Answers to PSACI Panel Questions

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Meeting of the PSACI Program Advisory Committee
Princeton Plasma Physics Laboratory
June 7-8, 2007

- **Three most important scientific accomplishments that impact predictive capability**
  - Quantitative description of ICRF mode conversion
    - Predictions validated with experimental measurements of power deposition of mode converted waves and PCI detection of mode converted wave structure
  - Self-consistent evolution of nonthermal particle distributions.
    - Predictions of velocity space structure validated against experimental observations from CNPA at low harmonic.
  - Full-wave EM field simulations of LH waves, including nonthermal electrons.
    - Validation against present day experiments underway [comparison with predicted hard x-ray emission, measured driven currents, possible wave scattering techniques].
- **Deliverables not yet able to attain and why ?**
  - Simulation of HHFW-fast beam interaction experiments on DIII-D and NSTX.
    - Finite ion drift orbit effects not yet included self-consistently.
  - Closed loop simulations with TORIC – SIGMAD – CQL3D.
    - Time and man power, but expect to be completed by project's end
  - Self-consistent antenna – full-wave code simulation of linear ICRF coupling
    - Time and man power, but expect to complete by project's end.

- **Deliverables not yet able to attain and why ? - continued**
  - RF sheath boundary conditions not yet implemented in 2D full-wave codes:
    - Difficulty in formulating the analytic sheath BC for proper implementation in solvers.
  - Only preliminary simulations of driven modes completed:
    - Difficulty with code convergence because of unanticipated mode conversion to short wavelength slow modes and possible inaccuracies in calculation of kinetic flux and Poynting flux.

- **Key contributions from CSET and SAPP Collaborators:**
  - **Implementation of in-core and out of core matrix inversion algorithms in AORSA and TORIC (E. D'Azevedo, ORNL)**
  - **Code optimization and speed up for AORSA and TORIC (E. D'Azevedo).**
  - **3D visualizations of nonthermal particle distributions and time dependent wave fields (V. Lynch, S. Ahern, ORNL)**

- **What science was enabled by using the maximum number of processor cores:**
  - 3D ICRF wave field reconstructions for ITER:
    - Needed to predict absolute level of power coupled (interfacing to 3D antenna code).
    - **2048 cores for 8 hours.**
  - Full-wave LH field simulation for present day size device (C-Mod):
    - Able to include important diffraction and focusing effects (may hold clue to understanding the spectral gap problem).
    - Provide accurate current drive predictions for AT scenarios with current profile control.
    - **4096 processor cores for 1 hour.**
  - Approximate efficiency at 10,000 cores is ~48% of theoretical maximum.
    - Based on AORSA scaling studies using ICW mode conversion problem.

- **Under what conditions will 3D effects become important and how will they be addressed:**
  - Wave propagation in non-axisymmetric edge of tokamaks.
    - Add a non-axisymmetric edge region with vacuum vessel details and then use a Green's function technique to couple to an axisymmetric core.
  - Propagation with large 3D magnetic island structures, ripple losses, etc. and in 3D confinement systems (stellarators).
    - 3D full-wave solver (AORSA3D or TORIC) or full PIC simulation.
- **Over the next two years what are the prospects for developing multi-scale adaptive spectral algorithms:**
  - Reasonable to expect wavelet solution of 1D ICRF mode conversion with FLR and all-orders conductivity.
- **How will we get self-consistent solutions if quasilinear theory breaks down:**
  - Gyro-center gauge theory (Qin *et al*.,) could be applied in time domain PIC approach (VORPAL)