SAND2019-12357C

Sandia National Laboratories

# Large-Scale Cinematic Visualization Using Universal Scene Description

## What is USD?

- Pixar's in-house scene API that was open-sourced in 2016.
- A file format that describes a scene graph
- Describes geometry, lights, animations, and shaders
- Composite USD files on top of each other
- Widely supported amongst tool vendors (Houdini, Maya, Unity, …)

## Why use USD for Cinematic Visualization?

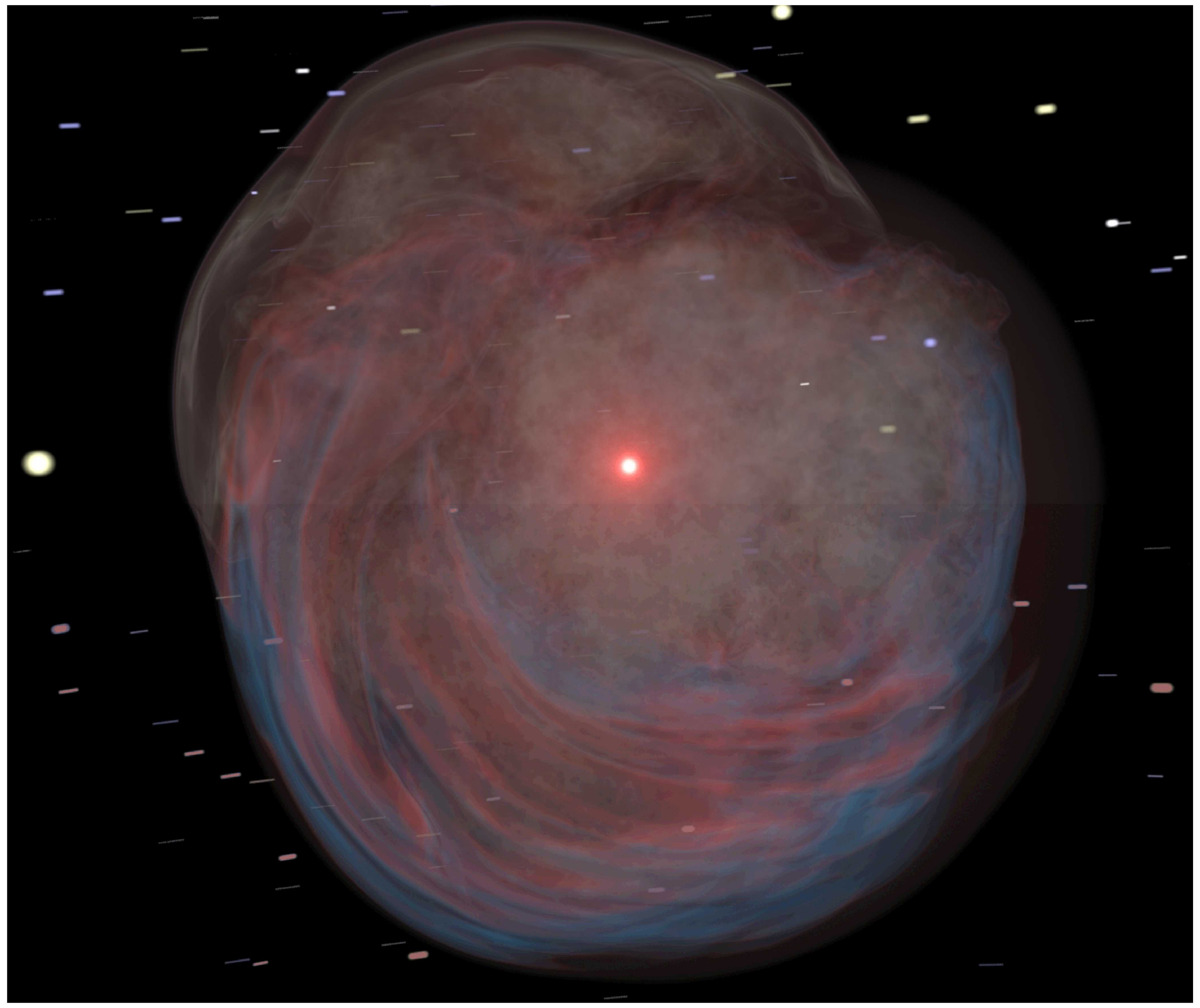
- Enables data interchange between computational models and Digital Content Creation (DCC) tools.
- Surface elements
  - quad, triangles, lines and points have a 1:1 correspondence
- Volumetric/Mesh Elements
  - Unstructured meshes convert directly
  - Regular meshes are converted to OpenVDB format
  - Curvilinear and Rectilinear need to be voxelized to a regular grid or converted to unstructured
  - Each portion of an AMR grid is converted as appropriate

## USD at Sandia

- USD is integrated into a custom version of the LLNL spack packaging system
- A command-line VTK converter is in use with a ParaView plugin under development

## Example Scenario

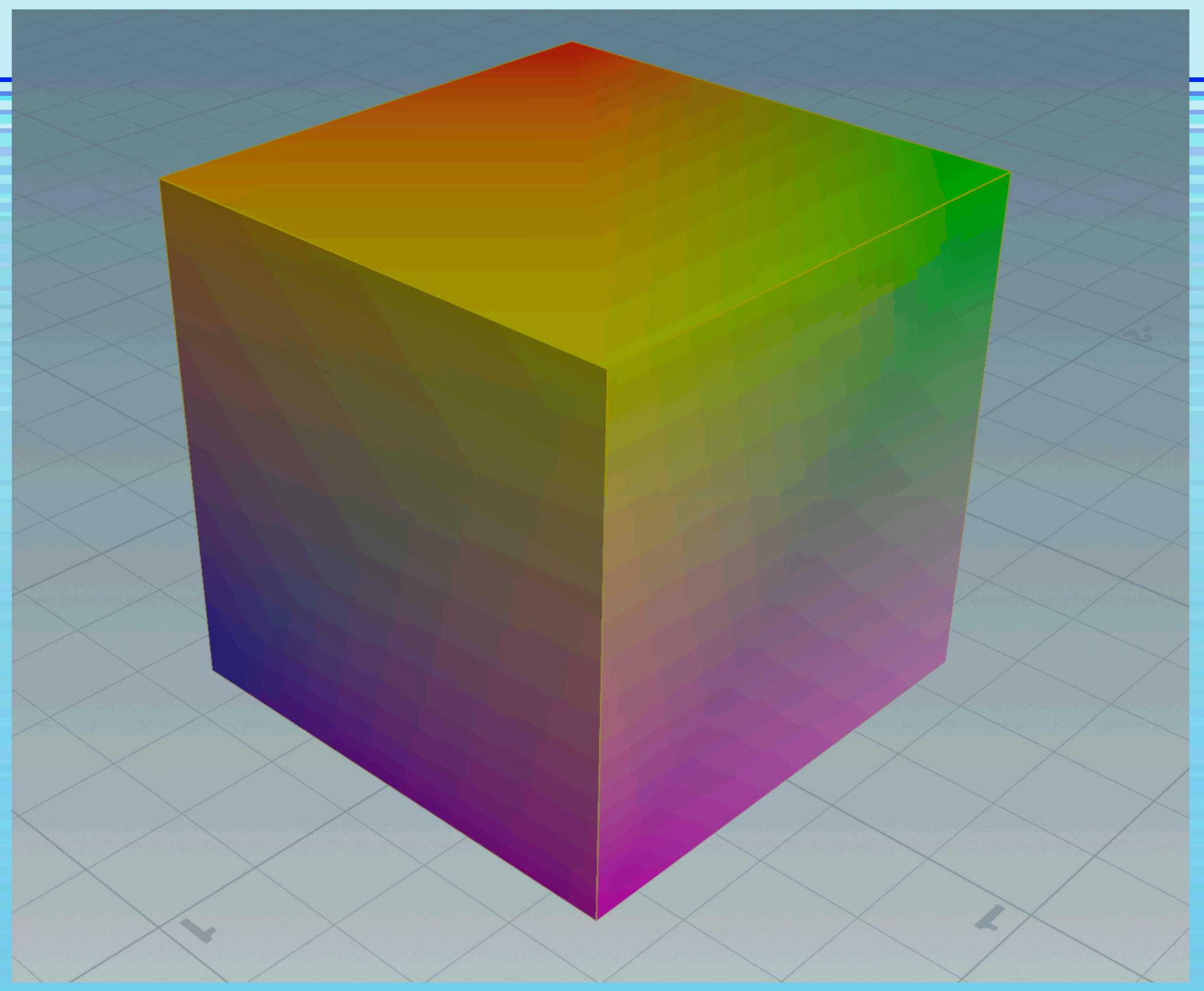
- For the image on the right, one timestep of a supernova explosion on a 430^3 regular grid was converted to OpenVDB format and wrapped in USD
  - The converted dataset was ~20% smaller due to OpenVDB's empty-space packing
- User-selected scalar and vector values were added to the USD file as "variants" (1-of-N values user-selected to import upon load)
- Data ranges are added as a separate top-level object that can be selectively imported
- A second USD file that references the first (a "composite" USD file) was created containing colors from mapping data values through a VTK/ParaView colormap
- The USD files were imported into Houdini and rendered



## Example USD File and Resulting Geometry

```
#usda 1.0
(
   defaultPrim = "World"
   endTimeCode = 1
   startTimeCode = 1
   upAxis = "Y"
)

def Xform "World
{
   def Mesh "mesh_0"
   {
      float3[] extent.timeSamples = {
         1: [(-0.5, -0.5, -0.5), (0.5, 0.5, 0.5)],
      }
      int[] faceVertexCounts.timeSamples = {
         1: [4, 4, 4, 4, 4, 4],
      }
      int[] faceVertexIndices.timeSamples = {
         1: [1, 5, 4, 0, 2, 6, 5, 1, 3, 7, 6, 2, 0, 4, 7, 3, 2, 1, 0, 3, 5, 6, 7, 4],
      }
      point3f[] points.timeSamples = {
         1: [(-0.5, -0.5, -0.5), (0.5, -0.5, -0.5), (0.5, -0.5, 0.5), (-0.5, -0.5, 0.5),
               (-0.5, 0.5, -0.5), (0.5, 0.5, -0.5), (0.5, 0.5, 0.5), (-0.5, 0.5, 0.5)],
      }
      color3f[] primvars:displayColor (
         interpolation = "vertex"
      )
      color3f[] primvars:displayColor.timeSamples = {
         1: [(1, 0, 0), (1, 0.5, 0), (1, 1, 0), (0, 1, 0),
               (0, 1, 1), (0, 0, 1), (1, 0, 1), (1, 0.5, 1)],
      }
   }
}
```



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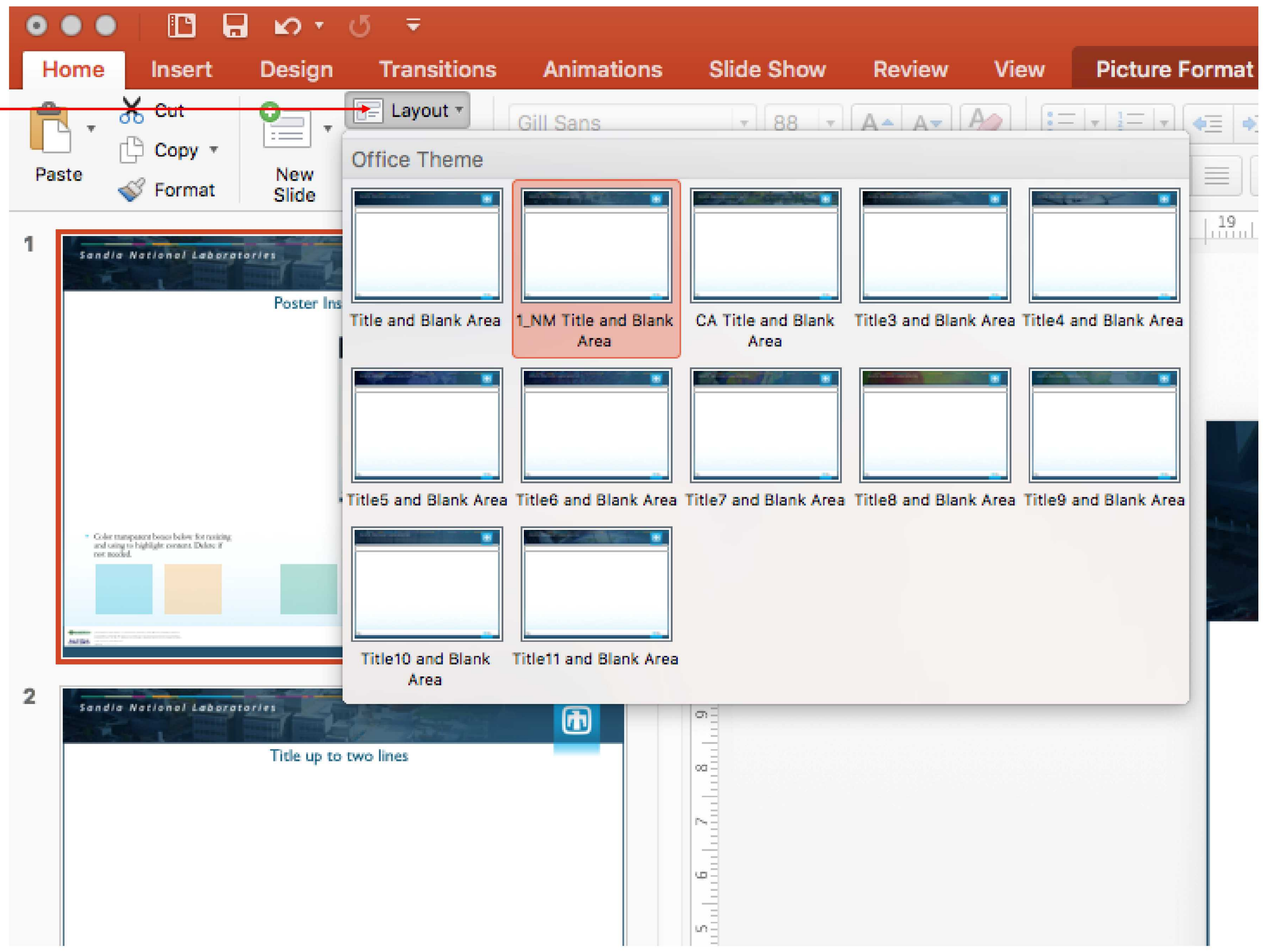

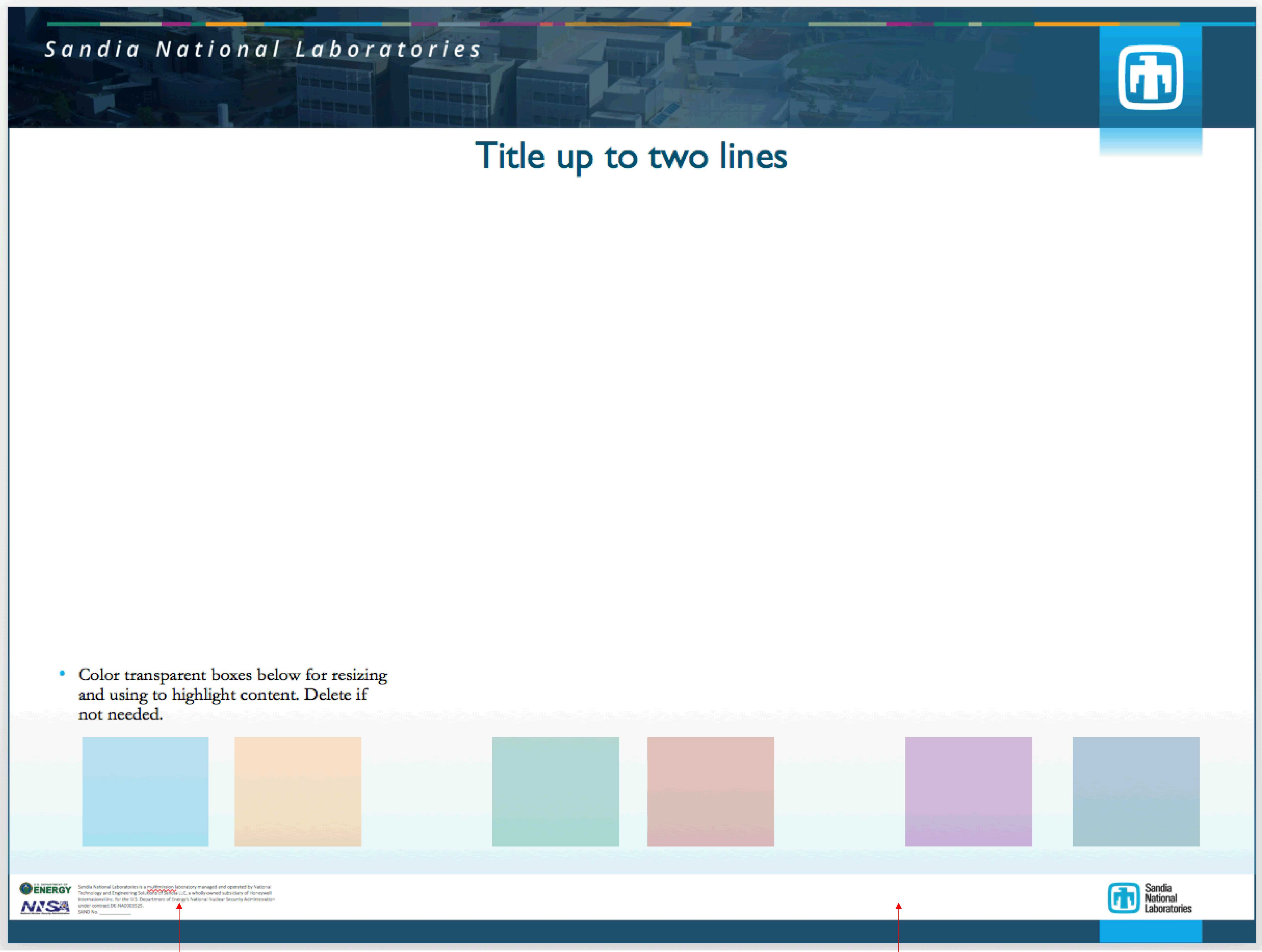

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Title up to two lines

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Body text/ support font: Garamond MT

Add Sand Number to the funding statement within the Master Title slide

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