PPPL PRINCETON PLASMA PHYSICS LABORATORY

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NSTX

Measurement of asymmetric plasma response to applied field (XP704)

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NSTX MHD result review
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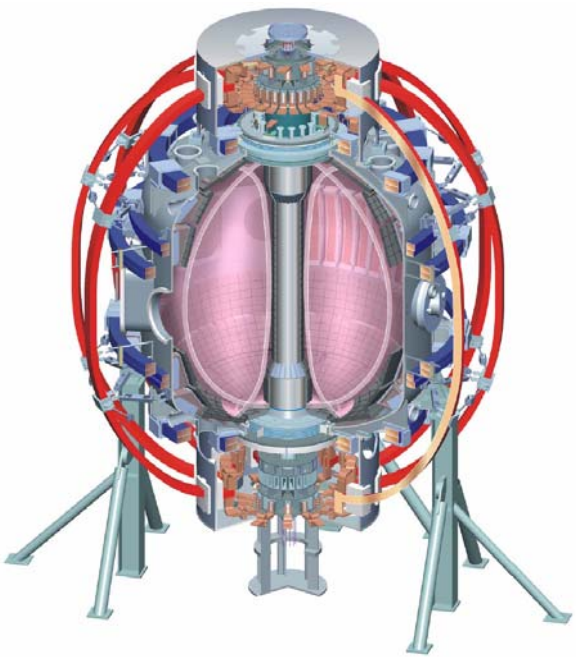

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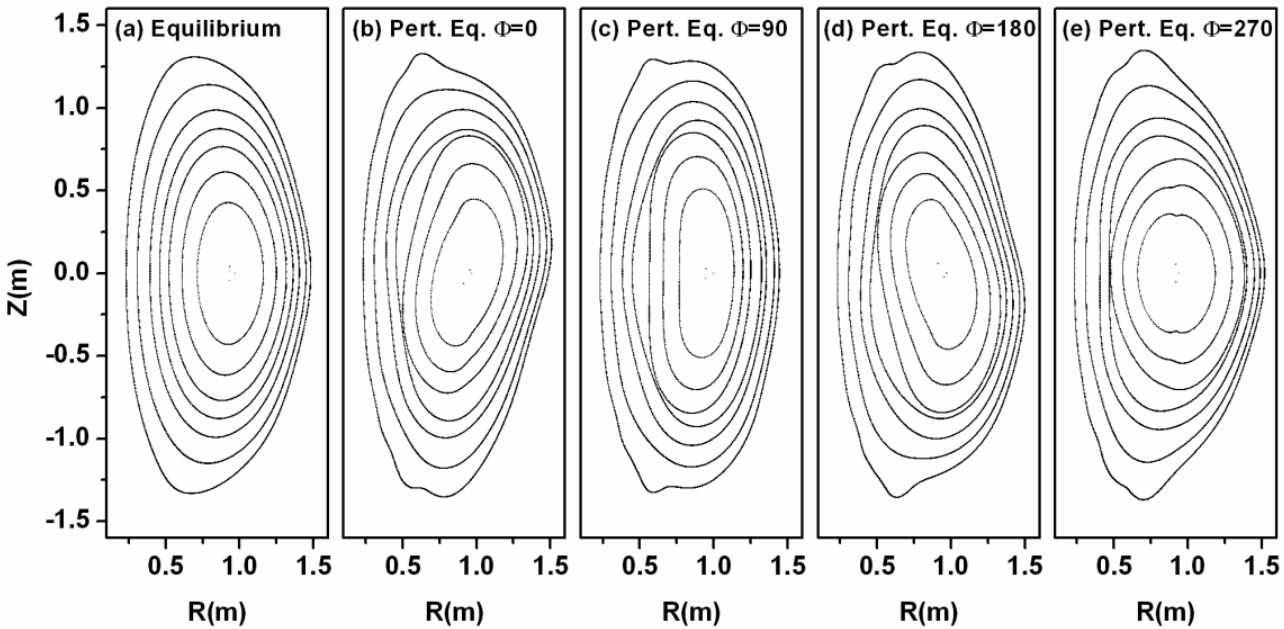
Experimental Goals

❑ Measure direct 3D plasma responses to asymmetric external magnetic perturbation and compare with the perturbed 3D equilibria computed by IPEC

❑ Study the feasibility of the ideal MHD approaches to the 3D plasma equilibria in tokamak plasmas and obtain useful information for future research of 3D effects in tokamaks

When applying n=1 external fields by EFC coils in NSTX

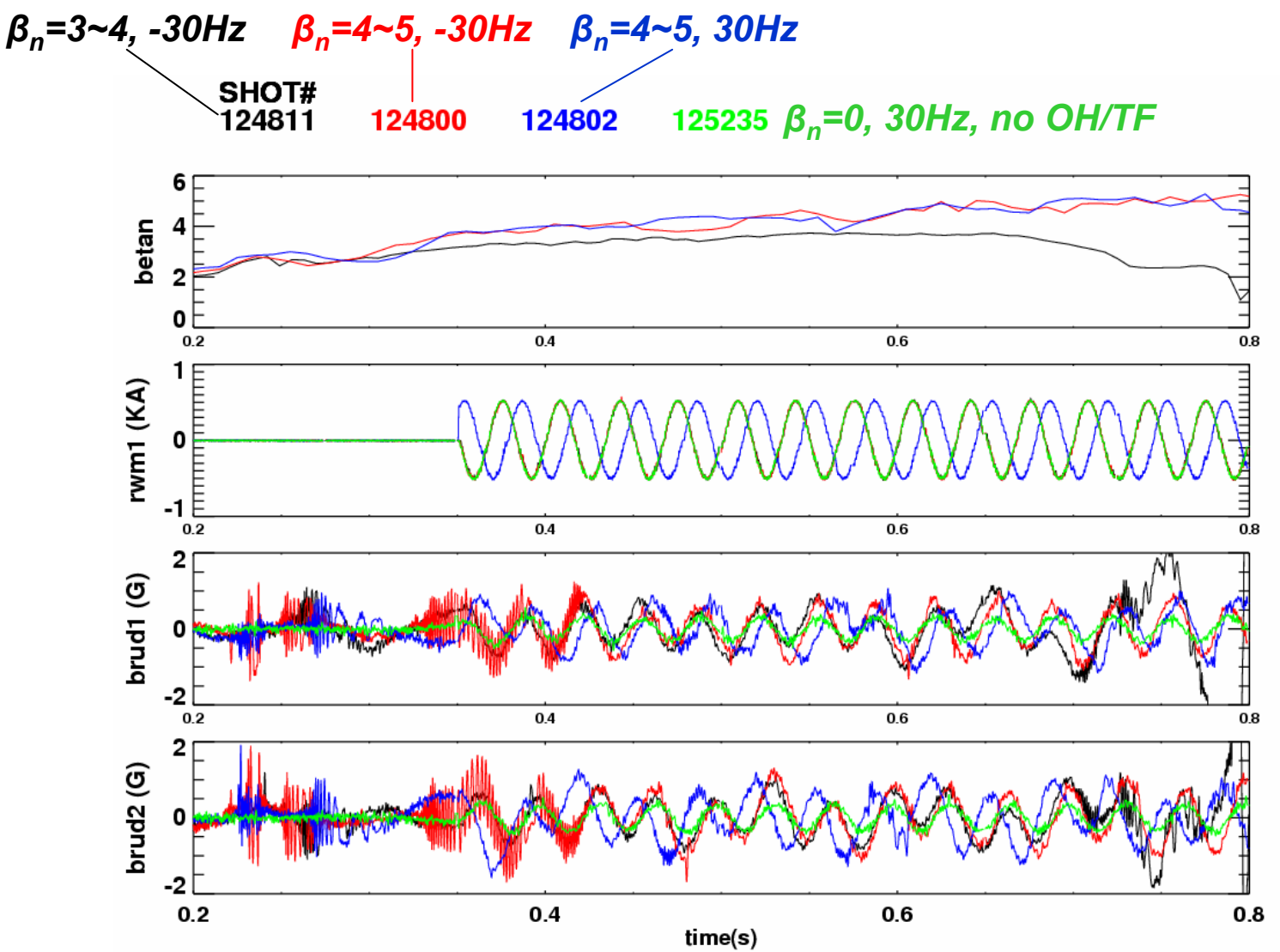


Diagnostics for asymmetric plasma response

- BR and BP sensors have cleanest n=1 plasma response:
  - Information in their spatial distributions are too complicated
  - Field differences between 180 apart sensors are used for measuring plasma amplification (Resonant Field Amplification, RFA)
  - **RFA's are measured at the range of applied n=1 rotating frequency (30Hz) from the sensors CAL_BB(P,R)RWMPPP(U,D)(1,2)**
- Langmuir probes have information, n=1 movement of X-point
  - They are not apart from by 180 in toroidal angle, however
  - Weighting factors are necessary to discriminate n=1 30Hz signals
- One or two shots have coherent 30Hz SXR signals
  - Assuming n=1 displacement, the amount of plasma displacement (~mm) will be analyzed and compared with computation

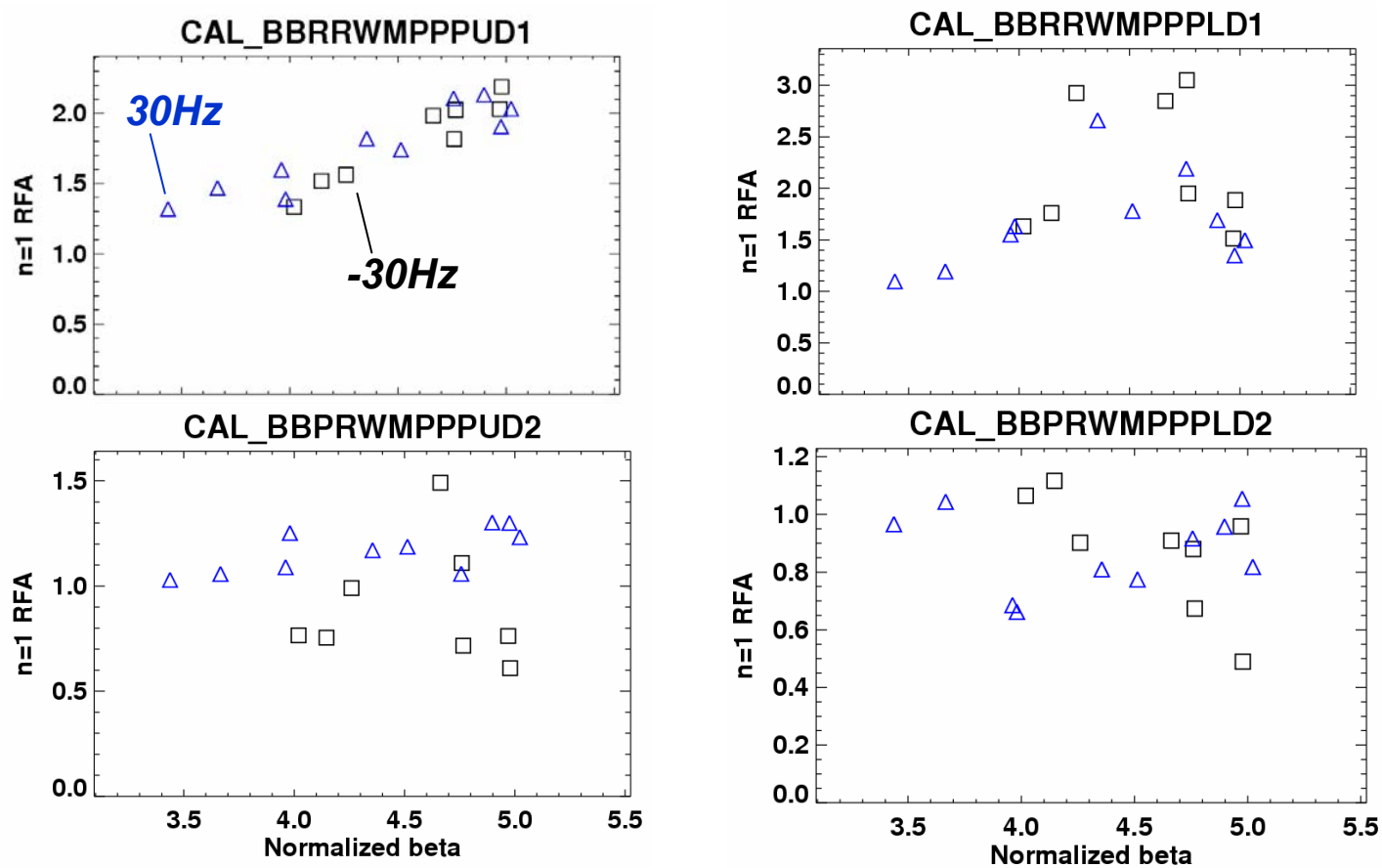
RFA by 30Hz n=1 fields in BR/BP sensors

- RFA = rms(30Hz n=1 fields in BR/BP sensors) w/o plasma



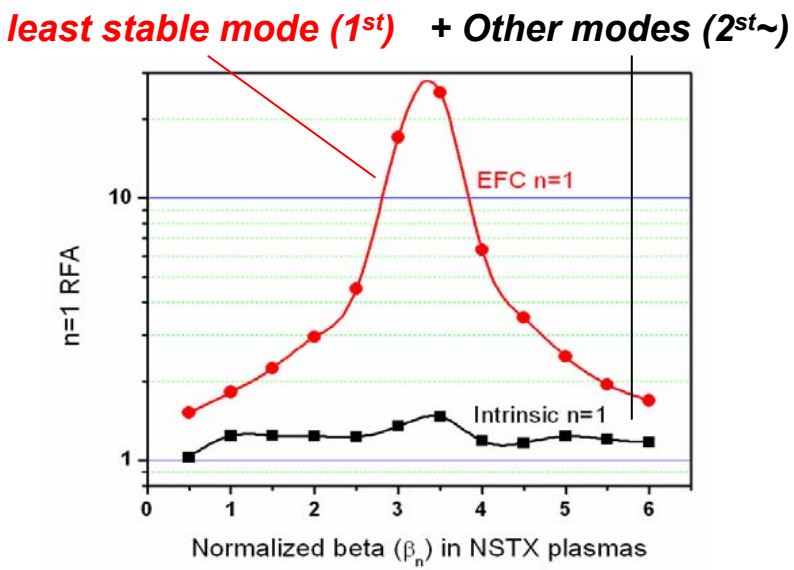
RFA as a function of normalized beta

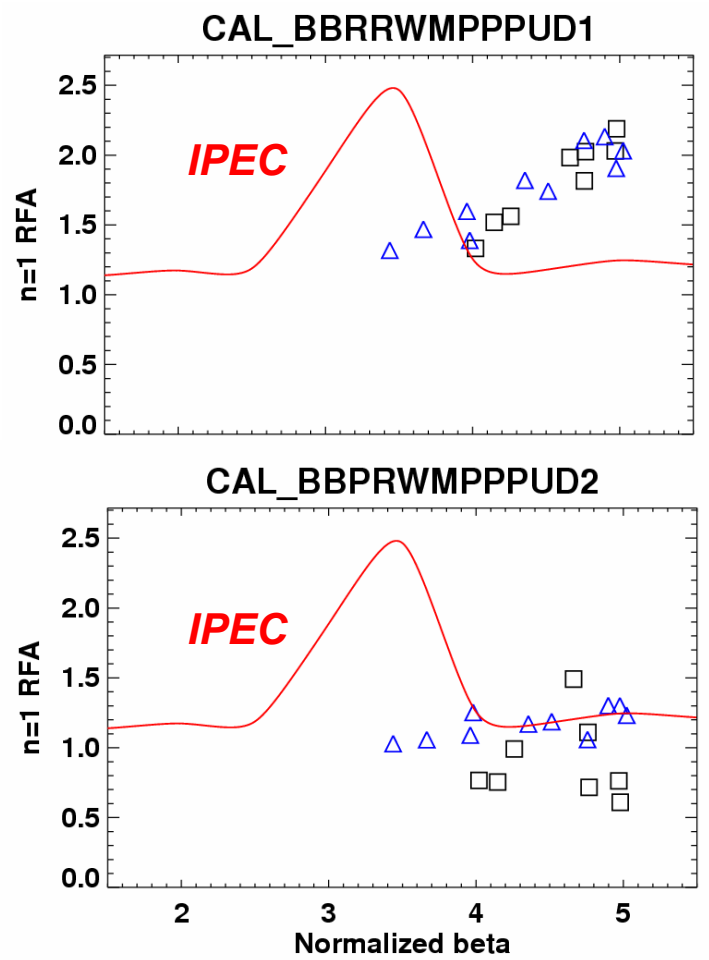
- RFA = rms(30Hz n=1 fields in BR/BP sensors) w/o plasma as a function of β_n within 3 periods of 30Hz signals
- No difference between co(30Hz) and counter(-30) responses indicates RWM-free plasma responses



Comparison with ideal theory

- RFA in ideal 3D equilibria = Plasma amplification on the boundary to (n=1 applied field + intrinsic field errors) using J. Menard's model at t=0.6s
- Multi-mode plasma response by IPEC gives similar expectations of RFA except for marginally stable plasma





Stable/Unstable plasma by ideal 3D MHD
Marginal plasma by ideal+viscous 3D MHD