Ideal-MHD ELM simulations with the BOUT++ code

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BOUT++ is a C++ framework for writing plasma fluid simulations with an arbitrary number of equations in 3D curvilinear coordinates. It has been developed from the original 3D 2-fluid boundary turbulence code BOUT. Though designed to simulate tokamak edge plasmas, the methods used are general and almost any metric tensor can be specified, allowing the code to be used to simulate (for example) plasmas in slab, sheared slab, and cylindrical coordinates. BOUT++ automates the common tasks needed for simulation codes, separating the complicated (and error-prone) details such as differential geometry, parallel communication, and file input/output from the user-specified equations to be solved. Thus the equations being solved are made clear, and can be easily changed with only minimal knowledge of the inner workings of the code. Benchmarking has been performed for linear and non-linear fluid and MHD test problems, including the Orszag-Tang vortex and comparisons to the BOUT code which will be presented.

The aim of this work is to develop non-linear ELM simulations in order to understand particle and energy loss mechanisms. As a step towards this, we will report linear ideal-MHD ELM simulations which have been compared to results from ELITE. A t-file formatted grid from a MHD equilibrium code, TOQ, has been converted into an input for BOUT++, and linear ELM simulations have been performed using a reduced ideal MHD model which includes both pressure and current drives. Instead of employing the surface terms which drive peeling modes at the interface between plasma and vacuum, we use a real parallel current profile peaked inside the pedestal due to the bootstrap current driven by steep pressure gradient. Agreement between the calculated growth rates and those from ELITE is within a factor of 2 over the range of mode-numbers analyzed. The diamagnetic stabilization has been observed in the BOUT++ simulations as toroidal mode number n increases. Several issues are still under investigation, for example at high mode-number, ELITE finds the growth-rate declining, whereas BOUT++ results showed them to be increasing in the absence of diamagnetic terms.