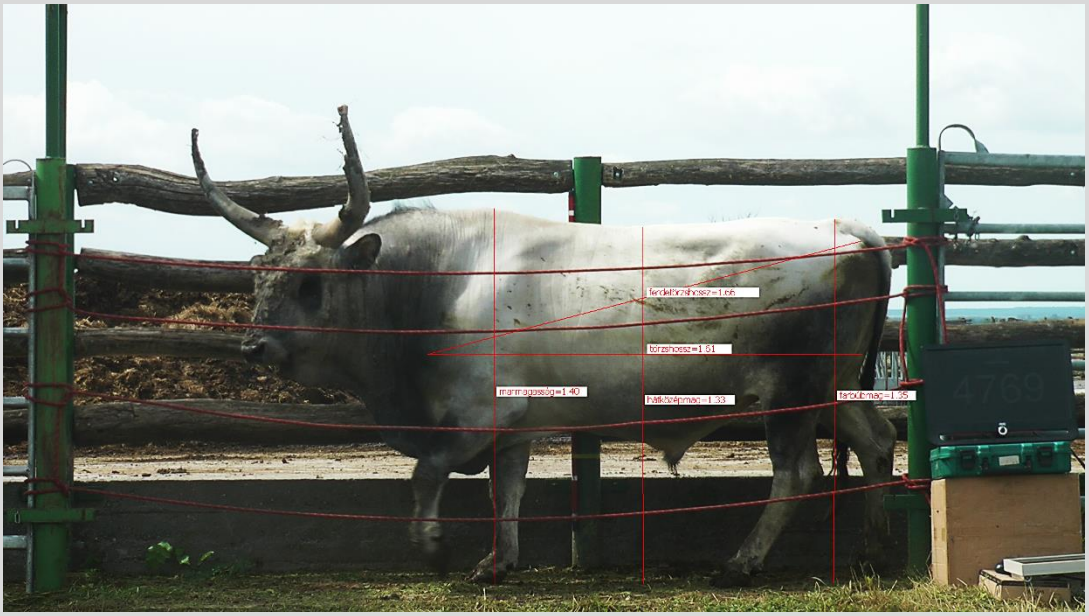
VATEM optometric animal measurement system



user manual v.1.
16/06/2017

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User manual of the VAM2 optometric animal measurement system

With the help of the Video Aided Body Measurement (VAM/VATEM) software it is possible to measure the body parameters of the animals walking through the place of recording by performing measurements on the images of the animals, using the optometric method.
Originally we prepared the first version of this software to be able to measure animals which are kept externally and which do not tolerate the traditional measurement technique. We have tried it out on Hungarian Grey cows, which are especially irritated by the human touch, and as they have long horns, it would indeed be very dangerous to touch them.

The method consists of two stages: the field and the software stages.
In the field stage we record the video footages for measurement, and in the software stage the measurements are performed with the VAM2 (VATEM2) software.
In the field stage it is possible to work at a 100 animal/hour speed, whereas in the software stage the speed of work is 5 minutes/animal.
The VAM2 software makes it possible to measure the animals in the video footages.

1. The field stage

The footages can only be measured properly, if all the necessary anatomic landmarks are visible in the standard position. This is the so-called "*standard image*", which is going to serve as the basis of the measurements.

In the standard position the animal is walking through the place of recording calmly, its leg which is closer to the camera is in a vertical position and is bearing weight, while the animal is stepping forward and the movement is at the fetlock joint; this is the moment when its leg on the other side is moving forward.

Picture 1: Cselló, a class I/II. bull from Sarród with ENAR number 32138-4534-3 and central registration number 29820, in the standard position. The ear tag screen can be seen in the picture on the right side.

1.1. **The place of recording**

For the recording it is recommended to choose a cattle race or a similar but more simple facility, where the animals can walk through in front of the camera one by one, in a single file. The easiest way is of course to use a cattle crush, but it is also possible to set up an appropriate facility with the help of mobile fencing elements and ropes.

However a pre-built cattle crush with a concrete floor is better in contrast to an improvised facility, as thanks to the even surface the appropriate step phase can be picked more easily, and the cattle will not trample the floor deeper.

Picture 2: The place of recording in Sarród with the camera recording the animals from above and the ear tag ID screens. The horizontal fencing is substituted with climbing ropes.

1.2. **The recording process**

When shooting the video, we want the animals to walk through the place of recording in a calm and placid manner. Objects placed in the proximity of the cattle race should be avoided, as they may frighten the animals, and the cattle should not be driven by the herdsmen too aggressively. The animal must be able to walk through the corridor in a safe way, and this is important not only from the point of view of the animal, since footages about an animal which has slipped or is frightened and is sprinting through the place of recording cannot be utilised.

The necessary anatomic landmarks must not be covered, therefore the facility should be set up in a way that if necessary, parts of the fencing or the rods can be removed. These parts of the fencing can be substituted by climbing ropes, for example, which will keep the animals within the corridor. Temple Grandin's research (1) provides essential information on the handling of cattle and also about the criteria necessary for them to walk in a calm manner.

1.3. **The placement of the cameras**

For the recording usually two cameras were used: one of them recorded the animal from above, while the other one recorded them from the side. The side camera was zoomed in a way that outside the place of recording (which was ca. 5 metres wide), the environment around was barely visible.

The camera recording from above was set to the widest visual angle. For the setting of the side camera we have also used an optical level (Carl Zeiss, Ni 002A), this way we were able to define the difference in level between the camera and the point of recording. The side camera was set at the same level as the expected wither height (140 cm). In order to avoid perspective distortion, the camera should be set up at a relatively distant location (15 metres). Of course in the case of the upper camera this was only possible to a limited extent (the upper camera was placed at a 5 metres height on a Manfrotto 16.4' Steel Boom Stand), therefore in order to measure as accurately as possible, this was the height we took into consideration when correcting perspective distortion.

After the setting of the cameras and the zoom the first footages were recorded about the levelling staff (GeoFennel BS 15-0), which served as a standard (etalon).

1.4. **The standard (etalon)**

The standard is kept in front of the side cameras, in the axis of the corridor and is swayed slowly horizontally as well as vertically. The swaying helps us choose the standard's horizontal position while measuring. The swaying measuring rod is shown to the side camera from the axis of the corridor, and to the upper camera it is shown also from the axis, in a ca. 130 cm height (which is the average height of the animals' back). Later we used a permanent fixed control standard, too, installed at the side of the corridor, visible in the zoom to check the accuracy of the measurement.

1.5. **Identifying screens**

In order to be able to identify the animals appropriately, it is useful, if the animals walk through in front of the camera one by one and not close to each other.

In the corner of the image there is a screen where it is possible to display the ENAR (Unified Identification and Registration System) number in the form of a QR code, serving the identification of the cattle. The ENAR number can be read from the ear tag to be displayed on the screen of the RaspberryPi card computer (which is controlling the screen), either using the bar code on the ear tag or, in the case of chipped animals, using an RFID reader. The program used for displaying the ear tag ID-s is written in the python programming code (eartag.py). It can be downloaded from the homepage of the university (vatem.univet.hu) and runs on the Linux operating system.

4. picture: Ear tag monitors, HDMI splitter, RaspberryPi card computer and wireless keyboard & mouse

1.6. **The video cameras**

When choosing the video cameras resolution is the primary concern. Since 2010 we have been using HD (1920 x 1080, Panasonic HDC-SD600) cameras in our studies. The images made by these new, 4K cameras are much more detailed, therefore they can improve the quality of the measurements. The quality and the light intensity of the camera lens (Leica Dicomar) was also important, as we did not want any distortions and blurs to erode the reliability of our measurements.

It is also essential that the upper camera can be controlled remotely (IR, WiFi) from the ground and that can be operated with a high capacity battery or a power supply unit. We have saved the data to a memory card, which is currently the easiest solution.

2. The software stage

2.1. **Installation**

The program runs on personal computers, in Windows 7, 8 and 10. The operation of the software might only be limited by the memory usage of videos played at the same time.
In order to install the program, a file titled VATEM2.exe must be started (it can be downloaded from vatem.univet.hu).

2.2. **The operation of the programme**

The program's main window shows the subtasks of the measurement. For the measurement these subtasks must be performed one after the other.

- First of all a measurement project must be created. The program will place the project in \Documents\VATEM2, in a folder whose name is identical with that of the new project.
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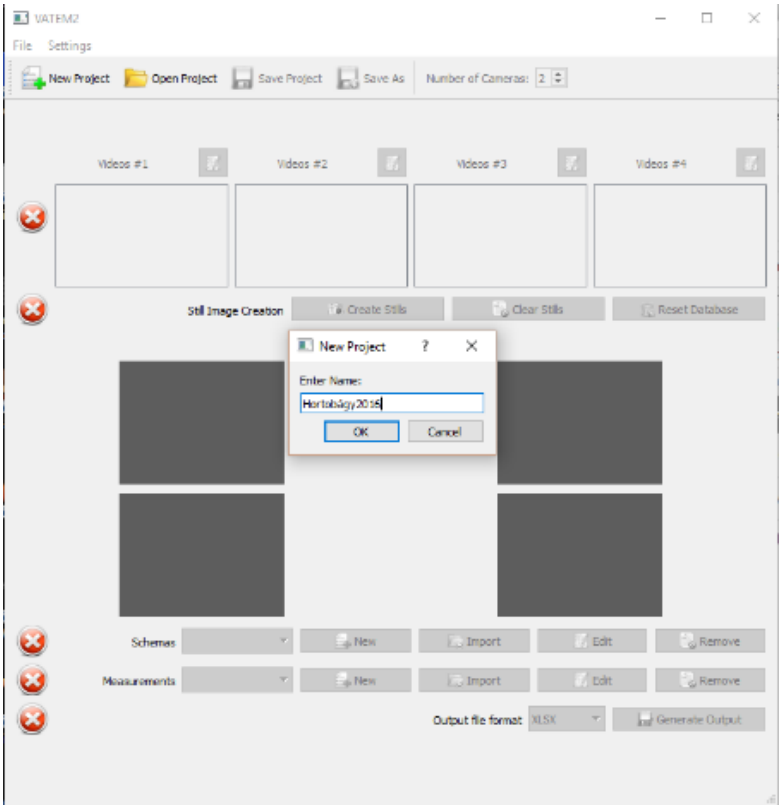
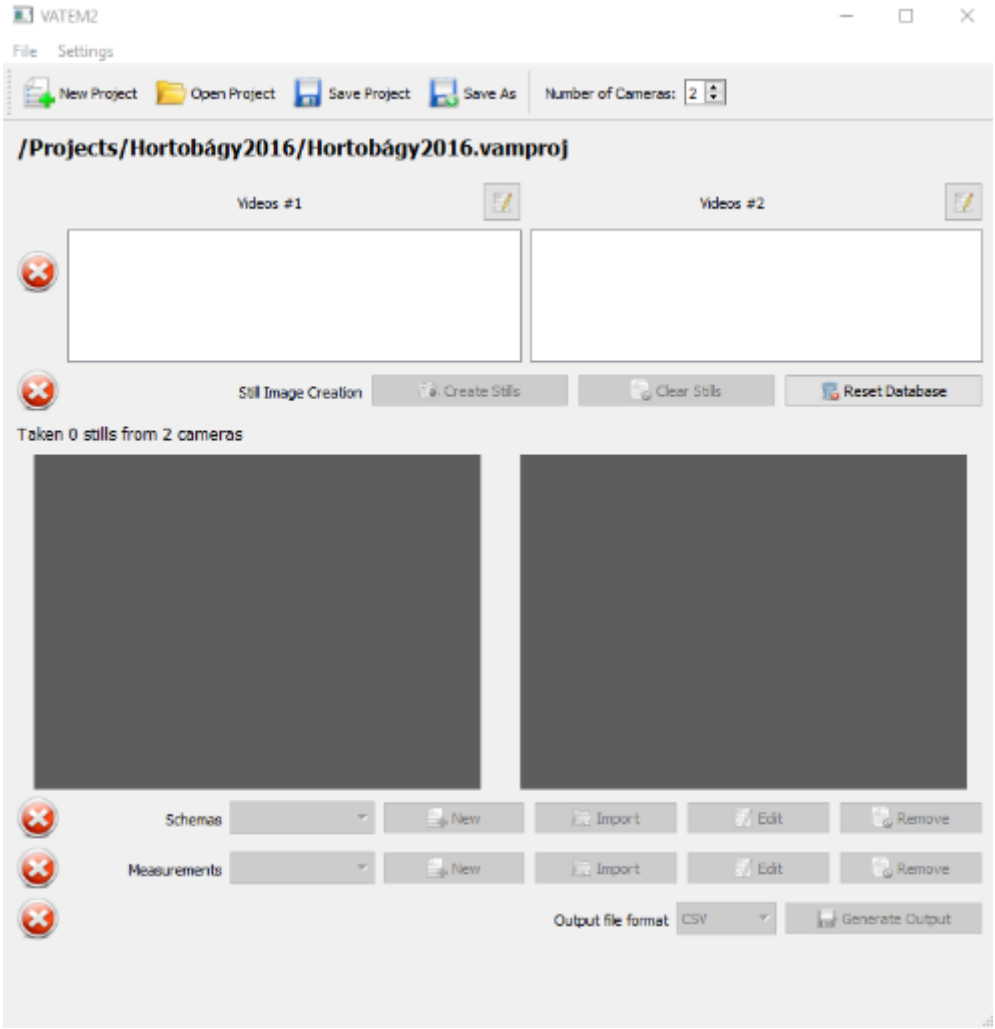
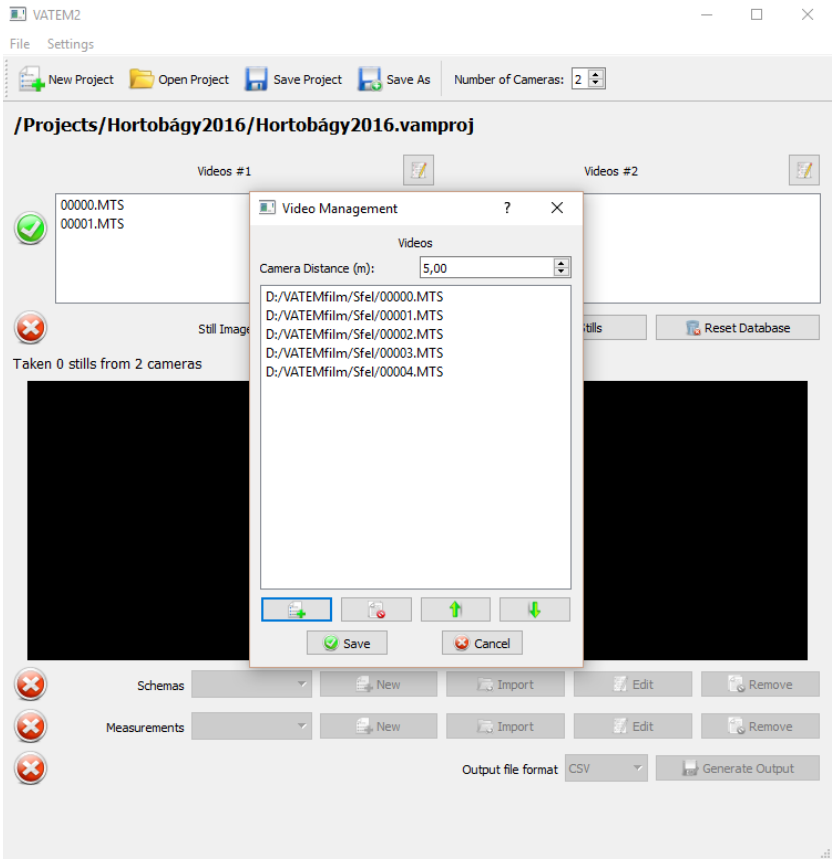


- The name of the active project and its access route is displayed at the top of the main window. The extension of the project file will be **.vamproj**. If we want to use a project saved earlier, then we have to open its **vamproj** file. If a new file is opened, the file opened earlier will be closed automatically. The projects are saved automatically in the background, but it is also possible to save them by pressing the **Save** button.

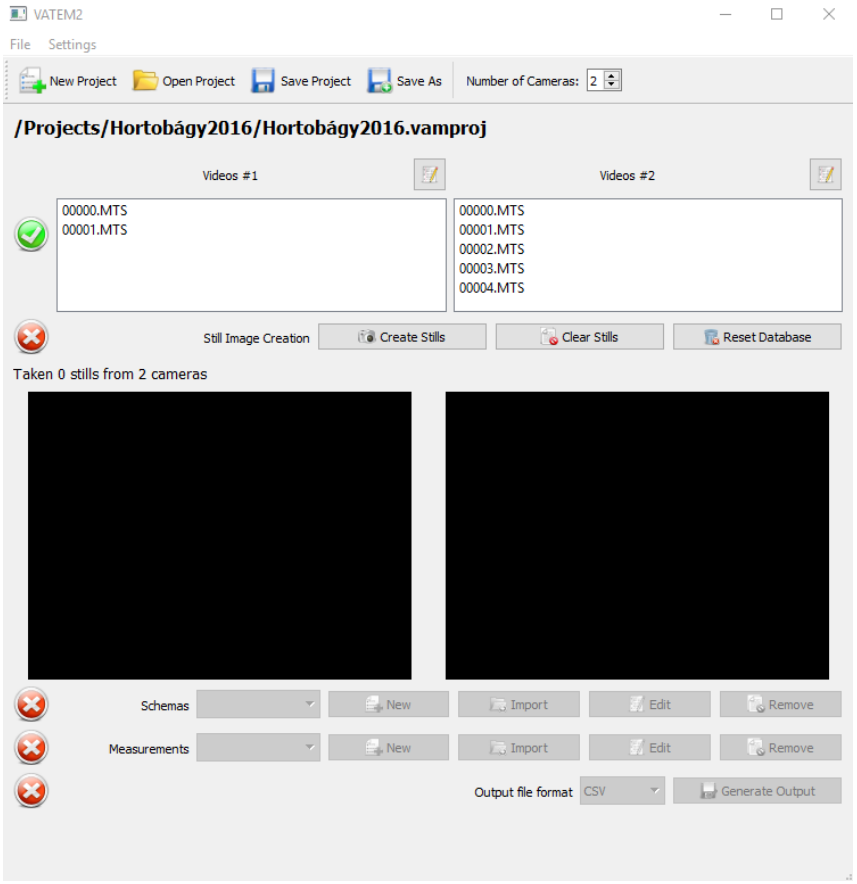


2.2.1. **The management of the video footages**

- The next subtask is to load the video footages to the camera windows with a matching number, by clicking onto the icon in the top-right corner. The video footages can be loaded separately for each of the cameras. The videos are are played by the software in the order of loading. The videos in the separate windows are synchronized (locked) with each other based on their recording time, so it is not a problem if the number of files is different. See in figure 3.
- By default the first window contains the videos recorded by the side camera. The software uses these images to correct perspective distortion.
- By default the second window shows the footages from the upper camera. For correction here we must provide the height of the camera.
- In windows #3 and #4 it is possible to load footages from any other cameras (e.g. recorded from the front, the back or any other perspectives).



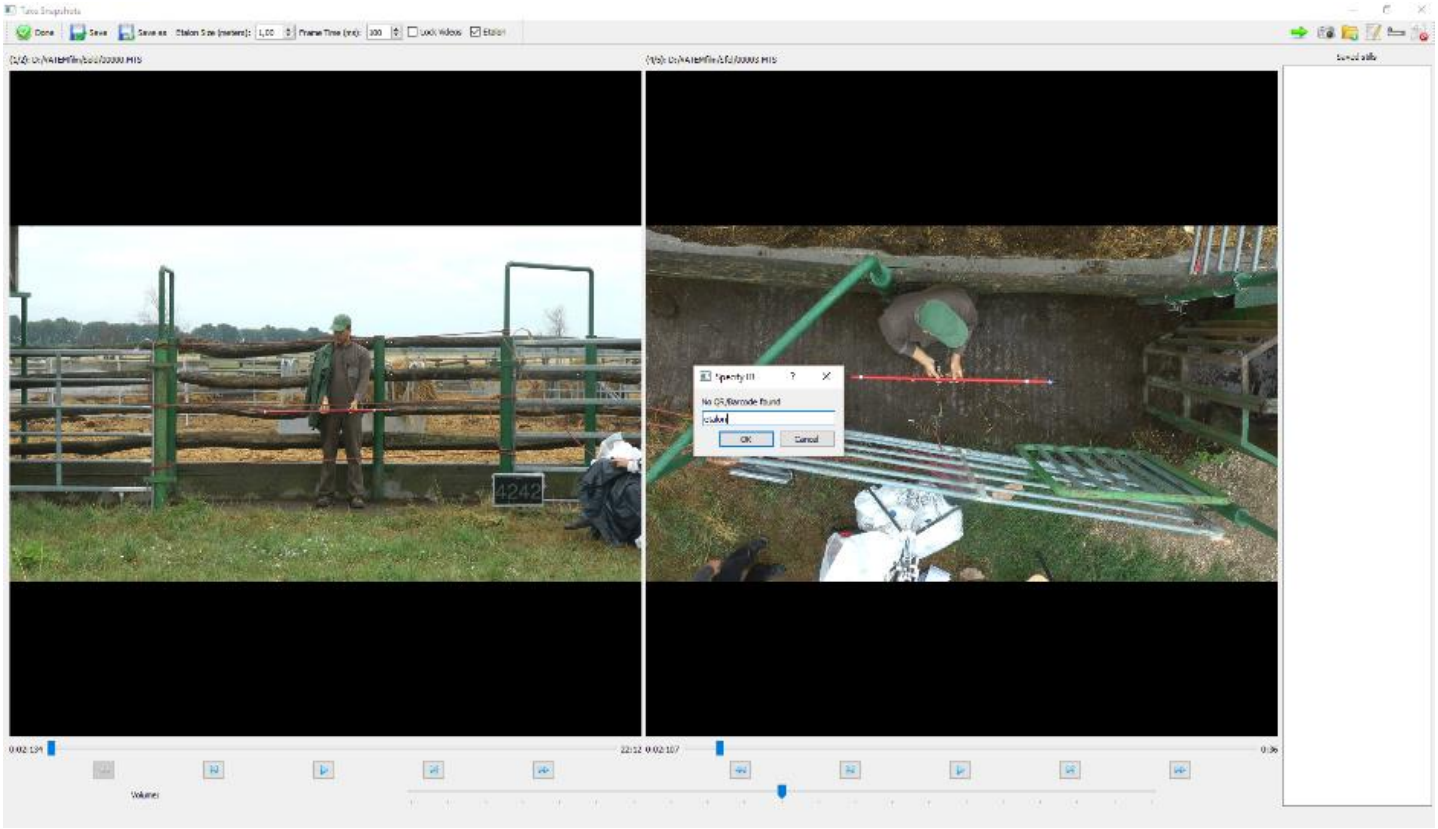
- Once the footages are loaded, the video management subtask is ready: this is indicated by a green tick on the left side.



2.2.2. Searching for snapshots

When pressing the button to search for snapshots a new window is opened, and in the top line we can read the following:

- The size of the standard (etalon) in metres: here we can provide the size of the standard used for the measurement. With the help of the indicated standard (etalon) the program will calculate the pixel/metre ratio for the given camera.
- Frame Time gives the time necessary for jumping backwards between the images during search.
- Lock videos: it locks the videos to the footage captured from the side. If the video captured from the side progresses by 1 second, then all the other videos will progress by 1 second, too. This plays an important role when looking for snapshots.
- With the green arrow it is possible to adjust the arrangement of the pictures.
- The etalon and standard images can be prepared using the camera icon.
- We can add ready images to be measured by clicking on the yellow folder icon. This way it may also be possible to measure old photographs if there is an object depicted in the image which can be used as a standard and whose length is known.
- With the icon showing a pencil we can rename the already finished image.
- With the icon depicting a measuring band we can set a finished image as a standard (this is mainly important in the case of loading ready images, as images chosen from the videos can be set as standards by ticking the etalon box).



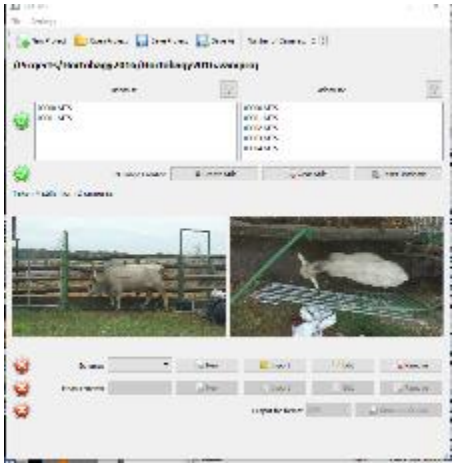
- Images can be cleared from the list by clicking the "deleted page" icon.

The footages can be played by clicking on the play button at the bottom of the "Take snapshots" window. Next to the play/pause buttons we can see the the buttons with which it is possible to jump from one still to the next. This way it is possible to pick exactly the still which we need as an etalon or standard frame. The length of the etalon must be provided in metres.

It is advised to lock the video footages with each other following the preparation of the images, as this way we can find the images belonging to the same animal more easily.

After clicking the "**camera**" icon, for a short period of time the software will automatically search for a QR code in the images (stills). If the software finds a QR code on the display, it will process it as the identifier of the animal, and will name the still accordingly. If it cannot find the QR code, it will ask for an identifier from the user, which can be read from the screen seen e.g. in figure 7.

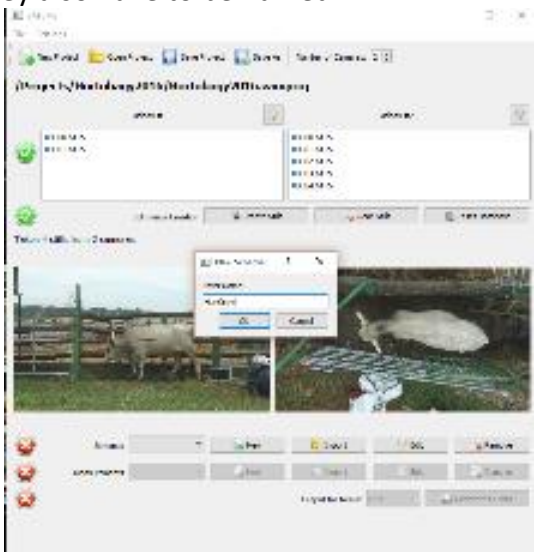
After choosing the right snapshots, the result is saved and the "Take snapshots" window is closed.



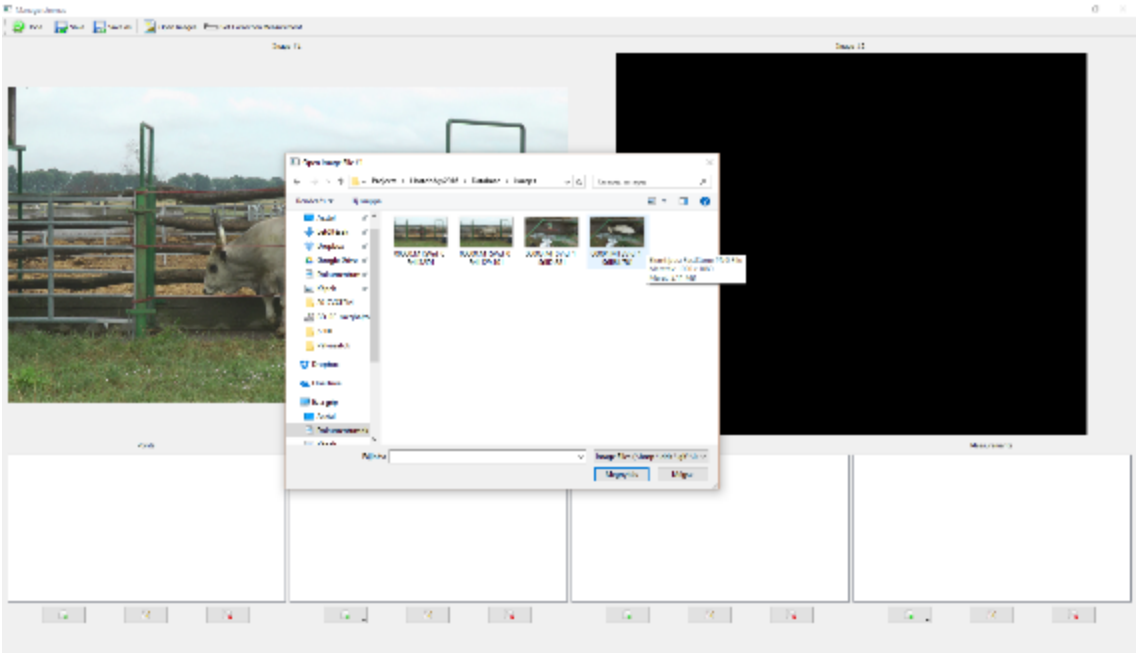
At this stage the image finished last can already be seen in the main window.

2.2.3. **Preparation of the measuring schema**

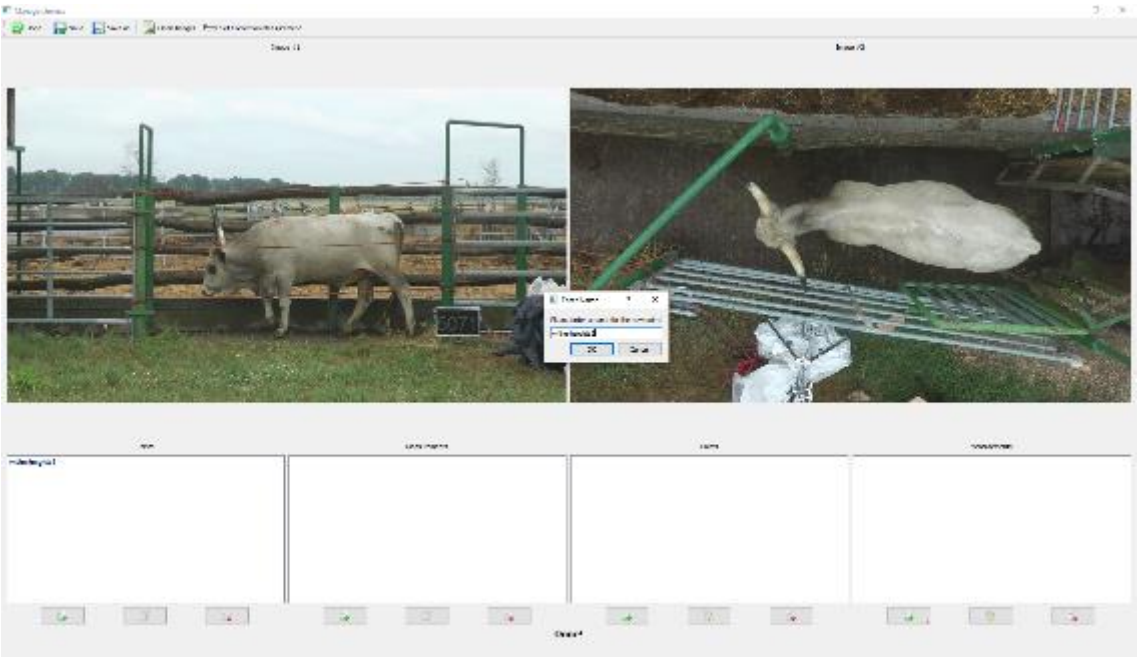
The measuring schema includes the body parameters to be measured, indicated by the anatomic landmarks (points) to be marked.
The measurement can be performed by marking the anatomic landmarks on the standard images. The necessary anatomic landmarks and sizes have to be fed into the measurement schemas in an organized way.
When a new schema is added, they also have to be named.



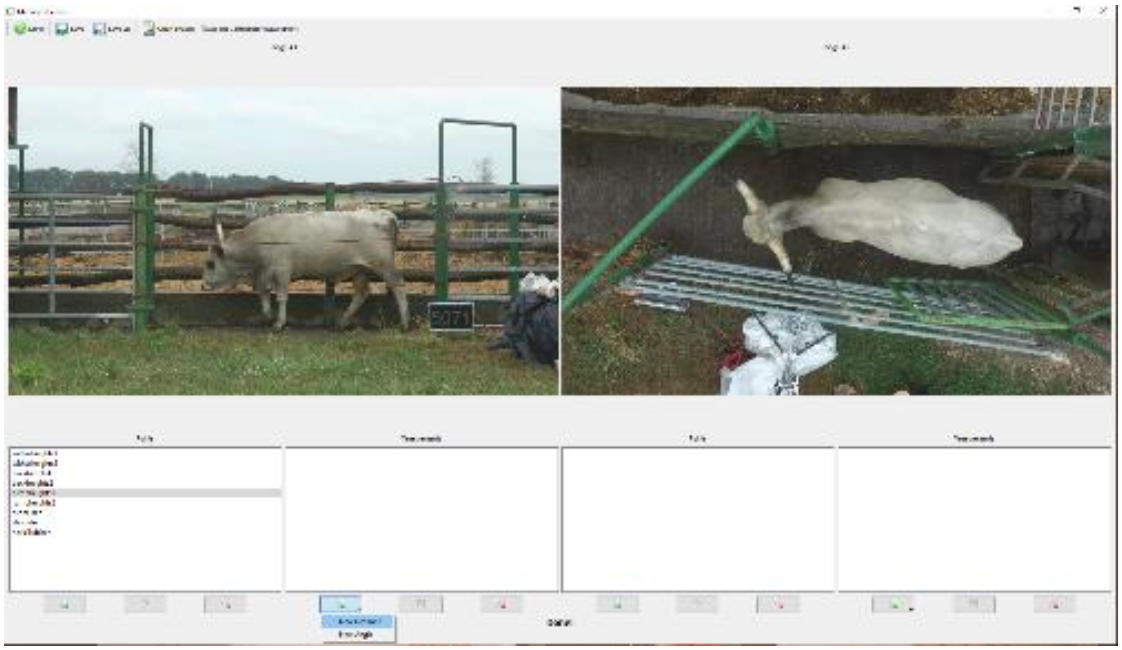
After that a number of schema windows equal to the number of cameras is opened. By using the "**open images**" button it is possible to select an image in each of the windows, which help us create the schema.



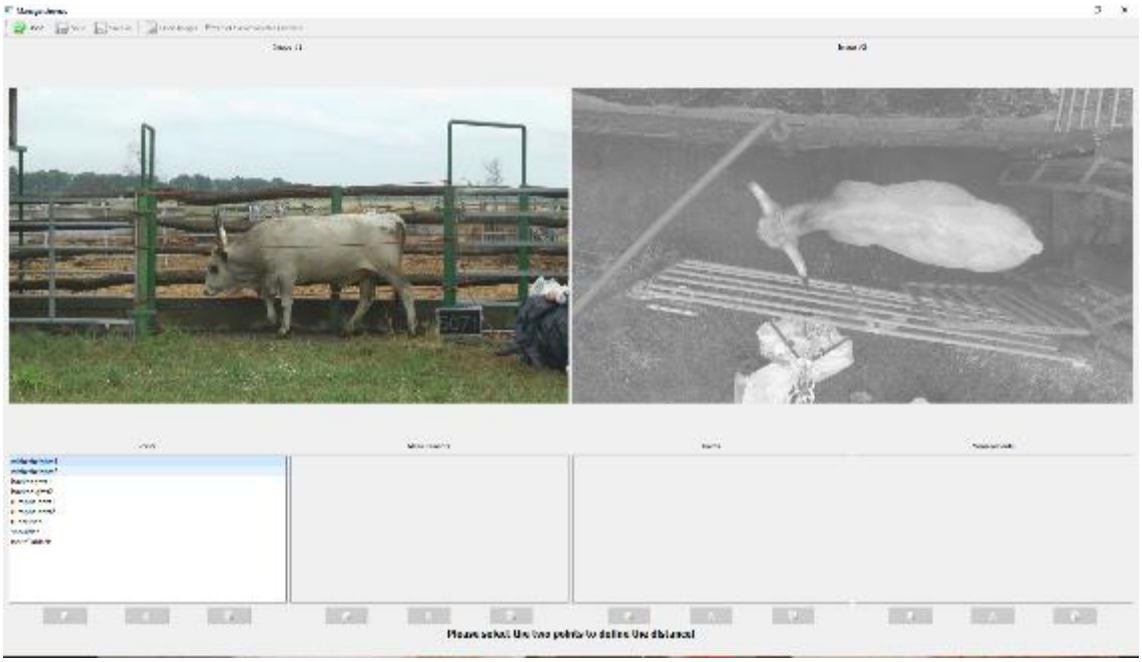
To add a new anatomic landmark, click on the "**Add point**" button below the image to be used, name the new landmark, then after clicking "**OK**" place the landmark on the image which was not darkened. This way when the sizes are defined the program will roughly draw the given parameter, and we can check if we have provided it properly.



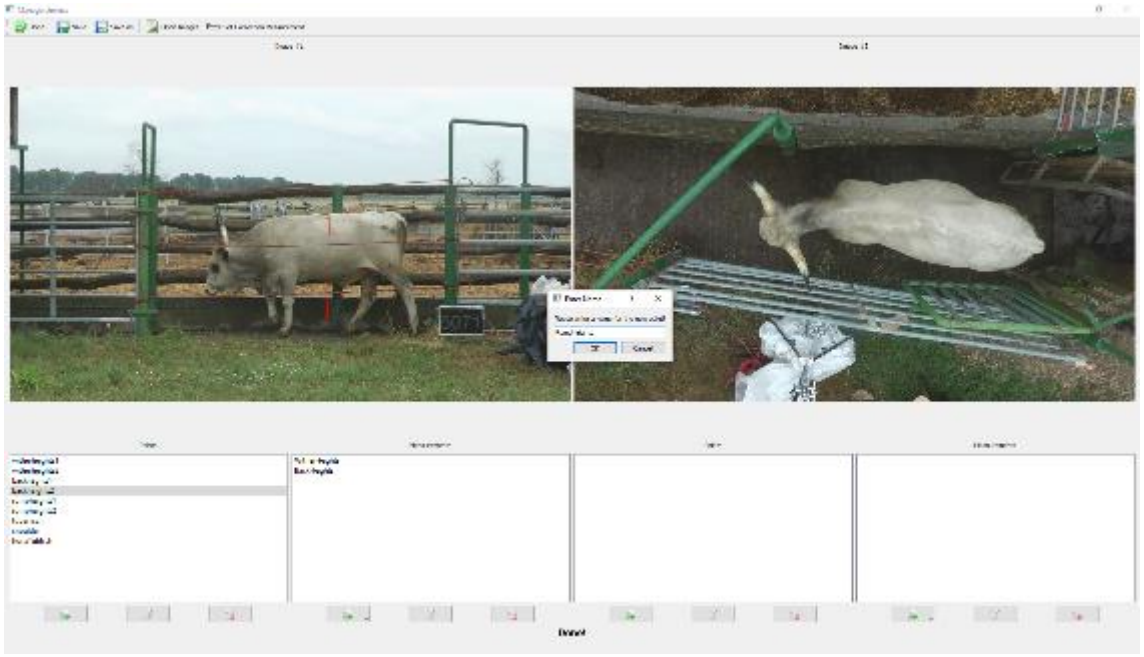
After specifying the anatomic landmarks the body parameters have to be defined, with the help of the landmarks (points). For this we use the "**Add measurement**" button, on the right side of "**Measurements**", below the image.

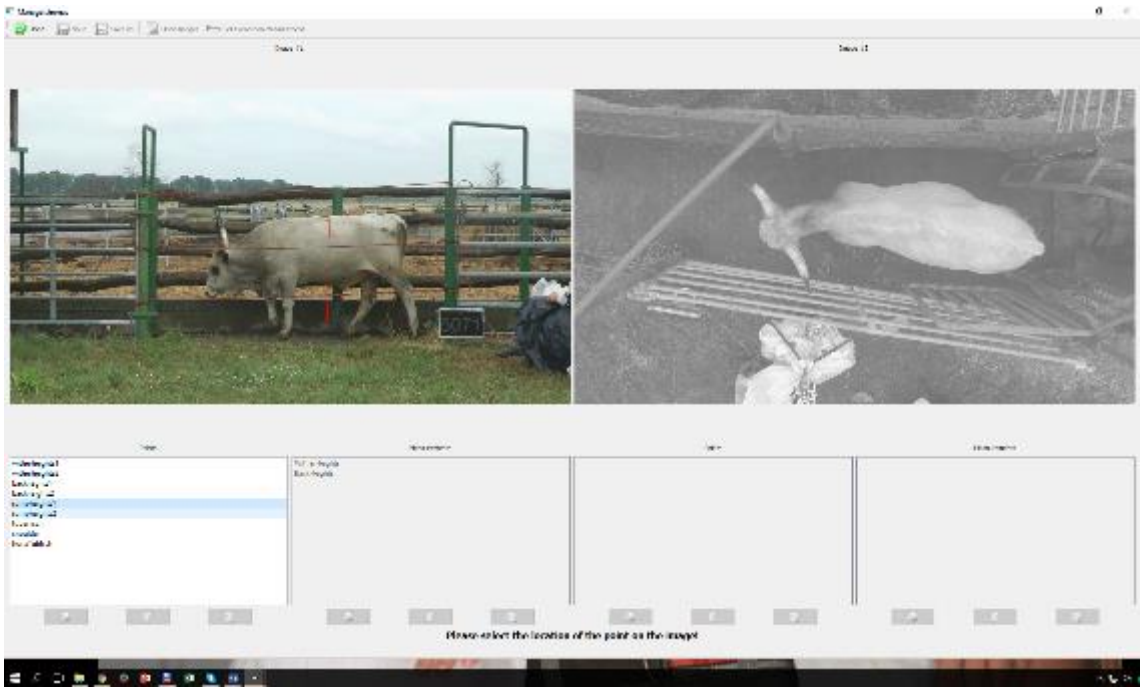


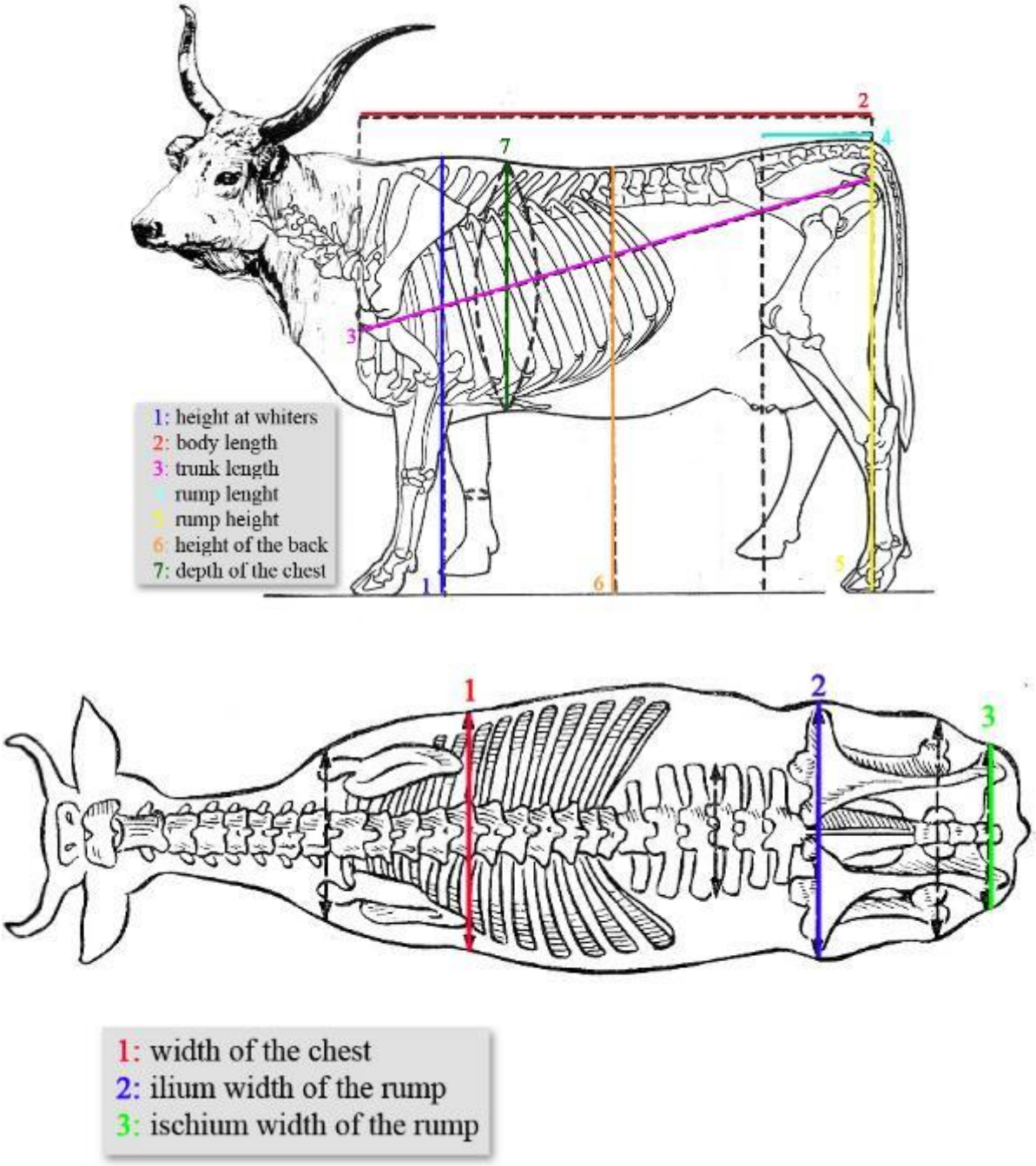
Before pressing the button however, we must choose if we want to determine a distance or an angle. It is possible to define a distance parameter by clicking on two points, while an angle can be defined by clicking onto three points.



Finally we have to name the measurement.





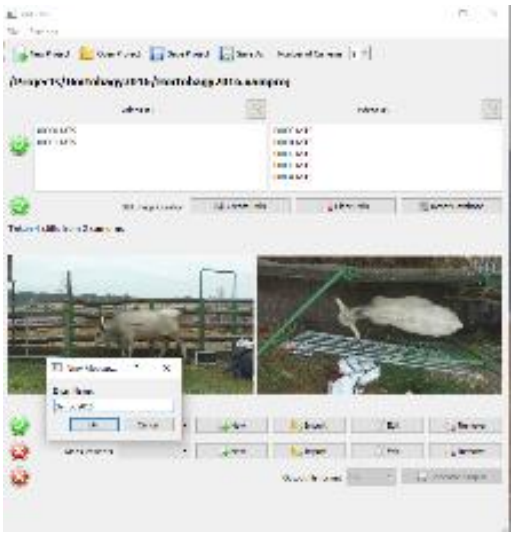


1. figure: The main cattle body measurements defined by the anatomical points

After that this can be done in all of the images one by one.
Once this subtask is ready, we can close the "Manage schemas" window, after saving the project.

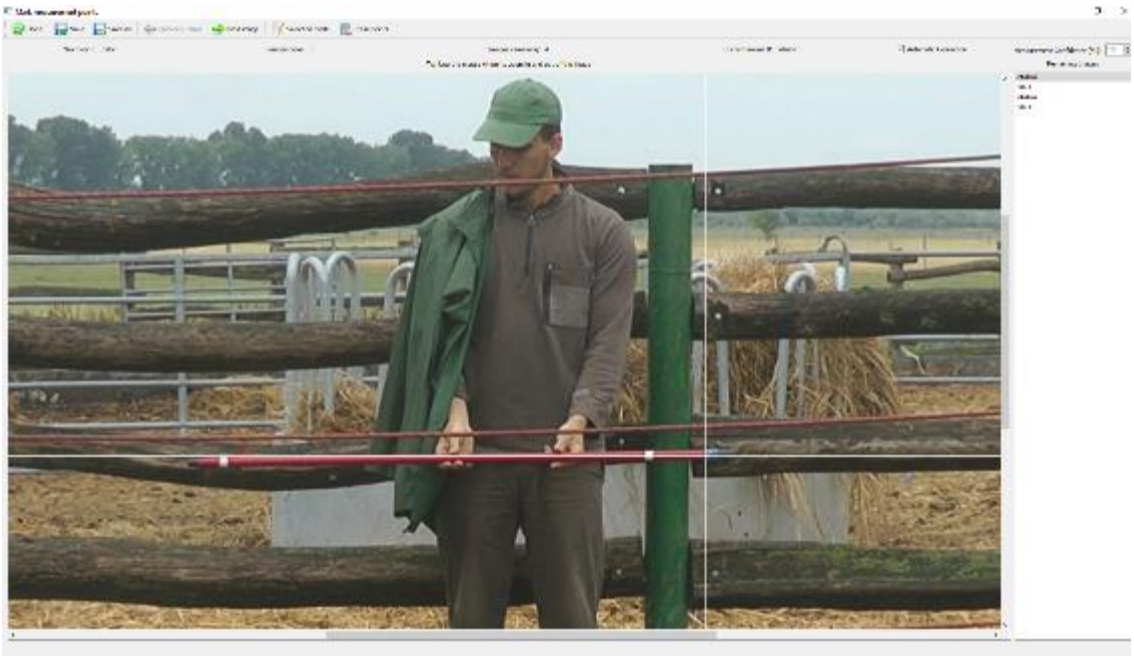
2.2.4. **The measurement**

In the next subtask the ends of the etalon and the anatomic landmarks will be indicated on the finished pictures.
Add a new measuring event to the project.

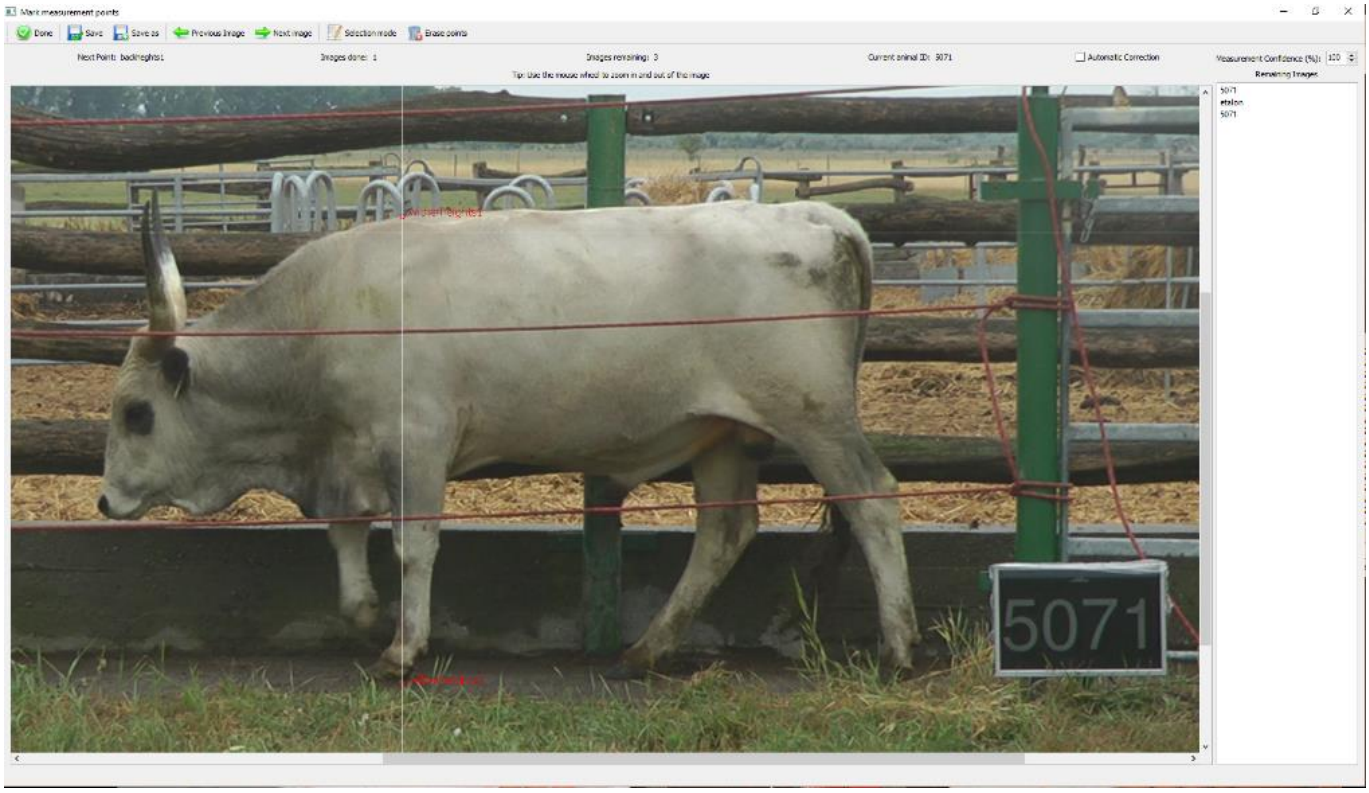


After that start the marking of the anatomic landmarks in the chosen images, in the "Mark measurement points" window.
On the right side of the window we can see a list of the selected images, and if it was selected so, the etalon's image will be the first one.
When selecting, the white reticle will follow the cursor, so that the landmarks which belong together can be exactly below each other and next to each other. For a greater accuracy, the image can be enlarged using the scroll wheel of the mouse. Information on our work can be seen above the image:

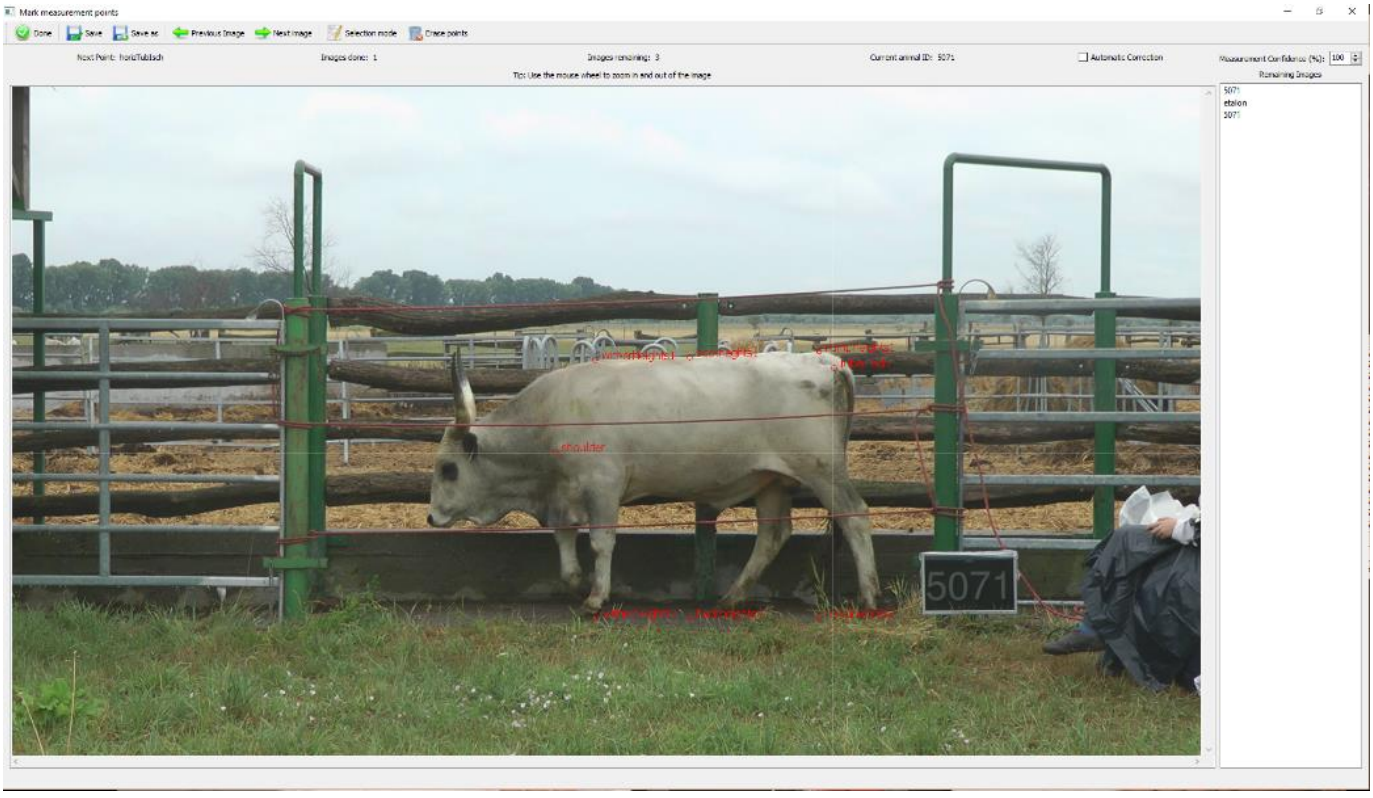
- **Next point**: the next landmark to be marked in the image.
- **Finished images:** the number of finished and measured images in the project, in which all the landmarks are marked.
- **Images remaining**: the number of remaining images to be measured in the project.
  Current animal ID: the identifier of the current animal (ENAR number, ear tag number).
- **Automatic Correction**: the program corrects perspective distortion by using the given camera distance.
- **Measurement Confidence** (%): the errors of standard images (sprinting, frightened animals, etc.) will decrease reliability of the measurement, and if such errors are noticed, it is possible to indicate that the image could not be assessed accurately. The reliability and confidence figures will also be indicated in the output database.



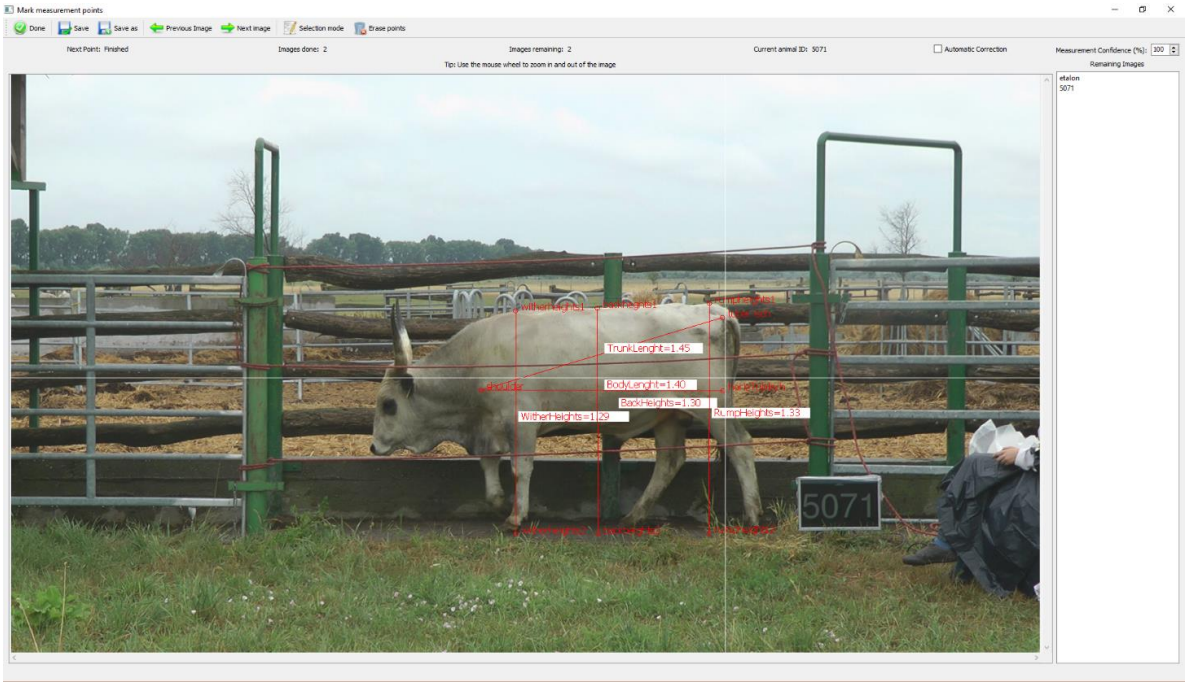
When measuring the animals the **next point** will always be the next landmark given in the measurement schema which is necessary for the measurement, and it is always in the order as provided in the schema. The images can be enlarged using the scrolling wheel of the mouse.
It is possible to jump between the current image and the previous or next one using the green arrows.

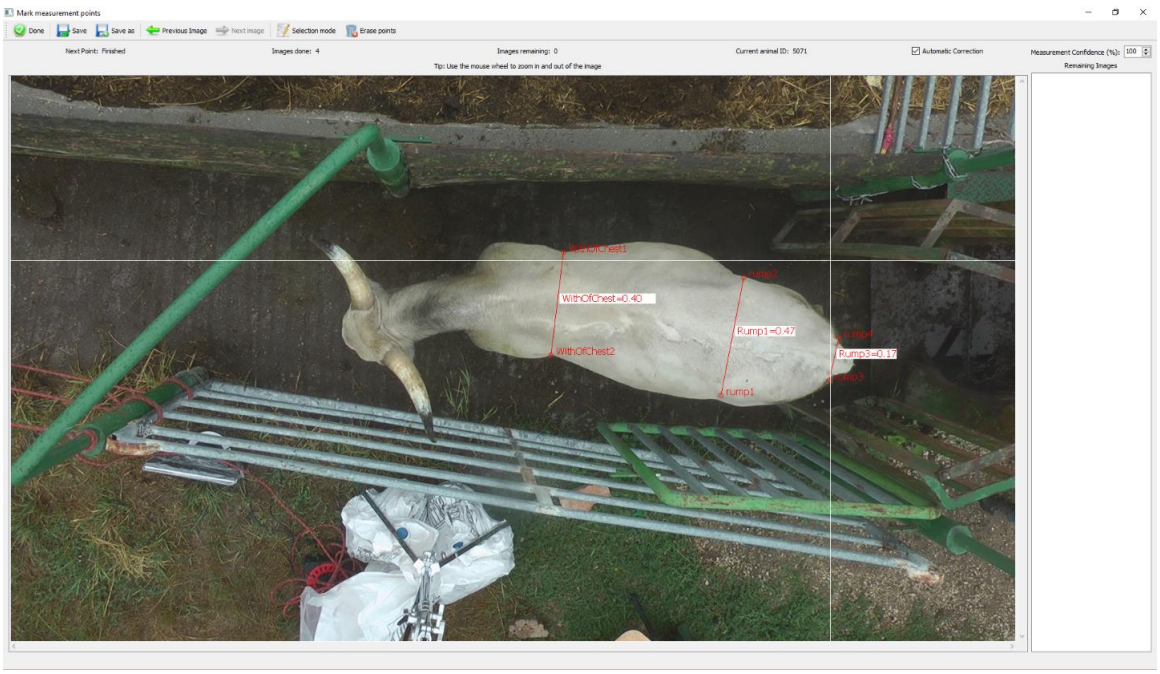


The program will not calculate the parameters until the last point is placed, and it will only mark those points which have been placed.



After the last necessary point is placed, the program will create the **measurement frame**, that is, it will calculate and write the sizes in the image, next to the lines indicating the parameter.

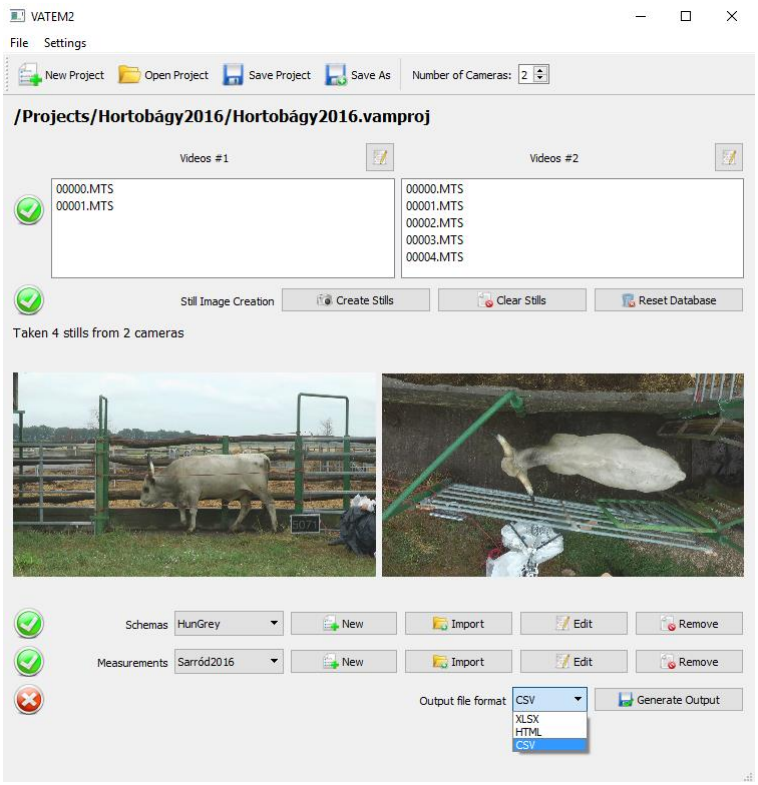




After placing all the necessary points (landmarks), save the project and close the **Mark measurement points** window.

2.2.5. **Exporting the data**

The data of the measurement can be saved in XLSX, CSV and HTML formats, in the given folder.



It is important that for documenting the measurement, the standard images and measurement frames will be saved by the project to the output folder of the library.