Neutron Wall Loading Update

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ARIES Project Meeting
Bethesda, MD
April 4 - 5, 2011
ARIES-ACT New FW/Div Configuration

- January 2011 Strawman
- **Key parameters:**
  - $R = 5.5 \text{ m}$
  - $a = 1.375 \text{ m}$
  - $\text{SOL} = 10 \text{ cm}$
  - Elongation = 2.2
  - Fusion power = 1907.4 MW
  - Ave. NWL = 2.8 MW/m² @ 10 cm from plasma surface

- **Surface areas:**
  - Plasma = 475 m²
  - FW area:
    - IB FW = 139 m²
    - OB FW = 313 m²
    - IB & OB FW = 452 m²
  - Upper & lower divertors:
    - IB plate = $22.5 \times 2 \text{ m}^2$
    - Dome = $28 \times 2 \text{ m}^2$
    - OB plate = $21 \times 2 \text{ m}^2$
    - Div total = 143 m²

- FW + Div Surface area = 595 m²
- Area of wall @10 cm from plasma = 547 m²

**Main features:**
- Curved IB FW (allowing 11 cm extra space at top/bottom)
- Per Kessel,
  - OB div plate @ R-a/2
  - IB div plate @ R-a
New vs. Old FW/Div Configuration

Smaller entrance to divertor region.

More conforming FW to:
- Capture neutrons before reaching divertor
- Allow 11 cm more space at IB top/bottom for DCLL He/LiPb manifolds
- Reduce nuclear heating at IB magnet.
3-D NWL Model

- Includes:
  - Plasma boundary
  - IB & OB FW
  - IB & OB div plates and dome.

- FW and divertor segmented vertically and radially to improve accuracy.

- 10 million particle history.

- Statistical error < 1%.

MCNP 3-D Model
Neutron Source Sampling

Options:

1. **Uniform** within plasma boundary.
   - Unrealistic, but used to check geometry (1/2011 ARIES presentation by El-Guebaly).

2. **Three-nested source regions** with variable intensity peaking at magnetic axis:
   - Good approximation.
   - Intensities borrowed from ARIES-RS: 63%, 32%, 5%.

3. **Actual distribution**:
   - Source density distributed on R-Z grid not available yet.
   - Results identical to 3-nested source, except for 10% higher peak at IB midplane (refer to 5/2008 NWL presentation by Wilson).
Three-nested Source Regions Within Plasma

Neutron Source Intensity:
63%, 32%, 5%

(Example: 10,000 particles random sampling)
**IB and OB Results**

Machine Ave NWL (P_f x 0.8/area):
- @ 10 cm from plasma surface: 2.8
- Peak OB NWL @ OB midplane: 4.7
- Ave OB NWL: 3.6
- Peak IB NWL @ IB midplane: 3 x 1.1* = 3.3
- Ave IB NWL: 2.3

*Correction factor for actual source distribution (refer to 5/2008 NWL presentation by Wilson).*
Divertor Results

Machine Ave NWL ($P_f \times 0.8/\text{area}$):

@ 10 cm from plasma surface: 2.8

Peak Div NWL: 2
Ave Div NWL: 0.7
Summary of NWL Results

**Machine Ave NWL** (P_f x 0.8/area):

- @ 10 cm from plasma surface: 2.8

**Peak IB NWL**: 3.3
**Ave IB NWL**: 2.3

**Peak OB NWL**: 4.7
**Ave OB NWL**: 3.6

**Peak div NWL**: 2
**Ave div NWL**: 0.7

Peak to average NWL = 1.68
Conclusions

• Peak NWLs will be used to redefine radial builds for ARIES-ACT:
  – 3.3 MW/m² for IB
  – 4.7 MW/m² for OB
  – 2 MW/m² for divertor.

• For ASC, peak to average NWL = 1.68 (not 1.5).