**Signal Propagator Code Tutorial**

**Libraries Used**

Most of these files will likely already be installed. However, if these are not installed the code will not work.

* External Libraries
  + NumPy
  + Matplotlib
  + SciPy
* Internal Libraries
  + Dataclasses
  + CSV

**Code Organization**

Code is organized into 3 steps.

1. Initialize the input data
2. Execute ray tracing algorithm
3. Execute the scattering matrix method algorithm

File organization is separated into three folders which execute each step and 3 external files. The external files include the exact parameters which need to be input, the file which runs the code, and a global class file with miscellaneous functions and constants. A csv file must also be included into the main folder which contains the csv data, organization of this data will be explained in the next section. A visual of how the files are organized can be seen in the figure below.

A computer screen shot of a black screen

Description automatically generated

**Inputs File & CSV Organization**

The input file has 8 inputs necessary to run the code. Additional parameters depend on the function desired to run the code.

* X\_input – the initial X-position of ray propagation (Necessary)
* X\_range – Range of x values at the surface (Necessary)
* Y\_range – Range of y values at the surface (Necessary)
* Frequency – the frequency of the propagating rays (Hz)
* Frequency\_range – the range of frequencies to test
* B\_field – the magnetic field vector being applied [Bx,By,Bz]
* B\_range – The range of magnetic field magnitudes to test
* Cfd\_data\_file – the name of the data file that data is being taken from. (Necessary)
* Height – length of propagation to test (Necessary)
* Run\_type – The type of data to compare/calculate. (Necessary)
  + Options: “PosComp” (position comparison), “FComp” (frequency comparison), “BComp” (magnetic field comparison)

The CSV file must have following labels for the corresponding headers:

* x > X-coordinates (m)
* y > Y-coordinates (m)
* nD\_O= > refractivity of O
* nD\_O2= > refractivity of O2
* nD\_N= > refractivity of N
* nD\_N2= > refractivity of N2
* nD\_NO= > refractivity of NO
* e- > electron number density (m­­-3)
* Tv > vibrational temperature (K)
* rho\_air > density of air (kg/m3)

These labels are default from paraview data extraction with the exception of the coordinate points

**Running Code**

To run the code, open the folder in your IDE and run the file Full\_Execute.py

**Appendix**

**(W.I.P.)**