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APEX Meeting 24

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R. Kaita, APEX "Cross-Cutting" Tasks: Past, Present, and Future
Outline

- Role of Cross-Cutting Tasks in APEX Vision
- APEX Accomplishments in Development of Liquid Wall Concepts
- Summary and Thoughts on Future of APEX
- Role of Cross-Cutting Tasks in APEX Vision
Objective: To identify and explore novel, possibly revolutionary, concepts for Chamber Technology that can substantially improve the attractiveness of future fusion energy systems.

Cross-cutting task ("Task B") supported two subtasks:

- Near-term ("Task I"): Identification of key issues and development of an R&D plan for implementing liquid surface module (LSM) in existing confinement device
- Long-term ("Task II/V"): Exploration of high-payoff liquid wall concepts

Role of Cross-Cutting Tasks in APEX Vision
APEX Accomplishments in Developing Liquid Walls for Magnetic Confinement Devices

- Critical role in programs of three toroidal magnetic confinement devices
  - NSTX: Near-term enhancement of existing high-performance spherical torus
  - CDX-U: Development of liquid lithium technology in confinement device for near term and long term applications
  - LTX: Theory and experiment “synergy” leading to funded Innovative Confinement Concept
Five-Year Plan includes surface coating in near term and flowing liquid lithium divertor in long term.

New capabilities:
- Fast pressure gauges
- Upgraded Langmuir probe array
- Director SpreD
- `D'' cameras for core heating
- n(c) / CHEERS, Zeff / MPTS (FY03)

New diagnostics:
- Lithium module (FY08, FY06)
- In-vessel cryopumps (FY06, FY03)
- Lithium pellets (FY03)
- Improved boronization (FY03)
- Improved sink (density) control
Earlier Skepticism Replaced with Definite plans for Near-term Lithium Wall Implementation in NSTX

Final design review targeted for early to middle of CY2004

Sample heated carbon tiles – Lithium will be evaporated onto sample heated carbon tiles for retractable e-beam system

CDX-U tasked to test coating system

Port covers and gate valves being installed on upper and lower dome ports

Near-term Lithium Wall Implementation in NSTX

Earlier Skepticism Replaced with Definite plans for
Liquid Lithium Experiments on CDX-U Motivated by APEX Focus on Liquid Walls

- New filling technique (UCSD)
- Tray after ~40 discharges
- Tray coverage ~80%
- Tray after fill
- Injector and tray immediately after fill
- Load liquid lithium onto 500°C
- Only thin coatings appear between runs
- Removed by argon glow, heating
- NO mobilization of the lithium
Liquid Lithium in Greatly Reduced Loop Voltage

CDX-U Utilizes a

Fixed V_L - Capacitor Bank

Clear Drop in V_L From

CDX-U Utilizes a

Note Separation of Lithium,

Also Increases by 17%

Discharge Duration

Hot, Clean Lithium < Hot Lithium < Cold Lithium < No Lithium

Clear Drop in V_L From

Fixed V_L - Capacitor Bank

CDX-U Utilizes a

Non-Lithium Data
LWalls are promising for OPPE.

- Outflux of impurities
- High bootstrap current
- High-<i>p</i>,
- Wall stabilized plasma
- LWalls add more

Low ion (Low ion limiter),
- Second stability regime (no
- No sawtooth oscillations,
- For particles and energy,
- Convection is a loss channel,
- No ITG influence,
- flatten temperature

Core fueling + Li absorbing wall offers enhanced edge temperature.

Theory Effort Related to APEX Task V

Lithium Tokamak Experiment (LTX) Based on...
Lithium Tokamak Experiment (LTX) to test transport and profile modification in plasmas with fully non-recycling walls.

- Liquid lithium wall
  - Plasma-aligned, heated shell for non-recycling wall
  - Recycled between discharges
  - Thin film technology for lithium wall

- Modify CDX-U for larger, higher current plasmas and add pellet injection and supersonic gas injection

- Non-recycling wall permits core fueling for "thick" temperature profile and MHD properties
  - Region in which new transport and fueling for "flat" temperature profile can be tested.
encouraged
been extremely fruitful and should continue to be
confinement theorists and experimentalists interact has
Synergy from chamber technologists interacting with
Endorse Mohamed Abdou’s idea for less frequent but
experiments planned and in progress with Liquid Lithium
Clear “evolution” from skepticism to major confinement
APEX significant in motivating innovative theories and

Summary and Thoughts on Future of APEX