European
Southern
Observatory

La Silla Paranal Observatory

# HARPS Secondary Guiding

Poster 7739-171

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## Introduction

HARPS, the High Accuracy Radial velocity Planet Searcher at the ESO La Silla 3.6m telescope, is dedicated to the discovery of exosolar planets and high resolution spectroscopy.
The current precision in the measurement of the radial velocity of stars down to 60 cm/sec in the long term, has permitted to discover the majority of the "super Earth" type of extra solar planets up to date. Several factors enter in the radial velocity error budget, among these is the guiding accuracy, which has direct influence on the light injection into the spectrograph's fiber.
Guiding is actually done by corrections directly sent to the telescope with frequencies in the range of 0.2 Hz-0.05 Hz, depending on the brightness of the target. Due to mechanical limitations of the telescope there is an expected relaxation time of approximately 2 sec.
The final objective of this modification is to reach radial velocities precision of 30 cm/sec with HARPS, that will allow the detection of Earth mass planets in close-in orbits.

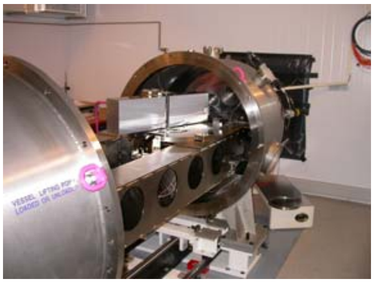

**Fig. 1** HARPS Enclosure.

**Fig. 2** HARPS Fiber Adaptor.

## Concept

In order to reduce the guiding error contribution to less than 10 cm/sec on the final Radial Velocity measurements, the centering accuracy at the end of integration, has to be better than 0".01 or 10 marcsec on HARPS.

After consideration of various alternatives we have chosen the concept of refracting the light by using a glass supported by an independent tip-tilt table having the advantage of not interfering dramatically in the actual mechanical configuration. The efficiency lost is limited and the installation and removal of it is easy and do not disturb the functioning of the HARPS instrument itself in case of a failure.

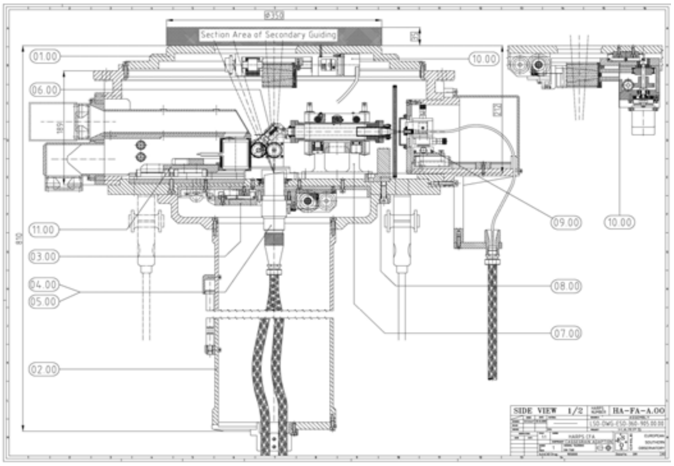


**Fig. 3** Location of Tip-tilt.

## Specifications

- Available space 350 mm diameter 35 mm thickness*
- Tip-Tilt range +/- 7.5 mrad (+/- 0.43 deg)
- Load to carry 500 grams
- Max frequency 10 Hz and Max amplitude at 10 Hz equals to 4 mrad
- Absolute accuracy 1 mrad
- Repeatability 0.1 mrad (10 microns over 100 mm)
- Resolution 0.01 mrad (1 micron over 100 mm)
- Pivot point position accuracy in x-y 3 microns
- Pivot point position in z not critical
- Pivot point stability in x, y 1 micron and in z during observation 1 micron
- Max temperature difference + 1°C (TBC)
- Maximum deviation from vertical 70 °

*(*) It was possible to increase this limit to 43 mm*

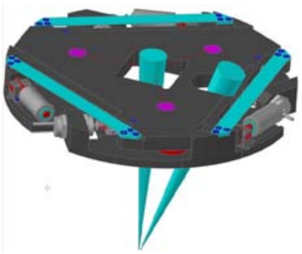

**Fig. 4** Tip Tilt light path

## Design and Fabrication

The design and fabrication of the unit was done by Tomelleri s.r.l., Villafranca, Italy following defined specifications and requirements. The unit was installed on top of the HARPS adaptor flange.

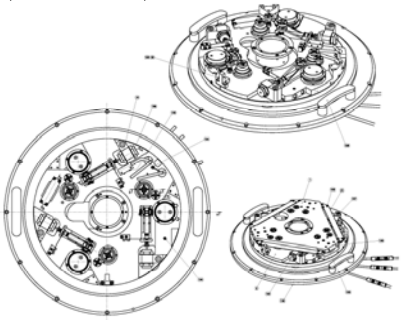

**Fig. 5** Tip Tilt table.

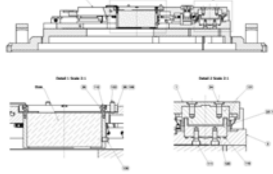

**Fig. 5a** Details

The table movement is done by means of three voice coil actuators, with a resolution of 0.1 microns, controlled by an amplifier included in a GALIL-YPE DMC-4030 controller. The position of the table is followed by three linear LVDTs with an error due to linearity of less than +/- 0.75 microns. With a peak stroke equal to 10 mrad the required stroke is the full available stroke of the LVDT equal to 2 mm, for which the accuracy is +/- 1 micron.

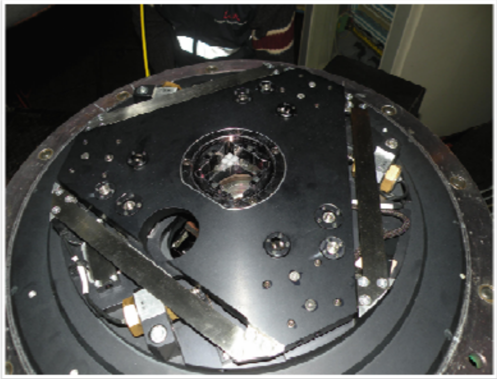

**Fig. 6** Tip-tilt table installed.

## Guiding and Acquisition

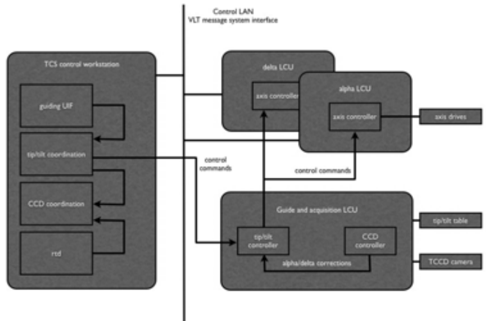


**Fig. 7** Software architecture.

The HARPS tip-tilt table subsystem accepts corrections at high frequency, which are calculated using relations regarding the movement of the image in the guide camera.
Both tip/tilt and guide/acquisition control software, running on the guide and acquisition LCU, are allowed to send directly Auto Guiding corrections to the tracking software running on the main axes LCUs.
The Guide and Acquisition LCU, is responsible for the control of the Technical CCD hardware and tip/tilttable hardware. All image-processing functions as well as the actual tip/tilt control loop and its serial communication software are deployed on this LCU.

## First Results and Conclusions

1. First tests in Verona:
   The results of the tests performed in Verona were exceeding the requirements and specifications of the unit stated in the design.
   Range: > 10 mrad (Requirement: 7.5 mrad)
   Absolute accuracy: Better than 5 microns for each of the 3 actuators (Requirement: better than 100 microns)
   Repeatability: Better than 2 microns on each of the 3 actuators (Requirement: better than 10 microns)
   Pivot point: Short term stability 2 microns (Requirement: better than 3 microns)
   Operation at different elevations: No variation down to 20 deg
   Temperature stability: Increase of up to 1°C when operating at 10 Hz
2. Integration in La Silla:
   Delays in the glass delivery made the testing only provisional as the glass used had different characteristics and less thickness (20 mm in comparison to the final doublet of 32 mm)
   Fig.6 shows the table installed in the HCFA and ready for installation in the telescope. The Tip-tilt table fit in the Cassegrain adapter at all its operating positions.
   The communication was preformed through the serial line, connecting the MVME2700 CPU serial ports via the MVMe712M transition module to the serial port of the tip-tilt table controller GALIL
   Basic functionality tests were performed on the assembled unit at the telescope. The unit was successfully controlled within the framework of the high level software used to control the telescope. More complex tests, or automatic guiding could not be performed because the high level guiding software was not yet functioning during the test time. In the last weeks the guiding with the final software has been successfully running in simulation mode and we look forward to the coming tests on the sky to complete the commissioning of this new unit.

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