

Stanford Dome Simulated Reconstruction Results

with backward ray tracing

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Introduction

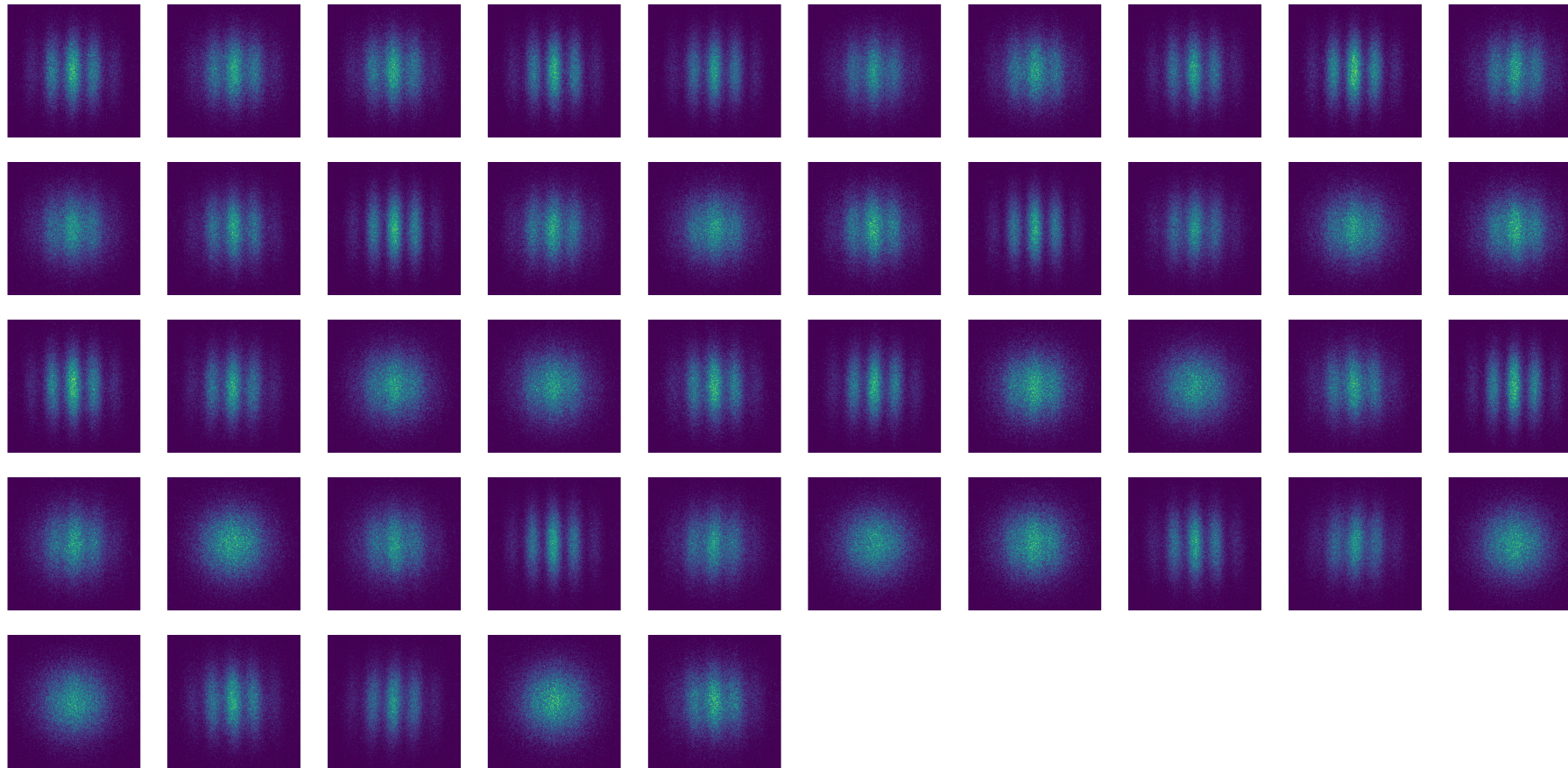
Maxime has been working on reconstruction for the Stanford setup using forward ray tracing

- Running into issues with computation — being able to generate enough rays to get a good reconstruction result
 - Not all rays from the cloud make it to the mirror/sensor

Today:

- First results running reconstruction with backward ray tracing (using Maxime's code as a starting point)
- Similar setup to paper results with:
 - One ray per pixel (origin at pixel center)
 - Pinhole camera model (traced through the center of lens)
- Next step is to include Maxime's rendering equation results for a full lens model

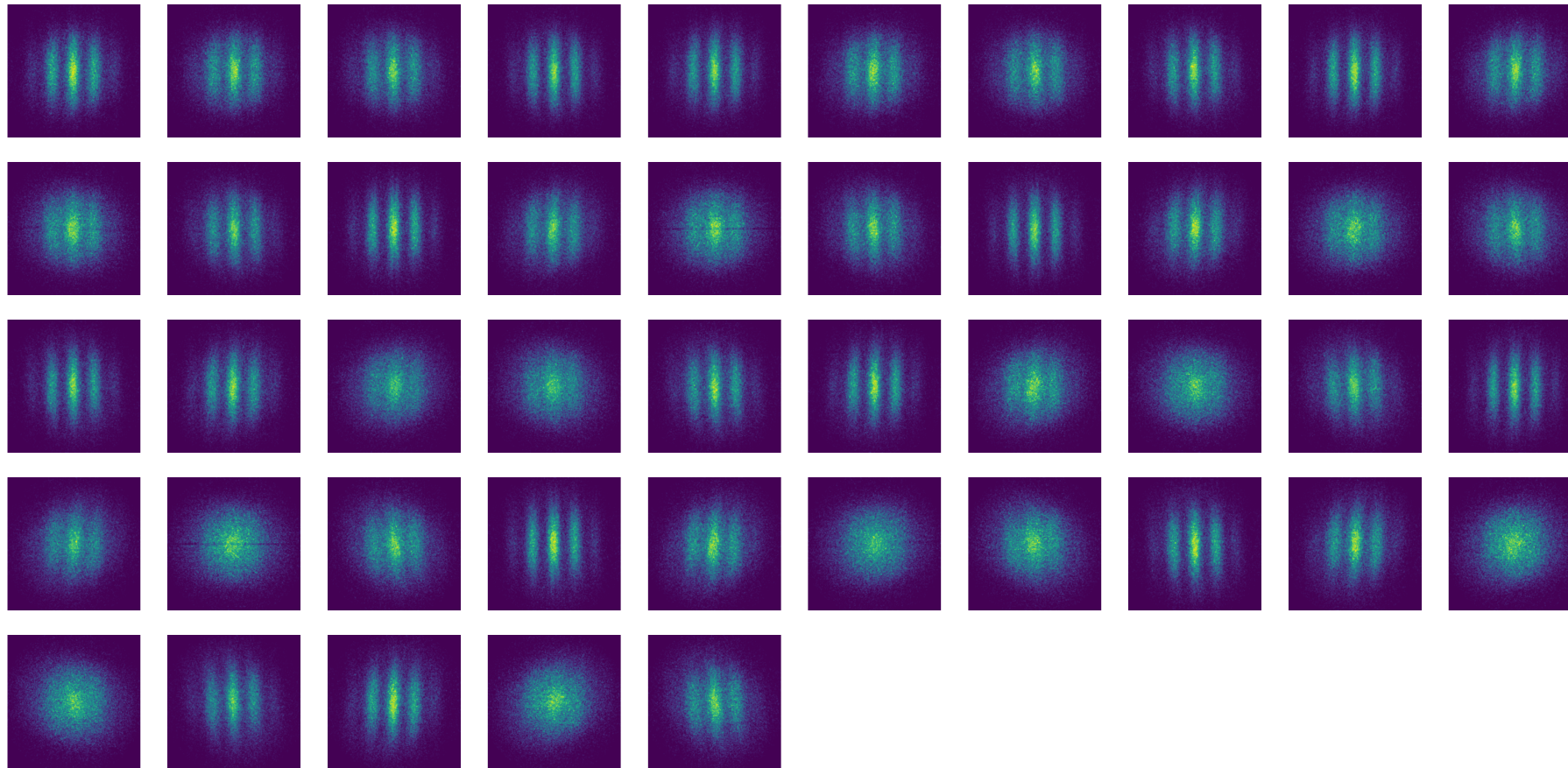
Data



For the following, we use forward ray traced images (above) as “measured” data, which include all lens effects

- 45 usable images with 200 x 200 pixel patches on a 13mm x 13mm sensor, plan to change to 13.1mm x 8.7mm, which will reduce views

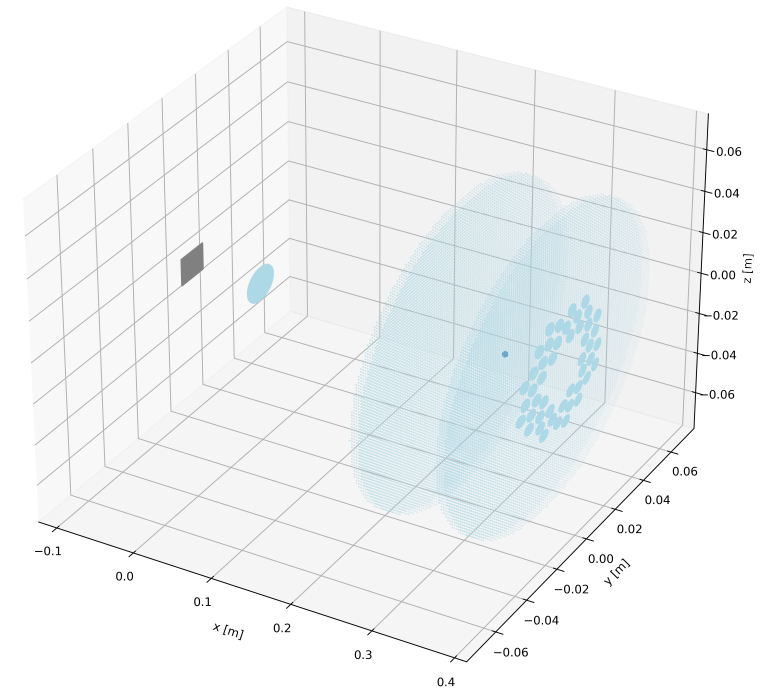
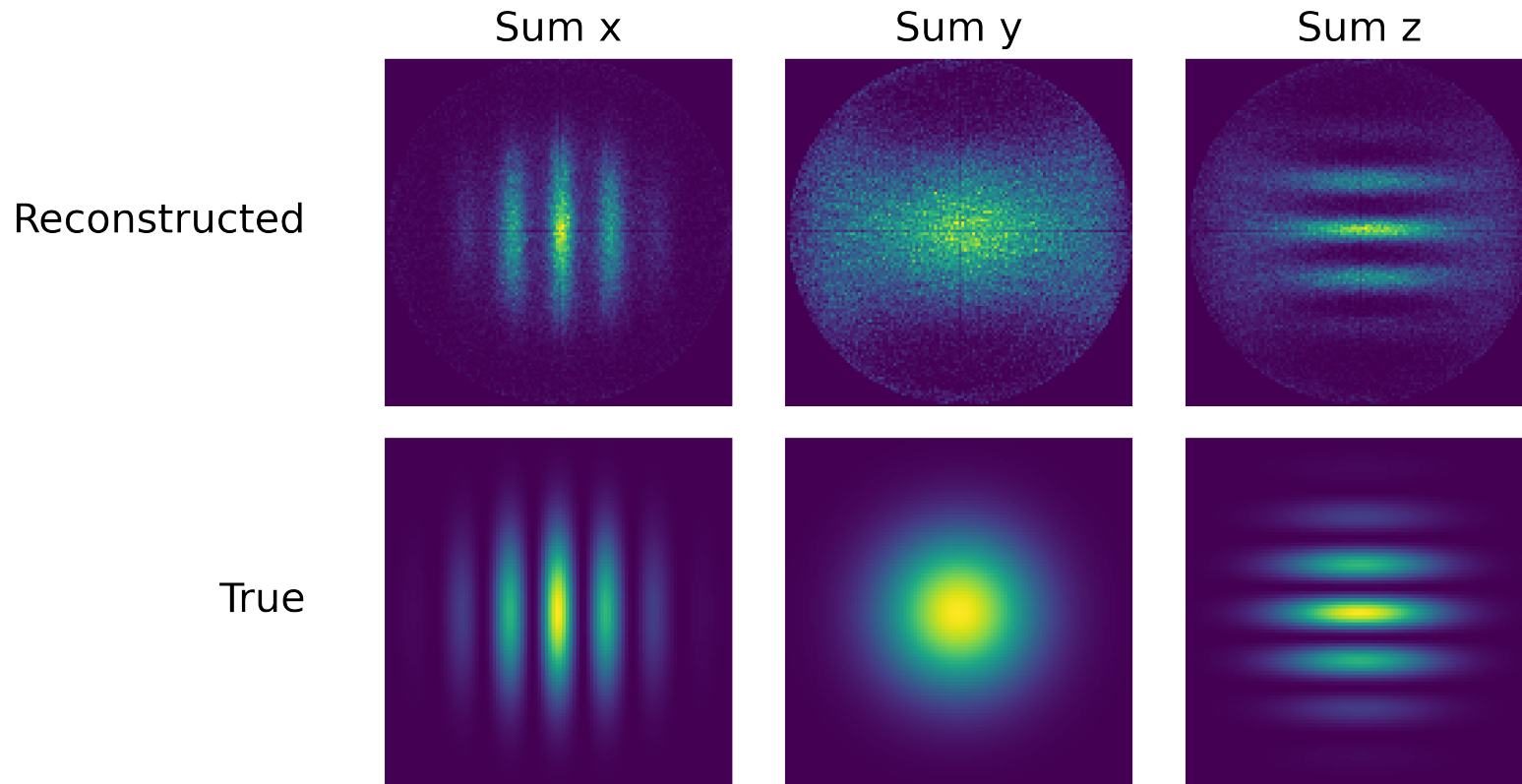
Voxel Reconstruction



Reconstructed views from voxel fitting

- Cube of 128 voxels per 2.6mm side, initialized at 0 (MC integration along rays in a 1.3mm radius sphere)
- Batch 1024 pixels/rays, 64 MC integration points per ray, 1400 training iterations (loss flattens out)

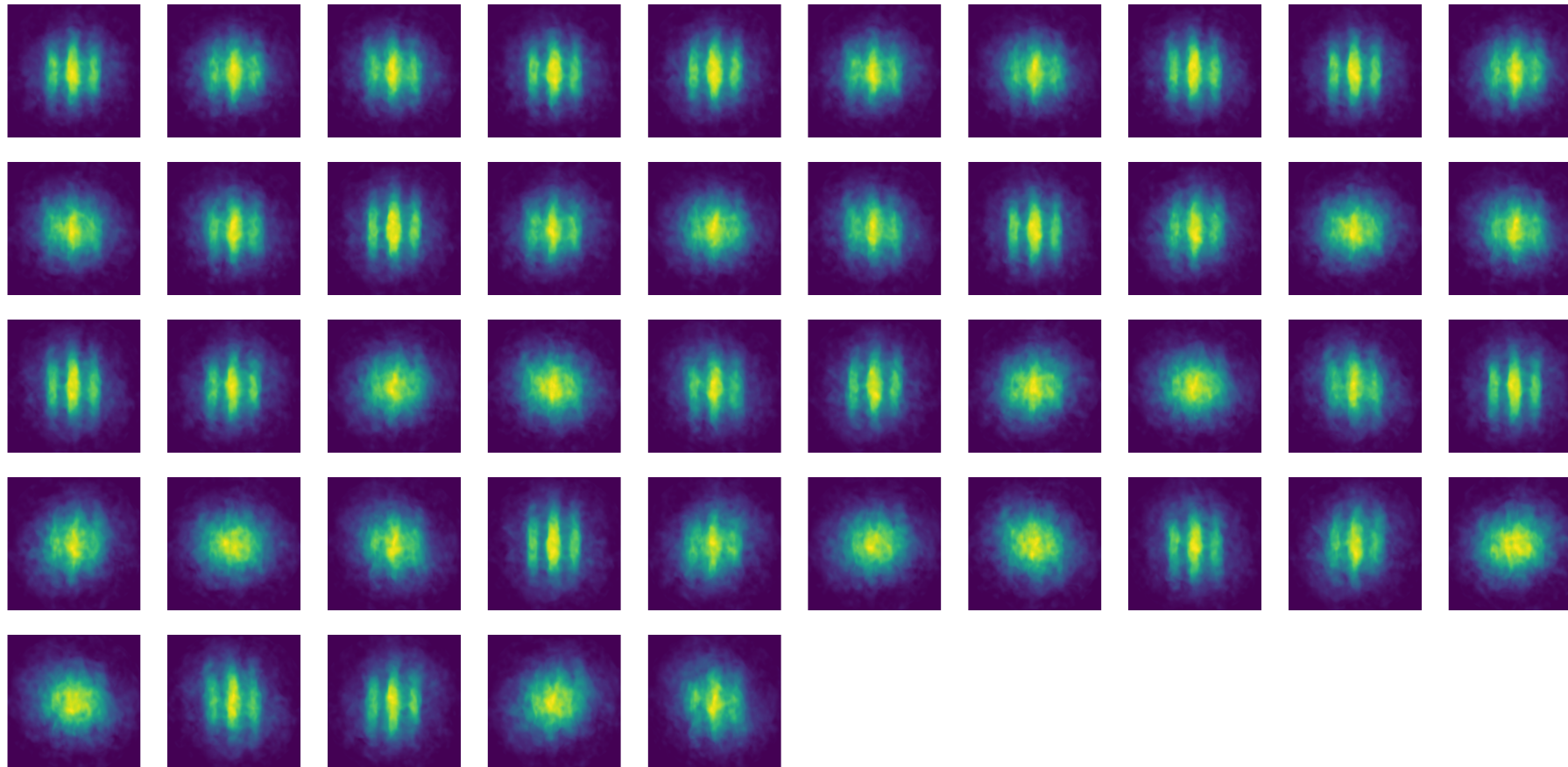
Voxel Reconstruction



Fun 3D plots to come — but marginals, summing along each direction. True density includes no imaging setup

- General features reconstructed, fringes are aligned with x (camera/mirror axis)
- Depth (e.g. sum along y) is a bit less constrained

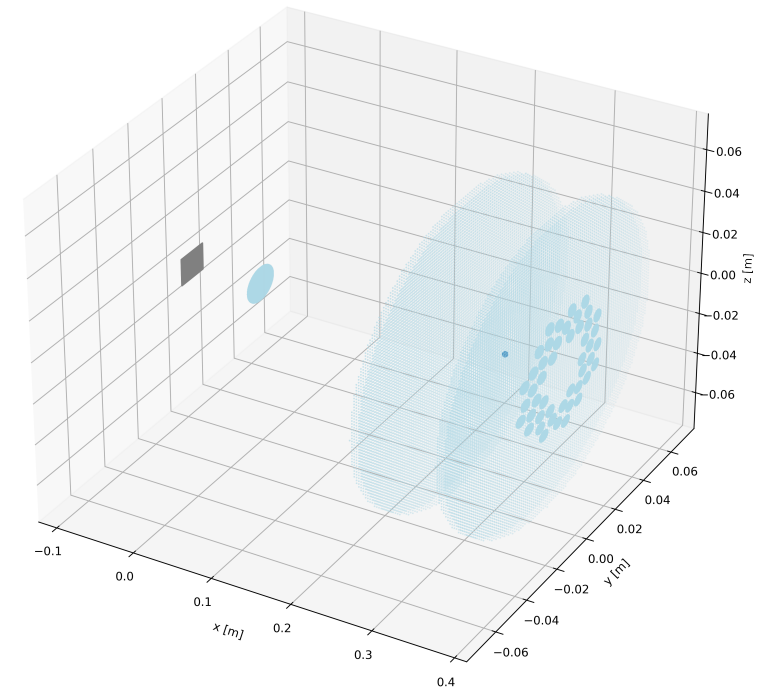
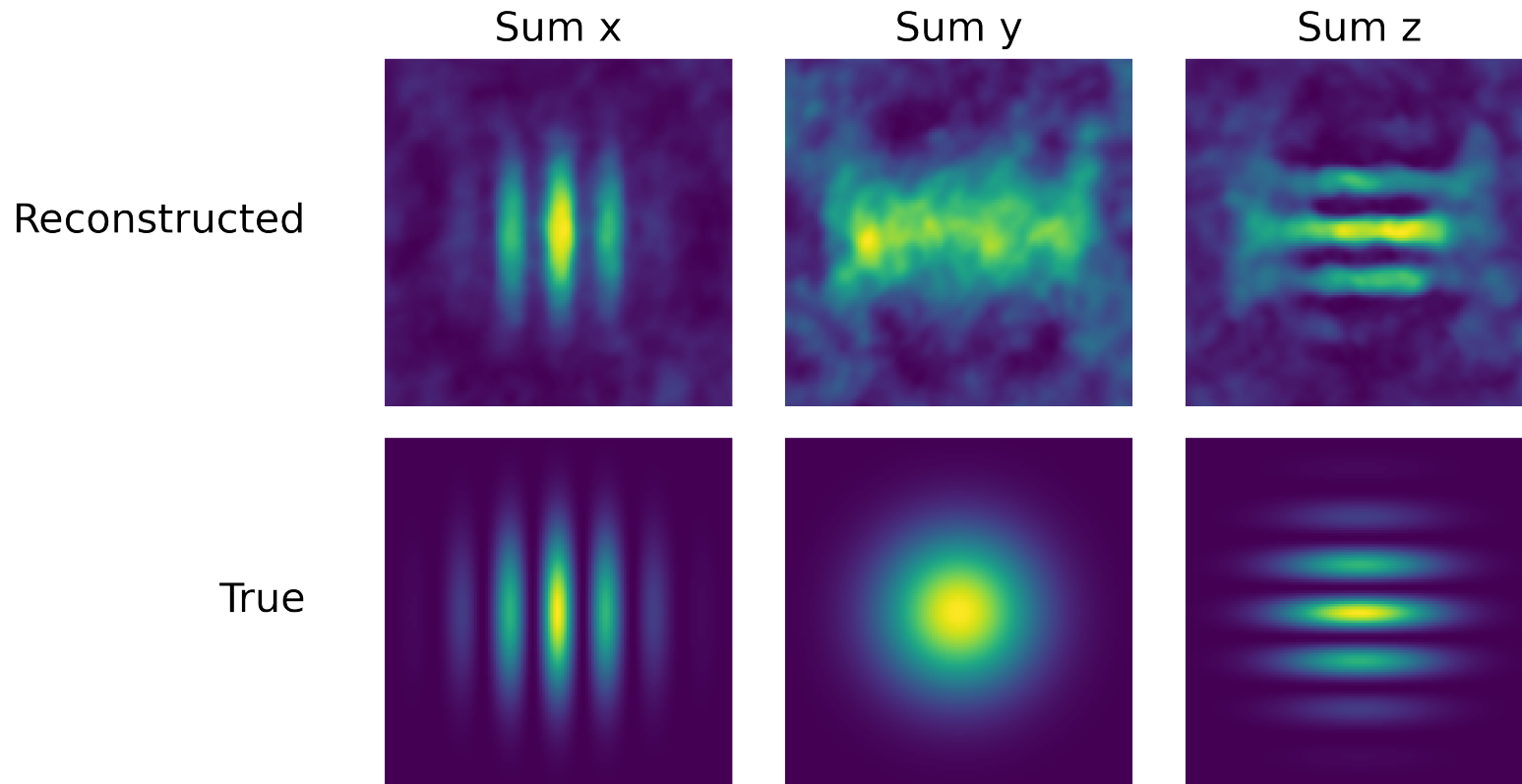
SIREN Reconstruction



SIREN neural network reconstruction (more preliminary)

- MC integration along rays in a 1.3mm radius sphere, batch 1024 pixels/rays, 64 MC integration points per ray, 20,000 training iterations (loss flattens out)

SIREN Reconstruction



Marginals, summing along each direction. True density includes no imaging setup

- General features reconstructed, fringes are aligned with x (camera/mirror axis)
- Similar macro features as voxel reconstruction — depth a bit less constrained

Conclusions

Pinhole model backward ray tracing reconstruction seems to work ok for both a voxel and a neural network model

- Simulated data uses forward ray tracing which includes full lens model
- Features are reconstructed, but notable spread in depth reconstruction, likely due to limited range of angles

Next steps:

- Incorporate full lens model
- Move to real sensor size (will lose a few more views)
- Studies of degradation (?) — e.g. how do we do if features aren't axis aligned
- Reconstruction improvements
 - Importance weighted MC samples, regularization, etc