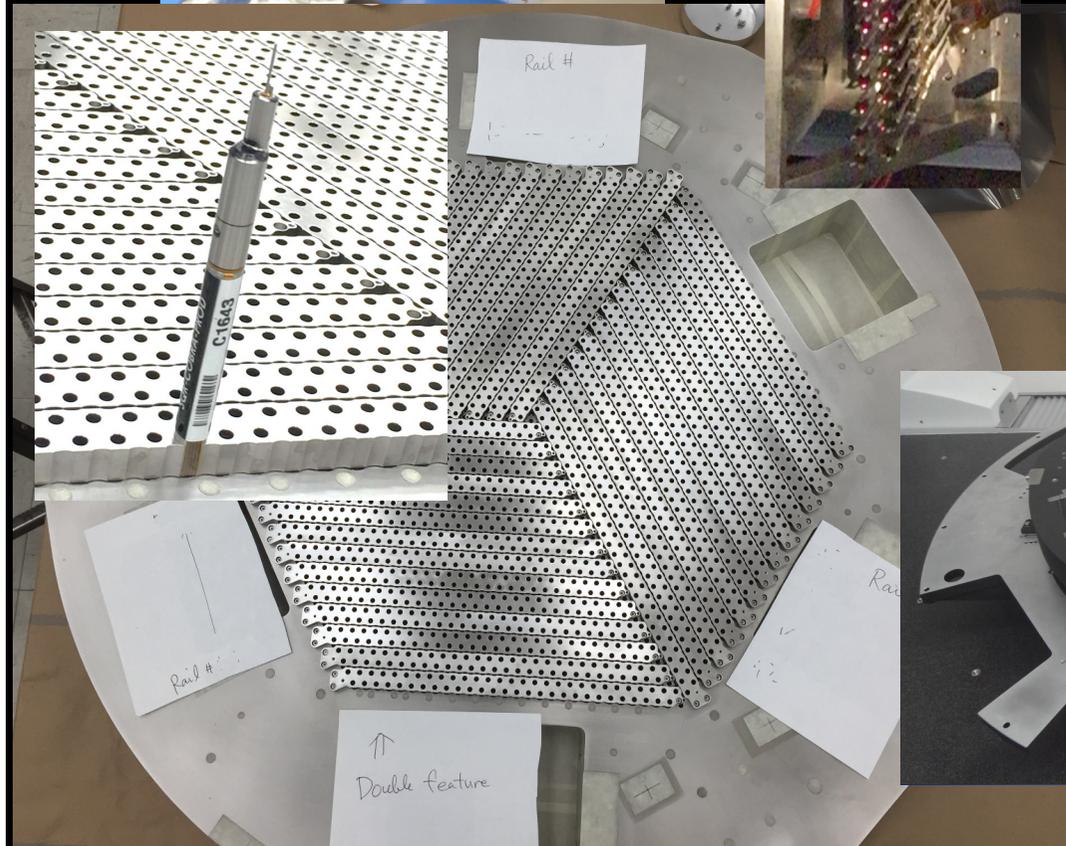
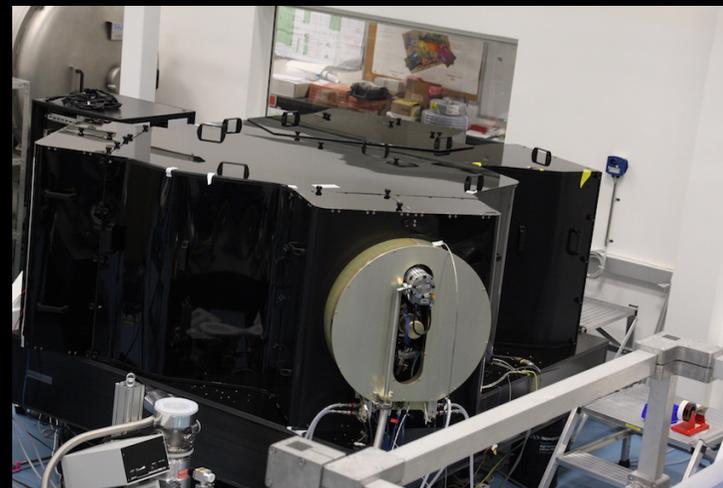
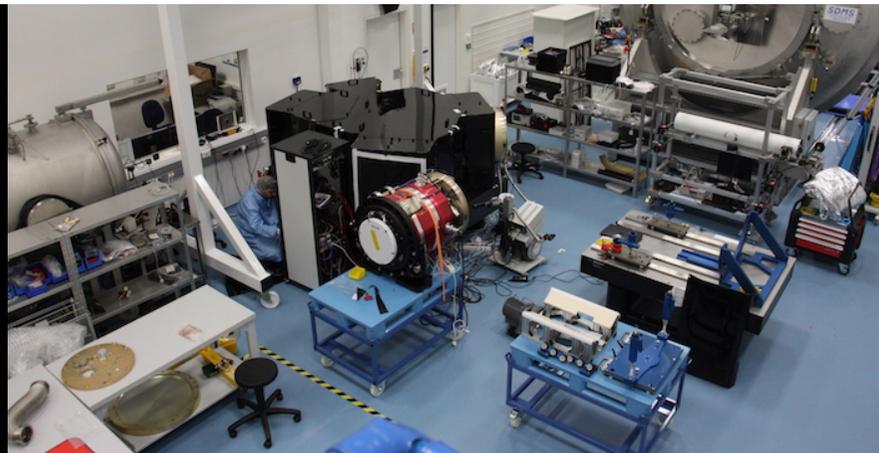
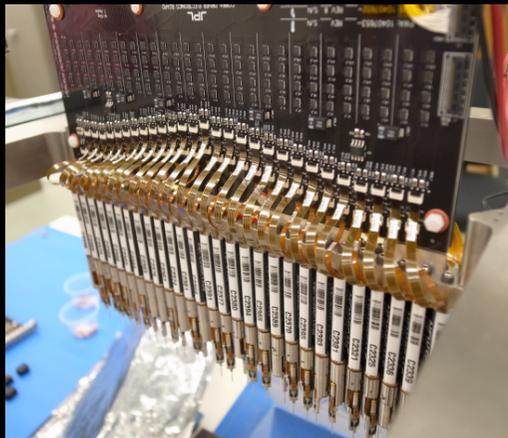
~ 1.5 deg



We just had the collaboration meeting at Caltech for Dec 9-13, 2019

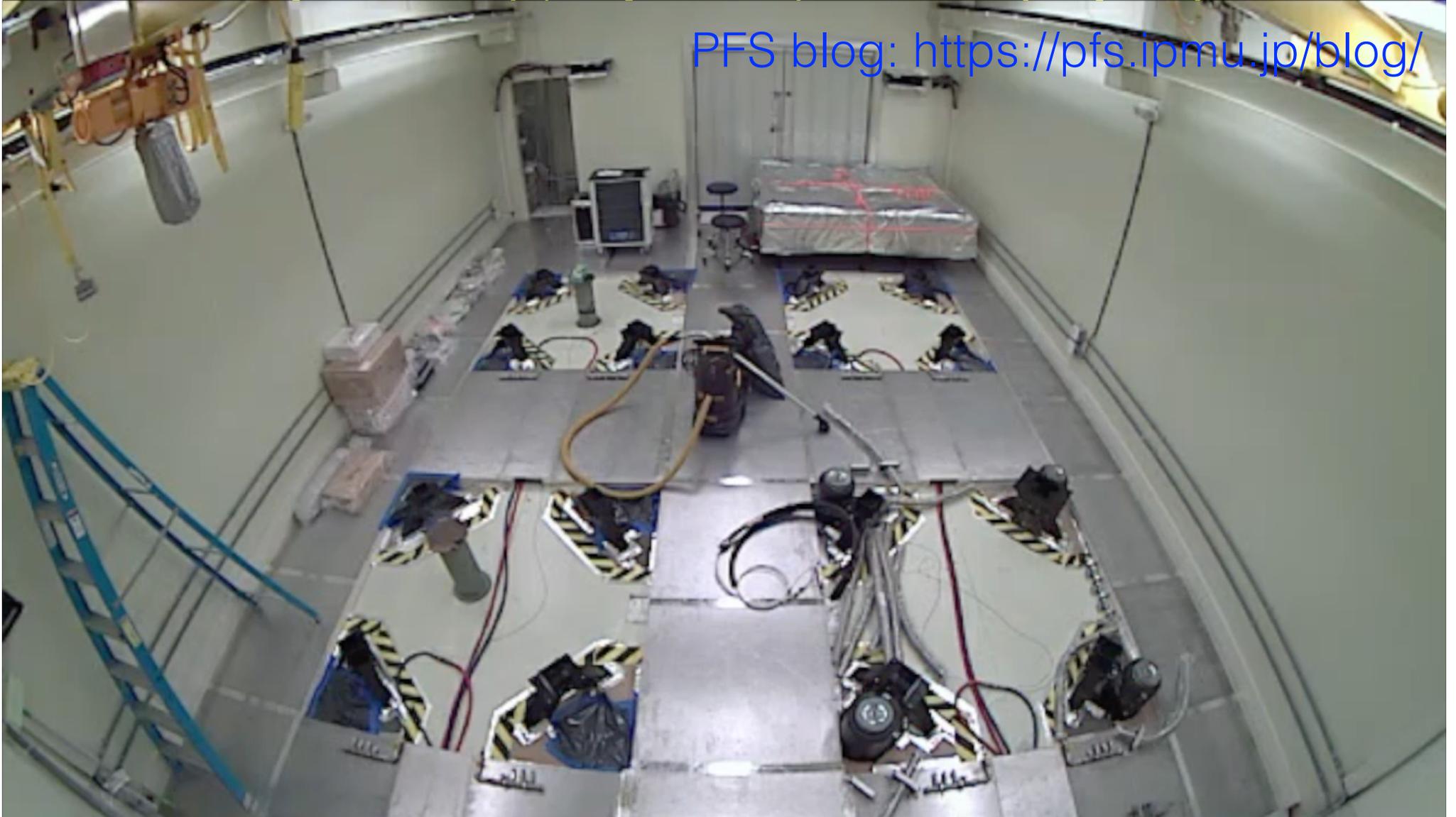


PFS is REAL!!!



Spectrograph System (SpS)

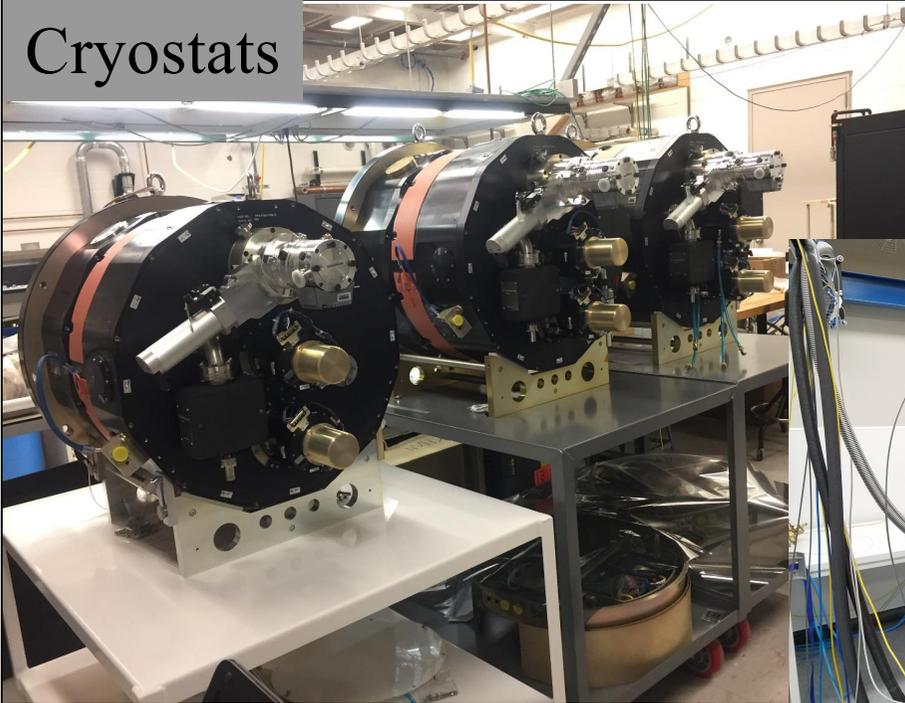
PFS blog: <https://pfs.ipmu.jp/blog/>



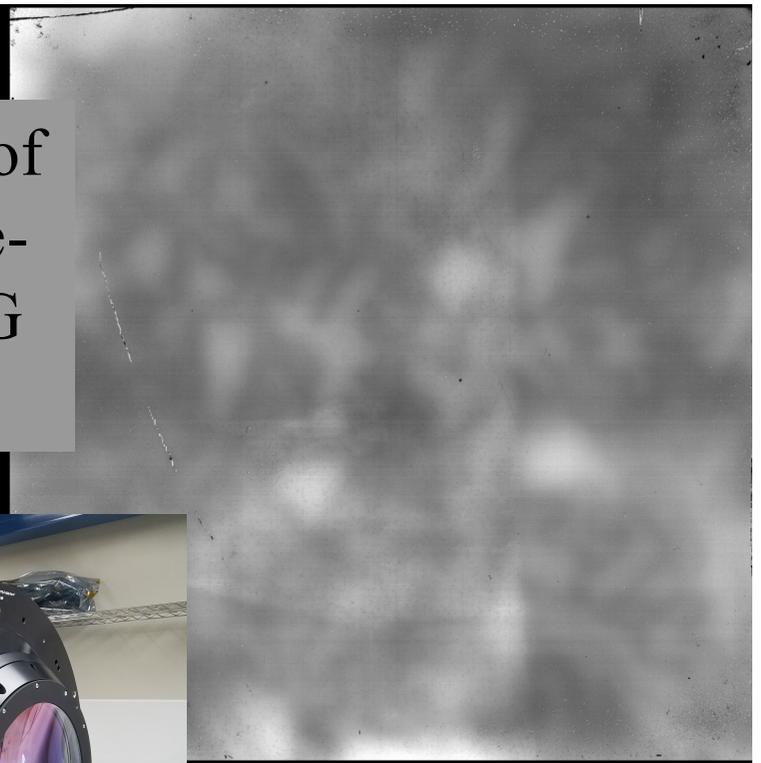
performance validation will be carried out.

NIR cameras

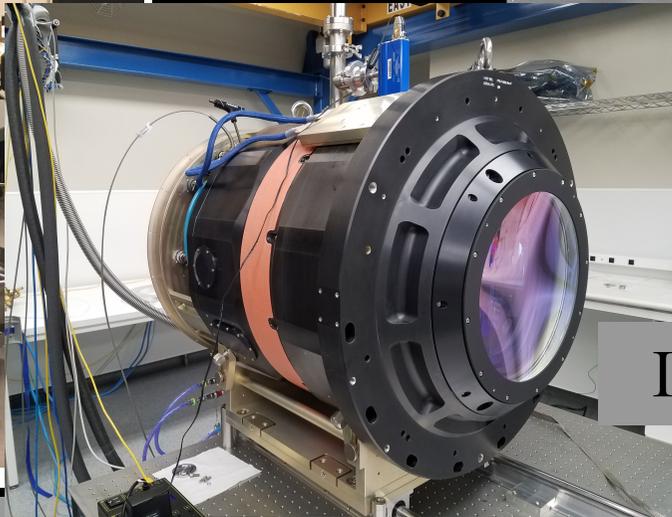
Cryostats



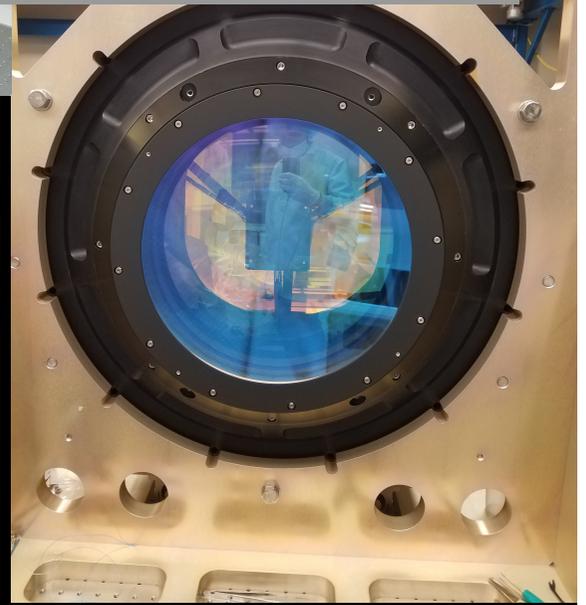
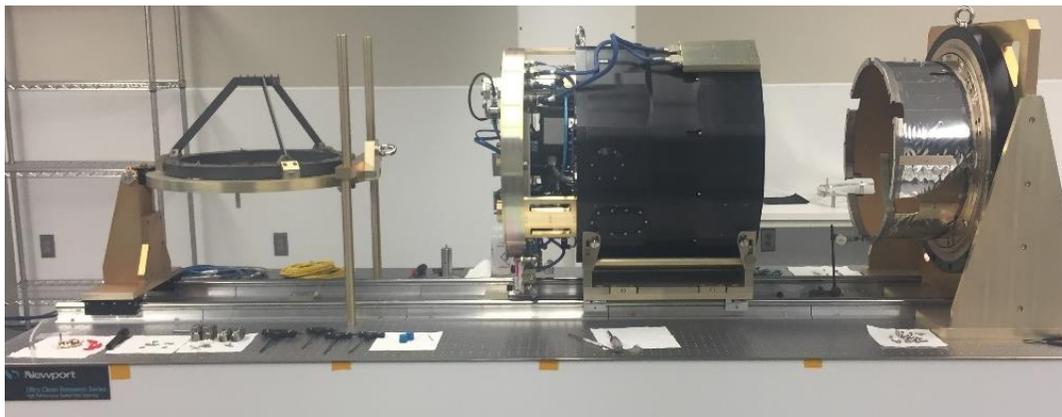
Dark frame of cold science-grade H4RG detector



Integrated camera



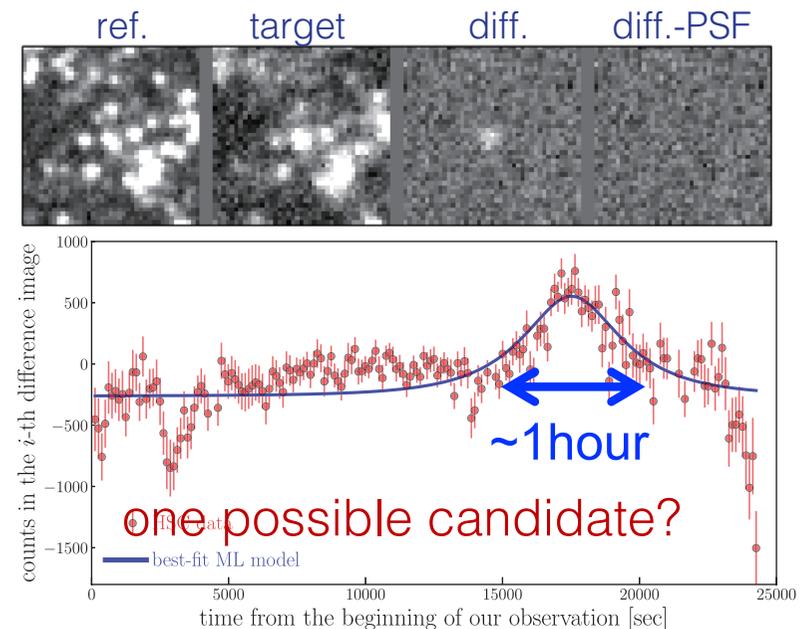
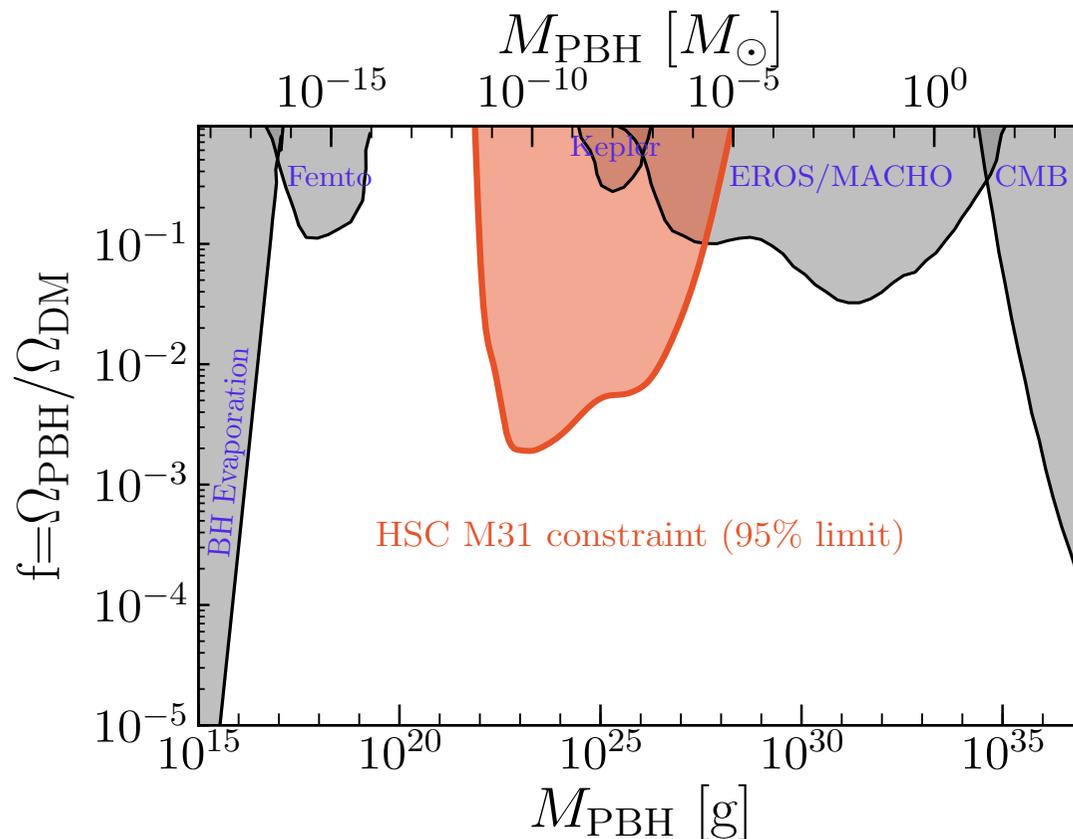
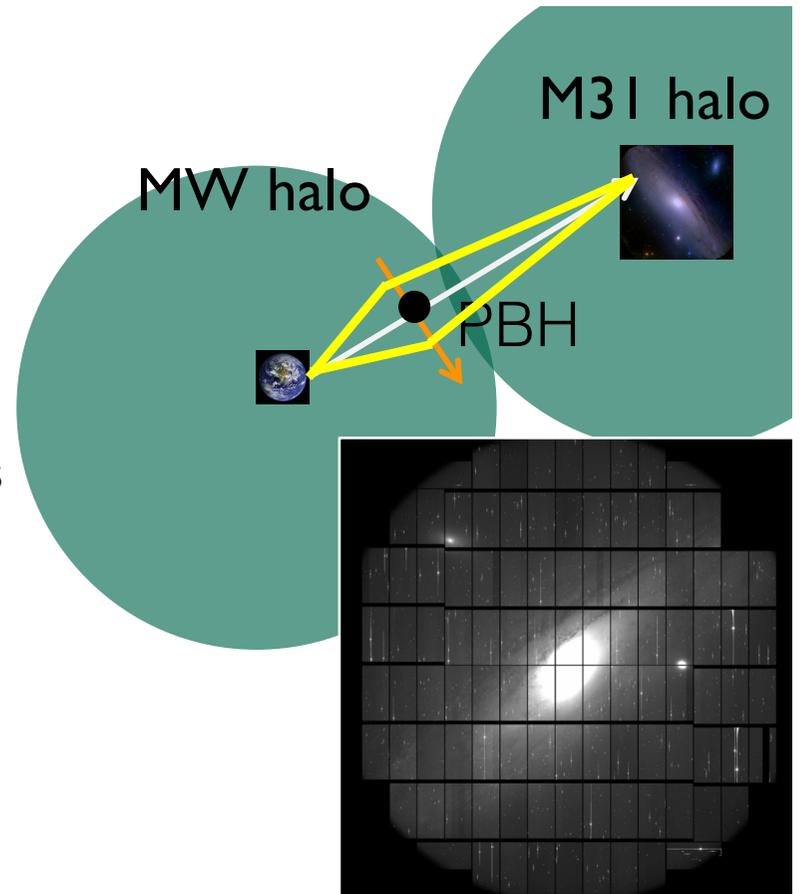
Opto-mechanics alignment



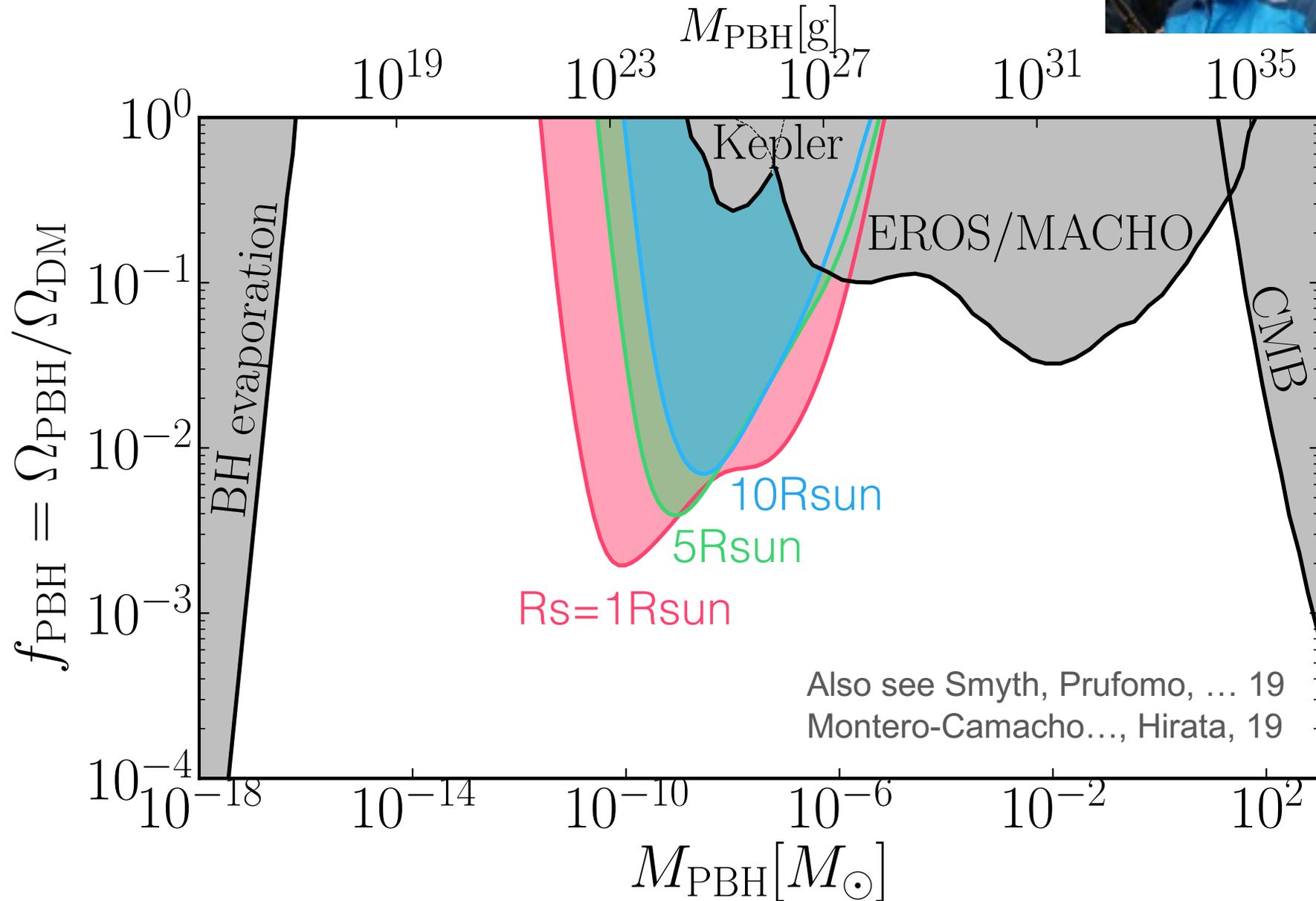
An HSC hunt of PBH

imaging (B02) + inflation (A01, A02)

- HSC (also eventually LSST) is a powerful instrument of microlensing
- Niikura et al. (2019); most stringent constraints on the PBH abundance around $10^{-9}M_{\text{sun}}$
- Triggered a lot of subsequent studies



Sunao Sugiyama (2nd grad),
Kurita, MT (2020, in press)



Subaru HSC can falsify multiverse-inspired PBH scenario (led by Sunao)

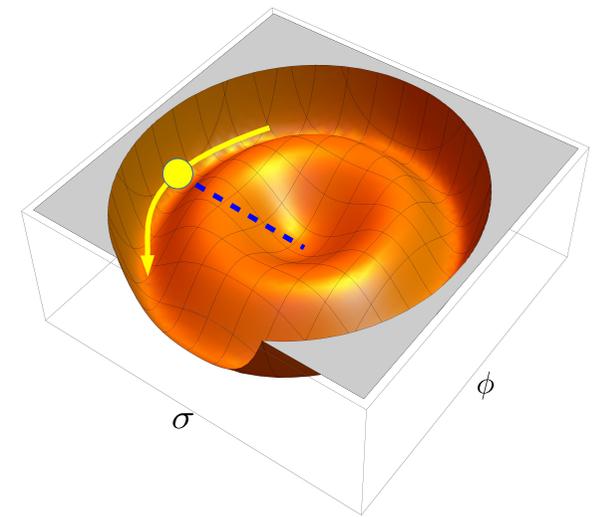
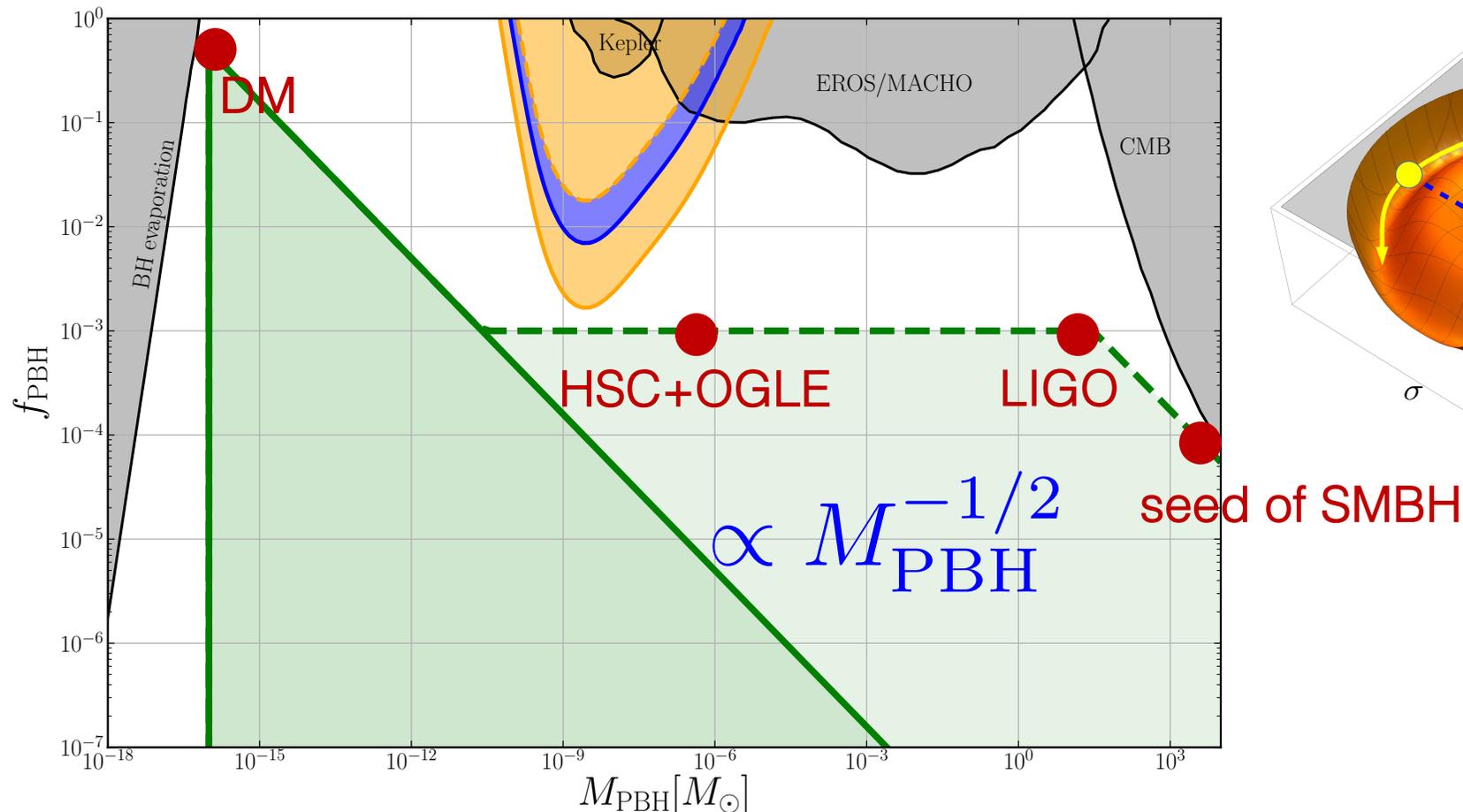
Niikura, MT, Yokoyama+ 19

Kusenko, Sasaki, Sugiyama, MT+, 20

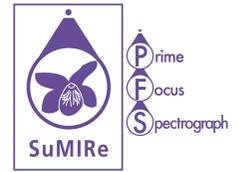


Sunao Sugiyama

Multiverse-inspired PBH model could explain all BHs at once!?

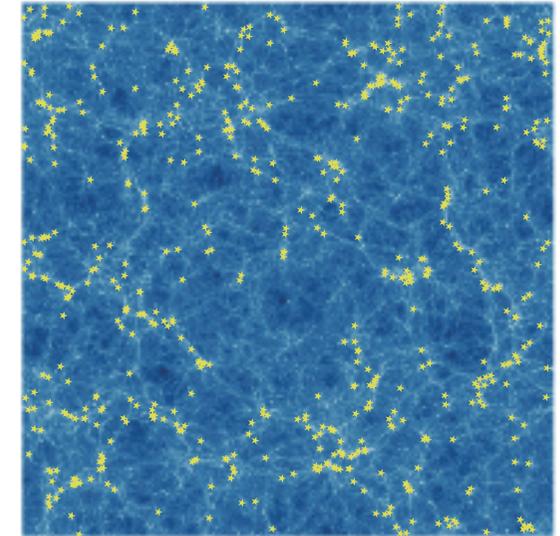
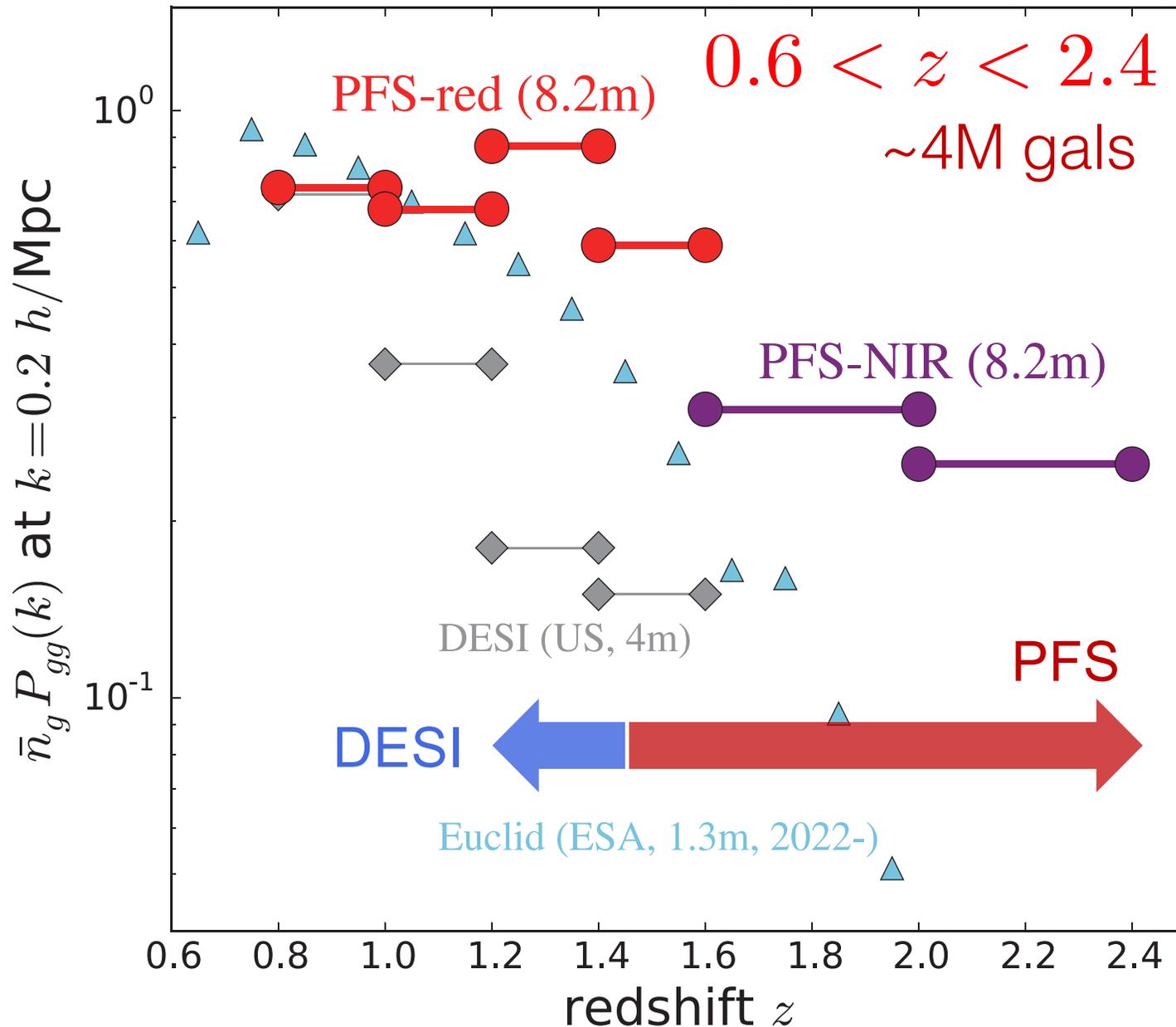


PFS Cosmology program

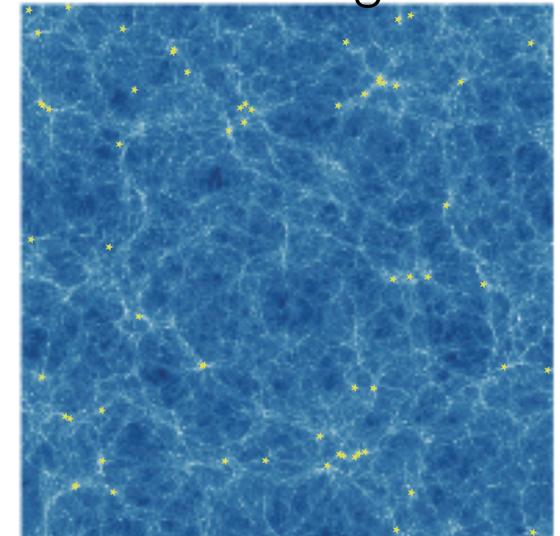


Best datasets at $z > 1$... before WFIRST(?) (NASA: 2025-)

PFS (8.2m) for $z \sim 1.5$ slice



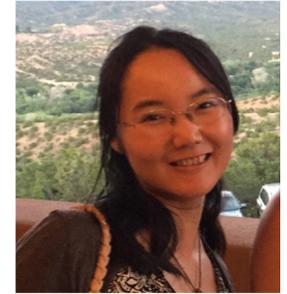
4m-class tel. e.g. DESI



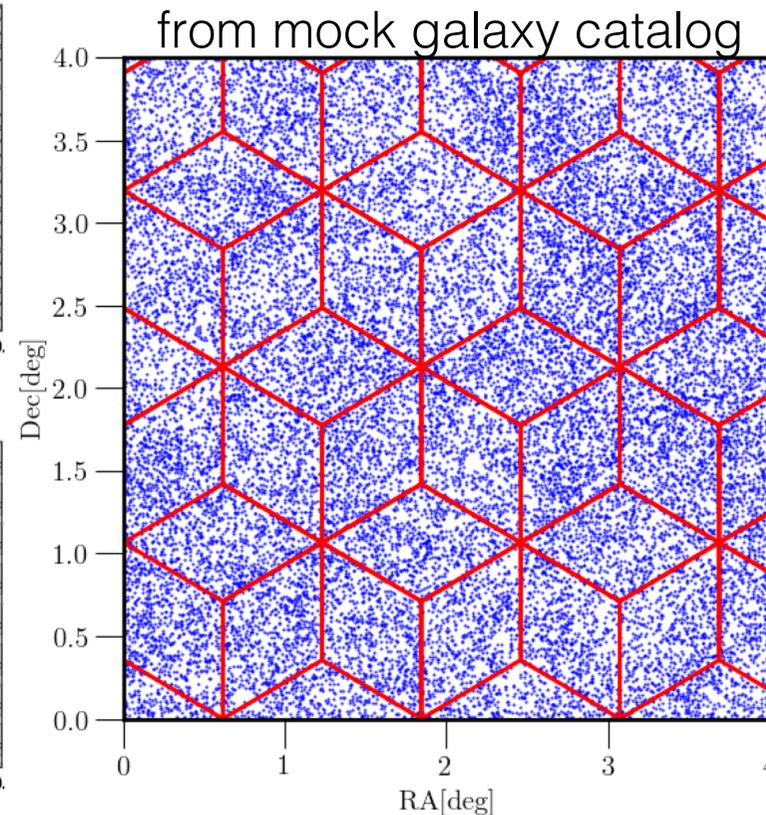
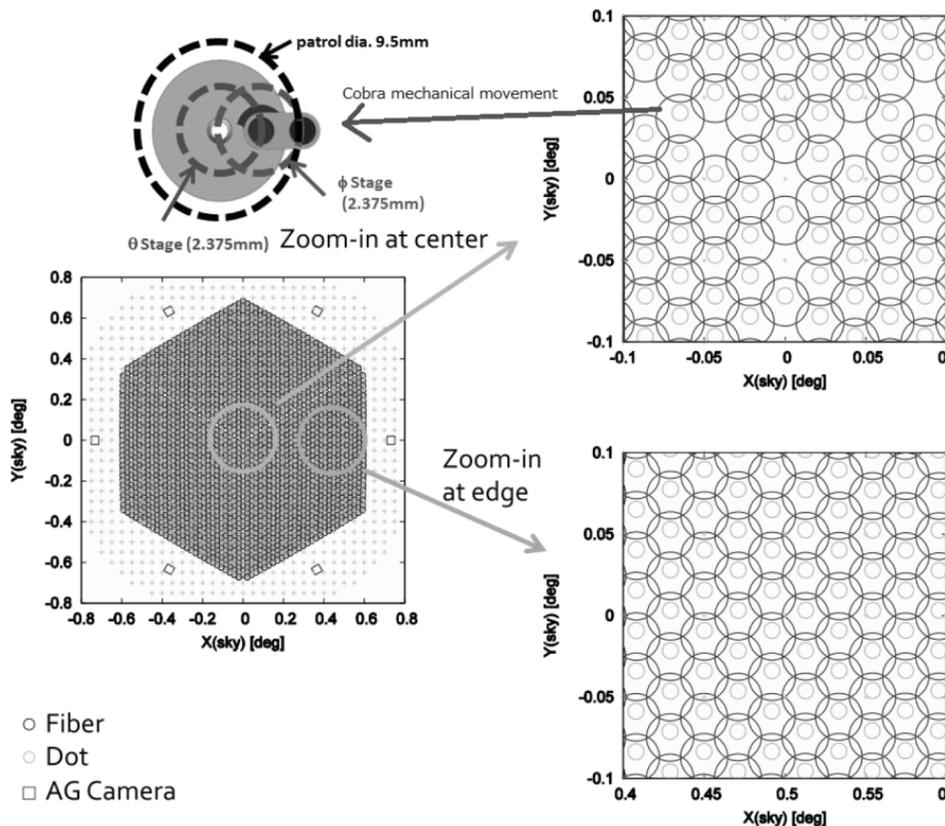
Deep redshift galaxy survey: $0.8 < z < 2.4$

B03+D01

- Almost all fibers for ELGs \Leftrightarrow DESI; BLGs, $z \sim 1$ LRGs, ELGs, QSOs
- Need to supply a sufficiently large number of targets in each field (**~ 8000 targets for 2400 fibers**); **2 visits** of each field
- Only **$\sim 50\%$** completeness of ELG targets ($\Leftrightarrow 90\%$ for BOSS)



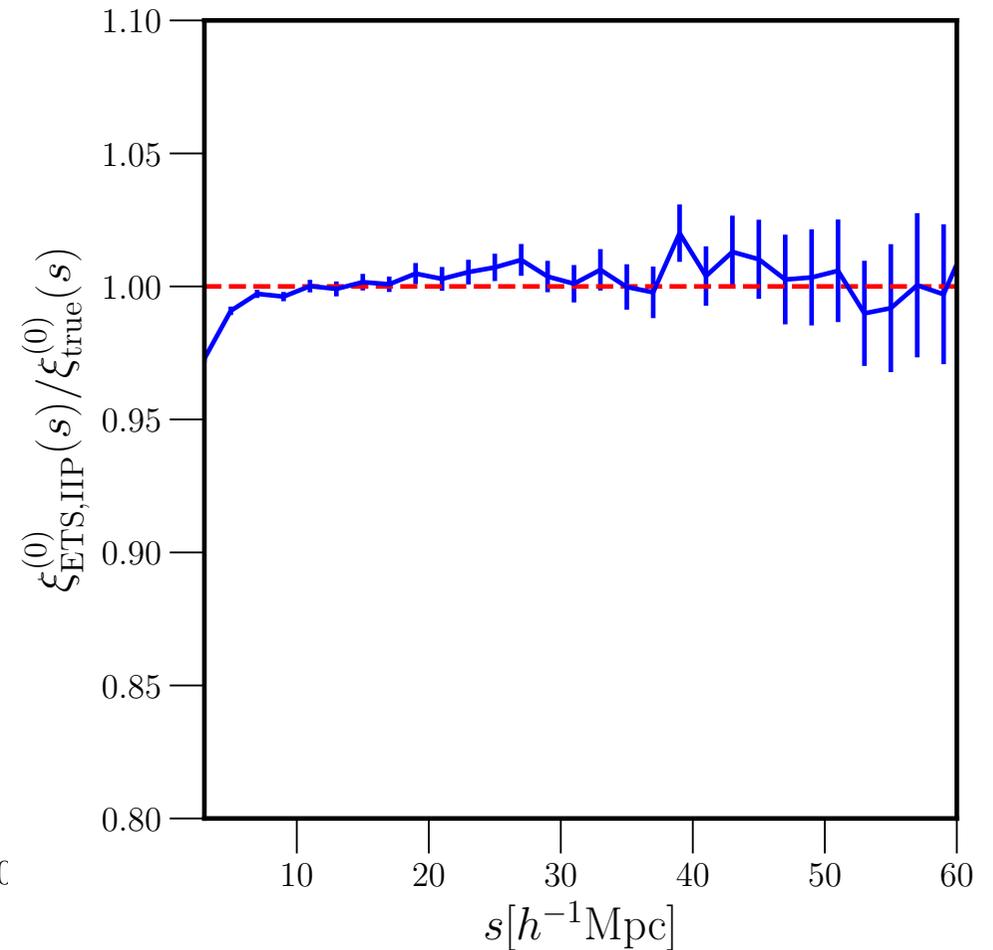
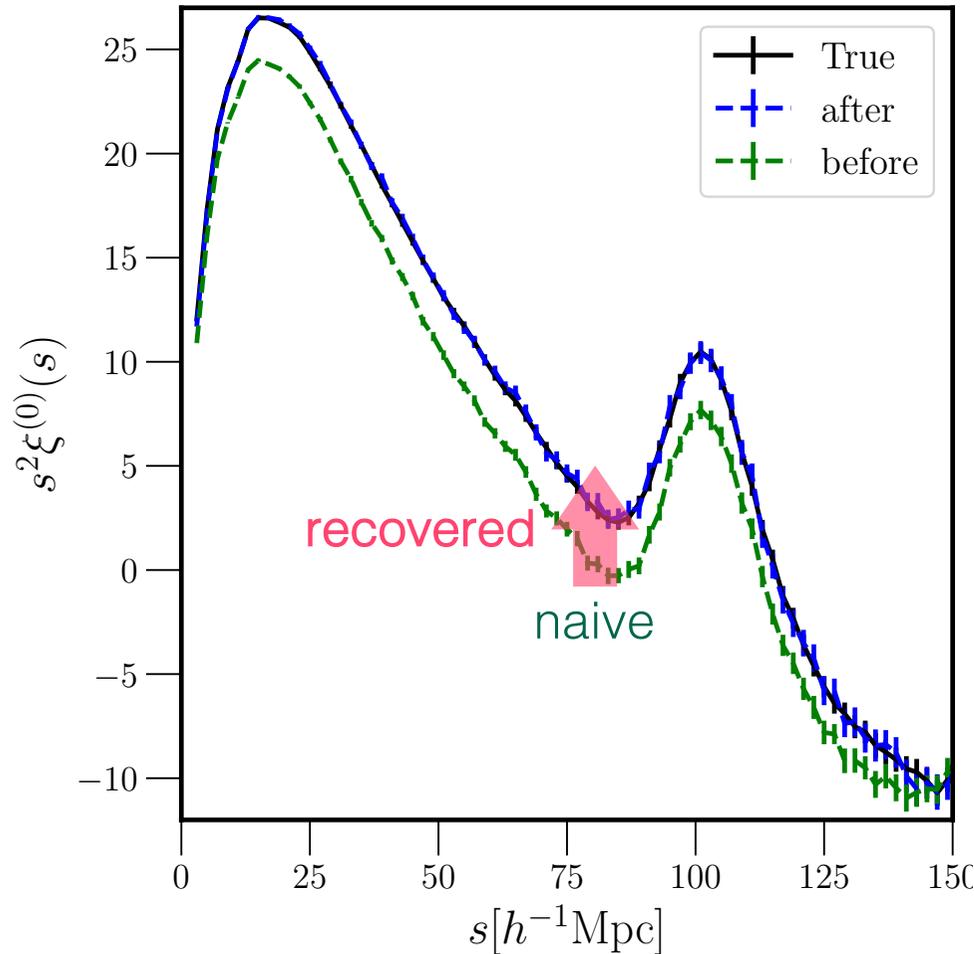
T. Sunayama
(Kavli IPMU)



R. Makiya
(Kavli IPMU)

A method mitigating fiber assignment effects

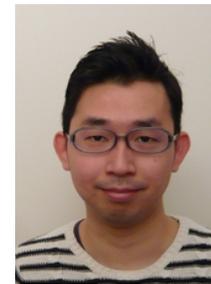
Sunayama, MT, Reinecke, Makiya, ..., Komatsu, Saito, Tamura, Yabe, submitted



Lesson: an imaging data, used for target selection, has to be sufficiently deep/homogeneous

Dark Emulator: fast “emulation” of LSS formation

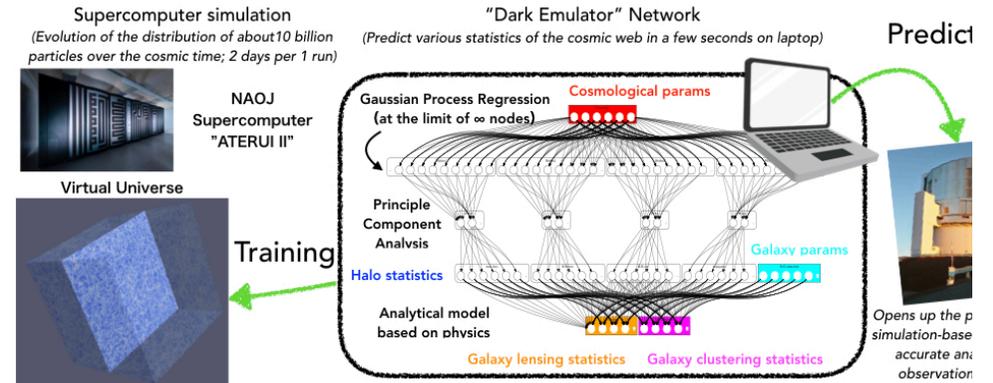
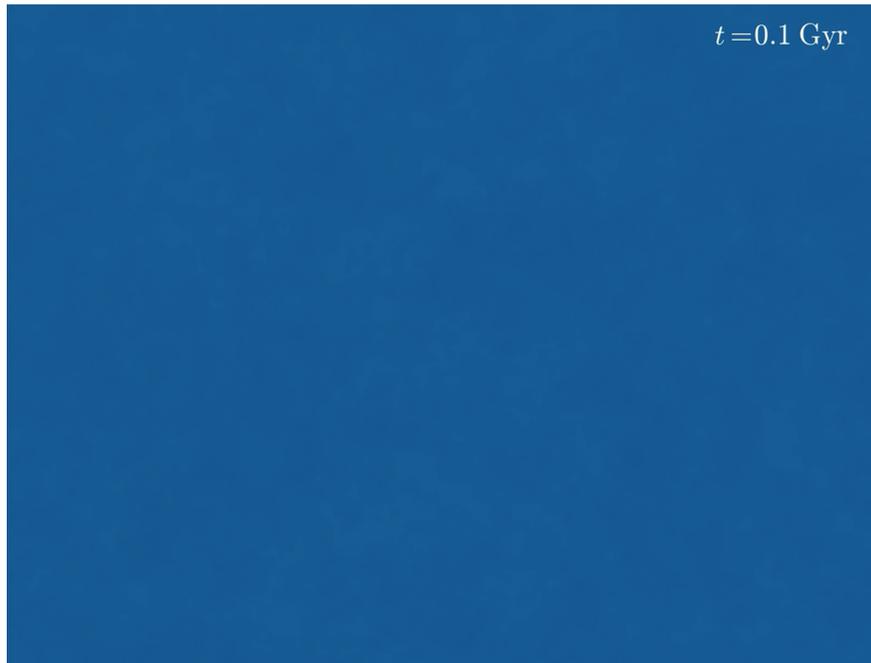
Nishimichi, **MT**, **Takahashi**+19



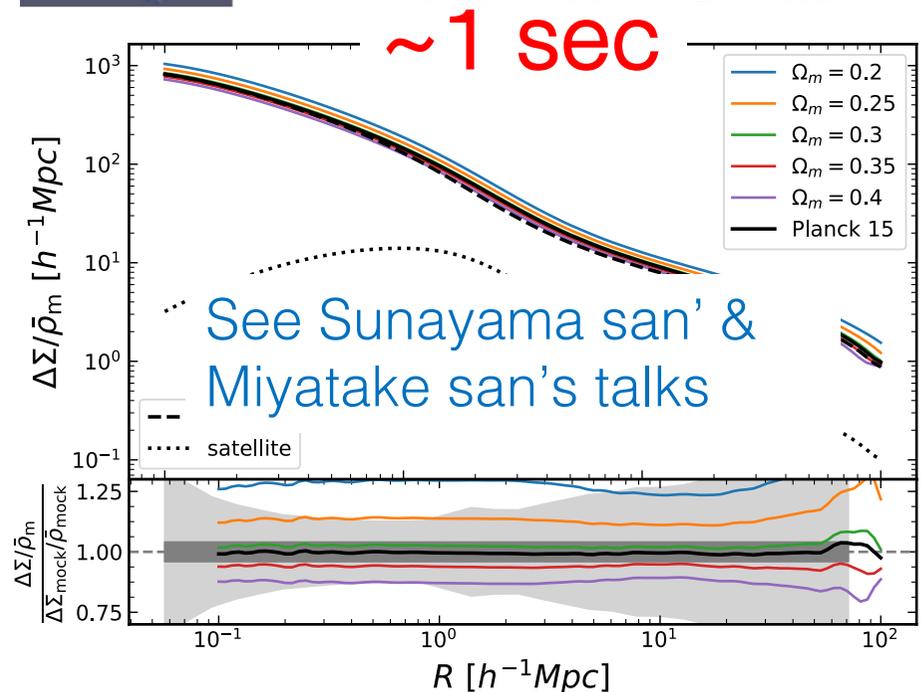
Takahiro Nishimichi
(Kyoto/KIPMU)



Yosuke Kobayashi
(KIPMU; 4th-yr)

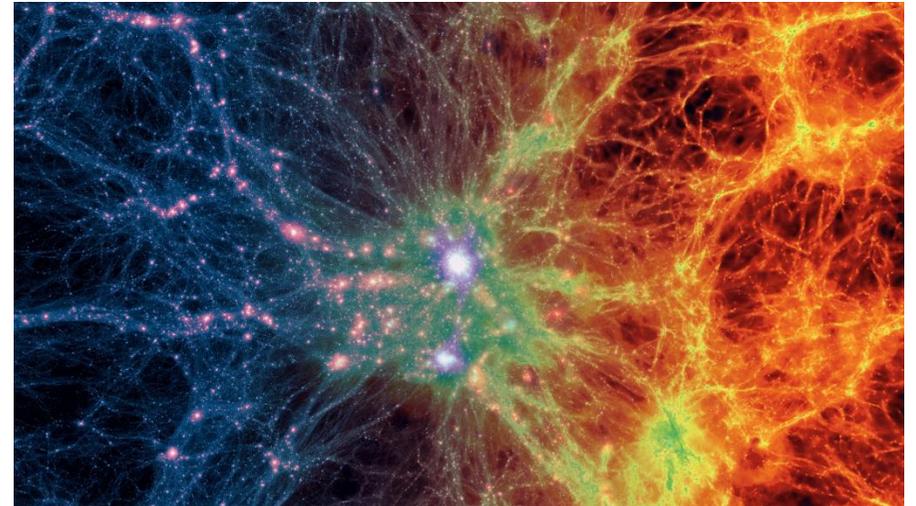
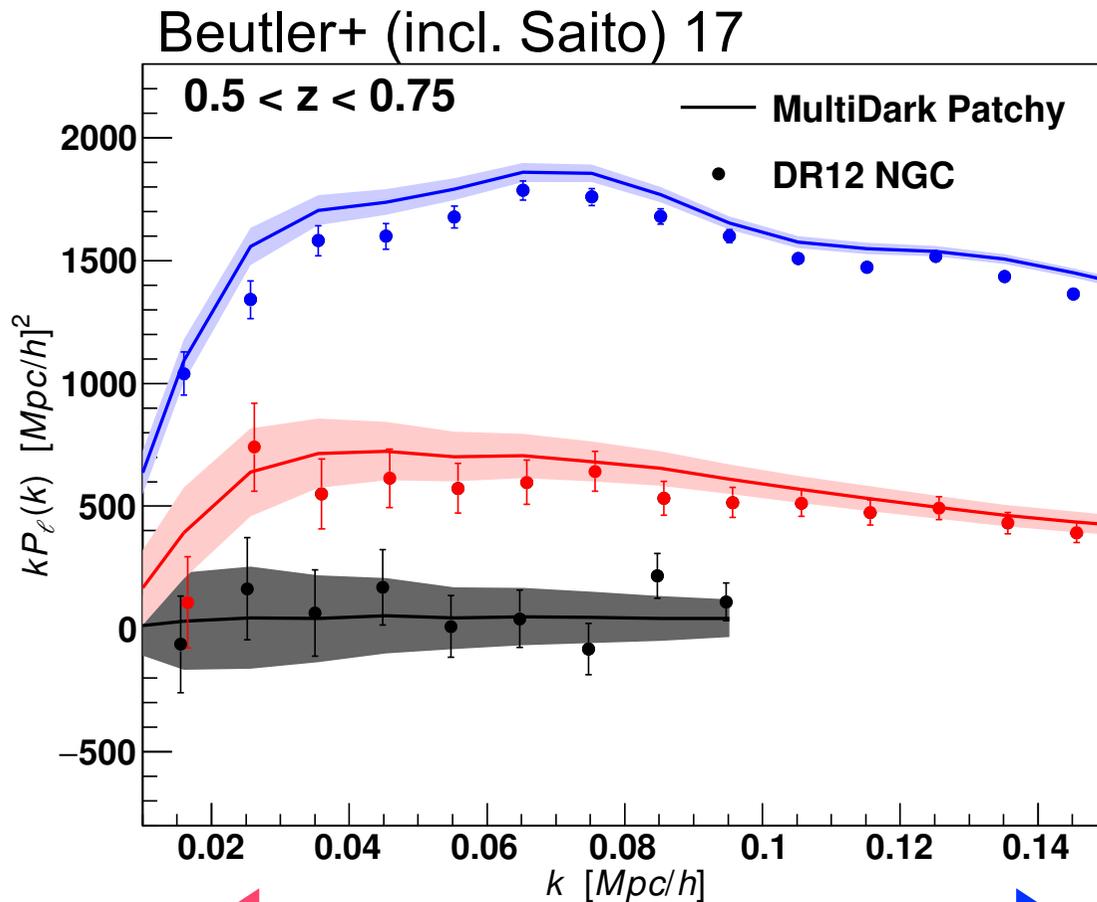


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- ~ a few days per cosmological model
- post-processing analysis of the sim data
- ~a few 100TB in total for 101 wCDM models (different redshifts, different halos, ...)

Challenges for PFS/DESI (or any Stage III/IV): robustness vs. statistical power



DM vs. **gas** (credit: Illustris)

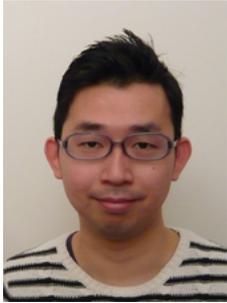
- *Challenges*: How to robustly extract cosmological information from high-precision galaxy data

small- k :
linear & robust

higher- k : nonlinear,
more stat. power & sys. effects

Cosmology Challenges

Nishimichi+ (incl. MT) in prep



Takahiro Nishimichi
(YITP/KIPMU)



me

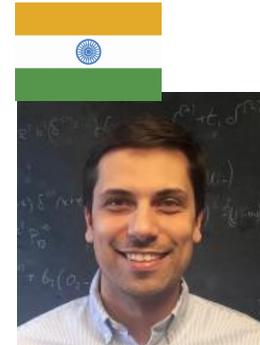
EFT is not useful

EFT should be correct/work



M. Zaldarriaga (IAS)

VS



M. Simonovic
(Cern)



M. Ivanov
(NYU)



L. Senatore
(KIPAC)



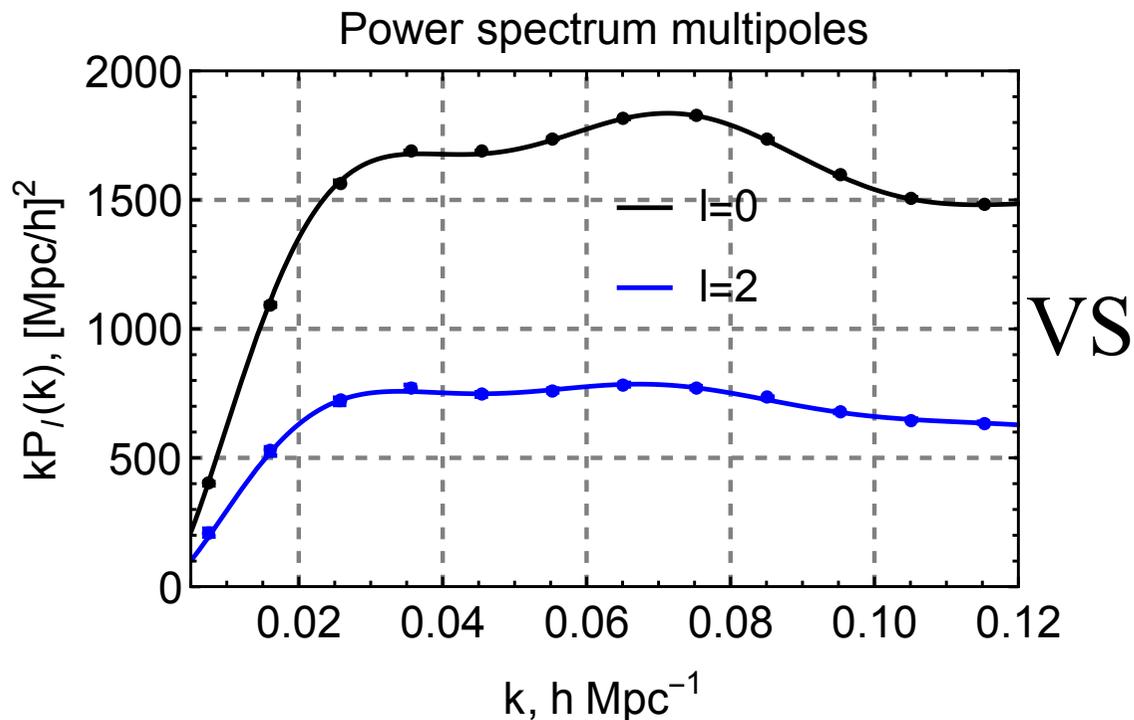
+ others

Cosmology challenges



$$V \sim 600 (h^{-1} \text{Gpc})^3$$
$$> 100V_{\text{BOSS}}$$

Blind cosmology analysis



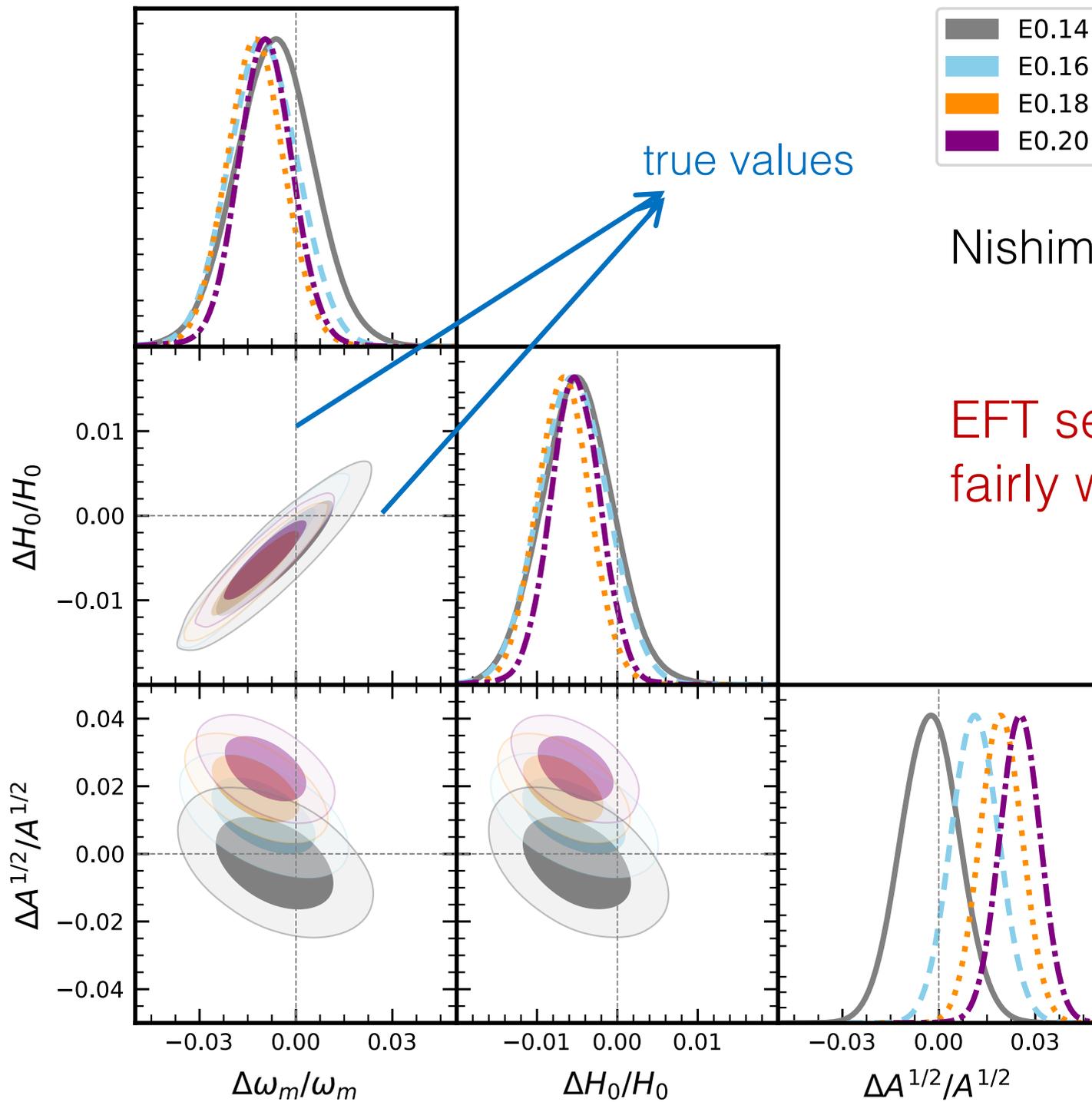
Effective field theory of LSS

$$P_\ell[k; p_\alpha, P^L(k), \text{nuisance paras}]$$

cosmological paras plus

$$b_1, b_2, b_{\mathcal{G}_2}, P_{\text{shot}} + c_{\nabla^2 \delta}^{(0)}, c_{\nabla_z^2 \delta}^{(2)}, c_{\nabla_z^4 \delta}^{(0)+(2)}$$

Japan team gave the **mock BOSS-like power spectrum** (including the AP effects), but **didn't** tell the other team the **cosmological model** used in sims.



Nishimichi+ in prep.

EFT seems working fairly well, but ...

summary

- *PFS is EXCITING!!*
- PFS instrumentation is relatively well **underway**; we envision we start our survey from 2022
- PFS allows for a **dense 3D mapping** of emission-line galaxies over the **wide redshift range** of $0.6 < z < 2.4$ (but narrower in area), a factor of a few denser than Euclid/DESI
- Development of the **analysis tool** (Sunayama et al.) in preparation for PFS cosmology
 - Please join us!
- **Unique science cases** are available with HSC+PFS (the same sky & same redshift)