User Manual for EDT-test

HREM Research Inc.

1. Introduction:

EDT/Collect Plug-In for **DigitalMicrograph** (**DM**) includes **EDT-test** that is used to check whether **EDT/Collect** works appropriately on your TEM.
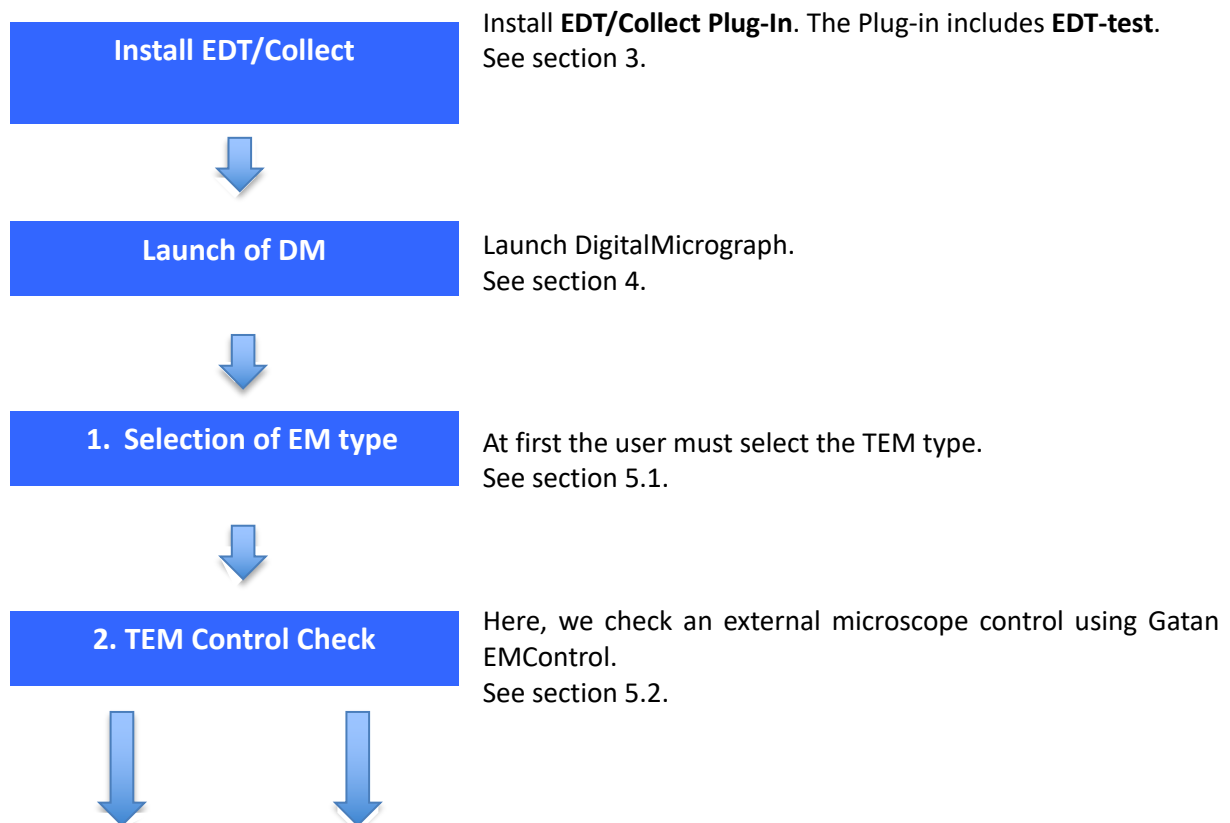**EDT-test** works without a license key, and performs the following tasks:
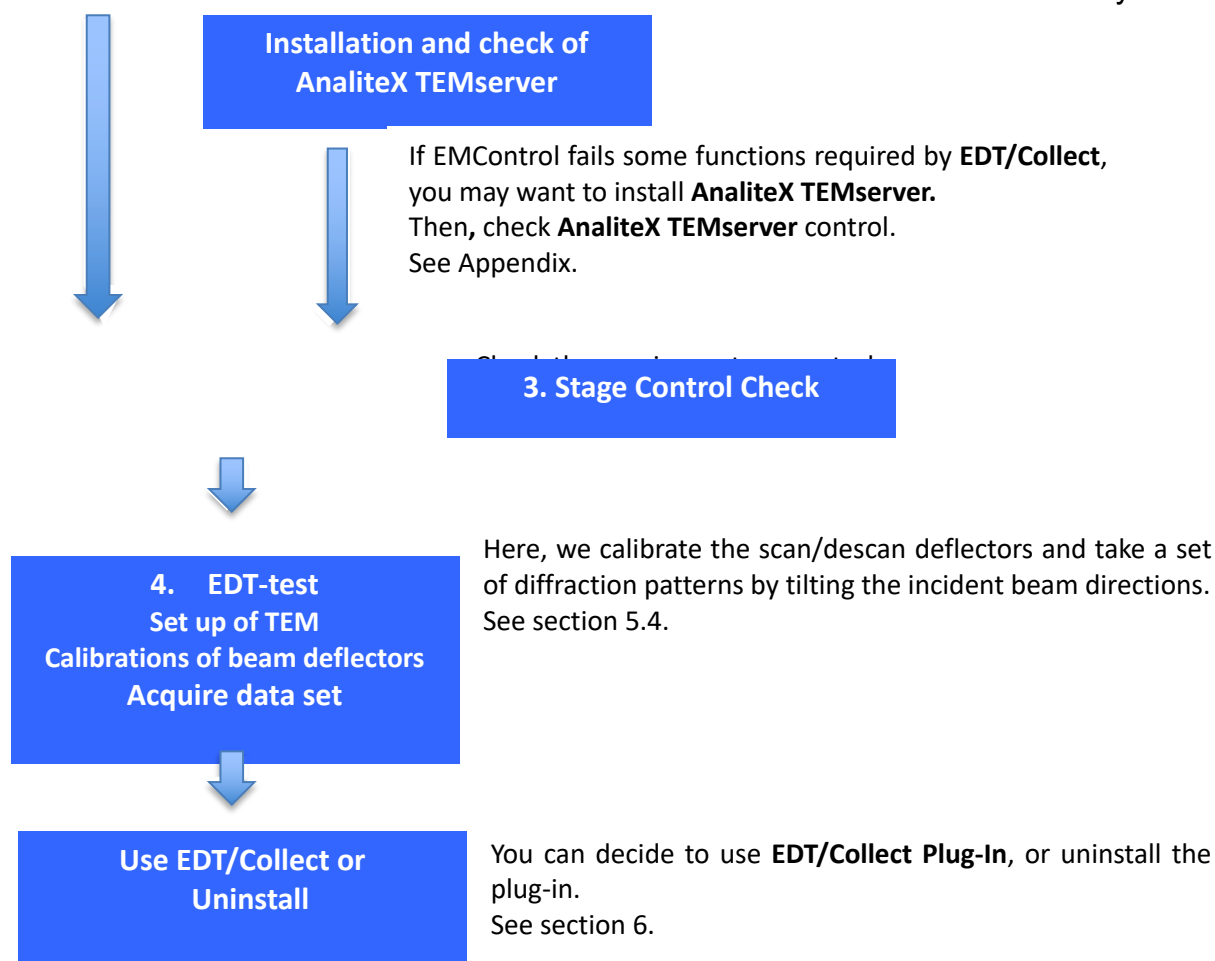
1. Check that **EDT/Collect** can control your TEM by using **GATAN EMControl** and/or **AnaliteX TEMserver**.
2. Check that **EDT/Collect** can control the mode change between Diff-mode and Imaging-mode.
3. Check that **EDT/Collect** can control the deflectors for the diffraction shift.
4. Check that **EDT/Collect** can control the specimen holder.

According to the results of **EDT-test**, you will find whether your TEM is appropriate to use the **EDT/Collect Plug-in**.

2. Work flow:

The action that you will take with this manual is summarized below. Details of these actions are described in the following sections.

Install EDT/Collect	Install **EDT/Collect Plug-In**. The Plug-in includes **EDT-test**. See section 3.
Launch of DM	Launch DigitalMicrograph. See section 4.
1. Selection of EM type	At first the user must select the TEM type. See section 5.1.
2. TEM Control Check	Here, we check an external microscope control using Gatan EMControl. See section 5.2.

Installation and check of AnaliteX TEMserver

If EMControl fails some functions required by **EDT/Collect**, you may want to install **AnaliteX TEMserver.**
Then**,** check **AnaliteX TEMserver** control.
See Appendix.

3. Stage Control Check

4.   EDT-test
Set up of TEM
Calibrations of beam deflectors
Acquire data set

Here, we calibrate the scan/descan deflectors and take a set of diffraction patterns by tilting the incident beam directions. See section 5.4.

Use EDT/Collect or Uninstall

You can decide to use **EDT/Collect Plug-In**, or uninstall the plug-in.
See section 6.

Note: During **EDT-test** the log file is created and saved. The location of the log file will be:
In case of Windows 7 or later versions:
"C: Users\"USERNAME"\Documents\EDT-Collect\EDTTestLog.txt",
In case of Windows XP:
"C:\Documents and Settings\"USERNAME"\My Documents\EDT-Collect\EDTTestLog.txt"
where "USER NAME" is the current Windows user name.

If you have any trouble in using **EDT-test**, you may want to contact HREM Research support with a copy of the log file.

3. Software Set up

3.1 Install EDT/Collect Plug-In:

EDT-test is included in **EDT/Collect plug-in** and works without a license key.

EDT/Collect plug-in is available as a plug-in to **DigitalMicrograph** of the Gatan microscopy Suite (GMS).
- 32 bit: GMS 1.x and GMS 2.x;
- 64 bit: GMS 2.x and GMS 3.x;

Software requirements
The following is a list of the software requirements necessary to run the **EDT-test**:
- **DigitalMicrograph (**GATAN^{TM})
- **IPU Plug-in** (Free-ware downloadable from www.hremresearch.com)
- **Gatan EMControl Plug-in** (a plug-in supported by Gatan to communicate with a microscope). This must be installed beforehand.
- (Optional) AnaliteX TEM Server (please consult the manual for the TEM server)

Install of the EDT/Collect Plug-in

EDT/Collect plug-in can be installed by drag-and-drop copy to the folder "PlugIns". The PlugIns folder should exist under a normal installation of **DM**.
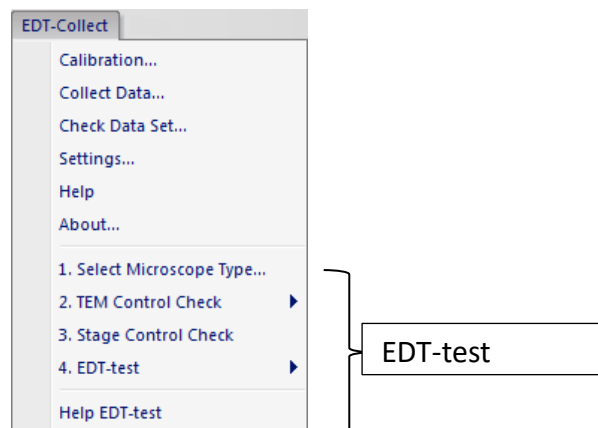
Installing IPU Plug-in

EDT-test uses some functions based on the Intel's MKL (Math Kernel Library) provided by **IPU plug-in**. All the files relating to **IPU plug-in** can be installed by drag-and-drop copy. Please consult the ReadMe file that comes with **IPU plug-in**.

4. Launch DigitalMicrograph

When **DM** is launched, **DM** gives warning "no license key for **EDT/Collect** ". However, you can ignore this warning, since **EDT-test** works without the license key.

The **EDT/Collect** menu appears after successful installation as shown in Fig. 1.
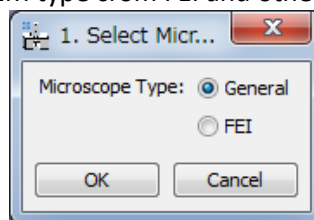

Fig.1 Pull-down menu of EDT/Collect

5. Execute EDT test

5.1 Select Microscope type

At first, you must choose "**1. Select Microscope Type…..**" command, then the window shown below will appear. Please select your TEM type crom FEI and other microscope (General), and then click OK!
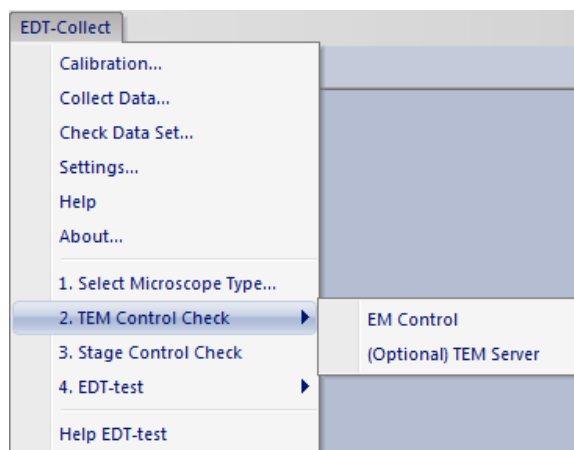

Fig.2 Window to select user's microscope type

5.2 TEM Control Check:

Then, you must choose "**2. TEM Control Check**". There are two sub menus: EM Control and (Optional) TEM Server, as shown in Fig. 3.

> **EDT/Collect** controls your TEM mainly through **Gatan EMControl plug-in**. However, some functions might not be implemented in your **EMControl**. In such cases, you need to install extra program called "**AnaliteX TEMserver**" to control your TEM.

Choose "**EM Control**" in the menu, and follow the messages that will appear, to check whether **EDT/Collect** can work only using Gatan's **EMControl** on your TEM.

Fig. 3 TEM Control Check, EM Control and (Optional) TEM Server.

At the end of "**EM Control**" check, you will obtain one of the four answers below.

A) Congratulations! All tests for EMControl are passed. EDT can control your microscope using only EMControl.

B) Diffraction shift using EMControl is not possible. If you want to use EDT, you have to install TEMserver, and then perform **(Optional) TEM Server**. (Please read the manual to install TEMserver.)

C) The microscope mode (image-mode /diffraction-mode) cannot be changed using EMControl. You have two choices:

> 1. Switch manually the microscope modes between image and diffraction during the data acquisition, when needed during the data collection.
> 2. Install TEMserver and perform **(Optional) TEM Server**. (Please read the manual to install TEMserver.)

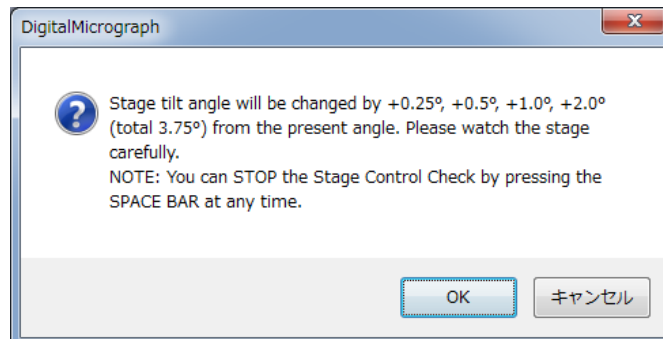D) Unfortunately, some test(s) of EMControl is (are) failed. Please send the log file to our support.

If you receive the message A), you can go to **section 5.3 "Stage Control Check"**.

If you receive the message B) or C), you may want to install the **TEM server** to use **EDT/Collect**. When you install **AnaliteX TEMserver**, please follow the procedures described in **Appendix**. After installing the TEM server, choose **(Optional) TEM Server** in the menu to check an applicability of **AnalteX TEMserver** on your TEM. Then, the dialog will open where you can edit the IP address and the Port that the EDT for Digitalmicrograph will use to communicate with the TEM server. (see Appendix of this manual and AnaliteX TEM Server manual).

5.3 Stage Control Check:

In this section you will check a specimen stage control on your TEM. Please insert a specimen stage into the TEM column without specimen. A single tilt stage is preferable.

By selecting "**3. Stage Control Check**" command, the dialog box shown in Fig. 4 appears.
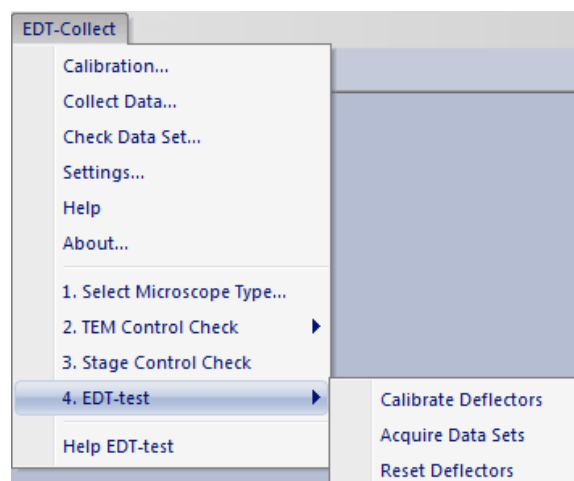

Fig. 4 Dialog box appear after selecting "**3. Stage Control Check**".

By pressing "OK", the tilt angle of the specimen holder will be increased from the present angle successively by +0.25°, +0.5°, +1.0°, +2.0° (totally 3.75°). The current angle, intended angle and actual angle are shown in the results window. Please check the move of specimen stage by your eyes.

NOTE: You can stop the stage tilt by *pressing the SPACE bar* in case of emergency.

5.4 EDT-test:

The EDT-test menu has three sub-menus: "**Calibrate Deflectors**", "**Acquire Data Sets**" and "**Reset Deflectors**" as shown below:

Fig. 5 EDT-test with sub-menu

EDT/Collect tilts the incident beam above a specimen and compensates the shift of diffraction patterns caused by the tilt of the incident beam. To do so, you have to calibrate the deflectors.

Before doing the calibratios you must set up your TEM. Particularly, it is important to fix the electron beam on a certain position of a specimen even after the incident beam is tilted. In this set up you need not to use a specimen.

The procedure to set up your TEM is as follows:

1.   Set the objective lens current at the standard current position. This current is for the zero-focus position, which is the eucentric specimen position.

2.   In the Image-mode the incident beam at the specimen plane should not move even when the beam is tilted (the pivot condition for the beam tilt). To fix the beam position, adjust the ratio between two beam-tilt deflectors using the beam tilt wobbler. This adjustment is very important.

3.   Insert a small selected-area aperture (SA) and spread the beam in the Image-mode.

4.   Switch into Diff-mode. Select an appropriate camera length; e.g. 300mm; and focus the incident electron beam into a small spot.

   CAUTION! Be careful not to exposure of the CCD camera to a strong electron beam! Use low intensity beam (spread the beam using the Brightness knob; use small spot size, for example 5; use small condenser aperture; insert small SA aperture in Imaging-mode).

5.   Bring the spot to the center of CCD camera in the diff-mode using diff-shift in FEI microscopes, or by PL-shift in other microscopes.

6.   Set the exposure time in the DM CCD control panel, considering the dynamical range of the CCD camera. If the exposure time is not enough, you can increase it later.

7.   When the TEM set up is finished and you are ready for the next tests, remove the CCD camera from the electron beam path for a while to avoid unnecessary exposure.

   Note: Once you have set the objective lens current, do not change it in the following test.
   Note: Once you have chosen a camera length in the calibration, do not change it in the following test.

5.4.1 Calibrate Deflectors
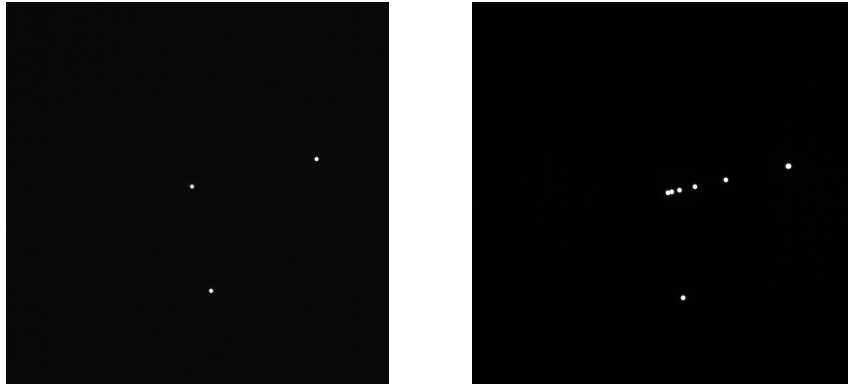
After finishing the microscope set-up, select the "**Calibrate Deflectors**" menu. Then, a new dialog box will appear. By following the message in the dialog box you can perform the calibrations on TEM deflector coils automatically. The calibrations are performed for incident beam deflector; and also for descan deflectors to compensate the incident-beam-shift. Descan is performed by Diff-shift in FEI microscopes, but PL-shift in other microscopes.

The process carried out during the calibration is as follows.
1.   obtain current x and y deflector settings (let's call them as X_0 and Y_0).
2.   obtain the incident beam position (original pattern).
3.   change the x-deflector by CV (so it becomes X_0+*CV, CV* is a change value).
4.   obtain the incident beam position (X-modified pattern).
5.   calculate the shifts of the incident beam position using cross-correlation.
6.   if the shifts is small, the CV value is automatically doubled and go to the step 3; if the shift becomes sufficient, the x-calibration is calculated, and change back the x-deflector.
7.   obtain the y-caliubration using the estimated x-calibration.

   Note: If the the camera length calibration has not been carried out for a selected CCD camera, the warning message appears and the deflector coil calibration stops. In such a case please calibrate the camera length according to the **DM** help.

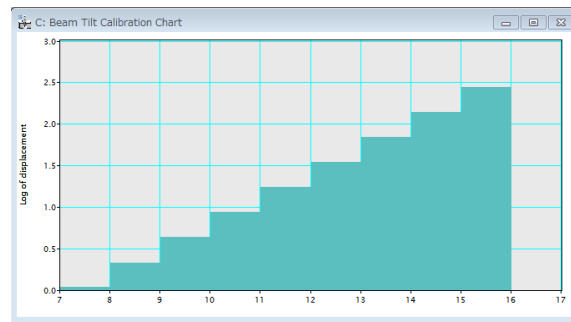Two images will appear during the calibration, and they look like below at the end of calibration.

Fig. 6 Images appear after the calibration process.

The left pattern shows the initial beam position (close to the center) and the *current* beam position that moves when the x-deflector current is increased. At the end you will have three spots that corresponds to the initial position and the final poditions for x and y calibrations.

The right pattern shows the cross-correlation patterns between the initial position and all the shifted beam positions for x-deflection and the one for y-deflection. The cross-correlation points for the x- and y-deflectors should be approximately perpendicular as shown inFig. 6.

At the end of calibration for each deflector, a calibration chart shown below will appear.

Fig. 7 Calibration chart

The calibration chart shows the displacement of the probe in CCD image versus the deflector control value. The deflector control value is increased by a factor of 2 each time. If the graph is not linear, the calibration may be unsuccessful. In such a case please check again the microscopr set-up conditions, especially the pivot condition for the beam tilt.
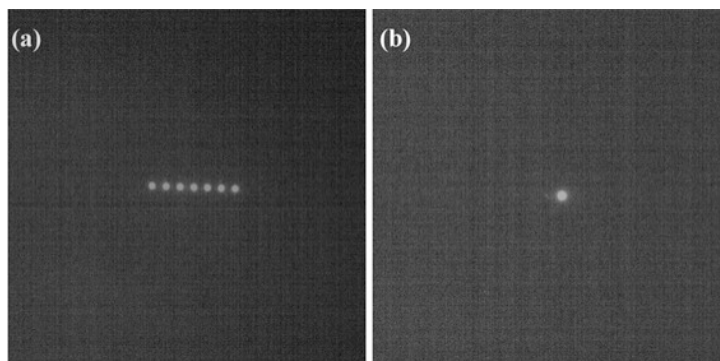
> **Note**: If the beam goes out from the SA-aperture during the calibration, the calibration may fail. Please adjust the pivot condition for the beam tilt at the SA-aperture position.

5.4.2 Acquire Data Sets

Using "**Acquire Data Sets**", the user can test whether the beam deflectors (scan) and the compensation of beam shift (descan) work correctly. This command collects two data stacks which consist of seven pictures obtained by changing the incident beam direction at -1.2°, -0.8°, -0.4° 0.0°, +0.4°, +0.8° +1.2°. (Angle is calculated from the slected camera length, the wave length (high-voltage) and the calcurated pixel/DAC value.)

One of the data set (image stack), as shown in Fig. 8a, is taken by only the beam tilt without descan (diffracrtion shift compensation). You can go though these pictures (the stacked image) using the **slice tool** of **DigitalMicorgraph (DM)**. (If you are not familiar with **DM slice tool**, please consult the manual of **DM**.) Seven spots must be located along the same direction with the same distance. Users can check the tilt direction and the tilt angle by measuring the distance between the spots.

Fig. 8 The images by summing up of images in a data set obtained (a) without descan and (b) with descan.

Another data set (as shown in Fig. 8b) is taken by the beam tilt with diffraction-shift compensation (so-called descan). If the descan is successful, you will see that the incident beam spots will appear at almost the same point.

If the results are not successful, the calibration in **section 5.4.1** may have not been performed correctly.

5.4.3 Reset deflectors

"**Reset deflectors"** command resets the microscope to the state before the start of "**Calibrate Deflectors**".

6. Use or uninstall EDT/Collect:

If all the command described above can be performed without any troubles, your TEM is suitable to use **EDT/Collect**. When you decide to use the whole part of **EDT/Collect**, the license key is required.

If users want to uninstall all programs related to EDT-test, delete the files for **EDT/Collect** that the user has copied into the **DM** "**PlugIns**" folder. If you have installed **AnaliteX TEMserver**, delete **AnaliteX TEMserver** folder under the "USERNAME", and delete also the config file in the folder that was created by **AnaliteX TEMserver**,

Appendix: AnaliteX TEMServer

Here, only the outline of Installation and use of the **AnaliteX TEMserver** is described. If necessary, please Consult AnaliteX TEMserver manual.

1.1. Install AnaliteX TEMServer:

AnaliteX TEMserver and installation manual are in a folder in the package of **EDT/Collect Plug-in**. Please read carefully details of the installation manual.

AnaliteX TEMserver requires **Microsoft .NET Framework 4 or 4.5** Windows XP. If your computer does not have this program, please install beforehand. **AnaliteX TEMserver** and related files must be placed in a folder under "USERNAME" as described in the manual of the **TEM server**.

1.2. Use AnaliteX TEMserver:

At first launch **AnaliteX TEMserver** (AnaliteX.TEM.exe) and stop it. Then, a folder will be created in the following places:

In case of Windows 7 or later versions:
"C: Users\\"USERNAME"\\Appdata\\Local\\AnaliteX\\AnaliteX.TEM.Server \\1.0\\"
In case of Windows XP:
"C:\Documents and Settings\"USERNAME"\Local Settings\Application Data\AnaliteX\ AnaliteX.TEM.Server\1.0"
where "USER NAME" is the current Windows user name.

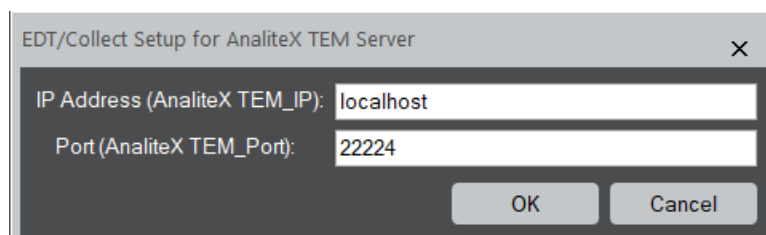**NOTE**: Since the folder may be hidden, the user need to visualize it.

The config file must be edited depending on the type of user's TEM (please consult the installation manual of AnaliteX TEMserver). The config file "AnaliteX.TEM.Server.exe.cofig" can be found in the folder of AnaliteX TEMserver for typical microscopes. You can use the sample config files as is, or edit the appropriate one for your system, if necessary.

To use the **AnaliteX TEMserver**, launch it again.

1.3. Check AnaliteX TEMserver:

By selecting "**(Optional) TEM server**" command shown in Fig. 3, the program checks automatically an applicability of **AnalteX TEMserver** on your TEM.

When you select the "**(Optional) TEM server**" command, the dialog below will open. Here, you have to set the same IP Address and Port as specified in the Config file of the AnaliteX TEM server. These settings are important for the EDT to communicate with the TEM server. When the DigitalMicrograph (DM) is installed on the TEM PC, you can use the default settings. On the other hand, when the DM is installed on a PC other than the TEM PC, specify explicitly the IP address of the TEM PC (where the TEM server is installed). In this case, when you specify the same IP address 127.0.0.1 (localhost), the TEM server and EDT cannot communicate each other.

EDT/Collect Setup for AnaliteX TEM Server	✕
IP Address (AnaliteX TEM_IP):	localhost
Port (AnaliteX TEM_Port):	22224
	OK Cancel

Setting name and their meanings:

"TEM_IP"	The IP address of the PC where the AnaliteX TEM server is istalled. The default IP addresss is 127.0.0.1 (same as localhost).
"TEM_Port"	This is the port number that the EDT will use to communicate with the TEM server. (Any reasonable unoccupied value from the range 0-65535). Currently the dafault Port is 22224.

When you click OK, a communication with the AnaliteX TEM server will be checked. If the communication has failed, you will receive message shown below in Fig. A-1.
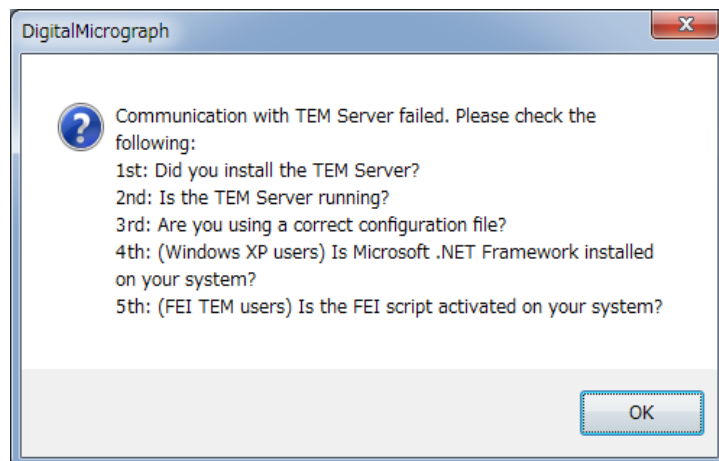

Fig. A-1 message in case of failure of communication.

In such case, click "OK" button and stop **DM**. Then, check carefully the messages in Fig. A-1. If users find any mistakes, please correct them. Then, launch the TEMserver again, and next launch **DM**.

If the communication test has passed, necessary tests to check the TEM mode change and Diff-shift control using the TEMserver will be performed. Eventually, you will receive one of the two messages below.

A)   Congratulations! TEMServer tests are passed. EDT can control your microscope using EMControl and TEMServer.

B)   Unfortunately, TEMServer test(s) is (are) failed. Please send the log file to our support.

If you receive the message A), you can go to **section 5.3 "Stage Control Check"**.