RaytraaS® User Manual

Official Software Documentation

Version 1.0

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Duisburg, Germany

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RaytraaS User Guides (short version)

Raytracing as a Service for Electromagnetic Simulation

1. Introduction

RaytraaS is a web-based electromagnetic (EM) raytracing platform for simulating radio-wave propagation in complex 3D environments. It uses Blender for scenario creation and a cloud-based engine to compute ray paths and model EM interactions, including specular reflections, transmissions, diffractions, and diffuse scattering based on high-frequency EM principles.

This manual guides you through accessing raytraaS, creating and exporting scenarios in Blender, defining EM parameters and raytracing settings, uploading simulation configurations, running simulations, and interpreting the results.

2. System Overview

RaytraaS separates interactive scene modeling from computationally intensive server-side simulation:

- **Blender** is used to create and annotate the 3D environment (geometry, materials, and EM-related tags).
- The **raytraaS web application** is used to upload scenario and configuration files, configure and launch simulations, and review results.

The raytracing engine in raytraaS is based on Geometrical Optics (GO) for modeling reflection and transmission/refraction phenomena and the Uniform Theory of Diffraction (UTD), or related models, for edge diffraction. These approaches are widely used in high-frequency EM raytracing frameworks.

3. User Access and Login

3.1 Account Requirements

To use raytraaS app, you need:

- A **username**
- A **password**

These credentials are provided by The Mobile THz Company (TMTC).

3.2 Login Procedure

1. Open a web browser and navigate to https://app.themobilethzcompany.com/
2. Enter your **username** and **password**.
3. Click **Login**.
4. Upon successful authentication, the dashboard will appear.

If the login attempt fails, verify that your credentials are correct and contact support if the issue persists.

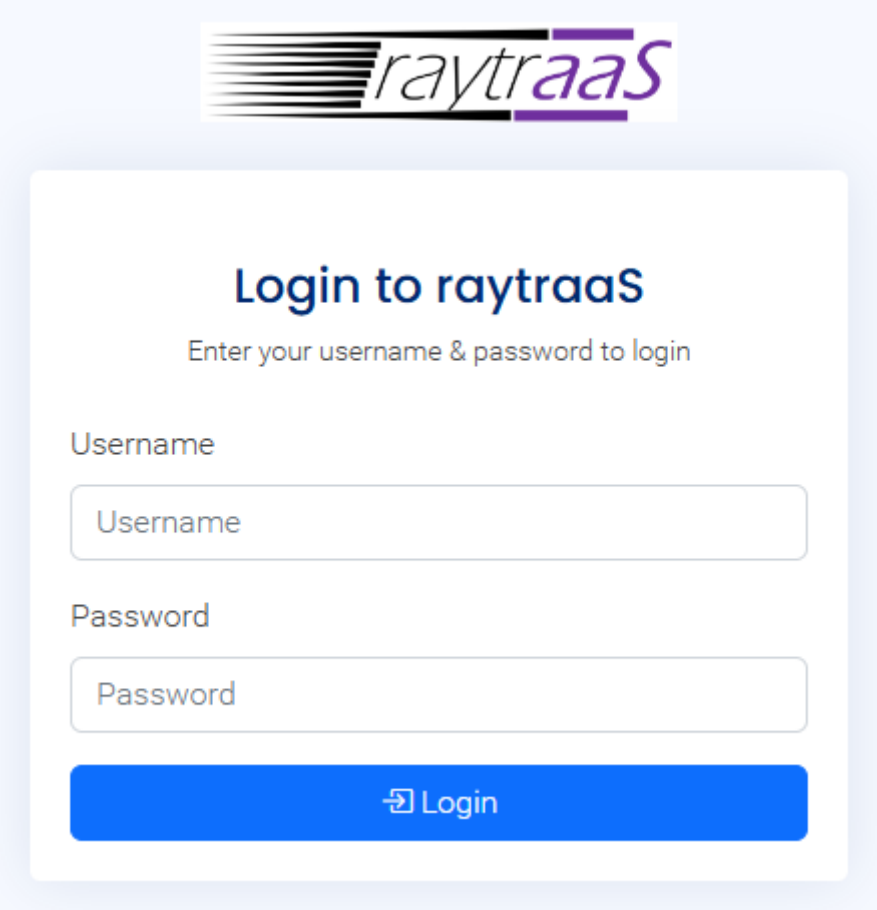


Figure 1: RaytraaS Login Page.

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4. RaytraaS Dashboard

After logging in, the main dashboard is displayed. It provides access to the following features:

- A button such as **New Simulation** or **Create Project**.
- A list of existing simulations, including their current status (e.g., Running or Finished).
- Links to **Results**, **Settings**, and **Help**.

The dashboard serves as the central starting point for creating, running, and managing simulations.

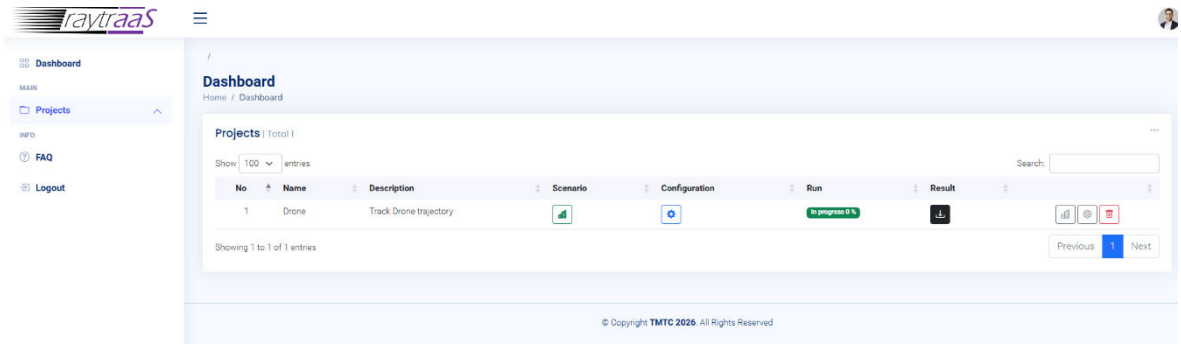


Figure 2: RaytraaS Dashboard User Interface.

5. Scenario Creation in Blender

RaytraaS uses Blender to define and prepare the 3D environment through which EM rays propagate.

5.1 Geometry and Objects

1. Open Blender and create or import the 3D environment (rooms, buildings, vehicles, equipment, or other relevant structures).
2. Verify that the geometry is clean and properly constructed. Avoid duplicate or overlapping faces, and inconsistent surface normals, as these may lead to incorrect or unexpected ray interactions during the simulation.
3. Group objects logically (e.g., walls, floors, furniture) to facilitate material assignments, EM property mapping, and subsequent scenario management.

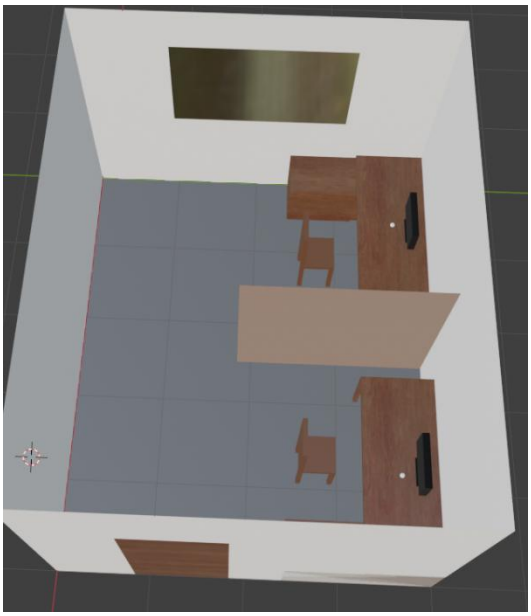


Figure 3: Blender 3D Scenario.

5.2 Material and EM Mapping

Material properties (e.g., dielectric constant, conductivity, loss tangent) determine how rays interact with surfaces, including their reflection, transmission, absorption, and attenuation

characteristics. In raytraaS, these properties can be assigned directly within the Blender environment using the raytraaS Blender plug-in.

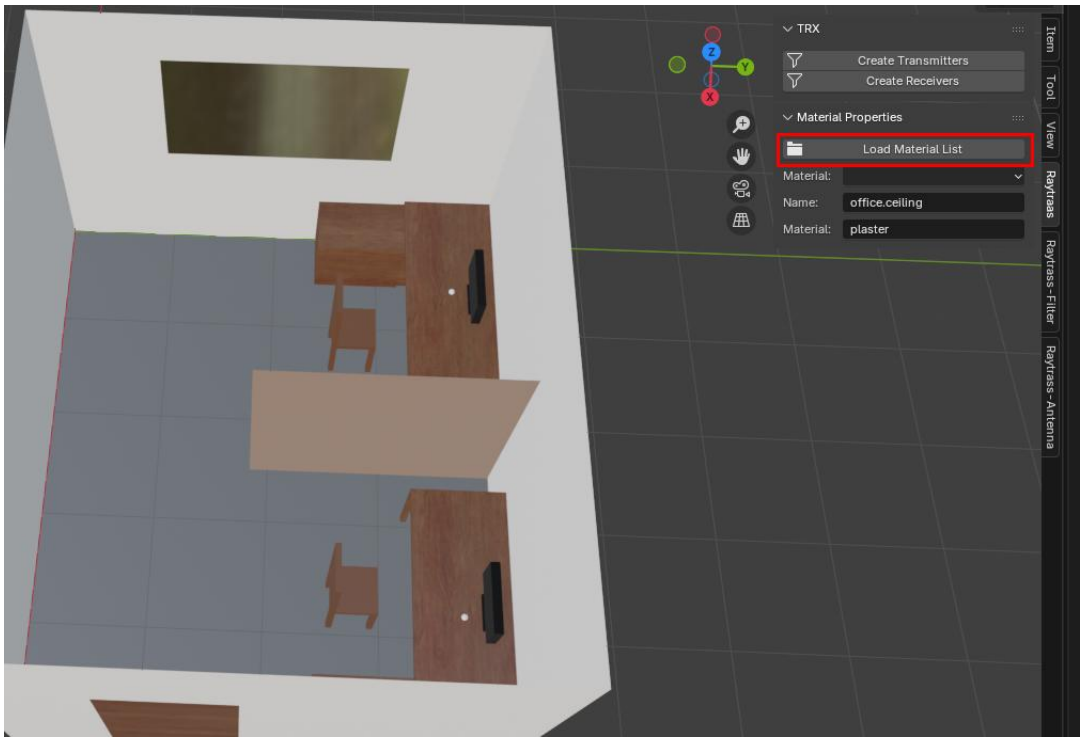


Figure 4: Assigning Materials to a Scenario.

For each material, consider defining at least the following EM parameters:

- Complex relative permittivity (Ɛr)
- Conductivity (σ) or loss tangent

5.3 Transmitter and Receiver Representation

Common approaches for representing transmitters and receivers in the Blender environment include:

- Create dedicated Blender objects, such as empty objects or small markers to represent the transmitter and receiver. Assign consistent names, such as **TX_1**, **TX_2**, **RX_1**, etc.
- Attach custom properties to the TX/RX objects such as antenna position, and orientation.
- Alternatively, define the transmitter and receiver coordinates only in the configuration file and keep the Blender scene purely geometric.

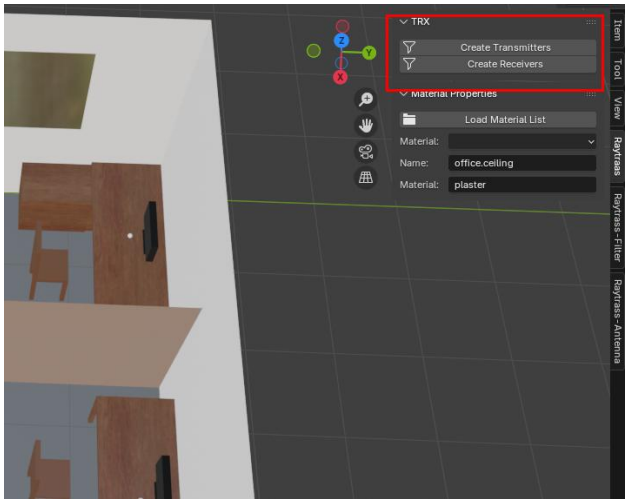


Figure 5: Create Transmitters and Receivers in Blender.

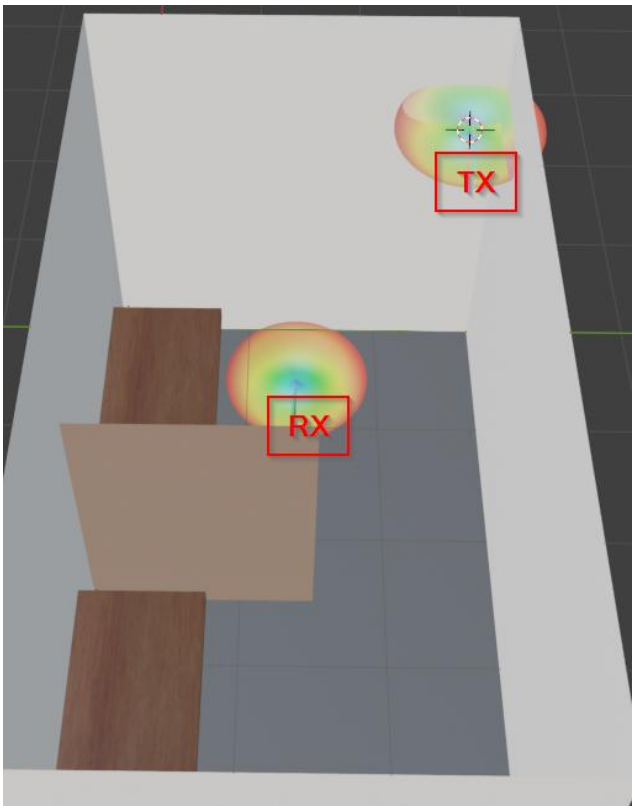


Figure 6: Transmitter and Receiver Antenna.

6. Electromagnetic and Raytracing Parameters

The simulation configuration defines the EM and numerical parameters used by the ray-tracing engine.

6.1 Frequency and Bandwidth

Raytracing is most effective when the wavelength is small relative to the characteristic dimensions of the scenario features, which is typical in high-frequency radio, radar, and THz applications.

In the configuration file, specify:

- **Center frequency** (e.g., 28 GHz, 77 GHz, 300 GHz).
- **Bandwidth** where applicable for wideband simulations.

6.2 Ray-Launching Parameters

Key parameters for the ray-launching process include:

- **Number of rays** launched per transmitter.
- **Angular distribution** (e.g., uniform over a sphere, sector limited, beam-shaped).
- **Maximum number of interactions** (e.g., reflections, transmissions, or scattering events) allowed before a ray is terminated.

Increasing the number of launched rays and the maximum number of permitted interactions can improve the representation of complex propagation paths, but it also increases computational time and memory requirements. These parameters should therefore be selected according to the required accuracy and available computational resources.

6.4 Non-Line-of-Sight Settings

Configuration options may include:

- Enable or disable diffraction.
- Maximum number of reflections, scattering, and diffractions permitted per path.
- Scattering model used to represent interactions with rough or diffuse surfaces.

Caution: Allowing multiple diffractions can dramatically increase ray count and complexity.

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7. Simulation Configuration File

The configuration file collects all of the above parameters.

7.1 Typical Contents

A typical configuration file contains:

- Global settings:
  - Project naming convention
  - Center frequency and bandwidth
  - Propagation medium parameters, including the speed of light or other relevant properties where applicable

- Transmitter settings:
  - Position and orientation
  - Antenna pattern and/or antenna gain
  - Polarization
  - Transmitted power, where applicable

- Receiver settings:
  - Positions, areas, or regions of interest
  - Reception radius or detection sphere size, where applicable to the selected raytracing algorithm

- Raytracing settings:
  - Angular sampling model
  - Maximum interactions/bounces

7.2 Creating the Configuration File

1. Use a text or code editor of your choice and follow the **raytraaS** JSON configuration syntax and schema.
2. Define all required sections (global, transmitters, receivers, materials, rays).
3. Verify that all names and identifiers referenced in the configuration file exactly match those defined in the Blender scene, including object names, material names, and transmitter/receiver markers.
4. Save the configuration file to your computer.

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8. Uploading the Scenario and Configuration

8.1 Start a New Simulation

1. Log in to **raytraaS** and navigate to the main dashboard.
2. Click **New Simulation** or **Create Project**.
3. Enter a descriptive **simulation name** and provide a brief description of the simulation and its purpose.

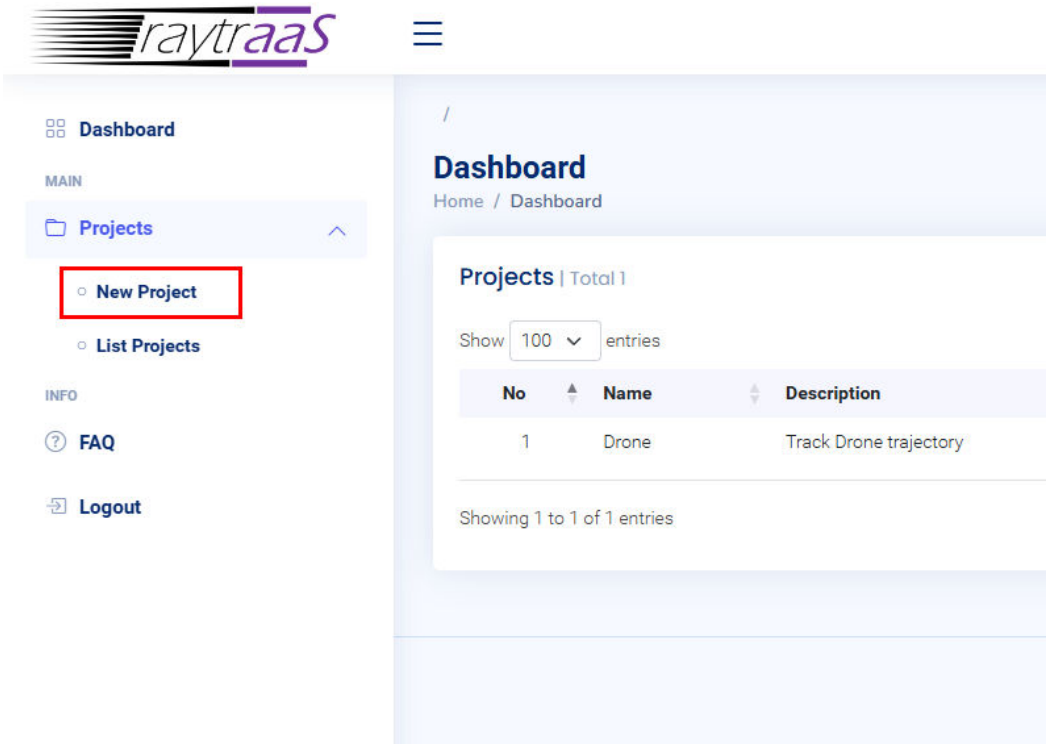


Figure 7: Create a New Project.

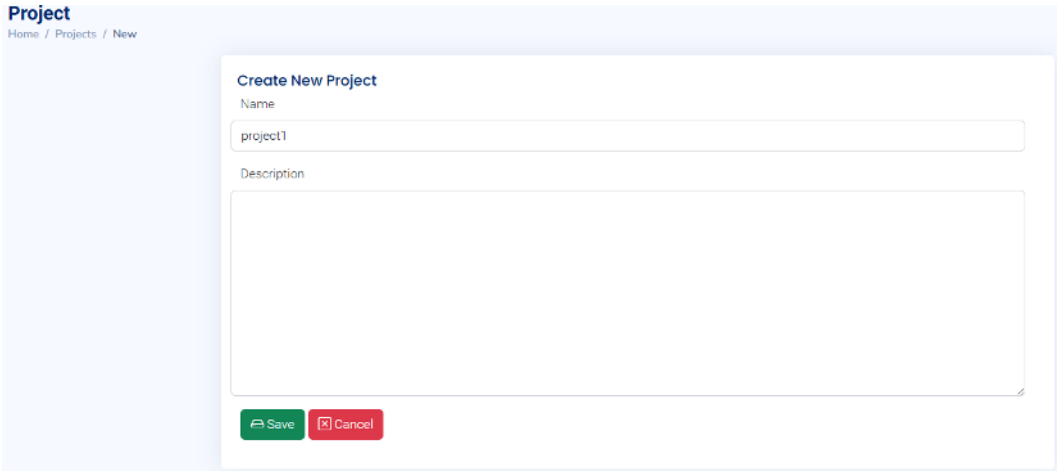


Figure 8: New Project Properties.

8.2 Upload Files

1. Under **Scenario File**, click **Browse** and select the exported Blender scene file.

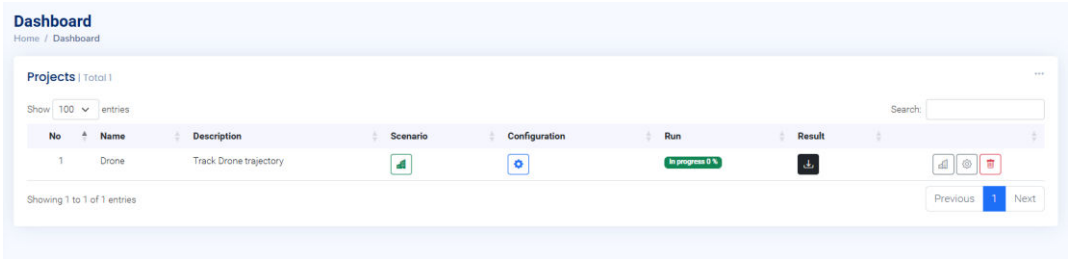


Figure 9: Import Scenario to raytraaS.

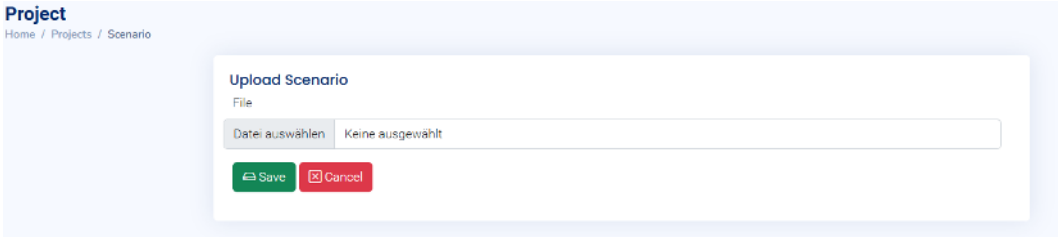


Figure 10: Upload Scenario Form.

2. Under **Configuration File**, click **Browse** and select the configuration file.

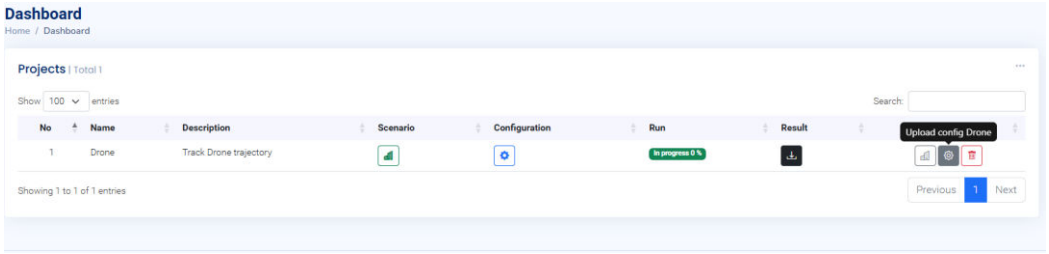


Figure 11: Import Configuration to raytraaS.

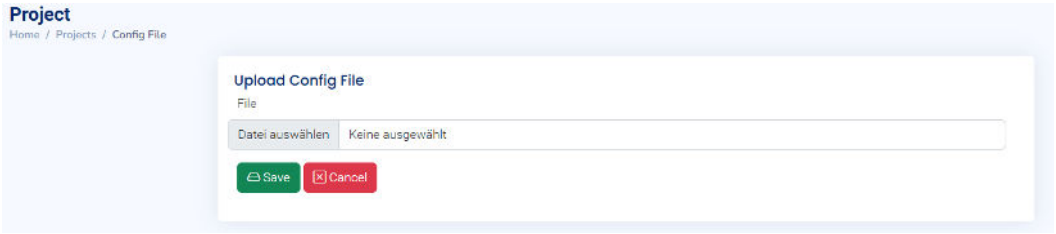


Figure 12: Upload Configuration File Form.

3. Upload both files.

8.3 Validation

RaytraaS checks:

- Scenario file readability.
- Configuration file syntax and required fields.

- Consistency between names referenced in the configuration file and those defined in the Blender scenario.

If validation fails, raytraaS displays error messages indicating the source of the problem and the required corrections, such as a missing transmitter definition, an invalid material name, or an incorrectly formatted configuration parameter.

Once all validation checks are successfully completed, the simulation is ready to be configured and executed.

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9. Running the Simulation

Once both files are uploaded and validated:

1. Click **Run Simulation** or **Start**.

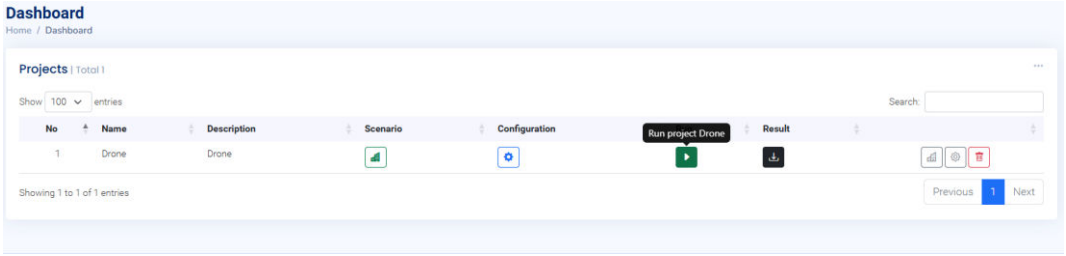


Figure 13: Simulation Run Button.

2. The job is submitted to the raytraaS server.
3. The status updates show whether the simulation is queued, running, finished, or failed.
4. The results can be downloaded from the project dashboard once simulation is completed.

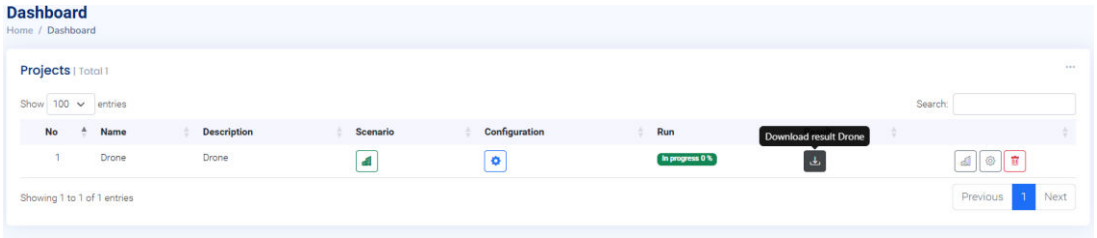


Figure 14: Download the Simulation Results.

Runtime depends on:

- Scene size and geometric complexity.
- Number of rays and interaction limits.
- Whether diffraction is enabled.

10. Viewing and Interpreting Results

10.1 Result Types

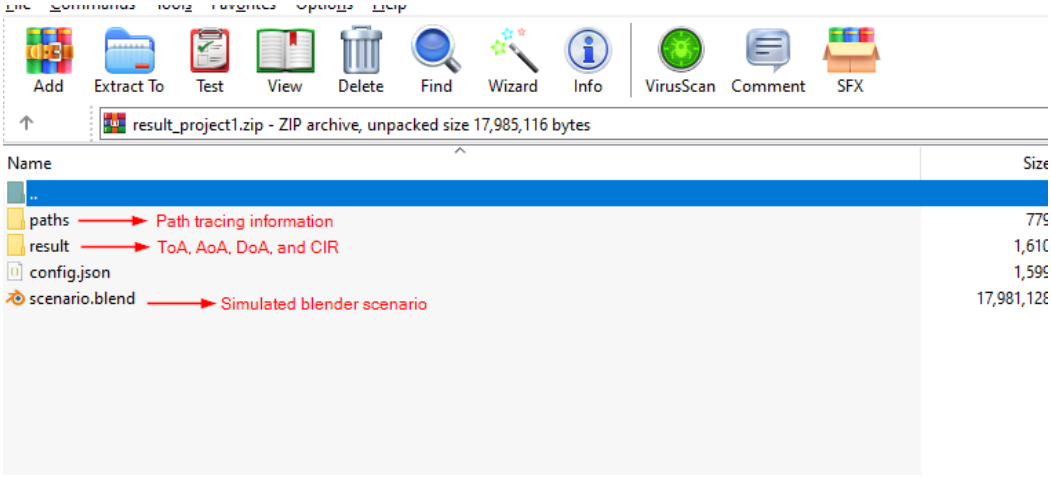


Figure 15: Downloaded Simulation Results.

RaytraaS can present:

- **Ray path visualizations**: showing ray lines, interaction points, and classification into direct, reflected, transmitted, and diffracted paths.
- **Per-receiver metrics**:
  - Received power or field strength.
  - Path loss and delay.
  - Number of contributing rays.
- **Time of Arrival (ToA), Angle of Arrival (AoA), Direction of Arrival (DoA), Complex Impulse Response (CIR), and a range of output data** in tabular formats that can be exported and further processed using numerical computing software such as MATLAB.

10.2 Analyse and Visualize Results

1. Install raytraaS blender addons.
2. Open the scenario.blend in downloaded results file.
3. Use visualization controls in Blender to:
   - Show/hide rays and interactions.
   - Filter by path type or number of bounces.
   - Focus on specific transmitters or receivers.
4. Export data:
   - Numeric results in .txt format.
   - Screenshots or rendered images of ray paths and fields for reports.

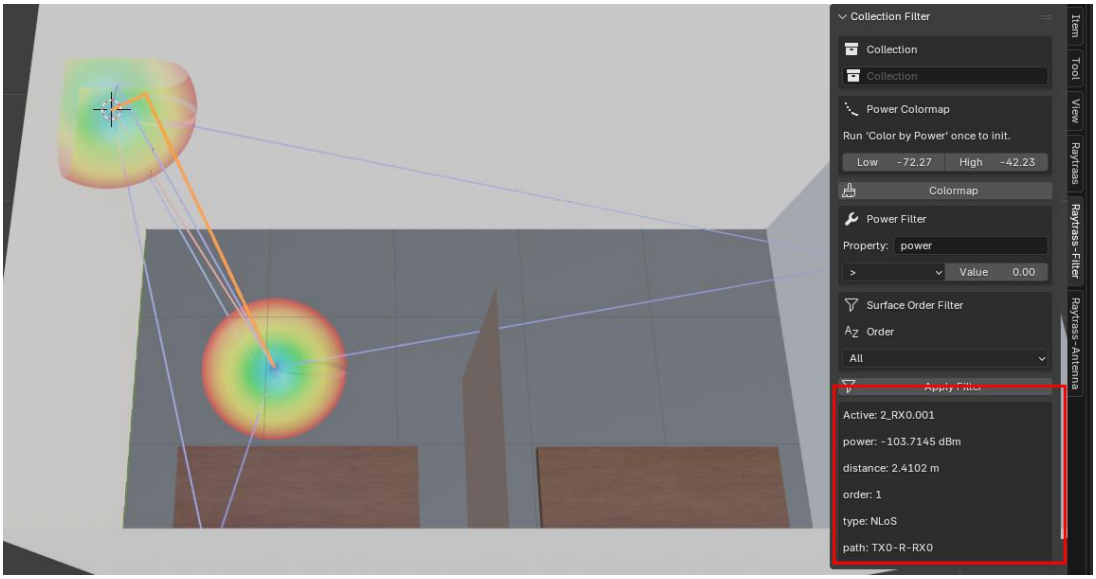


Figure 16: Visualize and Filter the Ray in Scenario.

Interpretation hints:

- Direct paths correspond to line-of-sight propagation.
- Reflected paths show interactions with surfaces; number and type of reflections influence path loss.
- Transmitted paths appear in scenarios with penetrable materials.

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11. Common Issues and Troubleshooting

Login problems

- Confirm username and password.
- Ensure no extra spaces or incorrect capitalization.
- Contact support if account issues persist.

Scenario file errors

- Verify export format and settings.
- Check for geometry problems (non-manifold, inverted normals).
- Ensure material names or custom properties follow the expected convention.

Configuration file errors

- Fix syntax issues (unclosed brackets, missing commas).
- Ensure mandatory fields (frequency, at least one transmitter and receiver) are present.
- Confirm that names for materials, transmitters, and receivers exist in the scenario.

Simulation failures

- Inspect error logs for hints.
- Reduce complexity (fewer rays, disable diffraction temporarily) and test.
- Check material parameters for invalid values.

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13. Support and Updates

For assistance and updates:

- Contact your raytraaS administrator or support team.
- Refer to online documentation, FAQs, and release notes.
- Keep track of changes to supported formats, EM models, and raytracing options for each software release.

Note: This short version of the user manual is without Appendices, Appendix notation, Glossary, and Bibliography.