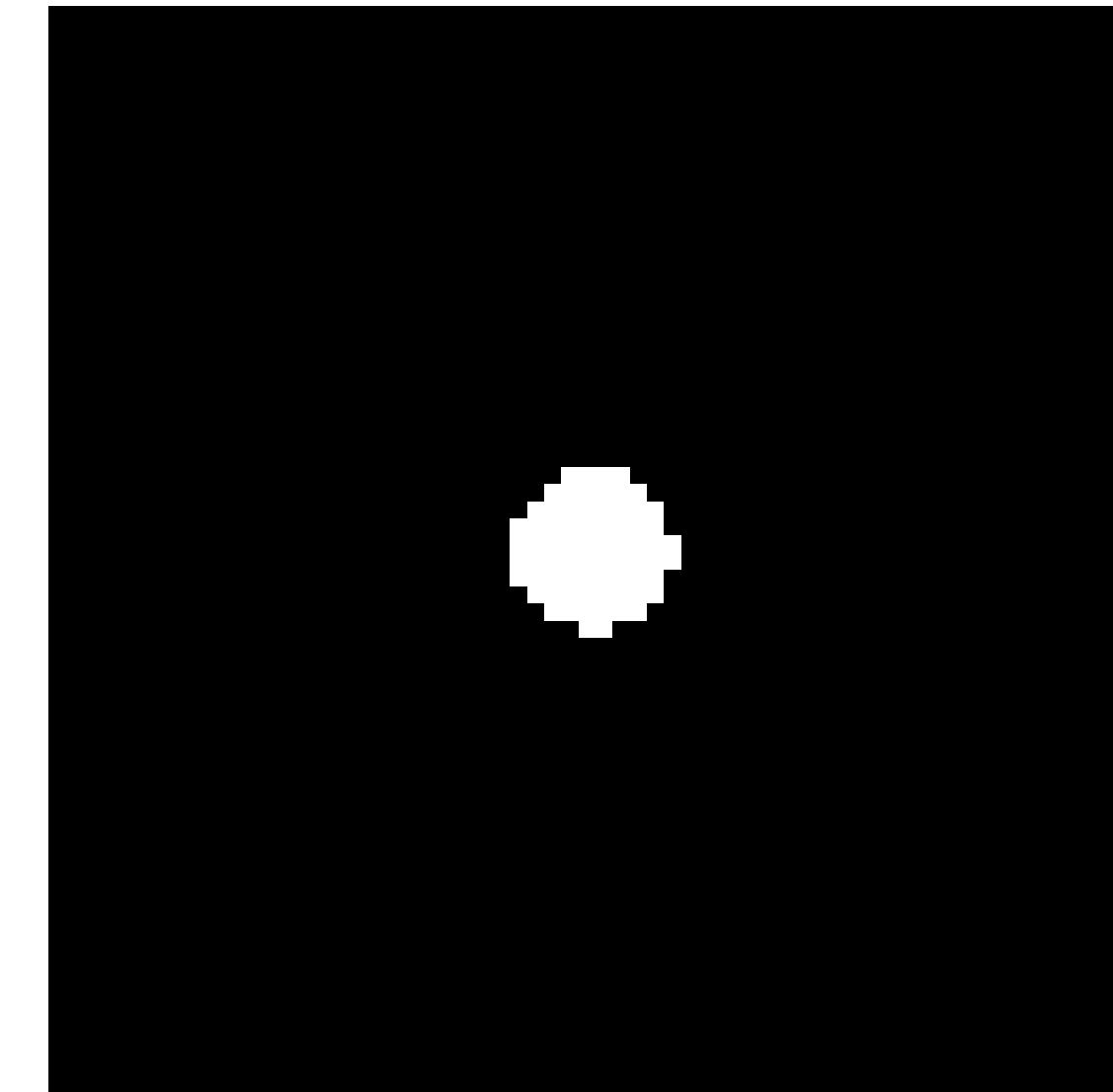
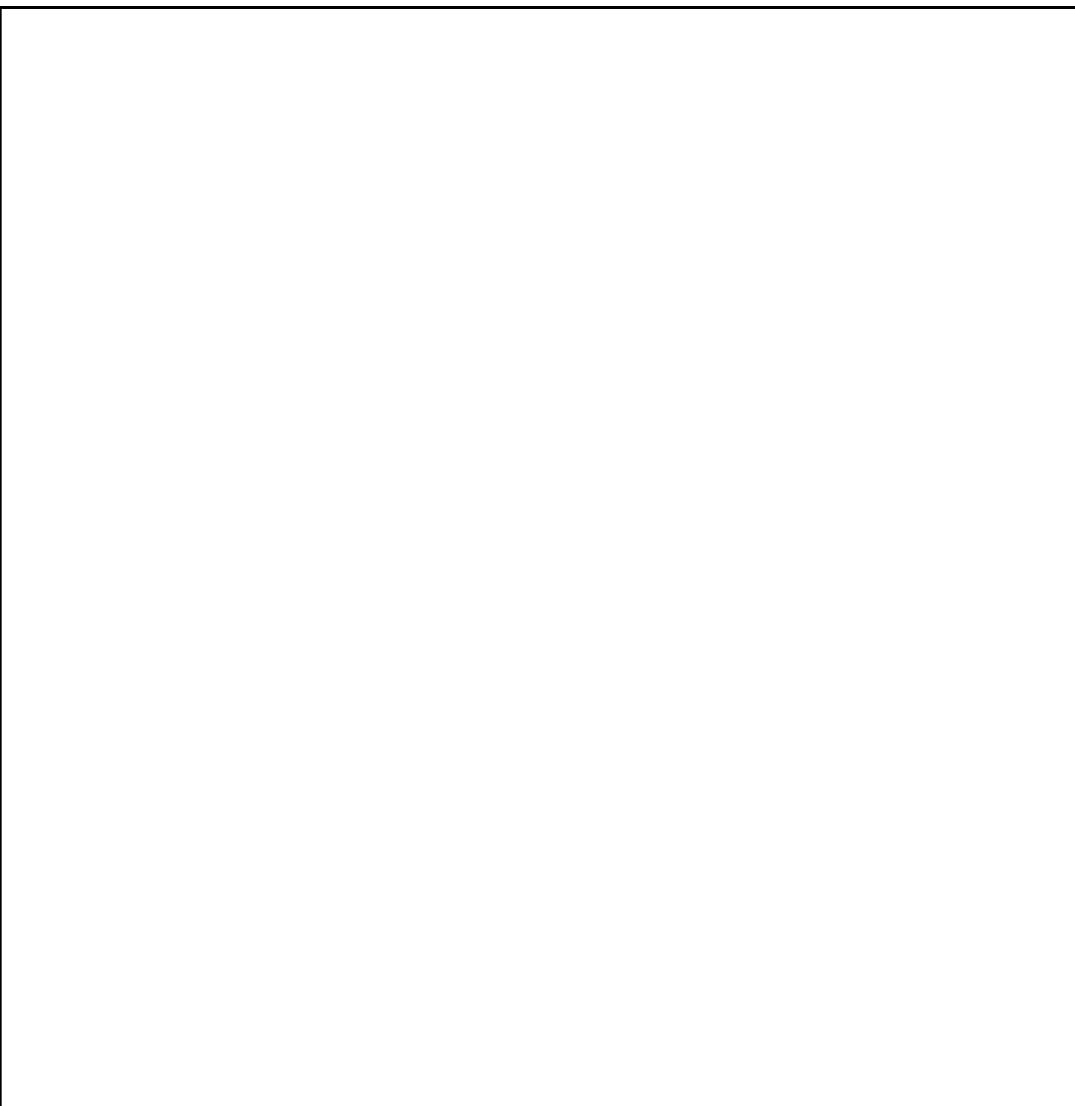


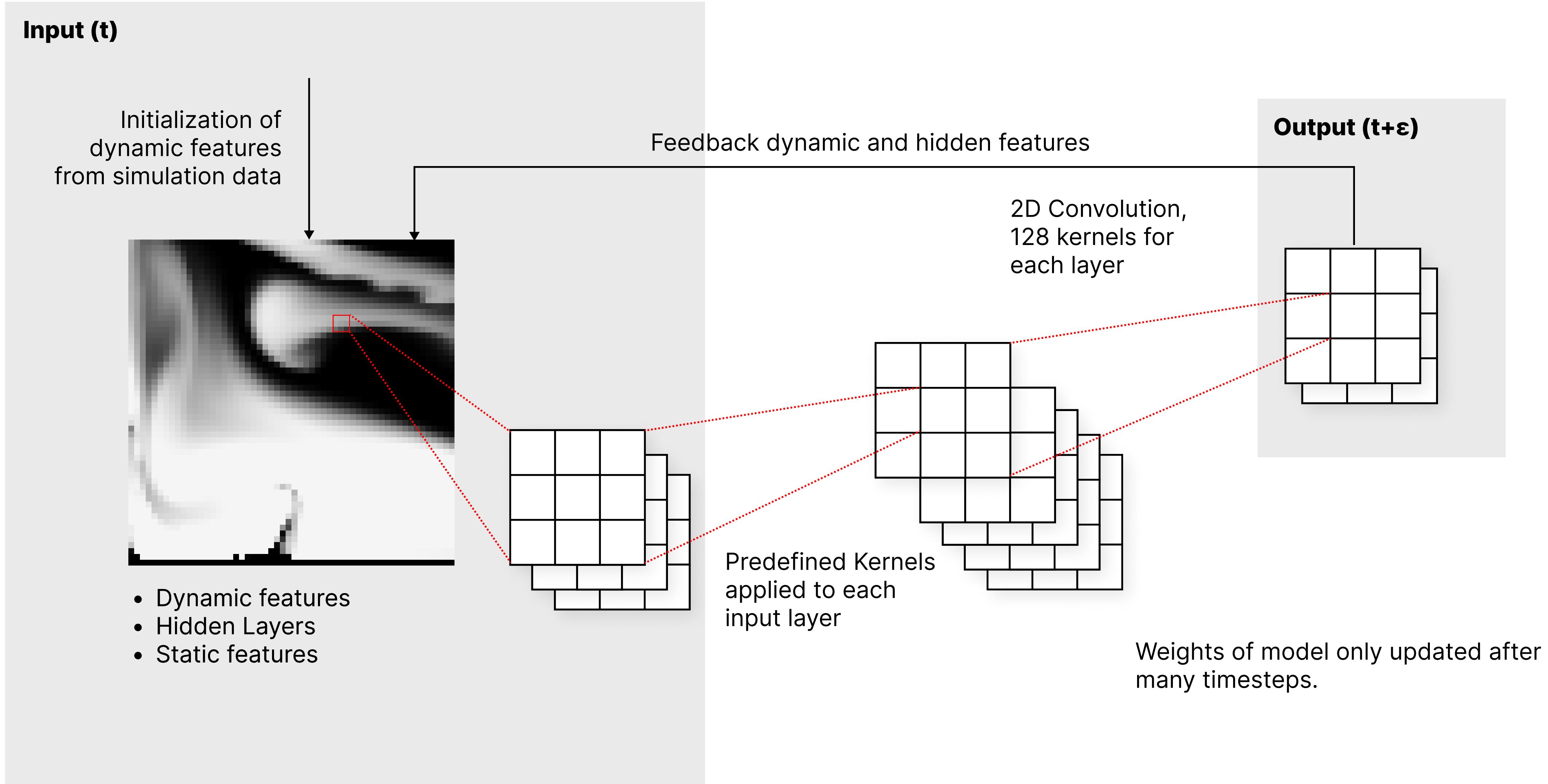
# Neural Cellular Automata (NCA) to learn Physics simulations

Andrin , Etienne  
team : I just want to do ai



# Our Model

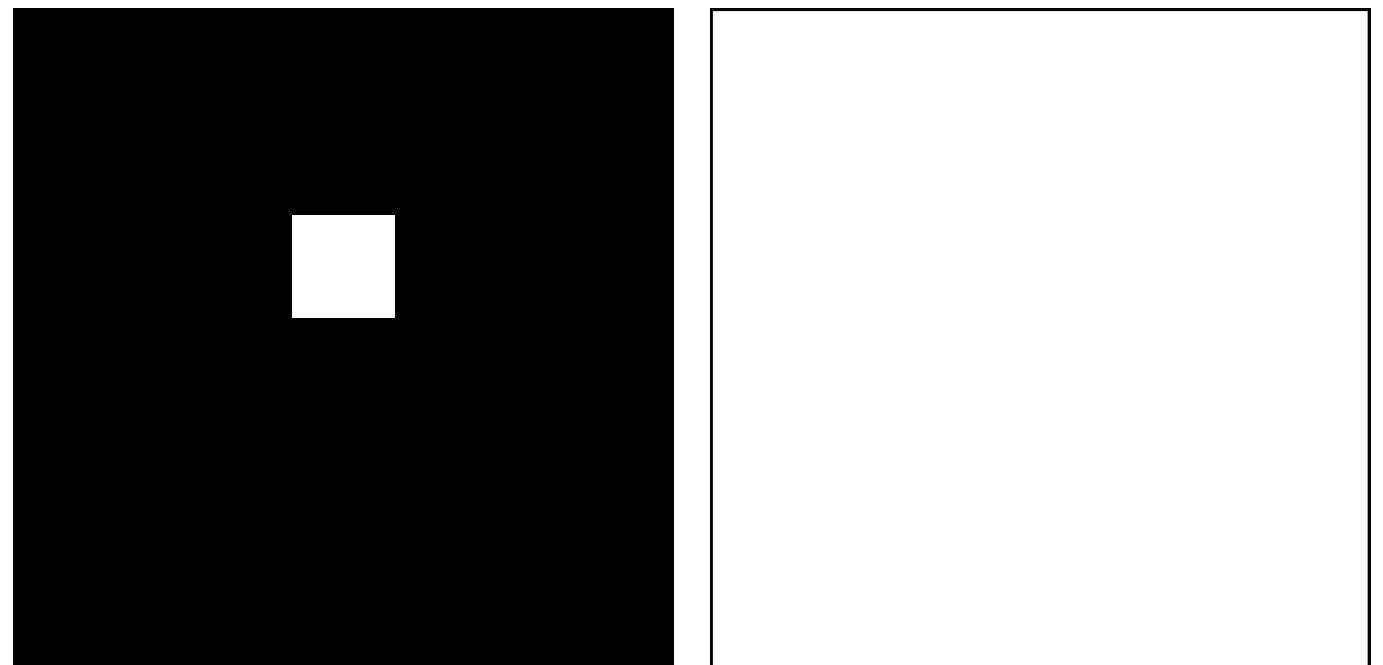
Cellular Automata Rule: Only use surrounding pixels to predict center pixel in next frame.



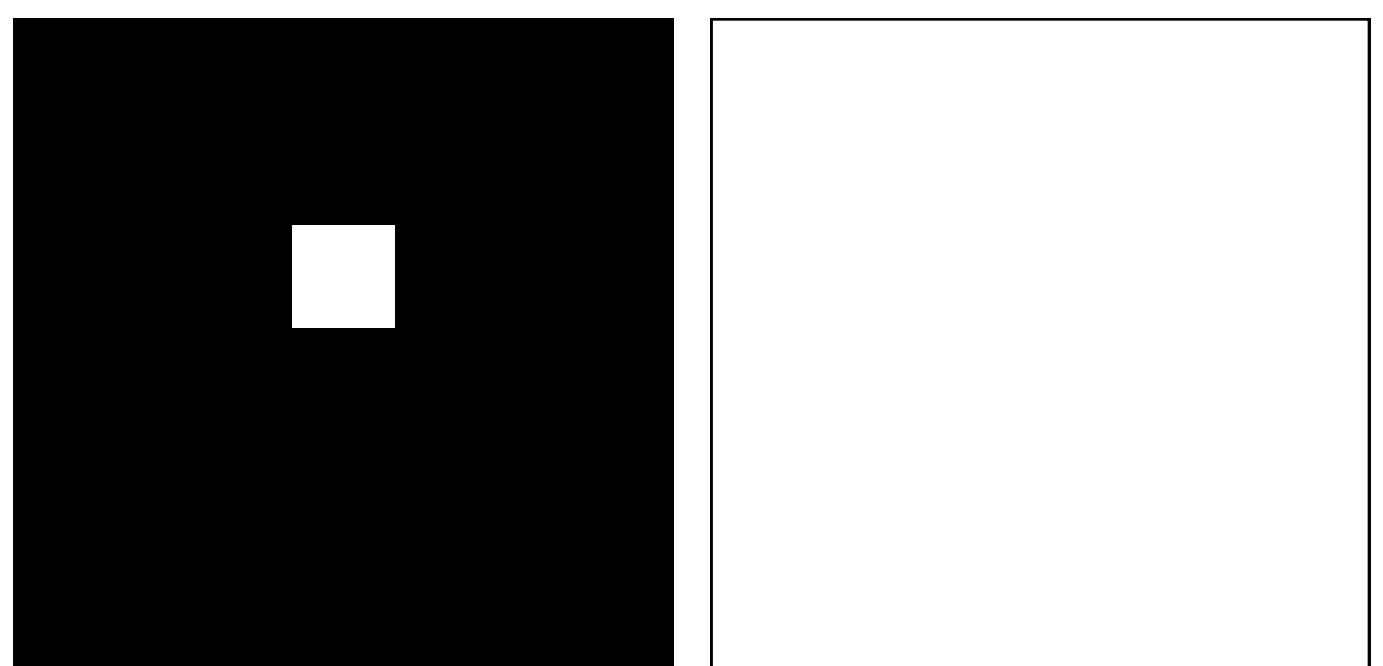
# Last Milestone

## Masking

epoch 100

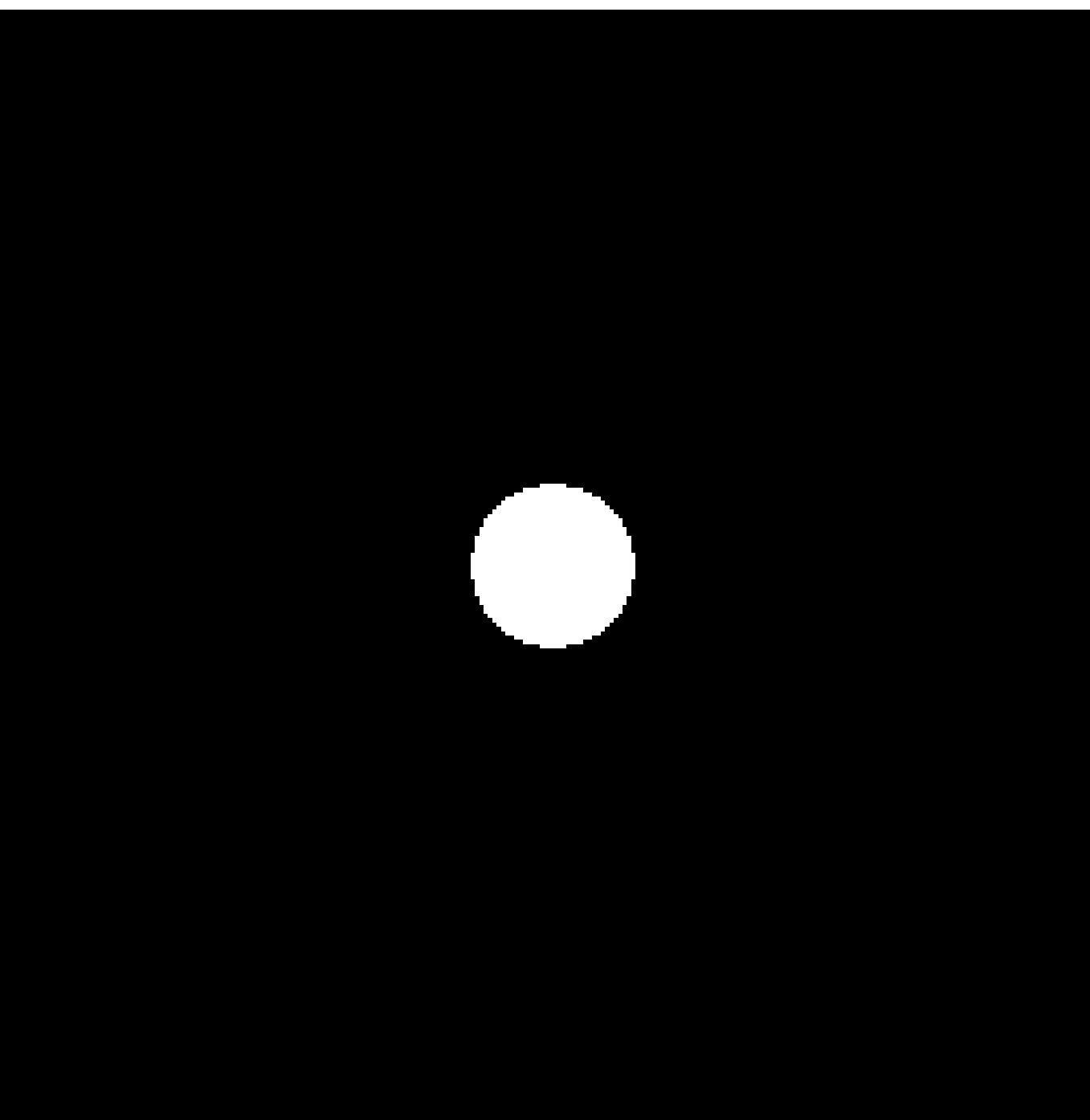


epoch 500

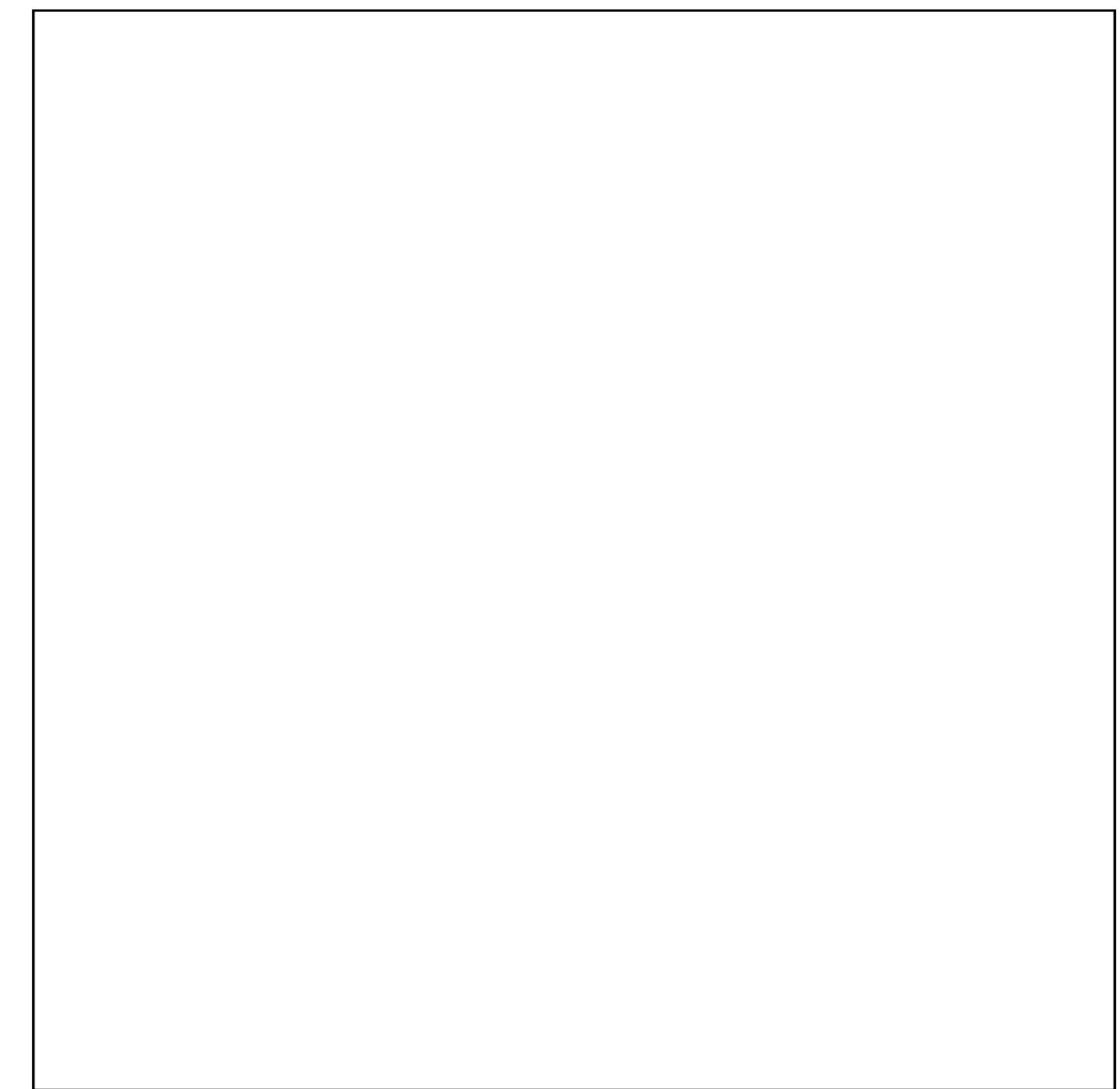


main chan.

hidden chan.

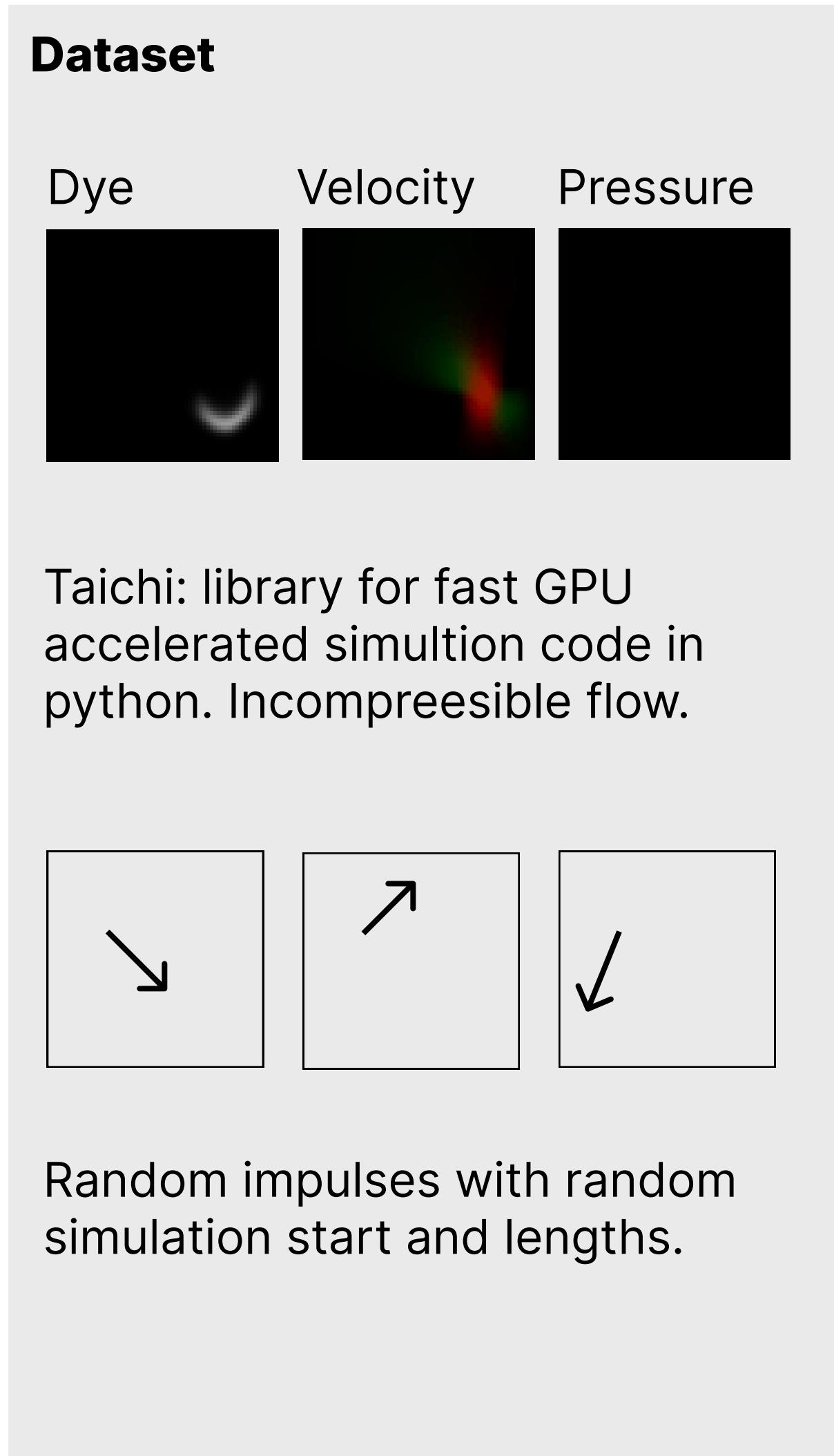


main chan.



hidden chan.

# Fluids



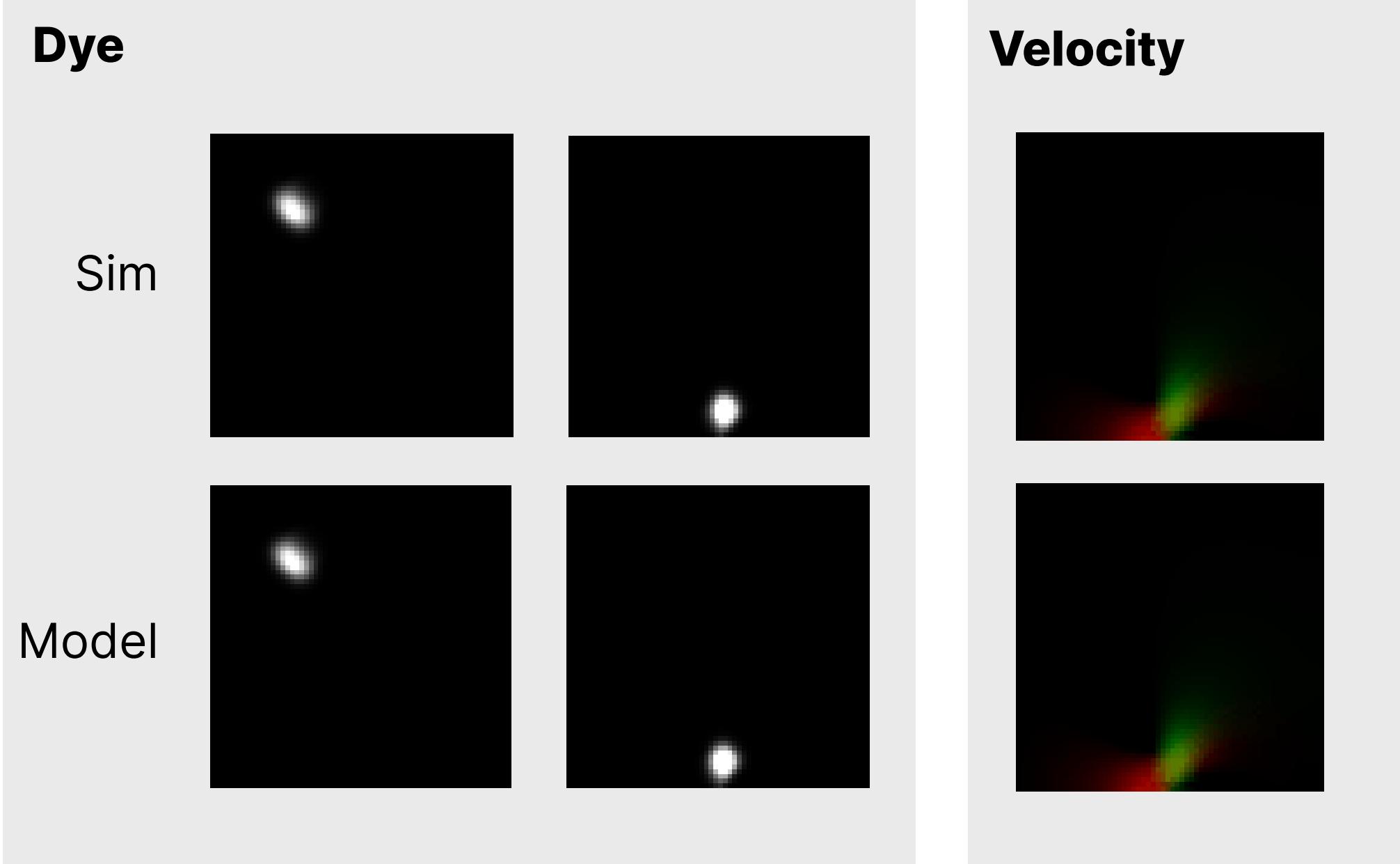
## Observations & Results

- Deeper network is not better
- Hidden layers unused with vel channel
- Small delta time in simulation greatly increases results.
- Added finite difference kernel:

$$\begin{array}{|c|c|c|}\hline & & \\ \hline & & \\ \hline 1 & -1 & \\ \hline & & \\ \hline\end{array}$$

$$\begin{array}{|c|c|c|}\hline & 1 & \\ \hline & -1 & \\ \hline & & \\ \hline\end{array}$$

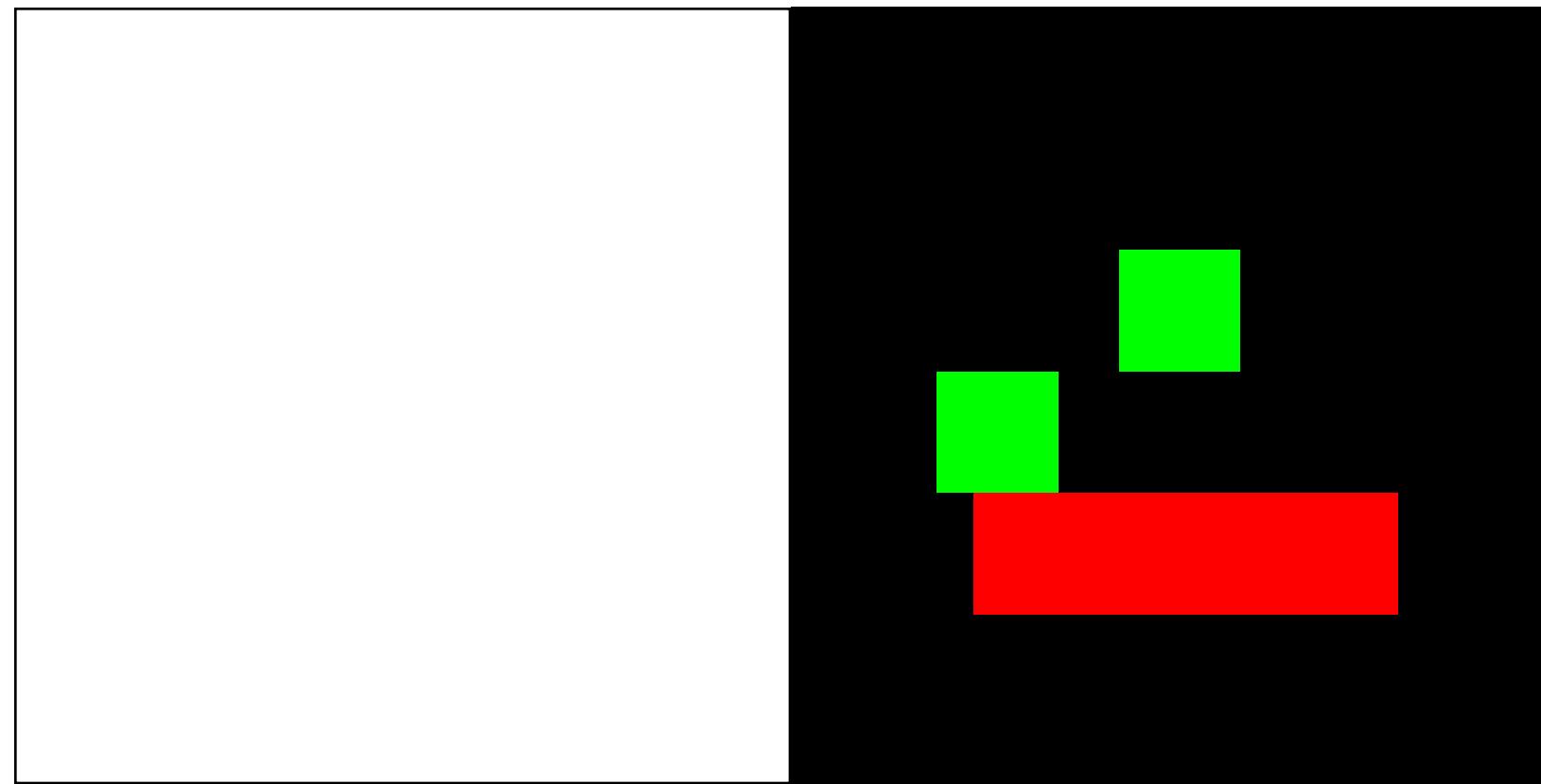
- Border and grid space position as static features



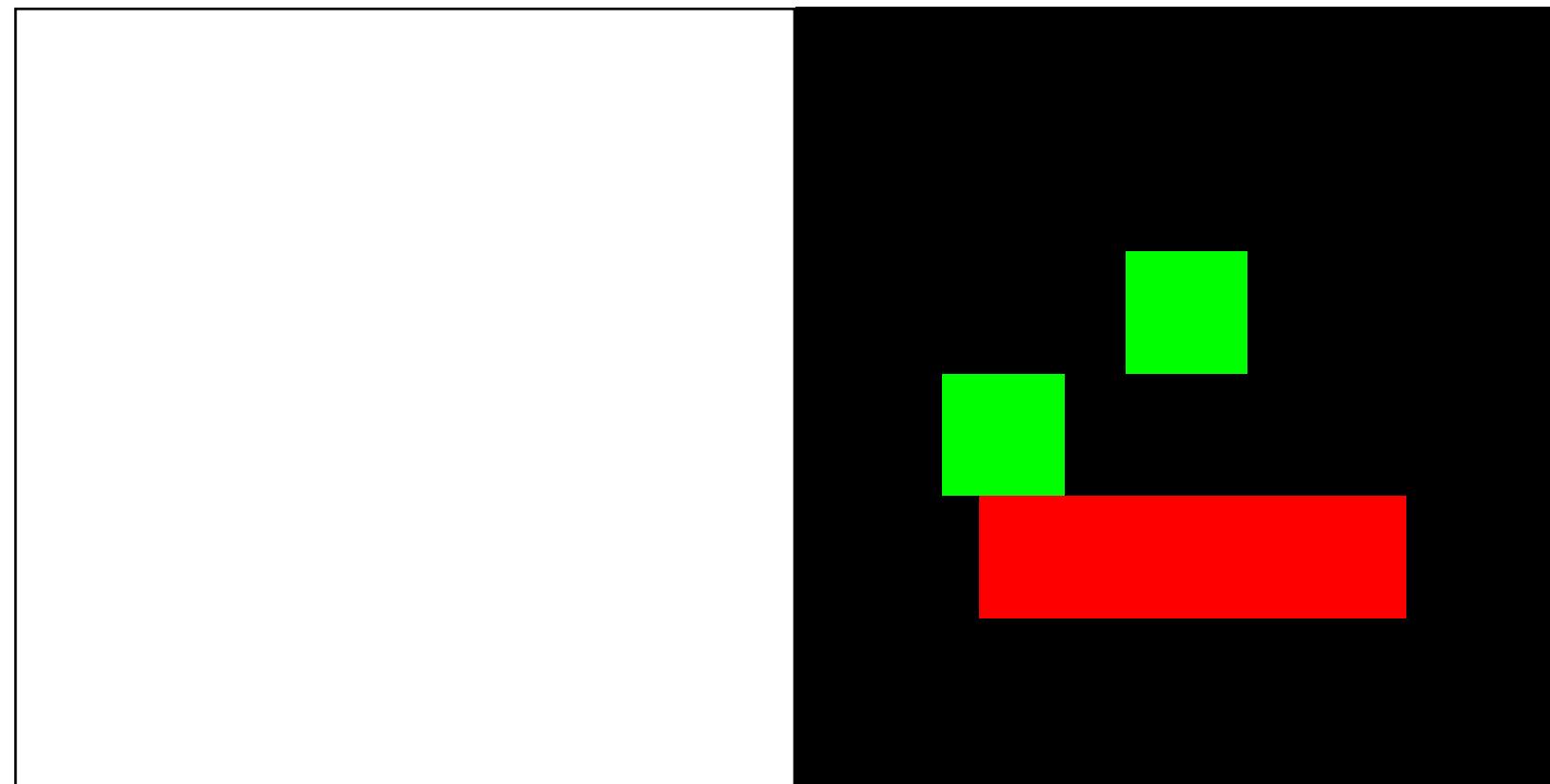
The advection and diffusion of the dye appears to work. However transport of velocity does not and is main reason for decreased simulation accuracy over time.

# Materials interactions

epoch 100



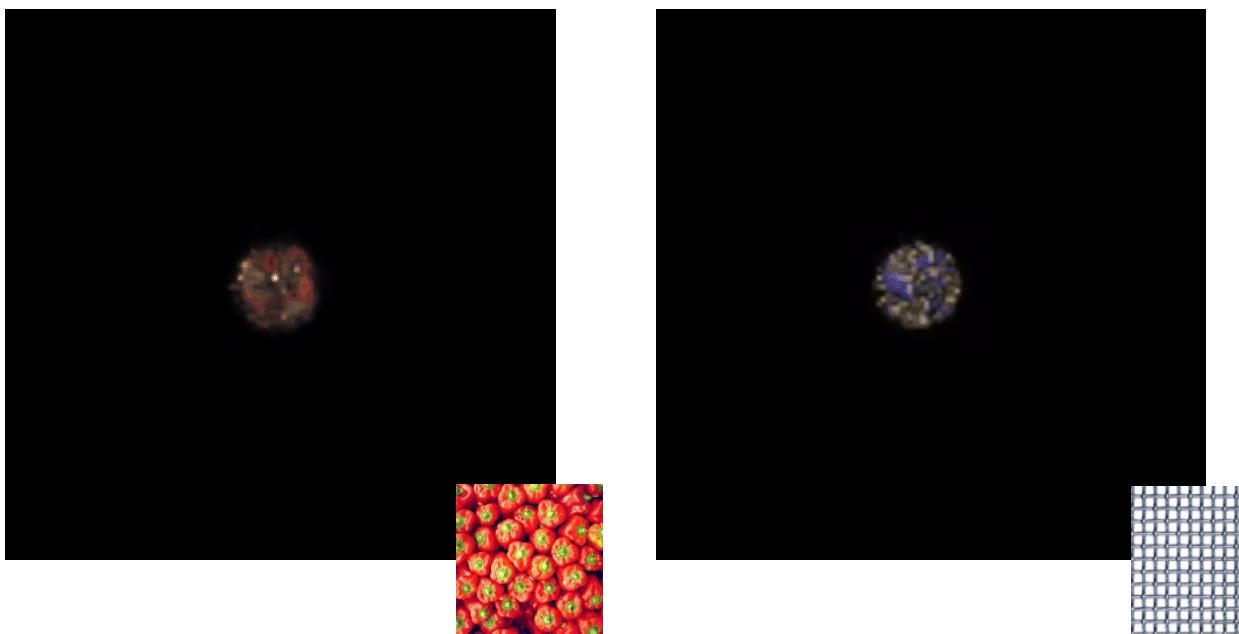
epoch 500



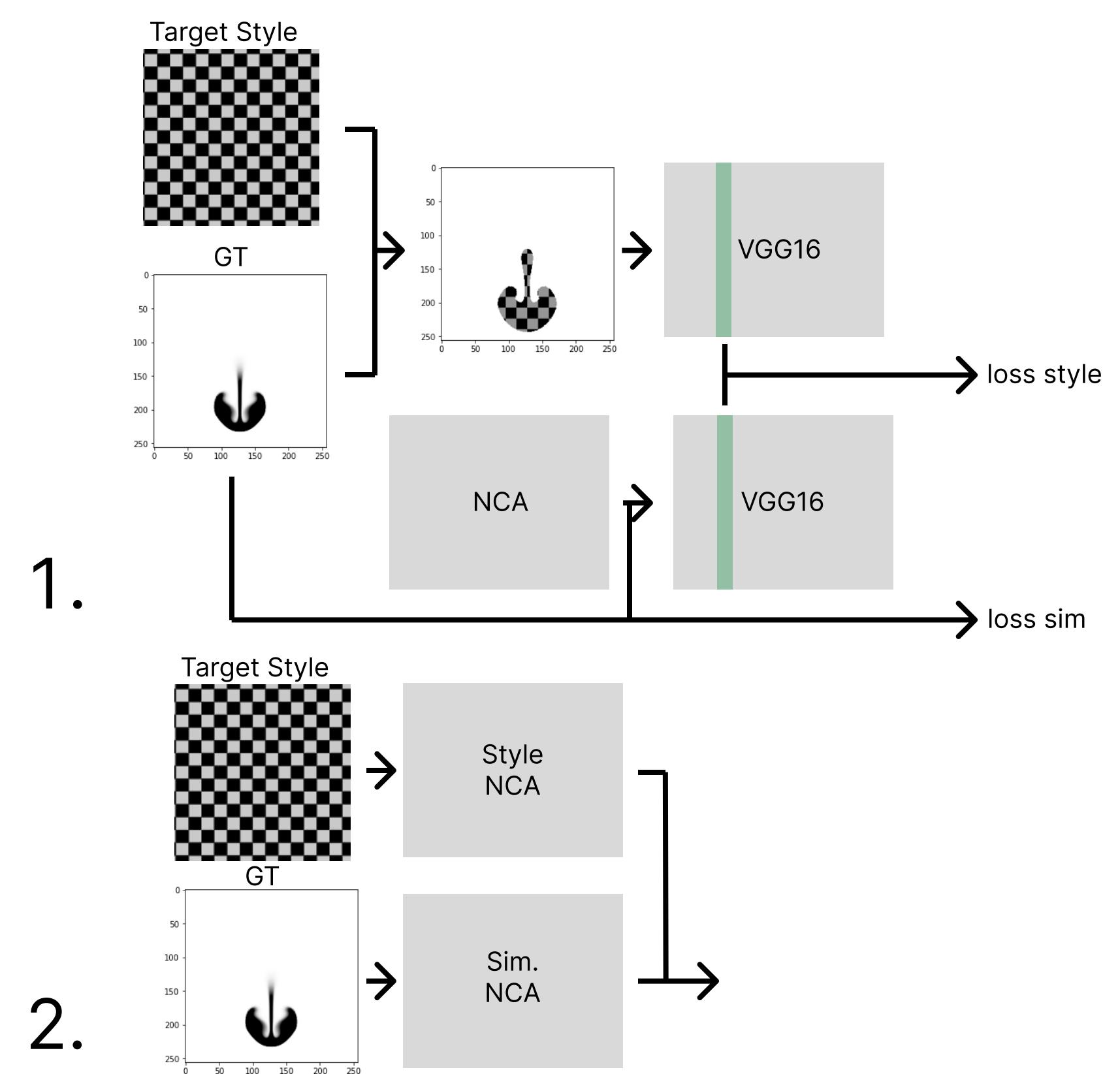
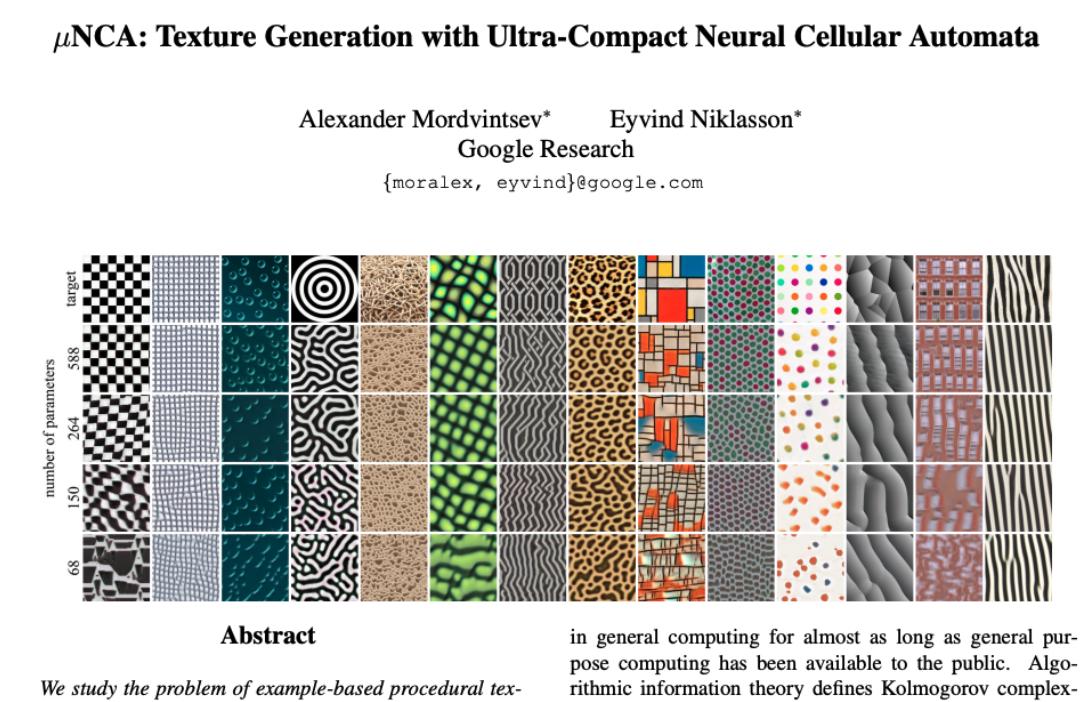
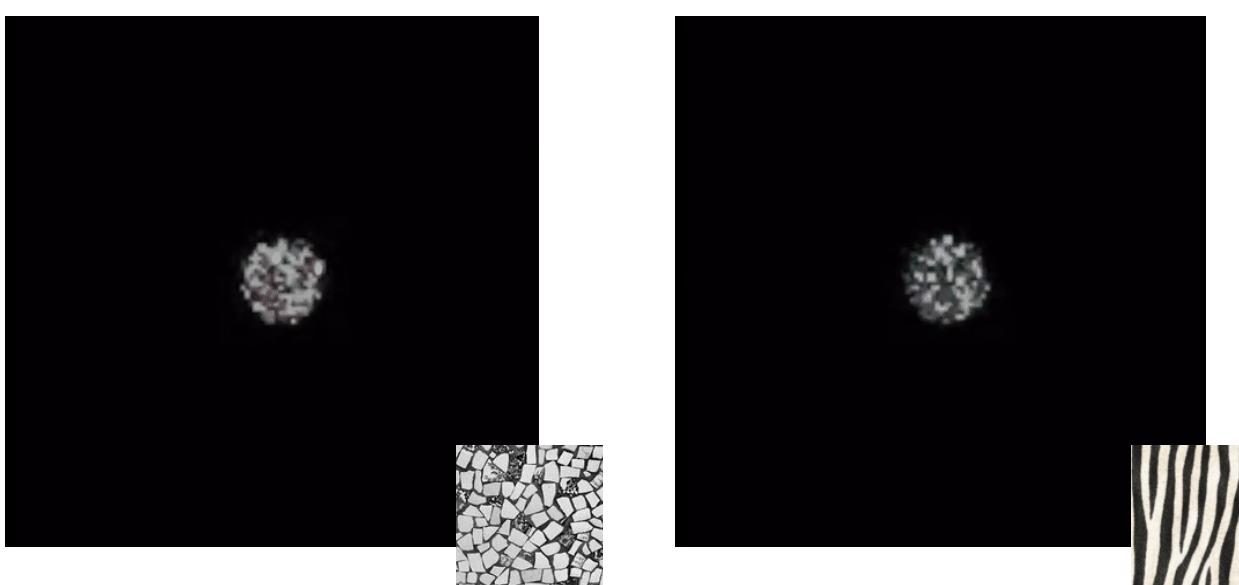
- try to learn to stop a falling green square
- use an extra channel per material type (here 2: green, red)
- look at the message passing at the moment of impact

# Styling the simulation

1.



2.



# Conclusion & Next

- Fun and interesting way to learn DL techniques
- Simple convolutions can learn basics physic dynamics
- The bigger the dataset the more it generalise
- We can learn simple interaction between different materials
- Variety and small timesteps in dataset was key for fluids
- We can mix style NCAs to add effects to the simulation

Minimal target:

- learn simple fluid sim.

Desired target:

- extend to different types of sim.

Bonus:

- 3D
- interaction

Possible future work :

- Optimise the size of the model, smaller and faster the better
- Use real videos of sim as dataset
- Dynamically enrich dataset according to loss