Non-Ia Supernovae Simulations in SNANA

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Outline

- Non-Ia Templates in SNANA
- Some Results for DES
- Summary

Current Templates and Issues

- Input templates due to
  - hard work of Taylor, Sako, Kessler, Nugent
  - not work of ANL group
- Our job is to analyze & criticize!
  - Nugent templates for Ibc, IIP, IIL, IIn
  - SDSS 5 Ibc
  - SDSS 5 IIP

Current Templates and Issues

- Nugent templates
  - Composite Type IIP model
    - based on Baron (2004)
    - tested in that paper on 5 SN
  - Type Ibc model
    - based on 1999ex
    - ~average of 3 SN in Hamuy (2002)

Current Templates and Issues

- Nugent templates
  - Type IIn
    - based on 1999el
    - almost 2 mags dimmer than normal IIn
  - Type IIL
    - from Gilliland (1999)
    - not much more known

Current Templates and Issues

- Nugent templates
  - No magnitude or color fluctuations
  - Added mag fluct. based on Richardson
  - Don’t really know if selection biases exist

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A COMPARATIVE STUDY OF THE ABSOLUTE MAGNITUDE DISTRIBUTIONS OF SUPERNOVAE

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TABLE 1
RESULTS

SN Type	$\overline{M}_{B,\mathrm{obs}}$	σ_{obs}	$\overline{M}_{B,\mathrm{int}}$	σ_{int}	Conf.	N
Normal Ia	-19.16 ± 0.07	0.76	-19.46	0.56	0.89	111
Total Ibc	-17.92 ± 0.30	1.29	-18.04	1.39	0.96	18
Bright Ibc.....	-19.72 ± 0.24	0.54	-20.26	0.33	~1	5
Normal Ibc	-17.23 ± 0.17	0.62	-17.61	0.74	~1	13
Total II-L.....	-17.80 ± 0.22	0.88	-18.03	0.90	0.91	16
Bright II-L	-19.12 ± 0.12	0.23	-19.27	0.51	~1	4
Normal II-L...	-17.36 ± 0.12	0.43	-17.56	0.38	~1	12
II-P	-16.61 ± 0.23	1.23	-17.00	1.12	~1	29
IIn.....	-18.78 ± 0.31	0.92	-19.15	0.92	~1	9

Shift mean brightness of Nugent IIn to match Richardson, plus fluctuate all 4 types with shown widths

Current Templates and Issues

- SDSS templates
  - currently used for comparison only
  - 5 Ibc
  - No extra smearing added

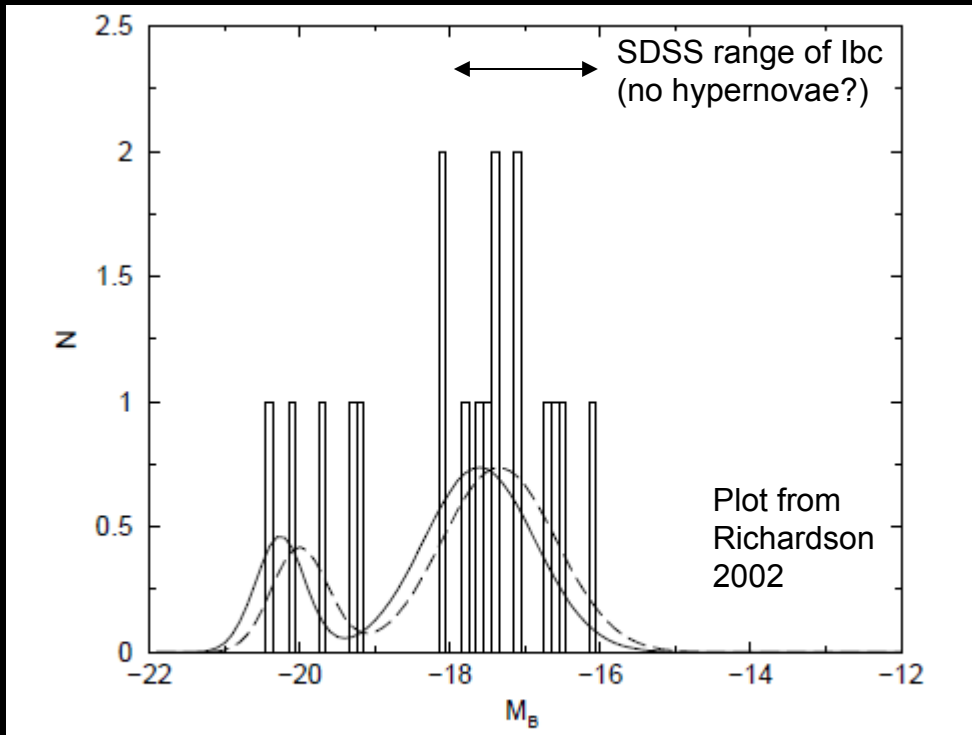


FIG. 7.—Same as Fig. 6, but for SNe Ibc divided into two groups of five bright and 13 normal events.

Current Templates and Issues

- SDSS templates
  - 5 IIP very consistent in absolute magnitude and spread with Richardson
  - Biased to be Ia-like?
  - Nothing for IIn or IIL?

Input Rates

Total CC rate

- Use $\alpha(1+z)^{\beta}$, with $\beta=3.6$ (same as SFR)
- Calculating α
  - use SNLS CC/Ia ratio 4.5 for z<0.4
- Gives $\alpha=6.8\times 10^{-5}$

Input Fractions

- Literature rather sparse on relative fractions
- Our relative fraction of Non-Type comes from
  - Mannucci (2004), Cappellaro (1999)
  - Discussion with Peter Nugent
- Using largest Ibc estimate to be conservative

Input Fractions

Type	% of Non-Ia
IIP	70%
Ibc	15%
IIL	10%
IIn	5%

DES Numbers

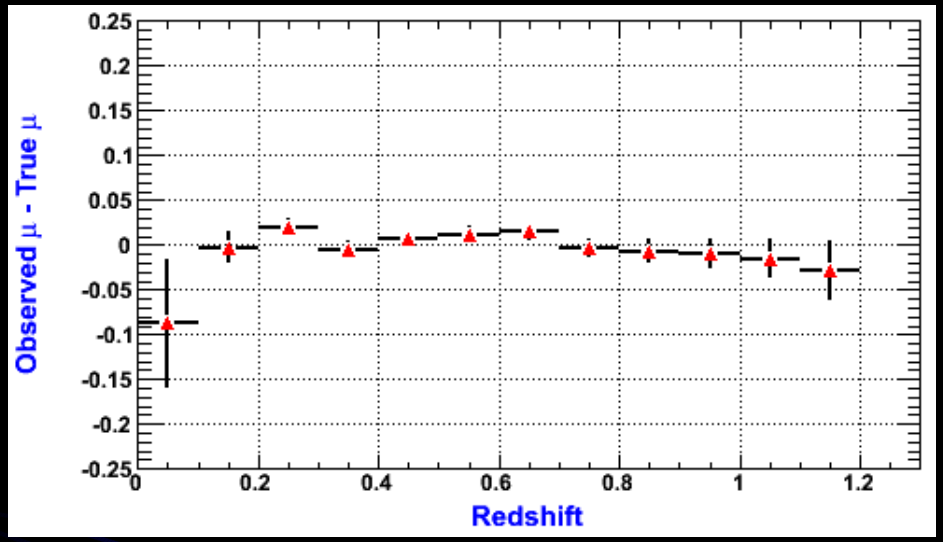
Assume 100% host galaxy spectra (specz)		
Type	# of SNe pass default cuts	# of SNe pass default cuts + fit. prob. > 0.1
Ia	3066	2954
Ibc Nugent	**486**	**183**
IIP Nugent	**775**	**10**
IIL Nugent	112	10
IIn Nugent	1417	26
Ibc SDSS	**165**	**25**
IIP SDSS	**2370**	**165**

Default cuts

- at least 5 total epochs with very small, non-zero S/N
- at least one epoch before and one 10 days after *B*-band peak
- at least one measurement above S/N = 10
- at least 2 more with above S/N = 5

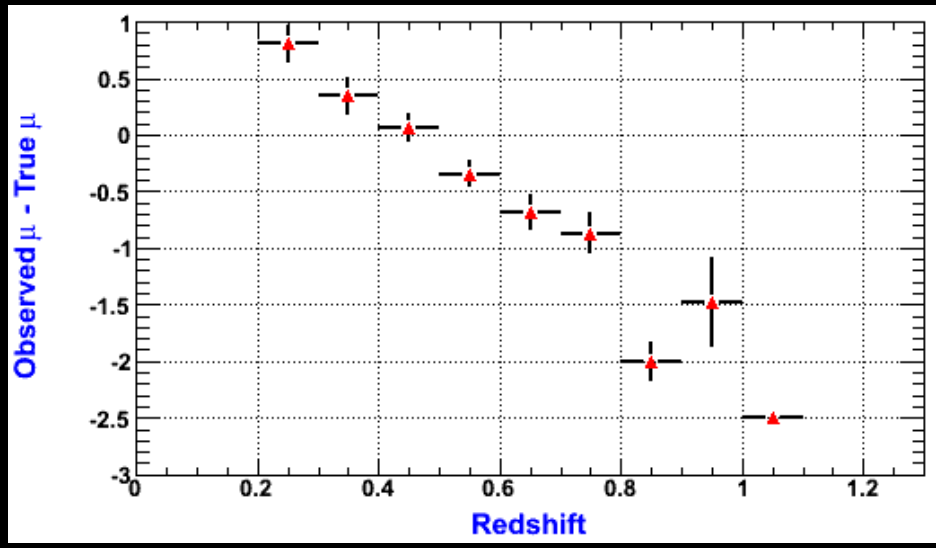
- 100,664 total SNe generated, 9344 Type Ia SNe
- About 7% contamination after fit probability > 0.1 cut

Using Nugent Templates

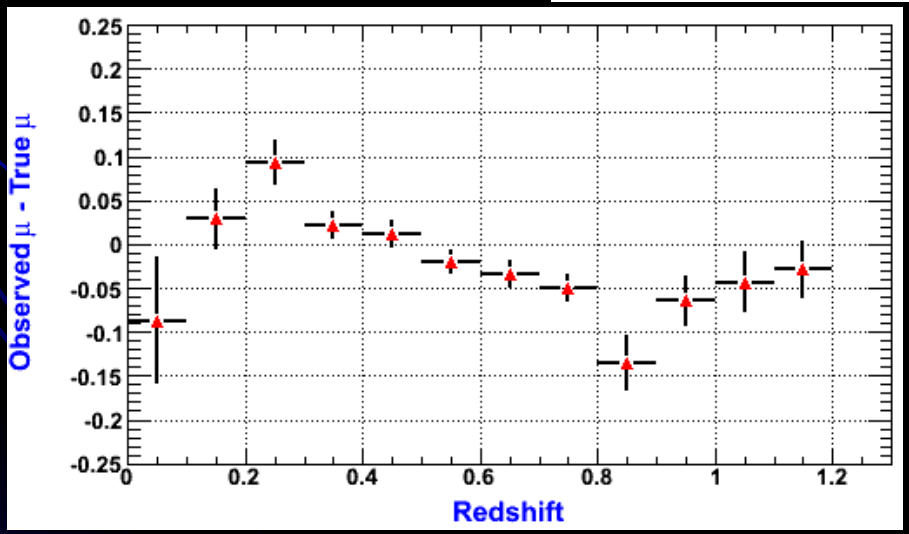


Type Ia

Note: change of scale



Core Collapse



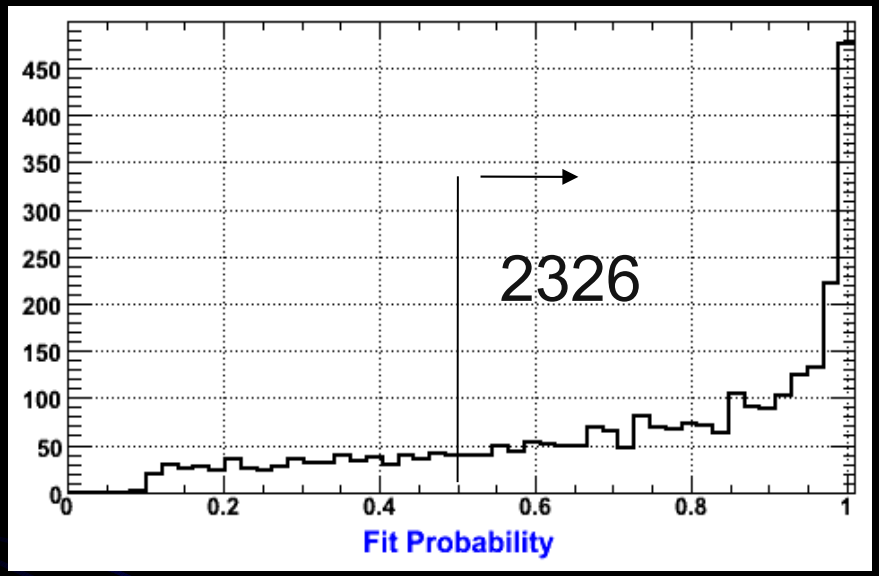
Entire Sample

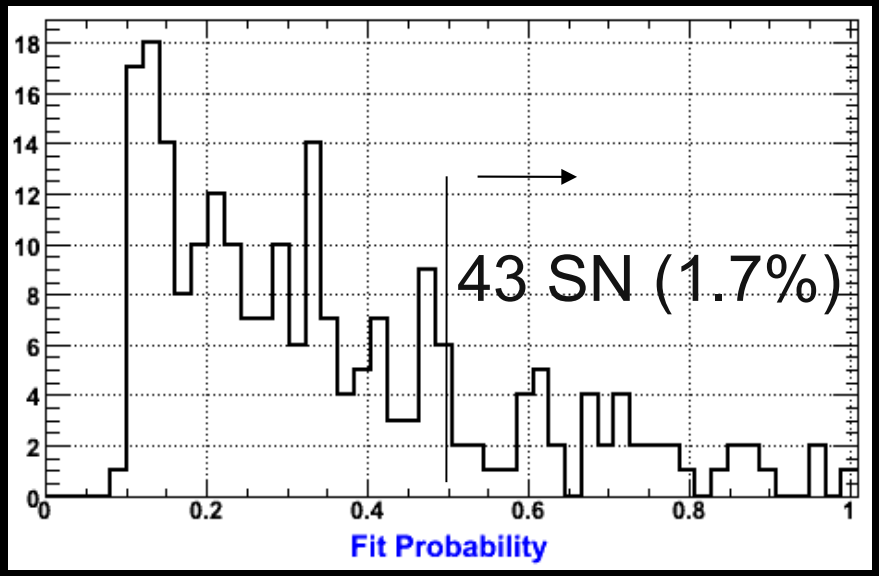
Cosmology Fit Using W-fit

- SN simulated with $w_0 = -1$
- Adding "contamination" reduces w_0 dramatically
- Need to reduce contamination, make a distance correction, or both

Assume 100% host galaxy spectra		
Type	Number of Events (Default Cuts + fit prob > 0.1)	w_0
Ia	2954	-0.983 (+0.058 -0.047)
Entire Sample	3183	-0.737 (+0.047 -0.038)

Tighter Fit Probability Cuts

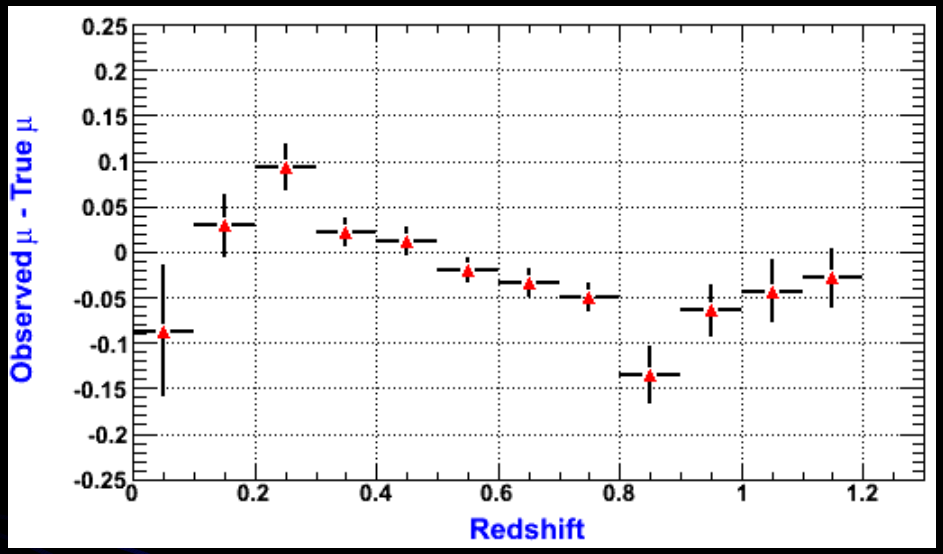




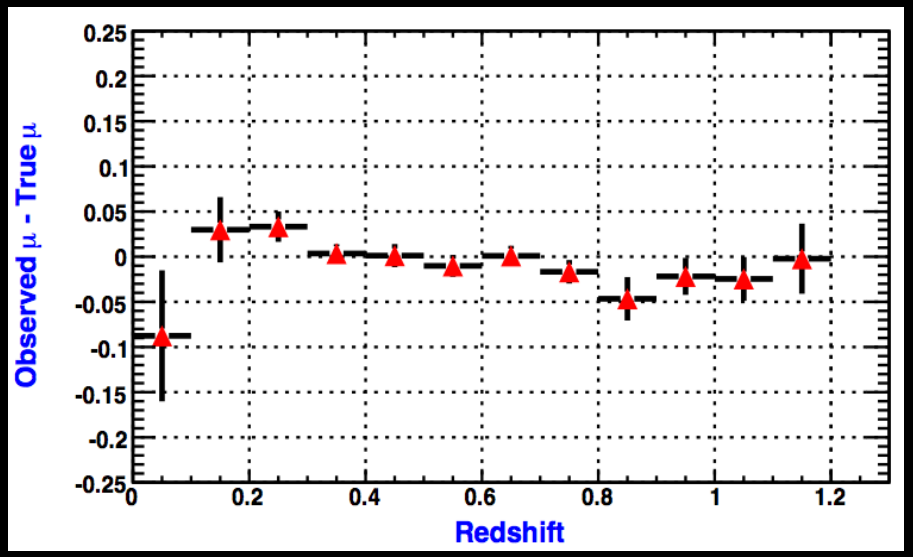
Type Ia ***Core Collapse***

- One way to reduce contamination: change fit prob. to > 0.5 cut
  - Loss of 600 Type Ia SNe vs fit prob. > 0.1 cut
  - Contamination drops from 7.2% to 1.7%

Tighter Fit Probability Cuts



Fit Prob. > 0.1

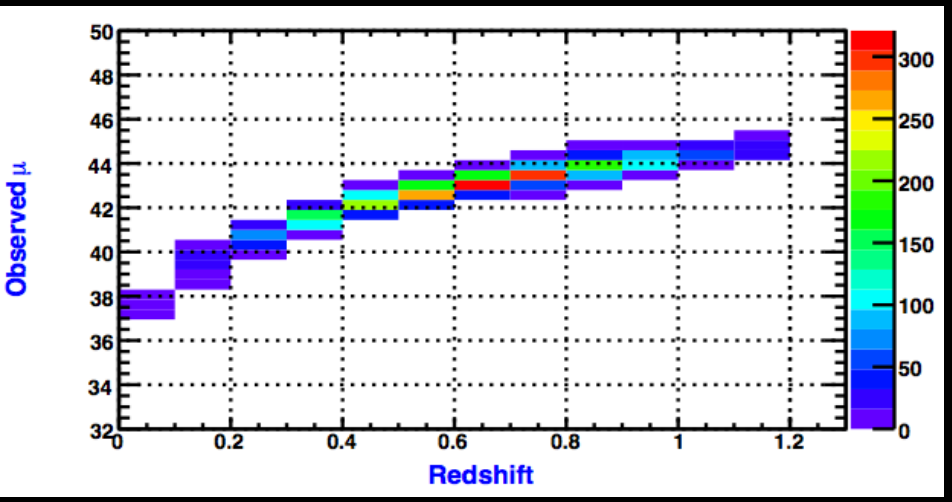


Fit Prob. > 0.5

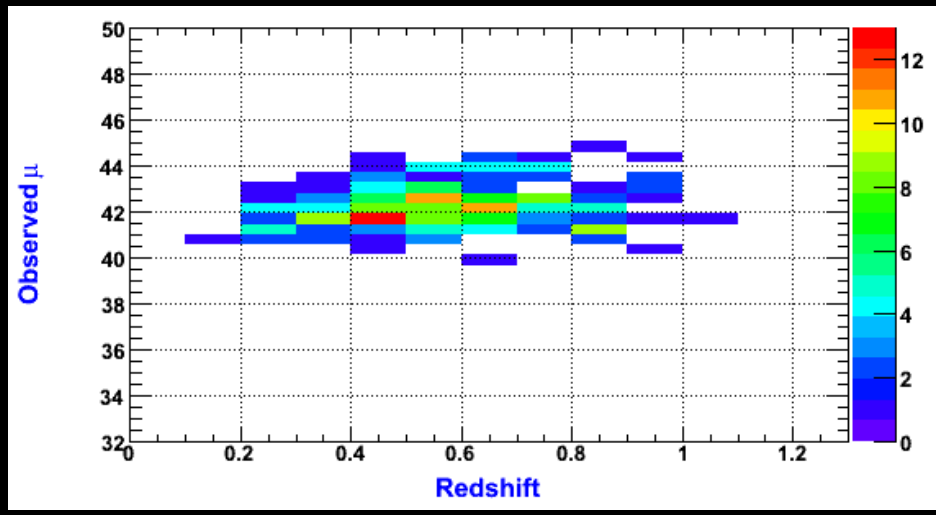
Assume 100% host galaxy spectra		
Type	Number of Events (Default Cuts + fit prob > 0.5)	w_0
Ia	2326	-0.958 (+0.059 -0.046)
Entire Sample	2369	-0.902 (+0.052 -0.048)

Contamination Indicators

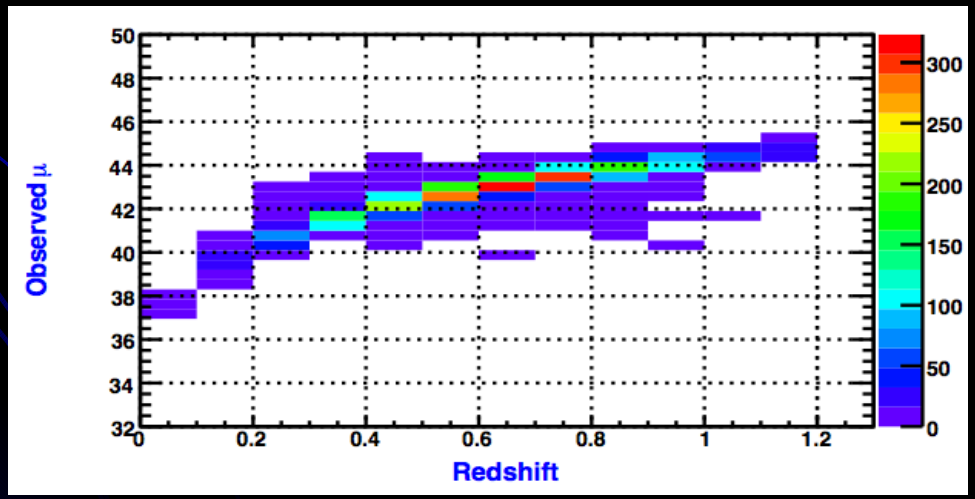
Note: Fit Prob. > 0.1



Type Ia

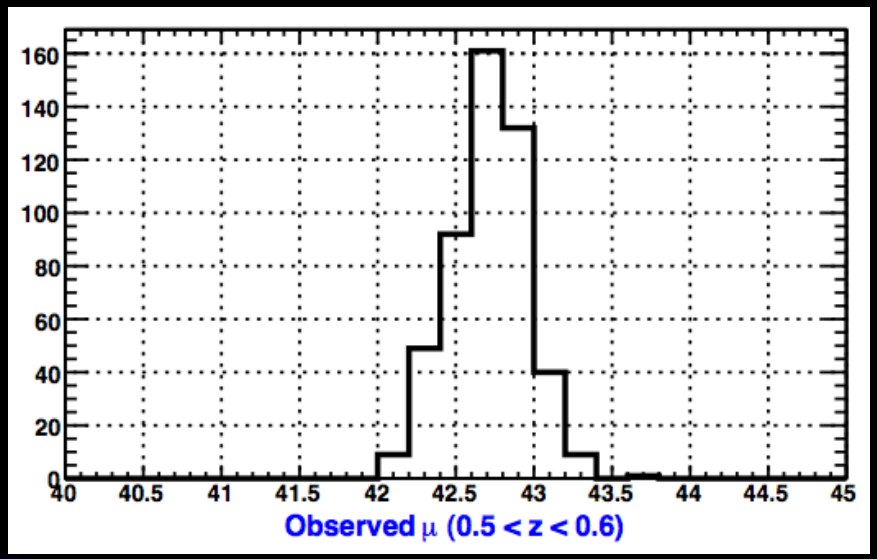


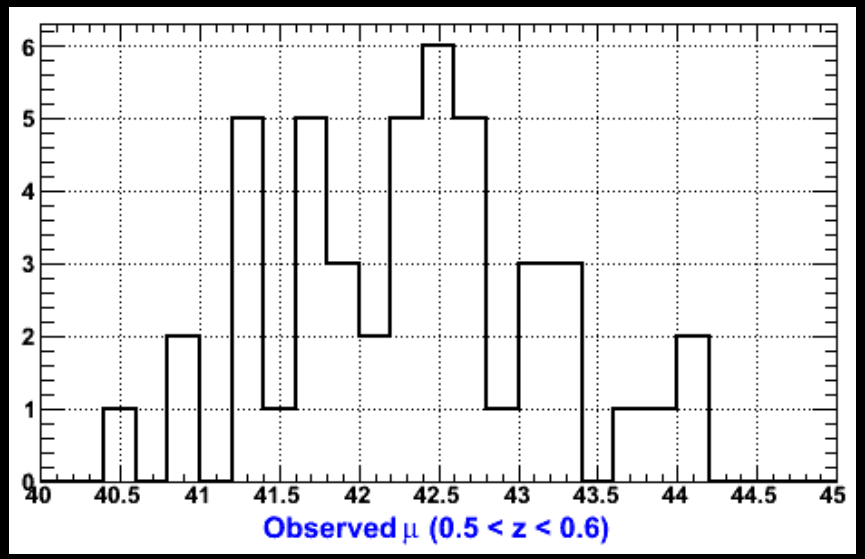
Core Collapse



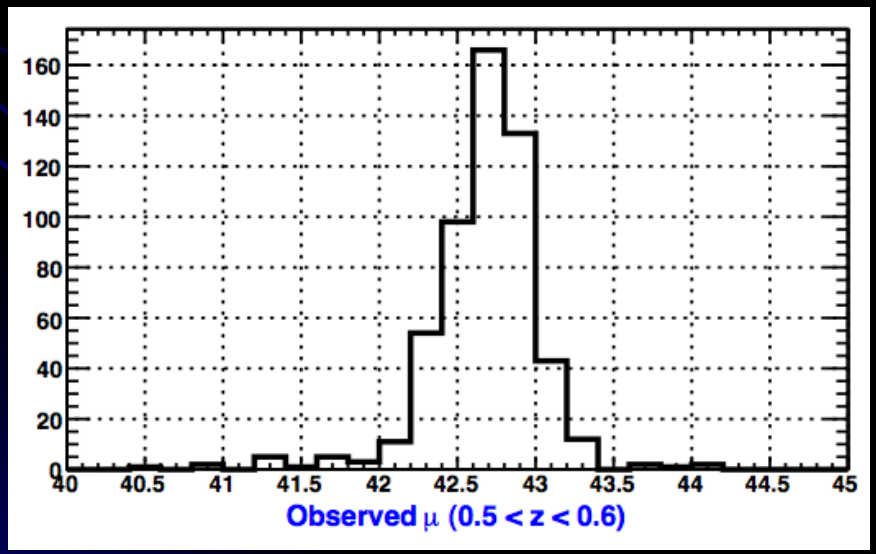
Entire Sample

Contamination Indicators





Type Ia



Core Collapse

Will perform a 2 component fit to estimate contamination bin-by-bin

Entire Sample

Summary

- Contamination studied using Nugent templates
- Fluctuations added using Richardson (2002)
- Contamination levels
  - ~7% if fit probability > 0.1 cut applied
  - ~2% if fit probability > 0.5 cut applied
- Working on two-component fit