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NSTX 2010 experimental proposals: LQG controller for RWM stabilization

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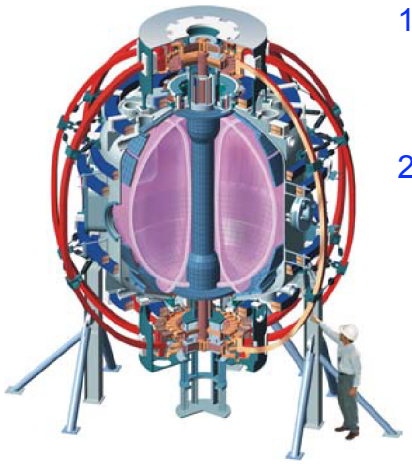

NSTX Research Forum
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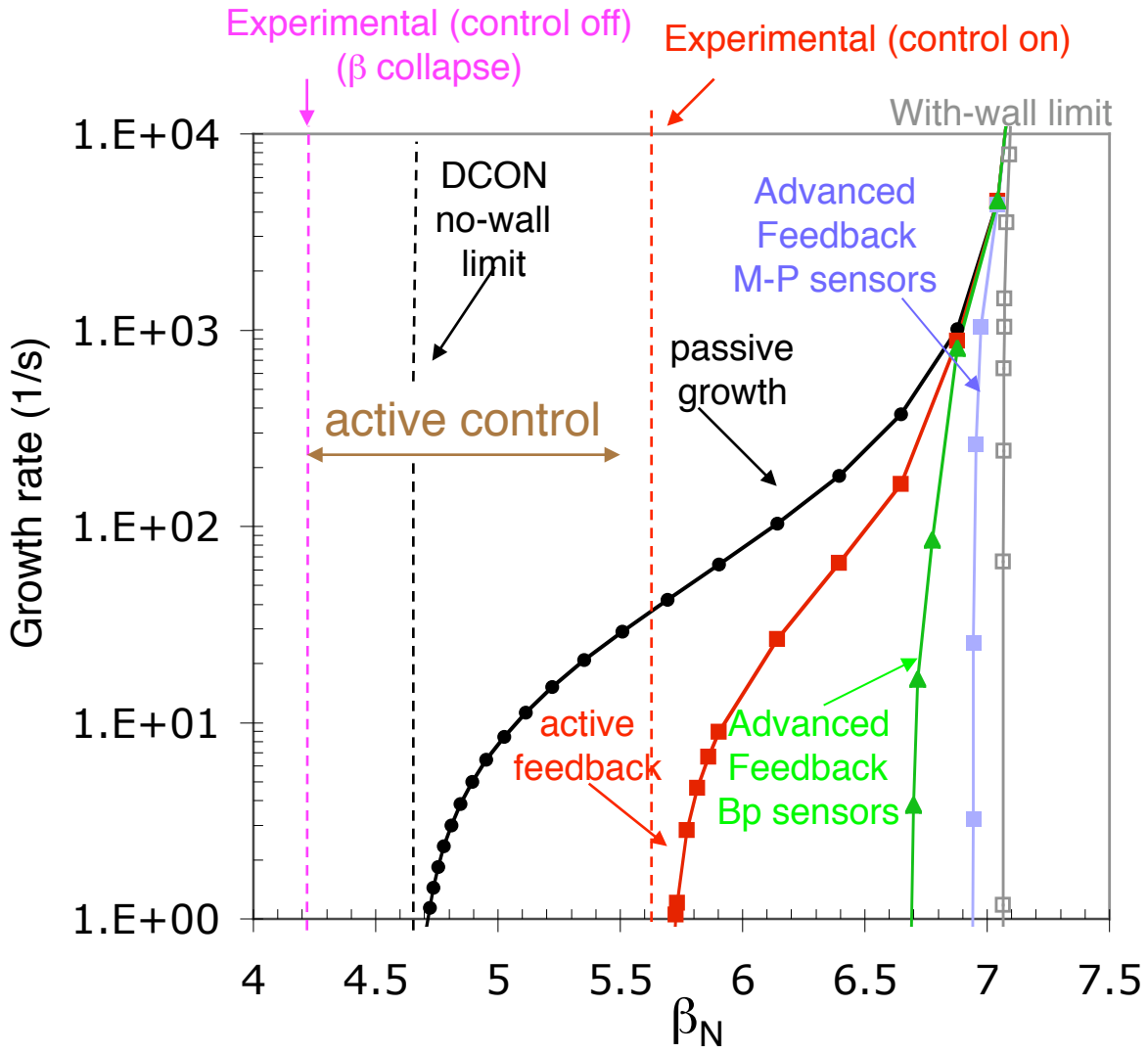
Princeton Plasma Physics Laboratory

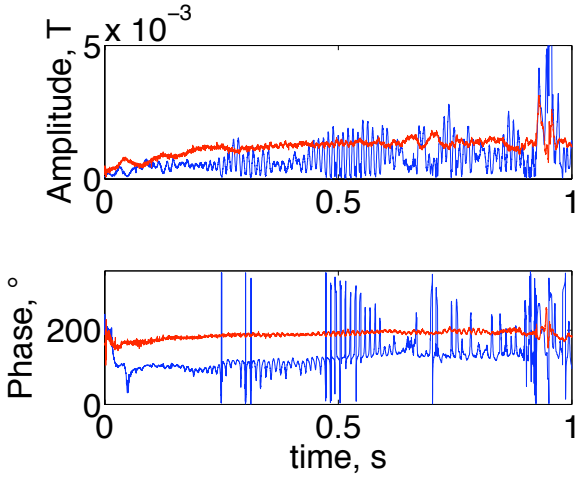
Linear Quadratic Gaussian controller (LQG) is theoretically capable of reaching higher beta limits

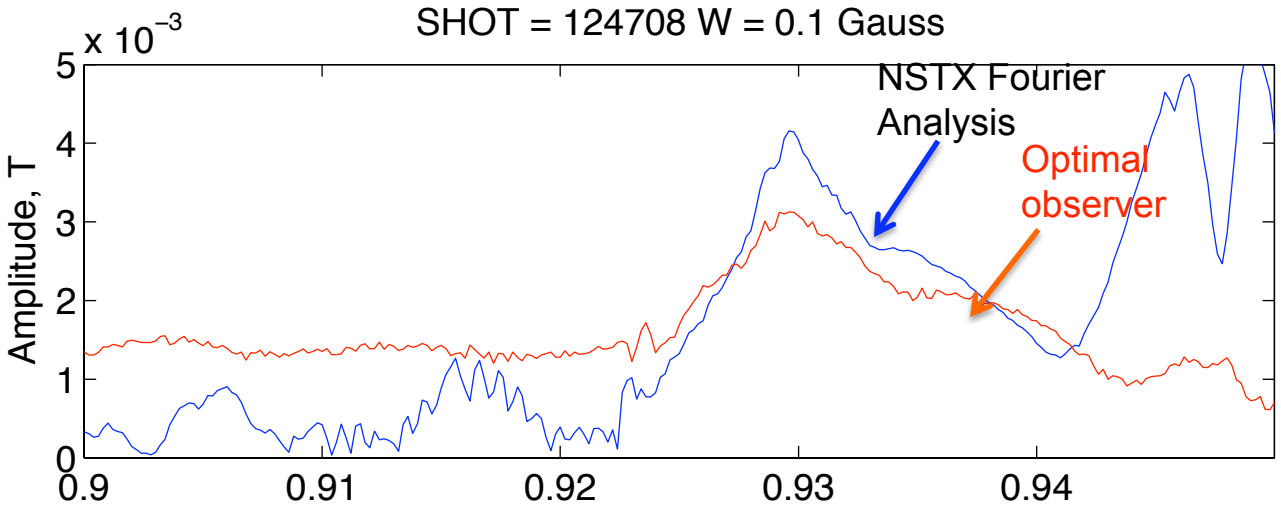
- Motivation
  - To examine stabilization of RWM using the newly-implemented LQG controller.
- Goals
  - Suppress RWM using LQG controller
  - Test the theory of state space based approach to RWM stabilization
  - Investigate the parameters of LQG implementation
  - Determine achievable beta normal for slow rotating plasma with LQG turned on
  - Estimate RMS of currents and voltages with LQG
  - Compare to PID performance
- Addresses
  - Milestone: NSTX R(10-01)
  - ITPA: NSTX R(10-01)

Advanced control techniques suggest significant feedback performance improvement for NSTX up to β_n/β_n^{wall} = 95%



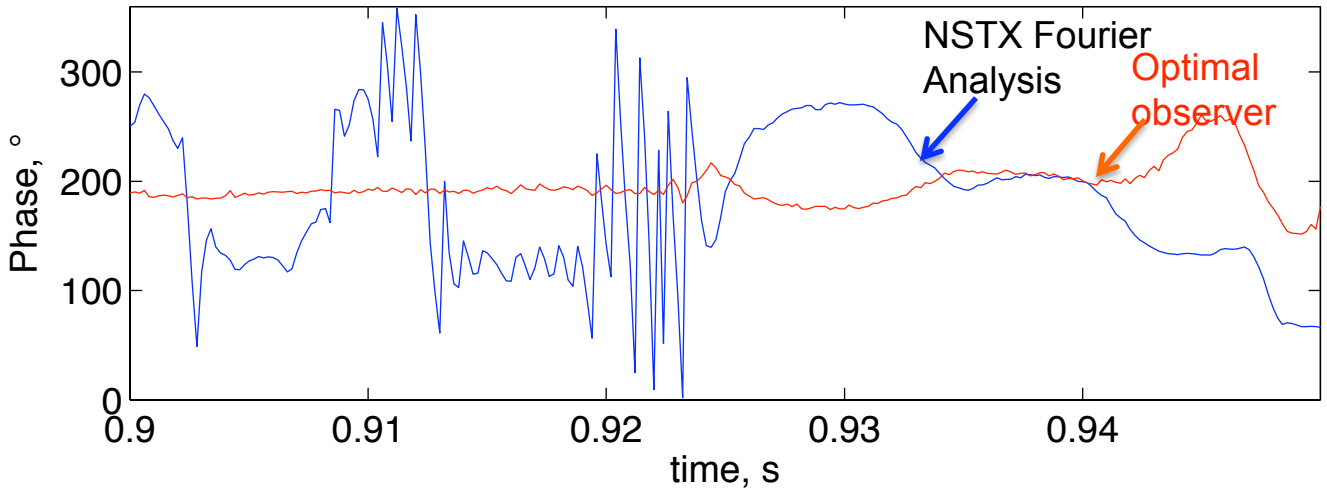
Preliminary results for mode amplitude and phase reconstructed by optimal observer for NSTX





SHOT=124708
Optimal observer parameters:

- Sensor noise 0.1 Gauss
- Number of states 7



LQG controller performance Run plan

Task	Number of Shots
1) Create a fiducial H-mode plasma or equivalent plasma (e.g. low l_i plasma) subject to an unstable n = 1 RWM to be used as a target, with n =3 magnetic braking used to create reduced plasma rotation.	
2) Slow rotating plasma	
A) Test various number of states	2
B) Test various noise amplitude	x 2
C) Test different filtered or non filtered Bp sensor data	x 2
3) Fast rotating plasma	
A) Test various number of states	2
B) Test various noise amplitude	x 2
C) Test different filtered or non filtered Bp sensor data	x 2
4) Comparison shots with PID controller	4
	Total: 20

1.5 run days requested ⟷

RWM XPs: Required / Desired Diagnostics

- The state-space LQG controller software available in PCS
- Required diagnostics
  - Internal RWM sensors
  - CHERS toroidal rotation measurement
  - Thomson scattering
  - Diamagnetic loop
- Desired diagnostics
  - USXR
  - MSE
  - Toroidal Mirnov array
  - Fast camera