Coil Design for NCSX

Recent Progress and Plans

S. P. Hirshman

Recent Coil Design Activities

- Chronology of Island Suppression Activity
  - Modular coil design with good surfaces
    - Strickler/Berry/Hudson
    - Status: incomplete, unproven for free boundary
      - proof of “principle” nearly completed
  - Saddle coil design with good surfaces
    - Woolley/Valanju/Miner
    - Status: still need to demonstrate proof of principle, benchmarking at all levels of coding

Saddles vs Modulars

- **Surface Preservation (PIES Reconstructions)**
  - **continue to show preference for modulars**
  - **spectral differences between saddles and modulars**
    - **still not analyzed, although Valanju/Brooks have capability in principle**
    - **discrete saddles give rise to high-m spectra**
      - **fundamentally different from modulars**
      - **may be more difficult to suppress with trim coils**

Saddles vs Modulars (cont'd)

- **Physics Preservation (VMEC Reconstructions)**
  - **continue to show slight preference for modulars (Zarnstorff)**
    - **discrimination on flexibility, physics**

Xerror vs Berror Scans for Saddles

- NESCOIL/GA (Valanju-Miner)
  - completed NESCOIL Xerror targeting scans
  - no clear indication that this solves surface quality problem (for finite no. saddles)
    - modest (?) improvement in some saddle PIES surfaces
  - infinite (60 coil) saddle limit
    - Xerror targeting shows definite improvement
    - need to determine minimum no. coils (>20) to adequately reproduce this limit
      - engineering acceptability

Combined PIES/COILOPT

- **Marriage of codes**
  - **Hudson-Strickler-Berry: apply island suppression algorithm to free-boundary plasma**
    - **previously, "fixed boundary"**
    - **fixed boundary suppression insufficient**
      - **6/9 island close to boundary not targeted in fixed boundary code**
- **Extensible to saddle coils**
  - **Strickler-Berry adapting COILOPT to saddle coils**

Coil Improvements: Schedule and Plans

- Island Suppression I (H-B-S)
  - Free-boundary proof of principle
    - for modulars (1-2 weeks)
    - for saddles (2-3 weeks, maybe less)
- Island Suppression II (W-V-M)
  - Complete debugging of Island Preserver code (1-2 weeks)
  - Integrate IP code into NESCOIL/GA (1-3 weeks)
  - proof of principle: after that

Parallel Development Activities

- Trim Coils
  - A. Brooks - leading this activity
    - determine coil topologies for low order resonance control and flexibility
- Improved saddle winding surface
  - P. Valanju, L. Berry
    - SURFOPT code merged with NESCOIL
      - allow variable current sheet-plasma distance
    - work nearly complete

Conclusions and Status

- Resonance suppression - Job #1
  - Integration of codes
    - some work complete, others still in progress
  - island suppression “proof-of-principle”
    - modular coils: imminent
    - saddle coils: not as close yet
      - H-S-B applicable in principle
      - W-V-M still under development
  - Xerror targeting for saddles
    - insufficient and inconclusive
      - PIES scan with no. coils still incomplete

Conclusions and Status (cont'd)

- **Trim coils**
  - **topology studies underway**
    - **spectrum targeting with discrete, accessible coils**
- **Conclude Xerror targeting study**
- **Finish variable surface NESCOIL development**