Comparing Simulations to Experiments: Early Experiences
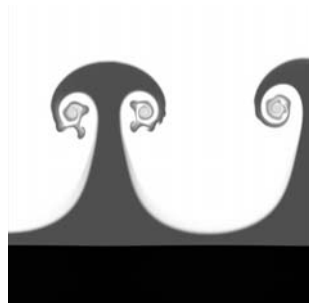
Chandrika Kamath and Thinh Nguyen
Center for Applied Scientific Computing
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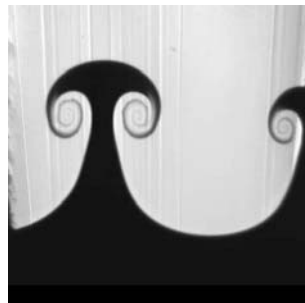
www.llnl.gov/casc/sapphire

Goal: compare 2-dimensional simulations to experiments

- **Interested in quantitative comparisons**
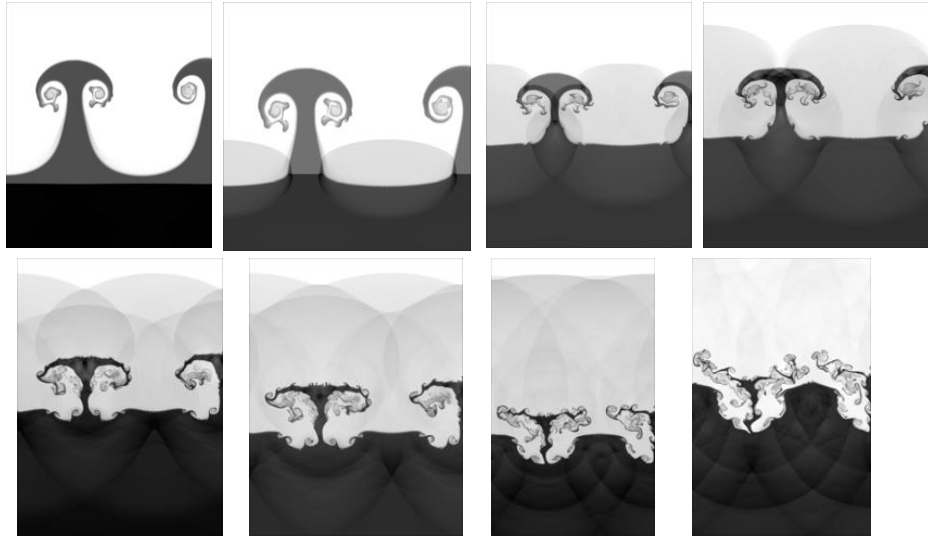- **Example: Richtmyer-Meshkov instability in a fluid mix problem**

Simulation data: Raptor code, Jeff Greenough (AX)   Experimental data: Prof. Jacobs, U Arizona

Joint work with Paul Miller and Jeff Greenough (AX)
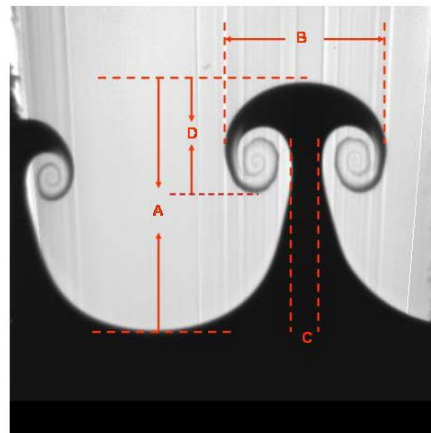
The simulations evolve over time showing the mix of the fluids

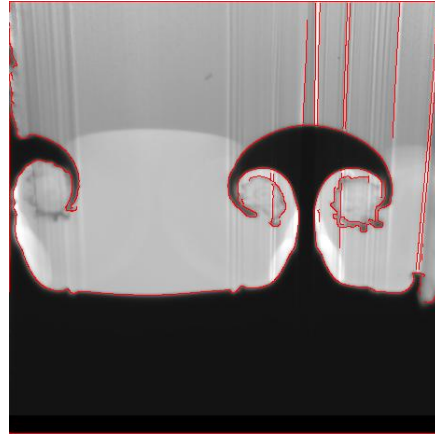# We need higher level features to compare the images at the early time steps

- Coarse-scale features: height and width of mushroom, width of stem, …

- Fine-scale features: number of twirls in spiral, number and location of bumps on spiral, …

The noise in the experimental images can interfere with feature extraction

Simple global techniques for denoising blur the image
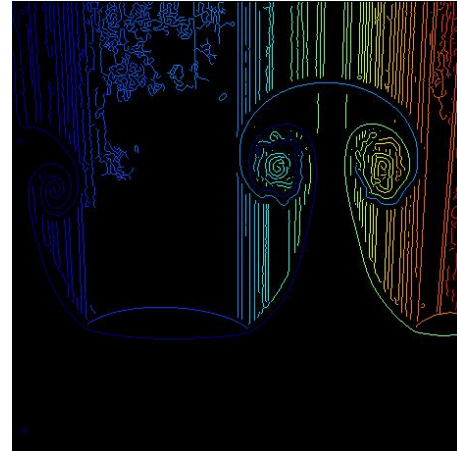

Median 1x5 filter   **Median 1x10 filter**

We exploit the structure in the noise to remove it from the images

Canny Edge Detector

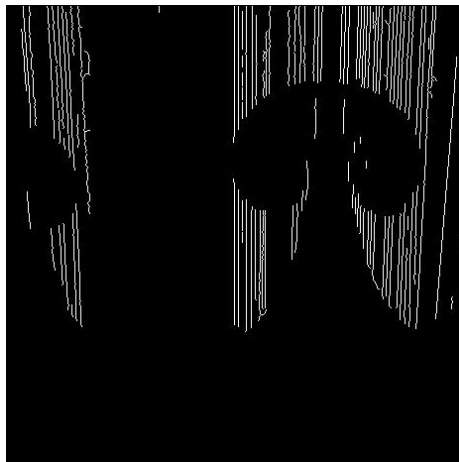**After connecting components**

The noise is in the form of long vertical lines in the image

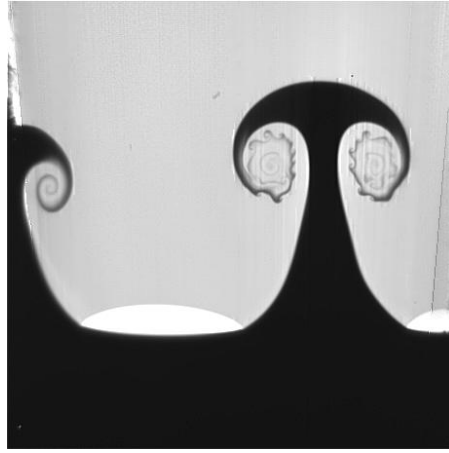**Components with a high aspect ratio**

Creation of a mask

We smooth the image in the region of the mask and sharpen elsewhere

Original

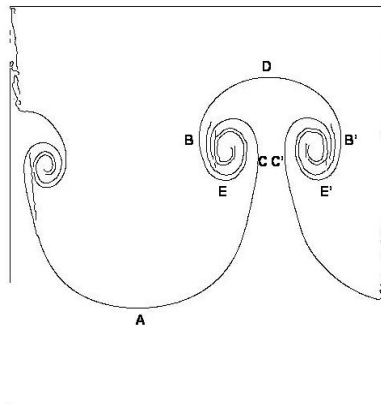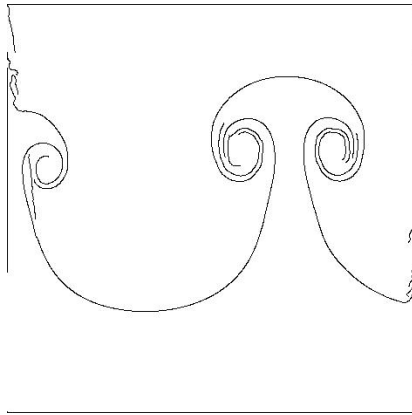**After noise removal**

Next, we can use the edge of the denoised image to extract the features

Features from the experiment, time=T1

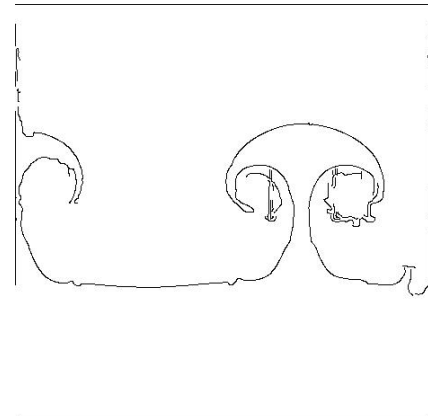**Height = 270**
Width = 176
Width of stem = 34

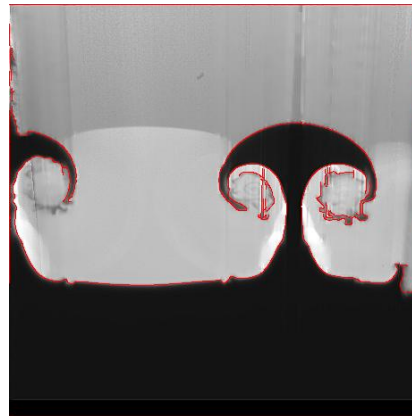**Height of cap (L) = 121**
Height of cap (R) = 120

Features from the experiment, time=T3

Height = 184
Width = 177
Width of stem = 17

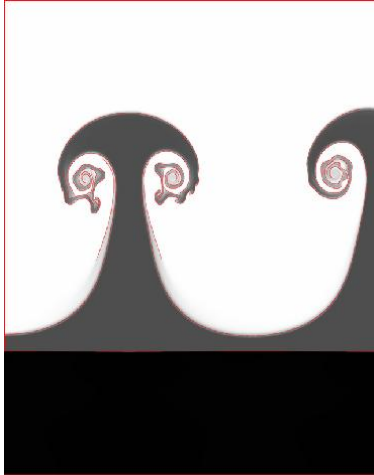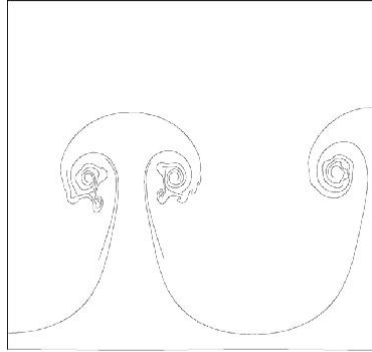**Height of cap (L) = 110**
Height of cap (R) = 116

We use a similar approach to extract features from the simulations
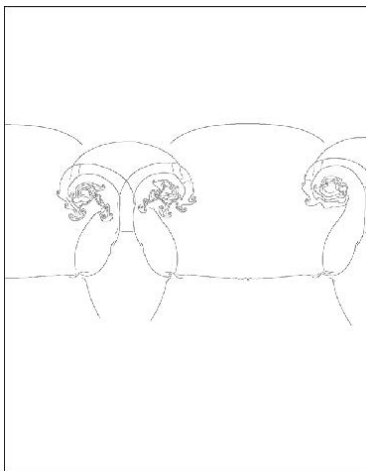

Height = 724
Width = 483
Width of stem = 90
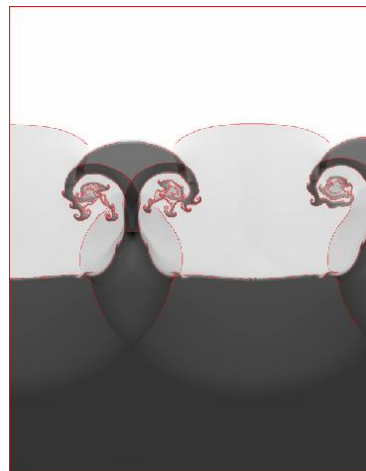
Height of cap (L) = 327
Height of cap (R) = 299

However the additional edges in the simulations can cause problems

Height = 455
Width = 485
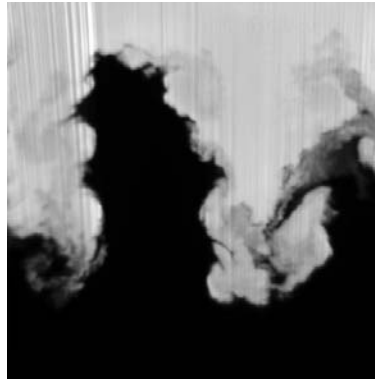**Width of stem = 47**

Height of cap (L) = 262
Height of cap (R) = 250

Future work

- **More robust segmentation and feature extraction**
- **Identification and extraction of features at later time steps**