



# Intro to Integrated Scenario Development

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# ISD Milestones

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- 03-2) Explore and characterize spherical torus plasmas having simultaneously good plasma containment and high plasma-to-magnetic pressure ratio for durations much larger than the energy containment times. (9/03)
- 03-3) Measure and analyze the effectiveness of using a combination of noninductive techniques to assist in startup and sustainment of plasma pulse lengths up to 1 s. (9/03)
- 03-4) Demonstrate on NSTX innovative techniques for starting up plasma currents in toroidal fusion devices that will allow these devices to be made simpler, run longer, and cost less to construct. (9/03)

# Machine improvements key to integration success

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- Error field reduction
  - Improved H-mode access
  - Higher beta limit
- High temperature bakeout
  - Better access to improved confinement
  - More flexible machine (easier to recover from events)
  - Better density control
- High field side gas puff
  - Better RF coupling in limited discharges?
  - Better H-mode access
- Improved control
  - Reduced plasma-wall interaction
  - Likely the key to success in CHI startup

# Goals of Integration ET

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- Simultaneous achievement of:
  - Long Pulse
  - High  $\beta$
  - Good confinement
- This implies steady state
  - Current drive?
  - Current profile control?
- Non-inductive Startup would be a huge benefit

# Control System Development Ideas

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- New Measurements (all need real-time interpretation)
  - Thomson scattering
  - CHERS
  - MSE
- Full kinetic rtEFIT
- RF - real time ray tracing?
  - Current profile control?
- NBI -real time Fokker-Planck? Monte Carlo?
- Real time MHD stability calculations ?

# Sustained development effort required

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- Different types of expertise required
  - Diagnostic interpretation
  - RF power deposition
  - NBI deposition
  - Plasma dynamics modeling on multiple time scales
  - Transport modeling
  - Control theory
- Standard analysis codes need to be modified for real time
  - Accuracy less crucial relative to speed

# Summary



- Integrated scenario development new task - likely to be a challenging one
- Any ideas on how to achieve this goal are welcome
- Non-inductive startup and sustainment are essential for the success of the ST concept
- Machine improvements will change the operating regimes of the experiment - need to remain flexible
- Physics based plasma control will be required in order to achieve steady state
  - Physics based plasma control requires sustained development effort