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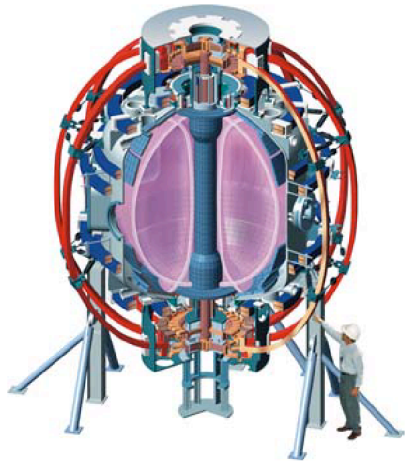

# Lithium Plasma Facing Components Issues for NSTX and ITER


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# Outline

1) Lithium for Particle Control

2) Lithium for Power Handling and Mitigation

3) Assessment for Uniqueness, ITER Relevance, and Consequences if Lost

4) Concerns for ITER Relevance and Responses

# Lithium for Particle Control


- Unique to US fusion program
  - No other major magnetic confinement facility uses lithium for particle control
  - Termination of NSTX ends development of lithium as plasma facing component in large fusion device
- Phased approach
  - Conditioning with lithium pellet injection
  - Divertor lithium film deposition
    - » Possible alternative to cryopumping
    - » Might be useful surface coating method for ITER

# Lithium for Power Handling and Mitigation

- Unique to US fusion program
  - No other major magnetic confinement facility plans power handling with lithium
  - Lithium divertor less sensitive to strike point location than cryopump
    - » Allows more plasma shaping capability
- Lithium divertor permits access to new regimes
  - Extremely low recycling (R<0.1)
  - High temperature across plasma profile

# Assessment of Uniqueness, ITER Relevance, and Consequences if Lost

| Element | Unique Domestic (UD) | Unique International (UI) | Near Term ITER Relevant (IR) | Consequences if Lost |
|---|---|---|---|---|
| **Power and Particle Control** | | | | |
| Lithium conditioning | UD | UI | IR | particle control will be required for ITER |
| **Power Handling and Mitigation** | | | | |
| Lithium Divertor Module | UD | UI | | Long term solution to Burning plasma PFC issues |

# Concerns for ITER Relevance and Responses


- H/D/T Pumping
  - Concern: no known means for efficiently extracting tritium from lithium to continue fueling long pulse ITER plasmas
  - Response: lithium still provides means of removing tritium inventory between shots that solid PFC alternatives do not
- Helium Pumping
  - Concern: lithium does not pump helium so conventional pumping techniques are required
  - Response: lithium has other benefits as PFC (e. g., low recycling wall) even if it does not replace conventional pumping techniques any other PFC alternative requires
- Power Exhaust and Erosion
  - Concern: enhanced material loss may limit permissible operating temperature for lithium PFC (PISCES)
  - Response: recent CDX-U experiments have shown that thin static pools of lithium can withstand high power loads without significant evaporation
    - » Previous experiments have not involved lithium volumes large enough to dissipate heat via convection

# Concerns for ITER Relevance and Responses - continued


- MHD Effects
  - Concern: MHD effects produce forces that redirect flow and suppress turbulence necessary to remove heat with flowing thin films
  - Response: operational scenarios (e. g., begin lithium flow after steady-state plasma conditions are established) or use of *jxB* forces from applied electric currents to restrain lithium (Woolley and Zakharov) can minimize MHD effects
    - » CDX-U experiments have successfully used static pools of lithium as limiter contacting last closed flux surface
- Safety
  - Concern: ITER plans call for very high water flows in PFC's so concepts requiring large quantities of liquid lithium in close proximity are not credible
    - » Confidence in baseline PFC design sufficient to preclude expensive replacement of coolant with helium
  - Response: lithium wall coatings may be offered as safe low Z alternative to tungsten if successfully demonstrated on devices like NSTX