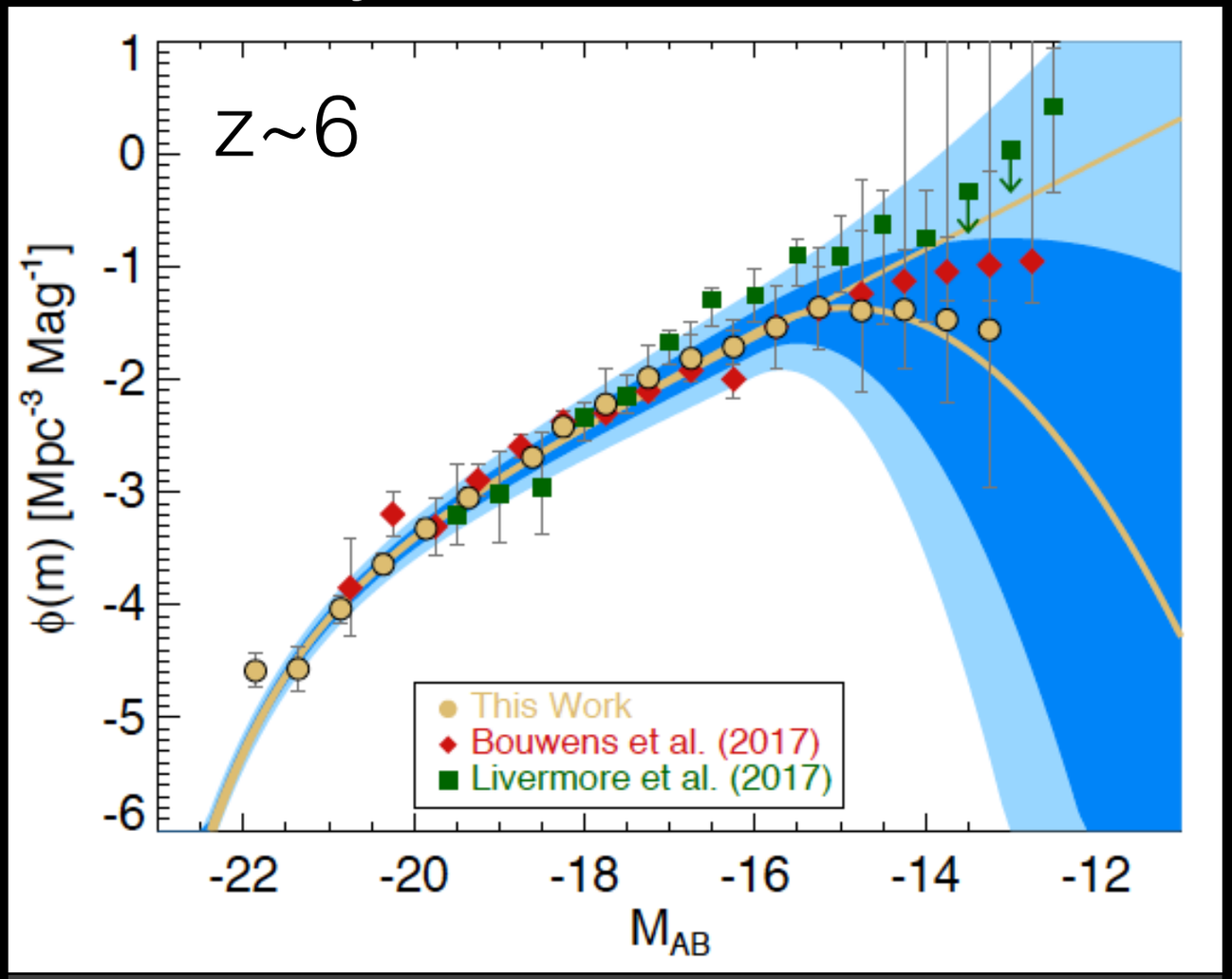
Observations of the bulk of the population of very high-redshift galaxies

Photometry

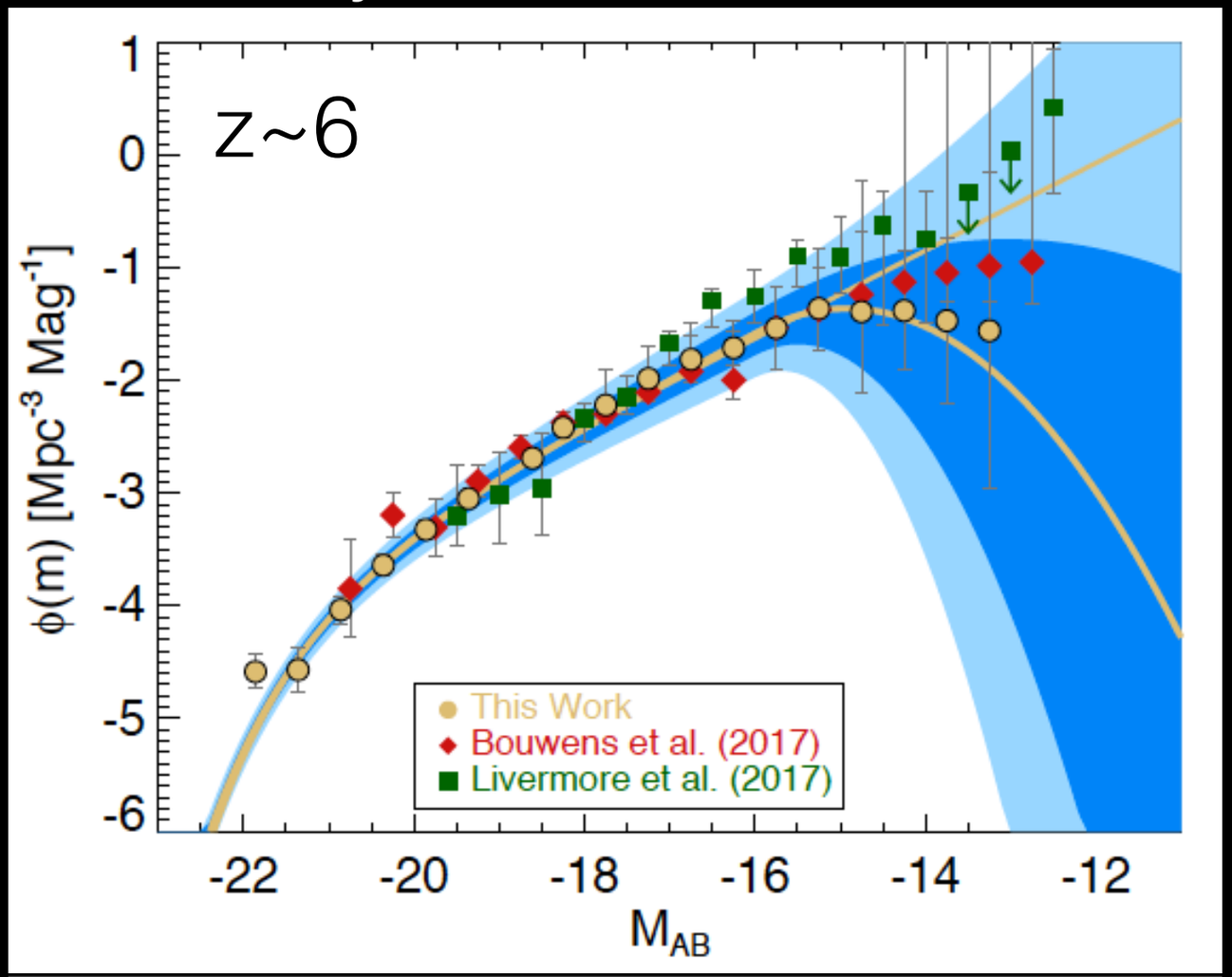


Atek+18

A deep JWST survey with a time investment similar to the HUDF, will reach UV absolute magnitudes − 16 (− 15.5) at z = 10 (z = 7), two magnitudes fainter than the current HST observations

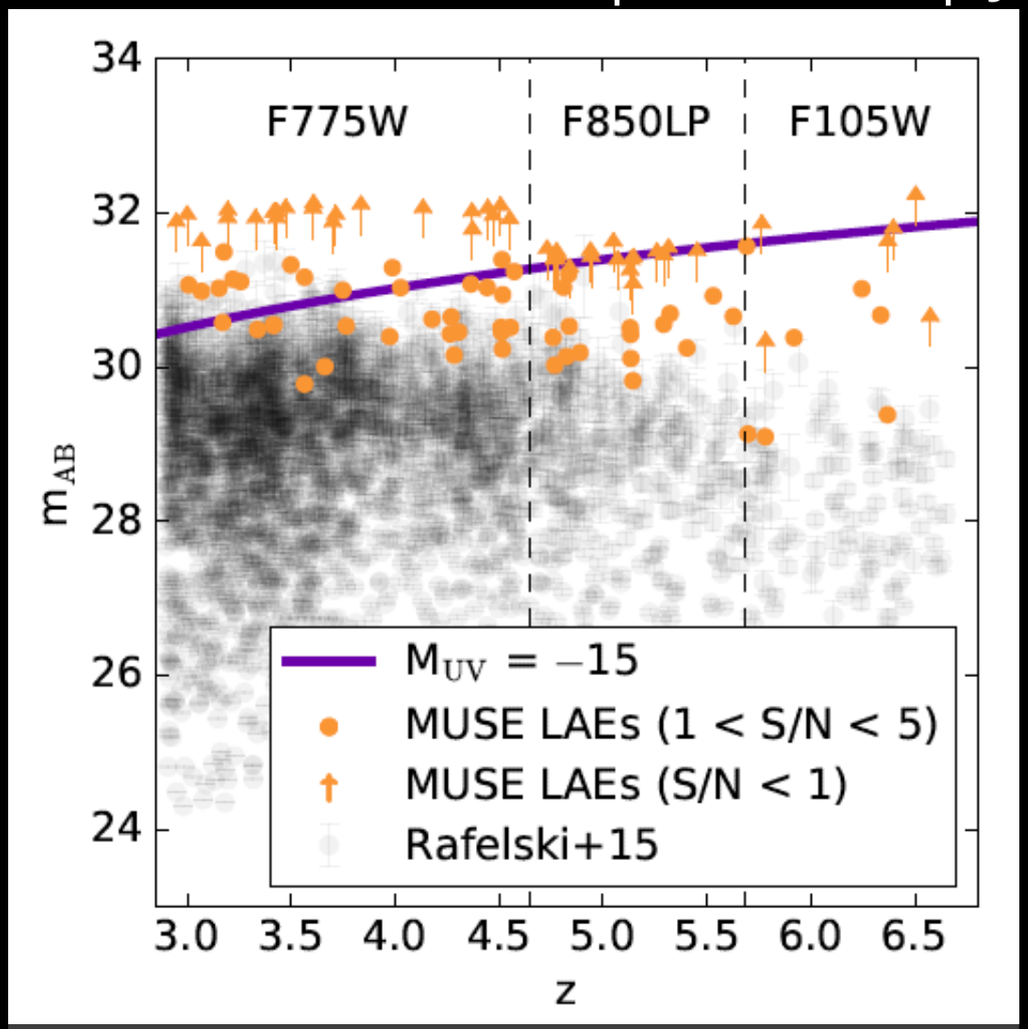
Observations of the bulk of the population of very high-redshift galaxies

Photometry



Atek+18

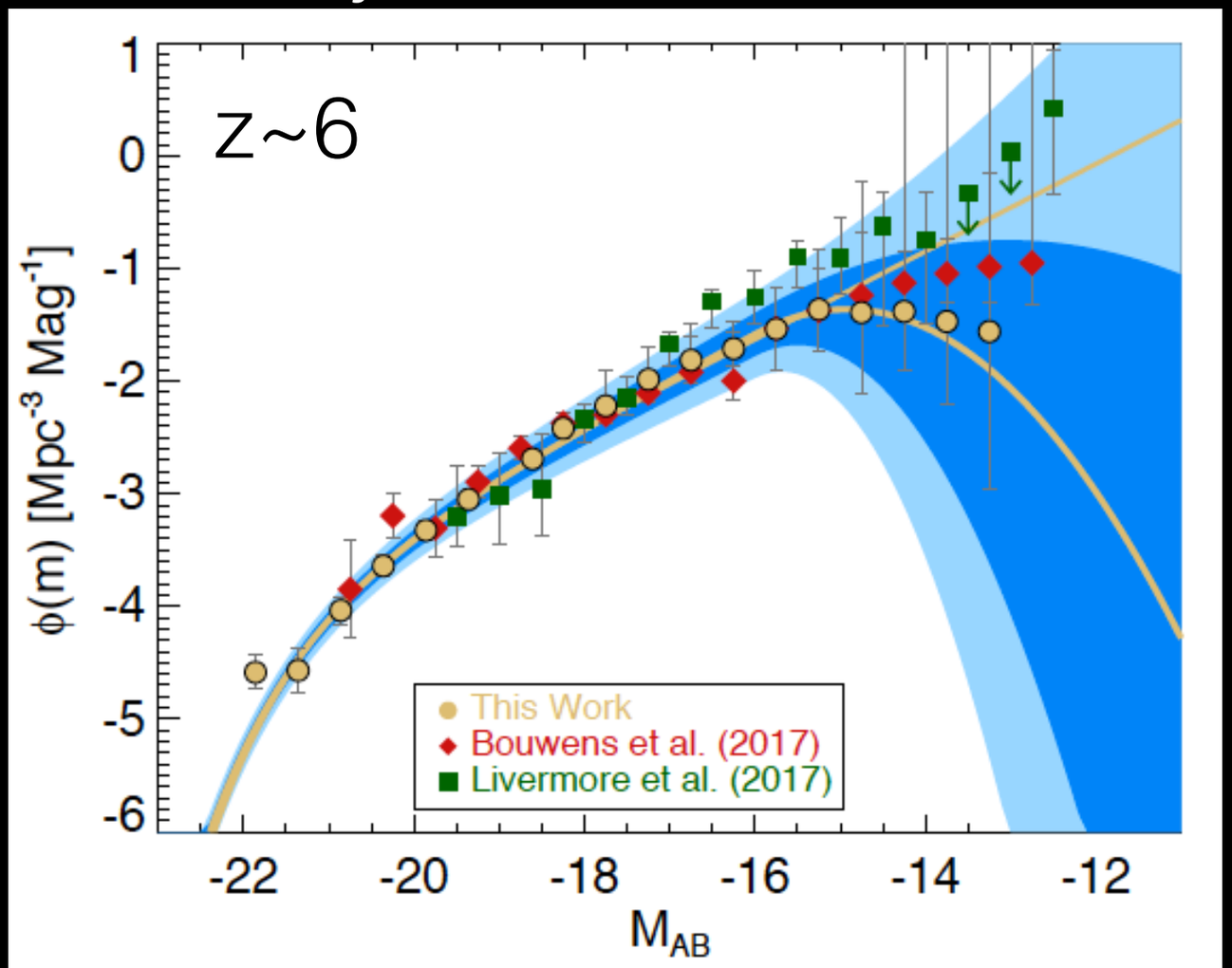
Spectroscopy



Maseda+18

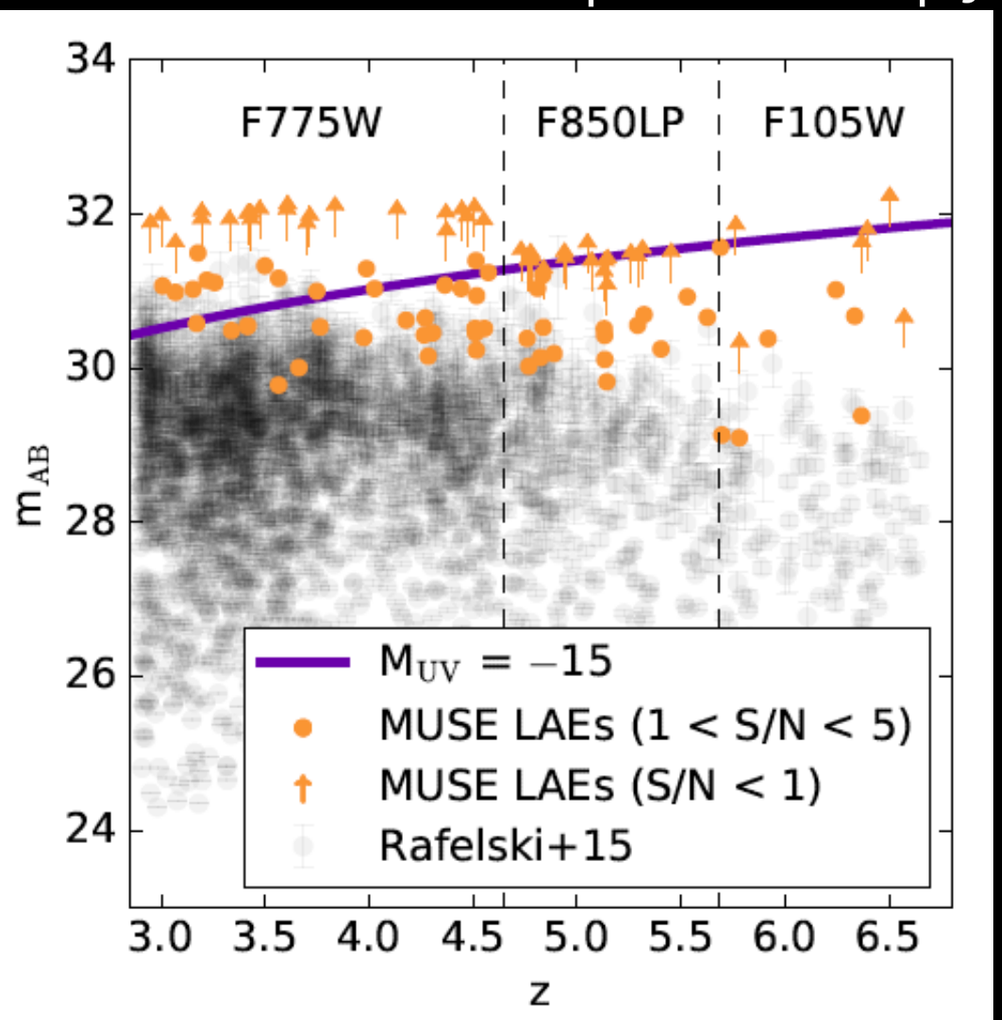
Observations of the bulk of the population of very high-redshift galaxies

Photometry



Atek+18

Spectroscopy

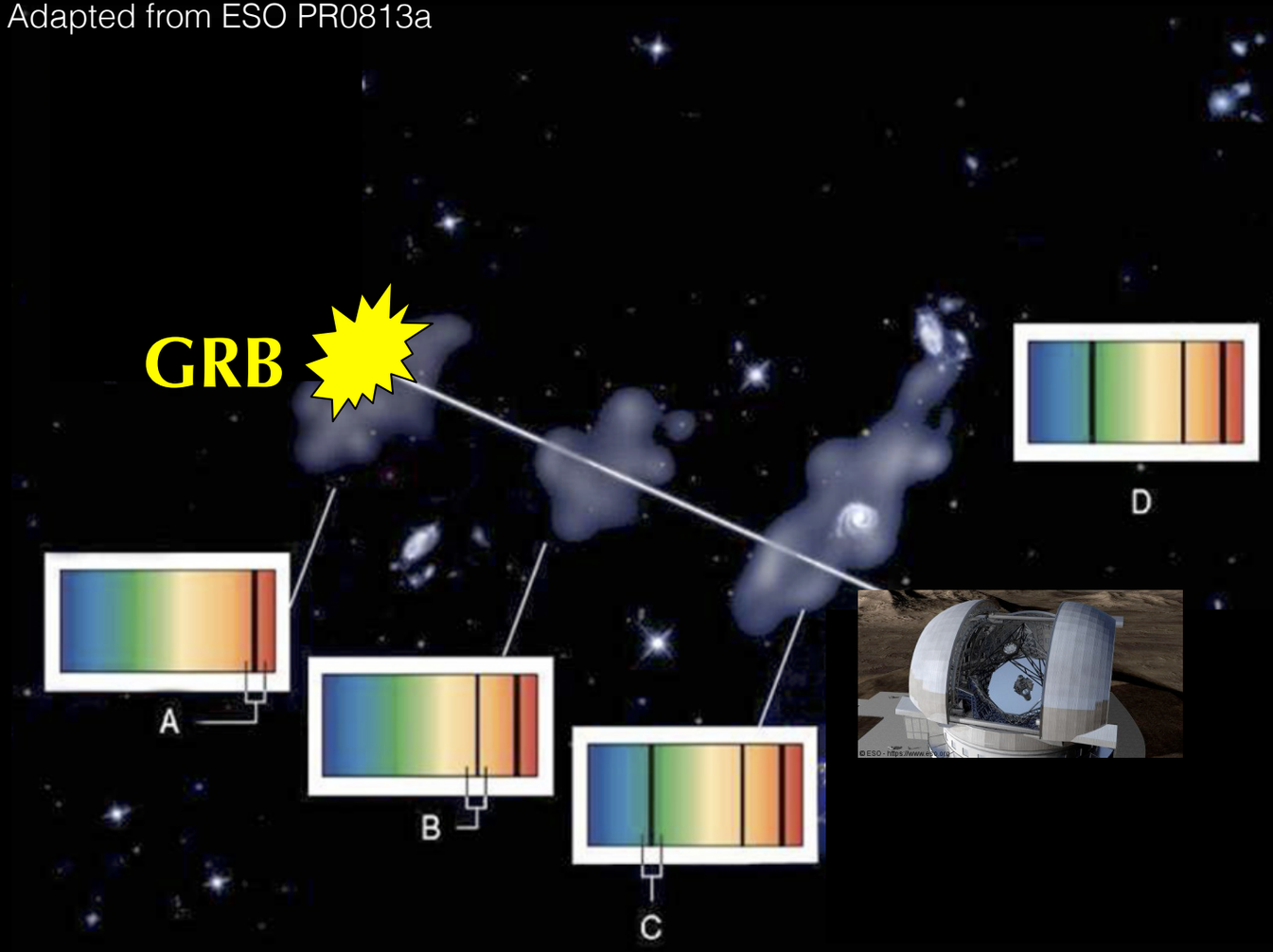


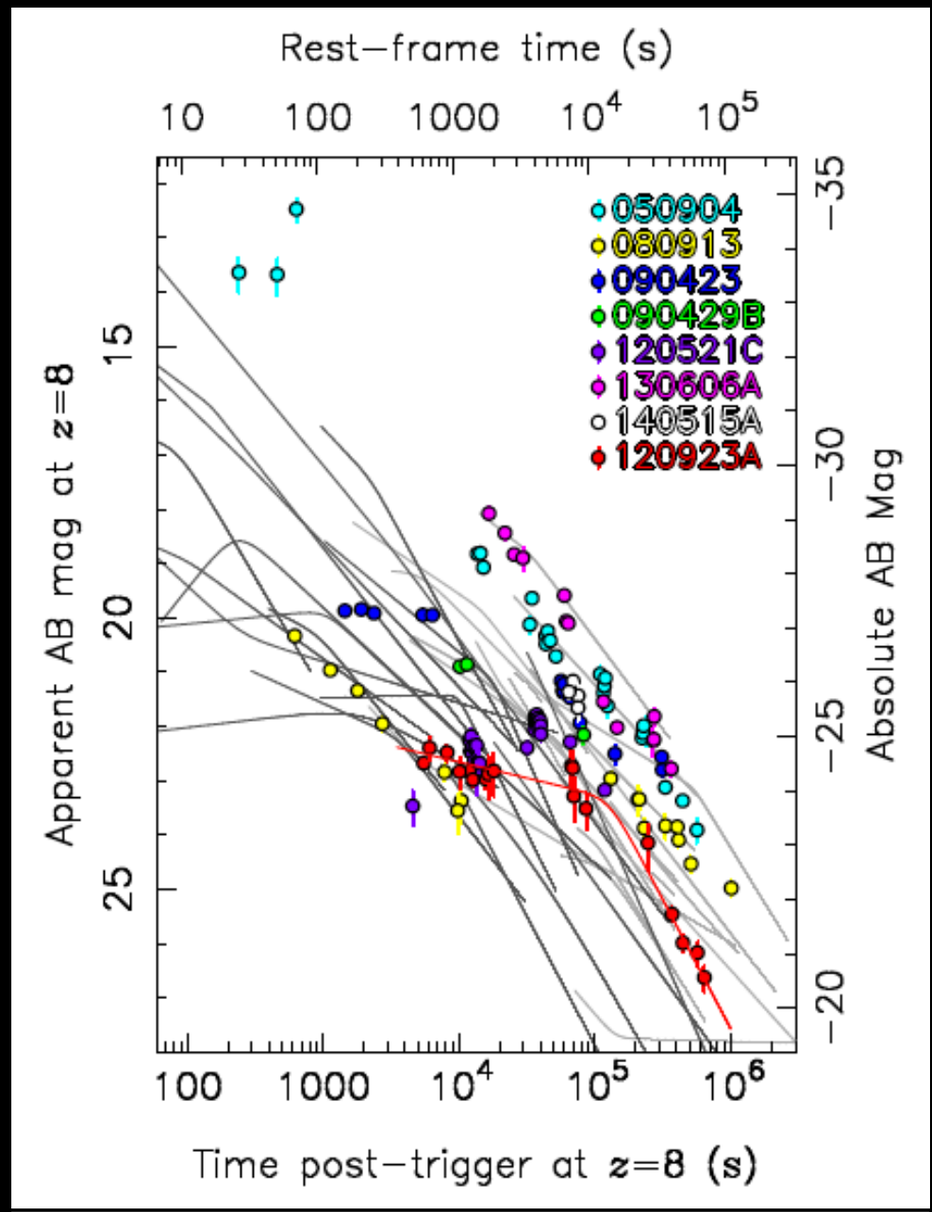
Maseda+18

No information on the ISM: bright continuum needed

Enlightening the first galaxies with gamma-ray bursts

Adapted from ESO PR0813a





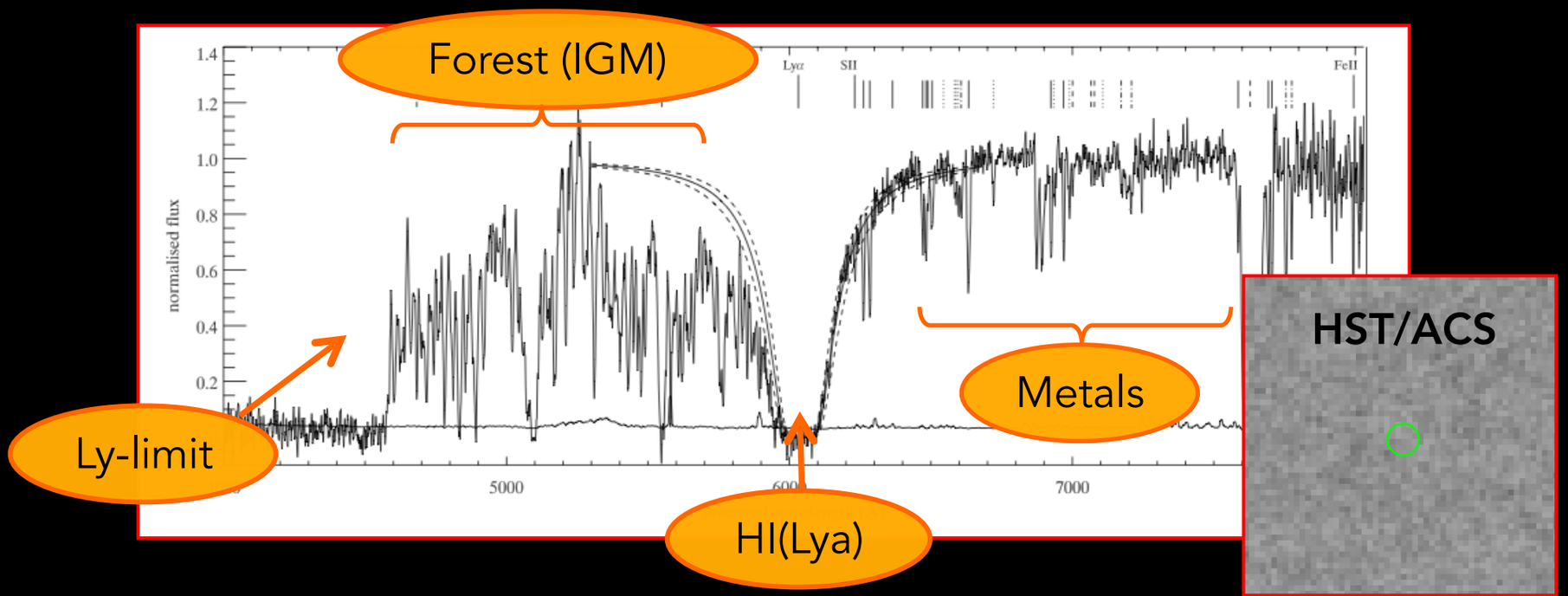
Tanvir+18

Detection: gamma rays

Pinpoint to SF galaxies at any redshift

Bright optical/near-infrared afterglows

Enlightening the first galaxies with gamma-ray bursts



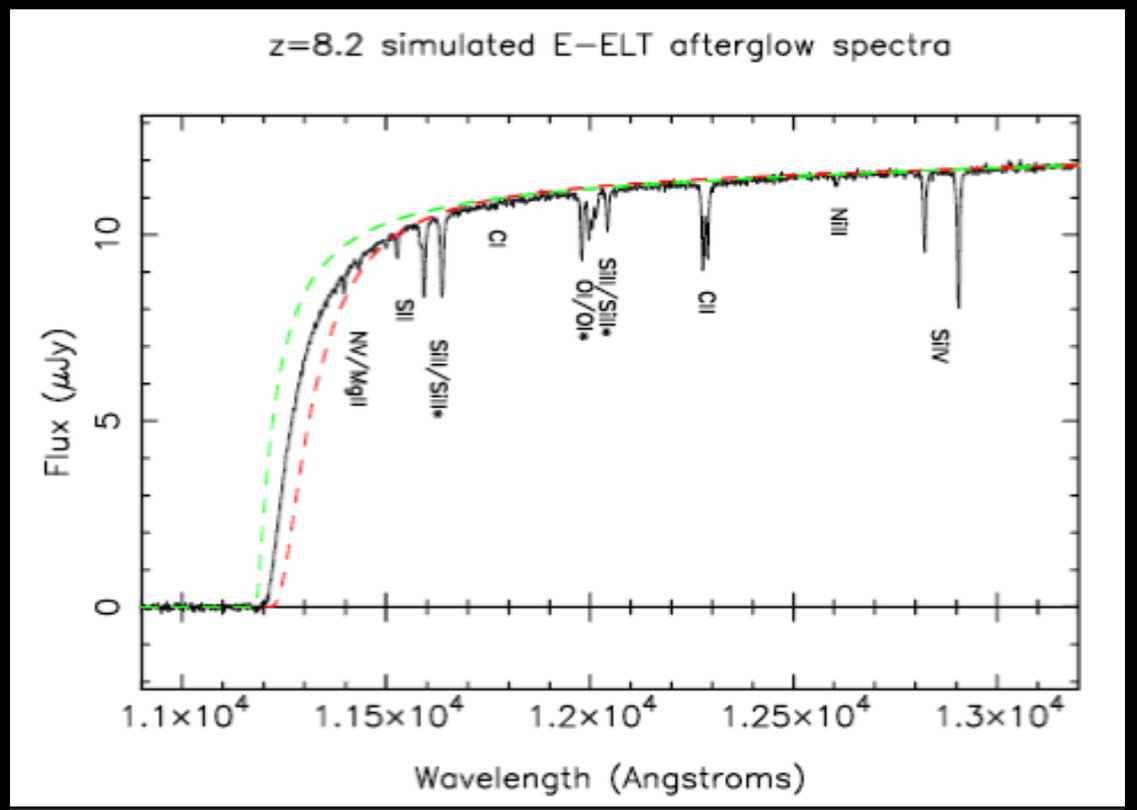
z=3.97

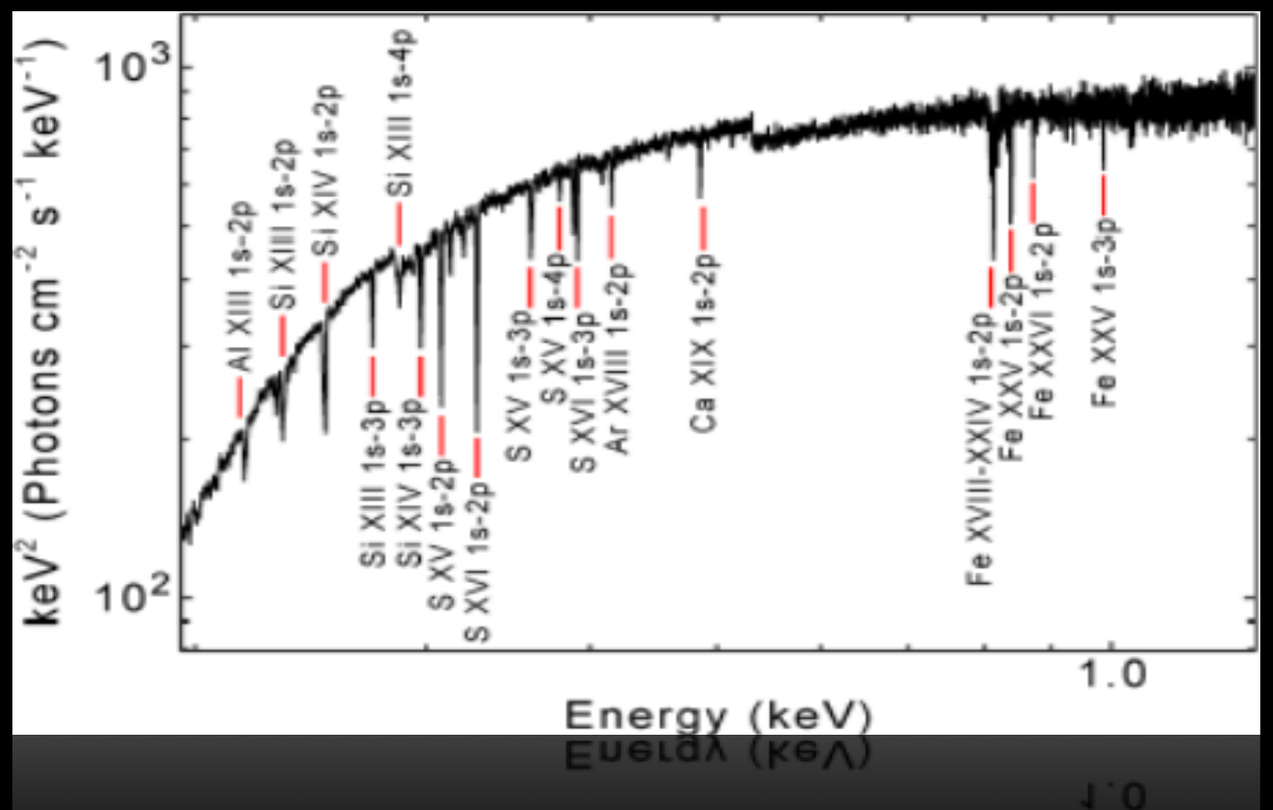
[Fe/H]=-2

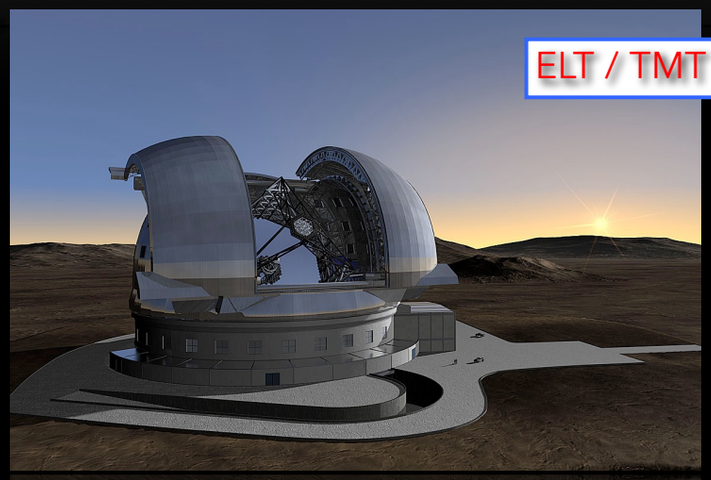
R>28.5

Chen+ 2005; Starling+2005

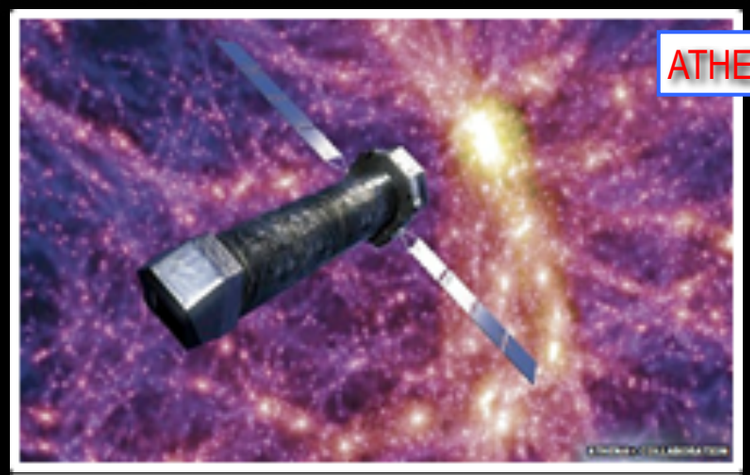
ELT & ATHENA SYNERGY







ELT / TMT / GMT



ATHENA

Courtesy of the THESEUS & ATHENA collaborations

Gamma-Ray Bursts Physics
(F. Daigne's talk)

Requirements for a GRB mission

- **Be sensitive to all classes of GRBs**
- **For each class of GRBs, be able to build a sample with prompt (including spectrum) + afterglow + redshift + host galaxy** (polarization ?)
- **For cosmology:**
  - **be able to detect a significant number of long GRBs at high z**
  - **provide rapidly accurate positions** (e.g. for high-res AG spectro.)
- **For MMA observations:**
  - **γ-rays: have a good sensitivity to short GRBs**
    cover a very large f.o.v.
  - **X-rays: ideally cover a very large f.o.v with a good sensitivity**
    otherwise: strategy is more complexe to define
  - **other wavelength: limit magnitude/flux + sky coverage**
- **Orphans ?**

High Energy Transient Sources (N. Webb's talk)

Summary

THESEUS should be able to make important contributions to :

Accretion and ejection physics

Understanding type 1a supernovae

Demographics of compact objects and thus understanding stellar evolution

The nature of neutron star matter

The origin of magnetars and their strong magnetic fields

The formation and evolution of supermassive black holes

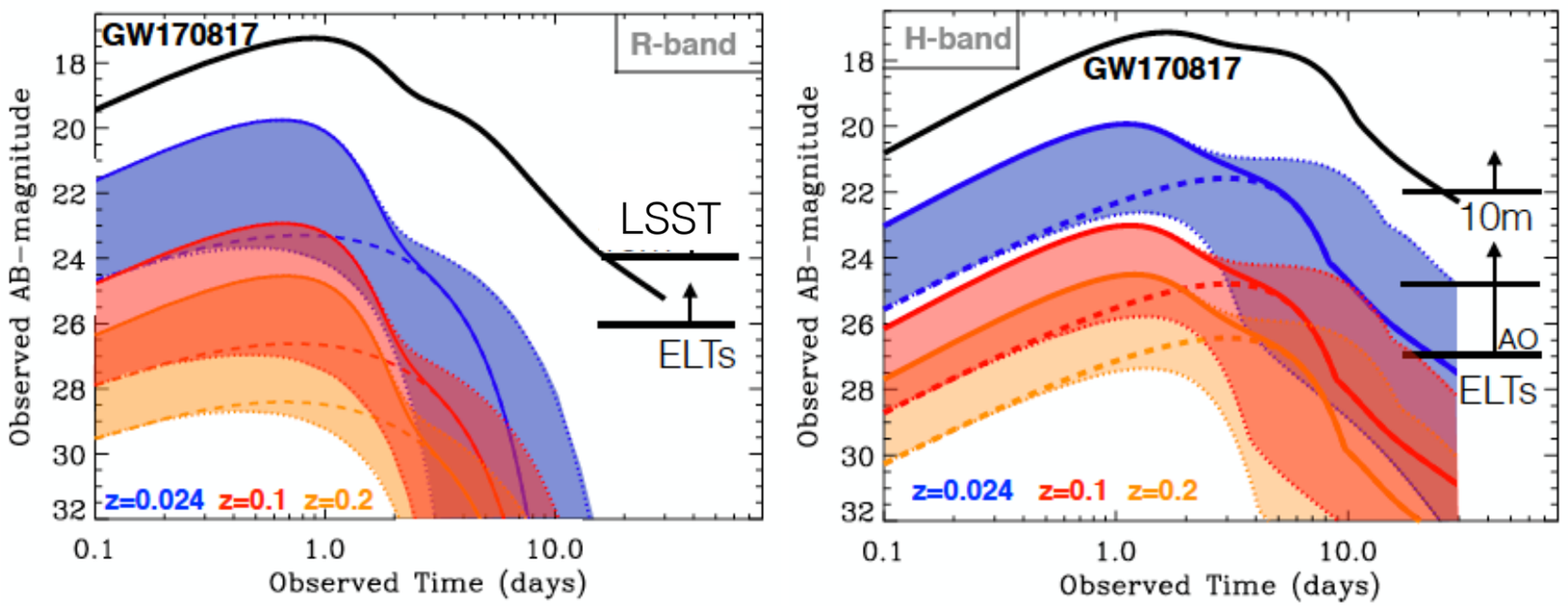
Discovery of new serendipitously detected (classes of) objects

Follow-up transients detected at other facilities

Gravitational Waves: Situation in >2025 (Phase Plus)

- LIGO - Virgo - KAGRA - LIGO India
- NSNS (rate: ?) ~ *15 times current volume*
- sky regions ~few/ten square degrees

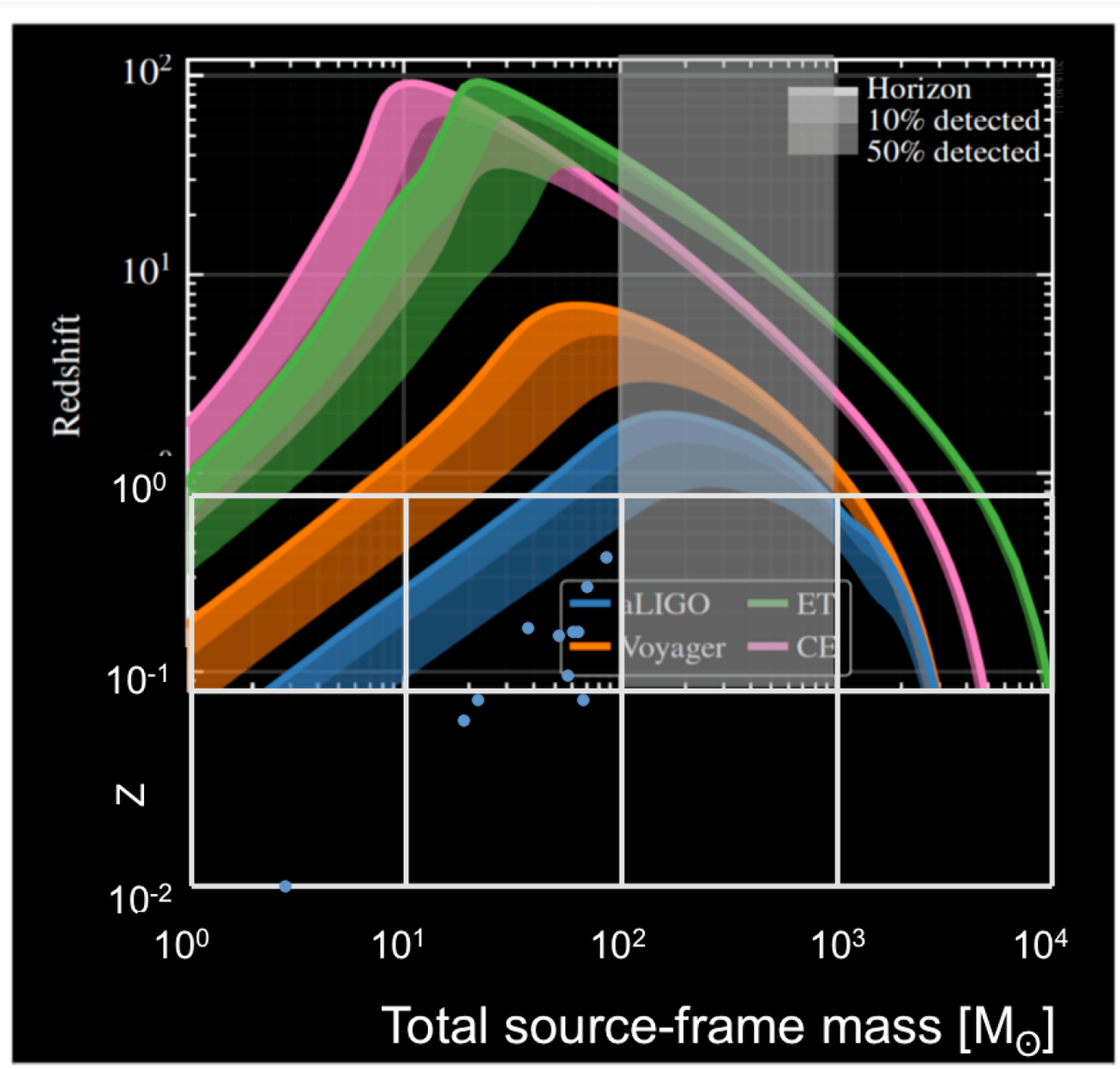
adapted from Chornock+2019



Too faint? Too many candidates? Only photometry?

Situation in ~2035

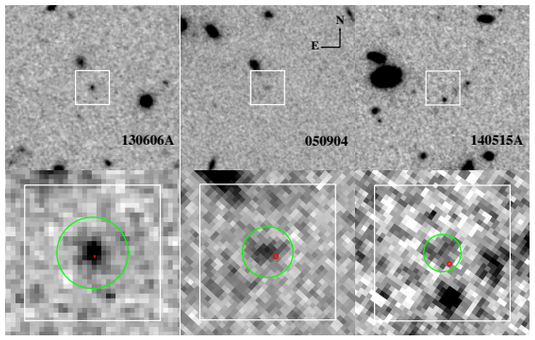
3G instruments for GW
EinsteinTelescope & CosmicExplorer

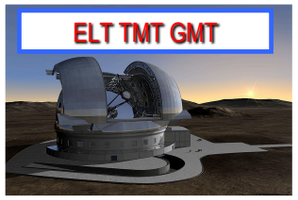


Rely on wide field space missions able to identify high-energy emission with good localization

theseus
TRANSIENT HIGH ENERGY SKY AND EARLY UNIVERSE SURVEYOR

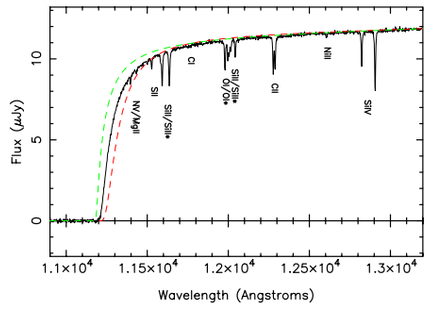
Star formation history, primordial galaxies

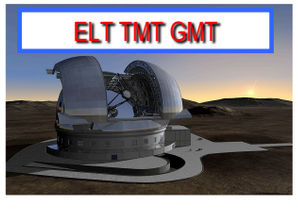




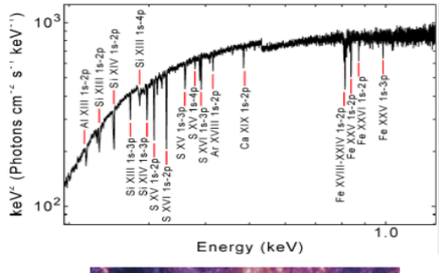
Neutral fraction of IGM, ionizing radiation escape fraction

z=8.2 simulated ELT afterglow spectrum

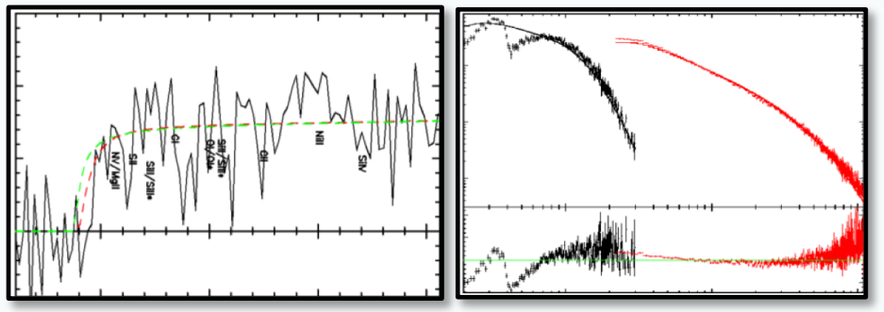


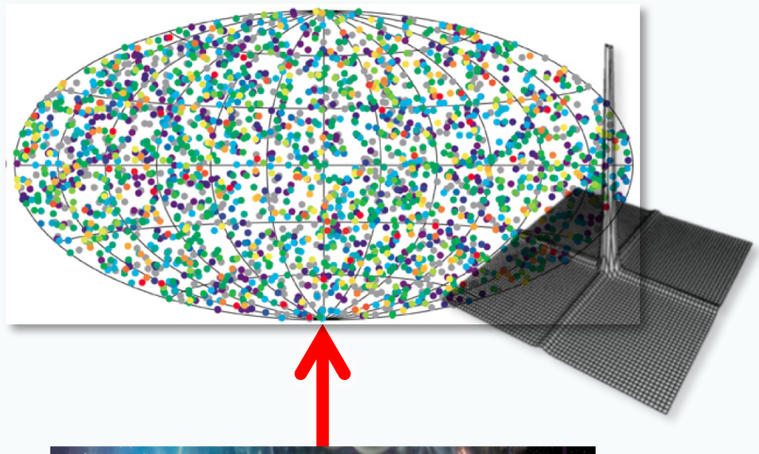


Cosmic chemical evolution, Pop III

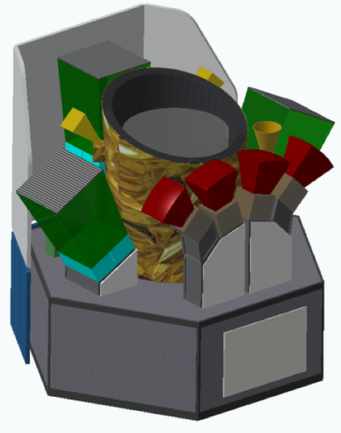


GRB accurate localization and NIR, X-ray, Gamma-ray characterization, redshift





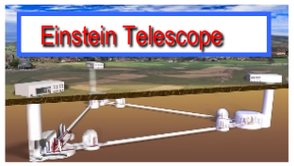
theseus
TRANSIENT HIGH ENERGY SKY AND EARLY UNIVERSE SURVEYOR

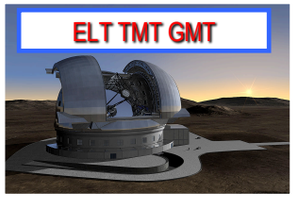


THESEUS SYNERGIES

Localization of GW/neutrino gamma-ray or X-ray transient sources
NIR, X-ray, Gamma-ray characterization

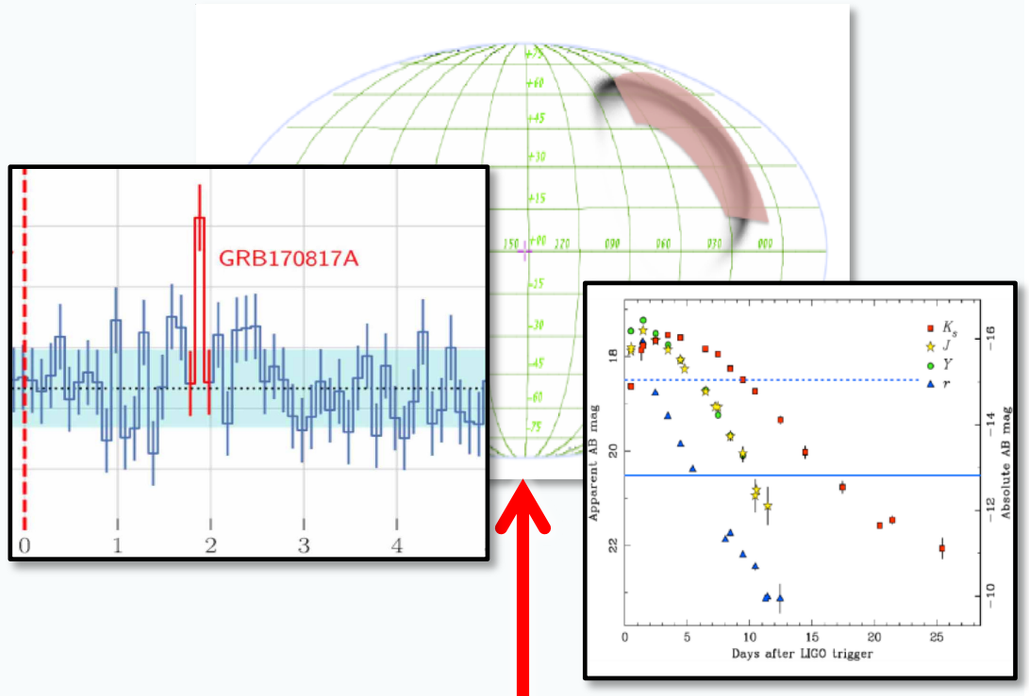
NS-BH/NS-NS merger physics/host galaxy identification/formation history/kilonova identification

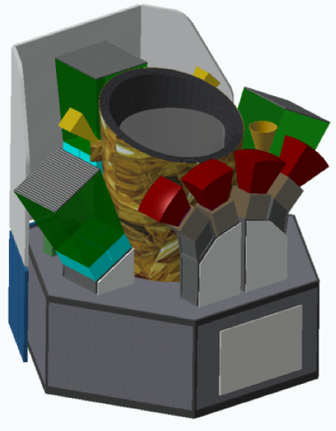




Hubble constant

r-process element chemical abundances





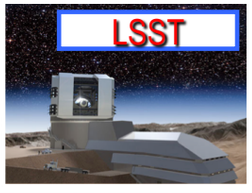
THESEUS SYNERGIES

Transient sources multi-wavelength campaigns

Accretion physics

Jet physics

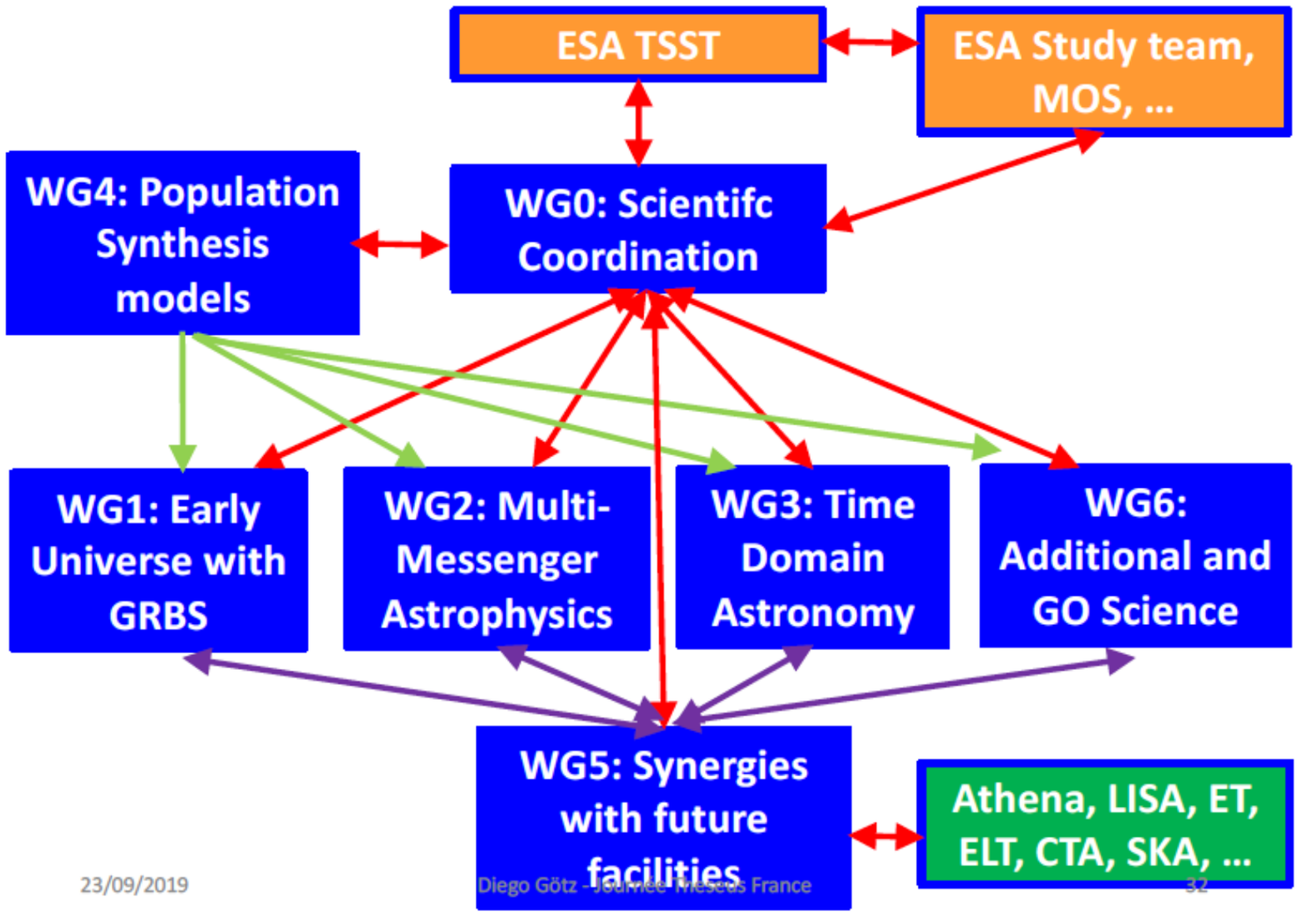
Star formation



Communauté GRB bien en place grace à SVOM

Synergie entre communauté galaxies grand-z et celle des GRBs reste à bâtir

Les scientifiques française ont l'opportunité de s'impliquer dans le groupes de travail THESEUS pour contribuer à la préparation du « yellow book » et au même temps nouer des contacts avec la communauté européenne



WG scheme and coordinators

- ❑ **SWG0**- Scientific Coordination (L. Amati, P. O'Brien, D. Götz, E. Bozzo) *TSST Members*
- ❑ **SWG1** - Exploring the early Universe with GRBs (N. Tanvir, L. Christensen, E. Le Floc'h)
- ❑ **SWG2** – Multi-Messenger Astrophysics (G. Stratta, R. Ciolfi, S. Paltani)
- ❑ **SWG3** – Exploring the time domain Universe (or "Non-GRB transients") (L. Hanlon, M. Caballero-Garcia, S. Mereghetti)
- ❑ **SWG4** - Populations synthesis models (G. Ghirlanda, R. Salvaterra, J. Osborne)
- ❑ **SWG5** - Synergies with future large observatories (S. Basa, P. Rosati, M. Branchesi)
  - SWG5.1 - Theseus after SVOM, EP, and GRB missions of the 20s: B. Cordier
  - SWG5.2 – Theseus – Athena (P. O'Brien)
  - SWG5.3 - Theseus – LISA (A. Sesana)
  - SWG5.4 - Theseus – 3G GW detectors (ET, CE) (M. Maggiore)
  - SWG5.5 - Theseus- SKA, Alma and large radio facilities (A. Ferrara)
  - SWG5.6 - Theseus- Extremely large tel. (ELT/TMT) synergies: (S. Vergani)
  - SWG5.7 - Theseus- CTA synergies: (F. Schüssler)
- ❑ **SWG6** – Observatory science (A. Blain, A. Castro-Tirado, A. De Rosa)