

ReNeW Theme 5 Workshop Introduction and Goals

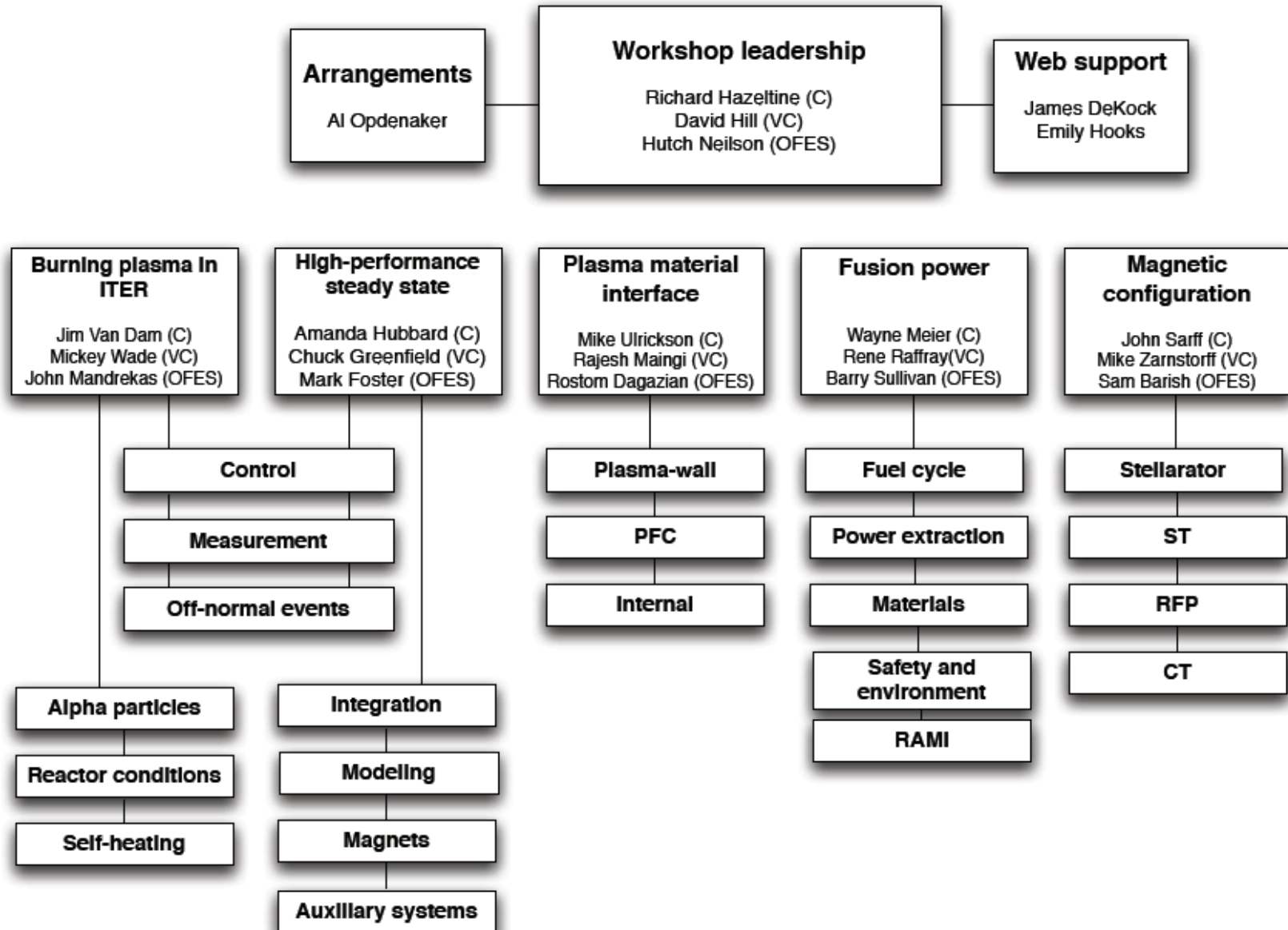
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Theme 5 structure originates from the FESAC Toroidal Alternates Panel (TAP)

- Five toroidal alternates were examined by TAP, with focus on the “ITER era” (next 20 years)
 - Stellarator
 - Spherical Torus (ST)
 - Reversed Field Pinch (RFP)
 - Compact Torus (CT):
 - Field Reversed Configuration (FRC)
 - Spheromak
- Toroidal alternates also appear in FESAC “Priorities, Gaps and Opportunities: Towards a Long-Range Strategic Plan for Magnetic Fusion Energy” (Greenwald report)
 - Basis for the organizational structure in ReNeW Themes 1 to 4
 - Examined research gaps to DEMO
 - Many issues generic to all magnetic configurations

Theme 5 is organized by magnetic configuration



Theme 5 organization

John Sarff (UWisc), Theme Chair

Mike Zarnstorff (PPPL), Theme Vice Chair

Sam Barish, OFES Champion

Panel Chairs

Stellartor: Dave Anderson (UWisc)

ST : Steve Sabbagh (CU)

RFP : Hantao Ji (PPPL)

CT : Bick Hooper (LLNL)

Cross-configuration Task Force (internal organization to Theme 5)

Mike Zarnstorff, chair

Stellartor: Jeff Freidberg (MIT), Jeff Harris (ORNL)

ST : Jon Menard (PPPL), Steve Sabbagh (CU)

RFP : Brett Chapman (UWisc), Carl Sovinec (UWisc)

CT : Richard Milroy (UWash), Mike Schaeffer (GA)

+ Panel Chairs

Workshop goals

- Our main opportunity for broad community discussion
- Refine research needs
- Develop research thrusts
- Issue discussion and prioritization should be resolved or very limited
 - Carried forward from TAP
 - Resolved by panel work already completed

Workshop goals

- Our main opportunity for broad community discussion

- Refine research needs
- Develop research thrusts

Focus this week

- Issue discussion and prioritization should be resolved or very limited
 - Carried forward from TAP
 - Resolved by panel work already completed

Workshop structure

- Input from ReNeW Themes 1-4
 - Themes 1,2: research need discussion from a few panels
 - Themes 3,4: research needs and thrusts as output from their joint workshop 2 weeks ago
 - All of ReNeW is mid-process, so this is **not** intended to be refined, rather stimulate cross-theme discussion
- Reports from the Theme 5 panels
 - Brief summary of process used by the panels
 - Recap of issues and gaps identified by TAP
 - Development of research needs
 - Draft or trial research thrusts as examples and starting points

Workshop structure, pg 2

- Community input
 - Accommodated (almost) all white papers, on site or via remote participation
 - Topics which cross configurations in plenary on Tuesday afternoon
 - Topics which are more configuration specific in parallel break outs Wednesday morning
 - Line between these often blurry
- Two Cross-configuration Task Force meetings, 5:30-6:30 Tues & Wed
 - Working sessions to identify compelling research thrusts that are broader science themes spanning configuration space
 - Everyone invited to contribute and participate

Workshop structure, pg 3

- Thursday morning plenary: panel reports and discussion of research thrusts, introduced or refined during the course of the workshop
- Thursday afternoon plenary: discussion of cross-configuration research thrusts
- 6 hours of parallel breakout time prior to Thursday is reserved for discussion, structured to best fits each panel's needs (most likely focused on research thrust development)
- 3 hours of parallel breakout time Thursday afternoon to organize next steps

Research thrust

- A primary output of the ReNeW process will be a set of Research Thrusts (target of 15 total from all Themes recommended at outset)
- Building blocks for the U.S. fusion program plan in the ITER era (20 yrs)
- Defined as a “multi-faceted attack on some question, or coherent set of questions, essential to magnetic fusion science and technology, using a combination of new or existing program elements”
 - Address important and compelling question(s) whose answers advance the development of magnetic fusion
 - Multi-faceted components: facilities, theory, modeling, collaboration, etc.
 - Described in sufficient detail to permit estimate of resource requirements
- A range of thrust size has been requested by DoE OFES
 - Size distinguished mainly by scope and resource requirements
 - Must be important and compelling at any size

What a research thrust is not

- An endorsement of a particular device proposal
- An endorsement of an upgrade to an existing facility
- An endorsement of a theory or modeling initiative
- A cost estimate for particular work, although sufficient detail should be provided for eventual estimates

(Borrowed from Mike Ulrickson's Theme 3 Workshop Introduction)

Special challenge for research thrusts in Theme 5

- What is the best way to cast important questions involving the alternates:
 - Specific to each magnetic configuration?
 - More compelling organized around general scientific questions?
- Each configuration requires a self-consistent and unique set of solutions to general scientific issues, e.g., confinement, stability, sustainment, controlled boundary interface, etc.
- Research on multiple magnetic configurations collectively advances and validates our understanding of fusion plasma science and technology
- Each of these perspectives is compelling, each is needed, and clearly not fully separable
- The cross-configuration task force was created to provide an organized discussion of this challenge (otherwise default is configuration specific)

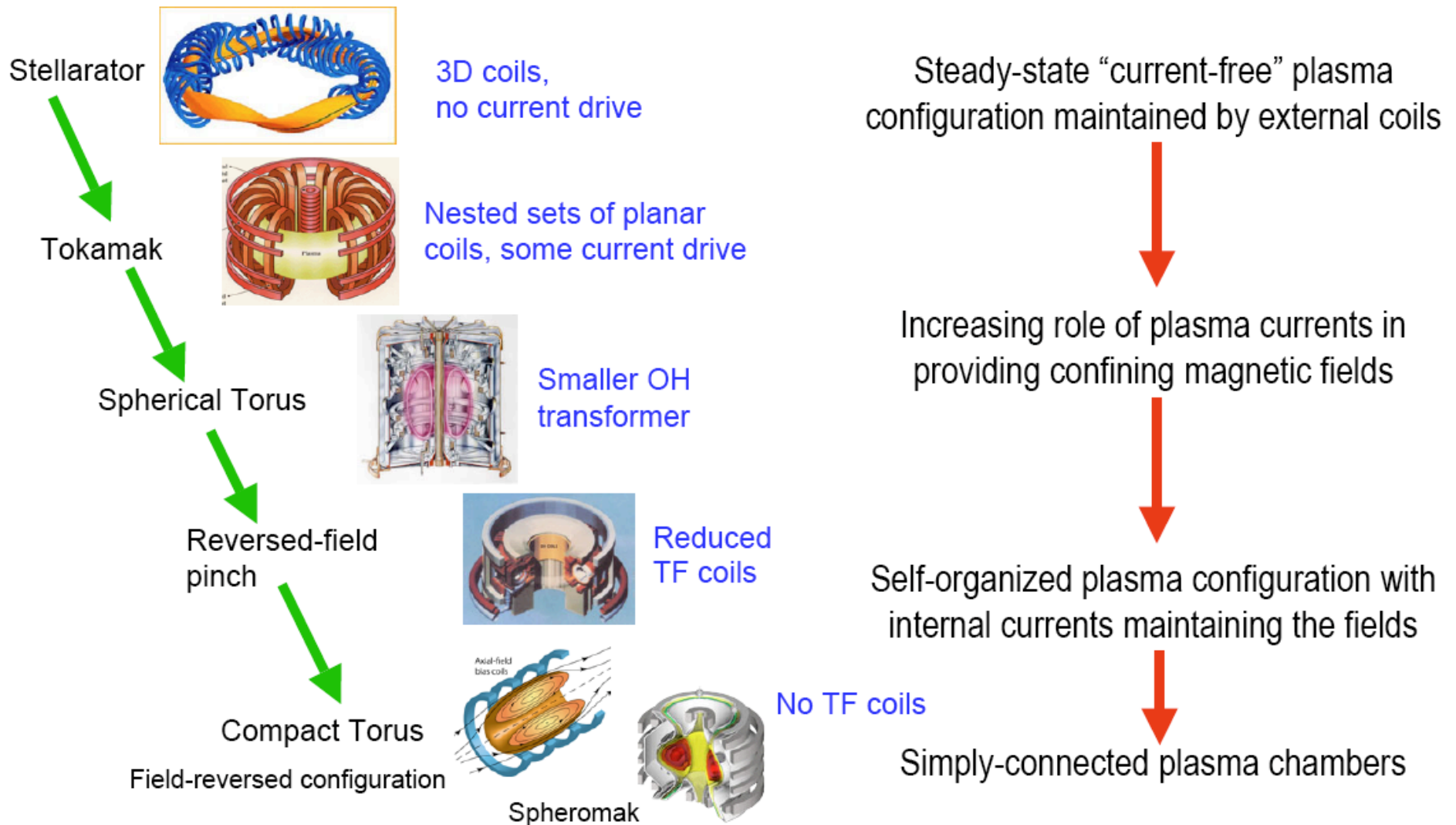
The ReNeW Report: Theme and Research Thrust chapters

- Chapter for each Theme (35 pg target)
 - Introduction to the theme
 - Section for each panel
 - Summarize issues and gaps (primary source is TAP report)
 - Describe research needs for compelling scientific questions, e.g., skills & expertise, facilities, theory, modeling, etc.
 - Describe in quantitative fashion as much as possible
 - Brief description of thrusts for the Theme
 - Plan: logical and temporal relationship of the thrusts
- Chapter for each Research Thrust (8 pg target)
 - Introduction to the research thrust
 - Scientific importance, opportunity, urgency
 - Scientific and technical research elements, with sufficient detail for rough estimate of cost and schedule
 - Benefit for magnetic fusion energy development, relation to other thrusts, scientific benefits outside of fusion

Steps following this workshop

- Panels draft the research needs for the Theme 5 chapter
- Refine our research thrusts prior to May 5-7 meeting of ReNeW Executive Committee
- Review and refine the set of consolidated research thrusts output from the Executive Committee prior to June 7-13 ReNeW workshop
- ReNeW Report complete mid-July

The range of magnetic configurations offers opportunity to optimize fusion development



Multi-configuration research grows fusion science, for example:

- Transport mechanisms
 - Will 3D quasi-symmetry reduce turbulent transport?
 - Why does confinement scale differently at low aspect ratio?
 - How will drift wave turbulence be modified by reversed shear and shorter connection length at low safety factor?
 - How does stochastic transport work, with magnetic self-organization, or with external sources of 3D resonant fields?
- Boundary control
 - Can expanded flux divertors be achieved in tori as well as mirror-like geometries, like the FRC?
 - How are radiative boundaries affected by 3D fields and shorter connection lengths?
- Density limits
 - Why do RFP and tokamaks appear to have the same empirical limit?
 - Why do stellarators exceed this limit?
 - How much 3D field is required for a higher limit? Or how much plasma current for a lower limit?

Thanks to

- Local PPPL staff
- The members of Themes 1-4 who took time to provide input
- Workshop participants, including those from abroad, and via remote access

Looking forward to a lively and productive meeting!