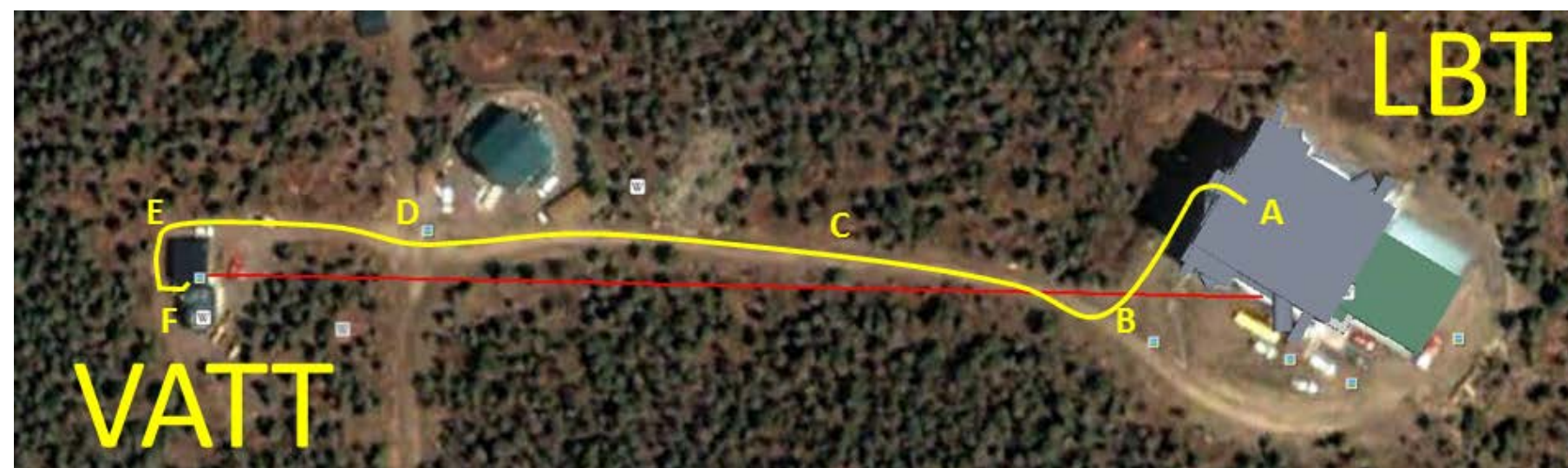


# The VATT-PEPSI connection

## First spectra, current status, upcoming VATT-PEPSI-TESS survey

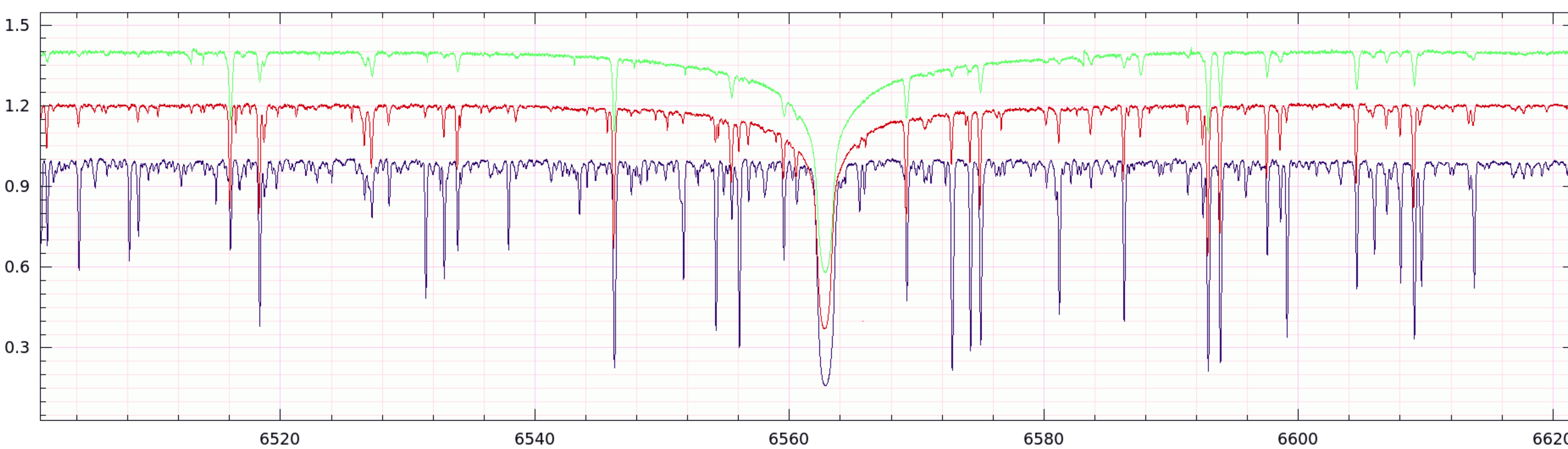
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**Abstract.** PEPSI is coupled to the 1.8m Vatican Advanced Technology Telescope (VATT) by a 450m underground fiber connection. The connection was used to commission the spectrograph and is now available for science. It provides currently two high-resolution observing modes with  $R=200,000$  (130L slicer) and  $R=260,000$  (100L slicer) for a total of 40 nights per year for the VATT community. Due to the fiber length it is recommended to use just the red arm of PEPSI, fiber transmission peaks in the red at 74% (CD-VI) and reaches a minimum of 5% in the blue at and below 400nm (CD-I). Fibers are 200 $\mu$ m core of type FBP from Polymicro. We present and compare commissioning spectra and lay out the upcoming VATT-PEPSI-TESS Northern Ecliptic Pole (NEP) survey.

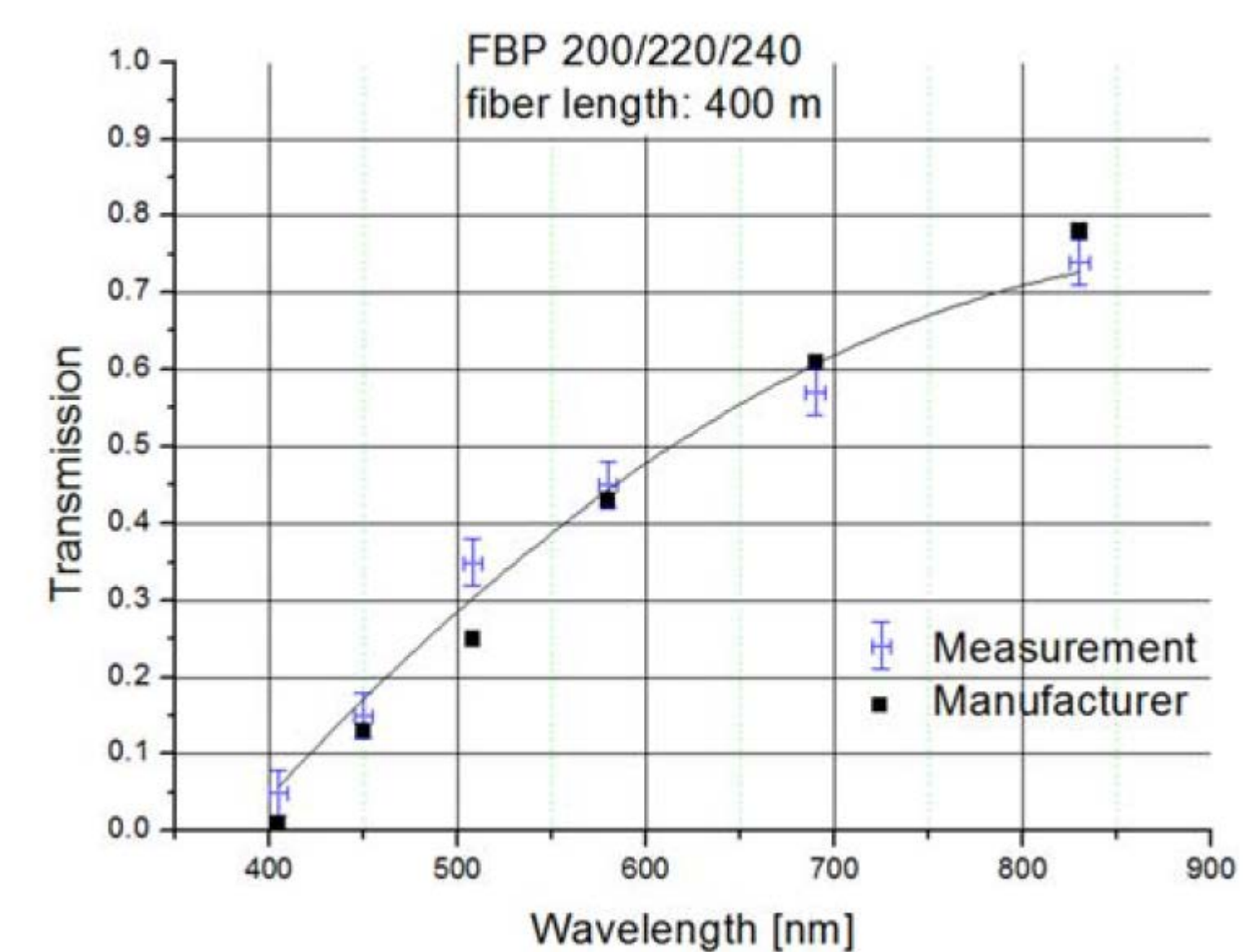


*Left.* The total fiber length from the spectrograph (point A) in the LBT building to the telescope fiber injection unit (FIU) on the VATT (point F) is 453m. 373m of this is in pipes beneath the road with vault access points B, C, D and F. The remaining length is within the two buildings.

*Below.* Fiber pulling picture sequence from the spectrograph (left), the LBT building, along the road at access vault D in the foreground, access vault E, entrance into the VATT building and up to the telescope (right). The latter picture shows the FIU with its fiber bundle on the left side in front of the yellow telescope mount.



*Fig.* Three bright stars thru the VATT ( $R=250,000$ , centered at  $H\alpha$ ). From top-to-bottom:  $\theta$  UMa (F7V, 30min,  $S/N=500$ ),  $\zeta$  Her (G0IV, 30min,  $S/N=640$ ),  $\alpha$  Boo (K2.5III, 100s,  $S/N=1000$ ).



*Fig.* Transmission measures for the VATT-PEPSI fiber connection. Our own measures are shown as error bars, the extrapolated manufacturer values are overplotted as black squares. The wavelength bins are equal to the central wavelengths of the six cross dispersers.

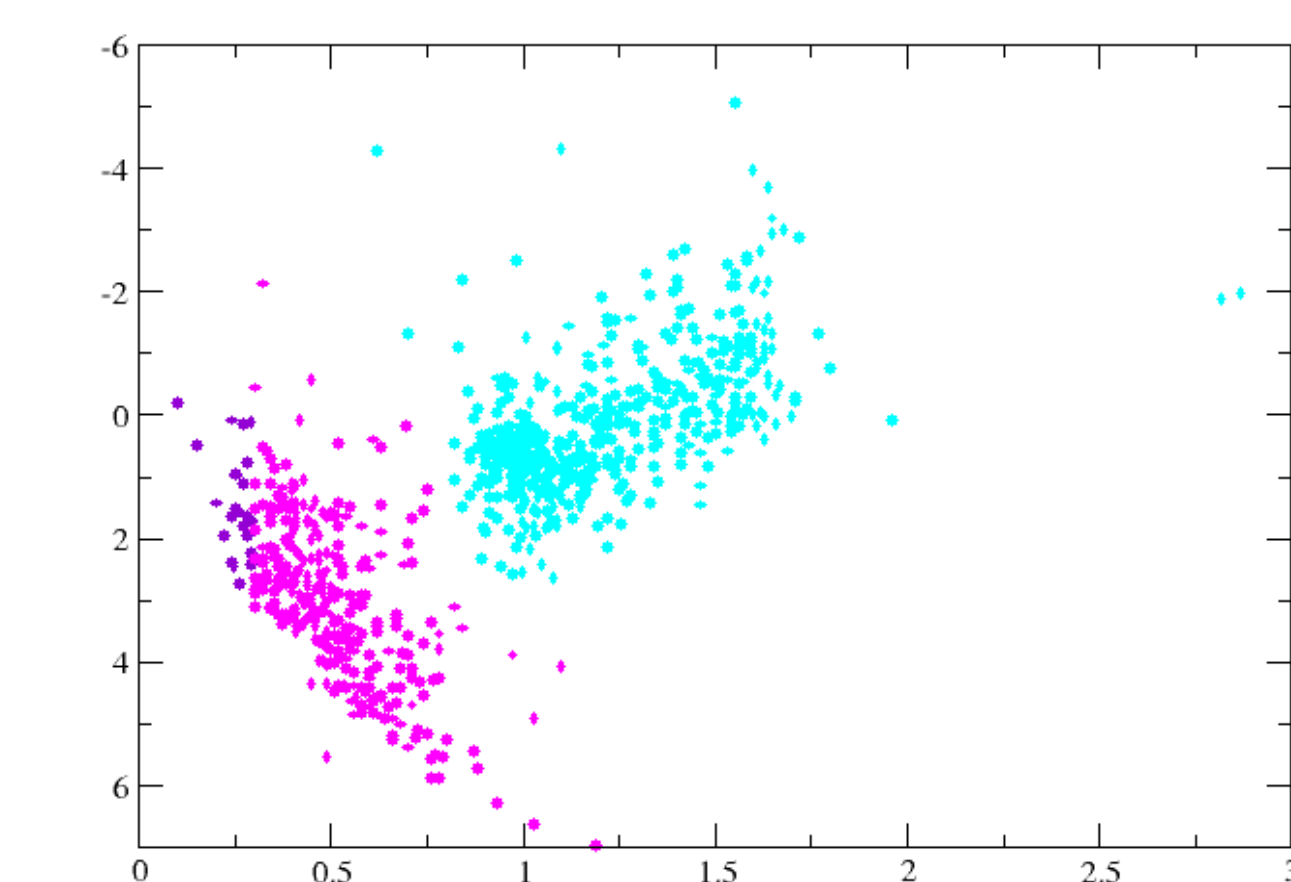
### The VATT-PEPSI-TESS NEP survey

This poster also lay out a high-resolution spectroscopic survey of future TESS stars around the Northern Ecliptic Pole (NEP). The survey field comprises of approximately 800 square degrees with 311 main-sequence stars brighter than  $V=8.5$ mag and cooler than  $F_0$ . Two  $R=200,000$  spectra will be obtained for each of these stars at different epochs. The first visit shall cover the wavelengths 480-544nm and 628-741nm, the second visit shall re-use the 480-544nm region but extend in the red to 741-912nm. Predicted  $S/N$  ratios for the limiting magnitude of 8.5mag in  $V$  for a single spectrum are 100:1 in the red and 50:1 in the blue for a 90-min exposure. Typical  $S/N$  ratios are 150 in the red and 120 in the blue. The survey kick-off took place in May 18-27.

The basic idea is to provide precise spectroscopic parameters for stars that are potential planet-host candidates for TESS. In particular, our spectra would deliver

- Two radial velocities good to 2-3 m/s.
- Precise global stellar parameters like effective temperature, gravity, metallicity, micro- and macroturbulence, vsini, and radii.
- Chemical abundances of selected elements including isotope ratios like  $^6\text{Li}/^7\text{Li}$  and  $^{12}\text{C}/^{13}\text{C}$  if applicable.
- Average line bisectors as a function of excitation as a measure for convective blueshift.
- Activity signatures like absolute Ca II IRT,  $H\alpha$  and  $H\beta$  line-core fluxes.

There are 311 dwarfs in the selected NEP field brighter than 8.5 mag in  $V$  and cooler than  $F_0$  with  $B-V > +0.3$  (Fig.). These are the priority targets of the survey. There are also 536 known giants in the same field with the same constraints.



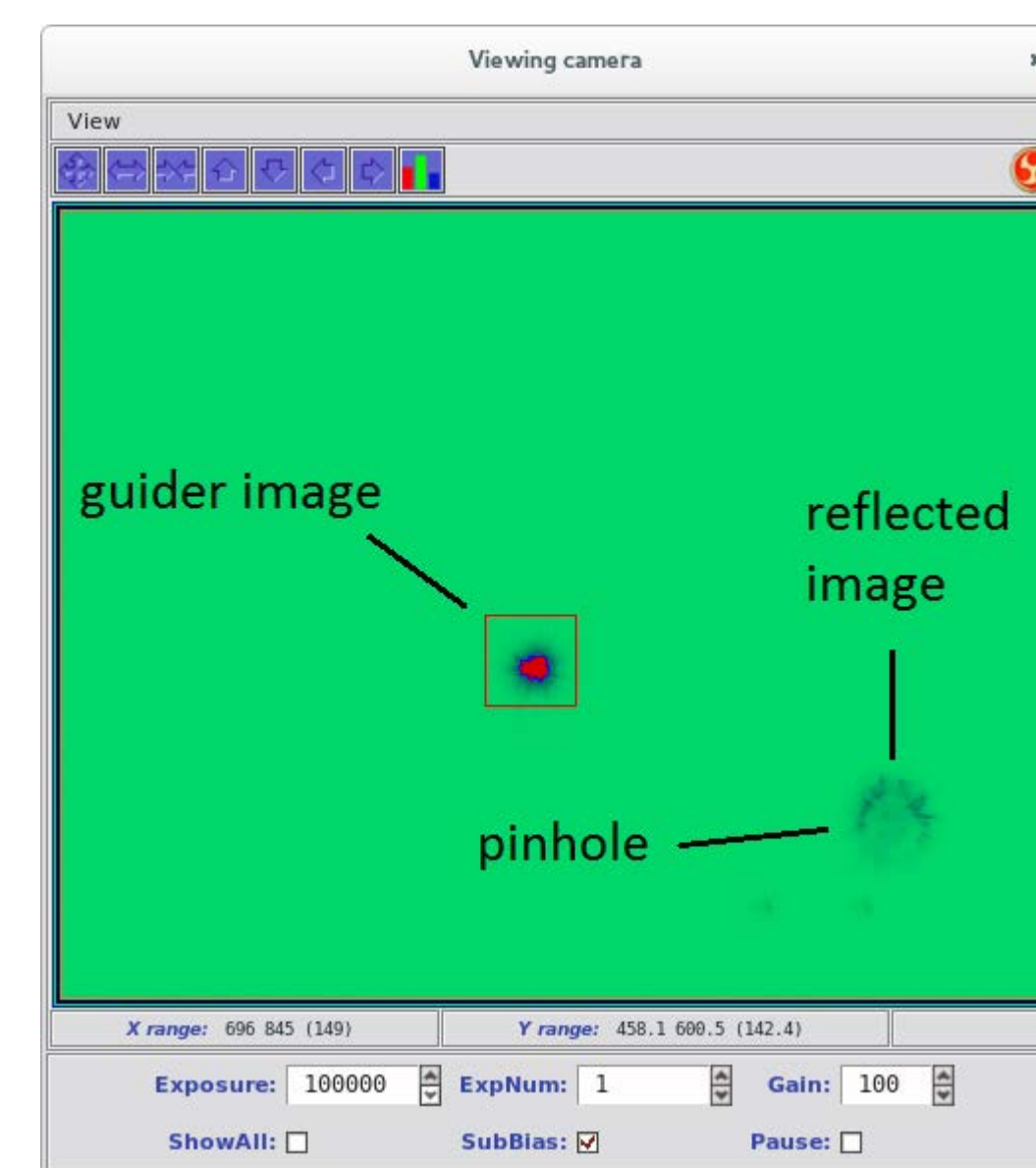
*Fig.* H-R diagram ( $M_v$  vs.  $B-V$ ) of the survey targets. Only the dwarf stars (magenta points) will be observed.

### Telescope-spectrograph user interface

The PEPSI VATT telescope adapter is equipped with a Basler acA1600-20gm/gc guiding camera which has a Sony ICX274 1600x1200 CCD with 4.4  $\mu$ m pixels. The scale on the CCD is 0.11 arcsec/pix. The camera is a GigE Vision closed-source standard interface which requires a 1GB Ethernet link. A separate local computer server Dell R220 is used to provide the high-speed Ethernet link to the camera and hosts the graphical user-interface to the guider application. The PEPSI control program is then linked to the guider GUI via the LBT0 general-purpose network over an X11-forwarding ssh socket.

The communication with the VATT telescope control system (TCS) is implemented with a dedicated Internet socket which accepts a number of interface commands. The PEPSI VATT control interface uses the commands to point the telescope to a target with the specified equatorial coordinates, to apply a small guiding corrections in RA/Dec, and to obtain status information of the current position of the telescope and its environment. The PEPSI VATT adapter is mounted in a fixed position in the Cassegrain focus flange with no de-rotator being used during observations.

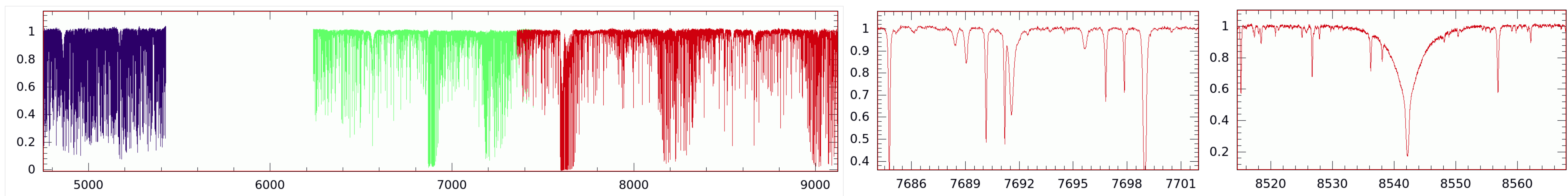
Guiding is done on the direct-reflected image of the observing target. The back-reflected image from the mirrored pinhole of the 200 $\mu$ m fiber is merely used to verify that the star is well centered on the pinhole (Fig.). This configuration is achieved with a grey beam-splitter which has a mirrored wedge on one side to offset the back-reflected image on diagonal of the CCD. The direct-reflected guider image takes a few percent of the target light. The guider application keeps the target at the specified hotspot position on the CCD by applying small corrections to the TCS to ensure that the star is well centered on the pinhole. The pinhole position can be otherwise interactively modified especially after mounting and dismantling the adapter in the Cassegrain focus.



*Fig.* Snapshot from the PEPSI-VATT guider CCD. This is what the user sees. Light to the spectrographs is confined by the pinhole. Its surrounding surface reflects light back to the guider CCD where it can be seen if the seeing is greater than the projected pinhole diameter (1.5").

More PEPSI information and other topics can be found on our web page at

<https://pepsi.aip.de>



*Fig.* The data product of the VATT-PEPSI-TESS survey. Left panel: Full wavelength coverage with CD-III (480-544nm), CD-V (628-741nm), and CD-VI (741-912nm). Right panels: Two zooms into example lines (K I doublet and one of the three Ca II infrared triplet lines). Spectral resolution is 200,000.  $S/N$  is 150:1 in the red and 120:1 in the blue with 90min integrations on a 7.5mag star.