

Technical Report:

Automated Observational Data Logging for the Large Binocular Telescope (LBT)

Software Version: 3.1 (dologv3p3.sh)

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1. Introduction: The Large Binocular Telescope (LBT)

The Large Binocular Telescope (LBT), situated on Mount Graham in Arizona, is a premier astronomical facility uniquely characterized by its binocular design. It utilizes two 8.4m primary mirrors on a single alt-azimuth mount, providing a total light-collecting area equivalent to an 11.8m single-aperture telescope and a maximum interferometric baseline of 22.8m.

Managed by an international consortium including the Istituto Nazionale di Astrofisica (**INAF**), the LBT serves as a high-resolution laboratory for advanced optical and infrared astronomy.

Within the international LBT consortium, INAF holds a 25% share of total observing time, which is managed and executed by the **LBT-Italia** group. The mission of this group is to coordinate Italian access to the facility and maximize scientific return for the national community. A central pillar of this mission is the support provided by LBT-Italia observers. These specialists are responsible for the execution of astronomical observations, ensuring that the complex binocular systems are optimized for the specific requirements of each program. The `dologv3p3.sh` tool was specifically developed to assist these observers in their core responsibilities, which include:

- **Observational Execution:** Scheduling and performing observations based on program ranking, Moon phase, and atmospheric conditions.
- **Quality Control and Logging:** Observers utilize the `dolog` tool to generate detailed, automated summaries of each night's activities. These logs serve as a bridge between the raw data repository and the final science-ready products.
- **PI Support:** The generated logs provide **Principal Investigators (PIs)** with an immediate and high-level overview of their project's progress. This transparency allows PIs to track the completion of science targets and the availability of necessary

calibrations (e.g., biases, flats, and arc lamps) shortly after the data is acquired.

Furthermore, LBT-Italia supports the entire lifecycle of a program, from the initial call for proposals to the delivery of reduced data products. The observers' logs are vital for the subsequent stages of the data chain, including spectroscopic data reduction and the eventual archiving of facility instrument data in the **LBT Reduced Science Data Center (LSC)**, where it is eventually made available to the public.

1.1 Instrument Suite and Scientific Capabilities

The LBT's binocular nature allows for flexible observing modes, including simultaneous imaging or spectroscopy in different wavelengths.

- **LBC (Large Binocular Cameras):** Dual wide-field prime focus imagers. **LBC-Blue** is optimized for shorter wavelengths (350–650 nm), while **LBC-Red** targets the 550 nm–1 μm range.
 - **MODS (Multi-Object Double Spectrographs):** A pair of low-to-medium resolution spectrographs providing dual-beam (Red/Blue) spectroscopy and imaging over a 6' field of view.
 - **LUCI:** Near-infrared (0.9–2.5 μm) instruments capable of multi-object spectroscopy and imaging, often utilized with Adaptive Optics (AO) for diffraction-limited resolution.
 - **PEPSI:** A high-resolution echelle spectrograph (\$R \approx 250,000\$) for detailed stellar and planetary atmosphere studies.
 - **SHARK-VIS/NIR:** Second-generation high-contrast AO instruments designed for direct imaging of exoplanets.
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2. System Architecture and Operational Logic

The `dologv3p3.sh` script is an automated utility designed to parse FITS metadata and generate structured night logs. It facilitates the transition from raw data acquisition to organized scientific reporting.

2.1 Directory Structure and Environment Management

The script operates within a strictly hierarchical file system to ensure data integrity and version control compatibility:

1. **Raw Repository Path (/lbt/data/repository):** The primary source where raw FITS files are stored in date-stamped directories (e.g., 20230917).
2. **Working Directory (/home/inaf/LOG):** A transient staging area where the script performs data extraction and generates temporary file outputs to prevent repository contamination.
3. **ScienceRuns Archive (/home/inaf/share/ScienceRuns/lbtobs/):** The final destination for processed logs, organized by year (e.g., 2026/dataLOG).
4. **Symlink and Path Correction:** The script includes automated checks to detect legacy paths (e.g., /home/inaf/ScienceRuns/...). If detected, the script automatically redirects to the modern share/ directory structure to maintain cross-version compatibility.

2.2 Data Categorization Methodology

Using the *dfits* and *fitsort* tools, the script analyzes specific FITS header keywords to sort observations into three distinct categories:

A. Science Observations

Observations are identified as "Science" based on partner affiliation and hardware states:

- **LBC:** Categorized if PARTNER == "INAF" and EXPTIME > 2s (filtering out technical snapshots).
- **MODS:** Identified when the CALIB unit is "OUT" (external to the light path) and PARTNER == "INAF".
- **LUCI:** Science frames are filtered by ensuring the CALIB keyword is not set to a calibration value and the mask is not in a "blind" position.

PEPSI and SHARK observations are not currently saved in the same Repository

B. Calibration Frames

The script detects various calibration types essential for data reduction:

- **Biases/Darks:** LBC uses the OBJECT keyword "BinoBias"; LUCI identifies darks when both internal filters are set to "blind".
- **Flats:** Categorized as "SkyFlats" (LBC), "Imaging Flats", or "Slitless Pix Flats" (MODS) based on mask and calibration unit configurations.
- **Arc Lamps:** Wavelength calibration frames are identified by the active status of internal lamps (Ne, Hg, Ar, Kr, Xe). In LUCI, the script specifically monitors Lamps 1 through 3 for this purpose.

3. Functional Analysis of dologv3p3.sh

The dologv3p3.sh script is a specialized Bash-based utility designed to parse FITS (Flexible Image Transport System) metadata to provide structured summaries of observing nights.

3.1 Operational Workflow

The script automates several critical steps for the observer:

5. **Environment Check:** It verifies the existence of the INAF data repository and the ScienceRuns directory structure.
6. **Repository Targeting:** It automatically identifies the most recent data folder (e.g., 20230917) or accepts a user-defined date as an argument.
7. **Metadata Extraction:** Using dfits and fitsort, the tool extracts specific FITS keywords to categorize data by instrument, observation type, and partner (focusing on INAF-led proposals).
8. **Categorization:** It distinguishes between **Science** frames and **Calibration** frames (Biases, Darks, Flats, and Arc Lamps) using internal conditional logic.
9. **Output Generation:** Structured .dat files are produced for each instrument, followed by a high-level night summary.
10. **High-Level Summarization** The script utilizes the `uniq -cd` command to aggregate the sorted data. This creates a count-based summary, allowing observers to see the total number of frames per object/filter combination at a glance.
11. **Archiving:** The script concludes by synchronizing the generated logs with a Subversion (SVN) repository for long-term record keeping.

3.2 Instrument-Specific Processing Logic

Instrument	FITS Keywords Analyzed	Processing Logic
LBC	FILTER, EXPTIME, PROPID, OBJECT	Identifies SkyFlat and BinoBias; filters for science frames with exposure times > 2 seconds.
MODS	CHANNEL, GRATNAME, CALIB, MASKNAME	Detects various arc lamps (Ne, Hg, Ar, Kr, Xe). Distinguishes spectroscopy from imaging flats and biases.
LUCI	GRATPOS, CAMERA, DIT, NDIT, READMODE	Categorizes darks via "blind" masks and summarizes

		spectroscopic observations by grating type (G200, G210).
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4. Execution Procedures

4.1 Environment Requirements

The script is designed to operate within the INAF synchronized environment. Before running the command, the observer must navigate to the specific **dataLOG** folder corresponding to the current observing year:

```
cd /home/inaf/share/ScienceRuns/lbtobs/YYYY/dataLOG
```

(Where YYYY represents the current year, e.g., 2026).

Operating from this location is mandatory because the script performs automated checks to verify the local path and relies on this directory structure to successfully execute Subversion (SVN) commits and archive the generated logs.

4.2 Running the Script

Once inside the dataLOG folder, the script can be invoked using the following syntax:

To generate a log for the most recent night:

```
bash dologv3p3.sh
```

To generate a log for a specific historical date:

```
bash dologv3p3.sh 20210919
```

5. Automation and Archiving

Upon successful processing, the script automates the archival process via Subversion (SVN):

- **Update Logic:** It checks for existing logs in the SVN, removes obsolete versions, and adds the newly generated directory.
- **Versioning:** The final command executes an svn commit, ensuring that the night's metadata is version-controlled and accessible to the broader INAF community.

6. Conclusion

The `dologv3p3.sh` tool significantly reduces the manual workload for LBT observers by providing a programmatic bridge between raw FITS repositories and formal night reports. Its ability to categorize complex calibration sequences and group science targets by program ID ensures high data integrity and operational transparency for the INAF scientific community.

A. Appendix

A.1 Terminal output example

Output from night of the 5th of March 2026. Being no MODS observations, these are currently reported as an error. It will be a warning in future versions.

This script creates logs from a specific night
version 3.1

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!!!Note that MODS imaging is not included yet!!!

EXAMPLES:

Log for last/current night:

```
bash dologv3p3.sh
```

Log for a specific night:

```
bash dologv3p3.sh 20230917
```

Now the year is set to 2025

You are using a symlink to ScienceRuns, I will correct this and move to

```
/home/inaf/share/ScienceRuns/lbtobs/2025/dataLOG
```

```
/home/inaf/share/ScienceRuns/lbtobs/2025/dataLOG
```

We are in /home/inaf/share/ScienceRuns/lbtobs/2025/dataLOG

you ask to look in /lbt/data/repository/20260305

Using repository: 20260305

We move in /home/inaf/LOG

this exists /home/inaf/LOG/20260305 in LOG

```
error: cannot open file [/lbt/data/repository/20260305/lbc*fits]
```

Summary LBC calib

Summary LBC science

error: cannot open file [/lbt/data/repository/20260305/mods*fits]

Summary MODS calib

error: cannot open file [/lbt/data/repository/20260305/mods*fits]

Summary MODS science

Summary LUCI calib

```
3 Flat LUCI1 unknown N3.75 clear J Mirror ---
```

```
4 arclamp LUCI1 LS_1.00arcsec N1.8 clear zJspec G200 ---
```

```
4 arclamp LUCI2 LS_1.00arcsec N1.8 clear zJspec G200 ---
```

...
... CONTINUE

Summary LUCI science

2 LUCI1 Mirror LS_1.00arcsec N3.75 OH_1060 z 2.5272842323 3
IT-2024B-012/LBT-2025B-T2137 Angela Malizia HIP32549
2 LUCI2 Mirror LS_1.00arcsec N3.75 OH_1060 z 2.5272842323 3
IT-2024B-012/LBT-2025B-T2137 Angela Malizia HIP32549
2 LUCI1 G200 LS_1.00arcsec N1.8 clear HKspec 200. 1 IT-2025B-039/LBT-2025B-T2095
Matilde Signorini SDSSJ105124.06+325410.2
2 LUCI2 G200 LS_1.00arcsec N1.8 clear HKspec 200. 1 IT-2025B-039/LBT-2025B-T2095
Matilde Signorini SDSSJ105124.06+325410.2

...
... CONTINUE

Save in svn: 20260305

A 20260305
A 20260305/luci-calib-20260305.dat
A 20260305/lbc-science-20260305.dat
A 20260305/summary-luci-20260305.dat
A 20260305/lbc-calib-20260305.dat
A 20260305/mods-science-20260305.dat
A 20260305/mods-calib-20260305.dat
A 20260305/summary-lbc-20260305.dat
A 20260305/summary-mods-20260305.dat
A 20260305/luci-science-20260305.dat
Adding 20260305
Adding 20260305/lbc-calib-20260305.dat
Adding 20260305/lbc-science-20260305.dat
Adding 20260305/luci-calib-20260305.dat
Adding 20260305/luci-science-20260305.dat
Adding 20260305/mods-calib-20260305.dat
Adding 20260305/mods-science-20260305.dat
Adding 20260305/summary-lbc-20260305.dat
Adding 20260305/summary-luci-20260305.dat
Adding 20260305/summary-mods-20260305.dat

Transmitting file datadone

Committing transaction...

Committed revision 3546.

DONE!

A.2 LUCI science logfile example

Example of logfile luci-science-20260305.dat for the night of the 5th March 2026:

```
FILE          INST GRATING MASKID CAMERA FILTER1 FILTER2 DIT NDIT PROPID PI_NAME OBJECT
luci1.20260305.0153.fits  LUCI1 Mirror LS_1.00arcsec N3.75 OH_1060 z 2.5272842323 3 IT-2024B-012/LBT-2025B-T2137
Angela Malizia HIP32549
```

```
luci1.20260305.0154.fits  LUCI1 Mirror LS_1.00arcsec N3.75 clear J 2.5
272842323 3 IT-2024B-012/LBT-2025B-T2137 Angela Malizia HIP32549
```

```
luci1.20260305.0155.fits  LUCI1 Mirror LS_1.00arcsec N3.75 OH_1060 z 2.5
272842323 3 IT-2024B-012/LBT-2025B-T2137 Angela Malizia HIP32549
```

```
...
... CONTINUE
```

A.3 LUCI calibration logfile example

Example of logfile luci-calib-20260305.dat for the night of the 5th March 2026:

```
FILE          INST MASKID CAMERA FILTER1 FILTER2 GRATING ---- class
luci1.20260305.0124.fits  LUCI1 LS_1.00arcsec N1.8 clear K G210 --- arclamp
luci1.20260305.0125.fits  LUCI1 LS_1.00arcsec N1.8 clear K G210 --- arclamp
luci1.20260305.0126.fits  LUCI1 LS_1.00arcsec N1.8 clear K G210 --- arclamp
luci1.20260305.0127.fits  LUCI1 LS_1.00arcsec N1.8 clear K G210 --- arclamp
```

```
...
... CONTINUE
```

A.4 LBC science logfile example

Example of logfile lbc-science-20260307.dat for the night of the 7th March 2026:

```
FILE          INST GRATING MASKID CAMERA FILTER1 FILTER2 DIT NDIT PROPID PI_NAME OBJECT
luci1.20260307.0024.fits  LUCI1 Mirror N30_FieldStop N30 clear K 5.1NOTSPECIFIED NOTSPECIFIED NOTARGET
luci1.20260307.0025.fits  LUCI1 Mirror N30_FieldStop N30 clear K 5.1NOTSPECIFIED NOTSPECIFIED NOTARGET
luci1.20260307.0026.fits  LUCI1 Mirror N30_FieldStop N30 clear K 5.1NOTSPECIFIED NOTSPECIFIED NOTARGET
luci1.20260307.0027.fits  LUCI1 Mirror N30_FieldStop N30 clear K 5.1NOTSPECIFIED NOTSPECIFIED NOTARGET
```