Preliminary MHD Analysis of Lithium Sample in DIMES/DIII-D

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2D Free Surface Flow Model

- Preliminary calculations utilized a 2D Navier-Stokers approximation (motion and current in xy-plane, pictured below) using induction formulation and VOF free surface tracking

$$\frac{\partial B_i}{\partial t} + (\vec{u}\cdot\nabla)B_i = -\nabla\times\frac{1}{\sigma\mu}\nabla\times B_i\hat{z} - (u\cdot\nabla)B_a - \frac{\partial B_a}{\partial t}$$

$$\frac{\partial \vec{u}}{\partial t} + (\vec{u}\cdot\nabla)\vec{u} = -\frac{1}{\rho}\nabla\left(p + \frac{B_i^2}{2\mu}\right) + \frac{1}{\rho}\nabla\cdot\tau + \vec{g} + \frac{1}{\rho\mu}\left(\nabla\times B_i\hat{z}\right)\times B_a\hat{z}$$

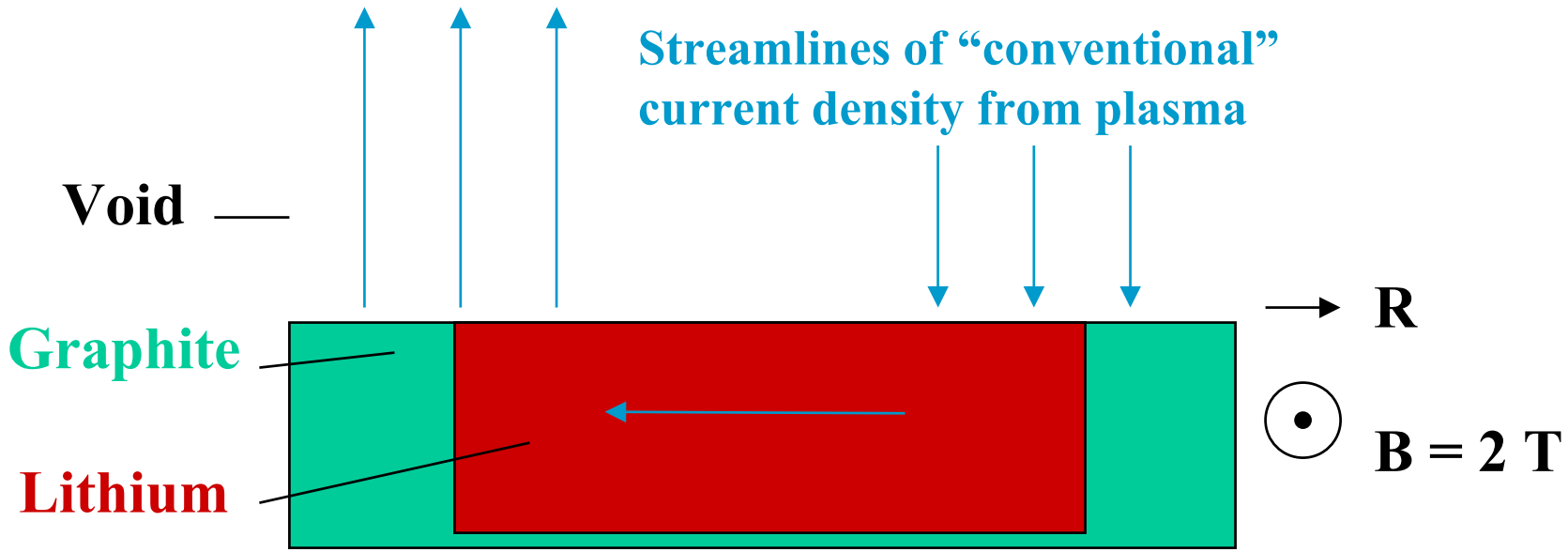
$$\frac{\partial F}{\partial t} + (\vec{u}\cdot\nabla)F = 0, \quad \nabla\cdot\vec{u} = 0$$

- Graphite can be treated with electrical (and wetting) properties of the void, or the liquid

Void ——

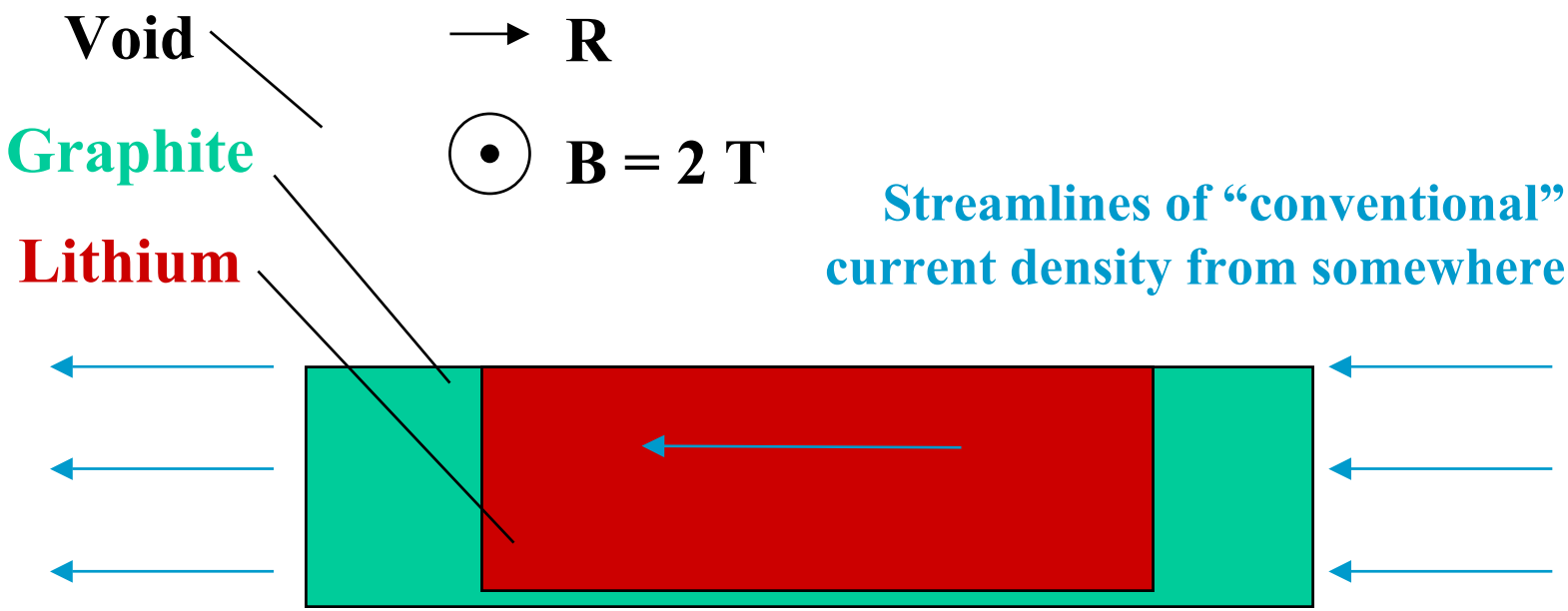
Reversing-Direction Top Current Scenario

- Graphite assumed to be non-wetted and poor conductor animation
- Assuming 40kA/m2 current density gives about 20 A coming into the DiMES sample



Side Current Scenarios

- Graphite assumed to be non-wetted and poor conductor animation
- Graphite assumed to be wetted and good conductor animation



Summary of results

- Reversing current from top (plasma) generates in the worst case a couple m/s upward velocity
- Side current simulations show that about 300-400 A of horizontal current through the DiMES sample is need to generate ~30 m/s upward velocity
- If the sample is wetted, longer destabilization times and lower upward velocities are observed