

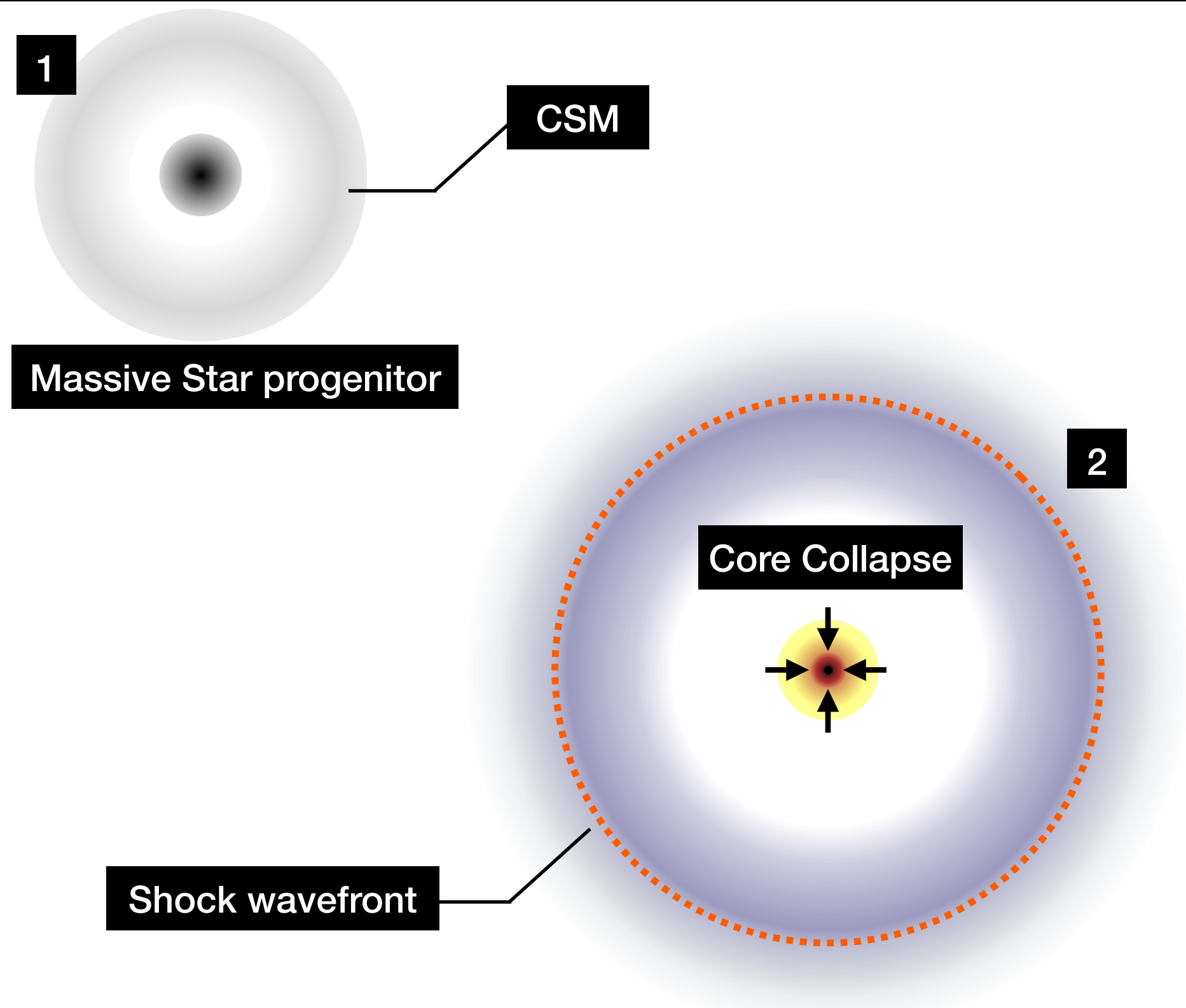


Flash features rate in the first year of ZTF

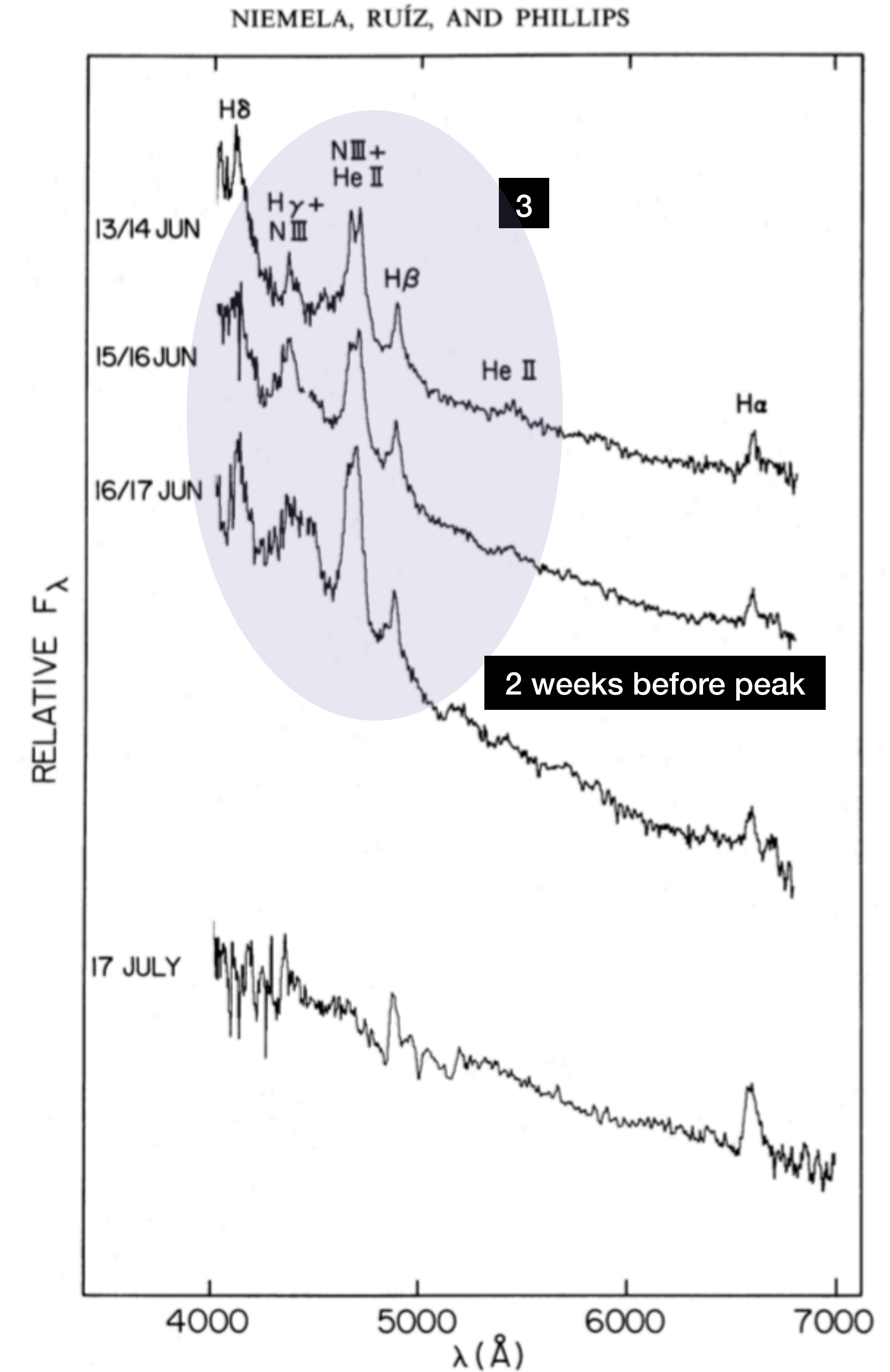
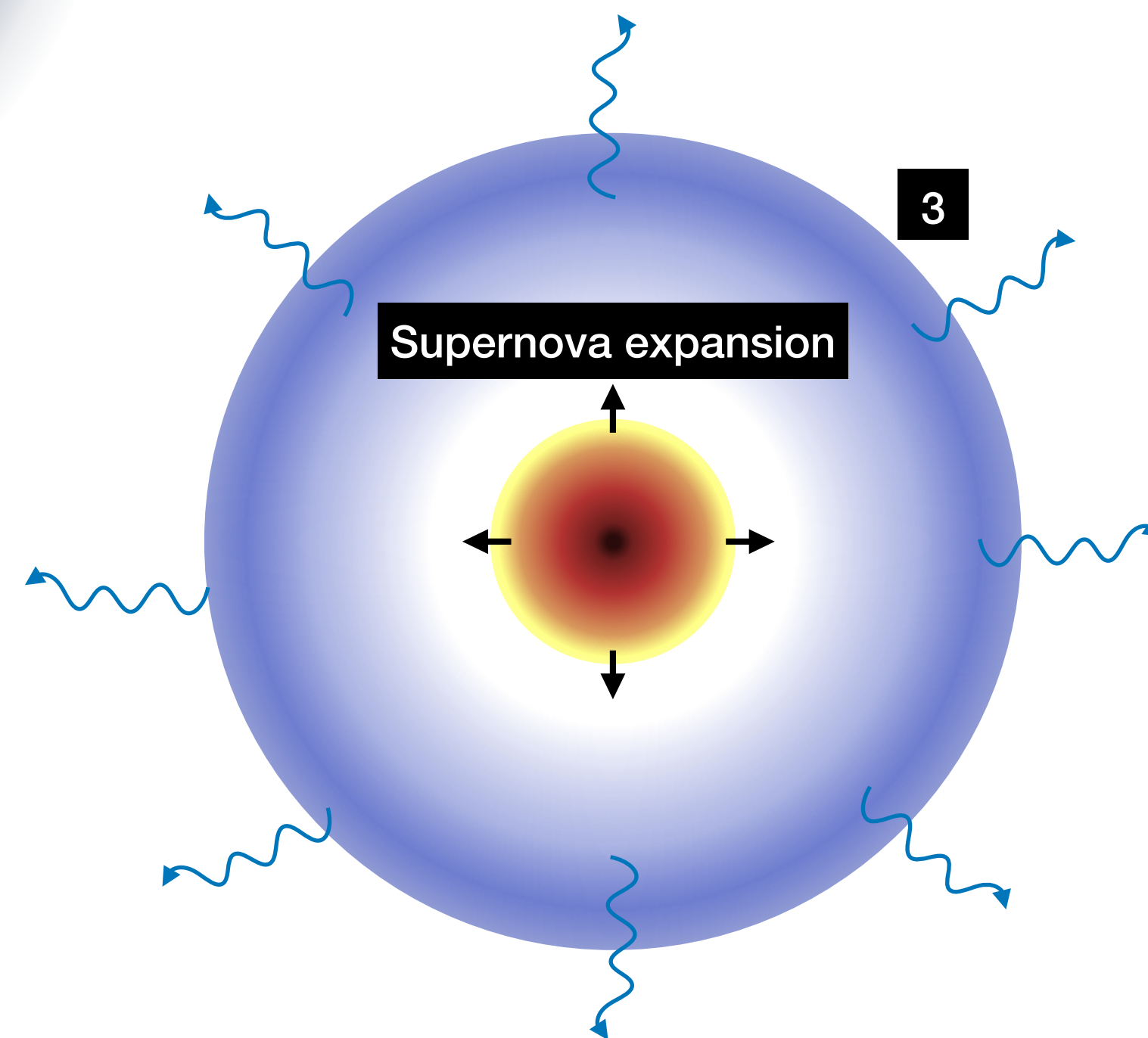
Systematic detection and study of Infant Supernovae

Rachel J. Bruch

Flash ionisation features : overview



Ionisation of the CSM



The Zwicky Transient Facility

High cadence multi band survey of the northern sky



P48

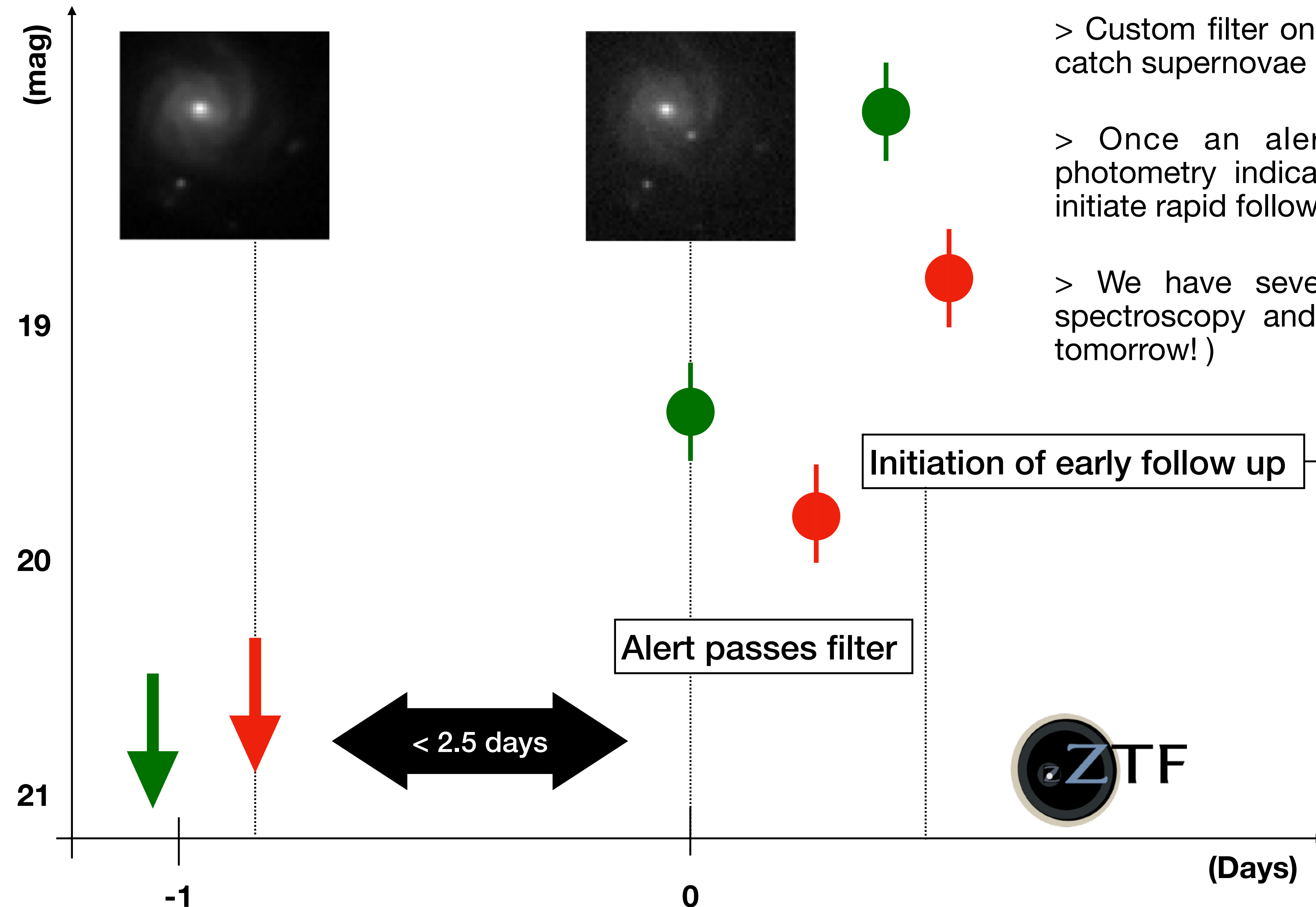


P60



P200

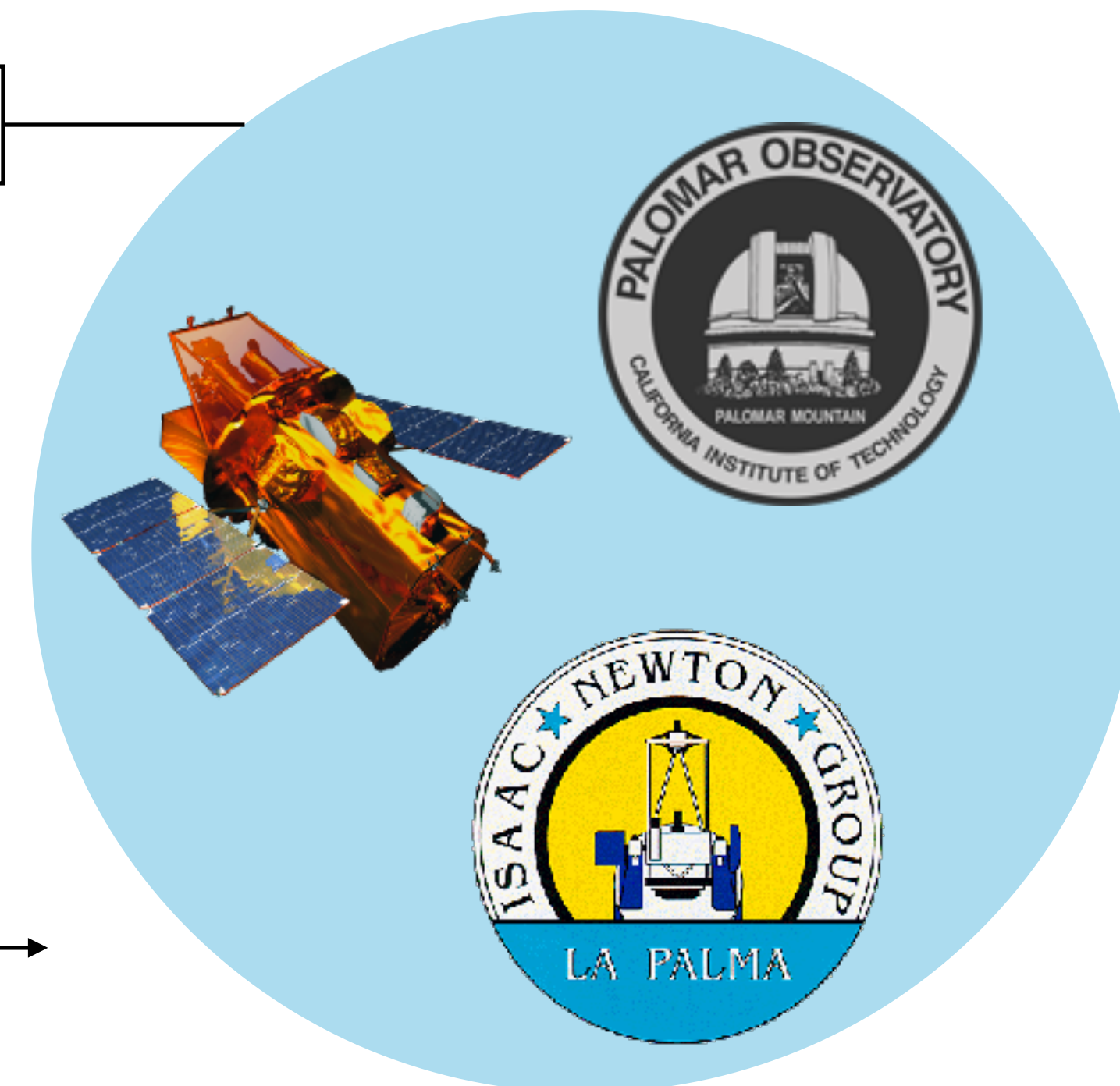
Looking for young SNe



> Custom filter on the alert distribution platform to catch supernovae in their infancy

> Once an alert satisfies our criteria (e.g. photometry indicative of hot event, fast rise) we initiate rapid follow up

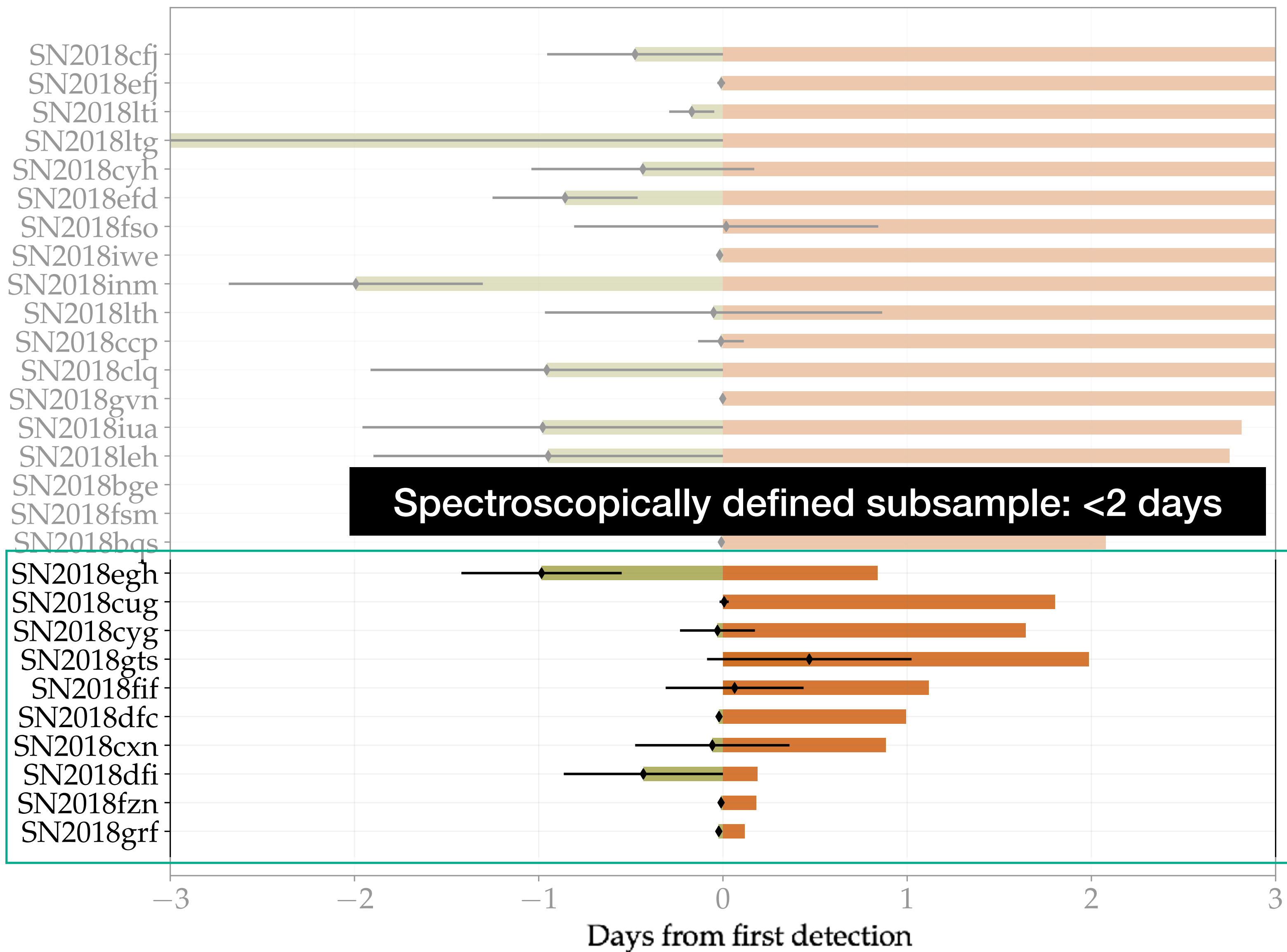
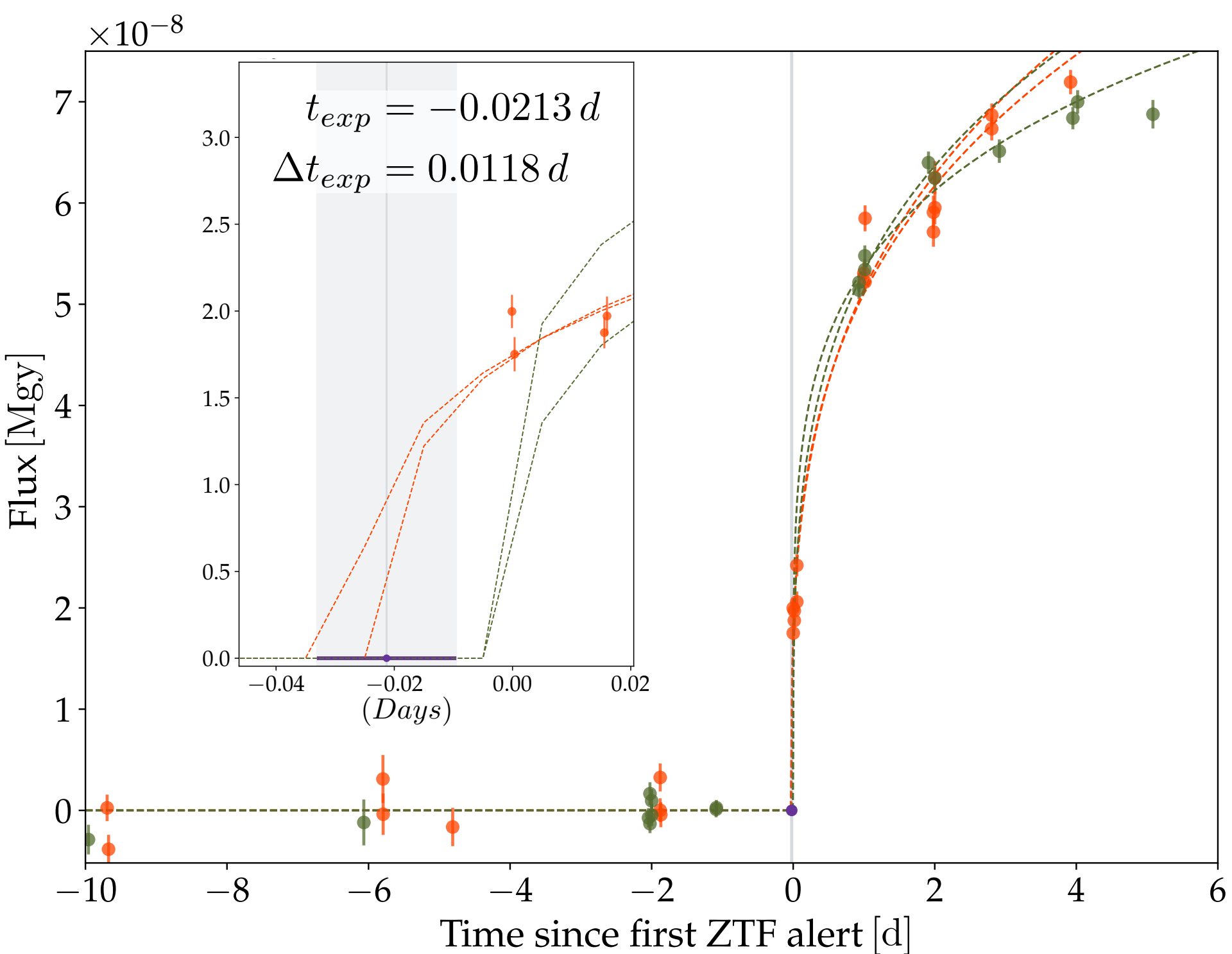
> We have several projects which need early spectroscopy and UV photometry (see Ido's talk tomorrow!)



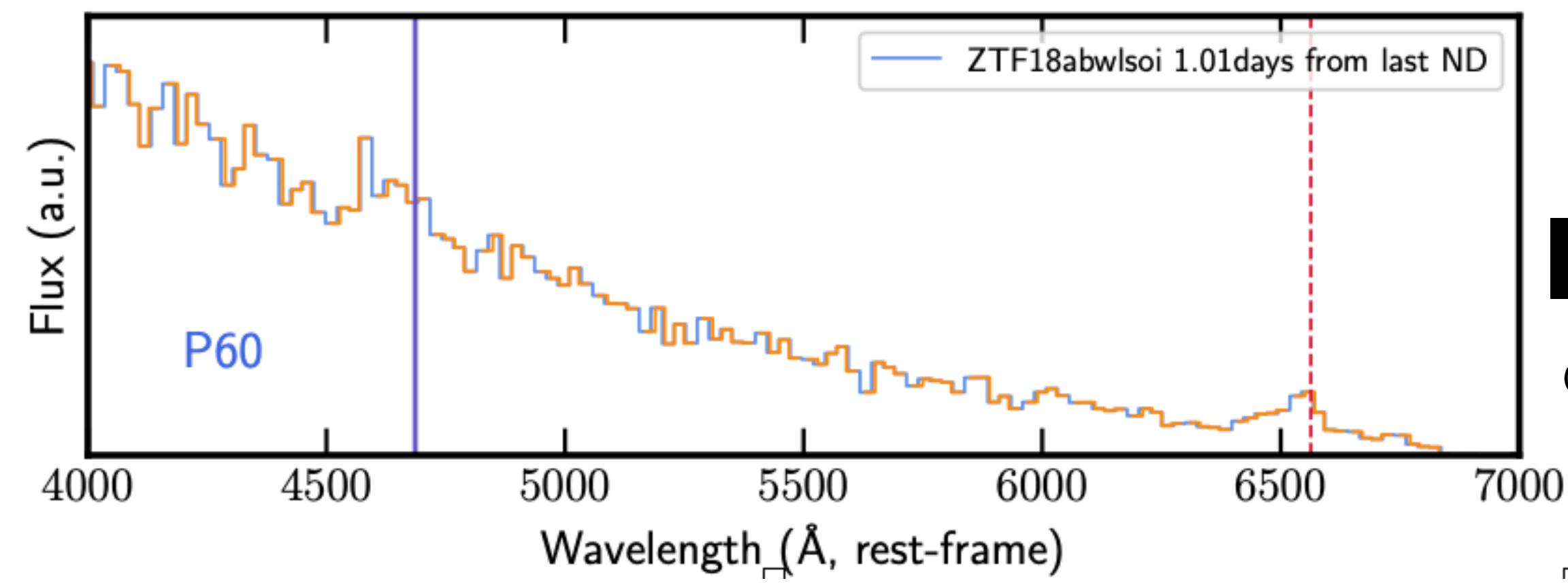
Sample summary

28 Real Infant SNe of Type II

Explosion time estimation



Identification of FIF

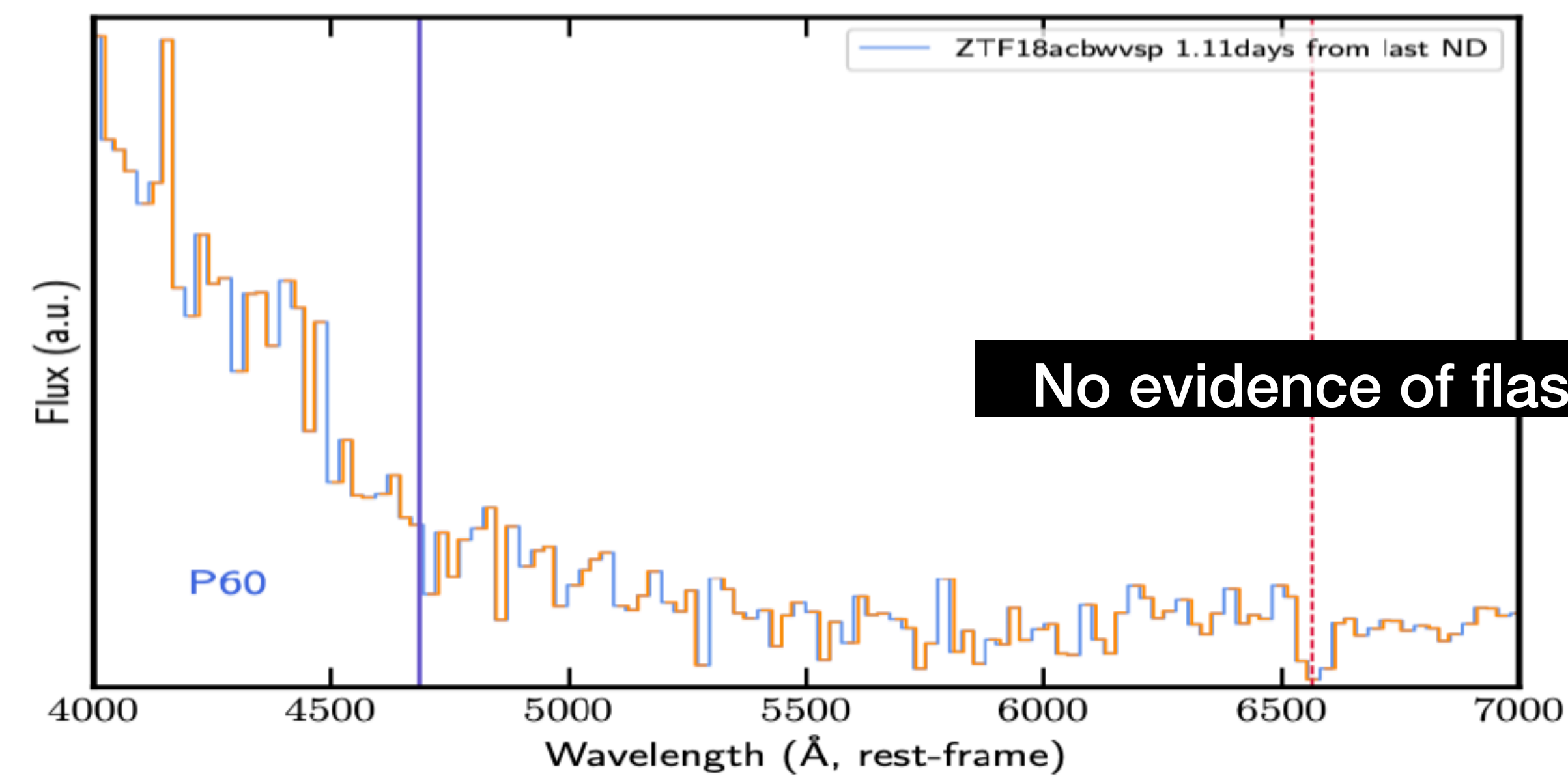


He II emission line⁽¹⁾

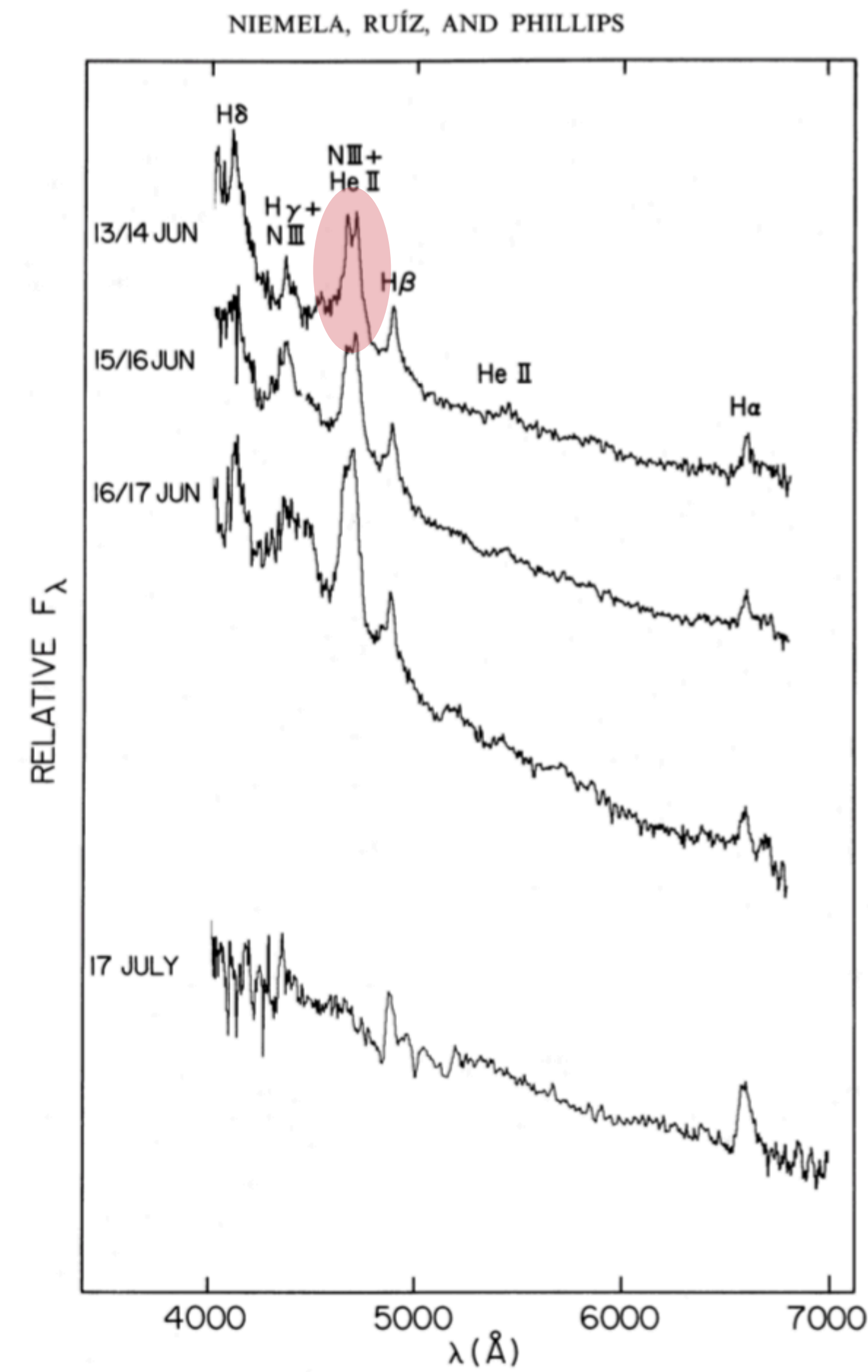
(1) : Indicative of flash ionisation features

--- H 6563 $\text{\AA}$

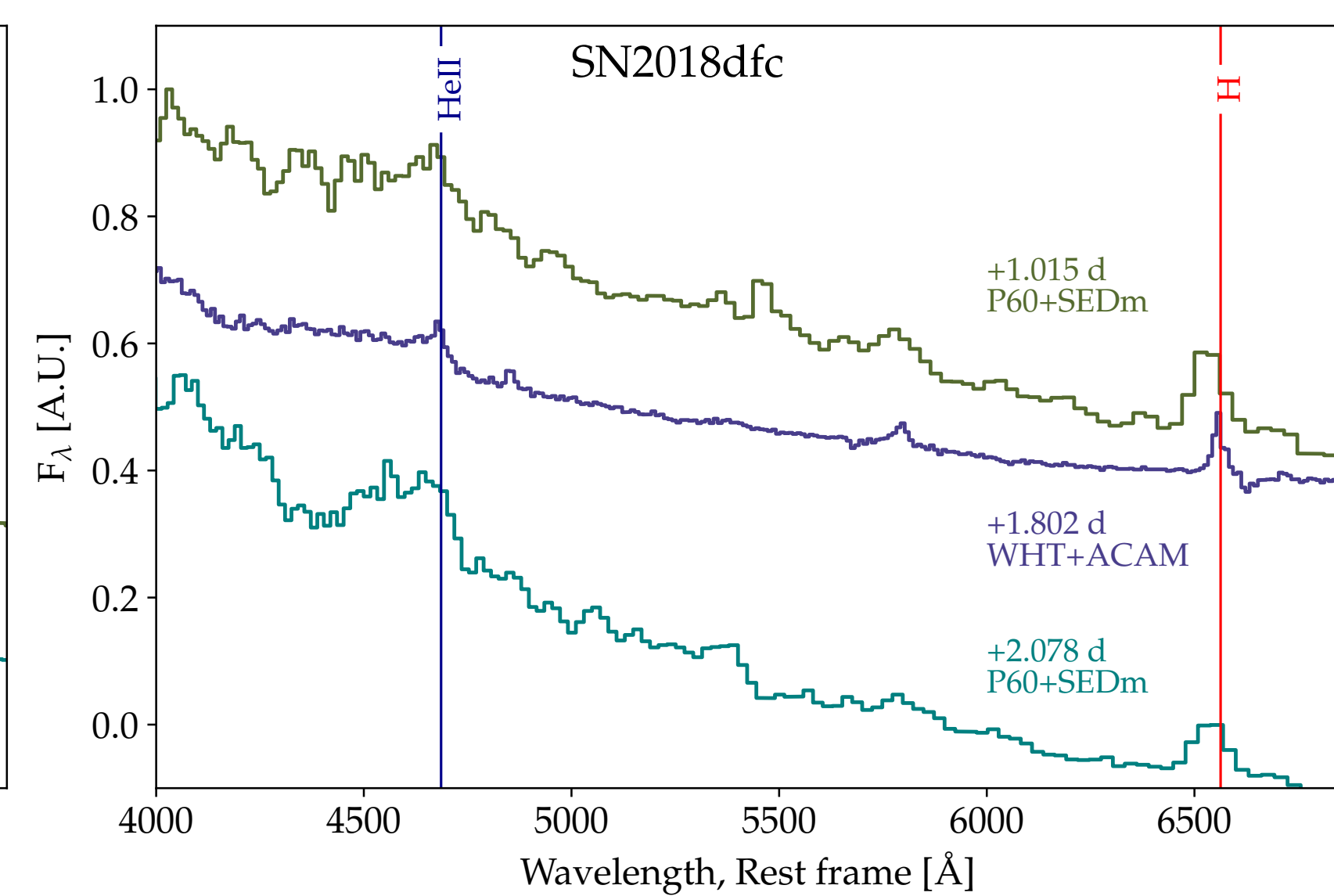
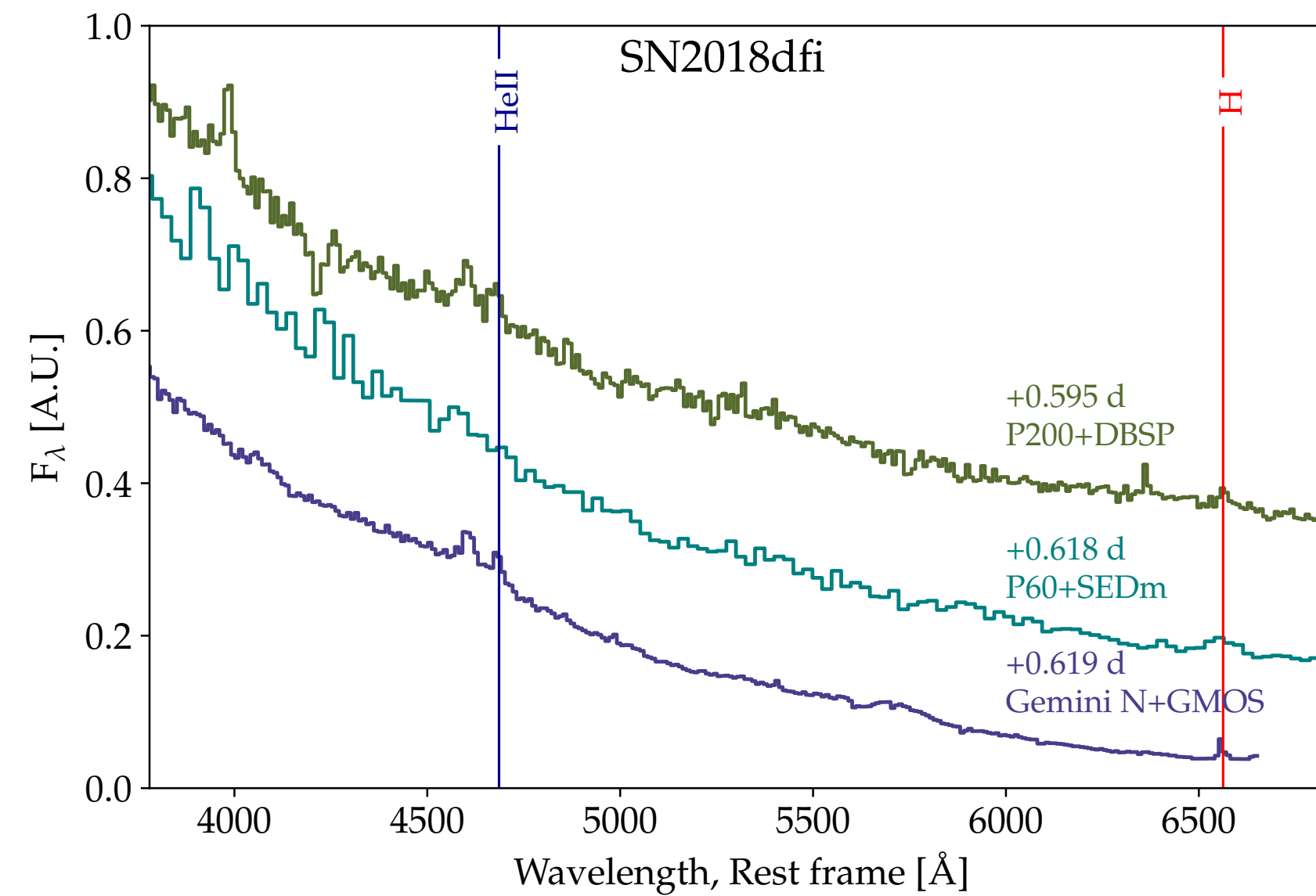
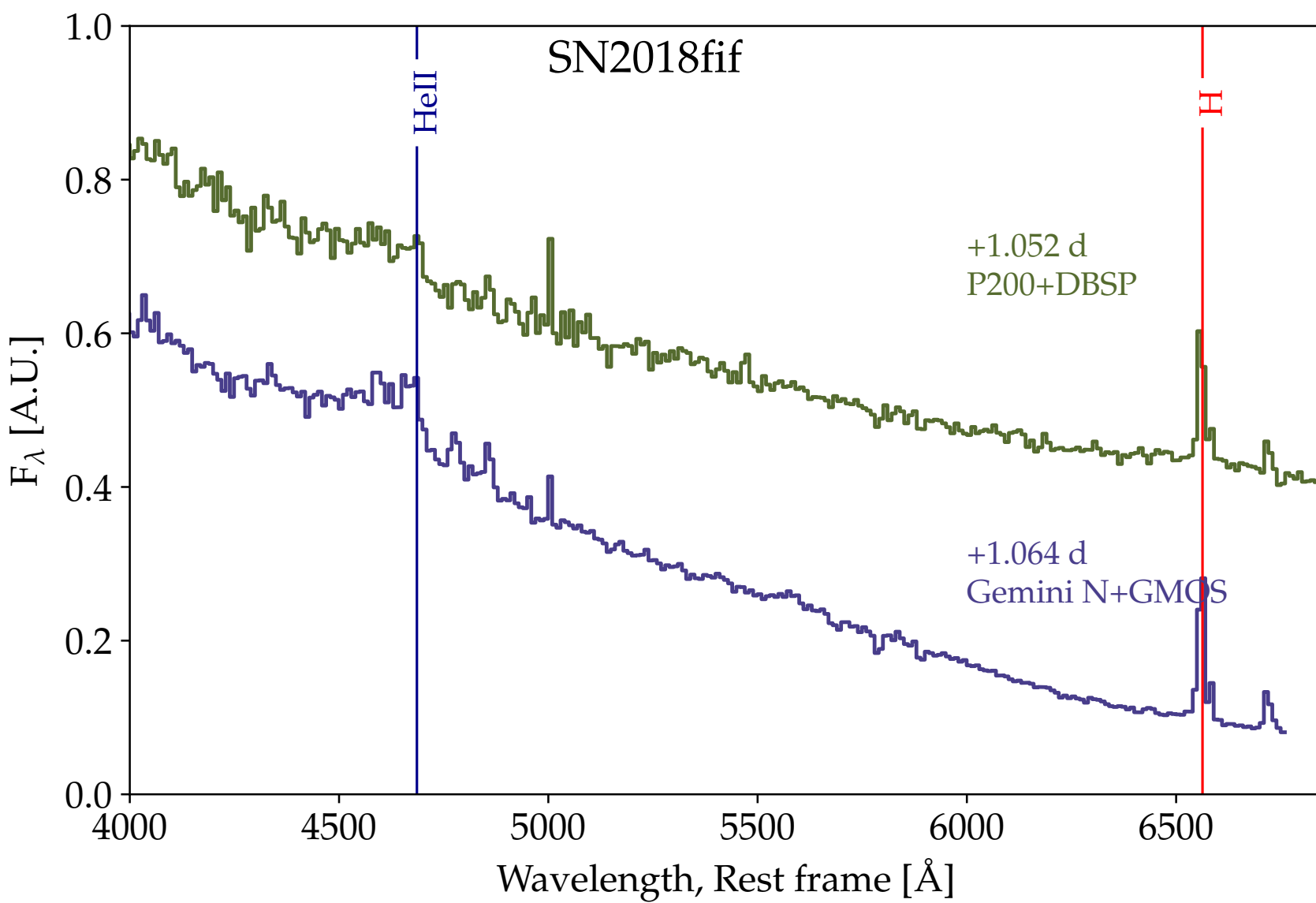
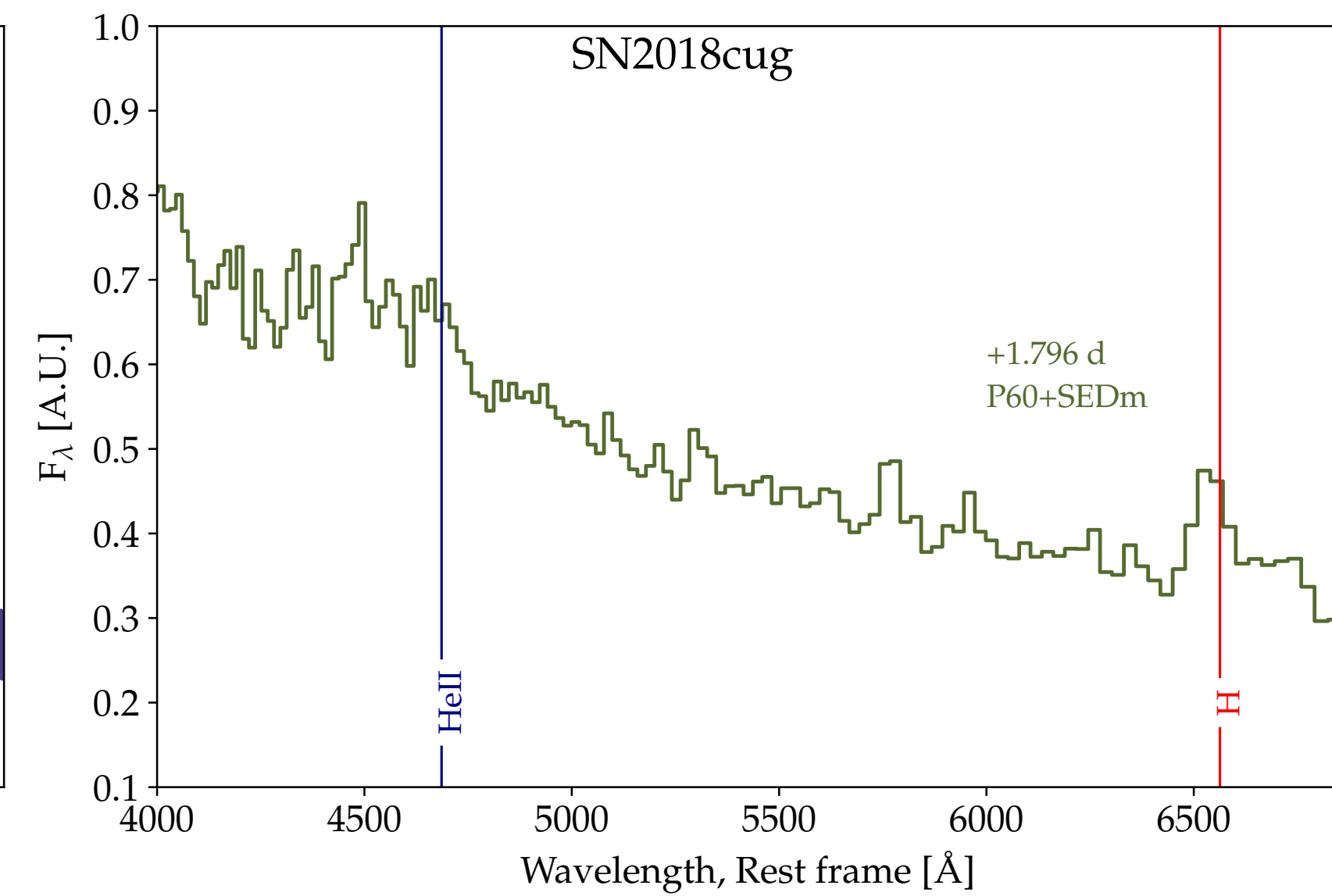
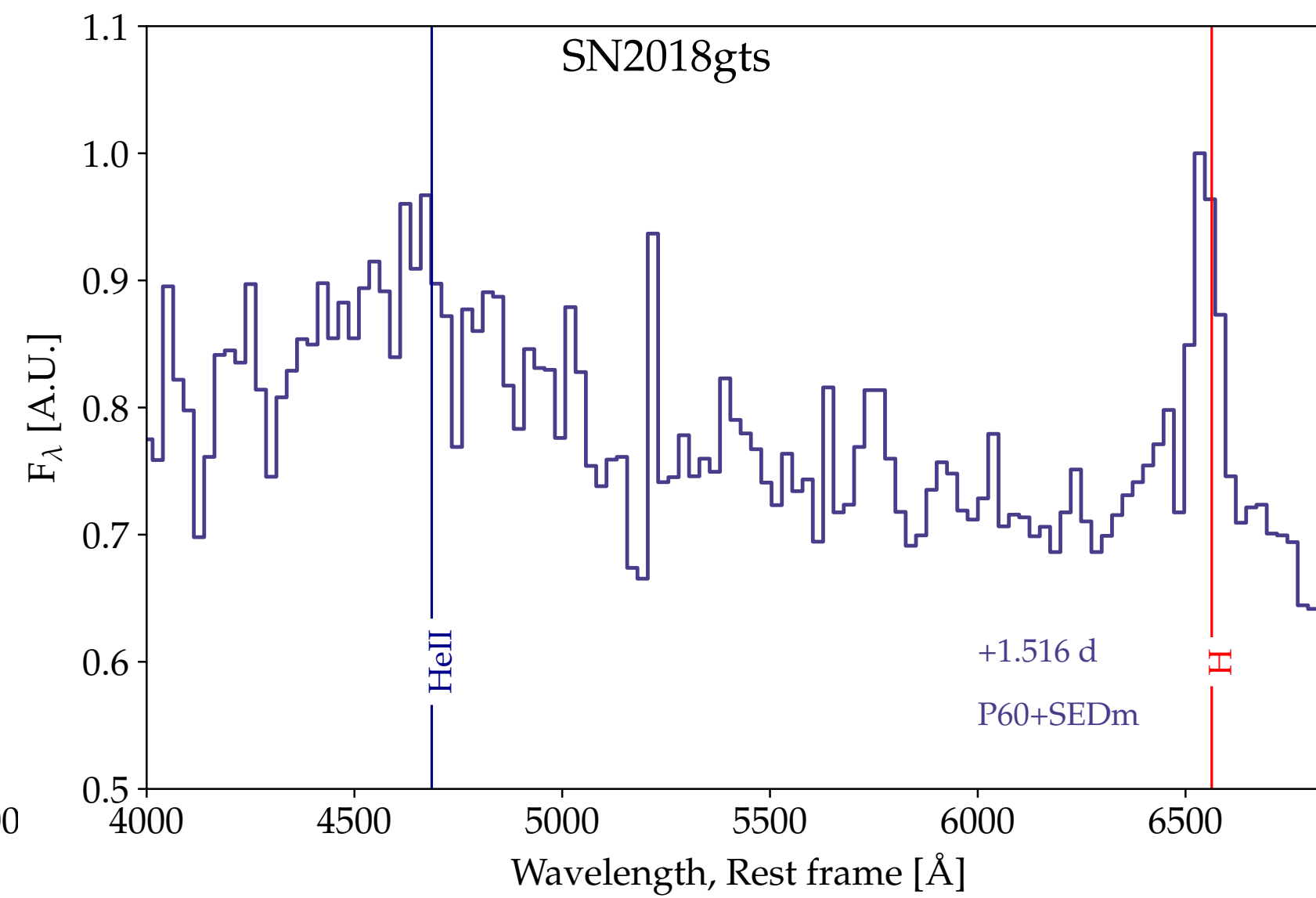
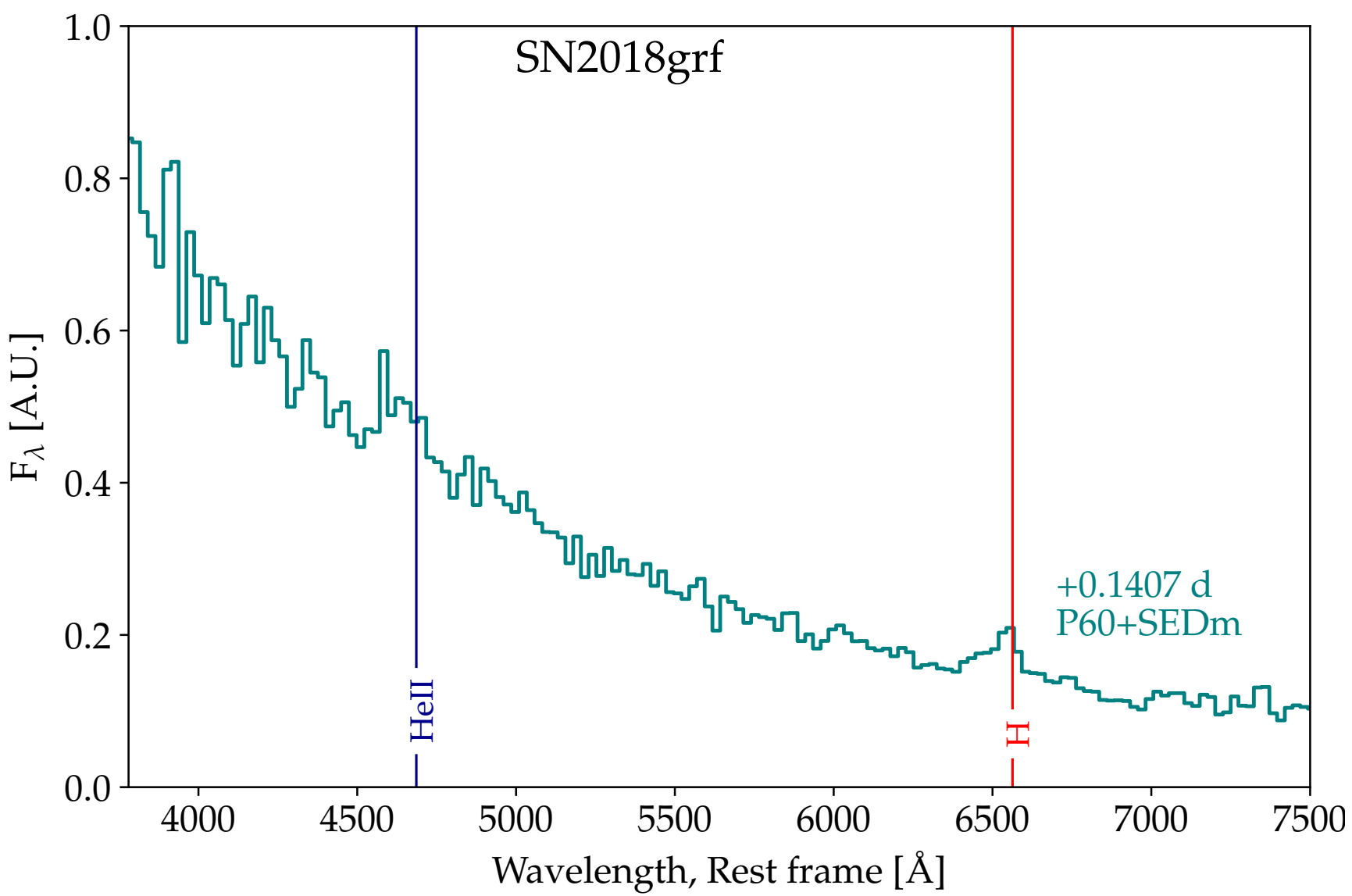
— He II 4686 $\text{\AA}$



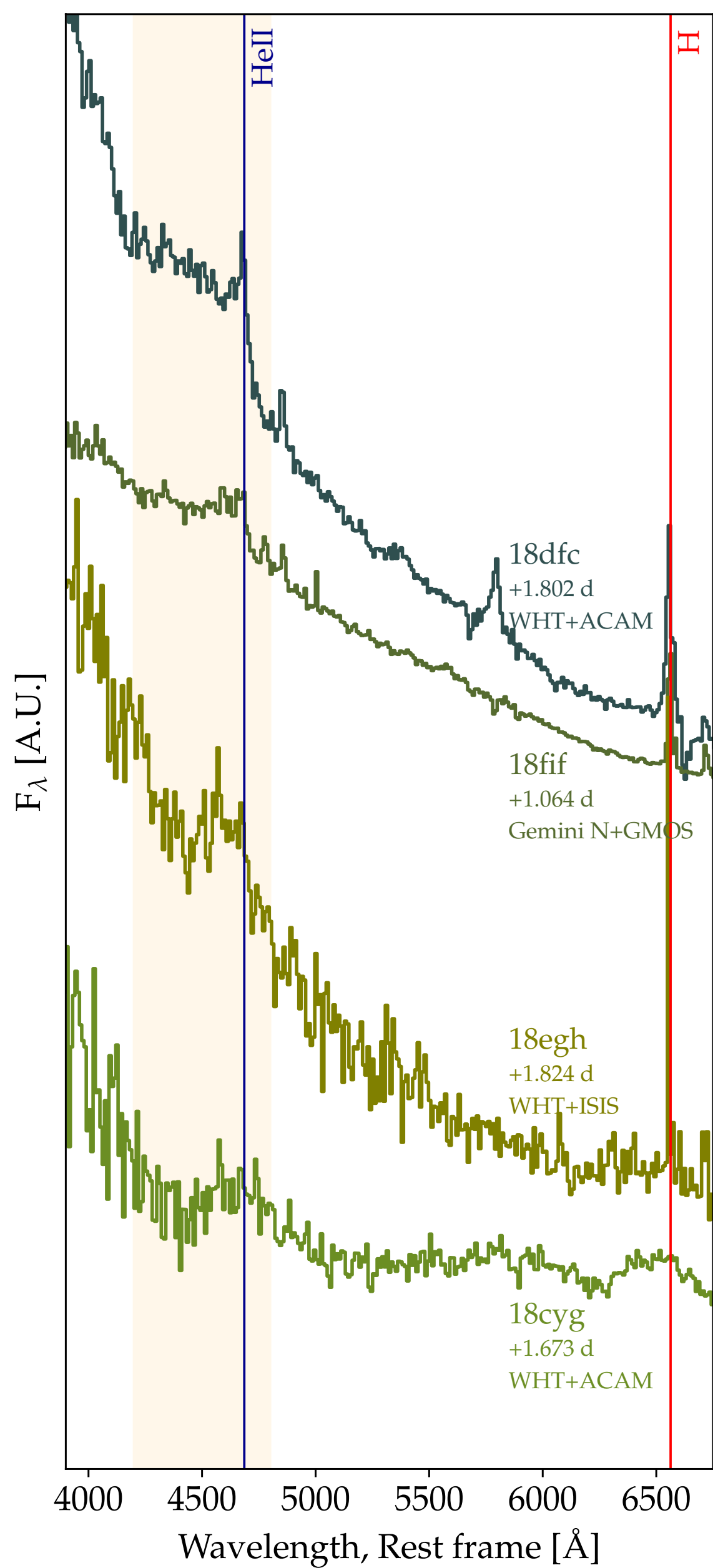
No evidence of flash ionisation features



6 Flash candidates



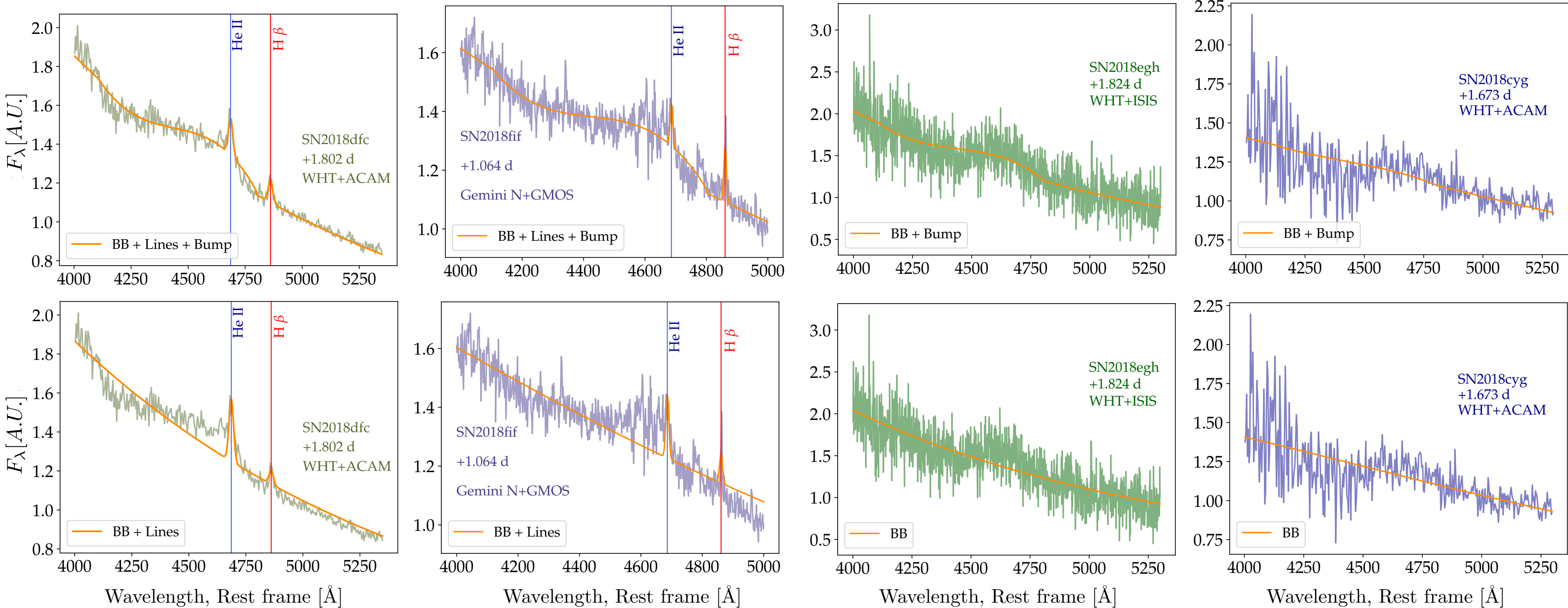
2 dubious flash candidates



> Model of BB+Lines (+Bump)

> Not conclusive, but structure occurred in several candidates

Name	Spectrum	Lines fit	χ_2/dof with bump	χ_2/dof without bump	Fit Interval [Å]
SN 2018dfc	P60+SEDm +1.015 d	[HeII, H β]	0.76	1.43	4000-5300
SN 2018dfc	WHT+ACAM +1.082 d	[HeII, H β]	1.66	4.09	4000-5300
SN 2018fif	Gemini+GMOS +1.064 d	[HeII, H β]	2.12	3.34	4000-5000
SN 2018egh	WHT+ISIS +1.824 d	[HeII, H β]	0.87	0.91	4000-5300
SN 2018egh	WHT+ISIS +1.824 d	No Lines	0.87	0.93	4000-5300
SN 2018cyg	WHT+ACAM +1.673 d	No Lines	0.90	0.90	4000-5300

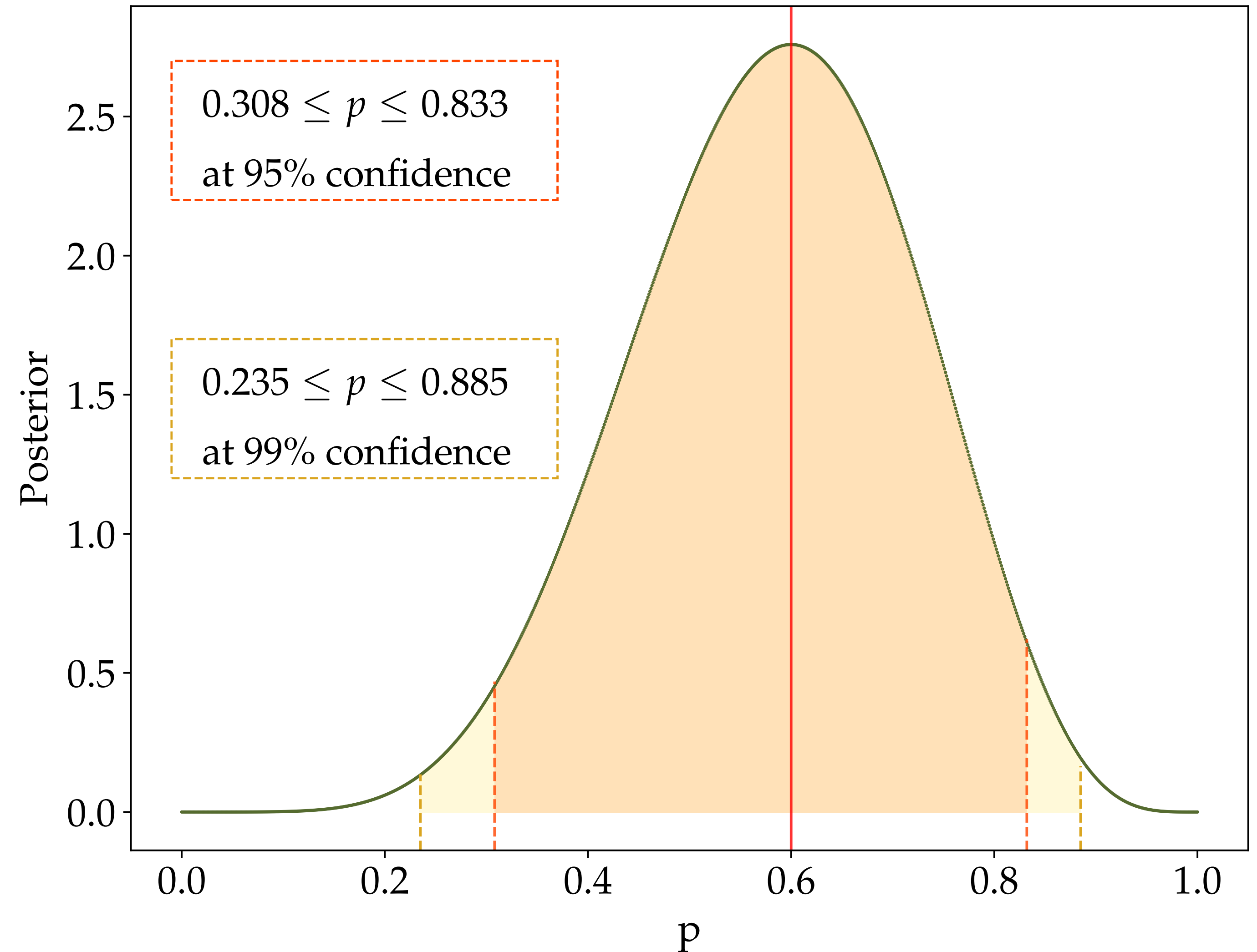


Fraction of flash features

> The majority of SNe II progenitors are embedded in CSM, this implies that they undergo mass loss prior to explosion

> Studies in previous surveys (e.g. PTF+iPTF) also predicted such a fraction, but we today have the means to achieve a systematic study within a well defined sample

> Future work will aim towards a fuller characterisation of flash features



Towards new studies

Systematic Infant Supernovae detection

Rigorous sample definition

> How common are flash features ? $\longrightarrow$ > 30% (~ 50 %)

> What are the different chemical compositions ? *Theoretical work initiated
(e.g. Jose Groh)*

> Duration of flash features ? *According to CSM extension?*



Yi Yang



Ido Irani



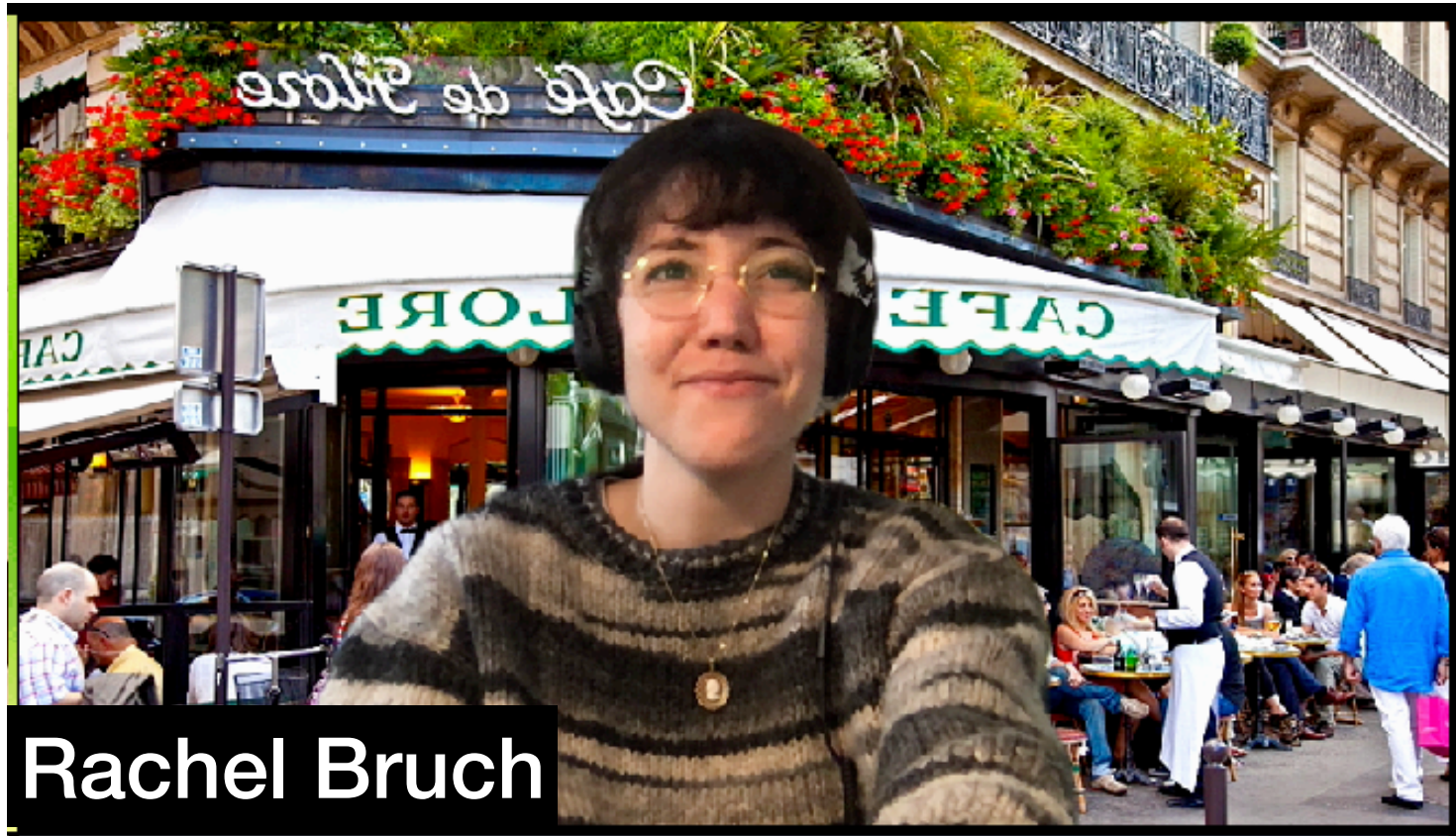
Ofer Yaron



Nora Strotjohann



Avishay Gal-Yam



Rachel Bruch



Erez Zimmerman



Samantha Goldwasser



Maayane Soumagnac



Mattia Bulla, Jesper
Sollerman, Suhail Dhawan



Steve Schulze

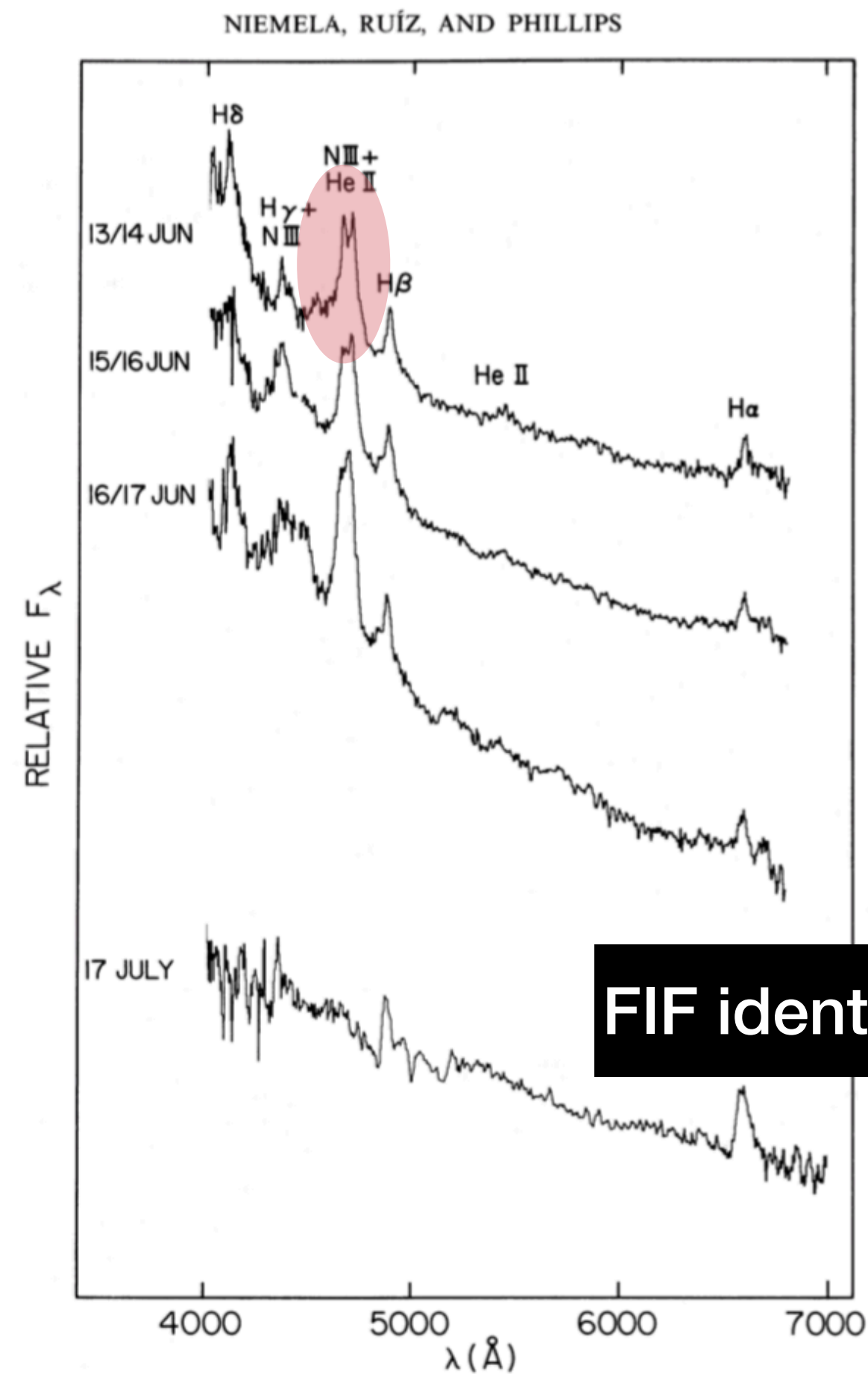
A large fraction of hydrogen-rich supernova progenitors experience elevated mass loss shortly prior to explosion

Rachel J. Bruch, Avishay Gal-Yam, Steve Schulze, Ofer Yaron, Yi Yang, Maayane T. Soumagnac, Mickael Rigault, Nora L. Strotjohann, Eran Ofek, Jesper Sollerman, Frank J. Masci, Cristina Barbarino, Anna Y. Q. Ho, Christoffer Fremling, Daniel Perley, Jakob Nordin, S. Bradley Cenko, S. Adams, Igor Adreoni, Eric C. Bellm, Nadia Blagorodnova, Mattia Bulla, Kevin Burdge, Kishalay De, Suhail Dhawan, Andrew J. Drake, Dmitry A. Duev, Alison Dugas, Matthew Graham, Melissa L. Graham, Jacob Jencson, Emir Karamahmetoglu, Mansi Kasliwal, Young-Lo Kim, Shrinivas Kulkarni, Thomas Kupfer, Ashish Mahabal, A. A. Miller, Thomas A. Prince, Reed Riddle, Y. Sharma, Roger Smith, Francesco Taddia, Kirsty Taggart, Richard Walters, Lin Yan

Spectroscopic detection of narrow emission lines traces the presence of circumstellar mass distributions around massive stars exploding as core-collapse supernovae. Transient emission lines disappearing shortly after the supernova explosion suggest that the spatial extent of such material is compact, and hence imply an increased mass loss shortly prior to explosion. Here, we present a systematic survey for such transient emission lines (Flash Spectroscopy) among Type II supernovae detected in the first year of the Zwicky Transient Facility (ZTF) survey. We find that at least six out of ten events for which a spectrum was obtained within two days of estimated explosion time show evidence for such transient flash lines. Our measured flash event fraction ($> 30\%$ at 95% confidence level) indicates that elevated mass loss is a common process occurring in massive stars that are about to explode as supernovae.

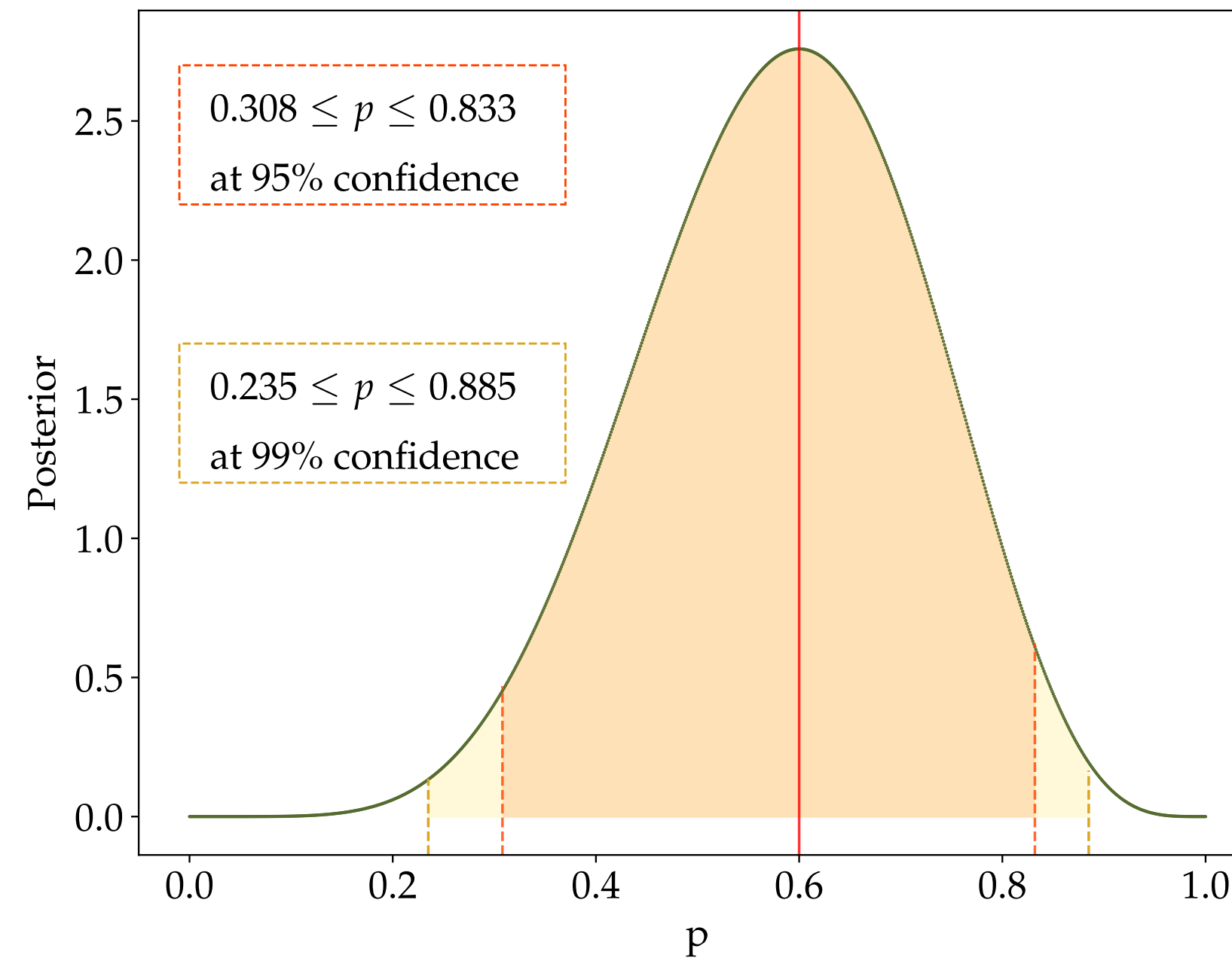
Conclusion

28 Real Infant SNe-II



FIF identification with HeII

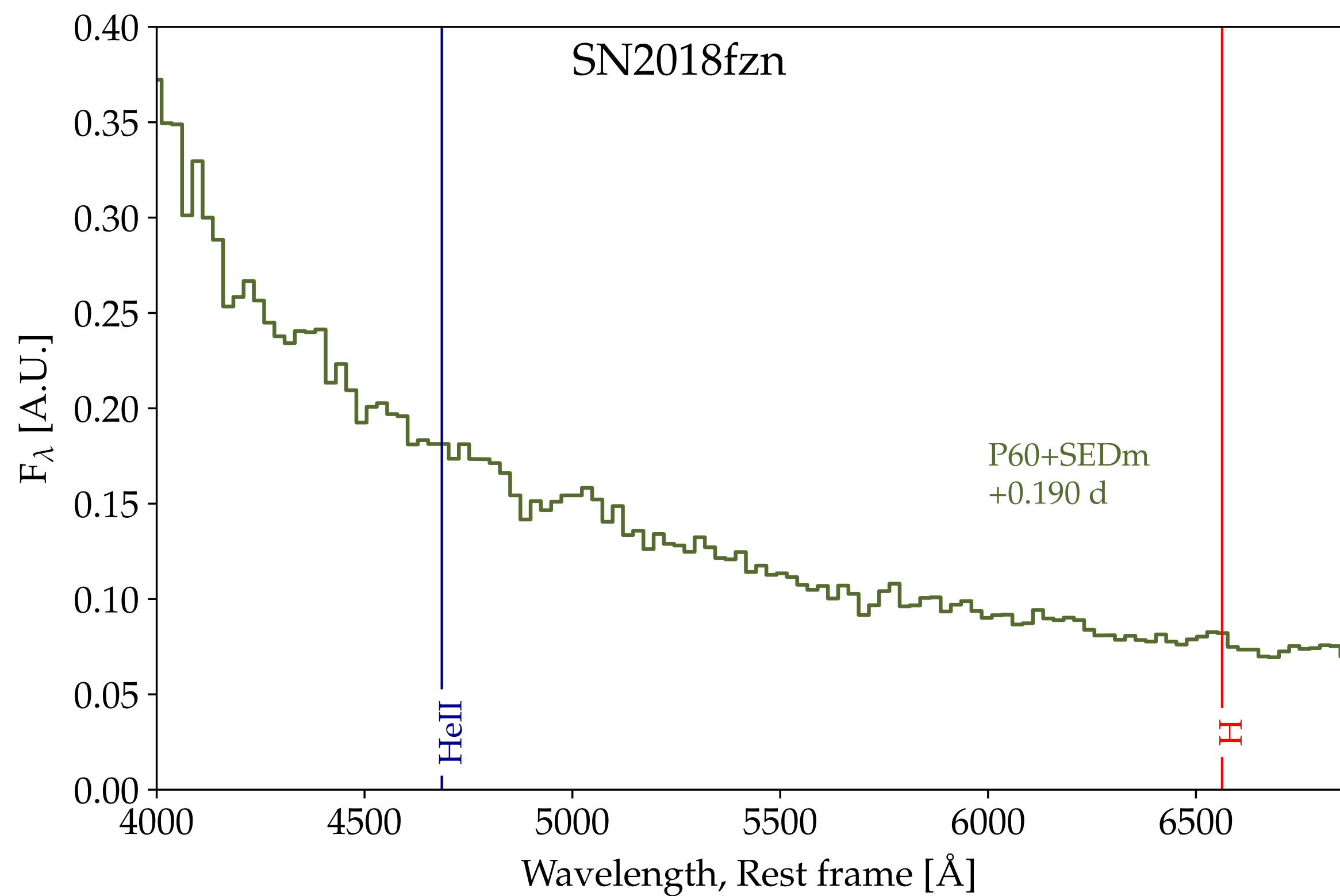
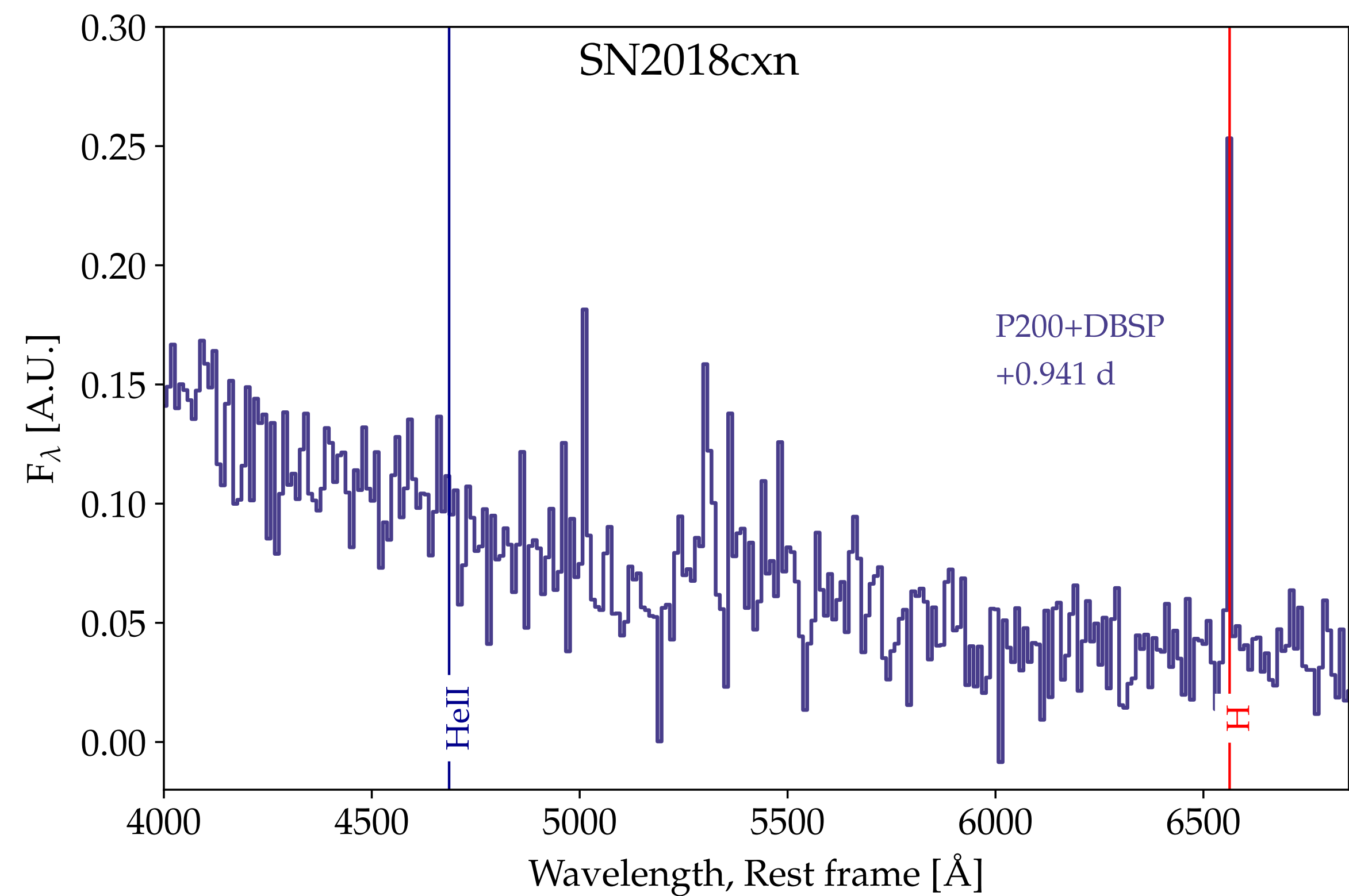
-> Indicative of CSM



Majority of SNe II progenitors show flash features

- > Elevated mass-loss prior to explosion are common
- > Today's new surveys now allow for such systematic search : opening for new questions and theoretical work

Non flasher infant candidate



No lines

Blue continuum