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Proposed project:

An India-UK joint program for kinetic plasma simulations aimed at training, simulations and code development.

Background

- Much of the current developments in fast-ignition, shock ignition, wakefield accelerators and high-power lasers requires extensive kinetic simulation support. Often the best choice is a particle-in-cell (PIC) code such as the one developed in the UK called EPOCH (Arber et al., Plasma Physics and Controlled Fusion, 57 (2015) 113001). The UK could conduct research purely by downloading PIC codes developed by others, the most noticeable example being OSIRIS from the UCLA group. However, by developing a UK based community developed code we have complete control over the source code which can be adapted for our specific needs. The EPOCH project also nurtures a group of PIC code experts and high-performance-computer (HPC) specialist able to optimize codes for the rapid developments in computer architectures.

UK-India opportunity

EPOCH is an open project so allows collaboration with any interested researchers. As a joint UK-India venture the there is the opportunity for joint developments of EPOCH across many projects. One example of such a project is from laser accelerator research…

Proposed project

Wakefield accelerator example: Often accelerator simulations are best performed in a boosted frame. This shifts the bulk plasma to relativistic speeds and amplifies the intrinsic errors in PIC codes from numerical Cherenkov radiation.

There are three EPOCH developments need to deal with this.

EPOCH developments needed to deal with this

- Use improved difference schemes for the beam direction, ideally spectral, so that errors in the numerical dispersion relation which cause numerical Cherenkov are minimised.
- Improve the field smoothing routines to remove the numerical Cherenkov.
- Use an energy conserving PIC scheme by changing the field to particle interpolation.
- Particle injection on moving boundaries.
- Diagnostics for specific experiments and analysis tools for lab-boosted frame transformations.

How to do this?

For an experienced PIC developer these could take up to a year to fully implement and test. They could therefore form part of a one-year UK-India code development project for a PDRA. Alternatively developing these algorithm changes and applying to experiments could constitute a full 3.5-year PhD project.

Developing a long-term programme

Beyond a single project this has the potential to develop into an on going programme of PIC code development and use. This could include training for users and developers of PIC codes in India, these already run in the UK, through to joint projects on simulations in support of experiments.