Overview of candidate options

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NCSX Project Meeting

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Purpose of coil topology study

- Explore alternate coil topologies around c82 plasma in parallel with the development of alternate plasma configurations

- The goal is to better understand the key characteristics of each topology and to weed out unattractive options ⇨ *be prepared to move forward*

Key characteristics

- Machine characteristics
  - Constructability
  - Access
  - Performance
  - Reconfigurability
  - Cost
  - Risk
- Plasma properties
  - Performance (confinement and stability)
  - Flexibility
  - Surface quality

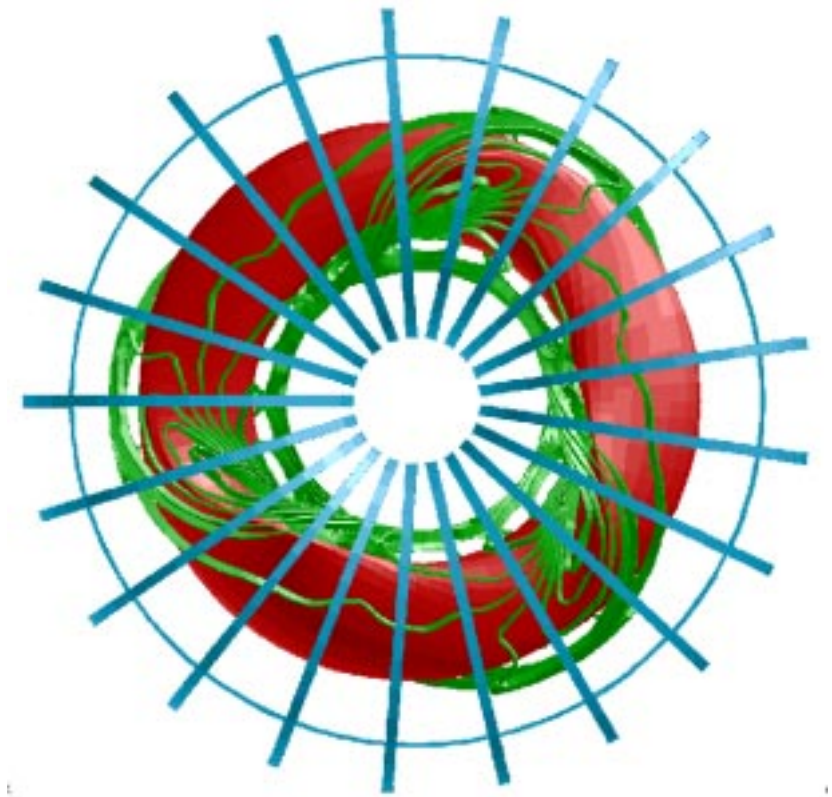
Topology option summary

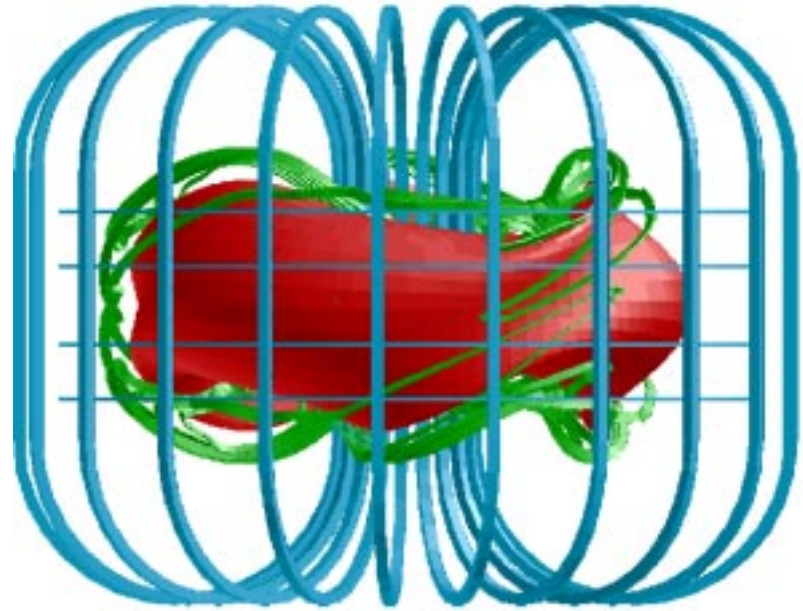
- Reverse engineered options based on c82 plasma
  - PBX
  - Tilted TF
  - L=3
  - Modular
  - No conformal coil (NCC) option

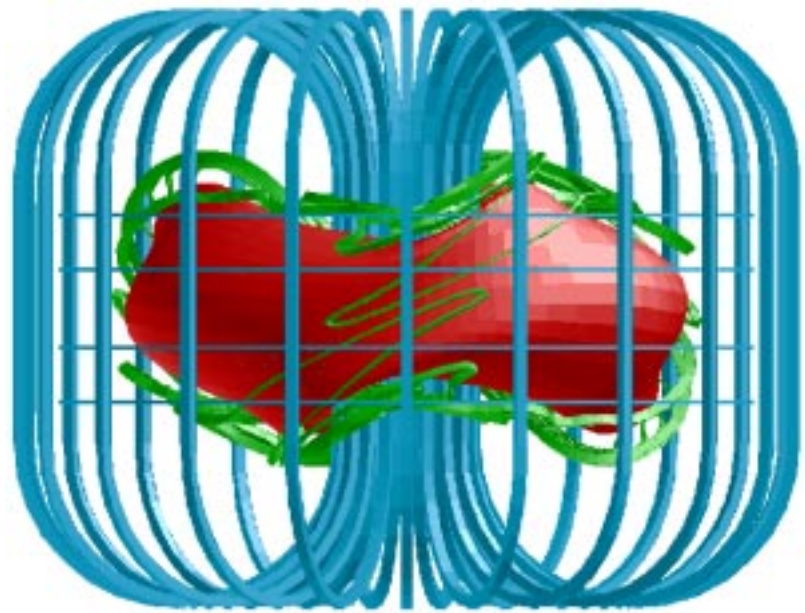
- Forward engineered options based on a flexible machine configuration and a vacuum configuration with attractive properties

PBX option

Case 4064.rev7
20 (vertical) TF coils
4 pair of circular PF coils





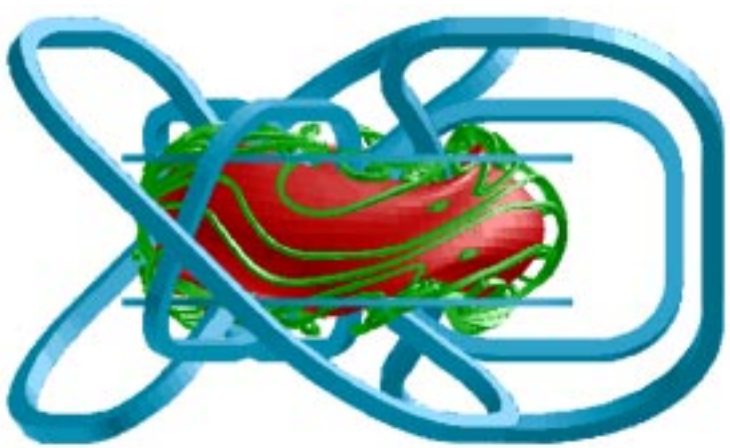


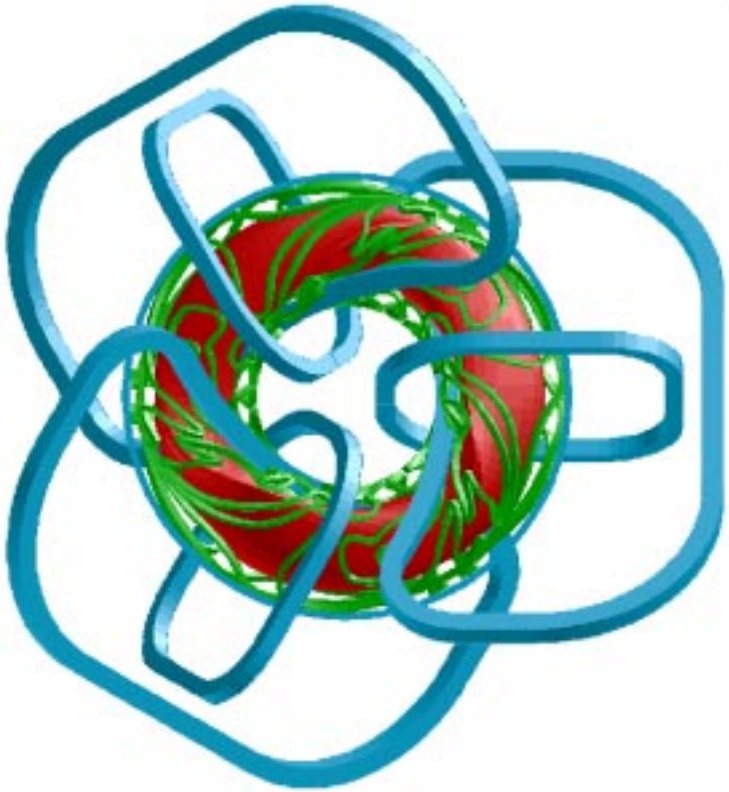
PBX option assessment

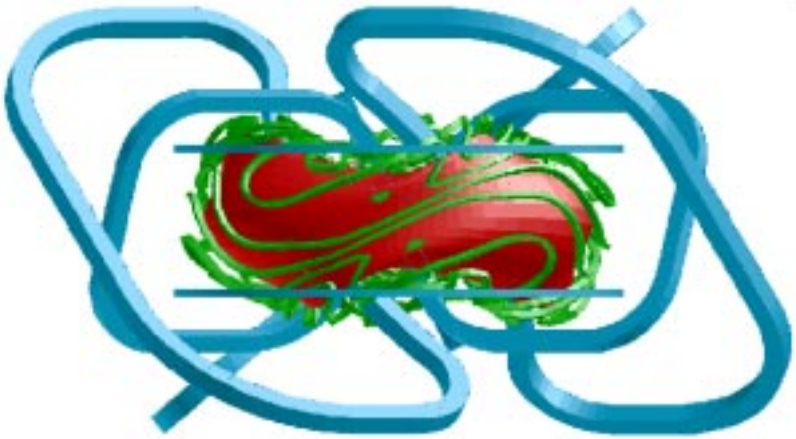
- Pros
  - Maximizes utilization of existing assets, should translate into cost benefit
  - Conformal coils wound in machined grooves in monolithic shell provides precise positioning with minimum deflections
- Cons
  - Limits plasma to narrow range in A
  - High J presents serious technical risks
  - Marginal access, awkward from above and below
  - Close-fitting conformal coils limit shape flexibility
  - Nested saddles undesirable for flexible plasma control – ‘same coil’ syndrome

Tilted TF coil option

Case 536.3
6 tilted TF coils
1 pair of circular PF coils





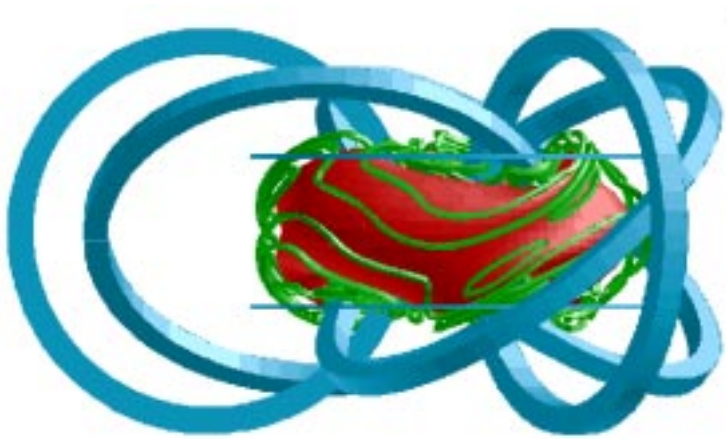


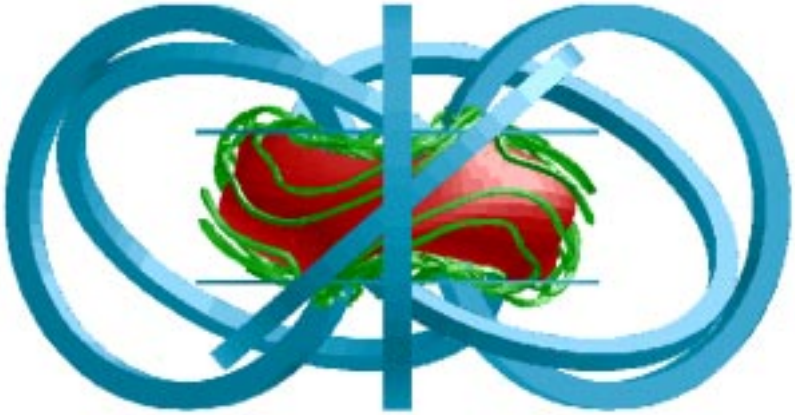
Tilted TF option assessment

- Pros
  - Replacing 1/R background field with ‘smarter’ field relieves technical risks of high J
  - Better in-out control with wavy PFs + saddles than with nested saddles only
  - Improved access from above and below – no cryostat to contend with
- Cons
  - Background field coils are ungainly – difficult to support structurally with large stray fields
  - NB access is more restricted, stray fields may be problematic
  - Close-fitting conformal coils still limit shape flexibility

L=3 coil option

Case 619.4
3 circular L=3 coils
3 circular (vertical) TF coils
1 pair of circular PF coils





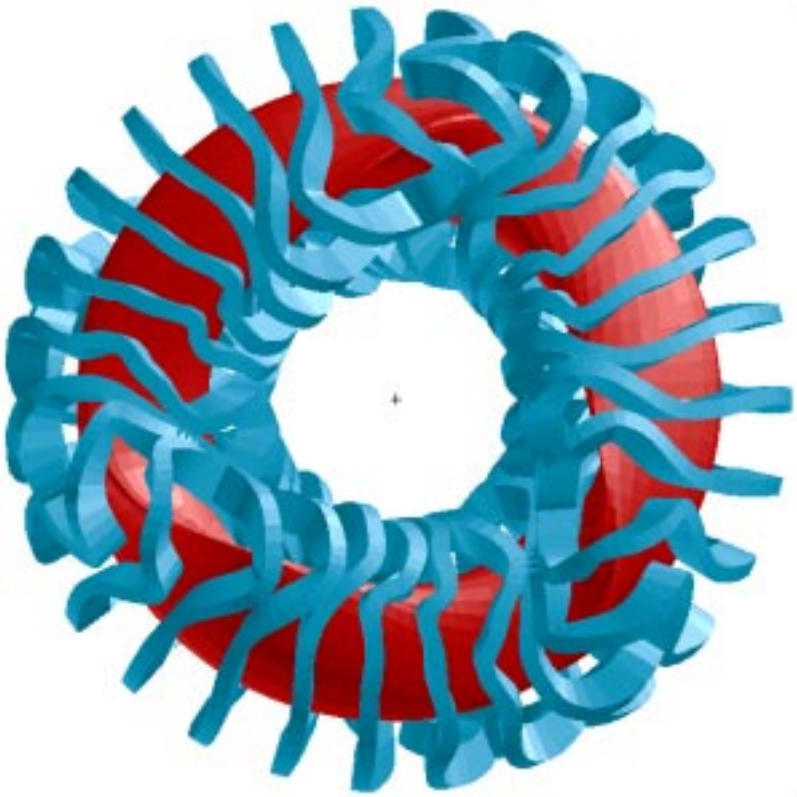
L=3 coil option assessment

- Pros
  - Current density is comparable or better than with tilted TF coil option
  - Ditto for flexible plasma control
  - More elegant background coil configuration – simple, circular coils can be wound or jointed, more easily supported
- Cons
  - Still have close-fitting conformal coils limiting shape flexibility
  - NB access is still restricted due to conformal coils, stray fields may be problematic

Modular coil option

Case 0424a1

27 coils (5 unique)

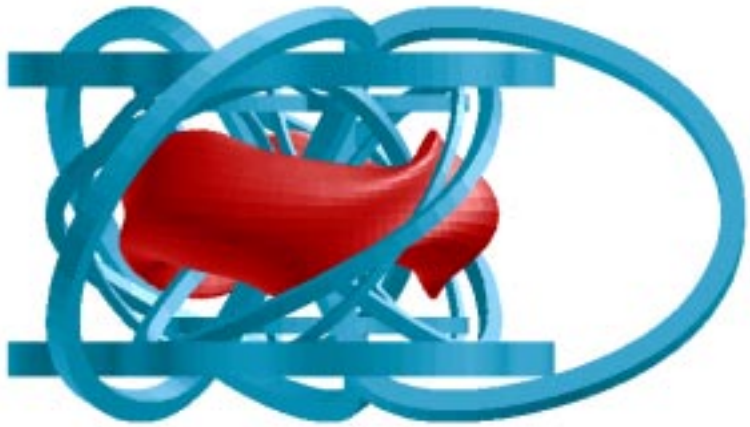


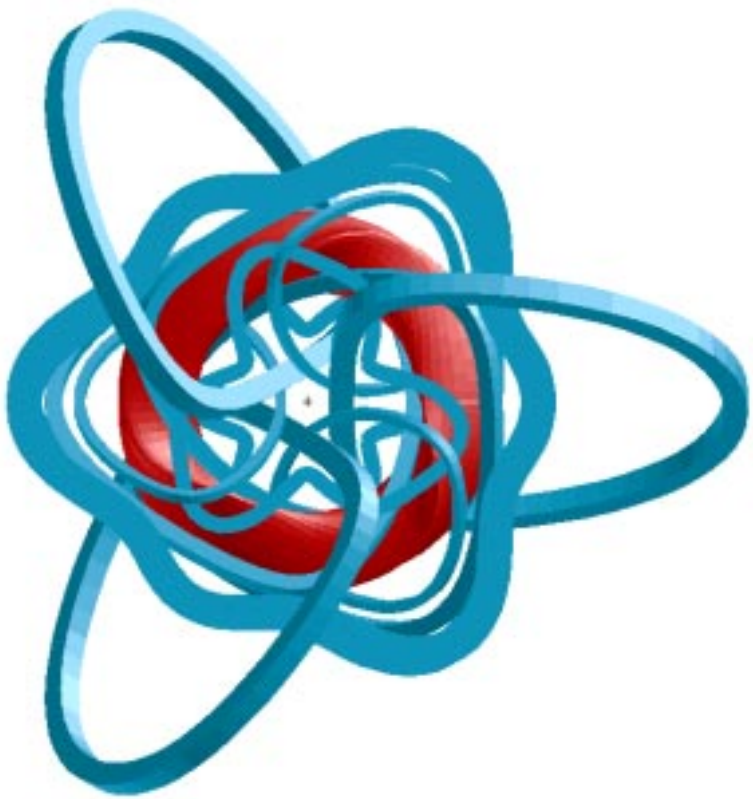
Modular coil option assessment

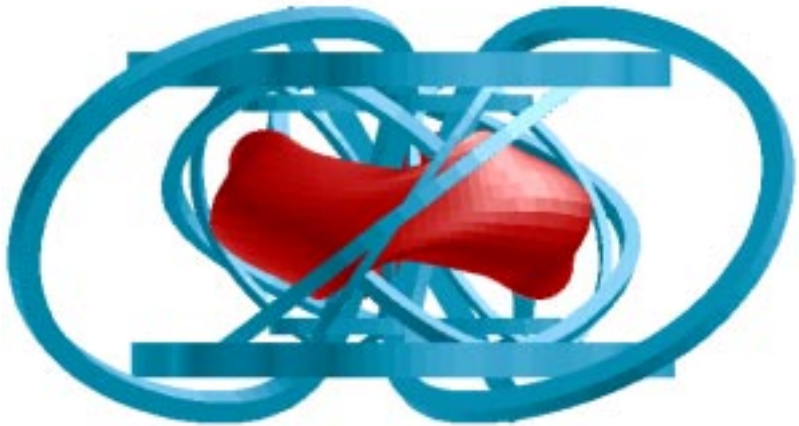
- Pros
  - Public acceptability – it is what people expect a modern stellarator to be
  - Low stray fields obviate concerns re NB
  - More space for shape flexibility (except inbd) than with close-fitting conformal coils
- Cons
  - Many unresolved technical issues (high J; coil-to-coil interferences; NB access; coil fabrication, support and alignment; cost)
  - More susceptible to field errors with 27 independently positioned and supported coils than with conformal coils in monolithic shell
  - ‘Same coil’ syndrome may negatively impact plasma control

NCC option

Case 564
All planar coils
3 L=3 coils
6 TF coils (3 @ v=0, 3 @ v=0.5)
2 pair of PF coils (varying R)







NCC option assessment

- Pros
  - *Potentially* the most flexible option – most space for shape flexibility, several different coil types with distinct signatures
  - Planar coils have low technical and cost risk, should have cost benfits
  - Best access
- Cons
  - Does not accurately reproduce c82 plasma – need to recover properties thru free boundary optimization
  - Interlocking coils pose problems for interferences, support, and construction
  - Large stray fields may be problematic for NB

Cross-cutting view of the options

8:30	Overview of Candidate Options (W. Reiersen)
9:15	Modular Coils (D. Strickler)
9:45	Discussion
10:15	Break
10:30	Properties of Reconstructed Plasmas (A. Brooks)
11:00	Discussion
11:15	Background Coil Design (P. Heitzenroeder)
11:45	Design of Close-Fitting Coils/Structures (D.Williamson)
12:15	Discussion
12:30	Lunch
1:30	Machine Configuration Design (T. Brown, M. Cole)
2:15	Cost Considerations (B. Nelson)
2:45	Discussion: Issues and Near-Term Plans (W. Reiersen)