

Supernovae Type IIn: Are they really *that* diverse?

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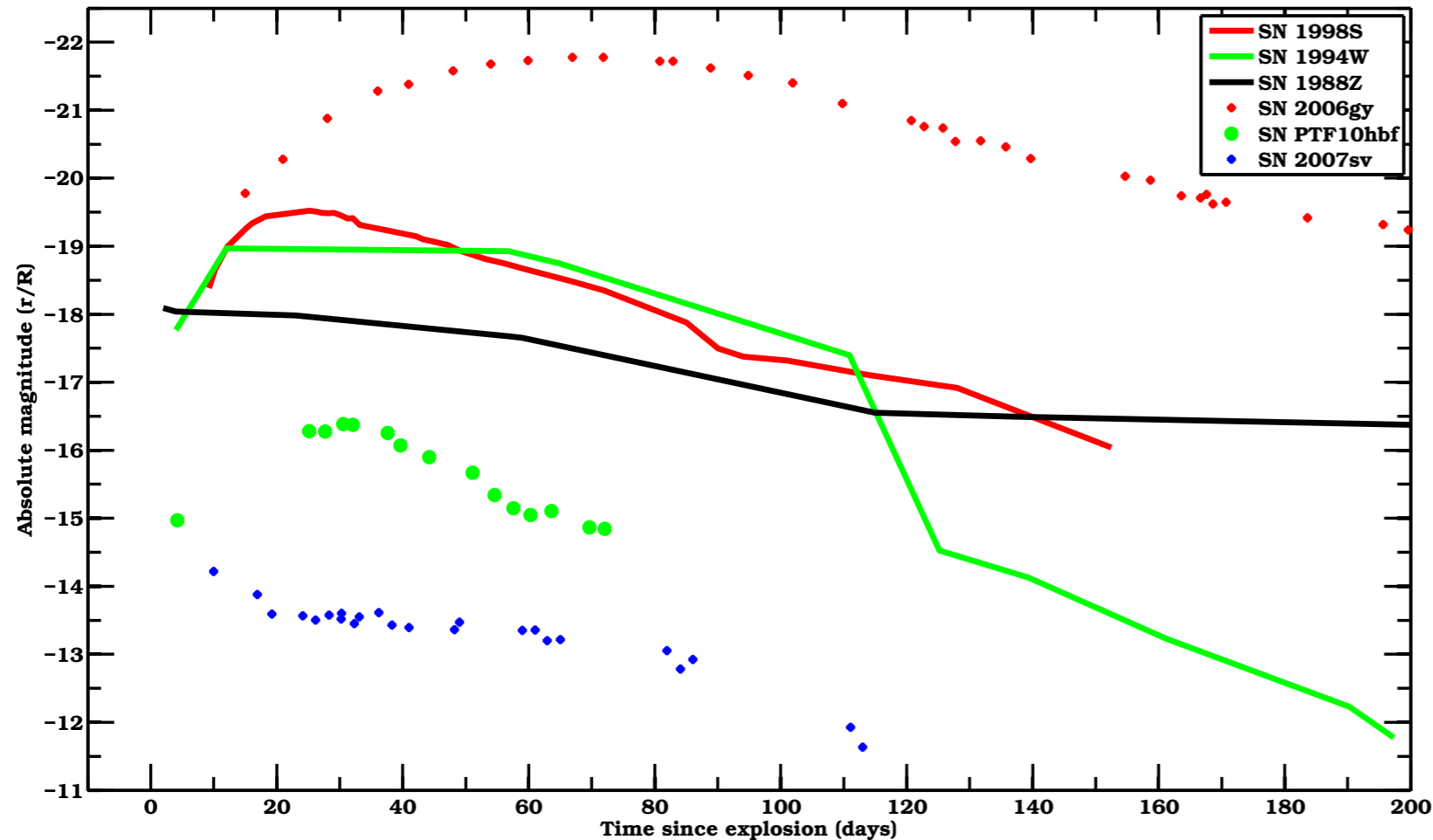
What the (i)PTF did and what ZTF can do

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Zwicky Transient Facility Team Meeting, 2018 August 8

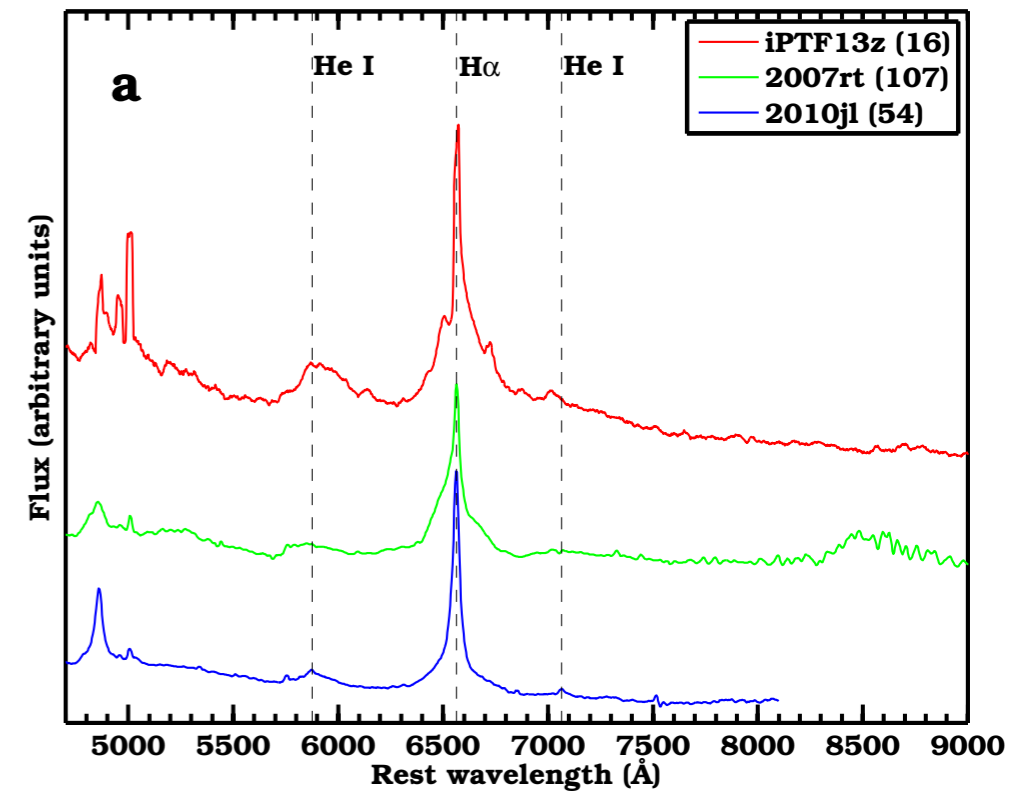
(Sounds familiar? Cf. my SN IIn talk given in this room 2014 June 2 during *Transient Universe as Seen by iPTF and ZTF*)

What gives a SN IIn spectrum?

- An energetic outburst happening inside a dense medium!



Diverse light curves

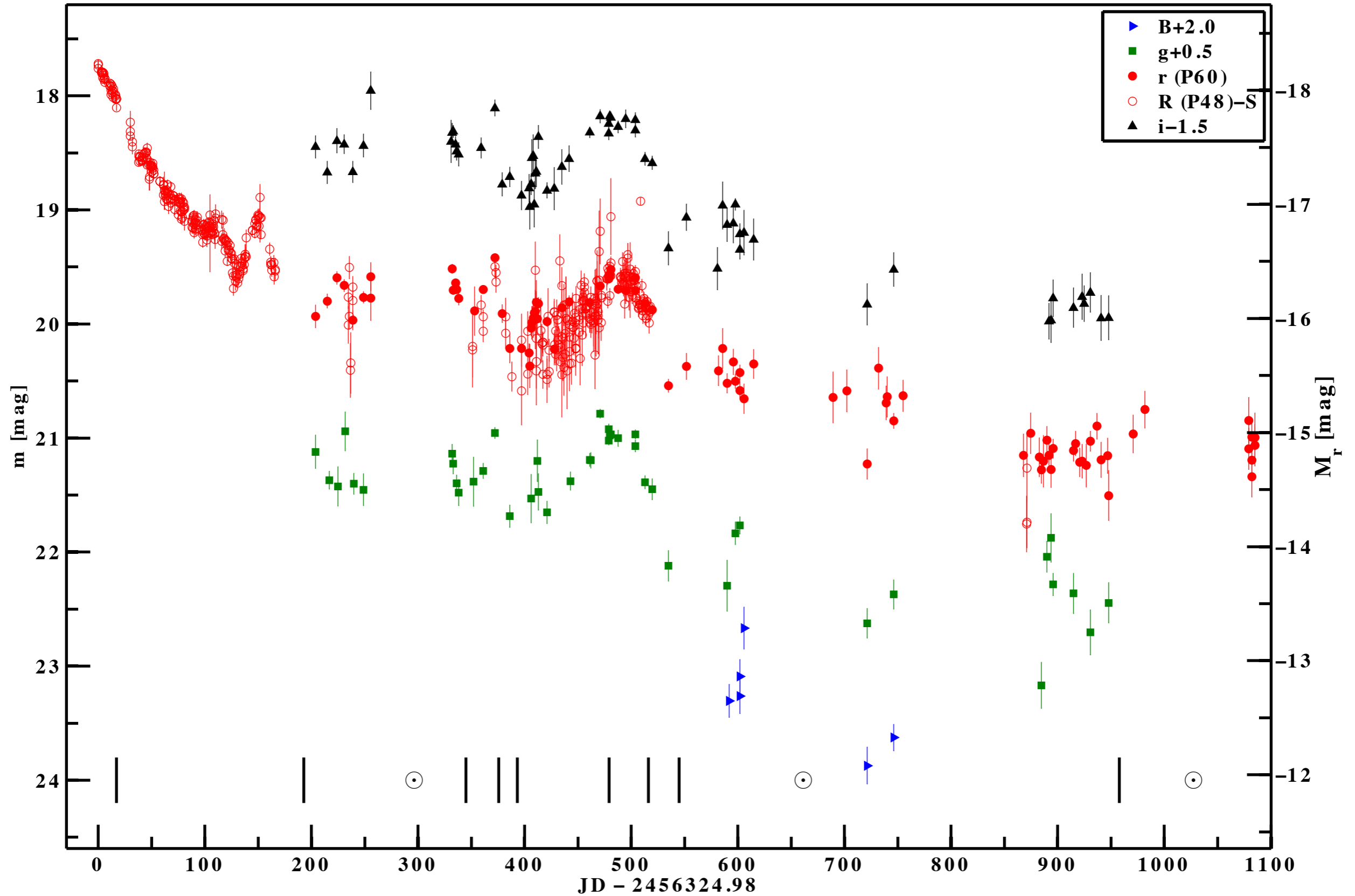


Spectroscopically defined
(Schlegel 1990)

See Nyholm lic thesis for references

Opportunity: The late mass loss history of the progenitor can be studied in detail.
Obstacle: Hard to tell if core collapse actually happened.

The bumpy light curve of Type IIIn SN iPTF13z

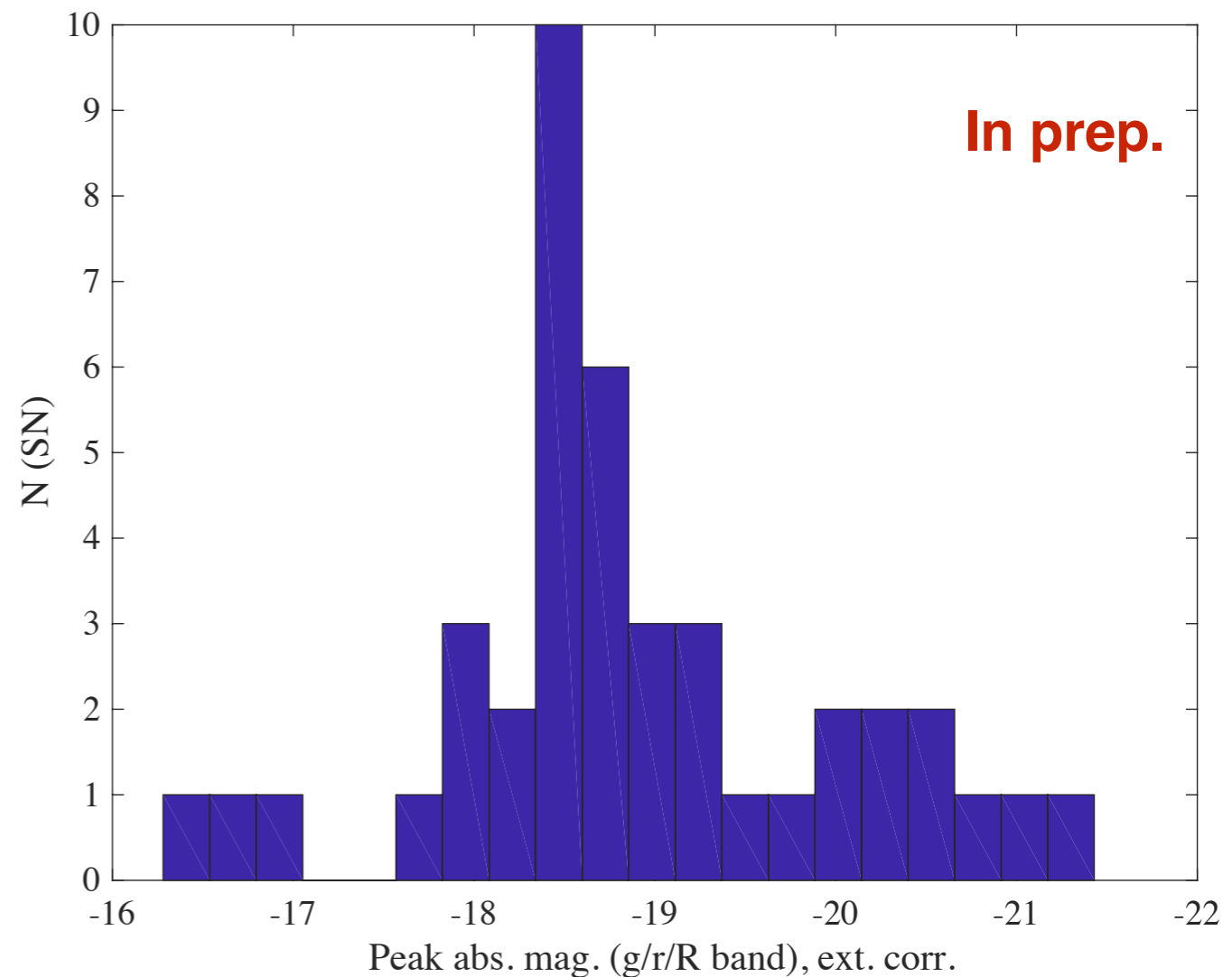
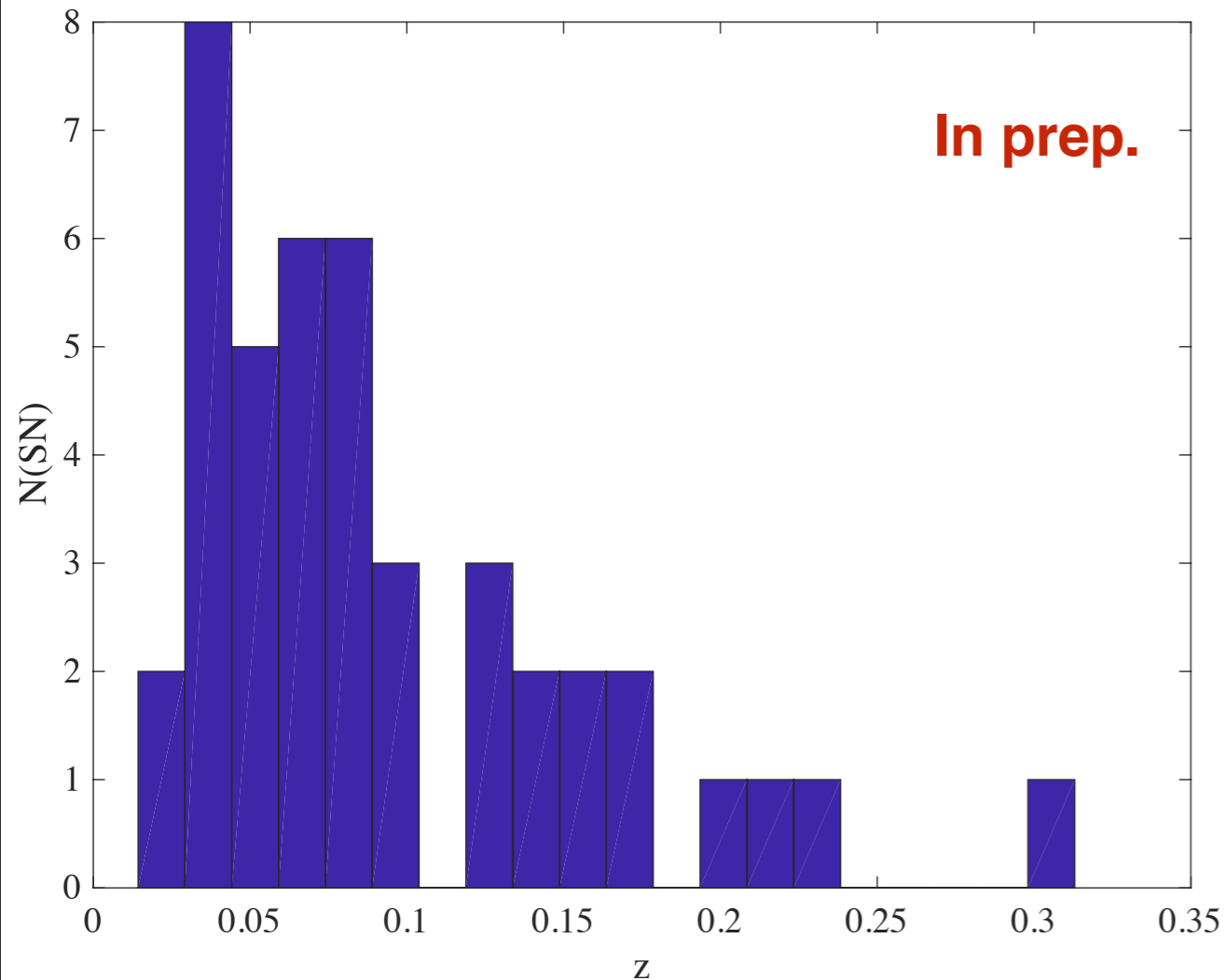


Musings on the need for larger, un-targeted SN IIn samples

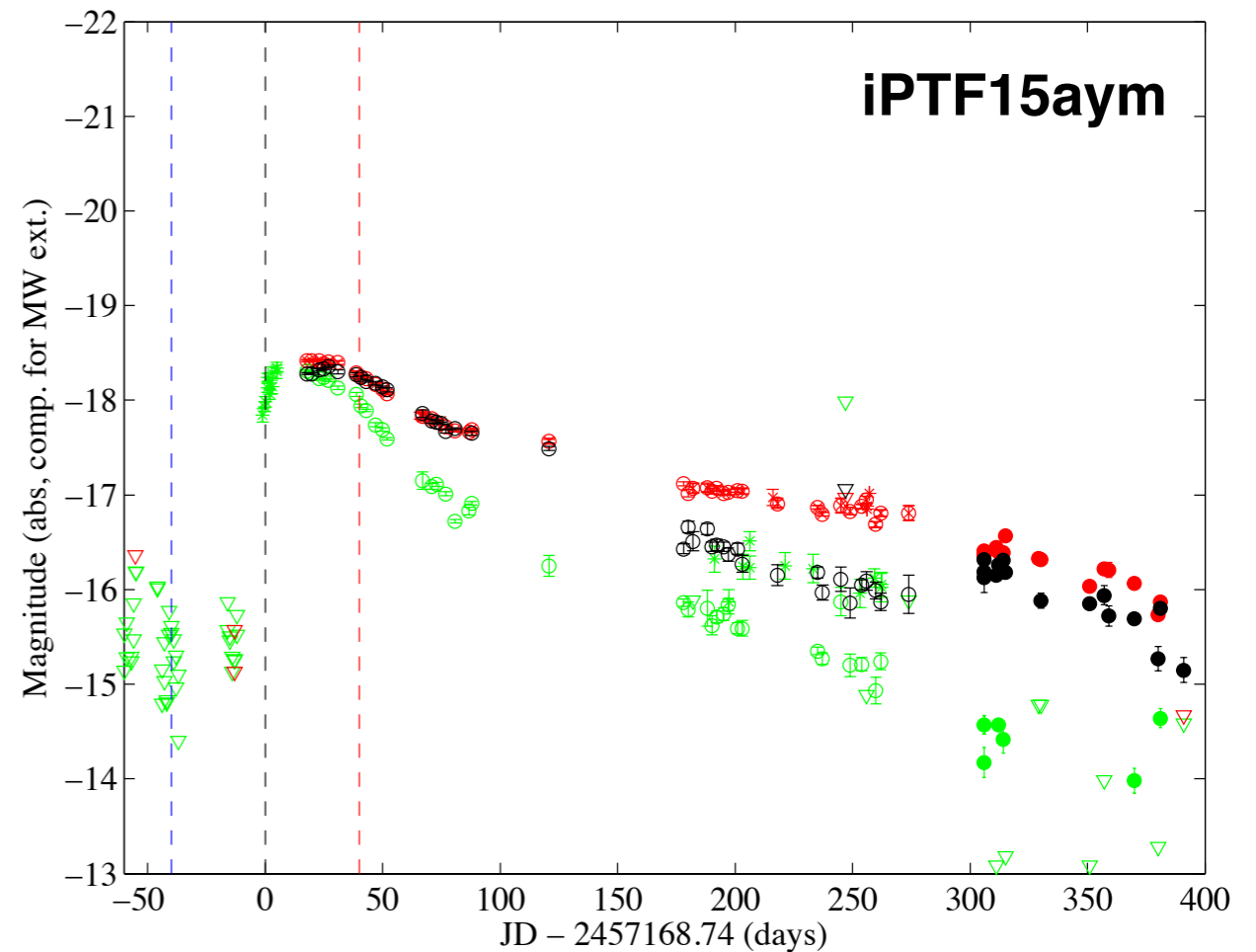
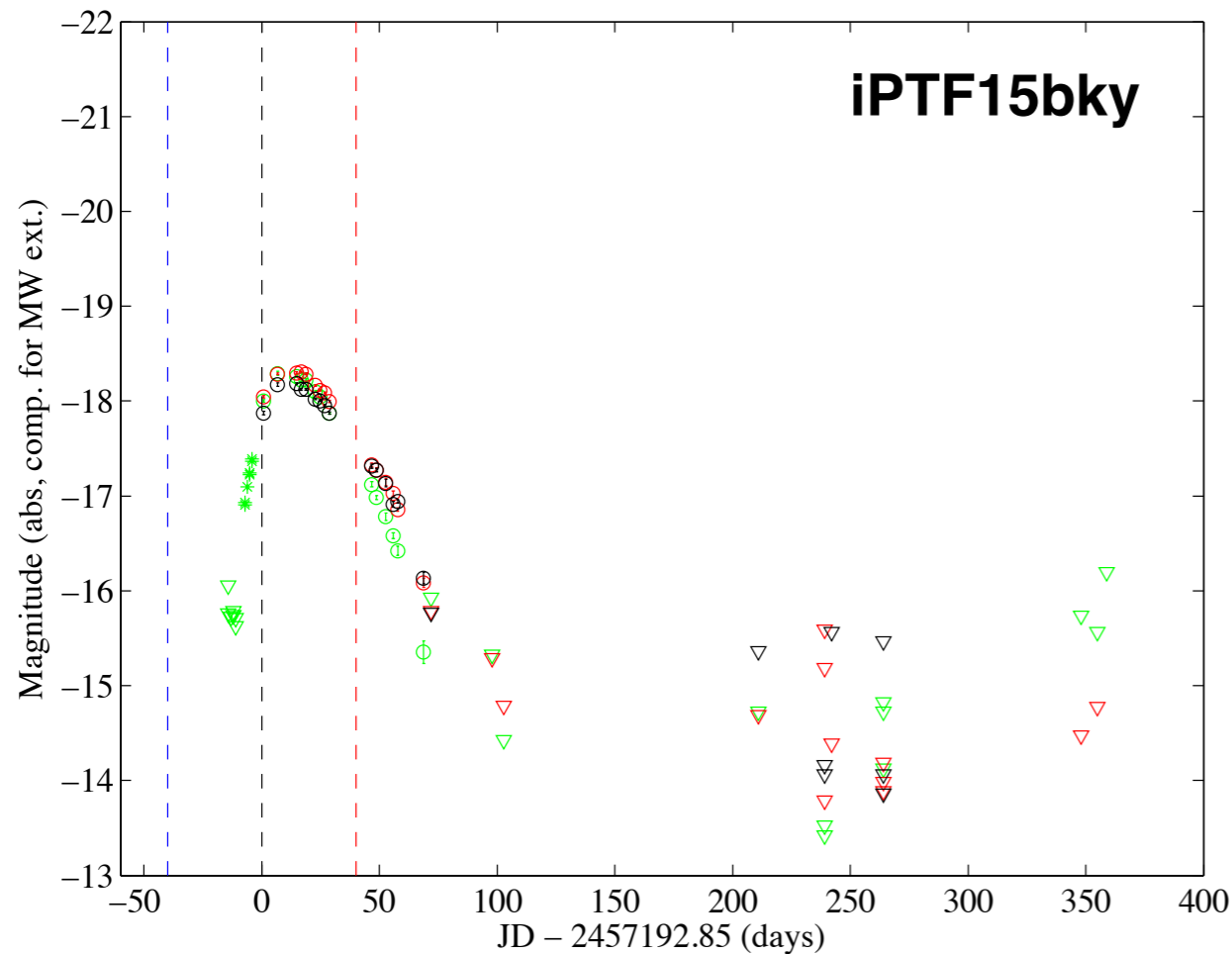
- Ca 480 known (public) SNe IIn as of 2018 August (cf. OSC).
- Skewed literature: SNe 1998S, 2009ip and 2010jl are studied in ca 20 refereed papers each (cf. ADS). Many other SNe IIn only documented in circulars.
- Not for the lack of easy SNe IIn to follow: Ca 140 SNe IIn at redshift < 0.02 ($\mu < 35$ mag) as of 2018 August (cf. Open Supernova Catalogue).
- The typical SN IIn sample study (about 10 in the literature) uses a sample of ca 10 SNe at $z < \sim 0.02$ from **targeted** surveys.
- Eran Ofek et al. (2014) used (i)PTF for the largest un-targeted SN IIn samples so far.
- We study a sample **43 SNe IIn**, from the **un-targeted** (i)PTF, selected to have good explosion epoch constraints.

Sample redshift and peak luminosity distributions of sample

- Original size of whole (i)PTF SN II sample: 111
- Size of (i)PTF SN II sub-sample fulfilling the "-40 d" condition: 55
- Size of (i)PTF SN II sub-sub-sample also fulfilling the "+40 d" condition: 43

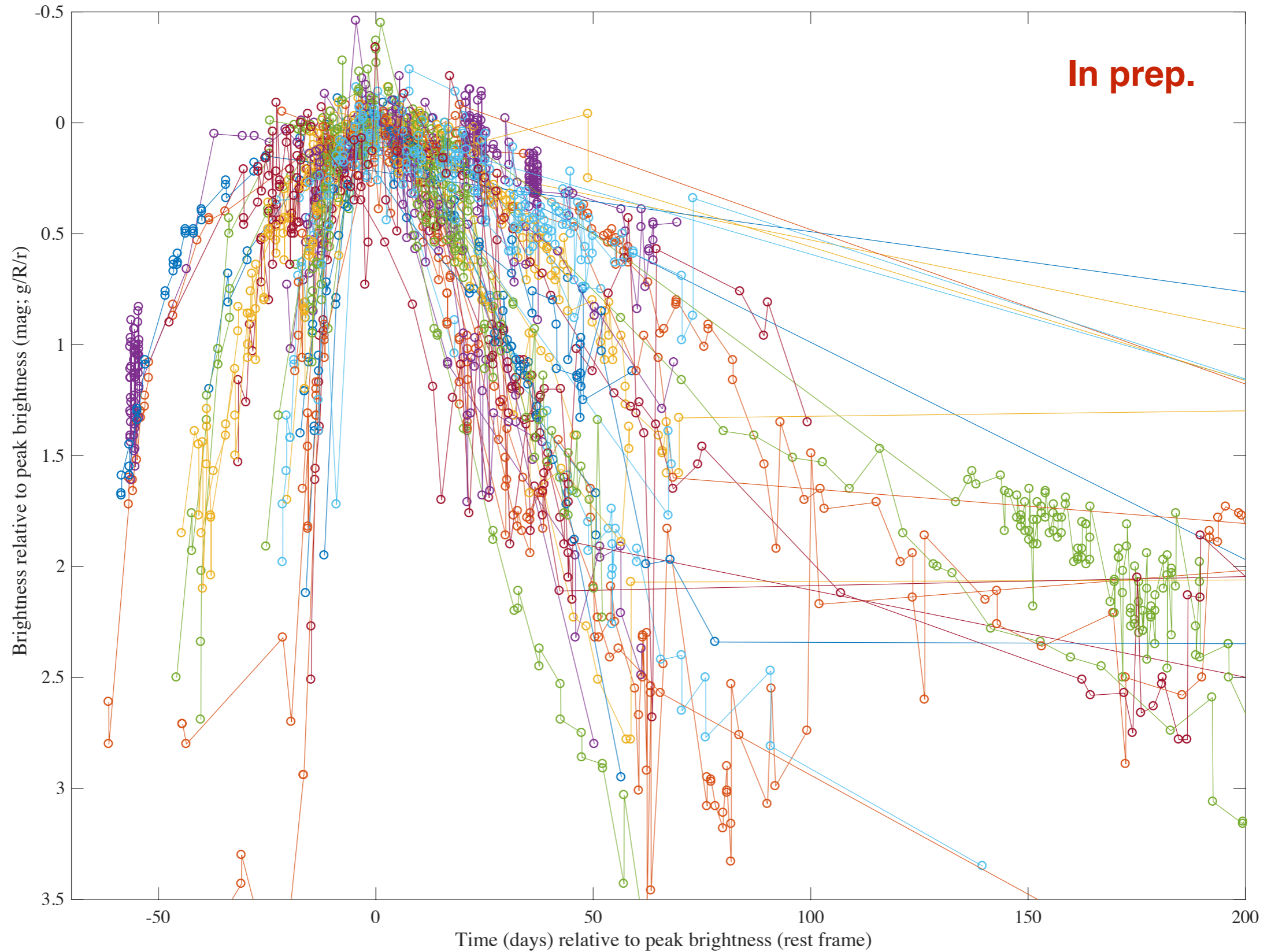


My (i)PTF sample of 43 SNe IIn



- Rise time/maximum brightness relation (cf. Ofek et al. 2014)
- Decline rates and decline rates statistics
- Shapes of light curve maxima (Diffusion peaks, plateaus etc.)
- Photometric host properties (ca 80 % of the sample sits in the SDSS field)
- All SNe in my sample, by selection, has well-constrained explosion epochs

SN folklore says that SNe IIn are very diverse...



What can ZTF do?

Conservative estimate for a ZTF SN IIn light curve sample:

5 SNe IIn classifications from ZTF currently on TNS (April-June 2018) suggests $\sim > 30$ SNe IIn per year and **~ 100 SNe IIn** during the planned 3 yr lifetime of ZTF. With the planned all-sky coverage in *g/r* band every 3 nights, this provides good basis for a well-characterised SN IIn light curve sample.

SNe IIn precursor and impostor studies:

The *g/r* band every 3 nights will also improve statistics on the precursors seen before some SNe IIn (SN 2009ip, iPTF13z, LSQ13zm...). Cf. work by Ofek et al., Tartaglia et al. etc., Smith et al.

SNe IIn at higher redshifts:

ZTF can find lensed SNe IIn at higher redshifts (see Ulrich Feindt talk).

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AGN Luminosity and Stellar Age: Two Missing Ingredients for AGN Unification as Seen with iPTF Supernovae

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