

soo-mee-ray

SuMIRe / PFS

Subaru Measurements  
of Images and Redshifts

PrimeFocus Spectrograph

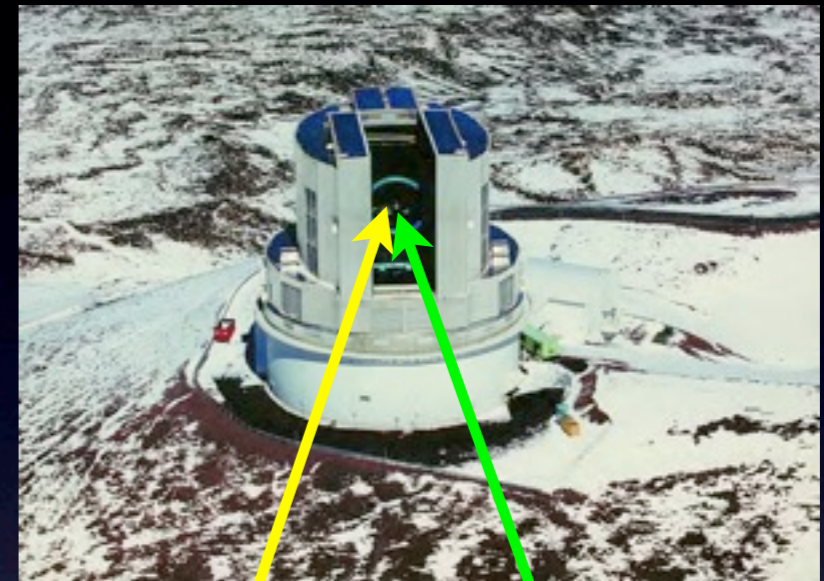
Hitoshi Murayama (Kavli IPMU & Berkeley)

Ripples of the Cosmos  
Durham, July 25, 2013



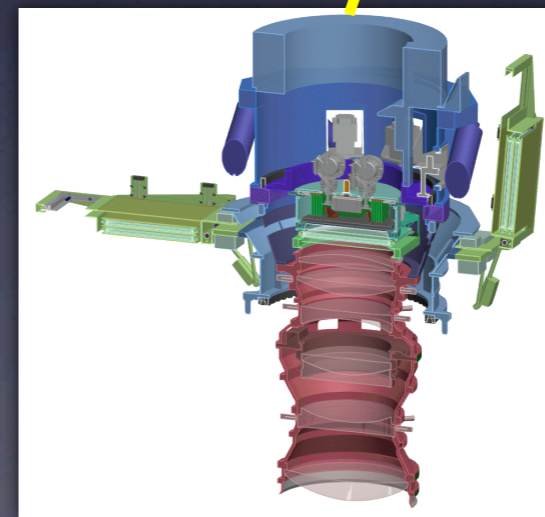


# SuMIRe

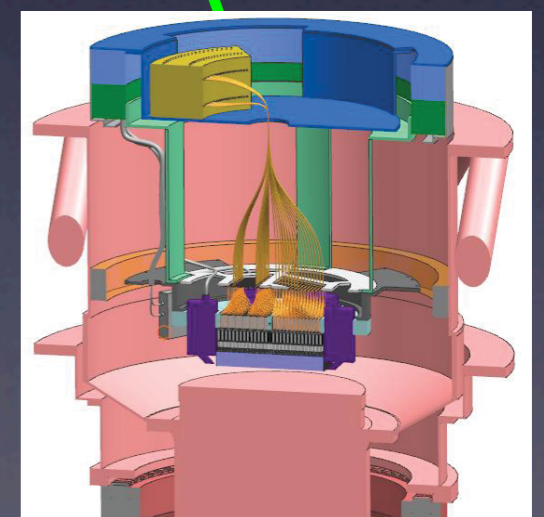


Subaru

- a 5+5 year survey program
- exploiting FOV  $\sim 1.5^\circ$  of 8.2m Subaru
- **Imaging** with HyperSuprimeCam (HSC)
  - 870M pixels
  - $\sim 20$ M galaxy images
  - 2014–2018, 300 nights
- **spectroscopy** with PrimeFocusSpectrograph (PFS)  $\neq$  PSF
  - 2400 optical fibers
  - $\sim 4$ M redshifts
  - 2018–2022? 300 nights
  - *like SDSS on 8.2m telescope!*

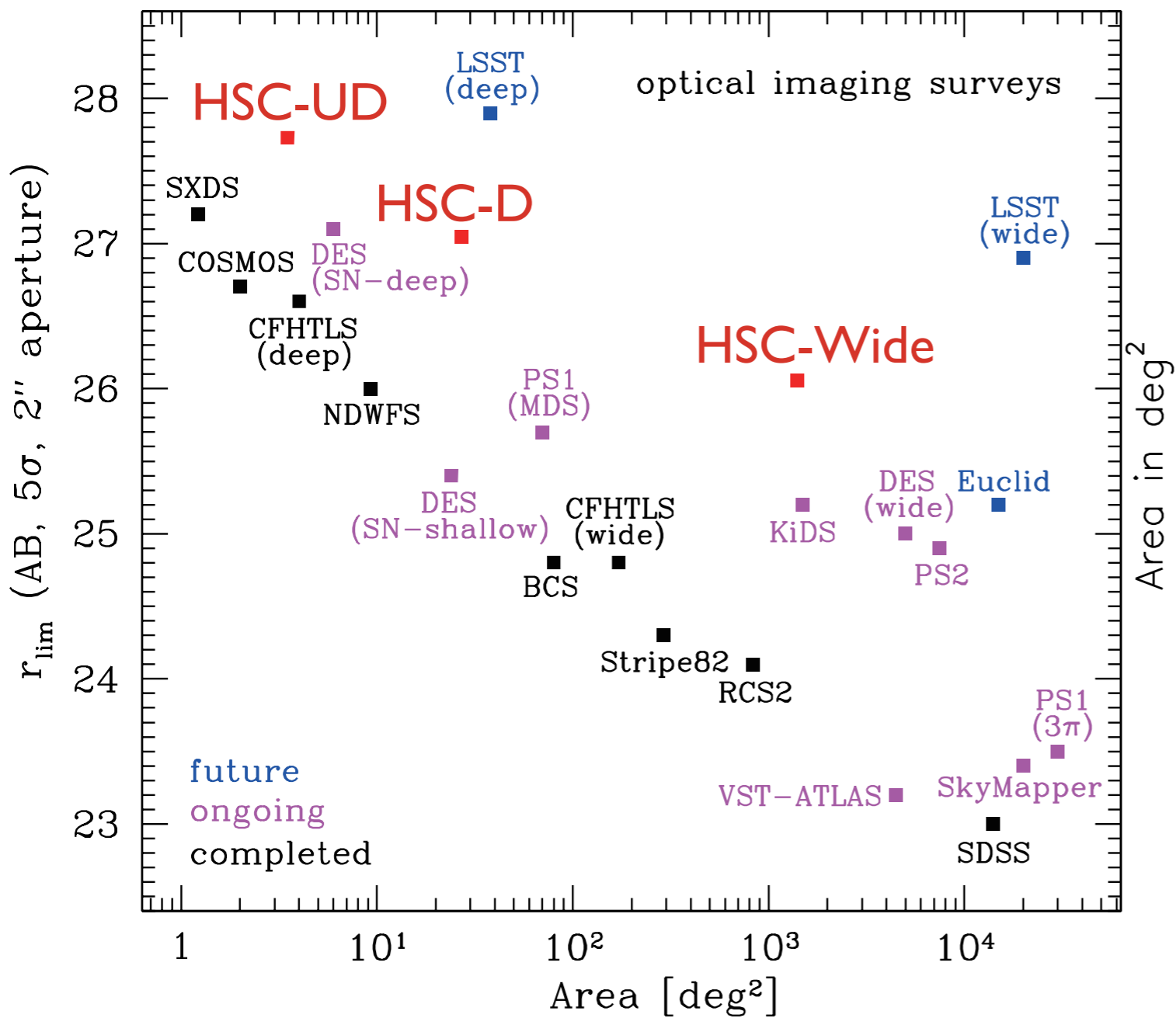


HSC

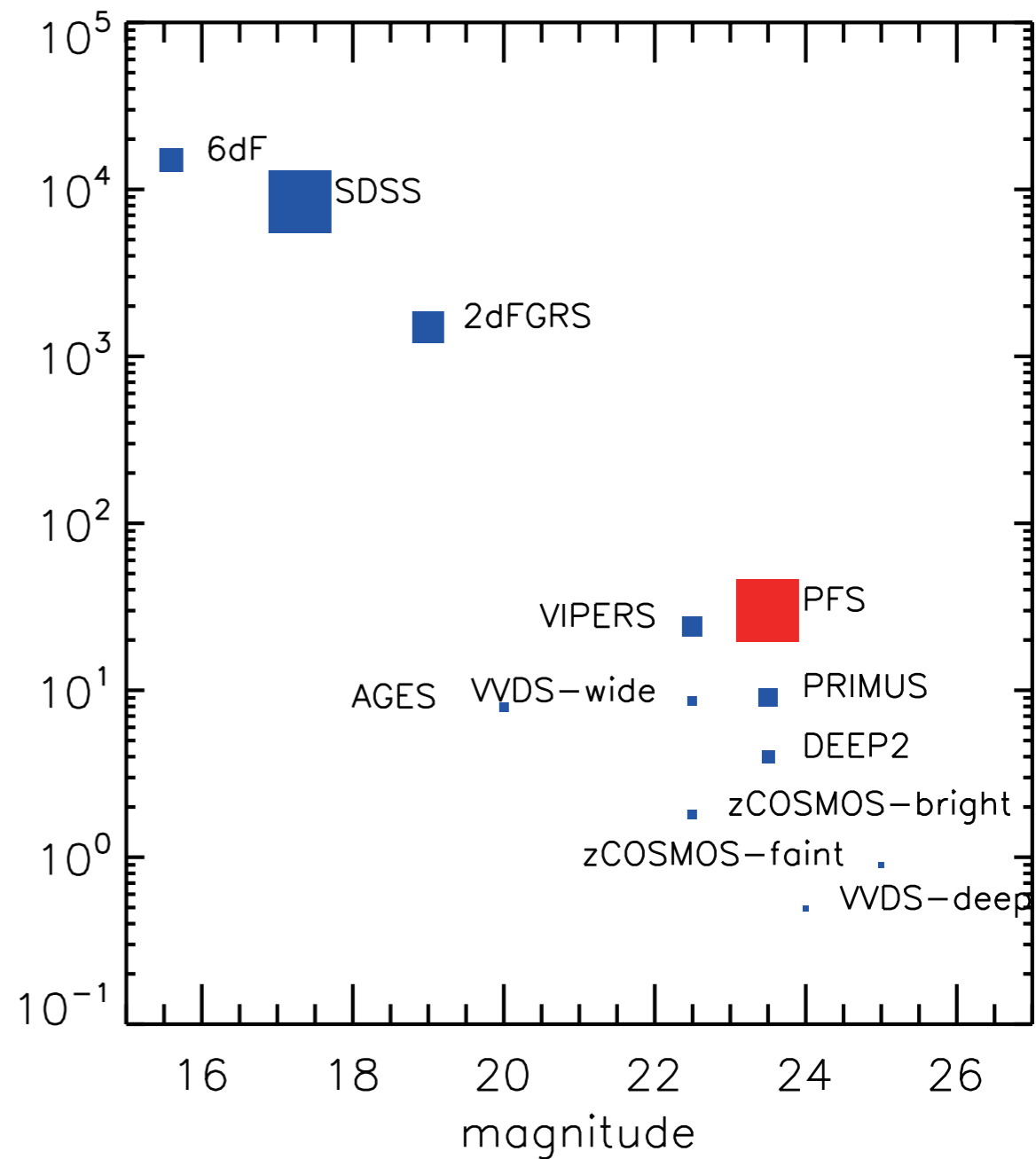


PFS

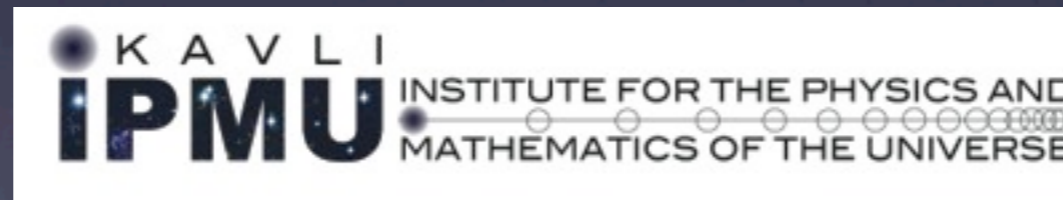
# imaging



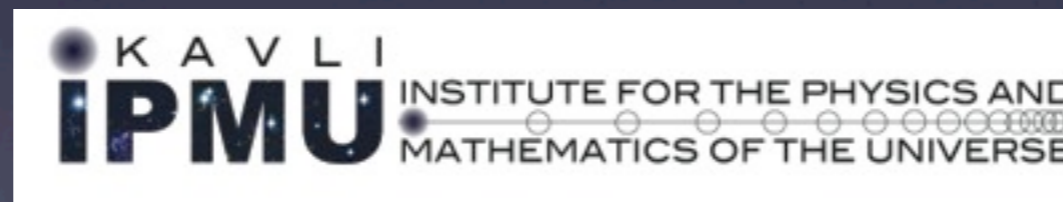
# spectroscopy



# HSC collaboration



# PFS collaboration



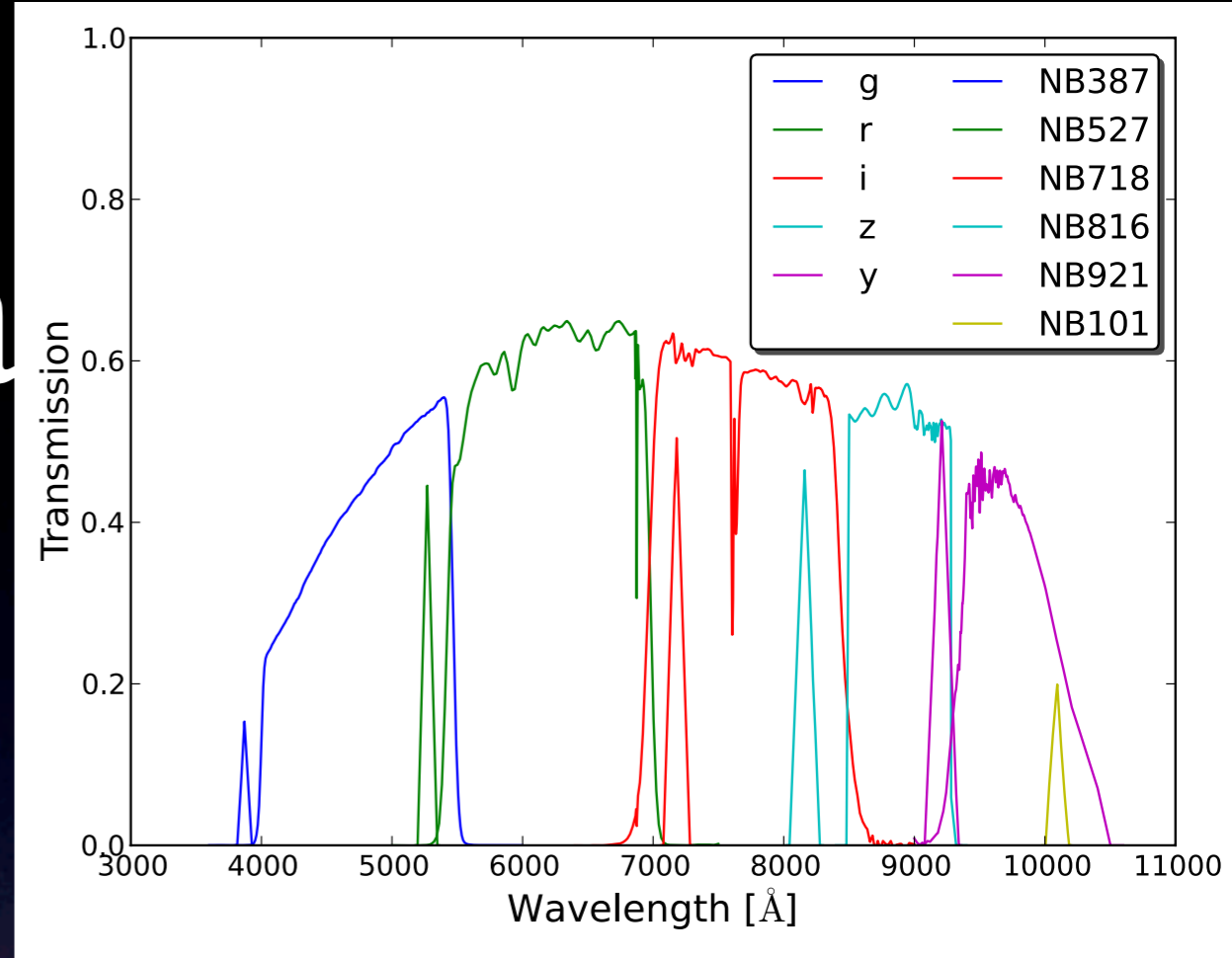
# HSC parameters

- FoV:  $1.5^\circ$ ,  $1.77 \text{ deg}^2$
- $15\mu\text{m}$ , 870M pixels
- *grizy* + 6 NBs
- three surveys, **approved to start Feb 2014**

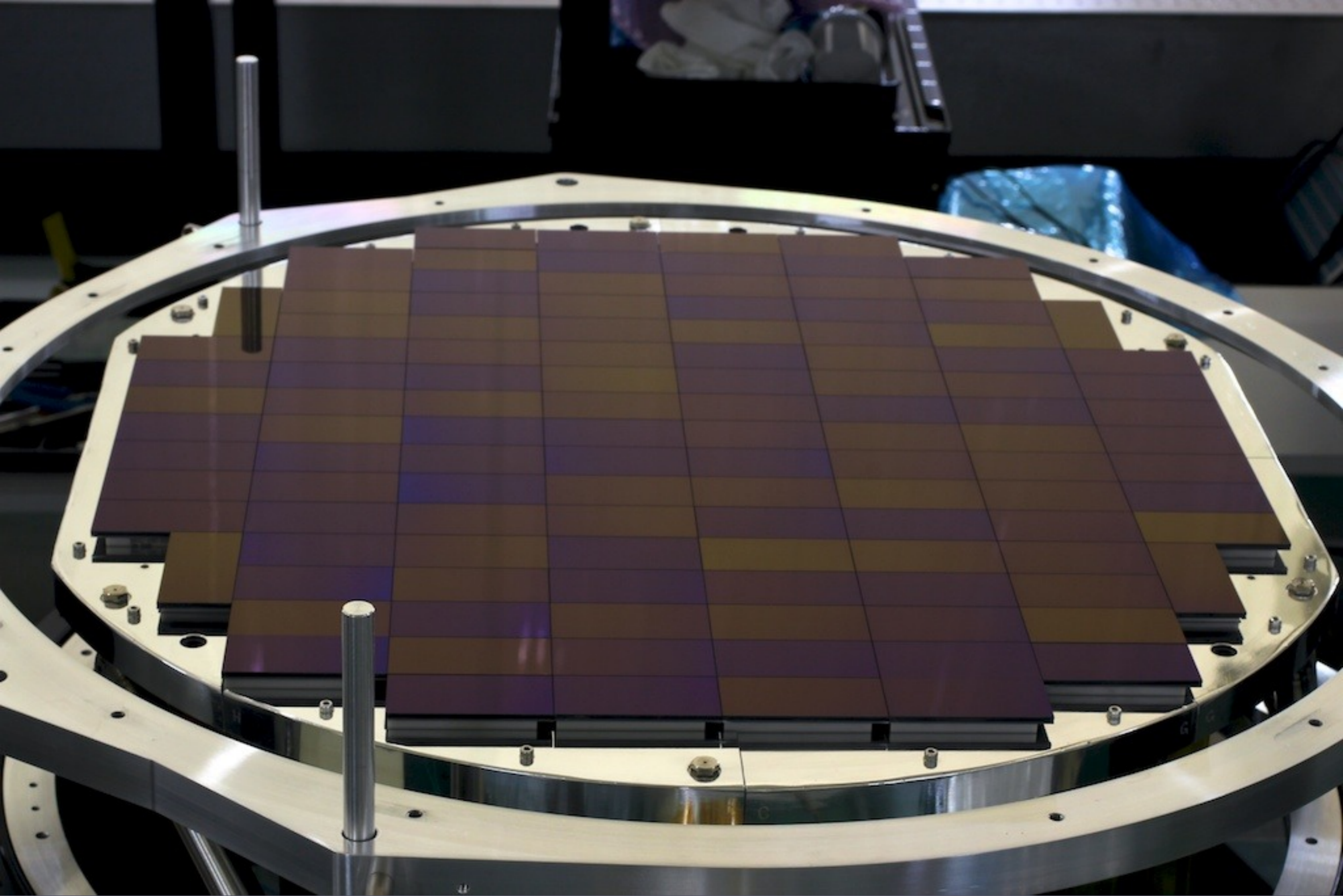
	area ( $\text{deg}^2$ )	pointings	$h^{-3}\text{Gpc}^3$	science
Wide	1400	916	4.4 ( $z < 1.5$ )	WL, galaxies $z \sim 1$
Deep	28	15	0.5 ( $1 < z < 5$ )	galaxies $z < 2$ , SNeIa
Ultra-Deep	3.5	2	0.07 ( $2 < z < 7$ )	LAEs, LBGs, SNeIa

# HSC para

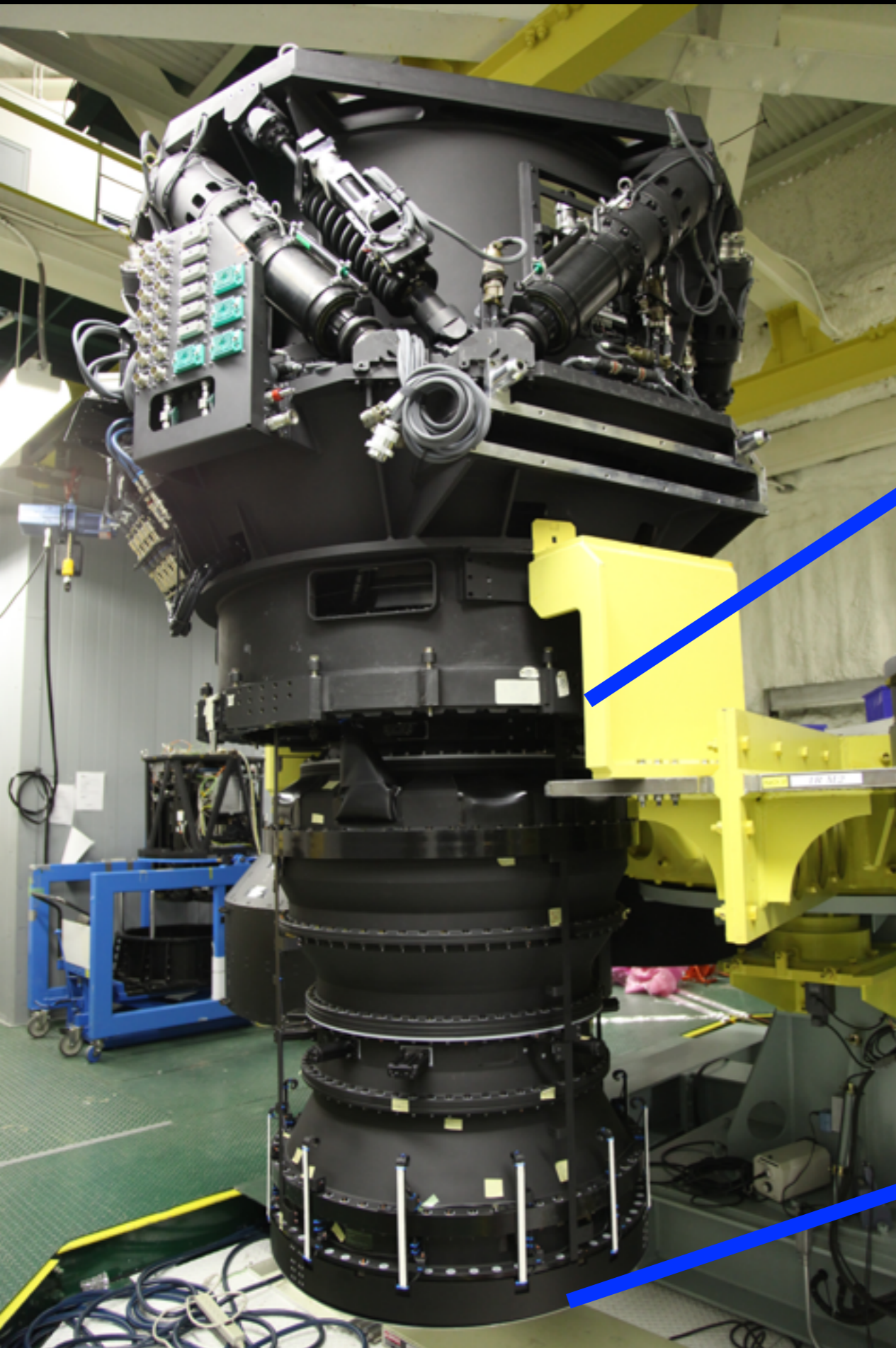
- FoV: 1.5°, 1.77 deg<sup>2</sup>
- 15μm, 870M pixels
- *grizy* + 6 NBs
- three surveys, **approved to start Feb 2014**



	area (deg <sup>2</sup> )	pointings	$h^{-3}\text{Gpc}^3$	science
Wide	1400	916	4.4 ( $z < 1.5$ )	WL, galaxies $z \sim 1$
Deep	28	15	0.5 ( $1 < z < 5$ )	galaxies $z < 2$ , SNeIa
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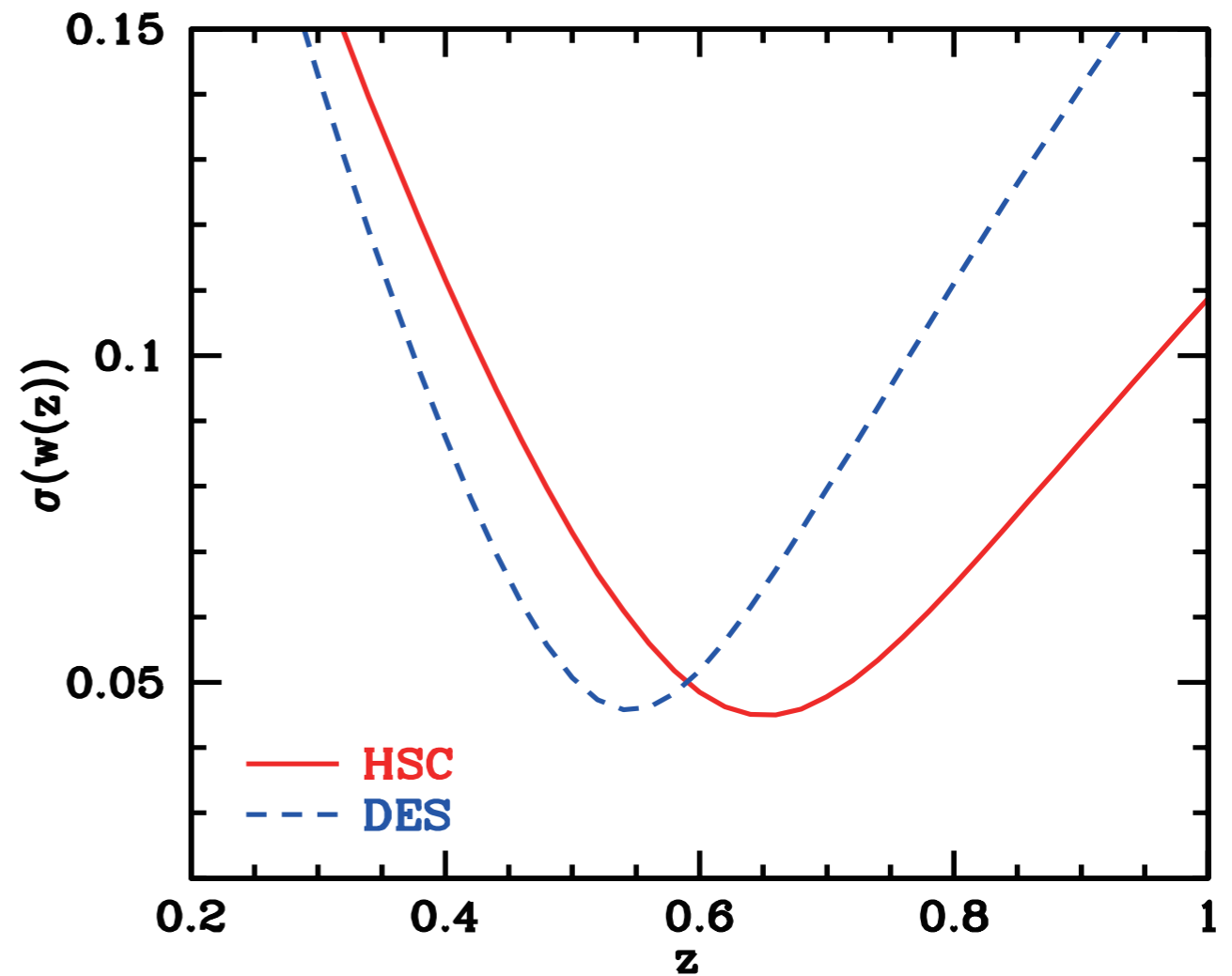
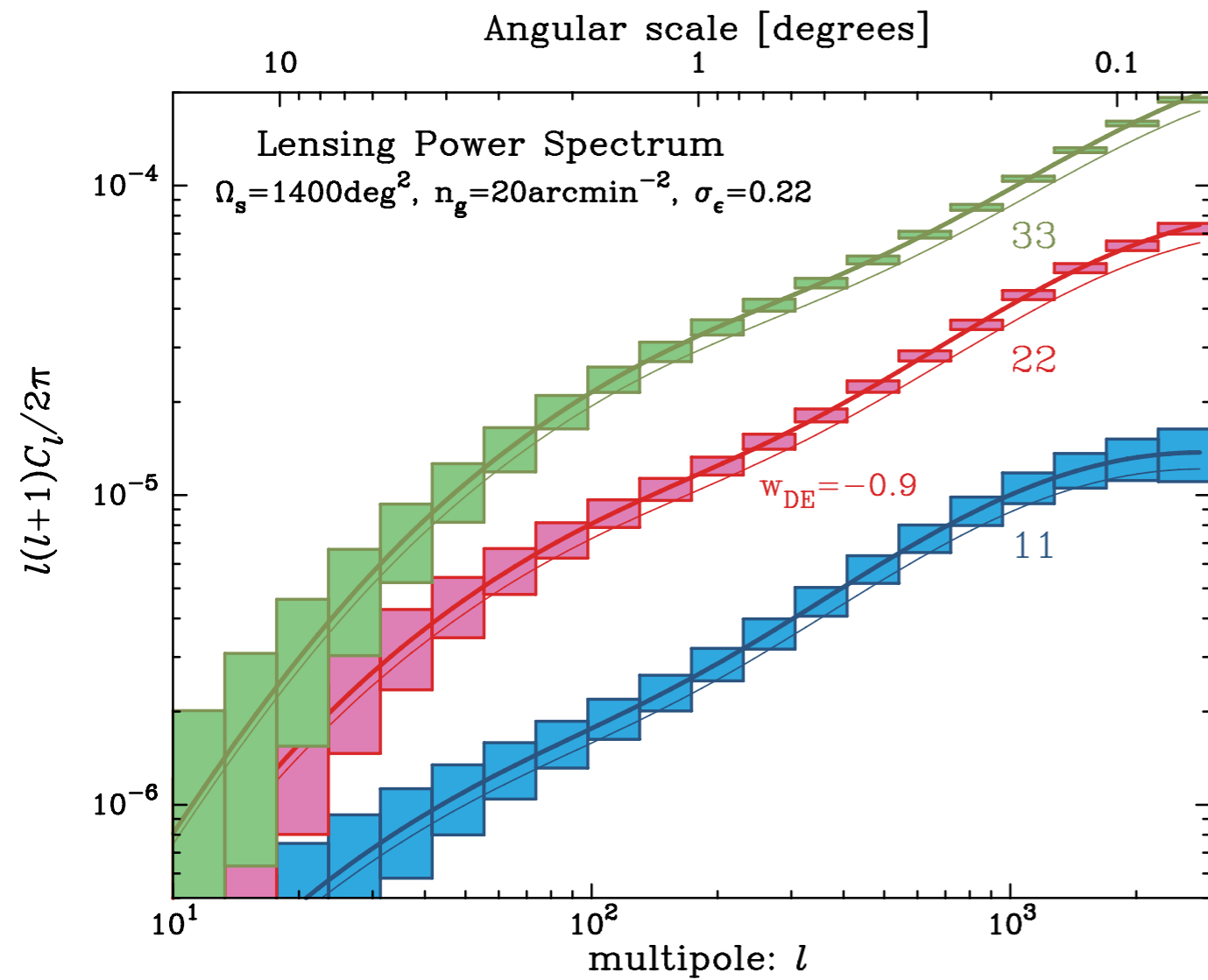


# すばる望遠鏡に搭載された Hyper Suprime-Cam

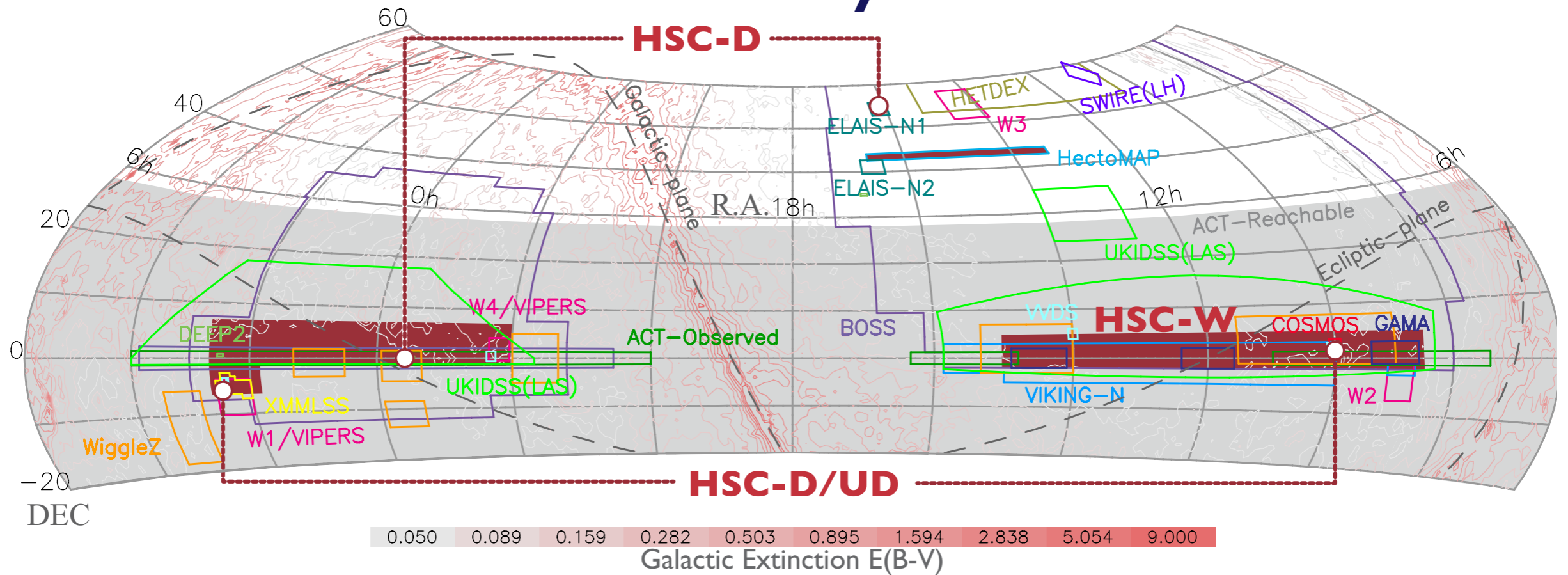
2012年8月16日撮影 (180倍速)

Installing Hyper Suprime-Cam on the Subaru Telescope

# Cosmic Shear



# HSC Survey Fields

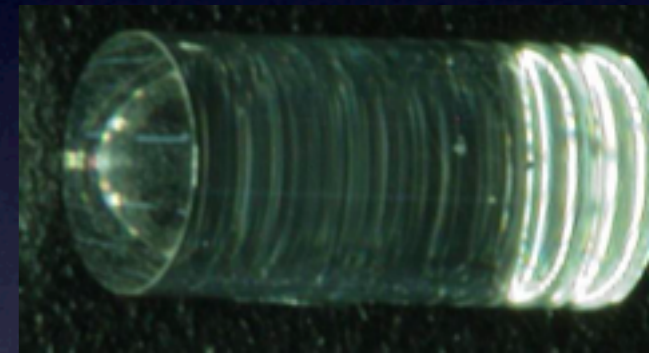


- HSC Survey Fields selected based on
  - Overlap with SDSS regions, and overlap with other interesting datasets (ACT CMB, NIR, spectroscopic surveys, ...)
  - Low dust extinction
  - Spread in RA

# PFS parameters

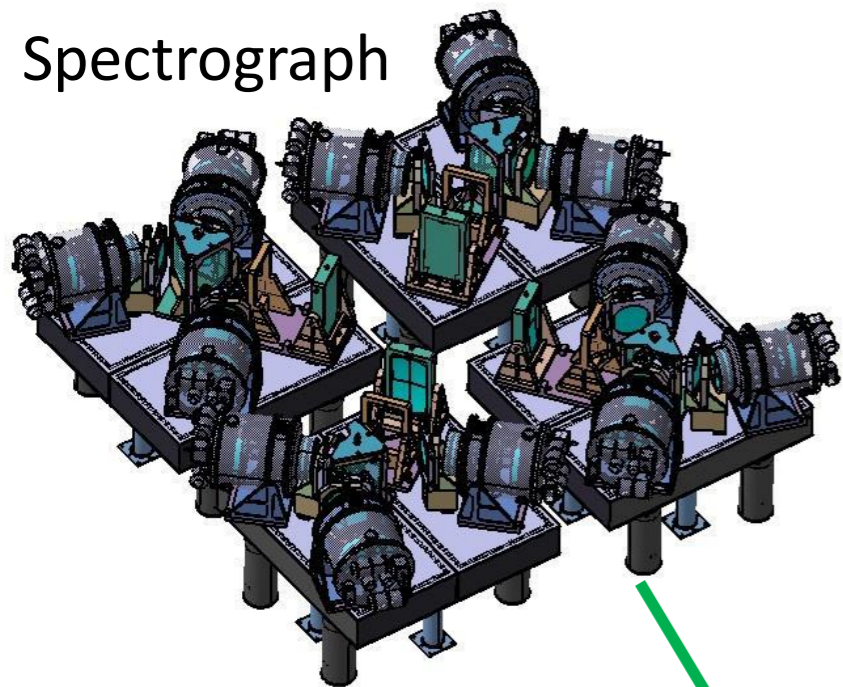


- 2400 fibers, 128 $\mu$ m, microlens f/2.2  $\rightarrow$  f/2.8
- FoV: 1.3 degrees
- share WFC with HSC
- 4 spectrographs for 600 fibers each
- $\lambda=0.38-1.26\mu$ m with three arms

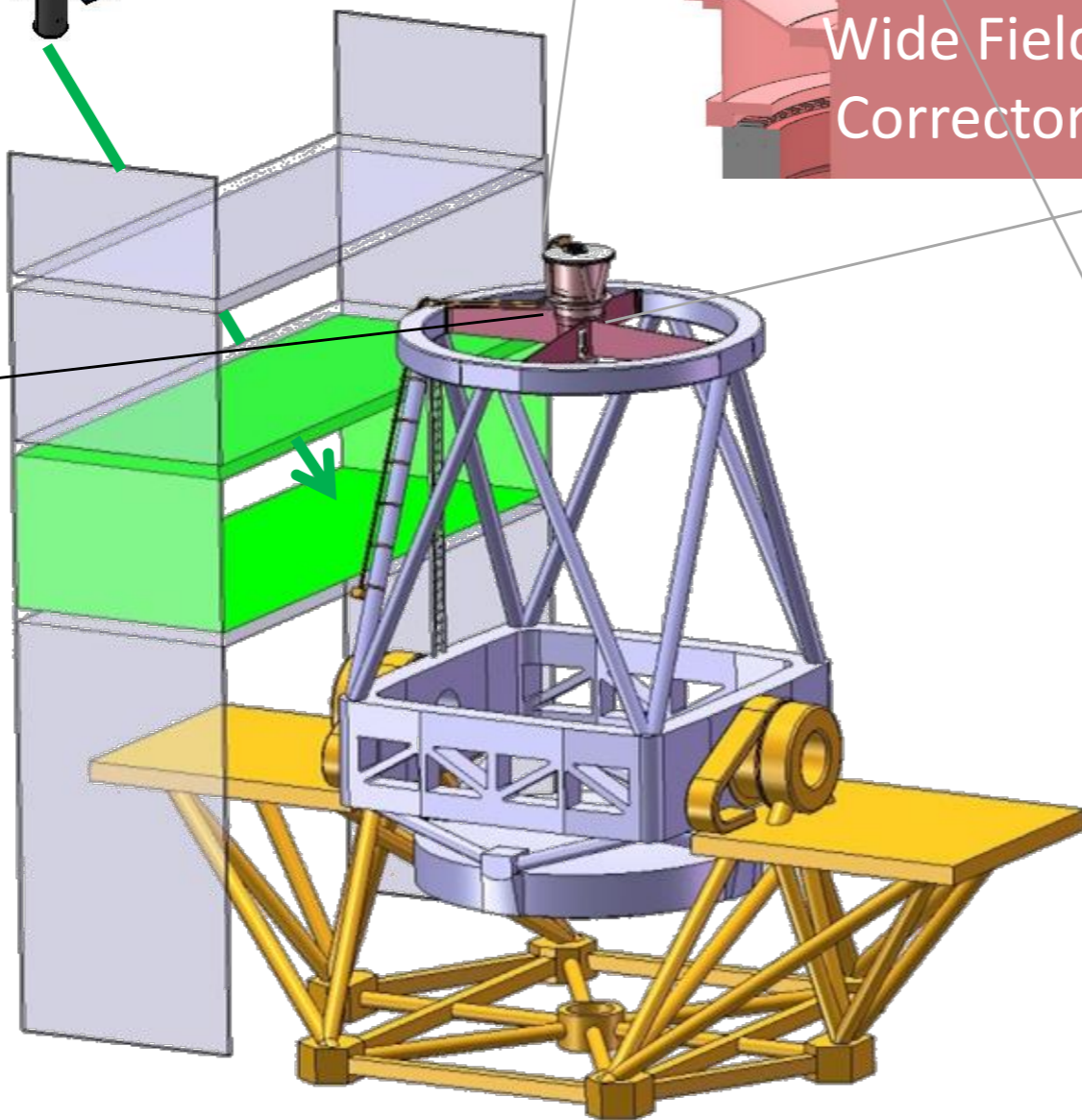


blue	2800–6400 nm	R~2500	Hamamatsu (special coating)
red	6400–9550 nm	R~3200, 5000	Hamamatsu (same as HSC)
near IR	9550–12600 nm	R~4500	Teledyne HgCdTe (<1.7 $\mu$ )

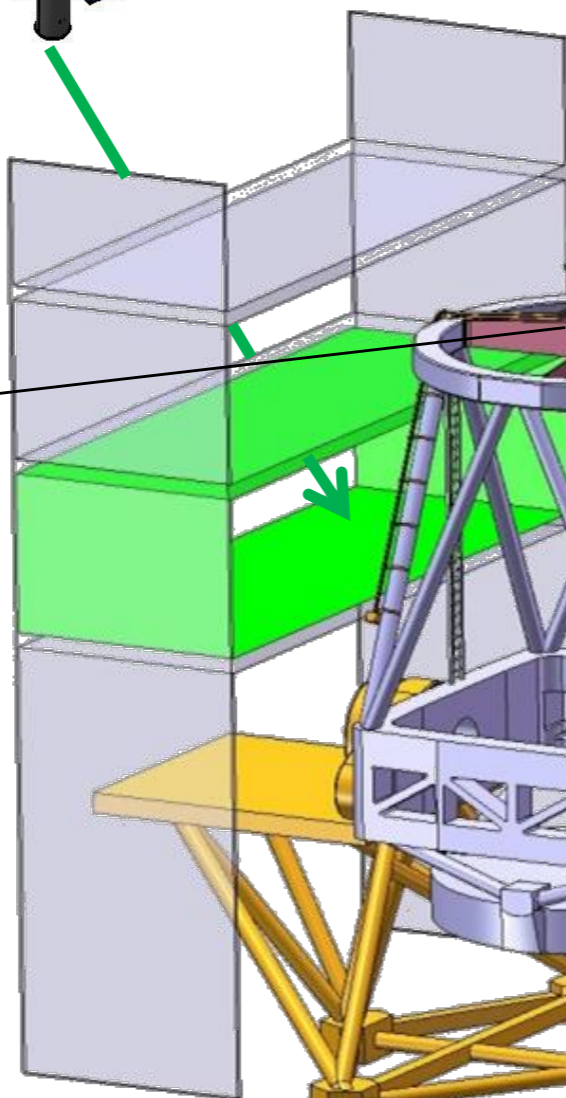
Spectrograph



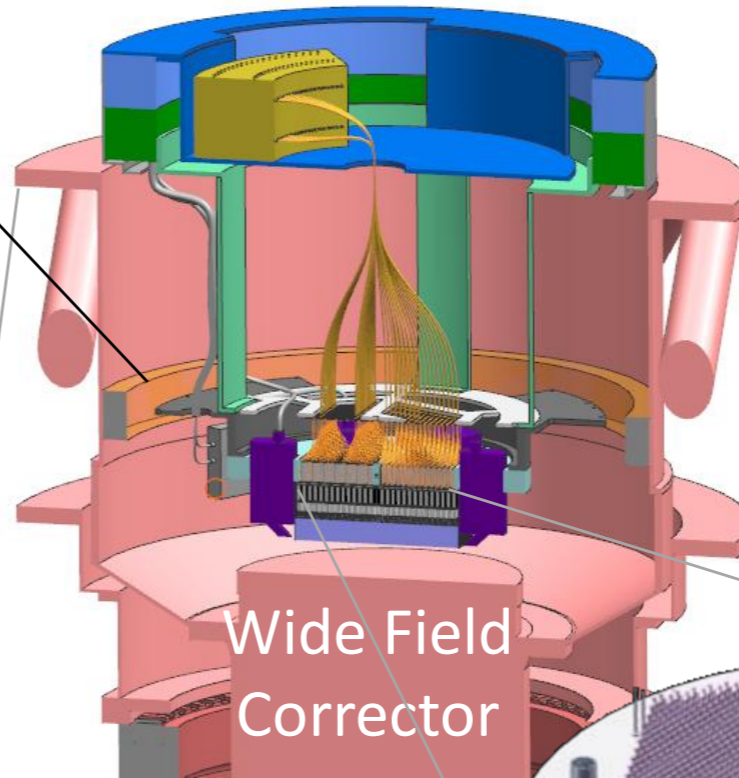
Rotator



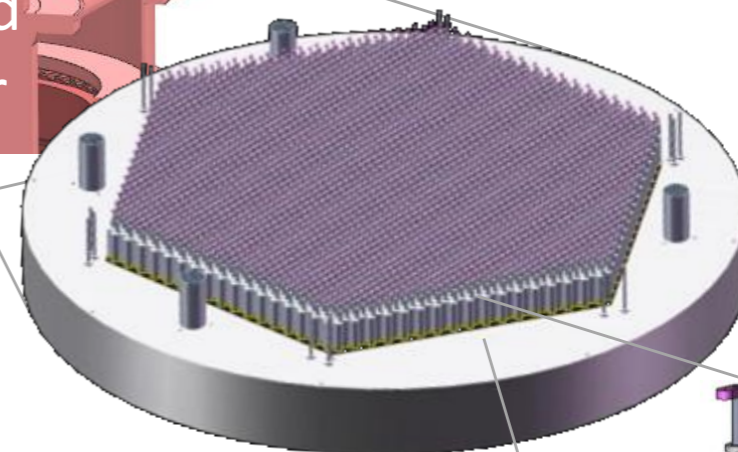
Fiber Connector



Prime Focus Instrument



Wide Field Corrector

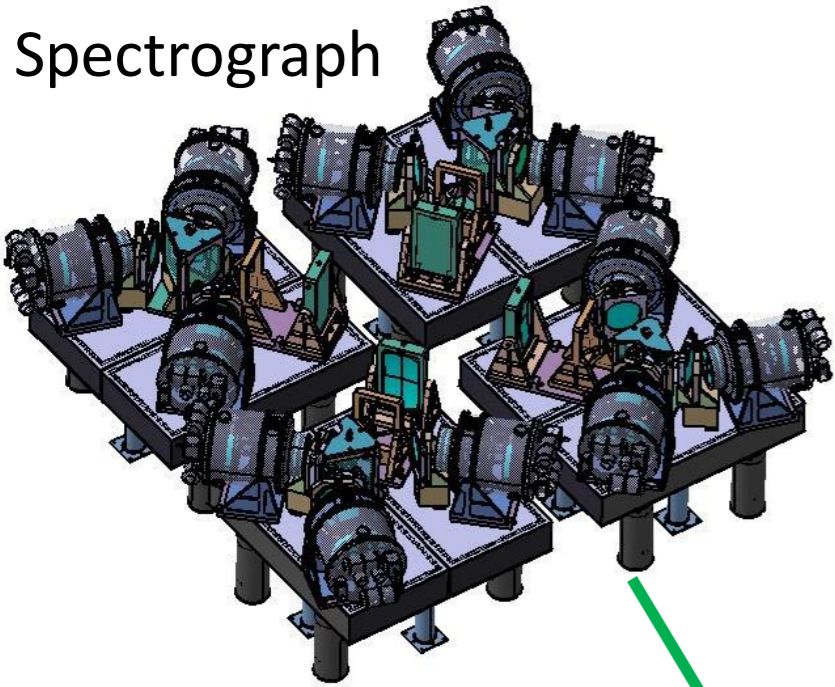


Fiber Positioner  
Cobra

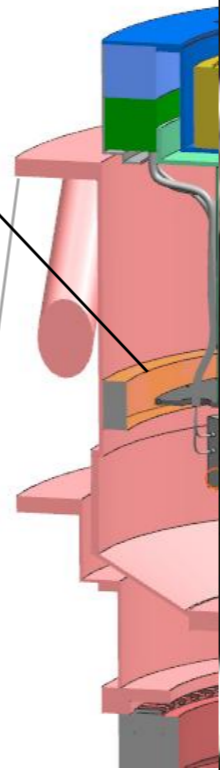


5 $\mu$  accuracy in 7 iterations  
7.7mm diameter

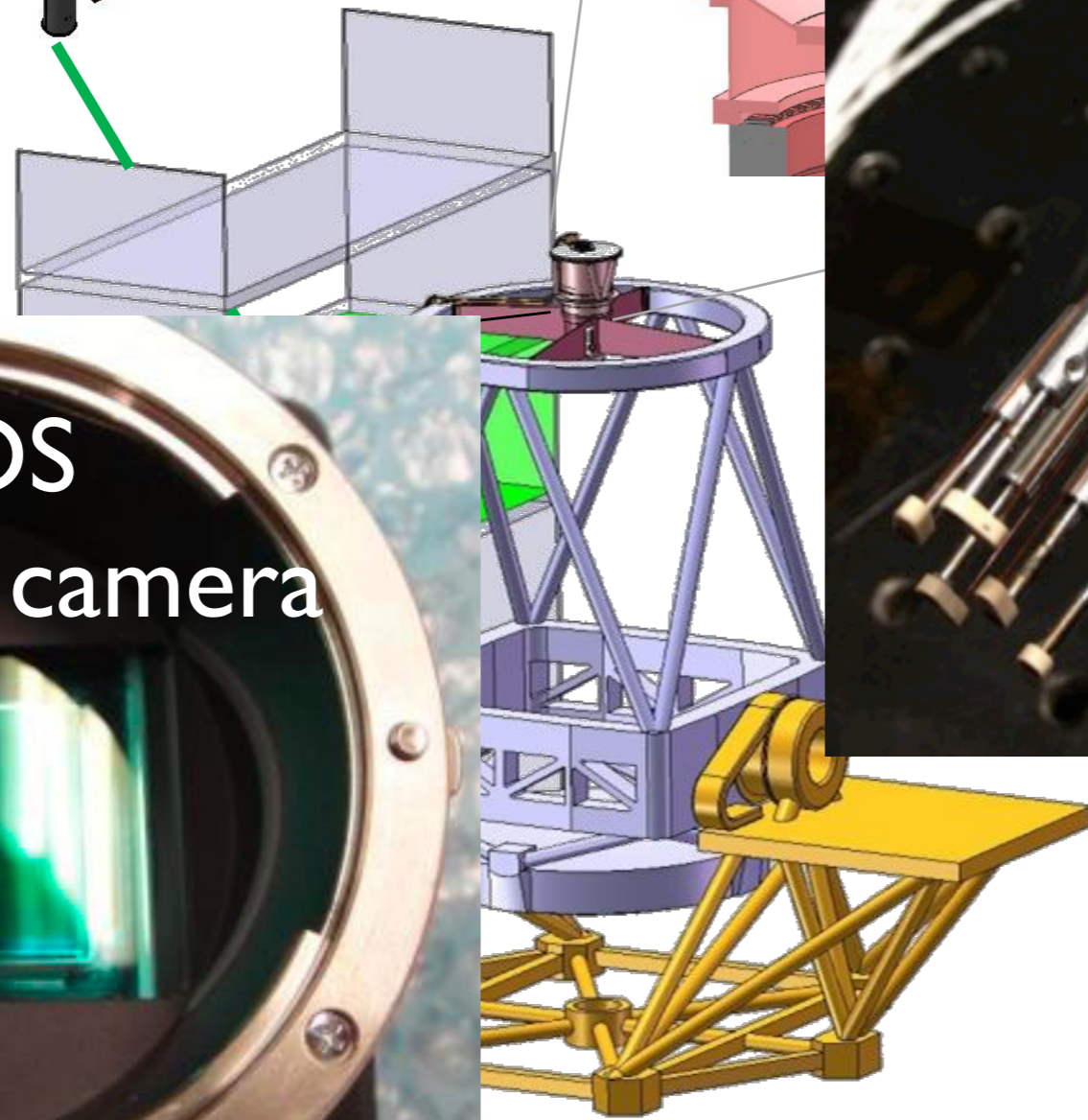
Spectrograph



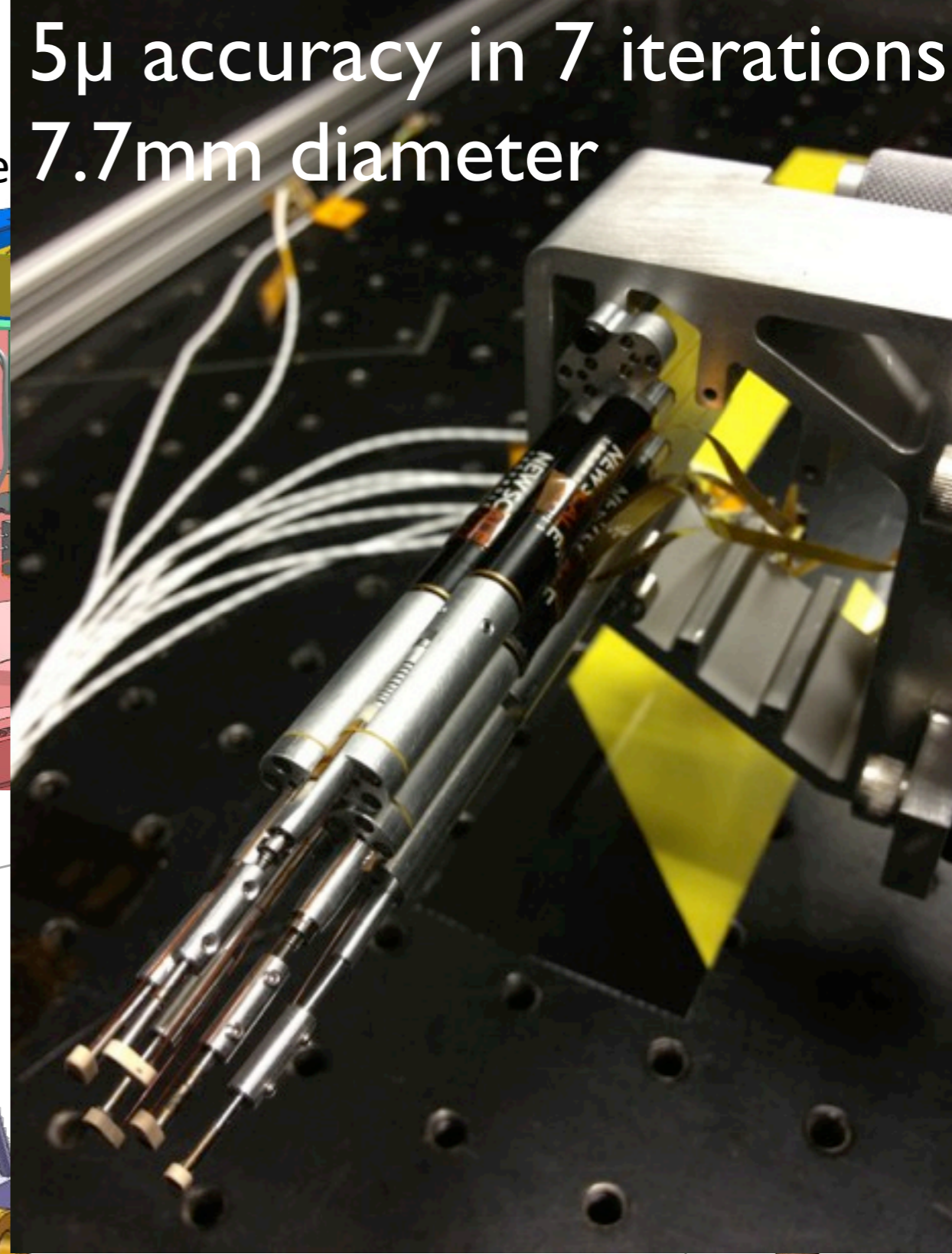
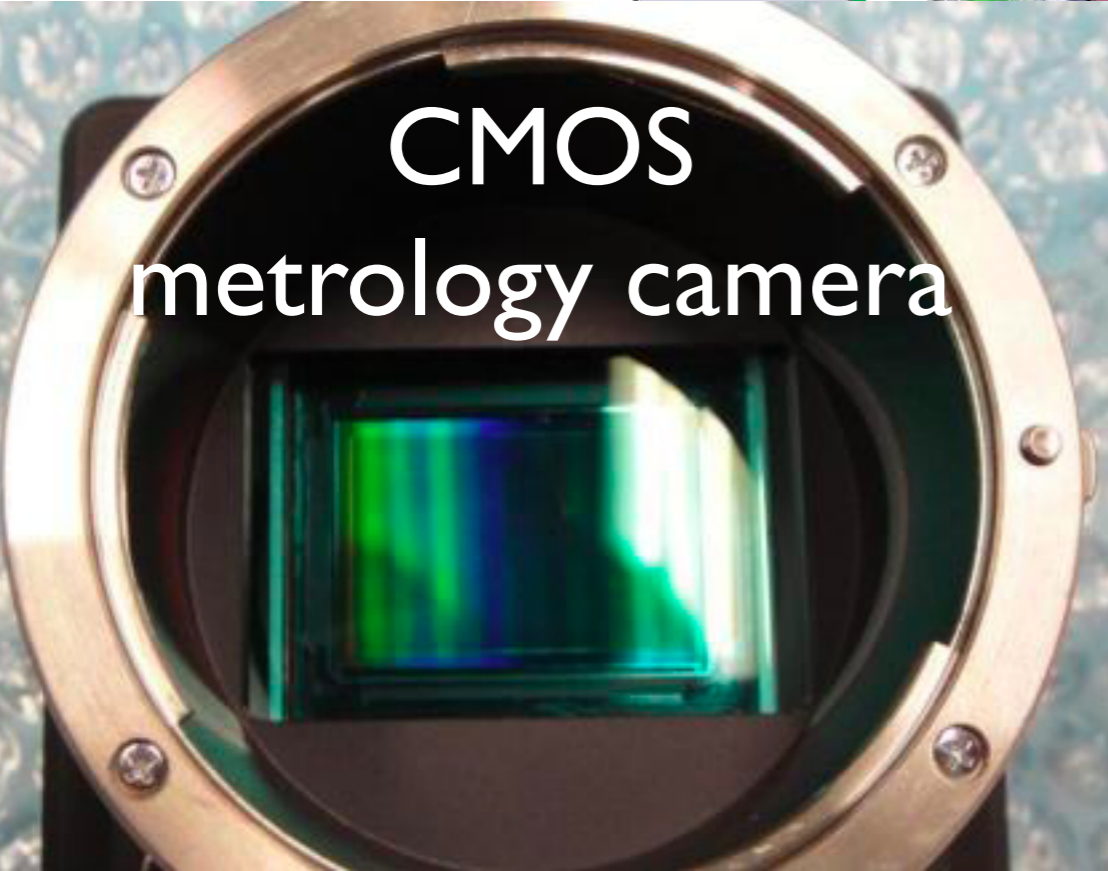
Rotator



Prime



CMOS  
metrology camera

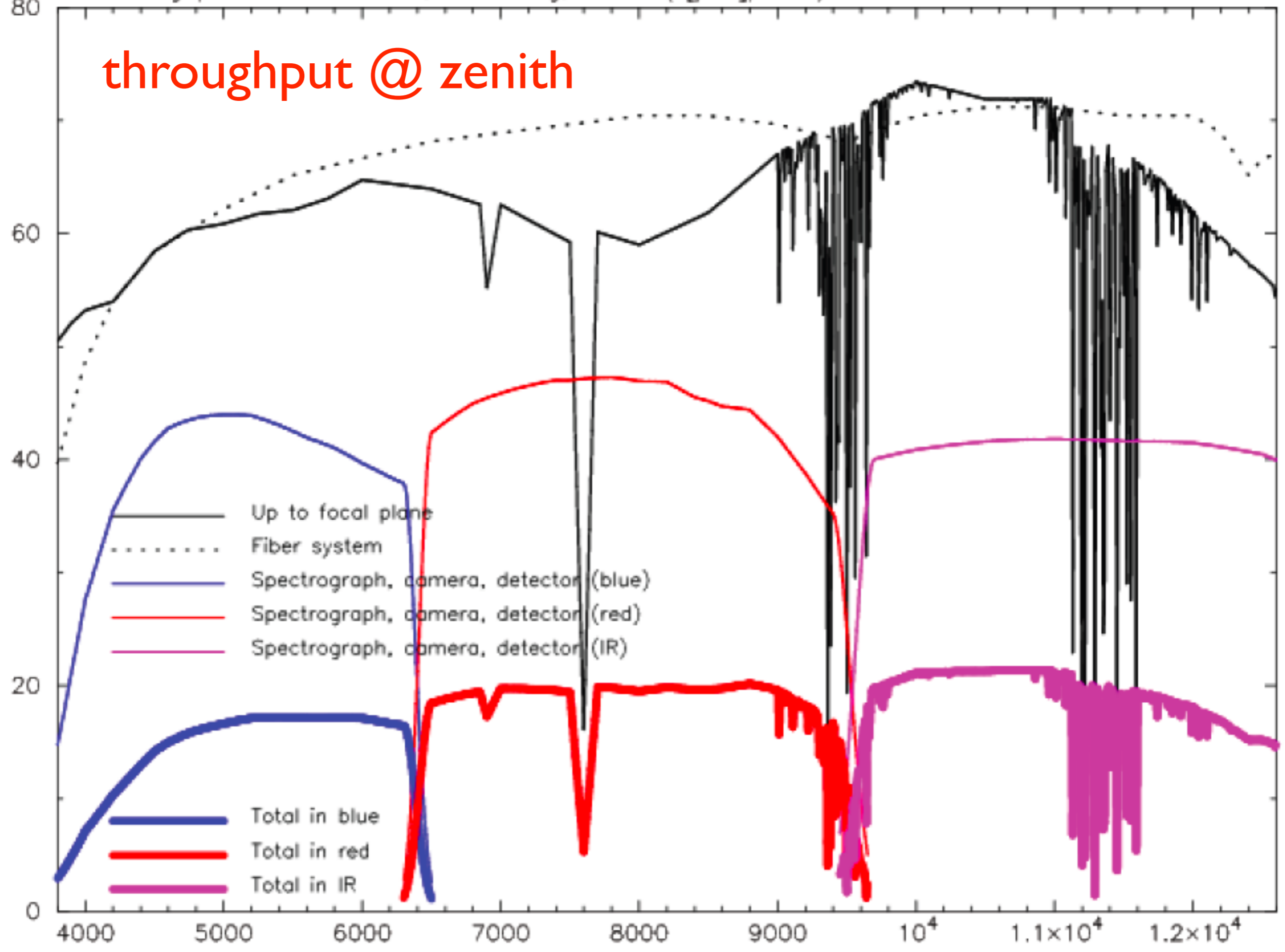


Fiber Positioner  
Cobra



throughput @ zenith

Throughput [%]



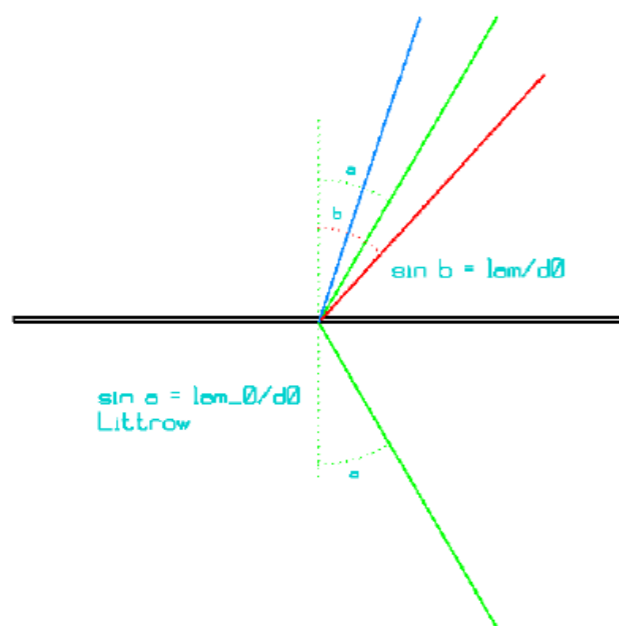
Wavelength [Å]



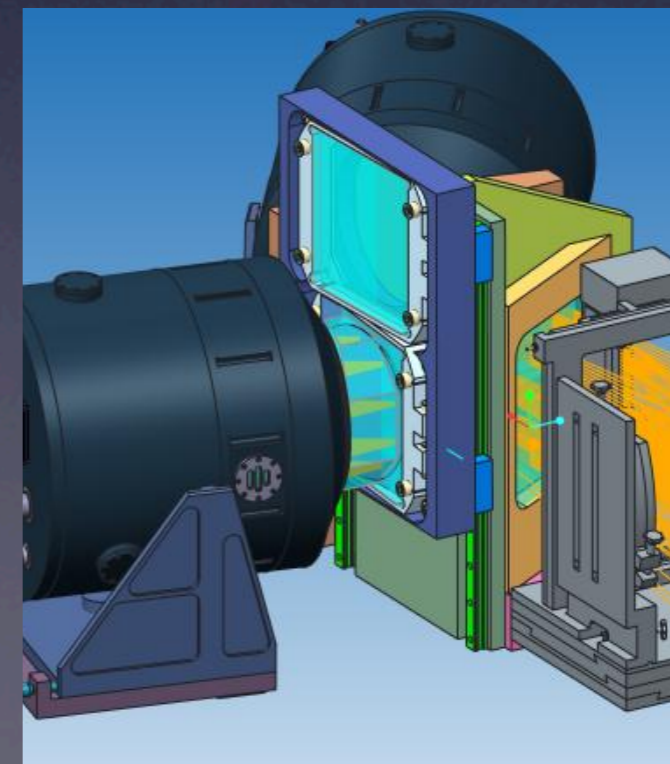
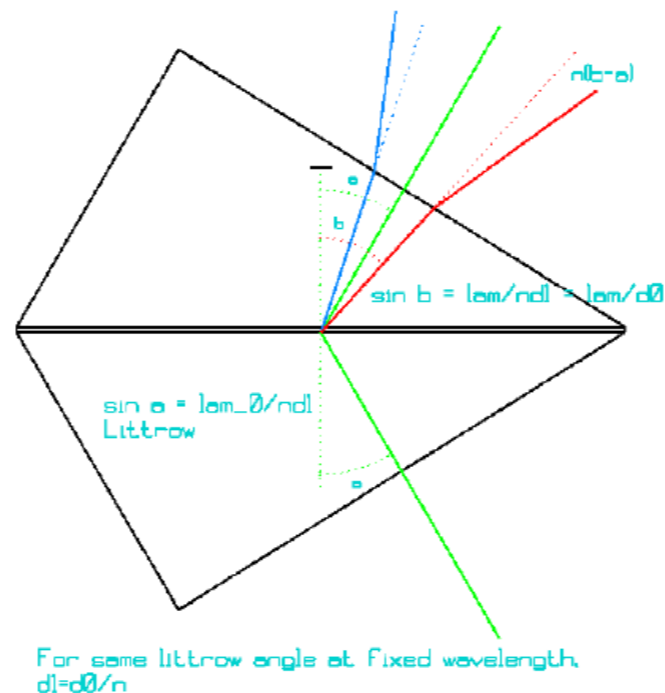
# Medium Resolution

- re-evaluation of galactic archaeology: dynamics study found very exciting together with the GAIA data, now with medium resolution option  $R \sim 5000$  for red
- simple design with little risk

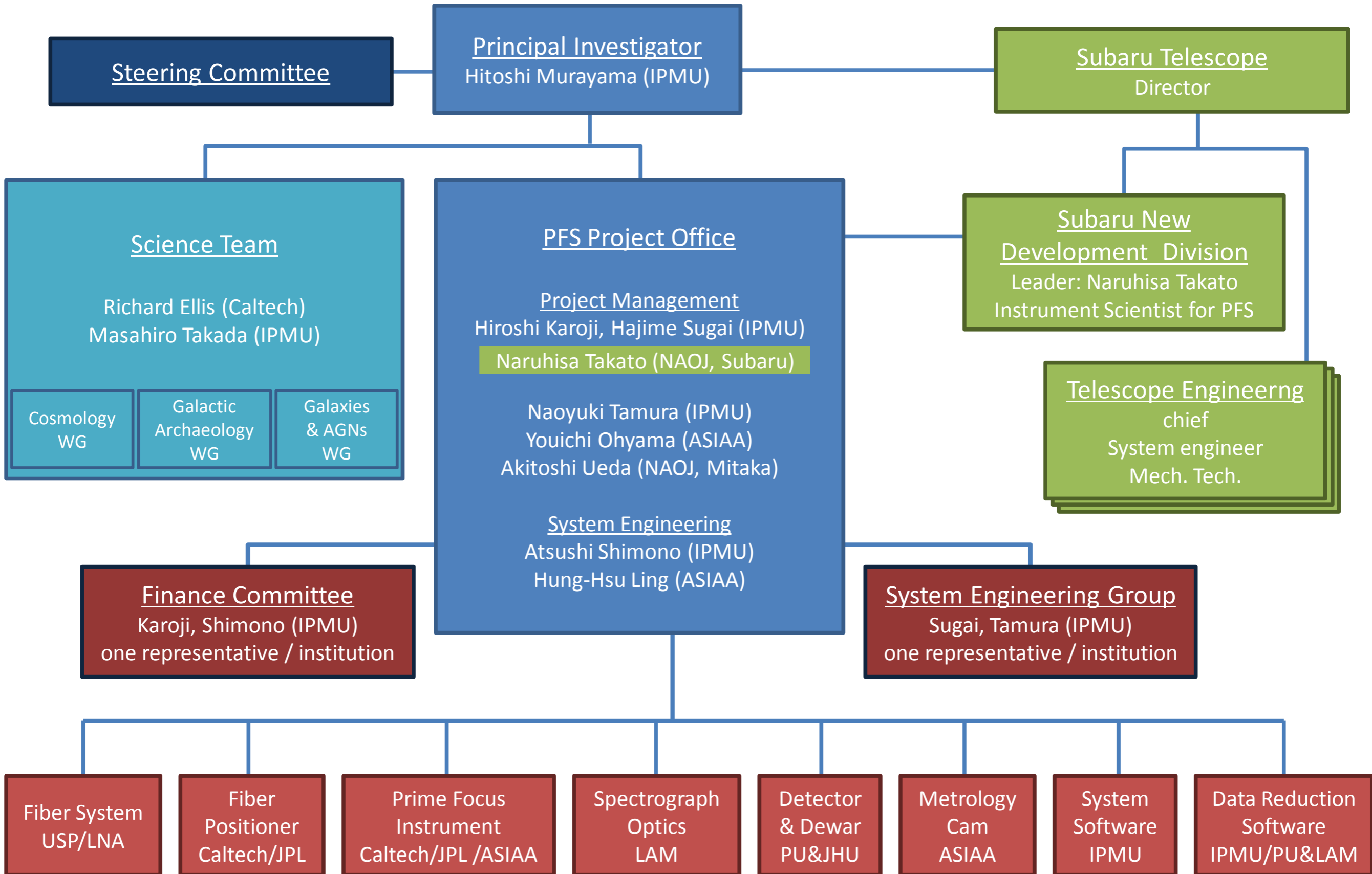
Low resolution - grating



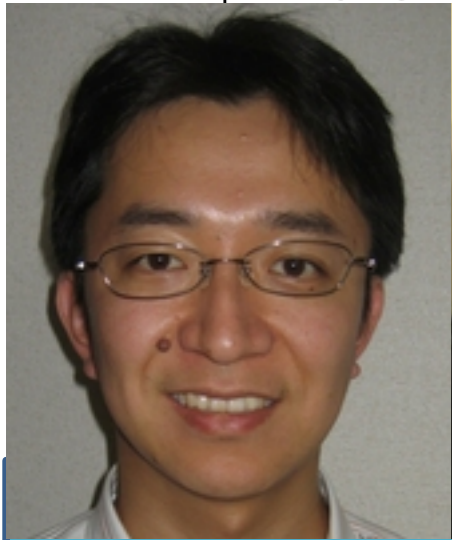
Medium resolution - grism



# PFS Organization Structure



# PFS Organization Structure



Principal Investigator  
Hitoshi Murayama (IPMU)

Subaru Telescope  
Director

Science Team  
Richard Ellis (Caltech)  
Masahiro Takada (IPMU)

Cosmology WG	Galactic Archaeology WG	Galaxies & AGNs WG
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PFS Project Office  
Project Management  
Hiroshi Karoji, Hajime Sugai (IPMU)  
Naruhisa Takato (NAOJ, Subaru)

Naoyuki Tamura (IPMU)  
Youichi Ohyama (ASIAA)  
Akitoshi Ueda (NAOJ, Mitaka)

System Engineering  
Atsushi Shimono (IPMU)  
Hung-Hsu Ling (ASIAA)

Subaru New Development Division  
Leader: Naruhisa Takato  
Instrument Scientist for PFS

Telescope Engineering  
chief  
System engineer  
Mechanical engineer

Finance Committee  
Karoji, Shimono (IPMU)  
one representative / institution

System Engineering Group  
Sugai, Tamura (IPMU)  
one representative / institution

Fiber System  
USP/LNA

Fiber Positioner  
Caltech/JPL

Prime Focus Instrument  
Caltech/JPL /ASIAA

Spectrograph Optics  
LAM

Detector & Dewar  
PU&JHU

Metrology Cam  
ASIAA

System Software  
IPMU

Data Reduction Software  
IPMU/PU&LAM



# Major Milestones

Jan 2011 endorsement by Subaru community

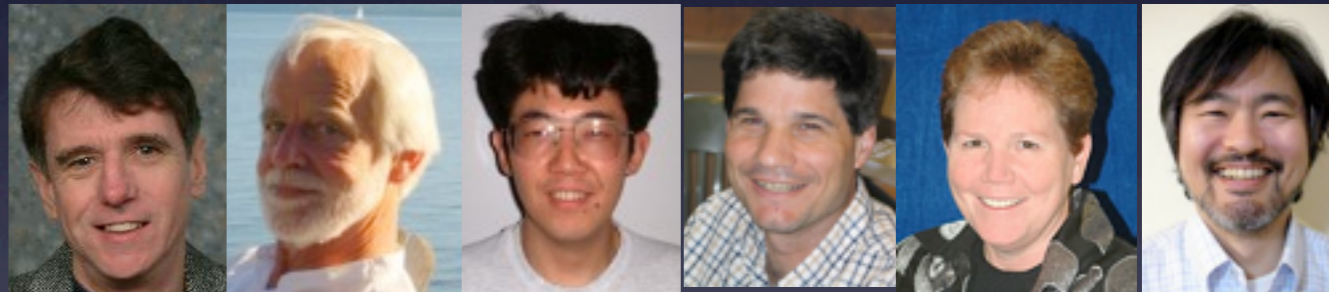
Dec 2011 MOU between IPMU & NAOJ

Mar 2012 CoDR

Oct 2012 Requirement Review

Feb 2013 PDR →

now subsystem CDRs

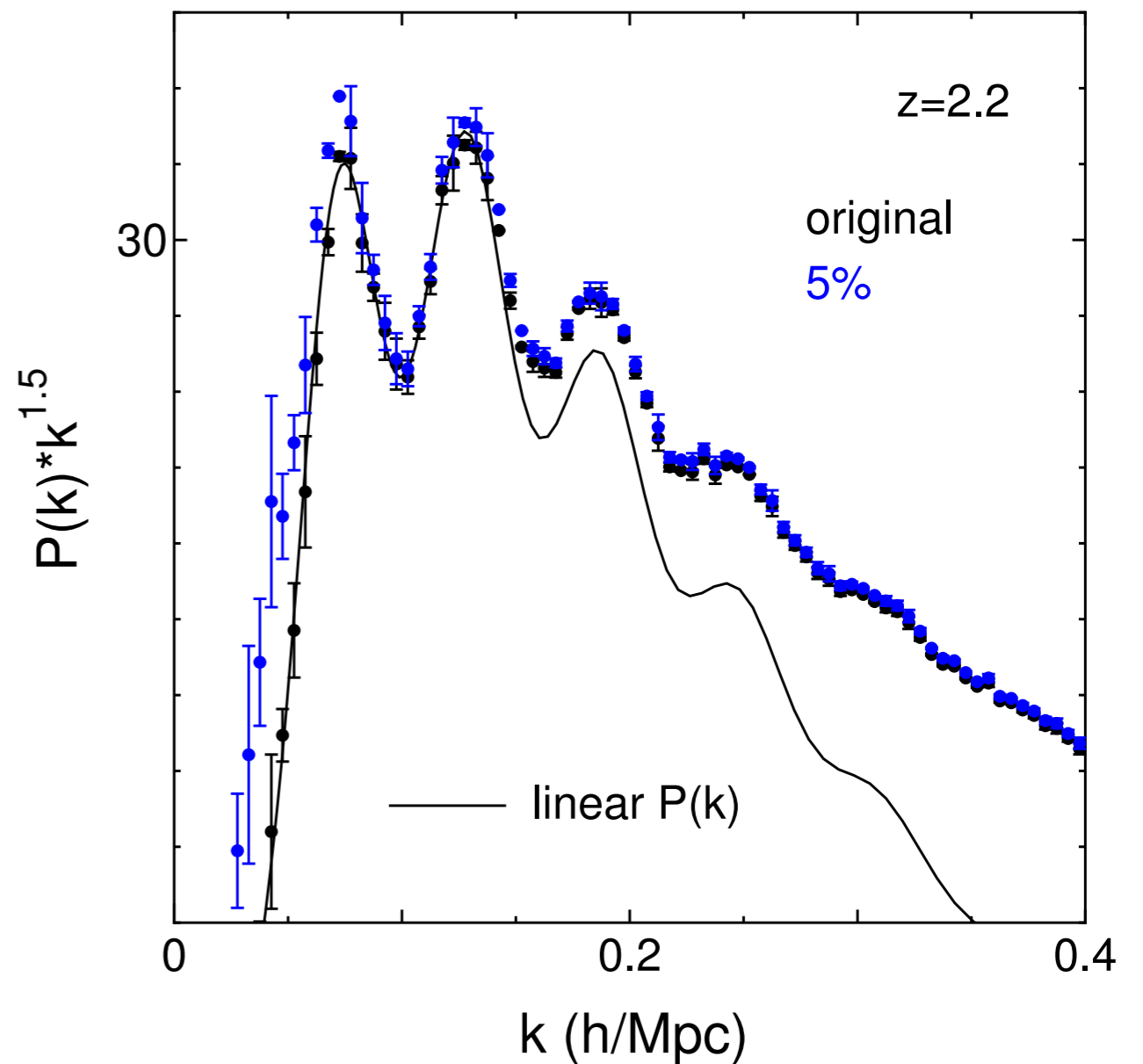
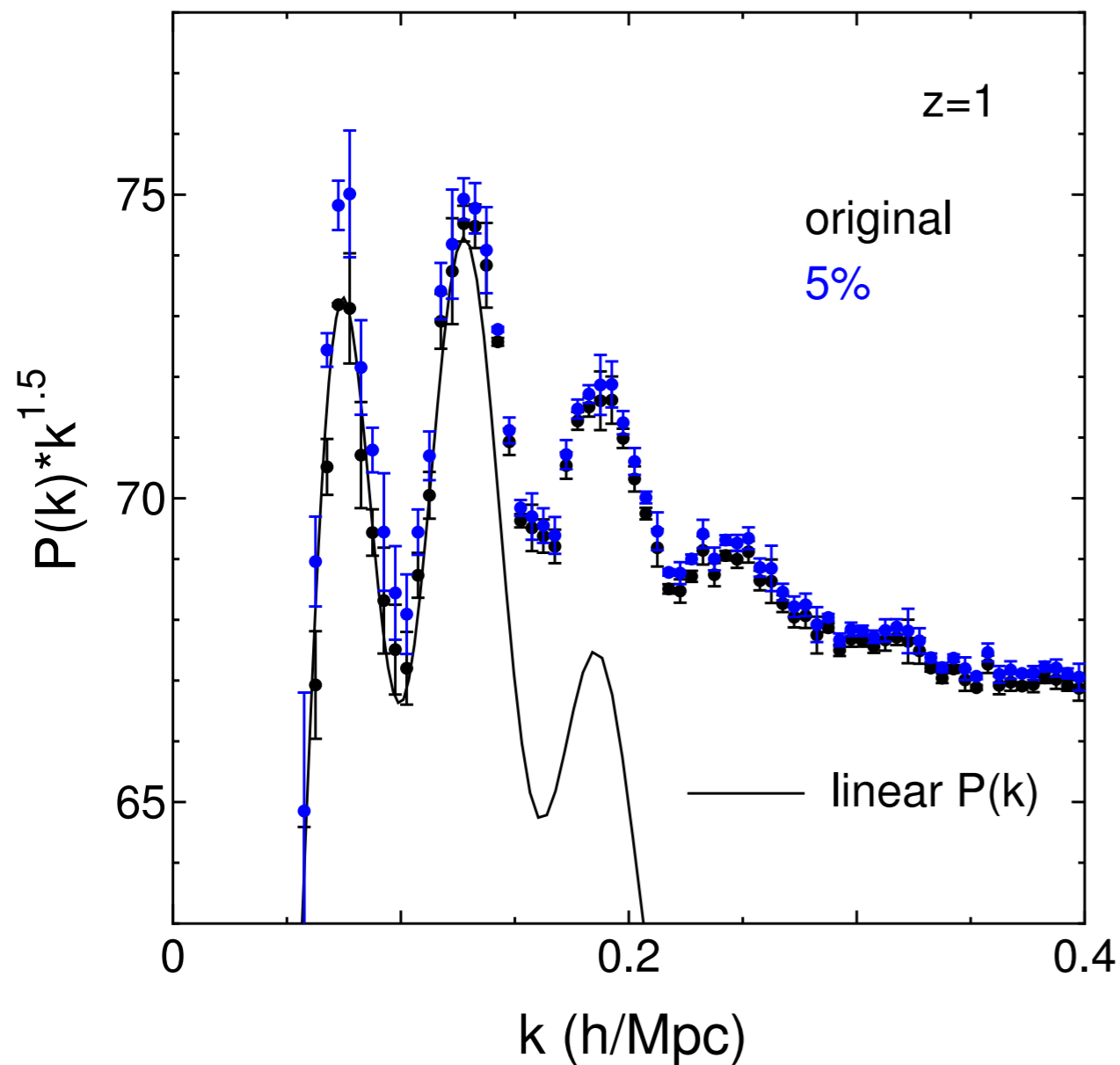


Jul 2016 System Integration, tests

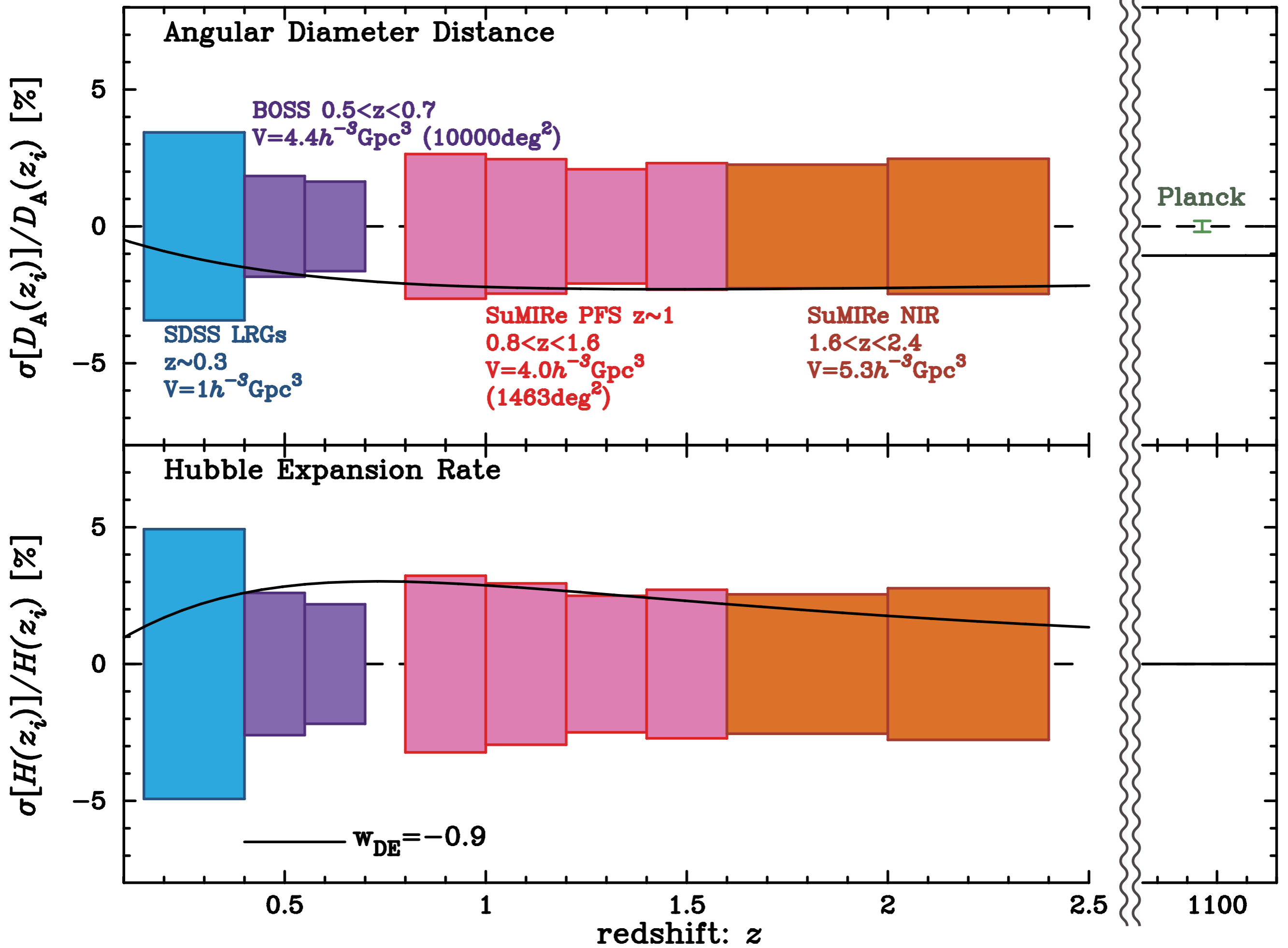
Jun 2017 Operational Readiness Review

Jul 2017 First Light (engineering)

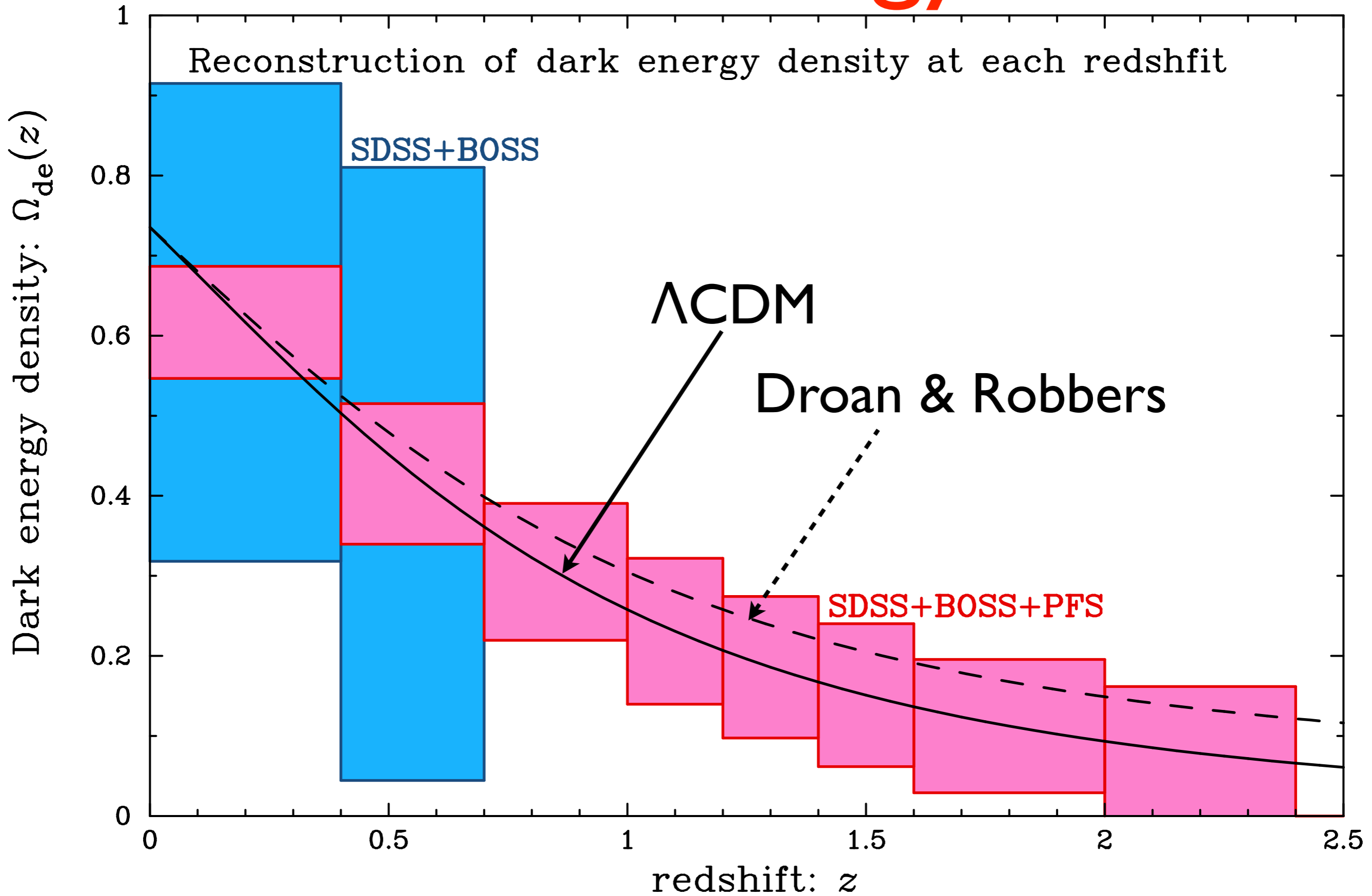
# Ripples, Ripples, Ripples



ELGs [OII]  $> 8.5\sigma$ , 15 min exposure



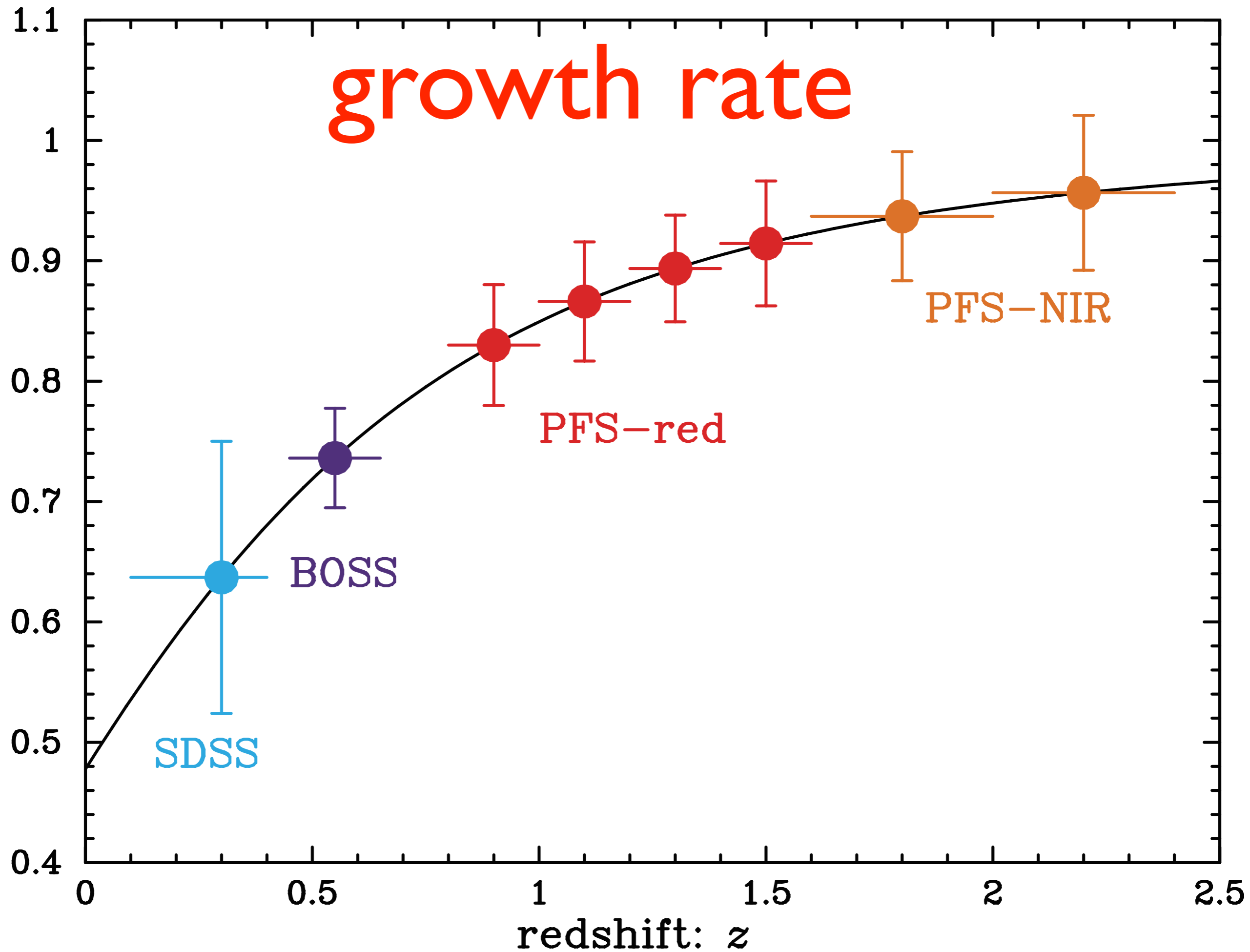
# Dark Energy





growth rate:  $f_g = d \ln D / d \ln a$

# growth rate





# PFS Rocks!

*Subaru Prime Focus Spectrograph*

<http://sumire.ipmu.jp/pfs/intro.html>