

AIMTRACE User Manual V 1.1

In the following, we would like to provide you with practical instructions for operating our AIMTRACE aiming trace system, so that you get as much enjoyment and success as possible from using the system and are able to identify and resolve any problems yourself.

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I. Components & functions:

As a first step, it is advisable to become familiar with the components of the system and their basic functions:

1. Sensor head: This contains all measuring systems. It should be mounted on the gun as rigidly as possible and largely parallel to the barrel axis. The optics should be focused to the corresponding target distance using the lens adjustment (i.e. for live fire, to the distance of the relevant event; for dry-fire training, to the distance of the correspondingly scaled target; Note: you can customise scaled targets on the AIMTRACE website). The line of sight between the sensor head and the target should be unobstructed and the lens should be clean.

2. Mount: The mount provides a rigid connection between the sensor head and the gun. It can be fitted in a few simple steps and is reproducible when re-used. Different versions are available depending on the gun: e.g. with a clamp on the air cylinder (various plastic inserts are available depending on the manufacturer) or using various rails. Depending on the version and the distance between the barrel axis and the optical axis of the system, the mount also includes adjustment screws for the vertical and, where applicable, horizontal alignment of the sensor head. Note: Like any mount, the AIMTRACE sensor head mount is sensitive to pressure and impact, so rough handling or careless setting down of the gun can cause misalignment and incorrect localisation of the aiming trace and the shot.

3. Computing unit: This performs all of the data processing and provides the Wi-Fi connection to your device. You can use any Wi-Fi-enabled device equipped with a web browser (e.g. tablet, laptop, mobile phone, ...) to configure the AIMTRACE system within a few minutes, display results and export sessions. The computing unit is connected via USB cable to the sensor head and to the power supply (e.g. USB-C power adapter or a suitable power bank). Note: The computing unit starts automatically as soon as the power supply is connected. To ensure that the computing unit correctly detects the sensor head, the sensor head should be connected to the computing unit before the power supply is connected. The computing unit should normally be switched off using the “Quit” button in the web application (see below).

4. Software: Once you have connected your device to the computing unit via Wi-Fi, you can launch the web application for configuring and calibrating the system and for displaying results in your browser and use it intuitively. After the computing unit has started, it may take a moment until the AIMTRACE Wi-Fi network appears in the Wi-Fi list of your device and you can select it (a typical network name would be “aimtrace_001”; the network password is provided separately). After selecting the network and logging in, it again takes a short moment until the web application can be opened in the browser at the address **192.168.50.1:5010** (enter it in the address bar, if necessary preceded by http://). Note: Please be aware that your device may no longer have Internet access while it is connected to the AIMTRACE Wi-Fi network.

II. Web application

In the following, we describe how the web application basically works, going through the program menus page by page. Note: As the software is continuously being developed, individual points may differ and new features may be added; however, the software is designed so intuitively that you will easily find your way around.

1. “Configuration”

Configuration is required on the one hand to define the framework of the planned session (e.g. selection of the event, details of the shooter) and on the other hand to adapt the system to the gun and the local conditions (e.g. actual distance to the target, trigger characteristics, lighting conditions). Fig. 1 shows the configuration page.

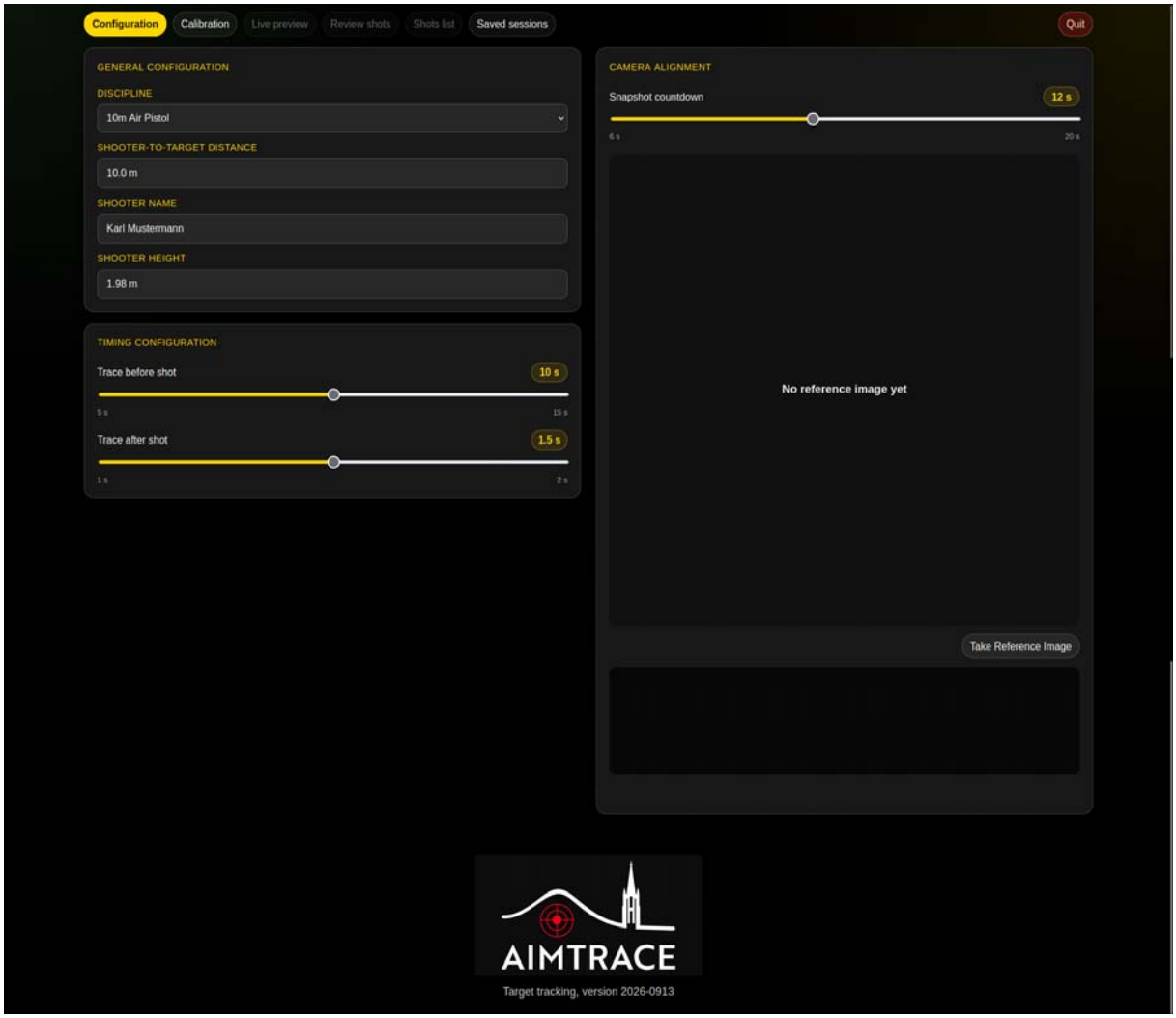

Figure 1: Configuration page

To configure the system, please proceed as follows:

General settings:

In the left part of the window, first select the planned event (currently available: air pistol or air rifle, 10 m each), to be shot either live or dry. Then enter the actual distance to the target (i.e. for live fire, the usual distance; for dry-fire training, the distance between the shooting position and the scaled target). Please add the name of the shooter (required for any data export) and their height (in metres). Note: Entering the actual distance and the height enables a correction, implemented in the AIMTRACE system, for the different distances from the shooter and from the sensor head to the target. This significantly improves measurement accuracy, especially at short distances or in dry-fire training.

In addition, the sliders allow you to choose how long the aiming trace is displayed before (5 to 15 seconds) and after (follow-through; 1 to 2 seconds) the shot.

Connecting the sensor head:

In this step, please check that the camera is working correctly, that the image is sharp and that the camera is correctly aligned (hardware), and adjust if necessary. To do this, take a “snapshot” of the camera image at the moment the shot is released:

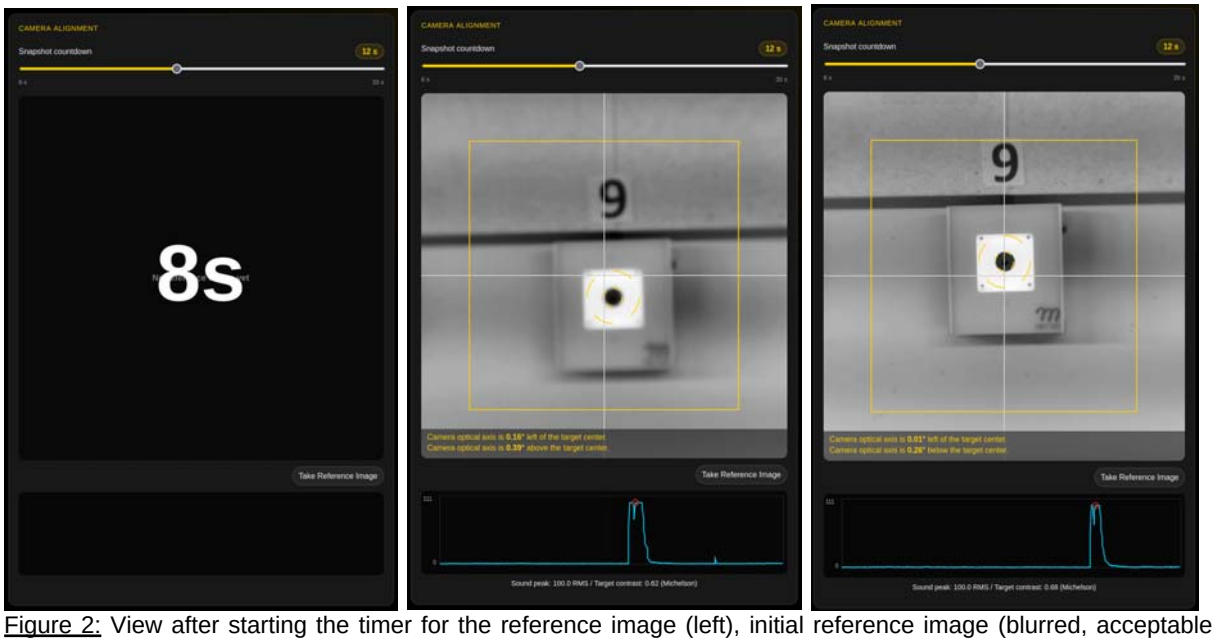

Figure 2: View after starting the timer for the reference image (left), initial reference image (blurred, acceptable alignment of the system's optical axis; centre), reference image after adjustment (sharp, good alignment; right)

Start the timer by clicking the “Take Reference Image” button (see Fig. 2 left) and bring the gun into the aiming area as usual. During the last 5 seconds of the countdown, the display flashes red. Please release the shot in the aiming area within this time window. The display then shows the camera image of the target (Fig. 2 centre and right), which allows you to check the image quality and the alignment of the camera. If required, you can adjust the duration of the countdown (see slider at the top of Fig. 2).

The reference image should be free of interference and show your target sharply. If this is not the case, focus and/or clean the optics, or make sure the target is sufficiently illuminated.

The centre of the image corresponds to the optical axis of the system; it is marked by a white crosshair (Fig. 2). Please make sure that your target lies completely within the area of the image marked in yellow and that the white crosshair is as close as possible to, or within, the target (black area of the target, i.e. the black aiming area). Correct detection of the target is indicated by a yellow circle around the black aiming area and the outermost ring. Note: The system only records movements within the area marked in yellow. If the target lies outside or at the edge of this field of view, the system will not work properly.

When mounted on a fixed rail, the correct (hardware) alignment described above should be achieved provided the mount is fitted properly. When mounted with a clamp on the air cylinder or on an adjustable rail, please watch out for unwanted tilting or asymmetric tightening of the screws and, if necessary, adjust the optical axis using the vertical and horizontal adjustment screws (if available). Note: Please familiarise yourself beforehand with how the sensor head tilts when the relevant adjustment screw is turned in or out; the image of your target then moves in the opposite direction within the optical field of view.

Please repeat taking the reference image until the optics are correctly set and the system is correctly aligned (hardware) (see the example in Fig. 2, compare centre and right).

Taking the “snapshot” also serves to determine the contrast setting for target detection and to capture the moment of shot release of the gun. This requires you to perform this capture under the actual conditions of the subsequent session (i.e. correct event, distance, dry/live fire, lighting conditions). Note: The “snapshot” does not require an exact shot in the centre of the target. However, as the “snapshot” is used for a pre-calibration of the position, a good shot makes the subsequent calibration easier (see below).

Pressing the “Quit” button (top right in Fig. 1; likewise on other pages) closes the software and shuts down the computing unit (visible from the LED on the computing unit changing from green to red). The current settings are saved automatically and are therefore available again on the next start. A running session is only saved if recording (see below) was active at that moment.

2. “Calibration”

In the next step, you perform the software calibration of the system. To do this, fire at least 1, ideally 3–5 calibration shots (i.e. live shots or, in dry-fire training, dry clicks).

While in live fire you can determine the actual position of the shots immediately (e.g. electronic scoring target, paper target, ...), in dry-fire training you have to rely on your call (i.e. the average position of your dry shots should correspond to the centre of the target). Please note that the sensor head has a finite acquisition speed, so that fast movements during shot release can lead to deviations between the actual shot position and the one displayed by AIMTRACE (“shake”). Please therefore make sure to release the shot as calmly as possible with optimal follow-through. In dry-fire training in particular, care should also be taken to release the shot as precisely as possible on target, since for a calibration without comparison with the actual shot positions it is assumed that the centre of the group coincides with the centre of the target.

Note: The “snapshot” taken during configuration (see above under 1.) only serves as an initial, rough pre-calibration of the centre. Depending on how accurately the “snapshot” was shot, the pre-calibrated centre may be more or less off-centre. So do not be confused if shots that were obviously well executed – and, in live fire, possibly also central – appear outside the centre of the shot display on the calibration page. The subsequent computational calibration serves precisely to correct this deviation.

After firing the calibration shots, you perform the actual calibration by pressing the “Center group automatically” or “Correct from ground truth” button (see Fig. 3). For this step, you can tick only those shots that meet the above requirements.

Two typical scenarios are described below:

Scenario A: dry-fire training. Fig. 3 shows the calibration page after 4 calibration shots in dry-fire training.

In the shooter's perception, shots 1, 3 and 4 were fired calmly, well centred and with good follow-through. The tight group confirms this impression, while the deviation of the group from the centre of the target is due to the calibration not yet having been performed (the “snapshot” mentioned above was probably a high nine). The 2nd shot was subjectively “jerked”, so it is excluded from the subsequent calibration (Fig. 4).

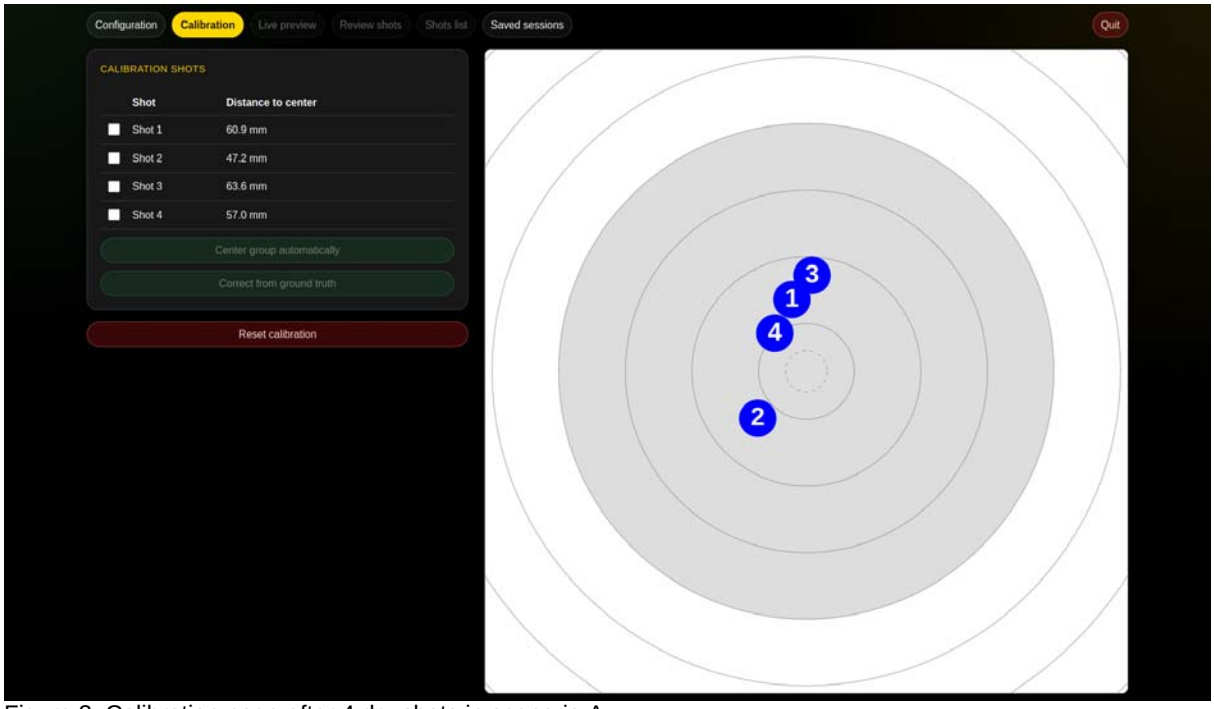

Figure 3: Calibration page after 4 dry shots in scenario A

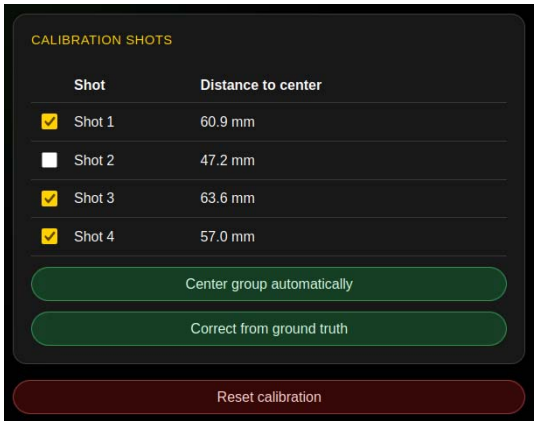

Figure 4: Selection of calibration shots 1, 3 and 4 in scenario A

The subsequent automatic calibration (click on “Center group automatically”) calculates and applies the calibration. The shot display then shows the calibrated shot positions (Fig. 5; in line with the shooter's impression, the centre of the group of shots 1, 3 and 4 now coincides with the centre of the target).

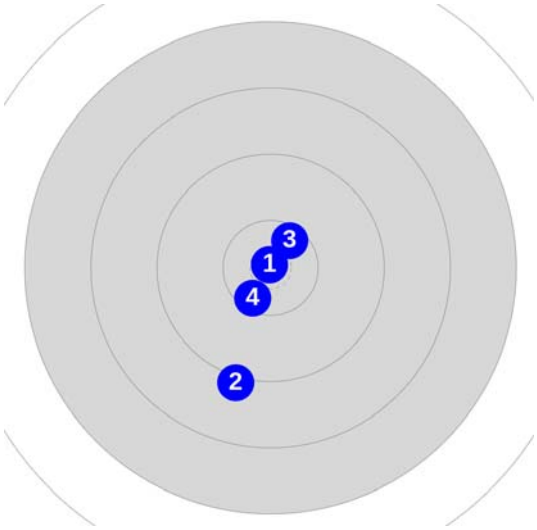

Figure 5: Shot positions after calibration in scenario A

The system is now calibrated and the dry-fire training session can begin (see following pages).

Note: For the automatic calibration, it is not necessary for all calibration shots to be in the centre. Only the centre of the group should lie in the centre, which is usually the case as the number of shots increases.

Scenario B: live fire. Fig. 6 shows the calibration page after 3 calibration shots in live-fire training.

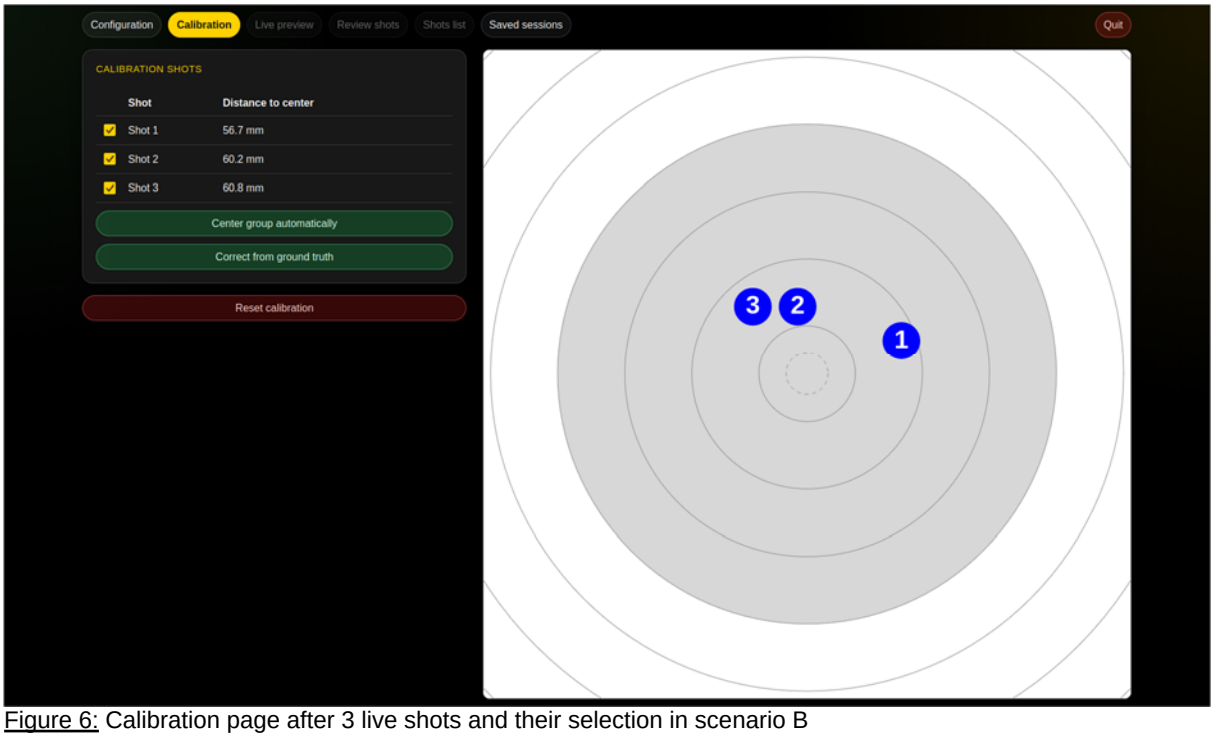

Figure 6: Calibration page after 3 live shots and their selection in scenario B

In the shooter's perception, the shots were fired calmly with good follow-through, although the call was not clean. In live fire, it is possible to read the exact shot positions immediately (e.g. electronic scoring target, paper target, …), so that, unlike in dry fire, no assumption about the shot positions has to be made (the call is therefore not decisive). In this case, all shots can be selected (see Fig. 6 left) and the calibration performed on the basis of the true shot positions.

To do this, first click the “Correct from ground truth” button and then, in the correct order, click on the actual positions of your calibration shots in the displayed target with the cursor or via the touchscreen of your device. The system then centres the shot pattern of the calibration shots on the actual shot pattern you entered (both shot patterns are displayed) (Fig. 7).

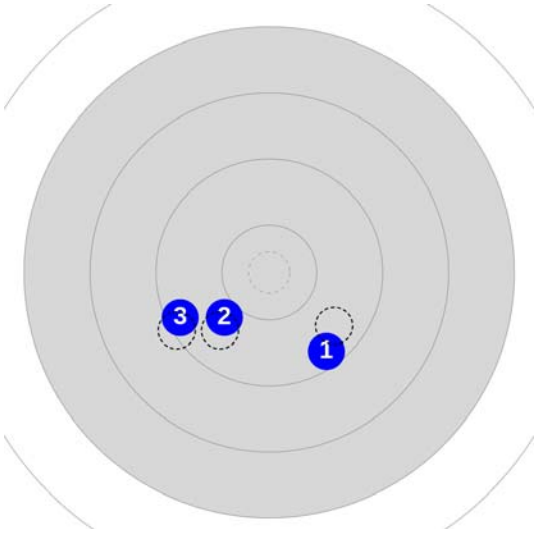

Figure 7: Shot positions (blue) after manual calibration. For this, the centre of the calibration shots was placed on the centre of the manually entered actual shot positions (dashed).

The system is now calibrated and the session can begin (see following pages).

Pressing the “Reset calibration” button resets the calibration (the settings made under 1. Configuration are retained).

3. “Live preview”

The “Live preview” function (Fig. 8) allows quasi-real-time tracking of the aiming and shooting process. This is particularly attractive for observation by third parties in training or in competition.

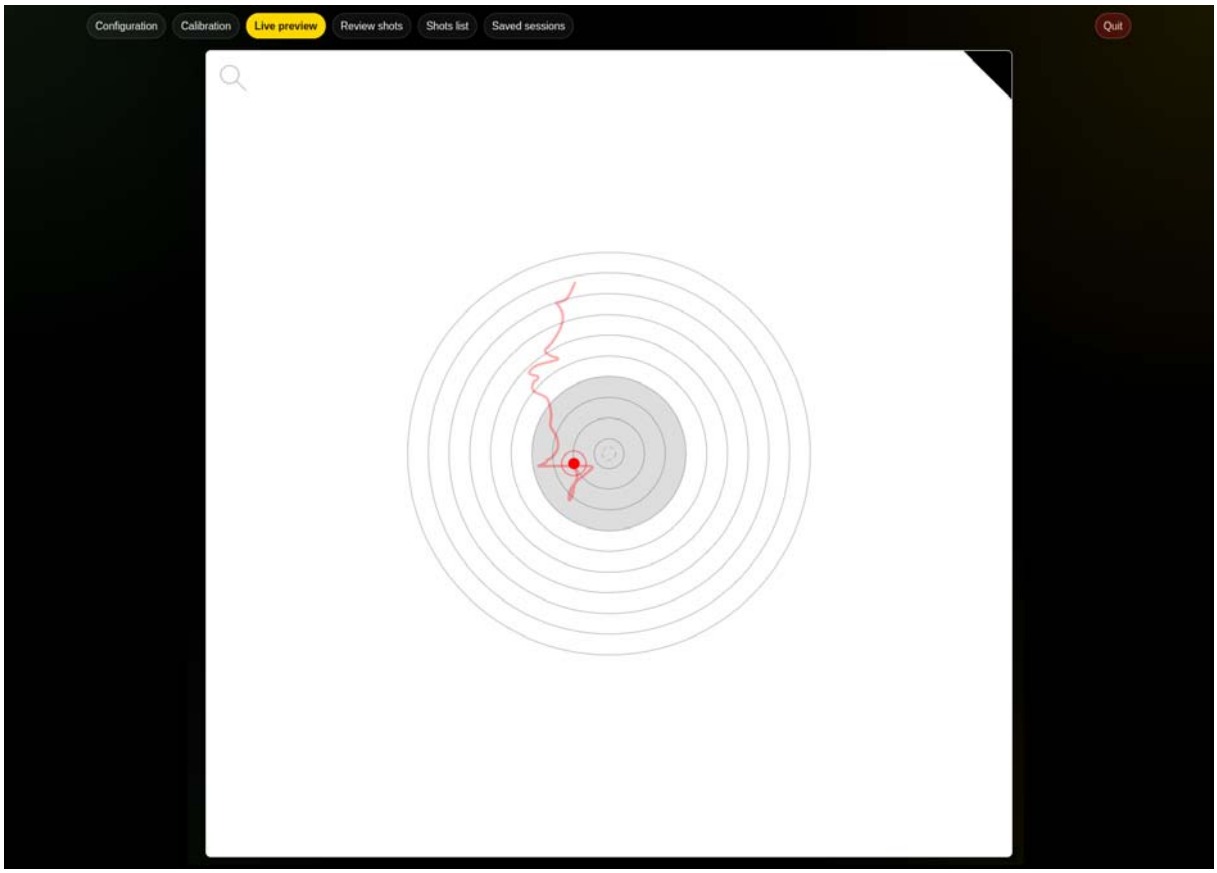

Figure 8: “Live preview” page

The display (Fig. 8) shows the current aiming position (red dot; if within the active field of view of the camera), the preceding aiming trace (red line; maximum duration 5 seconds) and – after the shot – the shot position (Fig. 9: blue dot).

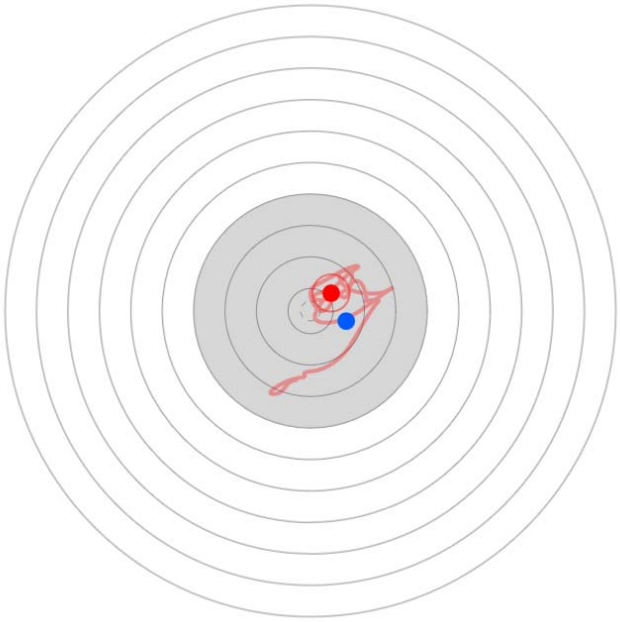

Figure 9: Aiming trace (red) and shot position (blue).

Clicking on the black triangle (“sighting target”) in the upper right corner of the target (see Fig. 8) starts recording the session (indicated by a red REC in the upper right corner of the target).

Clicking on the magnifying glass icon in the upper left corner of the target (see Fig. 8) allows you to adjust the display size.

4. “Review shots”

The “Review shots” function is the core application for the online analysis of individual shots, both live and dry (Fig. 10).

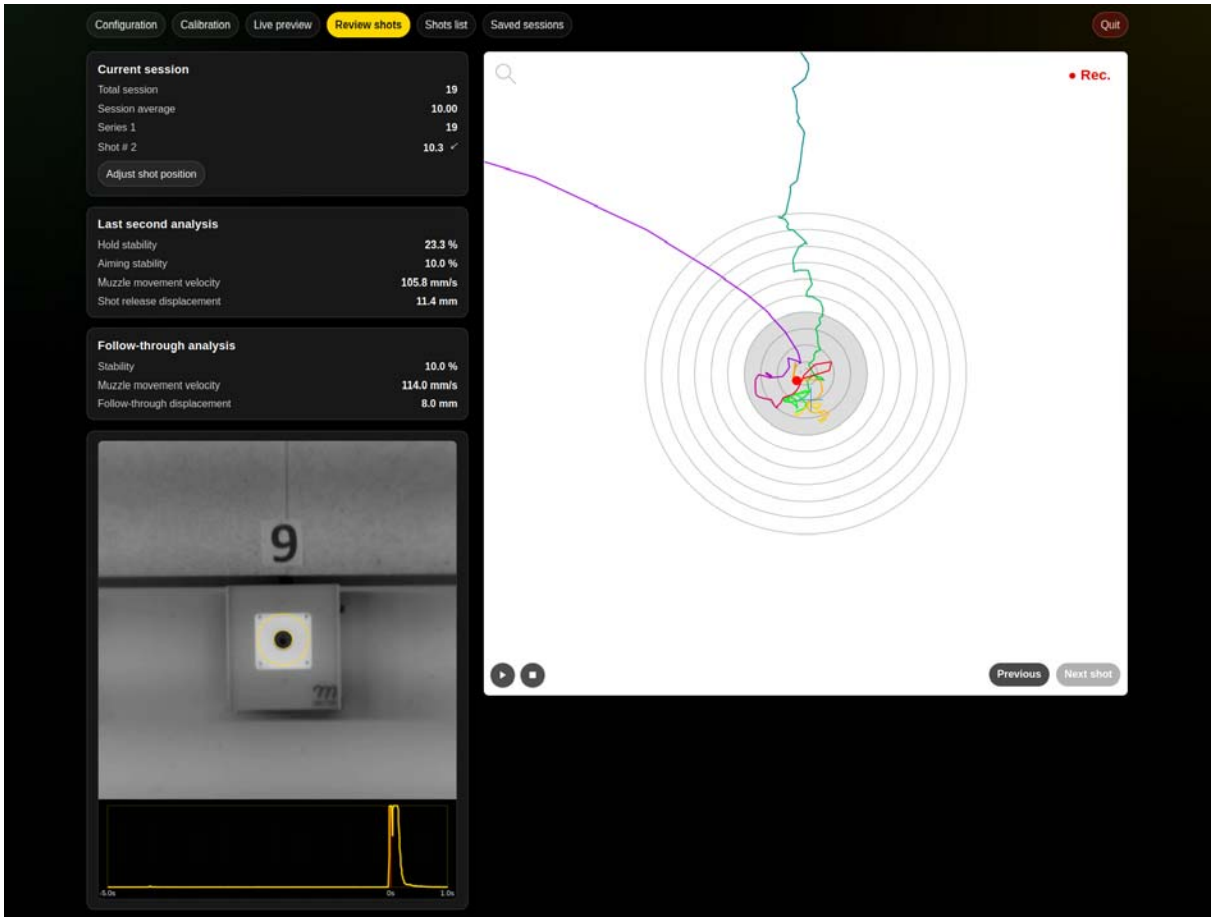

Figure 10: “Review shots” page

After each shot, the graphical target display shows the aiming trace and the shot position. The aiming trace over the last 5–15 seconds before the shot and 1–2 seconds (adjustable in the configuration) after the shot is colour-coded (Fig. 10):

- Blue → green: Approach before the shot / early aiming phase,
- Yellow: Last second before the shot / final aiming phase,
- Red → violet: Follow-through after the shot,
- Blue cross: Centre of the movement in the last second before the shot.

By clicking the “Play”/“Pause” and “Stop” buttons in the lower left corner of the target, the aiming trace can be shown in full, stopped or played back dynamically.

The “Previous” and “Next” buttons scroll to the previous or next shot (Fig. 10).

Recording of a session is started and the display size adjusted as described above (click on the black triangle/“sighting target” or the magnifying glass icon) (see Fig. 10 and 11).

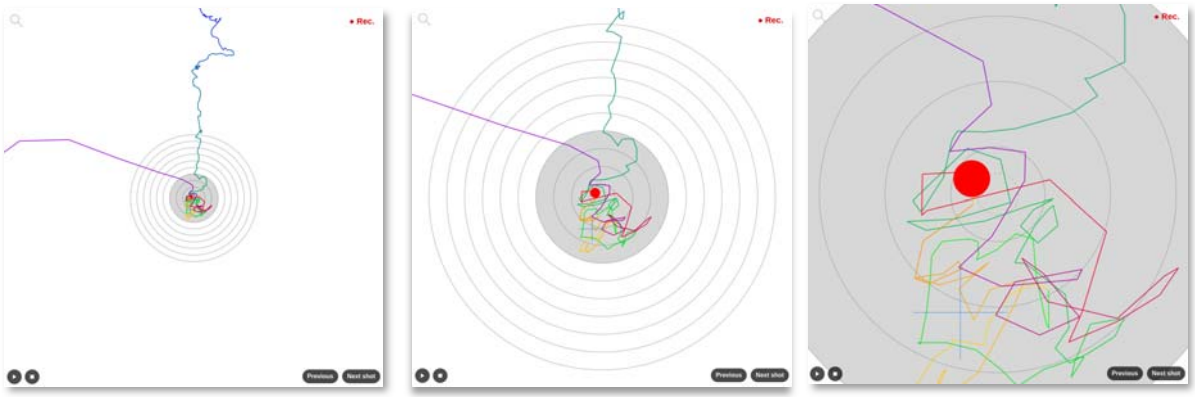

Figure 11: Display of the aiming trace, complete and unzoomed (left), slightly zoomed and focused on the initial movement (centre), and strongly zoomed and focused on the shot (right)

The result of individual shots, the current series and the entire session (incl. average score) is shown in the results field at the top left (Fig. 12).



Figure 12: Display of the current series and session score, and of the button for subsequent correction of the calibration.

In this field, the “Adjust shot position” button also makes it possible to adjust the calibration of the system afterwards.

This can be useful if, after a few shots, you notice a systematic deviation between your call or the actual shot position and the shot position displayed by AIMTRACE (e.g. because the calibration is suboptimal or the mount has been knocked out of alignment by rough handling). This adjustment is applied to the current and all subsequent shots. Note: Like the gun and the ammunition used, the AIMTRACE system has a limited precision. The size of the individual error components is subject to statistical variation, so correcting the calibration on the basis of individual shots is not recommended. Systematic errors can be identified most reliably over a series of shots (group of 3–5 shots).

In addition to the score, the middle and lower output fields on the left show detailed analyses of the final aiming phase (last second before the shot; Fig. 13 top) and of the follow-through (Fig. 13 bottom).

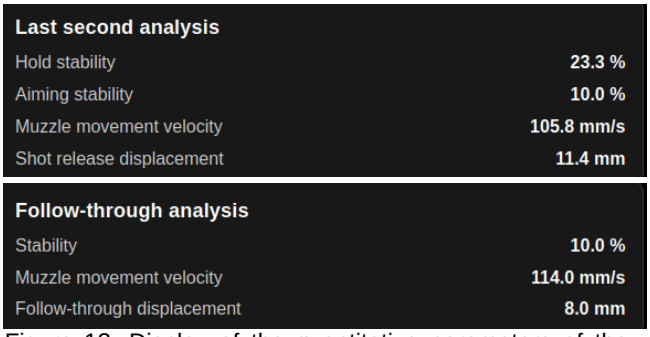

Figure 13: Display of the quantitative parameters of the final aiming trace in the last second before the shot (top) and in the follow-through phase (1 second; bottom).

Final aiming phase:

- "Hold stability": percentage of measurements in the last second that lie within an imaginary 10-ring zone around your own aiming centre (this parameter indicates how compact the hold area is).
- "Aiming stability": percentage of measurements in the last second that lie within the actual 10-ring zone (this parameter indicates how precise the hold area is).
- "Muzzle movement velocity": average speed of movement of the aiming point (on the target) in the last second before the shot (mm/s) (this parameter indicates how steady the aiming is).
- "Shot release displacement": distance between the aiming centre in the last second and the shot position (in mm) (this parameter indicates by how many millimetres the shot deviates from the aiming centre, e.g. due to poor trigger release).

Follow-through phase:

- "Stability": percentage of measurements in the first second after the shot that lie within an imaginary 10-ring zone around the shot position (this parameter indicates how compact the follow-through is).
- "Muzzle movement velocity": average speed of movement of the aiming point (on the target) in the first second after the shot (mm/s) (this parameter indicates how steady the follow-through is).
- "Follow through displacement": distance between the shot position and the centre of the follow-through in the first second after the shot (in mm) (this parameter indicates by how many millimetres the follow-through deviates from the shot position).

For quality control, the image at the bottom left of the "Review shots" page shows the camera image at the moment of the shot (Fig. 14).

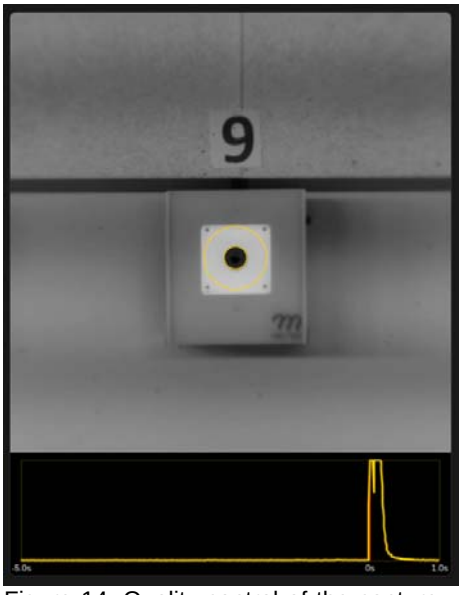

Figure 14: Quality control of the capture at the moment of the shot

5. “Shot list”

The “Shot list” page summarises the shots fired so far and also lists them individually: on the one hand aggregated for the 10-shot series and the entire session, on the other hand for individual shots in tabular and graphical form (Fig. 15).

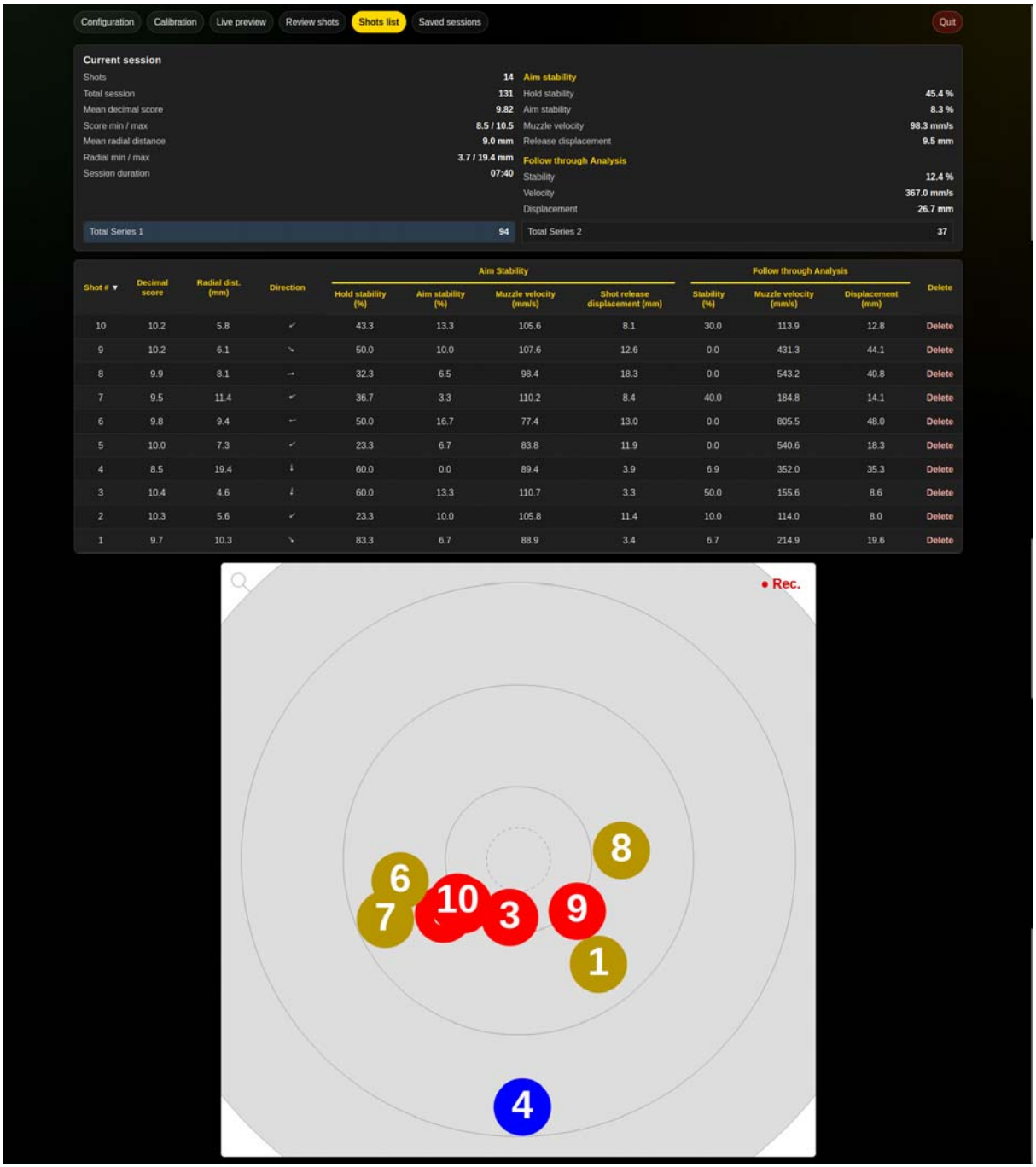

Figure 15: “Shot list” page. Here the completed first series has been selected, so that it is displayed in full in tabular and graphical form.

The values “Score min/max”, “Mean radial distance”, “Radial min/max” and “Session duration” refer to the session and indicate the minimum/maximum score, the mean distance from the centre, the minimum/maximum distance from the centre and the duration of the session, respectively.

The other parameters correspond to the parameters defined in the previous section.

Clicking on the 10-shot series shown in the lower part (Fig. 16) displays the detailed results of the respective series in the table (Fig. 17) and the shot positions in the graphical display (Fig. 18).

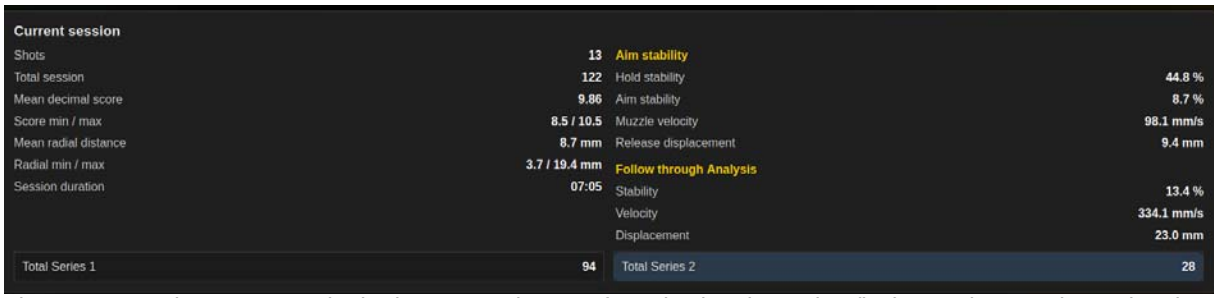

Figure 16: Session summary; in the lower part, buttons for selecting the series (incl. score). Here the 2nd series, still in progress, has been selected (bottom right)



Shot #	Decimal score	Radial dist. (mm)	Direction	Aim Stability				Follow through Analysis			Delete
				Hold stability (%)	Aim stability (%)	Muzzle velocity (mm/s)	Shot release displacement (mm)	Stability (%)	Muzzle velocity (mm/s)	Displacement (mm)	
13	9.3	12.8	↓	26.7	3.3	85.7	3.4	0.0	512.3	23.8	Delete
12	9.9	8.1	↘	53.3	20.0	103.2	8.2	16.7	184.7	14.3	Delete
11	10.5	3.7	↖	40.0	3.3	108.5	16.3	13.3	190.9	11.7	Delete

Figure 17: Table of the detailed parameters of the selected 2nd series, still in progress.

In the table, individual shots can be selected by clicking and deleted if required.

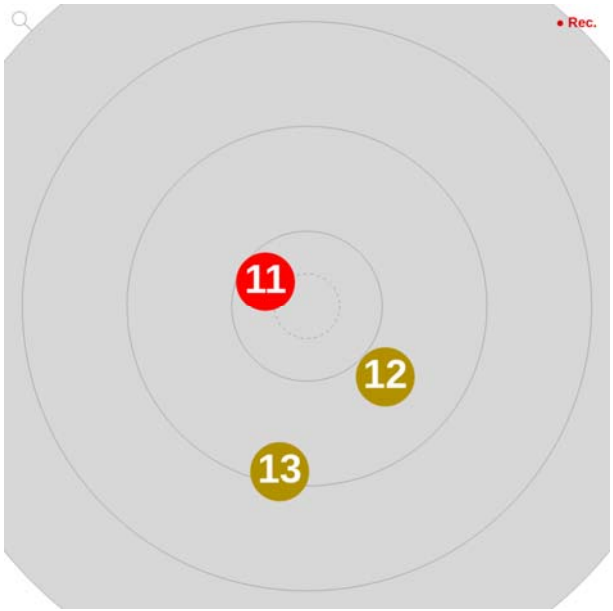

Figure 18: Graphical display of the shot positions of the selected 2nd series, still in progress.

Note: Please be aware that this information can currently only be viewed until the moment of saving. After that, the exported AIMTRACE data can be opened and viewed on the AIMTRACE website.

6. “Saved sessions”

This page displays all saved sessions. If required, the data can be exported (e.g. for viewing and further processing on the AIMTRACE website) or deleted (Fig. 19).

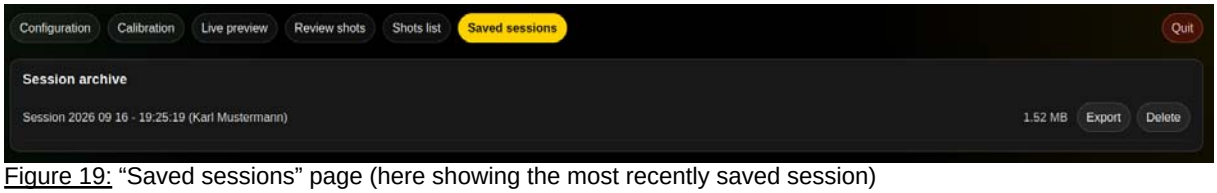

Figure 19: “Saved sessions” page (here showing the most recently saved session)

Note: To avoid data loss, data are saved continuously during recording, so that they should still be available even if a session is interrupted for technical reasons (e.g. switching off without properly ending the session, power failure).

III. Frequently asked questions (FAQ)

- *During configuration, despite a correct "dry click" in the aiming area, no "snapshot" is displayed or the target is not correctly detected.*

  This can have several causes. Please therefore check the following points systematically and correct them if necessary:

  - ➢ correct selection of the event,
  - ➢ use of the correctly scaled target,
  - ➢ correct entry of the actual distance to the target,
  - ➢ correct entry of the height (“.” as decimal separator),
  - ➢ correct focus setting of the optics (target should be sharp),
  - ➢ correct alignment of the optics, so that the target lies completely within the measuring field of the system (area of the image marked in yellow),
  - ➢ sufficient acoustic coupling of the sensor head to the gun (tighten the clamp firmly, do not place felt or similar underneath; you can assess the quality of the acoustic peak in the graph below the “snapshot” display; it should be clearly recognisable, as shown in Fig. 2, and stand out clearly from the background).

  If these measures have not resulted in correct detection, please connect the sensor head to a suitable device (e.g. laptop, PC, …) using the USB cable and check that the camera and the microphone are working.

IV. Contact



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