



Electromagnetic Counterparts of Gravitational Wave Sources at the Very Large Telescope

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Motivation

Exploit exceptional ESO facilities for future GW events

- 4, 8m telescopes with versatile instrumentation

Cohere European follow-up teams

- Efficiency is important, since GW170817 follow-up intensity can be expensive

Build scientific capability

- Working groups for Imaging, Spectroscopy, Polarimetry, Radio/submm, Infrastructure, Theory, External groups, Engagement

ENGRAVE is a follow-up programme, but tightly integrated with many discovery efforts.

- Members involved in: ATLAS, BlackGEM, GOTO, PanSTARRS, VINROUGE, VST, ZTF and more

Engrave

UT3 (Melipal)
SPHERE
VISIR
CRIRES (2019)

UT4 (Yepun)
AOF
HAWK-I
SINFONI
MUSE

UT2 (Kueyen)
FLAMES
X-SHOOTER
UVES

VST
OmegaCAM

UT1 (Antu)
NACO
FORS2
KMOS

Blue kilonova – FORS2, X-shooter
Red kilonova – HAWK-I, NACO, X-shooter
GRB afterglow – FORS, X-shooter
Kilonova polarimetry – FORS

Counterpart discovery: VST, VISTA
(collaborations with ENGRAVE)
Also: ATLAS, BlackGEM, GOTO, PS1, ZTF

GRB jet

$i=0$

Face-on

$i=90$

Edge-on



Depth

- 8m class imaging and spectroscopy from prime site. State of the art instrumentation.

Speed

- RRM provides <10 minutes response times
- Mostly observations in service mode, ready overrides, expert observers.

Versatility

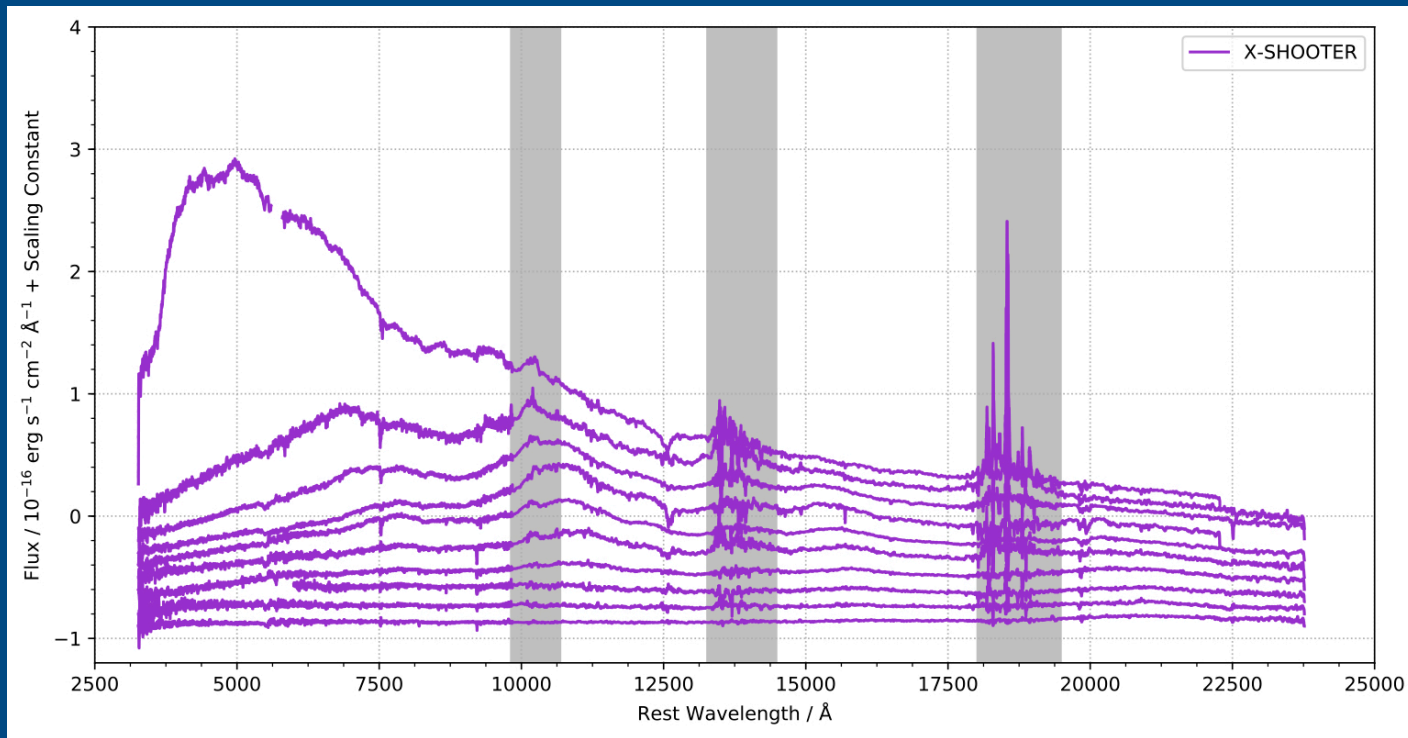
- Unique instrument set, from UV (3000Å) to mid-IR (4.5 microns), imaging, low/high resolution spectroscopy, polarimetry.

Simultaneity

- Capability to perform observations with multiple telescopes at the same time (e.g. GW170817)



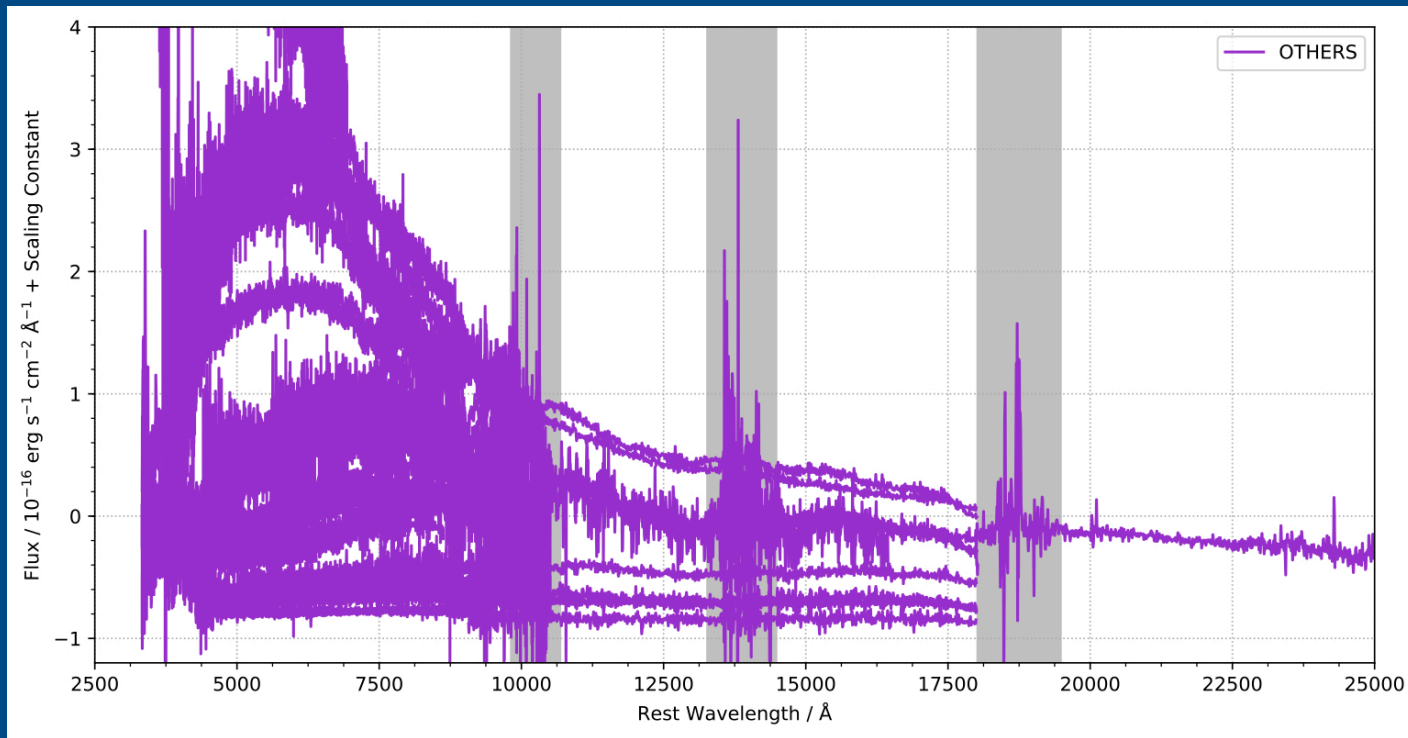
X-SHOOTER spectra AT2017gfo



James Gillanders (Pian et al. 2017, Smartt et al. 2017)



Every other spectra in open-KN database

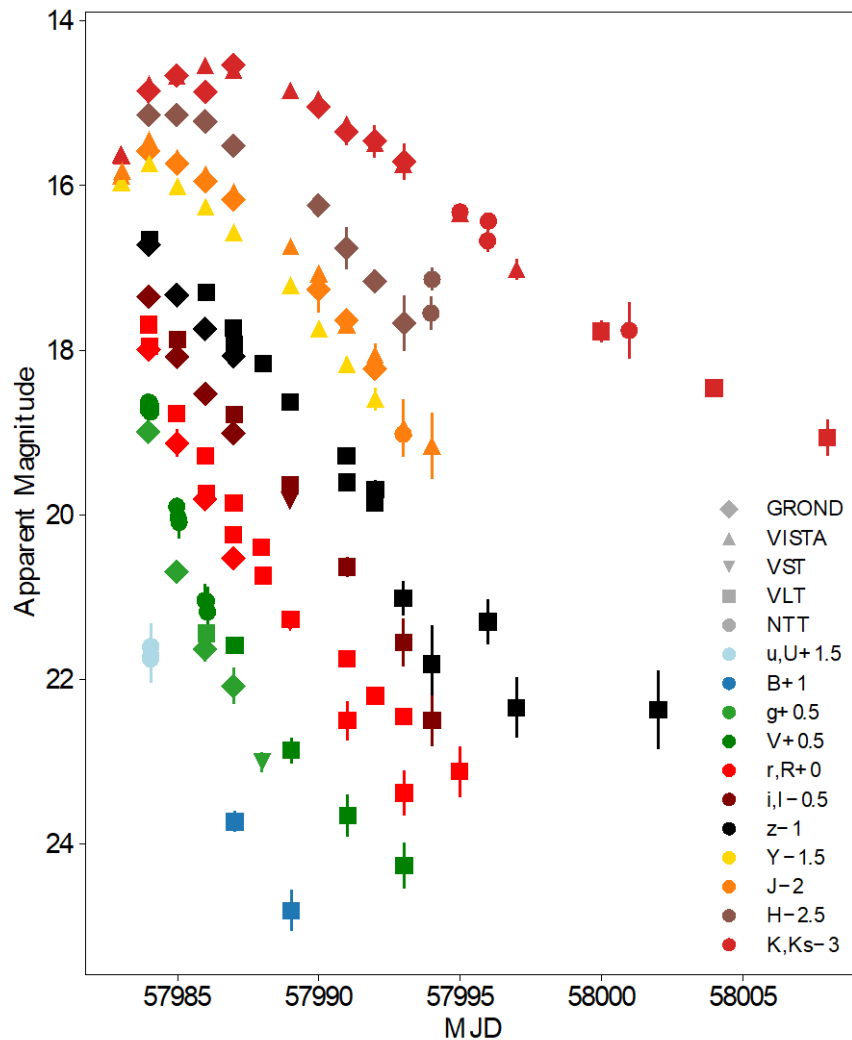


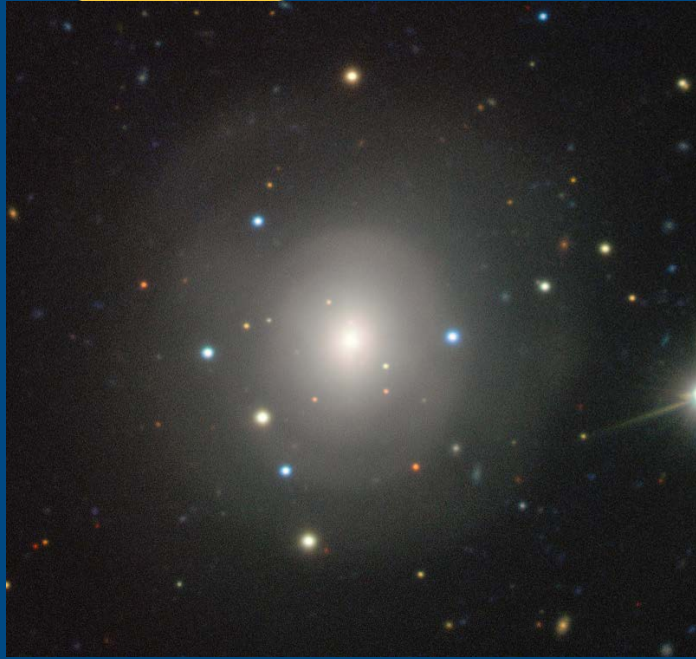
James Gillanders (Pian et al. 2017, Smartt et al. 2017)



ESO photometry

Pian et al. 2017
Smartt et al. 2017
Tanvir et al. 2017

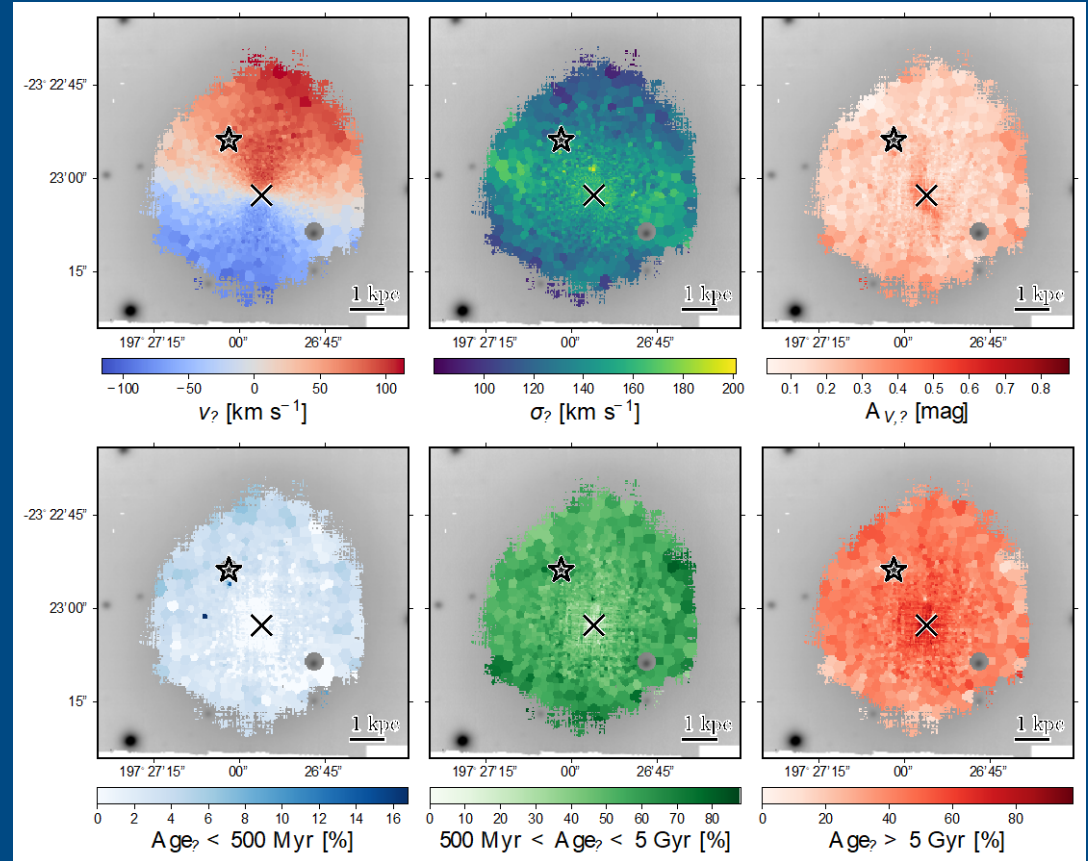


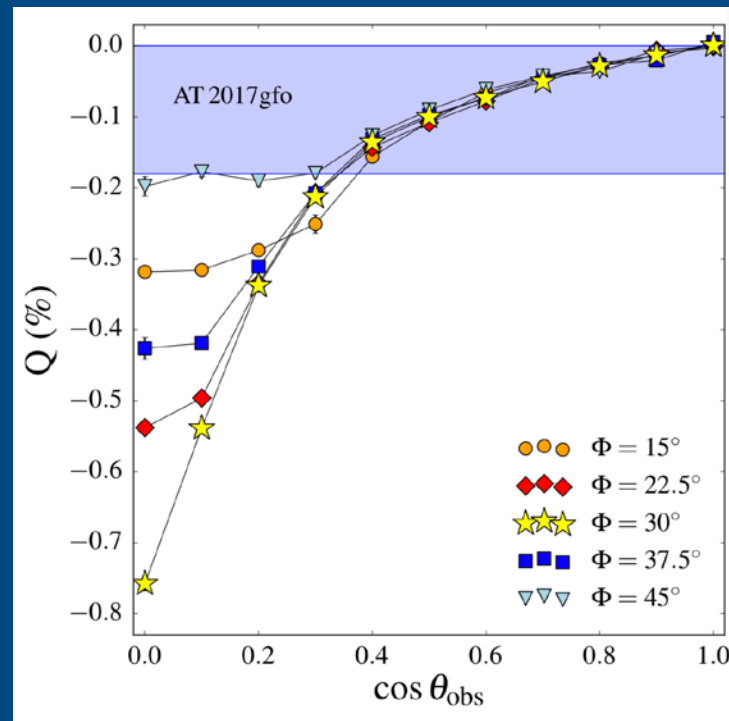
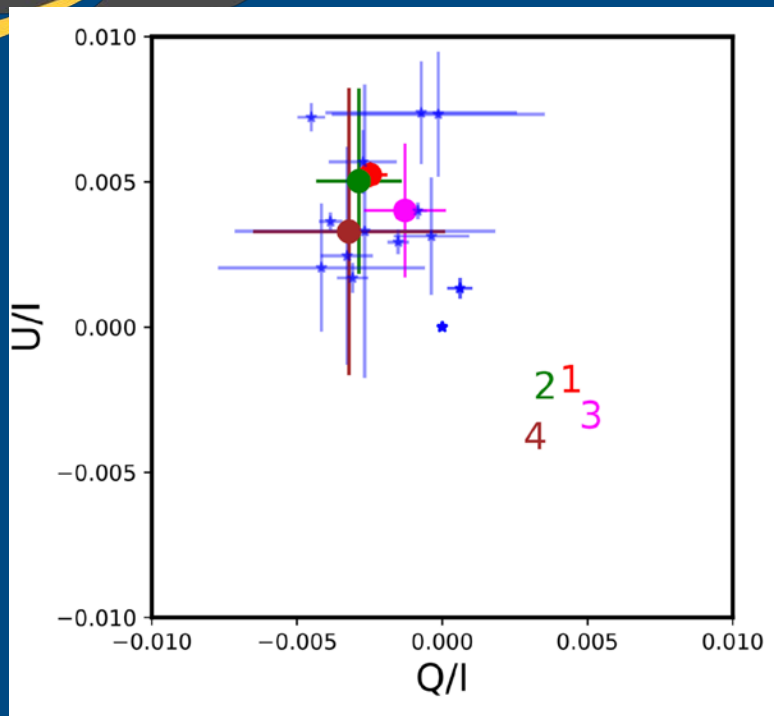


Levan et al. 2017, Hjorth et al. 2017

MUSE

Fast afterglows/Environments/Distances



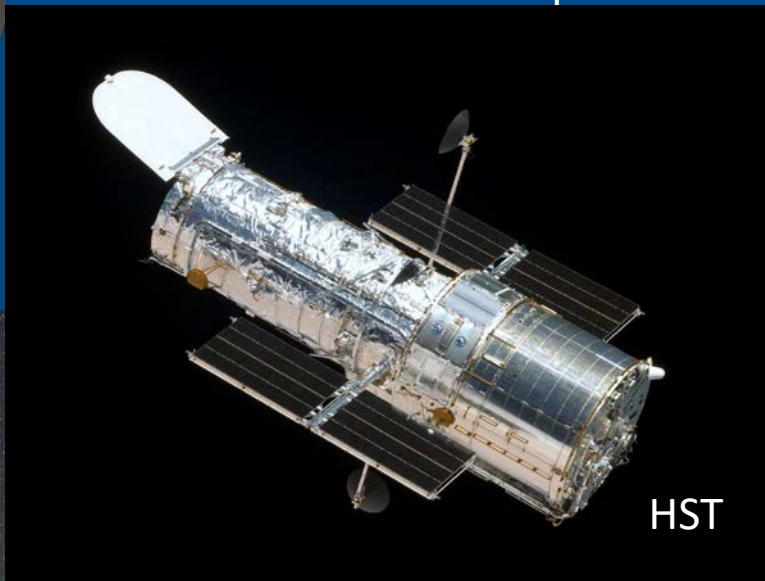




Beyond ESO

~240 hours VLT allocation plus

ALMA



HST

GTC





Membership

Amati **Anderson** Antier **Ascenzi** Ashall **Barbarino** Belloni **Benetti** Bensch **Bernardini** Bersier **Berton**
Bloemen **Blondin** Bolmer **Botticella** Branchesi **Brennan** Brocato **Brusa** Bruun **Bufano** Bulgarelli **Bulla**
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