Supernovae and Observing Strategy in LSST
Status and plans

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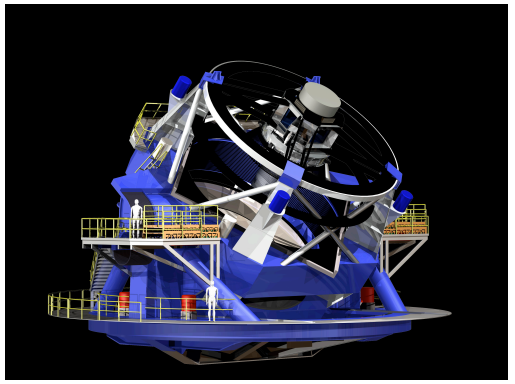
IN2P3/CNRS

LSST Observing strategy

- LSST telescope :
  - huge field-of-view 9.6 deg2
  - coverage : ~ 18000 deg2 of high Galactic latitude sky

  -> Wide-Deep-Fast imaging on the sky



- 3 types of cadencing :

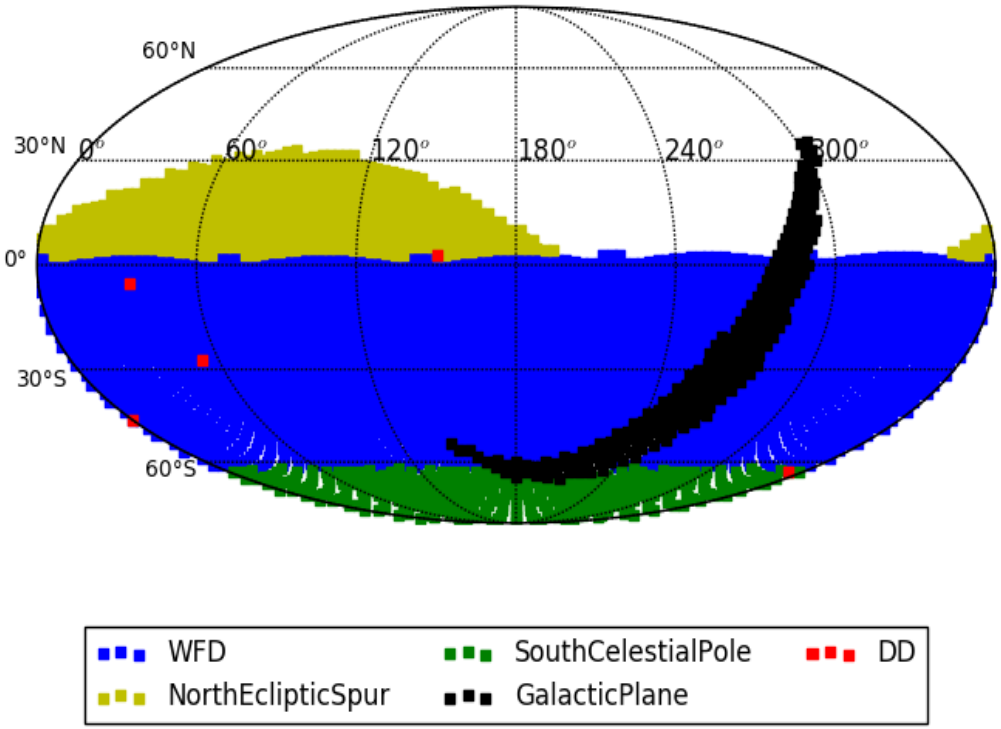
Cadencing	Sky region	Physics
Universal (uniform) "main survey"	south hemisphere	stellar parallax, proper motion, asteroids
Reduced number of repeat observations "mini surveys"	low Galactic latitudes	
	South Celestial Cap	Magellanic Clouds
	Ecliptic Plane (northern)	+ Near-Earth Asteroids, Main Belt Asteroids
Deep Drilling	5 fields	Variable objects

LSST Observing Strategy

- **Current baseline (minion_1016)**

Total number of visits : 2,448,282

1 visit = 2 exposures of 15s



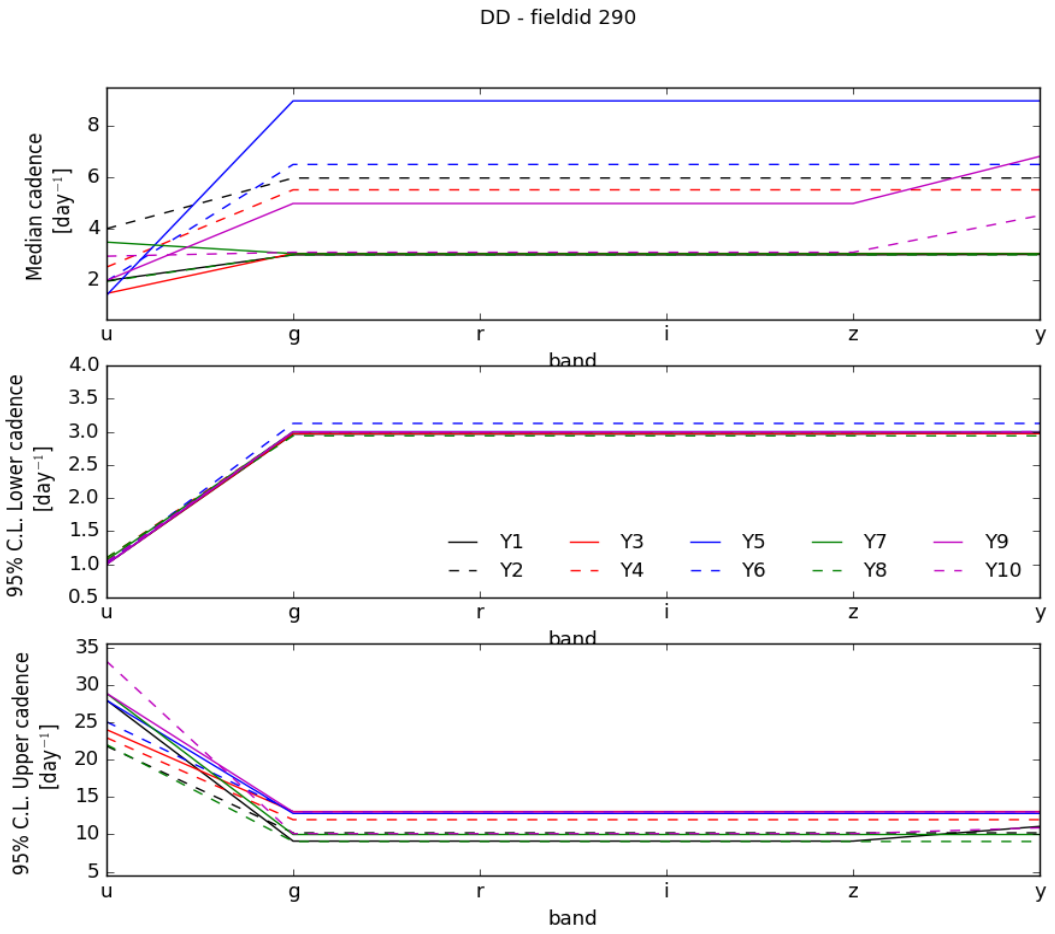
Deep Driling Fields

5 Deep Drilling Fields

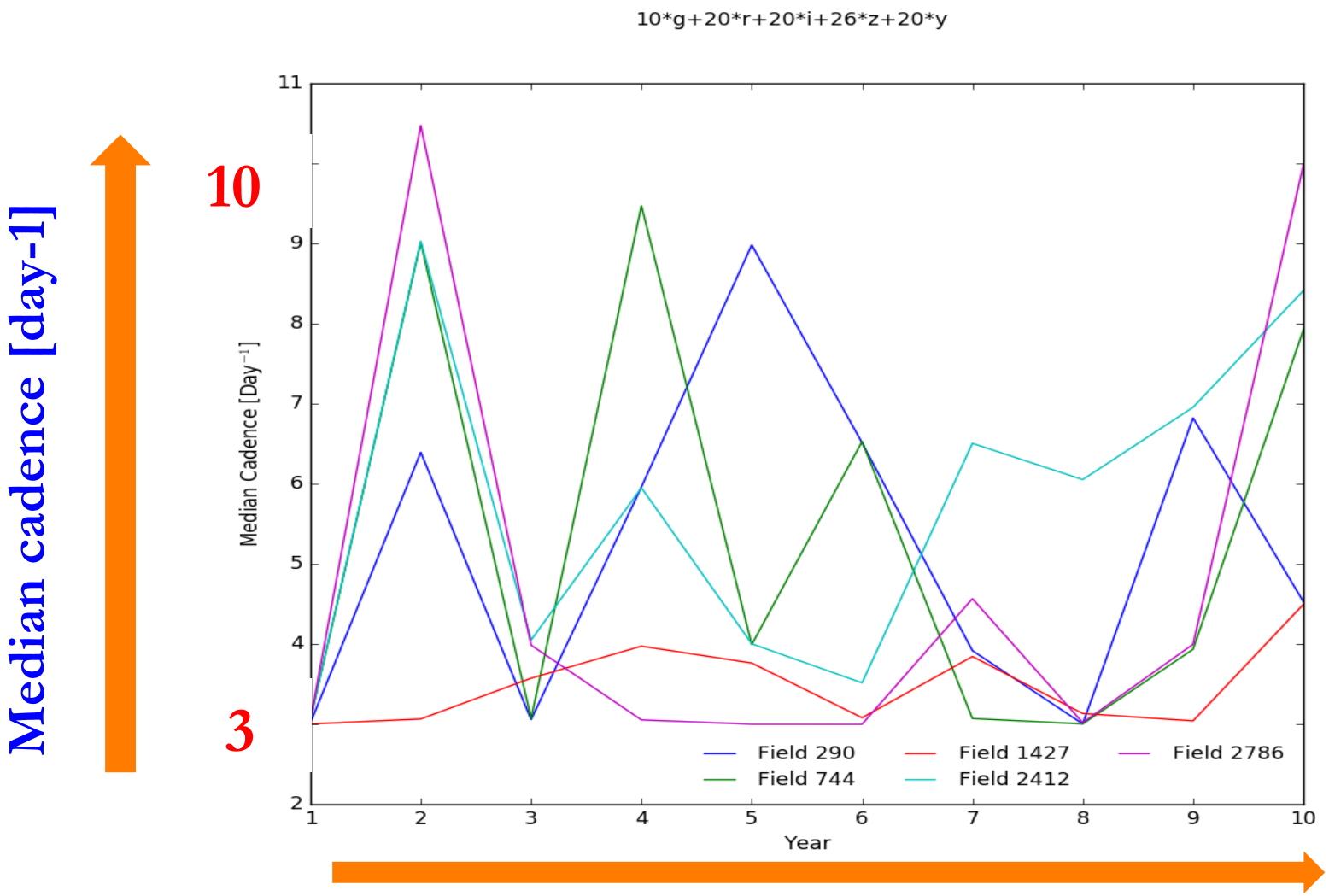
Field Id	Ra (deg)	Dec (deg)
290	349.4	-63.2
744	0.0	-45.52
1427	53.0	-27.4
2412	34.4	-5.1
2786	150.4	2.8

band	Observing time (%)	band	Observing time (%)
u	12.8	z	4.8
g	3.7	y	4.8
r	3.5	all	4.5
i	3.4		

Séquences (rgizy) (10,20,20,26,20) visits



Deep Driling Field



Deep Driling Field

140 days

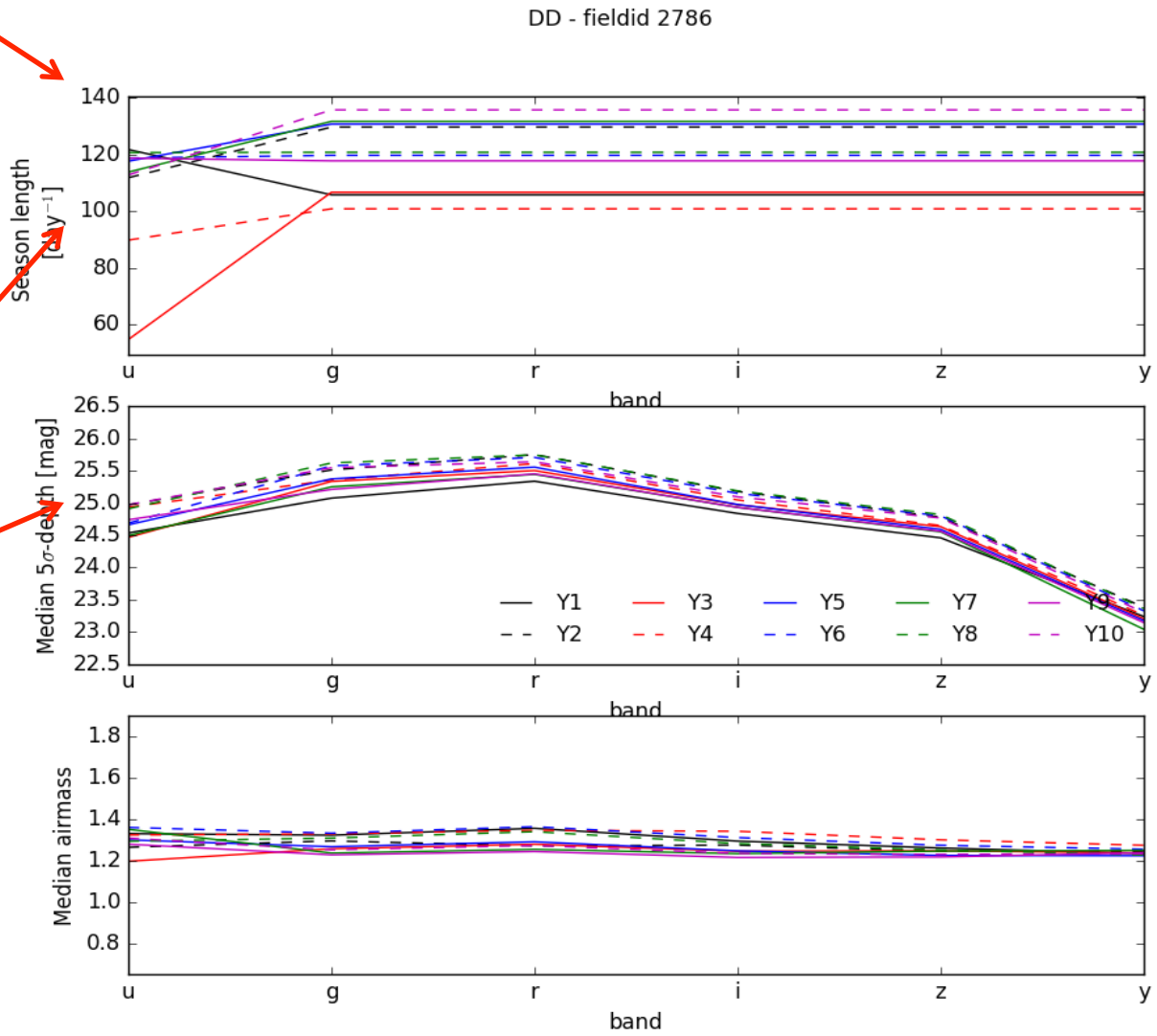
Season length

100 days

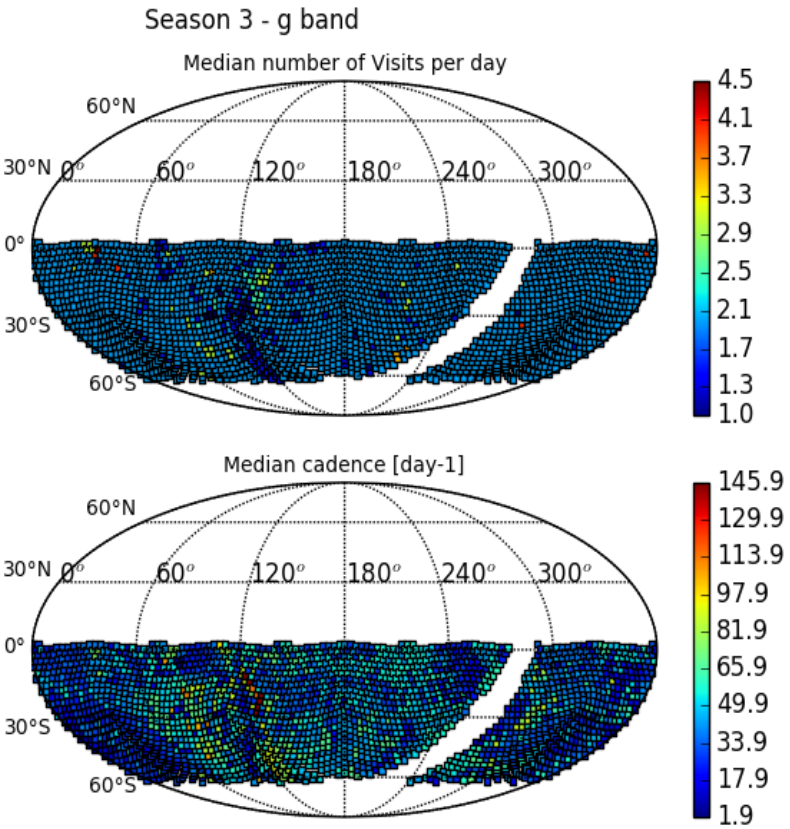
5σ depth

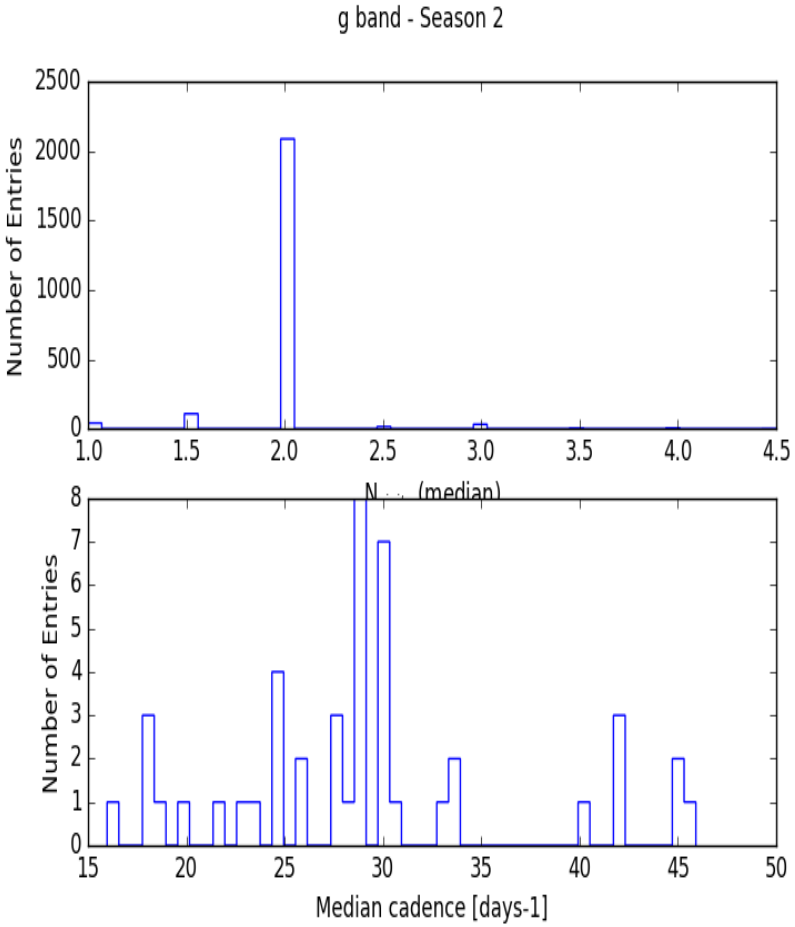
25.0

airmass

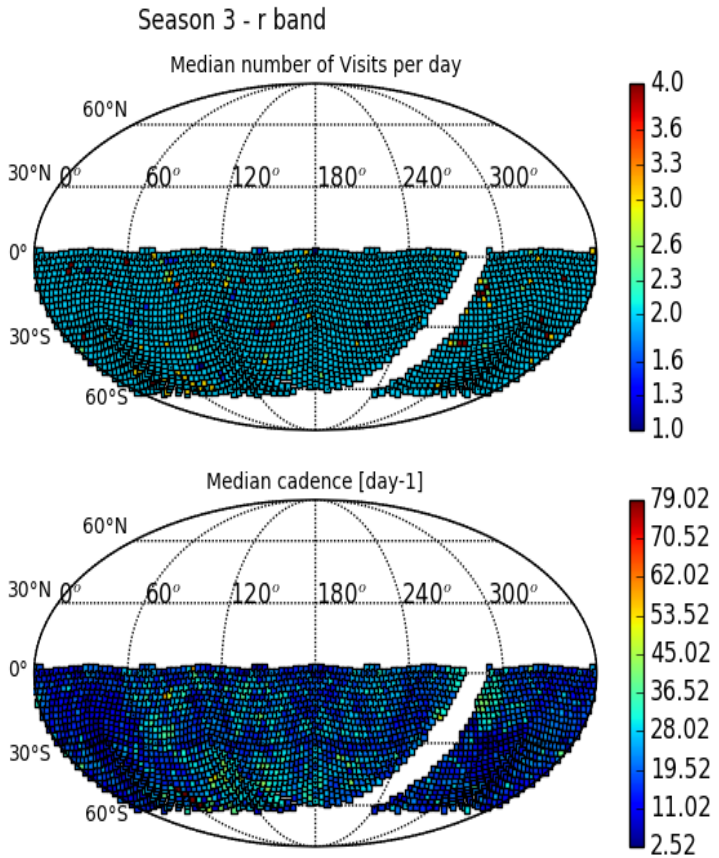


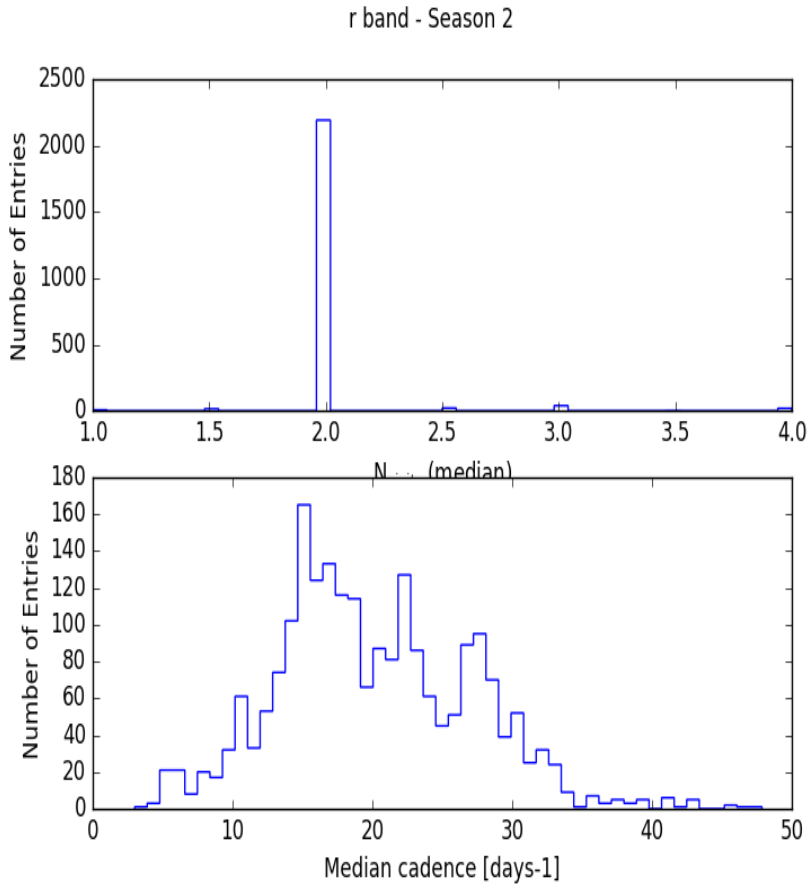
Wide Fields


Season 3 - g band
Median number of Visits per day
60°N
30°N
0°
30°S
60°S
0°
60°
120°
180°
240°
300°
4.5
4.1
3.7
3.3
2.9
2.5
2.1
1.7
1.3
1.0
Median cadence [day-1]
145.9
129.9
113.9
97.9
81.9
65.9
49.9
33.9
17.9
1.9


g band - Season 2
Number of Entries
2500
2000
1500
1000
500
0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
N . . (median)
Number of Entries
8
7
6
5
4
3
2
1
0
15
20
25
30
35
40
45
50
Median cadence [days-1]

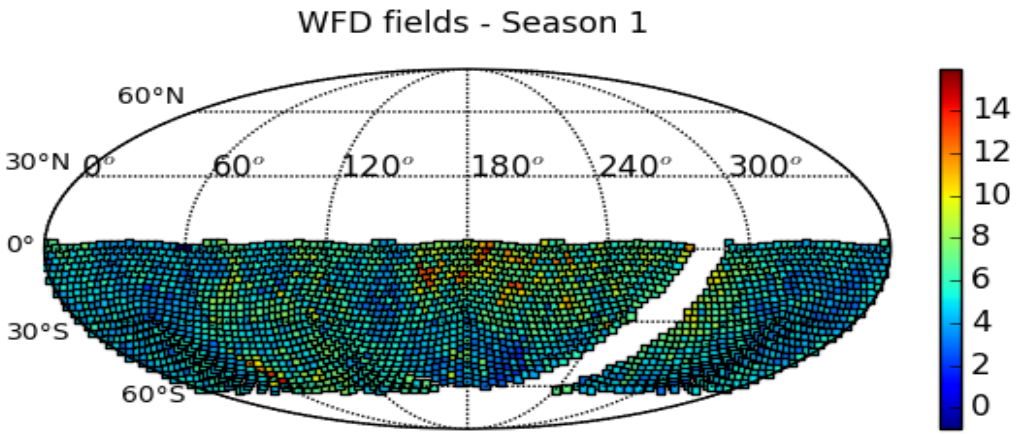
Wide Fields

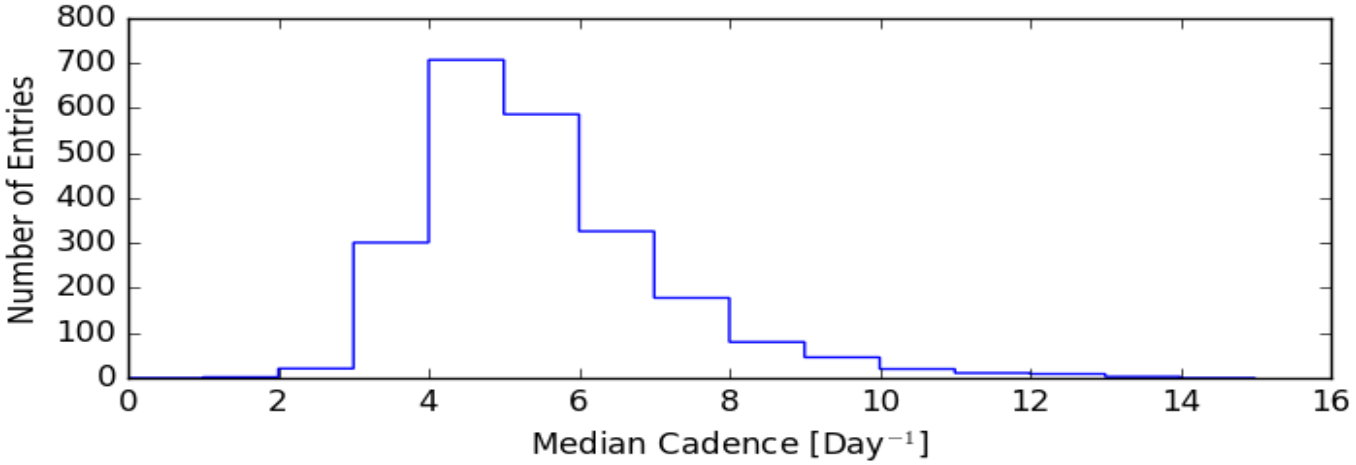

Season 3 - r band
Median number of Visits per day
60°N
30°N
0°
30°S
60°S
0°
60°
120°
180°
240°
300°
4.0
3.6
3.3
3.0
2.6
2.3
2.0
1.6
1.3
1.0
Median cadence [day-1]
79.02
70.52
62.02
53.52
45.02
36.52
28.02
19.52
11.02
2.52


r band - Season 2
Number of Entries
2500
2000
1500
1000
500
0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
(median)
Number of Entries
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
Median cadence [days-1]

Wide Fields

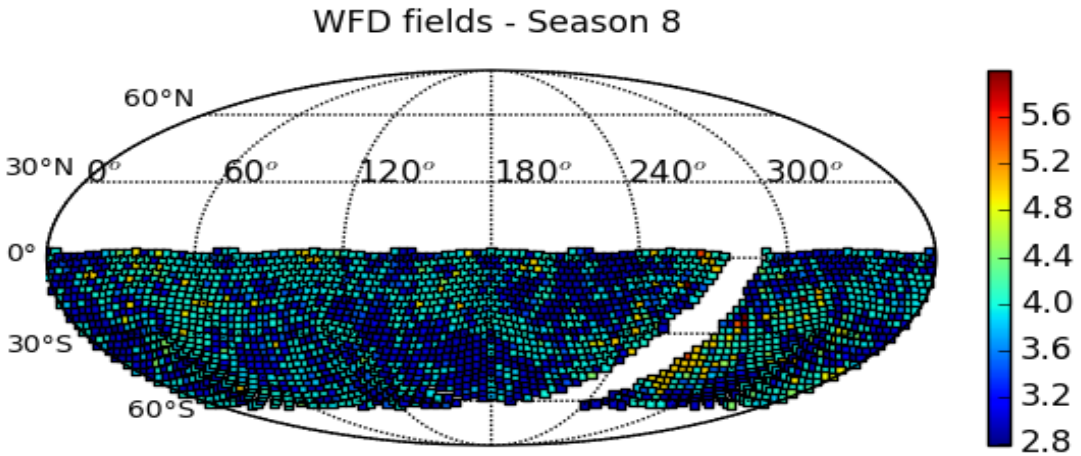
Au moins une visite pour un des six filtres

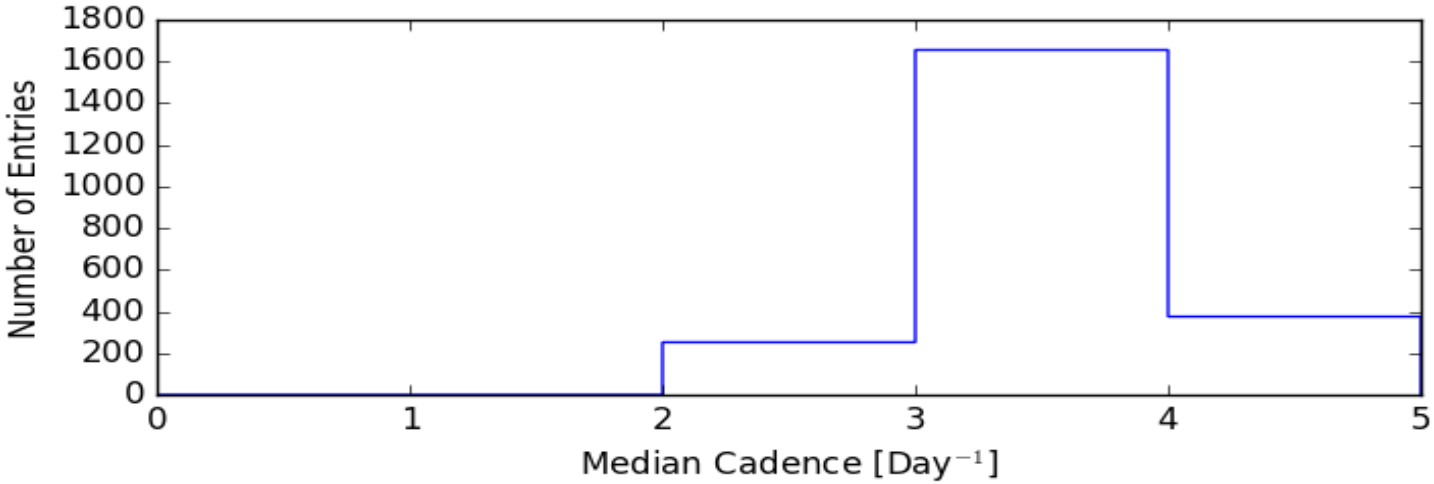




Wide Fields

Au moins une visite pour un des six filtres





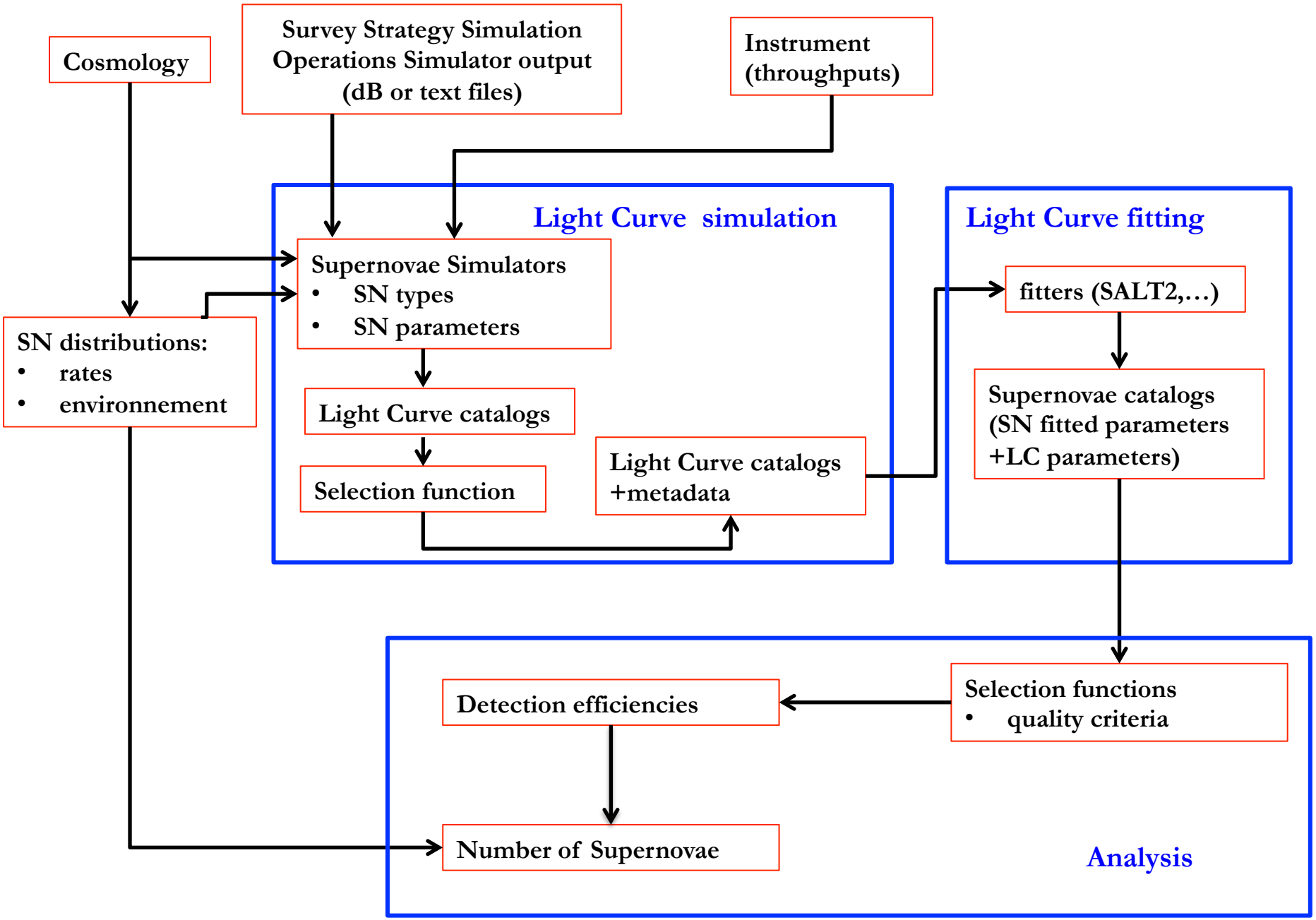
Observing Strategy and Supernovae

- In LSST, a large part of the supernovae will be identified thanks to light curves (flux vs time)
- Three major parameters will drive the quality and the quantity of the LC collected:

Parameter	Impact	Typical value
cadence +multiband observations	Light curve quality (SN parameters estimation)	median: 3 days-1 with limited variations
season length	Number of SN collected	170-180 days
deepness	High z detection	5-σ depth ~ 26.5, 26.2, 25.6, 24.7 for r, i, z, y bands

- Strategy to estimate the number of SN (Ia) collected by LSST:
  - LC simulations (observing conditions +SN parameter)
  - LC fits -> SN parameters
  - Selection criteria -> detection efficiency
    -> Sne Ia production rate

Number of type Ia Supernovae


Cosmology
Survey Strategy Simulation
Operations Simulator output
(dB or text files)
Instrument
(throughputs)
Light Curve simulation
Supernovae Simulators
• SN types
• SN parameters
SN distributions:
• rates
• environnement
Light Curve catalogs
Selection function
Light Curve catalogs
+metadata
Light Curve fitting
fitters (SALT2,…)
Supernovae catalogs
(SN fitted parameters
+LC parameters)
Selection functions
• quality criteria
Detection efficiencies
Number of Supernovae
Analysis

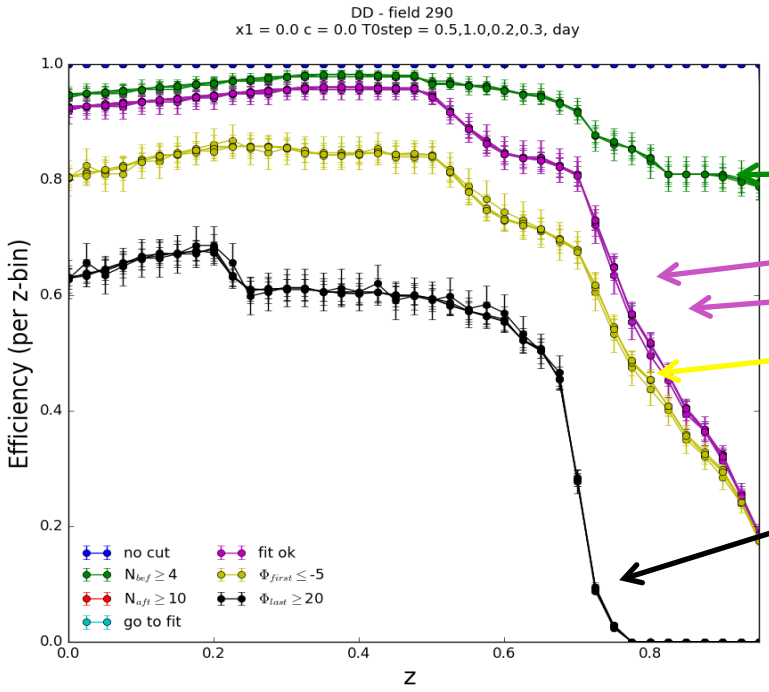
Observing Strategy and Supernovae

- **A first study has been performed using Minion_1016 and sncosmo as LC simulator**
  -> About 6000 SN after ten years of observations

- **Improvements being implemented:**
  1) **scan of the SN parameters in a more systematic way**
  2) **use another LC simulator for comparison (snsim)**

1) 4 parameters : z, T0 (Daymax in obs frame), x1, c
-> (x1, c) taken from Scolnic&Kessler(2016)
-> z : range=[0.01,1.1], step: 0.025
-> T0 : range: [MJD_{OBS}^{min}, MJD_{OBS}^{max}] , step ?

Observing Strategy and Supernovae



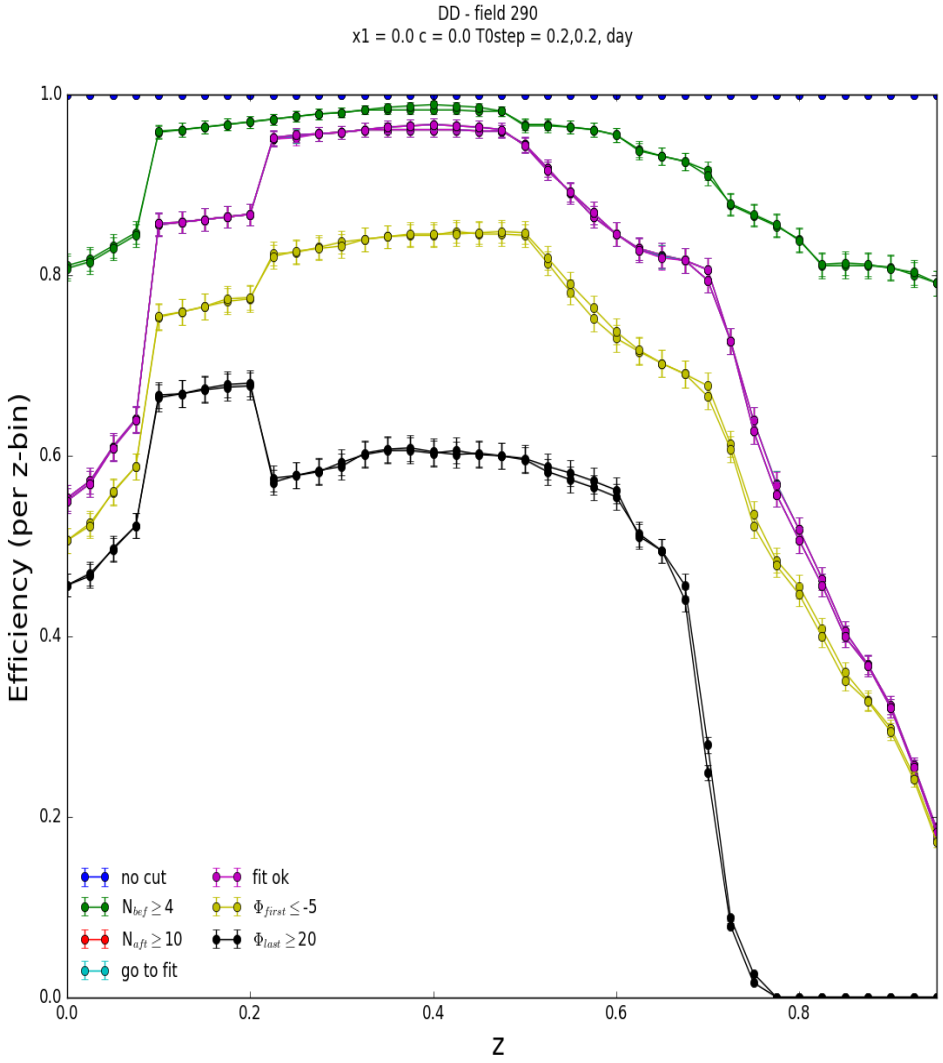
Selection cuts:

- **Nbef >= 4**
- **Naft >=10**
- **fit ok**
- **phase_first < -5**
- **phase_last > 20**

T0_step (day)	0.1	0.2	0.3	0.5	1.0
N_{LC} (x1=0., c=0.)	60192	30096	20064	6028	137
N_{LC} (millions)	12.4	6.2	4.1	2.5	1.2

with 95% from Scolnic&Kessler

Field 290 – Season 0



snsim vs sncosmo

- snsim much faster (x5)
- detection efficiencies compatible
- More comparisons in progress :
  - LC (mag, errors)
  - SN (fitted) parameters

Observing Strategy and Supernovae

- Infrastructure in place
- Minion_1016 :
  - finish the study (DD+WDF) -> number of SN ?
    -> DESC note
  - new metric + -> DESC note
  - snsim/sncosmo comp

- DESC Observing strategy Task Force:
  - conveners : M. Lochner & D. Scolnic
  - no official meeting at the moment ; only one informal (round table about software available)
  - Last Monday: Rolling cadence files (Wide) available

-> DESC @SLAC : make a qualitative statement about the improvement or lack-there-of of the alternate strategies compared to the baseline case.

-> This statement can be based on simple assessments of various metrics in the MAF output (already available below for each simulation) or can be done by taking the full output and incorporating it into your the group's analysis pipeline or running metrics you may have already implemented for the white paper.

-> have an initial statement prepared by the meeting. We ask that you send us a very short paragraph of conclusions just before the meeting, by Friday, 2nd February, basically stating whether or not the new strategies represent an improvement and a brief explanation of how you came to your conclusion.