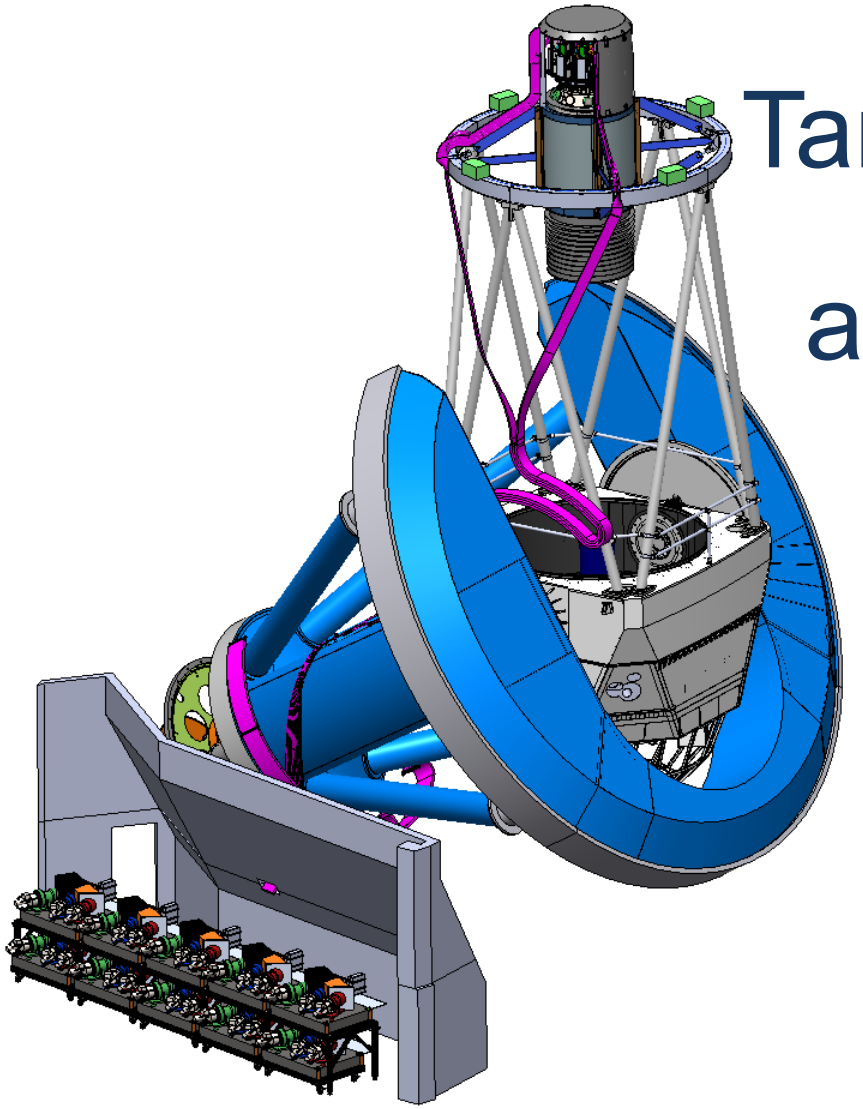


Target Selection in DESI and Survey Validation

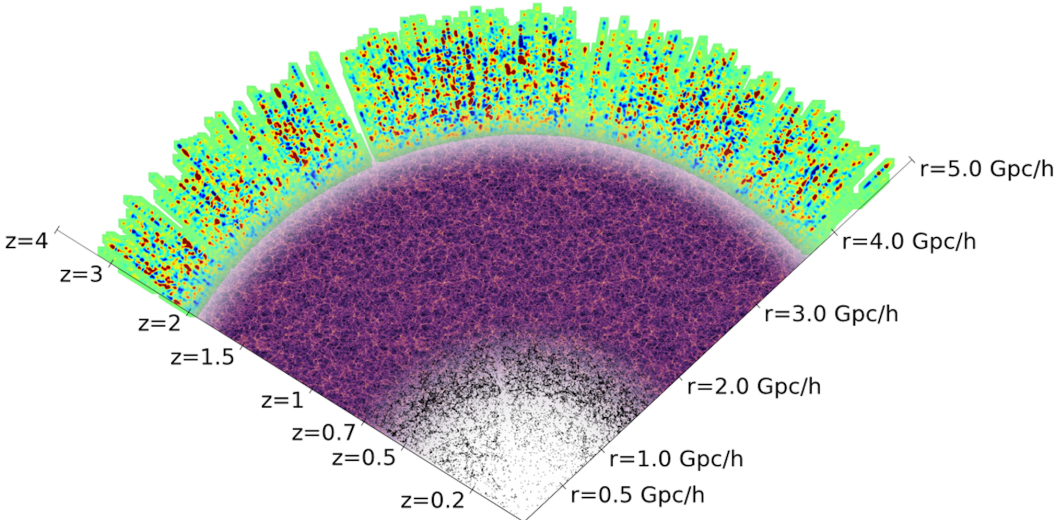
Christophe Yèche (CEA-Saclay)

The 5th joint meeting
eBOSS-DESI France

Saclay, May 7, 2019

Overview of Target Selection

Target Selection in DESI



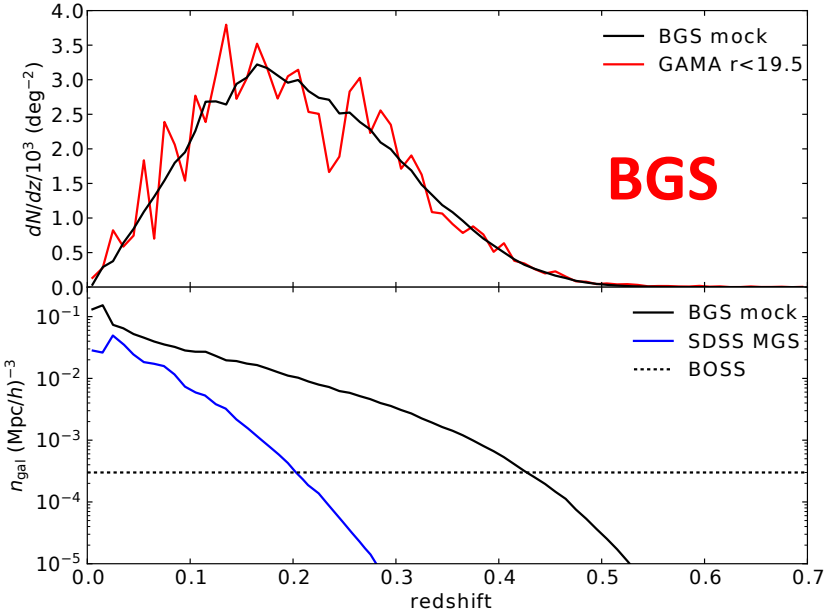
Two surveys

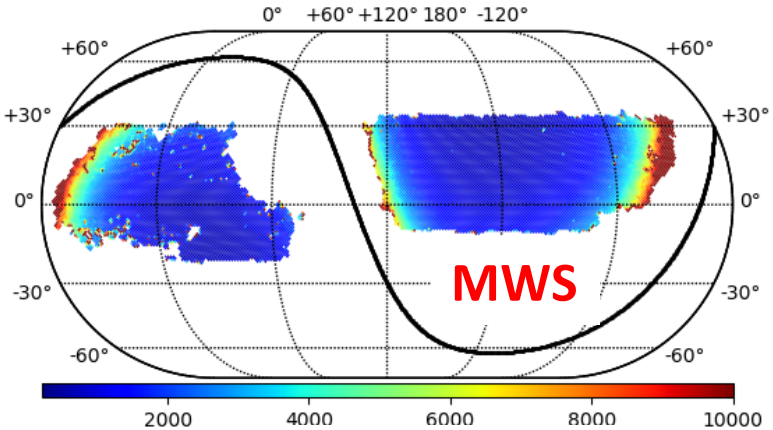
- Dark Time :
  - Dominated by ELGs
  - Bands optimized for ELG
- Bright Time :
  - ~4 nights/lunation
  - MWS/BGS share the observation time with the priority to BGS

Galaxy type	Redshift range	Bands used	Targets per deg^2	Exposures per deg^2	Good z's per deg^2	Baseline sample
LRG	0.4–1.0	g,r,z,$W1$	480	610	430	6.0 M
ELG	0.6–1.6	g,r,z	2400	1870	1220	17.1 M
QSO (tracers)	< 2.1	g,r,z,$W1$,$W2$	170	170	120	1.7 M
QSO (Ly-α)	> 2.1	g,r,z,$W1$,$W2$	90	250	50	0.7 M
Total in dark time			**3140**	**2900**	**1820**	**25.5 M**
BGS	0.05–0.4	r	800	740	710	9.9 M
BGS–Faint	0.05–0.4	r	600	460	430	6.0 M
MWS	0.0	g,r (Gaia μ)	800+	720	720	10.1 M
Total in bright time			**2200+**	**1920**	**1860**	**26.0 M**

Selection of BGS galaxies and MWS stars

0.05<z<0.4





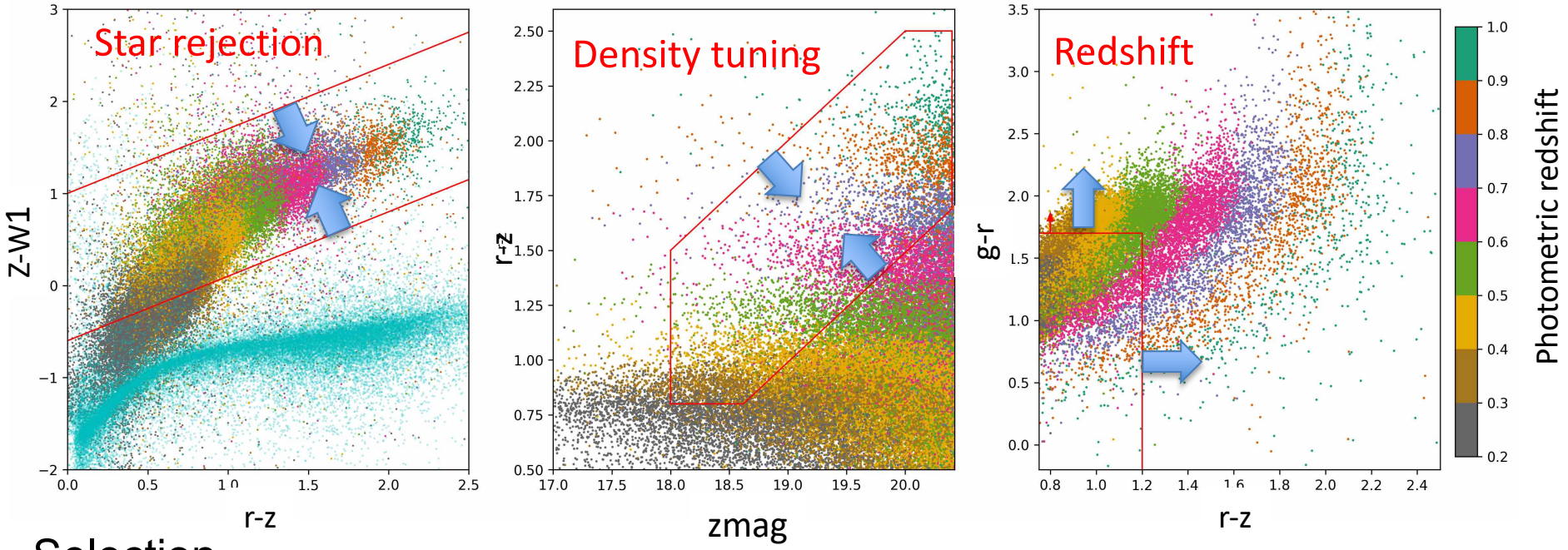
Target density deg^{-2}

- BGS Redshift distribution
  - Median z ~0.2 (z~0.1 for MGS)
  - 10 times SDSS density at z~0.3
- BGS Selection
  - Morphology by comparing Gaia G and r band: G-r >0 or G=0
  - r<19.5 (priority 1)
  - 19.5<r<20 (priority 2)
- BGS Target density
  - BGS-main: 800 deg^{-2}
  - BGS-faint: 600 deg^{-2}

- Milky Way Stars
  - Extra fibers used for MWS
  - Density: ~700 deg^{-2}
  - Selection based on GAIA
  - 8 M of stars in 16<r<19 range, down to r~20 for fainter stars

Selection of LRGs

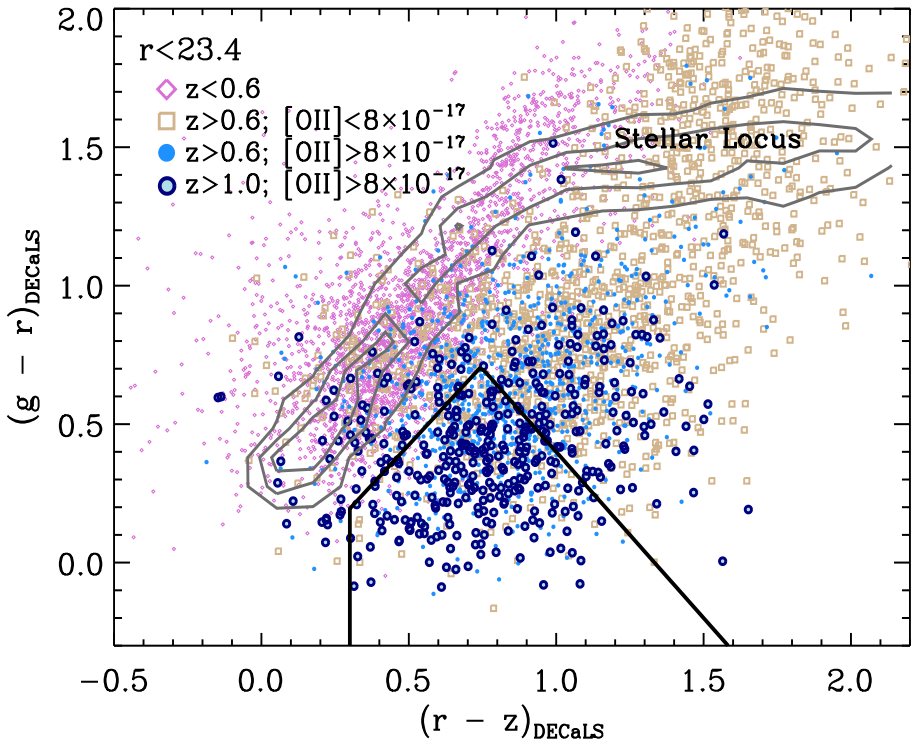
0.4<z<1.0



- Selection
  - z-W1 Vs r-z to veto stars
  - No morphology criterion
  - r-z>1.2 or g-r>1.7 for redshift range
  - Sliding color magnitude cut to tune the density: (z-17.18)/2 < r-z < (z-15.11)/2
  - Slightly different selections for DECaLS and MzLS+BASS
- Density
  - One pass (z<20) : 350 deg^{-2}
  - Two passes (20<z<20.4): 130 deg^{-2}
  - Good redshifts: 90% ~430 deg^{-2}

Selection of ELGs

0.6<z<1.6

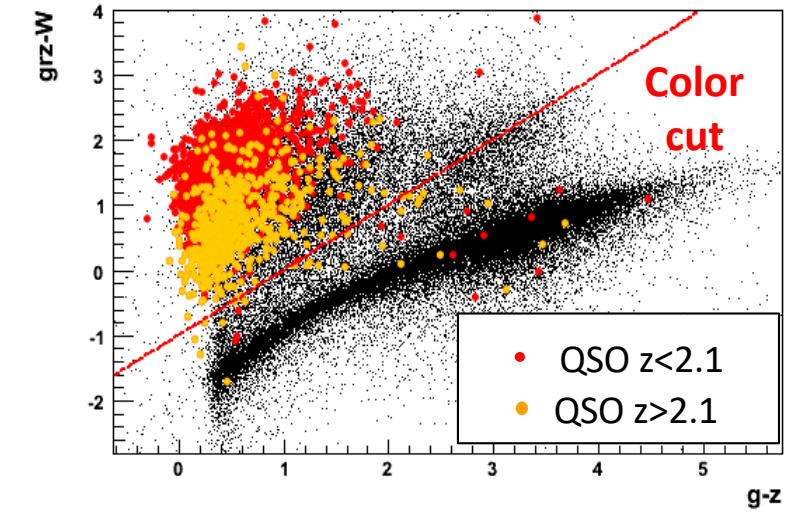


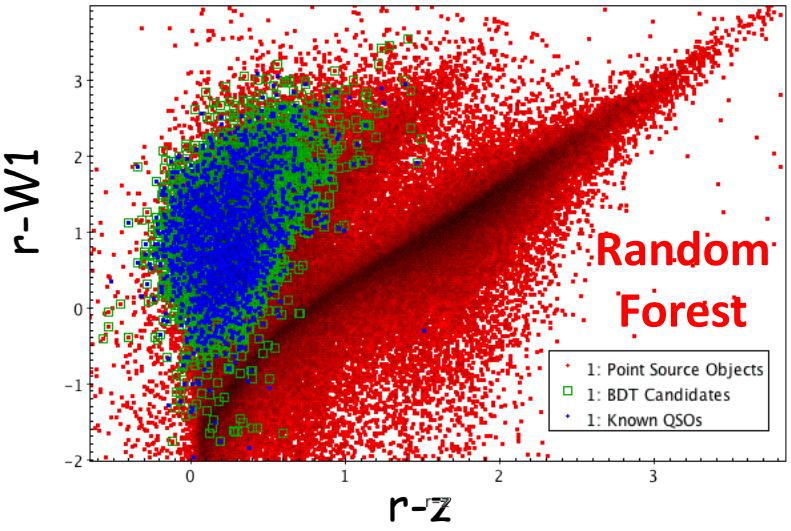
From DEEP2, validated with COSMOS

- Redshift distribution
  - Median z ~ 1.0
  - nP(k)>1 up to z~1.3
- Selection
  - g,r,z optical bands
  - g<~23.5 to reach density goal
  - No morphology criterion
- Different selection in North/South
  - g<23.6 → g<23.4 and color box
- Target density goal
  - 2400 deg^{-2}
- 2nd generation selection
  - Ongoing work to develop 2nd generation selections (Number Density Modeling and Random Forest)
  - Pilot surveys with MMT

Selection of QSOs

z < 2.1 (mean z ~ 1.5) → QSO clustering
z > 2.1 (mean z ~ 2.5) → Lyα clustering

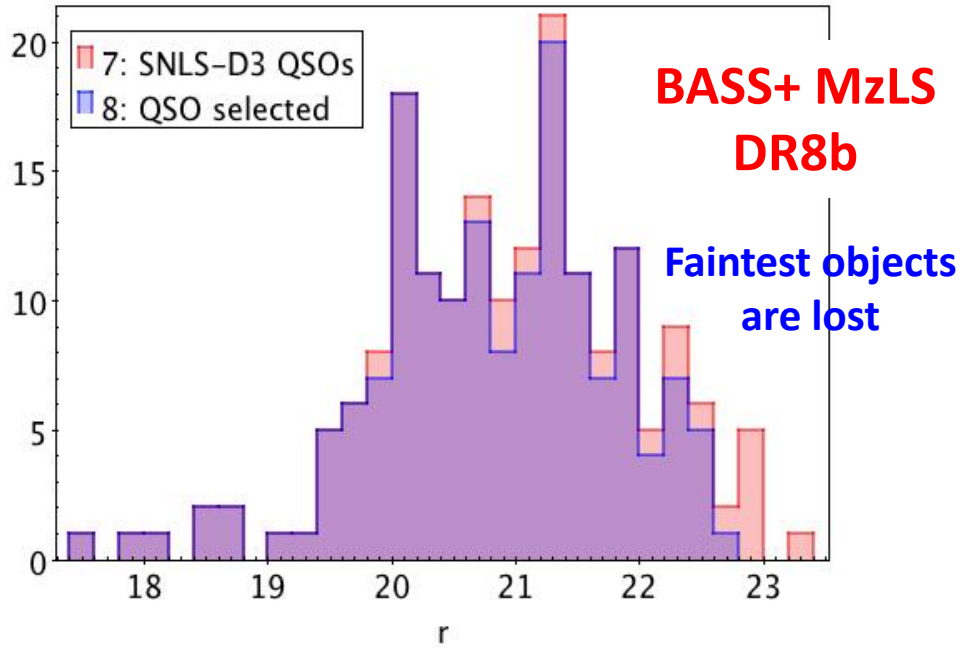


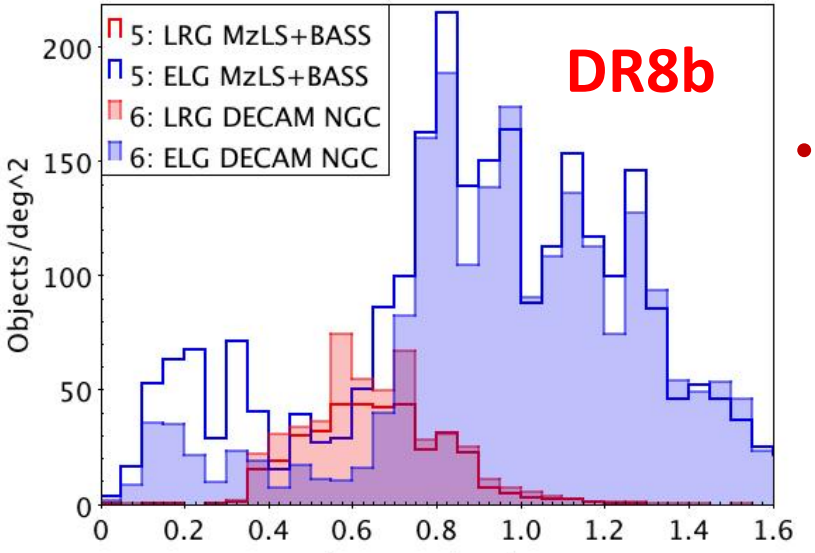


- Common main selection
  - Point source morphology
  - grz optical bands and W_1W_2 NIR bands
  - r<22.7
- Two approaches
  - 1st generation: Color cut selection
  - 2nd generation: Machine learning approach with Random Forest
- Target density goal
  - 260 deg^{-2}
  - Up to 4 passes for SNR of Ly-α QSO
- Success rate
  - z<2.1: 120 deg^{-2}
  - z>2.1: 50 deg^{-2}

Validations with DECaLS and BASS+MzLS

- Validation of QSOs
  - Use SLNS D3 field (1 deg^2) with QSOs selected by their variability (210 deg^{-2})
  - Achieve FDR goals : ~170 QSOs deg^{-2} with (>50) with z>2.1 but with a density a very low statistic…





- Validation of LRGs and ELGs
  - Photometric redshifts from Hyper Suprime-Cam Subaru (HSC)
  - Encouraging results with color cut selection for DECaLS
  - More low-z galaxies for BASS+MzLS

Preparation of Survey Validation

Goals of Survey Validation (SV)

- Quality of the spectra
  - Exposure times: achieve expected S/N
  - Calibration: test that calibration satisfies spectrophotometry requirements
  - Pipeline performances: Achieve redshift accuracy
- Validation of Target Selection (discussed in next slides)
  - Final target efficiency → Target densities
  - Final n(z) for each tracer
  - Finalization of the TS
- Observation constraints
  - 3-4 months at 50% efficiency
  - 100 / 60 fields per month for (LRG,ELG,QSO) / BGS
  - 4x times the nominal exposure time

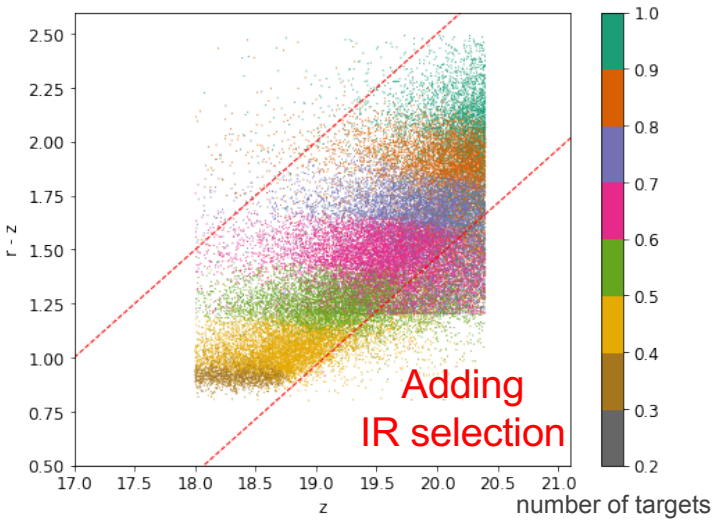
Preparation of Target Selection for SV

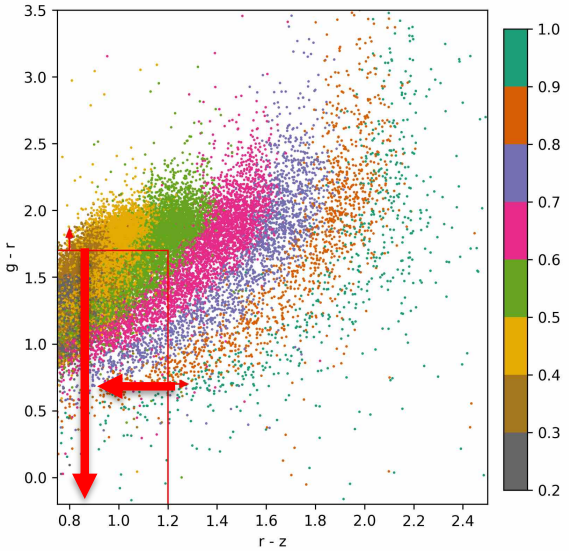
- Definition of the supersets
  - Relax the cuts
  - Alternative selections (LRGs: Optical/IR or QSO Color cuts/Random Forest)
  - Tune the redshift distributions
  - Optimize the redshift overlap: BGS/LRG, LRG/ELG
  - ~Double fiber budget compared to nominal selection

- Subsampling
  - If the density of superset too high → Subsampling according categories
  - Mandatory for LRGs, possible for ELGs, not required for QSOs
  - Subsampling managed by MTL (Merged Target List)

SV superset for LRGs

0.4<z<1.0

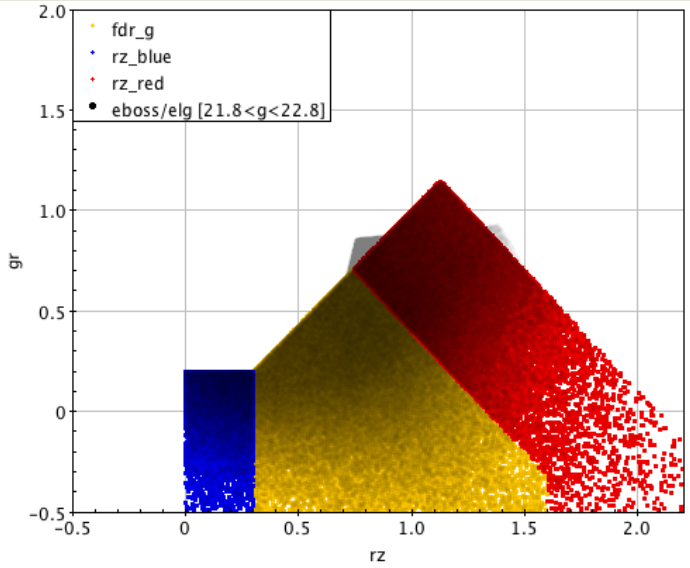


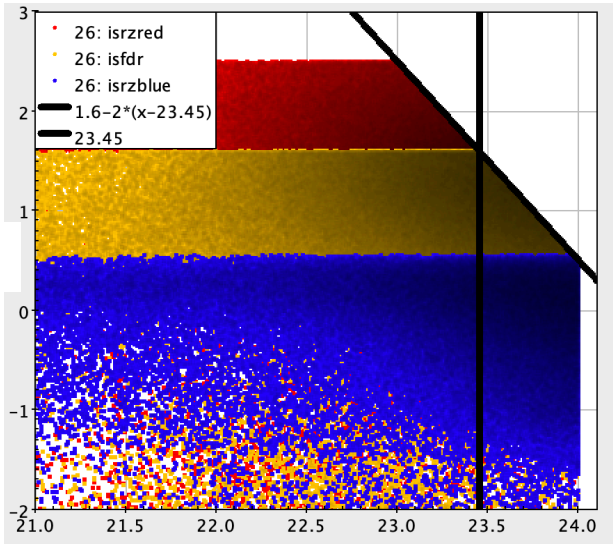


- Optical/IR selection
  - Sliding mag. cut :
    (W1 - 17.74)/0.4 < r-W1
- + Low-z extension
  - Bright LRGs (or z<19.4)
- + High-z extension
  - Faint LRGs (or z<20.8)
- + Relaxed cuts
  - Stellar rejection + Sliding cuts
  - + g-r <1.45
- + more relaxed cuts
  - No g-r cut and r-z>0.65
- Final budget
  - Five bits are defined
  - Optical+IR: 600 deg^{-2}
  - All bits: 2300 deg^{-2}

SV supersets for ELGs

0.6<z<1.6

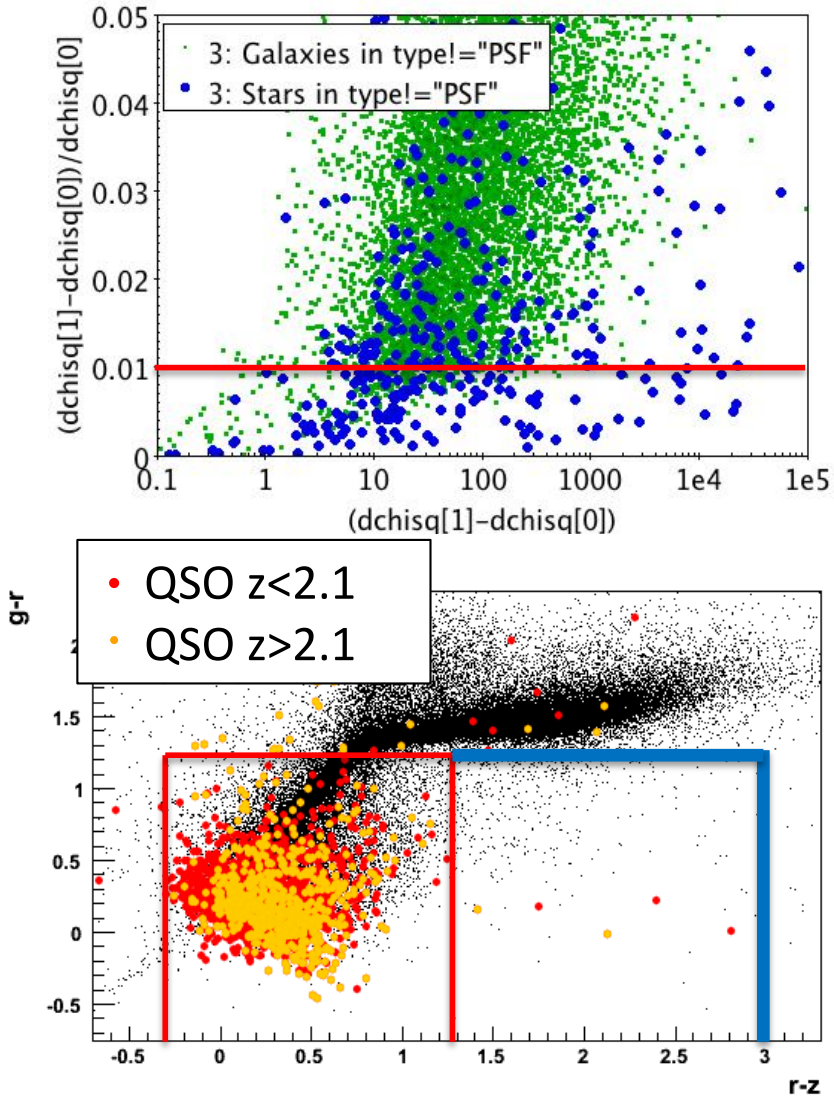




- Faint objects
  - Magnitude limit: 23.45<g<23.65
- Red region
  - ELGs with similar redshift
  - But lower OII flux…
- Blue region
  - ELGs with very high redshift and reasonable OII flux
  - But close to stellar locus and low-z galaxy region
- Three bits
  - Combination of faint / red / blue bits
  - Density: With sliding color cut on mag. to reject faint objects in red region → ~4500 deg^{-2}

SV supersets for QSOs

z < 2.1 (mean z ~ 1.5) → QSO clustering
z > 2.1 (mean z ~ 2.5) → Lyα clustering



- Relax PSF definition
  - Recover objects with (dchisq[1]-dchisq[0])/dchisq[0]<0.01
- Select fainter objects
  - Magnitude limit r<22.7 → r<23.0
- Relax color cut selection
  - Enlarge grz and WISE color boxes
  - Reduce star stripe
- Relax random forest
  - Tune RF probability
- Add High-z faint QSOs
  - 22.7<r<23.5 (optimization of f_{NL})
- Three bits
  - Color Cut / RF / high-z faint QSO
  - Density: 400/400/70 → 600 deg^{-2}
  - Completeness: ~95%

Observation in SV

- LRG and QSO observations
  - 10 fields (with 8x exposure time): faint LRGs and high-z QSOs
  - 10 fields (with 4x exposure time): bright LRGs and low-z QSOs
  - 10 fields (with 4x exposure time): all QSOs

- ELG observations
  - 25 isolated fields with 4x exposure time
  - Density: ~4000 deg^{-2}

- Schedule
  - From Feb./March 2020 to June 2020
  - 55 specific fields with increased exposure time (2-3 months)
  - Final TS selection → 1% survey (1 month)

SV and science is starting at DESI in less than one year!

Extra Slides

Science Requirements