Summary. — The Thirty-Meter Telescope is an ambitious project to build a giant segmented mirror telescope with fully integrated adaptive optics systems that will produce diffraction-limited images. A powerful suite of instruments is being developed that, coupled with the ability to rapidly switch between targets and instruments, will allow TMT to take advantage of GRBs to probe fundamental physics in extreme conditions and as the ultimate tomographic beacons, especially if some are as far as $z \sim 10$. This article gives a brief summary of TMT and its instruments, and some examples of the potential offered by observation of GRBs.

PACS 98.70.Rz - gamma-ray sources; gamma-ray bursts.
PACS 95.55.Cs - Ground-based ultraviolet, optical and infrared telescopes.

1. – Introduction

The TMT project is currently an equal partnership between Caltech, the University of California, and the Association of Canadian Universities for Research in Astronomy (ACURA) to construct a 30m telescope. TMT will have a 30-m f/1 primary mirror composed of 738 1.2m segments. The final focal ratio of the telescope will be f/15, and the field of view will be 20 arcminutes. Sites are being tested in northern Chile, Hawaii and Mexico.

The instruments and their associated adaptive-optics (AO) systems will be located on two large Nasmyth platforms, and each instrument station will be addressed by the articulated tertiary mirror. Although both seeing-limited and AO observing modes will be supported at TMT, it is clear that AO will be key in realizing the full scientific potential of the “D^4 advantage” offered by such a large aperture. The telescope, enclosure, AO subsystems and instruments are therefore being designed simultaneously as an end-to-end system under stringent requirements imposed by AO-based science.

Some key system features that will benefit GRB observations include:

- Rapid response: TMT is designed, as a system, to slew and acquire targets, set up active and adaptive optic systems, and be ready to observe with any instrument in less than 10 minutes.
• Adaptive optics: TMT’s AO systems will deliver high strehl images in the NIR and MIR, resulting in a $D^4$ advantage. Laser tomography adaptive optics will substantially improve the image quality in the visible. Since GRBs are initially point sources, they will benefit the most from full AO correction, unlike distant galaxies.

2. – Instrumentation

Most of the proposed instruments will capitalize on the $D^4$ efficiency gain and exquisite spatial resolution (7 milliarcsec images in J band) offered by diffraction-limited images. TMT instruments will be able to address a broad range of GRB science topics, including:

a) Identification of optical counterparts:

• WFOS (Wide Field Optical Spectrograph): Very efficient imaging and low resolution spectroscopy simultaneously in two wavelength bands $0.34 - 0.6 \mu m; 0.6 - 1.0 \mu m$

• IRIS: Low spectral resolution ($R = 4000$) integral field spectroscopy and imaging from $0.8 - 2.5 \mu m$, assisted by high strehl adaptive optics.

b) IGM, ISM, Chemical Evolution of the Universe, Fundamental Physics

• HROS: Very efficient high ($R = 50 - 100,000$) resolution spectroscopy from $0.34 - 1.0 \mu m$. S/N = 100 at $m_{AB} \sim 20$ for $R = 50,000$

• bNIRES: High resolution ($R = 50,000$) spectroscopy from $0.8 - 2.5 \mu m$. Assisted by high strehl adaptive optics ($D^4$ advantage). Continuum sensitivity (1hr, 100$\sigma$): Y, J or H $\sim 17.0$. For $z = 7$, NIRES spectra will cover Ly$\alpha$, Si II, Si IV, C IV, Ni II, Al III, Cr II and Zn II.

• rNIRES: $R = 100,000$ 3-5$\mu m$ spectroscopy, fed by a mid IR AO system or by an adaptive secondary. Continuum sensitivity (1hr, 100$\sigma$): $L = 13.5, M = 11.5$

c) Properties of Host Galaxies

• IRIS: Integral field spectroscopy with spatial resolutions of better than 100pc for all $z > 1$. In direct imaging, IRIS will reach point sources as faint as $K = 28$ ($K_{AB} = 30$) (3$\sigma$) in 3 hours.

3. – Summary

The design of the TMT observatory offers huge potential to exploit the benefits of GRBs. More details of TMT and its instruments can be found in [1, 2]

REFERENCES

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[2] Crampton D. and Simard L., in Ground-based and Airborne Instrumentation for Astronomy, edited by McLean I.S. and Iye M. (Proc. SPIE vol 6269) 2006, pp. 62691T1-15