



# MUST



清华大学  
Tsinghua University

# Multiplexed Survey Telescope

## Overview & Current Status

Cheng Zhao

on behalf of the MUST collaboration

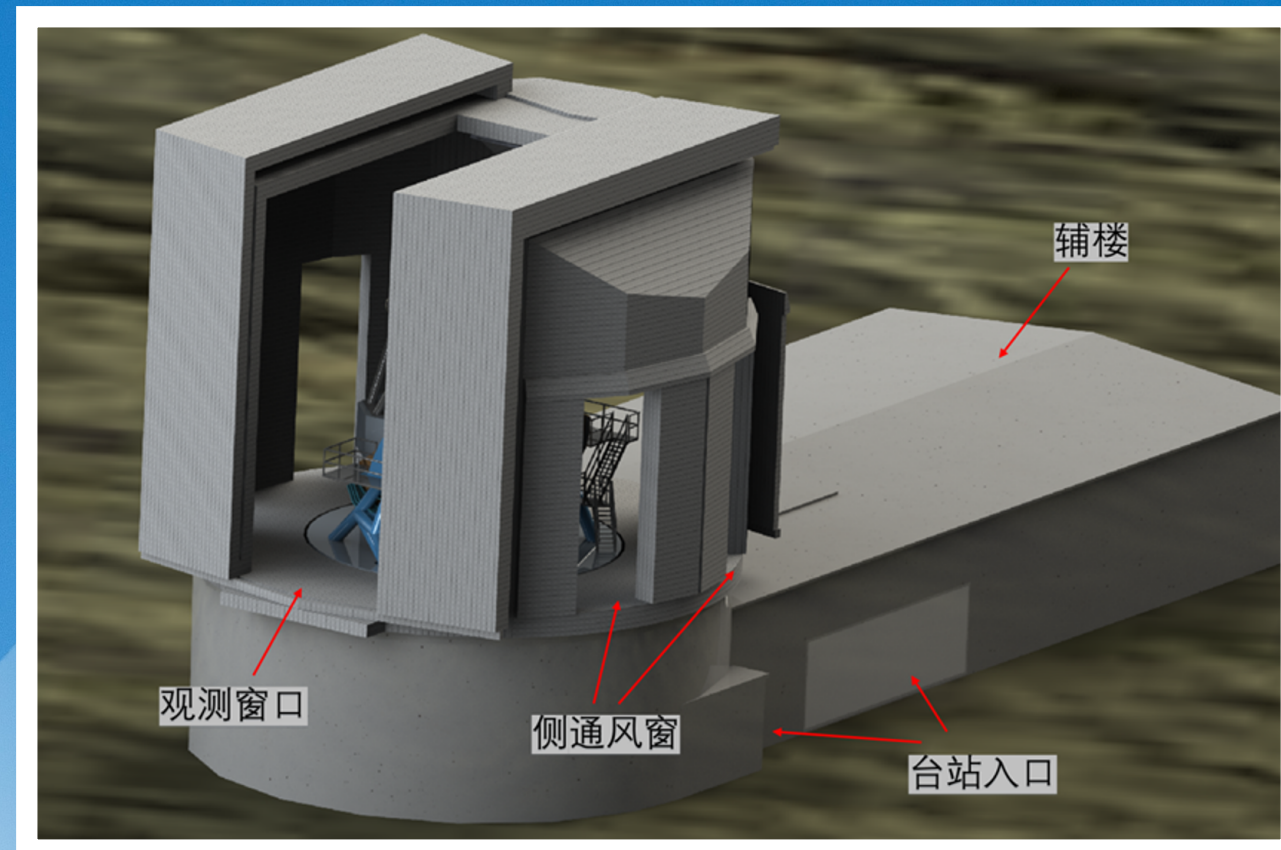
May 08, 2024 @ LBNL

Fundamental Physics from Future Spectroscopic Surveys





# MUST



A 4358m

B 4322m

D 4032m

E 4055m

C 4200m

X 3850m

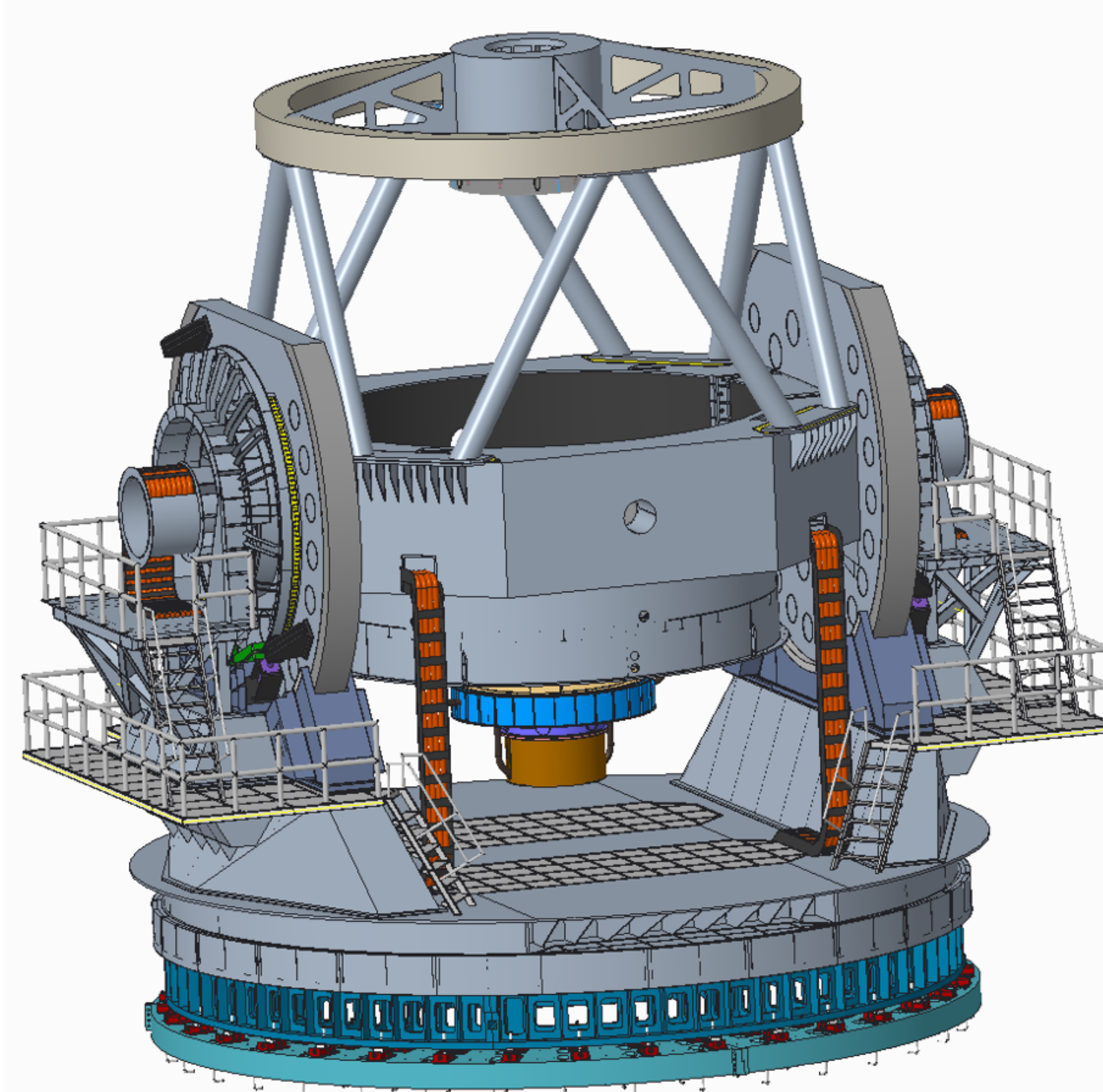
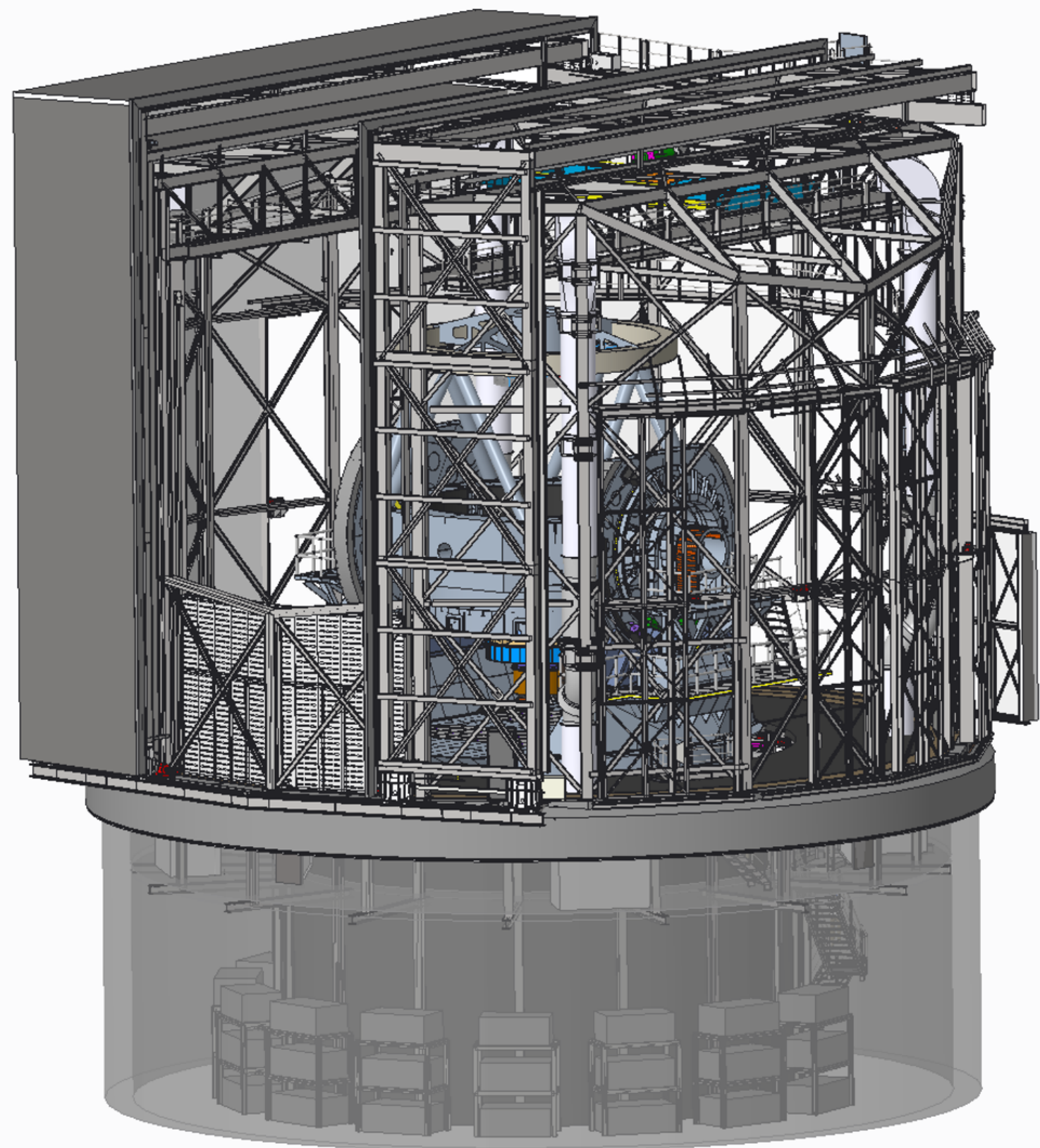
Saishiteng Mountain  
Lenghu, China







## The northern MegaMapper



**6.5 m**

Aperture

**5 deg<sup>2</sup>**

Field of View

**20,000**

Fibres

**0.36 – 1  $\mu$ m**

Wavelength

**3000 – 5000**

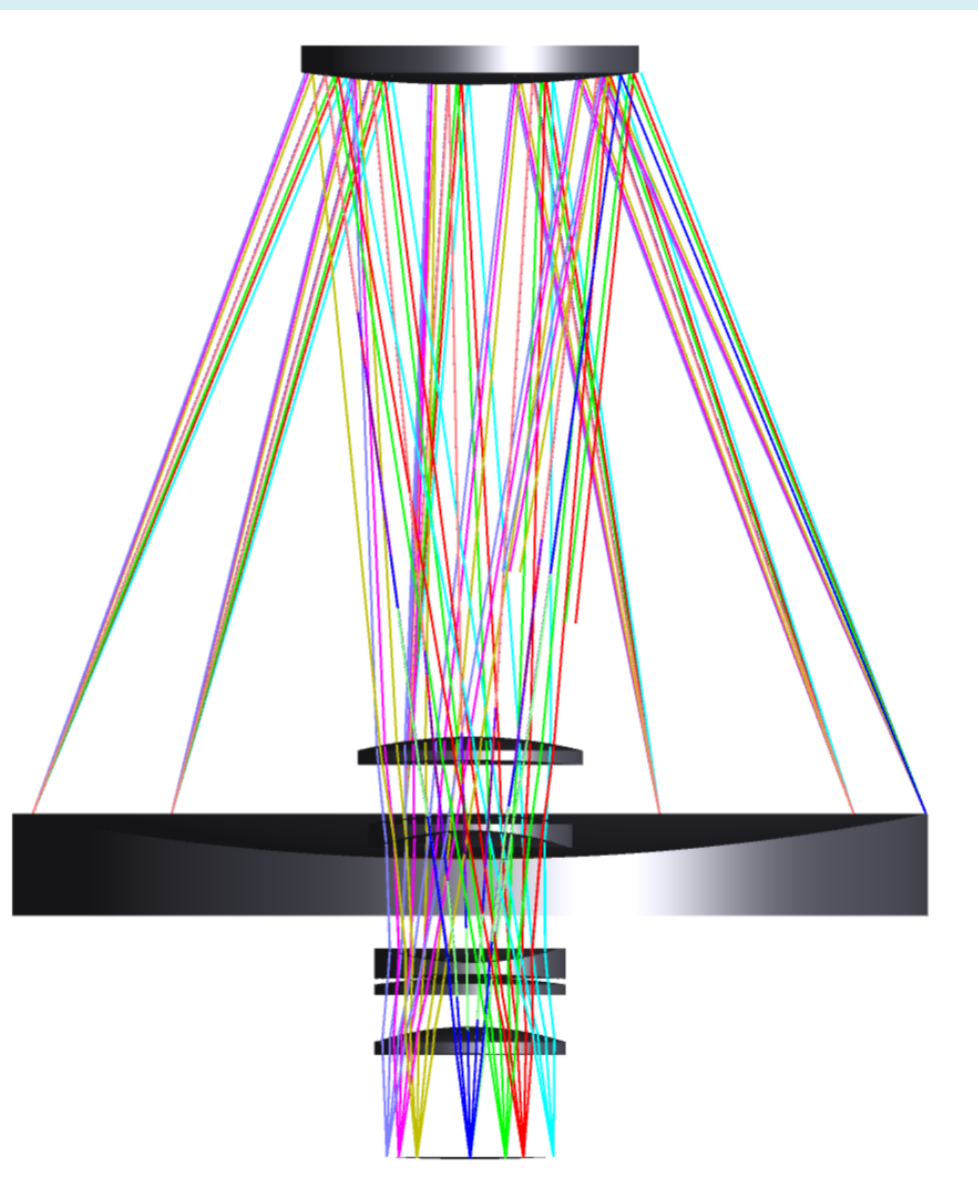
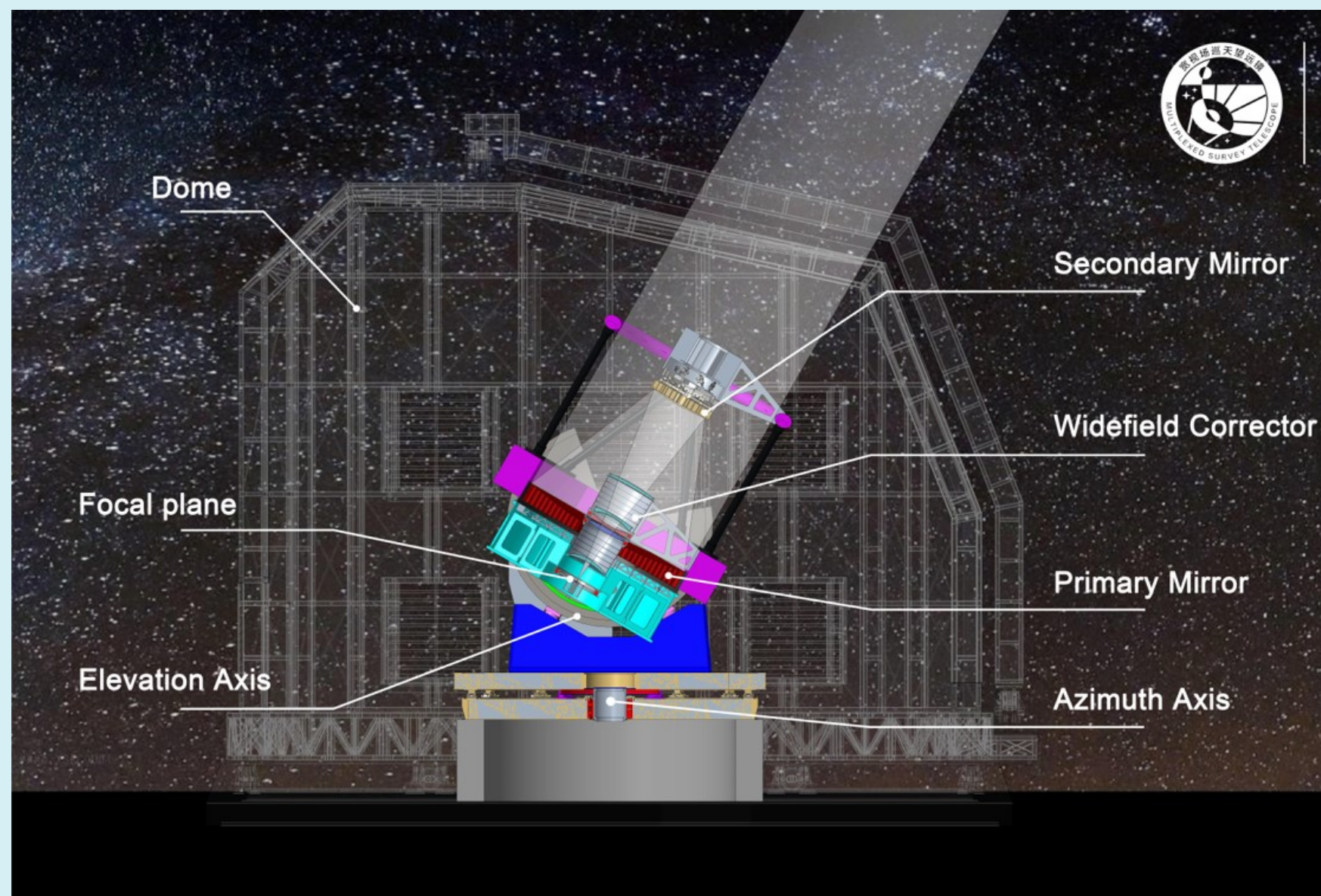
Resolution

**Early 2030s**

First Light

Credit: MUST Collaboration





## Optical Design

- ◉ A 6.5-m **R-C** design with a 2.45-m secondary.
- ◉ A **1.6-m** complex **WFC** to achieve  $\sim 5 \text{ deg}^2$  FoV.
- ◉ For a spectroscopic telescope, MUST has excellent imaging quality: **EE80 < 0.6 arcsec**

# 2

## Fundraising

- ◉ The total cost for construction is  $\sim \$200\text{M}$
- ◉ **The telescope itself is fully funded!**
- ◉ Great support from Tsinghua University.

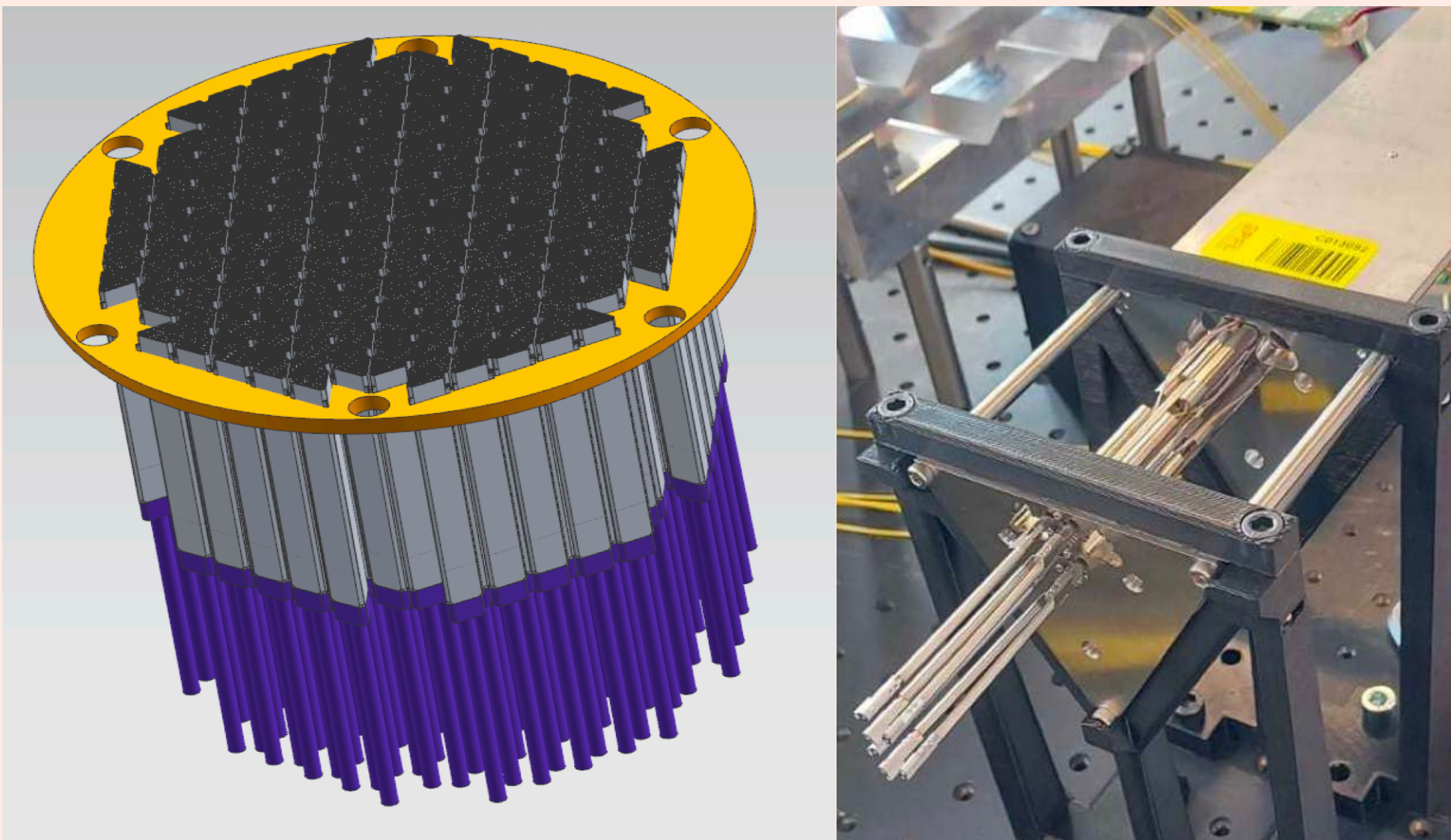






## Focal Plane

- ◉ Modularised fibre positioners designed by EPFL
- ◉ 63 fibre positioners with 6.2mm diameter per module
- ◉ 336 modules on the focal plane



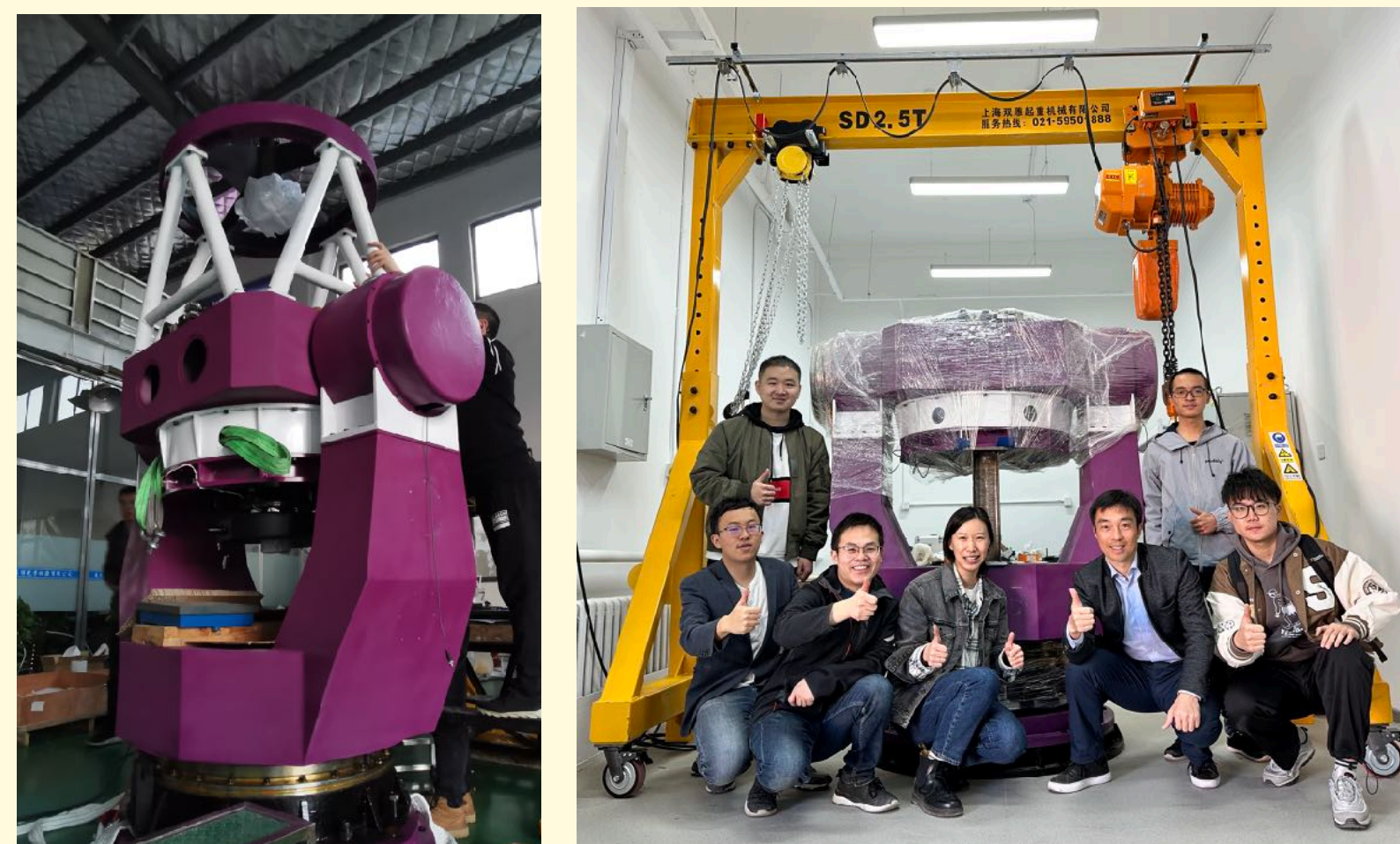
## Infrastructure

- ◉ Summit flattened by local government in 2023
- ◉ DIMM tower working



## Pathfinder

- ◉ Finish building a 65cm pathfinder.
- ◉ Will start to observe on the MUST site in 2024



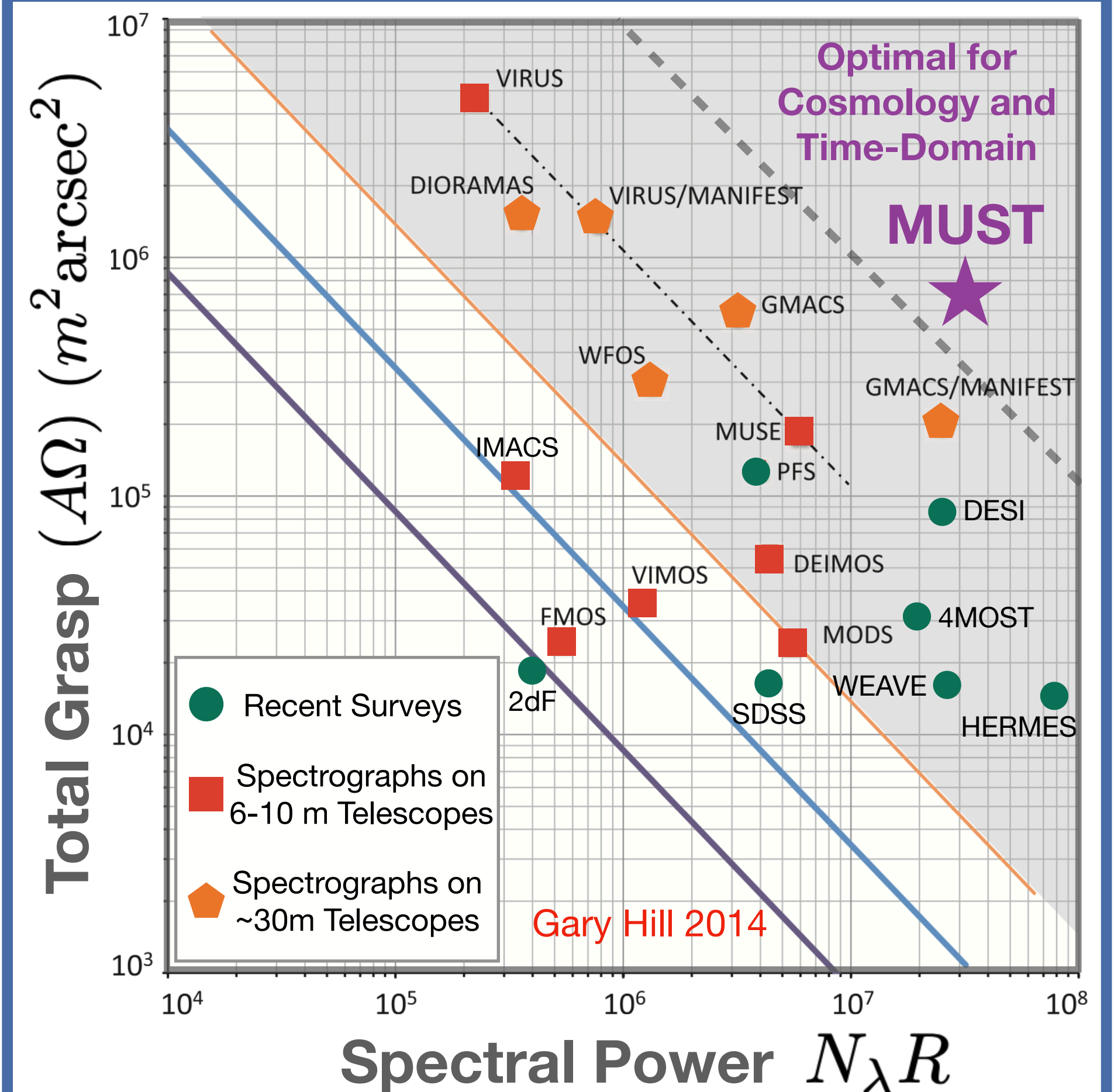


## We have Gathered Broad Community Inputs

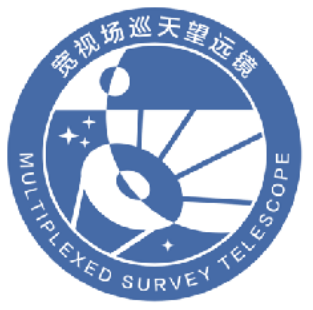
- We have organized the first scientific planning meeting in 2021 to hear the community inputs from very different fields, ranging from cosmology to solar system science.
- These inputs have become the foundation of our initial scientific vision.



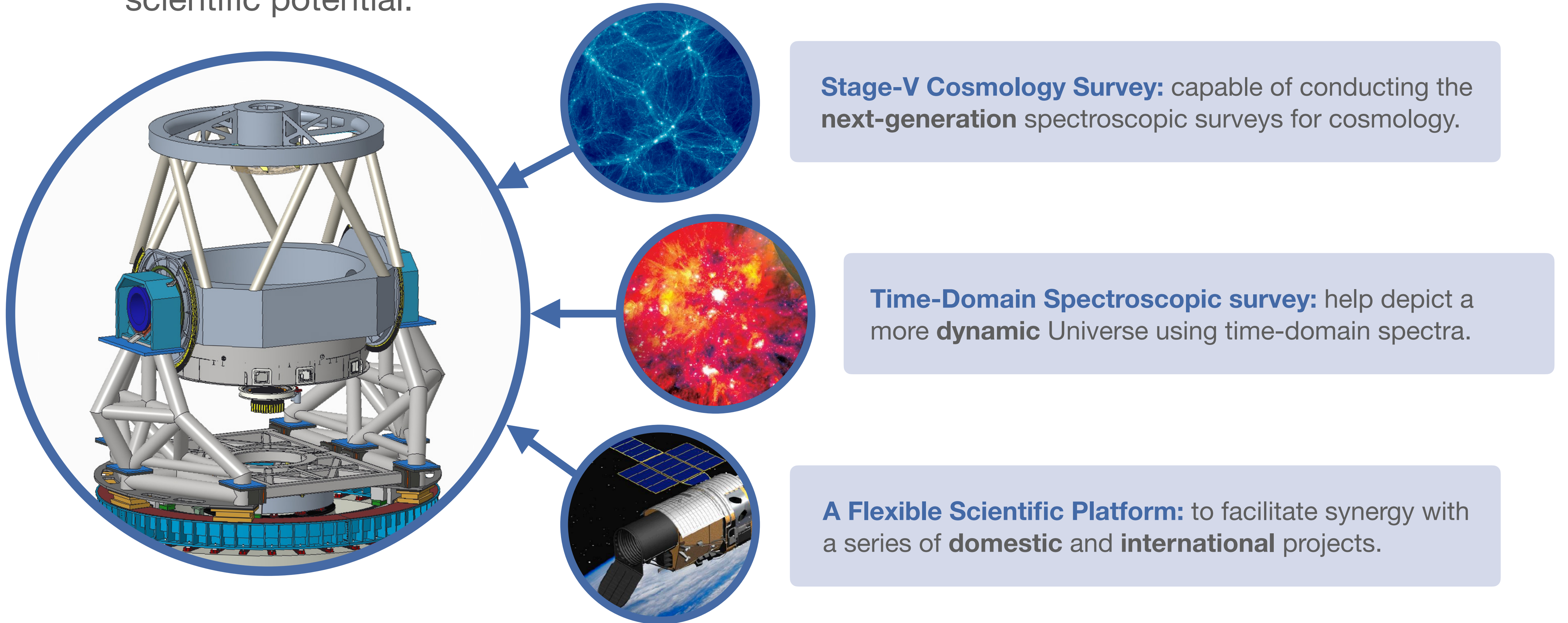
## Aiming for the Unique Parameter Space



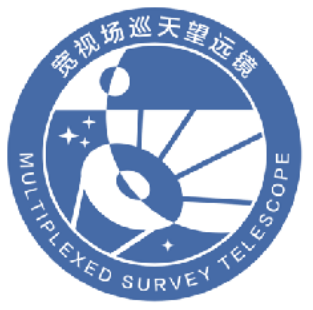




- While in a very early stage, we have identified **three main themes** to develop MUST's scientific potential.

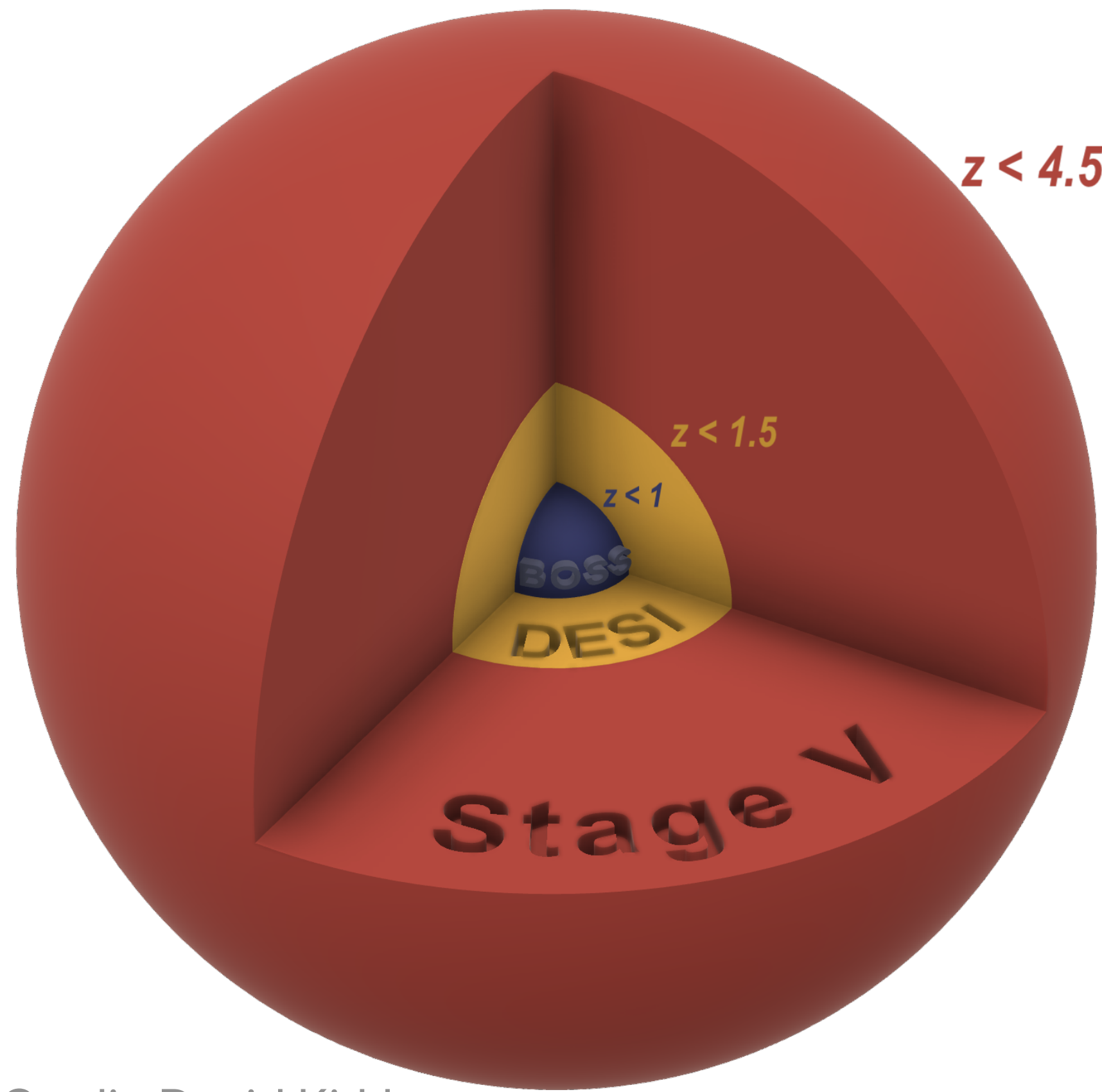






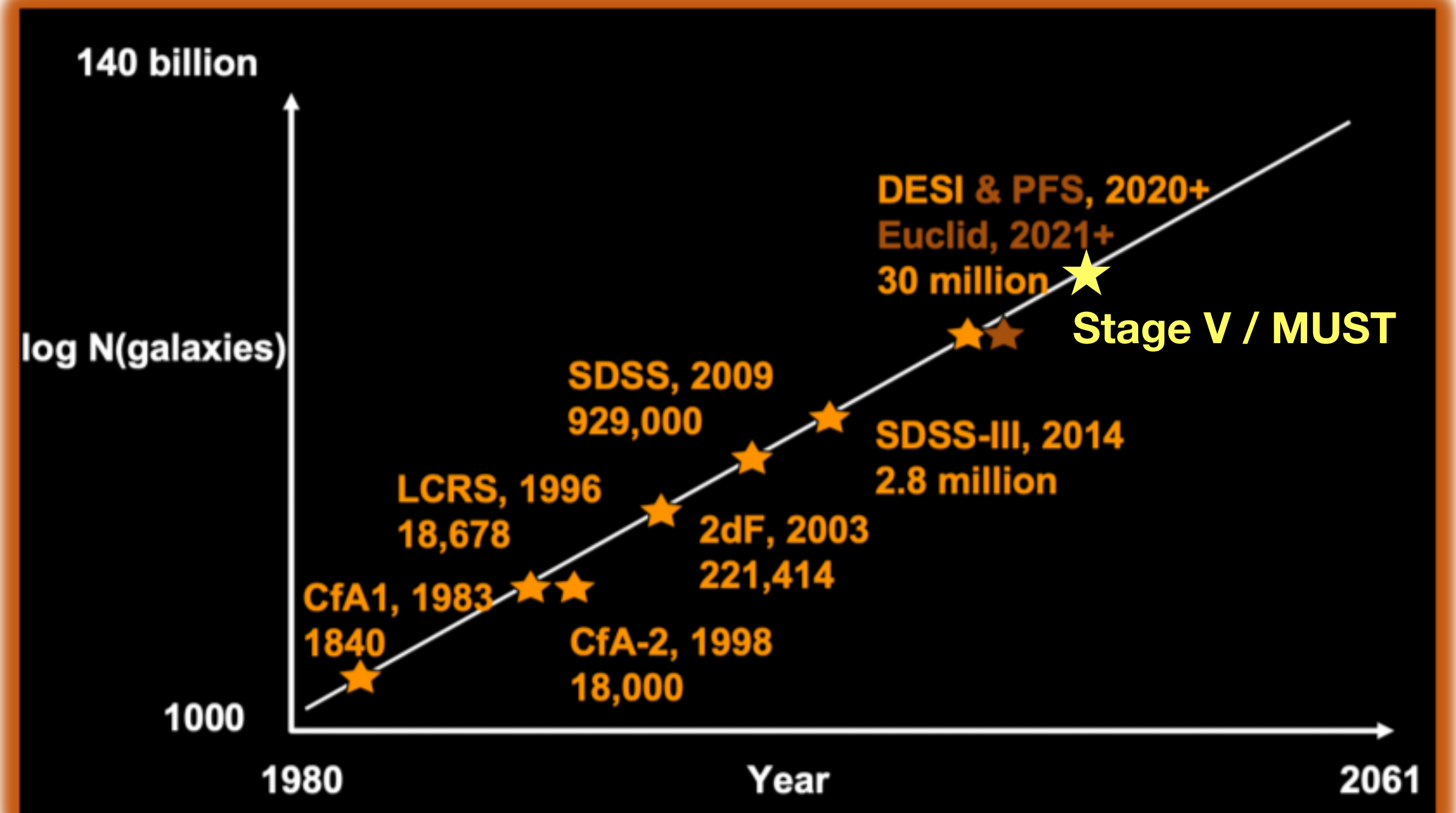
# Stage-V Spectroscopic Survey

Deep: large aperture



Credit: David Kirkby

Massive: highly multiplexed

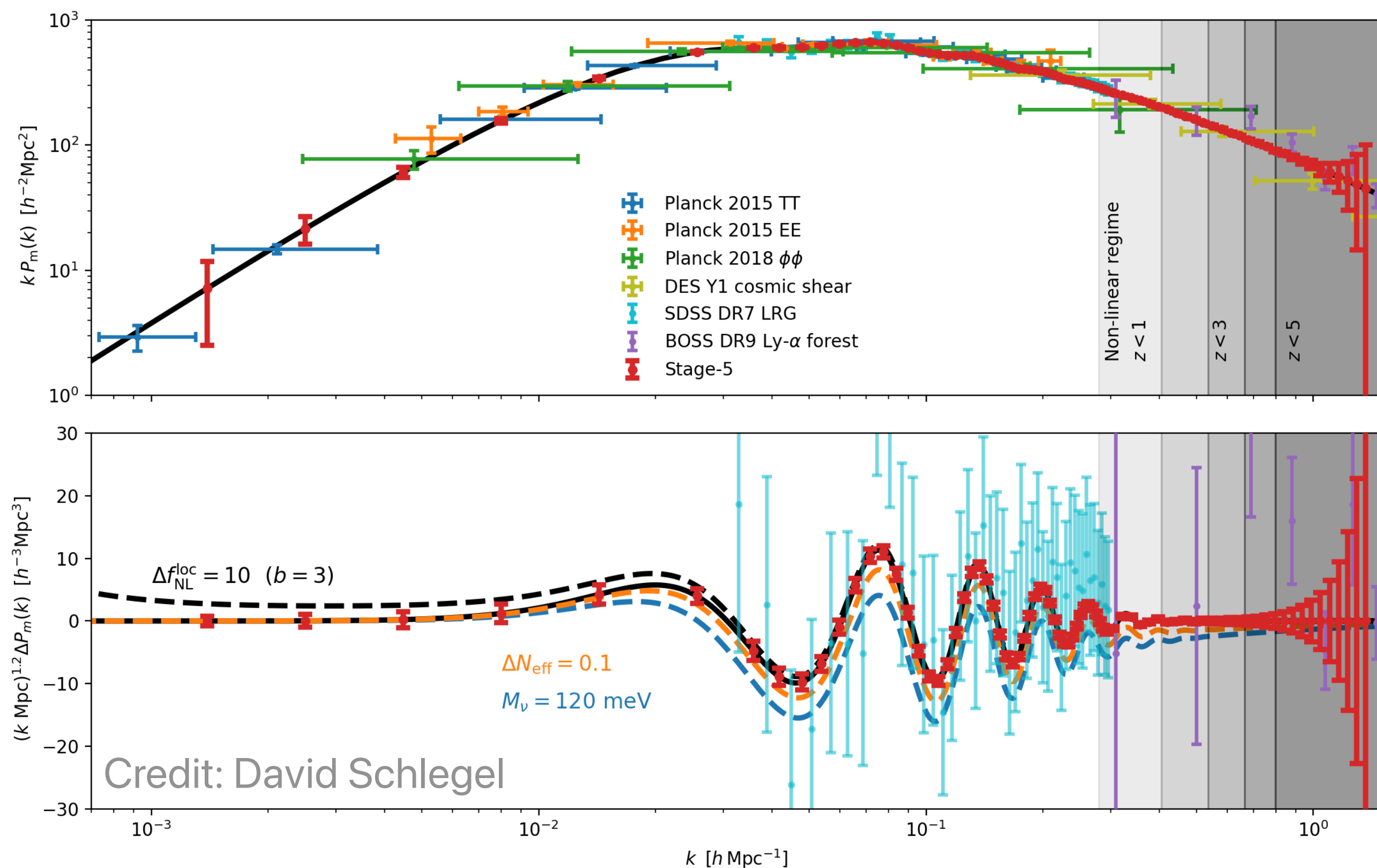






## Keys to the Next-Generation (Stage-V) Spectroscopic Cosmology Survey:

- **High redshift** → large volume
- **High density** → small scale



### High Redshift

- Early dark energy
- Primordial Physics
- Modified gravity
- Dark matter interaction
- Parity violation
- ...

### High Density

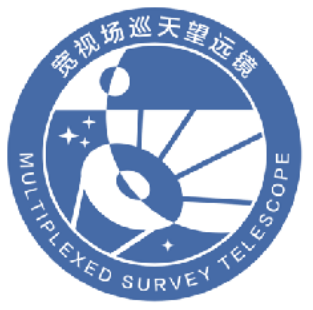
- Neutrino mass
- Nature of dark matter particle
- Light relics
- Peculiar velocity
- Baryonic effects
- ...

**Topics of this conference!**









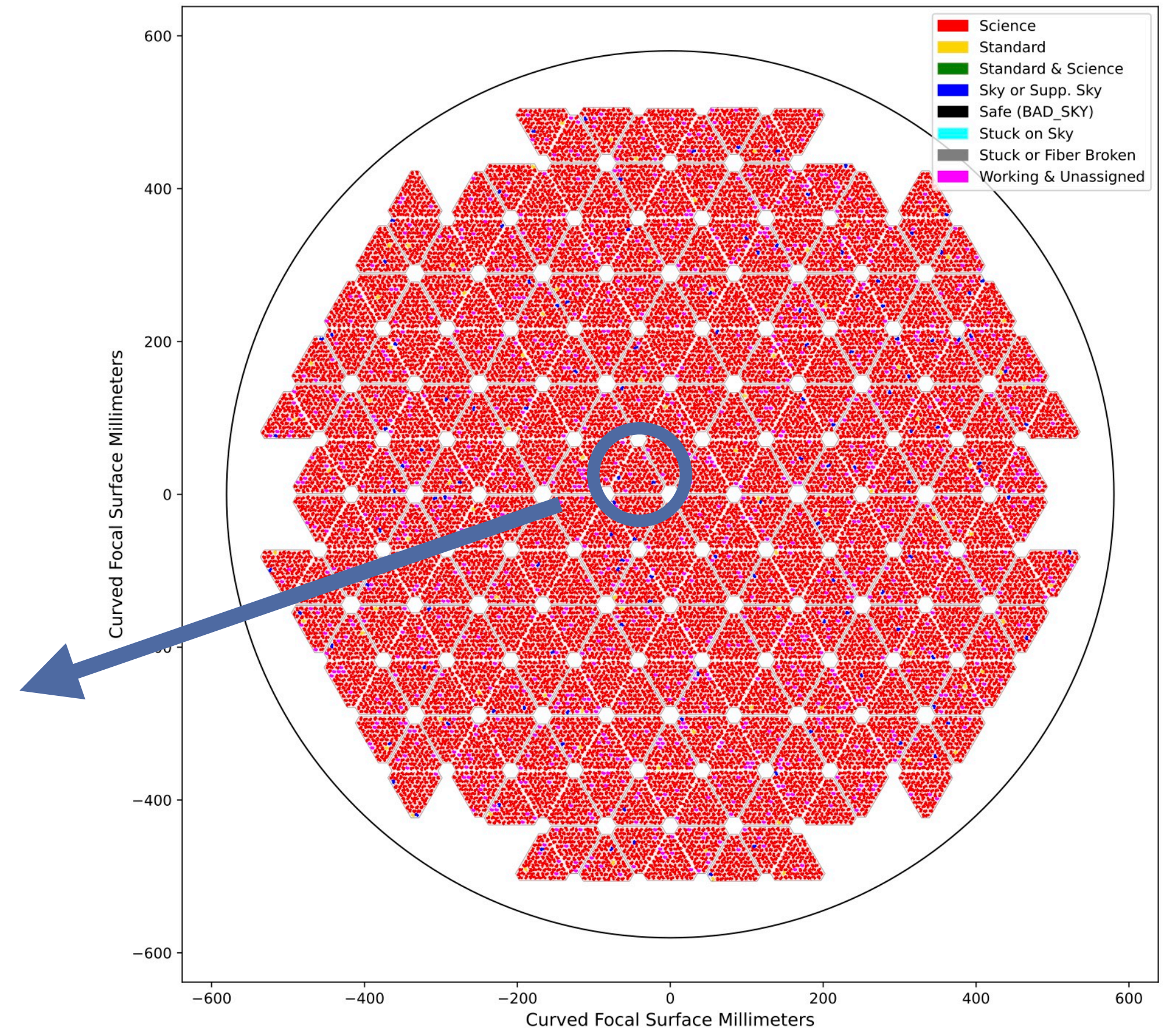
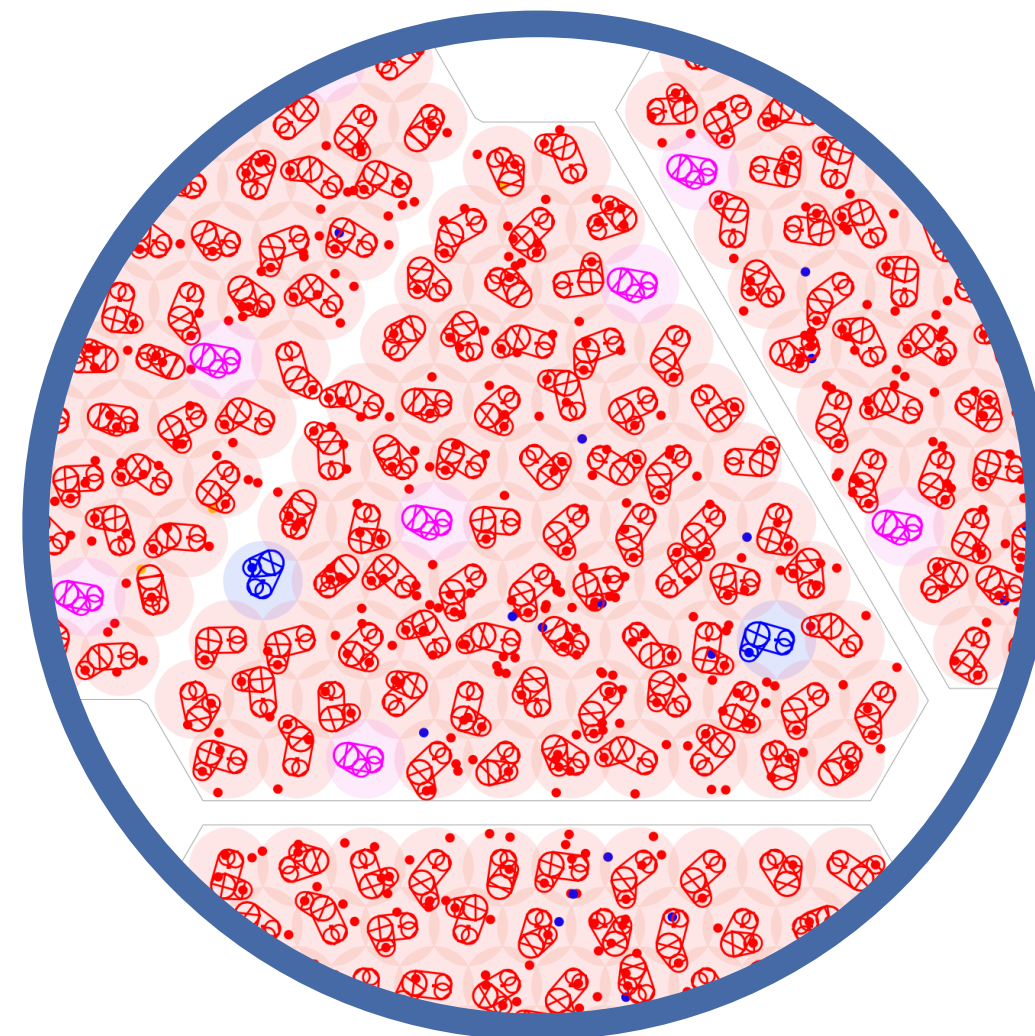
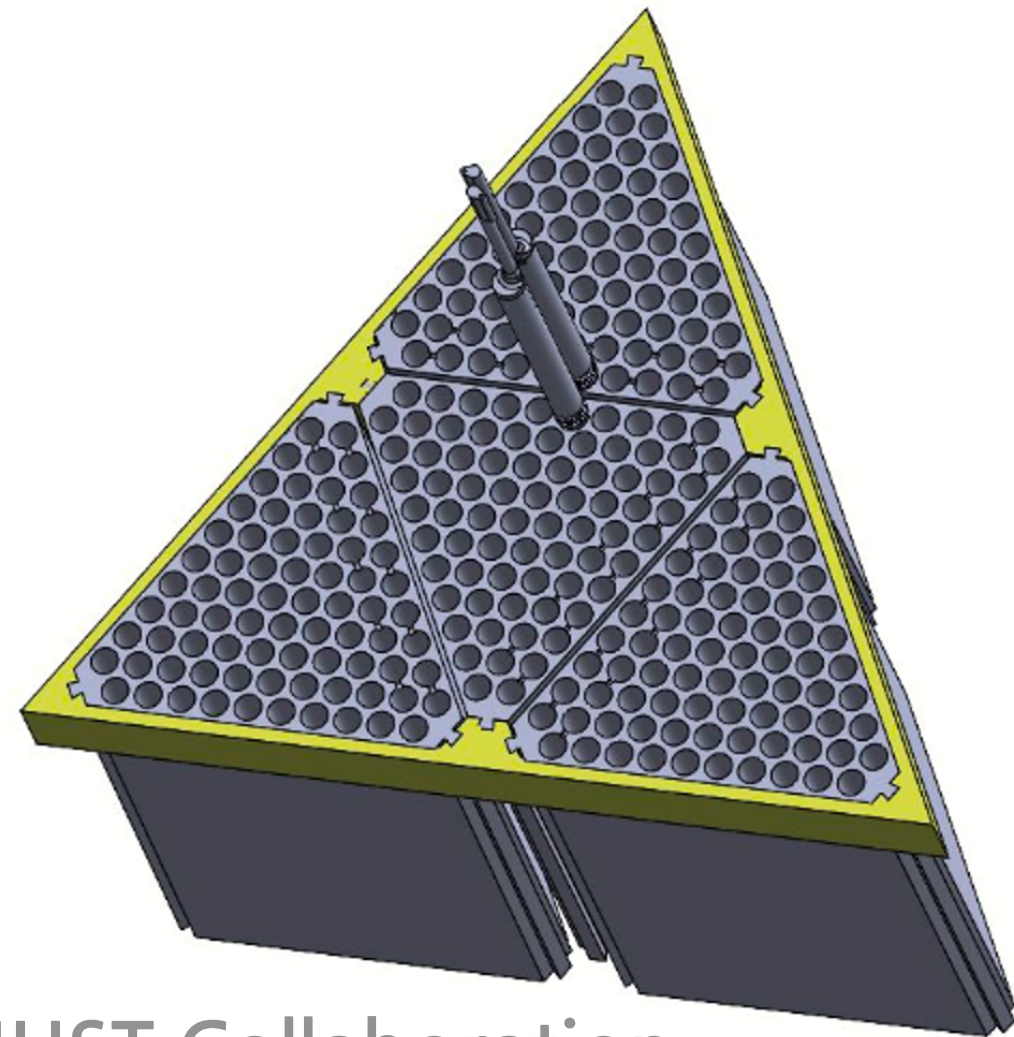
# Technical Challenge: Focal Plane

An initial concept of a modular focal plane with 10080 fiber positioners (using DESI fiberassign code)

## Major challenges:

- Fast fiber assignment with targets updated in real time
- Fast reconfiguration of fiber positioners
- Collision avoidance

**Development:** AI-based optimisation tool



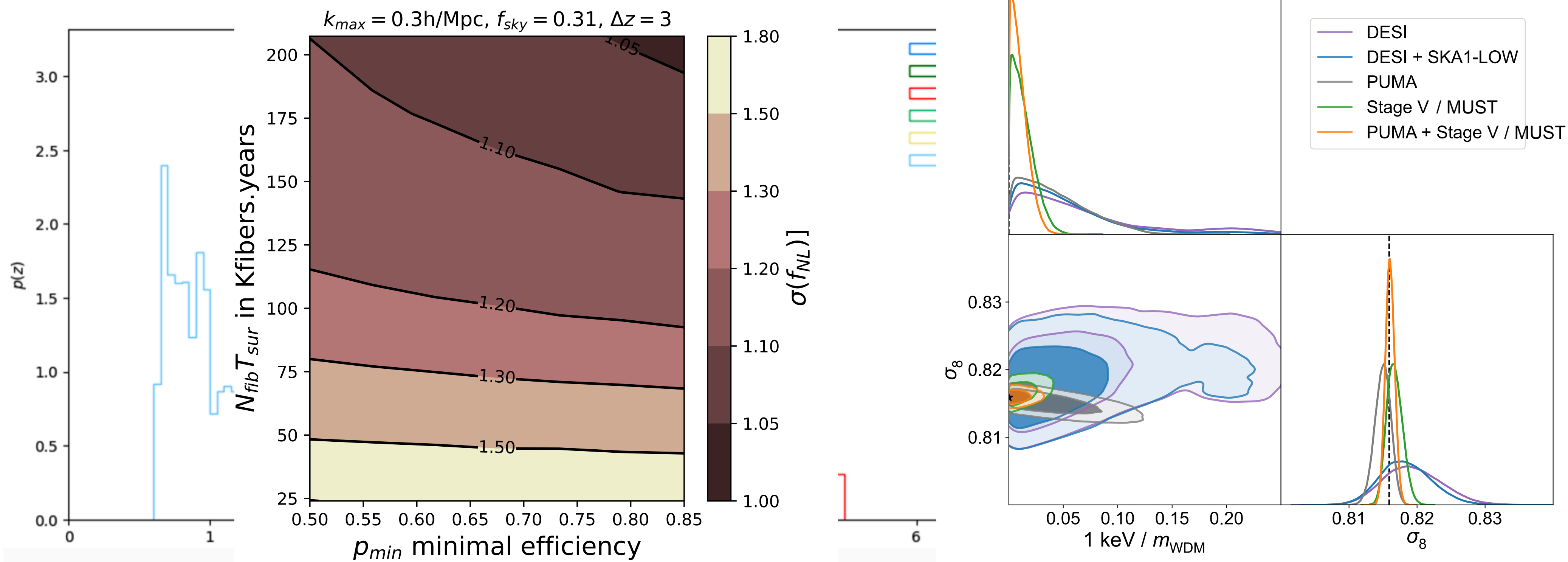
Credit: MUST Collaboration





Cosmological white paper in prep. (to be submitted this year)

- Preliminary Lyman Break Galaxy (LBG) selection based on HSC data
- Fisher forecasts for major science cases



Credit: MUST Collaboration, d'Assignies, CZ+ 2023

Zhang+ in prep.





# US Spec-S5 & MUST Synergy

1

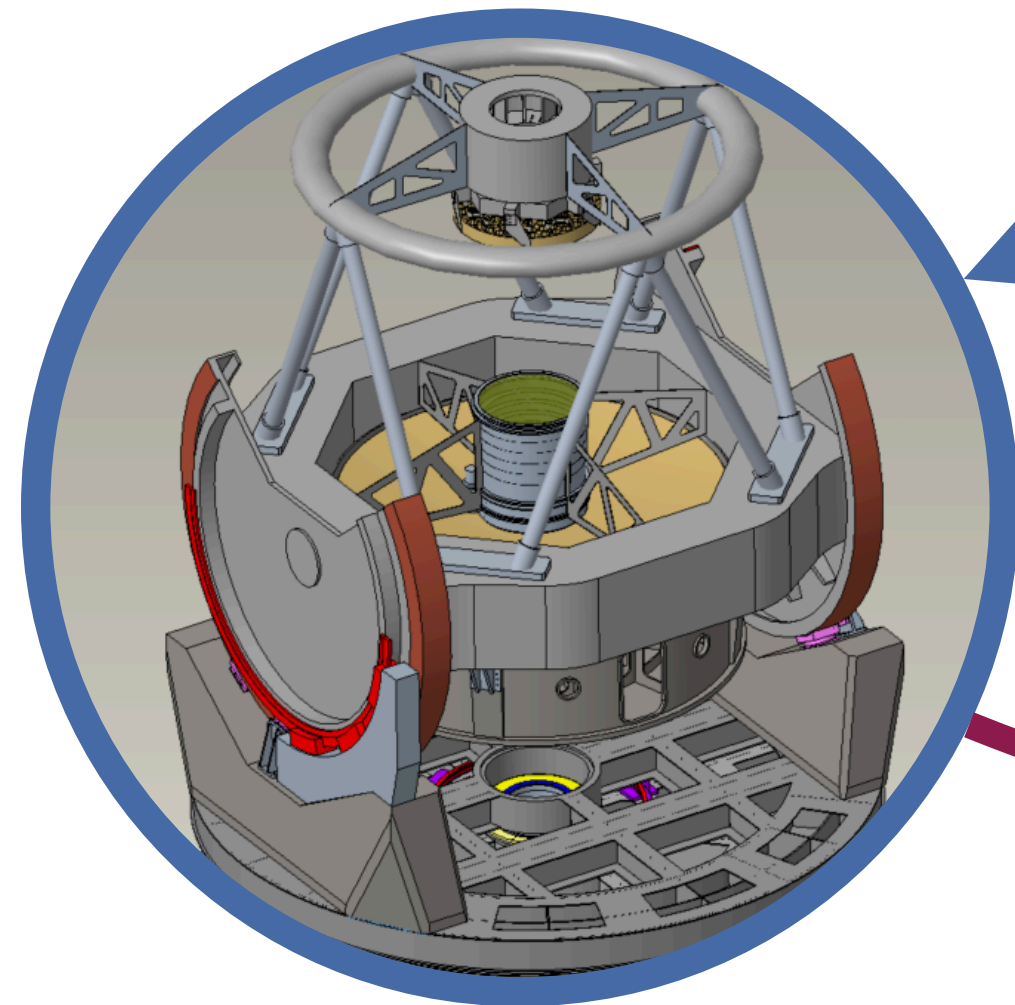
● **Volume & longitude complementary:** more statistics; smaller cadence for time domain

2

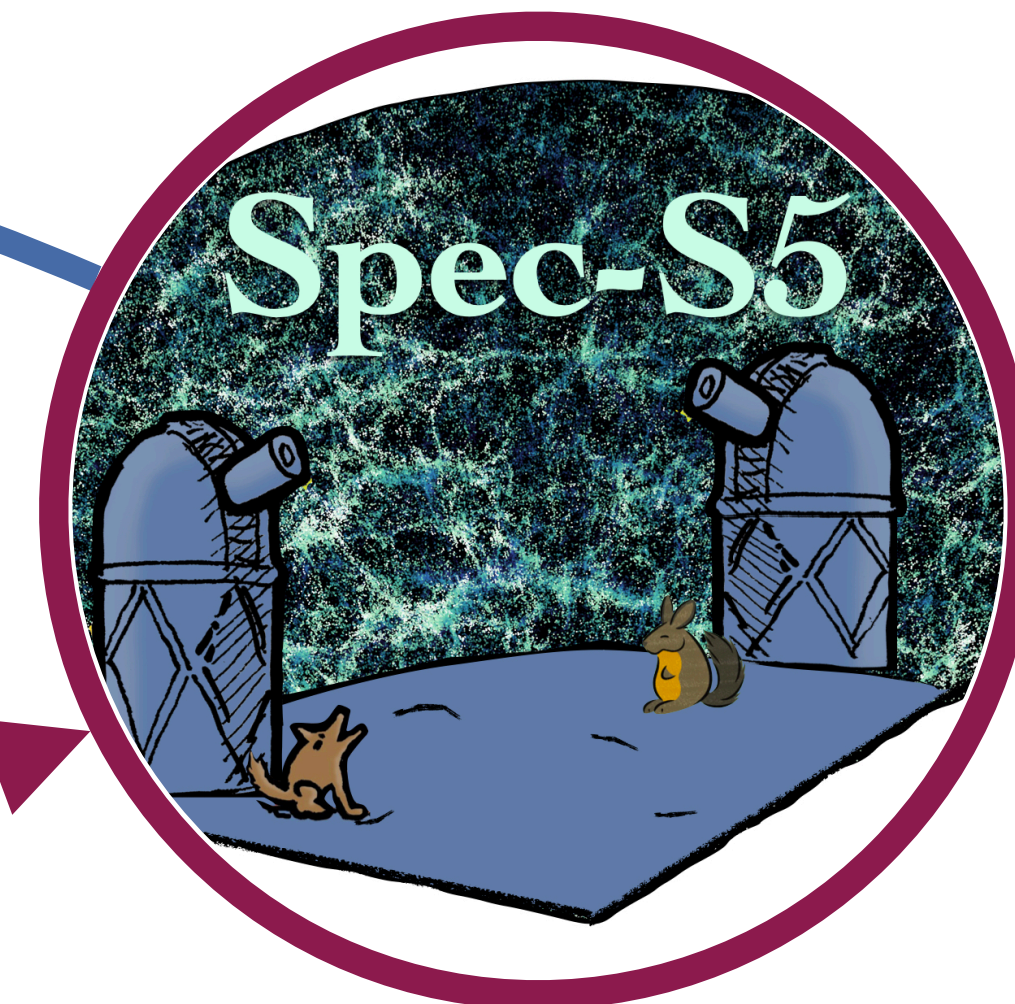
● **Cross validation:** will shed light on systematics

3

● **Software development:** survey strategy, fibre assignment, data analysis, etc.



We can do a  
lot of science  
together!







## Scientific Collaboration Policy

- We have drafted an initial version of the scientific collaboration policy and code of conduct.
- We aim to make it as friendly as possible to the junior members of the community including the international ones.



**MUST**  
MULTIPLEXED  
SURVEY TELESCOPE

多目标光谱巡天望远镜科学合作规范

MUST 科学合作组织 (MUST Science Collaboration)

October 9, 2022

**We sincerely welcome your participation and involvement!**

## Scientific Discussion and Communications

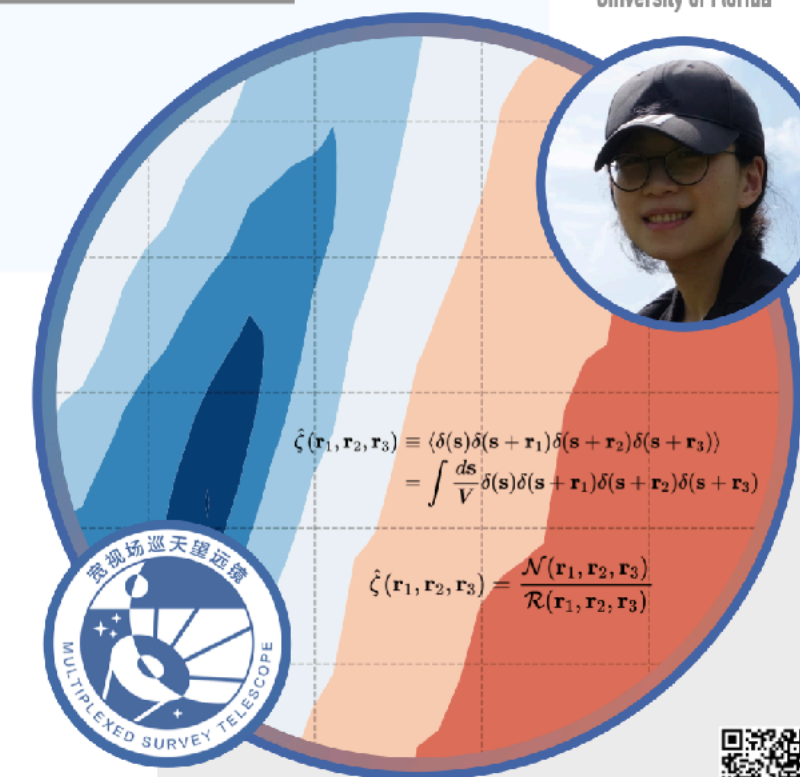
- We are organizing different types of on-line talks & discussions on different scientific topics related to MUST.
- The first few “We MUST Talk” seminars have drawn broad domestic attention.

### We MUST Talk **AUG 4**

Higher-Order Correlation Function of Large Scale Structures and Parity Violation Search

Aug 4 (Thu) 9:00 AM Beijing

Jia-Min Hou (侯佳旻)  
University of Florida



Zoom ID: 274 322 2637 PW: MUST

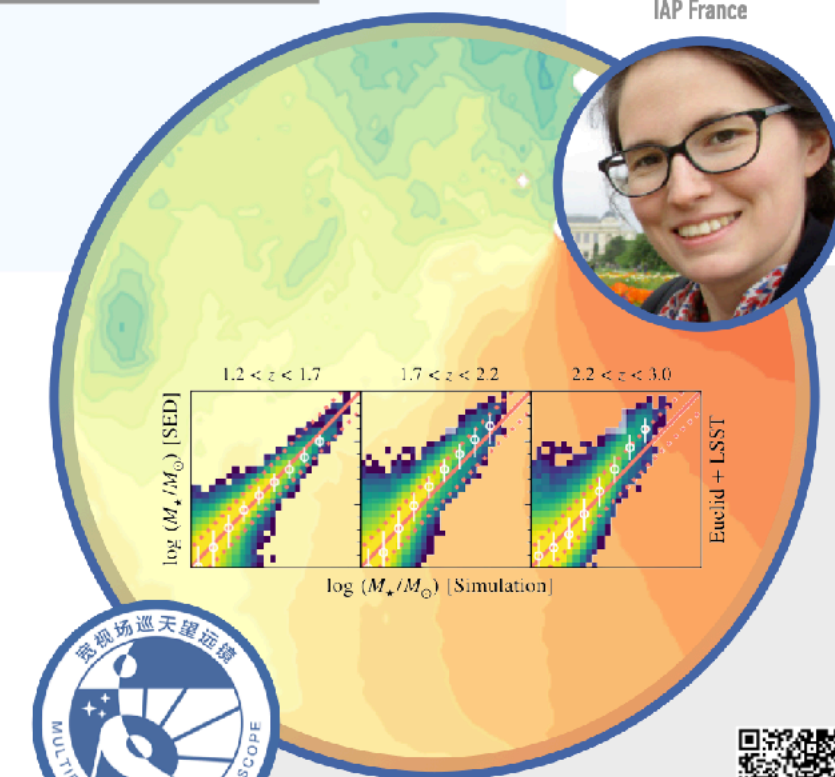


### We MUST Talk **AUG 25**

The Panchromatic Sky: SED-fitting performances and forecast for future imaging surveys

Aug 25 (Thu) 16:00 Beijing

Clotilde Laigle  
IAP France



Zoom ID: 274 322 2637 PW: MUST







# MUST



清华大学  
Tsinghua University

## MUST Scientific Vision:

- To play a major role in the Stage-V spectroscopic cosmology endeavor.
- To conduct large time-domain spectroscopic surveys.
- To become an international astronomical platform for decades to come.

<https://must.astro.tsinghua.edu.cn/>

Looking Forward to Your Comments and Advice !