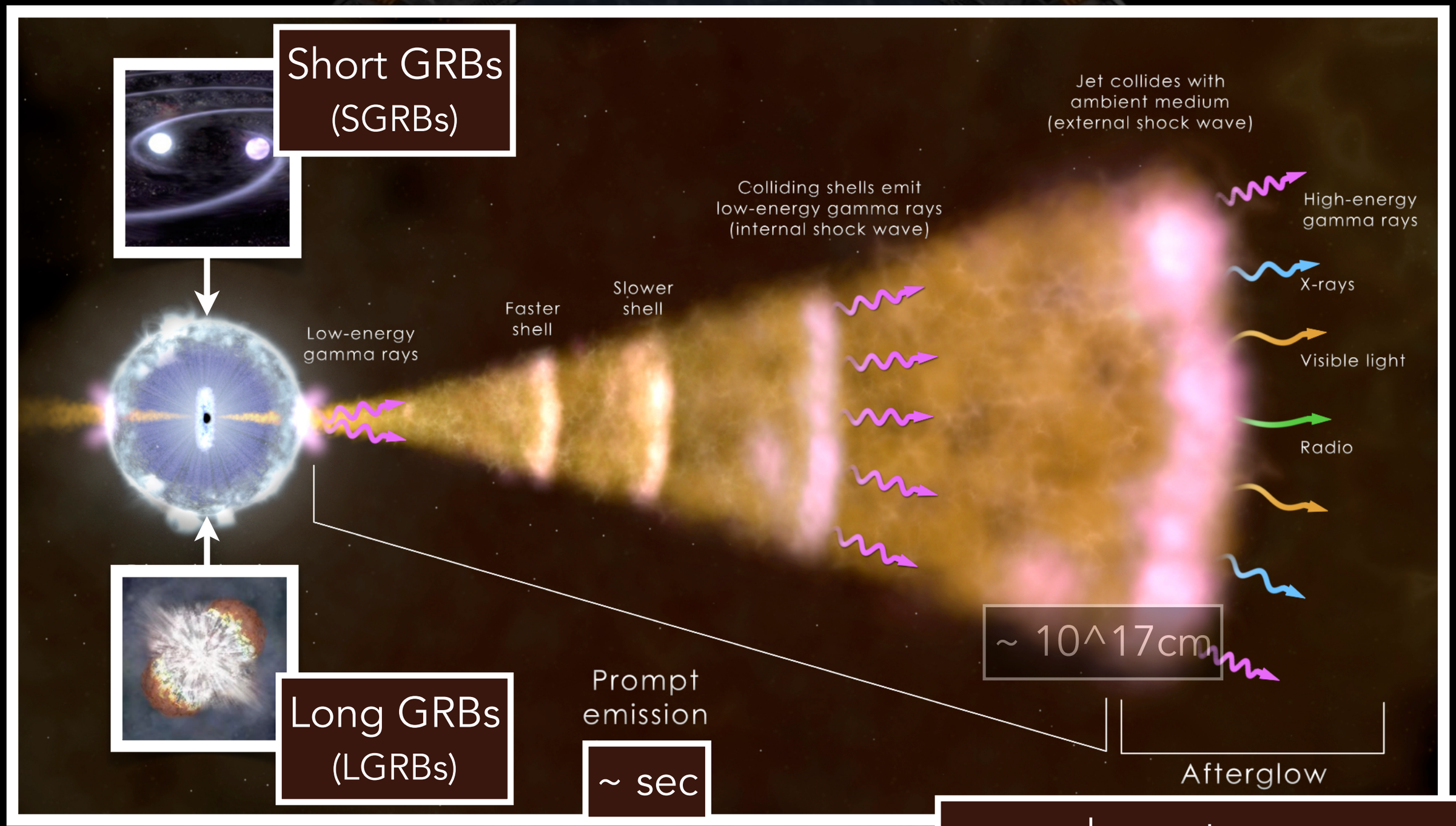
The *Stargate* collaboration

past, present and future
of GRB follow-up at ESO/VLT

S.D. Vergani

Les Sursauts gamma (GRBs)

jets ultra-relativistes associés à la formation cataclysmique de trous noirs

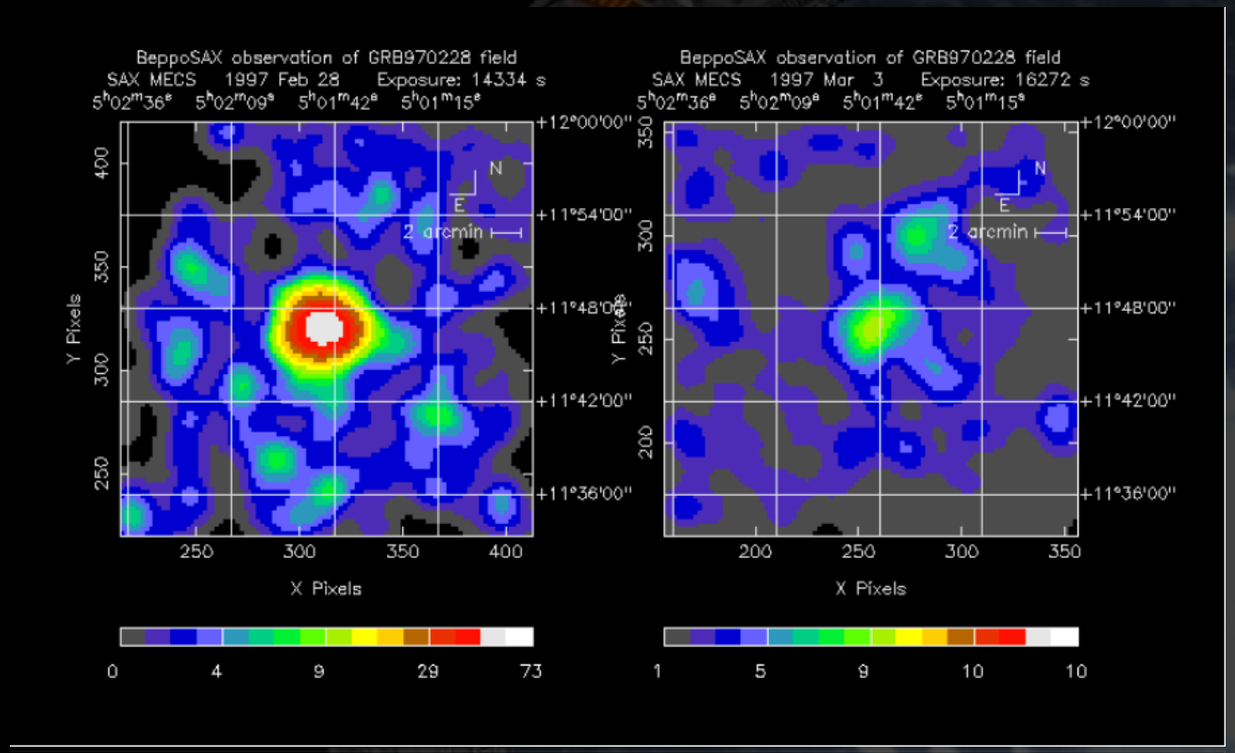


Credits: NASA

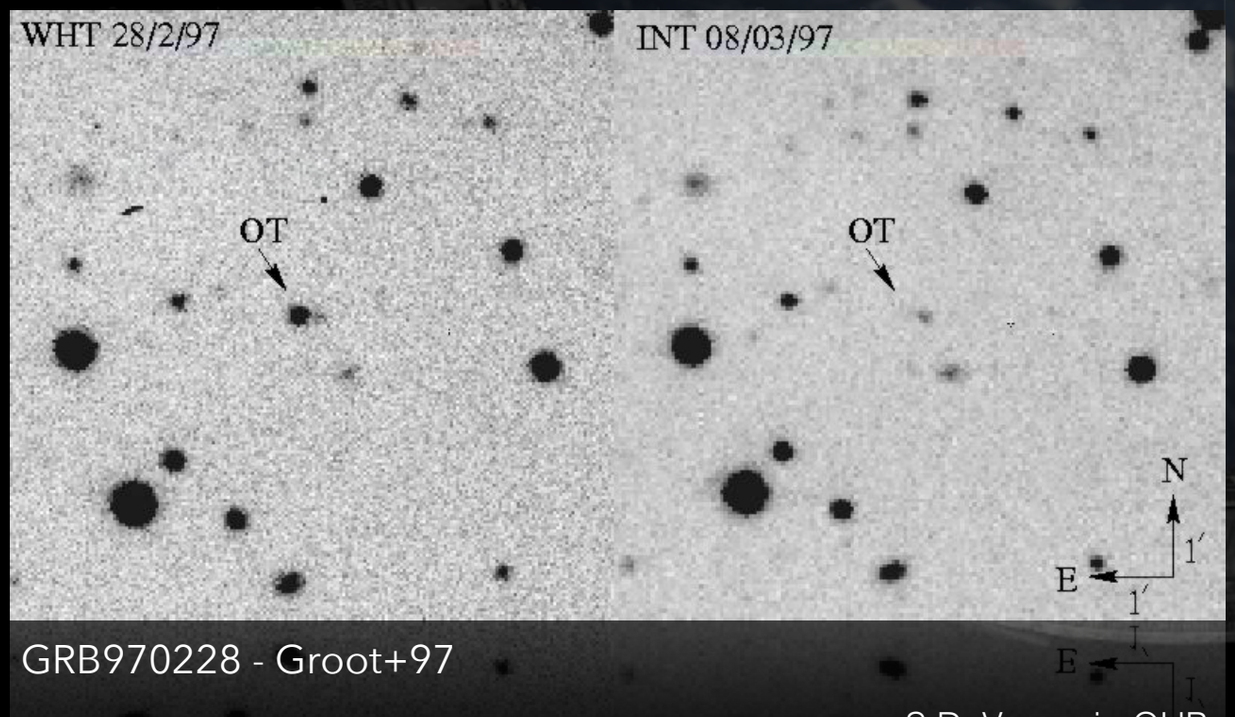
hours to years
depending on the frequency

First afterglows

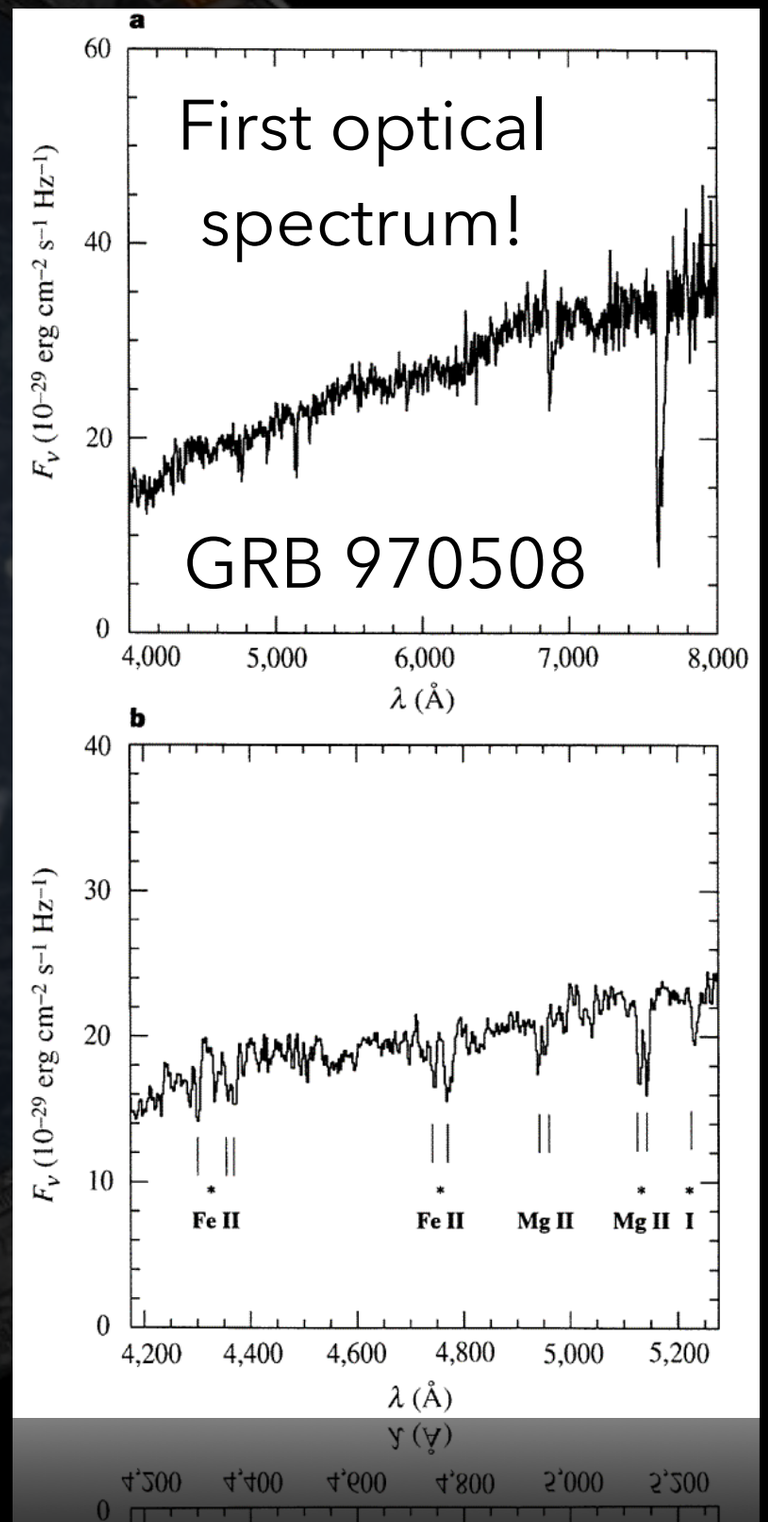
GRB970228 - Costa+97 - BeppoSAX



GRB970228 - Groot+97



Metzger et al. 1997



Very Large Telescope

1998: first light

1999: offered to the community

Target of Opportunity (ToO)

Very Large Telescope

NO *Swift* –> No rapid (X-ray) afterglow detection –> position

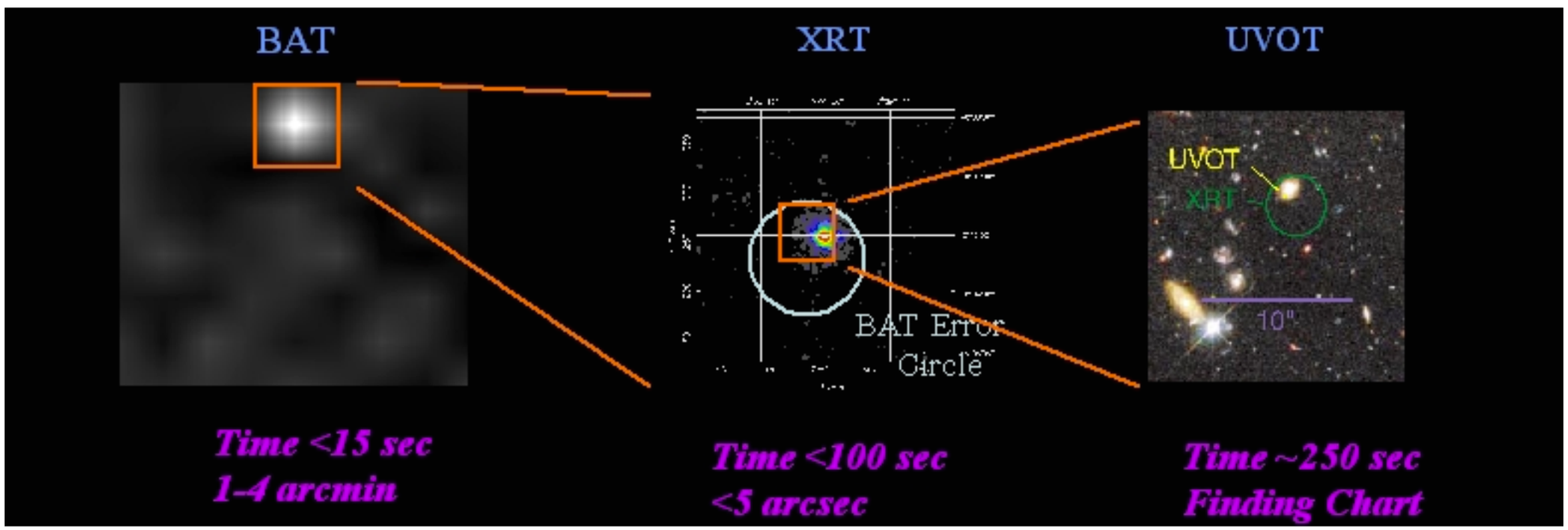
NO robotic telescopes

2004

+

VLT

Rapide Response Mode



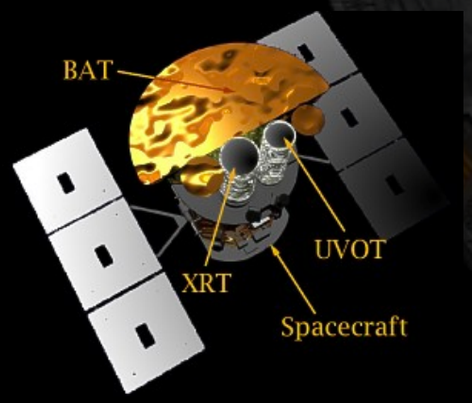
2004

+

VLT

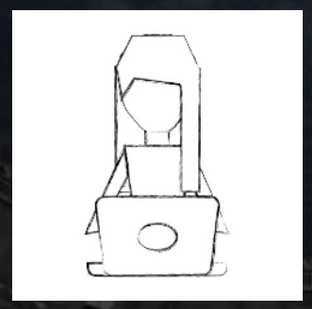
Rapide Response Mode

Alert



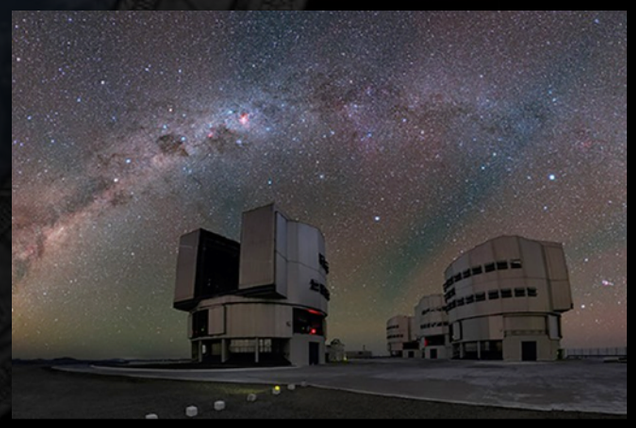
RRM (few minutes)

Sec



ToO (hours)

Observations

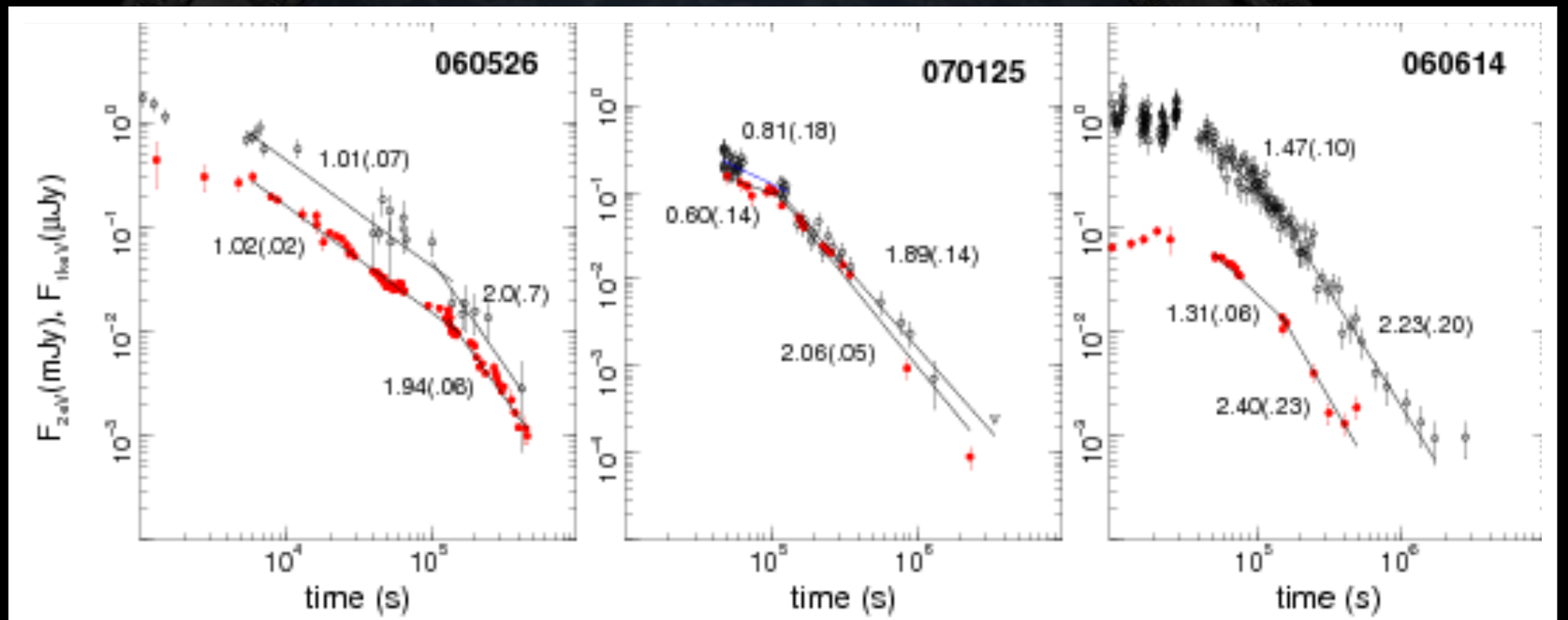


MISTICI (linked to *Swift*)
GRACE (the others)

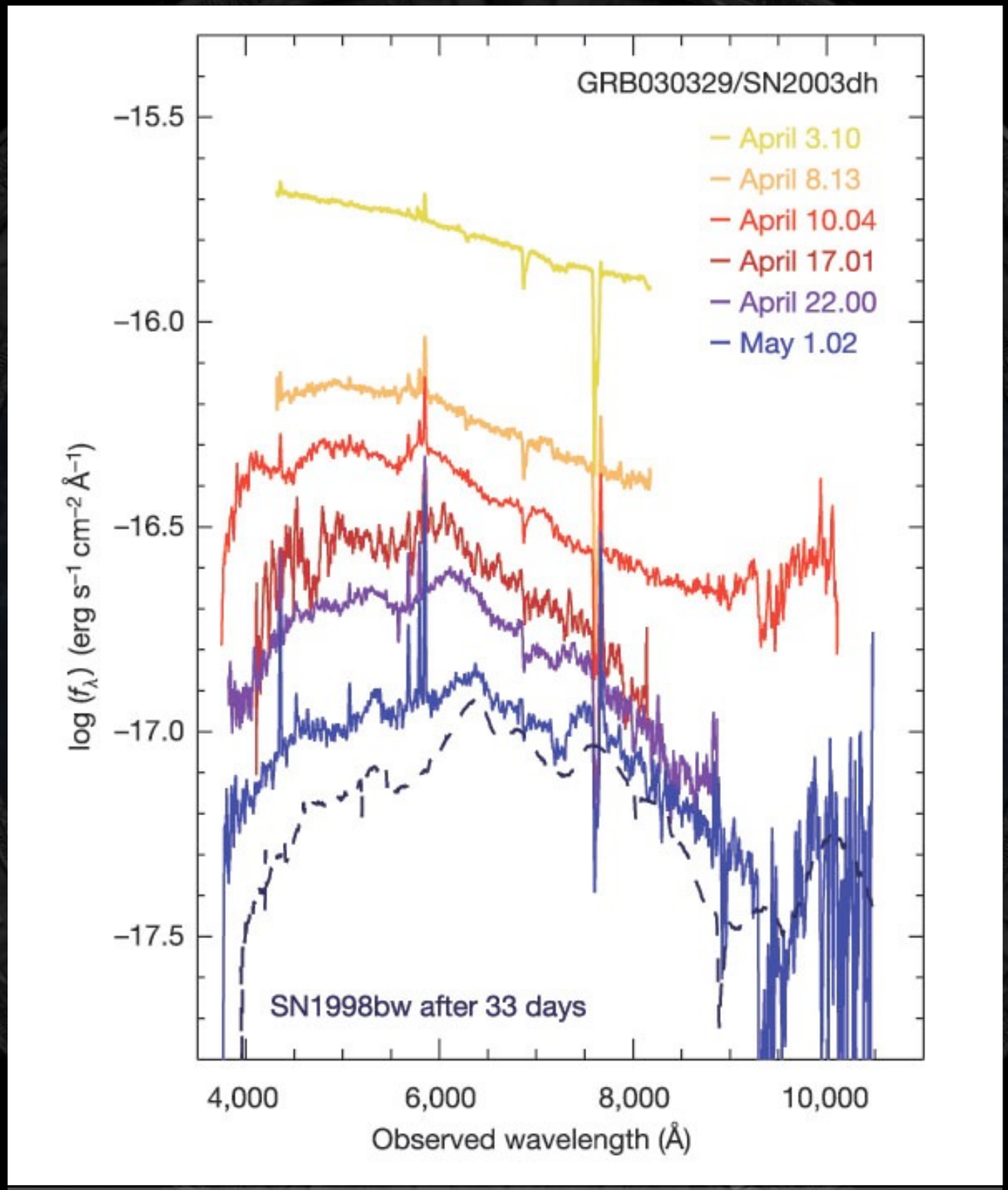
ESO experimented many policies :)

Photometry:
Deep observations to look for jet breaks

Panaitescu et al. 2009

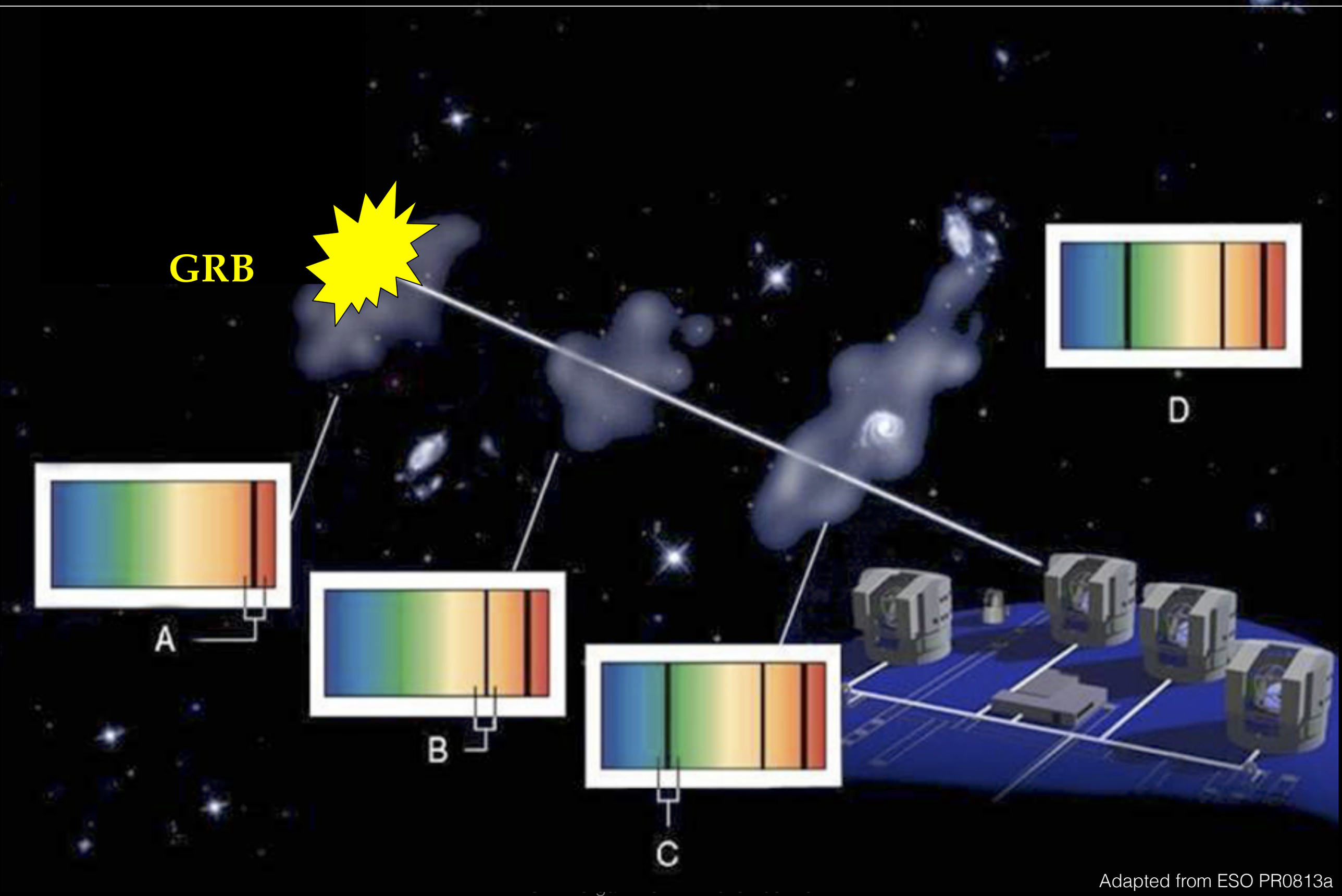


SN spectroscopy for cosmological GRBs



Hjorth+2003

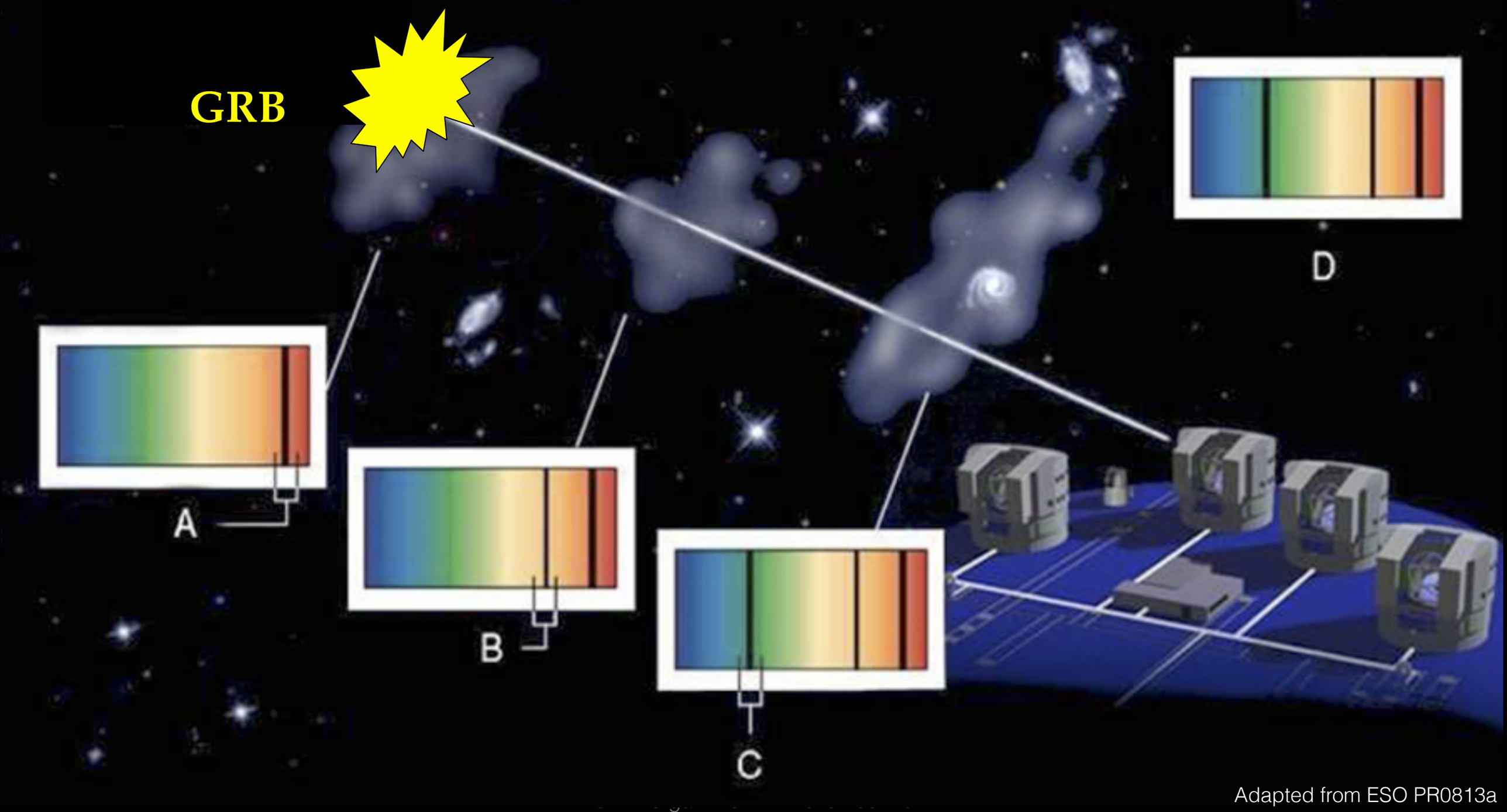
The importance of GRB afterglow spectroscopy



Adapted from ESO PR0813a

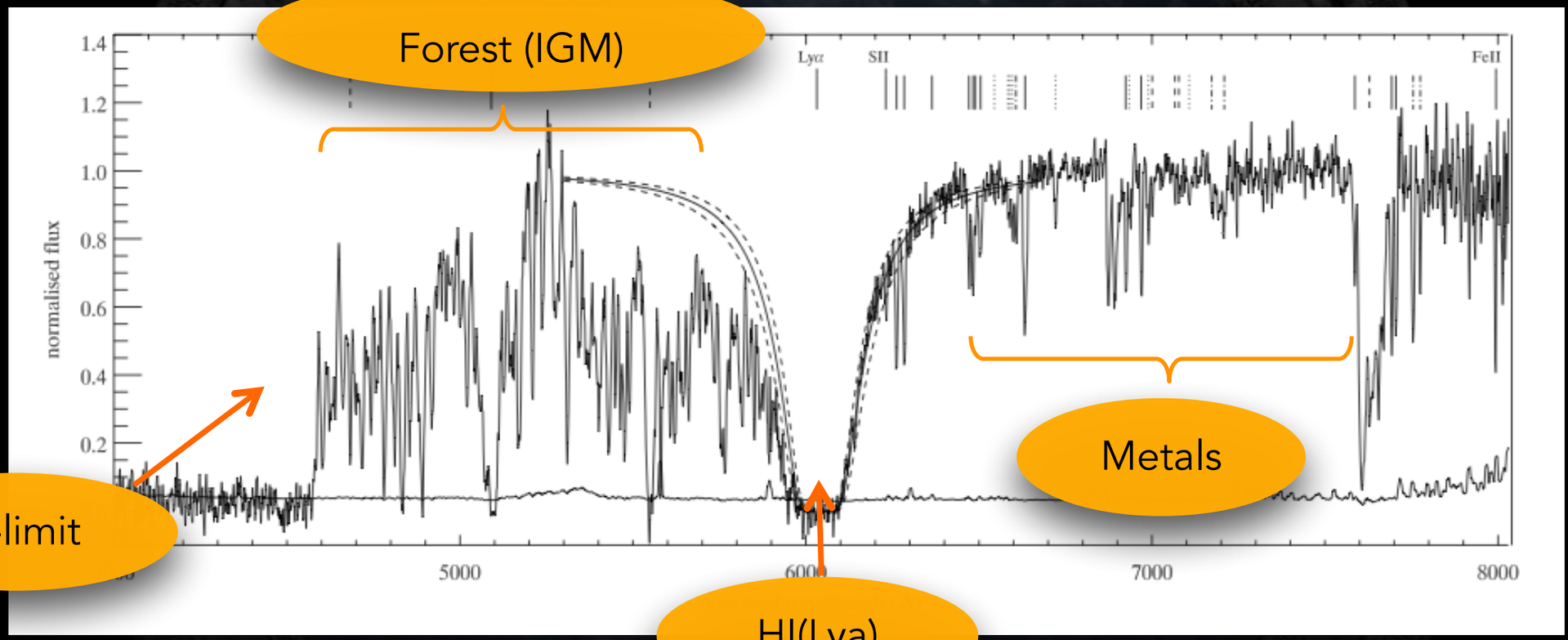
The importance of GRB afterglow spectroscopy

GRB redshift



Adapted from ESO PR0813a

The importance of GRB afterglow spectroscopy



Courtesy of Nial Tanvir

HST/ACS

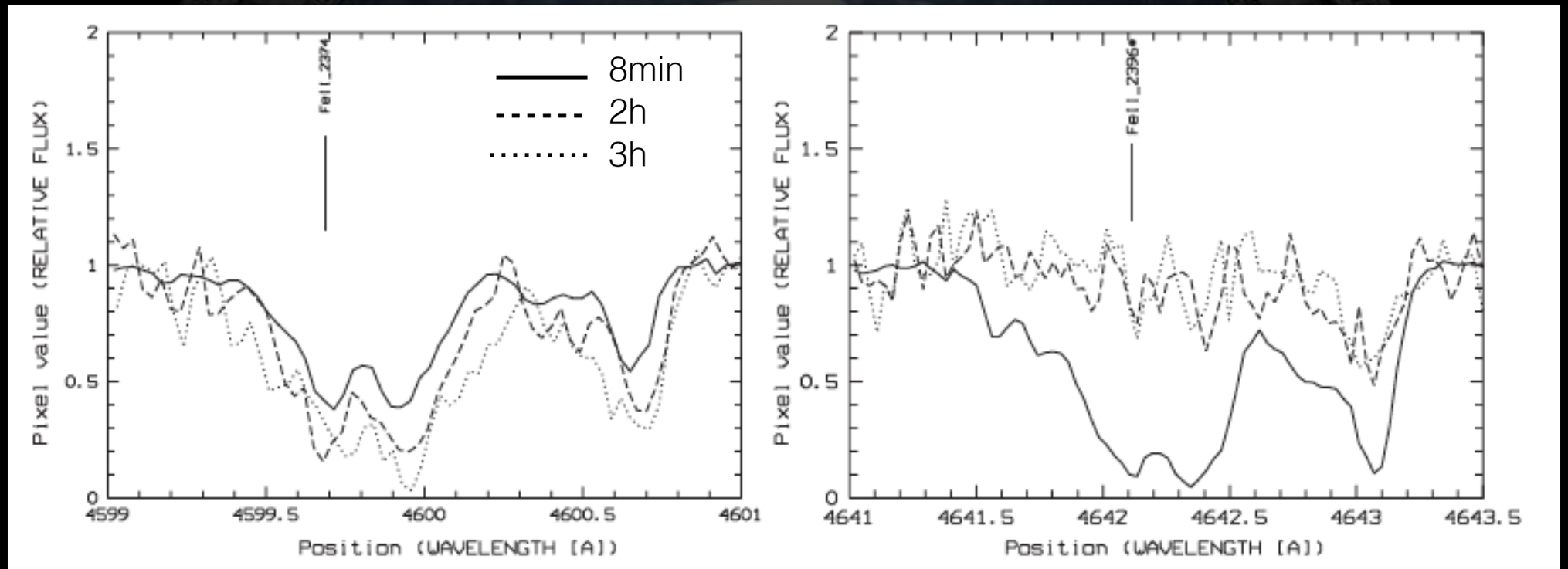
z=3.97

R>28.5

Chen+ 2005; Starling+2005

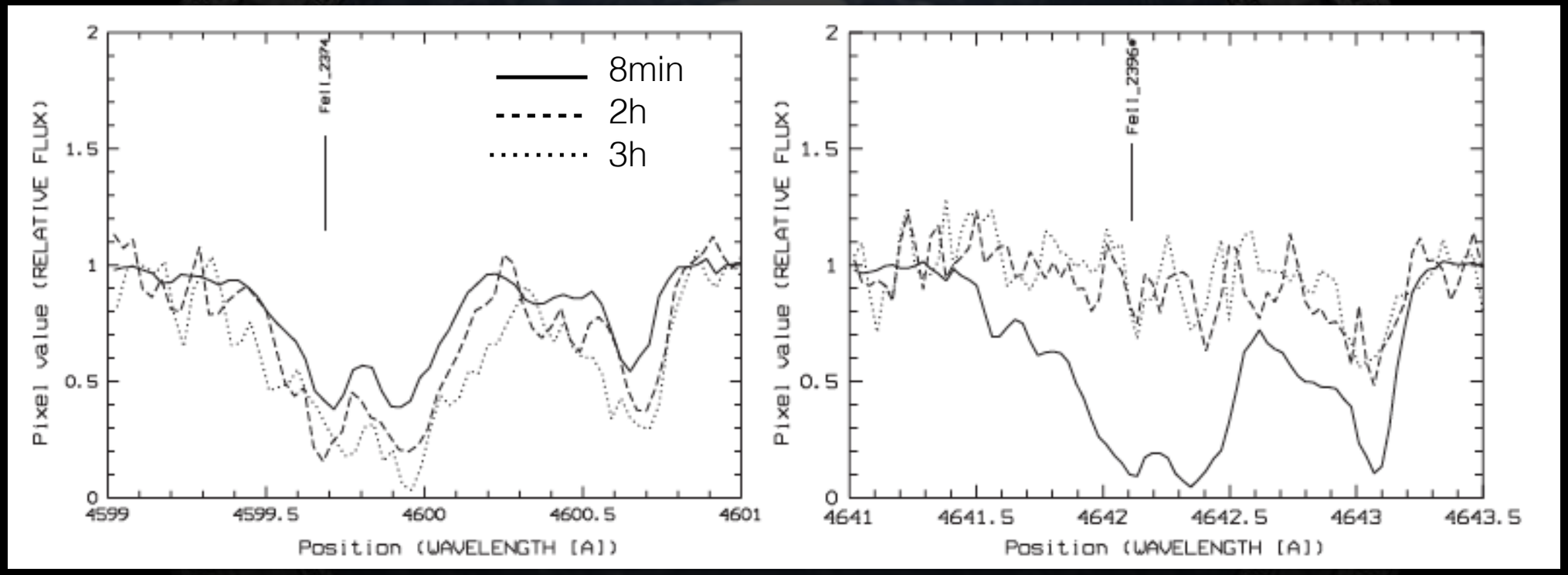
Spectroscopy:
A at early times amazing set of absorption lines
Variation of fine structure lines

D'Elia+09



Variation of fine-structure and meta-stable lines due to UV-pumping caused by the GRB afterglow radiation

D'Elia+09

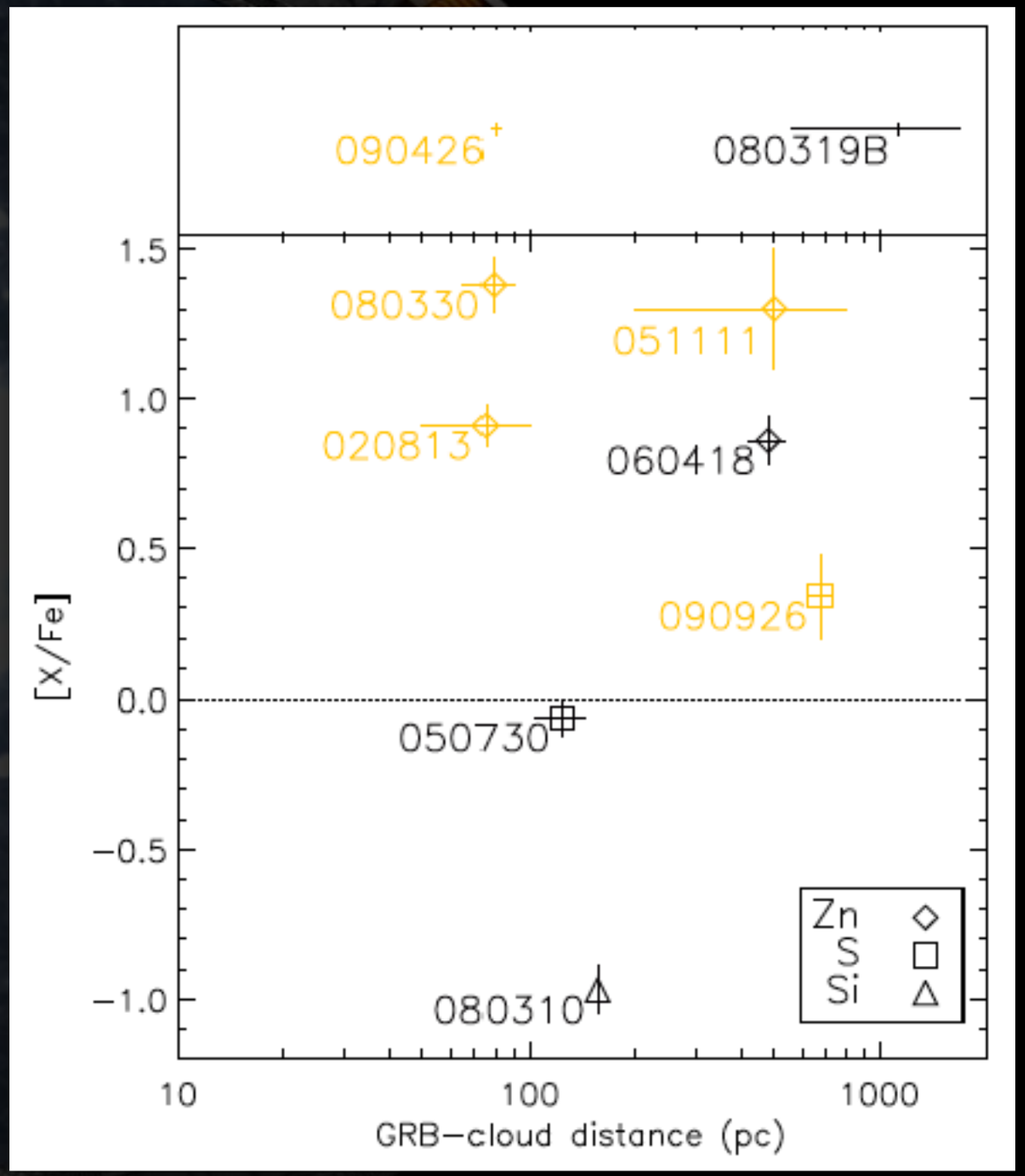


We can determine the distance of the closest clouds

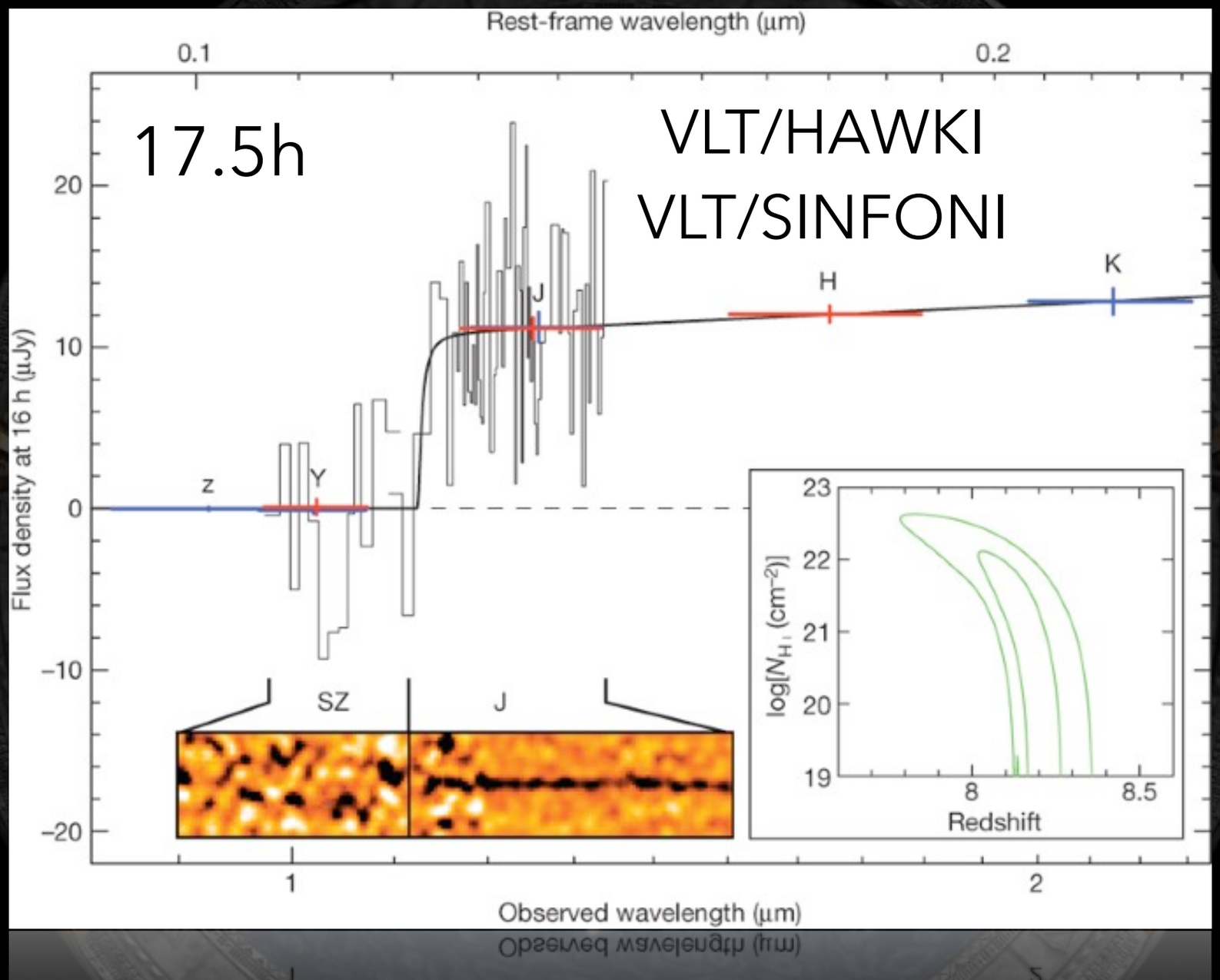
We are probing the star-forming regions (but not the circumburst environment)

Probing the ISM gas in detail up to the highest redhsift!

Vreeswijk+12



GRB090423 @ z=8.2 (Tanvir+2009)



+ limited by FORS spectral coverage and UVES sensitivity and coverage

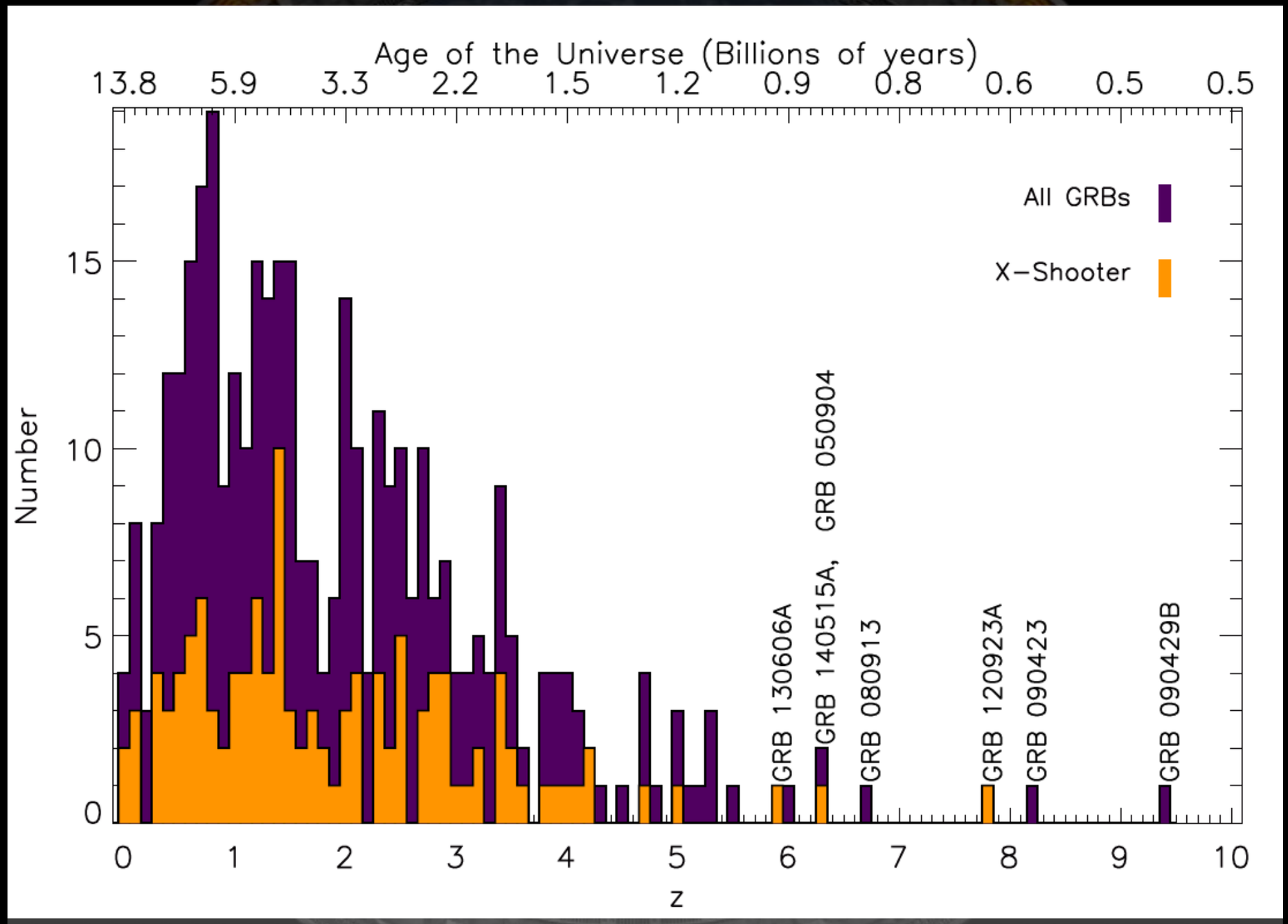
X-Shooter

- 3 echelle spectrographs
- Full range 3000 – 24000 Å in a single shot
- Resolution 5000 – 10000
- Slit length 11″
- m_{AB}~21 (1h, SNR=10; K~19)

Different groups:

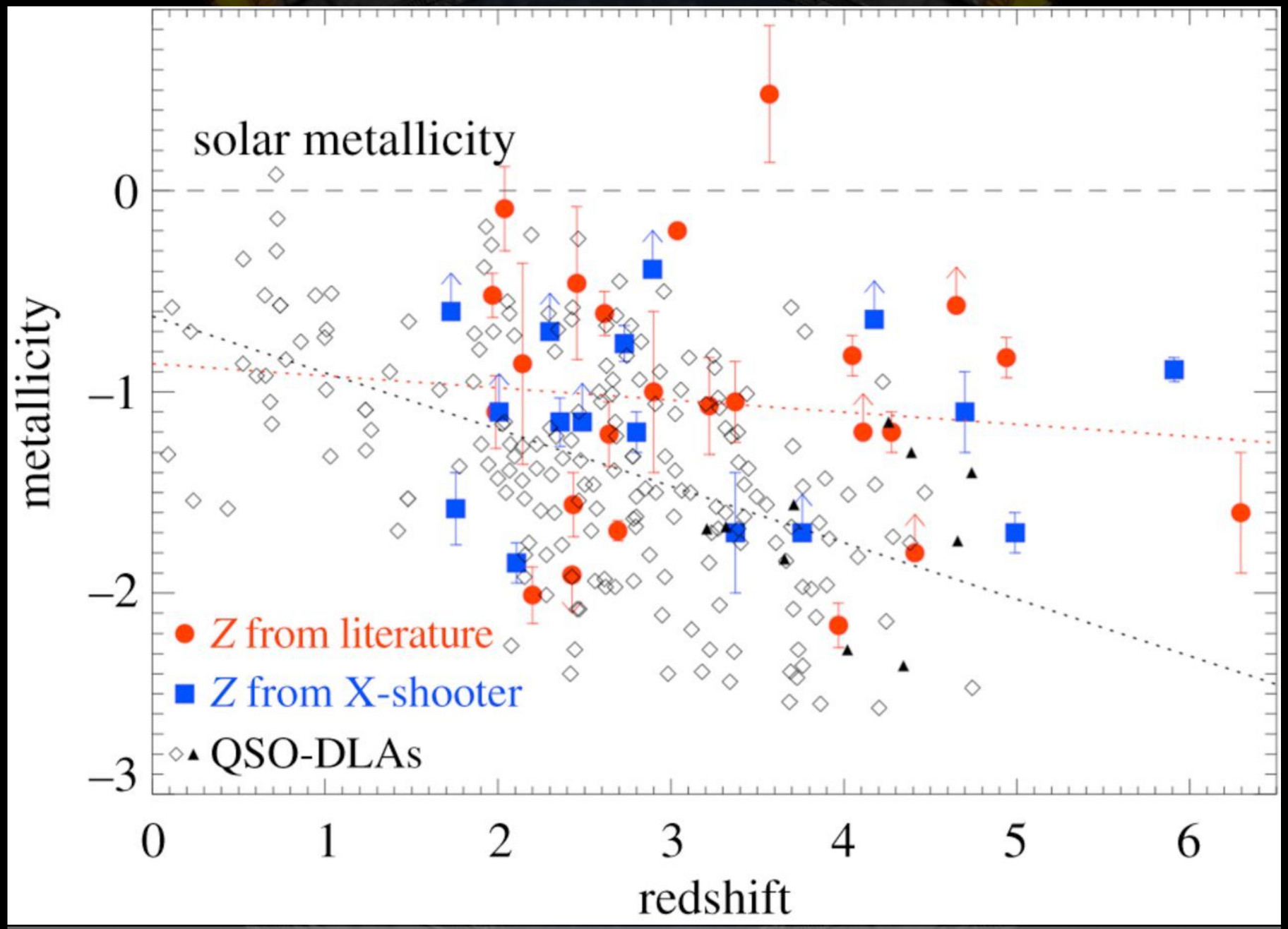
- X-shooter consortium (GTO + ToO/RRM afterglow spectroscopy PI: J. Fynbo)
- short GRBs
- low-z SNe
- other groups

Redshift determination



Courtesy of A. De Cia

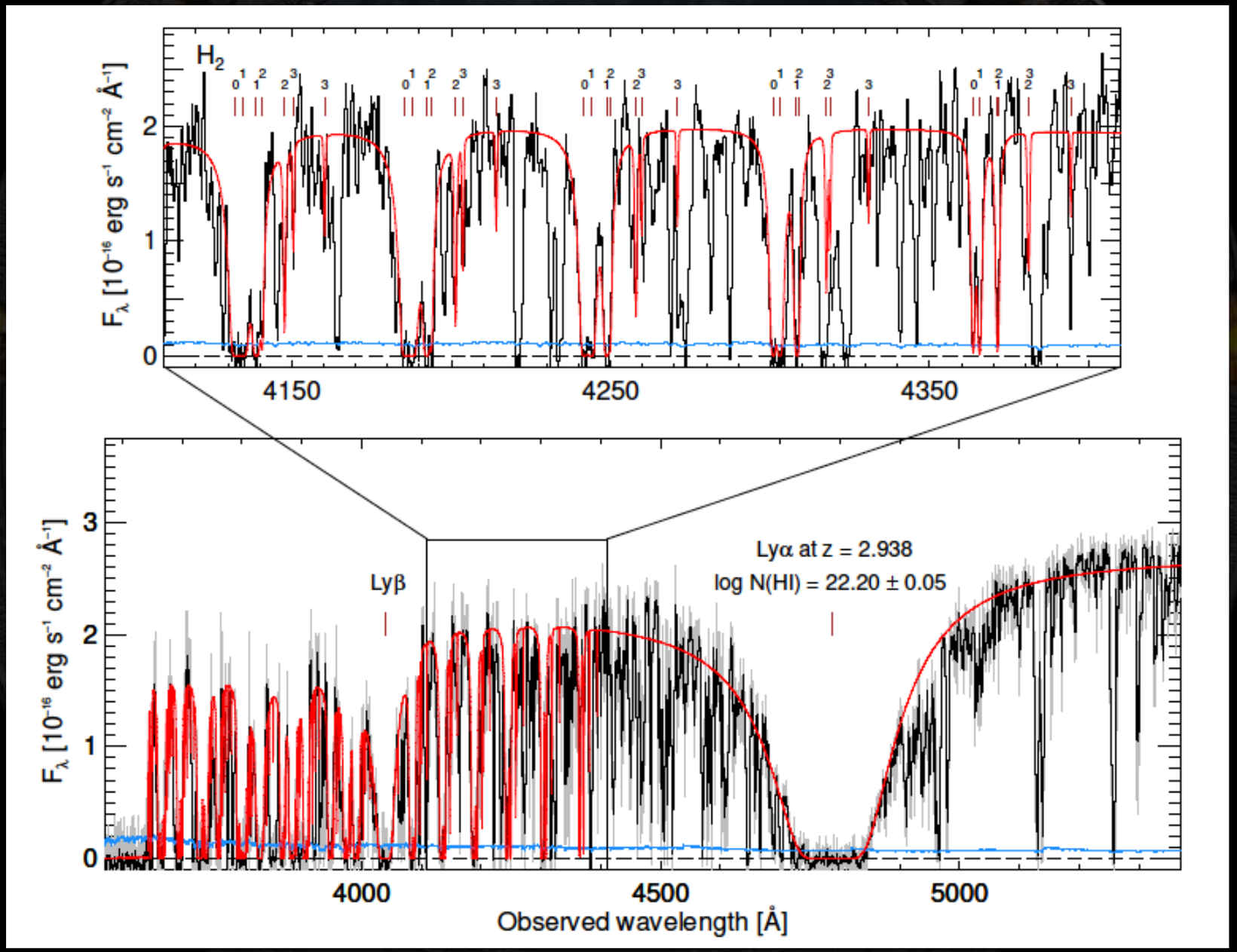
Metallicity



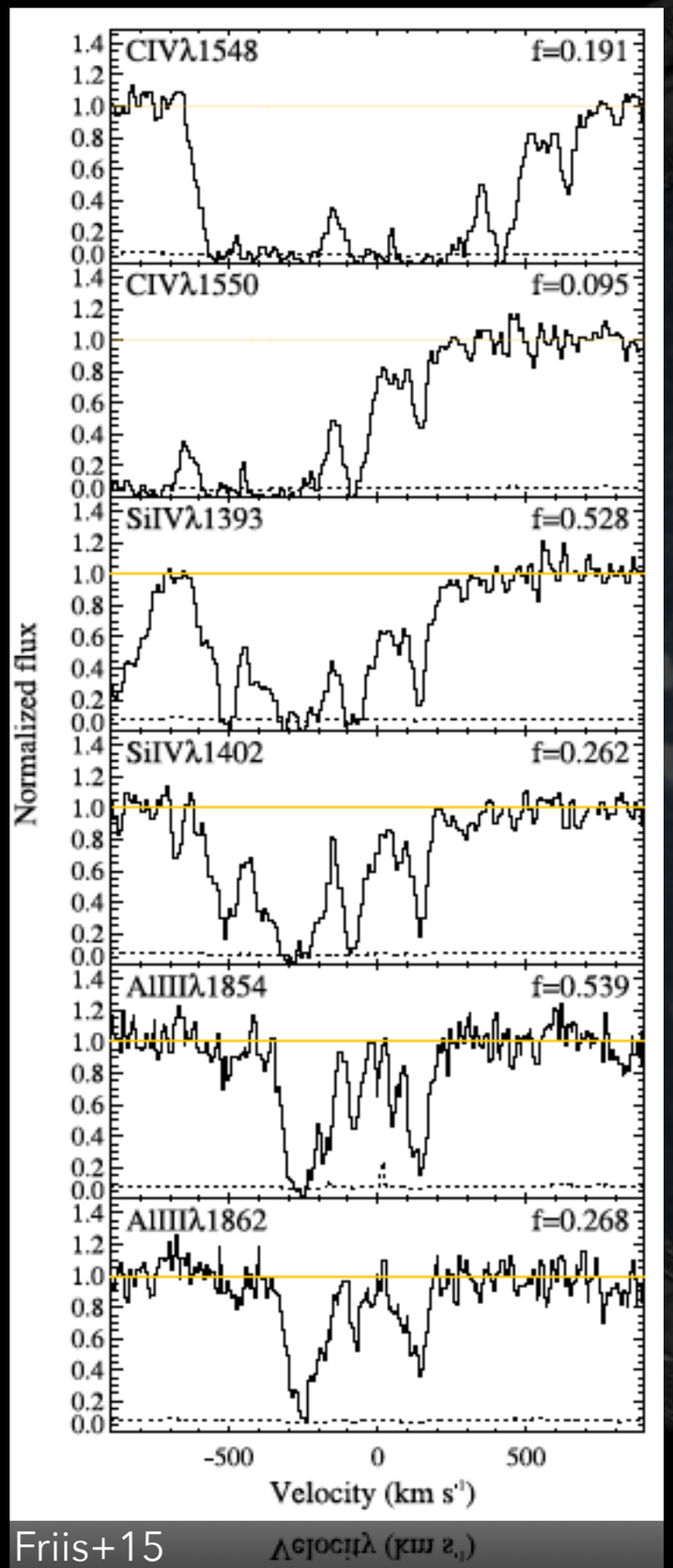
Adapted from Thöne+13

Direct H2 detection

Bolmer+19

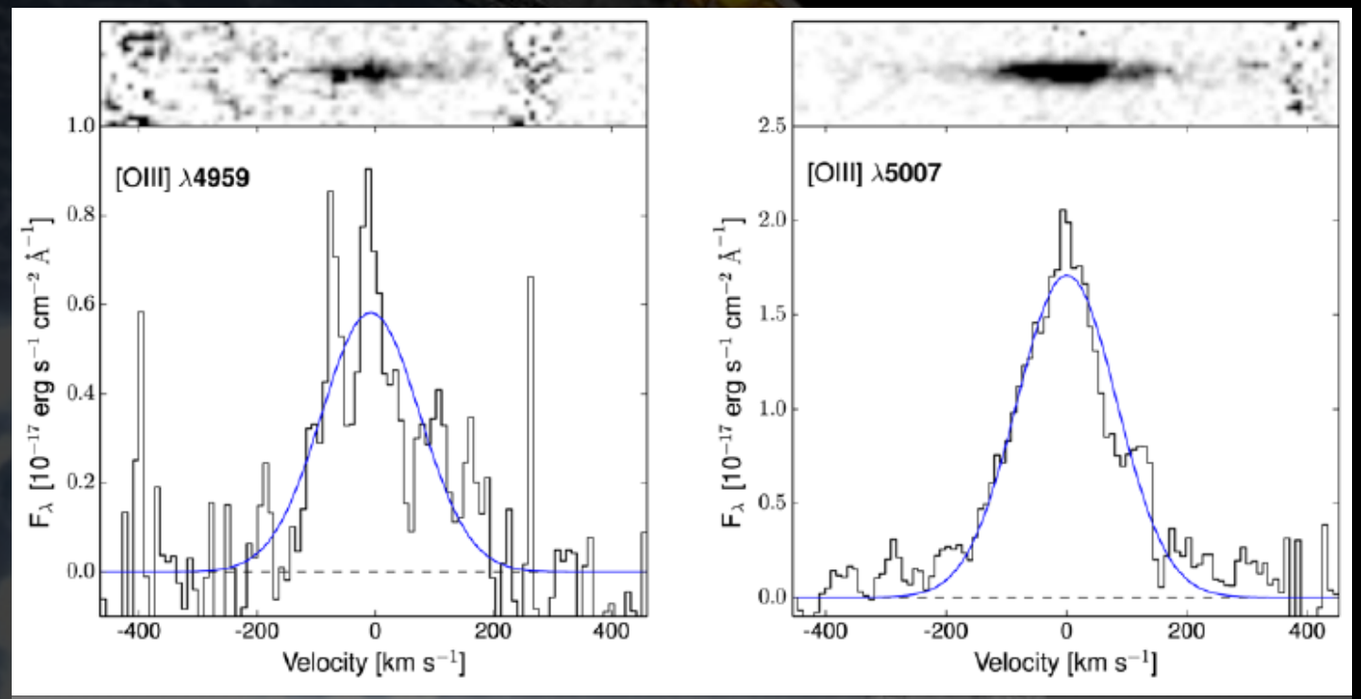


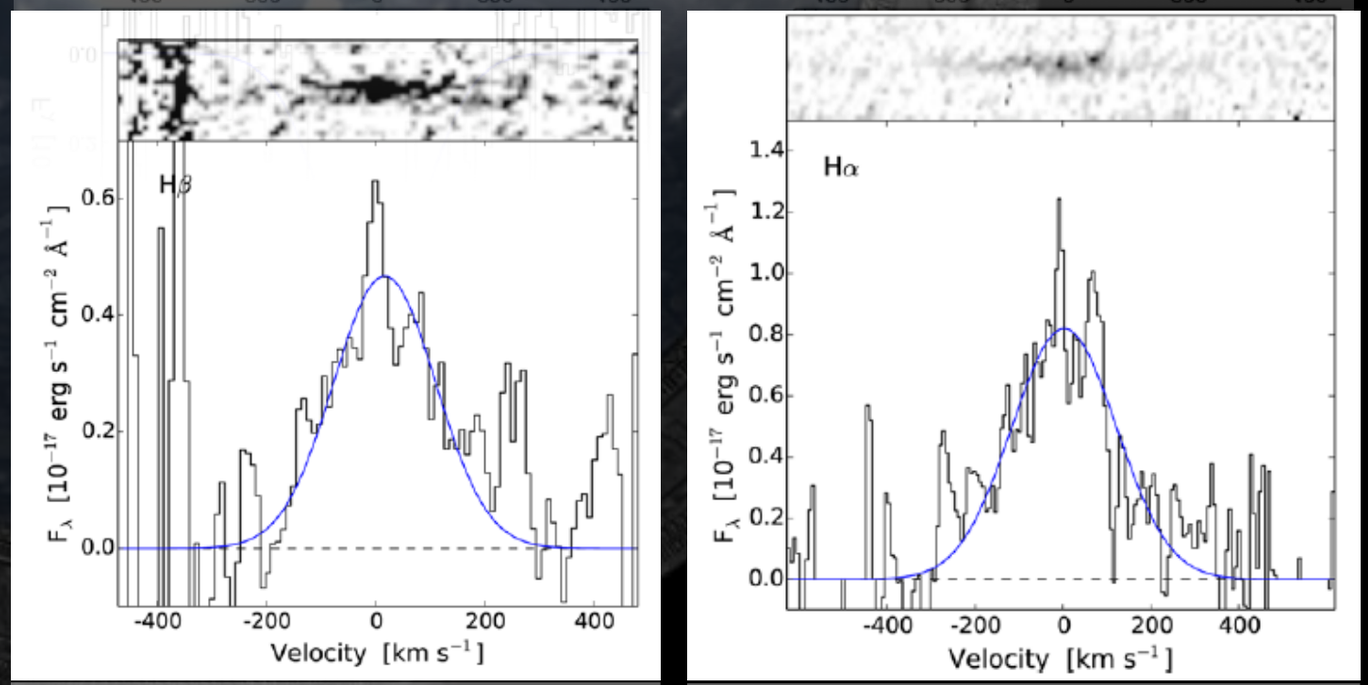
Emission AND absorption lines in the same spectrum



Friis+15

GRB 121024A @ z=2.3

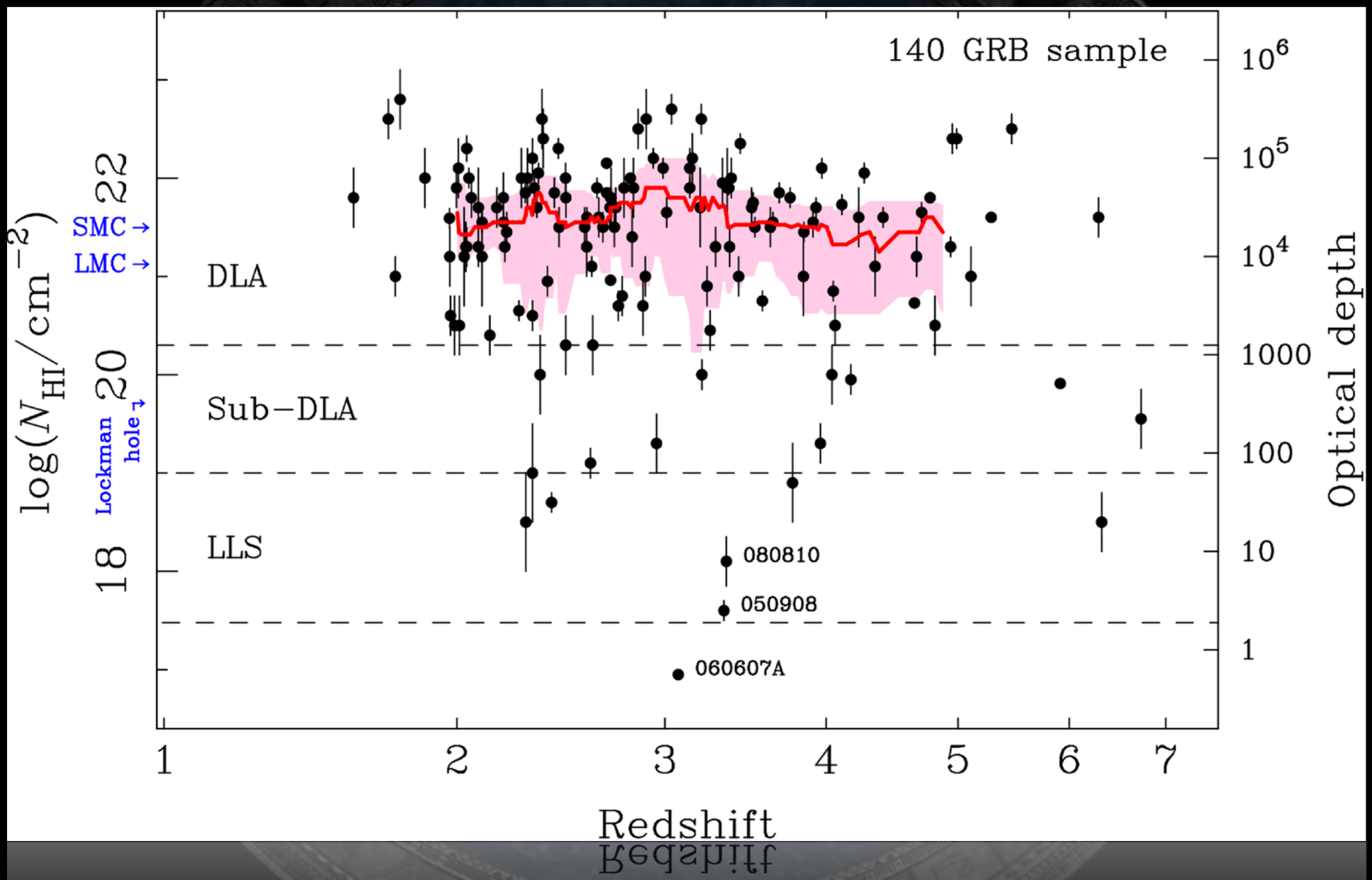




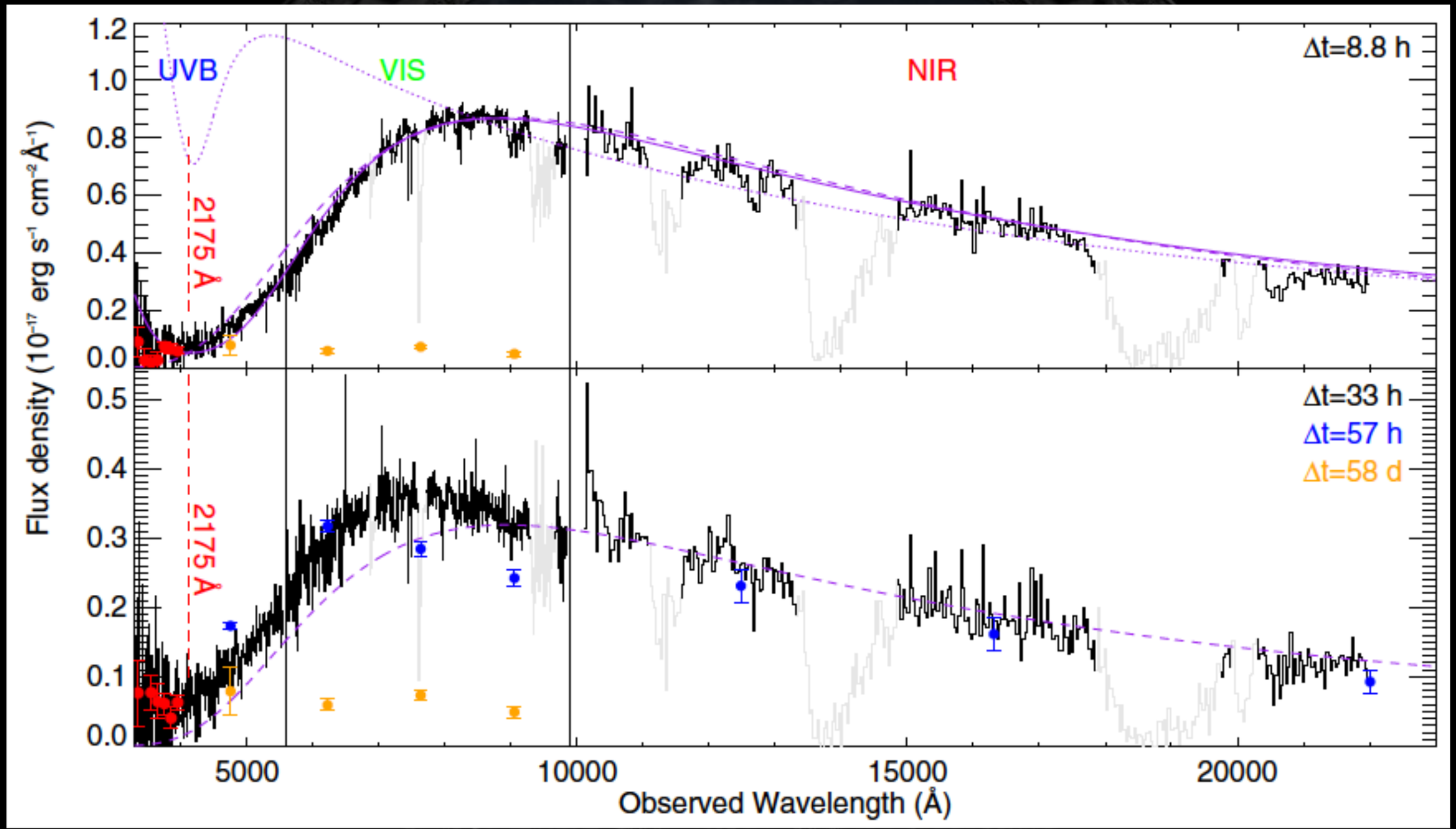
Friis+15

Statistical studies

Tanvir+19



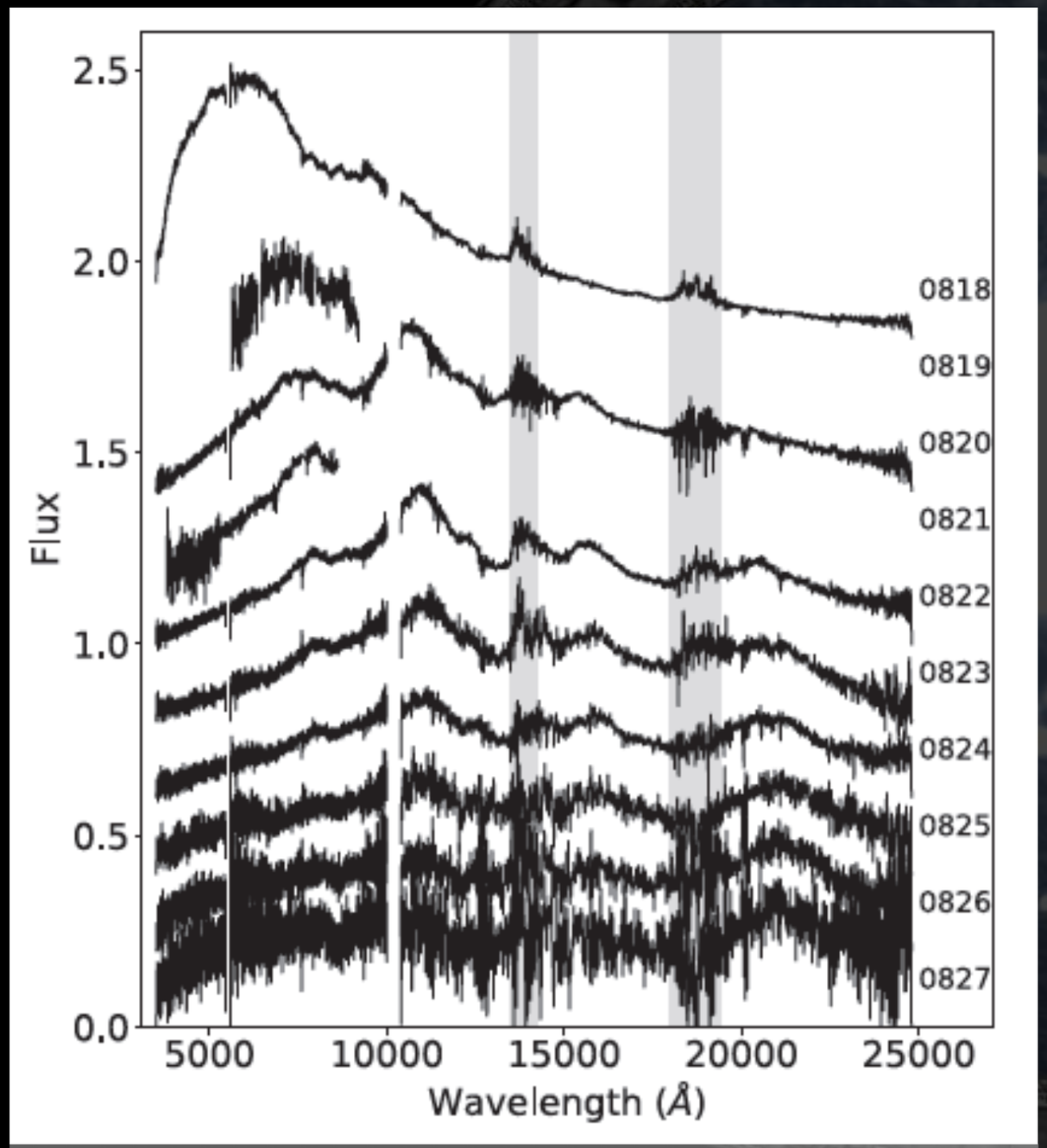
GRB 140506A @ z=0.889



Fynbo+14

ESO-VLT/X-Shooter

Pian et al. 2017, Nature



First spectral identification of a KN

- radioactive decay of **r-process nucleosynthesis**
- BNS merger **site for heavy element production in the Universe**

GW170817/GRB170817

Stargate

PIs: N. Tanvir, D. Malesani, S.D. Vergani

Low-z SNe separate

Altogether!

- Photometry
- Spectroscopy
- Polarimetry
- long & short GRBs

Stargate

PIs: N. Tanvir, D. Malesani, S.D. Vergani

Large Programme!
~30h/semester

Altogether!

- Photometry
- Spectroscopy
- Polarimetry
- long & short GRBs

Stargate

PIs: N. Tanvir, D. Malesani, S.D. Vergani

2 people on duty (24/7)
1 week every ~ 2months

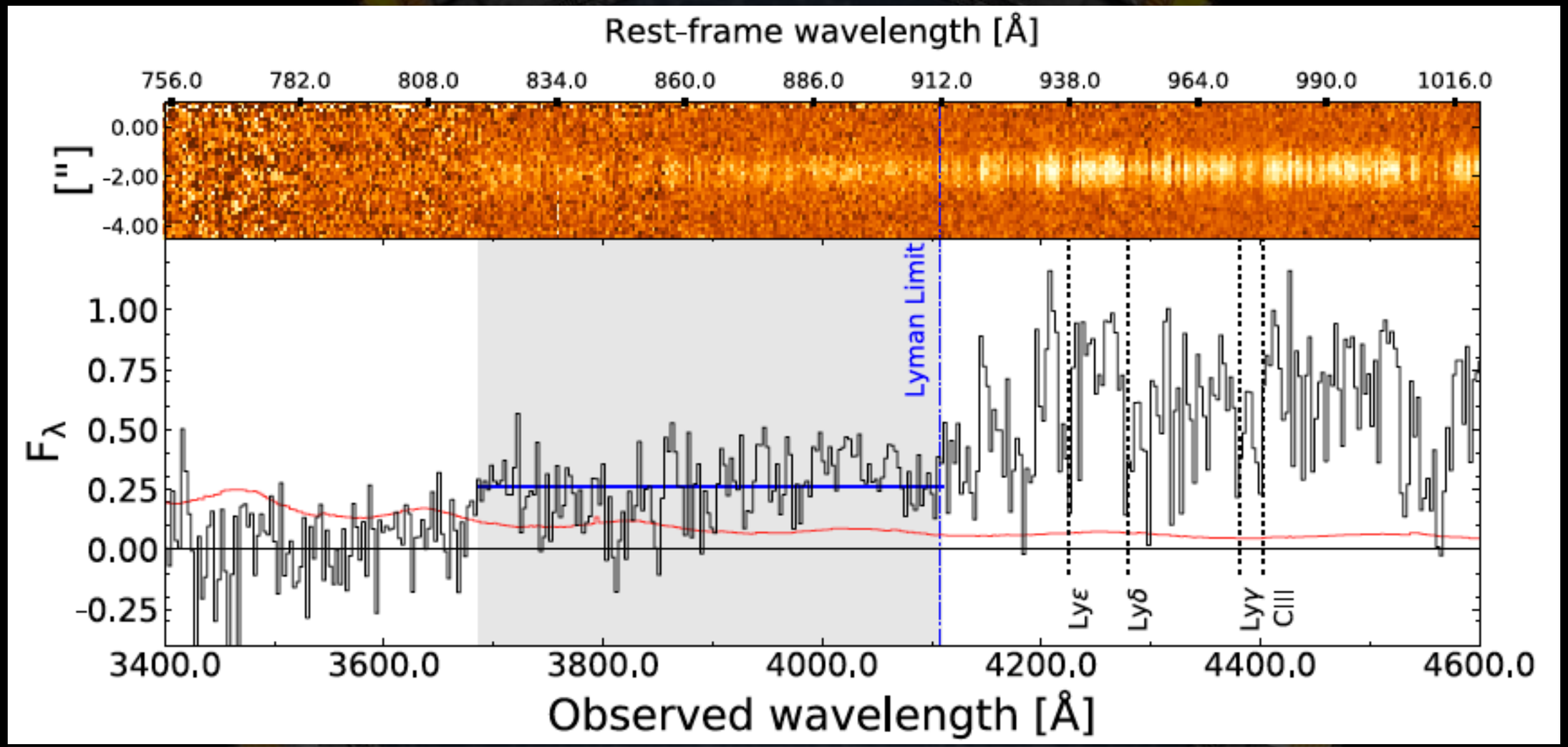
Altogether!

- Photometry
- Spectroscopy
- Polarimetry
- long & short GRBs

Lyman continuum leakeage

GRB191004B @ z=3.5

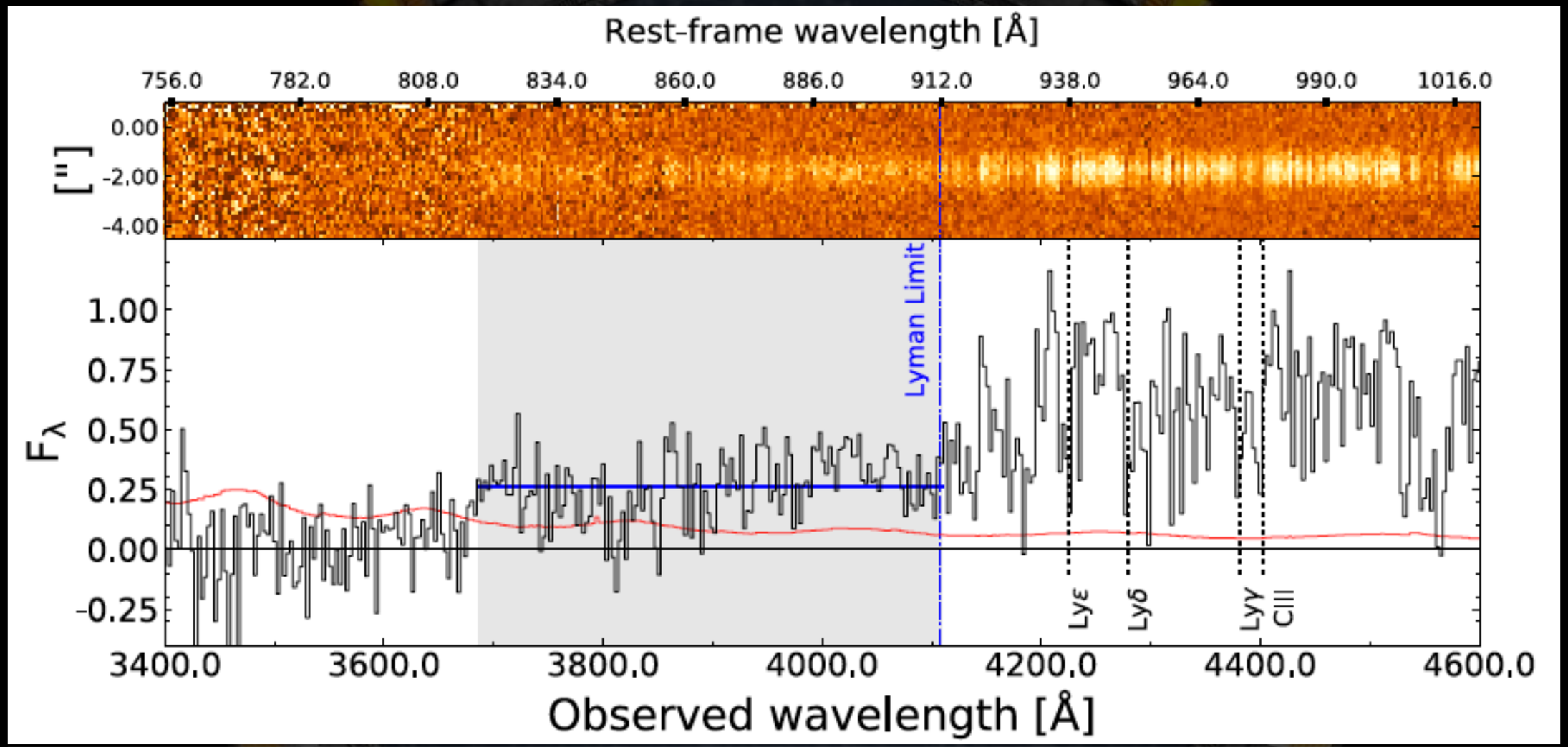
Vielfaure+2020



Lyman continuum leakeage

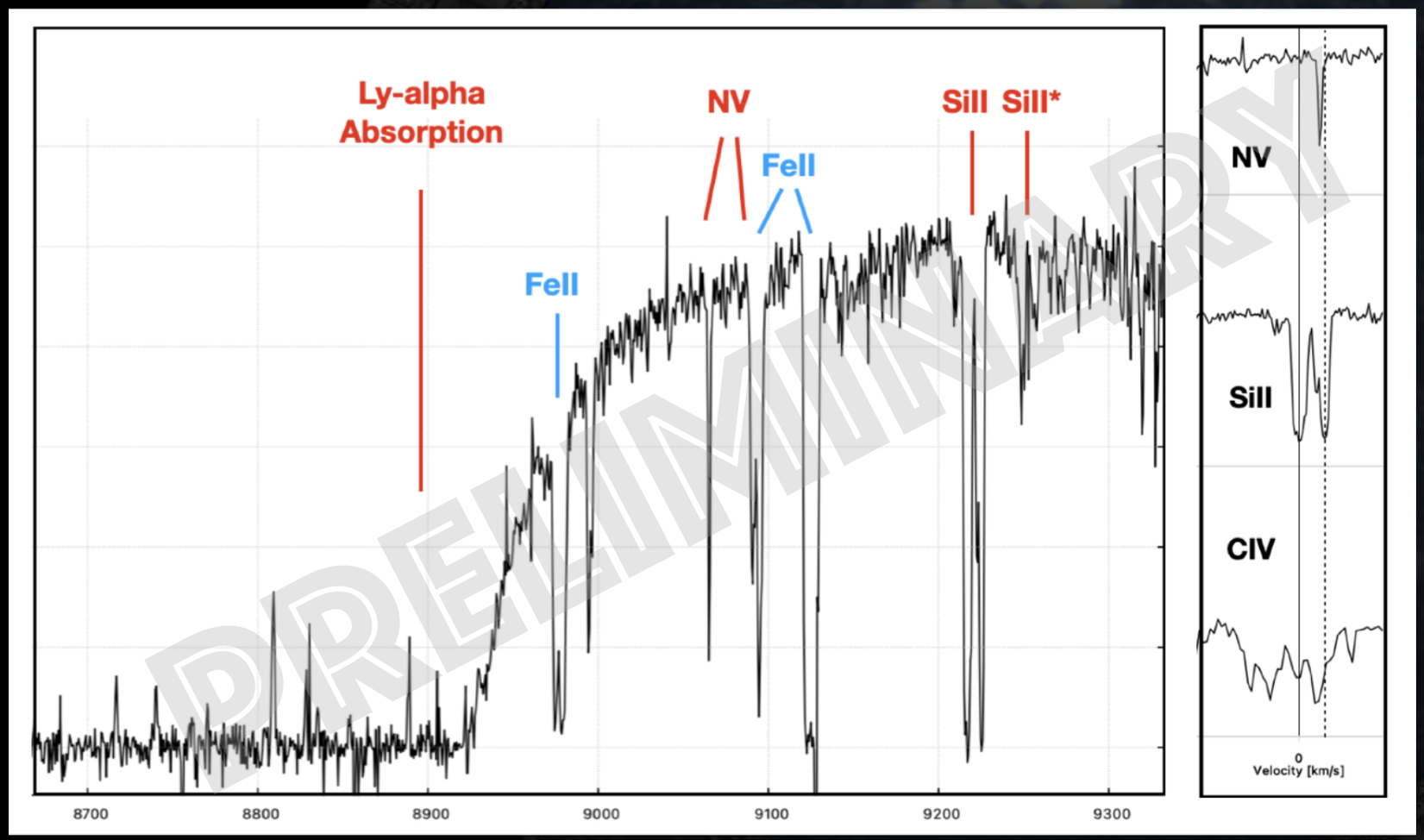
GRB191004B @ z=3.5

Vielfaure+2020



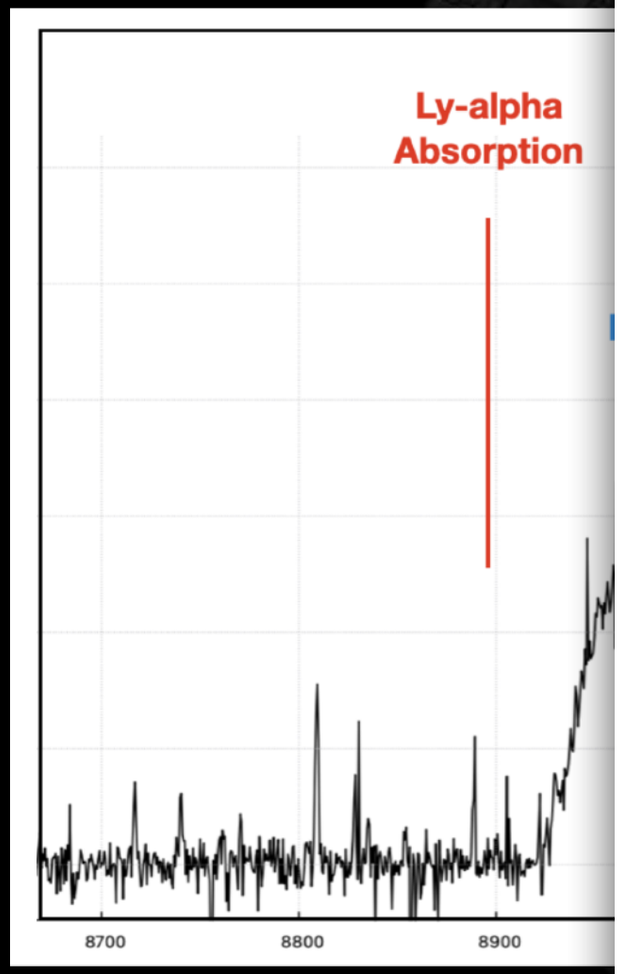
VHE GRB afterglow spectra
extremely rich of information

X-shooter spectrum of z=6.3 GRB afterglow

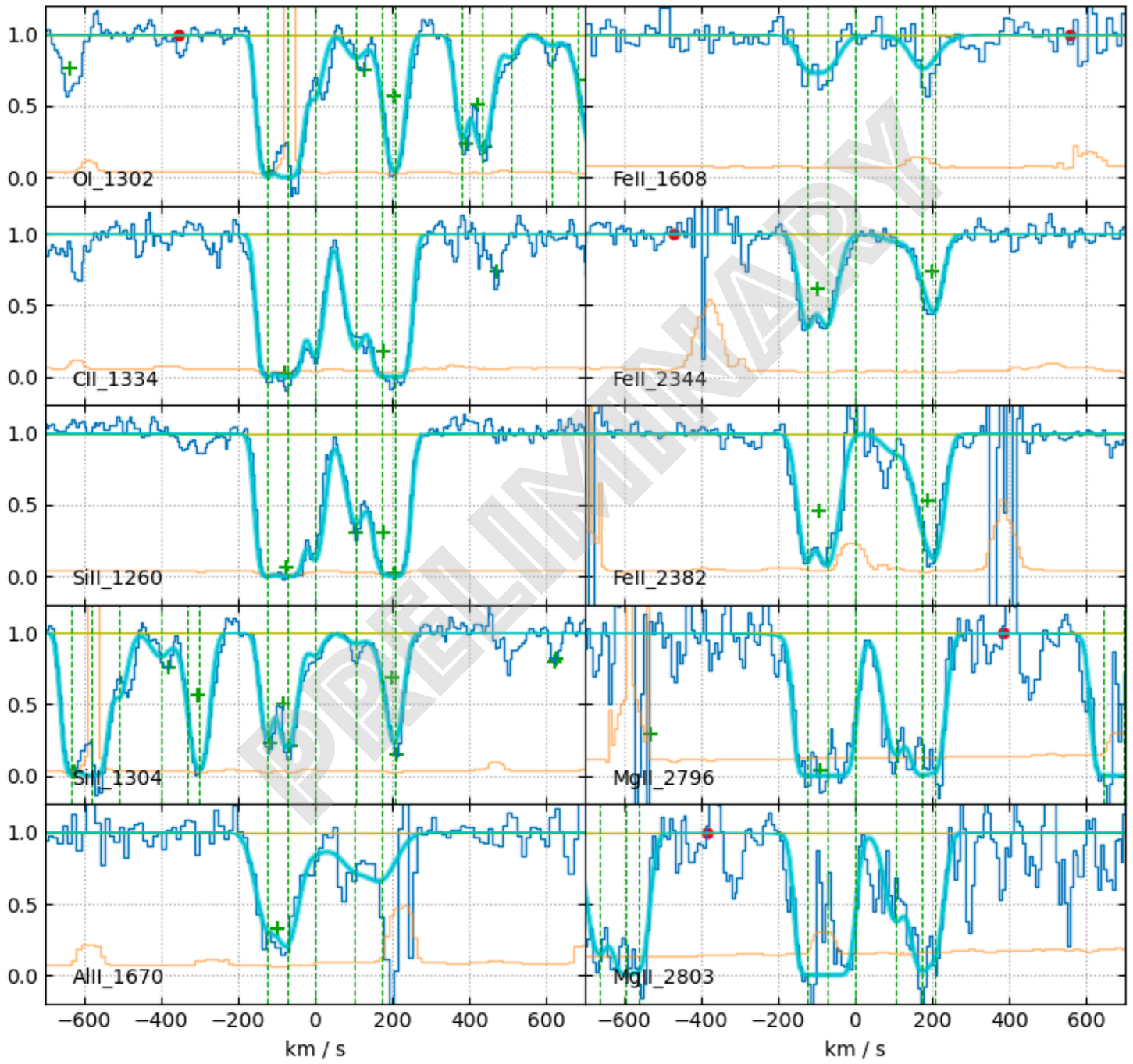


very high-z GRBs

X-shooter spectr



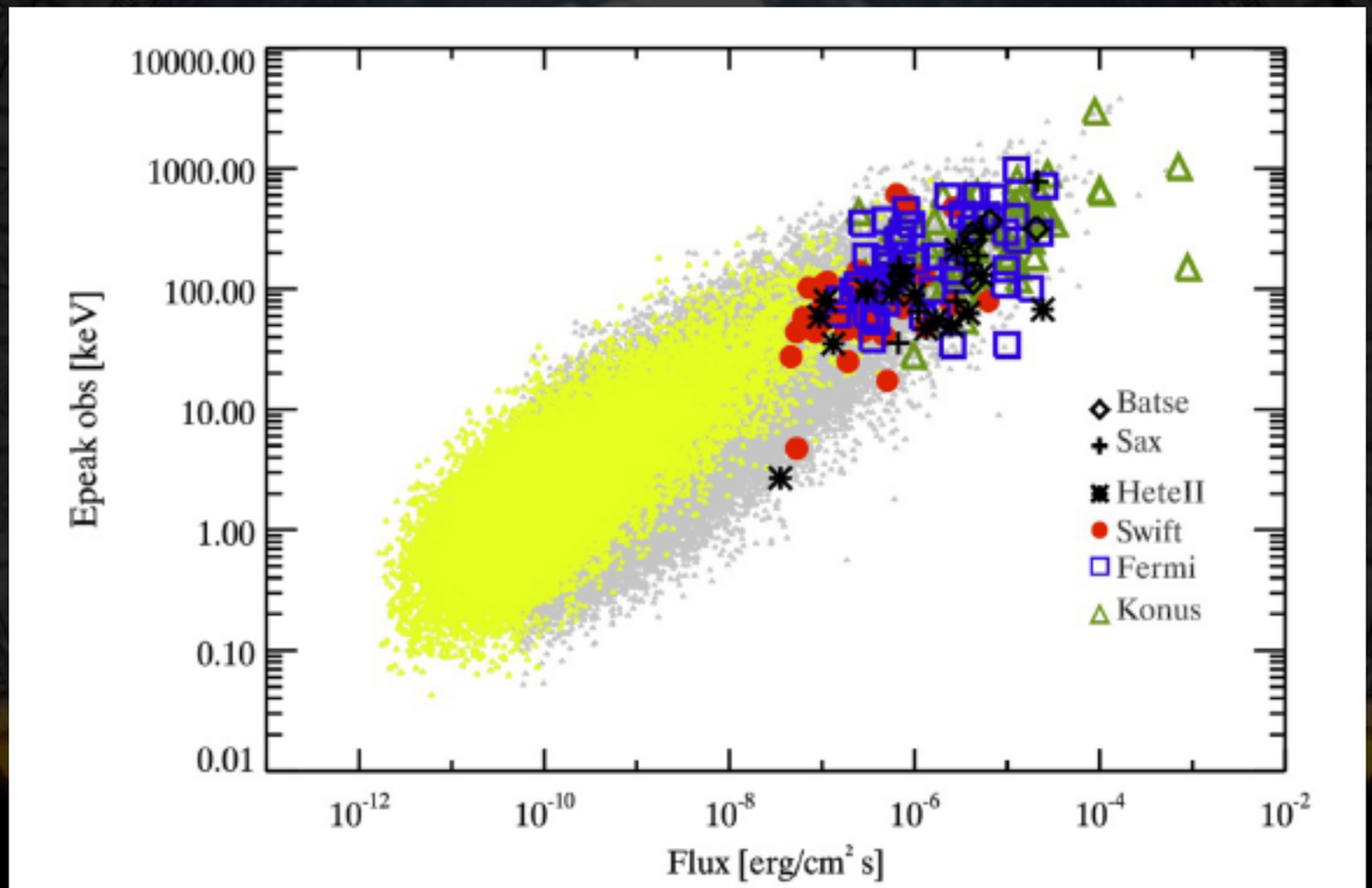
Saccardi+ in preparation



very high-z GRBs

We need to increase the number of high-z GRBs detected by the satellites

Ghirlanda+ 2015



z>5 population

Some statistics

159 localized GRBs

35 redshift
16 VLT (the others: most of them too North, by GTC)

~4/5 no redshift :
VLT technical nights / visitors
No XRT (or delayed)
Too faint
Not observable
Bad weather
Too north

Some statistics

159 localized GRBs

35 redshift
16 VLT (the others: most of them too North, by GTC)

~4/5 no redshift :
VLT technical nights / visitors
No XRT (or delayed)
Too faint
Not observable
Bad weather
Too north

Open collaboration
Some SVOM members

If you are willing to help (and respect some basic rules)
you are welcome to join!

Data public under a certain period
(From months to 1yr)

GCN with redshift and basic info immediately released

S.D. Vergani - OHP - November 2021