NCSX PVR Plans

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NCSX Project Meeting

Timeline (reversed)

- PVR/CSR (physics and engineering) – late March
- PVR-document sent out – mid-March (2 wks before review)
  - Purpose: document design and basis to convince reviewers and community that NCSX should be constructed and invested in
  - Draft outline, w/ identified authors

- PVR.doc completion of first draft – end of January
  - Aim early to allow completion of engineering by March
  - Much can be written now: don't delay
  - Identify holes, fill in after January

- PVR.doc, ½draft covering completed research – 20 Dec.
- Updated outline – 16 Nov.
  - Whole group
- Required task-list – 22 Nov.

NCSX PVR Draft Outline

This is intended as a list of topics to be presented and is an approximate outline for the PVR Document. It may also be close to the expected schedule of talks. Suggested primary authors are indicated. Volunteers are welcome. The order of sub-sections is not intended to be final.

1. Overview and Introduction *Neilson, Lyon*
2. Motivation and Goals *Zarnstorff, Lyon, Neilson*
   - 2.1. CS opportunity, FESAC goals
   - 2.2. AT context (*Zarnstorff, Neilson)*
   - 2.3. Stellarator context (*Lyon)*
   - 2.4. NCSX mission, physics program goals, and unique contributions to science and fusion energy.
   - 2.5. Potential reactor vision impact (*Lyon)*
3. NCSX Physics Capabilities Overview *Zarnstorff, Hirshman, Pomphrey, Reiman*
   Purpose: Introduce the design, overview characteristics and analysis, demonstrate ability to satisfy mission and goals, establish requirements. Subsequent chapters substantiate the physics basis and capabilities introduced here.
   - 3.1. Physics design, overview of physics characteristics *(Reiman, Ku)*
   - 3.2. Coil design, overview of characteristics including flux surfaces, required accuracy. *(Hirshman, Monticello, Reiersen, et al)*
   - 3.3. Reference scenario (s1, s2, s3, and time intervals) and alternate scenarios *(Lazarus)*
   - 3.4. Device flexibility and robustness *(Pomphrey)*
   - *3.5.* Heating & CD *(Kugel, Majeski)*
   - 3.6. Power & particle handling, first wall. *(Mioduszewski, Schmidt)*
   - 3.7. Diagnostics *(Johnson)*
   - 3.8. EM requirements: wall time constants, disruption handling *(Fredrickson, Fu)*
   - 3.9. Unique capabilities, relative to other experiments.
   - 3.10. Research plan, operation requirements (e.g. rep. rate, neutron sheilding)
4. Facility Design *(Reiersen, Nelson, et al.)*
   Purpose: Show that the facility can credibly be designed, constructed, and operated to meet the requirements and fulfill the mission.
   - 4.1. Device description, components *(coils, VV, PFCs)*, strategies *(e.g for controlling magnetic configuration accuracy)*
   - 4.2. Baking & cooling
   - 4.3. Engineering analysis. (*Not too much detail)*
   - 4.4. Site, Facilities, Power supplies, I&C, Data Acquisition. *(paragraph each)*
   - 4.5. Neutral Beams, ECH, and HHFW *(Kugel, Bigelow, Majeski)*
   - 4.6. Ports and access *(Cole)*

5. Equilibrium & flux surfaces *(Monticello, Hirshman, Reiman, Rutherford)*
   Purpose: Show that the equilibria are sound and have a sound basis
   - 5.1. VMEC & PIES
   - 5.2. benchmarking vs. experiments & codes
   - 5.3. Bootstrap current calculations for QAS (Monticello, Lin, White)
   - 5.4. flux-surface quality, repair
   - 5.5. neoclassical healing
   - 5.6. trim-coils for suppressing/inducing islands (if needed)
6. Ideal MHD stability *(Fu, Reiman)*
   Purpose: soundness of physics basis…
   - 6.1. Terpsichore, CAS3D, Cobra
   - 6.2. Benchmarking vs. experiments & codes
   - 6.3. Mercier & Ballooning stability
   - 6.4. Kink & 'vertical' mode stability
   - 6.5. Effect of wall and conducting structures on stability
7. Resistive stability *(Fredrickson, Reiman)*
   Purpose: soundness of physics basis…
   - 7.1. Present understanding vs. experiments
   - 7.2. Δ' analysis
   - 7.3. comprehensive analysis (Pies? M3D? *if needed*)
   - 7.4. neoclassical tearing
8. Heating & CD methods
   Purpose: soundness of physics basis…
   - 8.1. OH
   - 8.2. NBI *Spong, Kugel, Zarnstorff*
     - 8.2.1. PBX Beam characteristics
     - 8.2.2. Orbit losses
     - 8.2.3. Injection angles & location
     - 8.2.4. Co & counter configuration(s)
   - 8.3. HHFW *Majeski*
   - 8.4. ECH startup (is this needed?) *Bigelow*
9. Transport *Mikkelsen, Liewandowski/Lin, Zarnstorff, Mynick, Ross?*
   Purpose: soundness of physics basis…
   - 9.1. Neoclassical transport
     - 9.1.1. GTC, DKES, & analytic models
     - 9.1.2. Self-consistent Er & effects *(Mikkelsen, Liewandowski)*
     - 9.1.3. Comparison with experiments & between codes
     - 9.1.4. Flow damping
   - 9.2. Microstability (?) including Er effects? *Is this needed??*
   - 9.3. Stellarator & tokamak confinement & transport context
   - 9.4. Methods for obtaining enhanced confinement
   - 9.5. Transport simulations including neo. & anomalous models
   - 9.6. Expected plasma characteristics

10. Configuration flexibility and robustness *Pomphrey*
    Purpose: soundness of physics basis. In particular, that the device is flexible enough to achieve the mission.
    - 10.1. Profile robustness
    - 10.2. Flexibility to address each physics mission element
    - 10.3. General flexibility (for unforseen experiments)
11. Discharge scenarios *Lazarus*
    Purpose: soundness of physics basis. In particular, that it is plausible that the reference scenarios can be accessed
    - 11.1. Startup
    - 11.2. Evolution modeling
    - 11.3. Modeled scenarios
        - 11.3.1. With OHCD
        - 11.3.2. Without OHCD (?)
        - 11.3.3. Short and Long pulse expected evolutions
        - 11.3.4. Plasma quality during evolution; eddy current effects & limits
12. Power and Particle Handling *Mioduszewski et al.*
    Purpose: soundness of physics basis…
    - 12.1. Outer flux topology; expected power deposition pattern
    - 12.2. First wall system, impurity control, coatings, capabilities and plans (incl. Li)
    - 12.3. Initial limiter
        - 12.3.1. Design
        - 12.3.2. assessment
        - 12.3.3. neutral influx
    - 12.4. Possible divertor upgrades (sketches); required space
13. Diagnostics *Johnson*
    - 13.1. Baseline
    - 13.2. Discharge control strategy
    - 13.3. Diagnostics upgrades & strategy
    - 13.4. Adequacy of Access
    - 13.5. Data acquisition & analysis
    - 13.6. Opportunities for reuse and synergy; collaboration
14. Cost & Schedule for Construction and Operation *Neilson, Schmidt, Lyon*
    - 14.1. Design completion, reviews, cost profiles, schedule
    - 14.2. Management, collaboration plans, Laboratory context, institutional commitments.