

Suivi spectroscopique des Alertes

Le rôle de PESSTO

Leçons à en tirer

Michel Dennefeld (IAP-Sorbonne Univs.)

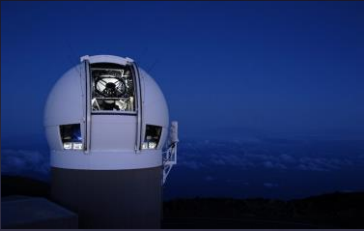
Montpellier, 5 juin 2018

Wide-field synoptic surveys : game changer !

10 square degree cameras + 1-2m telescopes



PTF-ZTF – low-z SNe (“factory” follow-up built in)



PS1 – high-z SNe (dedicated 4-8m follow-up)



+

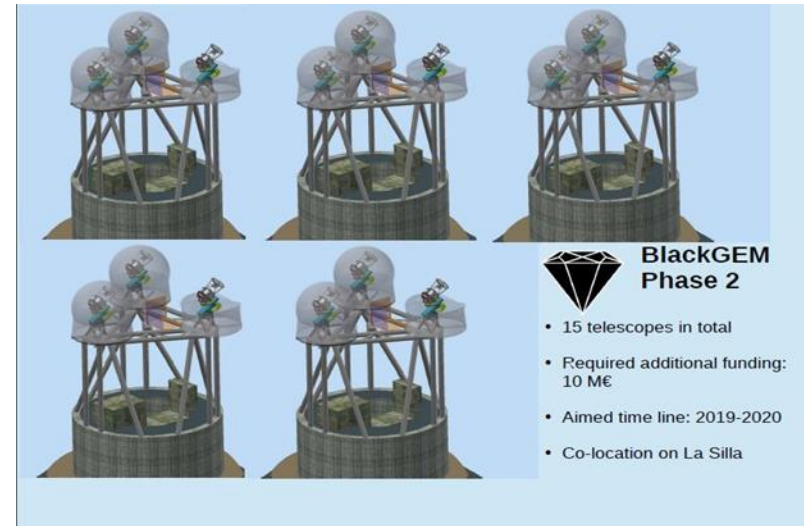


La Silla QUEST + SkyMapper

Many more surveys going on today...

- **ATLAS**: NASA asteroids, 2x 50cm, $\delta > -40$, $m=20$, Hawaii
- **MASTER**: 40cm, 20th mag Ural, Kislovodsk, IAC, SAAO,...
- **ASAS-SN**: 4 Hawaii + 2 CTIO, 14cm $V=17$, $\frac{1}{2}$ sky/night
- **DLT40**, PROMPT 41cm@CTIO $r \sim 19$, 600 galaxies/night
- **Black Gem**, 3 x 65cm/ mount
Prototype in SAAO is OK, 15 in LaSilla in 2019...

NEED SPECTROSCOPY !!



The PESSTO follow-up

(Public Eso Spectro Survey for Transient Objects)

- Large Program ESO
- S. Smartt (QUB) et al. (~ 100 co-I's)
- 90n per year : 9 months, 10n per month at the 3.5m NTT in LaSilla (2 observers/month)
- 4 yrs (2012-2016), plus 1yr extension (2017)
- Will classify ~2000 (667) SNe – all spectra reduced, classified and released within 24hrs (WiseRep)
- Will follow approx 150 (131) with full spectr. and phot. time series coverage
- ~100+ papers published up to now
- **Now extension for 2 years (2017-2019, e-Pessto)**
- Considering Request for another 2 years extension....

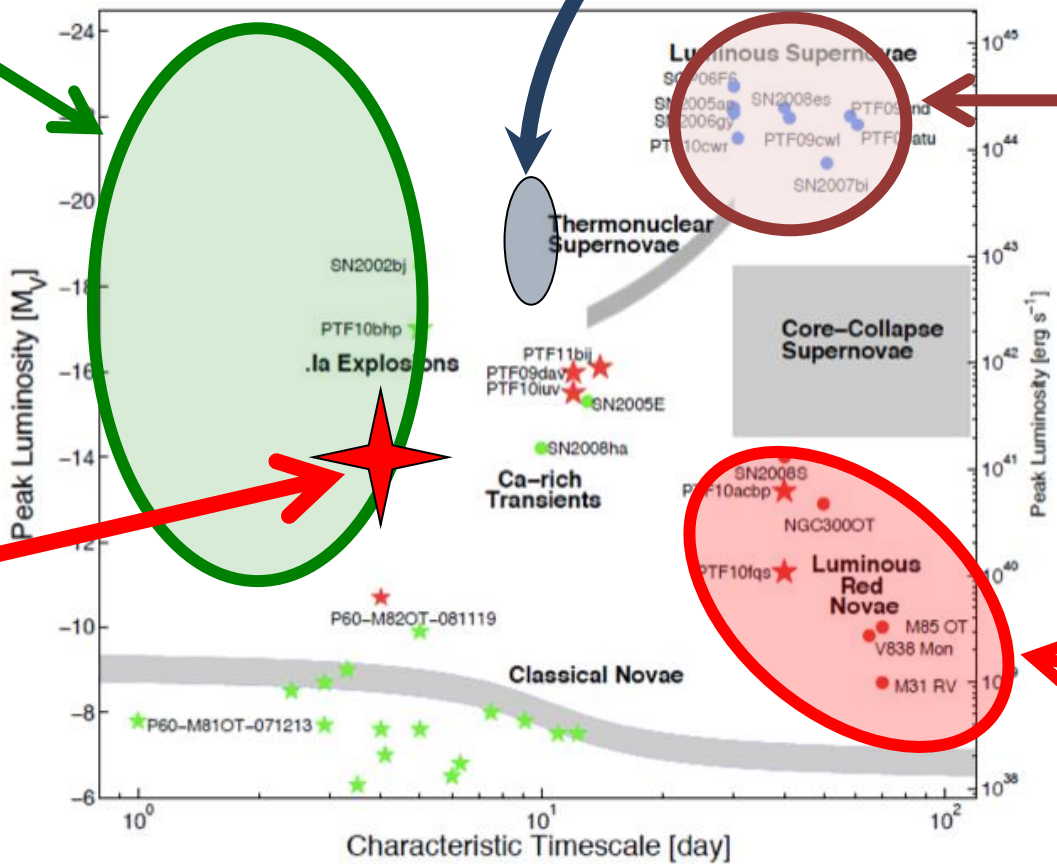
The PESSTO structure

- **Science Board** (S. Smartt (QUB), Chair)
- **Operating Team:**
 - Observing Management
 - Target and Alerts Team (K. Maguire)
 - Data Reduction and Quality Control (S. Valenti)
 - Archive Team (D. Young)
- **Science groups:** 22, including normal Ia's, superluminous Ic, weak IIP, interacting, etc...
In e-Pessto: 26 groups, including now GRB's and GW follow-up

When a given type is identified, a PI is nominated, in charge of collecting (other) data.
Rules for signing papers...

Optical Transients

the unknown



the bright

the faint

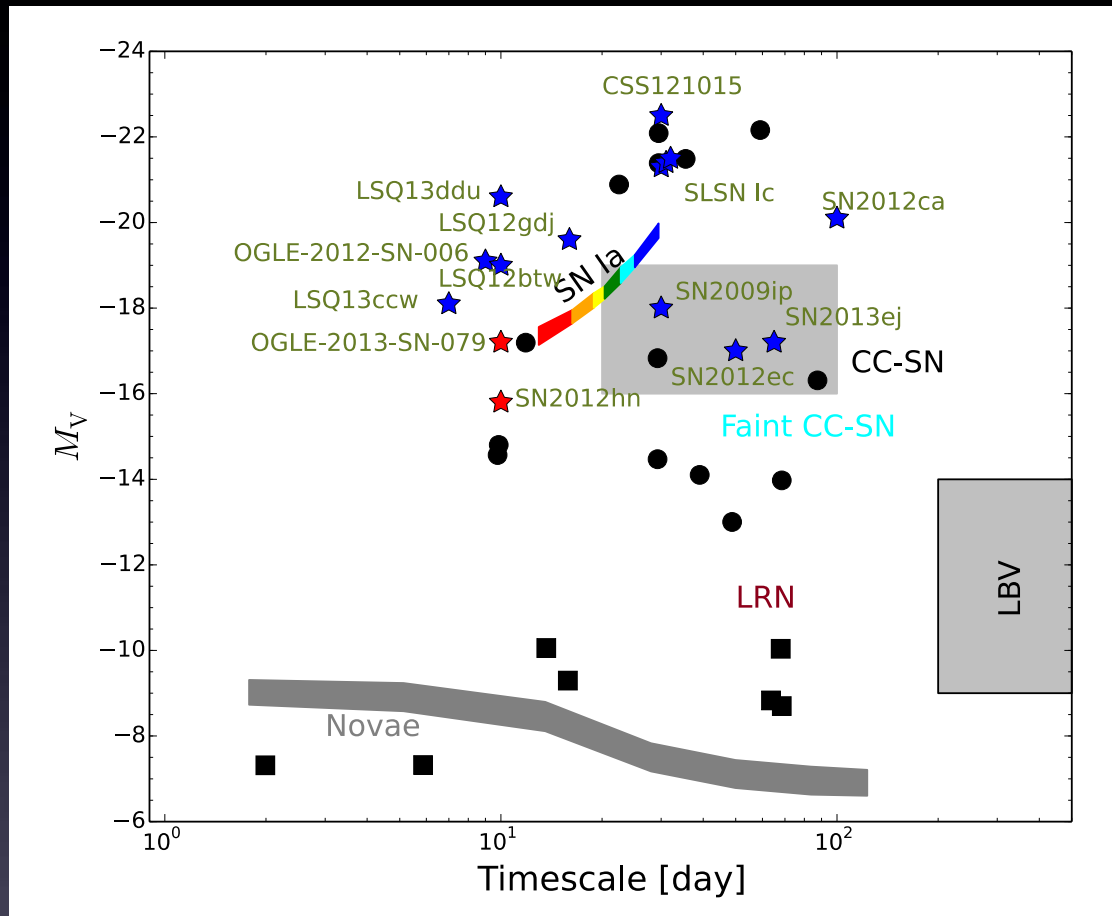
The first
"kilonova" ?
Tanvir 2013,
GRB130603B

What are the limits of physical explosions and transients ?

Transients : current science



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



What are the limits of physical explosions and transients ?

Actual status obviously evolving fast...

Stratégie d'Observations

- Ingestion automatique de « tous » les surveys (MARSHALL)
- Le TAT fixe des priorités générales pour les classifications
- En pratique, dépend (beaucoup) des observateurs!
- Priorité au suivi des objets précédents
- Dans e-Pessto, un peu plus de GRB's
- A mon sens, trop conservateur (pas assez de classifications ou objets autres que SNe (Pessto !))
- Devrait changer (un peu...) avec ENGRAVE ?

Key: The PESSTO Marshall

latest comment (1 day ago): Nuclear and rapidly evolving, history is quiet, potentially very interesting, current mag is about 20, and looks like that's the peak - [Iair Arcavi](#)

identity

OGLE15lo



priority: **HIGH**

list: classification

targets

pessto id: **883189**

object info

ra & dec:

03:33:09.91 -64:07:15.2

[53.29129 -64.12089]

predicted type:

SN

pre-disc non-detection:

276 days ago

(2015-01-04)

discovery date:

272 days ago

(2015-01-08)

date added to marshall:

1 days ago

(2015-10-05)

host info



contextual

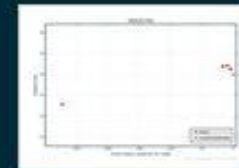
classification:

NT/SN/VARIABLE STAR/?

actions



lightcurve



lastest

magnitude:

19.75 OGLE
I-band
2015-10-03
+4d

current mag

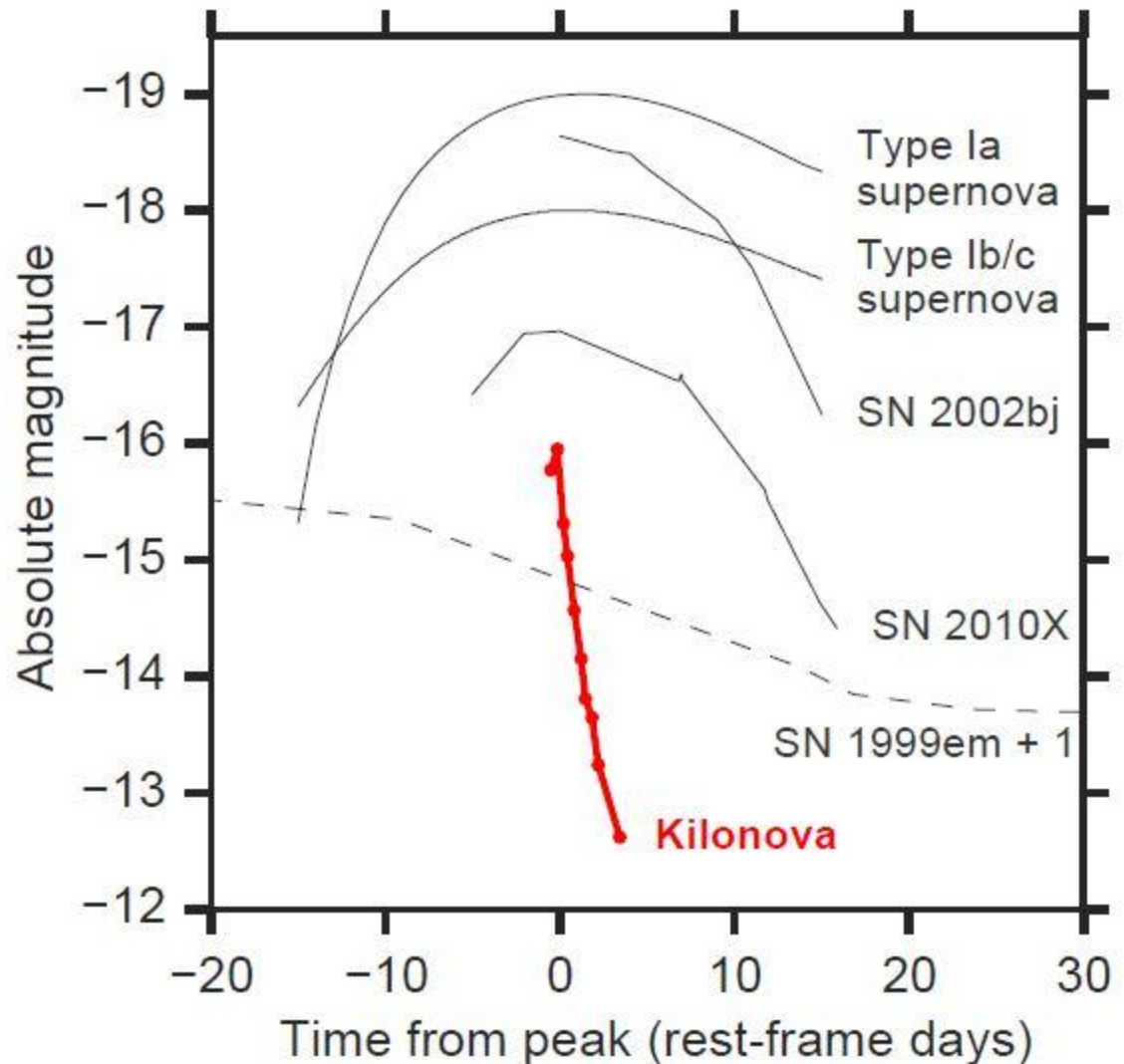
estimate:

20.00

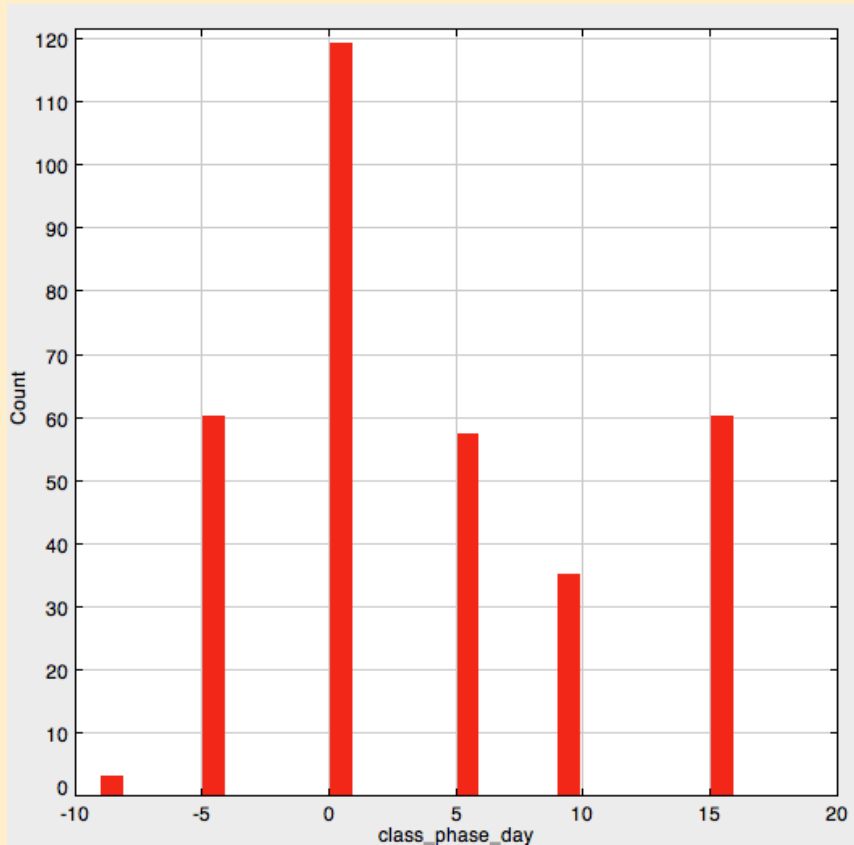
Lessons from the **kilonova** GW170817

- Kilonova long p models...
- First spectra ob PESSTO at NTT
- BB with T $\rightarrow \nu$ $\log F_\lambda$
- How many did past ??

-Spectra different from
 --Need to know classica
 peculiar cases also!!
 Rapid photometric evo
 Smartt et al, Arcavi et a



Phases at classification



+33
premax



+74
postmax

Pre-max : transient is very likely caught before maximum light
Max : transient is likely around maximum light
Post-max : transient is very likely after maximum light
Unknown : phase can not be discerned from the information in hand
NULL : if the transient is not a supernova

If the transient phase can be further refined we provide the following ranges

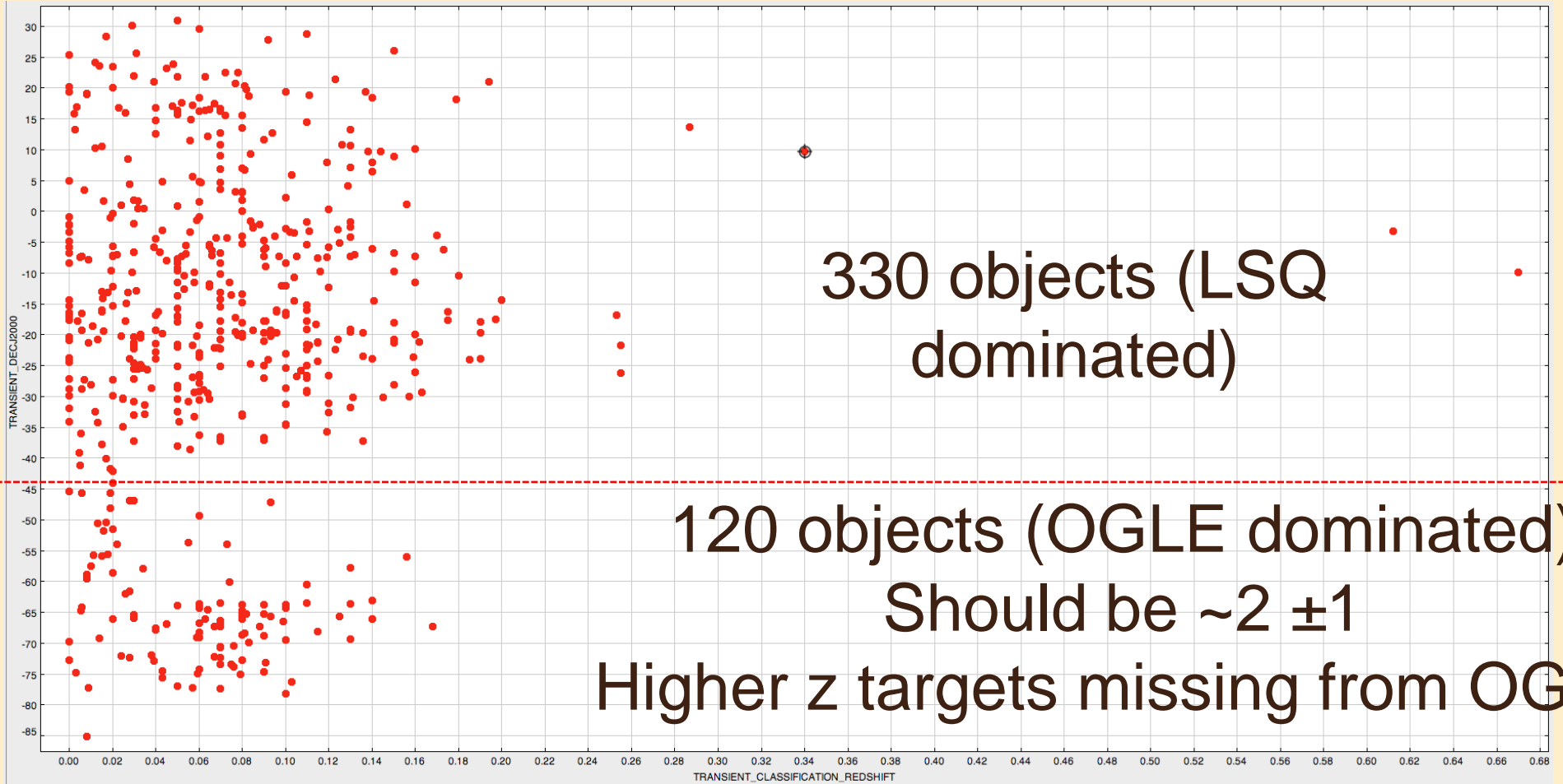
Table 6. Ranges of phase classification provided

TRANSIENT_CLASSIFICATION_PHASE_DAYS_LOWER_LIMIT	TRANSIENT_CLASSIFICATION_PHASE_DAYS_UPPER_LIMIT
NULL	-10
-10	-8
-7	-4
-3	3
4	7
8	10
11	20
20	NULL

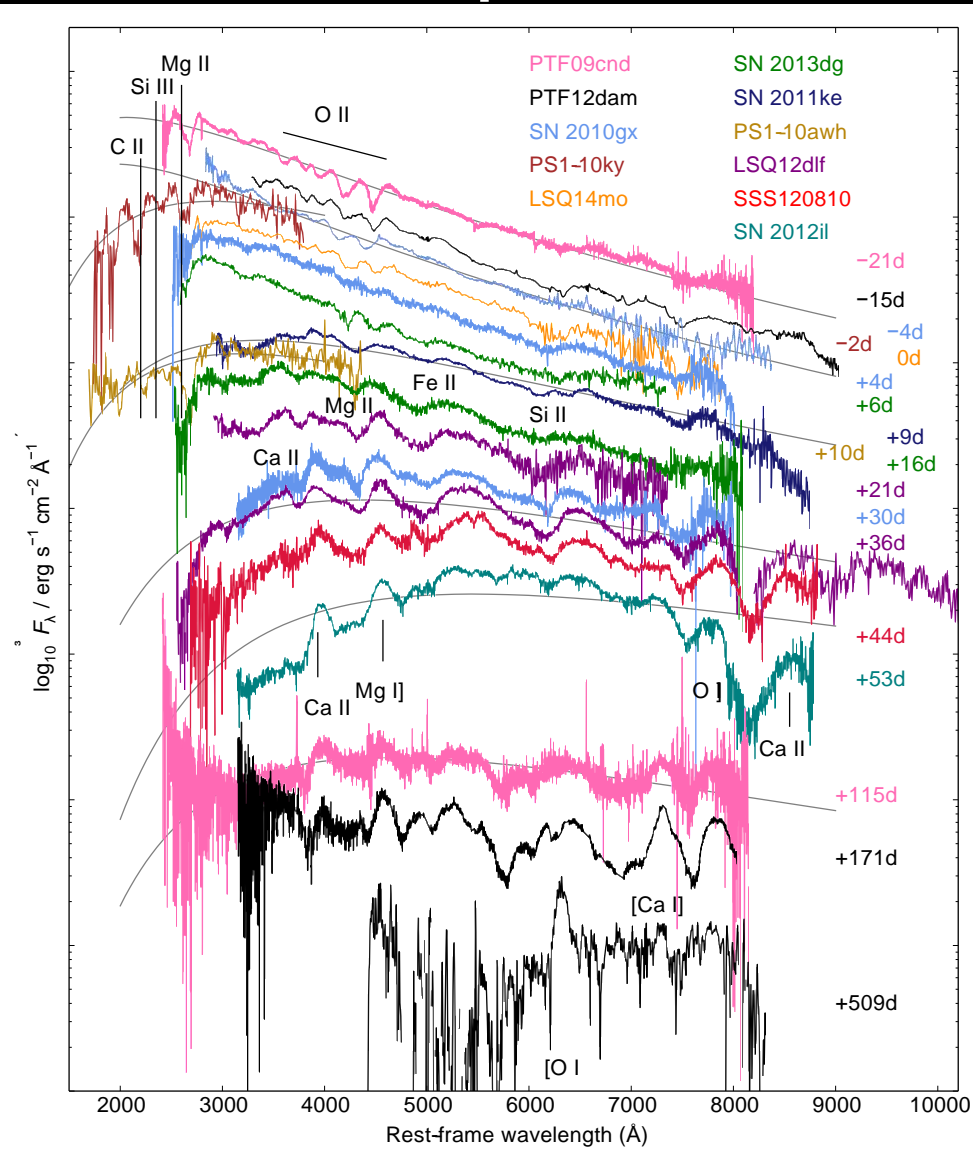
PESSTO Paper 2

- Describe minor updates to SSSDR2
- Stats and trends
- Use of phot-z
- “Featureless blue continuum” transients – what are they typically ?
- Young II-P/II-L/II-n, SLSNe around peak, CVs, AGN in certain z-range
- Issue of S/N and resolution

Distribution in z



Superluminous supernovae

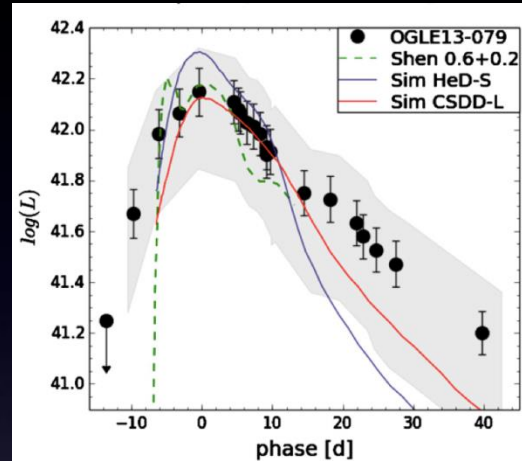
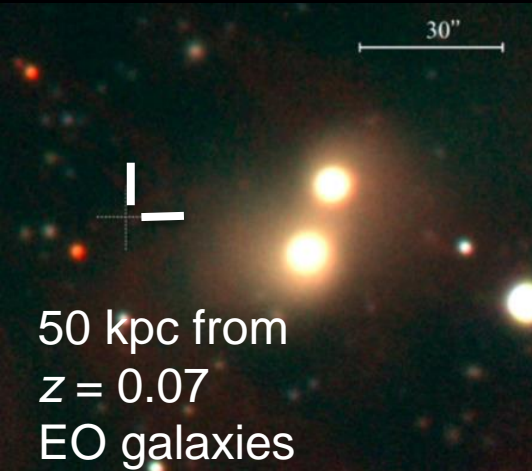


What are they : stellar Explosions in dwarf galaxies – 100 times more luminous than core-collapse SNe. Luminosity source unconfirmed. No hydrogen and helium seen in spectra

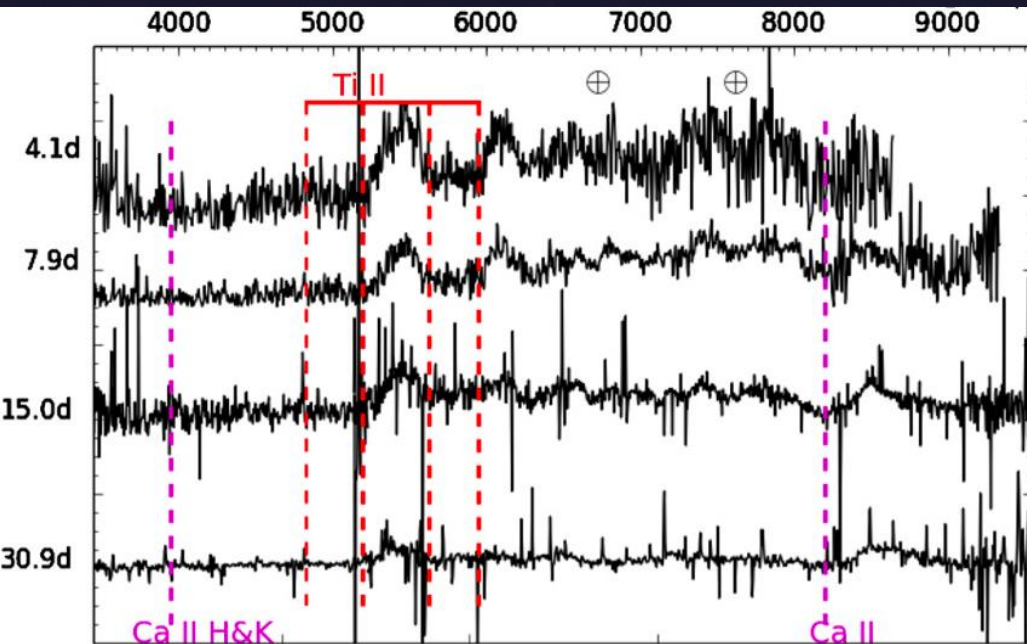
What is the physics powering this extreme luminosity ?
Current leading model – magnetar powering

Nicholl et al. 2014
Chomiuk et al. 2011, Berger et al. 2012,
Nicholl, Smartt et al. 2013,
Inserra, Smartt et al. 2013,
Chornock et al. 2013,
Lunnan et al. 2013+2014, Howell et al. 2013

OGLE13-79 : faint and fast fading

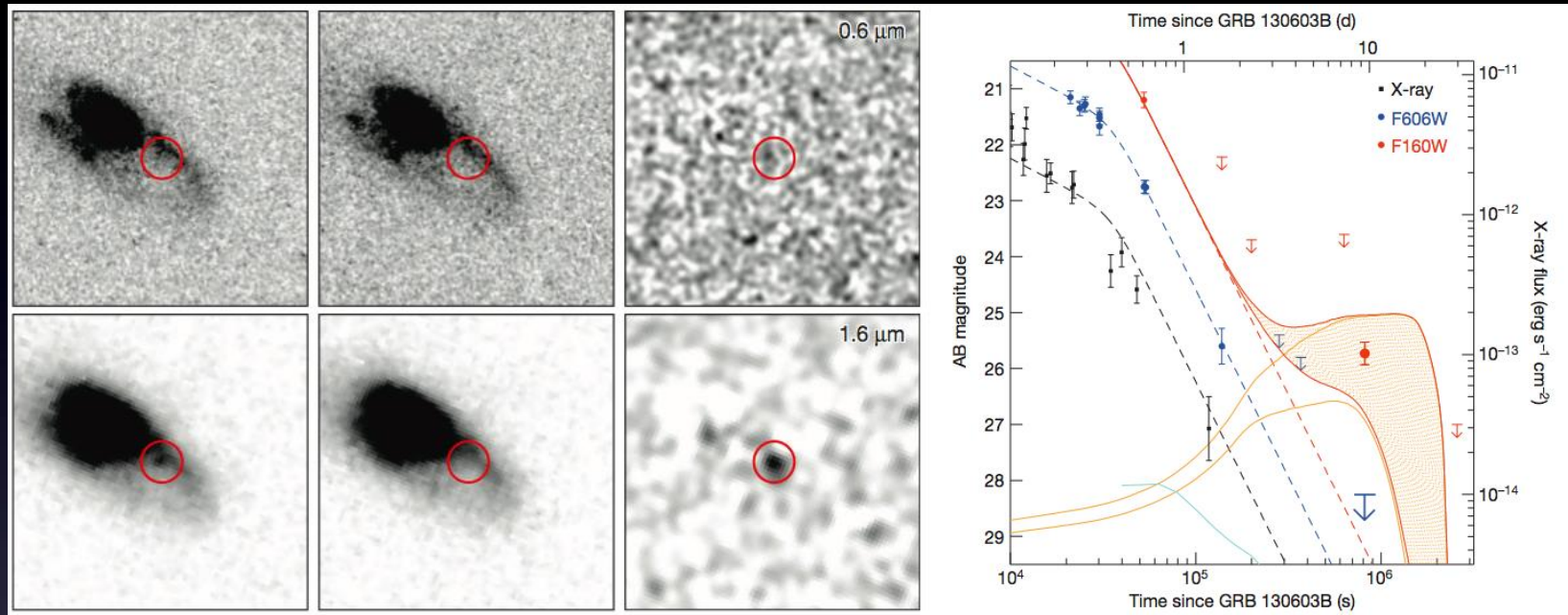


- Fainter than type Ia SNe
- Faster declining (factor 3) than SNe Ia
- “.Ia” = a tenth of a SNIa



- He shell detonation on a low-mass WD
- Ti and Ca are expected burning products
- Inserra et al. 2015 ApJL

Multi-wavelength : transient gamma-rays

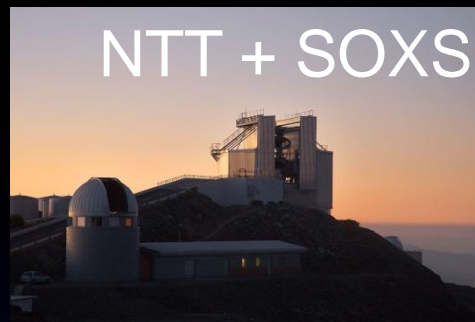
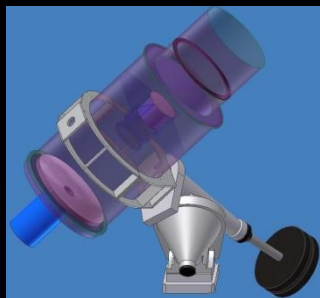


Tanvir et al. 2013, Nature

- Swift Short gamma-ray burst in galaxy at $z = 0.356$
- Detection of “afterglow” - then very faint “glow” 7 days after the gamma rays
- “Kilonova” model – two neutron stars merge, neutron-rich radioactive explosion, not as bright as a supernova
- Will these be the first gravitational wave sources in 2015-17 ?

Multi-messenger triggers : GWs, neutrinos,
gamma, x-ray, radio

0.5-1m with 10-30
Sq. degree camera



Dedicated,
>50%
PESSTO-
like ops



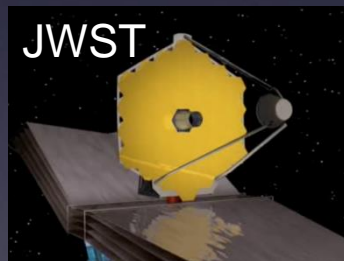
$m < 21$



VLT + xshooter,
FORS, HAWKI
Flexibility, large
fraction of ToO

$m < 23$

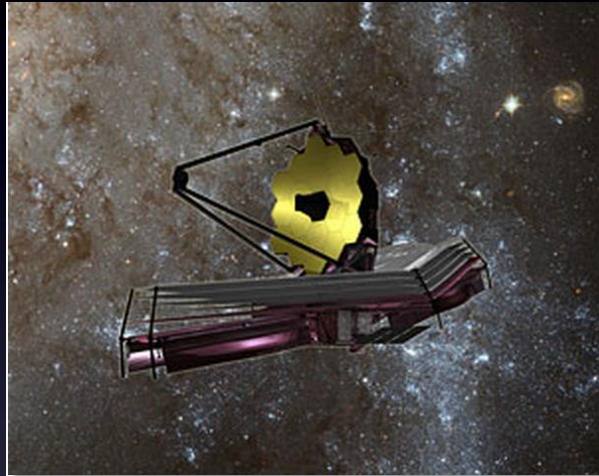
$m > 23$



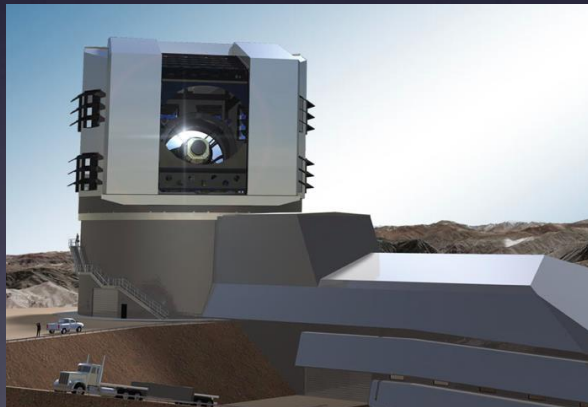
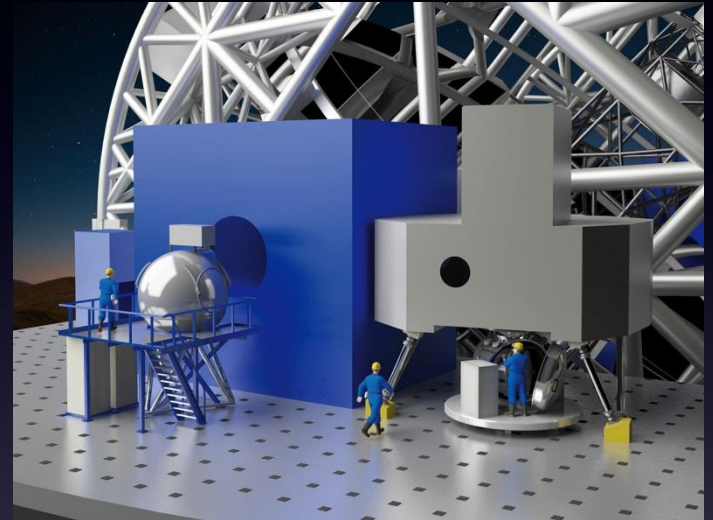
ELT + HARMONI
Fast response
mode



High-z : JWST, LSST and E-ELT



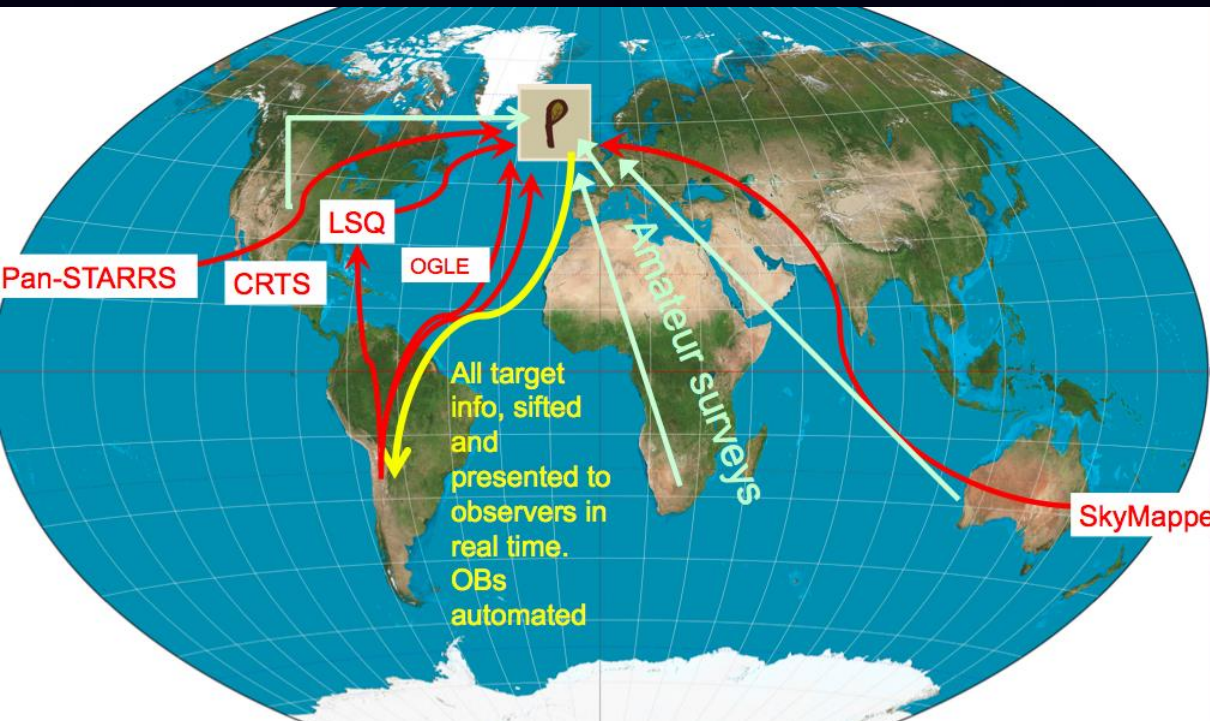
NIRSPEC
Surveys
 $H_{AB} > 25$



LSST
Surveys
 $z_{AB} > 25$

- Feed for ELT spectra
- ELT + HARMONI
- 4hrs gets $H_{AB}=25$ at $S/N \sim 20$ ($R \sim 500$)
- SLSNe at $z = 6-10$

Flexible, time-domain optimised operations



- PESSTO :cheap, efficient, flexible operational model
- Necessary if time domain work is main function of the telescope
- Very competitive science
- Remote observing : even more cost efficient

PESSTO : from survey discovery to publicly reduced data in < 24hrs.
Every night for 4 years

NTT with SOXS : cost effective, competitive science,
large ESO community

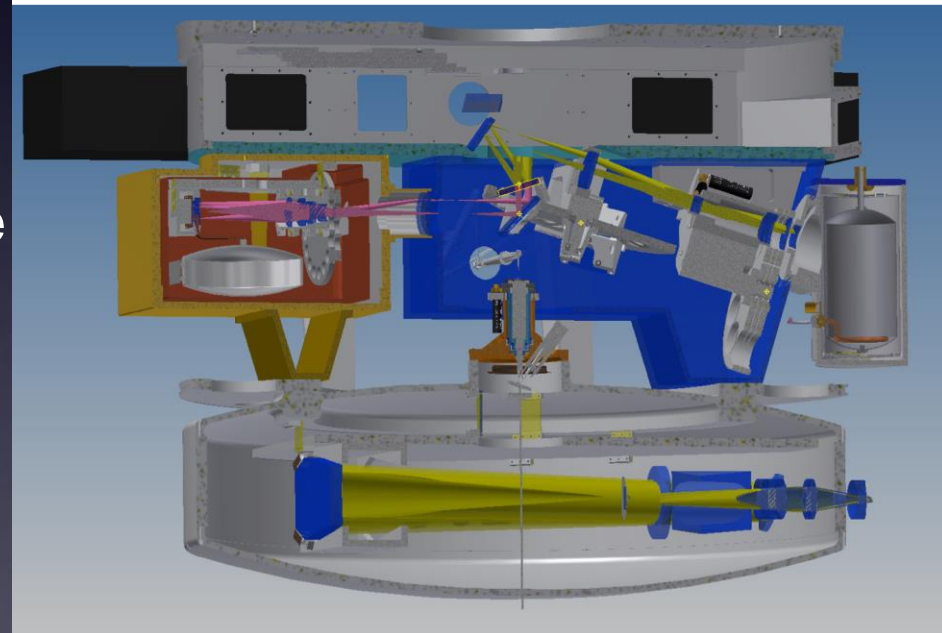


SOXS – “Son Of XShooter”

- In response to Call for Ideas for NTT 2016+
- **PI Sergio Campana (IT, UK, DK, Isr, Ch +)**
- A dedicated spectroscopic machine for the transient sky @ NTT
- Copy of “Not Transient Explorer”

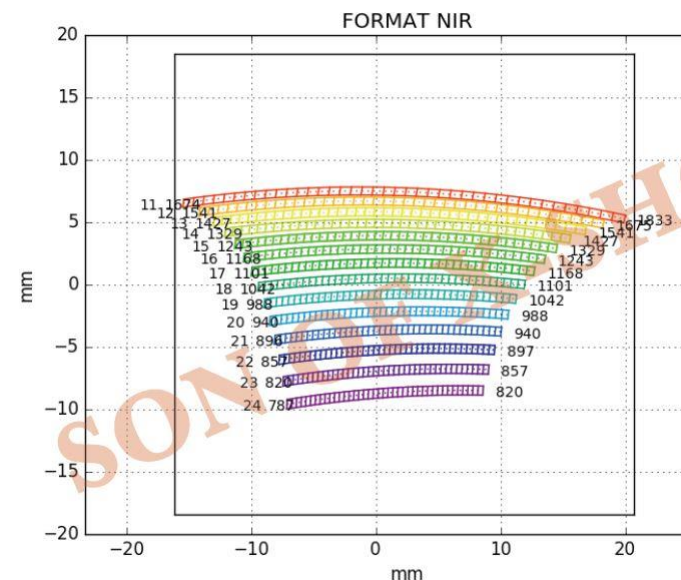
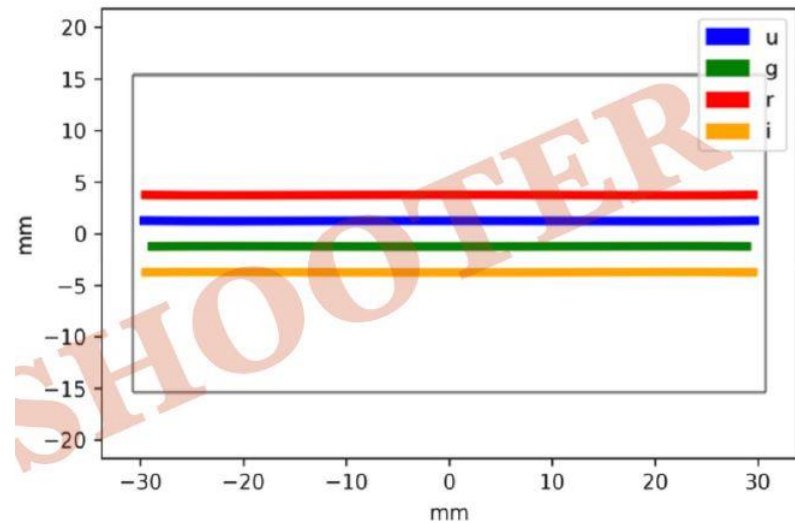
Table 1: Main characteristics of NTE spectrograph mode.

Wavelength coverage	0.32 – 1.77 μm
Spectral resolution	4,500
Slit length	20”
Pixel scale	$\sim 0.4''/\text{pix}$
Optical/NIR wavelength crossover	0.76 μm
Average blaze peak efficiency	$> 30\%$
Time to reach the sky limit	~ 15 min



More on SOXS...

- 0.35-2 μ , 2 arms
- R \sim 4500, 4k x 2k
- S/N \sim 10, 1h, R \sim 20
- FOV, 3'5, ugrizY
- GTO 180n/yr, 5 yrs
- FDR: 19July 2018
- Operations: 2021+
- Possibility to join ??



Et dans l'hémisphère Nord ??

- Pas d'accès aux « grands » télescopes...
- Quid du CFHT? (MSE viendra trop tard...s'il vient!)
- En attendant, accès limité au NOT (2.5m) dans le cadre de SVOM-NTE
- Nouveau spectro MISTRAL à l'OHP (T193)

Première lumière fin 2019...mais ce n'est qu'un 2m!

- Quelle stratégie de collaboration? (monnaie d'échange ??)

Simpler concept: Mistral/Sprat @ T193-OHP

Inspired from LT Telescope

Imaging and long slit

$\sim 4000\text{-}8000 \text{ \AA}$

VPH grating $R \sim 700$

Andor camera $2\text{k} \times 2\text{k}$

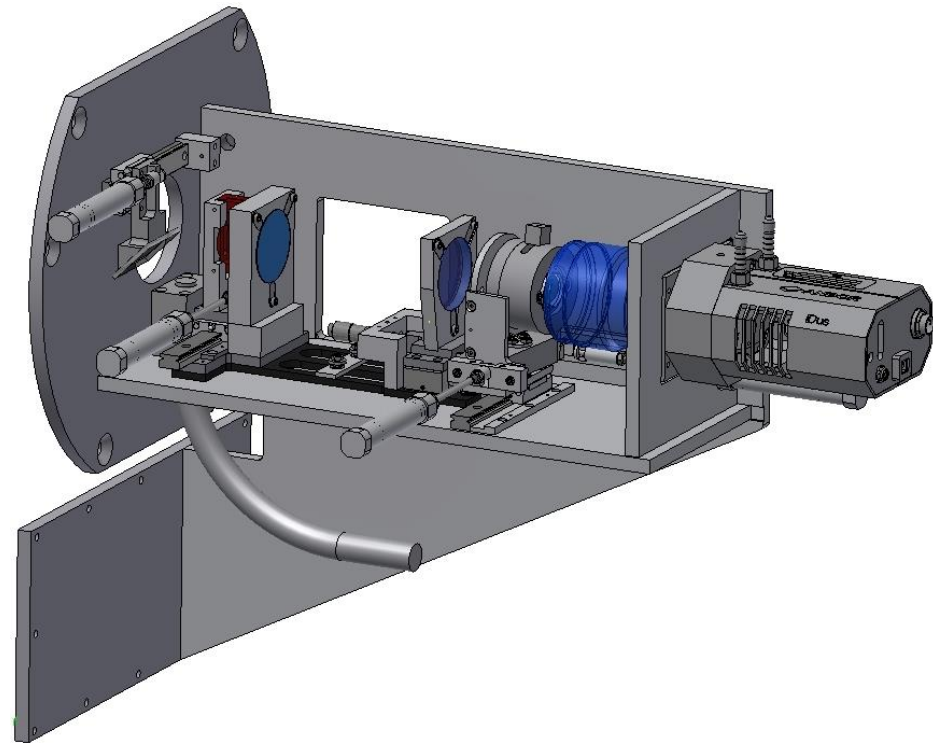
FOV $\sim 5'$

Design close to finished

First light end 2019

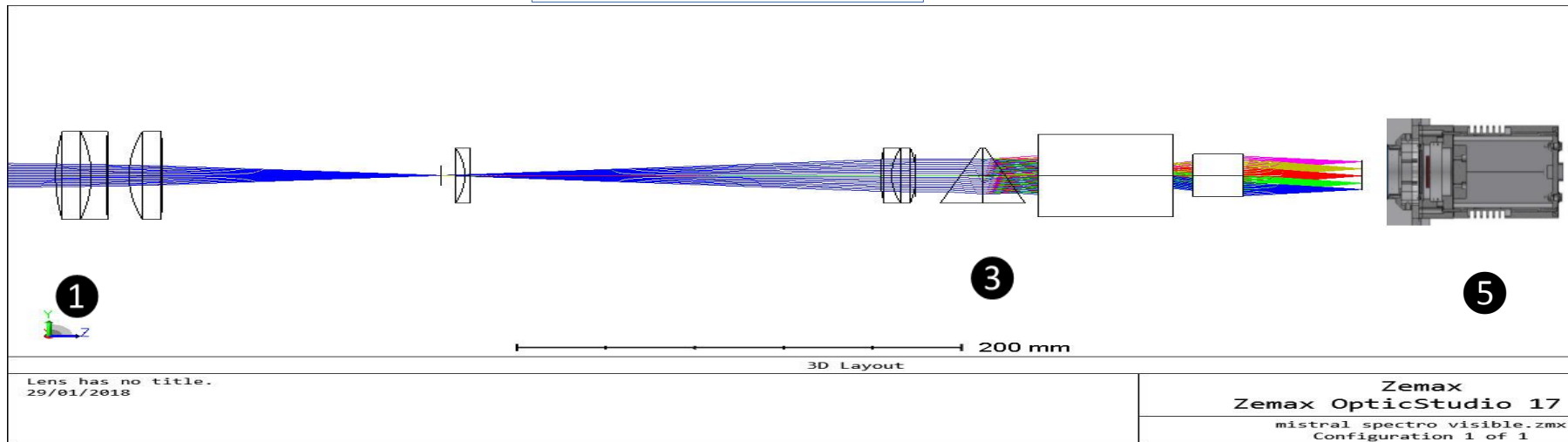
Mag ~ 19 in 1h, S/N ~ 10

+ operations....

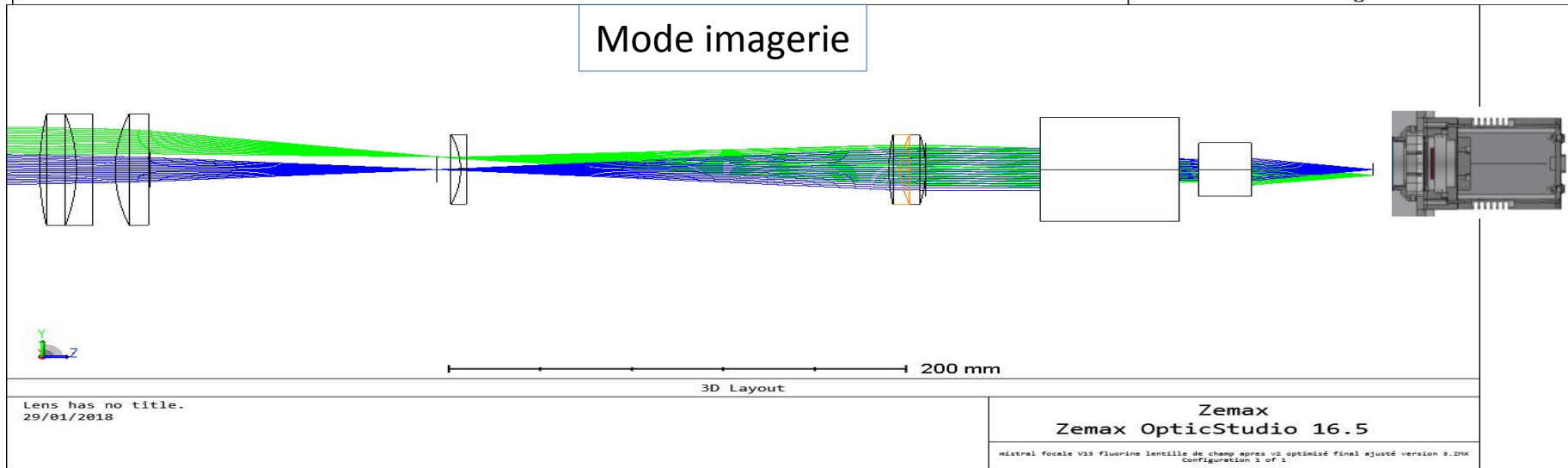


Design optique Mistral/Sprat 2018

Mode Spectrographe



Mode imagerie



Légende : ① Réducteur Focal ③ VPH 900 I/MM & 2x 30° Prisme ⑤ CCD 2k x 2k

Conclusion (pessimiste ?)

- On manque cruellement de temps de télescope dans l'hémisphère Nord...
- Un peu moins vrai dans le Sud...mais la France n'a pas accès à SOXS...(pour l'instant?)
- Possibilité peut-être de compléments VLT...
- Ne pas oublier la couverture photométrique!
- Si on n'apporte pas de « billes », cela se fera sans nous...