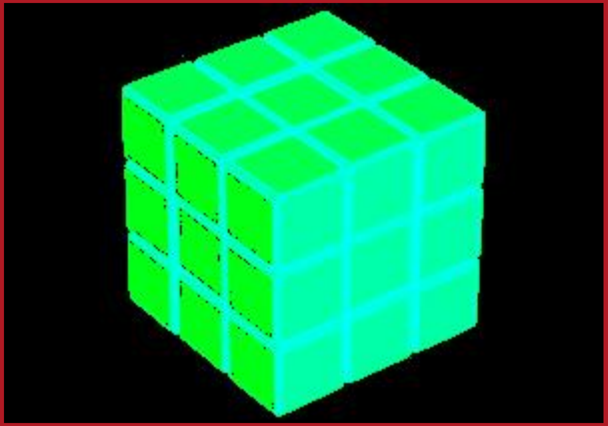
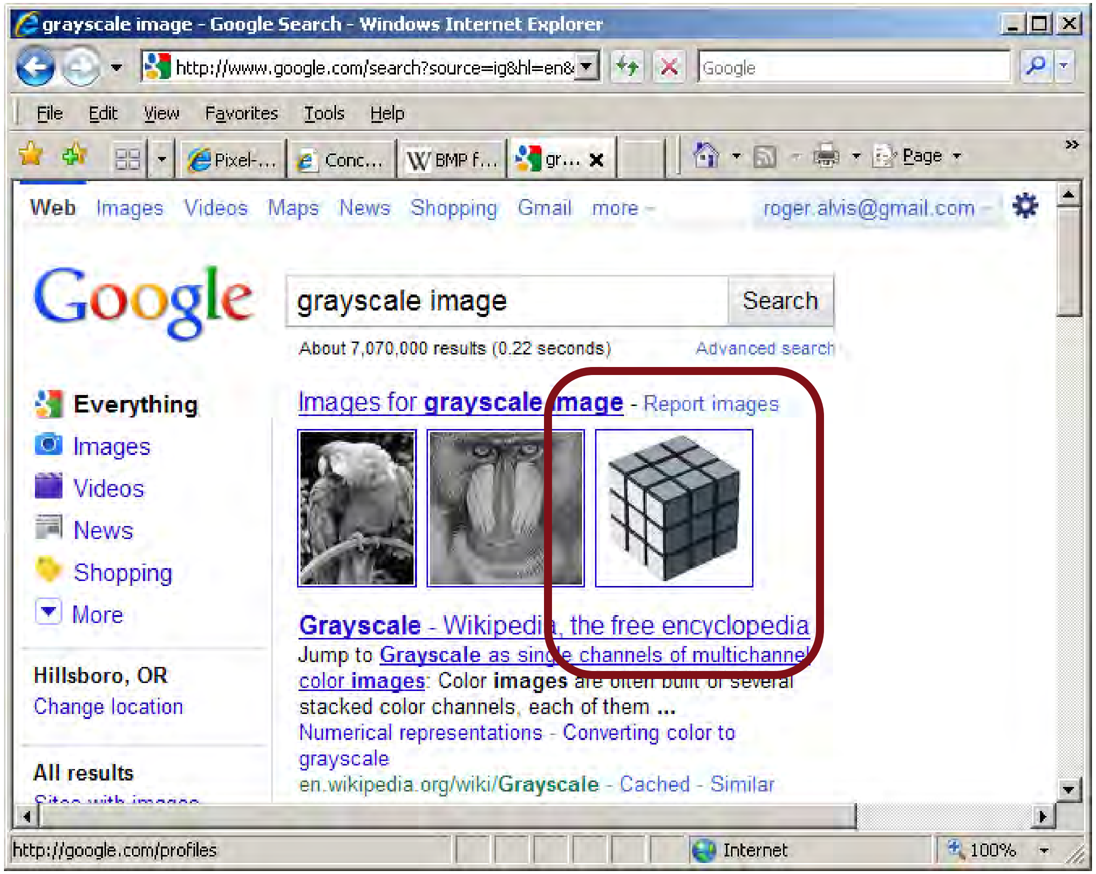


Converting an Image File
Into A SDB-Compatible BMP File

Roger Alvis, FEI Company
June 22, 2011

1. Locate Desired Image File*



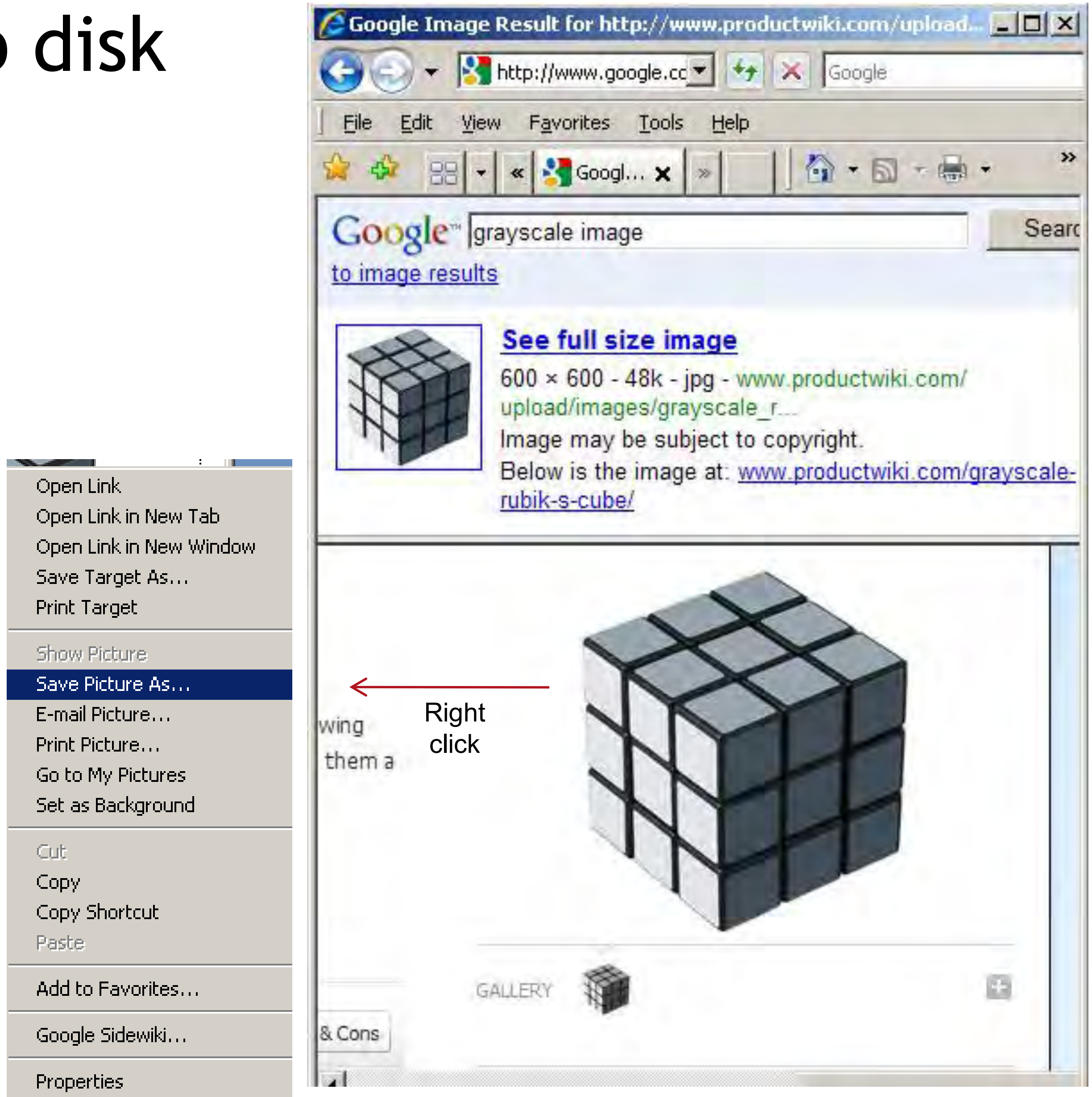
*This example uses a structure placed on a white field (background).

Additional image processing techniques not described in this document may be required to prepare an optimized bitmap for FIB milling.

FEI

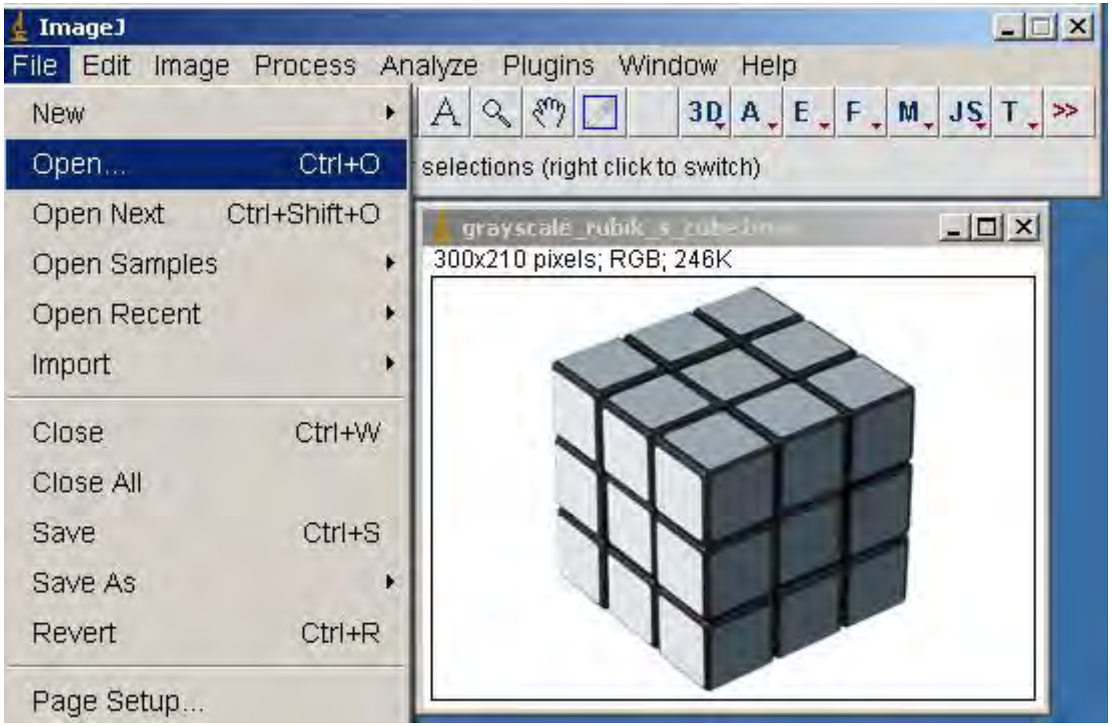
2. Save file to disk

Saving in any file format is OK at this point

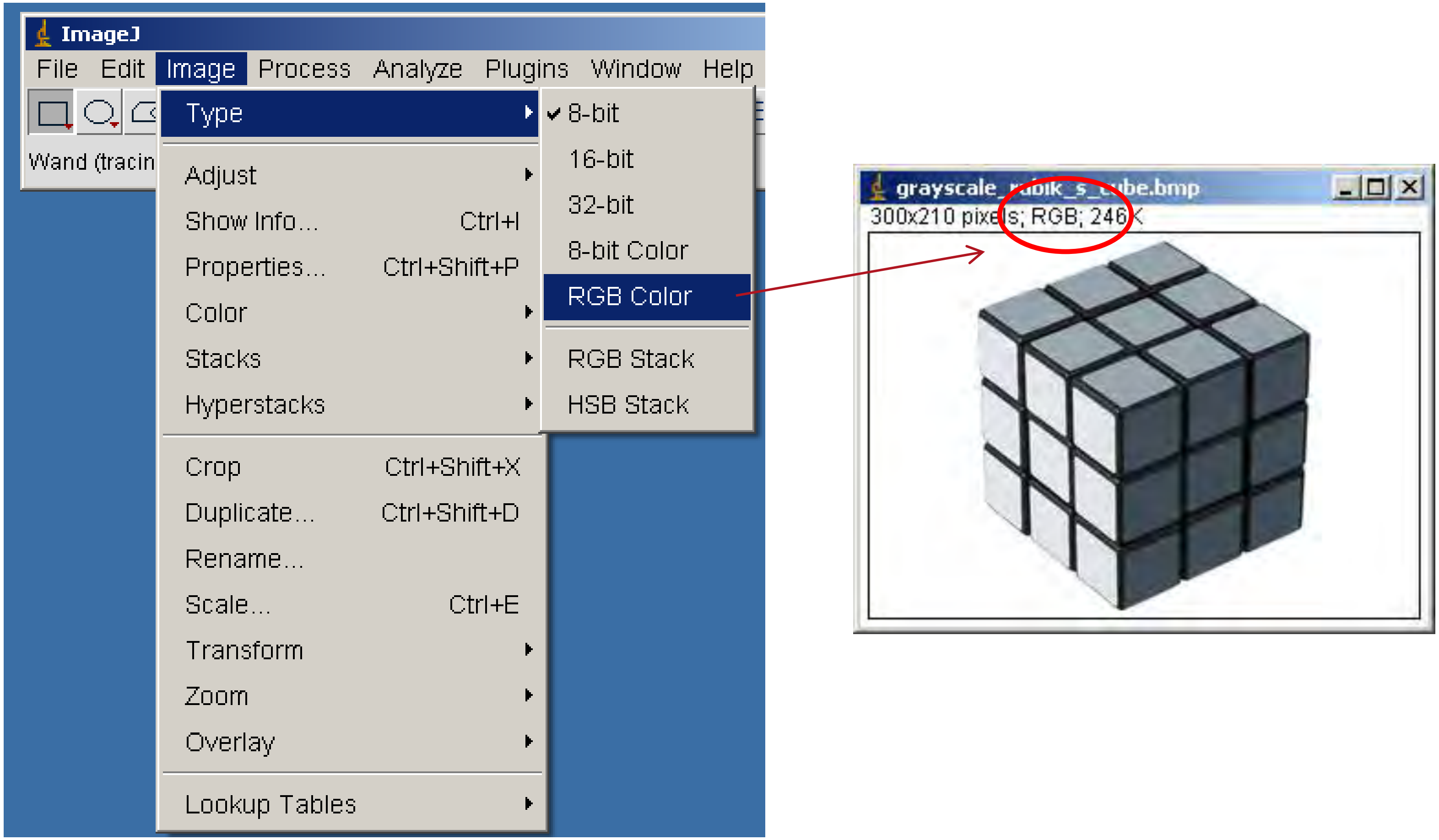


FEI

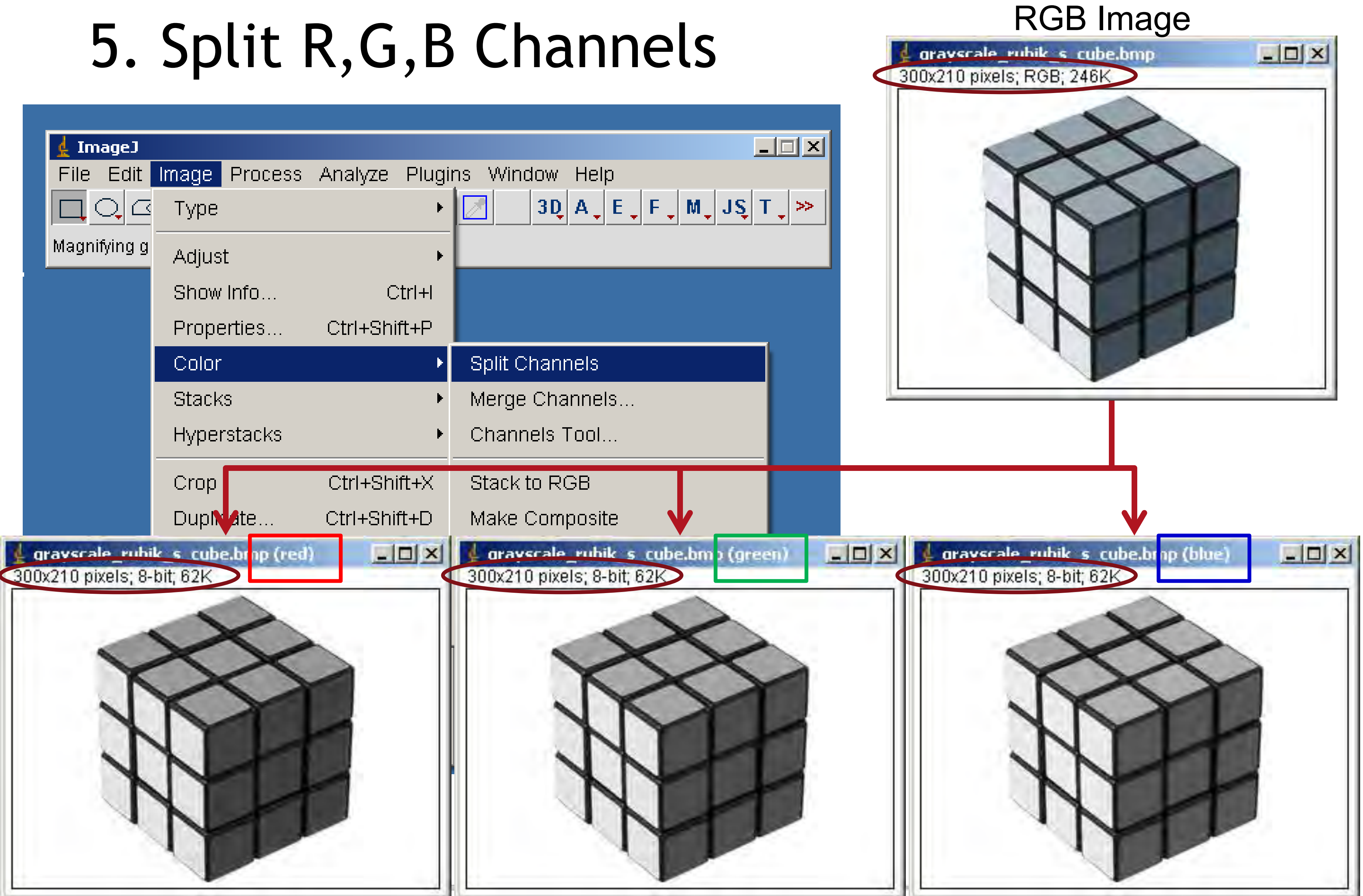
3. Open File in Image J



4. Convert to RGB Color (if necessary)



5. Split R,G,B Channels



6. Apply Bitmap Rules:

Bitmap Pattern

From the patterning page a pattern is available that allows you to import bitmaps as a pattern. A bitmap file must be saved as a 24 bits bitmap. Each pixels consists of a red, green and blue component (RGB).

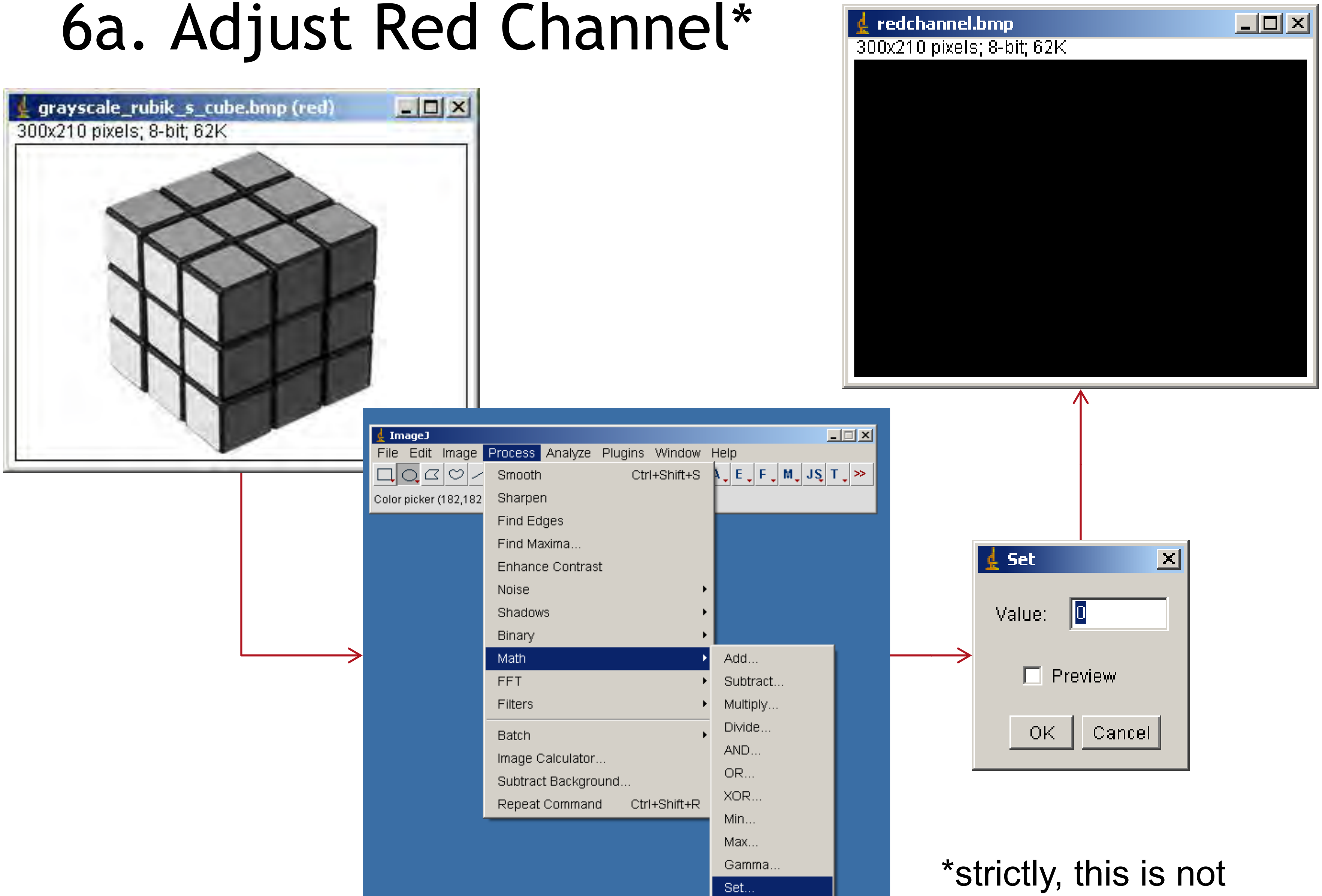
The **Red** component is currently not used. The **Green** component determines if the beam is blanked. Any other value then 0 will unblank the beam. The **Blue** determines the dwell time per pixel. If blue is set to 0 the dwell time of a pixel will be 100 ns. If blue is set to 255 the maximum UI dwell time is used. The dwell time for the pixels in between these values is linearly interpolated based on the blue component value between the 100ns and the maximum UI value and than rounded to the value from a (fixed) dwell time table with 124 entries.

When drawing a bitmap it is recommended to use black (0,0,0) for none milling points and blue for milling points.

TABLE 5-23 COLOR SETTINGS

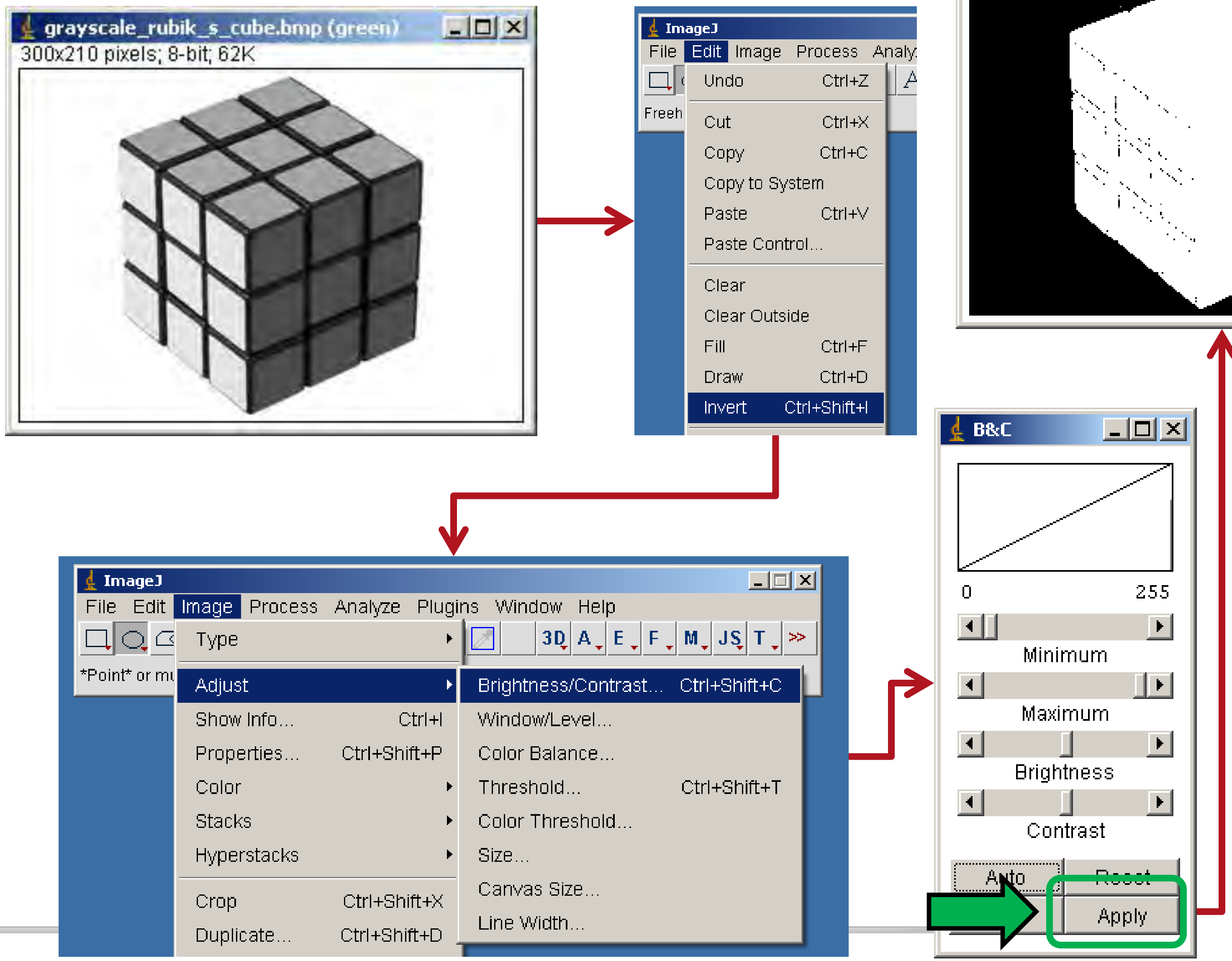
Colour	Result
RGB 0 / 0 / 0 – black	Beam is blanked
RGB 0 / 1 / 0	Beam is on, 100ns min dwell
RGB 0 / 1 / 255	Beam is on, Maximum dwell time
RGB 255 / 255 / 255 – white	Beam is on, Maximum dwell time

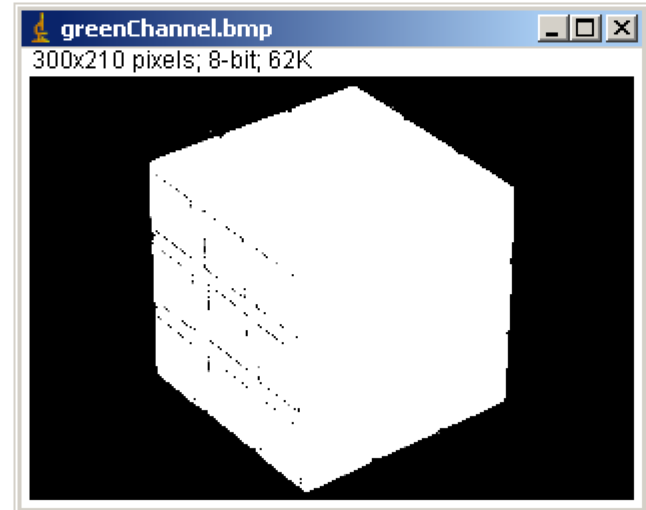
6a. Adjust Red Channel*



*strictly, this is not a required step

6b. Adjust Green Channel

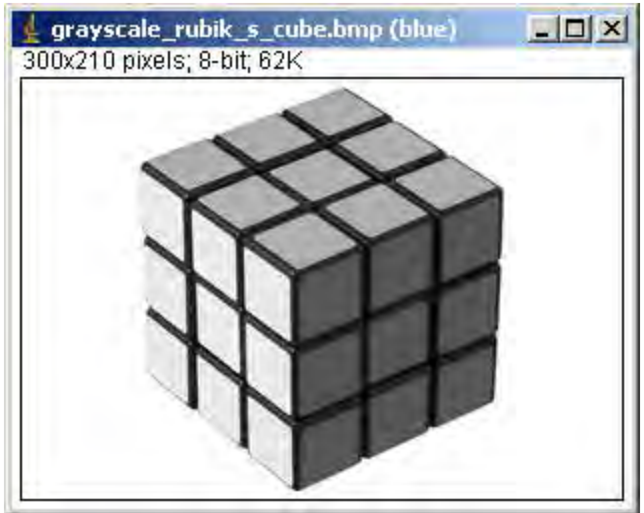


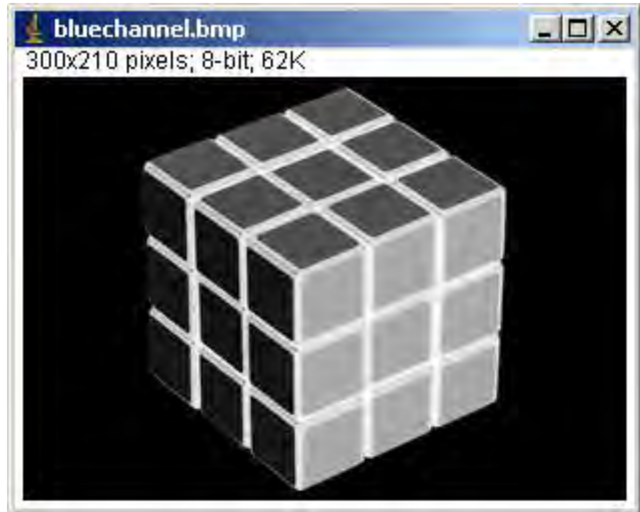


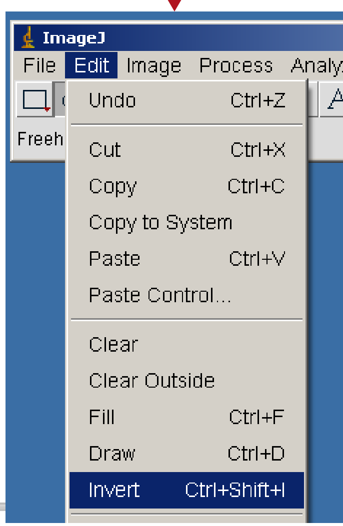
NOTEs:
After binarizing the inverted green channel, consider 'cleaning-up the 'beam-blanking mask' by saving it to disk and opening in an image editor program such as Photoshop or Paint. Use tools to clean up specks, as appropriate.

FEI

6c. Adjust Blue Channel







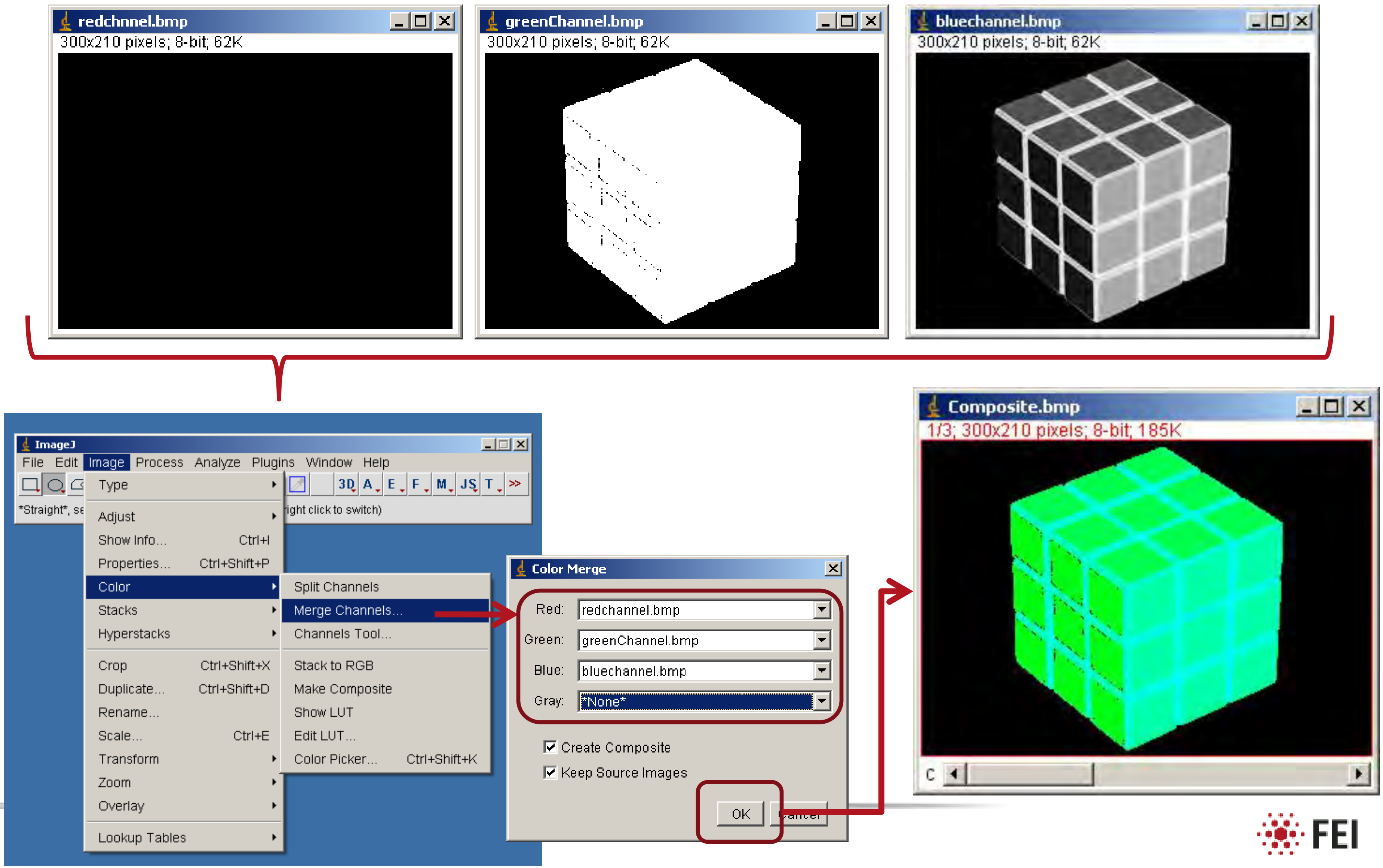
NOTES:

•The blue channel controls the dwell time, scaling gray value of zero to 100ns and, grayscale value of 255 to the maximum dwell time permitted by xTUI. Because longer dwell times (higher grayscale numbers) bright areas of the original image produce deeper milling. Typically deeper milling results in a darker area when imaged with ebeam SEs. For this reason, the blue channel is inverted to ensure that the contrast of the FIB milled image matches that of the original image.

•B&C of the blue channel can also be adjusted to ensure the dwell time of the beam at any given pixel neither under- or over-mills the sample.

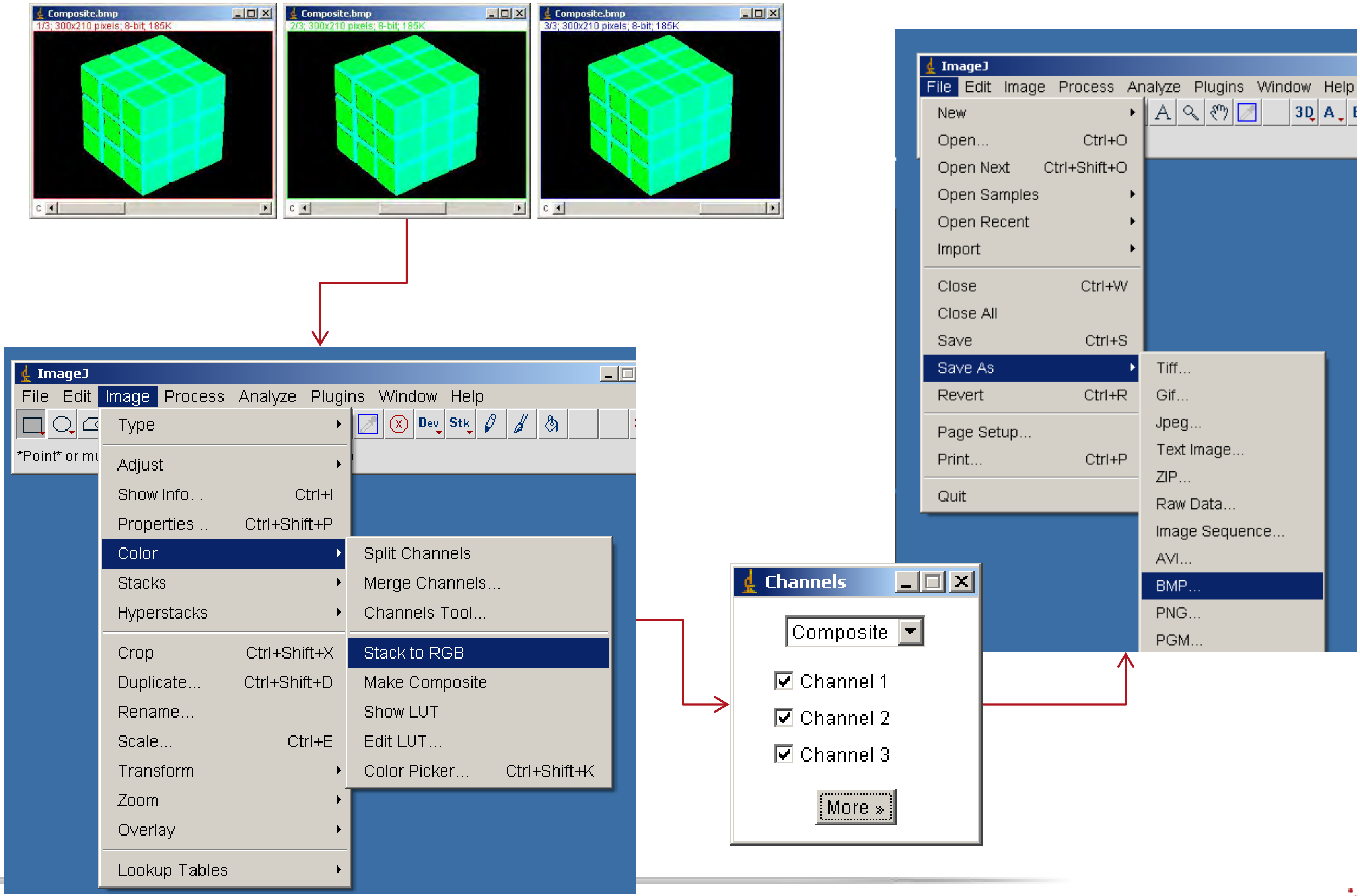
FEI

7. Merge Channels into a Composite Image



FEI

8. Convert Composite to RGB and Save as .BMP



Milling a Bitmap: Procedure

Milling a bitmap procedure

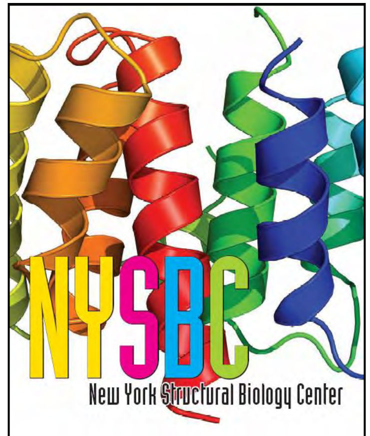
1. Select patterning page control
2. Select the bitmap shape on the bottom of the pattern selection dropdown menu.
3. Drag a square on the screen that represents the area of patterning. The position of the square can be changed by dragging.
4. Select File in the properties menu and load the bitmap using the open dialog. The bitmap should appear in the imaging quad.
5. Modify Aspect ratio to Free or Fixed depending if it is required to stretch the bitmap.
6. Optimize other properties such as applications file, depth, leading edge etc.
7. Start patterning.

Stream File Pattern

A stream file, created as an ASCII text or binary file that addresses the patterning DAC directly, produces custom pattern files to support a 12-bit DAC resolution, so the patterning field of view is divided into 4096 steps. The range in X is 0-4095, but in Y is approximately 280-3816. Y values outside of this range will be off the image area and may not scan correctly.

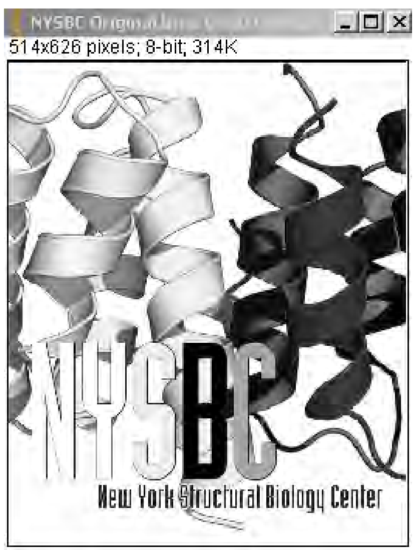
An Example from a Color Image

Original Image

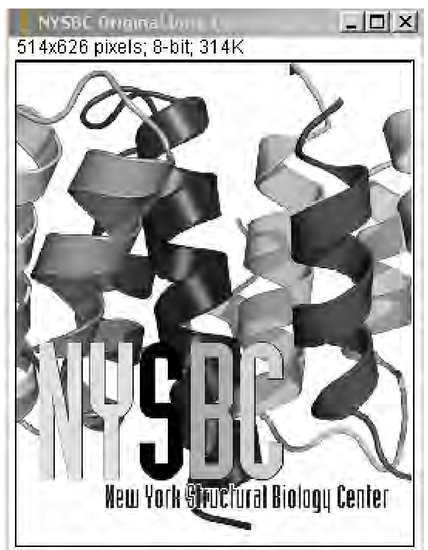


Split Channels

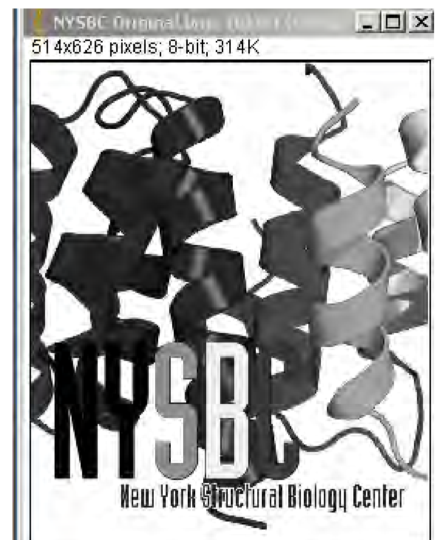
Red



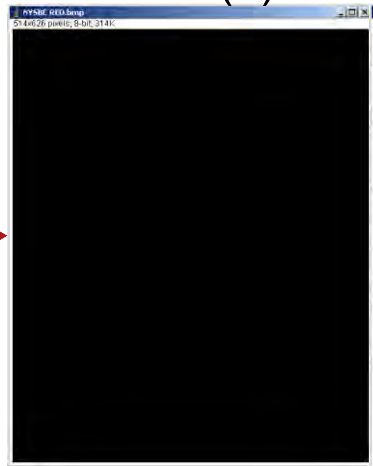
Green



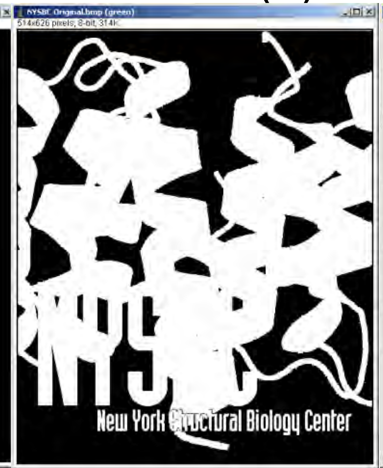
Blue



Red (2)



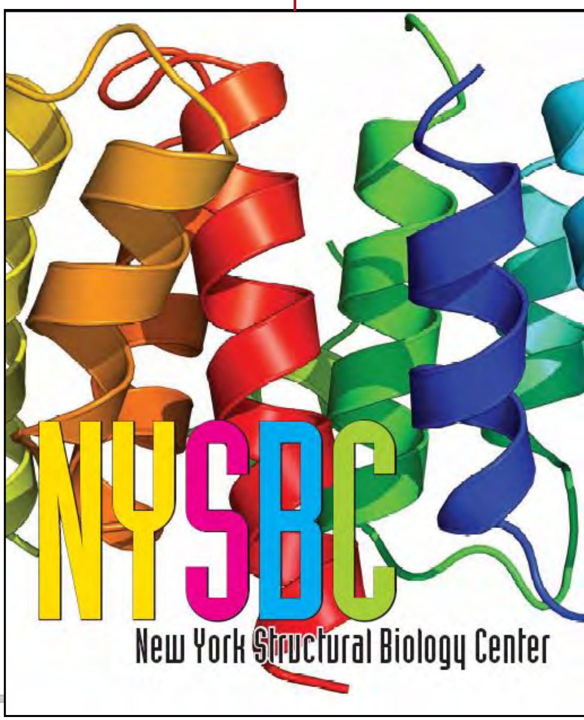
Green (2)



Blue (2)

Flatten Composite to RGB

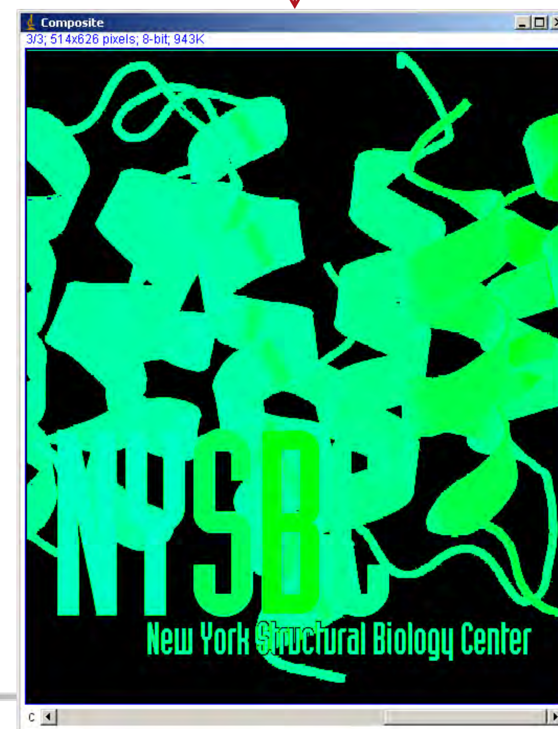
Original



Red Channel:
•Set to zero

Green Channel:
1. Choose best image *
2. Adjust Threshold**
3. Invert LUT

Blue Channel:
1. Soft B&C
2. Invert

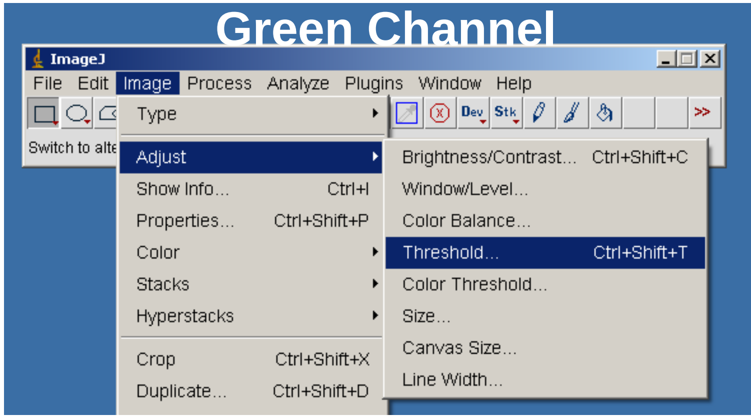


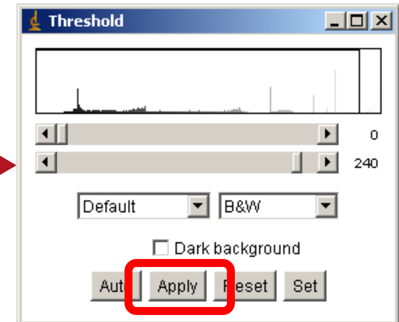
*Choose Best Channel for Green Layer

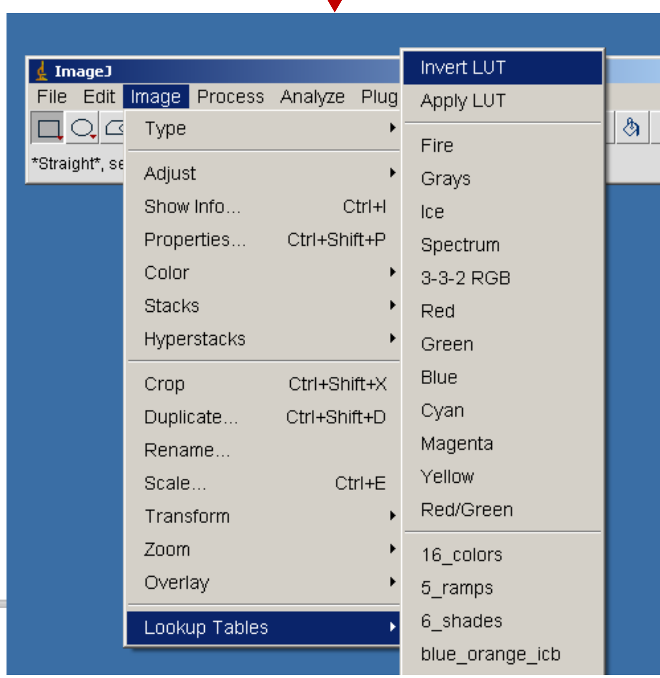
In fact, any one of these channels can be used for the mask (green) channel. Ultimately, one of the channels will be converted into a binary image (0→beam blanked, 255→ beam unblanked). So, examine the images and make a duplicate of the image with the least saturation in the pattern of interest. Here, notice that red drops the NY (255-white) and blue drops the NY (0-black), whereas the green channel appears to have no extreme values anywhere within the pattern of interest.

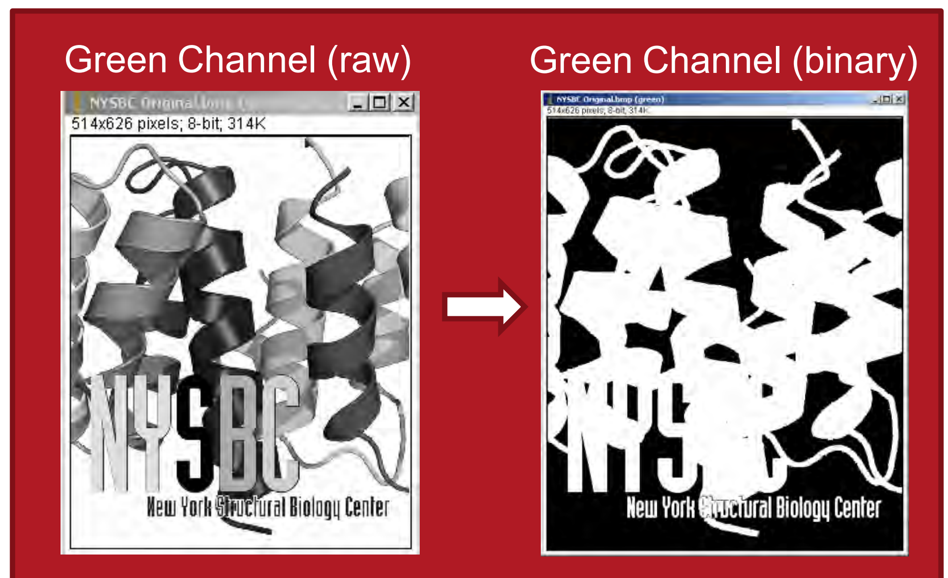
So, applying the ImageJ threshold function to the green channel will convert all pixels with values less than 255 to a value of 0, converting the image to a black pattern of interest on a white field. Thresholding appears to invert the LUT without changing the value of the pixel. You'll have to invert the image to create the final beam blanking mask (green layer) .

**Converting Image to Binary via Threshold









FEI