Meeting Charge and the Range of Possibilities for NSTX Research in 2004 - 2008

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NSTX Five Year Plan Ideas Forum

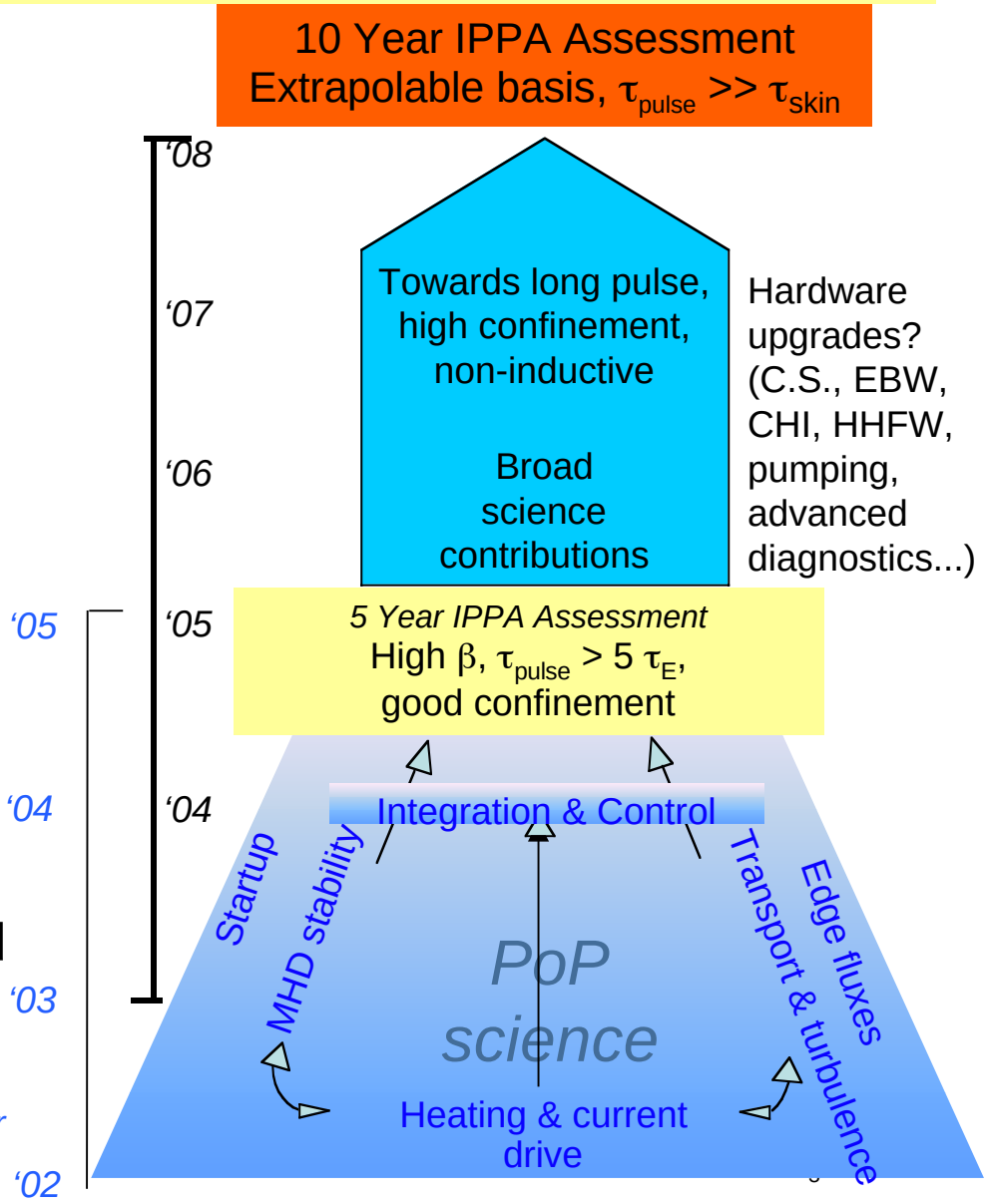
June 24 - 26, 2002

The goal of this meeting is to identify elements of a long-term research plan that builds on our recent results

- Recent results are remarkable: we should reach high
  - A unique opportunity for the national program
- A first step towards a crisp plan for 2004 - 2008
  - To be reviewed next spring
  - A recent request from DoE; get us in sync with review of C-Mod and DIII-D programs
  - We have to hustle to get our plan in shape

NSTX plan should reach high from a base of physics understanding

- Plan should form the basis for as deep and broad a physics basis as possible for the ST
  - Physics-based extrapolability
- Plan should describe how it will contribute broadly to plasma physics
  - Other devices
  - Astrophysics
- This meeting is the starting point to identify scientific, hardware, and runtime issues



In this talk: meeting charge, obligations for our planning, introduction to group plans

- Goals and milestones
- Discussion groups: context and plans
- Needed output of your discussions
- Meeting agenda

Two overarching IPPA milestones guide much of our planning

- 5 year goal: Make a preliminary assessment of the attractiveness of the ST regarding confinement, stability, high beta operations, non-inductive operations, and divertor heat fluxes
  - to be achieved early in the 2004 - 2008 time frame

- 10 year goal: Assess the attractiveness of extrapolable, long-pulse operation of the spherical torus for time scales much greater than the current penetration time scales
  - to be achieved in the 2009 timeframe

Charge #1: In your discussions, identify the scientific opportunities and issues and that must be addressed to reach these goals

There are major hardware issues to consider and opportunities to seize

- Center stack
  - Need to assess implications of improved capability, larger aspect ratio (double the field, current and flattop durations of NSTX)?
- EBW
  - Must identify requirements for non-inductive startup, NTM control
  - Need to identify modeling and experiments needed develop a sensible program
- CHI
  - Need to clarify how we will decide to proceed to an upgrade; identify needed upgrade capabilities
- Diagnostics
  - Need to identify areas where we have potential for pushing plasma science forward broadly
- Particle control
  - Must assess the necessity of cryopumping; the potential long term benefits vs. impact of a Li module
- HHFW
  - Should assess possible improvements & mods for max science

Charge #2: In your discussions, identify the major hardware opportunities and issues that must be considered to meet the IPPA goals.

IPPA scientific goals must also be addressed

IPPA Goal 1: Advance fundamental understanding of plasma... and enhance predictive capabilities through comparison of experiments, theory, and simulation

5 year IPPA goals in

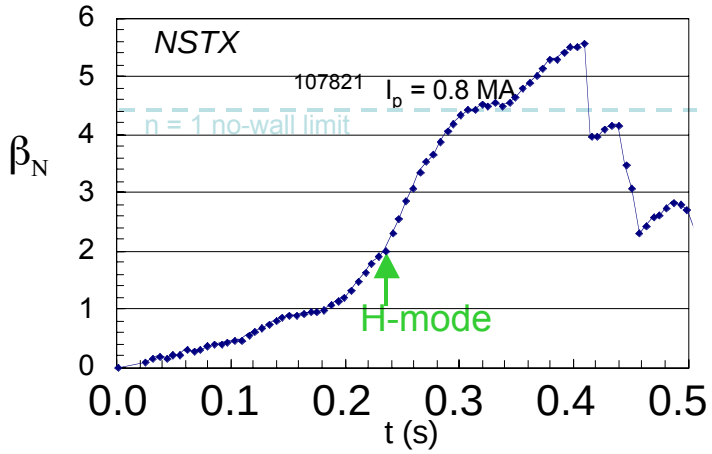
- MHD: predictive capability
- Turbulence and transport: turbulence exp't/theory comparisons
- Wave-particles: predicitve capability
- Boundary: advance ability to predict at high flux levels

- 10 year IPPA goals in all four areas
  - Develop fully integrated capability for predicting performance of externally controlled systems
  - Advance the forefront of non-fusion plasma science across a broad frontier
- To further this: let's develop advanced diagnostics and research with other facilities (DIII-D, C-Mod, JET, MAST, ASDEX-U, ...)

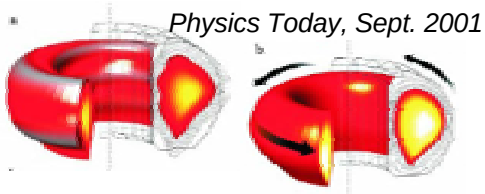
Charge #3: In your discussions, identify inter-device research opportunities, and research and advanced diagnostics that will enable contributions to other fields (e.g. astrophysics)

We are already confronting the physics and control of beta-limiting modes in high performance plasmas

- Operation above no-wall limit seen at the highest normalized beta values
  - Wall stabilization?
  - Rotation effects?

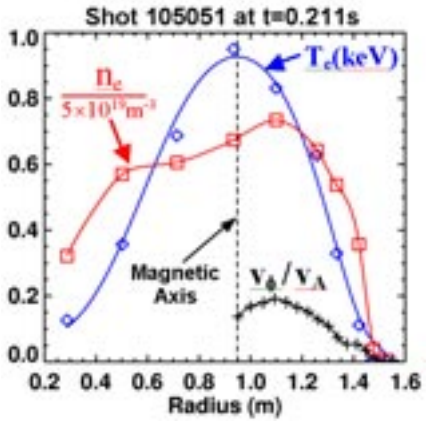


- Global modes: working group is already assessing stabilization strategies and needs



DIII-D
Physics Today, Sept. 2001

- NTM mode control an issue?
  - What are prospects and hardware requirements for EBW stabilization?
  - Rotational shear important?

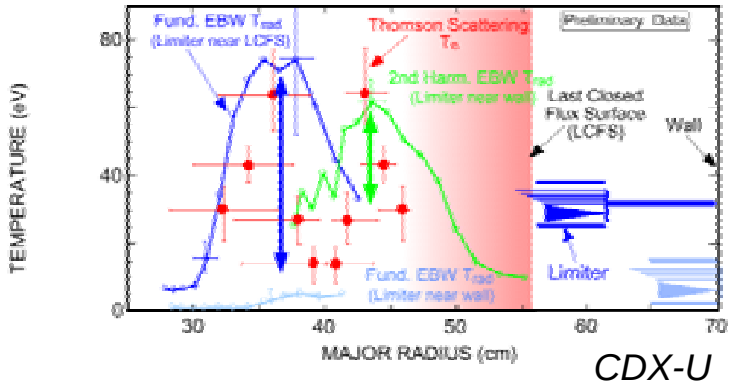


MHD discussions to move from the overarching to the specific

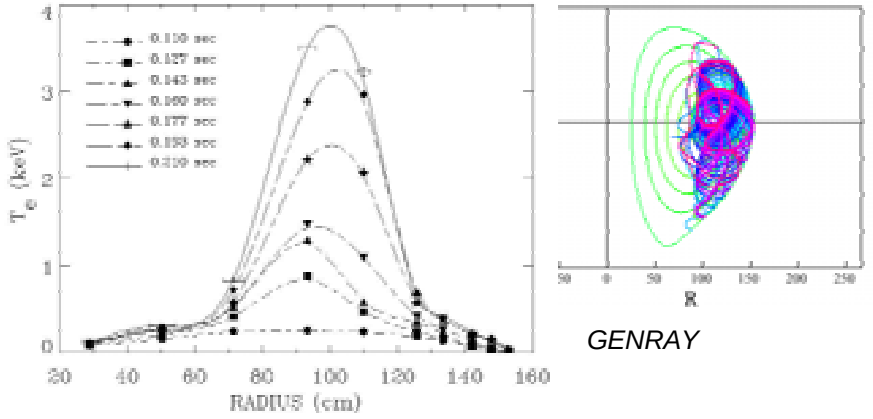
- 3.1 Long term program needs and implications for MHD (*Sabbagh, Gates, Menard, Maingi, discussion*) *Monday 1:30 - 3:15*
- 4.1 Physics goals, measurement, and theory needs (*Menard, Betti, R. Bell, Levinton, Peebles, Sabbagh, discussion*) *Monday 3:35 - 5:30*
- 5.1 Global mode stabilization (*Menard, Stutman, Navratil, Sabbagh, Kaye, Boozer, discussion*) *Tuesday 8:30 - 10:15*
- 6.1 Resistive MHD (including EBW & NTM) (*W. Park, Taylor, Pletzer, Sabbagh, Pacella, Stratton, discussion*) *Tuesday 10:35 - 12:15*
- 7.2 Transport/MHD/Boundary Combined (Pedestal, ELMs) (*Groebner, Kaye, Soukhanovskii, Bush, Snyder, M. Bell, discussion*) *Tuesday 1:30 - 3:15*
- 7.3 Fast particle MHD (TAE, CAE) and Astrophysics (*Gorelenkov, Heidbrink, Menard, Ji, discussion*) *Tuesday 1:30 - 3:15*

RF heating and current drive/initiation challenge central to our mission

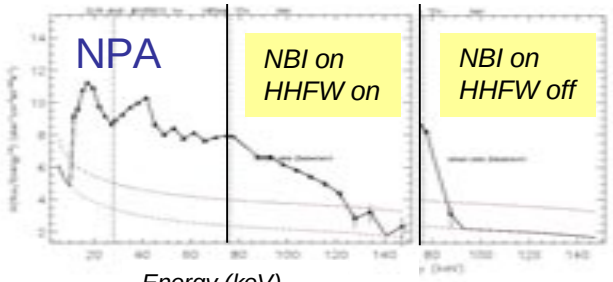
- EBW
  - What are resources required for non-inductive startup & mode stabilization?
  - What are opportunities with other facilities?
- HHFW
  - Early success with heating, fast particles, CD
  - What experiments, modifications, theory is required to take a qualitative step forward?
- CHI
  - Great progress, but what are the requirements for hardware and theory to establish its viability?



CDX-U



GENRAY

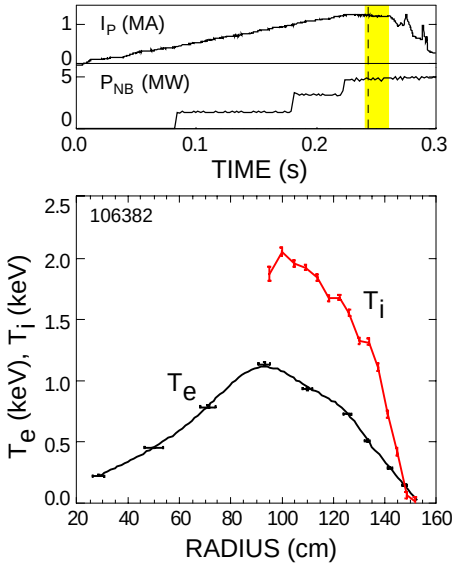


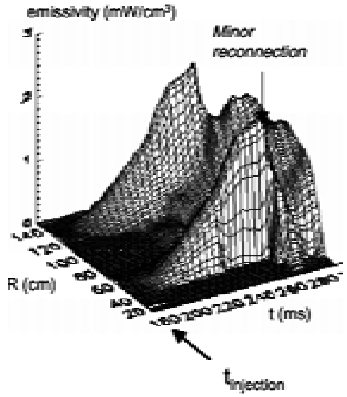
Heating/CD discussions will start with where we are, and will outline options to get to the desired goals

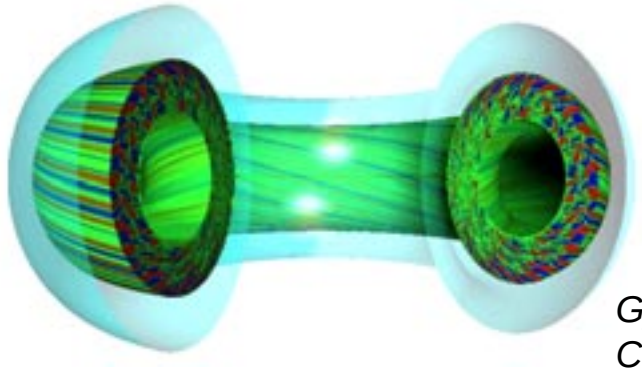
- 3.3 EBW: Goals for 2004 - 2008, Exp't Needs, Technology Issues, Theory, Modeling needs Monday 1:30 - 3:15
- 4.3 Coaxial Helicity Injection (*Schaffer, Raman*) Mon. 3:35 - 5:30
- 5.2 EBW Summary Discussion; HHFW (Discussion of goals, experimental plans) Tuesday 8:30 - 10:15
- 6.2 HHFW: Discussion of Technical plans, theory and modeling, diagnostics) Tuesday 10:35 - 12:15

Transport opportunities community-wide are deep, and NSTX can make high leverage contributions

- NSTX transport results suggest ion thermal transport is quite low; ideal lab for ETG turbulence?
- Nature of heating
  - Stochastic heating, if true, has deep implications
  - New physics in Qie? Research ideas?
- Critical broad issues: low and high k turbulence; turbulence dynamics at high β
  - ST need and opportunity
- *Diagnostics need to move in step with computation* - what are the opportunities?







Gyro: Candy, Waltz

Transport discussions will target ST-specific questions and advanced diagnostic opportunities

- 4.2 Heating and power balance issues (*Kaye, Gates , Gorelenkov, Menard, Stutman, Soukahnovski, Heidbrink, discussion*)
  Monday 3:35 - 5:30

- 5.3 Diagnostic development: Core turbulence, Radial electric field (*Park, Munsat, Peebles, Levinton, dicussion*) Tuesday 8:30 - 10:15

- 7.2 Transport/MHD/Boundary combined: Pedestal, ELMs (*Groebner, Kaye, Soukhanovskii, Bush, Snyder, M. Bell, discussion*) Tuesday 1:30 - 3:15

- 8.2 Theory: electrons vs. ions, zonal flows (*Lee, Waltz, Dorland, Houlberg, Budny, discussion*) Tuesday 3:35 - 5:30

Boundary physics: new physics opportunities may be central to practical needs

- What is the nature of the underlying cross field transport, and its relation to parallel transport?
  - Implications for modeling?
- What are requirements for density control?
- What do we have to do and model to establish basis for long pulse heat and particle management?

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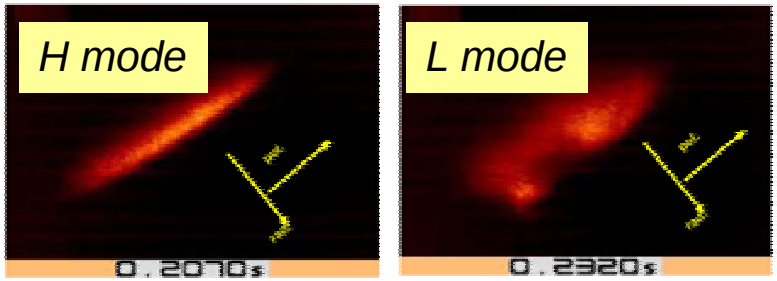
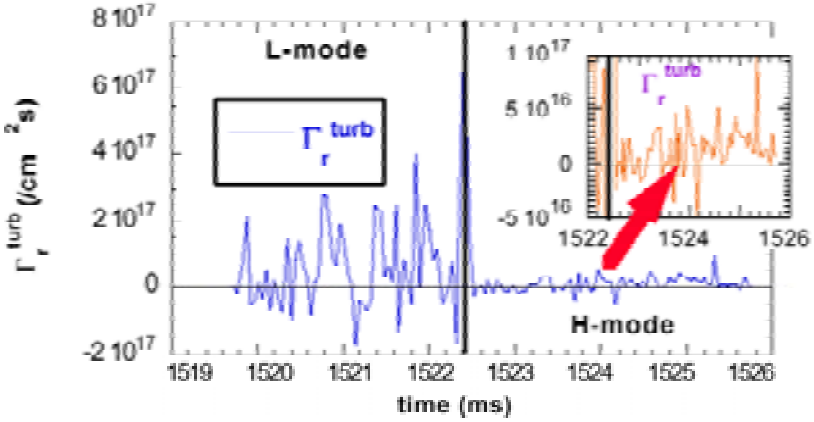




Boundary physics discussions will start will focus on fueling, particle and power handling, and edge transport

- 3.2 Particle Control and Fueling (*Maingi, Kugel, Kaita/Ulrickson, Menon, Soukhanovskii, Rasmussen, discussion*) Monday 1:30 -3:15

- 6.3 Edge Transport and Turbulence (*Maingi, Kugel, Xu, Boedo, Fenstermacher, Harvey, Stotler, discussion*) Tuesday 10: 35 - 12:15

- 7.2 Transport/MHD/Boundary combined: Pedestal, ELMs (*Groebner, Kaye, Soukhanovskii, Bush, Snyder, M. Bell, dicussion*) Tuesday 1:30 - 3:15

- 8.3 Power handling and impurities (*Maingi, Kugel, Paul, Skinner, discussion*) Tuesday 3:35 - 5:30

An attractive ST demands that integration of topical elements be a high priority

- Can we control a high beta, high bootstrap fraction, high heat flux plasma for long periods of time?
- What are the key elements in each area that have to be exercised simultaneously to achieve this?
- All of the topical discussions will have important integration elements to cover
- Integration discussions: All of Tuesday afternoon

This morning: plenary discussions, including input from other programs

Monday, June 24, 2002

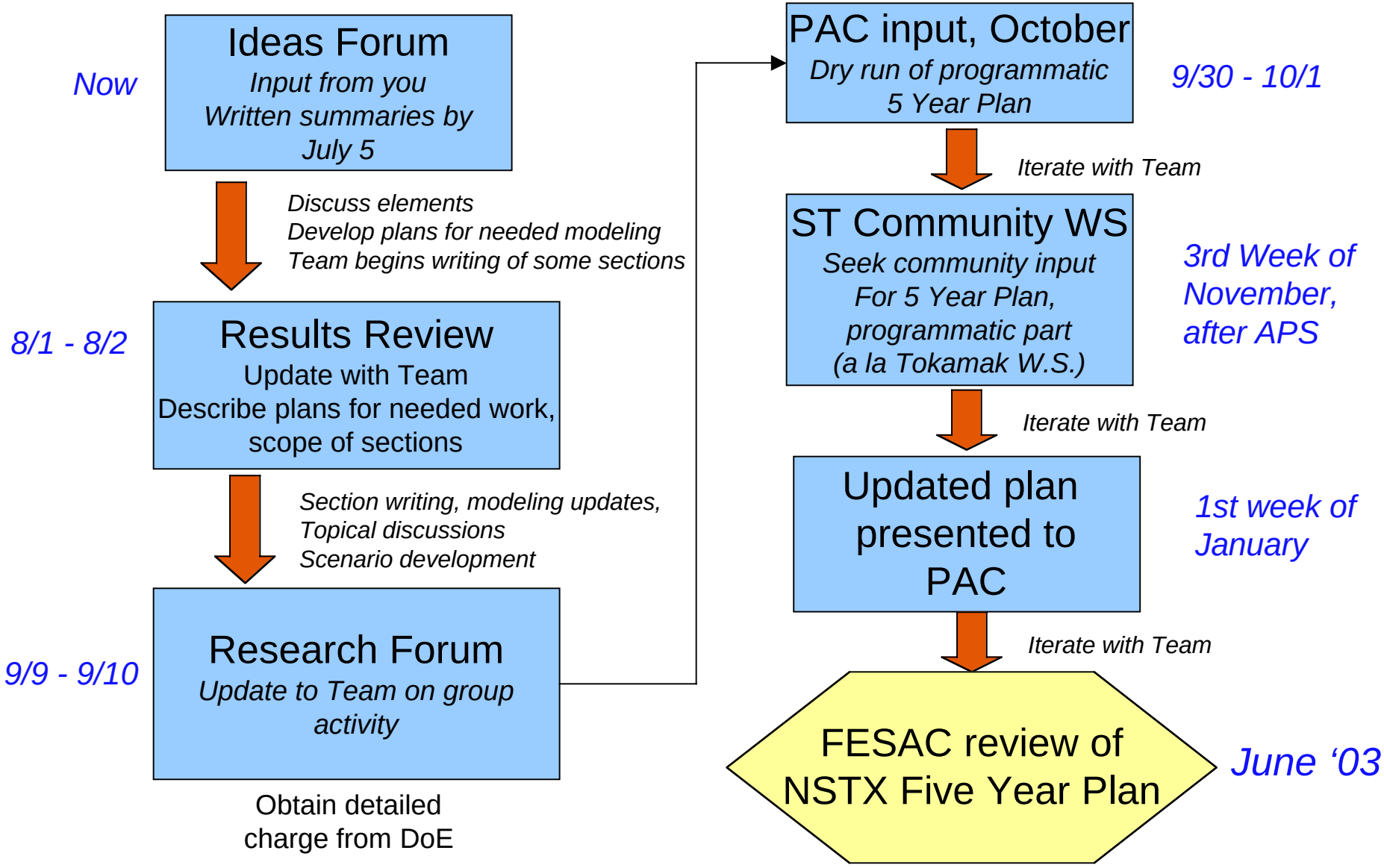
1. Plenary - *Gottlieb Auditorium*

Welcome	Director's Office and D. Priester, DoE	8:30 – 8:45
1.1 Goals of Forum and Elements of a 5 Year Vision	Synakowski	8:45 – 9:15
1.2 NSTX Facility and Upgrade Possibilities	Ono	9:15 – 9:40
1.3 The C-Mod Program and Plans for AT Scenario Development	Bonoli	9:40 - 10:20
- *Break* -		10:20– 10:40

2. Plenary *–Gottlieb Auditorium*

2.1 The DIII-D Program Plan for 2004 – 2008	Luce	10:40 – 11:20
2.2 The MAST ST Research Program	Akers	11:20– 12:00
2.3 Research on Pegasus	Fonck	12:00 – 12:15

This meeting is just the start of the planning process



Three charges are given to the discussion groups

Charge #1: Identify the scientific opportunities and issues that must be addressed to reach the IPPA 5 and 10 year goals

Charge #2: Identify the major hardware opportunities and issues that must be considered to meet the IPPA goals.

Charge #3: Identify inter-device research opportunities, and research and advanced diagnostics that will enable contributions to other fields (e.g. astrophysics)