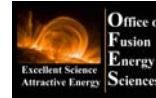


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# ReNeW Theme 5 ST Panel - Status

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ReNeW Theme 5: Optimizing the Magnetic Configuration Workshop

March 16<sup>th</sup> – 19<sup>th</sup>, 2009

Princeton Plasma Physics Laboratory

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# ST Panel / Community: providing guidance for an innovative applied research program supporting a reduced cost, rapid-build fusion device design

- **ST Panel Tasks / Goals**

- Produce report defining how the fusion “research needs” defined by Greenwald and FESAC TAP reports should be met
- Consolidate research plan guidance to fill the needs into “research thrusts” that synergistically combine with other ReNeW Themes

- **Outline**

- ST Panel tasks (and progress) leading up to March meetings
- ST Panel input/output conduits and discussion
- Knowledge gaps/research needs development
- ST Panel goals for the present meeting / procedure to meet them

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# ST Panel has completed ExCom requested tasks leading to this workshop

- Executive Committee Requested Tasks through March 16-19 Workshop
  - Solicit community input:
    - mass email sent (1/28/09)
  - Review issues as described in FESAC Toroidal Alternates Panel (TAP) report:
    - embodied in community distributed draft document of ST section V1.7 (1/28/09)
  - Identify scientific research needed to address the issues
    - Review and expand on research outlined in the FESAC TAP panel report
    - Draft write-up of research requirements, make available to community
    - Fold in community input on research requirements
    - embodied in community distributed draft of ST section V2.2 (3/10/09)
  - Develop draft “research thrusts” for discussion at March workshop
    - Completed – will be used as a starting point for this workshop

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# ST Panel I/O provided by several conduits

- ST Group: Direct input to/discussion of evolving draft ST section of document
  - Drafts posted: <https://burningplasma.org/forum/index.php?showtopic=653>
- ReNeW Forum (web bulletin board – largely unused so far)
  - Contribute to open discussions; start your own discussions
  - Registration instructions: <http://burningplasma.org/forum/>
    - Request authorization to ReNeW Forum: e.g. email: [sabbagh@pppl.gov](mailto:sabbagh@pppl.gov)
  - ST topic: <https://burningplasma.org/forum/index.php?showforum=114>
- White papers submitted describing community's ideas on how to resolve key issues, support/define research thrusts
  - Available at: [http://burningplasma.org/web/renew\\_whitepapers.html](http://burningplasma.org/web/renew_whitepapers.html)
- Input from March 2009 Workshops
- Direct contact to panel members
  - ST Group: 10 Panel members (see next page)

# ReNeW Spherical Torus Panel Members

Member	Institution	telephone	email
Steve Sabbagh	Columbia U.	(609) 243-2645	sabbagh@pppl.gov
Aaron Sontag	ORNL	(865) 574-1179	sontagac@ornl.gov
Vlad Soukhanovskii	LLNL	(609) 243-2064	vlad@llnl.gov
M. Kotschenreuther	U. Texas	(512) 471-4367	mtk@mail.utexas.edu
Dan Stutman	Johns Hopkins U.	(410) 516-7929	stutman@pha.jhu.edu
Dick Majeski	PPPL	(609) 243-3112	dmajeski@pppl.gov
Jon Menard	PPPL	(609) 243-2037	jmenard@pppl.gov
Nikolai Gorelenkov	PPPL	(609) 243-2552	ngorelen@pppl.gov
Chris Hegna	U. Wisconsin	(608) 263-0810	heгна@engr.wisc.edu
Martin Peng	ORNL	(865) 368-0917	pengym@ornl.gov

- Contact any panel member for authorization to access the ReNeW Forum (website bulletin board)
- Full advisor list (more than 30 advisors) posted at: <https://burningplasma.org/forum/index.php?showtopic=636>

# ST Panel report modifies FESAC TAP to better support ST ITER-era goal, and fusion more generally

- FESAC TAP Report ITER-era Goal: *Establish the ST knowledge base to be ready to construct a low aspect ratio component testing facility that provides high heat flux, neutron flux, and duty factor needed to inform the design of a demonstration fusion power plant.*
- TAP report understates research needs to inform/support ST-CTF, DEMO in certain areas
- ST Panel draft report modifications target ITER-era research to increase the probability of mission success
  - ❑ ST-CTF envisioned as an ST application, not a flexible research device
  - ❑ ITER-era research needs to examine plasma creation, sustainment, power handling, transport, profiles, control, stabilization with greater flexibility
  - ❑ Retain goal of higher beta operation to maximize neutron production efficiency
  - ❑ Greater support of continuous operation of DEMO-level plasmas
- ST Panel additionally discussing a modification of the ITER-era goal: *“Aggressively pursue improvements in the ST concept which advance an ST-based DEMO”*

# Proposed ST research vision now more consistent with ST ITER-era Goal

## Scientific Research during ITER era informing DEMO

### Research

#### Tier 1

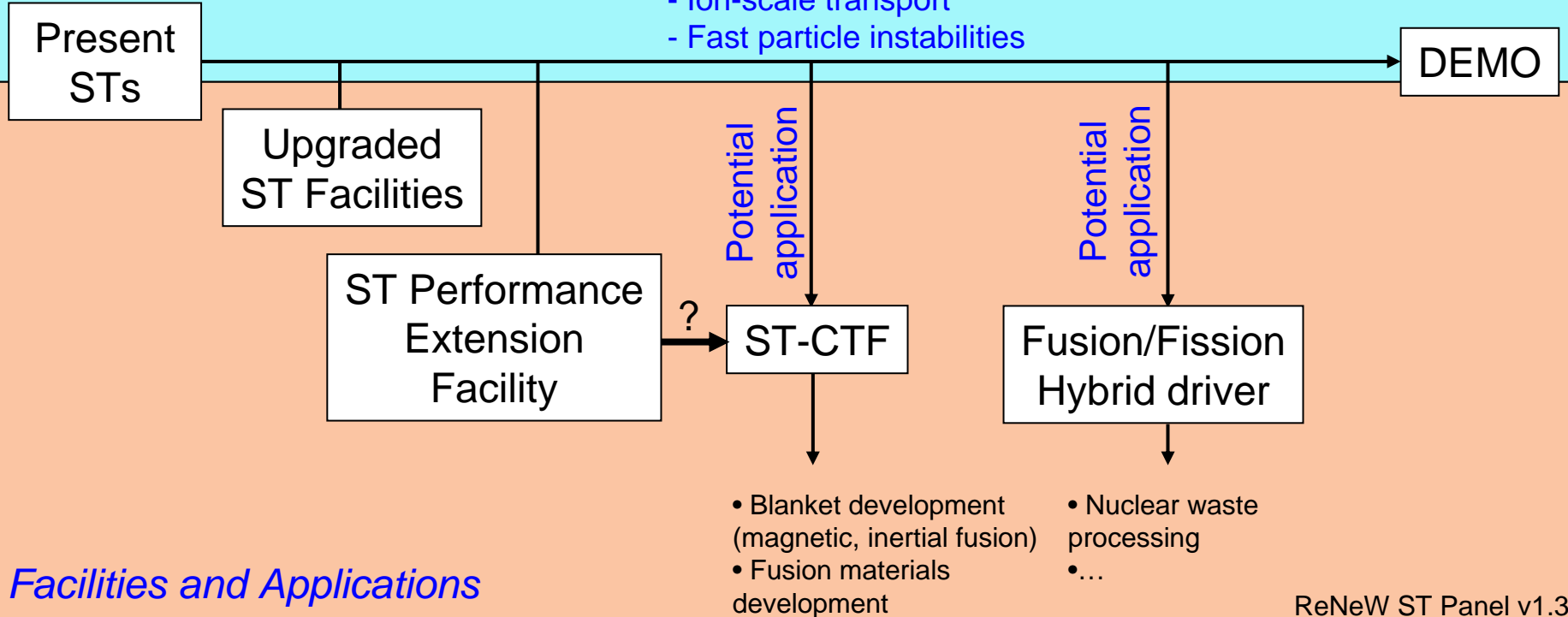
- Start-up and Ramp-up
- Plasma-material interface
- Electron energy transport
- Magnets

#### Tier 2

- Stability & Steady-State Control
- Integration
- Disruptions
- Heating & current drive
- Ion-scale transport
- Fast particle instabilities

#### Tier 3

- NTMs
- Continuous NBI systems



### *Facilities and Applications*

ReNeW ST Panel v1.3

# ST Panel Research Needs cross-cut well to ReNeW

## ST Panel Research Need ↔ ReNeW Cross-cutting Theme

- ❑ Plasma start up/ramp-up
  - ❑ Plasma-material interface
  - ❑ Electron energy transport
  - ❑ Magnets
  - ❑ Stability / Steady-State Control
  
  - ❑ Integration
  - ❑ Disruptions
  
  - ❑ RF Heating and Current Drive
  
  - ❑ Ion scale transport
  - ❑ Fast Particle Instabilities
  - ❑ NTMs
  
  - ❑ Continuous NBI systems
- ❑ Theme 2 HPSS: Auxiliary systems
  - ❑ Theme 3 Plasma-material interface
  - ❑ Theme 2 HPSS: Validated Modeling
  - ❑ Theme 2,3 HPSS: Magnets
  - ❑ Theme 1,2,3 BP/HPSS/PMI: Off-normal events; Control; Int. Comp.
  - ❑ Theme 2: HPSS Integration
  - ❑ Theme 1,2 - BP/HPSS: Off-normal events
  - ❑ Theme 2,3 HPSS/PMI: Auxiliary systems; Internal Components
  - ❑ Theme 1 BP: Confinement
  - ❑ Theme 2 BP: Off-normal events
  - ❑ Theme 1,2 BP/HPSS: Off-normal events; Control
  - ❑ Theme 2 HPSS: Auxiliary systems
- Also, connection between ST-CTF and Theme 4 materials issues
  - Work continues on prioritization, consolidation, etc. during this workshop

# Goals and tasks for ST Group at this meeting

## ● Goals

- Further develop knowledge gaps/research needs (from ST chapter)
- Compile research needs into “research thrusts”

## ● Procedure to meet goals

- Gather/use input from established communication lines, etc.
  - draft ST document, public input, etc.
  - other ReNeW Themes (Theme 1 - 4 web sites, status talks on Monday)
  - info from international program (talks Monday + Tuesday)
  - public input from white papers (Tues. afternoon, Wed. morning)
- Process input to meet goals
  - **ST Panel breakout session Wed. afternoon 1:00 – 5:30 PM**
    - See details on following slide
  - Theme 5 cross-configuration task force discussions
    - To find research Theme 5 thrust synergies; several times during this meeting

# ST White Papers / Schedule for Parallel Session

- **Cross-configuration/ST** Tuesday, March 17<sup>th</sup> (session 1:10 PM – 4:50 PM)
  - ❑ The Need for a Fusion Science Integration Experiment in the US (R.J. Buttery)
  - ❑ Severe divertor issues on next step devices, and validating the Super-X divertor as a promising solution (M. Kotschenreuther)
  - ❑ LiWall ST1, EAST1, ITER-100 - all exceeding ignition criterion (L. Zakharov)
  - ❑ Potential impact of low recycling equilibria and lithium walls on reactor design (R. Majeski)
- **ST parallel session** Wednesday, March 18<sup>th</sup> (12 min + 3 min discussion)
  - 9:00 AM ❑ Fusion Nuclear Science Research Thrust and the Required Full Fusion Nuclear Environment (M. Peng)
  - 9:15 AM ❑ Contributions of NHTX to the ST Development Path (J. Menard for R. Goldston)
  - 9:30 AM ❑ Research Thrust to Establish Predictive Simulation Capability for Fusion Nuclear Science (S. Diem)
  - 9:45 AM ❑ Limiting the Divertor Heat Flux to Enable Fusion Nuclear Science Research at Low-A (J. Canik)
  - 10:00 AM ❑ Research Thrust on Plasma Startup & Ramp-up to Enable Fusion Nuclear Science Research at Low-A (A. Sontag)
  - 10:15 AM ❑ Solenoidless Startup Research Thrusts for Tokamaks (J. Leuer)
  - 10:30 AM ❑ Understanding and Predicting Microtearing Instabilities in the ST (K. Tritz)
  - 10:45 AM ❑ Research Thrust on Plasma Startup & Ramp-up (R. Raman)
  - 11:00 AM ❑ Research Thrust on Advanced Plasma Fuelling (R. Raman)
  - 11:15 AM ❑ Benefits of moderate 3D fields in Tokamaks - NHTX as an example (N. Pomphrey)
- **Submitted (no presentation)**
  - ❑ Neutral Beam Development Plans and Needs for ITER (L. Grisham)

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# ST Panel breakout session (Wed 1-5:30 PM) - Agenda

- Brief summaries of present 12 Research Needs areas (from draft document ST section)
- Discussion of “Research Needs”
  - Completeness: (have we left anything out?)
  - Priority: (is present “tier” ranking adequate?)
  - Consolidation: (should we merge / split areas?)
  - Synergy: (explicit connections to other ReNeW panels?)
- Creation of Research Thrusts
  - Initial Research Thrust formation by ST Panel
  - Open discussion of Research Thrusts
    - Completeness, priority, consolidation, synergy
    - Size of U.S. effort, research device capabilities needed, coupling to international community
- Open discussion as desired

# (TEMPLATE) 1 Page Research Thrust slide – ST Panel

- e.g. “Creating/Understanding Continuous High Beta ST plasma”
  - (sub-thrust 1: note – sub-thrusts should comprise all ST panel gaps)
  - (sub-thrust 2: e.g. “plasma current initiation and sustainment”)
  - (sub-thrust 3)
- (Research Thrust 2)
  - NOTE: Thrusts should be defined by science, rather than facilities
  - NOTE: We can discuss/debate format, number/scope of thrusts, etc. as we like
- (Research Thrust 3)...

Effort Level Guidance (color-coded): Small: (black) Moderate: (purple) Large: (red)