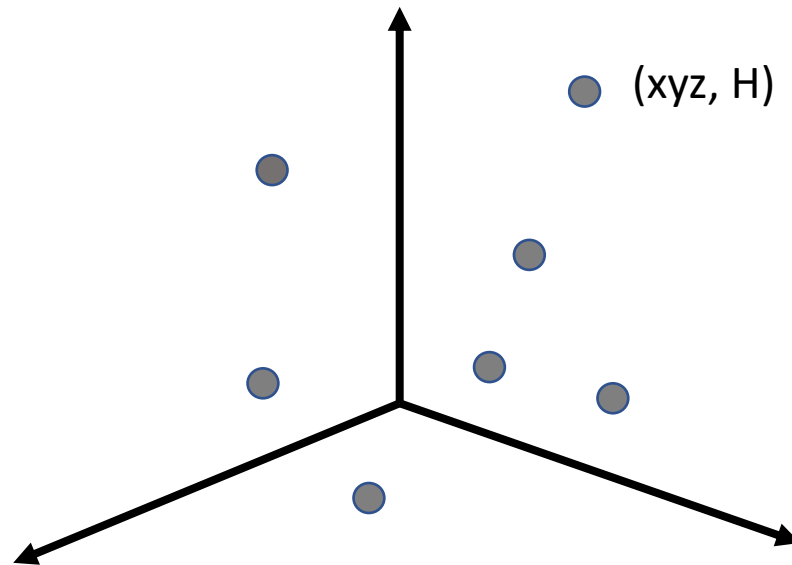# Differentiable Point-Based Radiance Fields for Efficient View Synthesis with imperfect masks

Presenter: Jason Yuan (jcyuan)

Original paper: Qiang Zhang, Szymon Rusinkiewicz, Seung-Hwan Baek, Felix Heide
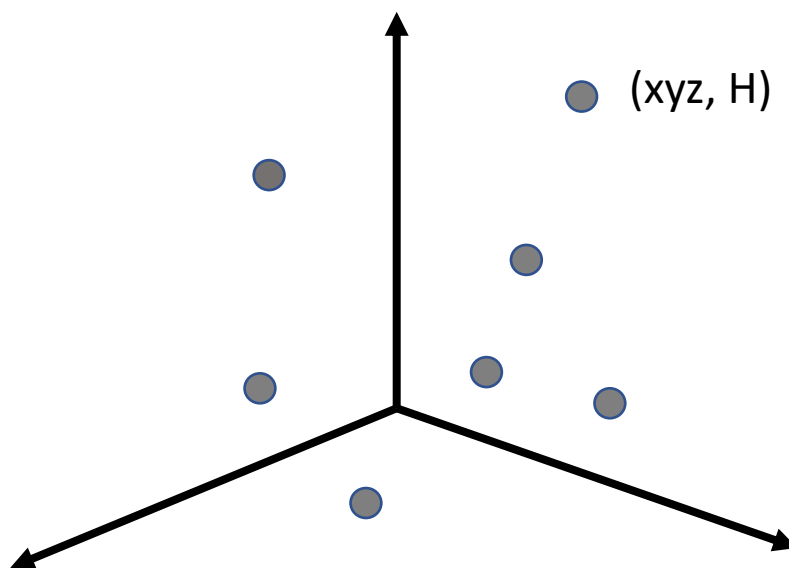Siggraph Asia 2022

Background

Model: 3D point cloud (xyz) w Radiance parameter (H). *Learnable* parameters. Optimize with SGD
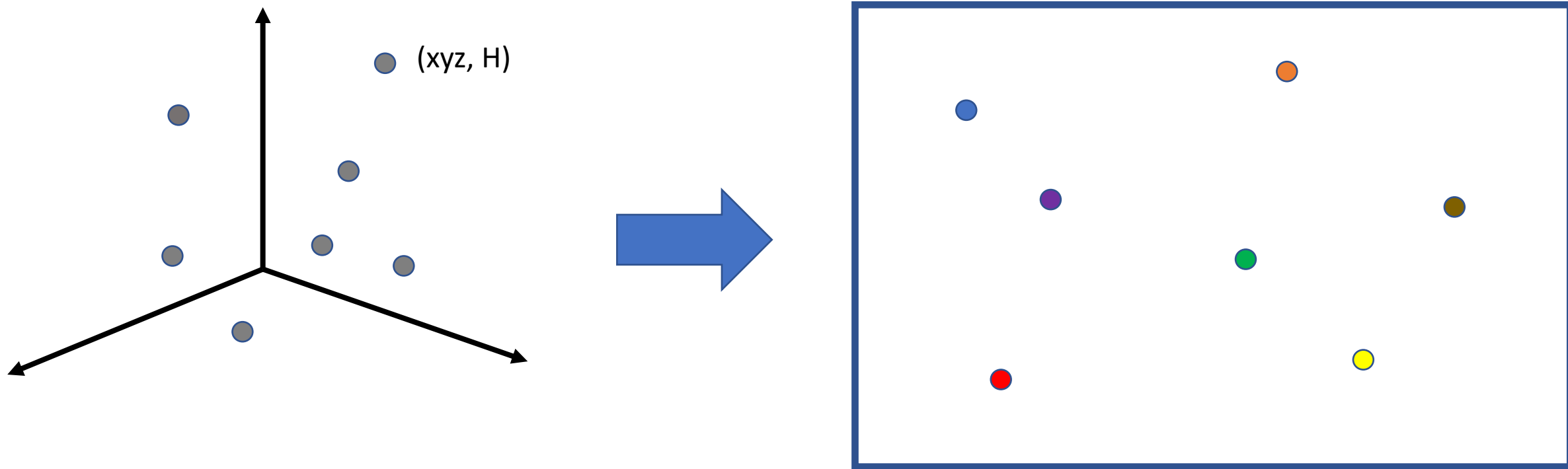

(xyz, H)

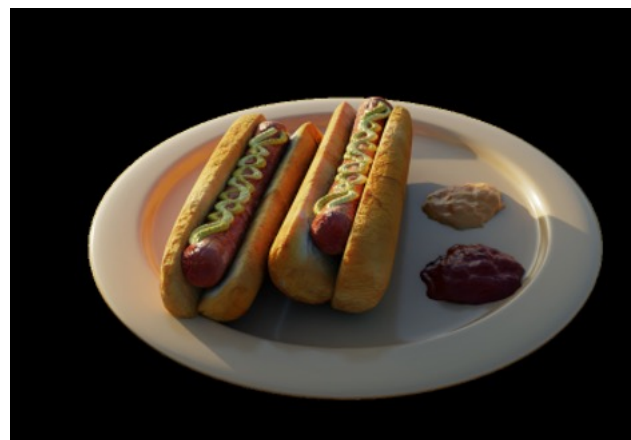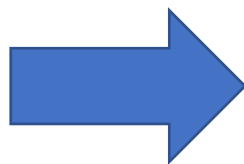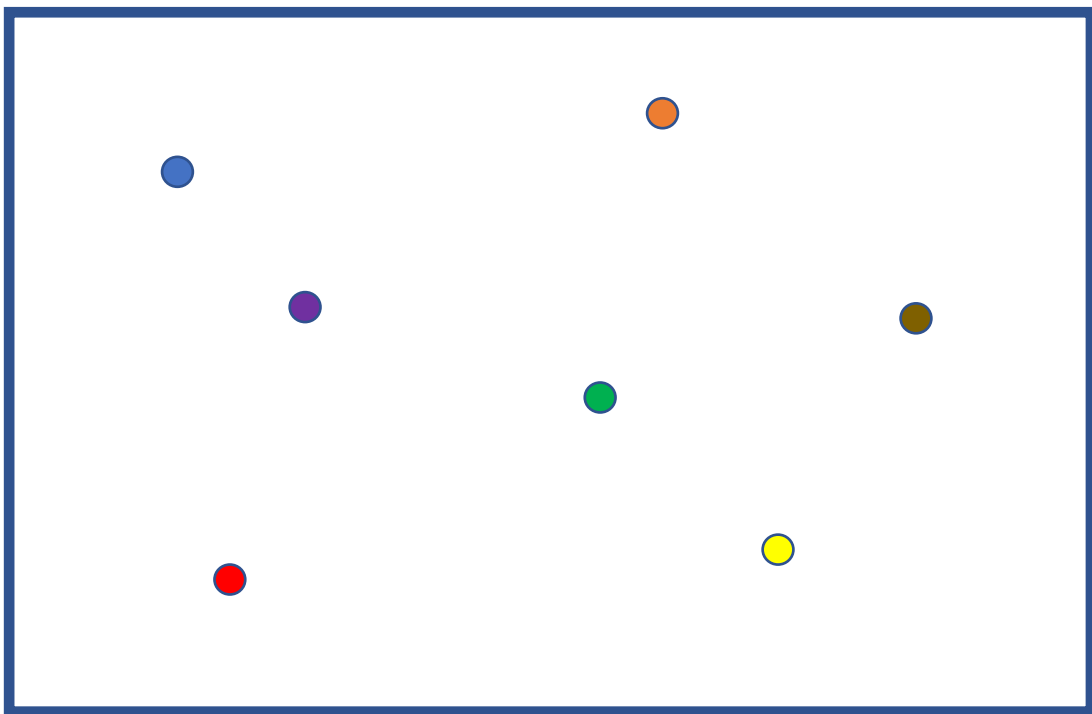Input: viewing direction (i.e. camera intrinsics/extrinsics info, parameters R,t,M)

R,t,M

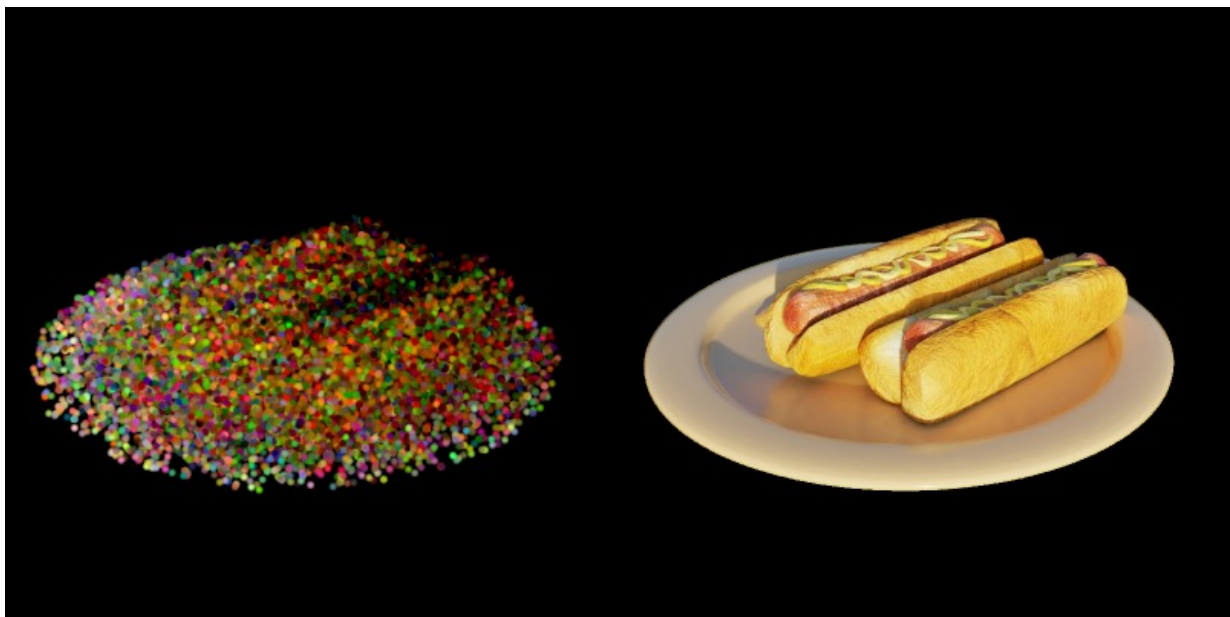(xyz, H)

Use R,T,M to project onto 2D and get view-dependent color
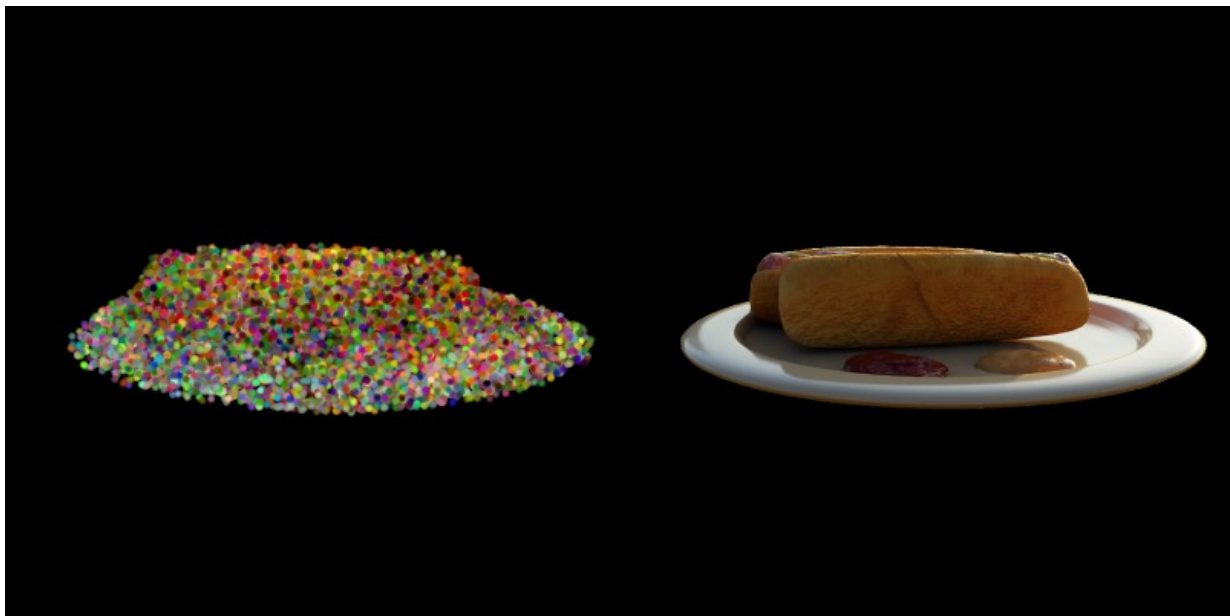

(xyz, H)

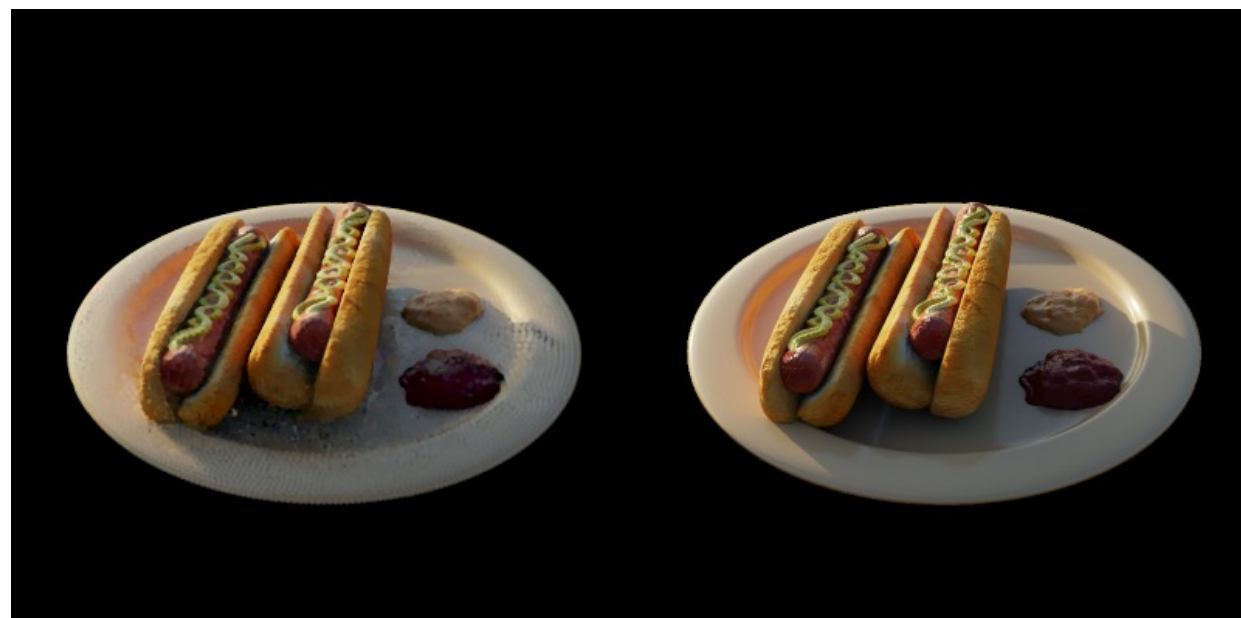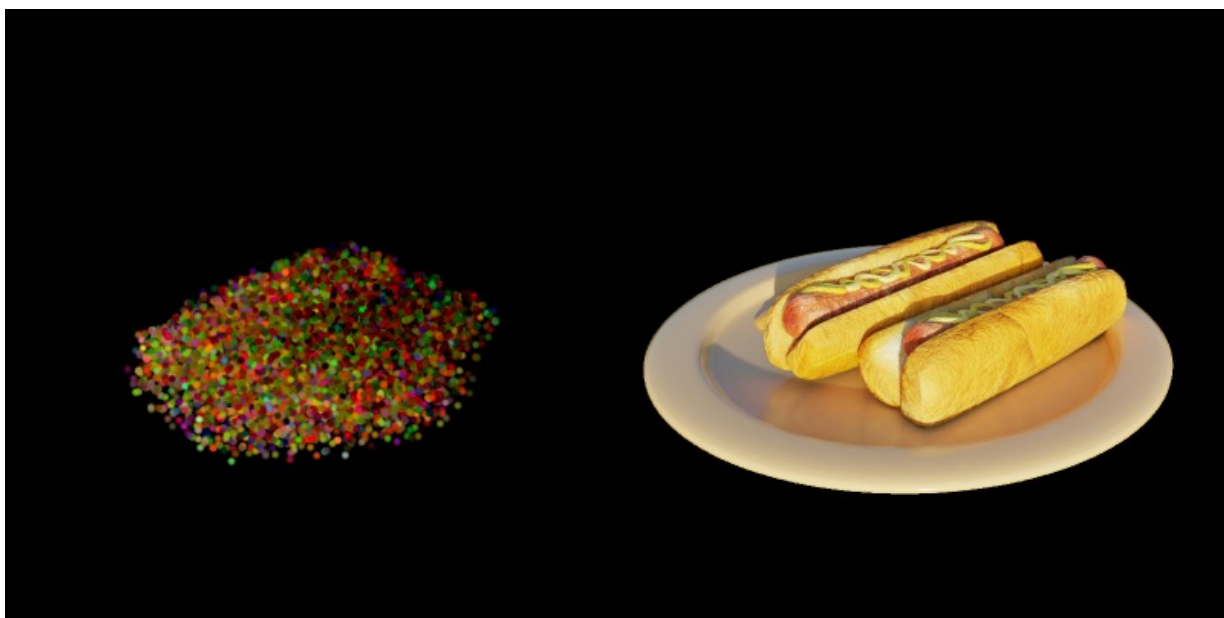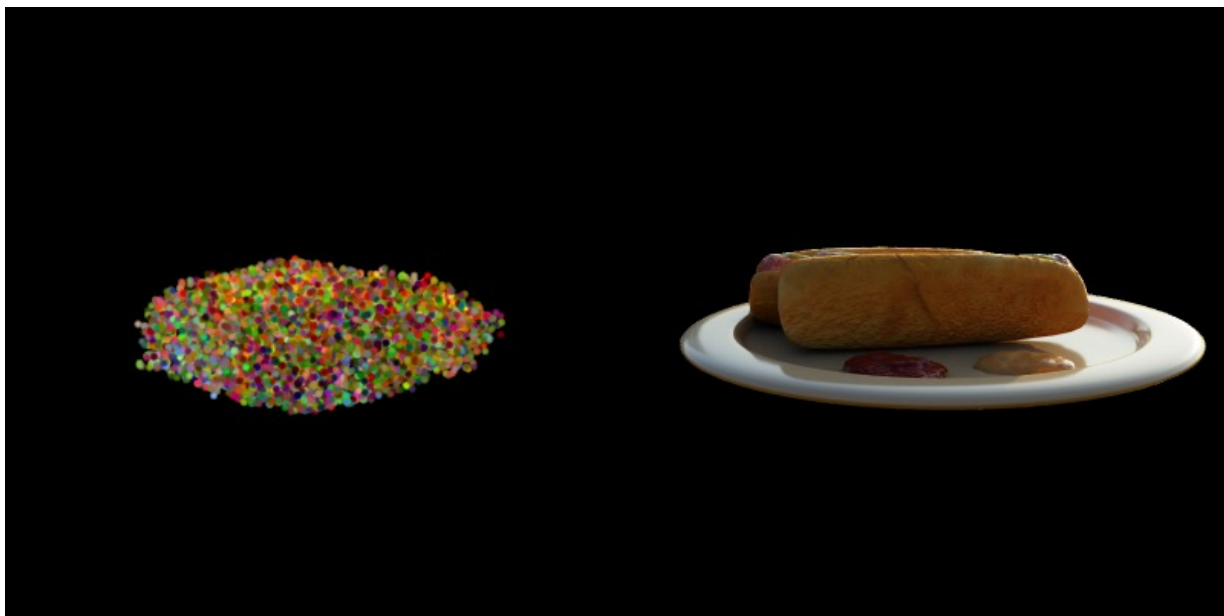Differentiable splat render the points:

Limitations

- Initialization of the point-cloud relies on having good object masks.
  - The algorithm: initialize points uniformly in where you think the volume is, ie spaces in 3D that fall into all of your masks
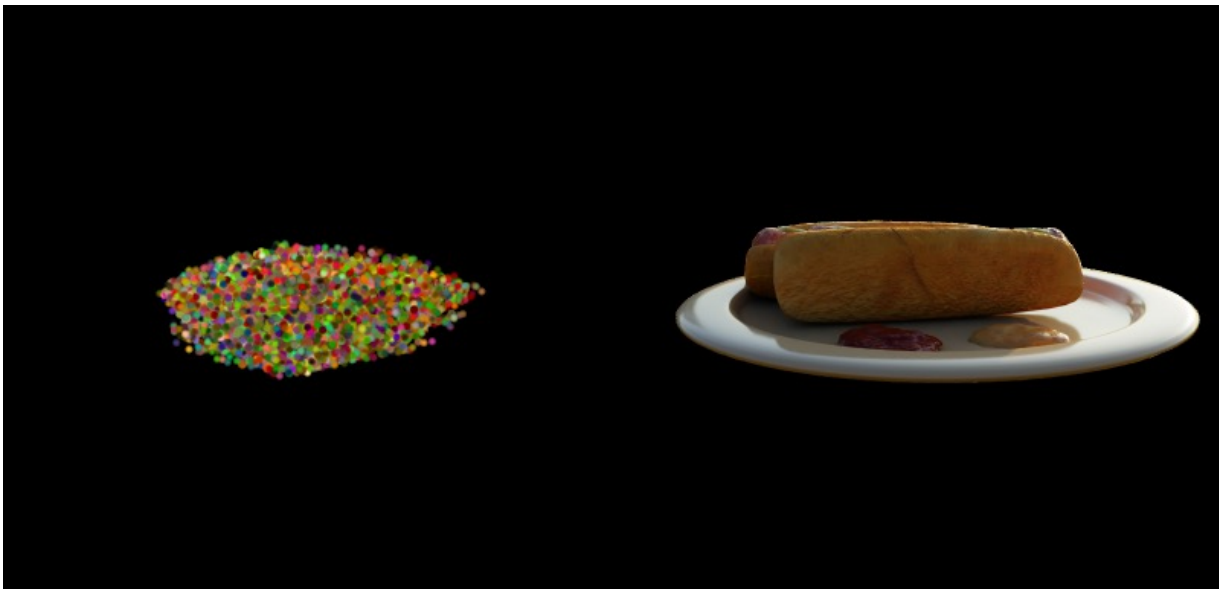
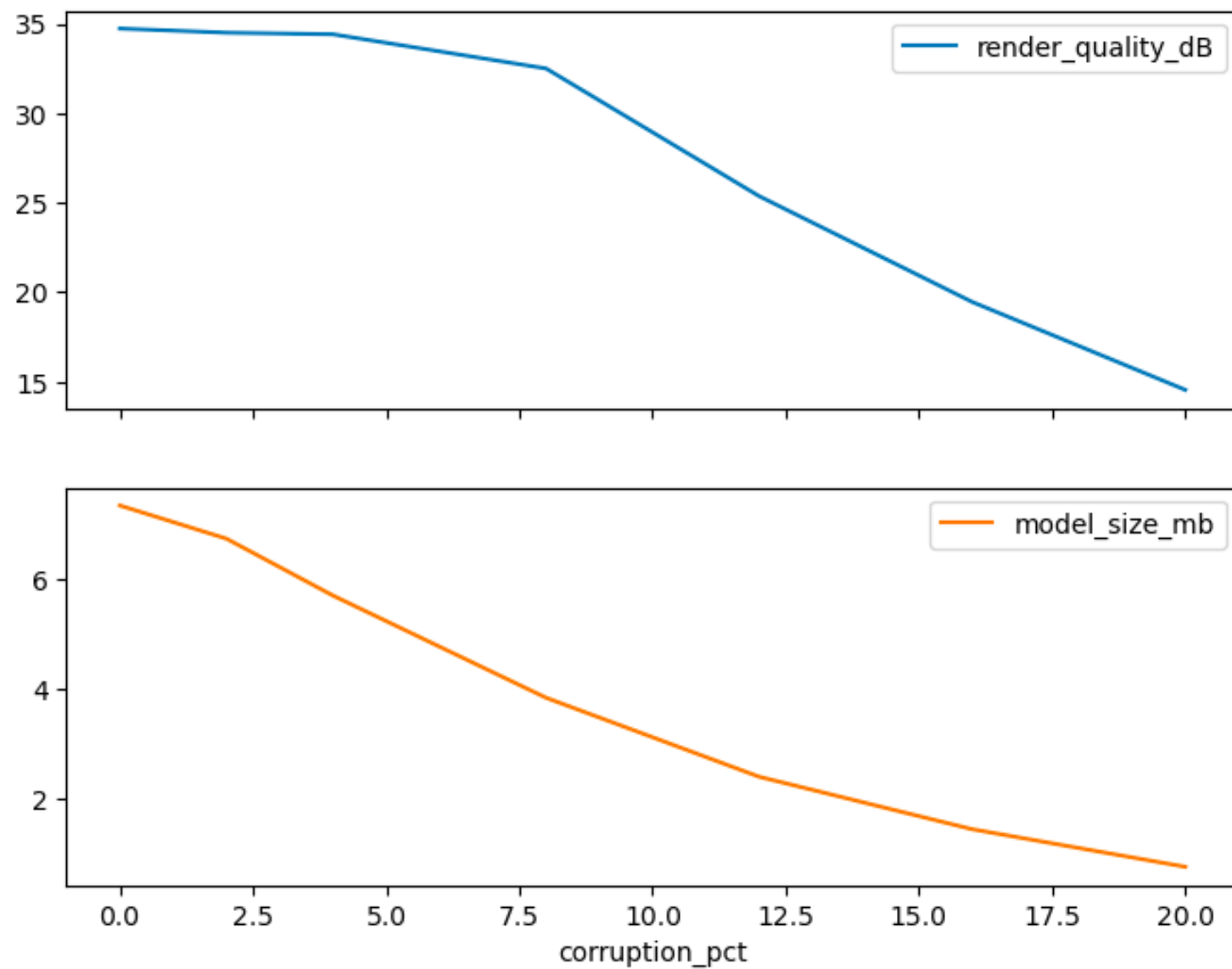# Problem: real world masks are imperfect

Original: mask is very, very good

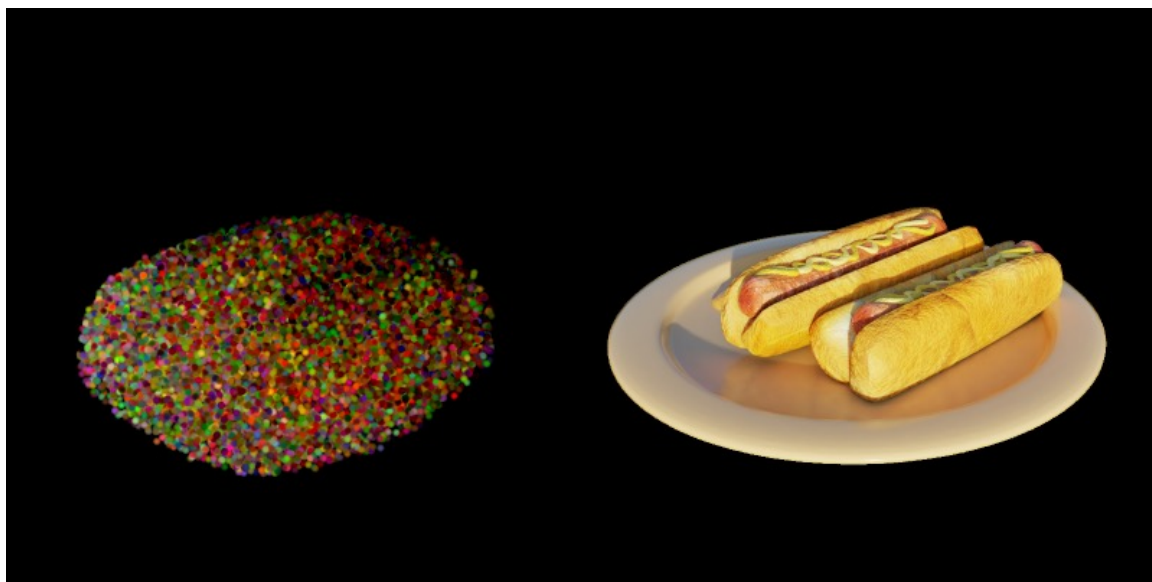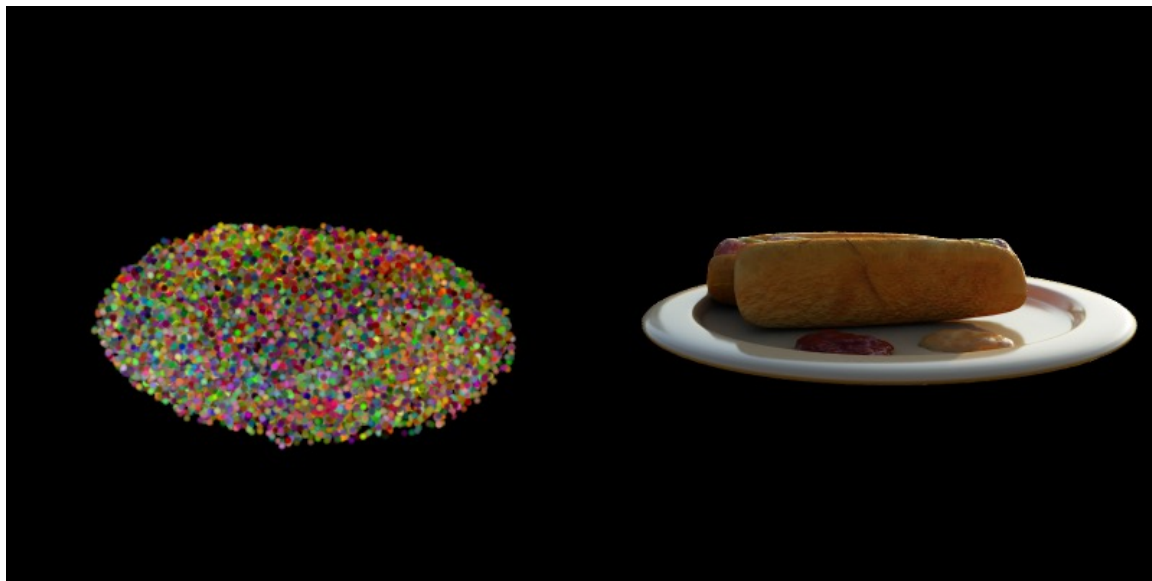8% corruption: initialization not great, quality worsens,

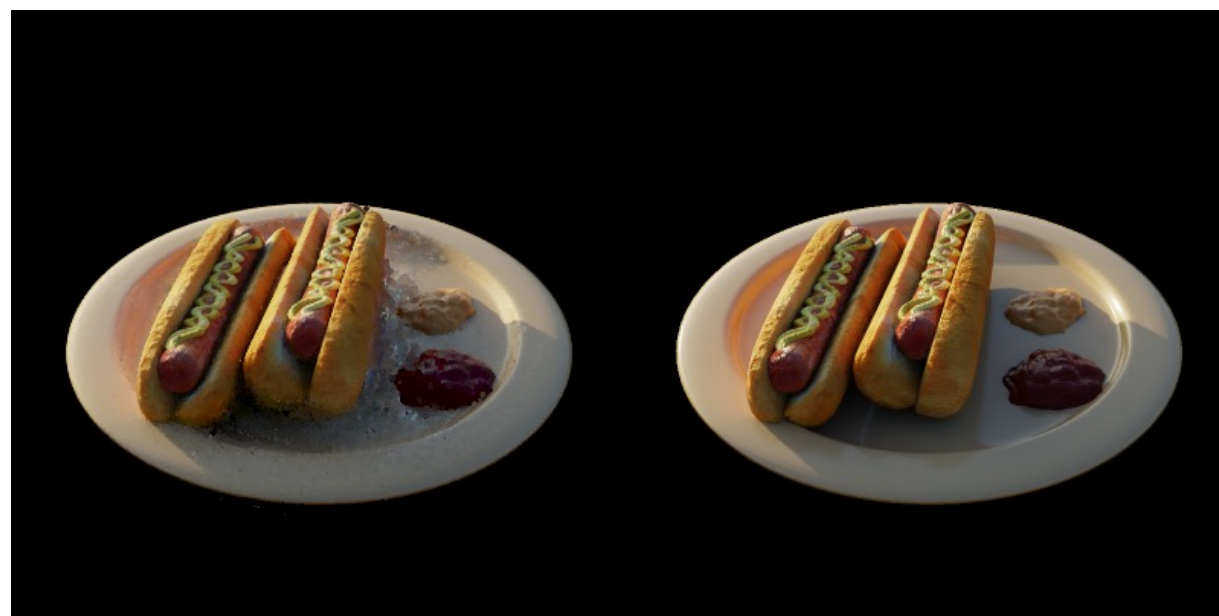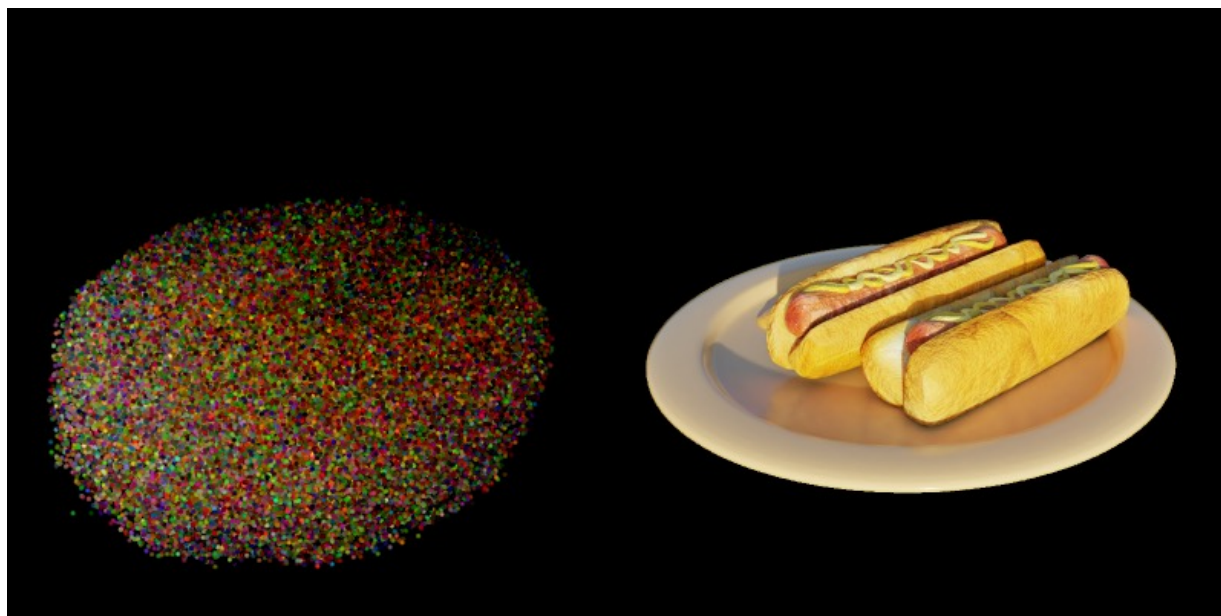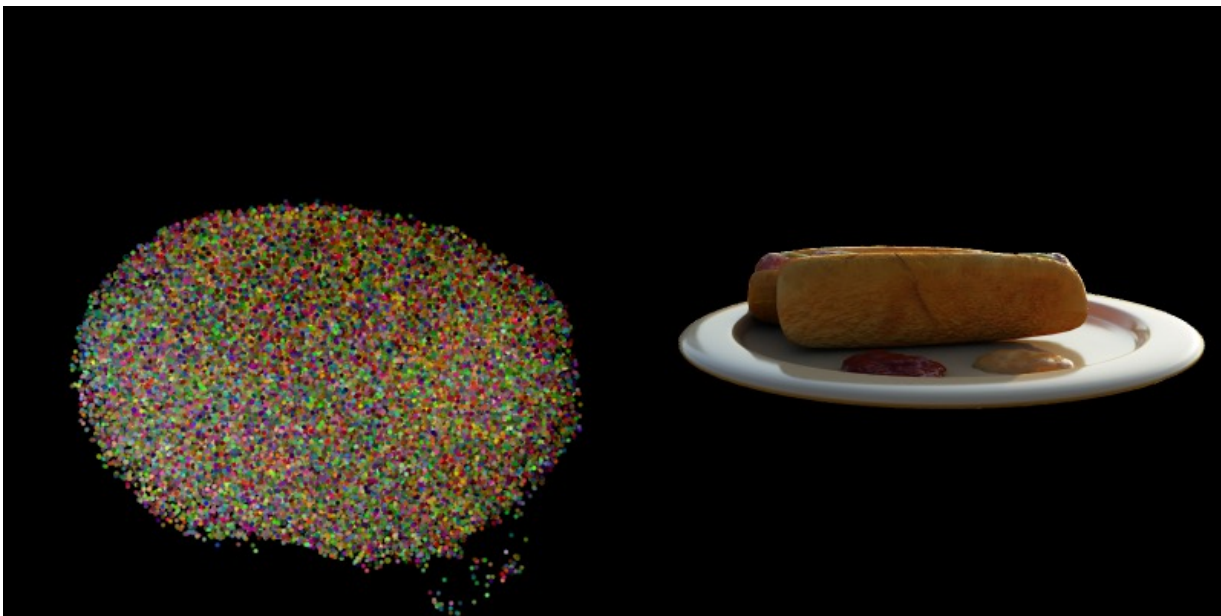12% Corruption: quality even worse, clear that masks are too restrictive

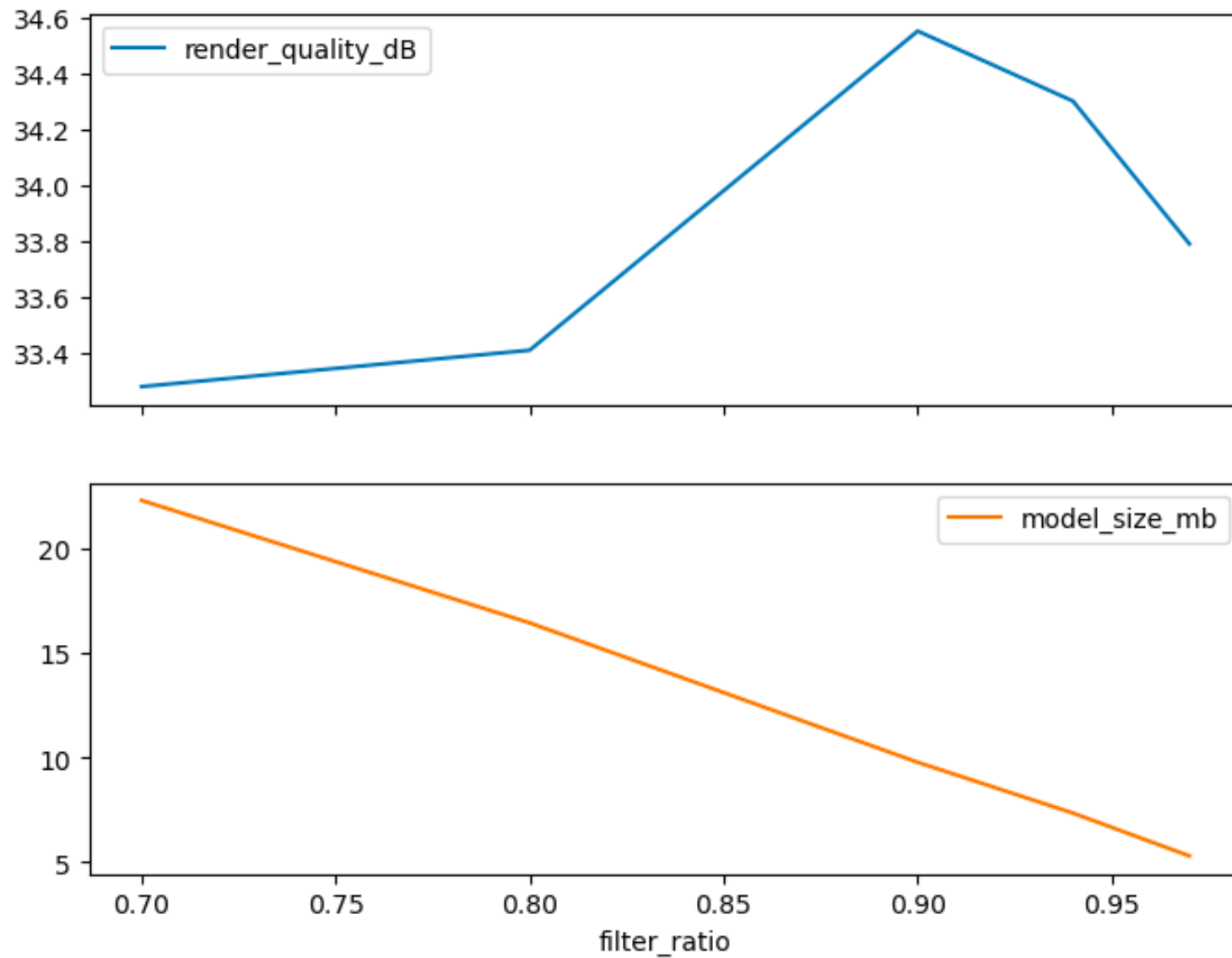As corruption increases, render quality and model size decrease

Solution

Fix corruption at 12%. Relax mask constraint 90%: point cloud is bigger, render quality improves
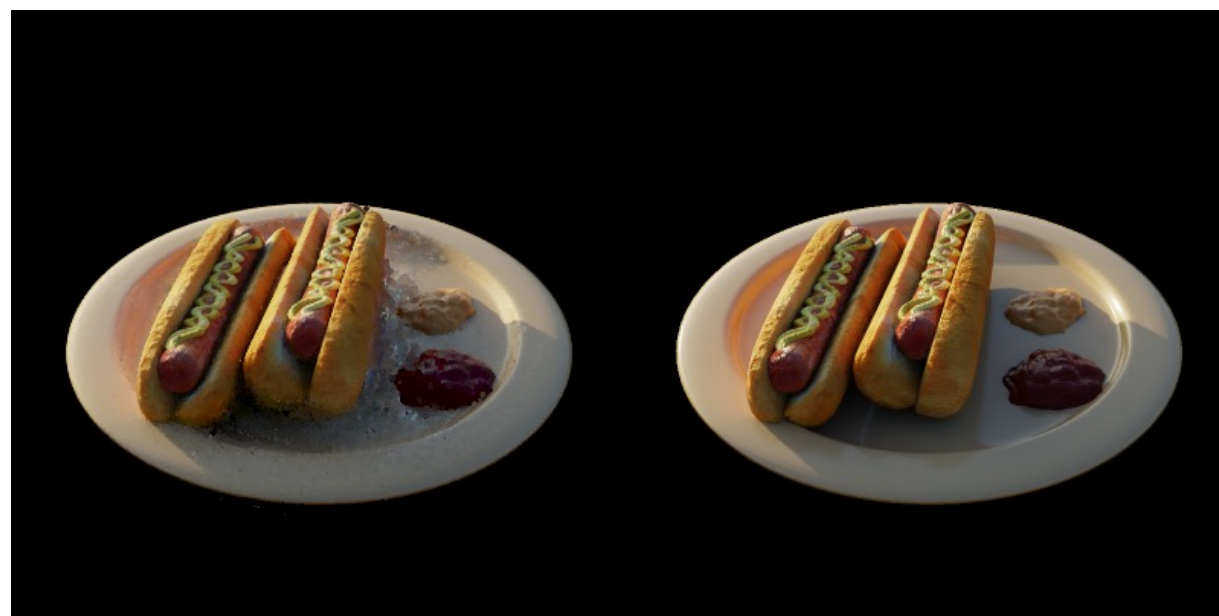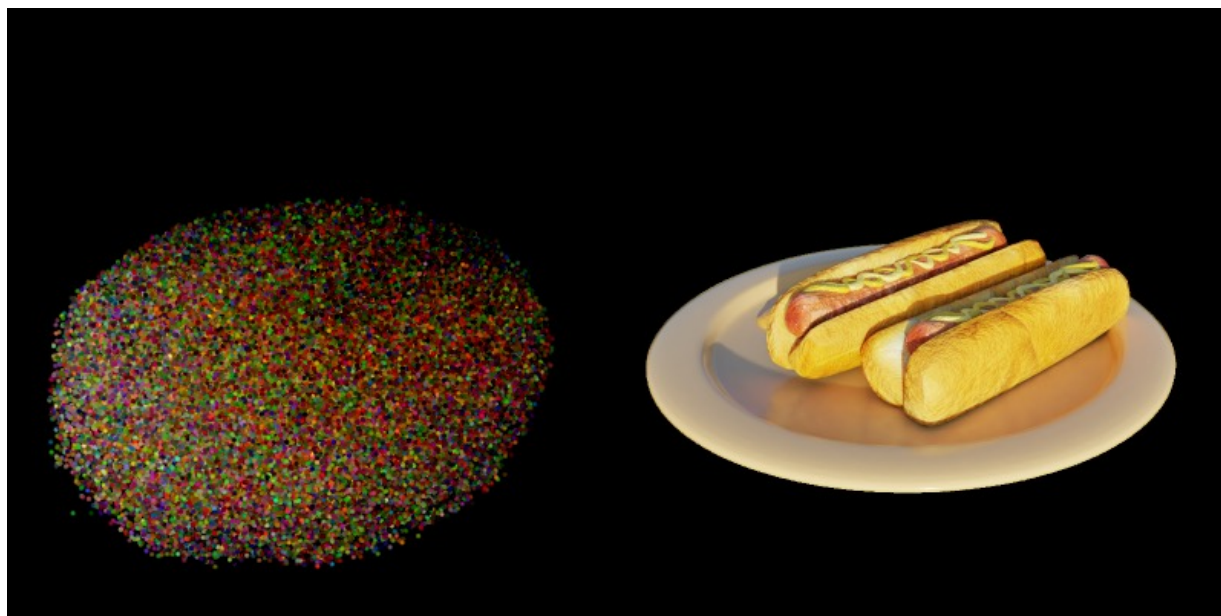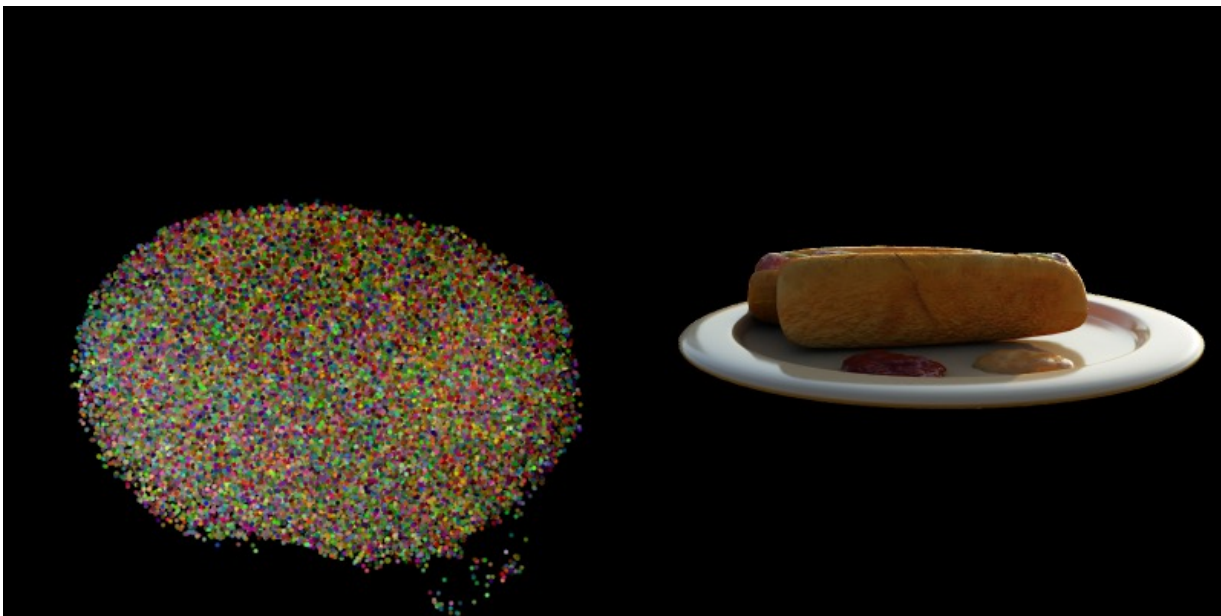
Fix corruption at 12%. Relax mask constraint 70%: point cloud initialization kind of bad, render quality decreases
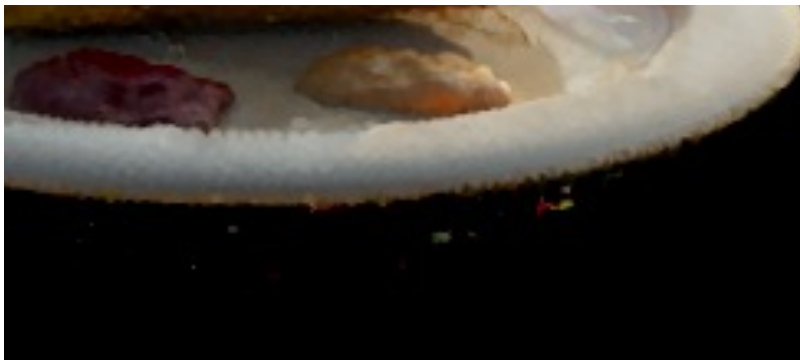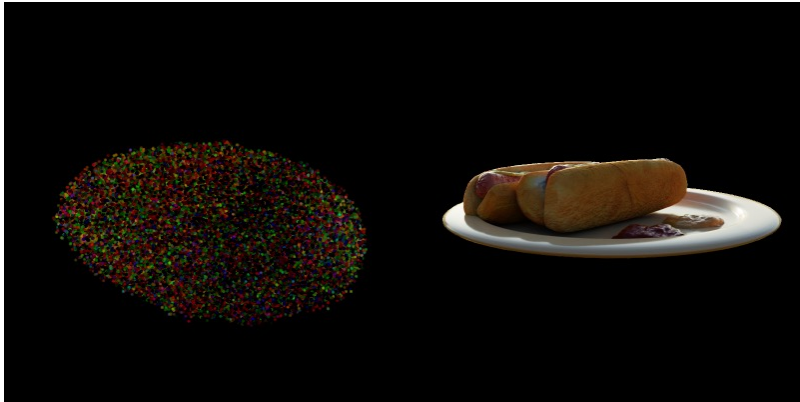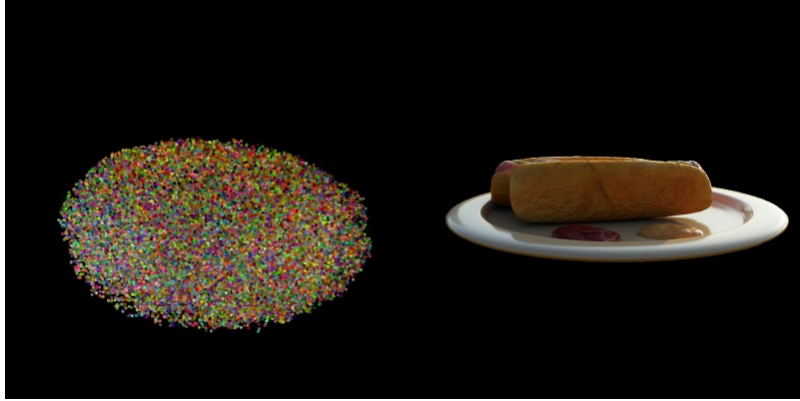
Fixed 12% corruption. Relaxing mask constraint improves render quality until it doesn't. Annoying to tune

Issues with this solution

If constraint too relaxed, presence of outlier points and not inaccurate initialization
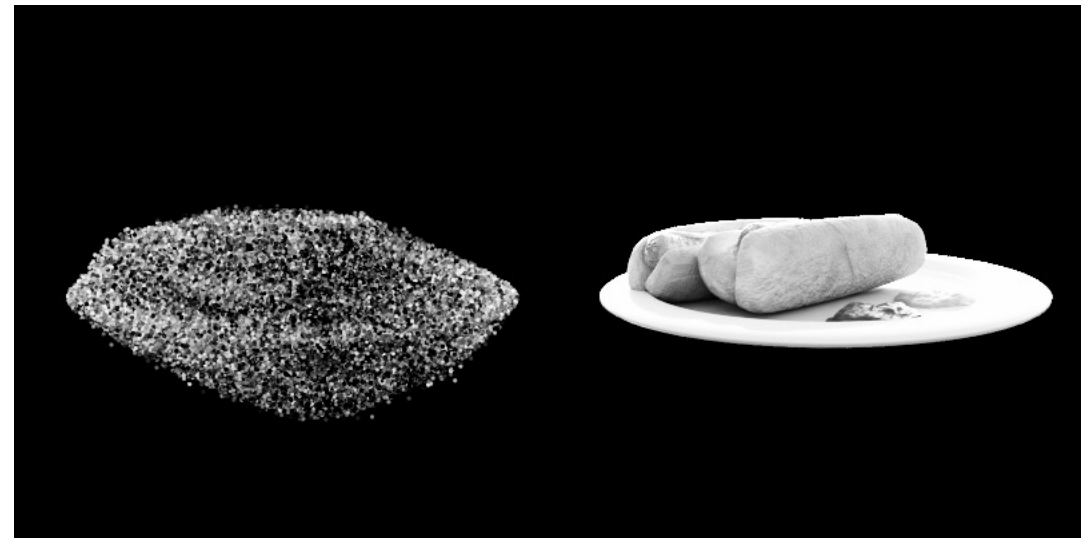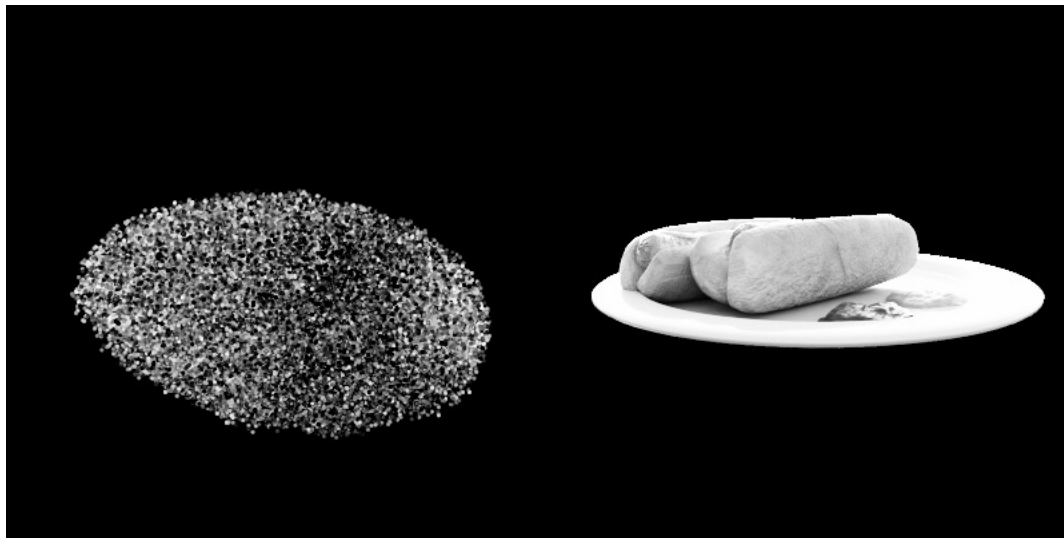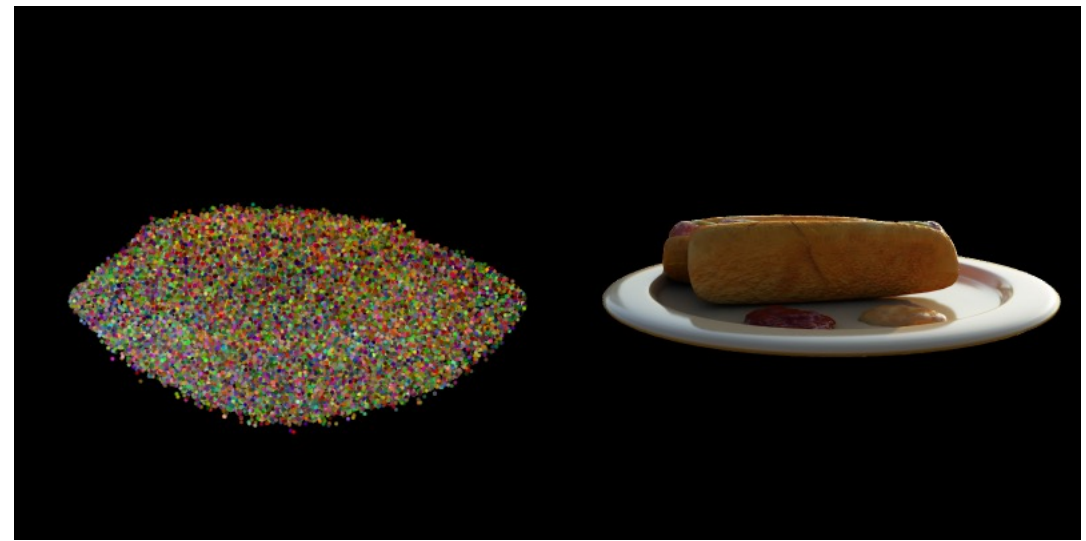
Corruption 12%, Mask constraint 70%:

Poorly initialized points are being blacked out instead moved around (ie position change) -> may be the cause of artifacts

Corrupt 12%, Filter 80%, 5 epochs into training

Solution, v2: relax mask + pretraining step
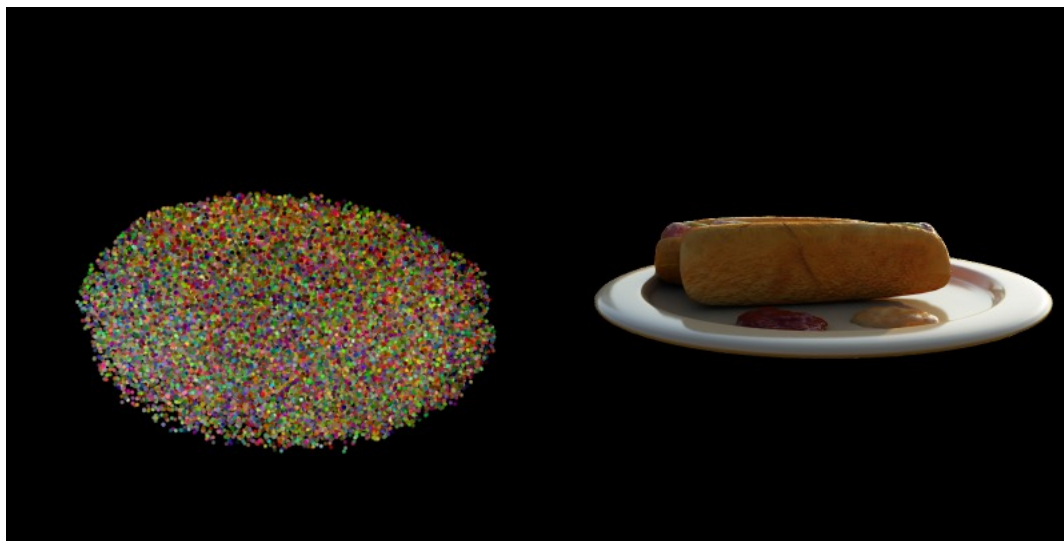
Proposed solution: a few epochs of training, only on the position + regularize (shrinkage towards to center)

Corrupt12%, filter 80%,

rendering quality 33.41 -> 34.12 dB, model size: 16.44 -> 16.08 MB, qualitatively better

12% corruption, 80% masks, + pre training

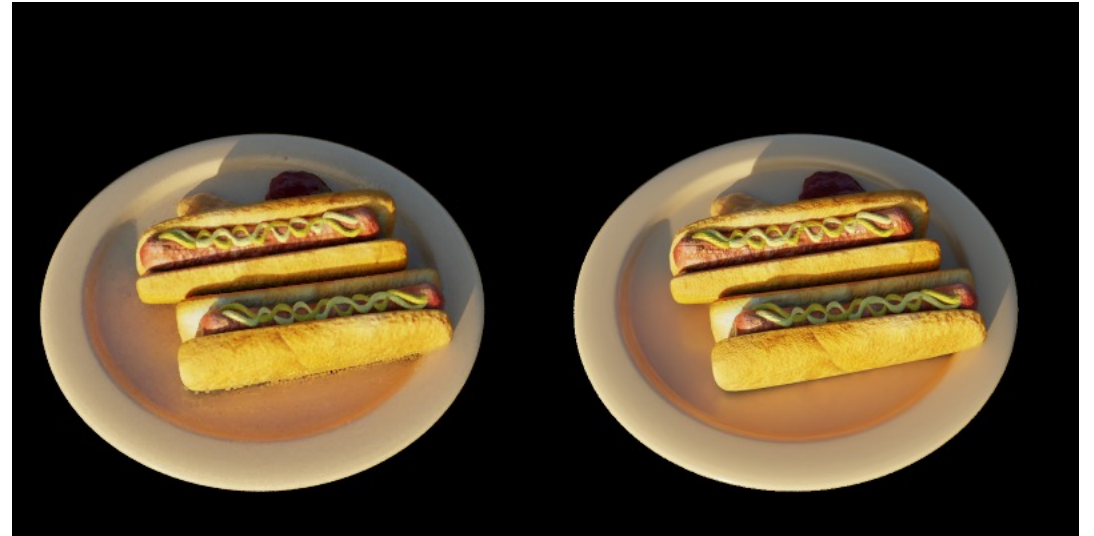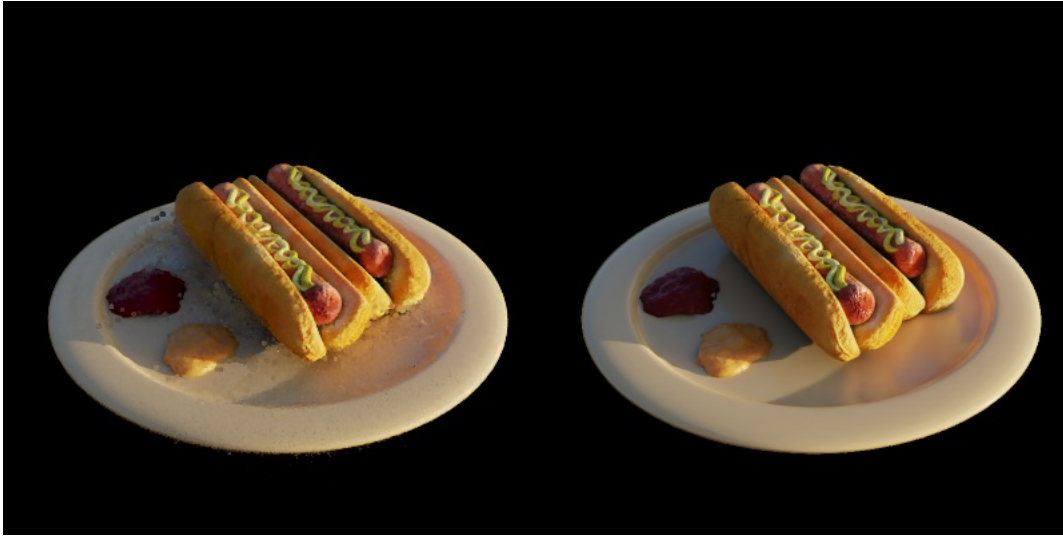More examples of small improvements

12% corruption, 80% masks, + pre training:

Summary

- Point Radiance Fields: fast alternative to NERF
  - But relies on masks

- In real world, masks are imperfect:
  - Showed empirically the degraded performance.

- Solution to this problem: relax mask constraint
  - Showed naïve version works but has new issues
    - Inaccurate initialization -> hard to optimize, artifacts
  - Proposed a potential fix
    - Pretraining + regularization