

Neutron Wall Loading Profile Using CAD/MCNP Interface and (progress report)

Mengkuo Wang

ARIES Meeting

June 16-17, 2004

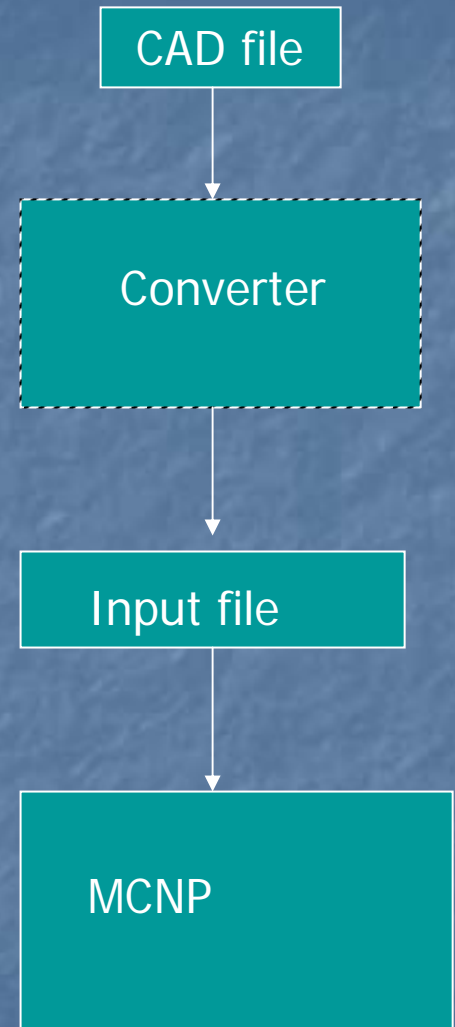
University of Wisconsin - Madison

Introduction

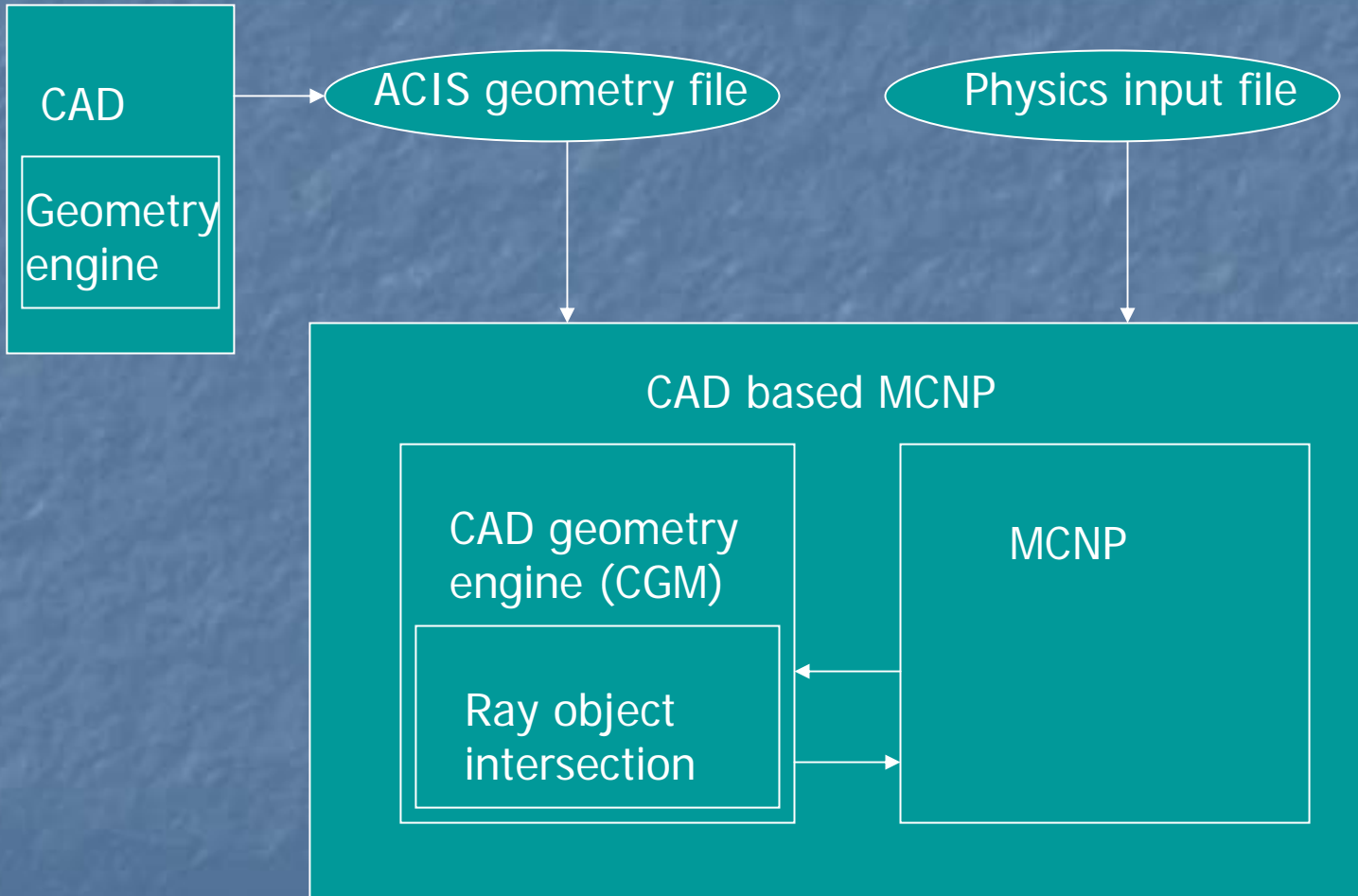
- Current Problem of MCNP
 - Not user friendly (input, visualization of geometric model and output)
 - Limited geometry/surface types
 - Compatibility
 - In many cases, CAD model exists before Monte Carlo simulation
- CAD: Focus on Geometry, includes the achievements in geometry modeling and computational geometry
- Geometry engine can be imported to other software
 - ACIS
 - No duplicated work

Why not Converter?

- Pros:
 - Focus is on input compatibility issues
 - No major modifications required for Current Monte Carlo Method
- Cons:
 - Suffer all the other limitations of Current Monte Carlo Method
 - Limited geometry type
 - Impossible 100% convert
 - Hard to add new geometry type
 - Always need update to catch the CAD software

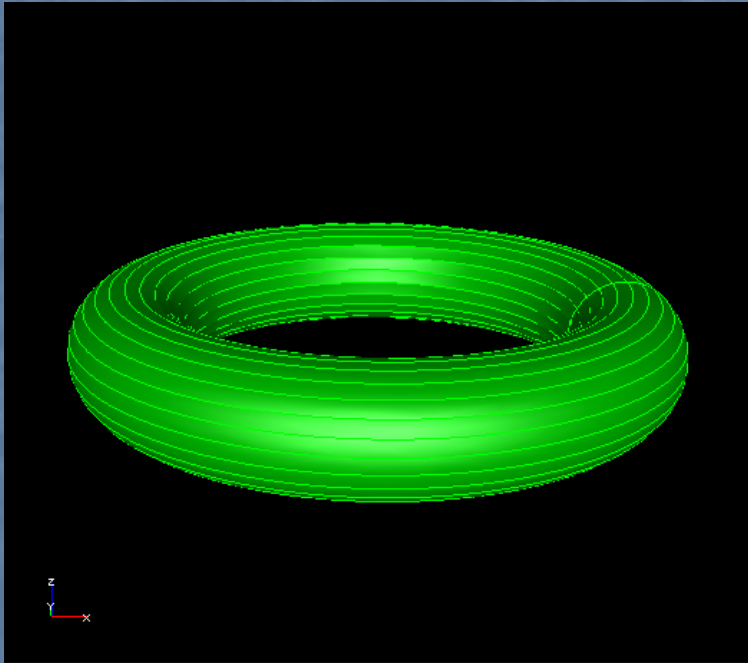


CAD based MCNP

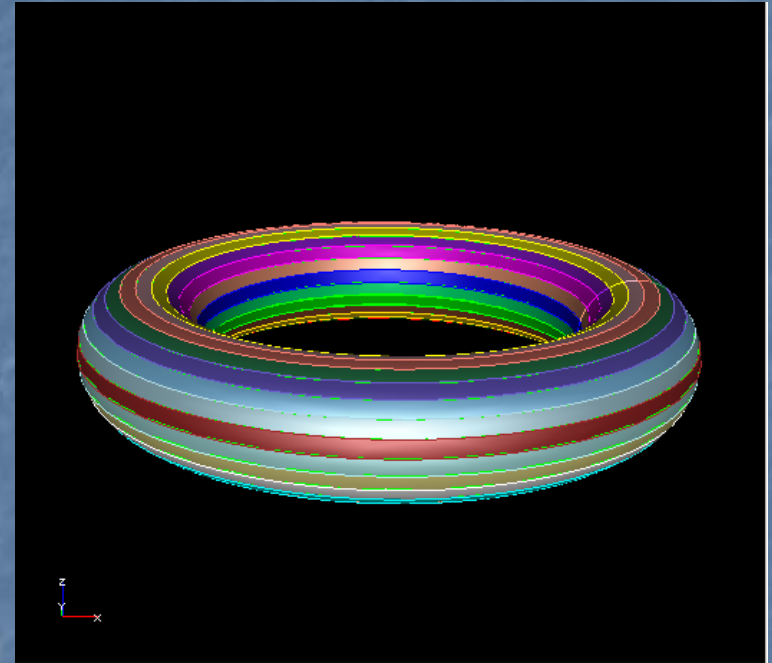


First step: torus

Plasma Surface



First Wall



First Wall divided poloidally
into 15 degree bins

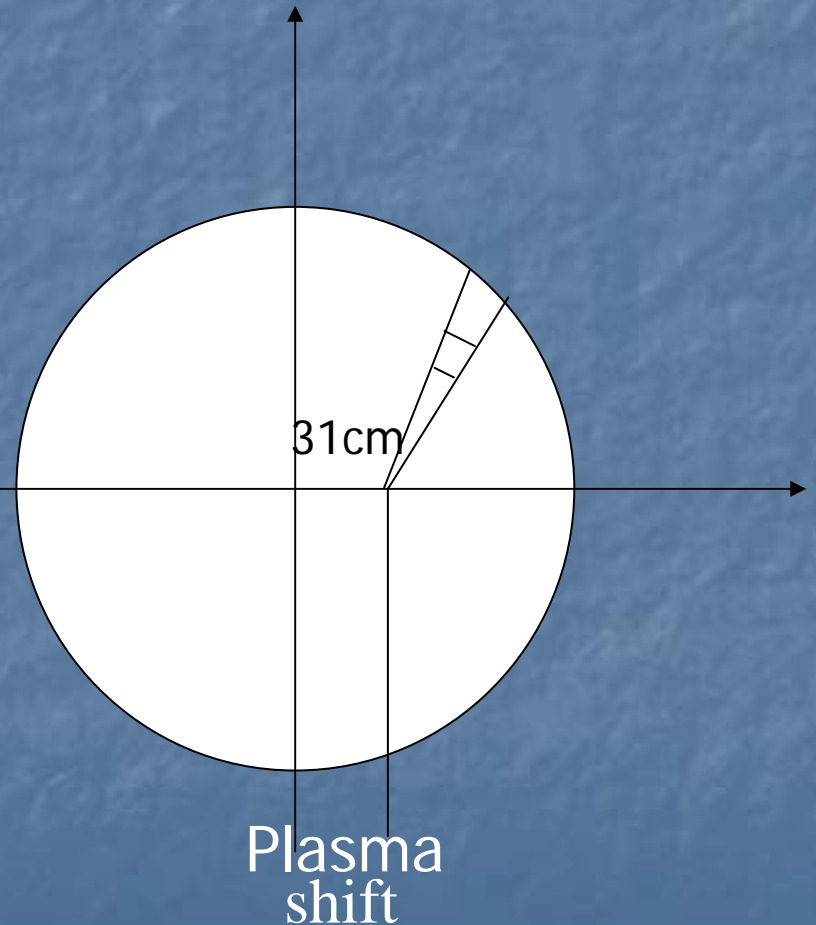
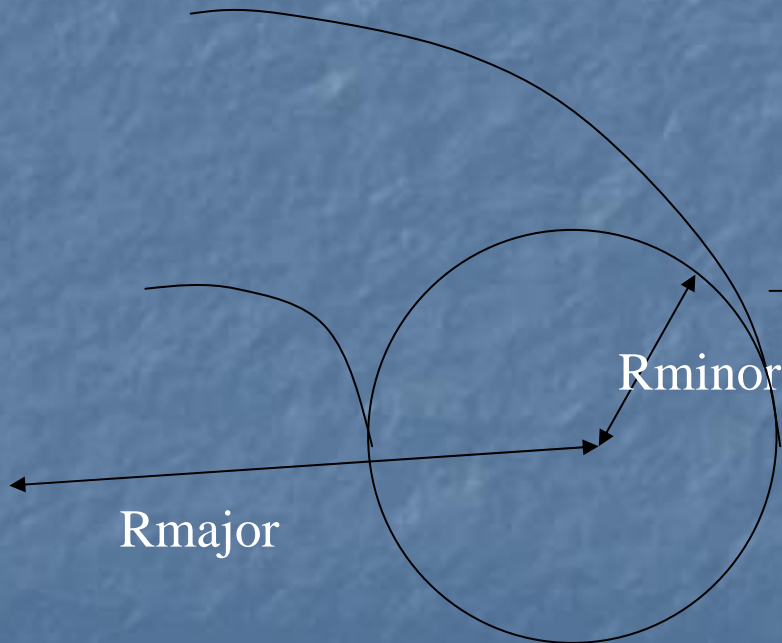
Analyzed Effect of Neutron Source Profile on Neutron Wall Loading Distribution

- Options:
 - Uniform Source
 - Line Source at magnetic axis (Shifted line source)
 - Actual Source (from J.Lyon)

Major Radius and Plasma shift

$R_{\text{major}} = 8.25 \text{ m}$

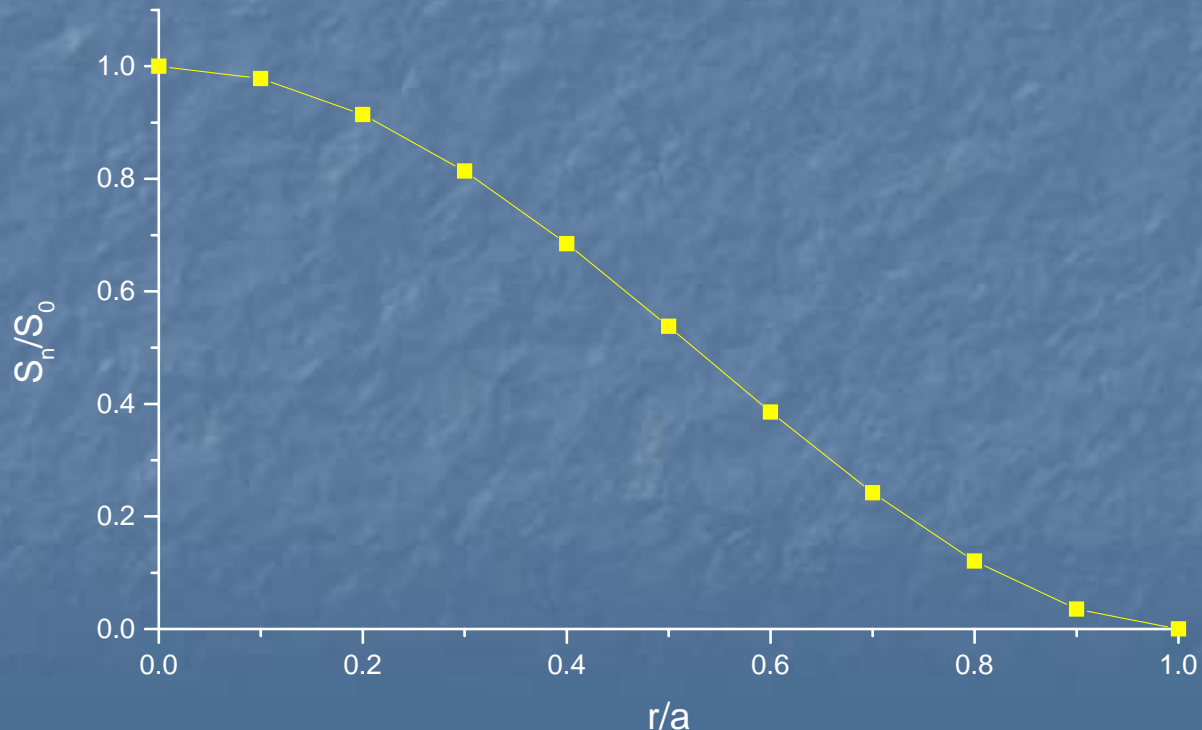
$R_{\text{minor}} = 1.85 \text{ m}$



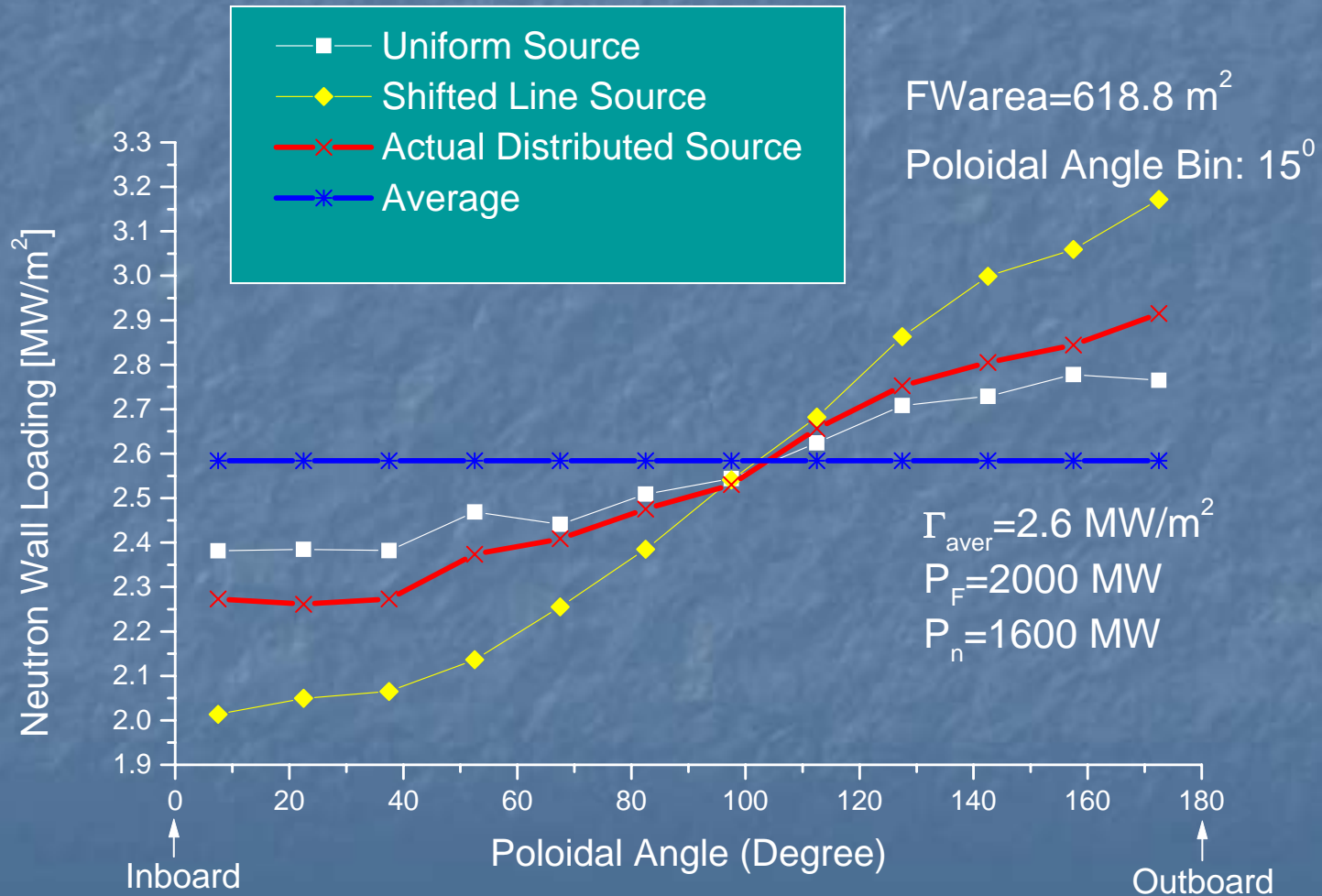
Actual Neutron Source Profile

- the neutron production rate (in $cm^{-3}s^{-1}$)

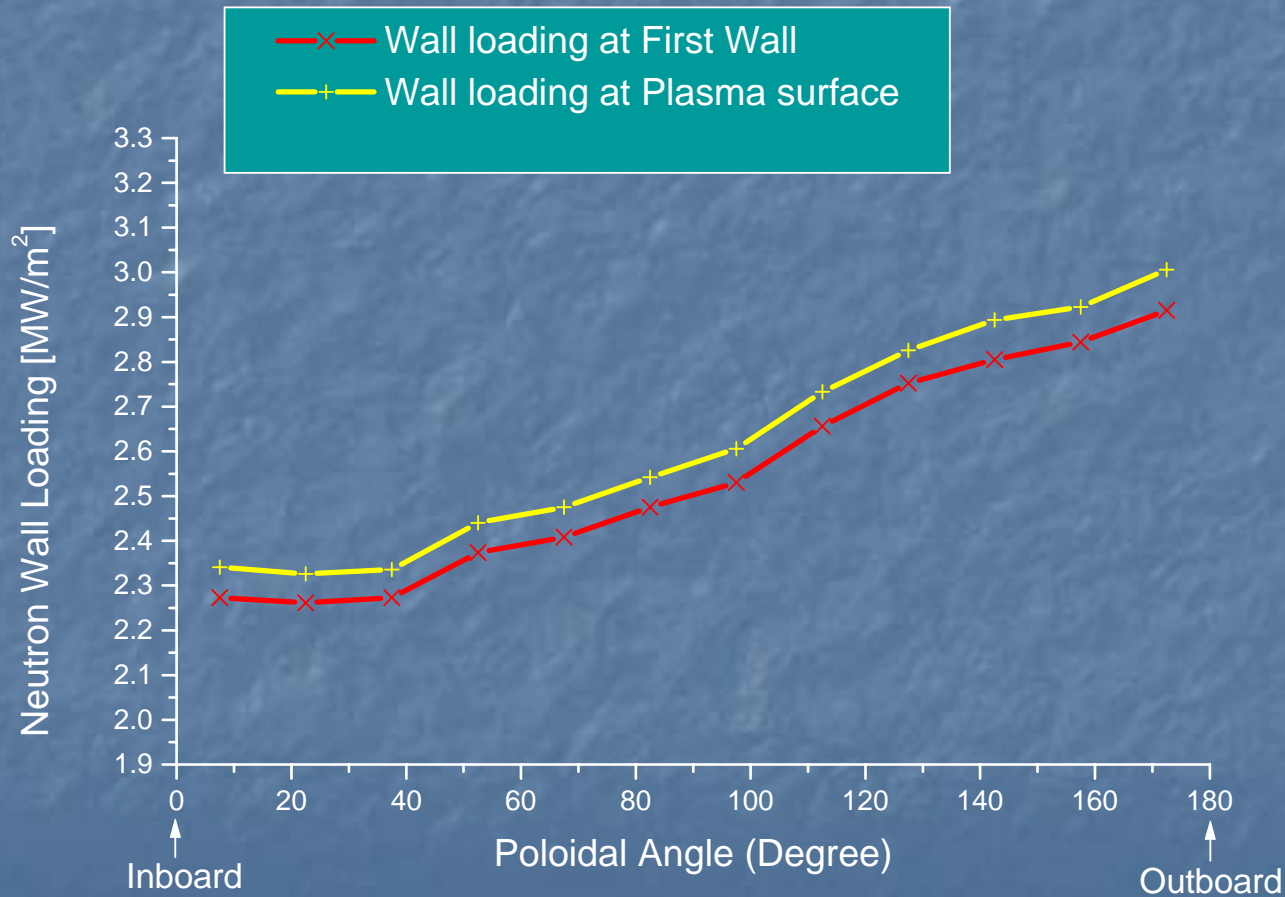
$$S_n(r/a) = S_0 [1 - 0.2(r/a)^2]^2 [1 - (r/a)^2]^{1.8}$$



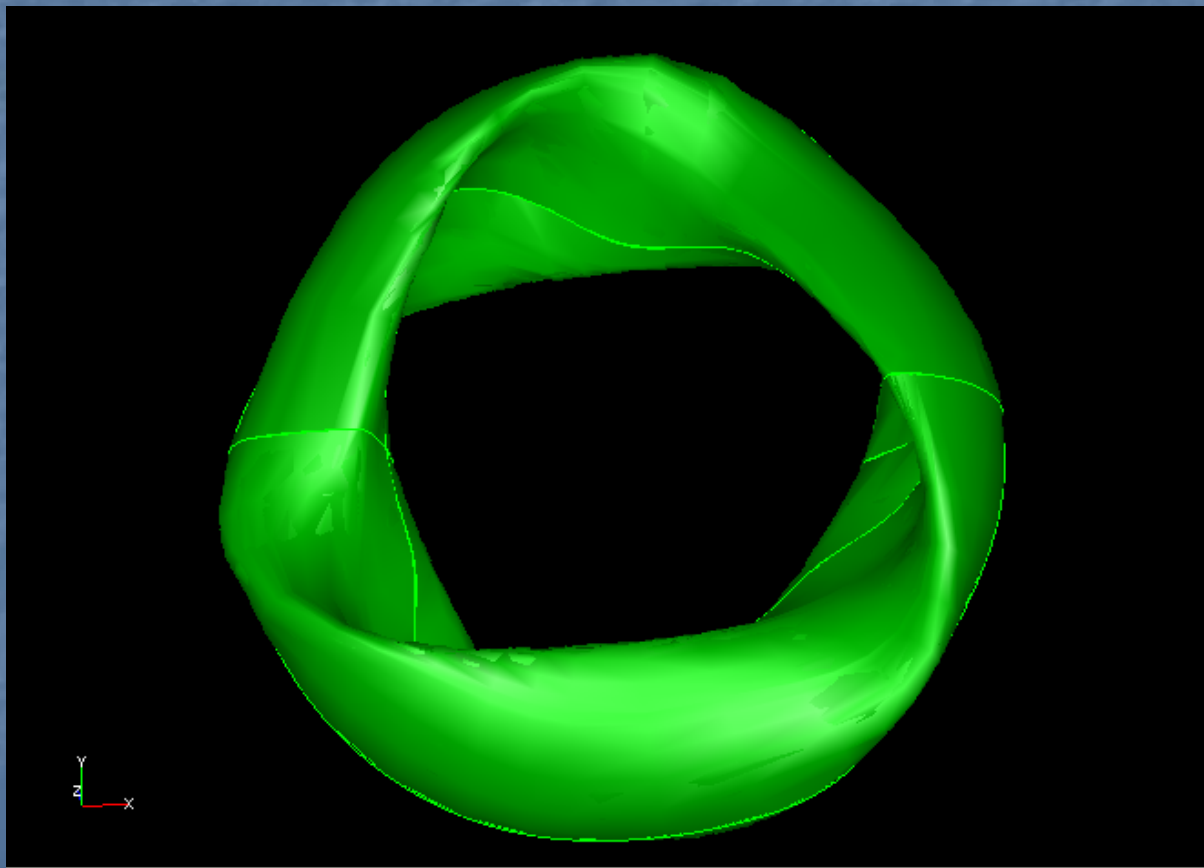
Peak IB and OB values differ by 15% - 20%



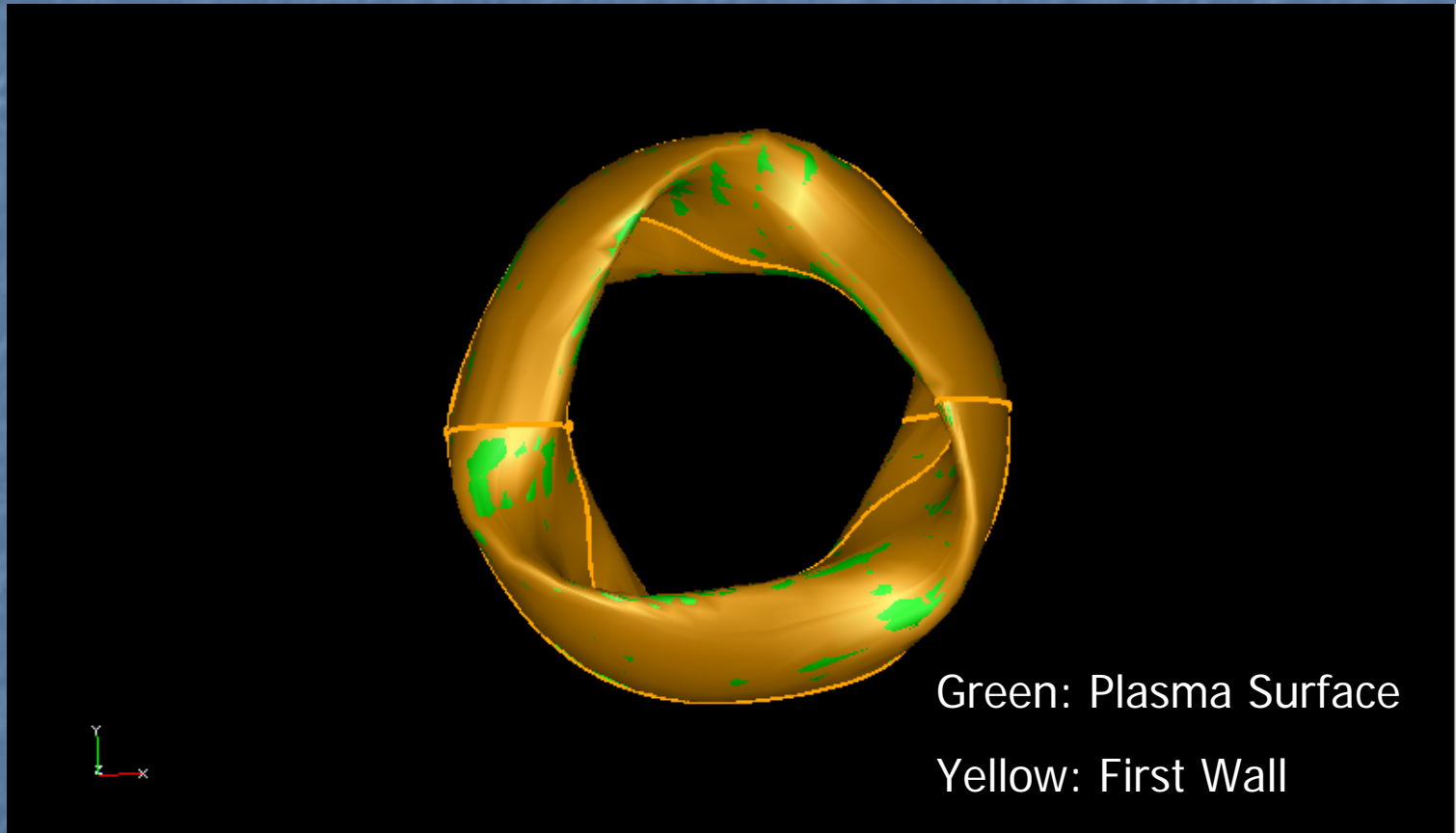
Result Differ by ~3% for 5cm SOL



3FP Stellerator Model



Problem: First Wall overlap with Plasma surface



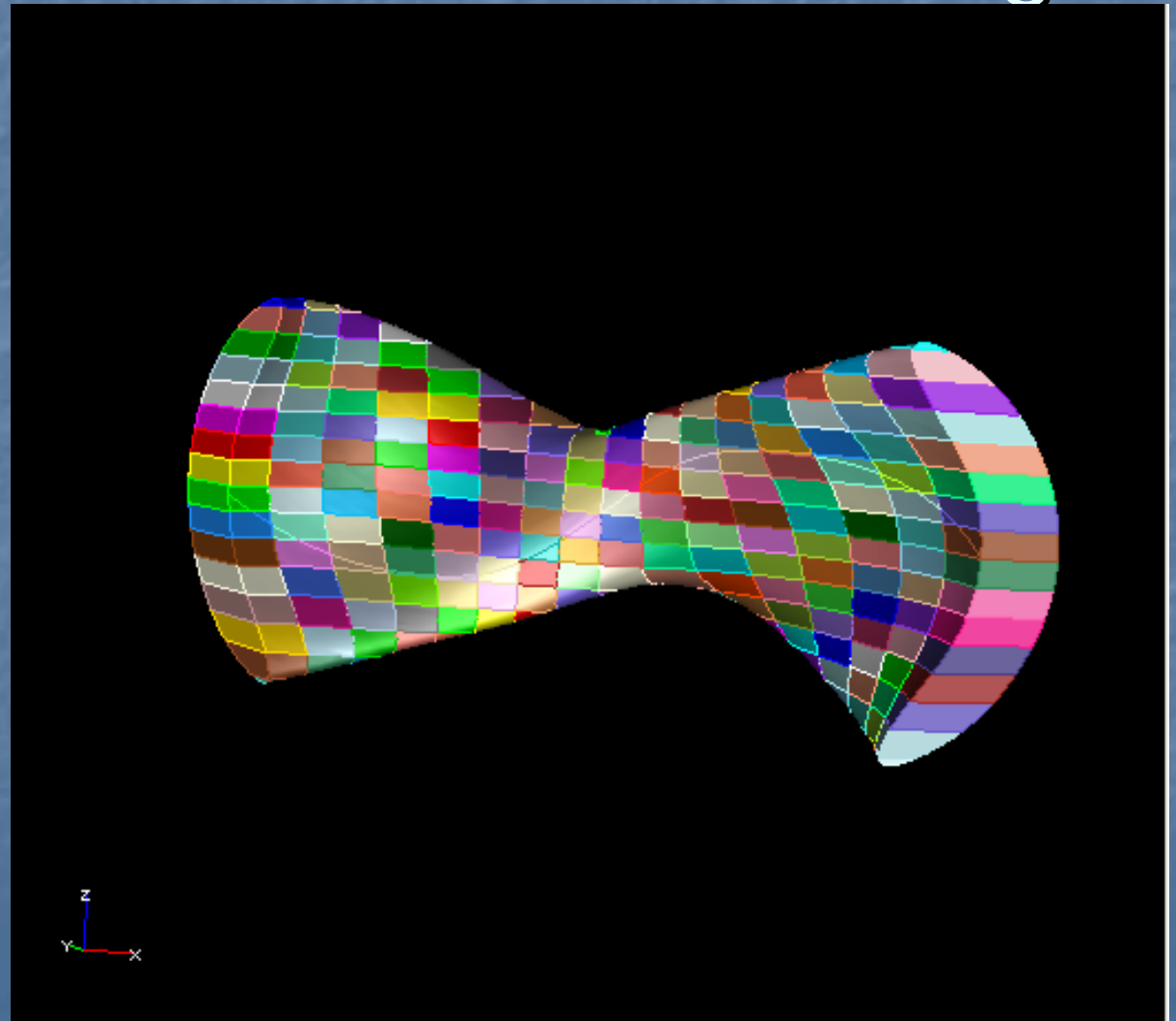
Possible reason: Offset function in CAD or Convert to ACIS

Wall subtract Plasma Surface

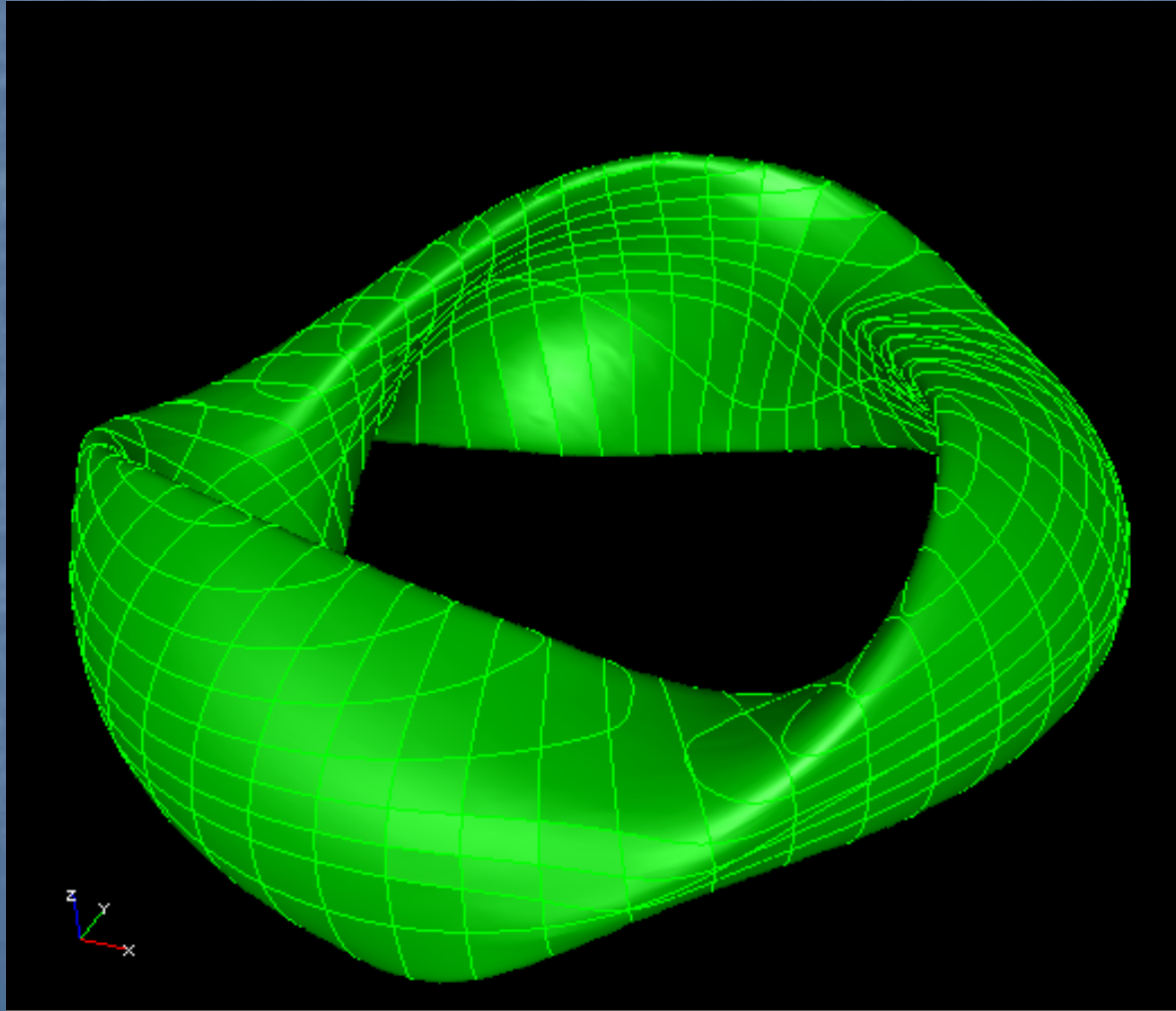


Temporary Solution: use plasma surface to estimate wall loading

- Horizon and toroidal subdivision



Use whole model for calculations



Future Plan

- Fix the geometry errors
- Speed up calculations
- Construct the good first wall

9 Xns of Plasma Boundary (red) and WP Center (green) Covering 1/2 Field Period (~9 m)

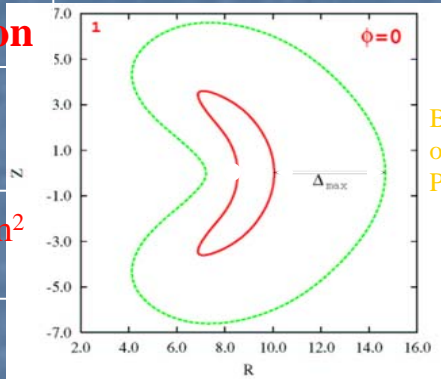
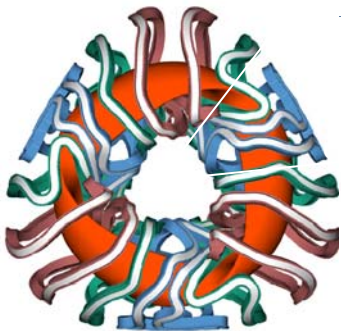
3 FP Configuration

$$\Delta_{\max} \sim 4.6 \text{ m}$$

Γ peaks @ $\sim 3 \text{ MW/m}^2$
at black dot

$$\Delta_{\min} = 1.2 \text{ m}$$

ARIES-CS Plasma and Coils



Beginning
of Field
Period

