# Using the Experience of the Liverpool Telescope to Solve the New Robotic Telescope Scheduling Problem

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## 1. The Problem

### Time Domain Astronomy

Time-domain astronomy observes rapidly changing targets, e.g. gamma-ray bursts and gravitational waves, whose nature varies on a scale of minutes. The NRT scheduler thus needs to make rapid decisions with the flexibility to move to these targets of opportunity quickly. [1]

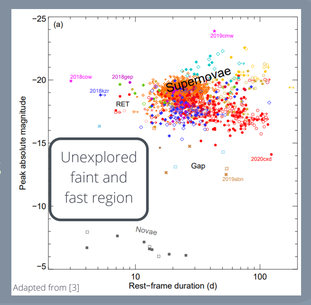
**23%**
**effiency gain**

The LT currently scores all possible queued observations choosing the highest scoring. Predicting forward environmental conditions for a 4-hour window could give efficiency gains of >23% by informing scheduling decisions. [2]

**40%**
**Time allocated for SPEC survey**

The NRT utilises an entirely new hybrid observing model with ~40% of the total telescope time ring-fenced for 'SPEC' time. This new model allows collaboration between investigators and results in less time spent repeating observations, boosting efficiency. [1]

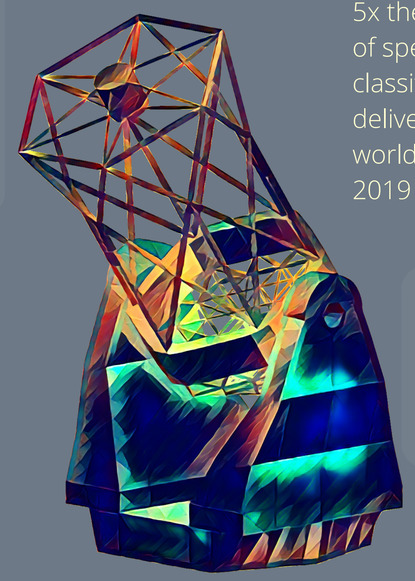
Current and future telescopes produce increasing numbers of fainter and faster targets (see right), dictating NRT's design requirements for more rapid follow-up spectral classification.




## 2. The New Robotic Telescope

**18**
**Mirror segments**

The NRT mirror has 18 hexagonal segments vs the single mirror on the LT, reducing weight and allowing faster slew speeds. [1]



5x the number of spectral classifications delivered worldwide in 2019 . [5]

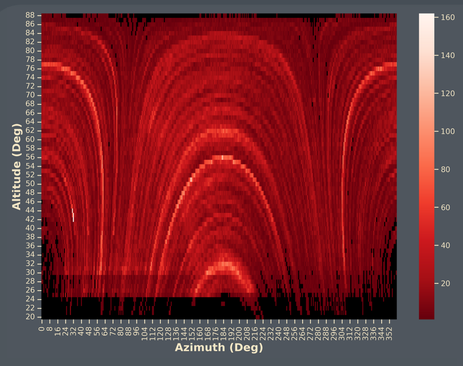
**10,000**
**targets classified per year**

The NRT promises a 20% sensitivity gain over the LT, which can only observe ~66% of gamma-ray bursts detected by Swift. [4]

**86%**
**Swift GRBs observable**

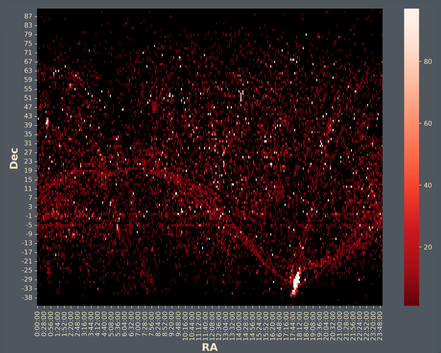
**30s** The time from receiving a transient survey's alert to being on target is 4x faster than the LT's current fastest response. [1]

## 3. The Experience




The LT, operational since 2003, has provided >4.1 million observations distributed across the sky (see left). The higher density towards the plot's centre shows that the LT scheduler prefers rising targets.

Although the LT's coverage is very distributed in stellar coordinates, preferred targets are revealed when historical data is plotted using celestial coordinates (see right). The Milky Way's galactic centre is at ~(17:40:00, -30).




**597**
**FITS headers used**

Each observation generates large volumes of metadata stored in FITS headers plus associated night reports and weather data creating a 'big data problem' to be solved. This will form the training data for the predictive algorithms used by the scheduler.


## 4. The Solution

### Work Package 1: Predictive modelling

Feature selection?

Multiple models?

Predictions generated

### Work Package 2: Simulation

Sky simulation?

Telescope simulation?

Schedule simulation?

### Work Package 3: Integration and Testing

Software Testing?

Statistical Testing?

Integration

### Further Information

References

Plain Text

NRT Webpage

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