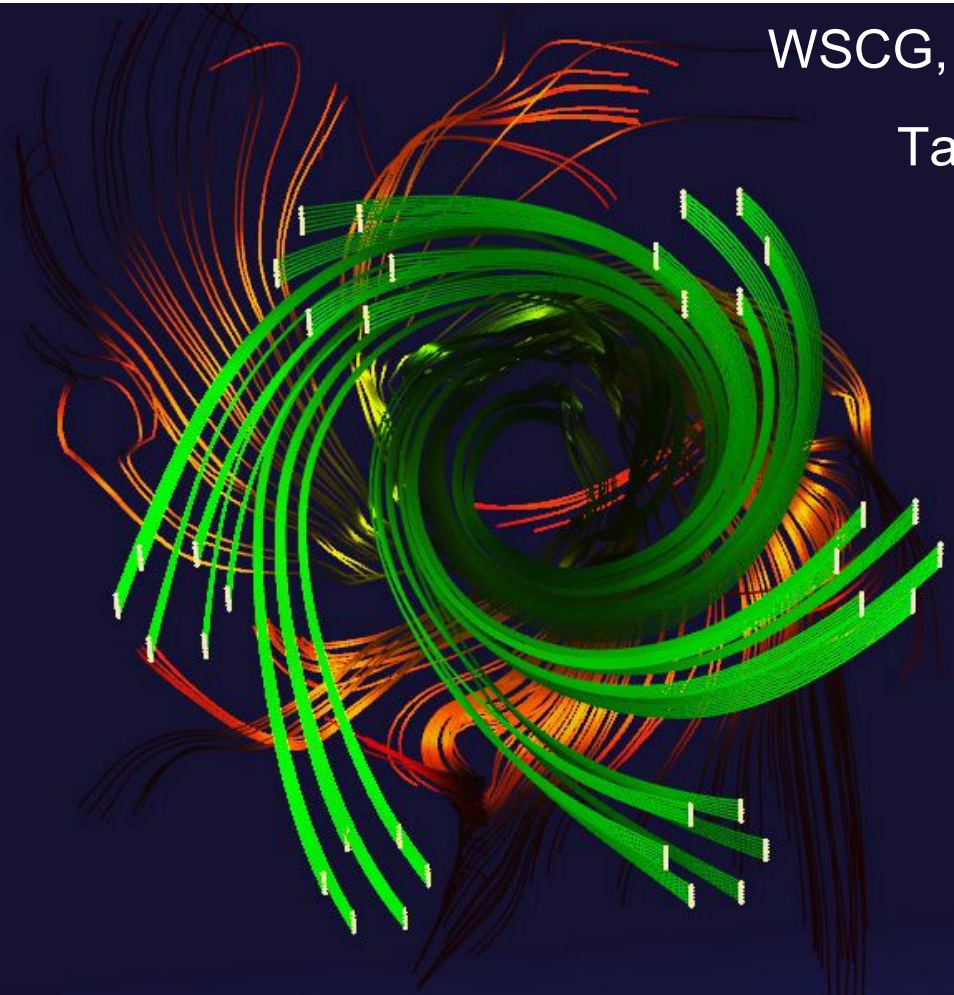
# Fiberbundle-Based Visualization of a Stir Tank Fluid

Benger Werner, Ritter Marcel, Archaya Sumanta, Roy Somnath, Jijao Feng

WSCG, February 2009, Plzen

Talk: Ritter Marcel



LSU
CENTER FOR COMPUTATION & TECHNOLOGY
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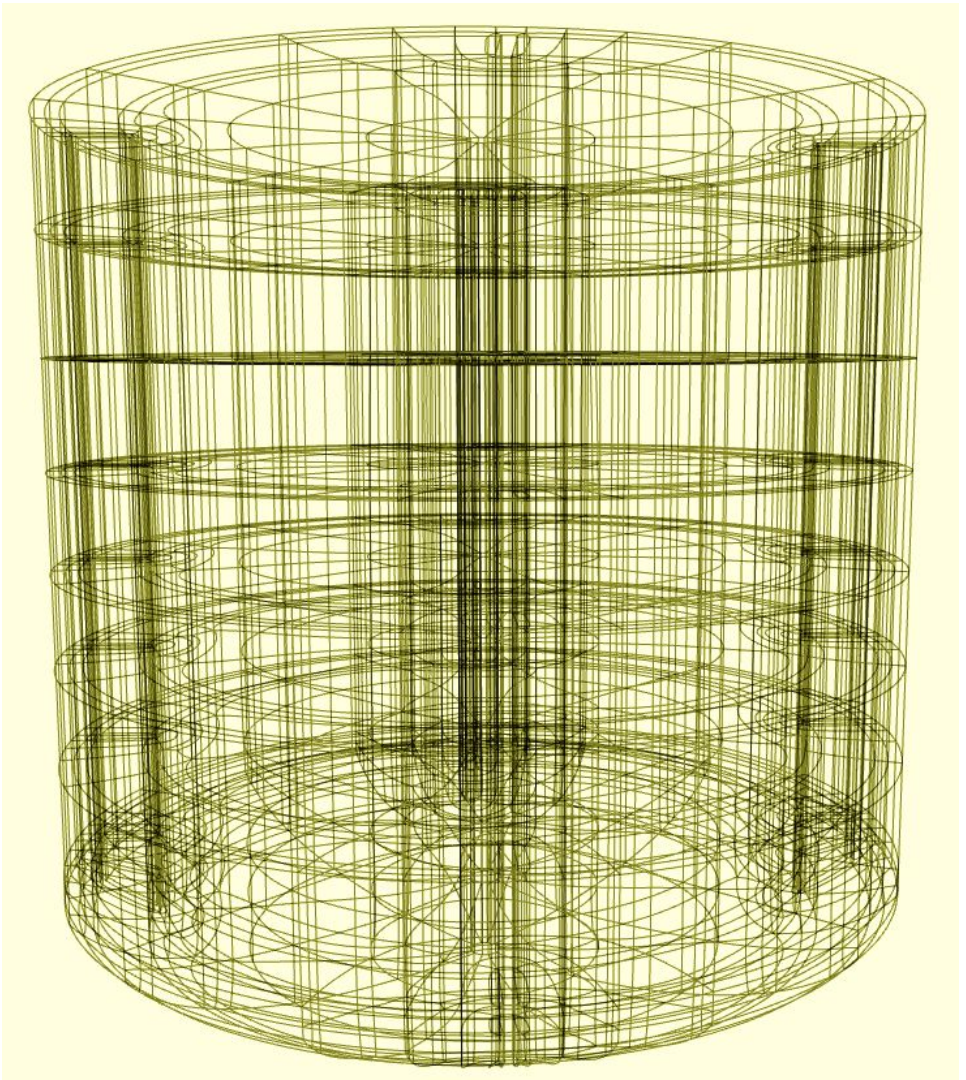
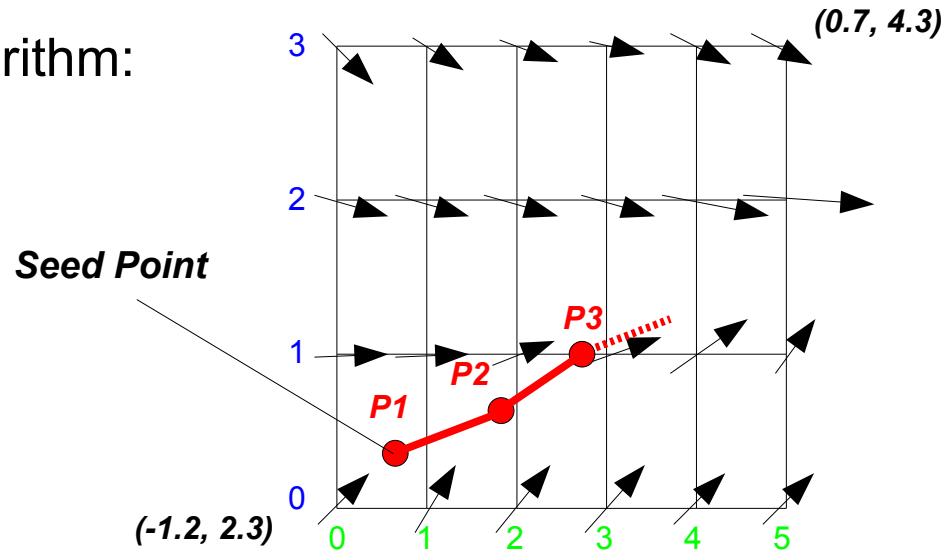
# Outline

1. Data to be Visualized
2. Fiber Bundle Data Model
    - Grid and Field Objects
3. Streamline Visualization in Vish
    - Module Separation
    - Using Grid Objects
4. Conclusion

- The Stirtank Dataset
  - Department of Mechanical Engineering (LSU)
    - Sumanta Acharya
    - Somnath Roy
  - 2088 curvilinear blocks
  - Vectorfield describing velocity
  - Scalarfield describing pressure

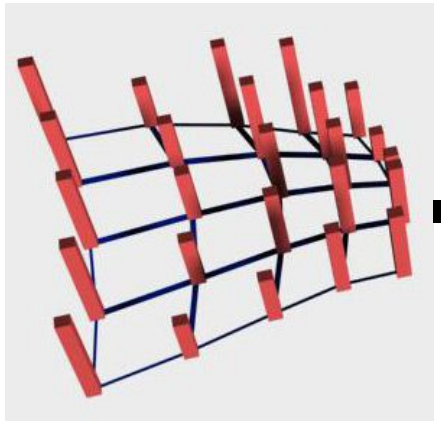


- Streamlines
  - Common tool to visualize vector fields such as the stirtank velocity field
  - Definition: $\frac{\vec{d}}{ds} c(s) = \vec{u}(c(s))$
  - Simple algorithm:



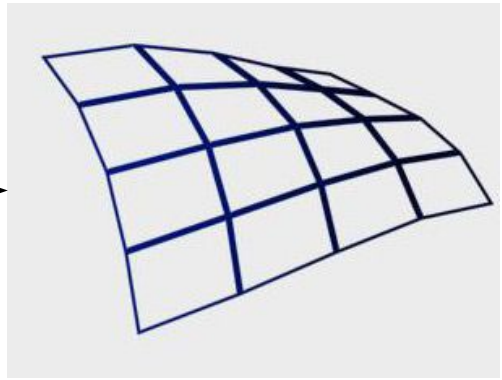

  - More complex in case of curvilinear multiblock data
  - What data structures should be used for the data?

- Data model based on the theory of Fiber Bundles
  - Identifies characteristics of scientific data
  - Consistent data organization
  - Separating *Base Spaces* (**Grid**) and *Fibers* (**Fields**)

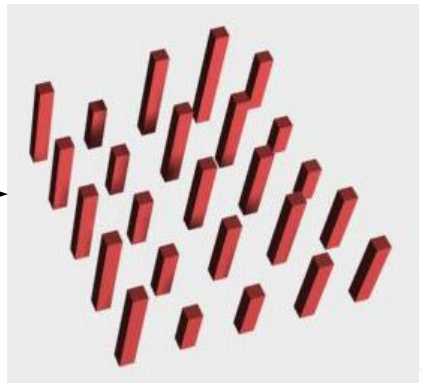


data:
scalar values on an
hexahedral curvilinear grid

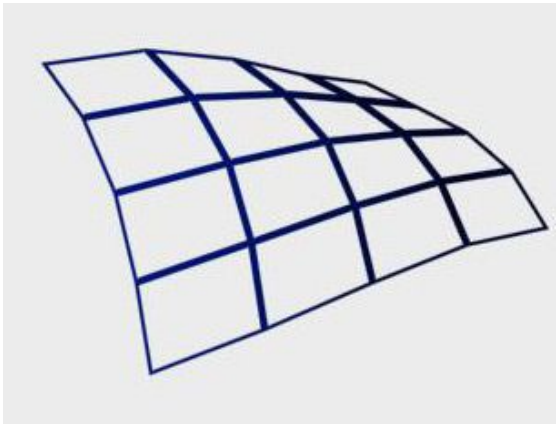
Grid (base space)

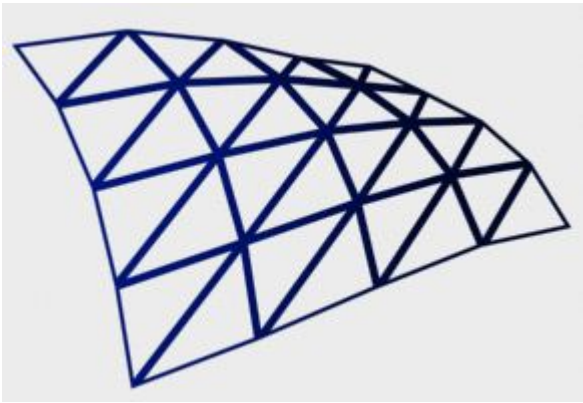


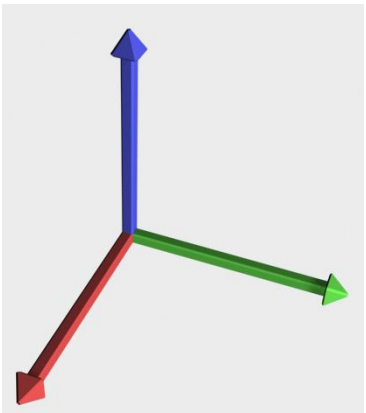
Field (fibers)

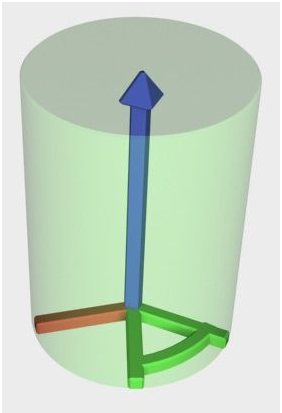


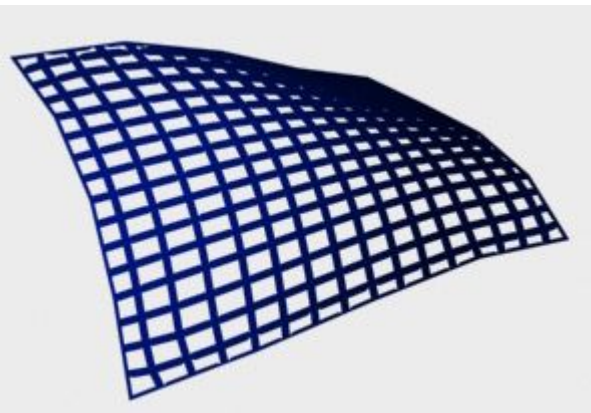
- Grid object:
  - Manifold describing the base space
  - Properties:
    - Topology
    - Refinement level
    - Coordinate representation
    - Vertex positions in representation



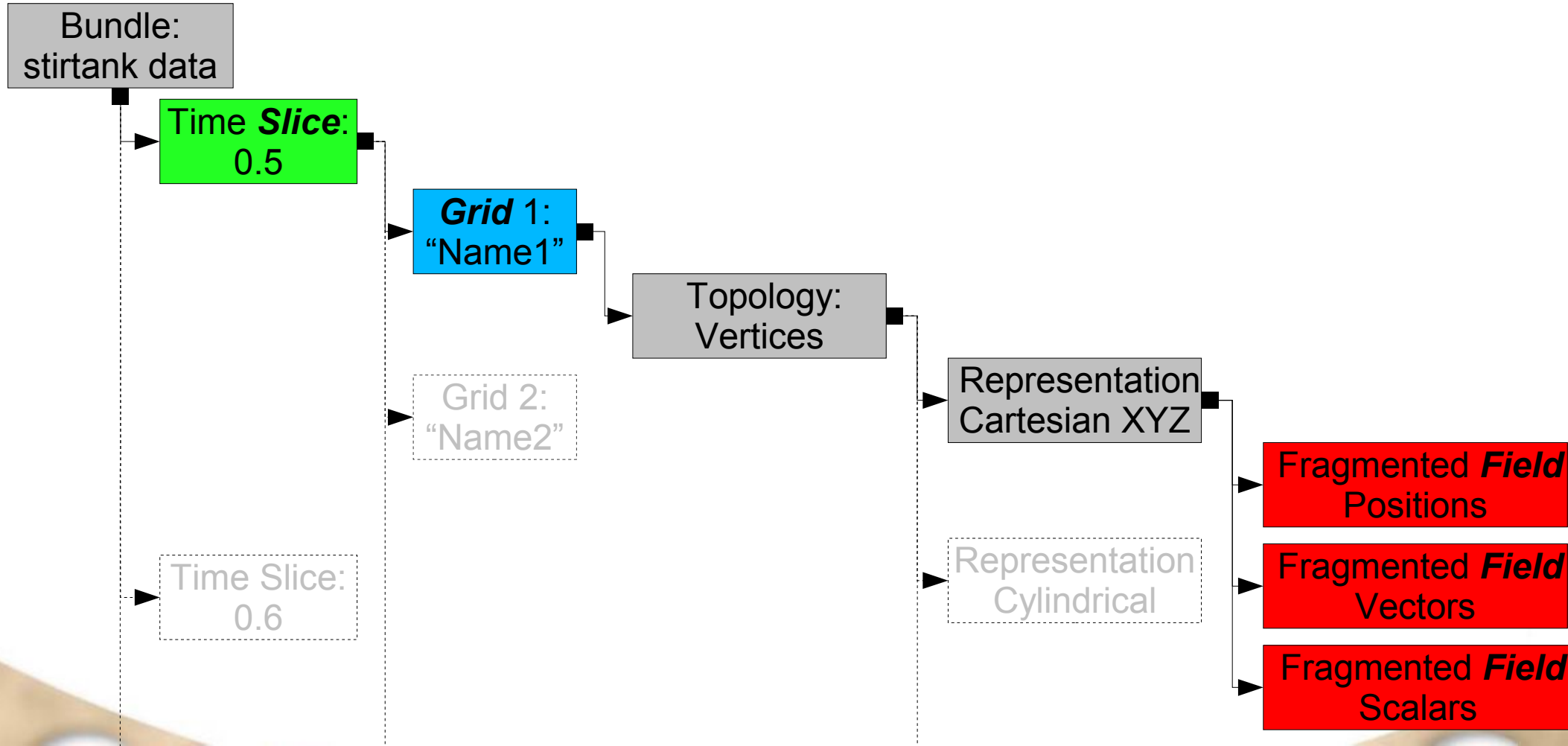






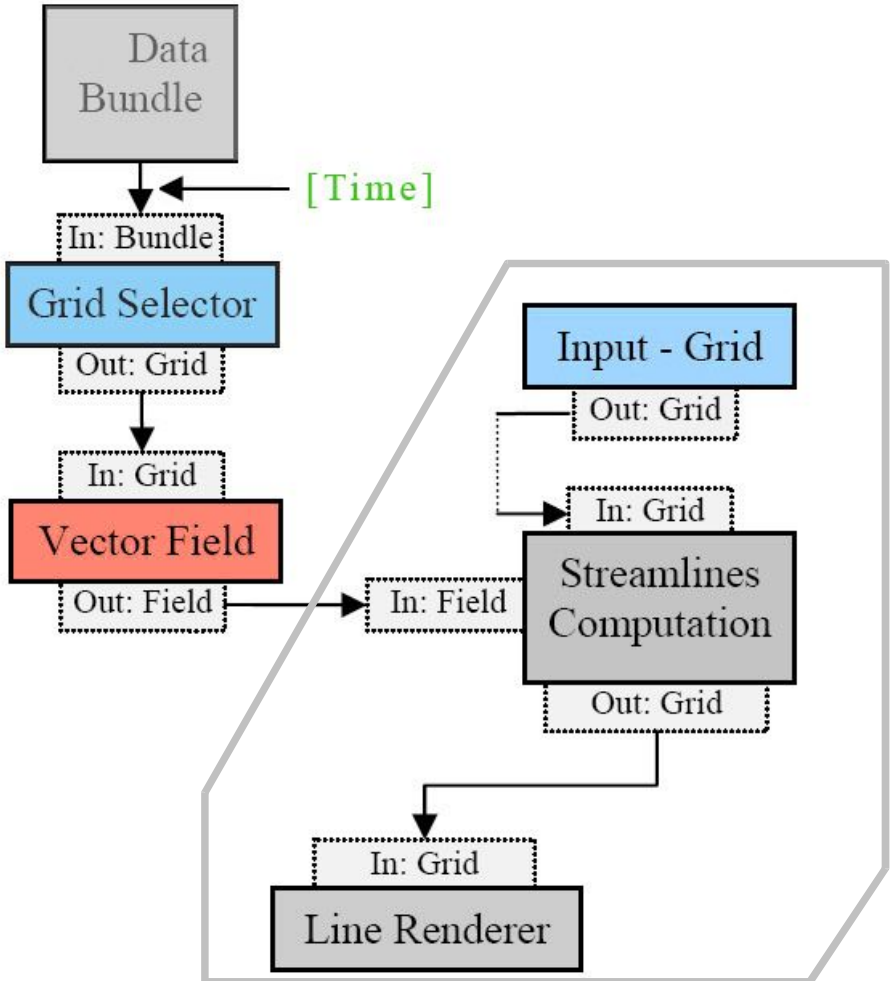


- Internal data structure (example stirtank)
  - Directory structure



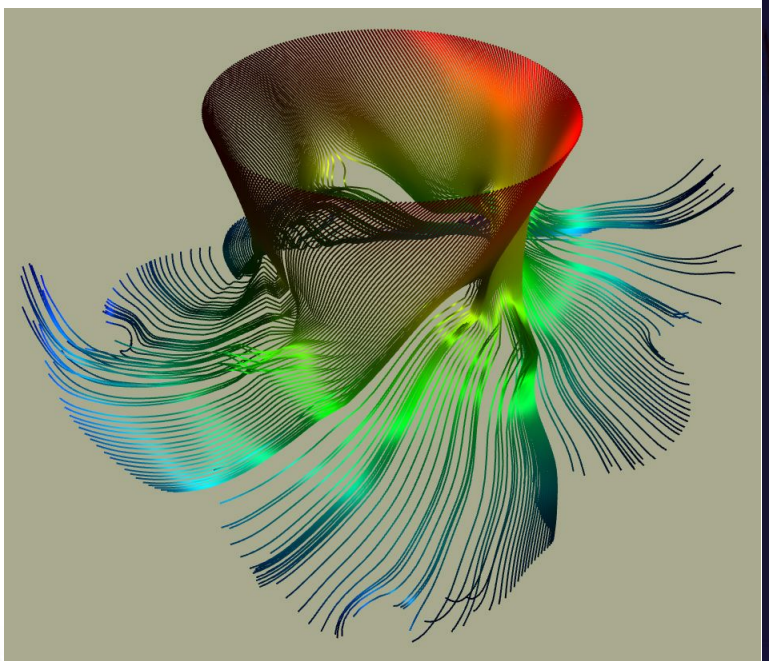
- The user only deals with
  - Bundles
  - Grids (parameterized e.g. with time)
  - Fields

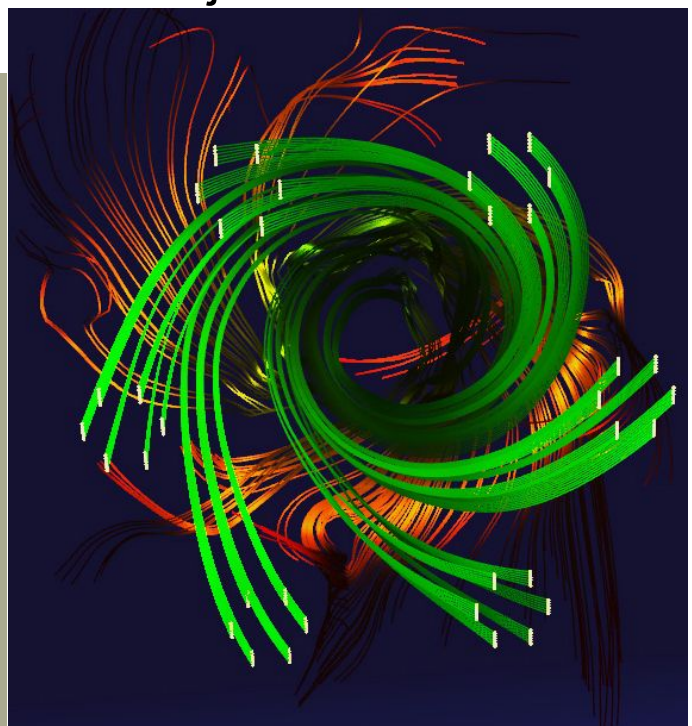
- Streamline-modules and Dataflow in VISH
  - all-in-one module solution was developed first
  - module separation lead to better code reusability



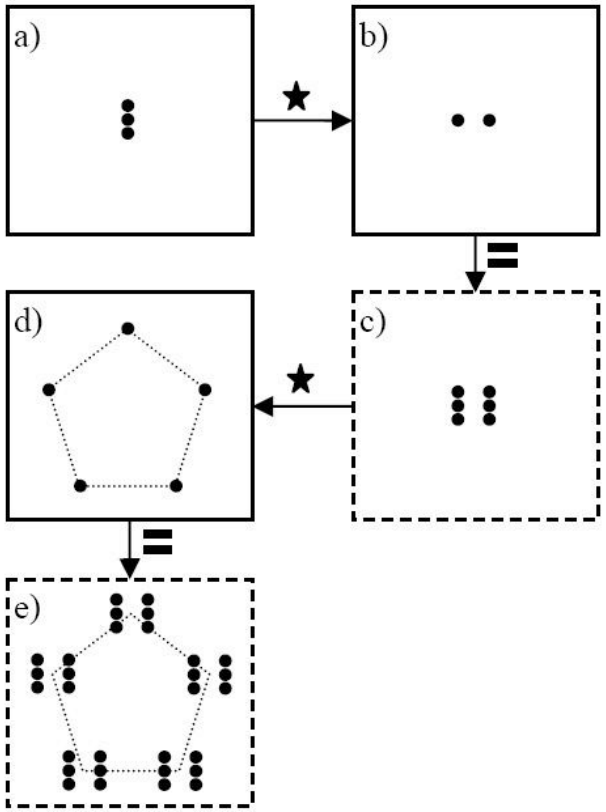

- Streamline-modules:
  - Defining seed points
    - output a Grid
  - Compute streamlines
    - input a Grid
    - output a Grid
  - Render line grids
    - input a Grid

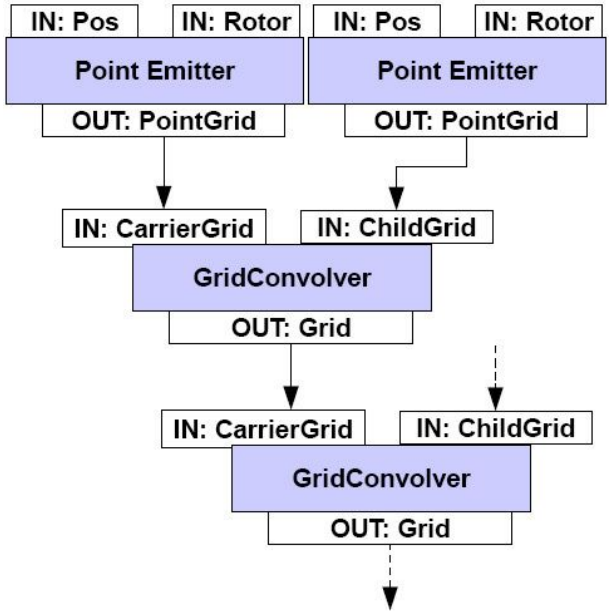
- Defining an Input Grid for seeding streamlines
  - first module created point Grids on defined geometries (like points on a line or circle)
  - idea of copying and transforming points based on other grid points, similar to the mathematical convolution operation -> ***GridConvolver*** ( a pure **Grid** operation on the **base space**)
  - led to some operations purely on Grid objects

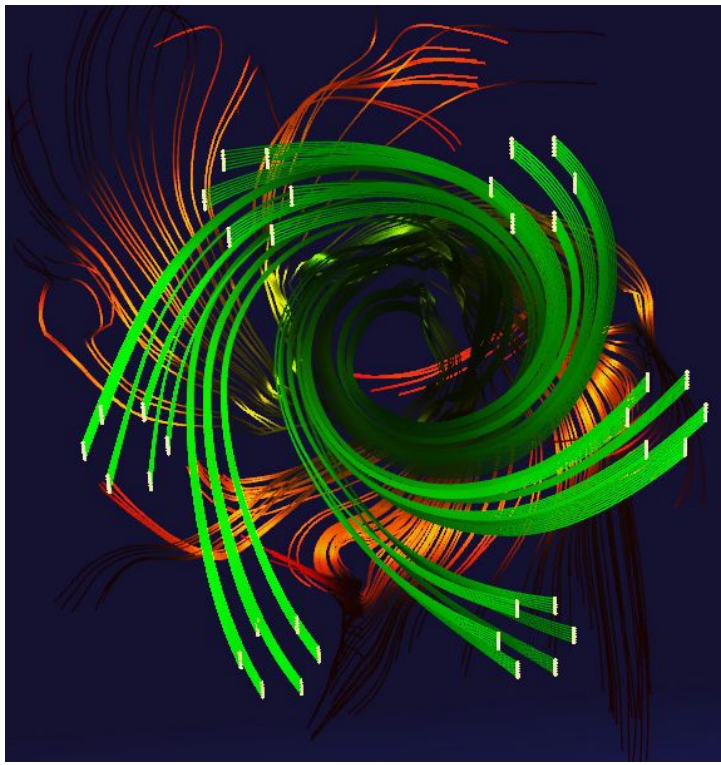




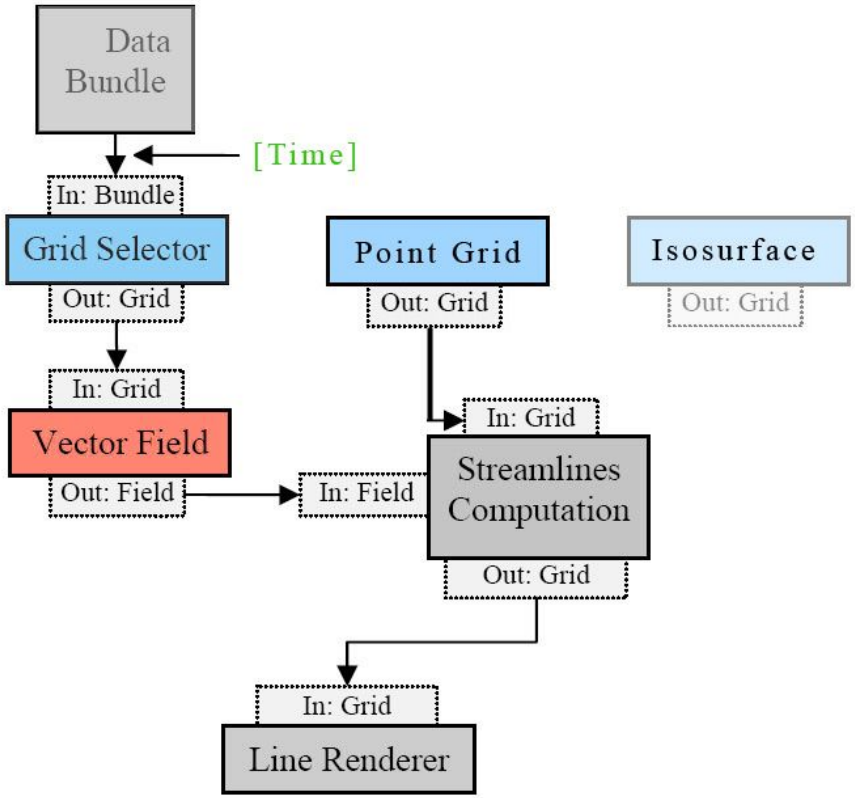
- Gridconvolver:

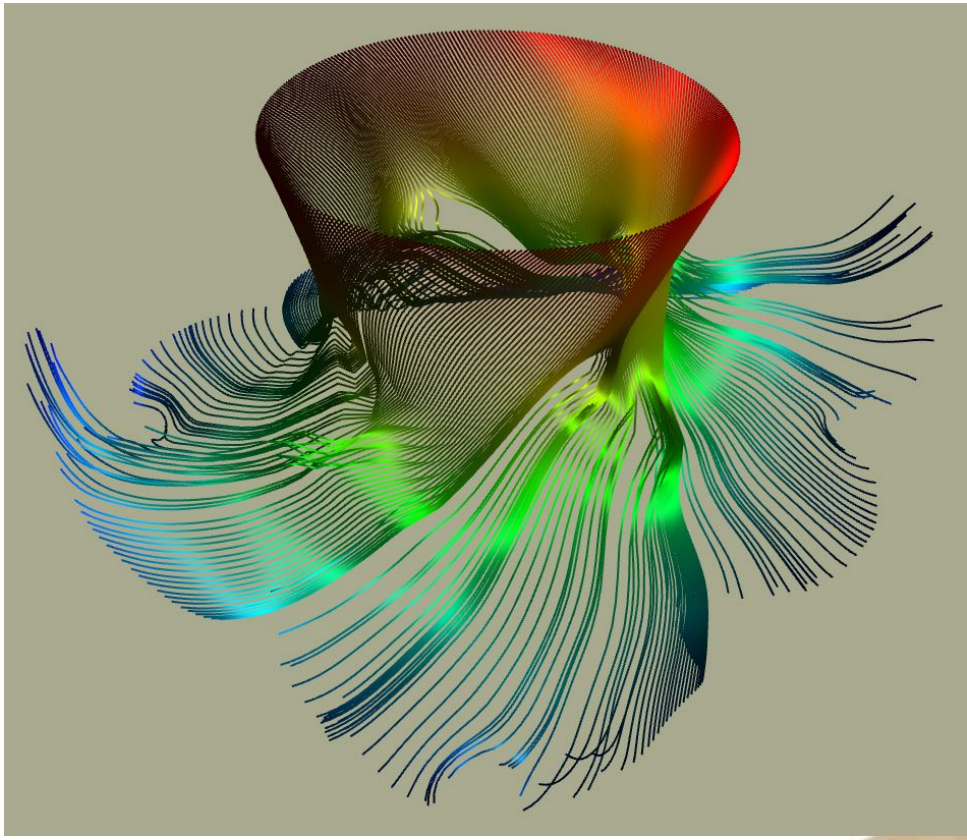


- Using the Input Grid
  - opened the possibility to use any other Grids for seeding, such as an isosurface of pressure
  - without any new code development



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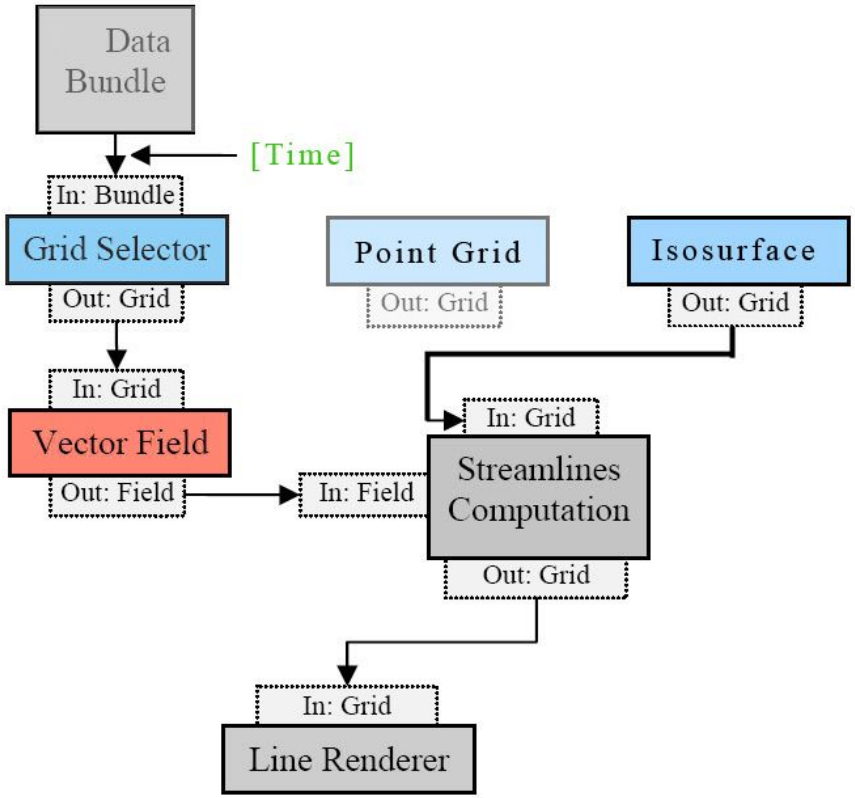
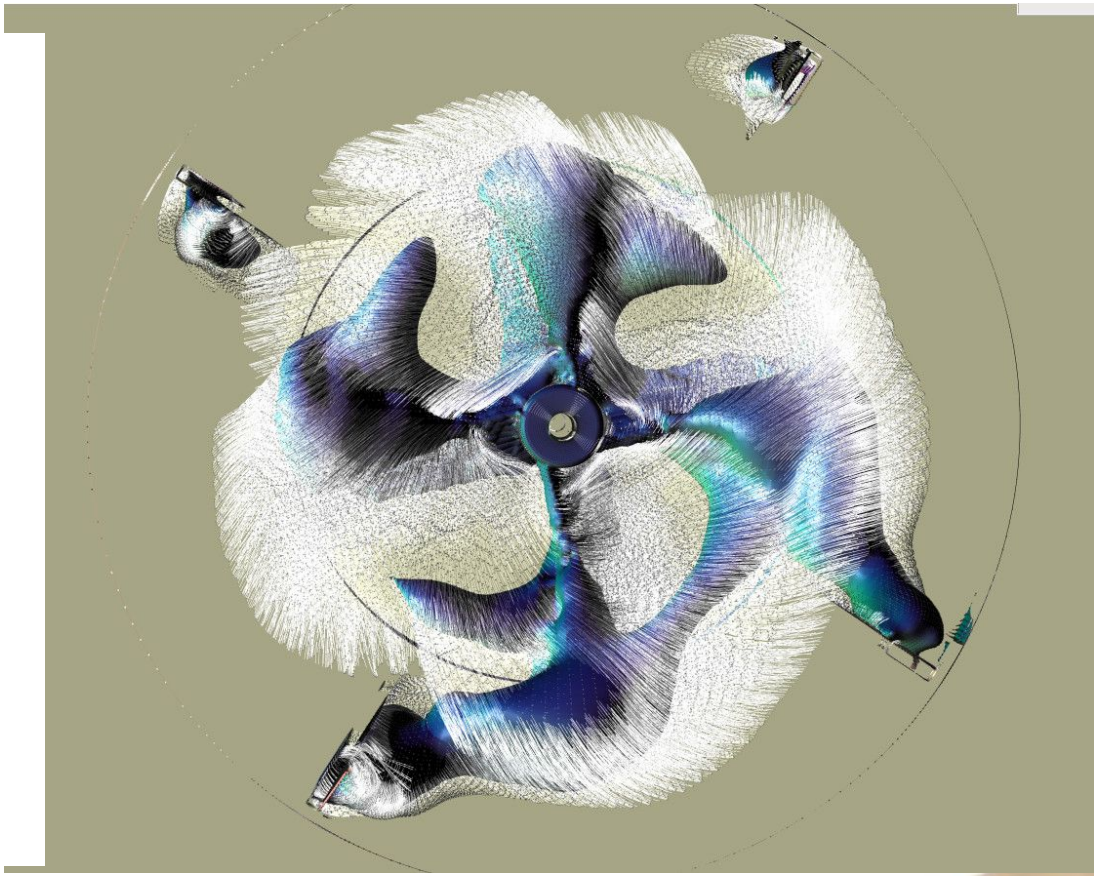
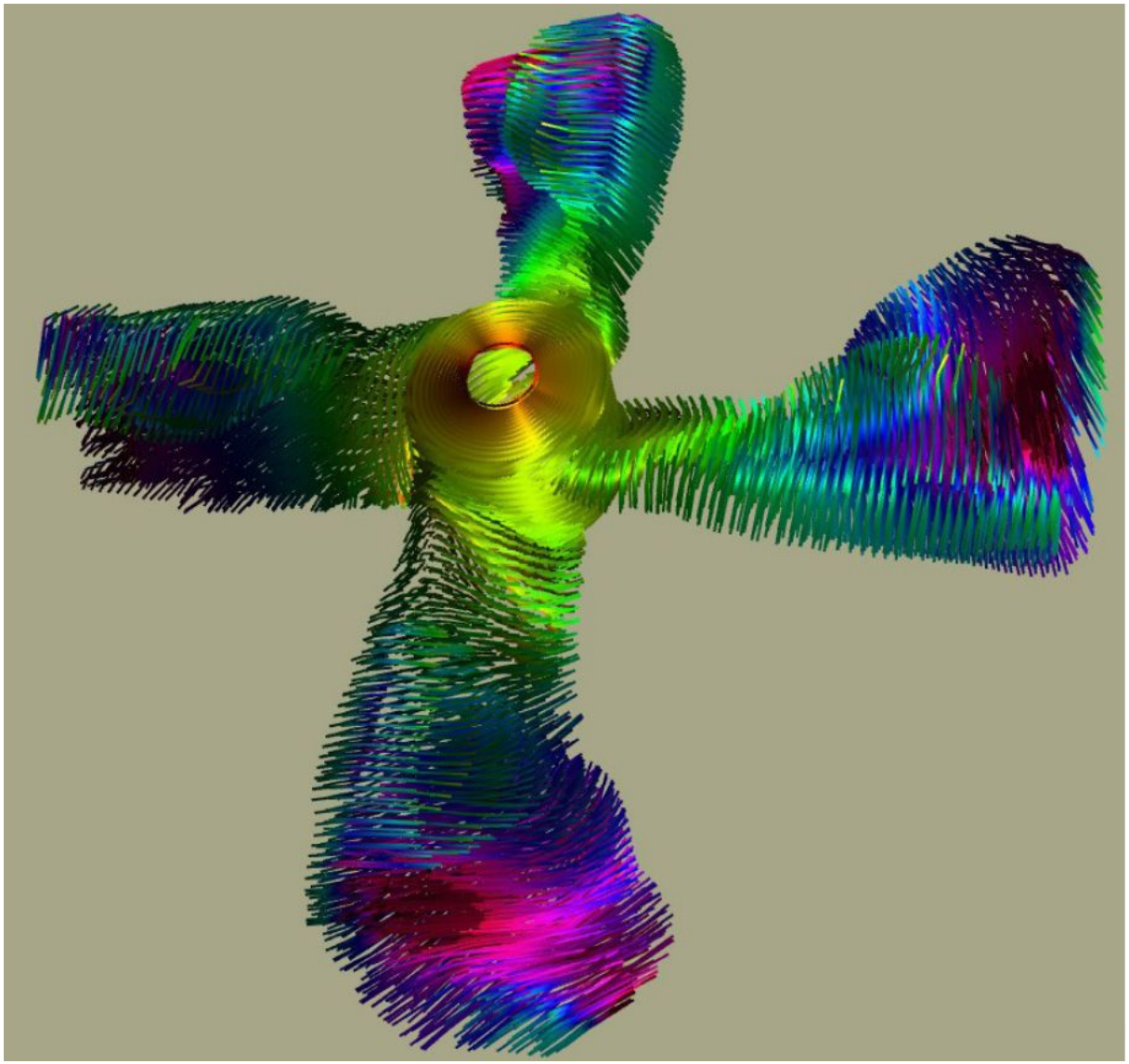


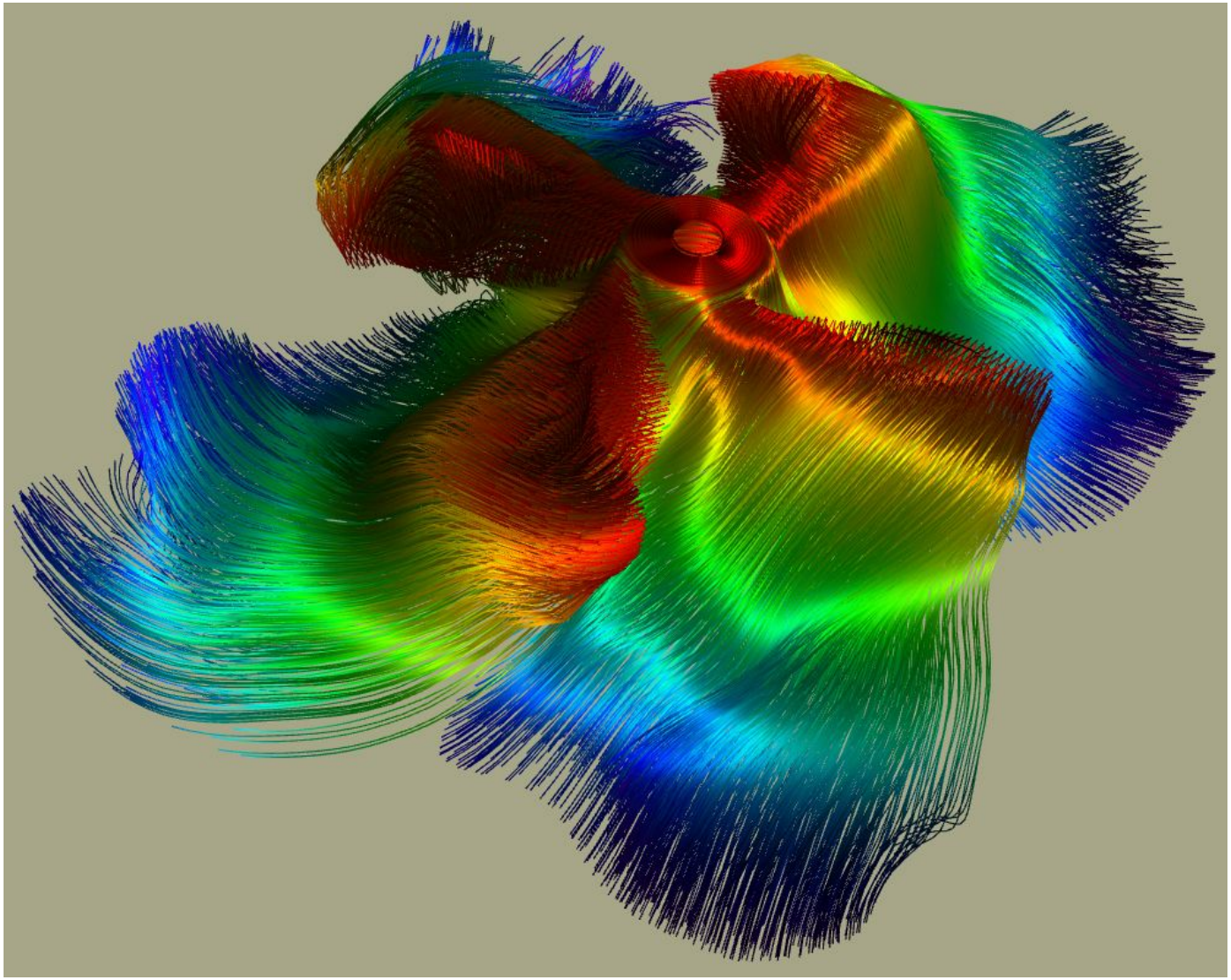



# 3. Streamline Visualization 5/6



- Streamlines seeded by isosurface of pressure helps to find reagons of vorticity in the velocity field
- Streamlines colored by magnitude

# 3. Streamline Visualization 6/6

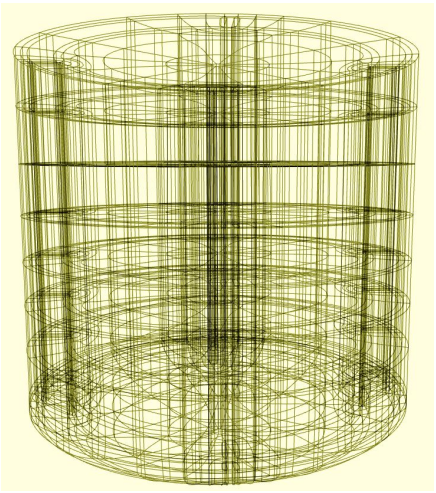


- Streamlines seeded by isosurface of pressure helps to find reagons of vorticity in the velocity field
- Streamlines colored by length

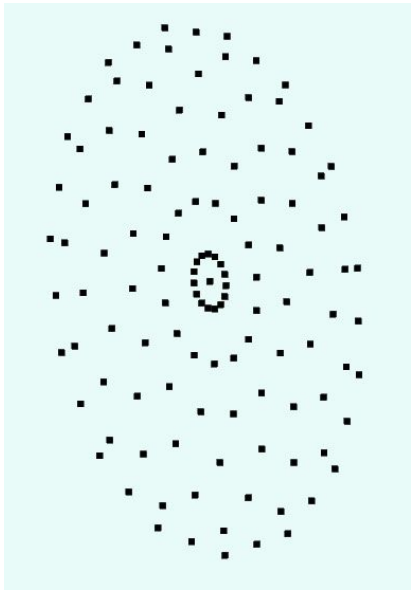
- Using the software framework Vish
  - simplified software development by using its infrastructure and features
  - ensures that scientists really can use the developed modules in the 3D visualization application
  - see: http://sciviz.cct.lsu.edu/projects/vish/

- Applying the Fiber Bundle Data Model for streamline visualization
  - revealed unexpected possibilities
  - made the approach very flexibly and reusable
  - up to now all data we encountered could be mapped into the Fiber Bundle Data Model

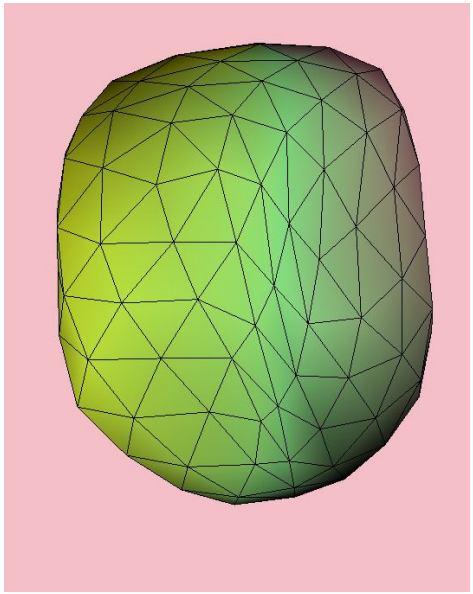
- Grids used in the *vish*ualization:



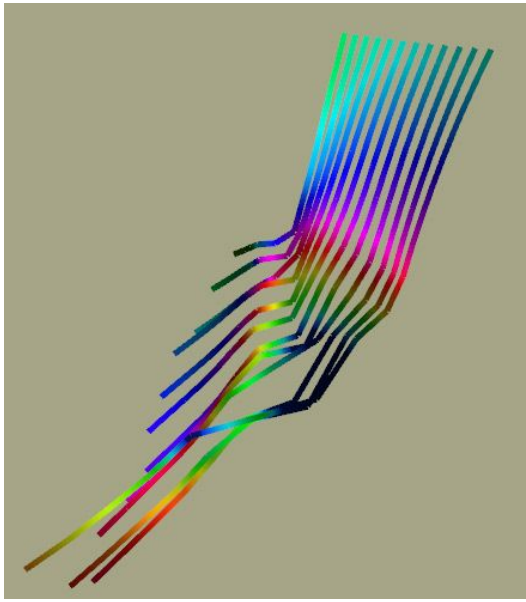
***Stirtank Grid:***
curvilinear multiblocks
hexahedral cells



***Seeding Grid:***
point grid
without connectivity



***Seeding Grid:***
iso surface
triangular surface



***Streamline Grid:***
line grids

# End

Thank you