

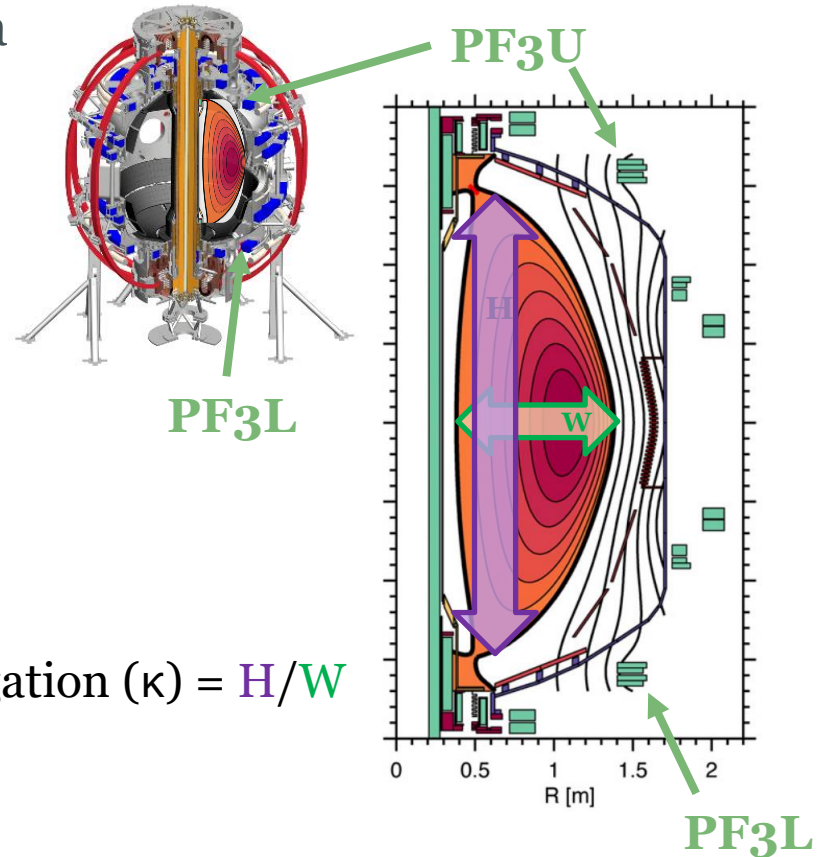
Improved Vertical Stability Model for NSTX-U

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Goal: Increase the elongation of the plasma

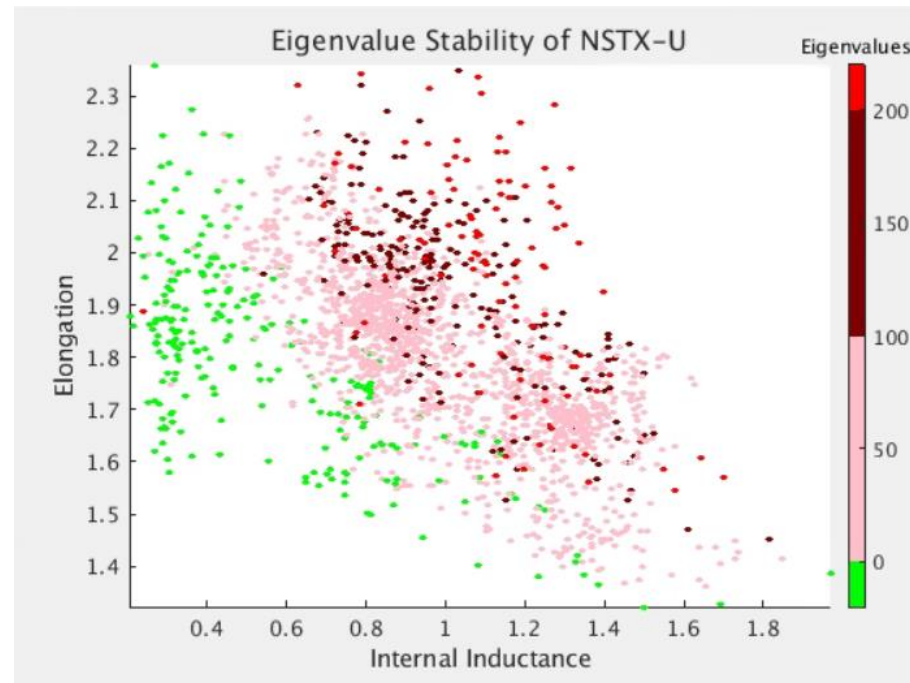
- Active Feedback allows for higher elongation limit
 - NSTX-U utilizes PF3 coil set as actuator
- Use modeling to understand elongation operation and limits



$$\text{Elongation } (\kappa) = H/W$$

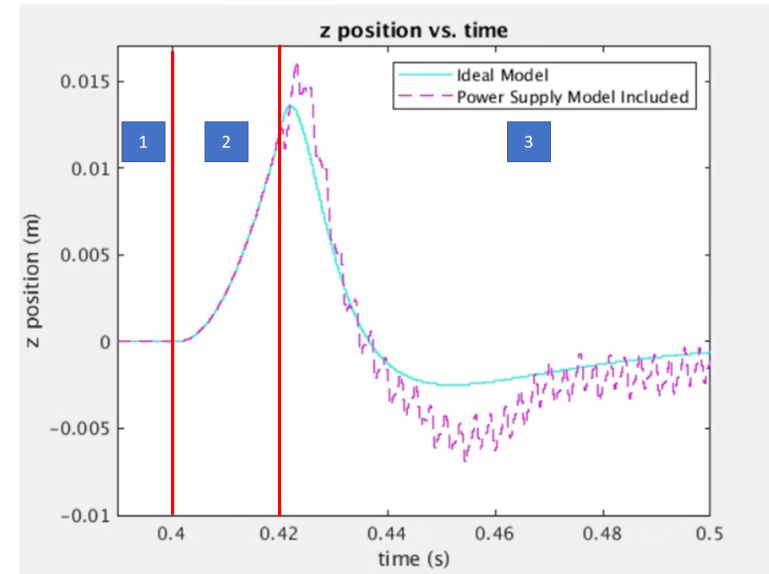
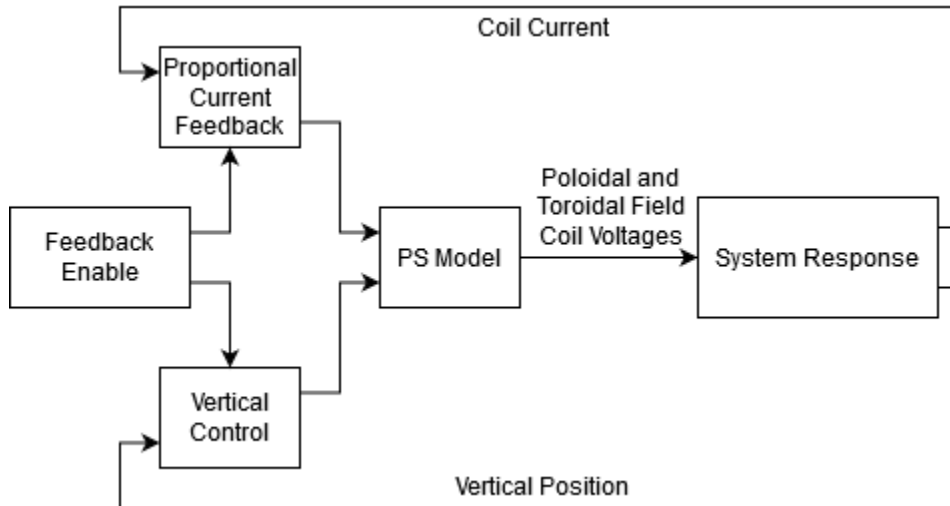


- Eigenvalues = measure of growth rate of vertical instability
 - Negative Eigenvalues are Open-Loop Stable
- Active Feedback has a threshold for controllable growth rate
- Higher elongation achievable at lower internal inductance





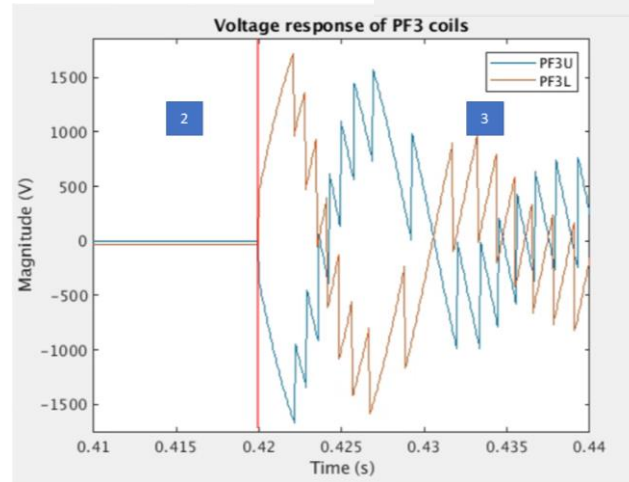
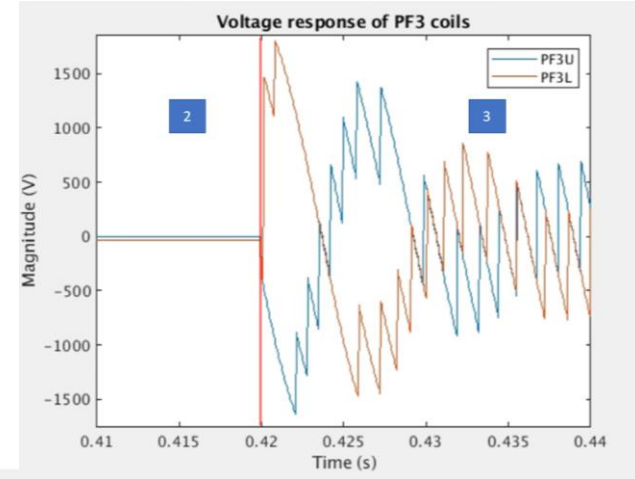
- Model was designed in SimuLink (simplified version below)
 - Power Supply model creates more realistic model
- Create a repeatable perturbation to vertical motion
 - Test the vertical position recovery





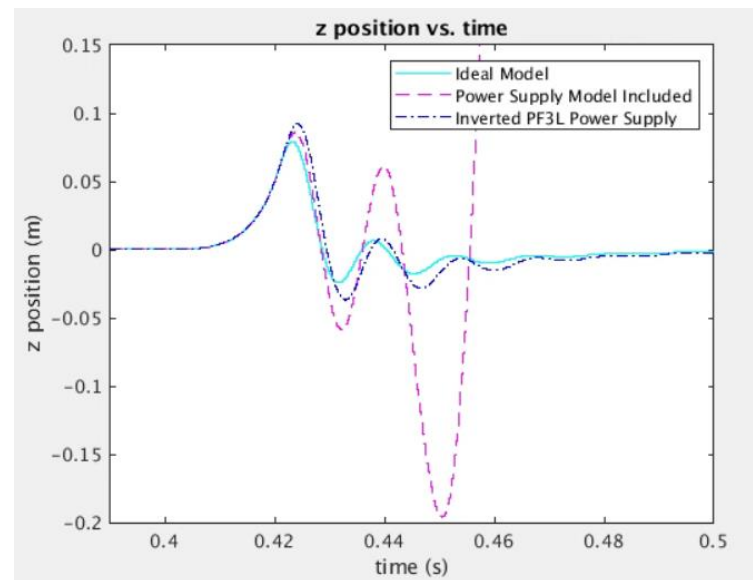
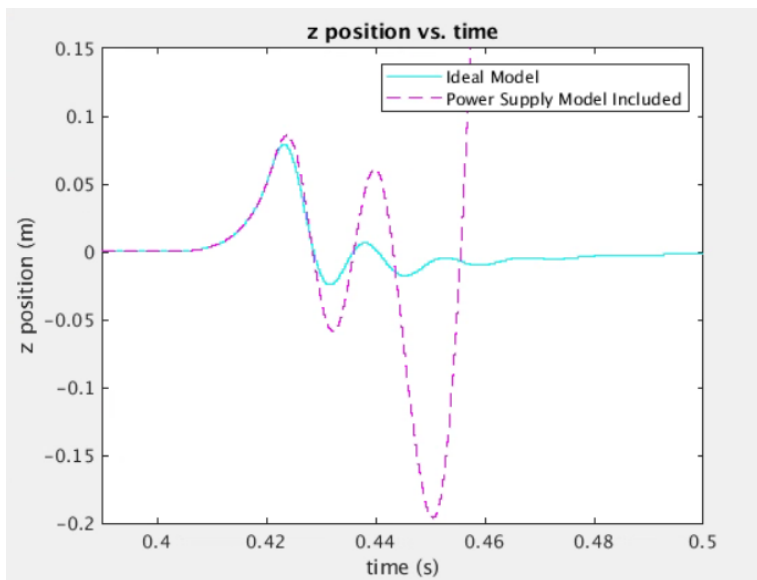
- Power supply voltage can respond more rapidly in one polarity
 - Voltage response of upper and lower coil are not symmetric

- The inverted orientation of PF3L causes a more symmetrical voltage response





- Power supply model can cause an ideally stable shot to become unstable
- Changing one power supply orientation can make the previously unstable shot stable again





The details of the power supplies affect the maximum plasma elongation.

- A more realistic model shows a lower controllability limit
- Changing the power supply orientation can change the result
- Including the power supply model in the simulations provides new opportunities to optimize the controllability



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