Divertor Options for ARIES-AT: Initial Considerations

Presented by A. René Raffray
ARIES-AT Divertor(1)

• Compatibility with Blanket Configuration

• Structural Material
  - SiC/SiC thickness < 1mm
    (σth ~ 235 MPa and ΔT_{SiC} = 250°C for q'' = 5 MW/m²)
  - W with thin SiC insert with or without structural function

• Possible Concepts

  - Dry Wall
    - Porous W HX concept with He coolant as in ARIES-ST
    - LiPb as coolant (Preferable to avoid in-reactor high pressure He but needs innovative scheme because of poor heat transfer removal capabilities)
  - Phase-change liquid metal (Li)

  - Liquid Wall (Sn-Li)
ARIES-AT Divertor(2)

- Better Definition of Design Requirements
  - Plasma edge modeling
  - Fraction of radiated transport power back to FW
  - Maximum heat flux and footprint
  - If no inboard slot, heat flux to which inboard PFC must be designed locally
LiPb Poloidal/Toroidal Flow for ARIES-AT Divertor

Plasma Heat Flux

LiPb

SiC/SiC

Toroidal Channel Dimension, y
LiPb Velocity and Effective Heat Transfer Coefficient as a Function of Divertor Toroidal Channel Thickness

Series Flow through Upper and Lower Divertor
Total LiPb Flow Rate = 29,300 kg/s

*Example Calculations:*
- \( q''_{\text{div}} = 5 \text{ MW/m}^2 \)
- \( \Delta T_{\text{SiC}} = 250 \text{ °C for 1-mm thickness} \)
- \( \Delta T_{\text{film}} = 135 \text{ °C for } h = 37,000 \text{ W/m} \)
- \( T_{\text{wall}}/T_{\text{max, SiC}} = 785/1035 \text{ °C} \)

Divertor Channel Toroidal Dimension = 4 cm
Divertor Channel Toroidal Pitch = 4.2 cm
Divertor Channel Poloidal Length = 1.5 m
Hartmann and Interaction Numbers as a Function of Divertor Toroidal Channel Thickness