

"Space Exploration is the ultimate
investment in America's Future"

George Bush



An International Leader
in Space Applications

Contact Information

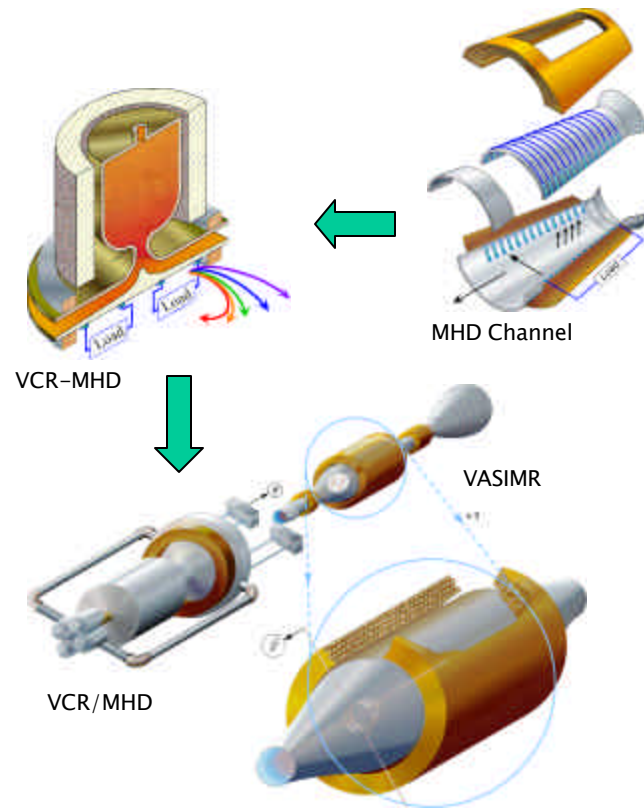
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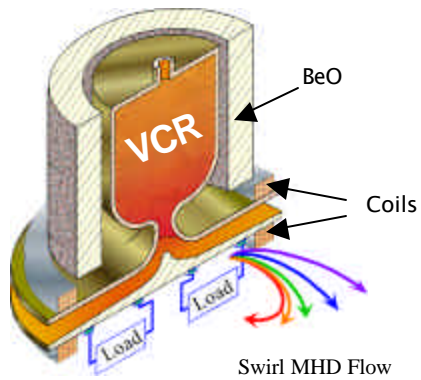
UNIVERSITY OF
FLORIDA



Fully Integrated VCR/MHD-Vasimr NEP System

The Innovative Nuclear Space Power and Propulsion Institute (INSPI) at the University of Florida has gathered together a multidisciplinary team of researchers who combine skills in materials science, computational fluid dynamics, radiological engineering and electrodynamic for the design and analysis of advanced nuclear electric propulsion (NEP) systems.

INSPI envisions a fully integrated ultralight and ultracompact power and propulsion system that would be capable of safely transporting a human crew to other planets of our solar system. INSPI and its industrial partners have developed concepts based on very low specific mass vapor core reactors with power magnetohydrodynamic (VCR/MHD). These systems could provide multimewatt power for NEP systems that dramatically reduce the mission time for human exploration of the entire solar system.



Gas & Vapor Fuel Reactor Design

- Multiphase UF_4 based Fuels
- High Temperature Compatible Materials
- Thermo-fluid Dynamic of Fissioning Plasma
- Static and Dynamic Nuclear Design

Although ultrahigh temperature gas core reactors (GCRs) or vapor core reactors (VCRs) are the way of the future, these advanced nuclear reactors have not been successfully taken from the drawing board and scaled laboratory experiments into prototype design. Coupled neutronics and computational fluid dynamic analyses have been performed to establish the nuclear and heat transport design characteristics of these systems. Designs for safe containment vessels for the high temperature UF_4 based fuels, and design of fuel circulation systems to meet the cooling requirements of such reactors, are also being addressed.

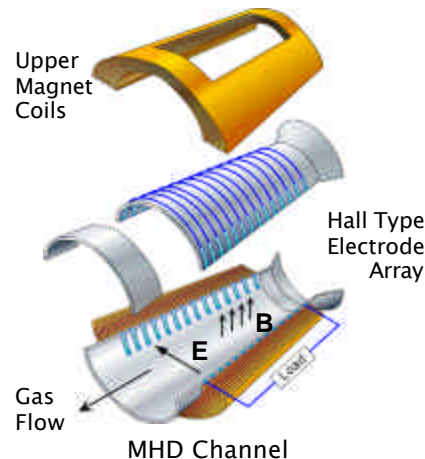
Disk MHD

The order of magnitude specific mass reduction in VCR/MHD systems is achieved by combing the fuel and heat transport medium into one and by using an ultrahigh temperature MHD Rankine cycle. Further reduction in total mass of the NEP system is achieved by direct coupling of VCR/MHD power to a whole host of electric thrusters. Current INSPI research is focused on the integration of the VCR/MHD system with the VASIMR (Variable Specific Impulse Magnetoplasma Rocket) being developed by the Advanced Space Propulsion Laboratory at NASA's Johnson Space Center. While a comprehensive program is beyond any one laboratory's effort, work at INSPI touches upon three major areas of NEP system design:

Gas and Vapor Fuel Reactor Design

Fission Power and Radiation Enhanced Ionization

Magnetohydrodynamic (MHD) Power Conversion

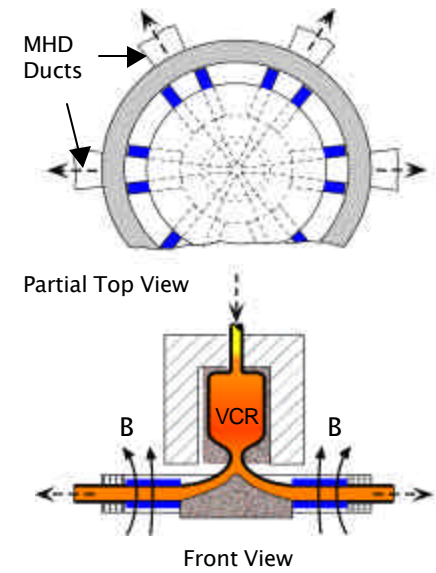


Fission Power and Radiation Enhanced Ionization

- Vapor Core Reactor Fuel/Working Fluid Conductivity
- Non-equilibrium Electron Temperature
- Ionization Enhanced Electron Mobility

The advantage of fissioning vapor or gas reactors is that they provide tremendous gas/working fluid ionization potential. This aspect of the research involves finding out how to optimize the ionized gas electrical conductivity for later conversion into electric power using MHD turbines. Both electron density and electron mobility contribute to conductivity but the ion density can be a problem when it gets too high and allows overly rapid recombination of electron and positive ions, thus reducing the electrical conductivity.

Efforts at INSPI are aimed at understanding how to maximize the electron mobility and maintain a reasonable but not too high ion density. Electron mobility, and hence ultimately the power conversion efficiency, is strongly connected with the reactor geometry, neutron flux, fission power density, and the configuration of the downstream magnetic turbine. With fission fragment interactions in the medium, electrical conductivities of about 10 to 100 mho/m should be attainable.



MHD Power Conversion

- Fuel Separation Technology
- High Electron Mobility
- Power Matching
- Cycle Analysis

Research focuses on analyzing combined MHD thermodynamic cycles to achieve near optimal efficiency in energy conversion from the reactor output. Indeed, magnetic "turbines" are the only existing power generators that can operate efficiently at temperatures in excess of 1500 °C which can be achieved in vapor core reactors. Proposed MHD generators will extract energy directly, at the highest quality, from the high conductivity working fluid expelled at high velocity from the reactor core. The remaining heat content of the fluid will be extracted at a lower temperature in a closed Rankine cycle before returning to the reactor.