

Studies of NTT/NOT spectra

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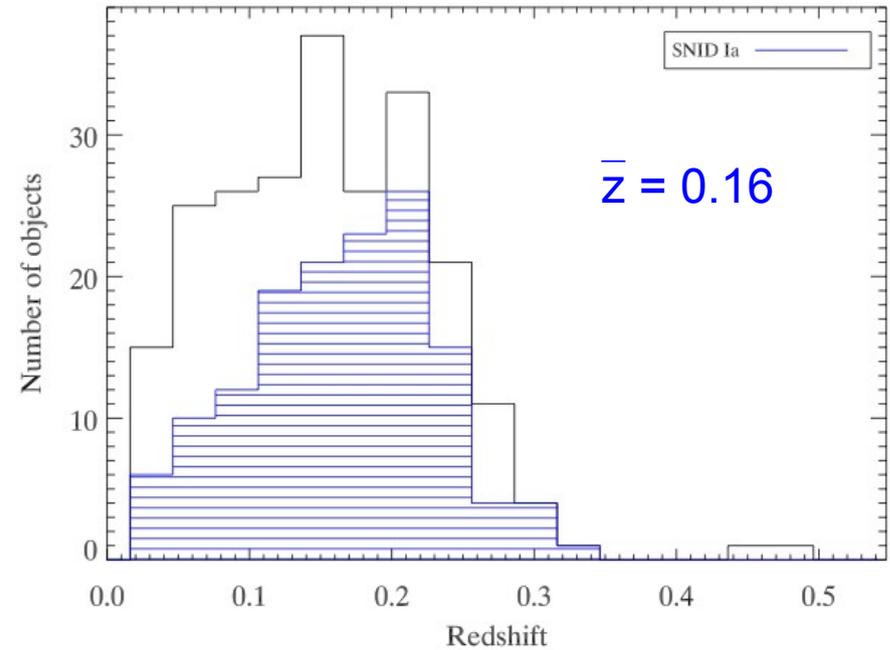


Outline

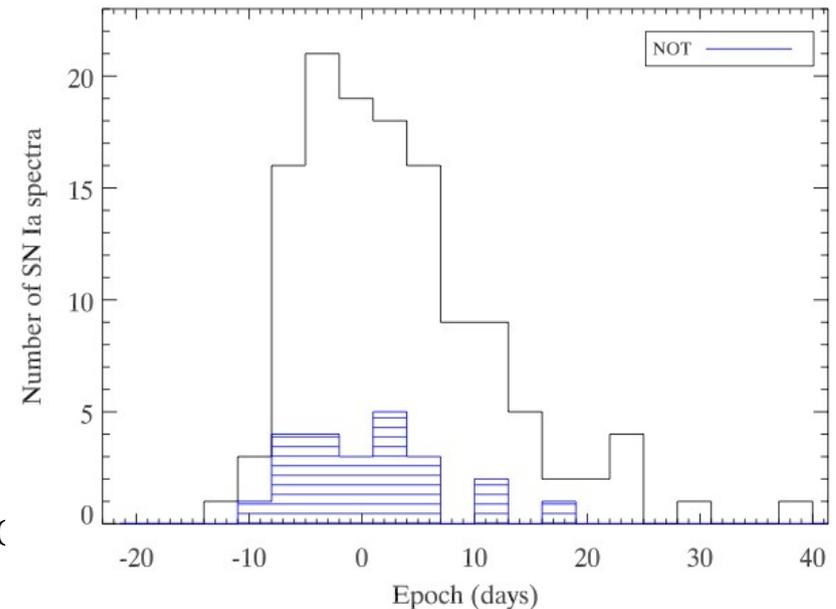
- Sample description
- Peculiar SNe
- Correlations p_{ew} vs redshift
- Correlations p_{ew} vs LC parameters
- Correlations with host galaxy
 - Properties (type, mass, SFR)
 - Distance (work in progress)
- Velocity gradients (work in progress)

NTT/NOT Spectra

| | Spectra | Objects |
|---------------|---------|---------|
| Total | 290 | 238 |
| with redshift | 280 | 228 |
| SN Ia | 169 | 141 |
| with good LC | 127 | 108 |
| SN Ia? | 3 | 3 |
| SN II | 26 | 23 |
| SN Ib/c | 12 | 8 |
| Not SN | 19 | 16 |
| Galaxy | 14 | 12 |
| Unclassified | 61 | 47 |

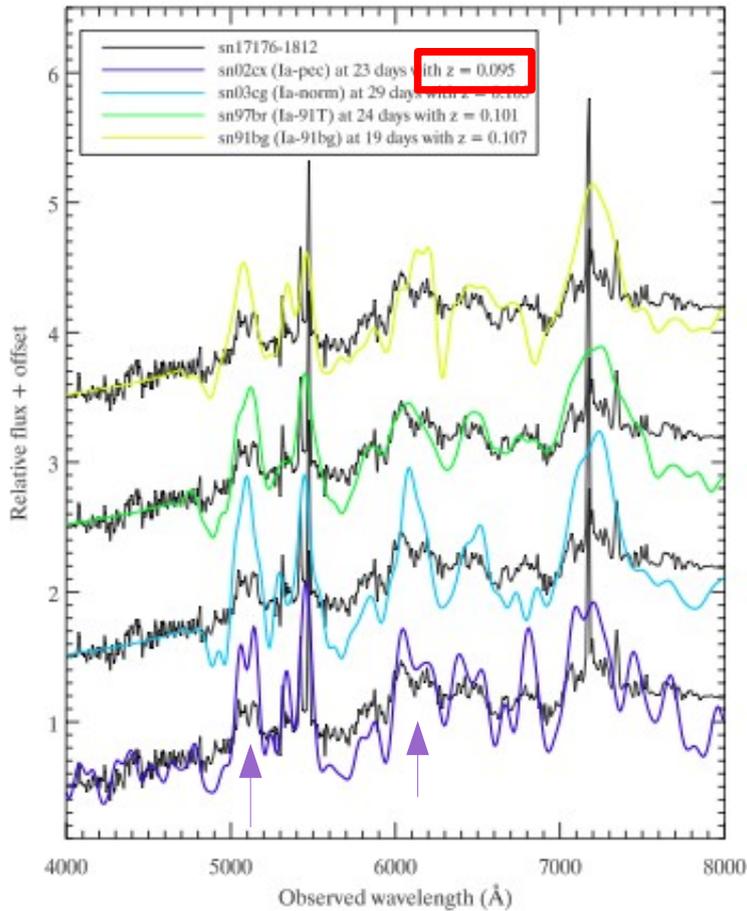


- Redshifts from Zheng et al.
- SALT LC fits -> epoch, LC parameters
- Representative LC parameters



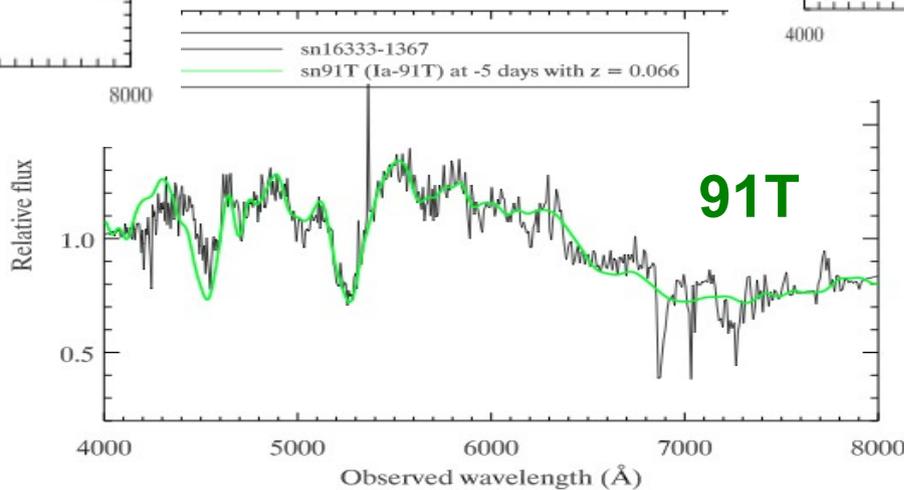
Peculiar SNe in the NTT/NOT sample

SN 2007ie



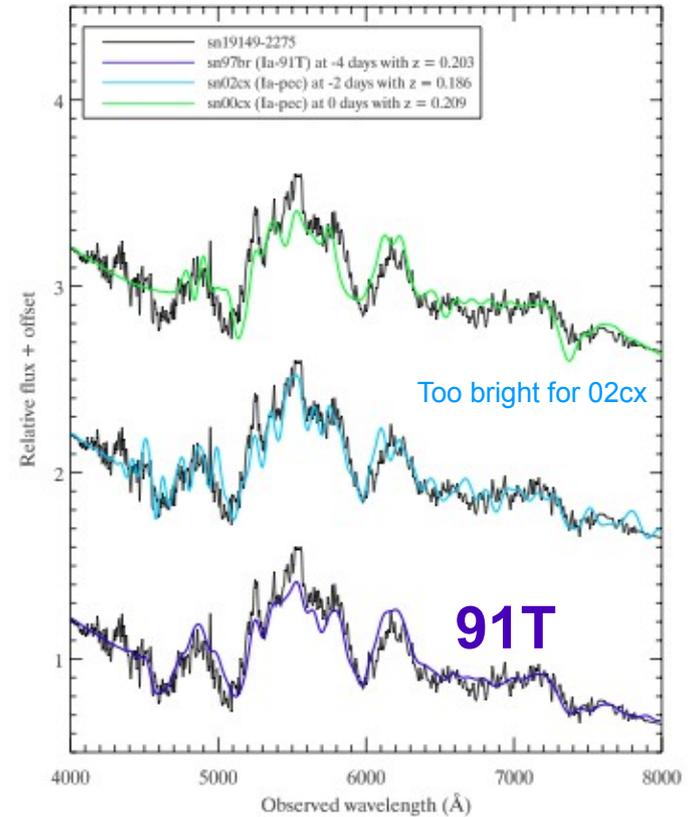
02cx

SN 2006on



91T

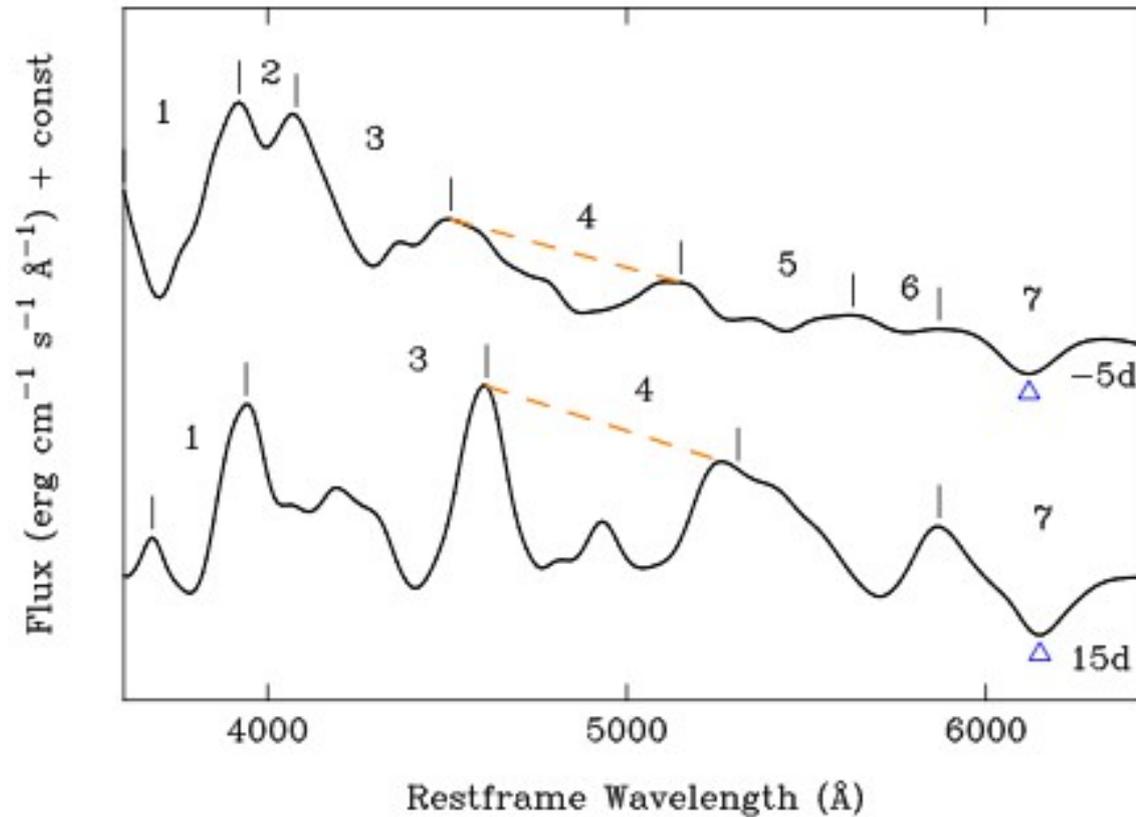
SN 2007ni



Too bright for 02cx

91T

Spectral features



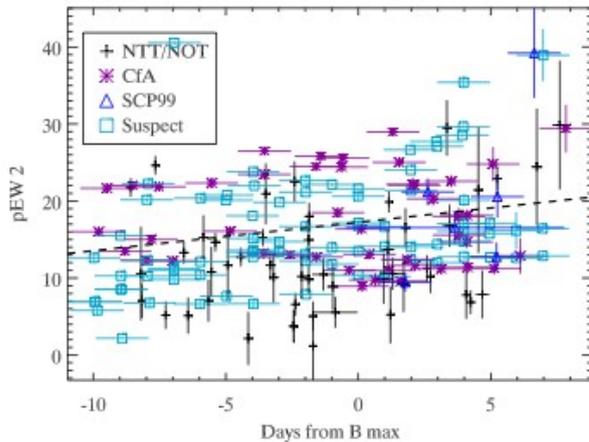
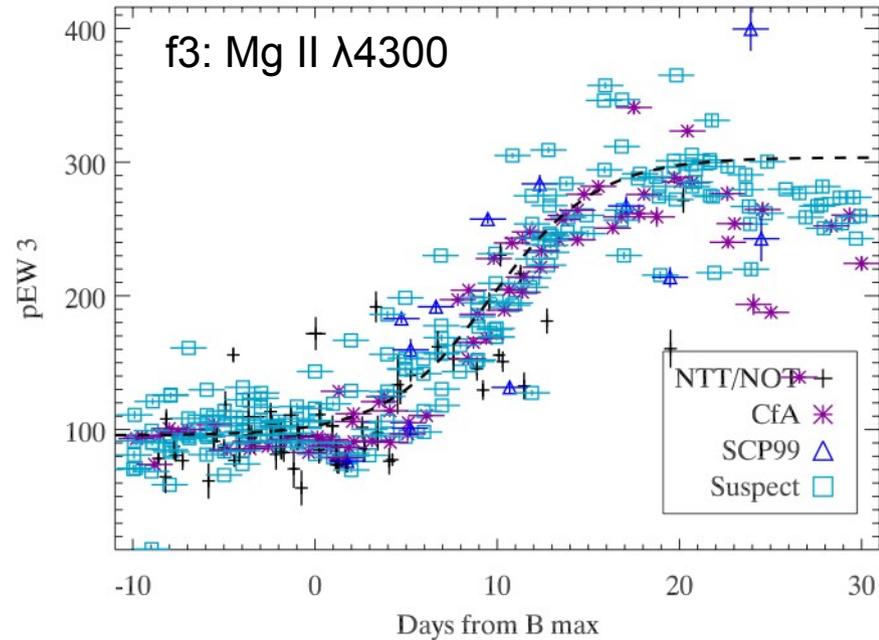
| Feature | Dominating line |
|---------|----------------------|
| f1 | Ca II H&K |
| f2 | Si II $\lambda 4000$ |
| f3 | Mg II $\lambda 4300$ |
| f4 | Fe II $\lambda 4800$ |
| f5 | S II W |
| f6 | Si II $\lambda 5800$ |
| f7 | Si II $\lambda 6150$ |

$$pEW = \sum_{i=1}^N \left(1 - \frac{f(\lambda_i)}{f_c(\lambda_i)} \right) \Delta\lambda_i,$$

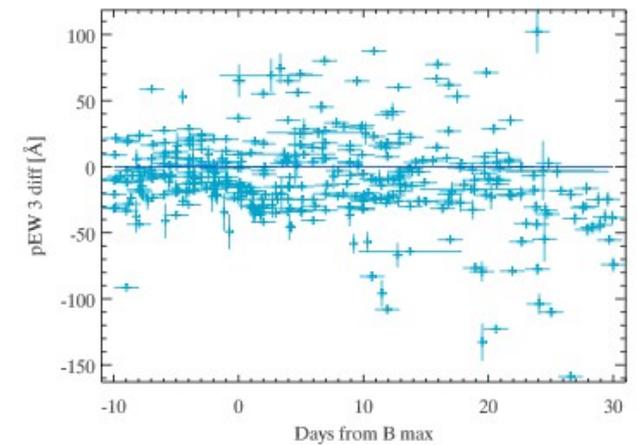
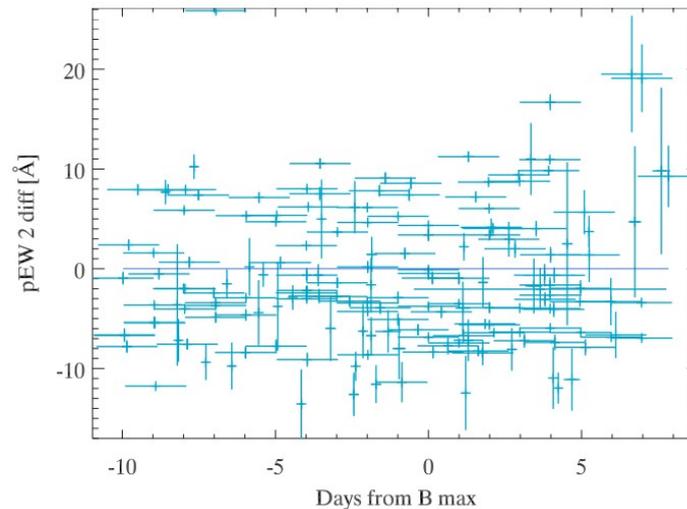
$$v_{\text{abs}} = c \frac{(\lambda_m/\lambda_0)^2 - 1}{(\lambda_m/\lambda_0)^2 + 1},$$

pEW vs epoch

- Remove epoch dependence by fitting a function to all normal SNe Ia -> can make comparisons over large epoch intervals.

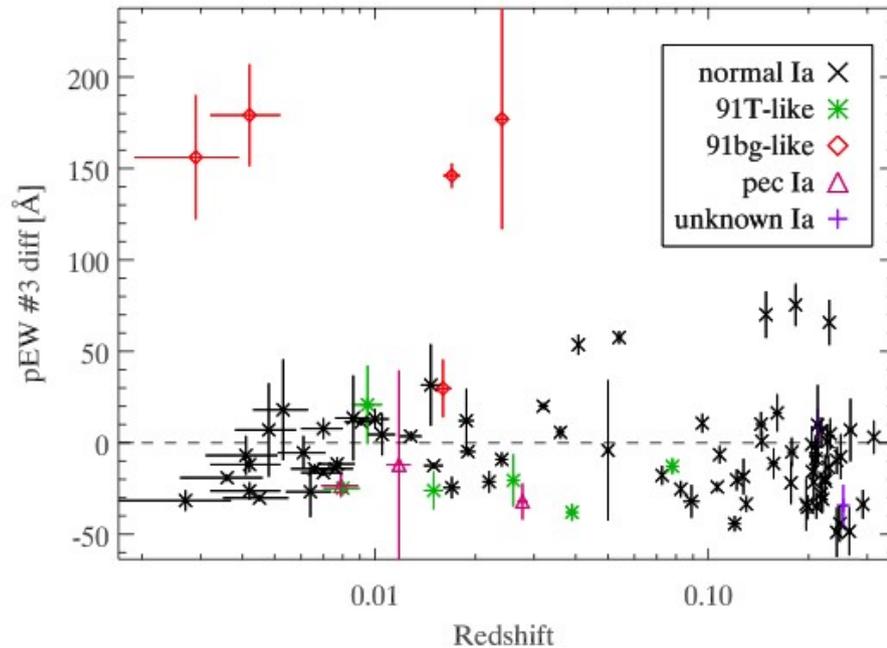


f2: Si II λ 4000

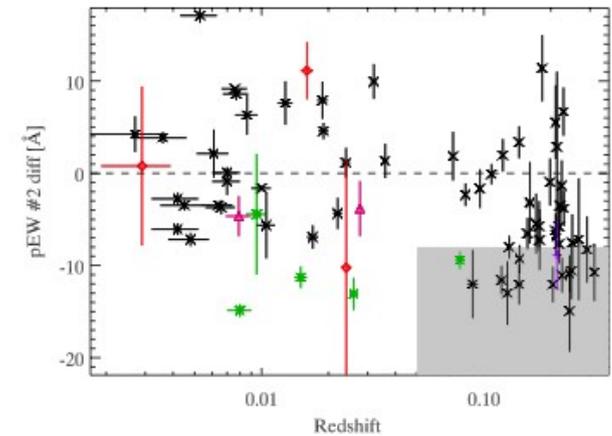


Correlations of pEW with redshift (around peak brightness)

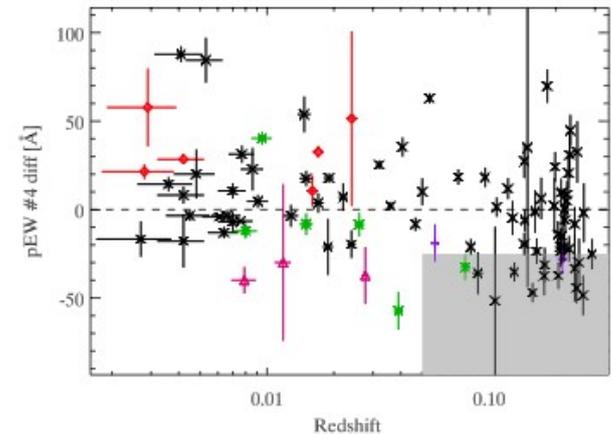
f3: Mg II λ 4300



f2: Si II λ 4000



f4: Fe II λ 4800

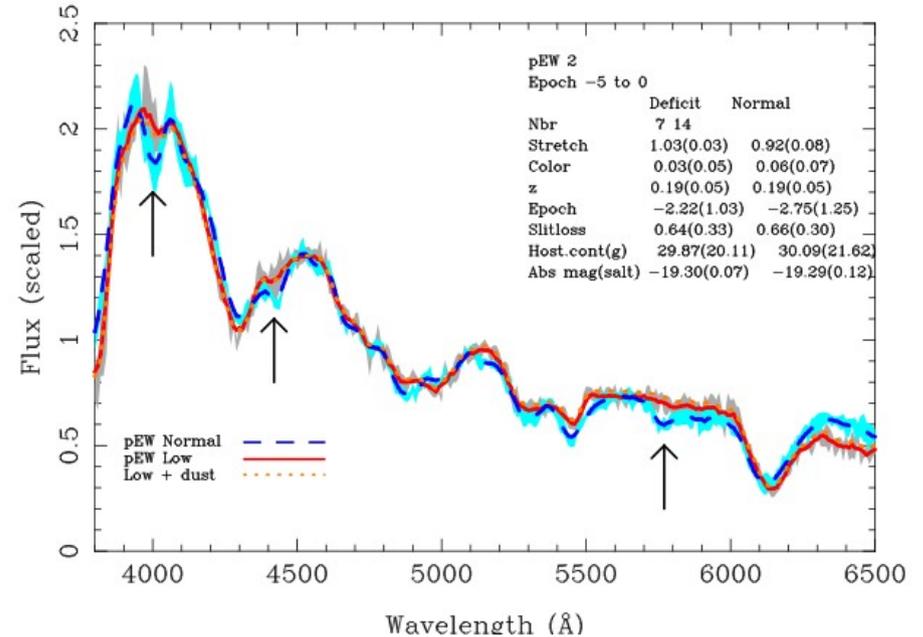


- For normal Sne Ia, no z dependence
- Non-normal Sne can deviate from the rest (less in high-z sample)
- For feature 2 & 4 -> PEW deficit group

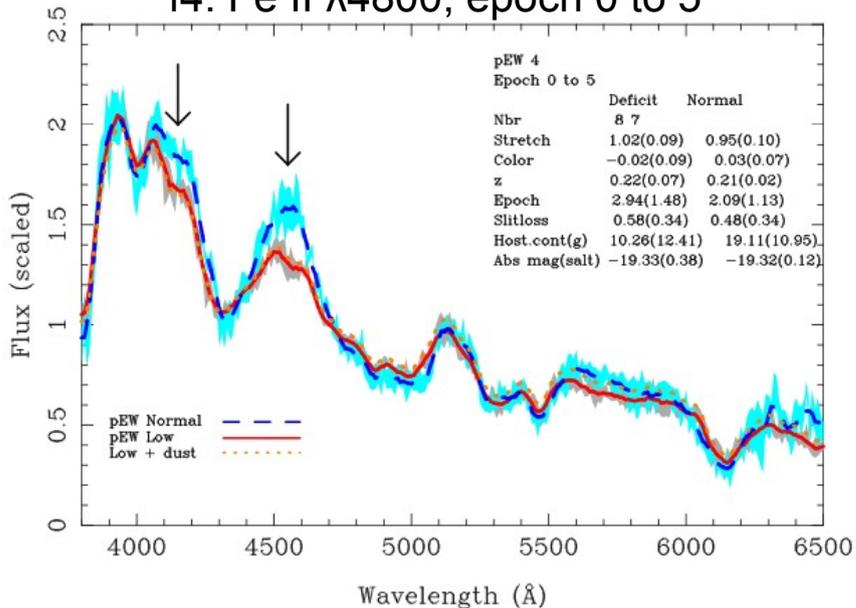
Pew deficit spectra

- Reference spectra vs **pew deficit**
- Deficit spectra have, in general, wide lightcurves and shallow Si features
- Could correspond to the slightly peculiar, shallow silicon (SS) SNe [99aw, 99bp, 99bn]

f2: Si II λ 4000, epoch -5 to 0



f4: Fe II λ 4800, epoch 0 to 5

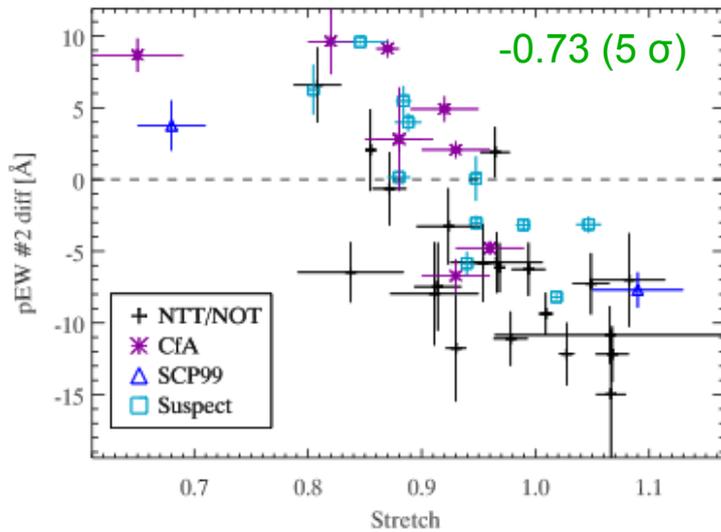


| | |
|----|----------------------|
| 21 | f2 and/or f4 deficit |
| 3 | Confirmed SS |
| 7 | Confirmed normal |
| 11 | Uncertain |

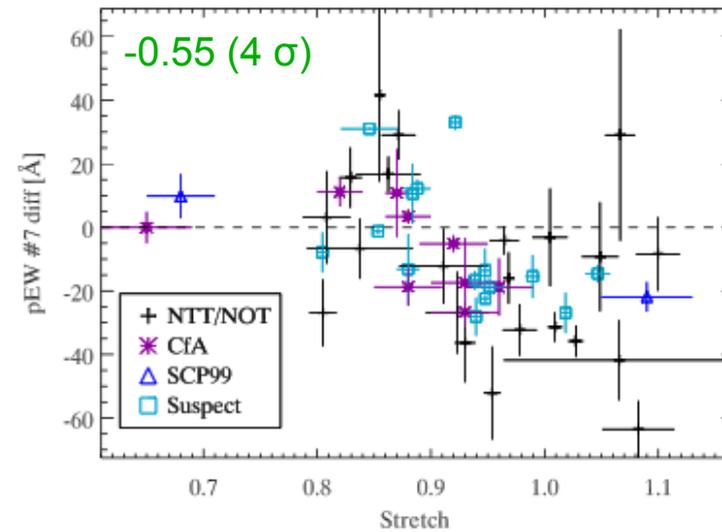
7% -32% SS SNe in NTT/NOT sample

PEW vs LC parameters at max brightness (+/- 3 days from peak)

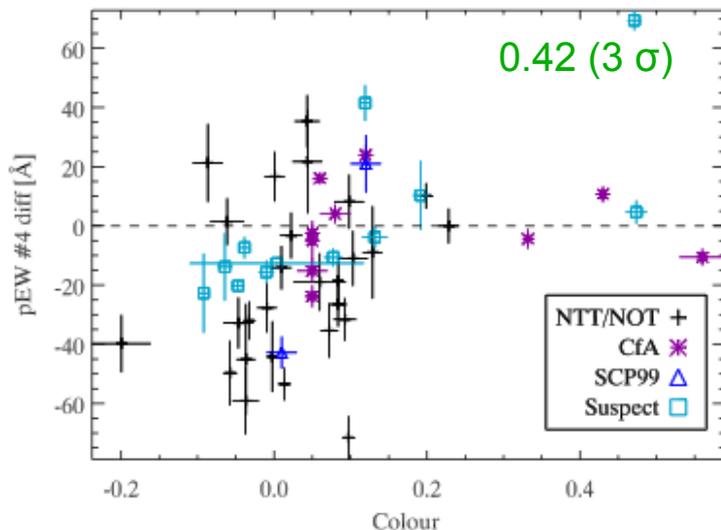
f2: Si II λ 4000



f7: Si II λ 6150

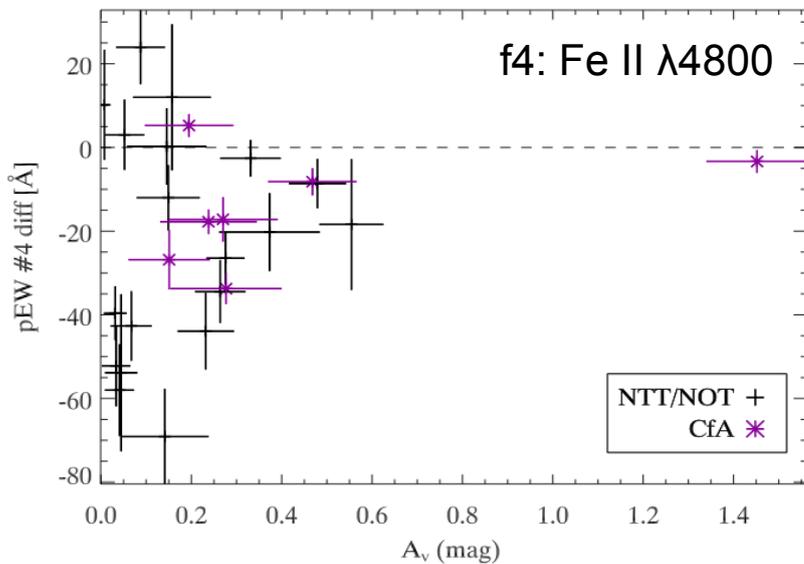
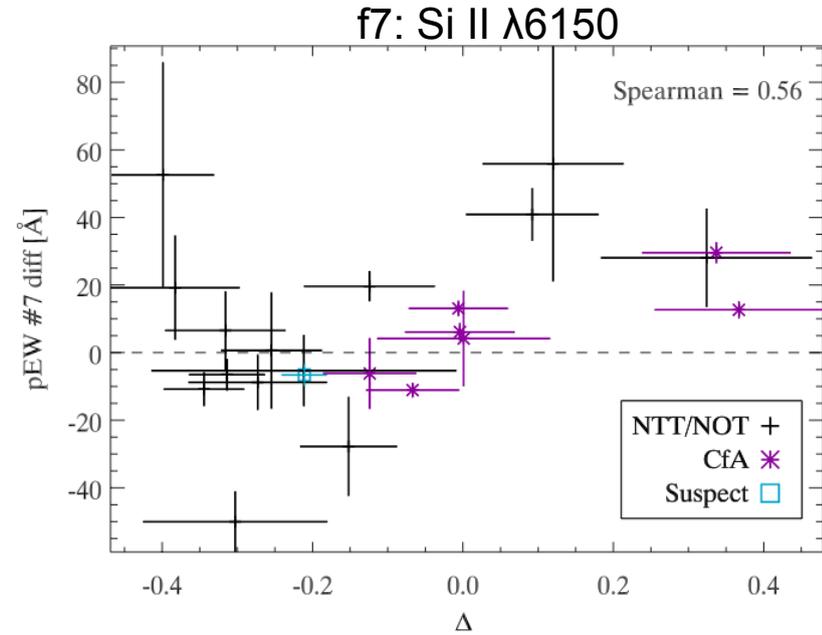
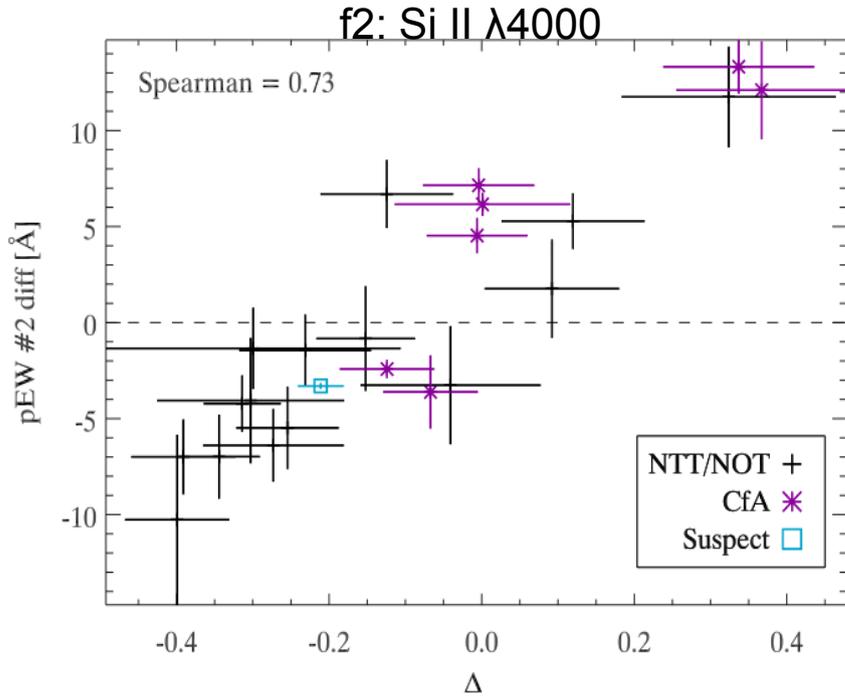


f4: Fe II λ 4800



- Strong correlation pew 2 vs stretch
- Correlation pew 7 vs stretch (less for low S/N)
- Correlation pew 4 vs colour
 - Valid up to $c \sim 0.2$ – sign different source of reddening?
 - Dust cannot explain it solely!
- Correlations in the same direction

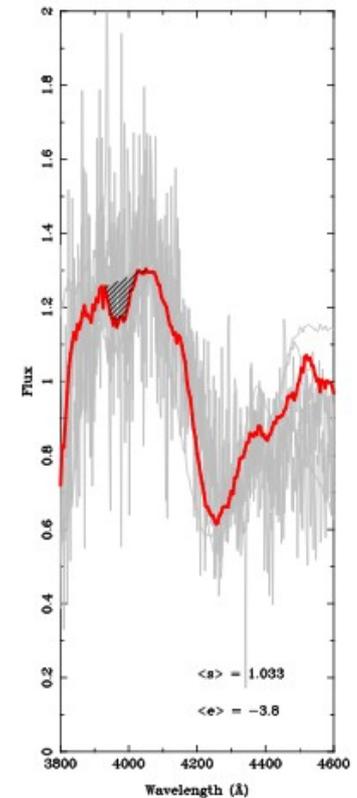
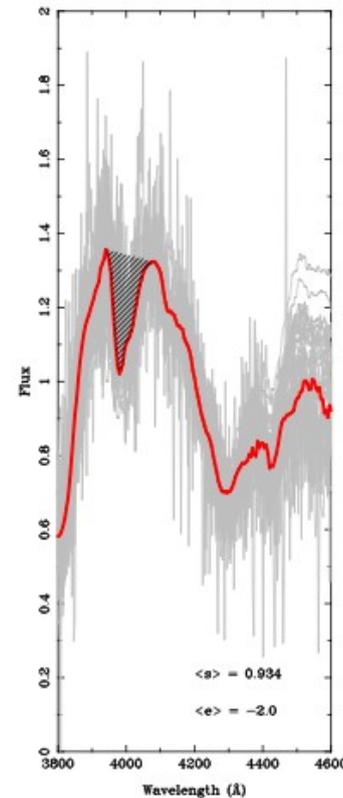
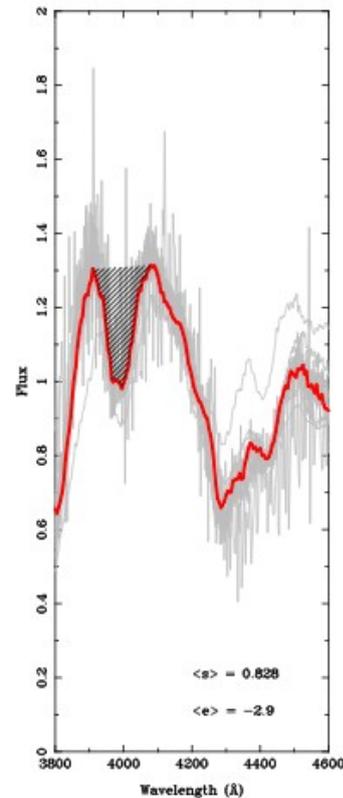
... and for MLC2k2



- Same as slide before (+/- 3 days from peak) but for MLC2k2 equivalents

Studying stretch dependence of pew 2

- Epoch -6 to 1 days past peak
(Spearman 0.75)
- 3 stretch bins
(0.8, 0.9, 1.0)

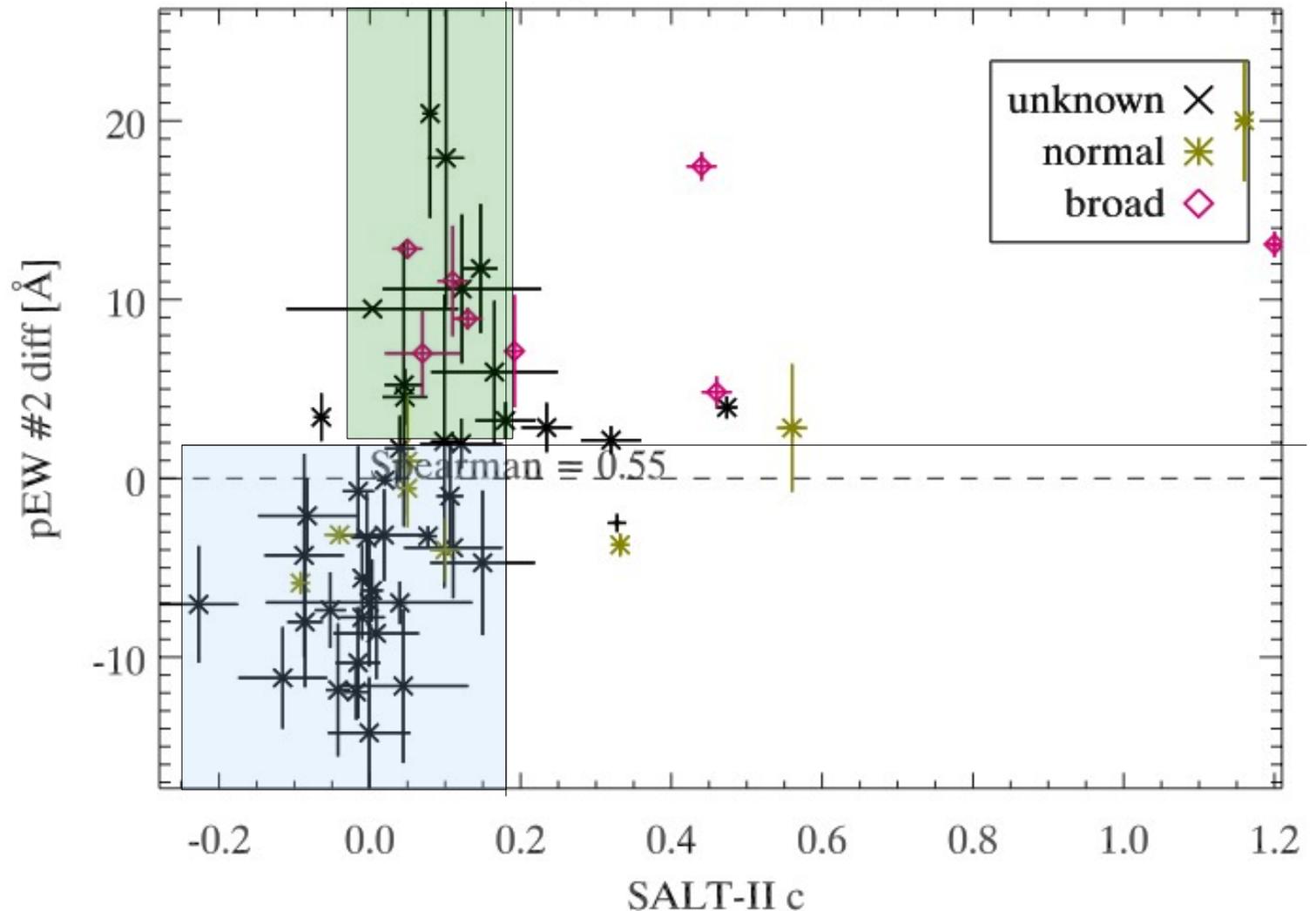


pEW f2 – SALT2 c – Branch type

Including SNLS VLT spectra

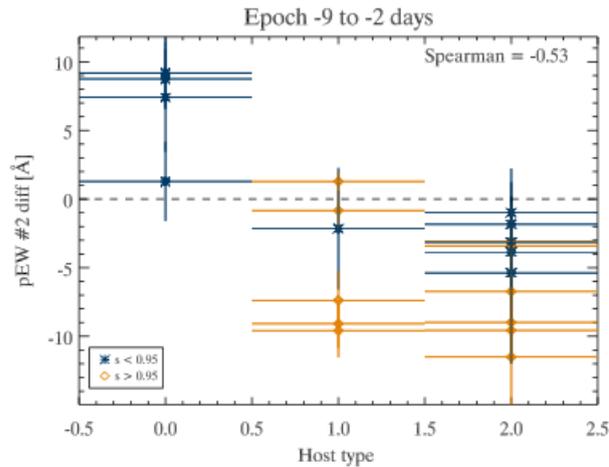
Epoch 0 to 8 days

- Related to spectral types defined by Branch et al
- Broad line SNe – less spread in colour
- Deviating for large c



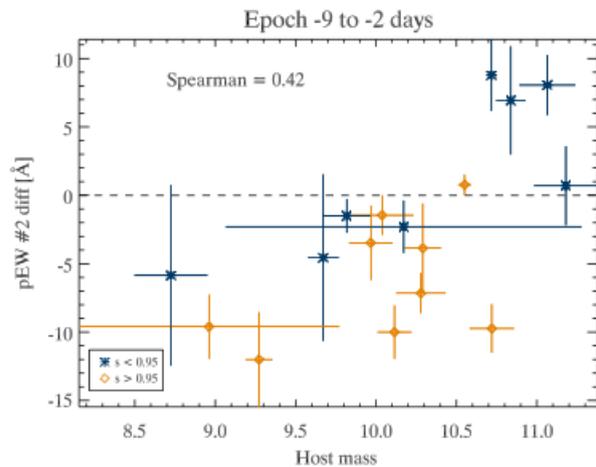
Correlations with host properties

f2: Si II λ 4000



For pre-peak spectra, two subgroups:

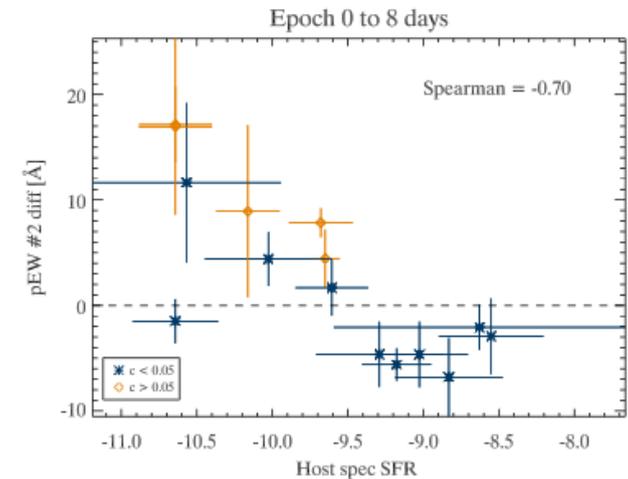
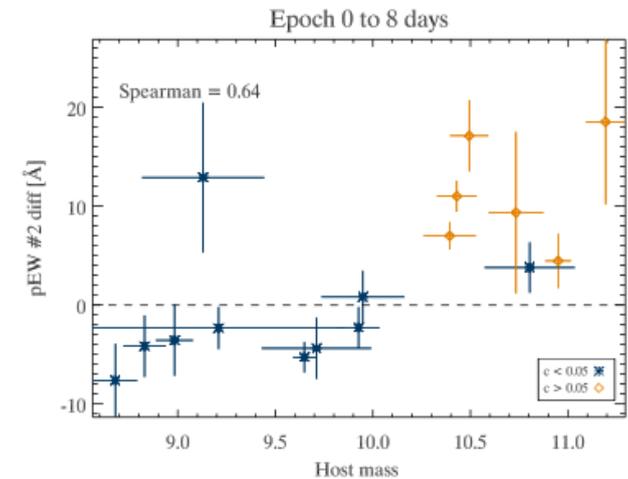
- Large pew 2 are found in passive galaxies with large mass



For post-peak spectra, two subgroups:

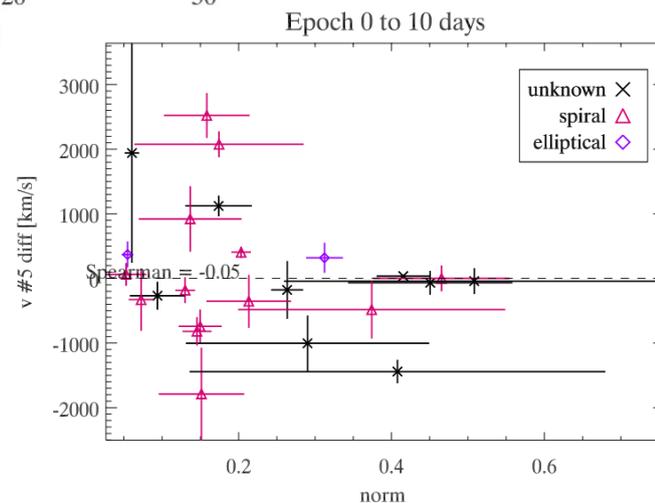
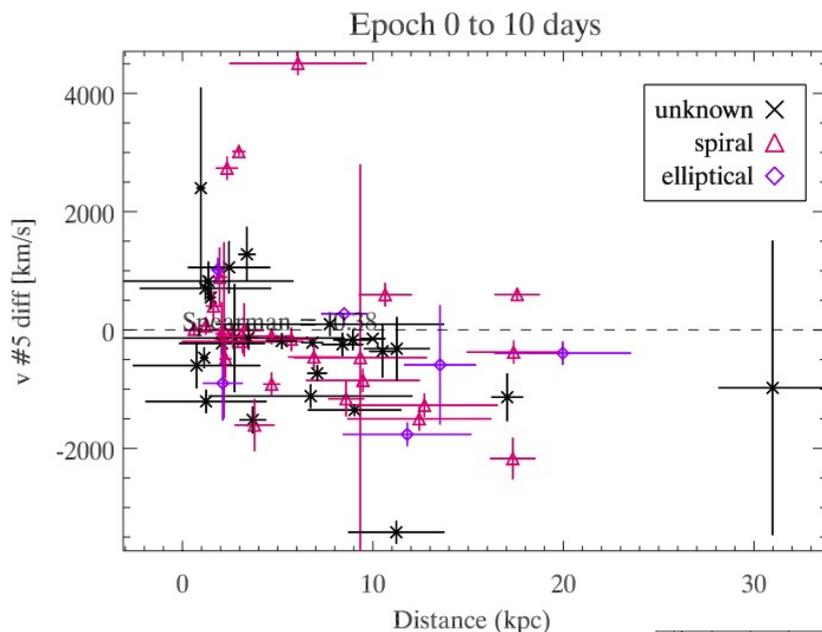
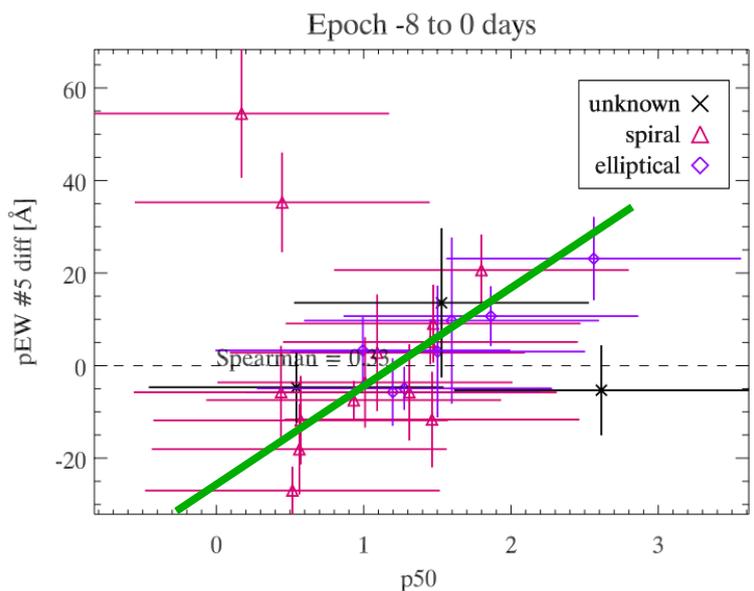
- Large pew 2 are found in massive galaxies with low sSFR

f2: Si II λ 4000



Correlations between spectral indicators and SN-galaxy distance

- Probing dust content, metallicity,
- See talk by Lluís

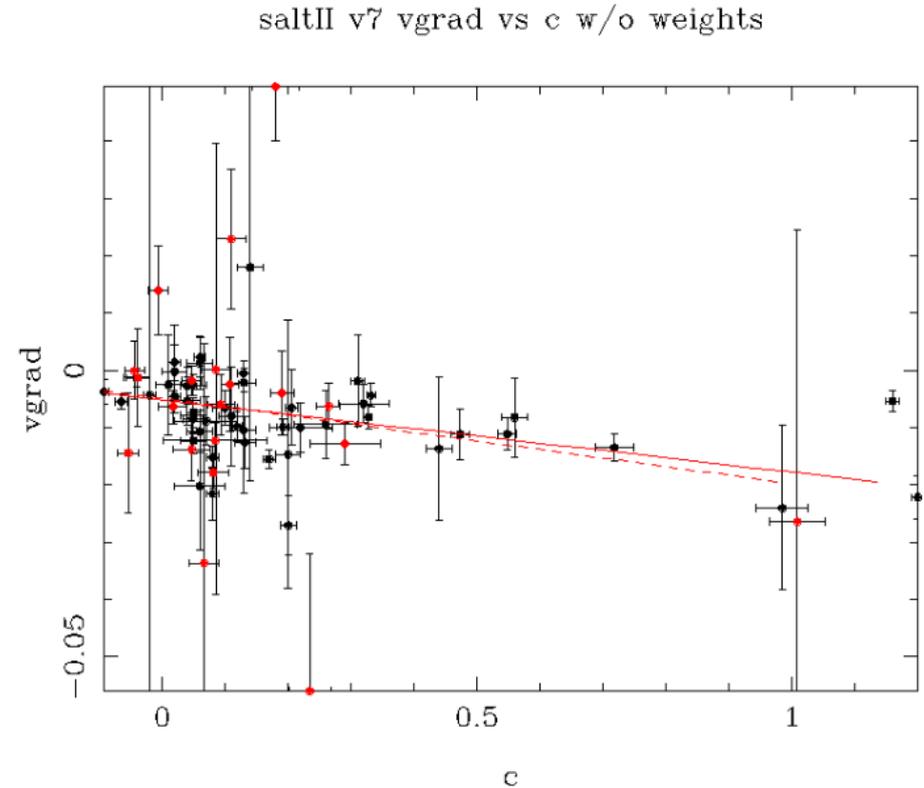
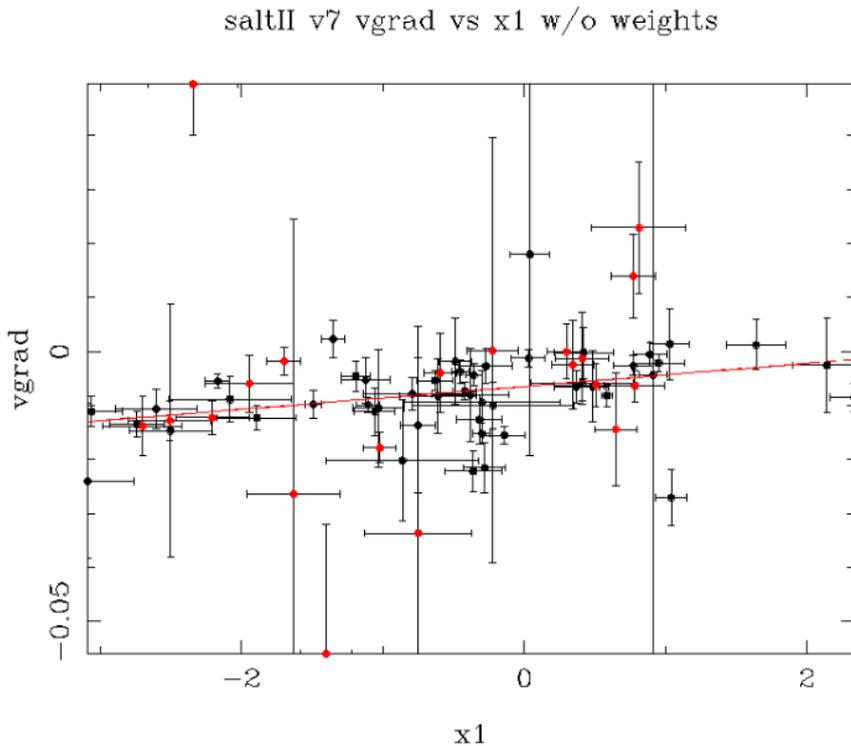


- Dependence with distance? Varying spread?
- Different for elliptical/spiral?
- Feature 5 most interesting

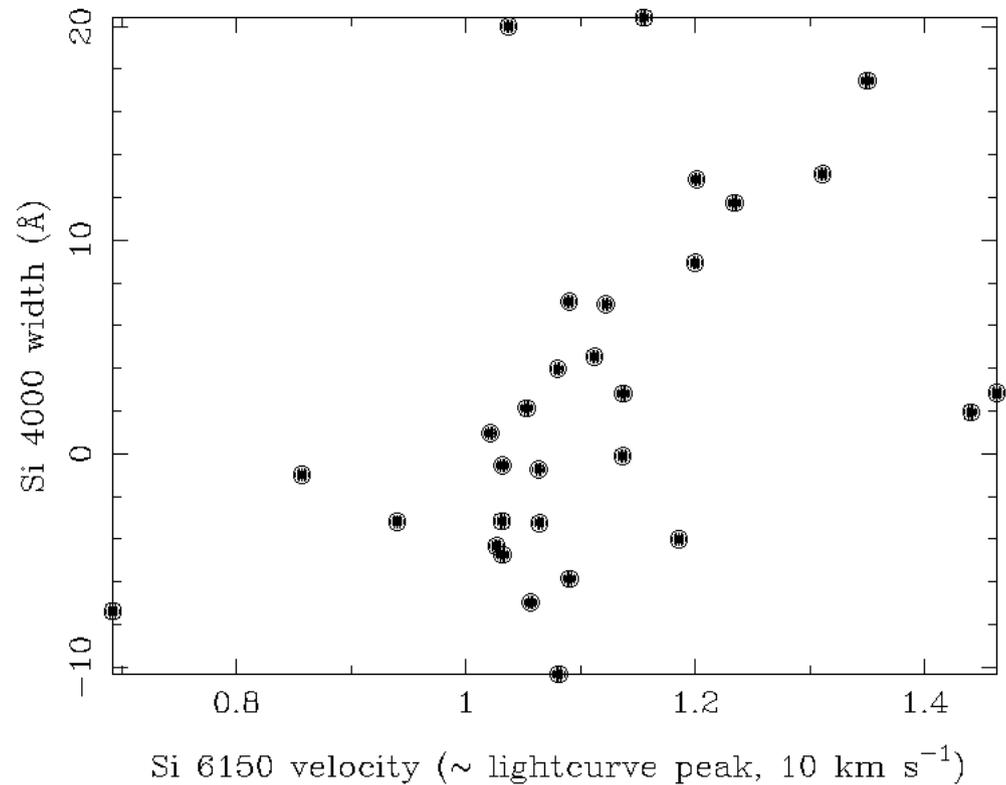
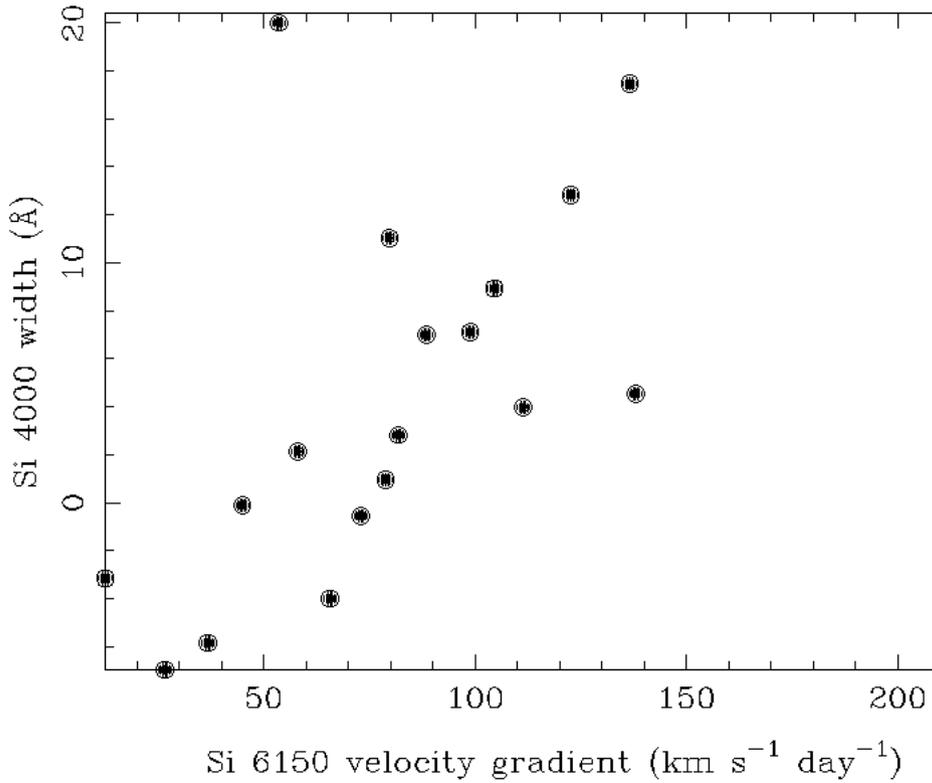


Velocity gradients

- Weak trends between velocity gradient of f7 (Si II $\lambda 6150$) and $x1/c$?



pEW f2 (Si II 4000) – velocity f7 (Si II 6150)



- Stable with respect to systematics

Summary

- 141 SNe Ia
 - 3 truly peculiar, 7-32 % shallow silicon SNe
- No significant correlation between p_{15} /velocity and redshift (up to $z \sim 0.2$)
- Strong correlation between stretch and p_{15} 2 (near peak brightness)
- Some correlations with SN colour, host properties
- Feature 5 potentially interesting for connection to SN-host distance
- Si velocity gradients under study