

The effect of fiber assignments on DESI galaxy clustering: SV3 galaxy mocks case

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DARK ENERGY
SPECTROSCOPIC
INSTRUMENT

U.S. Department of Energy Office of Science

IAC COSMOLOGY JAMBOREE 7th JUNE 2022

<https://indico.cern.ch/event/1149078/>

DARK ENERGY SPECTROSCOPIC INSTRUMENT

Dark Energy Stage IV experiment Spectroscopic survey

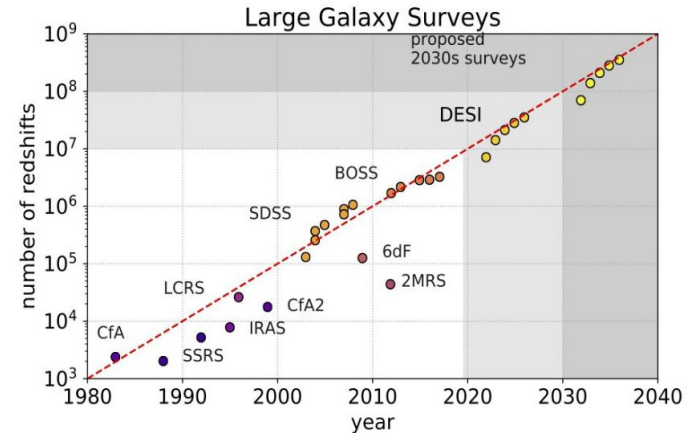
It will measure redshifts to ~40 million galaxies
and QSO until 2026

It uses the 4m Mayall Telescope in Arizona (it is the
twin telescope of Blanco in Chile)

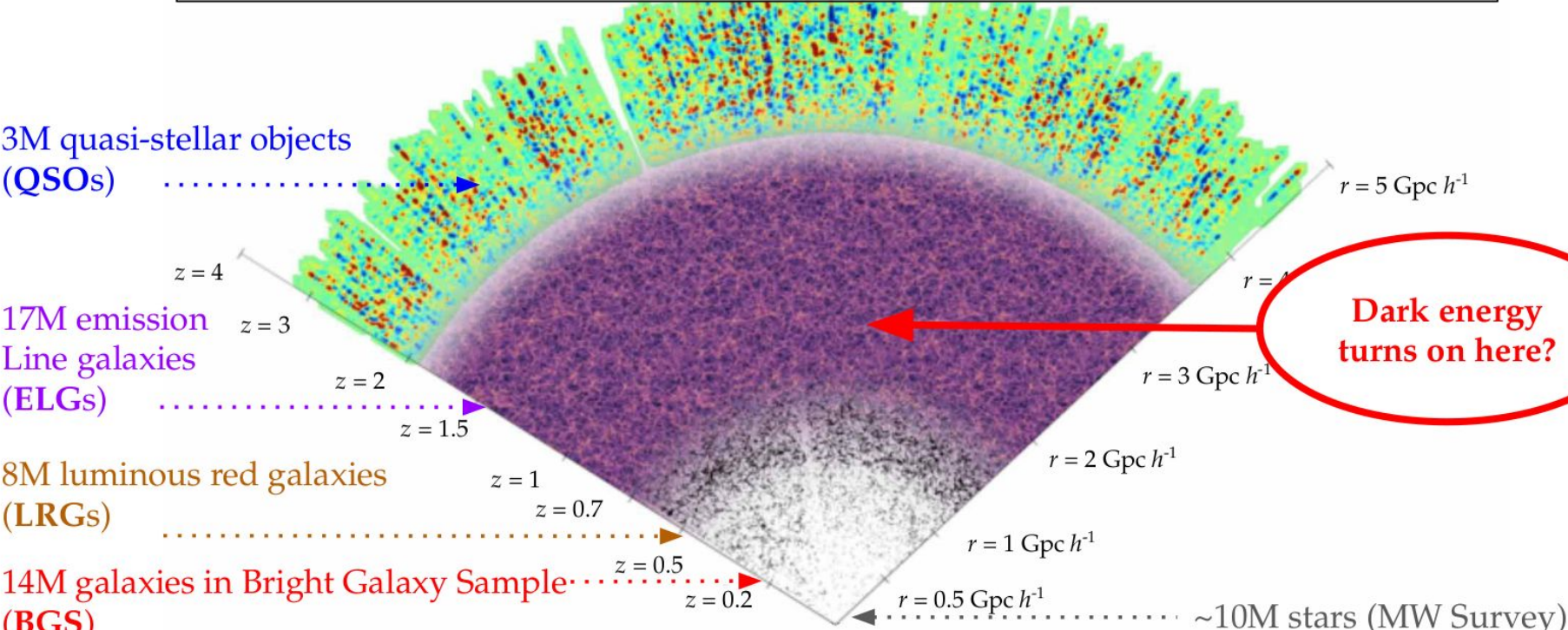
Main objectives:

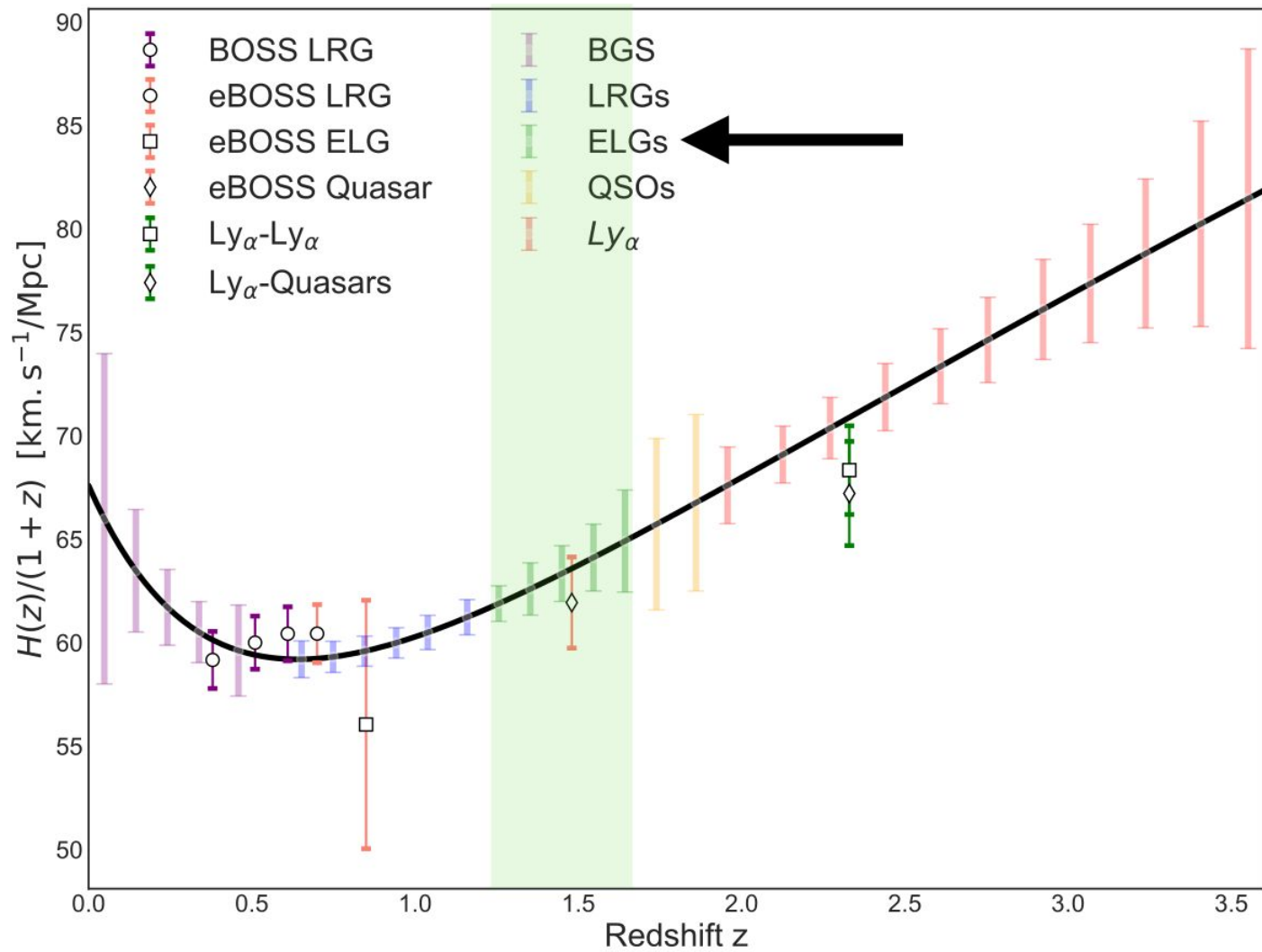
- Dark Energy
- Modify gravity
- Massive neutrinos

- [Bright Galaxy Survey WG](#) - Bright Galaxy Survey
- [Clustering, Clusters, and Cross-correlation WG](#) (
- [Cosmological Simulations WG](#) - cosmological sim
- [Galaxy & Quasar Clustering WG](#) - cosmology fro
- [Galaxy & Quasar Physics](#) - galaxy and quasar pt
- [Lyman-alpha Forest WG](#) - cosmology from the Ly
- [Milky Way Survey WG](#) - Milky Way Survey mail a
- [Spectroscopic Pipeline and Data Simulation WG](#)
- [Target Selection WG](#) - algorithms for target selec
- [Transients and Low-redshift cosmology](#) - time do
- [DESI-II](#) - Key science drivers and survey designs

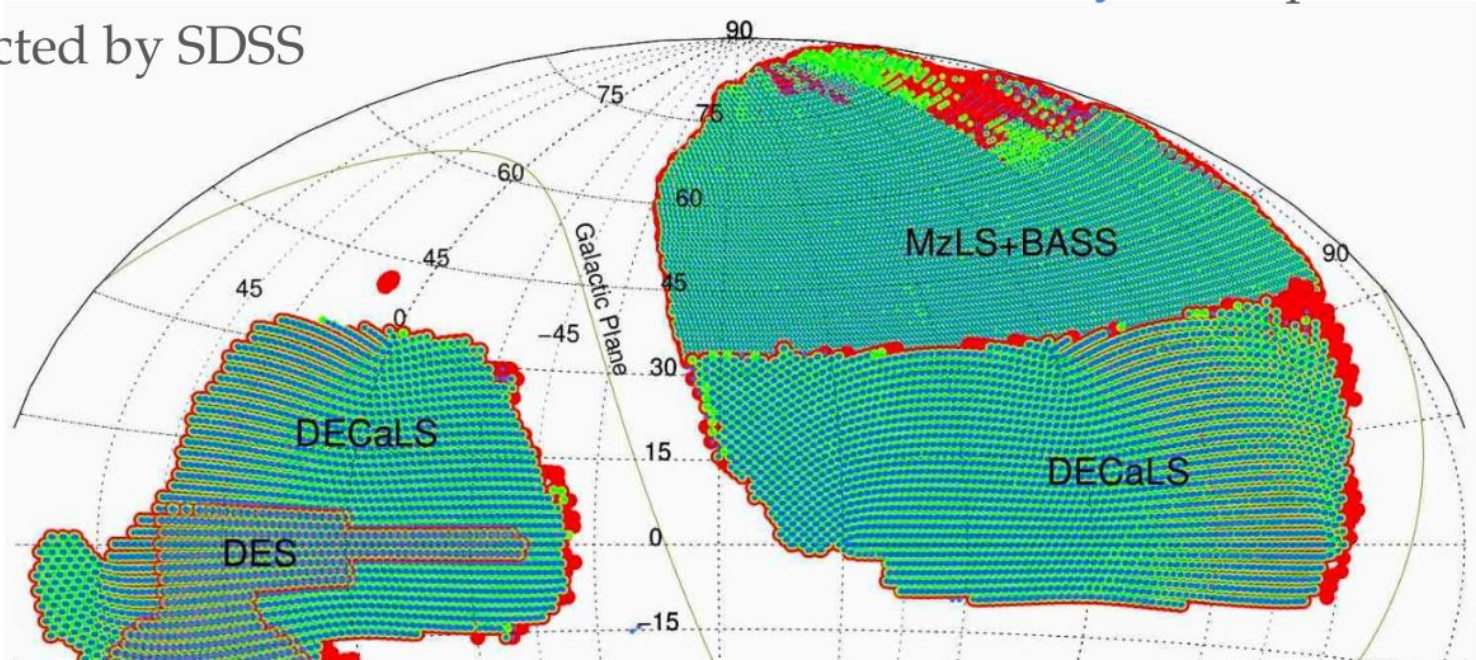


DESI is exploring a 30x larger map over a 10x larger volume than SDSS!





- DESI uses **$\sim 14,000 \text{ deg}^2$ of DESI Legacy Survey g,r,z + WISE IR** imaging to find targets
- It will collect **$\sim 40\text{M}$ redshifts (we have 13M already!)**, compared to $\sim 3\text{M}$ collected by SDSS



Current status - highlights

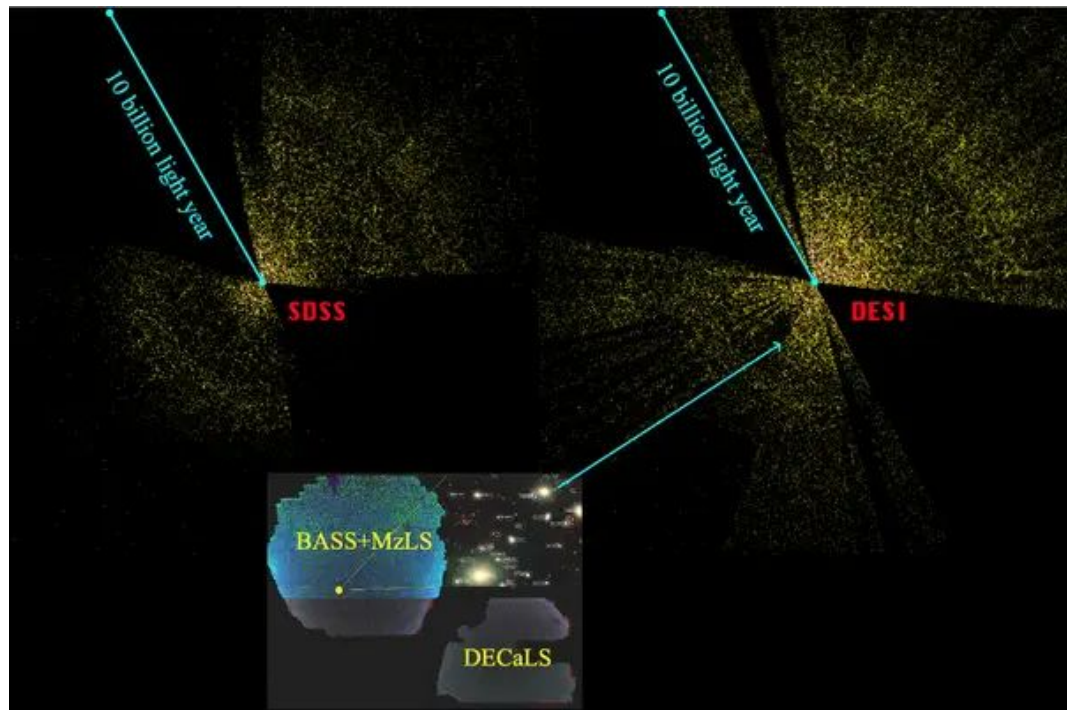
Started main operations ~ 1 year ago.

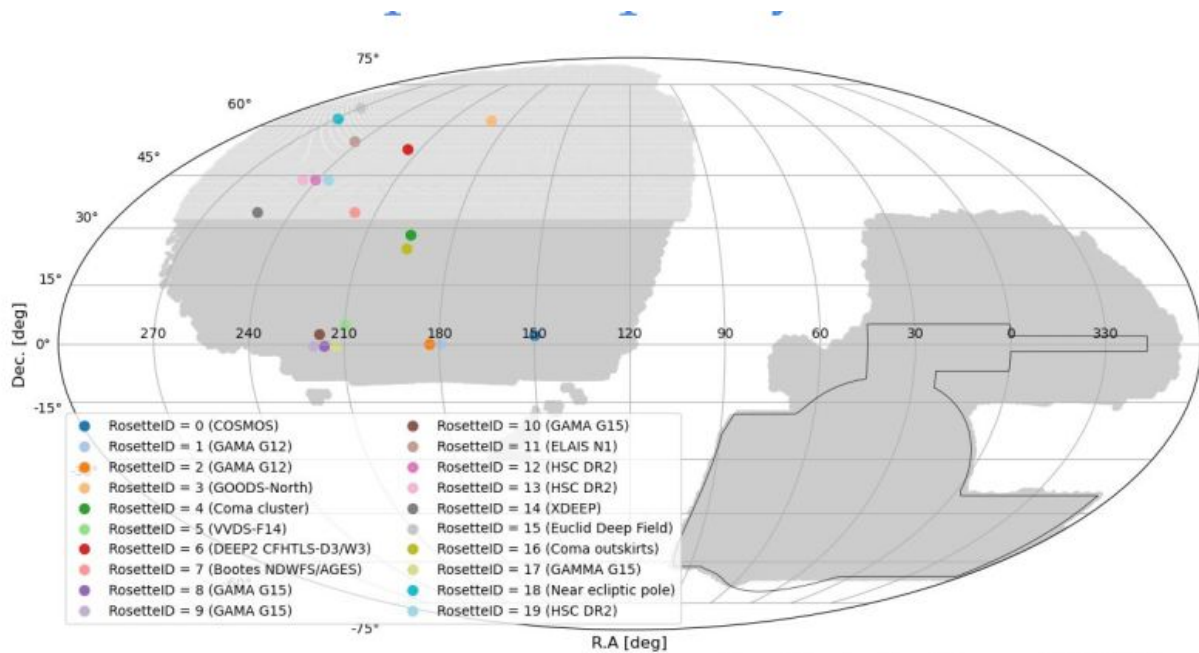
It is already bigger than SDSS!!!

7.5 million galaxies already

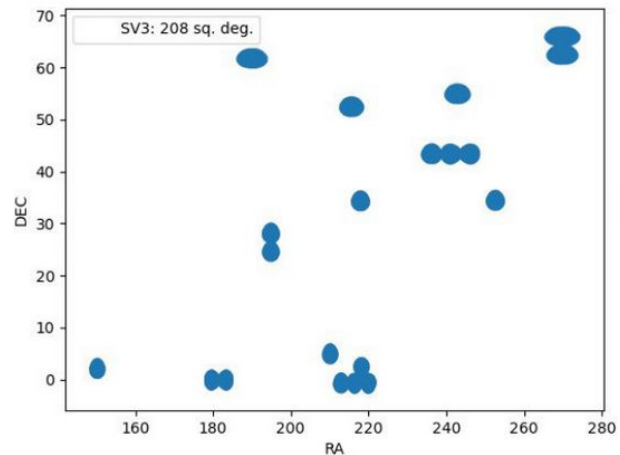
DESI Y1 forecasts:

- Y1 BAO combined at $z \sim 0.9$:
 - $\sigma(D_V/r_d) \lesssim 0.42\%$ (conservatively)
- Y1 RSD combined at $z \sim 0.9$:
 - $\sigma(f \cdot \sigma_8(k_{\max}=0.2)) \lesssim 1\%$
 - $\sigma(f \cdot \sigma_8(k_{\max}=0.1)) \lesssim 1.8\%$
- Y1 massive neutrinos:
 $\sigma(\Sigma m_\nu) \sim 0.063\text{eV}$
- Y1 f_{NL} : $\sigma(f_{\text{NL}}) \sim 9$





Credit: A. Raichoor / LBNL



SV3: 1% survey

- Final TS, 1.2x nominal t_{exp}
- 500 tiles, ~1M spectra

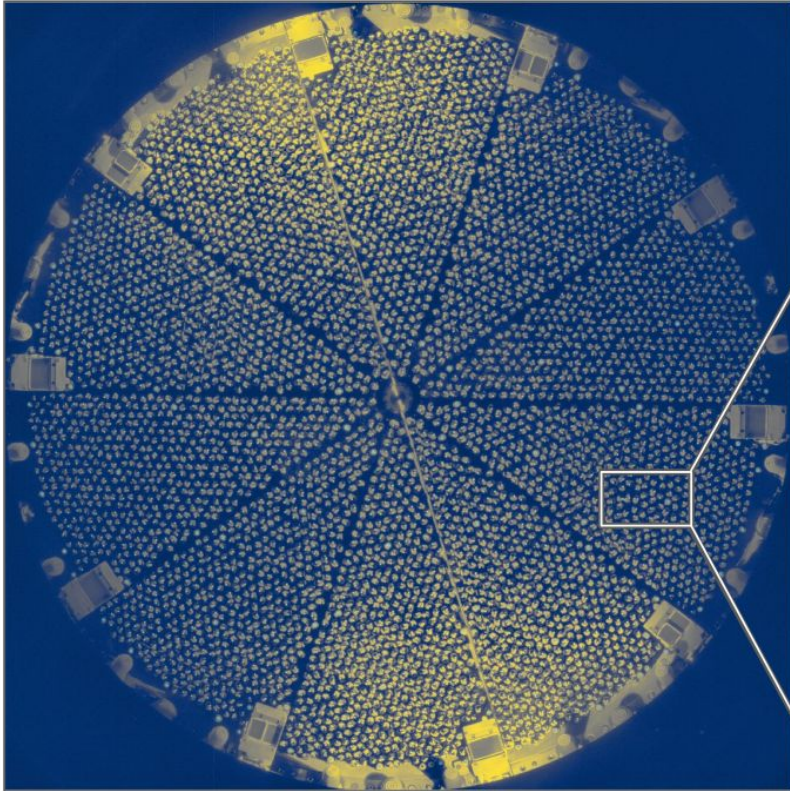
20 rosettes
~280 tiles



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DESI Focal Plane: 10 “Petals” with 5,020 Robotic Fiber Positioners



$\varnothing 107 \mu\text{m}$ fibers (0.7"), 12 mm patrol radii
~10 s move time

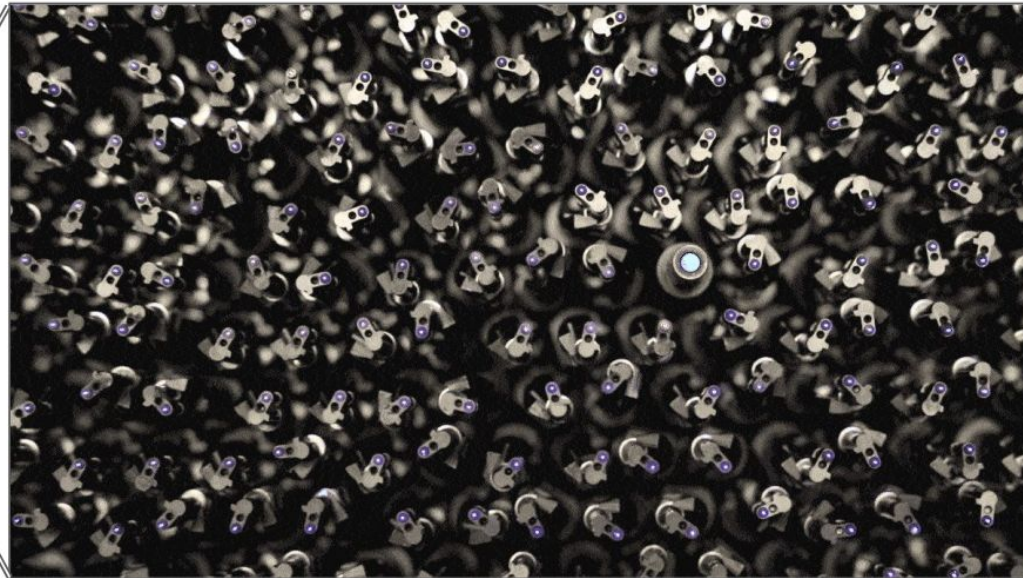
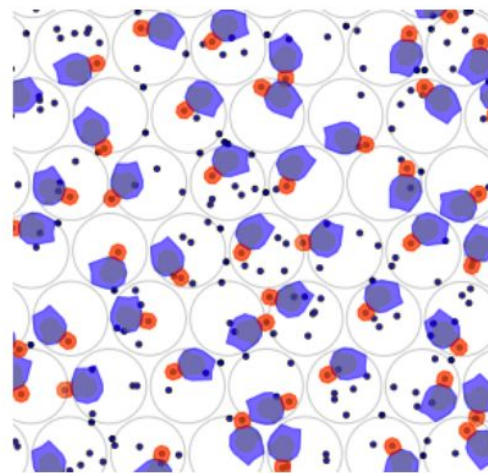
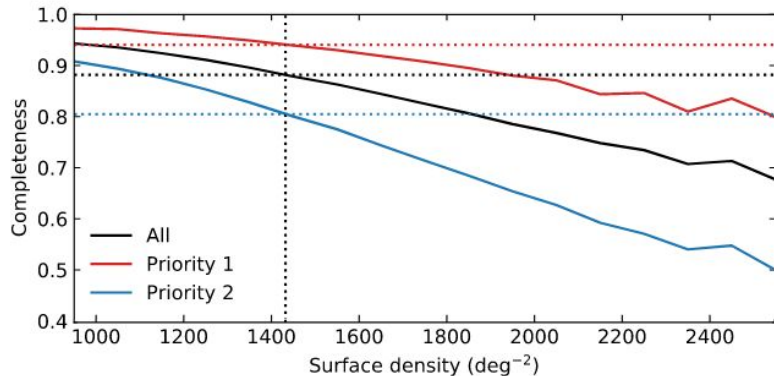
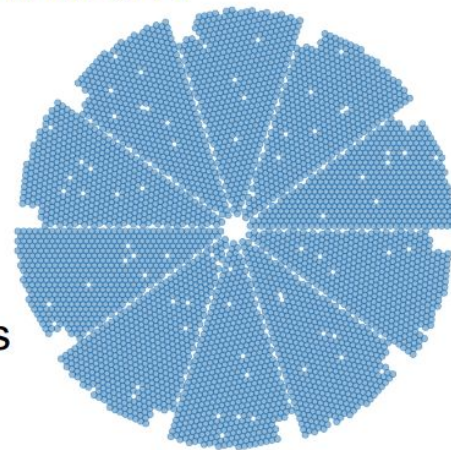




Figure 5. Fiber positioner robots are shown packed together on the focal plate. In addition to the fiber ferrule, each ϕ arm has a light-trap hole with a dark dye. The original concept for these light-traps was to be able to selectively extinguish bright stars in the field; in practice they have been most useful for identifying ϕ angles during hardware debugging. A projecting tab feature on each ferrule holder provides a simple but effective hard limit against clockwise over-extension.

DESI Fibre Assignment

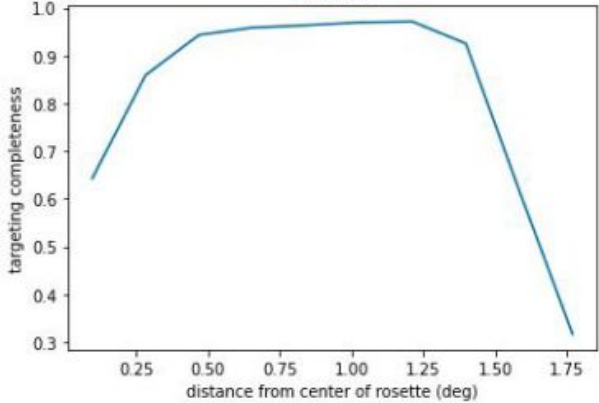
- Incompleteness due to fibre assignment
- Fibre positioners can block neighbouring positioners targeting certain galaxies
- Over large areas, surface density of fibres is fixed
- Galaxies will be missed in high density regions



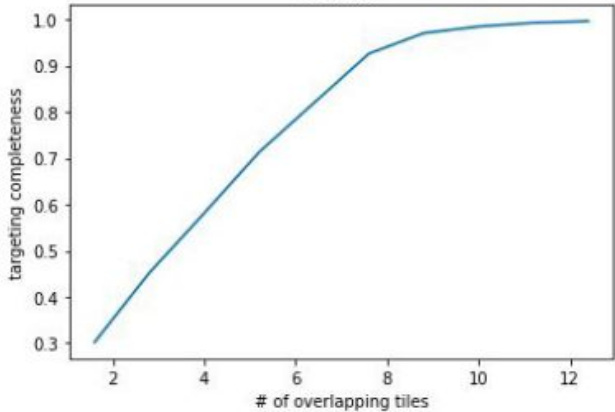
credit: Jaime Forero-Romero

SV3 Completeness and selection function

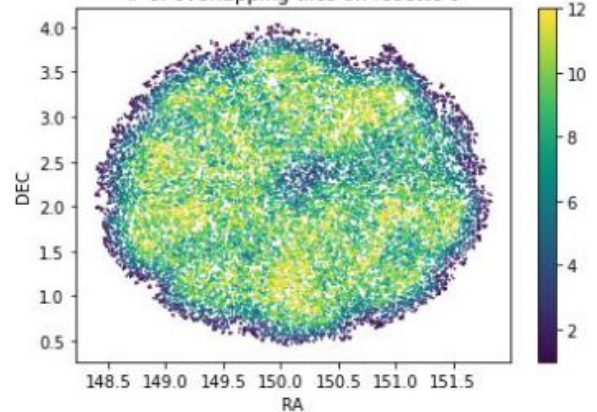
SV3 ELG



SV3 ELG



of overlapping tiles on rosette 0



How to estimate completeness and pair-weights?

The area of DESI focal plane is both complicated and dynamic

The finite number of available fibers implies the incompleteness in a particular area will be related to the total number of targets in the area and

thus fluctuations in completeness are driven by angular clustering of target sample

Effect can be corrected via pairwise-inverse-probability (PIP) weights

Requires many (>100) realizations of fiberassign

Fiberassign re-runs are tractable for data but not really for a large number of mocks

VETO masks applied to Data and mocks

Cut to good redshifts (given definition from targeting experts)

Add completeness weights (per observed target, eventually from alt MTL runs)

Add any weights for trends in redshift success vs. spec obs. properties

Add any weights for trends in projected density vs. imaging properties

Randomly sample data column to give columns to randoms

Assumes we are ok with radial integral constraint

If we can predict dN/dz of sample from first principles, can instead sample from that to get z

Blinding to be added

Alternate Merged Target List Implementation

Fiberassign re-runs are implemented via “AltMTL generation”

Original merged target lists from main survey are cloned and SUBPRIORITY field is re-randomized to create new initial target lists

Run Fiberassign using this alternative sample (SUBPRIORITY-shuffled)

Use all of the same fiberassign inputs (skies, hardware state, etc) as the real survey besides the primary target MTL

OUTPUT: A ‘bitweight’ file

- Contains TARGETID, BITWEIGHT, and PROBOBS
- TARGETID is the unique DESI identifier for a given object
- BITWEIGHT is a set of flags, compressed into 64 bit integers, that indicate whether an object was observed in each realization
- PROBOBS is the fraction of realizations in which a target was observed

Use for PIP

Use for IIP

Repeating all the process in SV3 mocks

Running AltMTL (256 realizations) on 1 mock ~ 12h to get PROB_OBS (IIP) and BITWEIGHT (PIP)

So far working **with 20 randoms** (same for all 25 mocks).

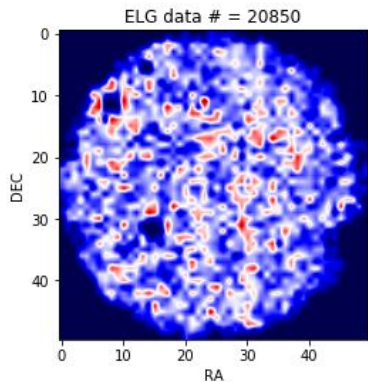
- Run fiber assignment with same hardware and conf as data (per date):
 - 20 randoms (could be up to 50) * 280 tiles
 - ~ 12h

Run LSS pipeline to get clustering catalog ~ 2h, to get unique file for LRG, ELG, QSO

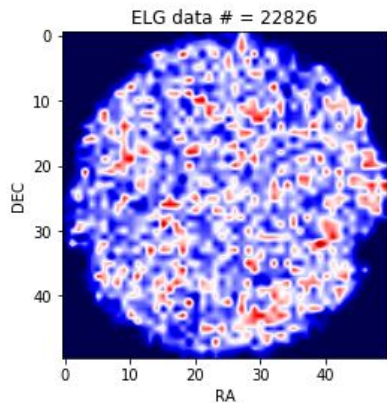
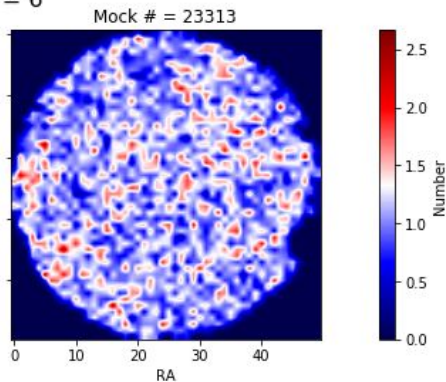
Run LSS pipeline on randoms ~2h

For one mock, total processing time ~ 1 day

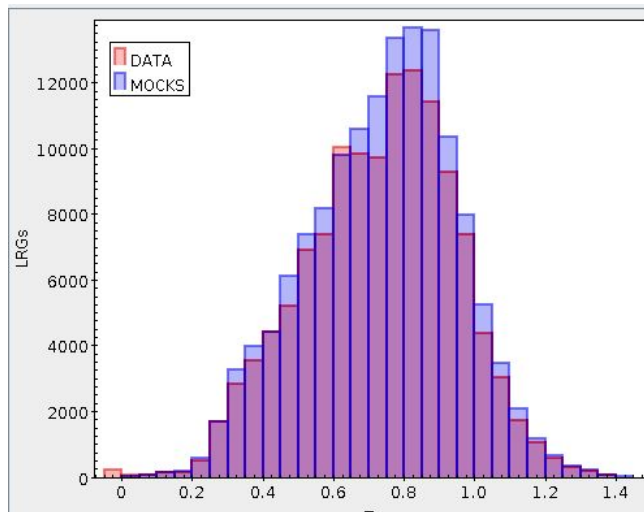
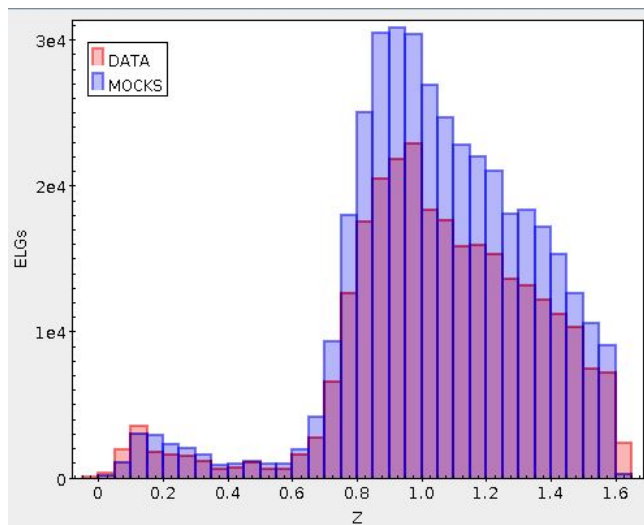
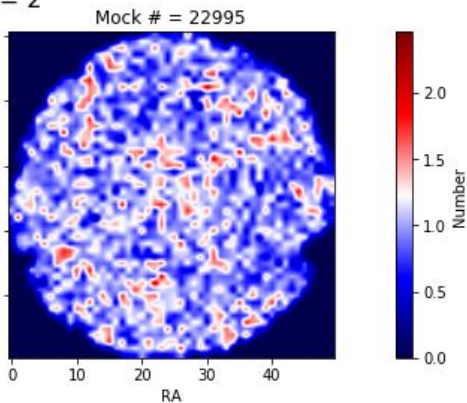
SV3 - Data comparison



NEW Rosette = 6

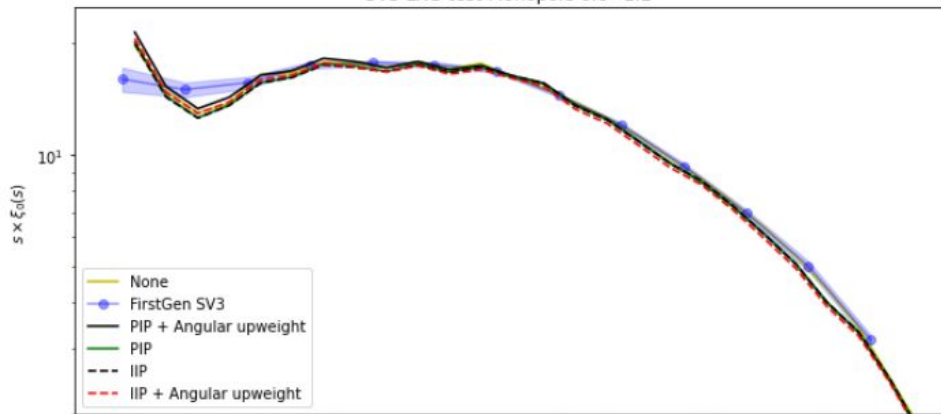


NEW Rosette = 2

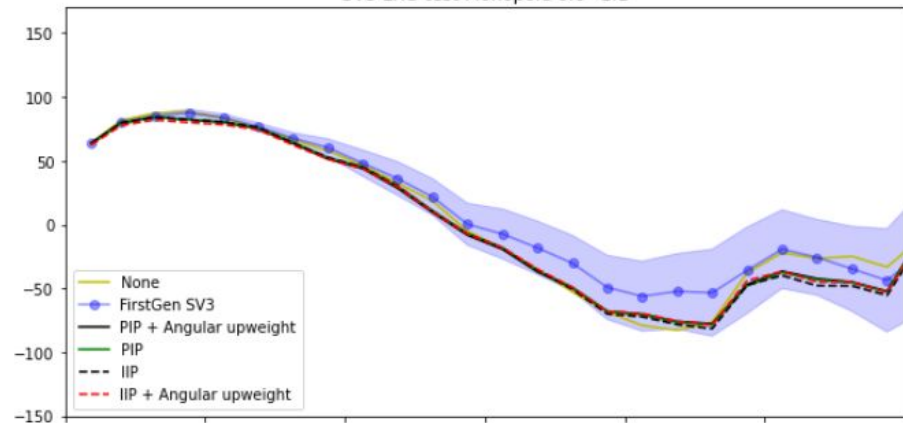


LRGs

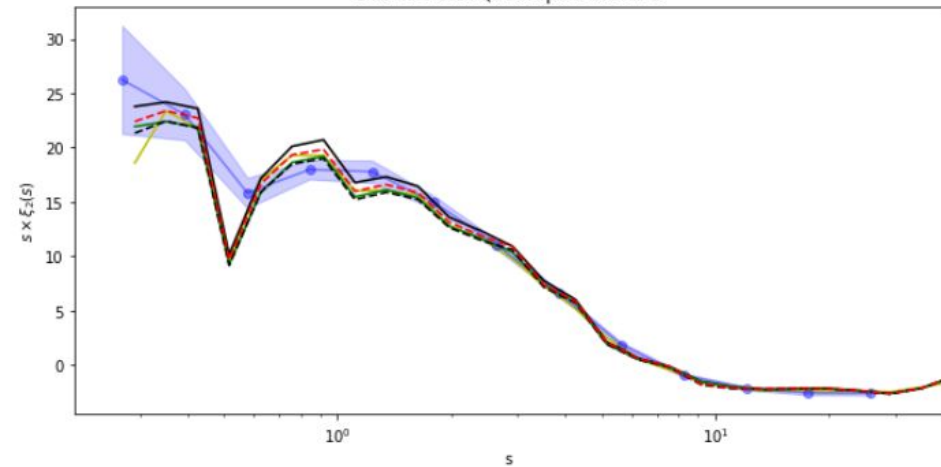
SV3 LRG test Monopole 0.6<1.1



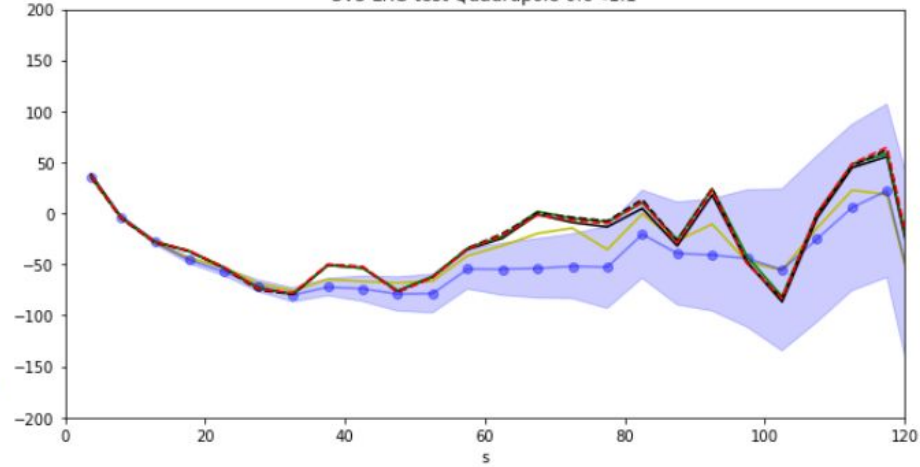
SV3 LRG test Monopole 0.6<1.1



SV3 LRG test Quadrupole 0.6<1.1

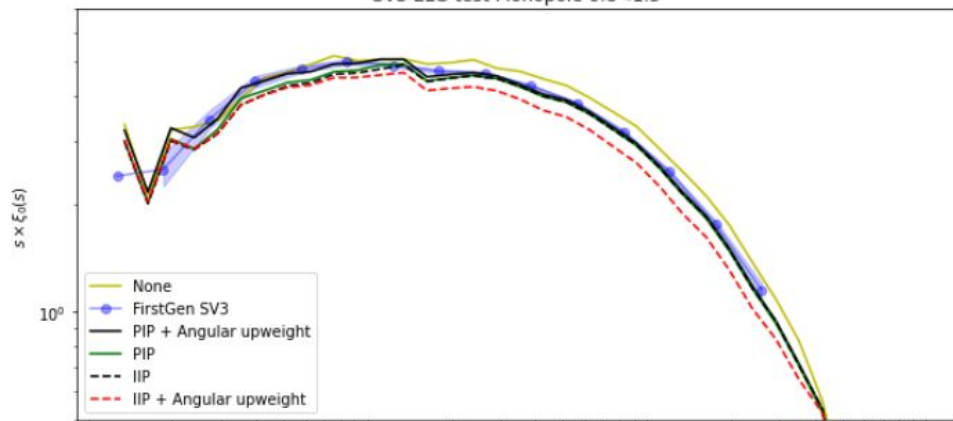


SV3 LRG test Quadrupole 0.6<1.1

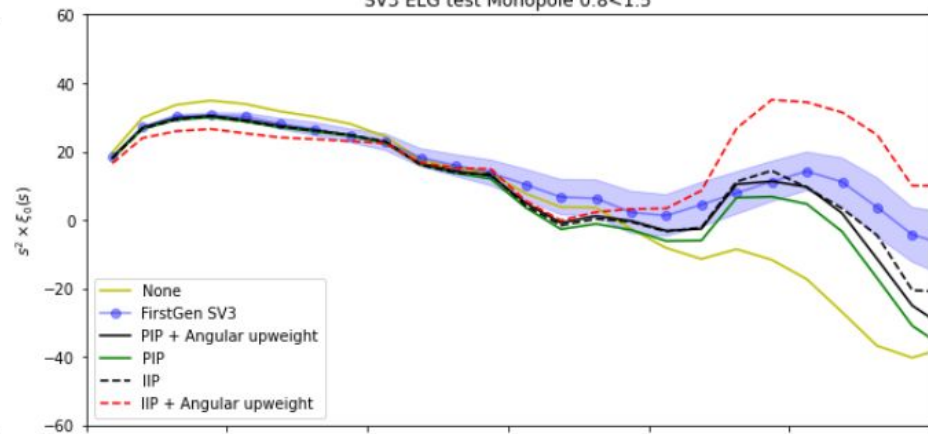


ELGs

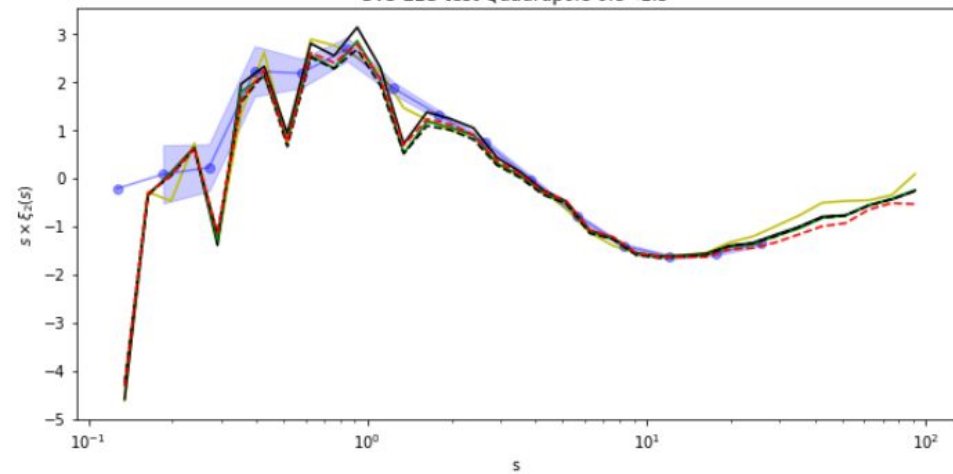
SV3 ELG test Monopole 0.8<1.5



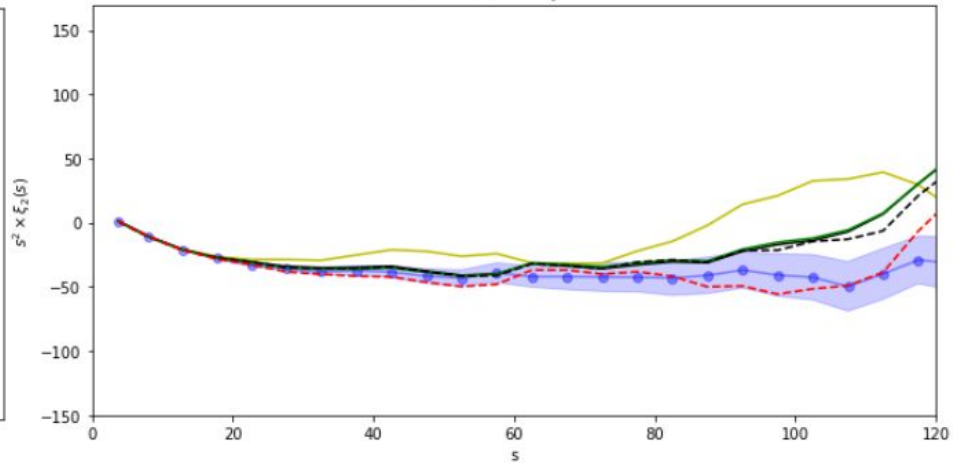
SV3 ELG test Monopole 0.8<1.5



SV3 ELG test Quadrupole 0.8<1.5



SV3 ELG test Quadrupole 0.8<1.5



Conclusions

Pipeline in mocks follows same procedure as in data. SV3 area is small.

Future release will need a dedicated lightweight pipeline (~1000 mocks)

Fiber Assignment seems to decrease clustering at large scales. Current weights does not mitigate this effect completely

Once pipeline has been finalized, we can proceed to estimate covariance matrices and parameter estimation with post-fiberassignment mocks

Ongoing: adapt to main survey (Y1)