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in České Budějovice

dataPartner

Particular example

BioWes

www.biowes.org

Project supporte by the Technology Agency fo the Czech Republic

Technology Agency
of the Czech Republic

... from ideas to applications

Example description

- This particular example demonstrates individual steps of BioWes system usage. Its advantages in comparison with current systems of experimental work and management of experimental data and metadata.
- The guide introduce basic functionality of the system. The detail description of individual functions and procedures is available in the help.

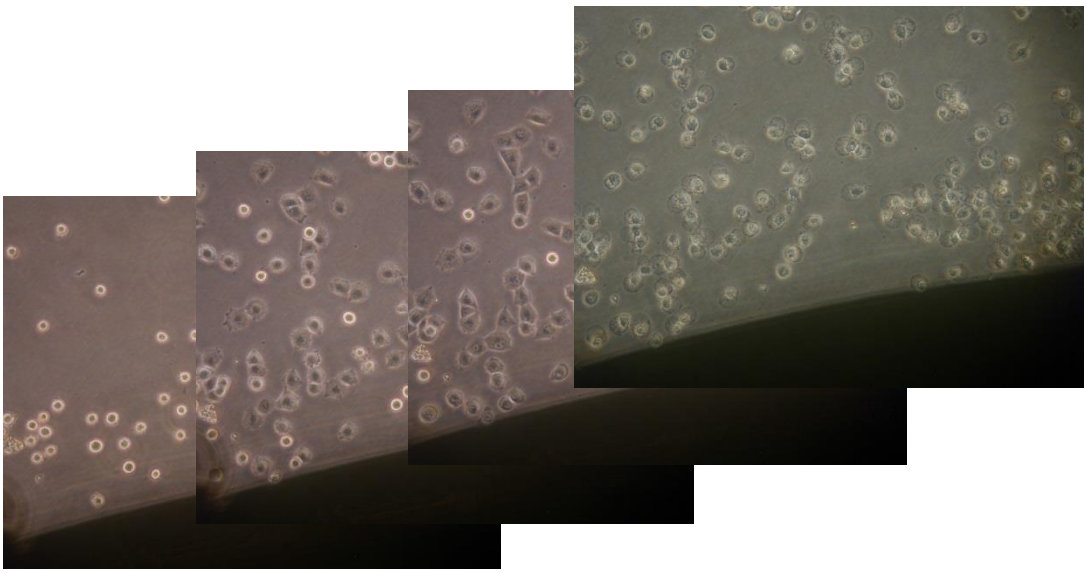
Particular example

Biocompatibility of materials:

- The aim of the biocompatibility experiment is to determine how the human body will react to the new material (dental implant).
- The first method of biocompatibility evaluation used before clinical tests is the tissue cells growth in the contact with the material.
- The method is based on the evolution of cell colony growth in defined time interval.(1-2 days).
  - The cells are put directly on the material inserted into the leachate of the material
  - Time lapse microscopy is used for the monitoring of cell activity. It produces series of images in given time intervals (2 minutes)
  - The expert analysis of cell behavior during time defines cytotoxicity level.
    - 0 – non toxic - cells are in contact with the material
    - 1 – weakly toxic – any is in the contact with material
    - 2 – middle toxic – there is zone of dead cells near the material - 30 um minimum
    - 3 – toxic – the cells are dead around the material
  - Several settings of experiment can influence the results
    - CO2 concentration
    - temperature
    - Cultivation medium
    - etc.

Particular example

- Investigation of bio compatible materials:
  - The sample of the material can be prepared in a different manner. This method of preparation may affect the results of the experiment and therefore must be included in the description of the experiment and method of sample preparation.
  - From the perspective of reproducibility it is necessary to capture all the variables that can influence the behavior of cells in the protocol of the experiment. All of these variables must be described in the protocol of the experiment



- Sample images from the time-collection microscopy

The procedure

The procedure of preparation, measurements (obtained experimental data and metadata) and subsequent manipulation of data can be summarized into the following steps:

1. Creating a user account to access the system
2. Create experimental protocol
3. Execution of a particular measurement
4. Evaluation of measurement
5. Sharing data and metadata for further analysis of the results

The classic approach

The classical approach of performing experiments and data manipulation includes the following specific implementation of the main steps:

1. Create experimental protocol
    1. Build a paper version of the experiment (typically Word document)
        - The use of standards is limited to knowledge of terminology
        - Unable to create Help for people conducting experiments in the form of preferences (the type of microscope)
        - Reusability of protocol is limited mostly to the person who created the protocol (protocols are not shared)
2. Execution of a particular measurement
    1. The experimenter performed according to the protocol experiment, experiment and experiment setup fills in the protocol
        - The person conducting the experiment need not fill in all the information necessary for repeatable experiments
        - Information provided by the measuring device must be manually added to the protocol
        - Protocols (eg, supporting protocol for sample preparation) can only link the identification numbers - you need to search these logs manually
    2. The measured data are not physically linked to the measurement protocols (data are stored on a computer connected to the meter or stored in a shared folder with restricted access without the hierarchy)
3. Analysis of measurement
    1. Data must be analyzed where they are stored or transferred (email, data file storage, sharing disk space)
    2. Cooperation of more people to the analysis is complicated
4. Sharing data and metadata for further analysis of the results
    1. Sharing and data search is complicated due to their heterogeneous storage, the terminology used and the separate storage of data and metadata

BioWes system

Use of BioWes for experimentation and manipulation includes the following specific implementation of the main steps:

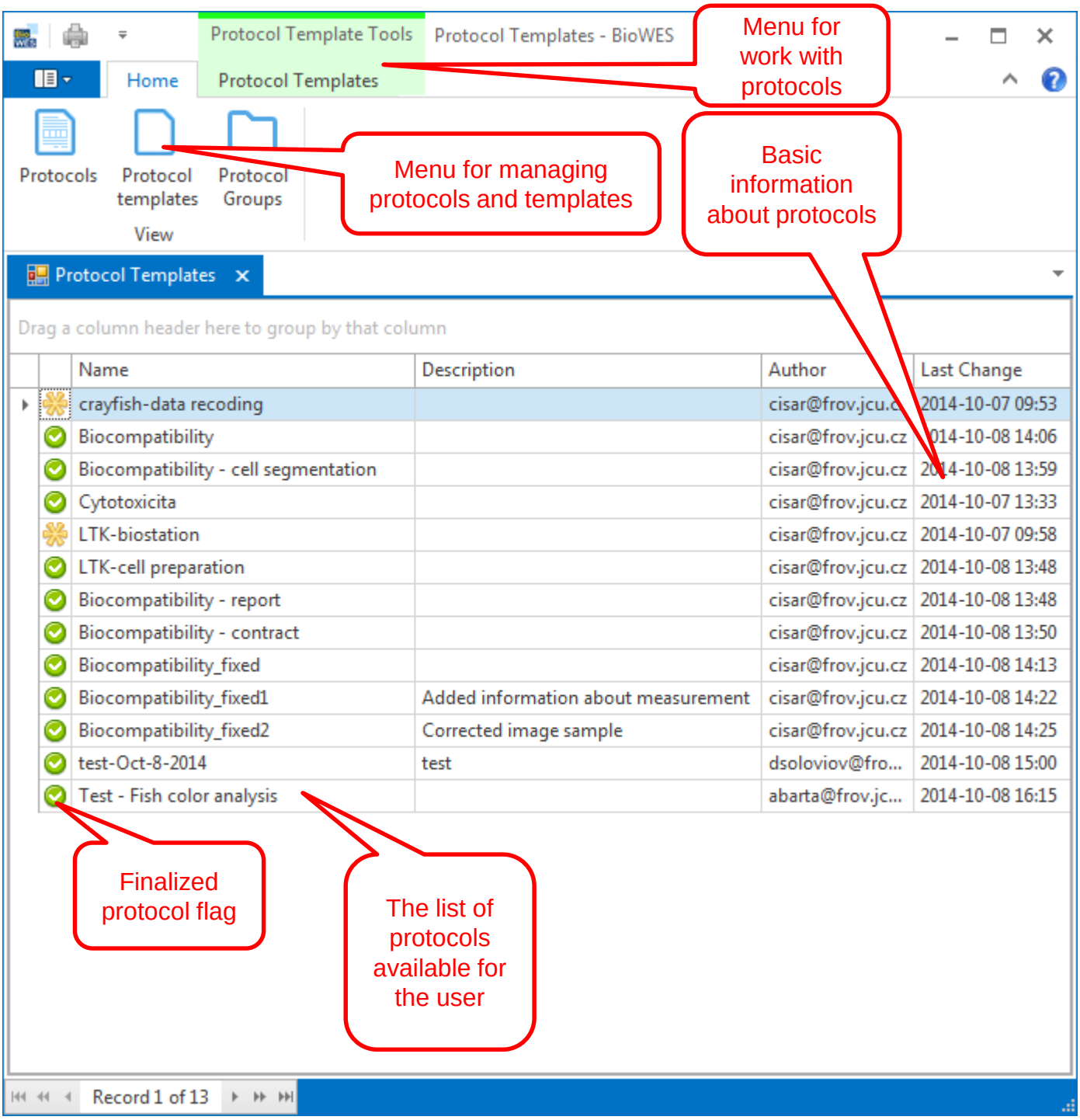
1. Creating experimental protocol
    1. Electronic model protocol - electronic version of the experiment, stored in the database
        - Graphic design using predefined components
        - Easy to use standardized terminology as a "whisperer"
        - The definition of preferences for each user input (usual input s - type of microscope, magnification)
        - Save the log in the database allows for easy re-use
2. Execution of a particular measurement
    1. The experimenter conducting an experiment using protocol template and completed the experiment setup by software
        - Software ensures completion of all relevant information in terms of repeatability
        - The possibility to automatically retrieve data from the measuring devices
        - Linking protocol with other supporting protocols
    2. The measured data are physically linked to the protocol. All the experiments are stored in the database together
3. Evaluation of measurement
    1. Easy sharing of experimental data or metadata
    2. Cooperation of more people is simple
4. Sharing data and metadata for further analysis of the results
    1. Sharing and retrieval of data is available through the web interface of the local database and allows easy collaboration and re-usability of metadata

Division of the system

The BioWes system is accessible through two basic access points

- Protocol manager (requires installation on local computer)
  - Provides access to the local database
  - Provides the creation of protocol templates, execution of a specific experiment and interconnection of experiments
  - It provides further analysis of experimental data using data-mining modules
- Web interface - local
  - Platform-independent access to the local database
  - Allows viewing of experimental data and metadata
  - Allows sharing of experimental data and metadata, and setting access permissions
  - Allows to search in metadata of the experiments

Protocol Manager



Creating a protocol template

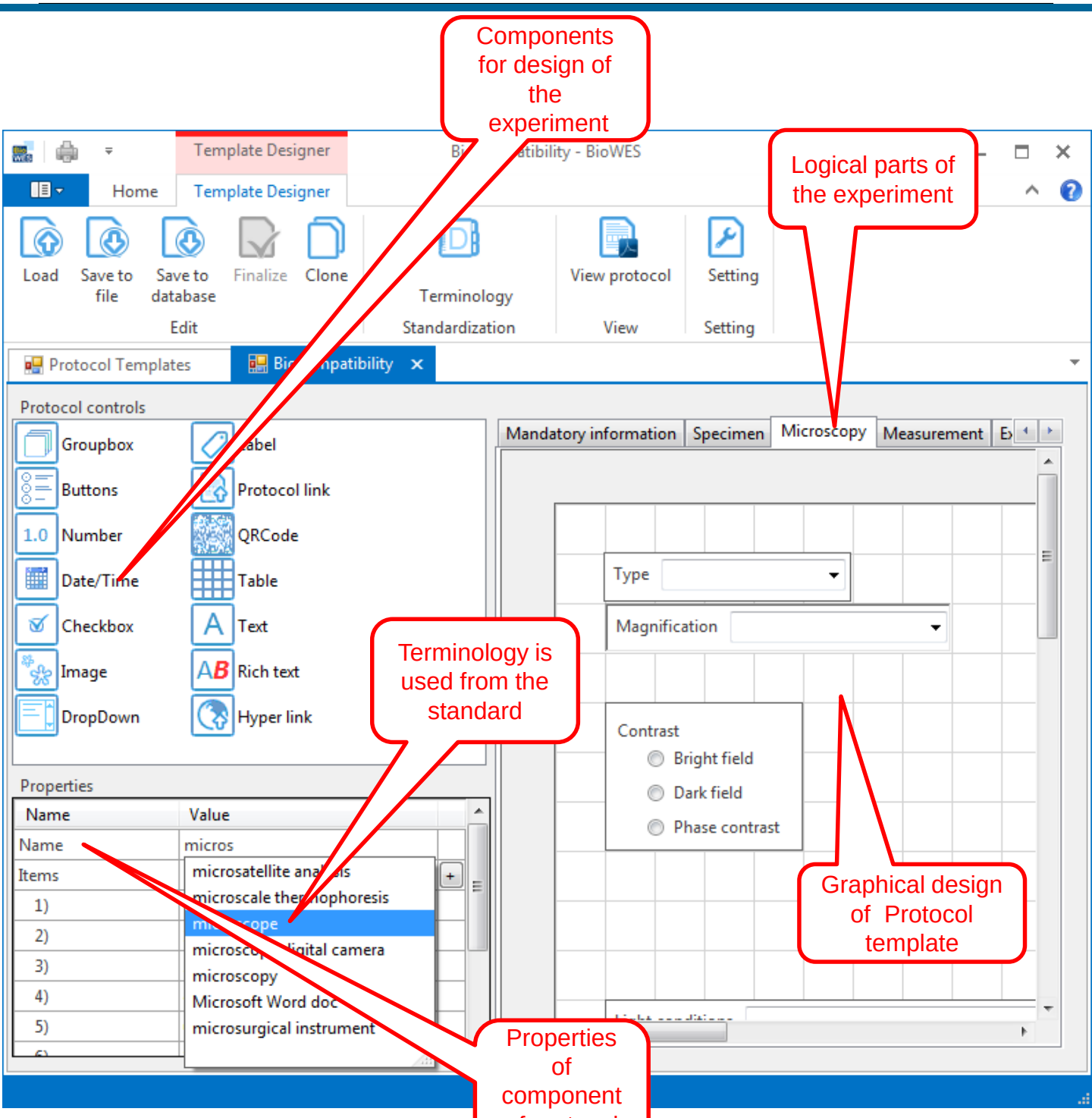
The process of creating a protocol requires expert knowledge of the experiment. The experiment is divided into logical parts (material description, a description of the sample, a description of the microscope, a description of data acquisition). The variables that need to be monitored during the experiment are identified for each part of the experiment and their values are recorded.

1. The user creates a new protocol template (modifies the existing model of the protocol) using the software Protocol manager
2. User will design a protocol template using a graphics application Protocol designer
3. The user saves a protocol template to the database
4. User shares protocol template to colleagues for final inspection and finalization (lock of template)

Creating a Bio – compatibility protocol template

- In Bio-compatibility experiment it is needed to record data about the material, microscopic specimen, the microscope settings and properties of the scanning
- For this reason, the protocol template is divided into four logical parts
- Terminology in the field of bio-compatibility is included in the ontology of Eagle-I Research Resource Ontology, available via the portal - Bioportal - the standard was connected and used to design of the protocol template using the software
- Some of the information of scanning images of cells can be retrieved by using a specialized plug-ins directly from the image itself and it is in this format protocol template plug-in used

Creating a Bio – compatibility protocol template



Creating a protocol template - Bio-compatibility

- The protocol template was stored in the database under the name Biocompatibility

Realization of measurement

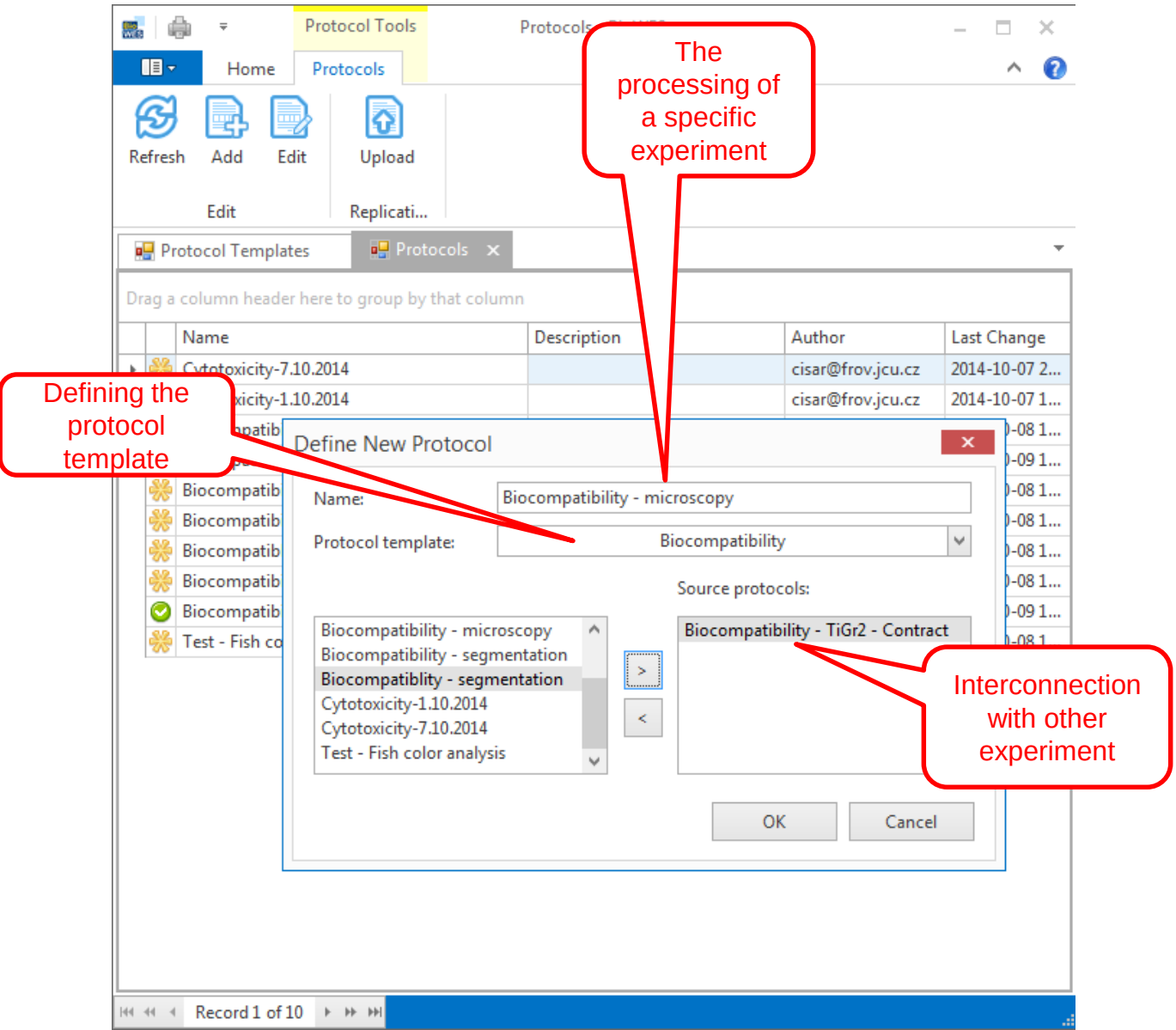
The process of a particular measurement is based on the usage of the Protocol template and the fulfillment of specific values. The user uses the information contained in the Protocol and fills information (using information provided by the measuring device) using the protocol generator.

1. The user creates a new protocol using software Protocol manager
2. User interconnect protocol with other protocols
3. The user makes the completion of all relevant information for a given experiment.
4. The user connects the experimental data to the protocol and stores them in a local database

Realization of the measurement

To measure cell cyto-toxicity, the protocol template Bio-compatibility stored in the database was used.

The protocol is linked to the sample preparation protocol (nano fibers), which was conducted prior to the experiment. The protocols related to the same experiment are linked in this way.

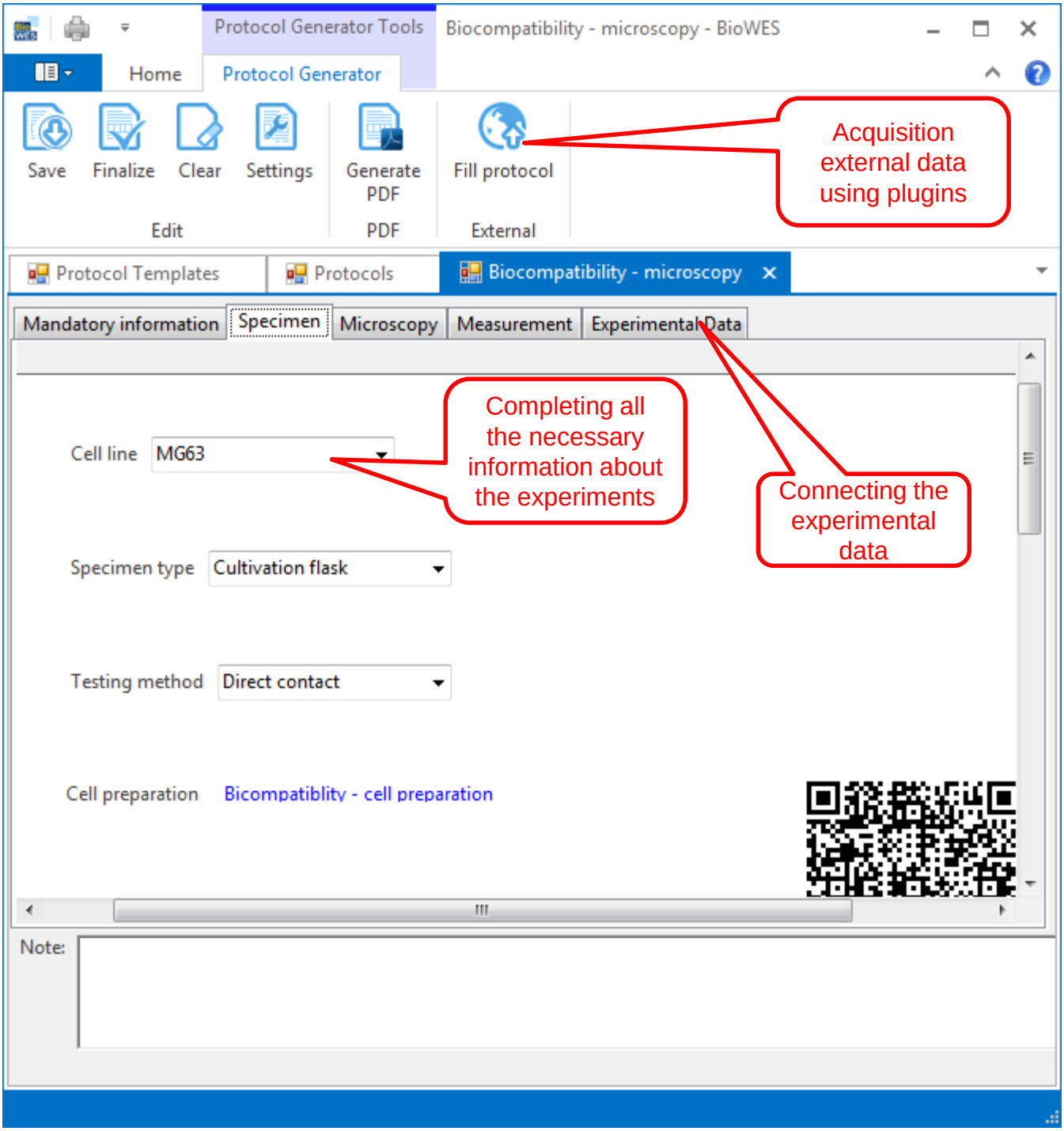


Realization of the measurement

The output of measuring cytotoxicity is a series of microscopic images of cells and material.

1. The user has filled in all the information about the cultivation, setting a microscope and a scanning method in the protocol
2. User received information about the camera from EXIF information stored in captured images
3. User stored the protocol with data into the database under the name Biocompatibility - microscopy

Realization of the measurement



Further data processing

As part of further data processing it is necessary to share data or metadata with coworkers. For this purpose, the Web interface of the local database is used.

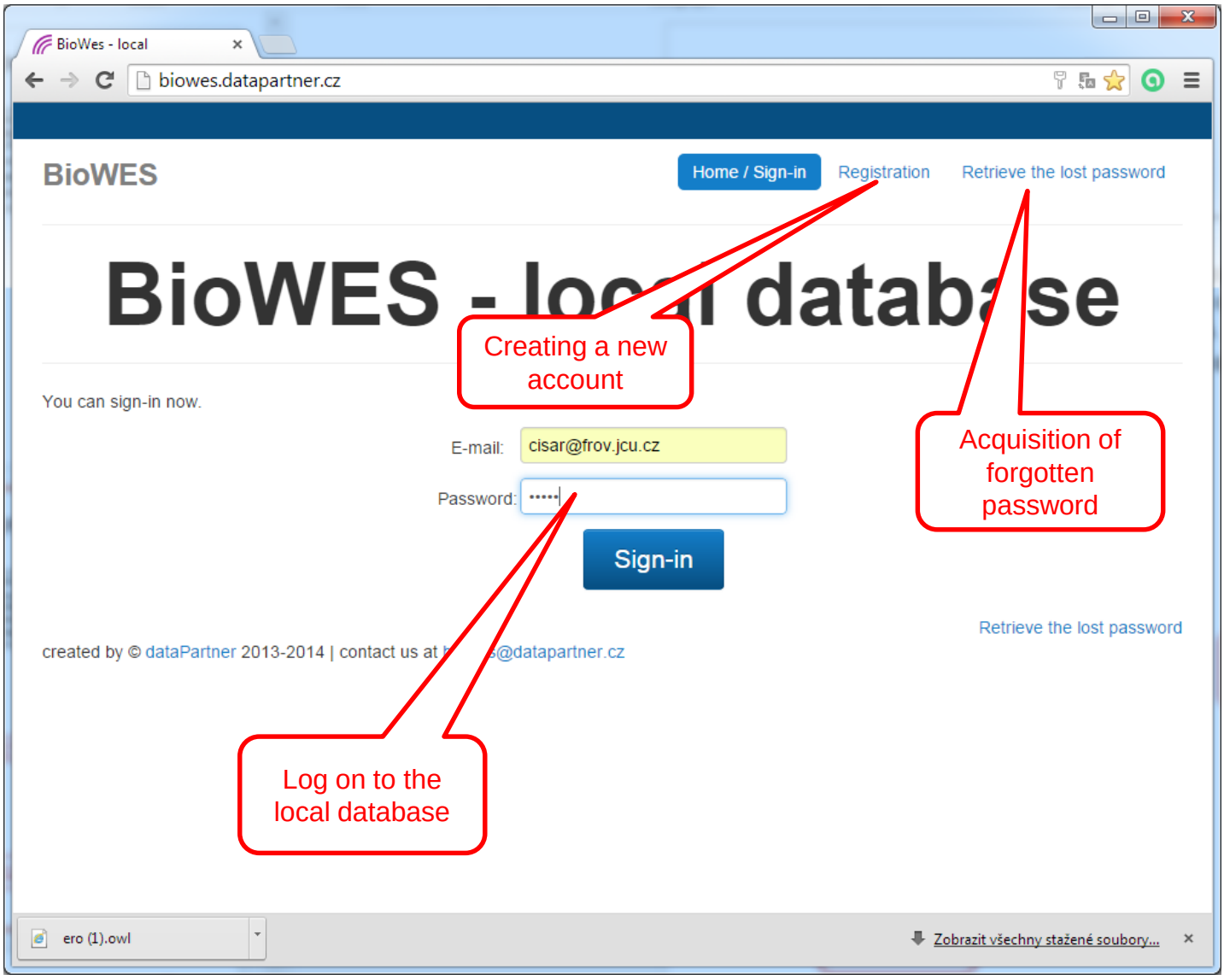
1. Sharing data with coworkers
2. Search of experiments by metadata experiment
3. Data processing and their re-store in the system
4. Visualization chain processing of experimental data

Further data processing

1. Sharing data with coworkers

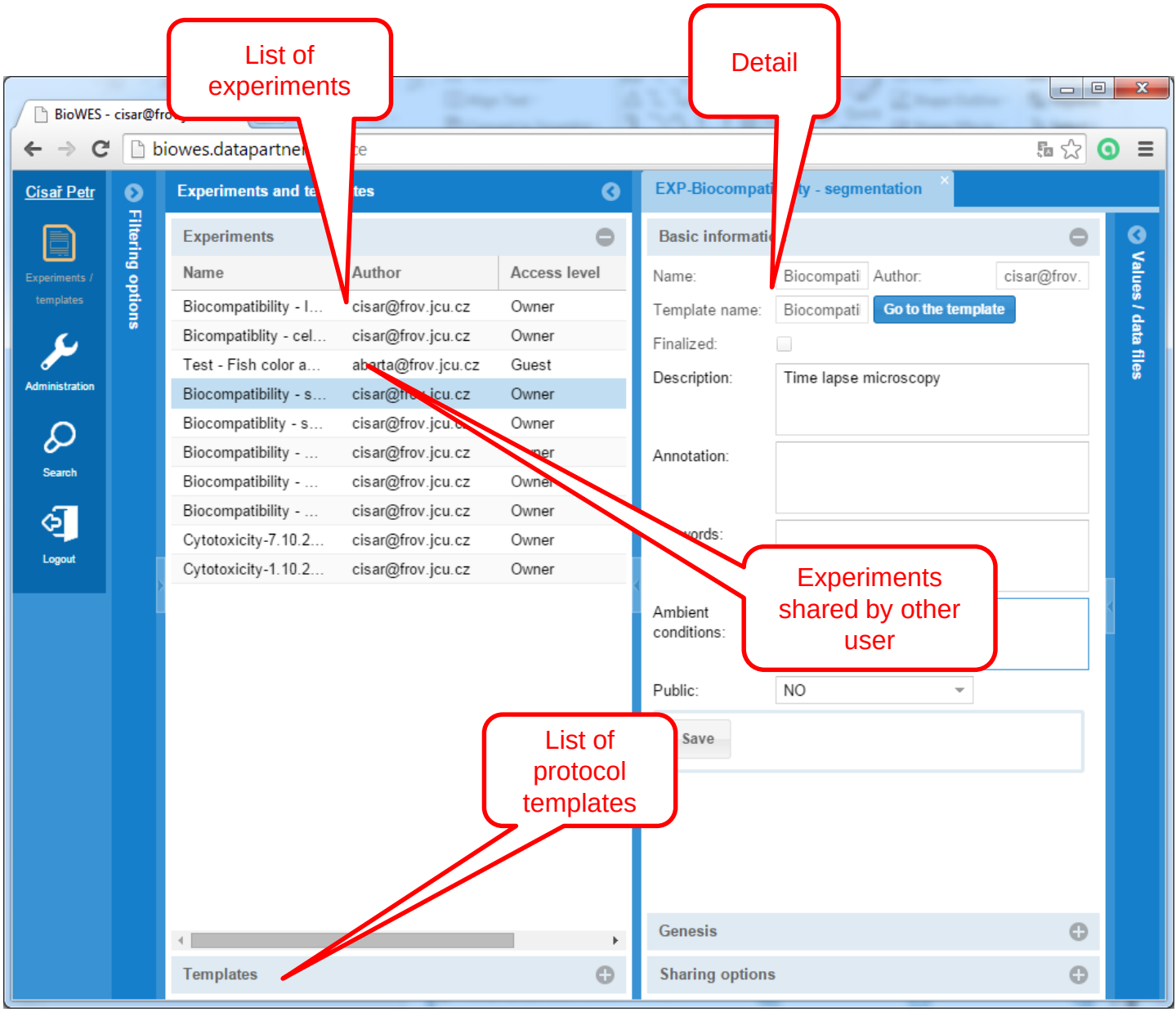
After obtaining the data from time-lapse microscopy data are shared to the worker that performs the detection of areas of cell colonies and evaluation of cyto-toxicity materials.

Using the web interface, the person who carried out the experiment log in to your account.



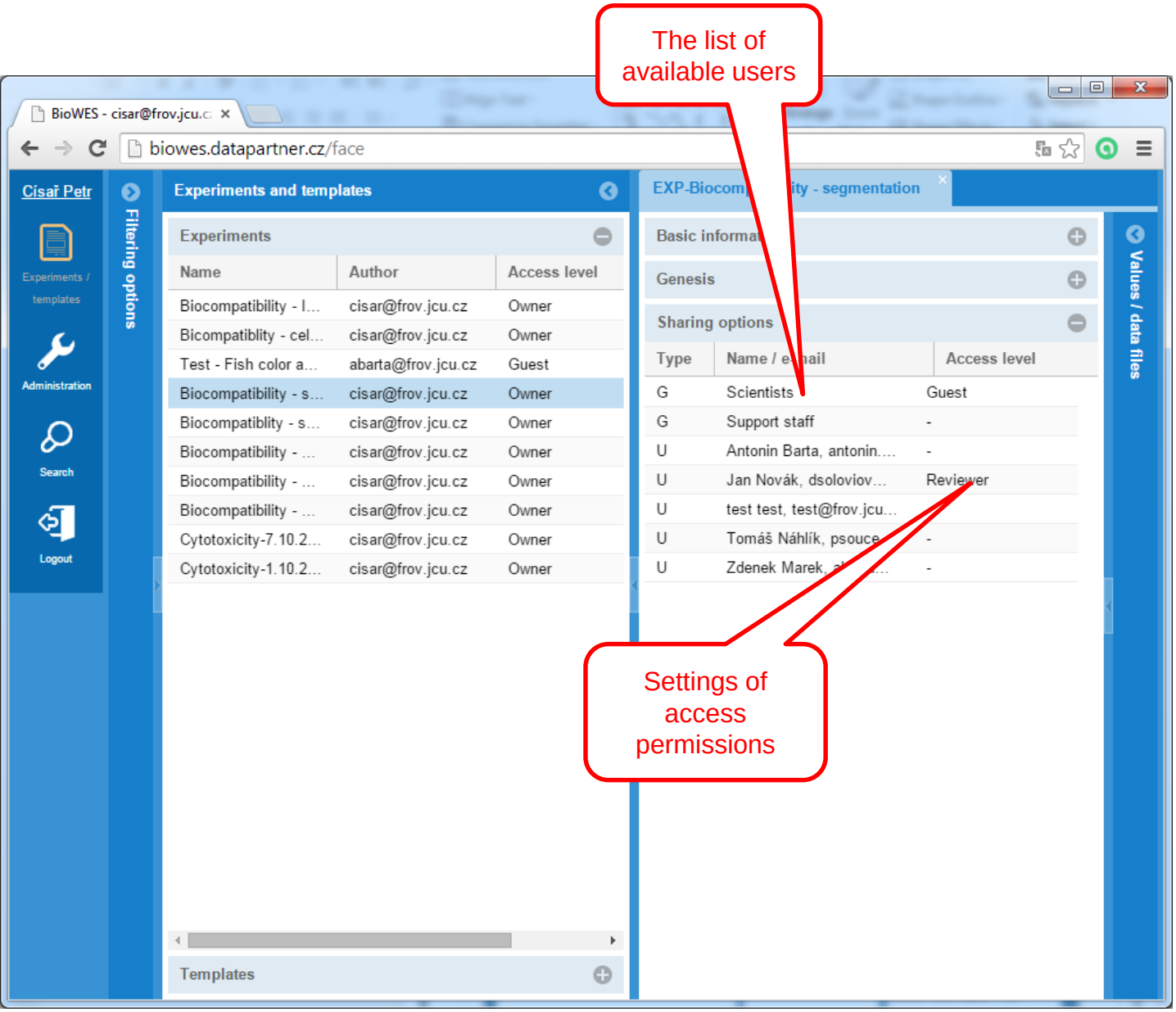
Further data processing

The web interface allows to obtain information about experiments or protocol templates, sharing, searching and downloading data from the local database.



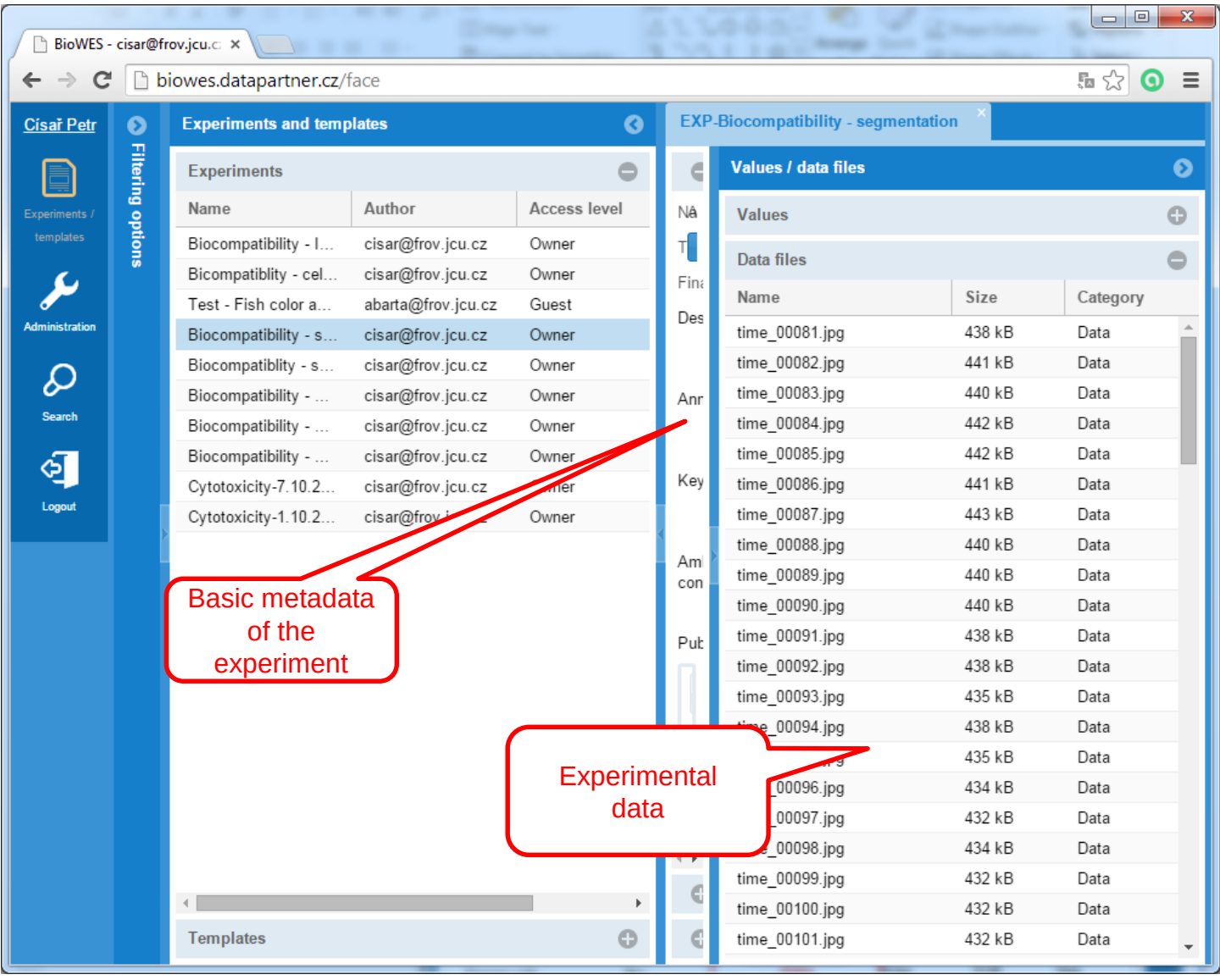
Further data processing

The experimenter shares experimental data to a worker who realize the processing using read-only rights to prevent modification of the measured data.

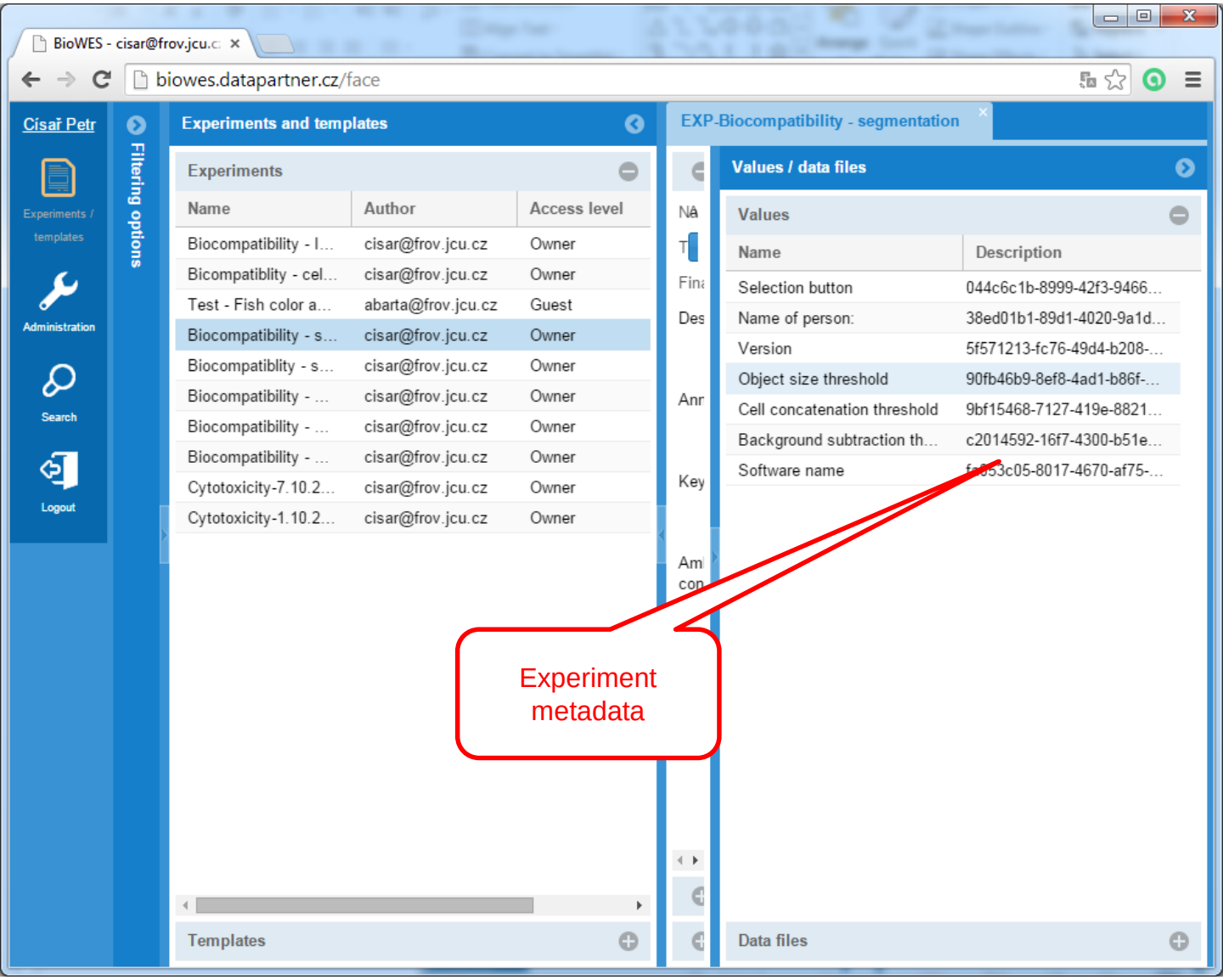


Further data processing

A worker who is responsible for further data processing logs into his account. Select a shared protocol and stores the experimental data from the database on his local computer through dialogue of experiment details.

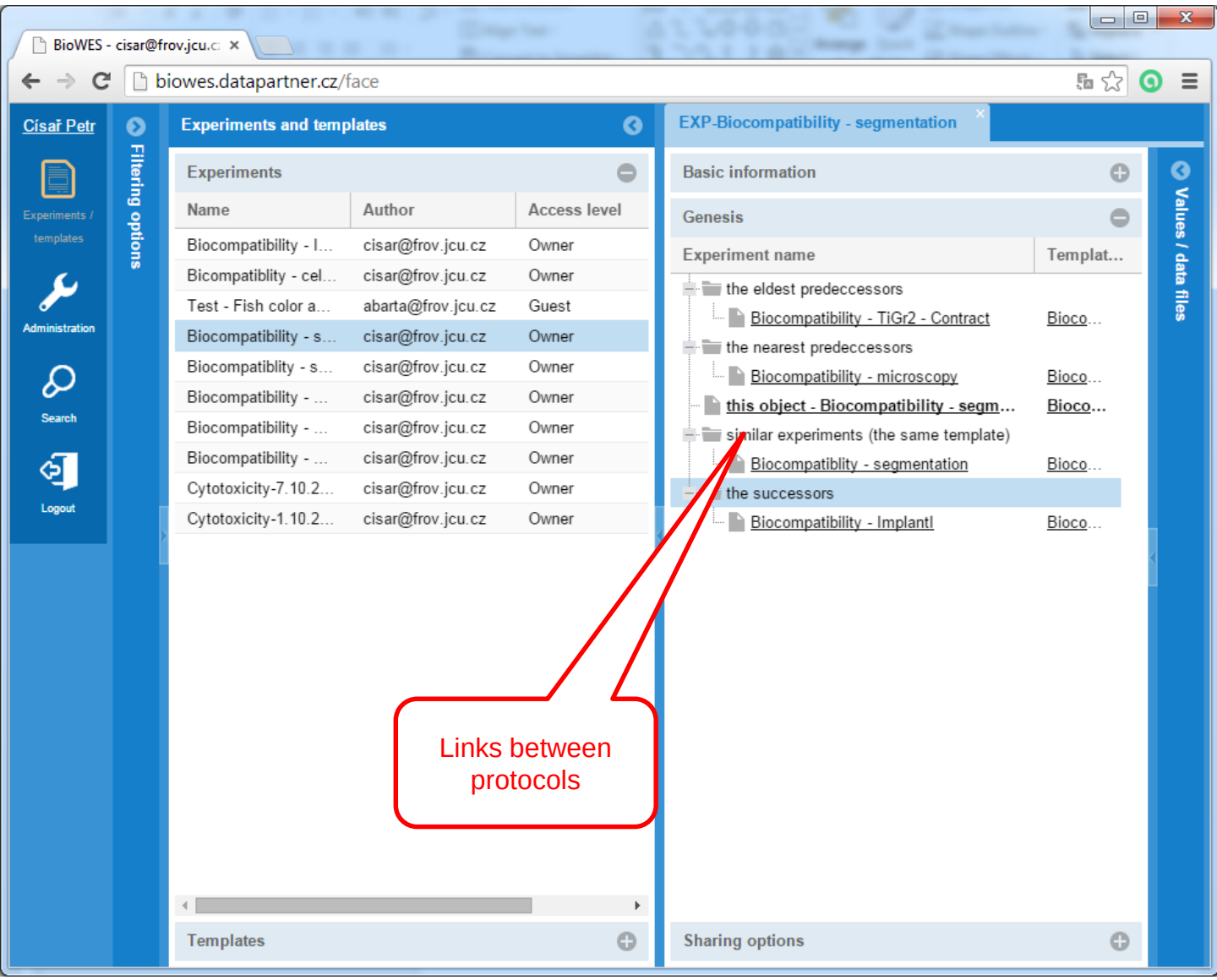


Further data processing



Further data processing

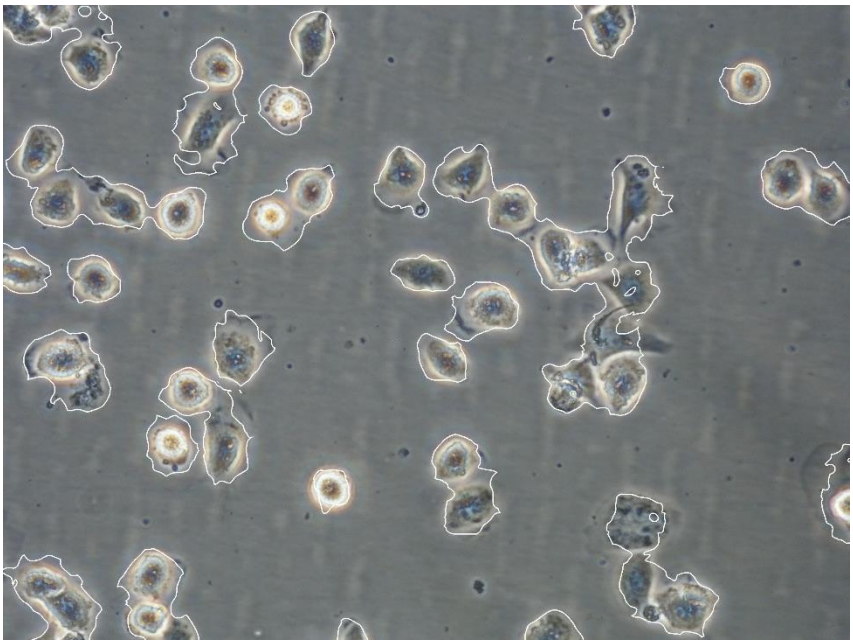
The data processing chain can be visualized in protocol genesis to see the relations between protocols.



Further data processing

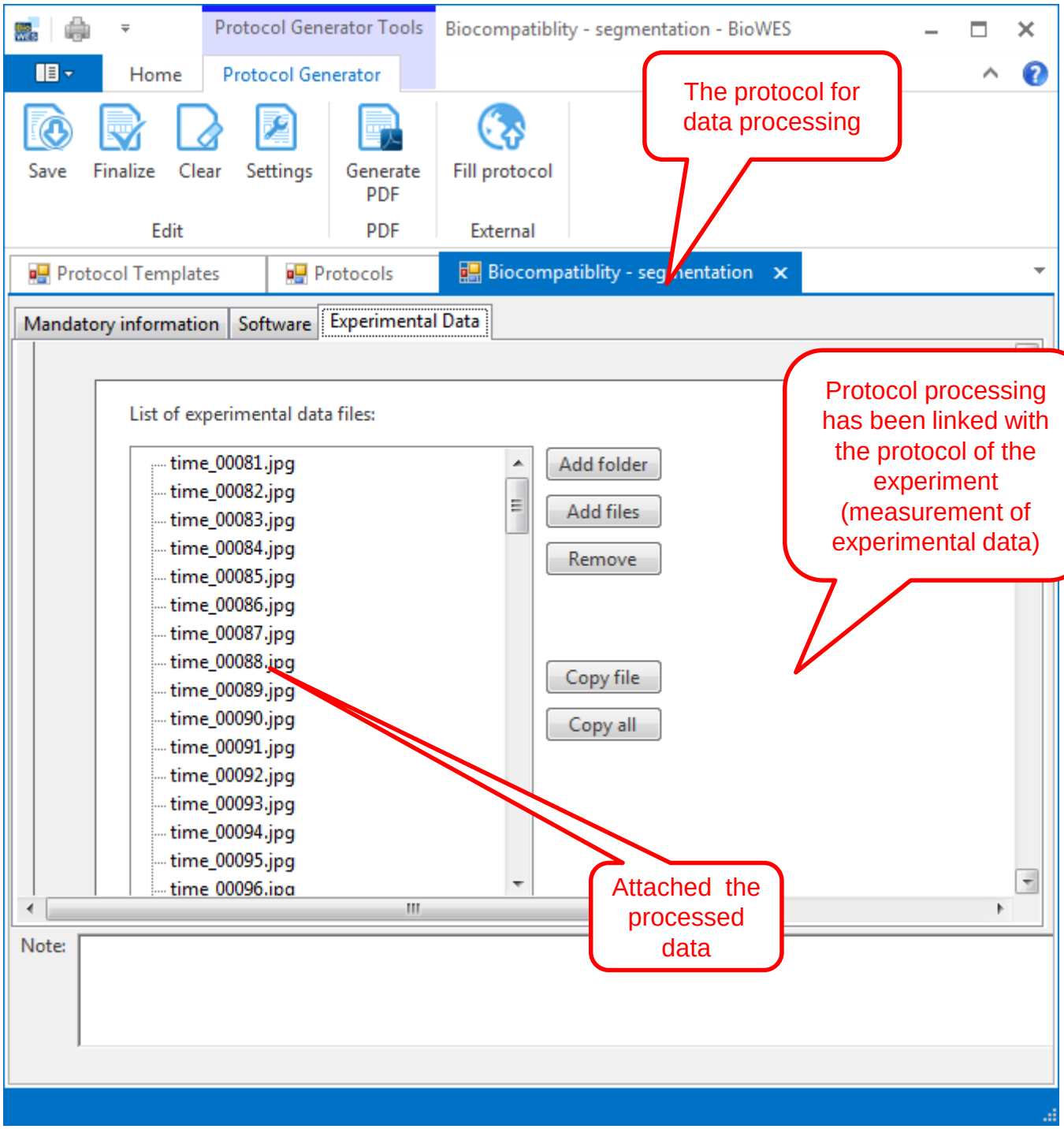
Data processing and their re-stored in the system.

As a further step, method of determining the cyto-toxicity is to determine the cell area during the measurement by which it is possible to determine the behavior of cells. For these purposes, the software for automatic segmentation of cells is used. For the segmentation, a new protocol (using Protocol manager) that contains information about setting up of segmentation methods (affects the outcome) is created and the segmented data are attached to protocol. This protocol is attached to the protocol describing a measured data. This creates a chain of data processing that can be visualized in the web interface.



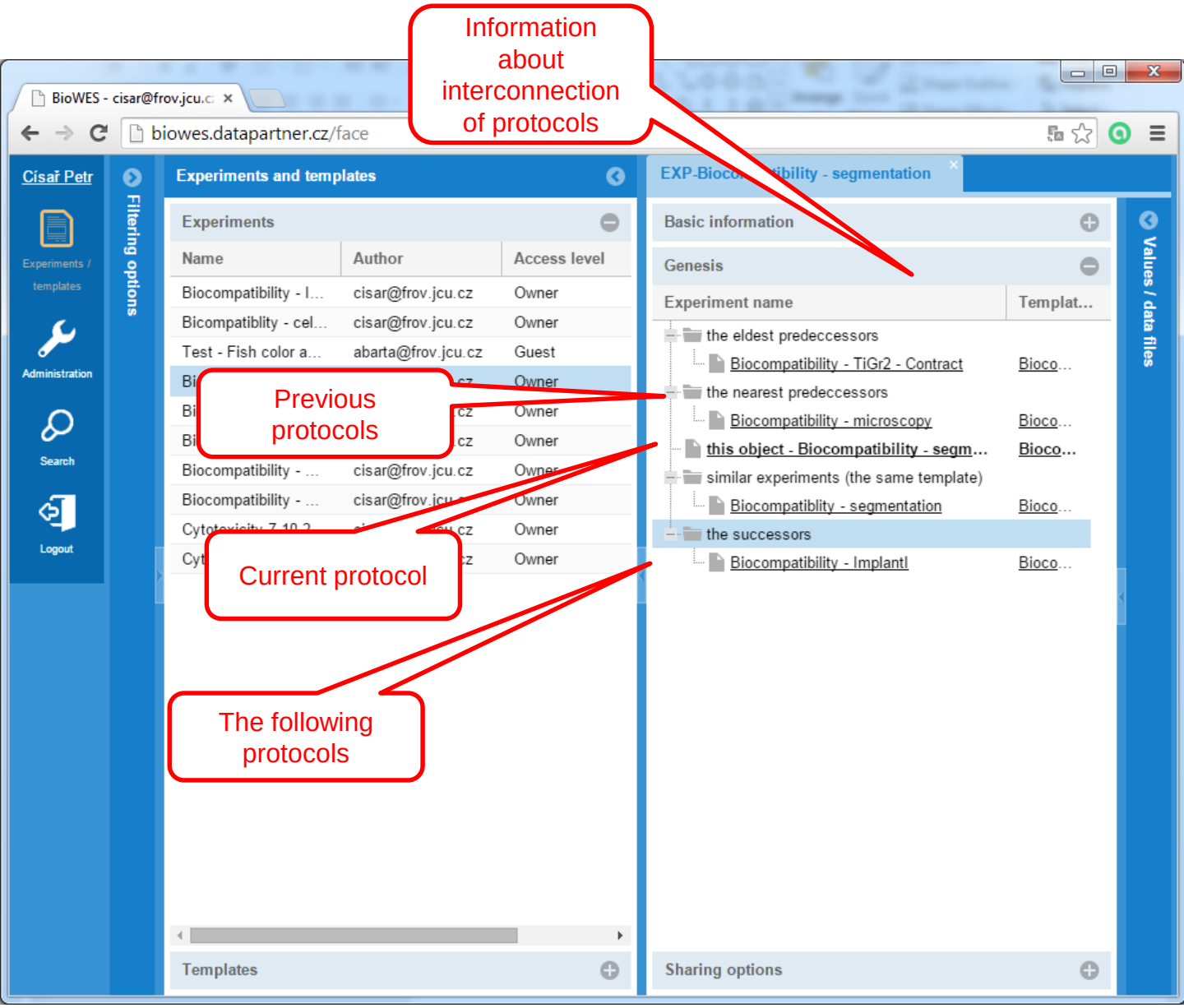
Example of segmented cells

Further data processing



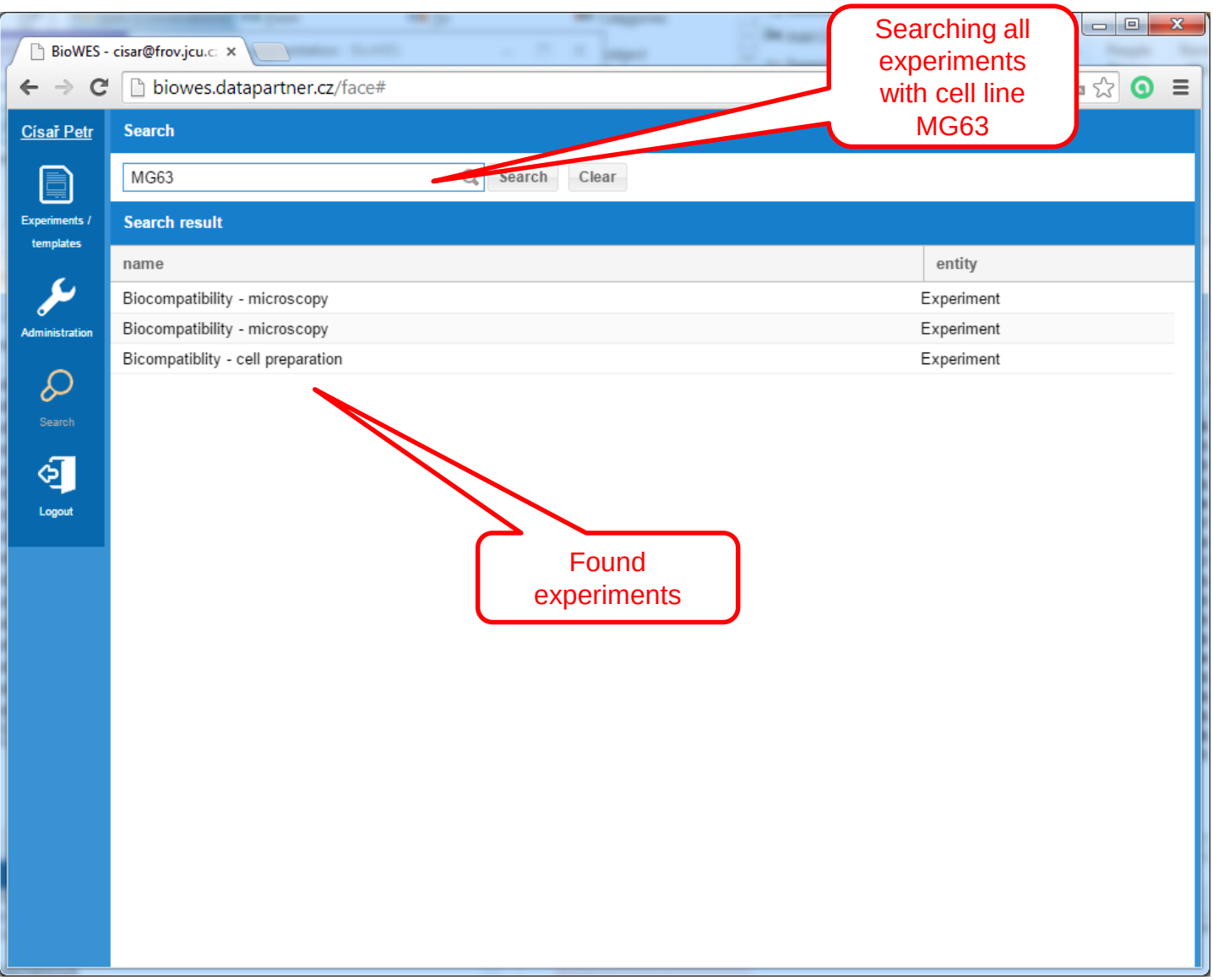
Further data processing

The employee shares the protocol of data processing to the supervisor, who will evaluate cyto-toxicity of the material based on the processed experimental data. The web interface provides information about the entire processing chain.



Searching

The web interface enables full-text search in the metadata model protocol and the protocols themselves. In this way it is possible to trace experiments with given conditions and get information about them.



The conclusion

The BioWes system allows several collaborators working over a single comprehensive experiment from the design of the experiment, actual measurement to the further processing of the experimental data.

Metadata (information about the experiment) and data (experimental data, processed data) are stored in a local database and interconnected.

All information is secured by access permissions that are fully managed by individual users.