Documentation

CLARIFICATION: Documentation scope will always cover only the newest currently available version of Specvis. I believe it is the best solution assuming, that each new version of Specvis is an upgrade to the previous one.

1. Requirements

Specvis was written in Java with the use of JavaFX8 libraries. Its source code is packed into executable *.jar file and can be run on any operation system, which has its dedicated Java Virtual Machine (JVM). For the most widely used operation systems JVM is delivered with other Java system tools in a form of Java Runtime Environment (JRE). It can be downloaded from the Oracle's website. **Specvis requires installation of the JRE in version 8u40 or above.**

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2. Content of the downloaded package

When one click download button on the Specvis homepage it will download *.zip archive, which contains four files:

- `Specvis.jar`
- `patients.s`
- `screen_luminance_scales.s`
- `conf.s`

`Specvis.jar` is an executable archive file. Depending on the operation system one is using Specvis can be launched in two different ways:

- Simple double click on the `Specvis.jar`
- Type in the command line `java -jar Specvis.jar`

One can also open it as an archive and find there compiled application's source code.

Files `patients.s` and `screen_luminance_scales.s` contains information about patients and screen luminance scales. In order to secure patients data from third person insight Specvis use specific encode-decode system, which ensures fair level of personal information protection.

File `conf.s` serves as a configuration file. By changing values of its variables one can set default settings for Specvis application (Figure 1).

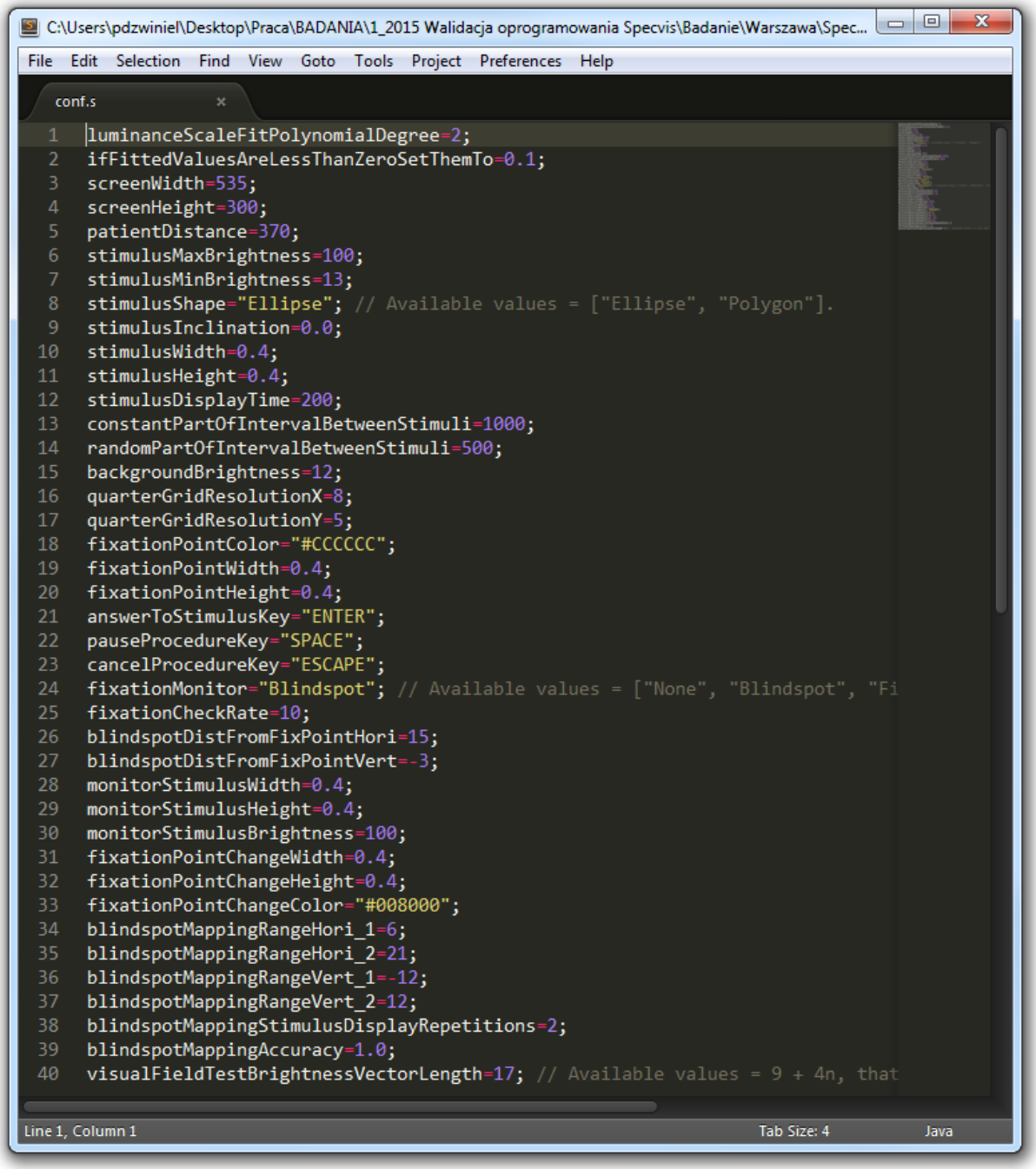

Figure 1. Screen of the opened `conf.s` file.

Below are described some of the less intuitive configuration variables.

- `luminanceScaleFitPolynomialDegree = int x` - based on luminance measurement of six brightness values Specvis creates 101-element vector of "luminance for given brightness" values, which is fitted polynomial curve of a given degree equal to "x". Its default value is set to 2, which is adequate for the exponential nature of the luminance/brightness function.
- `ifFittedValuesAreLessThenZeroSetThemTo = double x` - fitting 101-element curve to the example six luminance measurements, i.e. [0.32, 6.46, 23.33, 55.63, 97.79, 138.90], can result in that first elements of the fitted curve will be negative. Chi-squared goodness of fit statistic demands that observed and expected values are greater than zero. In this case, if first fitted element is negative, and we want to check how good fit is, it is necessary to change value of this element to positive value equal to "x".
- `stimulusMaxBrightness = int x` and `stimulusMinBrightness = int y` - value of those variables specifies maximum and minimum stimulus brightness values (from range 0-100), which are used in the creation of vector of brightness values which will be tested in the procedure.
- `quarterGridResolutionX = int x` and `quarterGridResolutionY = int y` - the result of 2x * 2y gives the number of cells, to which the screen will be divided. Each cell defines the area in center of which stimulus will be presented.
- `fixationMonitor = String x` - value of this variable describes type of the fixation monitor technique. There are three available

values, i.e. "None", "Blindspot" and "Fixation point change".

- `fixationCheckRate = int x` - fixation check rate specify how often Specvis will check fixation of the patient. This variable is used only when `fixationMonitor` value is else than "None".
- `blindspotMappingRangeHori_1 = int xh`, `blindspotMappingRangeHori_2 = int yh`, `blindspotMappingRangeVert_1 = int xv` and `blindspotMappingRangeVert_2 = int yv` - when mapping the blind spot Specvis first checks answers of the patient at the horizontal line on the left or right of the fixation point (depends of the examined eye). In order to reduce the duration of mapping procedure as much as possible Specvis checks only area within "xh" to "yh" degrees from the fixation point. Based on the results of the horizontal check Specvis assess the possible horizontal center of the blindspot. Next, it performs check for the vertical line crossing assessed horizontal center. Vertical area is also ranged, in this case by values "xv" and "yv".
- `blindspotMappingStimulusDisplayRepetitions = int x` and `blindspotMappingAccuracy = double y` - mapping the blind spot consists of displaying stimuli on horizontal and vertical line as described above. The spatial interval between each stimuli is described in degrees by value of "y". In each localization a given stimulus is presented "x" times. The greater value of "x" and the lower value of "y", the higher accuracy of blind spot mapping procedure (but also longer duration of the test).
- `visualFieldTestBrightnessVectorLength = int x` - this parameter describes length of the brightness vector, which is used in visual field testing algorithm. Value of this parameter has to be equal to 9 + 4n, where n has to be 0 or natural number.

One can write comments in `conf.s` file after `;` delimeter (Figure 2). However, comments can be written only in one line. In order to maintain the clarity of the file write comments after `//` comment symbol, eg. `// Batman.`

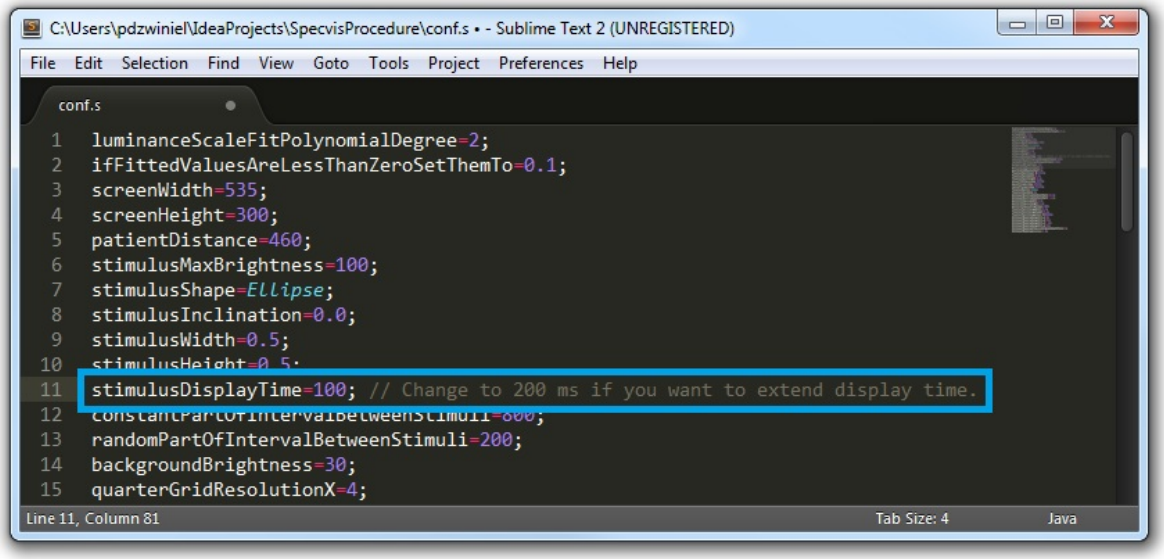

Figure 2. Illustration showing the use of comments in Specvis configuration file.

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3. Application overview

In order to start a new visual field sensitivity testing procedure one has to walk through four steps, in which it is necessary to define information about patient, screen, luminance scale, stimulus, background, fixation point, and fixation monitor technique.

3.1. Step 1/4 - Patient

First window (Figure 3), which will be shown to the user, demands choosing patient for which one want to perform the test, as well as the examined eye. If the patient came to one for the very first time, it is necessary to create its profile by clicking `New patient` and filling fields in newly opened window (Figure 4).

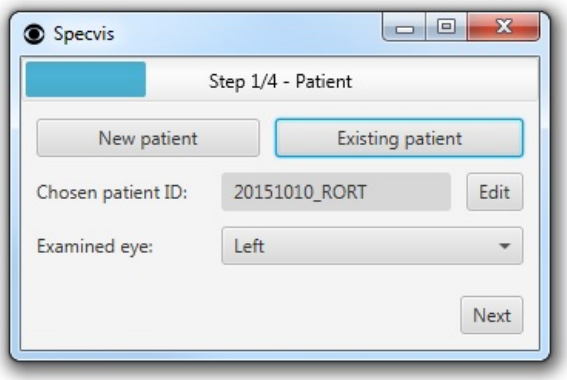

Figure 3. "Step 1/4 - Patient" main window.

One should provide patient basic personal information, as well as giving some aditional information about the patient, which can be expanded in the future.

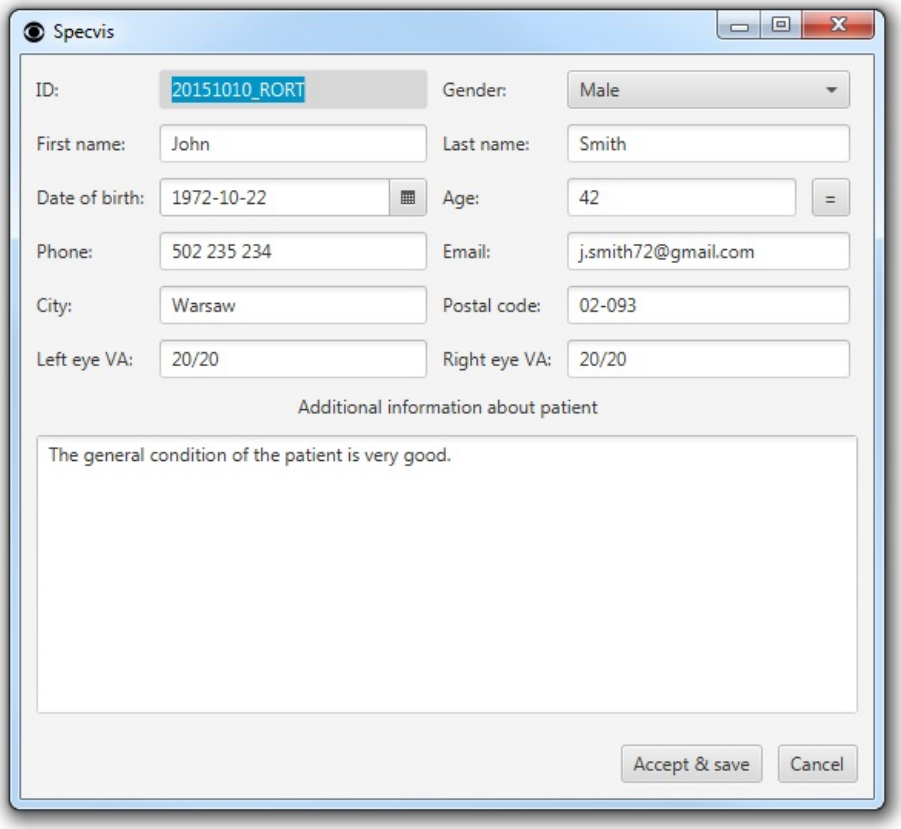

Figure 4. When adding new patient to Specvis, one has to provide its basic personal information. One can also edit already added patient. However, patient's "ID" is unchangeable.

If patient was added to the application before, one can choose it from the list by clicking `Existing patient` button and choosing it from the list (Figure 5). One can also modify patient personal information and add some new additional information by opening patient information window (Figure 4) available at button `Edit`.

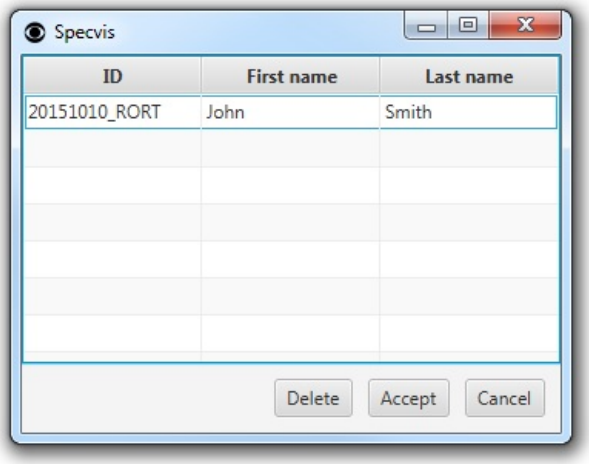

Figure 5. One can choose one of the previously added patients from Specvis simple databse.

Each patient has its own individual ID, which can be described as `yyyyMMdd_xxxx`, where `yyyyMMdd` is the date of patient addition, and `xxxx` is set of random 4 lower- and uppercase alphanumerical characters. All patient data is written in `patients.s` file.

3.2. Step 2/4 - Screen and luminance scale

Second window is divided into two key sections. In the first one (Figure 6) one can choose the screen, on which visual field test will be conducted as well as parameters of the chosen screen and patient distance from it. In the second section (Figure 7), one can create new luminance scale and assign already existing scales for stimulus and for background.

3.2.1. Screen

Screen section allows one to:

- Choose the display, on which visual field test will be held;
- Specify the size of the chosen screen;
- Specify the distance of the patient from the screen;

Based on the aforementioned values Specvis calculates visual field range, which will be tested in the procedure.

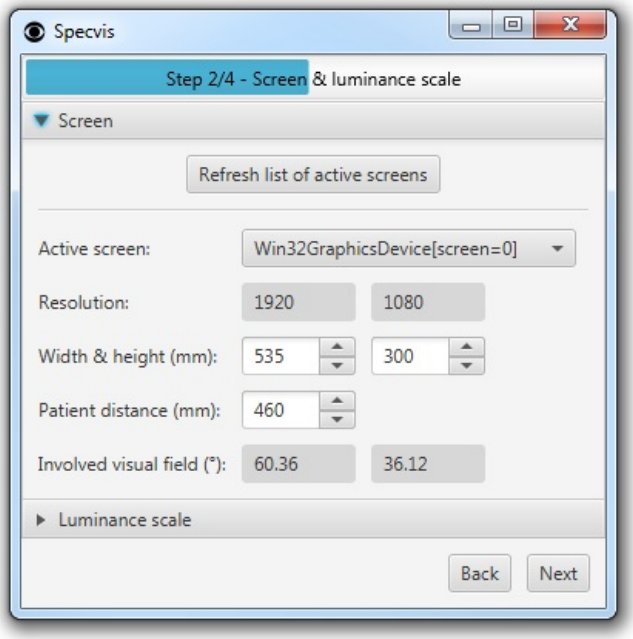

Figure 6. Screen section.

3.2.2. Luminance scale

Luminance scale section allows one to create new luminance scale or choose an existing one and assign different scales for stimulus and for background.

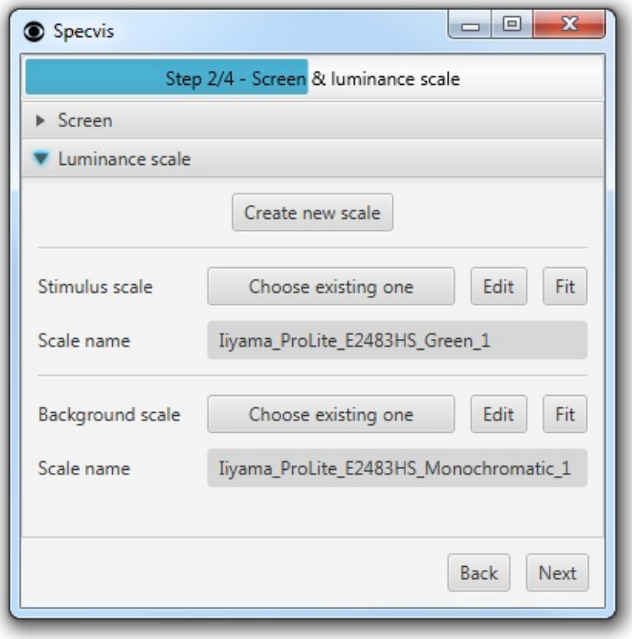

Figure 7. Luminance scale section.

Creation of a new scale available at `Create new scale` button is done by conducting luminance measurement (with the use of a photometer) of six next brightness values, i.e. 0, 20, 40, 60, 80, 100 (Figure 8).

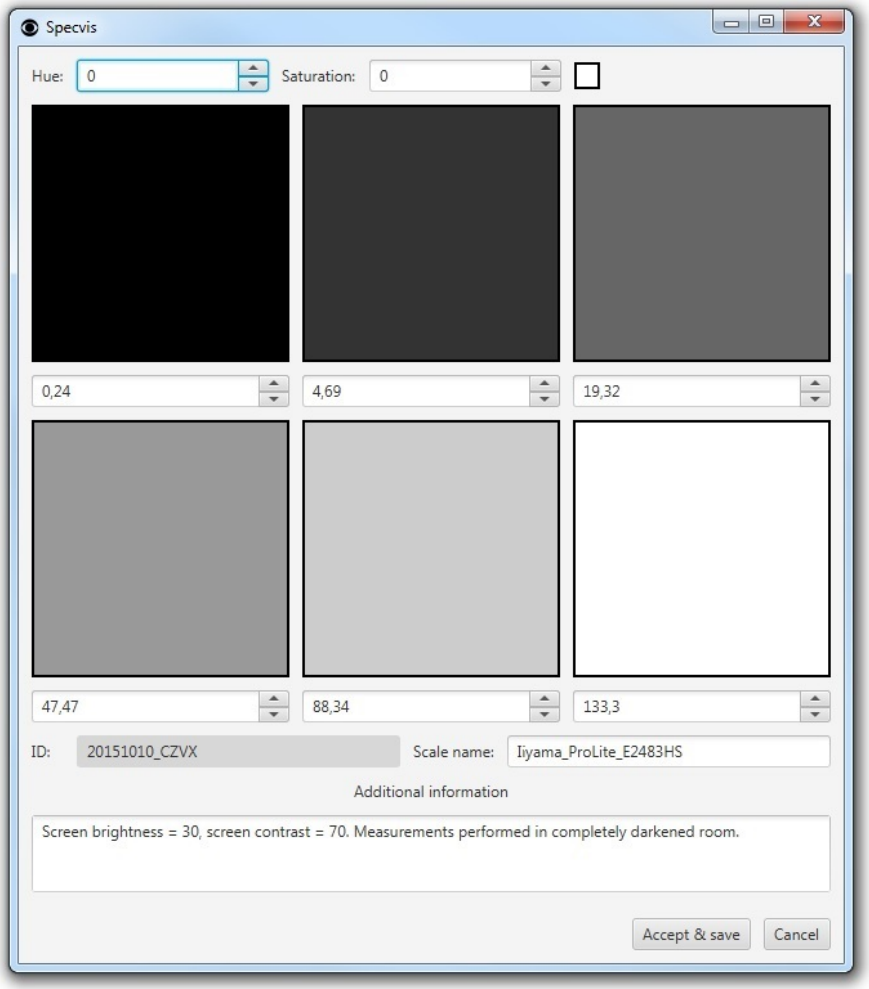

Figure 8. Window with square patterns of different HSB values. One has to measure and provide their luminance expressed in cd/m^2.

Specvis than fits to the measured luminance values polynomial curve of a given degree. This curve is a new luminance scale, which can be used by Specvis in the procedure of testing visual field sensitivity of the patient. Each fit has its goodnes of fit statistics expressed by chi-squared critical value and its p-value, as well as standard deviation. The closer p-value is to 1.0, the better fit is. One can check goodness of fit via `Fit` button (Figure 9).

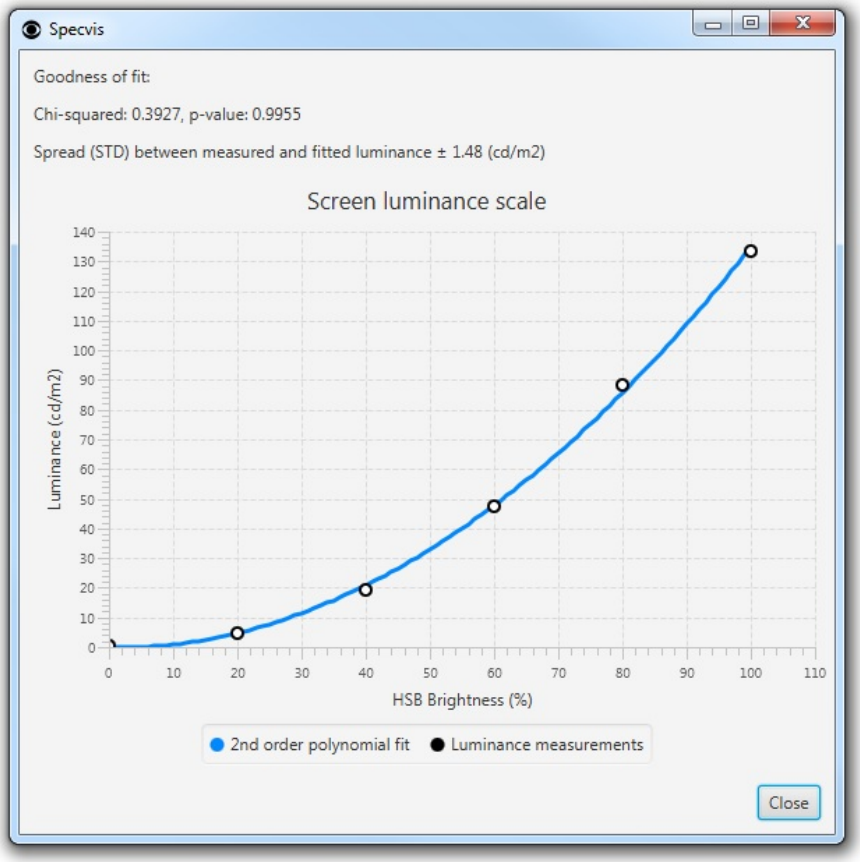

Figure 9. Goodness of fit window.

When one had already created luminance scale (or scales) for chosen screen, it is now possible to choose appropriate one for stimulus and for background by clicking `Choose existing one` buttons and selecting desired scale from the list. One can also edit chosen scale by clicking `Edit` button. All luminance scales data is written in `screen_luminance_scales.s` file.

IMPORTANT: It is crucial to perform luminance measurements in completely darkened room.

INFO: Specvis has some "built-in" luminance scales created for Iiyama ProLite E2483HS screen and various HSB values. Luminance measurements was performed with the use of manual photometer Konica Minolta LS-100.

3.3. Step 3/4 - Stimulus and background

In this window (Figure 10) one can define properties of the testing stimulus and background.

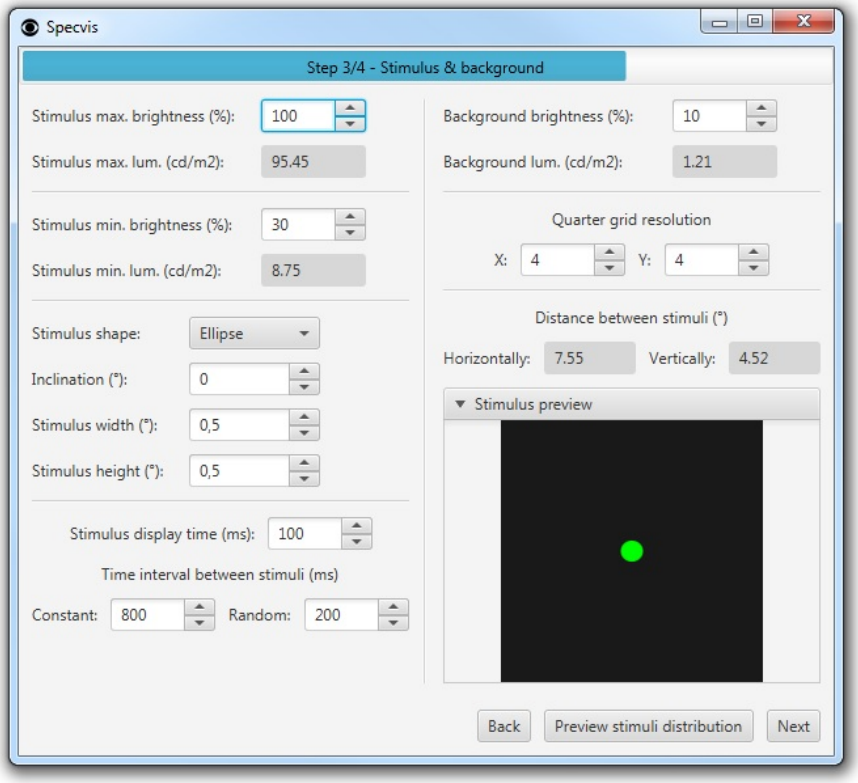

Figure 10. "Step 3/4 - Stimulus and background" window.

At this step one can also preview procedure stimuli distribution across the chosen screen by clicking `Preview stimuli distribution` button (Figure 11).

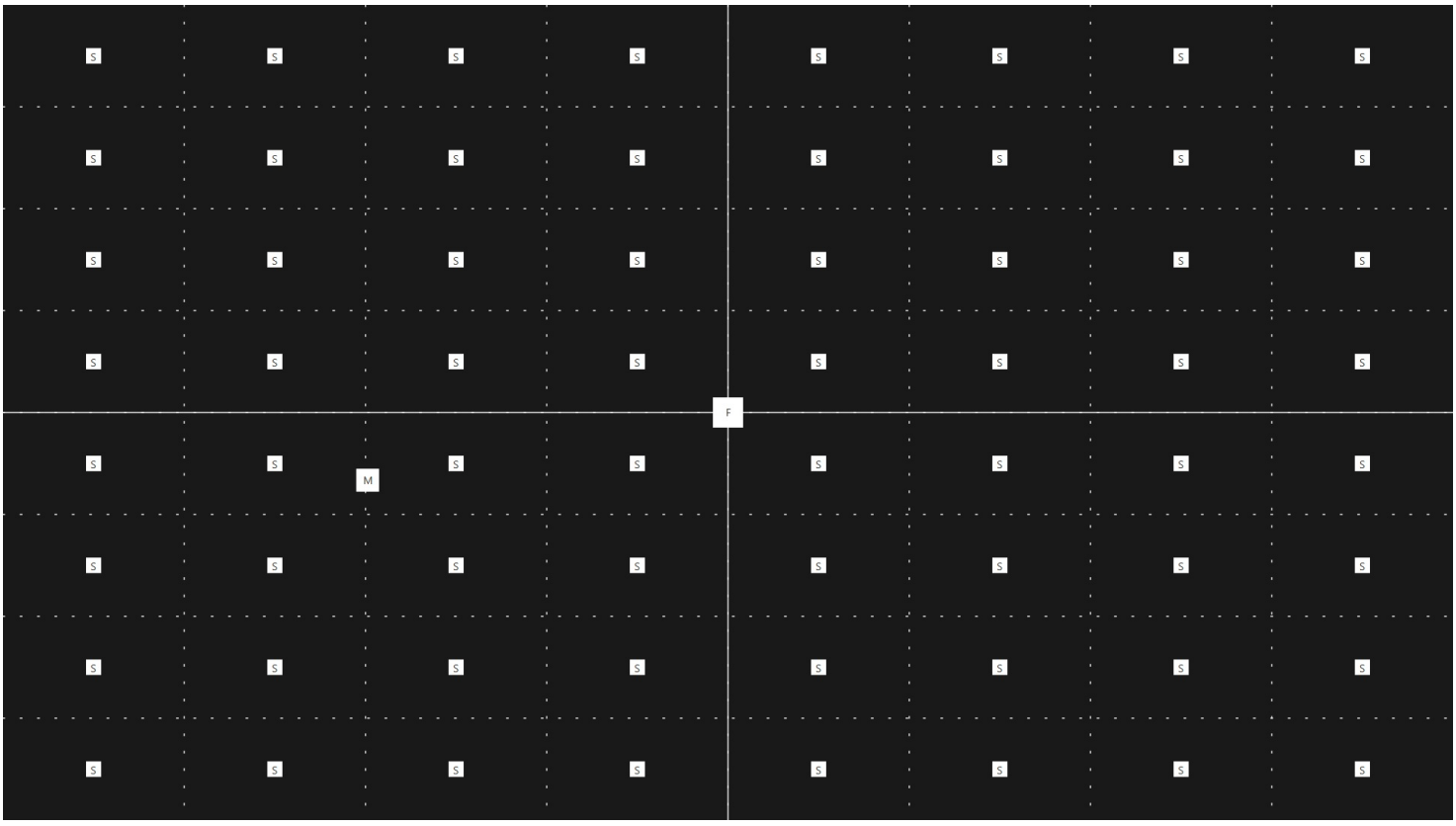

Figure 11. Stimuli distribution preview.

3.4. Step 4/4 - Fixation and other

"Fixation and other" is the last step before one can start a testing procedure (Figure 12 and 13). Here one can set fixation point characteristics and configure keys for the procedure. Here one can also choose fixation monitor technique and define its properties. In properties panel of fixation monitor "Blindspot" one can also start mapping blind spot procedure by clicking `Map blindspot` button.

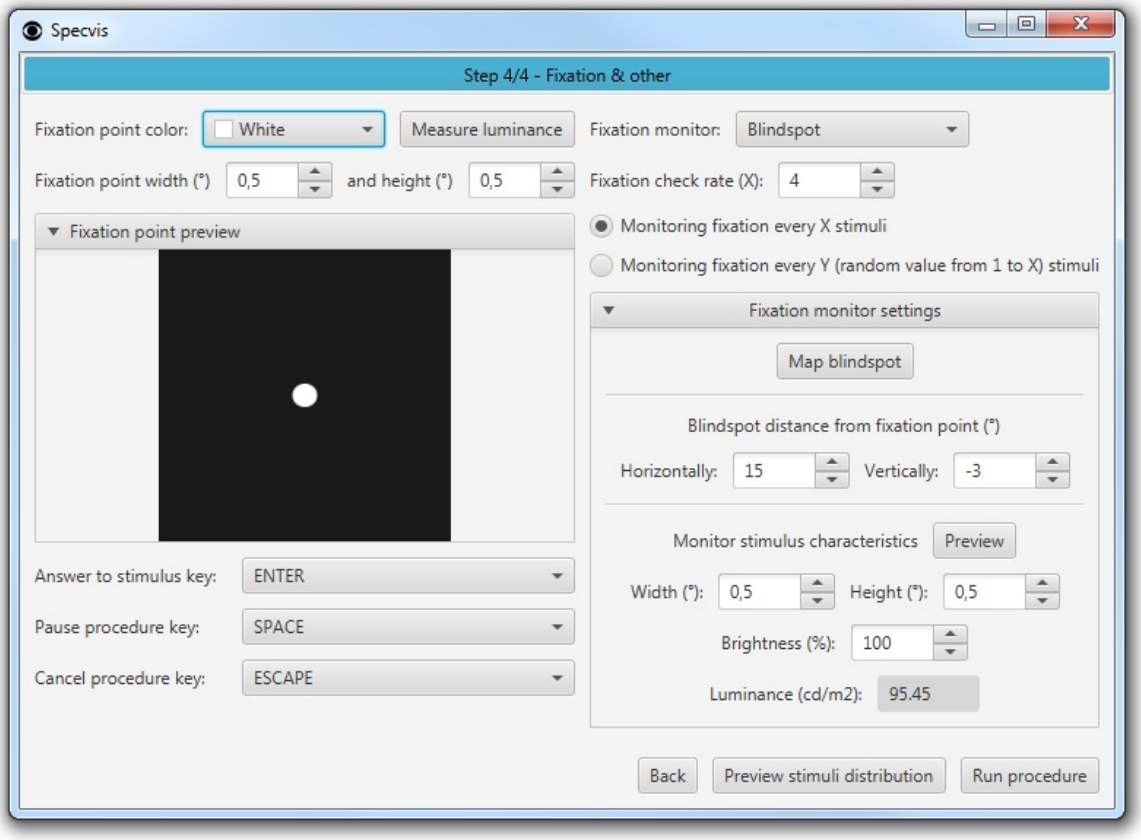

Figure 12. "Step 4/4 - Fixation & other" window.

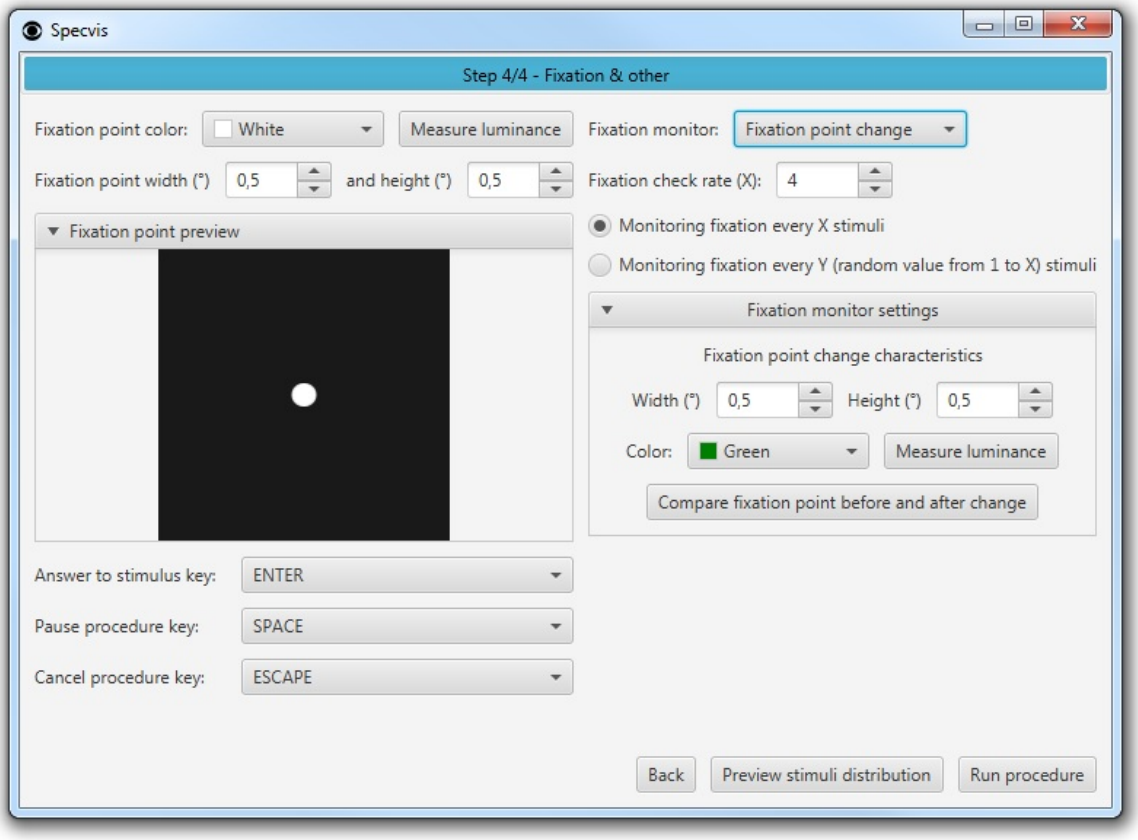

Figure 13. "Step 4/4 - Fixation & other" window.

3.5. Mapping blind spot

The blind spot of the human eye is located (in reference to the fovea) about 15° temporally and 3° below the horizontal line, and is roughly 7.5° high and 5.5° wide. Specvis allows to test blind spot position individually for each patient. In mapping blind spot procedure Specvis first map answers of the patient to stimuli displayed on the horizontal line segment between `H1` and `H2` (see Figure 14 - `FP` stands for fixation point). Based on the patient answers Specvis assess horizontal center of the blind spot, i.e. `centerX`. Next, Specvis map answers of the patient to stimuli displayed on the vertical line segment between `V1` and `V2`, which crosses `centerX` point. Finally, based on the patient answers Specvis assess vertical center of the blind spot.

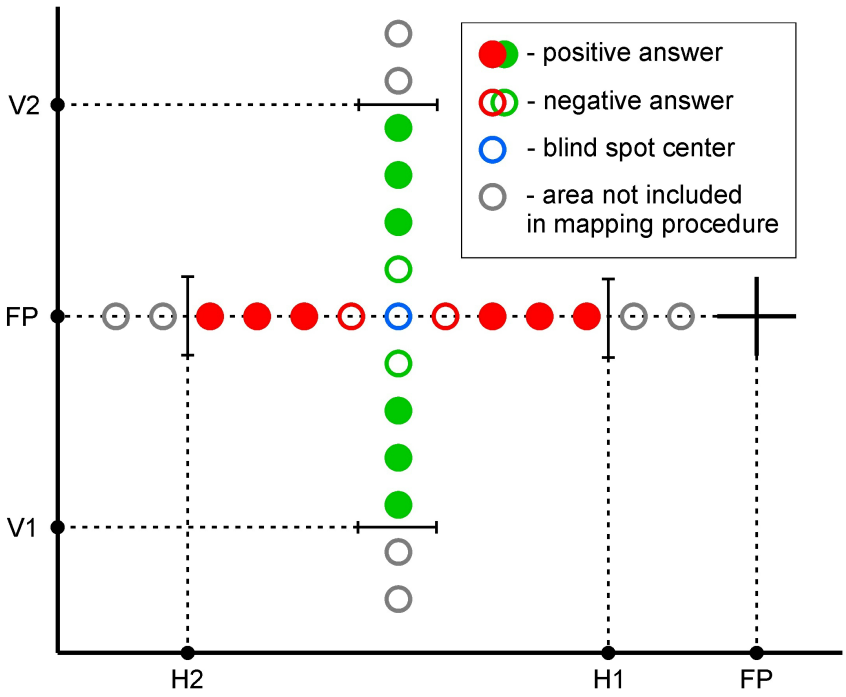

Figure 14. Mapping blind spot procedure scheme.

Horizontal and vertical ranges represented above by `H1`, `H2`, `V1` and `V2`, can be changed by manipulating chosen variables in `conf.s` file, i.e. `blindspotMappingRangeHori_1`, `blindspotMappingRangeHori_2`, `blindspotMappingRangeVert_1` and `blindspotMappingRangeVert_2`. By default values of those variables are set respectively to 6, 21, -12 and 12.

How many times the patient will need to respond to the presentation of stimulus in a given location depends on the value of `blindspotMappingStimulusDisplayRepetitions` variable in `conf.s` file. In the same file one can also change spatial interval between stimuli by setting value of `blindspotMappingAccuracy` variable. In default values of those variables are set respectively to 2 and 1.0.

Horizontal and vertical center of the blind spot is set respectively in default to 15° from the fixation point and 3° below the horizontal line. One can change those values by setting `blindspotDistFromFixPointHori` and `blindspotDistFromFixPointVert` variables in `conf.s` file.

3.6. Estimating visual field sensitivity

Each procedure consists of presenting stimuli in random order in predefined locations, i.e. "cells". Each location is used for stimulus display until Specvis determines the brightness value at which the patient does not perceive it in a given location. In practice, Specvis creates a vector of `n` equally spaced brightness values from range defined by minimum and maximum stimulus brightness. Value of `n` is equal to `visualFieldTestBrightnessVectorLength`. The first stimulus display for a given location is done for brightness value taken from the middle of the aforementioned vector. Values for subsequent stimulus displays depend on patient's answers (Figure 15).

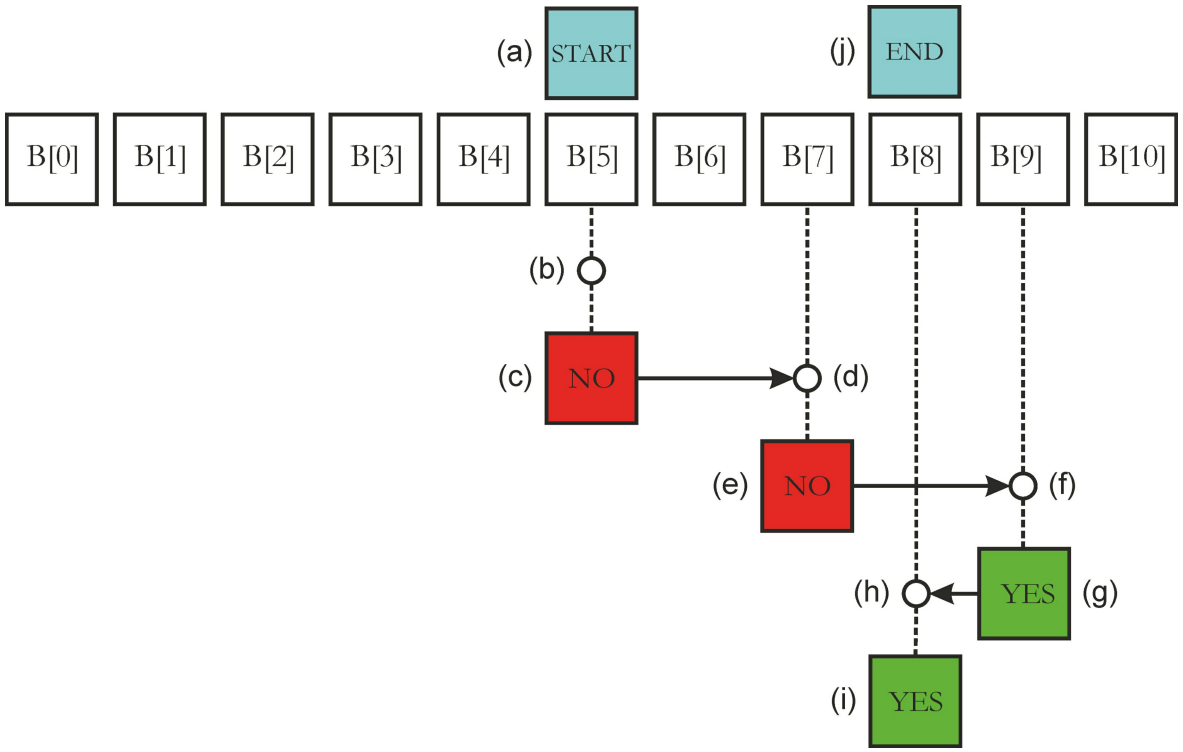

Figure 15. The procedure scheme for determining the brightness threshold for a given cell of the tested visual field. During initialization of the visual field test Specvis creates a vector of `n` equally spaced brightness values from range defined by minimum stimulus brightness (B[0]) and maximum stimulus brightness (B[11]). Resulting vector values are used as a scale in the procedure of estimating the brightness threshold for a given cell of the tested visual field. Example estimation of the brightness threshold can looks as follows: (a) beginning of the test; (b) display the stimulus of brightness value equal to B[5] element; (c) the patient responds negatively to the stimulus; (d) display the stimulus of brightness value equal to B[5+2=7] element; (e) the patient responds negatively to the stimulus; (f) display the stimulus of brightness value equal to B[7+2=9] element; (g) the patient responds correctly to the stimulus; (h) display the stimulus of brightness value equal to B[9-1=8] element; (i) the patient responds correctly to the stimulus; (j) the brightness threshold is equal to B[8] element.

IMPORTANT: It is crucial for patient to maintain fixation on the fixation point. Otherwise, results may be corrupted and it will be necessary to repeat the test. Hence, it is strongly recommended to use one of the Specvis fixation monitor techniques for checking patient's fixation and based on its results decide if test should be repeated.

```
RESULTS (FIXATION MONITOR)
Total fixation checks:  90
Positive fixation checks:       41
Fixation accuracy rate (%):     45.56
```

3.7. Session shell window

After hitting `Run procedure` button in "Step 4/4 - Fixation and other" window, one will see a special session window, which helds all information about settings, progress and results of the currently started testing procedure (Figure 16). It is worth mentioning, that one can see this window only if procedure is running on the additional second screen. When procedure is finished, one can next open window with results expressed in a form of graphical visual field sensitivity map (Figure 17). In this case one has to choose appropriate option from "Session" menu. One can also save session window content in a *.txt file.

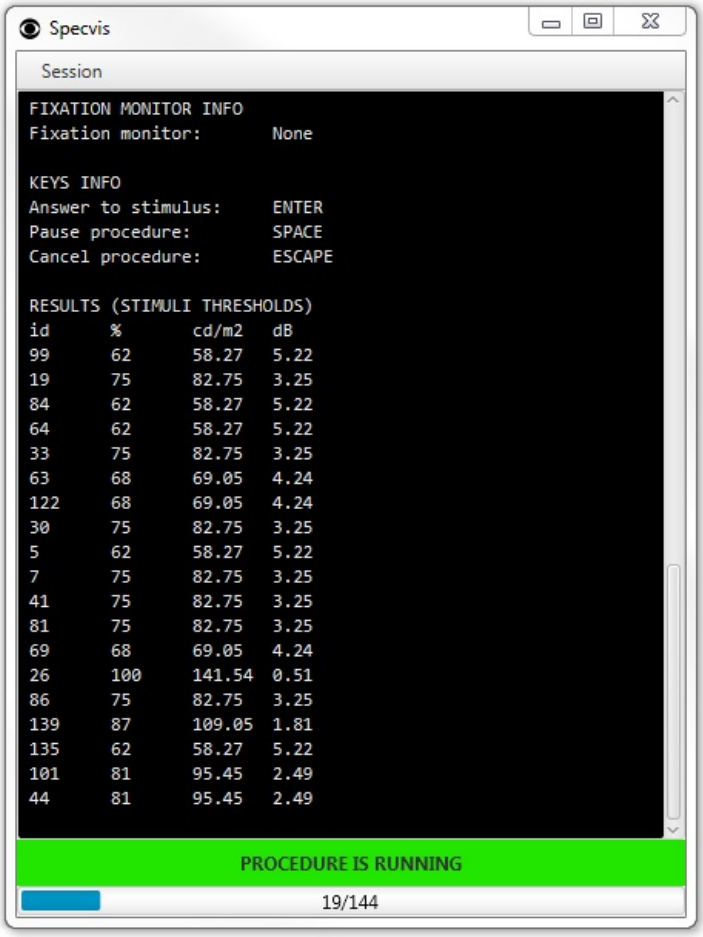

Figure 16. Session shell window during the procedure run.

3.8. Visual field map

The most important part of the testing procedure are its results. Beside their numerical form available at "Session shell window", their can be also expressed in much more friendly fashion, i.e. as visual field sensitivity graphical map. User can switch between its three available scales: (i) brightness scale (%); (ii) luminance scale(cd/m2); (iii) decibel scale (dB). It is also possible to turn off graphical representation of the results so there are shown only numerical values or vice versa. One can also save map as *.jpg file.

9.97	2.49	2.49	5.22	2.49	2.49	2.49	3.25	8.04	2.49	2.49	13.69
4.24	2.49	8.04	6.59	3.25	0.51	4.24	6.59	1.81	3.25	2.49	4.24
2.49	5.22	13.69	5.22	2.49	0.51	2.49	1.08	9.97	5.22	13.69	2.49
9.97	5.22	5.22	6.59	13.69	3.25	3.25	4.24	3.25	2.49	3.25	9.97
8.04	5.22	13.69	5.22	0.51	6.59	5.22	9.97	2.49	2.49	3.25	0.51
0.51	2.49	8.04	9.97	2.49	4.24	5.22	3.25	5.22	4.24	13.69	13.69
5.22	13.69	3.25	4.24	9.97	5.22	6.59	3.25	3.25	2.49	4.24	13.69
9.97	5.22	5.22	8.04	3.25	0.51	0.51	8.04	0.51	0.51	2.49	5.22
4.24	4.24	2.49	6.59	3.25	8.04	13.69	8.04	4.24	8.04	8.04	13.69
8.04	6.59	1.81	5.22	13.69	8.04	5.22	3.25	2.49	2.49	2.49	1.08
13.69	13.69	3.25	6.59	0.51	3.25	9.97	3.25	3.25	13.69	5.22	5.22
4.24	2.49	13.69	2.49	9.97	0.51	1.81	2.49	3.25	9.97	1.81	3.25

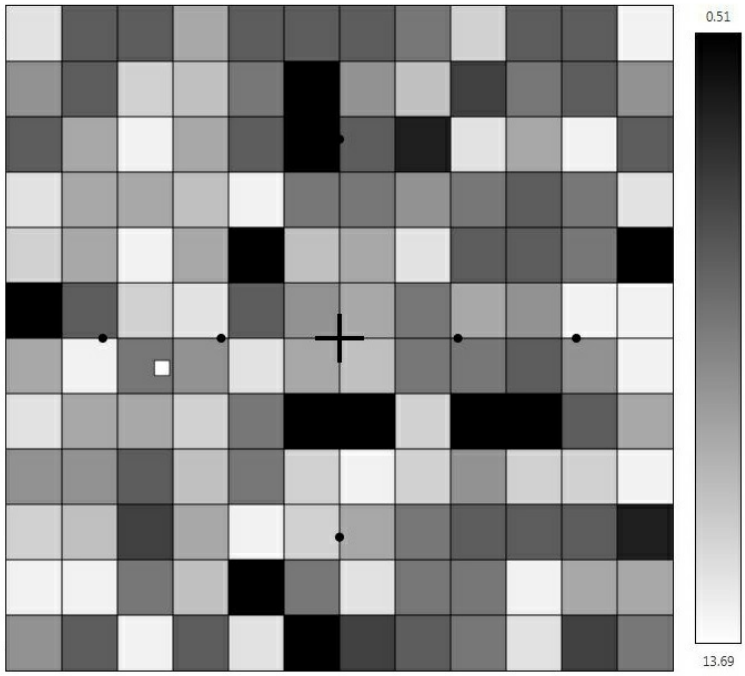

Figure 17. Visual field sensitivity graphical maps.

INFO: Decibel (dB) scale used by Specvis is assessed with the use of maximum luminance of the chosen luminance scale L_{Ref} and luminance of the background L_B. In order to express visual field sensitivity threshold for a given location L_T previously expressed in cd/m^2 one must calculate $10*\log_{10}(L_{Ref}/(L_T-L_B))$. The possibility to express results of the test in dB scale makes Specvis an interesting supplement for such professional techniques as automated static perimetry.