StackBuilder (on image update) tool – Help

credits

The tool was made by Bernhard Schaffer, SuperSTEM Laboratory Daresbury/UK.
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version: 2012-07-03
GMS: tested on both GMS 2.1 and GMS 1.9.4 but should work on all GMS versions as it uses basic core scripting.

purpose

This script is a versatile but crude way of streaming data from a 1D or 2D data container into a larger (3D) data container whenever the original data container is changed. This can for example be used to create time series of data acquisition by copying each 'updated' live display[1,2,3,4].

Contents

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[1] The script has been successfully applied to create stacks of rapidly acquired high-resolution STEM image to create high-quality images after drift corrected summing. See for example: "*Atomic scale imaging and quantification of electrical polarisation in incommensurate antiferroelectric lanthanum-doped lead zirconate titanate -MacLaren et al, Advanced Functional Materials, 22/2 (2012), pp. 261-266*"

[2] It has also been used to create time resolved image snaps during a spectrum-image acquisition. See: "*Evidence for molecular N_2 bubble formation in a (Ga,Fe)N magnetic semiconductor - Kovács et al., Proceedings of the Microscopy Conference, Kiel/Germany, August 2011, M1-p523 (journal paper pending)*"

[3] This script has also been used to acquire time-resolved EELS.

[4] The script may also be used to store "evaluation update", e.g. the live-FFT window while dragging the according ROI in the source image, or the various elemental maps while changing the extraction parameters etc.

Setup

install

Copy the *b_StackBuildOnImageUpdate.gtk* file into the plugins
folder and restart DigitalMicrograph. There should now be a new
menu entry:

B_ → SI → StackBuilder on image update
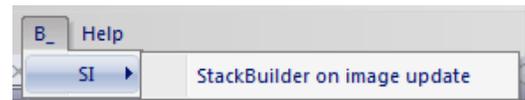
Using the tool

A quick step-by-step introduction

The tool is launched by selecting the menu entry. It does not have a tool palette. It "attaches" itself to the
front-most image displayed in DigitalMicrograph[5]. It will immediately prompt a dialog with some help text,
which needs to be clicked [OK], and a summary of the default settings in the results window.
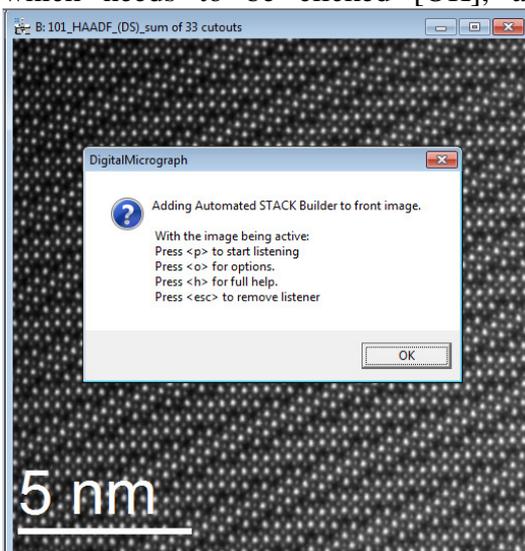
```
****************************
* AUTOMATIC STACK BUILDER *
****************************
* (c) 2012 B.Schaffer      *
****************************
Default setting:

...start paused. (Press <p> to start autobuilding)
...use every n-th update                : 0
...skip, if update faster than (sec)  : 0
...skip, if last pixel has not changed: 1
...Increase stack by #layers            : 3
...Copy image tags at each update     : 0
```

From now on, the script is handled by <u>having the source image selected</u> and pressing keys [6]. By default, the
script is on *pause* at start. It will also have created and displayed an empty data-container to which the data
will be streamed[7].

The streaming can now be started by pressing the [P] key to unpause/pause the streaming. It is completely
stopped (and removed from memory) by pressing the [ESC] button or by closing the source image. The
results window will give an according statement:

```
****************************
* AUTOMATIC STACK BUILDER *
****************************
* (c) 2012 B.Schaffer      *
****************************
Default setting:

...start paused. (Press <p> to start autobuilding)
...use every n-th update                : 0
...skip, if update faster than (sec)  : 0
...skip, if last pixel has not changed: 1
...Increase stack by #layers            : 3
...Copy image tags at each update     : 0
    11:17:29: <101_HAADF_(DS)_sum of 33 cutouts>    START stack building on updates
    11:17:33: <101_HAADF_(DS)_sum of 33 cutouts>    PAUSE stack building on updates
    11:17:35: <101_HAADF_(DS)_sum of 33 cutouts>    START stack building on updates
    11:17:37: <101_HAADF_(DS)_sum of 33 cutouts>    PAUSE stack building on updates
    11:18:22: <101_HAADF_(DS)_sum of 33 cutouts>    STOP  stack building on updates
```

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[5] If there is none, nothing will happen and you won't get any result.

[6] Pressing the key without having the source image selected will not result in any action.

[7] The container has a pre-defined size but will enlarge automatically in defined steps during streaming.

While the streaming is enabled (unpaused), the complete displayed data of the source image is copied over into a *slice* (3rd dimension) of the goal container. The title of this container and the progress window update accordingly[8].
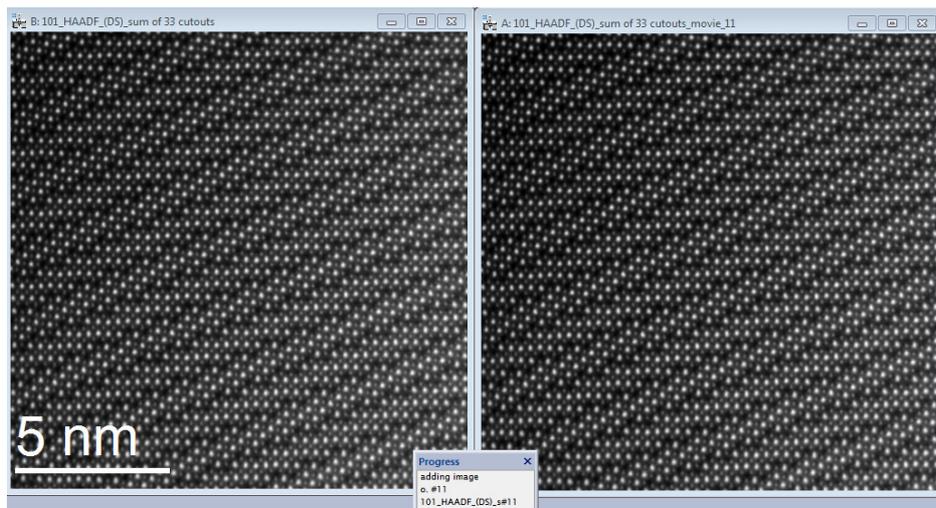
The copying-over is triggered at *each* data change event in the source image (i.e. a single pixel value is changed.) Therefore, some applications such as STEM imaging, which update only parts of images, will results into a steady streaming of data. To prevent this, some additional *conditions* can be activated:

- Copy only if the last (bottom right) pixel value has changed.[9]
- Copy only if a minimum time has passed.
- Copy only every n^{th} triggered update.

A streamed data set can be "finalized" at any time by creating a new (empty and small) goal-container. This is done by pressing [N].

A typical experiment therefore follows the following steps:
- ✓ Get *source* image front most and select menu entry
- ✓ Click dialog away. Experiment is now ready
- ✓ Press [P] to start streaming & start acquisition (or the other way around)
- ✓ Pause/unpause streaming as needed using [P]
- ✓ Finalize one dataset and start fresh one by pressing [N] [10]
- ✓ Stop & remove the script by pressing [ESC] or closing the source-image.

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[8] Note that the goal container is always a bit bigger and gets enlarged in "junks" when the space is filled. It is possible to set these junks to "1 slice", meaning that the container gets increased with each update and doesn't contain "empty" data. However, this requires a full data copy of the whole stack at each step and might decrease performance.
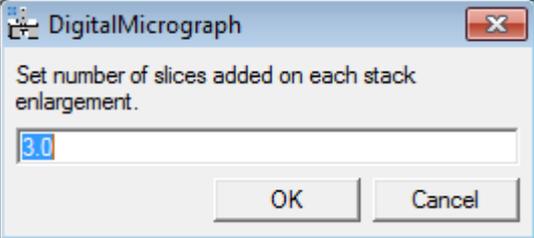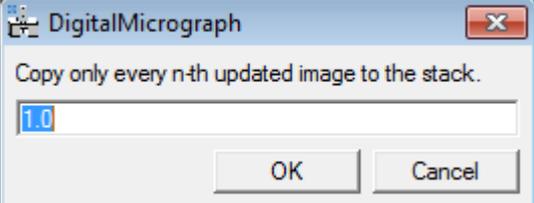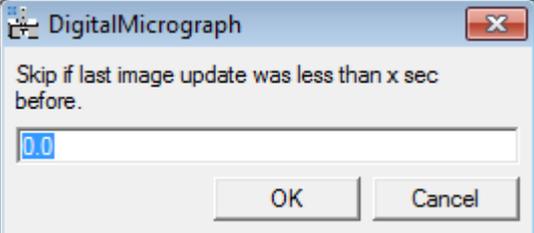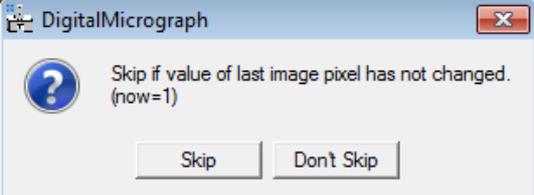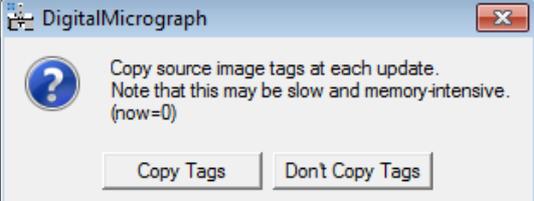[9] This is enabled by default and the standard for STEM imaging.
[10] It is generally a good idea to save & close the datasets at earliest convenient time, as it may take up a lot of memory.
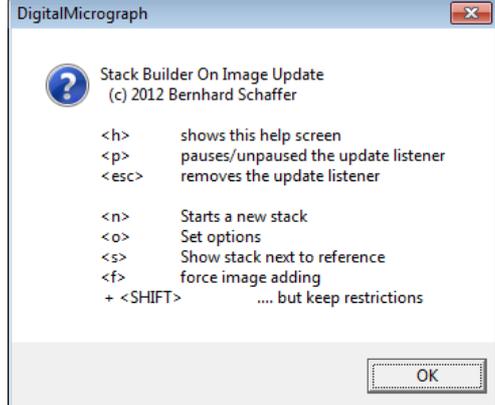
Options

General options

The script options can be changed by pressing the [O] button. A series of dialogs will appear:

DIALOG	INFORMATION
DigitalMicrograph Set number of slices added on each stack enlargement. `3.0` OK Cancel	A new stack will be of this size (in 3rd dimension), and each *increase* of the stack size is done with this size. Large steps improve performance as data copying happens less often, but a finalized data set may have many 'empty' zero-values slices.
DigitalMicrograph Copy only every n-th updated image to the stack. `1.0` OK Cancel	Condition to skip updates if the streaming is too fast.
DigitalMicrograph Skip if last image update was less than x sec before. `0.0` OK Cancel	Condition to skip updates if the streaming is too fast, or to create a time-resolved measurement. Note, however, that the delay between two copied data elements is *at least* this time, but not necessarily *exactly* this time, as the time is only checked whenever the update is triggered.
DigitalMicrograph Skip if value of last image pixel has not changed. (now=1) Skip Don't Skip	Condition to skip updates. Useful if image source is continuously filled from top to bottom as it is the case for STEM images. Enabled by default.
DigitalMicrograph Copy source image tags at each update. Note that this may be slow and memory-intensive. (now=0) Copy Tags Don't Copy Tags	This will copy over the whole tag-structure of the source image at *every* update. It is generally not advised. Note, that the tags are copied *once* at the beginning regardless of this option.

Special option during streaming

DigitalMicrograph Stack Builder On Image Update (c) 2012 Bernhard Schaffer <h> shows this help screen <p> pauses/unpaused the update listener <esc> removes the update listener <n> Starts a new stack <o> Set options <s> Show stack next to reference <f> force image adding + <SHIFT> .... but keep restrictions OK	A few additional keys can be used with the script. The full help can be displayed pressing the [H] key. [F] will trigger a single, immediate update. [F] & [SHIFT] simultaneously will trigger an immediate update, if the restrictive conditions are met. [S] arrange the stack next to the source.

Browsing the data

Standard tools
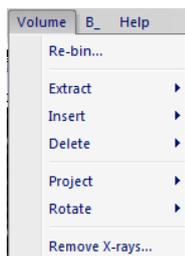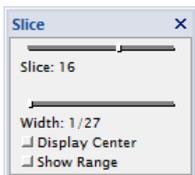
The final data is a 3D stack and can be handled with the default tools as any other 3D stack in DigitalMicrograph, in particular the "Slice tool" to display accordingly, and the volume manipulation menu.

TagStructure

There are also a lot of tags in the 3D stack:

- ☐ The *source* branch contains the original tag-tree of the source image (*Tags at creation*), a reference to the script used, and the time at which the stack was created [11]
- ☐ The *source tags* branch contains a list of tags, one entry for each streaming action. The entries contain the exact time of the streaming action, and – if the option was set – the complete tag-tree of the source image at that time.

Time is always stored in both system-clock time (hh:mm:ss) and *ticks* for higher accuracy.
The script command

```
        OKDialog( "t/sec = "+GetHighResTicksPerSecond() )
```

can be used to calculate the exact time from these numbers.

1-Dimensional data

Streamed 1D data (i.e. spectra) are still stored in 3D container with y-dimension of 1. By default, the stack is displayed in the LINEPLOT display type. However, this can always be changed in the display settings of the stack.

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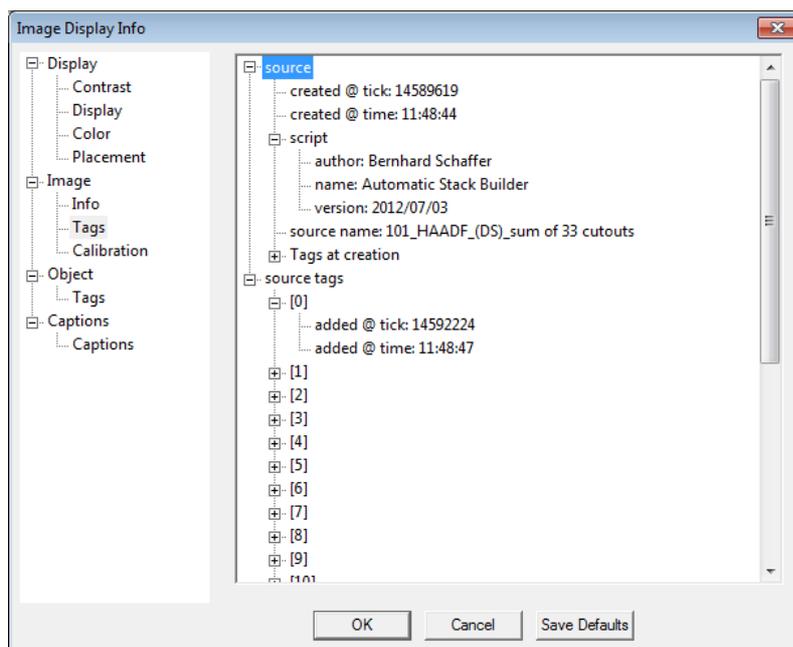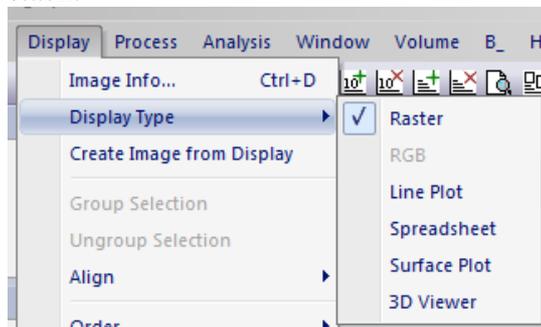
[11] This is *not* the time the first data was copied!

Additional notes

Data types

The script currently supports all data types but *binary* images.

Getting subsections of data only

The script attaches itself to the front-most image window. It is therefore not possible to use a ROI to only select a subsection of the image for the streaming. However, it is possible (by scripting) to create an extra display of a selected data section and then add the script to this window instead[12].
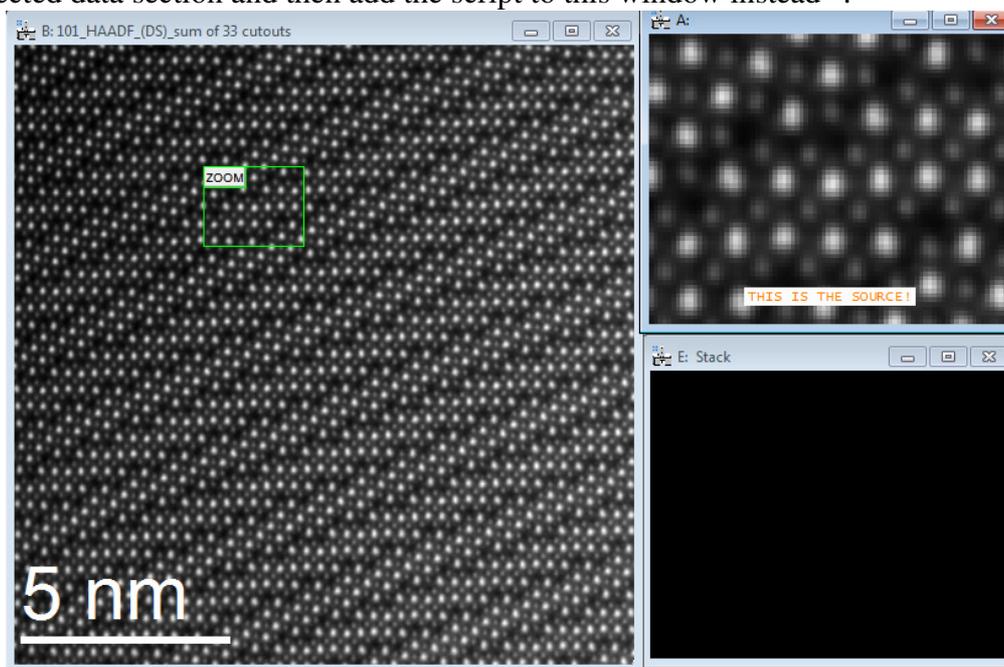
Memory issues & disclaimer

The script does not perform any checks on available memory. It is thus assumed that one might run into problems (maybe even application instabilities) if the script is used recklessly and huge image stacks are used. Use this script at your own risk!

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[12] The author provides an according "magnifying tool" script on request.