

# Software Reuse in the ILRS Network

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## Abstract

A concerted effort started a couple years ago within the International Laser Ranging Service Central Bureau (ILRS CB) to assemble and make publicly available on the ILRS web site as much applicable software for the laser ranging community as possible. This encompasses code written for the ILRS, code written by ILRS stations and centers, and code written by other agencies that has a significant applicability to Satellite Laser Ranging (SLR). The purpose was to provide known, vetted software as a starting point for new SLR stations or as reference for existing stations and analysts. The current status of this effort is discussed.

## Introduction

Standardization of software is difficult for a research community, such as the laser ranging community, involving multiple organization spread over many countries. Many groups start with different designs goals and different equipment. They build and upgrade over the years without always considering the advantages of using software that has been developed and vetted elsewhere. With the open source movement, and more SLR stations moving to open source operating systems and development tools, it only seems natural that making good quality open source software available to the ILRS stations is more timely now than even 10 years ago.

## Advantages and disadvantages of using standard software

Having a pool of ready-to-use, vetted, software and demonstration programs has the advantage of saving a great deal of effort for those building, renovating, or upgrading SLR stations. Those new to the field can learn a great deal from someone else's effort, and, hopefully, improve the software and allow their changes to be folded into the distribution. The only real disadvantage is the danger of the software being used as a "black box" without a clear understanding of what it does or how. This objection holds for commercial software as well.


## Advantages and disadvantages of contributing standard software

Having code available on the ILRS web site requires someone or some group to make the leap of faith that providing the fruit of their efforts would be rewarded by having better and more voluminous data available to the community. The drawback is for those who want to keep some competitive advantage by keeping their software proprietary. Also, some of those who might contribute do not have the resources (time, personnel) to make the software usable by other groups, especially if it contains copyrighted code or if funding for cleaning the code for publication is not available.

There is also the question of the software's copyright and the proper license to include (Apache, MIT, BSD, GPL, or other). The answer needs to take into account any restrictions from their funding agencies and national governments and, possibly, a legal process to open-source the software.

## Current Status – What is available

Currently, there are a number of software packages available on the ILRS website at <http://ilrs.gsfc.nasa.gov/technology/software/index.html>. There are packages to read/write/reformat/test the Consolidated Prediction Format (CPF) and the Consolidated laser Ranging Data (CRD) format, both standards for the ILRS. The code used to send and retrieve station status, known as EUROSTAT, is now available for downloading. Statistical code is also available. Mount model fitting software has just been added, and normal pointing and restricted tracking software should be available soon. A link to a web-based CRD checker is provided to assist in format testing. A lunar data web site link allows users to test their lunar data with a known analysis package.



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**Software**

Software provides a key element in the acquisition, reduction, and analysis of laser ranging data. Since so much time and effort has already been spent on creating software applicable to laser ranging, it is preferable to have the fruits of those labors be freely available when possible. Having a ready library of software will either spare builders of new stations the work of re-inventing the wheel or to at least provide a starting point from which to build something greater. Included below are links to software available on this and other web sites, to provide a central market of sorts for software of value to laser ranging. This software is generally free/open source, although it would be prudent to examine the licenses posted with the software before using it to insure abiding by its terms. In the spirit of the open source culture, please let us know how well this software meets your needs and provide any updates that would be useful for the laser ranging audience.

**Existing software on the ILRS web site:**

- [Consolidated Prediction Format \(CPF\)](#) Sample code: This code allows reading, writing, format checking, and converting the CPF files.
- [Consolidated Laser Ranging Data format \(CRD\)](#) Sample code: This code allows reading, writing, format checking, and converting the CRD format files.
- [Eurostat station status software \(AIUB\)](#)
- [Refraction - BIPM - Updates to the IERS Conventions \(2010\): Chapter 9](#)
- [DISTRIB \(link\)](#): This software computes various statistical information from a distribution of data.
- [CRD data format and content checker](#) (Web site, not source code)
- [LLR \(multi-format\) data verification](#) (Web site)
- [SLR normal pointing software](#) (TBD)
- [Sun avoidance software for telescope tracking](#) (TBD)
- [Tracking Restriction software](#) (TBD)
- [Mount model solution software](#)

**Existing useful software not directly related to the ILRS**

- [USNO NOVAS star and planet code](#)
- [RAL/UH Starlink star and planet code](#)
- [JPL DE-xxx Solar System Ephemeris code](#)
- [JPL DE-xxx Solar System Ephemeris \(binary\)](#)
- [JPL DE-xxx Solar System Ephemeris \(ASCII\)](#)
- [IERS conventions: algorithms and source code](#)

Software packages available for download generally have source code, documentation, and test cases. The latter allows a user to insure that results on their system match the standard runs. Some packages have been written that use copyrighted software from various books or other sources. To avoid rewriting the code, the subroutines have been replaced with references as to where to find the source code.

There are also links to software from other organizations that can be useful to laser ranging stations. These involve star and solar system prediction software and ephemerides (JPL DE-xxx series) as well as earth rotation/ITRF/ITRS code from the IERS. While not required for ranging itself, the software can be used as building blocks to build such tools as mount modeling and alignment software.

### Current Status – What is needed

Some of the software above is listed with “TBD” (To Be Developed). A couple of these packages (normal point and tracking restriction software) are close to being available for addition to the web site. The Software Library Study

Group has considered what additional software is needed for a “complete enough” set. There are requests to add lunar prediction and normal pointing software as well as circular search code for satellite acquisition. There has been an offer by GEST/UMBC to provide executables to display analysts' QA results at the station. Another offer, from EOS, is to provide software to create site and change history log file at the stations from XML files/data bases. Again, these will be executables only, for Linux and Windows.

The available and planned software deals mainly with formatting, prediction, and analysis – nothing (except restrictions and circular search subroutines) that interacts with station hardware. So much station control software is tied to specific hardware and station functions that going beyond the existing and proposed software may be difficult. If a station were to donate its entire software suite, it may be useful primarily as a study case for those developing or re-developing an SLR system.

The Software Library Study Group does not have resources to create new software or documentation nor the authority to impose coding styles, operating systems, or the like onto the laser ranging community. The current purpose is to identify software that already exists and make it available to all those interested.

### **One Request**

It is in the spirit of open source software to make improvements to the code available to the user community. This has happened several times with the CRD and CPF software, fixing bugs and expanding capabilities. Everyone using the ILRS software library is encouraged to provide updates they find useful for possible inclusion in the distribution. Updates and improvements can be sent to the author.

### **Conclusion**

The purpose of creating the software library was to make life easier for those starting in SLR, those upgrading a station to include new features, or anyone interested in the process of acquiring or analyzing SLR data, by provide a library of vetted software that has been used by SLR stations. Some code, such as that for tracking restriction and circular searches could save existing stations a great deal of time, since not everyone has these capabilities. While the list of software available is somewhat small, it represents some of the most important aspects of SLR station needs.

### **Special note**

Thanks to Judit Ries of the University of Texas Department of Astronomy for formatting and preparing the poster.