Intra Vascular Ultrasound Image Analysis

In Association with Mediguide

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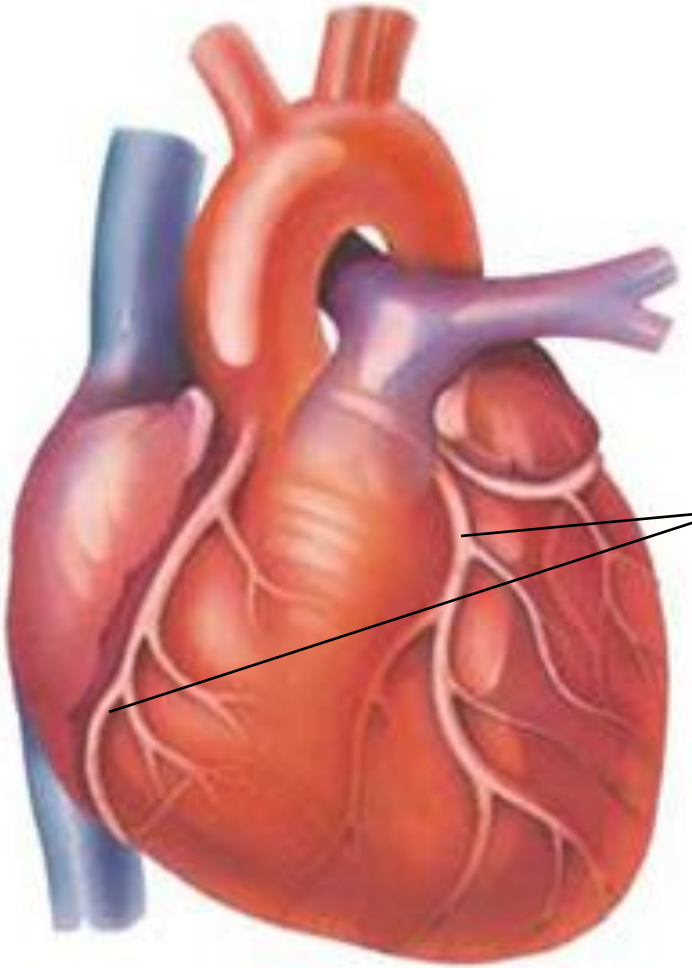
The Heart

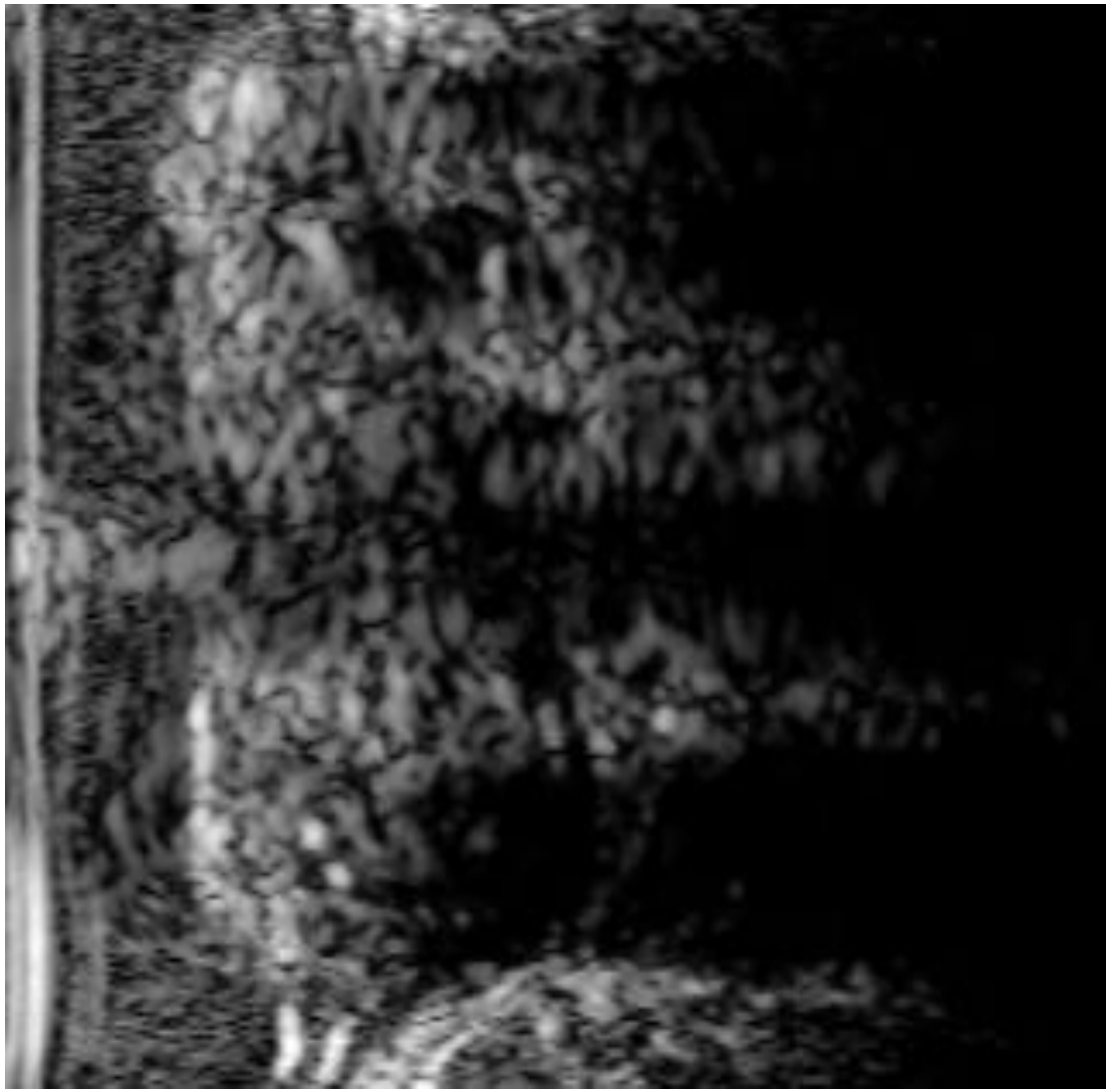


Coronary Artery

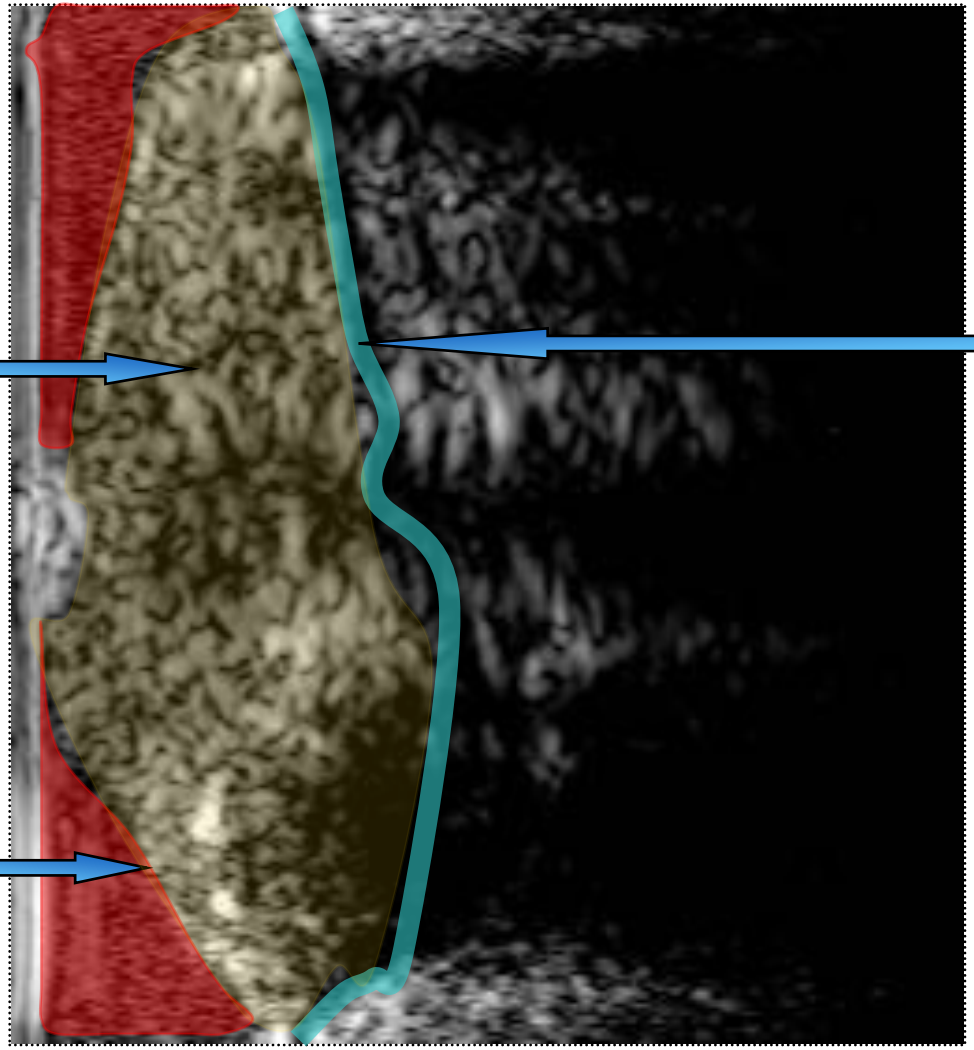
Coronary Artery Disease

Treatment of Artery disease

Dynamical Data Perception



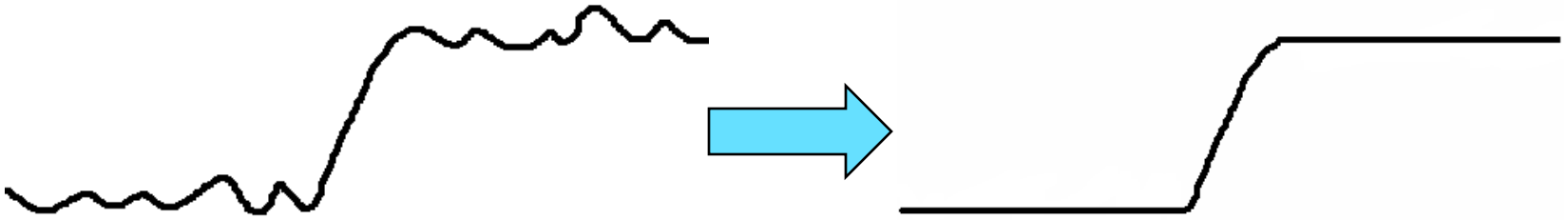
Plaque, blood and External Membrane



Project Goals

- **Ultrasound Coronary Artery Image enhancement**
  - **Help physicians to detect plaques**
  - **Possibly allow automatic detection of plaques and artery diseases.**

NonLinear Diffusion: Edge Preserving Smoothing

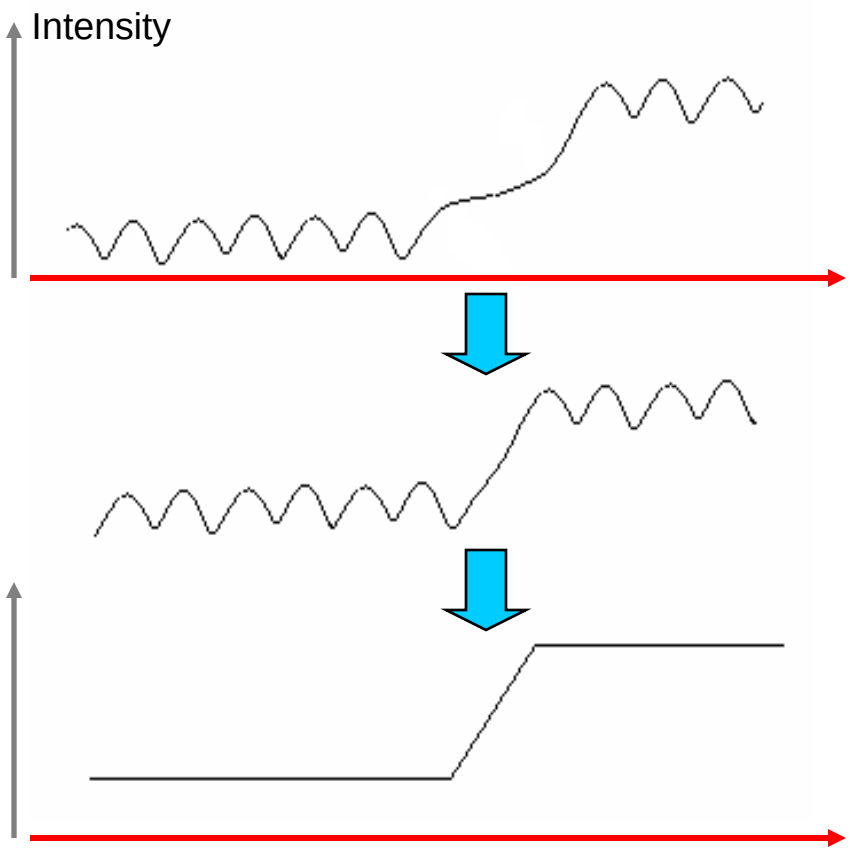


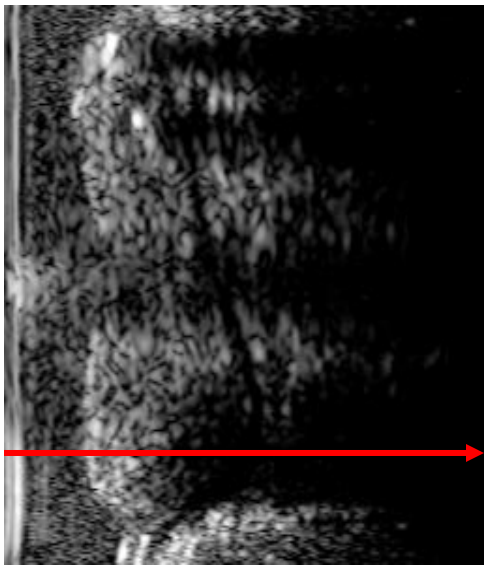
Here, points will move toward a line since the curvature is high.

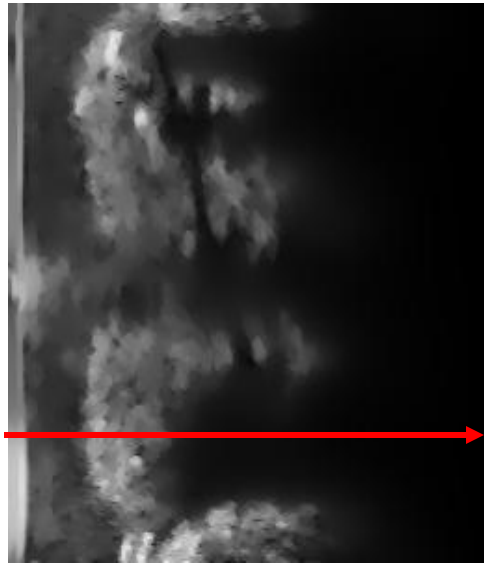
From a local point of view, here this is a steady state since there is a zero curvature, so this point will not move.

Edge Preserving Diffusion

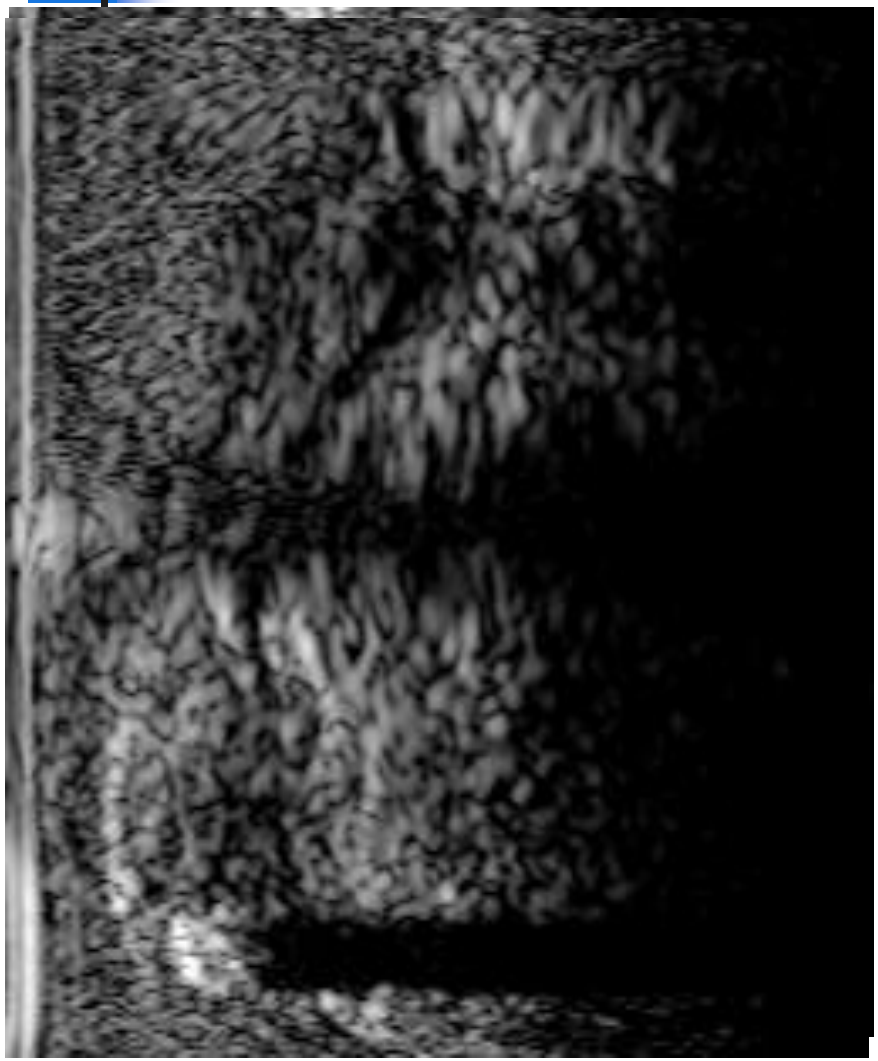
Geometric model assumption

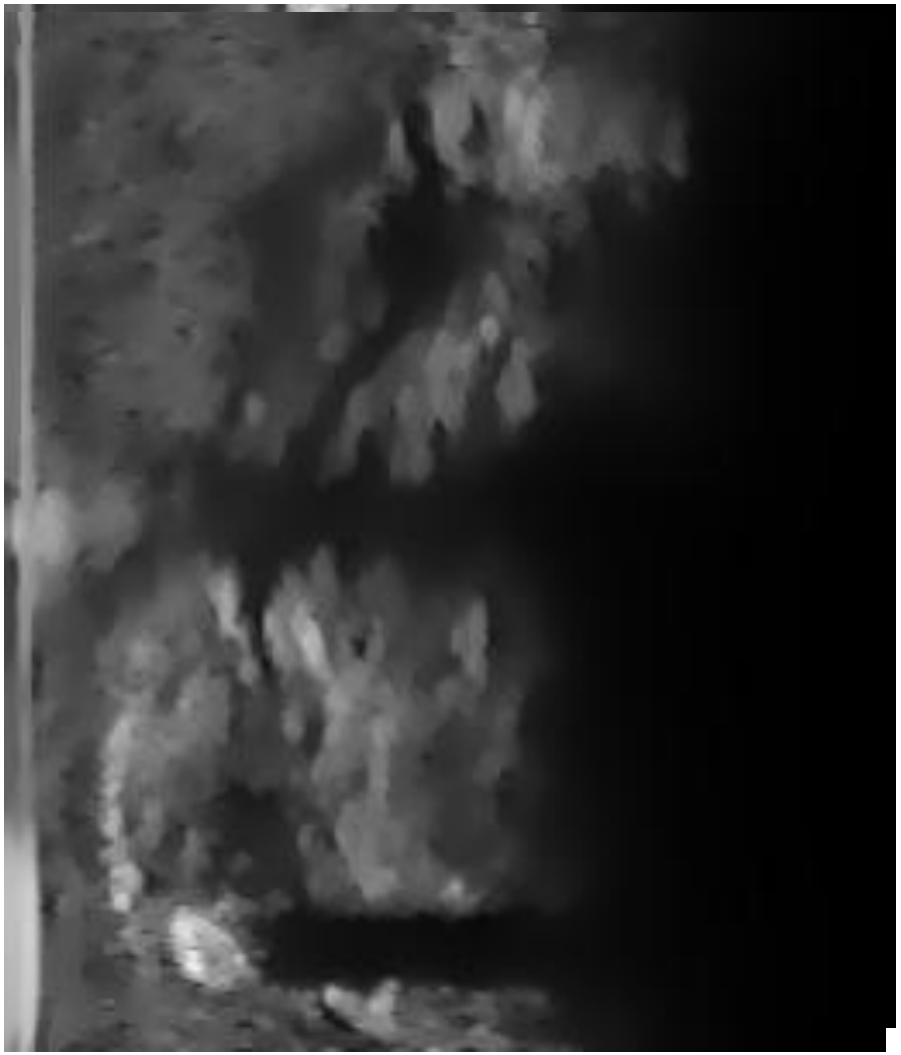






NonLinear Diffusion Results

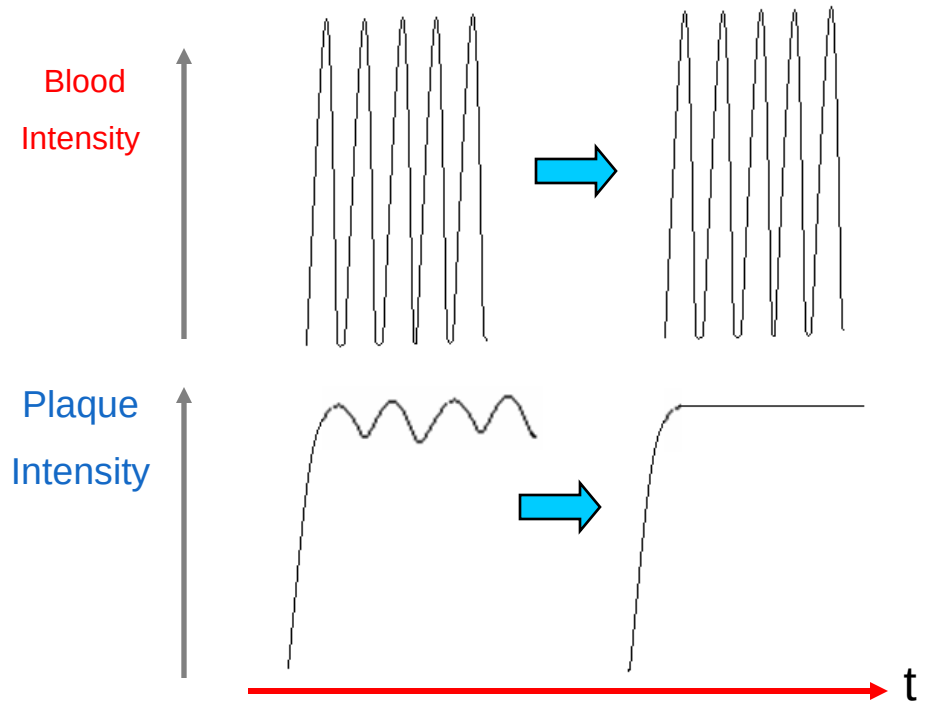


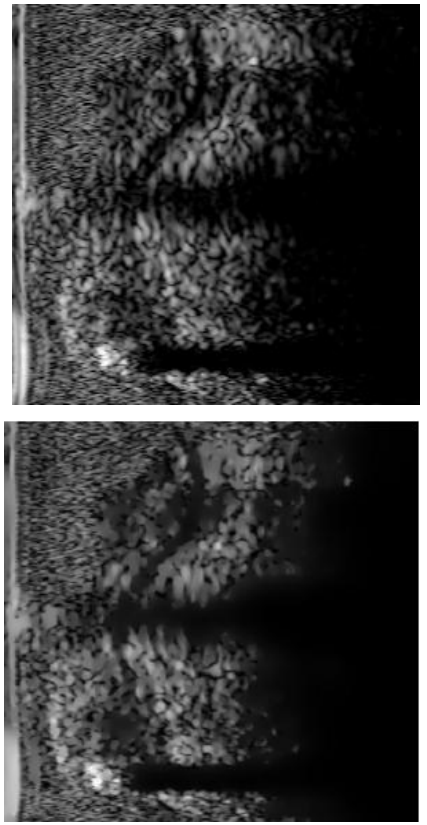


New Geometric Model Assumptions

- Blood is temporally sporadic $\rightarrow$ Huge gradient in 3D
- Plaque evolves temporally slowly $\rightarrow$ Low gradient in 3D

Therefore, applying 3D nonlinear diffusion should smooth the plaque without damaging the blood.

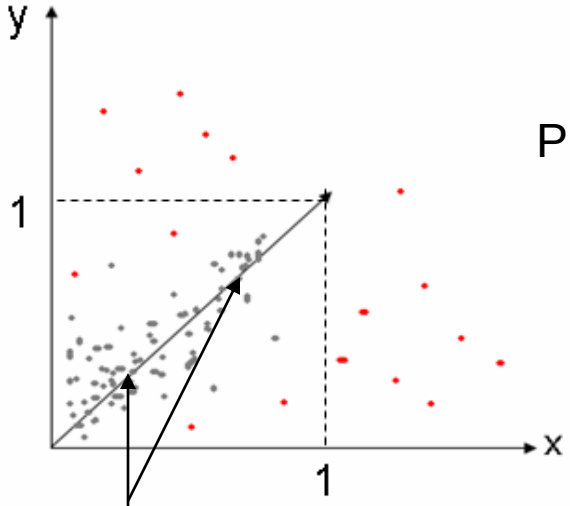




Robust Covariance Estimation: Principe

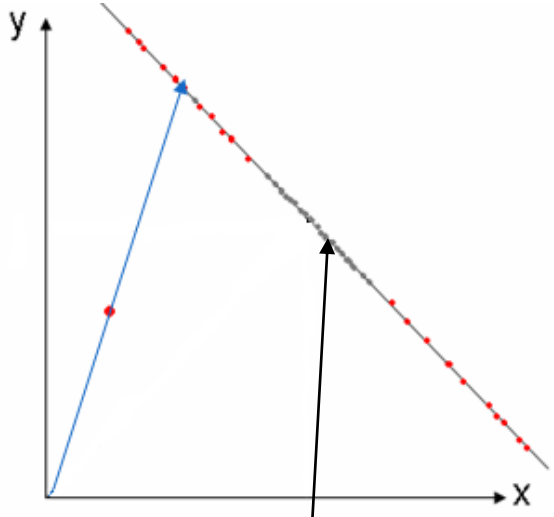
Red points → Blood

Gray points → Plaque



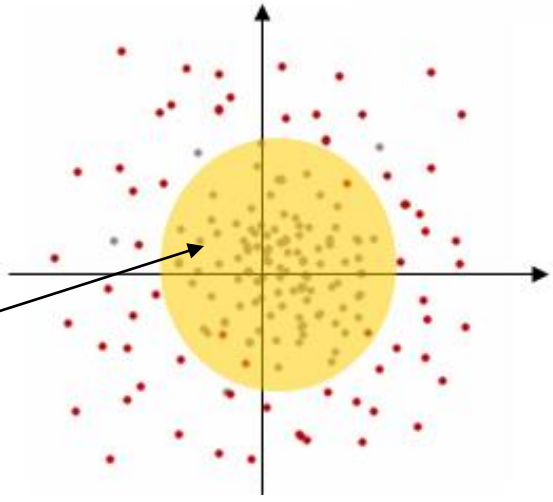
Multimodal distribution

Projection



Unimodal distribution

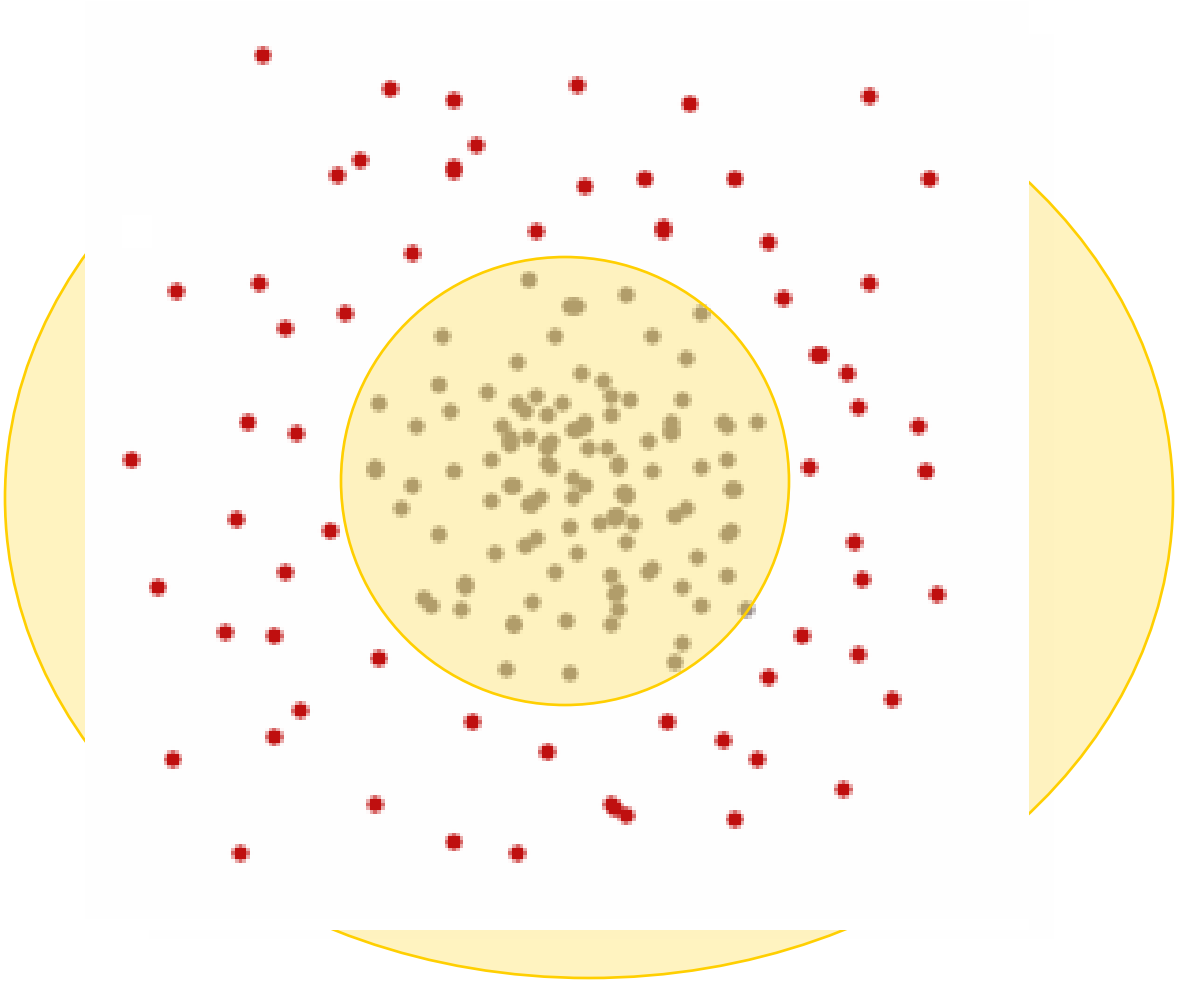
View on the plane



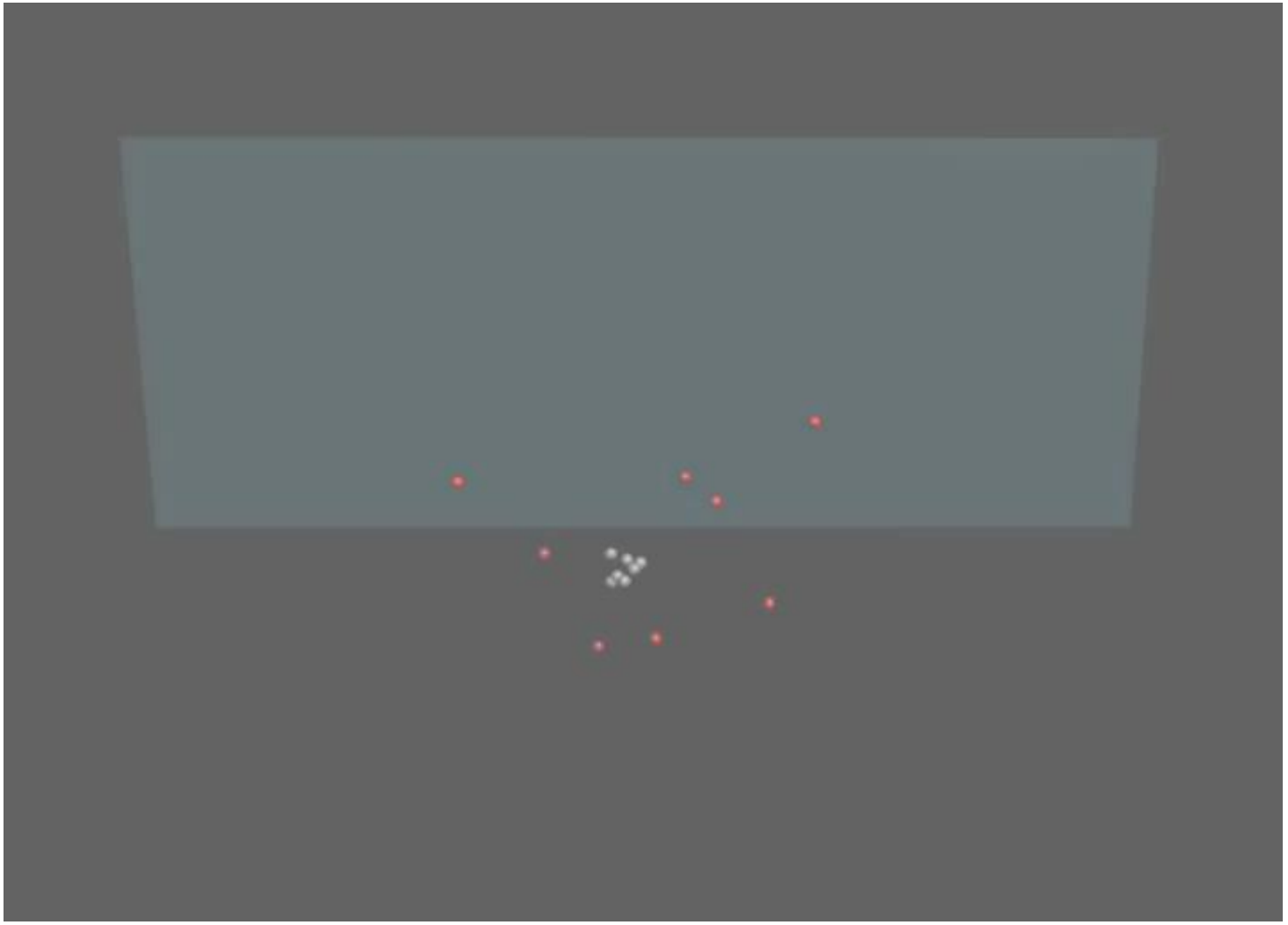
RCE

Estimated Gaussian

Robust Covariance Estimation: Algorithm



Robust Covariance Estimation: Summary



RCE Assumption Improvements

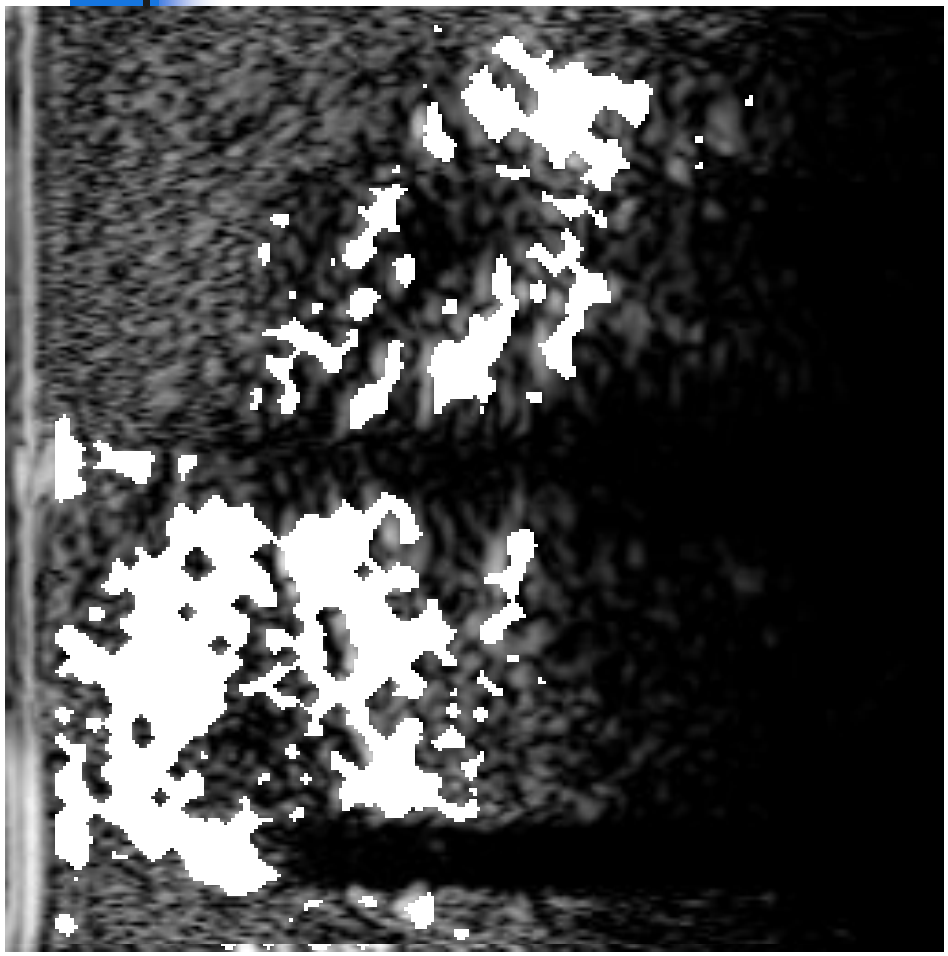
RCE Assumptions:

- Blood is temporally sporadic
- Plaque evolves temporally slowly

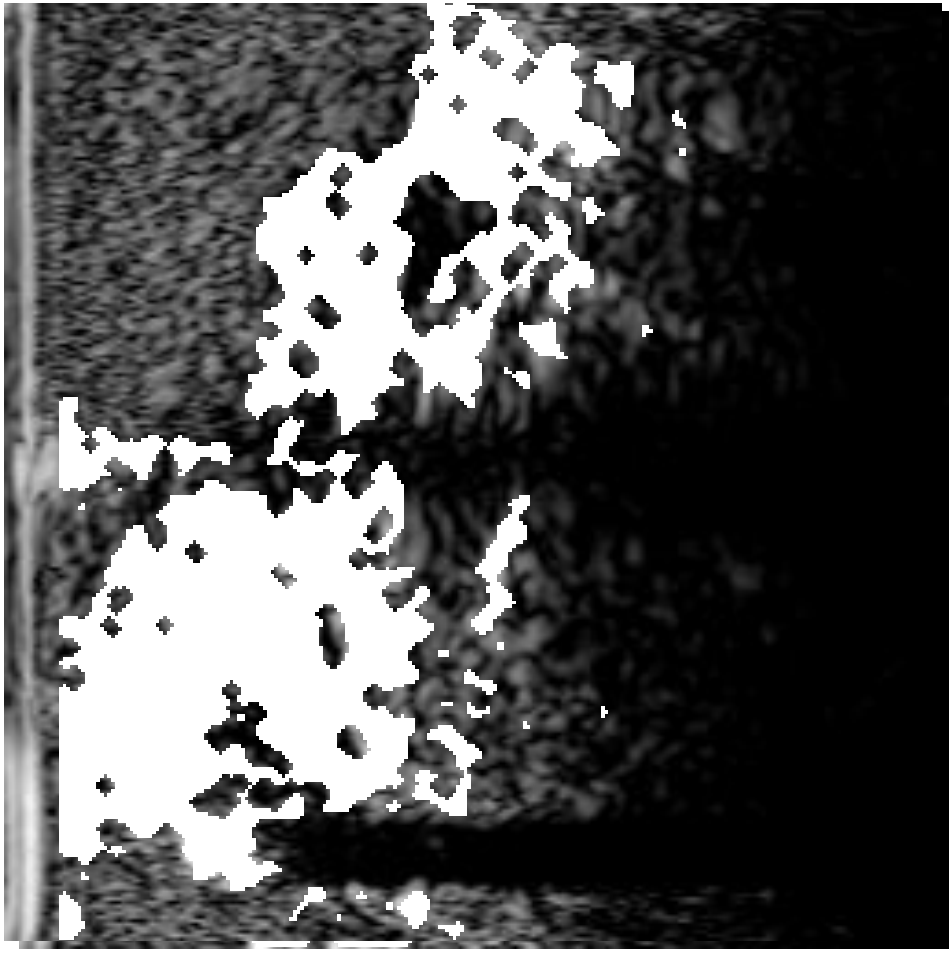
Improvement of the Assumptions:

- Registration of images
- Pre-Processing by 3D diffusion

RCE with Diffusion



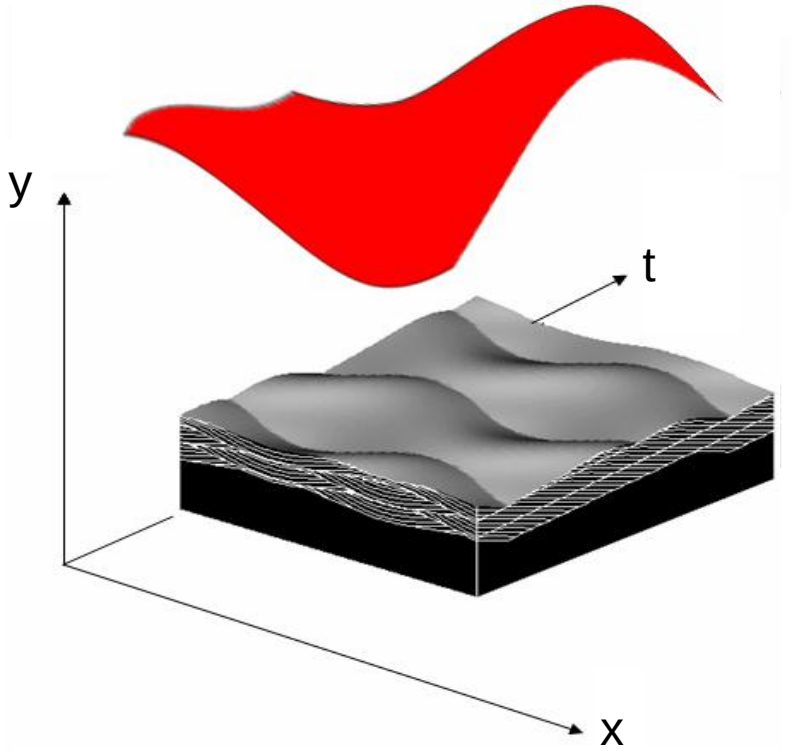
Registration + RCE



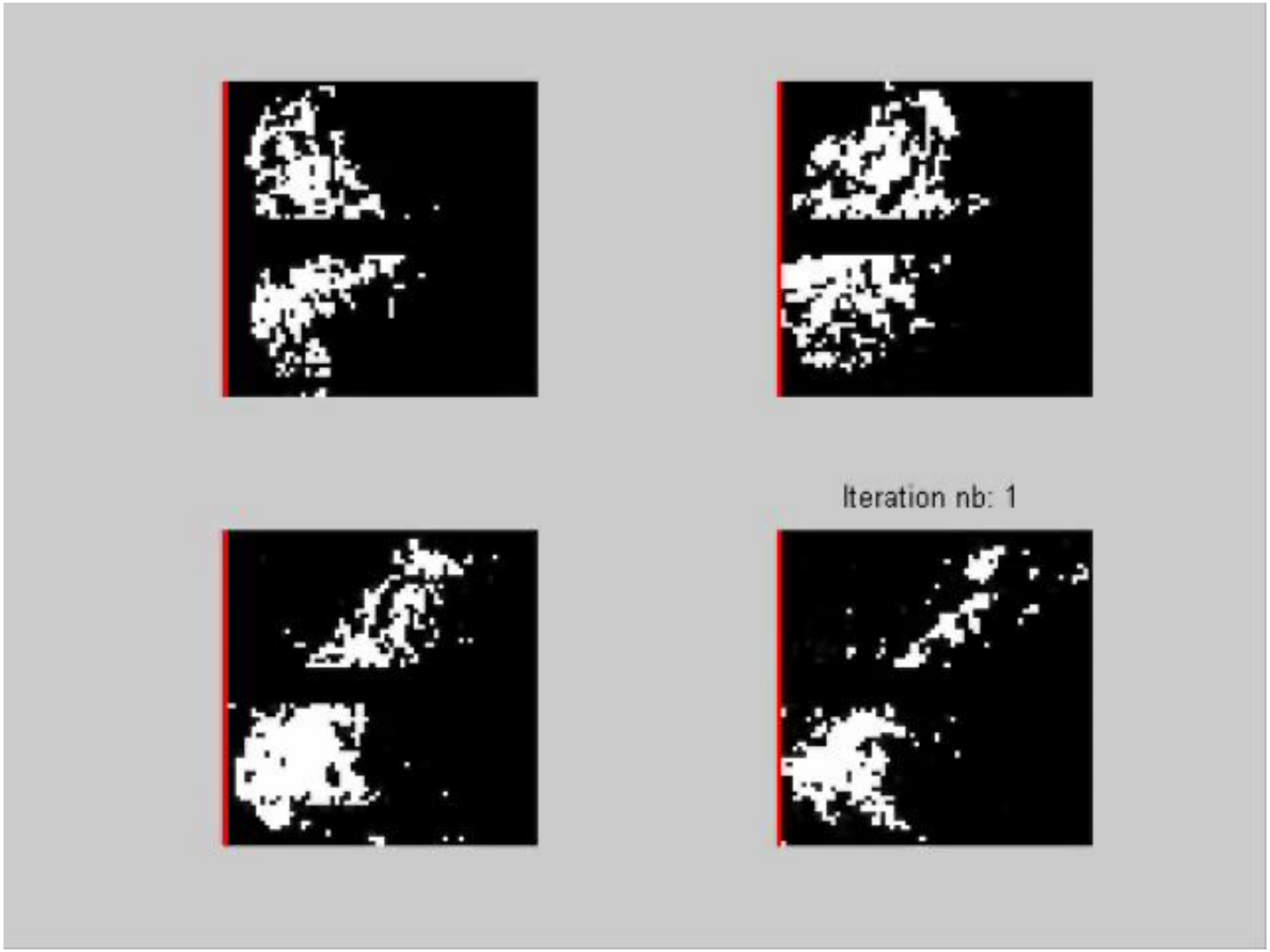
Registration +
3D Diffusion+ RCE

Active Surface

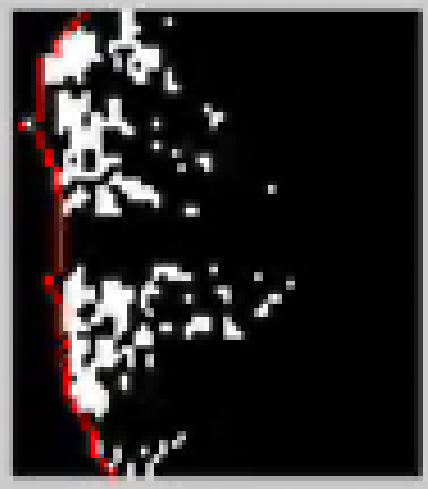
Active Surface is the 3D generalization of Active Contour in 2D. There are segmentation algorithms based on the evolution of a surface according to a flow. Many times, this flow converges toward the solution of a differential equation obtained when minimizing a functional.



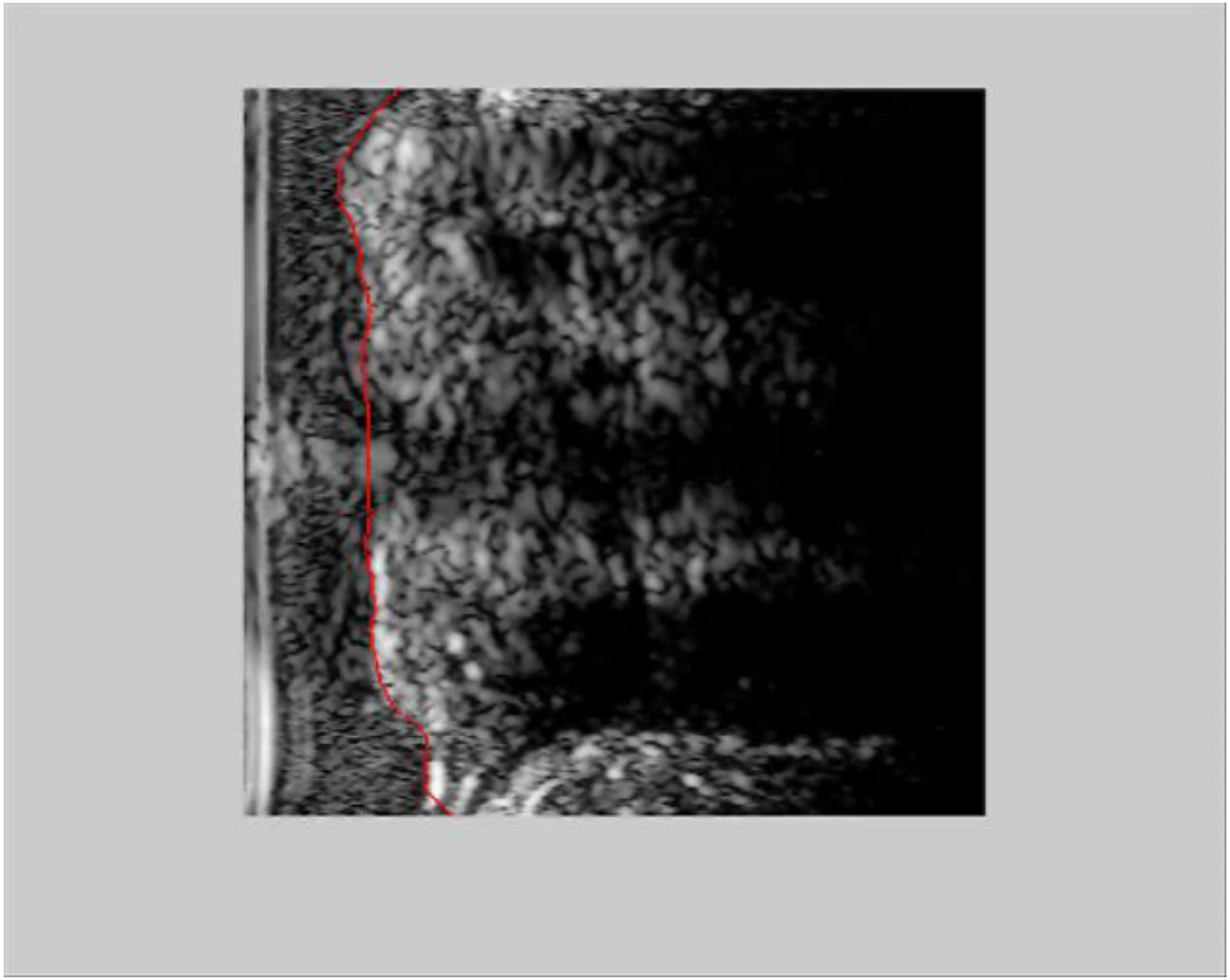
Active Surface Result



Active Surface Result



Active Surface Result



Thanks to…

- Our advisor Oleg Kuybeda
- Avishay Sidelsky from Mediguide
- SIPL