OBSERVING TIME PROPOSAL FORM 2008
for the Vacuum Tower Telescope (VTT)
at the Observatorio del Teide, Tenerife, Spain

Please send the completed form by email to: `tac@kis.uni-freiburg.de`
Deadline: 19 January 2008!

For retrieving this form[1] and for information on the VTT consult our web page:
http://obs.kis.uni-freiburg.de/tfs-index.htm

1 Applicants

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[X] We/I want to apply for time under the OPTICON ACCESS program.

For allocation of observing time the VTT TAC has two requests:

Request 1:

[X] We will deliver a technical report on our observing campaign – if granted – within one week after the last day of observation. This report will contain information on: names of observers and assistants, title of project, used instruments, instrument changes, positive feedback, problem feedback, seeing conditions, and a wish list. The report will be sent via email to `vtt@kis.uni-freiburg.de`.

Request 2:

Please let us know about any publication that results from VTT data sets by sending the references to H. Wöhl (`hw@kis.uni-freiburg.de`).

[1]Critical comments on this form are appreciated by R. Schlichenmaier (`schliche@kis.uni-freiburg.de`).

2 Justification

Title of Project: Spectroscopy of the quiet solar photosphere: properties of the shocks and the acoustic flux generation.

Scientific Objectives of Observing Time

(Please give a brief statement of the scientific objectives of the requested observing campaign. This information will be used to evaluate the scientific merit and the observatory's general capability to conduct the type of research you intend to do. Please make sure that all necessary information is provided.)

This observing campaign has two research objectives with the common aim to gain further insights into the dynamics of the solar photosphere by 2-D spectroscopic means. The two research objectives have been developed on the background and results of previous campaigns with different aims. Our research objectives are listed in the following by our priorities:

(1) Photospheric shocks:

From earlier observations we have hints that a detection of the photospheric shocks by their spectroscopic signatures is possible (Solanki et al., 1996, A&A 308, 623). Besides a detailed investigation of a particular shock event, statistics of their occurrence have been also derived for the first time by our team (Rybák et al., 2004, A&A 420, 1141).

Previous campaigns: Unfortunately, the data used in the latter work are of limited value due to the short duration of the time series of the spectra and due to less than optimal seeing conditions. Moreover, the results, gained in frame of the VTT/TESOS+Echelle campaign in November 2006, suffer from lower spatial resolution. Just one run was possible to acquire for positions near to the limb but only with the Tip/Tilt KAOS setup. The AO correction was not possible due to poor contrast[2]. Nevertheless, these data were reduced and the first results were already presented at the 3rd Central European Solar Physics Meeting in October 2007[3].

In order to reach our goal we need to acquire the data the with best spatial resolution possible. Therefore we plan to repeat our previous observing procedure updated on experience gained directly at the VTT from operation of the TESOS instrument in November 2006.

Aim: We plan to derive the locations of the shock signatures and the center-to-limb dependence of occurrence of the shocks caused by projection effects. To reach this goal, we would like to perform 2-D spectroscopic measurements of the quiet solar photosphere in one (or two) spectral lines using one of available 2-D spectroscopic instruments at the VTT – TESOS or alternatively Göttingen FPI (in case the TESOS will not be available). The Doppler lines of Fe I are chosen. In particular, the spectral characteristics as the continuum intensity, the Doppler shifts, and especially the line width broadening due to extreme difference of velocities of the plasma will be used to identify the shock signatures. Additionally, the spectral line profiles will be compared to the results of numerical simulations.

Note: The proposed observations can not be performed currently by Hinode/SOT instrument. The 2-D sequential scanning of the spectral profiles is possible with SOT/NFI instrument only with cadence of 30 s just per one spectral wavelength position (personal information: T. Berger, Hinode Data Analysis workshop, Orsay, October 2007).

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[2]Details available at http://www.astro.sk/~choc/open/06_opticon_vtt/06_opticon_vtt06.html

[3]Presentation available at http://www.astro.sk/ choc/3rd_CESPM_2007/rybak.ppt

Comparison with simulations: For future analysis the results of numerical simulations (CO^5BOLD code) in the form of synthetic spectral profiles (LINFOR3D code) have already been prepared by S. Wedemeyer-Böhm (60 snapshots, Fe I 543.4 nm line, CLV positions $\mu = 0.4$, 0.5, ..., 1.0). These synthetic data will be compared with the results of the proposed observations. A method for comparing results of the numerical simulations to the spectroscopic observations (Rybák et al., 2006) has been optimized for the 2-D observations. It will be used to degrade the results of the simulations to be compared with the observational results in a proper way.

The main goal of our attempt is to verify or falsify results on photospheric dynamics derived from three-dimensional numerical simulations of the solar convection with and without the magnetic fields. Such simulations predict frequent occurrence of the shocks, even in the spectral line forming layers of the photosphere. A statistical approach (see e.g. Rybák et al., 2006) and also case studies of the most prominent shock signatures will be performed using both the observational and numerical results.

(2) Location of the acoustic flux generation:

Is is widely accepted that the 5-min oscillations are stochastically excited by acoustic noise driven by turbulent convection in and below the solar photosphere as suggested by numerical simulations. It was observationally demonstrated that these acoustic events are localised in intergranular lanes (Rimmele et al., ApJ 444, 119, 1995; Goode et al. ApJL 495, L27, 1997; Espagnet et al., A&AS 109, 79, 1994; Espagnet et al., A&A 313, 297, 1996).

On the other hand, Khomenko et al. (A&A 369, 660, 2001) have found recently that the situation is more complex. They report that: a) oscillations above granules and intergranular lanes occur with different periods; b) the most energetic intensity oscillations occur above intergranular lanes; c) the most energetic velocity oscillations are localised above granules and lanes with maximum contrast; d) velocity oscillations at the lower layers of the atmosphere lead oscillations at the upper layers in intergranular lanes. This means that discrepancies with the accepted view and confusion still remain.

Aim: Basic questions about the origin of the acoustic flux and the differences between the acoustic flux in lanes and in granules are planned to be addressed using new high-spatial spectral measurements by the VTT using a 2-D spectroscopic instrument (the TESOS or alternatively the Göttingen FPI (in case TESOS will not be in regular operation in 2008).

We plan to verify or to falsify results published by Khomenko et al. (2001) and make progress in understanding of the evolutionary differences between the acoustic events in lanes and in granules. With the proposed observing program at the VTT we want to expand the time coverage up to at least 40-60 minutes.

In particular, the continuum intensity, the vertical motion (Doppler velocity), and the turbulent broadening (line width) will be compared using various lines spanning the photospheric layers with their formation range. Inversion of several spectral lines using the SIR code will be later carried out in order to determine the time evolution of the physical parameters through the photosphere for particularly selected events, where signatures of the acoustic flux is identified.

Long time series of spectra would allow to separate the 5-min velocity signal from the dynamics or thermodynamics of the granulation. Thus, the vertical stratification of the oscillation dynamics can be identified if the 5-min signal is filtered out.

Former projects

(If this proposal is a continuation of a former project, please provide a list of previous program titles and a brief progress report on a separate sheet. Please include references to publications which resulted from your earlier observing programs. Apropos: Please let us know about any publication that results from VTT data sets by sending the references to H. Wöhl: hw@kis)

We have experience with similar projects at the VTT and its Echelle spectrograph and the TESOS instrument since 1992. Programs performed within the last years were:

(1) Spectroscopy of the quiet solar photosphere, Nov 16 – 28, 2006

(2) Solar spectroscopy, July 3 – 18, 2004

(3) Granular spectra, April 1 – 16, 2002

(4) Shock signatures in Fe II lines, April 25 – May 1, 2000

References of publications related to the scientific contents and the data reductions of these projects are:

(1) Koza, J., Kučera, A., Rybák, J.; Wöhl, H.: 2006, A&A 458, 941-951

(2) Odert, P., Hanslmeier, A., Rybák, J., Kučera, A., Wöhl, H.: 2005, A&A 444, 257-264

(3) Rybák, J., Wöhl, H., Kučera, A., Hanslmeier, A., Steiner, O.: 2004, A&A 420, 1141-1152

(4) Hanslmeier, A., Kučera, K., Rybák, J., Wöhl, H.: 2004, Solar Phys. 223, 13-26

(5) Kučera, A., Rybák, J., Hanslmeier, A., Wöhl, H.: 2003, Hvar Obs. Bull. 27, 25–37

(6) Wöhl, H., Kučera, A., Rybák, J., Hanslmeier, A.: 2002, A&A 394, 1077–1091

3 Observing requests:

Amount of time requested: 10 days

Coordinated observation: (Please indicate if you are planning coordinated observations with other facilities.)

We intend to apply for the supporting observations from two space-born instruments – TRACE satellite and MDI/SOHO. Application for the Hinode support is under considerations. We shall apply for observing time once the VTT time will be granted and scheduled.

TRACE: In particular, we are interested in the high resolution images (0.5") taken by TRACE in the white light (WL) channel, UV 1600 Å continuum channel, and in the Lyman alpha channel. Expected exposure times are 0.2, 4, 2 sec, respectively. Therefore cadence of one set of these exposures per 20 seconds can be reached.

MDI/SOHO: high-resolution longitudinal magnetograms (0.6") of the 1-min cadence will be acquired with some intensitygrams (one per hour) for the co-alignment purposes.

The WL channels will be used for the post-facto co-alignment of the VTT, TRACE and MDI images.

Impossible Dates: (In order to make most efficient use of observing time in view of personnel limitations, the number of reconfigurations of the telescope and its instrumentation will be limited. We therefore will group observing requests of similar technical nature into combined periods. An attempt will be made to accommodate a very limited amount of "impossible time" in the schedule. There is absolutely no guarantee for success of this attempt. Please keep this in mind when specifying your restrictions above these lines. Please keep also in mind the possibility of having your observations made by a colleague in cases of time conflicts. Thank you for your cooperation.)

none

3.1 Instruments

In the following please specify the needs for your observing run. Please give an overview and describe additional needs at the end of this form in Sect. **??**.

Some of the following instruments can be used simultaneously: (TIP or Echelle) and (POLIS or TESOS or Göttingen FPI). Additionally, fast cameras for speckle bursts are available.

3.1.1 POLIS [ ]

The neutral iron lines at 630 nm are observed in polarimetric mode. The second channel (Ca H) only records Stokes I.

Slit: [ ] 15 μm (0.18") [ ] 40 μm

Imaging channel: [ ]
The relict of the correlation tracker channel can now be used for imaging in the continuum. For a list of available CCDs, cf. Sect. **??**.

3.1.2 TIP (Tenerife IR Polarimeter) [ ]

Wavelength range:

[ ] 1040 - 1100 nm [ ] 1200 - 1260 nm [ ] 1530 - 1800 nm

3.1.3 TESOS [X] (available: July until December 2008)

[X] Intensity Mode [ ] VIP (Vector Imaging Polarimeter) (Stokes I, Q, U, & V)

Please contact Thomas Kentischer (tk@kis.uni-freiburg.de) or Luis Bellot Rubio (lbellot@iaa.es) if you want to use VIP.

Please specify the spectral lines you want to use in the prefilter list (cf. Sect. **??**).

3.1.4 Göttingen FPI [X]

[X] Intensity Mode [ ] Polarimetric Mode (Stokes I, Q, U, & V)

If you apply for observing time with the Göttingen FPI, please consult:
`http://www.astro.physik.uni-goettingen.de/~nazaret/FPI_Manual/`

Please specify the spectral lines you want to use in the prefilter list (cf. Sect. **??**).

3.1.5 Echelle Spectrograph [ ]

Grating:

[ ] 63° Standard [ ] 62° Chrom. [ ] 55° IR

(The number gives the blaze angle in degrees. Put a question mark if you don't know!)

Spectral lines that you want to observe simultaneously:

You can observe up to 3 lines simultaneously. List the combination(s) that you want to use.

Set	Wavelength [nm]	Order	Remarks
1a			
1b			
1c			
1d			
2a			
2b			
2c			
2d			

[ ] I already have a predisperser mask.
[ ] I need a new prediserser mask.
[ ] Please help me calculating mask parameters.
[ ] I use the predisperser with mirror (no grating) and use filters (cf. Sect. **??**).

Slit width: The image scale on the entrance slit is 4.49 arcsec/mm.

[ ] 40 μm [ ] 60 μm [ ] 80 μm [ ] 100 μm (0.45") [ ] 150 μm
[ ] no slit (mirror)

Detectors in focal plane of spectrograph: cf. Sect. **??**.

3.1.6 Other instruments

In case you plan to use other instruments, please describe your needs in detail here.

3.2 Additional needs

3.2.1 Detectors: CCDs

[ ] PCO 1 (4072x2720) [ ] PCO 2 (4072x2720)
[ ] Sensicam (1376x1040) [X] DALSA II (1024 x 1024, faster)

Video Cameras: [ ] COHU 2/3" (RS170) [ ] COHU 2/3" (CCIR)

3.2.2 Interference Prefilters:

#	Central wavelength [nm]	FWHM [pm]	remarks
1	543.6	300	
2	557.8	830	
3			
4			
5			

3.2.3 Beam Splitter Spectr/Lab:

[X] CaK Beam splitter [ ] IR/VIS Beam splitter[1]
[ ] 50/50 % Beam splitter [X] Mirror

([1]: to be used if you observe with TIP & POLIS or TIP & TESOS.)

3.2.4 Media (Portable data storage devices)

Please specify numbers in checkboxes! Note: Media are expensive! Please recycle old tapes.

[ ] Exabytes DAT-Tapes: [ ] DDS-3 [ ] DDS-4

DLT-Tapes: [10] DLT-IV (black, for DLT4000 and DLT8000)
[ ] SDLT1-Tape (green, for SDLT320)

[1] LTO-Tapes (800GB uncompressed, 4 x faster than DLT)

[ ] S-VHS Tapes [ ] VHS Tapes

3.2.5 Computational environment

[ ] I need a computer account for

Full Name	User name

If you need dedicated IP-numbers for your own devices, please contact Peter Caligari (cale@kis.uni-freiburg.de, Tel.: ++49-761-3198-220)

3.3 Overview and technical description

[X] We want to make simultaneous measurements with different devices/cameras.

Give an overview and describe your plans, technical remarks, and wishes below:

The same technical setup of the VTT and its 2-D spectroscopic instrument can be used for both proposed research objectives:

- KAOS adaptive optics,
- a mirror to reflect light to the TESOS instrument,
- the TESOS instrument in the intensity mode,
- a dichroic mirror reflecting the G-band light through an interference filter on the DALSA-II camera.