Final report Marie Curie Grant SELEP …

The SELEP grant aimed at the strengthening of Dr. Bruno Chazelas's young career in the direction of *instrumentation in astrophysics.*

The fellow has a background in optical instrumentation applied to astrophysics. The objectives of this project was to expand his experience in new instrumentation domains, to develop his research background in astrophysics, and to acquire the experience of practical astronomical observation.

The project has been a success and a great opportunity for the fellow. During the project he could participate to numerous instrumental developments around the central subject of the research for extra solar planet. Moreover it gave him the possibility to access to some of the most advanced facilities in the world for astronomy.

Following the needs of the host institution and the necessary negotiation delay for the grant the implementation of the SELEP grant has started in 2009. The fellow has however started to work at the observatory of Geneva in 2008. During this year the fellow has been in charge of the system engineering of the PRIMA differential delay line integration and installation.

The implementation of the SELEP project had 2 sides, a participation to instrumentations projects and an initiation to the observational astronomy and a broadening of the scientific background of the fellow.

The fellow participated to mainly 2 projects of instrumentation for the research of extrasolar planet. The two projects are linked to the technique of the Precise Radial Velocity (PRV) measurement technique (measurement of the velocity of a star in the direction of the line of sight using the doppler effect).

First the fellow participated to the development of a new table spectral calibration source: a white light fiber fed Fabry-Perot etalon. It has been designed in 2008, been manufactured in 2009 and tested during the year 2009 and 2010. It showed very promising performances : it could cover nearly all the spectrum covered by the HARPS instrument, and at the scale of one night has proven a stability similar to the one of the Th-Ar (hollow cathode Thorium Argon lamp) standard calibrator. It has however several advantages such as a better spectral coverage, and a much better flux repartition. It avoid the flux saturation pollution issue of the Th-Ar. The source is installed on the HARPS instrument and there is a plan to offer this new calibration for regular observations. The success of this development lead the Observatory of Geneva to design a new Fabry-Perot system, with the aim to be able to produce a little series of calibration source. They could be used on HARPS-north, ESPRESSO and moreover it could be a way to for the Observatory of Geneva to participate in the different projects of building PRV instrument in the infrared.

Second the fellow studied the PRV instruments illumination through optical fiber. He had to develop modelling techniques that could explain and quantify observed precision limiting illumination linked phenomenons. This modelling tools also enabled the exploration of a new kind of optical fiber for PRV instruments: square and polygonal fibers. The properties of these new optical fiber could be first explored through simulation and then with a test-bench that has been

developed by the fellow. They show very promising properties in particular in terms of image scrambling. They have however strange properties in the far field (the angular distribution of the illumination) Which seem to have been partially understood. It is still necessary to do some research to find the best practical way to use these new fibers. The foreseen first applications of this development is for the PRV instruments SOPHIE (for an upgrade), HARPS north and ESPRESSO.

The other aspect of the project was to initiate the fellow with observational astronomy.

The fellow was involved in was the PRIMA project. The PRIMA facility is essentially transforming the VLTI in a double interferometer that thanks to an internal metrology can be linked. The ESPRI consortium composed of the Observatory of Geneva, the Max Planck institute for Astronomy of Heidelberg and the landessterwarte from Heidelberg in exchange for Guaranteed observation time on the PRIMA facility on a program for exoplanet detection through astrometry delivered ESO with a part of the facility : the differential delay lines (DDL). After the successful installation of the DDL in 2008 the PRIMA facility entered a commissioning period that is still ongoing. During the grant period the fellow participated in diverse way to prepare the ESPRI consortium scientific program. First the fellow participate to the data reduction effort needed to prepare the target catalog. Then the fellow had the responsibility to study systematics introduced by some design choice in the facility.

The fellow had access to the most advanced astronomical facilities during the grant:

- The fellow has had access to the HARPS instrument, both for on-sky testing and development of the Fabry Perot Calibration source.
- The fellow had access to the EULER swiss national telescope, the fellow participated to the telescope optical alignment and improved the pointing model of the telescope.
- The fellow had a 3 night run on AMBER at the VLTI in Paranal

This grant has been overall very successful for the fellow and help him to grow in his career :

He will stay in Geneva for a while being project manager of 2 instrumentation projects :

- The building of 2 additional DDL for PRIMA to complete the facility (project funded by ESO).
- The project NGTS, a collaboration between Geneva and british universities to build a successor to the WASP system, an automatic observatory made of 12 20 cm telescope with infrared sensitve CCD to detect transiting planet around K and late M stars, with a milimagnitude precision. Aiming at the detection of nueptune to super-earth planet around nearby and bright star in order to be able to further study them with other instruments like HARPS, ESPRESSO and others.