



U.S. Department of Energy's
Office of Science

**Fusion Energy Sciences
Program Update**

**Fusion Energy Sciences Advisory Committee
Gaithersburg, MD
July 16-17, 2007**

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FESAC 071607-rjf 1





Program Activities Since Last FESAC Meeting

- Budget Developments
- Grants and Solicitations
- ITER
- NCSX
- Planning Process
- Programmatic Workshops
- National Academy of Sciences Reviews and Reports
- OFES and Office of Science Personnel Notes



Some Program Highlights

- Exciting scientific results across the program
 - Simulation of sawteeth and comparison with experiments
 - Multi-scale nonlinear turbulence coupling and shear flow regulation of confinement properties
 - Quantitative Models of Wave- Particle interactions
 - Spontaneous plasma rotation and rotation effects on plasma stabilization
 - Magnetic chaos suppression of edge modes
 - Shock heating of a pre-compressed Inertial Fusion target demonstrated
- Supporting basic plasma science, concept understanding, ITER, and burning plasmas
- Progress in ITER Physics Basis – a special issue of Nuclear Fusion



FY 2008 Fusion Energy Sciences Congressional Budget Request

(\$ Millions)

	FY 2006 <u>Actual</u>	FY 2007 <u>July AFP</u>	FY 2008 <u>CONG</u>
Science	148.7	145.2	159.6
Facility Operations	104.2	122.9	237.0
Enabling R&D	<u>27.8</u>	<u>43.6</u>	<u>31.3</u>
OFES Total	280.7	311.7	427.9
DIII-D	55.1	56.7	59.7
C-Mod	21.5	22.3	23.5
NSTX	34.2	33.8	36.1
NCSX	17.8	16.6	16.6
ITER	24.6	60.0	160.0
Non-ITER	256.1	251.7	267.9



House Actions

- House Subcommittee has marked up a FY 2008 Appropriations Bill
- The Bill provides for the full amount requested, \$427.9 million
- The Subcommittee in its report
 - directs that the \$12.3 million requested for HEDLP be used to increase funding for the following
 - \$7.5 million for DIII-D, C-Mod and NSTX operations
 - \$1.5 million for the theory program
 - \$1.5 million for materials research
 - \$1.8 million for Experimental Plasma Research on alternative concepts
 - directs that, if there are delays in ITER, the funding made available be invested in the four areas above rather than retained for future ITER needs
- The Committee notes growth in ITER is affecting overall funding in Fusion and Science. Without ITER, Fusion is up only 3.8% while Science is up 13.4% instead of 15.8%
- Full committee action expected July 12 did not happen



Senate Actions

- Senate committee has marked up a FY 2008 Appropriations Bill
- The Bill provides for the full amount requested, \$427.9 million
- The Committee, in its report, indicates its pleasure that the Department has developed a multidisciplinary HEDLP research program and supports the \$12.3 million requested to support this program. It notes that a similar amount has been included in the NNSA program.
- Full Senate action is not expected before the last week in July.



Grants and Solicitations

- Theory: Solicitation Jan 07
 - <http://www.sc.doe.gov/grants/FAPN07-07.html>
 - The peer-review is ongoing; funding decisions expected ~ mid-Sept. 07
- SciDAC: Four solicitations Mar 07
 - <http://www.sc.doe.gov/grants/FAPN07-19.html> (RF)
 - <http://www.sc.doe.gov/grants/FAPN07-20.html> (MHD)
 - <http://www.sc.doe.gov/grants/FAPN07-21.html> (Turbulence)
 - <http://www.sc.doe.gov/grants/FAPN07-22.html> (Energ. Part.)
 - The peer-review is ongoing; funding decisions expected ~ mid-Sept. 07
- Diagnostics Development Program: Solicitation Feb 07
 - <http://www.sc.doe.gov/grants/FAPN07-10.html>
 - Currently identifying reviewers – proceeding very slowly
 - Anticipate funding decisions this Fall
- Plasma Physics Junior Faculty Award Program
 - Notice for FY2008 funding cycle has been published



US ITER Project Status

- Project office nearly fully staffed (~ 70)
- Management team's is focusing on Critical Decision (CD) timeline for US share of ITER project:
 - CD-1 (Approve alternative selection and cost range) FY 2007
 - CD-2 (Approve performance baseline) FY 2008
 - CD-3 (Approve start of construction) FY 2009)
 - CD-4 (Approve start of operations or end of project) FY 2014
- R&D studies with vendors (manufacturability, etc.) are being pursued
- Preparations for the start of procurements are underway
- Details will be presented by Jeff Hoy tomorrow AM



ITER Design Review Activities

- Intense effort during the past 6 months aimed at the development of the ITER cost and schedule baseline by end of FY 2007
- Working Groups are conducting design reviews on
 - Design Requirements and Physics Objectives (DRPO)
 - Safety
 - Buildings
 - Magnets
 - Vacuum Vessel
 - Heating and Current Drive
 - Tritium
 - Plasma Facing Components
- US Burning Plasma Organization is coordinating U.S. contributions to DRPO Working Group
- Jim Van Dam report on USBPO ITER activities tomorrow AM



July 2007 ITER Council Meeting

- July 2007 Interim ITER Council Meeting held in Tokyo
- Key topics included:
 - Ratification (expected late this summer)
 - EU, JA, KO, IN, US completed
 - CH, RU expected soon
 - Status of Domestic Agencies
 - IO Staffing Plans for 2007-08 and Recruitment
 - Project Resource Estimates and Budget for 2007-08
 - Guidelines for the Management of In-Kind Equipment
 - Management Advisory Committee and Science & Technology Advisory Committee
 - Test Blanket Module Program



NCSX Issue

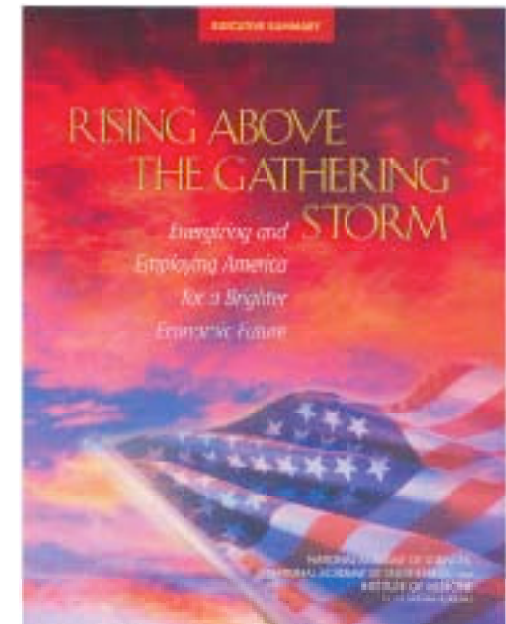
- Project baseline is TEC of \$92.4 M, completion in July 2009
- PPPL reports that the NCSX Team cannot complete the project within this baseline
- Steps are being taken to address the issue
 - August 15-16 Office of Science Lehman review will evaluate the remaining cost, scope and schedule for new proposed baseline
 - Expect to conduct focused science/programmatic review of the compact stellarator program after Lehman review
- OFES will keep FESAC and other stakeholders informed as our understanding develops



Need to Compete in an ACI World...

- Program activities need to evolve to compete in this new era
 - Participation in ITER = new scale for fusion science
 - Fusion plasma environment and corresponding new physics regime
 - Collaborative world-wide program
 - Likewise, NIF will drive HEDP/IFE discussions
 - Requires a world-leading domestic fusion science program
 - While promoting Plasma Science and HEDLP
- Significant challenges need to be addressed
 - Workforce issues over decades
 - Aging facilities in MFE; NNSA facilities in HEDLP
 - “Grid-locked” funding profile
 - Continuing community development towards science focus

Fusion = part of
SC’s part of the
American
Competitiveness
Initiative





Moving to a New Strategic Plan for FES to Address Challenges

- Resources needed to reinforce activities and initiate new directions
 - Bring present activities to healthier states
 - FSP TBM near-term + supporting engineering science
 - HEDLP Workforce opportunities
 - ITER research program, with upgrades (e.g., TBM, diagnostics, heating, etc.)
 - Evolution of domestic activities for world-class science in ITER era
 - Design support for potential initiatives and resultant facility needs
 - 20 year SC Facility Plan, FESAC Plan, OFES Strategic Plan Emerging discussions...
 - Need to start addressing these within our present resource levels
- Multi-tiered approach under consideration
 - Internal OFES planning with SC and OMB
 - Identify challenges (e.g., present “Opportunities” subpanel for large tokamak studies)
 - Will need similar studies for other elements of program
 - Use focused workshops to develop approaches to addressing issues
 - Will work with community to refine process - next FESAC meeting for more...



Workshops have been held to help guide program planning

- U.S. participation in proposed ITER Program on TBM
 - ORNL: May 29-30
- Common Issues in IFE and HEDLP...
 - San Ramon, CA: April 24-27
- Planning of Joint Program with NNSA on HEDLP
 - Argonne National Laboratory: May 22-24
- Fusion Simulation Project planning
 - Rockville: May 16-18



TBM Workshop

- Purpose: Determine the merits of using ITER as a test bed for the blanket program
- Findings: There could be potential scientific benefits to the fusion nuclear technology program from participation; however; the U.S. is not yet technically ready to embark on a TBM program
- Recommendations:
 - Maintain option to participate; but “ A strong well-funded scientifically based FNT program is necessary if the US is serious about resolving the scientific feasibility issues leading to fusion as an energy source.”
 - Fusion technology program must be strengthened if US participation is to be successful
 - “Because of low level of US readiness, ... US gets involved ... in a way that reduces the risk exposure to acceptable level but capitalizes in keys areas where US is or can be a world leader.”



TBM Developments at Interim ITER Council Meeting II (IIC-II)

- It is premature for the U.S. to implement a TBM program, and we have not agreed to do so.
 - U.S. has agreed to contribute 1/11th share of the civil construction costs for infrastructure upgrades needed to maintain the option to conduct a TBM program.
- Council Record of Decision: Noting that the testing of blanket modules is recognized as one of the operational requirements in the ITER EDA final report, the IIC:
 - Recognized the need to explore further the nature of the TBM programme and how it should be implemented. The legal framework, cost sharing, and programme schedule are among the critical issues to be agreed upon and decided by the Council;
 - Took note of the necessity to solicit additional funds from the Members according to the cost sharing formula for the construction phase in order to make near-term civil construction preparations for its implementation;
 - Requested the NDG to pursue the matter further through the TBM Ad Hoc Group (after adjusting the Terms of Reference and Membership) to prepare proposals on the following three issues by summer 2008 and report through MAC and STAC to the Council:
 - TBM selection and leadership and partnership principles;
 - Access principles to TBM background and Intellectual Property;
 - Overall resources needed to implement the TBM Programme and the mode of sharing.



Workshops Addressed HEDLP/IFE

- **IFE Workshop at San Ramon, CA**
 - With the expected ignition in NIF, DOE should plan for a transition from a laboratory ignition feasibility experiment to a program that addresses the science required for inertial fusion energy applications
 - Needs more development to identify a path to stewarding energy-related HEDLP/IFE studies
- **HEDLP Workshop at ANL**
 - Compelling scientific opportunities of high intellectual value exist across the field of HEDLP
 - A well-organized DOE program would produce significant and exciting advances of this emerging field of science
 - Three principal scientific themes emerged from the workshop
 - Enable fusion energy by HEDLP
 - Create, probe and control new states of matter in HEDLP
 - Ultra-fast dynamics: catching reactions in the act
- **HEDLP Program status: Francis Thio's presentation this afternoon**



FSP Workshop

- A national workshop was held to refine the long term vision for the FSP
 - The workshop was attended by forty one panel members, seventeen observers from national laboratories, universities, the DOE, and other federal agencies
- The first draft of the workshop report was completed on July 3, 2007 and distributed to OFES and the members of the FESAC subcommittee
- The report will also be evaluated by the Advanced Scientific Computing Research Advisory Committee
- FSP workshop report: this meeting by one of the workshop Co-Chairs, Prof. Arnold Kritz of Lehigh University



National Academy of Sciences Reports and Reviews

- Plasma 2010 Committee report
 - Plasma science is on the cusp of a new era.
 - Effective stewardship of plasma science as a discipline will likely expedite the applications of plasma science.
 - A presentation on the Report is scheduled for later today
- National Research Council (NRC) Review of the USBPO on US Scientific Participation in ITER
 - Review required by the Energy Policy Act of 2005
 - Grant awarded to NRC for the Review
 - NRC is in the process of planning the review



OFES Organization and Staffing Plans

- Evaluating changes to organizational structure
- FY 2007:
 - Recruit a Physical Scientist and an Admin Support person to OFES
- FY 2008:
 - Fill division head positions
 - Recruit three technical staff members and one program assistant to OFES
 - Recruit one technical staff member and one program assistant to DOE ITER Project Office at Oak Ridge
- Contact OFES at 301-903-4941 if you are interested in any of these positions
- NOTE: Office of Science is searching for a Principal Deputy and Deputy for Programs (Jim Decker's previous position).
 - The announcement is available as a handout.
 - Please alert us to any attractive candidates!



BACK-UP

Fusion Energy Sciences

(\$ in thousands)



Science

	FY 2006 Actuals	FY 2007 July AFP	FY 2008 CONG
DIII-D Research	24,274	24,636	25,264
C-MOD Research	8,490	8,382	9,133
International Collaborations	4,951	4,829	5,202
Diagnostics	3,763	3,773	3,959
Other	4,223	4,863	12,893
HBCU, Education, Outreach Reserves	(4,223)	(4,863)	(5,700)
SBIR/STTR (science)	0	0	(7,193)
Subtotal Tokamaks	45,701	46,483	56,451
NSTX Research	15,539	14,571	16,106
Experimental Plasma Research	21,389	16,506	20,638
HEDP	15,470	15,479	12,281
MST Research	6,445	6,760	6,970
NCSX Research	751	775	716
Subtotal Alternates Research	59,594	54,091	56,711
Theory	24,947	23,760	24,552
Advanced Computing/SciDAC	4,220	6,540	7,160
General Plasma Science	14,180	14,332	14,655
Science Total	148,642	145,206	159,529
<u>Facility Operations</u>			
DIII-D	30,780	32,022	34,405
Alcator C-Mod	13,032	13,880	14,322
NSTX	18,681	19,212	19,972
NCSX			
ITER			
Facility Ops times in weeks	7/14/11	12/15/12/0	15/15/12/0
NCSX MIE	17,019	15,822	15,900
GPP/GPE/ORNL Move	3,538	4,923	2,905
ACX			
ITER Preparation	5,294		
ITER MIE TEC Costs	15,866	37,000	149,500
Facility Operations Total	104,210	122,859	237,004

Enabling R&D

	FY 2006 Actuals	FY 2007 CONG	FY 2008 CONG
Plasma Technologies	14,787	13,376	13,452
Advanced Design	2,529	2,544	2,550
Materials Research	7,066	4,679	4,815
ITER MIE OPC	3,449	23,000	10,500
Enabling R&D Total	27,831	43,599	31,317
Total Fusion Energy Sciences	280,683	311,664	427,850
Recap			
DIII-D Res+Ops	55,054	56,658	59,669
C-Mod Res+Ops	21,522	22,262	23,455
NSTX Res+Ops	34,220	33,783	36,078
NCSX Res+Ops		775	716
ITER Res+Ops			
Facility Res+Ops Total	110,796	113,478	119,918
ITER TPC	19,315	60,000	160,000
Total, Core R&D Total	261,368	251,664	267,850



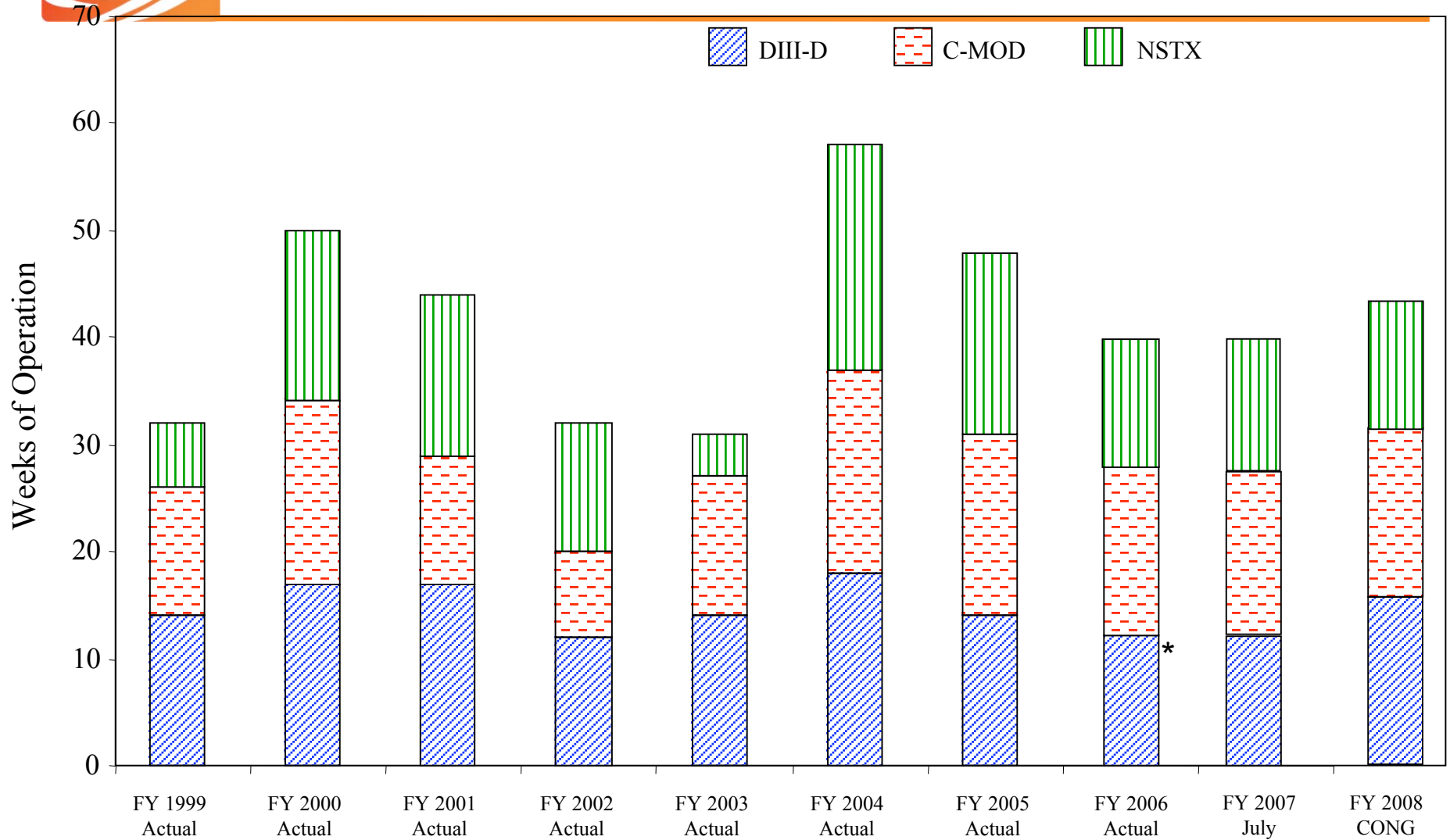


FY 2008 Fusion Program Plans

- o Continue U.S. ITER MIE Project (\$160.0M, +\$100.0M)
 - \$149.5M for Total Estimated Cost funding
 - \$10.5M for Other Project Costs funding (R&D support)
- o Increase Major Facility operations and research (+\$6.5M, + 3 weeks operations)
 - 15 weeks on DIII-D, 15 weeks on C-Mod, 12 weeks on NSTX
- o Most remaining program elements receive ~ 2.7% increase



Major Fusion Facilities Operating Times



*The 12 weeks of runtime in FY 2006 for DIII-D includes 5 weeks of run-time funded from the recovery of prior year balances.





Summary of Fusion Energy Sciences FY 2008 Program

Science (\$159.6M, +\$14.4 M)

- o Increase research at major facilities (+ \$2.9 M)
- o Increase Experimental Plasma Research (+\$4.1 M)
- o Decrease HEDLP (-\$3.2 M)
- o Increase Theory and SciDAC (+\$1.4M)
- o SBIR/STTR (\$7.2 M)
- o Miscellaneous Others (+2M)

Facility Operations (\$237.0M, +\$114.1M)

- o Continue ITER MIE (+ \$112.5)
- o Add 3 weeks of operations at DIII-D (+ \$2.4M)
- o No change in operating weeks at C-Mod or NSTX (+\$1.2 M)
- o GPP/GPE/Infrastructure (-\$2.0 M)

Enabling R&D (\$31.3M, -\$12.3M)

- o Reduce funding for ITER Other Project Costs (- \$12.5M)
- o Small Increases in Plasma Technologies and Materials Research (+\$.02M)



Fusion Energy Sciences Budget by Institution

(\$ in Millions)

<u>Institution</u>	<u>FY 2006 Actual</u>	<u>FY 2007 July AFP</u>	<u>FY 2008 CONG</u>
General Atomics	49.7	50.7	53.7
Lawrence Berkeley National Laboratory	5.3	4.8	4.9
Lawrence Livermore National Laboratory	13.4	12.5	12.0
Los Alamos National Laboratory	4.0	3.1	3.0
Oak Ridge National Laboratory	20.7	19.1	17.2
ORNL/PPPL ITER	20.8	60.0	160.0
Princeton Plasma Physics Laboratory	70.3	69.1	71.6
Massachusetts Institute of Technology	27.2	24.6	25.9
Other Universities	53.7	52.2	52.3
All Other	<u>15.6</u>	<u>15.6</u>	<u>27.3</u>
Total	280.7*	311.7*	427.9

*SBIR/STTR not included





International Developments in IEA, IAEA, ITPA

- IEA Fusion Power Coordination Committee (FPCC) Meeting on 2/28-29
 - Interactions with ITER scientific program
 - Consolidation of IEA agreements
- IFRC Meeting on 6/29/2007
 - G.S. Lee replaces P. Kaw as the IFRC Chair
 - ITER interactions with non-ITER Countries
 - IAEA Fusion Energy Conferences (FEC)
 - FEC 2008: Geneva, Switzerland; Oct 12-18
 - FEC 2010: Daejon, S. Korea
 - FEC 2012: San Diego, U.S. (U.S. proposal accepted by IFRC)
- ITPA – Being considered as a part of ITER Physics Organization
 - IFRC and FPCC continue to sponsor it in the meantime