



Supernovae in the InfraRed Avec Hubble

The aging (early spectral evolution) of SN 2020jgl (Xarel·lo)
and the quest for baby supernovae with GTC

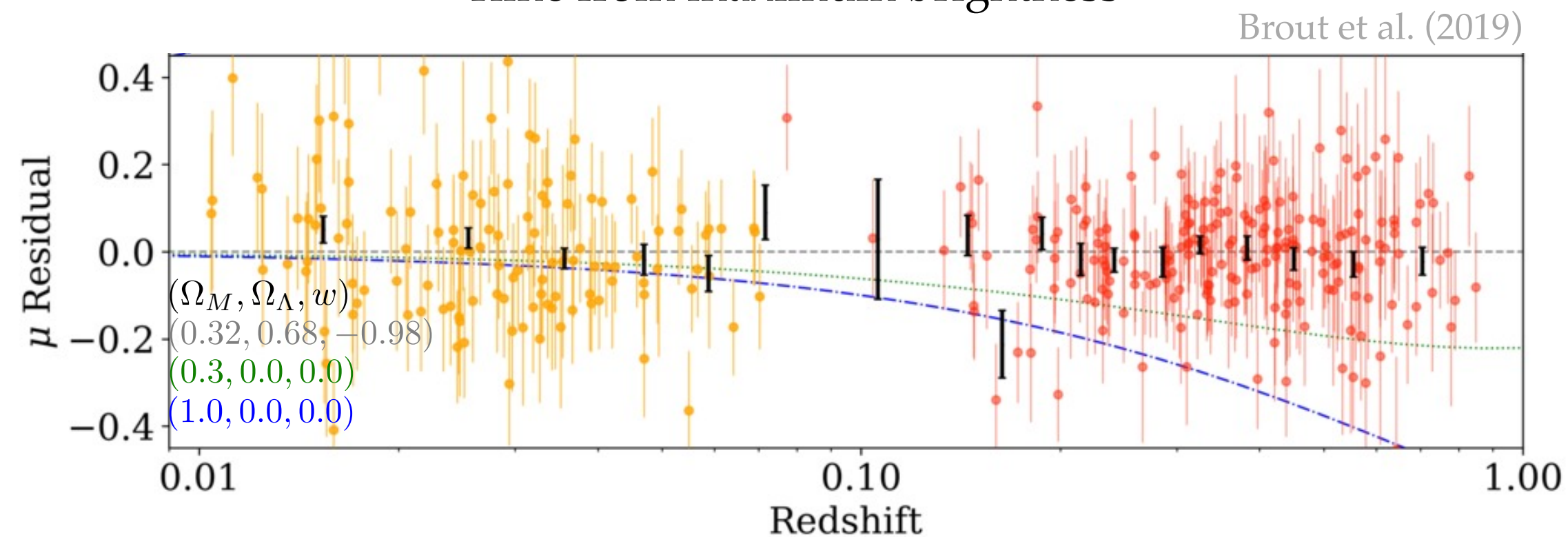
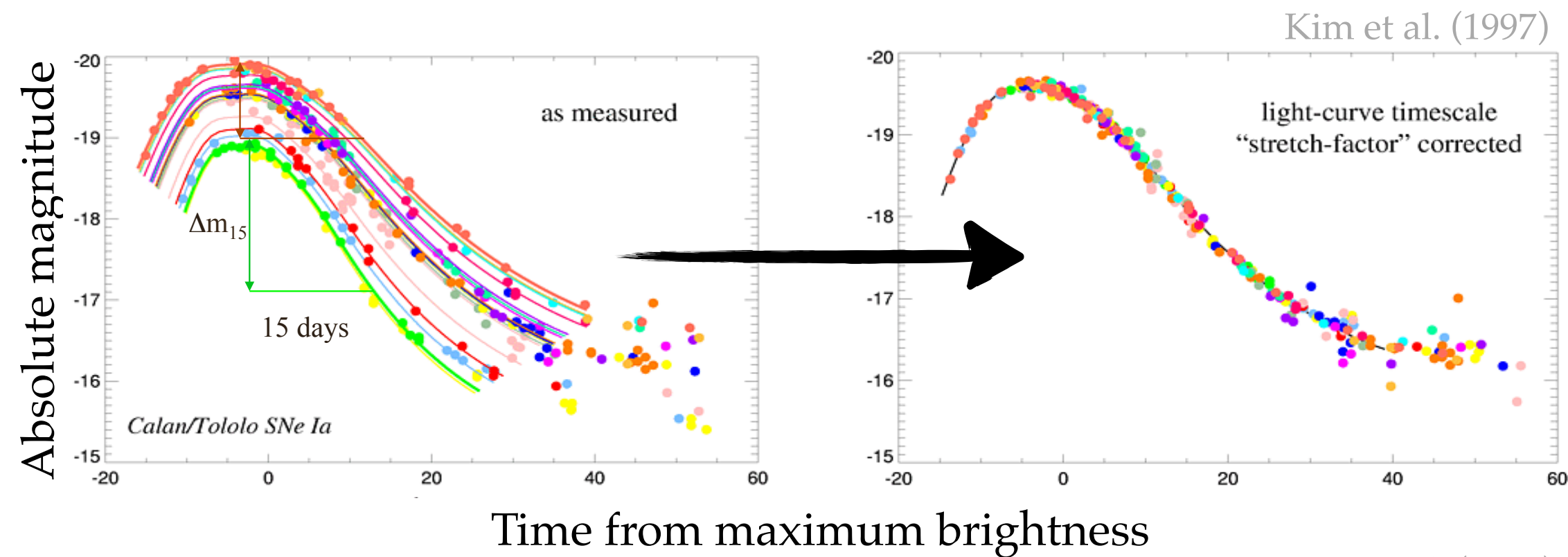


Lluís Galbany
MSCA-IF, U. Granada

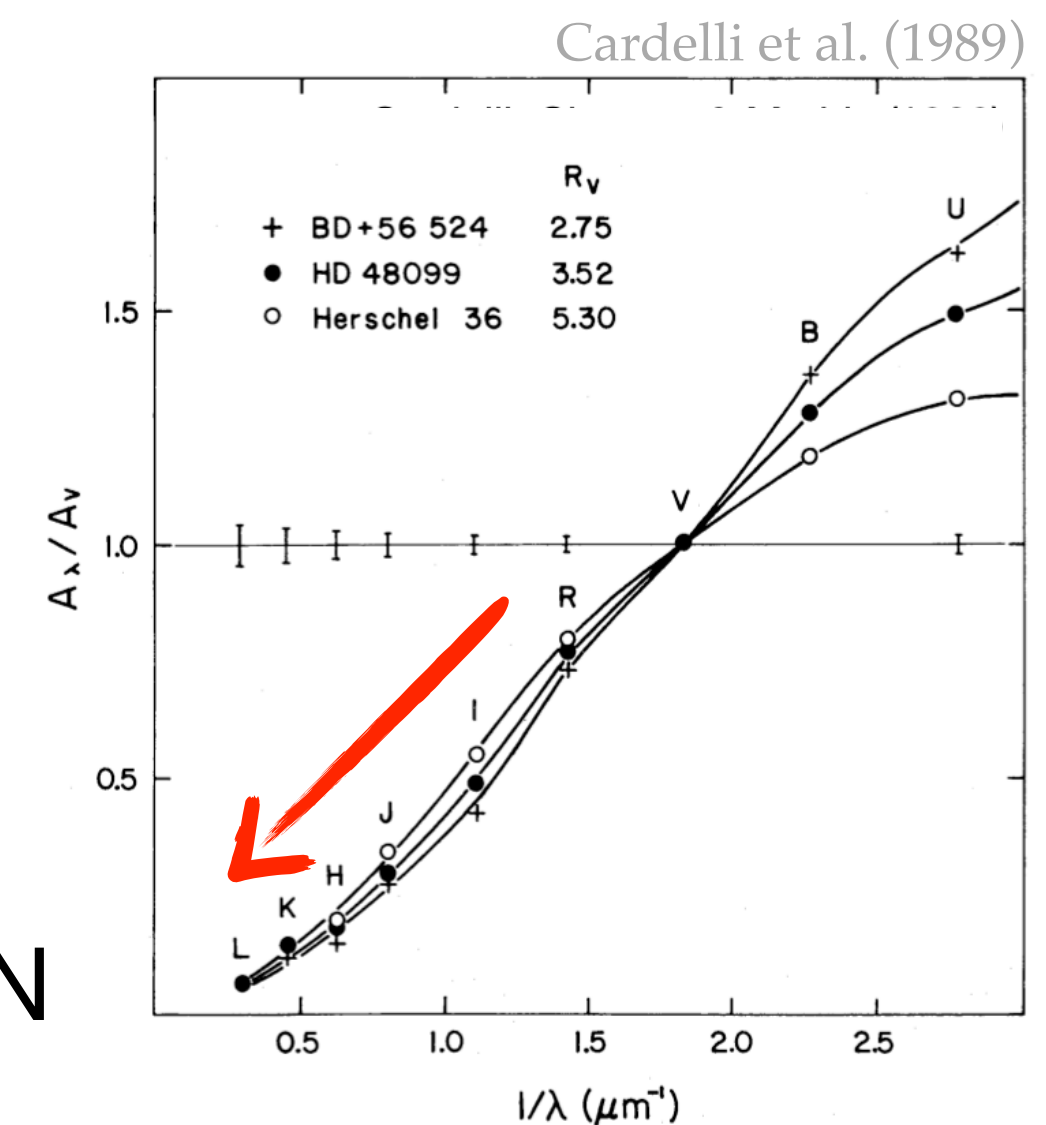
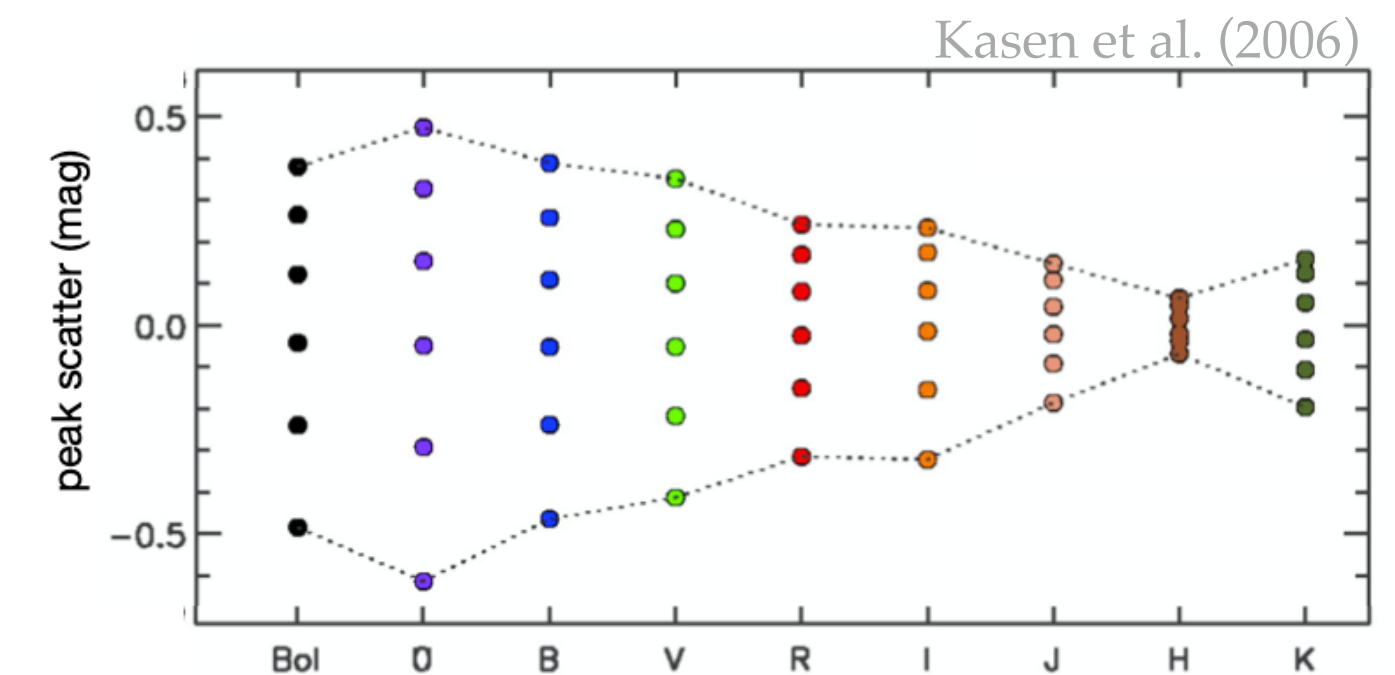
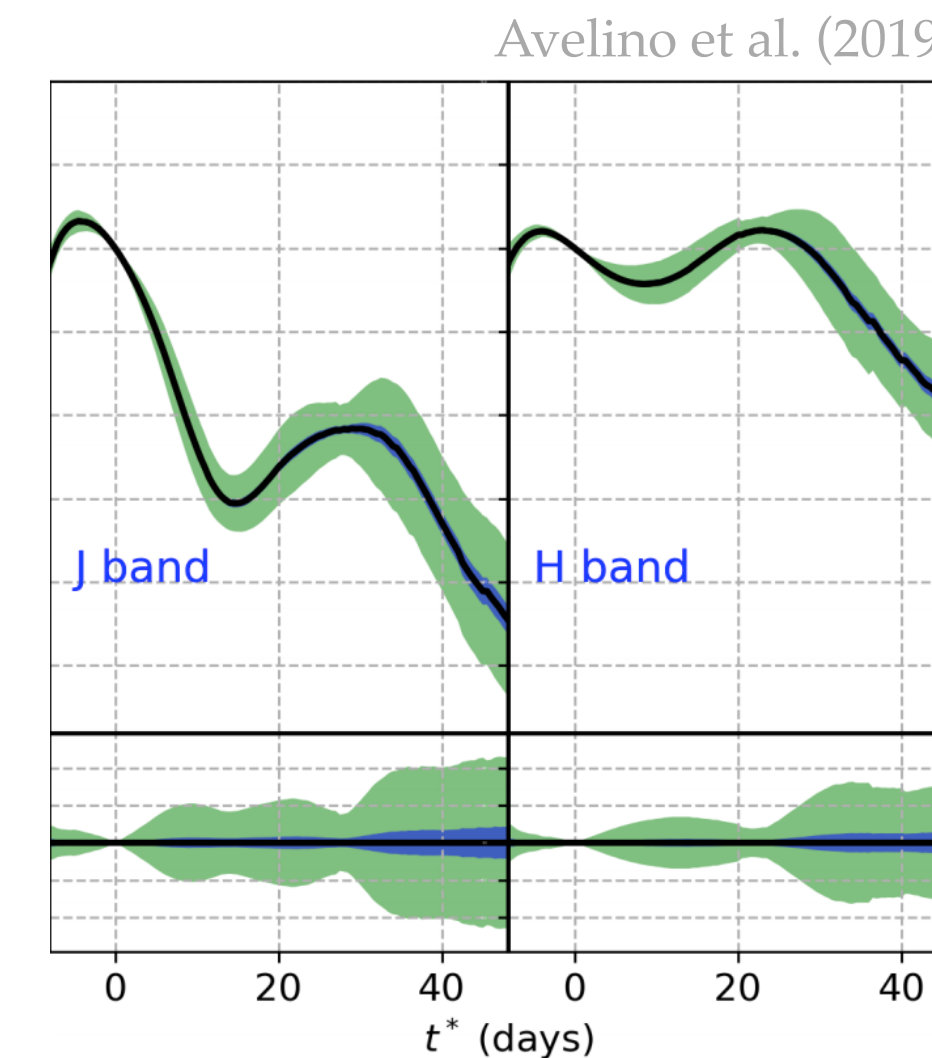
Type Ia supernova cosmology in the near infrared

Type Ia supernovae (SNe Ia) are the most precise extragalactic distance indicators to date. Empirical relations between **peak magnitude**, **light curve stretch** and **color**, allow the standardisation of their **optical** peak magnitudes down to $\sim 0.08\text{mag}$.

$$m_B^{\text{corr}} = m_B^{\text{obs}} + \alpha x_1 - \beta c$$



SN Ia are more natural standard candles in the near infrared (**NIR**). Both theoretically and empirically, it has been found that **NIR** SN Ia peak magnitudes are similar down to $\sim 0.11\text{ mag}$ (in **H-band**).



The main reason for the reduced scatter is dust extinction mitigation at NIR wavelengths.

However, there is a lack of SN Ia observations in the NIR...



Supernova in the InfraRed Avec Hubble

PI: Saurabh Jha (Rutgers)

HST Cycles 27 and 28 approved program to obtain NIR observations of **24 Hubble-flow** ($0.02 < z < 0.07$) **SN Ia** with WFC3/IR [2 objects per month Feb 20-21]

Photometry in 5 NIR bands: *F098M, F105W, F125W, F140W, F160W*

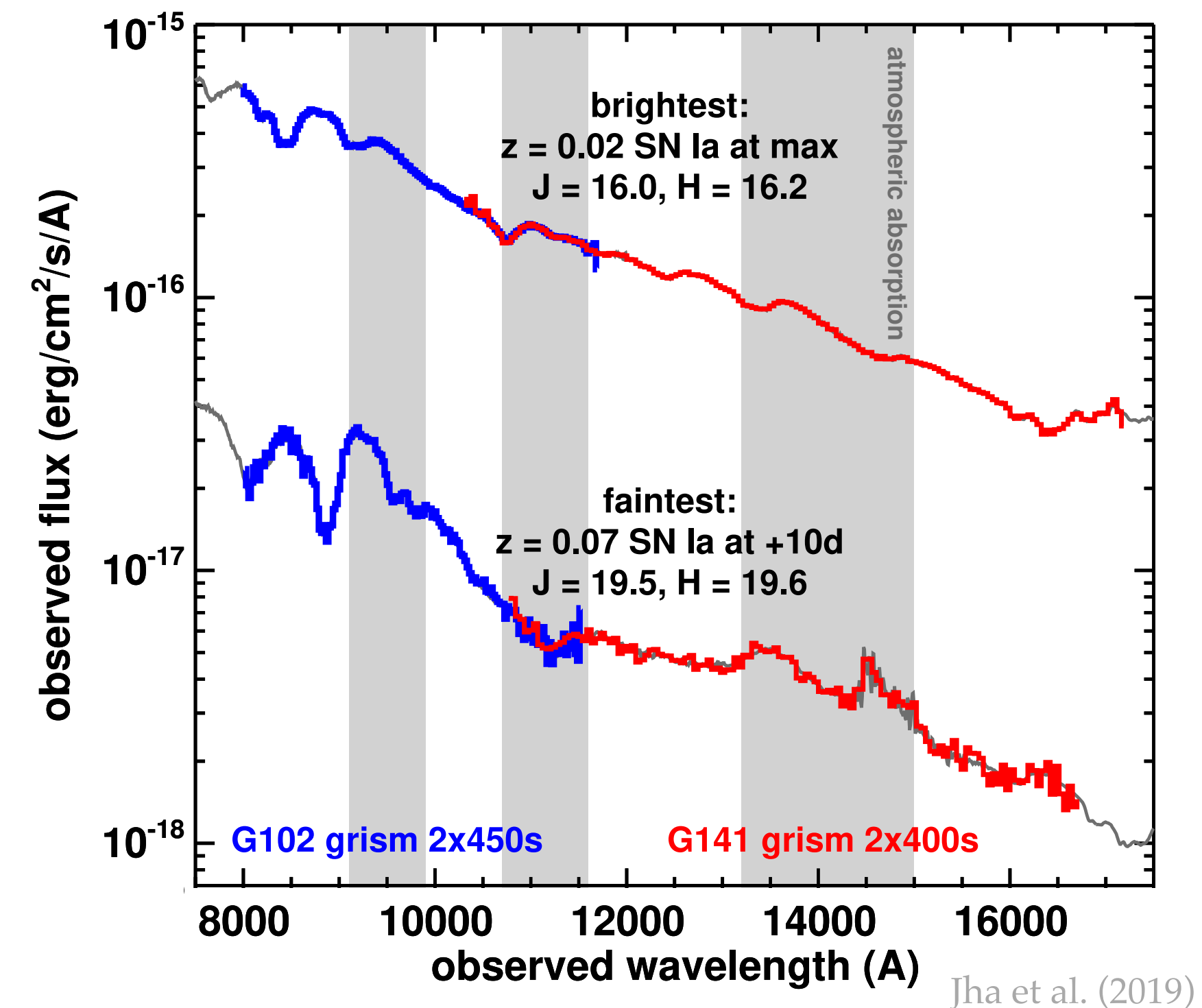
2 epochs of grism spectroscopy: *G102, G141*

- 3 key science goals:
- ★ rest-frame NIR SEDs for WFIRST
 - ★ 2.7% NIR SN Ia H_0 measurement
 - ★ HST Hubble diagram to $z = 0.6$ (w/RAISINs; high- z)

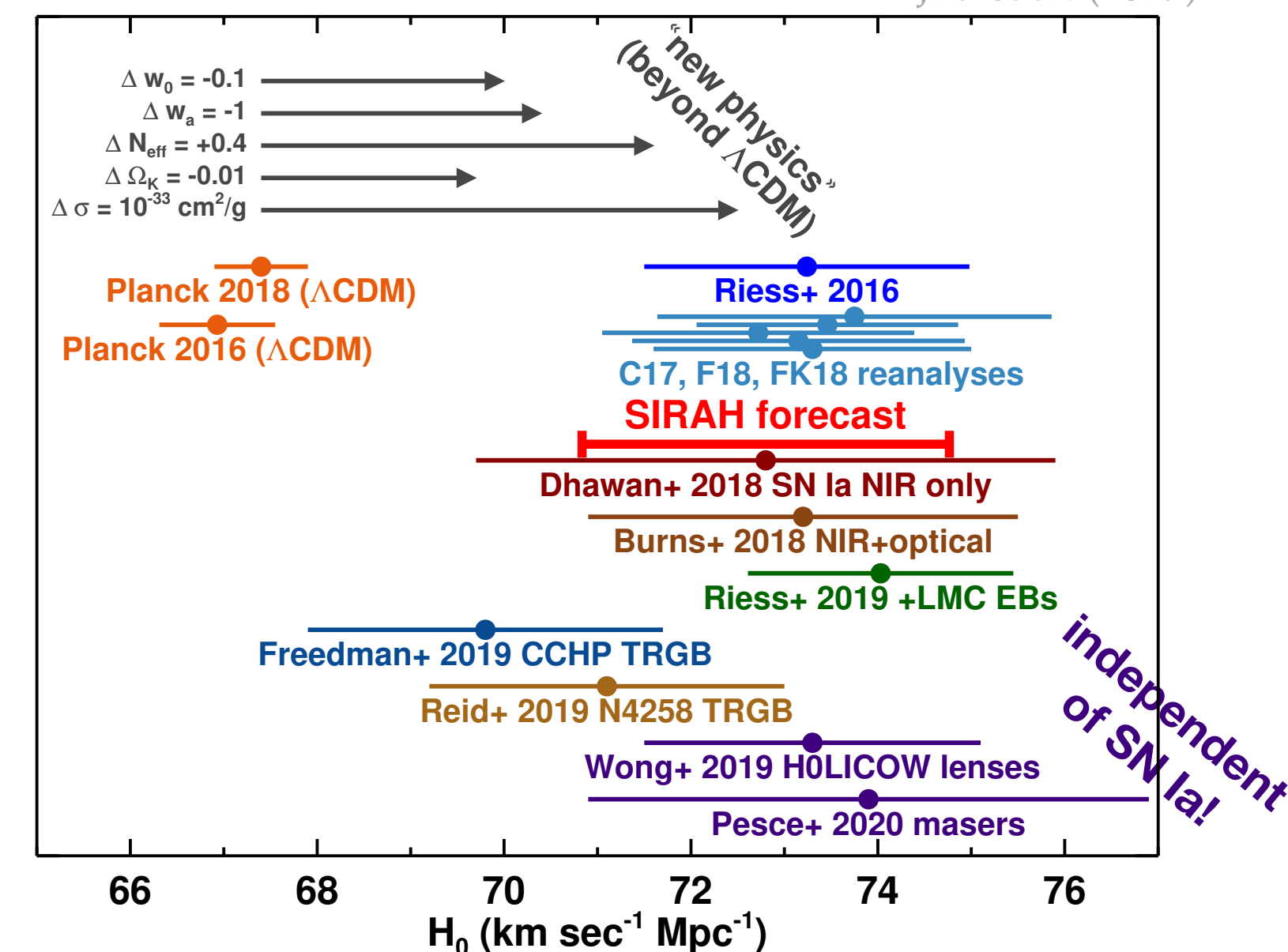
Around 2 week turnaround for HST: we need to trigger on very young SN Ia (few days post explosion) want near-max data.

Discovery: building on SN search surveys (*ZTF, ATLAS, PS, ASASSN*) and public brokers (*ALeRCE, Lasair, Antares*)

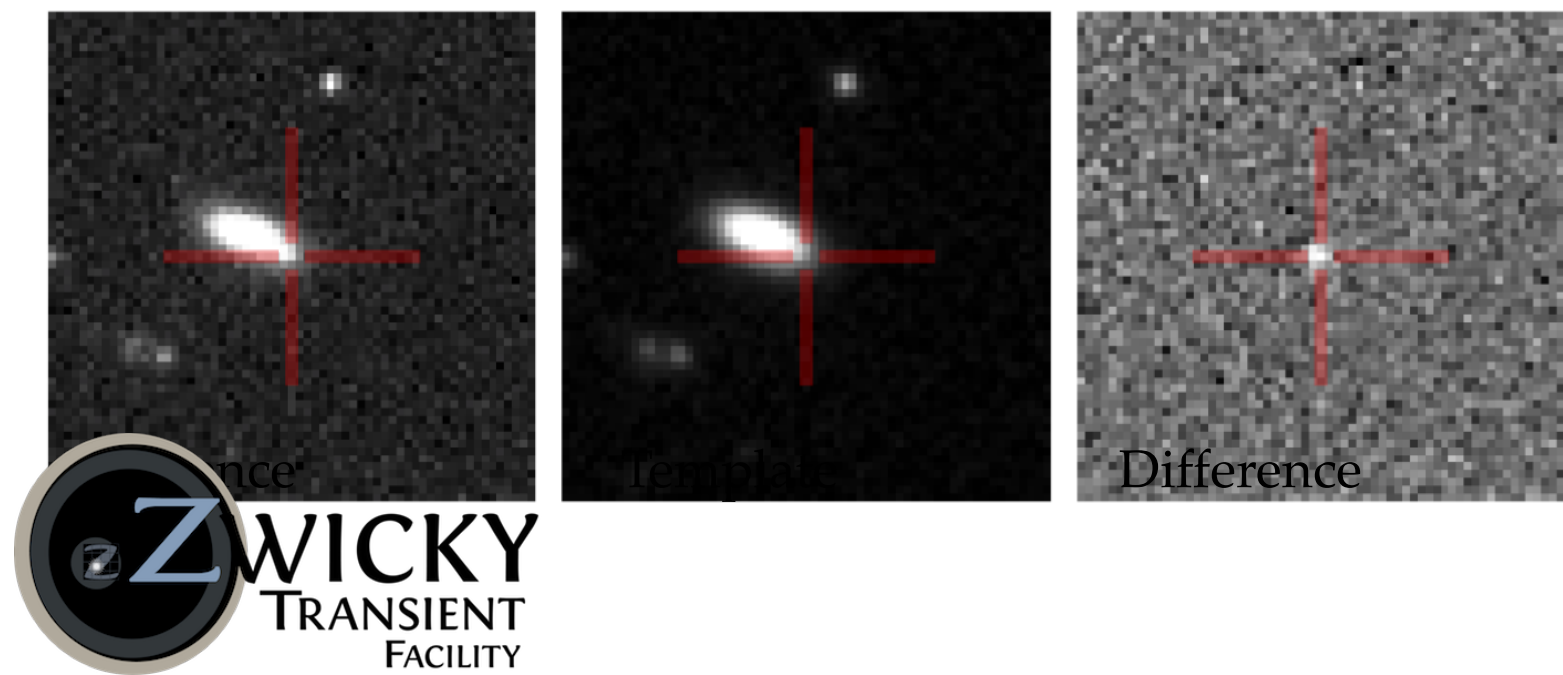
Classification: relying on ground-base **ToO** programs with large aperture telescopes (e.g. *GTC*!)



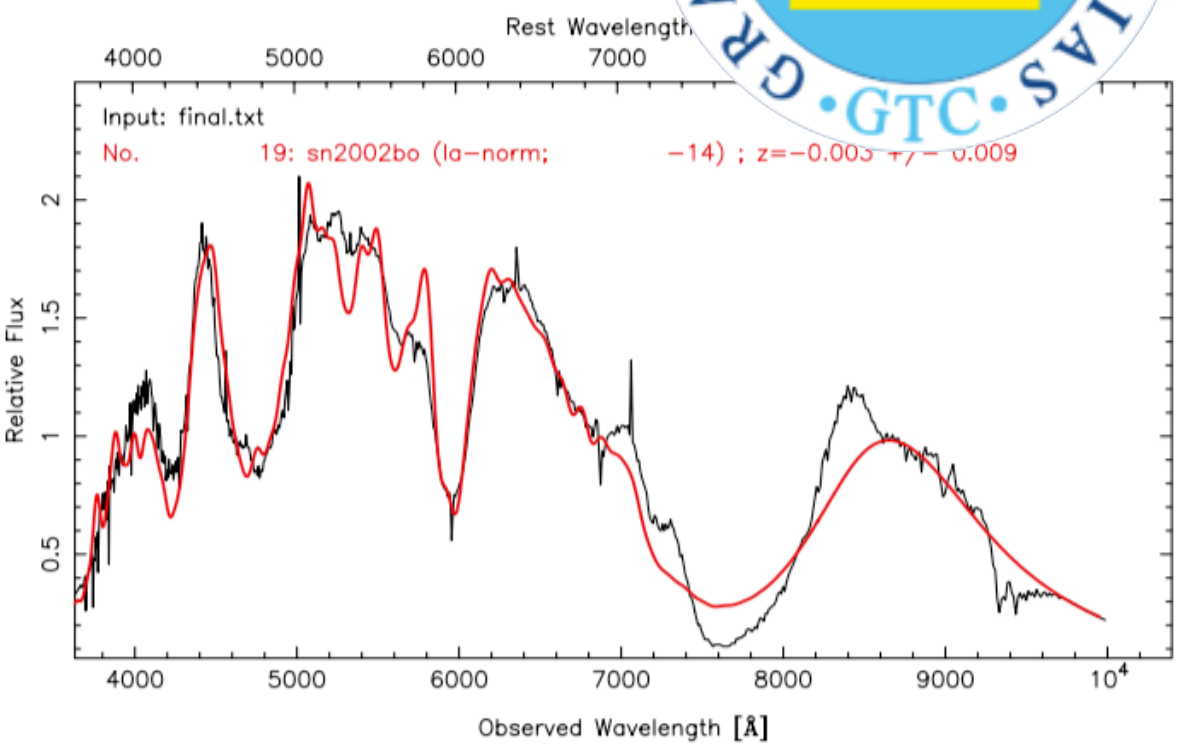
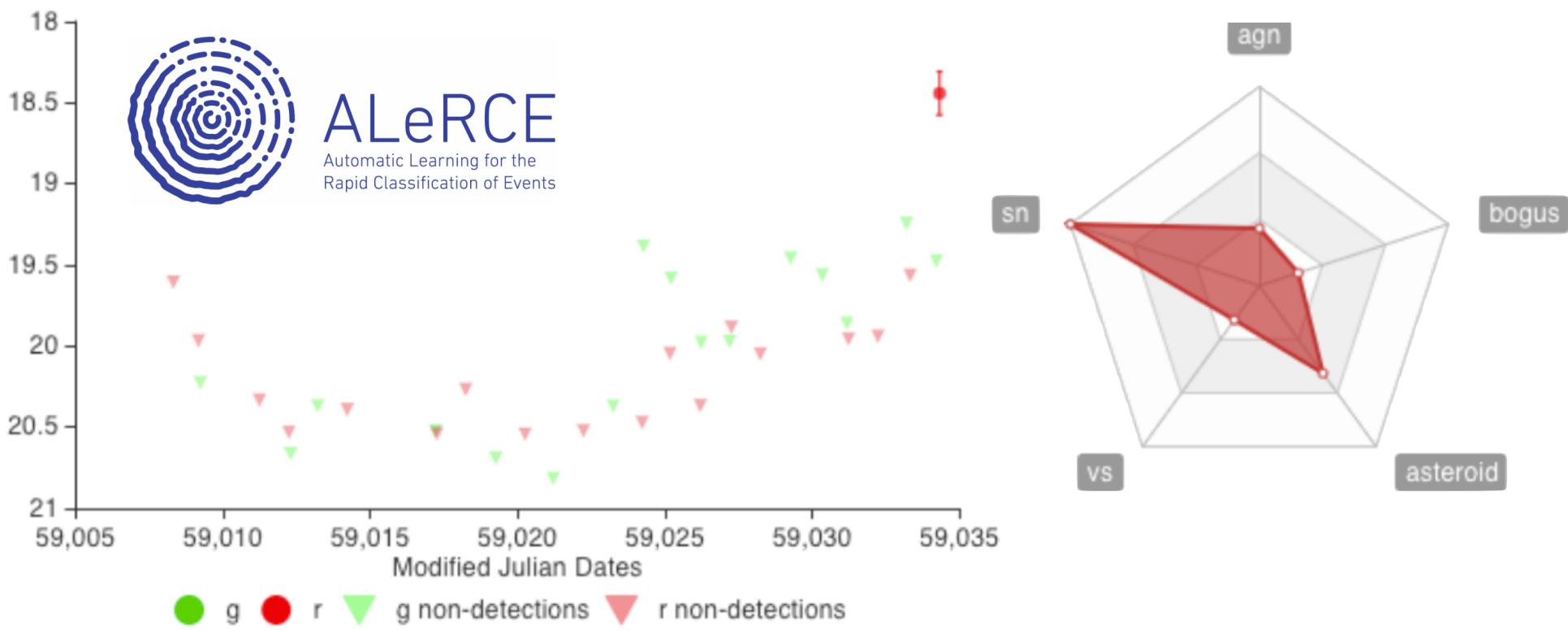
Jha et al. (2019)



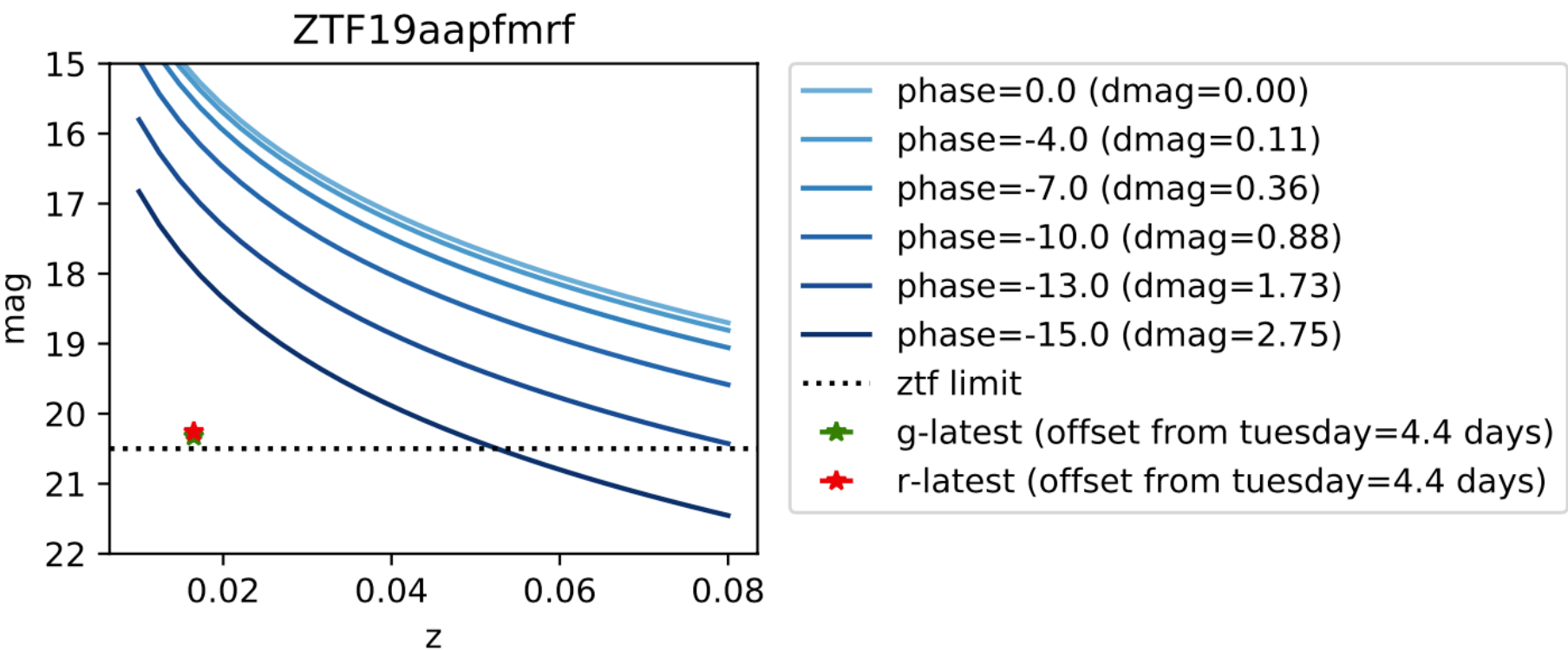
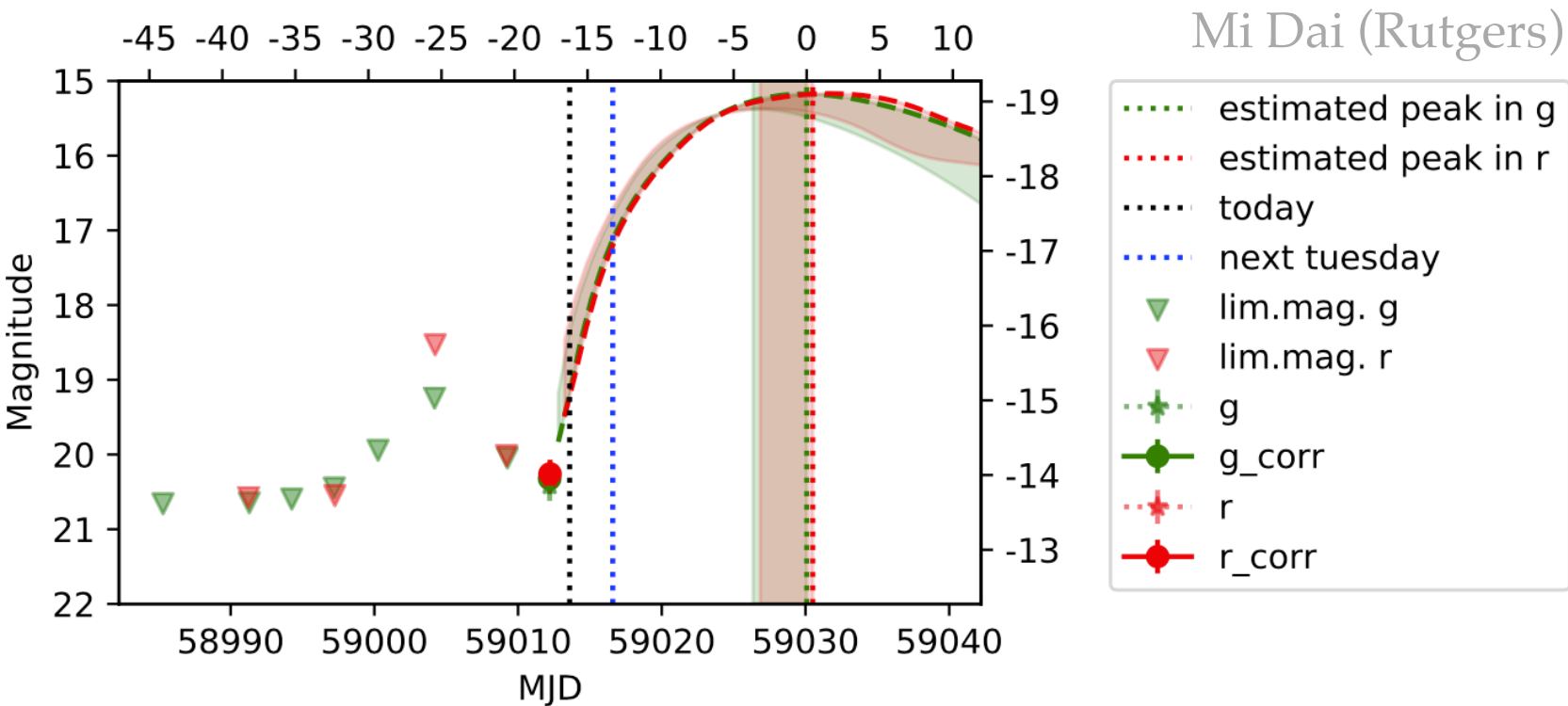
1. Surveys discover SN candidates



2. Brokers classify and organise these discoveries



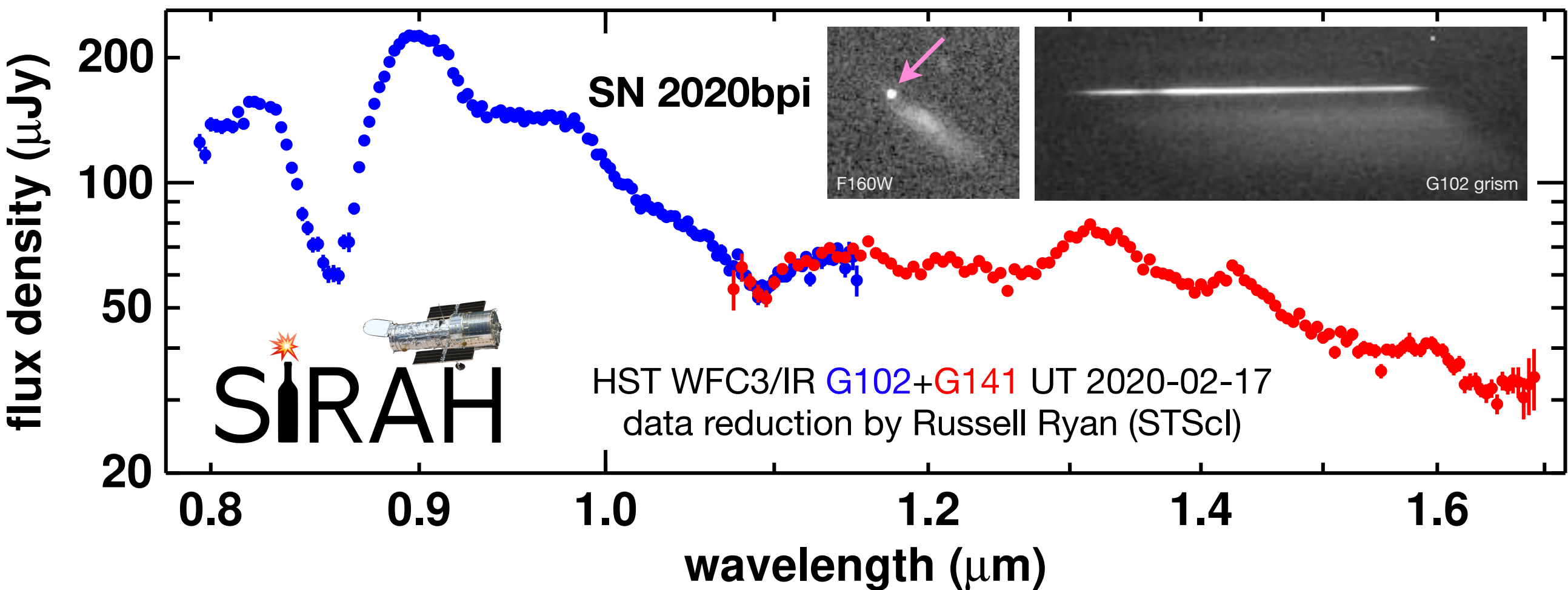
3. SIRAH searches for good young SNIa candidates from brokers



4. ToO programs request spectra to classify the best candidates

5. If a young SNIa, HST is triggered!

first ever rest-frame NIR spectrum of a maximum light SN Ia from space!





Proposal GTC52-20A (PI: Lluís Galbany):
Follow-up of infant SNe within 48h from explosion

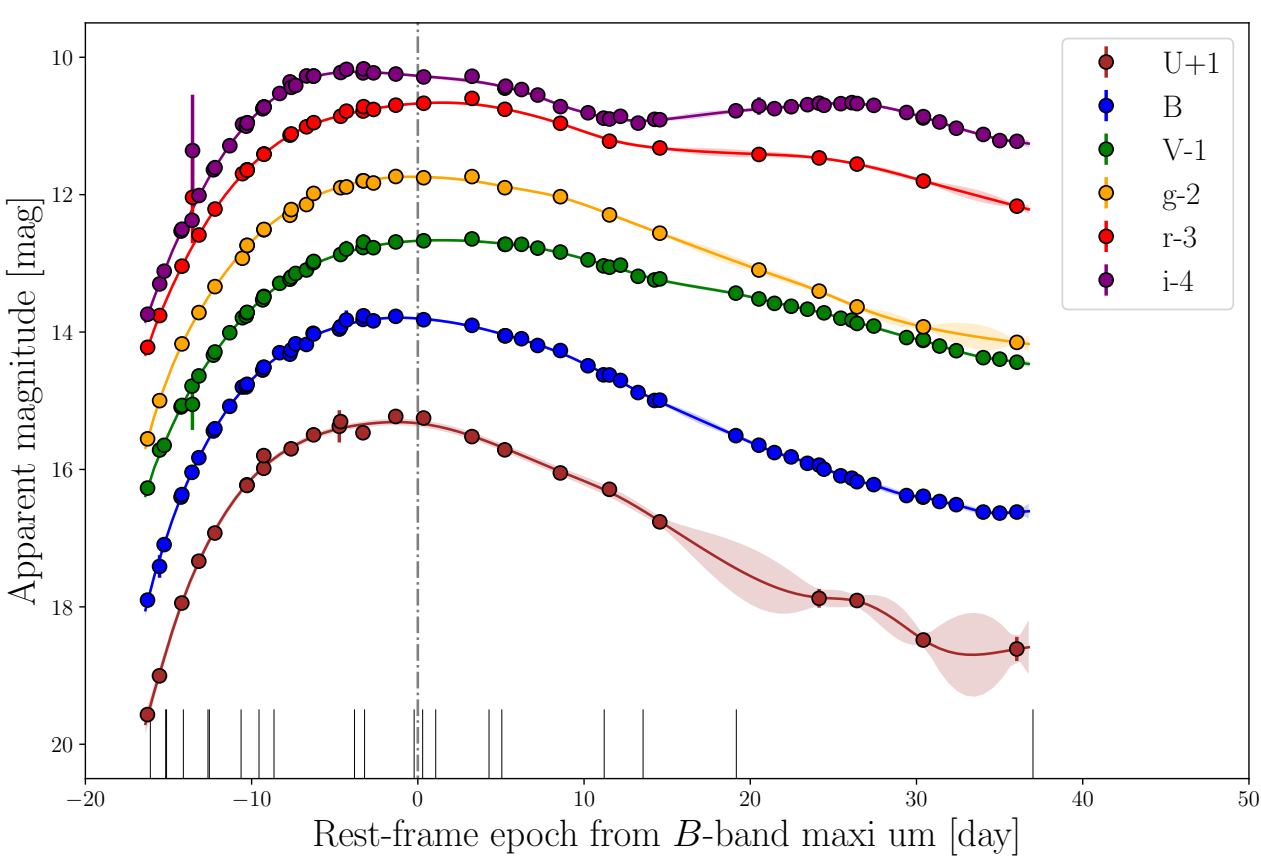
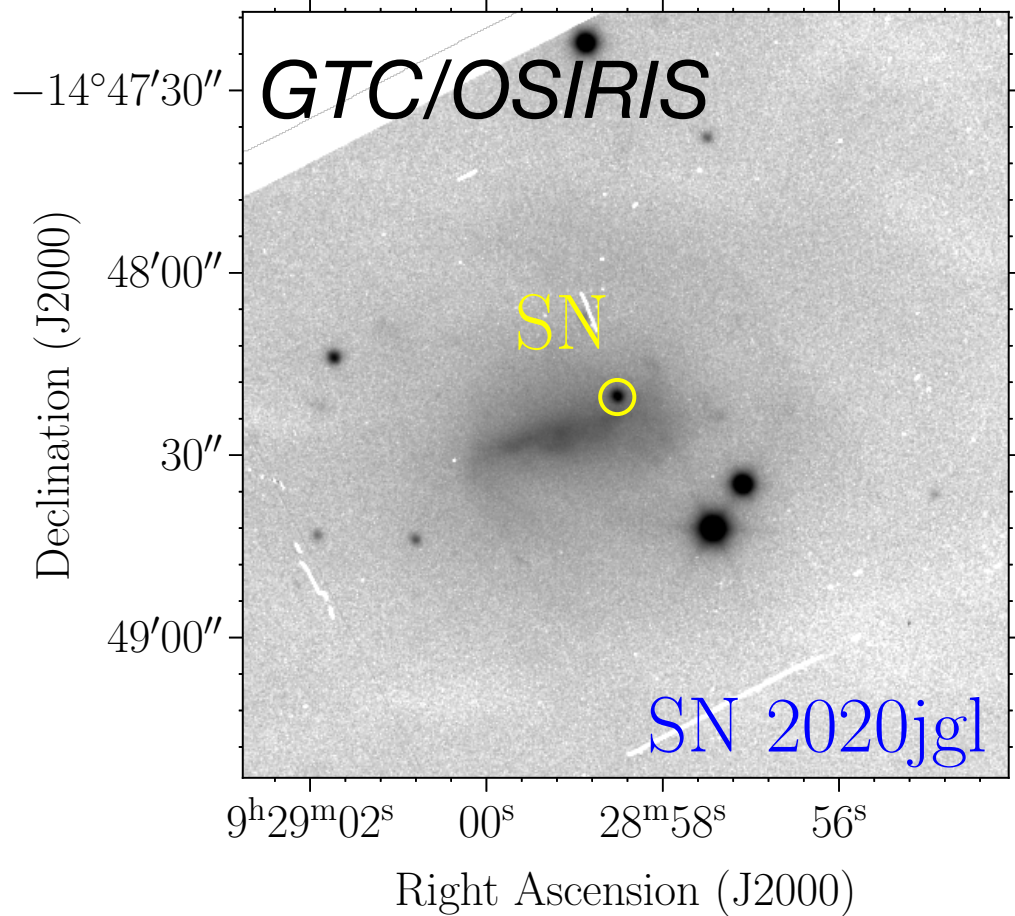
10 classifications of SN candidates

SN name	Type	Time from discovery
ZTF20aaxvzja - SN2020itj	II	15h 05.84m
ZTF20aaynrhh - SN2020jfo	II	16h 51.43m
ATLAS20lti - SN2020jgl	Ia	14h 34.39m
ATLAS20lts - SN2020jhf	Ia-91bg	1d 11h 48.75m
ZTF20abaovyz - SN2020kjt	II	18h 58.49m
ZTF20abapyxl - SN2020kku	Ia	18h 28.06m
ZTF20abbhyxu - SN2020kyx	Ia	22h 02.15m
ZTF20abazeye - AT2020krl	CV	3d 17h 44.88m
ZTF20abbplei - SN2020lao	IcBL	18h 45.72m
ZTF20abisitz - SN2020nny	II	17h 12.89m



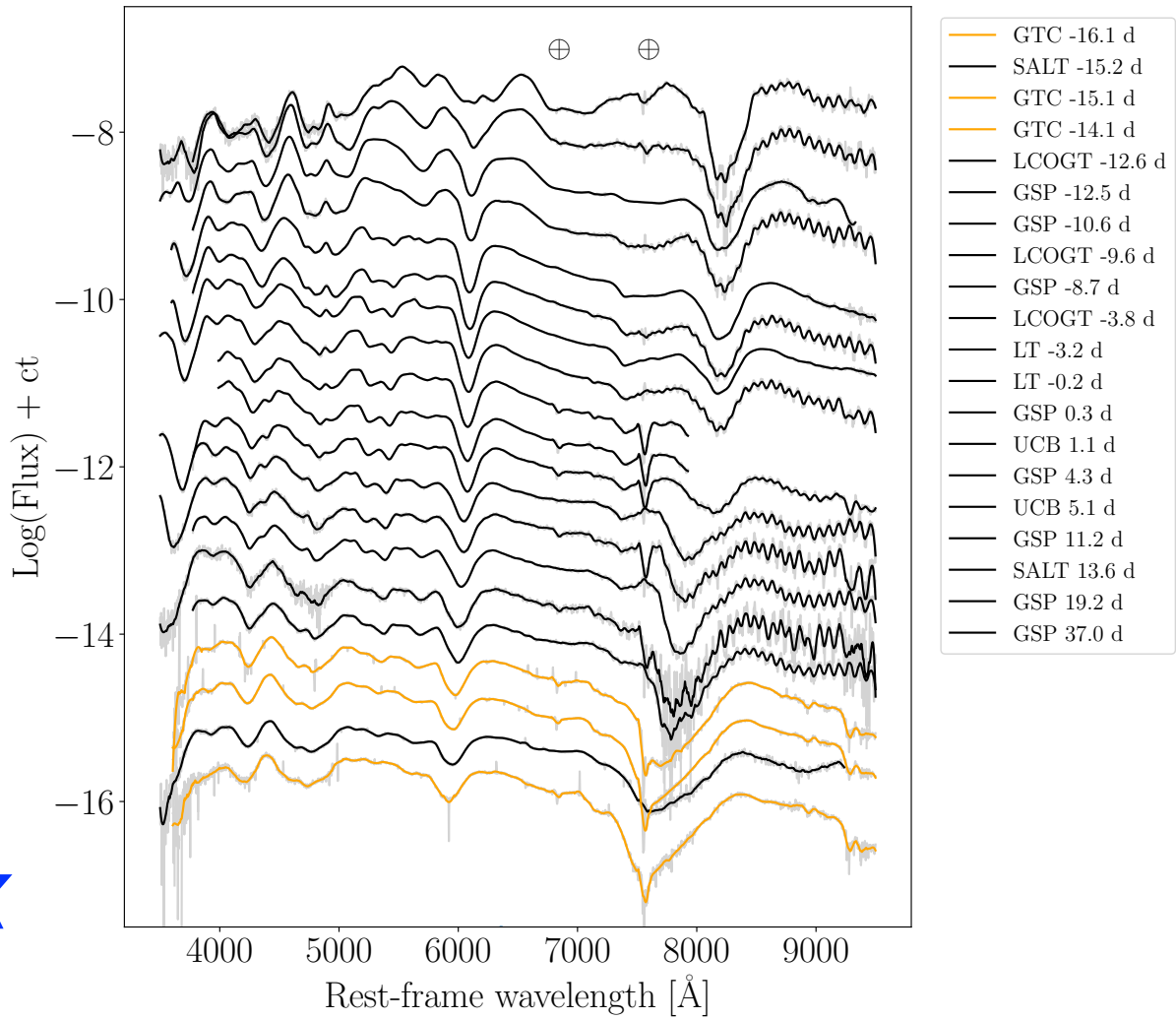
Triggered
by SIRA

Papers in
preparation

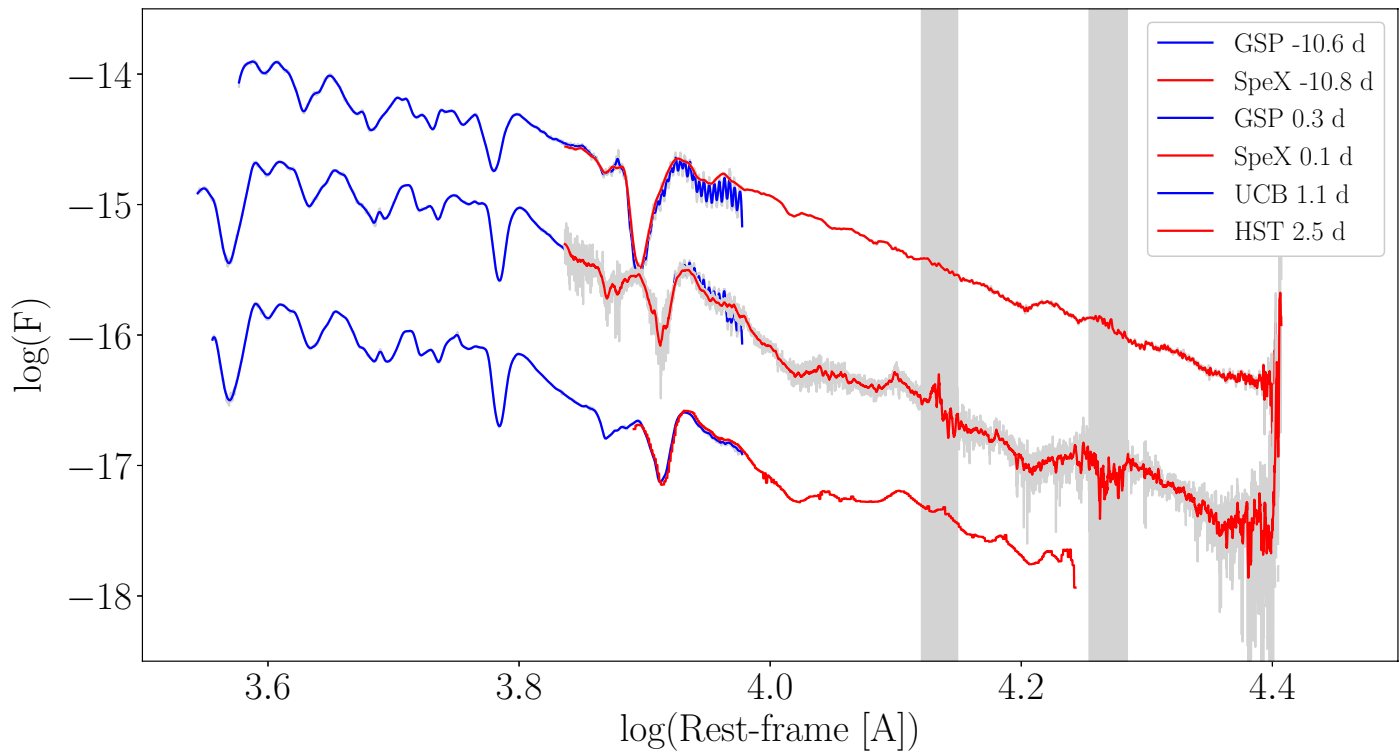


Las Cumbres telescope network
UBVgri photometry

Optical spectroscopic
sequence from: **GTC** +
SALT + Las Cumbres +
Liverpool + KAIT
12 spectra pre-max



SpeX + HST NIR
spectroscopy
(more to come...)



Impact and prospects for the future

- Continuing **GTC-OSIRIS** program for the classification of very young **SNe**, and allow further follow up that lead to individual studies of the most interesting objects
- New **GTC-EMIR** program to complement **NIR** spectroscopy of **SIRAH** targets and enable **SN Ia** subtyping
- New **NOT/TNG** program to complement **NIR** photometry of **SIRAH** targets to better populate the H-band light curve, and also provide J-band with prospect of constructing a J and H-band independent Hubble diagrams.
- Long-term project: The *Carnegie Supernova Project (CSP III)* will be focused on the study of infant **SNe**, starting in mid 2021, right after **SIRAH** observations are finished.
- Enhance the participation of *Spanish researchers/institutions* in **SN** physics/cosmology international collaborations (**SIRAH**, **CSP**, **DES**, **LSST-DESC**...)