EMWSD team meeting
Notes from the meeting held on 15 November 2021

Present: E. de la Fuente Garcia, C. Zannini, L. Giacomel, G. Iadarola.
Excused: -

- **Status of the studies (E. de la Fuente)**

Slides are available here.

  - New GitHub organization ImpedanCEI for the project development:
    - WarpBasics repository: containing the cube cavity simulations performed Warp and coupled with the Wake potential calculation
      - cube_cavity_mpi.py: prepared to run on parallel in htcondor
      - cube_cavity_impedance.py: old algorithm for WP and impedance
      - cube_cavity_poisson.py: new algorithm *in progress*
    - EMcLAW-test repository: with the box resonator test to study the applicability of FVTD numerical scheme to EM simulations
      - Prob.f90: where initial conditions are defined
      - metallic_material_3d.f90: defines the metallic region
      - inputs: defines the simulation domain, timesteps mesh and AMR refinement
  - Wake potential indirect integration (based on GdFidl method):
    - Overview of the mathematical approach and steps followed
    - First script made to implement the indirect integration: solve two Poisson problems in the transverse plane at pipe boundaries z=-l1 and z=l2 + Riemman sum to obtain the definite integral between l1 and l2.
      - Brief discussion on why only the TE and TEM modes are considered. An agreement was found that for the longitudinal wake potential, this modes are sufficient, but then this computation is obligated to use the Panofsky-Wenzel theorem to obtain the transverse impedance.
    - Problems detected: how to define s vector? Which is the s vector resolution and length? Which is the relation between the wakelength (WL) and the simulation time?
    - Study performed with CST to find the relation between wakelength, number of timesteps and length of s vector. Why don't the simulation steps seem to increase linearly with WL, as expected? Why the length of the s vector is less than the number of timesteps?
  - Box resonator
    - Presented the 1st objective of the study: obtain the order of the numerical scheme in both a conformal and non-conformal grid by computing the error with the frequency of the oscillating field. Compare the results with the convergence study by L. Giacomel.
    - Study the energy dissipation of FVTD method by computing the stored energy of the E field in the resonator (inspired by this Darmstadt study)
    - First simulations running but giving incorrect results due to a bud in materials definition.

- **Discussion (all)**

- The nomenclature needs to be changed. In CERN bibliography the s vector corresponds to the accelerator or device longitudinal coordinate while z is the distance between the source and the test particle. We will stick to that nomenclature for future discussions.
- Wakelength increases number of timesteps linearly once the simulation is not dominated by the domain length (WL >100). If the initial number of timesteps (450) are subtracted from the total of timesteps computed, the increase is linear. The increase in the s length is also linear once the negative values are subtracted. These negative values are used by CST to compute the upper half of the bunch since the origin of the source is set in the middle of the bunch.
- The difference between the length in the s vector and the number of timesteps are the steps needed to account for the first witness (test) particle to enter the domain. Therefore length(s) < number of timesteps.
- s vector (or, with the new nomenclature, z) is the distance from the source particle to the test particle. Therefore, the simulation time needed to compute is until the last test particle is outside the domain. Therefore $t \sim (WL + L_{domain})/c = N\Delta t$

- **Next steps (all)**
  - To test the new algorithm, first make sure the frequency of the computed fields is the same from CST simulations and from Warp simulations. Do this by probing the cavity at the center and obtaining a value for the electric field for each timestep and then computing the FFT for the frequency.
  - Other option to consider is to obtain the electric field directly from CST to try only the indirect integration wake potential algorithm.
  - Focus on the definite integral part of the wake potential calculation. Obtain the frequency and compare it with the direct integration method and with the frequency from the CST simulations ($f = 4.3\,GHz$). For that, longer simulations are preferred over short ones. Launching the simulation in htcondor may be needed.
  - Fix the problems with the materials in EMcLAW with the developers (to be discussed with Eduardo during this week).

Minutes by Elena de la Fuente Garcia