Numerical analysis of the cylindrical liner flux compression experiment

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In liner flux compression experiments, an initial magnetic flux of several Tesla is compressed to megagauss. A megagauss field interacting with the liner may cause two possible major effects. One is the thermal ionization of its inner surface caused by joule heating accompanying the diffusing of magnetic field into the liner. The other one is the RT instability growth on the inner surface of the liner caused by the push of the magnetic pressure. We studied those effects by numerical simulations, where the liner material chosen as stainless steel and the liner geometry as cylinder. Fig. 1 shows some of the results.

The magnetic diffusion process is studied by an 1-dimensional MHD code MC11D [1]. One can see in Fig. 1 the fast advancing of a sharp wave front. As discussed in a theoretical paper [2], the height of the wave front corresponds to a magnetic field threshold $B_c$ that is solely determined by the material properties, and Fig. 1 tells that this threshold for stainless steel is $\sim 320$ Tesla.

The possible RT instability growth is studied by a 2-dimensional MHD code. When the resistance of the liner is treated ideally as zero, RT instability grows obviously around the turning-around time of the liner. However, this RT growth doesn’t affect much the maximum magnetic flux density obtained. When a more realistic resistance model [3] is used, there is no obvious RT growth. Those results indicate that RT instability is not a main obstacle for flux compression in those experiments.

References


Figure 1: Top: magnetic field distribution evolution; Bottom: evolution of the liner with vanishing (left) and Burgess (right) resistances, pseudo-color represents the magnetic field diffused into the liner.