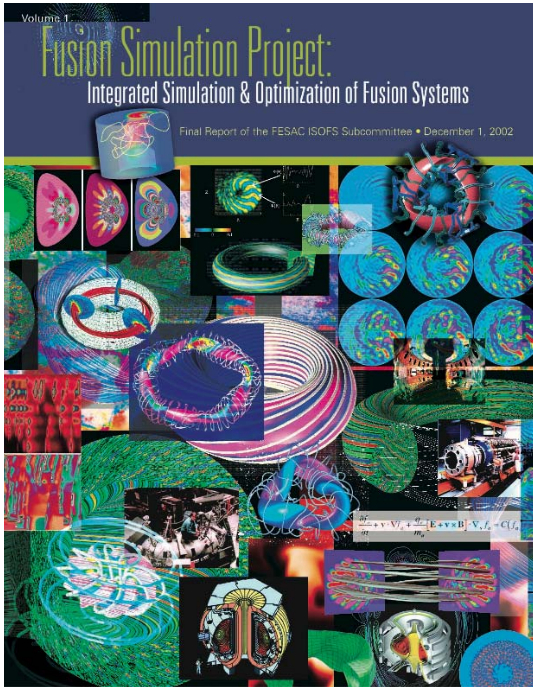
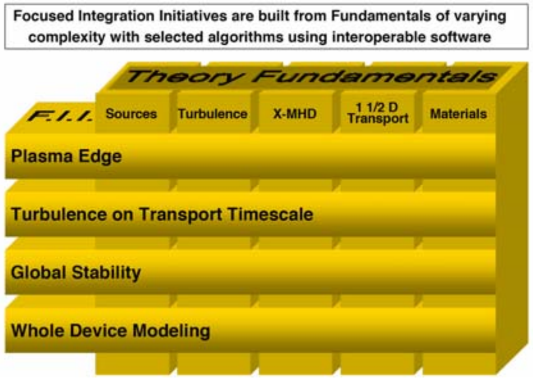
Near Term LANL ITER Interests

- **Participate actively in the Fusion Simulation Project.**
- **Continue to be involved in ITPA activities.**
- **Diagnostics --- teaming on packages, and new R&D as needed. Specifically, the intense diagnostic neutral beam could enable spectroscopic measurements of ion temperature, helium ash, and magnetic field profiles, with vastly improved signal/noise ratio. (at $1.4M/year level)**
- **Provide Tritium system engineering designs & expertise. (at $1M/year level)**

Fusion Simulation Project offers the US an additional opportunity to participate in ITER that leverages our existing capabilities

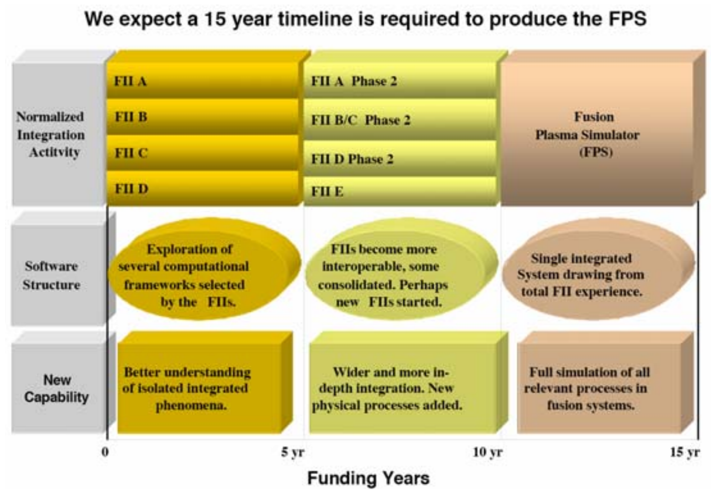
- In 2002, the FESAC Integrated Simulation & Optimization of Fusion Systems Subcommittee recommended that the US fusion program launch a Fusion Simulation Project (FSP)
- Technological growth of computing power by a factor of 10^{13} since 1945 is enabling science to tackle very difficult and complex problems
- In November, 2003, DOE formed the FSP Steering Committee to take the next step to make the project a real project (define specific goals, tasks, organization structure, concept for RFP,….)
  - Douglass Post, chair, Los Alamos National Laboratory
  - Donald Batchelor, Oak Ridge National Laboratory
  - Randall Bramley, University of Indiana
  - John Cary, University of Colorado
  - Ronald Cohen, Lawrence Livermore National Laboratory
  - Phillip Colella, Lawrence Berkeley National Laboratory
  - Steven Jardin, Princeton Plasma Physics Laboratory
- FSP purpose is to provide predictive simulation capability for burning plasmas, specifically for ITER if ITER goes forward
- FSP is planned to be a multi-institutional $20M/year effort for 15 years supported by OFES and OASCR
- Will build on and integrate existing capabilities (e.g. CD and MHD) and develop required new capabilities (transport, kinetic edge phenomena, etc.)



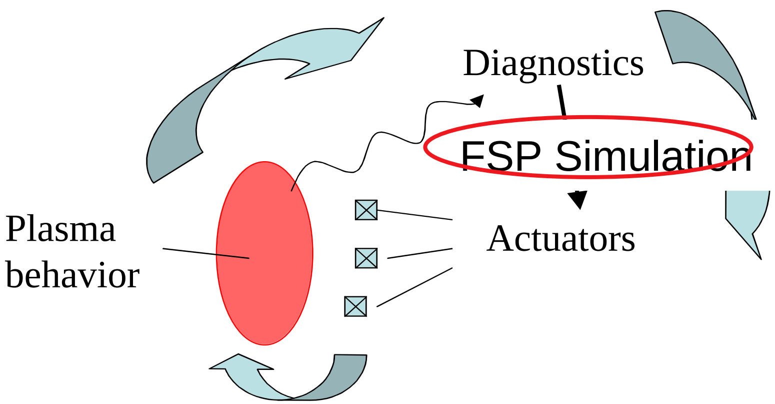


One—among many—candidate vision: ITER plasma control

- ITER Physics Team in Naka has requested that real-time control of the burning plasma will be essential to meet performance goals (e.g. long pulse ignited burn) and to avoid operational limits such as disruptions
- Other visions are being considered as well
- Planning workshop scheduled for mid-May, 2004



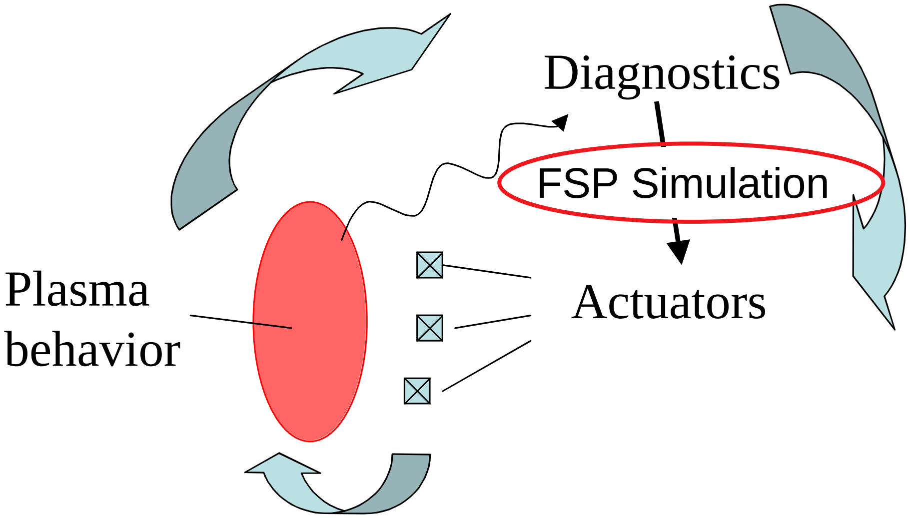
- ITER team vision: Use predictive simulation running in real time to extrapolate from measured plasma conditions to optimum plasma parameters
- With proper extensions, such a capability can bring together the disparate simulation efforts in the US
- Collaborations with EU and Japanese simulations potentially valuable as well



Plasma Control could unify all the simulation models.

- Use hierarchy of models in real time to interpret diagnostic data, predict possible performance, control actuators, plasma responds, new data is obtained, feedback and feed-”forward” control algorithm
- Hierarchy of models from fast and simple to slower and better
- Model all aspects of plasma behavior

- Will optimize performance of burning plasma experiments
- Will facilitate rapid testing of models and theory with real experimental data
- Can unify computational, theoretical and experimental fusion communities

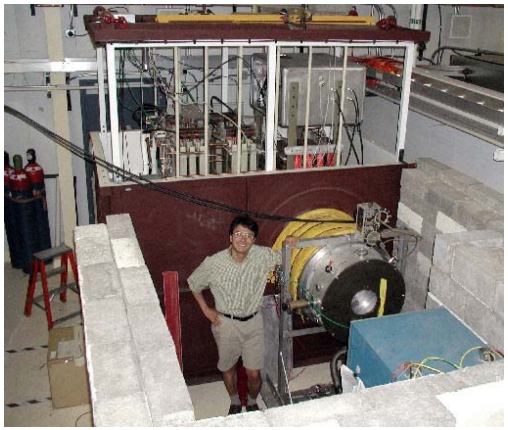


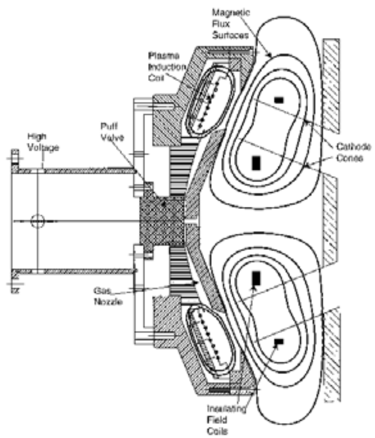
FSP Funding is not in OFES FY05 budget but an add-on is desired

- Expectation is that project should begin with ~ $4M for planning
- OASCR has put $1.3M into their budget for FY05
- Elements of the community have requested an add-on of ~ $3M

(NEW for FY06) OFES Proposal:
Intense Diagnostic Neutral Beam For Burning Plasmas (ITER)

Pulsed Ion Source - Magnetically Insulated Diode





Proposal Objective:

- FESAC panel on “A Burning Plasma Program Strategy to Advance Fusion Energy”: 2nd highest priority “ to develop enabling technology that supports the burning plasma research and positions the US to more effectively pursue burning plasma research”
- The highest priority for US contributions to the ITER project: “baseline diagnostics, plasma control, remote research tools, etc.”
- Diagnostic neutral beam (IDNB): Critical baseline diagnostics for CHERS and MSE - ion temperature profile, impurity and helium ash measurements, fast alpha distribution., and q profile.
- Intense (~ 50 A/cm^2), pulsed beam: better S/N and cost efficient.
- LANL has hardware, history & expertise (since 90s) and personnel for pulsed IDNB source R&D.

Proposed Technical Approach:

- Intense ion beam source: magnetically insulated diode (MID) with anode plasma for clean, intense (~ 50 A/cm^2) neutral beam
- Repetitive pulse operation: short pulses (1-2 μs) with high rep-rate (~ 30 Hz) to improve S/N ratio with low cost.
- Optimal beam energy of 125 keV/amu for CHERS and MSE.
- Low beam divergence: 1˚ divergence with modified electrodes and additional electric quadrupole beam shaping.

Task 1: Characterization and optimization of MID

- Operation MID facility (CHAMP) at LANL
- High beam extraction (50-100 times Child-Langmuir limit)
- Modeling of MID (two-fluid and PIC simulation).

Task 2: Deployment of prototype diagnostic beam

- Parallel beam extraction with electrode modification.
- Efficient neutralization and high rep-rate
- Deployment ready at major fusion facility in 4 years

Expected Cost and Schedule:

Task 1: 24 month effort headed up by LANL - P24 (outside collaboration and modeling) ~$1.4 M/yr
Task 2: 24 month effort headed up by LANL - P24 (collaboration with major fusion facility) ~ $1.4M/yr
Total: $5.6 M over 48 months

Deliverables:

Task 1&2: Technical reports on bulleted items and a numerical design tool for IDNB MID.
Task 2: Prototype intense diagnostic neutral beam for deployment.

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