User guide for the **XDU-RF-chain-simulation-main**

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1 Infrastructure

The **XDU-RF-chain-simulation-main** infrastructure is organised as follows:

- A main folder “XDU-RF-chain-simulation-main” containing 3 subfolders:“data”, “necessary”, “result”.

- A subfolder “data”. This subfolder contains input subfolders, which name are similar to “Stshp_AK_S23d_Iron_0.118_68.4_202.5_3”. An input subfolder should contain the electric field time domain information files of antennas, such as “a0.trace” contains 4-rows: [Time, *Ex*, *Ey*, *Ez*] .

- A subfolder “necessary” should contain the main code: “XDU RF chain code.py” , Two MATLAB data : “30_250galactic.mat”, “Complex_RE.mat” and 4 subfolders: “antennaVSWR”, “cableparameter”, “filterparameter” and “LNASparameter”. “XDU RF chain code.py” is the main code and is the only code that should be modified by the user. The subfolder “antennaVSWR” should contain three files: “1.s1p”, “2.s1p”, “3.s1p” represent the S11 test results of the X ,Y , Z port respectively. The subfolder “cableparameter” contains the “cable.s2p”, which is the S-parameter test results of the cable. The subfolder “filterparameter” contains the S-parameter test results of the filter: “1.s2p”. The subfolder “LNASparameter” should contain three files which represent the S-parameter test results of the X ,Y and Z port respectively: “1.s2p”, “2.s2p”, “3.s2p”.

- A subfolder “result” will contain output subfolders which have the same number and same name of input subfolders. These output subfolders contain 1 subfolder named “output” or “output_withoutnoise”, and 1 file: “parameter.txt”. The subfolder “output” contain 4 voltage subfolders: “voc”, “Vlna” , “Vlna_cable” , “Vfilter”. The files which naming follows the form “a0_trace.txt” under the voltage subfolders represent the time domain pulse of the open circuit voltage, the LNA output voltage , the cable output voltage and the filter output voltage, respectively. “a0_trace.txt” has 4 columns: [Time, *Vx*, *Vy*, *Vz*]. Of course, various folders and files under “result” can be automatically generated by the main program.

2 How to use **XDU-RF-chain-simulation-main**?

We detail here in practice the different steps to use the **XDU-RF-chain-simulation-main**.

2.1 Correct the format of the input files

For that, go in the folder “data”. Name your input folder in a format containing 8 strings such as “Stshp_AK_S23d_Iron_0.118_68.4_202.5_3” , where “Stshp” can be set to any word but make sure that each input folder starts with the word you set, “AK” and “S23d” are optional settings, “Iron” is the particle type, “0.118” is the particle energy with unit “*EeV*” , “68.4” is the incident zenith angle with unit “*deg*”, “202.5” is the incident azimuth with unit “*deg*”, and “3” refers to the third input when the previous settings are the same.

Under input folders, there are files naming follows the form “aNumber.trace” where “Number” is an integer starting at 0 that refers to the order of the antennas positions. Each “aNumber.trace” contains 4-rows: [Time, *Ex, Ey, Ez*] where time corresponds to the time window at the given antenna position with unit “*ns*” and *Ex, Ey, Ez* the projection of the E-field as function of time with unit “$\mu V / m$” and with the subscript *x*, *y*, *z* referring to directions that follows the standard ZHAireS convention.

2.2 Define initial parameters

To define the parameter of your target response open the file “XDU RF chain code.py”. We list below the different parameters that should be modified by the user:

(Please find the main program part first: Program comments included “==========!!!Start the main program from here!!!==========”)

- “savetxt”: “savetxt=0” means not to save the output file, “savetxt=1” means to save the output file.
- “show_flag”: “show_flag=0” means not to show pictures, “show_flag=1” means to show pictures.
- “noise_flag”: “noise_flag=0” means not to add galactic noise, “noise_flag=1” means to add galactic noise.
- “lst”: if “noise_flag” is 1, “lst” can be set to an integer from 0 to 23,corresponding to the galactic noise of local sidereal time 0h-23h in the LengHu on January 1, 2020.
- “Ts”: Time interval in "aNumber. trace" mentioned in Section 2.1

2.3 Launch the code

Once the parameters of the target response are set just launch the code “XDU RF chain code.py” to initiate the RF Chain simulation.

2.4 Get your Response output file

Once the RF Chain simulation procedure is completed you can get the responses corresponding to each input folder in the “result” folder. Your output folder will have the same name as your input folder mentioned in Section 2.1,like “Stshp_AK_S23d_Iron_0.118_68.4_202.5_3”.

In the output folder named like “Stshp_AK_S23d_Iron_0.118_68.4_202.5_3” , there is one file for information of each input particle named “parameter.txt”. In addition to this, there is a folder that includes the results of the RF link voltage calculations. If “noise_flag” is 1, it names “output”,otherwise names “output_withoutnoise”. As mentioned previously, the “output” or “output_withoutnoise” contain 4 voltage subfolders: “voc”, “Vlna” , “Vlna_cable” , “Vfilter”.

Under voltage subfolders, there are files naming follows the form “aNumber_trace.txt” where “Number” is an integer starting at 0 that refers to the order of the antennas positions. “aNumber_trace.txt” has 4 columns: [Time, Vx, Vy, Vz] where time corresponds to the time window at the given antenna position with unit “ns” and Vx, Vy, Vz the projection of the Voltage as function of time with unit “ μV ” and with the subscript x, y, z referring to directions that follows the standard ZHAireS convention.