US Program Overview

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6th IEA & JUPITER Joint Workshop on
Vanadium Alloys for Fusion Applications
June 21-22, 2002
Tucson, AZ

U.S. Department of Energy
Pacific Northwest National Laboratory

Outline

- US Fusion Program
- US Fusion Materials Program Budget, Review, and Recent Initiatives
- Japan-US Collaborations on Fusion Materials
- Restructured US Fusion Materials Program Approach, Organization, and Structure

US Fusion Program

- Annual budget has stabilized at about $250M
- Expect 5% budget increase in 2003
- TFTR decommissioning is near completion; $20M/year used for TFTR will be applied next year to increase operating time of US plasma experiments (D-IIID, NSTX, C-MOD)
- Will begin fabricating of National Compact Stellarator Experiment (NCSX) in 2003
- July 2002 Snowmass Fusion Summer Study on US options/strategy for a burning plasma experiment
- US still evaluating position on joining negotiations for ITER construction

US Fusion Materials Program

- Funding for structural materials stable at $7M/year
- Major program review completed
  - Reviewed by panel of experts in August 2001
  - Report on panel findings can be viewed at http://vlt.ucsd.edu/peer.html
  - Community developed action plan in response to findings (available at above web site)
- Continuing restructuring from R&D orientation to materials science orientation
  - Some activities reduced (e.g., development-related aspects of vanadium alloy work)
  - Some activities enhanced (e.g., modeling activities and university role in program)

US Fusion Materials Program

Initiatives in 2002

- Established Materials Engineer role to bridge between materials and design/technology communities

- Planning for innovative fusion materials research (community workshop planned for August)

Japan-US Collaborations
MEXT-DOE (JUPITER-II)

- Entering second year of 6-year collaboration

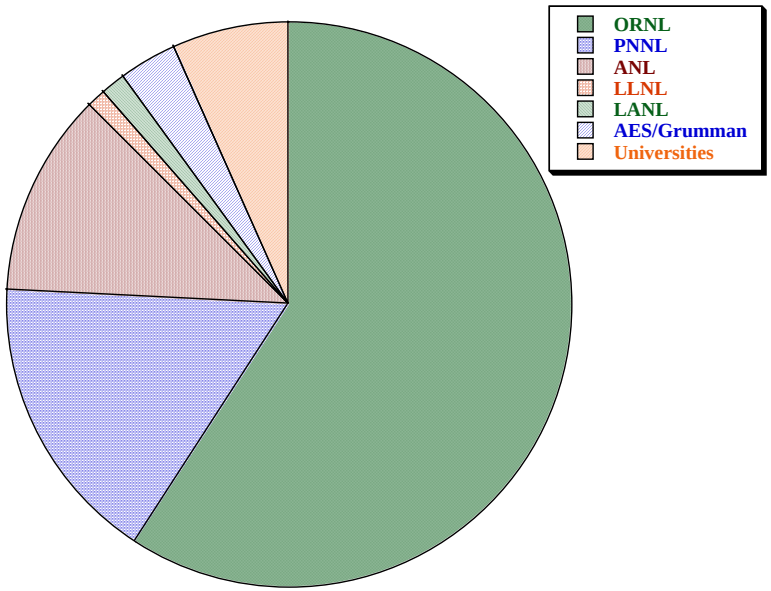
- Collaboration has many unique features
  - Many elements (10 technical tasks)
  - Multiple experimental facilities (ORNL, PNNL, INEEL, UCLA)
  - Broad technical scope (multiple issues of 3 blanket concepts)
  - Numerous exchanges (6 workshops and 27 personnel exchanges in FuY 01)
  - Small budget for all of the above ($1.25M/year from each side)

- Very important to US research on V alloys

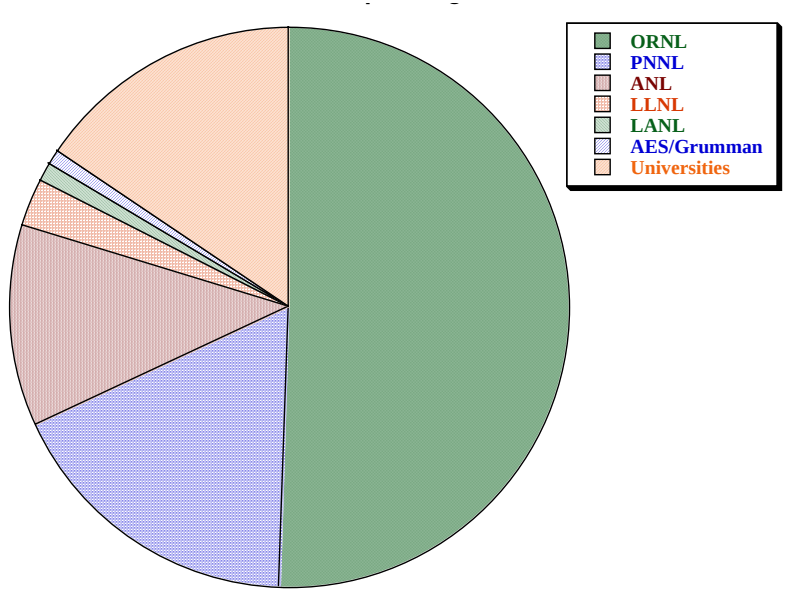
Japan-US Collaborations
JAERI-DOE

- In third year of 4-year Phase IV program
- Increasing participation by US and Japanese universities
- Important to US research on reduced activation F/M steels
- At SC meeting in March, agreed on Phase IV experiment plan and on PIE plans and schedules

Fusion Materials Sciences Institutional Budgets



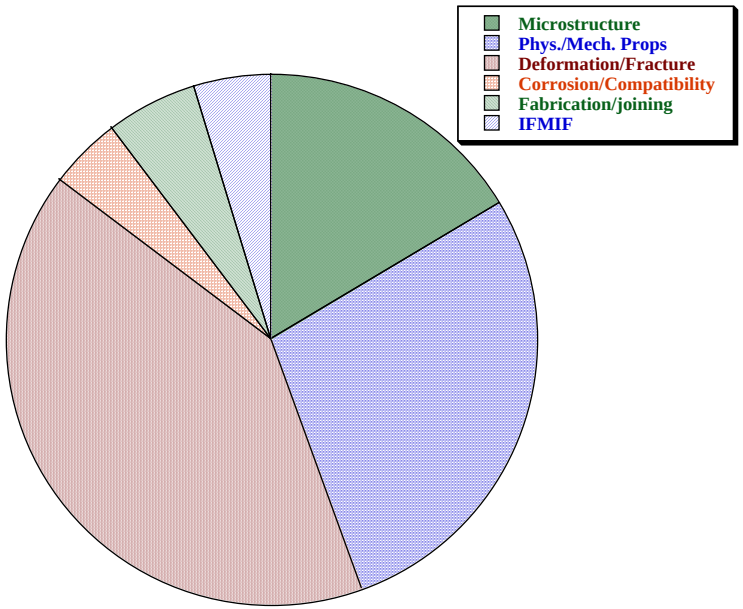
Total FY98



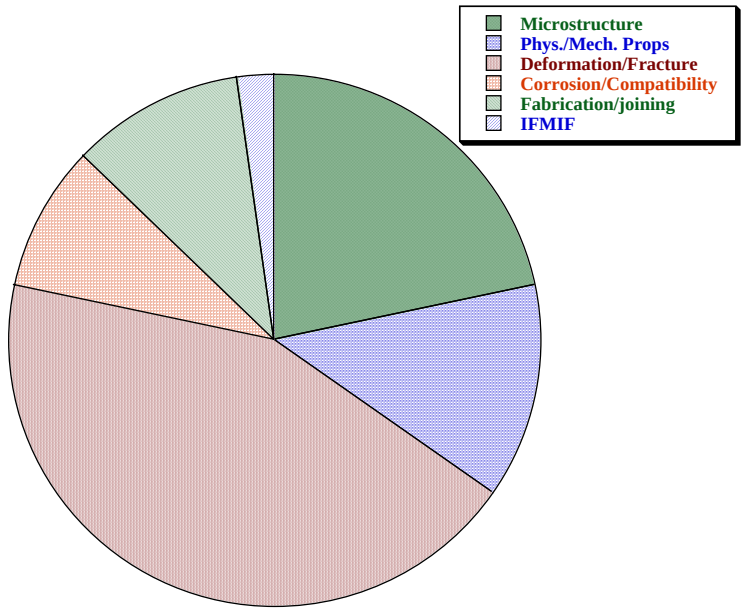
Total FY01

- University funding has tripled in the past 3 years
- Significant personnel changes have occurred at institutions

Fusion Materials Sciences R&D Portfolio



FY98 funding



FY01 funding

Continued emphasis on mechanical properties

Materials Science Restructuring Themes

	Pre-Restructuring	Restructured
Orientation	Fusion Materials ***Development***	Fusion Materials ***Science***
Mission	Schedule-driven development of materials for fusion power (ITER blanket test modules, DEMO, É)	Fundamental understanding of scientific underpinnings of materials for fusion
Organization	Lead lab for each candidate structural materials class (V alloy, F/M, SiC/ SiC)	Integrated national teams focused on key cross-cutting issues
Approach	Experiments for semi-empirical correlations	Experiments to guide/ validate theory and modeling

Fusion Materials Science Mission Statement

- Advance the materials science base for the development of innovative materials and fabrication methods that will establish the technological viability of fusion energy and enable improved performance, enhanced safety, and reduced overall fusion system costs so as to permit fusion to reach its full potential
- Assess facility needs for this development, including opportunities for international collaboration
- Support materials research needs for existing and near-term devices

Example of Change in Approach to Materials Research - Vanadium Alloys

Old Approach (*Development*)	New Approach (*Science*)
• Select reference alloy (V-4Cr-4Ti)	
• Focus most research on this alloy (narrow scope)	• Focus research on fundamental understanding of BCC materials
• R&D planning based on need to develop materials to meet device construction schedule	• Research planning based on theory and modeling requirements of BCC materials
• Experiment-based R&D to build engineering data base	• Experiments used to guide and validate scientific theory and models
	• Study model BCC alloys/ surrogate materials encompassing V alloys

Features of Restructured Fusion Materials Science Program

- Science-based materials research
- Principal product is *basic knowledge, theory, and models* needed to resolve feasibility issues of fusion materials
- Primary role of experiments is to guide and validate theory and models
- Utilize, leverage, and expand on revolutionary advances in computational and experimental methods (e.g.,nanoscience) for fusion materials design
- While focusing on long-term viability and attractiveness issues of fusion materials, apply expertise in near-term to current issues of plasma research and IFE studies

Structure of the Fusion Materials Science Program

Fusion Materials Science Program

	Theory-Experiment Coordinating Group*				
	Microstructural Stability	**Physical & Mechanical Properties**	**Fracture & Deformation Mechanisms**	**Corrosion and Compatibility Phenomena**	**Fabrication and Joining Science**
Materials for Attractive Fusion Energy					
• **Structural Alloys*** - Vanadium Alloys - F/M and ODS Steels - High T Refractory Alloys - Exploratory Alloys					
• **Ceramic Composites*** - SiC/SiC, other CFCs					
• **Coatings**					
• **Breeder/multiplier Materials**					
• **Neutron Source Facilities**					
Materials for Near-Term Fusion Experiments					
• **PFMs (Refractory Alloys, etc.)**					
• **Copper Alloys**					
• **Ceramic Insulators**					
• **Optical Materials**					

*asterisk denotes Fusion Materials Task Group

Interactions With the International Fusion Materials Community

Science issue	Activity	US	Japan	EU	Russia	China
Deformation & fracture	V alloys	IEA working gp.			IEA working gp.	
		DOE/Monbusho				
Deformation & fracture, Nanoscience (ODS)	Ferritic steel	IEA working group				
		DOE/JAERI				
Deformation mechanisms, enhanced thermal cond.	SiC/SiC	IEA working group				
		DOE/Monbusho				
		DOE/JAERI				
Cross-cutting theory & modeling phenomena	Theory & modeling	IEA working group				
Electric, dielectric props.	Ceramic insulators	IEA working group				
		DOE/Monbusho				
Accelerator physics, liquid jet thermohydraulics, He gas cooling technology	Neutron source (IFMIF)	IEA working group				