IFU and MOS spectroscopy for the follow-up of gravitational wave events

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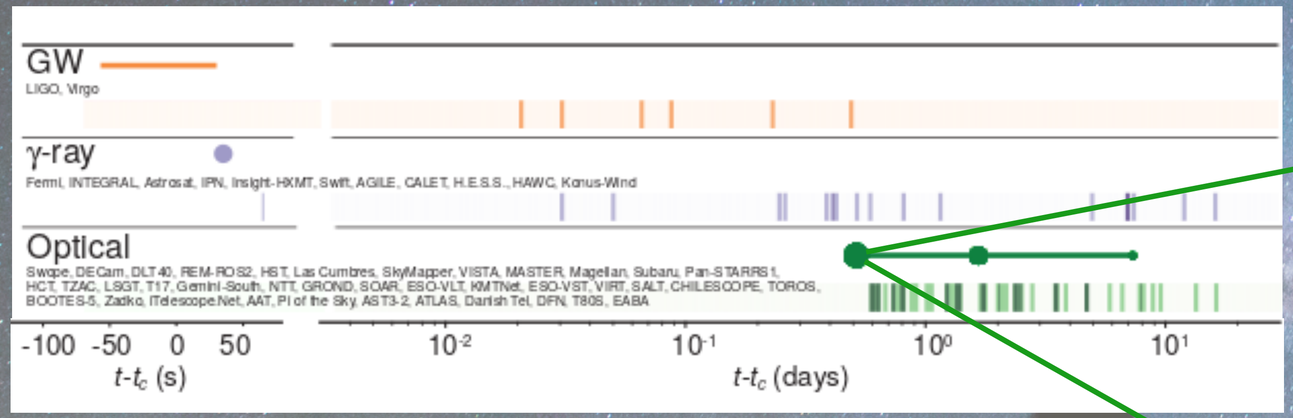
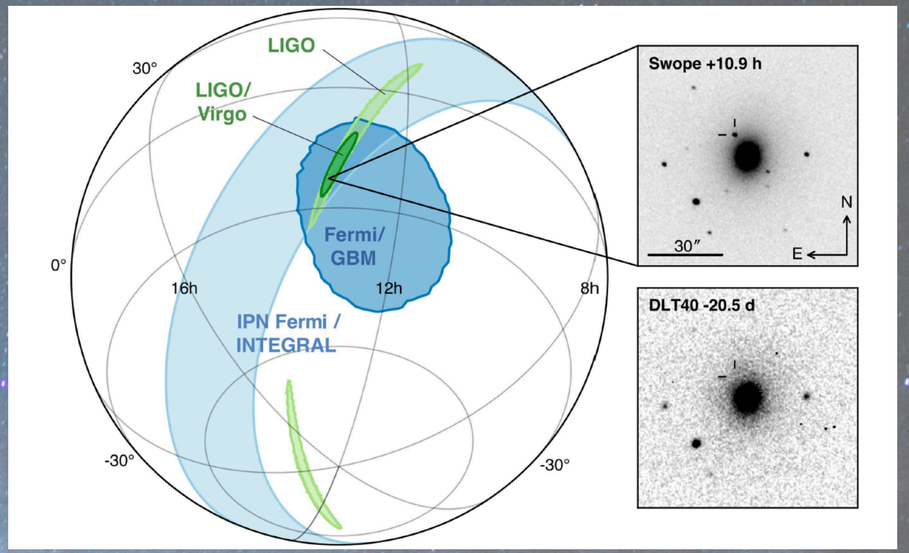
The follow-up of GW170817

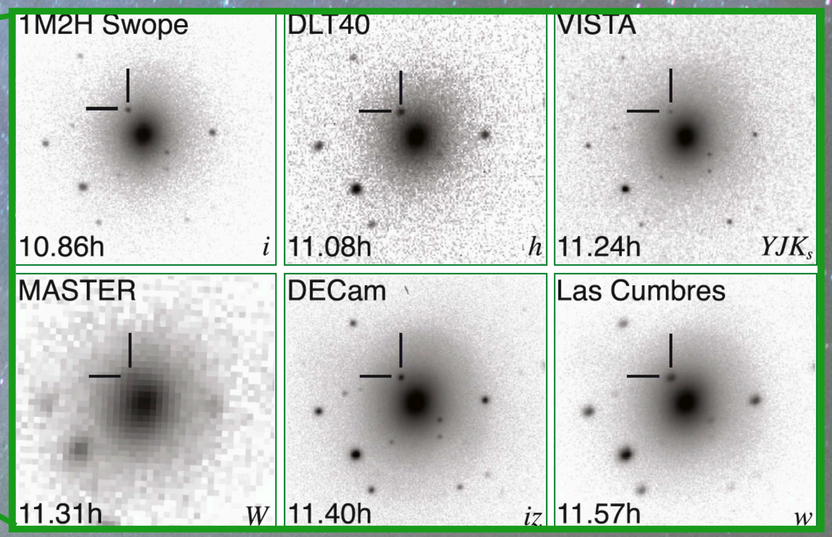
A milestone for multi-messenger astronomy

Wide-field surveys coverage and galaxy targeted searches of the optical counterpart inside a ~30 deg^2 error region



Abbott+17





AT2017gfo

No analogous detection during HLV O3

HLVK O4 ongoing

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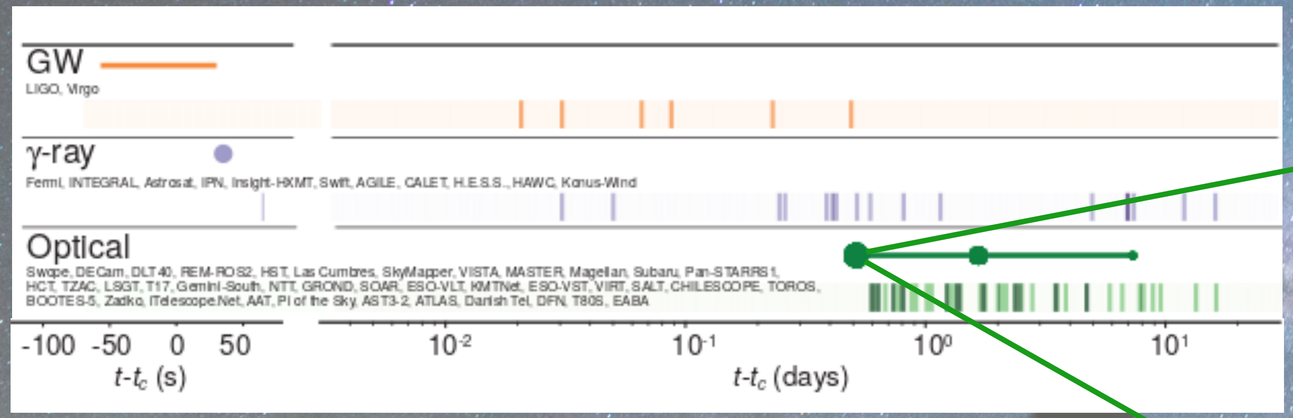

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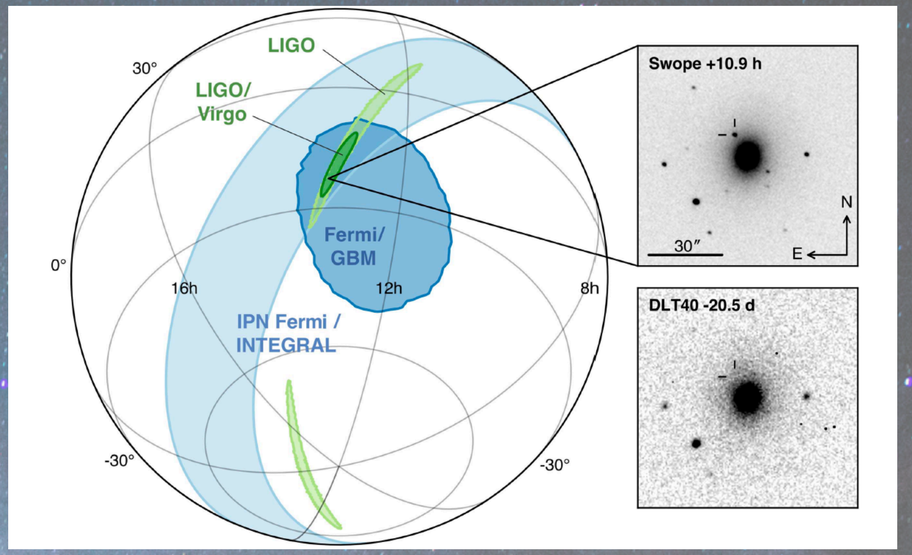
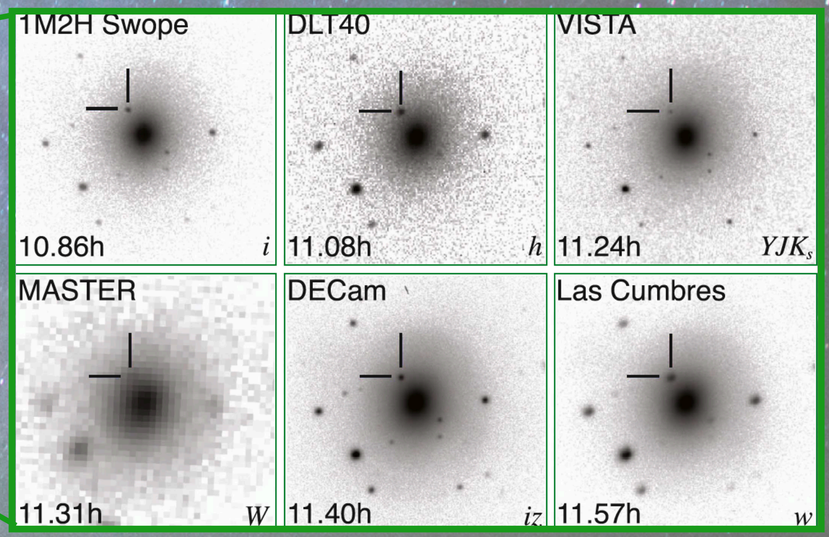


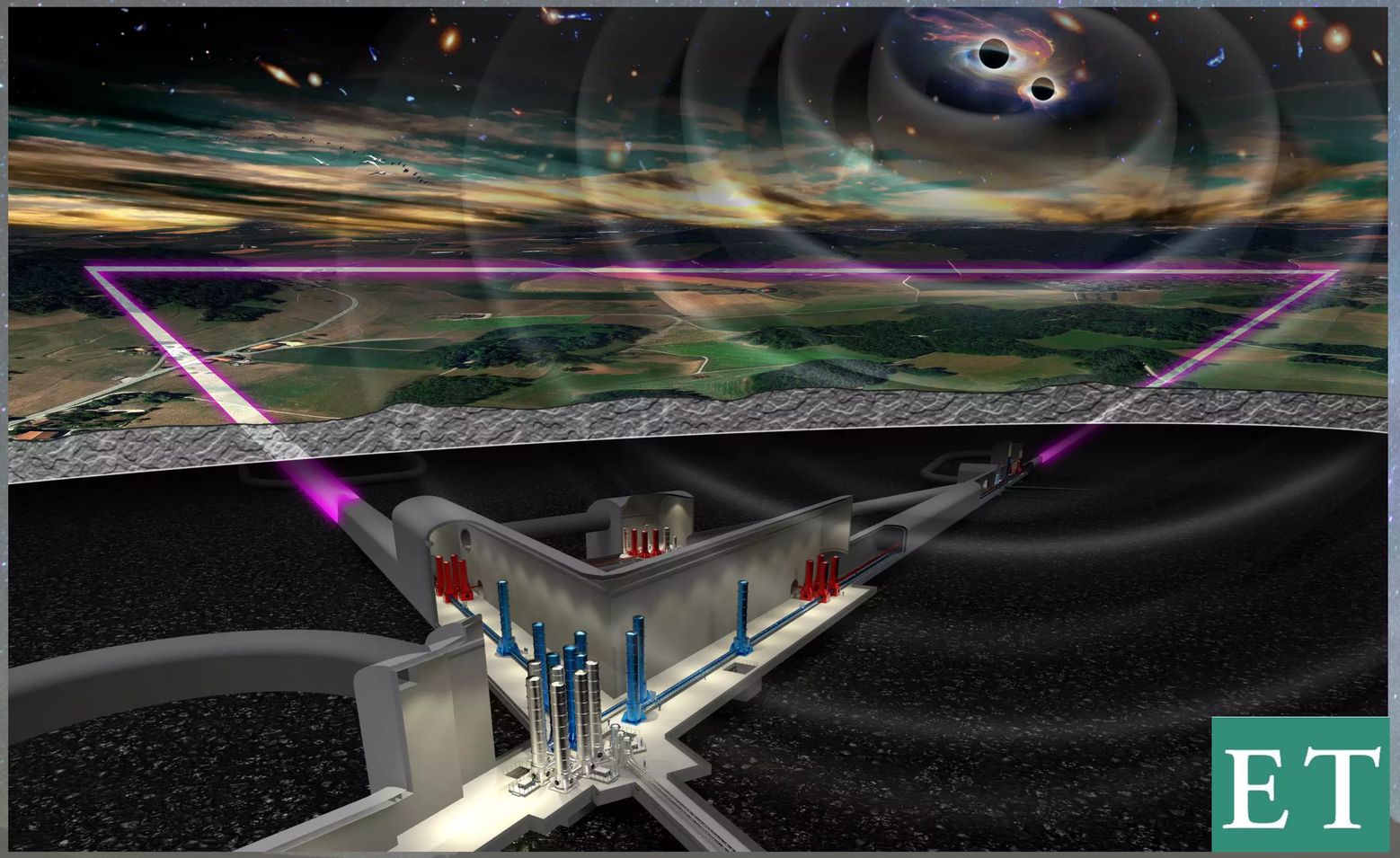


AT2017gfo

	BNS detection rate
HLVK O4	$7.7^{+11.9}_{-5.7}$

Colombo+22

Next generation GW detectors: Einstein Telescope



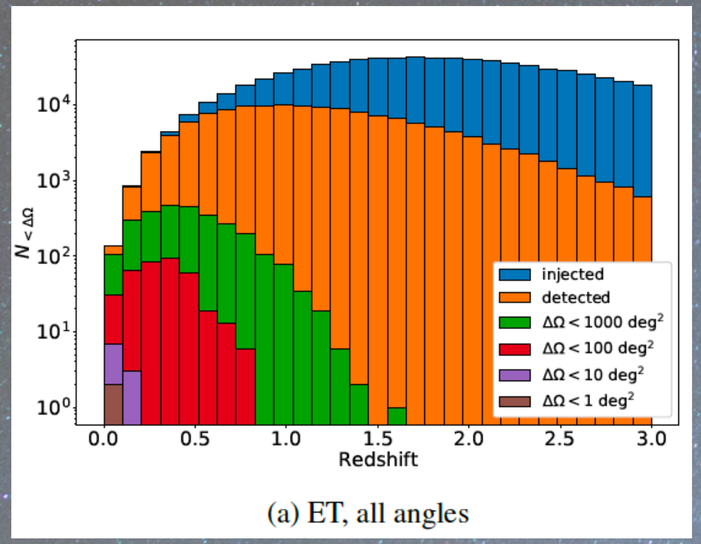
In the **ESFRI** RoadMap

⟶ Late 2030s

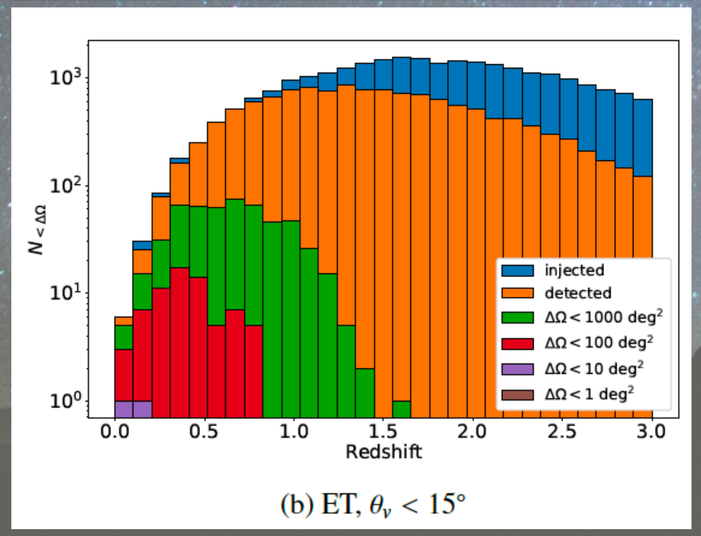
Possibility of monitoring BNS **before merger**

Sensitivity reaching kHz frequencies: the **post-merger** signal will be accessible

Einstein Telescope



(a) ET, all angles



(b) ET, $\theta_v < 15°$

Ronchini+22

Larger volume explored

Higher number of events

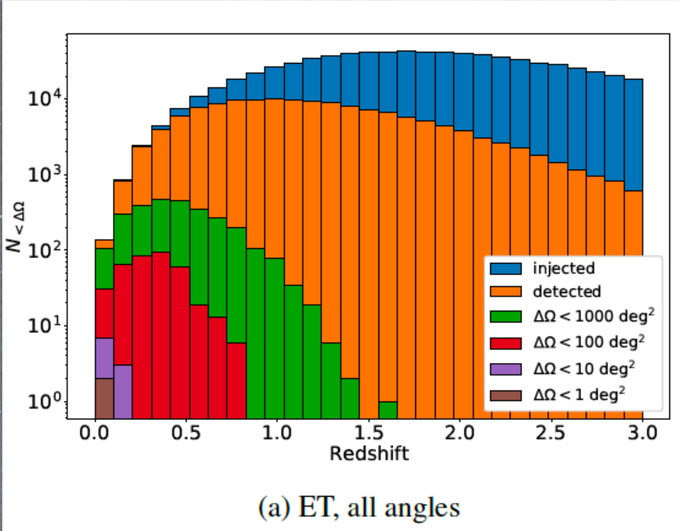
Faint optical-NIR counterpart to be found in large error regions

Large FoV and high sensitivities will be necessary for the EM follow-up, in addition to an optimised **observational strategy**

Division 4 of ET Observational Science Board: Multimessenger Observations
co-coordinated by Susanna Vergani

The acquisition of **multiple spectra** at the same time will play a key role in **identifying** and **characterising** EM counterparts

Einstein Telescope



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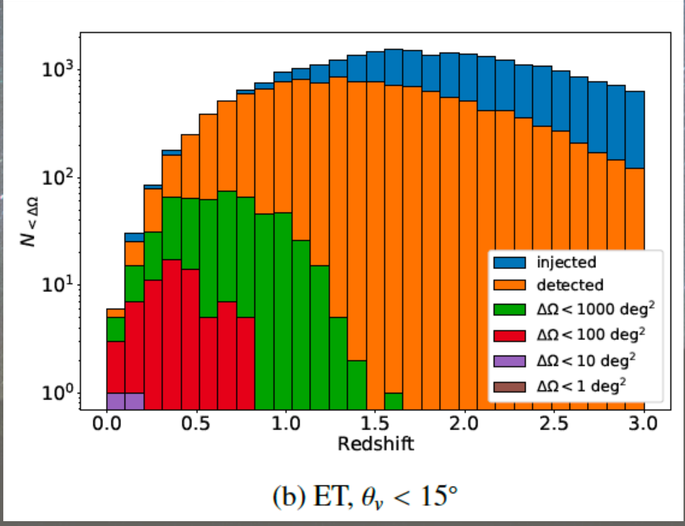

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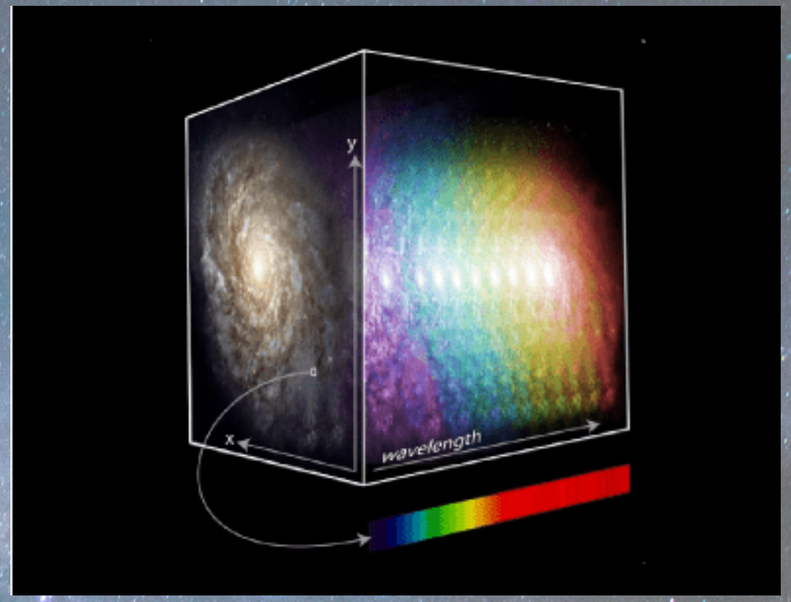
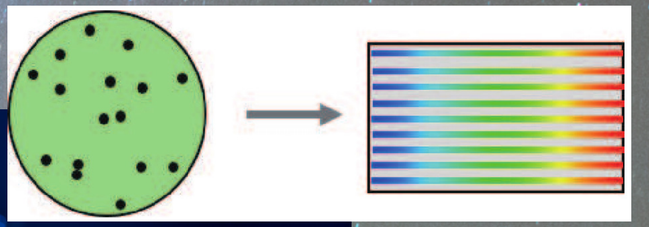
Integral-field and multi-object spectroscopy

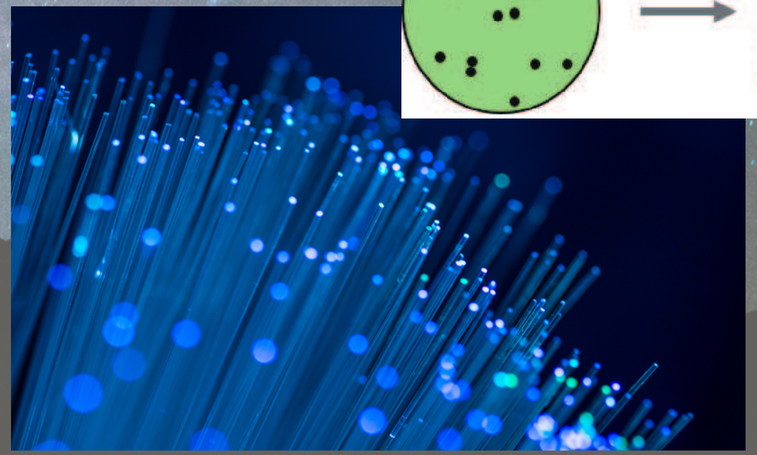
IFS: a spectrum for each pixel of the 2D field image

MOS: fibres to acquire multiple spectra simultaneously





Hang-xin +19

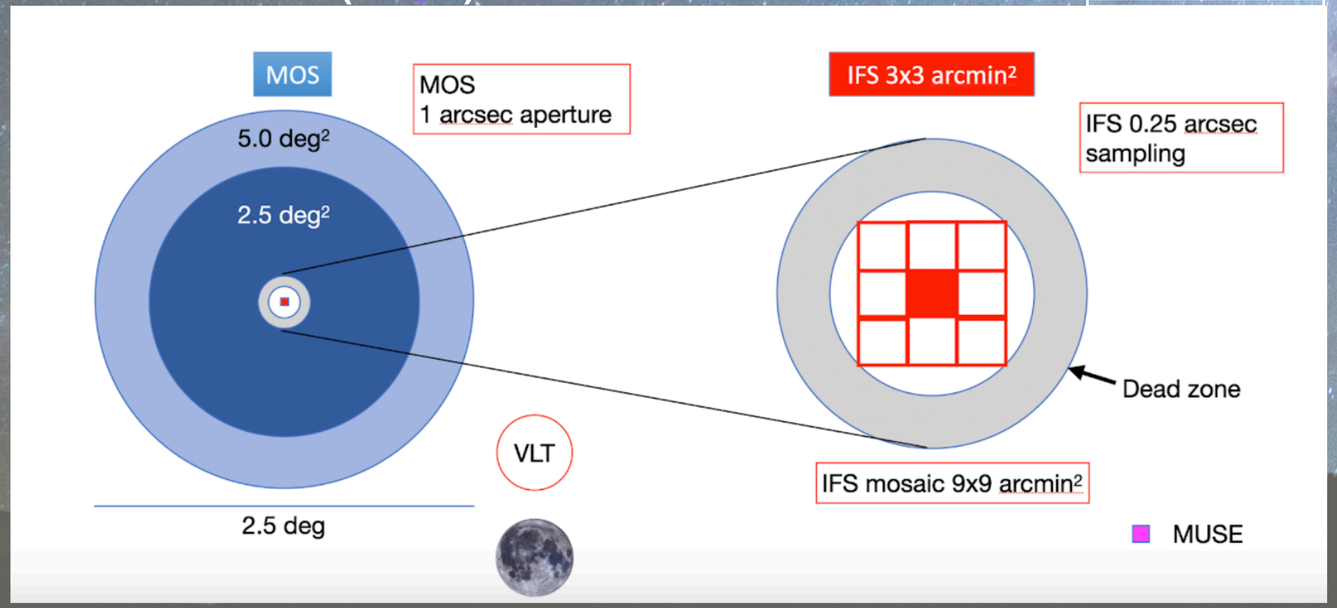


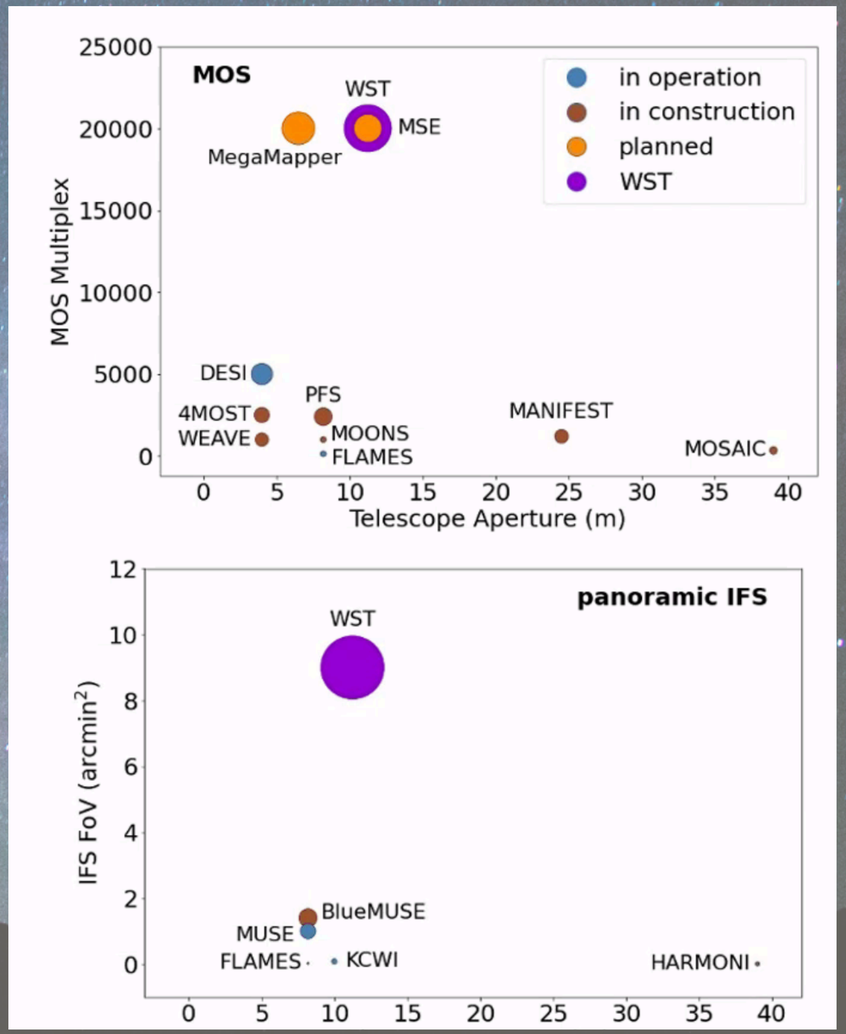
IFS and MOS with the Wide-field Spectroscopic Telescope

Large field of view and high **multiplexing**

Equipped with both **IFU** and fibres (**MOS**)

PI: Roland Bacon **(CRAL)**

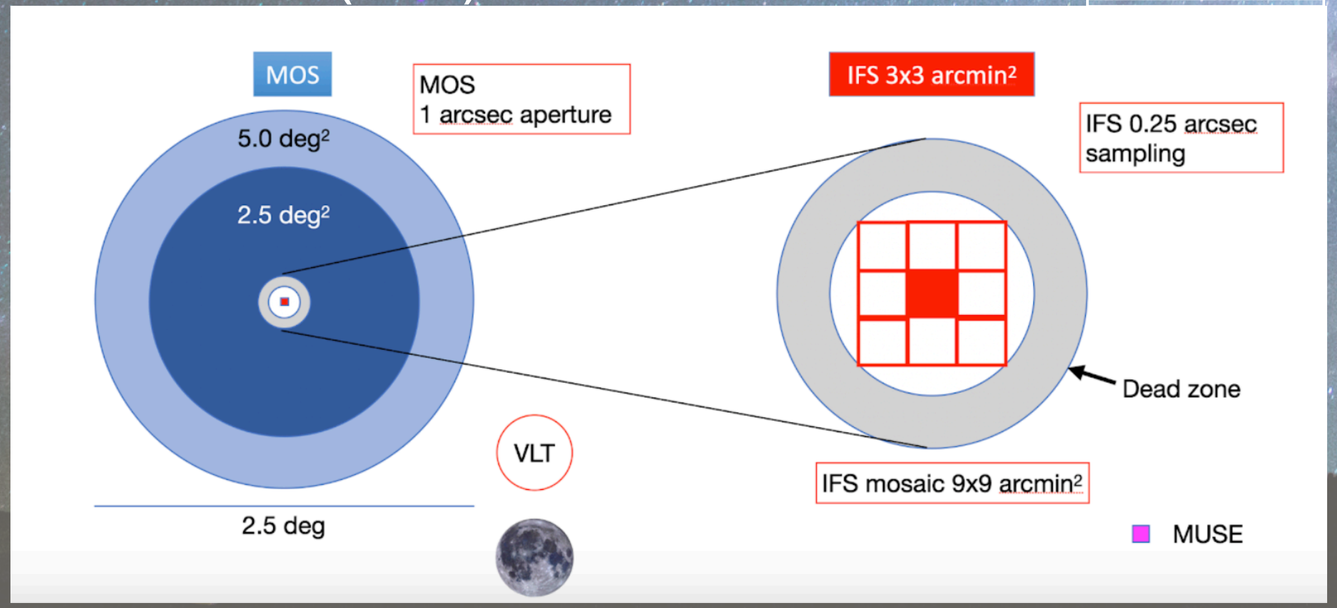


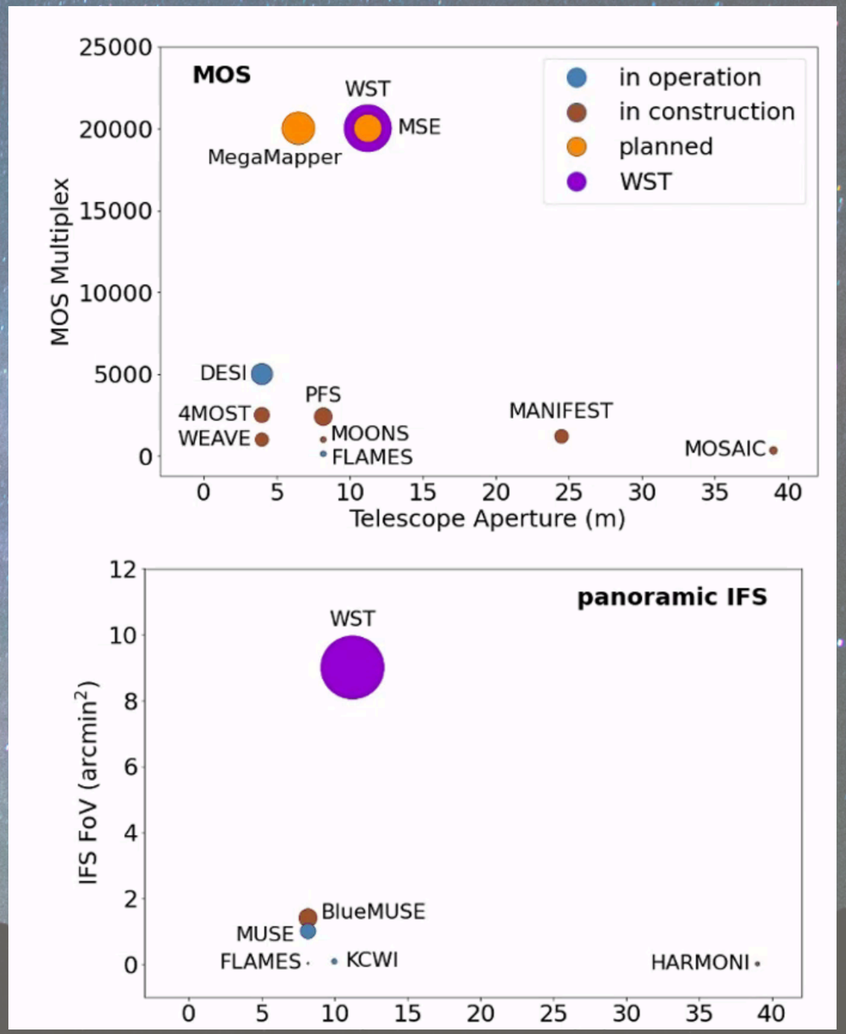


IFS and MOS with the Wide-field Spectroscopic Telescope

Science case "**WST - ET synergies for BNS multimessenger observations**"
within the WST Time Domain Working Group

PI: Roland Bacon **(CRAL)**





ET-WST synergy

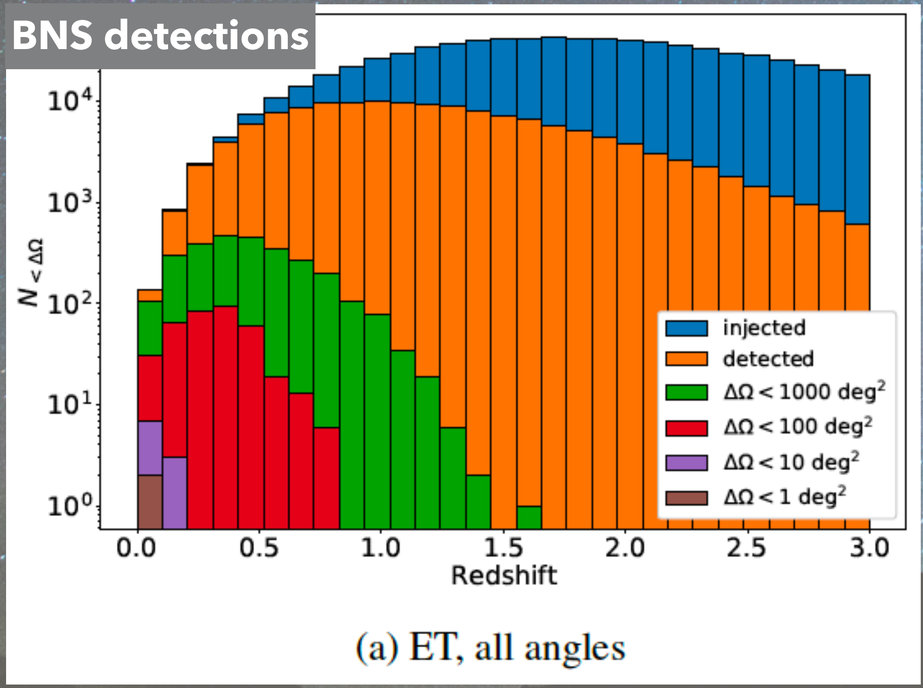
ET simulations

KN + GRB simulations

GSSI group & Milano Bicocca PROMETEO group

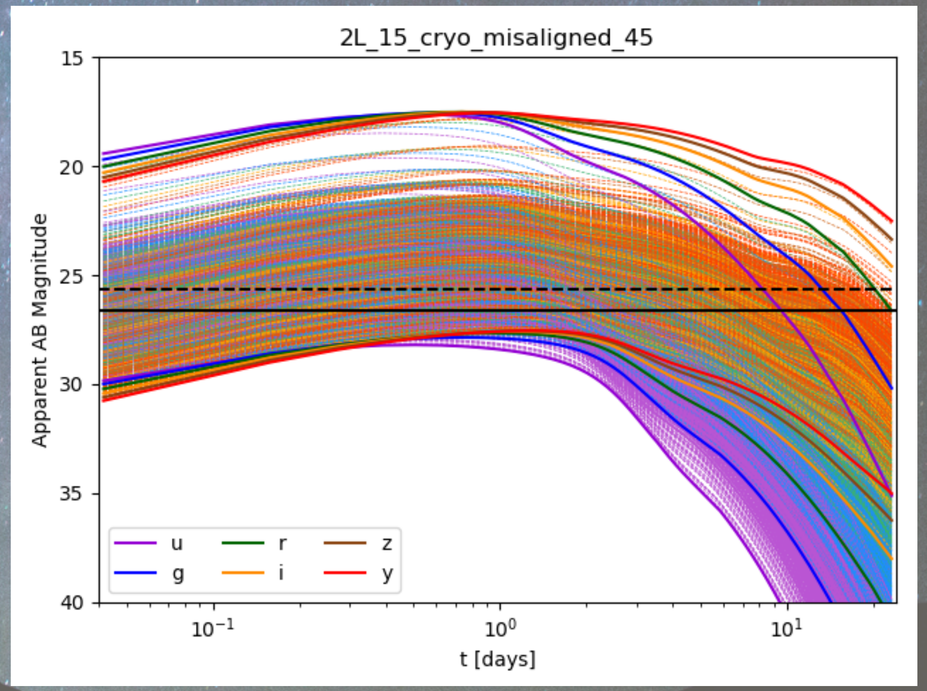
WST simulator

BNS detections



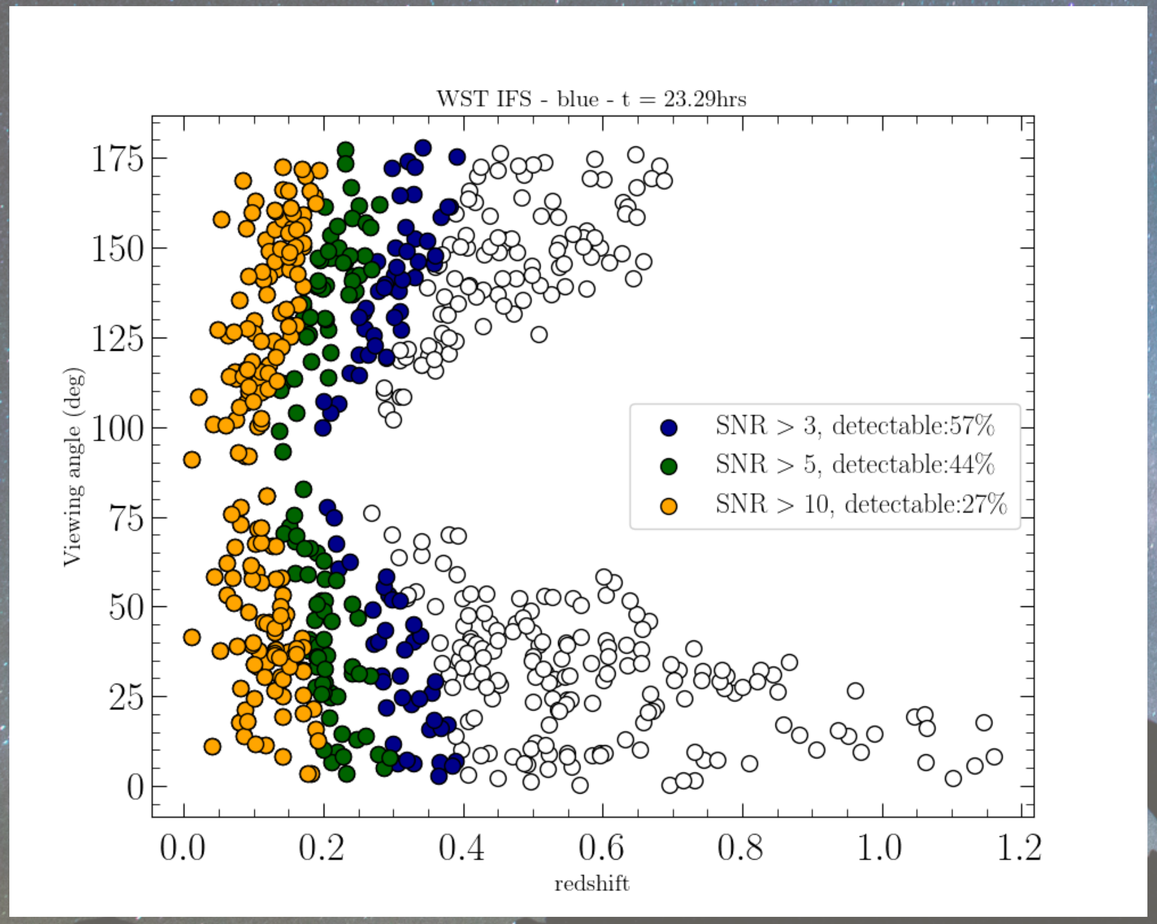
(a) ET, all angles

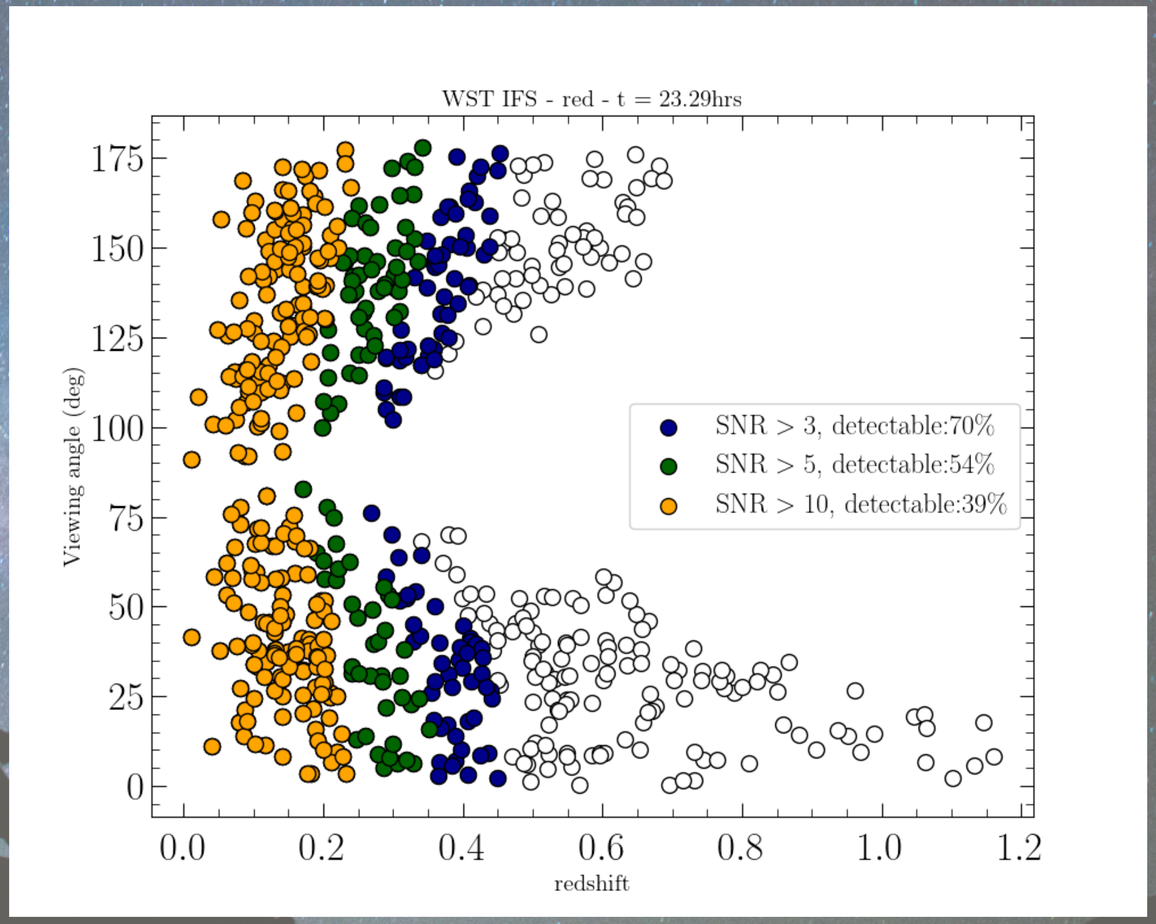
Ronchini +22



ET-WST synergy

Preliminary results





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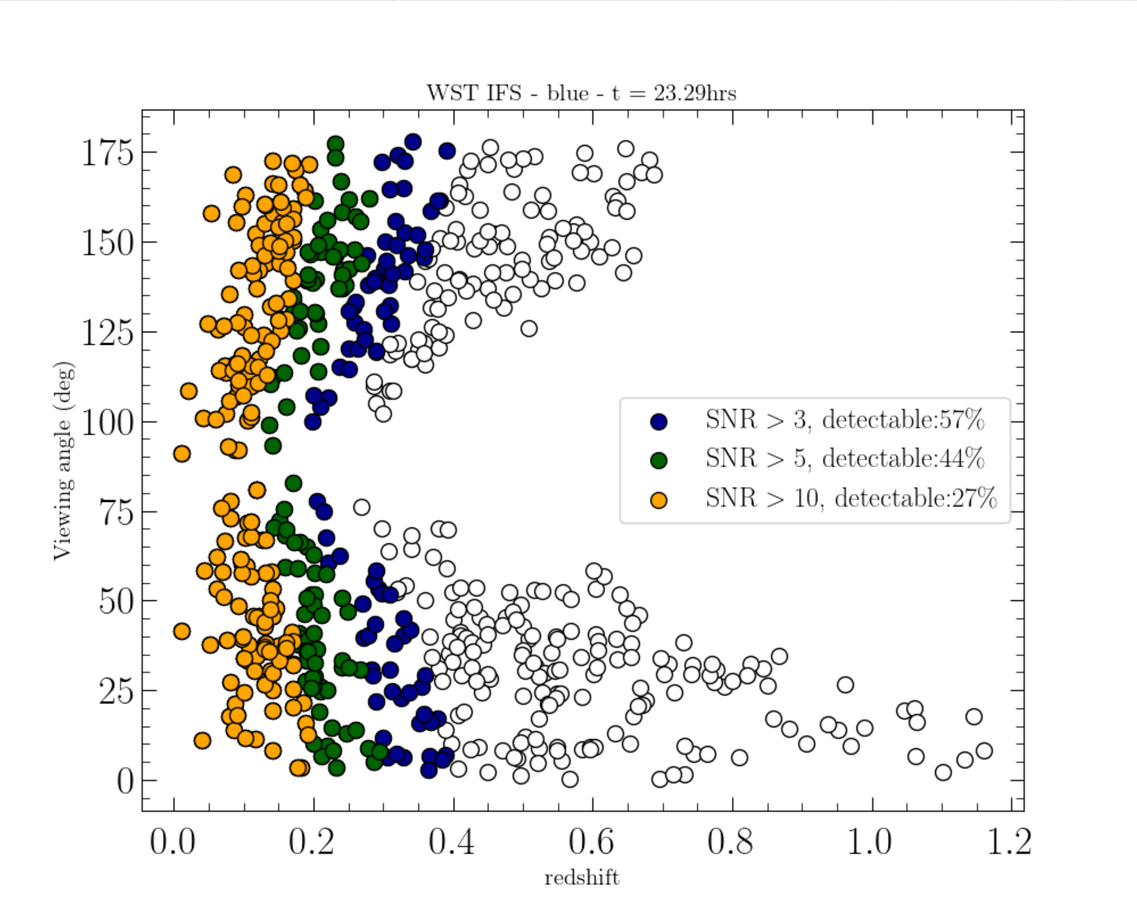

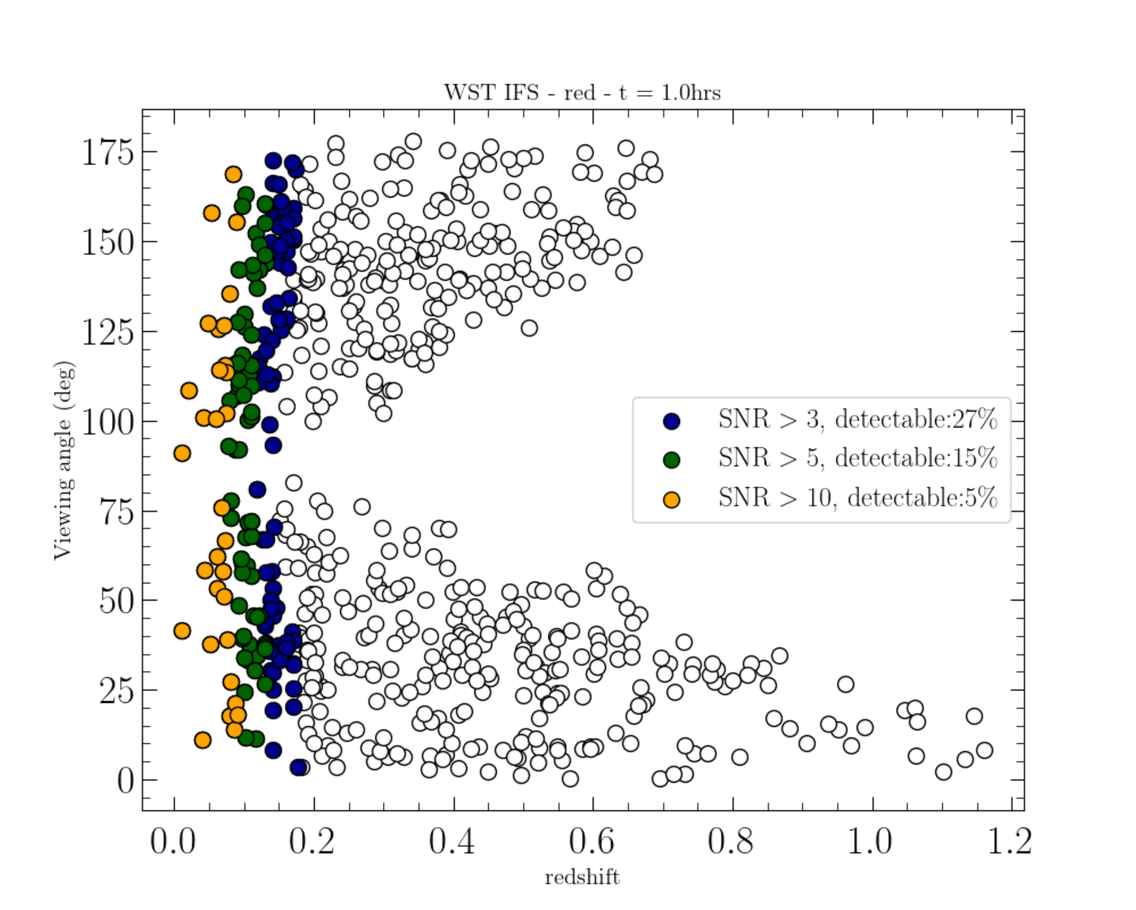

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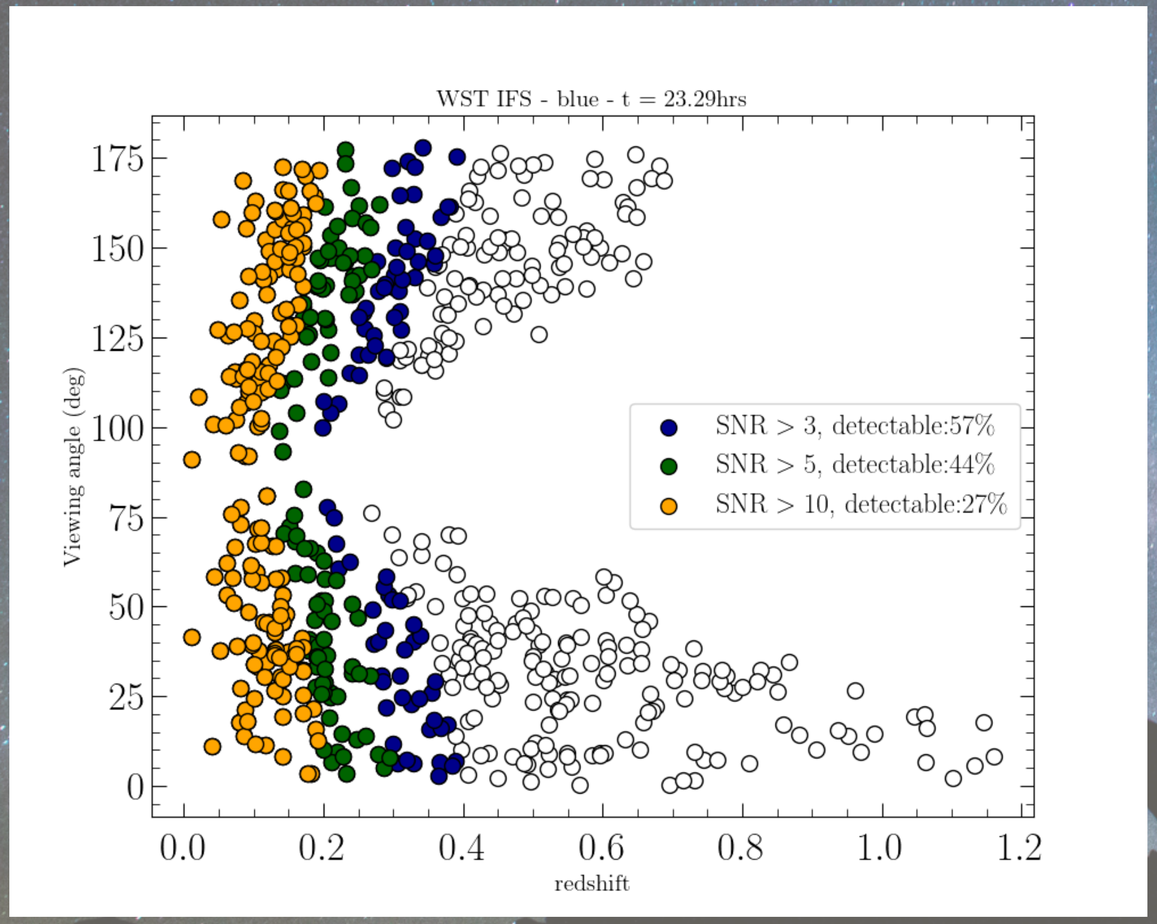

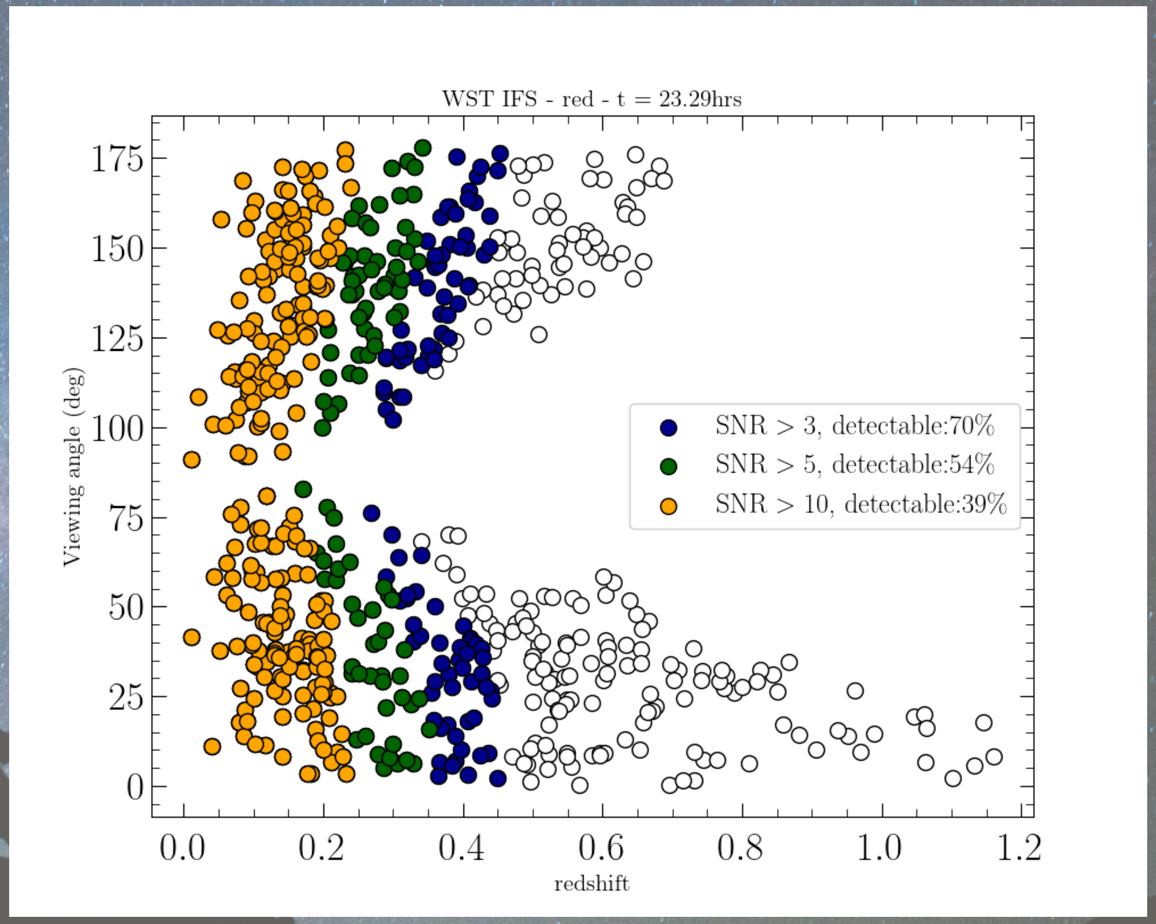

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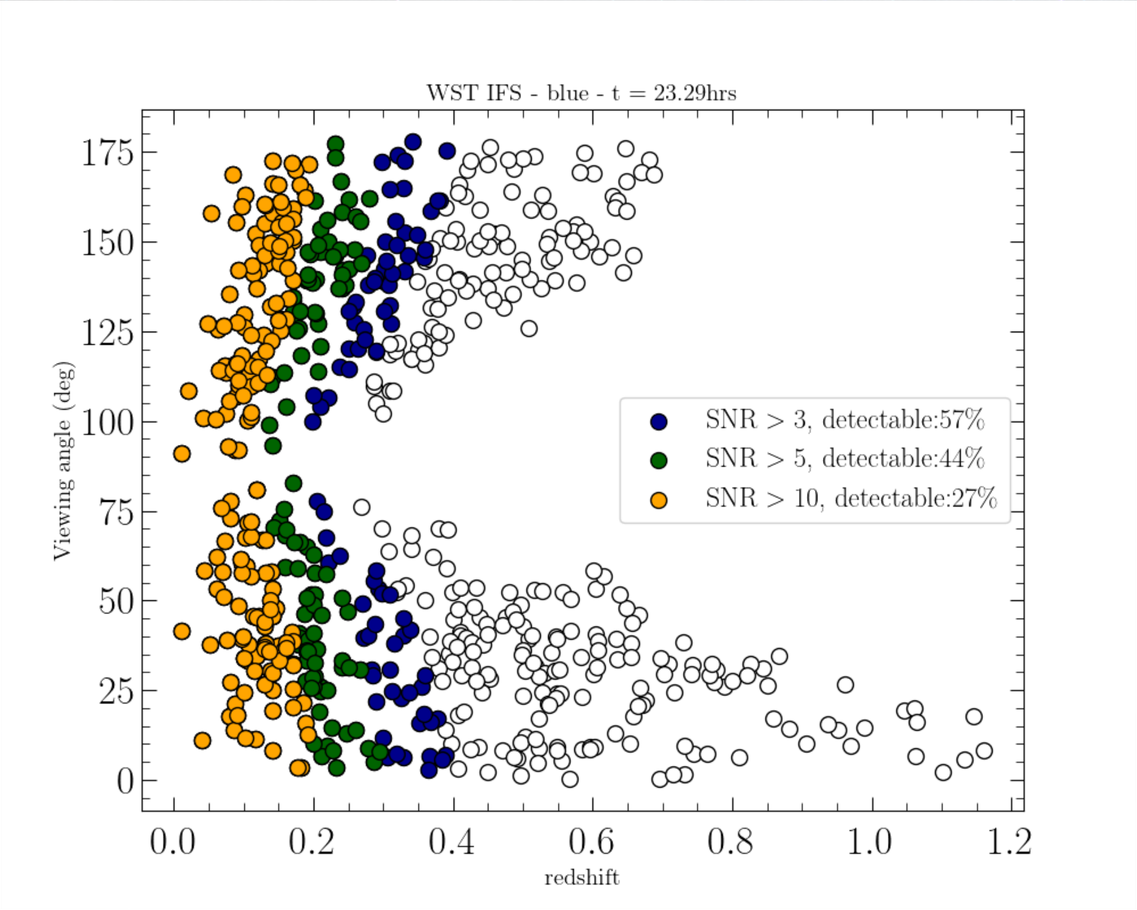

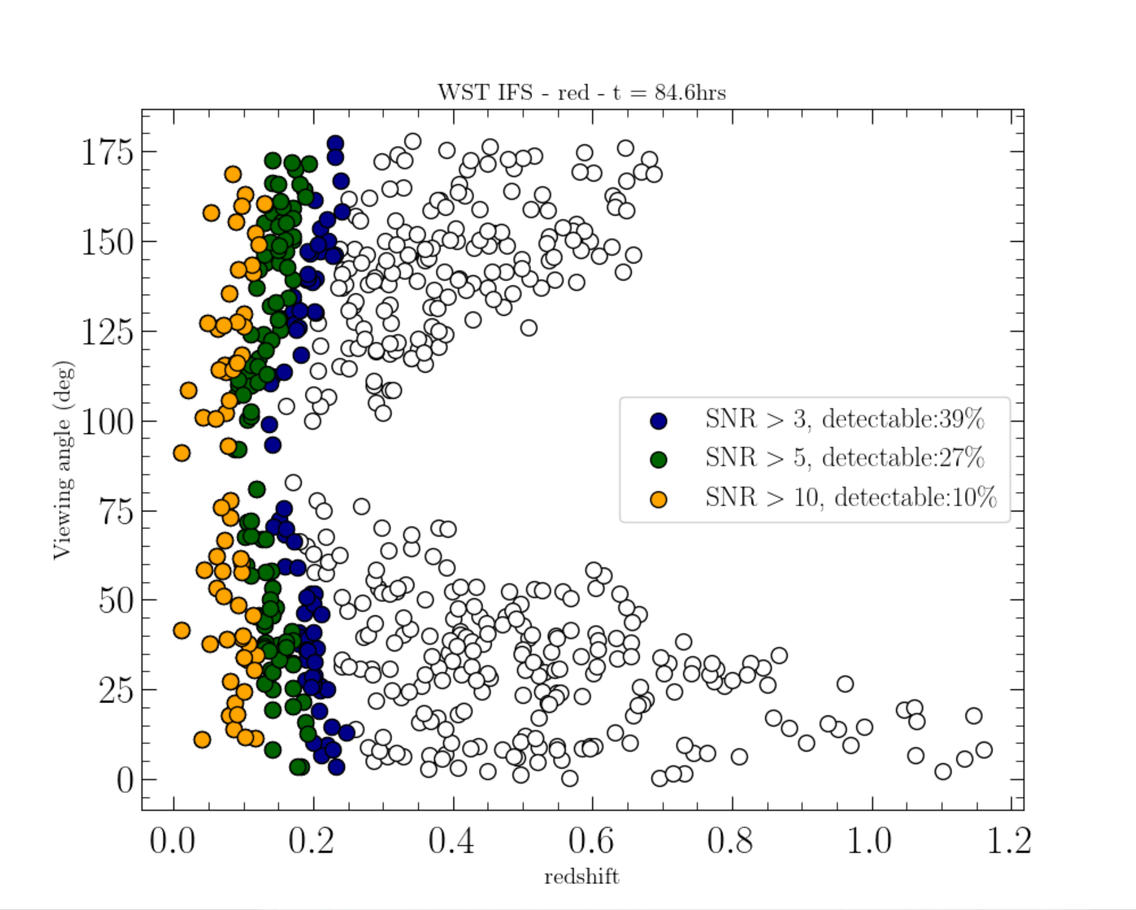

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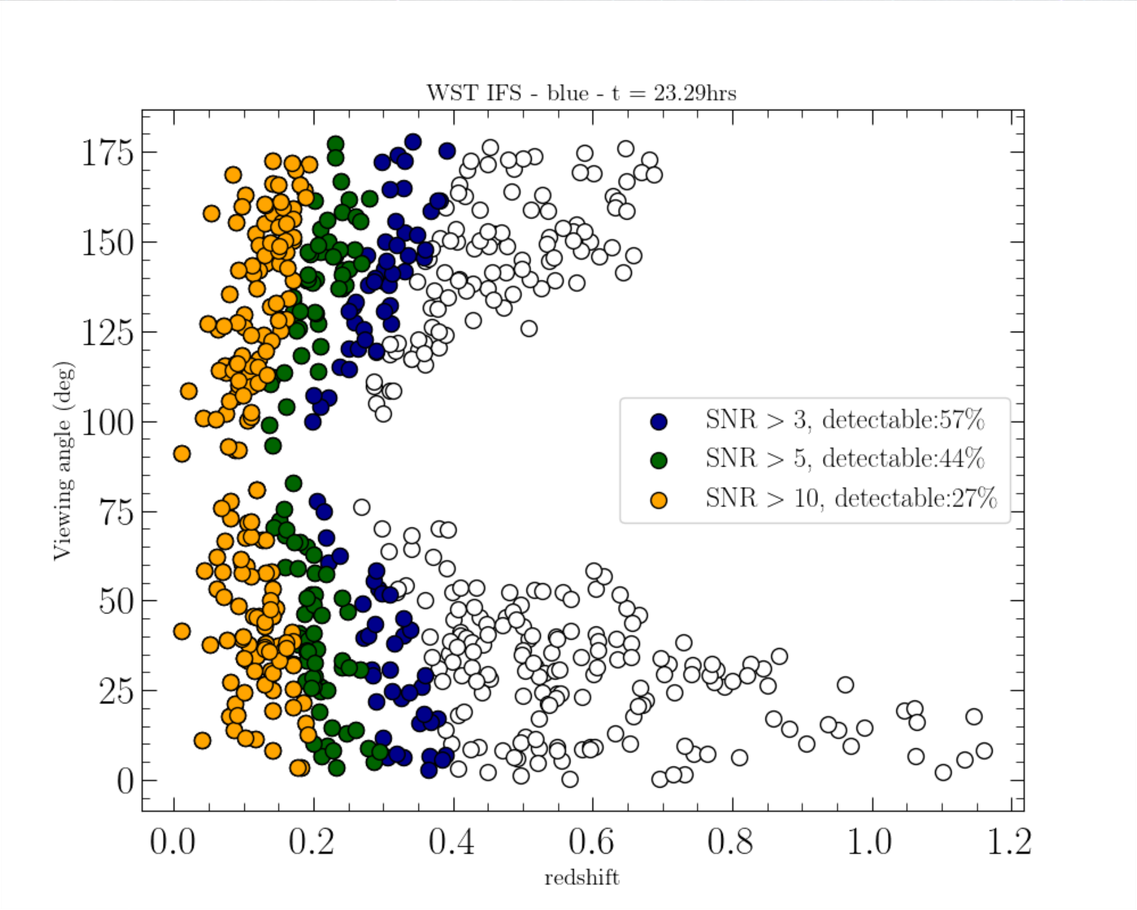
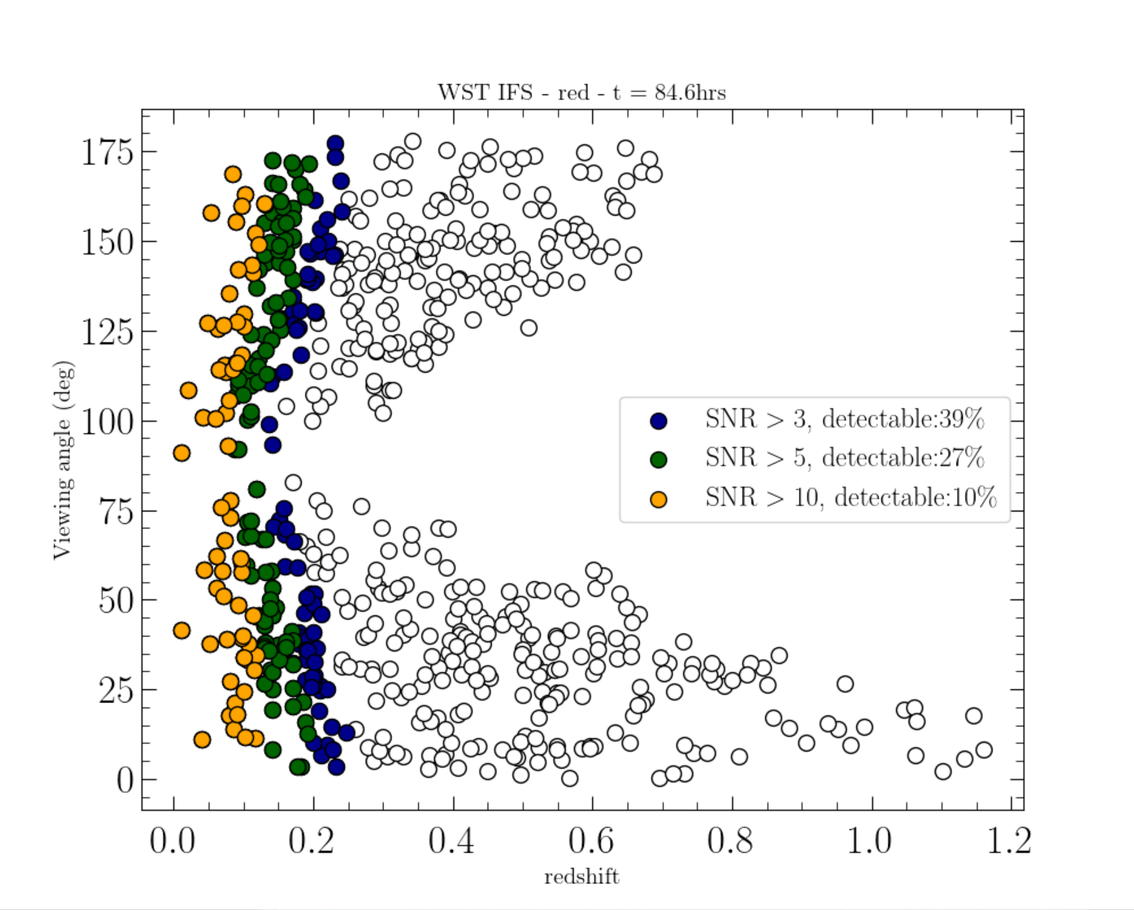


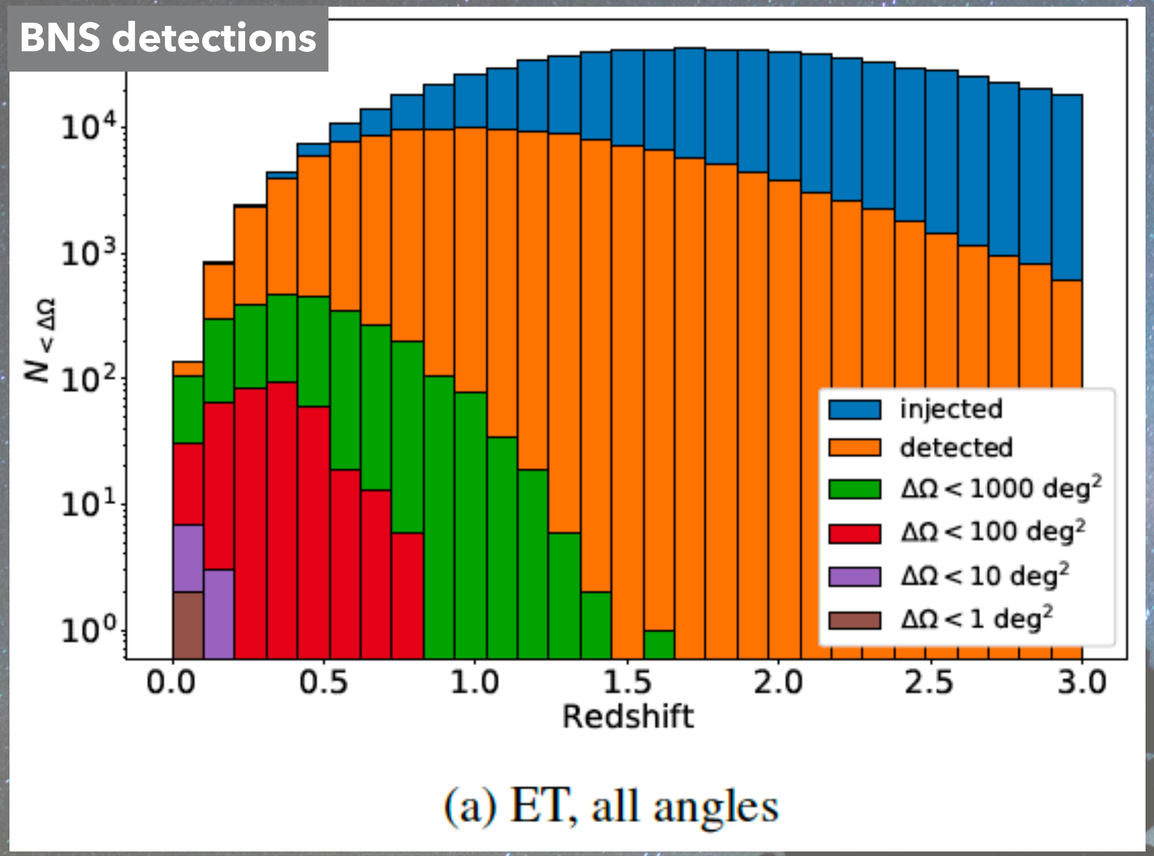


+ simulations for MOS

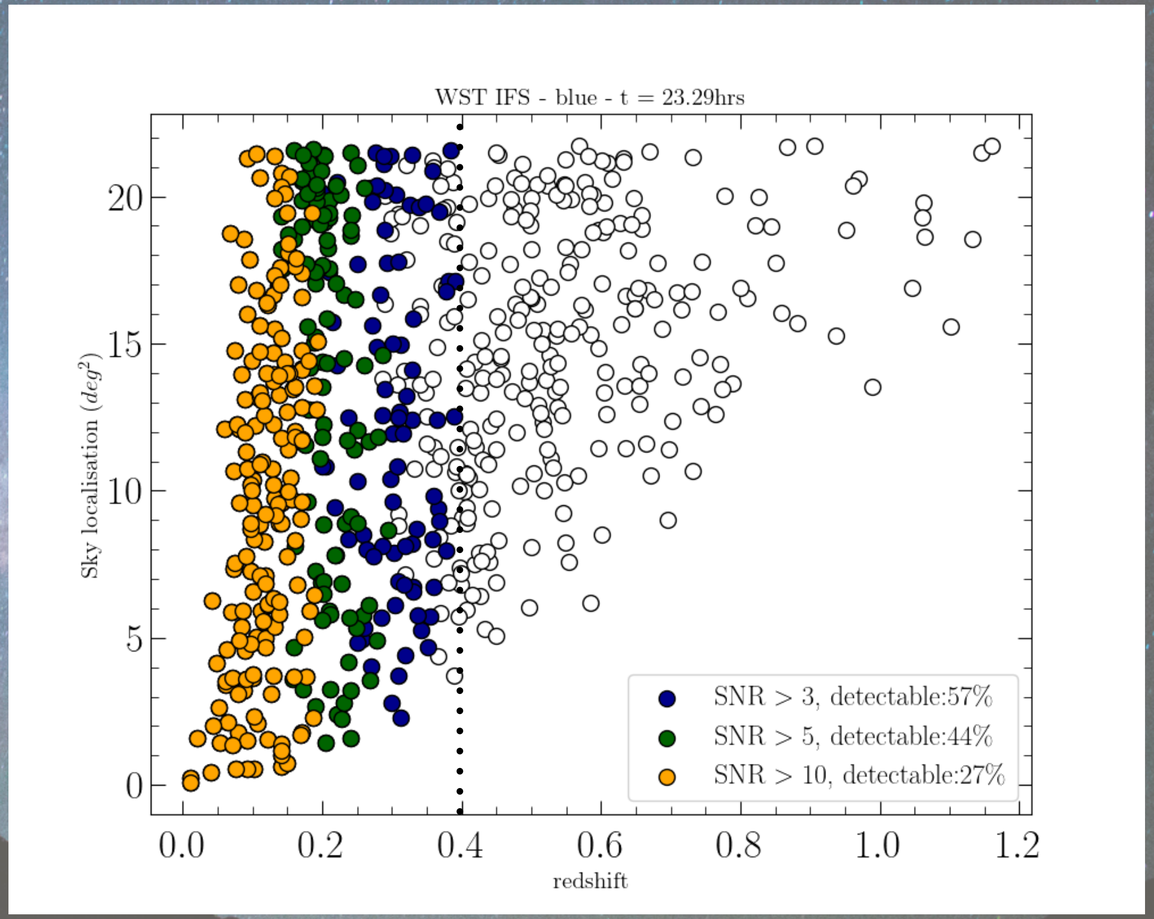
ET-WST synergy

Preliminary results

BNS detections



Ronchini +22



ET-WST synergy

Diagnostics

- How many counterparts will be detectable?
- Up to which redshift?
- Optimal exposure time?
- Time constraints on ToO?
- How many exposure to tile the error region of well localised events?
- Pointing strategy with MOS fibers?
- Requirements for WST?

ET-WST synergy

+ simulations for **off-axis afterglows** and **KN** emission based on more generic theoretical models

+ predictions for LVK **O5**

Diagnostics

- How many counterparts will be detectable?
- Up to which redshift?
- Optimal exposure time?
- Time constraints on ToO?
- How many exposure to tile the error region of well localised events?
- Pointing strategy with MOS fibers?
- Requirements for WST?

Conclusions and future prospects

Next generation GW interferometers will explore a **large volume** and detect a **huge number of BNSs**
GW signals **error regions** will likely be **large** and the **EM counterparts** will probably be **faint**

An observing strategy is necessary: **IFU** and **MOS** spectroscopy will be key players for the **identification** and **characterisation** of optical-NIR counterparts of GW detections

Simulations to assess the impact of the **ET-WST synergy,** that is promising to study KNae and off-axis afterglows in the 2030s


Thank you for your attention!