HARPS3

High Accuracy Radial-velocity Planet Searcher 3

ING SEMINAR - 26TH APRIL 2019
Features of HARPS3

- Close-copy of HARPS/HARPS-N
  - $R = 115,000$, $\lambda$ range: 380 – 690 nm
- Entrance fibre diameter 1.4 arcsec - better matched to seeing
- **Full-Stokes, dual-beam polarimeter** (integrated in the design of the Cass fibre adapter)
- Echelle grating substrate: **Zerodur Class 0 SPECIAL**
- **Detector Unit**:
  - A new design continuous-flow cryostat
  - Enhanced CCD calibration
- **Robotic operation**
Project overview
Cassegrain fibre adapter
Mechanical design ISO view

- Telescope interface
- Spacer
- Cassegrain unit optics box assembly
- Cameras
- Electronics cabinet

Global dimensions: 435 x 466 x 326 mm
Total mass ~ 138 kg

Slide credit: Jan Kragt, NOVA
Optical model

Slide credit: Jan Kragt, NOVA
HARPS3-POL

Telescope Focal Plane

D1
ADC1
ADC2
QWP/HWP
PBS
Tip/Tilt Mirror (x2)
D2 (x2)
Fiber Mirror
D2 (x2)
ND1 (x2)
Fold Mirror (x2)
D2 (x2)
Camera Sensor (x2)

Pol 2
Pol 1
200 mm

Slide credit: Patrick Dorval, Leiden
Fibre-link

- Octagonal fibres + double scrambler
- ~17 m fibre length => efficiency boost in the blue
HARPS3 Room

Coudé
East
Room layout

Thermal enclosures: HTE1 (entire space), HTE2 and HTE3
Spectrograph system

Picture credits: HARPS-N project
More pretty pics courtesy of HARPS-N project
Spectrograph Optics

Ray trace of main spectrograph optical components:
The light is injected at (1). The large (770mm diameter) parabolic collimating mirror (2) is used in triple pass. (3) Echelle grating, (4) flat fold mirror, (5) grism (cross-disperser), (6) until focus are the 6 lenses of the camera objective.
HARPS3 Echelle

- Echelle grating substrate: Zerodur Class 0 SPECIAL, CTE = 0 ± 0.010 · 10^{-6}/K
- September 2018: 1st stage of manufacturing complete (Mosaic Substrate Verified)
- Alignment stage will be completed in the next few months
- Delivery anticipated before the end of this year
Detector Unit

- e2V chip: CCD231-84-0-G57
- CCD controller: ESO NGC unit
- New design continuous-flow cryostat
- Enhanced CCD calibration
  - 10 cm/s (Earth-like planet signal) == 1e-4 pixel!
Grade 5 CCD Inspection

- Already received the Grade 6 and Grade 5 devices
- Expecting delivery of the Science (Grade 0) chip in June 2019
  e2V chip: CCD231-84-0-G57
Continuous-flow cryostat

- ~1 mK rms stability ... verification tests this summer
- Vacuum pressure inside detector unit ~2x10^{-6} mbar
Calibration Unit

8 switchable light sources allowing illumination of Fibre A or Fibre B in any combination.

Image credit: P. Dorval, Leiden
Important Milestones coming up this year:

- Camera ITT
- Telescope refurb ITT
- Cass Adapter WP (includes Cal Unit) Final Design Review
- Vacuum System ITT
- HARPS3 Room Design Review
- All other spectrograph optics (collimator, grism ...) ITTs
- CCD integration into new detector head unit
- Dataflow simulation test
- Announce telescope closure date to community (Sep/Oct)
- Delivery of Echelle grating to Cambridge
- Software systems FDR (Dec)
Schedule

2019

- HARPS3 is now fully funded – full steam ahead!
- Final design reviews for Cass fibre adapter unit, telescope upgrade plans, software systems
- Delivery of Grade0 CCD
- Assembly and testing of new continuous flow cryostat
- Delivery of Echelle grating

2020

- Completion of outfitting INT’s East Coudé room
- INT roboticization works begin

2021

- Assembly, integration and testing in labs (all sub-systems)

★ HARPS3 First Light  ~July 2021
Extra slides ...
Schematic of CCD measurement

Laser → 50:50 Splitter → Delay line → 1->2 Switch → 1->16 Switch → Baseline Control → Detector

- Laser
- 532nm Diode 40mW
- 380-700nm Fiber Stretcher
- Chose any pair
- Machined block with precise grooves for fibers
- 2K detector, room temp

Measuring the effective pixel positions for the HARPS3 CCD, Richard Hall et al., SPIE 2016, new paper in prep – 2019

Method based on previous works by Shaklan+ 1995, Crouzier+ 2012
A schematic of the phase-swept data-cube. A column of the data from a single pixel yields a sine-wave which contains pixel displacement information.

The phase difference between the dashed lines is due to the component of the pixel displacement in the direction of the wavevector.