Dynamic Geometry Displacement

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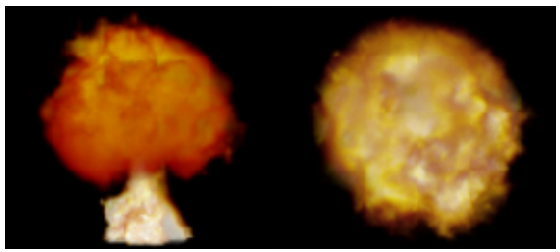
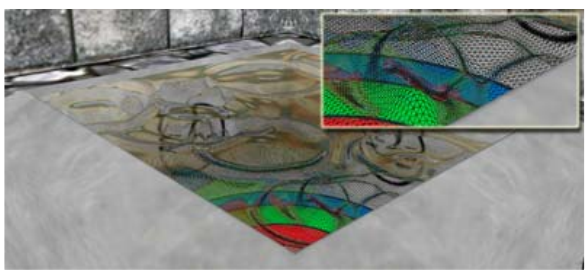
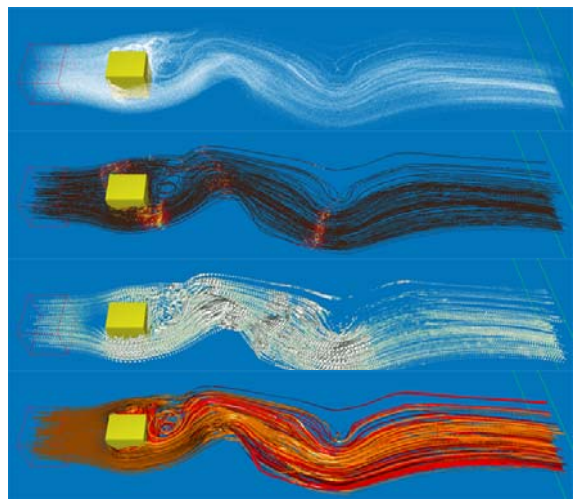
Geometry processing on GPUs

- so far: GPGPU limited to texture output



- new APIs allow geometry generation on GPU





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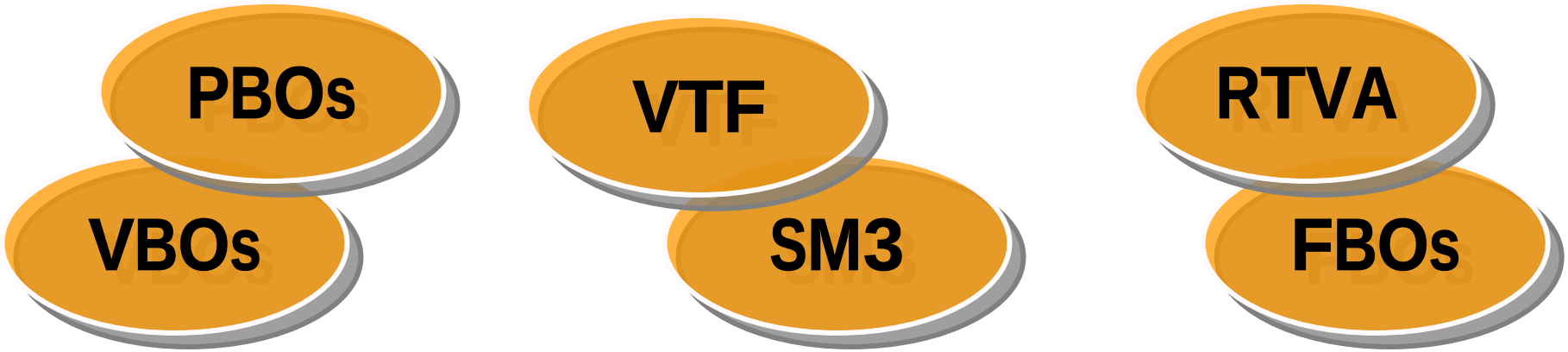
API Bubbles

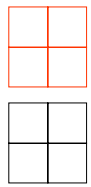


- Shader Model 3.0 with Vertex-Texture-Fetch (VTF)
- Pixel-Buffer-Objects (PBO)
  to Vertex-Buffer-Objects (VBO) copy
- Frame-Buffer-Object (FBO)
  with Cast/Render-To-Vertex-Array (RTVA)
  extension

PBO, VBO Copy

You need:

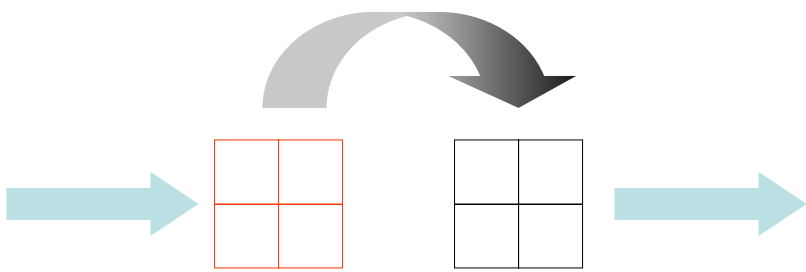
- **floating point pbuffers**
- **a VBO** *(glGenBuffersARB)*



Application Loop:

- **Write geometry data into a pbuffer**

- **Copy data from pbuffer to VBO** *(glReadPixels)*
- **Set vertex array pointers to the VBO** *(glBindBufferARB, glVertexAttribPointerARB)* *and* **Render geometry as usual** *(glDrawArrays, glDrawElements)*



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FBO cast to Vertex-Array

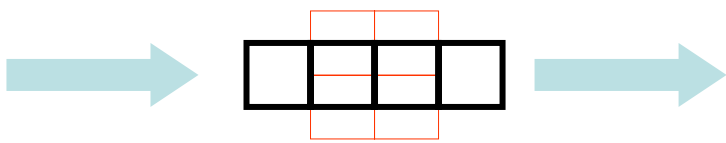
You need:

- floating point FBOs that support RTVA 

Application Loop:

- Write geometry data into the FBO

- Bind FBO as Vertex-Array
- Render geometry as usual
  (glDrawArrays, glDrawElements)



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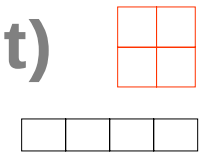
SM3 with VTF

You need:

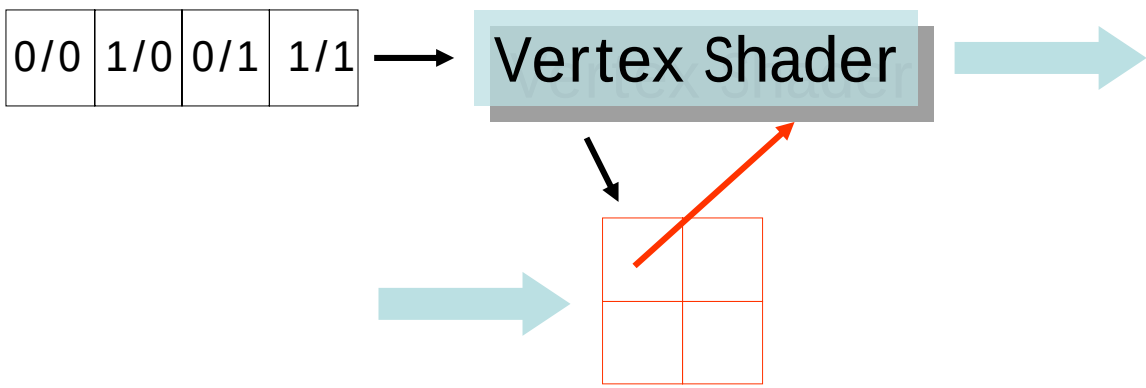
- render targets (pbuffer, FBO, DX render target)
- a static Vertex-Buffer/ Vertex-Array



Application Loop:

- Write geometry data into the render target

- Render the static Vertex-Buffer enable a vertex shader that fetches from the render target



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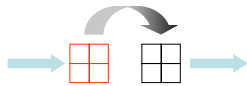
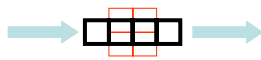
Comparison

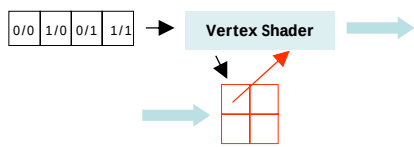
- **PBO, VBO Copy**
  - availability
  - requires memcopy , OpenGL only



- **FBO cast to Vertex-Array**
  - no memcopy
  - availability, OpenGL only



- **SM3 with VTF**
  - multi vendor, OpenGL/DirectX, flexible
  - more code, requires latest GPU



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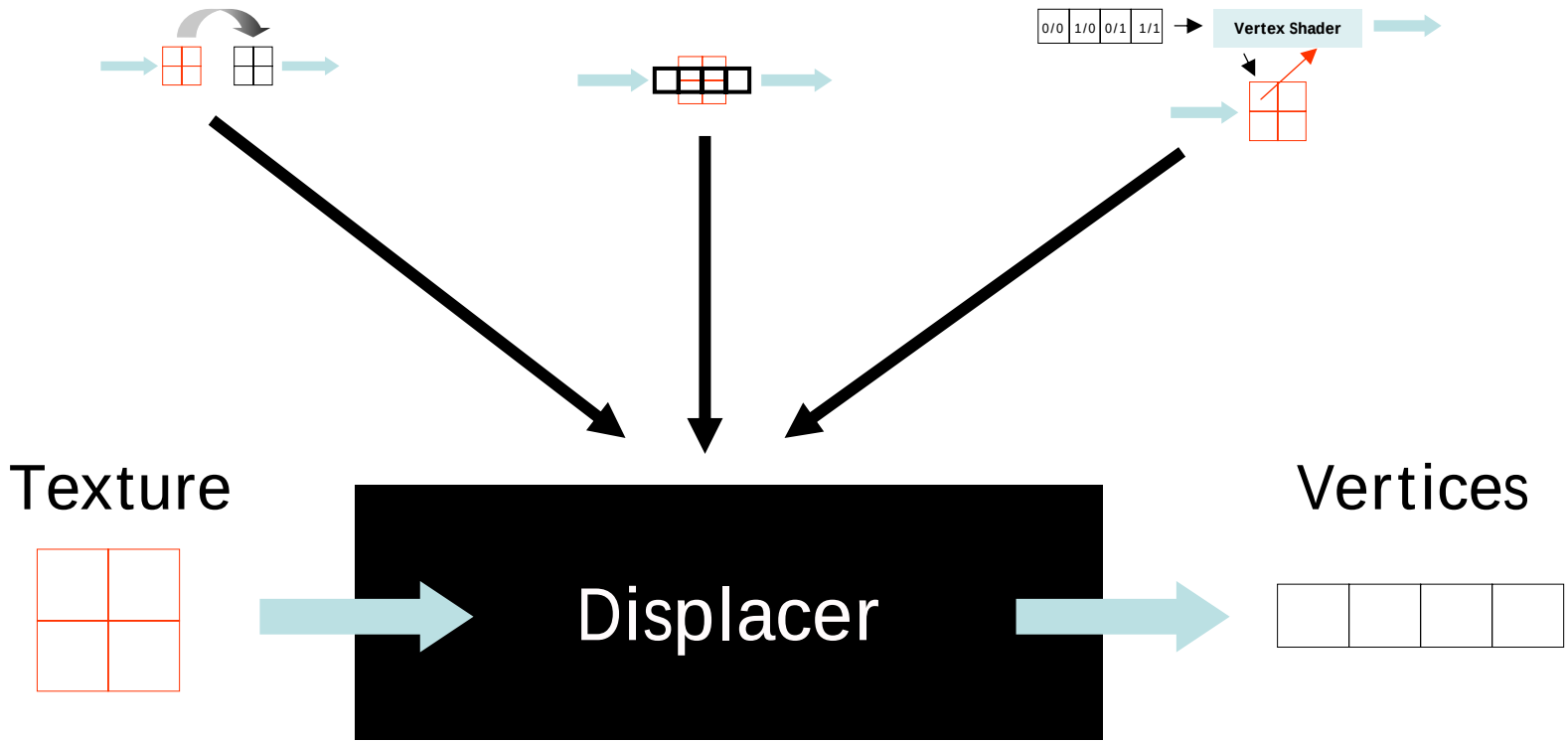
… it's all the same somehow …



In principle, all 3 methods take one or more textures as input and displace a vertex stream accordingly, this makes them interchangeable.

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Examples

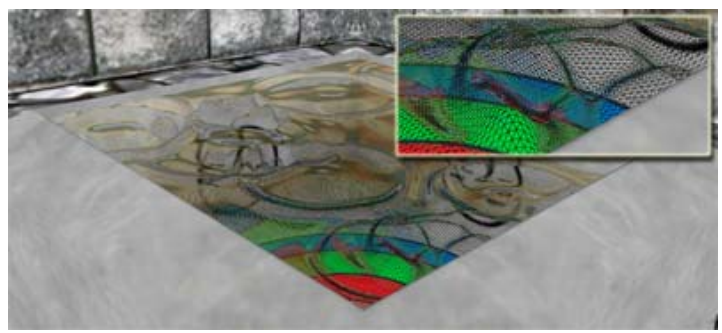
Fluid Simulation

Particles

3D Smoke & Fire

Water Simulation

Grid displacement



3D Water Surfaces

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Examples

Fluid Simulation

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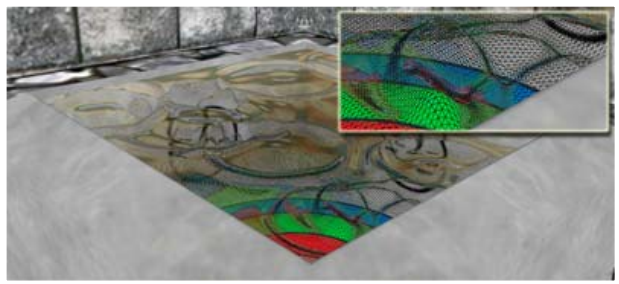
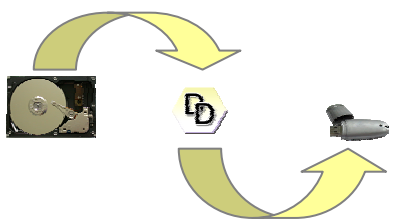
3D Smoke & Fire

Water Simulation

Grid displacement



3D Water Surfaces



Point Compression

Point Decompression

Point Rendering

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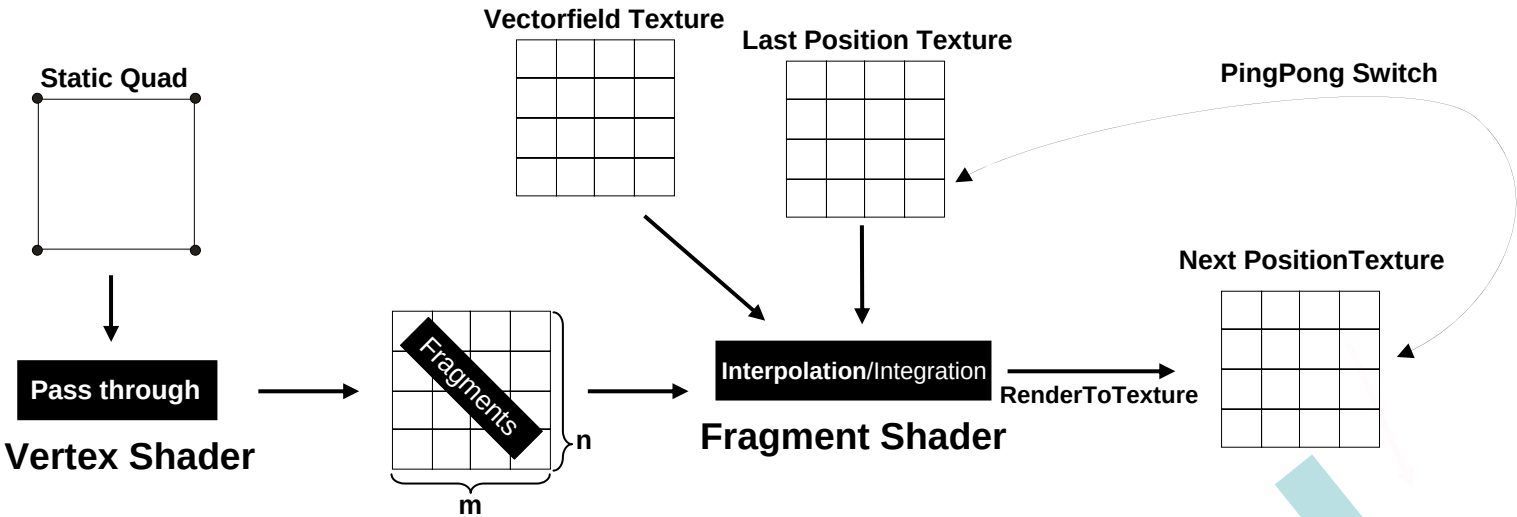
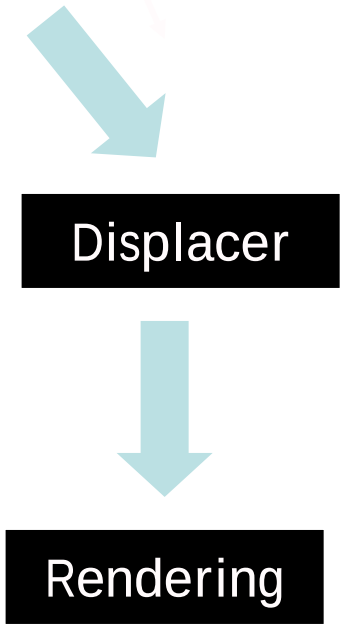
Example 1, Particle Tracing



Observed Speedups for 3D Vector fields

- Interpolation (x100)
- SIMD Integration (x20)
- SM 3.0 Particle Rendering (x20)

ATI X800 XT vs. Pentium 4 3Ghz



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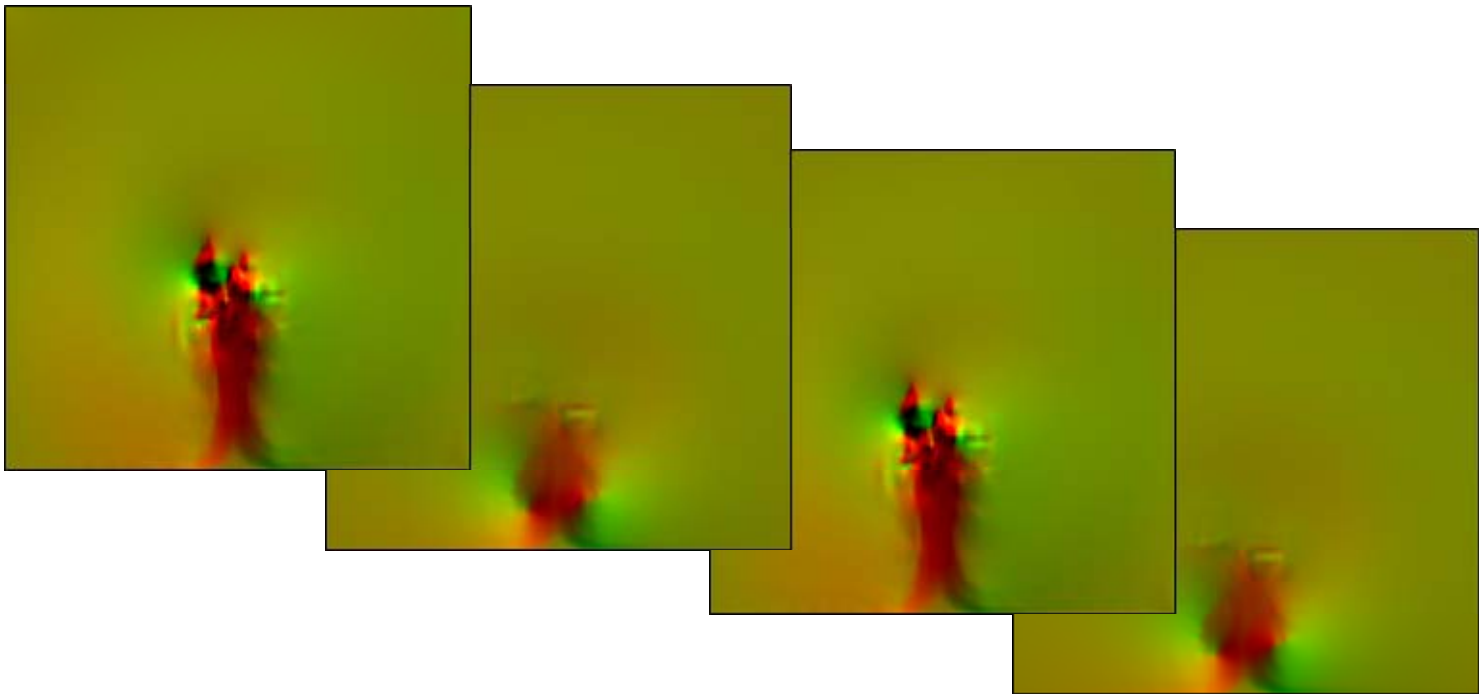
100+ fps Smoke with GPU Particles I



Step 1:

- **do a couple of independent 2D fluid simulations**
- **run at a few hundred FPS on current GPUs**

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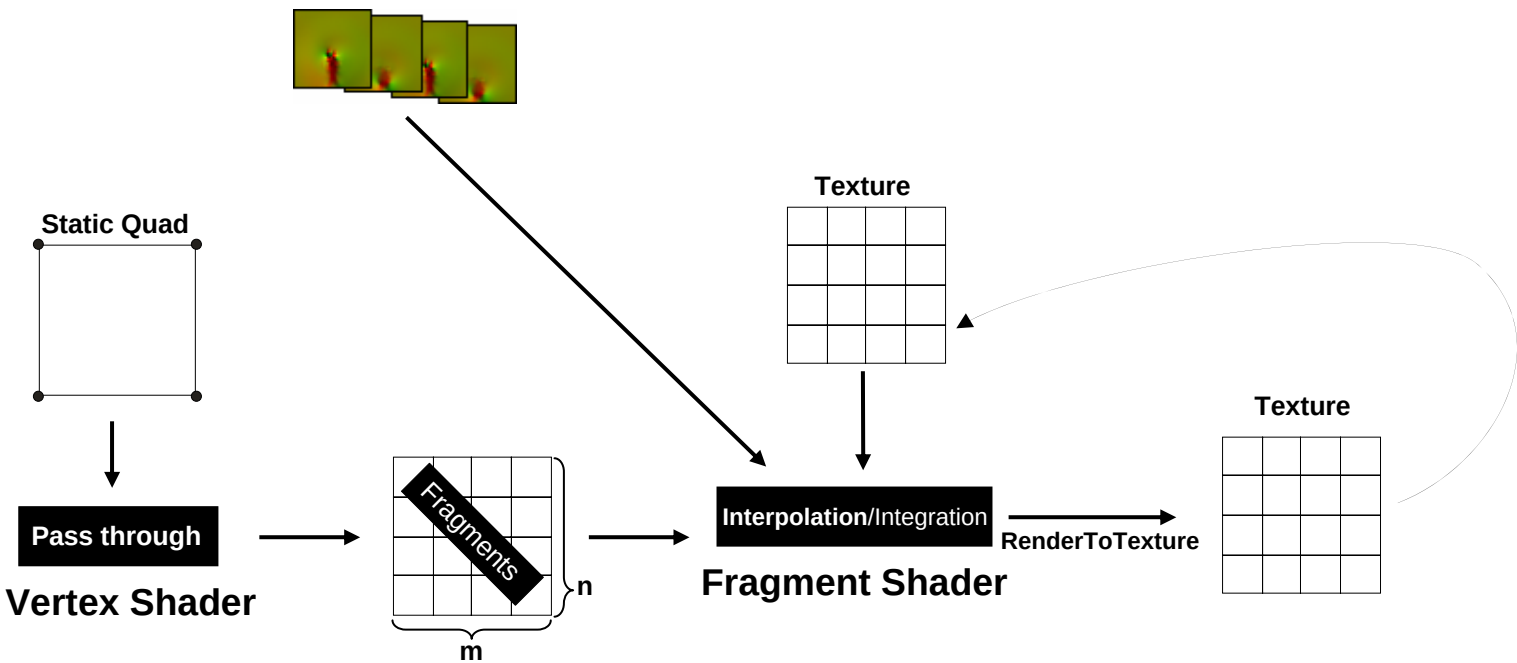
100+ fps Smoke with GPU Particles II



Step 2:

- Bind the output of the simulation as vector field textures for the particle advection

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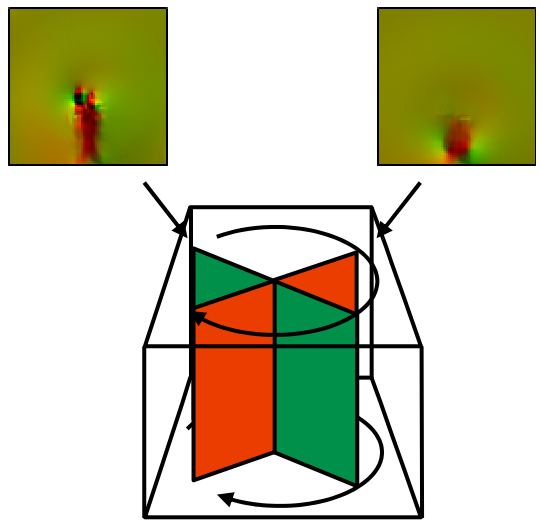
100+ fps Smoke with GPU Particles III

Step 3: Let the interpolator compute the revolution

```
float3 sample2DNSExtr(float3 position) {
  float4 translPosition;
  translPosition.xy = position.xz*2-1;
  translPosition.zw = float2(-translPosition.y,translPosition.x);
  float l = length(translPosition.xy);
  float4 f4TexCoords = float4( (sign(translPosition.x)*l+1.0f)/2.0f, position.y,
                               (sign(translPosition.z)*l+1.0f)/2.0f, position.y);
  float2 f2SimulationA = tex2D(sVFieldA,f4TexCoords.xy).xy;
  float2 f2SimulationB = tex2D(sVFieldB,f4TexCoords.zw).xy;
  translPosition  /= l;
  float3 f3SimulationA, f3SimulationB;
  f3SimulationA.y  = f2SimulationA.y;
  f3SimulationA.xz = translPosition.xy*f2SimulationA.x*sign(translPosition.x);
  f3SimulationB.y  = f2SimulationB.y;
  f3SimulationB.zx = translPosition.zw*f2SimulationB.x*sign(translPosition.z);
  f3SimulationB.z = -f3SimulationB.z;
  float3 f3Simulation = lerp(f3SimulationA,f3SimulationB,asin(abs(translPosition.z))/1.57f);
  return f3Simulation;
}
```



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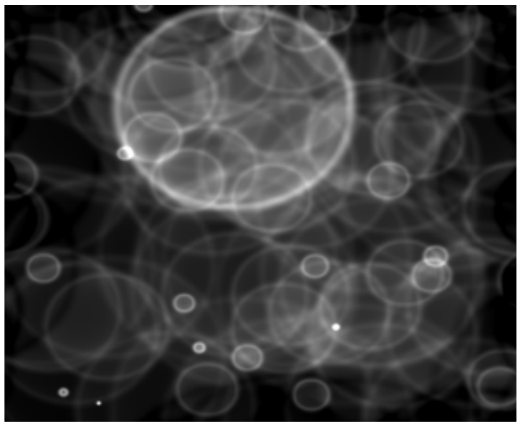
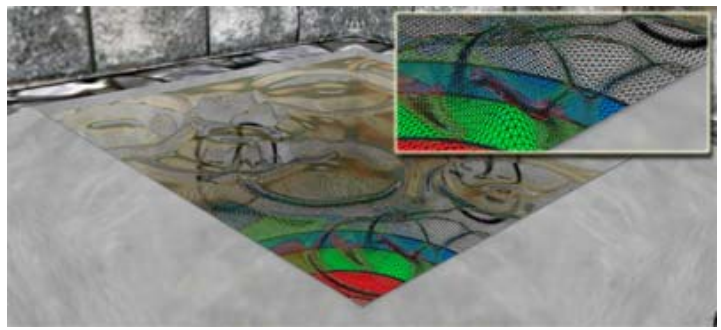
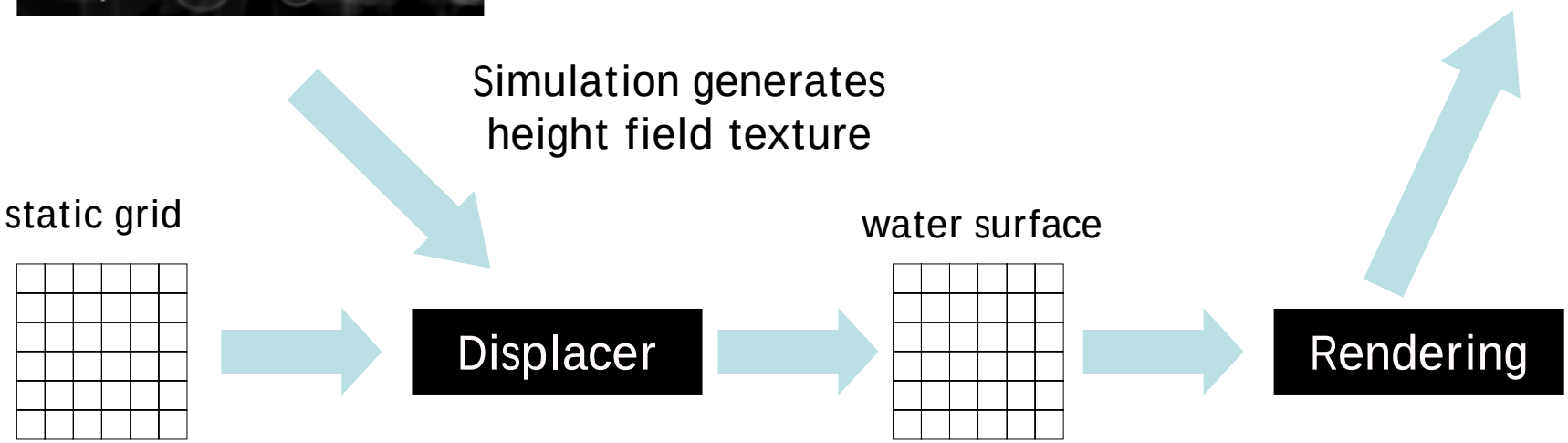
Example 2, Water Surface







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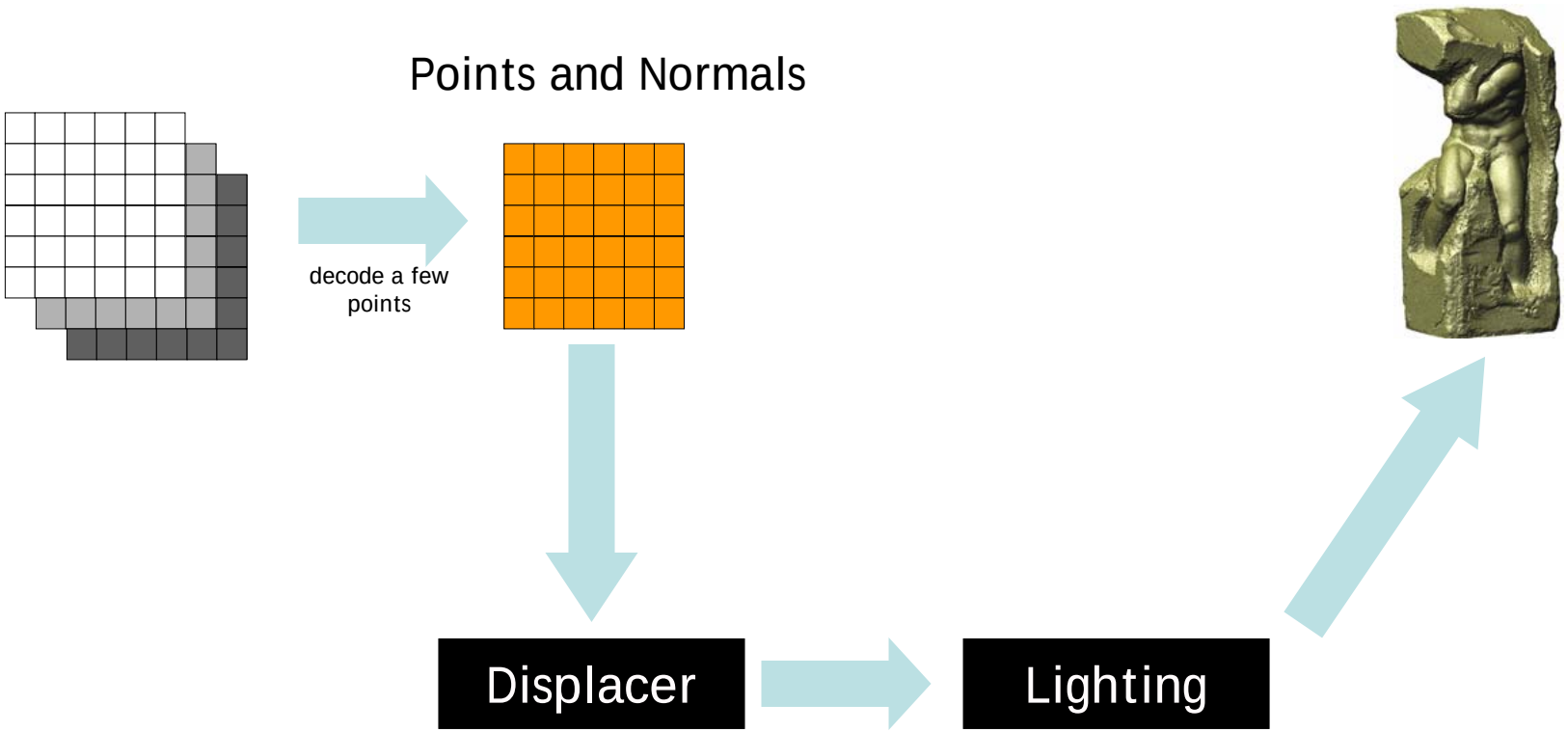
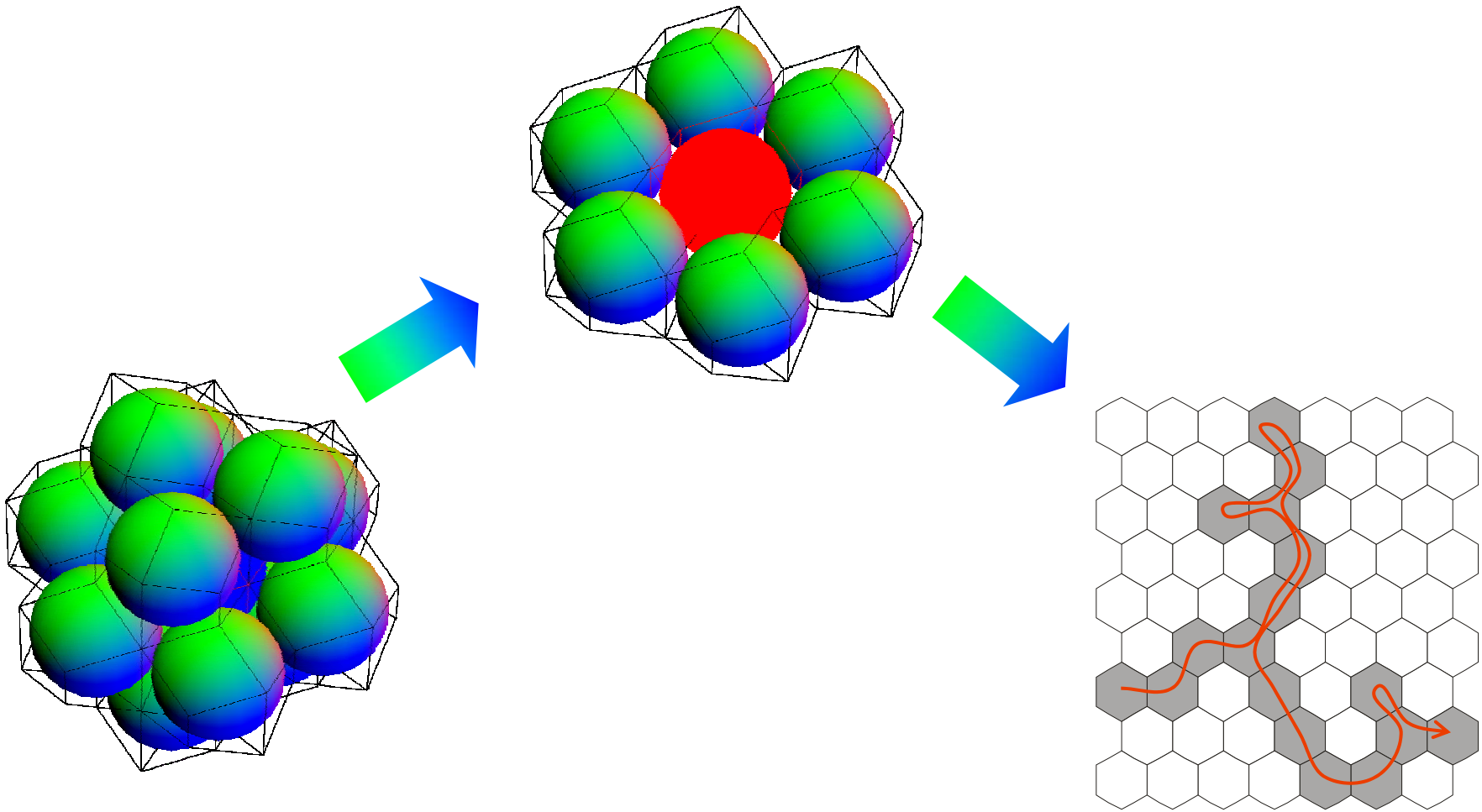
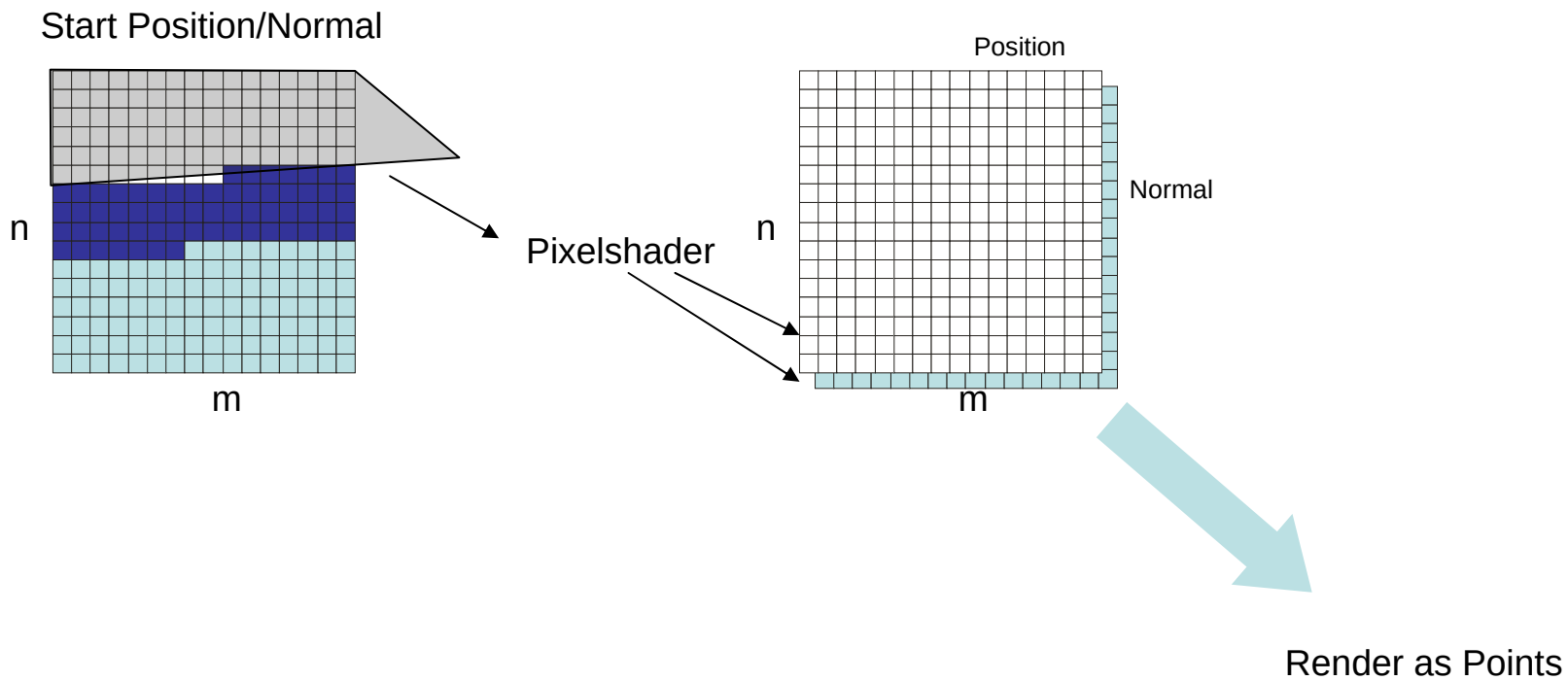
Example 3, Point Compression



Example 3, Point Compression (cont.)



Example 3, Point Compression (cont.)



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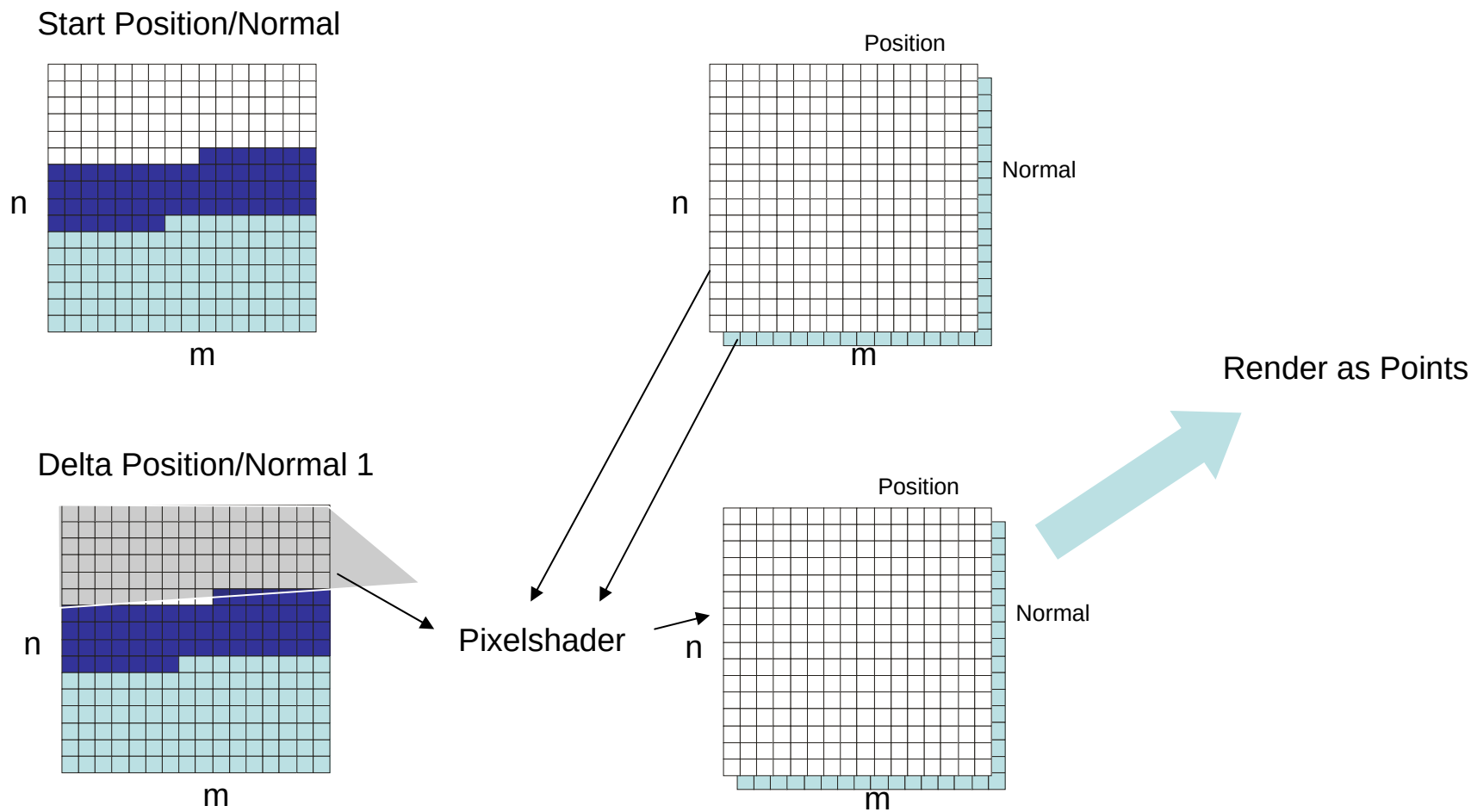
Example 3, Point Compression (cont.)



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The End

Websites:

http://www.gpgpu.org

http://wwwcg.in.tum.de/Research/Publications/Compression

http://wwwcg.in.tum.de/Research/Publications/Windtunnel