

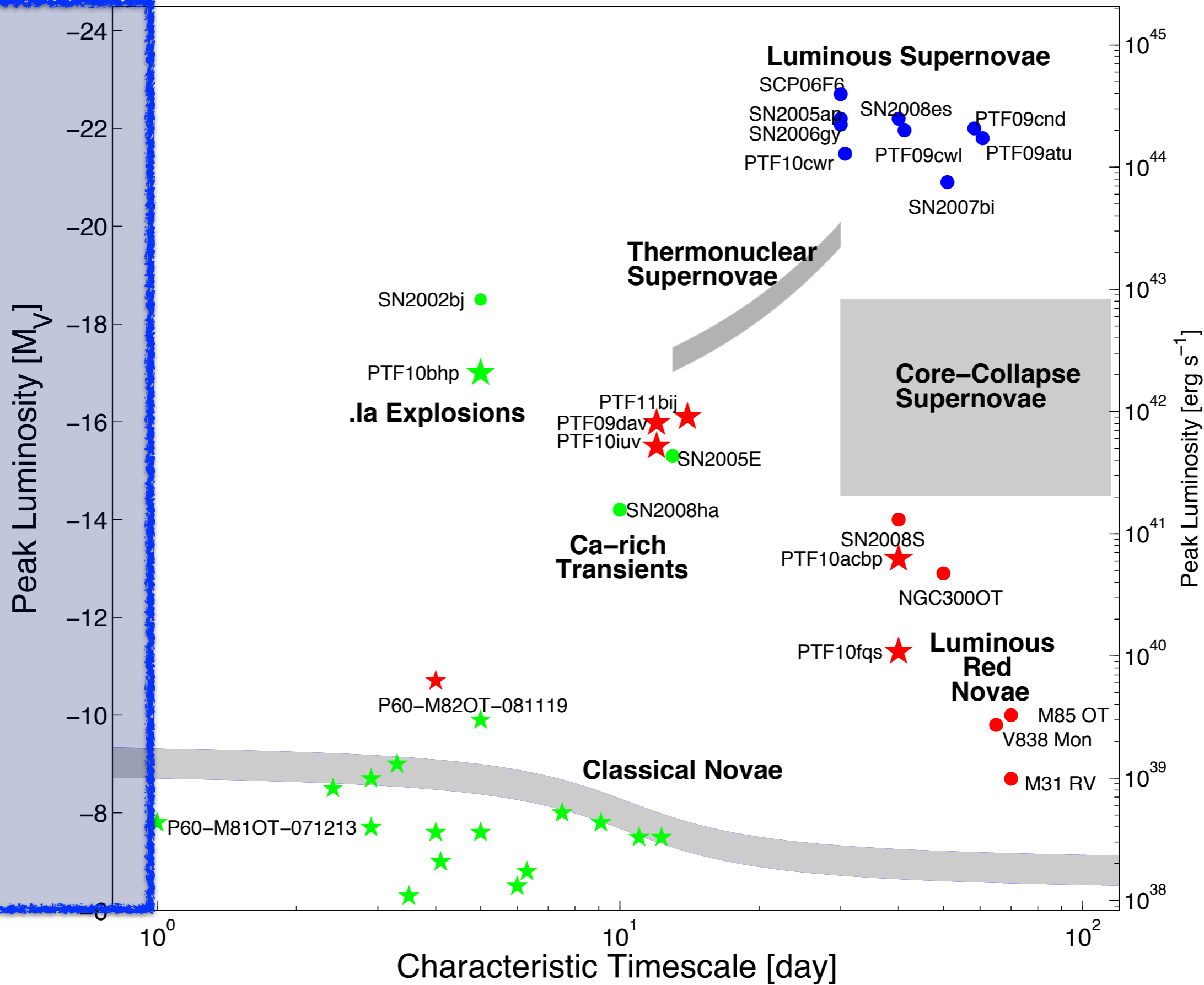
Northern Sky Transient Survey w/ Tomo-e Gozen

諸隈 智貴 (東京大学)

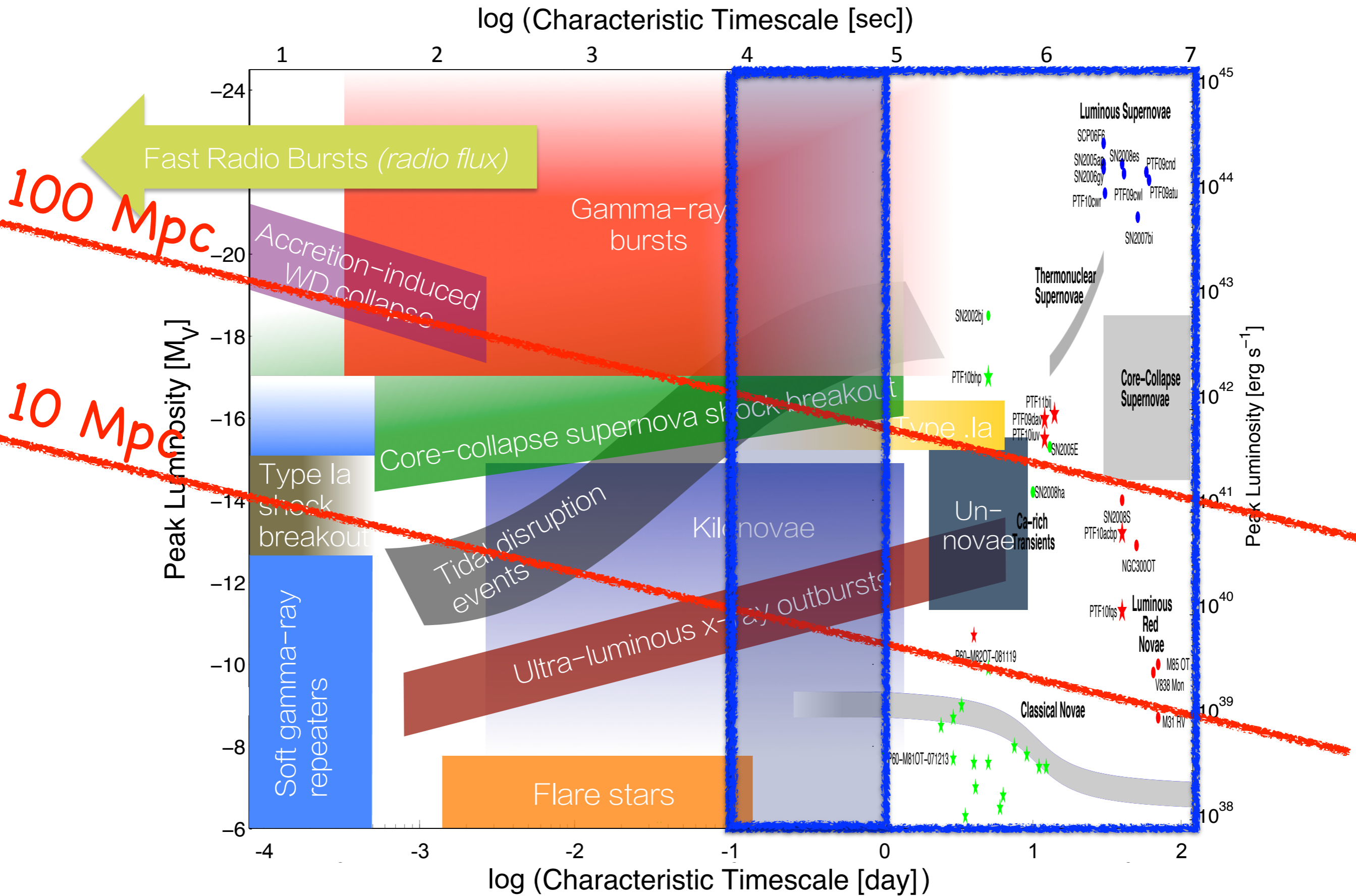
Tomoki Morokuma (Univ. of Tokyo/IoA)

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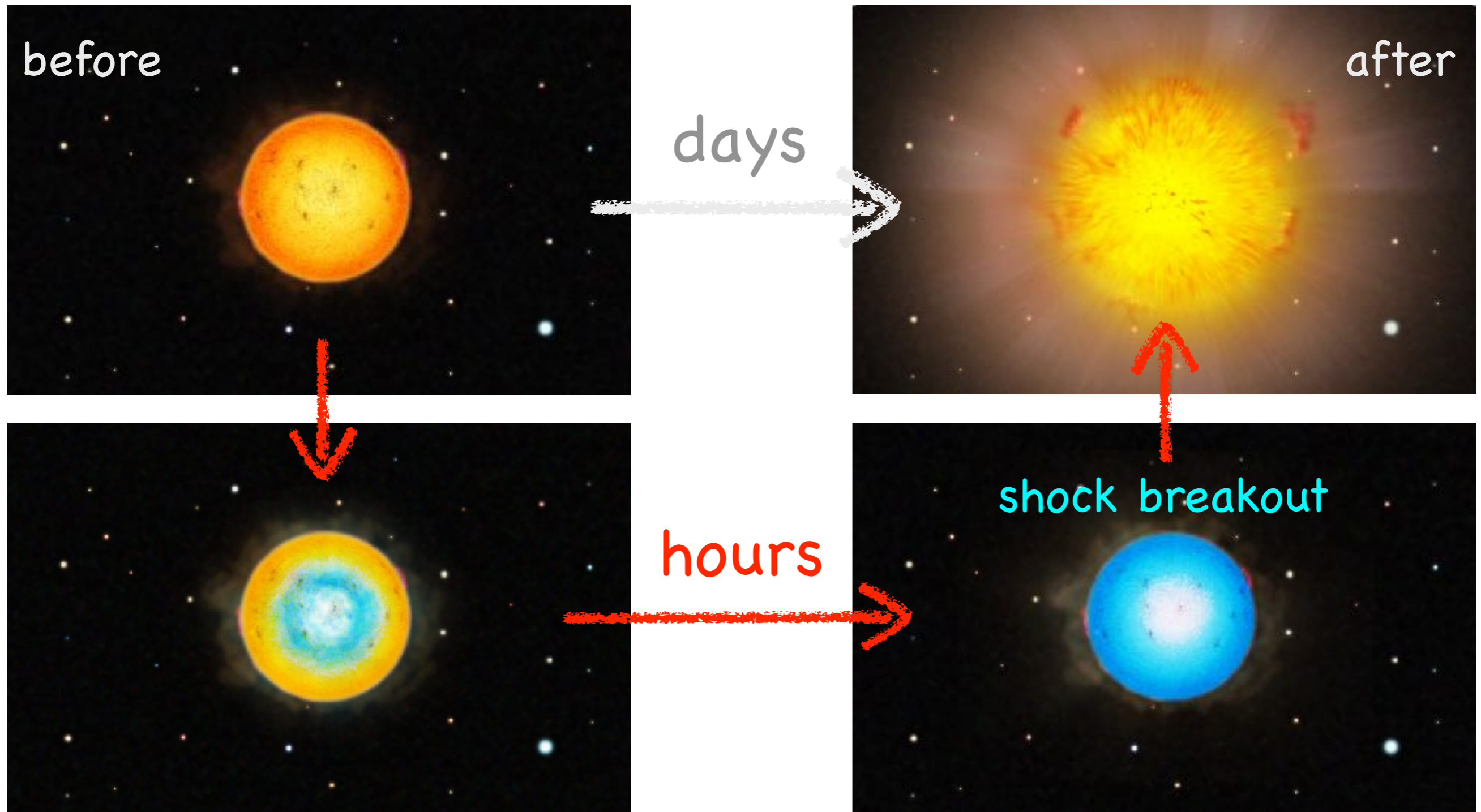
Kasliwal 2011, Cooke (http://www.astro.caltech.edu/~ycao/B&ETalks/B&E_FRBs_Cooke.pdf)



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"Moment" of Supernova Explosion

Supernova Shock Breakout



Proposed Science Cases@previous workshops

- supernova
- GW counterpart / kilonova
- neutrino counterpart
- comet, asteroid
- meteor
- NEO
- space debris
- moving objects
- pulsar
- super-flare, M dwarf flare, CV
- Ultra-Long GRB
- Fast Radio Burst
- AGN
- X-ray transient, UV transient

*cadence?
survey area?
survey region?
depth?*

Northern Sky Transient Survey w/ Tomo-e Gozen

10,000 deg² - 2 hr cadence - 18 mag depth

10,000 deg² - 1 day cadence - 19 mag depth

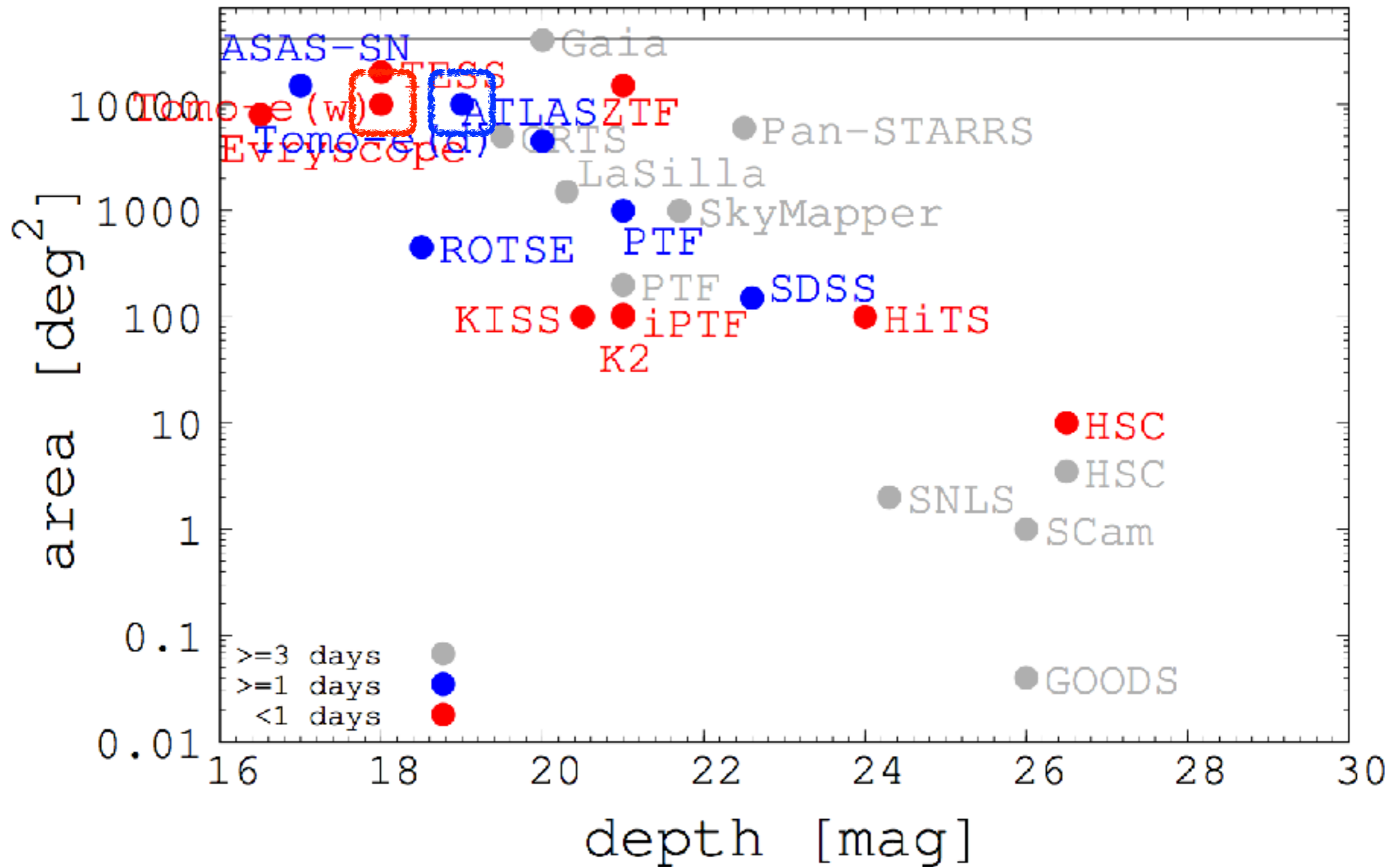
- no filter: effectively g+r bands (): last year
- 1 visit
 - 6 (3) sec exposure: [0.5 sec exposure] x 12 (6)
 - ~18-19 mag
 - 2x3 or 2x2 dithering
 - ~60 deg² (partially vignetted by ~30%)
- cadence: ~2 hours
- survey area / 2 hrs: ~7,000 (10,000) deg², EL>40 (30) deg
- 2-4 (3-5) times visits per night
 - ~19 mag for daily stacked data
- weather factor: usable (half), photometric (30%)
- reference: PS1?

Tomo-e Gozen SN Survey vs Kiso Supernova Survey (KISS) w/ KWFC

	Tomo-e SN Survey	KISS
instrument	Tomo-e Gozen	KWFC
sensor	CMOS	CCD
readout time	~0 sec	120 sec
period	2018 fall -	2012/4-2015/9 (3.5 yrs)
survey area [deg ²]	7,000	50-100
cadence	2 hours / 1 day	1 hour
exposure time / visit	6 sec	180 sec
depth	18 mag / 19 mag	20-21 mag
filter	no (~g+r)	g
#(SBOs), #(SNe) / yr	5, 1000	O(0.1)-O(1), 100
data storage	daily-stacked image SN cutout images	all data saved
reference	-	TM, Tominaga, Tanaka+2014

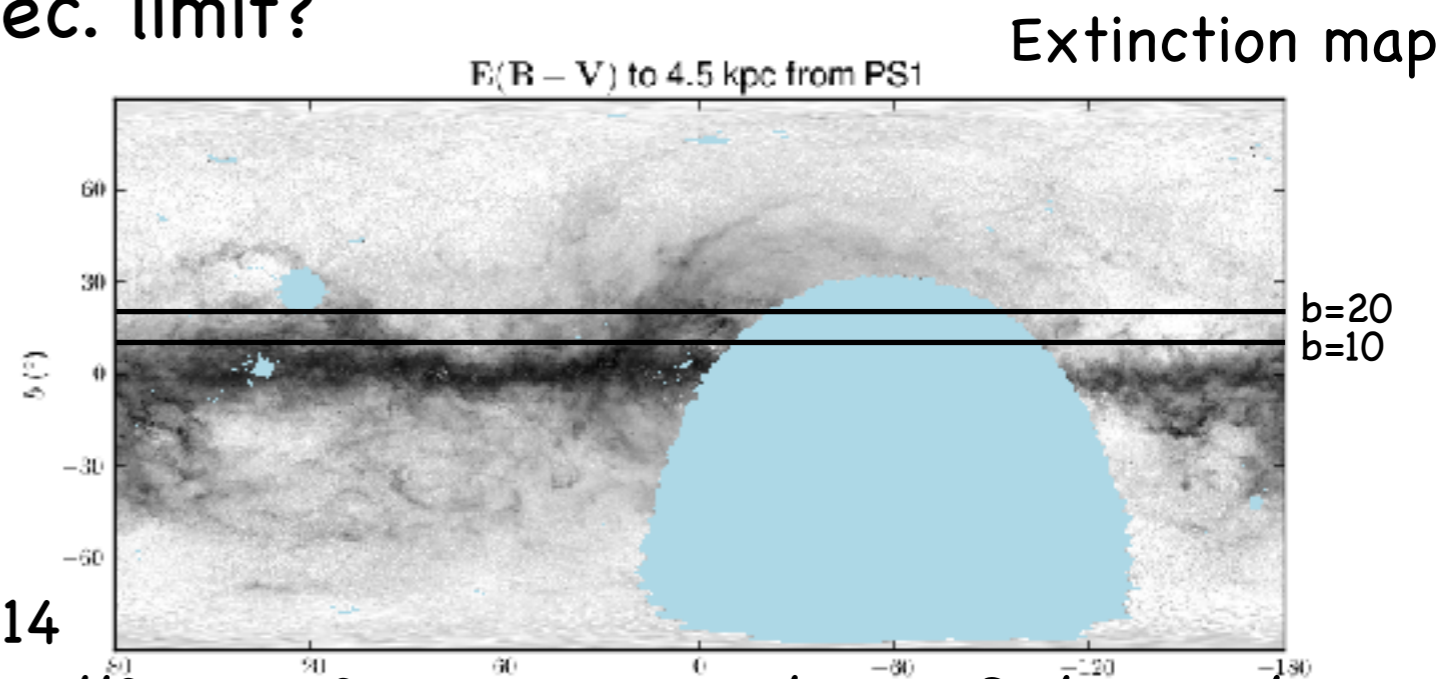
Tomo-e Gozen SN Survey vs other SN surveys

year 2018



Requirements for Survey Design

- ❑ Multiple visits per night: hopefully $N(\text{visit}) \geq 3$
- ❑ Small motion: not go far away for the next pointing
 - ❑ To avoid extra time for telescope pointing (14 sec for 9 deg)
 - ❑ Especially for azimuthal direction (dome rotation)
- ❑ Not too short time intervals from previous visits: $\Delta t > 1.5$ hours
- ❑ Not avoid Galactic Plane
 - ❑ Avoid less useful(?) regions?: $\sim 10 < |b| < \sim 20$
 - ❑ Limit the number of visits?
- ❑ special regions even below Dec. limit?
- ❑ Higher elevation preferred

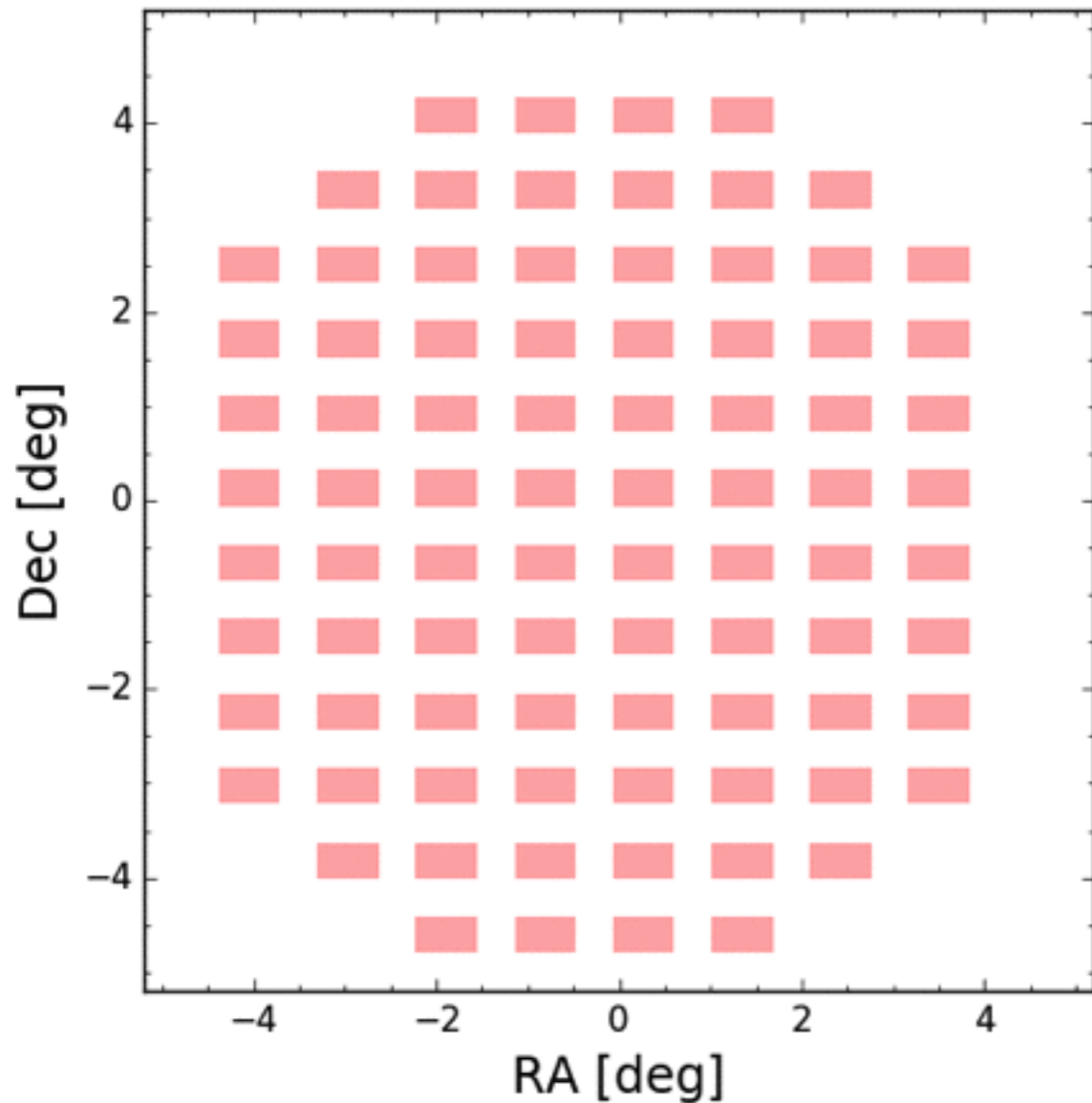


Survey Simulation

	ELmin	delta t min	Dec_min	Dec_max
20180707a	40	90	-5	80
20180707b	40	180	-5	80
20180707c	45	90	-5	80
20180707d	50	90	-5	80
20180707e	35	90	-5	80
20180707f	30	90	-5	80

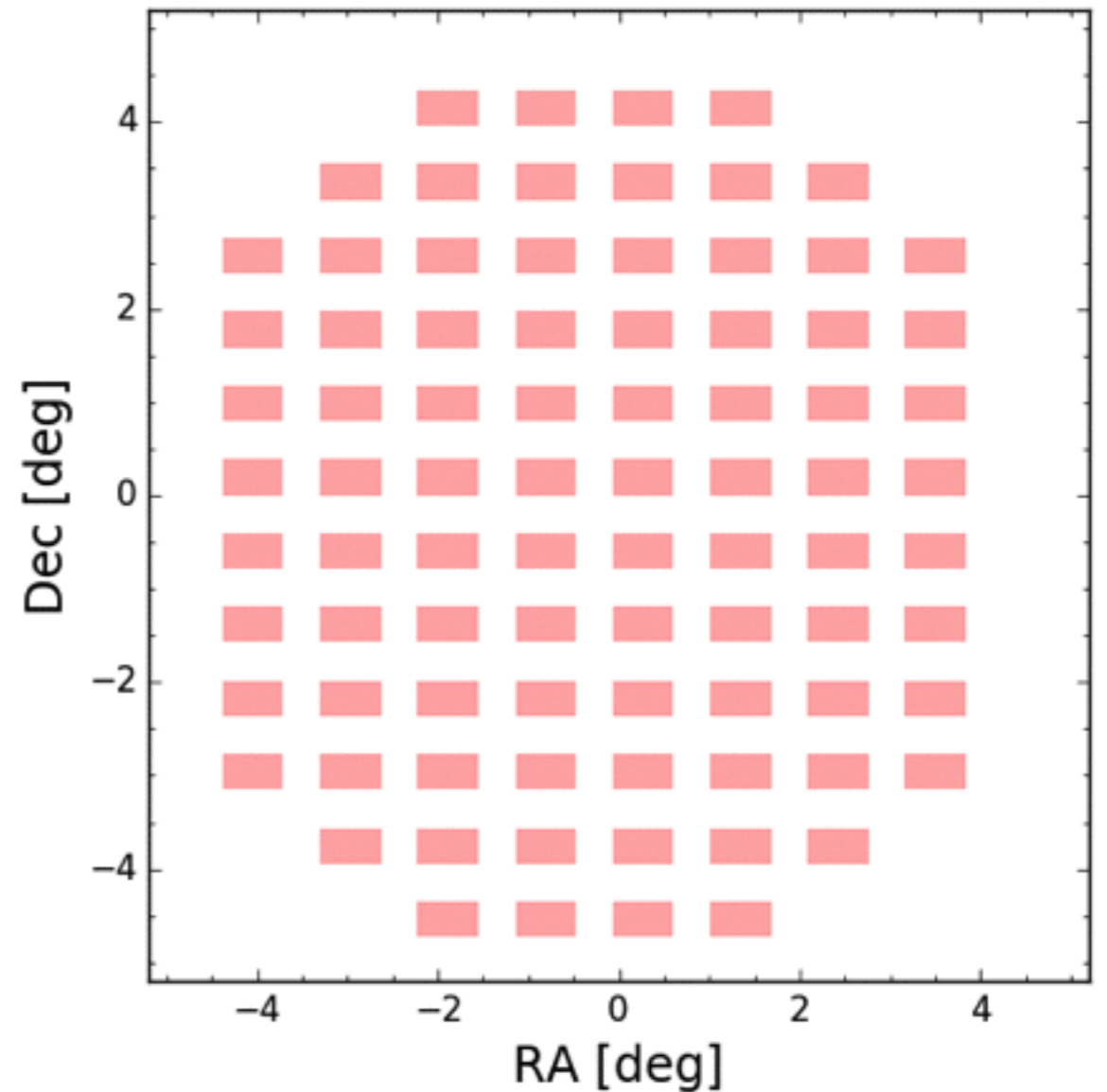
- 2x2 dithering: some gaps on the sky
 - too much overlaps in 2x3 dithering

2x3 dithering



no gap
but large overlap

2x2 dithering

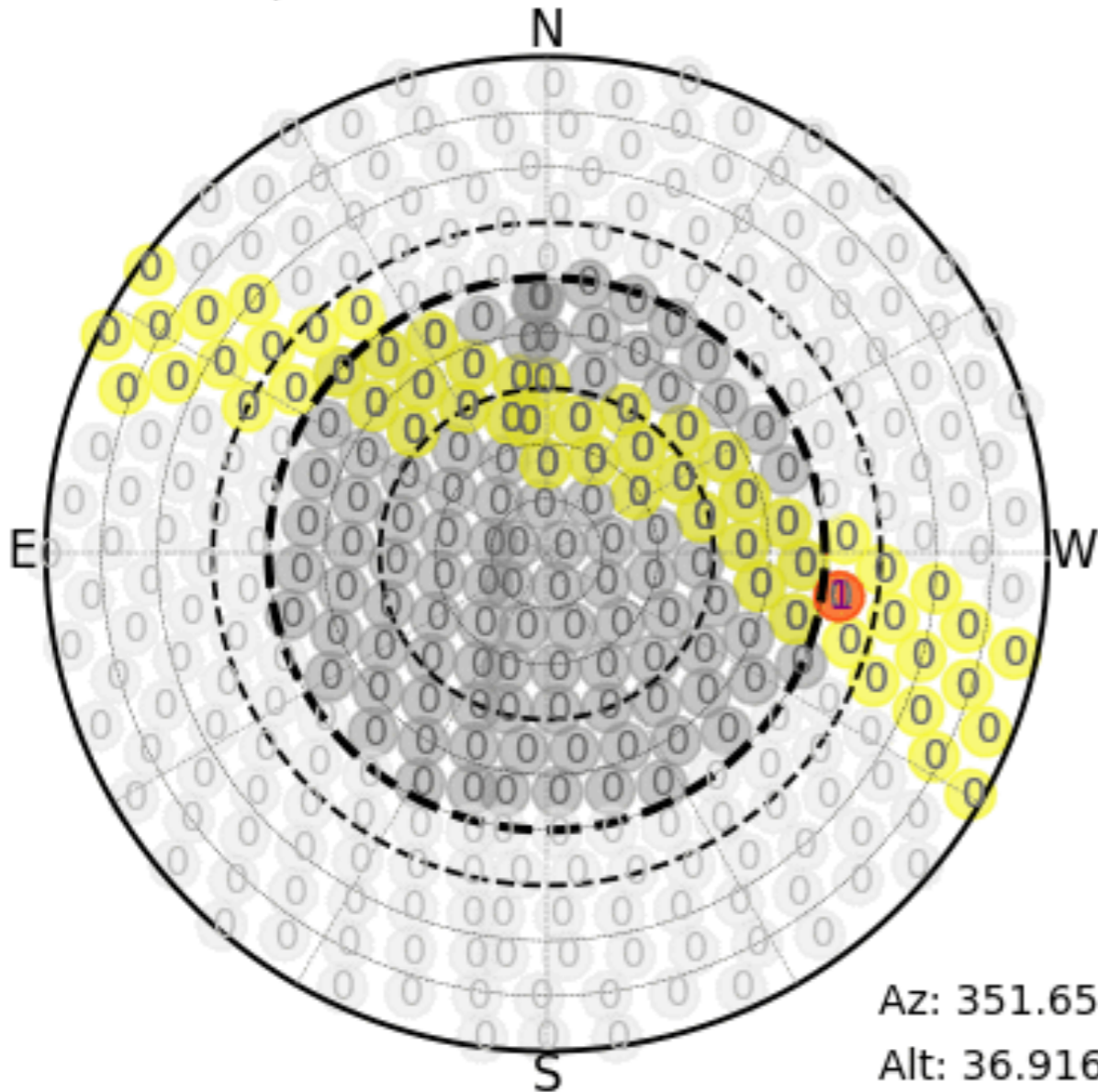


small gap
small overlap
(to be quantified)

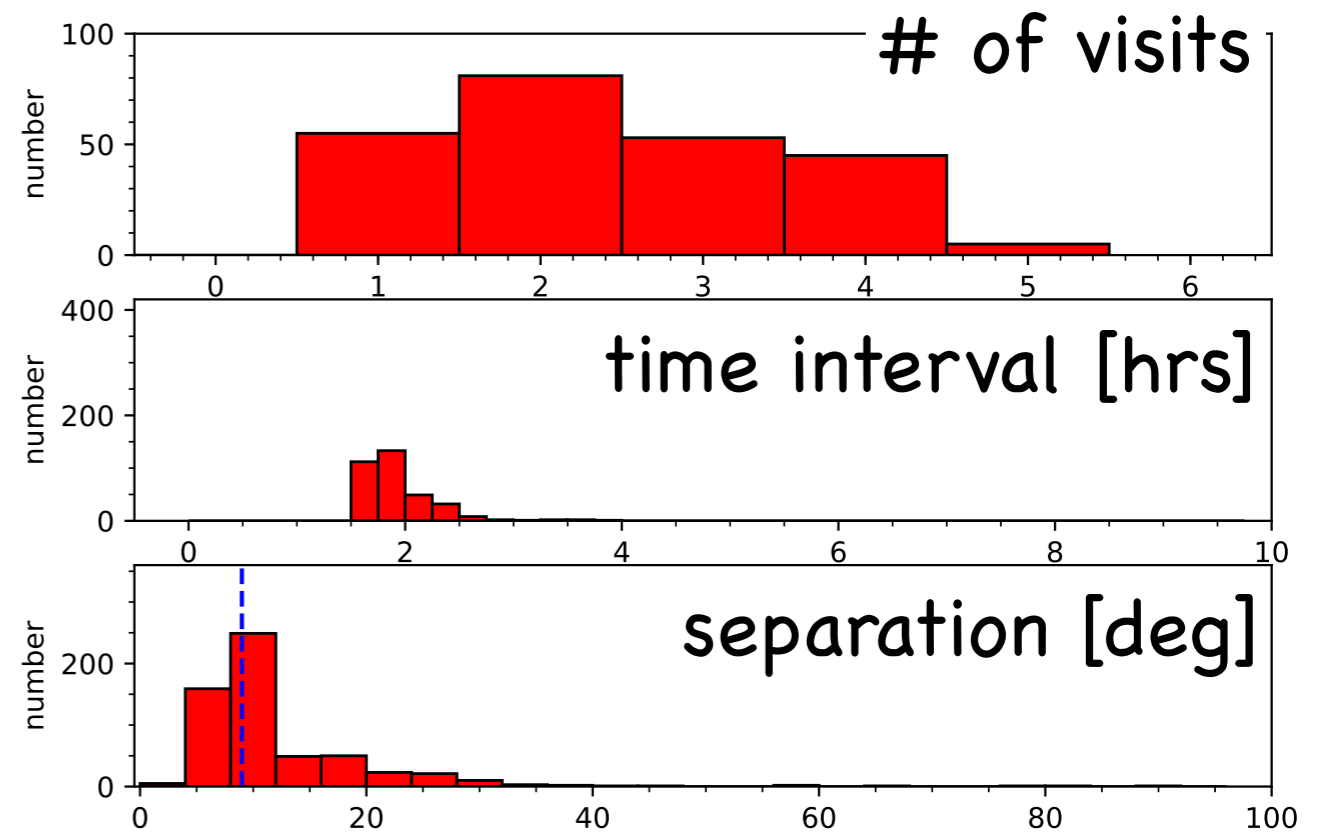
Survey Simulation 1

581 visits (~35,000 deg²)
for 10 hours

0000, 2018-11-21T19:00:00.000



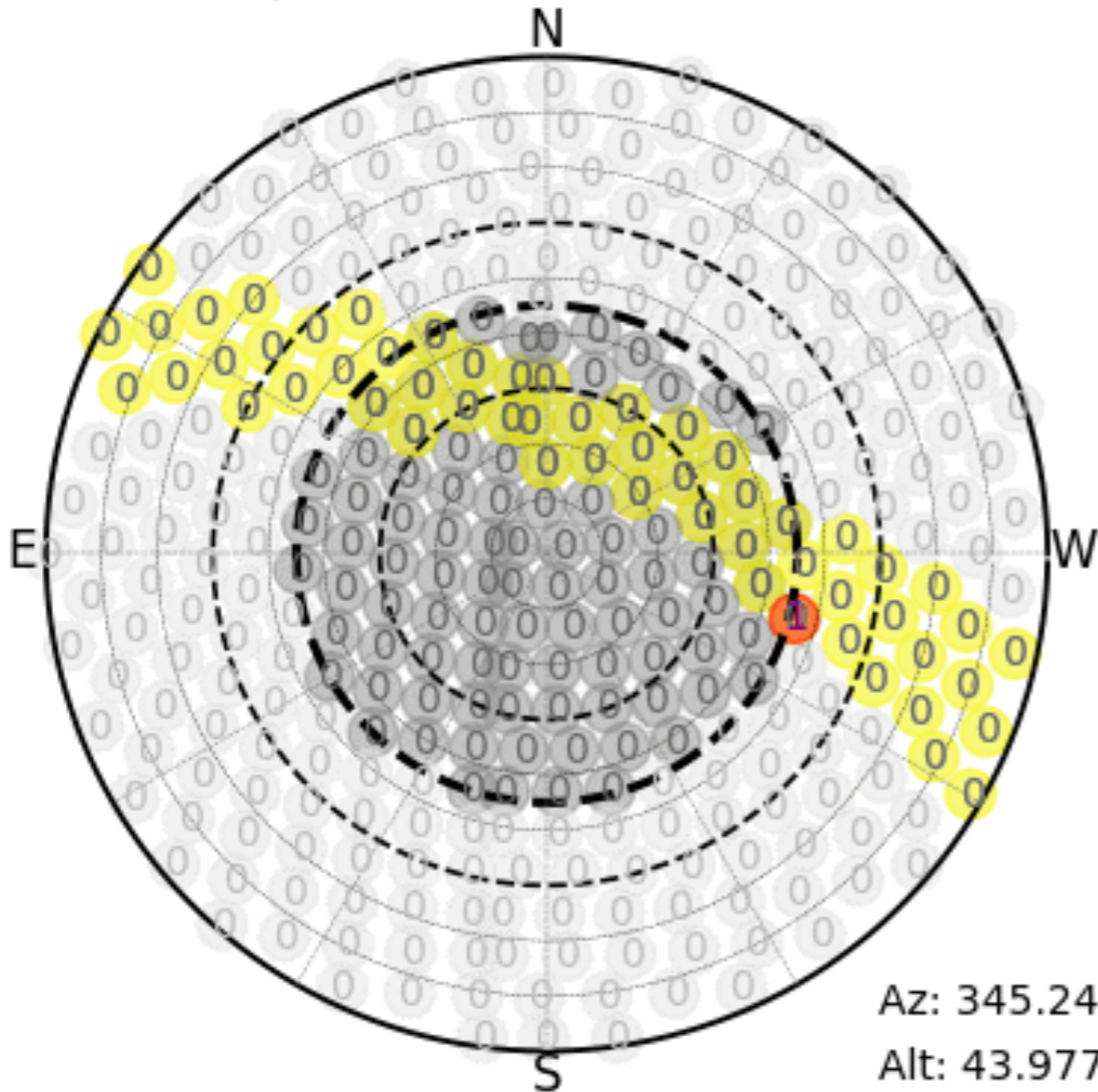
	ELmin	delta t min	Dec_min	Dec_max
20180707a	40	90	-5	80
20180707b	40	180	-5	80
20180707c	45	90	-5	80
20180707d	50	90	-5	80
20180707e	35	90	-5	80
20180707f	30	90	-5	80



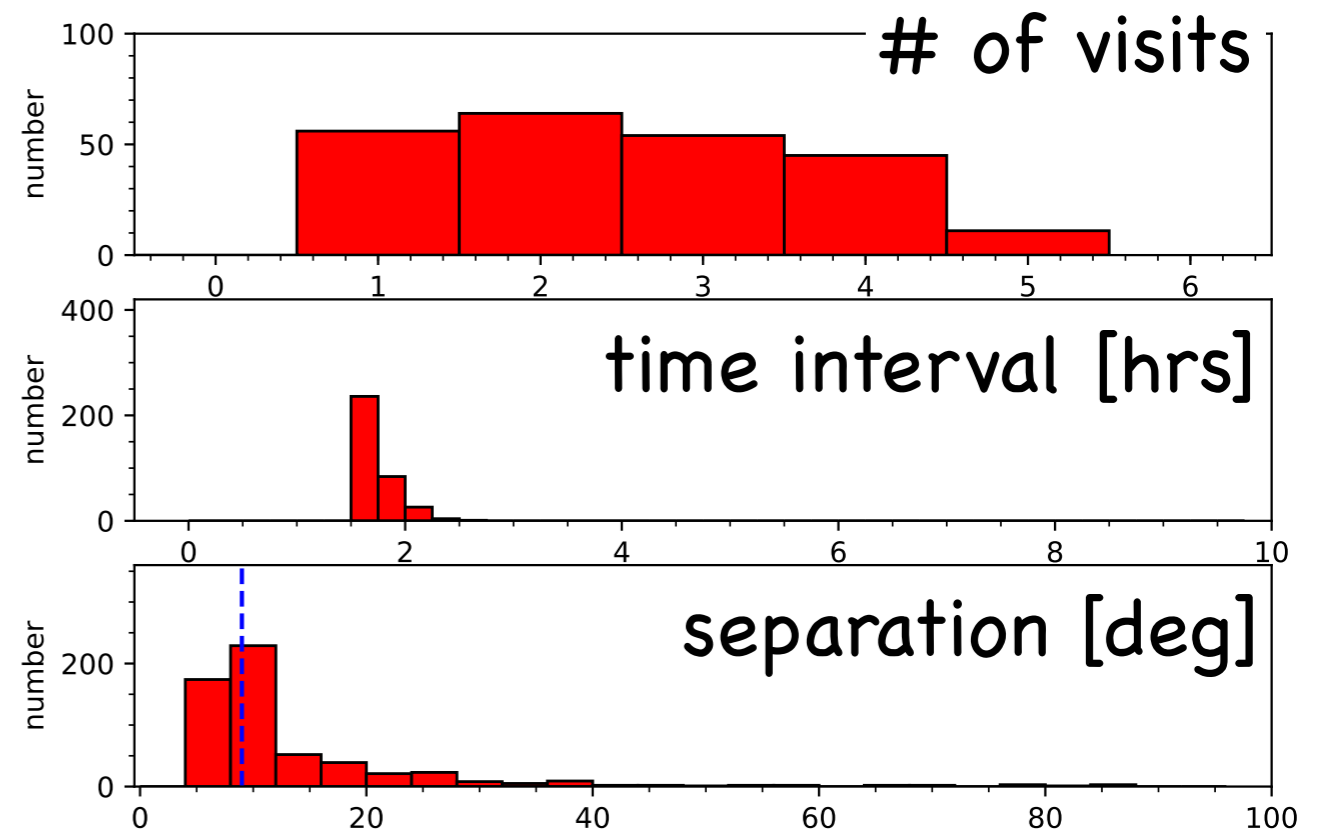
Survey Simulation 3

581 visits (~35,000 deg²)
for 10 hours

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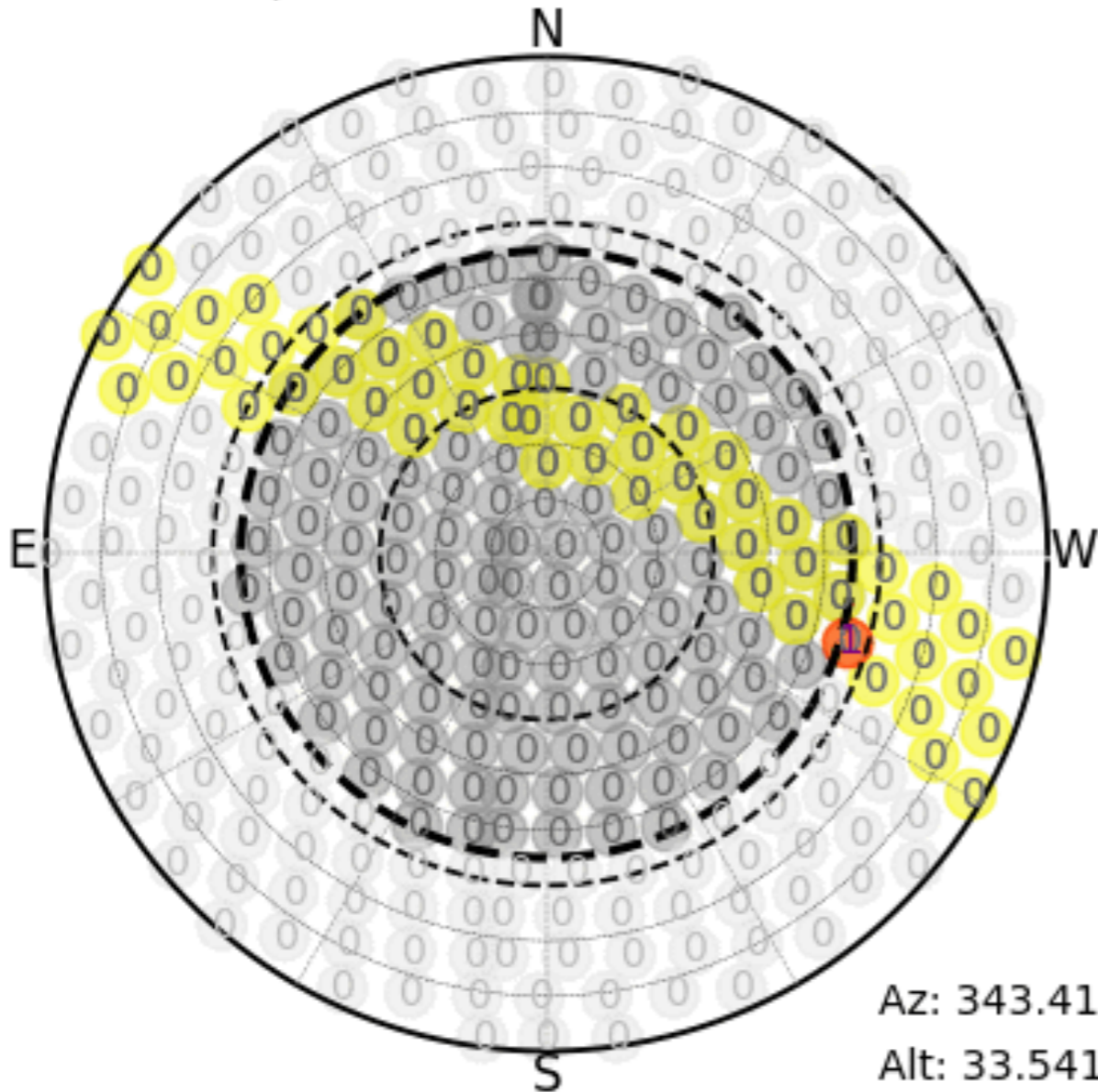
	ELmin	delta t min	Dec_min	Dec_max
20180707a	40	90	-5	80
20180707b	40	180	-5	80
20180707c	45	90	-5	80
20180707d	50	90	-5	80
20180707e	35	90	-5	80
20180707f	30	90	-5	80



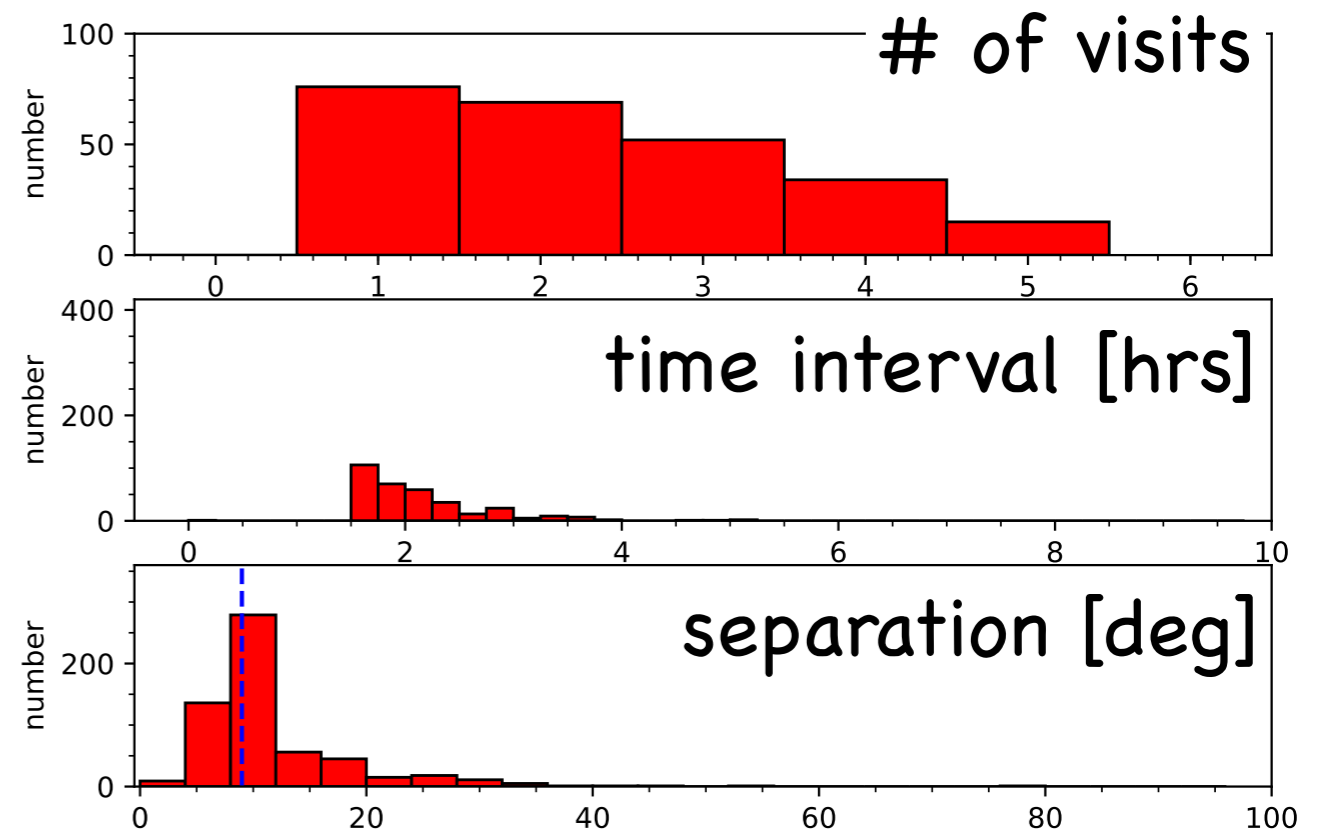
Survey Simulation 5

581 visits (~35,000 deg²)
for 10 hours

0000, 2018-11-21T19:00:00.000



	ELmin	delta t min	Dec_min	Dec_max
20180707a	40	90	-5	80
20180707b	40	180	-5	80
20180707c	45	90	-5	80
20180707d	50	90	-5	80
20180707e	35	90	-5	80
20180707f	30	90	-5	80

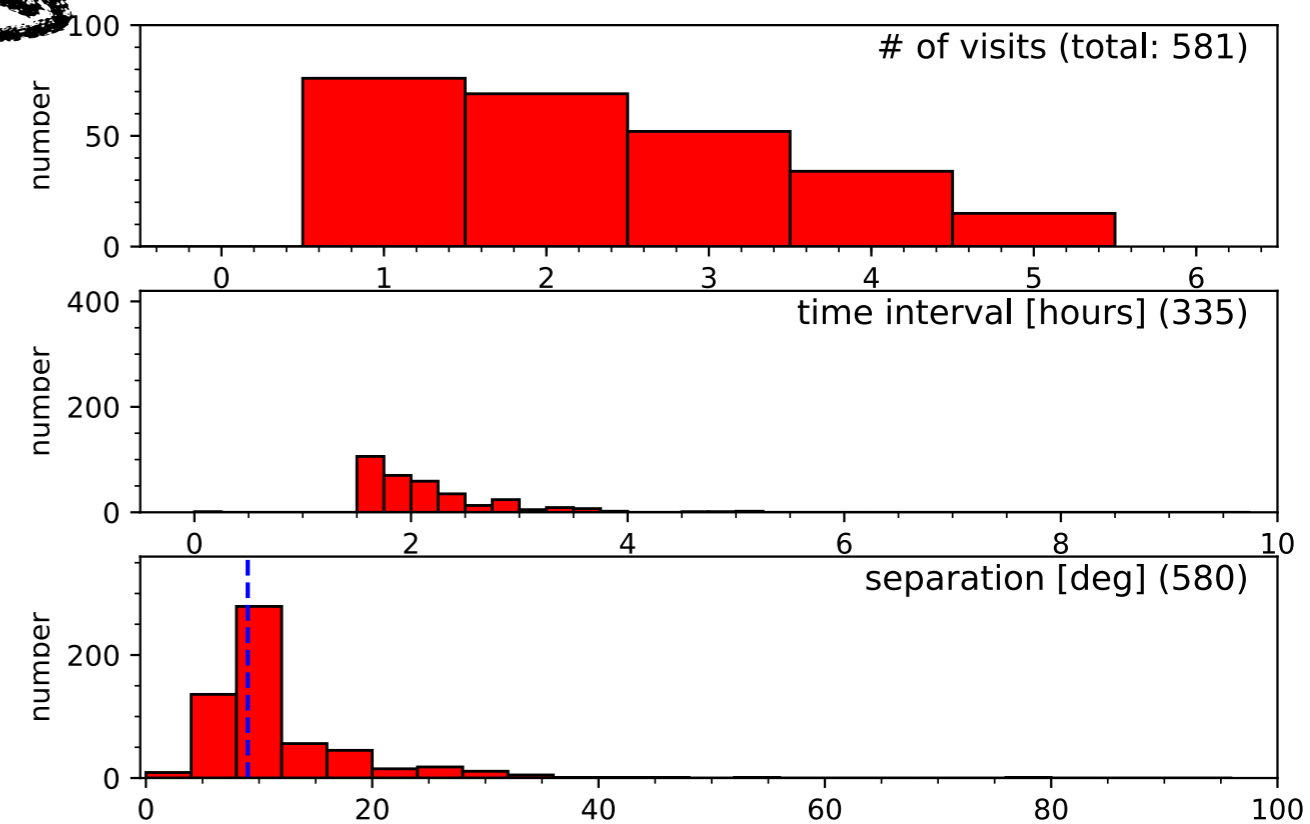
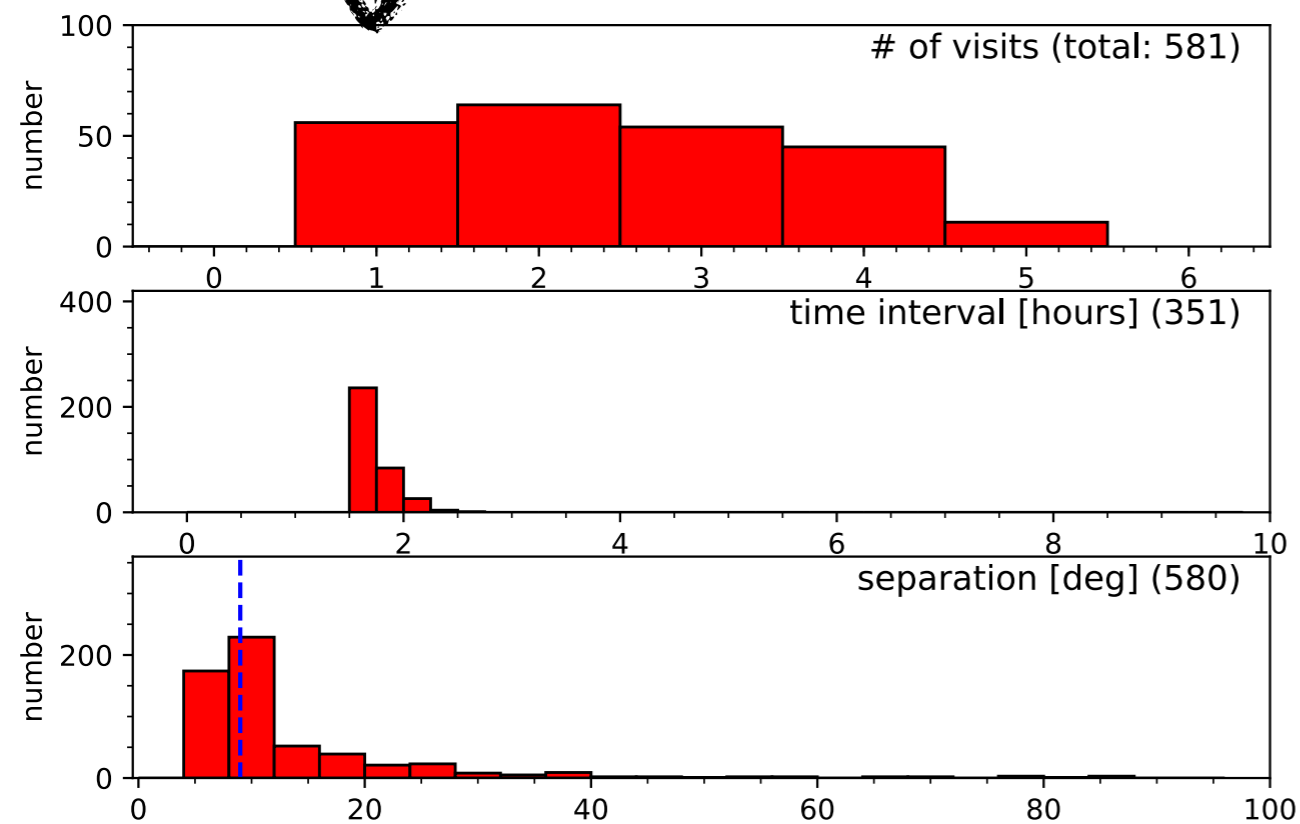
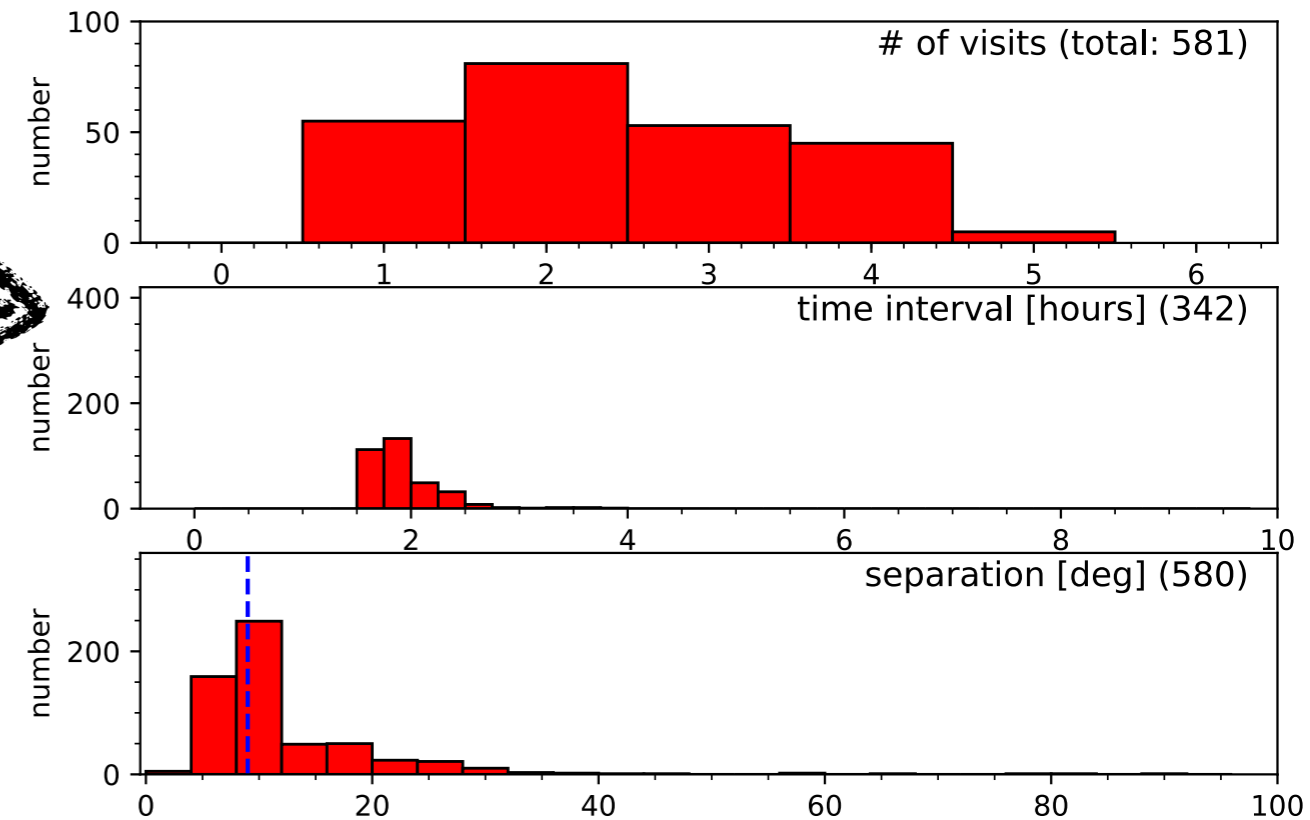


X: increase small-#-visit fields

Survey Simulation Comparison

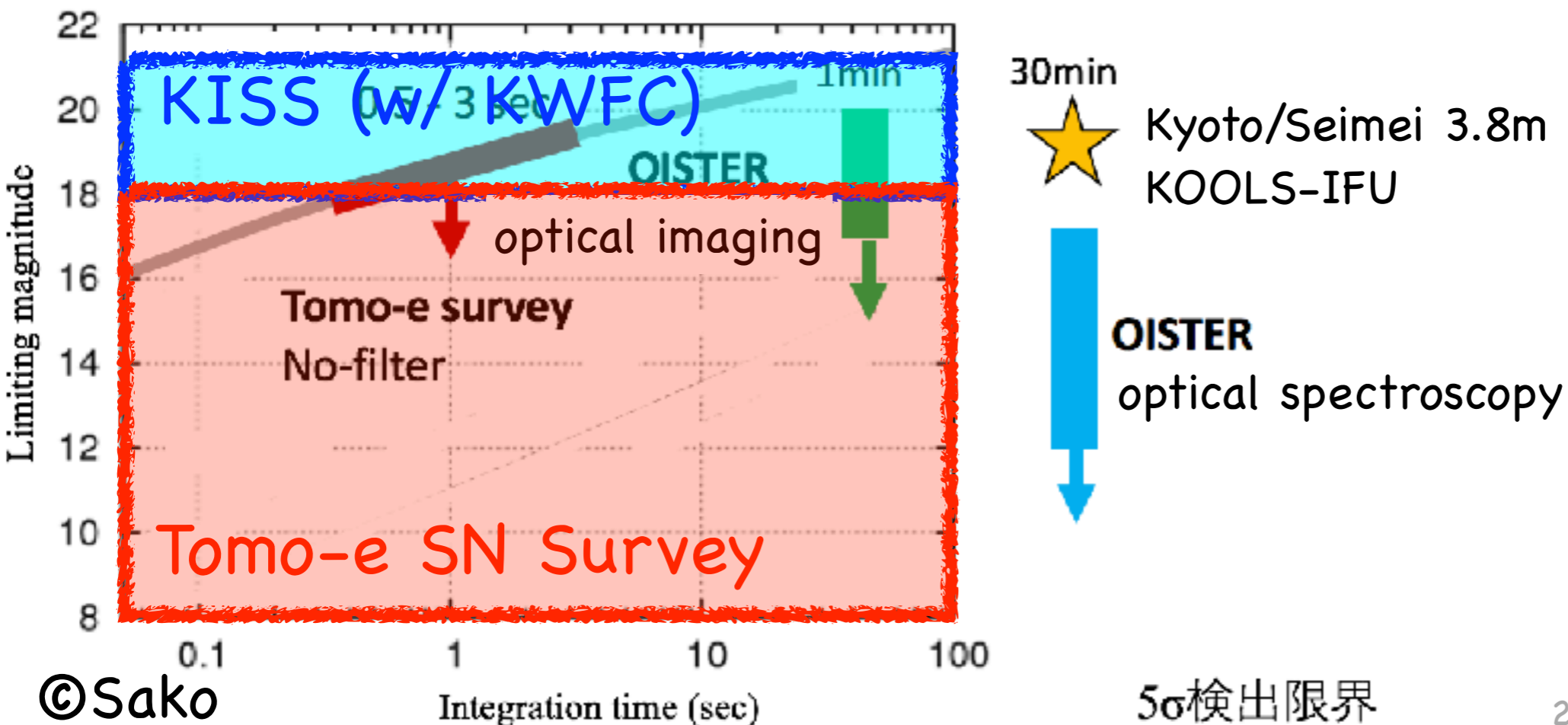
581 visits (~35,000 deg²)
for 10 hours

	ELmin	delta t min	Dec_min	Dec_max
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20180707d	50	90	-5	80
20180707e	35	90	-5	80
20180707f	30	90	-5	80



Follow-up Scheme

- After discovering SN candidates...
 - spectroscopic identification
 - multi-band light curves
- KISS: KISS international collaboration + OISTER
 - # of spectroscopic observations (29 spec-ID+) limited: too faint
 - TM+2014, Tanaka+2014, TM+2017, Gabanyi+2018, Kokubo+ in prep.
- Tomo-e survey: bright enough for OISTER domestic telescopes
 - SN: discovery ==> follow-up within the same night



Summary

- ❑ Northern Sky Transient Survey is being planned and started soon (from this fall).
- ❑ 2x2 dithering, 7,000 deg / 2 hours, 18 mag depth
- ❑ 2-4 visits / night
- ❑ Do these survey parameter match your sciences?
 - ❑ If yes, suggest any (minor) changes or special options to realize your science cases.
- ❑ (domestic) Quick follow-up observations
- ❑ Test observations were done based on previous (worse) simulation.
- ❑ Image subtraction, data management (DB etc.), quick (and low false-positive) discovery machine development works are being done.
- ❑ plan to consider weather conditions (avoid cloudy region and choose clear sky region)
- ❑ need to name the survey (after Tomo-e?)