Defining the Vacuum Vessel Geometry

NCSX Project Meeting

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Vacuum Vessel Configuration Must:

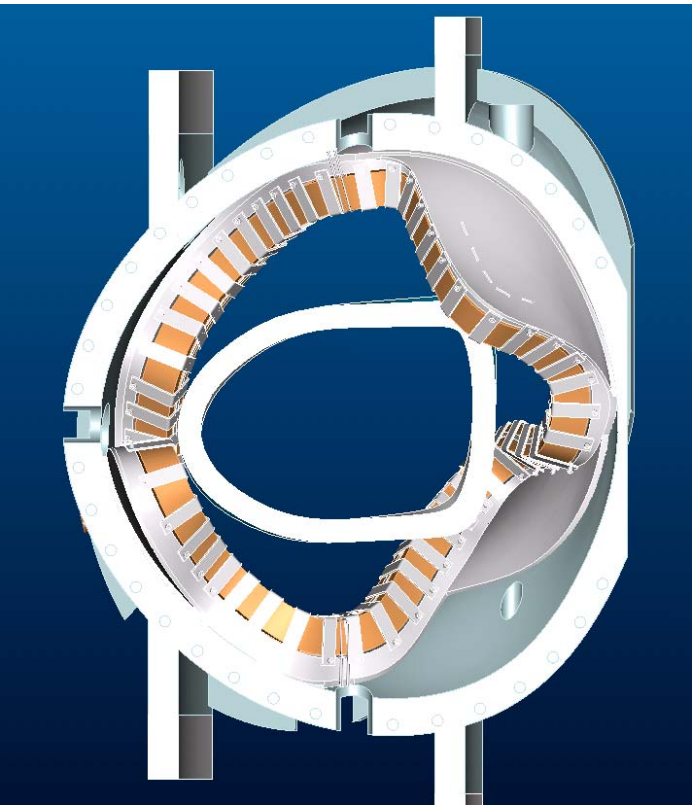
- As a minimum, enclose the reference plasma configuration defined by PIES, with a 2 cm scrape-off to the last closed flux surface
- Hopefully, enclose the m=5 Island structure outside the last closed flux surface to allow island divertor operation
- In general, larger is better to support a wider range of plasma operation

In addition

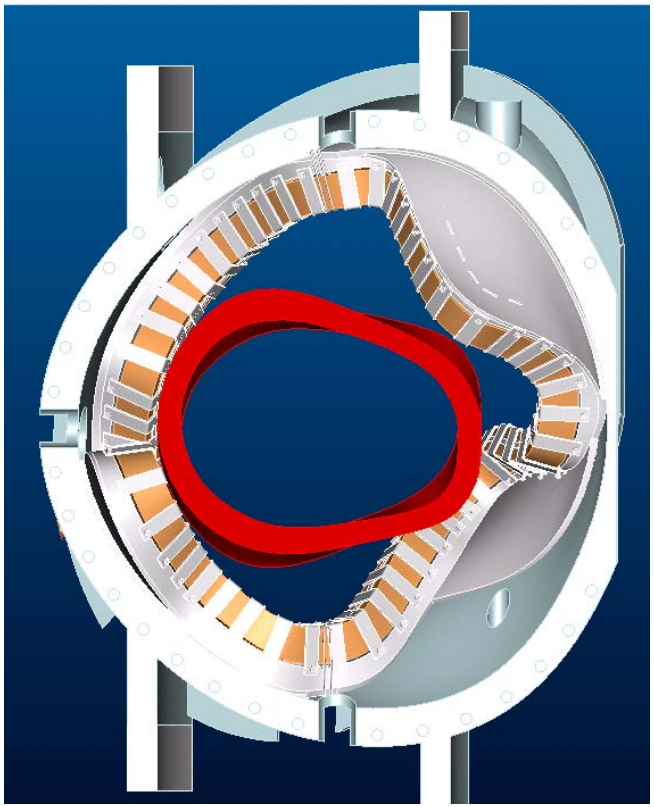
- Vessel interior envelope must accommodate a first wall structure
- Vessel exterior must accommodate cooling tubes and insulation.
- Vessel thickness is to remain at 0.375" to satisfy structural needs and limit eddy current time constant
- The total envelope allowed for the fw, vv , cooling tubes and insulation is 10 cm
- Provisions must be made for the RF antenna.
- The final assembly must provide at least 2 cm clearance to the Modular Coils (after tolerance stackup) to accommodate differential thermal expansion of the vessel and coils.

Furthermore

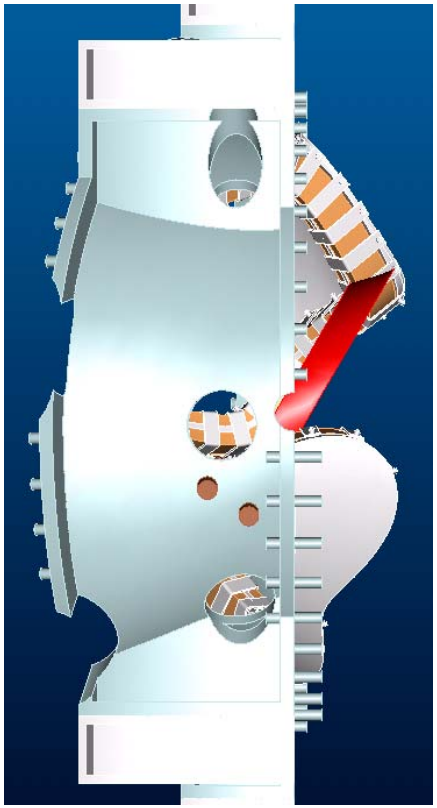
- The Vessel will be further limited in size by the need to assemble the Modular Coil Assembly, consisting of three coils, over a single field period of the vessel.
- A three coil assembly will be passed over each end of the vessel. During assembly, a clearance of ~2? cm is desirable.
- It is further desirable to be able to assemble the coils over the vessel with a well defined motion (2 dof if possible) or with a finite number of steps
- The assembly of the three field periods can also impact the vessel geometry or at least the assembly joint geometry. Based on the cdr design, the vessel assembly joint needs to be tilted by 30 from the vertical to avoid interference with the wings of the modular coils that otherwise overhang the joint



Assembly interference
CDR Design



Possible Fix

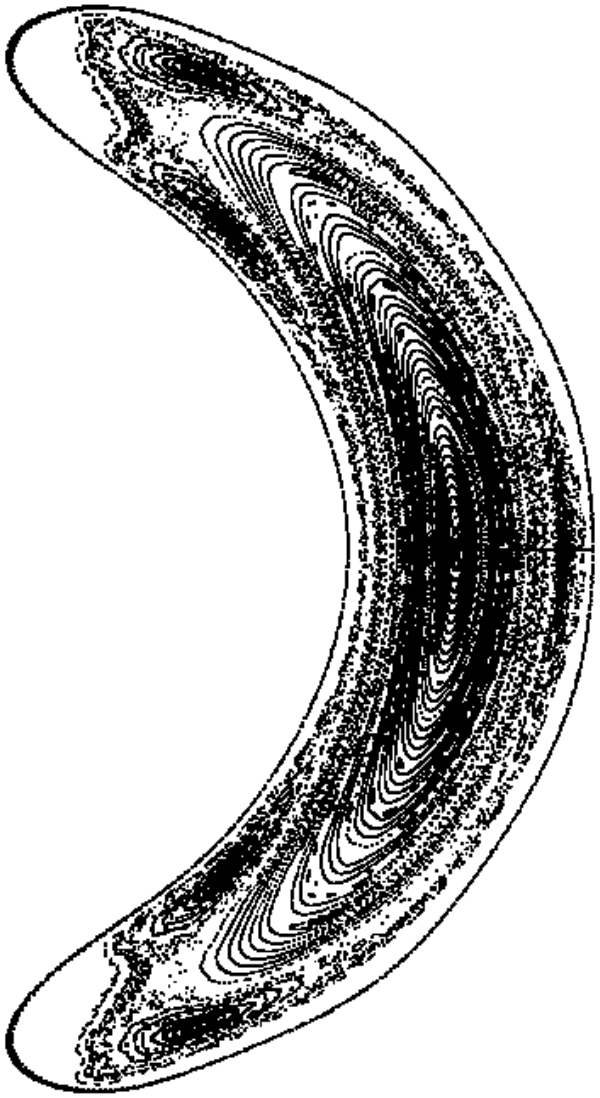


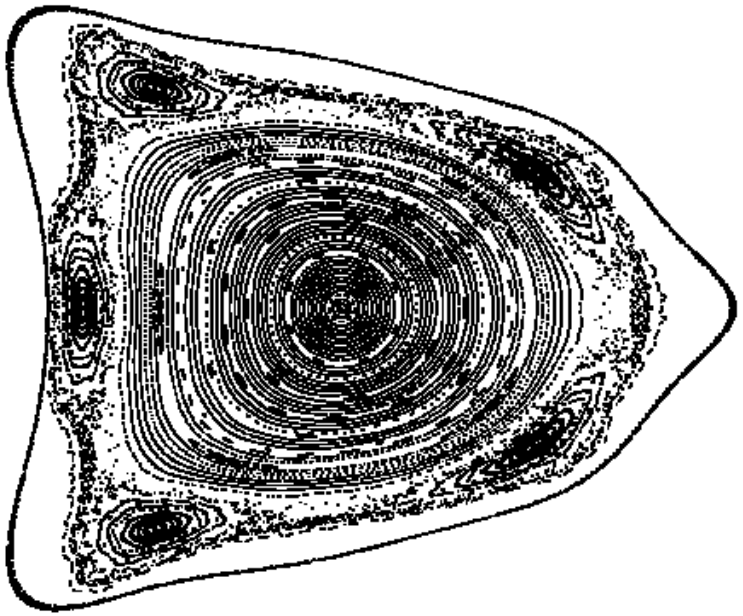
30 deg tilt

Approach

- Physics (Don Monticello) has provided a fourier representation of the LCFS from PIES (there is a surface outside the m=5 island chain in the multi-filament pies run).
- Engineering (Dave Williamson & Mike Cole) is confirming the stackup of dimensions between the front face of the First Wall and the Modular Coils. Dave is also working to establish the 3D representation of the m47 coils needed to interference checks
- A code is being developed to determine feasibility of assembly of a given vessel geometry with the m47 modular coils. All 6 dof can be varied. Initial tests of code on simplified geometries are encouraging. Results will be used to tailor VV geometry.
- ProE models are being used (using their mechanism capability) to validate the assembly process.

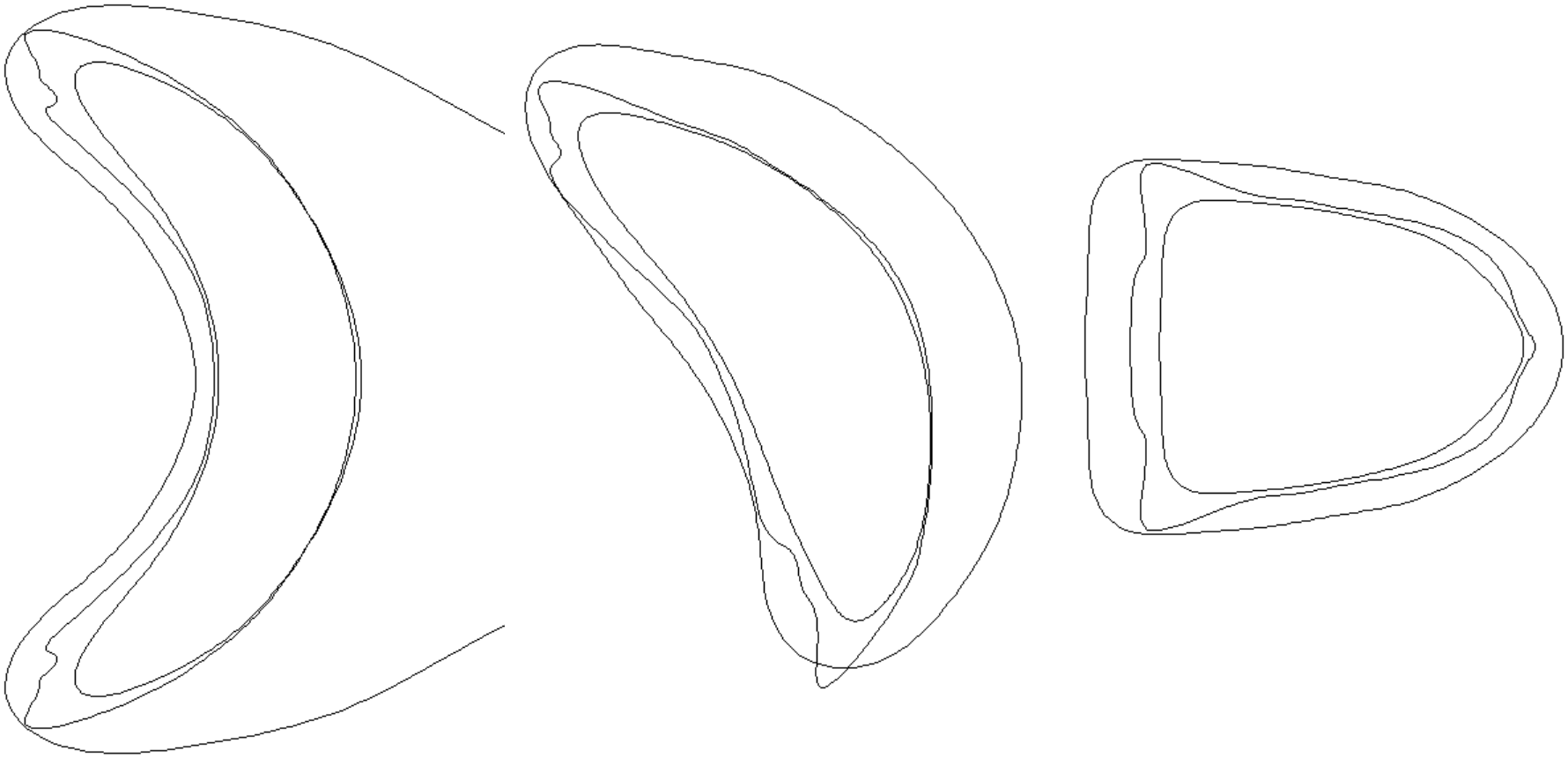
Pies* Results for M47 with Multi-filaments





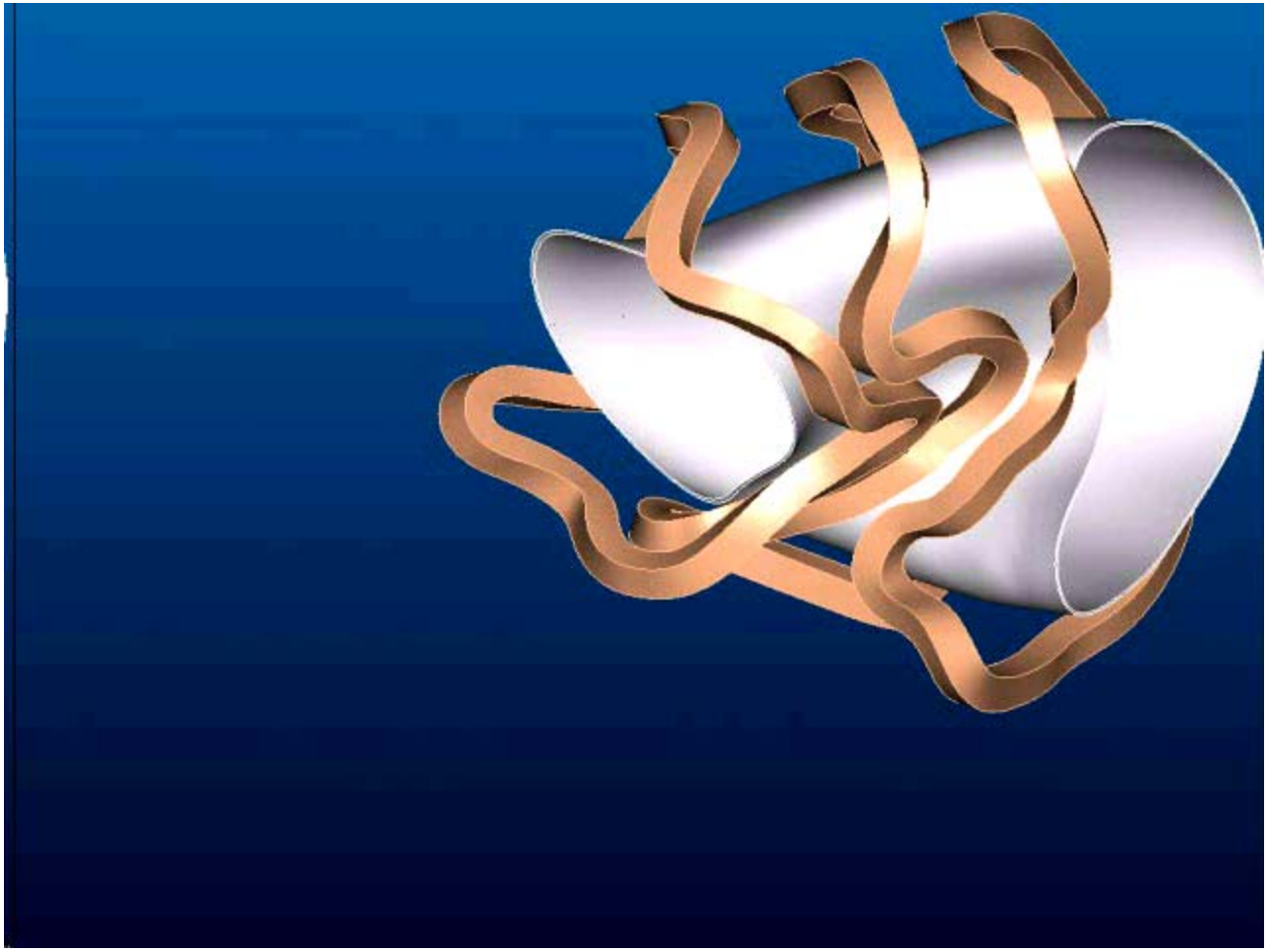
Converged?

Overlay of PIES and VMEC Boundary for M47 Coils with 091702 First Wall Geometry



Note: Not clear yet if VV based 091702 FW can be assembled with M47 Coils

2 DOF assembly not quite there yet



M47 Coils with VV based on 091702 FW
Assembly along straight (inclined) path with rotation

Approach, cont'd

- An alternate, reverse engineering approach is being pursued in parallel, where a simplified assembly sequence is prescribed and the maximum vessel envelope is determined. ProE models of earlier designs are used to establish the simplified assembly sequence.

Summary

- Data basis exists and/or is being confirmed to define Vacuum Vessel Geometry

- Tools (codes) are being developed to assist in defining geometry in conjunction with Modular Coil Assembly