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From 1-D fluid models to 3D PIC simulations for resonant PWFA experiments at SPARC_LAB

Considerable interest has been shown in the last few years in compact plasma accelerators characterized by extremely high accelerating gradients generated, e.g., by high brightness particle beams (Plasma WakeField Acceleration mechanism - PWFA). PWFA is currently under investigation at SPARC_Lab test facility [1] – INFN-LNF (Frascati, Italy). SPARC_Lab is an ideal place to test PWFA schemes due to the versatility offered by the high brightness photo-injector. At present train of ultra-short (100 fs) low emittance electron bunches can be generated and manipulated to achieve high accuracy temporal separation.

Our work spans from simple and fast one-dimensional fluid [2] simulations to fully 3D PIC simulations (ALaDyn Code [3]). One-dimensional fluid models are somehow too simple to catch the entire underlying physics, nevertheless they offer a simple and fast tool to asses working points. We discuss how these models can be analytically modified to extend its validity in the quasi-non-linear regime to phenomenologically account for damping effects and how it compares with 1D-PIC code as well as on the on-axis results of fully 3D-PIC code.

We will also show fully 3D simulations for a plausible two bunches (driver plus witness) SPARC_Lab configuration. We discuss pros and cons of a strongly elongated driver, maximum achievable transformer ratios and energies.

References

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