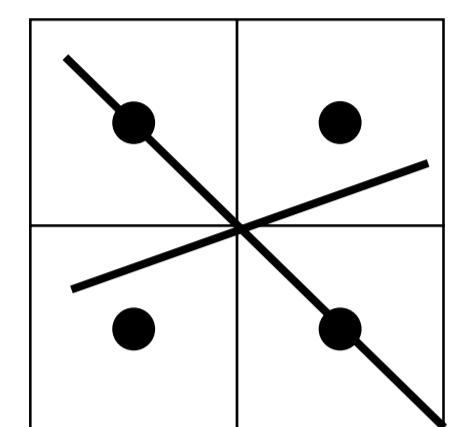
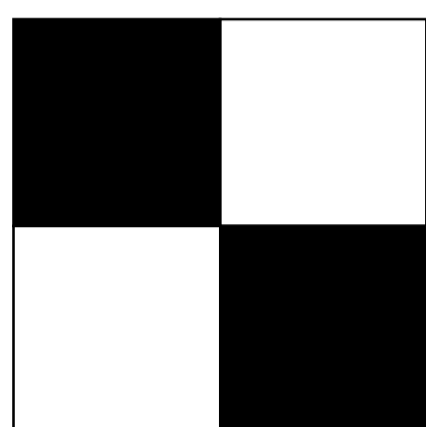


## Background

- Hair-shaped objects
  - Thin
  - Transparent



Rasterization



Some strands disappear

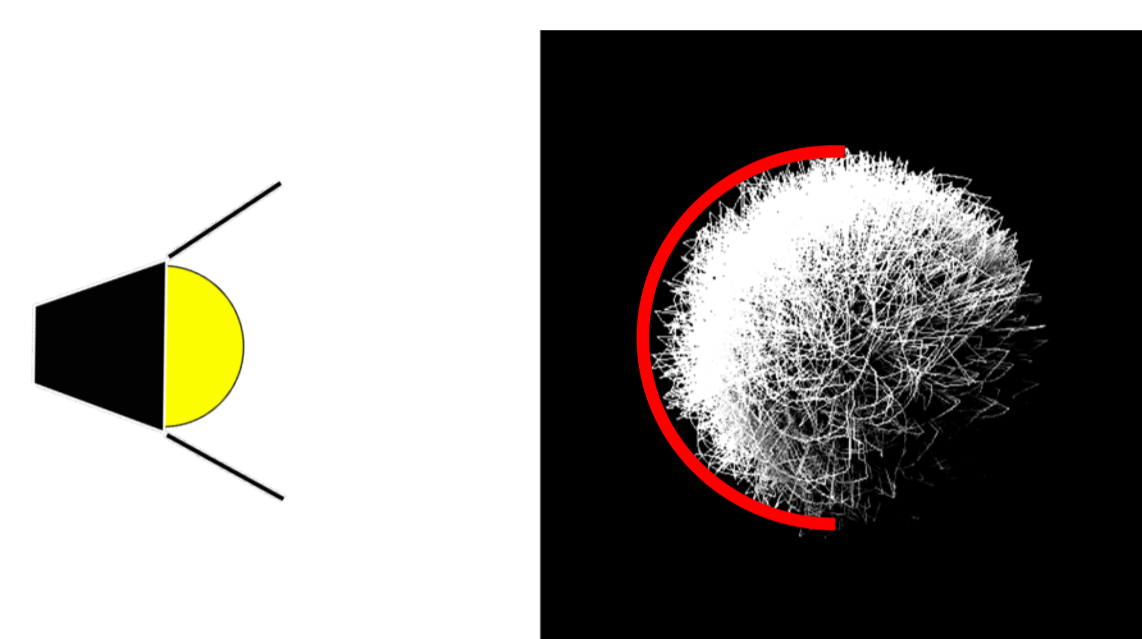
- Image Space Anti-Aliasing (ISAA)
  - Speed and quality depend on filter size

## Previous Shadowing

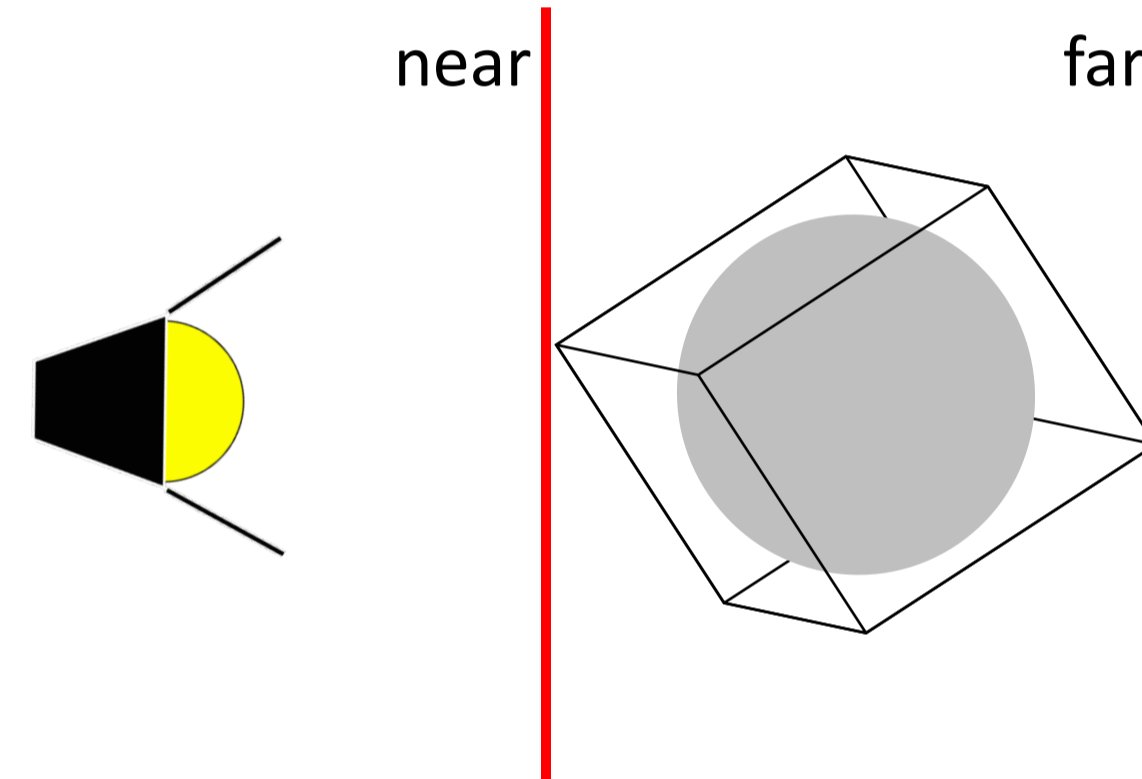
- Shadow Map [Williams 1978]
  - Using depth values
  - Real-time
  - Aliasing
- Opacity Shadow Maps (OSMs) [Kim and Neumann 2001]
  - Using opacity maps
  - Transparent shadows
  - Zonal aliasing
- Deep Opacity Maps (DOMs) [Yuksel and Keyser 2008]
  - Accelerated OSMs
  - Zonal aliasing removed

## Procedure

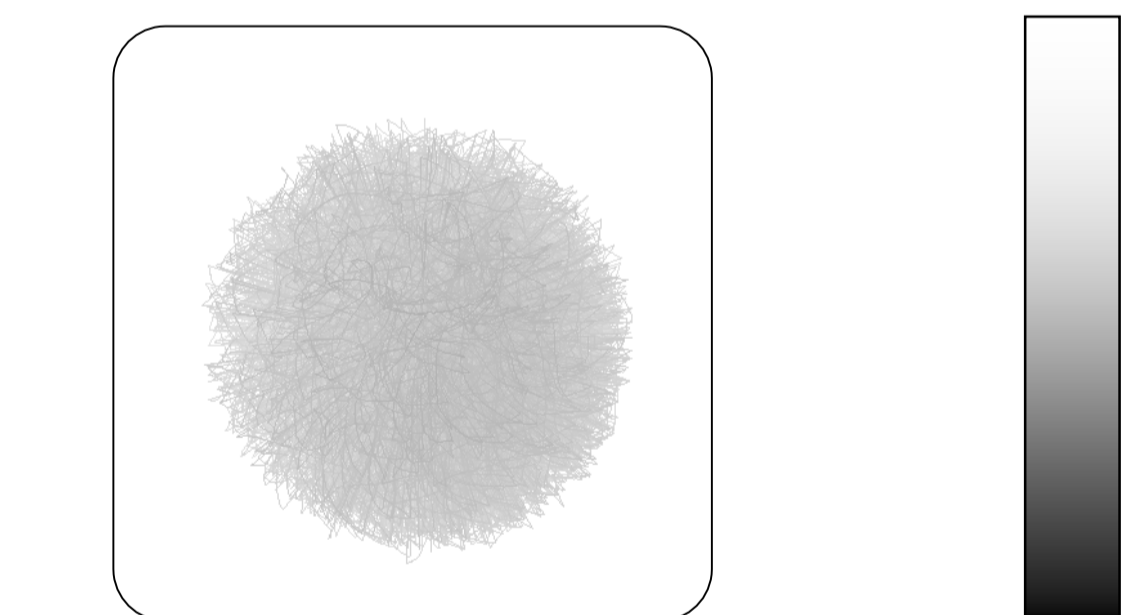
Get depth values



- Convert to the light source coordinate system
- Record distances from light to nearest points

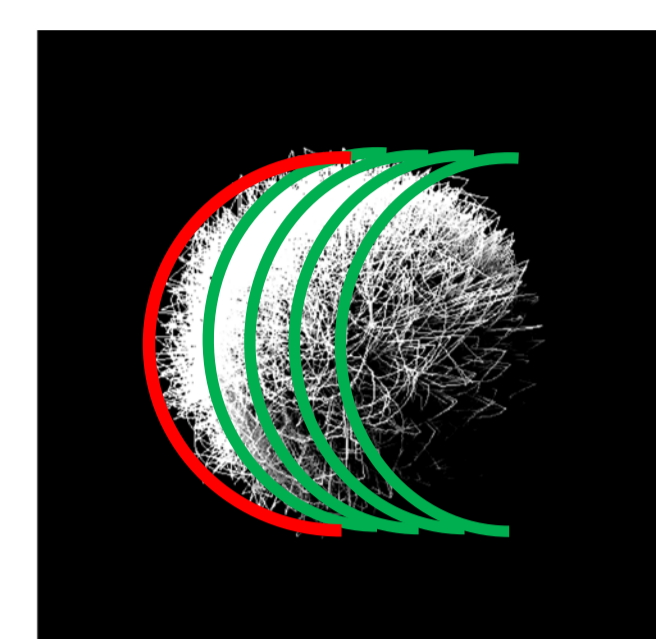


- Use bounding box when clipping for improving accuracy



Depth Map visualized

Get opacity values

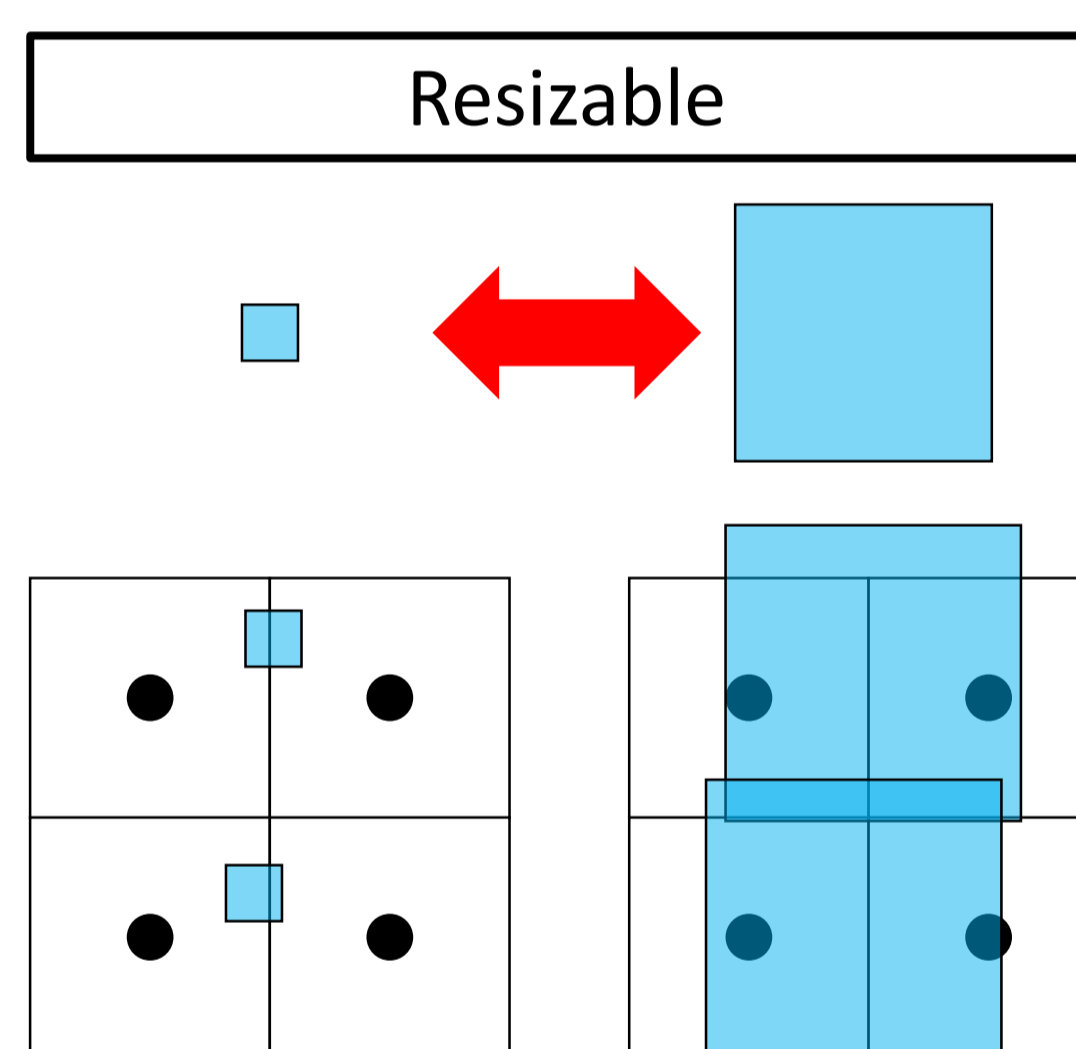


Use cloud of shadow splats

- Record density values for each point on a splat along a ray from the light source

**Object Space Anti-Aliasing**

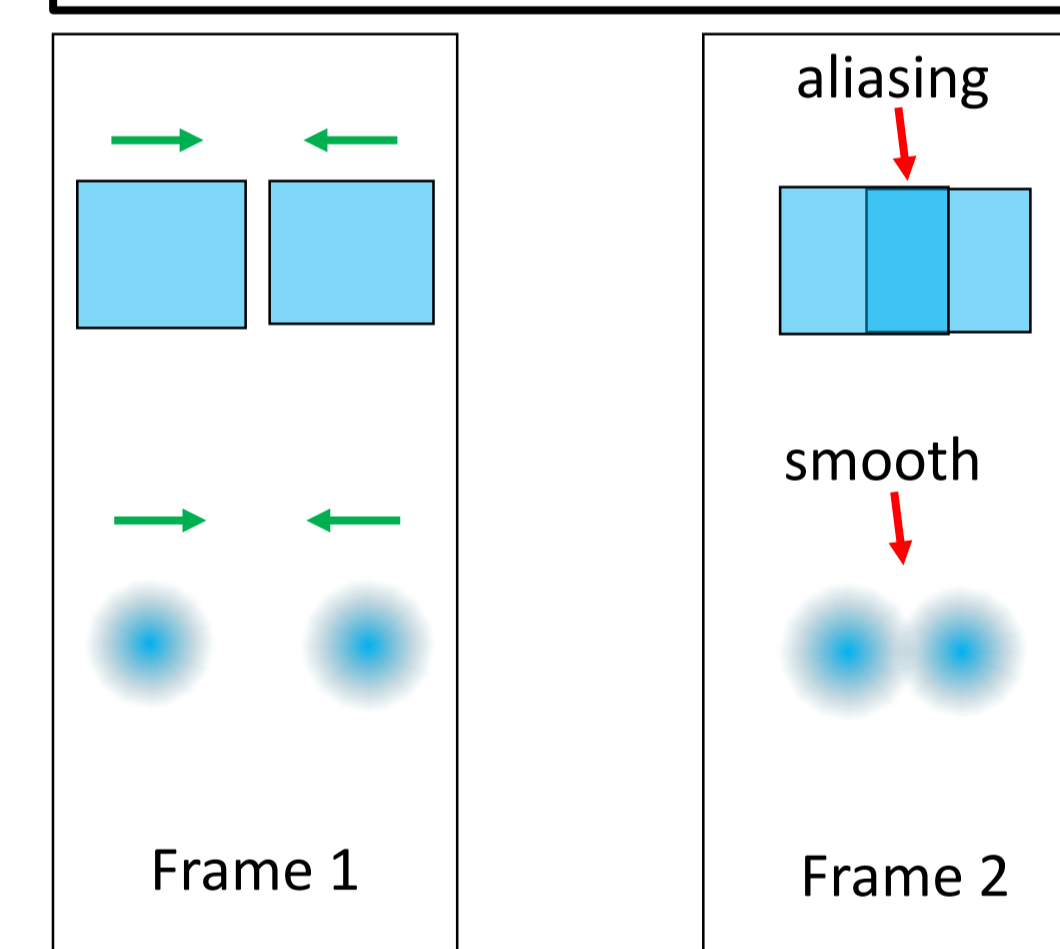
Resizable



- Get splats cover the center of a pixel

Rasterizing error removed

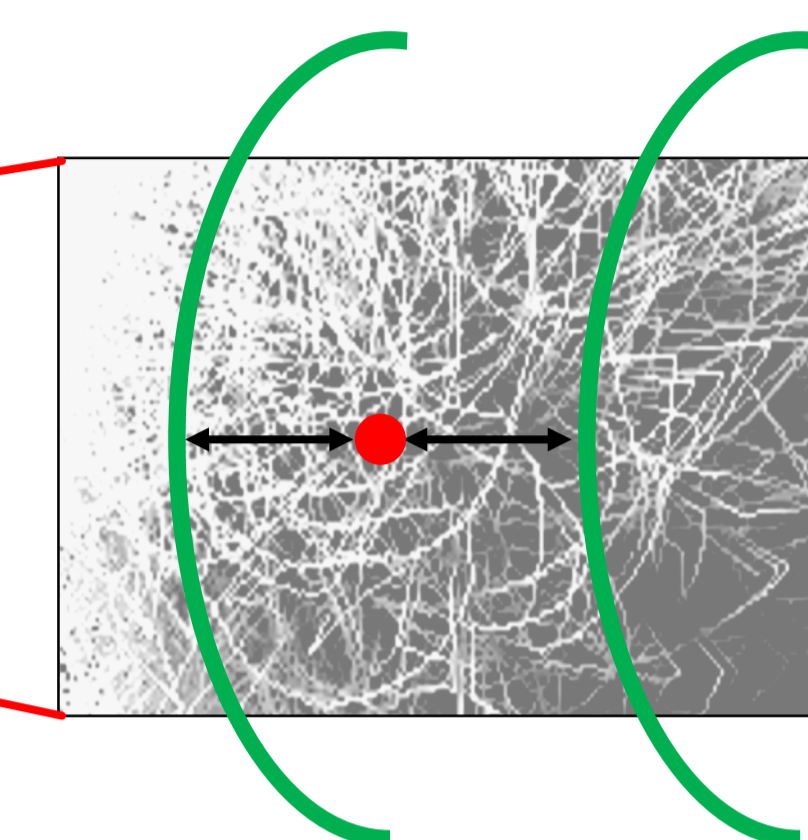
Distribution of opacity values



- Concentric distribution
- Overlapped splats make total opacity values change smoothly

Temporal aliasing also decreased

Render

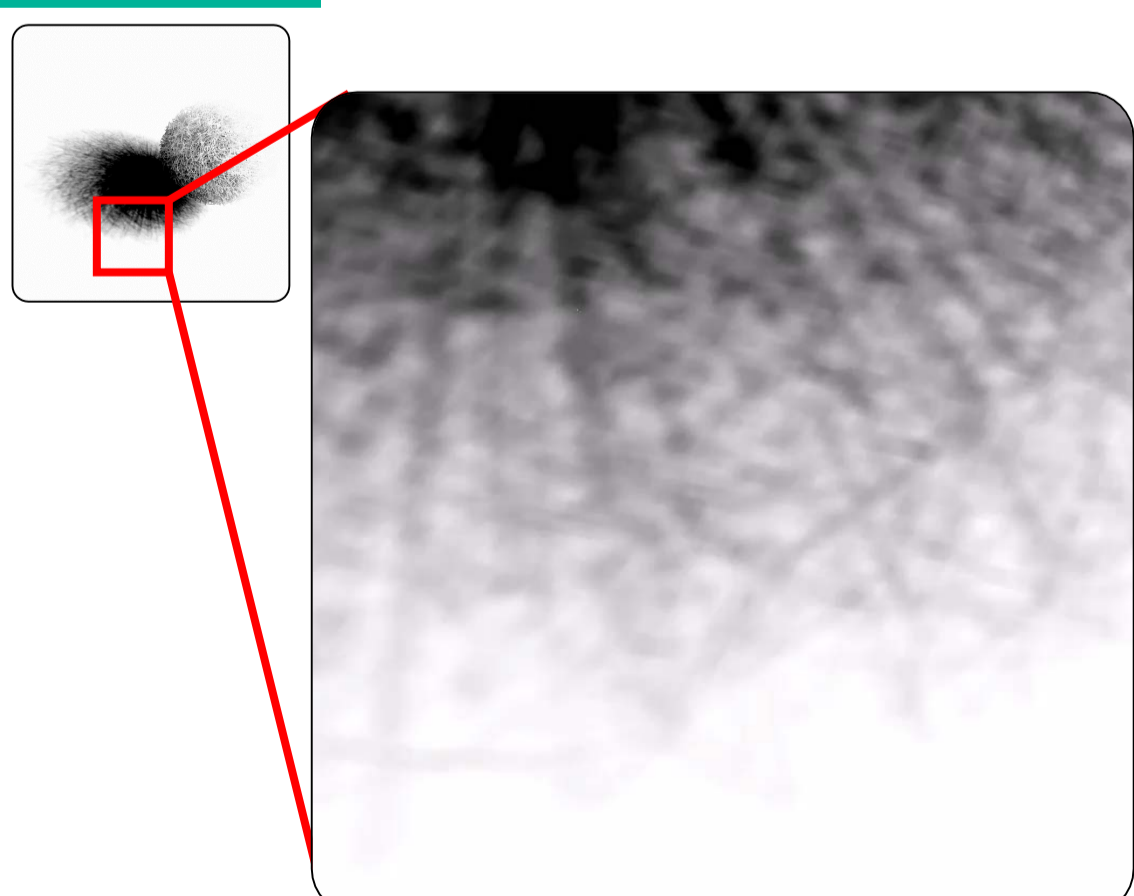


- Choose an appropriate pair of consecutive Opacity Maps (green lines) w.r.t. Depth Map when rendering arbitrary point

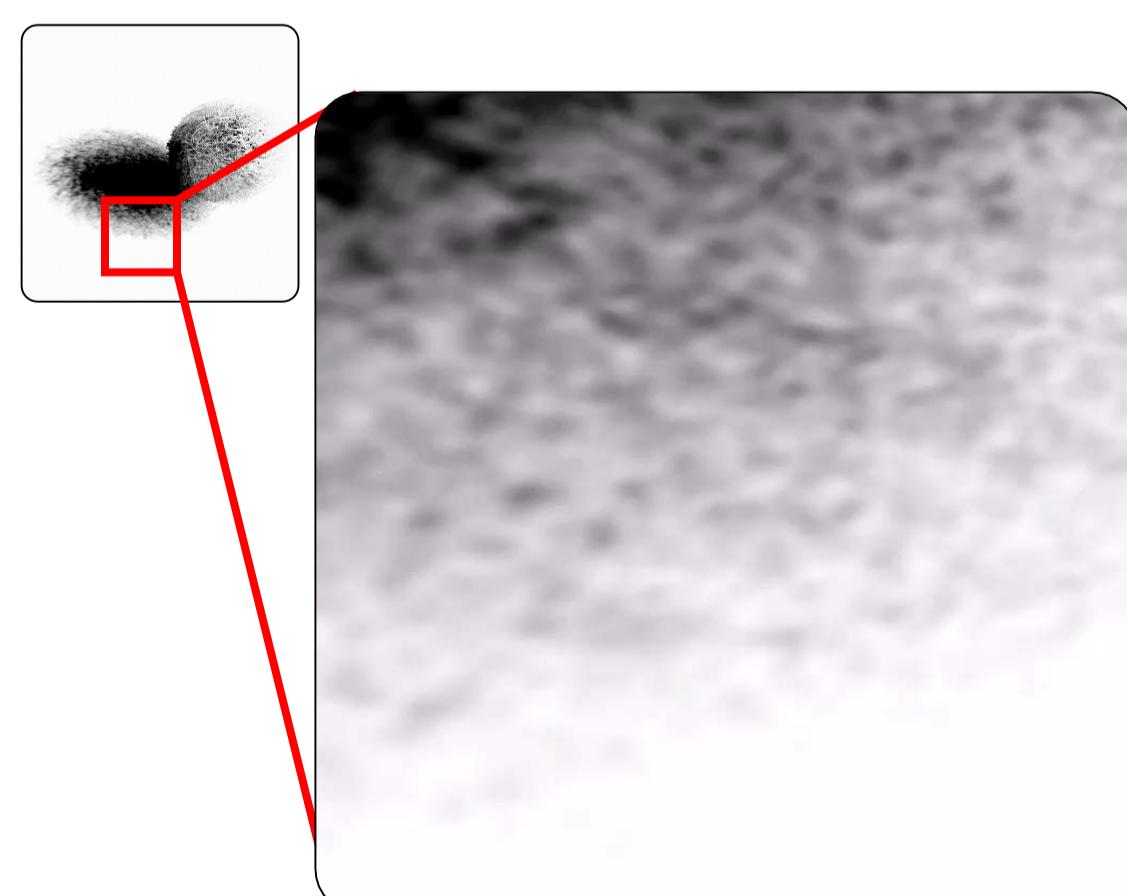
- Interpolate the opacity values and render anti-aliased shadows

- Do not have to use post processing with ISAA

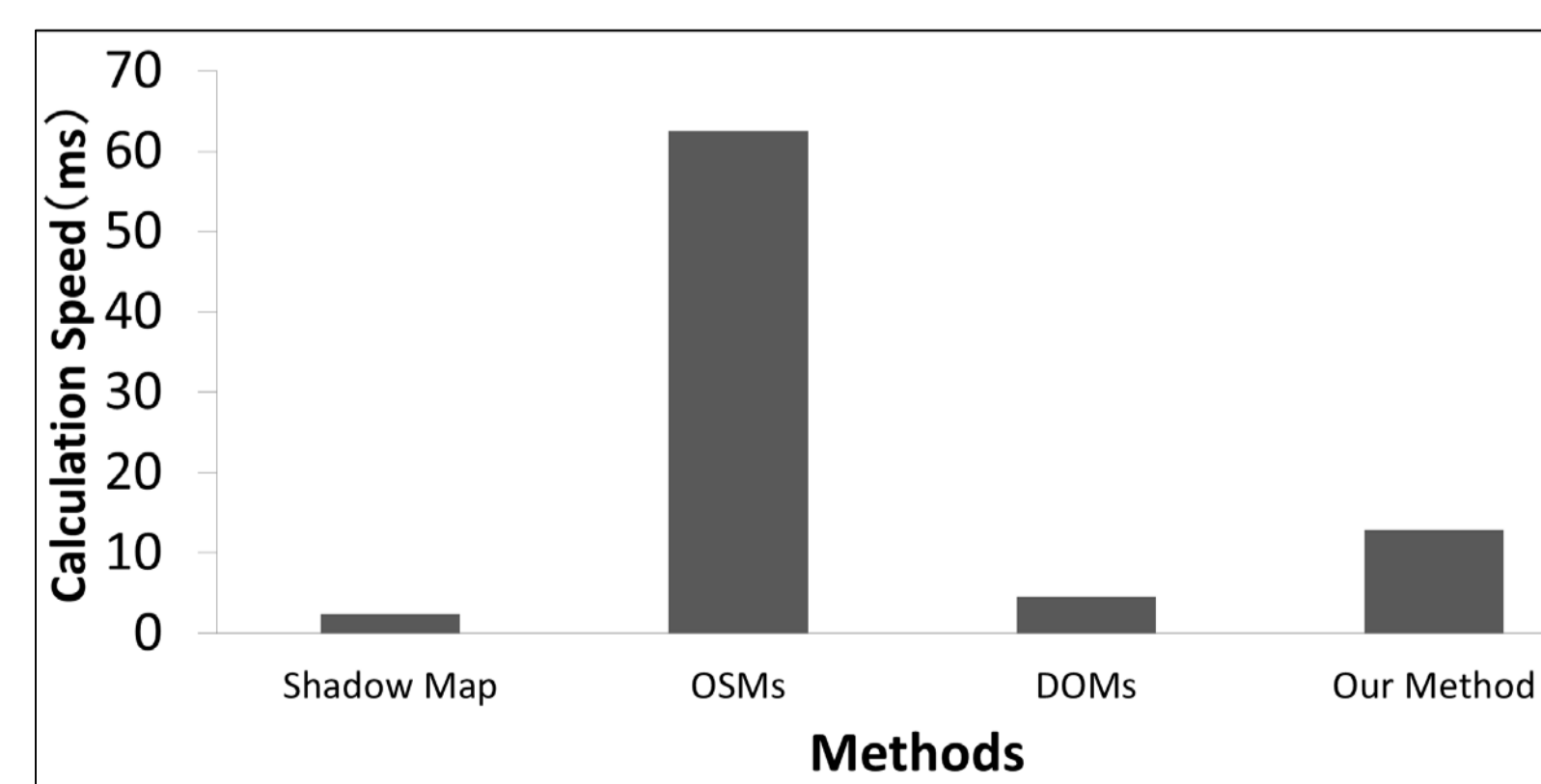
## Results



DOMs with ISAA



Our method



- Slower than DOMs while still executable in real time

## Execution Environment

OS: Windows 8.1 64bit  
 CPU: Intel Core-i7 3.4GHz  
 GPU: GeForce GTX760  
 RAM: 32GB  
 API: OpenGL 4.0  
 Triangle polygon: 2,880,000  
 Vertices: 1,441,098

## Limitations

- Detailed shapes cannot be represented
- Difficult to render hard shadows

## Future works

- Speed-up through combining neighboring splats
- Adopted to multiple light sources