Advanced Space Propulsion Technology Development at MSE Technology Applications, Inc.

NASA JPL/MSFC/UAH 12th Advanced Space Propulsion Workshop

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MSE Inc.

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Advanced Energy and Aerospace Division

MSE Technology Applications, Inc. (MSE) is a multidisciplined technology company specializing in the research, development, engineering, testing, and evaluation of new technologies for application in the advanced energy and aerospace technology fields. MSE's customer base includes several U.S. federal agencies and private sector organizations. The advanced space propulsion research being conducted at MSE for the National Aeronautical and Space Administration (NASA) and other agencies are very diverse and have the potential to be utilized in many different applications. The skill base that has been assembled by MSE through the Department of Energy (DOE) National MHD Power Generation Program has provided the aerospace community with a resource in the electromagnetic and related area that can be efficiently utilized to address high priority space propulsion technology development issues.

MSE Technology Applications Testing Facility

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Advanced Space Propulsion Projects

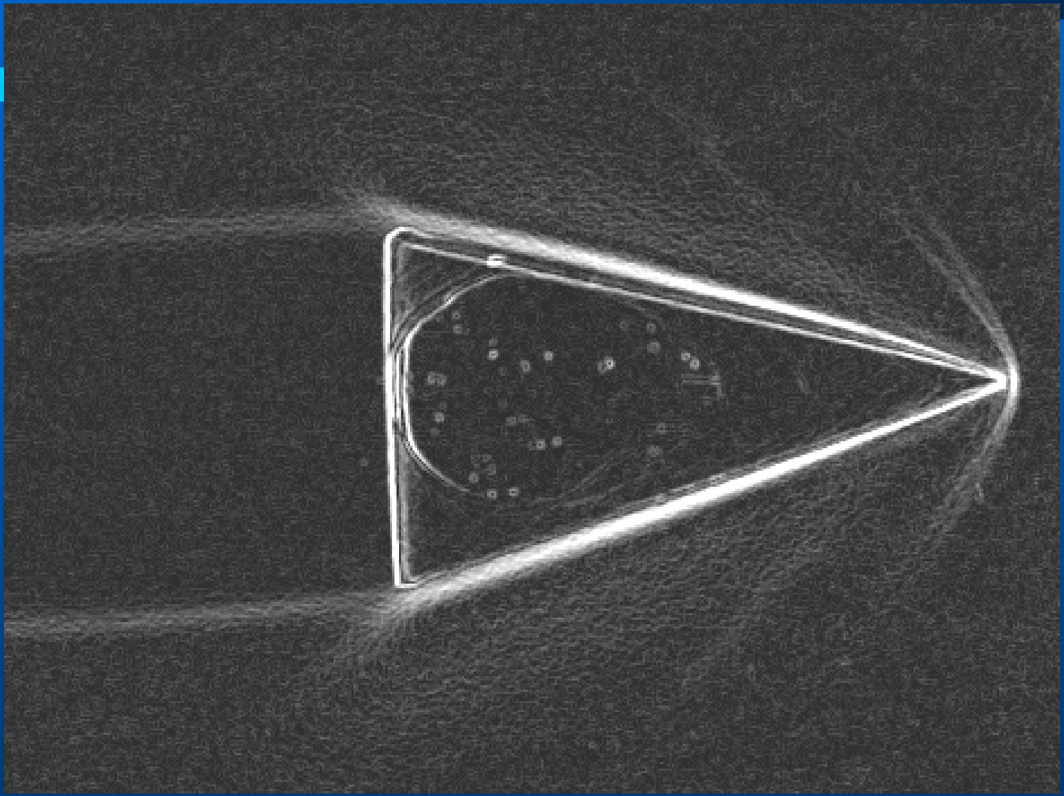
- Plasma Flow Control / Drag Reduction for High Speed Vehicles.
- Electromagnetic Propulsion Concepts: Advanced MHD Energy by-pass concept.
- Deeply Cooled Turbojet / Rocket Combined Cycle and Pulse Detonation Engine Technology Development.
- Plasma Space Propulsion: Computational studies and design on plasma propulsion devices and magnetic nozzle.

Plasma Flow Control / Drag Reduction for High Speed Vehicles

- Theoretical analysis: The prospects for the existence of shock-dispersion effects from a homogeneous WINP are bleak indeed. If a successful model of WINP with anomalous properties is to be found, it is very likely to be an inhomogeneous plasma state, and possibly with a strong non-Boltzmann component.

- Experimental Result: (Ohio State University). Only Thermal effect observed.

Plasma Flow Control / Drag Reduction for High Speed Vehicles



Shock weakening by the plasma in a 30% N_2 – 70% He mixture. Two flow images with RF discharge off and RF discharge on are differentiated to highlight the shock front location and then added together. The larger angle shock (117^o) corresponds to the "RF on" frame, and the smaller angle shock (105^o) corresponds to the "RF off" frame

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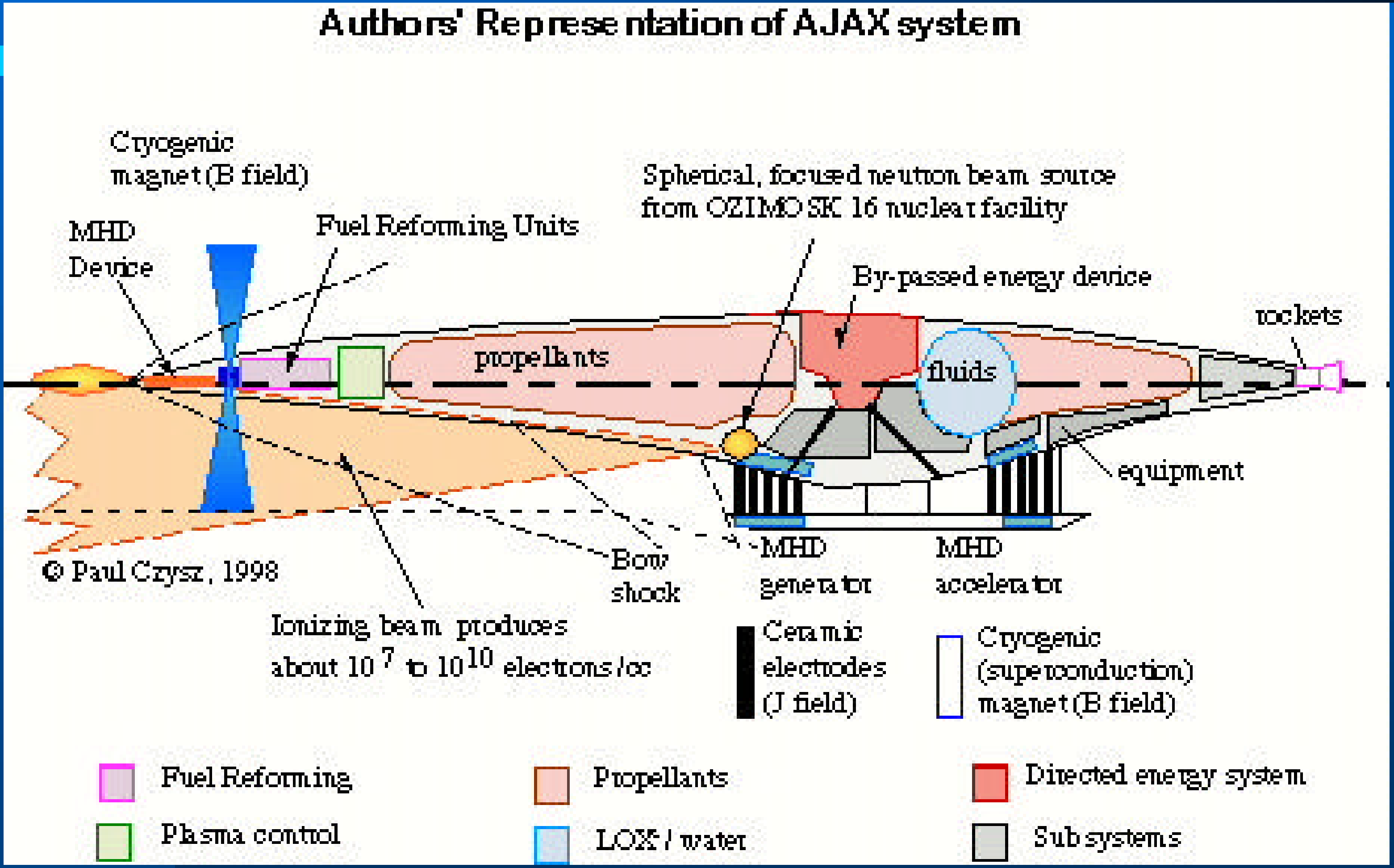
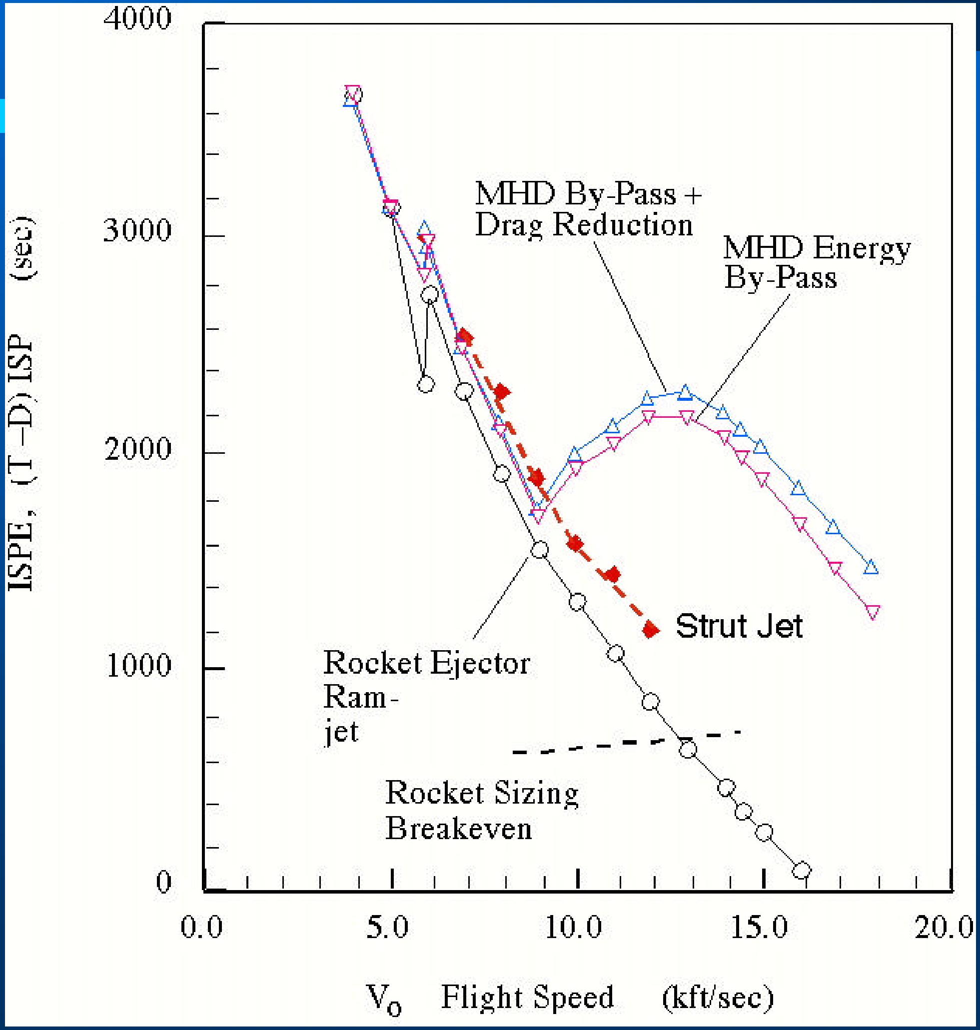
Electromagnetic Propulsion Concepts: Advanced MHD Energy by-pass concept

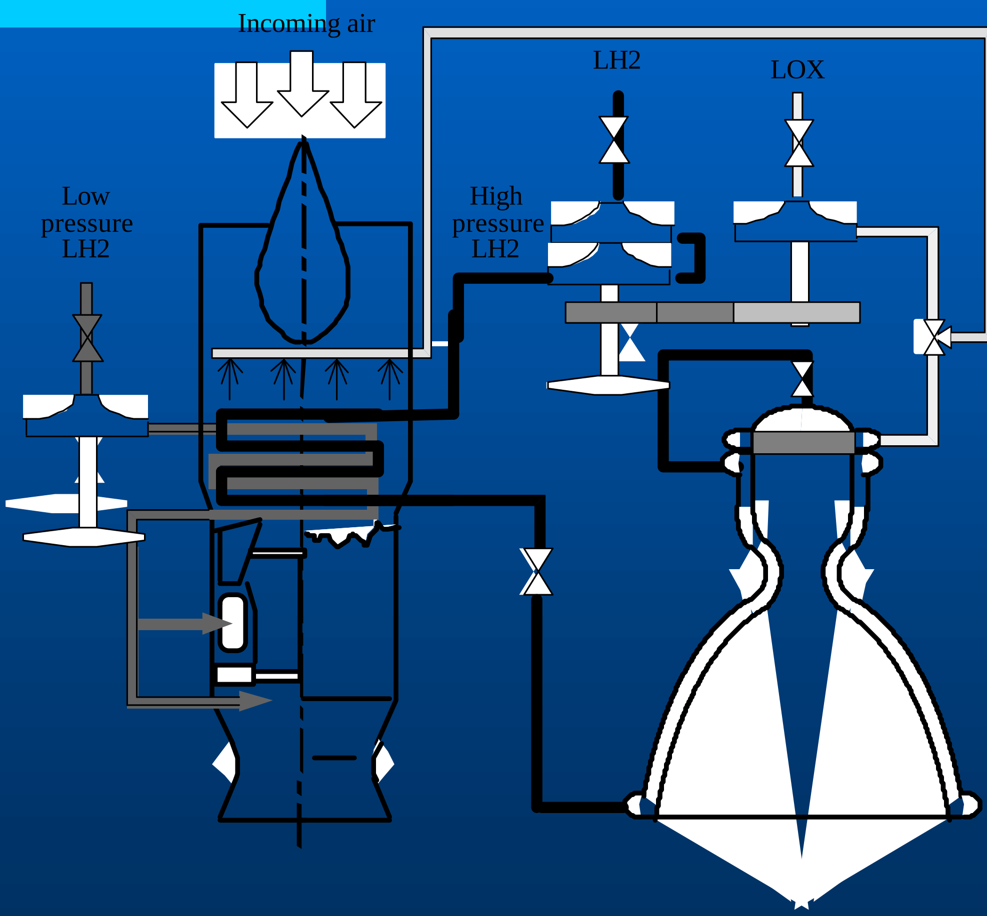


Electromagnetic Propulsion Concepts: Advanced MHD Energy by-pass concept



Deeply Cooled Turbojet / Rocket Combined Cycle Propulsion Concept

Basic configuration of the RL10-based KLIN Cycle.



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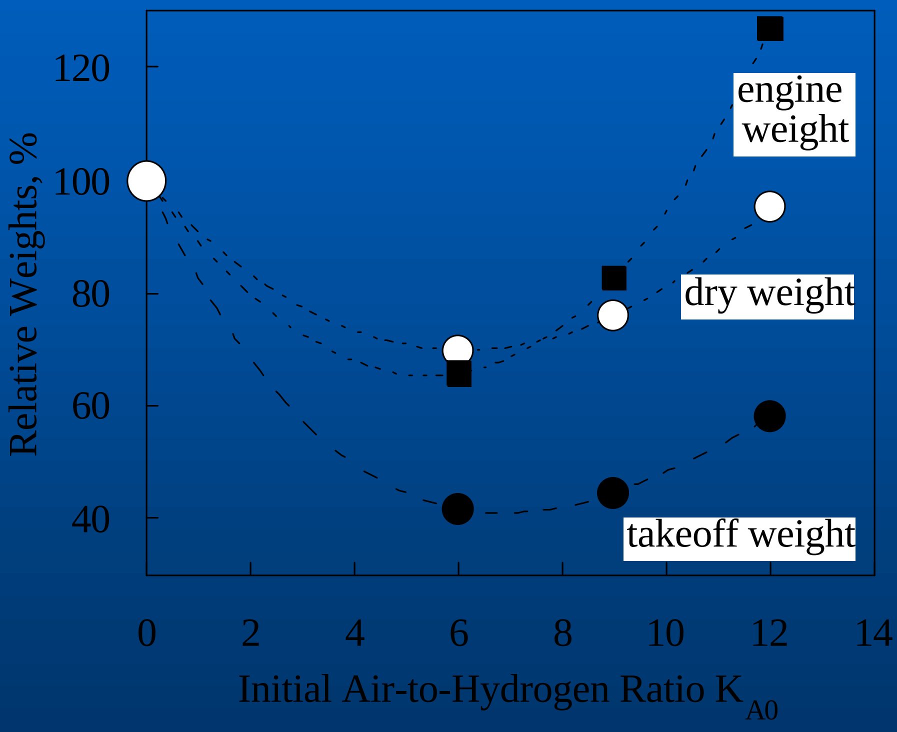
Deeply Cooled Turbojet / Rocket Combined Cycle Propulsion Concept

Comparison of the weights of all-rocket launcher and the KLIN Cycle launcher as a functions of the air-to-hydrogen ratio.



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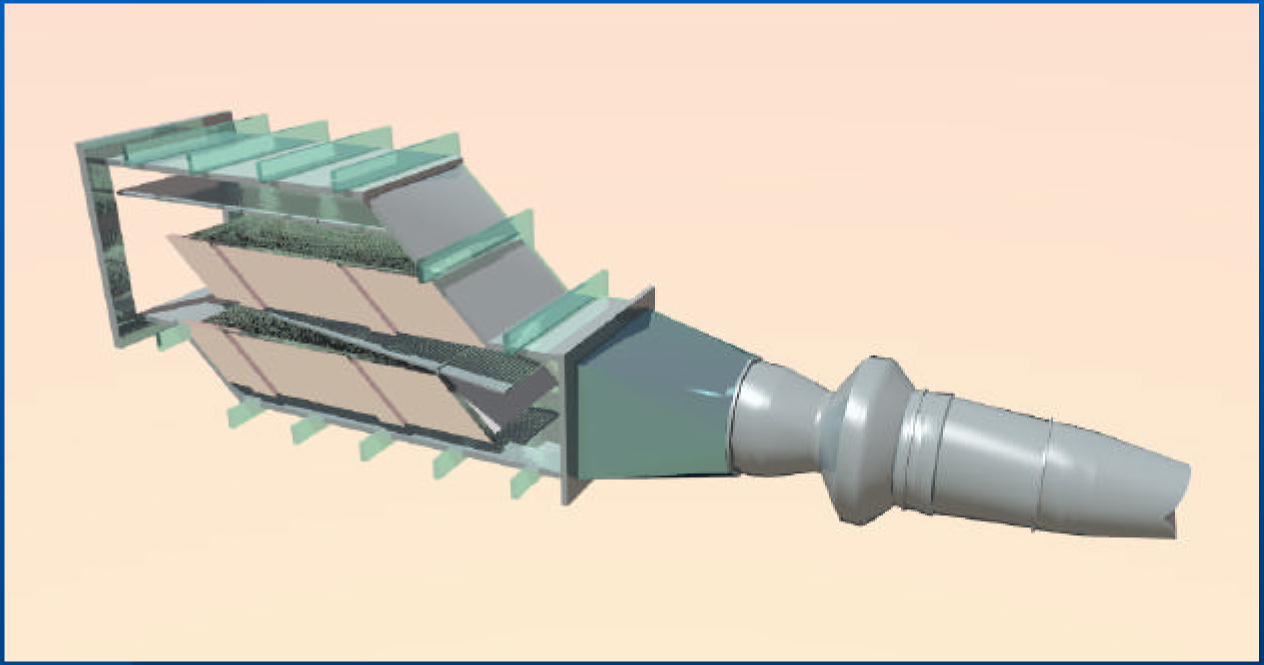
Deeply Cooled Turbojet / Rocket Combined Cycle Propulsion Concept



DCTJ demonstrator

Pulse Detonation Engine Technology Development

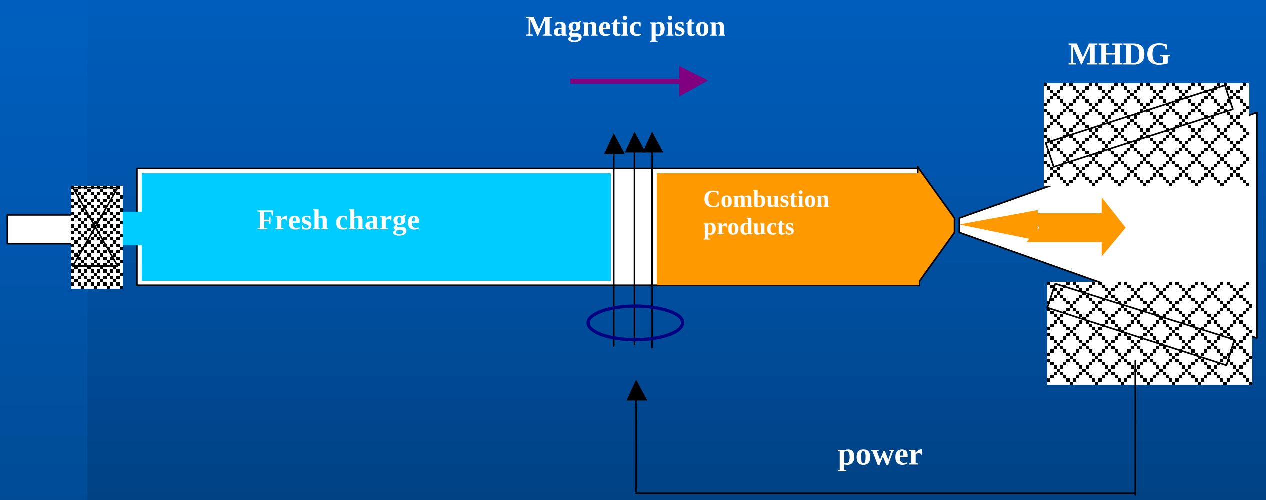


Figure 15: Schematic of operation of the energy-bypass PDRE cycle. After detonation in the chamber, the combustion products are pushed by a magnetic piston to maintain the conditions at the entrance to the nozzle at constant pressure. Behind the piston, a fresh charge is immediately introduced. The power required for the compression work is obtained from a MHD generator in the nozzle.

Pulse Detonation Engine Technology Development

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Plasma Space Propulsion

- **Test of plasma expansion into low-pressure dump tank**
- **Ideal MHD,** b **<< 1**
- **Flux-Interpolated Constrained-Transport shock-capturing TVD scheme (**ÑB º **0)**
- **Planar configuration**

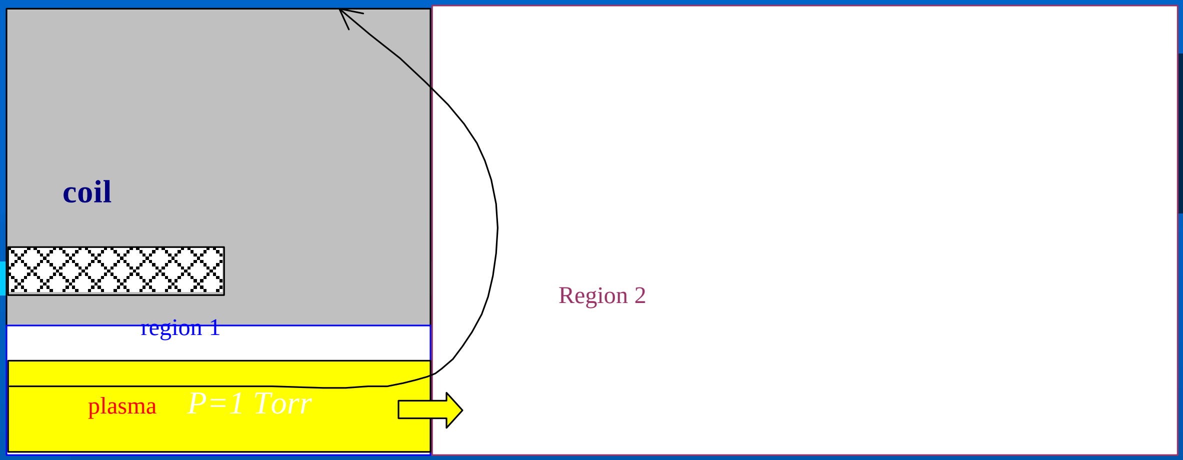

Figure 1: **Schematic of planar test case. Grey area indicates an insulating solid with an embedded current-carrying coil. Region 1 is at relatively high pressure, but only the yellow domain is at non-zero initial velocity.**

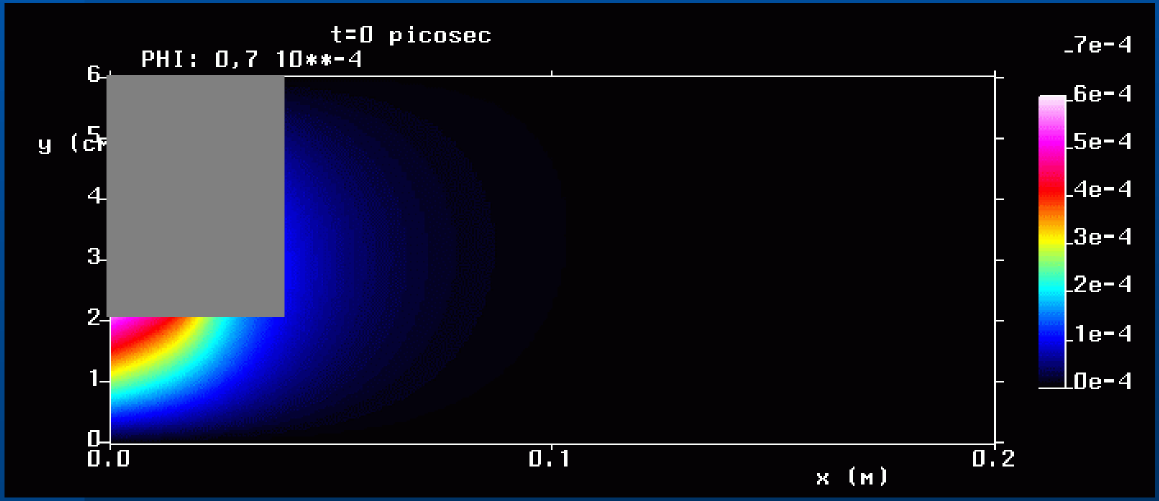

Figure 2: Initial value of the vector potential (z-component), including the insulator area.

- A_z **evolution (contours – field lines)**