



# MAF Metrics

Lynne Jones

Peter Yoachim & Eric Neilsen

2nd SCOC workshop November 2021



U.S. DEPARTMENT OF  
**ENERGY**



# An overview of metrics in MAF

- A list of all metrics in rubin\_sim is available in the online documentation
  - @ [rubin-sim.lsst.io](https://rubin-sim.lsst.io/rs_maf/metricList.html) [https://rubin-sim.lsst.io/rs\\_maf/metricList.html](https://rubin-sim.lsst.io/rs_maf/metricList.html)
  - Can be helpful for finding more information on a specific metric
- We don't run all of these metrics though
  - Some aren't obviously useful (e.g. '[FftMetric](#)' to calculate FFT of visit times)
  - Some may be redundant with other metrics - can we just run one for simplicity, ease of use/interpretation, or are they really different?
  - Some we don't know how to configure to provide meaningful information
- To see what we are currently running - look at the metric outputs
  - <http://astro-lsst-01.astro.washington.edu:8080/> (multiple metric outputs per run)
- Knowing HOW a metric is run is important - the configuration changes the output and meaning.
  - Configuration details generally captured in metric output names; 'maf.batches' provide the exact details.

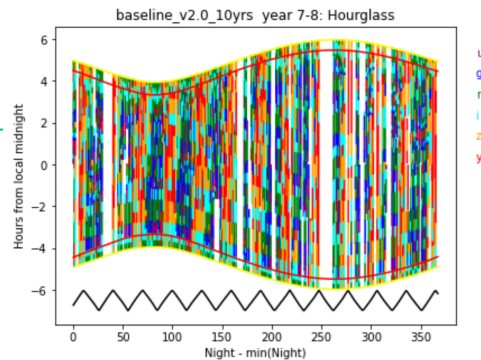
# What metrics are we running?

---

- Attempt to list and categorize them here: Look at output metric pages for more details
  - <https://astro-lsst-01.astro.washington.edu:8080/>
    - ‘*Glance*’ - a small group of metrics we can run fast and check to see if simulation had anything go really obviously wrong
    - ‘*Metadata*’ - a large group of metrics that catalog basic things about the visits (things like airmass distributions, intervisit gaps, saturation magnitudes, coadded depths, number of visits, ..)
    - ‘*SSO*’ - metrics for solar system objects (time intensive to run and require extra steps for evaluation, thus saved separately, but really useful for SSO science)
    - ‘*Science*’ - a growing group of metrics targeted at high-level science evaluation (TDE discovery, Microlensing discovery, cosmology static science metrics, ..)

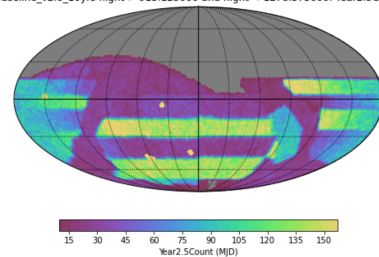
# 'Glance' metrics

- Most of the glance metrics are aimed at detecting problems with the simulation
- Number of visits, coadded depth, number of visits as a function of alt/az, visits associated with various 'notes' in the scheduler output, filter changes and open shutter fraction, slew information, basic SRD metrics (fO/astrometry) — mostly useful for SST
- 'Hourglass' shows when filters are used
- 'Roll check' snapshots a bit of the rolling cadence and can be helpful for visualizing rolling cadence general effect



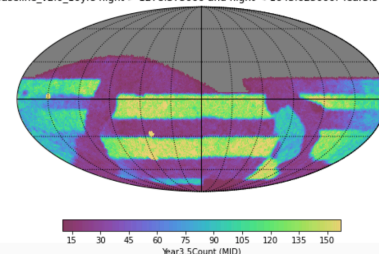
## Year2.5Count

baseline\_v2.0\_10yrs night > 913.125000 and night < 1278.375000: Year2.5Count



## Year3.5Count

baseline\_v2.0\_10yrs night > 1278.375000 and night < 1643.625000: Year3.5Count





# 'Metadata' metrics

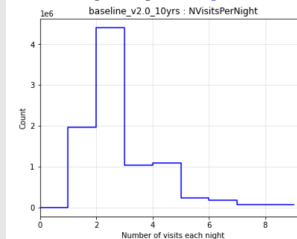
- Primarily characterizing physical properties of the simulation
- Airmass, Normalized airmass, Alt/Az, Single visit depth, Coadded depth (with and without galactic dust extinction), Saturation magnitudes, Hour Angle, Distance to Moon, Rotation angle, Sky brightness, Solar elongation, Seeing, T\_eff, Number of visits (per night, per filter, on the sky..)
- Open Shutter fraction, Filter changes, Slew times, Number of visits
- Intranight gaps, Internight gaps, Interseason gaps and length, Pair fractions
- SRD metrics - fO, parallax, proper motion, rapid revisits

## OpSim Run: baseline\_v2.0\_10yrs

Run List	Opsim Configuration	Metrics List	All Results	Multi Color	Summary Stats
----------	---------------------	--------------	-------------	-------------	---------------

- [Airmass](#)  
All visits  
WFD
- [Alt/Az](#)  
All Observations  
Per filter
- [Coadded M5 Maps](#)  
All visits  
WFD
- [Extragalactic Coadded M5 Maps](#)  
All visits  
WFD
- [Filter Changes](#)  
Per Night  
Whole Survey
- [Fivesigmadepth](#)  
All visits  
WFD
- [Ha](#)  
All visits  
WFD
- [InterNight](#)  
Night gaps
- [IntraNight](#)  
Pairs
- [IntraSeason](#)  
Season length
- [Moondistance](#)  
All visits  
WFD
- [Normairmass](#)  
All visits  
WFD
- [Nvisit Summary](#)  
Proposal distribution
- [Nvisits Maps](#)  
All visits  
WFD
- [Nvisits Per Night](#)  
All proposals  
DD

### NVisitsPerNight HealpixSlicer npz JSON



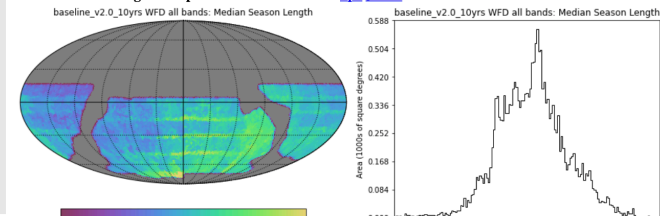
Histogram of the number of visits in each night, per point on the sky, all proposals.

Group: IntraNight; Subgroup: Pairs; Slicer: HealpixSlicer

MetricName	Metadata	Median	Mean	Rms	N(-3Sigma)	N(+3Sigma)	Count	Min
Fraction of visits in pairs (10-60 min)	gri	0.62	0.61	0.07	331	122	33703	0.0000
Fraction of visits in pairs (20-90 min)	gri	0.54	0.53	0.07	247	104	33703	0.0000
Fraction of visits with a revisit < 60 min	gri	0.42	0.41	0.06	237	126	33703	0.0000
Median Intra-Night Gap		0.56	0.55	0.04	175	6	33657	0.0100

Group: IntraSeason; Subgroup: Season length

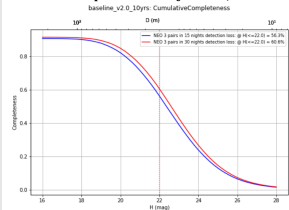
### Median Season Length HealpixSlicer WFD all bands npz JSON



# 'SSO' metrics - Discovery

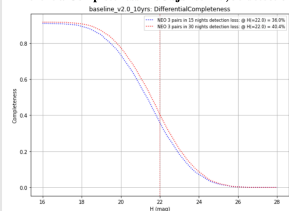
- Suite of metrics, run with multiple populations of solar system objects
- Discovery metrics : different criteria for discovery (3 pairs in 15 nights, 3 pairs in 30 nights, 6 singles in 60 nights, Trailed discovery)

CumulativeCompleteness MoObjSlicer 15, 30 detection in loss pairs nights 3 NEO [npz JSON](#)



CumulativeCompleteness metric(s) calculated on a MoObjSlicer grid, for ops

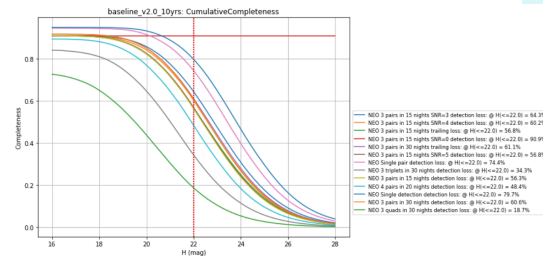
DifferentialCompleteness MoObjSlicer 15, 30 detection in loss pairs night



DifferentialCompleteness metric(s) calculated on a MoObjSlicer grid, for ops runs baseline\_v2\_0\_10yrs, for metadata values of 15, 30 detection in loss pairs nights 3 NEO .

Group: NEO; Subgroup: Completeness; Slicer: MoObjSlicer				
MetricName	Metadata	Nobj <= 22.0	Nobj <= 25.0	Value At H=22.0
CumulativeCompleteness	NEO 3 pairs in 15 nights detection loss	--	--	0.56
DifferentialCompleteness	NEO 3 pairs in 15 nights detection loss	15329.92	56195.22	0.36
CumulativeCompleteness	NEO 3 pairs in 15 nights trailing loss	--	--	0.57
DifferentialCompleteness	NEO 3 pairs in 15 nights trailing loss	15448.28	63195.71	0.37
CumulativeCompleteness	NEO 3 pairs in 30 nights detection loss	--	--	0.61
DifferentialCompleteness	NEO 3 pairs in 30 nights detection loss	16468.76	64516.50	0.40
CumulativeCompleteness	NEO 3 pairs in 30 nights trailing loss	--	--	0.61
DifferentialCompleteness	NEO 3 pairs in 30 nights trailing loss	16595.44	72158.39	0.41
CumulativeCompleteness	NEO 3 quads in 30 nights detection loss	--	--	0.19
DifferentialCompleteness	NEO 3 quads in 30 nights detection loss	5242.86	9374.16	0.06
CumulativeCompleteness	NEO 3 triplets in 30 nights detection loss	--	--	0.34

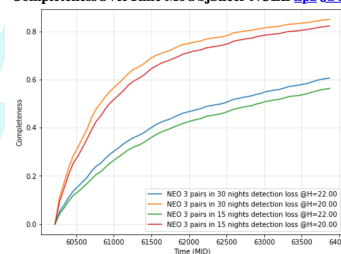
Group: NEO; Subgroup: Completeness; Slicer: MoObjSlicer				
MetricName	Metadata	Nobj <= 22.0	Nobj <= 25.0	Value At H=22.0
CumulativeCompleteness	NEO 3 pairs in 15 nights detection loss	--	--	0.56
DifferentialCompleteness	NEO 3 pairs in 15 nights detection loss	15329.92	56195.22	0.36
CumulativeCompleteness	NEO 3 pairs in 15 nights trailing loss	--	--	0.57
DifferentialCompleteness	NEO 3 pairs in 15 nights trailing loss	15448.28	63195.71	0.37
CumulativeCompleteness	NEO 3 pairs in 30 nights detection loss	--	--	0.61
DifferentialCompleteness	NEO 3 pairs in 30 nights detection loss	16468.76	64516.50	0.40
CumulativeCompleteness	NEO 3 pairs in 30 nights trailing loss	--	--	0.61
DifferentialCompleteness	NEO 3 pairs in 30 nights trailing loss	16595.44	72158.39	0.41
CumulativeCompleteness	NEO 3 quads in 30 nights detection loss	--	--	0.19
DifferentialCompleteness	NEO 3 quads in 30 nights detection loss	5242.86	9374.16	0.06
CumulativeCompleteness	NEO 3 triplets in 30 nights detection loss	--	--	0.34



Plotting all of the cumulative completeness curves together.

Group: NEO; Subgroup: Completeness over time

CompletenessOverTime MoObjSlicer NULL [npz JSON](#)

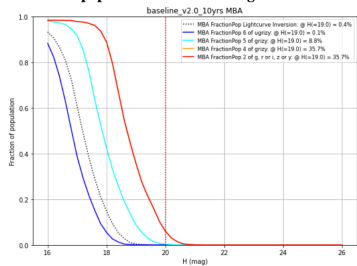


# 'SSO' metrics - characterization

- Basic suite of metrics, multiple populations of solar system objects
- Characterization metrics
  - Likelihood of detecting activity lasting a given length of time or fraction of the period
  - Color determination
  - Lightcurve inversion
  - For these, details of the metrics change for different populations (primarily 'inner' vs. 'outer' solar system)

Group: MBA; Subgroup: Characterization Fraction

Fraction of population for colors or lightcurve inversion MoObjSlicer MBA



LightcurveInversion\_Asteroid calculated on a MoObjSlicer basis.

Group: MBA; Subgroup: Color/Inversion

Group: MBA; Subgroup: Color/Inversion; Slicer: MoObjSlicer				
	FractionPop 2 of g, r or i, z or y	FractionPop 4 of grizy	FractionPop 5 of ugrizy	FractionPop 6 of ugrizy
MBA	0.36	0.36	0.09	0.0006

Populations:

PHA, NEO (Granvik)

MBA, Jovian Trojan, (Grav S3M)

TNO (L7 model), SDO (Shenkman)

# 'Science' metrics

- We place these in some general categories
  - we know there are overlaps & things we've split into different categories than someone else might use
- SRD metrics - defined by SRD
- Cosmology (DESC) - more specifically, DESC static science driven by WFD + SNIa
- Variables/Transients - A variety, featuring several metrics that simulate the light curves of an input population and look at specific discovery/identification requirements
- AGN - AGN in the WFD
- Galaxies - Number of galaxies
- Milky Way - Number of stars & brown dwarfs

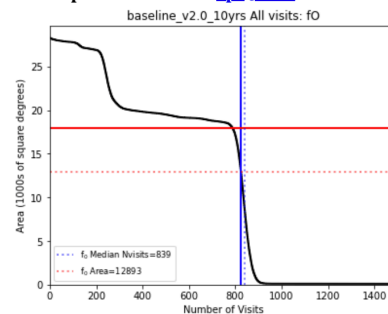
## OpSim Run: baseline\_v2.0\_10yrs

Run List	Opsim Configuration	Metrics List	All Results
----------	---------------------	--------------	-------------

- [AGN](#)  
[SFError](#)  
[TimeLags](#)  
[nQSO](#)
- [Cosmology](#)  
[1: Static Science](#)  
[2: LSS](#)  
[3: WL](#)  
[4: Camera Rotator](#)  
[5: SNe Ia](#)
- [DDF depths](#)  
[DD: COSMOS](#)  
[DD: ECDFS](#)  
[DD: EDFSa](#)  
[DD: EDFSb](#)  
[DD: ELAIS1](#)  
[DD: XMM-LSS](#)
- [Galaxies](#)  
[Galaxy Counts](#)
- [Milky Way](#)  
[Brown Dwarf](#)  
[N stars](#)
- [SRD](#)  
[FO metrics](#)  
[Parallax](#)  
[Proper Motion](#)  
[Rapid Revisits](#)  
[Year Coverage](#)
- [Scaling Numbers](#)  
[Lightcurve Pts](#)  
[N gals](#)
- [Variables/Transients](#)  
[KNe](#)  
[Microlensing](#)  
[Periodic Stars](#)  
[SLSN](#)  
[TDE](#)  
[TimeGaps](#)

Group: SRD; Subgroup: FO metrics

fo HealpixSlicer All visits **npz.JSON**



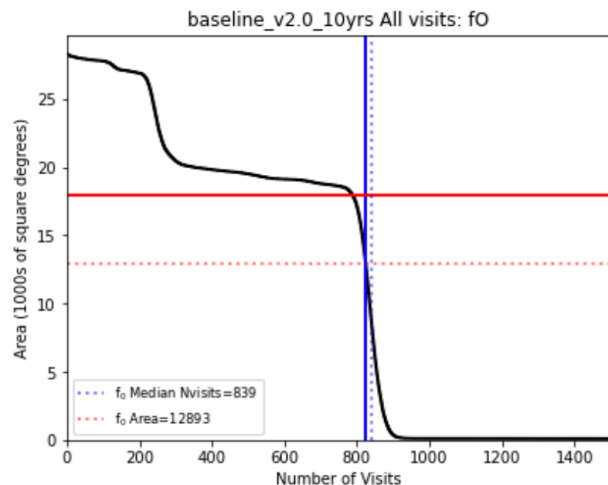
The FO metric evaluates the overall efficiency of observing. foNv: on 18000.00 sq deg if compared to benchmark) receives at least 825 visit

Group: SRD; Subgroup: FO metrics; Slicer: HealpixSlicer	
	<b>fo</b>
	<b>All visits</b>
<b>foArea</b>	12893.23
<b>foArea/benchmark</b>	0.72
<b>foArea_750</b>	18620.57
<b>foNv MedianNvis</b>	839.00
<b>foNv MinNvis</b>	787.00
<b>foNv/benchmark MedianNvis</b>	1.02
<b>foNv/benchmark MinNvis</b>	0.95

# Science Metrics: *SRD* - fO

- Area covered to minimum number of visits per pointing,
- Median and Minimum number of visits per pointing over given area,
- fO metrics (fO area, fO N<sub>v</sub>)

fO HealpixSlicer All visits [npz JSON](#)



	Minimum	Design
Area	15,000 deg <sup>2</sup>	18,000 deg <sup>2</sup>
Visits	750	825

Group: <i>SRD</i> ; Subgroup: <i>FO metrics</i> ; Slicer: <i>HealpixSlicer</i>	
	<b>fO</b>
	<b>All visits</b>
<b>fOArea</b>	12893.23
<b>fOArea/benchmark</b>	0.72
<b>fOArea_750</b>	18620.57
<b>fON<sub>v</sub> MedianNvis</b>	839.00
<b>fON<sub>v</sub> MinNvis</b>	787.00
<b>fON<sub>v</sub>/benchmark MedianNvis</b>	1.02
<b>fON<sub>v</sub>/benchmark MinNvis</b>	0.95

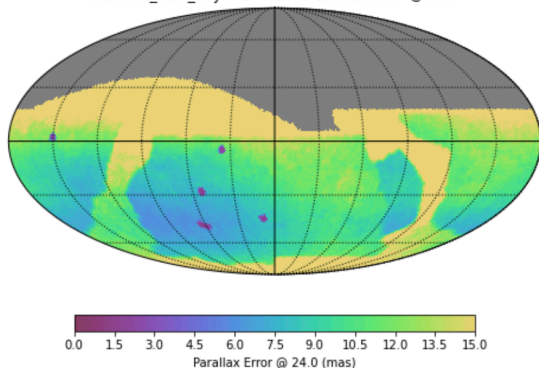
# Science Metrics: *SRD* - parallax

- Parallax Error

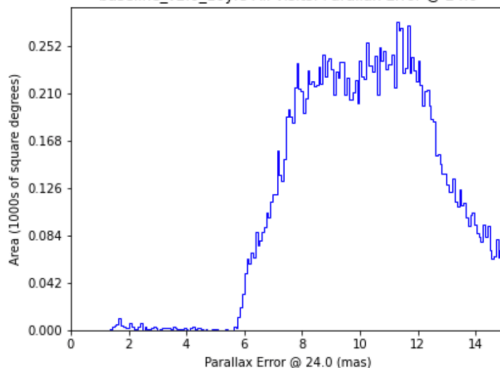
- Also calculate normalized parallax error (comparison to ‘best possible’ if all visits 6 months apart), and parallax factor coverage and parallax-DCR degeneracy
- Calculated for flat SED @  $r=22.4$  and  $r=24.0$  (but could use others)

**Parallax Error @ 24.0 HealpixSlicer All visits** [npz](#) [JSON](#)

baseline\_v2.0\_10yrs All visits: Parallax Error @ 24.0

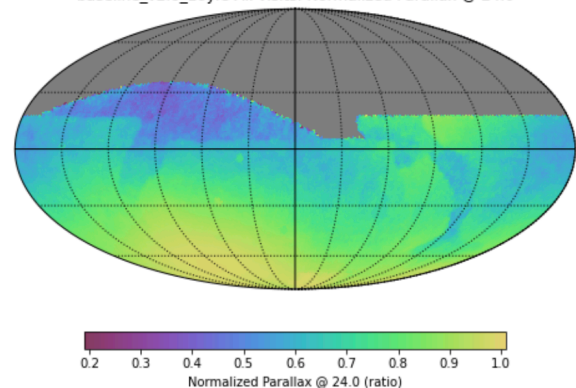


baseline\_v2.0\_10yrs All visits: Parallax Error @ 24.0



**Normalized Parallax @ 24.0 HealpixSlicer All visits** [npz](#) [JS](#)

baseline\_v2.0\_10yrs All visits: Normalized Parallax @ 24.0

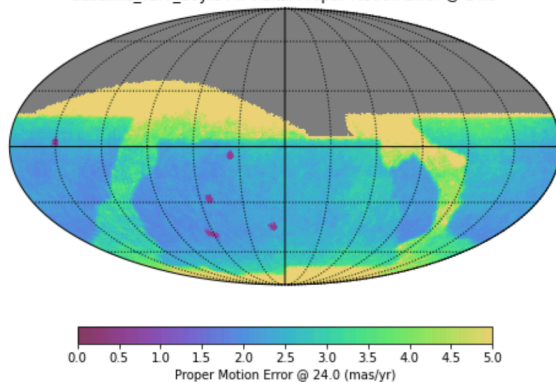


# Science Metrics: *SRD* - proper motion

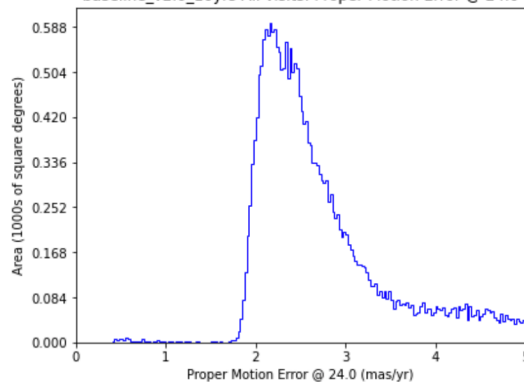
- Proper motion errors
  - Also calculate normalized proper motion error (comparison to 'best possible' all visits at first and last day of the survey).
  - Calculated for flat SED @  $r=20.5$  and  $r=24.0$  (but could use others)

**Proper Motion Error @ 24.0 HealpixSlicer All visits** [npz](#) [JSON](#)

baseline\_v2.0\_10yrs All visits: Proper Motion Error @ 24.0

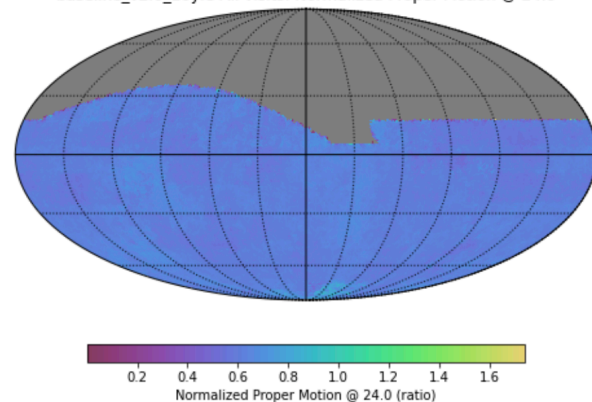


baseline\_v2.0\_10yrs All visits: Proper Motion Error @ 24.0



**Normalized Proper Motion @ 24.0 HealpixSlicer All visits**

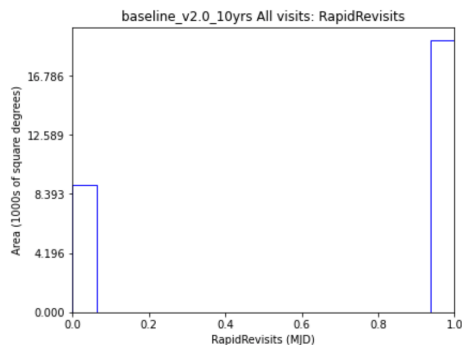
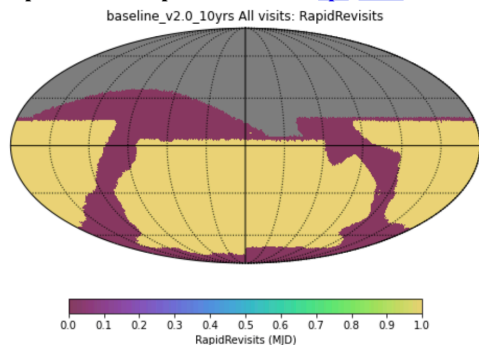
baseline\_v2.0\_10yrs All visits: Normalized Proper Motion @ 24.0



# Science Metrics: *SRD* - rapid revisits

- SRD specifications on visits gaps between 40s and 30 minutes
  - Count of ‘quick revisits’ + ‘rapid revisit metric’

## RapidRevisits HealpixSlicer All visits [npz JSON](#)



Rapid Revisit: area that receives at least 82 visits between 0.667 and 30.0 minutes, with at least 28 of those visits falling between 0.667 and 20.0 minutes.

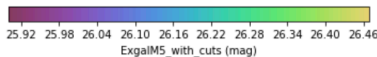
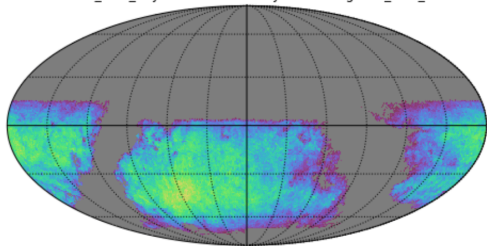
Group: <i>SRD</i> ; Subgroup: <i>Rapid Revisits</i> ; Slicer: <i>HealpixSlicer</i>		
	NumberOfQuickRevisits	RapidRevisits
	All visits	All visits
Median	180.00	--
Mean	177.88	--
Rms	612.60	--
N(-3Sigma)	0	--
N(+3Sigma)	103	--
Min	0.0000	--
Max	17973.00	--
Area (sq deg)	--	28112.95



# Science Metrics: *Cosmology*

- DESC static science metrics evaluated on dust-extinction coadded depth in *i* band
  - Area that meets depth requirements, coadded depth, RMS of coadded depth, 3x2pt FOM emulator
  - Number of galaxies visible in this footprint
  - Median number of visits per pointing

baseline\_v2.0\_10yrs i band non-DD year 10: ExgalM5\_with\_cuts

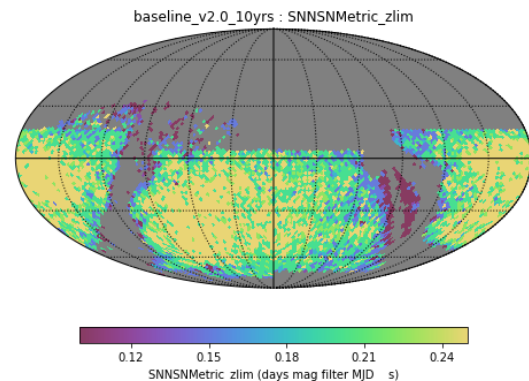
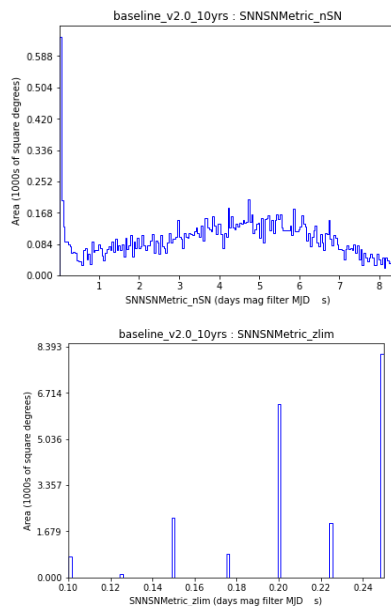
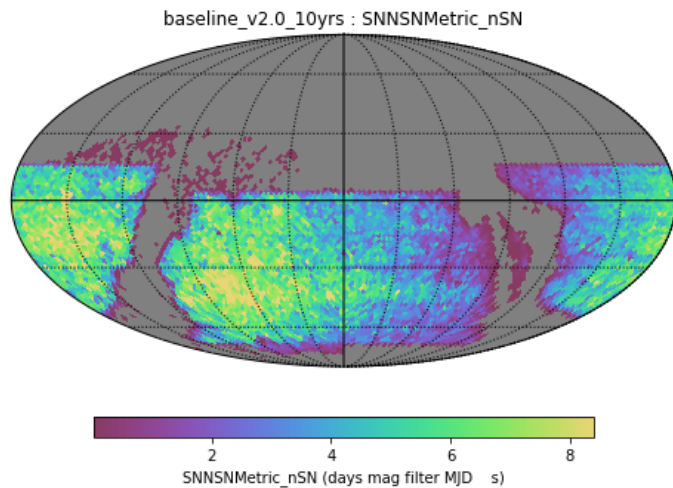


Group: <i>Cosmology</i> ; Subgroup: <i>1: Static Science</i> ; Slicer: <i>HealpixSlicer</i>							
MetricName	Metadata	Median	Mean	Rms	3x2ptFoM	3x2ptFoM_simple	Effective Area (deg)
ExgalM5_with_cuts	i band non-DD year 1	25.05	25.04	0.16	27.74	257.58	17287.77
ExgalM5_with_cuts	i band non-DD year 3	25.59	25.60	0.18	32.83	301.68	16957.09
ExgalM5_with_cuts	i band non-DD year 6	25.93	25.92	0.12	36.61	341.64	17041.86
ExgalM5_with_cuts	i band non-DD year 10	26.18	26.17	0.11	37.91	464.94	16711.18

Group: <i>Cosmology</i> ; Subgroup: <i>2: LSS</i> ; Slicer: <i>HealpixSlicer</i>			
MetricName	Metadata	N Galaxies (18k)	N Galaxies (all)
DepthLimitedNumGalaxiesMetric	i band galaxies non-DD	4568638365.30	4568638365.30

# Science Metrics: *Cosmology* - SNIa

- SNIa metric creates a population of SN, evaluates resulting ‘observations’ of the SN in the simulation against criteria for discovery/identification. Counts number detected and median redshifts.



Group: *Cosmology*; Subgroup: *5: SNe Ia*; Slicer: *HealpixSlicer*

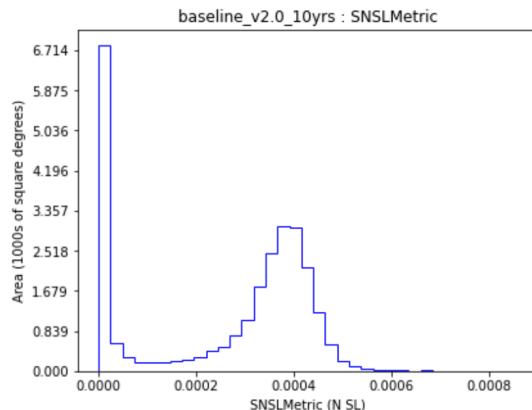
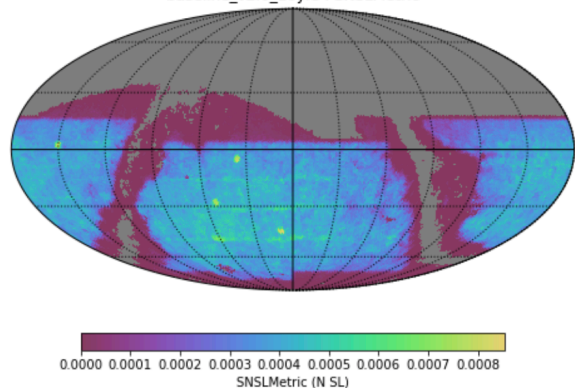
MetricName	Metadata	Median	Mean	Total detected	Total on sky
SNNSNMetric_nSN		16.24	16.63	25374.97	3072.00
SNNSNMetric_zlim		0.23	0.21	321.60	3072.00

# Science Metrics: *Cosmology* - SLSN

- Similar to SNIa, but searching for a Strongly Lensed SN population (rare) - returns number detected

SNSLMetric HealpixSlicer [npz](#) [JSON](#)

baseline\_v2.0\_10yrs : SNSLMetric



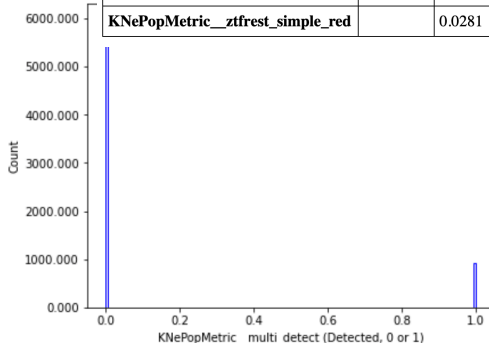
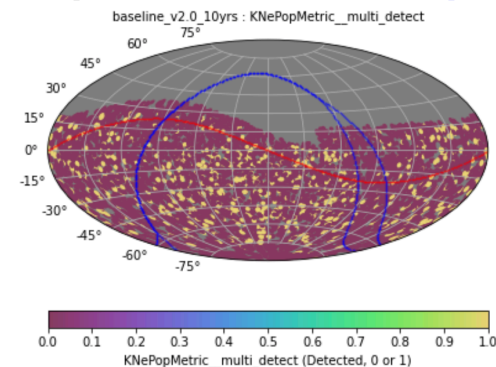
Strongly Lensed SNe, evaluated with the addition of galactic dust extinction.

Group: <i>Variables/Transients</i> ; Subgroup: <i>SLSN</i> ; Slicer: <i>HealpixSlicer</i>						
MetricName	Metadata	Fraction detected in footprint (mean)	Fraction detected of total (mean)	Total detected	Total lightcurves in footprint	Total lightcurves on sky
SNSLMetric		0.0003	0.0002	8.12	31421.00	49152.00

# Science Metrics: *Variables/Transients* - KNe

- KNe metric - injects KNe light curves into simulated visits at uniform points on the sky & evaluates what could be detected. KNe metric returns counts of expected sources using a range of different detection criteria.

KNePopMetric\_multi\_detect UserPointsSlicer [npz JSON](#)



Group: *Variables/Transients*; Subgroup: *KNe*; Slicer: *UserPointsSlicer*

MetricName	Metadata	Fraction detected in footprint (mean)	Fraction detected of total (mean)	Total detected	Total lightcurves in footprint	Total lightcurves on sky
KNePopMetric__blue_color_detect		0.0130	0.0090	90.00	6939.00	10000.00
KNePopMetric__multi_color_detect		0.12	0.08	832.00	6939.00	10000.00
KNePopMetric__multi_detect		0.13	0.09	932.00	6939.00	10000.00
KNePopMetric__red_color_detect		0.04	0.0253	253.00	6939.00	10000.00
KNePopMetric__ztfrest_simple		0.04	0.0280	280.00	6939.00	10000.00
KNePopMetric__ztfrest_simple_red		0.0281	0.0195	195.00	6939.00	10000.00

# Science Metrics: *Variables/Transients* - Microlensing

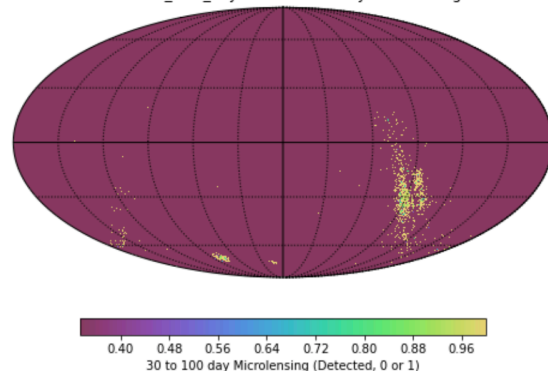
- Microlensing metric - injects microlensing light curves with a variety of crossing times, distributed across the sky according to stellar density maps, evaluates whether the light curve amplification could be detected in the resulting observations
- Using several 'bins' of crossing times - 1 to 10, 10-30, 30-100, 100-1000 days - to evaluate the microlensing detection rate

Group: *Variables/Transients*; Subgroup: *Microlensing*; Slicer: *UserPointsSlicer*

MetricName	Metadata	Fraction detected in footprint (mean)	Fraction detected of total (mean)	Total detected	Total lightcurves in footprint	Total lightcurves on sky
1 to 10 day Microlensing		0.48	0.47	4739.00	9881.00	10000.00
10 to 30 day Microlensing		0.69	0.68	6796.00	9881.00	10000.00
100 to 1000 day Microlensing		0.98	0.97	9717.00	9881.00	10000.00
30 to 100 day Microlensing		0.94	0.93	9322.00	9881.00	10000.00

30 to 100 day Microlensing UserPointsSlicer [npz JSON](#)

baseline\_v2.0\_10yrs : 30 to 100 day Microlensing



Microlensing events with crossing times between 30 to 100 days.

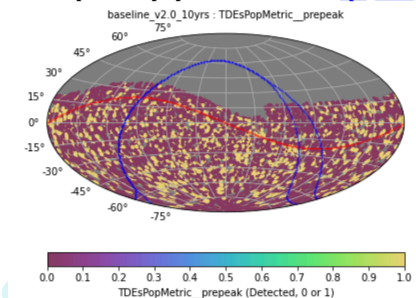
# Science Metrics: *Variables/Transients* - TDE

- TDE metric - injects TDE light curves uniformly across the sky, evaluates possibility of detection using a range of criteria

Group: *Variables/Transients*; Subgroup: *TDE*; Slicer: *UserPointsSlicer*

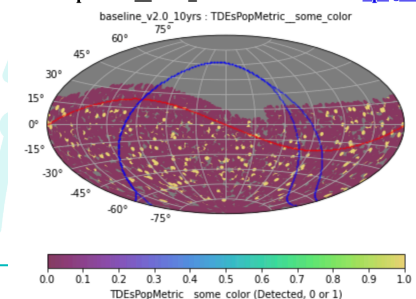
MetricName	Metadata	Fraction detected in footprint (mean)	Fraction detected of total (mean)	Total detected	Total lightcurves in footprint	Total lightcurves on sky
TDEsPopMetric__prepeak		0.27	0.19	1879.00	6939.00	10000.00
TDEsPopMetric__some_color		0.07	0.05	506.00	6939.00	10000.00
TDEsPopMetric__some_color_pu		0.0144	0.0100	100.00	6939.00	10000.00

TDEsPopMetric\_\_prepeak UserPointsSlicer [npz JSON](#)



TDE lightcurves that could be identified

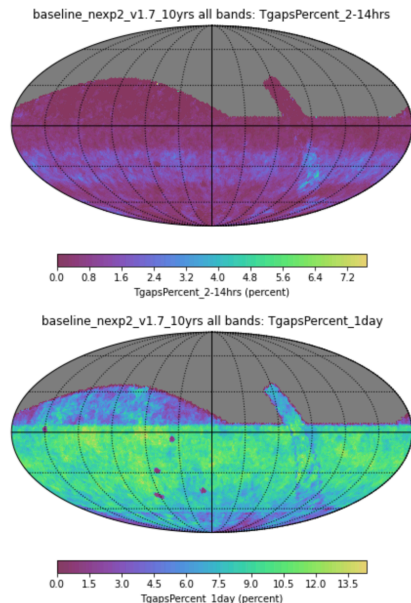
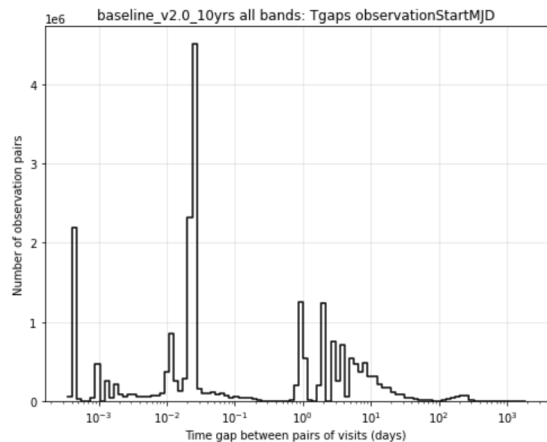
TDEsPopMetric\_\_some\_color UserPointsSlicer [npz JSON](#)



# Science Metrics: *Variables/Transients* - Time Gaps

- Number and fraction of gaps between visits, looking specifically for time between visits of between 2-14 hours and around 1 day

**Tgaps observationStartMJD HealpixSlicer all bands**

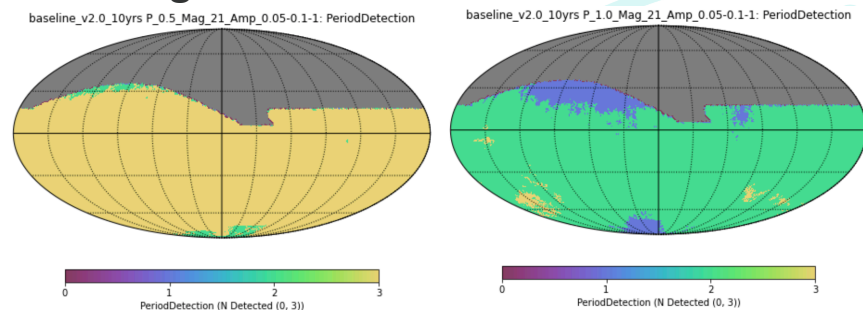


Group: *Variables/Transients*; Subgroup: *TimeGaps*; Slicer: *HealpixSlicer*

MetricName	Metadata	Median	Mean	Rms	N(-3Sigma)	N(+3Sigma)	Count	25th %ile	75th %ile	Min	Max
TgapsPercent_2-14hrs	all bands	0.94	1.08	0.86	0	60	33684	0.45	1.58	0.0000	33.33
TgapsPercent_1day	all bands	9.13	8.12	3.02	0	0	33684	5.84	10.32	0.0000	14.99
TgapsPercent_2-14hrs	u band	0.0000	1.40	1.87	0	386	30328	0.0000	2.00	0.0000	20.00
TgapsPercent_1day	u band	5.08	5.21	3.75	0	245	30328	2.33	7.41	0.0000	50.00
TgapsPercent_2-14hrs	g band	0.0000	0.62	0.98	0	468	33545	0.0000	1.35	0.0000	7.14
TgapsPercent_1day	g band	4.69	4.93	3.03	0	113	33545	2.63	6.94	0.0000	33.33
TgapsPercent_2-14hrs	r band	1.47	1.51	1.40	0	152	33593	0.0000	2.26	0.0000	100.00
TgapsPercent_1day	r band	8.99	8.34	3.94	0	2	33593	5.76	11.18	0.0000	20.34
TgapsPercent_2-14hrs	i band	1.09	1.29	1.30	0	317	33602	0.0000	2.04	0.0000	50.00
TgapsPercent_1day	i band	7.69	7.24	3.54	0	3	33602	4.82	9.79	0.0000	25.00
TgapsPercent_2-14hrs	z band	1.40	1.68	1.68	0	194	33580	0.0000	2.50	0.0000	100.00
TgapsPercent_1day	z band	10.32	9.51	4.67	0	1	33580	6.43	12.90	0.0000	23.60
TgapsPercent_2-14hrs	y band	0.60	0.95	1.16	0	295	30457	0.0000	1.60	0.0000	33.33
TgapsPercent_1day	y band	6.11	5.75	3.03	0	33	30457	4.00	7.83	0.0000	28.57

# Science Metrics: *Variables/Transients* - Periodic Stars

- PeriodicDetect metric evaluates if, given a sinusoidal LC of a given period and amplitude, the resulting variability could be distinguished from a uniform light curve
- Run at a variety of periods, amplitudes, and mean magnitudes
- Tend to see:
  - @  $r=21$ , can detect amplitude=0.05;
  - @  $r=24$  usually need amplitude=1
  - For Periods < 1 day: uniform and good
  - For Periods > 1 days: uniform and good
  - For Periods = 1 day:
    - some non uniformity
    - lower performance



Group: *Variables/Transients*; Subgroup: *Periodic Stars*; Slicer: *HealpixSlicer*

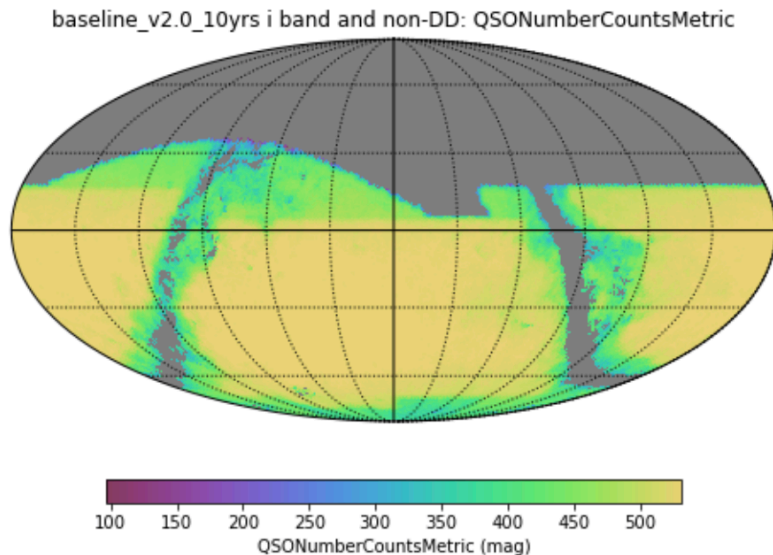
MetricName	Metadata	Median	Mean	Rms
PeriodDetection	P_0.5_Mag_21_Amp_0.05-0.1-1	3.00	2.96	0.25
PeriodDetection	P_0.5_Mag_24_Amp_0.05-0.1-1	1.00	0.99	0.09
PeriodDetection	P_1.0_Mag_21_Amp_0.05-0.1-1	2.00	1.93	0.33
PeriodDetection	P_1.0_Mag_24_Amp_0.05-0.1-1	0.0000	0.05	0.21
PeriodDetection	P_2.0_Mag_21_Amp_0.05-0.1-1	3.00	2.96	0.26
PeriodDetection	P_2.0_Mag_24_Amp_0.05-0.1-1	1.00	0.99	0.10



# Science Metrics: *AGN* - *nQSO*

- Coadded depth + dust extinction + quasar luminosity function = number of expected QSOs
- (Will update to run in each bandpass)

Group: <i>AGN</i> ; Subgroup: <i>nQSO</i> ; Slicer: <i>HealpixSlicer</i>	
	<b>QSONumberCountsMetric</b>
<b>i band and non-DD</b>	15621781

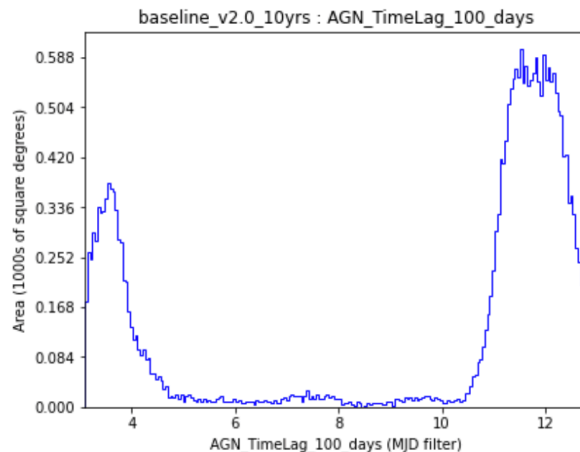
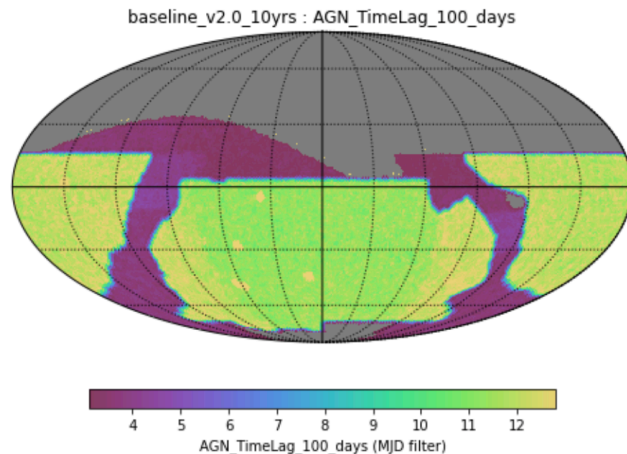


# Science Metrics: *AGN* - Time Lags

- Look at gaps between visits, compare to how often sample the sky compared to a defined 'lag' (interval) — counting sampling intervals

Group: <i>AGN</i> ; Subgroup: <i>TimeLags</i> ; Slicer: <i>HealpixSlicer</i>	
	AGN_TimeLag_100_days
<b>Median</b>	11.45
<b>Mean</b>	10.74
<b>Rms</b>	46.94
<b>N(-3Sigma)</b>	0
<b>N(+3Sigma)</b>	54
<b>Count</b>	32317
<b>25th %ile</b>	4.45
<b>75th %ile</b>	12.04
<b>Min</b>	2.20
<b>Max</b>	3732.23
<b>AreaThreshold</b>	27123.45

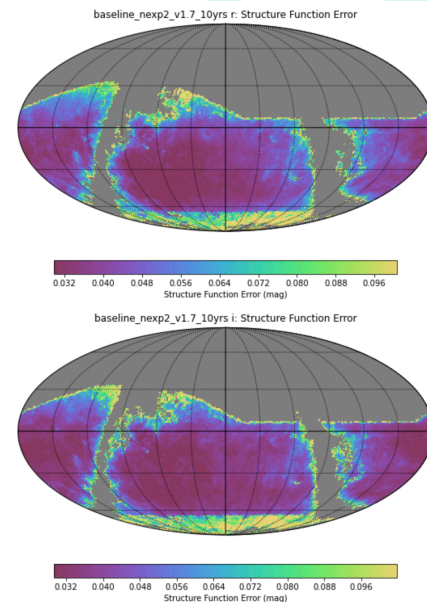
AGN\_TimeLag\_100\_days HealpixSlicer [npz](#) [JSON](#)



# Science Metrics: *AGN* - Structure Function Error

- Evaluate the time gaps at a point in the sky, including SNR (given fiducial magnitude for the object), translate to estimate in error on SF that would result
  - Using magnitudes 0.5 brighter than mean individual image depth
  - Includes dust extinction for each visit

Group: <i>AGN</i> ; Subgroup: <i>SFError</i> ; Slicer: <i>HealpixSlicer</i>												
MetricName	Metadata	Median	Mean	Rms	N(-3Sigma)	N(+3Sigma)	Count	25th%ile	75th%ile	Min	Max	AreaThreshold
AGN SF_error	u band	0.04	0.05	0.03	0	528	23365	0.0288	0.05	0.0156	0.33	11466.43
AGN SF_error	g band	0.05	0.06	0.0278	0	472	25303	0.04	0.06	0.0227	0.35	5616.55
AGN SF_error	r band	0.04	0.05	0.0232	0	560	26959	0.04	0.06	0.0227	0.33	7205.34
AGN SF_error	i band	0.04	0.05	0.0267	0	614	28588	0.04	0.05	0.0182	0.41	11750.11
AGN SF_error	z band	0.04	0.05	0.0287	0	564	29529	0.04	0.06	0.0204	0.40	9874.29
AGN SF_error	y band	0.04	0.05	0.03	0	619	27388	0.03	0.05	0.0187	0.32	11872.65

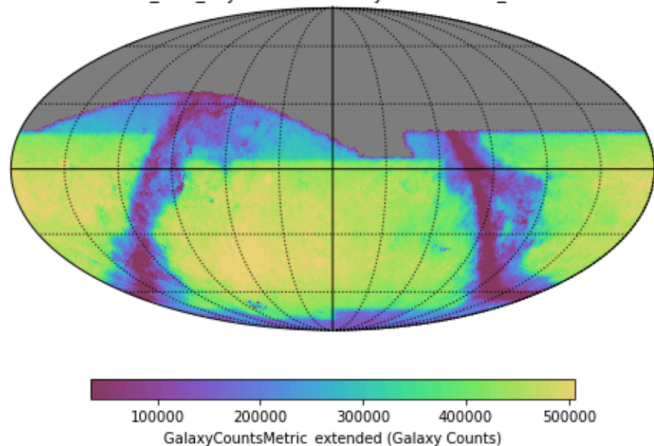


# Science Metrics: *Galaxies* - nGalaxies

- Count the expected number of galaxies across the sky, based on coadded depth in *i* band

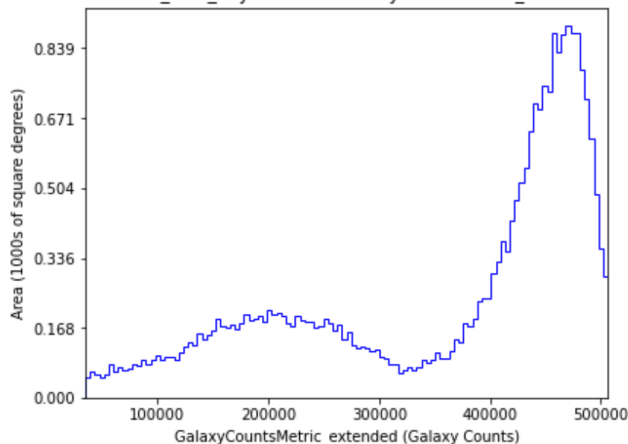
GalaxyCountsMetric\_extended HealpixSlicer *i* band [npz JSON](#)

baseline\_v2.0\_10yrs *i* band: GalaxyCountsMetric\_extended



Group: <i>Galaxies</i> ; Subgroup: <i>Galaxy Counts</i> ; Slicer: <i>HealpixSlicer</i>			
MetricName	Metadata	N Galaxies (18k)	N Galaxies (all)
GalaxyCountsMetric_extended	<i>i</i> band	9757544671.99	12036279324.51

baseline\_v2.0\_10yrs *i* band: GalaxyCountsMetric\_extended

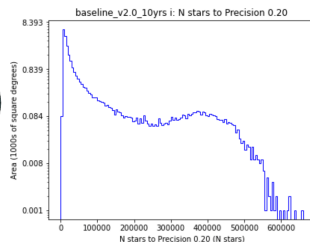
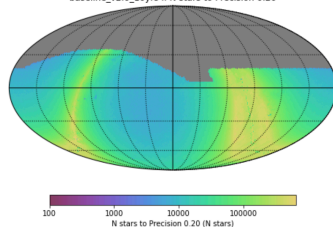


# Science Metrics: *Milky Way* - N stars

- Count the number of stars across the sky, based on coadded depth — and including or not-including crowding effects
  - Does not include 3d dust model (or any dust extinction)

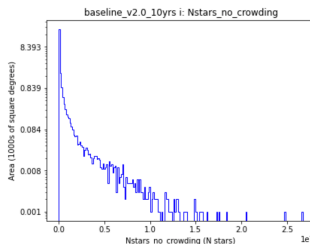
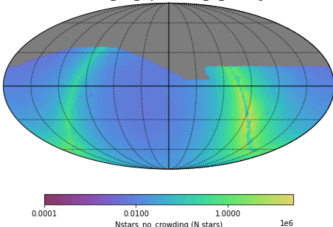
N stars to Precision 0.20 HealpixSlicer i npz JSON

baseline\_v2\_0\_10yrs i: N stars to Precision 0.20



Nstars\_no\_crowding HealpixSlicer i npz JSON

baseline\_v2\_0\_10yrs i: Nstars\_no\_crowding



Group: *Milky Way*; Subgroup: *N stars*; Slicer: *HealpixSlicer*

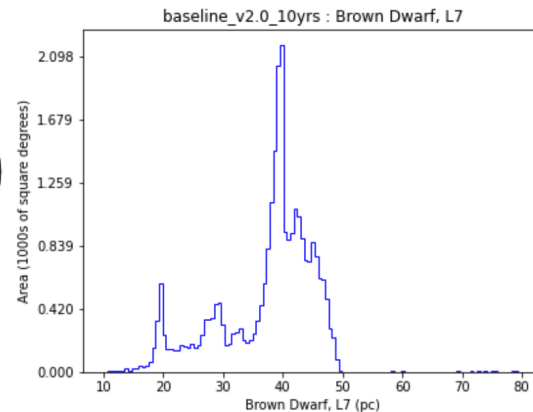
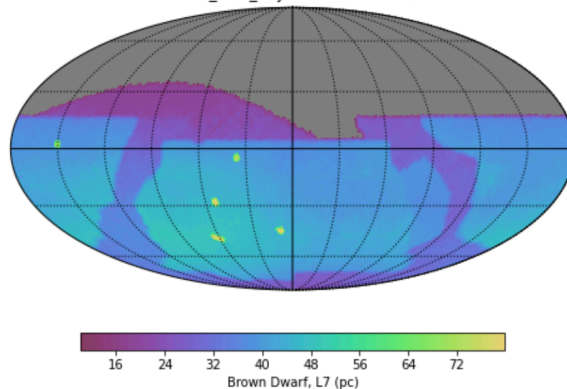
MetricName	Metadata	Total N Stars, crowding	Total N Stars, no crowding
N stars to Precision 0.20	u	1022087198.17	--
Nstars_no_crowding	u	--	1430751590.66
N stars to Precision 0.20	g	2140359213.79	--
Nstars_no_crowding	g	--	4224375872.46
N stars to Precision 0.20	r	2610227552.32	--
Nstars_no_crowding	r	--	6415299847.54
N stars to Precision 0.20	i	2888298912.06	--
Nstars_no_crowding	i	--	8015689460.79
N stars to Precision 0.20	z	2857745123.18	--
Nstars_no_crowding	z	--	8126772587.22
N stars to Precision 0.20	y	2558421649.67	--
Nstars_no_crowding	y	--	6968300845.02

# Science Metrics: *Milky Way* - Brown Dwarfs

- ‘Brown Dwarf Parallax Metric’ - calculates the distance to which a given parallax SNR could be measured, for the specified spectral type
  - Then calculates the total volume which can be probed to a parallax SNR of (10) for a population of L7 brown dwarfs

**Brown Dwarf, L7 HealpixSlicer [npz](#) [JSON](#)**

baseline\_v2.0\_10yrs : Brown Dwarf, L7



Group: <i>Milky Way</i> ; Subgroup: <i>Brown Dwarf</i> ; Slicer: <i>HealpixSlicer</i>
<b>Brown Dwarf, L7</b>
168086.07

# What metrics are we running?

---

- Attempt to list and categorize them here: Look at output metric pages for more details
  - <https://astro-lsst-01.astro.washington.edu:8080/>
    - ‘*Glance*’ - a small group of metrics we can run fast and check to see if simulation had anything go really obviously wrong
    - ‘*Metadata*’ - a large group of metrics that catalog basic things about the visits (things like airmass distributions, intervisit gaps, saturation magnitudes, coadded depths, number of visits, ..)
    - ‘*SSO*’ - metrics for solar system objects (time intensive to run and require extra steps for evaluation, thus saved separately, but really useful for SSO science)
    - ‘*Science*’ - a growing group of metrics targeted at high-level science evaluation (TDE discovery, Microlensing discovery, cosmology static science metrics, ..)