SuperLuminous Supernovae

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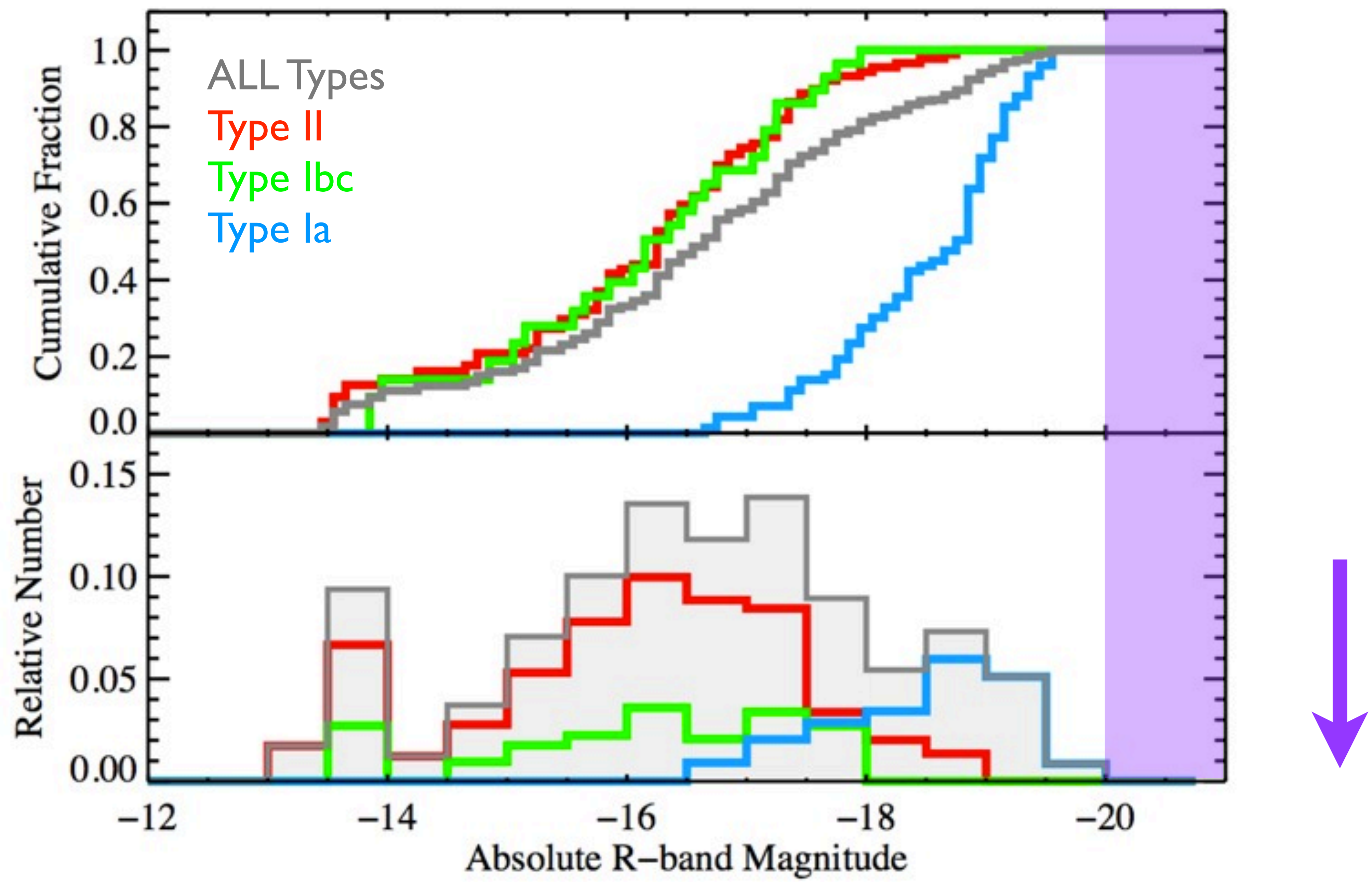
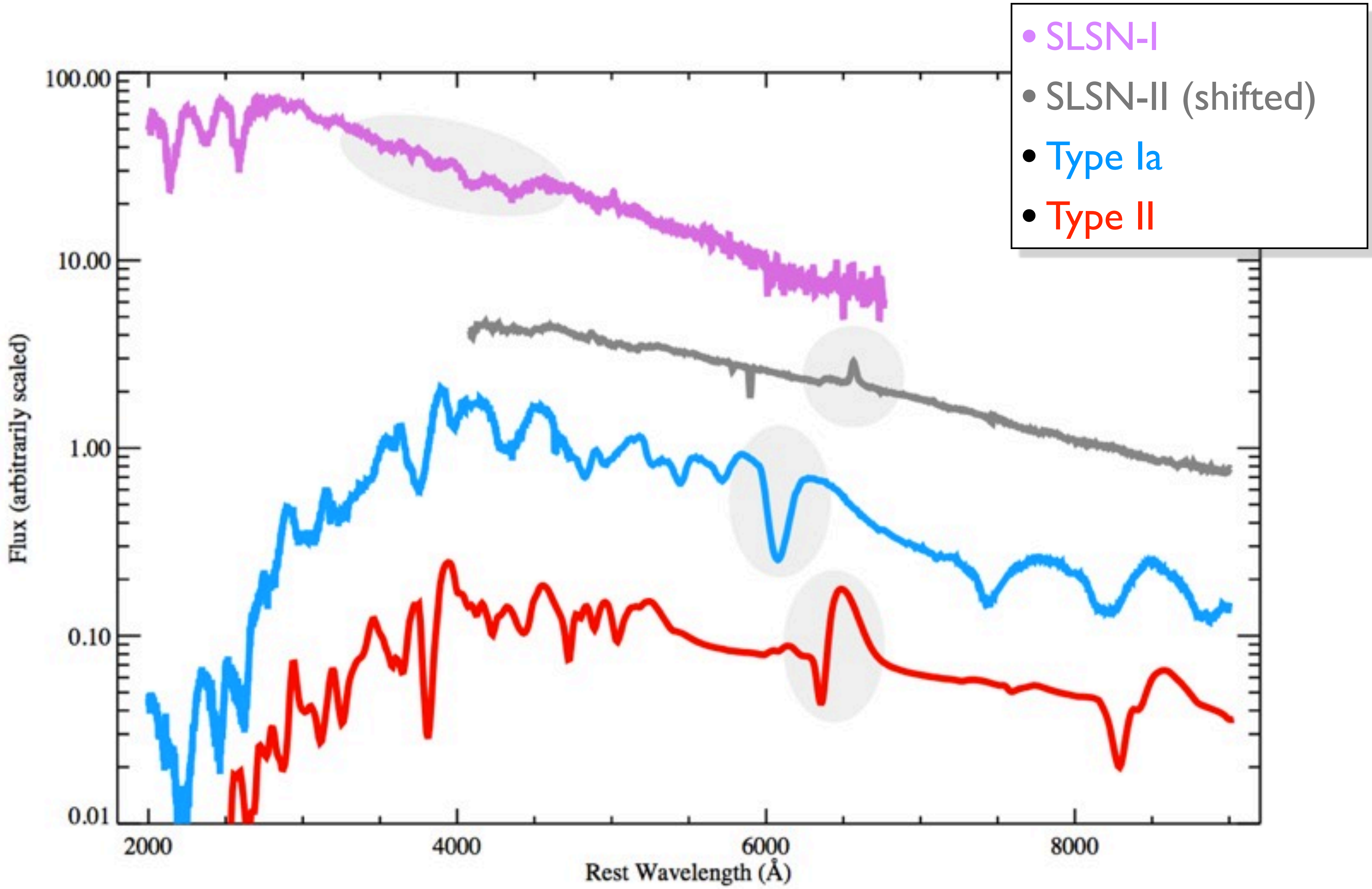
December 12, 2012

Absolute Magnitude Distribution of Supernovae

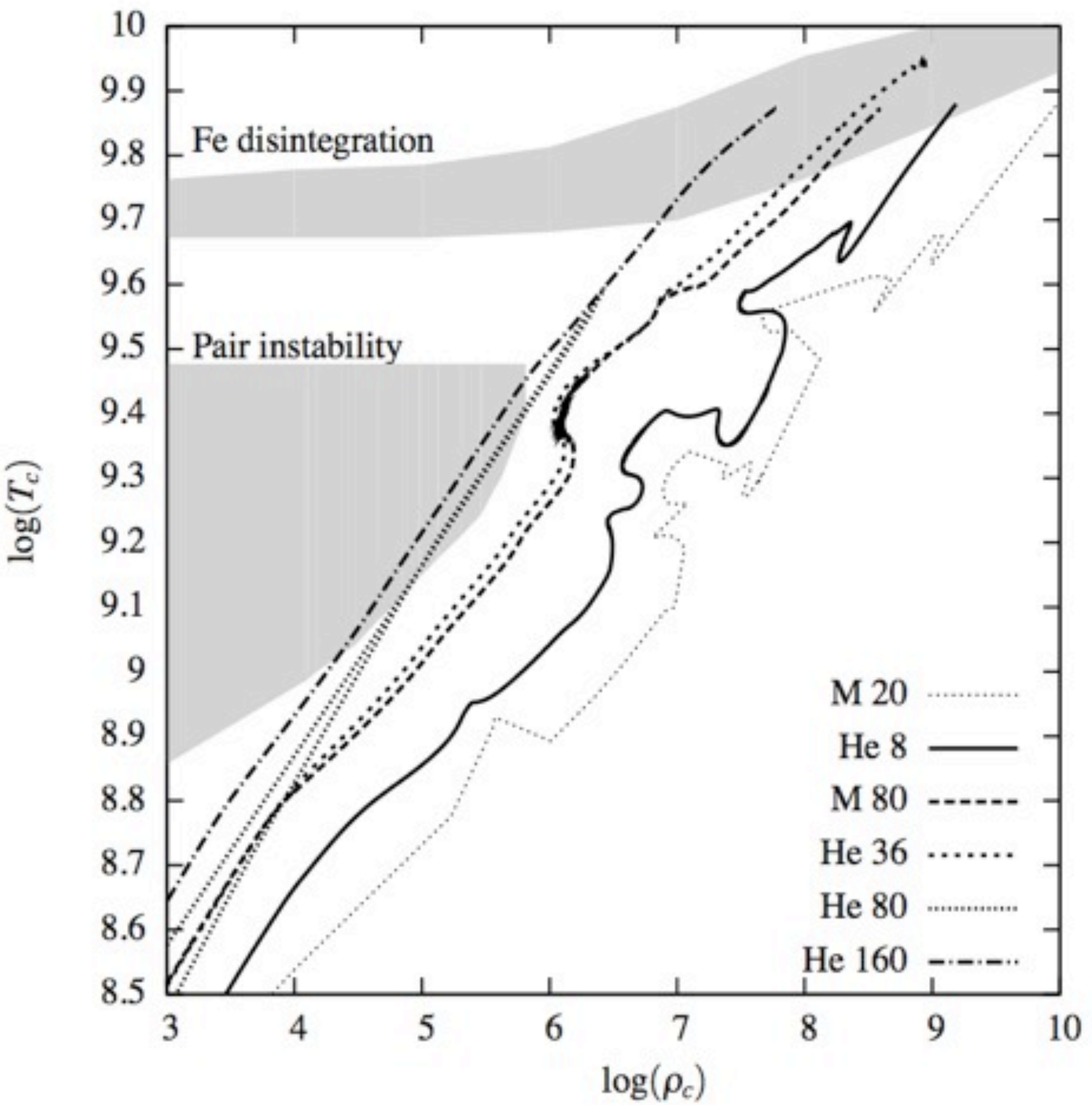


Data from LOSS (Li et al. 2011)

SLSN Spectra



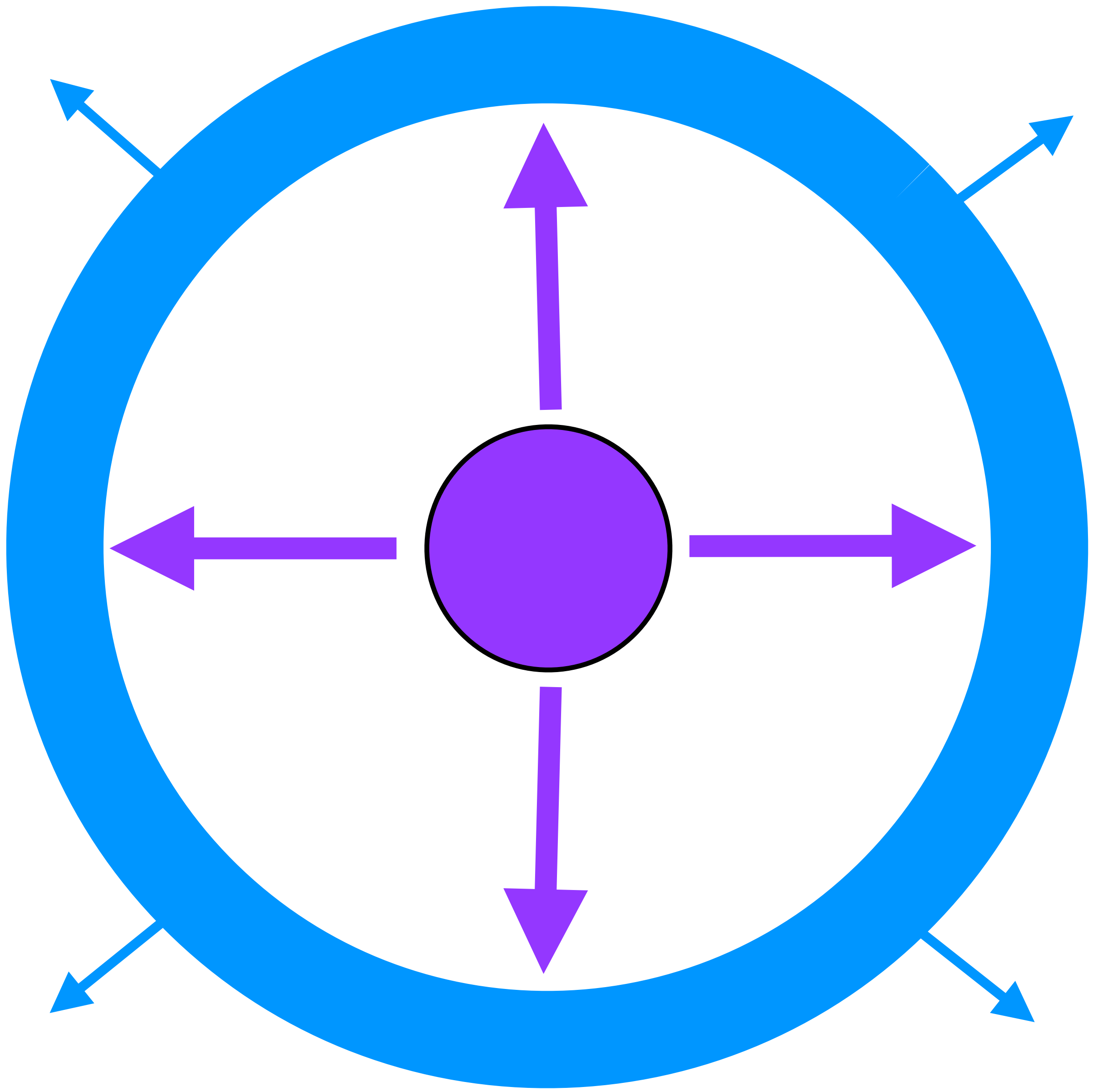
Pair-Instability SNe



Waldman 2008

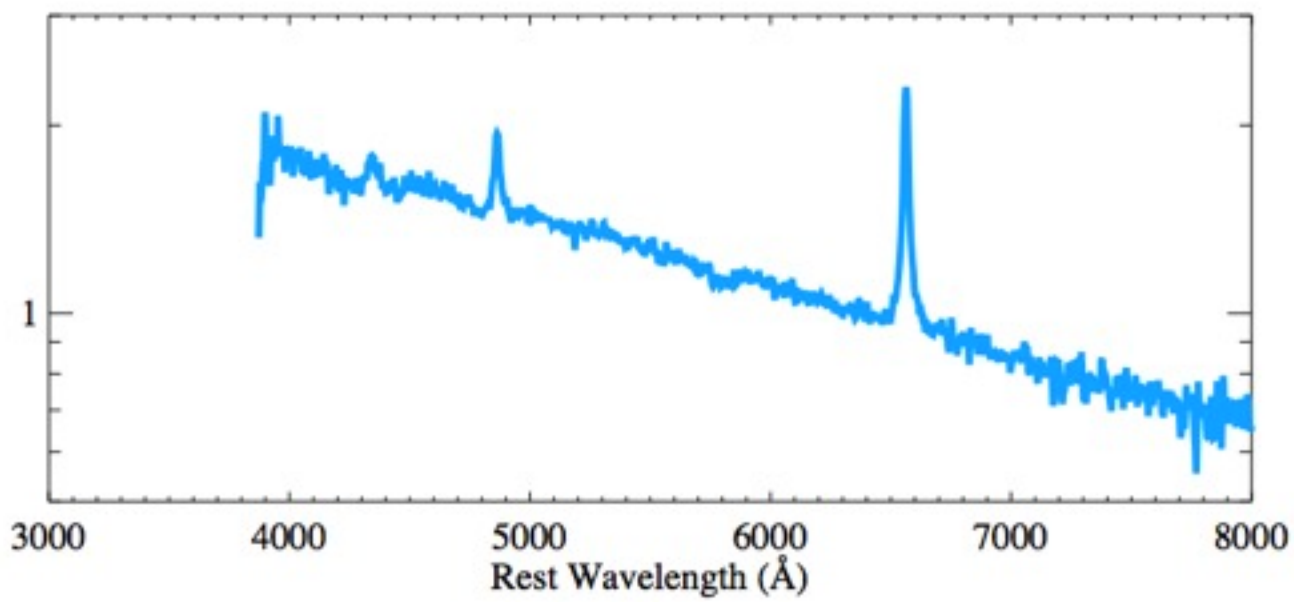
- First Proposed it the 1960's (Rakavy et al. 1967; Barkat et al. 1967)
- Massive stars are supported by radiation pressure
- At high temperatures, photons are created with E > e+e-
- Losses to pair production soften the EOS, and lead to instability
- Expected fate of the first (low metal, high mass) stars

Shell Scenario

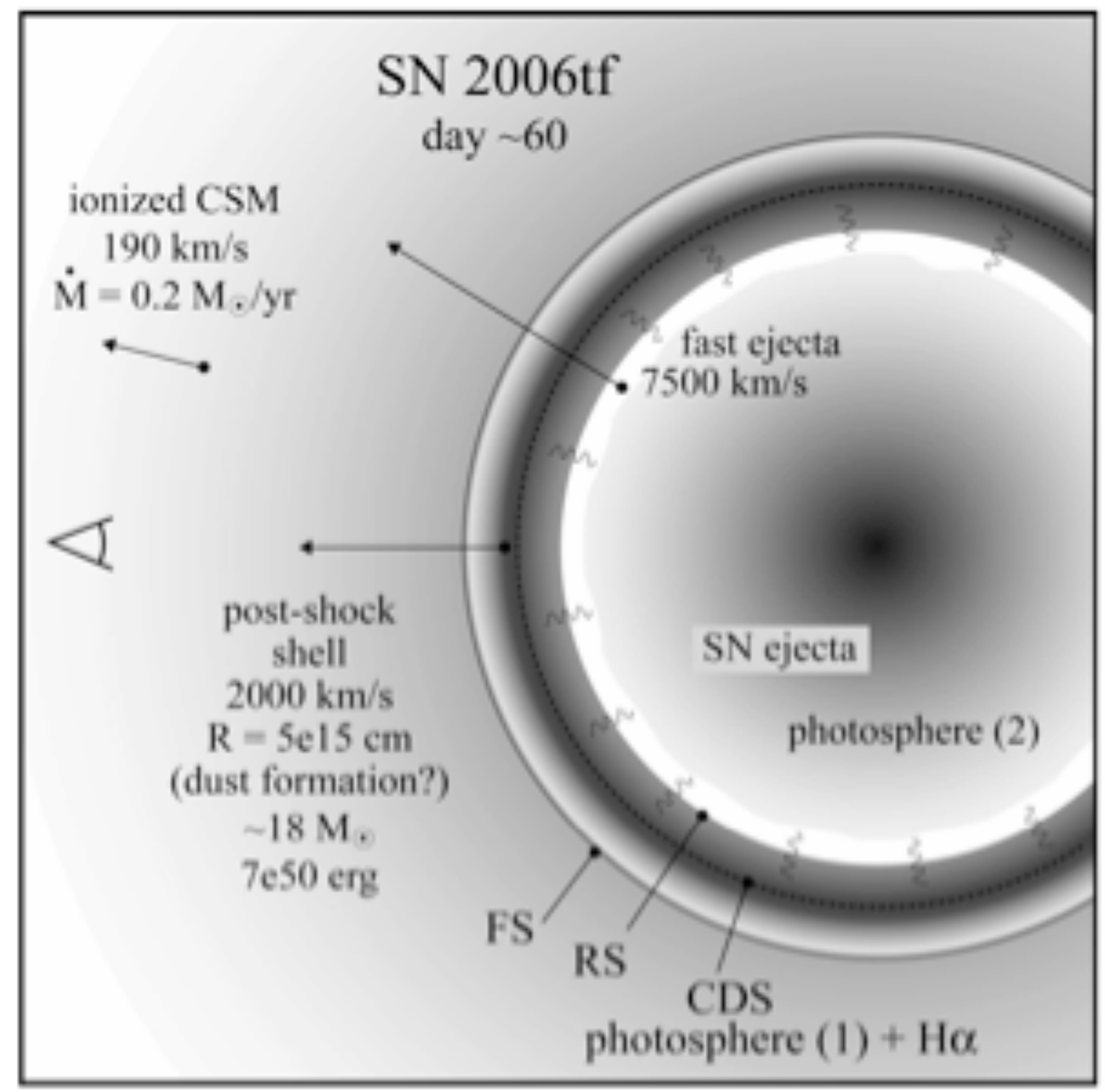


- outer shell at $\sim 10^{15}$ cm (expanding at a few 1000 km/s?)
- energy injected from with in

Interaction Power

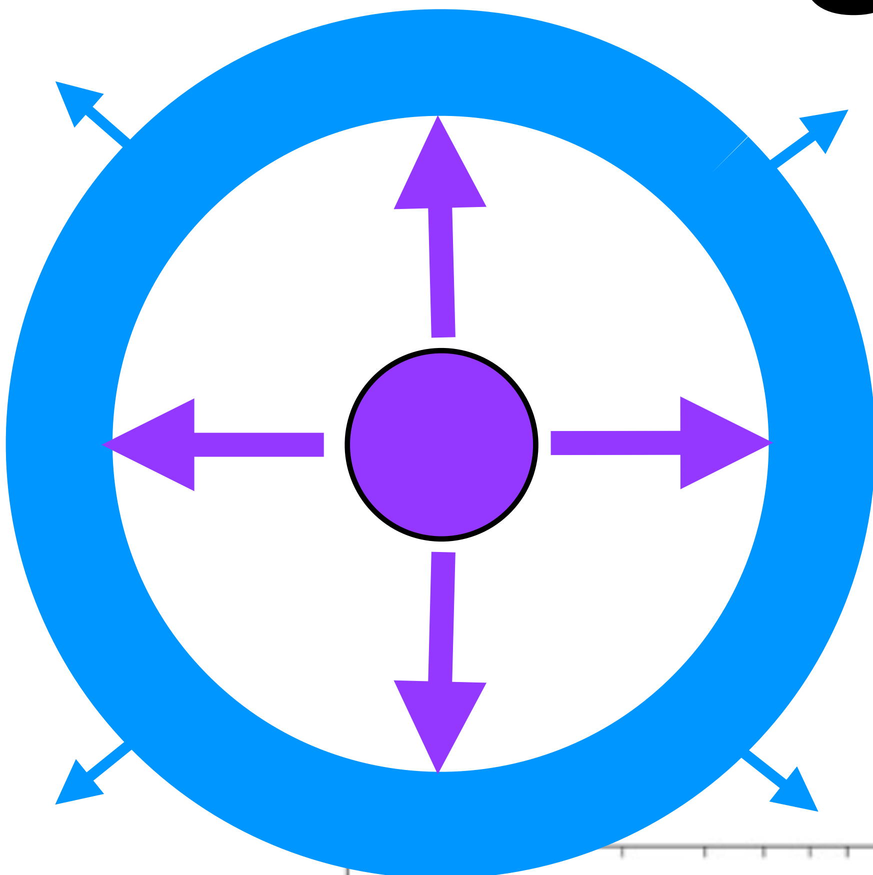


Ejecta run into surrounding material (progenitor wind, shells, etc.)



Smith et al. 2008

Magnetar Power

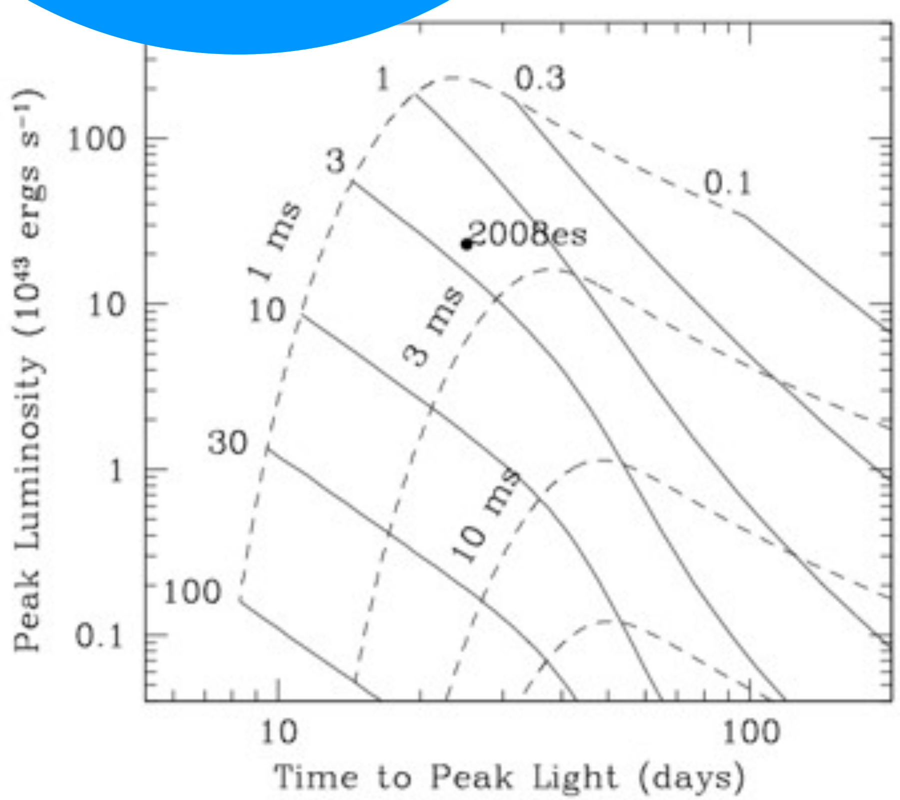


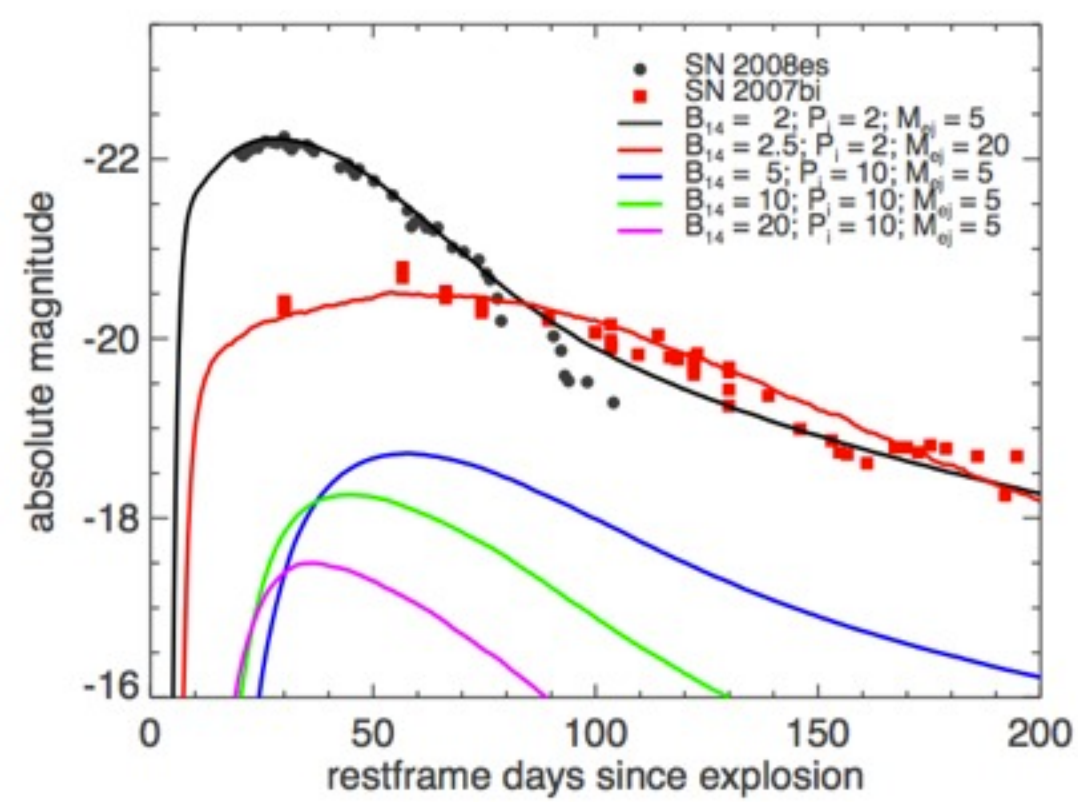
$$E_p = \frac{I_{ns}\Omega_i^2}{2} = 2\times 10^{50} P_{10}^{-2}\ \mathrm{ergs},$$

$$t_p = \frac{6 I_{ns} c^3}{B^2 R_{ns}^6 \Omega_i^2} = 1.3 B_{14}^{-2} P_{10}^2\ \mathrm{yr},$$

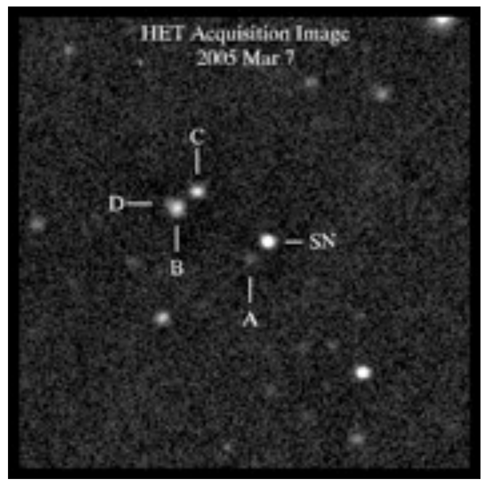
$$L_{peak} \sim \frac{E_p t_p}{t_d^2} \sim 5\times 10^{43} B_{14}^{-2} \kappa_{es}^{-1} M_5^{-3/2} E_{51}^{1/2} \mathrm{erg\ s^{-1}}$$

Kasen & Bildsten 2010; see also Woosley 2010

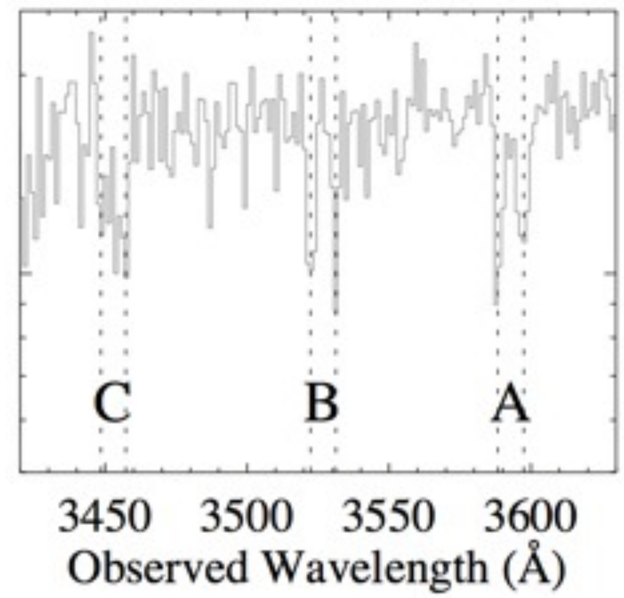


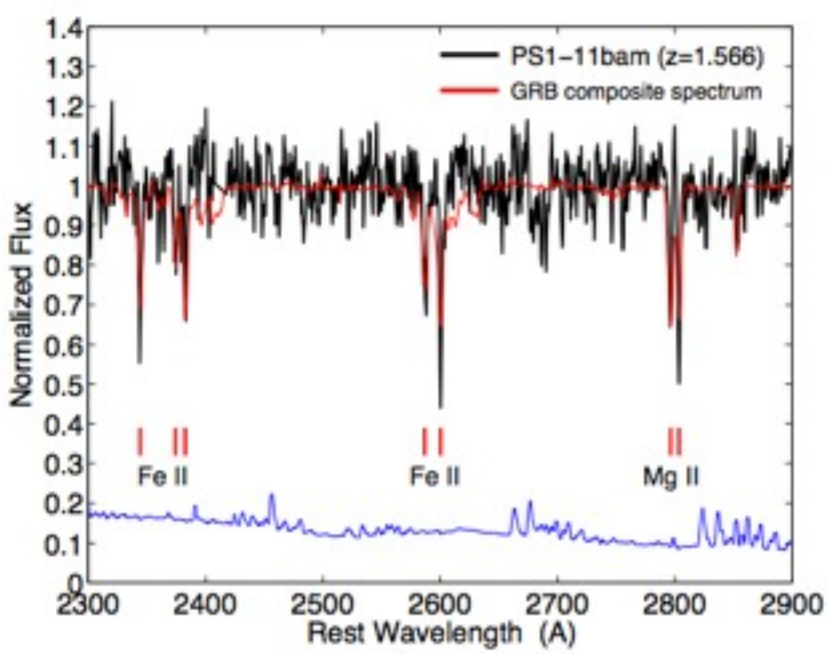


What ever they are, SLSNe are potential useful probes!

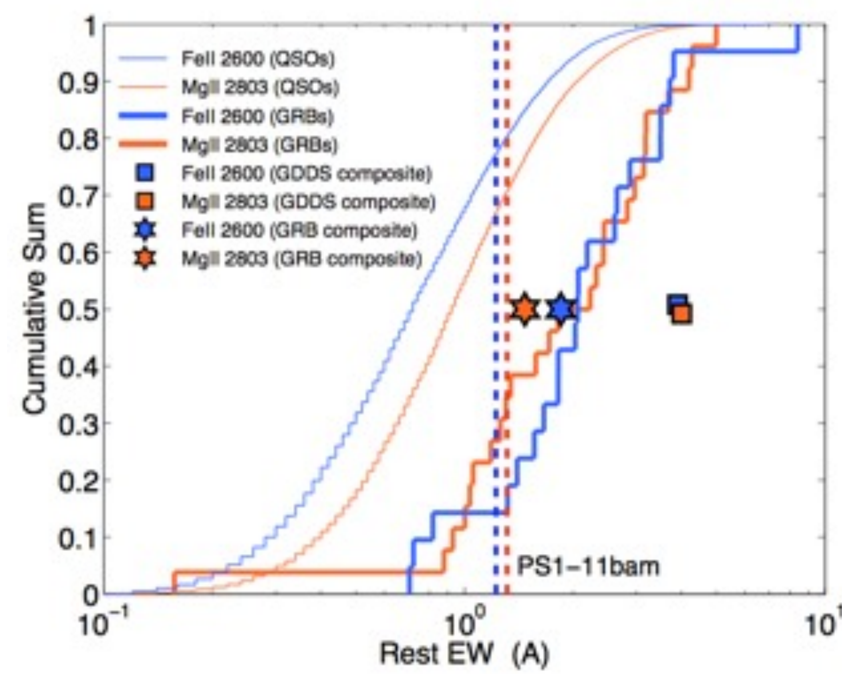


SN 2005ap
z=0.238



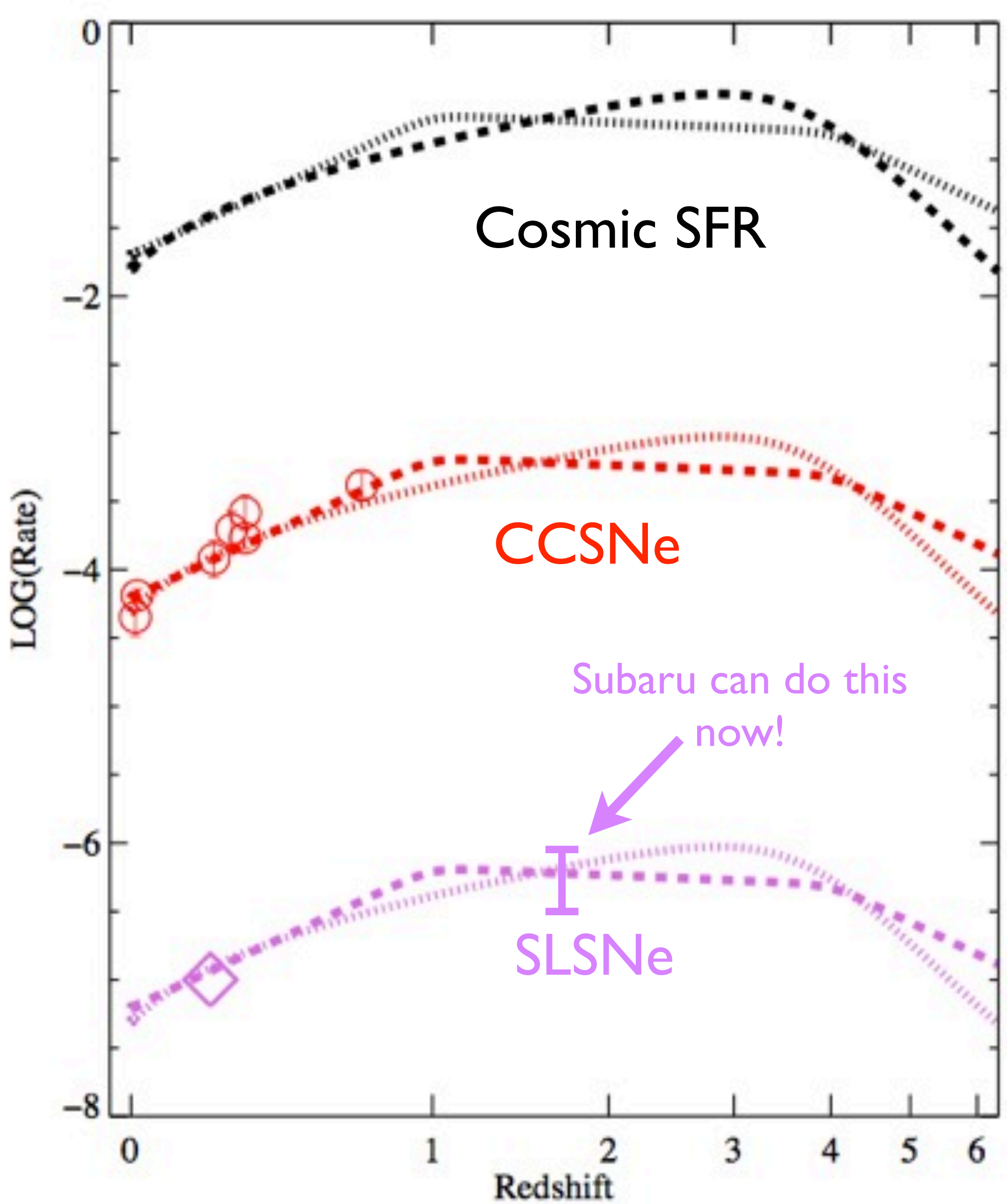


PS1-11bam
z=1.566



Berger et al. (2012)

What ever they are, SLSNe are potential useful probes!



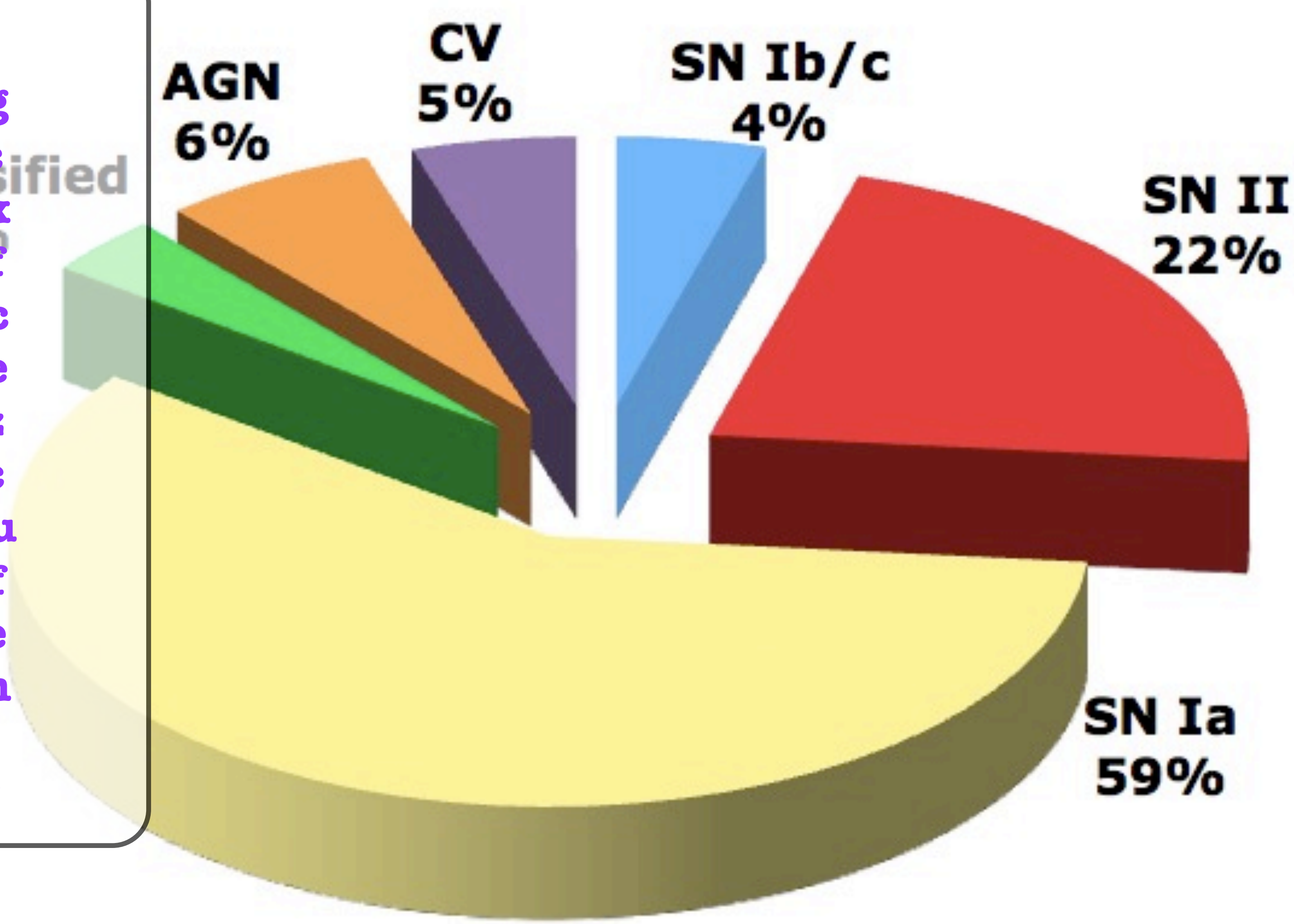
$$R_{\rm SN}(z) = \dot{\rho}_*(z) \frac{\int_{M_{\rm min}}^{M_{\rm max}} \psi(M)\, dM}{\int_{0.1}^{100} M \psi(M)\, dM}$$

see Masaomi Tanaka et al. (2012)

PTF Spectroscopic Sample (all types)

PTF SLSN

12dam	12epg
11rks	12efc
11dij	11hzx
10aagc	11dsf
10vqv	10yyc
10uhf	10xee
10nmn	10tpz
10jwd	10scc
10cwr	10qwu
10bjp	10qaf
09cwl	10ooe
09cnd	10heh
09atu	10fel
	09uy



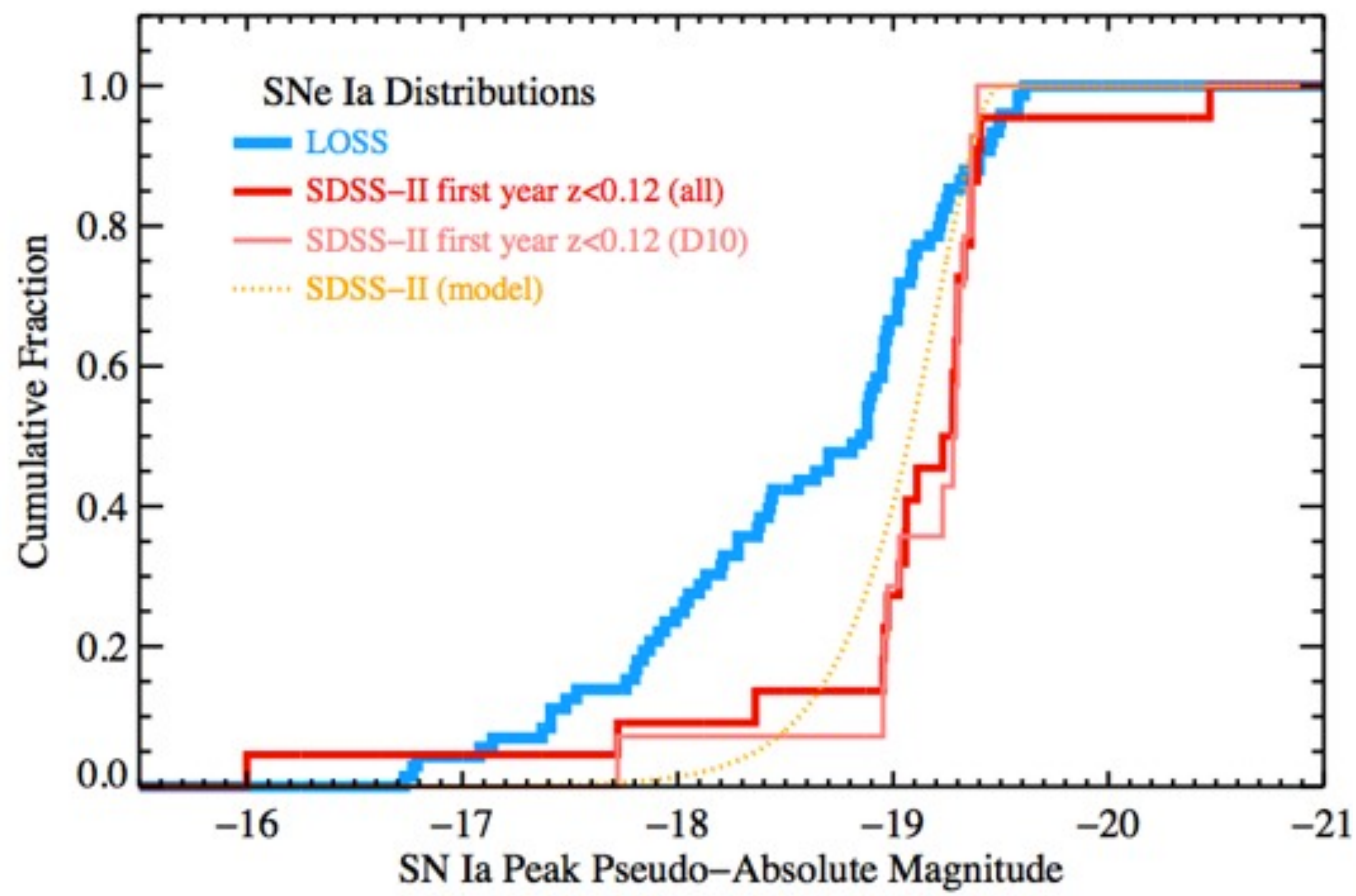
1821

~~1052~~ Spectroscopically Confirmed PTF Transients To Date

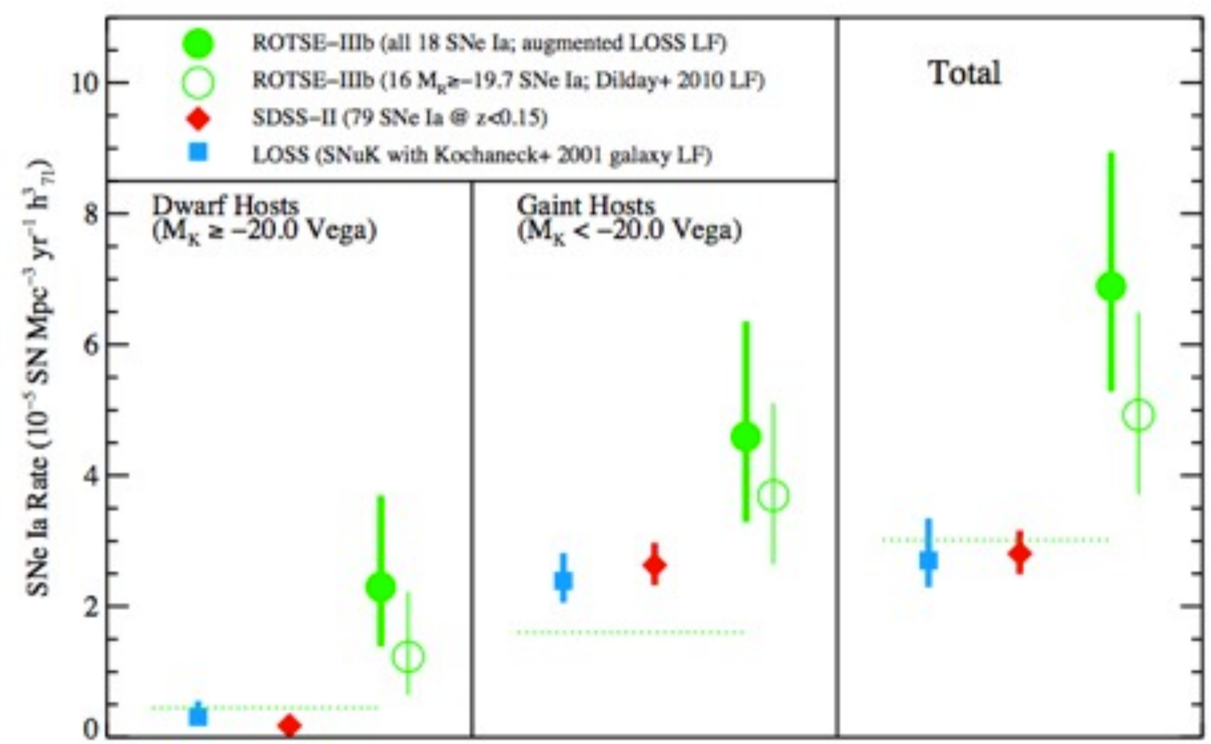
SNe From ROTSE-IIIb

- TSS/RSVP
  - 0.45-m ROTSE-IIIb telescope
  - 1.85 X 1.85 degree FoV
  - Began in Fall ‘04
  - **1-3 day cadence, M_{lim} ~ 18**
  - Target selection without (intentional) host bias
  - High quality spectra of all transients
  - >90 SNe to date including 7-8 LSNe
  - Only spectroscopically complete Transient Survey

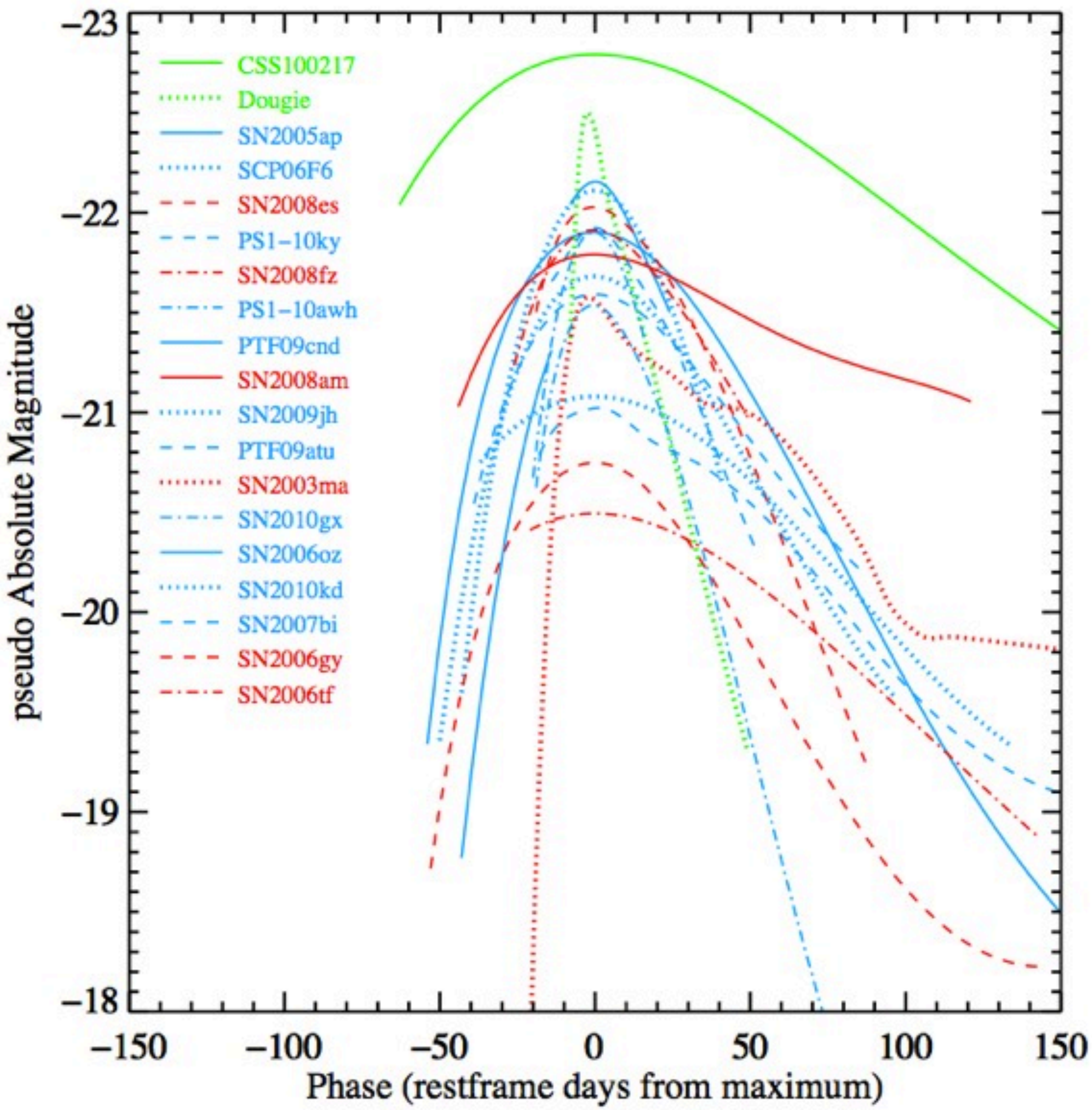
pseudo-Absolute Magnitude Distributions (pAMDs)



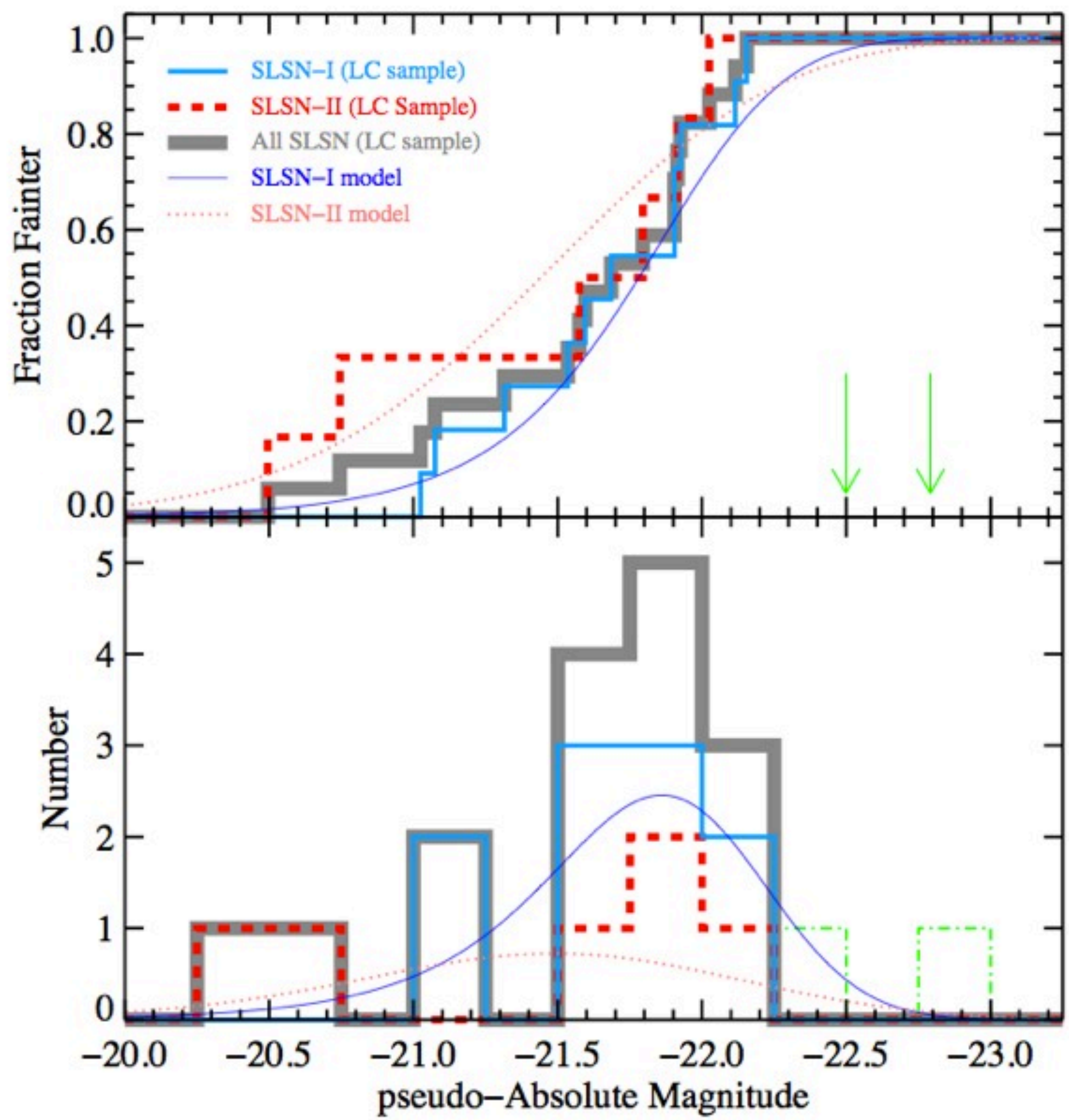
Type Ia



SLSN Light Curves

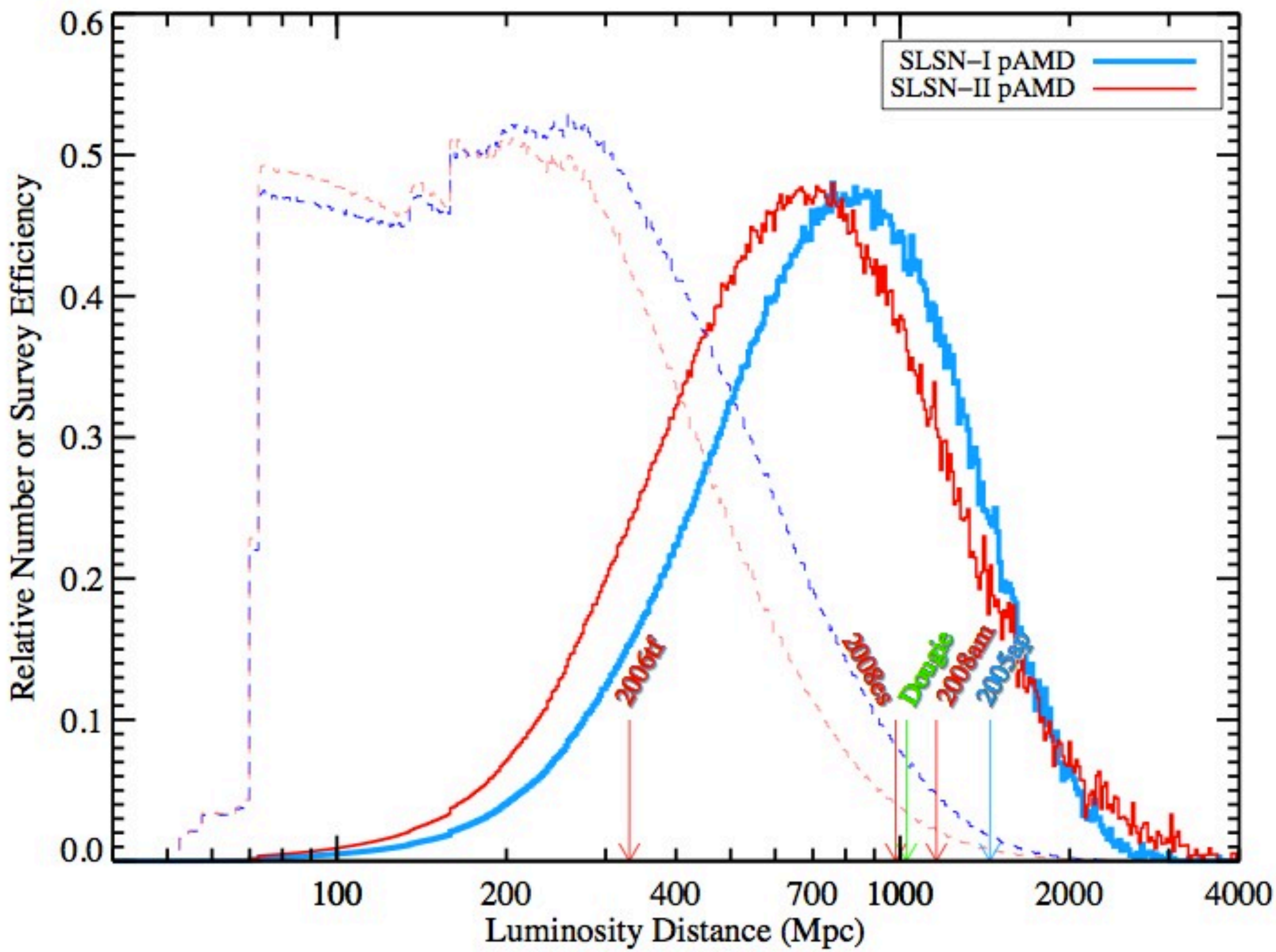


SLSNe pAMDs

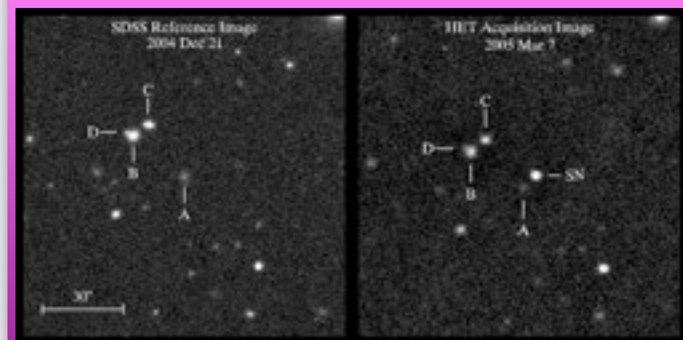


SLSN−I (LC sample)
SLSN−II (LC Sample)
All SLSN (LC sample)
SLSN−I model
SLSN−II model
Fraction Fainter
1.0
0.8
0.6
0.4
0.2
0.0
Number
5
4
3
2
1
0
−20.0
−20.5
−21.0
−21.5
−22.0
−22.5
−23.0
pseudo−Absolute Magnitude

ROTSE-IIIb Survey Efficiency



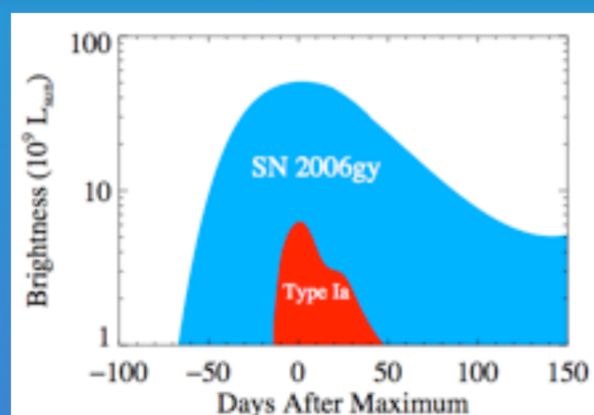
Local SLSN Rates (based on ROTSE-IIIb sample)



SLSN-I

~30 events/Gpc^3/yr

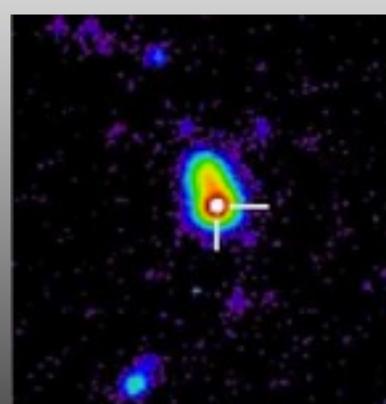
(z~0.17)



SLSN-II

~150 events/Gpc^3/yr

(z~0.15)



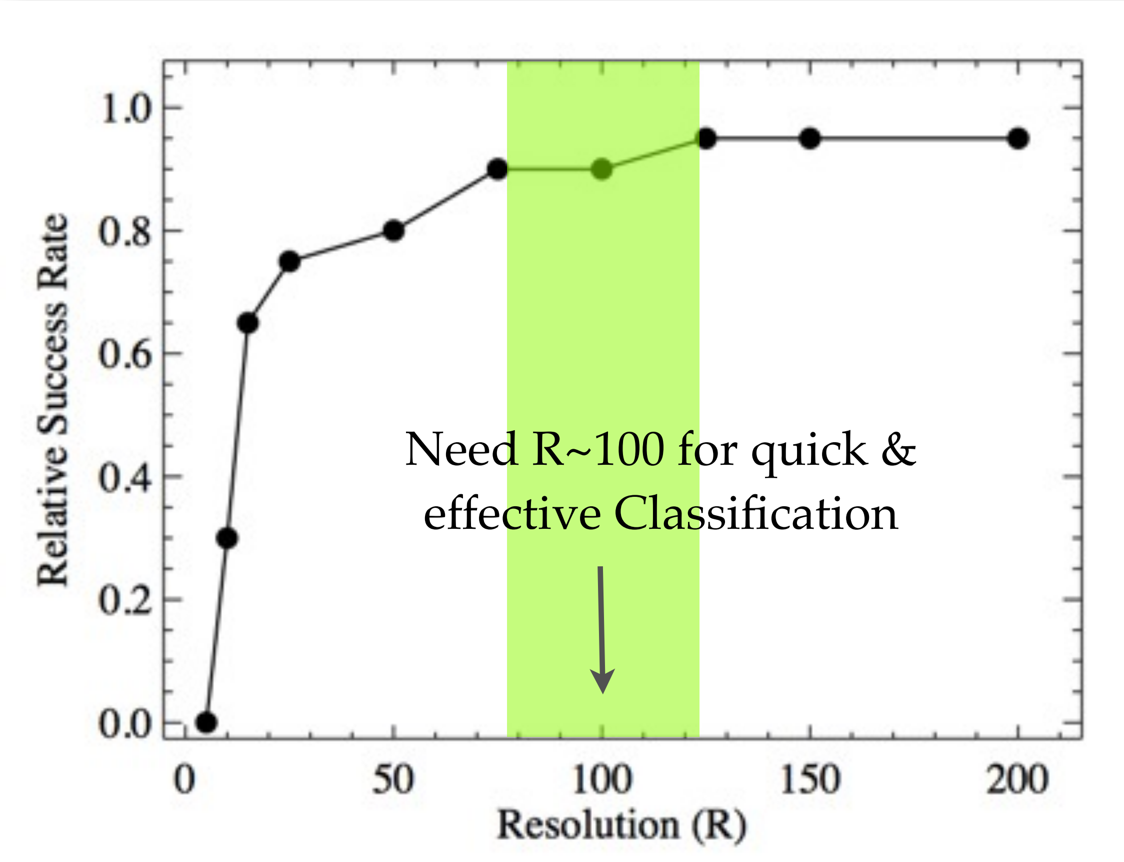
All SLSN-like events

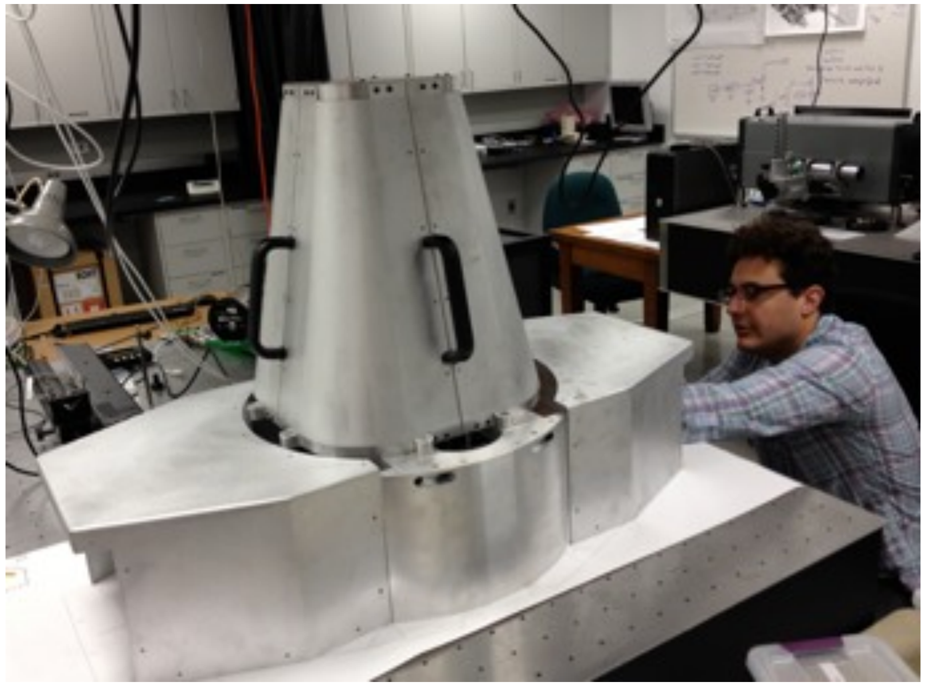
~200 events/Mpc^3/yr

(z~0.16)

Compare to CCSN: ~10^5 events/Gpc^3/yr and SNIa: ~$3x10^4$ SN/Gpc^3/yr

SED-Machine



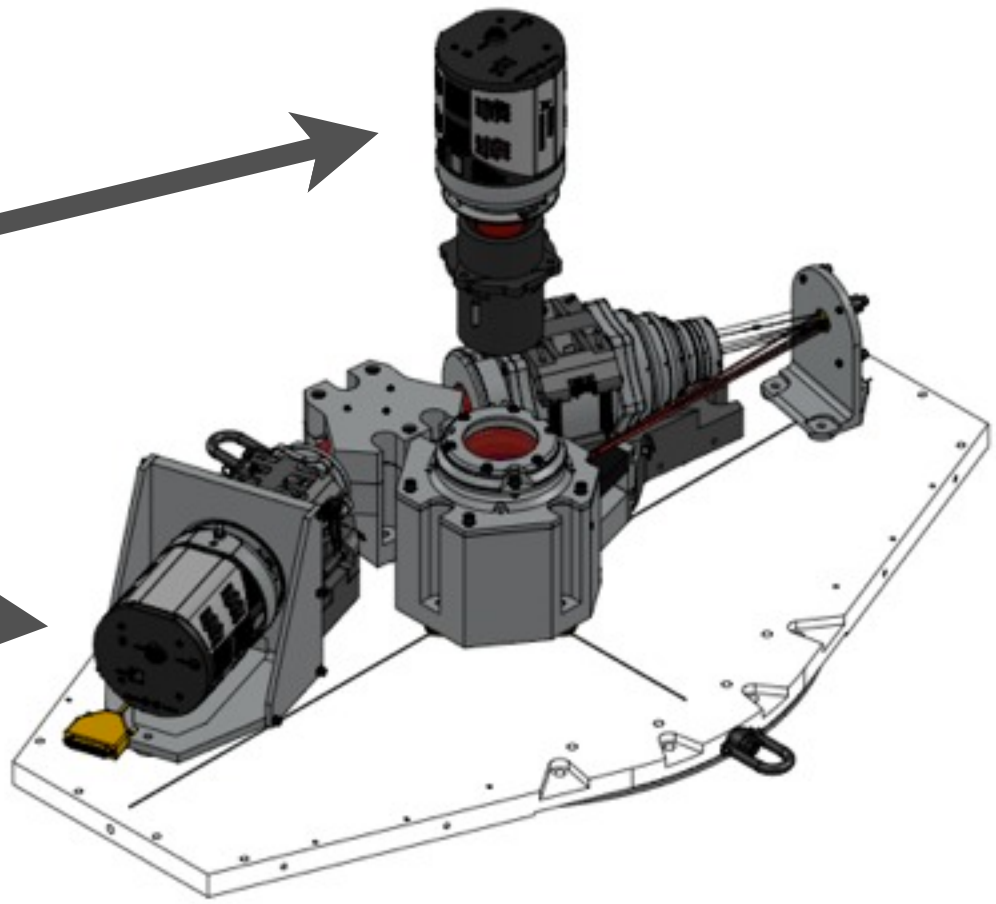


Designed for efficient classification of optical transients

Imaging Channel
four ~6'x6' areas

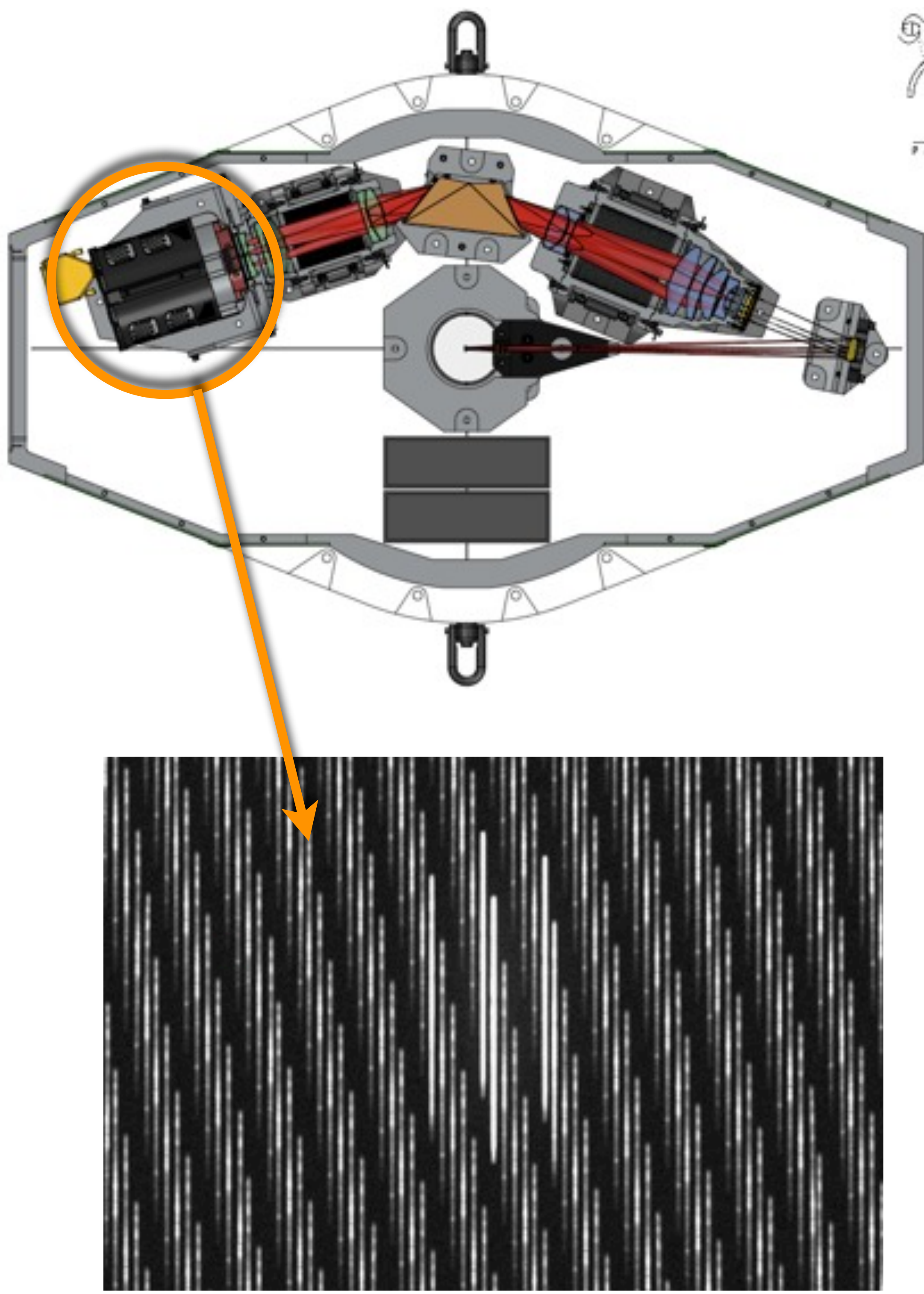
Spectroscopic Channel
IFU (~26"x26", 0.75" spaxels)
R~100, 3700-9200λ

Fully Funded, glass in hand
Commissioning early Spring 2013



SED-Machine

Integral Field Spectra



Photometry of Surrounding Field