# Digital Compositing

CS5245 Vision & Graphics for Special Effects

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# Digital Compositing

Digital compositing means:

"digitally manipulated integration of at least two source images to produce a new image."

- The new image must appear realistic.
- It must be completely and seamlessly integrated, as if it were actually photographed by a single camera.

# Digital Compositing

- A scene in *Spartacus* shot with green-screen.

- The scene composited with real elements and CGI elements.

Images taken from *Computer Graphics World*, April 2004.

# Digital Compositing

Main topics

- Alpha Blending: blending foreground and background
- Keying: separating foreground and background
  - Luma, chroma, difference keying
- Rig Removal: removing unwanted elements,

Other topics:

- Read [Kel00].

# Alpha Blending

$$C = \alpha F + (1 - \alpha) B$$

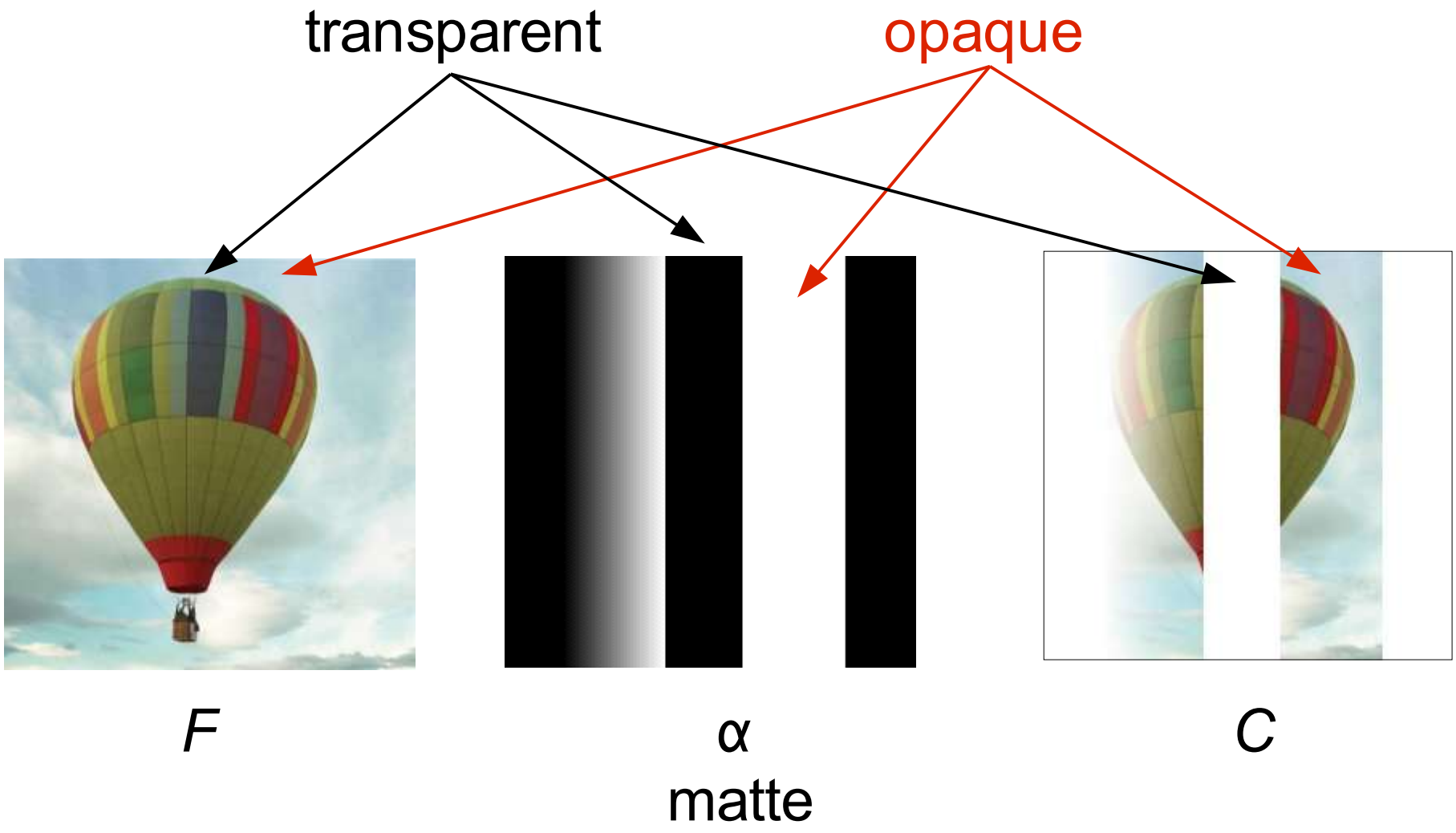
- $F$ : foreground image
- $B$ : background image
- $C$ : composition
- α : opacity or transparency
  An image of α values is called a matte.
- The above operation is performed on each corresponding pixel.

# Alpha Blending

- If $\alpha = 1$, then $C = F$,
  foreground is shown, i.e., foreground is opaque.
- If $\alpha = 0$, then $C = B$,
  background is shown, i.e., foreground is transparent.
- $0 < \alpha < 1$: semi-transparent, e.g., shadow, smoke, etc.

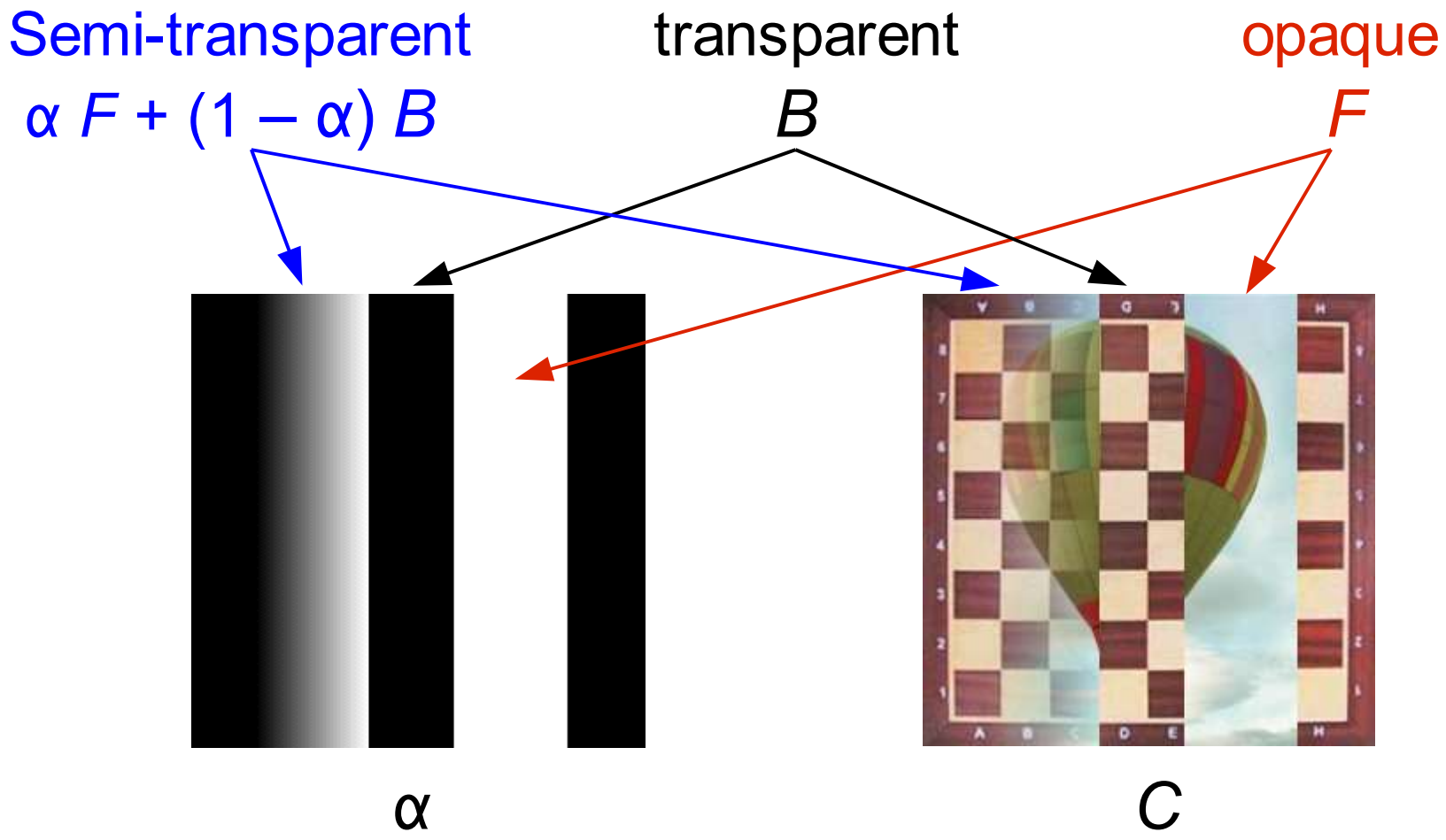
# Alpha Blending

Example: No background *B*



# Alpha Blending

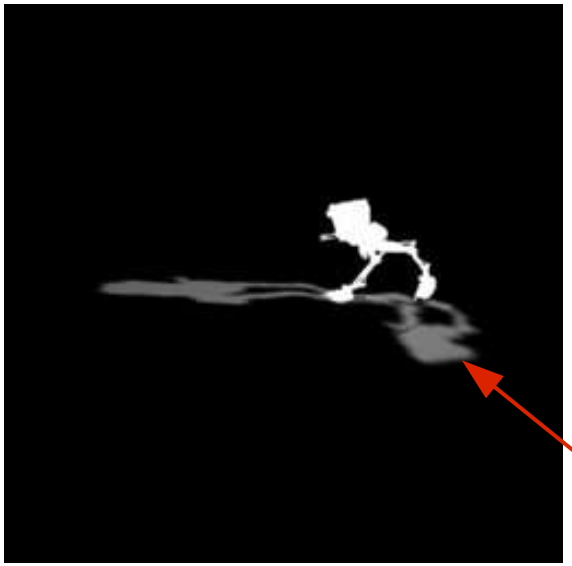
Example: With background *B*



# Alpha Blending

Example:

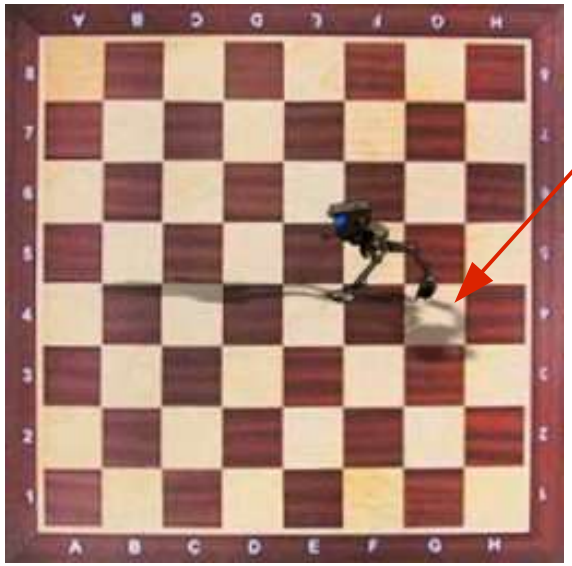
*F*



α

shadow

*B*

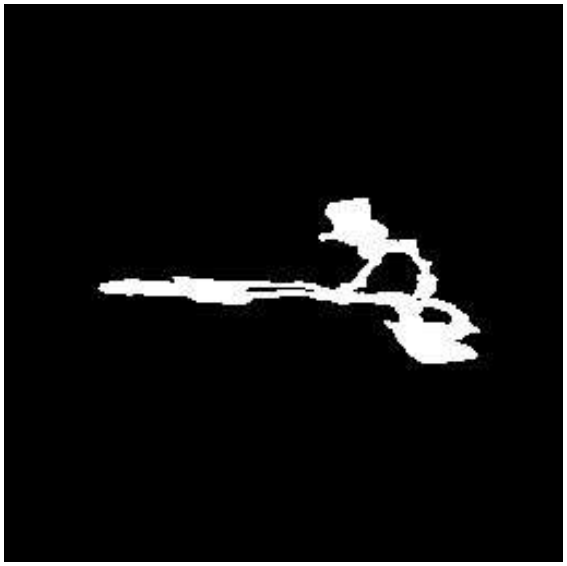


*C*

# Alpha Blending

Notes:

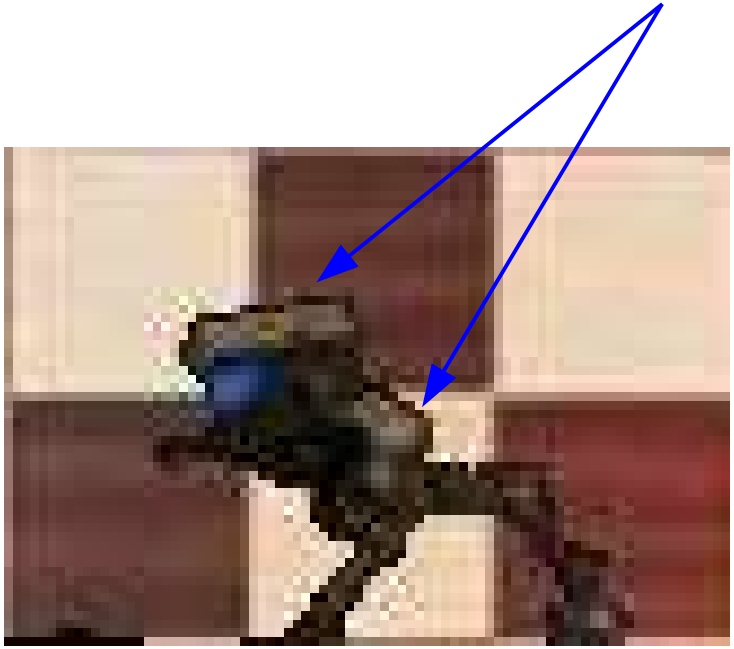
- For shadow, $\alpha$ must take fractional value ($0 < \alpha < 1$). Otherwise, shadow looks unreal.



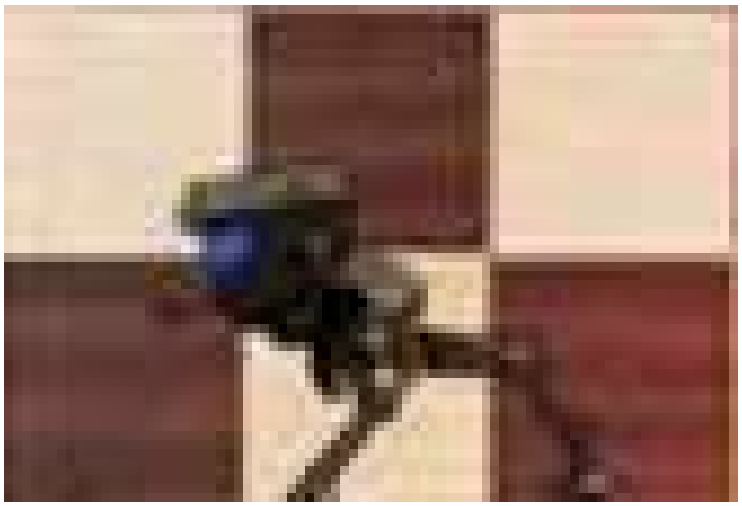
a bad matte results in a bad comp

# Alpha Blending

- $\alpha$ at boundary area should also be fractional. Otherwise, have dark fringes; unrealistic.



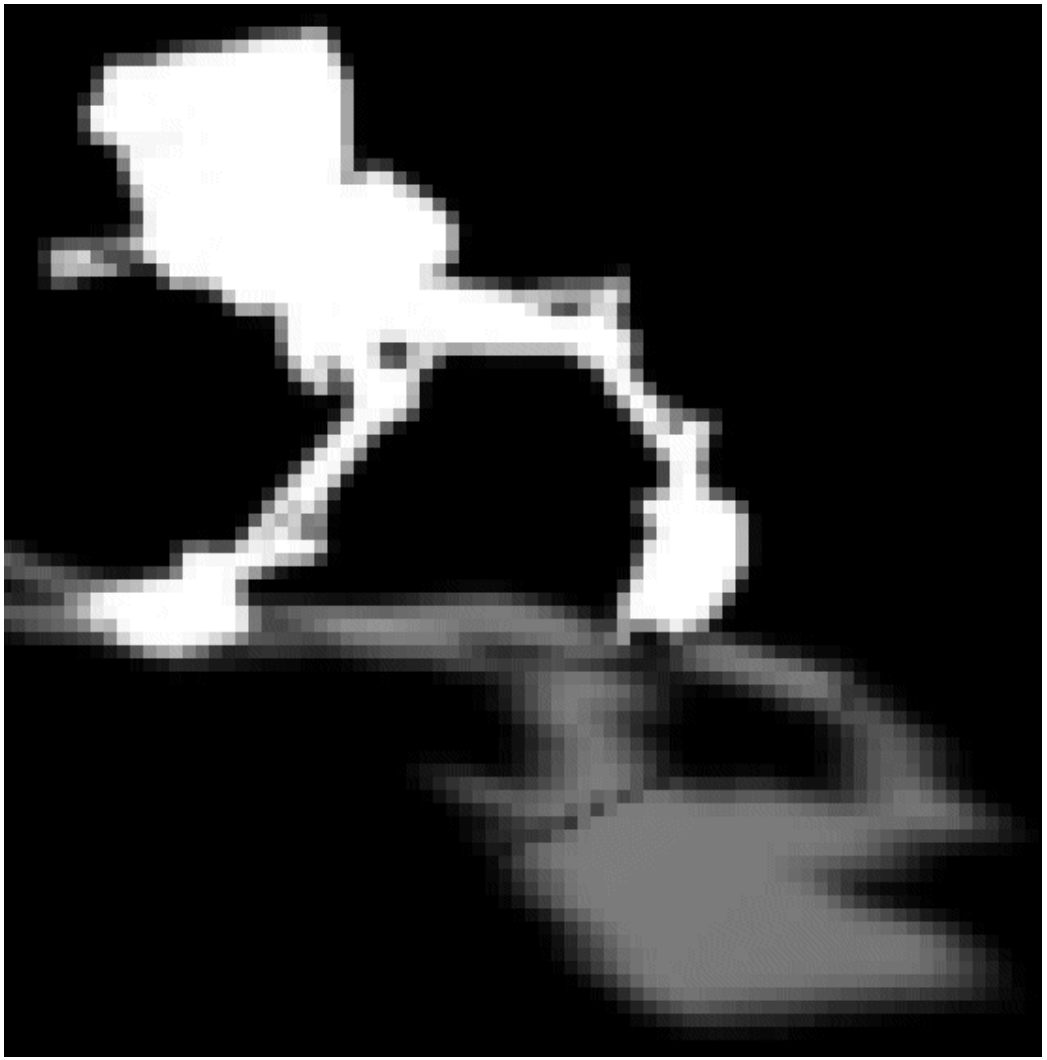
a bad comp



a better comp

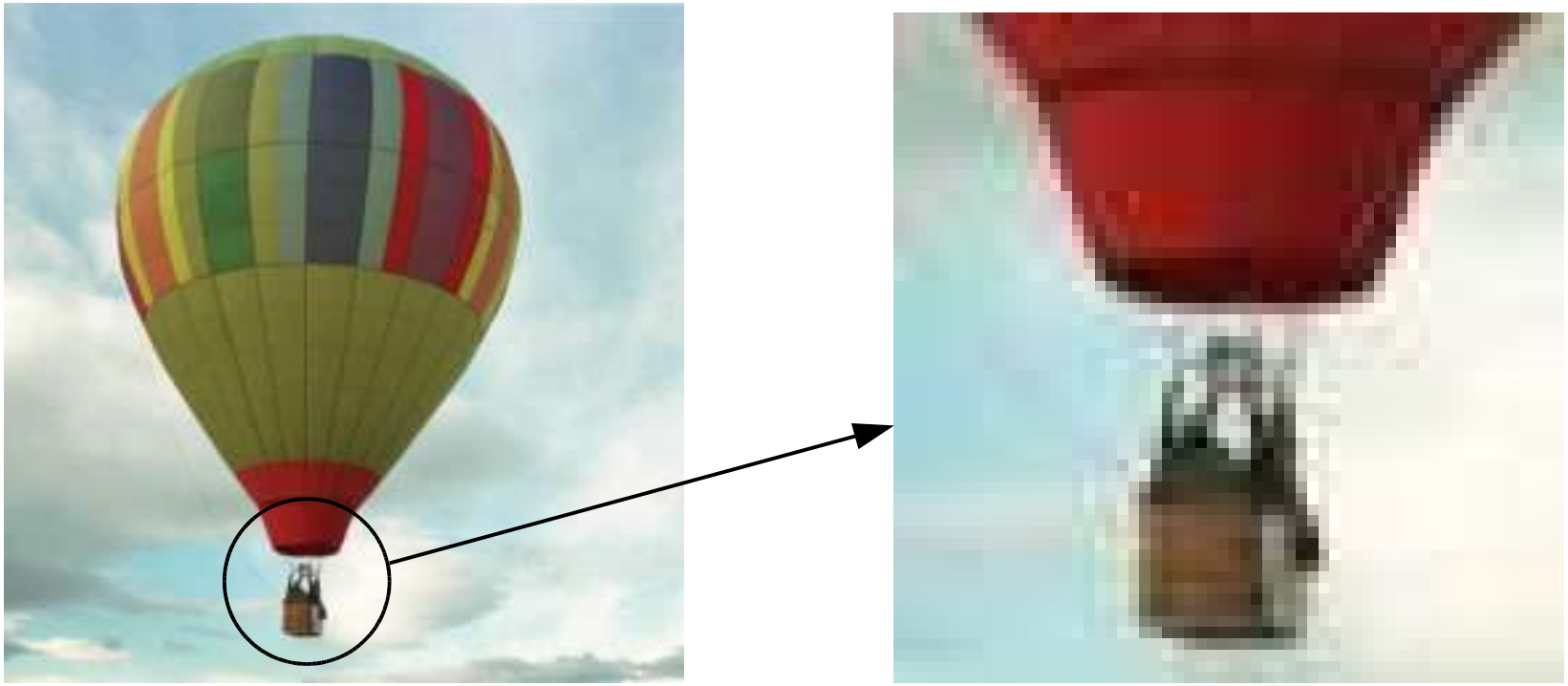
# Alpha Blending

- A good matte has fractional $\alpha$ in shadow, and along object boundaries and shadow boundaries.



# Alpha Blending

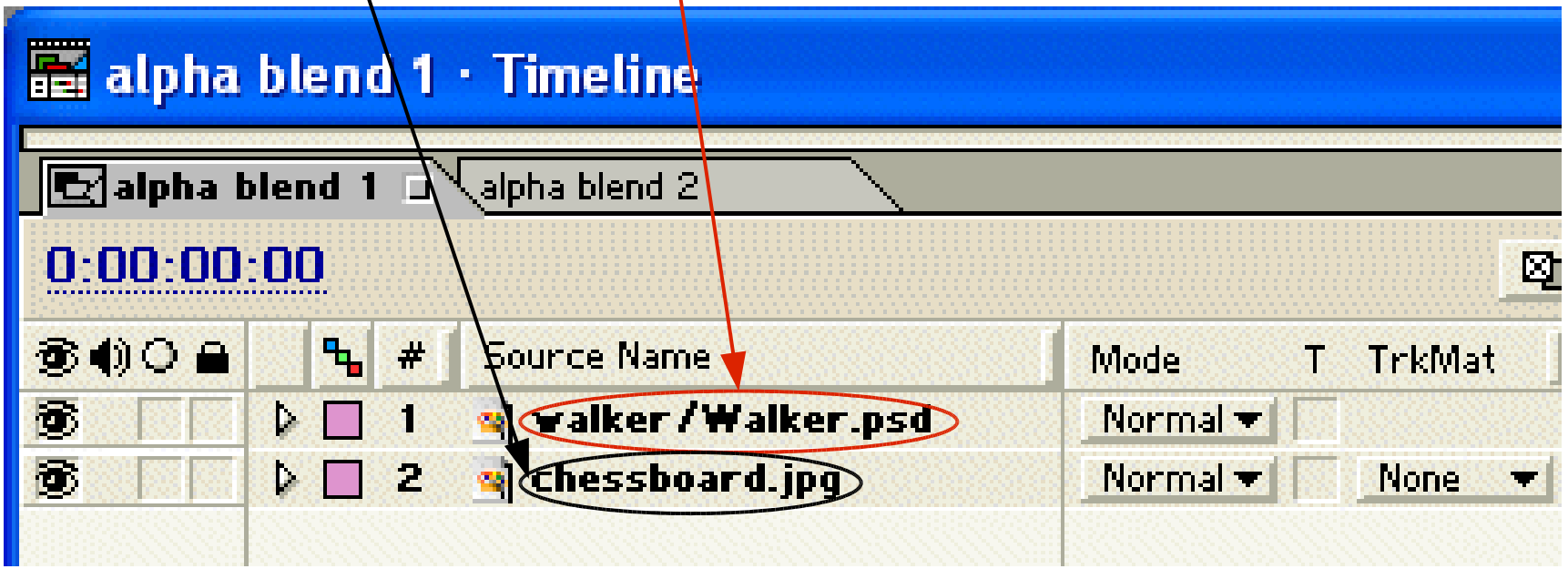
- Real images have smooth boundaries, no fringe.



# Alpha Blending

Method 1: Using a foreground image with alpha channel.

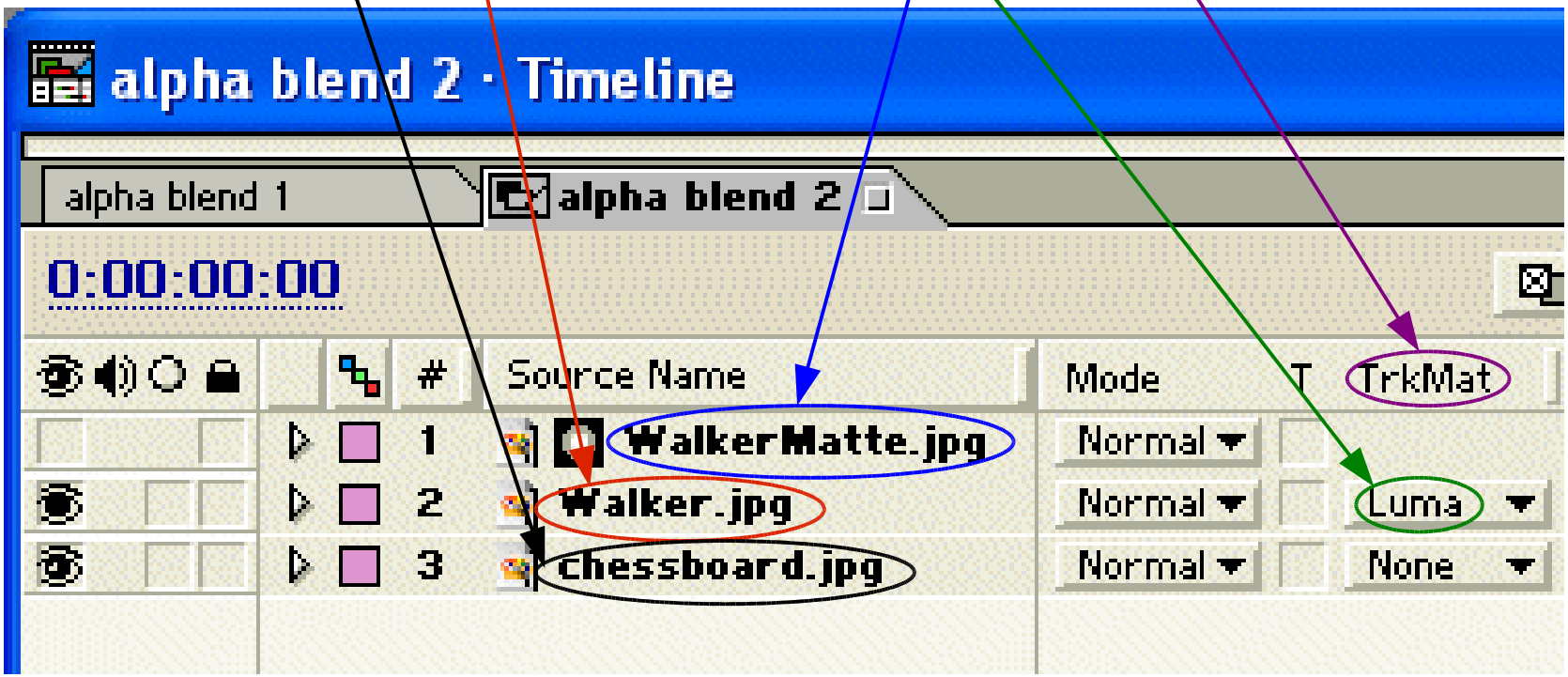
- Import object layer of foreground image.
- Import background image.
- Composite the foreground layer over background image.



# Alpha Blending

Method 2: Using foreground image without alpha channel.

- Import foreground image and matte.
- Import background image.
- Composite using luminance-based track matte.



# Keying

- Separating foreground from background, creating a matte of foreground.
- Also called *pulling a matte* (of foreground), or *keying out* (i.e., making transparent) *background*.
- Recall:

  A good matte has fractional $\alpha$ in shadow, and along object boundaries and shadow boundaries.

# Keying

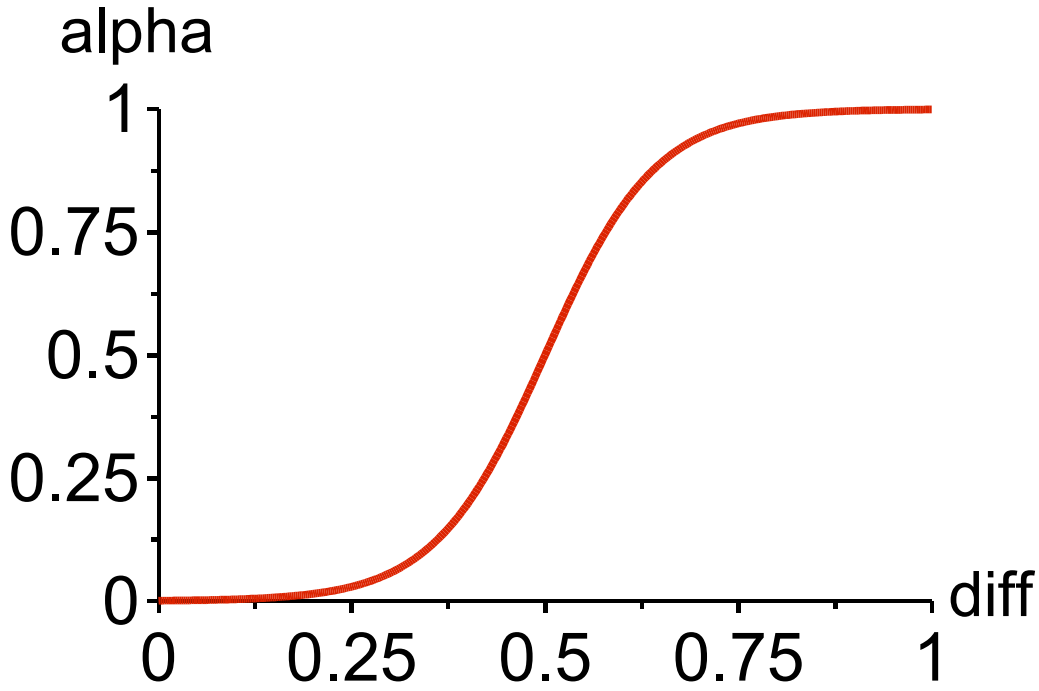
Basic methods:

- Luma keying:
  based on luminance (i.e., intensity)
- Chroma keying:
  based on color (i.e., bluescreen, greenscreen)
- Difference keying:
  requires a clean plate, i.e., a background image without the foreground element.

# Keying

Basic idea:

- Compute difference between foreground and background (based on luma, chroma, or color)
- Very small diff $\Rightarrow \alpha = 0$.
- Very large diff $\Rightarrow \alpha = 1$.
- Intermediate diff $\Rightarrow$ intermediate $\alpha$



# Luma Keying

- Key out the background based on luminance.
- Useful when background has a uniform luminance that is very different from foreground luminance.
- Example:

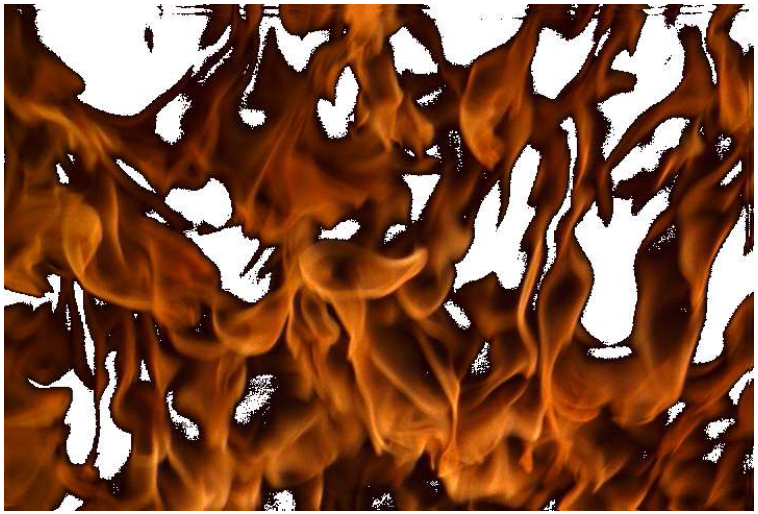
# Luma Keying with After Effects

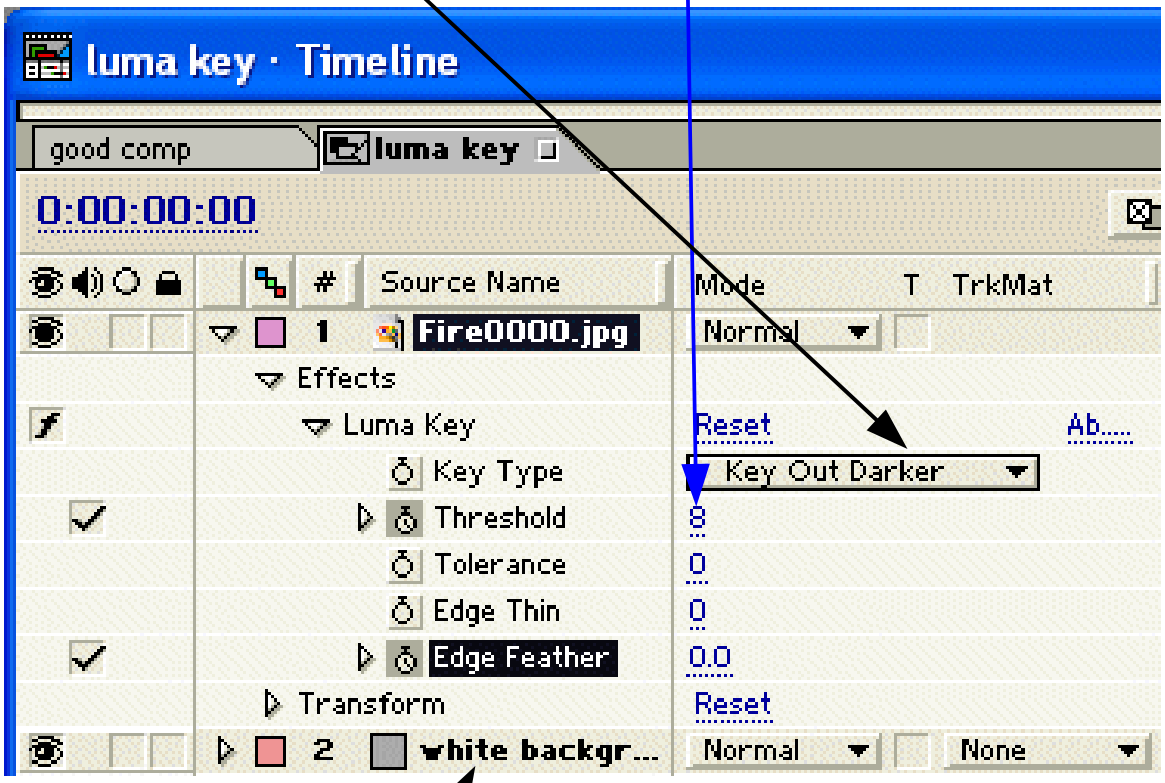
- Select layer, choose “Effect > Keying > Luma Key”.
- Has several options:
  - Key out brighter, key out darker
  - Key out similar, key out dissimilar

- Caution:
  After Effects standard version supports only binary matte:
  - keyed foreground is opaque ($\alpha = 255$)
  - keyed out region is transparent ($\alpha = 0$)
  - cannot have semi-transparent regions (other $\alpha$)

# Luma Keying with After Effects

Example: Key out black background with threshold.

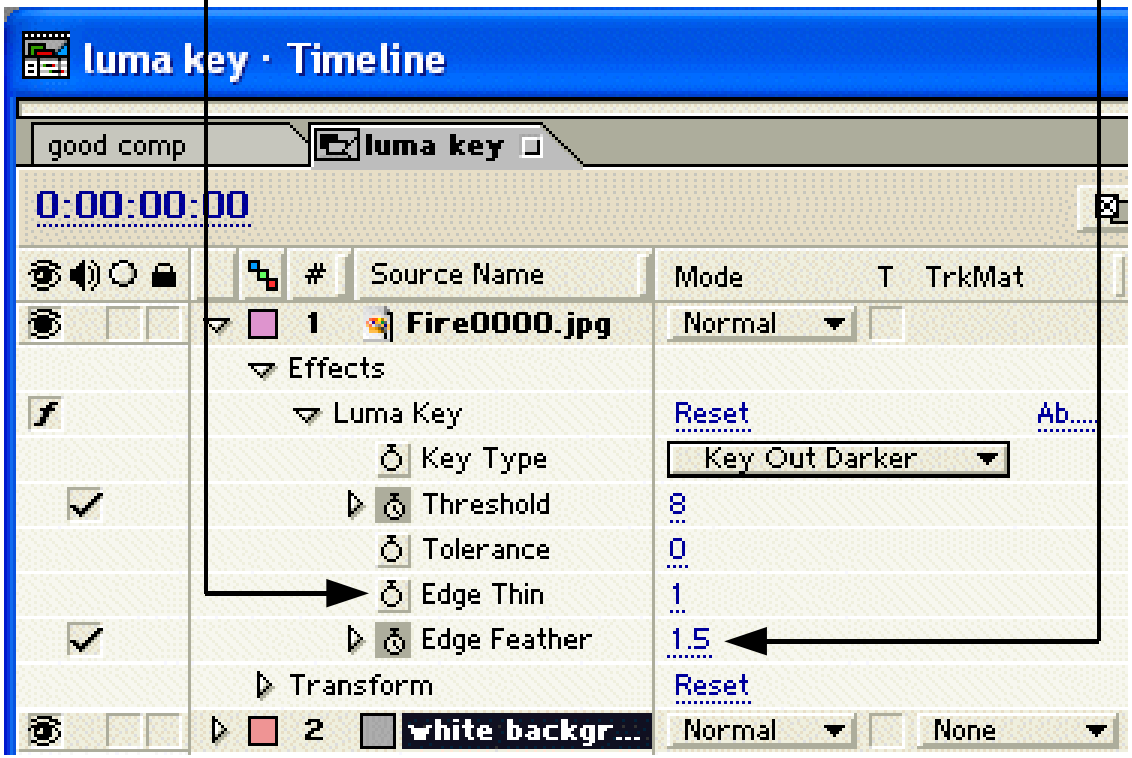





white background inserted for easy inspection only

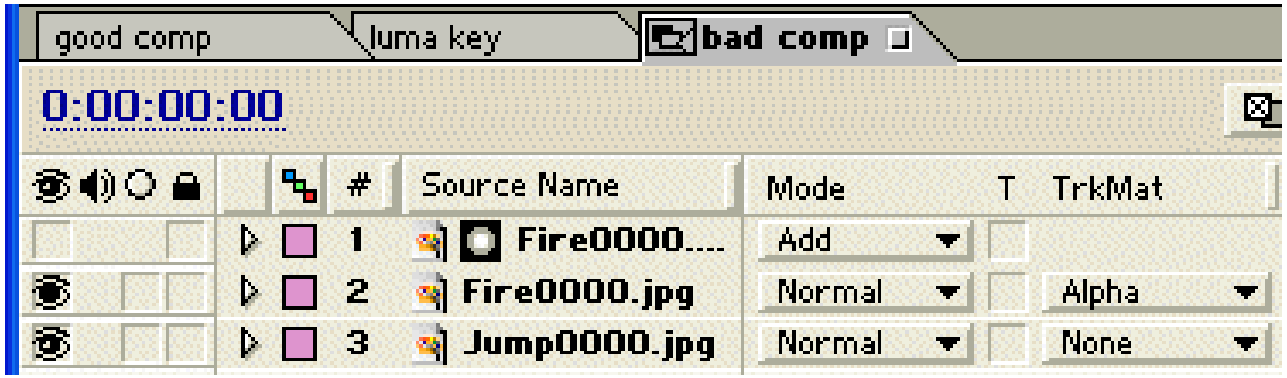
# Luma Keying with After Effects

- Reduce fringe thickness and soften edges.




# Luma Keying with After Effects

- Keyed foreground is opaque ($\alpha$ = 255).




Comp by alpha matte looks odd.
Fire should not be opaque.

# Luma Keying with After Effects

- With gray-scale matte, fire becomes transparent.


Demo

# Chroma Keying

- Key out the background based on color.
- Useful when background has a uniform color that is very different from foreground color.
- Example: Image shot with blue screen.

# Chroma Keying

Some characteristics of blue screen image:

- Blue spill:
  Light reflected from blue screen;
  must be removed.
- Partial transparency:
  Also looks bluish;
  must retain partial transparency.
- Rig:
  Used to support actor/prop;
  Must be removed.

# Chroma Keying

- Another example of blue spill:

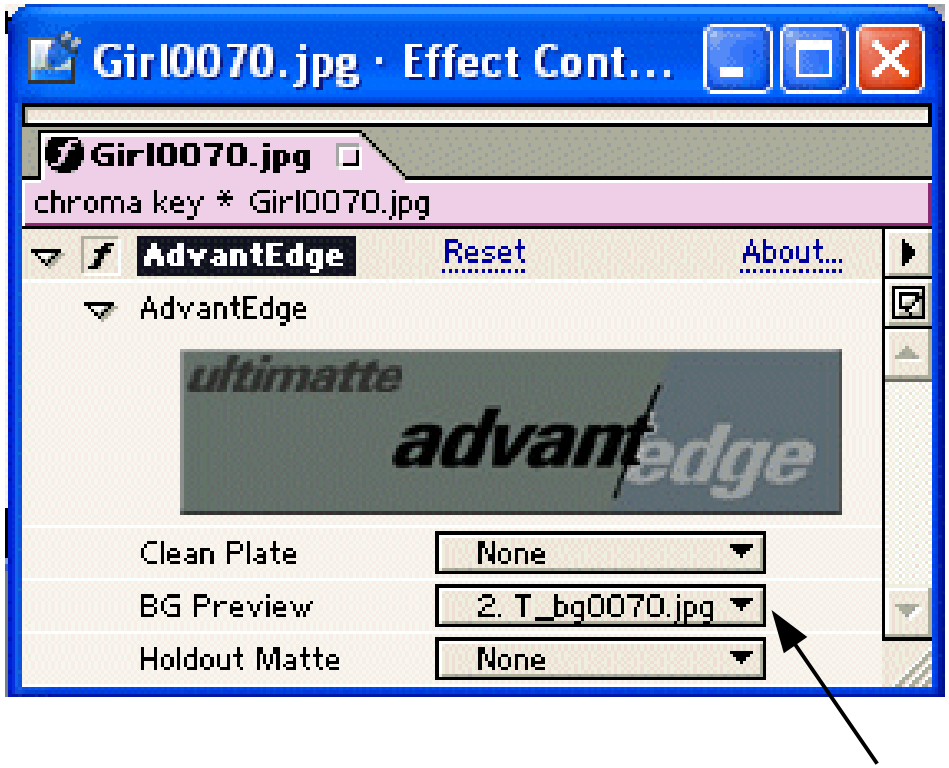
- To reduce blue spill, move foreground object far away from blue screen.

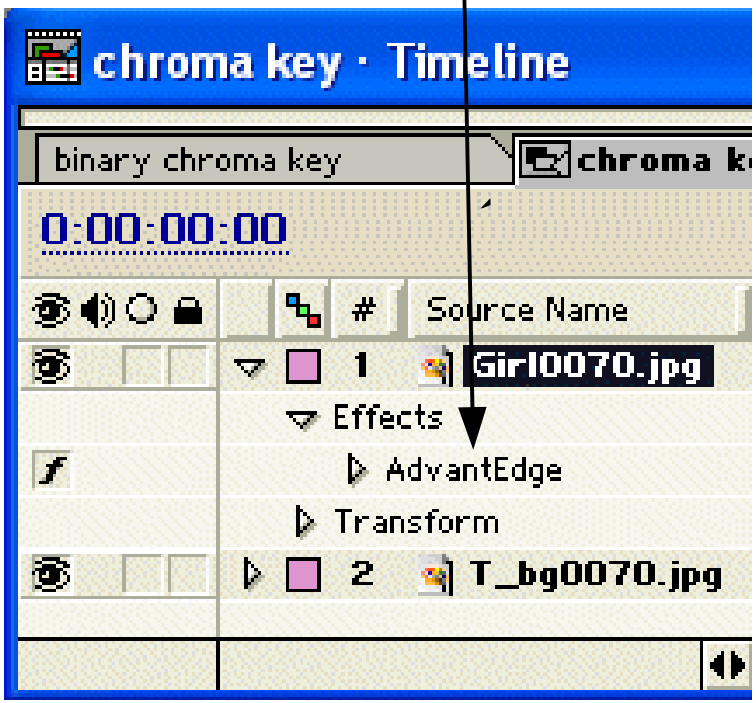
# Chroma Keying

- If binary matte is pulled, get bad results.
- Clothe is semi-transparent.
  Now, it contains background color.

# Chroma Keying with Ultimatte AdvantEdge

- Ultimatte AdvantEdge is a plug-in to After Effects.
- Select layer, choose “Effect > Ultimatte > AdvantEdge”.




- Can include background image.

# Chroma Keying with Ultimatte AdvantEdge

In AdvantEdge

- Use “Screen / Sample Backing” to sample a set of backing colors, i.e., colors of blue screen.

# Chroma Keying with Ultimatte AdvantEdge

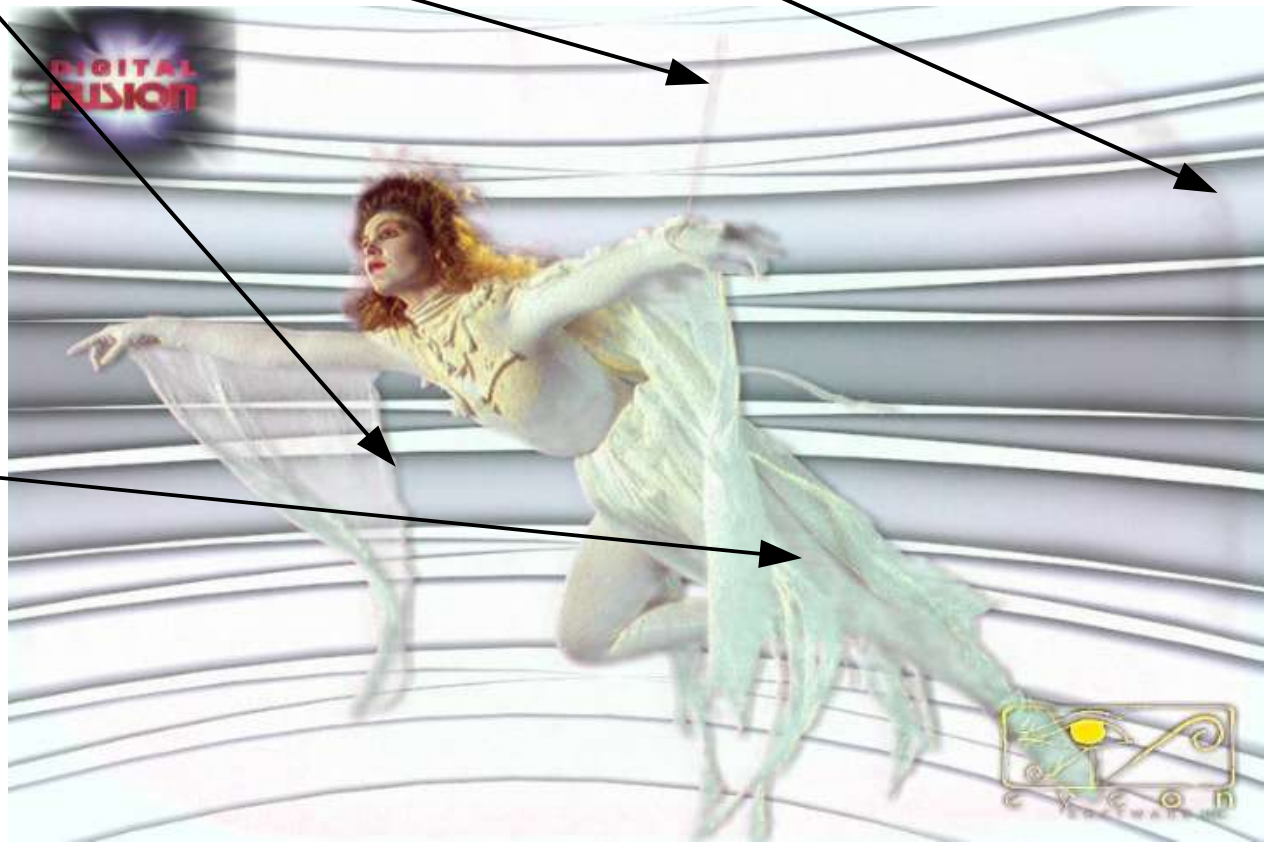
- Sample backing colors.

# Chroma Keying with Ultimatte AdvantEdge

- Produce gray matte: with transparent parts.
- Performs default spill suppression.

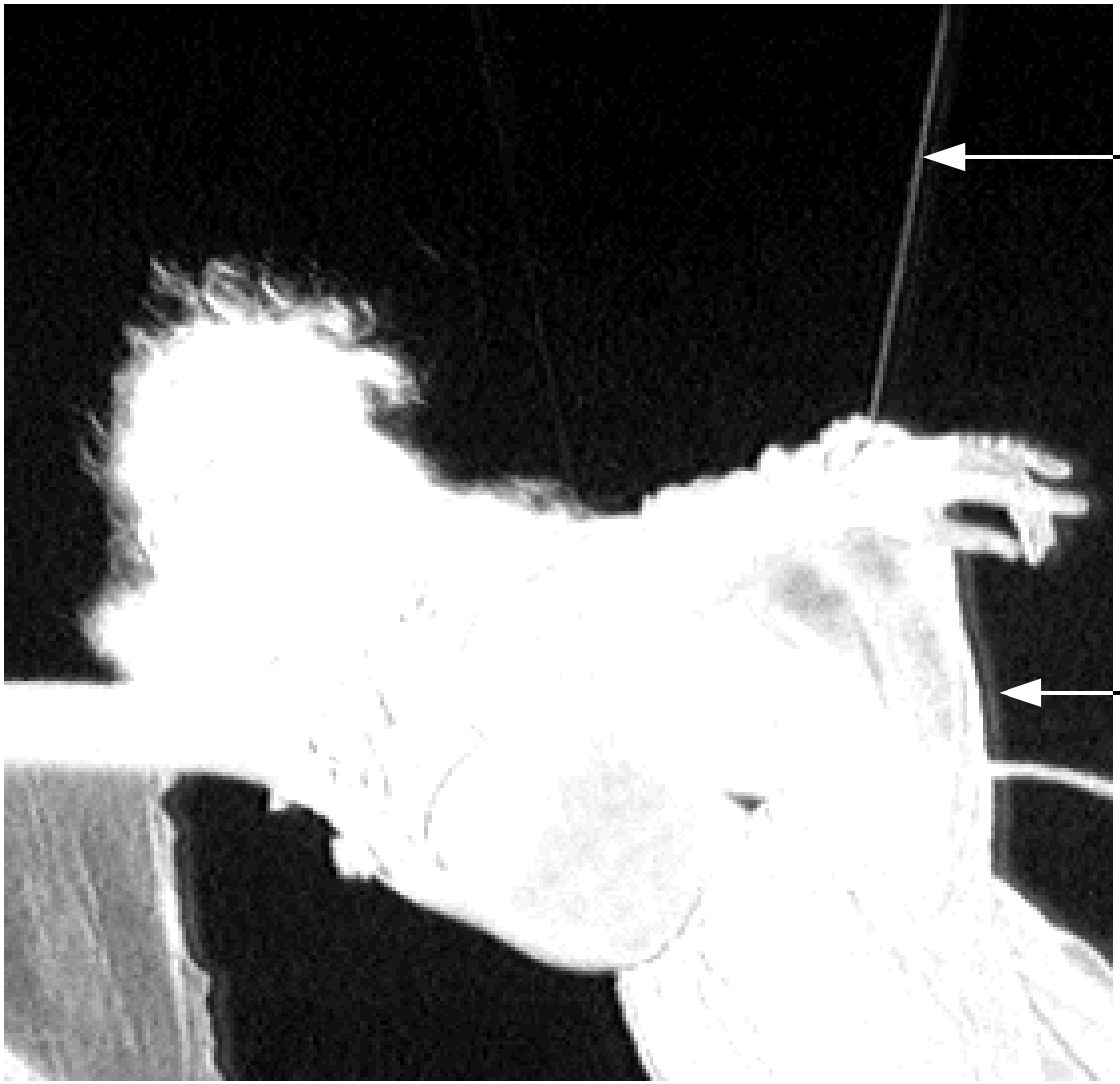
# Chroma Keying with Ultimatte AdvantEdge

- Need to remove fine rig, screen non-uniformity, fringe effect.
- Need to remove leg transparency.



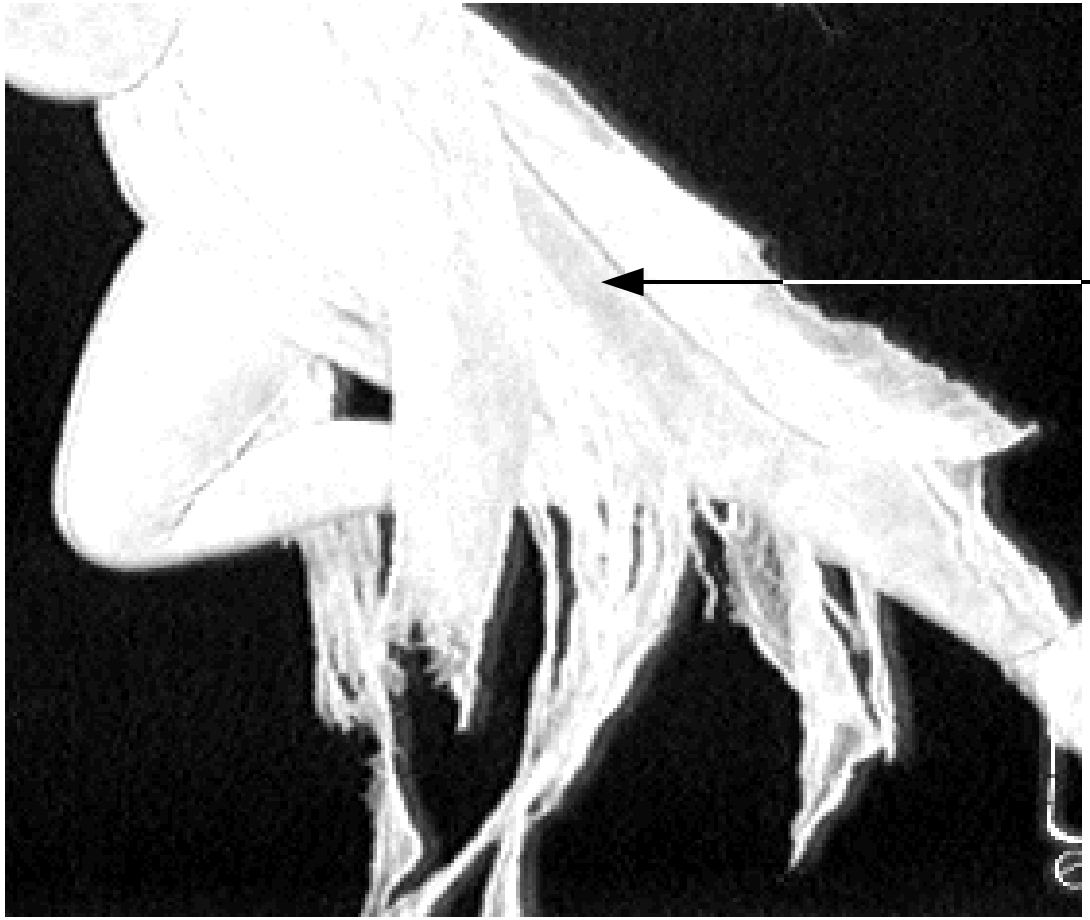
# Chroma Keying with Ultimatte AdvantEdge

- Problems appear clearly in matte.



# Chroma Keying with Ultimatte AdvantEdge

- Problems appear clearly in matte.

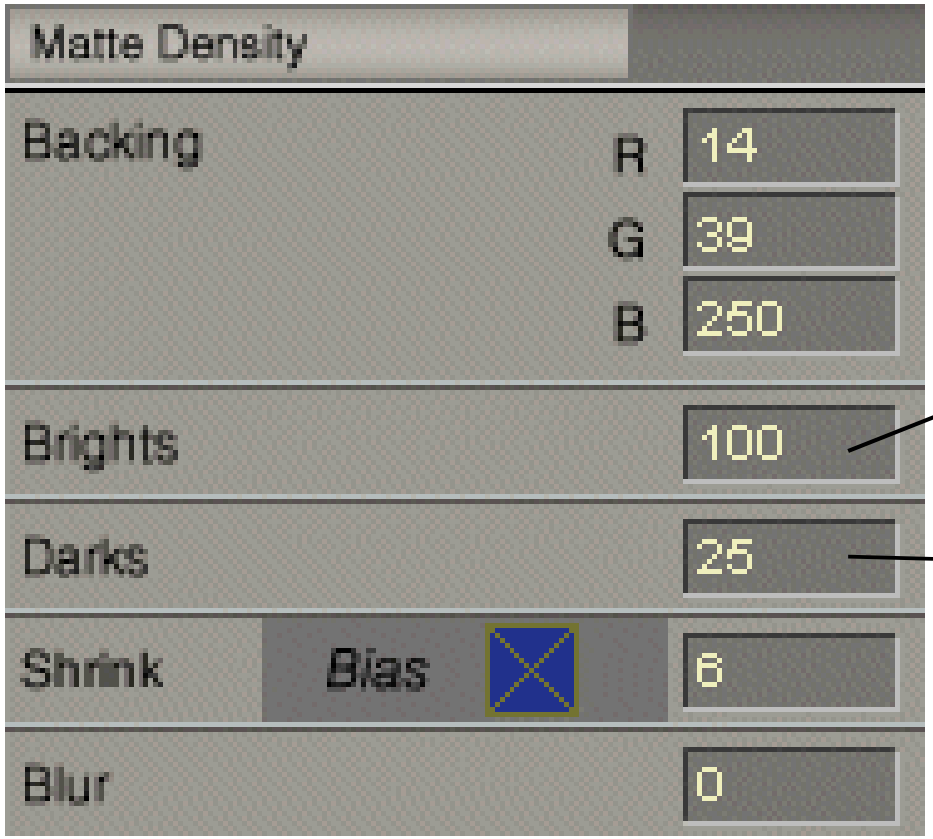


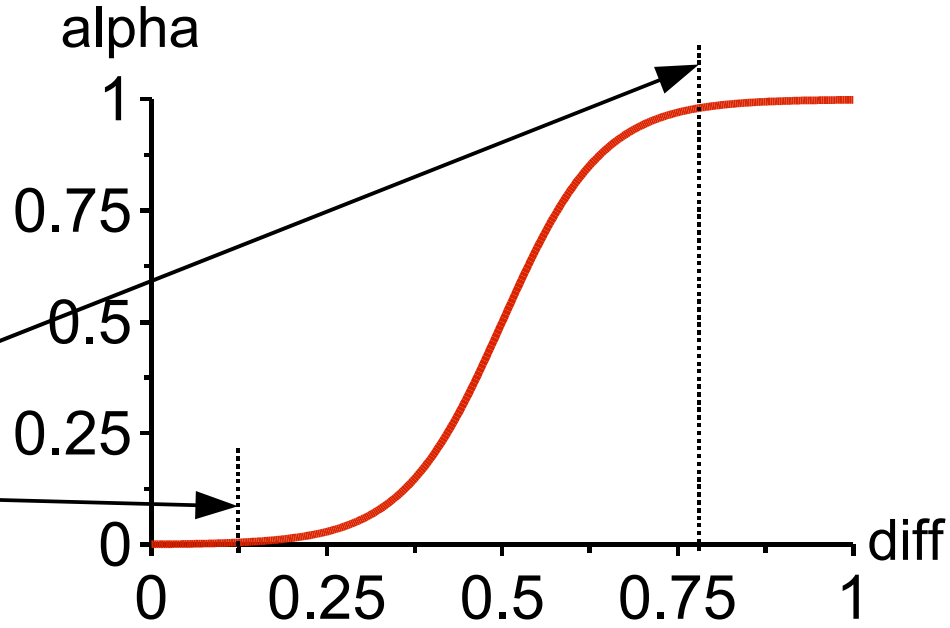
# Chroma Keying with Ultimatte AdvantEdge

- Adjust matte density (α) of foreground to make leg opaque.
- Shrink matte to remove fine rig, fringe effect, screen non-uniformity.

# Chroma Keying with Ultimatte AdvantEdge

- Adjusting matte density is equivalent to adjusting matte thresholds.



# Chroma Keying with Ultimatte AdvantEdge

- After matte refinement:

# Chroma Keying with Ultimatte AdvantEdge

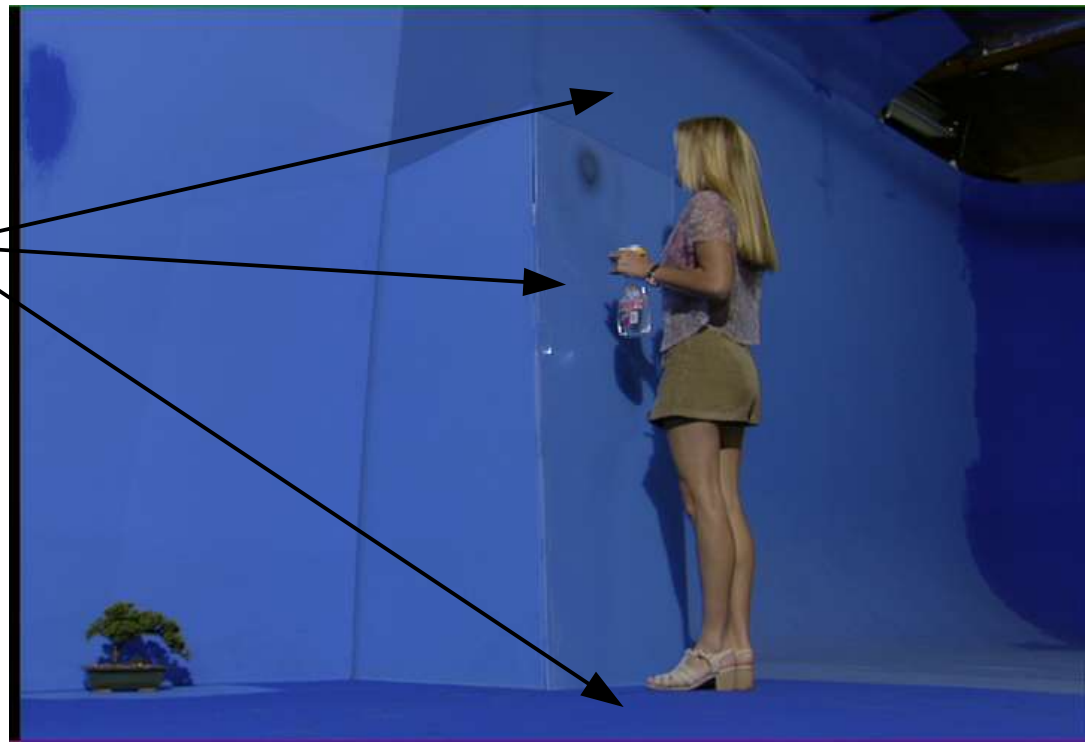
- Final comp:


Demo

# Difference Keying

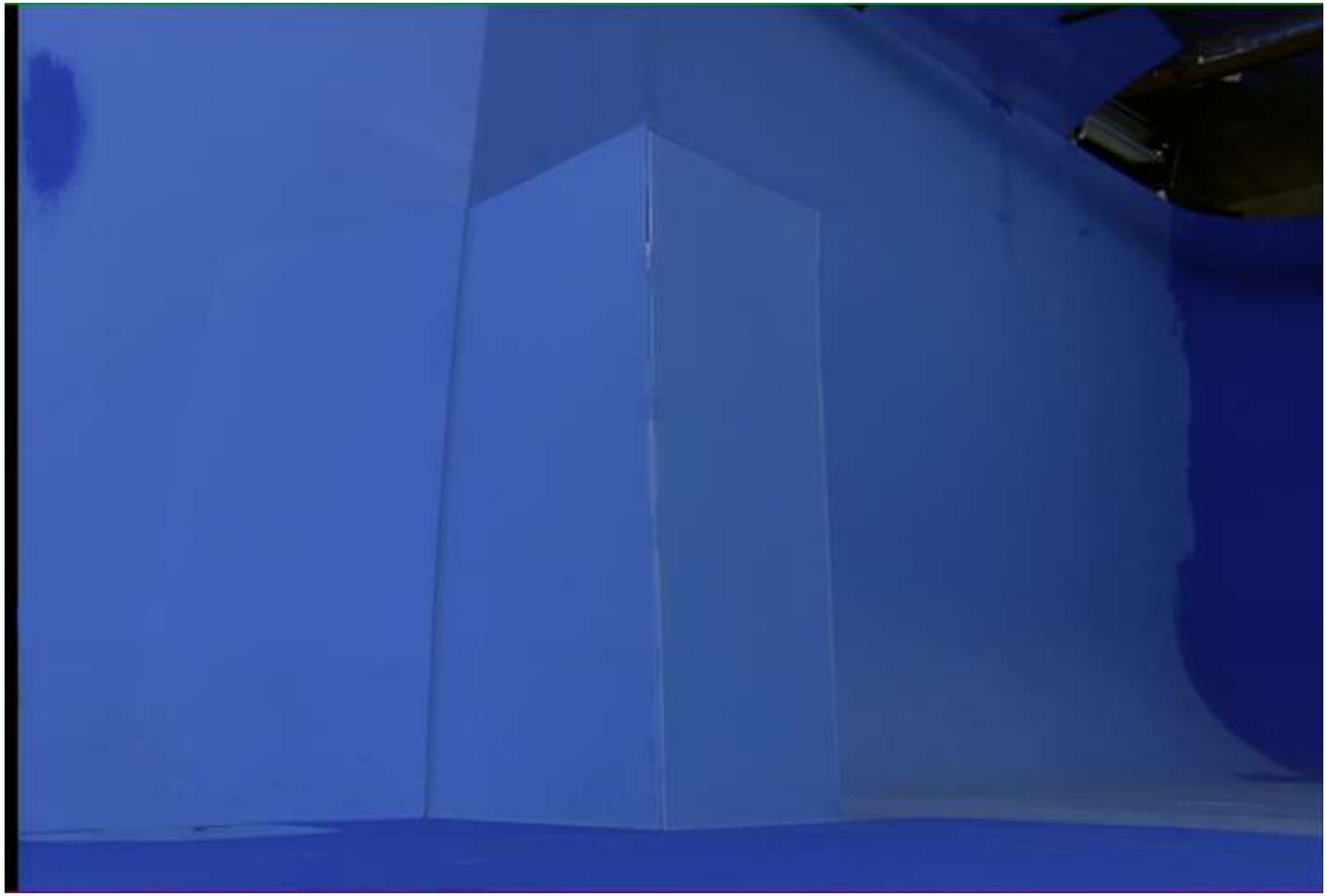
- More general than luma and chroma keying.
- Key out background based on pixel-wise color difference between foreground and background footage.

- Can be used when:
  - Blue screen is not perfect, e.g., many shades of blue.
  - Background is not blue screen.



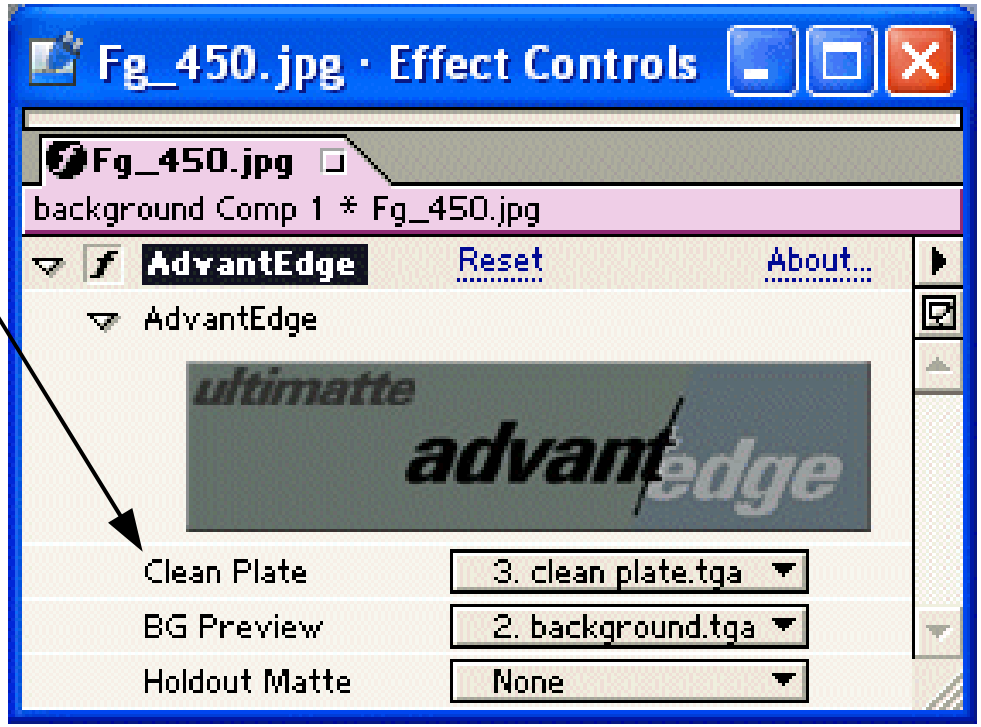
# Difference Keying

- Requires clean plates of background footage.



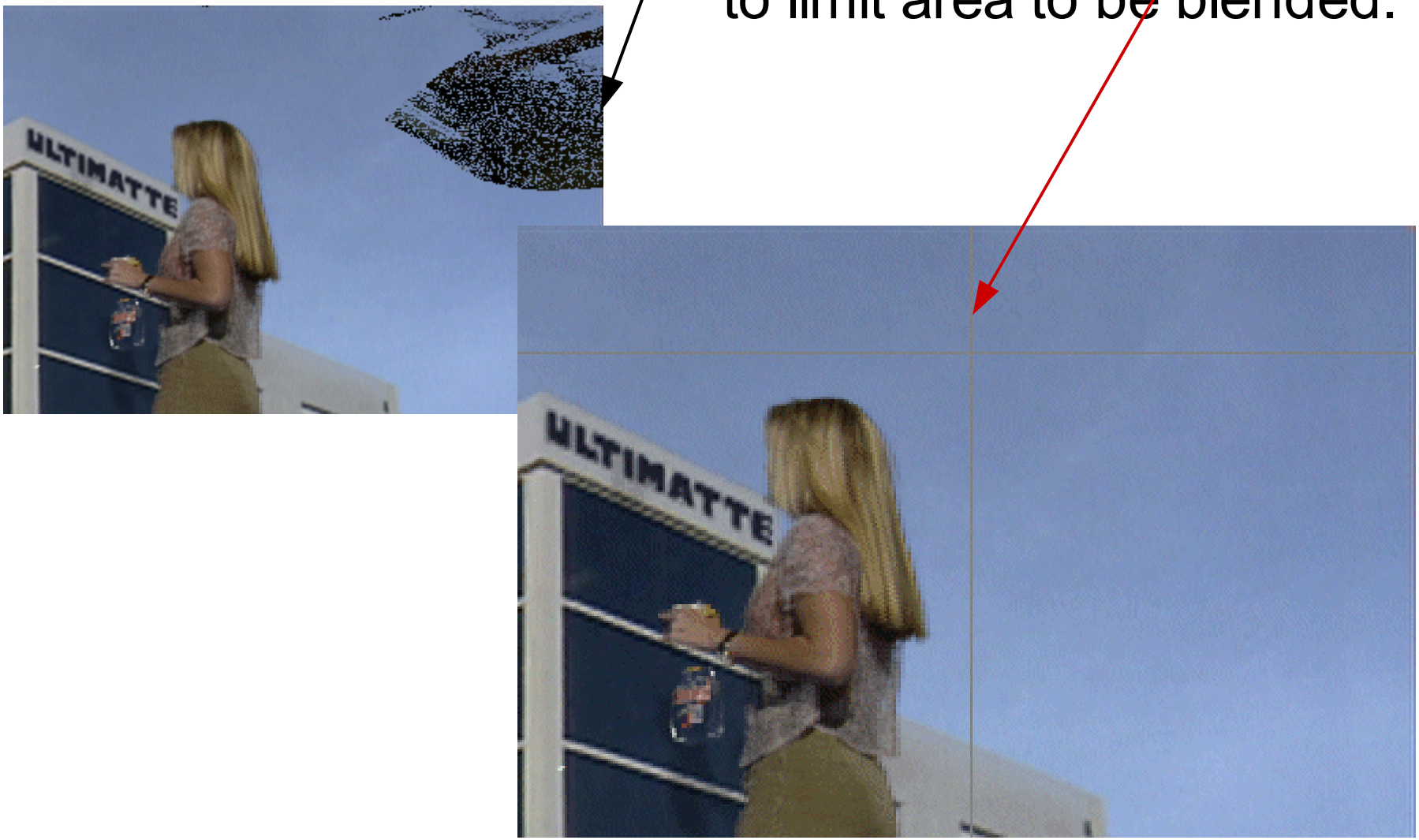
# Difference Keying with Ultimatte AdvantEdge

- Include clean plate.
- Then, do it in a similar way as chroma keying.
- AdvantEdge can use clean plate to do screen correction, i.e., handle imperfect blue screen.



# Difference Keying with Ultimatte AdvantEdge

- If screen correction is imperfect, can use guide lines to limit area to be blended.



# Difference Keying with Ultimatte AdvantEdge

- Final comp:


Demo

# Rig Removal

- Rigs are equipment that support the actors or props.
- Sometimes, rigs cannot be removed by keying alone.
- So, have to apply masking technique to remove rigs.
- Need clean plate of background footage.
- If camera moves, then need motion-controlled camera:
- Computer controls camera to move the same way twice:
  - Without foreground objects; get clean plate.
  - With foreground objects.

# Rig Removal

Basic Idea:

- Apply a mask to mask out the rig.
- Then, replace pixels in masked area by corresponding pixels in clean plate background.
- If rig moves in footage, then have to animate the mask accordingly.

# Rig Removal

Example: Let's assume that this chess piece is a rig.

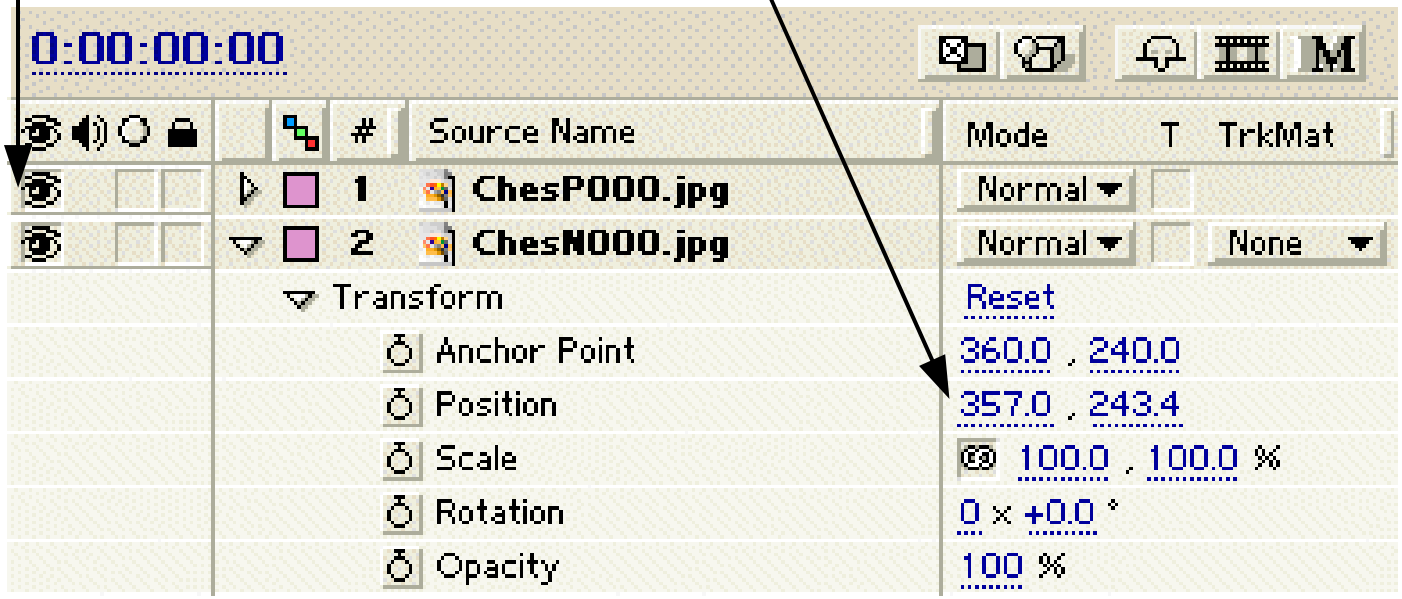
- Foreground
- Clean Plate

# Rig Removal

1. Align Clean Plates:
   - Check misalignment between foreground and clean plate. Motion-controlled camera can't be perfect.
   - Comp difference of foreground and clean plate. It can reveal misalignment as prominent edges.

# Rig Removal

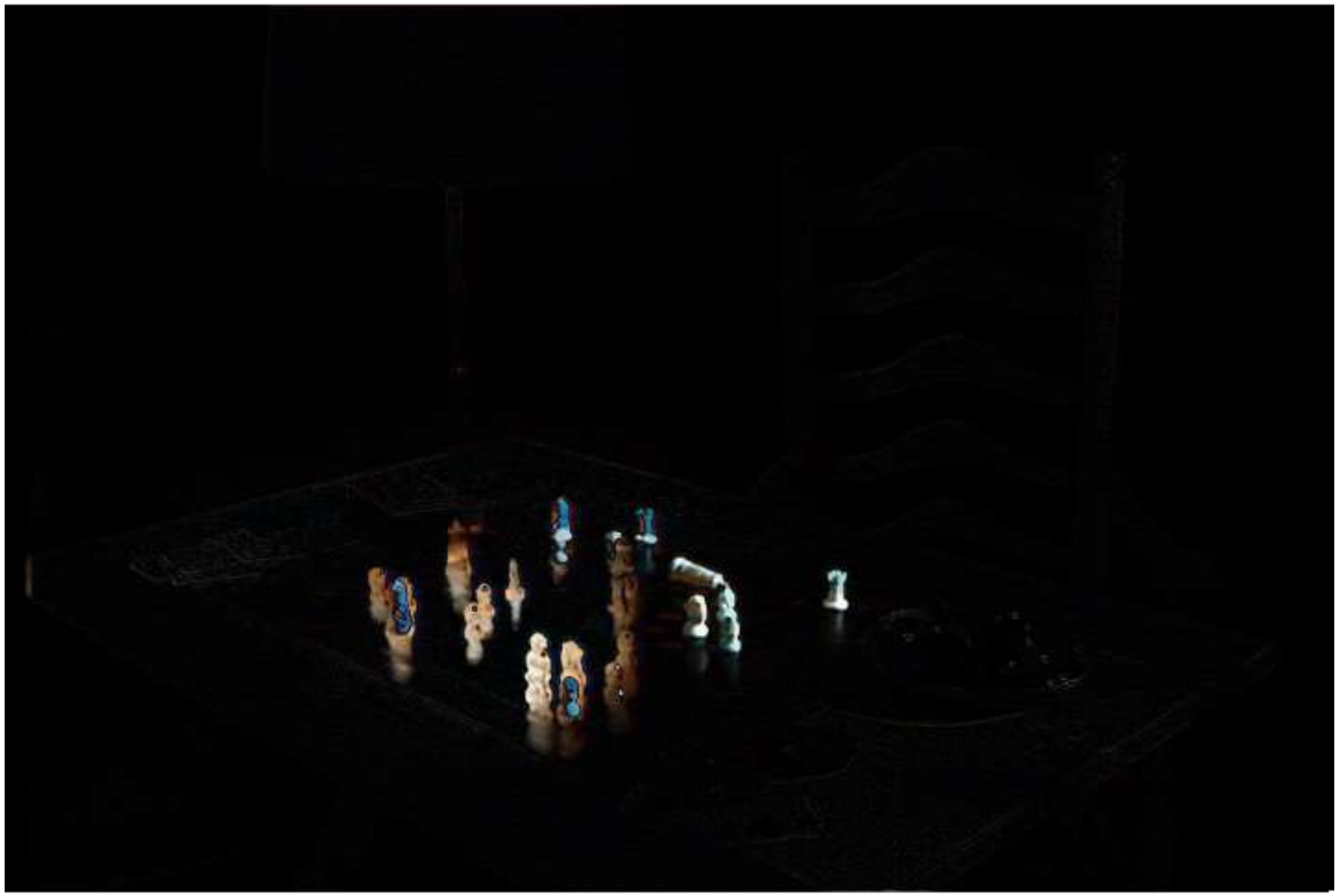
- Toggling visibility setting can also reveal misalignment.
- For this example, translation of clean plate is sufficient to align it with foreground image.




- Note: To use real number coordinates, have to set layer quality to “Best”.

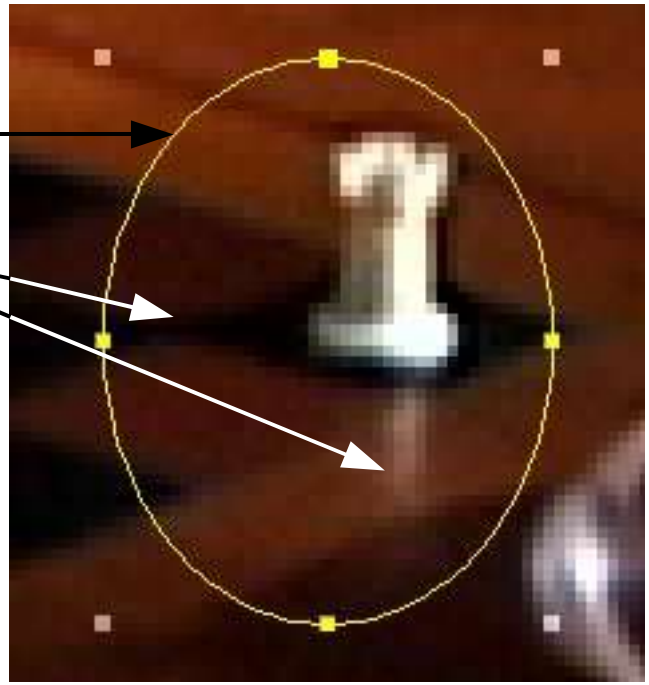
# Rig Removal

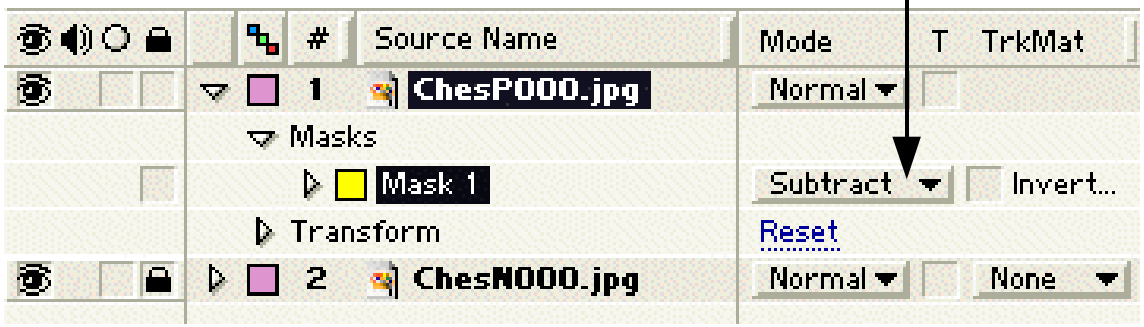
- Difference comp after alignment:



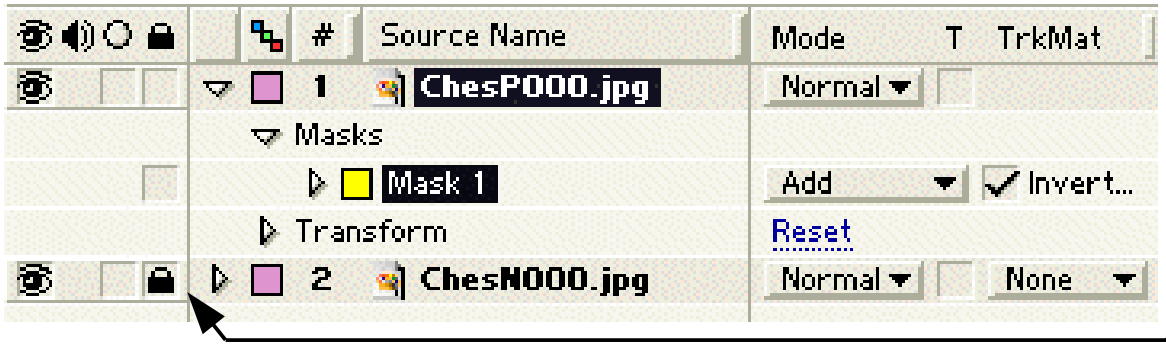
# Rig Removal

2. Mask Out Rig:
   - Put a mask over rig.
   - Include rig shadow.
   - Set mask mode to “subtract”.






or



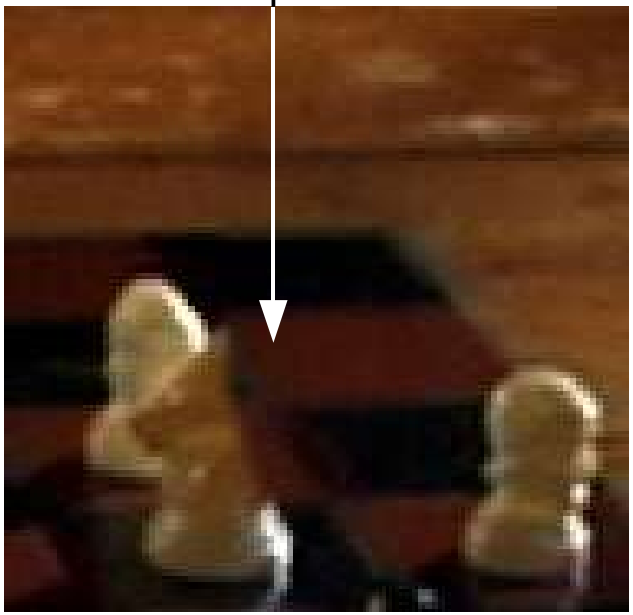

Note: Can lock layer to avoid accidental changes

# Rig Removal

- Result for first frame:

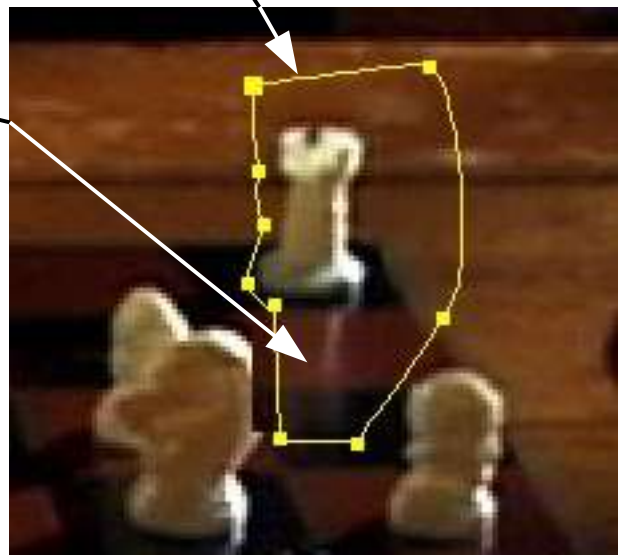
# Rig Removal

- Oval shaped mask may not work in general.
- Example: An oval mask will also mask out part of another foreground element.



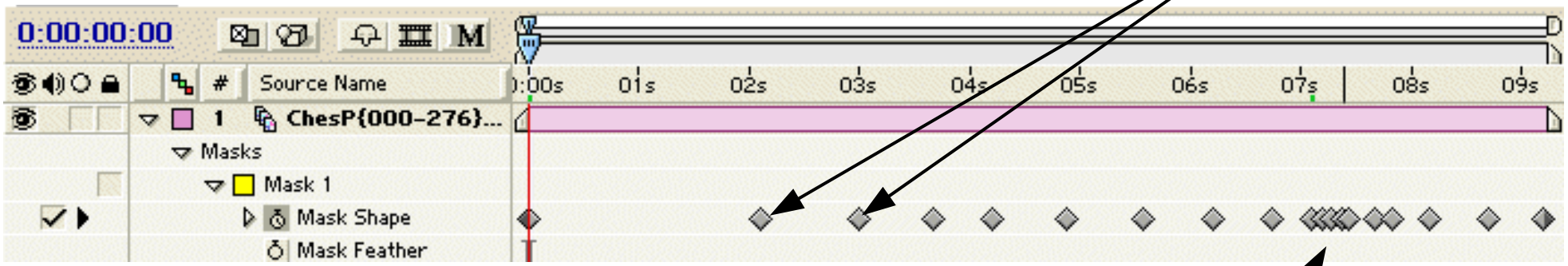
# Rig Removal

- Need to manually set the mask shape.
- Manually setting the outline of mask, matte, or foreground element is called rotoscoping.
- A rotoscoped matte is called a roto-matte for short.
- Adjust matte outline to mask out rig and shadow but keep other required foreground elements.



# Rig Removal

3. Animate Roto-Matte:
   - Move matte to cover rig in subsequent frames.
   - Make large matte to minimize the number of keyframes that need rotoscoping.




Rig is close to foreground elements.
Need to adjust matte frequently.

Demo

# Summary

Topics covered:

- alpha blending
- keying: luma, chroma, difference keying
- rig removal

There are many other topics relevant to compositing.

For details, read [Kel00].

# References

[Kel00] D. Kelly, Digital Compositing In Depth, Coriolis Group, 2000.