Progress, Issues and Near-Term Plans

W. Reiersen

NCSX Project Meeting

July 12-13, 2000

LI383 family looks good for coils

- Modular and 1/R + saddle options both show promise that feasible design solutions can be developed (DS, AB)
  - Max J and complexity reduced
  - Significant design issues remain
- Alternate background coil options not yet explored
  - Less urgency with lower J and complexity for modulars and saddles
  - Better access with modulars and saddles
  - Less design freedom than before taking into account NB stray field constraints
  - Not yet on radar screen

LI383 properties need demonstration

- Stability, QA, and adequate surface quality need to be demonstrated with real coils
  - Kink stability achieved with modular coils, ballooning unstable in small region near edge, QA degraded by 1.56 (AB)
  - Kink stability achieved with saddle coils at higher iota, ballooning unstable in small region near edge, QA degraded by 1.91 (AB)
- LI383 surface quality marred by large m=5 islands near edge in fixed boundary (DM)
  - Urgently needs to be fixed
  - Impact of real coils (free boundary calculation) needs to be assessed

Other plasma configuration families are still in the race

- Reconstruction has been problematic for the two period LI283 option (AB)
  - LI283 has the virtues that it is low aspect ratio and could fit within PBX
- Targeting coil complexity and current density in the optimizer has resulted in significant improvements in high kappa family
  - A3k2.45b5.00 has J ~ 16 kA/cm^2 (CK)
  - Multiple high (7+) island chains piled up near edge in fixed boundary calculations (DM)

Excellent progress has been made in developing modular coil designs

- CoilOpt used profitably to reduce the complexity and Jmax in modular coil design to practical levels for several plasma configurations (DS, LB)
  - Major accomplishment which eluded us when we relied on ONSET
- Excellent progress in developing a machine configuration with modular coils (DW)
  - Critical issues include minimum radius of curvature, current density (assuming room temperature coils), fabricability and assembly

Access looks better than ever

- Modular coil option appears to naturally provide adequate access is few coils (<7) per period are used (MC)
- Access can be improved in modular coil option by pulling one of the outer legs further out (MC)
- Access for 1/R + saddles option looks OK with new (and fewer) TF coils
  - C82 concept looks directly applicable to new plasma configurations – no configuration development started on 1/R + saddles option for new plasma configurations

Cost algorithms have been exercised on modular and 1/R + saddles options (BN)

- Need to critically review cost differences and resolve concerns
- Primary purpose is to identify cost drivers so cost growth can be contained
- Secondary purpose is to quantitatively understand cost differences between candidate options
- More design work is needed to develop modular and 1/R + saddle options to refine cost algorithms and develop design data required by cost algorithms

What are our objectives?

- First objective is to provide engineering input necessary to support selection of reference plasma configuration (August)
- Second objective is to develop the designs of candidate machine configurations to the point where we can assess their feasibility and choose between them (September)

So what next…

Develop modular and saddle coil designs for LI383 that adequately recover plasma properties

- VMEC reconstruction with modular coils looks OK
  - Explore improvements possible by adding 1/R field and making 4 independent modular coil circuits (WR)
  - Assess and improve properties for S0 and S1
  - Assess feasibility of providing higher iota (ala II378) and higher beta (ala II379) configurations with good properties
  - Pass coil data to Physics for assessment of confinement (LPK) and surface quality (DM/CJ)
- Need to…
  - establish design criteria for minimum radius of curvature (BN)
  - incorporate curvature constraint in CoilOpt (DS)
  - develop revised modular coil design that meets all constraints (min ρ, adequate NB access, J_{max}, etc.) (DS/LB)

More work needed on saddle coils

- Poor ballooning stability at reference iota
- Coil data should be passed to Physics to assess whether PIES shows a significant difference in surface quality for saddles and modulars
- Continue optimization with StellOpt for reference operating point
- Pass coil data to Physics for assessment of confinement and surface quality once reference operating point adequately reconstructs
- May require improved saddle coil design (more contours or optimization)
- Move on to startup and higher iota and beta points
- Minimum radius of curvature needs to be tracked against allowables for saddles, too

Continue development of machine configurations for modular and saddle options

- Modular focus – fabricability of coils, definition of coil structure, assembly, expanded VV boundary for shape flexibility (w/o compromising assembly), dealing with $J_{max} > 10$ kA/cm^2
- Saddle focus – update machine configuration for LI383, definition of TF and PF coils and structure, expanded VV boundary for shape flexibility
- Resolve costing issues

Provide additional support as required for selection of reference plasma configuration

- Develop modular and saddle coil designs for preferred high kappa option, assess feasibility
- Develop modular and saddle coil designs for 2 period option if reconstruction problems can be overcome