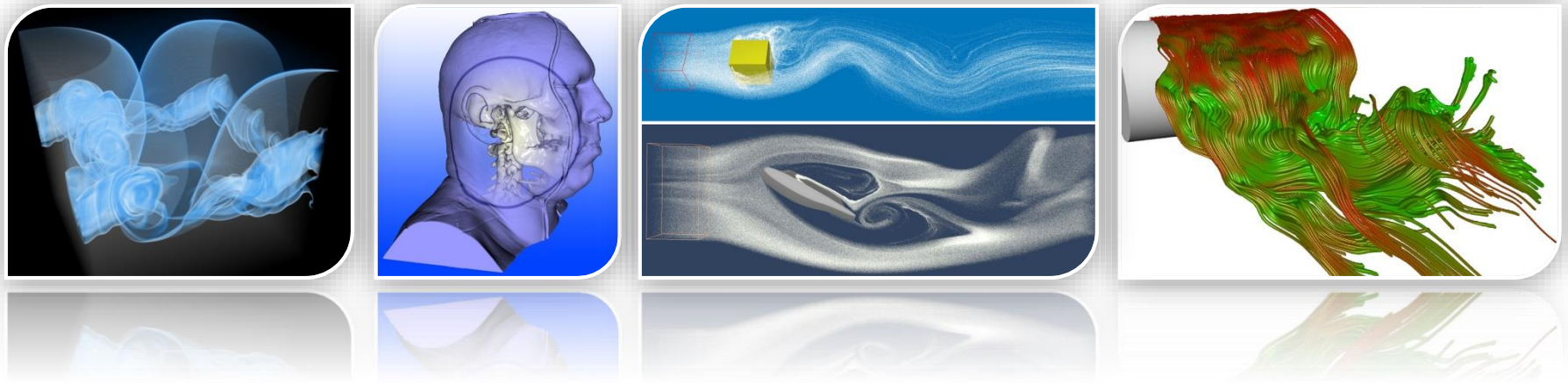
Master Practical Course

Interactive Visual Data Analysis



tum.3D

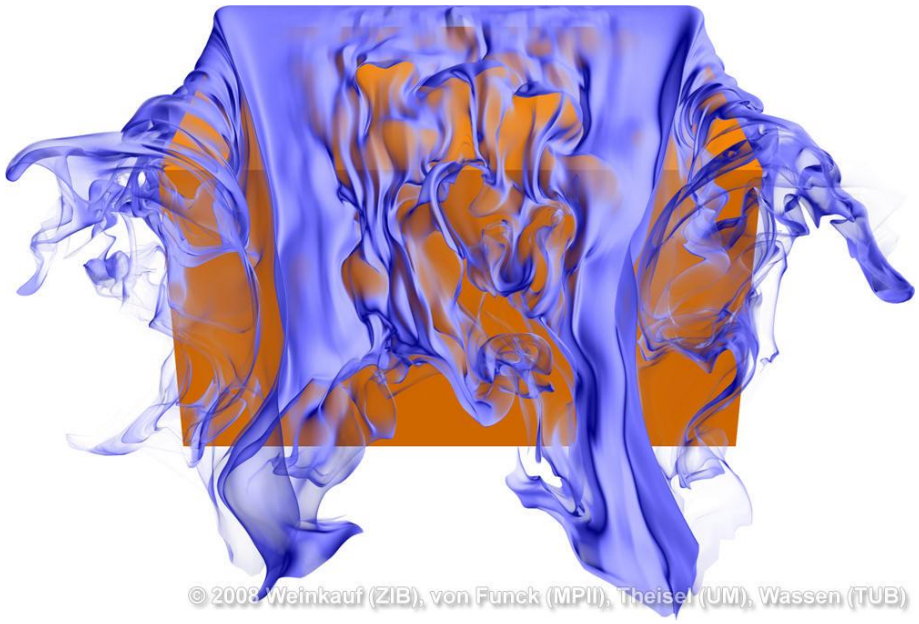
computer graphics & visualization

Today

- Assignment 11: Implement a paper!

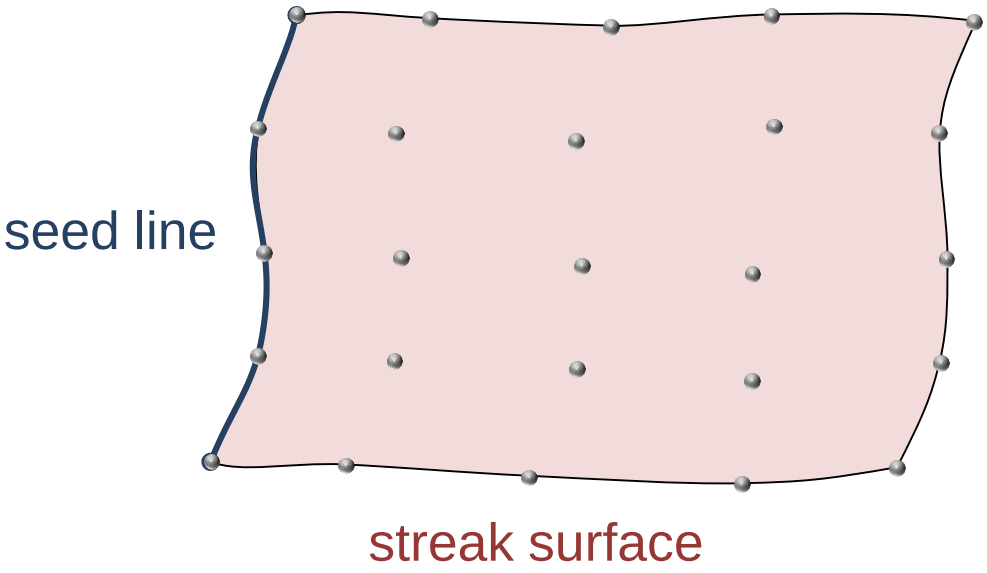
  Smoke Surfaces: An Interactive Flow Visualization Technique Inspired by Real-World Flow Experiments,
  W. von Funck, T. Weinkauf, H. Theisel, and H.-P. Seidel,
  IEEE Transactions on Visualization and Computer Graphics, 14(6):1396–1403, 2008. *(Homepage)*

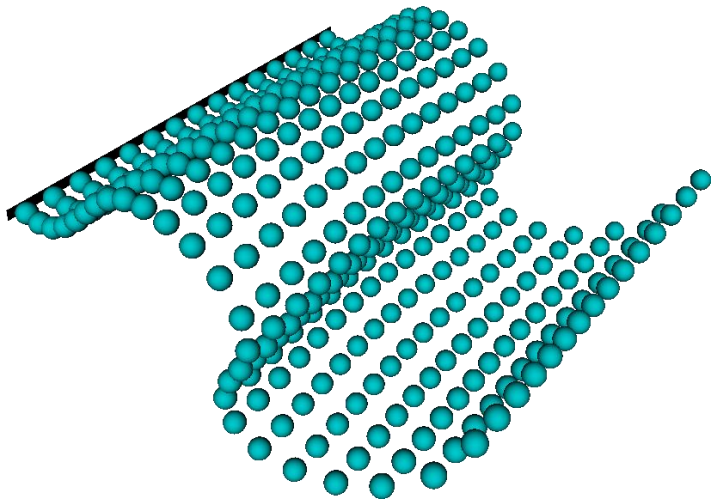
  – You can build upon exisisting features like particle tracing and streak lines
  – Some simplifications
  – Let‘s have a look at **streak surfaces** first…



Streak Surfaces

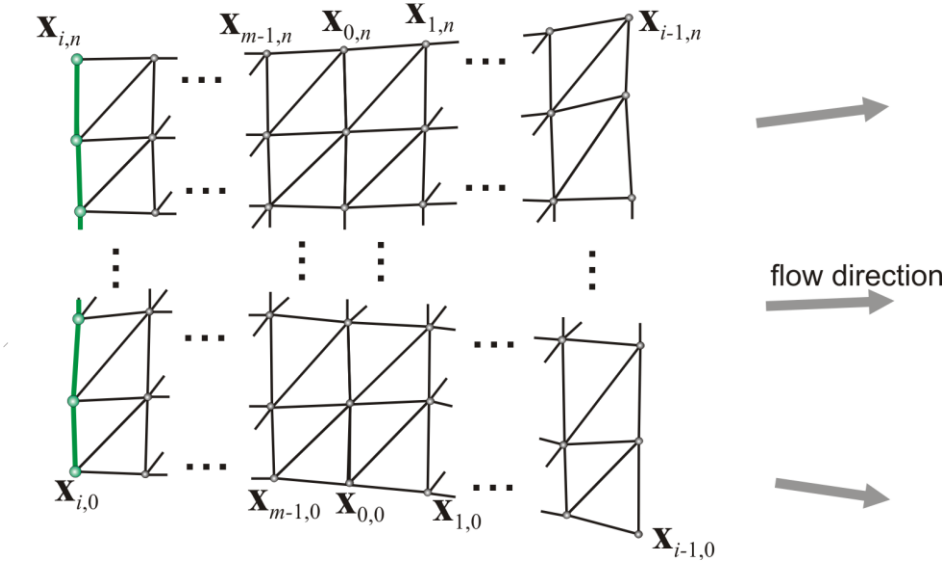
- Reminder – Streak Line: Repeatedly seed particles from a point, render as line strip
- Streak Surface: Repeatedly seed particles from a line/1D curve, triangulate and render surface





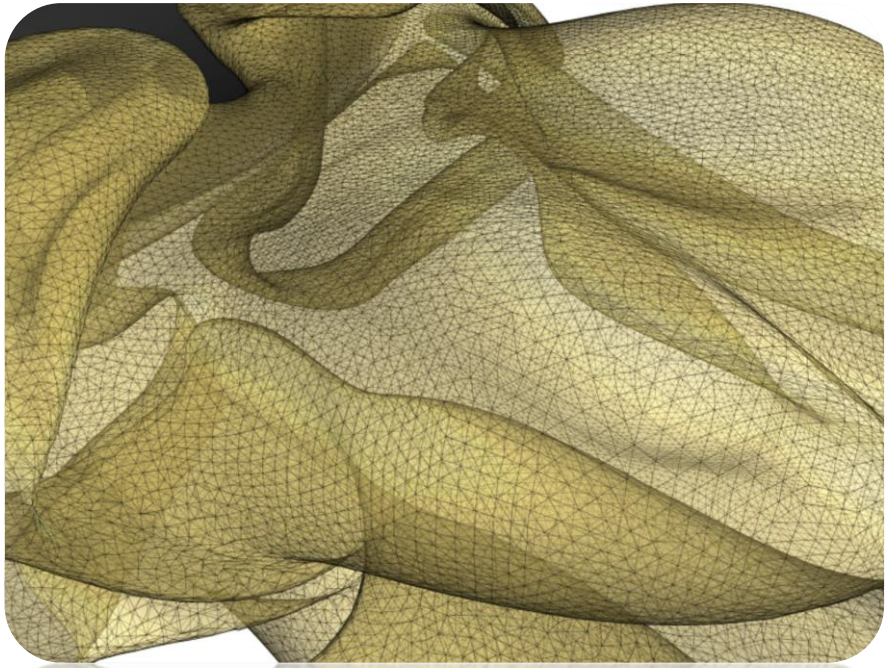
Streak Surfaces

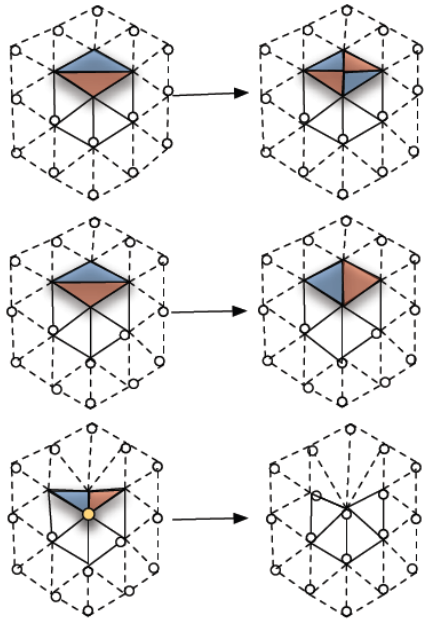
- Seed a regular array of particles (n streak lines of length m with seeding points on a line)
- Surface triangulation: $2 \cdot (n-1) \cdot (m-1)$ triangles



Streak Surfaces

- Problem: Particles can diverge arbitrarily → need to adapt surface mesh after each advection step



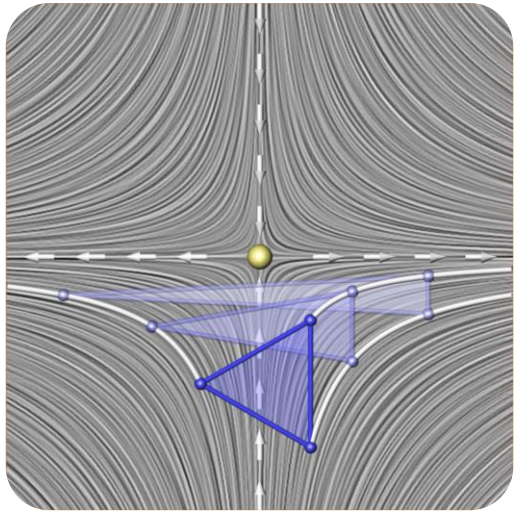


Edge split / flip / collapse operations to adapt surface*

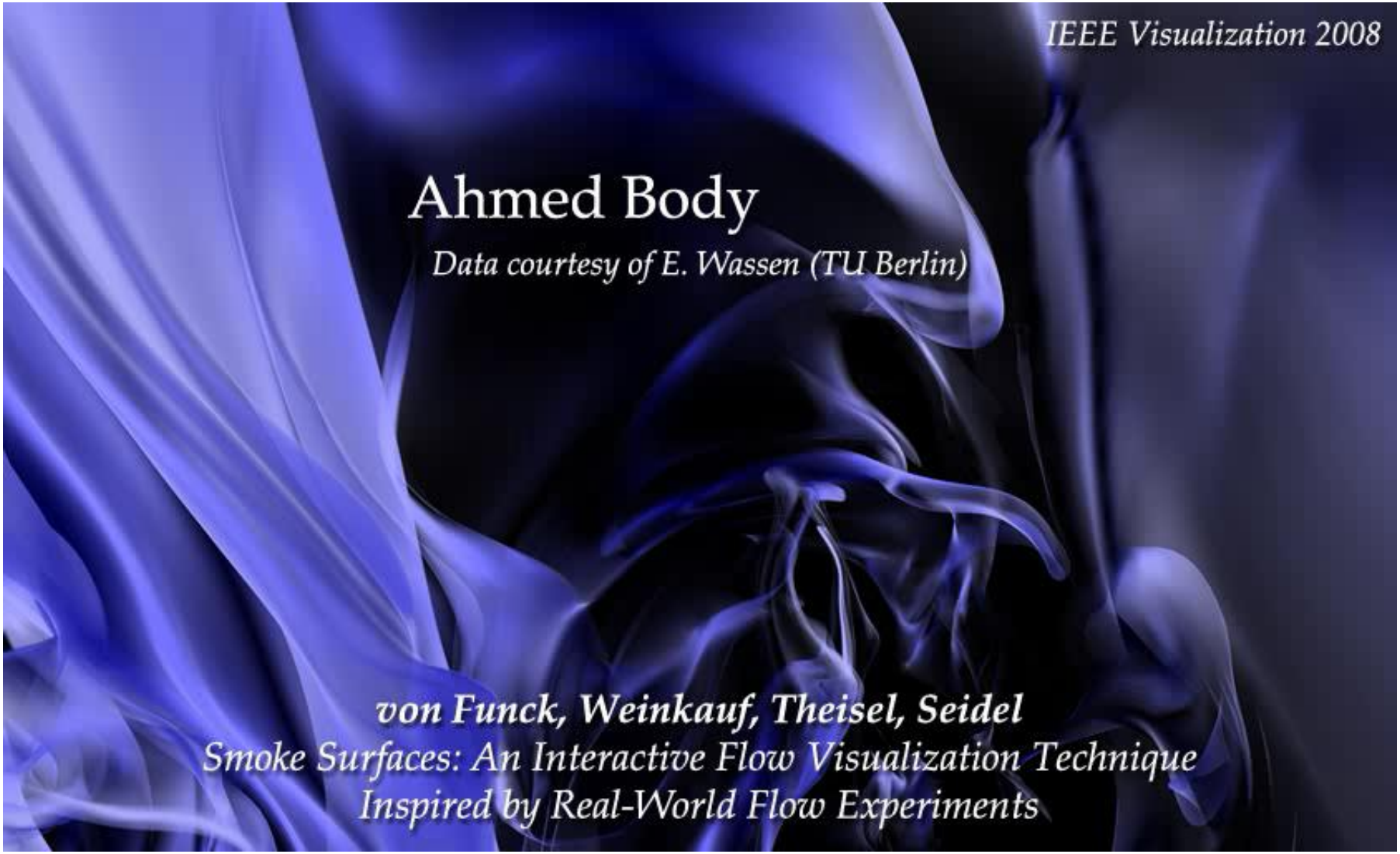
***Time and Streak Surfaces for Flow Visualization in Large Time-Varying Data Sets**
Krishnan, H., Garth, C.; Joy, K.I.
IEEE Transactions on Visualization and Computer Graphics, 2009

Smoke Surfaces

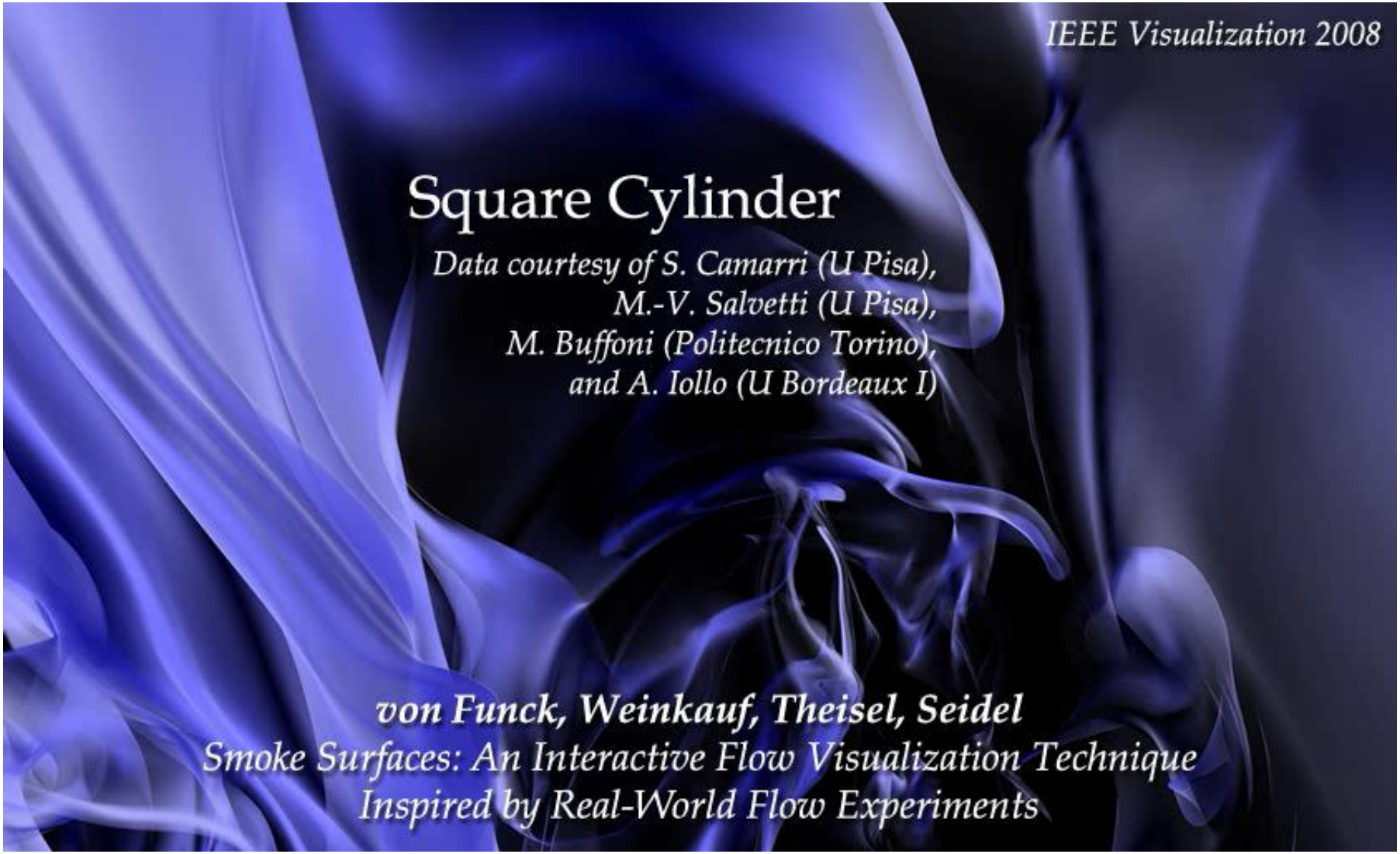
- Problem: Particles can diverge arbitrarily → need to adapt surface mesh after each advection step
- Smoke Surfaces: Avoid remeshing, couple shape of triangles to opacity (mimics thin layers of smoke)



Smoke Surfaces

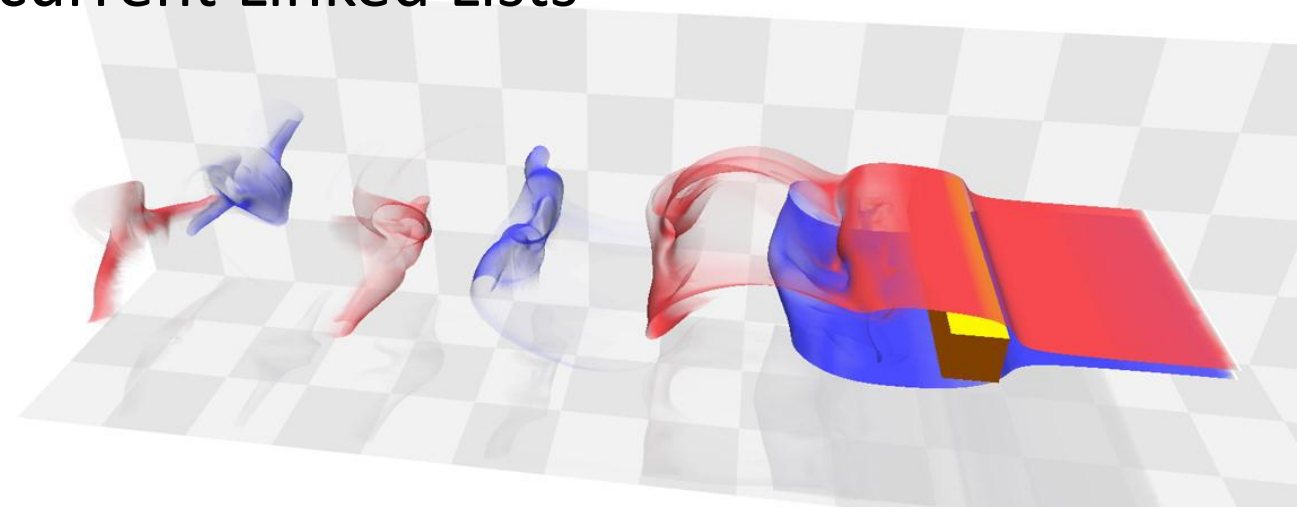


Smoke Surfaces



Transparency & Depth

- Criteria for calculating triangle transparency are described in the paper
- Problem: Possibly multiple layers of smoke
  → Depth sorting required
  - Sort all smoke triangles according to z-value (can fail)
  - Order independent transparency: Depth Peeling, Stencil Routed A-Buffer, Concurrent Linked Lists
- Next week: Concurrent Linked Lists



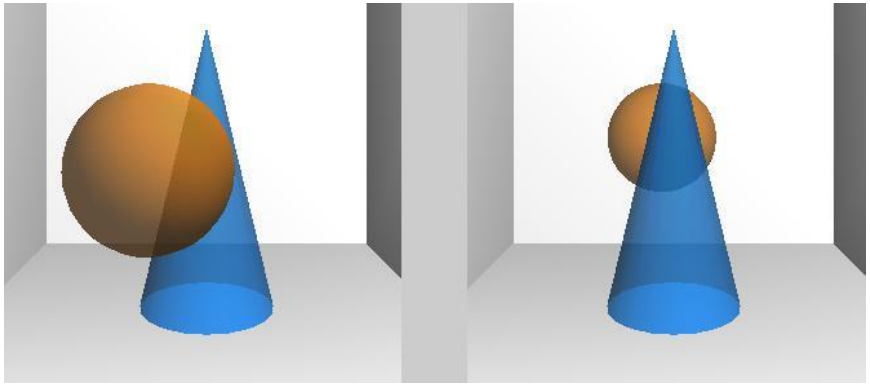
Blending Order

- Blending of two fragments:
  $(C_{new}, \alpha_{new}) = (C_F, \alpha_F) \circ (C_B, \alpha_B)$ such that:

$$C_{new}\alpha_{new} = C_F\alpha_F + (1-\alpha_F)C_B\alpha_B = C_F\alpha_F + C_B\alpha_B - C_B\alpha_F\alpha_B$$
$$\alpha_{new} = \alpha_F + (1-\alpha_F)\alpha_B \qquad = \alpha_F + \alpha_B - \alpha_F\alpha_B$$

- In general $\circ$ is not commutative:

$$(C_F, \alpha_F) \circ (C_B, \alpha_B) \neq (C_B, \alpha_B) \circ (C_F, \alpha_F)$$



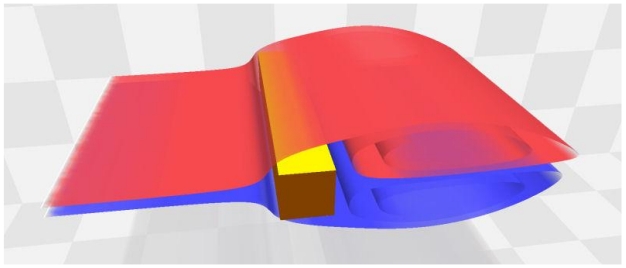
- **Special case: If $C_F = C_B$, then $\circ$ is commutative!**

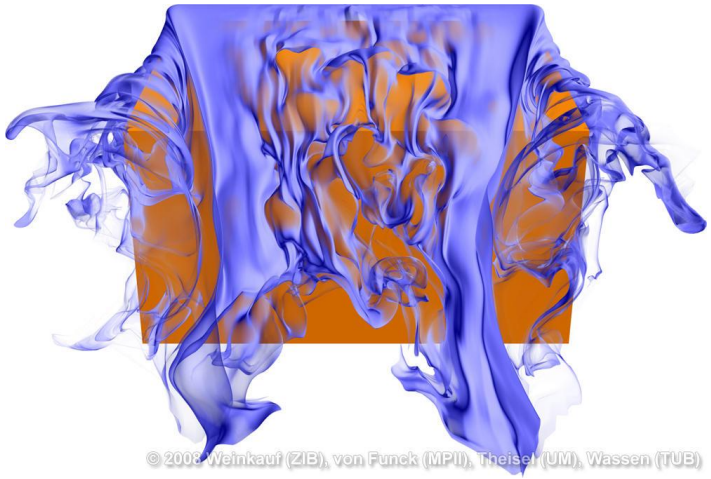
Order Independent Blending

- Simplification: Constant color
  - All layers of smoke have the same color (but alpha can vary)
  - No Phong lighting (no brighter and darker fragments)
  - No surface texture

→ Rendering order doesn‘t matter

→ Smoke surfaces will look rather unimpressive for now





Questions ?