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Title

3D modeling of a continuous arc with anisotropic mesh adaptation.

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Abstract

When an aircraft is struck by lightning, the current injected can vary between 200A up to 200kA. The lightning strike can be broken down into two phases. In the pulsed phase, the current intensity can go to 200kA in a few micro-seconds and in the continuous phase, the current is constant with intensities of a few 100A and for durations of hundreds of milliseconds.
In the case where the arc is sweeping on the fuselage, and is able to move freely, the arc can be characterized as a free burning arc. This type of arc is of industrial interest especially in the field of welding, arc furnaces, and switchgear for example.
The numerical modeling of this phenomenon is very complex as it involves different physics (fluid dynamics, electromagnetism, radiation ...), and the computational costs in the case of 3D simulation are extremely high because the refinement required at certain points in the mesh results in a mesh containing up to several hundred million cells.
An ideal solution to reduce this calculation cost would be to mesh only where necessary, and therefore to have a mesh that will adapt in space and time according to the physics encountered.
The magnetohydrodynamic (MHD) 2D/3D code Taranis developed at ONERA is coupled with feflo.a [1], an anisotropic mesh adaptation code developed at INRIA. With this coupling, it becomes possible to simulate 3D configurations at drastically reduced computing costs.
To show the interest of these adaptation tools in the framework of plasma simulation and to validate the MHD code Taranis, the simulation of a test case of a free-burning arc is performed [2].
It is a configuration consisting of a point cathode and an anode plane, where the cathode acts as a MHD pump to propel the plasma towards the plate. The continuous arc formed is stationary and it is similar to a free burning arc. It is a configuration well detailed experimentally and numerically in the literature, and can therefore be used to validate Taranis code. Most of the modelling in the literature is done in 2D axisymmetric geometry due to the cost of a calculation, but can also be done in 3D [3] at a reduced cost here with mesh refinement.

References

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