Compact Stellarator Configuration Development Planning

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ARIES Team Meeting

October 4, 2002

Proposed Plan

This meeting

- Discuss and agree on overall approach.
- Work out advocate-team and core-team tasks.

Follow-up after the meeting

- Come up with a work plan and schedule.

Approach

FY-03: First steps toward a C.S. configuration optimized for a power plant

- Optimization tool development
  - Figure of merit for targeting alpha confinement.
  - Engineering targets, e.g., plasma-coil separation, coil space allocation, bend radius.
  - Figure of merit for cost.
  - Stellarator system code improvements.
- Configuration-space exploration to identify promising design-space regions
  - Variables include iota, R/⟨a⟩, R, B, β, QA / QP.
  - Coil representations: Both NCSX-like (modular coils) and improved concepts (e.g., tilted coils) need to be looked at.

Later:

- Year 2: Systematic trade studies leading to reference configuration selection
- Year 3: Design development and costing based on selected configuration.

May go more slowly due to slow start this year and R&D character of the task.

For now focus on FY-03 planning.

Tasks

Compact Stellarator Advocate Team

Project direction (PPPL / ORNL) : J. Schmidt, J. Lyon, P. Heitzenroeder, H. Neilson, B. Nelson, W. Reiersen, M. Zarnstorff

- PPPL ($180k)
  - Configuration optimization (L. P. Ku, M. Zarnstorff)
  - Alternatives exploration (N. Pomphrey, H. Mynick, W. Reiersen)
- ORNL ($70k)
  - Alpha loss calculations (D. Spong)
  - Stellararator Systems Code (J. Lyon)
- GA ($50k)
  - Stability (A. Turnbull)?
- Universities
  - Physics and engineering input (D. Anderson, et al. U. Wisconsin)
  - Concept optimization (P. Garabedian, NYU; A. Ware, U. Montana)

ARIES Core Team (UCSD / UW / RPI)

- Input to designers on engineering criteria for CS reactors.
- Feedback to designers on engineering implications.

Discussion Notes I

Action Items

- Compile combined contact list (CS team & core team) **BOB**
- Next meeting: Jan., 8-10 or 13-15 (UCSD)
- Conference calls monthly
- Suggest background reading on stellarators (review papers, annotations) **Jim**
- Contact Germans, re collaboration with their reactor studies (**FN**)
- Contact Japanese, re US-Japan workshop March in Japan (FN)

NCSX & QPS Design Information

- NCSX conceptual design documentation: http://www.pppl.gov/ncsx/Meetings/CDR/NCSXDocumentation.html
- QPS Physics documentation: http://qps.fed.ornl.gov/pvr/docment.htm
- Pro-E models: CS Team: P. Heitzenroeder (PPPL) or B. Nelson (ORNL); Core Team: X. Wang (UCSD)
- Plasma and coil Fourier representations: CS Team: M. Zarnstorff or A. Brooks (PPPL); Core team: F. Najmabadi (UCSD)

Discussion Notes II

Tasks (rough priority order)

- Optimizer criteria evaluators (physics)
  - Alpha loss (stripped-down ORBIT too time-consusming? 2nd invariant method. Look at GWB.) **Spong, Mynick, Mau**
  - Flux surfaces (PG has some ideas for January). **Garabedian**
  - Stability (linear resistive and non-linear) **Turnbull**
  - What field on axis?
- Physics Studies
  - Explore configuration space with modular coils. **Ku, Garabedian**
  - Explore physics potential of tilted coils. **Pomphrey, Mynick.** Engineering guidance: **Reiersen**
- Engineering Studies (Use NCSX/QPS CAD models as starting point.)
  - Blanket & shield concept for stellarators. Variable thickness. Neutronics., maintenace, etc…
  - Magnets. S/C parameters, Bmax evaluator, space. Use COILOPT for Bmax? High-T S/C and Low-T. **Heitzenroeder, Bromberg**
  - Divertors, pump duct. Look at German wor
  - Cost models **Waganer**
- Update the stell. Systems code. **Lyon**
  - Real 3D geometry.
  - Update costing models (work with Les)
  - Self-consistent E-field.
- Optimizer criteria evaluators (await results of engineering studies)
  - Blanket / shield thickness (vs θ, φ) variable thckness vs power, radius
  - Magnets (space, bend radius, Bmax, S/C criteria)
  - Maintenance (requirements, space)
  - Divertor space (see analysis by NCSX group- A. Grossman, UCSD).
  - Cost
- Optimizer Capability Improvements
  - Merge design-point and configuration optimizers. Longer term
  - Profile optimization
- **ECH startup.**