

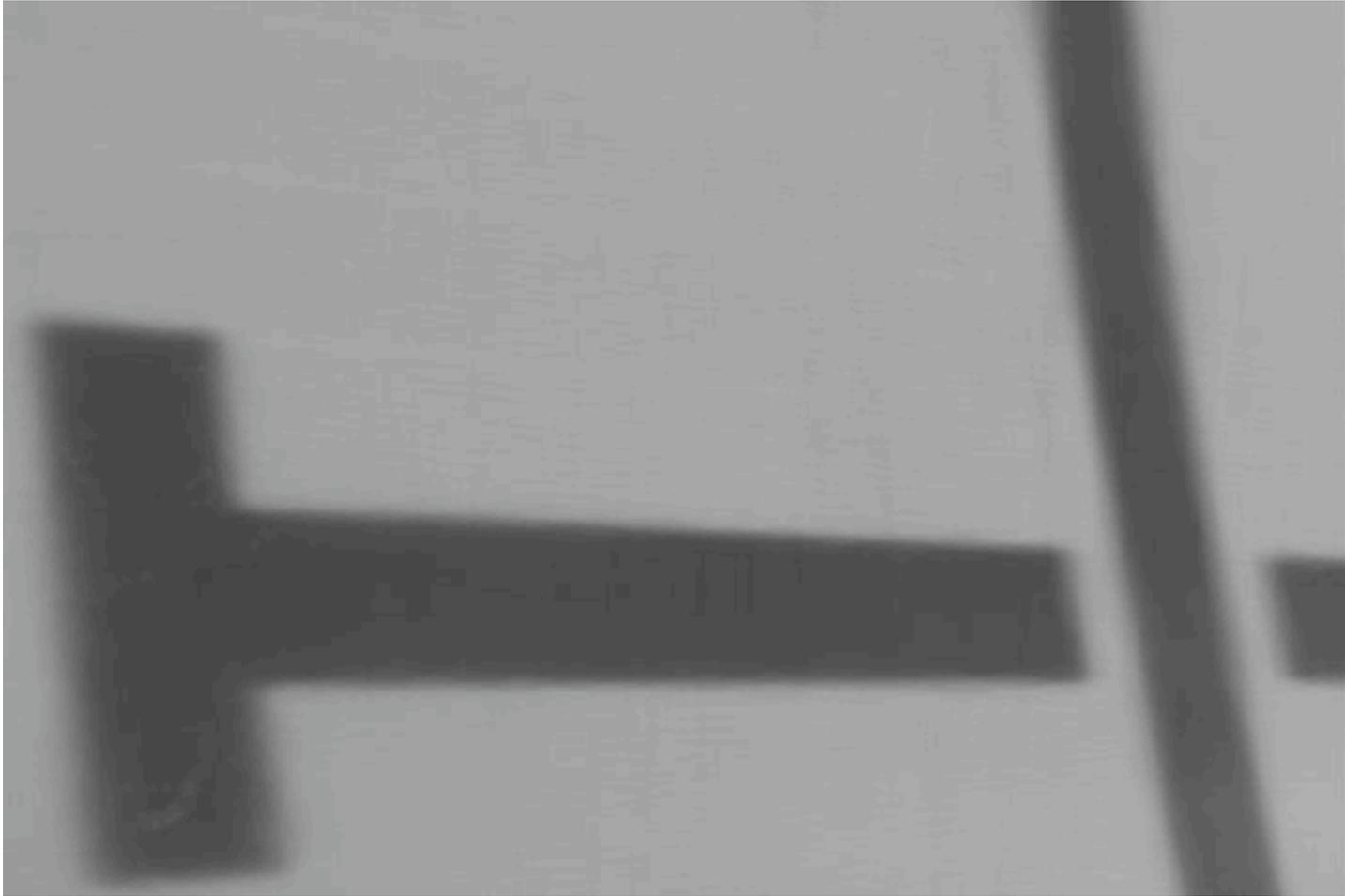
# Seeing Through Water...

A. Efros & J. Shi

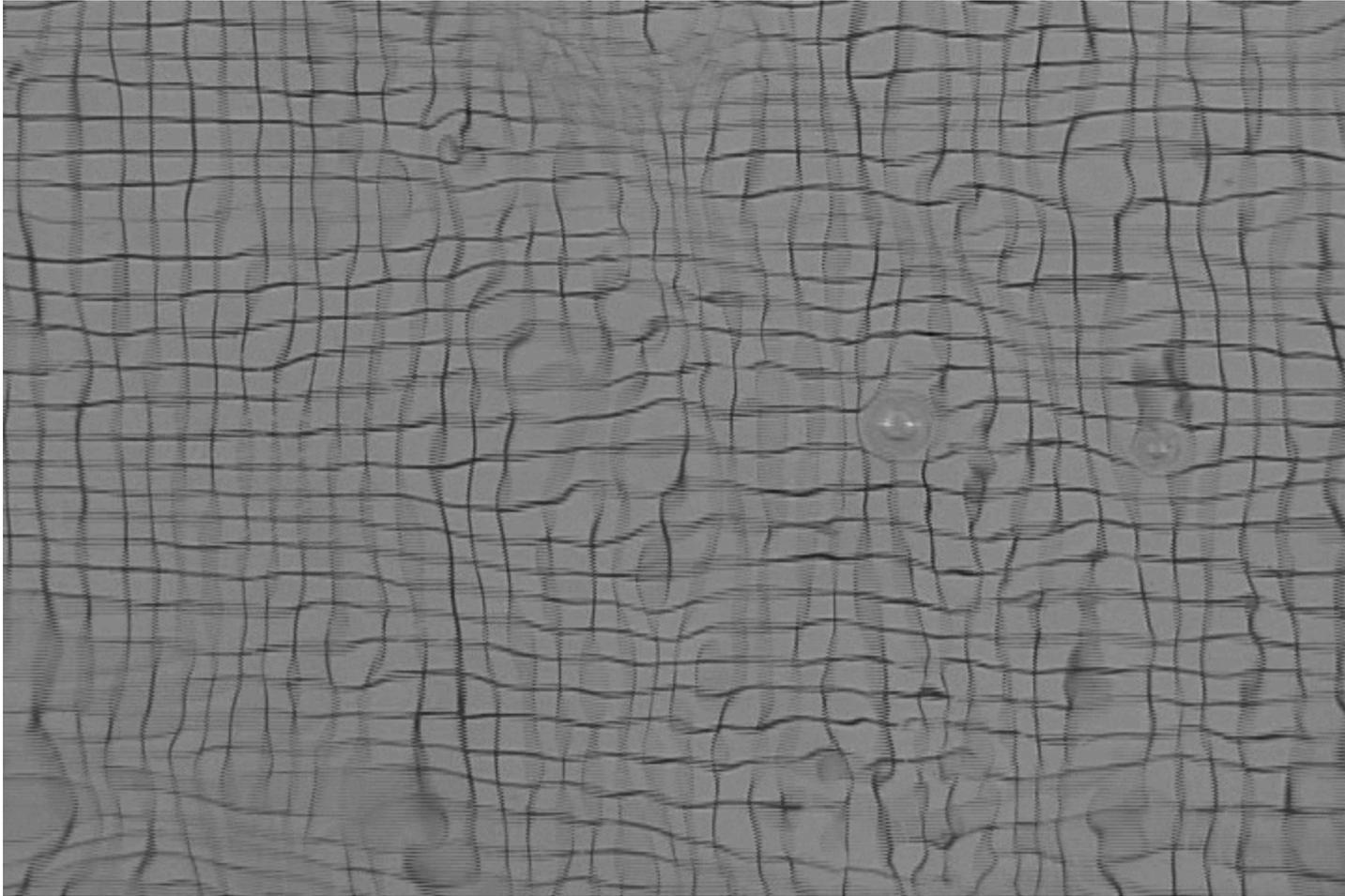
# Problem Setting



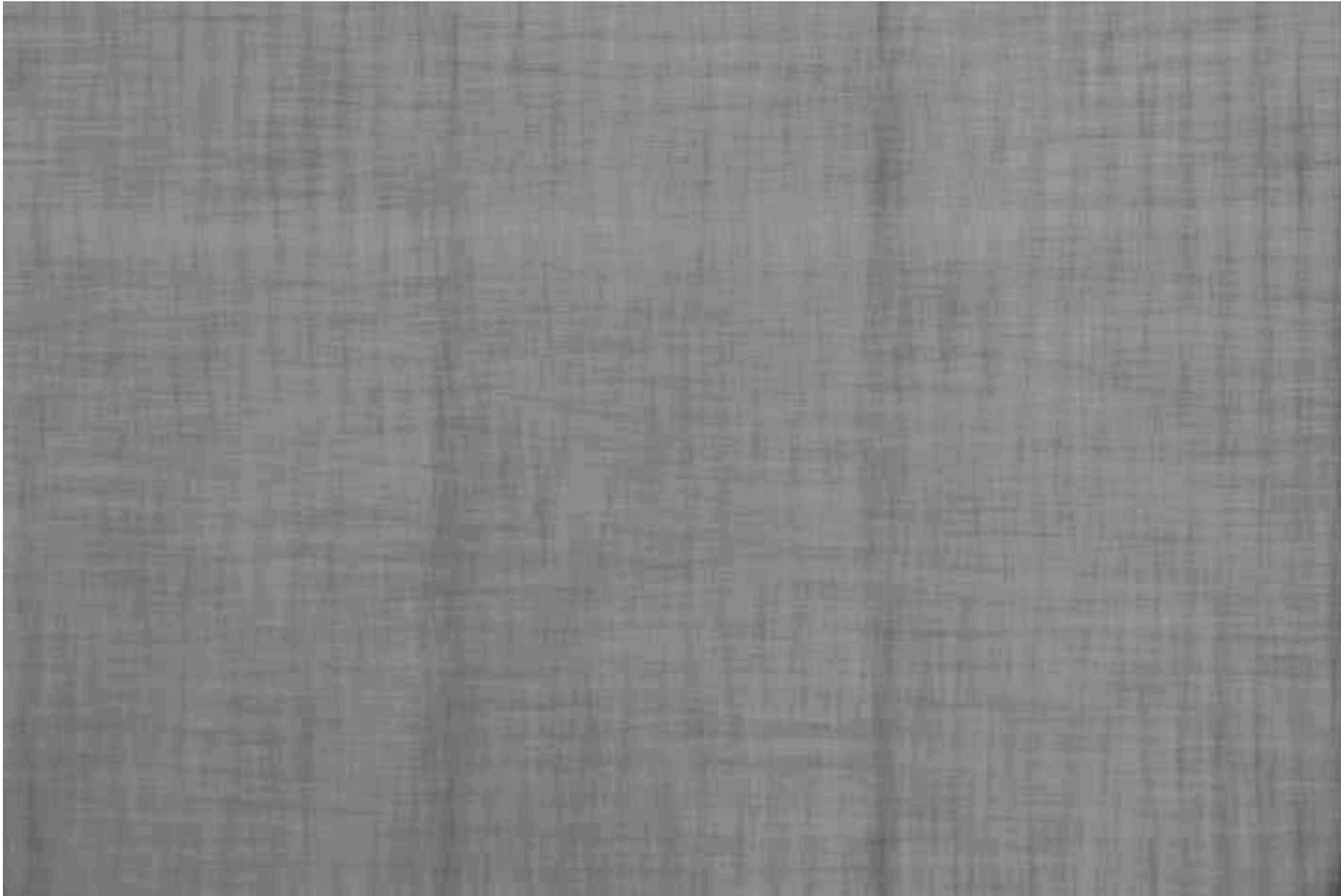
Easy!



...and this?

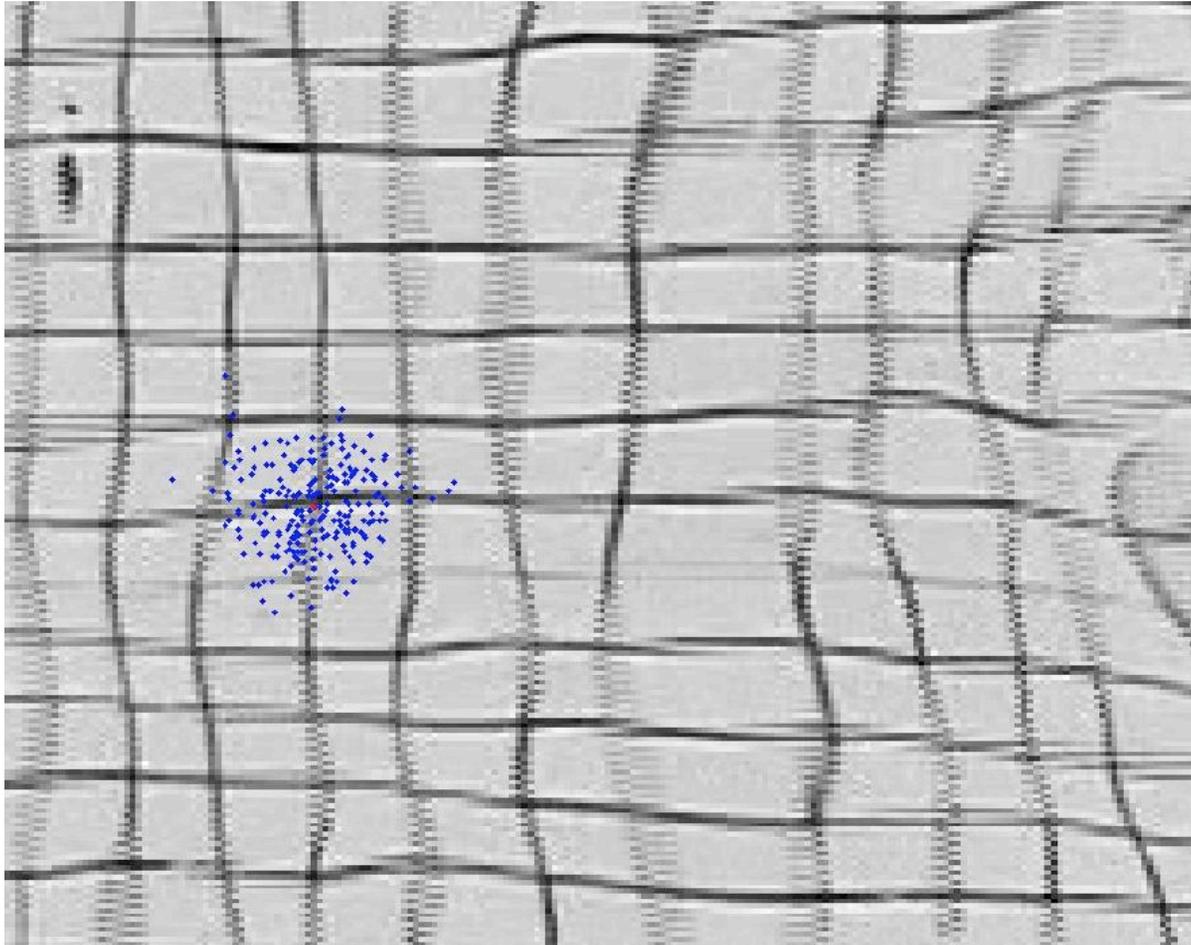


Not really



# The physics

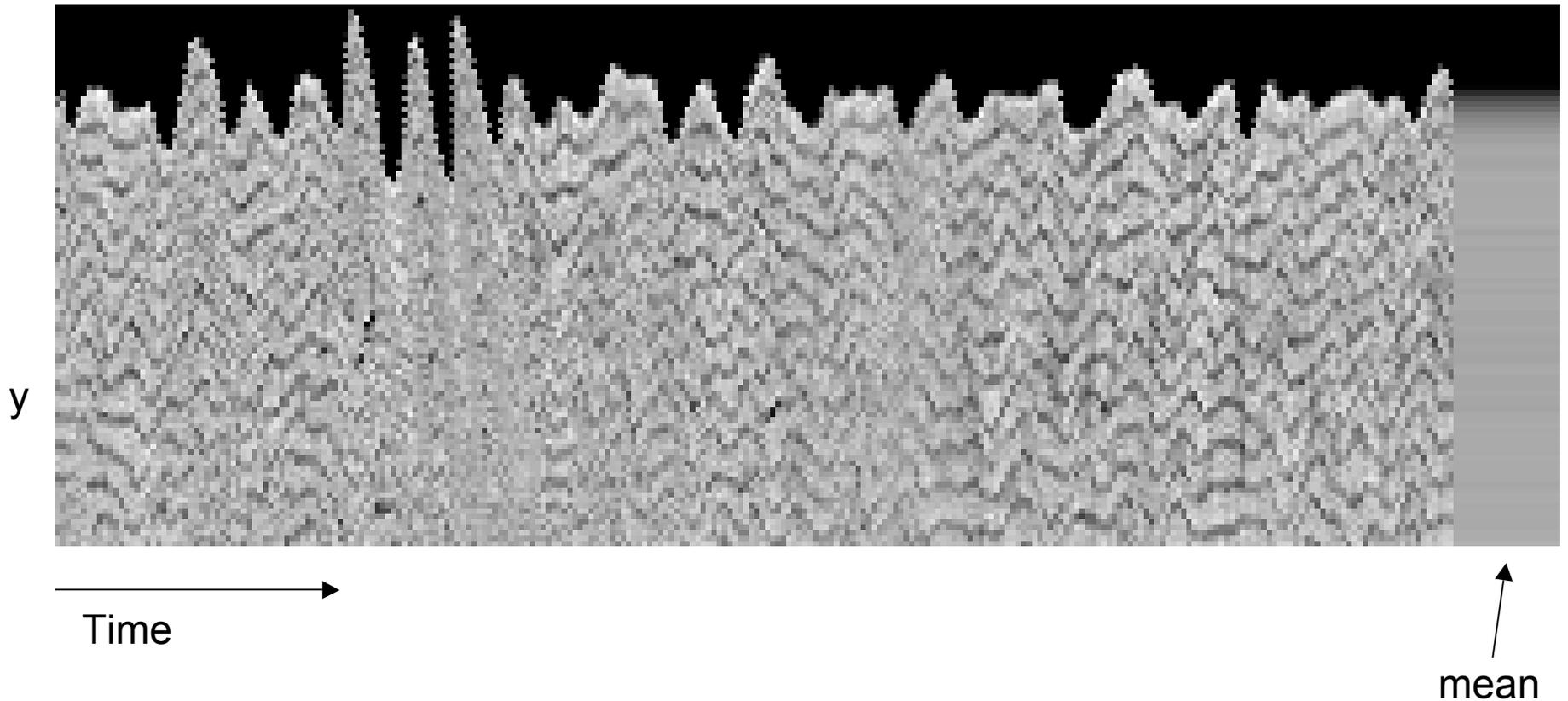
Snell's  
law



Observation 1: time is of the essence!

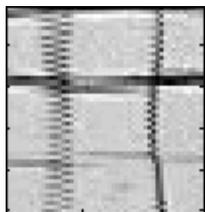
# A case for patches

Time slice

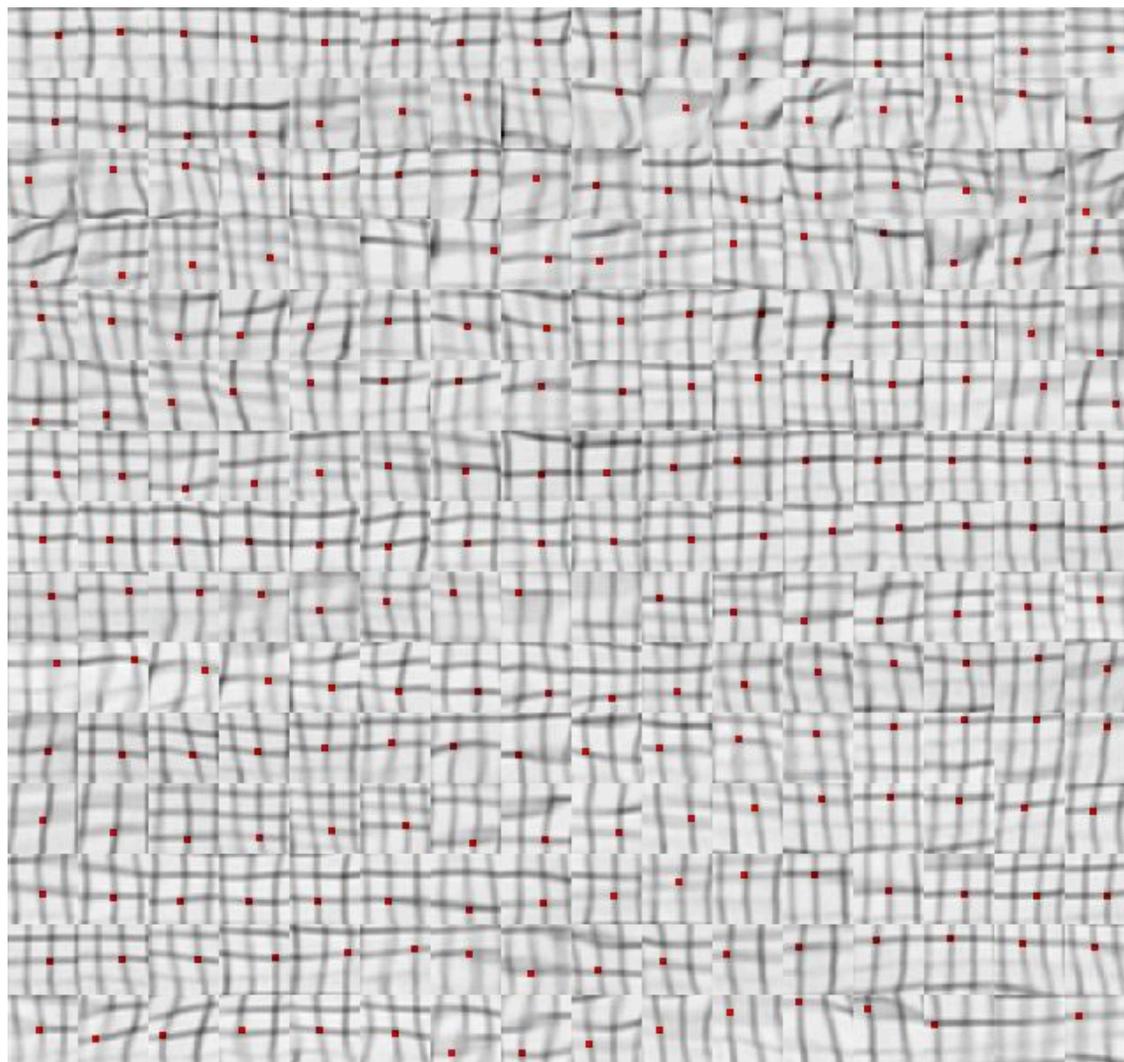


Observation 2: down with pixels – long live patches!

# Tracking?

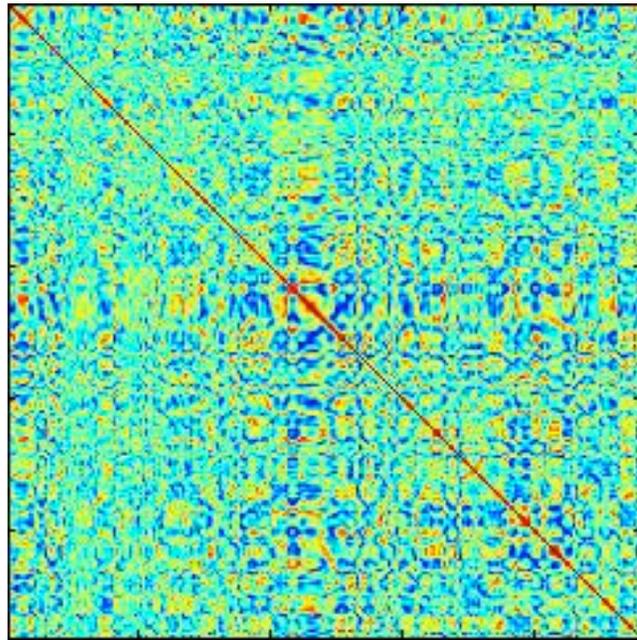


patch  
video



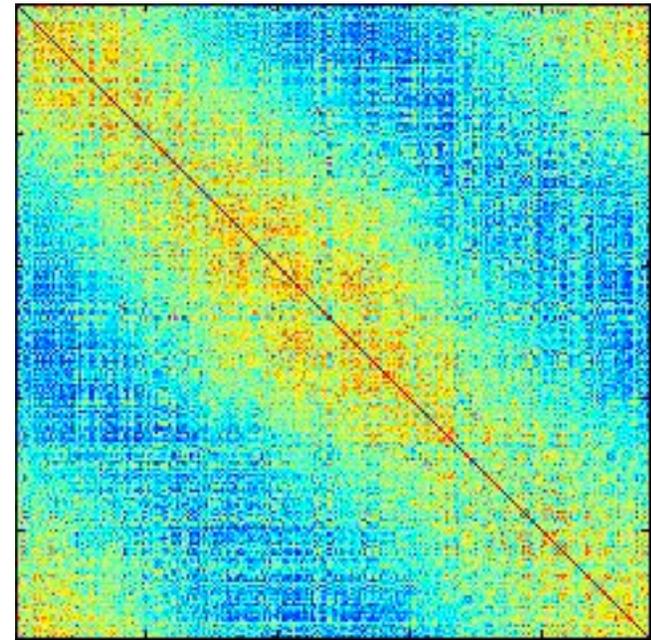
50x50 patches

# Sorting



Affinity matrix

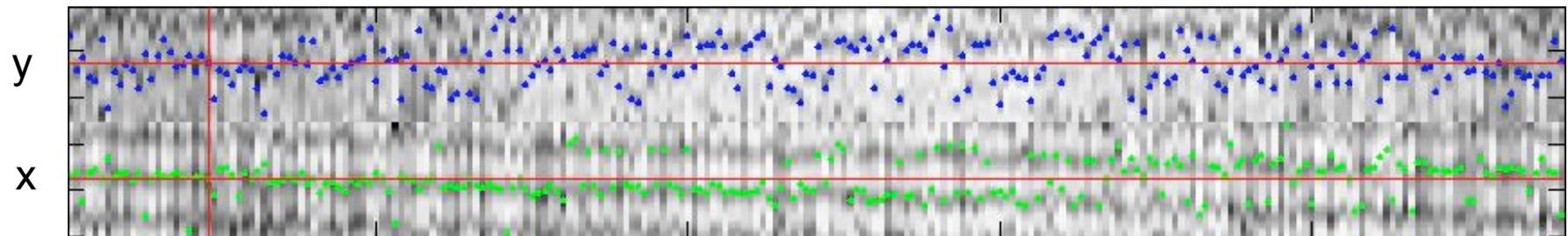
NCut  
→



sorted by using 2<sup>nd</sup> & 3<sup>rd</sup>  
eigenvectors

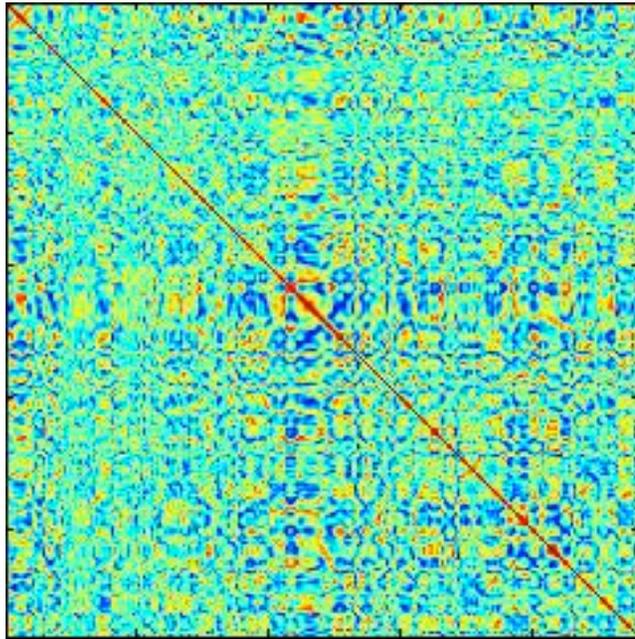


sorted video



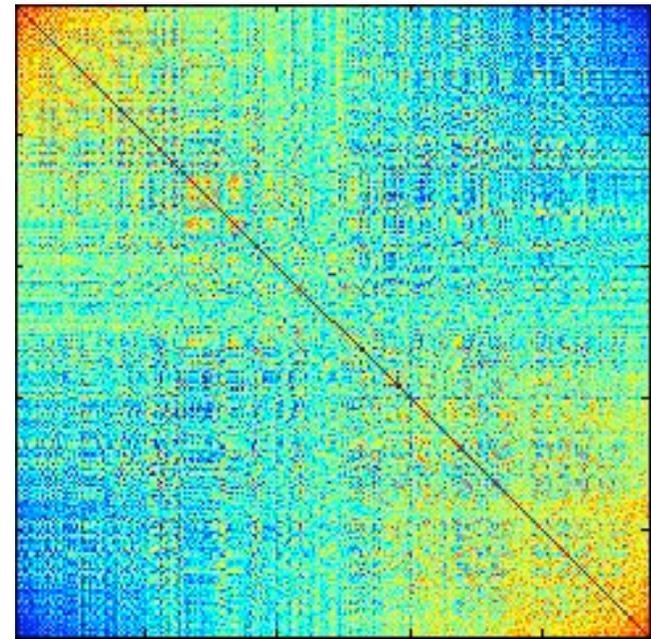
Sorted time slice

# Clustering

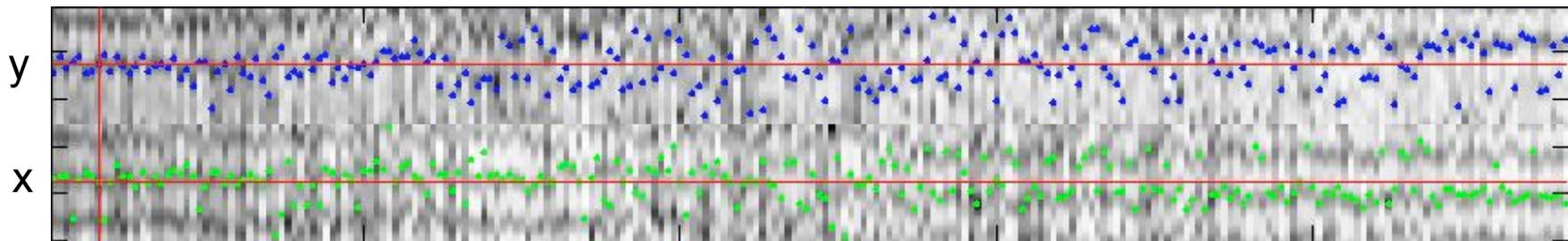


Affinity matrix

NCut  
or PCA  
→

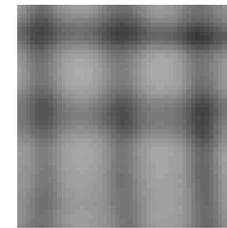
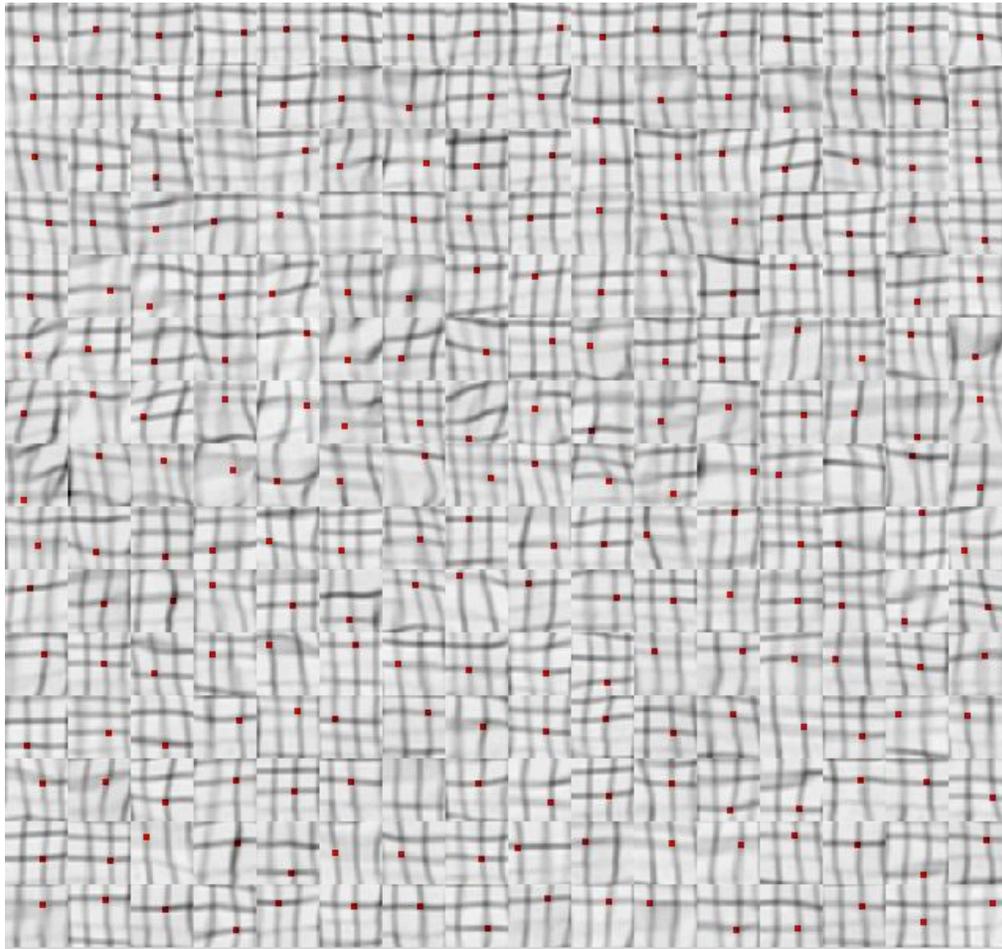


sorted by using 1<sup>st</sup>  
eigenvector

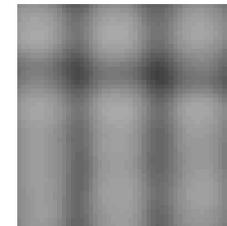


Clustered time slice

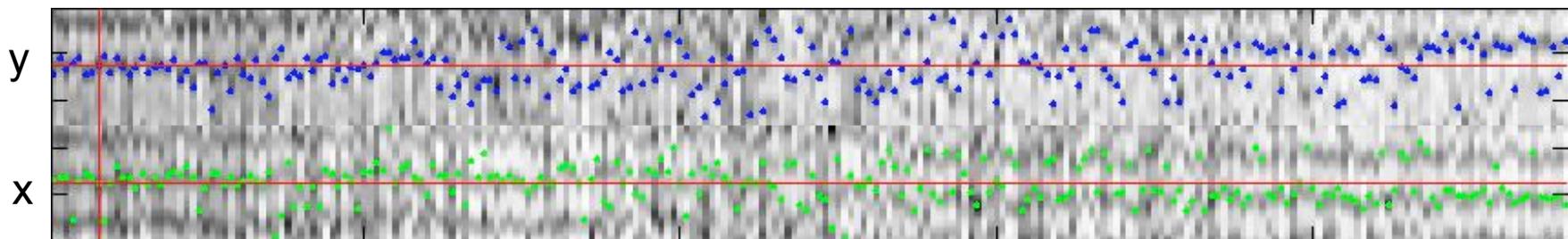
# The impostor cluster problem



Cluster 1 mean

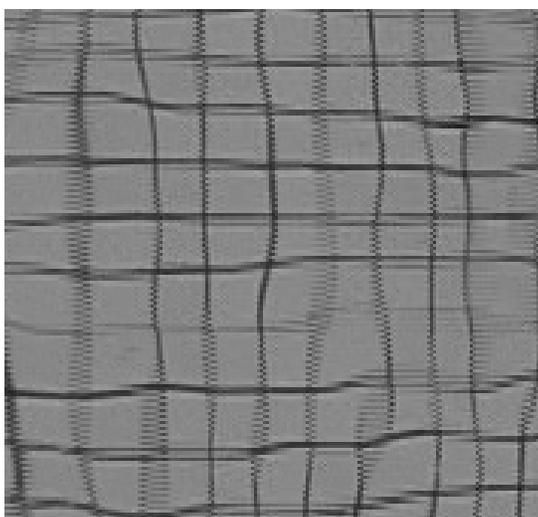


Cluster 2 mean

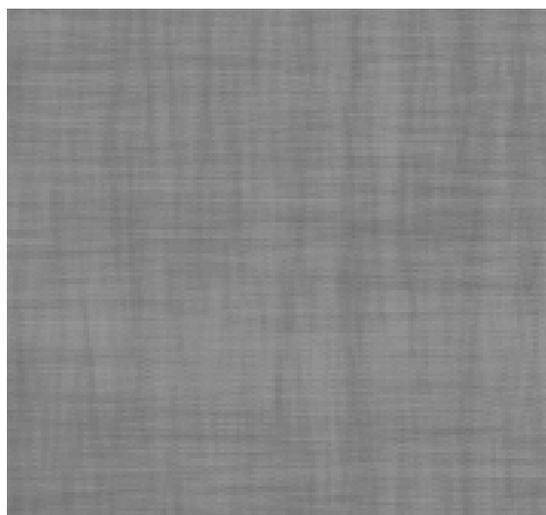


# Algorithm v.0

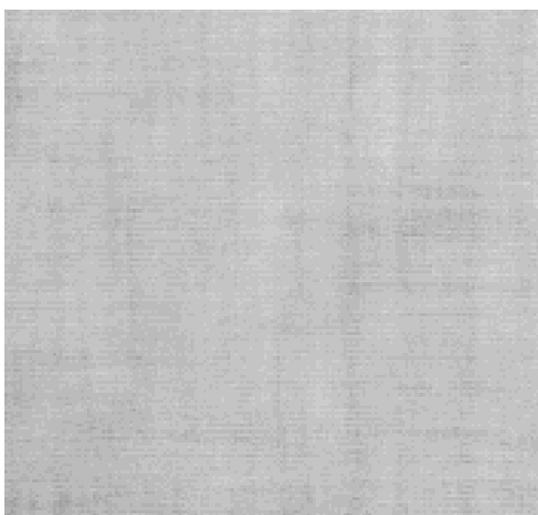
- For each patch column through time:
  - Cluster using SVD, sorting by 1<sup>st</sup> eig.v.
    - Drop it if 1<sup>st</sup> eig.v. is not prominent
  - Decide which cluster to take by:
    - Tightness of cluster
    - coherence (spatial and eigenvector)
  - “Splat” cluster mean into accumulator image
  - Hope for the best!



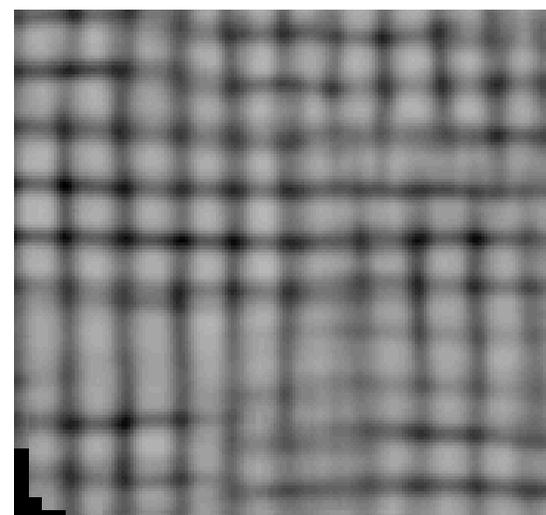
Input video



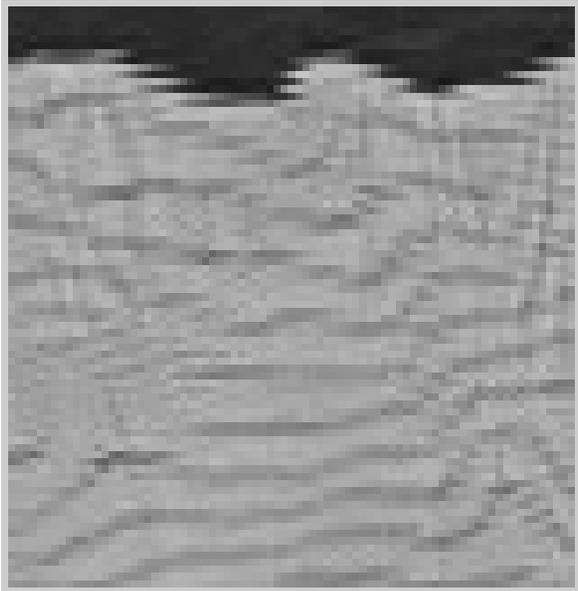
mean



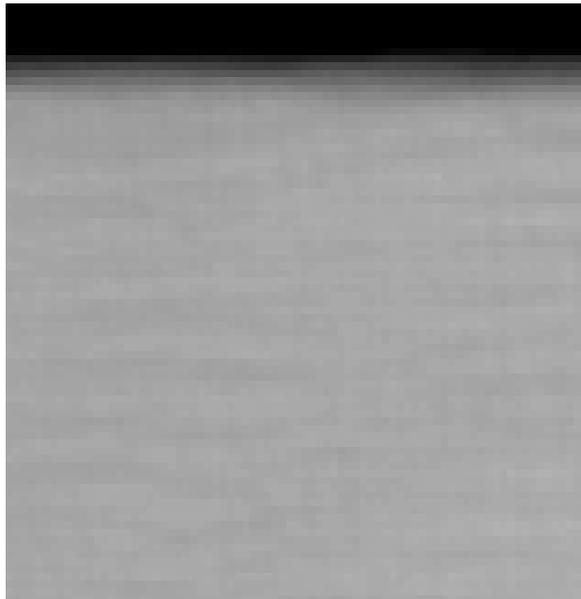
median



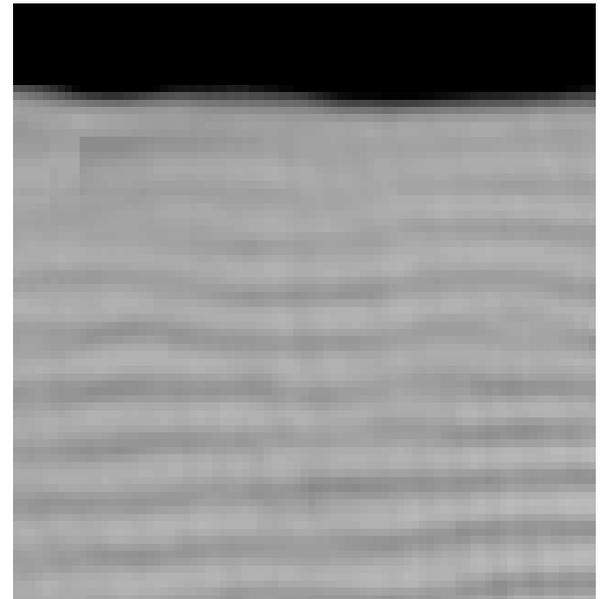
Our result



Input video



Mean image



Our result

# Questions

- Is it possible to recover the true cluster?
- Is it possible to track by sorting?
- Is there enough information in the video?
  
- If this works:
  - Other motion textures: flag, trees, clothing?
  - Shift-invariant features for recognition?
  - Non-tracking trackers