

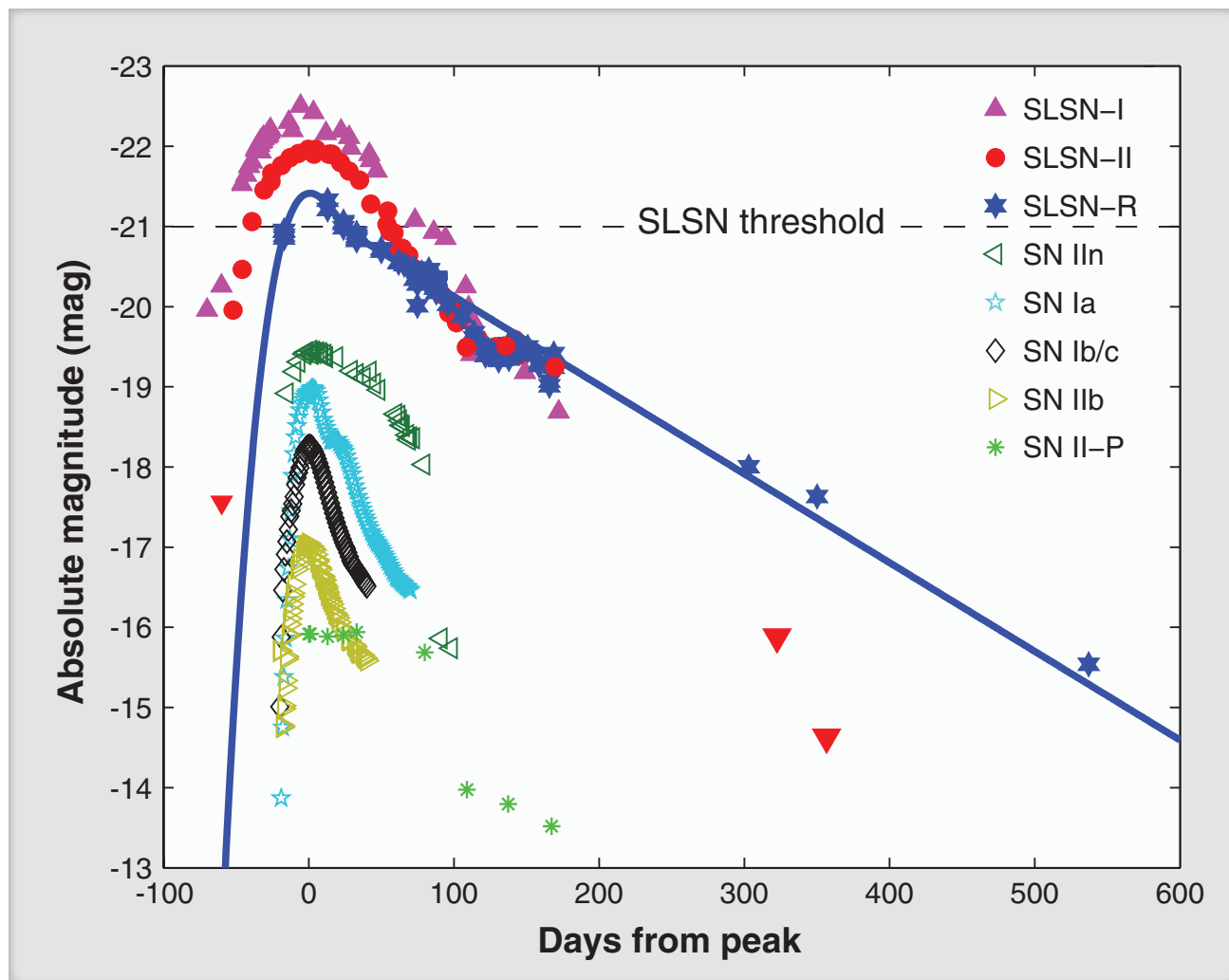
Luminosity distribution of luminous SNe from HSC transient survey

Masahiro Matsuda (Tohoku Univ.)

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Tomoki Morokuma, Jiang Jian (Univ. Tokyo),
Nozomu Tominaga (Konan Univ.), and HSC Transient WG**

1. Luminosity distribution of CCSNe
2. HSC data & selection of luminous SNe
3. Event rate of luminous SNe

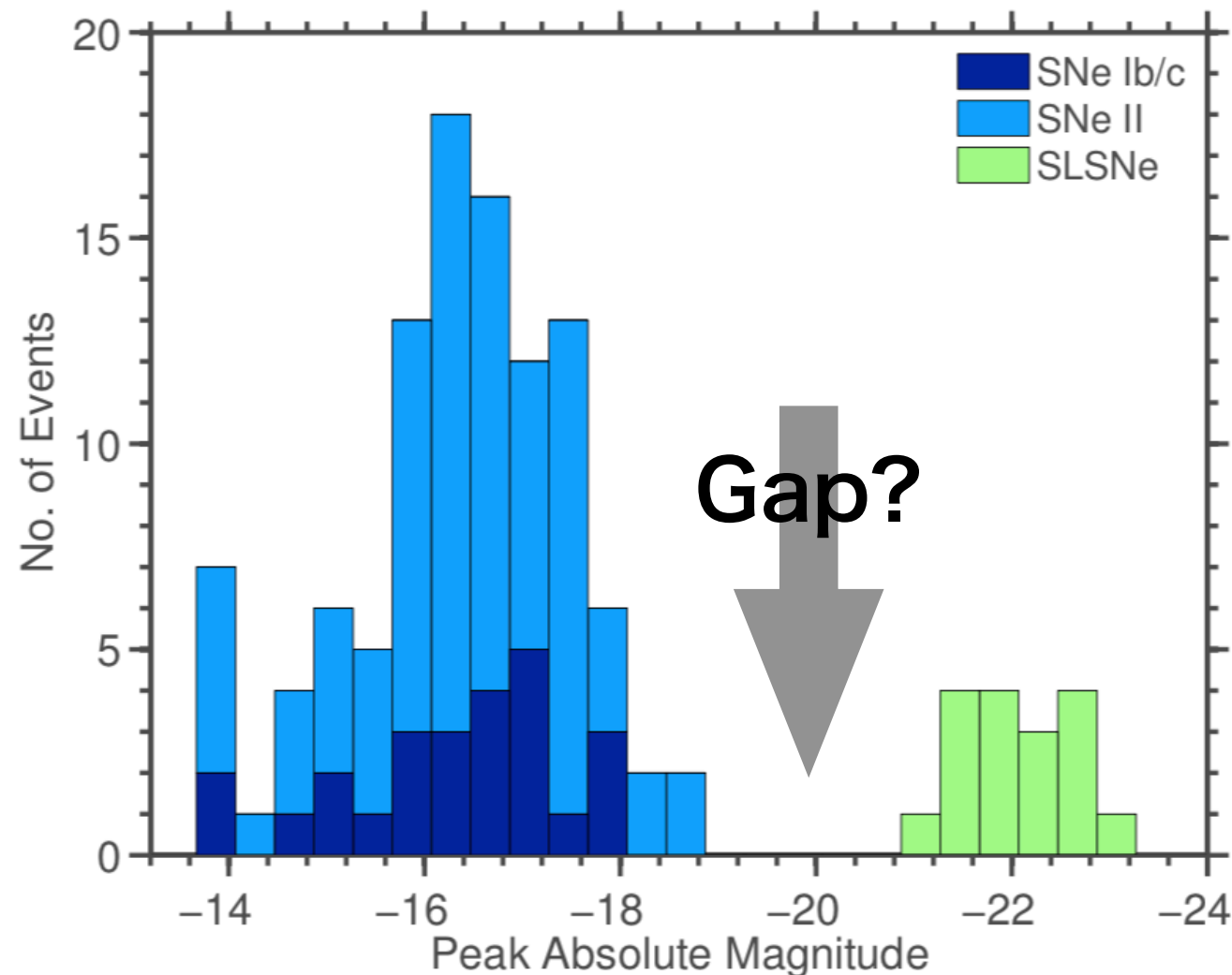
Diversity of Core-Collapse Supernovae



(Gal-yam et. al. 2012)

- CCSNe have **large diversity** of luminosity.
 - SNe Ib/c: -16 ~ -19 mag
(e.g., Drout et. al. 2011)
 - SNe IIn: -18 ~ -19.5 mag
(e.g., Keiwe et. al. 2012)
 - SLSNe: -21 ~ -23 mag
(e.g., Gal-yam et. al. 2012)
-
- What is the **true luminosity distribution** of CCSNe ??

Luminosity distribution of CCSN



Luminosity distribution
(From Arcavi et. al. 2016)

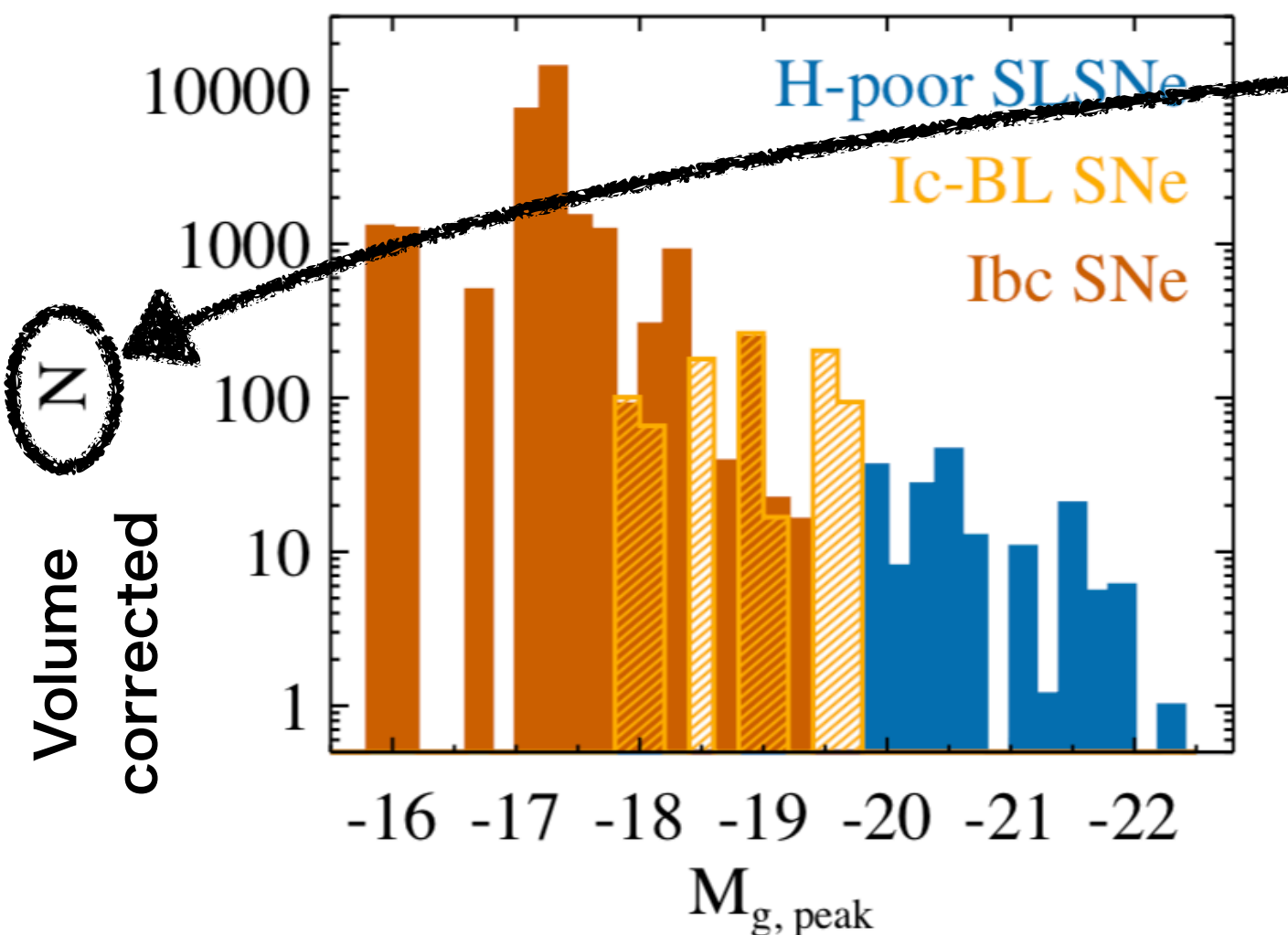
Gap
Between normal SNe & SLSNe

© **Bimodal distribution or Continuous distribution ?**

Luminosity distribution of CCSN

◎ Some report of SNe in the luminosity gap

(Arcavi et. al. 2016 , De Cia et. al. 2018)



(De Cia et. al. 2018)

- Event number (not event rate)
- Bias that focus on SLSN

Need to search SNe without bias

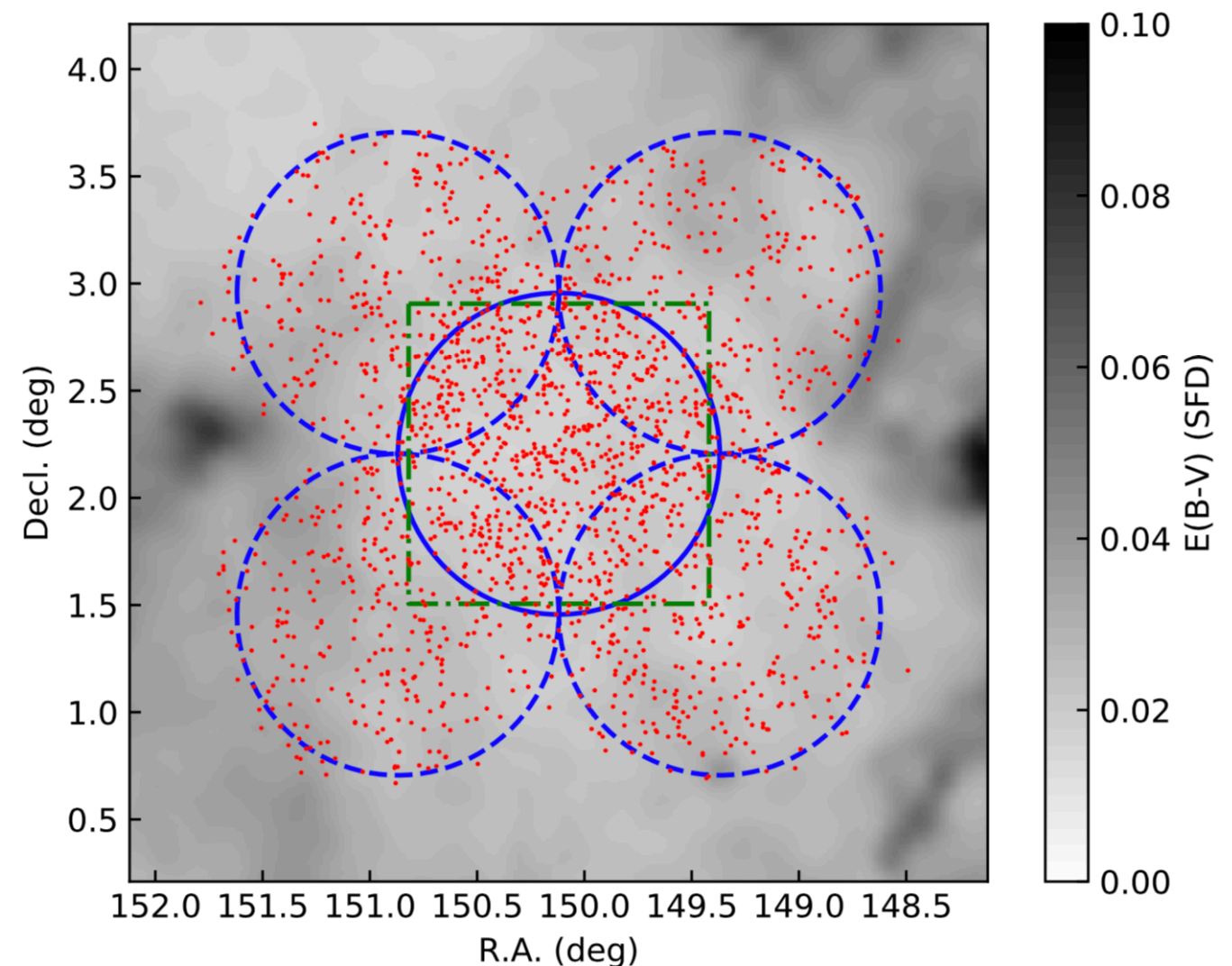
HSC-SSP Transient Survey

1. Luminosity distribution of CCSNe
- 2. HSC data & selection of luminous SNe**
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※See T. Moriya's talk

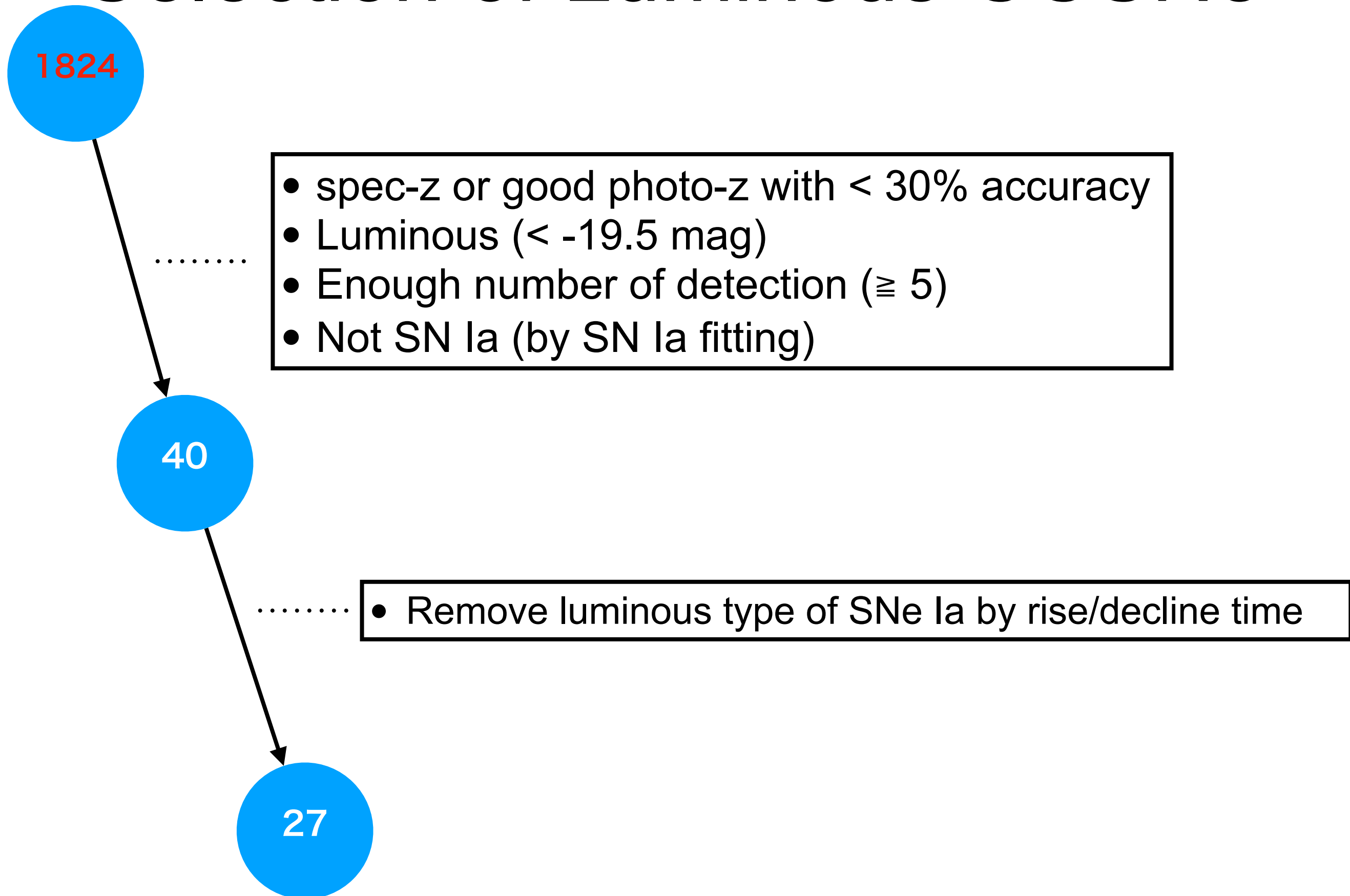
HSC transient survey

- Hyper Suprime- Cam (HSC) of the Subaru telescope.
- Ultra- Deep layer (1.77 deg²)
- Deep layer (5.78 deg²)
- About 24~26 mag depth.
- Over 6 and 4 months from 2016 to 2017.
- **1824** supernova (SN) candidates in total.

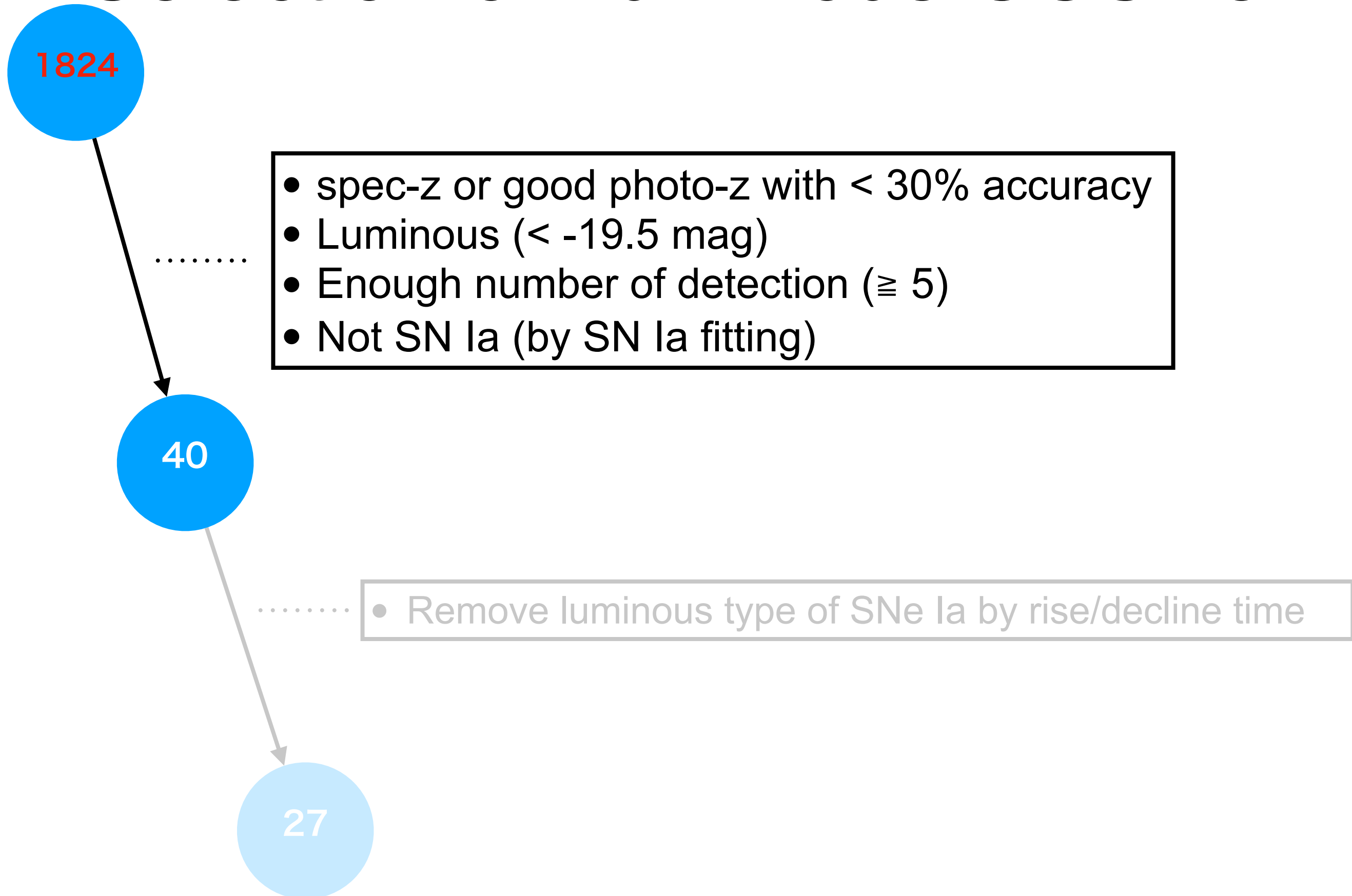


(Yasuda et. al. 2019)

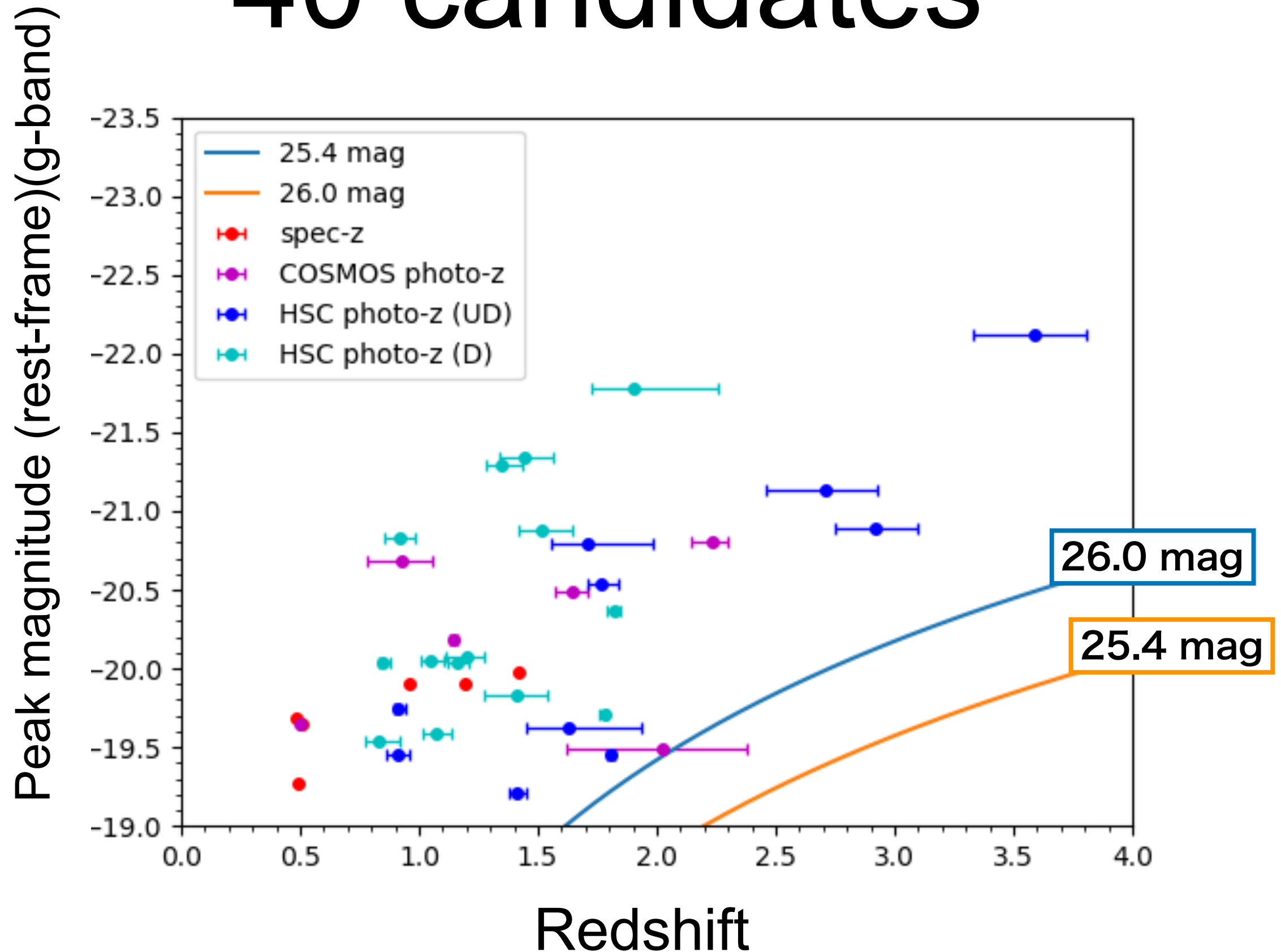
Selection of Luminous CCSNe



Selection of Luminous CCSNe

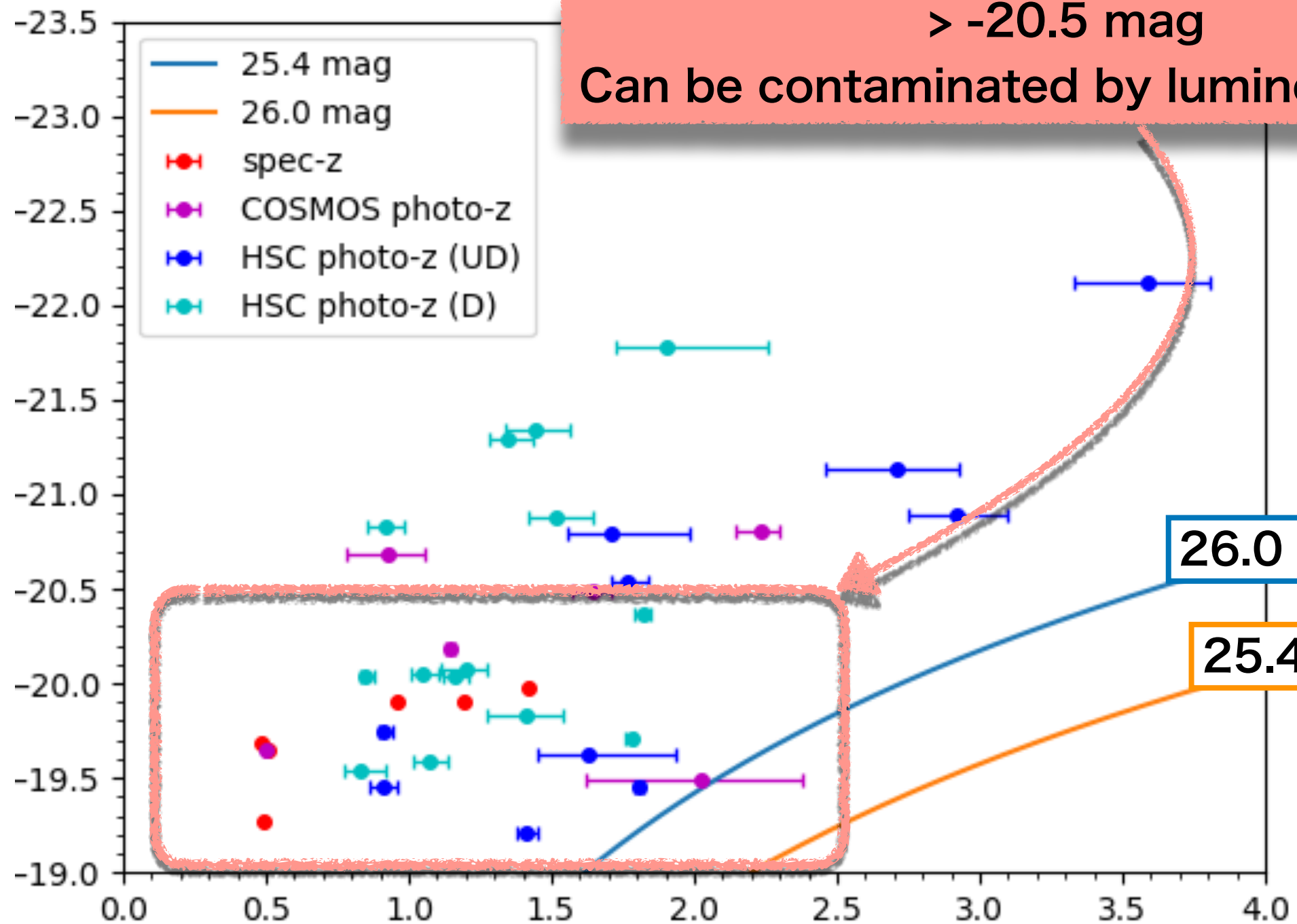


40 candidates



40 candidates

Peak magnitude (rest-frame)(g-band)



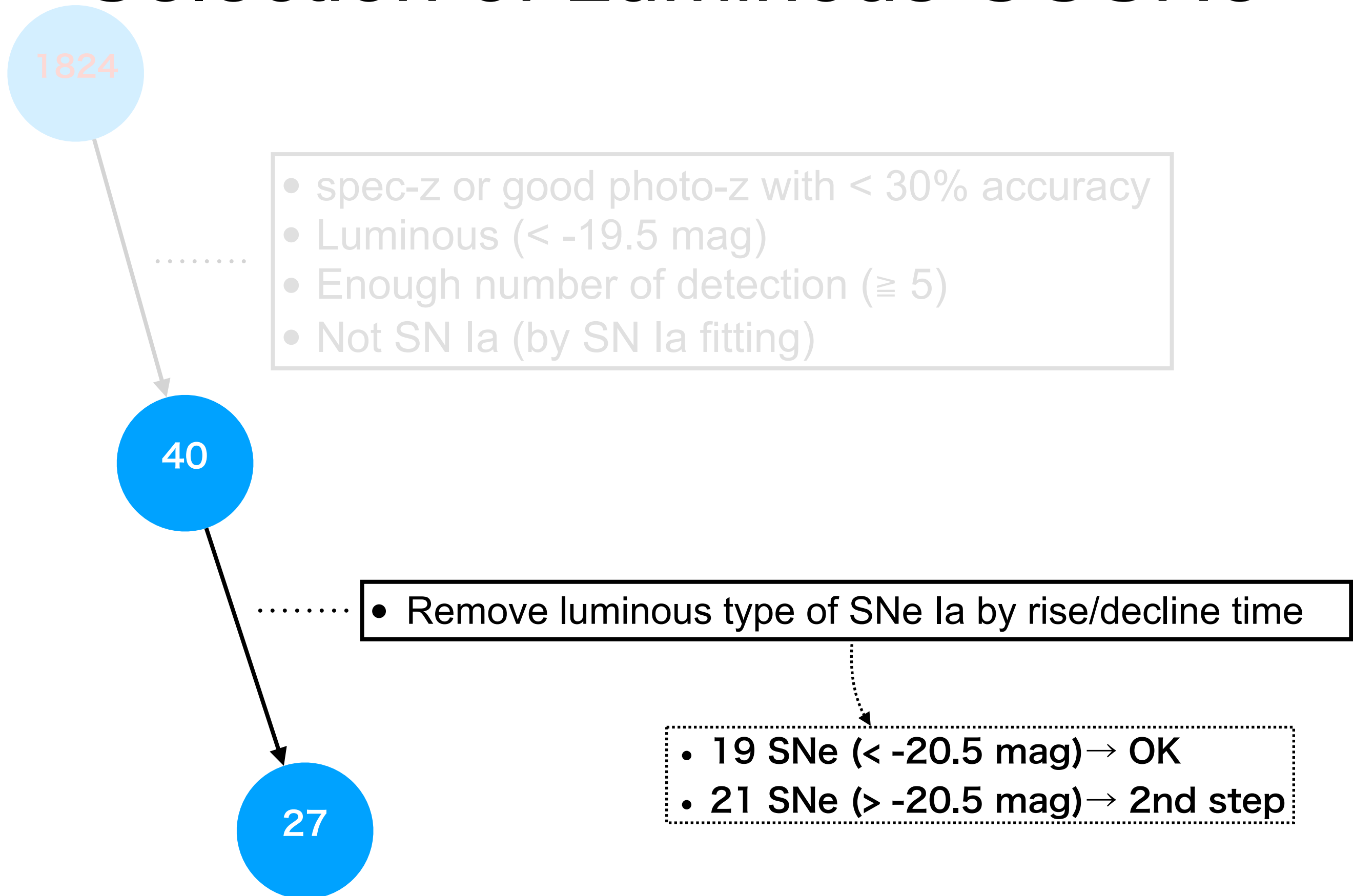
> -20.5 mag
Can be contaminated by luminous SNe Ia

26.0 mag

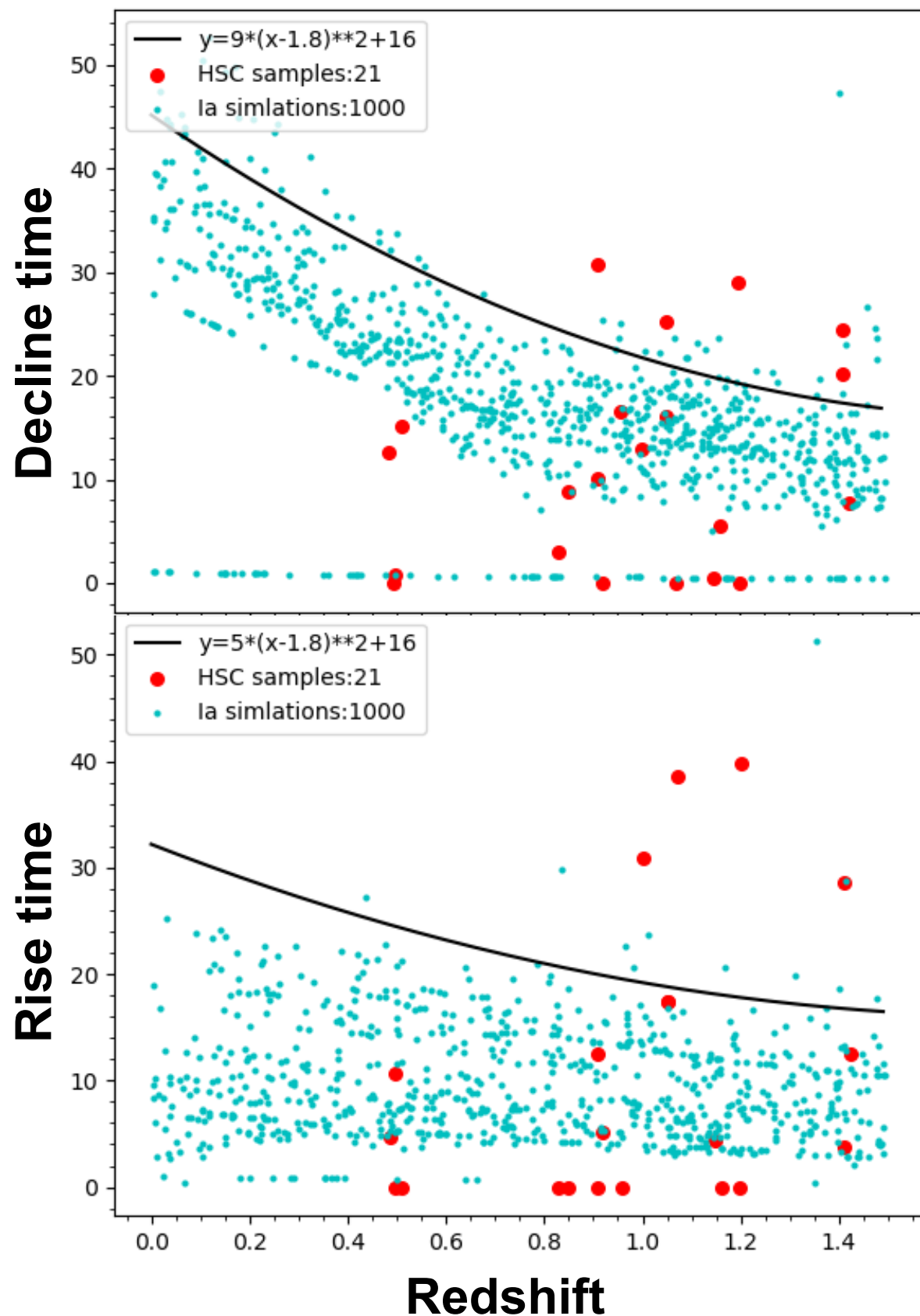
25.4 mag

Redshift

Selection of Luminous CCSNe



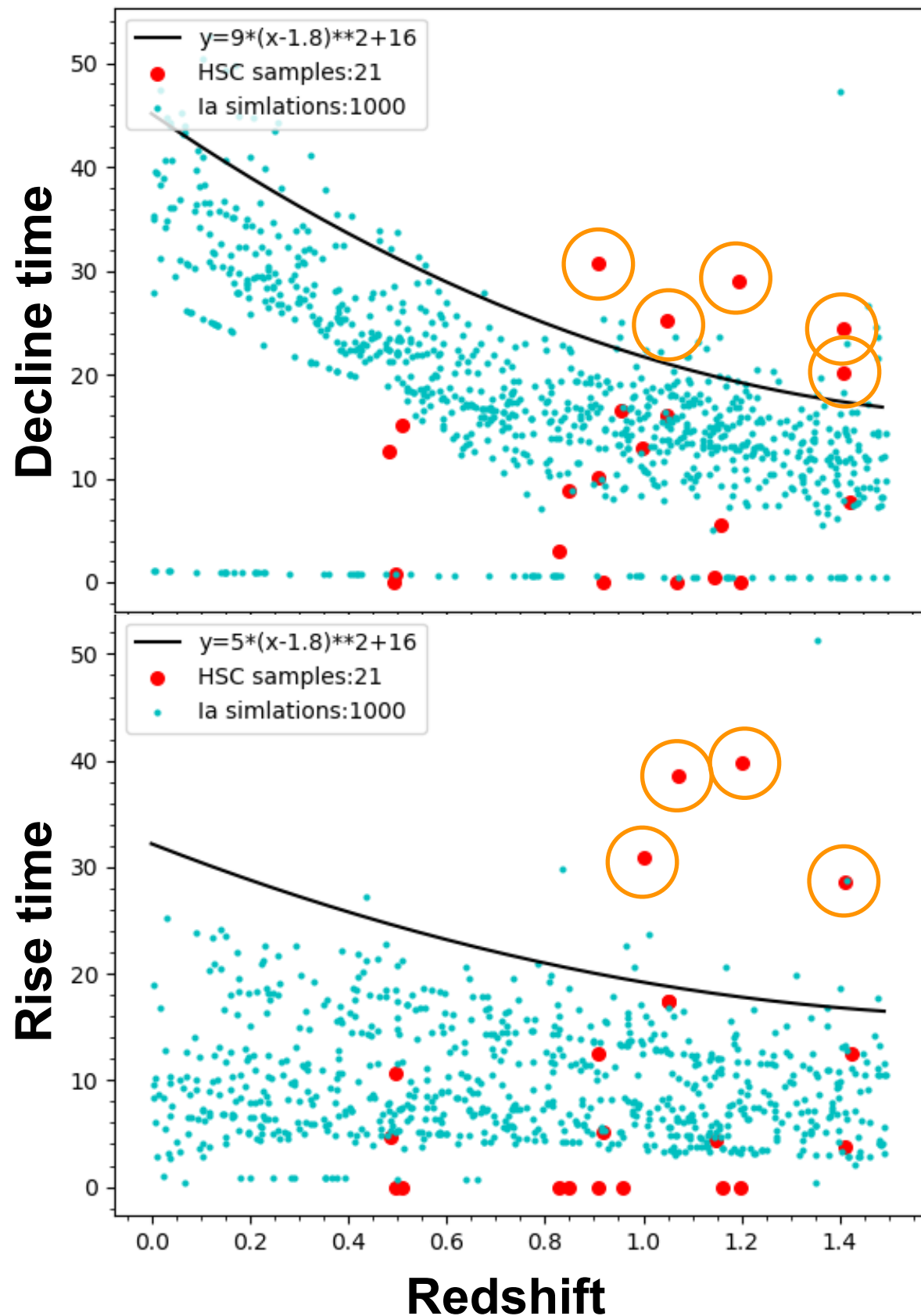
Simulation of SNe Ia



- 19 SNe (< -20.5 mag) \rightarrow OK
- 21 SNe (> -20.5 mag) \rightarrow 2nd step

- Generate 1000 SNe Ia with sncosmo (Berbary et. al. 2016) to remove luminous SNe Ia > -20.5 mag @ $z < 1.5$
- Select SNe with longer timescale than SNe Ia.
- 8 samples are selected.
- $8 + 19 = \mathbf{27}$ samples

Simulation of SNe Ia

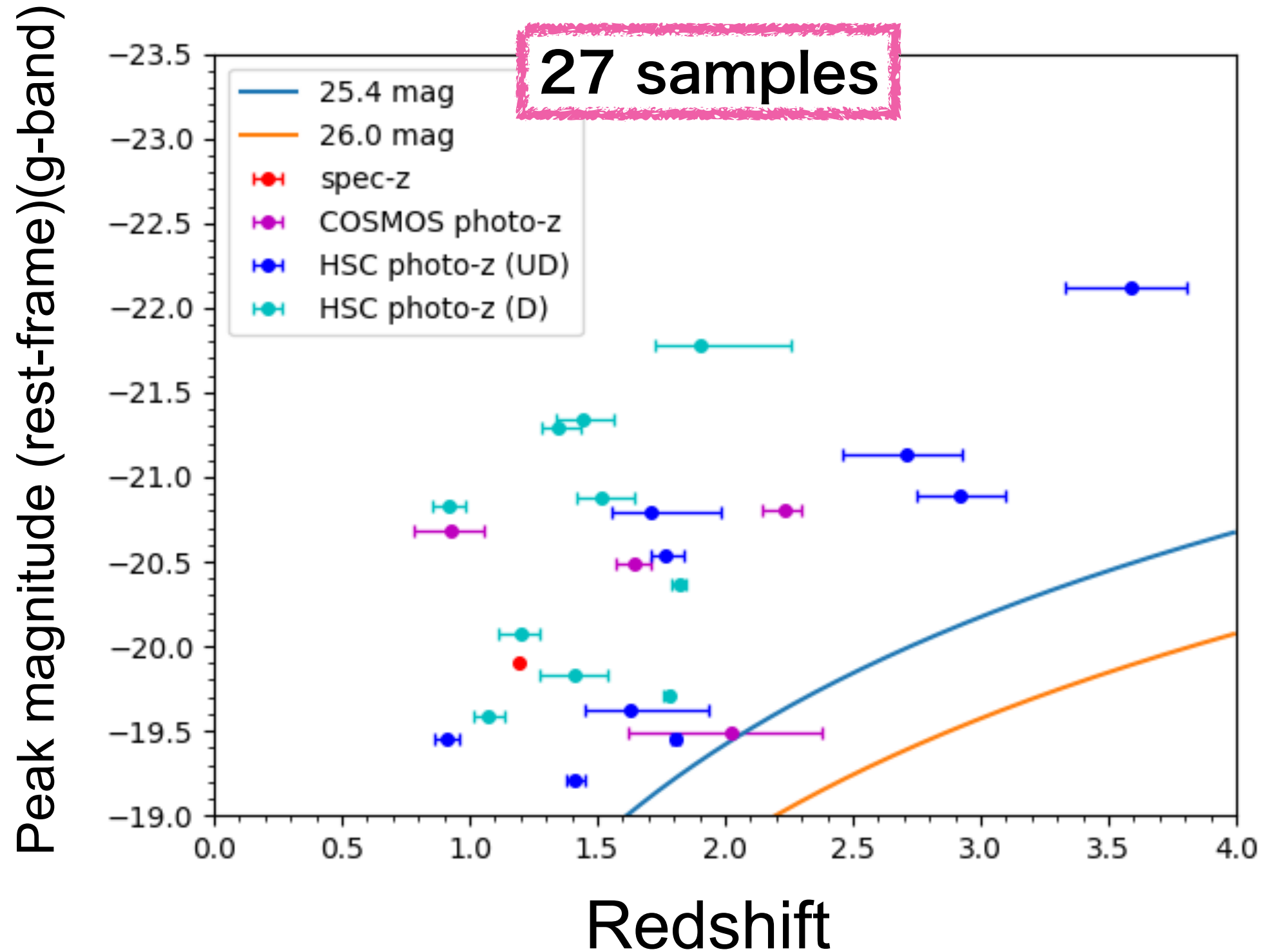


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- Generate 1000 SNe Ia with sncosmo (Berbary et. al. 2016) to remove luminous SNe Ia > -20.5 mag @ $z < 1.5$
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- 8 samples are selected.
- $8 + 19 = 27$ samples in total

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Final samples of luminous CCSNe

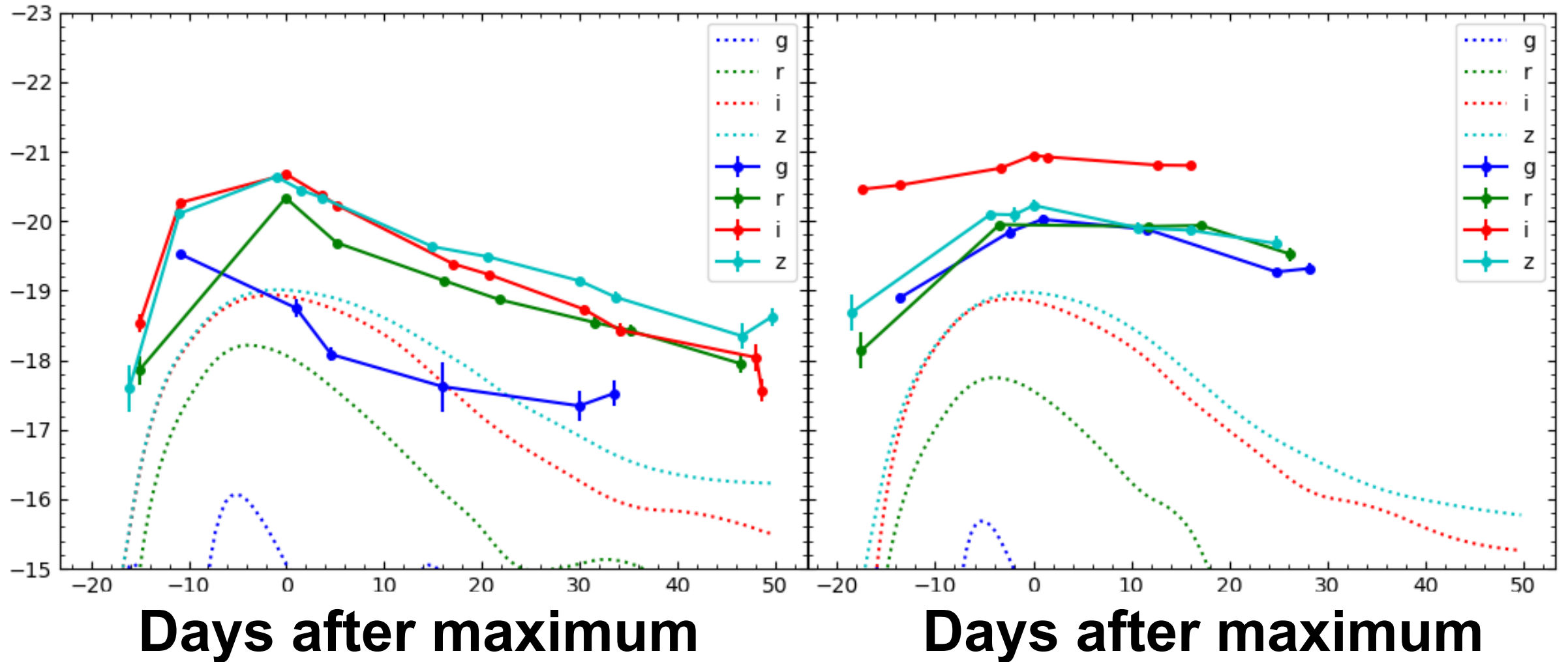


Examples of Light Curve from HSC

Z = 0.929

Z = 1.05

Absolute Magnitude

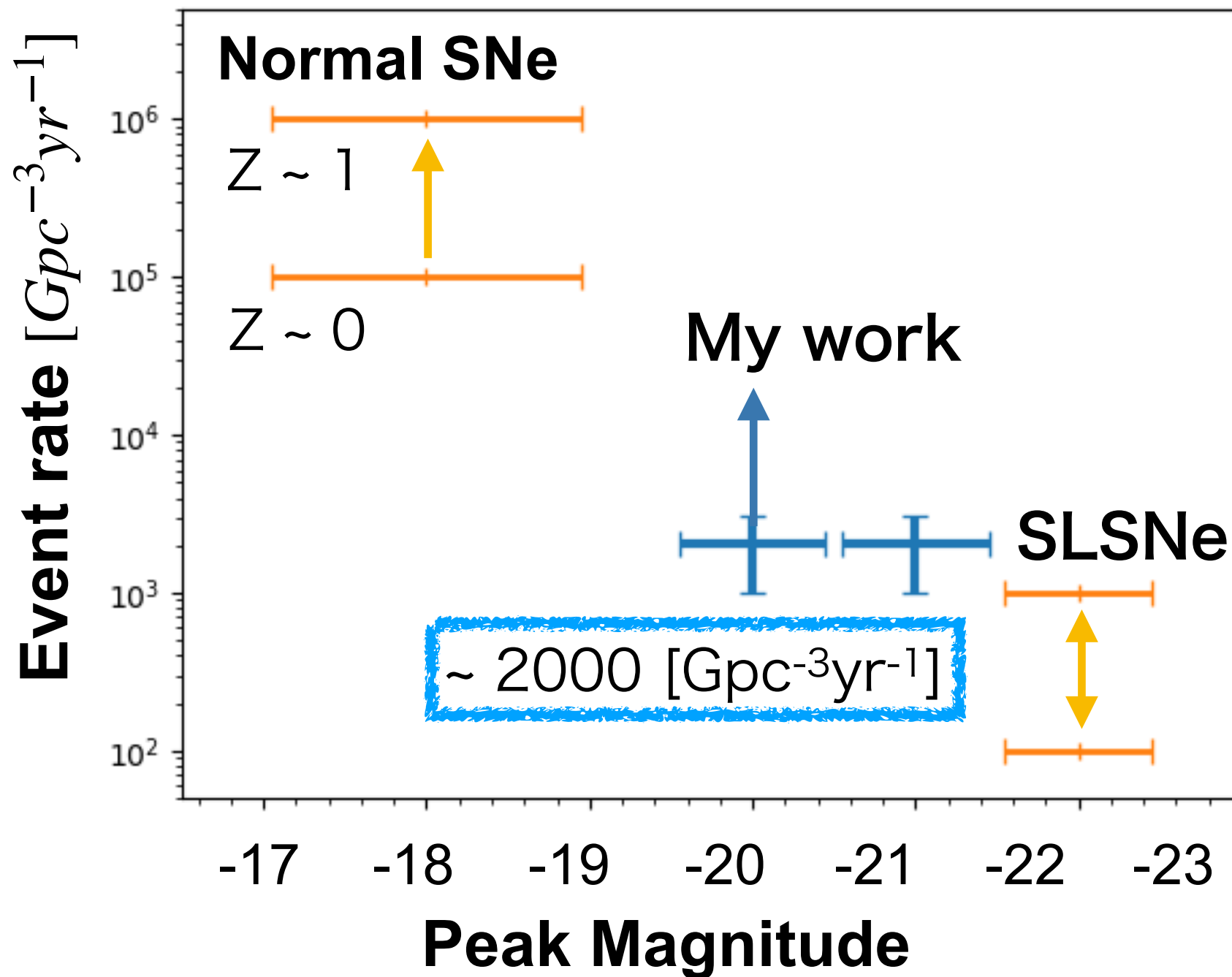


※x-axis : Rest frame

※with simulated Ia SNe for compare

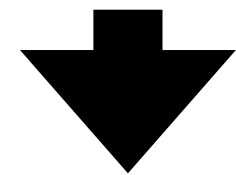
Event rate at $0.5 < z < 1.5$

$z = 0.5 \sim 1.5$



$$V = \frac{4}{3}\pi D_{co}^3 \frac{\Omega}{\Omega_{all}}$$

$$t = \frac{t_{obs}}{1+z}$$



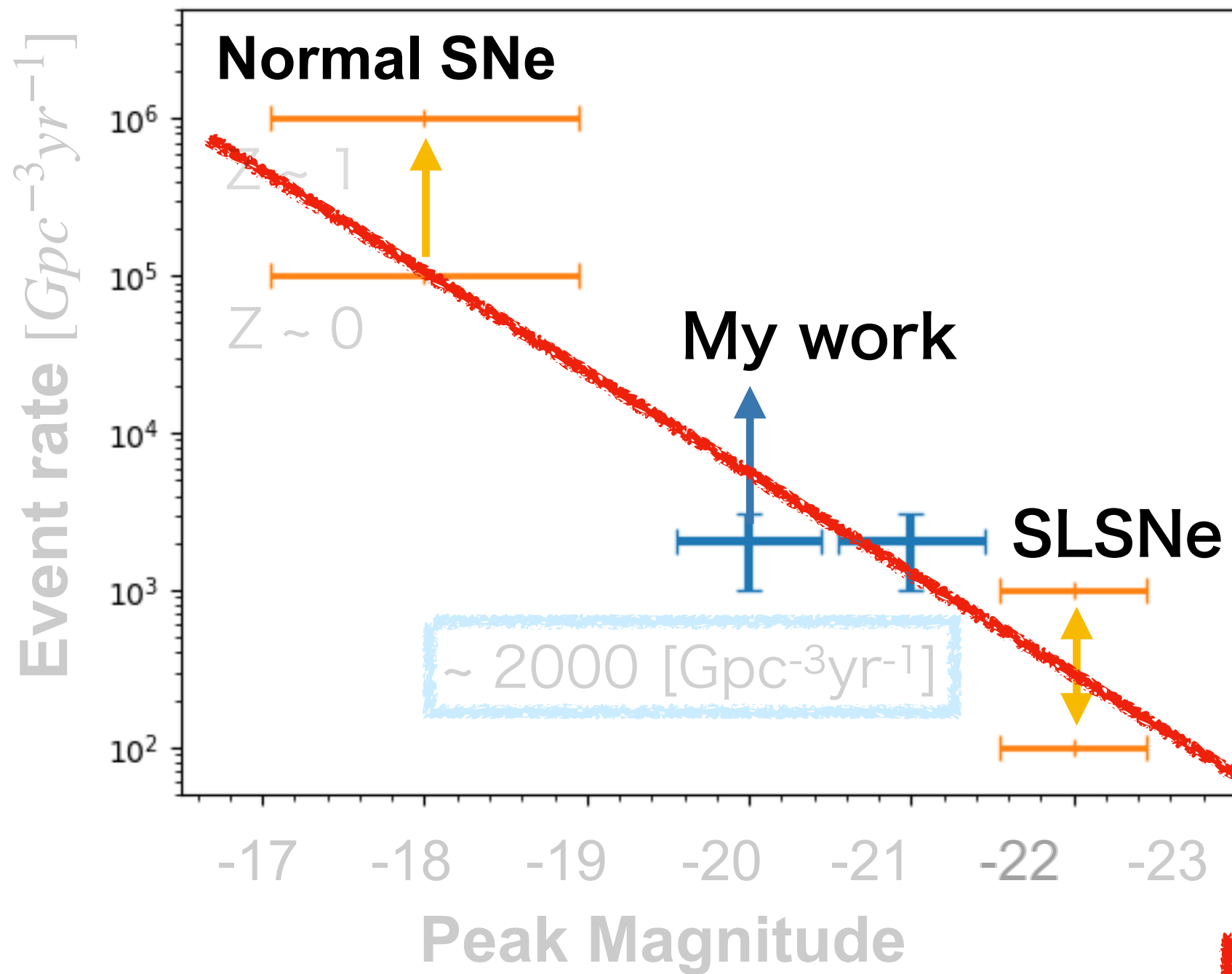
$$\text{Event Rate} = \frac{N}{\epsilon * V * t}$$

(Rate of CCSN: Dahlen et. al. 2018, Gal-yam et. al. 2012)

SLSN: Cooke et. al. 2012, Quimby et. al. 2013, Moriya et. al. 2019)

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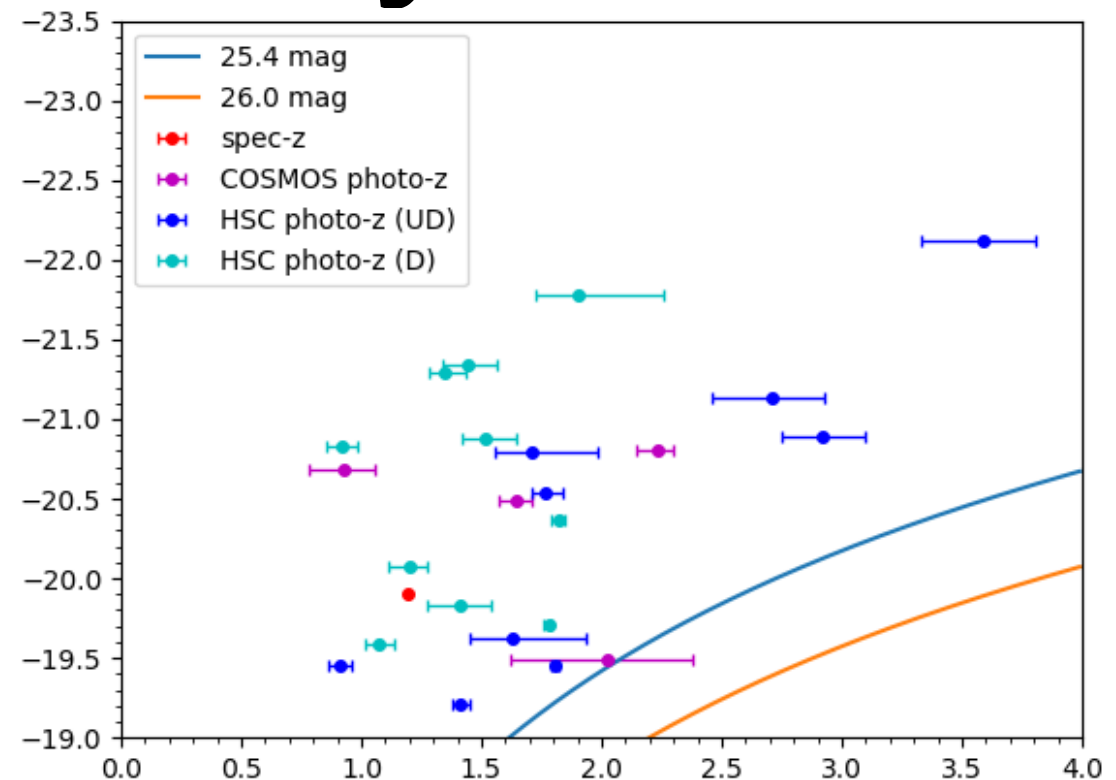
Continuous distribution

(Rate of CCSN: Dahlen et. al. 2018, Gal-yam et. al. 2012)

SLSN: Cooke et. al. 2012, Quimby et. al. 2013, Moriya et. al. 2019)

Summary

- Found **27** Luminous SNe
 - -19.5 ~ -20.5 mag : **9 SNe**
 - -20.5 ~ -21.5 mag : **10 SNe**



- event rate @ $0.5 < z < 1.5$
 - -19.5 ~ -20.5 mag : **> 2000** [/Gpc³/yr]
 - -20.5 ~ -21.5 mag : **~ 2000** [/Gpc³/yr]

- **Continuous luminosity distribution**

