

Manual for Installation and Calibration

Version 1.5 2025/01

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1. Introduction

RyngDyng by Archery Analytics supports archers by autonomously detecting arrows hitting the target. All arrow positions will be measured accurately and stored in a database, together with other useful information such as bow tuning parameters, weather conditions, etc.. Thus, all data will be available for later analysis.

High performance digital cameras and advanced image processing algorithms similar to those used in artificial intelligence applications deliver a high accuracy in a live environment.

RyngDyng is an easy to handle and highly autonomous system. Archers can perform their training or participate in tournaments without being bothered with complex calibration procedures and pressing buttons or other interactions with the running system.

2. Preparation

In most situations, the system will be operated and controlled by the RyngDyng App. In professional tournaments you can also use the tournament management software [I@nseo](#). Furthermore, the professional edition of the [Artemis app](#) offers the possibility to record arrows with RyngDyng.

In this document, we describe how to control RyngDyng using the free RyngDyng App by Archery Analytics. The detailed manual for this app is available using this link:

https://www.archery-analytics.com/en/public/support/app_manual

The RyngDyng App is a web based app that can run on any device with a modern browser (Android, iOS, PC, Mac, Linux ...). The app is installed by entering the following link into the browser:

https://www.archery-electronics.com/static/app_coach/index.html



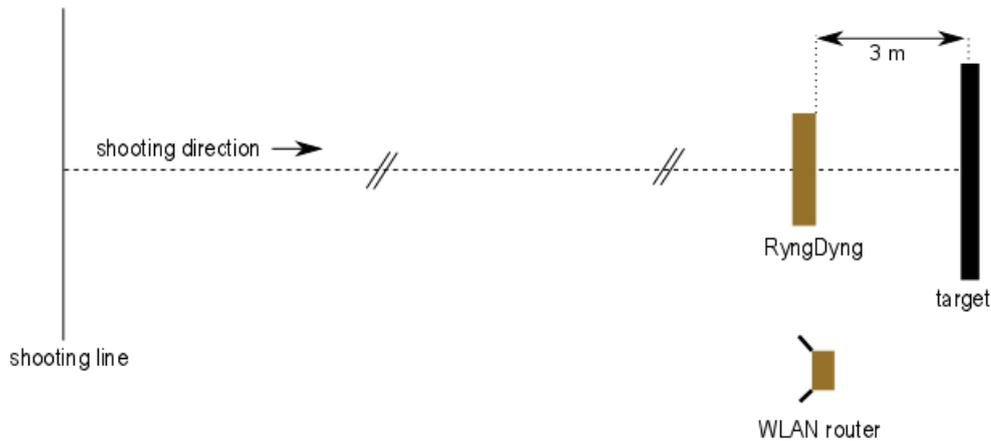
Alternatively, you can scan the QR code to the right to read the URL.

At least one archer should be created in the app and linked to the server account so that recorded hits can be assigned to the archer and saved in the server into the personal account. Instructions are available here: [Manual on Registration and Activation](#)

3. RyngDyng Position

There is no need to have a very accurate positioning of RyngDyng relative to the target. It is good enough to have a distance of **300 ± 5 cm** from the foot-point of the center of the target to the front of the RyngDyng case. This distance is about the same as three times the length of the RyngDyng case from the front of a tilt target (= 285 cm).

Important note: The ground RyngDyng is standing on should be firm and solid. If it is too soft or flexible, the stands might sink down after calibration of the system, resulting in a high inaccuracy of the position measurement. If necessary, use wooden boards or stone plates.



1. Set-up of Wi-Fi router and RyngDyng

The optimal position for the Wi-Fi router is in proximity to RyngDyng and **1-2 meters above ground**. The antennas should point outwards, see figure above. This gives the maximum reach of the network in direction towards the shooting line. If reach is not far enough you can place the router closer to the shooting line, but no more than 15 meters away from RyngDyng.

4. Networking and powering on

RyngDyng has been designed to also operate independent of the main supply and on a wireless network. Type RD600 is powered using USB-C PD. Type RD720 has got its own power supply and you can power it using a power station with 110V/220V outlets. RyngDyng connects to the router WiFi automatically, but you can also use an Ethernet cable connected to the LAN port of the router.

First, power on the RyngDyng Wi-Fi router by connecting it to a USB-C charger or USB-C power pack. After one minute, the orange LED will light up regularly and indicate that the RyngDyng wireless network is available. Then, power on RyngDyng by connecting it to the USB power pack resp. to the charger. RD720 needs a push to the power on/off button to get powered on. After about another minute, RyngDyng will be up and running and automatically connected to the WiFi network. Now, connect the RyngDyng App with your RyngDyng. Of course, your device running the app should also connect to the RyngDyng WiFi network.

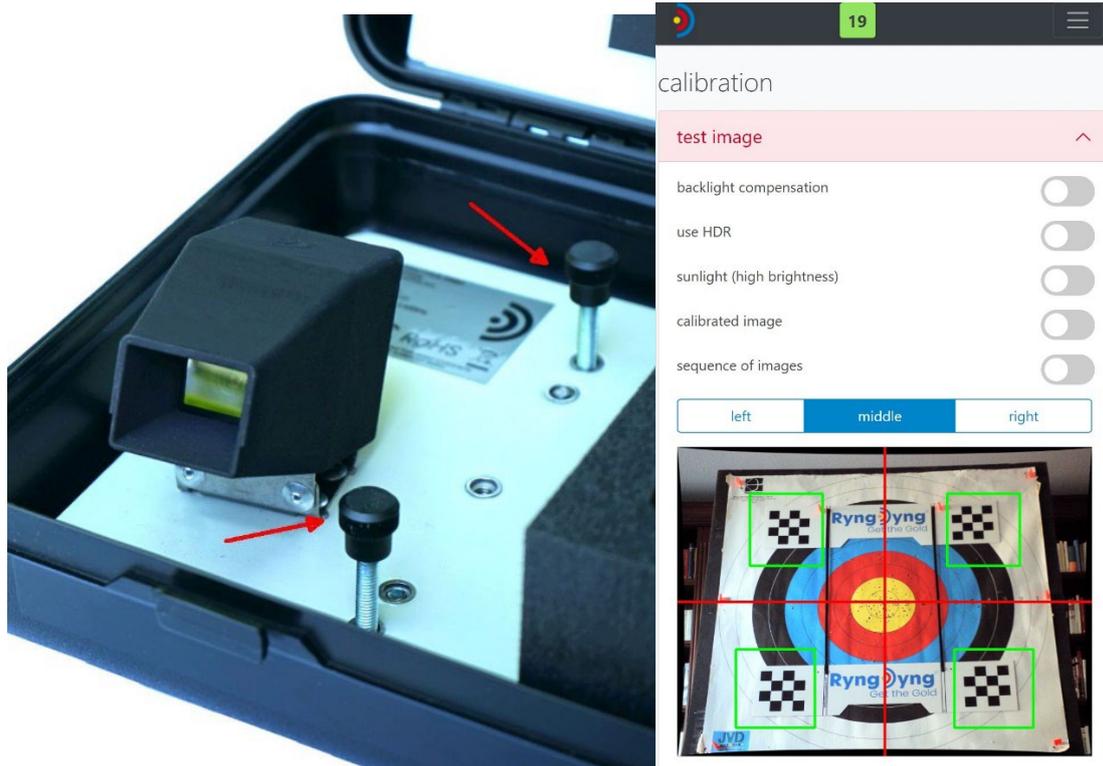
Some mobile devices keep leaving the RyngDyng WiFi because it usually does not provide internet access. In this case, deactivate 'mobile data' in the device and/or to deactivate other WiFi networks in the device. Then the device will be forced to remain stable in the RyngDyng network.

It is also possible to establish a bridge between the RyngDyng WiFi network and another network having internet connectivity (see document [How to establish Internet access](#)). Then, your device will no longer try to switch to another network searching for the internet.

5. Orientation

The RyngDyng cameras should be oriented towards the center of the target. This orientation procedure is supported by means of test images including a hair cross. To retrieve test images, in the RyngDyng App go to **calibrations** -> **test image** and press the buttons (left – middle –right).

The hair cross should point to the center of the target. An accuracy of ± 5 cm is good enough for this adjustment. To alter the horizontal position, slightly rotate the RyngDyng case. Vertical adjustment is done by the adjustable stands.



2. Adjustable stands

3. Hair cross in test image

For adjusting the position, it can be helpful to switch on the 'sequence of images'. If this option is activated, new test images are automatically displayed every 2 s. The image sequence ends after a few seconds and you can restart if necessary.

When checking the test images, also look for obstacles that might hinder the sight of the cameras. E.g., remove all blades of grass directly in front of the cameras.

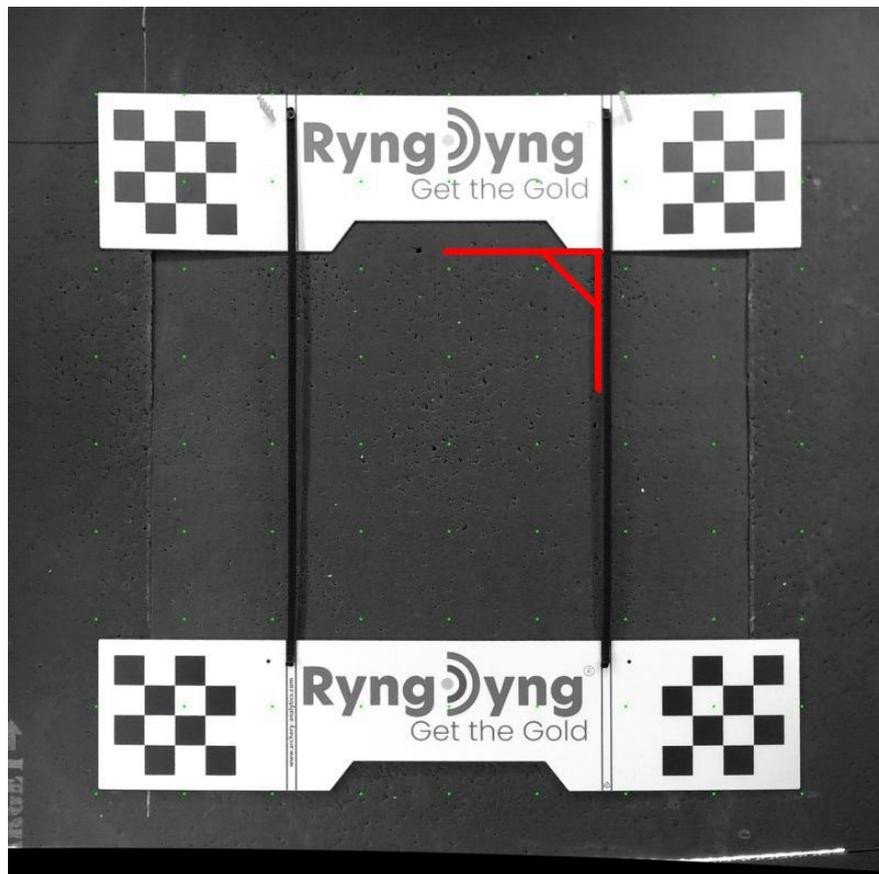
The lighting conditions should be such that no light reflections can be seen directly on the colored rings and the colors are not overexposed (yellow in particular sometimes does appear as white). In difficult lighting conditions, backlight compensation or dimming using the sunlight switch can help. HDR should only be used in exceptional cases, e.g. if disturbing light reflections cannot be removed in any other way.

6. Geometric Calibration using the Chessboard

Geometric calibration is done with the help of 'chessboards'. First, pin the upper chessboard plate onto the target. The flexible bands between will hold the bottom chessboard in position.

Please check the following conditions when pinning on the chessboard plates:

1. The upper chessboard plate should be horizontally aligned with the target
2. The target center should have the same distance to the upper and lower chessboards and to the left and right vertical bands. In other words: the center of the target is aligned with the center of the four chessboards.
3. The vertical bands start from the upper edge of the upper chessboard plate and end at the upper edge of the lower chessboard plate.
4. The bands may not be twisted. If twisted, untwist by rotating the band around their mounting pins in the chessboard accordingly.
5. There is a right angle between the upper chessboard plate and the vertical bands (see red marks in image above)
6. The chessboard plates are tightly aligned with the flat surface of the target, i.e., they do not protrude or bulk out. If necessary, use further pins to hold them down (but keep the chessboards themselves clear of pins).



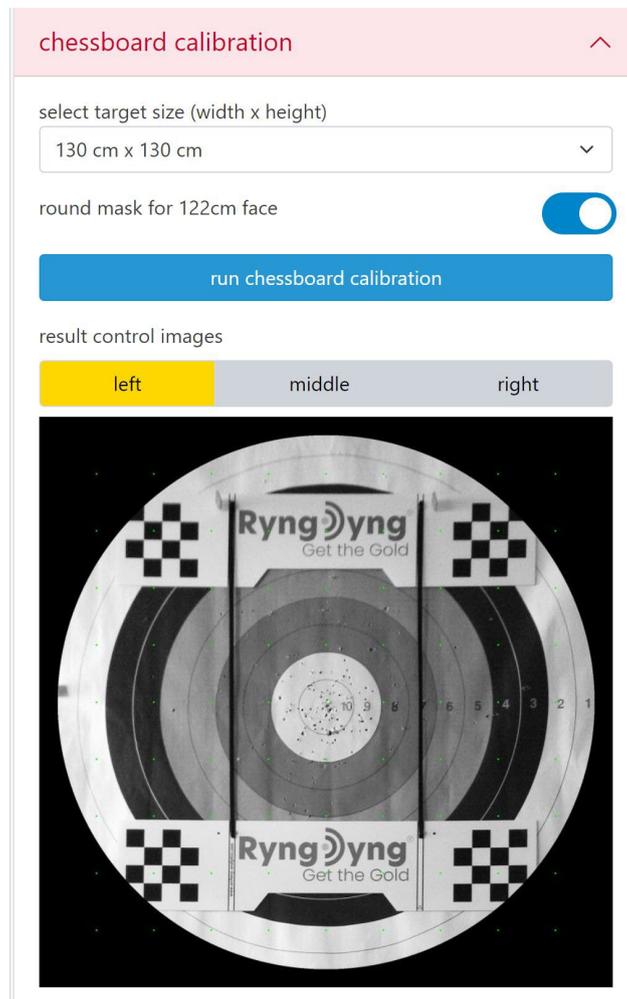
4. Chessboard plates on target, the required right angle marked in red

It is good enough to check these conditions by the sight of eye; no special measurement equipment is needed for that.

It does not matter if there is a target face on the target or whether the target is blank. Important is that the chessboards and the target surface are all 'in one plane' and no target pins are under the chessboards and lift them up.

You can check the position of the chessboard by retrieving a test image. The chessboards will be located within the green markers, if they are mounted as described above (see 3. Hair cross in test image above)

If position of chessboards is ok, go to **calibrations** -> **chessboard calibration**:



5. Chessboard calibration menu in RyngDyng App

Various standard target sizes are offered for calibration. Furthermore, you can add your own size to the list. It is important to select a target size as small as possible. Only the area with the target faces should be included, not the background with trees and sky. You can switch on the **round mask** for 122 cm target faces. Then, only the circle area of the target will be observed for arrows.

After target size is selected, press the button **run chessboard calibration**. After a few seconds, the result of the calibration will be displayed: Three similar looking images, one for each camera (left - middle - right). The target with the chessboards is shown from a central perspective and the image size matches the selected target size. If one of the images deviates significantly from the others, the chessboard calibration must be repeated. The cause of the error can be found with the help of test images (see also the section below on lighting conditions).

In case of insufficient light conditions or partially hidden chessboards, the calibration procedure can take up to 1 minute, as RyngDyng will try many different camera settings in order to find the chessboards.

As can be seen from the example, the chessboard calibration also works if a target face is present beneath the chessboards. However, it is very important that there are no pins under the chessboards and that the chessboards lie flat on the surface. The general rule is that the chessboards and the target face should form "one level". This is the only way to achieve high accuracy in measuring the position of the arrows.

In the view **calibrations -> quality checks** you will find the result of the calibration. The date of the last chessboard calibration is shown as well:

quality checks	
chessboard calibration	
of	17.8.2022, 13:15:06
quality chessboard calibration	★ ★ ★ ★ ★
width	130 cm
height	130 cm
round mask for 122cm face	yes
found targets	
ABCD	122cm
position of target faces	★ ★ ★ ★ ★
quality ring calibration	
no ring calibration available yet	

6. Status of chessboard calibration as shown in the RyngDyng App

RyngDyng stores the result of the chessboard calibration permanently and therefore it will be available after a reboot of the system. If the positions of target and of RyngDyng have not changed, there is no need to re-calibrate after a reboot.

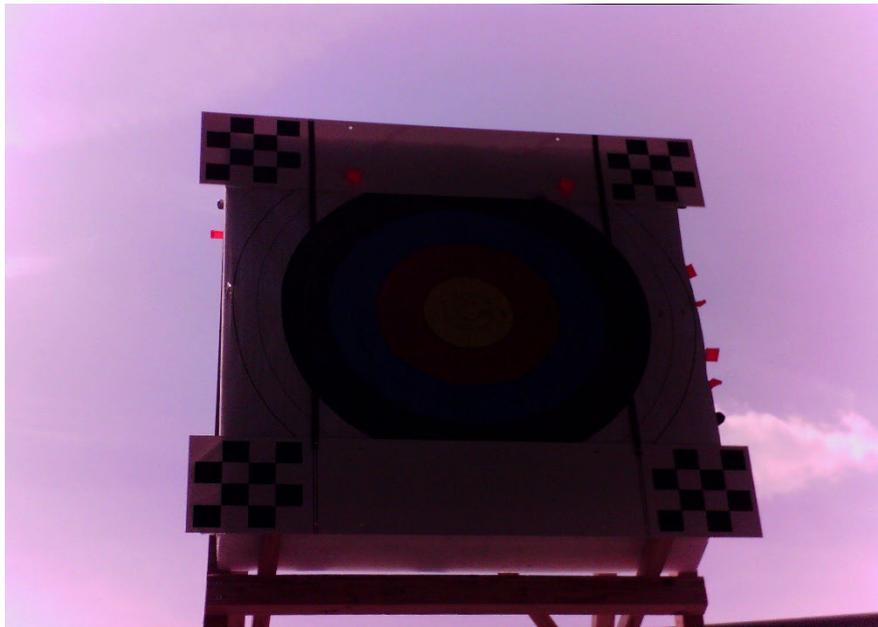
However, even a small change of the positions **after** chessboard calibration will decrease the accuracy of the position measurement. The system is quite sensitive in that respect. The **calibration quality** shows such displacements. This quality measure is calculated during every target face recognition activity and during every start arrow detection procedure.

If only three or less yellow stars are left, better re-calibrate or bring back RyngDyng and target to their original positions. It may be helpful to mark the exact positions of target and RyngDyng on the ground to have information on whether something moved.

For indoor competitions, it is certainly helpful to mark the exact position of the RyngDyng and the target stands on the floor and check them after each end. In this way, moved target stands and/or RyngDyng can be brought back to the marked positions.

Usually, chessboard calibration does not pose any problem for the cameras in most light conditions. There are, however, some special conditions to pay attention.

First is backlight. The image below shows a recorded test image of a situation, where there is full sunlight behind the target (a small 80 cm target leaving a lot of bright sky around). The chessboards can hardly be recognized, as they appear much too dark.



7. Backlight situation in bright sunlight

The problem can be solved by activating the backlight compensation of the cameras. Go to **calibrations -> test image** and switch on the backlight compensation. The next image shows the same situation with activated backlight compensation:



8. Activated backlight compensation

In such situations, let the backlight compensation be switched on all the time during usage of the RyngDyng system.

The second potential problem with light conditions is a sharp shadow edge on the chessboard. In the image below you can see edges of shadows crossing the chessboard corners and therefore disturbing the chessboard recognition algorithm:



9. *Shadow edges on the chessboard corners*

Shadows will in not cause problems in general. In the following image, one of the chessboards is in the shadow while the others are in the sun. With this image, chessboard calibration did work without any problem:



10. *Shadow on chessboards without causing problems*

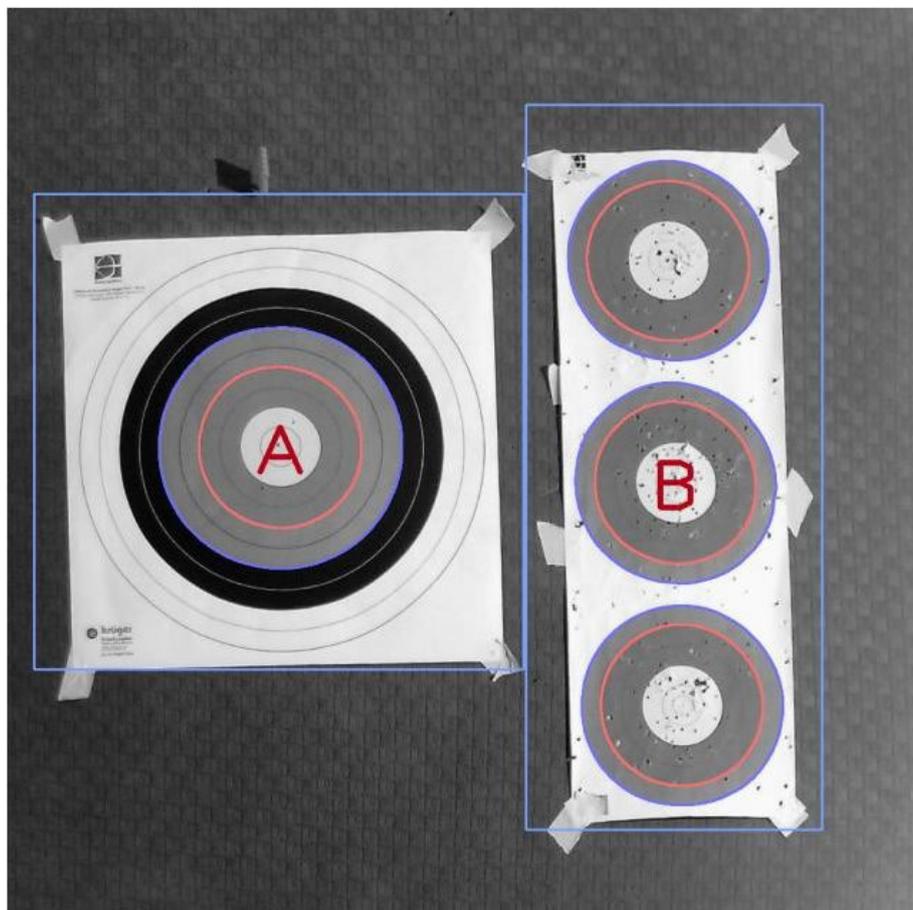
In case there are shadow edges on the chessboards, just provide more shadow in order to remove the edges and chessboard calibration will work as expected. Target face pins may cause shadows crossing the squares when sunlight is coming from the side.

11. Target face recognition

After the chessboard calibration, remove the chessboards and put the target faces onto the target. Make sure they are tightly pinned down, especially in windy environments. The more even the target face is and the closer it is pinned to the target surface, the higher will be the accuracy of the position measurement.

RyngDyng will automatically recognize standard target faces and their layouts according to WA, NFAA as well as Las Vegas spots¹.

In the RyngDyng App, go to **calibrations** -> **target recognition** and press **target recognition**. After a few seconds, the result is being displayed as a gray image with some color marks:



11. Recognized target faces with tournament letters A and B

The outer border of the blue rings of the recognized target faces are redrawn in blue color and the border of the red rings with red color. The target is labeled with the possible letters for the archers in a tournament. Around the paper there is a thin blue line indicating the area that is observed for arrows for that target face.

In the RyngDyng App, a summary of all calibration data is available under **calibrations** -> **quality checks** (see image 6. Above)

¹ Those with yellow-red-blue rings in standard colors, NFAA field targets and a some others

In contrast to the chessboard calibrations, data on target faces is not stored permanently. That is, after each reboot of the system, recognizing target faces is a necessary step.

The **shift of target faces** indicate whether target faces and/or target have been displaced from the position that was measured during target face recognition procedure. E.g., if you replace target faces and put them on at 2 cm distance from the previous position, this will result in less yellow stars. If only three or less yellow stars are left, repeat the target face recognition step.

Using the checkbox switches, you can assign different tournament letters to the target faces. For example, you can assign the same letter A to two 3-spots and the shoot 6 arrows at these two 3-spots. As a result, 6 arrows will be recorded for target A instead of 3 arrows each for targets A and B.

12. Quality of ring calibration

At each start of the arrow detection (i.e. usually after each end), RyngDyng measures the exact contours of the colored rings. That's why you should start the arrow detection as a test (on the **hits** page of the app) after finding the target faces and also check the result of the ring calibration under **calibration -> quality checks**:

quality checks
^

chessboard calibration

of 17.8.2022, 13:15:06

quality chessboard calibration ★ ★ ★ ★ ★

width 130 cm

height 130 cm

round mask for 122cm face yes

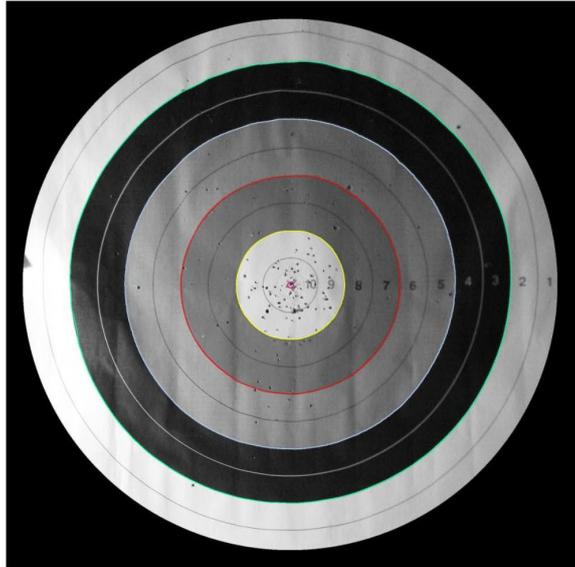
found targets

ABCD 122cm

position of target faces ★ ★ ★ ★ ★

quality ring calibration

	yellow	★ ★ ★ ★ ★
ABCD	red	★ ★ ★ ★ ★
	blue	★ ★ ★ ★ ★
	black	★ ★ ★ ★ ★



12. quality of ring calibration after starting the arrow detection

In addition to the stars for the individual color rings, the test image shows whether the contours of the colored rings have been recognized accurately. For an exact position measurement and scoring of the arrows, it is necessary that e.g. the yellow area has been precisely traced by a yellow line, analogous to the other colors.

Since the ring calibration is carried out again after each end, you can always check whether the quality still meets your requirements. During competitions, care will be taken to ensure that the yellow area is not too tattered and therefore the yellow line can no longer be perfectly round.

13. Configurations for archers



configuration for Jochen

save cancel

target face

shooting distance (m): 18

target face: A B C D

shooting direction: SW

notes: training for FITA round

bow

arrows tab/release

sight settings

environmental conditions

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13. Configurations menu for archers and their settings

By ticking the box, this athlete is assigned to the faces that he or she will use. The shooting direction is used together with the time of the hit to be able to call up the position of the sun later. The shooting distance should always be specified, since then the Arrow Grouping Indicator (AGI) can be calculated for each end. A saved setting is valid until it is overwritten by a new setting (but no longer than 1 day).

For details, please see the App manual, [Manual for the RyngDyng App](#).

If no archers are assigned to the target faces, RyngDyng is fully functional anyway, but there are some important differences to note:

- If no archer is assigned to a target face and an arrow is detected for that face, one hit message is sent out and the name field in that message is `ryngdyng<sn>@archery-analytics.com` where `<sn>` is the serial number of the device. This way, anonymous arrows are assigned to this 'user'.

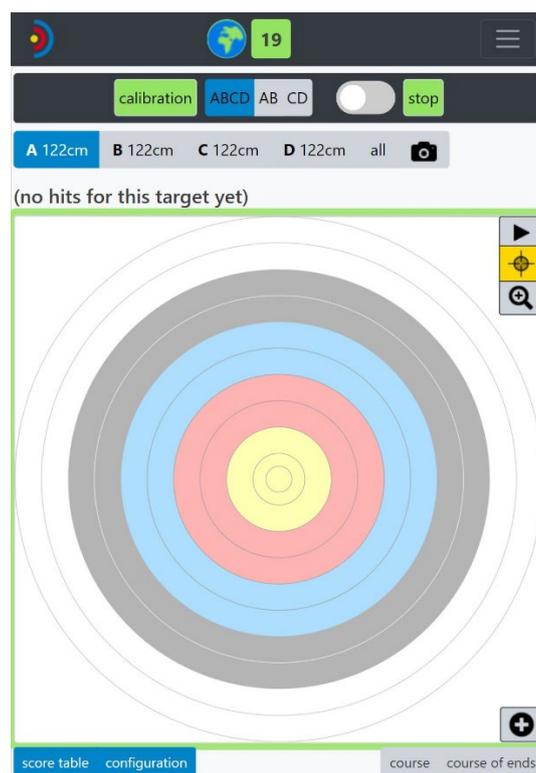
- If no archer is assigned to a target face, the bow type is unknown. RyngDyng assumes a recurve bow and calculates the scores accordingly.
- If no archer is assigned to a target face, the measured arrow shaft diameter is used to determine the score (especially in close proximity to a ring border)
- If an archer is assigned to a target face, the configured arrow shaft diameter is used instead of the measured one. This is more accurate. The hit messages contain the name of the assigned archer.
- If several archers are assigned to a target face and an arrow has been detected, one hit message is sent out for every archer².

Whether archers have been configured and assigned to target faces, this information is also displayed on the [hits](#) page (below the statistical figures).

14. Detection of arrows

a) Starting and stopping arrow detection

If the calibration was carried out successfully, the arrow detection can be started. After the start, the new status is shown like that:



14. Active arrow detection

At each start, the rings of the faces are finely calibrated, as there could have been slight shifts in the previous end. This takes a few seconds.

² By setting a shooting sequence, you can ensure that the right arrow gets assigned to the right archer. See app instructions for details.

In the App, the target faces can be selected in order to have a live view on the detected arrows.

To stop arrow detection, press the button that now is labeled with **stop**.

The slide switch next to the start/stop button activates “fast mode”. The first measurement is taken after just 0.5 s (with the RD720; 1.5 s with the RD600) and displayed in the app. After the arrow has come to rest, a second position measurement is taken and a correction is sent to the app. This gives you a very quick indication of where the arrow is.

b) Person recognition

RyngDyng is able to automatically recognize if persons are moving between cameras and target, e.g., when pulling arrows. This feature can be turned off or on, as required, in the App under **RyngDyng - > settings**³

During training sessions, automatic person recognition will enable a fully automatic operation, as no buttons need to be pressed for starting and stopping arrow detection. During tournaments, a central system might better control start and stop mode instead of automatic person recognition.

When person recognition is enabled and persons are detected, RyngDyng enters the paused mode. The frame around the displayed target will turn to yellow.

When all persons have left the space between cameras and target, RyngDyng will automatically start arrow detection again and a new end number is used.

If there is wind and the target face has not been fixed well, the movement of the target face could also trigger the person detection algorithm. Therefore, it is recommended to pin down the target faces tightly, and secondly, consider to not use automatic person detection during tournaments in windy environments. You can adapt the sensitivity of person detection on page **RyngDyng -> Settings**.

15. Requirements for optimal results

Any optical system requires appropriate light conditions in order to function correctly. Furthermore, the quality and stability of the object being observed also has an impact on the accuracy of the results.

a) Light conditions

RyngDyng automatically adapts to various light conditions, from in-door to bright sun. However, there are some extremal conditions where digital cameras will no longer work as expected. Situations to avoid include:

- **Sunlight** always poses a challenge for digital cameras. Therefore, use the sunlight visors available in our online shop when operating RyngDyng in sunlight.
- **Direct sunlight into the lenses of the cameras**, i.e., when the sun is directly ,behind‘ the target and the sun shields of the cameras can no longer avoid direct sun light falling into the lenses. In such situations, also the archers will be ‘looking into the sun‘ and have difficulties seeing the target.
- **Strong light reflections on the target faces**. Those appear as white spots in the test images; note that the RyngDyng cameras are equipped with polarization filters that filter out most reflections. Light reflections can also appear in-door, if strong lamps are mounted above the targets. In extreme cases using the HDR mode of the cameras can help.

³ For RD720, the default setting for person recognition is ,disabled‘

- **Too few light** during evening or night hours (images will appear too dark in that case)

If light conditions are within the normal range, calibration and arrow detection will succeed (see below).

b) Quality of target

A flat surface for the target faces and for the chessboard calibration is essential for accurate measurement. If the target has a depression or the center of the damper protrudes, this will affect the accuracy of the position measurement. The basic rule is that the chessboards and the target faces should be in the same plane. The greater the difference between the chessboard plane and the faces plane, the greater the inaccuracy in the position measurement. An offset of 1-2 cm can lead to measurement errors in the order of a few mm.

c) Stability of target

The target should be very stable. Incoming arrows should not cause the entire target to wobble and existing arrows to vibrate strongly. You can recognize unstable targets by the fact that “false positives” occasionally occur, i.e. arrows are reported where there are none.

If it is not possible to achieve good target stability, the sensitivity of the arrow detection can be reduced under **RyngDyng -> Settings** (e.g. to a value of -5 or -10).

d) Wind

RyngDyng recognizes arrows on basis of differences in subsequent images. Only the relevant area defined by the recognized target faces will be observed. Moving objects in the background such as trees will be masked out.

If, however, the target face itself is moving because of wind, RyngDyng will start to search for arrows. In some cases this could result in a ‘false positive’, that is a detected arrow is reported while there isn’t one. Or, the processor of the computer is constantly busy working on arrow recognition, leading to slow recognition times or even missed arrows.

It is therefore essential, especially in windy weather, that the target faces are securely fastened with a sufficient number of pins. The target faces should also not protrude, as the wind can easily attack them. This is particularly important for round disks. The target faces should be placed completely and flat on the target base, if necessary by folding over the protruding corners.

At international outdoor tournaments, for example, we always use 12 pins for a 122 target.

If you cannot completely prevent the movements in windy conditions, you can reduce the sensitivity of the arrow detection under **RyngDyng -> Settings** (e.g. to the value -5 or -10).



15. 122 cm target face on a straw target with wrapped around edges

e) Moving shadows

If the target is half in the sun and half in the shadow, there are mechanisms provided to cope with this difficult light condition (see section on calibration below). However, if the shadows are fast moving such as those from tree leaves in the wind, RyngDyng is triggered to search for arrows all the time. This could lead to a heavy load of the processor so that real arrows may be missed.

Therefore, make sure that there are **no fast moving shadows** on the target. Slow movements of shadows such when the sun is turning over time, will not cause problems.

f) Quality of target faces

RyngDyng can reliably work with used target faces, but there are some limitations.

Tattered target faces will diminish the accuracy of position measurement. You should consider replacing used faces if the lines separating the rings have too many holes or parts of the paper are missing. Of course, single holes from arrows will not cause problems.

Depending on your requirements on the accuracy of the position measurement, you can go with rather used faces, or, just use fresh and even faces.

g) Tuning of System parameters

The setting for some parameters affect the accuracy of the arrow detection. Therefore, they can be adapted to the respective (lighting) conditions.

An important parameter is the **contrast threshold for arrow detection**, which can be set by RyngDyng admins⁴ on the **RyngDyng -> Settings** page. The default value is 45, with a lower

⁴ On request, Archery Analytics can assign the *RyngDyng admin* role to archers with an account at our server

value dark arrow shafts can be better recognized against a dark background, as well as very bright, silvery shafts against a light background.

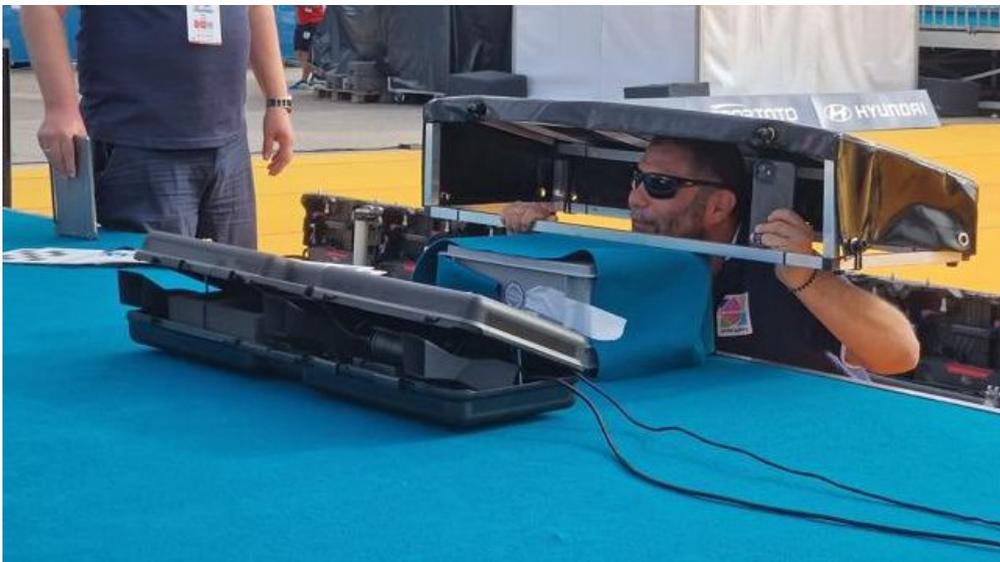
If you notice that some arrows are not detected or that there are gross errors in the position measurement, then this parameter should be reduced, e.g. to the value 40. Then you would test the values 38 or 42 in order to see at which value no arrows are lost and an accurate position measurement is possible. The rule is that the value should be set just low enough to ensure that all arrows are detected, but no lower.

The second important parameter is the **sensitivity of the arrow detection**. The default value is 0. If “fake” arrows that do not exist are reported for unstable targets or in windy conditions, this value should be reduced to -5 or -10.

Finally, the **sensitivity of the person detection** has a default value of 50. If people pulling arrows are not reliably detected, this value can be increased to 55 or 60. A higher value may be necessary, especially if RyngDyng has been installed on ceilings. However, if the person detection is triggered spontaneously, e.g. by wind, then reducing this value can solve the problem.

h) Rain

Short showers of rain will not cause harm to RyngDyng, but the housing is not full waterproof. So, if you want to use it during extensive rain, there is a need for further rain protection. For example, you could place a second and waterproofed housing over RyngDyng. Make sure that the cameras still have a clear view onto the target.



16. Mounting a rain cover for a World Cup event

In very heavy rain, it might be possible that the view of the cameras is affected and big raindrops trigger the arrow detection algorithm. However, when big raindrops are disturbing the view on a distance of 3 m, archers at a distance of 50 m or 70 m most likely will no longer be able to see the target at all.

12. Software Updates

If software is available for the RyngDyng app, the app indicates this and the new software is installed by pressing the update button.

New software versions for RyngDyng are released regularly, at least once a year. When connected to RyngDyng, the app will indicate when new software is available for RyngDyng ([RyngDyng -> Information page](#)).

RyngDyng must be connected to the Internet for the software to be installed. The best way to do this is to create a bridge between the RyngDyng WLAN and another network. This is described in the document [How to establish Internet Access](#).

If there is an Internet connection, RyngDyng will automatically download and install the new software when it starts up. After the next restart, the new software will be active and you can see the new version number in the app under [RyngDyng -> Information](#).

If you have missed getting new RyngDyng software for a long time, it can happen that the RyngDyng app can no longer connect to RyngDyng⁵. In this case, there are some emergency mechanisms to reactivate the system. These can be found in the [RyngDyng forum](#).

⁵ Due to expiration of SSL certificates