# Target of Opportunity (ToO) Observation Manual: LBT-Italia

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## 1. Introduction to the Large Binocular Telescope (LBT)

The Large Binocular Telescope (LBT), located on Mount Graham in Arizona at an altitude of 3,221 meters, is one of the world's most advanced optical and near-infrared facilities. Its unique design features two 8.4-meter primary mirrors mounted on a single steerable structure. This "binocular" configuration allows it to achieve the light-collecting area of an 11.8-meter telescope and, in interferometric mode, the spatial resolution of a 22.8-meter telescope.
The Italian National Institute for Astrophysics (INAF) is a 25% partner in the LBT Corporation. Through LBT-Italia, the Italian community has access to a wide range of state-of-the-art instrumentation:

- LBC (Large Binocular Camera): A pair of wide-field (23'x25') cameras optimized for the Blue and Red channels.
- MODS (Multi-Object Double Spectrograph): Twin spectrographs providing low-to-medium resolution spectroscopy and imaging in the optical (320–1000 nm).
- LUCI: Near-infrared (1–2.5 μm) instruments providing imaging, long-slit, and multi-object spectroscopy (MOS), often used with Adaptive Optics.
- PEPSI: A high-resolution echelle spectrograph and polarimeter (R up to 250,000).
- SHARK-NIR / VIS: High-contrast imaging instruments designed for exoplanet detection and stellar environment studies.

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# 2. Target of Opportunity (ToO) Observations

## 2.1 Strategic Vision and Evolution

The management of time-critical observations has undergone a significant evolution within the LBT-Italia framework to better serve the needs of modern astrophysics.
Since 2016 LBT Italia has dedicated special attention to astronomers that request observing in Target of Opportunity (ToO) mode. We know that it is essential to encourage coordination between the P.I. and the astronomer at LBT, both in the preparation of setups and during the observational phase. This latter fact is crucial as the brightness of the transient is often not precisely known. Previously, all observations required the director's approval, a condition that greatly limited ToO observations. This change in philosophy has made it easier to observe and follow-up sources using the ToO mode.

## 2.2 Application and Eligibility

Users can apply for any target during the observing period, including time-constrained observations such as planetary transits or Targets of Opportunity. ToO observations (e.g., Gravitational Waves, Gamma-Ray Bursts, Supernovae, and similar unpredictable events requiring prompt follow-up) may be requested; however, they will be executed only if they receive a very high ranking from the Time Allocation Committee (TAC).
For observations that require execution across different partners' time (cross-partner triggers), the **Time Domain Observation (TDO) Policy** must be followed.

### Summary of the TDO Policy

The Time Domain Observation Policy was established to coordinate high-priority transient science across the LBT consortium. Key points include:

- **Definition of TDO:** Observations of transient sources that must occur within a specific time window.
- **Cross-Partner Triggers:** If a high-priority TDO occurs during another partner's scheduled time, the "Home" partner (the one who owns the night) is generally expected to allow the trigger, provided the program has been pre-approved by the TDO coordination group.
- **Compensation:** Mechanisms are in place to compensate partners who lose time to another partner’s high-priority ToO trigger, ensuring fair distribution of telescope resources.

- **Data Rights:** Data typically remains the property of the PI who triggered the observation, though specific collaborative rules may apply for large-scale events (like Gravitational Wave follow-ups).
- *The full policy can be accessed here: https://lbt.inaf.it/LBT_TDO_Policy_Feb2019.pdf*

### 2.3 ToO Execution Procedure

To ensure a successful and rapid response, the following technical procedure must be followed by the Principal Investigator (PI):

1. **Notification:** The PI, or a designated team member, must contact the LBT-Italia observers via email at: **lbt-italia-obs@inaf.it**.
2. **Required Documentation:** The contact email must include the following essential information:
    - Target coordinates (RA/Dec).
    - Selected instrument(s) and specific configuration.
    - Sky-condition constraints (e.g., seeing, lunar phase, transparency).
    - A clear finding chart.
    - A completed observation setup file created using the **LBT Observing-Tool (OT)** software. *(Note: Documentation for script preparation can be found at https://scienceops.lbto.org/script-preparation/)*.

3. **Submission Deadlines:** The trigger email must arrive before the start of the observing night, **preferably before 15:00 local time**. This allows the LBT-Italia staff sufficient time to evaluate the setup, check for technical feasibility, and confirm the observation plan.

4. **Data Delivery:** Once the observations are completed, the PI will be automatically notified by the **Centro Italiano Archivi Astronomici (IA2) LBT archive**, where the data will be made available for download.

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## 3. Nightly Operations and the Role of the Support

# Astronomer

## 3.1 Pre-Night Preparation

At the beginning of each observing run, the **LBTO team** welcomes the astronomers and briefs them on the current status of the telescope and instruments. The observing schedule is then updated based on this information and the prevailing weather conditions. This plan is further refined daily, accounting for completed programs, expected conditions, and any incoming **ToO** or **DDT** (Director's Discretionary Time) requests.
Daily activities begin **two hours before sunset**. During this window, the staff tests instrument performance and management software, and the first calibration images are acquired.

## 3.2 Environmental Constraints

At LBT, the "astronomical night" is defined as the period when the sun is at least **12 degrees below the horizon**. Observations are subject to strict environmental limits to protect the facility:

- **Humidity:** Must remain below **95%**.
- **Wind Speed:** Wind against the secondary mirror mounts (and LBC instruments) must not exceed **20 m/s**.
    - *Note: This limit may be adjusted at the discretion of the Telescope Operator (TO) based on safety considerations.*

## 3.3 The Role of the Support Astronomer

During the night, the LBT-Italia support astronomer is responsible for the technical execution of the science programs. Their duties include:

1. **Program Selection:** Deciding which program to observe based on real-time weather conditions and in close coordination with the Telescope Operator.
2. **Instrument Configuration:** Loading the specific instrument setups and scripts provided by the PIs via the Observing Tool (OT).
3. **Observational Execution:** This involves pointing the telescope and maintaining continuous coordination with the TO. Because different observations require specific offsets and dithering patterns, the astronomer must oversee every telescope movement.

4. **Spectroscopic Alignment:** Spectroscopy requires significant manual interaction with the software. The astronomer must ensure the target is precisely centered within the slit before moving the dispersing elements into the optical path and beginning the integration.

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## 4. Summary of ToO Workflow for PIs

To ensure a successful and efficient observation trigger, Principal Investigators must follow a specific workflow. The process begins with an initial notification sent via email to the LBT-Italia observing team at **lbt-italia-obs@inaf.it**. This request should be submitted as early as possible and preferably before **15:00** (CET, corresponding to the Italian Time) on the day of the intended observation, providing the staff with enough lead time to evaluate the setup and confirm its feasibility.

Technical preparation is a critical step, requiring all observation scripts to be created using the official **LBT Observing-Tool (OT)** software. The trigger email must contain all necessary documentation, specifically the target coordinates, the chosen instrument configuration, a clear finding chart, and the exported OT setup file. Once the observation has been successfully executed, the PI does not need to take further action to retrieve the data; an automatic notification will be sent by the **IA2 LBT Archive (Centro Italiano Archivi Astronomici)**, where the files will be ready for download.

To wrap up the technical requirements, here is a quick-reference table for PIs triggering a ToO:

| **Requirement** | **Specification** |
|---|---|
| **Notification** | Email to lbt-italia-obs@inaf.it |
| **Deadline** | Preferably before **15:00** (CET) |
| **Setup Tool** | LBT Observing-Tool (OT) |
| **Required Files** | Coordinates, Finding Chart, and OT Script |
| **Data Access** | Automatically via the **IA2 LBT Archive** |