ST Macroscopic Equilibrium and Stability Summary and Comments

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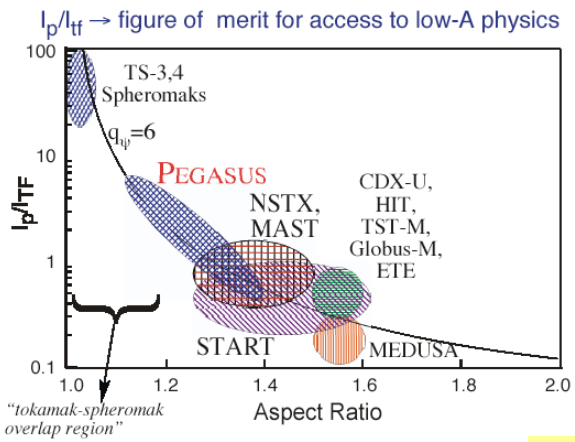
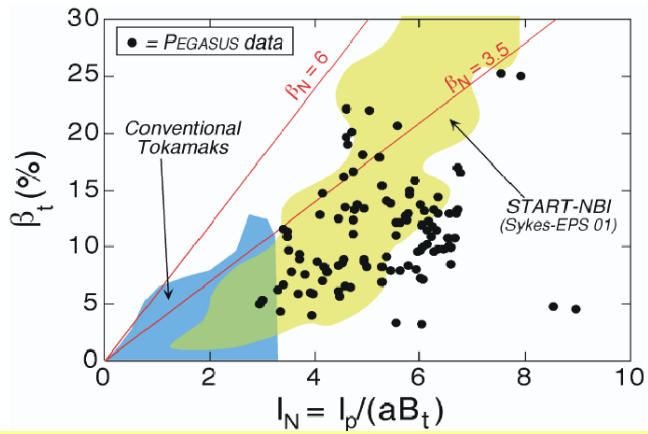
Exciting developments in experiment are mirrored by progress in theory/computation

- *Five presentations where given:*
  - Sontag: Equilibrium and Stability Characterization of A < 1.3 Plasmas in the PEGASUS Toroidal Experiment
  - Gates: NSTX Stability Properties
  - Micozzi: Ideal MHD Stability Diagram of Simply Connected Magnetic Configurations with Unitary Beta
  - Hayashi: Nonlinear Simulations of MHD Activities in Spherical Tokamak
  - Park: M3D Simulation Studies of NSTX
- Progress in Theory/computation & experiment coupling is strong

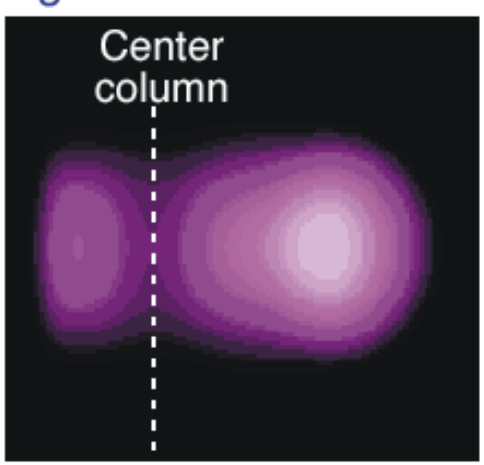
Pegasus making significant progress in exploring ultra-low aspect ratio





Sontag, U. Wisconsin

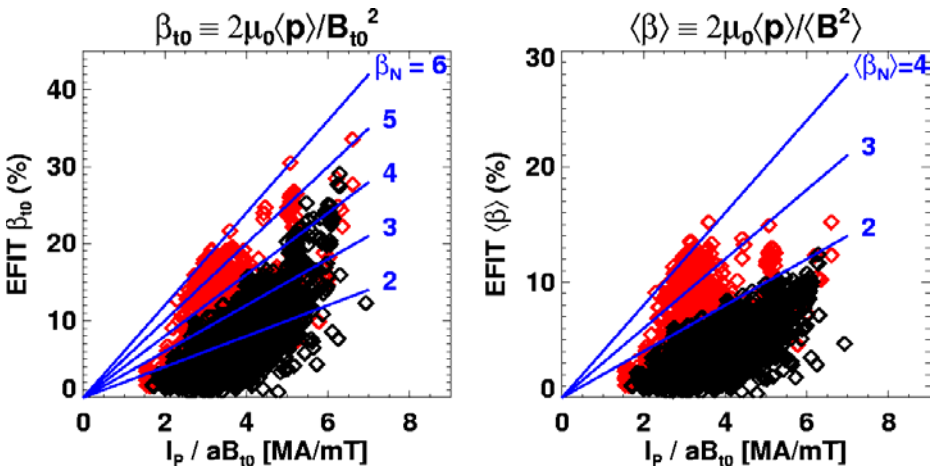
Tangential PHC SXR image



- Readily accesses 20% toroidal beta with ohmic
- Diagnostics enabling assessment of profiles: ~ 0 central shear
  - critical measurement for MHD theory assessments
- Soft limit with I_p observed
  - role of resistive MHD & reduced V-s with reduced TF being explored

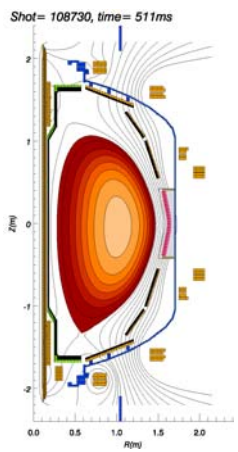
Very encouraging results. Looking forward to higher elongation operations. As capability improves, how do we best take advantage of overlap with "conventional low A"?

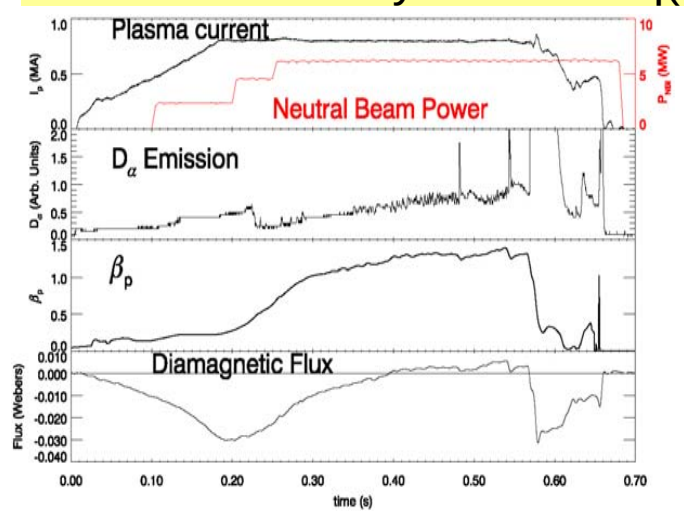
High beta regimes explored on NSTX



- Ideal no-wall limit exceeded: rotation likely playing a role
  - Wall coupling
  - Saturation of internal modes?
- Ideal with-wall limit encountered?
- Diagmagnetic plasmas generated
  - Is theory geared up to investigate diagmagnetic regimes?
- Detailed analysis awaits q(r,t)

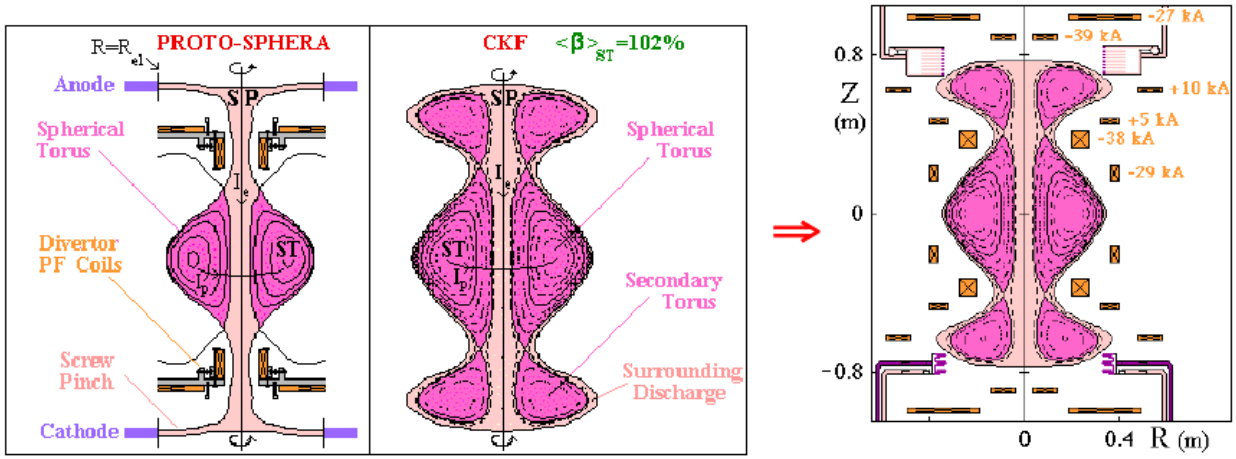
- What can we learn from MAST and moderate A in joint XPs (ITPA is ready)
  - Wall/no-wall
  - ELMs
  - NTMs
  - In what physics area should NSTX make the most sensible connection with Pegasus?



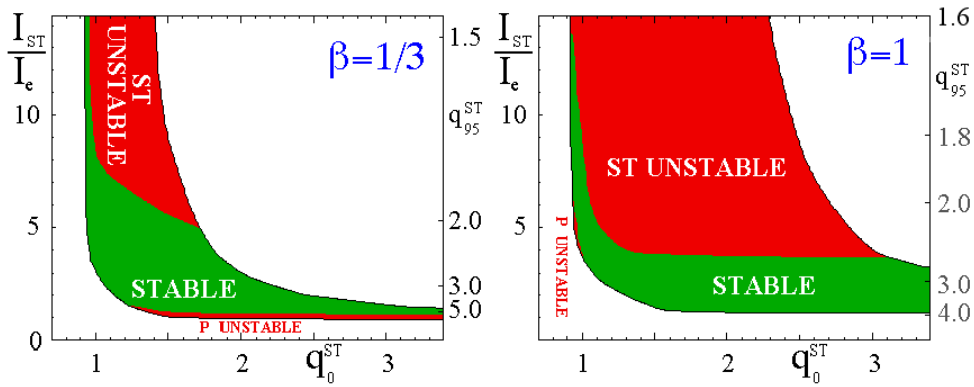


Gates, PPPL

Ideal stability calculations exploring viability of innovative configurations



- Ideal MHD stability boundaries of simply connected, unrelaxed CKF configurations explored
  - Analysis based on superposition of two axisymmetric, force-free fields
  - Stable regions found with unity beta for flat pressure; beta < 1 allows for some ∇p



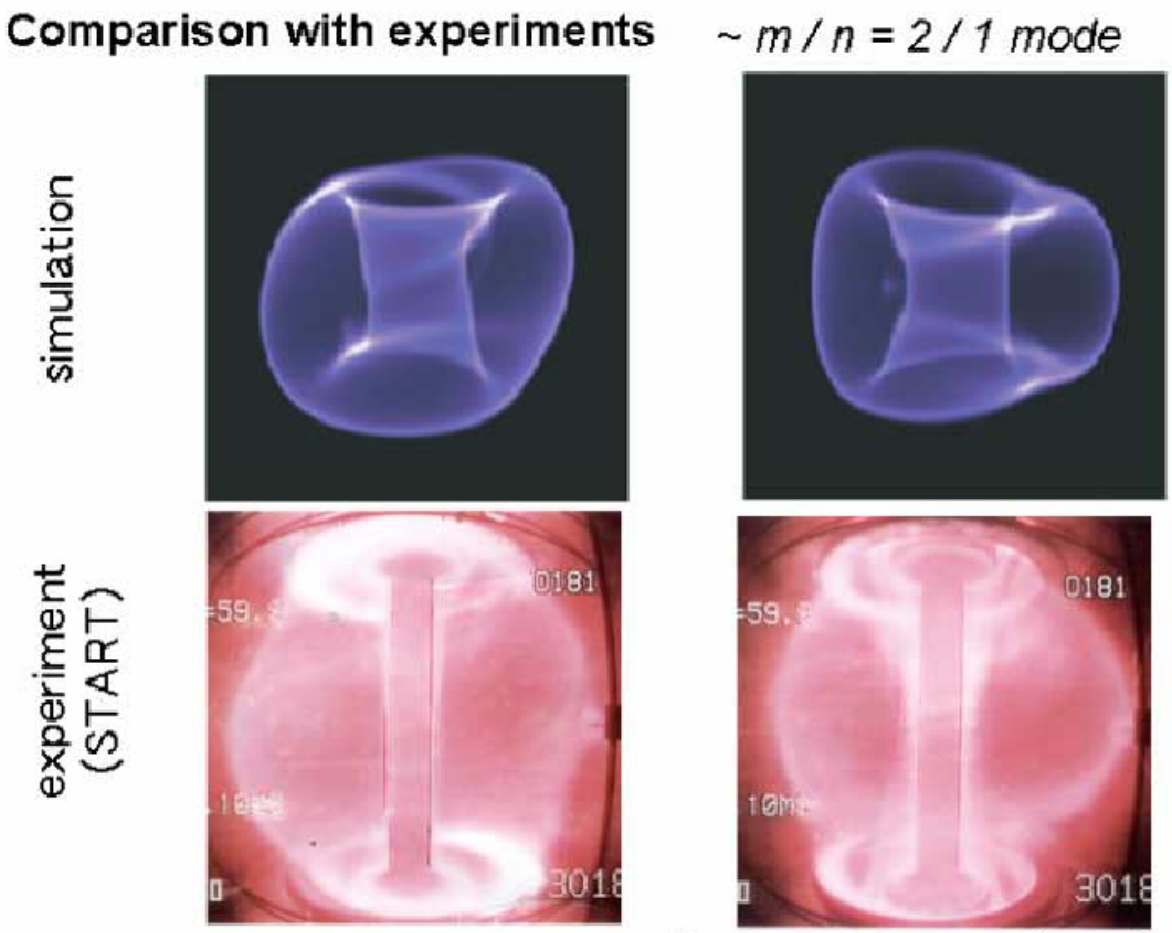
Stability even at β=1
in absence of any conducting shell around the plasma
for toroidal mode number n=1, 2, 3

- Can they be studied on PROTO-SPHERA?

Micozzi, CR-ENEA

Nonlinear MHD simulations capturing details of experiment

- Evolution of varoius kinds of relaxation phenomena in the ST
- Strong effort to simulate the measurement "eyes"

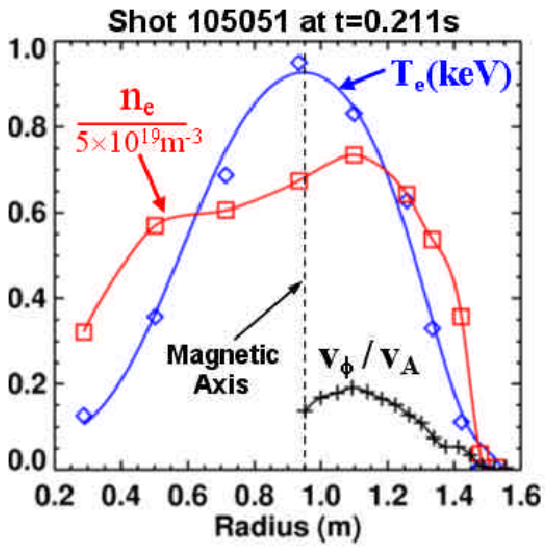


(by courtesy of Drs. A. Sykes and M. Gryaznevich)

Hayashi, NIFS

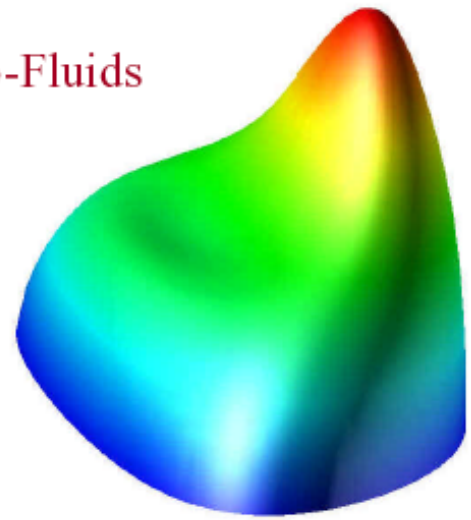
M3D code allowing direct comparison to experiment

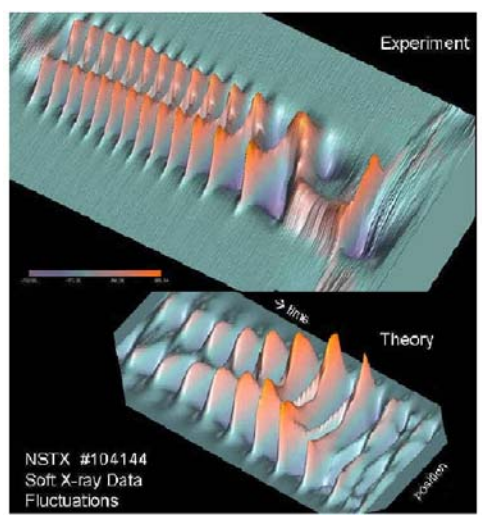
NSTX experimental data



• M3D project Various levels of physics explored. What is best to apply depends on the problem at hand

Two-Fluids





• Measured : asymmetric density with strong rotation seen in the code. scale length on-axis accurately reproduced

- General character of internal modes reproduced but saturation and wall locking not in code results

- self-consistent treatment of rotation needed

Park ,PPPL

Are there ways we can improve how we go about the business of experiment/theory comparision?

- Theory & experiment results are impressive.
  - Theory results are highly relevant to what experiments do
    - Guiding new concept ideas, helping advance present devices, highlighing experimental signatures to look for - but can we do better?
  - Are the right measurements being made for comparison to the codes? What measurements are missing?