3D visualization of the electromagnetic field intensity distribution for UHF-RFID-identification

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IDP Presentation
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Agenda

Introduction

- UHF-RFID-System demands reliable detection of transponders

- A knowledge of the field strength distribution in an area of interest
  - Speeds up optimizing the installation

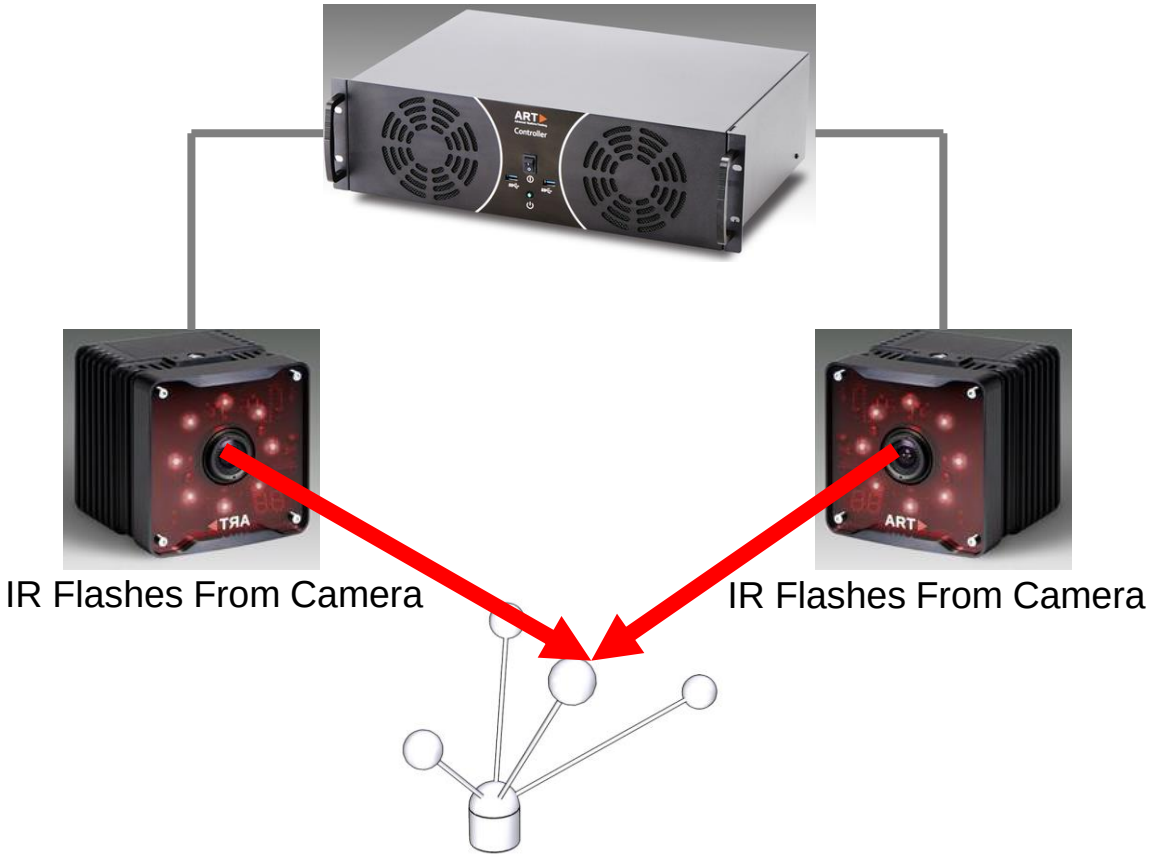
- The general goal of the whole project:
  - Create a method and hardware to measure the field strength distribution.
  - Using a mobile device

Problem Definition

- Building a model of examined installation in 3d virtual world.
  - Should be fast and intractable (Using tracking system).
- Assist the user during measurement by specific visualization.
  - Make the measurement process faster.
  - Collect enough data for an accurate visualization.
- Visualize collected data in different ways.
  - Investigate appropriate visualization methods.
  - To detect weak/strong parts of the environment.

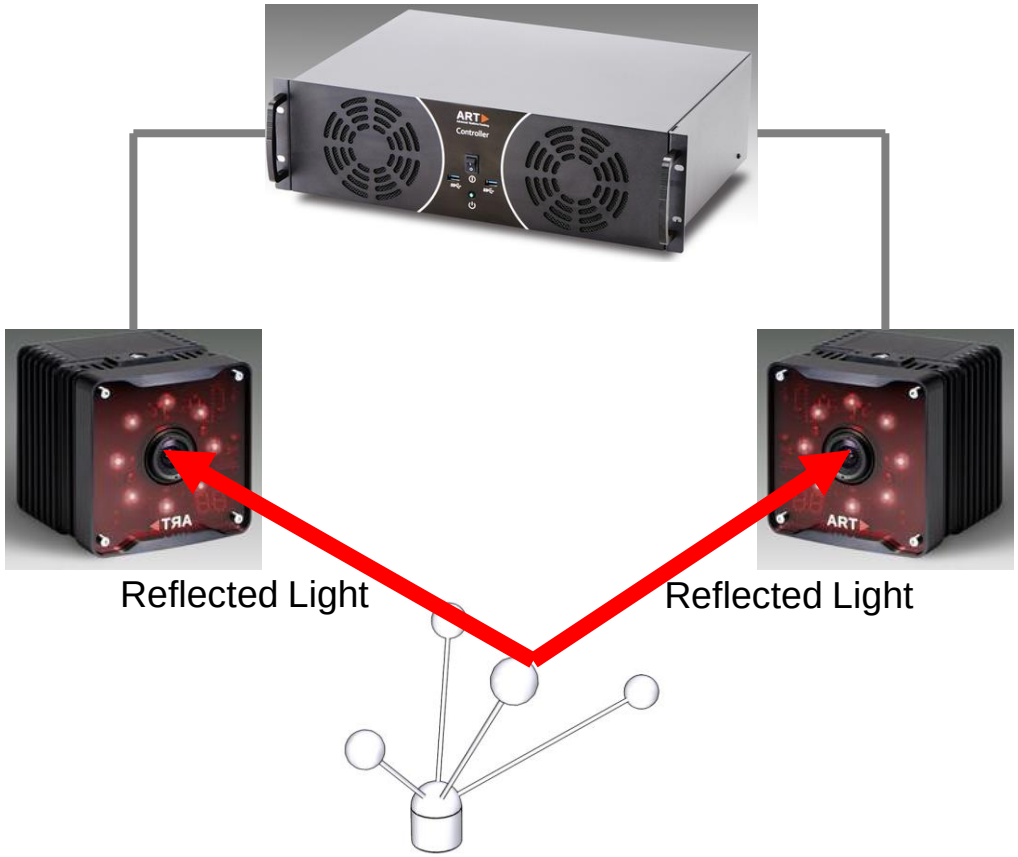
Tracking System

- ART-Tracker



Tracking System

- ART-Tracker



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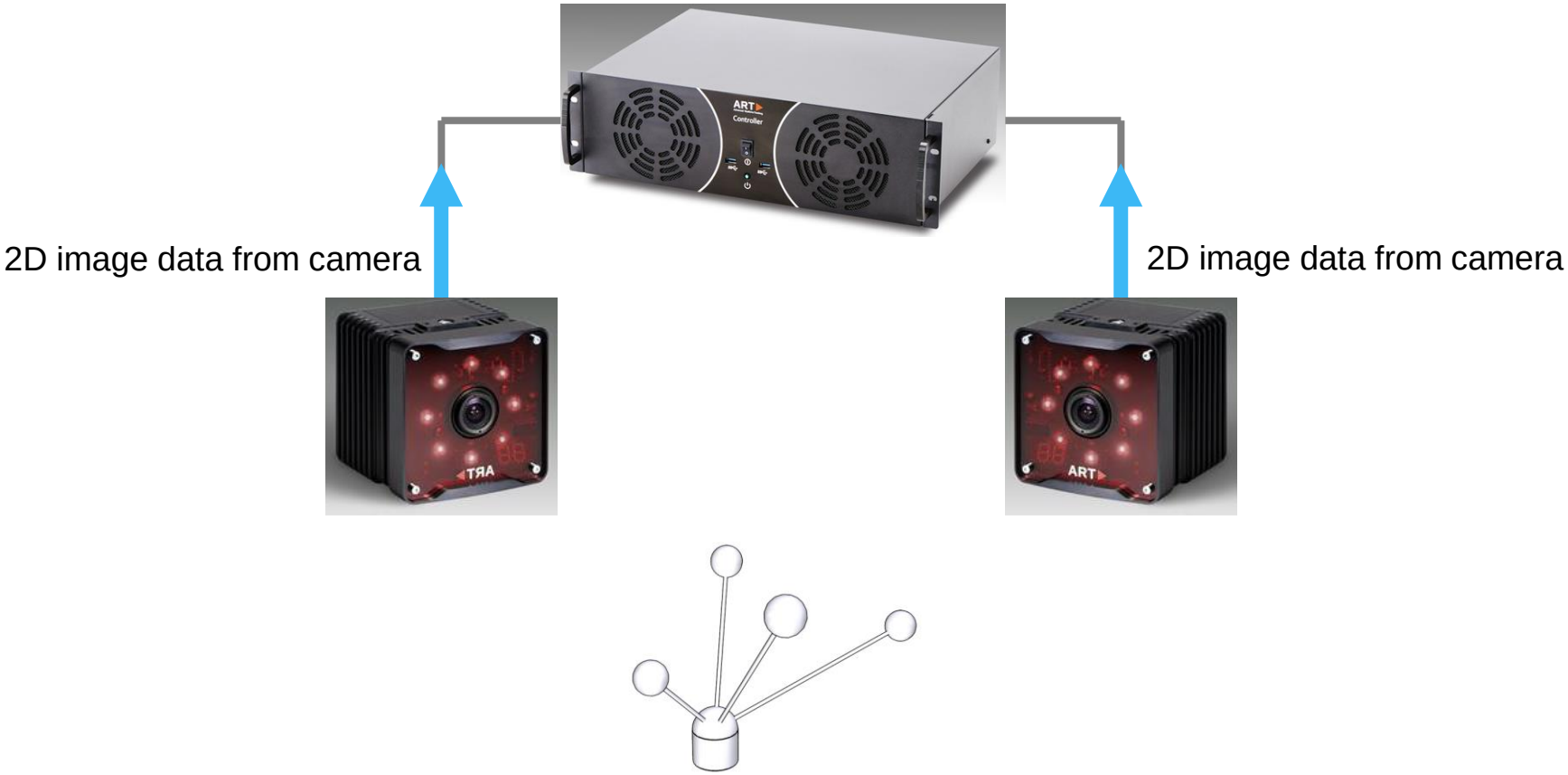

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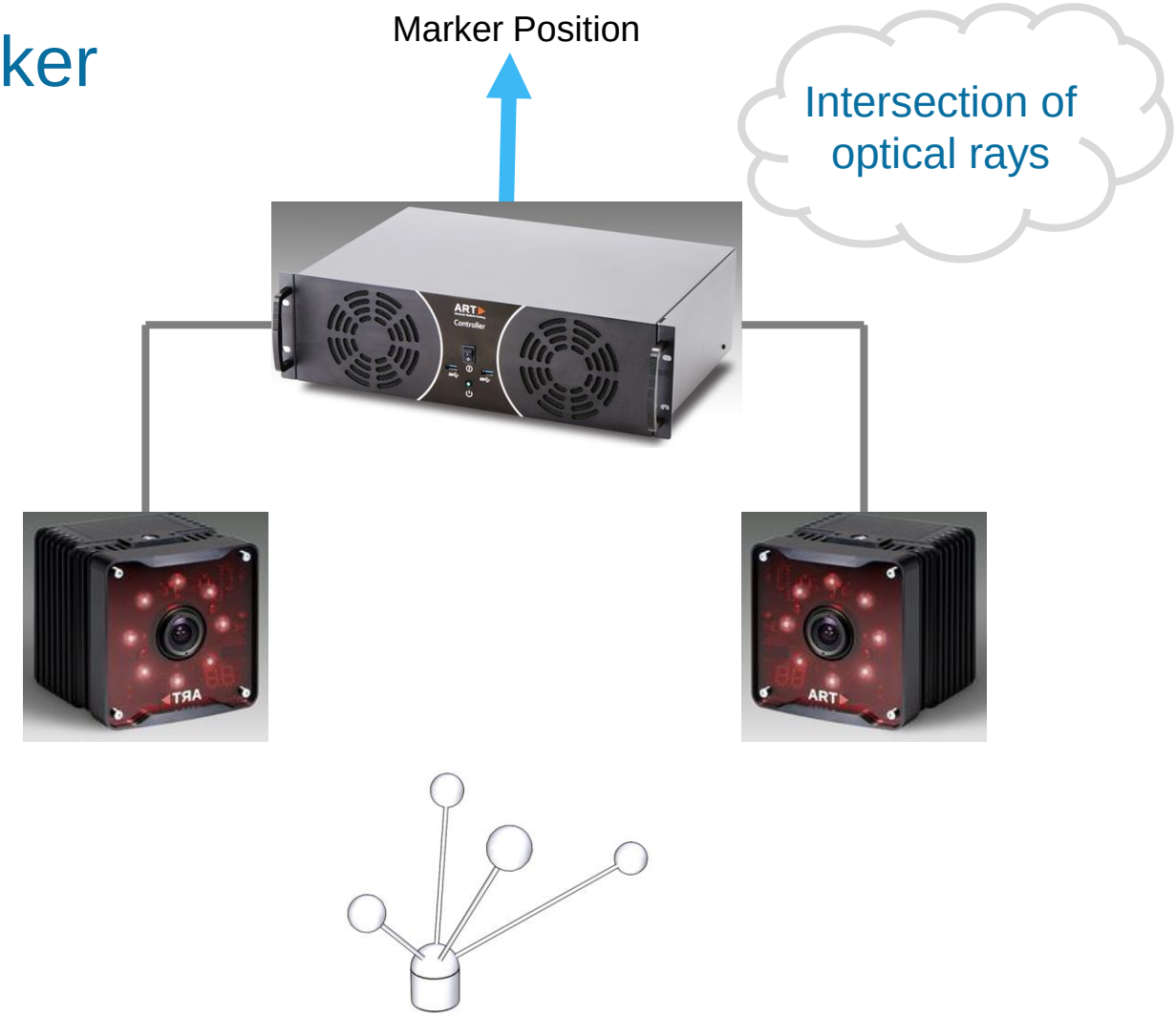
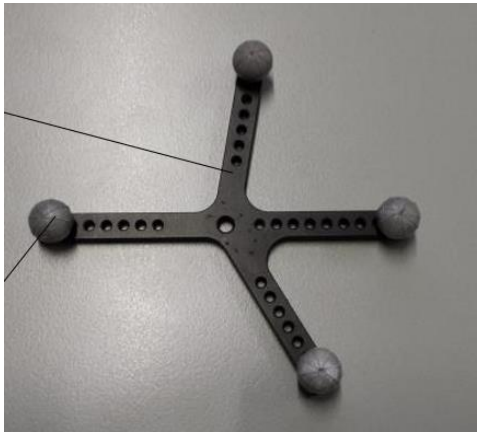
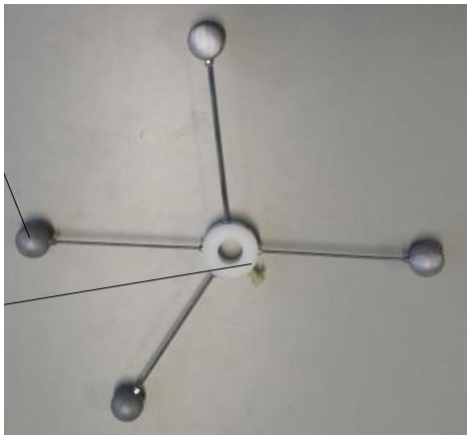


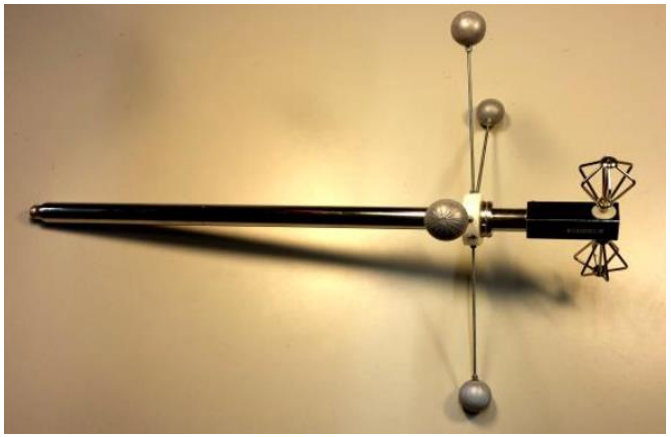
Markers



Coordinate System Origin Marker



Antenna Pose Marker



Dipole Tracking Marker

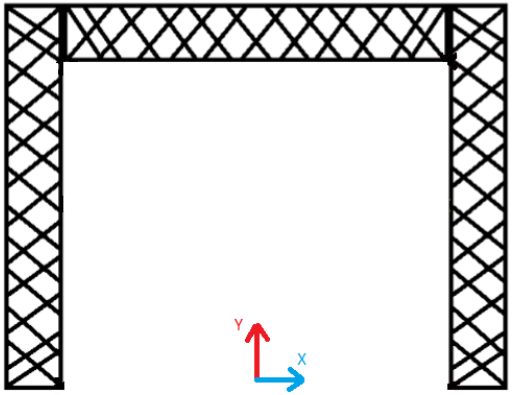
Setting up the virtual world

- Requirements
  - Environment coordinate's origin
  - Gate dimensions
  - UHF Antenna's position and orientation

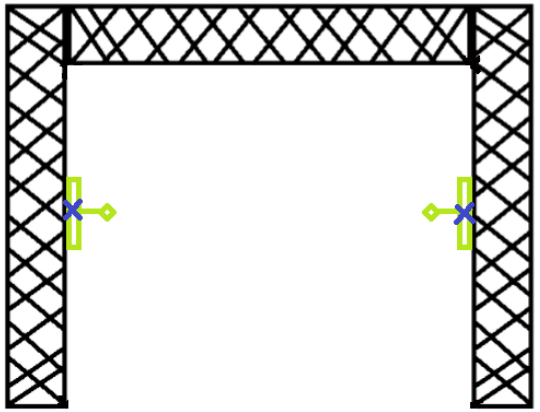
- Defining these specifications:
  - Manually using mouse or keyboard.
    - Requires measurements
    - Hard to measure orientation and position accurately
  - Use a tracking system to detect them by processing the images.

Setting up the virtual world

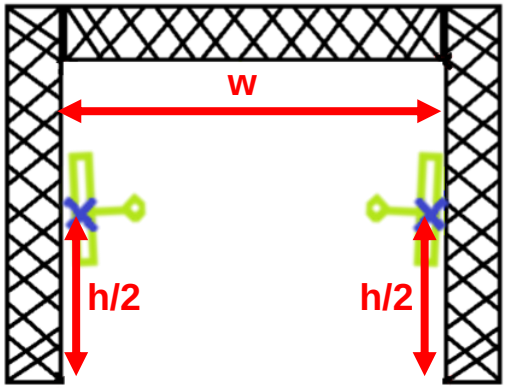
- Defining environment coordinate system's origin

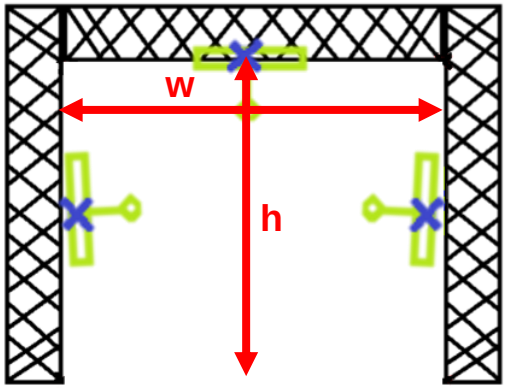


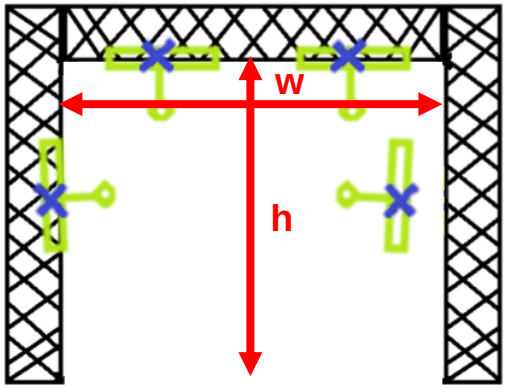
- Defining Antenna's position and orientation
  - Defines the gate's dimensions implicitly



Gate Dimension Determination

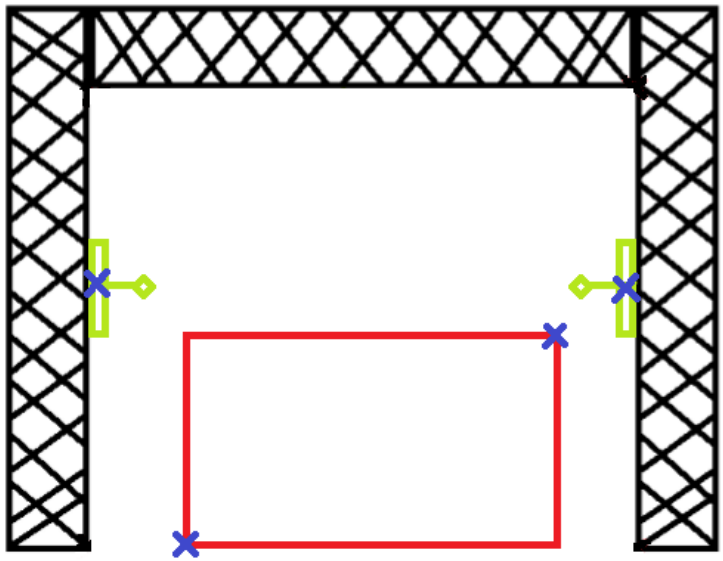


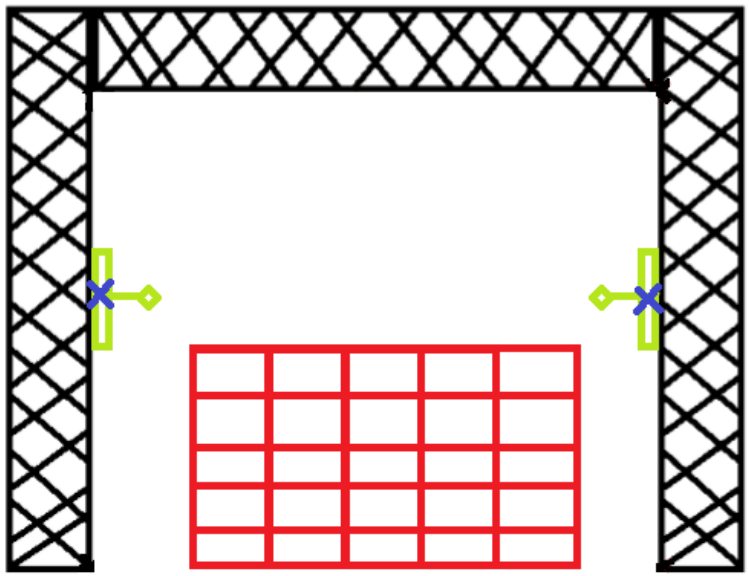




Data Collection

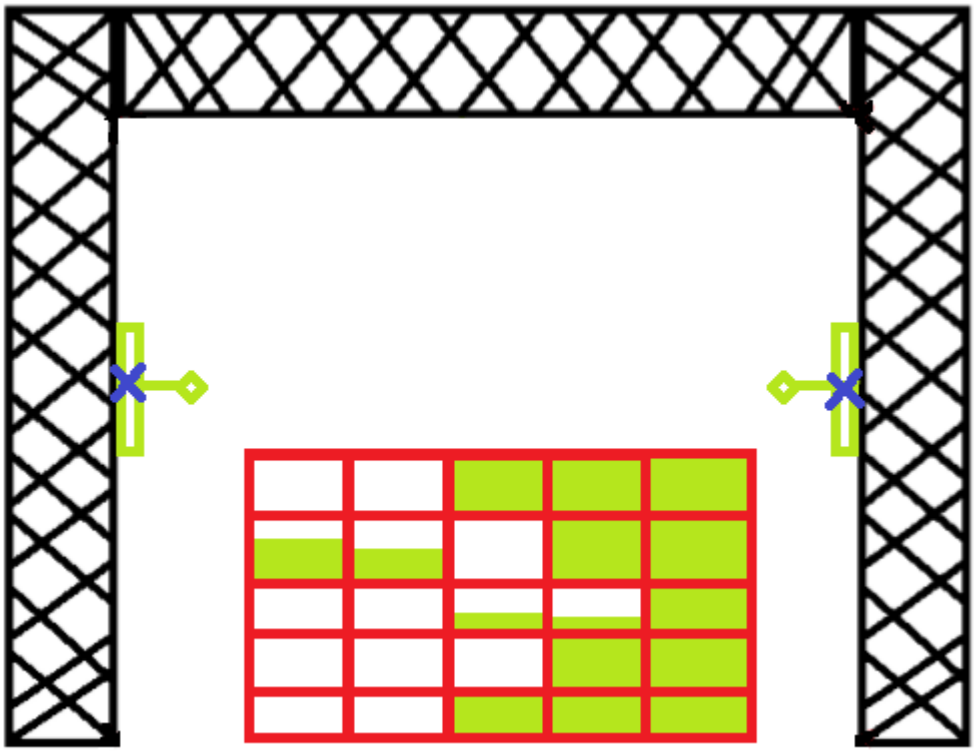
- **Area of interest** is an axis-aligned bounding box which the magnetic field values in it is of interest.
- Defining the area of interest:
  - Using dipole's head to determine its min and max points.
  - Manually enter the area of interest resolution.



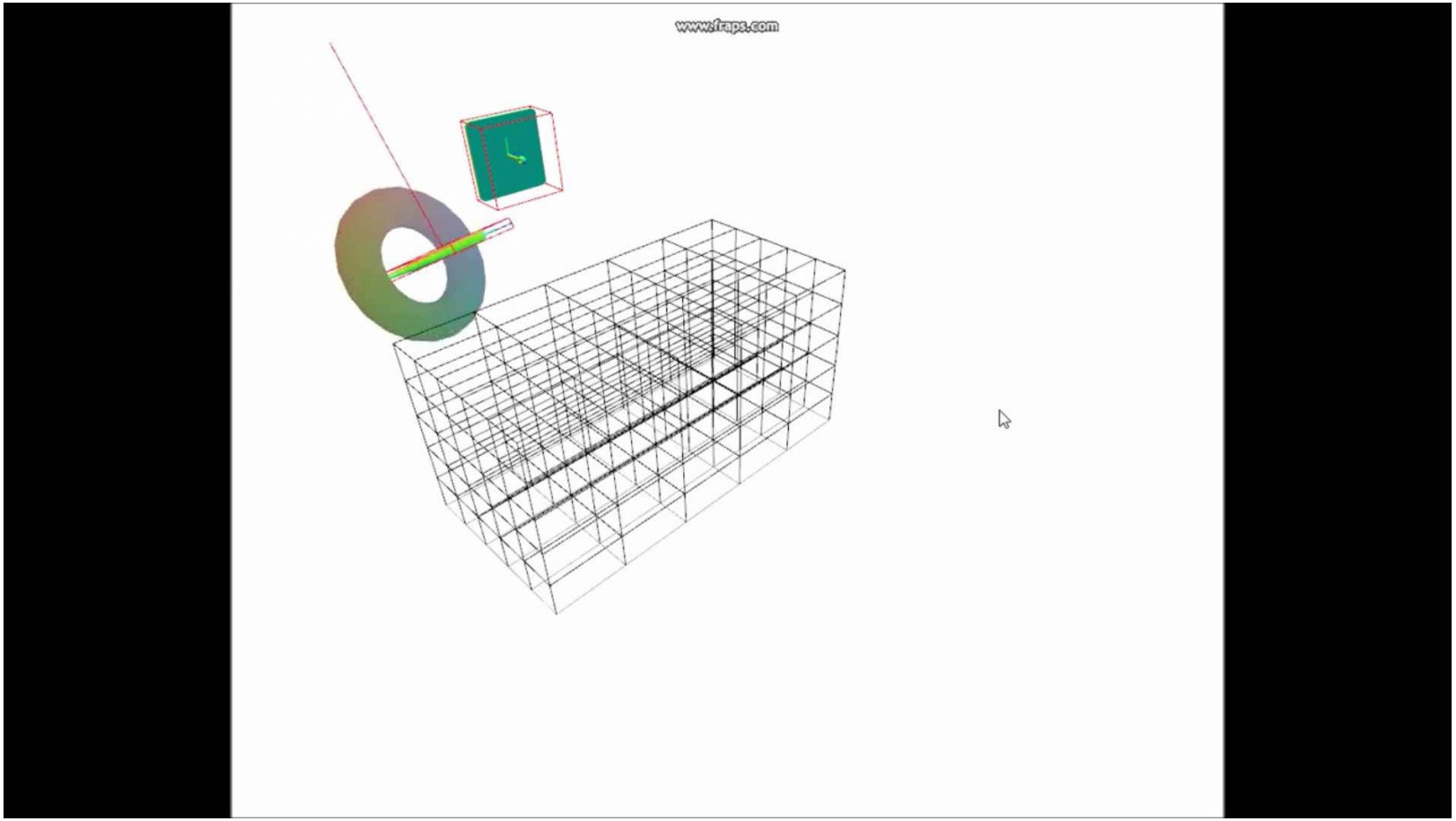


User Assistant During Data Collection

- **Progress bar per grid's element**

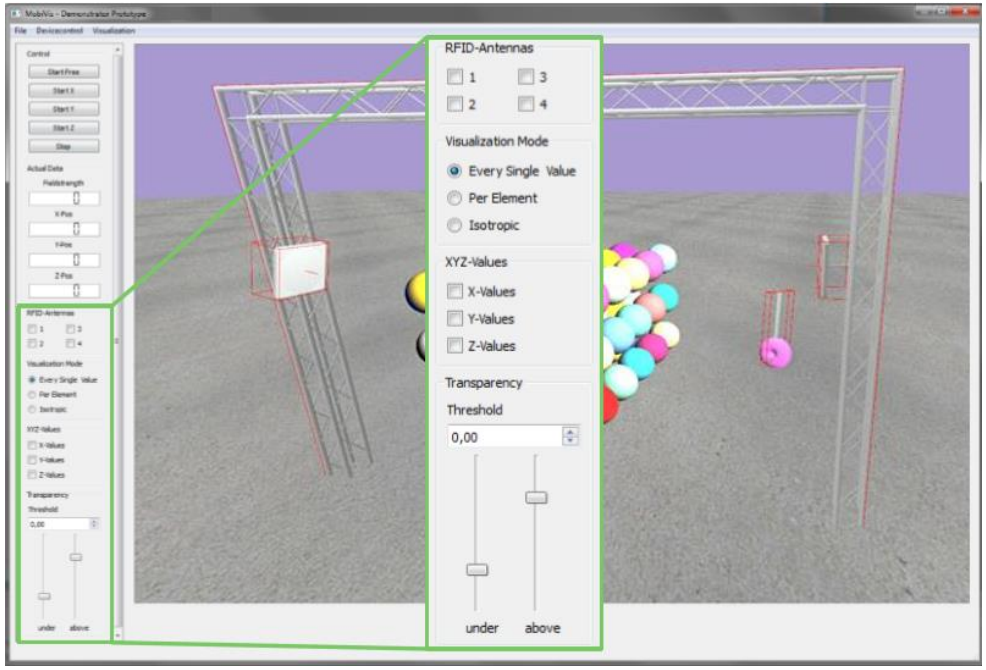


User Assistant During Data Collection



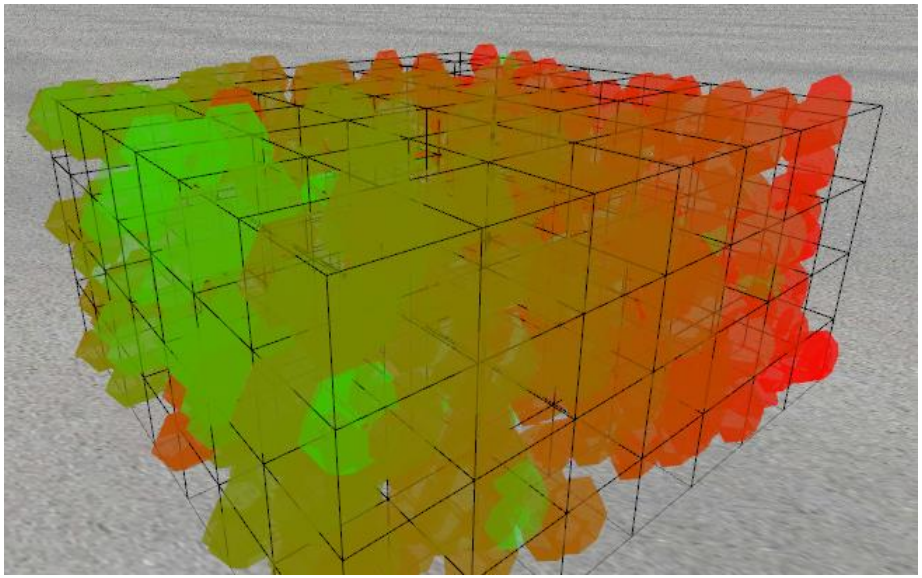
Data Visualization

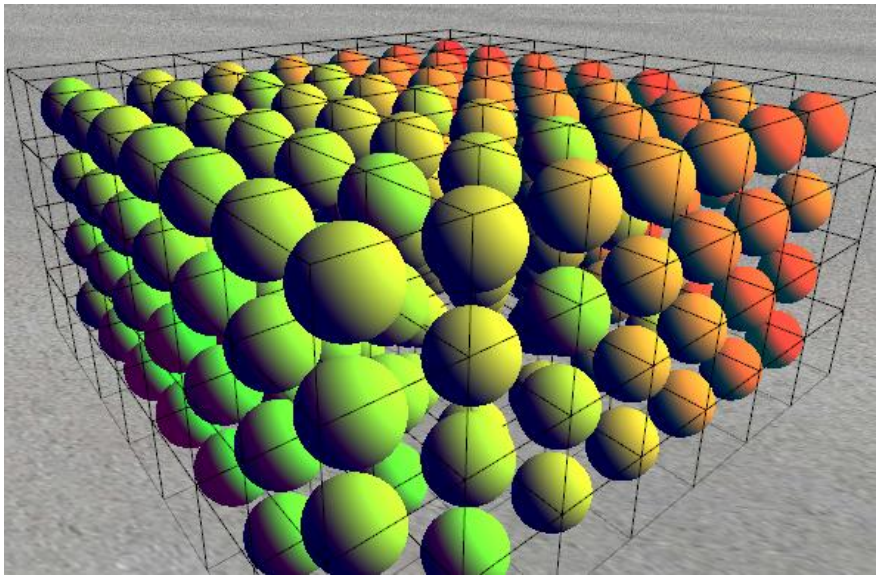
- Visualizing all collected data
- Visualizing magnetic field magnitude
- Visualizing grid elements
- Visualizing the magnetic field volume



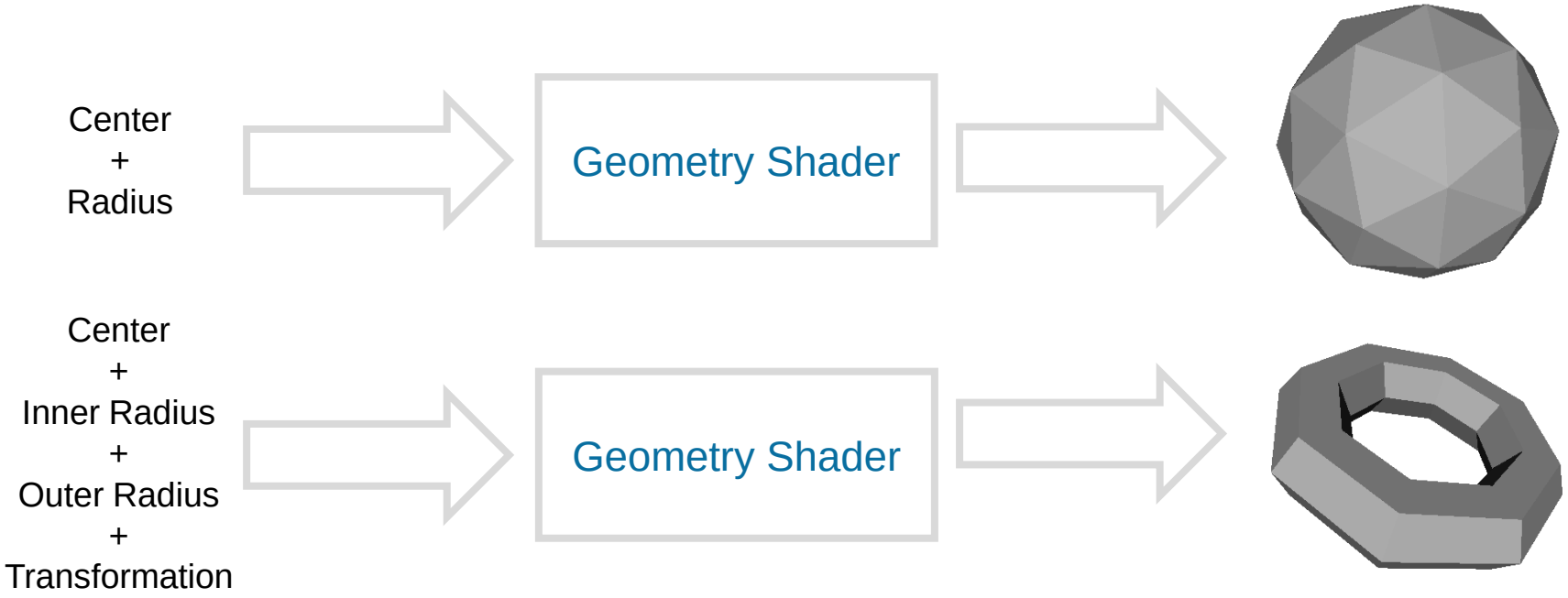
Torus/Sphere Glyph

- Rendering high number of torus/spheres on GPU
  - Generating geometries on the GPU using geometry shader
  - Using higher order primitives method





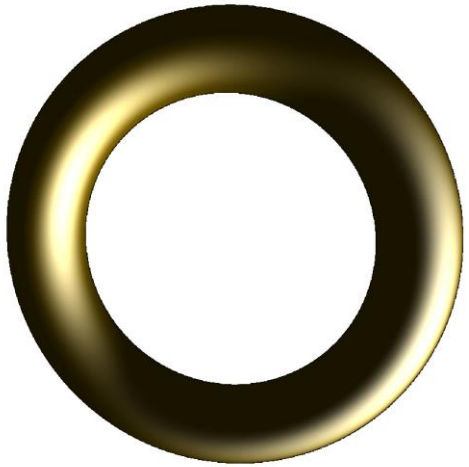
Torus/Sphere Glyph using Geometry Shader



- Cons:
  - Not smooth -> Limitation in number of generated primitives and vertices.

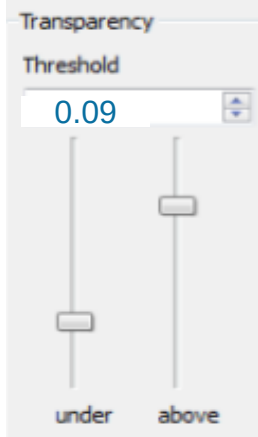
Torus/Sphere Glyph with Higher-Order Primitives (HOP)

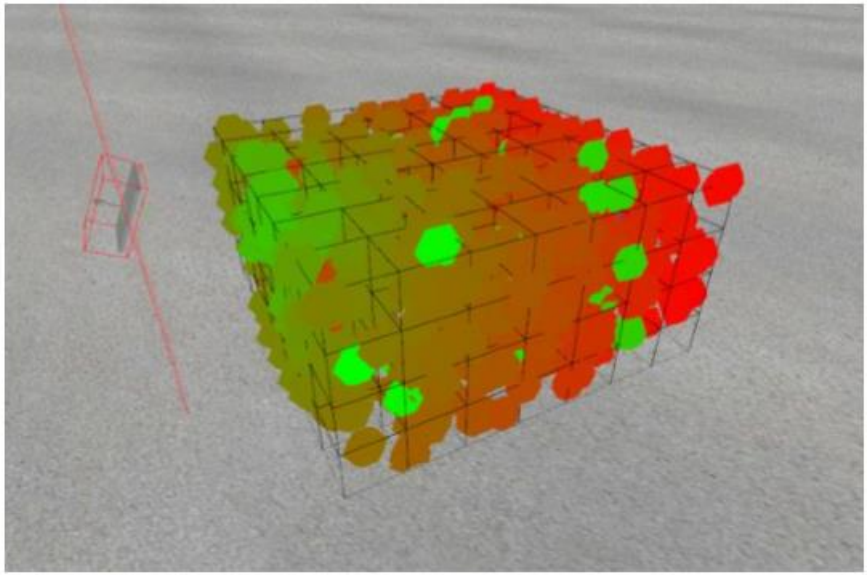
- Ray-casting sphere/torus:
  - Intersecting ray-sphere equation
  - Intersecting ray-torus equation:
    - Quartic Function
    - Requires double precision computation to reduce aliasing
- Pros:
  - Pixel-Accurate Primitives

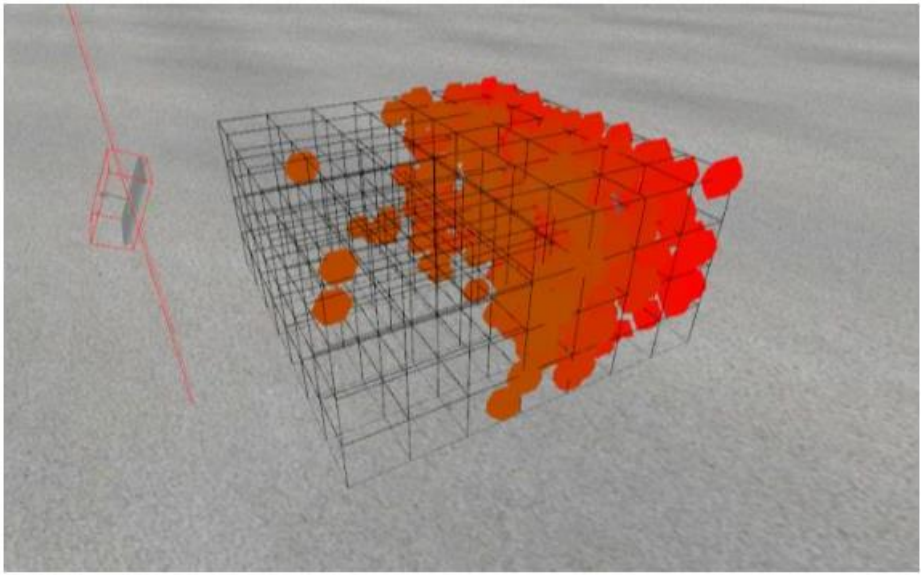


Transparency

- Focus on part of dataset using transparency
  - Using two scrollbars to define transparency for weak/strong values

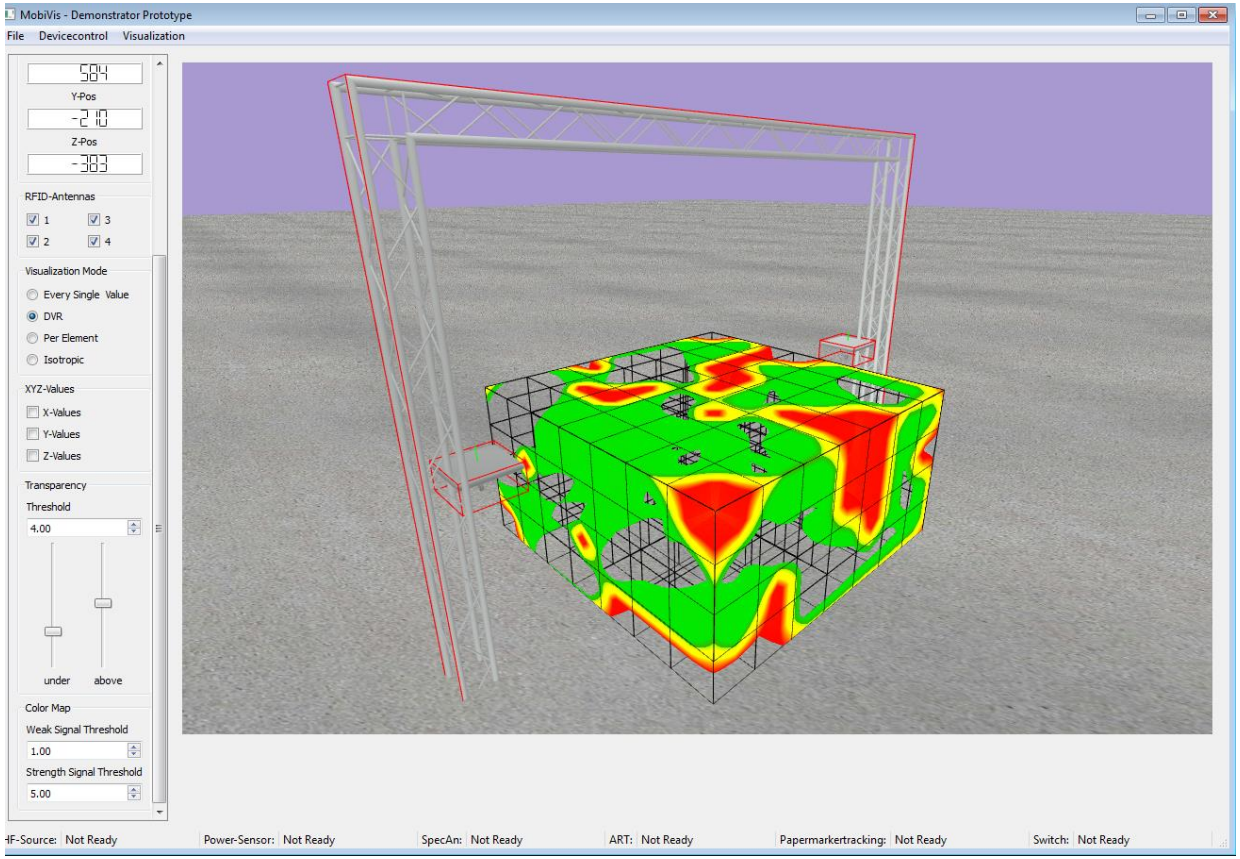






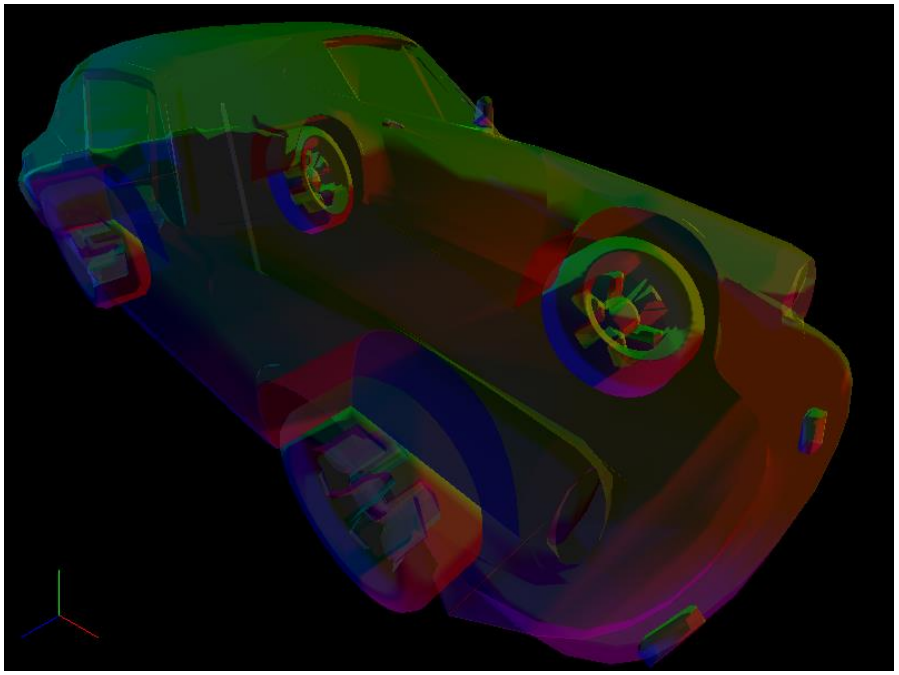
Direct Volume Rendering (DVR)

- 2D Projection of a 3D scalar field
  - Ray casting the volumetric data

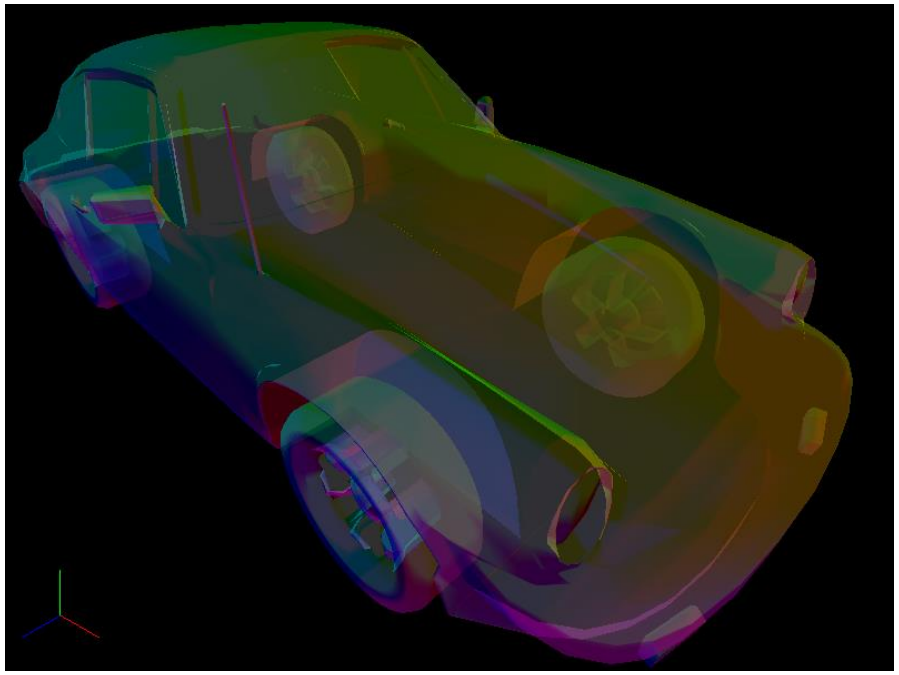


Future Works

- Add Order Independent Transparency (OIT)



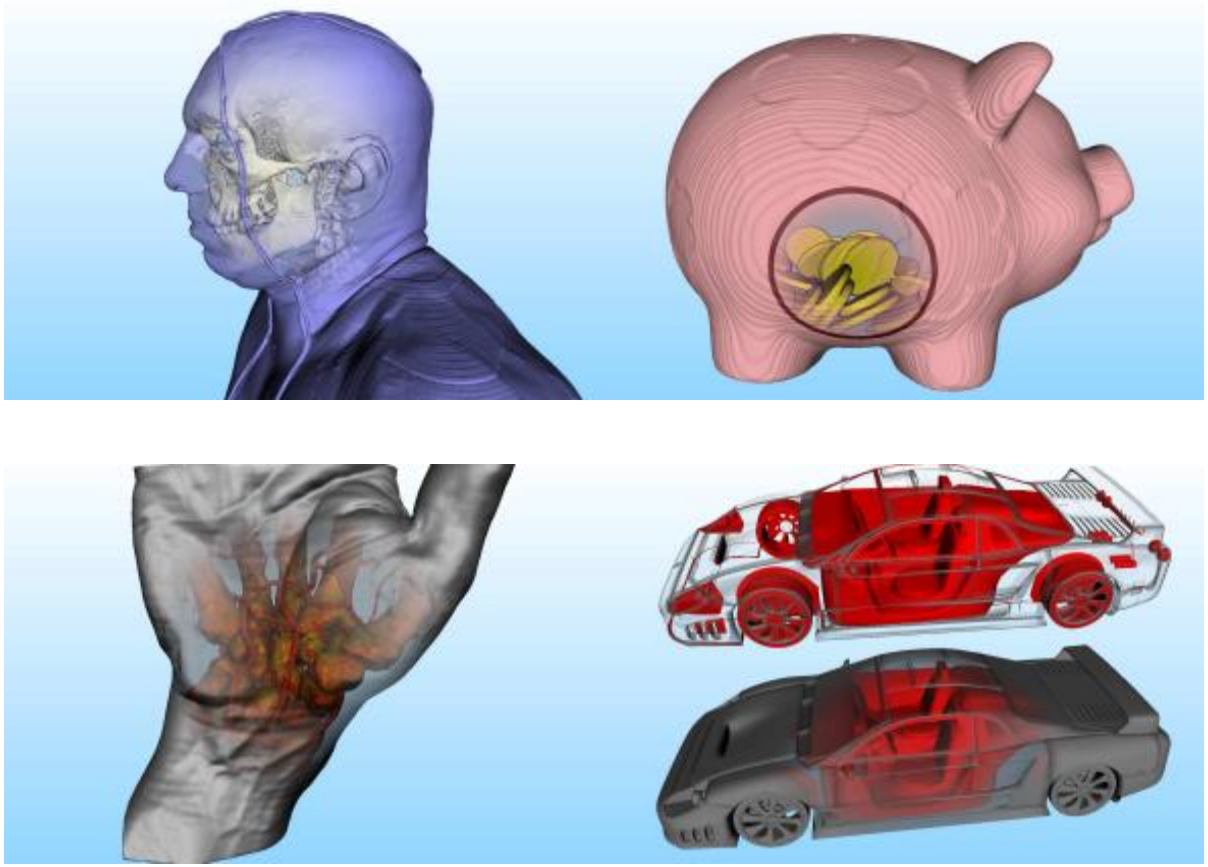
Wrong rendering order



Right rendering order

Future Works

- ClearView Technique to focus on a specific part of dataset



Vielen Dank für Ihre Aufmerksamkeit!

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