Current status of K-SPEC for A-SPEC

> Perhaps the one unifying characteristic is that surveys tend to support a broad variety of studies, many of which haven't been thought of by the survey's originators. Another unifying

Djorgovski+12

Survey Science Group Workshop 2023
2023. 1. 18.

Jae-Woo Kim (KASI)
& A-SPEC Team

Spectroscopic Surveys

Large Imaging Surveys

- SDSS
- DES
- LSST
- Space Telescope: Euclid, Roman Space Telescope

=> Huge number of sources

Spec-z Survey becomes more important!!!

Current/Future Spec-z Survey

Wide Field-of-View

- DESI: 8deg^2
- 4MOST: 2.5deg diameter

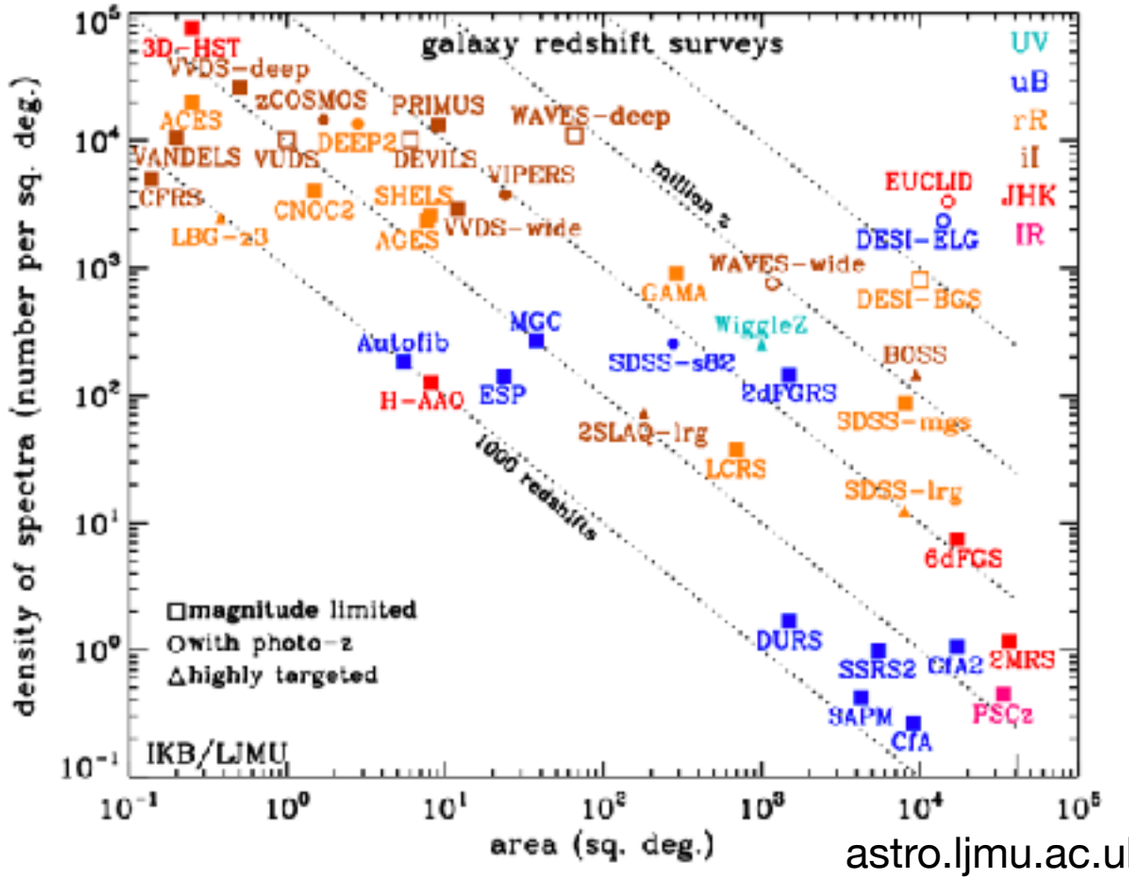
Large Survey Telescopes

- DESI: 4m
- 4MOST: 4m
- MSE(?): 8-10m

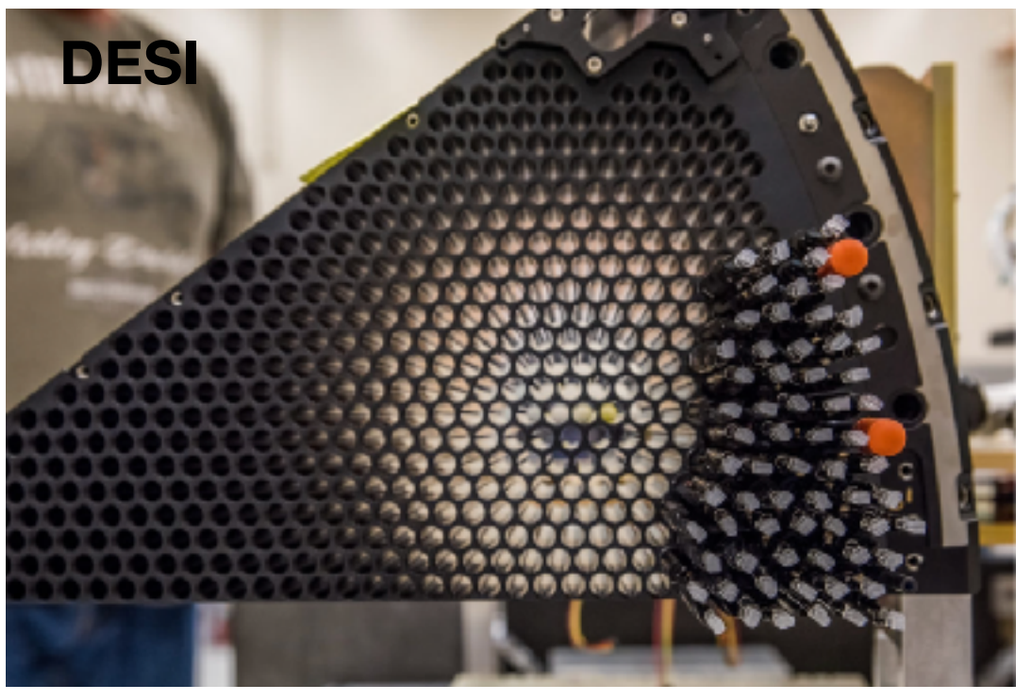
Multiplex (at once)

- DESI: 5,000 targets
- SDSS-V: 500 targets
- 4MOST: ~240 targets

Deeper & More with large telescopes



astro.ljmu.ac.uk



www.desi.lbl.gov

Why do we need a new survey?

Science cases demanded for the low-z universe

Galaxy Evolution & Galaxy Cluster

- Local superclusters and their members (with K-DRIFT)
- Construction of a complete catalog of galaxy clusters/groups
- Connection between BCG and host clusters
- Evolutionary stage of galaxy clusters from their environment
- Effect of cluster-cluster interaction on galaxy properties
- All-sky bright quasar survey

Cosmology

- Cosmic expansion history and dark energy
- Accurate measurement of local density for the Hubble parameter discrepancy
- Cosmological study with local galaxies
- Reconstruction of the local dark matter distribution
- Testing isotropy in the local universe

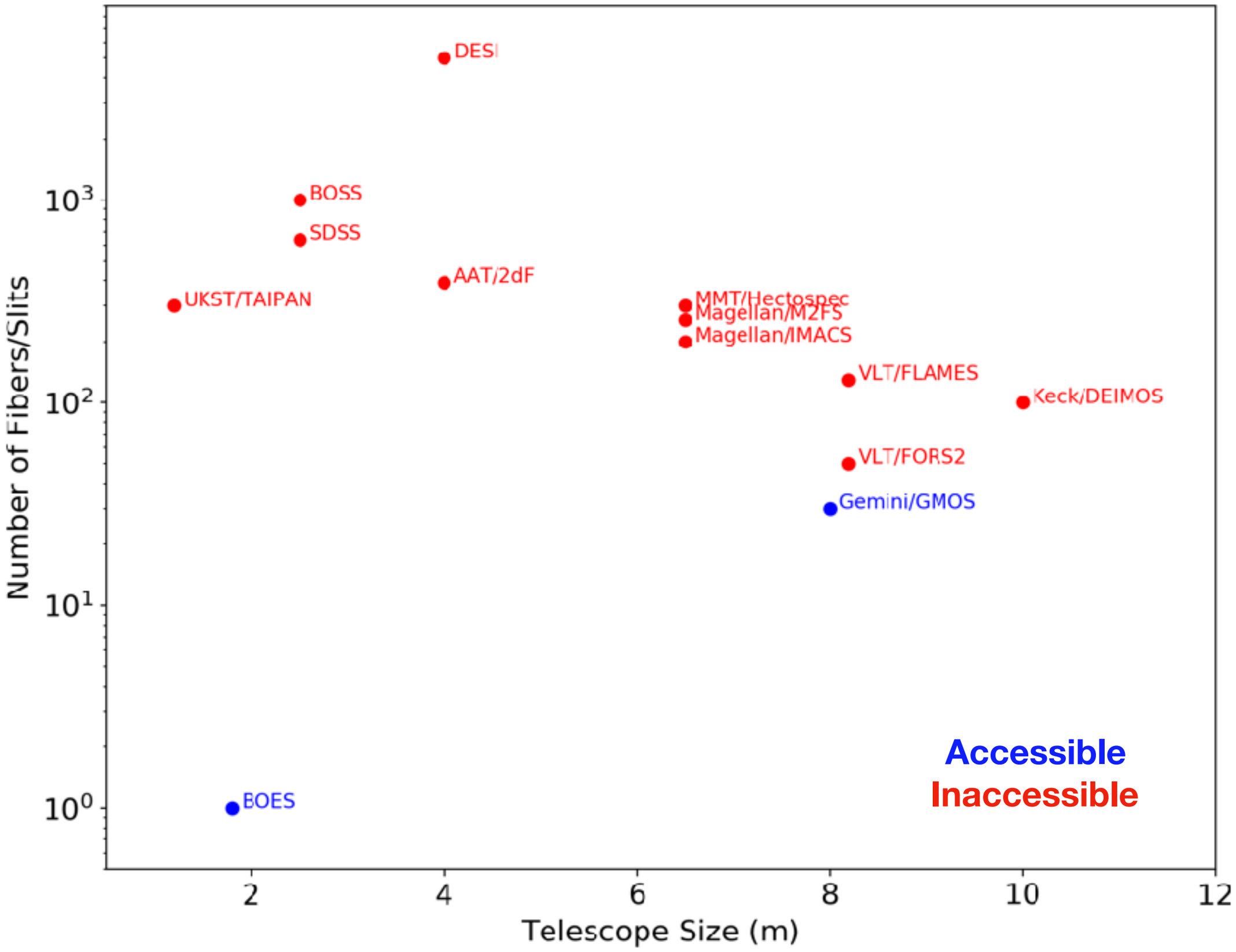
Stellar

- Nearby stars & halo stars
- Chemical linking of dynamical substructures and stellar stream in the MW
- Red supergiant stars in LMC & SMC

"Broad variety of studies, **many of which haven't been thought of by the survey's originators**"

Djorgovski

Optical Multi-Object Spectrograph



What we need?

Spectroscopic Data

Spectra of sources
- redshift, spectral lines, etc

Large Volume
- wide sky coverage

Complete

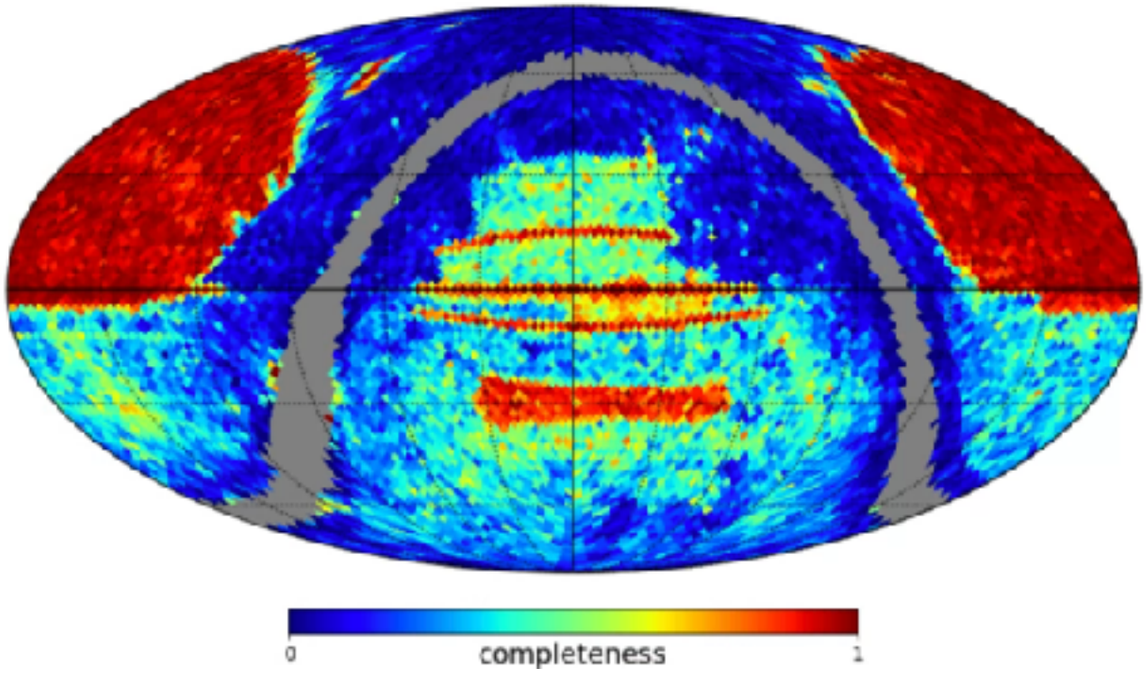
All-sky Spectroscopic Survey (A-SPEC)
- Few all-sky surveys
- Ks<13.75 galaxies

MOS Instrument

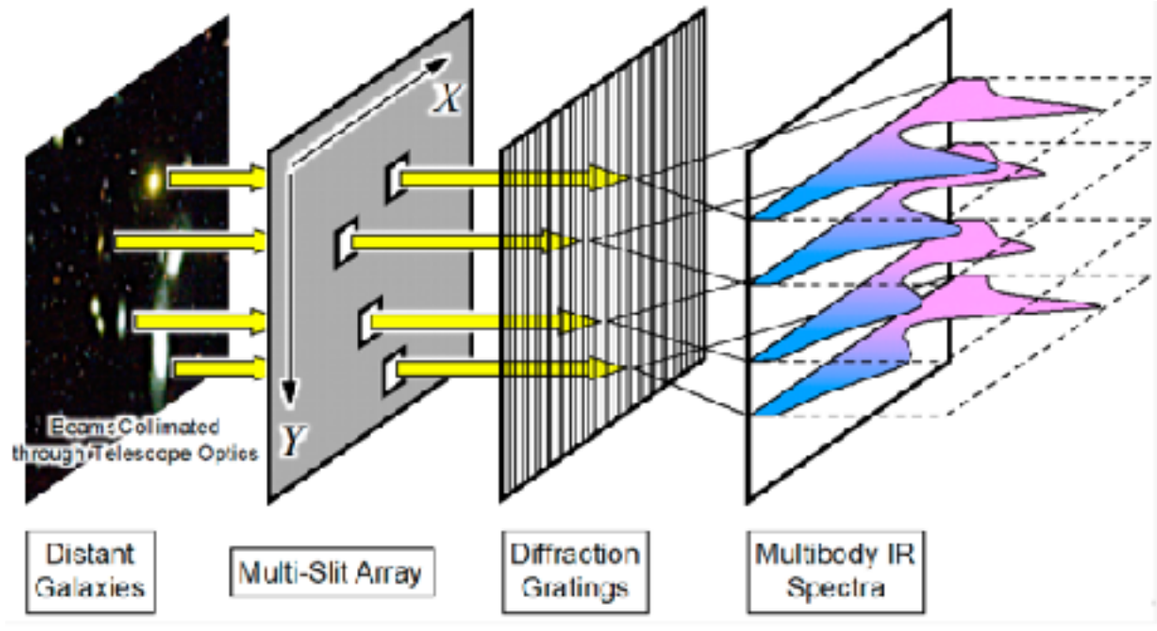
Multi-object spectroscopy
- Fibre fed spectrograph

Wide Field of View
- at least a few deg^2

New Instrument (K-SPEC)
- Our own one for the survey

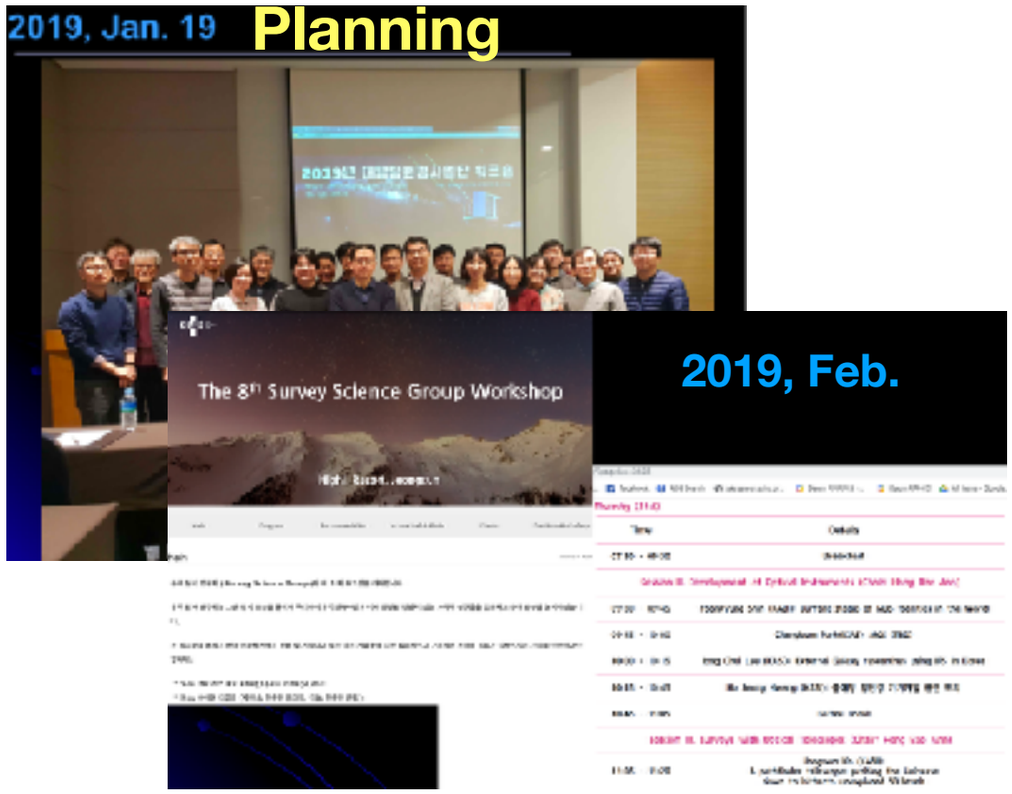


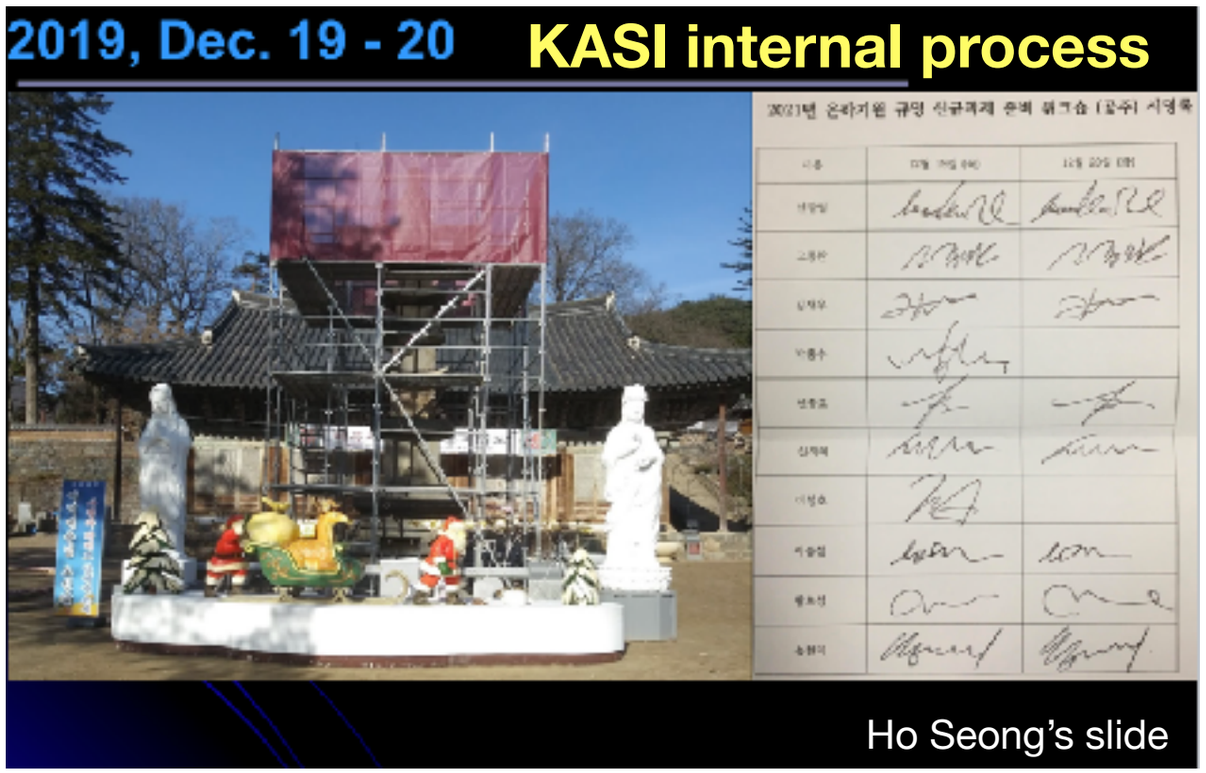
Jong Chul's slide



https://www.mdpi.com/2072-666X/11/8/782/htm

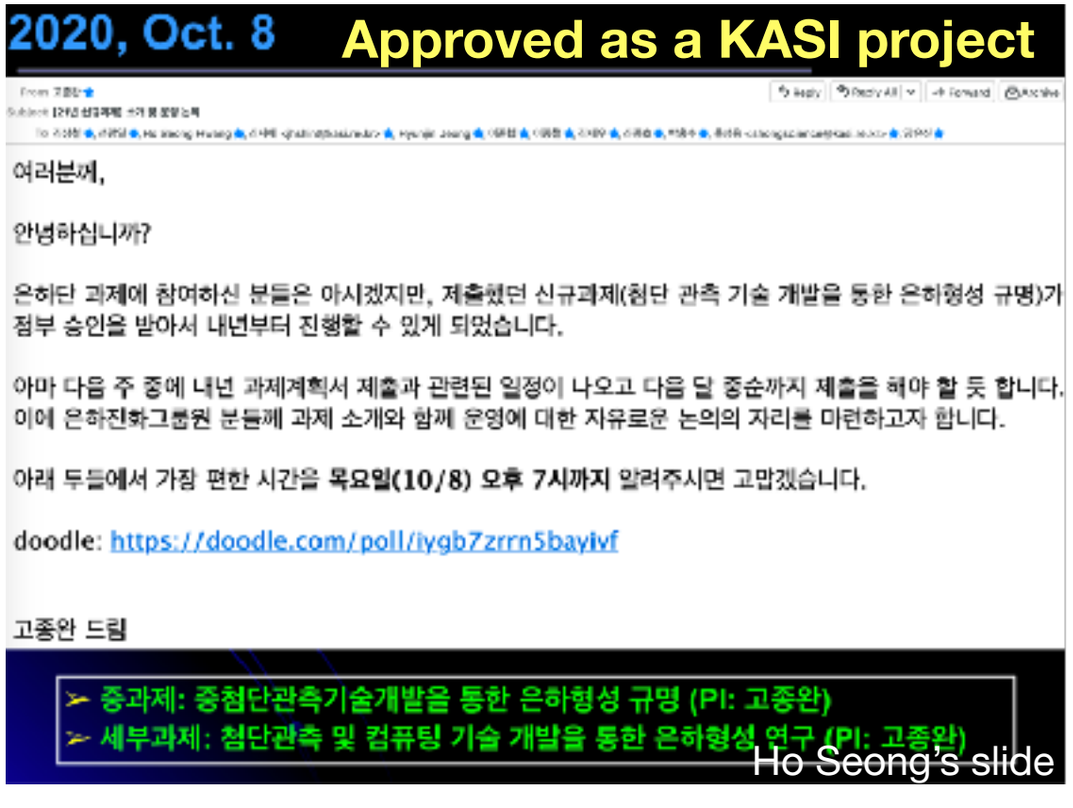
Since 2019





KASI project since 2021

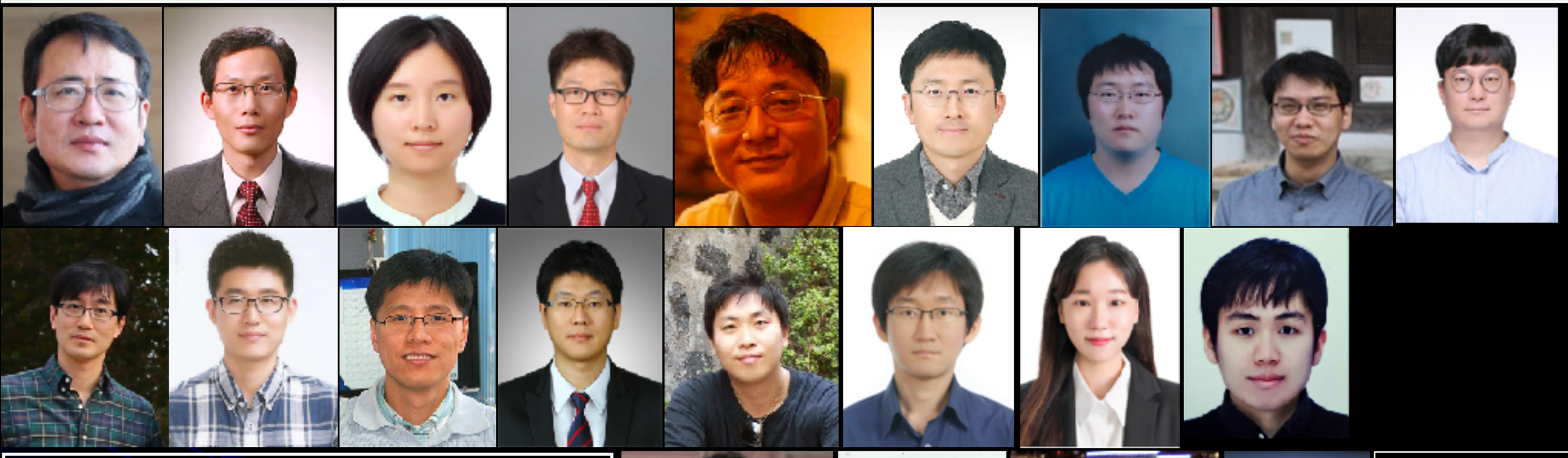




➢ Team Members (27 in total: 21 professors/staffs, 3 postdocs, 3 grad students)

➢ KASI (Project management: Planning, Manufacture, Science)

- ➢ Galaxy Evolution/Cosmology Group
  (Sang-Hyun Chun, Sungwook Hong, Minhee Hyun, Jongwan Ko, Jong Chul Lee, Jae-Woo Kim, Yongmin Yoon)
- ➢ GMT Science/Instrumentation Group
  (Kang-Min Kim, Moo Young Chun, Chan Park, Heeyoung Oh, Ho-Gyu Lee, UeeJeong Jeong)
- ➢ Technology Center for Astronomy and Space Science (Sungho Lee, Yunjong Kim)
- ➢ KMTNet Operation Group (Chung-Uk Lee, Yongseok Lee)

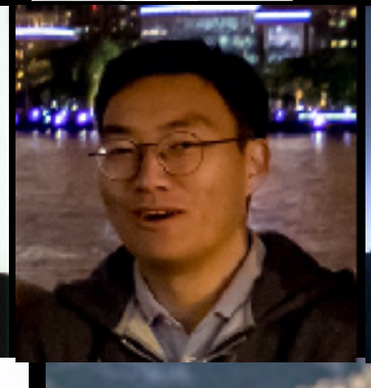


➢ Domestic Collaboration

- ➢ KIAS (Planning, Science:
  Changbom Park, Junsup Shim)
- ➢ SNU (Management, Manufacture:
  Ho Seong Hwang, Dongkok Kim)
- ➢ CNU (Science: Hyunmi Song, Dachan Kim)
- ➢ Ajou (Fiber Positioner:
  Young-Man Choi, Hyun-Ho Lim)









Kim, Dongkok

Lim, Hyun-Ho

➢ International Collaboration

- ➢ University of Arizona (MOS design: Haeun Chung)
- ➢ Penn State University (Science: Donghui Jeong)
- ➢ Macquarie University (Spectrograph)







Kim, Dachan

Ho Seong's slide

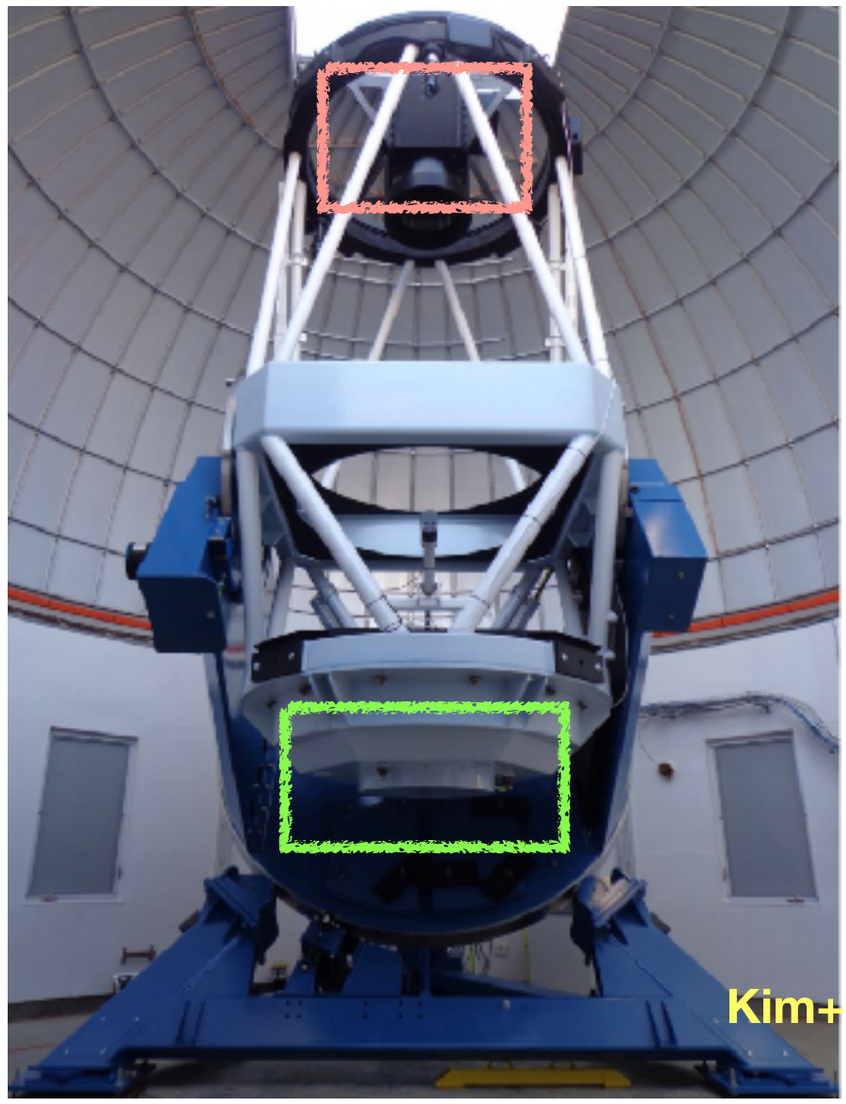
1st Step: Southern Sky with KMTNet SSO

First light in Jan. - Feb. 2025

Mapping ~23,000 sq.deg

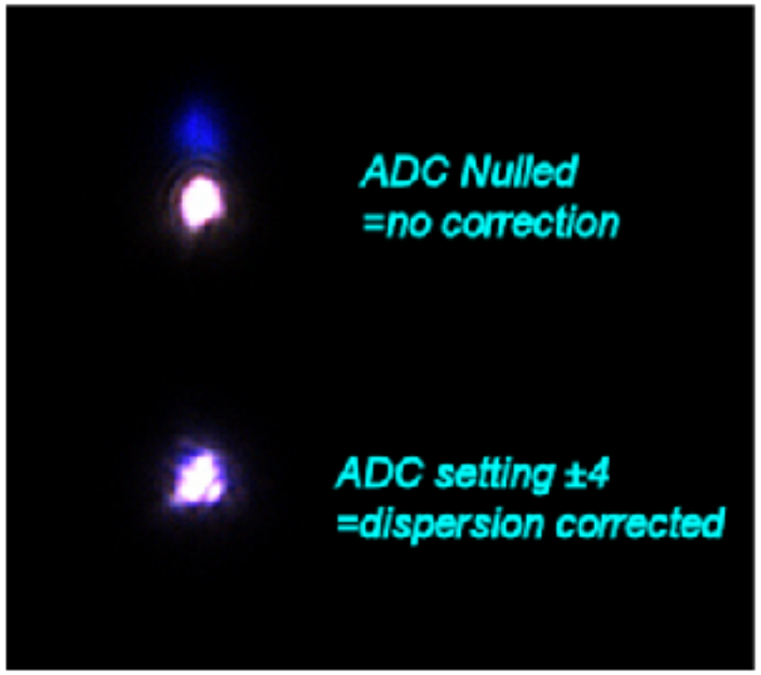


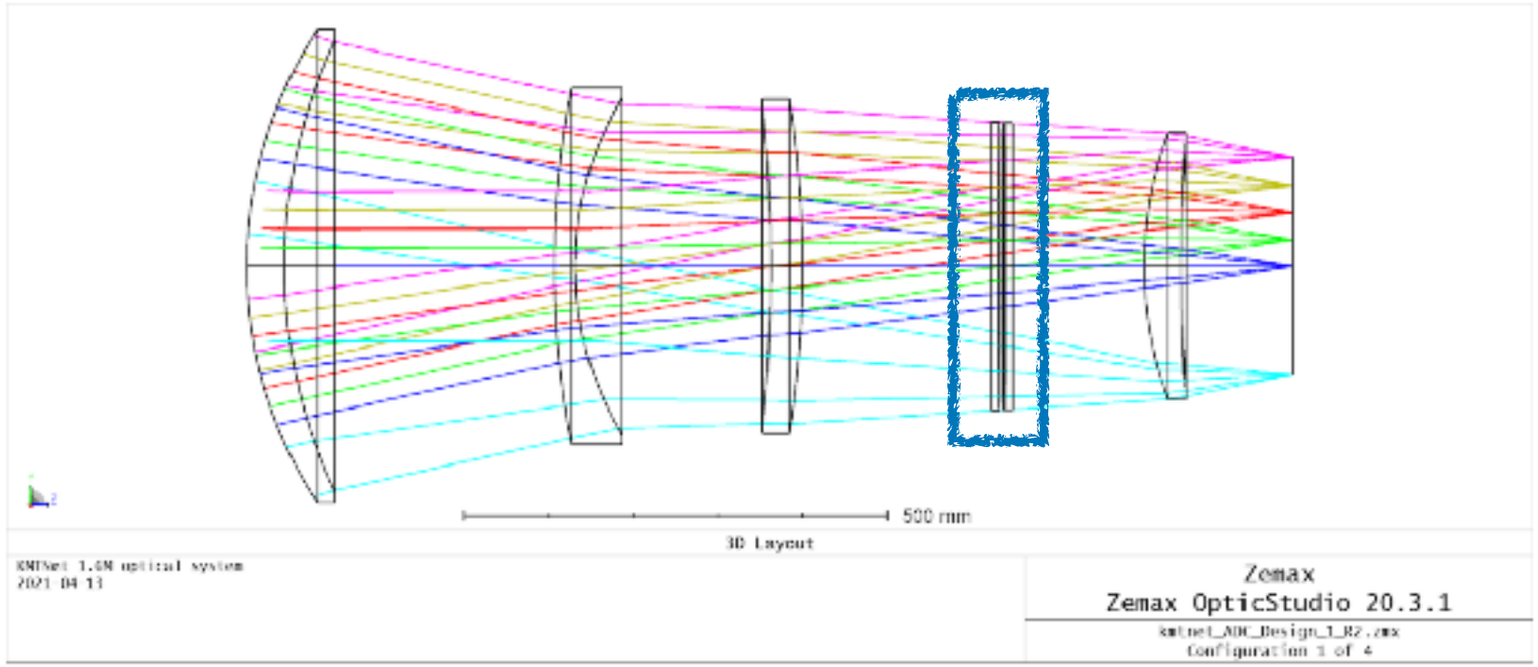
[Fiber Positioner]
[Focal Plane H/W (guiding, plate, cage)]
[Spectrograph]



[Atmosphere Dispersion Corrector]
[Metrology System]

Atmospheric Dispersion Corrector





Dispersion depending wavelength & airmass

ADC box replacing the current filter box on KMTNet

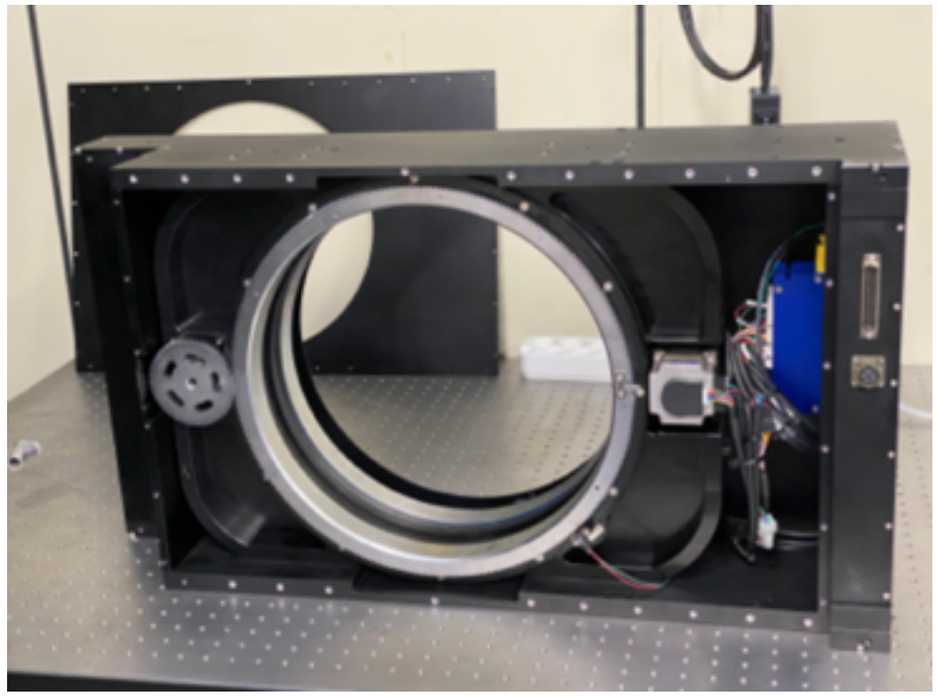
Two wedge prisms

- Diameter: 350mm
- Wedge angle: 0.329deg

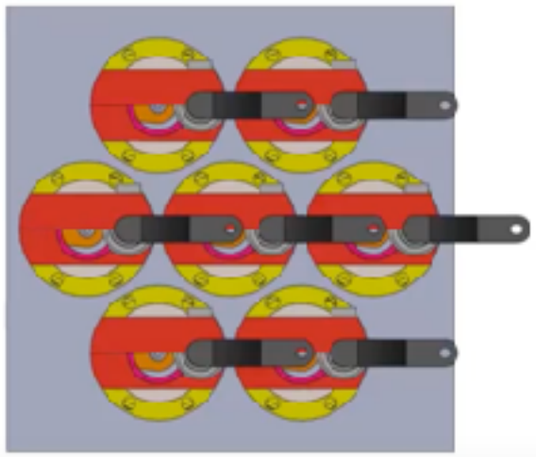
Oppositely rotating for correction

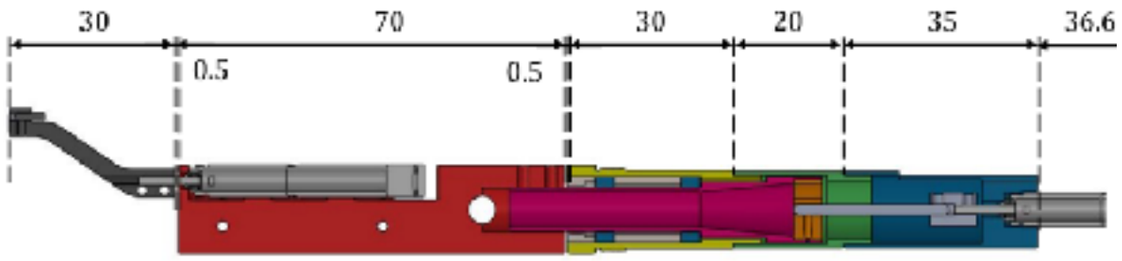
Dispersion depending on the wavelength < fiber size

Performance Test in 2023

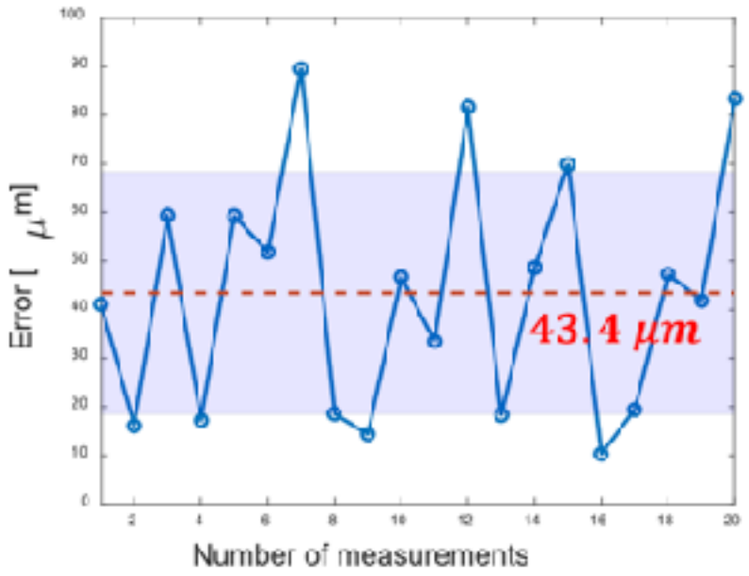


Fiber Positioner

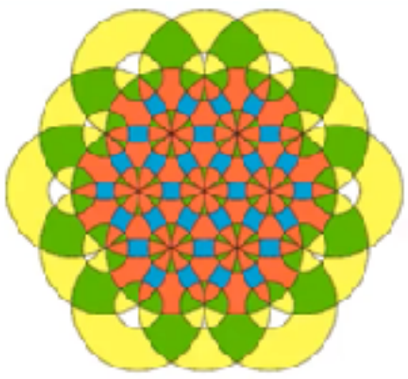








By Youngman Choi & Hyun-Ho Lim



Two rotary motors (theta-phi) like DESI and SDSS-V

Each positioner holds 75μm (~ 3 arcsec) diameter fiber

Each positioner covers 16.8mm (~ 11 arcmin) radius

Center of each is covered by neighbors = denser

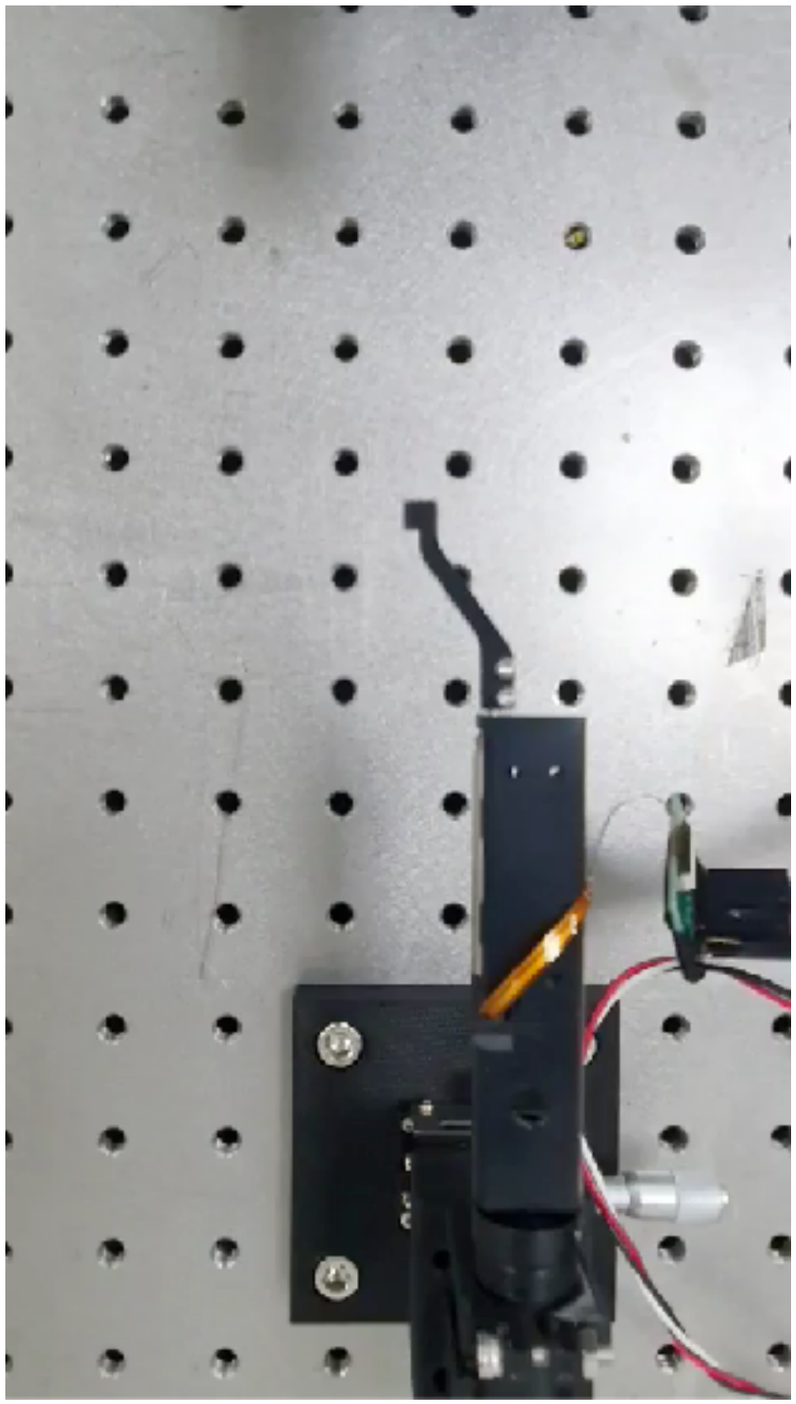
43μm positioning accuracy with the 1st proto-type (aim: 100μm)

Final goal of <3μm (~0.1 arcsec) with the metrology system

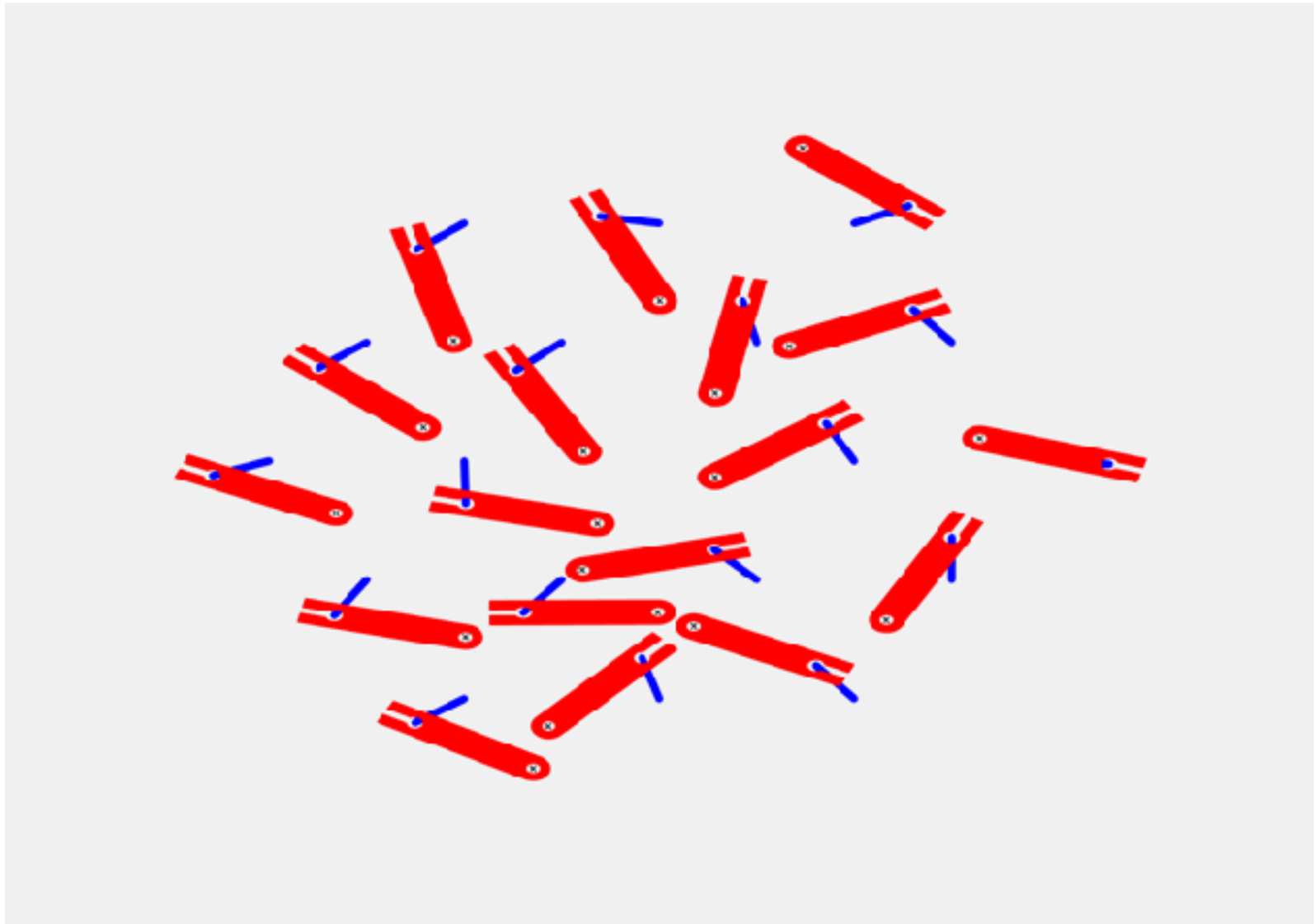
7 positioners for testing the motion algorithm in 2023

Fiber Positioner

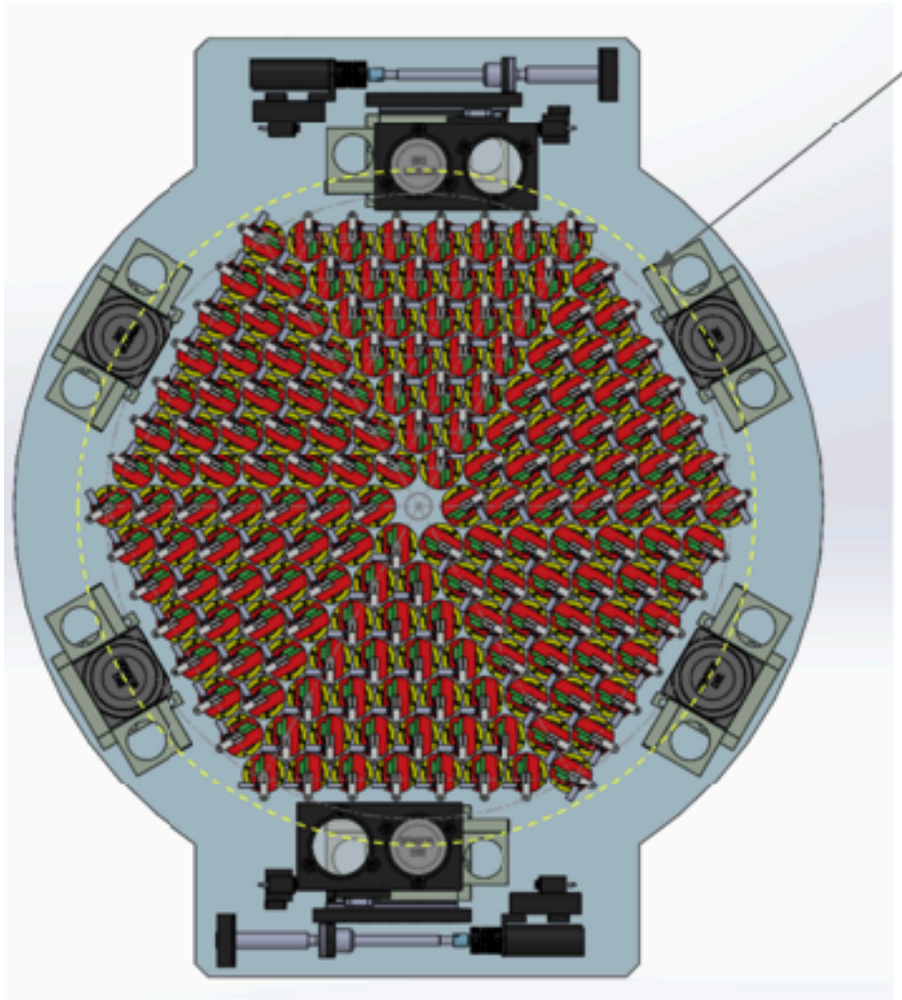
Positioner Proto-type



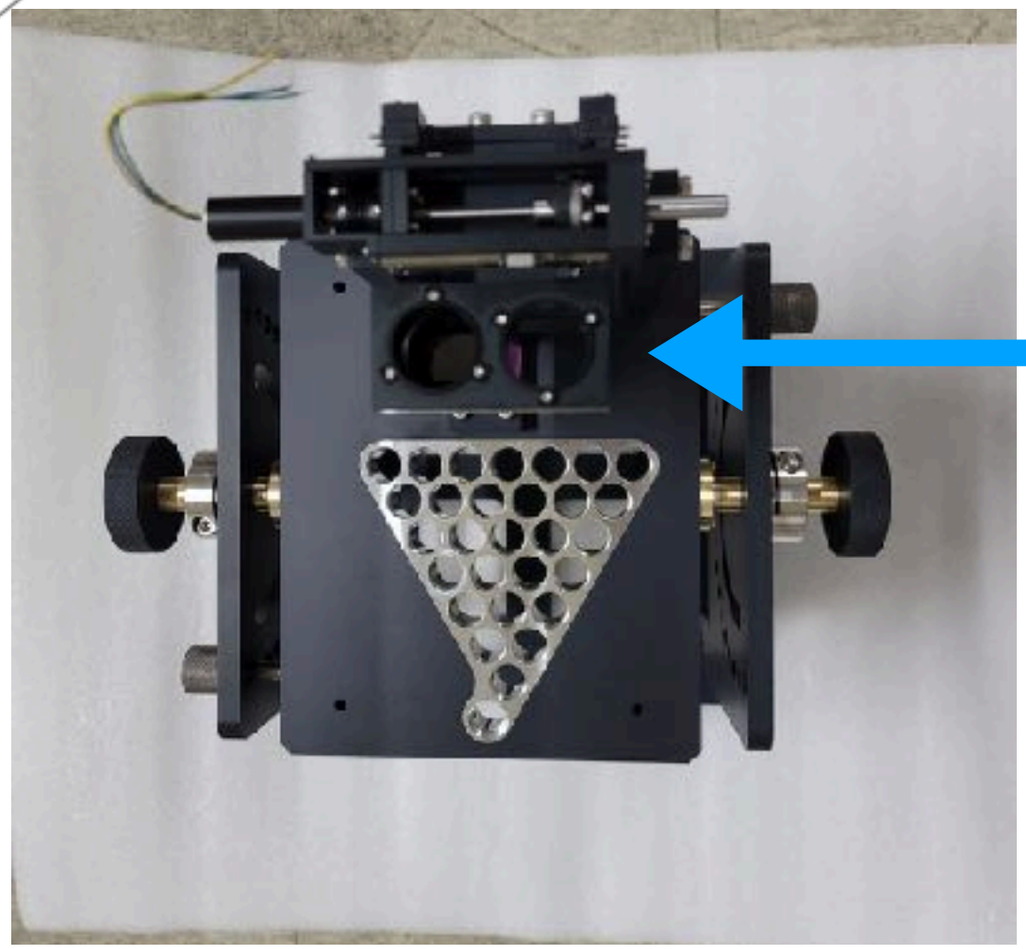
Positioner Motion Algorithm



Focal Plane



Φ 260 – diameter of guide camera center





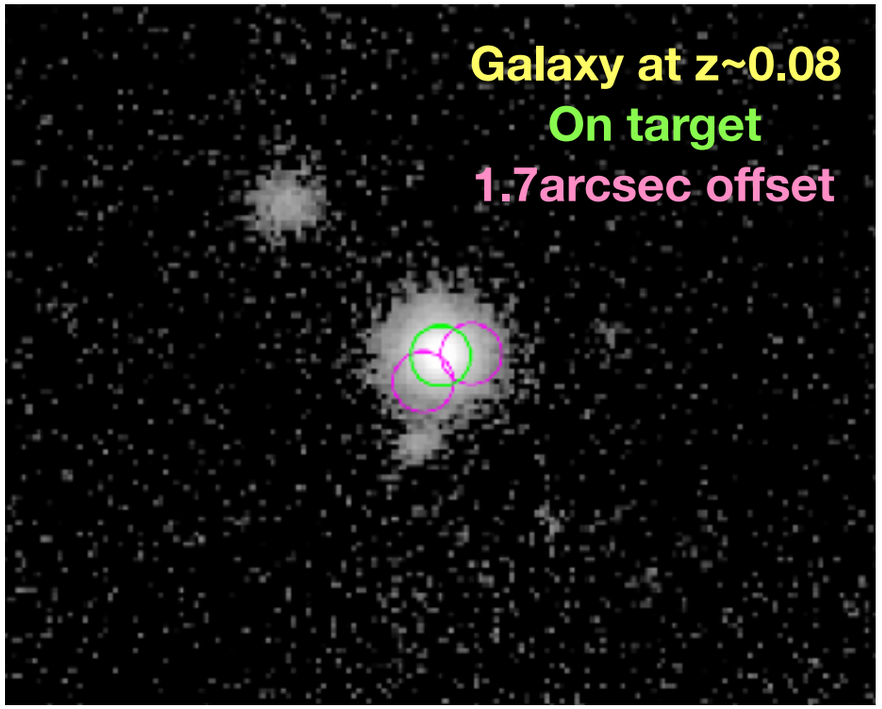
Replacing the current imaging camera

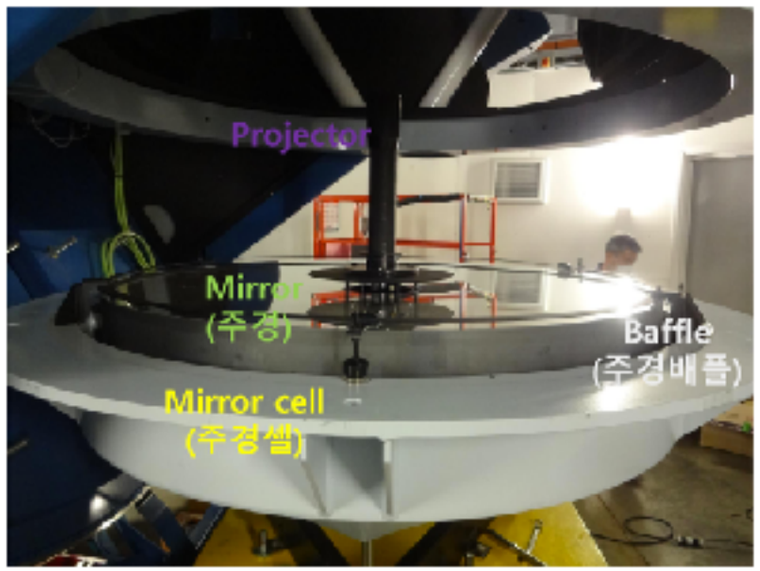
Focal Plane hosts

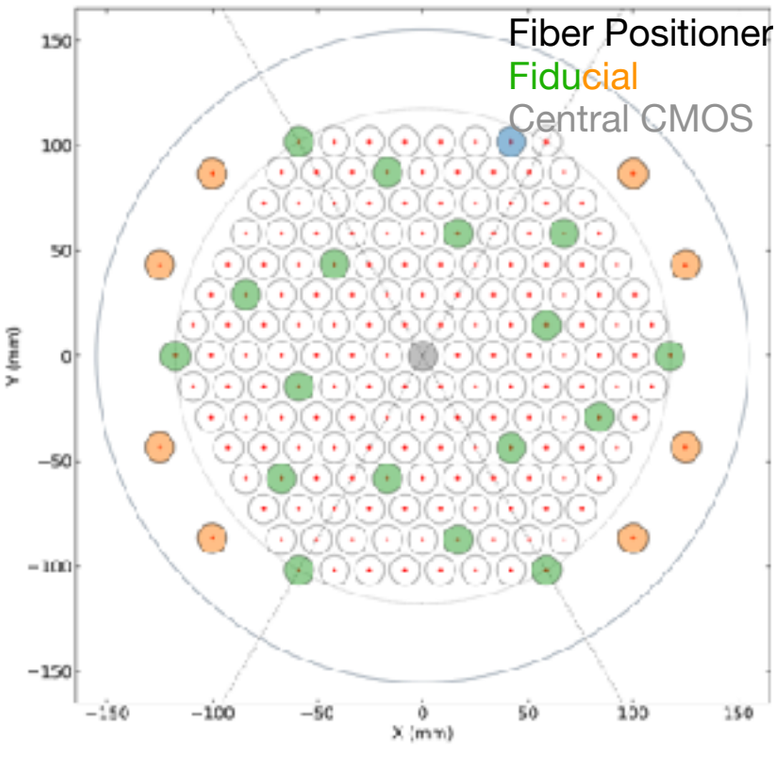
- **150 fiber positioners** in 256mm diameter
- **7 CMOS cameras** with SDSS r filters for guiding, focusing & Alignment
- **26 fiducials** as a reference for the metrology

Assembly test and preparing the final version in 2023

Metrology System







By Dongkok Kim & Ho Seong Hwang

43μm positioning accuracy of positioners = 1.7 arcsec on the sky

Metrology system for more accurate fiber positioning

Small telescope in front of the primary mirror & CMOS camera

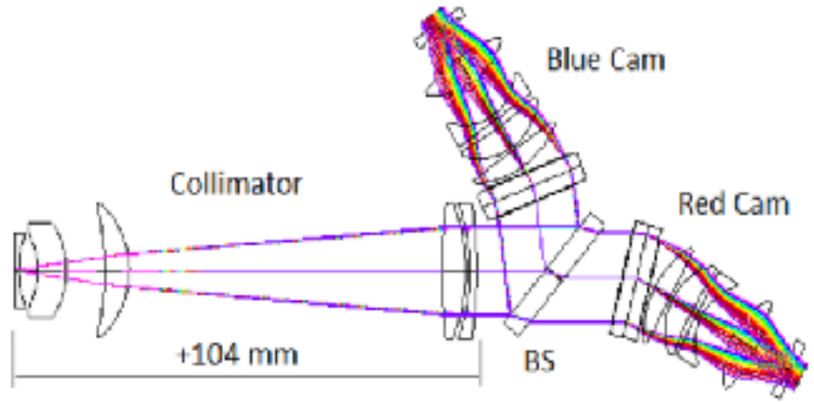
Taking images of back-illuminated science fibers for positioning

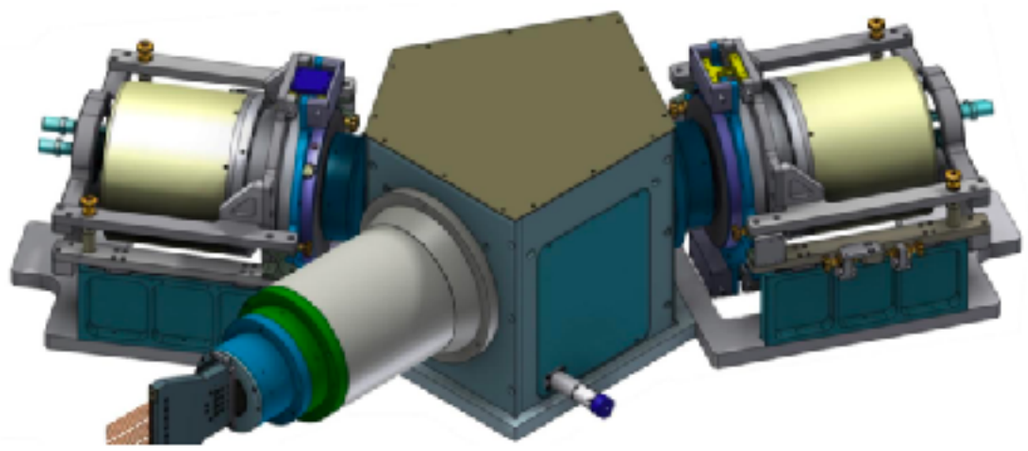
Taking back-illuminated science fibers iteratively with correcting positions

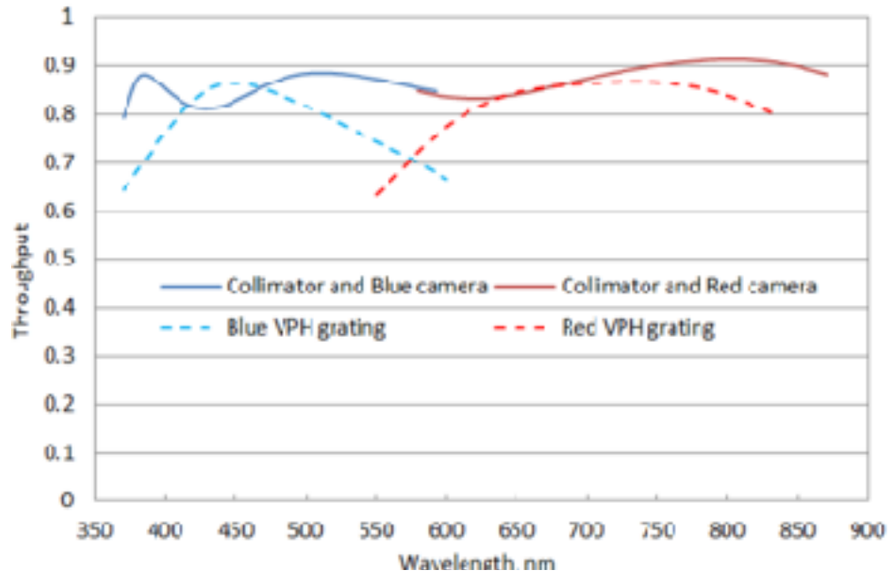
Calculated positioning error of <1μm with simulation (aim: <3μm)

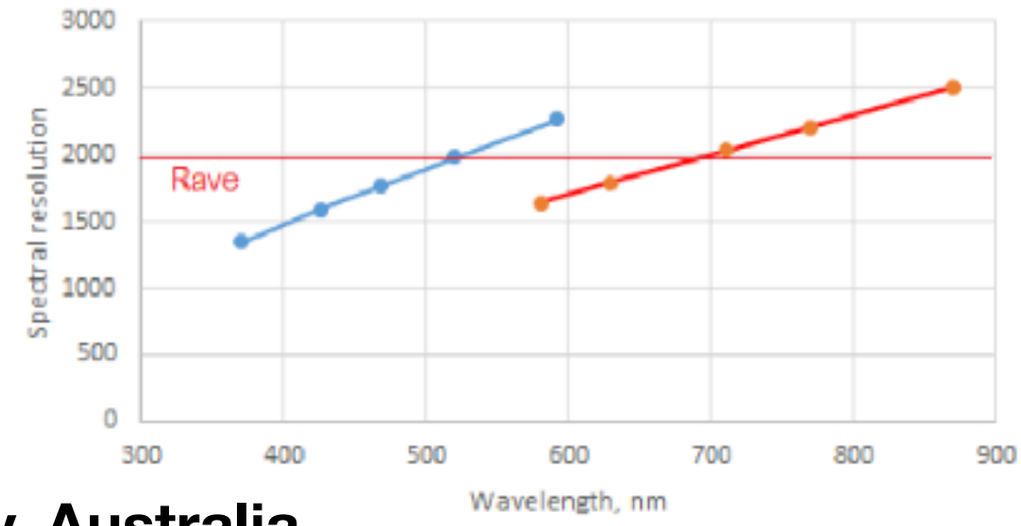
Performance Test and Finalising in 2023

Spectrograph









Collaboration with AAO in Macquarie University, Australia

Supported by the Korean Spectroscopic Survey Consortium (KASI, KIAS and SNU)

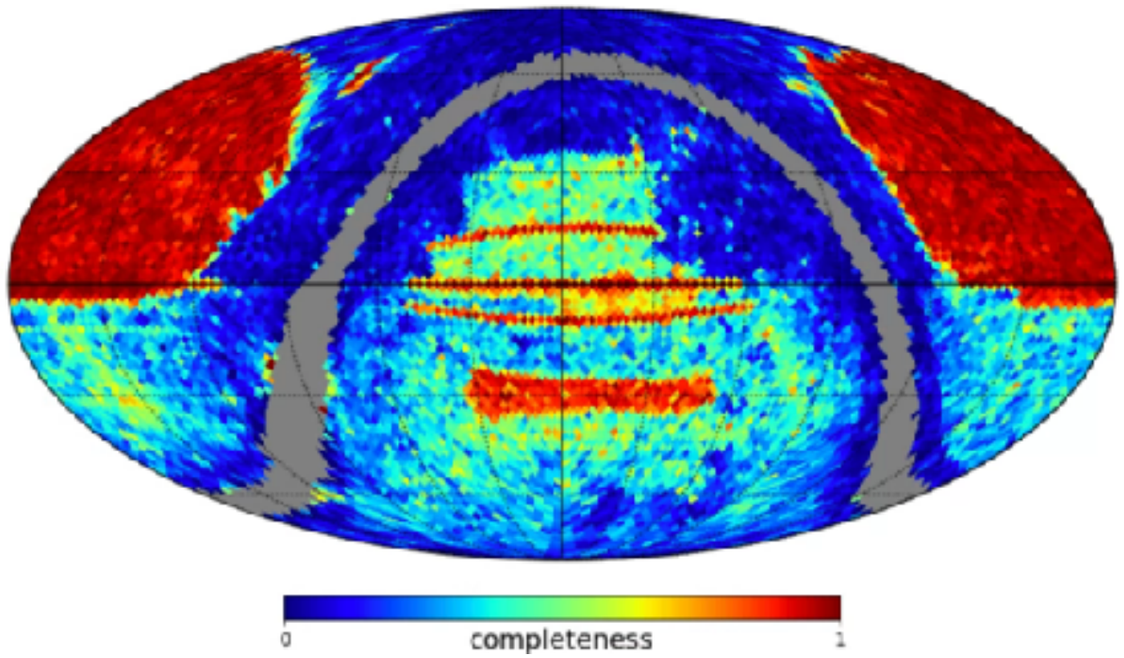
Nearly identical to the TAIPAN spectrograph

Optimized spectrograph for KMTNet

- Optics for KMTNet f/3.2
- Wavelength coverage of **370-870nm**
- Mean Spectral Resolution of **R>1600 for blue & R>1800 for red**
- **150 fibers** with a back-illumination system

Currently, Optical & Mechanical designs are completed.

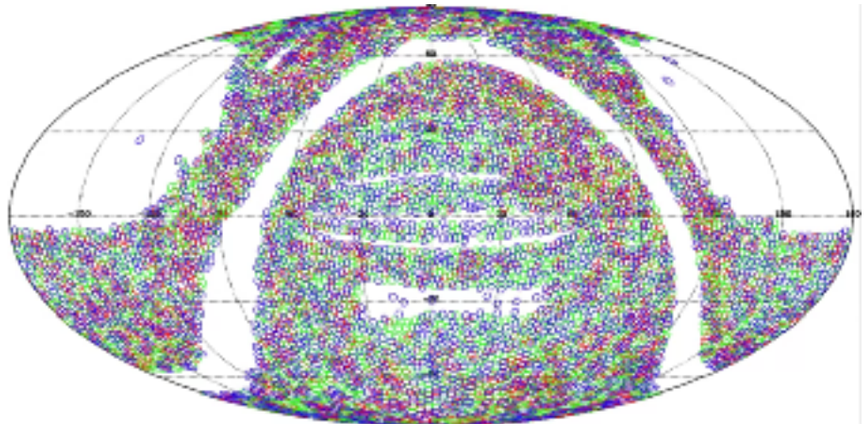
Survey Plan



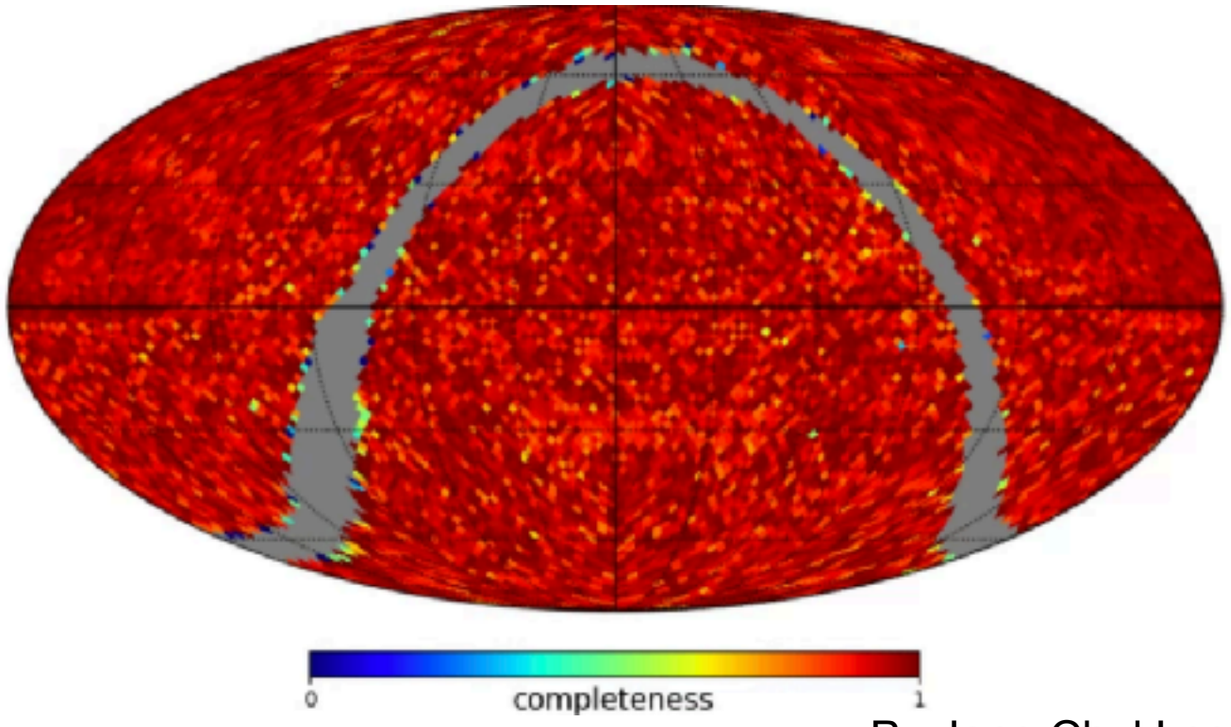
Currently, for Ks<13.75 galaxies

- 41.9% completeness for decl.<22.3
- 33.6% completeness for decl.<0

Tiling



More pointing for denser field



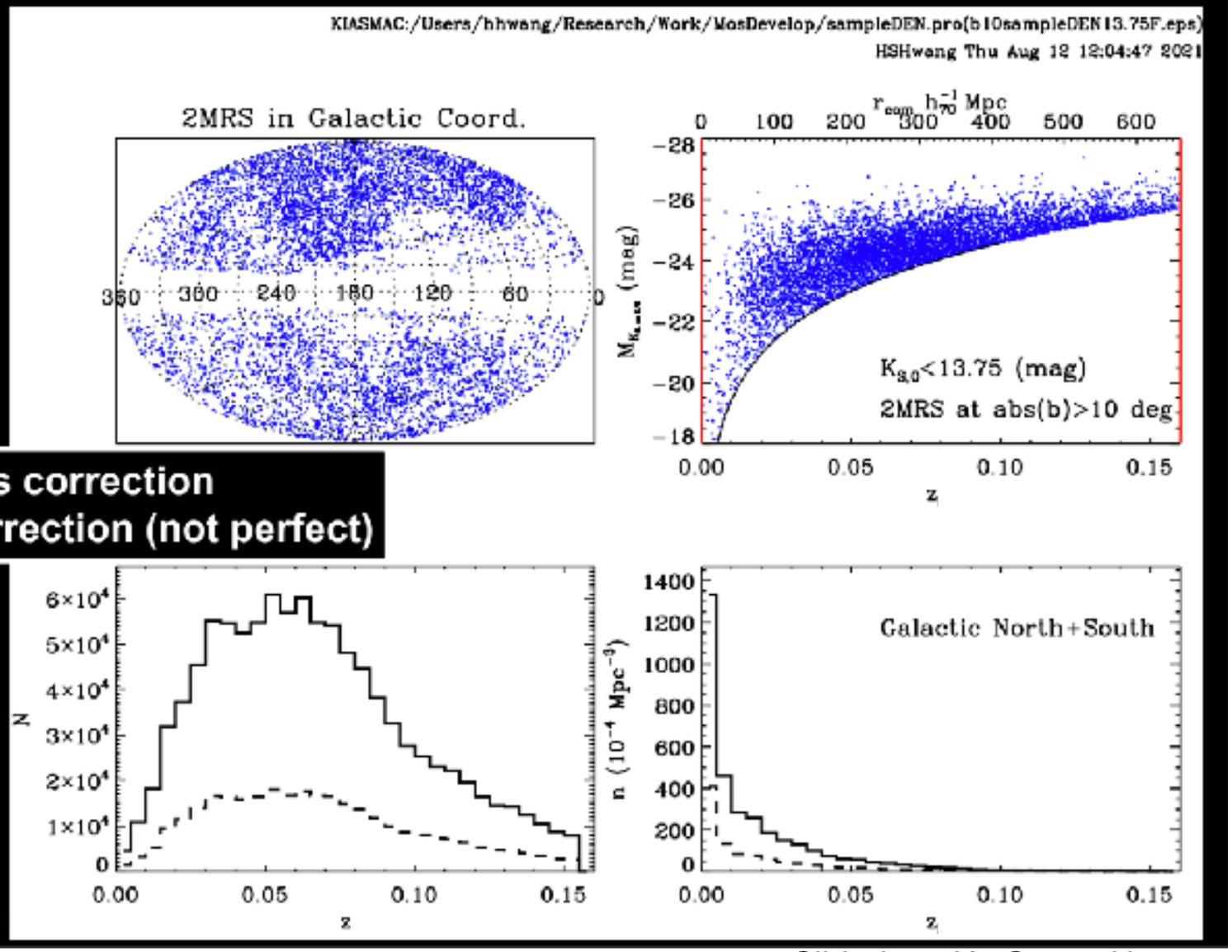
Aiming >90% completeness

- For Ks<13.75 galaxies (~782,000 sources)
- On the nearly entire sky

By Jong Chul Lee

Expected Data

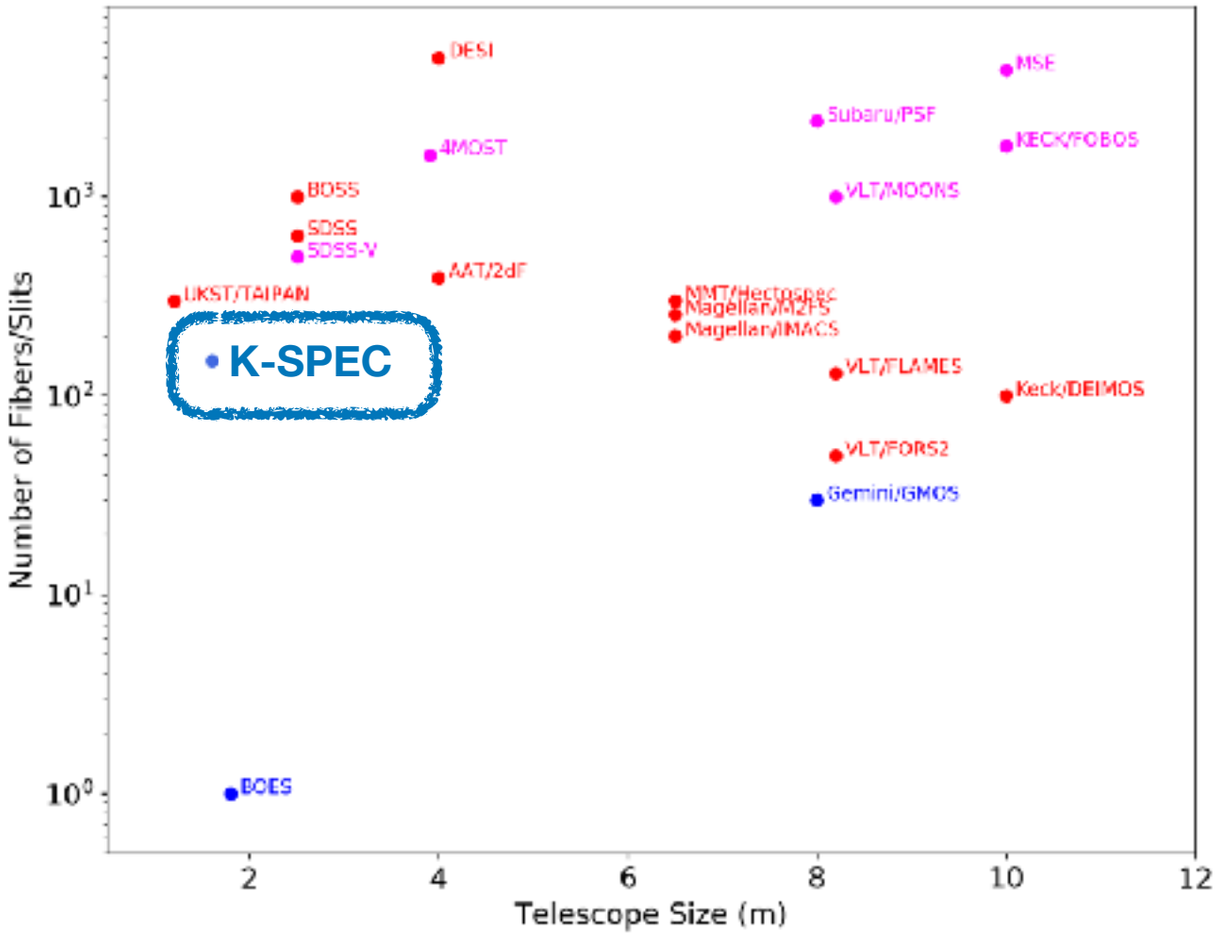
1. Target Selection Criterion: ~782,000 sources
    1. Any sources with K_S<13.75 mag (r~16.8) in the 2MASS Extended Source Catalog
        1. To construct a good(?) sample of galaxies at z<0.15
    2. Masked region:
        1. l<30 or l>330 (Galactic bulge): |b|<8 deg
        2. l>30 or l<330: |b|<5 deg

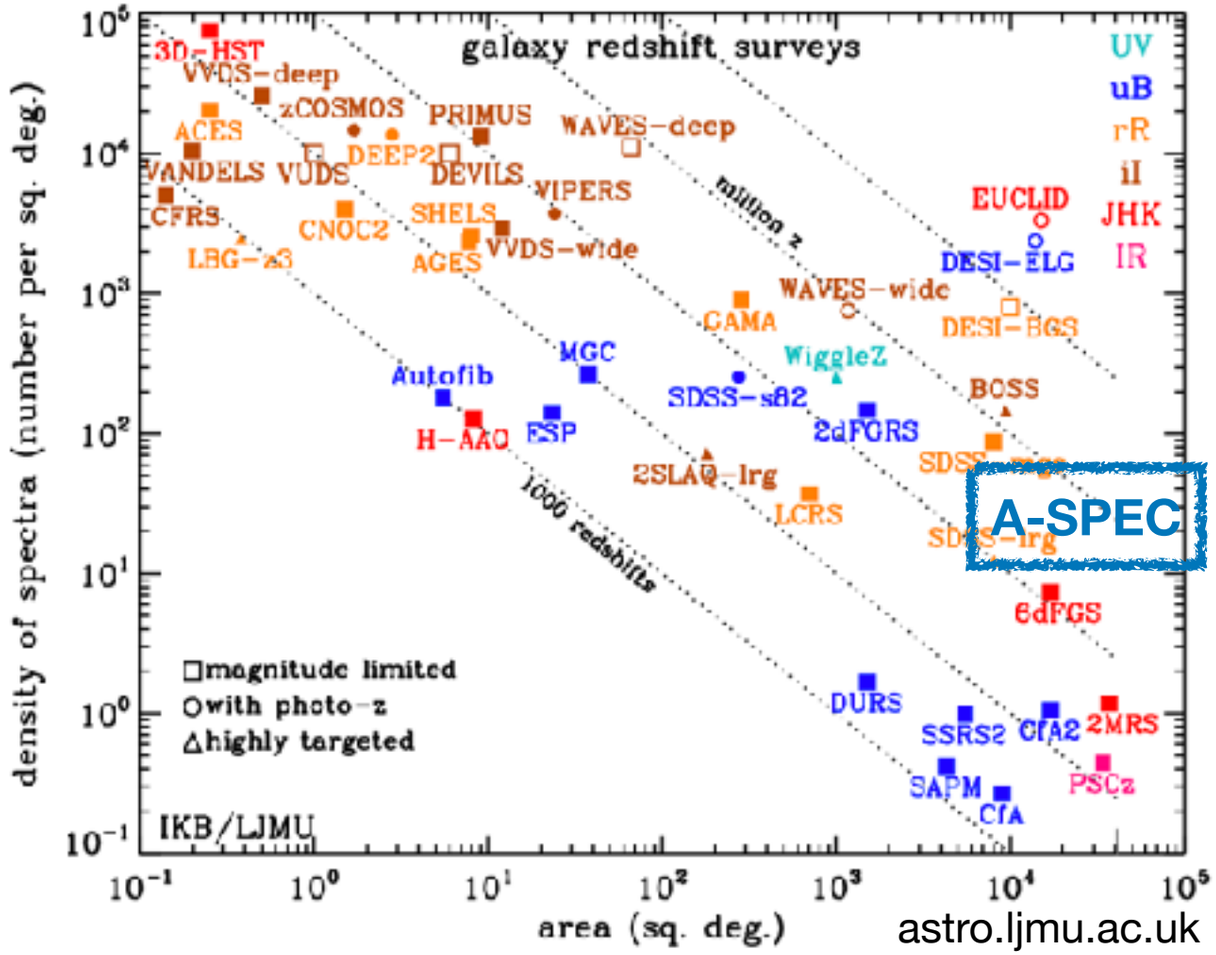


Slide from Ho Seong Hwang

Summary

- 1st all-sky spectroscopic mapping with 1st MOS instrument developed in Korea
- Allowing us to study interesting topics from stellar objects to cosmology
- KMTNet SSO for the southern hemisphere survey
  - First light in Jan. - Feb. 2025
  - ~23,000 sq.deg
  - 150 fibers
  - 370-870nm with R>1600 for blue and R>1800 for red
- We are developing many components!!!
- **In 2023, Testing all components & Preparing the final ones**
- **Hope to release a wonderful data in a few years!!!**





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