ET-WST synergy for next generation multi-messenger observations

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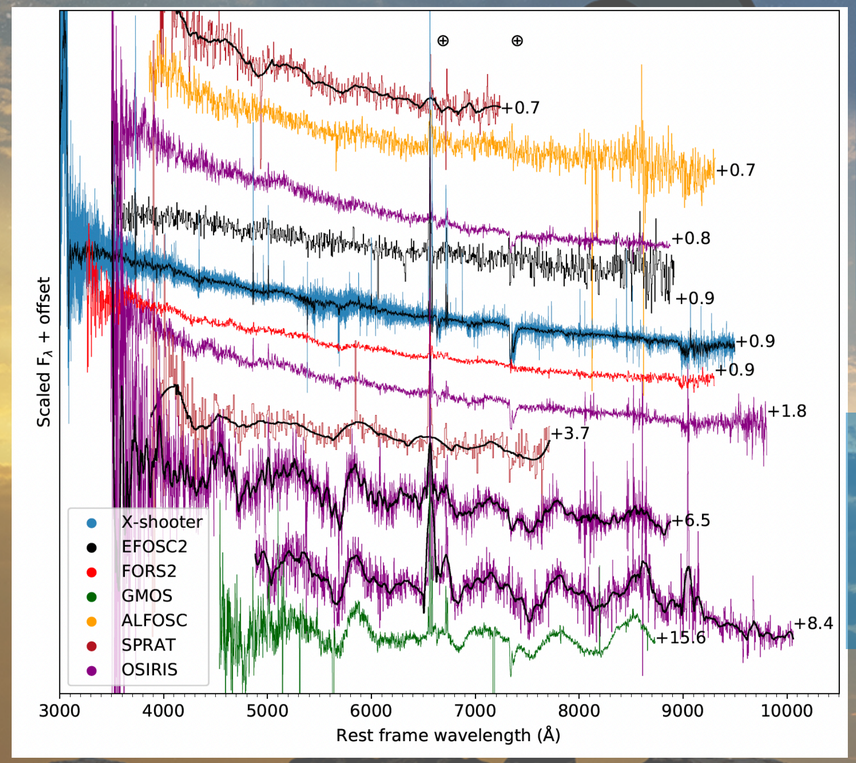
The importance of spectroscopy for EM counterpart characterisation and identification

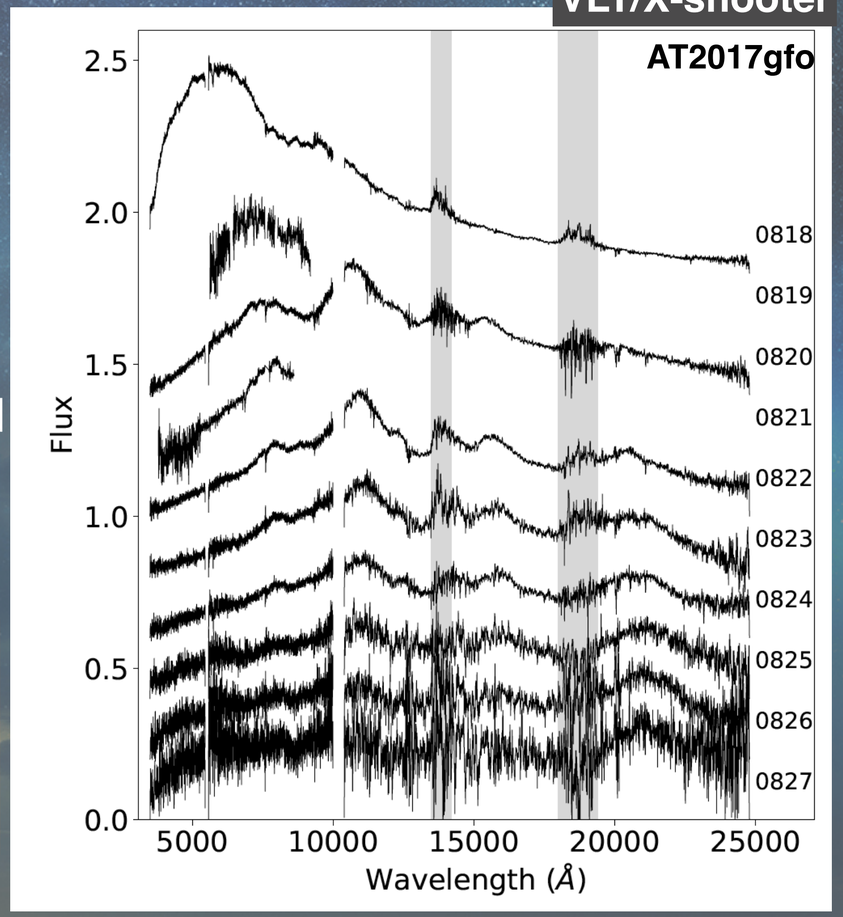
GW-GRB170817 follow-up campaign: wide-field surveys coverage and galaxy targeted searches of the optical counterpart inside a ~30 deg^2 error region



Agudo+23

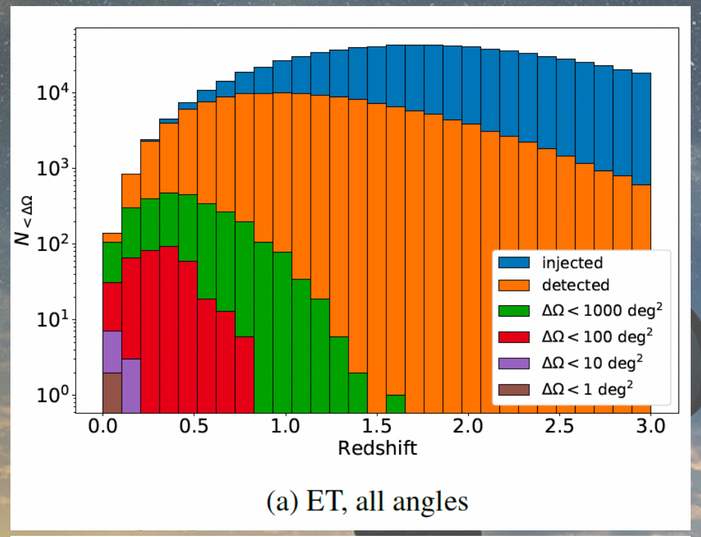
The spectrum of AT2017gfo: important for the study of **physics of the phenomenon,** the **environment**, **heavy elements nucleosynthesis** and for the **KN identification**

The spectrum of **SN2019wxt**, a GW event counterpart candidate, then classified as SN

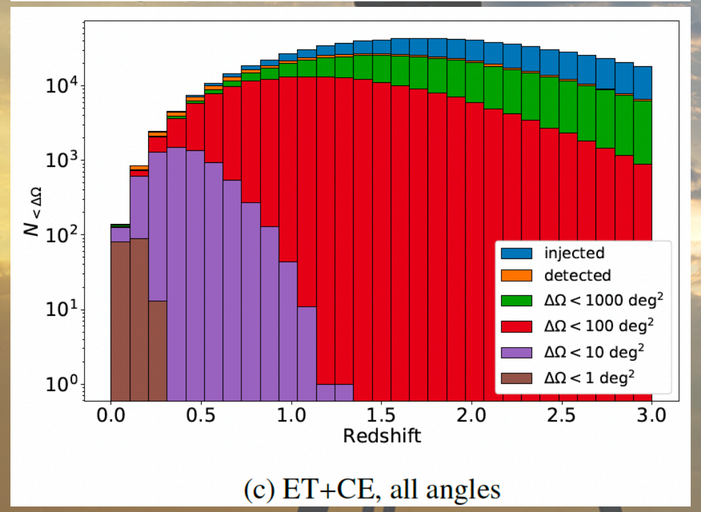


Pian+17

BNS detections with ET and EM follow-up



(a) ET, all angles



(c) ET+CE, all angles

Ronchini+22

Larger volume of the Universe explored
Higher number of BNS detections

Faint optical-NIR counterparts to be found inside large error regions

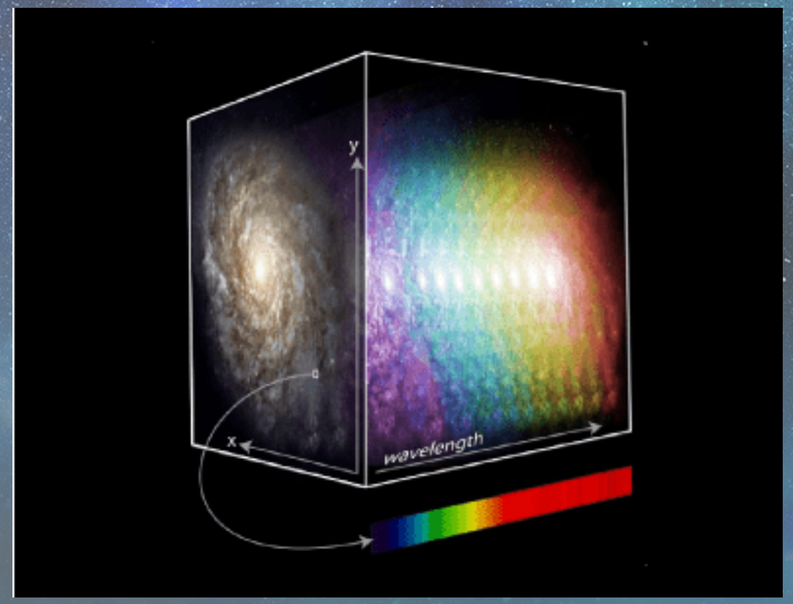
Large FoV and high sensitivities will be necessary for the EM follow-up, in addition to an optimised **observational strategy**

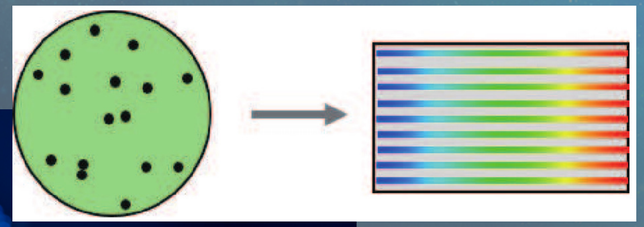
The acquisition of **multiple spectra** at the same time will play a key role in **identifying** and **characterising** EM counterparts

Integral-field and multi-object spectroscopy

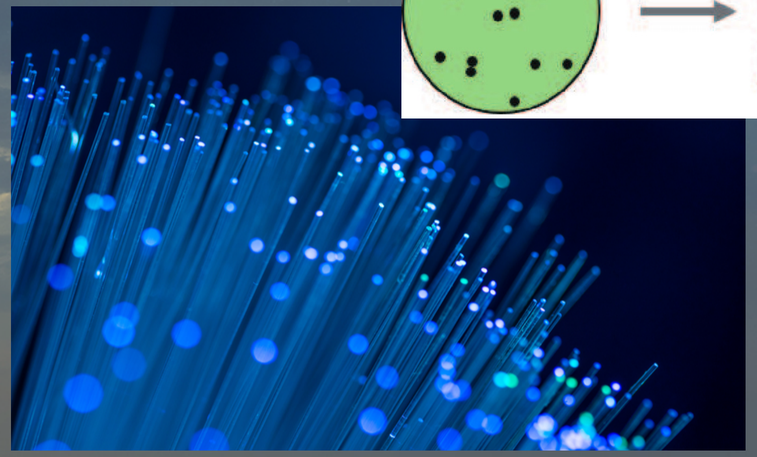
IFS: a spectrum for each pixel of the 2D field image

MOS: fibres to acquire multiple spectra simultaneously





Hang-xin +19

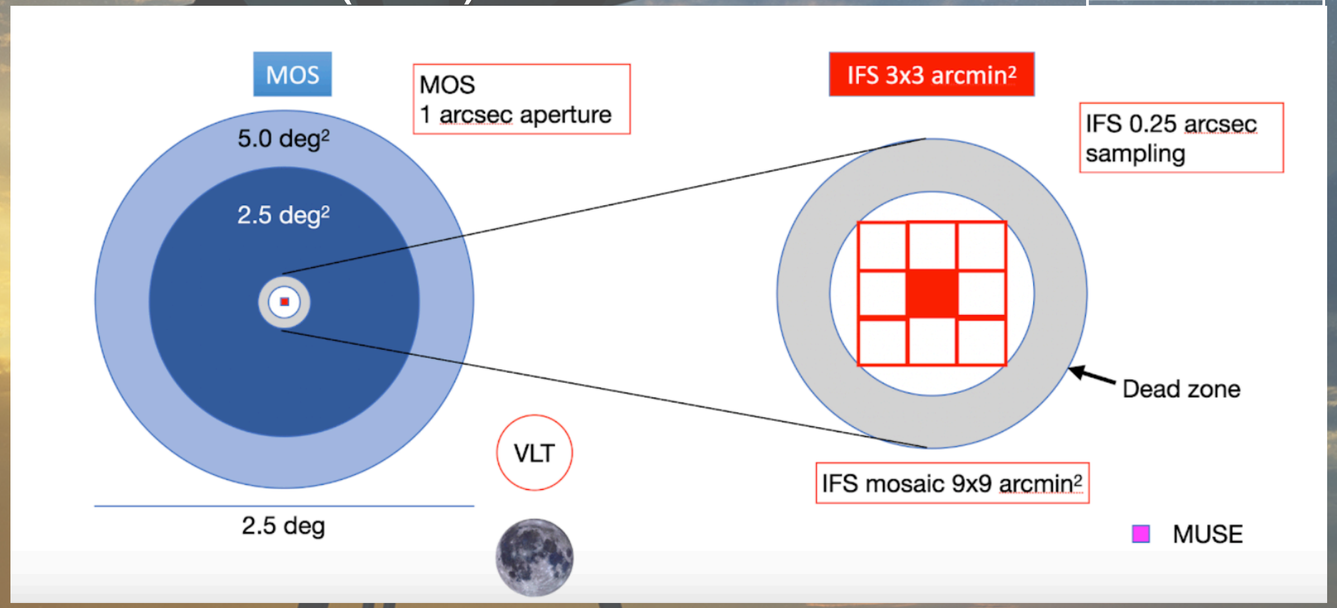


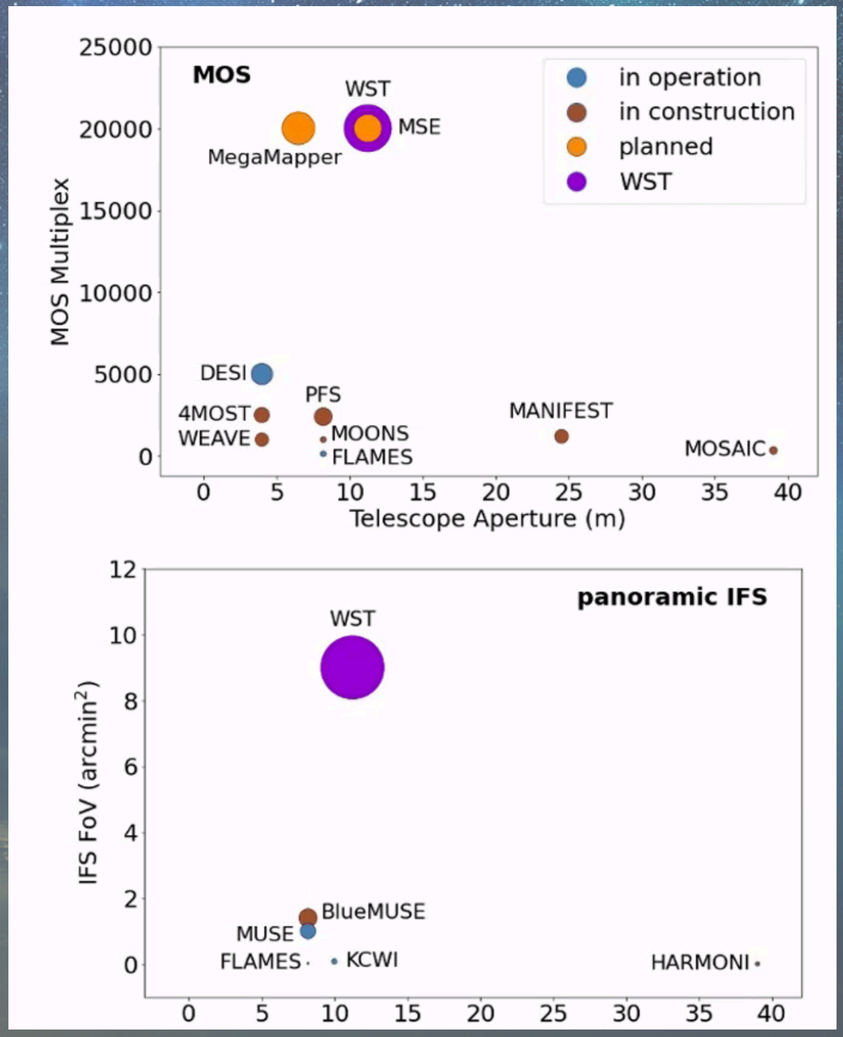
IFS and MOS with the Wide-field Spectroscopic Telescope

Large field of view and high **multiplexing**

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

PI: Roland Bacon **(CRAL)**



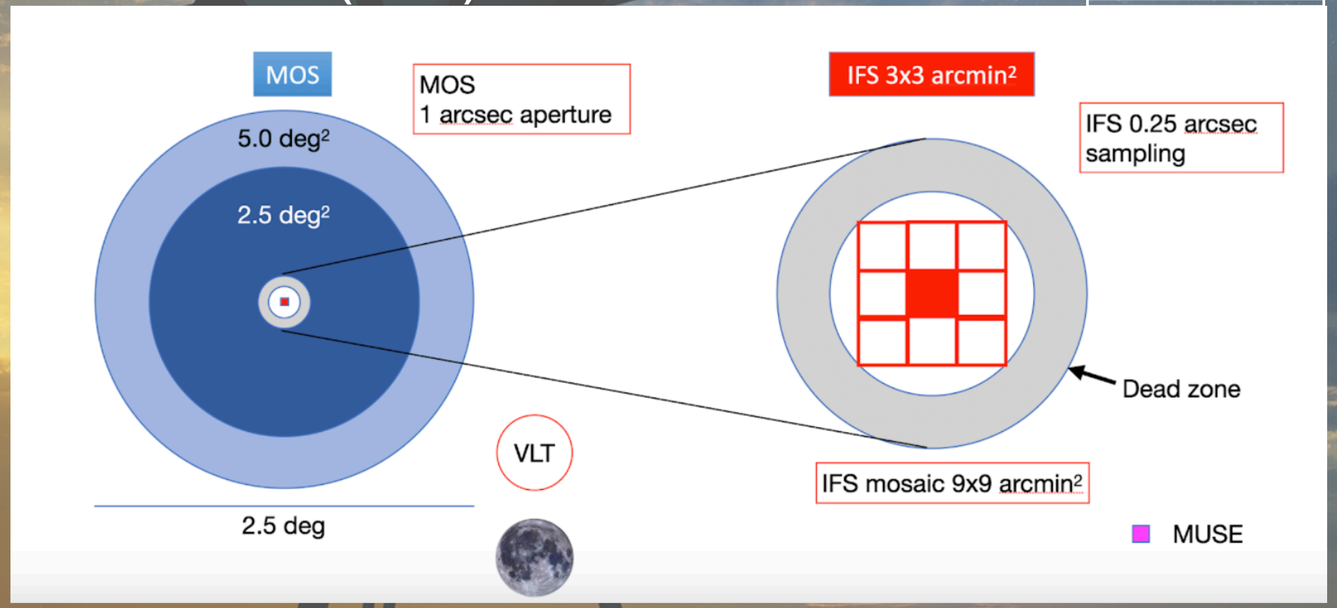


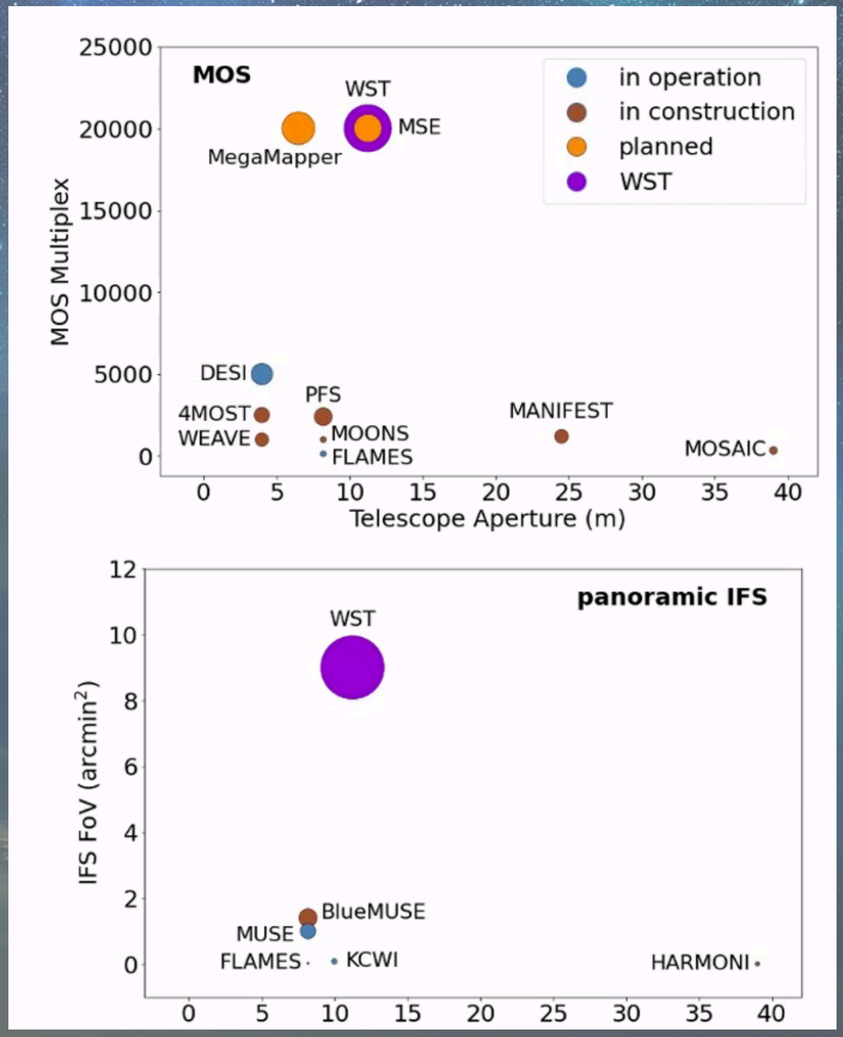
IFS and MOS with the Wide-field Spectroscopic Telescope

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

Division 4 of the ET OSB: Multimessenger Observations

PI: Roland Bacon **(CRAL)**

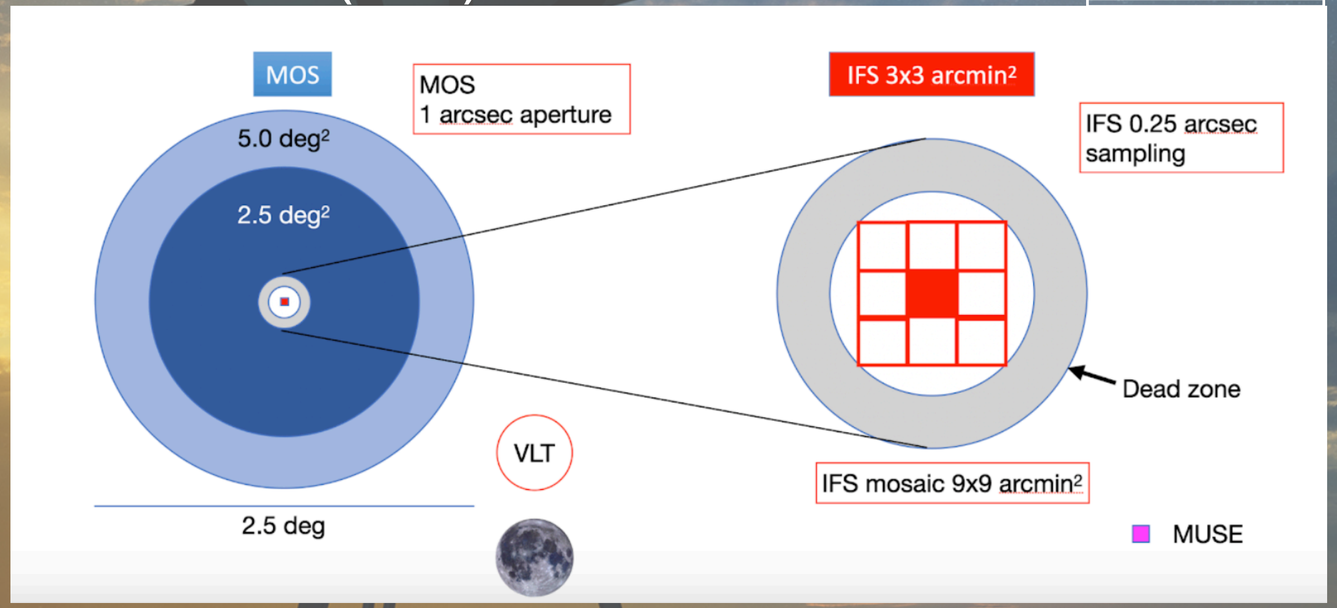




IFS and MOS with the Wide-field Spectroscopic Telescope

Two ways to use **WST** for EM **counterpart detection**, **characterisation** and **identification**

PI: Roland Bacon **(CRAL)**



Stand-alone scenario
Galaxy targeted search with IFS and MOS within the GW signal error region

Synergy with optical-NIR photometric observations
IFS and MOS used to target the counterpart candidates found by optical-NIR surveys

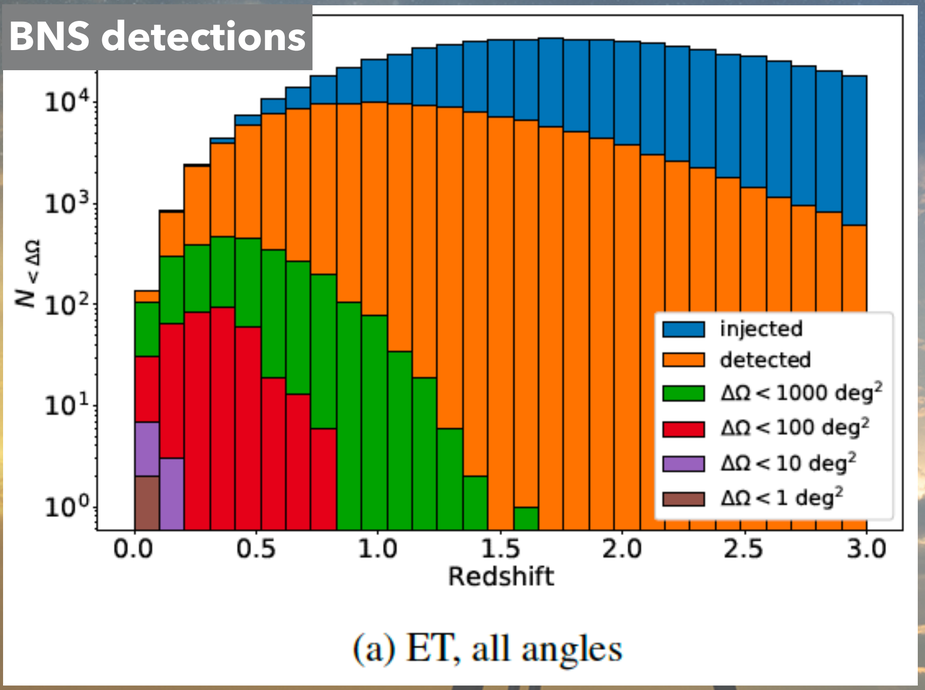
ET-WST synergy

ET simulations

KN + GRB simulations

GSSI group (& Milano Bicocca PROMETEO group)

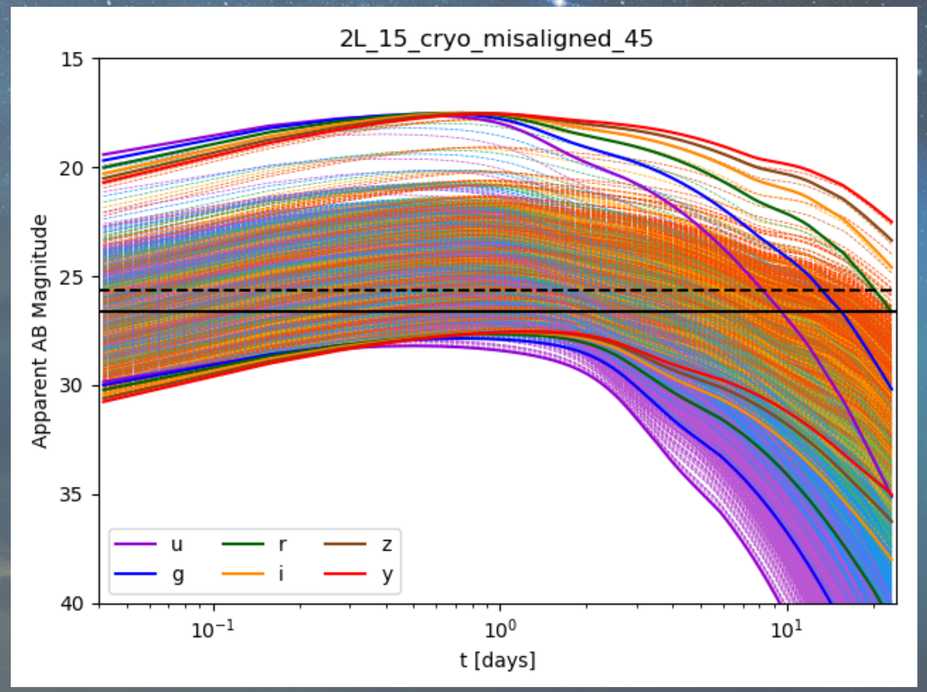
BNS detections



(a) ET, all angles

Ronchini +22

WST simulator



ET-WST synergy

ET simulations

KN + GRB simulations

GSSI group (& Milano Bicocca PROMETEO group)

WST simulator

- explore the **detectability** and **characterizations** with WST of the EM counterparts of ET BNS

- analyse how the results depend on the **observable properties** of the population of **ET BNSs**, such as their distribution in **redshift**, **viewing angle** or sky **localisation uncertainty**

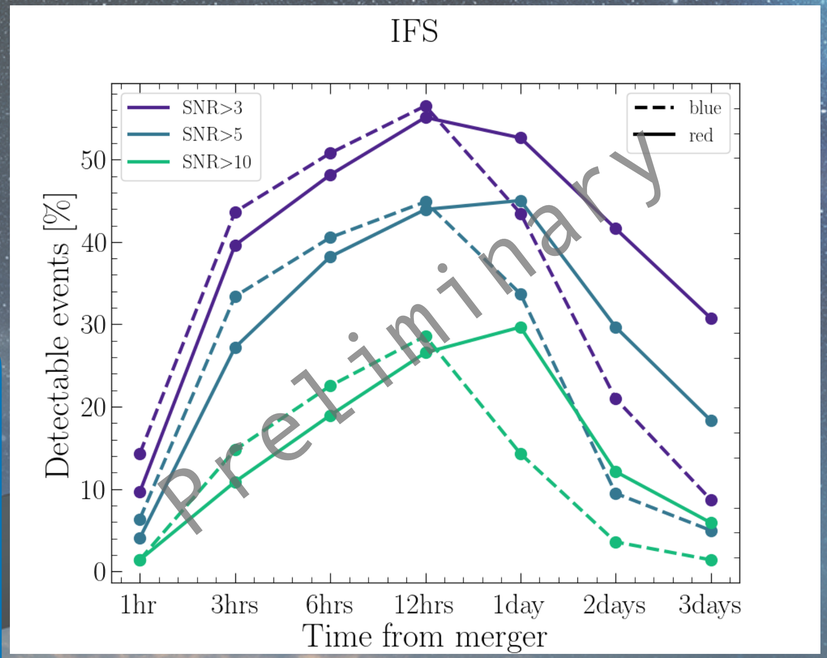
- analyse how the results depend on the **intrinsic properties** of ET BNSs, such as NS **EoS** and the component **mass distribution**

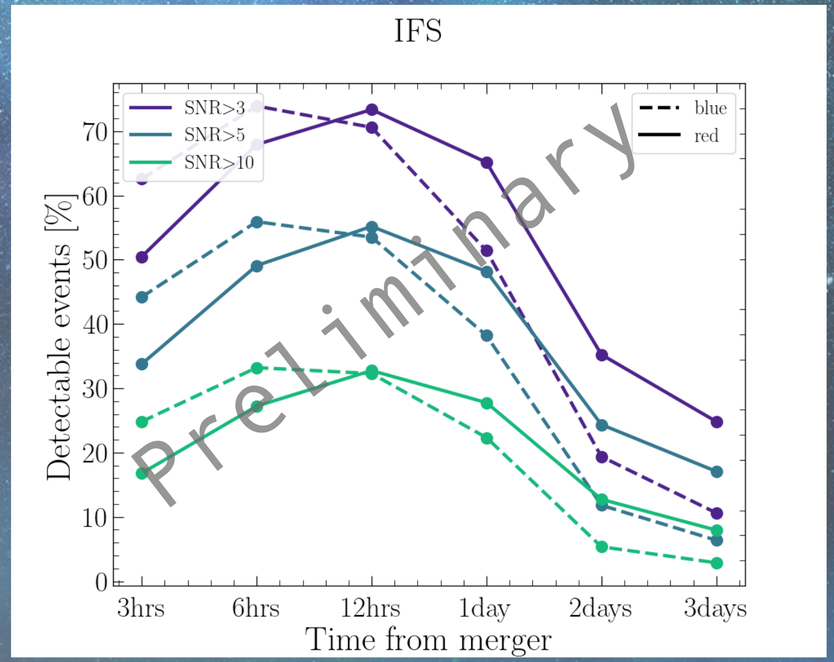
ET-WST synergy

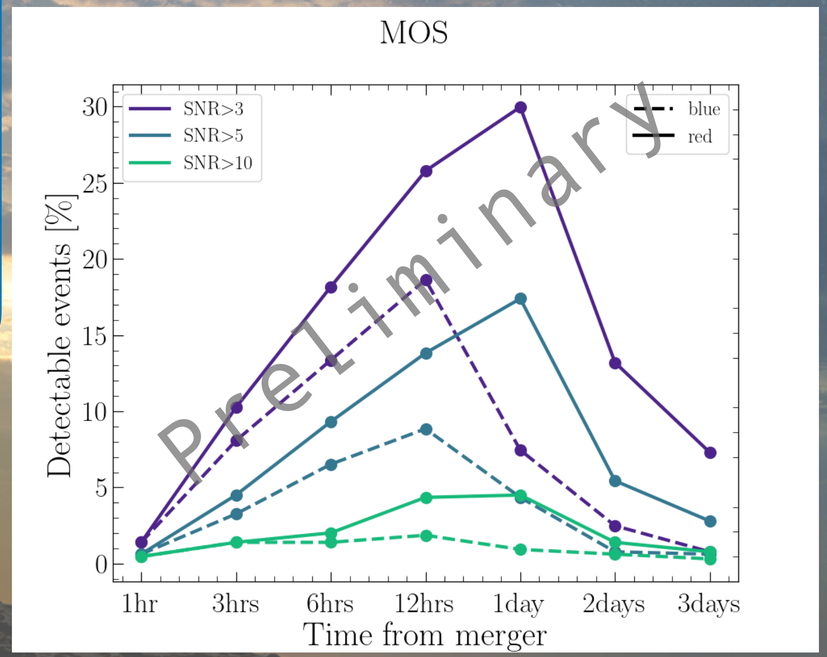
Preliminary results

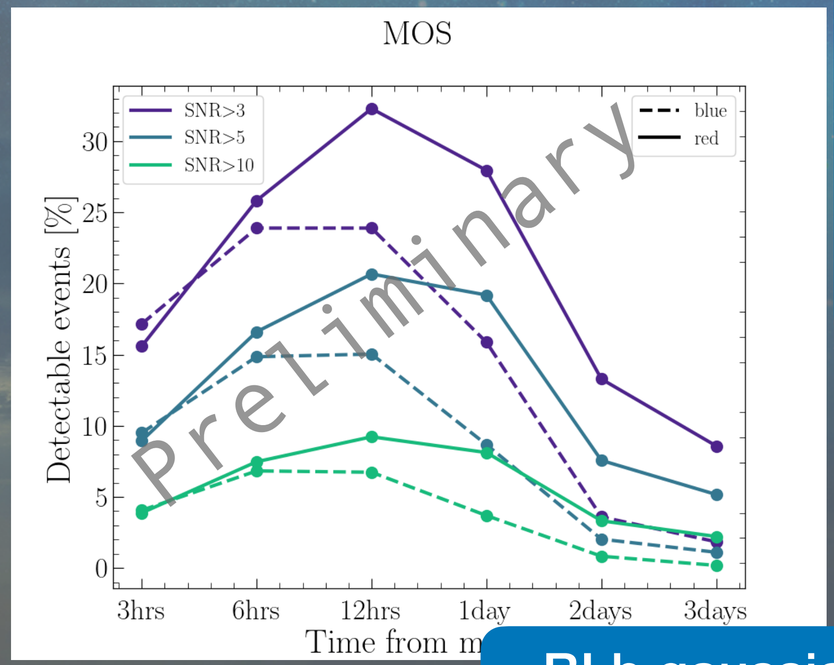
We sample the counterpart population properties at **different times** after the merger

AT2017gfo KN model









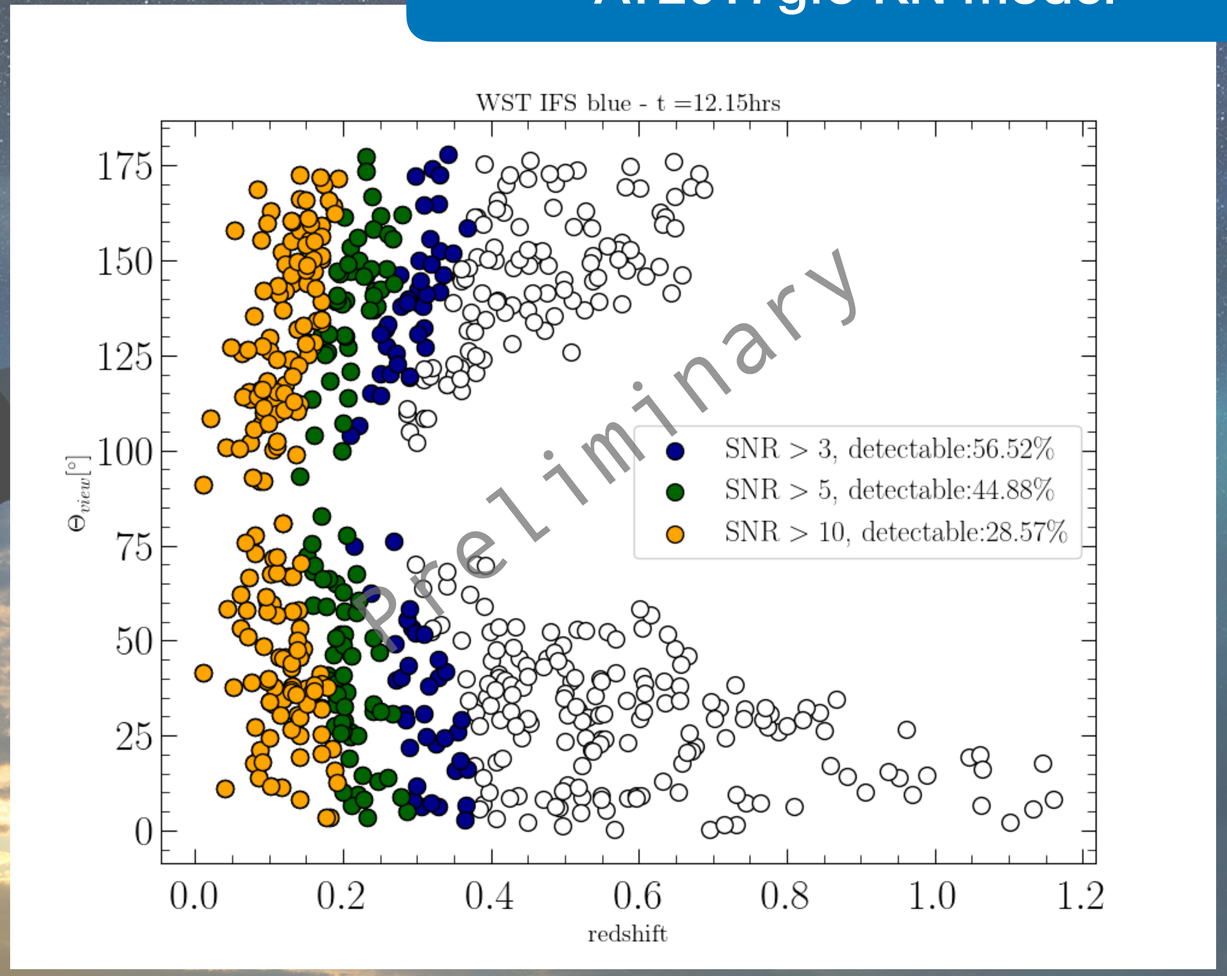
KN theoretical models

BLh gaussian

ET-WST synergy

Preliminary results

AT2017gfo KN model

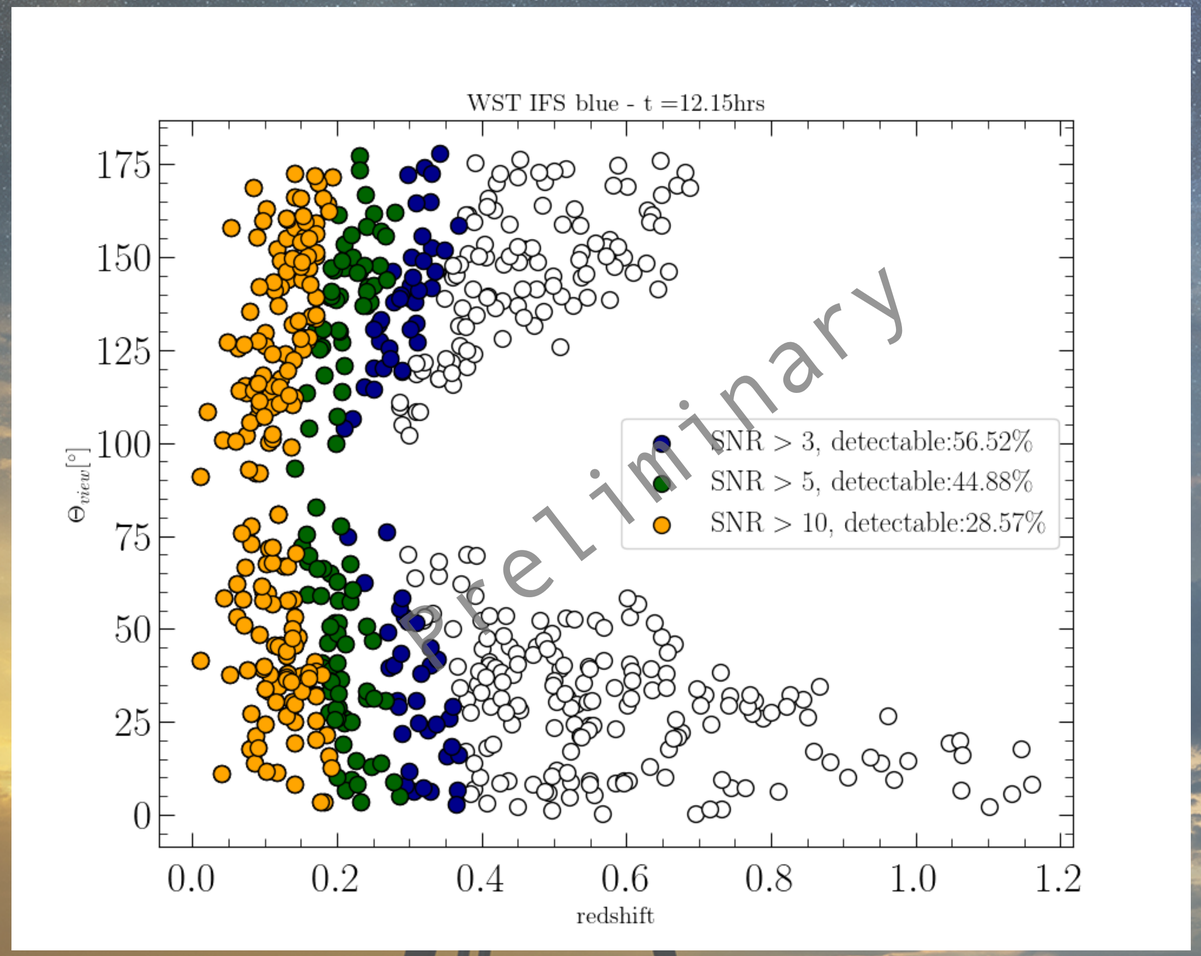


White points: **ET BNS** detections for **1 year** of operations
Colored points: **WST IFS detections** with one **60 minutes exposure**

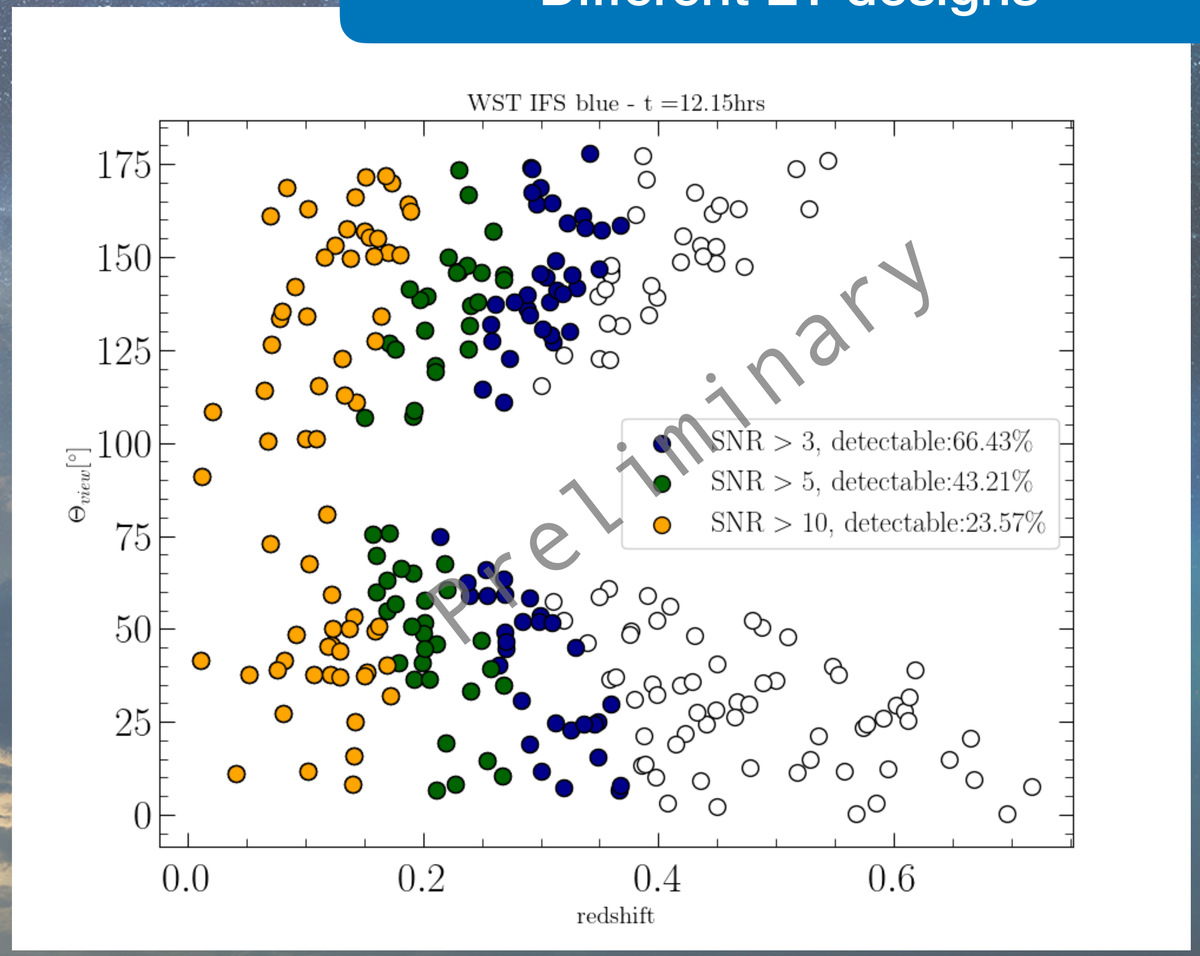
ET-WST synergy

Preliminary results

Different ET designs



2L configuration



Delta configuration

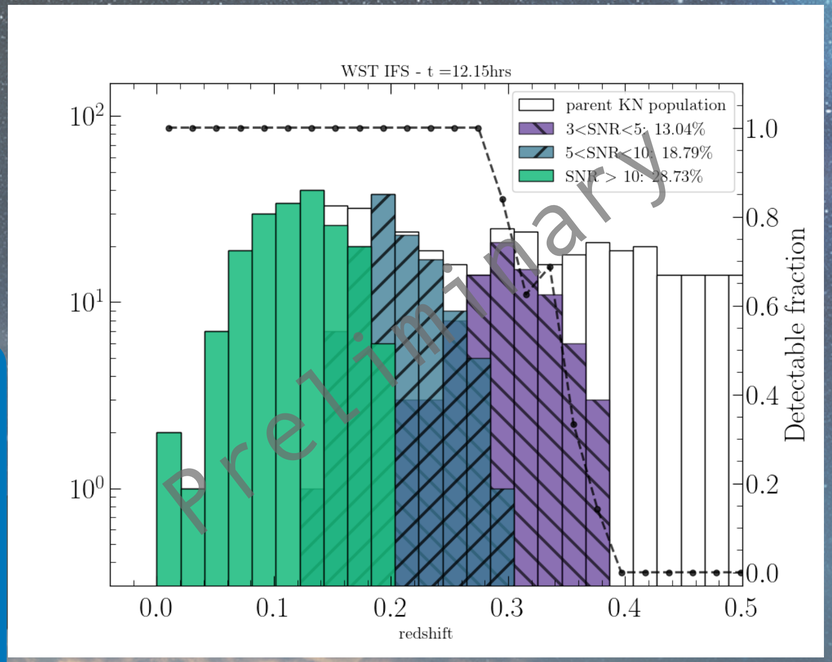
ET-WST synergy

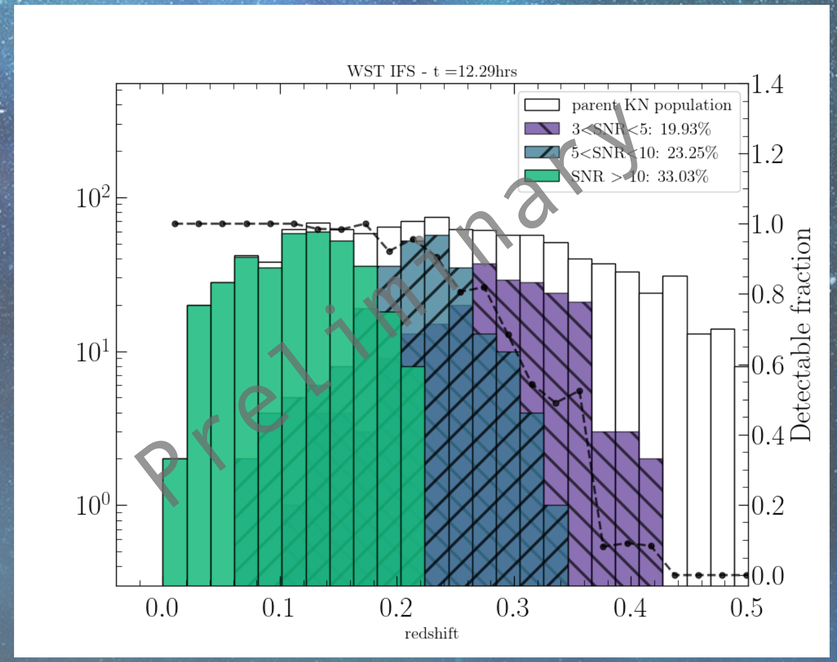
Preliminary results

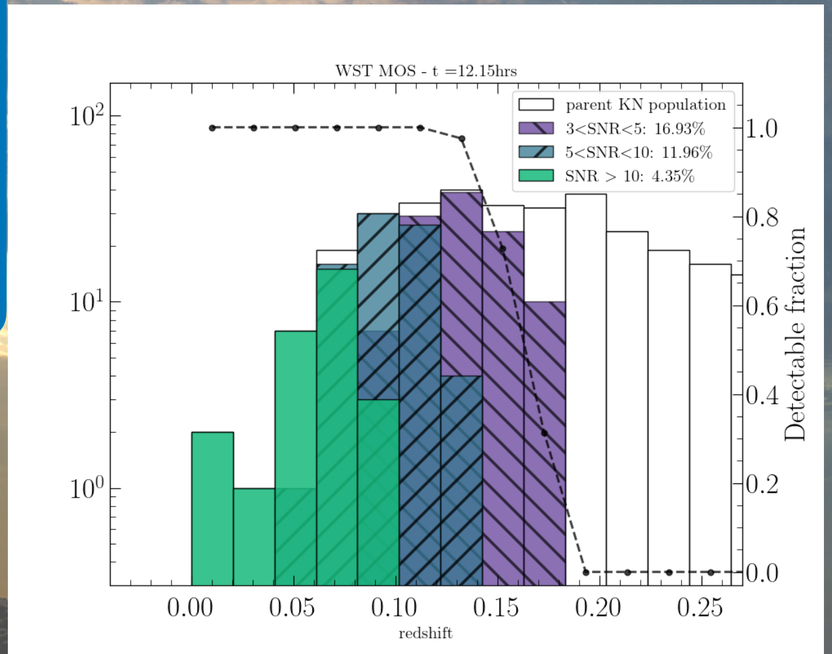
White: **ET BNS** detections

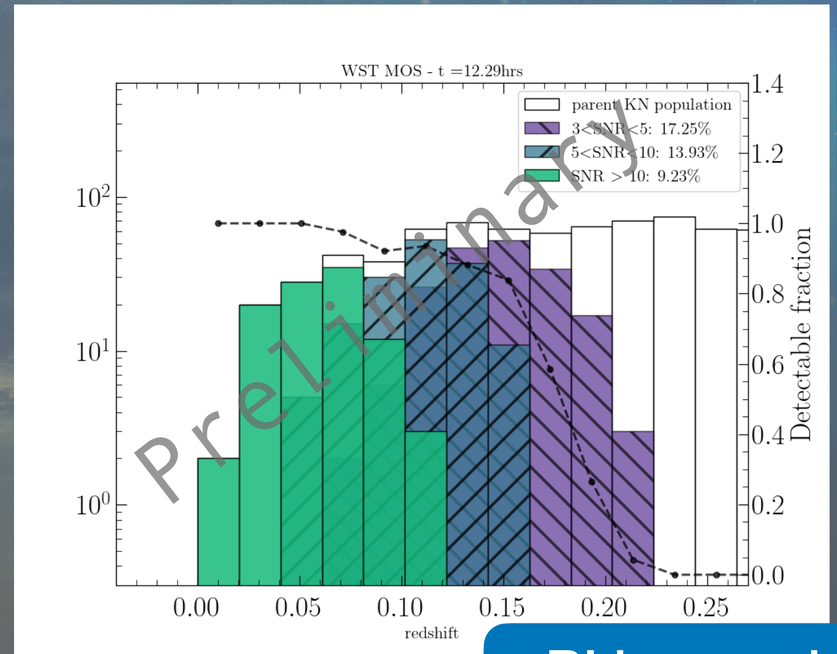
Colored: **WST detections** with one **60 minutes exposure**

AT2017gfo KN model









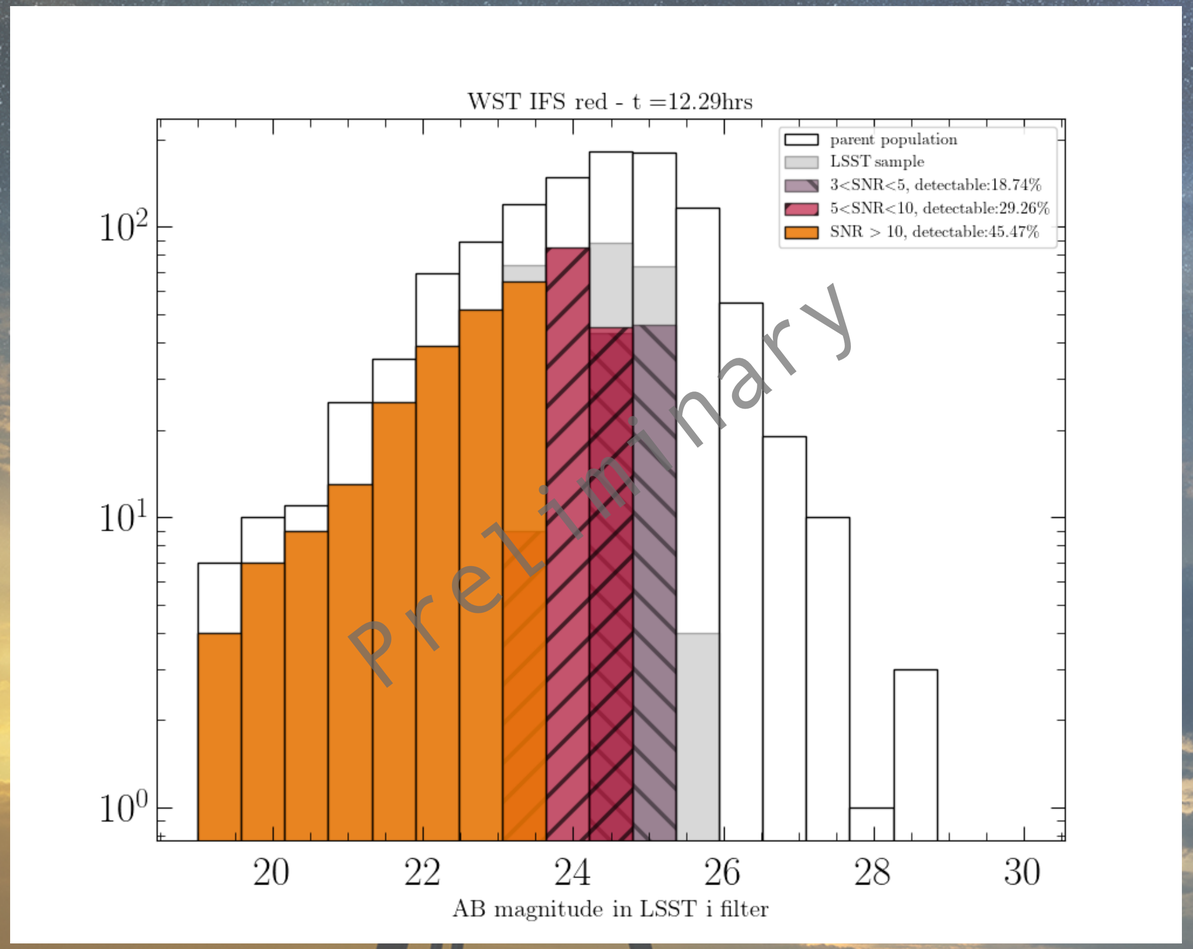
KN theoretical models

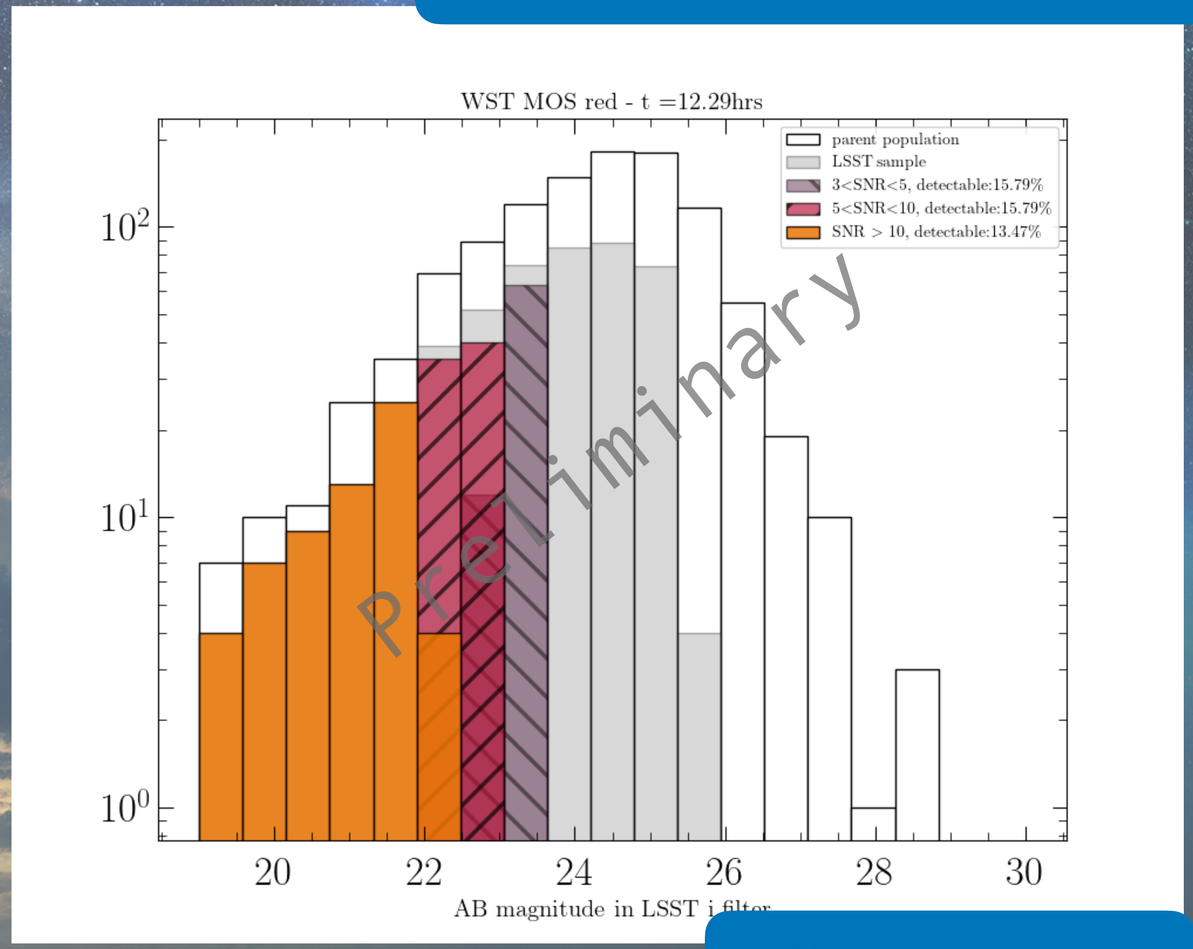
BLh gaussian

ET-WST synergy

Preliminary results

Comparison with VRO





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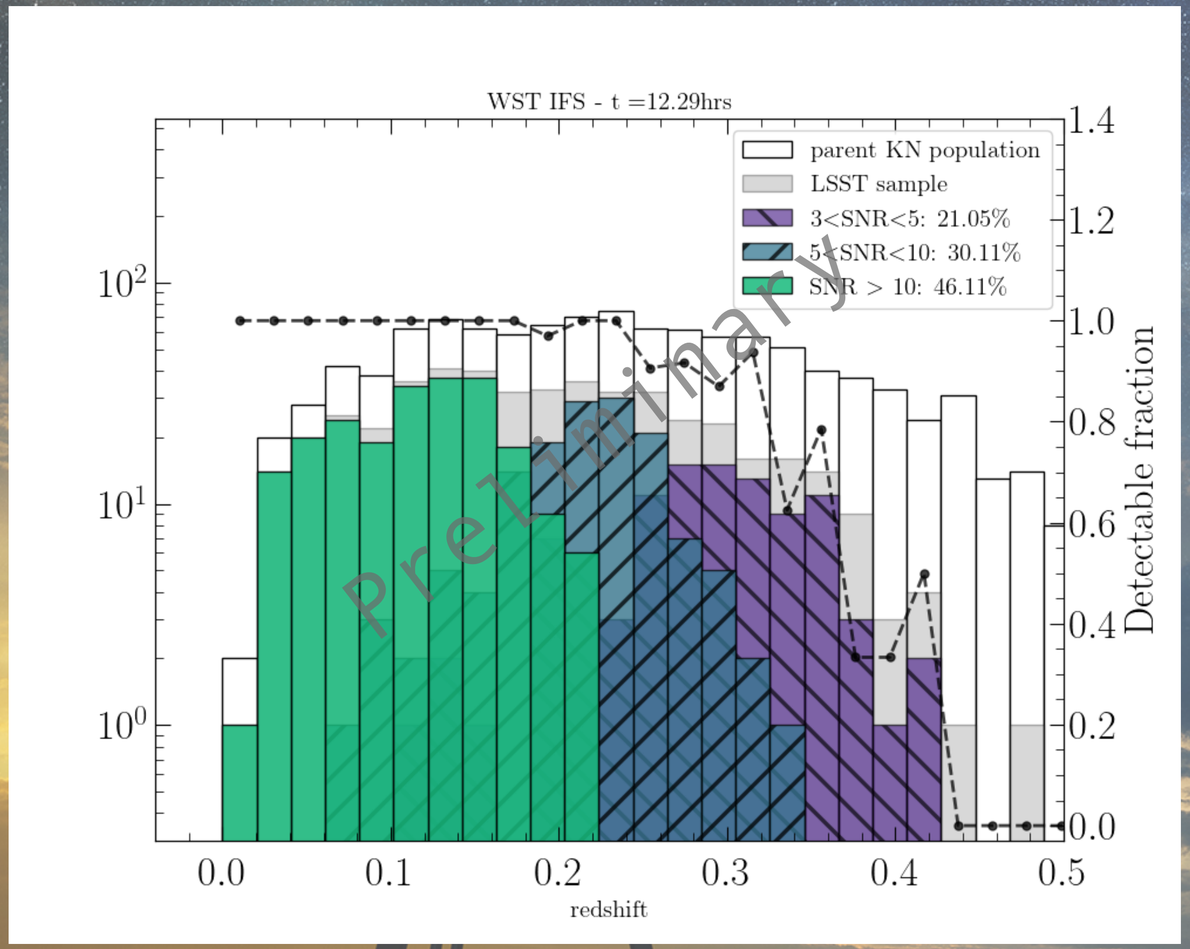

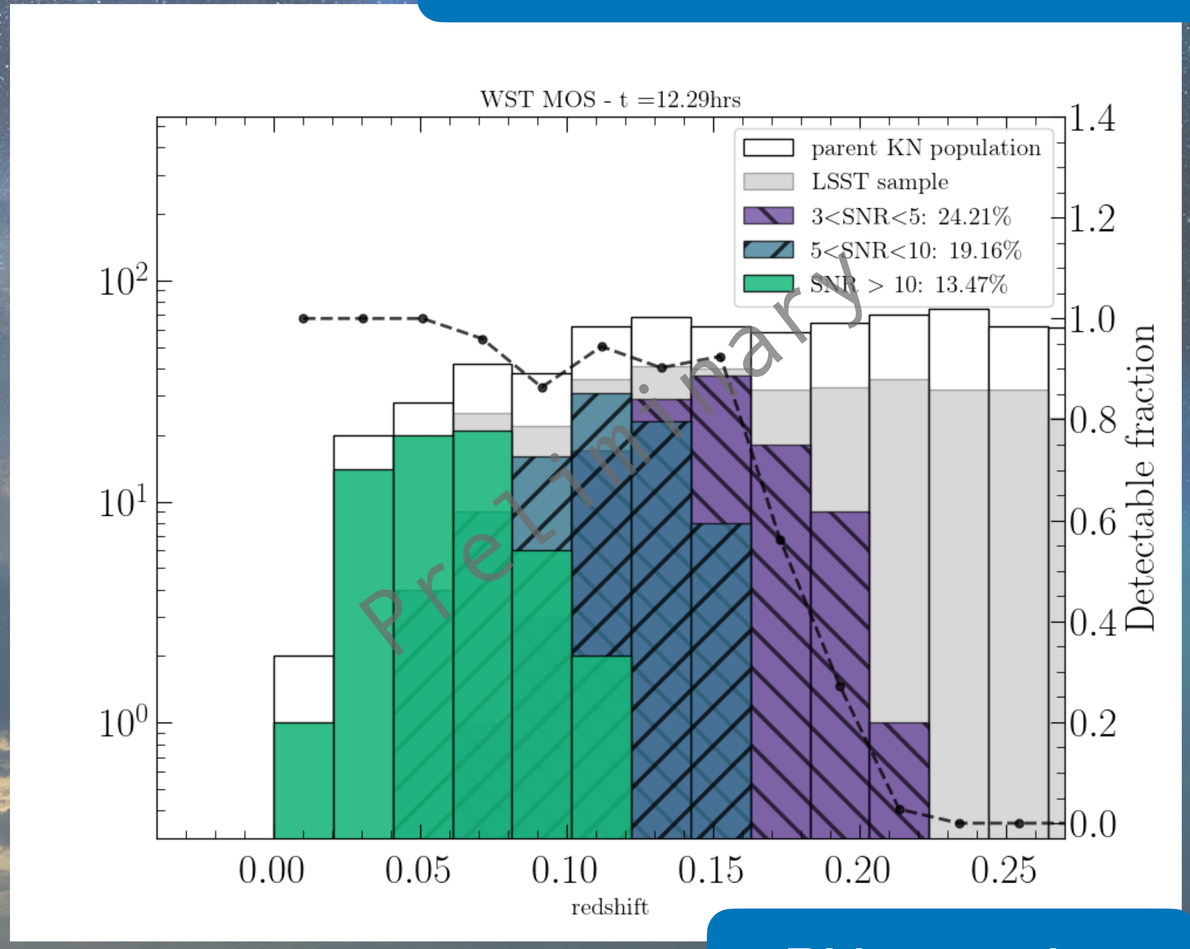

BLh gaussian

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
Two possible scenarios: WST alone or working in synergy with optical-NIR photometric observations

Ongoing work: performing simulations with KN+**GRB afterglow** emission


Thank you for your attention!