Engineering Recommendation

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NCSX Project Meeting

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Need to focus on one target

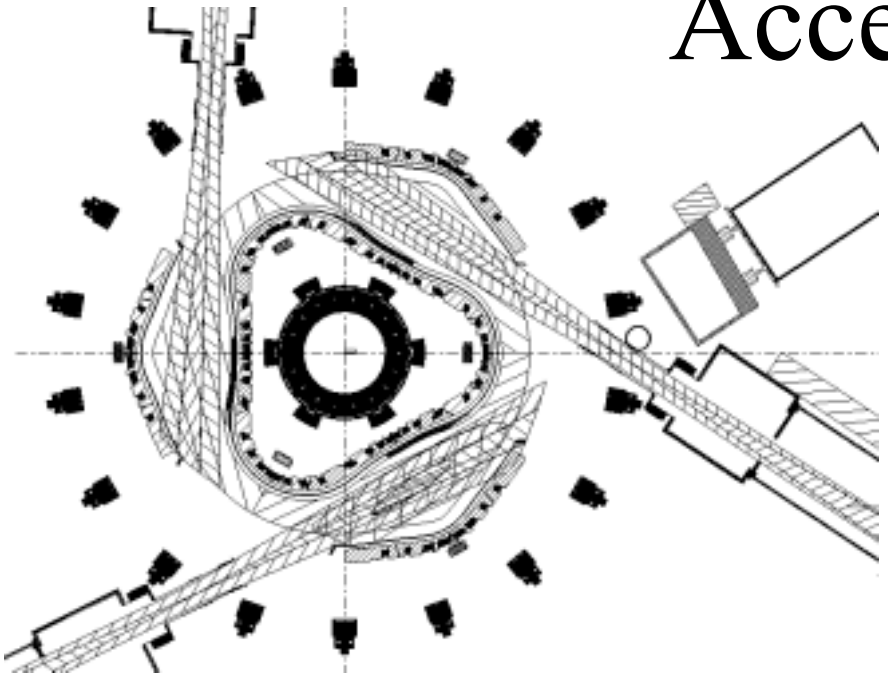
- PVR *final* documentation is due in 8 weeks
- Need to *demonstrate plausibility* and *provide initial cost and schedule estimates*
- Where are we today?
  - Tools, plasma configurations, coil designs and machine configurations still evolving to address known deficiencies
  - No complete, validated cost and schedule estimates developed
- Schedule for April DCSR is also tight

Engineering considerations strongly favor the saddle option

4 Key Differentiators

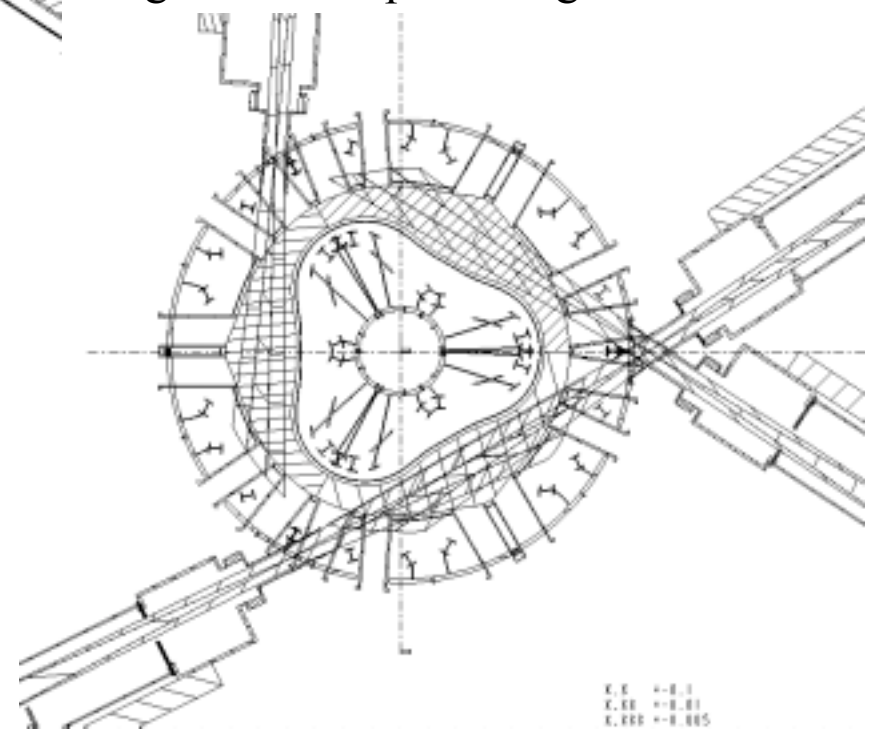
- Access
- Adaptability
- Power
- Maturity

Access favors saddles



Saddle Coils

- Ample window for NBI with optimal injection angle
- Insensitive to changes in saddle coil geometry
- Prospects for accommodating HHFW, diagnostics are promising



Modular Coils

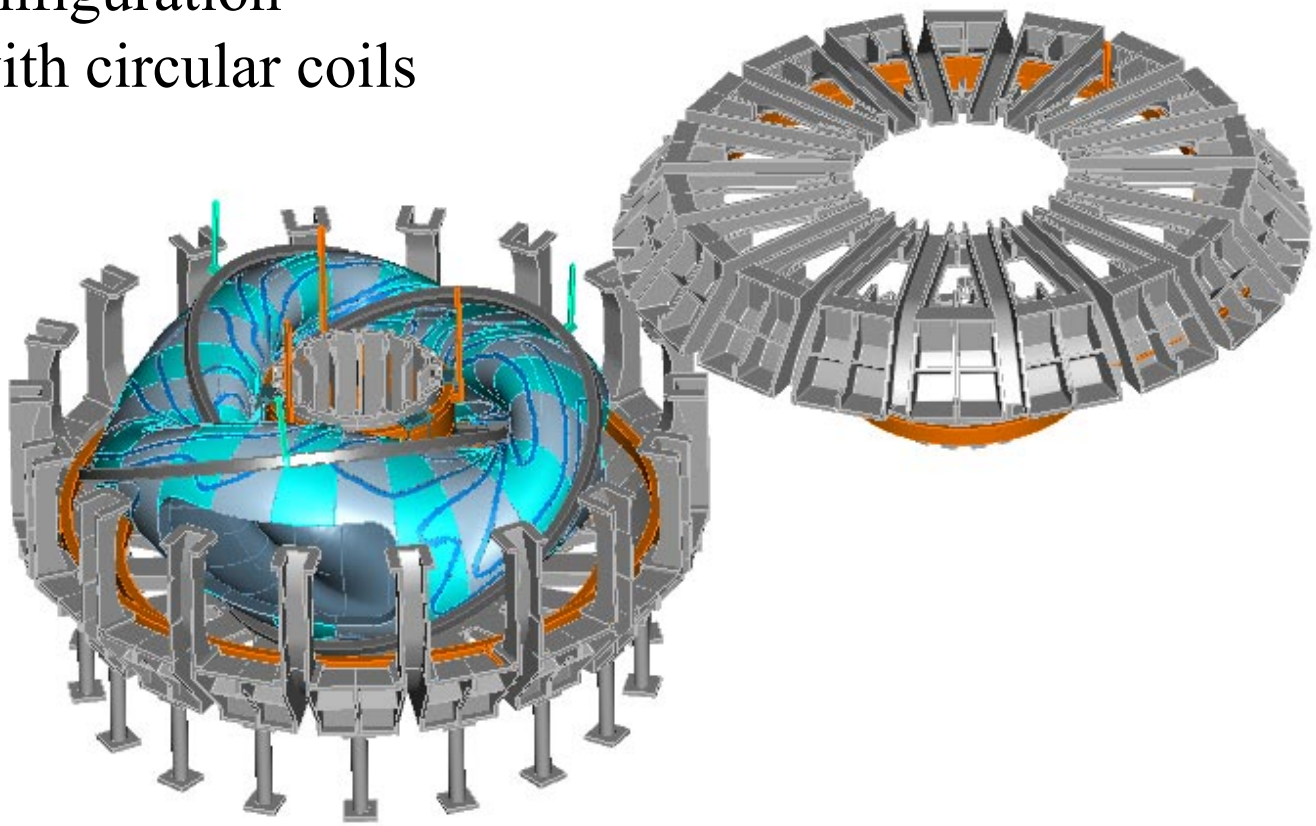
- NBI interferes with modular coil, integral structure, and TF coil (not shown) at v=0
- NBI window is sensitive to changes in modular and TF coil geometry
- Prospects for accommodating HHFW, diagnostics are uncertain

The saddle option is *inherently more adaptable*

- Adaptability is the *ability to accommodate additional (trim) coils*
  - Flexibility
  - Field error correction
- Additional coils would likely be located outside the saddle or modular coils
- The outside surface of the saddle coils is much closer and more accessible
  - Lower current, improved performance

Case study: L=3 coil set added to saddle option to study impact on flexibility

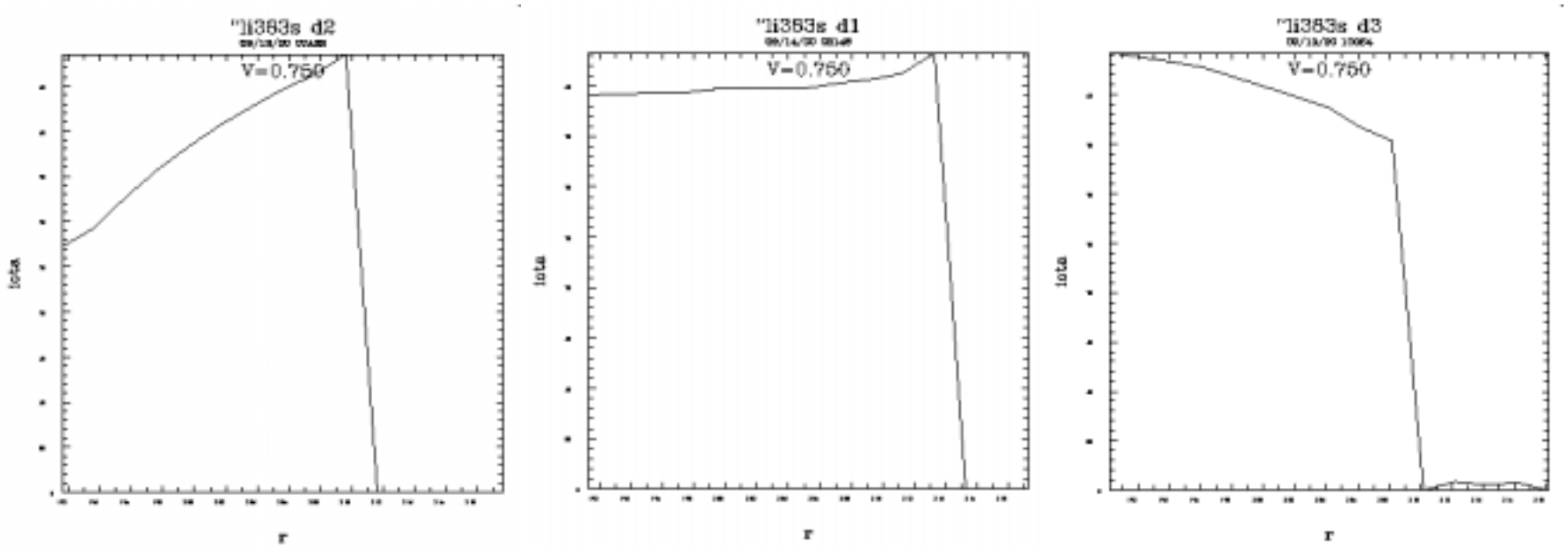
Virtually no configuration impact, even with circular coils



Case study: L=3 coil set added to saddle option to study impact on flexibility

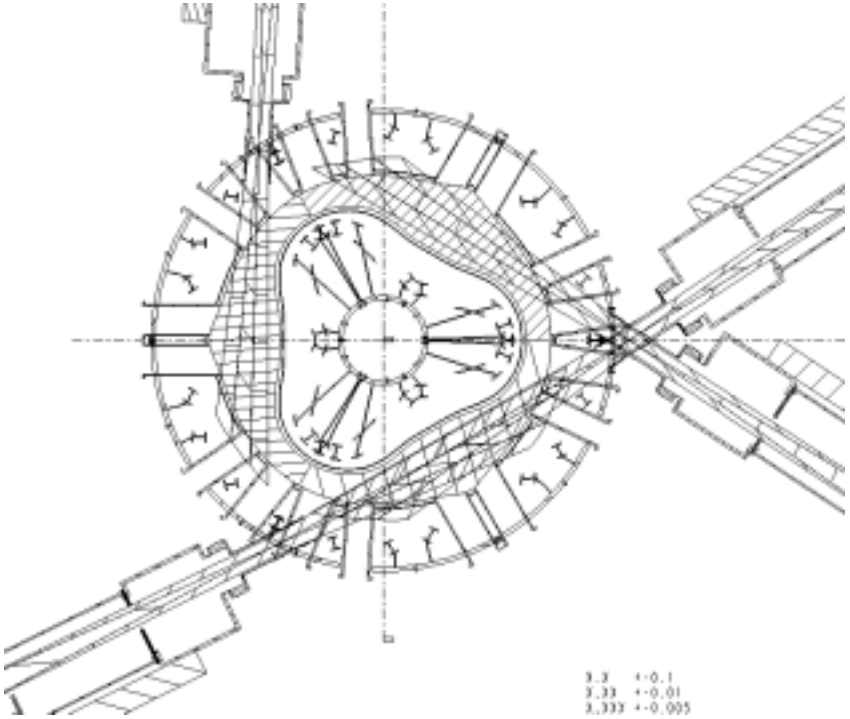
Improved control of iota profile (shear)

May be important for divertor operation



Case study: L=3 coil set added to saddle option to study impact on flexibility

Not possible with modular coils



The saddle option has *inherently lower power requirements*

- PF coils in modular option are much further away with larger currents
  - Consistent with reference scenario and Lazarus' results
  - Higher power costs, larger EM loads, reduced flexibility

- Modular coils and TF coils must be varied (order 10%) on short timescales (100ms) to dynamically control iota
  - Much larger inductances than saddle coils, faster ramp rates than TF coils in saddle option
  - Higher power costs, reduced dynamic flexibility

The saddle option is *more mature*

- Tremendous progress made recently in developing the modular option but it is not yet comparable to the saddle option
- We are more confident that we can make the saddle option work because we are further along in developing critical features
  - Fewer unknowns translates into less risk in fabrication, assembly, access, and structural design
  - Tight schedule adds more weight to concept maturity

Recommendation: *Adopt the saddle option as the reference for the PVR and DCSR*

- So much to do…
  - Fix the physics deficiencies in li383
  - Update and improve the saddle coil (magnetics and mechanical) design
  - Develop updated current waveforms for reference scenario
  - Develop quantitative flexibility requirements
  - Re-visit time constant requirements for shell, reduce # of pieces
  - Demonstrate adequate access (NBI, HHFW, diagnostics, personnel)
  - Validate structural design
  - Develop power system design
  - Aggressively address key feasibility issues
    - R&D in progress to confirm ΔT limits in conductor
- So little time…