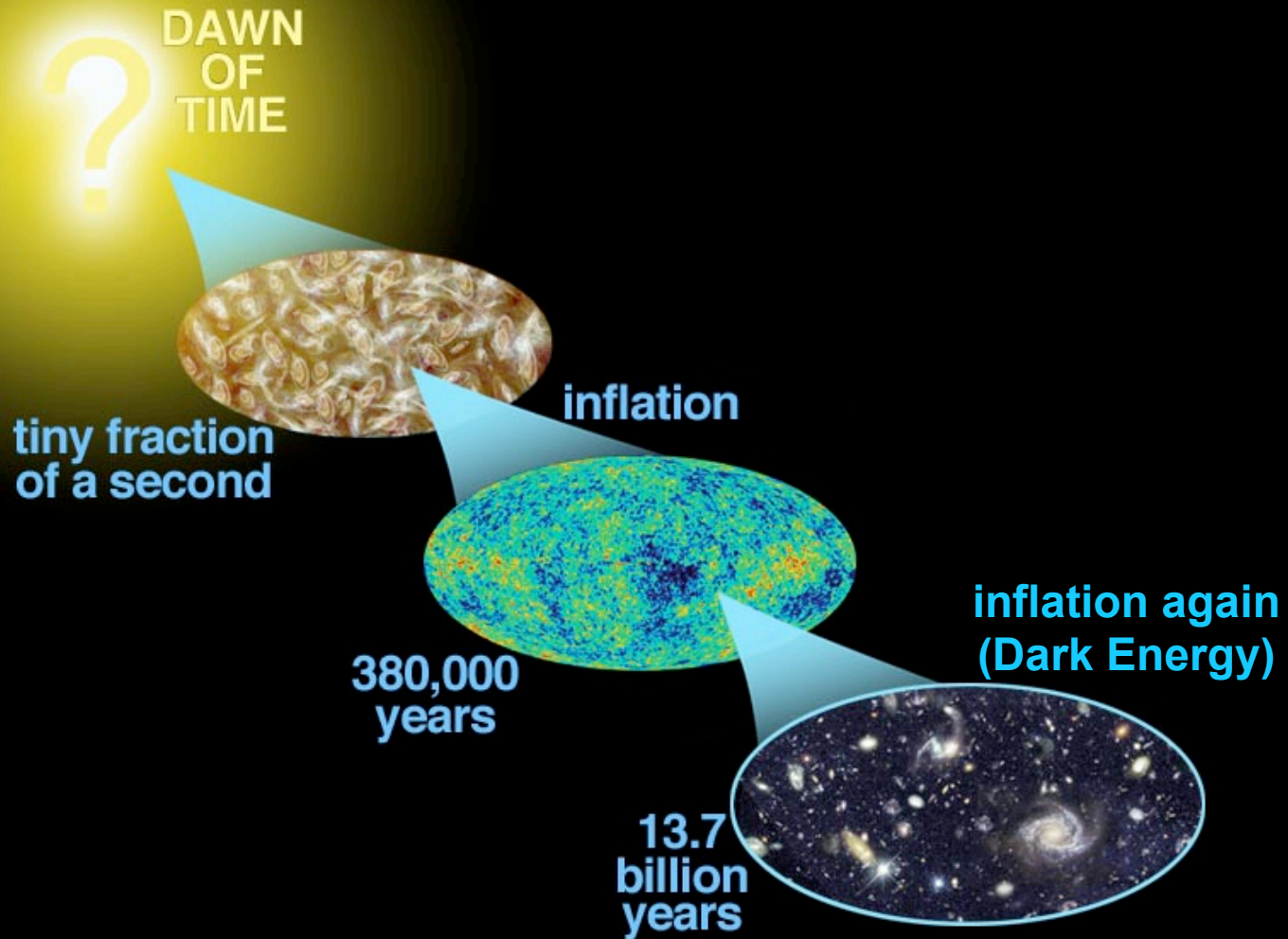# Cosmic frontier at Berkeley Lab
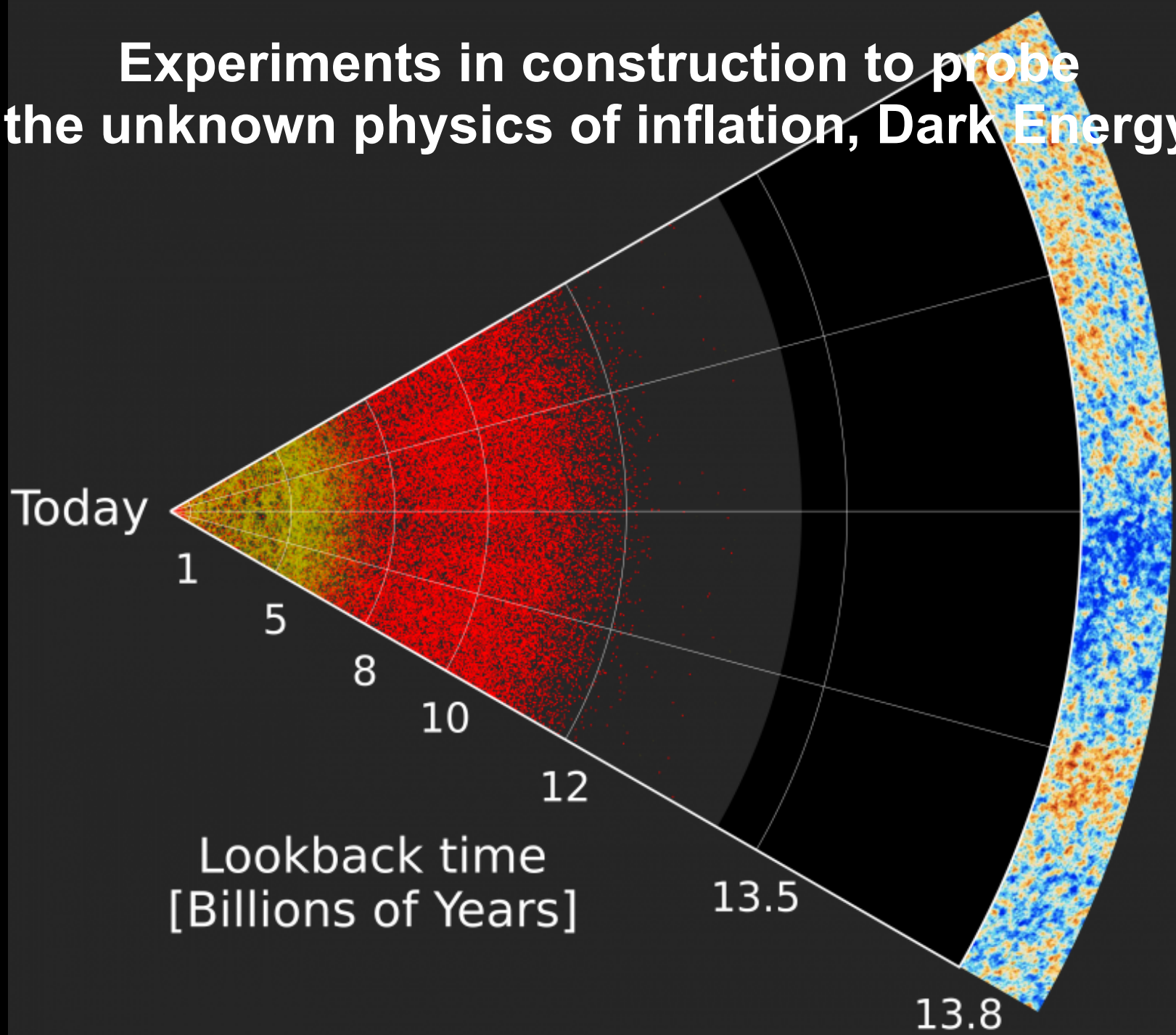
- Supernova cosmology (SNfactory, SCP, LSST)
- Redshift surveys (DESI)
- Cosmic microwave background (Simons, CMB S-4)

David Schlegel

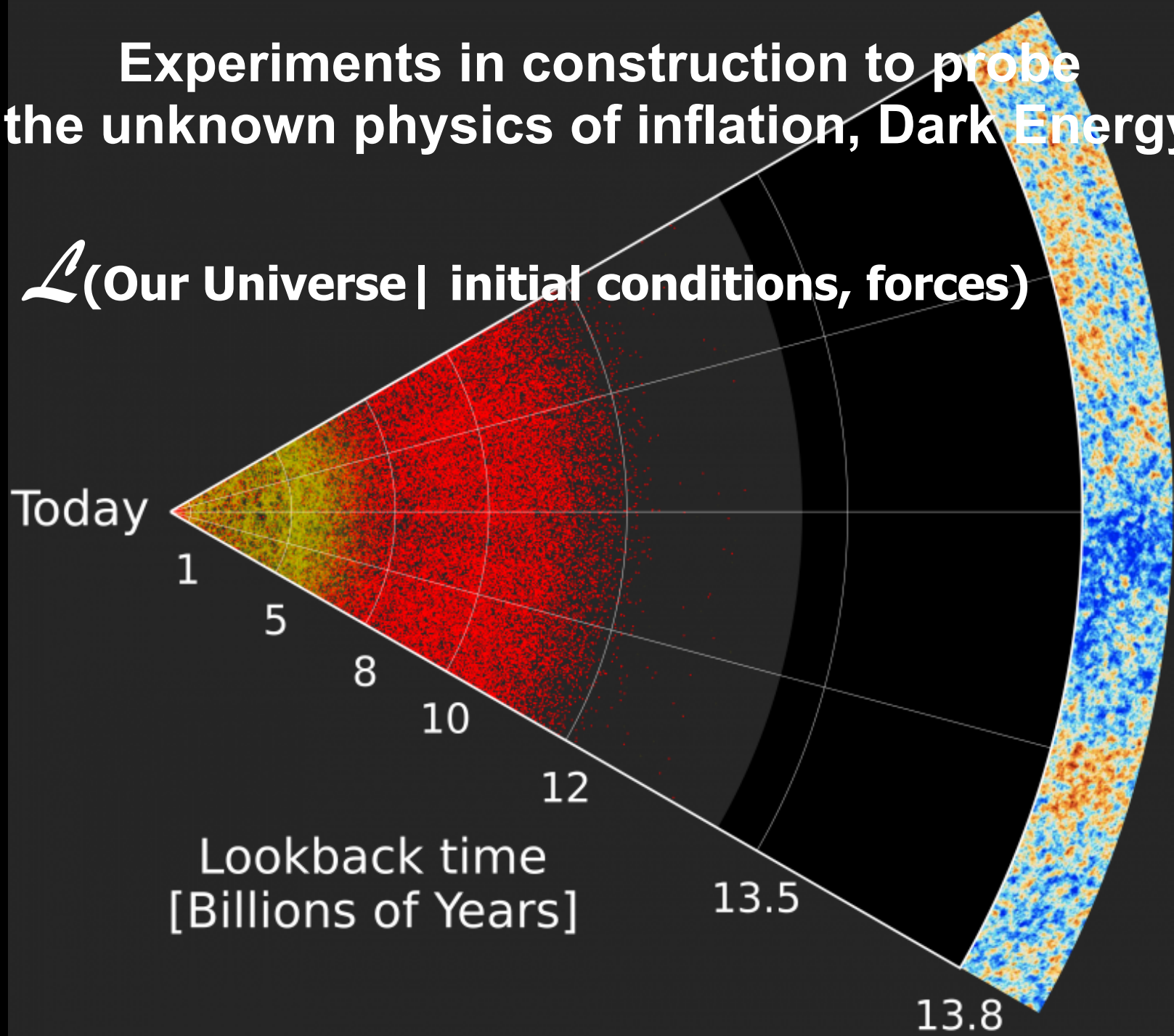# Experiments in construction to probe the unknown physics of inflation, Dark Energy

DAWN OF TIME

tiny fraction of a second

inflation

380,000 years

inflation again (Dark Energy)

13.7 billion years

Experiments in construction to probe the unknown physics of inflation, Dark Energy
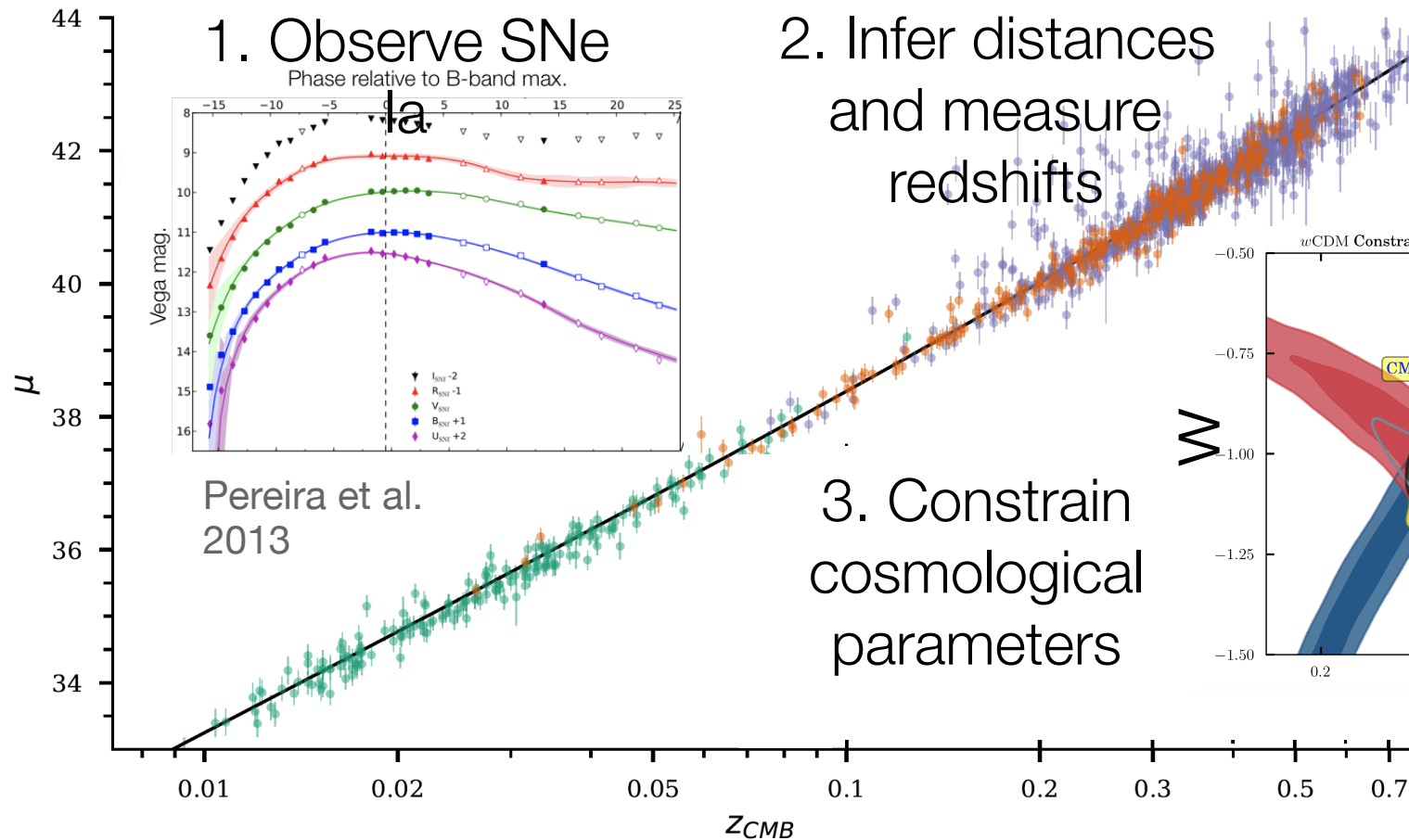
Today

1

5

8

10

12

Lookback time
[Billions of Years]

13.5

13.8

Experiments in construction to probe
the unknown physics of inflation, Dark Energy
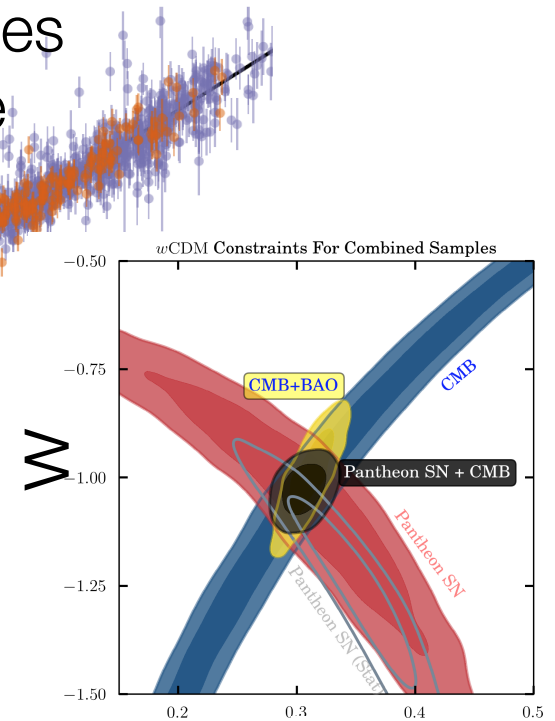
$\mathcal{L}$(Our Universe| initial conditions, forces)

Today

1

5

8

10

12

Lookback time
[Billions of Years]

13.5

13.8

Supernovae Cosmology Project

1. Observe SNe Ia

Phase relative to B-band max.

Pereira et al. 2013

2. Infer distances and measure redshifts

3. Constrain cosmological parameters

wCDM Constraints For Combined Samples

CMB+BAO

CMB

Pantheon SN + CMB

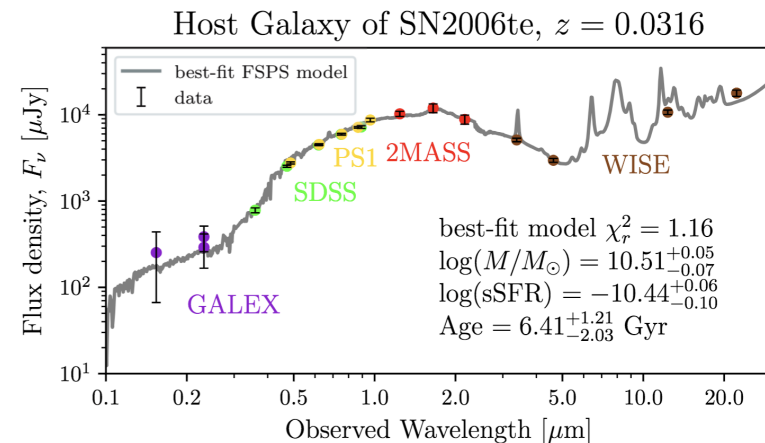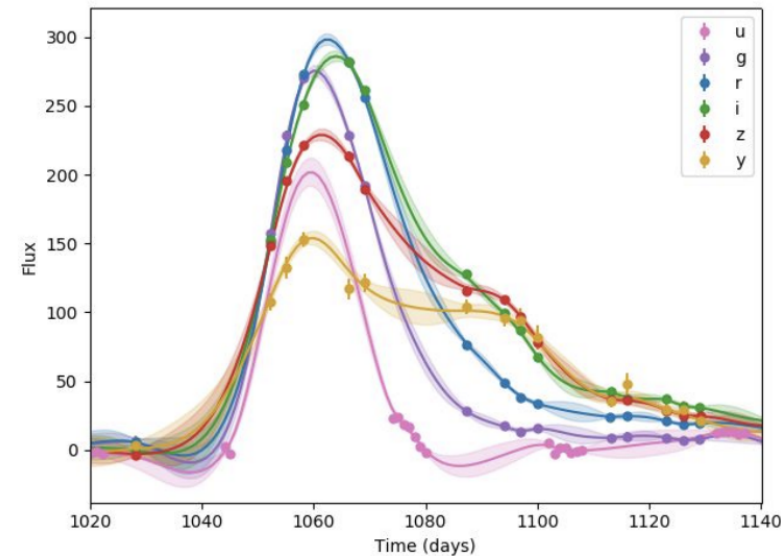Pantheon SN

Pantheon SN (Stat)

μ

z_{CMB}

Ω_m

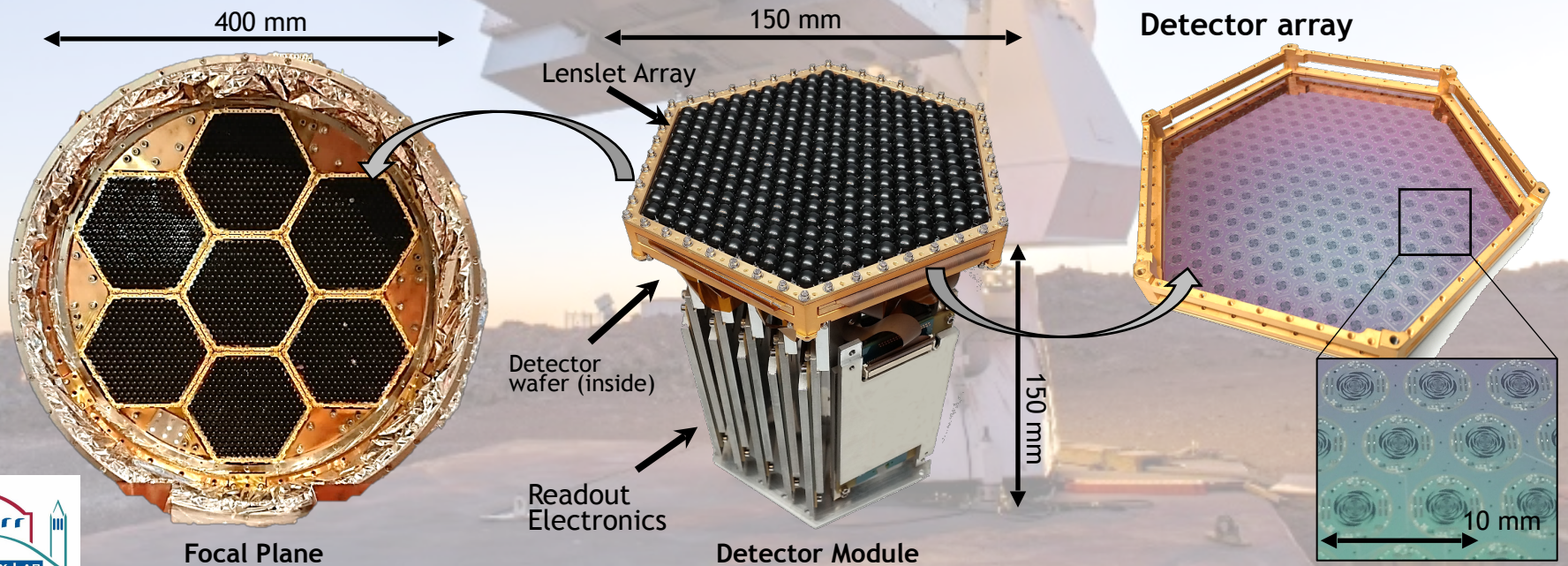Jones et al. 2018
Scolnic et al. 2018

Supernovae Cosmology Project - Current projects

- Machine learning for:
  - Modeling (understanding SN physics)
  - Improving distance measurements
  - Classification of transients
- Understanding relationships between SNe Ia physics and their host galaxies
- Build/improve software pipelines for reducing IFU data
- Prepare for future large surveys (WFIRST and LSST)
- Use supernovae to probe gravity via peculiar velocity measurements

Host Galaxy of SN2006te, $z = 0.0316$

best-fit FSPS model
data

GALEX SDSS PS1 2MASS WISE

best-fit model $\chi_r^2 = 1.16$
$\log(M/M_\odot) = 10.51^{+0.05}_{-0.07}$
$\log(sSFR) = -10.44^{+0.06}_{-0.10}$
Age $= 6.41^{+1.21}_{-2.03}$ Gyr

Cosmic Microwave Background Instrumentation

Design, fabrication and characterizizationof microfabricated superconducting ultra-sensitive detectors and readout electronics for astrophysics and other high energy physics (dark matter for example) experiments

Detector array

400 mm

150 mm

Lenslet Array

Detector array

Detector wafer (inside)

150 mm

Readout Electronics

Focal Plane

Detector Module

10 mm

Berkeley Lab

Dark Energy Spectroscopic Instrument (DESI) being installed @ Kitt Peak, Arizona

First light in September 2019
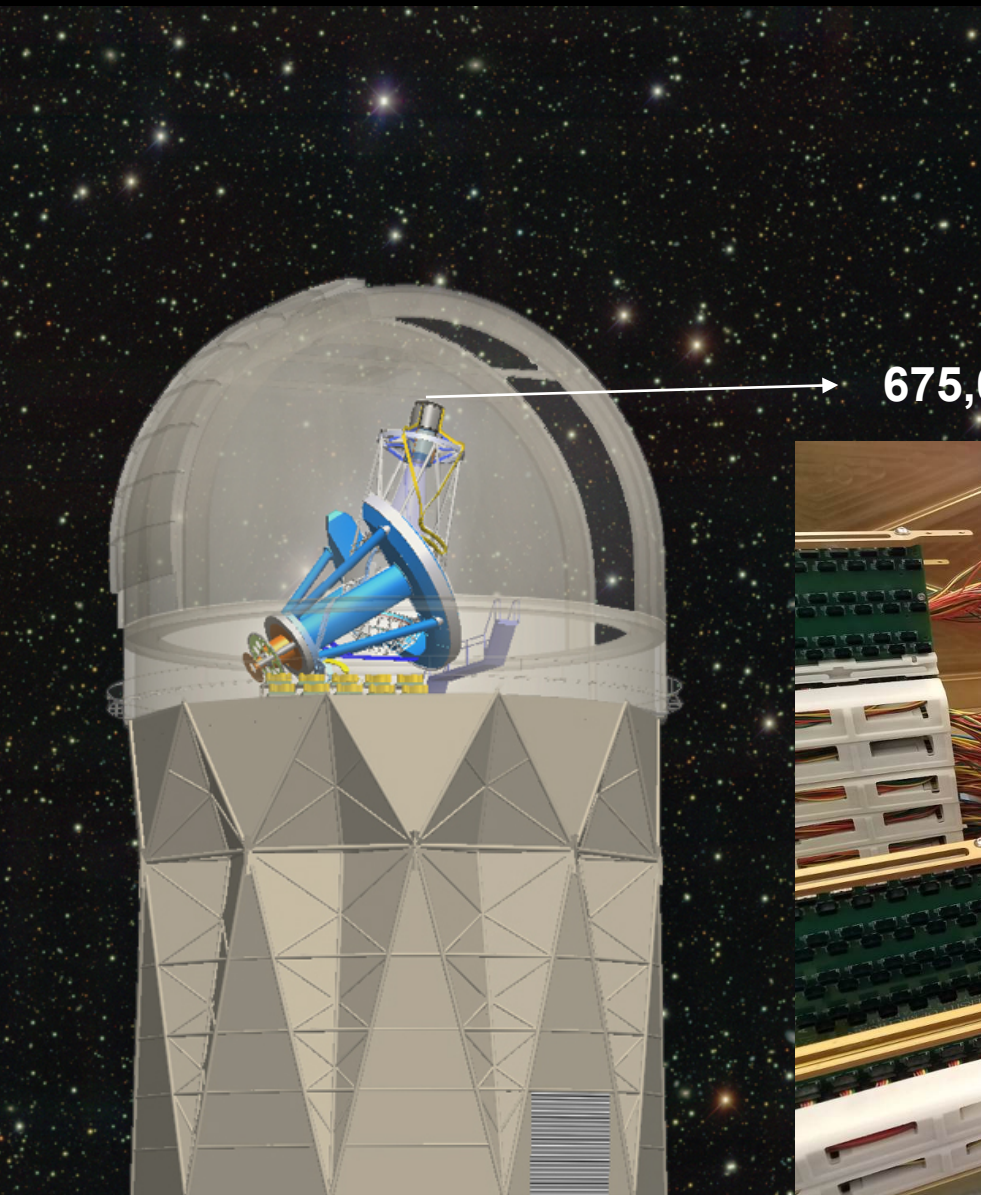
"Some assembly required"
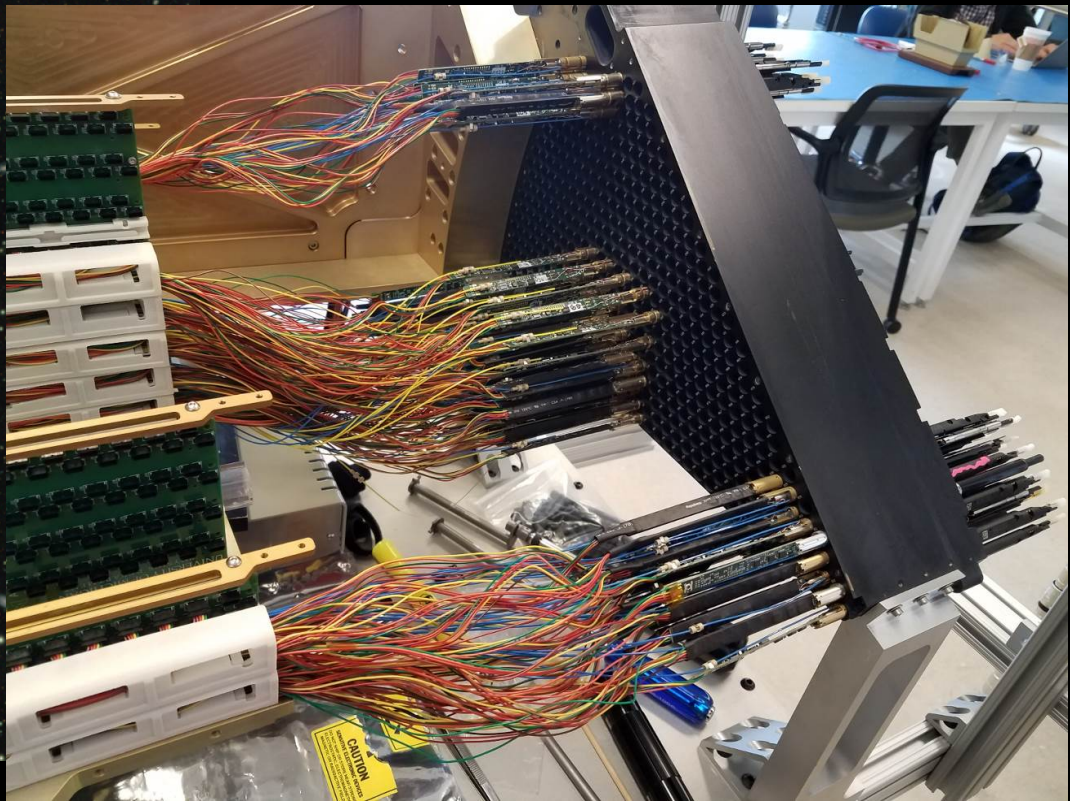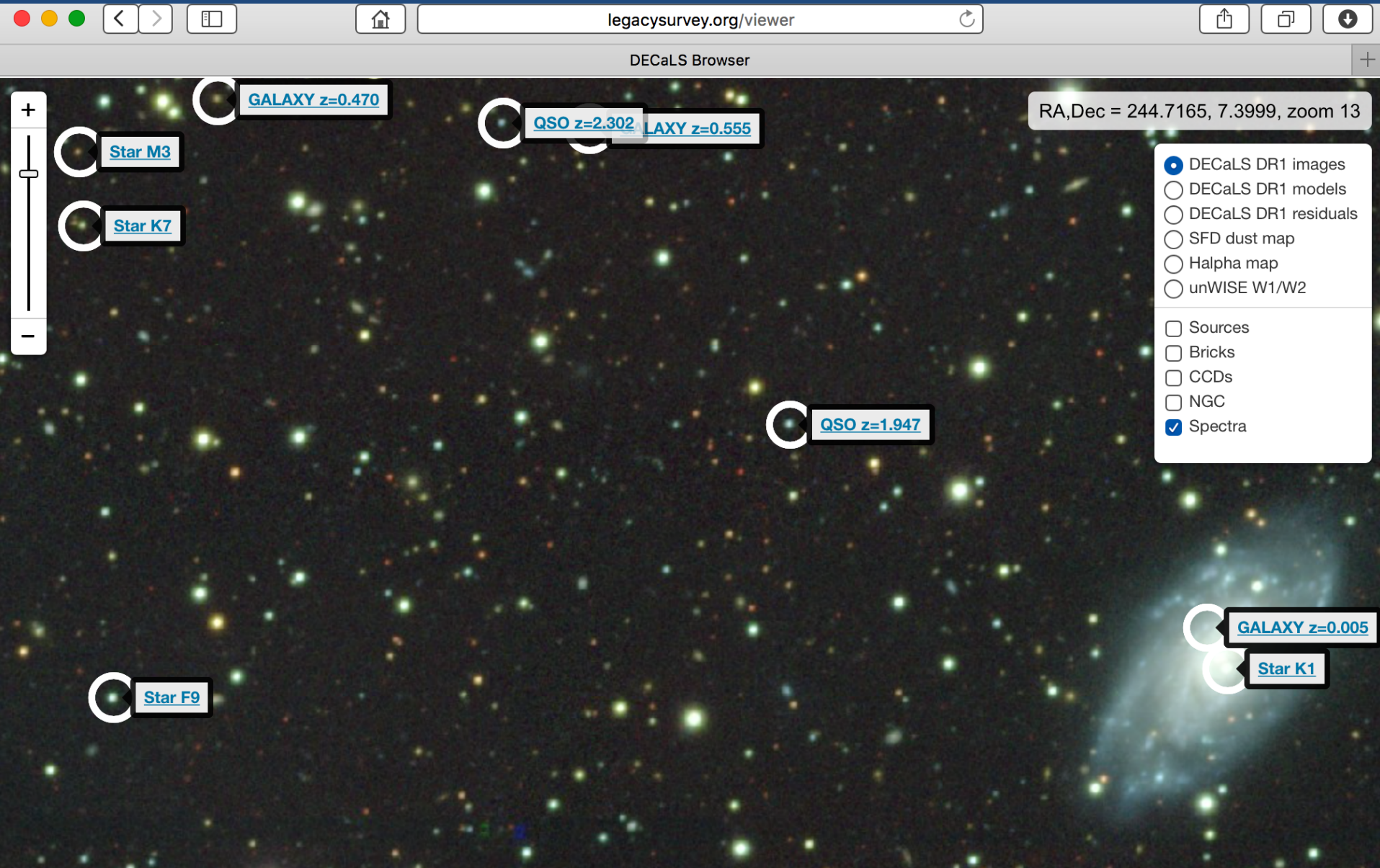
DESI status

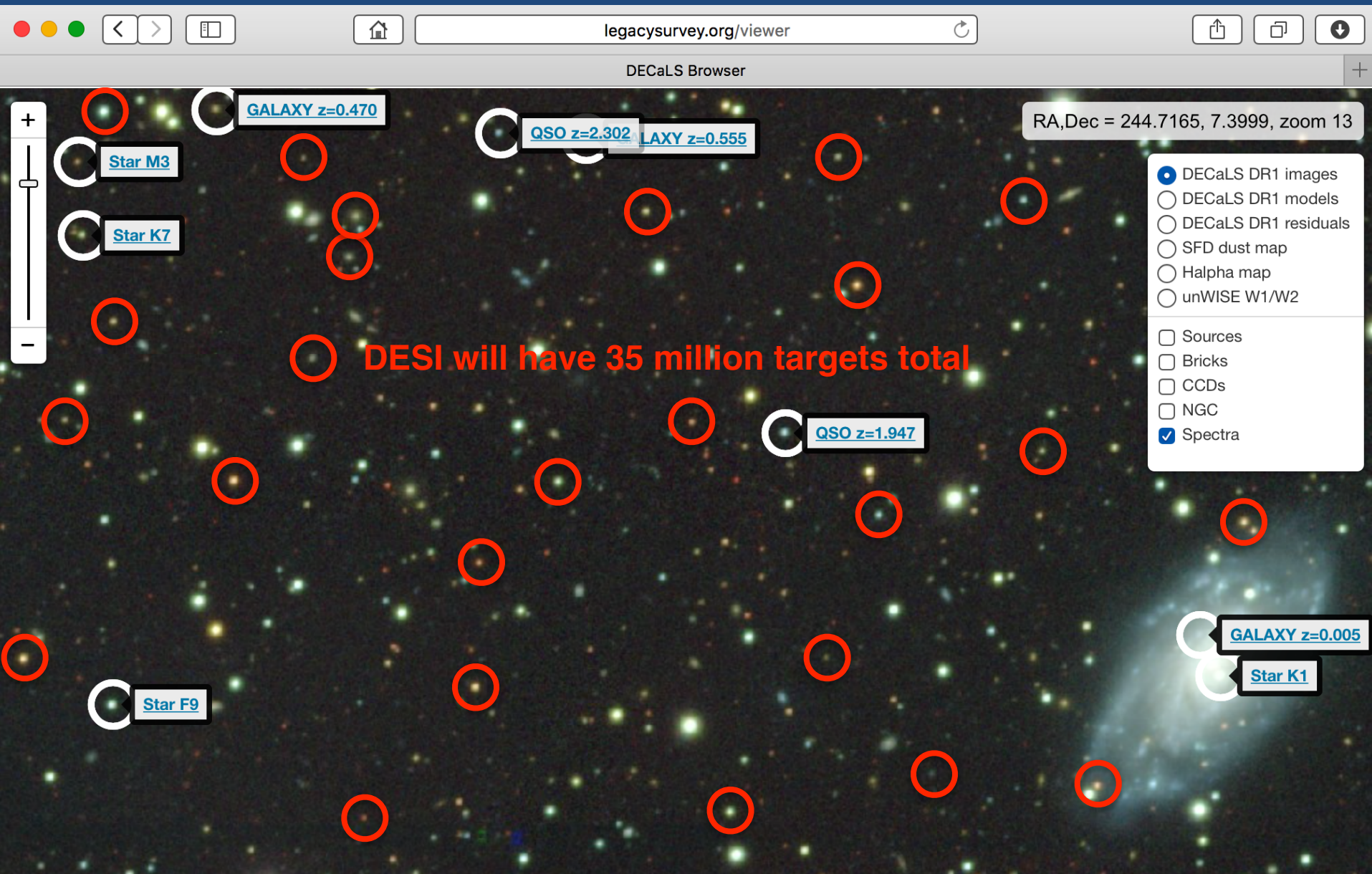675,000 total parts on this focal plane

DESI imaging surveys - completing now

DESI redshift surveys - starts Sep 2019

Berkeley Lab facilities — Engineering Division

Berkeley Lab facilities — Molecular Foundry

Berkeley Lab facilities — NERSC computing

Berkeley Lab facilities — NERSC computing