D2.9/Summary of the deliverable: "Implementation of FSI solver for elastic deformations of TMM"

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Biological flows often involve large to extreme deformations of the medium in therapeutic applications. An example of such deformations is in histotripsy (Khokhlova, et al., 2015) or sonoporation (Prentice, et al., 2005) beyond the elastic regime that can lead to a plastic flow or even beyond to fracture of the soft tissue. Fluid-Structure Interaction problem are classically modelled by the Arbitrary Lagrangian-Eulerian approach (Paquette, 2017), or by the Immersed Boundary technique coupled to a Finite Element Solver (Boustani, et al., 2019). However, Lagrangian methods are known to be inadequate for large deformations. Previous studies in the Eulerian setting modelled the soft tissue as a fluid where only normal stresses are accounted for. Here we propose to use the compressible diffuse interface approach of (Ndanou, et al., 2015) modelling the multi-material problems based on a Eulerian formulation of hyperelasticity and capable of handling dynamics appearances of cracks with the addition of on-the-fly mesh refinement techniques (Papoutsakis, et al., 2018). Specifically, we focus on the dynamical interactions of bubbles with soft tissue in the scope of therapeutic ultrasounds.

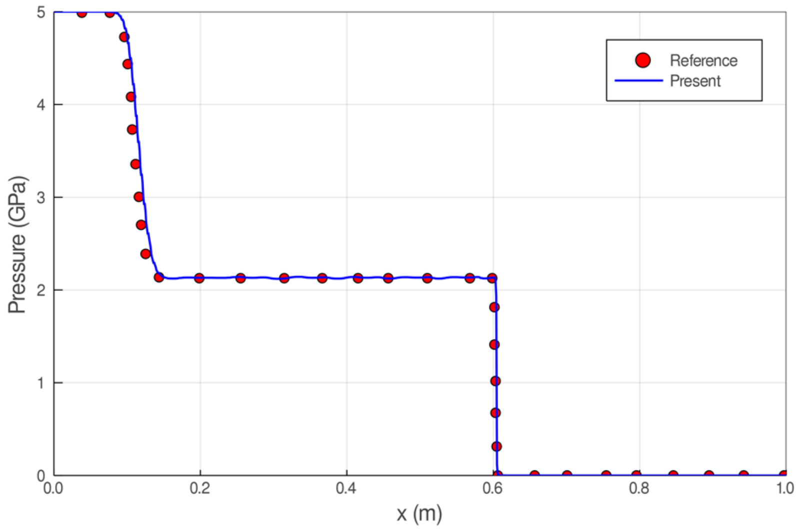

Figure 1. Pressure in the Copper-Air shock tube with high pressure (5E4) and high density ratio (178) where the interface is located at x = 0.6 m