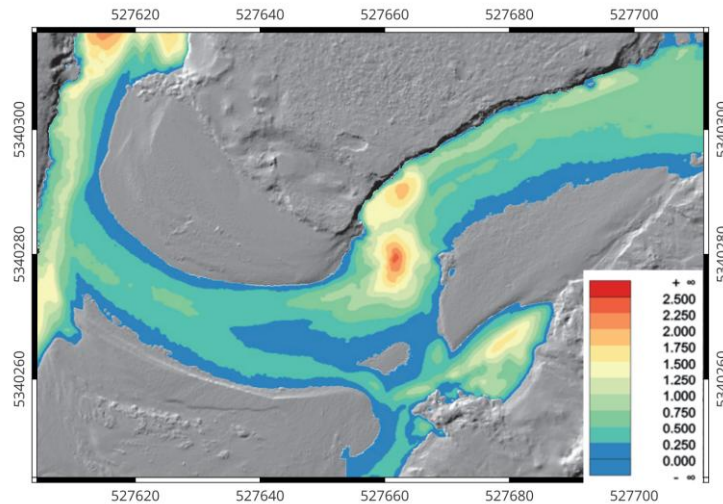


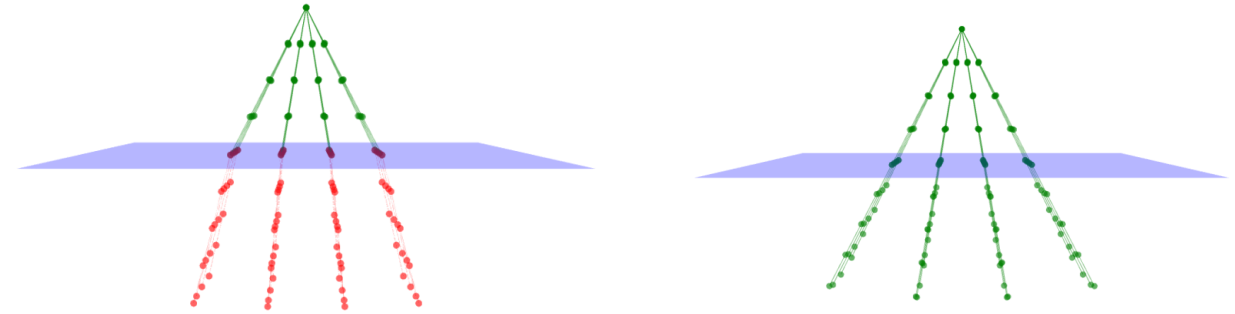
Analysis of refraction-aware neural radiance fields (NeRFs) for 3D reconstruction of underwater scenes



Markus Brezovsky, Anatol Günthner, Frederik Schulte, Lukas Winiwarter, Boris Jutzi, Gottfried Mandlbürger

Agenda

- Motivation
- Methods
- Problems
- First results
 - Real world dataset
 - Simulation dataset
- Outlook

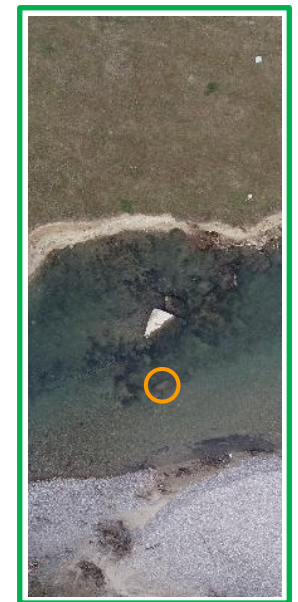
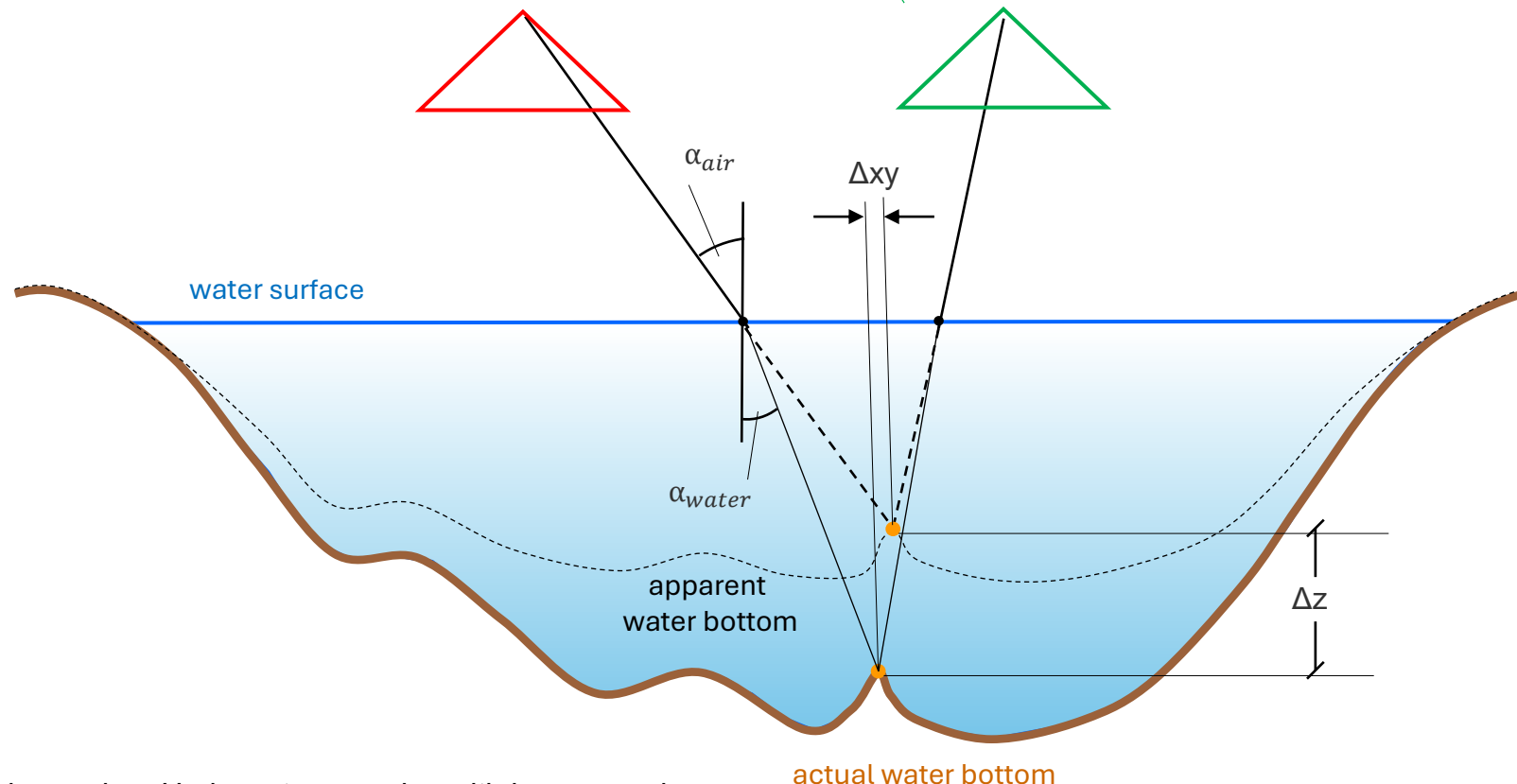
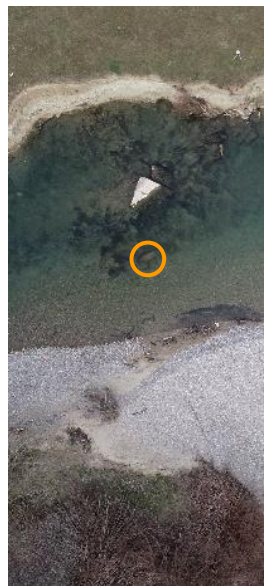


Bathymetry - the measurement of depth

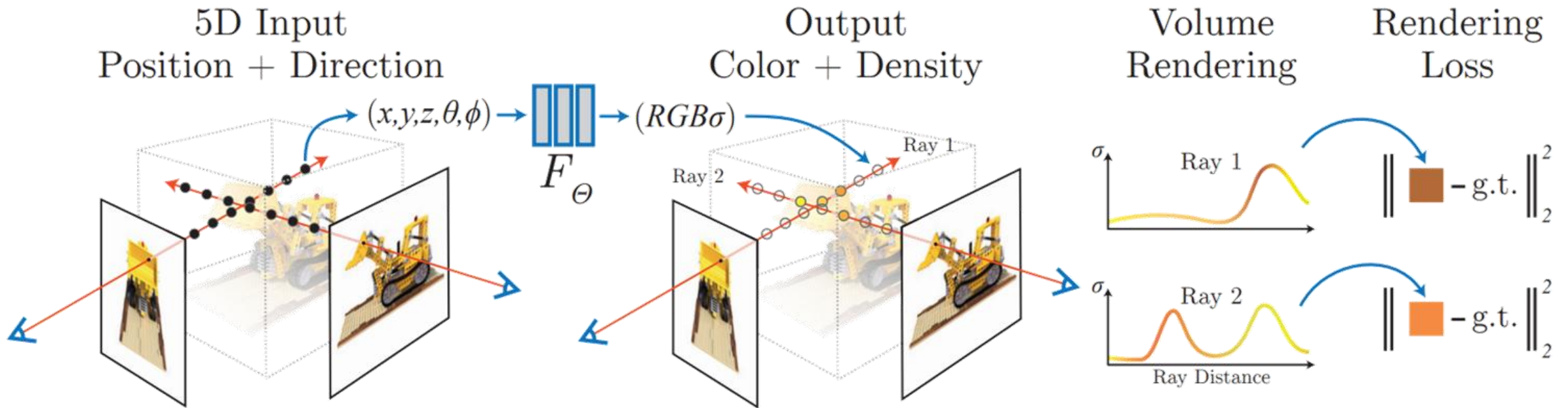
- "bathys" (βαθύς) meaning "deep"
- "metron" (μέτρον) meaning "measure"

$$\frac{n_{air}}{n_{water}} = \frac{\sin \alpha_{water}}{\sin \alpha_{air}}$$

Snells' law of refraction

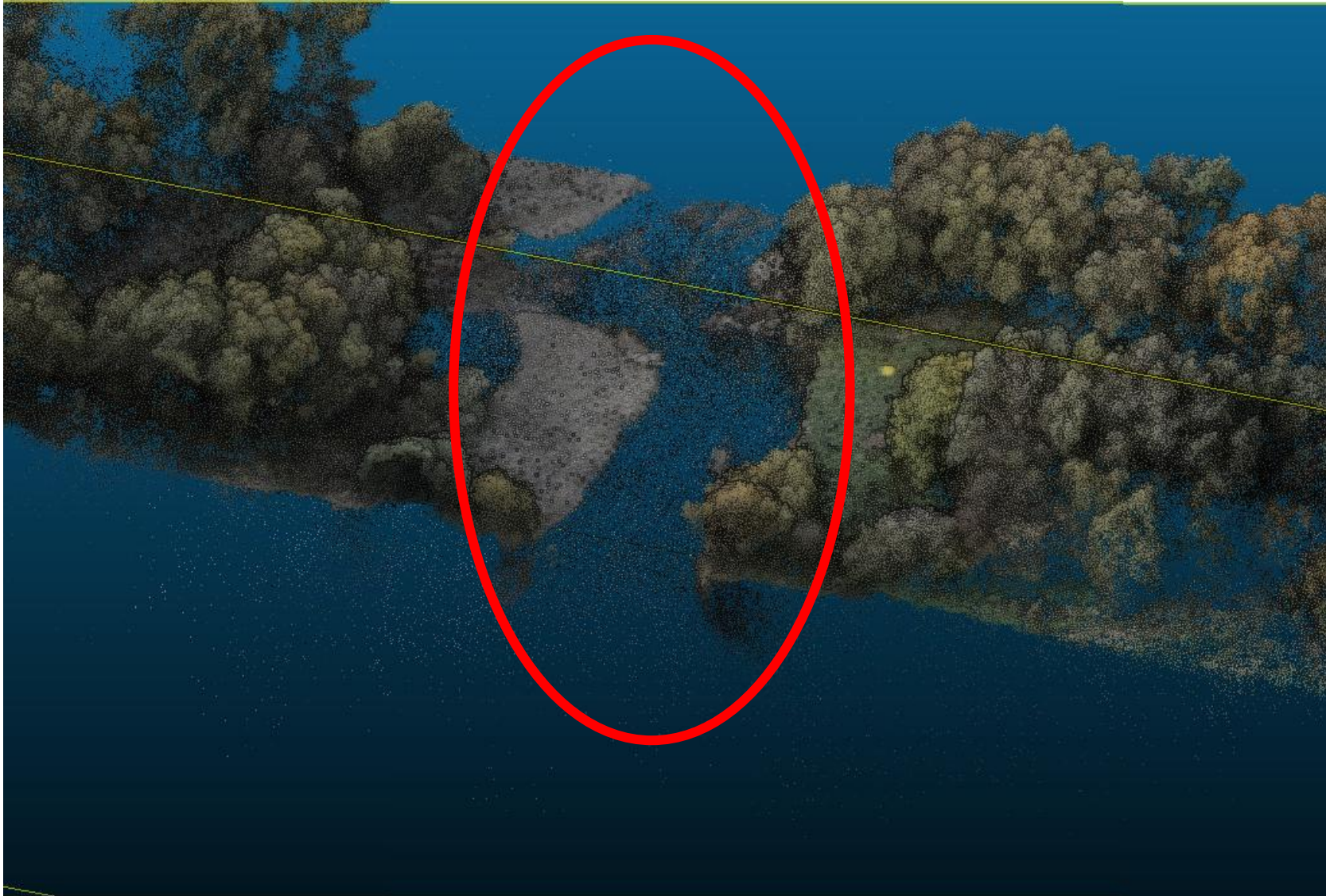


Method – NeRFs



Mildenhall, B., Srinivasan, P. P., Tancik, M., Barron, J. T., Ramamoorthi, R., & Ng, R. (2020). NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis.

Problem of standard NeRFs



Aim: 3D reconstruction

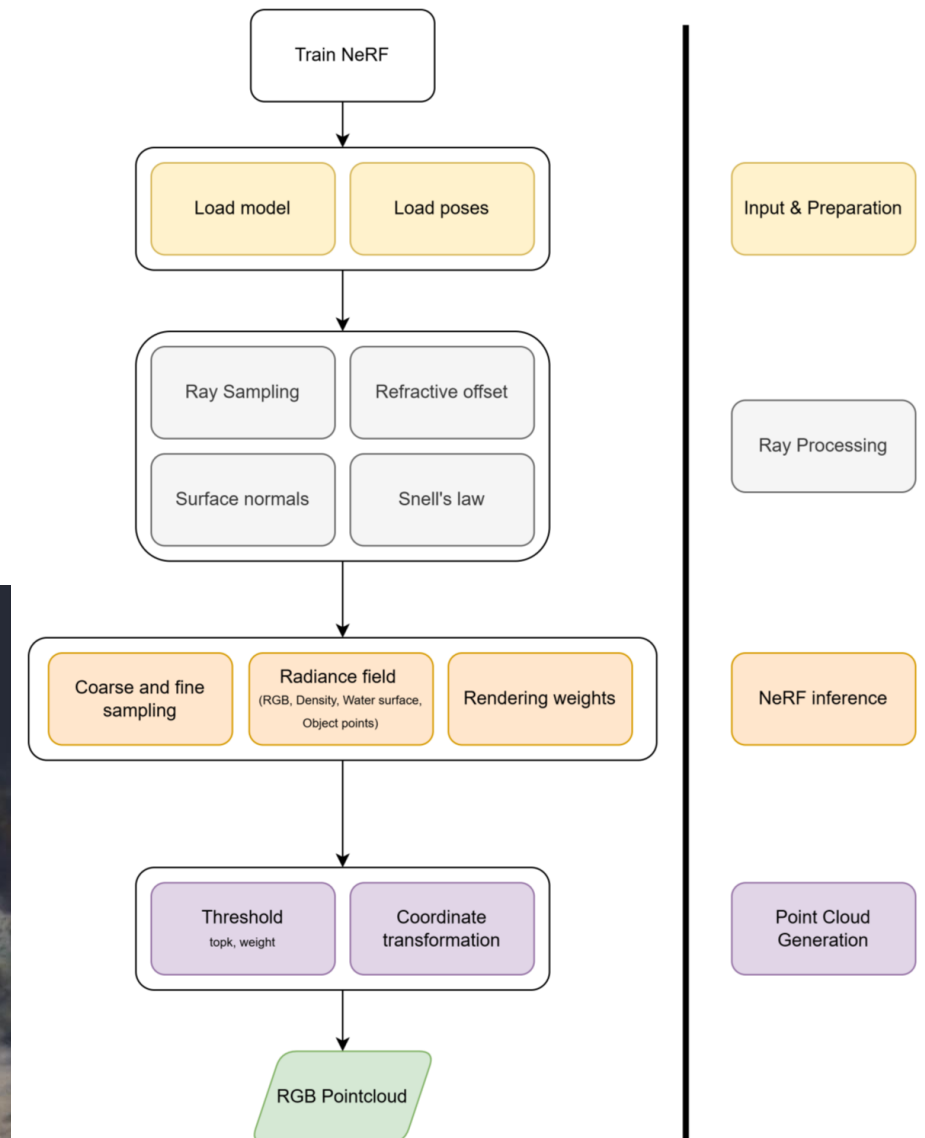
- **Input:** RGB picture
- Mask Overlay
- **Output:** 2D rendering
- 3D Pointcloud Export



extrapolated

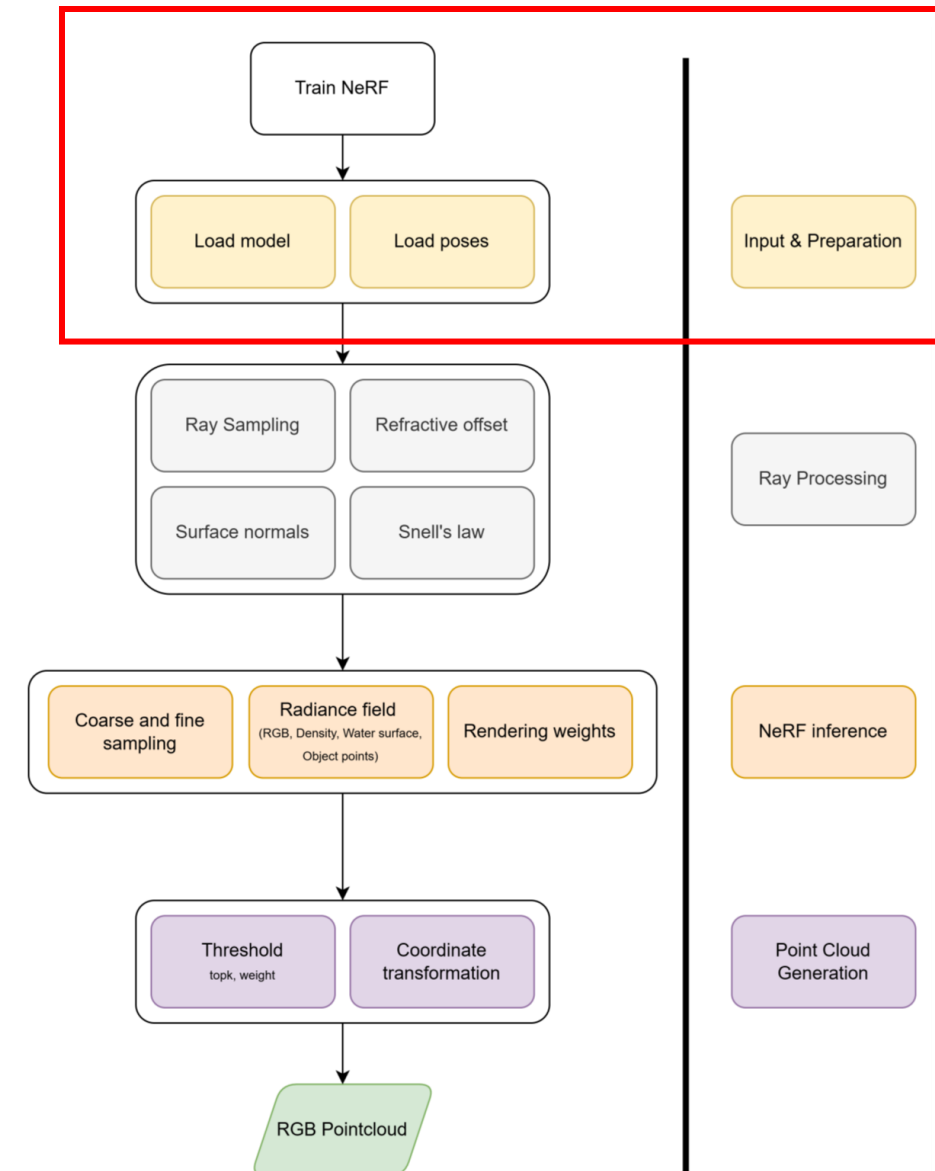
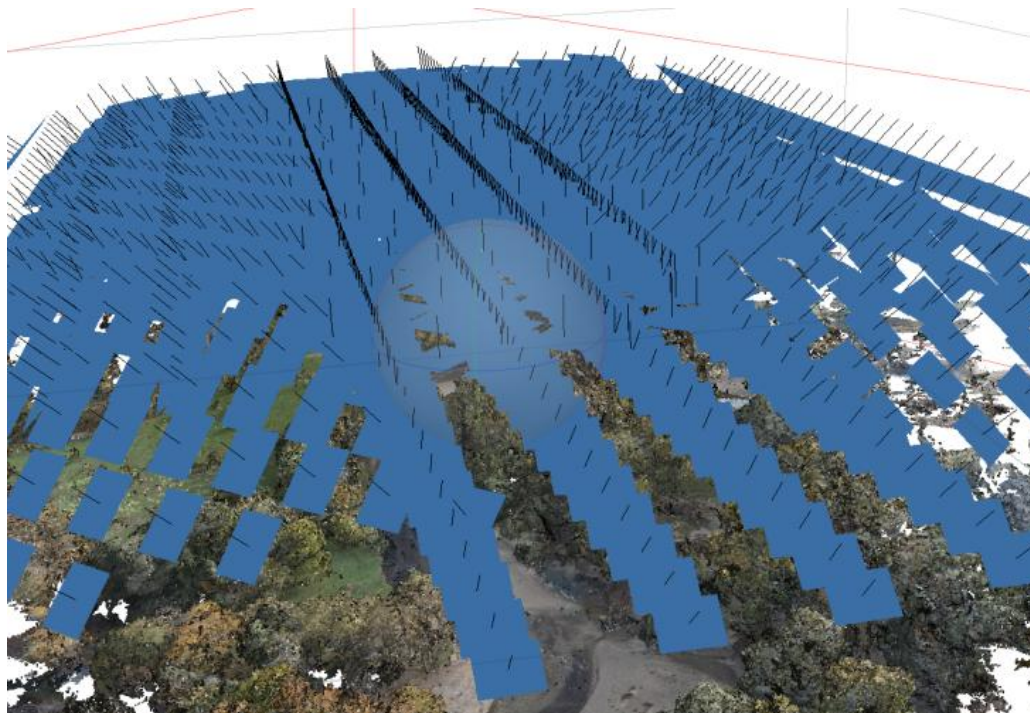
3D reconstruction Workflow

1. Input & Preparation
2. Ray Processing
3. NeRF inference
4. Point Cloud Generation



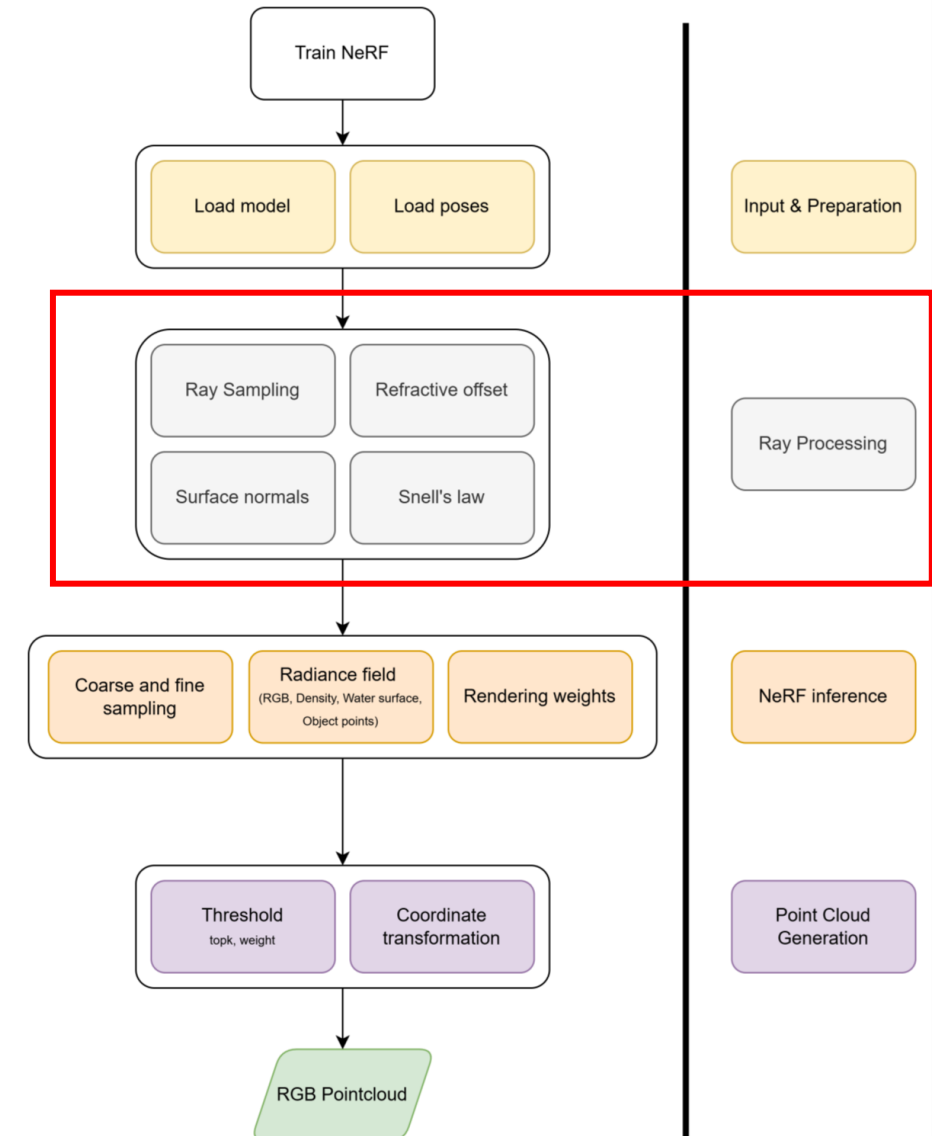
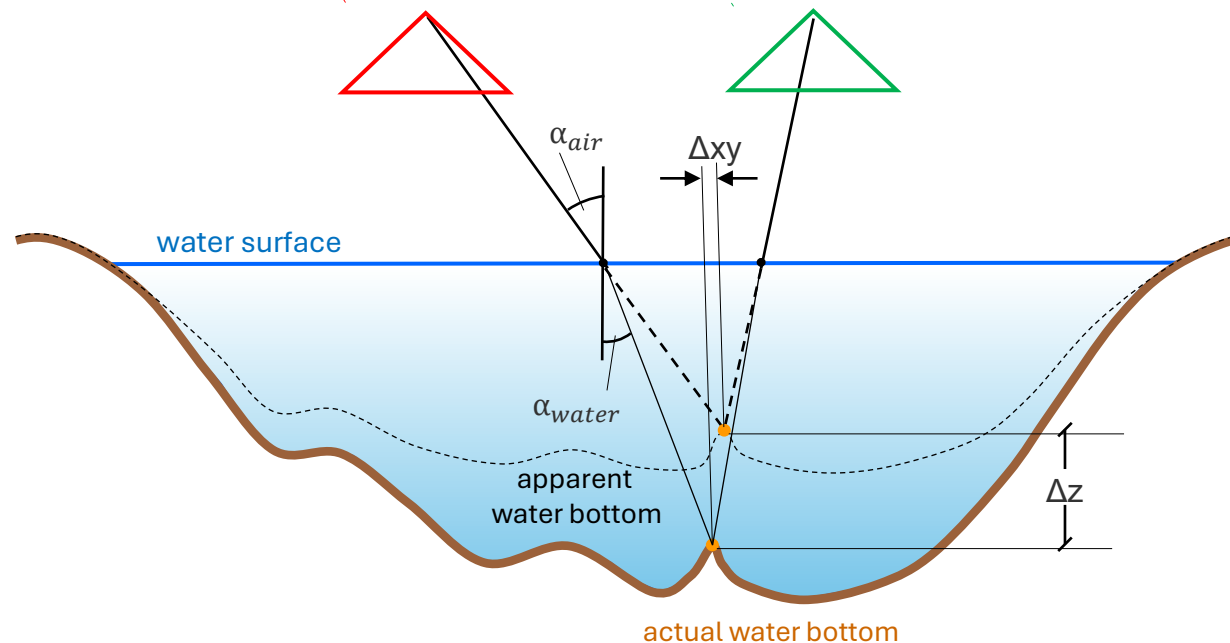
Input & Preparation

- Load model checkpoint
- Load poses
- Load mask (water/air)



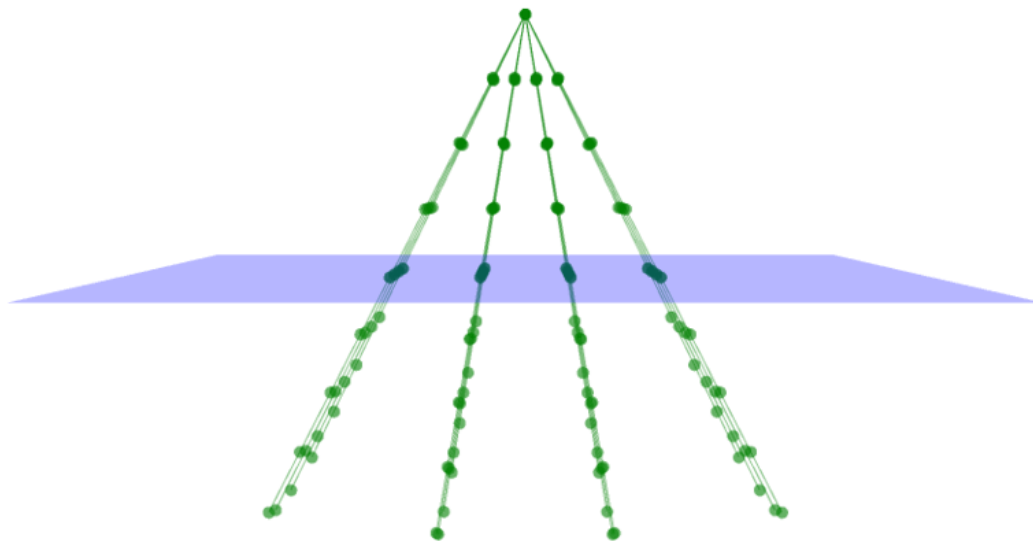
Ray Processing

- Ray Sampling
- Refractive offset
- Surface normals
- Snells' law

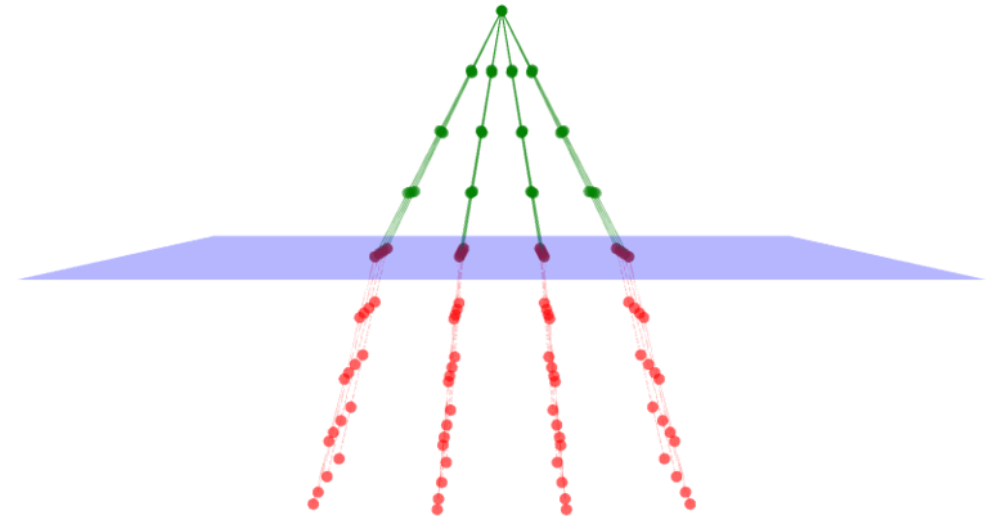


Ray Processing

Vanilla Ray Sampling

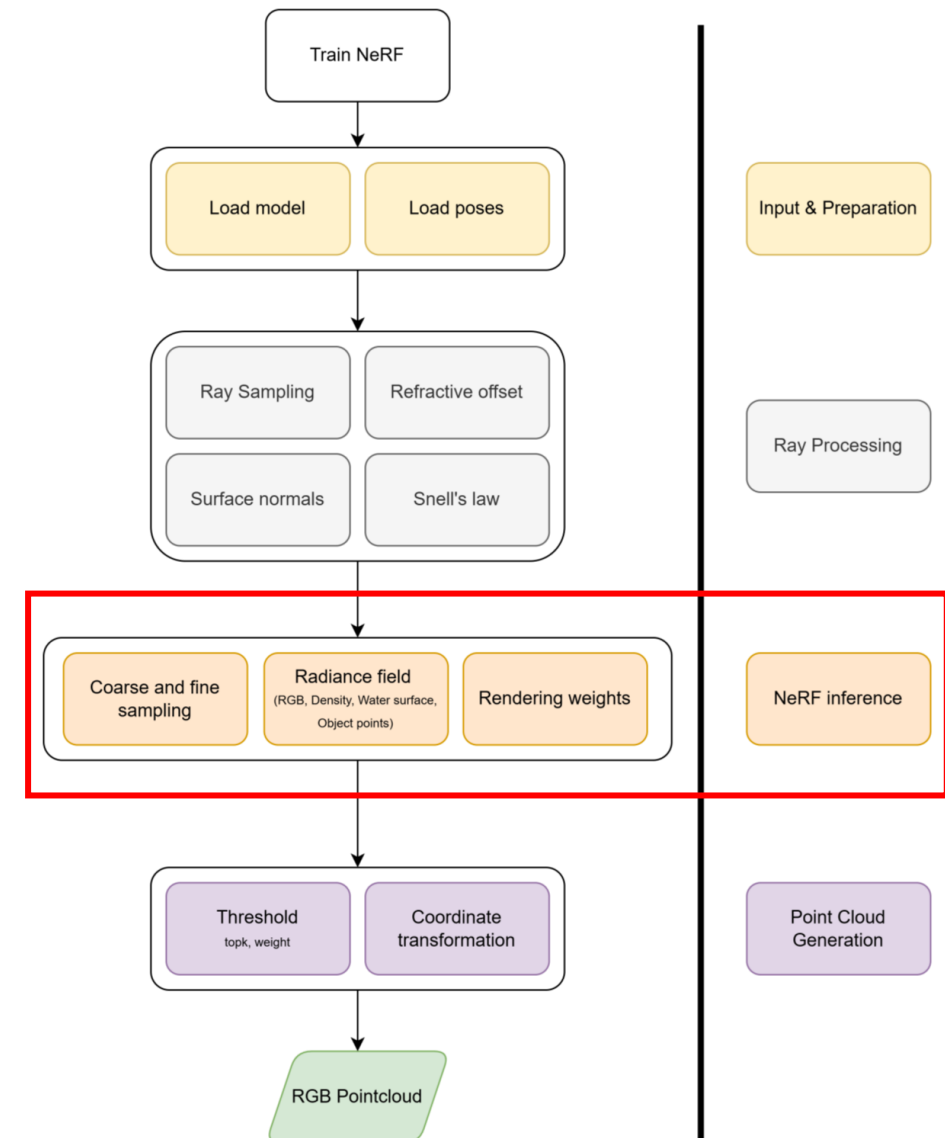


Refraction aware Ray Sampling



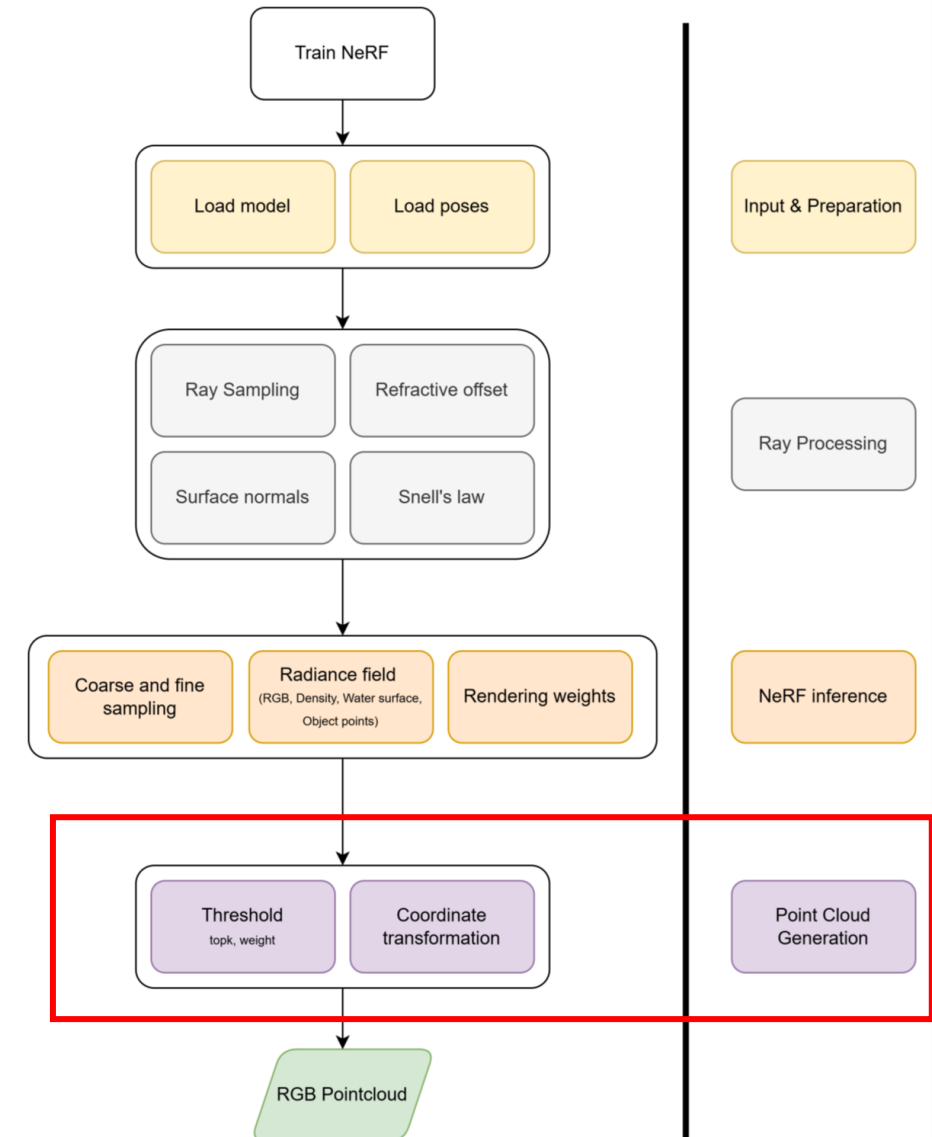
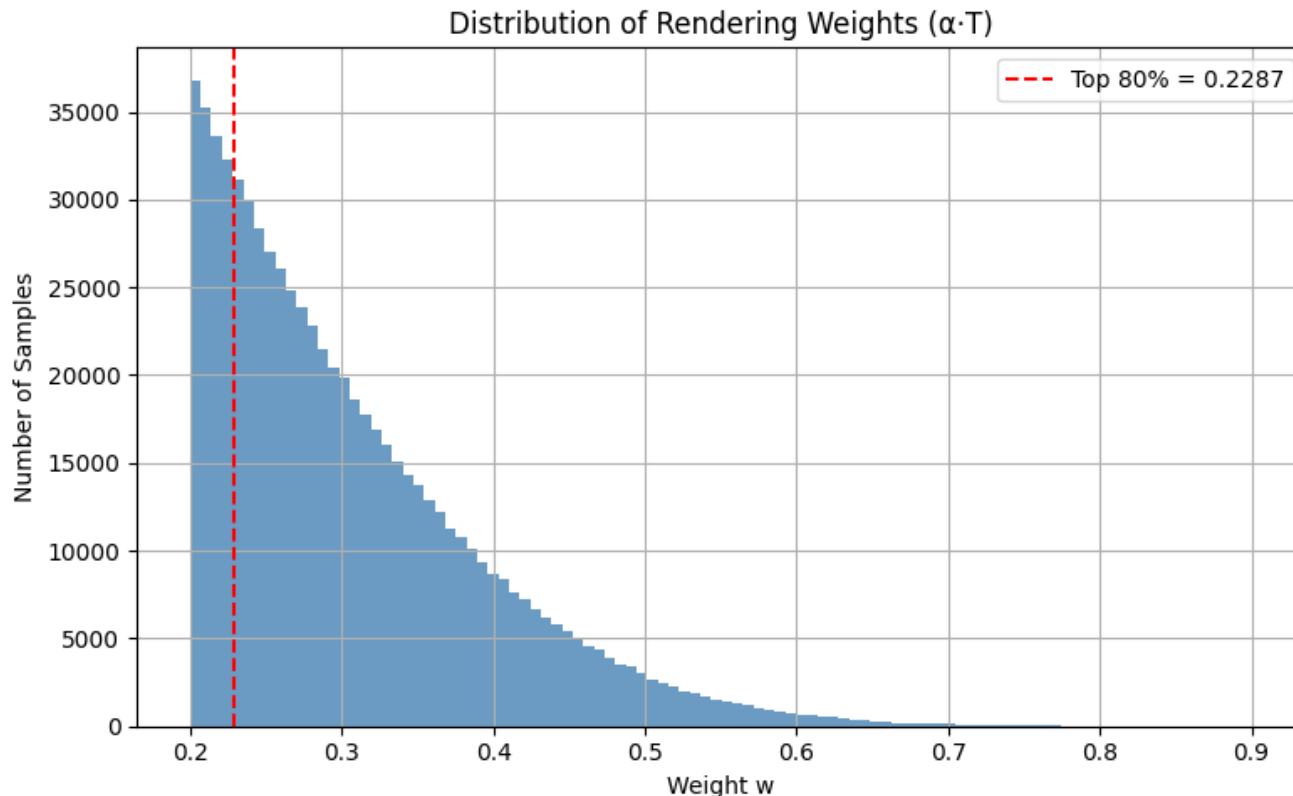
NeRF inference

- Coarse and fine sampling
- Query **RGB**
- Query **water surface points**
- Query **object points**
- Query **weights**



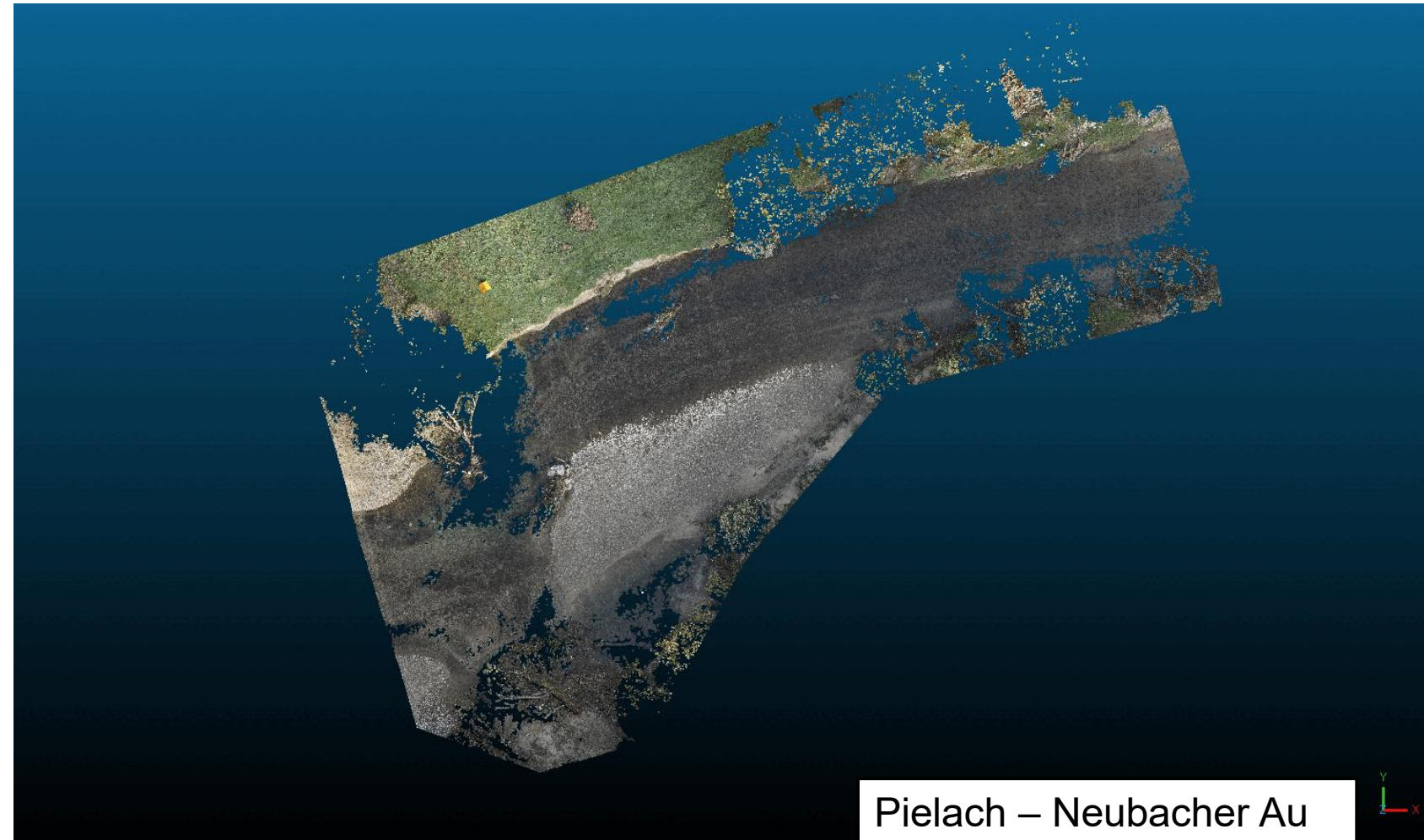
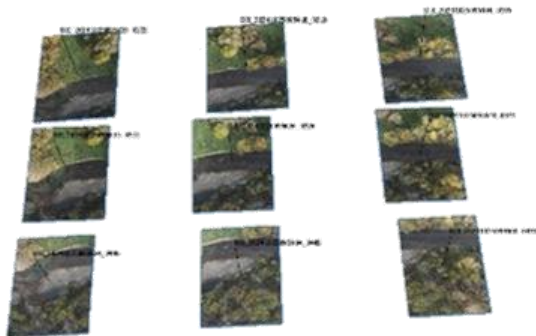
Point Cloud Generation

- Set output threshold (weight)
- Coordinate transformation
- **work in progress**



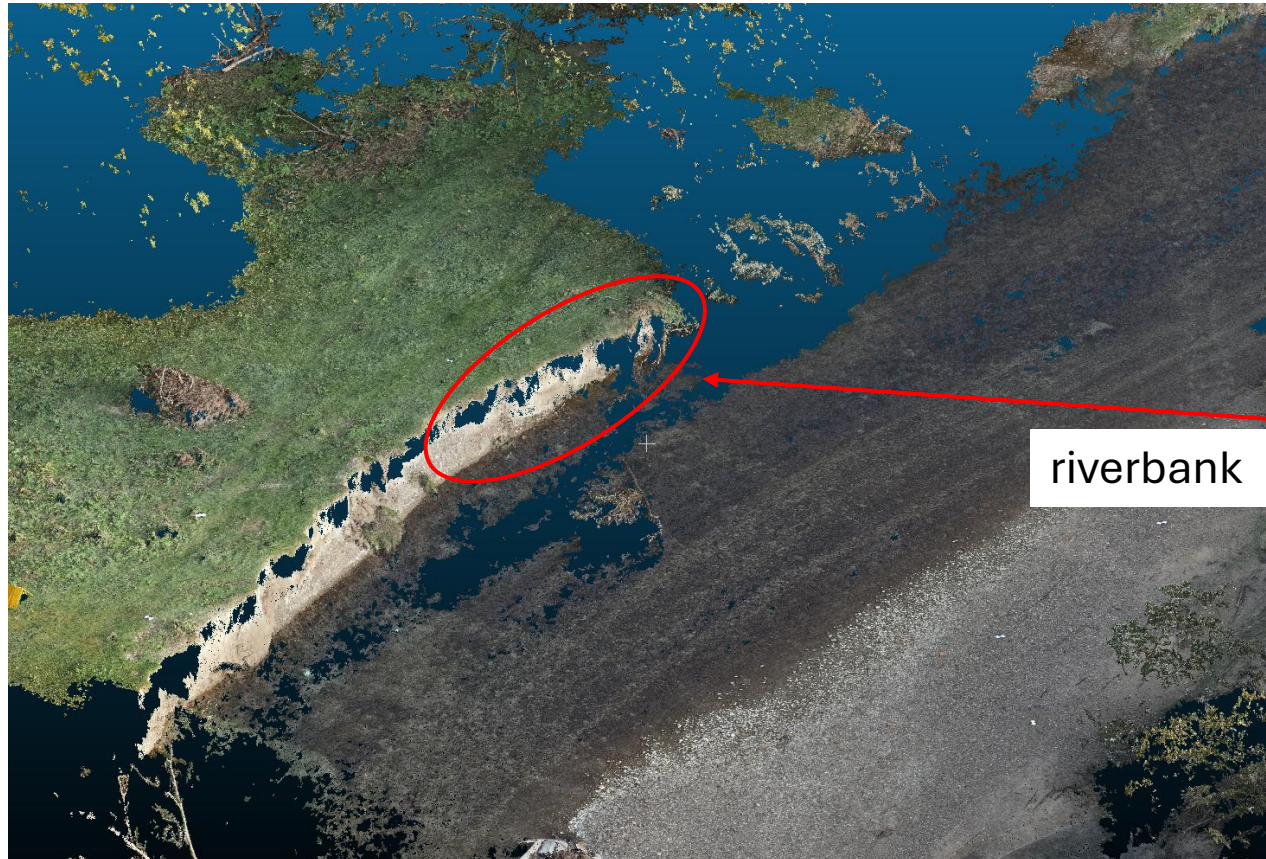
3D reconstruction - mask

9 Nadir | Baseline: ~24.7m

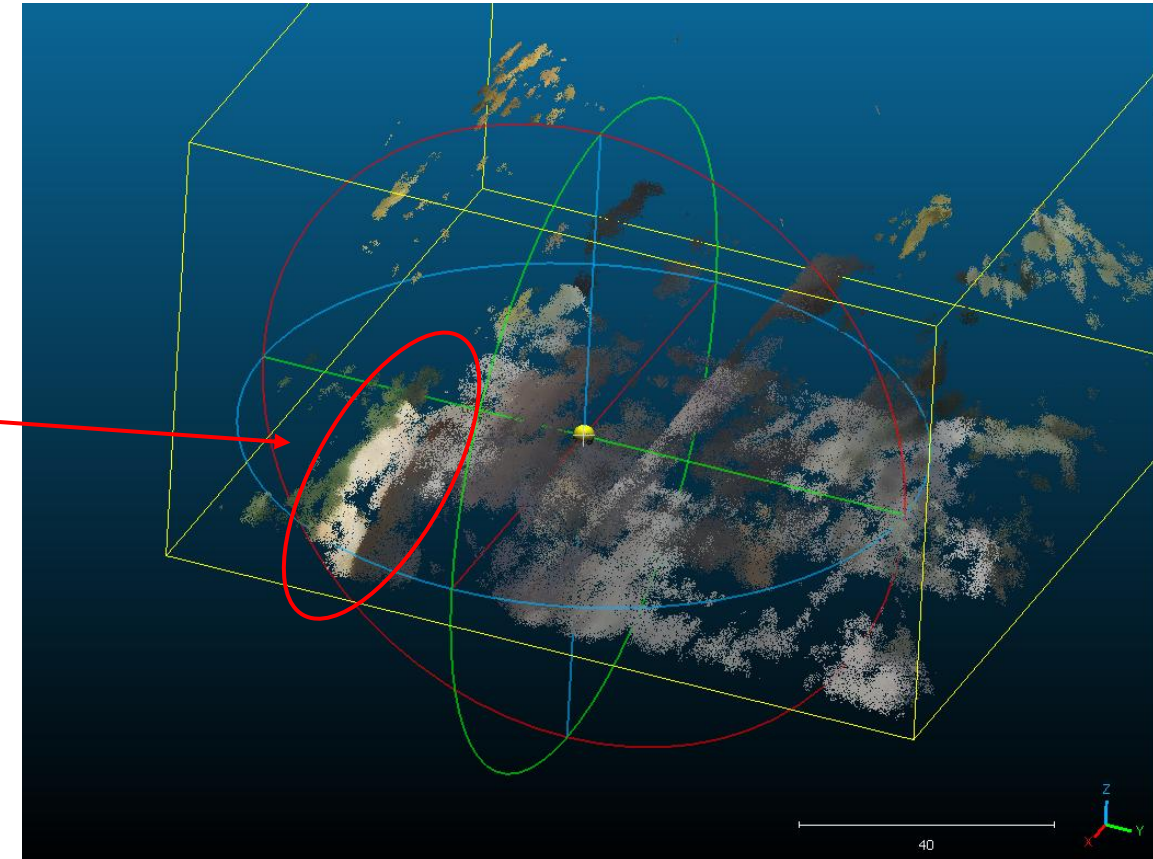


Pielach – Neubacher Au

3D reconstruction – no mask

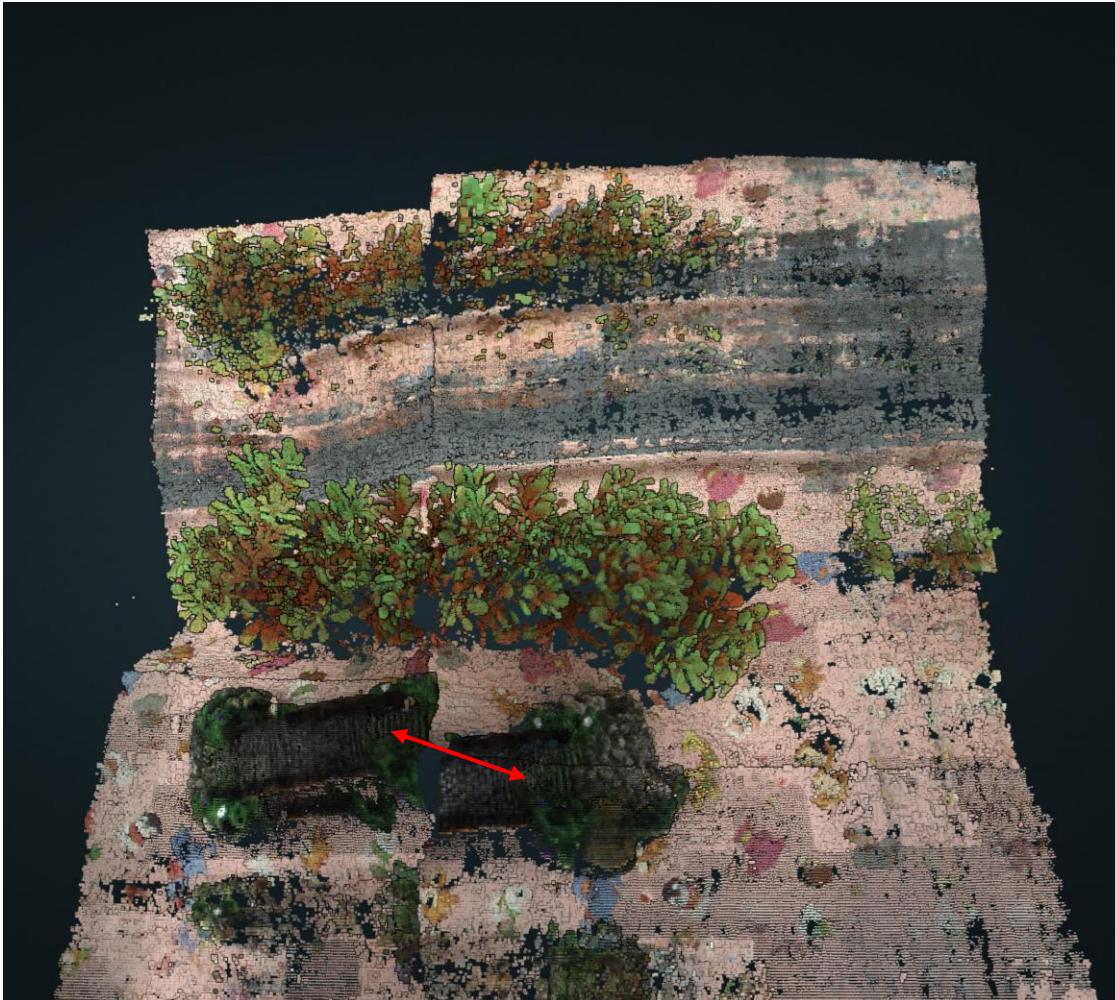


DIM – Pointcloud



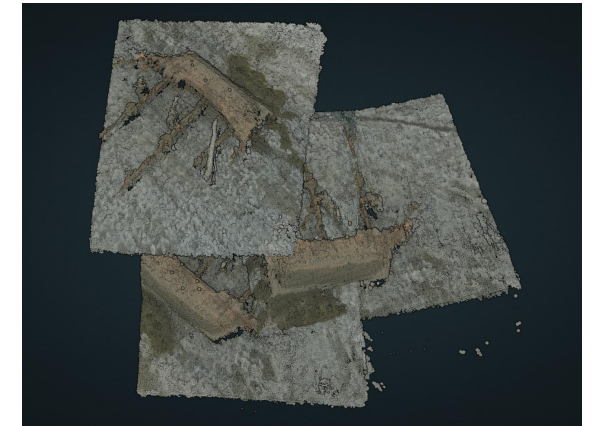
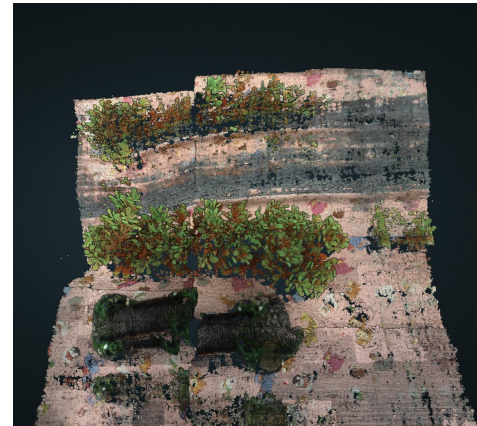
BathyNeRF - Pointcloud

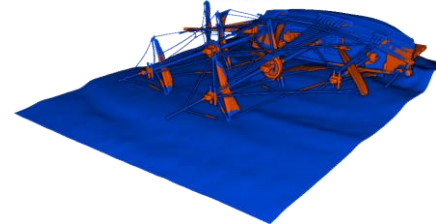
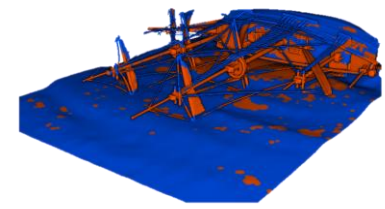
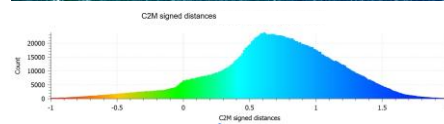
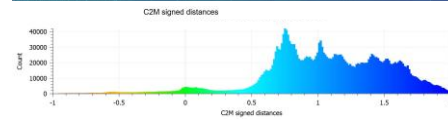
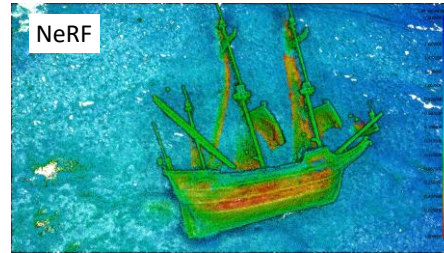
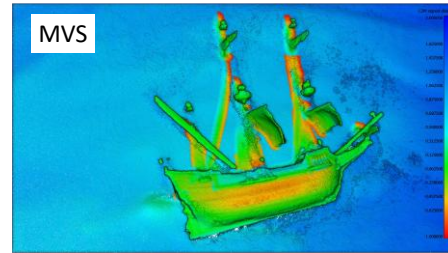
Challenges



Outlook

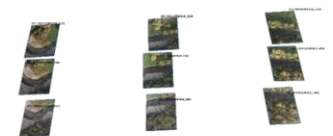
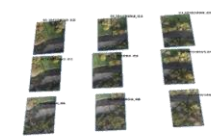
- solve alignment issue
- improve pointcloud precision (camera geometry)
- evaluate pointcloud against Ground truth (Ship dataset)
- evaluate water surface level against Ground truth (Ship dataset)
- solve georeferencing issue
- improve training time
- automatic mask creation





9 Nadir | Baseline: ~24.7m

9 Nadir Extended | Baseline: ~44.9m



9 Oblique | Baseline: ~22.75m

9 Oblique Extended | Baseline: ~47.8m

