ReNeW Progress and Future ARIES Involvement

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U.S. Fusion Energy Sciences: Strategic Planning for the ITER Era

- ITER is the vehicle for MFE burning plasma research.
  - Sets a planning time frame of ~20 years: the "ITER era".

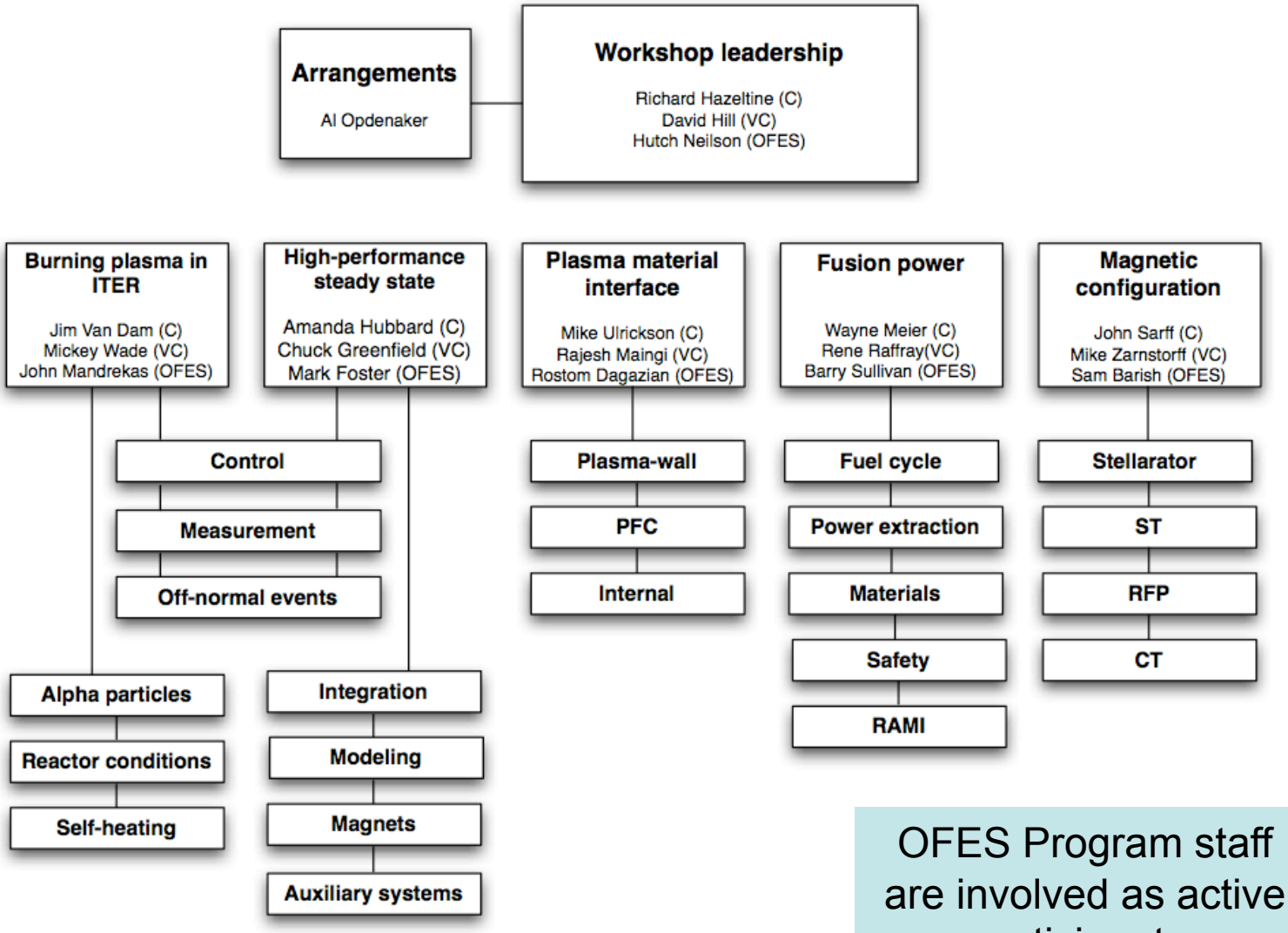
- MFES research needs are broader than ITER's scope.
  - FESAC documented the MFE issues and research gaps that ITER cannot resolve. [Greenwald Panel (2007), Toroidal Alternates Panel (2008)] Themes:
    2. Creating predictable, high performance steady state plasmas
    3. Taming the plasma-material interface
    4. Harnessing fusion power
    5. Optimizing the magnetic configuration
  - ITER's own issues and gaps comprise a 5th Theme, considered the FES program's highest priority:
    1. Achieving and Understanding the Burning Plasma State in ITER

What Research is Needed in the ITER Era?

ReNeW will provide broad-based input to DOE from the fusion science community.

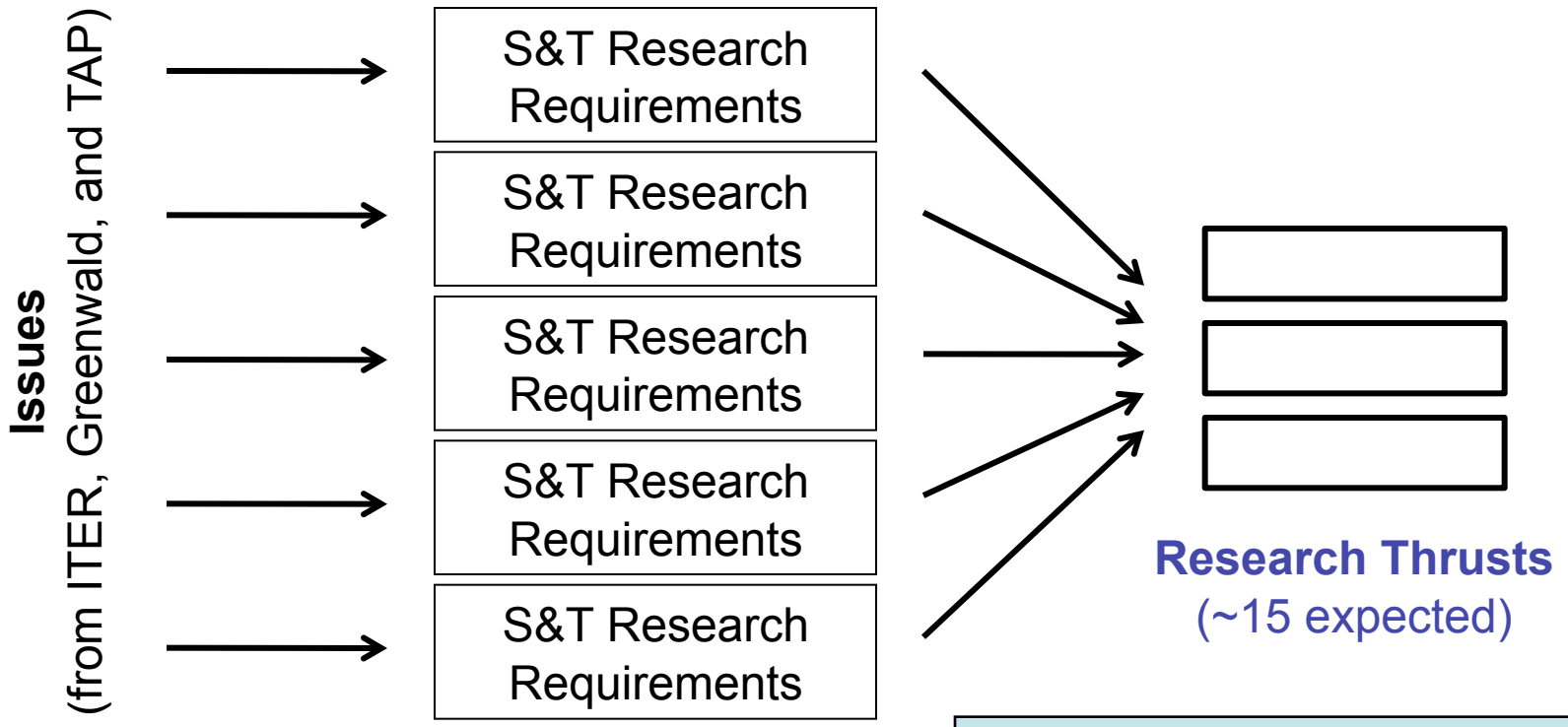
- Strategic planning is DOE's job, but the "Voice of the Community," expressed via ReNeW, can influence government planning and decision-making in a positive way.
- Community was asked to describe the research requirements, i.e. the S&T research required, to follow up on the ITER, Greenwald, and TAP issues.
- ReNeW is addressing the full set of MFE issues and will provide a menu of **Research Thrusts** as input to DOE's strategic planning.

ReNeW Organization Aligns with the Issues



OFES Program staff are involved as active participants.

Work Flow: Issues ➔ Requirements ➔ Thrusts



Research Thrust: "an organized, multi-faceted attack on some question, or coherent set of questions, essential to magnetic fusion energy science and technology, using a combination of new and existing program elements."

ReNeW Product: MFES Research Needs Report - 1

Theme Chapters (one for each theme)

- Re-cap what the Theme is about
- Research requirements, issue by issue (i.e., panel by panel)
  - What is the issue? (Re-cap of Greenwald, etc.)
  - What are compelling scientific questions that must be answered?
  - What skills, expertise, tools, conditions, etc. are needed to produce answers?
- What are the key research thrusts for this Theme?

  ➔ What needs to be done?

MFES Research Needs Report - 2

Thrust Chapters (one for each thrust)

- Scientific importance and opportunity
  - What scientific questions will be answered?
  - What opportunities (understanding, innovations, capabilities, partnerships) will be realized?
- Research content
  - Describe the work elements in detail; explain how elements inter-relate;
- Benefits for Magnetic Fusion Energy
  - How would this Thrust make progress toward fusion energy? How does it relate to other Thrusts? What are the scientific benefits to other fields/programs?

ReNeW is Making Good Progress

✔	**Jan/Feb**	Received >250 white papers from community.
✔	**March**	Held open workshops for each of the 5 Themes.
✔	**April**	Posted interim research thrust status report.
	April	Now drafting Theme chapters.
	May	**ExCom meeting, May 5-7**
		Goals: mature Theme chapters; draft Thrusts.
	May	Refine Thrusts. Draft Thrust chapters.
	June	**ReNeW Meeting June 8-12**.
	June-July	Wordsmith and submit report.

Goal for June ReNeW and Final Report:

- Thrust chapters describe scientifically compelling thrusts.
- Thrusts address issue-driven research needs.
- Research needs are clearly spelled out in the Theme chapters.

ReNeW Workshop Agenda, June 8-12

Preliminary

	Monday, Jun 8	Tuesday, Jun 9	Wednesday, Jun 10	Thursday, Jun 11	Friday, Jun 12
8:30 AM	Plenary (P): RDH welcome and logistics	B: ExCom meets; work on chapter drafts continues	B: ExCom meets; teams continue work on thrusts	P: continue thrust summaries	P: wrap-up
9:00 AM	P: Perspectives from OFES and others				
9:30 AM					
10:00 AM	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
10:30 AM	P: Perspectives continued	Break	B: Thrust teams meet (with communication between teams)	P: continue thrust summaries	Excom wrap-up
11:00 AM	P: Theme 1 Chapter summary and discussion	P: Begin presentations of draft thrusts; ~45minutes per Theme			
11:30 AM					
12:00 PM	Break	Break	Break	Break	Adjourn
12:30 PM	Break	Break	Break	Break	
1:00 PM	P: Theme 2 Chapter summary and discussion	P: Continue thrust presentations	P: finish thrust integration---thrust content finalized	P: continue discussion of inter-connections, over-all plan	
1:30 PM					
2:00 PM	P: Theme 3 Chapter summary and discussion		P: initial discussion of connections between thrusts, research plan		
2:30 PM					
3:00 PM	P: Theme 4 Chapter summary and discussion		P: begin thrust summaries	B: thrust teams refine thrust descriptions	
3:30 PM					
4:00 PM	P: Theme 5 Chapter summary and discussion	P: Discussion of thrust integration; thrust teams formed			
4:30 PM					
5:00 PM	Breakout (B): Themes work on Chapter drafts	P: Discussion of thrust style and format			
5:30 PM	Reception		Dinner		

- Working meeting for ReNeW members. Plenary (P) & breakout (B) sessions.
- Content: Report-writing and discussion.

ARIES Involvement in ReNeW

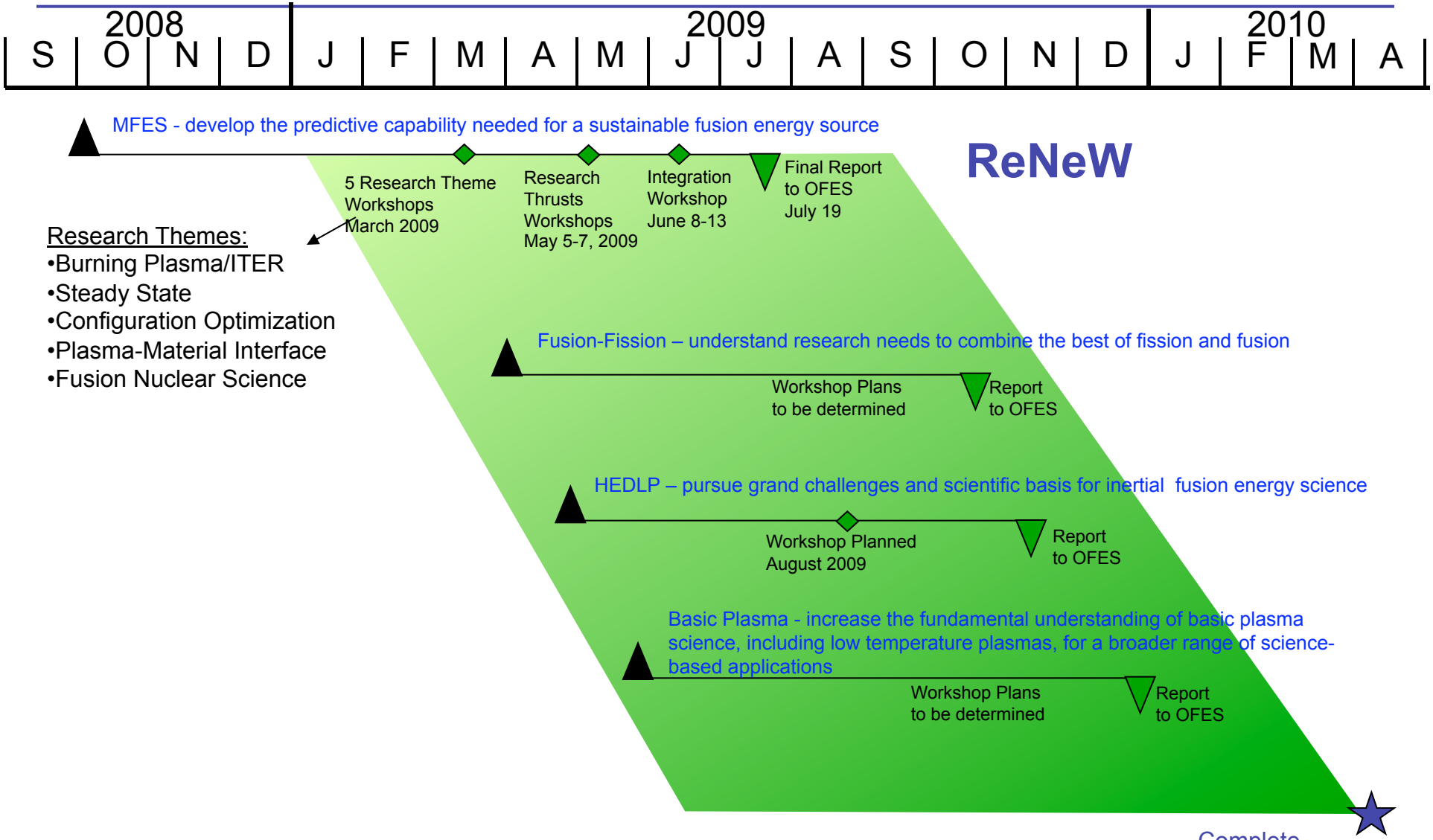
- Many ARIES team members have been actively involved in ReNeW: as Theme leaders, panel members, contributors.
  - **Success of ReNeW depends on support and involvement of wider MFES community.**
- ARIES work has informed the discussions:
  - Reactor studies, e.g. ARIES-AT, -CS, etc., help to clarify research requirements.
  - Technical readiness levels used by many groups to quantify status and gaps.

ReNeW team will continue to need support of the wider community.

Remaining tasks:

- Document research requirements (emphasize the important science)
- Tighten up the Thrusts
  - Combine and consolidate where it makes sense.
  - Identify the motivating scientific questions being addressed.
  - Ensure quality control (challenge ourselves with tough questions; convince a skeptical readership)
  - Identify clear logical linkages and sequencing among Thrust elements.
- Document the Thrusts.
- Produce a report that the community can support.

Fusion Energy Sciences Research Needs Workshops and Strategic Planning Process



FES Strategic Planning After ReNeW

Personal Views

What support can the research community offer?

- Continue to support the community research needs planning process in FY-10 (previous slide).
- Support strategic decision-making by analyzing options.
  - For example, scoping of missions and design requirements for potential new facilities. Quantify capabilities, costs, and risks.
  - Roadmapping of possible futures under different assumptions.
- Support risk management decision-making.
  - Identify and evaluate risks along the path to fusion energy ("what could go wrong?")
  - Identify risk mitigation research activities ➔ develop the scientific basis for solutions that might be needed.

A Risk Register for Magnetic Fusion - 1

Risks "What could go wrong?"	**Potential Mitigation Plans** Perform research to understand the science needed to develop:
Disruptions may compromise the integrity of large fusion devices, prevent long-duration plasmas, or limit operation to low performance regimes.	Disruption avoidance solutions. Examples: Active control strategies based on PAM (Predict-Avoid-Mitigate), including diagnostics and analysis tools to predict disruptions and actuators to avoid disruptions; passive stability through the use of non-axisymmetric shaping as in 3D tokamak perturbations or stellarators.
A burning plasma may be uncontrollable, since the input power must be small compared to output.	Low-power plasma control tools. Examples: non-axisymmetric magnetic fields either as low-level tokamak modifications or stellarators, neutral beams or RF waves, or modifications to the plasma-wall interface.
Diagnostics critical for control of a burning plasma may not work or survive in a fusion environment.	Control strategies, including needed diagnostics, compatible with plasma control requirements and the fusion environment.

A Risk Register for Magnetic Fusion - 2

Risks "What could go wrong?"	**Potential Mitigation Plans** Perform research to understand the science needed to develop:
Availability may be too low due to the complexity of the confinement system.	Components and systems with improved maintenance characteristics. Examples: Demountable coils based on high-temperature superconductors; simpler magnetic configurations such as CTs or mirrors; aneutronic advanced-fuel fusion systems.
The lifetimes of first wall and divertor materials facing a burning plasma may be too short.	Plasma-facing materials compatible with a steady-state burning plasma. Example: liquids such as lithium. Integrated scientific basis for core plasma, edge plasma, and materials science.
Divertor and first wall peak heat fluxes may be too high.	Solutions which distribute the first wall heat loads and reduce peaking factors: Examples: enhanced flux expansion as in snowflake divertors; expanded target area as in Super-X divertors; radiative edge; ergodic edge or island divertors as in stellarators.

Summary

- ReNeW provides an opportunity for community input to fusion strategic planning for the ITER era.
- Arrival of a new administration with strong scientists in decision-making roles is a unique favorable situation.
- ReNeW is on track to produce a good report on compelling MFES research needs for the ITER era.
  - Important that we follow through on the remaining work.
- Although post-ReNeW strategic planning process has not yet been defined in detail, help from the community will surely be needed.