DES Supernova Cosmology with Gemini

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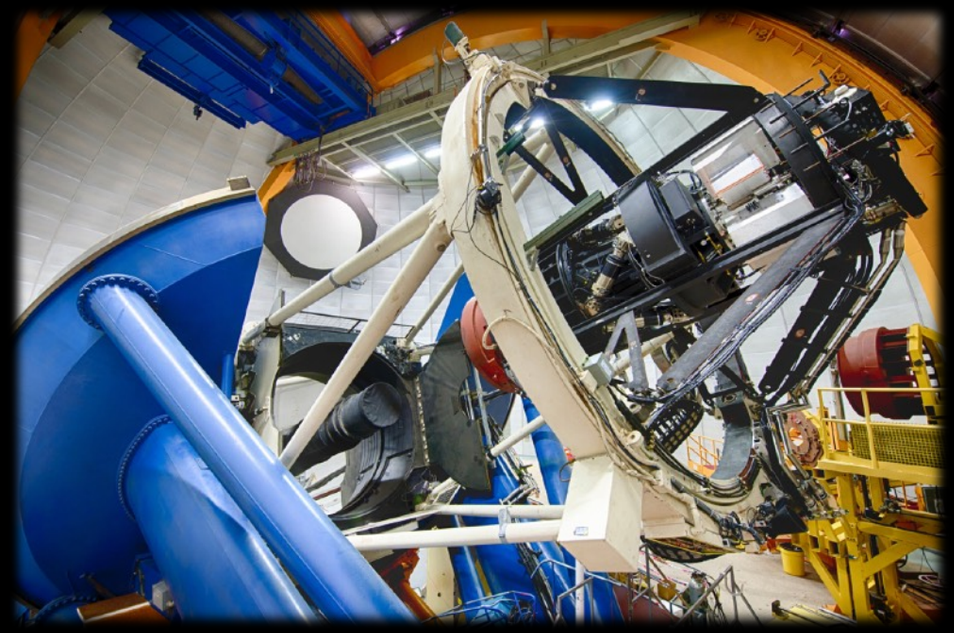
UC SANTA CRUZ

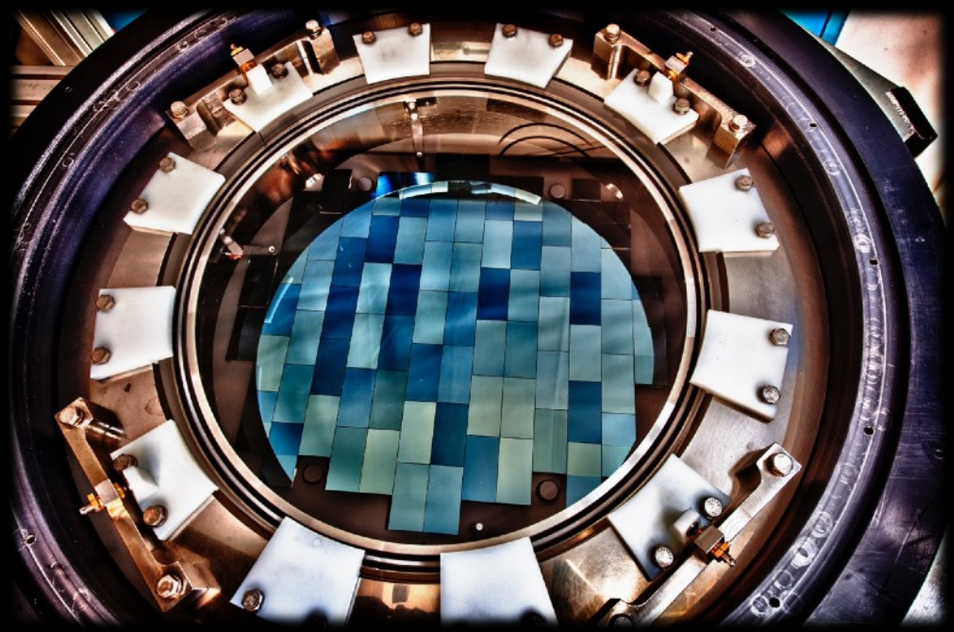
THE DARK ENERGY SURVEY

GEMINI OBSERVATORY

THE DARK ENERGY SURVEY

DES is a 5-year survey to probe the dark energy using galaxy clusters, weak lensing, large-scale structure, and type Ia supernovae.

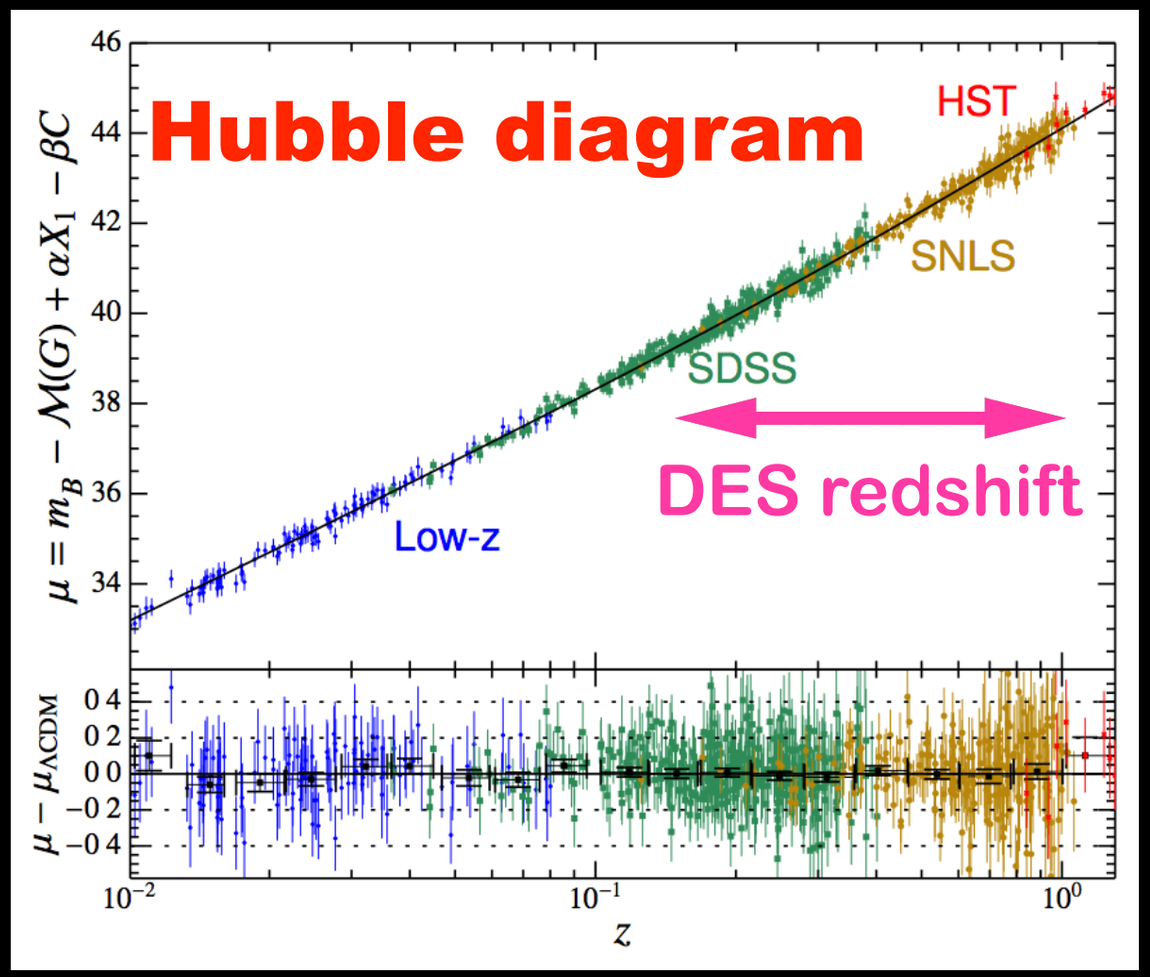




Blanco 4-m telescope

Dark Energy Camera

SN Ia cosmology



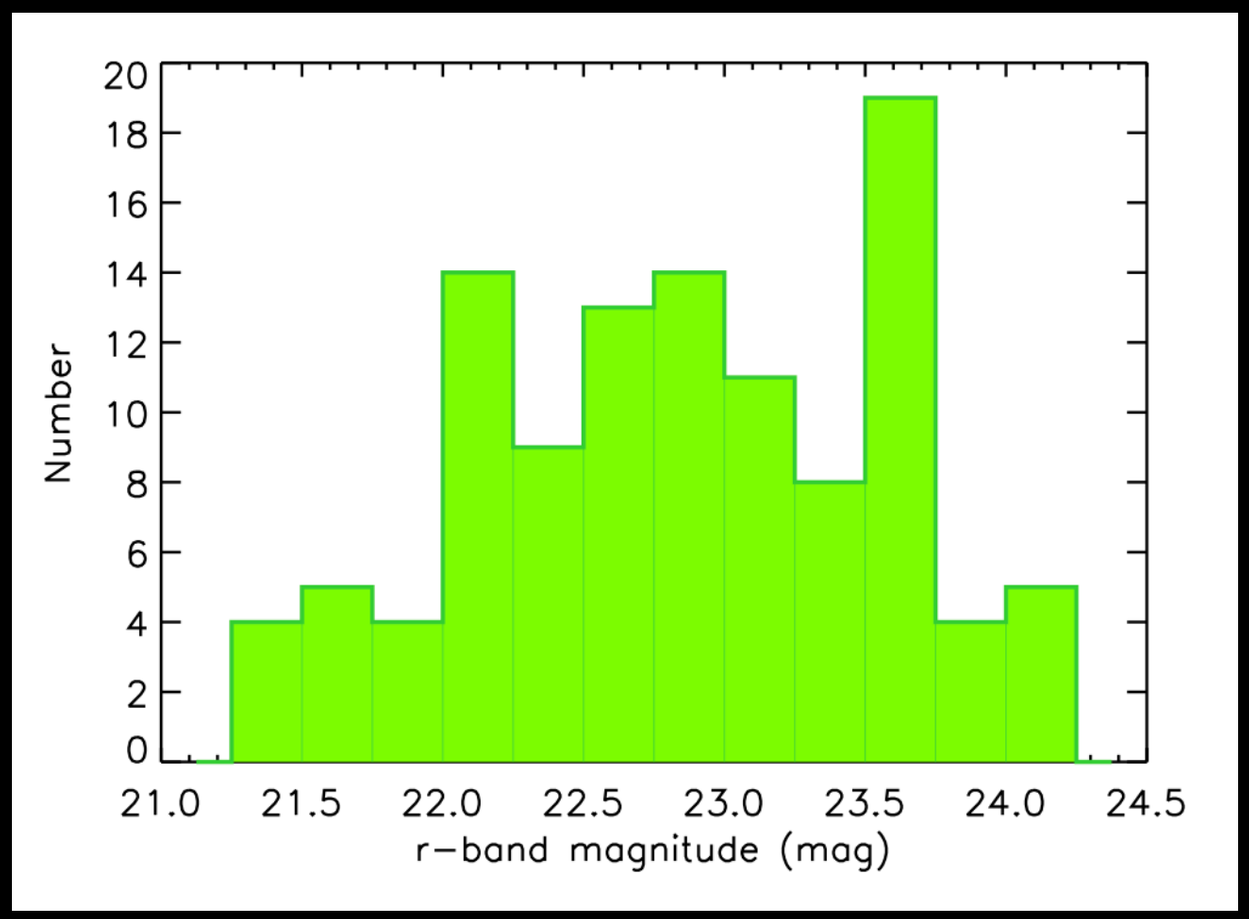
(Betoule+ 2014)

Using SNe Ia as distance indicators

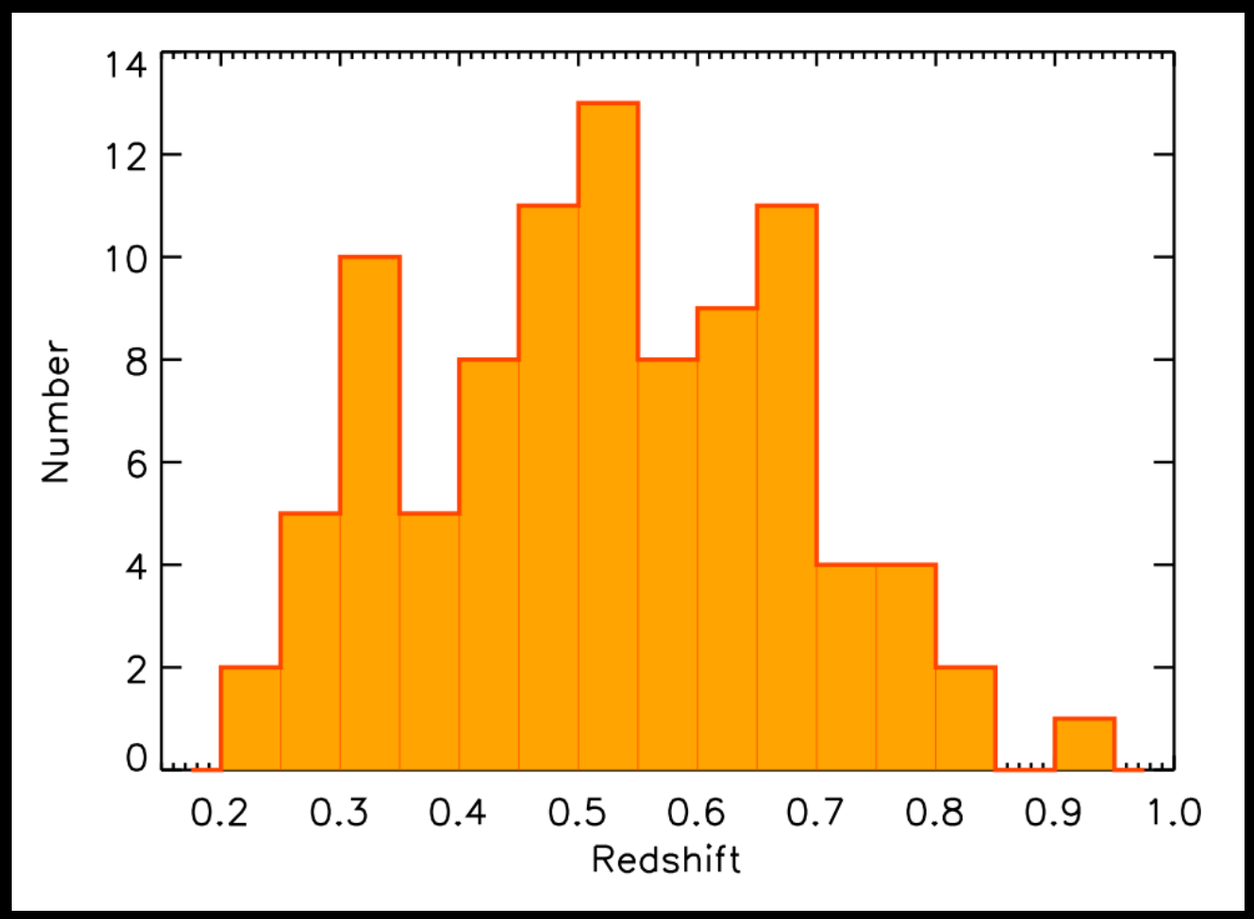
DES is a photometric survey, but the spectroscopic follow-up plays an important role in:

1. Classification
2. Redshift
3. SN properties (e.g., ejecta velocity)

DES SN Ia sample for Gemini



r ~ 21 - 24 mag



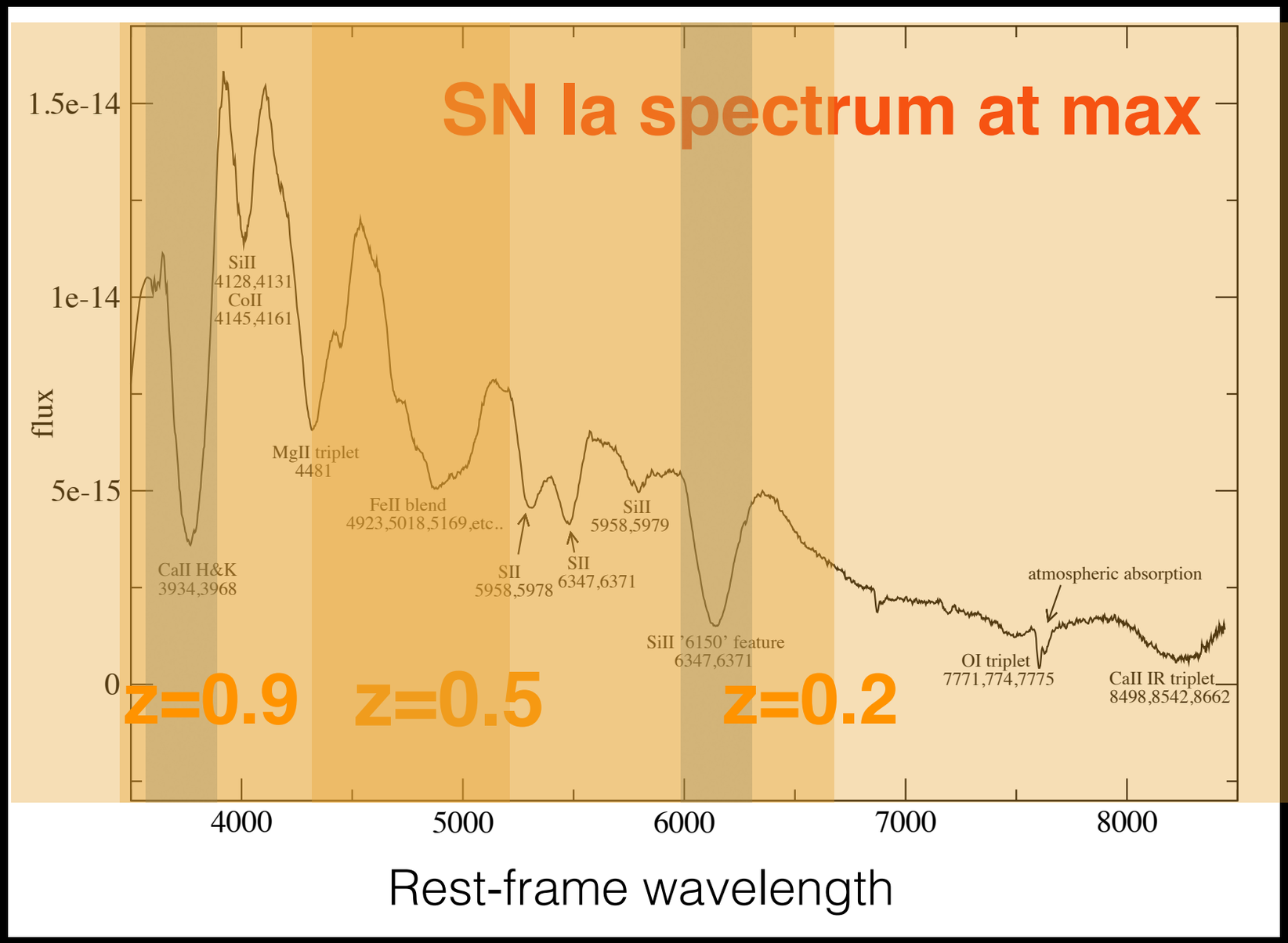
z ~ 0.2 - 0.9

Program overview

PI: Foley

Program ID	Time awarded	Ranking	Time used
GN-2015B-Q-10	21.5 hrs	band 1	100%
GS-2015B-Q-7	21.5 hrs	band 1	50%
GN-2016B-LP-10	49.5 hrs	band 2	61%
GS-2016B-LP-10	5 hrs	band 2	100%
GS-2016B-Q-41	26.5 hrs	band 2	100%
GN-2017B-LP-10	49.5 hrs	band 1	100%
GS-2017B-LP-10	49.5 hrs	band 2	64%
Total	223.0 hrs		

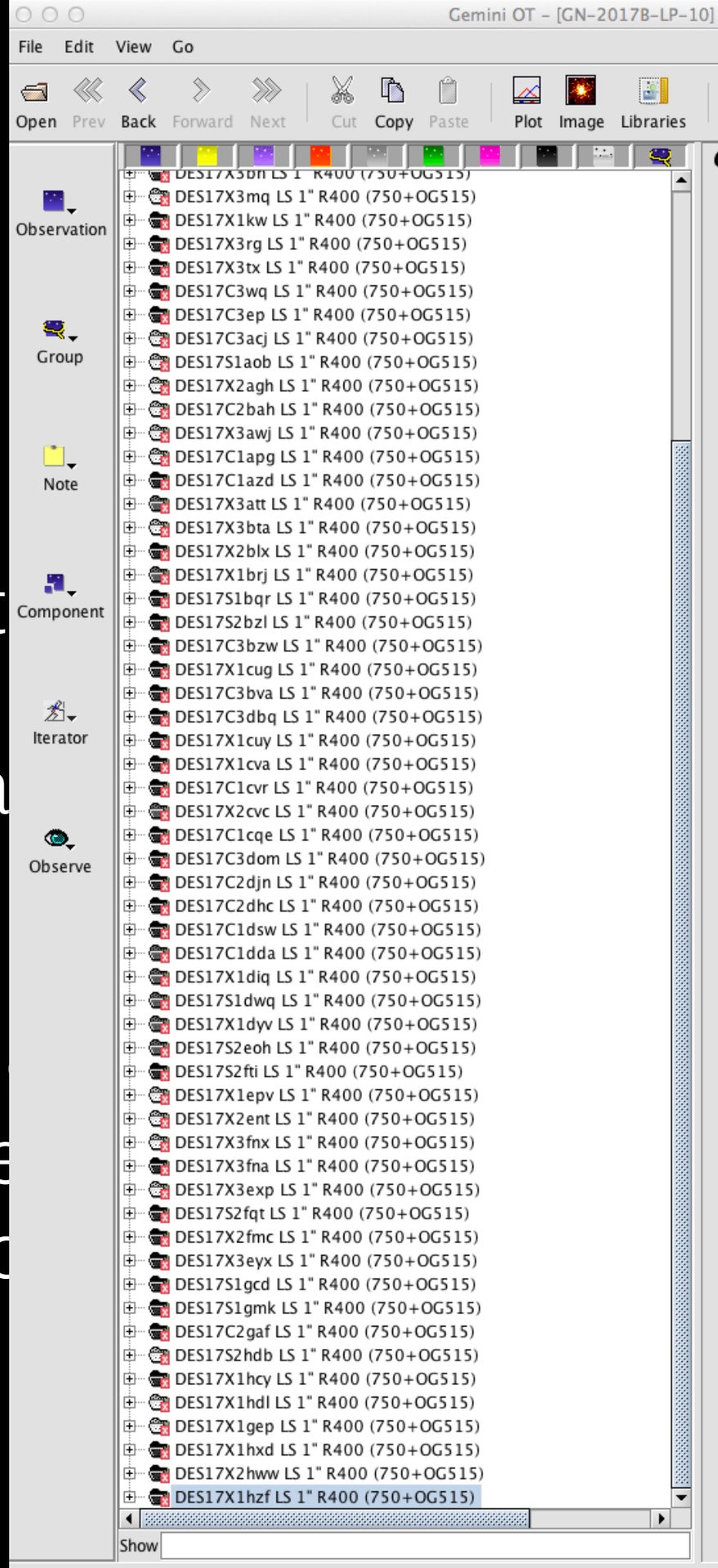
Instrumental setup



GMOS **R400** grating + **OG515** block filter, central wave=**750nm**
Spectral coverage ~**5000-10000 Ang** (in obs. frame)

Scheduling

- Put in 3-4 targets in queue each t
- Renew the targets in a ~3-day ca them "**fresh**".
- Try to maximize the diversity of th **position** and **luminosity**) to incre chance to be scheduled by coord

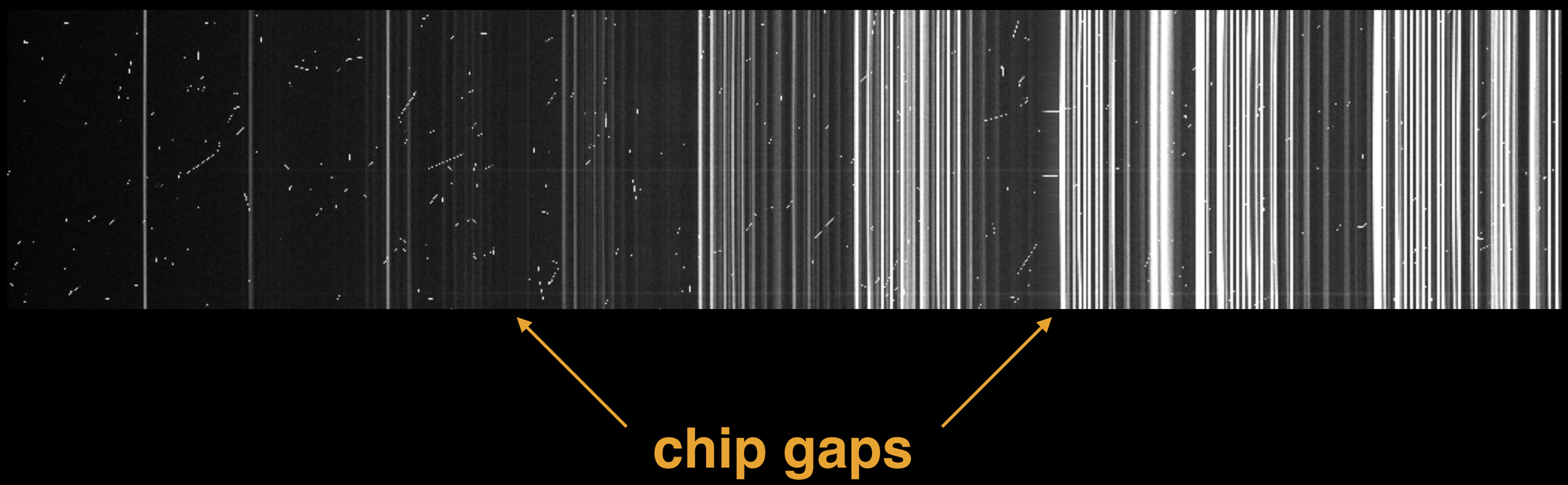


Data reduction

1. Merge CCD chips and overscan/bias correction
2. Flat-fielding and cosmic-ray removal
3. 1D spectrum extraction
4. Wavelength calibration
5. Flux calibration and telluric correction

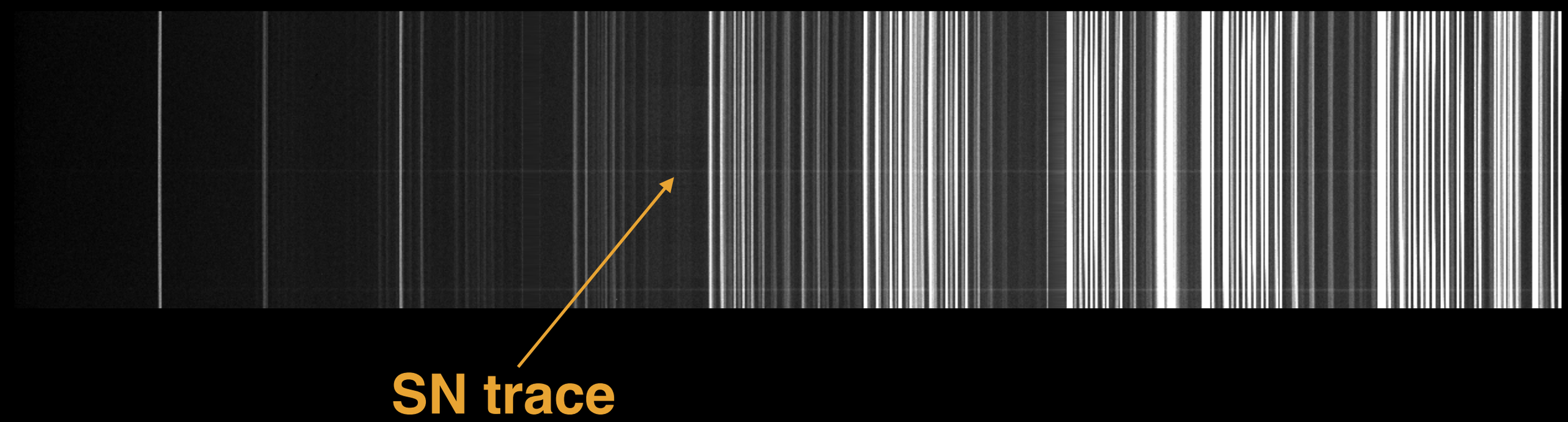
Data reduction

1. Merge CCD chips and overscan/bias correction



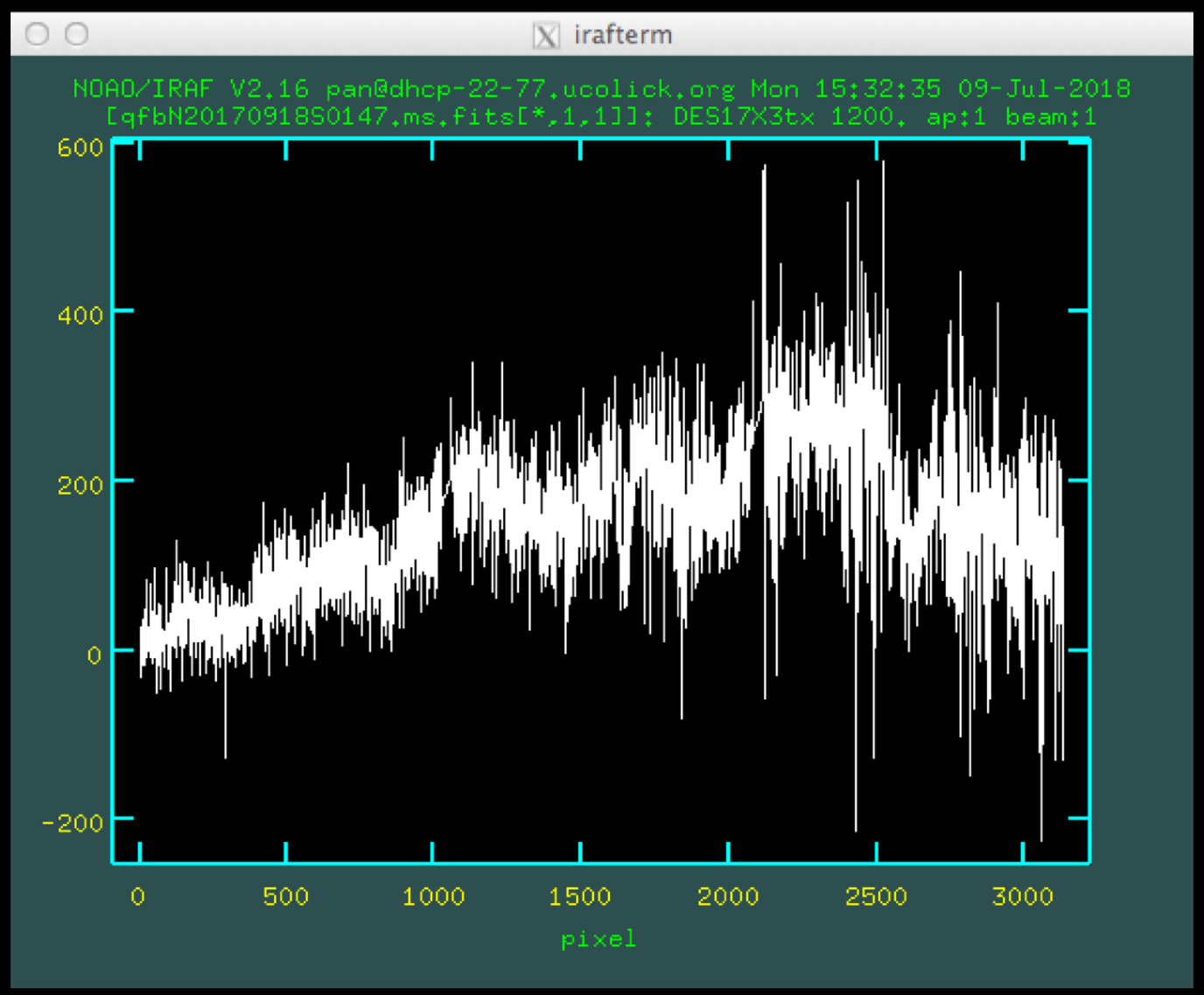
Data reduction

2. Flat-fielding and cosmic-ray removal



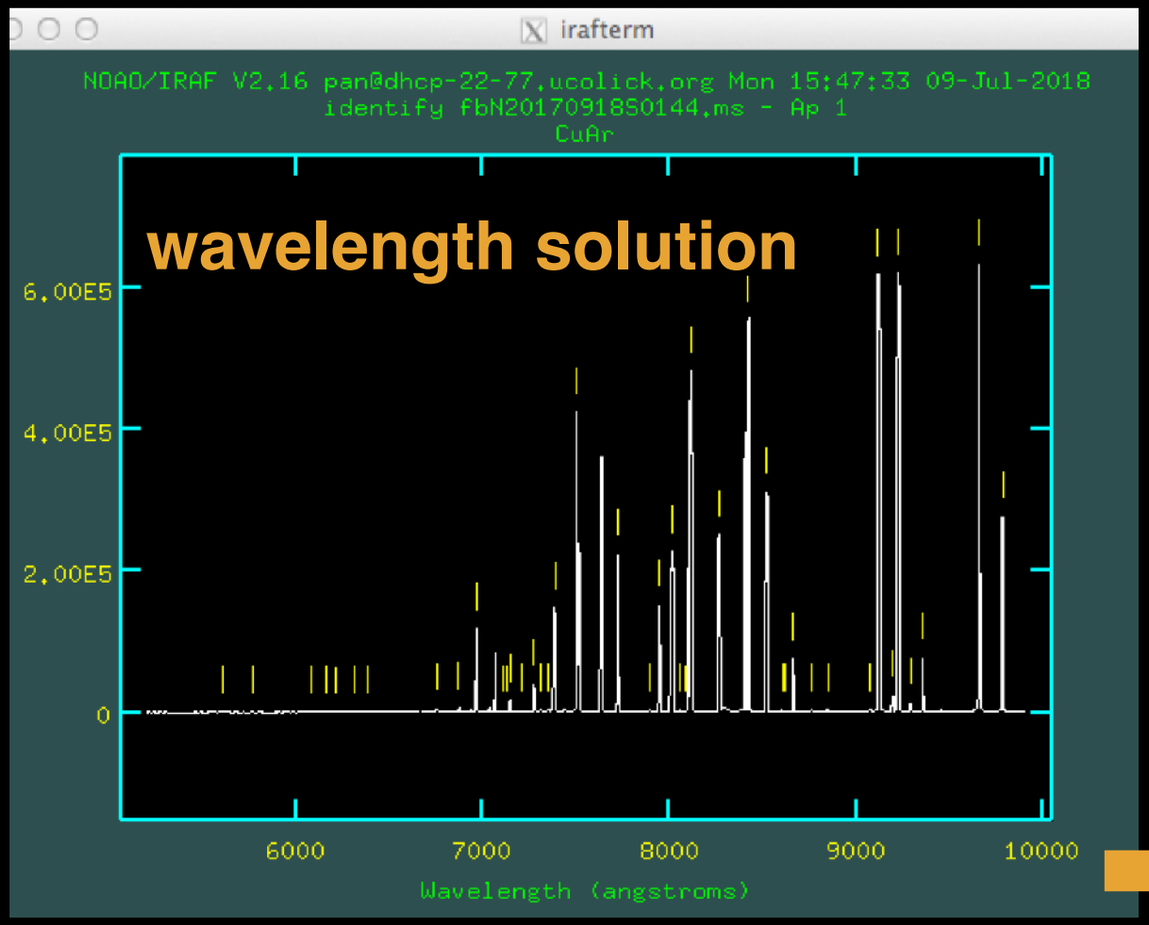
Data reduction

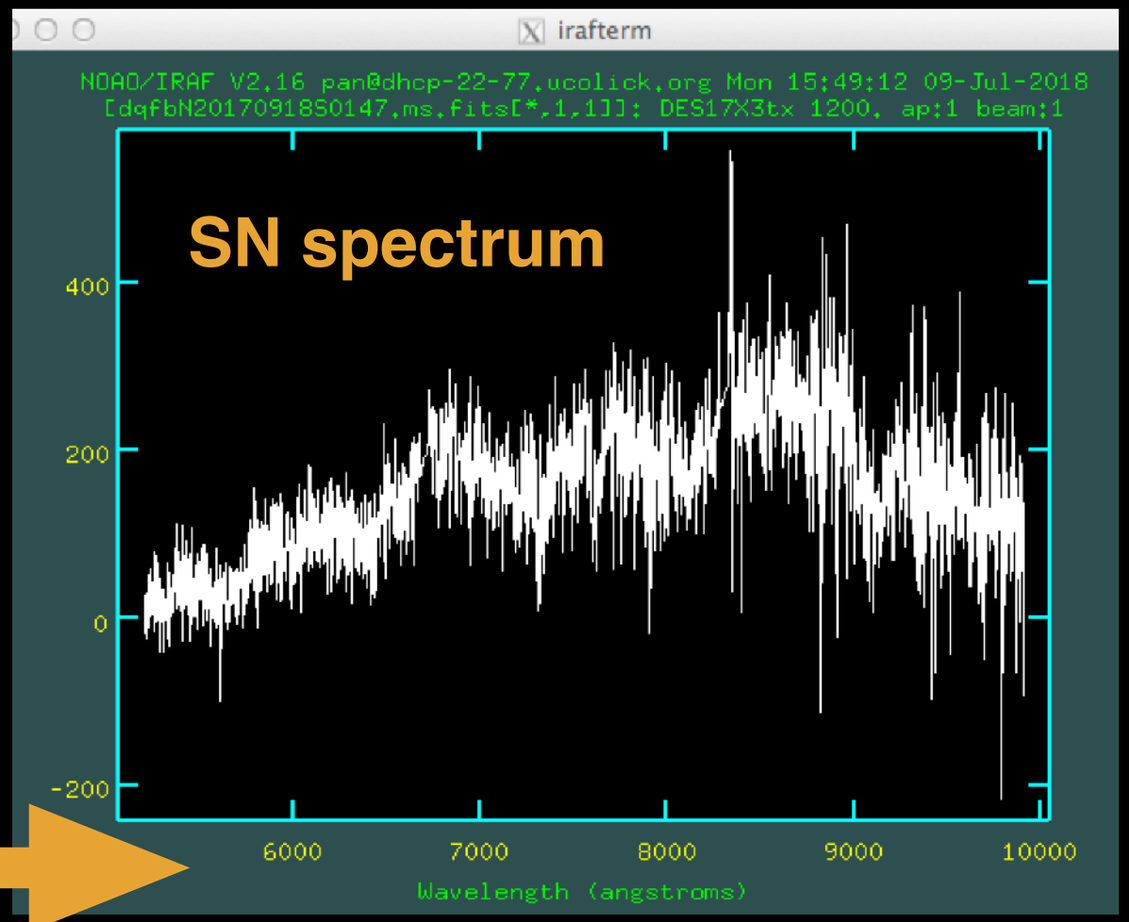
3. 1D spectrum extraction



Data reduction

4. Wavelength calibration

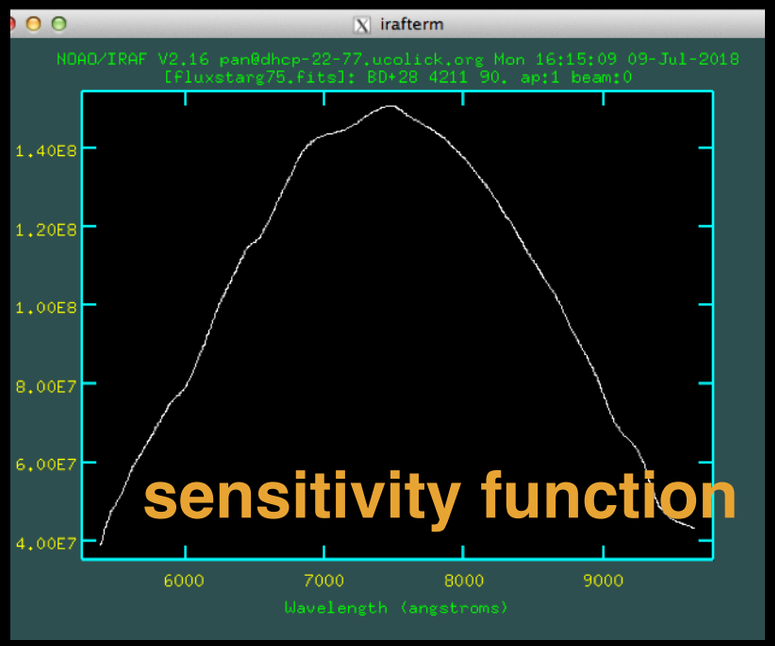


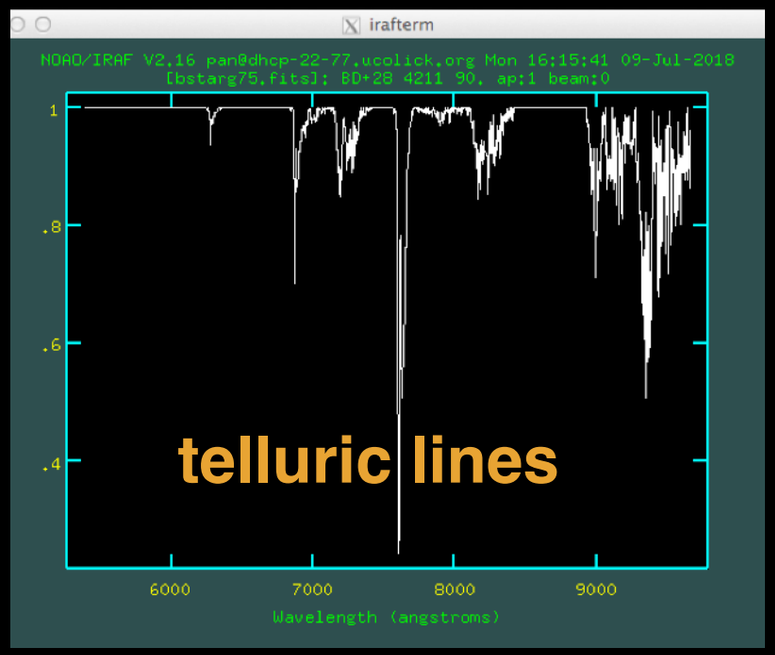


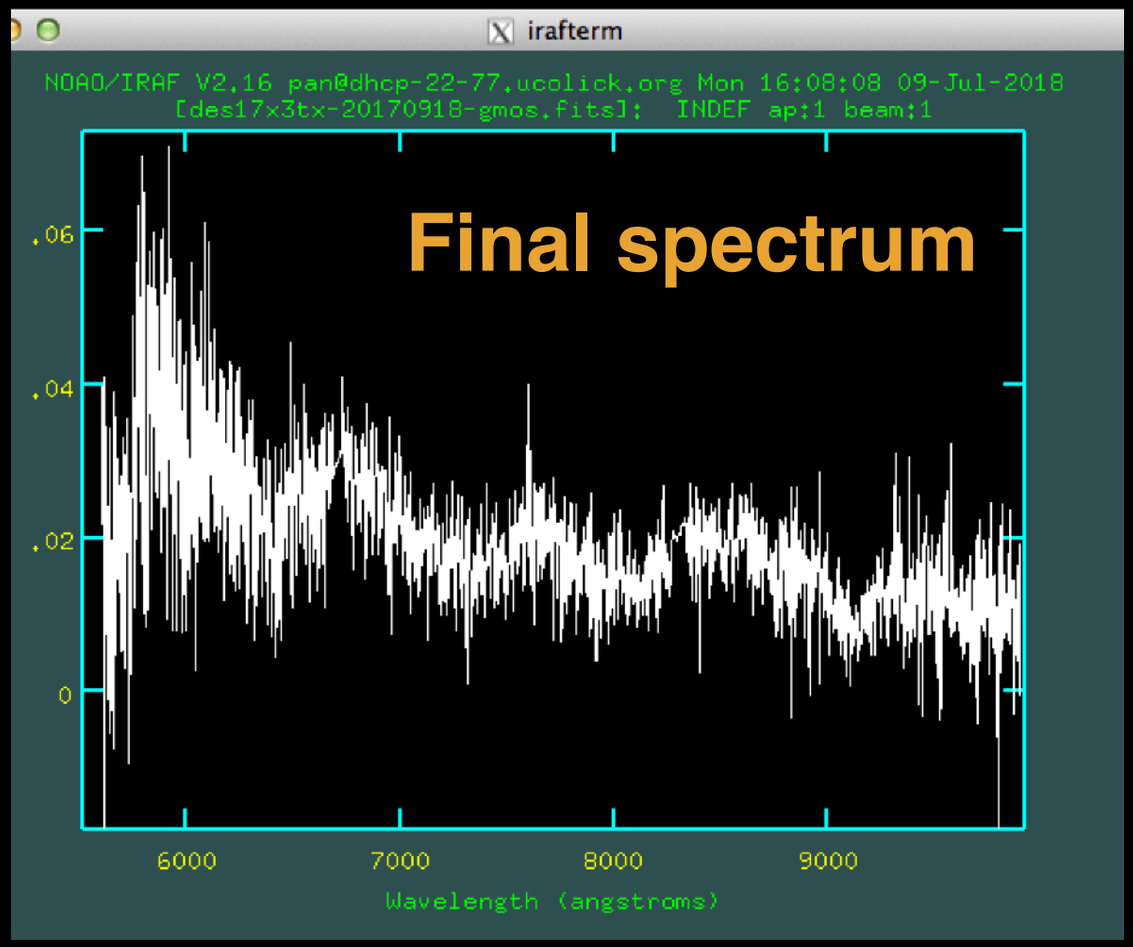
apply the solution to the SN spectrum

Data reduction

5. Flux calibration and telluric correction

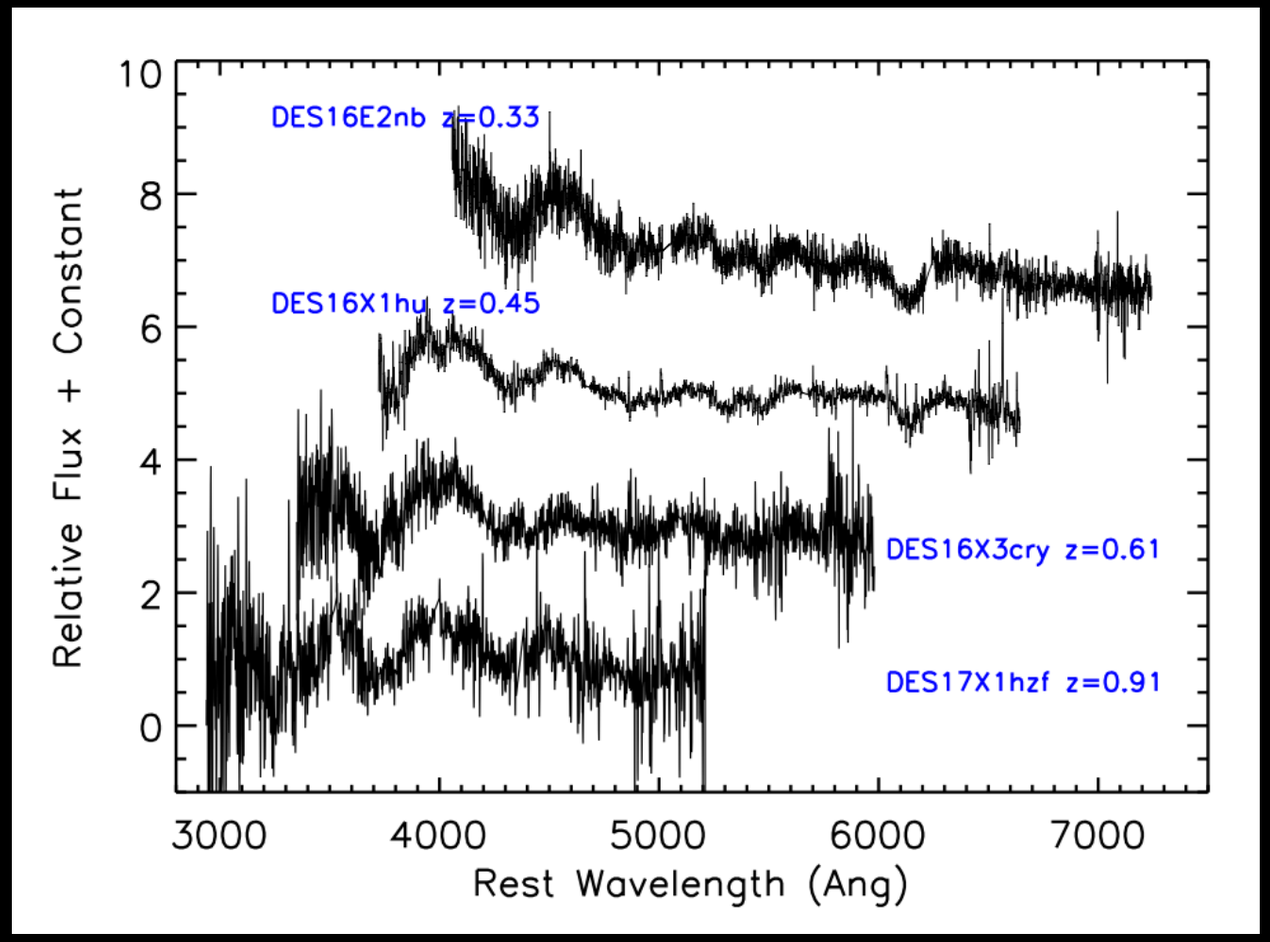






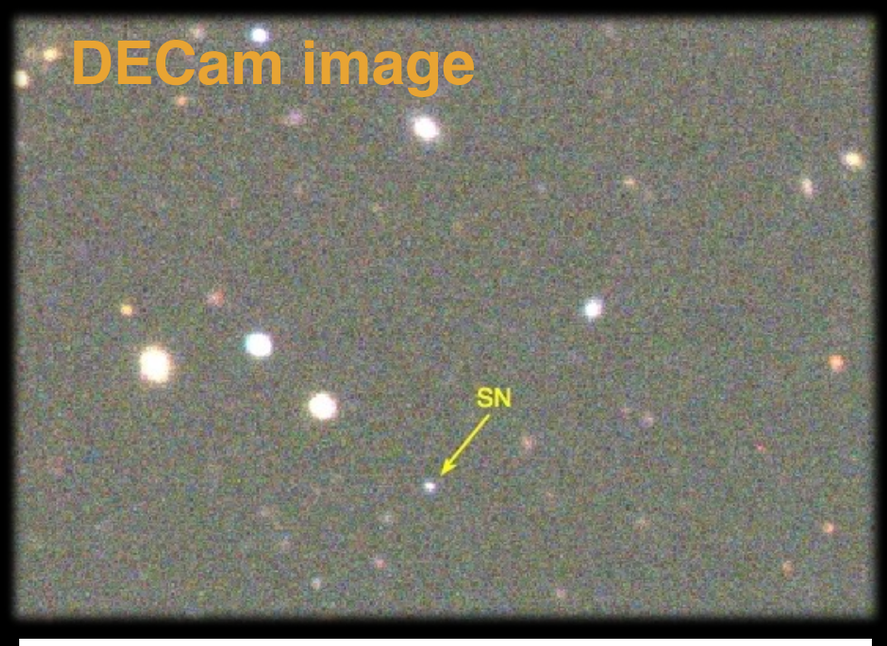
Results

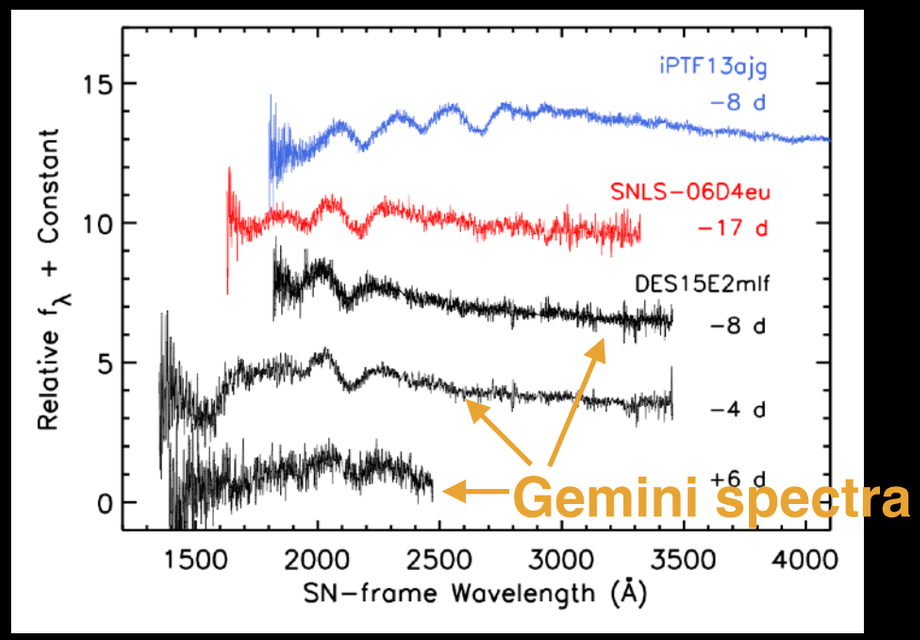
- Total 106 DES objects were observed by our Gemini program.
- 90 of them were successfully classified as SN Ia (~85% success rate), with the most distant one up to z~0.9.



SN Ia spectra from Gemini

DES15E2mlf: A spectroscopically confirmed superluminous supernova at z=1.86





(Pan+ 2017)

GEMINI OBSERVATORY

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Gemini Confirms Super-distant, Superluminous Supernova

July 20, 2017

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Spectroscopy using the Gemini Multi-Object Spectrograph on the Gemini South telescope in Chile verifies the extreme distance of one of the most distant superluminous supernovae ever studied. The following text is reproduced from the University of California Santa Cruz press release issued on July 21, 2017. The paper is available here.

At a distance of 10 billion light years, a supernova detected by the Dark Energy Survey team is one of the most distant ever discovered and confirmed.

SANTA CRUZ, CA--The death of a massive star in a distant galaxy 10 billion years ago created a rare superluminous supernova that astronomers say is one of the most distant ever discovered. The brilliant explosion, more than three times as bright as the 100 billion stars of our Milky Way galaxy combined, occurred about 3.5 billion years after the big bang at a period known as "cosmic high noon," when the rate of star formation in the universe reached its peak.

The Gemini South telescope during
For more images see the Gemini Im

Thank you!

For more interesting science of our program,
please go to Ryan Foley’s talk on Thursday!