The Zwicky Transient Facility
Bright Transient Survey

C. Fremling, Y. Sharma, A. Dugas, S. Kulkarni + students (Caltech)
N. Blagorodnova, R. Walters, J. D. Neill (P60 SEDM team)
J. Sollerman, A. Goobar (OKC), D. Perley, K. Taggart (LJMU), M. Graham (UW), A. Miller (Northwestern)

The Zwicky Transient Facility
Bright Transient Survey

P48

SEDM

P200

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The ZTF Bright Transient Survey (BTS)

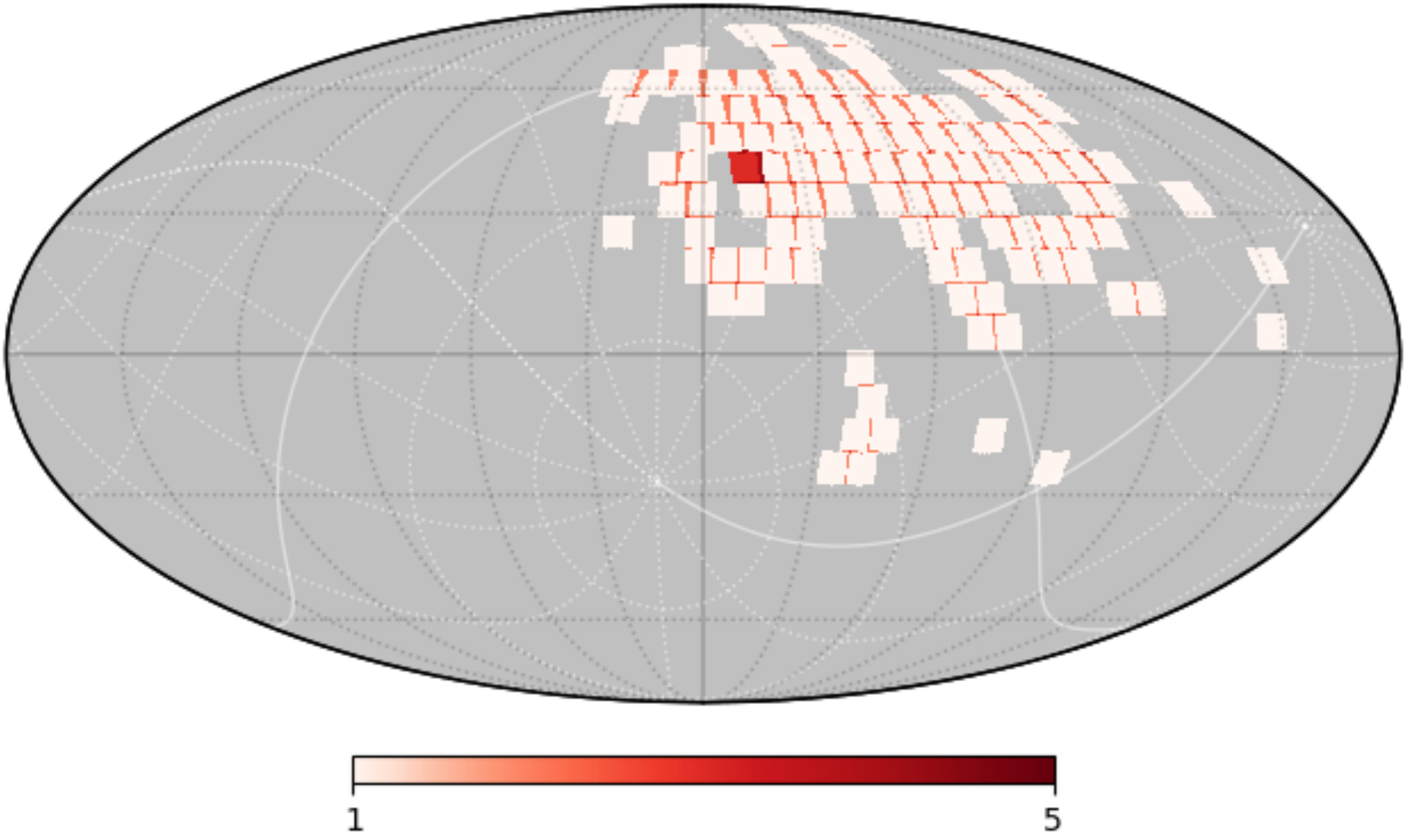
Magnitude limited survey, complete to 18.5 mag.

Data from the public ZTF Northern Sky Survey

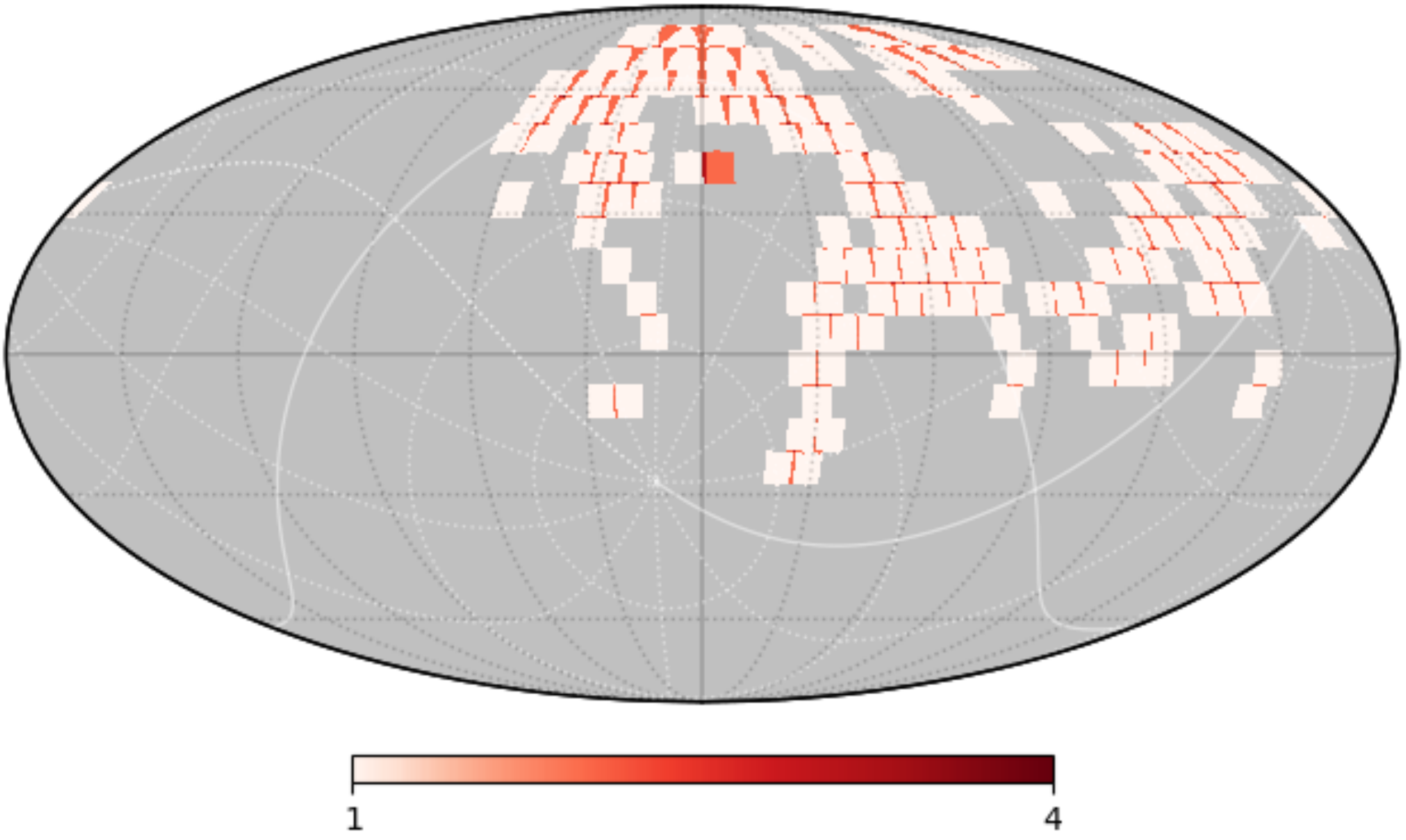
("Celestial Cinematography"; Bellm & Kulkarni, 2017, Nature Astronomy 1, 71)

3 day cadence, Northern Sky in g & r filters

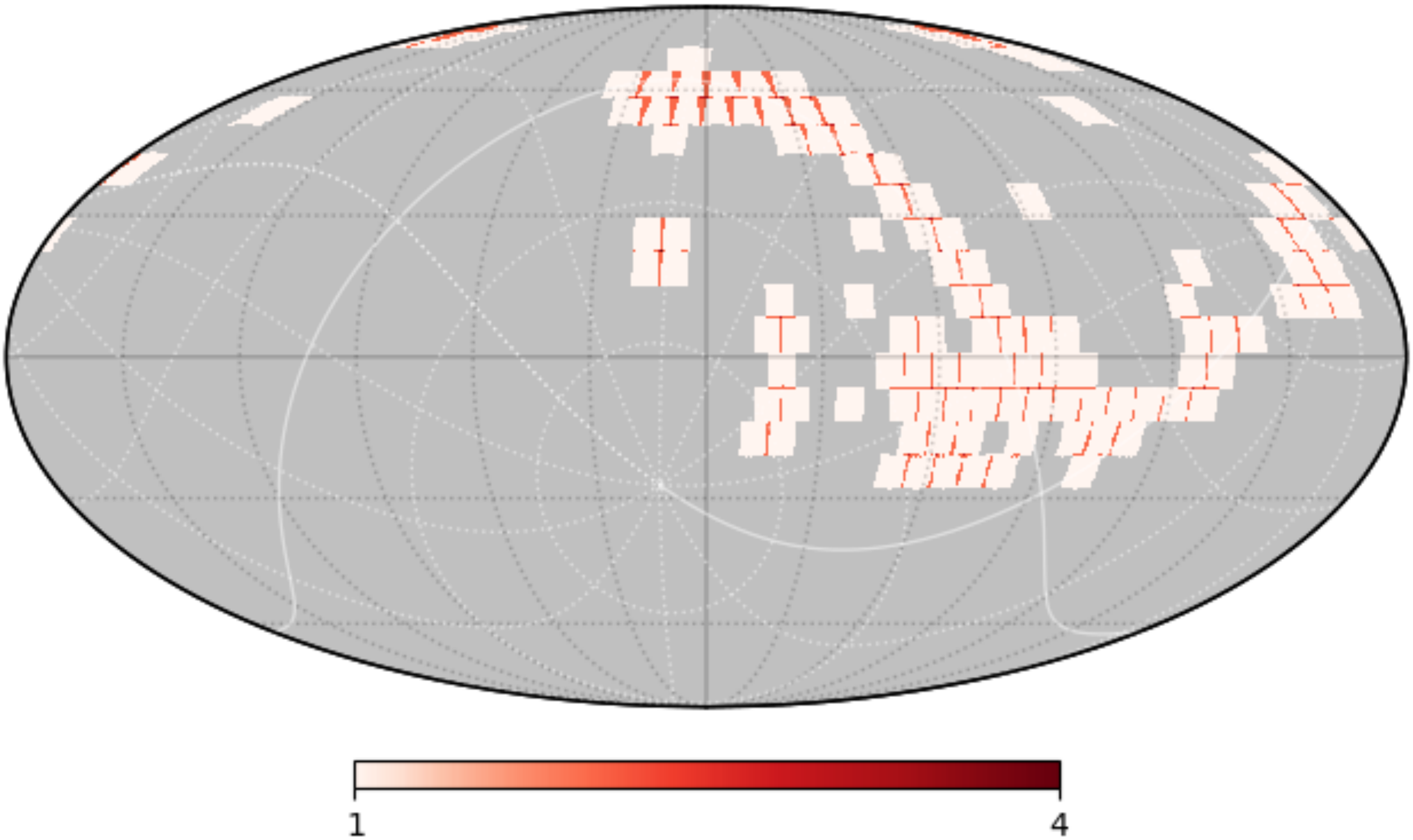
ZTF : R : Equatorial : Public Survey : 2018-07-03



ZTF : R : Equatorial : Public Survey : 2018-07-04



ZTF : R : Equatorial : Public Survey : 2018-07-05



1

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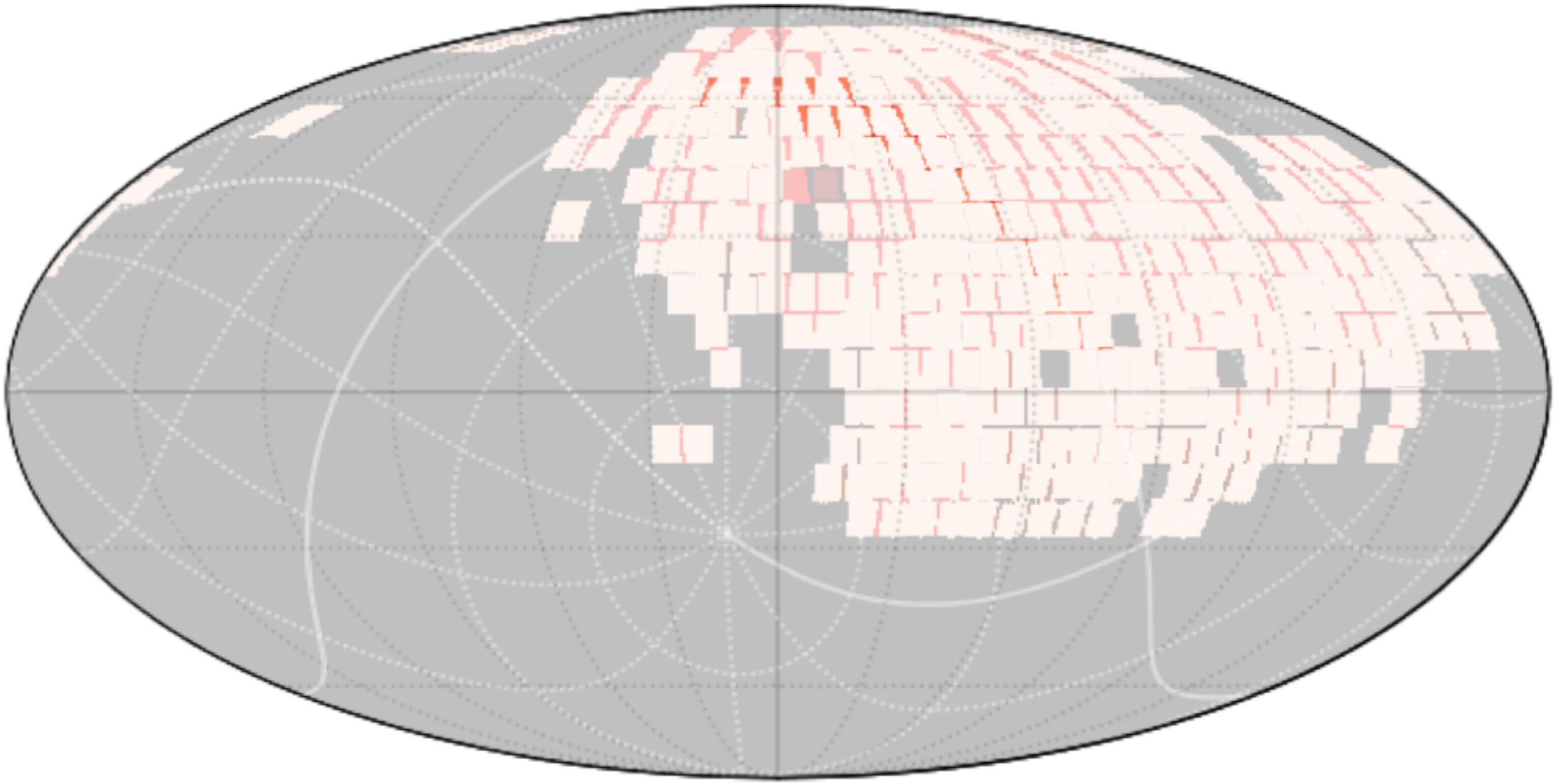
ZTF : R : Equatorial : Public Survey : 2018-07- **3-5**



1

The ZTF Bright Transient Survey (BTS)

The public ZTF Northern Sky Survey
~200 000 alerts per night

https://ztf.uw.edu/alerts/public/

MARS
Make Alerts Really Simple

Lasair
Antares

The ZTF Bright Transient Survey (BTS)

BTS

Magnitude limited survey, complete to 18.5 mag.

1. Send all SN candidates < 19 mag to the Transient Name Server

2. Classify subset (<18.5 mag) using Palomar 60 inch with SEDM

The ZTF Bright Transient Survey (BTS)

BTS candidate filter

(1) Transient candidate brightness < 19 mag.

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(2) Transient candidate > 20 arcsec from bright stars (r < 15 mag).

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(3) Minimum of two detections separated by > 30 minutes.

The ZTF Bright Transient Survey (BTS)

BTS candidate filter

(1) Transient candidate brightness < 19 mag.
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(3) Minimum of two detections separated by > 30 minutes.
(4) No star-like source spatially coincident with the transient
(we employ a machine-learning star-galaxy separator, based on PS1 data; cf. Miller et al. 2017, AJ, 73).

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(we employ a machine-learning star-galaxy separator, based on PS1 data; cf. Miller et al. 2017, AJ, 153, 73).
(5) Galactic latitude cut of 7 degrees.
(6) Final human vetting to filter out clearly bogus alerts and stel alerts
(might not be needed as real-bogus system of ZTF improves)

The ZTF Bright Transient Survey (BTS)

BTS candidate filter

Candidates that pass our filter, and human vetting, are automatically sent to the Transient Name Server (TNS) once daily.

Official start, 2018 June 2

ATel #11688

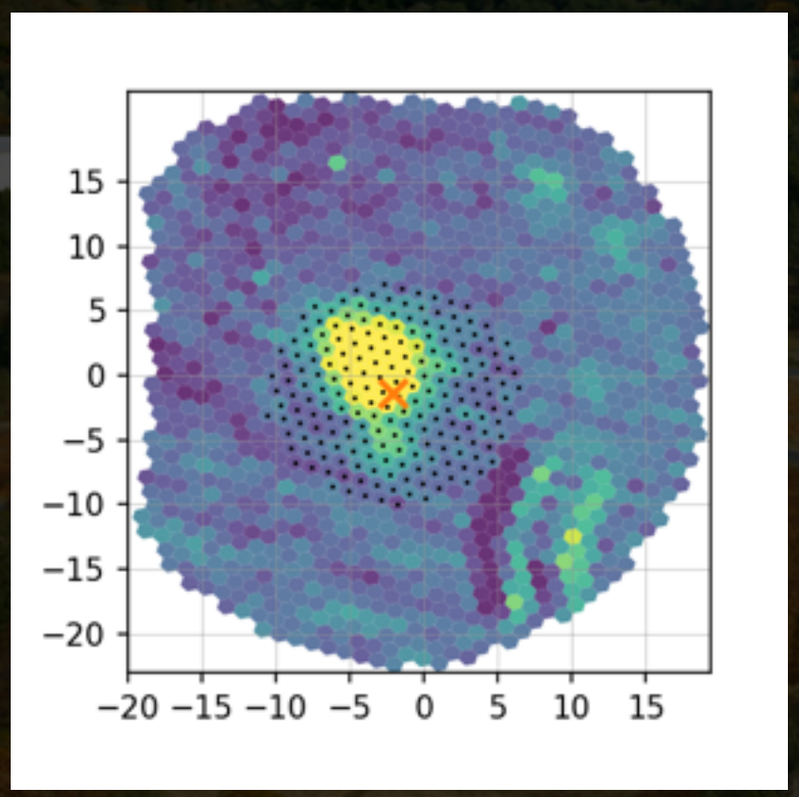
The ZTF Bright Transient Survey (BTS)

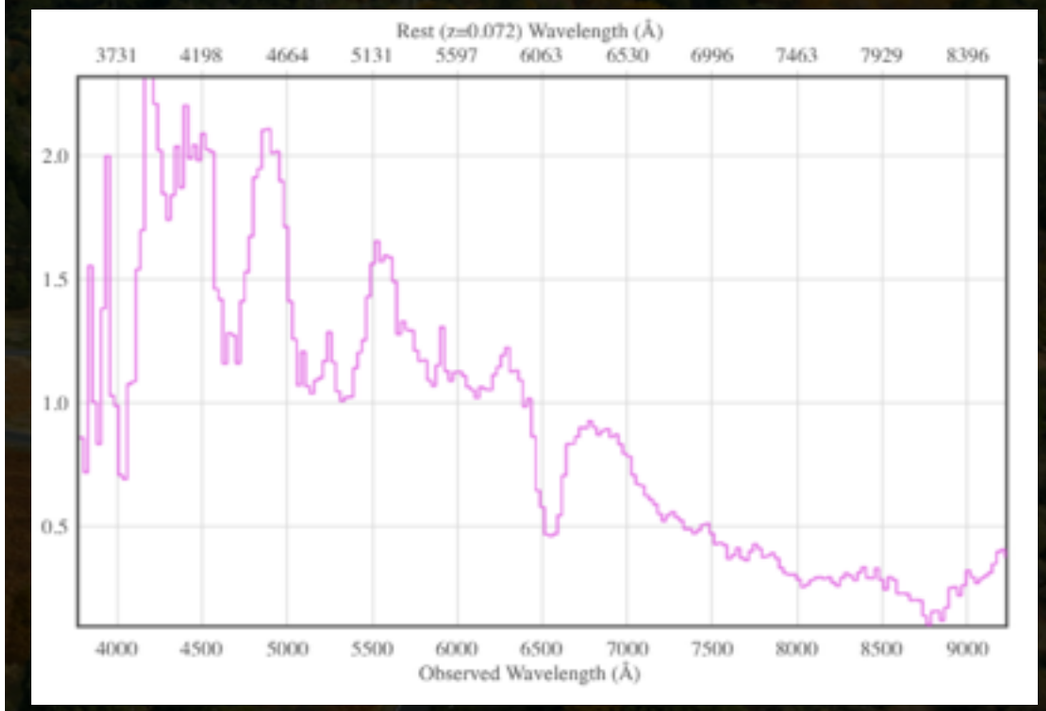
SEDM classifications

Goal is spectroscopically classify all transients brighter than 18.5 mag, using SEDM. Currently we trigger at ~19 mag.

The ZTF Bright Transient Survey (BTS)

SEDM classifications



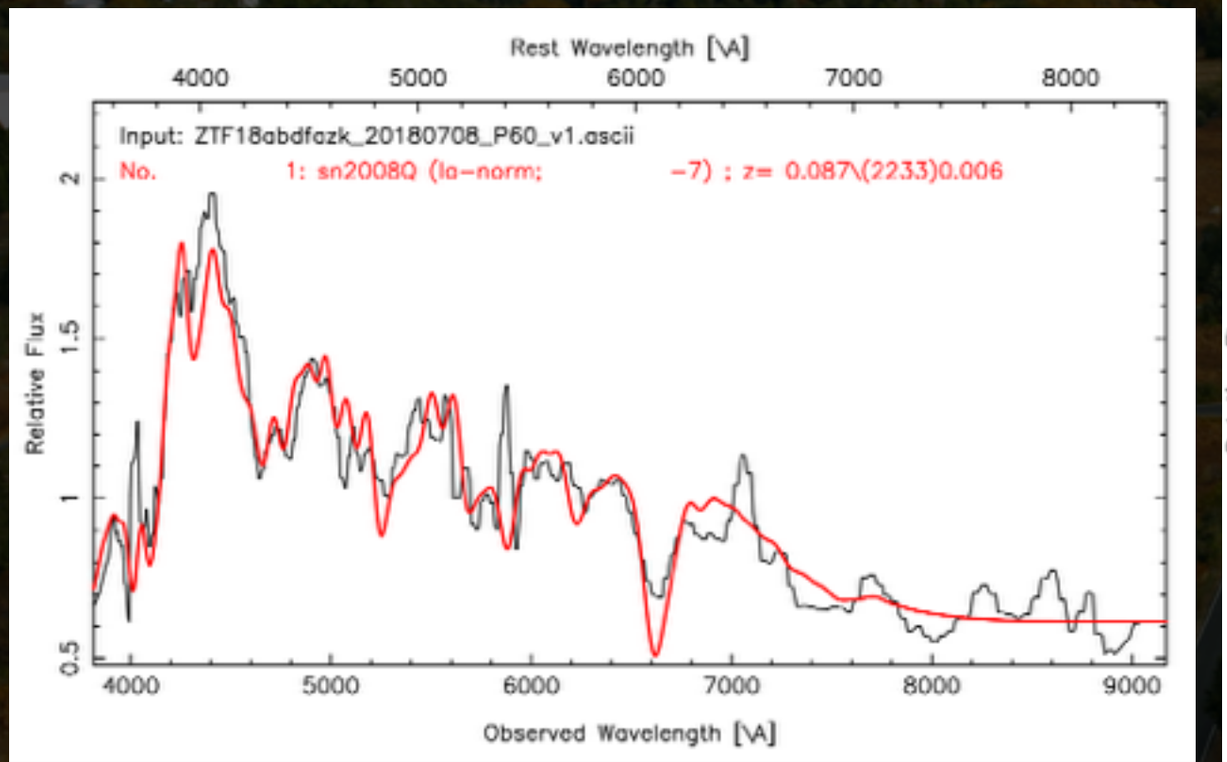


SEDM, 18.5 mag
25 min exp

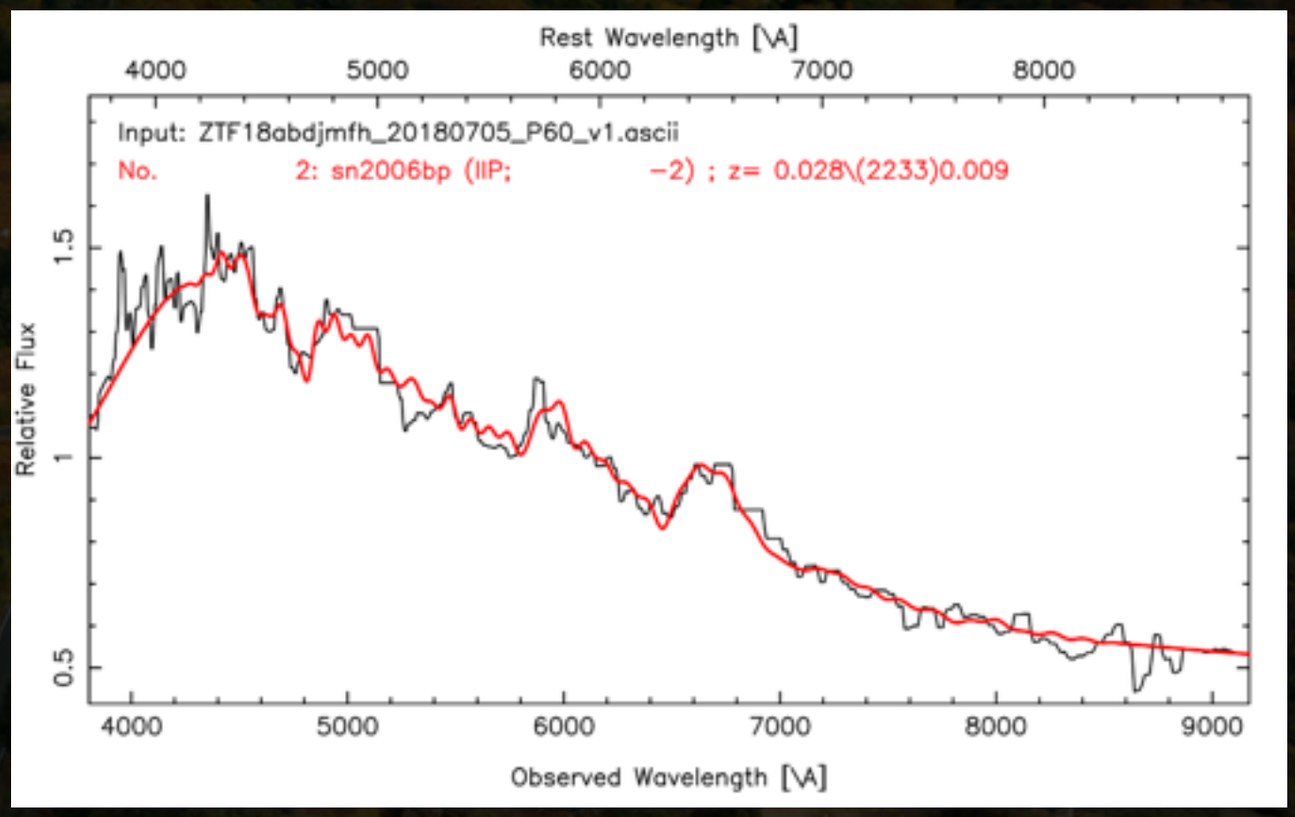
The ZTF Bright Transient Survey (BTS)

SEDM classifications

Based on SNID



SN Ia



SN II

The ZTF Bright Transient Survey (BTS)

BTS classifications

Daily, publish successful classifications to TNS

Weekly, publish successful classifications as ATels
(see e.g. ATels 11829, 11830)

The ZTF Bright Transient Survey (BTS)

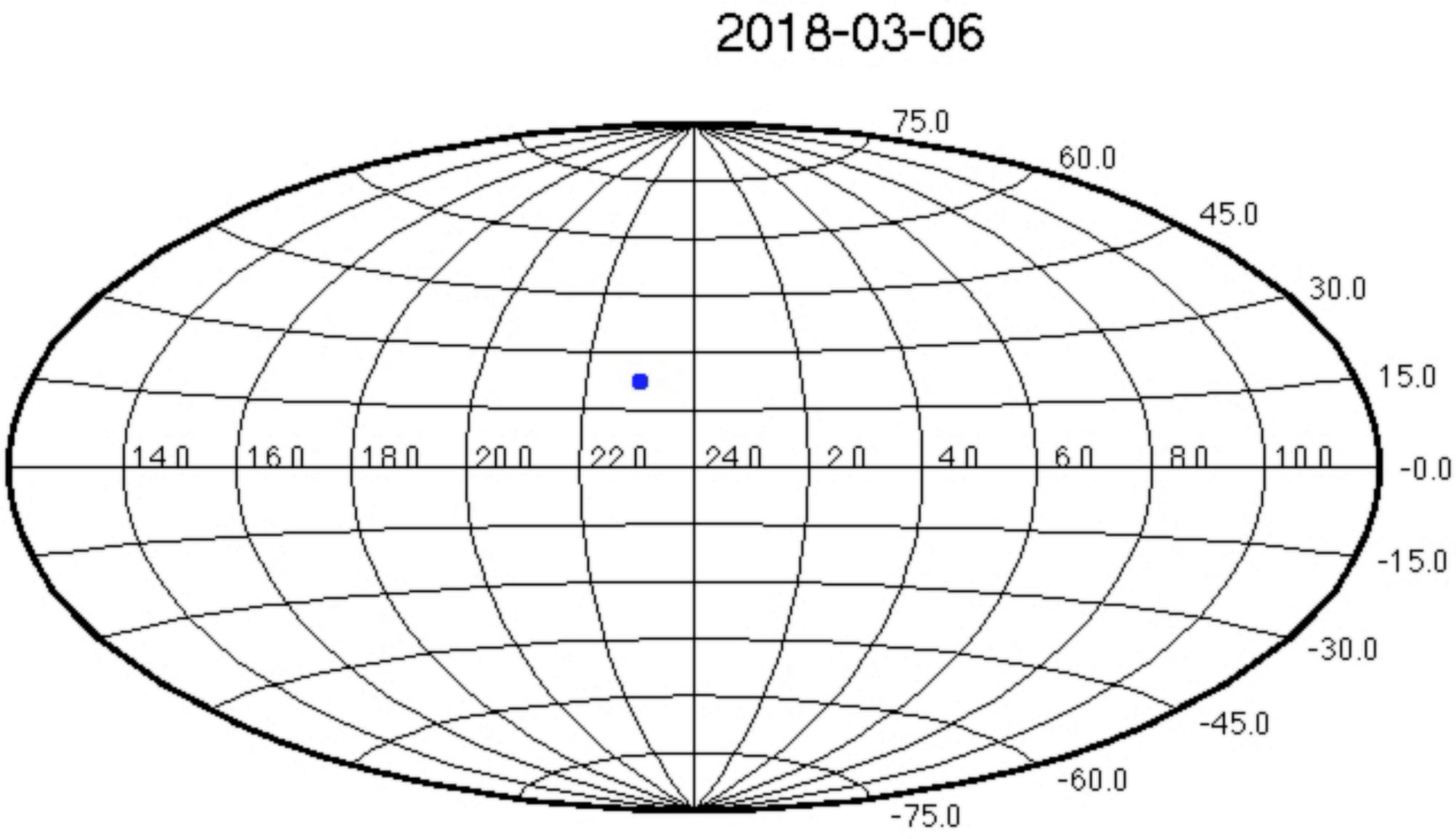
BTS

Magnitude limited survey, complete to 18.5 mag.

1. Send all SN candidates < 19 mag to the Transient Name Server

2. Classify subset (<18.5 mag) using Palomar 60 inch with SEDM

The ZTF Bright Transient Survey (BTS)



The ZTF Bright Transient Survey (BTS)

BTS preliminary results

In total, as of 31 Dec 2018, we have classified:

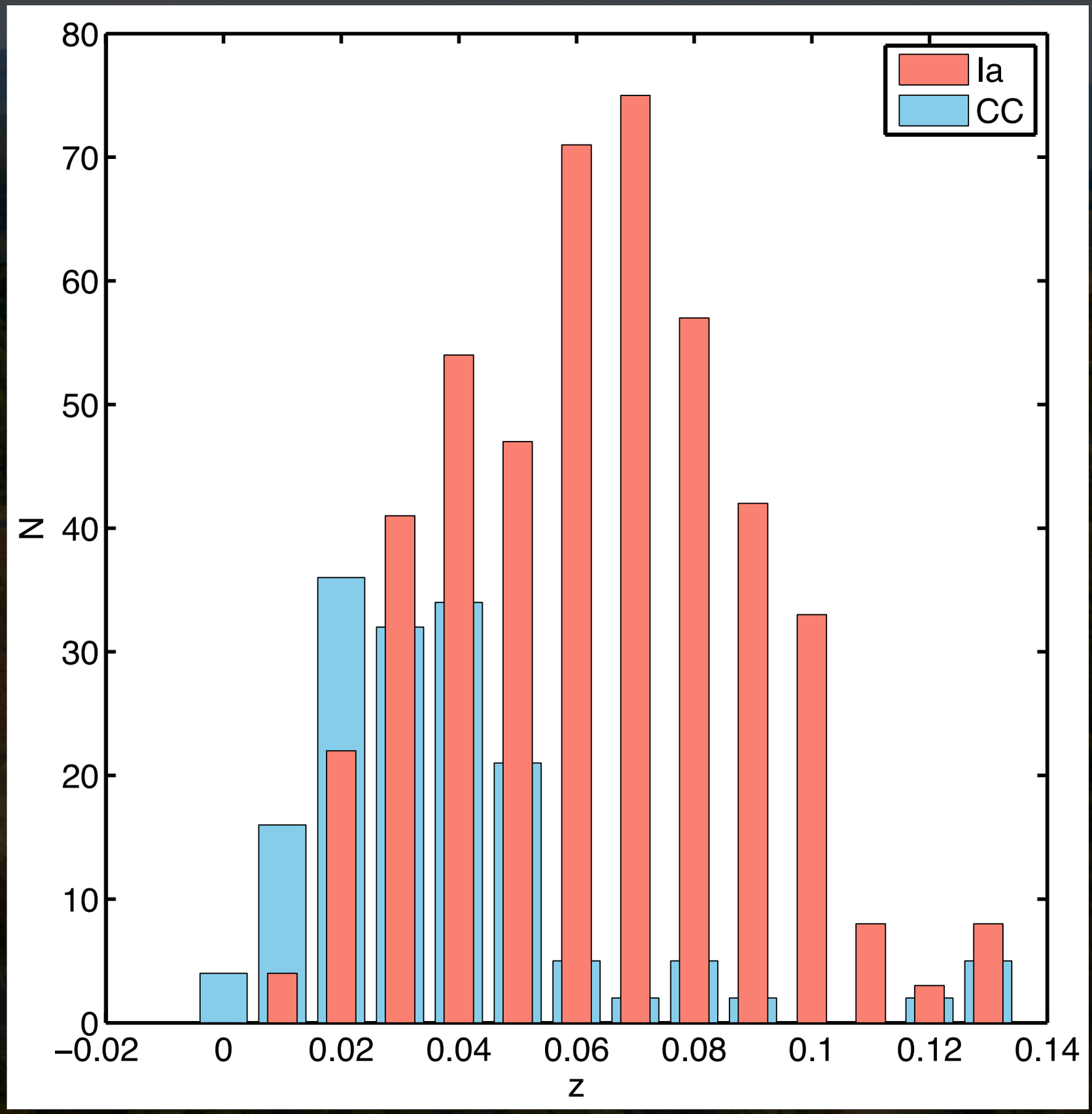
539 SNe Ia

217 CC SNe

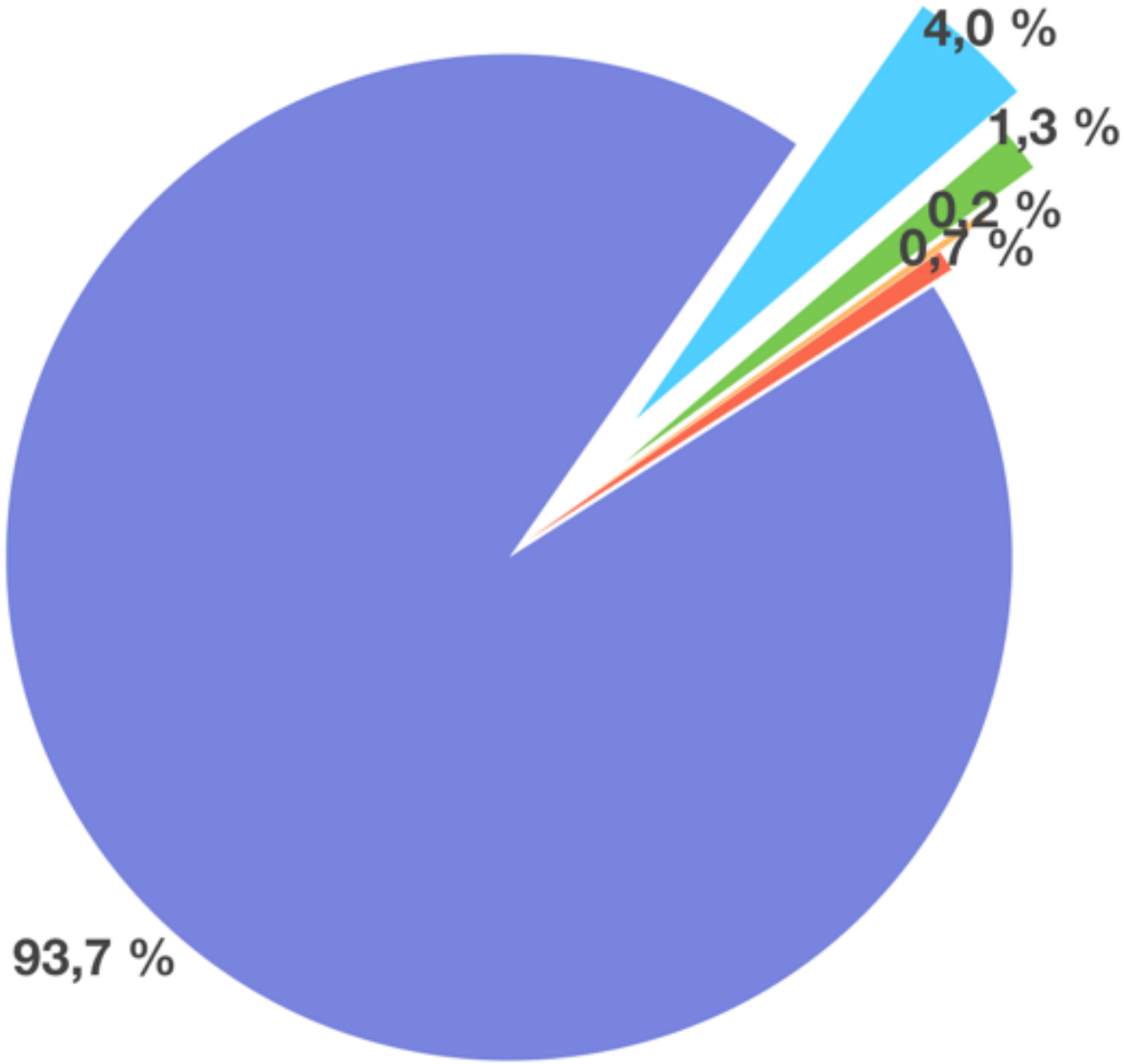
Total in ~7 months:

756 SNe

The ZTF Bright Transient Survey (BTS)



The ZTF Bright Transient Survey (BTS)

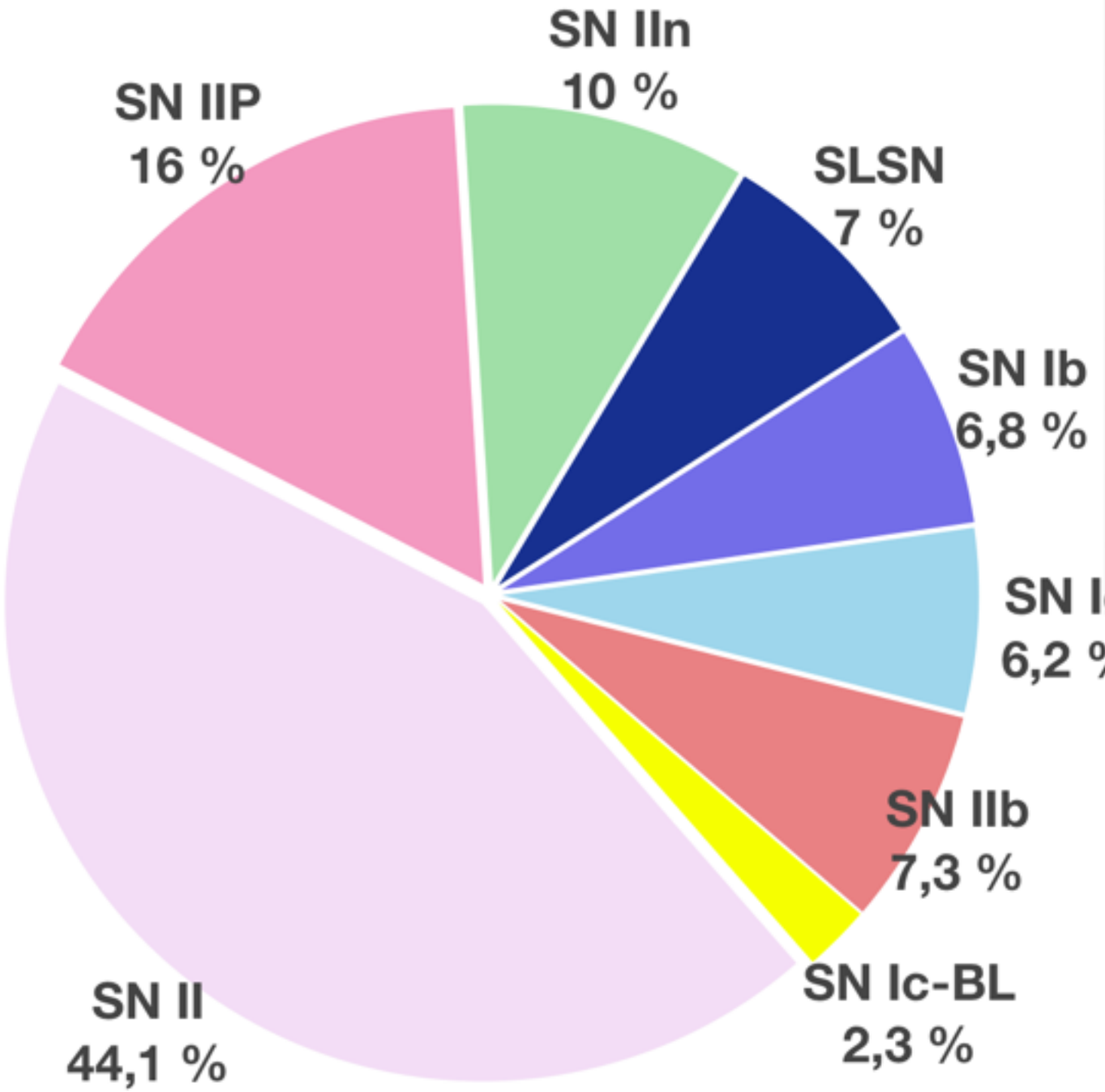


BTS Type Ia SNe (total: 445)

SUBTYPE	NUMBER
SN Ia-norm	417
SN Ia-91T	18
SN Ia-91bg	6
SN Ia-02cx	1
SN Ia-pec	3

Note: this is based on SNID matching only, no LC info used

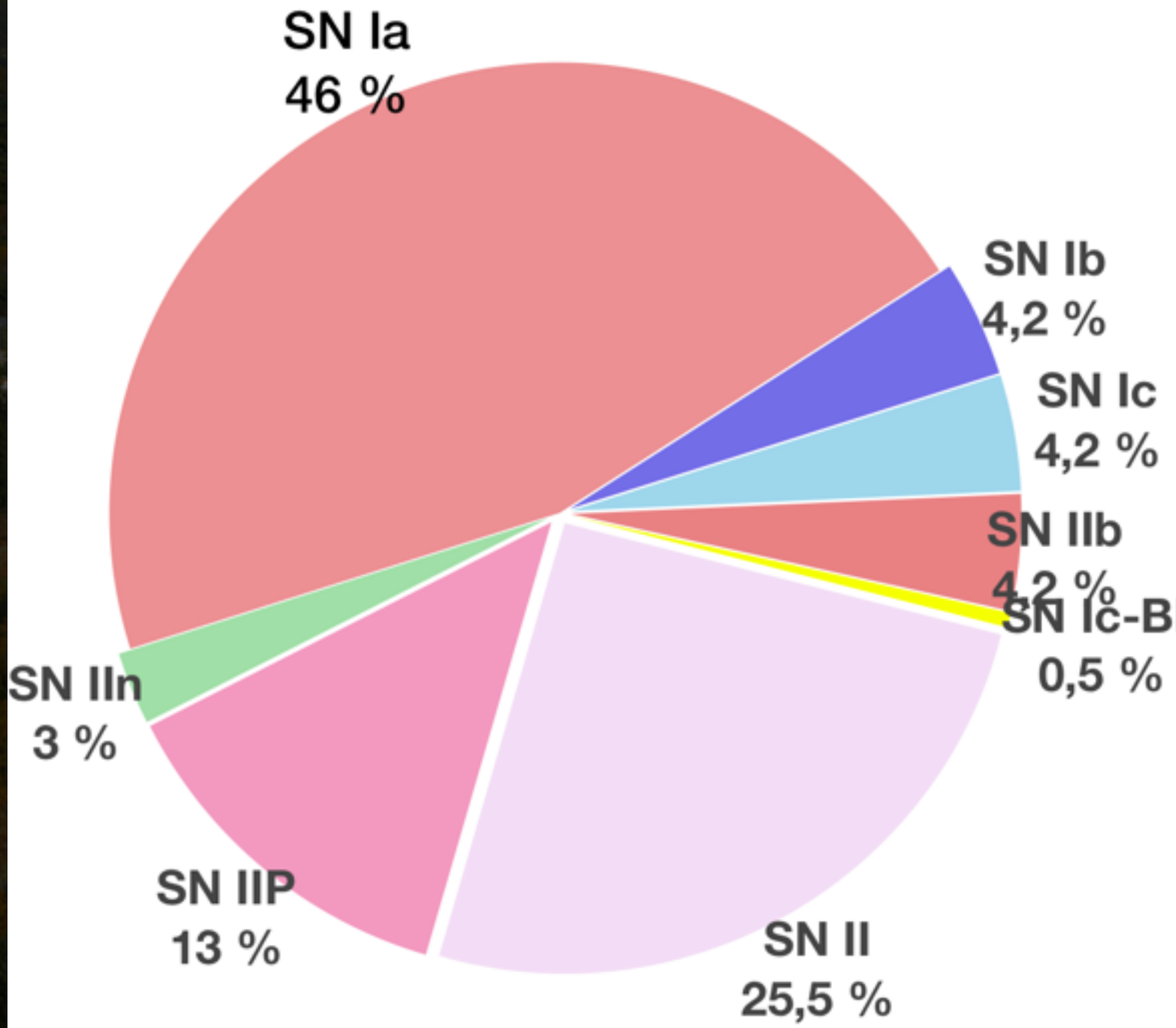
The ZTF Bright Transient Survey (BTS)



BTS CC SNe (total: 177)

SUBTYPE	NUMBER
SN Ib	12
SN Ic	11
SN IIb	13
SN Ic-BL	4
SN II	78
SN IIP	29
SN IIn	17
SLSN	**13**

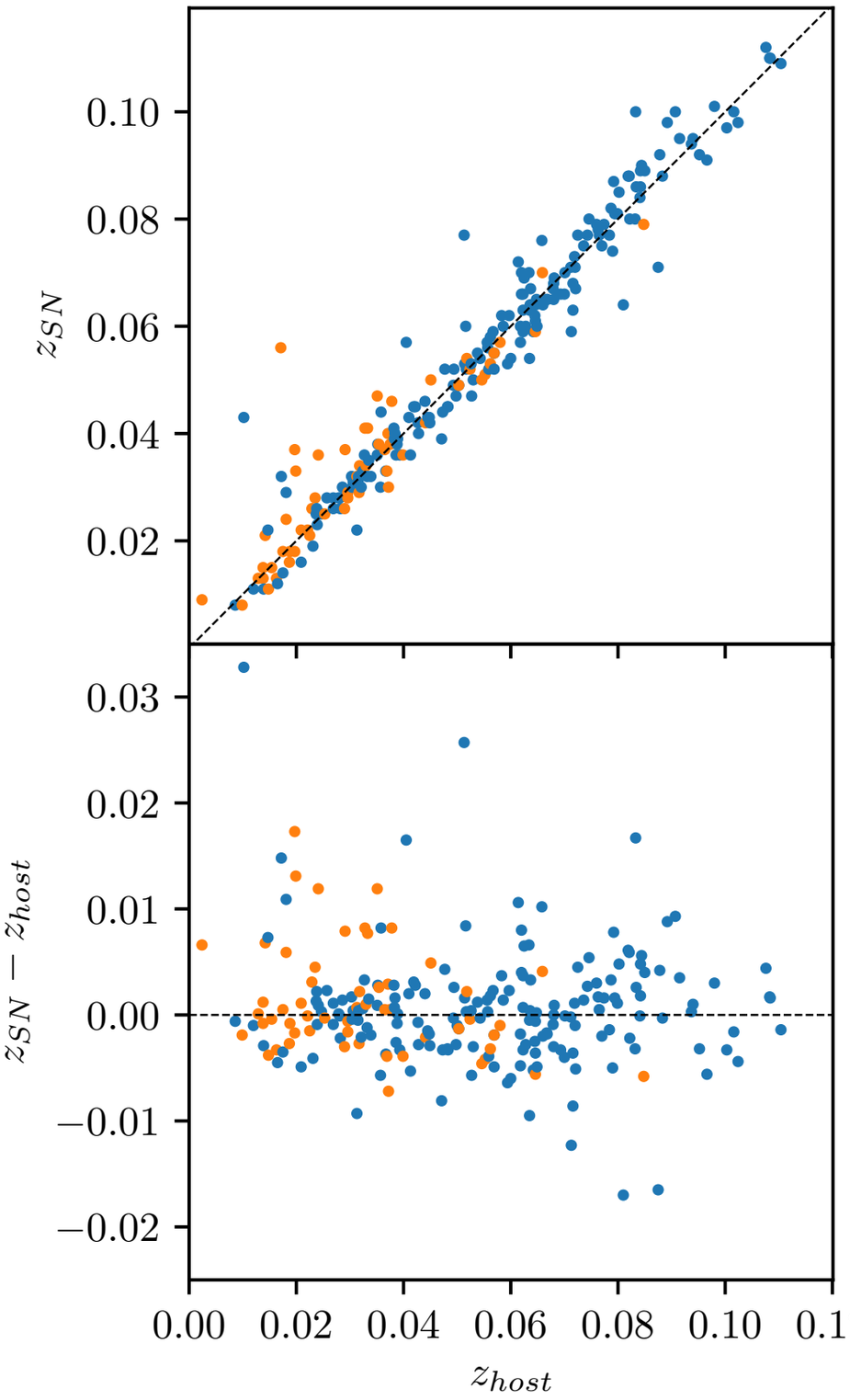
The ZTF Bright Transient Survey (BTS)

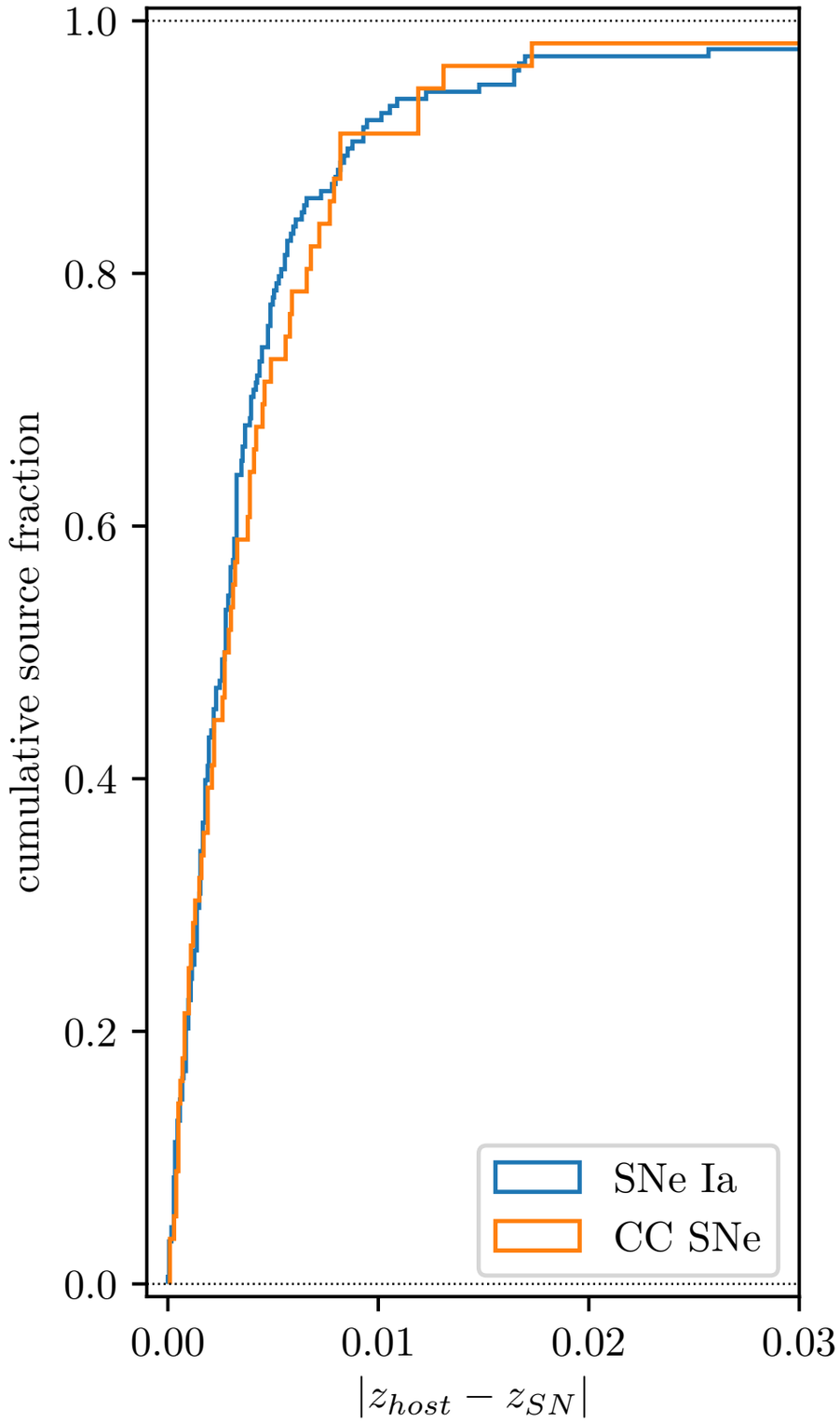


BTS SNe at z<0.04 (total: 192)

SUBTYPE	NUMBER
SN Ib	8
SN Ic	8
SN IIb	8
SN Ic-BL	1
SN II	49
SN IIP	25
SN IIn	5
SLSN	0
SN Ia	88

The ZTF Bright Transient Survey (BTS)





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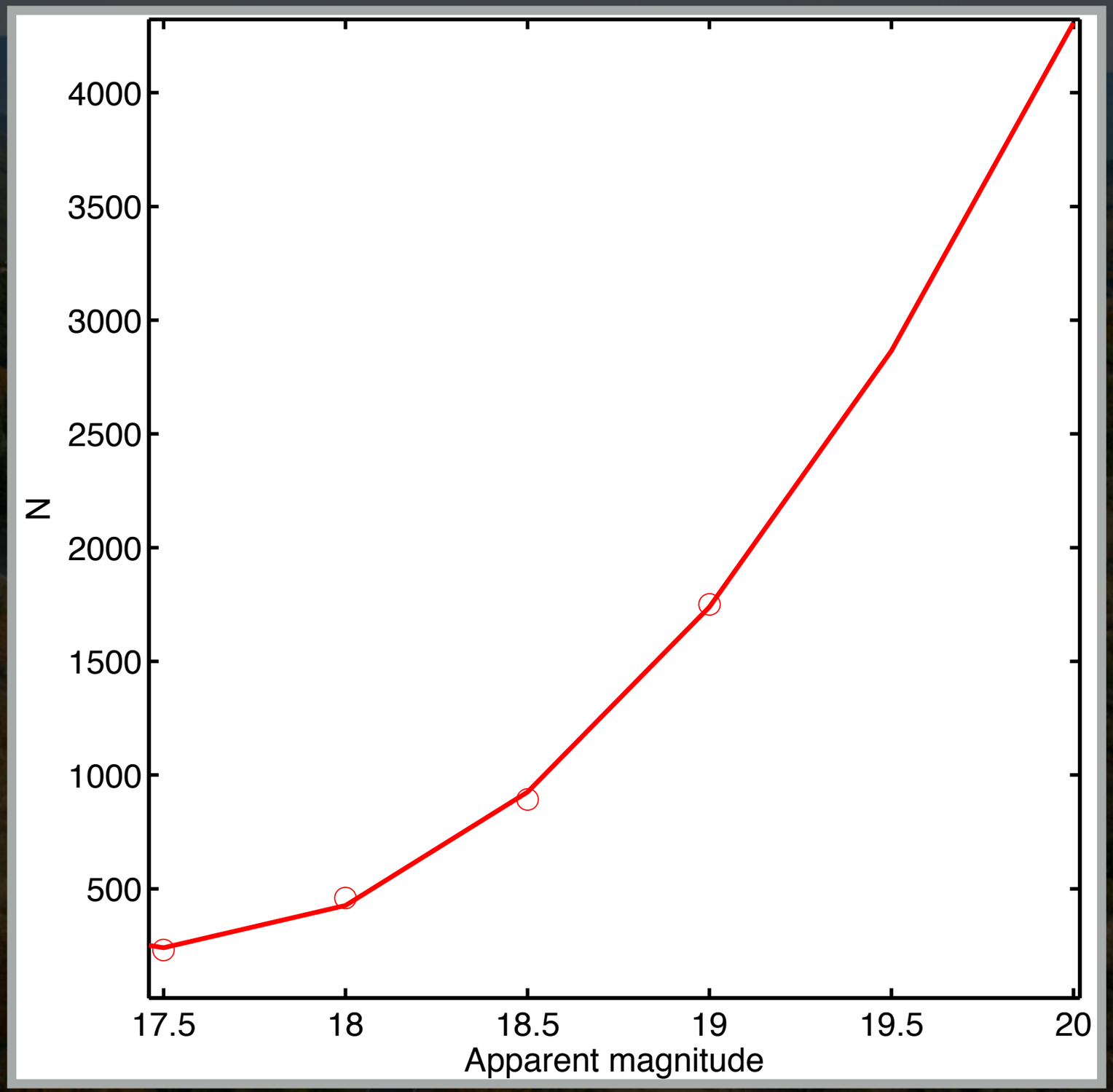


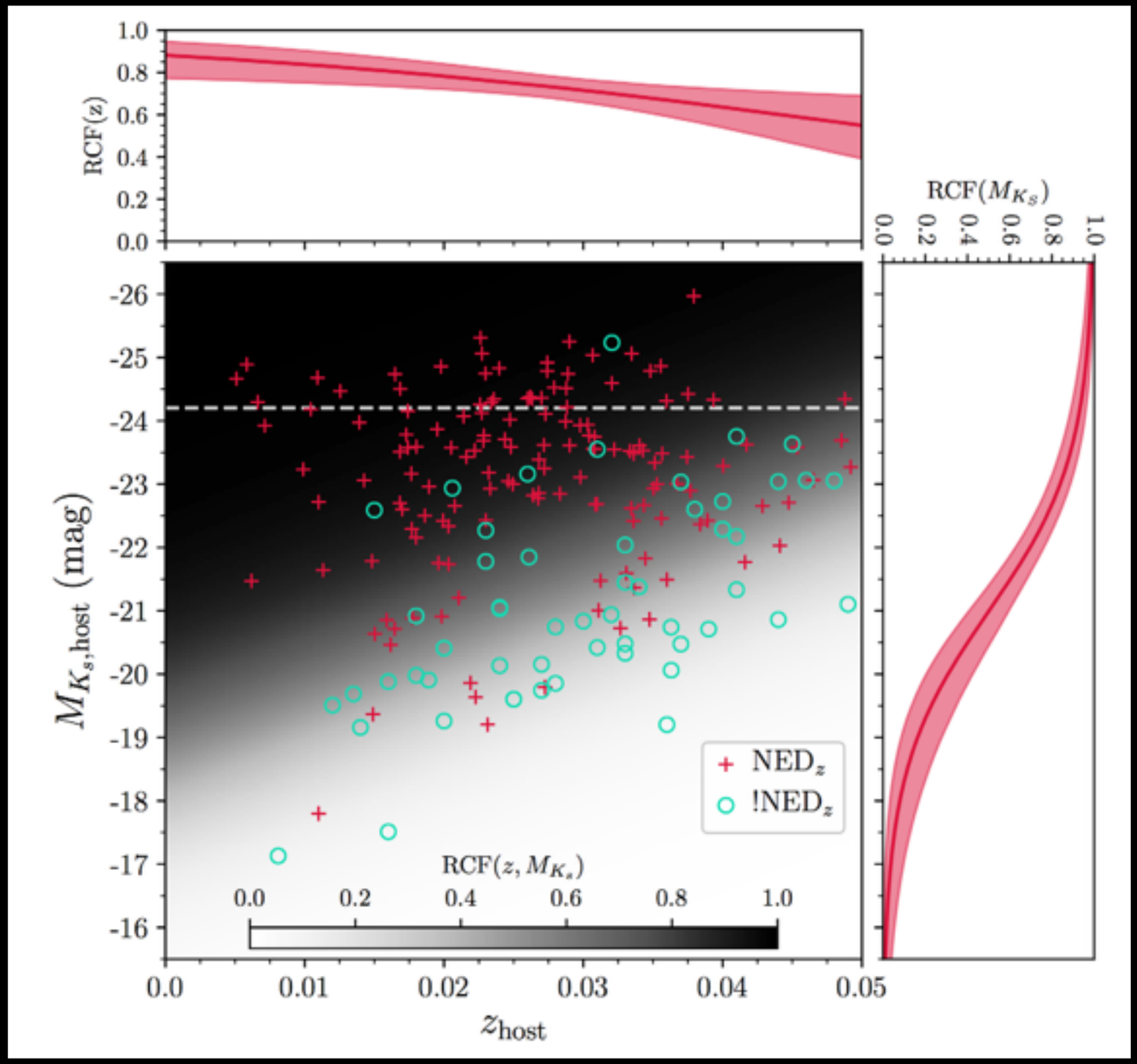
Total SNe from ZTF, simulation

Redshift Completeness of local galaxy catalogs

Preliminary results from ZTF BTS

$$\mathrm{RCF} = \frac{\text{SN hosting galaxies with known spectroscopic redshift}}{\text{Total number of SN hosting galaxies}}$$

Previous work based on ASAS-SN sample



Kulkarni et al., 2018

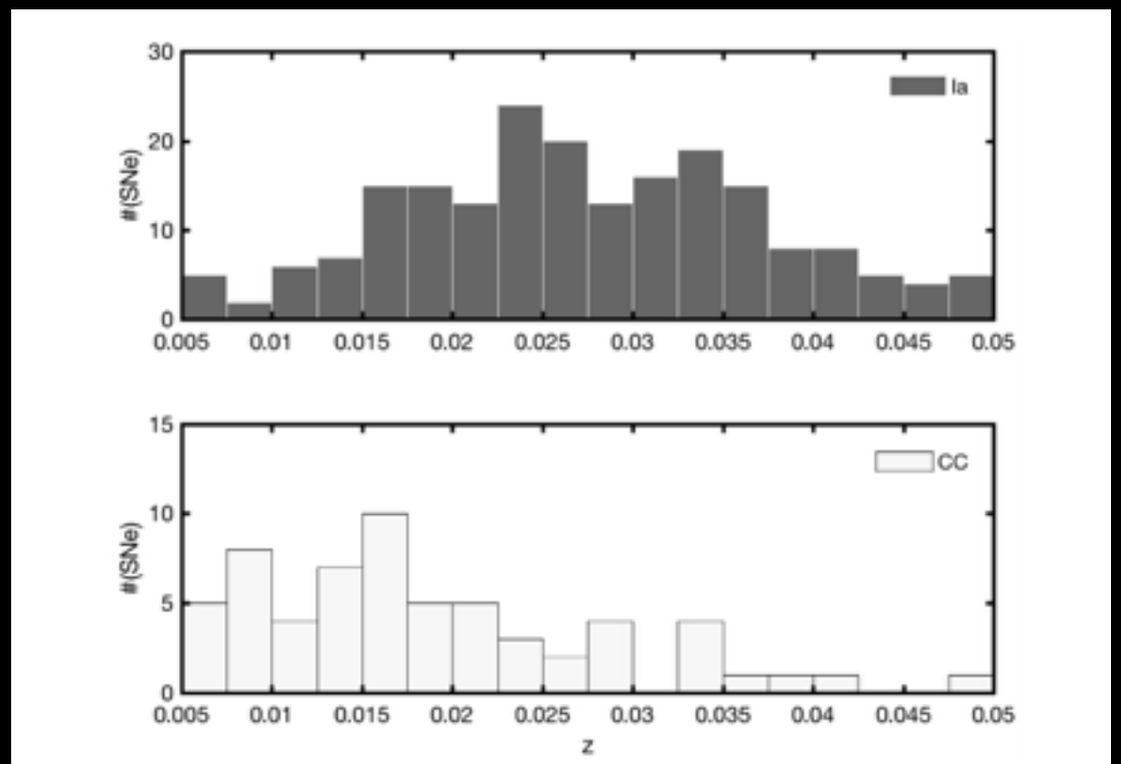
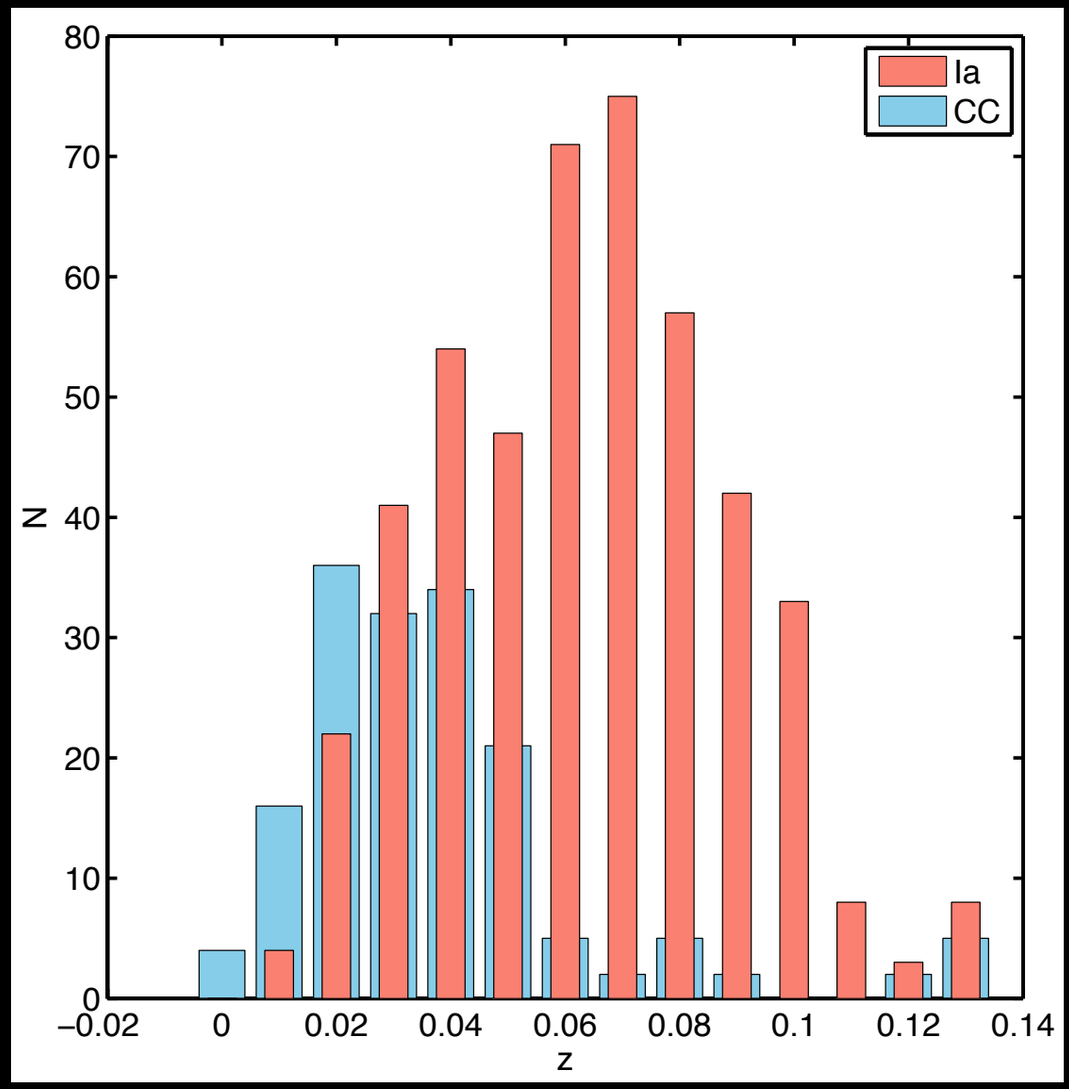
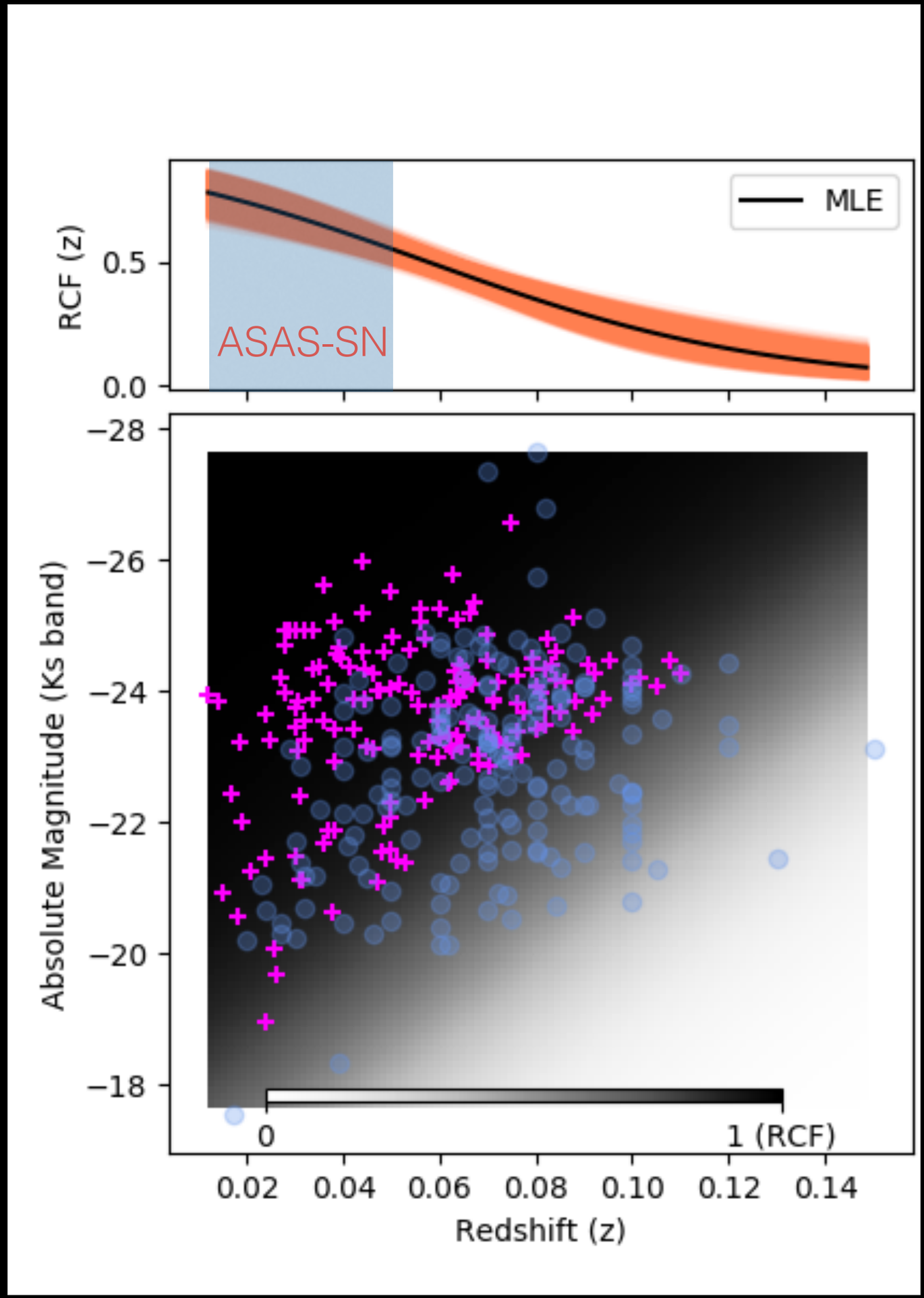


FIG. 1.— Histogram of $z \leq 0.05$ SNe of type Ia (*top*) and core-collapse (*bottom*) from the *A1* and *A2* catalogs.

ASAS-SN



ZTF BTS 6 months



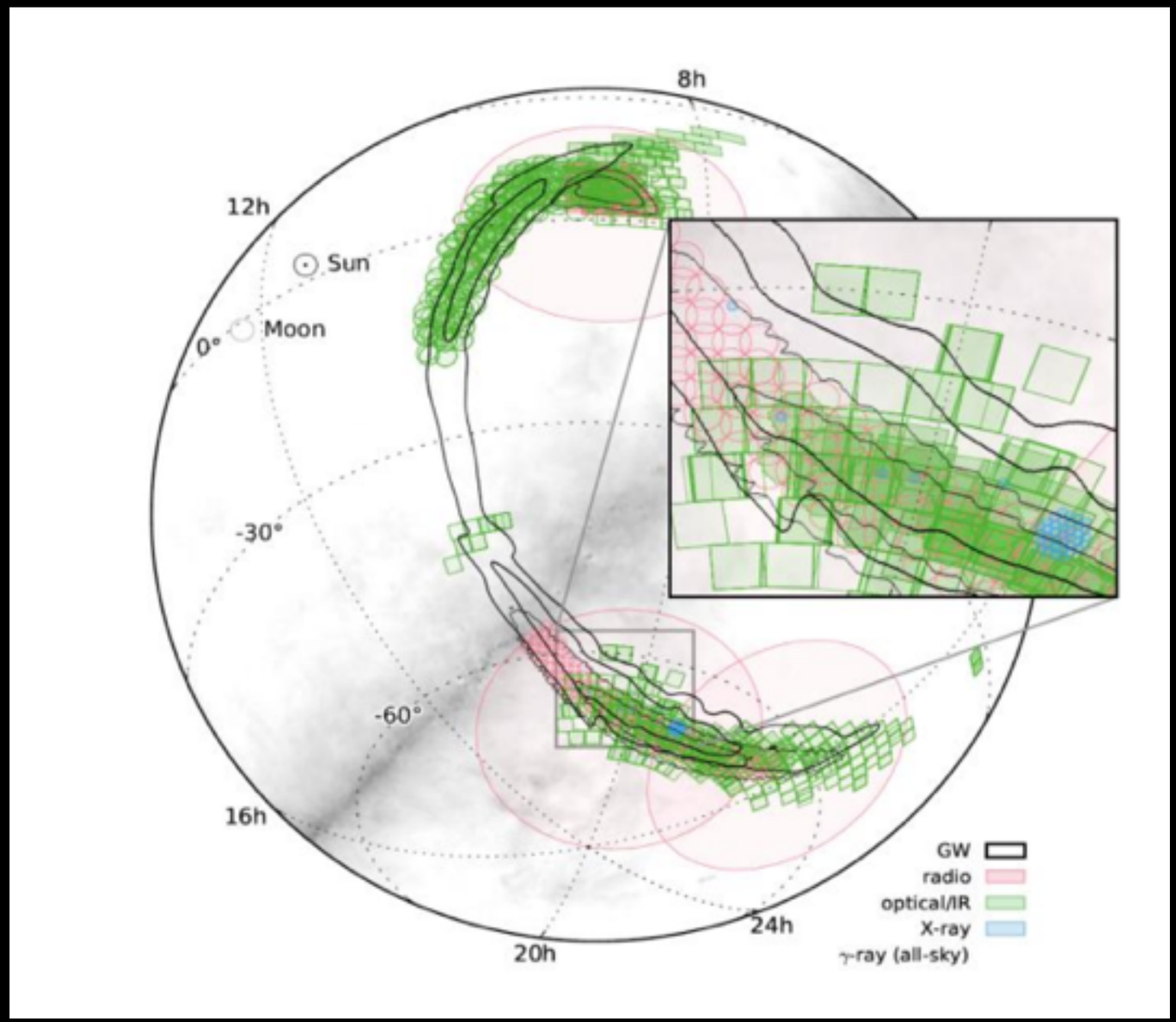
ZTF
preliminary
result

Project suggestions

- Use RCF information to inform GW followup
- Which galaxies currently lack redshifts?
- Correct Volumetric SN rates using RCF
- Compare RCF found with SNe to other methods

Related projects

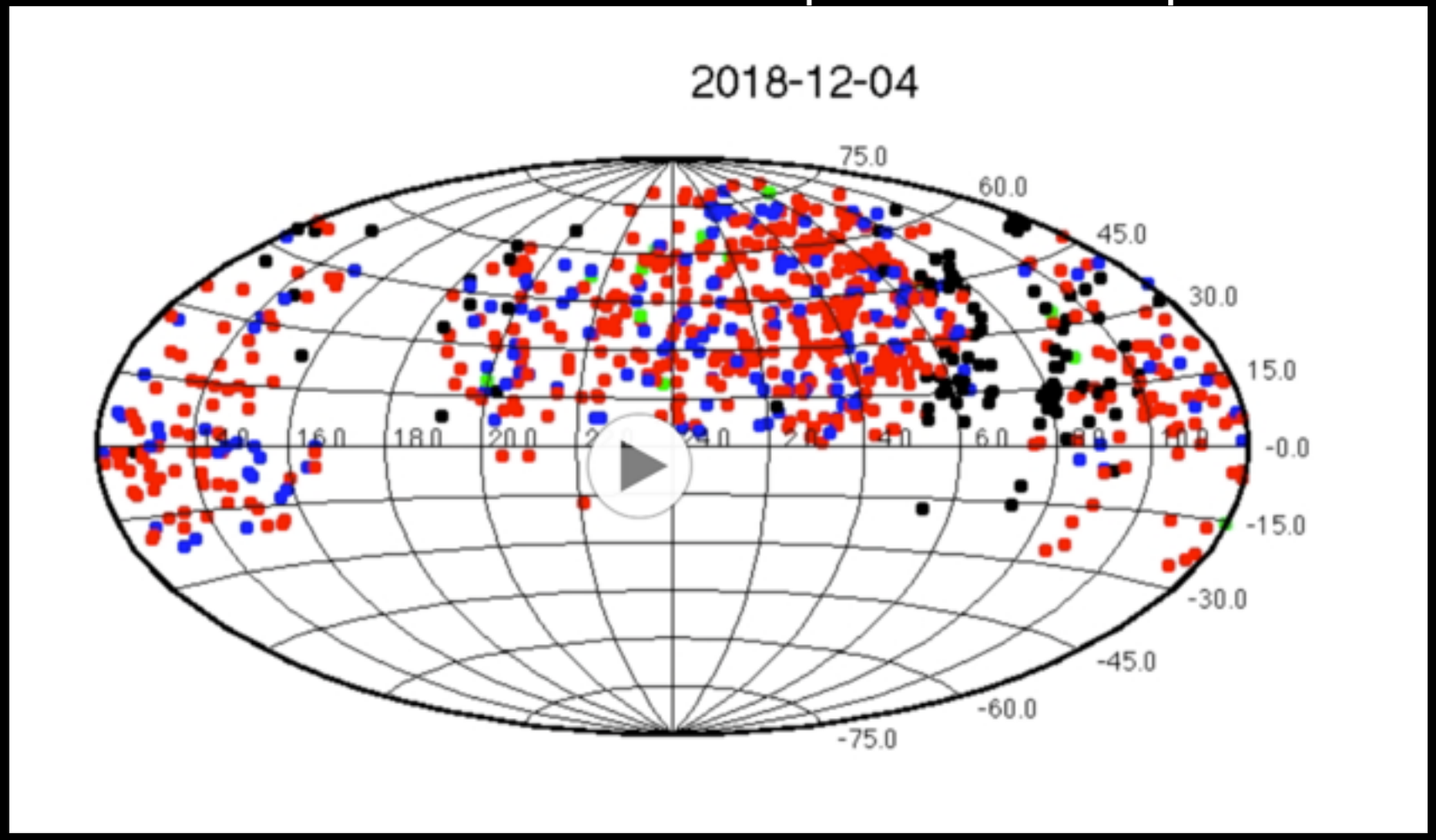
- Use BTS RCF information to inform GW followup



Abbott et al. (2016)

Related projects

- Which galaxies are missing redshifts, and where are they?
- We can inform future spectroscopic efforts



The one-year ZTF/BTS survey will result in a sample of 1000-1500 SNe Ia. With this sample, a regional/directional RCF can be evaluated (e.g., high and intermediate Galactic latitude regions, see Fig. 2). This could inform e.g., DESI, PSF.

Related projects

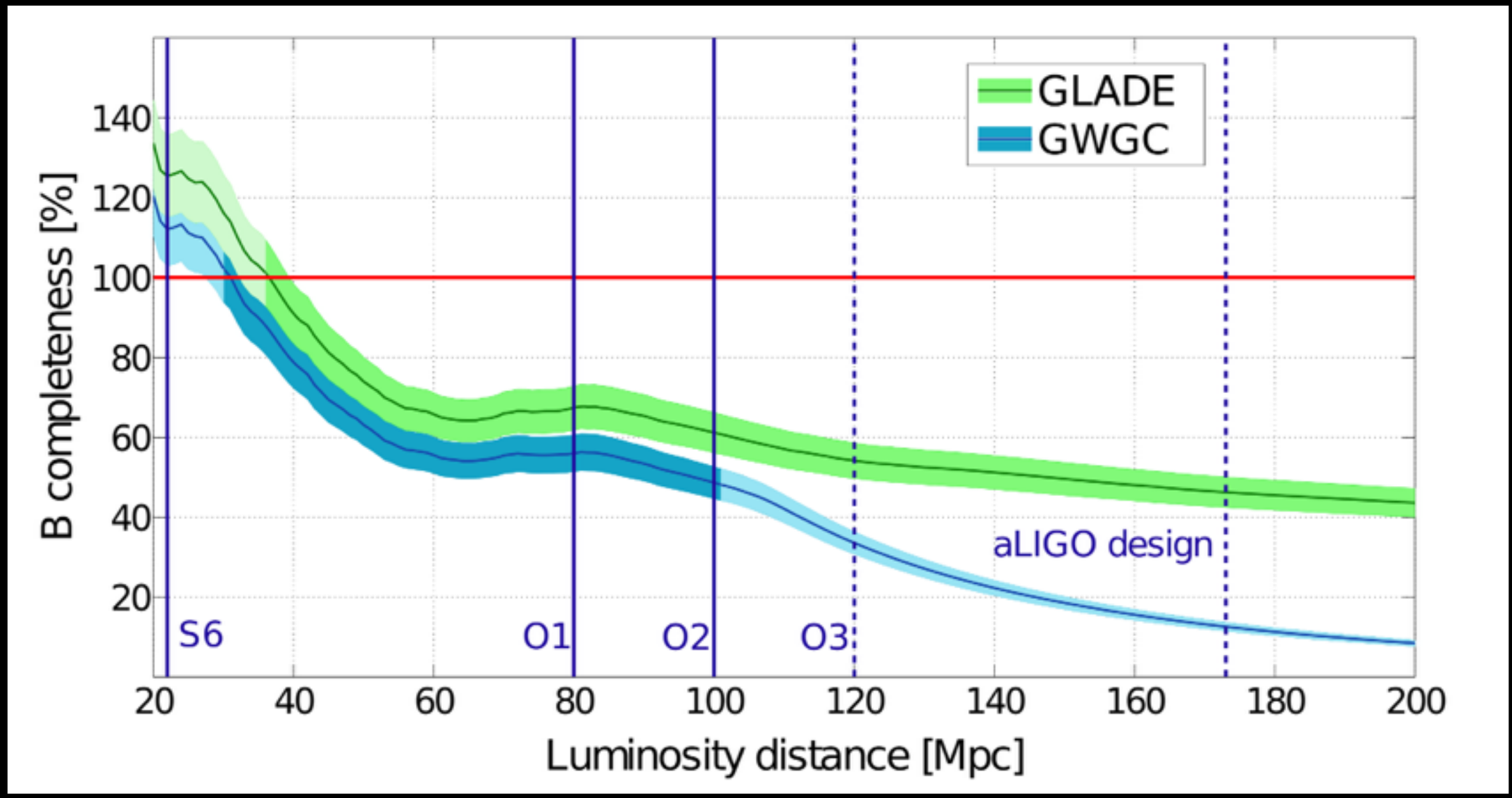
- Correcting volumetric SN rates

Volumetric SN rates from untargeted, wide-field surveys requires the identification of all galaxies within a specified distance. The BTS measurement of the RCF will provide the correction factors needed to account for missing galaxies when calculating the volumetric rates.

Note: current rates on e.g., SN Iax (5 – 30%; e.g., Li et al. 2011; Foley et al. 2013; Miller et al. 2017)

Related projects

- Compare RCF found with SNe to other similar measurements



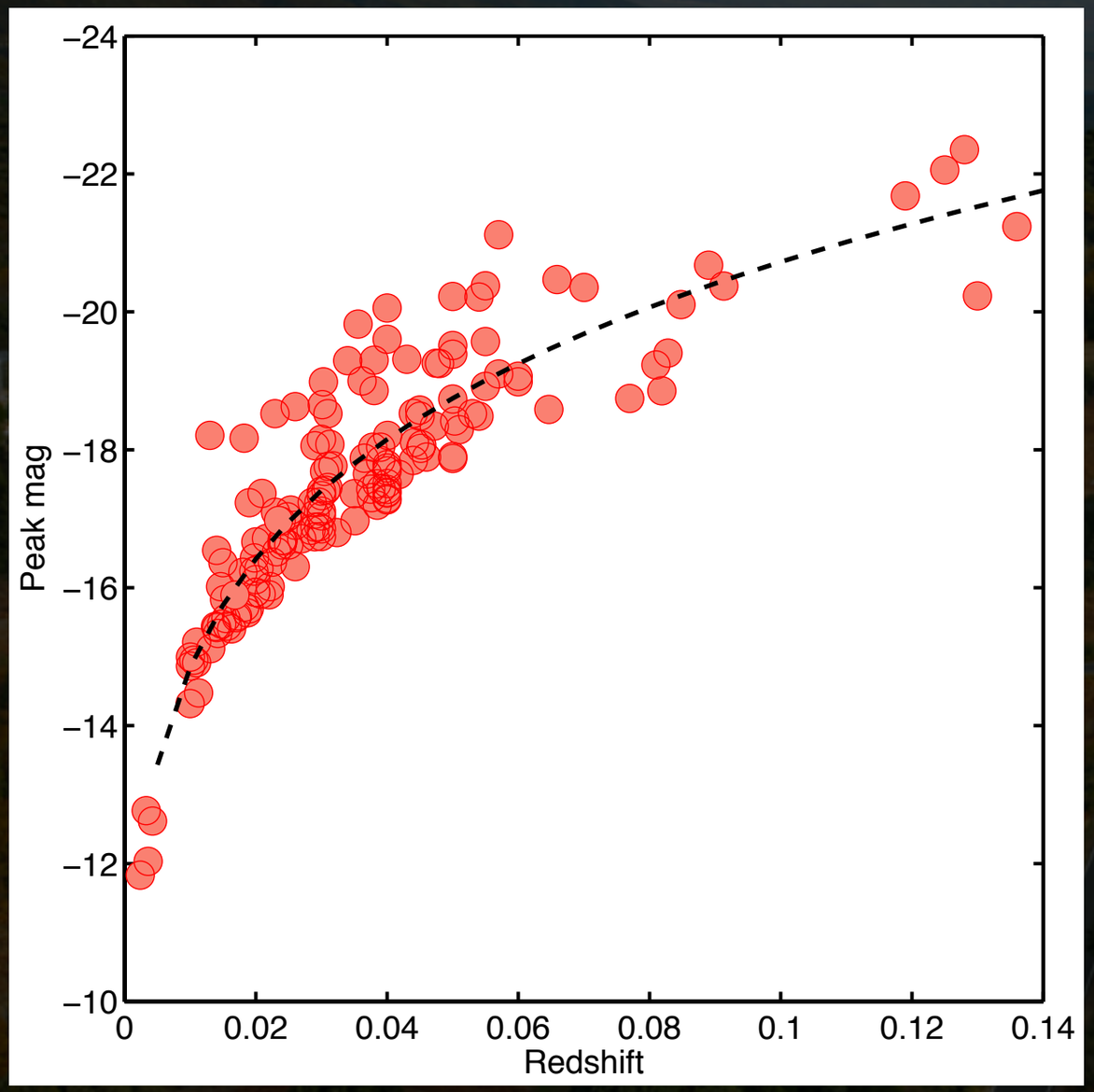
e.g, GLADE (Dálya et al., 2018)

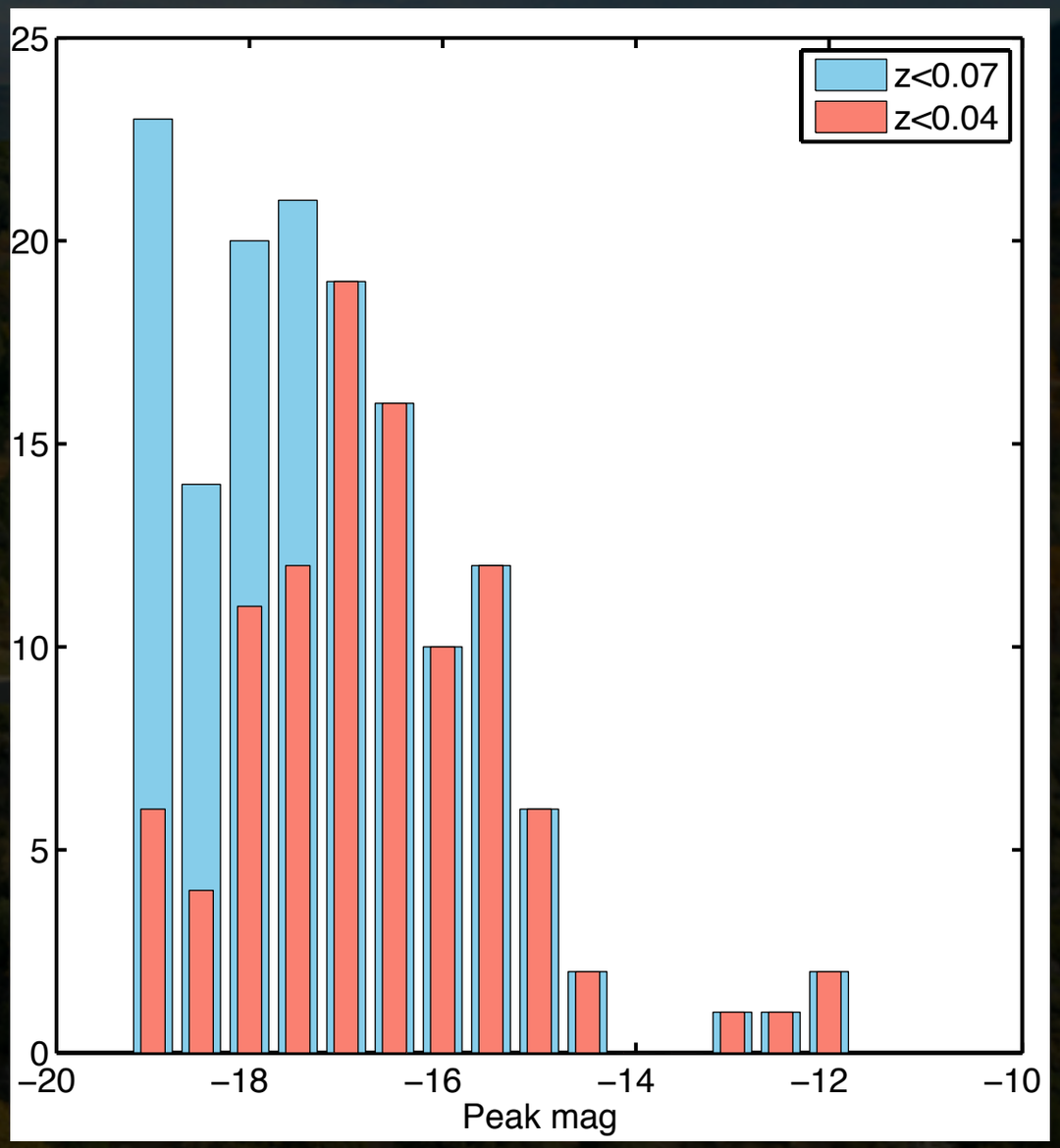
Suggestion: query SDSS galaxies for photo-z and spec-z and compute RCF

Related projects

- Use BTS SNe to investigate SN host galaxy properties
- Investigate luminosity functions of SN types
- Investigate matter distribution of the universe?

The ZTF Bright Transient Survey (BTS)

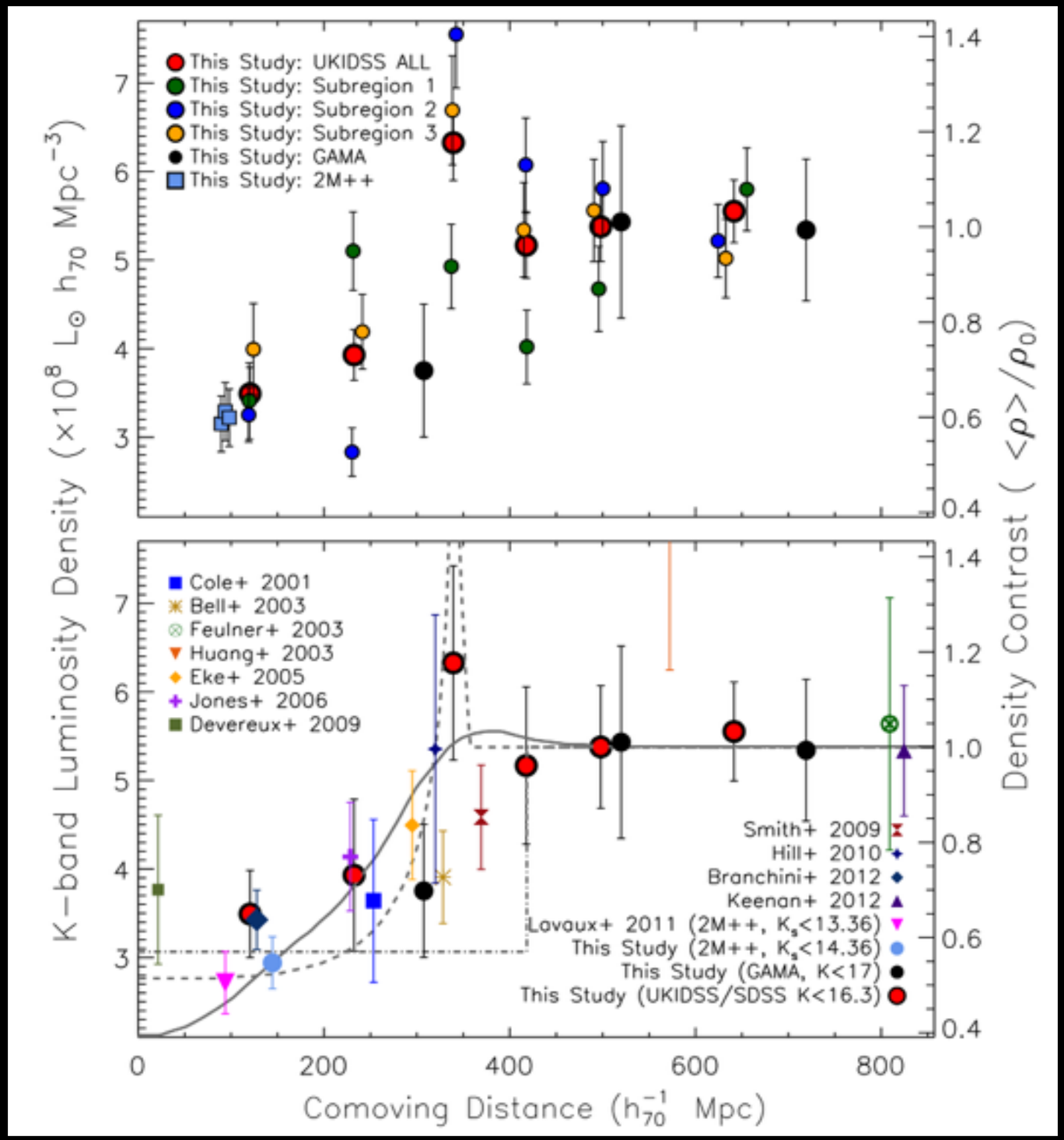




CC SNe, z vs Lum. and Lum. function

Related projects

- Investigate matter distribution (”Hubble bubble”)



Keenan et al., (2013)

- Investigate matter distribution (”Hubble bubble”)