Neutron Wall Loading Updates

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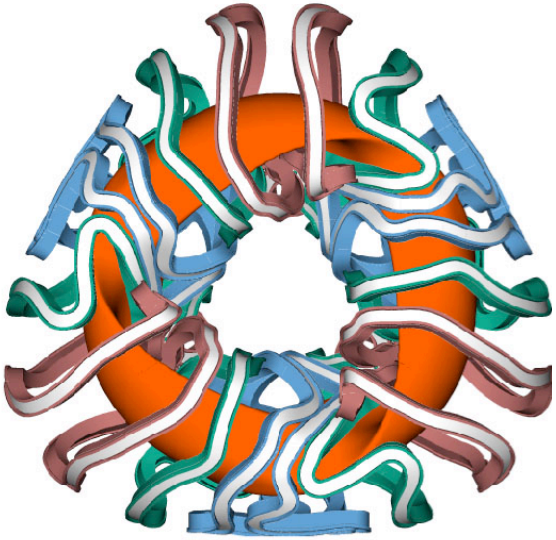
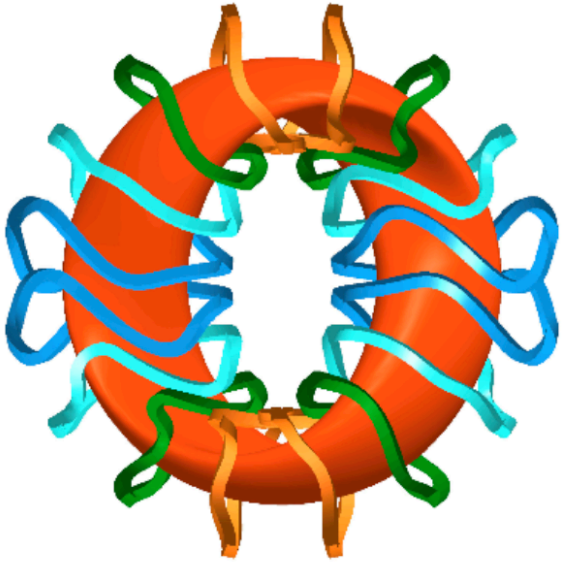
UCSD

Objectives

- Highlight main NWL results.
- Check accuracy of simple model at discrete Xns.
- Compare ARIES-CS and HSR-4 models.
- Future plan.

ARIES-CS Plasma and Coils





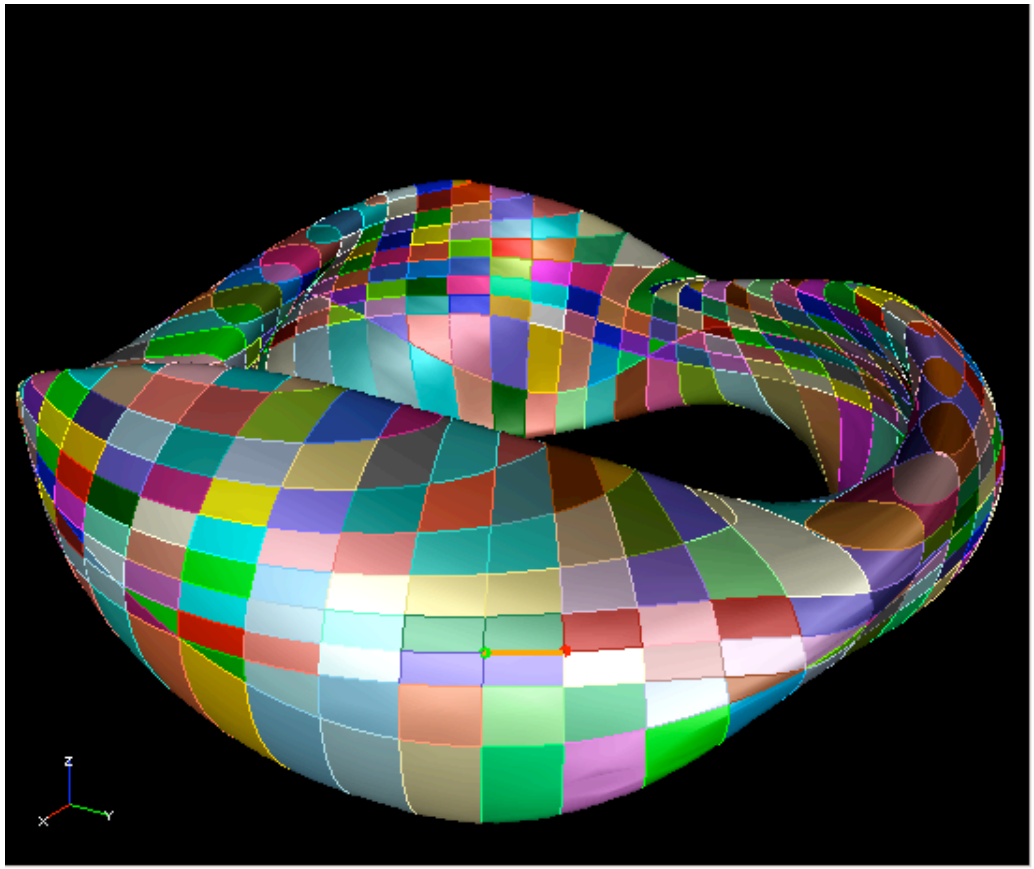
3 FP Configuration
R = 8.25 m
a = 1.85 m

2 FP Configuration
R = 7.5 m
a = 2 m

Selected configuration for NWL analysis

CAD / MCNP Model

- Neutrons tallied in discrete bins.
- Toroidal angle divided every 7.5°.
- Vertical height divided into 0.5 m segments



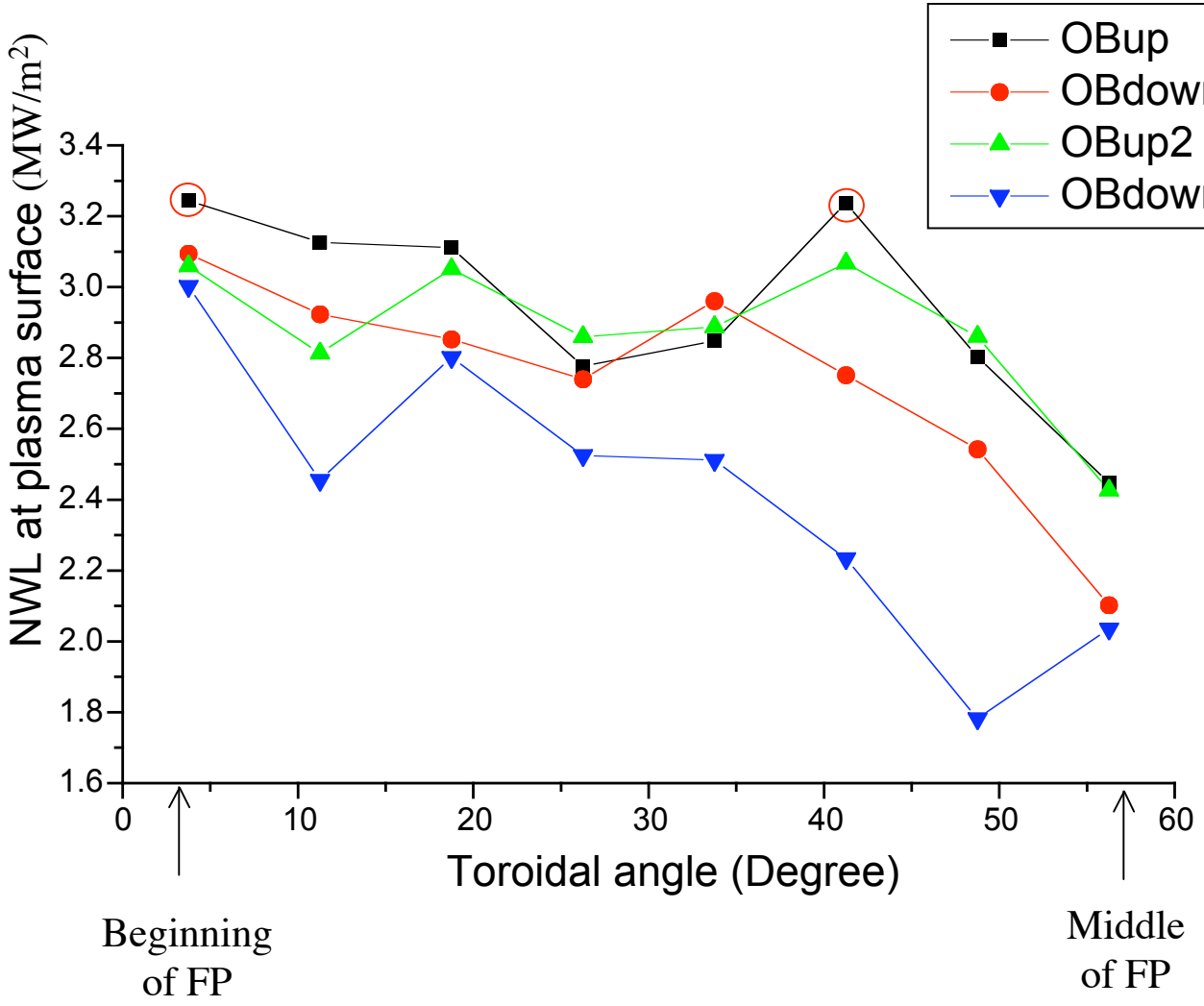
NWL @ Plasma Surface

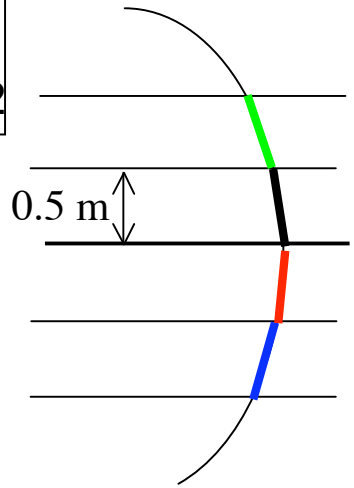
(3-FP Configuration, P_f= 2,000 MW, P_n= 1,600 MW)

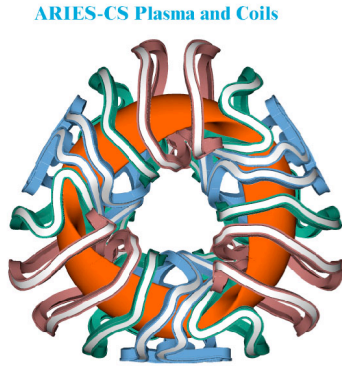
	Plasma Surface	First Wall (5 cm SOL)
Surface Area (m^2)	800.6	825
Average □ (MW/m^2)	2.0	1.94
Peak □ (MW/m^2)	3.24	? (~ 3.1)
Peak/Ave Ratio	1.62	? (~1.62)

Multiply □ at plasma surface by ~0.97 to get NWL @ FW

Peaks Above/Below OB Midplane within ±1 m

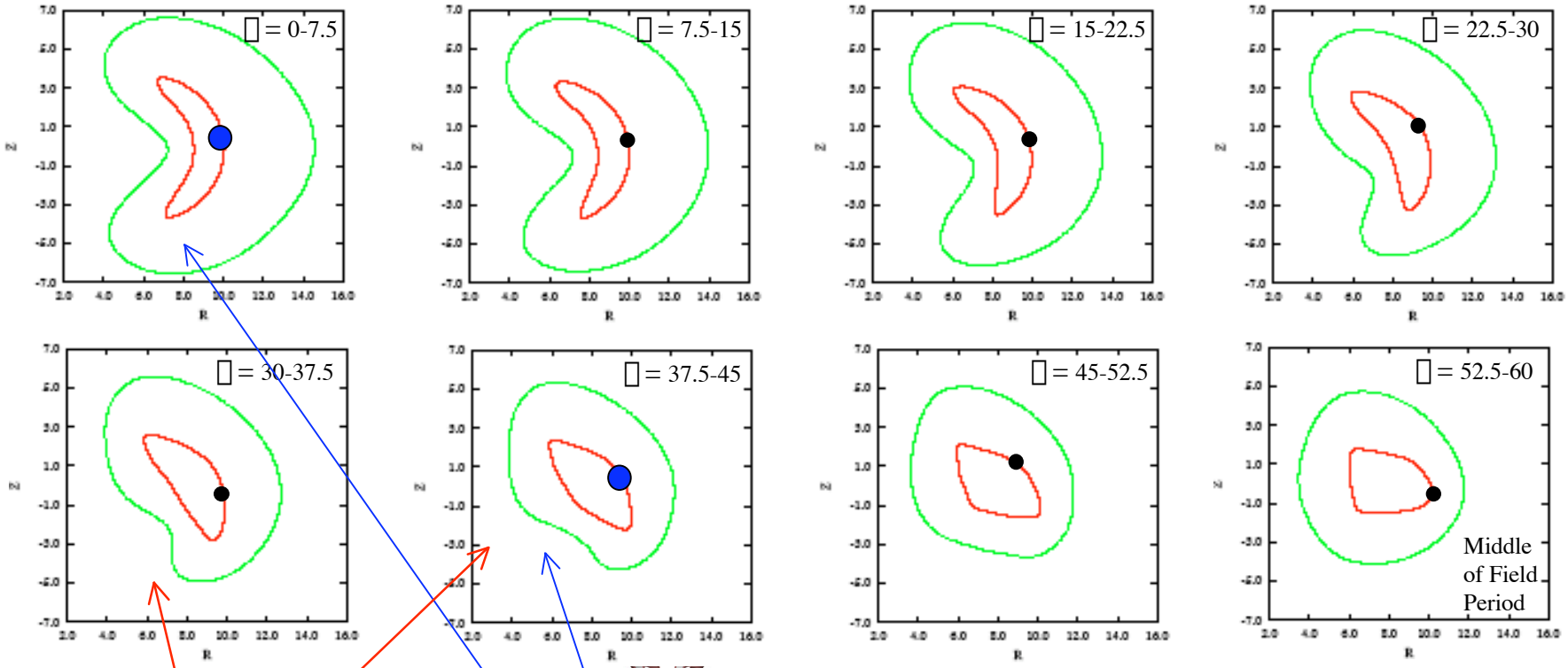


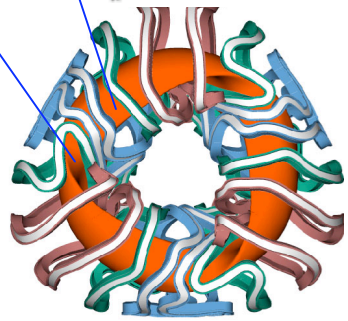




□ Peaks near OB Midplane
(Marked with Dot at 8 Xns Covering 1/2 Field Period)

Beginni
of Field
Period

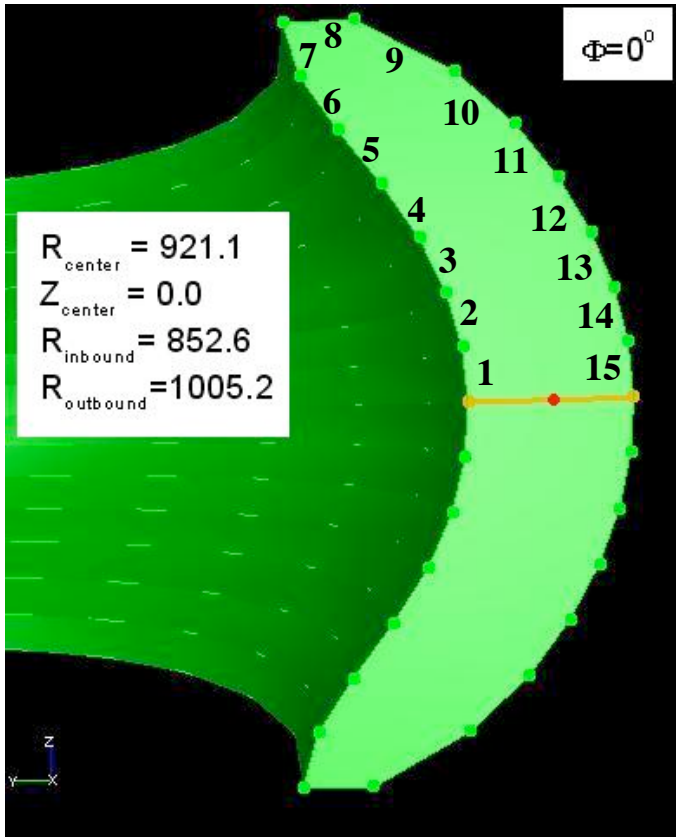


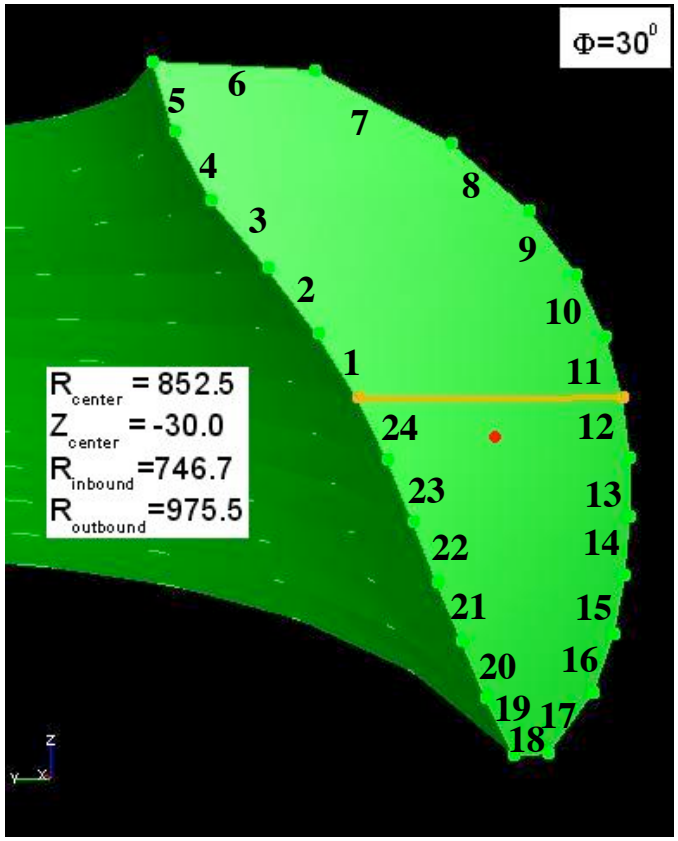


Critical Xns for FP maintenance scheme

□ peaks @ ~3.24 MW/m^2 at □ = 0-7.5° **and** □ = 37.5-45°

Accuracy of Simple Model

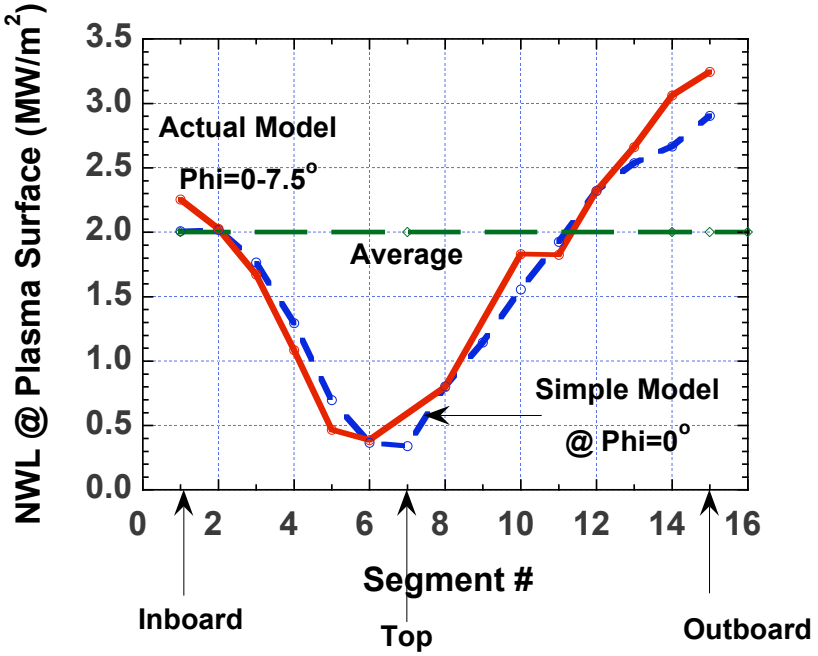


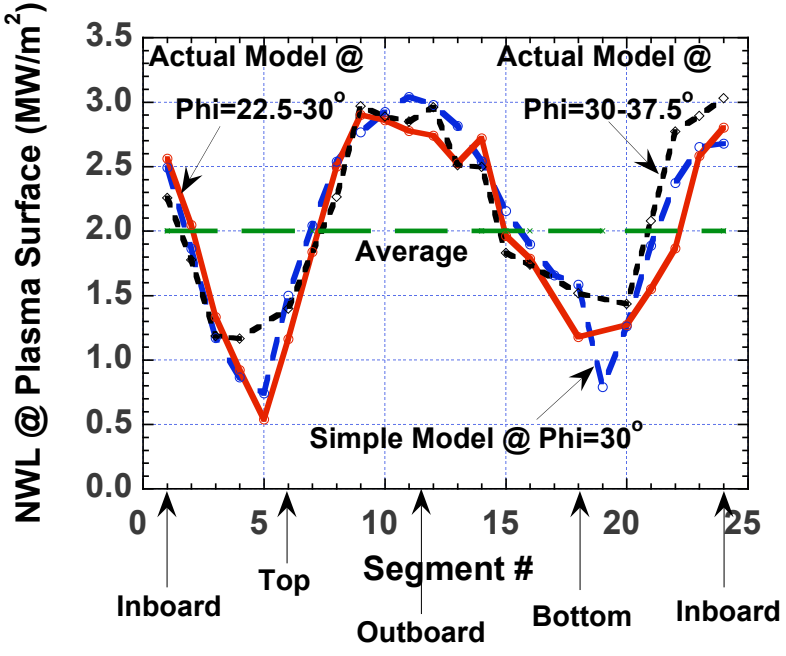


Toroidally uniform, simple model at certain Xn needs:

- Less effort
- Short computing time

Simple Model Estimates OB Peak within 20%





- Simple model fails to estimate □ @ top/bottom (up to factor of 2 difference).
- Exact modeling is needed for top/bottom regions.

ARIES-CS vs HSR Comparison

	ARIES-CS	HSR-4
Code	CAD-MCNP	IPP- Germany
Computing method	Monte Carlo	Deterministic
□ evaluated at	3-D plasma surface	3-D FW
Surface definition	CAD	2-D Fourier series function of toroidal/poloidal angle, divided into quadrangles
N source profile based on	n & T profiles	n & T profiles
Magnetic shift	yes	yes
N source location and angle	Monte Carlo	Monte Carlo
NWL or Flux?	NWL	Flux
Location of peak □	Outboard	Inboard
Aspect ratio	4.5	8.6
Peak to average □ or flux ratio	1.6	1.8

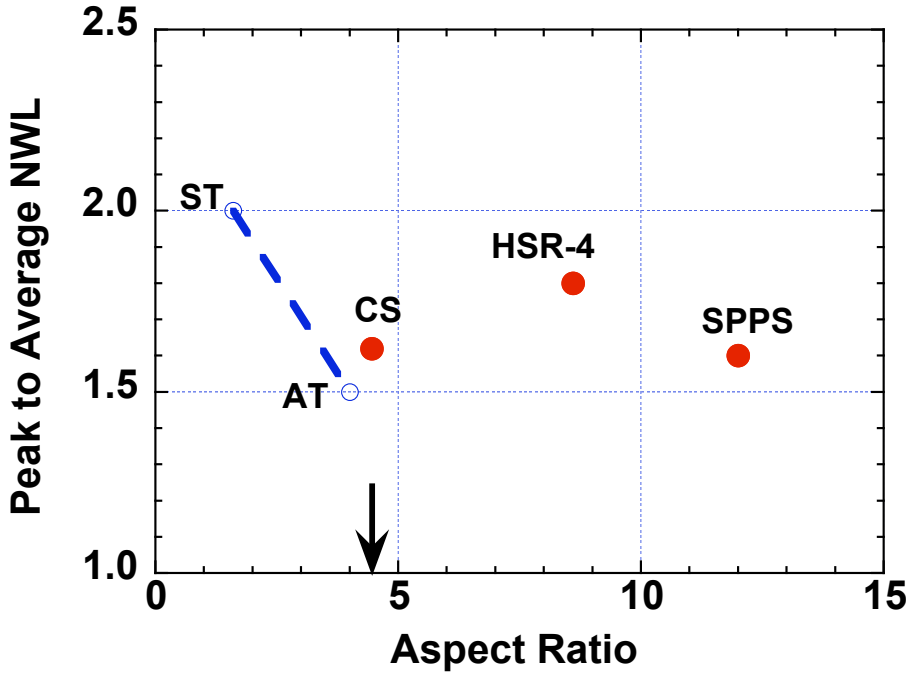
Peak to Average □ Ratio vs A

Tokamaks:

- ARIES-AT
- ARIES-ST

Stellarators:

- ARIES-CS
- HSR-4
- SPPS



- Average □ and peak/ave. ratio depend on complexity of FW.
- Wiggly FW with strong indentation offers large surface area and low average □.
- For identical FW shape, peak/ave. ratio tends to drop with A (as for tokamaks).
- Trend does not hold for designs with different FW shapes.

Future Plan

- Speed up calculations.
- Model 2-FP configuration (8, 12, or 16 coils?)
- If CAD drawings are available for all components, include blanket, shield, divertor, and penetrations for more accurate estimate of overall TBR and M_n.

Other UW activities:

- CAD/MCNP work for ARIES-CS gained interest on international level.
- Results presented in Sept 04 at TOFE, ITER neutronics workshop, and IEA Neutronics workshop drew attention of ITER team.
- In Sept 04, Shimomura (ITER Director) sent request to US ITER Project Director (Ned Sauthoff @ PPPL) to include CAD/MCNP development activity for ITER.
- UW submitted proposal to DOE to develop CAD/MCNP coupling for use in ITER nuclear analysis.□