



# Supernovae in the InfraRed Avec Hubble

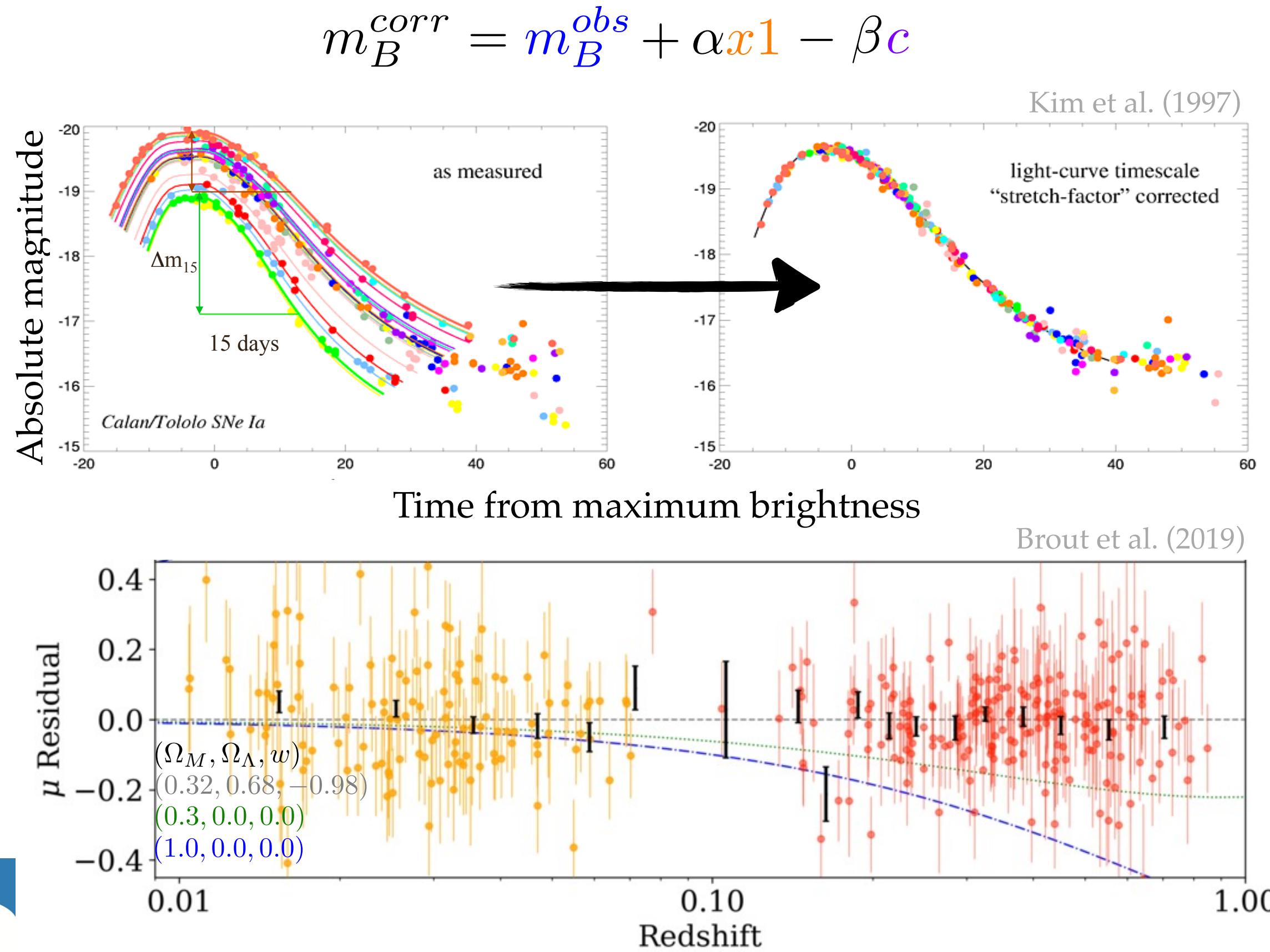
The aging (early spectral evolution) of SN 2020jgl (Xarel·lo)  
and the quest for baby supernovae with GTC



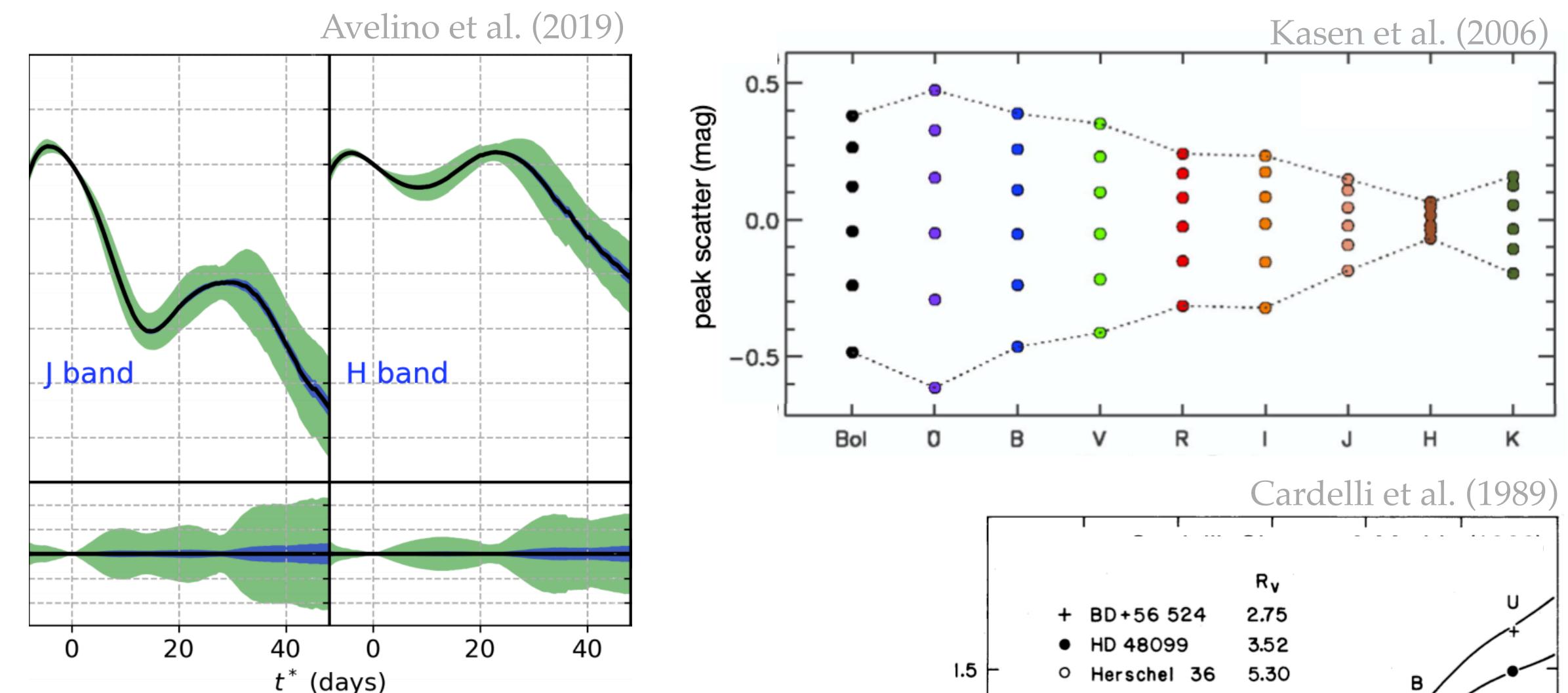
Lluís Galbany  
MSCA-IF, U. Grananda

# 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  $\sim 0.08$  mag.



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  $\sim 0.11$  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...



PI: Saurabh Jha (Rutgers)

## Supernova in the InfraRed Avec Hubble

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]

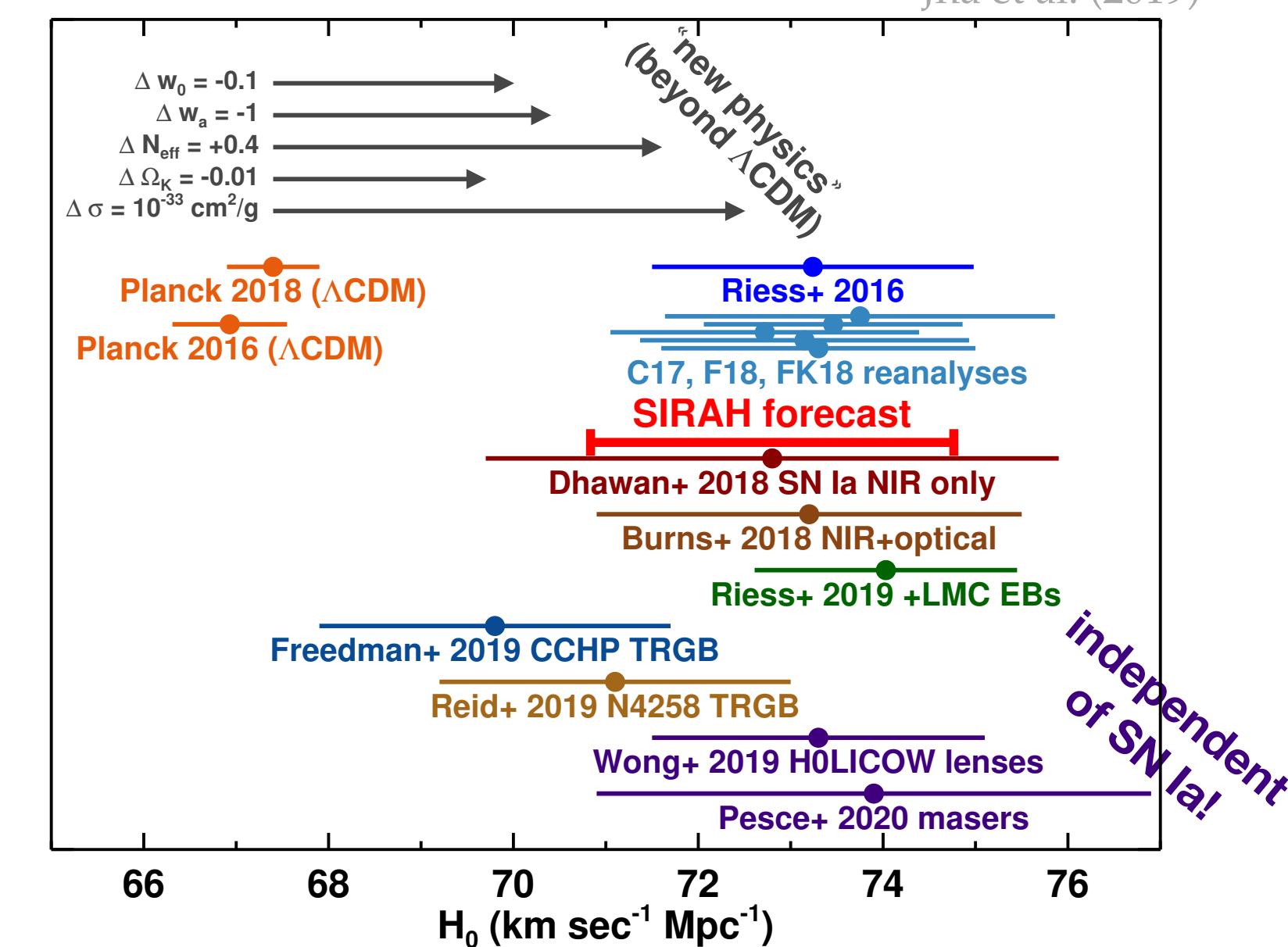
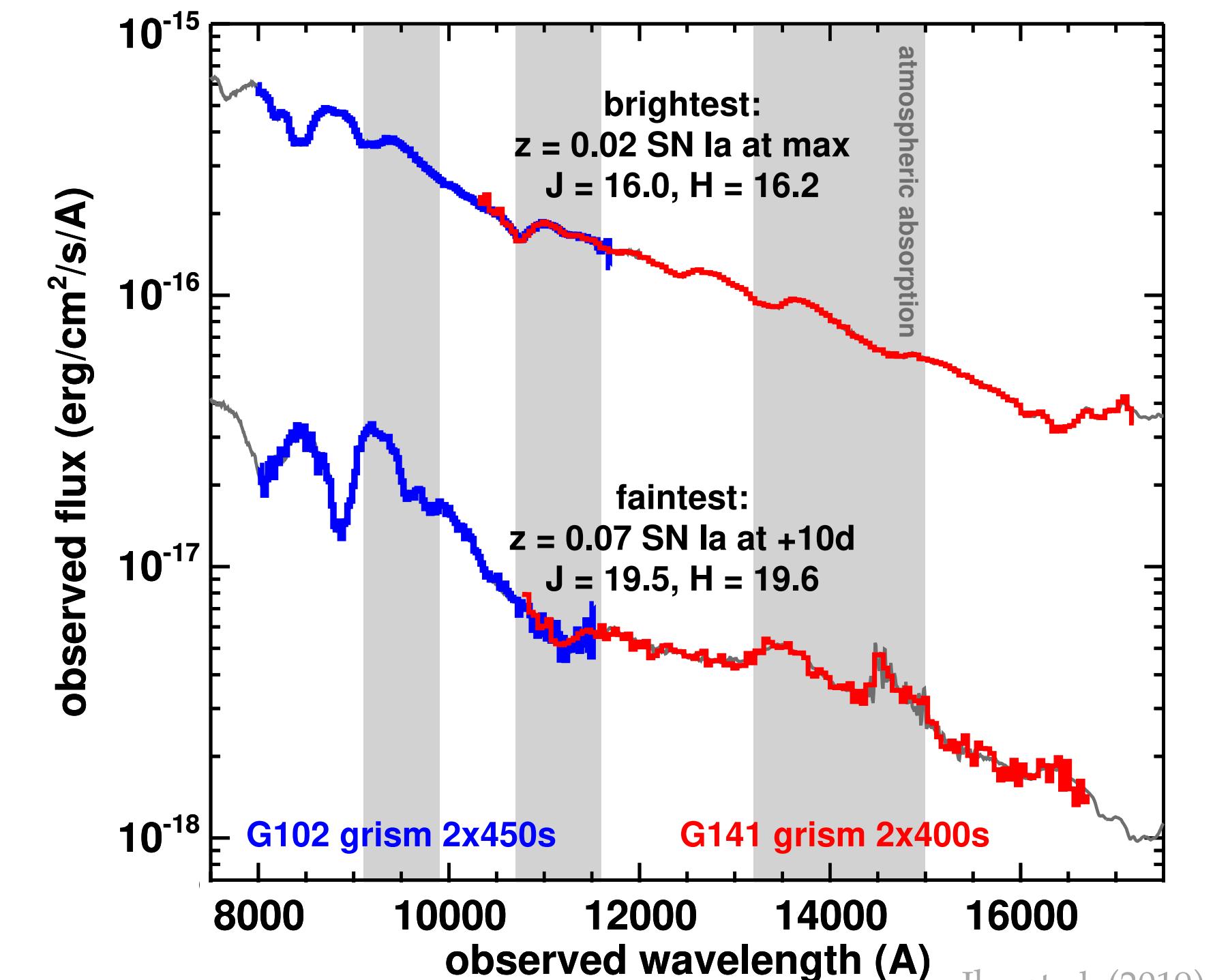
Photometry in 5 NIR bands: *F098M, F105W, F125W, F140W, F160W*  
2 epochs of grism spectroscopy: *G102, G141*

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/RAIS/NS; *high-z*)

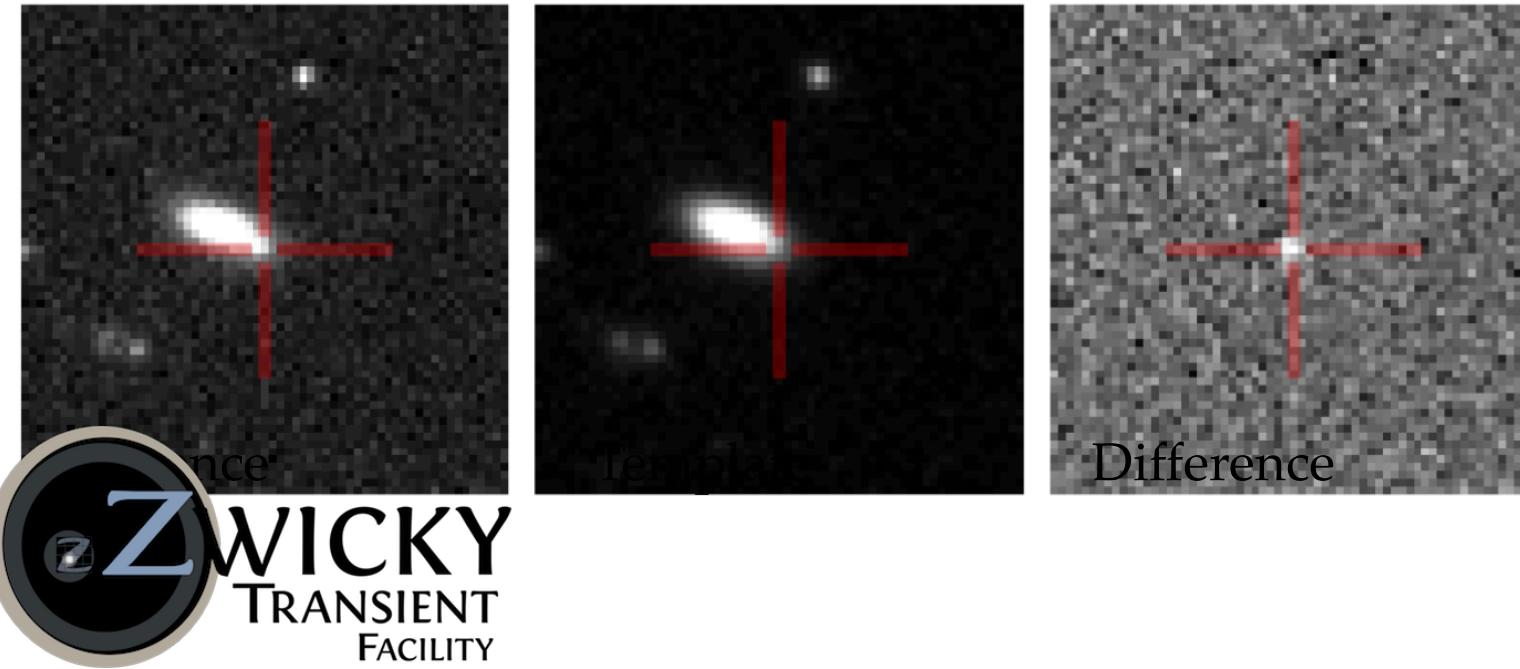
**Around 2 week turnaround for HST:** we need to trigger on very young SN Ia (few days post explosion) want near-max data.

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

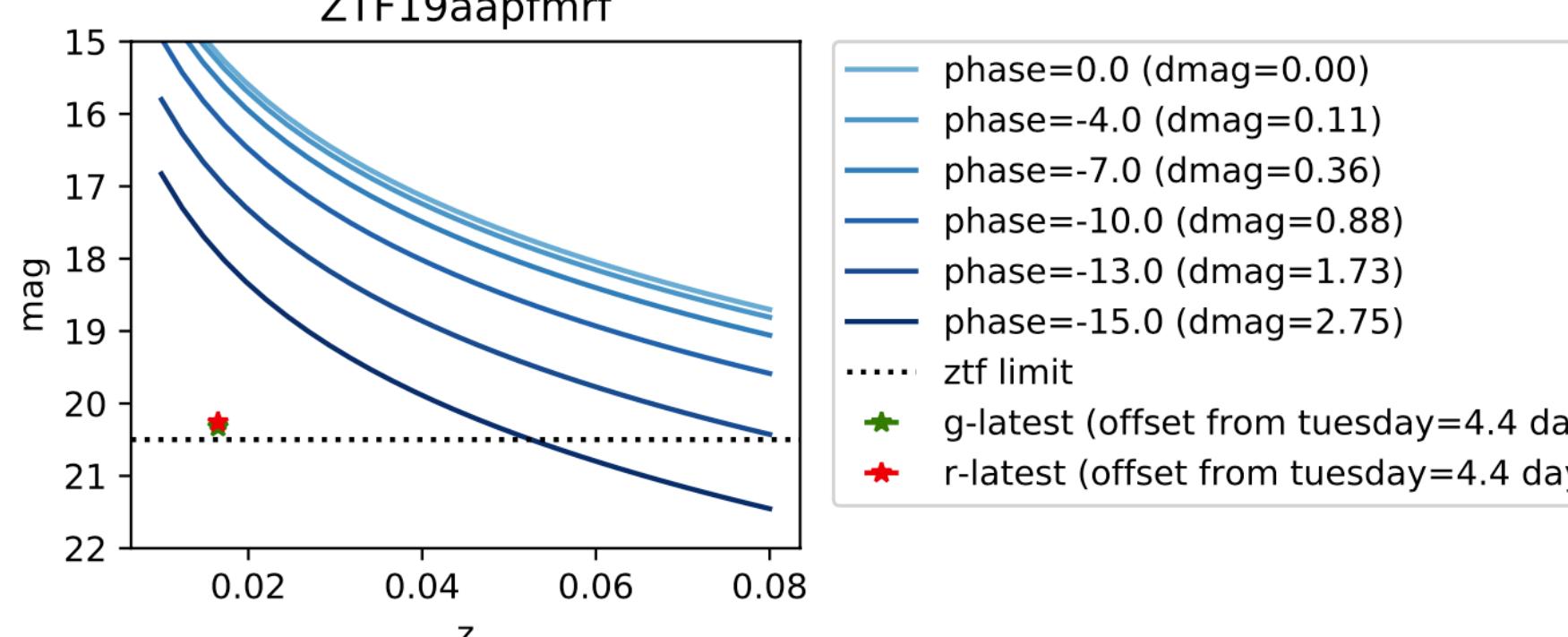
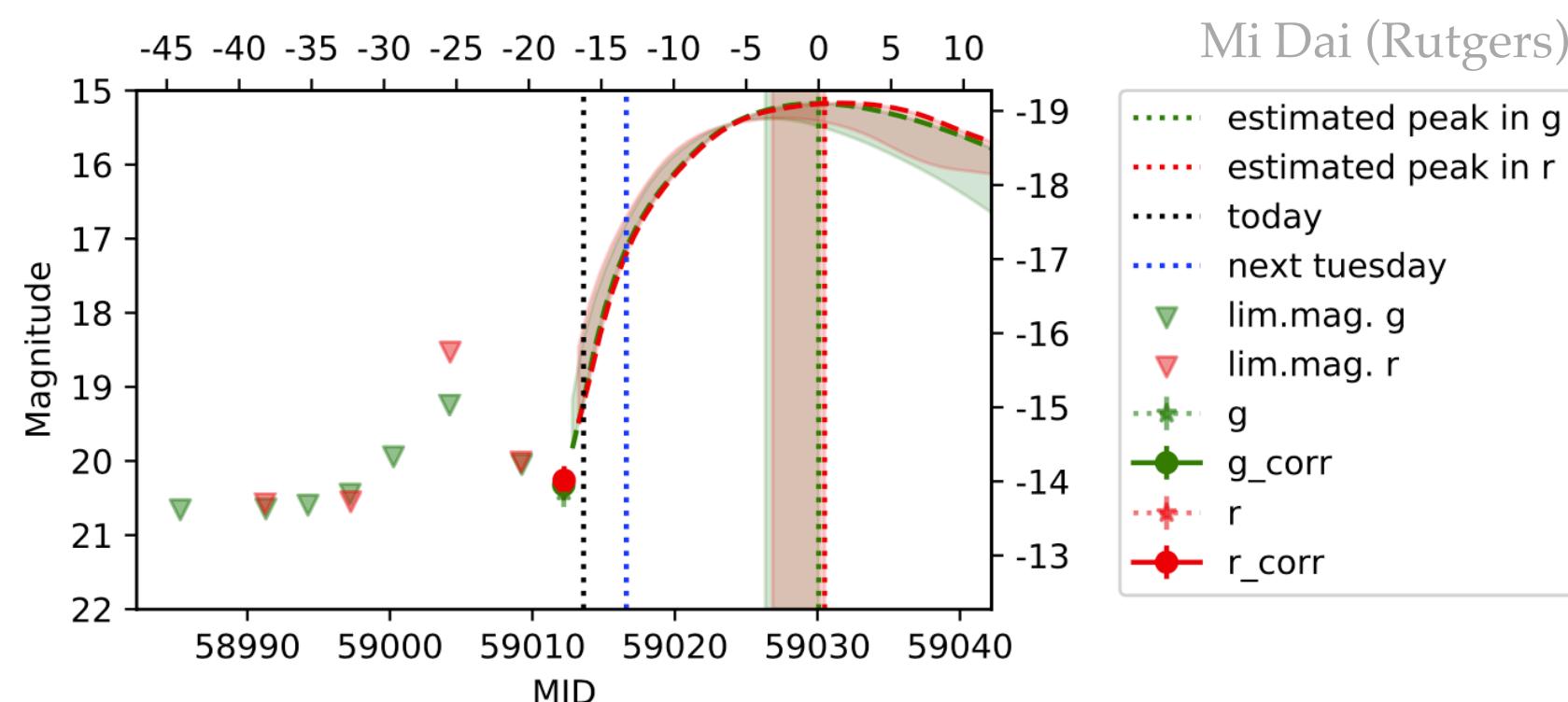
**Classification:** relying on ground-base **ToO programs** with large aperture telescopes (e.g. **GTC!**)



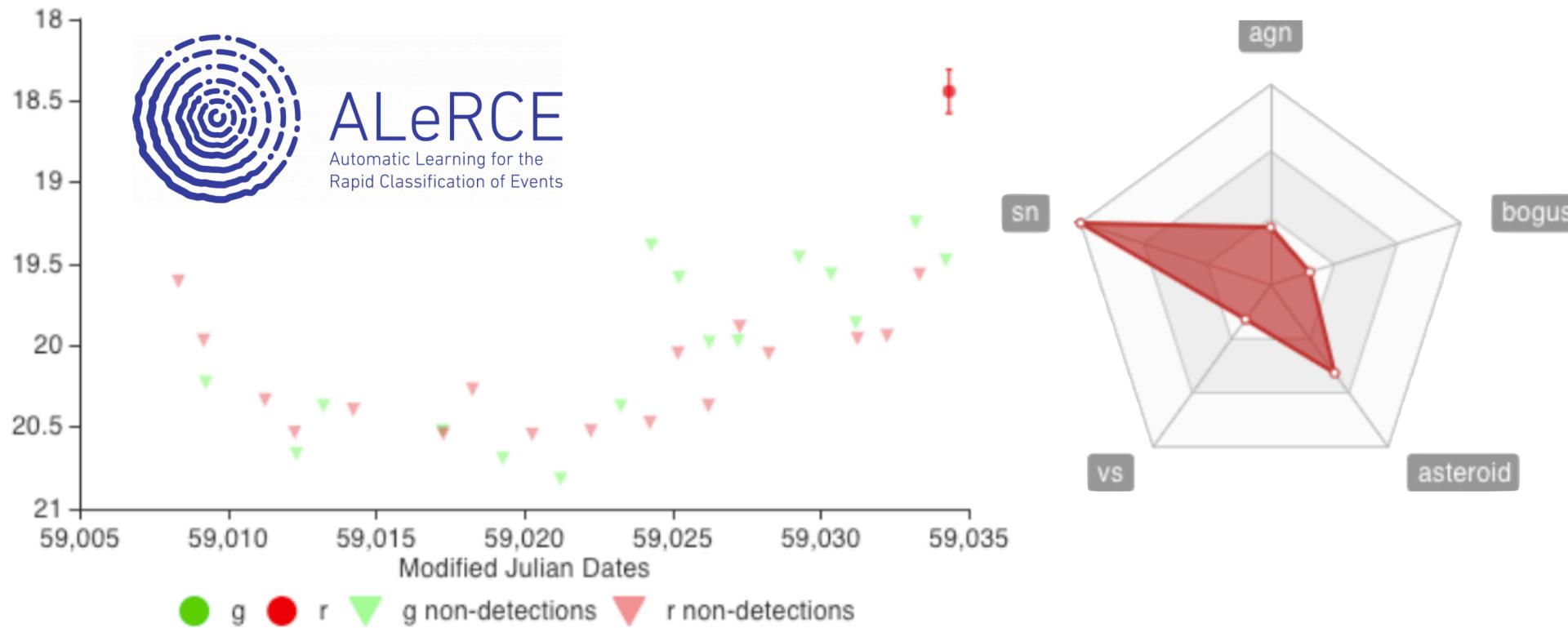
## 1. Surveys discover SN candidates



## 3. SIRAH searches for good young SNIa candidates from brokers

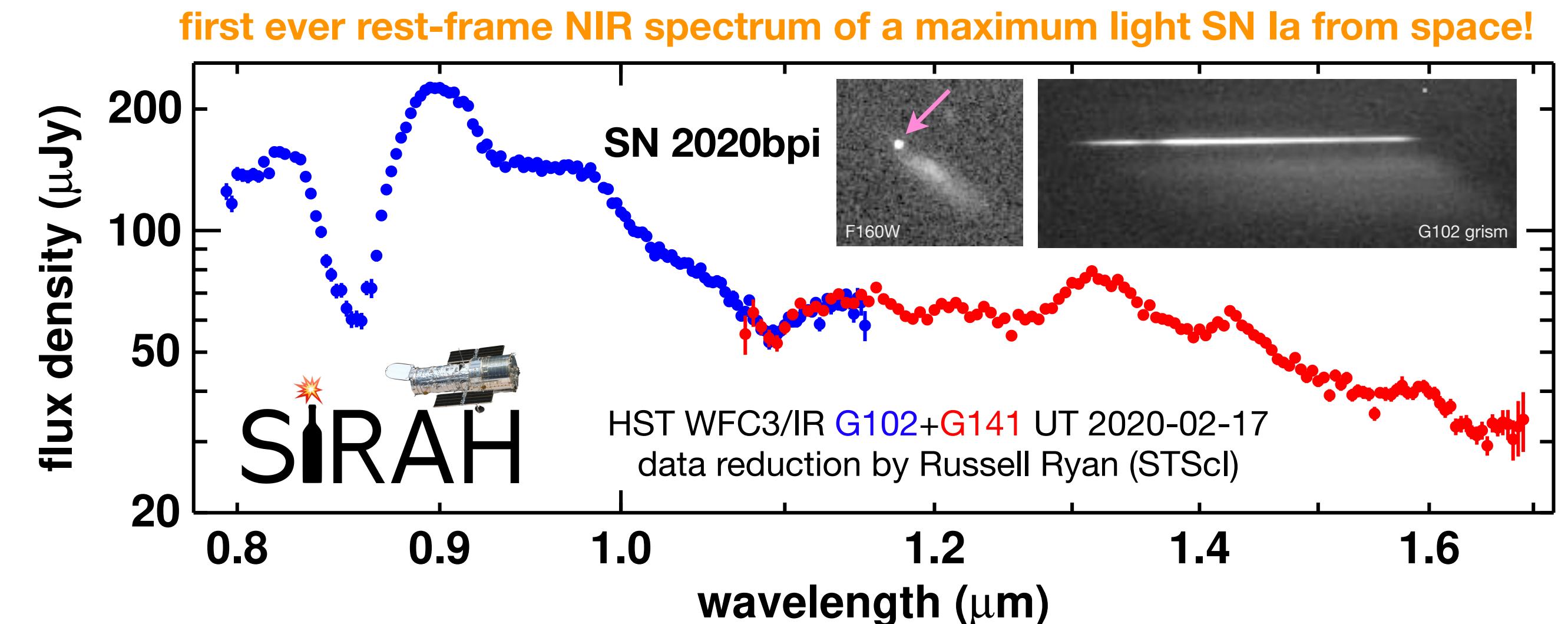


## 2. Brokers classify and organise these discoveries



## 4. ToO programs request spectra to classify the best candidates

## 5. If a young SNIa, HST is triggered!





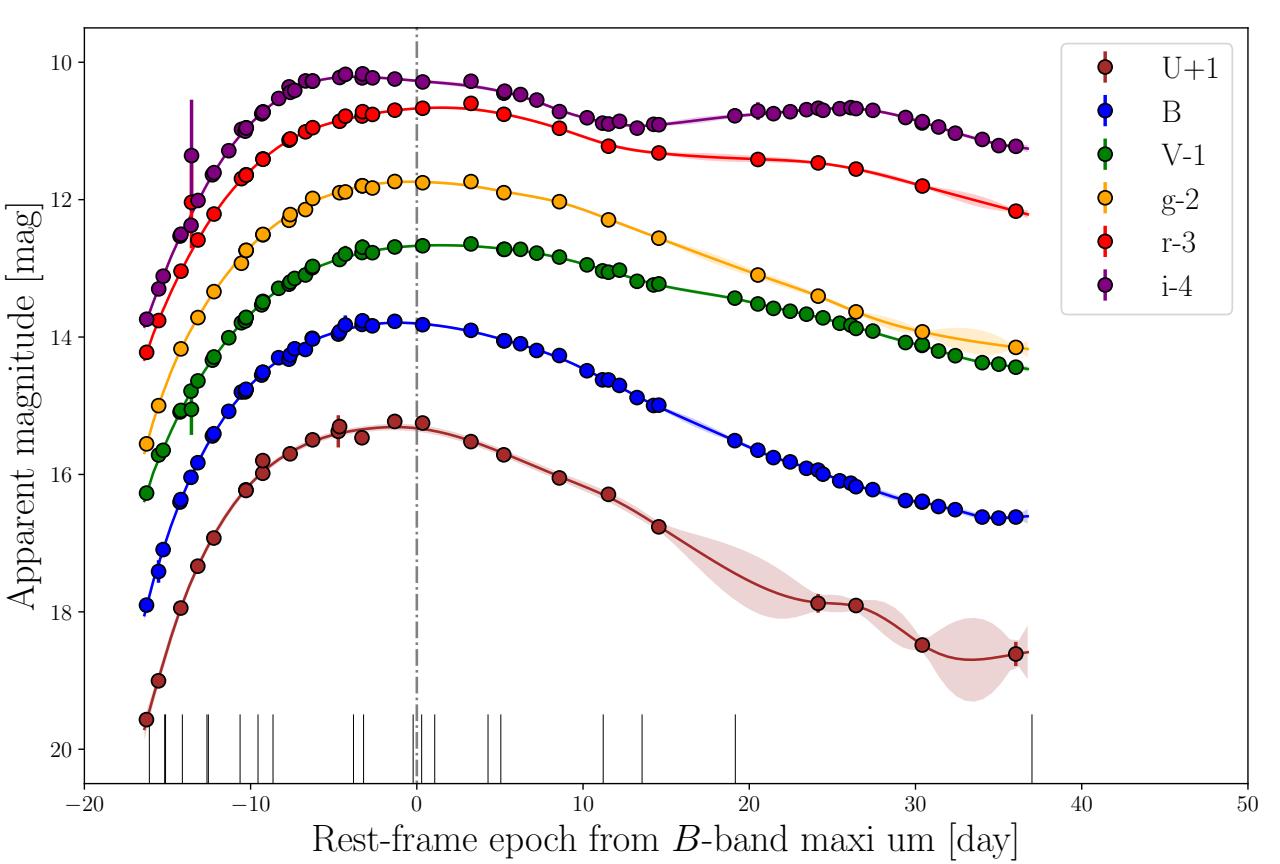
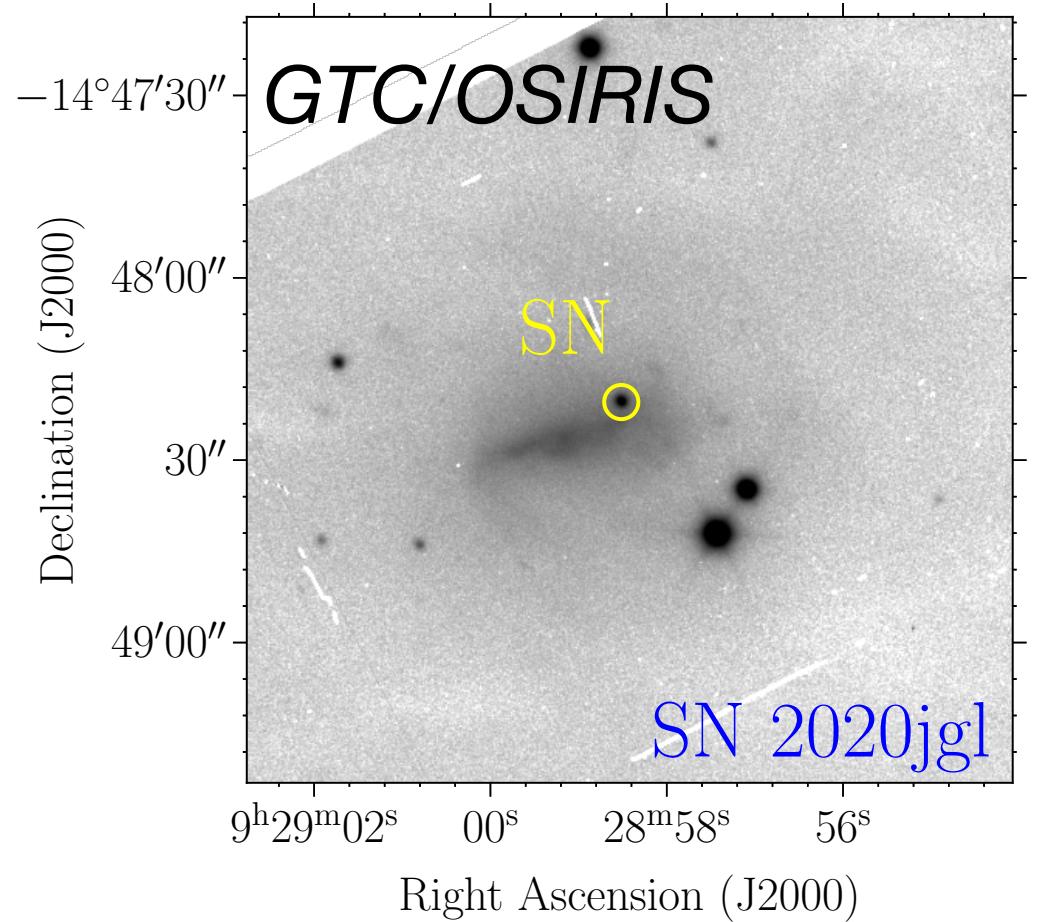
# Proposal GTC52-20A (PI: Lluís Galbany): *Follow-up of infant SNe within 48h from explosion*

## 10 classifications of SN candidates

SN name	Type	Time from discovery
ZTF20aaxvzja - SN2020itj	II	15h 05.84m
ZTF20aaynrrh - SN2020jfo	II	16h 51.43m
<b>ATLAS20lti - SN2020jgl</b>	Ia	<b>14h 34.39m</b>
ATLAS20lts - SN2020jhf	Ia-91bg	1d 11h 48.75m
ZTF20abaovyz - SN2020kjt	II	18h 58.49m
ZTF20abapyxl - SN2020kku	Ia	18h 28.06m
<b>ZTF20abbhyxu - SN2020kyx</b>	Ia	<b>22h 02.15m</b>
ZTF20abazeye - AT2020krl	CV	3d 17h 44.88m
ZTF20abbplei - SN2020lao	IcBL	18h 45.72m
ZTF20abisitz - SN2020nny	II	17h 12.89m

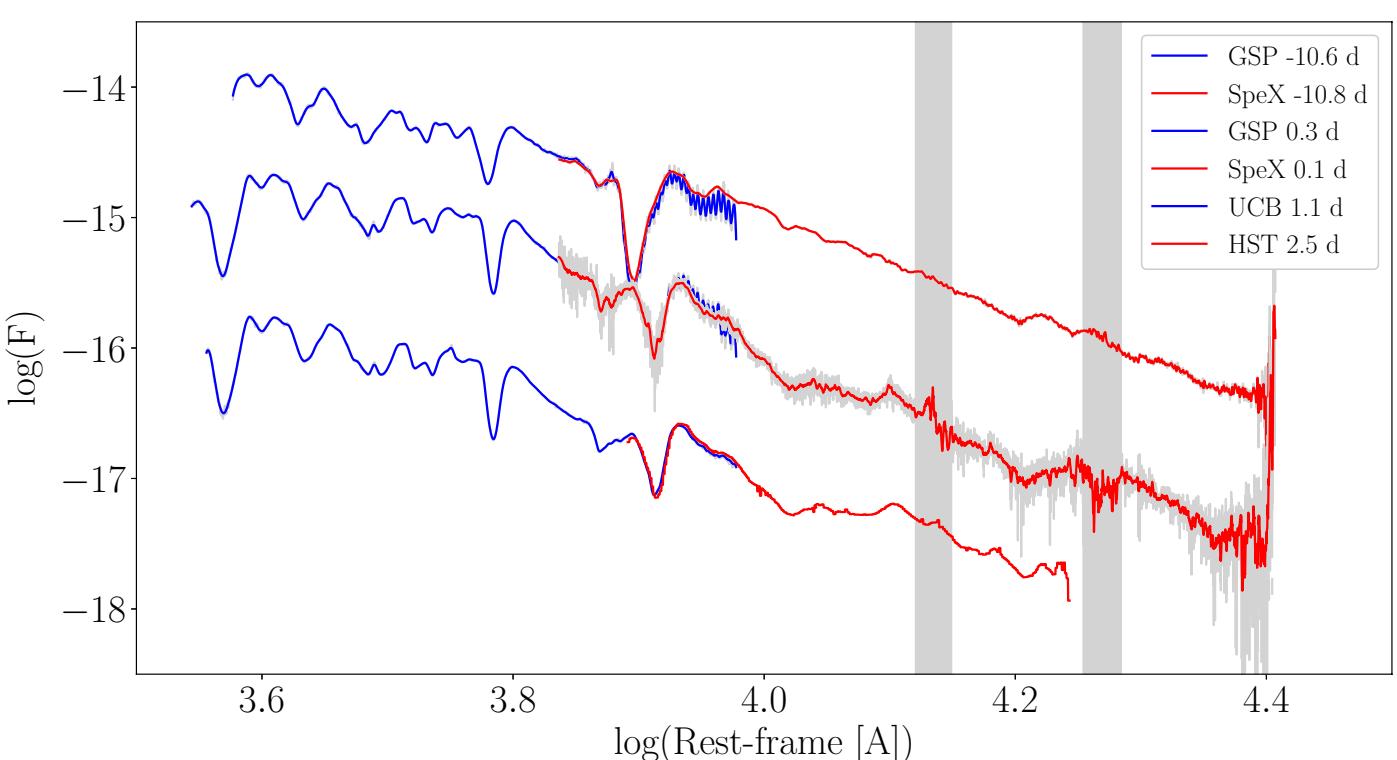
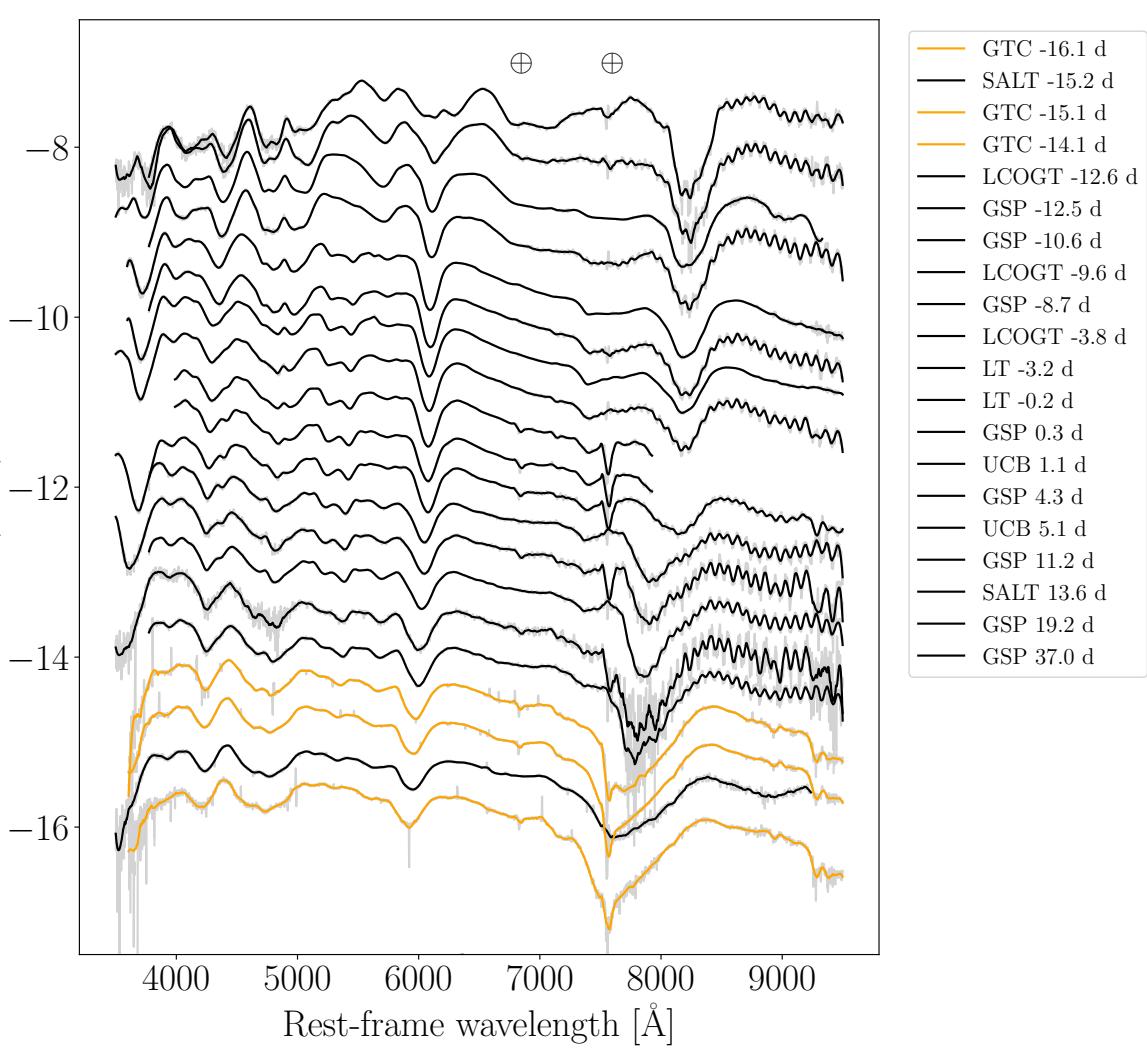
Triggered  
by SIRAH

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 **SNIa** 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**...)