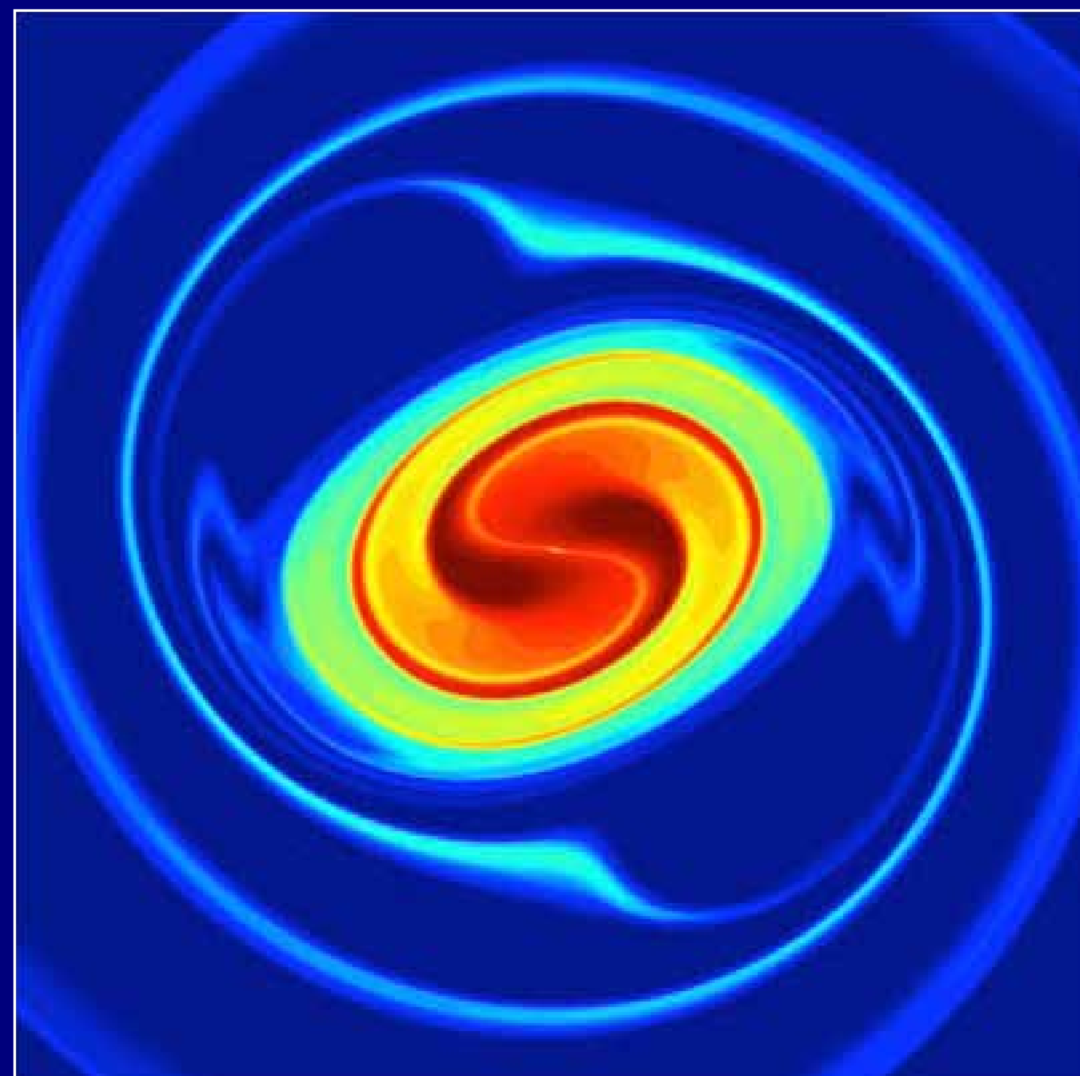
ReNeW

Research Needs Workshop for Magnetic Fusion Energy June 7-13, 2009

Richard Hazeltine, ReNeW Chair

http://burningplasma.org/Renew.html

Research Needs for Magnetic Fusion Energy Sciences



Report of the Research Needs Workshop (ReNeW)
Bethesda, Maryland – June 8-12, 2009

U.S. DEPARTMENT OF ENERGY

Office of Science
U.S. DEPARTMENT OF ENERGY

OFFICE OF FUSION ENERGY SCIENCES

Acknowledgements

ReNeW was commissioned and supported by the Office of Fusion Energy Science (OFES), US Department of Energy (DOE).

Most of the hard work performed by

David Hill, Vice Chair

Hutch Neilson, DOE liaison

ReNeW Executive Committee

Other ReNeW's

- US Office of Basic Energy Sciences (BES), within DOE, originated ReNeW process and inspired ReNeW on magnetic fusion energy (MFE).
- ReNeW's on fusion-fission hybrids, and on high-energy-density laboratory physics (HEDLP) are now underway.
- Following comments pertain specifically to MFE ReNeW.

Purpose, Process, Product

- ReNeW was a Workshop that produced a Report.
- The ReNeW report attempts to provide a foundation for planning US fusion research in the ITER era–roughly the next two decades
  - how can US fusion scientists best contribute to ITER?
  - what research activities should be performed in parallel with ITER?

Purpose, Process, Product

- ~200 fusion scientists and engineers, mostly but not exclusively from US
- ~9 months of planning activity: meetings, teleconferences, calculations, debates...
- Culmination: week-long Workshop in June, 2009, to create 200-page report to DOE. Final report submitted September 3, 2009.

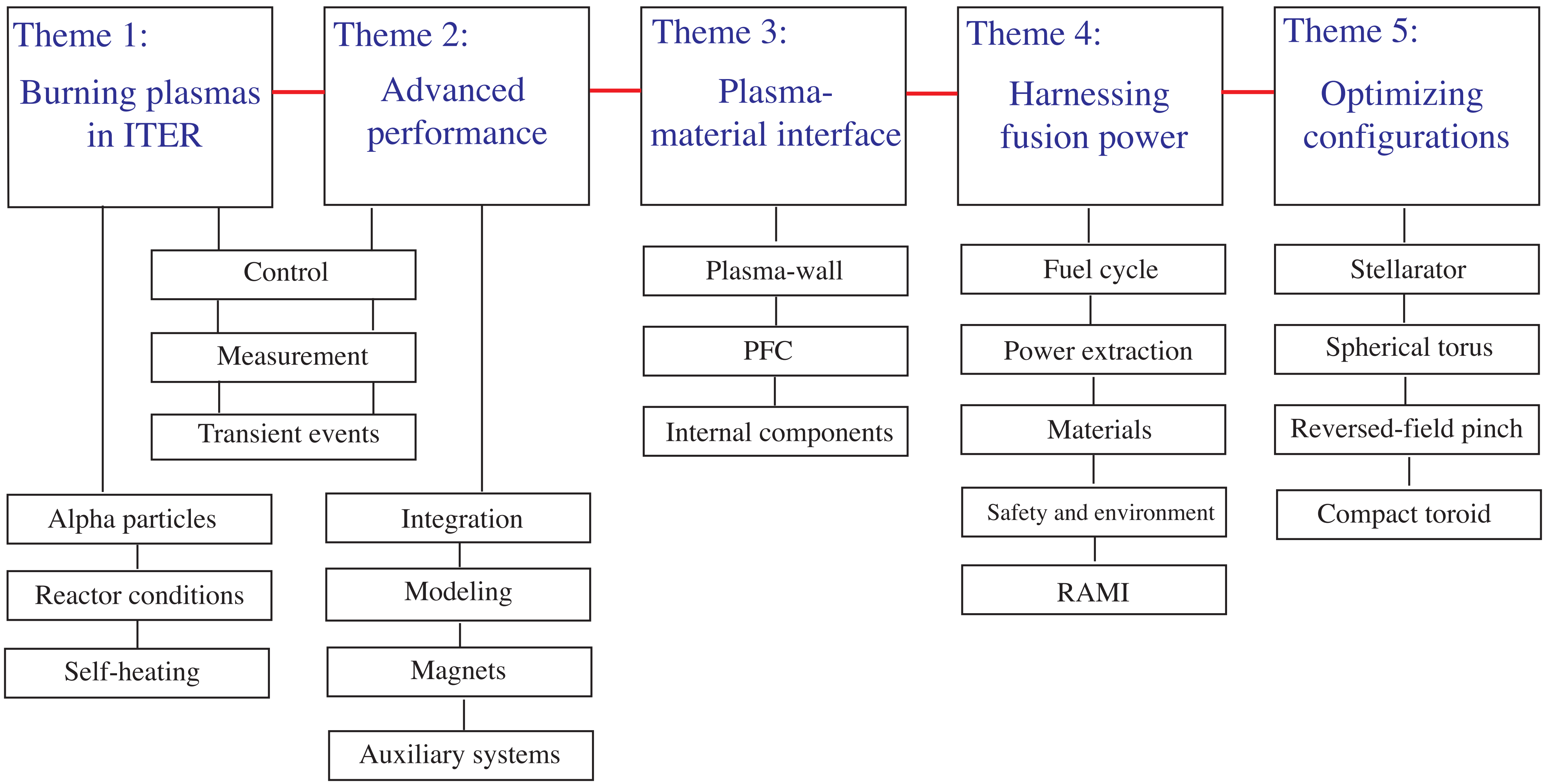
Purpose, Process, Product

- ReNeW constructed a set of proposed activities, called thrusts, for magnetic fusion research
  - a research portfolio, rather than a program plan: no timelines, decision points, milestones, etc
- Thrust: an organized, multi-faceted attack on a coherent set of questions that are essential to the goals of magnetic fusion research
  - each thrust provides an element in the program plan to be constructed by OFES

Division of planning effort

- Scientific community (ReNeW):
  - identifies key technical issues and opportunities
  - describes required research activities, and how they can fit together
- Government (OFES):
  - chooses, and regularly updates, a timeline that fits the expected funding climate
  - assigns detailed institutional and programatic responsibilities

ReNeW organized by Panels, within Themes



Workshops

- Five Theme Workshops, held in the early Spring of 2009, identify research requirements.
  - strong community participation, vigorous debate
  - public comment, including "white papers"
- June Workshop uses research requirements to construct 18 thrusts, each grounded in a compelling program need.
  - 181 hardworking attendees
  - final consensus on 18 thrusts, including logical and temporal connections between them

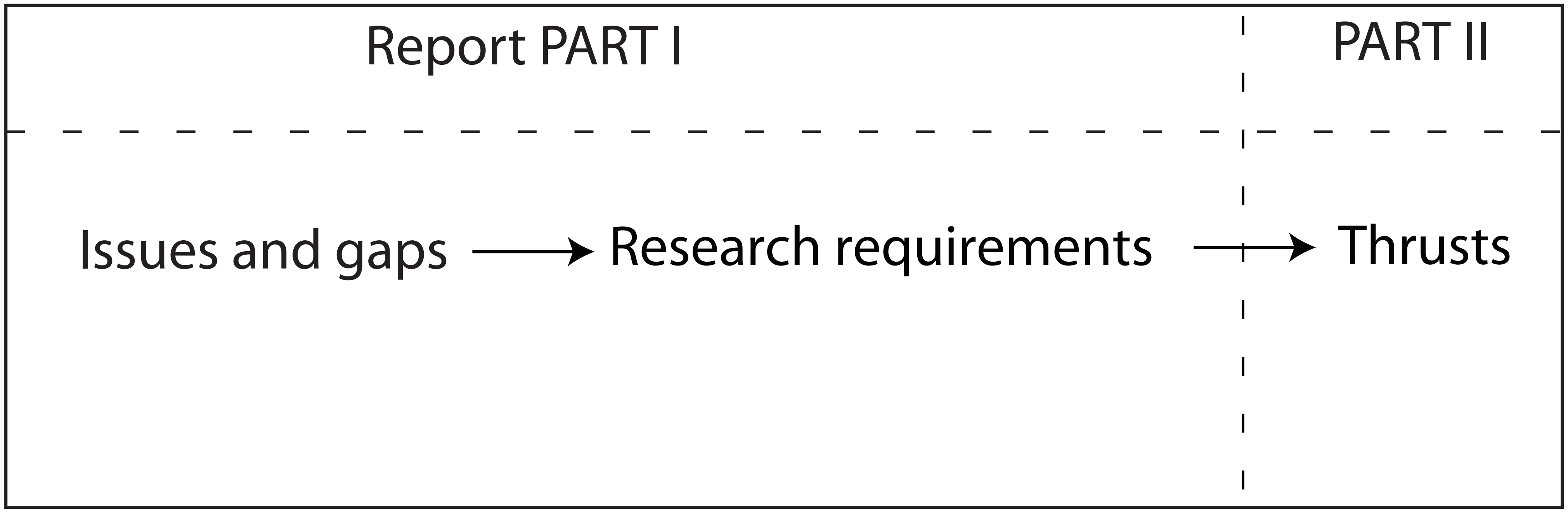
Building on previous studies

Strict rule of ReNeW: avoid repetition!

Three previous community reports provided key issues, as starting point for ReNeW:

- Priorities, Gaps and Opportunities Panel, chaired by Martin Greenwald ("Greenwald report")
- Toroidal Alternates Panel, chaired by David Hill ("TAP report")
- Energy Policy Act (EPAct) task group of the U.S. Burning Plasma Organization ("EPAct report")

2-step process, 2-part report



- Part I: identifying research requirements
  - needed facilities, codes, parameter regimes...
- Part II: building thrusts
  - integration of research activities into discrete, coherent programs

Typical thrust includes:

- Advance in fundamental science and technology

  - such as the development of broadly applicable theoretical and simulation tools, or frontier studies in materials physics.

- Confrontation with critical fusion challenges

  - such as plasma-wall interactions, or the control of transient plasma events.

- The potential for major transformation of the program

  - such as altering the vision of a future fusion reactor, or shortening the time scale for fusion’s realization.

Thrusts grouped by Themes:

1: Burning plasma in ITER
2: Creating predictable, high performance steady-state plasmas
3: Taming the plasma-material interface
4: Harnessing fusion power
5: Optimizing the magnetic configuration

- Themes provide organizing principle for Report, but
  - interaction between Themes is necessary and constant
- All Themes involve plasma physics, and all involve technology and engineering, but
  - 2 of the 5 explicitly emphasize engineering-technology issues: a new perspective for US fusion program

Theme 1: Burning plasmas in ITER

Thrust 1: Develop measurement techniques to understand and control burning plasmas.

Thrust 2: Control transient events in burning plasmas.

Thrust 3: Understand the role of alpha particles in burning plasmas.

Thrust 4: Qualify operational scenarios and the supporting physics basis for ITER.

Theme 2:
Creating predictable, high performance steady-state plasmas

Thrust 5: Expand the limits for controlling and sustaining fusion plasmas.

Thrust 6: Develop predictive models for fusion plasmas, supported by theory and challenged with experimental measurement.

Thrust 7: Exploit high temperature superconductors and other magnet innovations to advance fusion research.

Thrust 8: Understand the highly integrated dynamics of dominantly self-heated and self-sustained burning plasmas.

Theme 3:
Taming the plasma-material interface

Thrust 9: Unfold the physics of boundary layer plasmas.

Thrust 10: Decode and advance the science and technology of plasma-surface interactions.

Thrust 11: Improve power handling through engineering innovation.

Thrust 12: Demonstrate an integrated solution for plasma-material interfaces compatible with an optimized core.

Theme 4:
Harnessing fusion power

Thrust 13: Establish the science and technology for fusion power extraction and tritium sustainability.

Thrust 14: Develop the material science and technology needed to harness fusion power.

Thrust 15: Create integrated designs and models for attractive fusion power systems.

Theme 5:
Optimizing the magnetic configuration

Thrust 16: Develop the spherical torus to advance fusion nuclear science.

Thrust 17: Optimize steady-state, disruption-free toroidal confinement using 3-D magnetic shaping, and emphasizing quasi-symmetry principles.

Thrust 18: Achieve high-performance toroidal confinement using minimal externally applied magnetic field.

Summary

- ReNeW Report presents an exciting portfolio of challenges for the realization of fusion power
- Report structure reflects new perspective on fusion community planning
  - distinctive planning roles for research community and government planners
- Report content reflects changing perspective on magnetic fusion research
  - evolving balance between plasma physics and technology