Spectroscopy of Transients
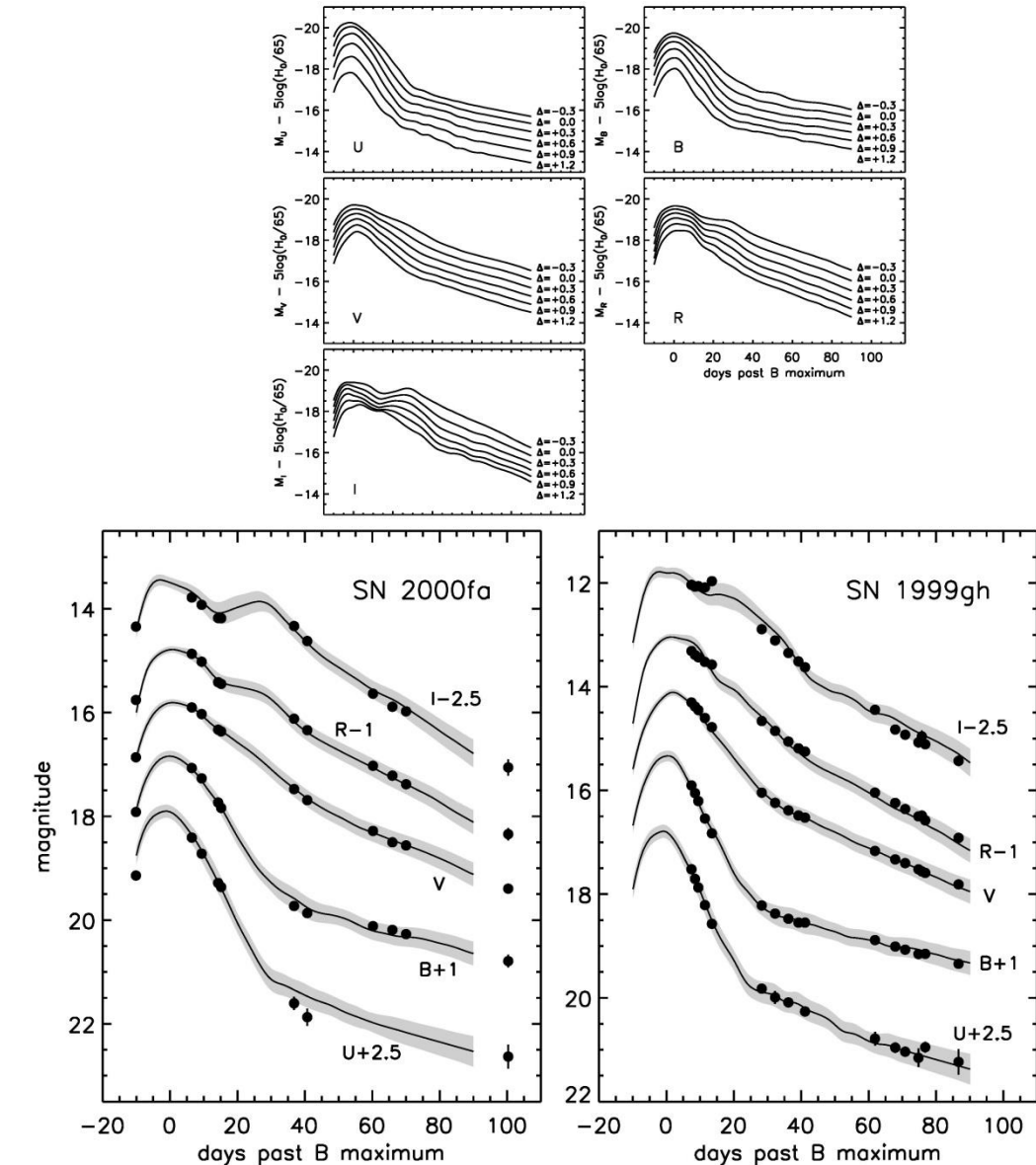
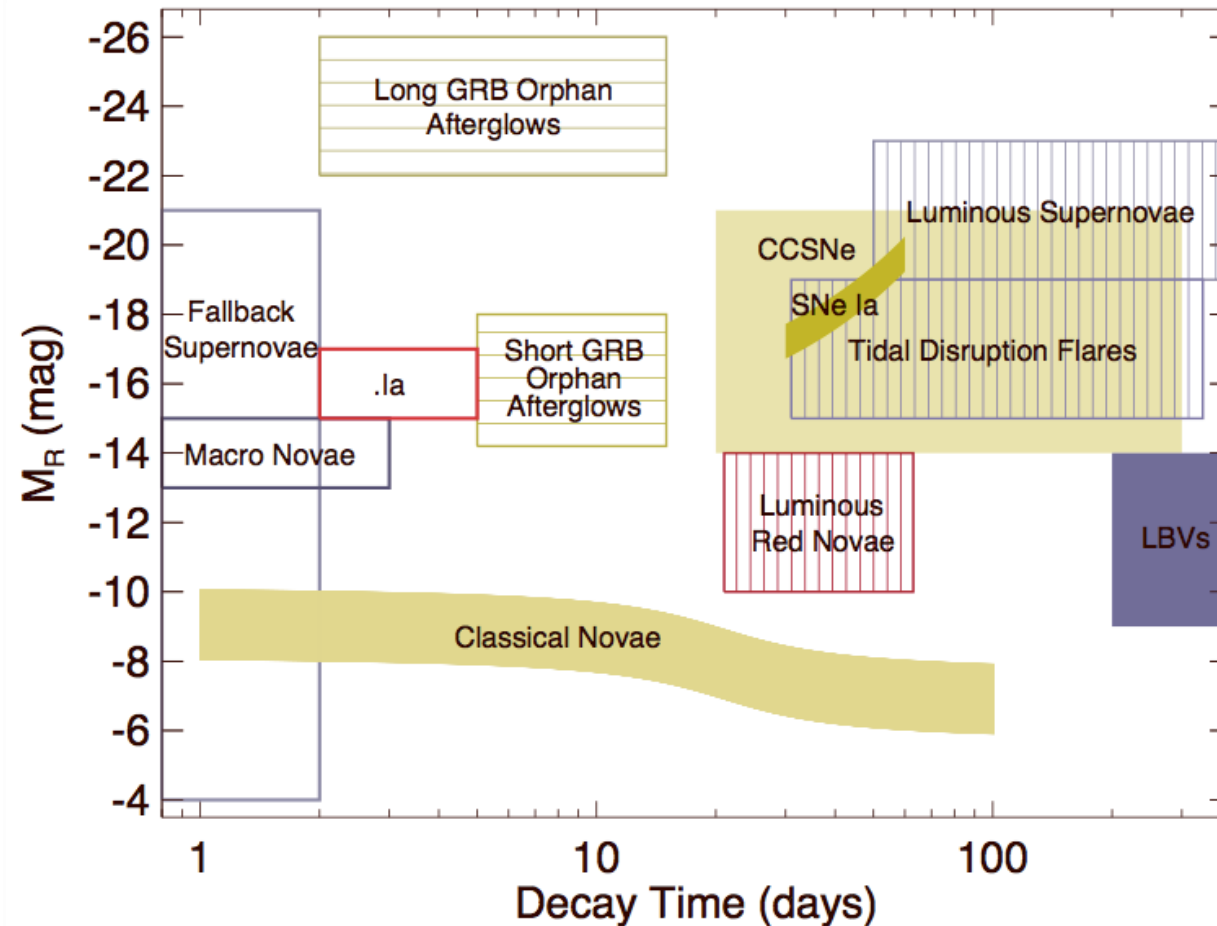## Examples and requirements

M.Dennefeld (IAP/Paris)

Frejus May 2023

Standard SNe Ia's photometric follow-up: (you do'nt always need spectroscopy...)

- Uncomplete light-curves to fill-in...

- Use of templates per SN type (e.g. Jha et al. 2007 for Ia's)

- Can easely complete scarce sampling

- Important to find Ia's maximum

The transient zoo:
there are more than just Ia's...

EXPLORING THE OPTICAL TRANSIENT SKY WITH THE PALOMAR TRANSIENT FACTORY, Kulkarny et Kasliwal 2009
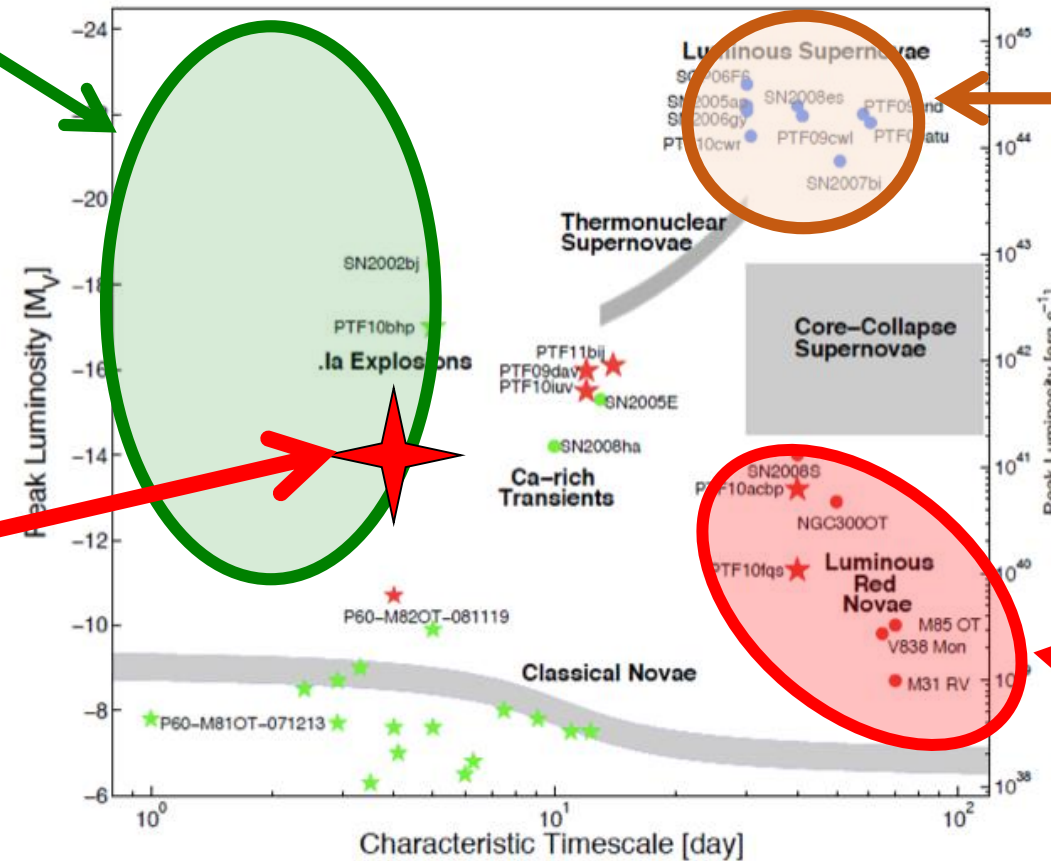
Cf. Kulkarny and Kasliwal (2009)

Distinguish between transient, and variable source!

Optical Transients

What are the limits of physical explosions and transients ?

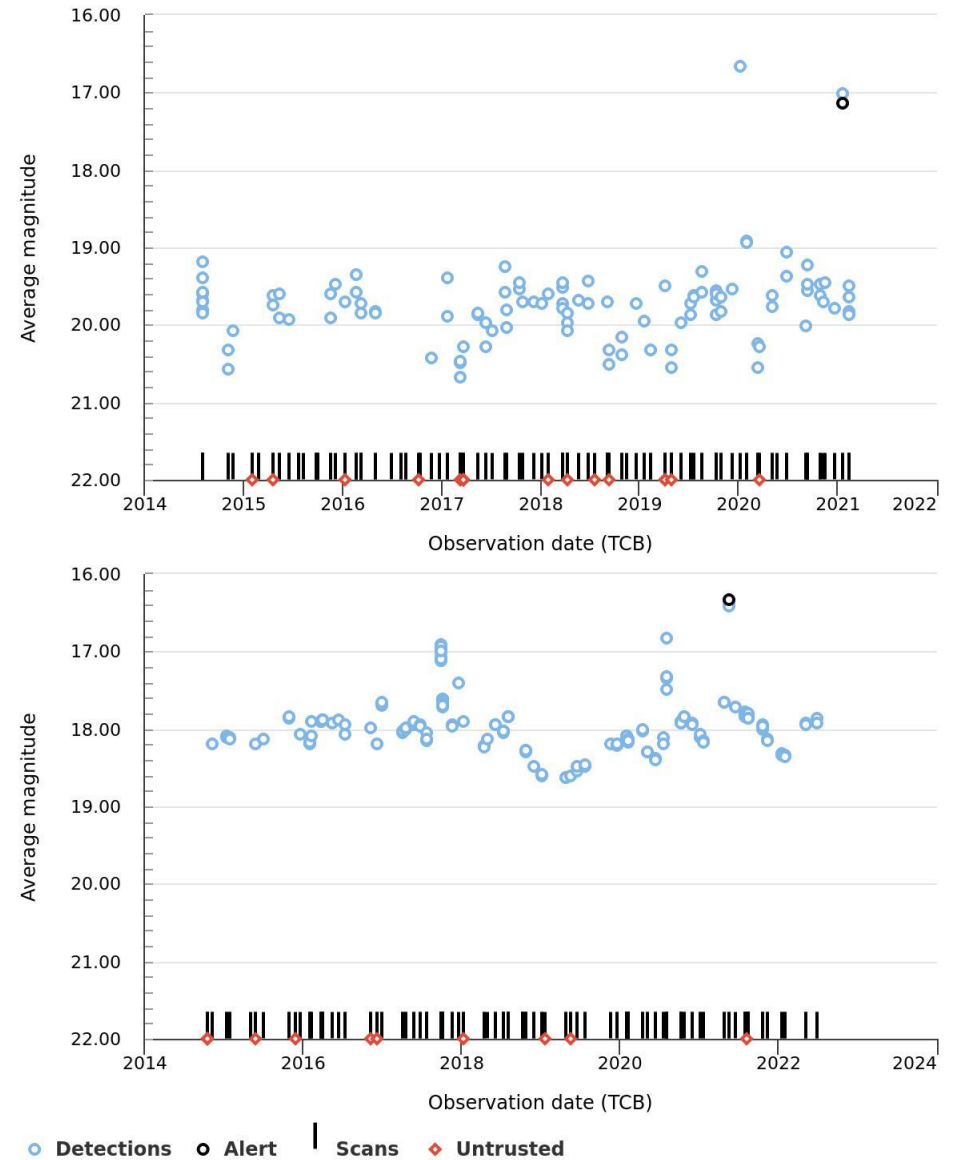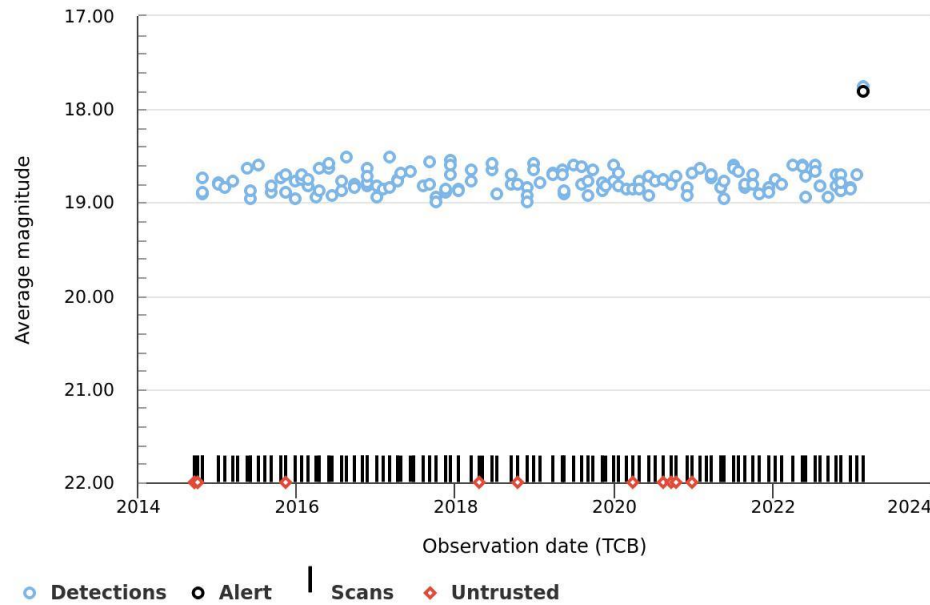Image credit : Shri Kulkarni, Mansi Kasiwal , C. Inserra

Smartt et al.
2015:
Survey description and
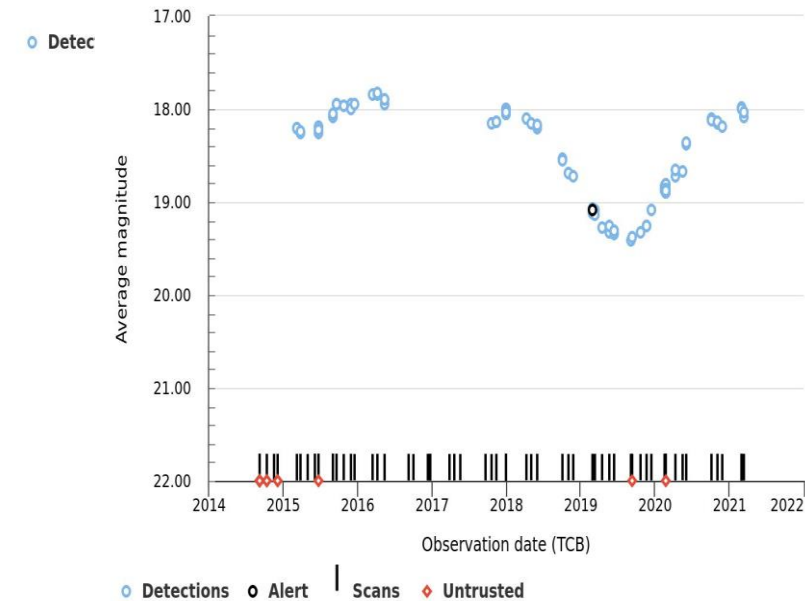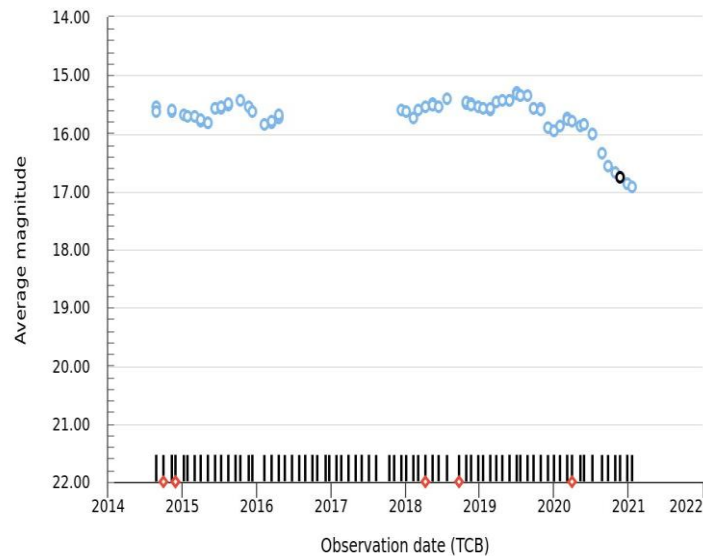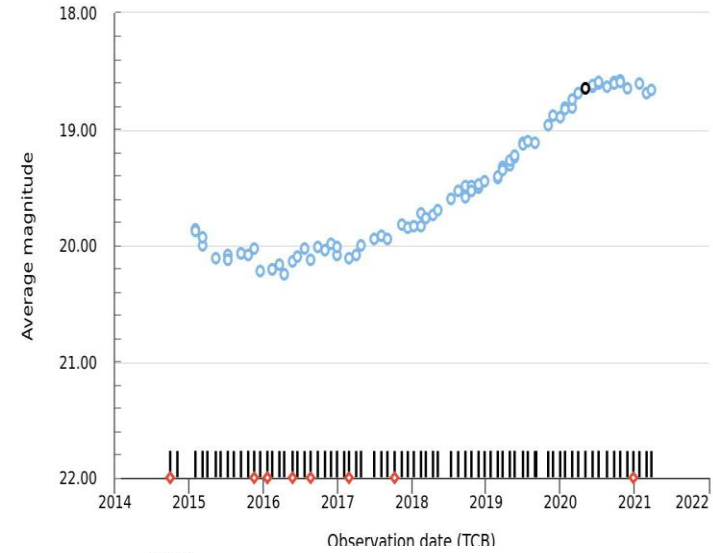products from the first
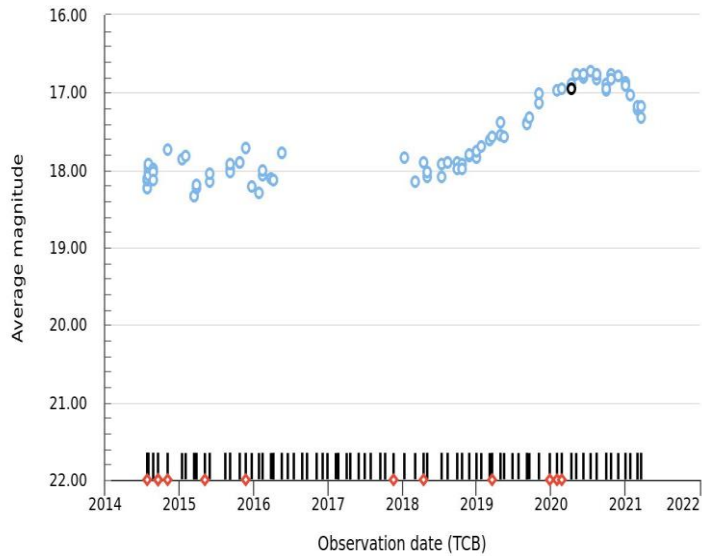data release by PESSTO,
A&A, 579, 40

The PESSTO survey (ESO-NTT) is filling the voids for transients…

AGN variability: various types… Flares ? SNe ?

- ## Need long-term behaviour…(years)
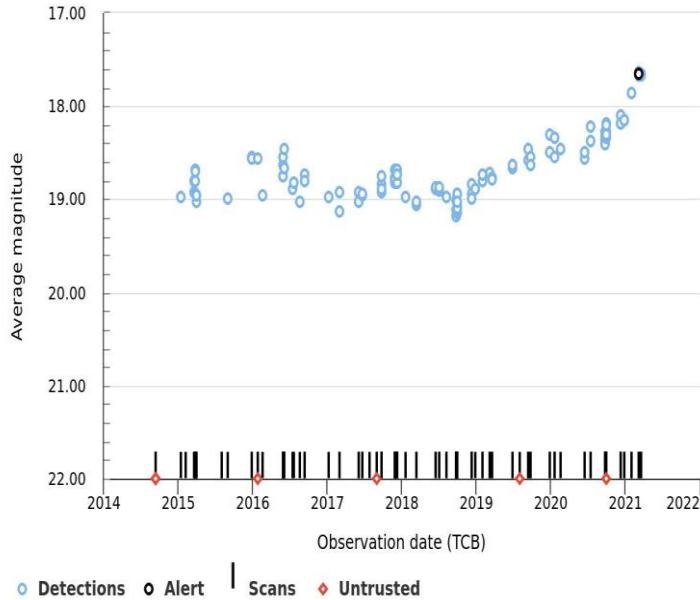
  (pb with ZTF…)

Examples of QSO non-erratic variations…
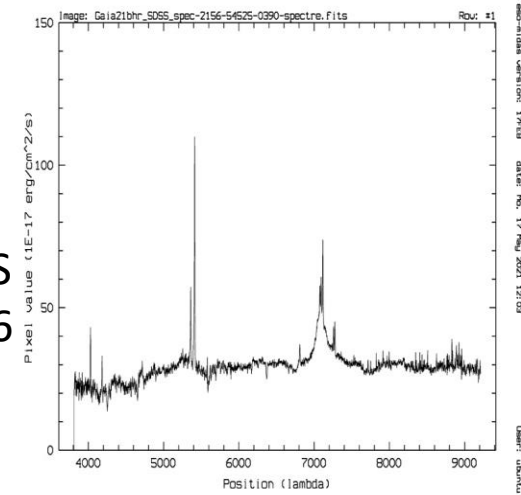## (here from Gaia_Alerts, up or down…)

Scale in X:
Several years

Some examples of QSO variations:
Changing Look Quasar (21bhr)

SDSS
2006

NOT
2021

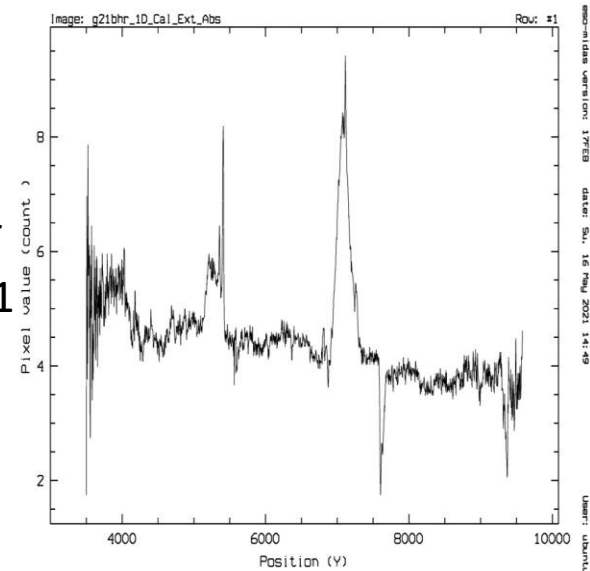Gaia says (11/3/21) : 1.5mag rise in Sey 1 galaxy
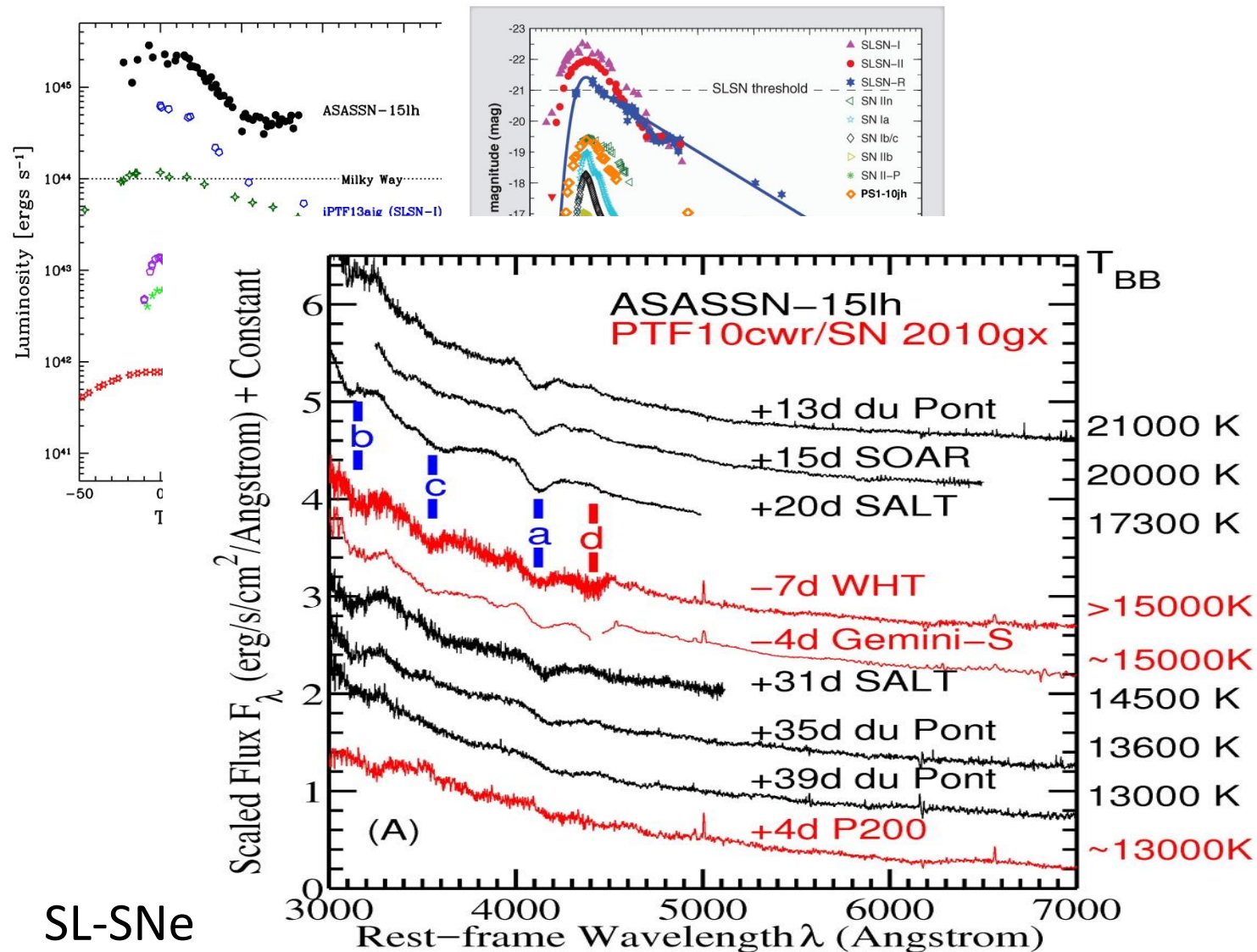
Broad lines appear…

SuperLuminous SNe or Tidal Disruption Events ??

- Close to center (< 1")
- Blue continuum
- Almost featureless Spectra
- e.g. PS1-10jh (Strubbe '15), or ASASSN-15lh (Dong et al. '16)
- For SNe: OII absorption lines
- For TDE's: H, He or nothing, depending on progenitor…
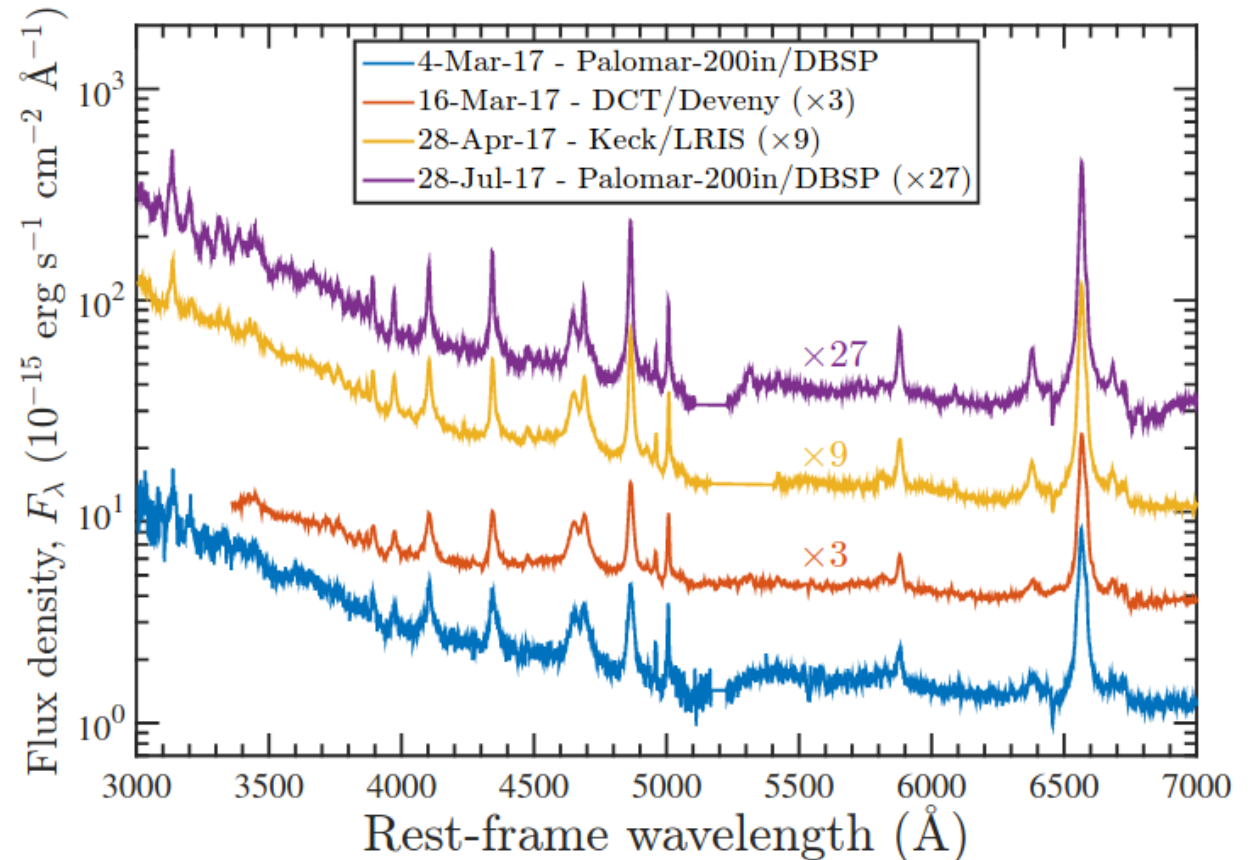- **Not to confuse with AGN "standard" variability…**

SL-SNe

SuperLuminous SNe or Tidal Disruption Events ??

- Close to center (< 1")

- Blue continuum

- Almost featureless Spectra

- e.g. PS1-10jh (Strubbe '15), or
  ASASSN-15lh (Dong et al. '16)

- H, He or nothing, depending
  on progenitor...

- **Not to confuse with AGN
  "standard" variability...**

TDE's

SN…. or TDE ?

- AT2017fro discovered 27/7/2017

(later by Gaia, 3/9/2017)

- First classified as SN by ASAS-SN

- Abs. Mag. = -23 !

- SN…or AGN ?
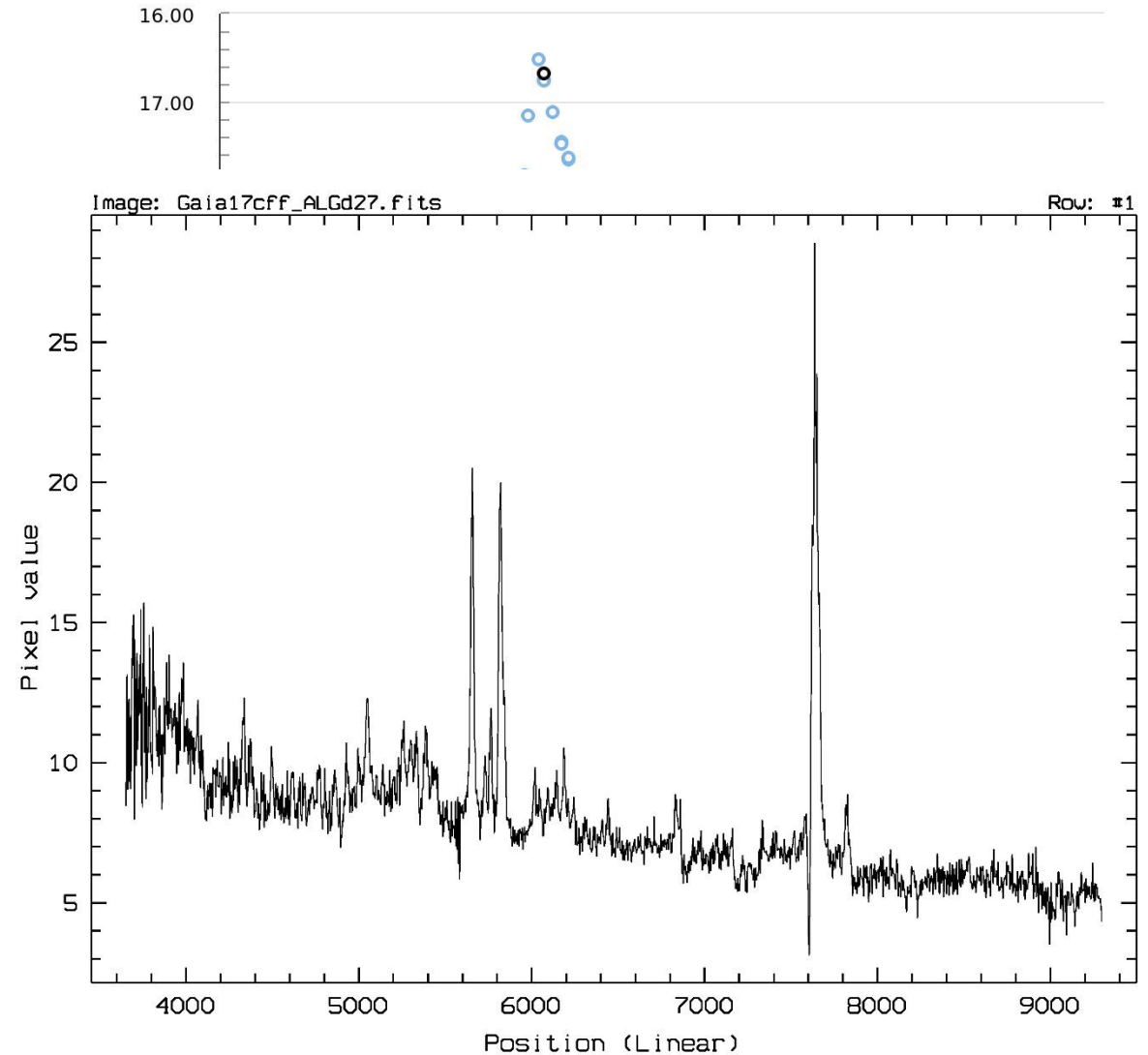
- First spectrum

unclear… (Floyds, 9/2017)

SN…. or TDE ?

- AT2017fro discovered 27/7/2017
(later by Gaia, 3/9/2017)
- First classified as SN by ASAS-SN
- Abs. Mag. = -23   !
- SN…or AGN   ?
- New spectrum, NOT
04/2023, after event: NLS1 !
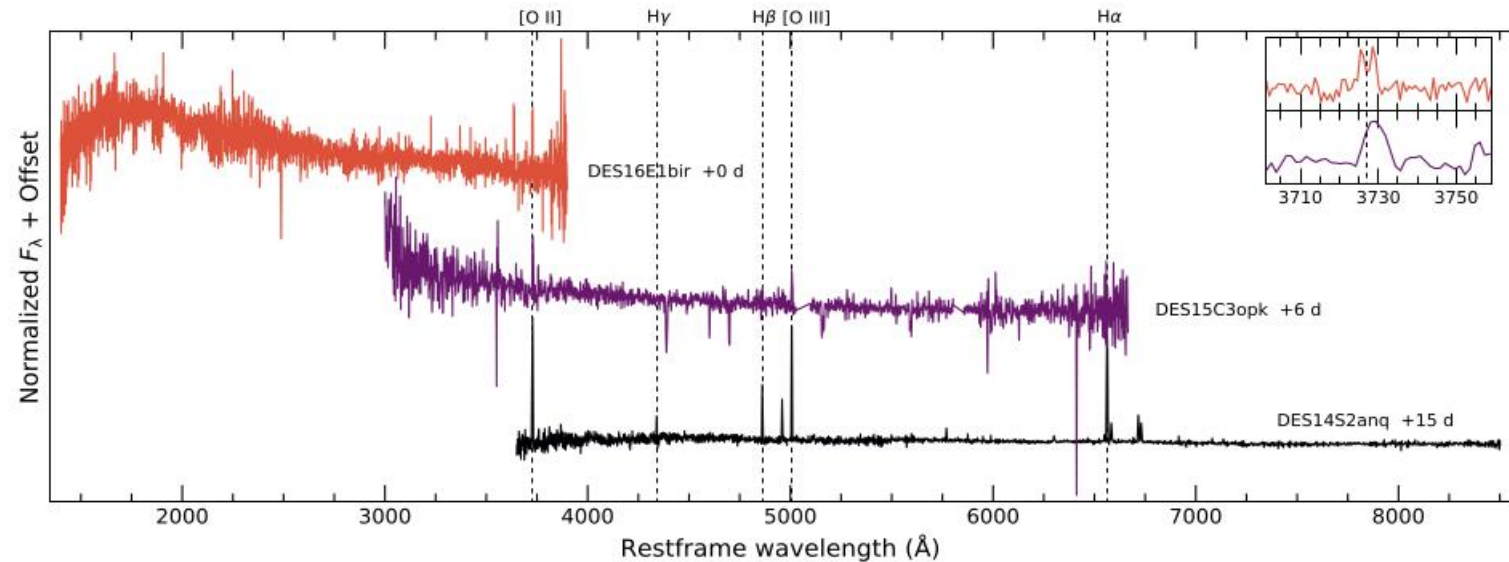

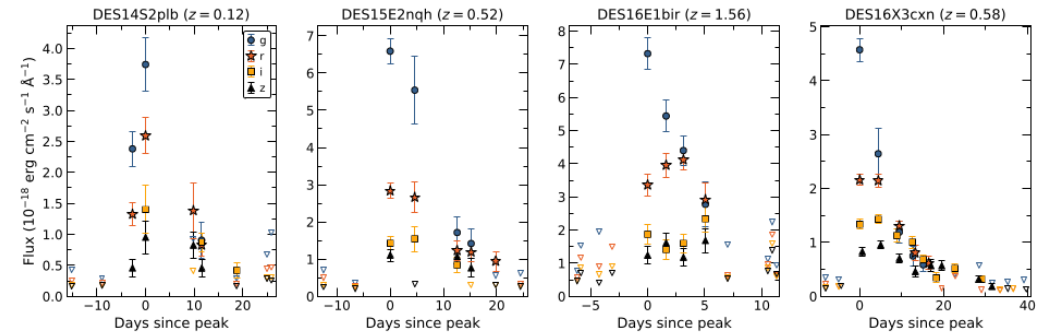Image: Gaia17cff_ALGd27.fits   Row: #1

FBOTs : what are they ?

- Fast Blue Optical Transients
- Quick rise (< 10 days)
- Black-Body, T ↘ with time
- Feature-less spectrum

- CC-SN ?
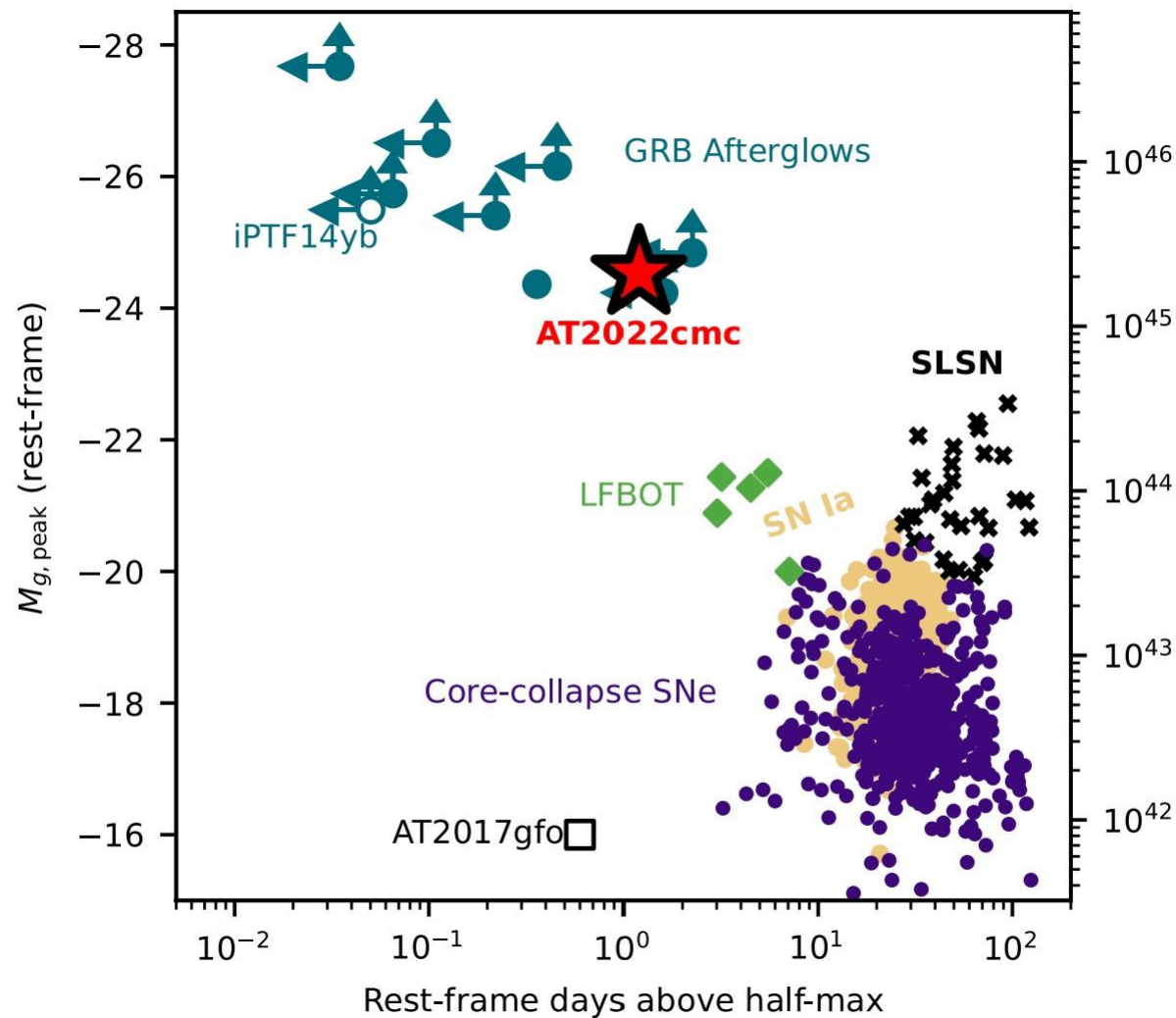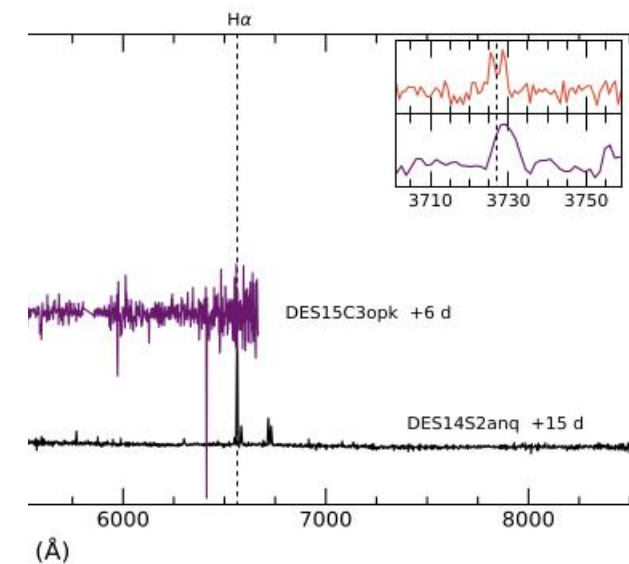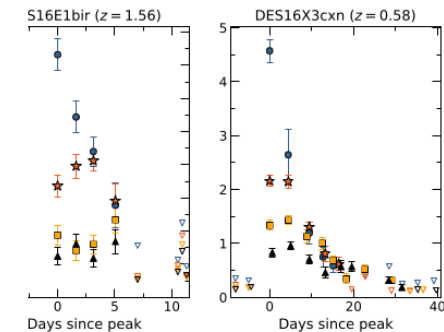- Optically thick envelope?

In some cases, dormant AGN wakes up: AT2022cmc luminosity between GRB's and FBOT's

- Fast Blue Opti
- Quick rise (< 1
- Black-Body, T
- Feature-less s

- CC-SN ?
- Optically thick

LSST follow-up: calibrating photo-z with spectroscopy !

	u	g	r	i	z	y
1 visit	23.9	25.0	24.7	24.0	23.3	22.1
10 yrs	26.1	27.4	27.5	26.8	26.1	24.9

- Spectro impossible for 2E10 objects....

- Photo z mandatory:

 -Training: colour ∞ z (30,000+ objects needed)

 -Calibration: minimize systematics and dispersion

(~ 100,000 spectra needed...)

(Newman et al. 2009)

How discrepancy between two phot-z methods scales with $Z_p - Z_s$

Gaia_not_fits_2023a.tar.bz2

What do we wish ?

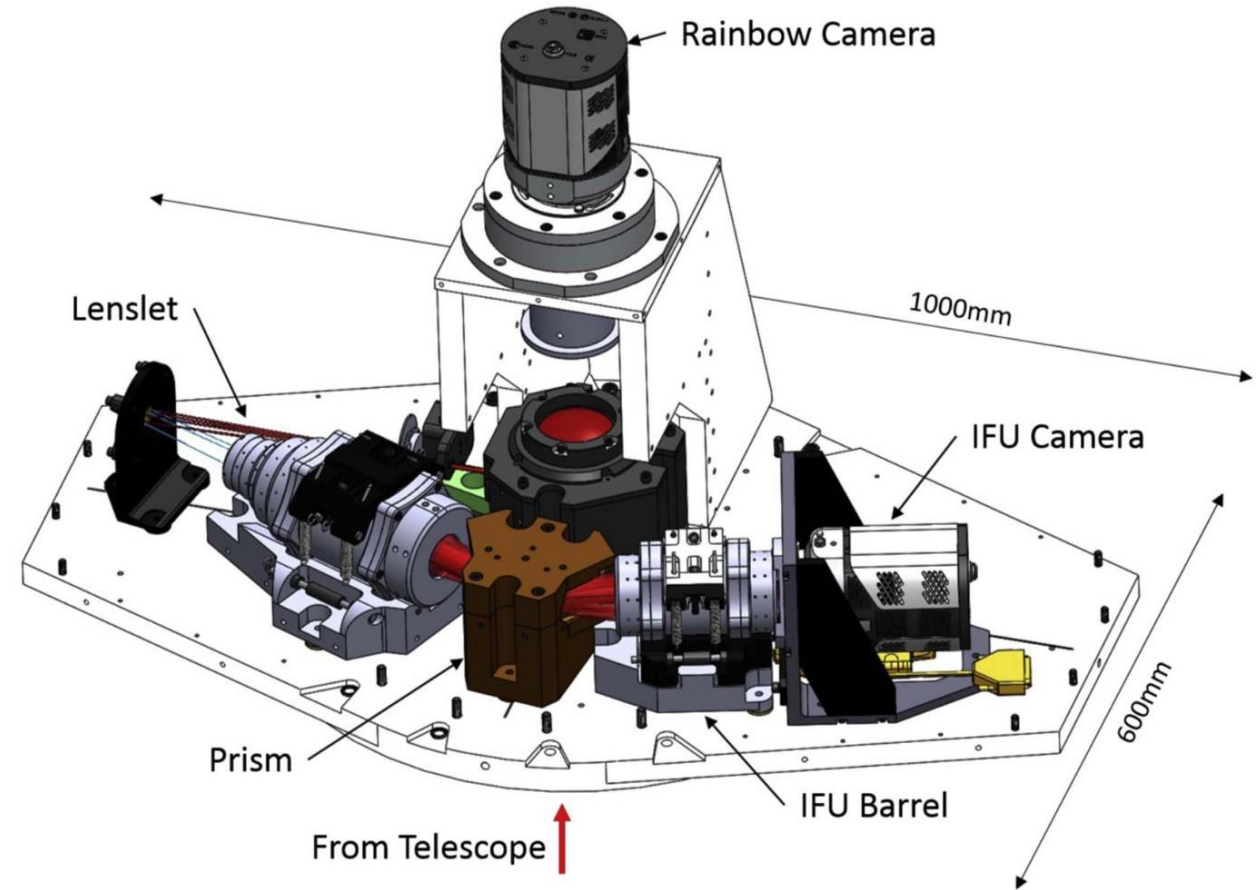- ALL !!
- Wide spectral coverage: 3700 Å --- 2.5 µ   ??   2 arms…
- Resolution 1000 at least (resolve Hα/[NII], or –700 km/s (NLS1))
- High sensitivity
- Good angular resolution
- This means we need a dedicated 8m telescope (VLT-UT 5) !!
- Or EierliegendesWollMilchSchwein…

Compromises have to be made…

Let's see what can be done with 2m telescopes

Example of the SED-machine at Palomar 60"

- Camera + IFU

- 4 filters: u,g,r,I   FOV 13' x 13'

- IFU: R=100,   FOV 28" x 28" , 3500-11000 Å

- Peak efficiency :9% @6500Å

- CCD 2k x 2k, 13.5µ, -55C

- Limiting mag: 19-20, 1h

- Advantage of IFU: robotic pointing! Host subtraction…
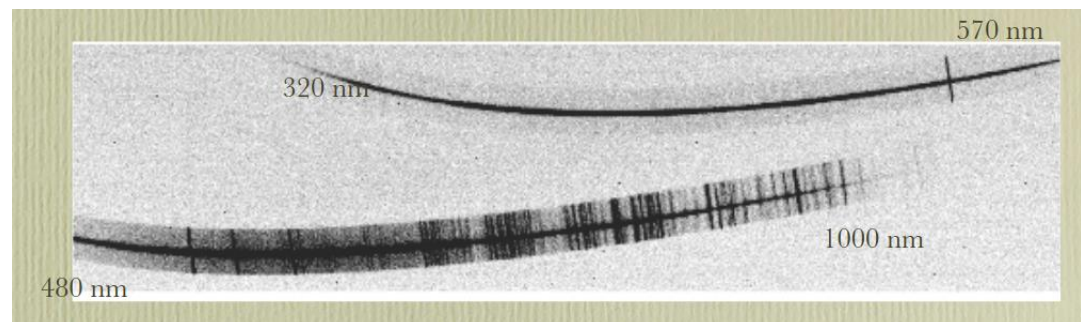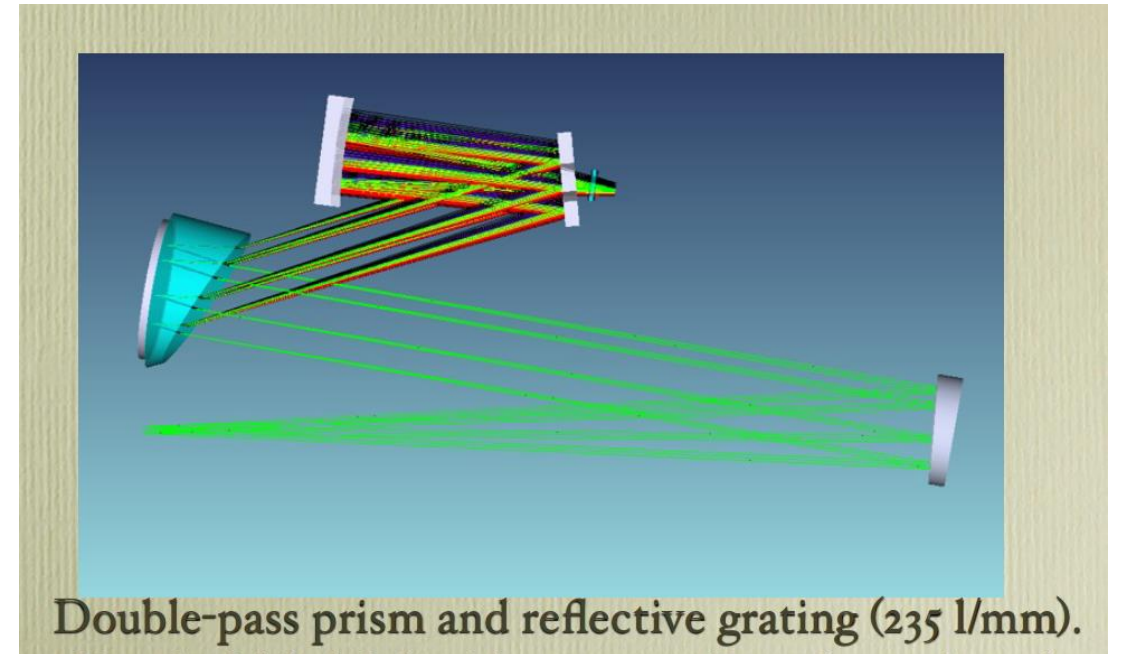
FLOYDs spectrographs at LCOGT 2m

Cross dispersed, low resolution
R = 400 (blue)-700 (red end)
1st order: 5400-10000 Å
2d order: 3200-5700 Å
1h, S/N=10: g 18, r 19

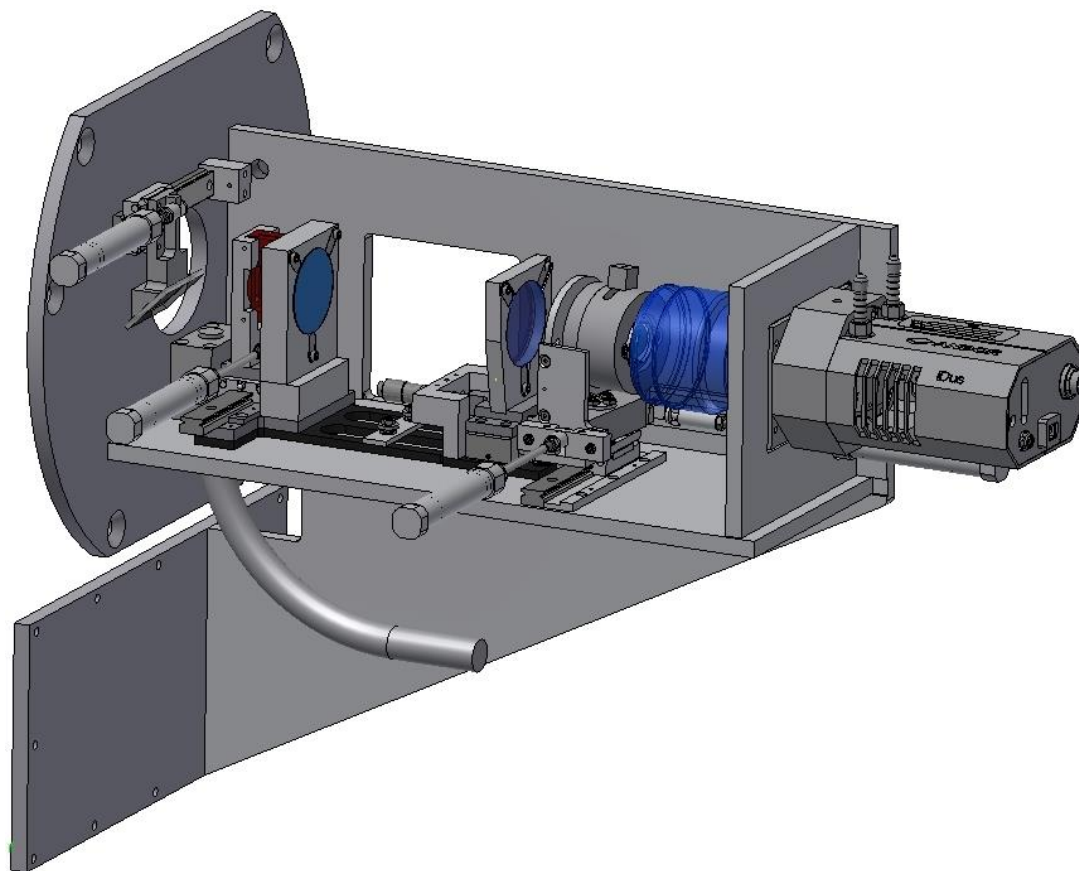Double-pass prism and reflective grating (235 l/mm).

SPRAT at Liverpool 2m telescope
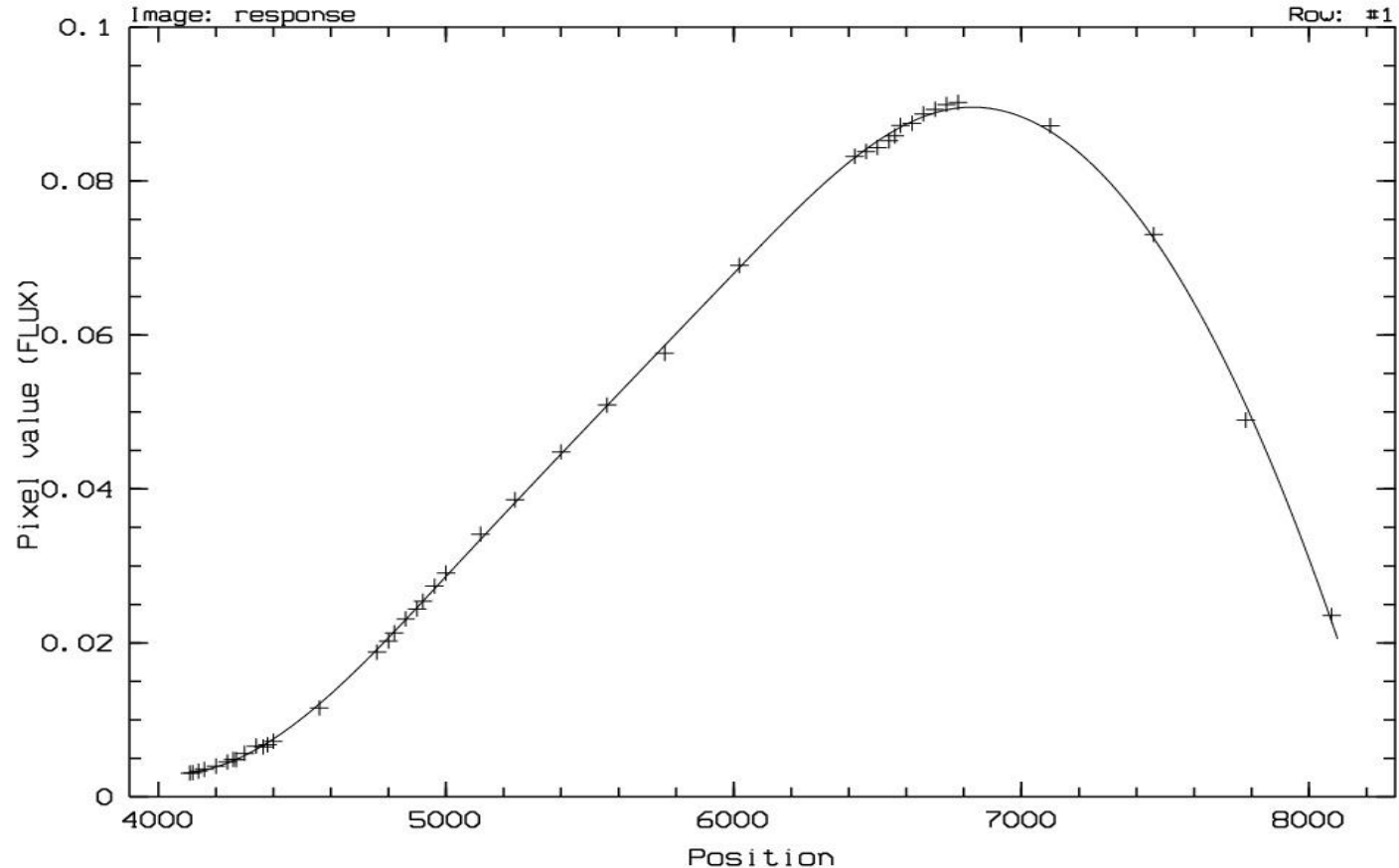## (Rapid Acquisition of Transients)

- Low resolution (R 350), high throughput
- VPH grating, 600 l/mm
- 4000-8000 Å (red option)
- Slit 1"8, 95" length
- 19.5th mag, 1200s, S/N=10

- Automatic axcquisition
- Served as model for Mistral@OHP

Example of Mistral @ T193-OHP

- Blue (4000-8000) or
- Red (6000-10000 Å)
- R=700, VPH grating
- Peak efficiency :15% @6800Å
- Deep Depletion CCD 2k x 2k, -90C
- Limiting mag: 19-19.5, 1h
- At folded Cassegrain, some improvements under way

Blue grating: efficiency drops rapidly on the blue side

How do we proceed in practice to get telescope time ?