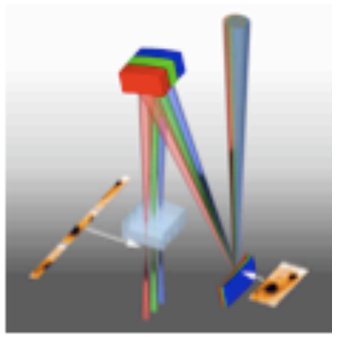
l'Observatoire de Paris | GEPI

Galaxies Étoiles Physique et Instrumentation



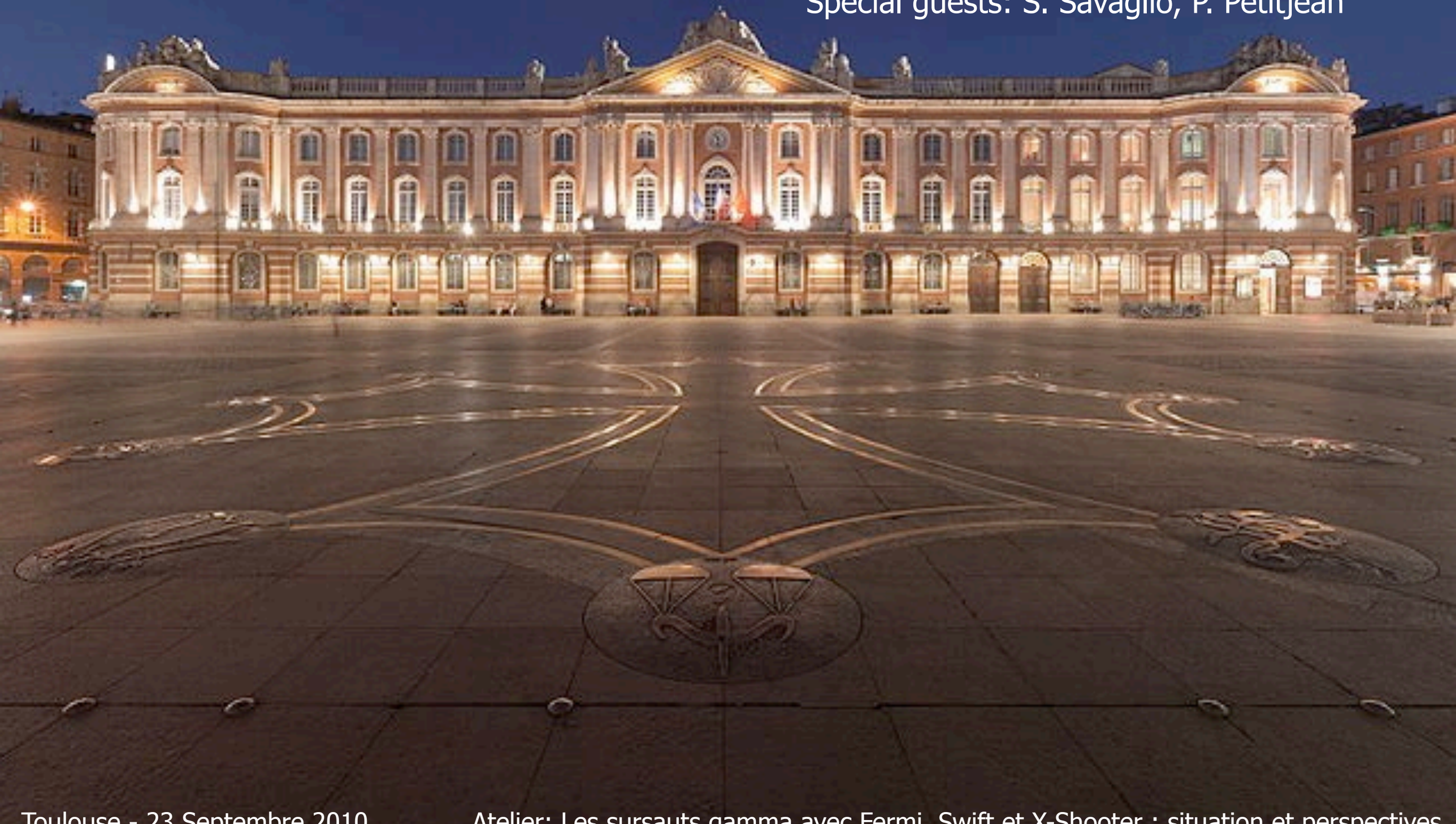
Observations des GRB avec X-Shooter et contraintes sur les progéniteurs

S. Vergani, P. Goldoni & H. Flores

GRB with the XSHOOTER : first results

Susanna D. Vergani (GEPI-APC-IAP)

On behalf of the X-shooter GRB collaboration
Special guests: S. Savaglio, P. Petitjean



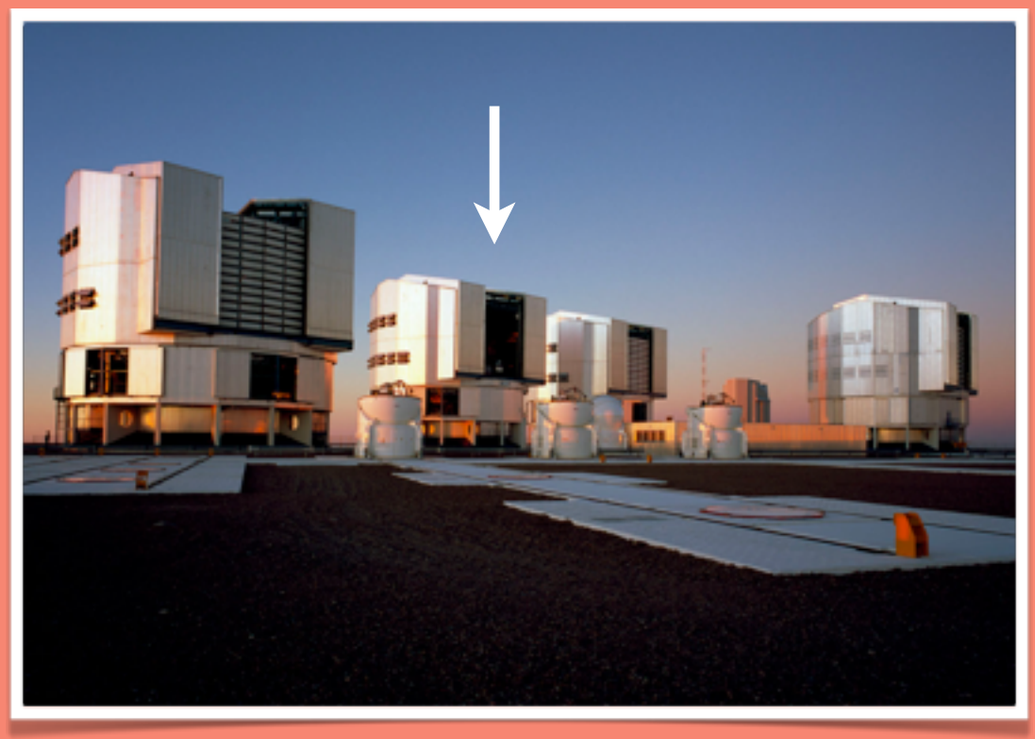
Toulouse - 23 Septembre 2010 Atelier: Les sursauts gamma avec Fermi, Swift et X-Shooter : situation et perspectives

P.I. Board: S. D'Odorico (Chair), F. Hammer, L. Kaper, P. K. Rasmussen, S. Randich
Project Manager: H. Dekker
Instrument Scientists: J. Venet (Garching), E. Mason (Paranal)

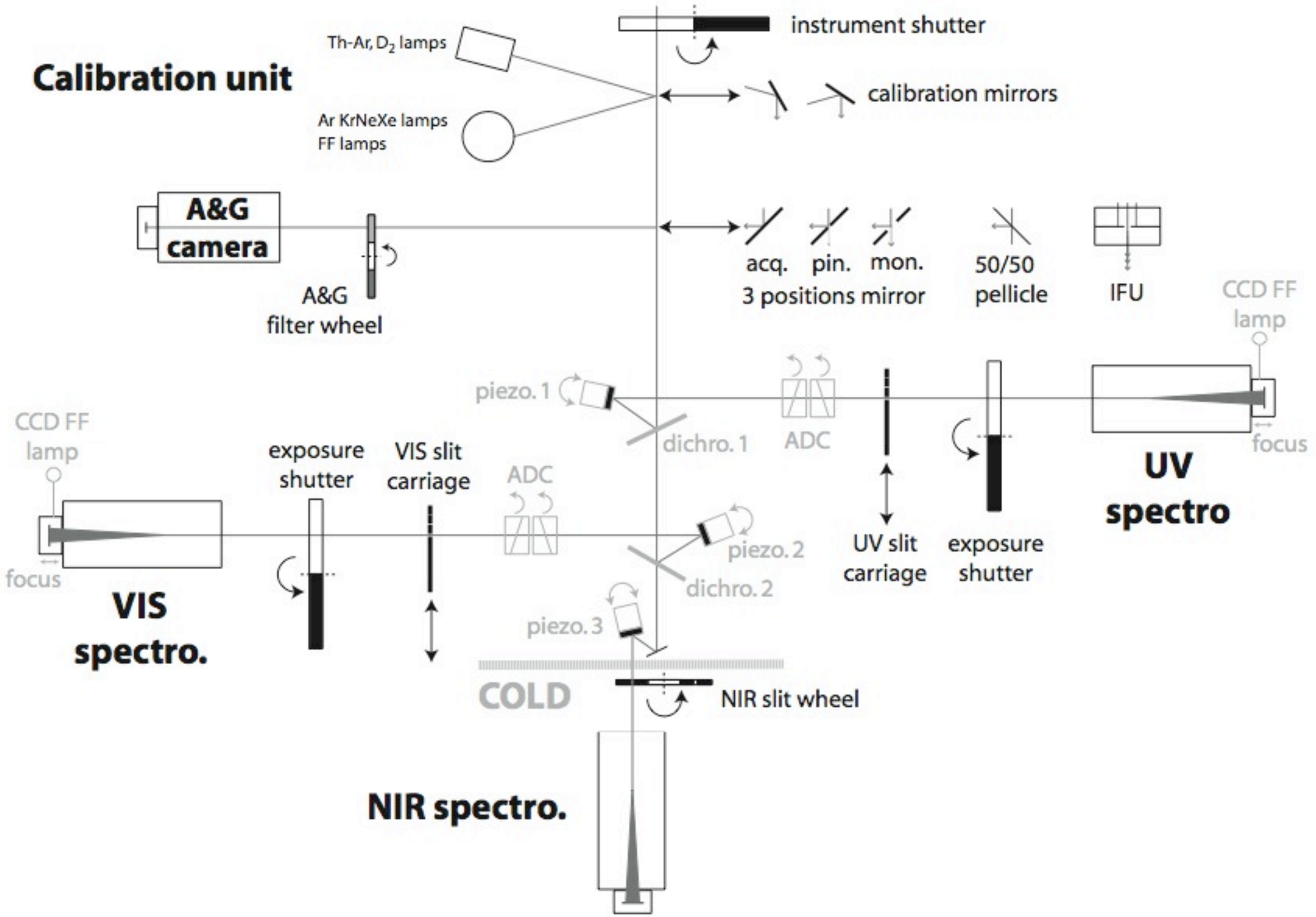
- Copenhagen University Observatory, Niels Bohr Institute (DK)
- Institute for Physics and Astronomy in Aarhus (DK)
- Astronomical Institute 'Anton Pannekoek' from the University of Amsterdam (NL)
- Department of Astrophysics from the University of Nijmegen (NL)
- Netherlands Foundation of Research in Astronomy (ASTRON, NL)
- Osservatorio Astronomico di Brera (INAF, IT)
- Osservatorio Astronomico di Trieste (INAF, IT)
- Osservatorio Astronomico di Palermo (INAF, IT)
- Osservatorio Astrofisico di Catania (INAF, IT)
- GEPI, Paris Observatory (FR)
- AstroParticule et Cosmologie institute (Universite Paris 7, CNRS and CEA, FR)
- European Sourthern Observatory (ESO)

XSHOOTER: 2nd Generation instrument @ VLT

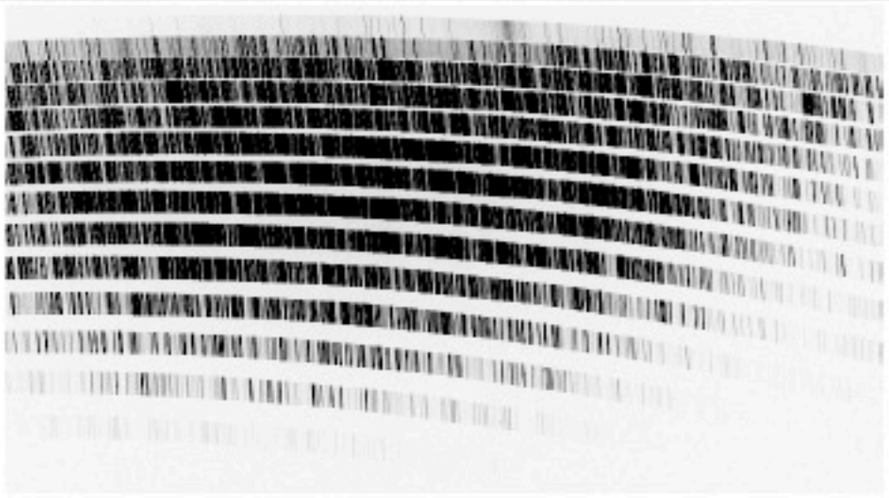
- 3 echelle spectrographs
- Full range 3000 – 24000 Å in a single shot
- Resolution 5000 – 10000
- Slit length 11"
- Integral field unit 1.8" x 4"
- m(AB)~21 (1h, SNR=10; K(AB)~19)



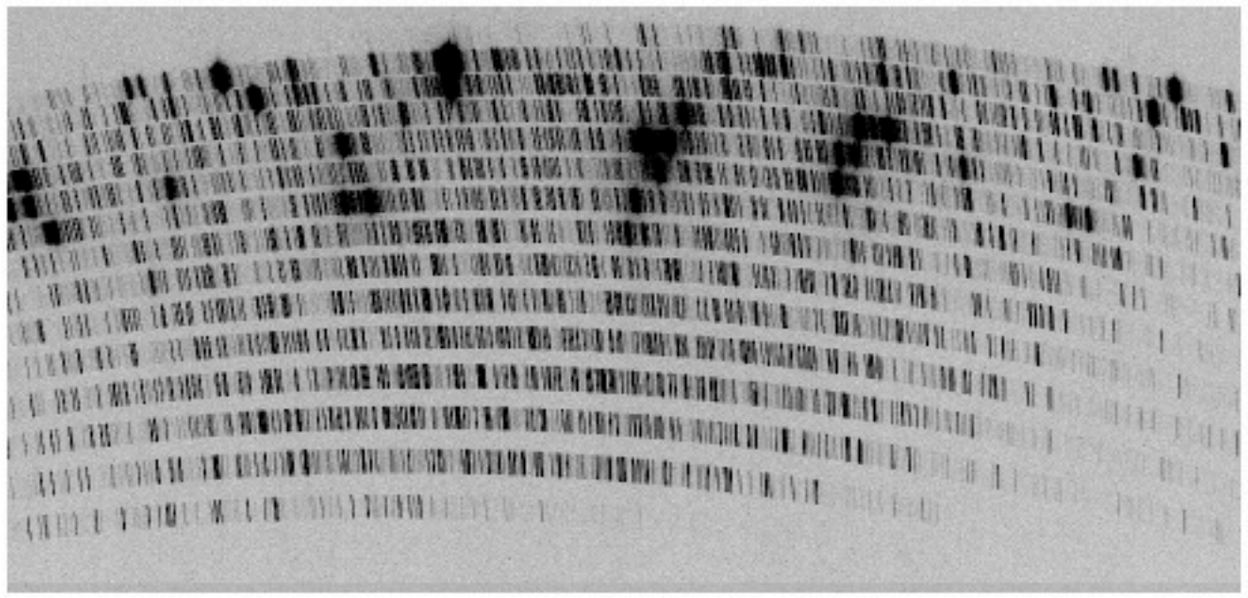
UVB			VIS			NIR		
Slit width	**R λ/Δλ**	**Sampling [pix/FWHM]**	**Slit width**	**R λ/Δλ**	**Sampling [pix/FWHM]**	**Slit width**	**R λ/Δλ**	**Sampling [pix/FWHM]**
0.5	9100	3.5	0.4	17400	3.0	0.4	11300	2.0
0.8	6200	5.2	0.7	11000	4.8	0.6	8100	2.8
1.0	5100	6.3	0.9	8800	6.0	0.9	5600	4.0
1.3	4000	8.1	1.2	6700	7.9	1.2	4300	5.3
1.6	3300	9.9	1.5	5400	9.7	1.5	3500	6.6
IFU	7900	4.1	IFU	12600	4.2	IFU	8100	2.8


Calibration unit
Th-Ar, D2 lamps
Ar KrNeXe lamps
FF lamps
instrument shutter
calibration mirrors
A&G camera
A&G filter wheel
acq.
pin.
mon.
3 positions mirror
50/50 pellicle
IFU
CCD FF lamp
piezo. 1
dichro. 1
ADC
focus
UV spectro
CCD FF lamp
exposure shutter
VIS slit carriage
ADC
UV slit carriage
exposure shutter
piezo. 2
dichro. 2
piezo. 3
focus
VIS spectro.
COLD
NIR slit wheel
NIR spectro.

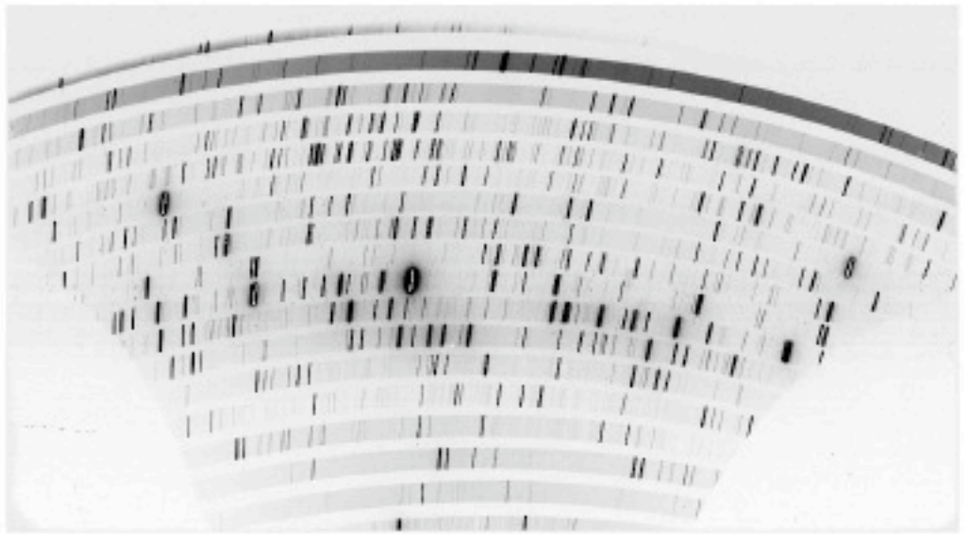
Raw calibration data



UVB

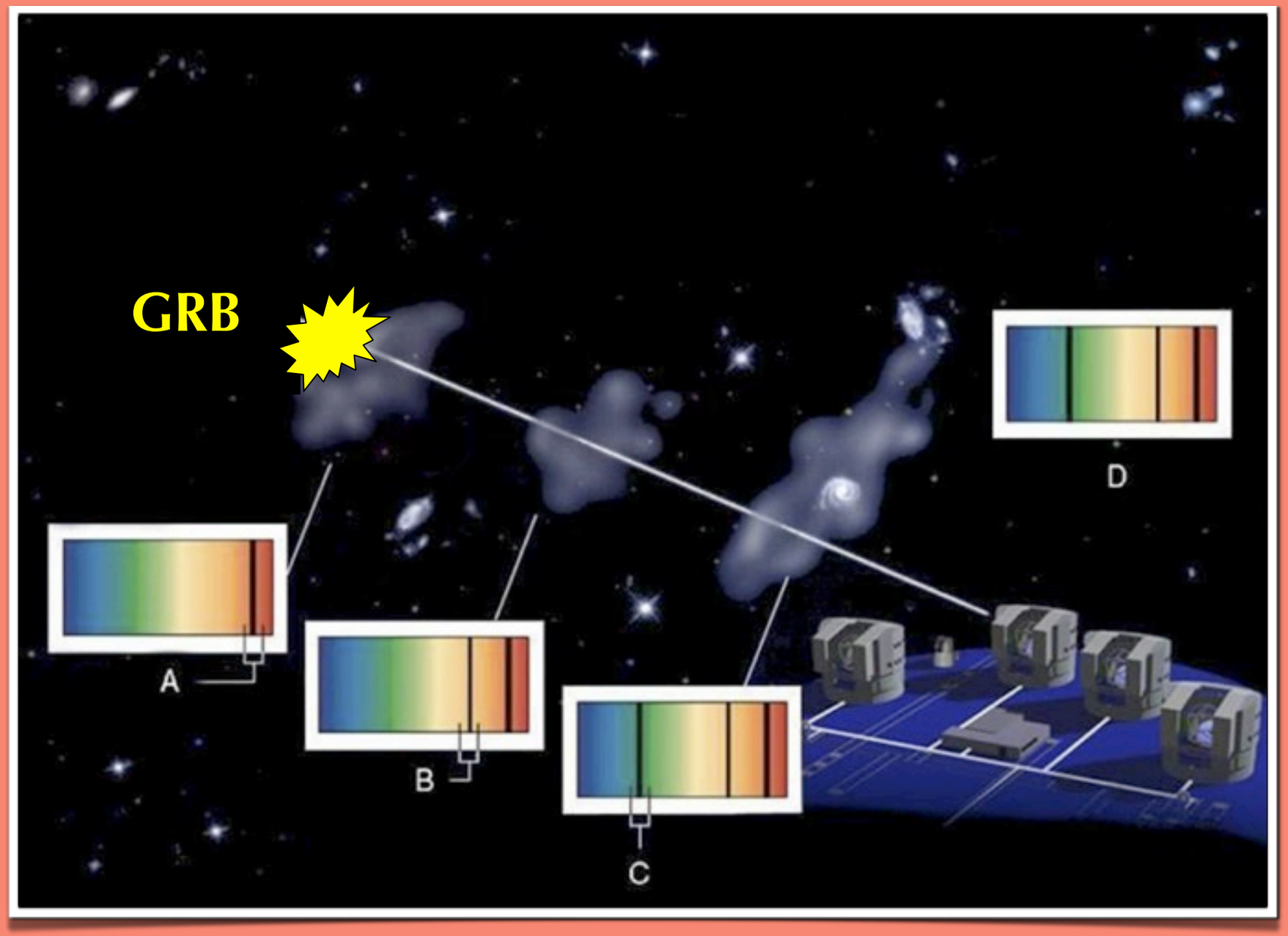


VIS



NIR

Open to the ESO community: October 2009
Consortium GTO time: partly dedicated to GRB science



GTO to study GRB afterglow spectra
PI : J. Fynbo
French-Italian GTO to study GRB host galaxies
PIs : Silvia Piranomonte (INAF-Rome) / Hector Flores (GEPI-Paris)

The X-shooter/Swift GRB afterglow legacy survey

Goal: Construct a well-defined, statistically useful sample of GRBs with measured redshifts, metallicities, molecular content, and extinction curves

Large collaboration: Danemark Italy Netherland & France
PI: J. Fynbo

With the X-shooter survey we expect to provide:

•Metallicity (we have measured metallicities for 4 GRB afterglows)

•Study important element as ZnII, CrII and α elements over a much wider redshift range.

•GRB afterglows allow investigation of random foreground absorbers, complementing QSO.

•Reconciling the abundance patterns of GRB absorbers and other types of absorbers will be a major goal (see also Fynbo et al. 2008, ApJ, 683, 321).

Sample criteria (ToO).

* GRB triggered onboard by Swift.
* Galactic $A_V \leq 0.5$ mag.
* XRT started observing within 10 minutes since the GRB; an XRT position must be distributed within 12 hr.
* The target must be visible for at least 60 min at least 30° above horizon, with the Sun below -12°.
* No bright closeby stars.

Trigger criteria (RRM).

The robot sends a trigger if at the moment of the GCN notice the GRB if:
* Galactic $A_V \leq 1.0$ mag.
* Error radius < 60".
* No limit on declination.
* No constraint on Moon phase or distance.
* Elevation in the sky > 22° (both now and 15 min after the trigger).
* Sun elevation < -12° (both now and 15 min after the trigger).
* The X-ray position must be available less than 1 hr after the GRB.

Organization:

Burst activator in each country

French BA : S. Vergani P. Goldoni & H. Flores

Example:

Time period Burst Advocates (BAs)
Oct 1-5 Valerio D'Elia + Antonio de Ugarte Postigo
Oct 5-12 Daniele Malesani + Justyn Maund
Oct 12-19 Andrew Levan + Nial Tanvir
Oct 19-26 **Hector Flores** + **Paolo Goldoni**
Oct 26 - Nov 2 Páll Jakobsson + Daniele Malesani
Nov 2-9 **Susanna Vergani** + Klaas Wiersema
Nov 9-16 Paolo D'Avanzo + Silvia Piranomonte
Nov 16-23 Jens Hjorth + Paul Vreeswijk
Nov 23-30 Angelo Antonelli + Stefano Covino
Nov 30 - Dec 7 Johan Fynbo + Darach Watson

GCN: Only if object is identified

An high z GRB observed with X-Shooter

measured a metallicity of 0.1 solar for the z = 4.669 GRB 100219A in P84

(the highest absorption line metallcity determine reliably for any class of objects to our knownledge).

Reconciling the abundance patterns of GRB absorbers and other types of absorbers will be a major goal (see also Fynbo et al. 2008).

Status:

P84: Only eight bursts fullfilled the trigger criteria. Four of these could not be observed because of weather, mirror-recoating, or visitors. The low number of triggers is a result of an unusual low number of well-localized Swift bursts observable from Paranal.

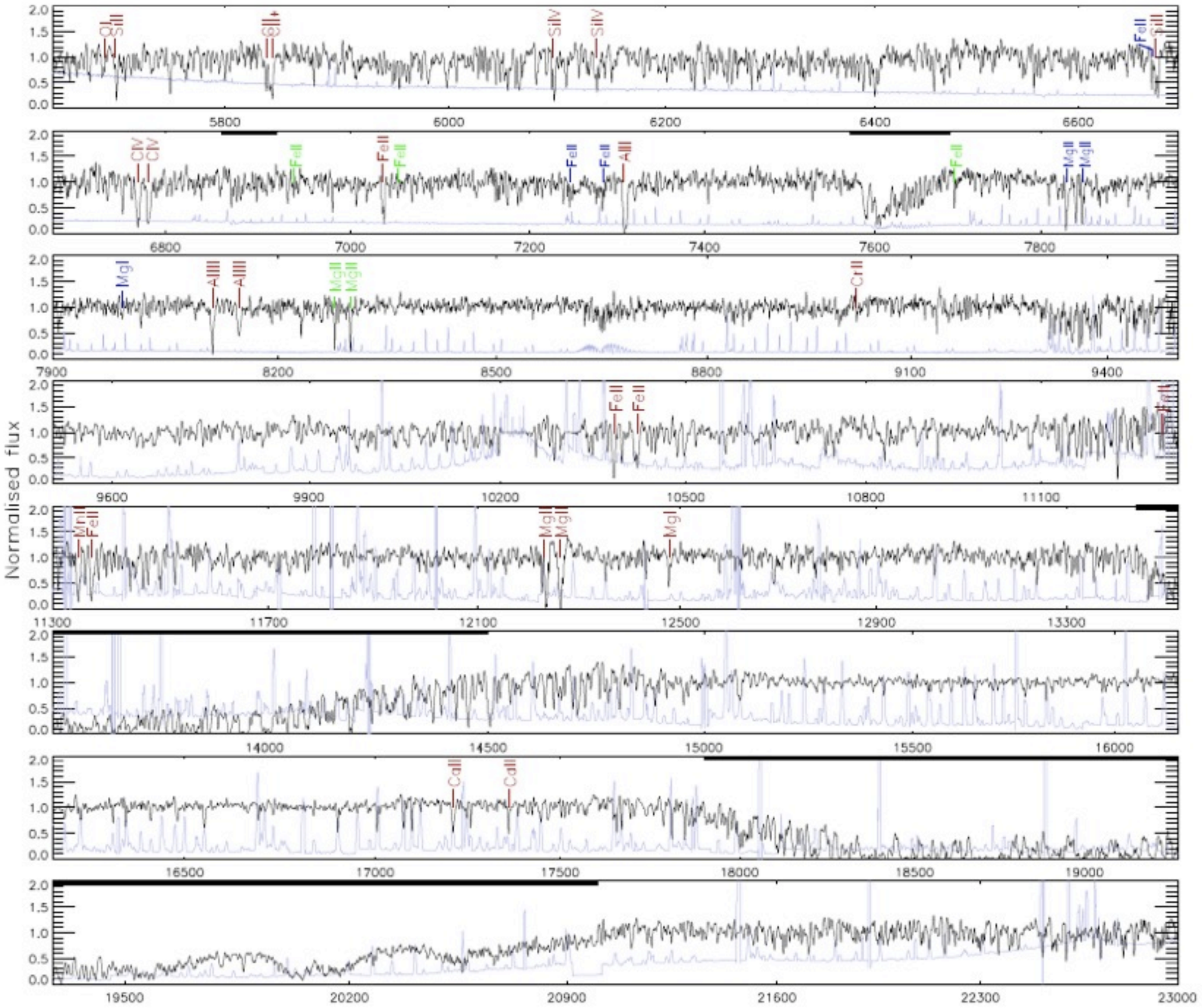
Papers in preparation:
GRB091018 (Wiersema et al.),
GRB091127 (Vergani et al.),
GRB100219A (Th¨one et al.),
GRB-SN GRB100316D (paper led by Bufano).

P85: 15 bursts have full-filled our trigger criteria, but 7 could not be observed due to bad weather (4), visitors (1), technical problems (1), and faintness of the afterglow (1). Papers are in preparation:

Papers in preparation:
GRB100418A (de Ugarte Postigo et al.),
GRB100425A (Skuladottir et al.),
GRB100621A (Watson et al.),
GRB 100814A (Vergani et al.).

13 GCNs

GRB 090313 (z=3.37): X-shooter's first shot at a gamma-ray burst (De Ugarte Postigo et al. 2010, A&A)



GRB 090313:

X-shooter's first shot at a gamma-ray burst

λ_{obs} (Å)	Feature (Å)	z	EW_{rest} (Å)
Host galaxy at $z = 3.37$			
5695.71	O Iλ1302.17	3.37402	0.36±0.11
5705.96	Si IIλ1304.37	3.37450	0.58±0.12
	C IIλ1334.53		
5839.99	C II*λ1335.66	3.37413	0.88±0.12
	C II*λ1335.71		
6096.13	Si IVλ1393.75	3.37389	1.14±0.13
6135.08	Si IVλ1402.77	3.37354	1.03±0.10
6678.24	Si IIλ1526.71	3.37428	0.95±0.08
6770.31	C IVλ1548.19	3.37303	0.91±0.07
6781.67	C IVλ1550.77	3.37310	0.89±0.06
7035.95	Fe IIλ1608.45	3.37437	0.62±0.06
7308.47	Al IIλ1670.79	3.37427	1.29±0.06
8111.69	Al IIIλ1854.72	3.37355	0.71±0.04
8146.86	Al IIIλ1862.79	3.37347	0.56±0.05
9019.61	Cr IIλ2062.23	3.37371	0.14±0.02
10385.9	Fe IIλ2374.46	3.37401	1.12±0.10
10420.9	Fe IIλ2382.77	3.37348	1.11±0.17
11312.1	Fe IIλ2586.65	3.37326	1.21±0.49
11347.5	Mn IIλ2594.74	3.37327	1.04±0.14
11372.2	Fe IIλ2600.17	3.37363	1.29±0.11
12233.7	Mg IIλ2796.35	3.37486	1.94±0.15
12267.9	Mg IIλ2803.53	3.37588	1.90±0.13
12476.5	Mg Iλ2852.96	3.37317	0.51±0.05
17207.2	Ca IIλ3934.78	3.37311	1.21±0.06
17359.6	Ca IIλ3969.59	3.37314	0.45±0.04
Intervening system at $z = 1.96$			
6937.93	Fe IIλ2344.21	1.95960	0.15±0.04
7052.26	Fe IIλ2382.77	1.95969	0.18±0.04
7695.64	Fe IIλ2600.17	1.95966	0.31±0.04
8276.48	Mg IIλ2796.35	1.95974	0.50±0.03
8297.48	Mg IIλ2803.53	1.95965	0.59±0.05
Intervening system at $z = 1.80$			
6673.45	Fe IIλ2382.77	1.80072	0.34±0.05
7240.68	Fe IIλ2586.65	1.79925	0.48±0.06
7280.21	Fe IIλ2600.17	1.79989	0.67±0.07
7830.87	Mg IIλ2796.35	1.80039	1.35±0.10
7849.07	Mg IIλ2803.53	1.79970	1.31±0.08
7987.58	Mg Iλ2852.96	1.79974	0.48±0.08

Spectrum from 570 to 2300nm: 2 inter. System detected

Determination of column densities

GRB 090926A (D'Elia et al. 2010, A&A)

study the environment and intervening absorbers

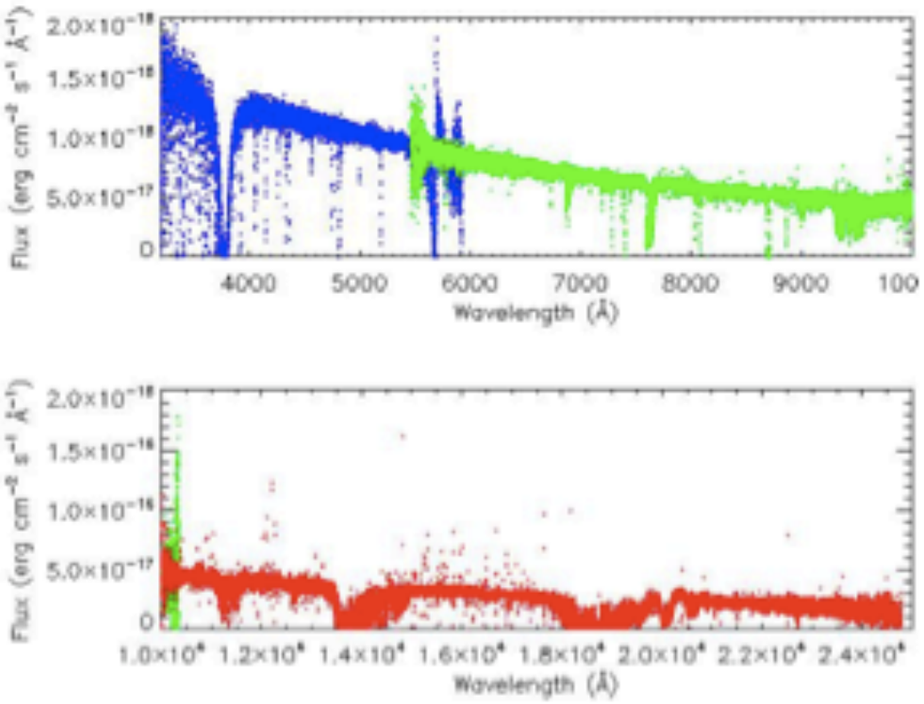


Table 4. Redshifts, absorption line column densities and equivalent widths for the intervening systems.

	Species	Transition	Redshift	log (N/cm^{-2})	EW$_r$ (Å)[a]
1	CIV	1548, 1550	1.9466	13.70 ± 0.03	0.15 ± 0.04
1	HI	Lyα	1.9466	14.64 ± 0.04	
2	CIV	1548, 1550	1.7986	13.63 ± 0.03	0.11 ± 0.03
2	HI	Lyα	1.7986	14.56 ± 0.07	
3	CIV	1548, 1550	1.7483	13.90 ± 0.02	0.21 ± 0.03
3	HI	Lyα	1.7483	14.98 ± 0.41	
4	MgII	2796, 2803	1.2456	12.39 ± 0.05	0.19 ± 0.06
4	MgI	2852	1.2456	11.47 ± 0.13	

[a] Rest frame equivalent widths for Mg II λ2796 and C IV λ1548; EW errors are given at the 2σ confidence level.

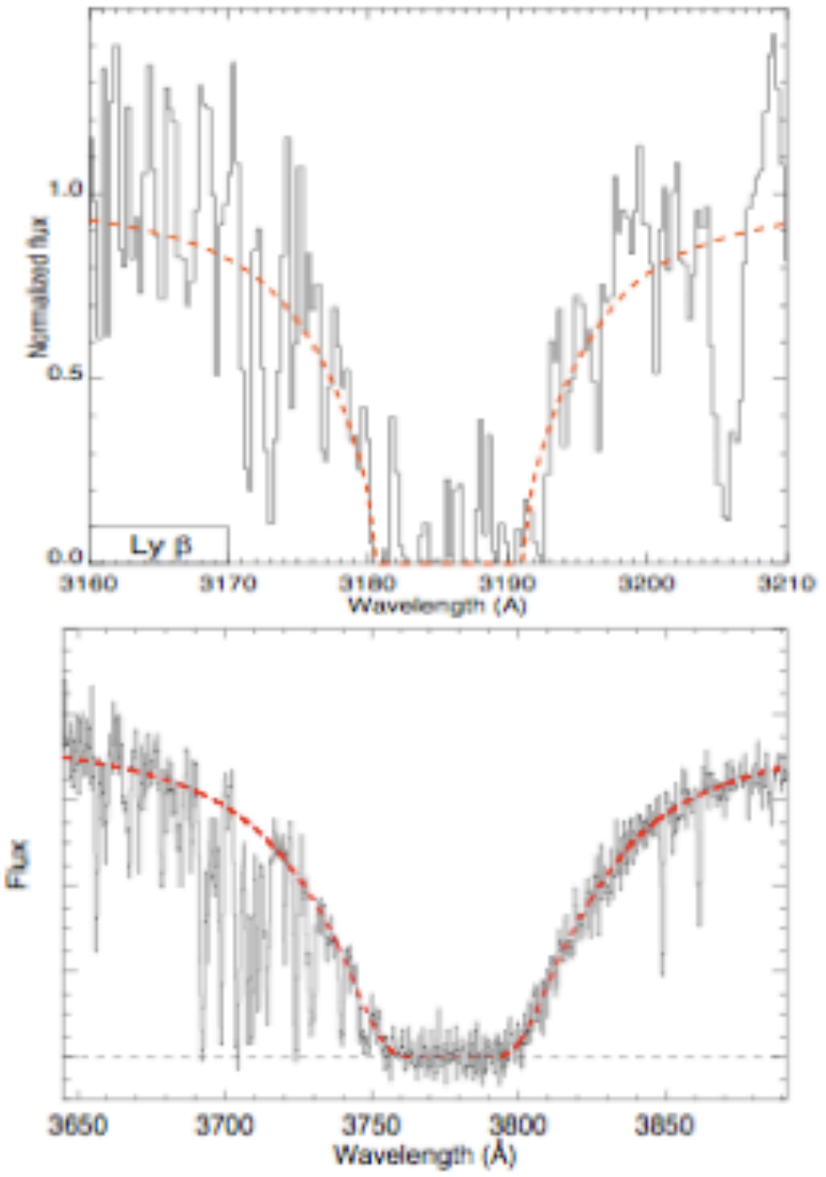
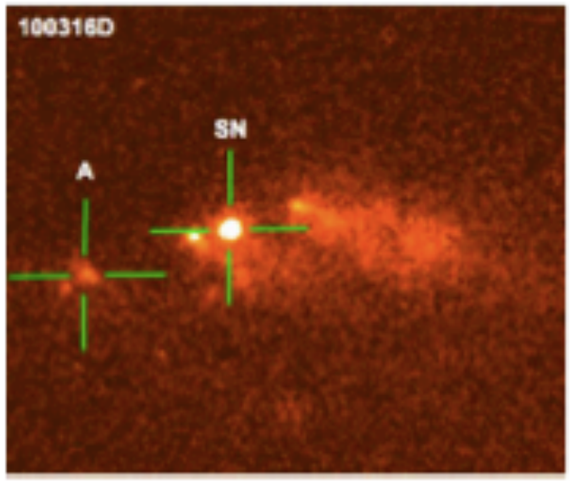
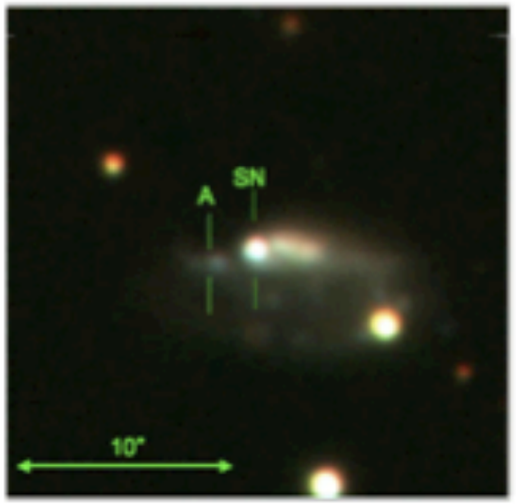


Fig. 5. The Lyβ (top panel) and Lyα (bottom panel) absorption features at the GRB 090926A redshift. The dashed lines represent the single Voigt component, best fit model, centered at the redshift of the red component ($z = 2.1071$) of the metallic lines.

GRB-SN GRB100316D

Discovery of the nearby long, soft GRB 100316D with an associated supernova





(Starling et al. 2010, arXiv)

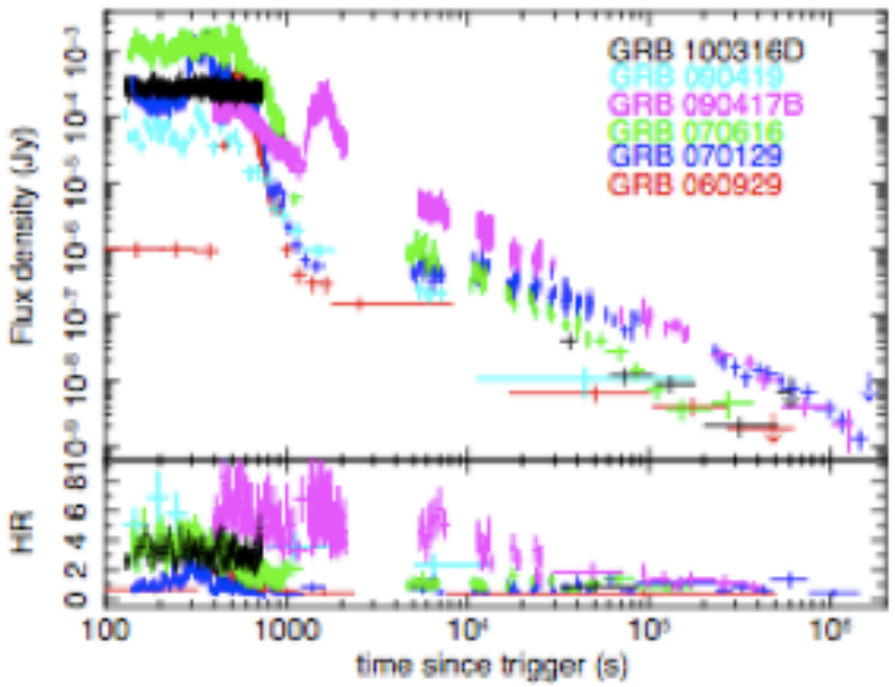


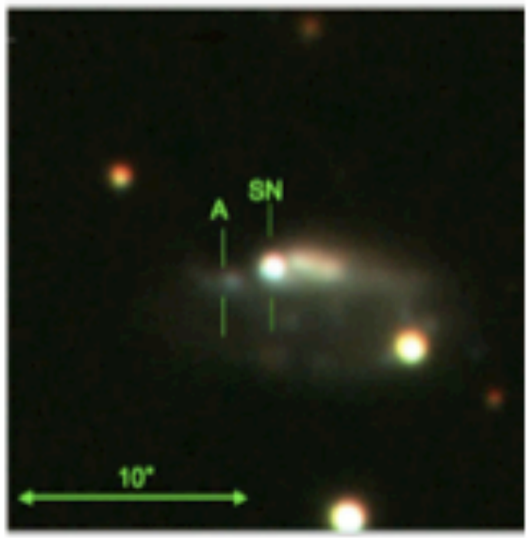
Figure 9. Upper panel: X-ray light curves in flux density at 1.7 keV against time since trigger for a sample of *Swift* XRT-observed very long prompt emission duration (>400 s) GRBs (excluding 060218). Lower panel: (1.5–10 keV)/(0.3–1.5 keV) hardness ratios derived from the XRT count rate light curves.

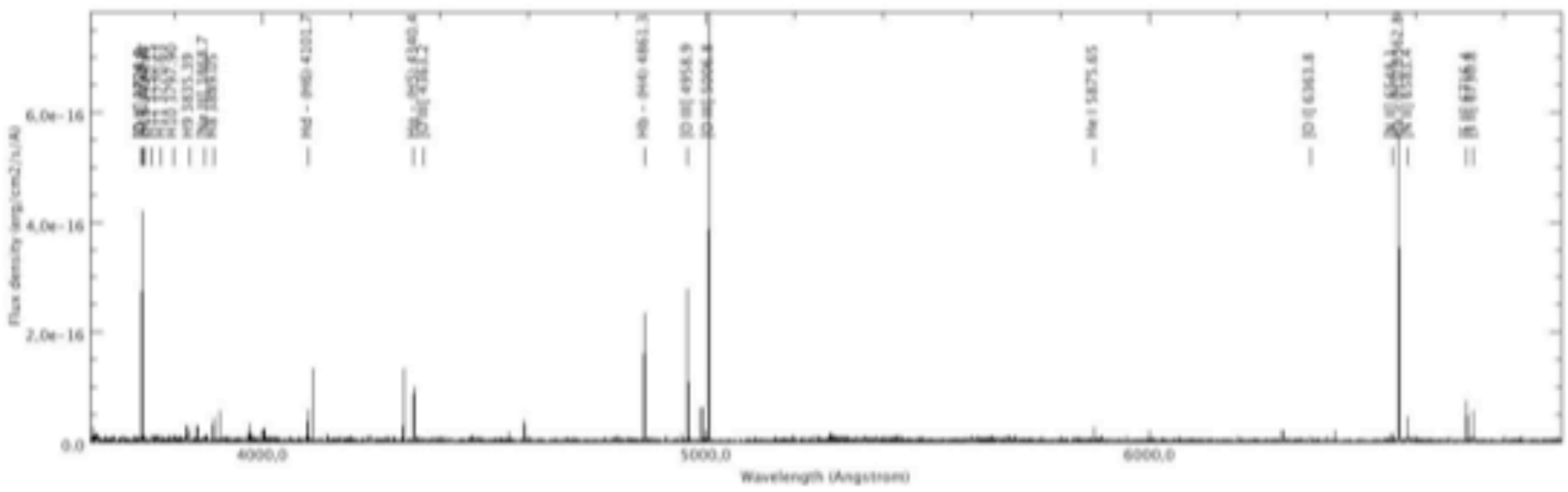
Similar to GRB060929

But
GRB-SNe host galaxies shows a great diversity in the environments.

GRB-SN GRB100316D

Three epochs follow-up with X-Shooter





X-Shooter UVB + VIS spectrum

Same metallicity in two epochs:

Ongoing analyses

X-Shooter:French Italian GTO program

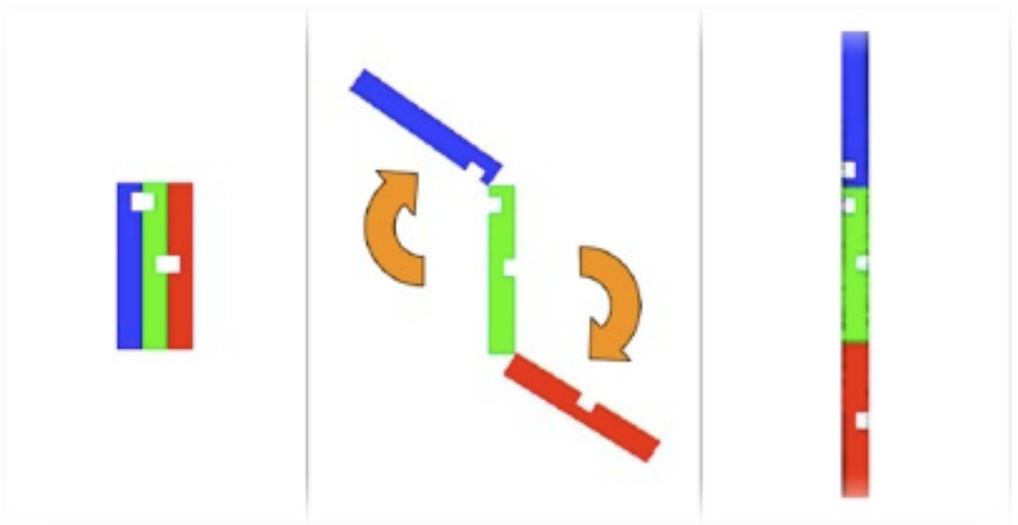
GTO The physical properties of the GRB host galaxies

PI: S. Piranomonte (I) H. Flores (F)

More than 10 z>1 GRBs observed using the slit mode and 5 low z using the IFU mode.

GOAL : Study the Integrated properties (longslit) or map (IFU)of long GRB host galaxies

- ✓Velocity field and sigma map
- ✓Electronic density
- ✓Extinction
- ✓Metal content
- ✓SFR
- ✓Etc …



Summary:

First of all: X-Shooter works !! ESO pipeline works for slit mode.

Ongoing GTO Legacy survey is a successfully collaboration: 8 papers in preparation

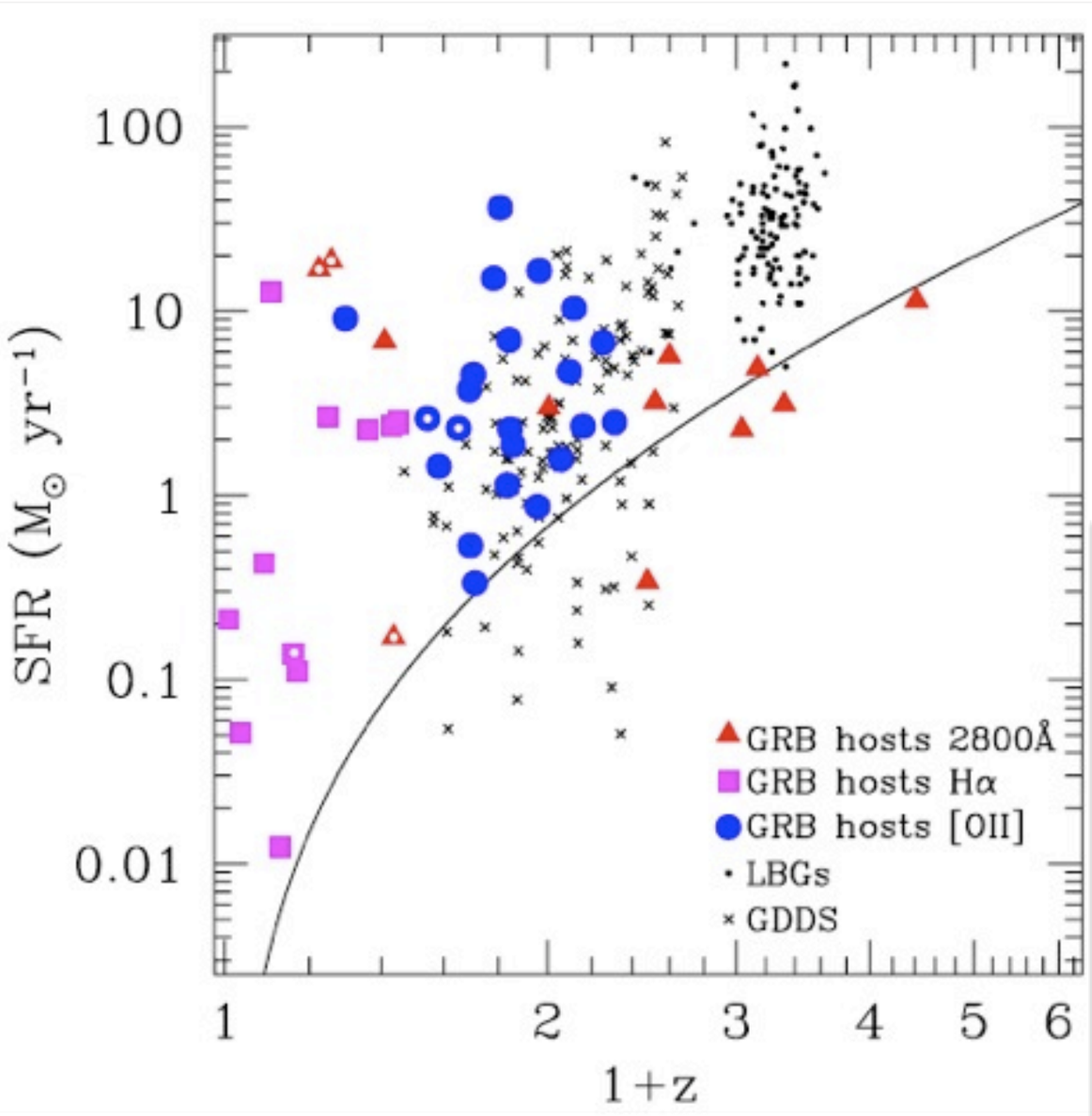
High-z: First run reduced and paper in preparation (See S. Vergani talk)

Low-z : IFU data reduction: pipeline under construction

French-Italian GTO to study GRB host galaxies
PIs : Silvia Piranomonte (INAF-Rome) / Hector Flores (GEPI-Paris)

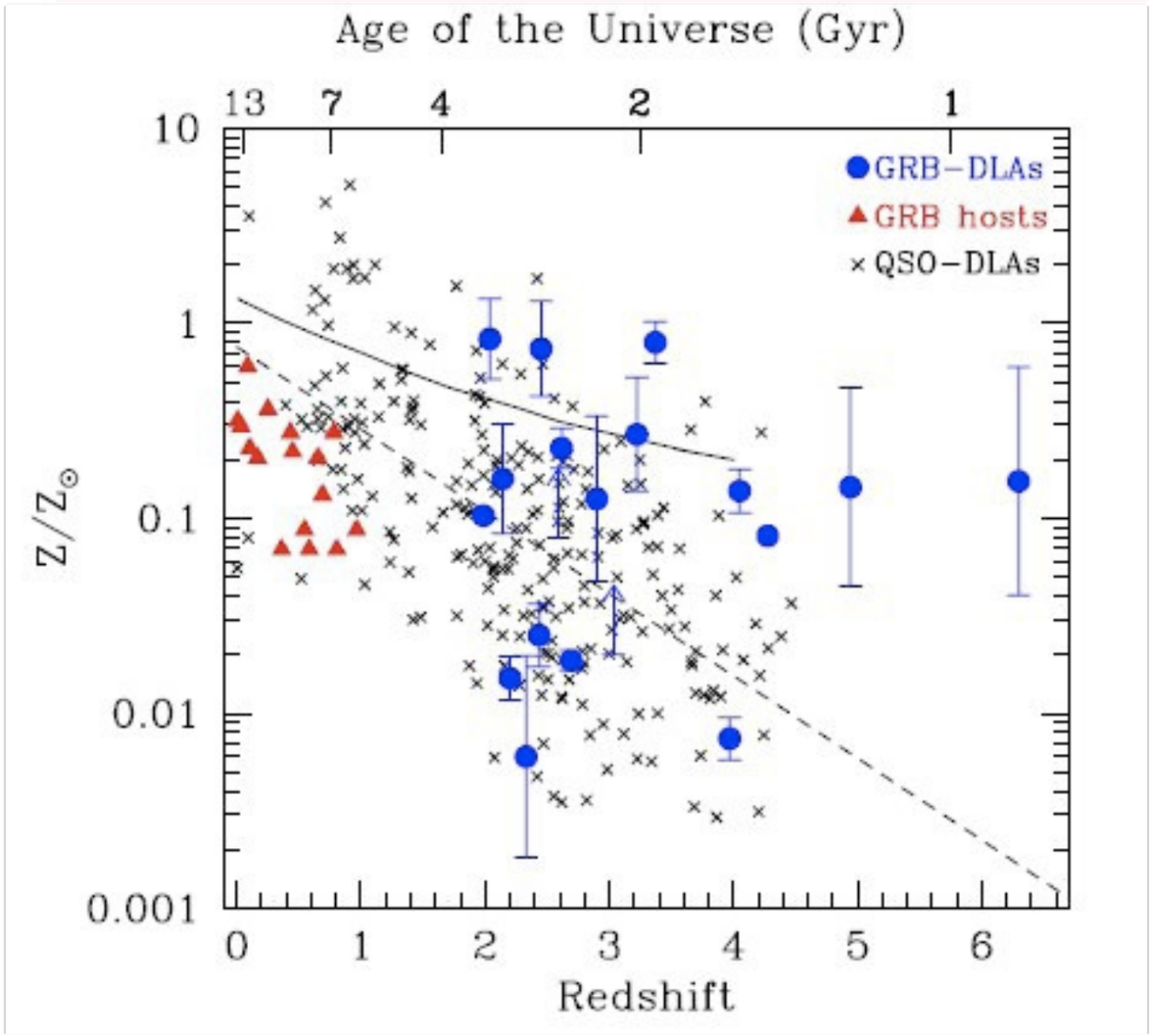
- **Slit spectroscopy: z ≳ 1 host galaxies**
  - **Extend emission lines spectroscopic host galaxy studies to high z : SFR, extinction, metallicity… (e.g. Savaglio et al. for z<1)**
  - **Comparison with GRB-DLAs**
  - **Comparison with surveys of galaxies**

Balmer lines, [OII] and [OIII] doublets, [NII], [NeIII], ….



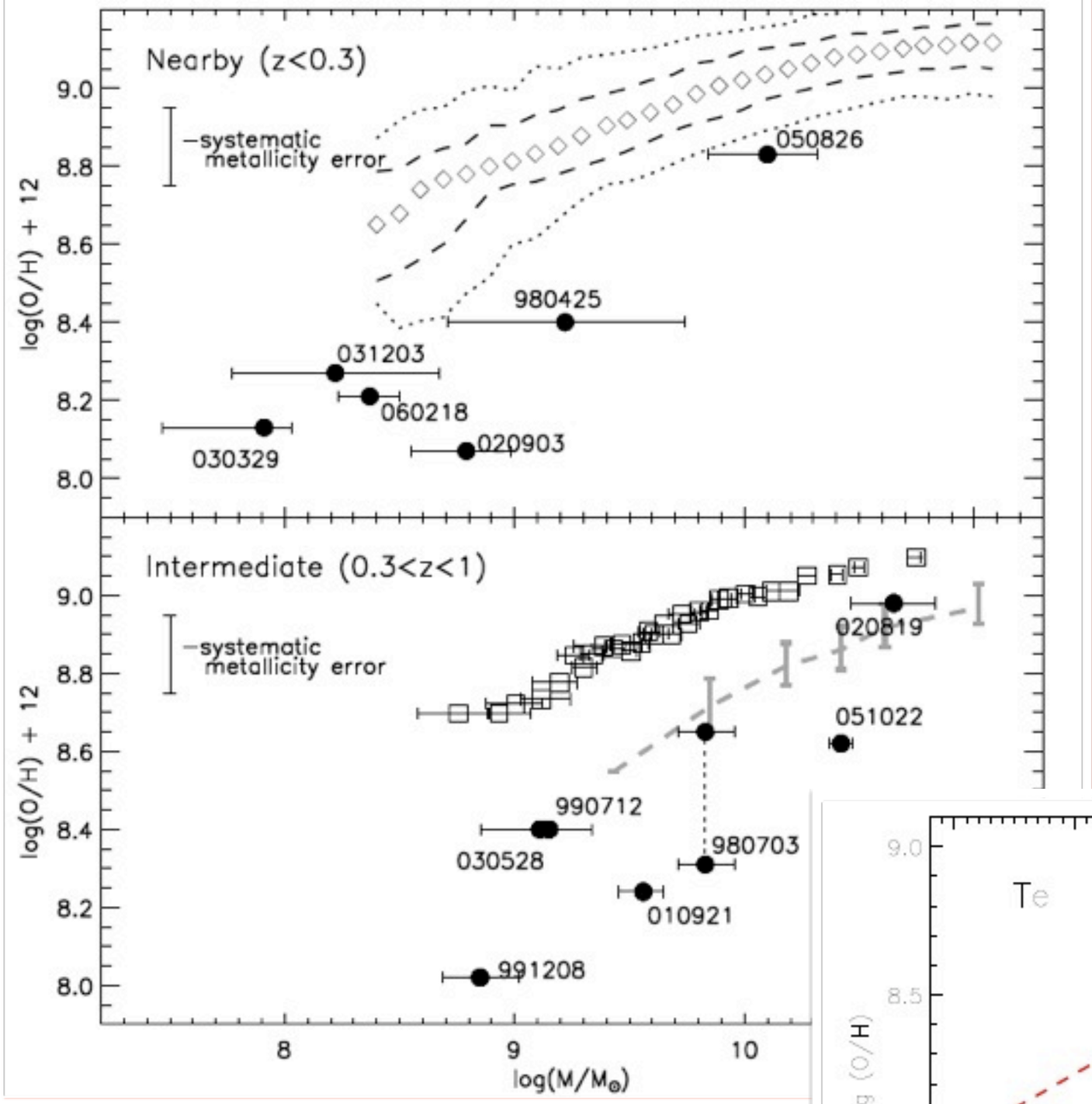
Star formation rate

Metallicity



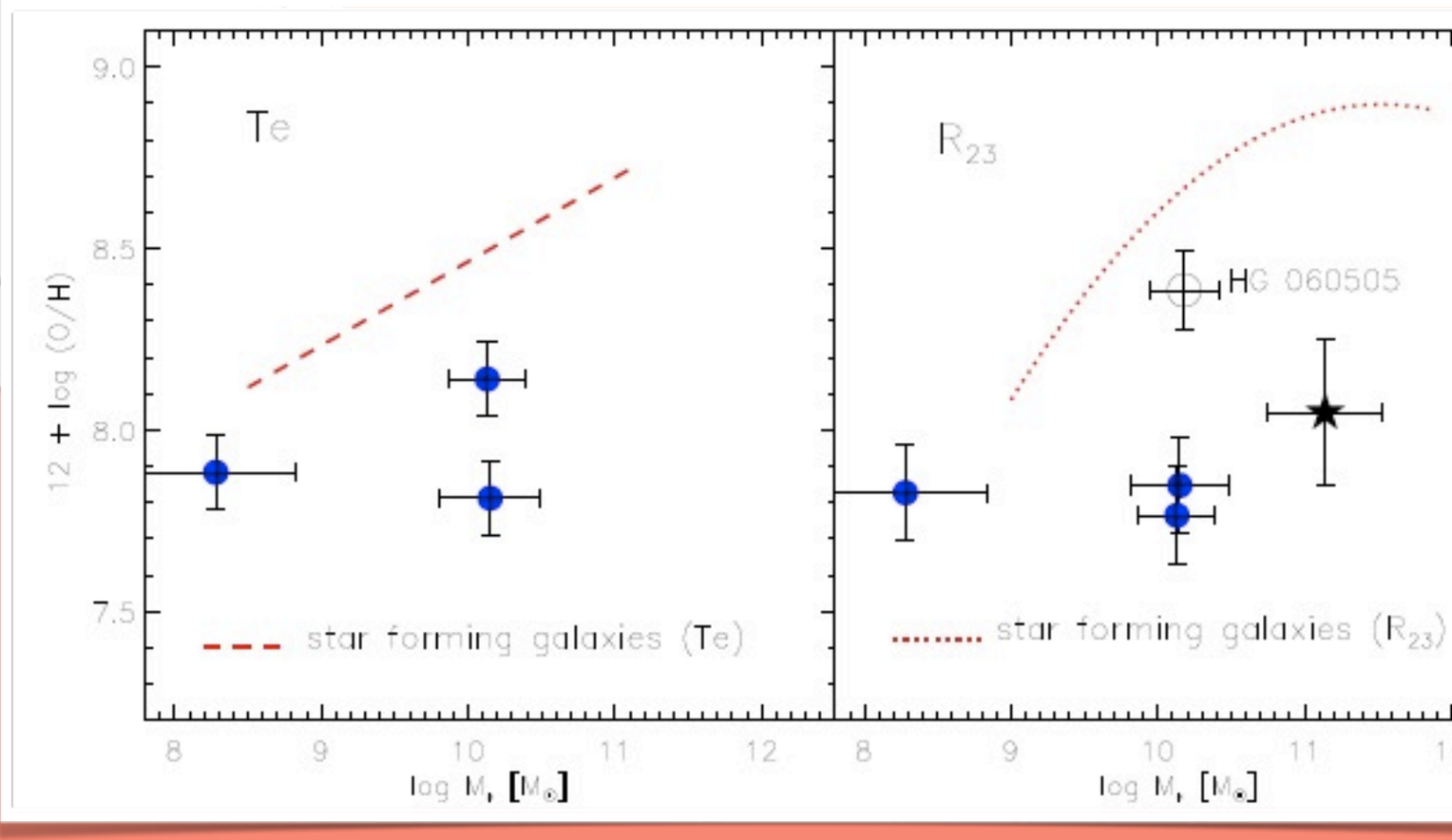
Savaglio et al. 2009

Mass vs Metallicity

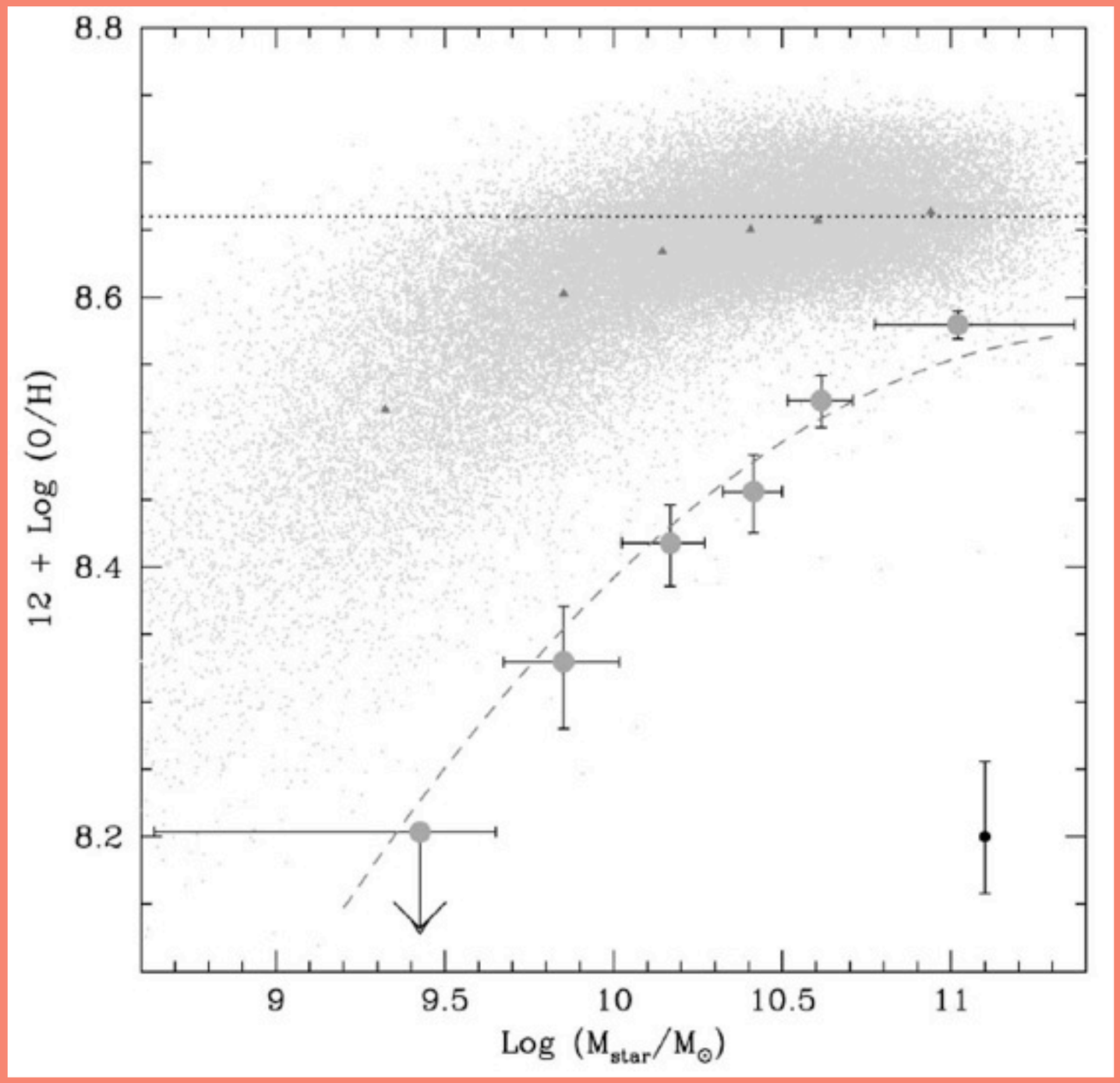


Levesque et al. 2010

Han et al. 2010



Mass vs Metallicity at z ~ 2



Erb et al. 2006

New instrument : first selection based on galaxies with one or more emission lines already detected in the optical

GRB 021004 z~2.3
GRB 000210 z~0.8 dark
GRB 000911 z~1.1
} November 2009

GRB 990506 z~1.3 dark
GRB 011211 z~2.1
} March 2010

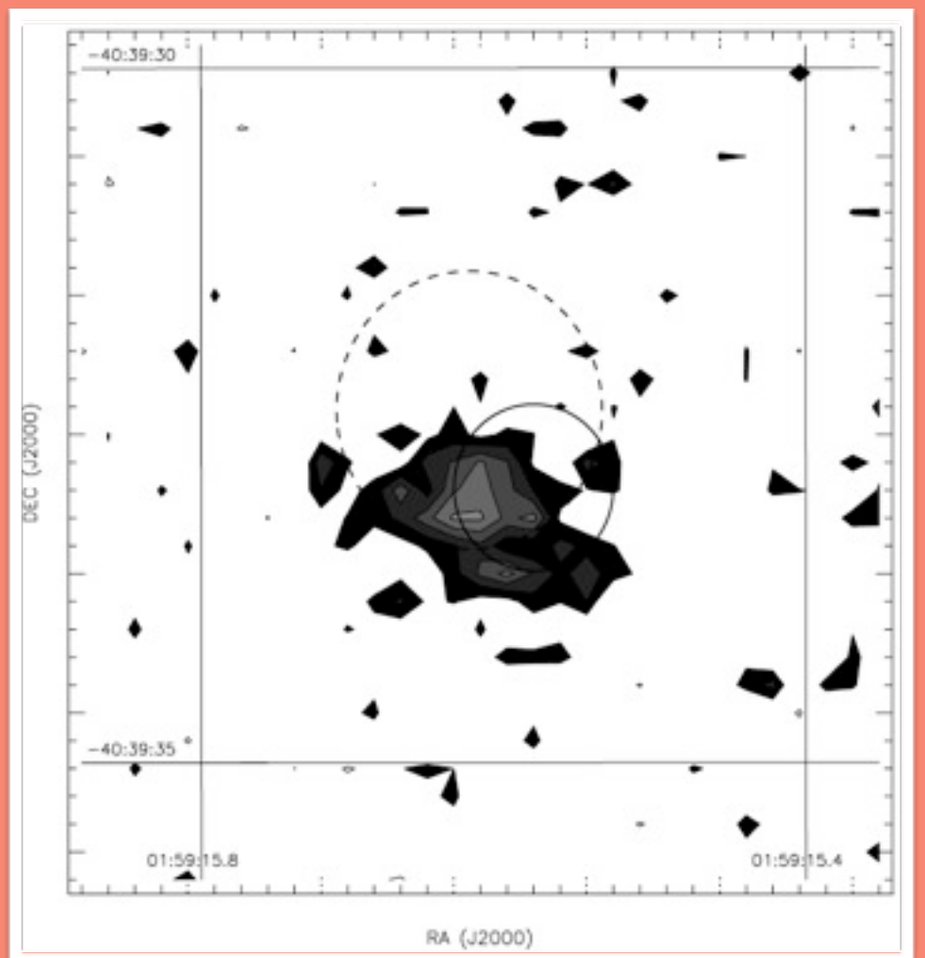
1 - 2 hours

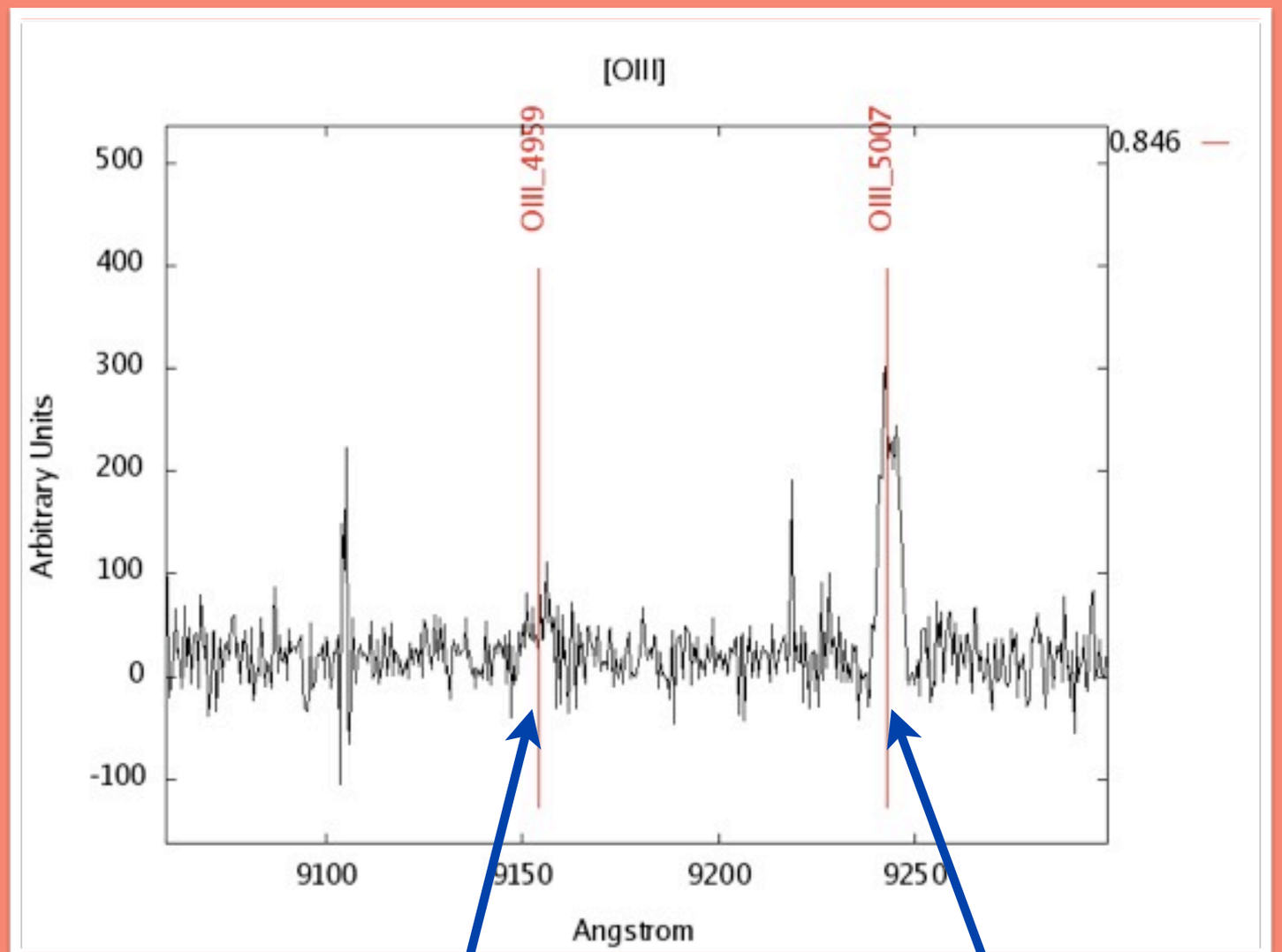
GRB 000418 z~1.1
GRB 060801 z~1.1 short
} April 2010

GRB 071117 z~1.3
GRB 070506 z~2.3
GRB 050820 z~2.6
GRB 080805 z~1.5
GRB 080520 z~1.5
GRB 080413B z~1.1
} August 2010

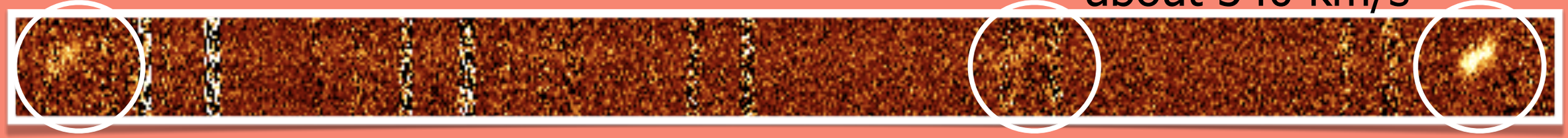
GRB 000210 z=0.846; dark; m_r=23.5; m_J=22 starburst

(Piro et al. 2002; Gorosabel et al. 2003)





about 340 km/s

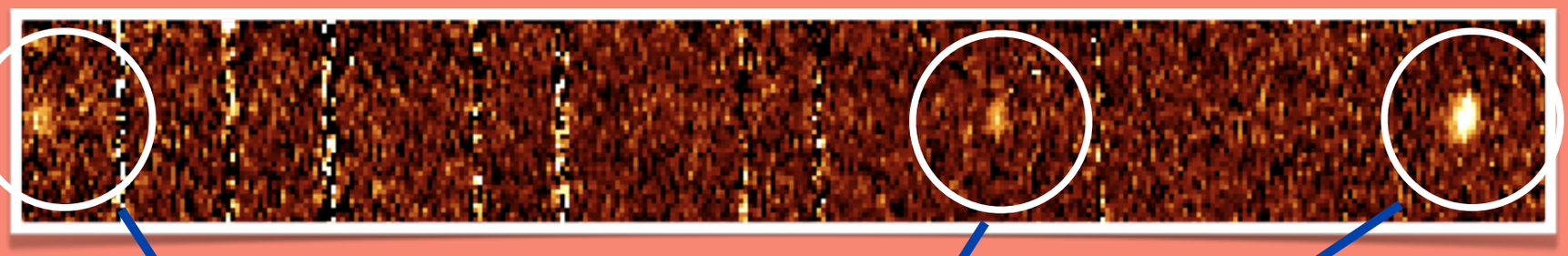


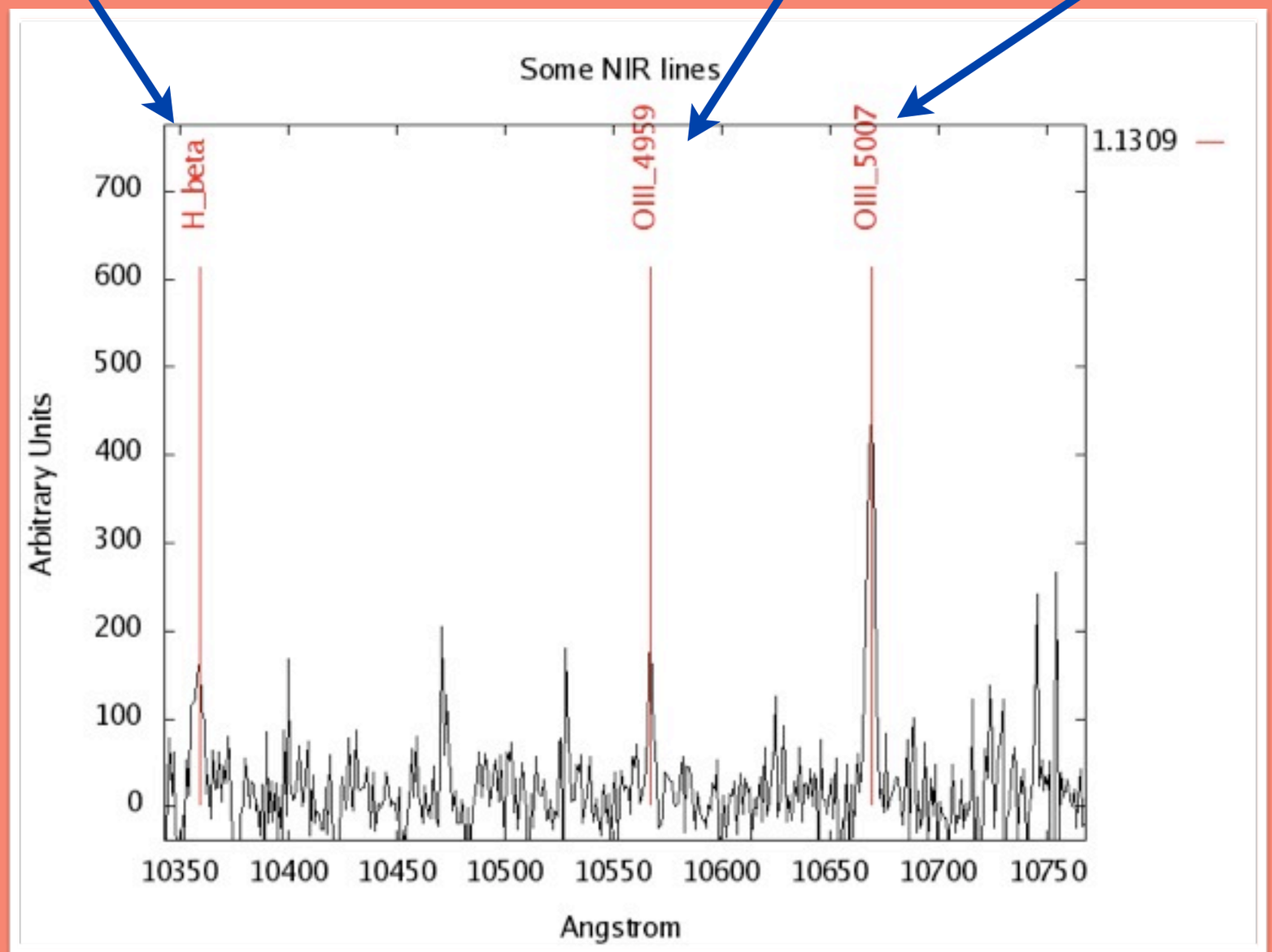
H-beta [OIII]4959 [OIII]5700

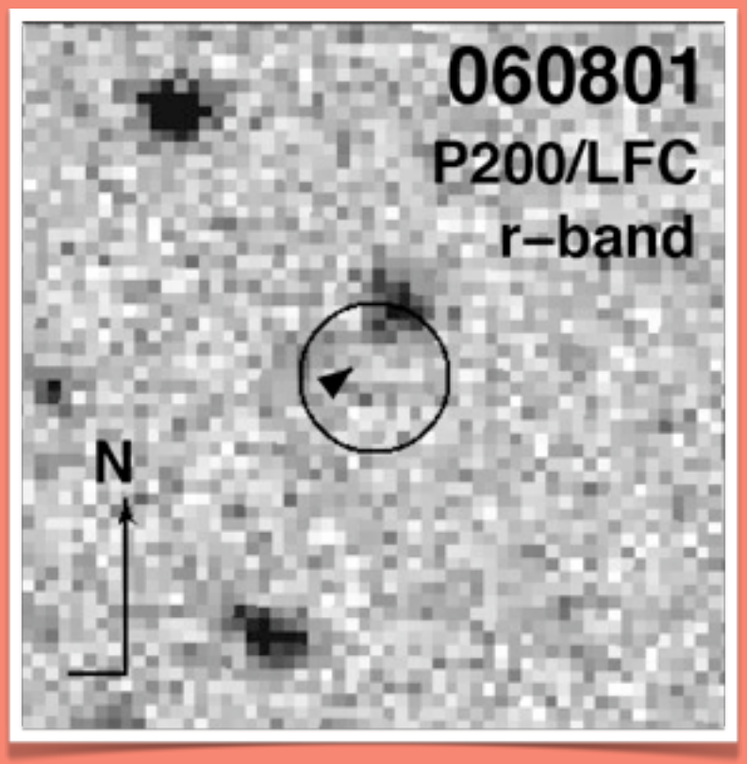
but also [OII]; NeIII; H-gamma; H-beta; H-alpha (but sky)

GRB 060801 z=1.1304; short GRB; m_r=23;

(Berger et al. 2007-2009)

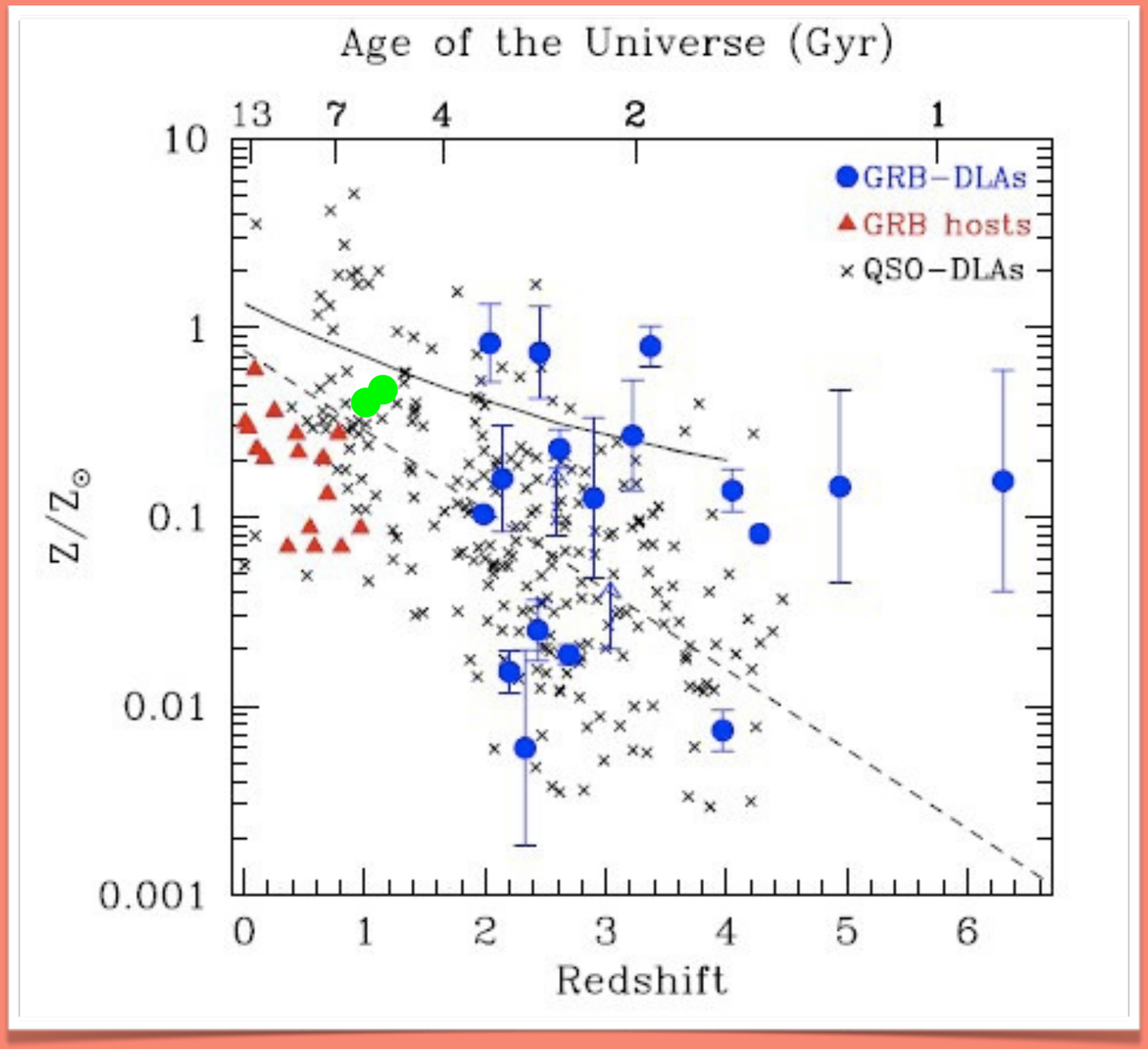






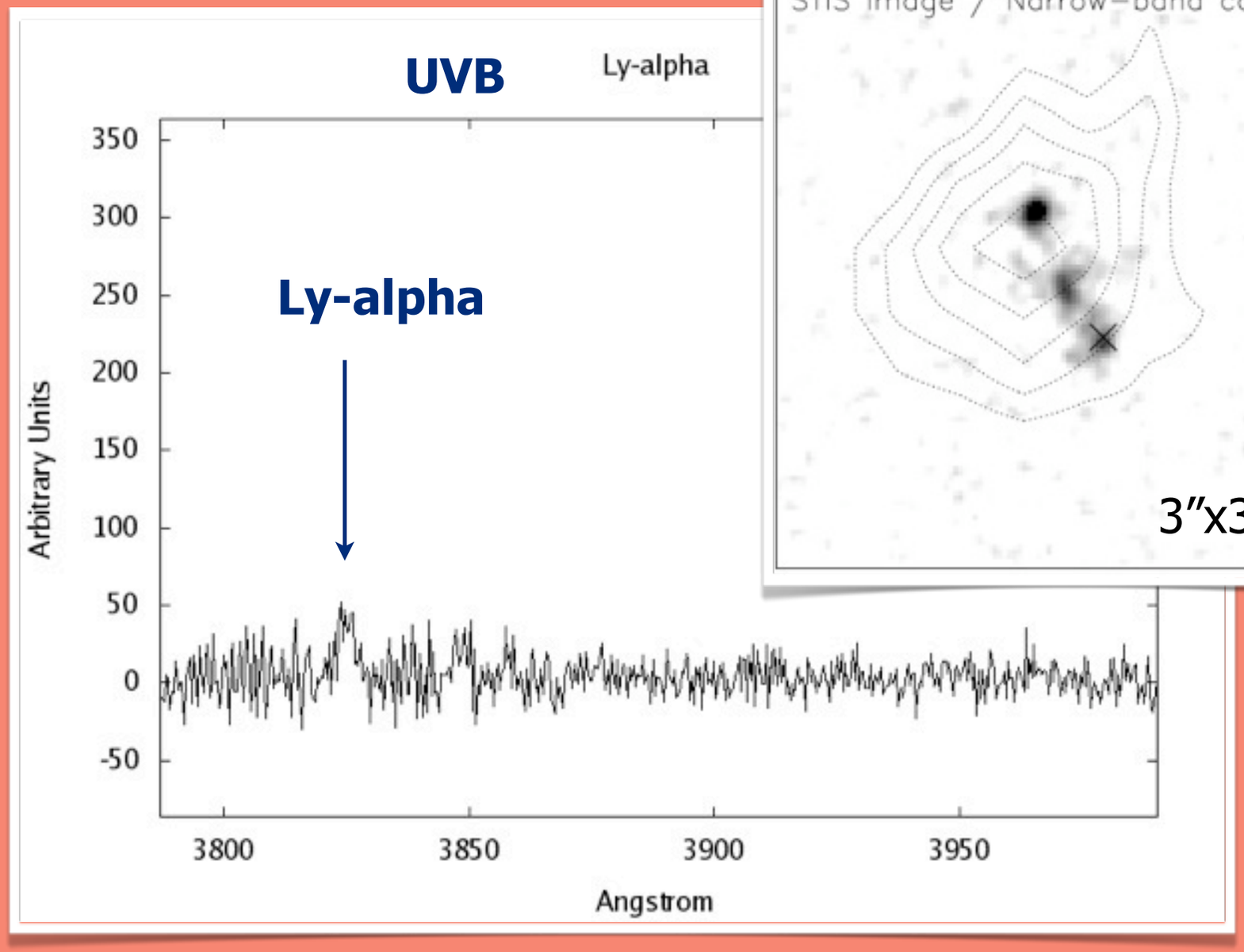
H-alpha (but sky)
H-beta; H-delta; H-gamma
NeIII_3869; [OII]...

Metallicity

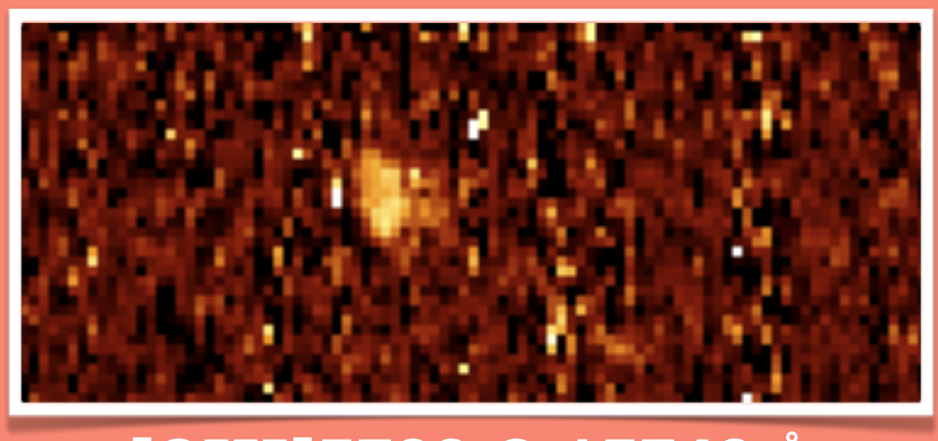


GRB 011211 z=2.1410; m_r=24.9; m_H=25; LAE; GRB-DLA

(Fynbo et al. 2003; Vreeswijk et al. 2006; Chen et al. 2008;....)

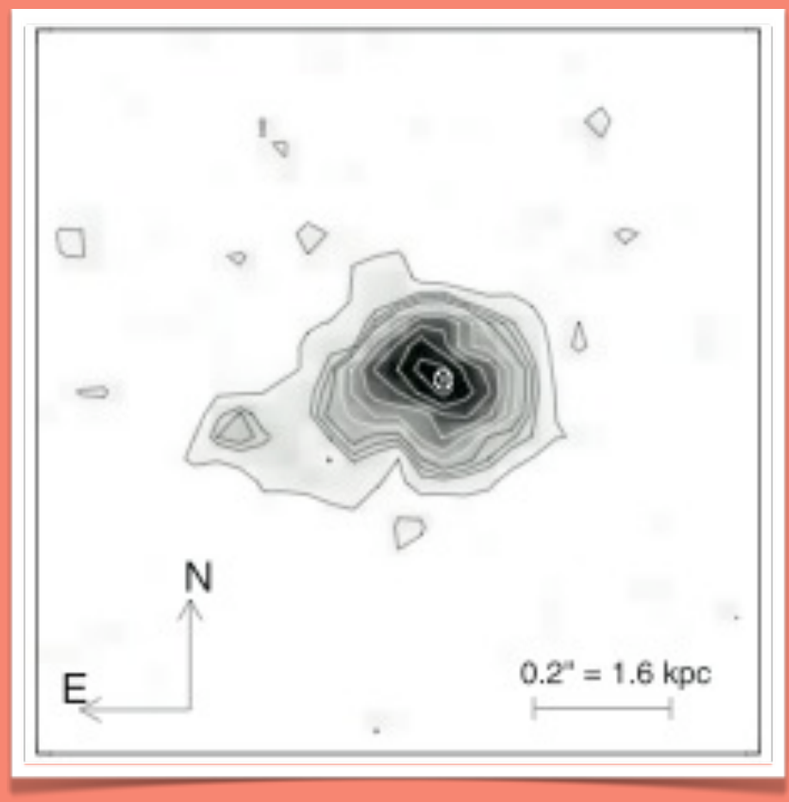


NIR



[OIII]5700 @ 15740 Å

GRB 021004



- One of the best studieded GRB

- Afterglow light curve sampled from X to radio
- VLT/UVES afterglow spectrum (and many other)
- Lyman-alpha emission in the afterglow spectrum

- HST host galaxy observations UVB to NIR (Fynbo et al. 2005):
  m_r= 24.4
  Blue starburst galaxy

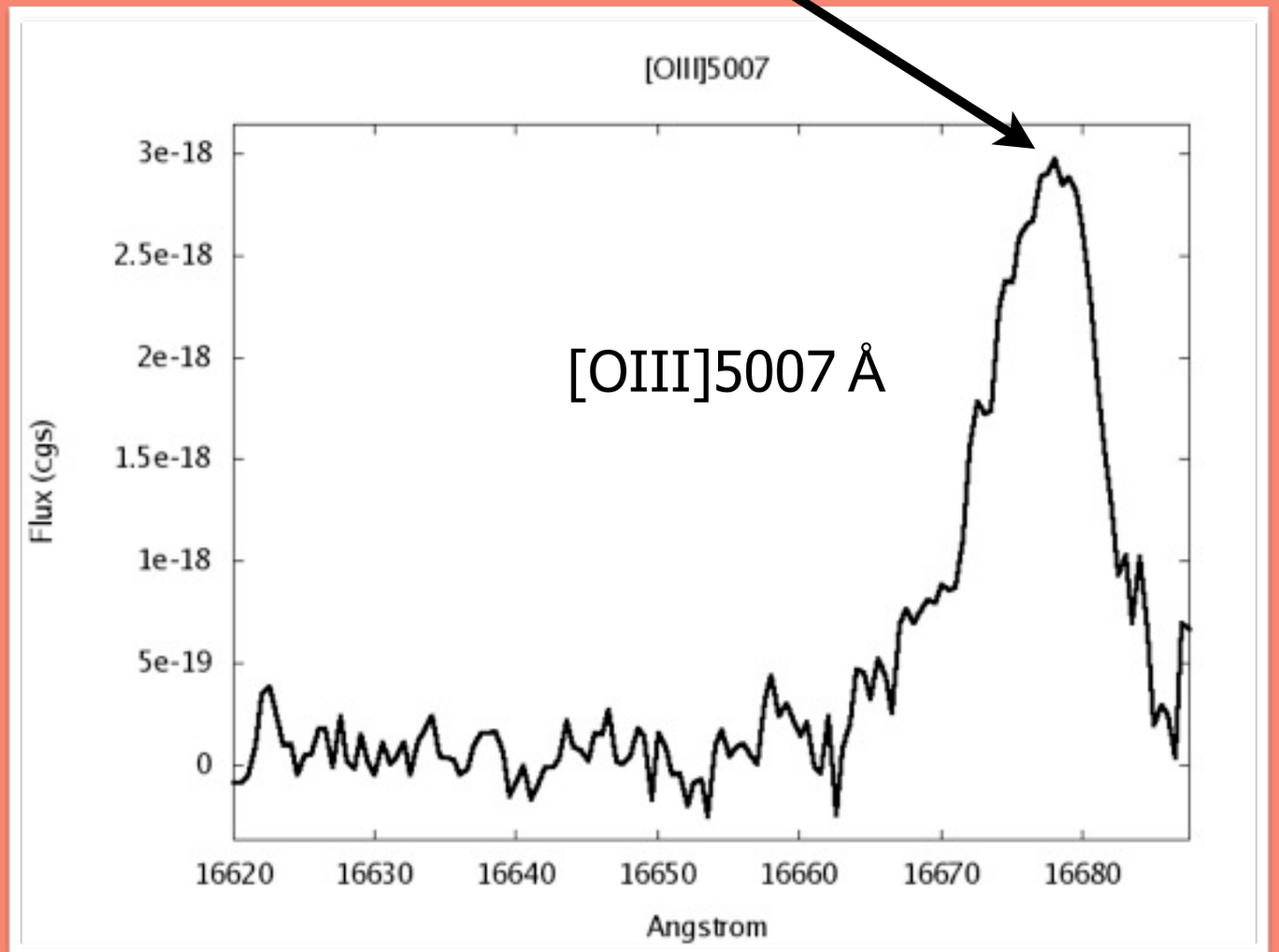
- Tentative [OIII] and H-alpha VLT/ISAAC detections
  (Castro-Tirado et al. 2010)

- SCUBA observations (Tanvir et al. 2004):
  no detection

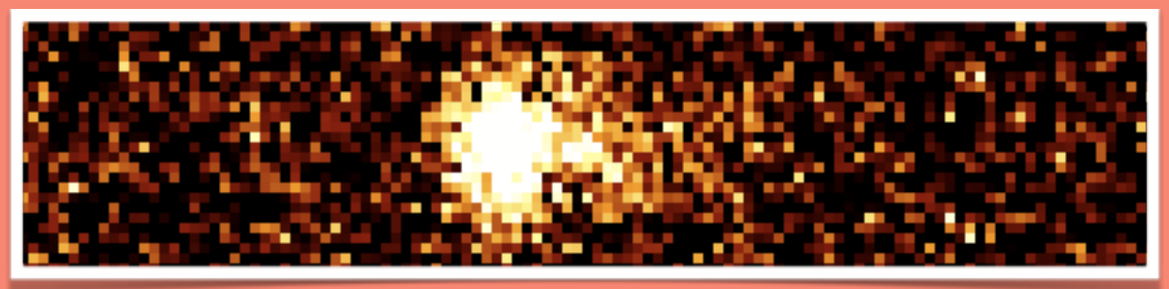
Preliminary results (Vergani et al. in preparation)

detection of [OIII]5700Å doublet, H-alpha, H-beta, Ly-alpha
Limit for [OII]

2D NIR spectrum [OIII]; z = 2.33102

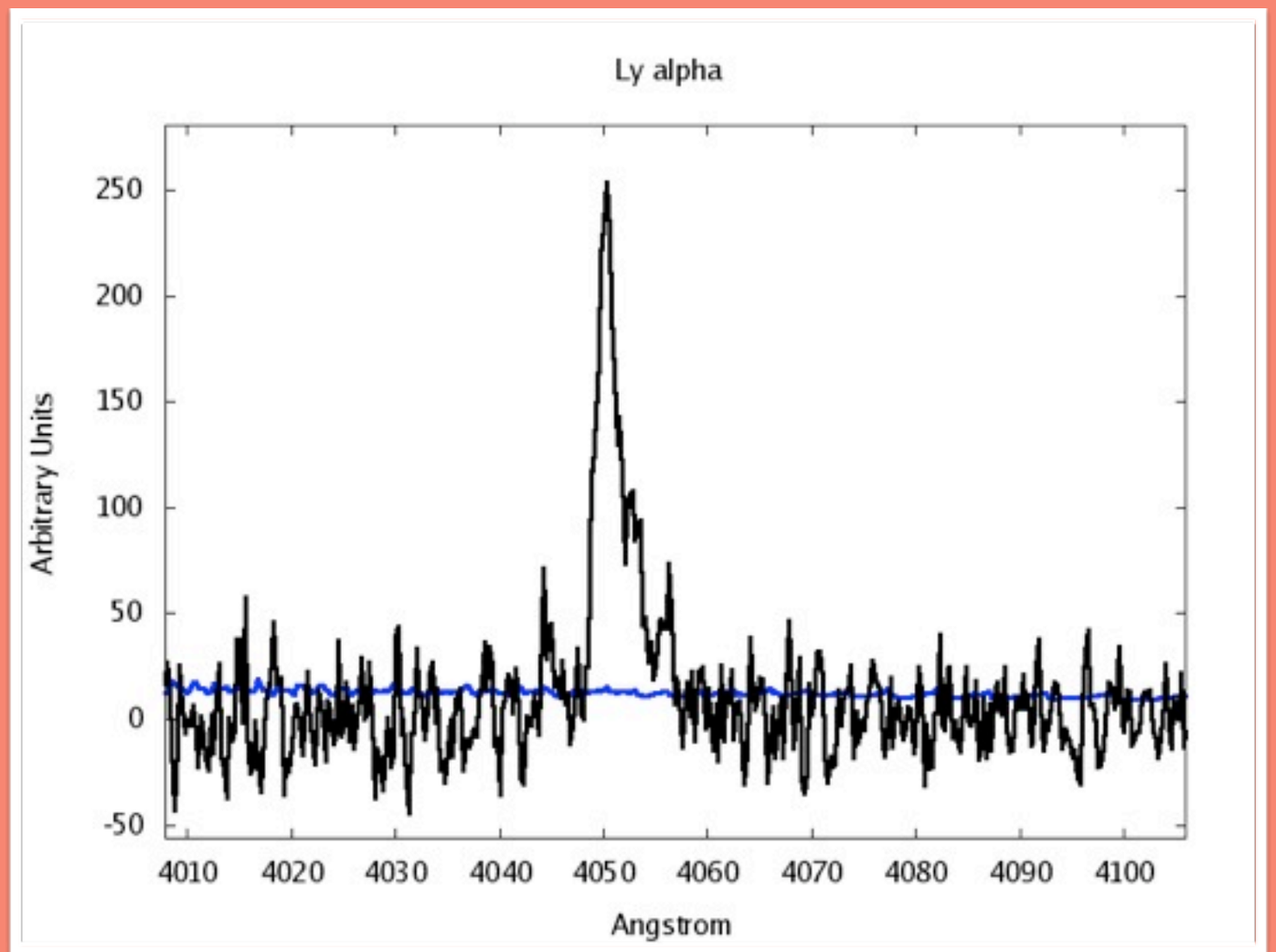


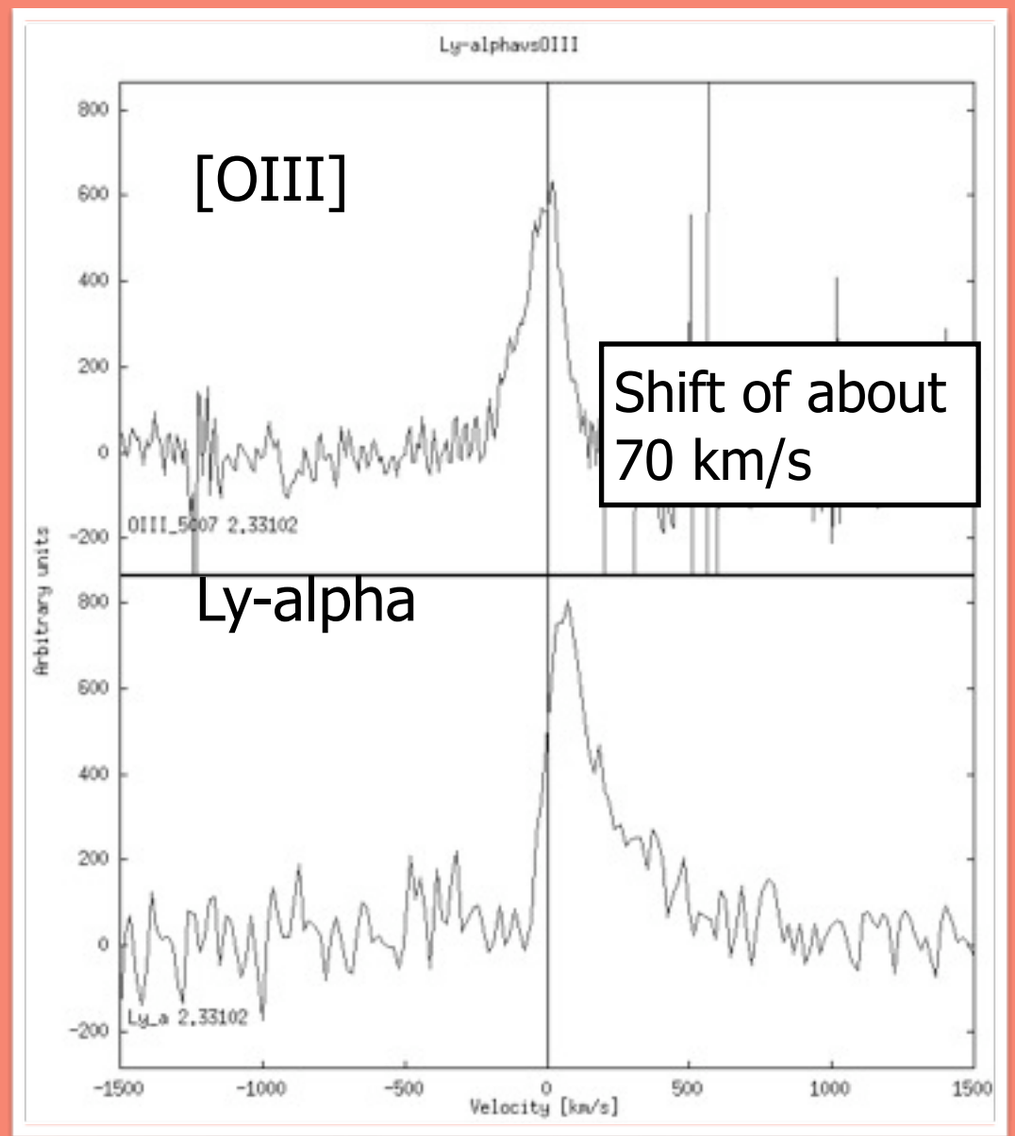
2D UVB spectrum z = 2.33177

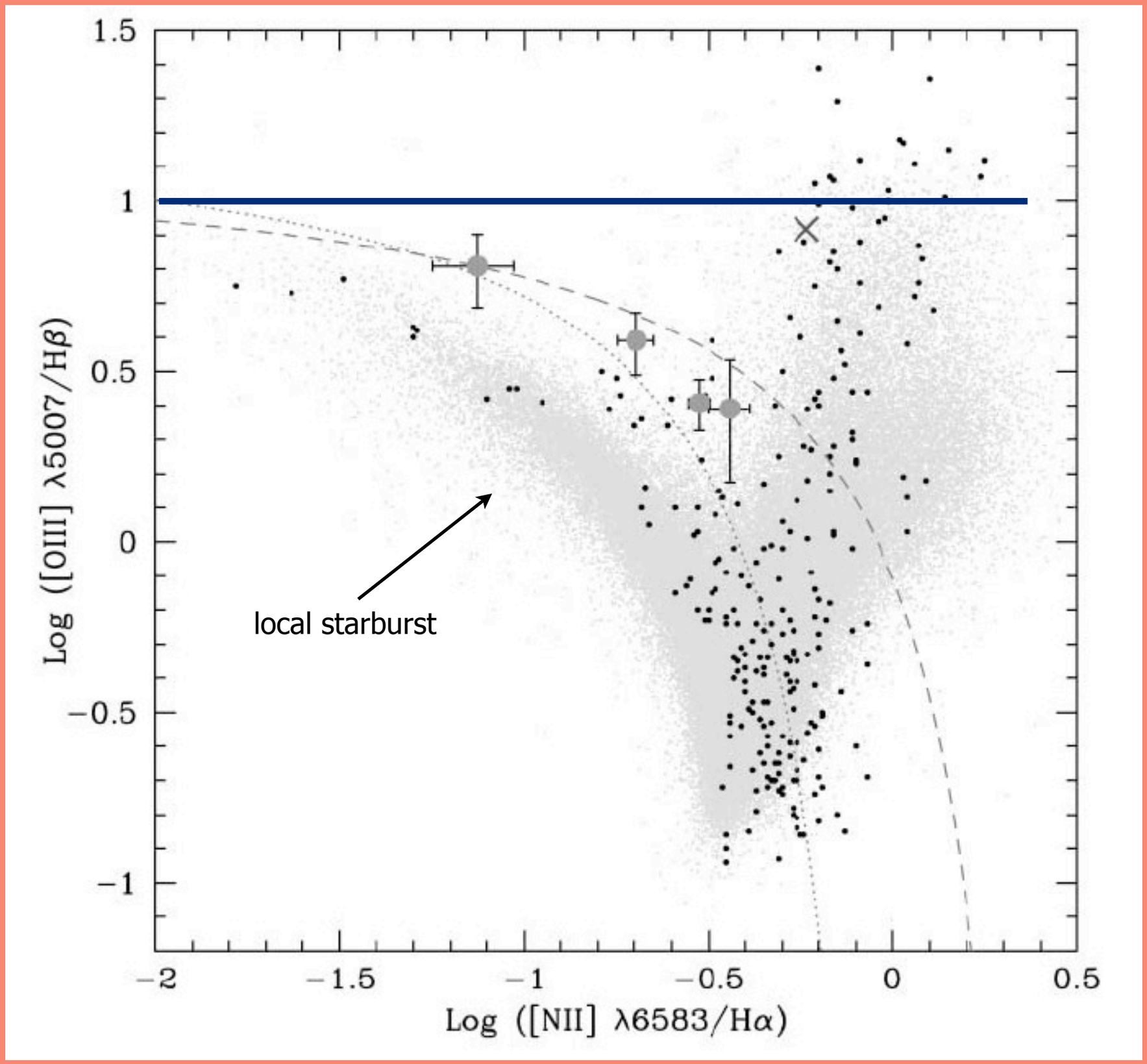


Spatially more extended than [OIII]

Asymmetric profile typical of LAE

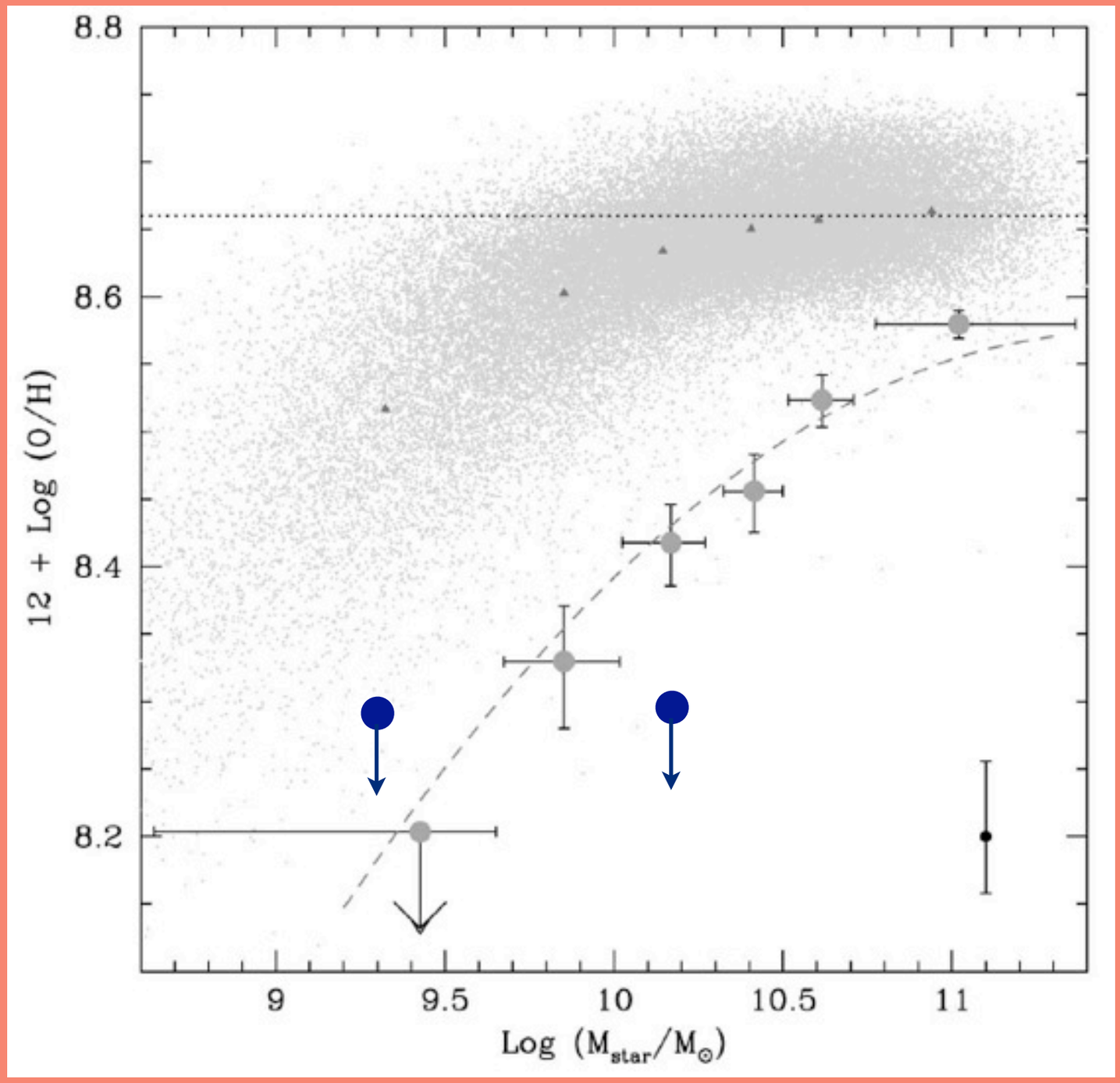






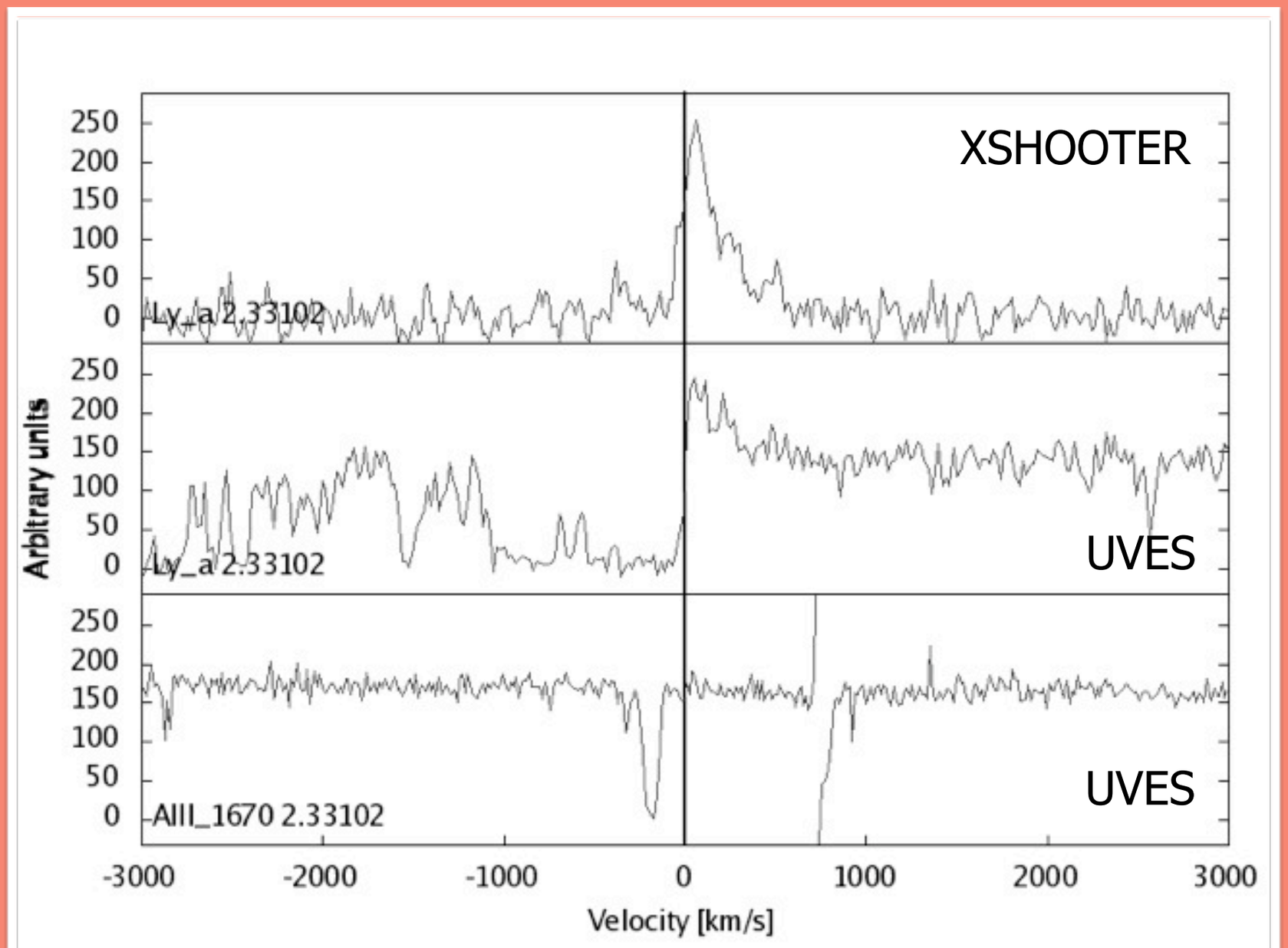
Erb et al. 2006

Mass vs Metallicity at z ~ 2



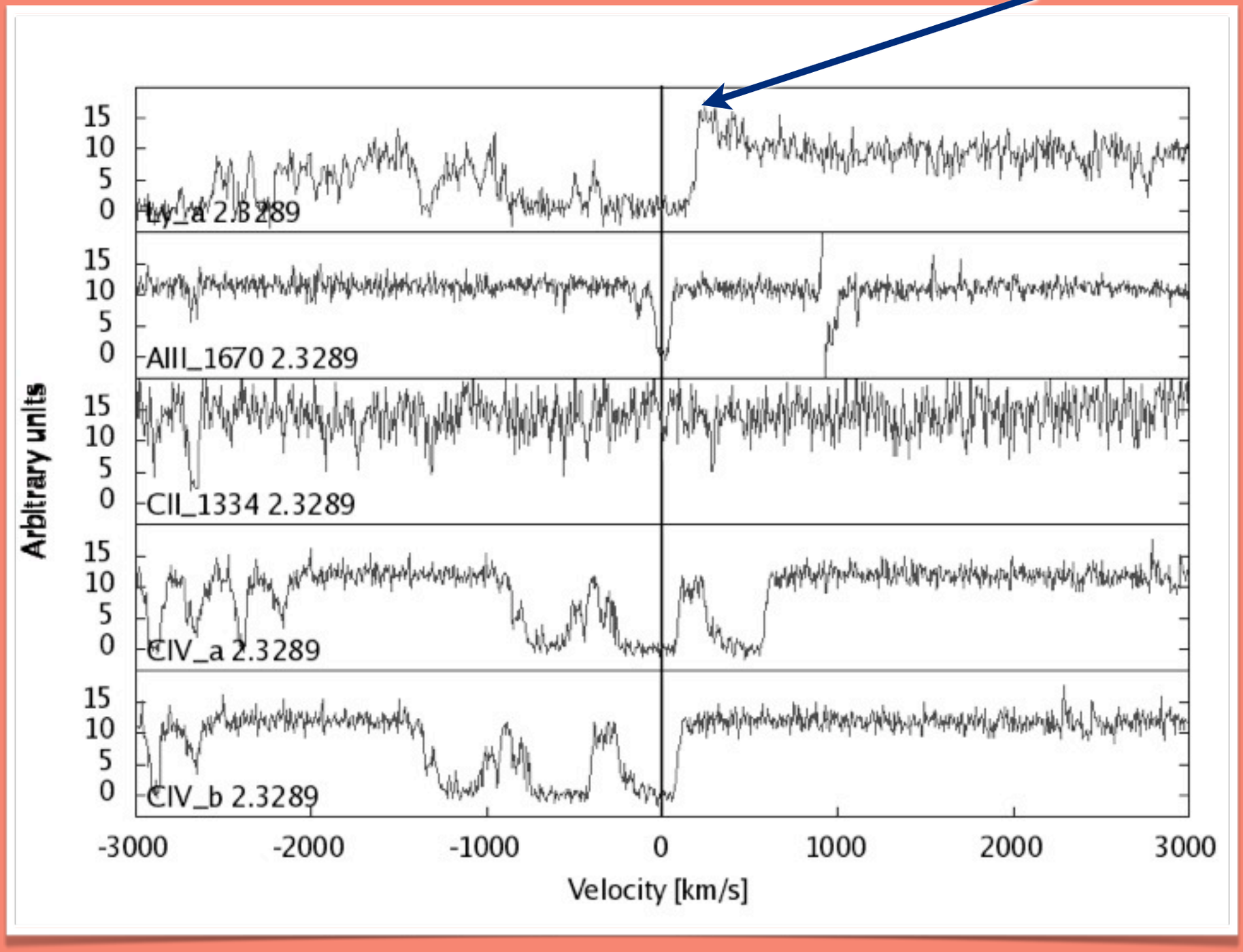
Erb et al. 2006

Lyman-alpha absorption difference of 1/10 only (a few 10^17 ergs/s/cm^2)



UVES afterglow spectrum

Absorbers at z=2.3289
Emission of Lyman-alpha z=2.33167
Δv=250km/s



(Sub-)DLA excess close to the GRB-DLA
(Vergani et al. 2009)

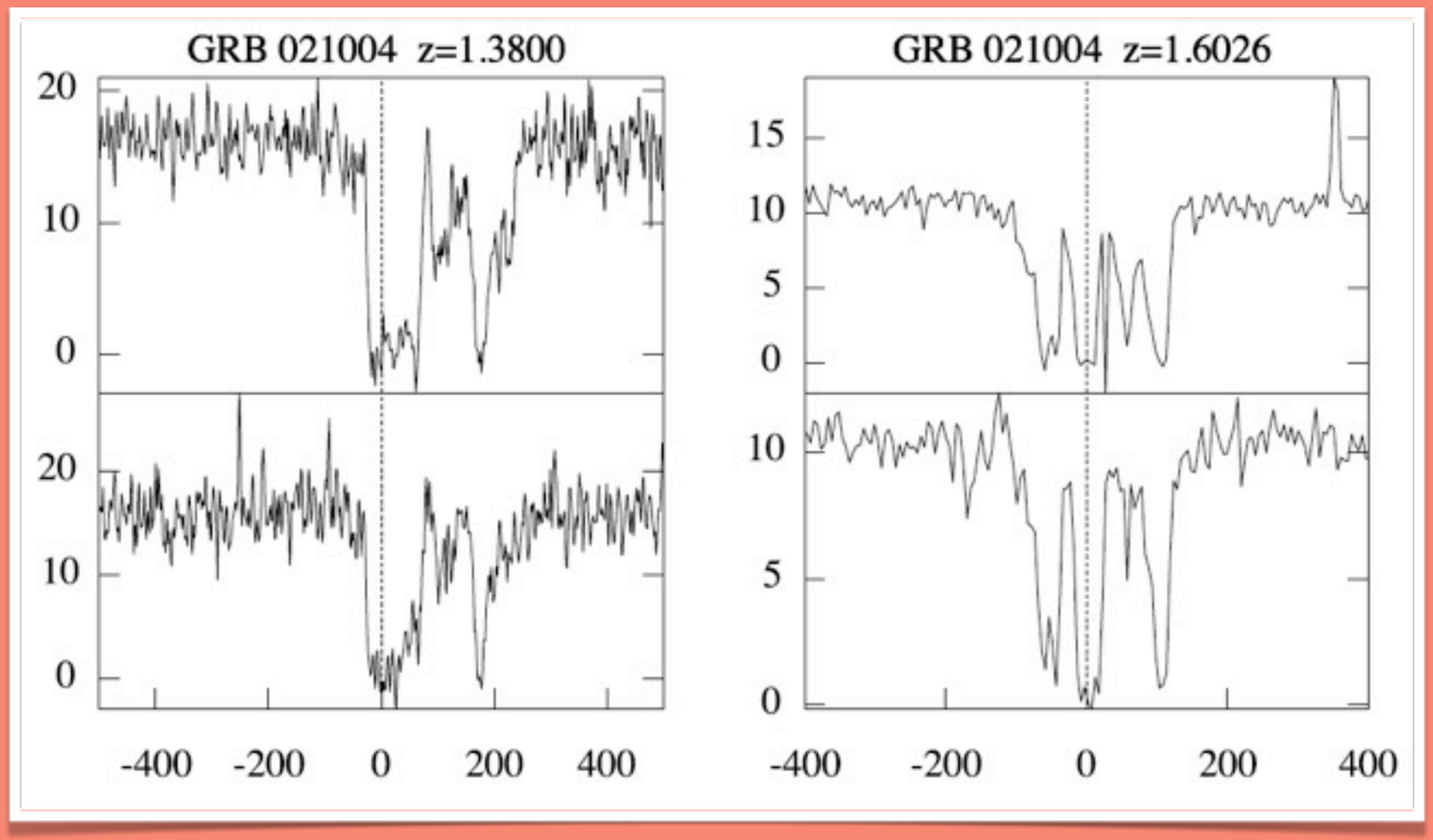
<u>Absorption up to 3000km/s:</u>

- WR wind ? (Fiore et al. 2005;...)
- Close-by galaxy ?

(Chen et al. 2007)

2 strong MgII intervening systems (Vergani et al. 2009;...)

MgII doublet



Wr = 1.6 Å

Wr = 1.4 Å

Excess of strong MgII absorbers along GRB lines of sight

Prochter et al. 2006; Sudilovsky et al. 2007; Porciani et al. 2007; Cucchiara et al. 2009; Vergani et al. 2009; Tejos et al. 2009

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QSO

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QSO

GRB

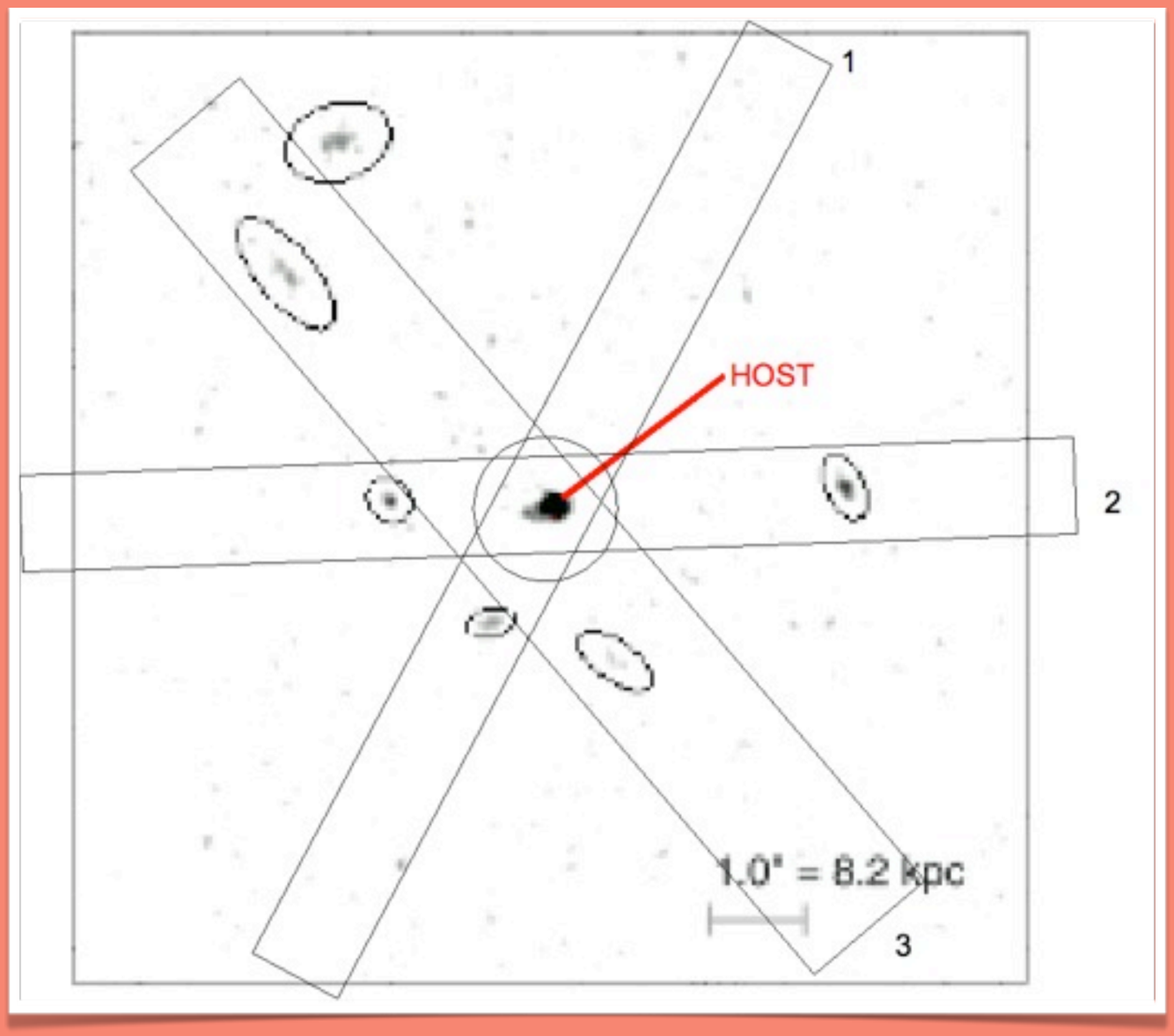
GRB 021004

X-shooter observations (nodding)

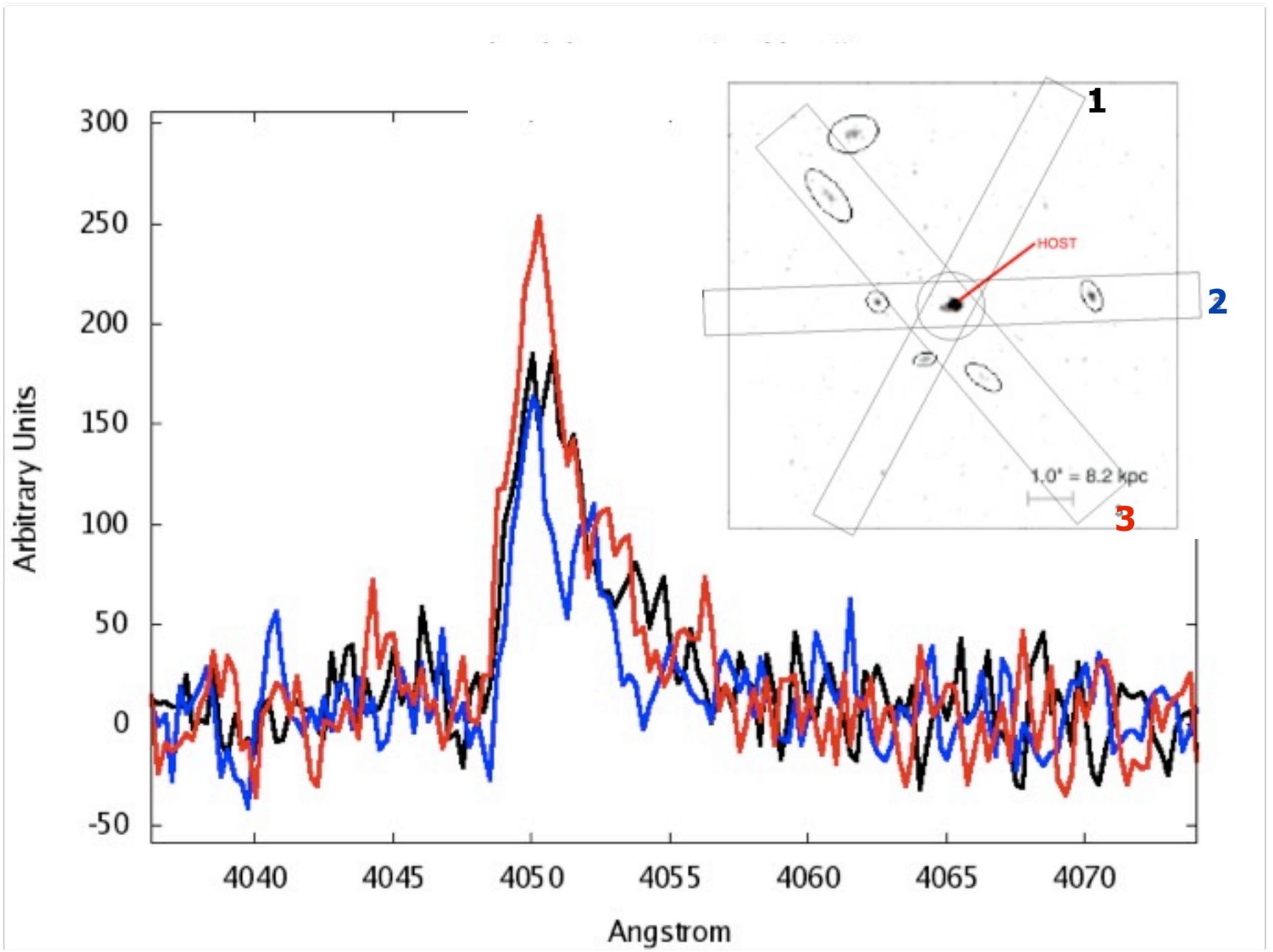
Slit position 1
Slit UVB 1.0" R=5100 t_exp=4800
VIS 0.9" R=8800 t_exp=4800
NIR 0.9" R=5100 t_exp=5200

Slit position 2
Slit UVB 1.0" R=5100 t_exp=3600
VIS 0.9" R=8800 t_exp=3600
NIR 0.9" R=5100 t_exp=5200

Slit position 3
Slit UVB 1.6" R=3300 t_exp=4800
VIS 1.5" R=5400 t_exp=4800
NIR 1.5" R=3300 t_exp=5200



Determine if the close-by galaxies are associated to the foreground absorptions

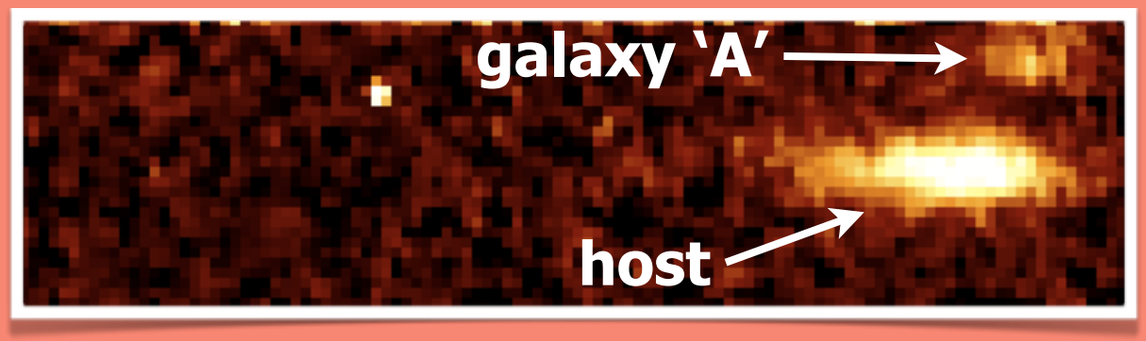


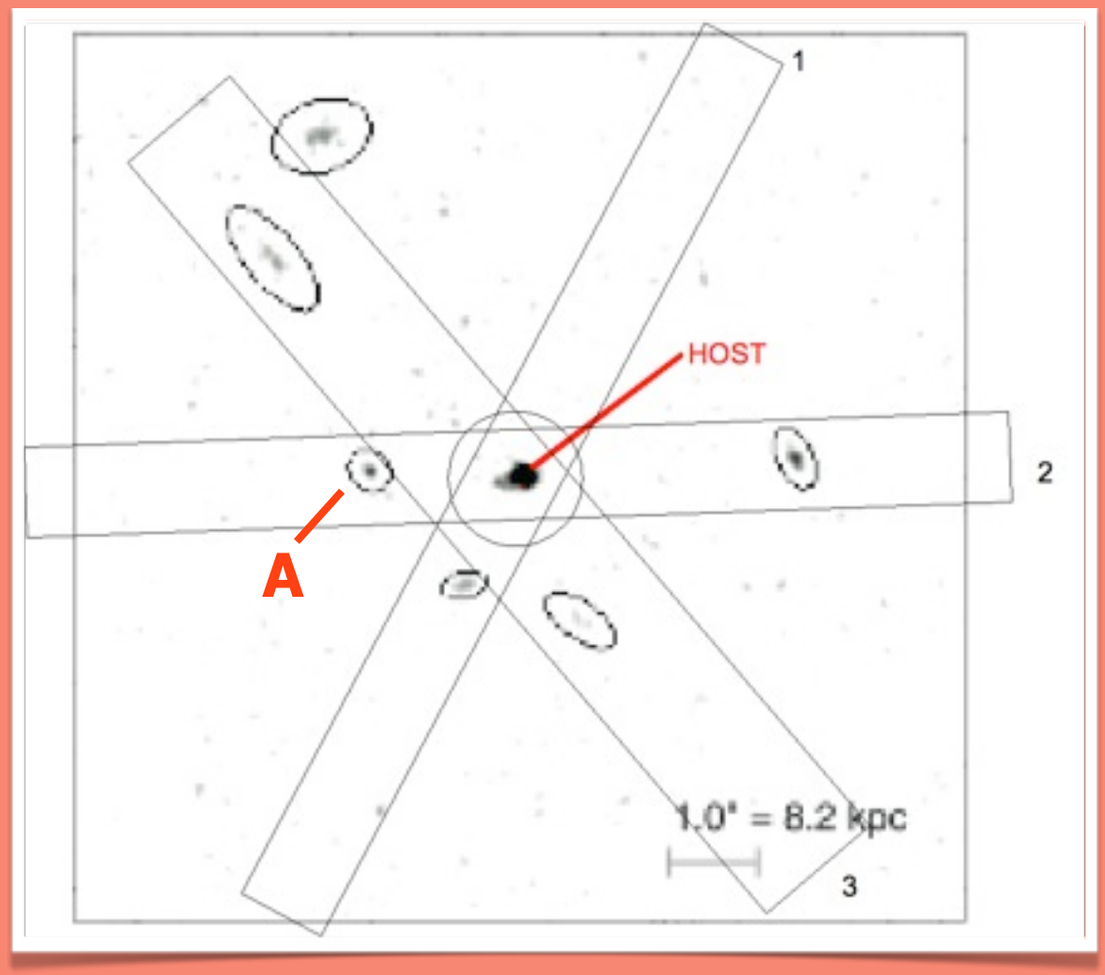
Verhamme et al. 2006

NHI, Vexp, b

Properties and distribution of the neutral gas

[OIII] 5007 Å





Interactions between the host and 'A' ?

High velocity absorbers: outflowing gas ?

No detections of intervening absorbers counterparts

Merci!