VTF
Visible Tunable Filter

VTF Instrument Performance Calculator (3.3)
User Manual

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Change Log:

Reason for change	Issu	Rev.	Date
Add information about config files	D	1	2017-01-12
Add information about filter change time; correct typos	D	2	2017-June-08
Small corrections; add paragraph on user-defined scan step files; new config file format	1	0	2017-July-03
Add section 6: Trouble shooting	1	1	2017-Oct-10
Modify Sect. 3 "Spectral line settings", for Version 2.2 of the IPC	1	2	2018-Feb-12
New issue to account for BETA version of IPC. Manual contains small corrections here and there; New Fig. 2; Sect. 2: new role of ID window	2	0	2018-Apr-13
Adapt nomenclature to SPEC-0122. Change of work package name – now SW/software	3	0	2018-Dec-11
Include the DHS peak data rate in the GUI	3	1	2019-Feb-13
ROI and binning are now global parameters	3	2	2019-Mar-7

Abbreviations and Acronyms

Abbreviation	
ATST	Advanced Technology Solar Telescope
CWL	Center Wavelength
DKIST	Daniel K. Inouye Solar Telescope (new name of project since Dec. 2013)
FOV	Field of View
FPI	Fabry Perot Interferometer
FWHM	Full Width (at) Half Maximum
IPC	Instrument Performance Calculator
VBI	Visible Broadband Imager
VTF	Visible Tunable Filter

Table of Contents

1. Introduction

The VTF IPC is a software package, written in Java. It allows potential users of the VTF to explore the capabilities of this instrument. The IPC includes all operational modes of the VTF. To facilitate its use, the IPC is structured in different categories. Scientists who are not familiar with the VTF should primarily use the "Default" or "Basic" configurations.

General information about the usage of the VTF IPC:
- After entering a new value, use the TAB key to go to the next field and to refresh all output entries.
- To refresh the Simulated Line Scan, click in the "Central Wavelength" field of the line that you want to be plotted.
- The "File" menu allows to open an existing data set, and to save the present one.
- The "Edit" menu allows to reset all entries to their default values.
- "Help" shows the text part of this document.

Version 2.3 of the IPC was also revised "under the hood" to simplify future upgrades or modifications.
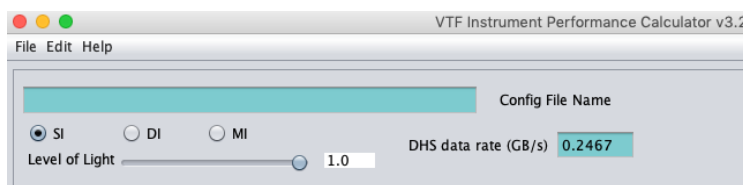
2. Global Parameters

Figure 1: Top part of IPC with the global settings. Data rate is shown per camera. Light level can be varied between 0.0 and 1.0

Config File Name:
This is an output window, which is only used if you read an existing Config.properties file. In that case, the full file name will be displayed in the window.

Instrument mode:
- Polarimetric Imaging (Full Stokes Polarimetric Spectroscopy)
- Doppler Imaging (Intensity Spectroscopy)
- Intensity Imaging (Monochromatic Narrowband Imaging, no spectral scanning)

Light level: Default: 1.0 (Disk center, high solar elevation). This parameter can be used to account for observations at low elevation or outside disk center. Values between 0.0 and 1.0 are possible. The IPC does not know about target positions and therefore cannot provide automatic light-level correction.

The following input fields are located below the plot window:
Number of repeats: This is the number of repetitions of scans of the chosen lines. One repeat is one spectral scan of all chosen lines, including repetitions of individual line scans chosen with "Iterations".

Delay between repeats: This number adds a pause between consecutive cycles to achieve a desired cadence. Only positive values are accepted.

3. Spectral Line Settings

Here are three tabs: **Defaul**t, **Basic**, and **Advanced:**

1. **DEFAULT** refers to the VTF default mode, which is polarimetric imaging, full spatial resolution, SNR of 650 or more, and a cycle time of less than 15 s for photospheric lines. On this tab, all line parameters are preset to optimized values. This is a good entry point for the unexperienced user.
2. **BASIC** is the standard input window of the IPC. Here you can choose the instrument mode, the camera binning and other parameters. Spectral scanning is now possible with critical sampling (=1/2 of the spectral resolution) or 2x undersampling (recommended only in Doppler Mode and for strong lines).
3. **ADVANCED** allows, in addition to "BASIC", to freely define a (e.g., non-equidistant) line scan pattern. Note that not all scan pattern may be supported by the standard VTF data processing pipeline.

In each tab, there are 10 columns to choose spectral lines and line scan parameters. Three of these columns are visible in the GUI, the remaining ones are accessible with the horizontal scroll bar below the line entries.

Line Counter	Line 1	Line 2	Line 3
Line	FeI_630.25	0	0
Scan Mode	blue-red	blue-red	blue-red
Binning	1x1	1x1	1x1
ROI	4096x4096	4096x4096	4096x4096
Central Wavelength (nm)	630.25	0	0
Exposure Time	25.0	25.0	25.0
Steps: Left–Right–Sum	−5 5 11	0 0 0	0 0
Spectral Step (pm)	3.15	0	0
Acquisitions	8	8.0	8.0
SNR	667	0	0
Scan Position (nm)	0.0	0.0	0.0
Iterations	0	0	0
Timing (sec)	12.34	0.0	0.0
Push to Reset Line	RESET	RESET	RESET

Figure 2: Central part of the IPC with the line scan parameters.
Up to 10 spectral lines are possible, 3 of them shown here.

Line: Spectral line to be observed. The list contains those lines, where a prefilter exists. Note that is possible to select the same line in more than one column, with different parameter settings.

Scan Mode: Either unidirectional (red -> blue) or nested (starting at the red end, spiraling inward)

Binning: 1x1, 2x2, or 4x4 is available. If you change the binning for 1x1 to 2x2, the number of accumulations will change to keep the SNR constant. This can be overruled by setting a different number of accumulations (in BASIC or ADVANCED mode). This is a global parameter, valid for all spectral lines.

ROI: Region of interest. At this time, a 4096x4096 ROI is preset (full camera chip). Other centered ROIs which are available: 2048x2048, 1024x1024. This is a global parameter, valid for all spectral lines.

Central Wavelength: Wavelength of chosen spectral line

Exposure Time: 25 ms by default. Shorter times are possible, but frame rate will not increase.

Steps (left - right - sum): Use the two input fields to enter the number of scan step on the left (blue) and on the right (red) side of the nominal line core position. The rightmost output field displays the number of scan steps (Examples: (i) asymmetric scan around line core: (-8, 5, 14), (ii) symmetric scan: (-10, 10, 21). The number of scan steps is N=<abs(left)> + <right> + 1, where the additional point is the line core position. Default settings are symmetric around the line core and chosen to completely include a photospheric line. For chromospheric lines, only the core region is scanned. The useful scan range is mainly limited by the FWHM of the prefilter. The technical limit of the VTF itself is about 1.2 nm. An error message will pop up, if the chosen scan range is larger than ± 0.5xFWHM in default and basic mode. The advanced mode is restricted to ±0.25nm. Non-equidistant scan patterns are possible in ADVANVED mode (see below).

Spectral step width: By default, critical sampling is used, i.e., 2 steps per spectral resolution element, wavelength dependent. In BASIC mode, under-sampling by a factor of 2 is available. In ADVANCED mode, 3-fold under-sampling is possible, in addition, user-defined scan patterns can be entered. The scan range is again limited to ± 0.5xFWHM of the respective pre-filter (advanced mode ±0.25nm).

Acquisitions: In spectropolarimetric mode, a number of repetitions at the same wavelength position and for the same modulation state is needed to reach a certain SNR, or a certain polarimetric accuracy. Changing this number will cause changes in SNR and in cycle time. A value of 8 means that the four polarization states are recorded 8 times at each wavelength point.

SNR: This parameter is linked to the number of accumulations. If the latter is increased, the SNR will also increase (proportional to the square root of the number of accumulations). If the SNR value is changed, the Accumulations will change accordingly. If a very small value for the SNR is entered, the exposure time will go down as well.

Scan position: This is the wavelength, in nm, that is used in INTENSITY mode. For the Na 589.0 line, a "Scan position" of 589.01 will take a monochromatic image in the red wing of the line. This parameter is not active in the other VTF modes.

Iterations: This parameter allows to repeat line scans of the corresponding line within an instrument program that contains several different spectral lines. A value of Zero mean that the line scan will be performed once.

Timing: This is an output value and shows the time needed to complete the spectral line under consideration.

User defined scan steps (ADVANCED only): Here you can enter any scan pattern (in pm, relative to the respective line core) that is compatible with the physical limitations of the instrument:

- Total scan range ≤ 0.5 nm,
- Largest single scan step: 0.1 nm.

The scan positions are entered in a text file. When clicking the corresponding field (once), a default text file opens. You may

(i) edit this file and then save it on your local computer, or
(ii) you may use the "Load Existing File" button to load an already existing file, then press "Apply Loaded Scan Steps", or,
(iii) you press "Reset and Close". This restores the previous scan settings.

Note1: The user defined line scans will be performed in the order given in the text file.
Note2: Value for Binning and ROI is applied to all spectral lines, to avoid camera reconfiguration between line scans.

4. Output & Display

Total Run Time: Time needed to complete the program with all repeats and cycles., given in minutes and seconds. The total run time includes a *Wait Time* of 2.0 s between filter changes. This *Wait Time* becomes only active, when the cycle time per line is shorter than 2 s.

Data Volume: This is the data volume *per camera* in GByte, using 2 bytes per pixel. The grand total depends on the chosen mode (Polarimetric: 3 cameras, Doppler: 2 cameras, Intensity: 1 camera).

DHS data rate: This is the peak data rate per camera, computed for a (fixed) frame time of 34 ms. Full spatial resolution (=*1x1 binning*), together with full frame (=*ROI 4096x4096*) leads to a data rate of 987 MByte/s. Lower values can be achieved by using 2x2 or 4x4 binning and/or a smaller ROI.

The graph shows the chosen line (blue) together with the scan pattern (red squares) and the transmission profile of the corresponding prefilter (green line). To update the graph, click in the "Central wavelength" field of the line to be displayed.

File menu:
"Save ..." will save all settings of the **active tab** (Default, Basic or Advanced) in a text file. A dialog box will open and ask for a folder to store and for a file name <NAME>. Two files will then be written to the specified folder, named ConfigFile_<NAME>, and Config.properties_<NAME>. The file named ConfigFile_<NAME> is formatted for human reading; the Config.properties contains the same information, formatted to be read by the IPC.

"Open ..." will open a previously stored Config.properties_<NAME> file and restore all settings in the corresponding tabs. Existing settings will be overwritten. The file name (and path) will be displayed in the corresponding window of the IPC. Config files based on earlier versions of the IPC (3.1 and below) may not be read properly (some settings could be missing).

5. How to get the IPC

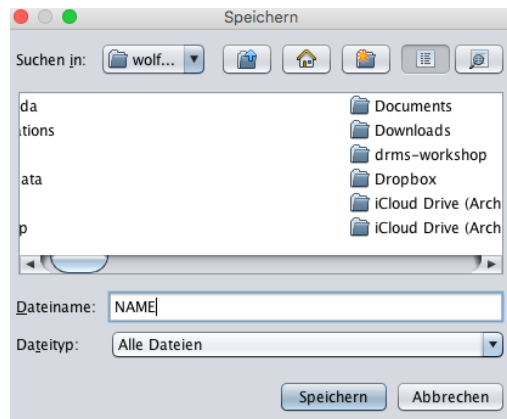The IPC and this manual are found on the following web page:
http://www.leibniz-kis.de/de/projekte/visible-tunable-filter/instrument-performance-calculator/

6. Trouble opening the IPC?

Mac users: If you cannot open the IPC via double click, right-click the icon and choose "Open ...".
Then, enter your admin password to open the IPC. You only have to do this once.