High Power Targetry Workshop
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Summary of MHD Modeling and Simulations

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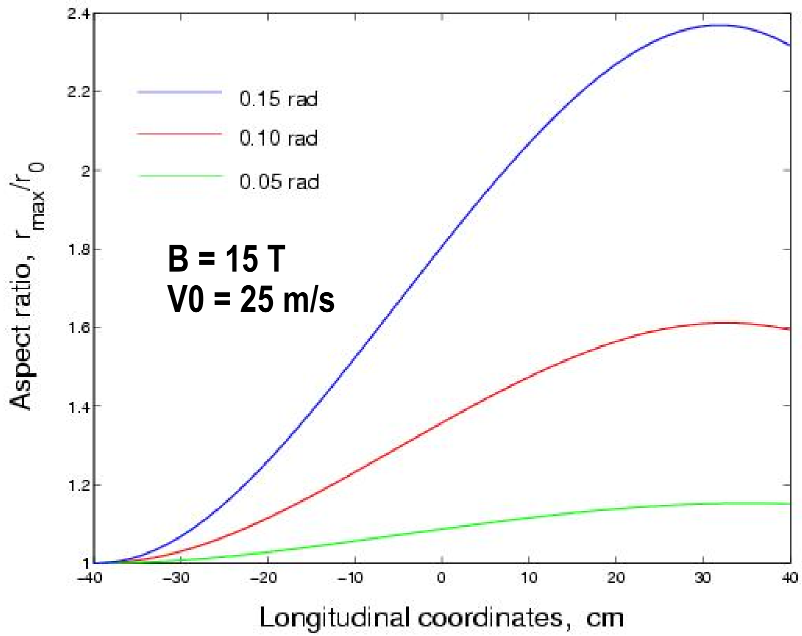
Development of New Models and Numerical Algorithms for the FronTier Code Enabling Target Simulations

- New mathematical models and numerical algorithms for bubbly and cavitating fluids
  - Heterogeneous method (Direct Numerical Simulation)
  - Riemann problem for the phase boundary
  - Dynamic cavitation algorithms based on nucleation theories

- New algorithms for MHD flows with geometrically complex free surfaces
  - Embedded boundary method for the elliptic part of MHD equations
  - Partially structured finite element grid generation conforming to interfaces

Numerical Simulations of Mercury Targets

- Deformation of the mercury jet entering a magnetic field
  - Aspect ratio of the jet cross-section was estimated to be < 1.4
  - Jet deformation depends on the jet entrance angle and velocity



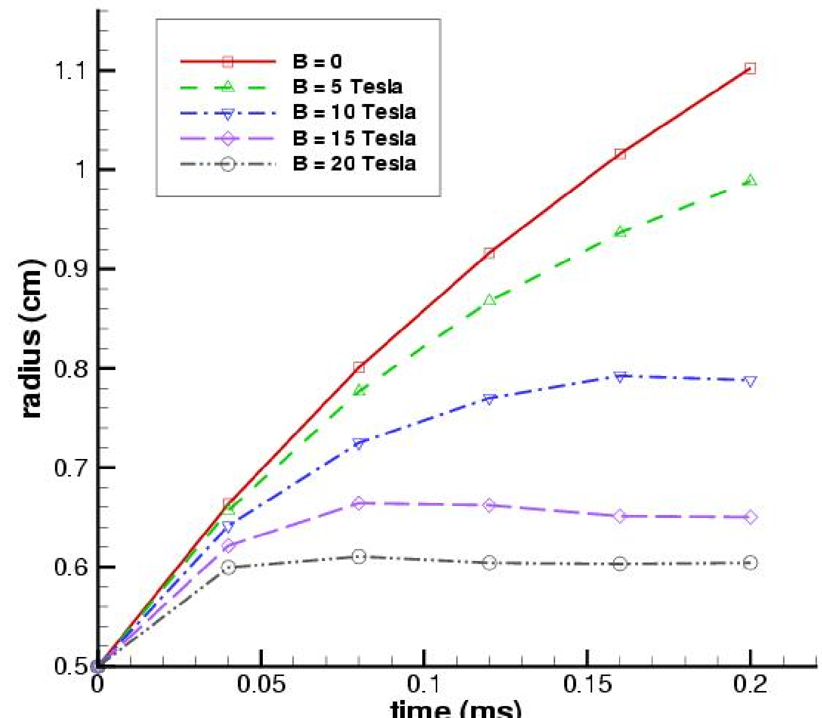
Aspect ratio of the cross-section of the jet entering 15 T solenoid at different angles

Numerical Simulations of Mercury Targets

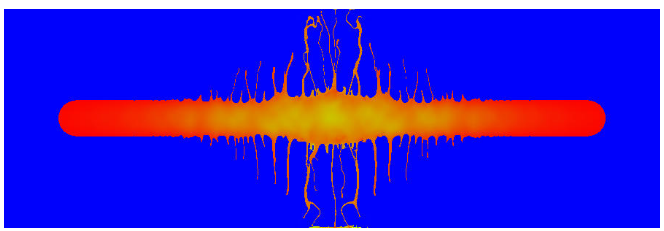
■ Simulation of the mercury jet target interacting with a proton pulse in a magnetic field

- Studies of surface instabilities, jet breakup, and cavitation
- MHD forces reduce both jet expansion, instabilities, and cavitation

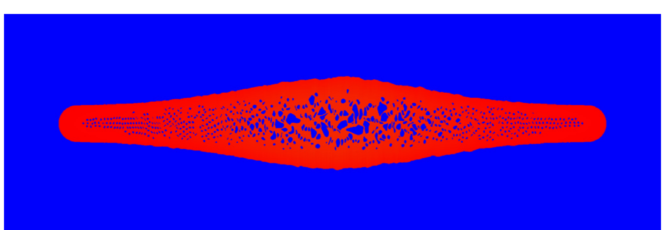
Stabilizing effect of the magnetic field



Jet surface instabilities



Cavitation in the mercury jet



Numerical Simulations of Mercury Targets

- Studies of the cavitation damage mitigation in the SNS target using layers of non-condensable gas bubbles
    - Integral effect of pressure peaks induced by cavitation bubbles was reduced by ~50 times
    - The mitigation efficiency depends on parameters of bubbly layers

Proton pulse induced pressure peaks on the entrance window in the pure mercury (left) and mercury containing gas bubbles (right). The pressure decay is much faster in bubble mercury (Notice that the total time is 2 ms on the left graph and 0.2 ms on the right graph). Cavitation was studied in these two pressure distributions and the estimated mitigation efficiency was 42.