

# Direct measurement of plasma response using Nyquist Contour

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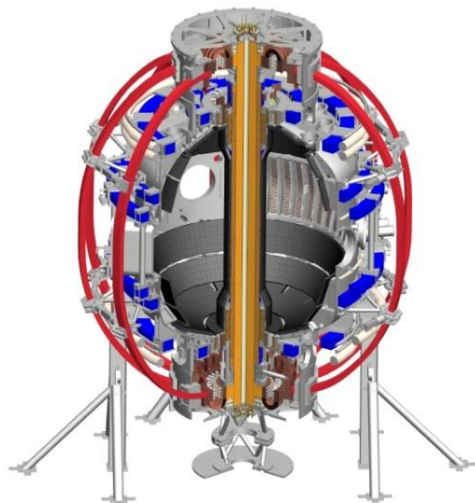
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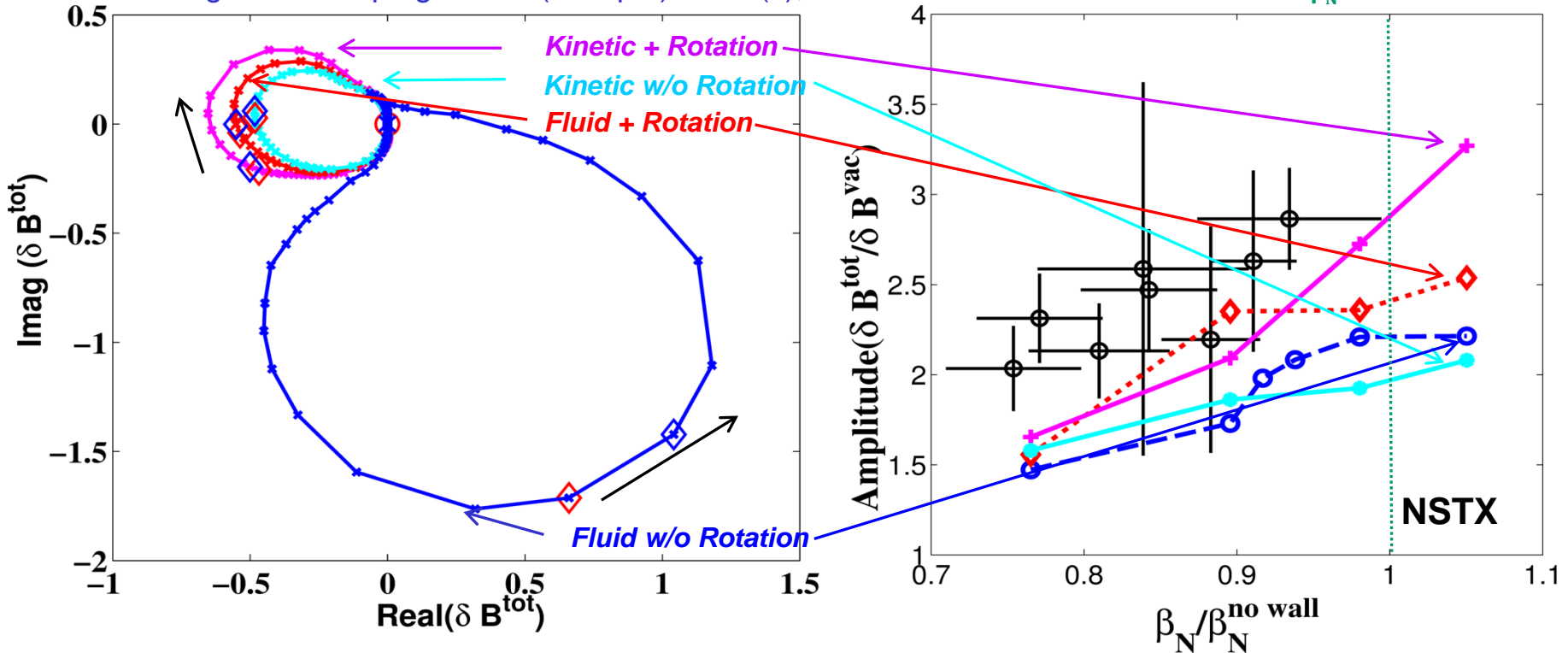
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# Plasma Response Study with Nyquist Plot in NSTX-U

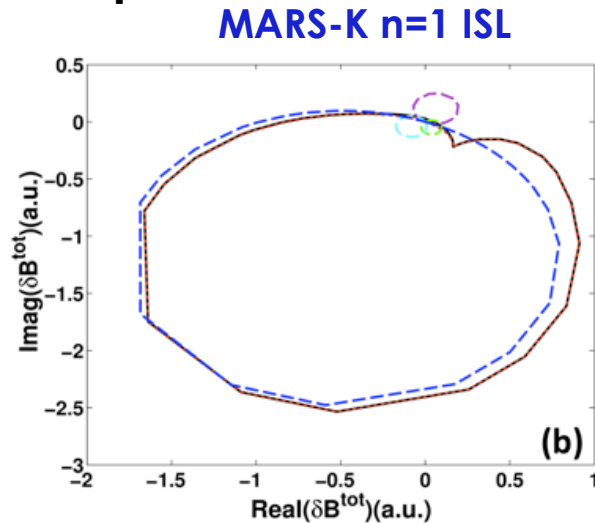
- Nyquist diagram can be generated by scanning coil frequency from -infinity to +infinity.
- Fluid vs. Kinetic plasma response shows different Nyquist contours.
- Comparing experimental and simulated Nyquist plots can
  - Validate kinetic plasma response physics;
  - Reveal multi-mode response to n=1 and n=2 perturbation;
  - infer growth/damping rate of (multiple) mode(s);



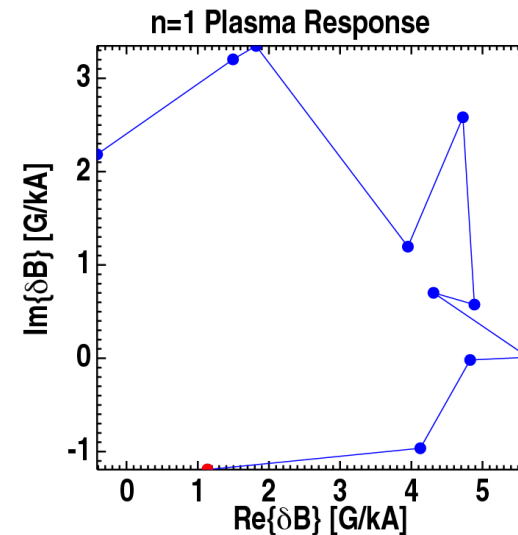
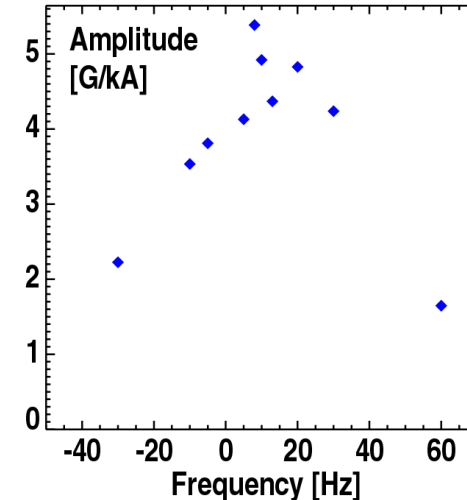
MARS-K can be used to perform modelling, and results to be compared with NSTX-U experiments.

# Existing DIII-D Data Shows Initial Evaluation of Nyquist Contour

- First I-coil frequency scans in DIII-D resolved peak in  $n=1$  plasma response
  - H. Reimerdes, PRL 2004
  - LFS magnetics reveal  $n=1$  structure
- **Nyquist contour similar to MARS-K model for weakly-shaped plasma**
- **Finish more complete frequency scan for  $n=1$  and  $n=2$  response in NSTX-U plasmas**



## 2003 $n=1$ ISLD Data – I-240 coil



Courtesy of M.J. Lanctot

# Shot Plan (1-2days)

- Option 1: beta value can be well controlled in each discharge
  - Find 2-3 target plasmas with the different beta value (below, near or above no-wall beta limit)
  - Apply magnetic perturbation and vary frequency up to +/- a few hundred Hz in steps
  - A number of discharge required to complete Nyquist contour will depend on shot duration
- Option 2: beta value cannot be well controlled
  - Find one target plasma with increasing beta value across no-wall limit
  - Apply magnetic perturbation with a fixed frequency in each shot
  - Change frequency from shot to shot to complete Nyquist contour
- Both  $n=1$  and  $n=2$  response experiment can follow above procedure