TESCAN FIB-DIC Acquisition

Instructions for use

Version 1.0

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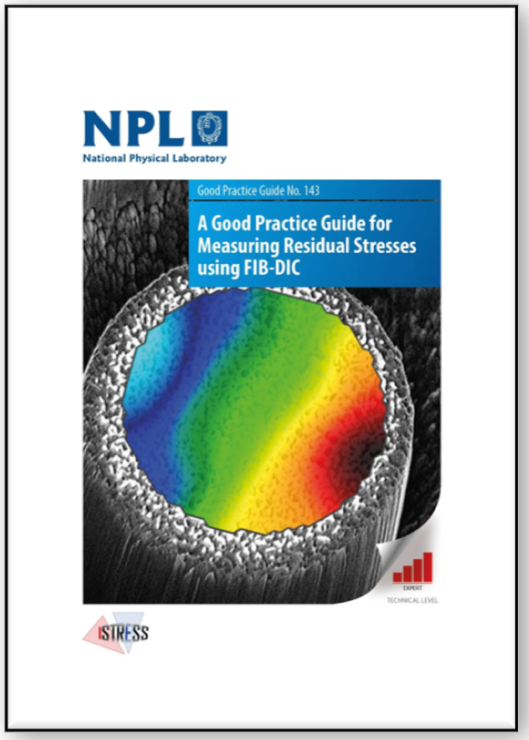
1 Introduction

The FIB-DIC module is intended for automated acquisition of image data for measuring residual stresses using the FIB-DIC technique. With this method standard geometries are milled using the focused ion beam (FIB) and the surface displacements resulting from relaxation captured from the scanning electron microscope (SEM).

The FIB-DIC acquisition module was developed as a part of the european FP7 iSTRESS project "*Prestandardisation of incremental FIB micro-milling for intrinsic stress evaluation at the submicron scale*" supported by funding from the European Commission under EU Contract NMP.2013.1.4-2.

The FIB-DIC technique and terminology is well described in a Good Practice Guideline:



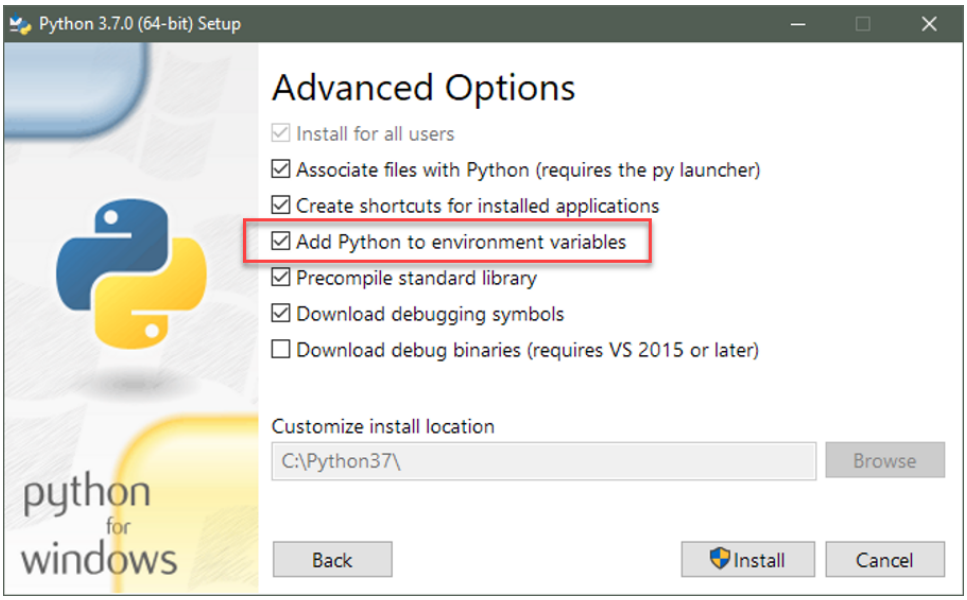
http://www.npl.co.uk/upload/pdf/gpg143.pdf

2 Installation of the FIB-DIC software

Compatibility

The FIB-DIC software is compatible with TESCAN FIB-SEM microscope manufactured from 2010 and later with the latest control sw update.

1. Extract the package into any folder on the microscope PC.
2. From the "packages" folder, run installation of the Python 3.7 installation.
   - In the options select **Add Python to environment variables**.



   - Restart the PC.

3 Setting Up FIB-DIC Acquisition Process

3.1 Prerequisites

1. Make sure the FIB-SEM control software is running.
2. The both SEM and FIB are ready to use.
3. If GIS is used for deposition, must be heated for at least 10 mins before the deposition.
4. The sample must be tilted to **55°** and navigated in the **FIB-SEM intersection** (see FIB-SEM manual).
5. Known material properties:
    - Milling rate (for calibrating a new material; see FIB-SEM manual)
    - Young's Modulus and Poisson ratio

3.2 Making fiducial marker

1. In the TESCAN FIB-SEM control software, navigate the sample to the position where the measurement should be done.
2. Open the *AutoDIC.dbp* project in the **DrawBeam** software.
3. Select the *DriftCorrection 1* layer and run it to make the fiducial marker.
4. In the **Geometrical transformation** panel: turn on the Tilt correction **Follow sample surface** mode.

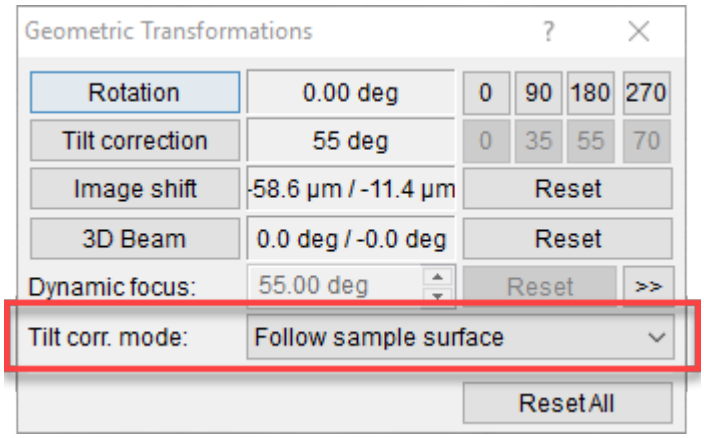


Figure 1 Geometric transformations are set to the **Follow sample surface** mode.

3.3 Depositing pattern for DIC

If the sample surface is not rough enough for DIC correlation, it is recommended to use a e-beam deposition of the random point pattern.

1. Select a layer for deposition a pattern appropriate to selected milling shape e.g. for Ringcore 5 µm milling, select a Sunflower 5 µm pattern deposition.

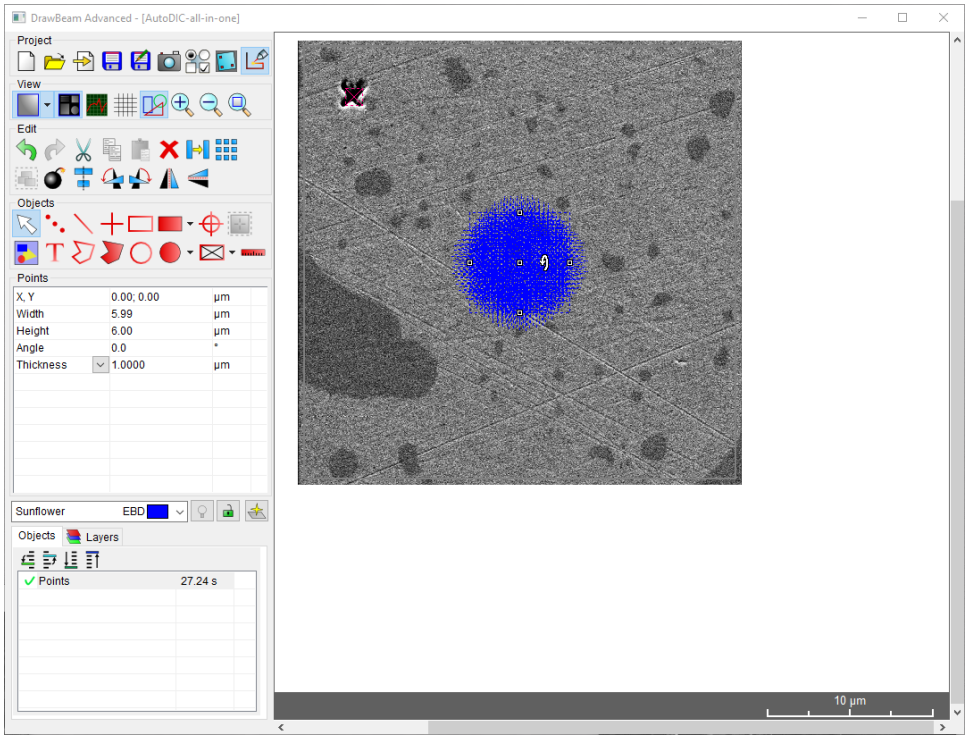
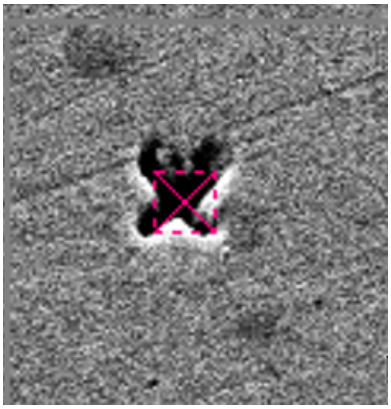


Figure 2 Fine alignment of the EBID pattern position.

2. Set the conditions for electron beam deposition:
    a. Open the **Beam Blanker** panel and set electrostatic beam blanker to the **Enable Beam on Acquisition** mode.
    b. Set the SEM beam conditions to about 1 nA (e.g. Analysis / Depth mode 5-10 kV, BI=15) and adjust the image centering and astigmatism perfectly.
3. Select the SEM image as a background for the DrawBeam canvas using the 

to see where the pattern will be placed.
4. Insert the GIS to the working position for Pt deposition.
5. Align the SEM image of the fiducial to the cross from the *DriftCorrection 1* layer in the DrawBeam using **SEM image shift**.



6. In the DrawBeam process panel click on  icon to recalculate the beam current and Run the deposition layer.

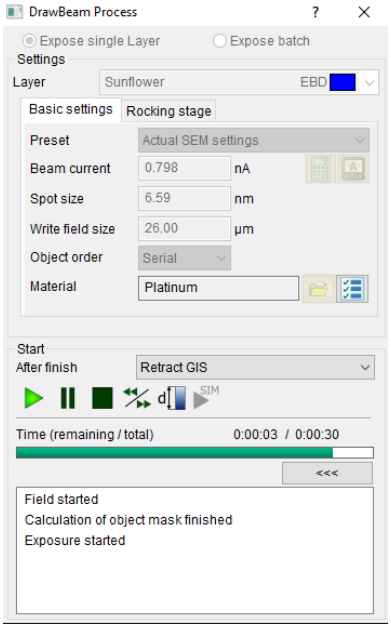


Figure 3 Running the deposition of the pattern.

7. Wait until the layer is finished and then retract the GIS (if not selected to retract it automatically).

3.4 Starting the FIB-DIC software

1. To start the software, double-click on the *FIB-DIC.bat*.
2. The GUI on the following figure should start + console window with process log.

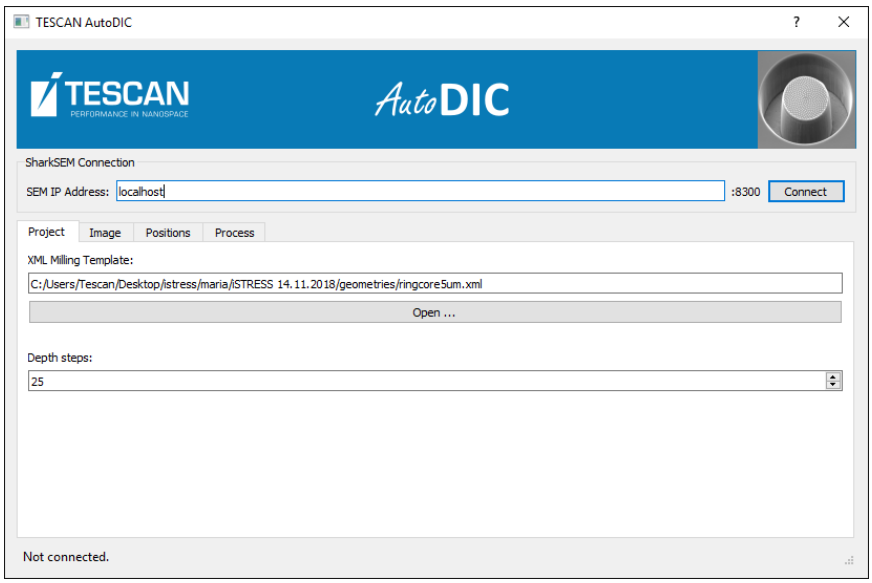
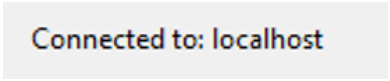


Figure 4 FIB-DIC acquisition software interface.

3. Check the IP address of the microscope („localhost“ should work well if installed on microscope

PC) and click on **Connect** to establish the remote connection. The *Connected to …* should appear in the statusbar when connected.



3.5 Selecting milling geometry

The FIB-DIC software allows selecting a template defined milling geometry.

The geometry is defined in the XML file compatible with the SharkSEM Remote DrawBeam control (see SharkSEM Remote Control - DrawBeam Extension documentation). The selected template represents a „DrawBeam Layer“ as a single depth step in the FIB-DIC acquisition procedure.

1. Select the milling XML template from the „geometries“ folder in the FIB-DIC main folder, e.g. *ringcore5um.xml* represents a single step with 200nm depth for ring core 5 µm diameter geometry.
2. Select the number of the depth steps follow the recommendations in the Good Practice Guideline - e.g. the total depth for the ring core geometry should be the same as the internal diameter of the ring core, i.e. 25 steps are necessary for *ringcore5um.xml* geometry.

3.6 Setting the imaging conditions

In the FIB-DIC software **Image tab** you can set up imaging conditions for each acquisition step.

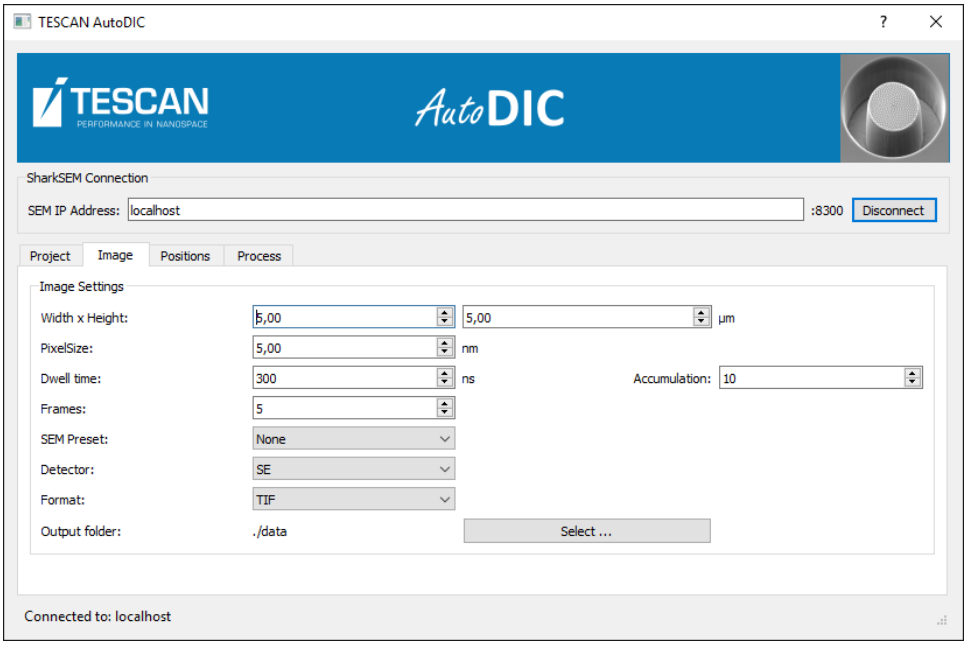


Figure 5 Defining image acquisition parameters.

The **Width x Height** represents image dimensions in micrometers.

The **PixelSize** defines the image resolution.

The **Dwell Time** defines the image acquisition speed.

The **Accumulation** defines a number of scans accumulated within one frame (using DCFA).

The **Frames** count stands for number of images that will be stored in each step (for better statistics).

The **Detector** defines an imaging channel that will be used for image acquisition.

The **Format** of the image for storing in 16bit TIFF or PNG.

The data will be stored into the **Output folder** in the [position name]_img_000#.* notation.¨

If the image acquisition requires some specific conditions which are not available during the FIB milling step, e.g. switching to immersion UH-Resolution mode, then this conditions must be stored in the **SEM Preset**. If a SEM preset is selected for imaging, then it will recall the stored conditions before each imaging step.

Please make sure the Preset is updated right before the acquisition start.

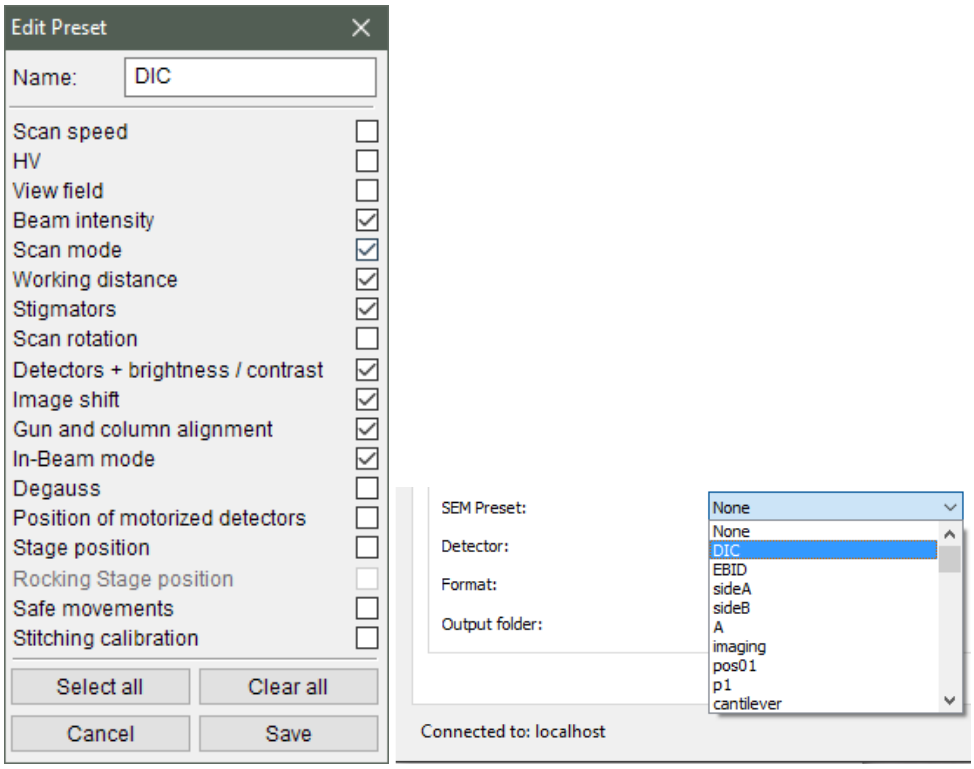


Figure 6 SEM preset definition.

3.7 Defining a measurement position

Multiple measurement position can be defined. It expects the marker is present.

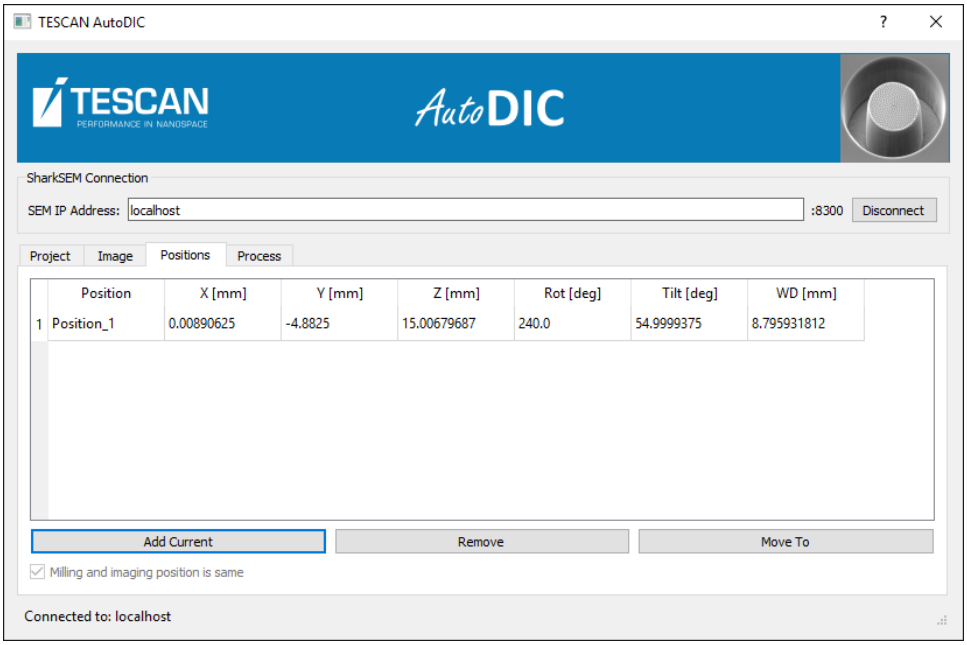
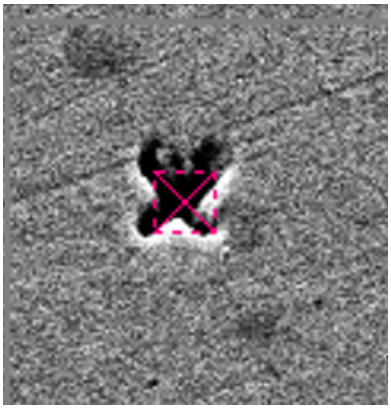


Figure 7 Defining a new position.

1. Navigate to the measurement position.
2. Align the SEM image of the fiducial to the cross from the *DriftCorrection 1* layer in the DrawBeam using **SEM image shift**.



3. In the FIB-DIC sofwtare **Position** tab click on **Add current** to add a new position in the list.
4. You can change the name of the position, this will be then used as a prefix to the image data e.g. [position_name]_img_0001.TIF.

3.8 Starting acquisition process

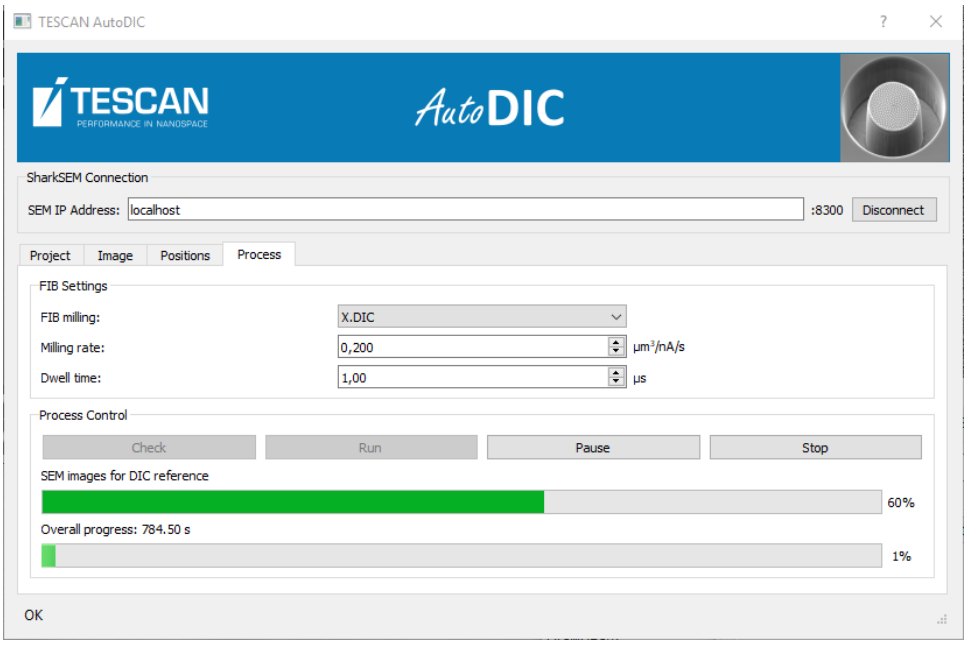


Figure 8 Running FIB-DIC acquisition.

1. To start the acquisition process select a **FIB milling preset** from the list.
2. Define a **Milling rate** of the sample material in µm3/nA/s and dwell time in µs. This values will overwrite the default values from the XML milling templates. For more info about the parameters see DrawBeam manual.
3. Click on the **Check** button to check the FIB condition and estimate the acquisition time.
4. Click **Run** to start the process.

> **Note:** During the acquisition the process can be **paused**. It will finish the current operation and pause. After resuming the operation it will continue with next processing step.

> **Note:** During the process you can monitor progress on the progress bars or on detailed logging output. The process log is also stored to the file.