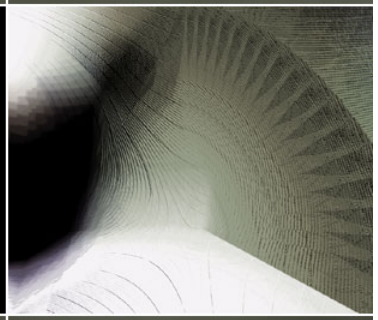
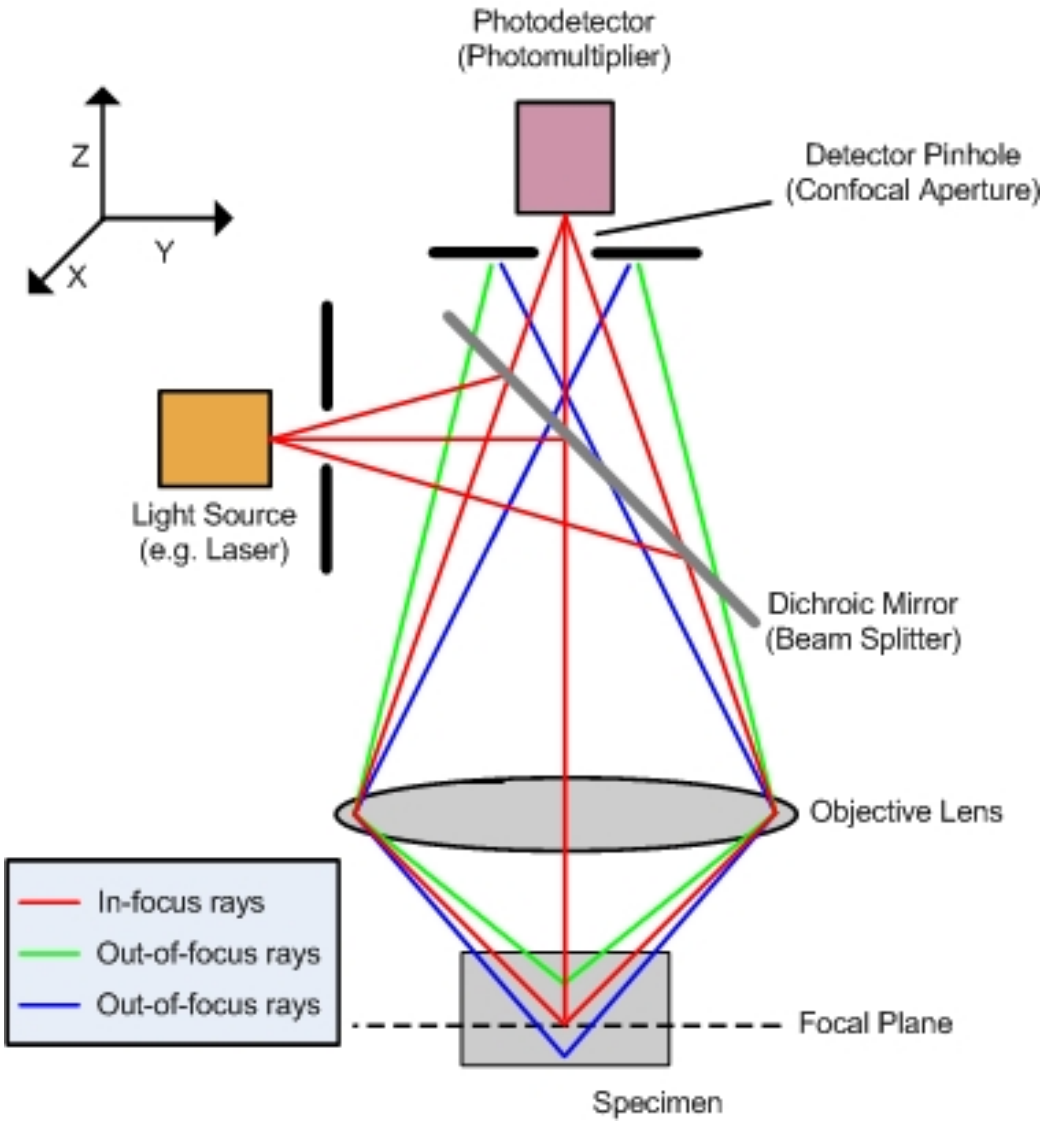
Visualization Techniques for 3D Microscopic Imaging Data



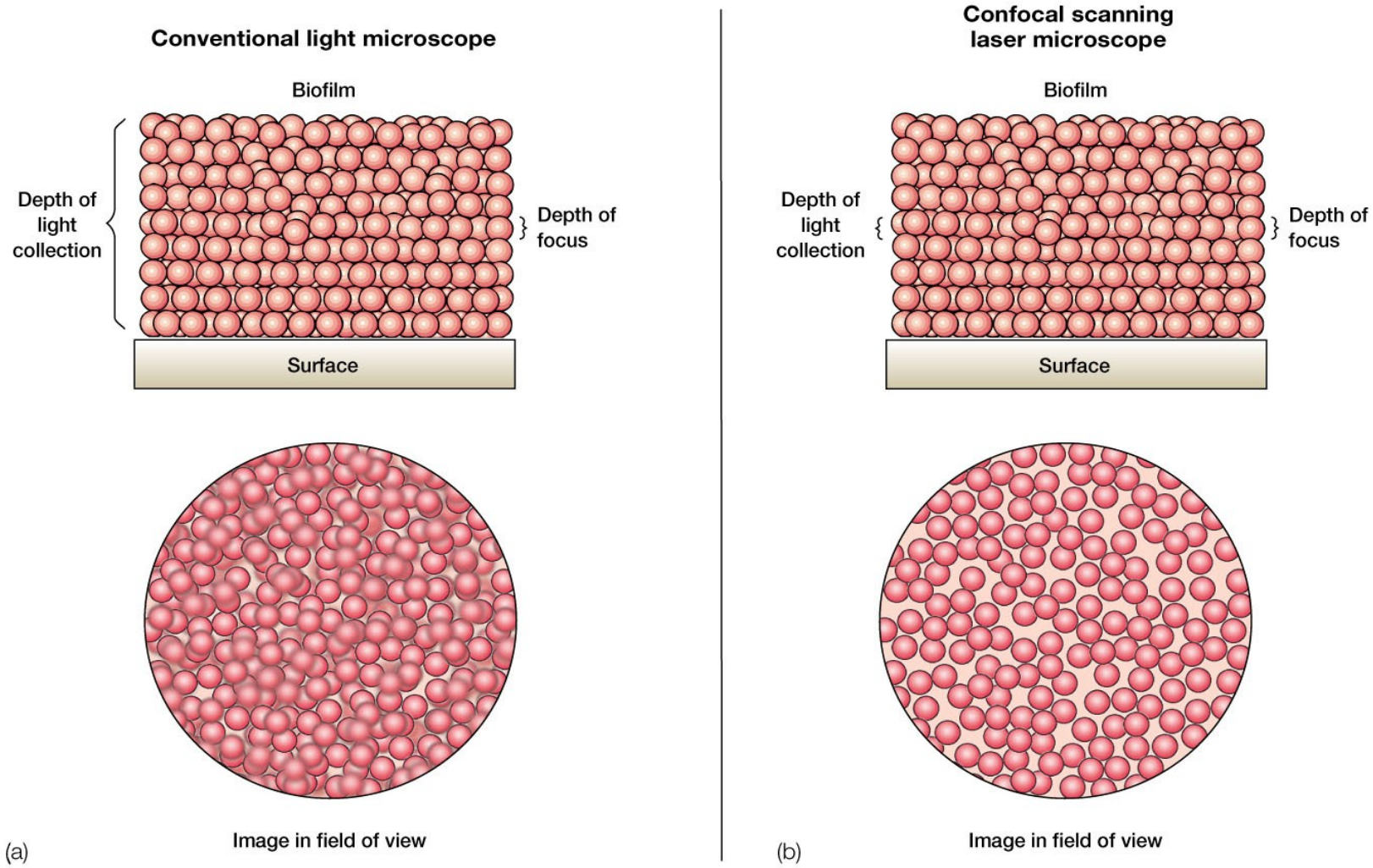
Denny Wong

Confocal Microscopy



- **Reject regions above or below focal plane**
- **Higher axial resolution**
- **Suitable for serial noninvasive optical sectioning**

Result


Conventional light microscope
Biofilm
Depth of light collection
Depth of focus
Surface
Image in field of view
(a)
Confocal scanning laser microscope
Biofilm
Depth of light collection
Depth of focus
Surface
Image in field of view
(b)

Confocal Data Characteristics

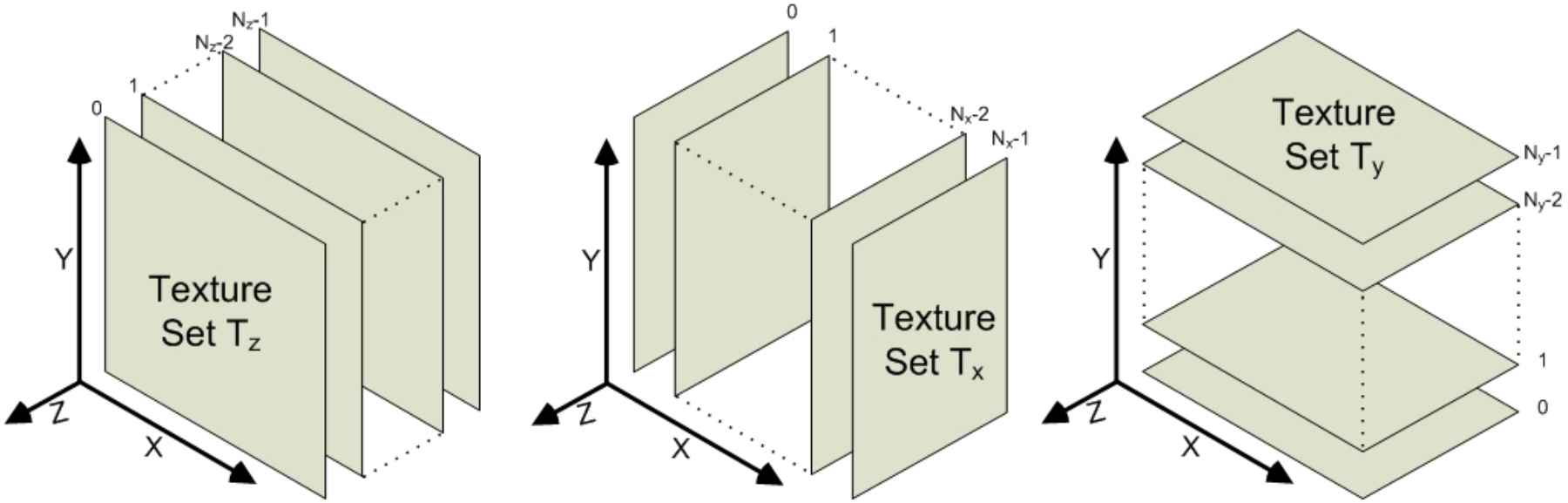
- **Quite different from other scientific data (e.g. MRI & CT)**
  - **Noise**
  - **Multiple channels**
  - **Object complexity**
  - **Thin data volume**

Using 2D Texture Sets

- **Traditional ways using 2D textures to represent 3D Data**
  - **One set only.**
  - **Switch Between Sets.**
  - **Generate slices on the fly.**
- **Our approaches.**
  - **Weighted Blending (Use accumulation buffer)**
  - **Stencil based acceleration (Use stencil buffer)**

Three 2D Texture Sets

- **One texture set: T_z has best quality**
- **Using three texture sets to avoid rendering artifacts**



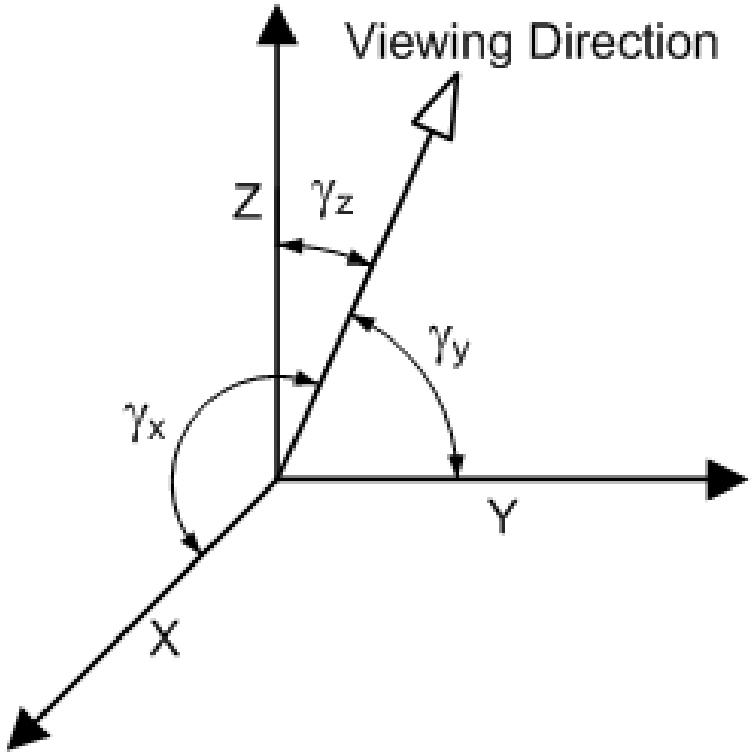
Weighted Texture Blending

- **Images resulting from blending texture sets T_x , T_y and T_z are $I_x(i,j)$, $I_y(i,j)$ and $I_z(i,j)$**
- **Weights for texture sets T_x , T_y and T_z are $w_x(i,j)$, $w_y(i,j)$ and $w_z(i,j)$**
- **Final image is weighted sum of these three images.**

$$I(i,j) = w_x I_x(i,j) + w_y I_y(i,j) + w_z I_z(i,j)$$

Weighted Texture Blending

- **Weight for each set**

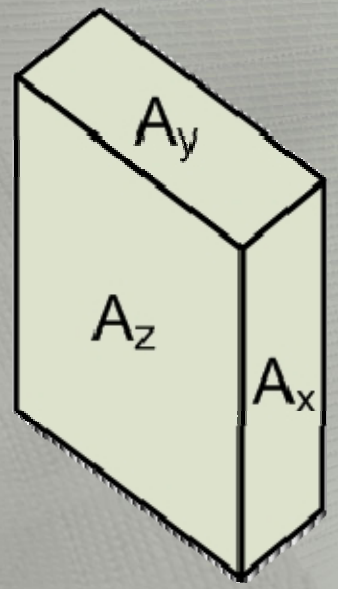


$$\begin{cases} w_x = \cos^2 \gamma_x \\ w_y = \cos^2 \gamma_y \\ w_z = \cos^2 \gamma_z \end{cases}$$

$$w_x + w_y + w_z = 1$$

Weighted Texture Blending

- **Consider the thin shape**



$$\begin{cases} w_x = A_x \cos^2 \gamma_x / A_{sum} \\ w_y = A_y \cos^2 \gamma_y / A_{sum} \\ w_z = A_z \cos^2 \gamma_z / A_{sum} \\ A_{sum} = A_x \cos^2 \gamma_x + A_y \cos^2 \gamma_y + A_z \cos^2 \gamma_z \end{cases}$$

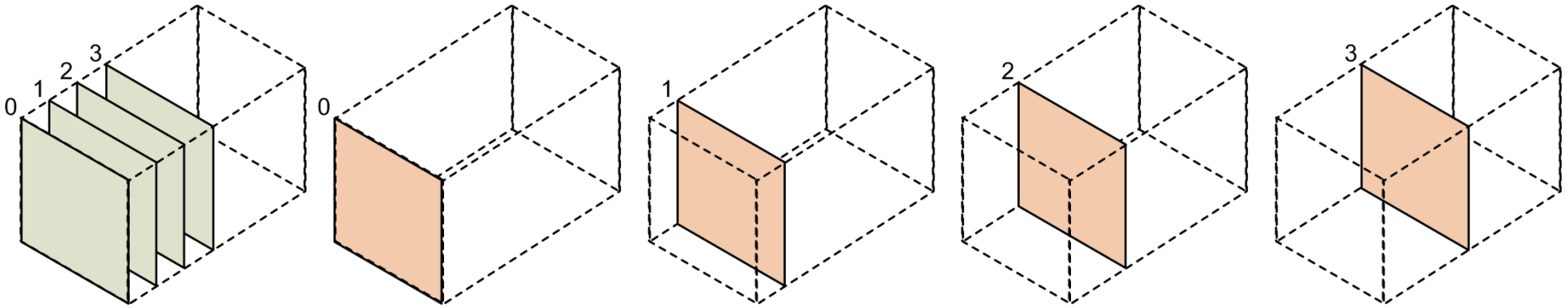
- A_x, A_y, **and** A_z **are the areas of faces of the data volume in the x, y, and z directions**

Stencil Based Blending

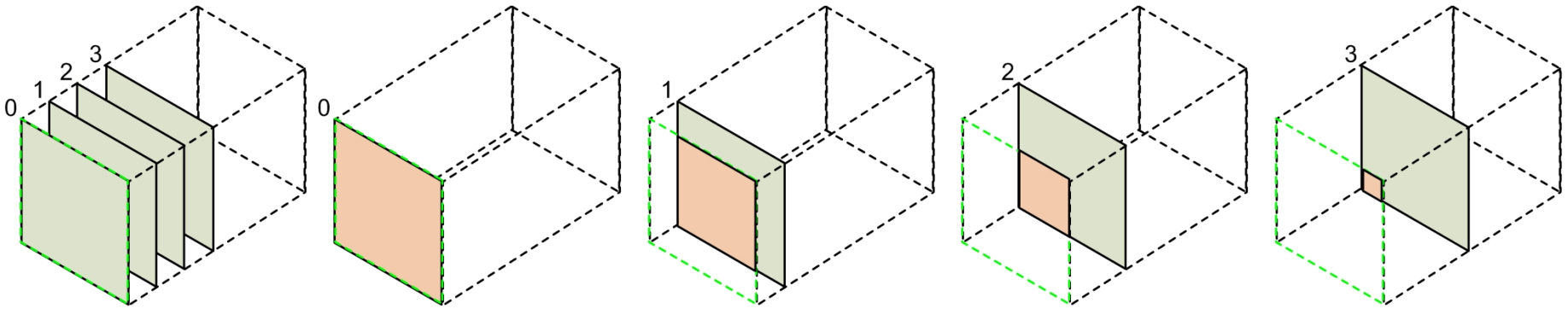
- **Drawback of weighted blending**
  - **Rendering speed is significantly slowed**
- **Stencil based blending**
  - **Only draw needed portion of the texture proxy polygon**
  - **Only draw one third of the total area comparing with weighted approach**

Stencil Based Blending

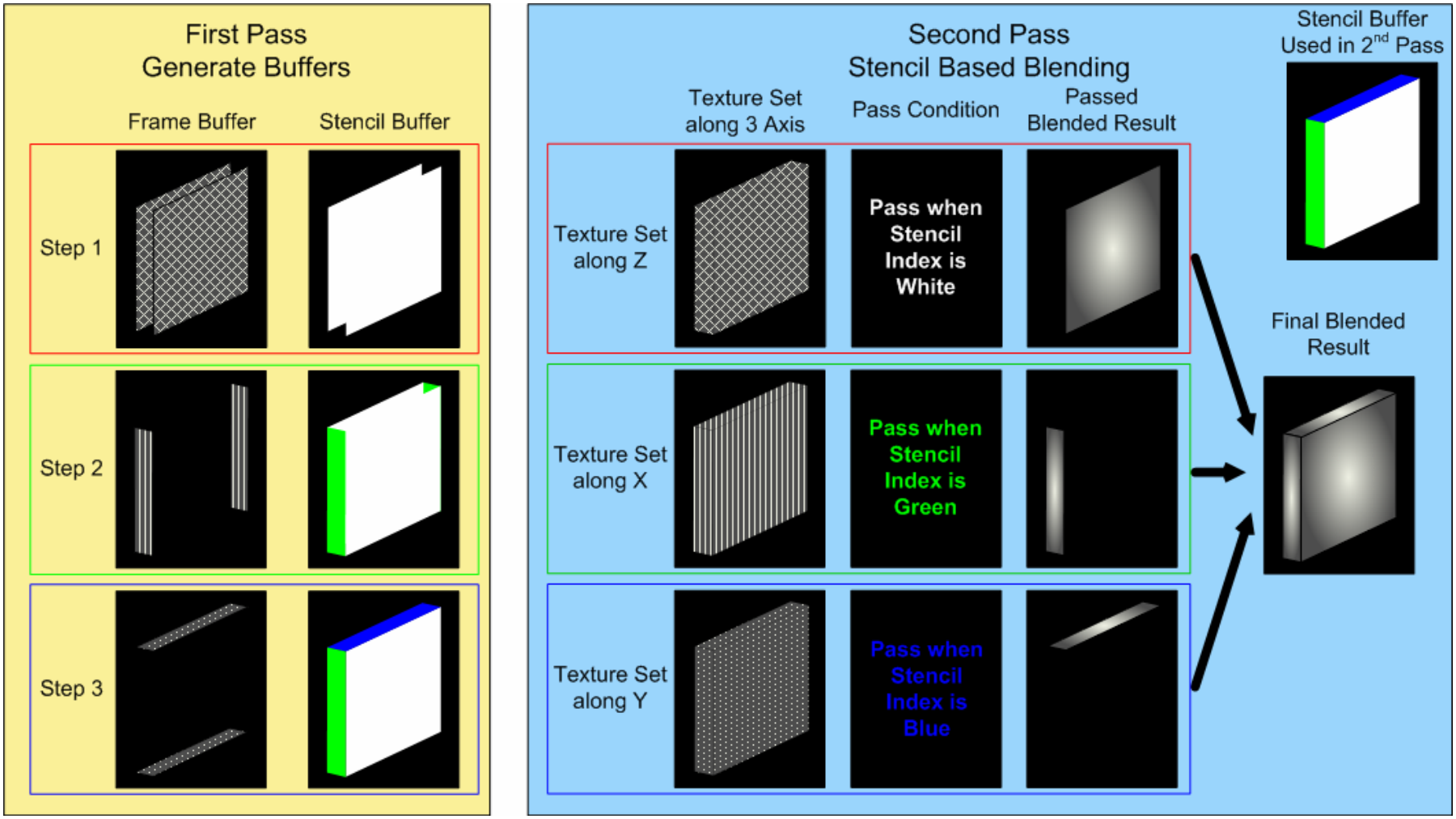
Normal Blending



Stencil-based Blending



Two Pass Process

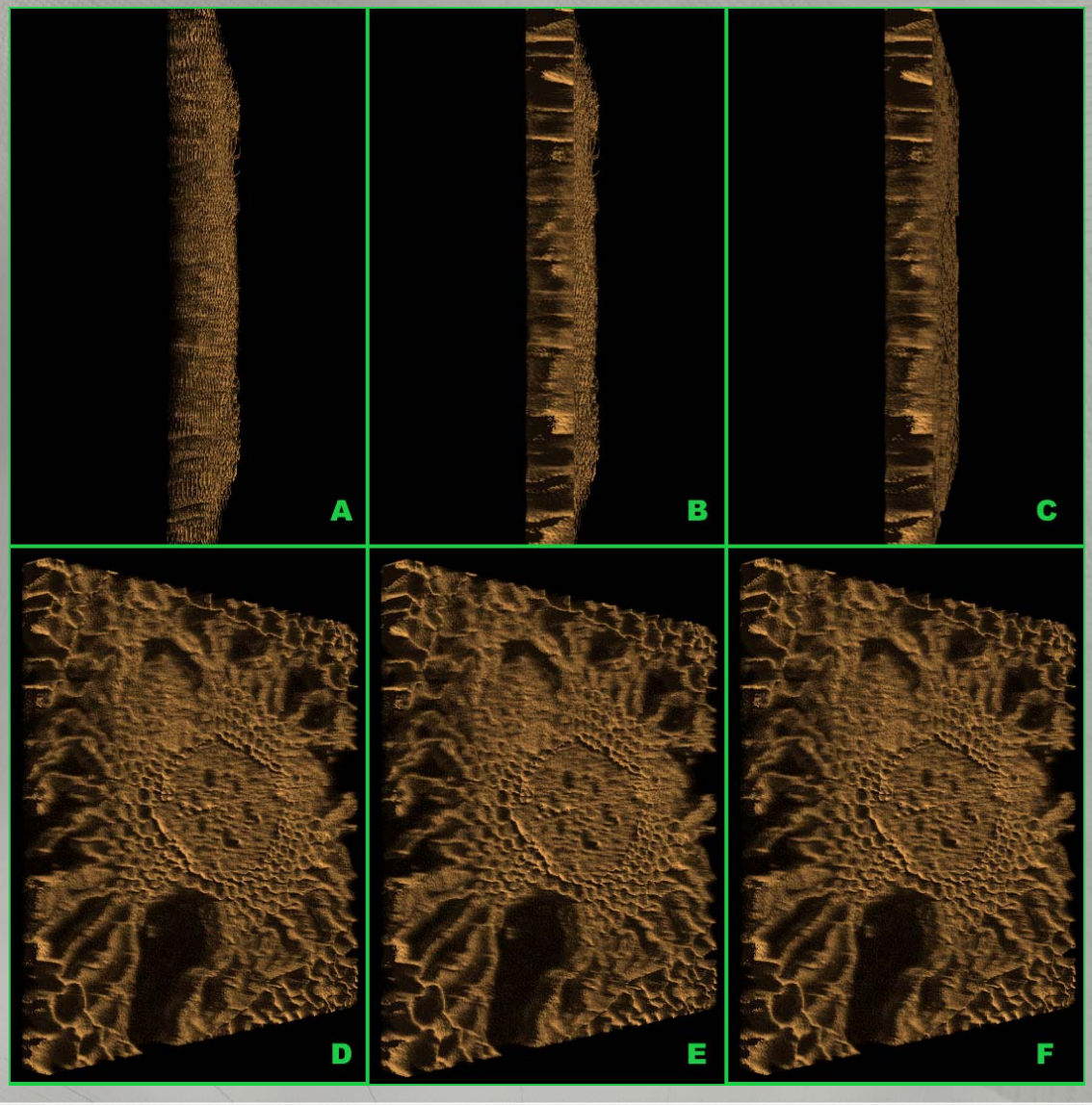


Performance

- Pentium M 1.6 Ghz system with 1GB memory
- ATI MOBILITY Radeon 9600 Pro Turbo display adaptor with 128MB on-board memory

Rendering Mode		FPS	
		50.4 degrees	74.5 degrees
Method 1	One texture set	77	102
Method 2	Stencil-based	46	49
Method 3	Weighted blending sets	27	33

Different Blending Mode



The End

Thanks for your attention

Questions ?