*Death of Massive Stars: Supernovae and Gamma-Ray Bursts*
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# Observing GRBs and Supernovae at Gemini Observatory as Target of Opportunity (ToO)

**M. Lemoine-Busserolle[1], K. C. Roth[1], E. R. Carrasco[2], B. W. Miller[2], A. W. Stephens[1], I. Jorgensen[1] and B. Rodgers[2]**

[1]Gemini North Observatory, 670 N. A'Ohoku St, Hilo, HI, USA 96720
[2]Gemini South Observatory, c/o AURA, Casilla 603, La Serena, CHILE

**Abstract.** The Gemini Observatories primarily operate a multi-instrument queue, with observers selecting observations that are best suited to weather and seeing conditions. The Target of Opportunity (ToO) observing mode is intended to allow observation of targets that cannot be specified in advance but which have a well defined external trigger such as distant supernovae or Gamma Ray bursts. In addition, the instrument and configuration best suited to observe the ToO may depend on properties of the event, such as brightness and redshift which again are impossible to know in advance. Queue observing naturally lends itself to Target of Opportunity (ToO) support since the time required to switch between programs and instruments is very short, and the staff observer is trained to operate all the available instruments and modes. Gemini Observatory has supported pre-approved ToO programs since beginning queue operations, and has implemented a rapid (less than 15 minutes response time) ToO mode since 2005. ToOs comprise a significant fraction of the queue (20–25% of the highest ranking band) nowadays. We discuss the ToO procedures, the statistics of rapid ToOs observing at Gemini North Observatory, the science related to GRBs and supernovae that this important mode has enabled.

**Keywords.** telescopes, supernovae, observations, gamma rays: bursts.

## 1. ToOs Trigger Types and Procedures

ToOs observations are a good match to queue observations. Because the science teams and template observations are approved in advance, the triggering of ToO observations involves no additional approvals, maximizing the efficiency and minimizing the time between detection of ToO targets and the collection of science data. This is particularly important for GRBs which often fade by 3-4 magnitudes in the first hour after their detection.In case of RAPID response trigger, the observation will be done within the next 24 hours. The minimum response time is about 20 minutes and these triggers can interrupt ongoing observations, both classical and queue. A STANDARD trigger will in general be executed more than 24 hours in the future. This is essentially identical to the normal queue mode except that the targets are not known in advance. Thus, observations will be placed in the queue based on science rank and observing conditions constraints (for more details see http://www.gemini.edu/?q=node/11014). All types of ToO observations can be prepared and submitted using the standard fetch/store operations of the Observing Tool (OT). The basics of ToO Phase II preparation are the same as for regular queue programs. However, in this case the PI needs to define template observations that will be used once the targets are known. Programs that observe more transient objects (e.g. SNe, GRBs) often use many instrument modes so they have to have more triggering options. All facility instruments that are offered for queue observing are available for ToO triggers, although GMOS MOS ToO programs are not accepted at this time. The instruments currently available on a given night, and details of the


**Figure 1.** ToO notification in the Observing Tool.

GMOS North and South configurations, are kept up to date and are available for both the North and South telescopes. Standard ToO Gemini North laser guide star (LGS) observations are allowed; however, targets must be defined at least 8 days in advance of the start of the LGS observing block in which the observations are desired. Template observations should be made by the investigator for each instrument configuration that will be needed and should be stored in a folder called Templates. Once the investigator or the PI software triggered the observation a new active observation is generated in the observing database. In case of Standard ToO, an e-mail is automatically sent to the queue coordinators and the observation is given high priority in the queue generation for the next available night. For Rapid ToO, a windows pops up on the screen of the observer and any actives observing tools. These popup windows contain useful information on the target visibility and observing constraints. An audible alert in the control room occurs at the same time as the popup window and it only stops when the window is closed (Fig. 1). Once the notification is acknowledged by the observer the objective for imaging observations is an acquisition time of less than 6 minutes (including slew). For normal long-slit spectroscopy the objective is 15 minutes (currently the acquisition time is approximately 16 minutes and the slew time is 2 minutes.)

## 2. Science Highlight

Gemini Observatory rapid ToO follow-up observations of GRB optical have led to several breakthroughs in the understanding of these phenomena. In addition, standard ToO observations facilitate follow-up observations of supernovae as well as systematic monitoring of time variable targets. Some of science highlights that have resulted from GRBs and SNe observations can be found on the Gemini web site: The 2011 Nobel prize for physics citation recognizes two teams for the discovery of the accelerating expansion of the universe based on observations of SNe (http://www.gemini.edu/node/11688); the most distant GRB ever seen (http://www.gemini.edu/node/11634); and the first supernova to be discovered using laser guide star adaptive optics (http://www.gemini.edu/node/11226).

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### Reference

Roth *et al.* 2010, *Proc. SPIE 7737*, 77370N (2010)