ReelSmart™ Motion Blur User's Manual, OFX plugin version

What is ReelSmart Motion Blur?

Automatically add more natural-looking motion blur to a sequence using ReelSmart Motion Blur. Our tracking technology is at the heart of ReelSmart Motion Blur, so there is no handwork involved. Of course you can add as little or as much blurring as you need, and even remove some motion blur. You can even can blur one sequence by using the motion from another for very interesting effects. RSMB also comes with a companion plugin which allows you to blur based on pre-rendered motion vectors.

To find out more about RE:Vision Effects and our product lines, visit our website at http://www.revisionfx.com.

ReelSmart Motion Blur supports 8 and 16 bits per pixel and floating point processing. The plugin has been tested on Mac, Windows and Linux (32 and 64b), and in the Foundry Nuke, Autodesk Toxik, Eyeon Fusion, and Assimilate Scratch.

How ReelSmart Motion Blur (RSMB) works

The plug-in calculates the motion between two successive frames in a sequence, calculates the motion from one frame to the next, and applies blur based on the calculated motion. No motion between two frames, no blur. This is useful to know when trying to figure out why RSMB doesn't apply blur to frames from a 3:2 pulldown sequence or animation done on "2"s, etc. Please note the plugin expects deinterlaced (progressive) material.

ReelSmart Motion Blur comes as two plugins. RSMB3, which blurs image sequences by tracking pixels from frame to frame and RSMB3Vectors, which uses motion vectors (usually from a 3D animation system) to blur an image sequence.

Before You Start, EXTREMELY IMPORTANT.
Common problems discussed here!

For all applications:

- **ReelSmart Motion Blur** works most intuitively on progressive material and in projects, compositions or sequences that are specified to be progressive.
- Another note on fields... if you have 3:2 pulldown in your source footage, you will want to **remove 3:2 pulldown** before processing with **RSMB**. If there is no motion between two frames then there will be no blur. This is useful to know when trying to figure out why RSMB doesn't apply blur to frames from a 3:2 pulldown sequence or animation done on "2"s, etc.
- The plugins of RSMB are installed on Windows in C:\Program Files\Common Files\Ofx\Plugins , on Mac in "/Library/OFX/Plugins" and on Linux in "/usr/OFX/Plugins". The path defined by the environment variable OFX_PLUGIN_PATH is supposed to be searched as well by the host application. Consult your host user manual for alternative OFX path location.

Toxik 2008

- Within toxik the two plugins of RSMB show up in a grouping in the tools palette named OFX REVision Effects..

Known issue 2008: occasionally while interacting you might end up with a red frame and that red frame will be kept in the cache. This is due to a problem in 2008 when interrupting (that is changing a slider during a render will cause an interruption). This should not happen during a real sequence render. If you get a red frame, you will have to interact with a non animated parameter to force a redraw. This apparently should be fixed in 2009.

Updating Plugins: For the future when we update a plugin and add and remove parameters it might break your comp/project/database when reopening a comp with the effect in it, either the tool will be said “not present” in which case you need to create a new instance and copy the values OR it might be missing some parameters entry in which case you will need to destroy the .xml file of the tool cached for example on Win32 here: C:\Program Files\Autodesk\Autodesk Toxik\resources\toolUi\ofx

Premult-Unmult: Toxik assumes unpremulted (straight) rgba inputs, and we provide an unpremultiplied image back. There is an Unpremult button in the image import tool as well as a unpremult node tool which should be applied before our tools when images are in a premultiplied format.

Nuke

- Within nuke the two plugins of RSMB show up in a RE:Vision Effects menu in the main menu bar

Premult-Unmult: Nuke assumes premultiplied rgba inputs, and we provide that back. If your input is straight/unpremultiplied, use the premultiplied tool before our tool.

Fusion

- Within Fusion the two plugins of RSMB show up in a REVision Effects menu in the tools menu. Note if you have native Fusion tools from us, it will show up in a different menu.

Premult-Unmult: Fusion assumes premultiplied rgba inputs, and we provide premultiplied images back. If your input is straight/unpremultiplied, use a tool with a post-multiply before our tool.

Others

- We don't know all the possible OFX host application in the universe, If you get unexpected behavior from another host then the listed above, please forward the problem to your host application and to us. Currently we only officially support the listed host applications in the Compatibility section of our website.

RMSB3

Usage of RSMB3, the ReelSmart Motion Blur plugin that performs frame-to-frame tracking in order to add motion blur. RSMB from Vectors is described later in this manual.

If you just want to track a sequence and add motion blur based on automatic tracking, then the following settings are of initial interest to you. Later we will describe how to apply a foreground separation matte to aid in the tracking, and describe when that might be useful..

At first we will consider the use of the plugin where you do not specify an input for the FG Matte source. In this case there is simply the whole image to track and then motion blur, so the image isn't split up into a BG and FG areas to track, and the image has just the Main area. In the case where you do not specify an input clip for the FG Matte source clip, you only have a Main image to track, and so should only consider the BG_Main: Blur Amt and BG_Main Sensitivity settings. Basically, the BG_Main settings apply to the Main (or whole image) when there is no foreground separating matte and applies to the background area when a separating matte is specified in the FG Matte input clip.

Of course, in order to blur anything you must specify an input Source clip.

Display:

1. Source Blurred : This setting displays the final **RSMB** result. This setting has all the layers that you have specified (via mattes) blurred individually and composited back together.
2. Sourcer UnBlurred: This setting displays the original color source; no blurring is done.

If you are using a matte to separate the footage into foreground and background layers (each tracked separately), then the following display settings are useful. Separating the footage into separate layers will be discussed below.

3. FG Blurred: This display setting shows the foreground layer motion blurred.
4. BG Blurred: This display setting shows the background blurred.

   The individual layer 'Blurred' settings (F1 Blurred, BG Blurred) are very useful when you are separating the source footage using mattes. The single layer "Blurred" settings allow you to see an individual layer blurred without having to wait for all layers to be calculated and composited.

Track Frame:

In **RSMB** , you have the choice of using the Previous frame,or the Next frame in the sequence to calculate the motion at each pixel of the frame being blurred. When at the first frame of a sequence then the next frame is used for motion calculation even if **Track Frame** is set to Previous.

Main BG: Blur Amt

Simply put: 0, means no blur. 1.0 means blur the "standard" amount (blur using the direction and amount of motion found). Of course you may add in as much or as little as desired. The default amount of 0.5 corresponds to 180 degree camera shutter opening.

To remove motion blur, provide a negative amount of blur. Keep in mind that RSMB may not be very effective at removing motion blur in imagery that has large amounts of motion blur.

TIP: When the sequence being processed has a cut or dissolve embedded, you may want to reduce the motion blur amount (or even set it to zero) during the transition.

Alt Track Src **(an input clip for the plugin)**

When this clip is left unconnected, the Source input's calculated motion is used to blur the layer.

On some sequences you might say to yourself, "if only I could enhance the colors used in the tracking process, but then use the colors from the original sequence for the motion blurred sequence." For example, the tracking of **RSMB** might not work particularly well on a low contrast or dark sequence. Or, the reverse, you might have heavily filtered the image sequence you want to motion blur, but you think you might get better tracking results by using the original footage as the imagery to be tracked. For these reasons we allow you to change the source that is used for tracking purposes. If Alt Track Src is left unconnected then the source that **RSMB** is applied to is used for both tracking and the color of the **RSMB** sequence. However, if an Alt Track Src clip is specified, then this sequence is used for tracking and the color is retrieved from the clip that RSMB is applied to. Of course, **RSMB** assumes that both the Alt Track Source and clip that RSMB is applied to line up exactly in time.

If an alternate motion clip is supplied, then it must have the same pixel dimensions as the Source clip; otherwise a **semi-transparent red image** will be produced to let you know that there is an error.

			
Figure 1	Figure 2	Figure 3	Figure 4

Using an alternate motion source:

- Figure 1: Original low contrast sequence
- Figure 2: Blurred frame using original sequence. The whole image is moving but the low contrast and luminance causes poor performance of **RSMB**'s tracking.
- Figure 3: Image enhanced, but used only for the tracking portion of **RSMB** by specifying it as the Alt Track Source.
- Figure 4: The original colors in Figure 1 are used for the blurred sequence, but the tracking is performed on a sequence represented by Figure 3. Note that the whole image is blurred as expected.

Main_BG: Sens:

With respect to supplying a separate piece of footage to track you might say "I don't have time to experiment with image processing my footage to specify an alternate motion source," or worse, "I try to color correct my footage and it does not help the tracking!" If objects still "gloop" together when they shouldn't, then you can try manipulating the Main_BG: Sens parameter. **Motion Sensitivity limits how much pixels can move.** A value of zero assures that pixels can't move very much, and a value of 100 allows pixels to move as much as the motion estimator can calculate. The default value of 70 might sometimes be a bit too "ambitious" for some material... by reducing the sensitivity you might be able to create a more satisfactory result where there is large motion rather then some sort of inappropriate swirl that **RSMB** might introduce. Conversely, if there is only one object in the scene and it moves in large amounts, the default value of 70 may not be ambitious enough.

This control is different than the amount of blur that is applied after motion estimation.... Motion Sensitivity actually limits how far pixels are tracked, and the Blur Amt controls how much blur is added based on the tracking.

This setting is most useful when there are passing objects and a background object is blurred too much by the foreground motion. If objects in the foreground and background pick up each other's motion when they shouldn't then you can try changing the Motion Sensitivity setting to a lower value.

Splitting your input sequence into one foreground layer and a background layer.

Let's assume you have a sequence with one foreground object. Let's also assume that you have a matte for this object at each frame. We now describe how to improve **RSMB**'s tracking by using this matte.

RSMB allows you to specify a matte so that you can track a foreground object separately from the background.This can help immensely with blurring "spilling" over from a foreground object to the background or vice-versa. Except for specifying nice anti-aliased edges of the foreground, make sure that the matte you supply is full-on white. For example, be careful to not have tiny holes in the supplied matte input.

Important: Make sure that pixels are ZERO (not near-zero) where the **background** should be seen otherwise you might corrupt the result. Keying a foreground can sometimes leave a matte near-zero, but not actually zero. Also, make sure that the areas that are absolutely the foreground are full-on (1.0, not *almost* full-on). Areas of transition between the background and foreground (the edges of a foreground object, for example), may be supplied values between full-on and full-off.

Note that when a pixel in the supplied foreground matte is neither full-off nor full-on that the corresponding pixel in the color source will be partially used to track the foreground and partially used to track the background which, when not at an edge of an object, can confuse the tracker. Set the Display setting to either FG Blurred or BG Blurred when in doubt of how a pixel in the color source is being used for the foreground and background separation. As a safety measure, you may want to supply **RSMB** a threshholded matte input (that is, all pixels either full-on or full-off) when the layer separation feature presents you with confusing results

If a foreground matte is supplied, then it must have the same pixel dimensions as the color source; otherwise a **semi-transparent red image** will be produced to let you know that there is an error.

Please note that while using a foreground matte can dramatically improve results, **RSMB** needs to calculate one or two additional motion estimations per frame (because **RSMB** generates motion for the foreground, and motion for the background), so it can take more than twice as long as without a foreground layer.

To specify a matte to separate an image into foreground and background areas, connect a clip to the FG Matte input source. This matte clip can be either 1 or 4 channels. The following parameters are only meaningful if you have a matte source connected.

- **FG: Blur Amt**: The motion blur amount to use for the foreground object.
- **FG: Sens**: It is helpful to specify a foreground motion sensitivity that is separate from the main layer motion sensitivity (for example, something moving over a stable background), so it is provided here (see above for the Motion Sensitivity description that is used for the background layer).
- **Use Chan**: If the FG Matte source is 1 channel deep, then this setting can be ignored. In the case of a 4 channel input for FG Matte, this setting specifies which channel of the FG Matte clip the mask should be retrieved from.
- **FG Inv Matte Shrink**: This allows you to specify (in pixels) the amount the inverse of the foreground matte should be shrunk when tracking and creating the main (background) layer. If you see a dark line or similar artifacts where you know the edges of your mask are, just raise this value.

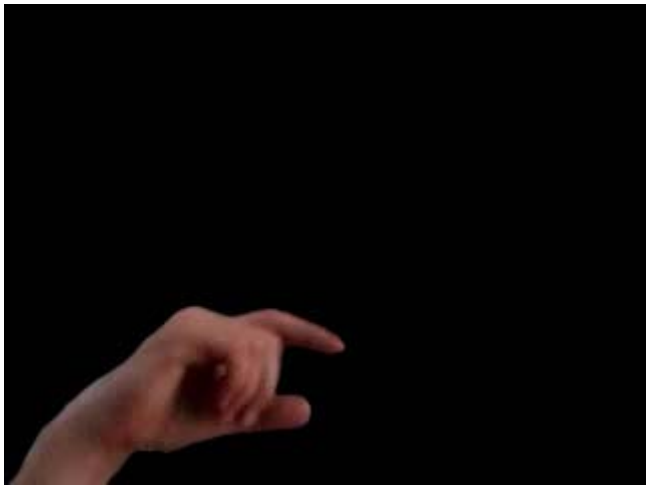
It is now appropriate to specify the other two settings of the Display setting:

In order to describe the foreground layer option of **RSMB**, pictures are worth a thousand words! So let's say we have the following image, and matte for the foreground object:

Source Image

Matte for Foreground Object

Using the matte for the foreground and the inverse of the matte for the background we get the following two pictures:



Matte used to separate out foreground.

Inverse of matte to specify background.

Note that while the matte specifies the foreground quite nicely, some of the pixels of the foreground spill into the background! By specifying how many pixels to shrink the inverse of the foreground matte (the FG Inv Matte Shrink value), we can reduce or eliminate the spillage. By specifying a value of 1.5 we get the following picture:

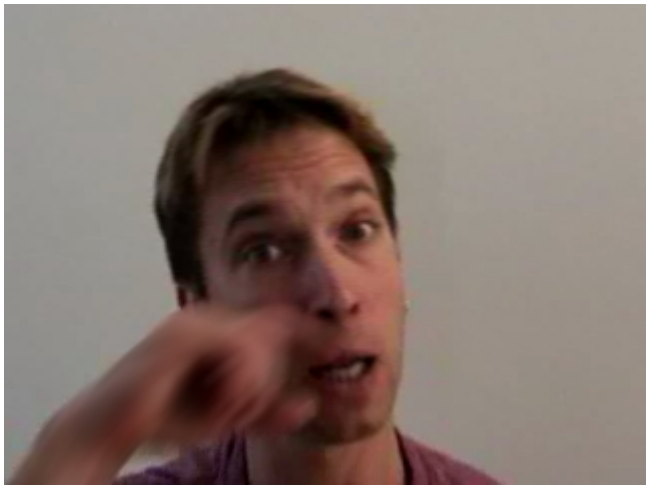
Shrinking the inverse of the matte to get a better background by specifying a FG Inv Matte Shrink value of 1.5.

Note you might ask, "won't that create a gap in my final output?" The answer is no! Through clever filling and compositing, we track the background separately from the foreground, and fill in missing information in the background as best we can!

If we display just the FG layer by setting the Display menu to FG Blurred we get the image of the hand above (blurred of course). However, if we set this menu to BG Blurred what do we see? The following figure answers that question.

Setting the Display to BG Blurred. Note that **RSMB** does the best it can to fill in the missing information. Keep in mind that in the final result **RSMB** will be compositing the foreground layer on top of this.

Two results are presented, one using no layer separation and one with layer separation.

	
Motion Blur without foreground layer separated. Note: stationary head keeps hand from being tracked properly.	Motion Blur using foreground layer mask option. Foreground and background motion kept separate. Hand now blurred appropriately.

Potentially Problematic Footage

If you have not used **RSMB** yet, this section might prove to be a little bit esoteric. This information will be of more use to you as you become more familiar with **RSMB** and want to understand how to generate the best possible results.

It might happen that **RSMB** does poorly in specific instances. The idea here is not to discourage you and tell you it does not work but, rather, to give truth in advertising. As you become an expert user, you learn to predict the kind of material that can cause problems.

1. "Picket Fence": A very regular pattern in motion (for example someone wearing a t-shirt with fine stripes) with an object moving in front of it (e.g. the same person hand for instance) might confuse the motion vector calculation. Any very structured pattern rotating can cause "blind spots" for the analyzer.

2. "Transparency": Overlay of semi-opaque surfaces might create unexpected results. Some camera settings for example will streak under fast motion and that can create disappointing tracking results.

3. "Short Interval Defects" : Sudden global illumination change (e.g., a flash), strobing, dust, ... can create unexpected / undesired results. Also, if there is a piece of hair or a scratch on the scanned film for a frame this would influence the tracking so you really should try to clean such defects before processing.

4. "Duplicated Frames": **RSMB** does not provide automatic duplicated frame detection support. As such, you will need to remove duplicated frames before the application of **RSMB**. Also, you should be aware that if your material has 3:2 pulldown you should remove it beforehand. The same

applies to animations on 2's. If you leave the duplicate frames (or fields, in the case of 3:2 pulldown) the freeze-frame, inherent in the duplication of the frames, will be stretched (or sped up, as appropriate).

5. "Alternate Motions": When motions going in different direction are layered it is possible that the dominant motion affects (spills into) the background motion.

6. "Specular Highlights": If you have moving lights, e.g., a shiny object that reflects the light as it moves, it might cause problems because when the motion estimator attempts to match two images, as the motion estimator will tend to follow the highlight as if it was an object. (of course, sometimes this is what you want).

7. "Ultra-Fast Structured Motion": We are very particularly perceptive to human actions. We have sometimes seen that certain complex rapid motion such as someone doing a frenetic dance creates interframe displacements that are just too big for our motion estimator to resolve satisfactorily. When planning a shoot for an effect that involves **RSMB** in the pipeline, consider that for **RSMB** fast articulated motion should be easier for front facing subject then sideway views as there will be less pixels traveled per frame on the screen, which is really the only thing that **RSMB** cares about.

9. "Fast Cuts": When blurring footage, **RSMB** does not "see" cuts in your footage. As such, you should work with **RSMB** on each portion of a cut individually. That is, if you apply **RSMB** on some finished footage with fast-cut advertising content or some MTV like action that has dissolves and multi-layered of actions going in and out, it will do something but the result might be more predictable if used on the unprocessed content (before doing dissolves...) source elements individually (or you might prefer to animate the Motion Sensitivity in phase with your dissolve).

10. "Occlusions": Problems caused by object motions tend to be one frame problems and localized in an area of the frame which is called an occlusion, which is some pixels that you see on one frame but are not visible on the other as a result of camera and/or that object motion.

11. “Limited Reach”: As a rule of thumb considers that **RSMB** will be most accurate for pixel displacements that are a maximum of 5% of your image resolution (for 720x486, this comes to a maximum horizontal displacement of 35 pixels or so). With displacements larger than that **RSMB** will start to become less precise as it tries to separate motions from one another in an image sequence.

12. "Compression Artifacts": Certain video coding techniques such as DV compressors use 8 by 8 pixels blocks (intraframe) based compression. What this means for you is that if for instance you have a sharp edge that moves, it will switch of 8 by 8 block and therefore locally it's neighbor values will be all different (substantially not like 2-3 values over 255 but sometimes 40 off near an edge). This is why green screen like setups perform badly with DV... Without smoothing the source, this can sometimes certainly create tracking problems. As such you probably should set Alt Track Src to a gaussian blurred version of the input sequence.

RMSB With Vectors

Usage of RSMB3_Vectors, the ReelSmart Motion Blur plugin that performs blurring by using motion vectors supplied to the plugin.

The settings of **RSMB Vectors** are:

Source: (an input clip). This specifies the clip to be blurred. If the setting is left unconnected, then **RSMB Vectors** will render a transparent image to let you know you need to set the Source input.

Motion Vectors (an input clip): This setting specifies the input clip to use as Motion Vectors. We will describe our motion vector format below. If the setting is left unconnected, then **RSMB Vectors** will render a transparent image to let you know you need to set the Motion Vectors input.

Blur Amount: The amount to blur. The default of 0.5 corresponds to a 180 degree shutter angle. A negative value removes motion blur (see the regular **RSMB** manual for more info).

Max Displacement: The maximum displacement used when you created the motion vector image files (see the above discussion on the file format).

Vector: Scale X, Vector: Scale Y: Used to scale the motion vectors internally once they've been converted to floating point. Note: a -1 value for Vector: Scale Y can correct for the Y component of your motion vectors pointing in the incorrect direction.

IMPORTANT: Alpha Channel Info.
RSMB Vectors assumes that the vector information at a particular pixel is not valid if the the alpha channel **in the motion vector image** is less than full-on at a particular pixel. Note that transparent source imagery (not motion vector imagery) will be blurred properly, because the alpha for the color source is independent of the alpha for the motion vector image sequence.

It is important to set the alpha to full-on values for the motion vector images where motion vectors are known to be valid. Areas of the motion vector image where the motion vectors are not known (or are known to be bad) should have alpha set to zero or any value other than full-on. It is imporant to categorize each pixel in the motion vector file as good or bad for **RSMB Vectors** to work properly. For example, when rendering vectors from a 3D animation system it is useful to set the alpha channel to the same alpha channel that is used for compositing the element.

For example, lets say we have the following image created from an animation system.

Examples of incorrect and correct setup of motion vector files for use in **RSMB Vectors**.

Incorrect Motion Vector creation: Areas of unknown motion vector data set to (0,0) displacement.

Correct Motion Vector creation: **Alpha** of areas of unknown vector data set to 0.

Animation blurred with motion vector image above. Areas with (0,0) displacement do not get blurred. As such, notice the harsh edges around the hand and right foot.

Animation blurred with vector file above. Areas where the vector information not known are now blurred appropriately.

Color Space and Gamma

Since the Motion Vectors image represents actual values (is data that has a special mathematical meaning), make sure no gamma or other similar transformation is performed on the data. For example in *Nuke* this might mean if your input is not float that you need to press the “raw data” checkbox in the Reader panel to avoid your image getting an sRGB conversion.

Motion Vector Format

In this section we describe our motion vector format.

We assume that X is positive going from left to right. And the positive Y designates motion going UP (which is the opposite of After Effect's coordinate system, for example).

We assume that X,Y vector information is encoded in the red and green channels of the image. In addition we assume the vector information has been normalized so that both X and Y range from -1 to 1, presumably using some constant value to divide the X and Y component values. We call this normalization value the Max Displace value.

In 8 bits per channel, we assume that -1 corresponds to pixel value of 0 and that +1 corresponds to 254. We have chosen to map (-1,+1) to (0,254) because with this scheme we can represent a 0 displacement with a pixel value of 127 (in a scheme that maps (-1,+1) to (0, 255), a 0 displacement value corresponds to pixel value of 127.5, which cannot be represented exactly).

So you can convert floating point motion vectors X,Y to 8 bit red,green values with the following pseudo-code:

- // We wish to map (-MaxDisplace, +MaxDisplace) to (0,254)

  ```
  //First, map (-MaxDisplace to +MaxDisplace) to (0, 1)
  float fred = ((x/MaxDisplace)+1)*0.5;

  /* clamp values if needed */
  if (fred<0) fred = 0;
  if (fred>1) fred = 1;

  /* assign pixel value */
  unsigned char red = fred*254.0 + 0.5; /* rounding is preferred to truncation, but this is your choice */
  ```

- ```
  float fgreen = ((y/MaxDisplace)+1)*0.5;
  if (fgreen<0) fgreen = 0;
  if (fgreen>1) fgreen = 1;
  unsigned char green = fgreen*254.0 + 0.5; /* rounding is preferred to truncation, but that's your choice */
  ```

HOWEVER, it is not advised to use 8 bits per channel to store your motion vectors. In 16 bpc, you should map (-MaxDisplace,+MaxDispalce) to (0, 65534) (note: the maximum is 64434 and not 65535). When saving 16 bits per channel the formulae become:

- ```
  // First, map -MaxDisplace to MaxDisplace to 0 to 1
  float fred = ((x/MaxDisplace)+1)*0.5;

  /* clamp values if needed */
  if (fred<0) fred = 0;
  if (fred>1) fred = 1;

  /* assign pixel value */
  unsigned short red = fred*65534.0 + 0.5; /* rounding is preferred to truncation, but that's your choice */
  ```

- ```
  float fgreen = ((y/MaxDisplace)+1)*0.5;
  if (fgreen<0) fgreen = 0;
  if (fgreen>1) fgreen = 1;
  unsigned short green = fgreen*65534.0+0.5.
  ```

The blue channel is ignored.

In floating point, no clamping is done, so a max Displace of 1.0 can be used on a pure floating point pipeline.

Does the motion vector file need to be the same resolution as the source being blurred?

The answer is NO. However, note that if the motion vector file is half the resolution of the source material that when the motion vector displacements will be appropriately adjusted. Now the smaller or larger image needs to be the same image ratio, otherwise the motion will be misaligned with the color source.

For example, if the motion vector file is 1/2 the image resolution of the source material, then internally the motion vector file's resolution is made to match that of the source imagery, and the
  ```

MaxDisplace value is scaled by a factor of 2. (E.g., a value of 40 pixels in the 1/2 resolution vector file should match to 80 pixels in the source resolution).