The Advanced Power Extraction Study
APEX

Chamber Technology Goals Used in APEX to Calibrate New Ideas and Measure Progress
1. High Power Density Capability
   Average/Peak Neutron Wall Load ~ 7 / 10 MW/m²
   Average/Peak Heat Flux ~ 1.4 / 2 MW/m²
2. High Power Conversion Efficiency (>40%)
3. High Availability (MTBF>43 MTTR)
4. Simpler Technological and Material Constraints

APEX Goals
Identify and explore NOVEL, possibly revolutionary, concepts for chamber technology that might:
1. In the near-term: enable plasma experiments to more fully achieve their scientific research potential
   Average/Peak Neutron Wall Load ~ 7 / 10 MW/m²
   Average/Peak Heat Flux ~ 1.4 / 2 MW/m²
2. In the long-term: substantially improve the attractiveness of fusion as an energy source
3. Lower the cost and time for R&D

APEX is Organized as a Partnership Between Plasma Physics and All Elements of Science & Technology

Motivation for Liquid Wall Research
What may be realized if we can develop good liquid walls:
- Improvements in Plasma Stability and Confinement
  Enable high β, stable physics regimes if liquid metals are used
- High Power Density Capability
- Increased Potential for Disruption Survivability
- Reduced Volume of Radioactive Waste
- Reduced Radiation Damage in Structural Materials
  Makes difficult structural materials problems more tractable
- Potential for Higher Availability
  - Increased lifetime and reduced failure rates
  - Faster maintenance

Experimental Determination of Vapor Fraction and Boiling Flow Regime in Magnetic Field
An experiment is necessary to determine if the postulated EVOLVE vapor channel concept is possible and to investigate the MHD effects on the boiling flow regime.

Exploration of Innovative Advanced Solid Wall Concepts
- The Goal is to Identify and Address Fundamental Issues
- High Power Conversion Efficiency (>40%)
- Simpler Technological and Material Constraints
- Lower the cost and time for R&D

Innovative Concepts Proposed by APEX Can Extend the Capabilities of Plasma Devices and Attractiveness of Solid Walls
- Novel concept based on use of high temperature refractory alloy (e.g. tungsten) with innovative heat transfer/transport scheme for evaporation of lithium
- Low pressure, small temperature variations greatly reduce primary and thermal stresses
- High power density, high temperature (high efficiency) capabilities

APEX is a Partnership Between: DIII, CDX-U, PICES

Midplane and Lower Divertor Liquid Surface Modules in NSTX

CLiFF - Convective Liquid Flow First Wall

Liquid Wall Fusion Reactor Concept

Experimental design uses an X-ray, image technique to image the flow regime of a conductive metal in a magnetic field

Previous experiments indicate that the onset of nucleate boiling is not altered substantially by the B-field. It is not clear what will happen to the flow regimes

The key non-dimensional parameters involved in boiling Li can be reproduced by injecting He into Na.