

# Baryon Oscillation Spectroscopic Survey (BOSS) Infovis

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## ABSTRACT

As an intern in the Advanced Computing for Science department, I am creating a dynamic webpage to visualize the status and progress of one of the world's premier cosmology surveys, the Baryon Oscillation Spectroscopic Survey (BOSS). I am improving analytical tools to make it easier to track the survey progress by understanding the status of the plates. Cosmologists involved with the project have millions of spectra of astronomical objects, taken from thousands of 'tiles' of the sky, but their primary means of tracking this data had been a static webpage with a single giant table, which did not lend easily to analysis. Using HTML, CSS and JavaScript, I have replaced their static table with an interactive table, interactive plots to study the data quality, dashboards and dynamic queries for exploratory analysis. The completion of this project will help illuminate patterns in the data collected from BOSS by putting it in a more discernible and accessible arrangement.

## About BOSS

**Angular Diameter Distance:** The ratio of an object's actual size to its angular size as viewed from earth.  
**Redshift:** This happens to light given off by an object moving away from an observer.

Baryon acoustic oscillations provide a standard ruler for measuring the angular diameter distance of cosmic objects and for measuring the expansion rate as a function of redshift. This standard ruler helps to calculate the expansion rate of the Universe and further our understanding of dark energy.

BOSS, using an upgraded version of the Sloan Digital Sky Survey fiber-fed spectrographs, has been mapping out baryon acoustic oscillation signature and redshifts with groundbreaking accuracy since 2009 and is scheduled to continue doing so until 2014 at which time it will have collected information from 1.5 million Luminous Red Galaxies.

This information is used to make a three-dimensional map of the universe to study Dark Energy, gravity, galaxies, and quasars, and it will improve the currently known constraints on the acceleration of the expansion rate of the Universe.

## PROBLEMS WITH STATIC PAGE

- Difficult to conveniently search and display a subset of the rows. Web browser search-on-page features only go so far.
- No sorting options. Ideally, cosmologists would like to be able to sort by quality, sort by status, etc.
- When looking at a column of more than 2000 numbers, it is easy to overlook an outlier. Noticing outliers is a critical part of "situational awareness" to make sure cosmologists catch any problems early on, and have the opportunity to fix.

## SOLUTIONS

Multiple plots with color coding make it easy for cosmologists to spot outliers.

Links hide/unhide certain columns to suppress information when not needed.

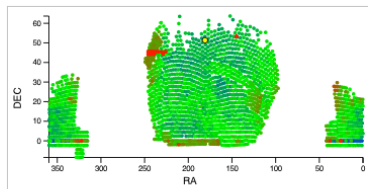
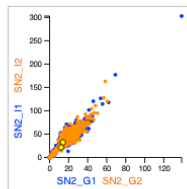
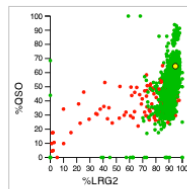
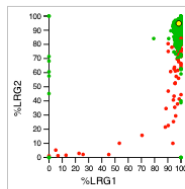
Hovering over a plot point highlights the corresponding points on the other plots and tells you which row of data you are looking at in a tooltip below the plots. Clicking a point freezes this information on the screen so that you can move your mouse and still see it.

Color coding in both the table columns and the plots can help to highlight outliers or bad data. In the DEC vs. RA plot color coding is continuous and users can select what aspect of the data they want the color coding to highlight.

With a search bar, cosmologists can now conveniently search and display a subset of the rows. This subset of rows can also be displayed on the plots by pressing the enter key.

### BOSS Plates

Plate Quality • Plate List • All Columns



Color by DEREDSN2 • Color by %LRG1 • Color by %LRG2 • Color by %QSO

One can think of RA and DEC like latitude and longitude of the sky. The white space in the DEC vs. RA plot is caused by the Milky Way band since we cannot see through it to observe cosmic objects behind it. This plot helps cosmologist locate area of the sky that may need to be re-observed.

Placing the table inside its own scrollable window allows users to scroll through the data while keeping important figures on the screen.

### Current Plate:

Search: [bad] Press enter to plot filtered results.

Plate	MJD	RUN2D	RUN1D	Quality	SN2_G1	SN2_I1	SN2_G2	SN2_I2	Badpix	%LRG1	%LRG2	%QSO	2D	Combine	1D	Col
6683	56388	v5_6_5	v5_6_5	bad	13.9707	32.3116	12.0896	21.6089	0.0284988	98.3051	94.7964	64.532	Done	Done	Done	F
6455	56357	v5_6_5	v5_6_5	bad	9.4389	19.4374	9.88444	19.1389	0.0257968	100	84.2105	53.4314	Done	Done	Done	F
6372	56341	v5_6_5	v5_6_5	bad	4.94692	6.4459	3.83939	6.6016	0.0572429	100	75	33.3333	Done	Done	Done	S
5151	56335	v5_6_5	v5_6_5	bad	2.2603	4.92977	2.20279	4.56821	0.021636	93.8272	10	34.2246	Done	Done	Done	S
5707	56217	v5_6_5	v5_6_5	bad	10.8267	22.1538	9.13601	19.1997	0.0410092	98.6842	82.3204	48.3254	Done	Done	Done	F
6037	56160	v5_6_5	v5_6_5	bad	4.32209	9.16684	4.14185	8.87286	0.024233	95.7143	61.1111	49.7436	Done	Done	Done	C
6063	56077	v5_6_5	v5_6_5	bad	10.7409	23.6883	12.498	23.4401	0.0367901	99.5575	86.5707	49.4444	Done	Done	Done	C
5172	56065	v5_6_5	v5_6_5	bad	7.03815	16.8742	7.01382	15.5308	0.0204664	99.375	85.0622	64.9038	Done	Done	Done	F
5186	55987	v5_6_5	v5_6_5	bad	2.55986	11.812	2.82235	10.5282	0.0648617	95.6522	82.7574	50.2304	Done	Done	Done	S
5330	55986	v5_6_5	v5_6_5	bad	10.5035	27.9878	9.2527	24.3815	0.0306787	98.1595	83.9631	54.7739	Done	Done	Done	F
5705	55973	v5_6_5	v5_6_5	bad	8.95021	17.6683	11.821	28.8313	0.0566816	98.3957	72.8633	58.3784	Done	Done	Done	S
4346	55949	v5_6_5	v5_6_5	bad	9.1884	16.9977	9.20702	19.5036	0.0343867	100	85.1301	44.6667	Done	Done	Done	F
5121	55855	v5_6_5	v5_6_5	bad	8.69182	20.3564	9.34415	21.8352	0.0175312	97.3422	84.0909	38.2514	Done	Done	Done	F
4723	55748	v5_6_5	v5_6_5	bad	2.59427	5.2658	2.43469	5.59693	0.0150995	94.2857	25.3394	46.2185	Done	Done	Done	F
4847	55713	v5_6_5	v5_6_5	bad	3.15347	5.77998	2.59229	5.77459	0.0161458	98.6207	41.3136	53.0172	Done	Done	Done	r
4621	55603	v5_6_5	v5_6_5	bad	9.64838	29.5028	9.74932	25.9942	0.0164455	100	91.0603	62.3853	Done	Done	Done	F
4025	55330	v5_6_5	v5_6_5	bad	5.6391	13.6838	5.23238	12.1101	0.0215603	97.9167	68.9908	37.788	Done	Done	Done	F
4010	55321	v5_6_5	v5_6_5	bad	5.43548	18.2166	6.3814	19.1771	0.0303244	98.2143	67.6864	44.3902	Done	Done	Done	F
3818	55308	v5_6_5	v5_6_5	bad	0.780656	2.13222	0.838663	1.51893	0.0127309	45.3125	2.07547	17.6056	Done	Done	Done	F
3827	55298	v5_6_5	v5_6_5	bad	0.85554	0.53333	0.85554	0.53333	0.0127309	100	100	100	Done	Done	Done	F

Showing 1 to 100 of 109 entries (filtered from 2,194 total entries)

First Previous 1 2 Next Last

With more than 2,000 rows, optional pagination is key to speeding up load time.

Hover to highlight a row and the corresponding data points.

## ACKNOWLEDGMENTS

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