The New Robotic Telescope - A new instrument for transient science, coming in 2023

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ABSTRACT

We are entering a new era of synoptic surveys where alerts for young transients are increasing at a rate faster than they can be followed up. The bottle-neck is related to spectroscopic follow-up, with the problem getting worse as surveys get wider and deeper, moving towards the LSST era. To remedy this dearth of spectral follow-up we are building a fast-slewing, fully robotic 4m class telescope on La Palma, to be known as the New Robotic Telescope (NRT)[1]. The workhorse instrument is to be a medium resolution, high-throughput IFU spectrograph. Other proposed first light instruments include a fast readout camera, a wide field camera and a polarimeter. The aim of being on target 30 seconds following an alert will allow us to explore a previously difficult to observe parameter space. Many areas of transient physics will be positively impacted by fast and frequent spectral follow-up of transients at early times. For example, the relative frequency of the ever-increasing zoo of exotic supernova subtypes can be addressed and their unusual environments probed. The new facility will work in parallel with the synoptic surveys by not only providing object classification, thanks to the broad spectral range to be covered, but will also better observe the high velocity features in early time SN Ia spectra. Early spectral observations will help to pin down contested issues like deflagration and detonation models; the single/double progenitor question and spectral evolution of rare supernova subclasses. Other key science drivers include gravitational wave counterpart follow-up and gamma-ray bursts. The advantages of having a fully robotic observatory is that both down-time and time-to-target are significantly reduced. The New Robotic Telescope will work in harmony with the Liverpool Telescope[2], which is run by the same group and currently holds the record for largest fully robotic telescope.

The Telescope

Location

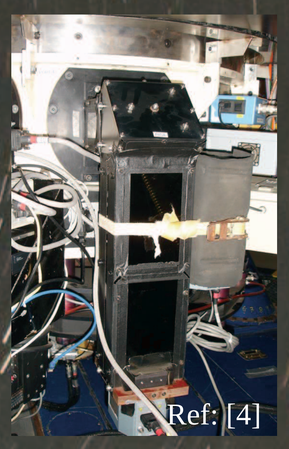
The site for the NRT will be that of the current Carlsberg-Meridian Telescope, next to the William Herschel Telesope, on the island of La Palma.
The Liverpool Telescope also resides on this island, allowing transient alerts to be followed up simultaneously with both robotic telescopes.

Proposed First Light Instruments

The first-light instruments are to be a fast readout camera, wide field camera, polarimeter and a spectrograph.There also exists a provision for portability of instrumentation from the Liverpool Telescope.

High-speed photometer

– RISE/SHOC/GUFI-like –



FOV: ~8'
Fast readout ~50 fps
Broadband - u`,g`,r`,i`,z`

Wide field camera

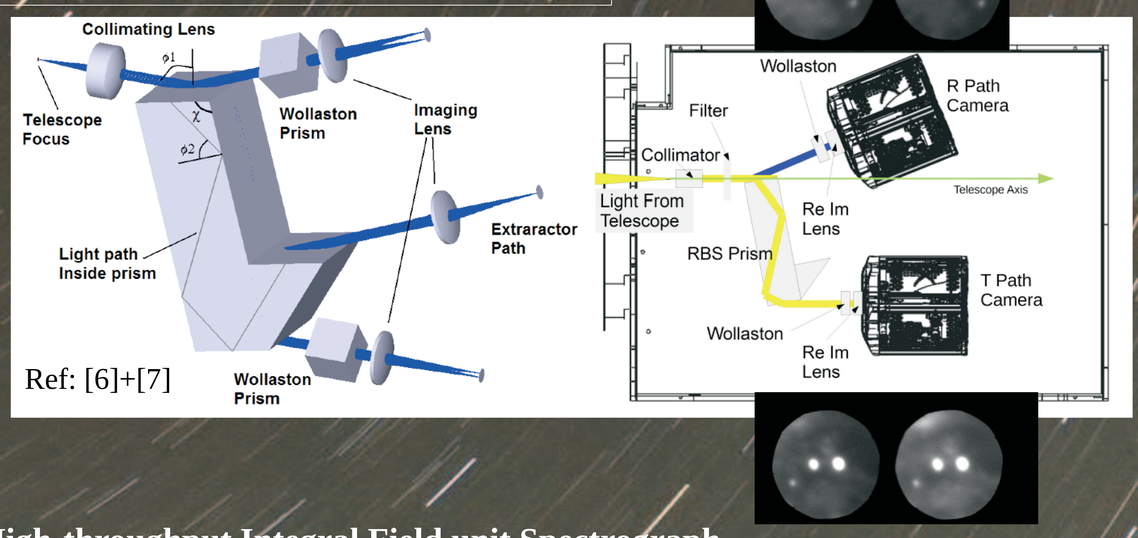
– IO:O-like –

FOV: ~15'x15'
Seeing limited over full-field
Broad- & narrow-band (Hα + [OIII])

High-time resolution polarimeter

– GASP or MOPTOP-like

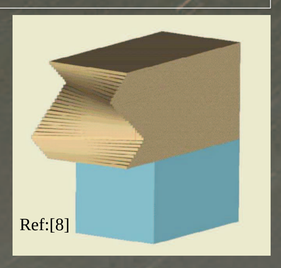
~second time resolution on all 4 Stokes parameters
~0.2% linear polarisation sensitivity for 10^6 counts

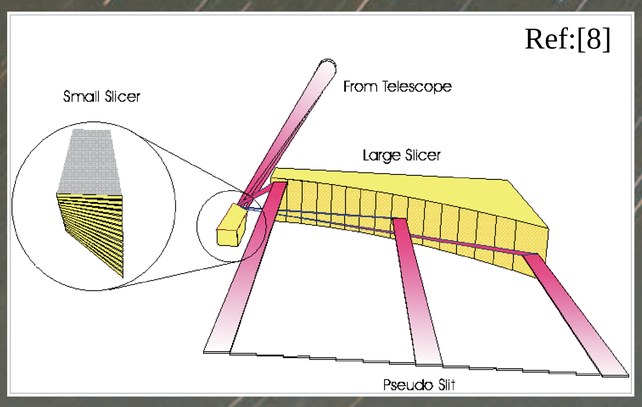


High-throughput Integral Field unit Spectrograph

– SPEIR –

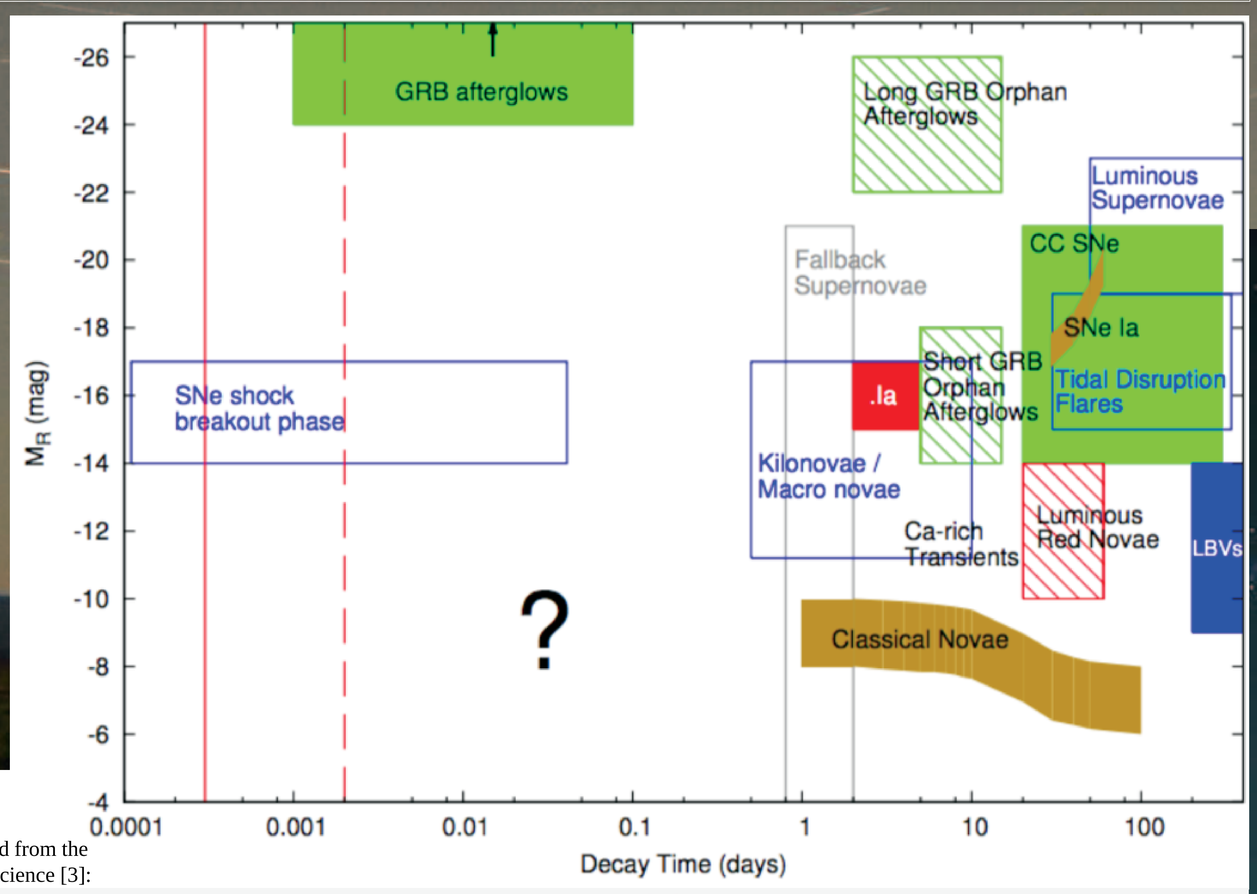
- 2 arm spectrograph
- Image slicer IFU, based on SPIFFI [8]
- Spectral resolution of ~ 1000





Science Case

-Ultra-rapid (<30 seconds) spectroscopic and polarimetric follow-up of electromagnetic counterparts of gravitational wave (aLIGO/Virgo) and neutrino (IceCUBE/ANTARES) sources and new radio (e.g. LOFAR/SUPERB) and high energy (e.g. SVOM, Fermi, Einstein Probe) transients.
-Rapid (<1hr) spectroscopy and polarimetry of (e.g. LSST/ZTF) supernovae (SNe) to explore the shock-breakout phase and find spectral signatures of the progenitor, and of recurrent novae (the supposed progenitors of Type Ia Sne).



Adapted from the LSST science [3]:

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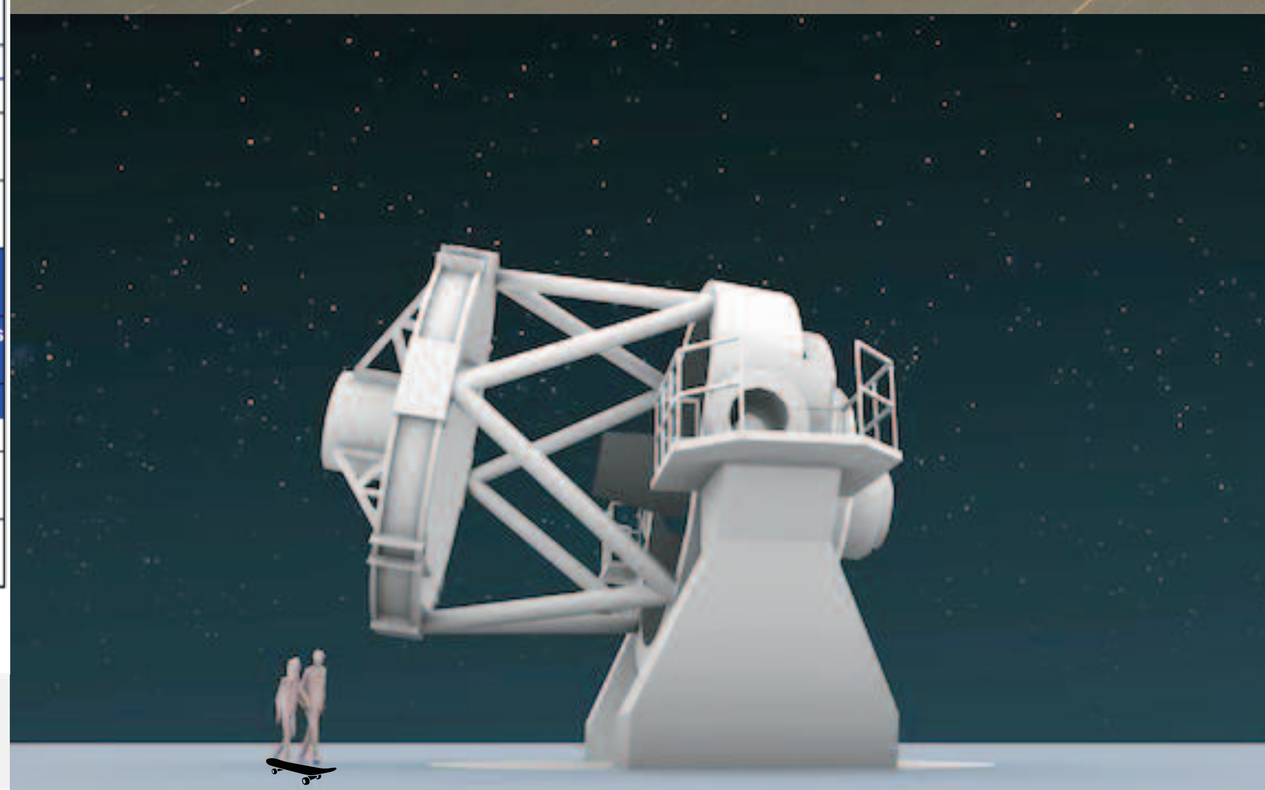

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