

Report of NSTX Program Advisory Committee (PAC-19)

February 22-24, 2006

Committee Members Present:

James W. Van Dam (University of Texas)—chair
Charles M. Greenfield (General Atomics)
Martin Greenwald (Massachusetts Institute of Technology)
Thomas R. Jarboe (University of Washington)
Haruyuki Kimura (Japan Atomic Energy Agency)—substitute for Mitsuru Kikuchi
Brian Lloyd (UKAEA Culham)
Paul W. Terry (University of Wisconsin)
Michael A. Ulrickson (Sandia National Laboratory)
Michael C. Zarnstorff (Princeton Plasma Physics Laboratory)

Ex-officio:

Martin Peng (Oak Ridge National Laboratory)
Masayuki Ono (Princeton Plasma Physics Laboratory)

Committee Members via Remote Participation:

Cary B. Forest (University of Wisconsin)—February 22
Donald L. Hillis (Oak Ridge National Laboratory)—February 22-24
T. K. Mau (University of California, San Diego)— February 22

Committee Members Absent:

Mitsuru Kikuchi (Japan Atomic Energy Agency)
Michael E. Mauel (Columbia University)
William M. Nevins (Lawrence Livermore National Laboratory)

1. Introduction

The NSTX Program Advisory Committee (PAC) held its 19th meeting at the Princeton Plasma Physics Laboratory on February 22-24, 2006. This was the first PAC meeting held under the new three-day format, which allowed more time for presentations and for Committee deliberations. It also allowed an opportunity for two of the international members of the PAC to give special seminars on the morning prior to the start of the meeting.

The PAC appreciated that the NSTX presentations were formatted so as to provide information that helped the PAC members answer the two charge questions. The PAC also appreciated the NSTX management's description of how the project had responded to the PAC-17 and PAC-18 recommendations.

The PAC feels that NSTX has made excellent progress last year. The research program during these 18 run weeks was very successful. A few examples of research highlights are the following:

- Discharges with record pulse lengths, high bootstrap fraction, and large non-inductive current fraction were achieved with the new divertor poloidal field coils and by operating with sustained H-mode and high normalized beta.
- High-precision control of the X-point balance was achieved through use of real-time EFIT for shape control.
- Resonant field amplification of the resistive wall mode was measured with MHD spectroscopy.
- Electron thermal transport at the plasma edge was studied through temperature perturbations induced by lithium pellet injection.
- Significant fast ion losses were found with multi-mode bursts.
- Electron Bernstein wave damping at the upper hybrid resonance can reduce B-X-O coupling in some H-modes.
- High elongation and high triangularity were found to reduce heat flux to the divertor. This bodes well for a future ST-based CTF.

- The density was well controlled during coaxial helicity injection. This greatly facilitated the experiments, allowing the achievement of 60 kA solenoid-free startup.

2. Research Plans

The first charge to the PAC at this meeting was as follows: *Do the proposed research plans for FY2006-08 take appropriate advantage of the new capabilities of NSTX to address both burning-plasma and ST-specific scientific goals?* The PAC had an overall affirmative response to this charge. In general, the NSTX research plans for FY 2006-2008 are well thought out and appropriate. The 11 run weeks for the coming year are carefully allocated and have good focus on ST-specific research goals (including the goal of a future Component Test Facility) and also beneficial synergy with ITPA physics goals.

In the following subsections, more detailed comments are offered concerning the NSTX research plans.

Turbulence and Transport

The NSTX plans for studying *electron thermal transport* and high wave number fluctuations represent a crucial issue to which NSTX can make unique and important contributions. It is quite appropriate for this to be a high priority activity represented by the milestones that have been selected. The work on electron transport takes advantage of the NSTX unique regimes and the new scattering diagnostic. The MSE system will also be of great value in this investigation. NSTX contributions to the ITER scaling efforts have been very useful; however, the point of diminishing returns may soon be reached. The PAC encourages the NSTX program to ensure that in these scaling studies, sufficient focus is paid to understanding the underlying physics mechanisms.

The plans for measurement of high-wave-number fluctuations using tangential scattering for a variety of plasma conditions seem compelling and well thought-out. The perturbative studies involving gradient scale lengths in H-mode, e-ITBs, etc., are quite promising. For FY07 there is an important milestone of correlating turbulence spectra with transport. However, controversies within the theory community about ETG transport, some of which hinge on whether there are radial streamers, will likely make comparisons with theory difficult unless the experiments can characterize anisotropy, i.e., the ratio of poloidal to radial wave number. This is an important consideration that should be part of the decision point on new diagnostic development. The PAC suggests an early evaluation of the prospects for measuring anisotropy in the scattered spectrum, which is probably the outstanding theoretical issue for ETG turbulence. (Note: NSTX has plans to study anisotropy at the end of the FY07 run.)

Turbulence modeling (e.g., with the use of the GYRO code) will be crucial for deriving maximum benefit and information from the high-wave-number fluctuation measurements. It is not clear that this effort is moving forward commensurately with the diagnostic development, experimental plans, and milestones. The PAC feels that the modeling efforts should be accelerated, subject to the availability of human and computational resources. The PAC encourages work on a number of interesting avenues of study with nonlinear gyrokinetic analysis. Comparisons with measured R/L_{te} might shed light on electron transport questions; the results seem to be markedly different than those from standard aspect ratio machines. The effect of magnetic shear is another area where quantitative comparisons might be possible. Inter-machine comparisons could also be useful, since there are now high-k fluctuation diagnostics on all three major US experiments. A first step might be to identify operational regimes in which some of these devices are predicted to be in the same regime with respect to electron transport.

Concerning anomalous *ion transport*, the PAC notes that NSTX is already considering the opportunity to exploit error field braking or high-harmonic fast wave heating for studying ion transport in the low-rotation/low-ExB-shear regime and comparing the results to existing predictions.

Plans to study *momentum transport* on NSTX will be aided by the capability to infer flow fluctuations and Reynolds stress. Efforts to extract this kind of information from the gas-puff imaging measurements, while obviously subject to resource limitations, are laudable and should be encouraged. The null result on bi-coherence at the L-H transition is particularly intriguing, since it is different from published DIII-D results.

Particle transport is a key process in efforts on particle control; however, particle transport studies on NSTX were not described to the PAC. It is understood that such studies are not of the same priority as electron thermal transport. Nevertheless, the NSTX focus on particle control makes it worthwhile to ensure that opportunities to advance the understanding particle transport are not missed.

Macroscopic Stability

The use of feedback coils for control of *resistive wall modes and error fields* will be the main focus for NSTX macroscopic stability studies in 2006. This is an important area of work, and NSTX (along with DIII-D) has particular expertise in this area. The NSTX work is very timely since any decision to add RWM coils to ITER will have to be taken soon and since the RWM coil set on NSTX is similar to that proposed by the US for ITER. The NSTX work is well coordinated with corresponding work on DIII-D.

The PAC suggests one issue for further consideration. In ITER, the RWM coils must be behind the port shield modules, which are about 500 mm thick. The response speed for penetration of either an error field signal from the plasma or a correction (feedback) field from the RWM coil will be limited, due to the eddy currents generated in the shield modules. NSTX could provide useful information to ITER if it would explore the effect of bandwidth on the ability to control RWMs—in particular, the limitation of bandwidth to low frequencies, i.e., the minimum bandwidth needed. (The high frequency cut-off in ITER will likely be around 20 Hz.)

Disruptions are another important macro-stability issue. The NSTX schedule has no dedicated run time for the study of disruptions; however, the NSTX staff is confident about expecting to acquire useful data in this area from several other scheduled experiments. The PAC encourages the NSTX team to follow through on providing data and analysis to the ITPA disruption database.

The 2006 research program on NSTX includes no investigation of *neoclassical tearing modes*. In 2007, one such experiment is listed. The PAC judges this to be appropriate, since realistically the experimental time allocated to MHD studies is insufficient for another major focus beyond that of resistive wall modes. The PAC does urge the NSTX team to keep the neoclassical tearing mode experiment on the schedule for 2007. Although neoclassical tearing modes are apparently not common on NSTX, there are cases where experimentally observed MHD activity has not yet been identified and could potentially correspond to neoclassical tearing modes; the “possible hybrid” regime seen late in sustained high beta discharges is such an example. Clear identification of this MHD activity could provide useful information both for the study of neoclassical tearing modes and for comparison of this regime to hybrid scenarios obtained in other devices.

Fast Particle Instabilities

NSTX research on *super-Alfvénic ion instabilities and transport* is high-quality work. It is definitely relevant to spherical tori (including CTF), since STs routinely operate with fast ion velocities that are from one to three times the shear Alfvén velocity. This work is also quite relevant to burning plasmas, such as ITER, because fusion-product alpha particles will be super-Alfvénic, as will also negatively charged neutral-beam-injected fast ions. Recently a further point of relevance to ITER has emerged, in that ITER expects to have multiple high-toroidal-mode-number unstable Alfvén eigenmodes (due to its small Larmor radius normalized to minor radius), and NSTX has been able to observe such multiple modes, even though its ρ_* value is not low.

An intriguing pair of questions emerges: First, why has there been no observation in NSTX—and also in MAST—of any Alfvén cascade modes in reversed-shear operation? In contrast, DIII-D has seen multiple cascade modes with reversed shear. Second, why does NSTX see multiple Alfvén modes with normal (non-reversed) shear operation—whereas DIII-D does not? The answers to both questions are likely related to the special low-aspect-ratio nature of NSTX, which causes its plasmas to have high beta, large fast ion beta fraction, and low shear. These two questions pose interesting challenges to theory and experiment.

The energetic particle studies continue to exploit close interaction with theory and simulation, both of which should be regarded as NSTX “capabilities.” The agreement of the experimental results with both linear and nonlinear theory is remarkably good; an example is the measured square-root dependence on time for the frequency chirping of GAE/CAE hole-clump structures. The PAC notes that the Joule experimental milestone about fast ion modes should profit from fruitful synergy with a related DOE/OFES theory milestone and with the ITPA task MDC-9.

Heating and Current Drive

Electron Bernstein waves have the potential to make an important contribution to off-axis current drive for the optimization of high-beta plasmas in future spherical torus devices. In view of the large investment costs, the choice of the optimum EBW frequency is critically important. Emission measurements for EBW provide useful guidance, and the radiometer improvements—such as the extended frequency range and the remotely steerable antennas—are important developments. Both NSTX and MAST provide indications that EBW emission may be suppressed in some frequency ranges for certain plasma conditions. In particular, emission studies on MAST have shown that emission at 28 GHz is not as robust with respect to changes in machine conditions (such as H-mode transitions) as

are lower frequencies. If 28 GHz is going to be the frequency of choice for future NSTX upgrades, it would be wise in present-day experiments to concentrate on 28 GHz emission experiments over a wide range of machine conditions and thus map out where 28 GHz EBW can be used. It is therefore important to ensure, by means of further comprehensive emission measurements and detailed modeling, that the choice of optimum EBW heating frequency is robust against variations in plasma parameters. The good agreement of initial EBW emission measurements with modeling results from the CQL3D/Genray codes is encouraging. Further verification of theory with respect to the emission view angle, scheduled for FY06, is a logical follow-up. Collaboration with the MAST EBW effort, in code benchmarking and current drive experiments, is to be encouraged.

The focus in *high-harmonic fast wave* studies has been on the important issue of wave coupling and absorption in the edge region. Given the tight funding situation, the PAC applauds the effort by the NSTX group to leverage related modeling in the SciDAC RF project in order to come up with a useful analysis tool for this task. However, it is unclear how much priority the SciDAC project is giving to this work; it appears to be starting to pay some attention, but otherwise NSTX will need to expend its own effort. Going to a directed high- k_{\parallel} (14 m⁻¹) antenna might mitigate the problem with edge absorption, but it may result in lower current drive efficiency during ramp-up. Thus, were funding to become available, a careful analysis will be needed to decide if the HHFW antenna should go forward.

The PAC feels that NSTX needs to figure out what the long-term role of HHFW will be. Although its wave-particle physics is interesting, how HHFW fits into the long-term vision for NSTX or for a Component Test Facility (CTF) is unclear. The PAC wonders if the HHFW system is receiving enough run time to allow it to become a useful tool. The PAC notes that later this year, some HHFW studies that piggyback on edge coupling experiments will be carried out.

The exploitation of HHFW together with high-power neutral beam injection is inhibited by the interaction of HHFW with the fast beam ions. However, there may be some value in exploring—at least theoretically in the first instance—possible synergistic effects of HHFW and EBW heating and current drive.

The PAC suggests an investigation of the scheme of *combined EBW current drive and HHFW heating and current drive* to see whether current drive performance in NSTX might be improved. The NSTX results on EBW current drive are encouraging, although some power loss occurred due to collisional damping at the plasma edge. High-harmonic fast wave heating also showed considerable power loss due to parametric decay instability at the plasma edge. In addition, absorption of HHFW in the plasma core can be enhanced with increasing electron temperature. The PAC speculates, therefore, that if both waves were to be injected simultaneously, a synergistic effect could be expected.

Boundary Physics

The boundary physics goals for FY06-07 are well planned and well prioritized. These research activities should provide specific information for spherical tori, as well as results that are useful for burning plasmas.

Beginning the FY06 run period with a few days of *lithium evaporation experiments* to perfect the evaporation technique for density control has the potential for a positive impact on several other planned experiments: e.g., low-collisionality transport studies, coaxial helicity start-up, H-mode pedestal studies, etc. This is a good example of setting priorities for the NSTX experiments. It would be advisable to begin with modest amounts of lithium evaporation in order to touch base with the pellet experiments. The NSTX team should be careful not to take too small steps on the path to lasting effects (for many shots) on the plasma density. Simple estimates indicate that a quantity of about 0.5 gm is required for long-lasting effects. Hopefully, such a magnitude of evaporation could be tested before the end of the three-day initial run period.

The lithium program is rightly given high priority: NSTX needs to make sure that this receives sufficient attention to support the pumping/fueling decision point. The NSTX team is aware that they must do more than remove particles; they must learn how to control the density. This may require a fair amount of effort and run time. Divertor operation (e.g., on CTF) compatible with low-density operation will be another severe challenge. As the lithium program is carried out and data are obtained, NSTX should be thinking about particle control schemes—e.g., liquid lithium or cryopumping—that extrapolate to long pulse.

Pedestal physics measurements are shedding light on important physics processes in the edge. The PAC is pleased with the plans for future exploration along this line. The new Enhanced Pedestal H-mode regime (EPH) with a proper Te pedestal is very interesting. Will there be enough run time to follow up on these interesting results?

Allocating some of the contingency run time for EPH studies might be a good idea. These experiments are included in the ITPA list of things to be done.

The PAC encourages the work carried out with the *gas-puff imaging diagnostic* and the analysis of these results. Even though no entirely satisfactory edge model exists, comparisons with code models could still be useful. Two questions about the codes have to do with whether synthetic diagnostics for these codes are practical, and whether the codes are mature enough yet to be compared with brightness measurements.

Diagnostic cross-comparisons for boundary fluctuations are potentially very useful. Various diagnostics that characterize fluctuations by accessing different boundary regions have produced results that need to be understood. An example is reflectometry (from inside the pedestal), which shows a reduction in radial correlation length with no change in amplitude, and GPI (from outside the pedestal), which shows no change in correlation length and a reduction in amplitude. The reciprocating probe offers the possibility of sorting out these puzzles. Discharges that allow the probe to bridge these regions should be sought and studied. Probe studies should also take full advantage of the ability to measure the density/potential cross-phase—and, therefore, particle transport—in the context of differences between L-mode and H-mode.

It is important to make sure that the *scrape-off layer turbulence/transport studies* are accomplished. This is a high-leverage activity for scaling/prediction of power deposition width, recycling, density limits, and other boundary-related topics. Comparison with standard-aspect-ratio devices could help elucidate the underlying mechanisms. Another area for comparison is the role of topology and edge flows in the H-mode threshold and ELMs.

The *dRsep scan* for locating the large versus small ELM boundary and for diagnosing material migration experiments could be important, since these issues are neither boundary nor wall. Because many ELM investigations are ongoing, some attention should be paid to locating the large versus small ELM boundary. These experiments are included in the ITPA list of things to be done.

Start-Up and Long-Pulse Operation

Important progress has been made on *CHI start-up* during 2005, with the generation of closed flux surfaces at 60 kA. There are reasonable expectations that the current could be increased to several hundred kA in 2006, thus generating hotter plasmas and providing a better target for efficient HHFW heating. Improvements to the HHFW antenna voltage feedback should improve reliability of coupling to such plasmas. HHFW has already been successfully used to generate high bootstrap fraction in 250 kA discharges. Given the strategic importance to the ST concept, it is appropriate that high priority—even a milestone—be given in FY06 to improved CHI start-up and, in particular, the hand-over to efficient auxiliary heating and further plasma current ramp-up. More run time than three days may be necessary.

The PAC feels that the NSTX team needs to develop a clear strategy, including options and decision points, for how to achieve the goal of non-inductive start-up and ramp-up. The PAC is concerned that these important ST-related tasks might not get the run time needed for success. The NSTX team does plan to re-examine this question at the time of the FY06 mid-run assessment.

The PAC also recommends that the FY08 Integrated Scenario Development physics milestone be clarified so as to explicitly include start-up and ramp-up issues, which are crucial for the ST. The PAC suggests broadening the internal research goals associated with this milestone to include a statement about “Assessing the hand-off and ramp-up of non-inductively produced plasma current.”

The PAC encourages activities in *integrated modeling* for start-up and long-pulse operation. This could provide an organizing principle for what is a fairly broad and not entirely coherent program. Right now there are too many options and too many threads to follow—probably too many to work through exhaustively. The PAC also notes that integrated modeling tools that can work starting from breakdown are needed not only for NSTX, but also for producing a target plasma for “advanced tokamak” operation in ITER. Specific application of such modeling tools to NSTX would be useful for evaluating ST start-up issues and also for developing and verifying these modeling techniques for broader utility beyond the ST program. The PAC requests that, at its January 2007 meeting, the NSTX provide an update about the work on start-up/long-pulse integrated modeling and how it relates to future plans.

3. Facilities and Upgrades

The second charge to the PAC at this meeting was as follows: *Do the proposed facility and diagnostics upgrades for the FY2006-08 time frame position NSTX to maximize its contributions, given financial constraints?* The PAC also had an overall affirmative response to this charge. The NSTX facility and diagnostics upgrades for FY 2006-2008 are well planned and appropriate.

Quite a few of the proposed new installations are leveraged on incremental funding in the FY2007–08 timeframe. For heating and current drive, two examples are the 1-4 MW EBW system and the $k_{\parallel} = 14 \text{ m}^{-1}$ HHFW antenna. In view of the high cost of some of these components (e.g., gyrotrons) and the continuing tight budget situation, the practicality of the proposed FY07-08 research plans is somewhat dubious. The proposed activities may need to be prioritized in terms of their potential impact on ITER and/or on the development of the spherical torus concept.

The NSTX team is to be commended for their plans with respect to the tangential scattering diagnostic for turbulent transport studies. The advance planning for plasma conditions under which the diagnostic will be deployed is at a mature stage of development. These planned projects make excellent use of upgrades and facilities in addressing both burning plasma and ST-specific goals.

The energetic particle research program is also taking advantage of new NSTX diagnostic capabilities—specifically, fluctuation and fast ion diagnostics. Moreover, the MSE diagnostic now provides the radial profile of the current, which is a critical input to energetic particle studies. The MSE diagnostic is scheduled for improvement in FY07-08. Installation on NSTX of the new D_{α} diagnostic (FIDA) for measuring the fast ion energy distribution and radial profile—now under development at DIII-D—is not planned until FY 2008; the PAC agrees that this schedule is not inappropriate, given financial constraints and the fact that this is an incremental diagnostic not in the base plan.

The PAC continues to wonder whether results in the next few years will support a decision for an expensive EBW system. As perhaps the only radio-frequency current drive scheme, EBW seems critical for the spherical torus as a reactor. Whether EBW would be critical for a spherical-torus Component Test Facility—e.g., for start-up and for high-power-flux/off-axis current drive to maintain stability—needs to be clarified. Adequate resources should be allocated to EBW studies in order to permit an informed decision about the EBW strategy at the end of FY06.

The poor absorption of high-harmonic fast waves at low k_{\parallel} may be explained, at least partially, by parametric decay instabilities near the plasma edge. Although these instabilities are expected to be weaker at high toroidal field, the NSTX team would be wise to explore the possibility of a revised antenna design that could allow higher k_{\parallel} . This would also be beneficial for coupling to target plasmas generated by the coaxial helicity injection (CHI) method.

The addition of the lithium evaporator should provide much better density control and open new areas for experiments and enhance important physics research.

In terms of boundary diagnostics, the edge rotation diagnostic (passive, non-beam) has been on the schedule to be upgraded for several years. It has contributed significantly to the NSTX program in the past, and, if upgraded, would provide excellent E_r measurements well into the scrape-off layer. The PAC recognizes that this is an important diagnostic; however, it endorses the decision that poloidal CHERS is of higher priority. Likewise, the fast infrared camera is important because of the possibility of incurring large ELMs at low collisionality with lithium, where it would be important to understand power loading and detachment and re-attachment. For the past two years, the IR camera has been postponed due to budgetary constraints. Again, however, the PAC endorses the decision that poloidal CHERS has higher priority.

The PAC noted the recent development of various start-up strategies (JT-60U, Pegasus, CHI, and iron core). With regard to outer PF null start-up and plasma current ramp-up, the recognition that an iron core might be incorporated into future devices has rightly shifted the emphasis to flux consumption minimization through a variety of techniques (e.g., early H-mode, early heating, error field compensation, etc.), rather than true non-solenoid start-up and plasma current ramp-up. These studies are likely to benefit from lithium conditioning and will be an important element in extending long-pulse operation in the near term. An engineering assessment of an iron core is needed, with plasma included in the analysis. Also, boundary conditions for the poloidal field at low aspect ratio with an iron core should be considered.

The PAC was pleased to learn that the TF joints are reliably operating at 4.5 T.

APPENDIX A — PAC-19 Charge

**National Spherical Torus Experiment
Program Advisory Committee
19th Meeting**

**Princeton Plasma Physics Laboratory
Conference Room LSB-318
February 22-24, 2006**

CHARGE

There has been substantial progress towards an international Joint Implementing Agreement for ITER, resulting in the formation of the US Burning Plasma Organization and increased focus on ITPA Joint Experiments. The recent FESAC Facilities Panel Report identified key areas in which NSTX can make unique, important contributions to the science basis for ITER. The report also identified unique, important information that NSTX can provide in support of a compact U.S. Component Test Facility. It is critical that NSTX research plans support both burning plasma physics and the development of the ST configuration. Fortunately there is very substantial overlap between these goals.

NSTX has recently added critical new capability, including a unique system for highly localized high-k scattering measurements, active control of RWM coils in a configuration similar to that proposed for ITER, and intense lithium coating.

- 1) Do the proposed research plans for FY2006-08 take appropriate advantage of the new capabilities of NSTX to address both burning-plasma and ST-specific scientific goals?
- 2) Do the proposed facility and diagnostics upgrades for the FY2006-08 time frame position NSTX to maximize its contributions, given financial constraints?

APPENDIX B — PAC-19 Agenda

National Spherical Torus Experiment Program Advisory Committee 19th Meeting

Princeton Plasma Physics Laboratory
Conference Room LSB-318
January 20-21, 2005

AGENDA

Wednesday, February 22, 2006

1:00	<i>Coffee & Donuts, PAC Executive Session</i>	
1:15	Rob Goldston	Welcome and Charge to the PAC
1:25	Steve Eckstrand	Comments from DOE
1:30	Jim Van Dam	Agenda and Plan of Meeting
1:35	Jon Menard	FY05 Campaign and Milestone Accomplishments
2:35	Martin Peng	Strategic Goals & Research Priorities
3:00	<i>Coffee Break</i>	
3:20	Masa Ono	Facility Plans
4:05	PAC Executive Session	
6:05	<i>Adjourn</i>	
7:00	<i>PAC Dinner</i>	At the Ono's

Thursday, February 23, 2006

8:00	<i>Coffee & Donuts</i>	
8:30	Roger Raman	Run Plan for FY06
9:10	Mike Bell	Turbulence and Transport
9:40	Stan Kaye	Confinement Scaling and ITER Relevance
10:10	<i>Coffee</i>	
10:20	Aaron Sontag	Macro-stability
11:00	Eric Fredrickson	Super-Alfvénic Ion Driven Instabilities and Transport
11:40	<i>Lunch and PAC Executive Session</i>	
	PAC requests brief reports on :	
	1) Considerations of Time Delay Estimation of edge flow field—Stewart Zweben	
	2) EBW—Is 28 GHz optimal ? How many MWs for what goals ?—Gary Taylor	
1:10	Gary Taylor	EBW and HHFW (include Pegasus)
1:50	Dennis Mueller	Transient CHI
2:20	Henry Kugel	Lithium Wall Coating and Recycling Control
2:45	<i>Coffee</i>	
2:55	Rajesh Maingi	Boundary Physics
3:40	Dave Gates	Toward Stable Steady State Operation (include Ramp-up)
4:20	<i>PAC Executive Session</i>	
7:00	<i>Adjourn</i>	

Friday, February 24, 2006

8:30	<i>Coffee & Donuts</i>	
8:40	Jim Van Dam	Feedback and Questions
8:50	<i>PAC Executive Session</i>	
10:00	<i>Coffee</i>	
12:00	<i>Lunch</i>	
1:00	Jim Van Dam	Debriefing
1:30	<i>Adjourn</i>	