

## **ETC-42 Exposure Time Calculator: Evolution and New Functionalities**

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**Abstract.** We developed at CeSAM (Centre de données Astrophysiques de Marseille) ETC-42, an Exposure Time Calculator compliant with Virtual Observatory standards. ETC-42 has been designed to facilitate the integration of new sites, instruments and sources by the user. It is not instrument-specific, but is based on generic XML input data. It is used in several project implementations (EUCLID, PFS, IRIS, WISH, EELTs) covering a wide wavelength range, from NIR to UV. The previous release has been optimized to achieve gain of computation time. New functionalities for automatic input parameterization have been added to target specific instrumental configuration and to give an increased level of user-friendliness. This article describes the new functionalities : fixtures, sdaptive optics, Fabry Perot implementation and two new builder tools to create Telescope transmission curves and sky brightness tables. And, in order to facilitate the integration to the Virtual Observatory environment, VO drag and drop functionality is now available.

### **1. ETC-42**

Most ETCs are black boxes with no possibility to easily include some instrument modification and artefacts or sources. Usually, ESA, ESO and other specific Instrument Centers have developed their own ETC in order to provide simulation of instrument performances. Most of the time, ETCs are independent and outputs are different one from each other, even for the same queries. Therefore, we decided to build up an "open" ETC that will be usable by standard astronomical community and by instrument specialists. It is generic enough to be adaptable to any new project : site, instrument, target and operation mode. As any ETC, the goal is to estimate the exposure time needed with respect to source, site, instrument and observation parameters specifications. Standard outputs of the ETC include : signal to noise ratio, total integration time, observation time specifications, noise components.

### **2. New Functionalities**

Thanks to a continuous development, new functionalities have been included to this last version of ETC-42.

#### **2.1. Fixtures**

The fixture is a new functionality to allow any user to install a dedicated ETC. The parametrization of the dedicated ETC is a combination of one instrument and one site. A specific choice of sources can be added to the parameters set. The fixture setup is stored in a specific place on the remote LAM server (<http://projects.lam.fr/projects/etc>). The dedicated install is done easily

by targeting any specific fixture and can be installed from everywhere by typing the command line :

```
java -Detc.fixtures="NameofFixture" -jar ETC.jar
```

A list of fixtures are available on the ETC site, it includes telescopes : EUCLID (NISF), IRIS, WISH, PFS and more to come.

## 2.2. Adaptive Optics

Adaptive Optics is more and more used in observations and instrumentation in order to deal with turbulence induced by the atmosphere of earth. Adaptive optics are mechanisms that change the shape of the primary mirror, to cancel out the turbulence effects and provide a better, sharper image on the detector. ETC-42 is now able to deal with Adaptive Optics features. Indeed the PSF profile of the instrumental panel can be defined from the Strehl ratio combined to a Reference wavelength. ETC-42 will compute the corresponding PSF and will apply this PSF to the profile of the source. The signal to noise ratio is computed taking into account this new PSF.

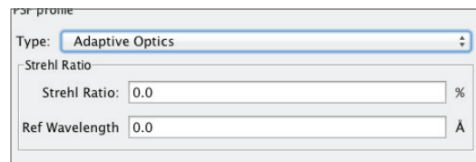


Figure 1. Adaptive optics panel

## 2.3. Fabry-Perot

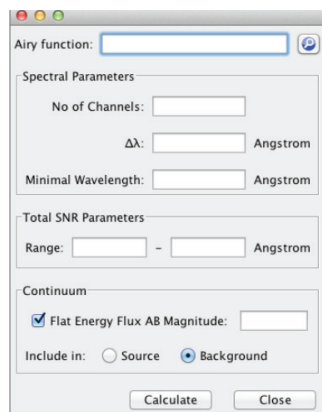


Figure 2. Fabry-Perot S/N computation panel

In the astronomical world, Fabry Perot (FP) data are very specific. Using scanning Fabry Perot, extended line emitting targets can be observed with a large field of view, within a short spectral range (from 100 to 5 Angstroms) and with high resolutions (from 1000 to 20000). Observation data cubes allow then to derive and to focus mostly on emission line flux maps, velocity maps and velocity dispersion maps. The FabryPerot observing mode is defined as a set of several images at different wavelengths. A new plugin has been developed to deal with Fabry Perot observations. This plugin allows to compute the signal to noise ratio of an observation on a tuneable wavelength interval. The plugin has specific inputs like the finesse, the wavelength range (or the number of channels combined with the wavelength bin in Å). The signal-to-noise ratio is computed on the integrated signal. It takes into account the spectral range to restrict the computation only to the valid range. It allows as well the user to add an underlying continuum to the observation.

## 2.4. Transmission Creator

Using the ETC, the user defines the total transmission of the optical system including the detector response. On several instruments, people do not have a good knowledge of the transmission curve. It is now possible to create a synthetic transmission curve with some basic mathematical functions. Indeed a transmission creator module has been added to the software to facilitate the creation of a new transmission curve of the instrument, using different shapes (continuous, band-pass or Gaussian). The goal of this module is either to compute the signal-to-noise ratio with a basic transmission curve or to be able to compare several transmission curve models to validate a technical choice.

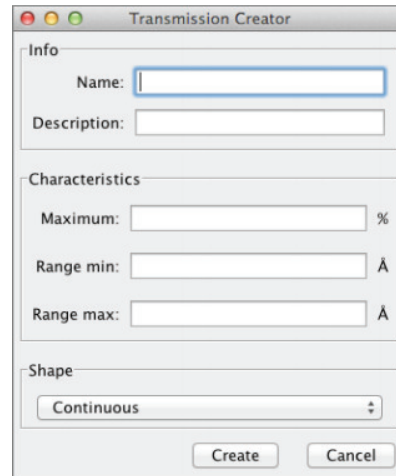


Figure 3. Transmission Creator computation panel

## 2.5. Sky Brightness builder



Figure 4. Sky brightness plug-in panel

A new plugin to build a sky brightness depending on the phase of the moon has been integrated. It allows the user to add a new sky background. As the sky noise depends also on the moon phase, the plugin can add several phase of a same sky base. Several types of the same sky can be defined (bright, grey, dark or any other label you might want to put). The module can use brightness tables to create the overall brightness of the sky. It includes the possibility to extract the sky brightness curve from observations and measurements made with filters and taking into account their associated errors.

## 2.6. VO Drag and Drop facilities

For a better integration with the VO formats, a new Virtual Observatory Drag and Drop facility has also been included. Just because it is so simple to drag and drop. This functionality allow to grab a VOTable file and drop it on the source panel to have this source listed in

the available sources. This library is available on demand and will very soon be accessible at <http://projects.lam.fr/> (stay connected).

### **3. Conclusion**

We are providing to the community a generic ETC. New developments have been integrated in the last version of ETC including Adaptative Optics module developed with people from LAM and ONERA, component creation tool for Transmission and Sky Brightness, Fabry-Perot plugin and fixtures facility. An independent drag and drop library has also been developed and is available on demand. There is still some new developments to come: full Spectroscopy (IFU, slitless) and Images as output (simulation). If you wish to participate in the development, be ETC-42 testers (using real data), or contribute to the instrument and site configurations, please, contact us or leave a message (<http://projects.lam.fr/projects/etc>)

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