

GLAS

Grond-laag Laser Adaptieve optiek Systeem

Ground-layer Laser Adaptive optics System

A Rayleigh laser beacon for NAOMI

Laser Traffic Control System

User Manual

Project name Ground-layer Laser Adaptive optics System

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List of abbreviations and acronyms

Dec	Declination
FOV	Field of view
Host	Computer providing web services for LTCS
ING	Isaac Newton Group of Telescopes
INT	Isaac Newton Telescope
Laser impacted	Observations that are sensitive to the laser light
LTCS	Laser Traffic Control System
ORM	Observatorio del Roque de Los Muchachos
OVR	Override flag
RA	Right ascension
UI	User Institution
URL	Universal Resource Locator
WHT	William Herschel Telescope

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1 INTRODUCTION

The purpose of this document is to describe the use of the LTCS (Laser Traffic Control System). The LTCS is a system to predict and avoid interference between the lasers installed on the ORM and the observations being carried out at the other telescopes.

2 HOW THE LTCS WORKS

This section briefly describes how the LTCS works and how it protects the observations being carried out at other telescopes. The information presented here is necessary in order to understand the LTCS web interface.

2.1 Collecting pointing information

The first thing the LTCS needs for predicting collisions between the telescopes and the laser are the coordinates of the target of every telescope on sky. For this reason each telescope on site provides a URL, automatically created, containing the target information. The LTCS receives the telescope URLs periodically and extracts the necessary information from all the relevant telescopes.

There are two types of information in the URLs, positional information and non-positional information. Positional information consists of the RA, DEC and Equinox for the target of the telescope. Non-positional information includes the FOV of the instrument mounted on the telescope, a flag showing if the observation is laser sensitive, a flag saying whether to record the data or not and finally a flag for the laser status.

2.2 Predicting collisions

Every time a telescope changes its position or its non pointing information, the LTCS calculates potential collisions that may occur for this telescope for the next three hours. This calculation is also carried out when the telescope with the laser moves to a new target. The calculation will take into consideration all the telescopes that have indicated in their URL that they are laser sensitive.

The LTCS will cease to perform additional calculations for one hour unless a telescope moves. If a telescope moves, then the calculation will be performed again for a three hour period. After an hour has passed, the predictions are automatically recalculated, so valid predictions are always available for at least two hours.

2.3 In case of collision

If the LTCS calculates that a collision is in progress and the laser does not have priority it will shutter the laser automatically. After the collision has passed the LTCS will be updated accordingly.

This system can also be used by the AO observer to check if the laser-enabled telescope can be moved to a new target without interfering with the observations of the other telescopes.

3 USING THE LTCS

The main purpose of the LTCS is to protect the observations being made at the ORM by shuttering the lasers when they don't have priority during a collision. This procedure is automated and the interaction with the users (observers, telescope operators and laser operators etc) is limited to the presentation of basic information such as the system healthiness and the collision predictions. For this purpose the LTCS uses a series of web pages located on a web server which is accessible by the other UIs.

In addition it can also be used as a query tool, which allows the user to determine if they can observe a new target safely.

Another tool that is available within the LTCS is the scheduler. This allows users to provide the pointing information for two telescopes together with a time in the future and the system will predict if any collisions will occur.

3.1 The LTCS web pages description

From henceforth the computer providing the web services for the LTCS will be referred to as the "*host*". The users should replace this name with the real name (or IP number) of the web server. For the ING this computer is "ltcs.ing.iac.es".

The following paragraphs will describe the web pages which comprise the user interfaces of LTCS.

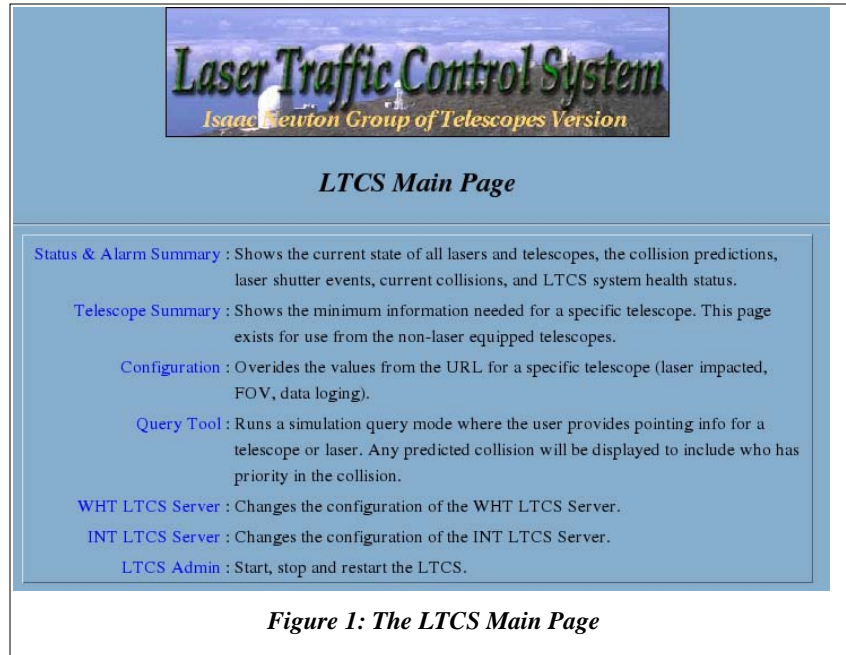
3.1.1 The LTCS main page

This provides a menu for all the other pages and it gives a brief description about the functionality of each page. From this page the user can navigate to all other LTCS pages through a series of links.

To access this page the user should use the URL address <http://host> (for example <http://ltcs.ing.iac.es>). The links in this page provide direct access to the following pages:

- "Status & Alarm Summary"
- "Telescope Summary"
- "Configuration"
- "Query Tool"
- "WHT LTCS Server"
- "INT LTCS Server"
- the "LTCS Admin"

The LTCS main page is shown in Figure 1.



3.1.2 The Status & Alarm Summary Page

This is the page that the users should refer to during their observations. It is the web page in which all the information of interest to the user is presented. It contains information about the health of the system and whether any collisions are predicted. It provides information about potential collisions between their telescope and a laser. It also identifies who has priority. The page refreshes automatically every 10 seconds.

Observatories				Lasers				
	URL State	OVR State	Laser Impacted		Laser State	Shutter Event (site,duration)	Predictions (number, site list)	
	INT	OK	NO	YES	WHT	Shuttered	INT, 1043 (secs)	None
	NOT	OK	NO	NO				
	WHT	OK	NO	NO				
Collisions								
	Laser	Scope	Started	Ends	Priority			
	WHT	INT	15:42:40	16:00:30	SCOPE			
Laser "ON" Preview (Predictions & Collisions)								
	Laser	Scope	Starts	Ends	Priority			
Heartbeat Status :				Collector	GA_Engine	Status_Mgr		

Figure 2: The Status & Alarm Summary page

Detailed information includes the health of the system, the health of the URLs from each telescope, the status of each laser, the collision predictions and the collisions. To improve the legibility of this page, certain events are colour coded (Figure 2).

3.1.2.1 The Observatories Table

This table presents the user with the health for each telescope. The information available will include the URL state, the OVR state and whether or not the telescope is laser impacted.

	<i>URL</i> <i>State</i>	<i>OVR</i> <i>State</i>	<i>Laser</i> <i>Impacted</i>
<i>INT</i>	OK	NO	YES
<i>NOT</i>	OK	NO	NO
<i>WHT</i>	OK	NO	NO

Figure 3: The Observatories Table

The *URL state* box shows the state of the telescope's URL address. Each time the LTCS accesses a telescope URL it updates this box. The possible values are *INIT*, *OK*, *STALE* or *FAILED*. The following table contains a description of each state:

<i>URL State</i>		
<i>Value</i>	<i>Colour</i>	<i>Description</i>
INIT	yellow	The URL state is <i>INIT</i> when the LTCS hasn't received the URL. There are no positioning data for this telescope so the telescope is excluded from the calculations.
OK	green	When the URL state is <i>OK</i> the LTCS has received the URL and extracted the necessary data. If the observation of this telescope is laser sensitive it will be included in all the collision calculations.
STALE	yellow	The <i>STALE</i> state shows that the datum in the URL is old. This check is carried out using the timestamp taken from the URL. The time before the URL is considered to be stale is configurable. In this state the telescope is excluded from any collision calculations.
FAILED	red	If the LTCS cannot access the URL (because, for example, of network problems) or if the datum in it is invalid (missing or incorrect parameters), the <i>FAILED</i> state is shown. The telescope will be excluded from any calculations. This would warrant an investigation of the problem.

The *OVR State* box indicates if the user is overriding the pointing information from the URL (See the section entitled Configuration Page). The possible values are summarized in the following table:

<i>OVR State</i>		
<i>Value</i>	<i>Colour</i>	<i>Description</i>
NO	green	When the override state is <i>NO</i> , this indicates that the user is not overriding any information in the URL.
YES	yellow	When the override state is <i>YES</i> the user is overriding the non pointing data from the URL. The data that could be overridden are the laser impacted flag, the FOV diameter and the data logging flag.

The *Laser Impacted* box indicates if the observation of the telescope is laser sensitive or not. The colour in this box indicates how the laser impacted flag is set. The possible value and colour combinations with a small description are summarized below:

<i>Laser Impacted</i>		
<i>Value</i>	<i>Colour</i>	<i>Description</i>
YES	green	In this case the telescope's observation is laser sensitive. The telescope will be included in all the collision calculations.
NO	light blue	The telescope's observation is not laser sensitive and the telescope will be excluded from all the calculations.
NO	yellow	The <i>URL state</i> is stale, so the telescope is set as laser insensitive. The colour is yellow because the telescope is excluded from any calculations because the timestamps in its URL are old, even though observations may be continuing.
???	red	This means that there was a problem when retrieving the information from the laser-sensitive telescope. In this case the telescope is excluded from all collision calculations.

3.1.2.2 *The Lasers Table*

Information regarding each laser-enabled telescope is displayed in the Lasers table. The laser state is indicated along with any shuttering events and any collision predictions.

	<i>Laser State</i>	<i>Shutter Event (site,duration)</i>	<i>Predictions (number, site list)</i>
WHT	Shuttered	INT, 1043 (secs)	None

Figure 4: The Lasers Table

In the Laser State box the user can see the state of the laser. This is the state as far as the LTCS is concerned which may not reflect reality. For example the laser state will

be shown as shuttered in the event of a collision but will not be shown as shuttered if, for example, the dome stops tracking. The description of the Laser State box is shown below:

<i>Laser State</i>		
<i>Value</i>	<i>Colour</i>	<i>Description</i>
Off	light blue	This means that the laser is not in operation. In this case the laser is excluded from any collision calculations.
On	green	The laser is not currently propagating on sky, but it is in operation. It is included in the calculations, but the results are shown in the “Laser On Preview” table.
On-Sky	orange	The laser is propagating on sky. Either there is no collision at present or the laser has priority in the current collision.
Shuttered	red	The laser would like to propagate on sky, but it is shuttered because of a collision.

In the Shutter Event box the user can see the collision which is responsible for shuttering the laser. The following values are possible:

<i>Collision</i>		
<i>Value</i>	<i>Colour</i>	<i>Description</i>
None	light blue	There is no collision responsible for shuttering the laser. This means one of the following is true: a) the laser state is OFF, b) the laser state is ON, c) the laser state is On-Sky and there is no current collision or d) the laser state is On-Sky and there are collisions but the laser has priority.
(site, duration)	red	In this case there is a collision occurring in which the laser doesn’t have priority and is shuttered because of this. If there is more than one collision happening, the longest one is shown here. The “site” is the name of the telescope with which the collision has occurred and the “duration” is the number of seconds until the end of the collision.

In the Predictions box the user can see all the collisions the LTCS has predicted will occur, for an “On-Sky” laser.

<i>Predictions</i>		
<i>Value</i>	<i>Colour</i>	<i>Description</i>
None	light blue	The LTCS has predicted that no collisions will occur for this laser or the laser’s state is OFF.
(number, site list)	yellow	In this case, the LTCS has predicted collisions for this laser. The “number” is the number of predictions and the

<i>Predictions</i>		
<i>Value</i>	<i>Colour</i>	<i>Description</i>
		“site list” is a list of telescopes with which the collisions will occur. If a telescope name is red this means that the telescope has priority and the laser will shutter. If the telescope name is green this means that the laser has priority and it will not shutter.

3.1.2.3 *The Collision Predictions Page*

The Predictions box in the Lasers table does not provide full information about the predicted collisions. For this reason the list of names in this box is linked to another page, the “Collision Predictions Page”. On this page the user is provided with more detail about all the collisions the LTCS has predicted.

Field	Value	Units
<i>Involved Telescope</i>	<i>INT</i>	
<i>Laser Has Priority</i>	<i>NO</i>	
<i>Time to Collision</i>	<i>9688</i>	
<i>Duration</i>	<i>3495</i>	<i>Seconds</i>
<i>Start Time</i>	<i>18:53:08 May 24 2007 WEST</i>	
<i>End Time</i>	<i>19:51:23 May 24 2007 WEST</i>	
<i>Crossing Distance</i>	<i>1870.3982074711</i>	<i>Meters</i>
<i>Crossing Altitude</i>	<i>3739.30593901686</i>	<i>Meters</i>
<i>Angle between Laser & Telescope</i>	<i>11.5591012779598</i>	<i>Degrees</i>
<i>Angle between Laser & Separation Vector</i>	<i>50.9834199037921</i>	<i>Degrees</i>

Figure 5: The Collision Predictions Page

In the above example there is only one collision prediction. In the case where there is more than one prediction there will be one table for each prediction.

Only the predictions for a specific laser (depends on which laser was selected in the laser prediction box) will be available on this page. There is one page for each laser on site.

The information available to the user is:

<i>Collision Predictions</i>	
<i>Field</i>	<i>Description</i>
Involved Telescope	Name of the telescope with which the collision will occur.
Laser Has Priority	This field indicates whether the laser or remote telescope will have priority when the collision occurs. The possible values are <i>YES</i> or <i>NO</i> . When the laser has priority (it will not shutter) and the field has the value <i>YES</i> . When the laser will shutter it will have the value <i>NO</i> .
Time to Collision	This is the time (in seconds) until the collision will occur.
Duration	This is the time (in seconds) indicating the duration of the collision.
Start Time	This is the start time of the collision in a user friendly format (time and date).
End Time	This is the end time of the collision in a user friendly format (time and date).
Crossing Distance	<div style="display: flex; align-items: center;"> <div style="font-size: 4em; margin-right: 10px;">}</div> <div> <p>These are details about the geometry of the collision.</p> <p>The normal user will not be interested in this information.</p> </div> </div>
Crossing Altitude	
Angle between Laser & Telescope	
Angle between Laser & Separation Vector	

3.1.2.4 The Current Collisions Table

This table presents the user with information about the actual collisions (current collisions). This is useful for both the laser operators and the observers at the non-laser telescopes.

<i>Laser</i>	<i>Scope</i>	<i>Started</i>	<i>Ends</i>	<i>Priority</i>
WHT	INT	16:16:40	16:56:58	SCOPE

Figure 6: The Collisions Table

The laser operators can determine how many telescopes are causing the laser to be shuttered. The observers can determine if there is a collision with their telescope and who has priority. Should they have priority, the laser will be interrupted and will not propagate until priority has been relinquished. If the laser has priority, it's possible that the laser light will affect the observations.

The following table contains a detailed description of the fields of the Current Collisions table.

<i>Current Collisions</i>	
<i>Field</i>	<i>Description</i>
Laser	Name of the laser involved in the collision.
Scope	Name of the telescope involved in the collision.
Started	Time the collision started (format is HH:MM:SS).
Ends	Time the collision will end (format is HH:MM:SS).
Priority	When the laser has priority it has the value <i>LASER</i> and is green. When the telescope has priority it has the value <i>SCOPE</i> and is yellow.

3.1.2.5 *The Laser “ON” Preview table*

In this table the user can see the collisions and the predictions calculated by the system for the lasers that are in the “ON” state. The laser operator can look at this table when the telescope is on target, before he propagates the laser on the sky, to check if there will be any collisions that will shutter the laser. The observers at the other telescopes can see if the laser would interact with their observation were it to be propagated.

<i>Laser</i>	<i>Scope</i>	<i>Starts</i>	<i>Ends</i>	<i>Priority</i>
WHT	INT	16:17:58	16:56:58	LASER

Figure 7: The Laser "ON" Preview Table

The information shown in this table is similar to the information shown in the Collisions table. The difference is that this table contains current collisions as well as predictions for the lasers that are in the “ON” state. The users can distinguish the predictions from the current collisions by checking the start time.

3.1.2.6 *The Heartbeat Status Table*

In this table the users can see the health of the system. The LTCS has three main parts: the Collector, the GA_Engine and the Status_Mgr. If these three systems are working correctly, then the boxes of the table will be green. Should any of these items fail, then the box will be red.

If any part of the LTCS is not working correctly, then all information provided by this system must be treated as suspect, so the laser will be shuttered.

3.1.3 The Telescope Summary Page

The essential information is always available on the “Status & Alarms Summary” page. However, for certain users the information presented may be excessive. Therefore this summary page is available for users of non-laser telescopes.

The information available is the health of the system, the state of the URL from the telescope, the override state of the telescope, the laser sensitivity of the telescope and

a message informing the user of any predictions or collisions.

Each collision prediction is shown with the corresponding times against an orange background. Collisions in progress appear as an alarm against a red background.

This page also contains a button that redirects the user to the Query Tool for this specific telescope. It is important that this page is not used for the laser equipped telescopes.

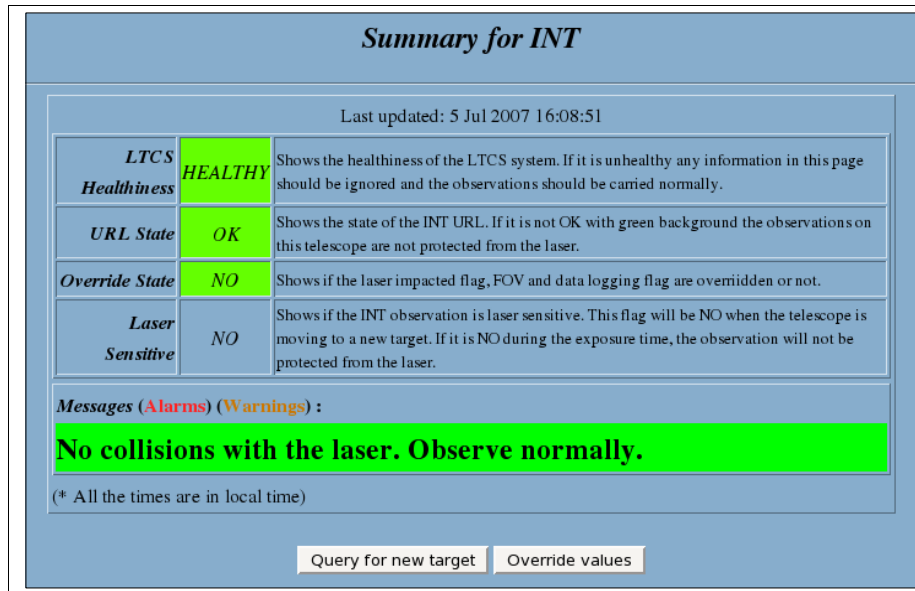


Figure 8: The Telescope Summary

3.1.4 The Telescope Summary Web Service

For those telescopes that would like to integrate the LTCS information with own their systems without having to use the LTCS web interfaces, the LTCS provides a query service. The same information that is available via the Telescope Summary web page is also accessible through a web service. This web service, in combination with the query tool web service, can replace the LTCS web pages.

The URL of this web service is:

`http://host/screens/telescope_sum_ws.php`

It accepts, as a parameter, the name of the telescope. For example:

`http://host/screens/telescope_sum_ws.php?scope=INT`

This web service returns a string, which is easy to parse. The values of the string are separated with a carriage return character as shown below:

```
LTCS_Healthiness = healthy
URL_state = ENABLED
OVR_state = NO
Laser_Impacted = NO
Collisions_no = 0
Predictions_no = 0
```

Previews_no = 0

LTCS_Healthiness can be either “healthy” or “unhealthy”. The former value indicates that the system is functioning correctly whereas the latter suggests that certain parts of the system have failed.

URL_state can be either “ENABLED”, “STALE” or “FAILED”. These values indicate that the URL of the specified telescope is fine and is updating regularly, contains old data or cannot be accessed; respectively.

The OVR_state will have one of two values; “YES” or “NO”. If the value is “YES”, this indicates that the values set in the configuration tool are overriding the non-pointing information within the URL.

Laser_Impacted variable can have one of two values; “YES” or “NO”. This specifies whether the telescope is laser sensitive or not.

Collisions_no is a variable that holds the actual number of current collisions. Only the collisions that involve the actual telescope, that is using this service, are counted and the collisions are only counted if the telescope does not have priority. If this number is greater than 0, then the following additional information will be available with each collision:

```
Collision_01_name = WHT
Collision_01_end = 1183649413
```

where Collision_XX_name is the name of the laser involved in the XXth collision and Collision_XX_end is the time that that collision will end, in seconds from 1/1/1970.

Predictions_no is a variable that holds the number of predicted collisions. Only the predictions that involve the actual telescope, that is using this service, are counted and the predictions are only counted if the telescope does not have priority. If this number is greater than 0, then the following additional information will be available with each prediction:

```
Prediction_01_name = WHT
Prediction_01_start = 1183392193
Prediction_01_end = 1183482193
```

where the Prediction_XX_name is the name of the laser involved in the XXth collision and the Prediction_XX_start and Prediction_XX_end are the start and end times of the predicted collision, in seconds from 1/1/1970.

Previews_no holds the number of collision predictions that have been calculated with lasers that are in the “ON” state. Although these lasers are not currently propagating on-sky, they are scheduled to be used throughout the night. Only the predictions that involve the actual telescope, that is using this service, are counted. If this number is greater than 0, then the following additional information will be available with each prediction:

```
Preview_01_name = WHT
Preview_01_start = 1183392193
Preview_01_end = 1183482193
```

where the Preview_XX_name is the name of the laser involved in the XXth collision and the Preview_XX_start and Preview_XX_end are the start and end times of the collision, in seconds from 1/1/1970.

3.1.5 The Configuration Page

In some cases users might want to override some of the information that the LTCS receives from the URLs. To improve the flexibility of the system the LTCS allows such functionality. The information that the users are allowed to override are the laser impacted flag, the field of view, the data logging flag and the laser state.

The laser impacted flag, which indicates whether a telescope is laser sensitive or not, can be overridden to give the user the ability to allow the laser to observe a target irrespective of any collisions. If the observer deems that the observations are laser insensitive, then the laser impacted flag can be set to “NO” thus excluding the telescope from any collision calculations. This flag can also be overridden in the case that the URL states that the observation is not laser sensitive when, in fact, it is. The observers will recognize this problem by the fact that their telescope will be labelled as being not laser-impacted in the Observatories table of the “Status & Alarm Summary” page.

The field of view can be overridden to give the users the ability to alter this value. This will usually be altered to increase the FOV thus minimising the possibility of the observations being affected by the laser.

The laser state can be overridden for the laser equipped telescopes. This is mainly for testing purposes and thus is not recommended for standard operational use.

Finally, the data logging flag can be overridden to protect sensitive pointing data. If it's set to “Off”, the telescope's RA and DEC will not be logged in the case of a collision.

The users must be very careful when overriding any of the above information, because any mistakes could lead to collisions being ignored by the LTCS.

3.1.5.1 The Configuration Login Screen

To override the data for a given telescope the users must be authenticated. To do this, one must select the “Configuration” option from the LTCS main page. This will display the “Configuration Login Screen”.

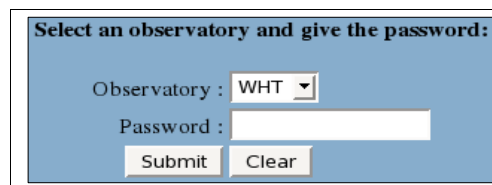


Figure 9: The Configuration Login Screen

On this screen the user can choose, from the drop down menu, the telescope to configure. A valid password needs to be entered into the Password field.

The “Clear” button resets the screen and the “Submit” button redirects the user to the appropriate *Telescope Configuration* page, assuming that the password was correctly given.

3.1.5.2 Telescope Configuration

Below is a representation of the page that allows the authenticated user to override certain aspects of each telescope:

The screenshot shows a configuration form with a light blue background. It contains several settings with radio buttons and a text input field. At the bottom are 'Submit' and 'Restore' buttons.

Override run-time URL control fields?	<input type="radio"/> Yes <input checked="" type="radio"/> No
Will lasers impact viewing?	<input type="radio"/> Yes <input checked="" type="radio"/> No
Telescope FOV diameter	<input type="text" value="1.6"/> (Deg) $0 \leq \text{FOV} \leq 1.67$
Data Logging	<input checked="" type="radio"/> On <input type="radio"/> Off
Laser State:	<input checked="" type="radio"/> On-Sky <input type="radio"/> On <input type="radio"/> Off
<input type="button" value="Submit"/> <input type="button" value="Restore"/>	

Figure 10: The Telescope Configuration Page

The page is telescope specific. The title shows the name of the telescope that will be affected by these changes.

With the “*Override run-time URL control fields?*” option the user can select if the data specified will override the data from the URL or not. The option “*Yes*” means that the URL data will be overridden. If the user sets this option to “*No*”, the rest of the options will be ignored and the URL data will not be overridden.

With the “*Will lasers impact viewing?*” option the user can change the laser impacted flag. When set to “*Yes*” the telescope’s observations will be considered to be laser sensitive and will be included in all collision calculations. When set to “*No*”, the telescope’s observations will be considered laser insensitive and will be excluded from all the calculations.

At the “*Telescope FOV diameter*” prompt, the user can give a value to override the field of view within the URL. This FOV follows the same specifications as the FOV from the URL. Thus its value is given in degrees and effectively subscribes a cone that protects the observation and anything else that might be sensitive to the laser (for example, auto-guiders and the like). The value of the FOV must be a positive number less than 1.67° .

With the “*Data Logging*” entry, the user can determine if, during a collision, the pointing information of the telescope should be stored or not. When data logging is set to “*On*” the data will be stored.

The “*Laser State*” option will only be available for those telescopes that are laser-equipped. With this option the user can override the laser state by entering one of the following values “*Off*”, “*On*” or “*On-Sky*”.

The “*Submit*” button allows the user to save the changes. If the changes have been accepted correctly, then the message “Update completed” will be displayed. If not, then an error message will be shown.

The “*Restore*” button will reset the displayed values to the values that are currently in use.

3.2 The Query tool

The pages described above provide real-time information about the LTCS. These

pages are sufficient for protecting the observations at the ORM from the lasers. However, sometimes it's necessary to determine whether a future observation will be laser impacted, based on present time information. The LTCS provides an extra tool for checking future targets, the Query tool.

With this tool the observers and laser operators can retrieve from the system information with regards to what will happen if they move to a new target. These checks can be carried out before they actually move the telescope and start their new observation. The result of this query will be a list of potential collisions with the other telescopes at their current targets.

The Query tool has two interfaces, a user-friendly web page, which the users can access from a web browser and a web service. The latter is designed to be used by scripts and returns the results in an easy to parse string.

3.2.1 The Web Page

The users can access the query tool web page by following the link from the LTCS main page. This link will redirect them to the “Query Selection Screen”, where they can chose, from a dropdown menu, the telescope for which they would like to make a query.

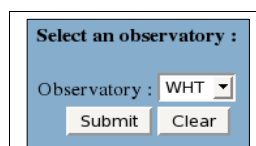


Figure 11: The Query Selection Screen

After the user selects a telescope they will be redirected to the Query Tool page.

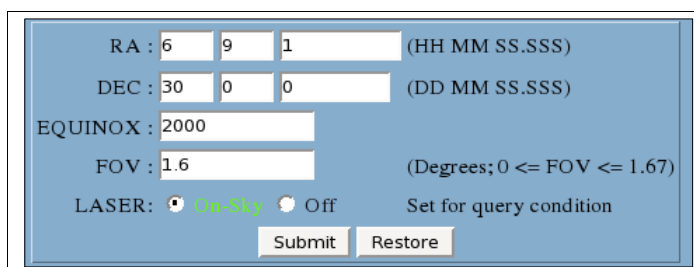


Figure 12: The Query Tool Page

On this page, the user enters information about the target they would like to observe. More specifically they specify the:

- RA: The right ascension of the target
- DEC: The declination of the target
- Equinox: The equinox of the target
- FOV: The field of view of the instrument in use
- LASER: The laser state

The LASER option is shown only for laser-equipped telescopes. Its purpose is to specify if the telescope is operating a laser or not.

Once the above information has been supplied, the user should press the “Submit”

button to send the data to the LTCS.

The results from the query will be either a message that no collisions were predicted or a list of predicted collisions including details of the start time and which telescope has priority. If the user is an observer on a telescope without a laser they can ignore the results and continue observing. However, in this case, if the telescope doesn't have priority, the laser will not be shuttered.

3.2.2 The Web Service

The query tool web service does exactly what the Query Tool page is designed to do. The difference is that the former accepts all user input as URL parameters. The URL of the query tool is:

`http://host/screens/web_service_sim.php`

The parameters are:

- telescope: The name of the telescope
- ra: The right ascension of the target in hours
- dec: The declination of the target in degrees
- equinox: The equinox of the target
- fov: The field of view of the instrument in degrees
- laser_state: The laser state (OFF or ON-SKY)

The telescopes that do not process a laser should set the laser_state to OFF. An example of a valid URL is given below:

`http://host/screens/web_service_sim.php?telescope=INT&ra=4&dec=45&equinox=2000&fov=1.6&laser_state=OFF`

After the query completes, the web service returns a string with the result. If there are no collisions predicted it returns the string "NONE".

If there is a collision it returns the name of the telescope involved, the starting and ending time in seconds from now and who has priority. If the collision is scheduled to happen immediately the starting time will be a negative number. The priority will be one of two words; LASER or SCOPE.

If any of the parameters are invalid or missing, the returned string will be "WRONG INPUT".

4 SUGGESTED OBSERVING PROCEDURES

This chapter suggests a few observing procedures for all the telescopes (laser equipped or not). These procedures are only suggestions and each telescope can decide to follow a different routine which is adapted and tuned for their particular telescope.

The scenario described below is for starting an observation on a new target.

4.1 Laser Assisted Observation

This is a scenario for an observation at a laser equipped telescope, using the laser.

4.1.1 Starting up the LTCS GUI

The laser operator should start a web browser and open the “Status & Alarms Summary” page. This page should stay open during the whole of the laser run.

4.1.2 Checking the LTCS status

The laser operator should check the following before he continues with any other operation.

4.1.2.1 *The LTCS health*

This is easily done by ensuring that the three boxes of the “Heartbeat Status” are all green. Should one or more of these boxes be red then the LTCS is not working correctly. To resolve the problem the laser operator can restart the LTCS from the LTCS Admin page.

4.1.2.2 *The Telescope URL state*

The URL state of the telescope must be OK. If it is stale or in an error state the laser operator can restart the application that provides the URL.

Specifically, for the WHT telescope this program is the WHT LTCS Server and it can be restarted from the LTCS web page, following the WHT LTCS Server link. In the case that the problem persists, the laser operator should check that the CorbaDramaInterface is running.

4.1.2.3 *The Laser state*

The Laser State (if the laser is on) should be “On”.

If the laser state is “Off” the LDSO should check that the laser is physically powered on. The laser should not propagate on-sky if the laser state is “Off” because the telescope will be omitted from the LTCS calculations.

Note that when moving to another target the laser will be shuttered automatically.

4.1.3 Using the Query Tool

Before moving to a new target the laser operator should check, using the Query Tool, that the laser will not collide with any on-going observations. Should the Query Tool identify collisions, the following actions may be taken:

1. If there is sufficient time to carry out the observation before the collision occurs, the observer of the laser-enabled telescope could decide to move to the target and perform the observation.
2. If the predicted collision is due to finish within a short, acceptable timeframe, the observer of the laser-enabled telescope may choose to wait for the collision to end. In this situation the observer should deploy the beam dump, move to the target and wait until priority is passed to the laser.
3. Choose another object to observe.

4.1.4 Prior to propagating the laser

If the previous steps were completed successfully the telescope should now be on target. The observer should check the “Laser “ON” preview” table which is available from the “Status & Alarm Summary” page. This will ensure that no subsequent collisions have been identified in the short time period between step 4.2.1.3 and actual laser propagation.

Skipping this step may result in the laser being shuttered immediately or during the observation.

4.1.5 Propagating the laser

At this point the laser can be propagated on-sky. After propagation, the laser operator should check that the laser state changed to “On-Sky”. From henceforth, the “Lasers” table on the “Status & Alarm Summary” page should be regularly checked for new predictions and unexpected changes in the LTCS status.

4.1.6 Finishing the observation

When the observation is complete, the beam dump should be deployed. At this stage the state of the laser should change to “ON”.

4.2 Observing Without a Laser

This is a scenario for an observation at a non-laser telescope whilst another telescope is using a laser.

4.2.1 Starting up the LTCS GUI

The observer should start a web browser and open the “Telescope Summary” page. This page should stay open during the whole of the laser run.

4.2.2 Checking the LTCS status

The observer should check the following before they continue with any other operation.

4.2.2.1 *The LTCS healthiness*

The observer should ensure that the LTCS system is working properly. For this they should check that the LTCS Healthiness box is green. If the system is unhealthy (red) the observer can completely ignore the LTCS and continue observing. It’s wise to check regularly the LTCS to see if it has been activated.

4.2.2.2 *The Telescope URL state*

In order for the observations to be protected from the laser, the URL state from the telescope must be OK and the telescope must be defined as “Laser Impacted” (except when moving between targets). If either one of these conditions is not met the observation will not be protected from the laser.

If the URL is stale or in an error state the laser operator can restart the application that

provides the URL (this is telescope dependent).

Specifically, for the INT telescope, the INT LTCS Server can be restarted to fix the problem. The INT LTCS Server can be accessed from the main page of the LTCS.

4.2.3 Using the Query Tool

Before moving to a new target the observer should check, using the Query Tool, that the new position will not cause the telescope to collide with an on-going laser-assisted observation. To access the Query Tool they can use the button located on the “Telescope Summary page”. In the case that no predicted collisions have been identified, observations can continue as normal. However, should the Query Tool identify collisions, the following actions may be taken:

1. If there is sufficient time to carry out the observation before the collision occurs, the observer could decide to move to the new target and observe.
2. If the predicted collision is due to finish within a short, acceptable timeframe, the observer may choose to wait for the collision to end. In this situation the telescope should stay on target and wait until priority is passed to the telescope.
3. Choose another object to observe.
4. Observe the current object ignoring the LTCS (in this case the laser may interfere with the observation).

4.2.4 During the observation

At this point the observation can start. From henceforth the “Telescope Summary” page should be checked regularly for any collisions and predictions.

Some telescopes may have other ways to inform the observers. For example, in the INT a warning message will appear in the talker if a collision is predicted and the telescope does not have priority. Similarly an alarm will be raised if a current collision exists and the telescope does not have priority.

4.2.5 Moving to a new target

When the observation finishes the above steps, from 4.2.3 onwards, should be repeated before moving to a new target.

The above steps are simply suggested procedures. An observer could decide to skip the query step and move to a new target directly and then check for potential collisions created by this action on the “Telescope Summary” page.

Similarly, an observer could choose to ignore completely the LTCS in the case that their observations are not affected by the 515nm laser. In this case they should override the telescope’s URL and set the laser impacted flag to “NO”.

5 CONCLUSION

The Laser Traffic Control System is designed to minimise the possibility that light from the laser-enabled telescopes will interfere with the observations of the other telescopes on site. These other telescopes may or may not be laser-enabled. With the

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proper use of the query tool by both the operators of the lasers and the observers at the other telescopes, the collisions should be avoided.