JMMC

ASPRO LIGHT USERS REQUIREMENTS

Authors:

Jean-Philippe Berger <Jean-Philippe.Berger@obs.ujf-grenoble.fr> — LAOG/JMMC

Author: Jean-Philippe Berger	Signature:
Institute: LAOG/JMMC	Date: 23/06/2004
Approved by: Gérard Zins	Signature:
Institute: LAOG/JMMC	Date: 29/06/2004
Released by: Gilles Duvert	Signature:
Institute: LAOG/JMMC	Date: 29/06/2004

Change record

Revision	Date	Authors	Sections/Pages affected
	Remarks		
1.0	23/06/2004	J-P. Berger	all

Table of contents

Appendix

1 Introduction

1.1 Object

The goal of this document is to describe the functionalities that Aspro-Light, a JMMC future software, should have. It is astronomer oriented and contains no software technology discussion. This document is mostly based on an initial document written by Gaspard Duchêne, feedback information from Aspro users provided by J-P Berger and the subsequent meeting between G. Duvert, G. Duchêne and J-P. Berger late december 2003 and between G. Zins and JP Berger in january 2004.

1.2 Abbreviations and acronyms

JMMC	Jean-Marie Mariotti Center
VLTI	Very Large Telescope Interferometer
AMBER	Astronomical Multi BEam Recombiner
MIDI	MID-infrared Interferometric instrument
ASPRO	Astronomical Software to PrepaRe Observations

2 Aspro-Light main functionalities

Aspro-Light is a software that will be designed to help an astronomer to prepare observations with a long-baseline interferometer. It can seen as a simplified version of Aspro the currently available JMMC software. It's main caracteristics should be:

- It will be mainly optical interferometry oriented and should focus on VLTI although other interferometers might be included later. Instruments MIDI and AMBER only should be considered;

- It will only require a minimum of interferometry knowledge from the user and therefore should embed as much technical aspects as possible. Specialists should refer to Aspro to access more configuration options;

- **It should stick as much as possible to instrument real world (provide interferometer actual configurations, performances, instrument actual performances);**

- It should provide the user with all the elements (numbers and scientific plots) required to fill an interferometer observing proposal;

2.1 Assumptions

It is assumed that the user of this simplified version of ASPRO is an astronomer with no previous experience of optical long baseline interferometry that only has a basic knowledge of its basic principles (resolution $\propto \lambda/B$; visibilities are the most easily usable output of an interferometric observations; etc...).

2.2 Scientific goals

Aspro-Users want an answer to the following question: given the assumed properties of my target, will interferometric observations be i) feasible, and ii) helpful in constraining its actual morphology?

3 Proposed Architecture for Aspro-Light

3.1 Overall Scheme

The overall scheme suggested for the simplified version of ASPRO is presented in Figure 1, where the first three modules are for entering the known/assumed parameters of the object and the observational set-up whereas the third module contains the calculations of the PSF, a plot of the (u, v) coverage, the visibilities and the error analysis on the assumed model. Warning should be considered at various stages along the way, so that an impossible configuration cannot be calculated all the way through (too faint object or object not in the sky at the right time, etc...). In the following, we describe in more details the questions that should be asked to the observer in each menu as well as some of the output that should be produced.

NB: We propose to limit Aspro-Light to VLTI generation 1 instruments: AMBER/MIDI
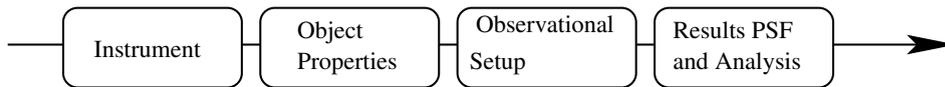
Figure 1: Proposed scheme of menus/modules for the simplified version of ASPRO.

3.2 Instrument

In this section the user can choose between the available instruments MIDI or AMBER. As illustrated in the pop-up window (Figure 2). The reason for doing that first is that this information will condition the information (magnitudes) required when defining the observed object.
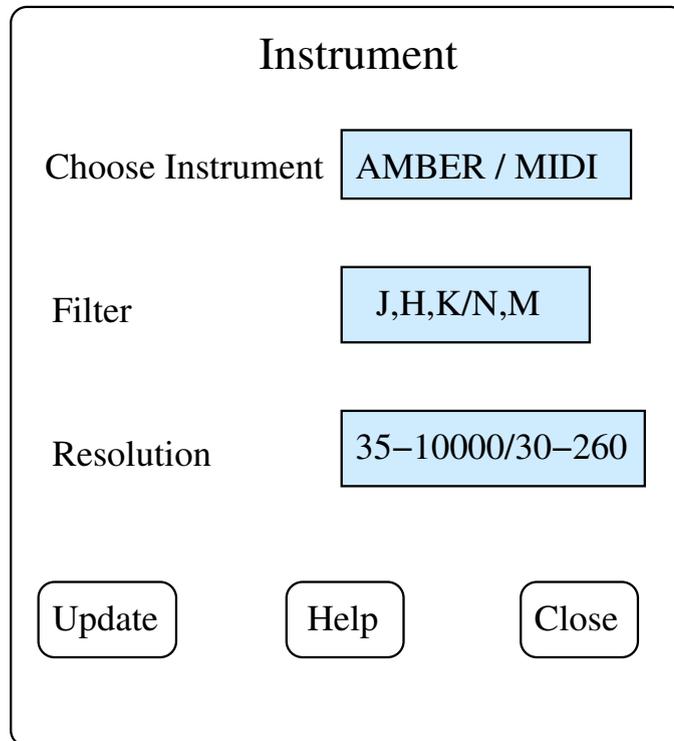
Figure 2: Proposed pop-up window for the instrument selection. The empty squared boxes represent zones where the user is asked to enter a value whereas the shaded boxes are a pull-down menu. Bottom round boxes are simple buttons

Buttons/Fields:

name	Action/Comment
Instrument	AMBER or MIDI
Filters	Available filters
Spectral resolution	for SNR calculation purposes
Update	Validates the choices
Help	
Close	Close the window

3.3   Objects Properties

This menu should open a pop-up window similar to the one illustrated in Figure 3. This should include the object's name (used only for labelling the output plots) and coordinates, as well as the magnitudes that can be useful later on: J, H and K necessarily for the AMBER ETC, N,M for the MIDI ETC, and maybe also V if guiding on the source itself in the visible is necessary for acquiring the object(as in the case of MIDI observations). There is no need to ask for a whole suit of magnitudes, unless they are necessary for the guider and/or the ETC. *In case the object is too faint at V (or whatever visible magnitude is appropriate for acquiring), a warning should be emitted that the object is not observable.*

We suggest two ways of defining the object. The first one would be the first generation option followed by the second possibility.

1. For the first version of the software it is suggested a "one object" philosophy for the software. This means that the users enters all the object caracteristics by hand with the possibility of saving and retreiving the object card name.

2. In a second step the user should be authorised to save an object card in a catalog or load it from a catalog. The catalog interface should allow to add, remove a star card. Creating, retreiving, uploading a catalog should be easy and secure (in the sense that other users should not be allowed to access the catalog if aspro-light is run on a remote server).

The second half of this window contains the model of the object. No calculation should be made at this step, which is just a recording of the model parameters. Two modelling possibilities should be offered:

1. Model parameters can be defined in the same way Aspro does (see source modelling panel) except that we suggest only one function will be allowed. (uniform disk, binary, exponential, ring ...). Model will be therefore describe with a maximum of 3 parameters i.e the first three parameters listed for each function in the current version of ASPRO should be held fixed at "0 0 1"

2. Aspro-Light should let the user provide his own favorite model as this is potentially a common use of the preparation software. We suggest a simplification with Aspro current way of dealing with homemade model. We suggest that the user should only have to provide the name of the image filename and the size of the corresponding field in arcsec. Aspro-Light should take care of the all the dimensioning part (counting pixels etc...) fits format is a minimum but being able to load jpeg/ bitmap formats would be a plus.

The modelization will be considered monochromatic done at average wavelength computed from the instrument filter/resolution choice.

The "Help" button would contain the proper format for the object's name, coordinates and magnitudes, the model's parameters list and their format and the proper format for the homemade models.

Object's Properties

| Load from catalog | Single Objet |

Name [_____]

RA [_____]   Dec [_____]

Magnitudes   V [_____]
             J [_____]
             H [_____]
             K [_____]
             N [_____]
             M [_____]

Model Functions | List of functions |

Homemade Model

Filename   [_____]

Field of view   [_____]

| Update | | Help | | Close |

Figure 3: Proposed pop-up window for the object definition. The dashed boxes represent zones where the user is asked to enter a value whereas the shaded box is a pull-down menu.

Summary:

Buttons/Fields:

Name	Action/Comment
Load from catalog	Opens catalog manager and allows to pick up a star's card
Single Object	First generation option
Object Name	
Right Ascension (Epoch 2000)	
Declination (Epoch 2000)	
V Magnitude	if required to check observ-ability
Observation Magnitudes	restricted to the chosen in-strument operating magni-tudes
Model function	1 component model (aspro of-fers 2)
Model Parameters	3 parameters (enough for sim-ple models)
Homemade Model	Load file and ask for image size (or field of view)
Update	Validates the choices
Help	
Close	Close the window

Warnings

In case the object is too faint at *V* (or whatever visible magnitude is appropriate for acquiring), a warning should be emit-ted that the object is not observable.

3.4 Observational Set-Up

This menu, whose proposed pop-up window is illustrated in Figure 4, contains all the information necessary for the set-up of the observations: Date and hour angle, seeing. The requested seeing is only here for the ETC calculation later on VLTI configuration.

The date of observation and hour angle coverage on source are entered here by the user. *If the object's coordinates and requested observing date does not allow the entire hour angle coverage requested, or there is vignetting, a warning should be emitted.* We could have a button to display the time coverage with the twilight zone and the baseline available range, more or less as it currently exists, so that in case of such a

problem, the observer can figure out how to solve it.

It should be possible the choosen configuration to a previous one.

Figure 4: Proposed pop-up window for the observational set-up. The boxes have the same meaning as in Figure 2.

Three levels of interferometer configuration definition are interesting:

1. If the number of available telescopes is small a single pull-down menu with all possible configurations (six 2-telescope and four 3-telescope configurations, disregarding order).There should be a button to get a pop-up map of VLTI with the available stations indicated to help the user choose.

2. If this number is too great there should be a table with configurations sorted by baselines/orientations. For each configuration one could provide the expected beam size on the sky for different HA and declinations.

3. It should be possible to ask for a suggestion that would use internal fitting algorithm based on the object/morphology defined previously. In that case the user choice in that window would be to push a "suggest" button. Choosing this possibility would require to wait for the next window (results) to check which is the best configuration.

Contrary to Aspro the user should not have to worry about delay-lines choice. It would be important to come up with some algorithm that optimizes the delay to provide the largest possible coverage within the time/coordinates contraints provided by the user.

Summary

Buttons/Fields:

name	Action/Comment
Date	
Hour Angle Coverage	from to
Seeing	Excellent/Average
VLTI configuration	three options described above
New Config	Erases previously defined configs
Save and add	adds the config to the current one
Update	Validates the choices
Help	
Close	Close the window

Warnings

If the object is too faint in the relevant broad-band filter for the proposed resolution, a warning should be emitted.

If the object's coordinates and requested observing date does not allow the entire hour angle coverage requested, or there is vignetting, a warning should be emitted

3.5 Results, PSF and Analysis

Now that all parameters have been set, we can now calculate all the relevant information: PSF, (u, v) map of the object's model and its coverage by the proposed observations, the associated visibilities with errorbars, and finally the expected accuracy of the model adjustement on the future datasets.

Once fed with this information, the observer will be able to decide

- whether his choice of VLTI configuration (or Aspro-Light suggestion) and hour angle coverage is appropriate to sample the geometry of his object (from the (u, v) map),

- whether the expected largest changes of visibilities are statistically detectable given the signal-to-noise of the data (from the visibility plot),

- estimate how constraining the proposed observations will be (from the error analysis). If (s)he is unhappy with the results, the observer will have to change something in his set-up, save the changes and re-run the calculations in this menu.

As opposed to the previous two modules, which were only information-gathering in nature, this is where calculations should be run. From top to bottom (but not sequentially), the menus call for the PSF creation

Results, PSF and analysis

Point Spread Function   [Display]

UV Map and Coverage   [Display]

Plot [V^2/CPha]   as a function of   [HA, Bp, U, V, θ]
                        [Go]

Error analysis on model   [Go]

Fit another model   [Go]

[Help]   [Close]
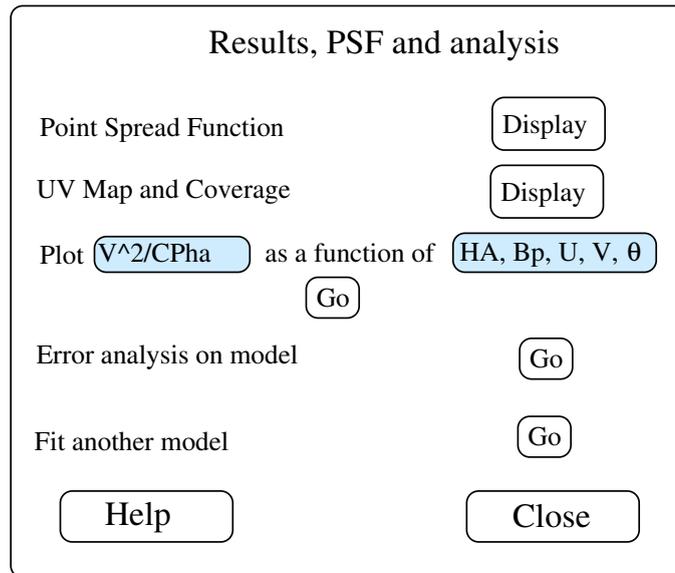
Figure 5: Proposed pop-up window for the creation of the PSF and for the extraction of quantitative results/predictions for the assumed models.

based on the (u, v) coverage, the representation of the model in the (u, v) plane, superimposed with the proposed coverage, and the corresponding visibilities together with their uncertainties as derived by the ETC. It should be possible to plot the observables (i.e visibilities and closure phases) as a function of the most simple parameters (Hour Angle, Position Angle, u and v coordinates and projected baseline).

All the plots can be done in a graphical window similar to Aspro's current one.It would be nice to offer the possibility of saving any of these plots as Postscript files to be incorporated into the proposal. Saving them as ASCII tables would also be of great interest to include in the users own sofwares..

The fourth menu ("Error analysis on model") calculates the uncertainties on the parameter of the assumed model (i.e., the same model as defined in the "Object" module). This will tell the user how good/bad the observations are to constrain his favorite model of the target. The fitting results i.e. model parameters estimation with corresponding chi2 should be retrievable. It is important to be able to overplot visibility and closure phase curves computed with the fit as a function of the most simple parametes (Hour Angle, Position Angle, u and v coordinates and projected baseline).

A last menu that is new to ASPRO (although the material is there to run it easily) but that could be useful to users is suggested: it would offer the possibility of fitting another model on the visibilities to determine if it is possible to disentangle between two possible models (say, for an extended object, binary system *vs* ellongated gaussian) without refilling the first module. In particular, it would be nice to allow rhe user the possibility to overplot the alternative model on the previously defined one, say, in the visibility plot. Discrimination between the models should be based on the resulting χ^2 value.

Finally the calibrator issue should be dealt with at this level. Fitting a model on the data will require to evaluate visibility errors which should include a calibrator diameter error estimation, this is mandatory since it is well known that calibration is important source of error. Two possibilities could be offer to the aspro user the first one being simpler than the second one.

- Include a standard calibration error based on the probability of finding a calibrator with caracteristics as close as possible to the target. Aspro-Light user should be warned of this.

- Check for calibrator using an adequate software (e.g. JMMC calibrator finder) that would retrieve information from available databases. This is obviously a more complex option that is not considered as a priority for Aspro-Light first generation.

Summary Buttons/Fields:

Name	Action/Comment
Point Spread Function	plot a figure
UV Map and coverage	plot a figure
Visibilities/Cloure phases	Display as a function of HA, Baseline u,v θ
Error analysis on model	plots best model curve and gives fitted parameters and corresponding χ^2, mentions calibration issue
Fit another model	Allows to enter new model
Help	
Close	

Warnings

Calibration issue

3.6   Fixed quantities and options

- A minimum elevation of 30º is probably a reasonable value for most simple cases. Also, we might need to force a 87º (or so) maximum elevation because of the alt-az mount that goes crazy so close to zenith.

- A 30 min/calibrated point observing frequency (or is it a shorter delay?) has to be fixed, so that people do not think they can get a point every five minutes, including calibrators!. This should be uptdated based upon actual informations.

- A 50 % on-target proportion is most likely to be typical for most programs.

- The plotting ranges should be held to default values (i.e., 200 m in the (u, v) plots). Also the plot of the PSF should be in one mode, most likely contours with default spacing.

- The gridding/weighting mode for creating the PSF should also be left to default parameters.

- All filenames and variable names should remain hidden to the user.

- The calibrators do not have to be specified at this point if Aspro-Light is meant to be used for phase I proposals. However we recommend the issue to be kept in mind (see previous subsection).

4   General software requirements

It should be possible to keep all the windows opened at the same time (unlike Aspro).

It would be nice to have a contextual help in addition to the help button that would pop-up a baloon with help text (like Aspro).

It would be nice to be able to restore a whole session (from instrument to model and interferometer config) in case of a crash.

We do not recommend secured access to Aspro-Light that would require the user to identify.

If Aspro-Light is run on the user server it should be easy for him to update the instrumental parameter to fit to the latest VLTI configuration.