



U.S. DEPARTMENT OF
ENERGY

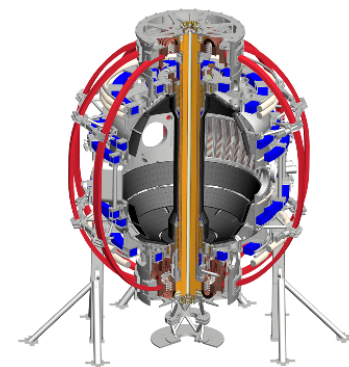
Office of
Science



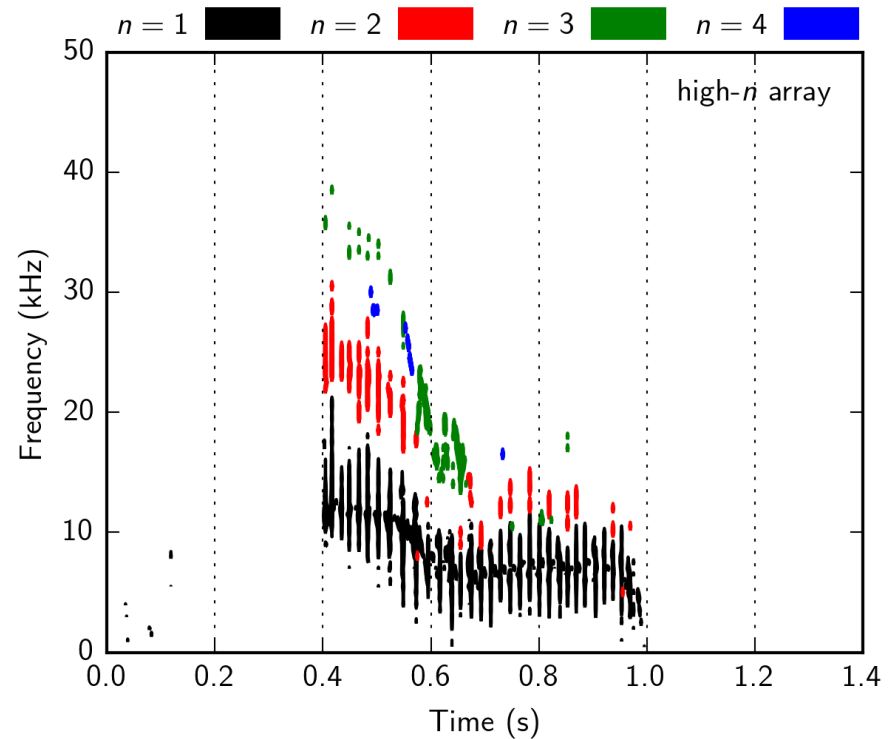
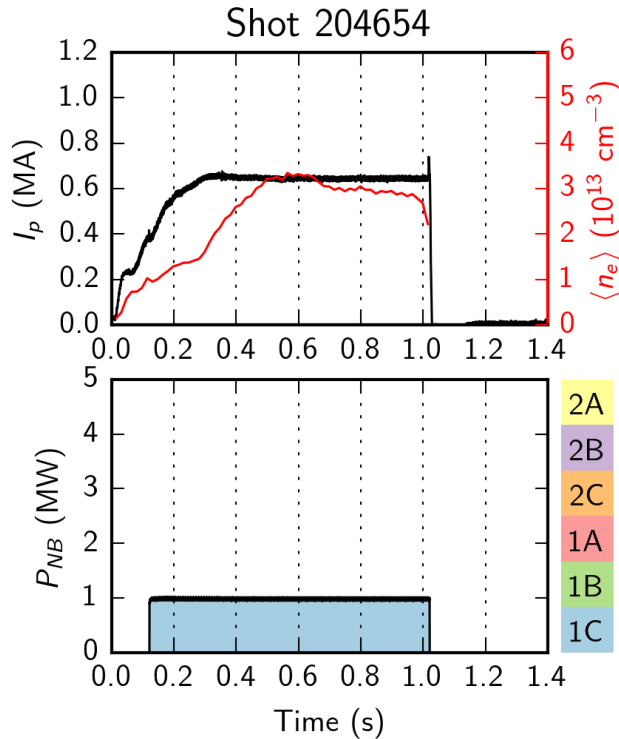
MHD Discussion

Clayton E. Myers

June 14, 2016

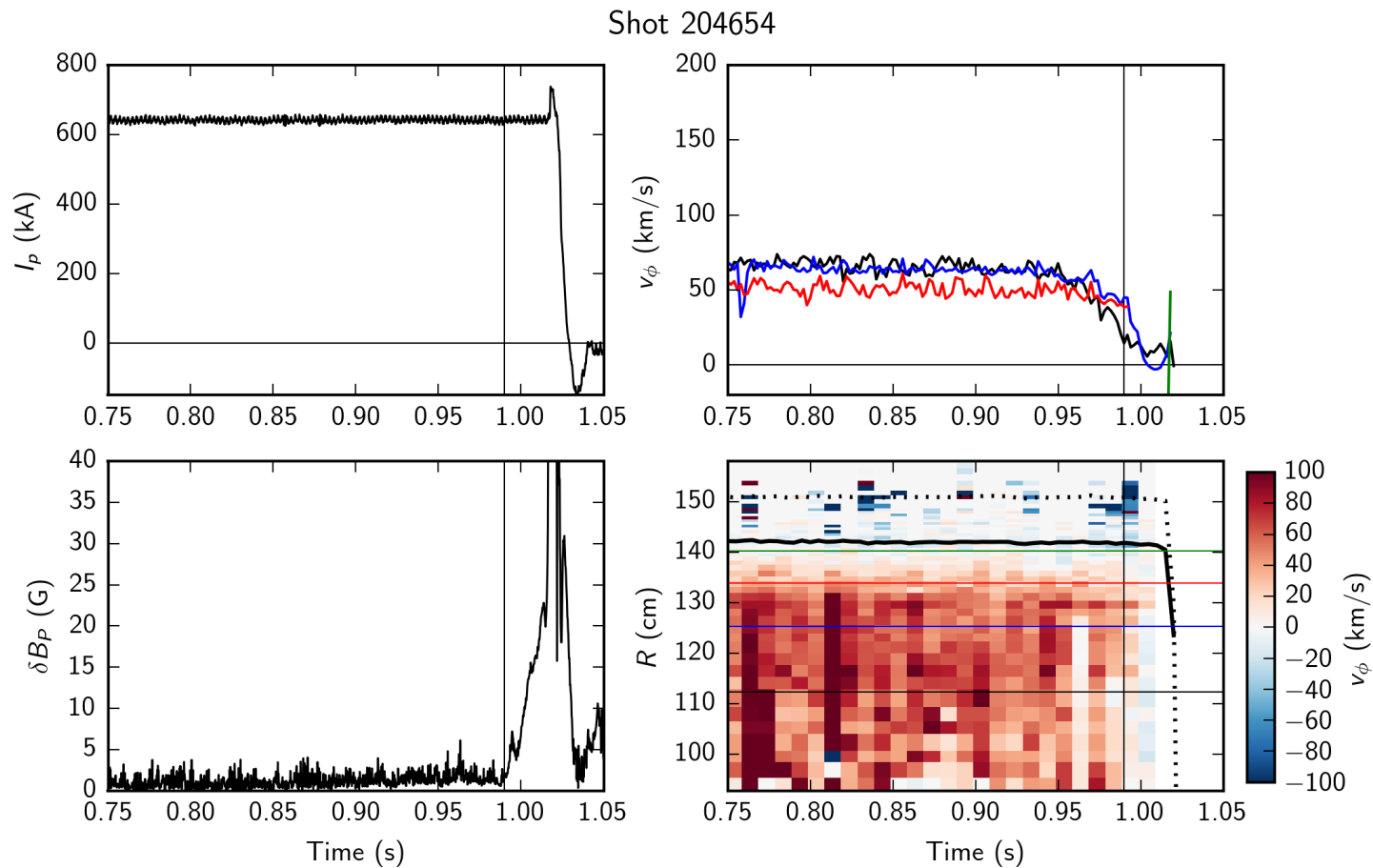


MHD activity – High-density compass scan

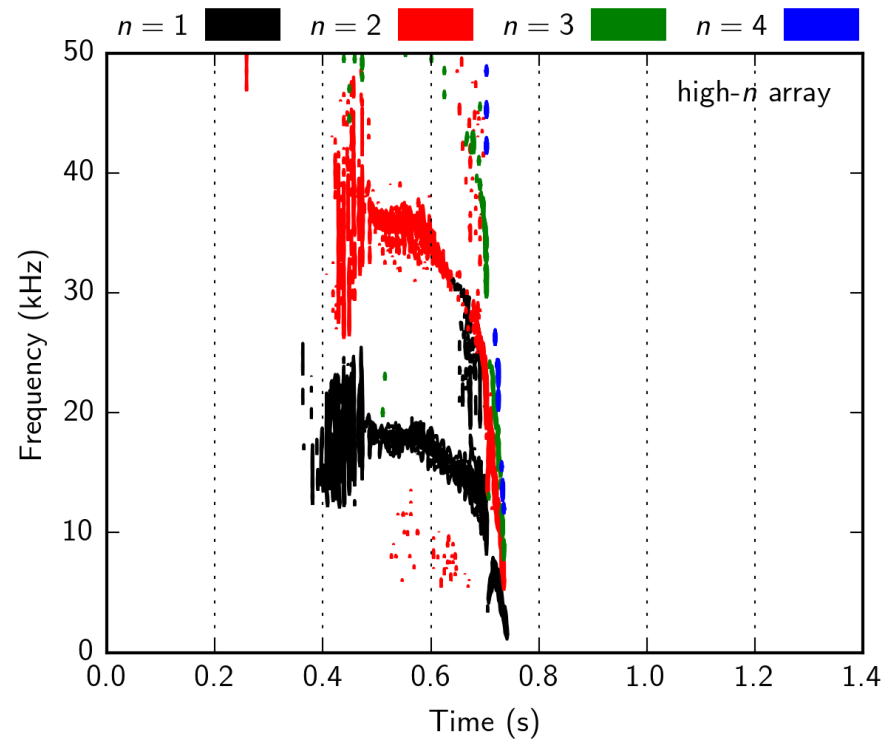
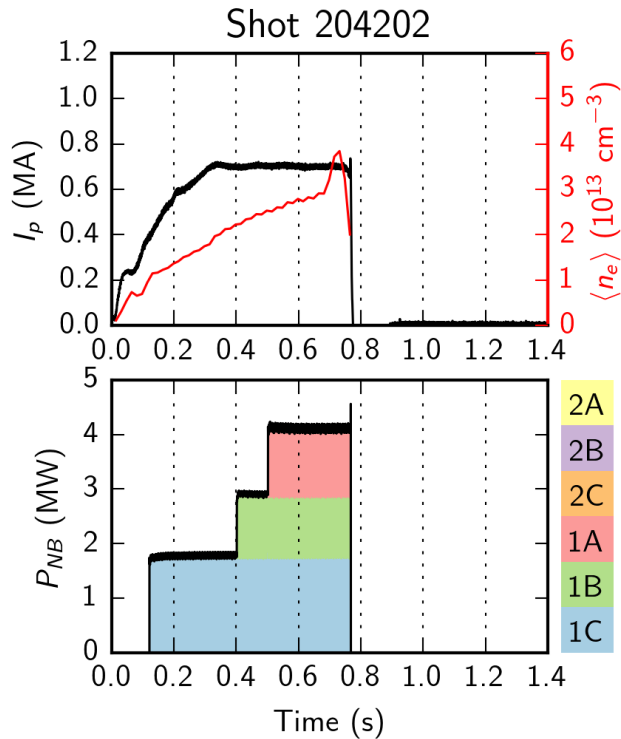


- Sawtooth spectra trail off as the plasma gets close to locking
- Sawtooth spectra change with density, still trail off

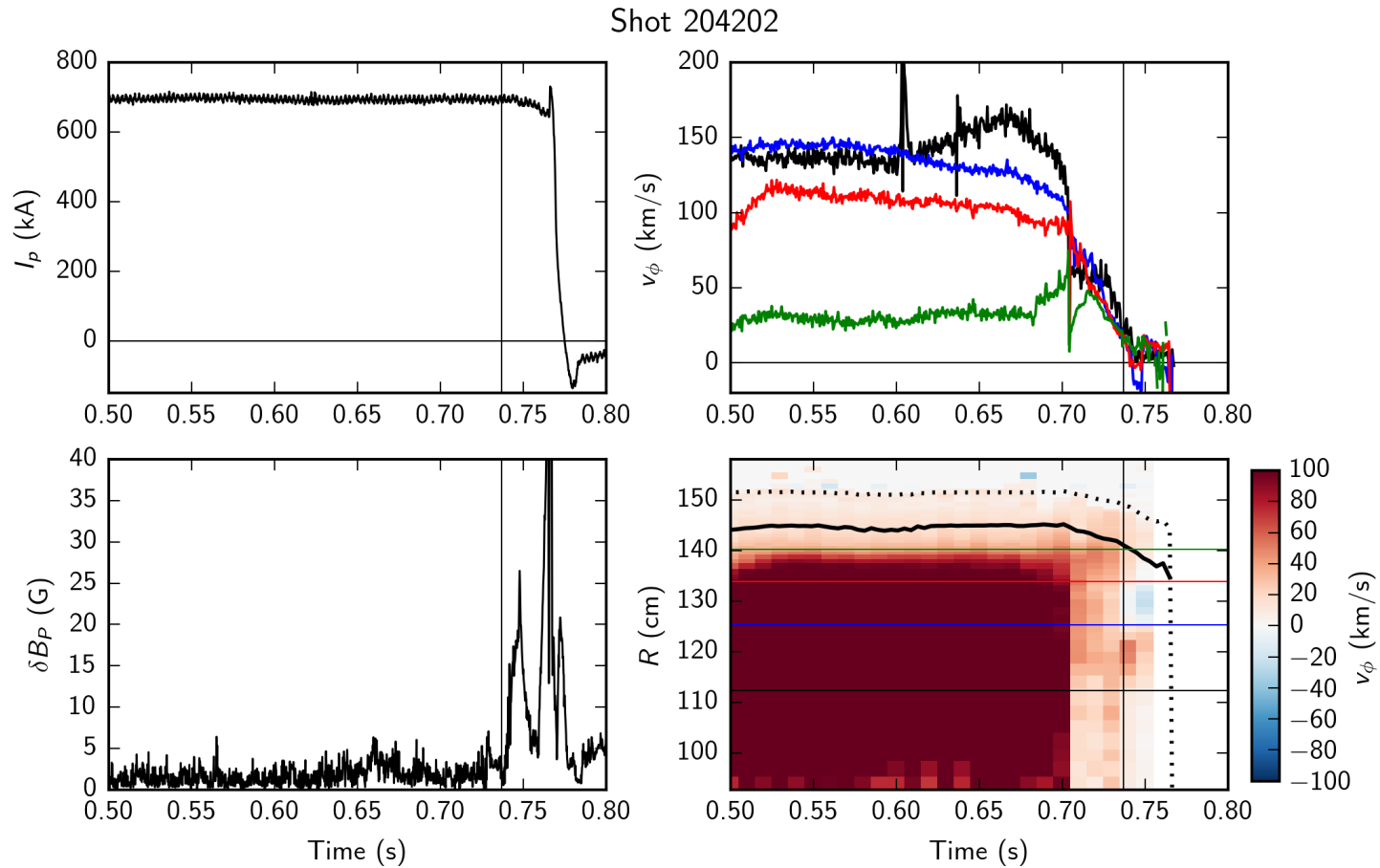
Rotation data – High-density compass scan



MHD activity – Stacked NB1 shot



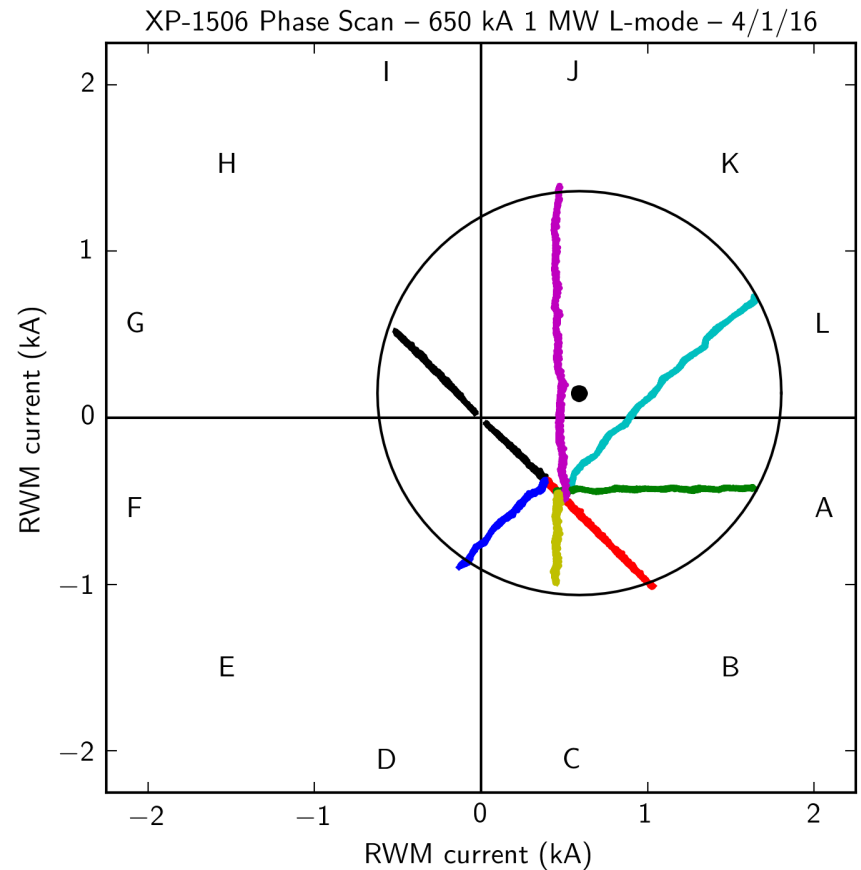
Rotation data – High-density compass scan



Backup

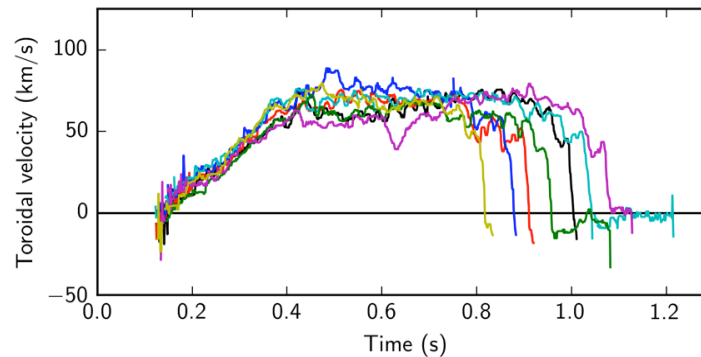
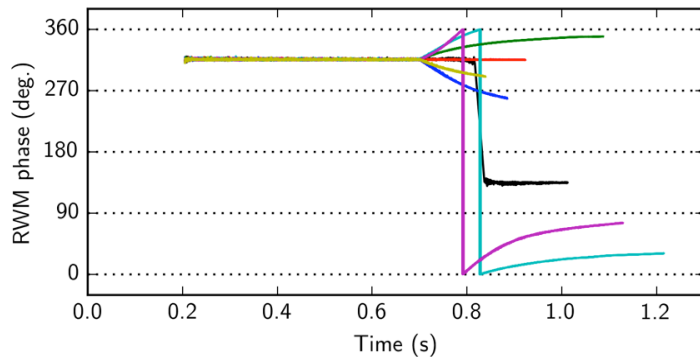
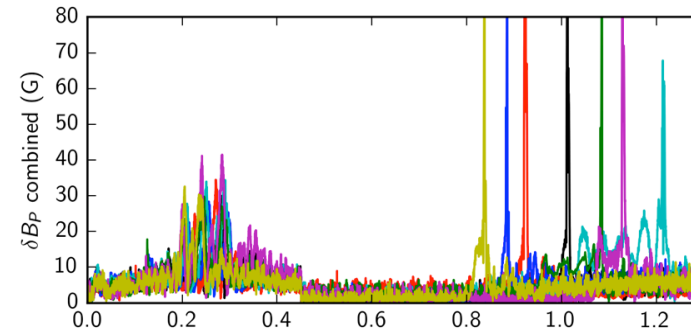
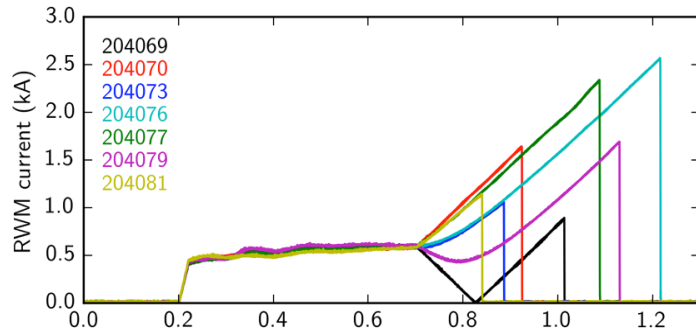
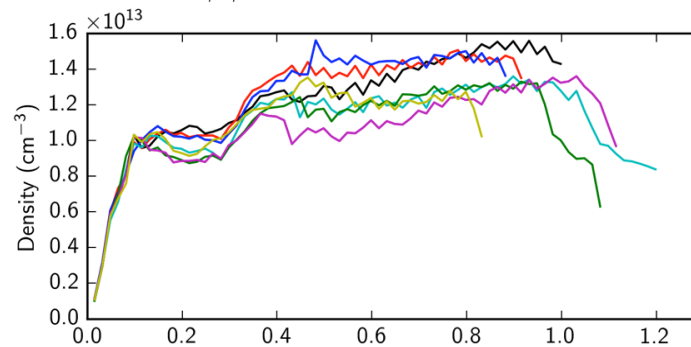
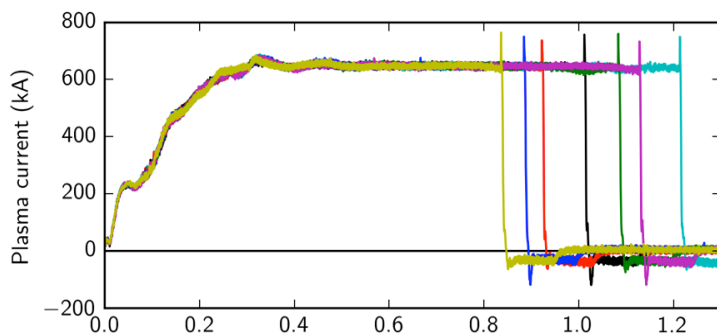
XP-1506 Compass Scan – 1 Apr 2016

- XMP-1506: $n=1$ compass scan
 - Goal is to determine optimum $n=1$ EFC as maximum ‘distance’ from locking
 - Primary diagnostic = RWM sensors
 - Apply density scaling of $(n_e/n_{e,avg})^{-0.98}$ as per Menard et al. [NF 2010]
- Results
 - Well-resolved circle with amplitude of $I_{RWM} \sim 610$ A and phase $\sim 15^\circ$
 - Supports the 900 kA ohmic results
- Path forward
 - Use these results as the ‘standard’ prescription for PF5-proportional EFC
 - This new prescription was in use for Shots 204112 and 204118, which are the best NSTX-U H-modes to date



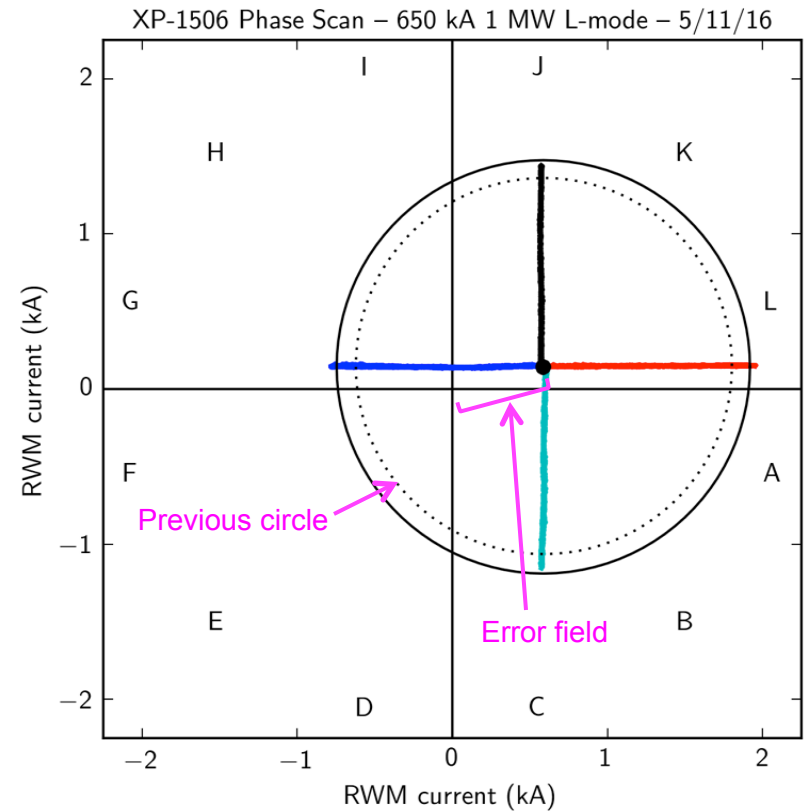
Compass scan shot compilation

XP-1506 Phase Scan – 650 kA 1 MW L-mode – 4/1/16



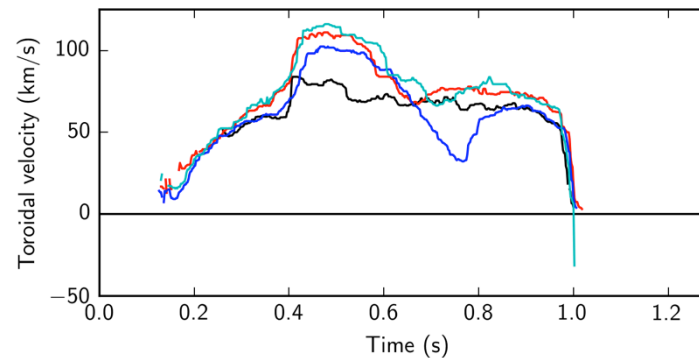
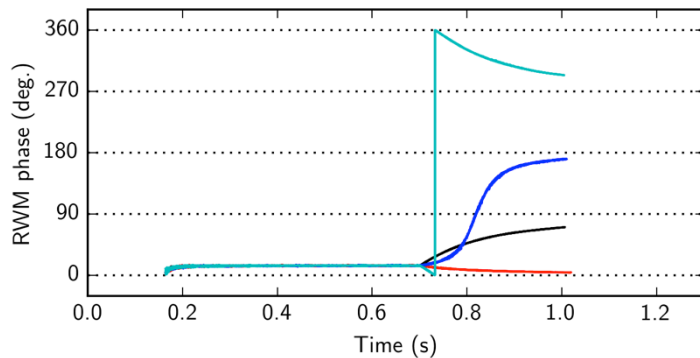
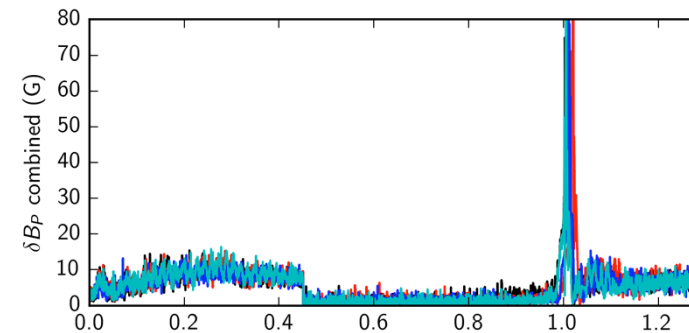
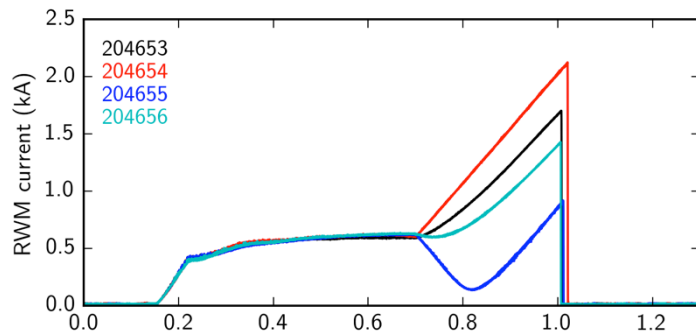
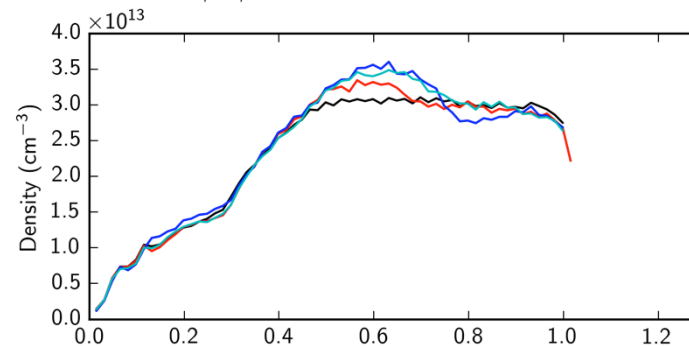
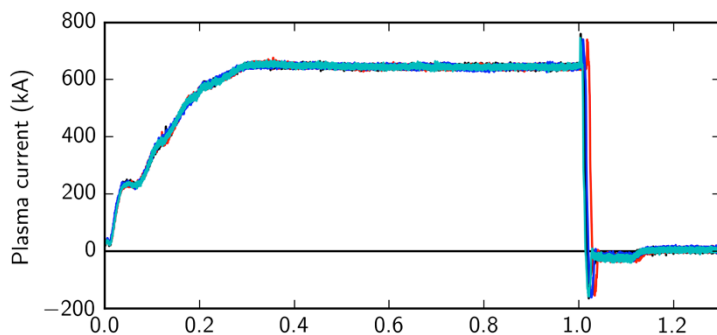
Second compass scan at higher density – May 11

- XMP-1506: $n=1$ compass scan
 - Conduct second compass scan at higher density ($\times 2.1$) to investigate locking threshold scaling
 - No density normalization applied to data
- Results
 - Well-resolved circle centered at the same $I_{RWM} \sim 600$ A and $\phi \sim 15^\circ$ correction
 - The locking threshold only increases by $\sim 10\%$ in spite of much higher density ($\times 2.1$) and slightly higher rotation ($\times 1.2$)
- Path forward:
 - This pre-programmed EFC is presently used in every NSTX-U discharge
 - The small change in locking threshold warrants further investigation



Compass scan shot compilation

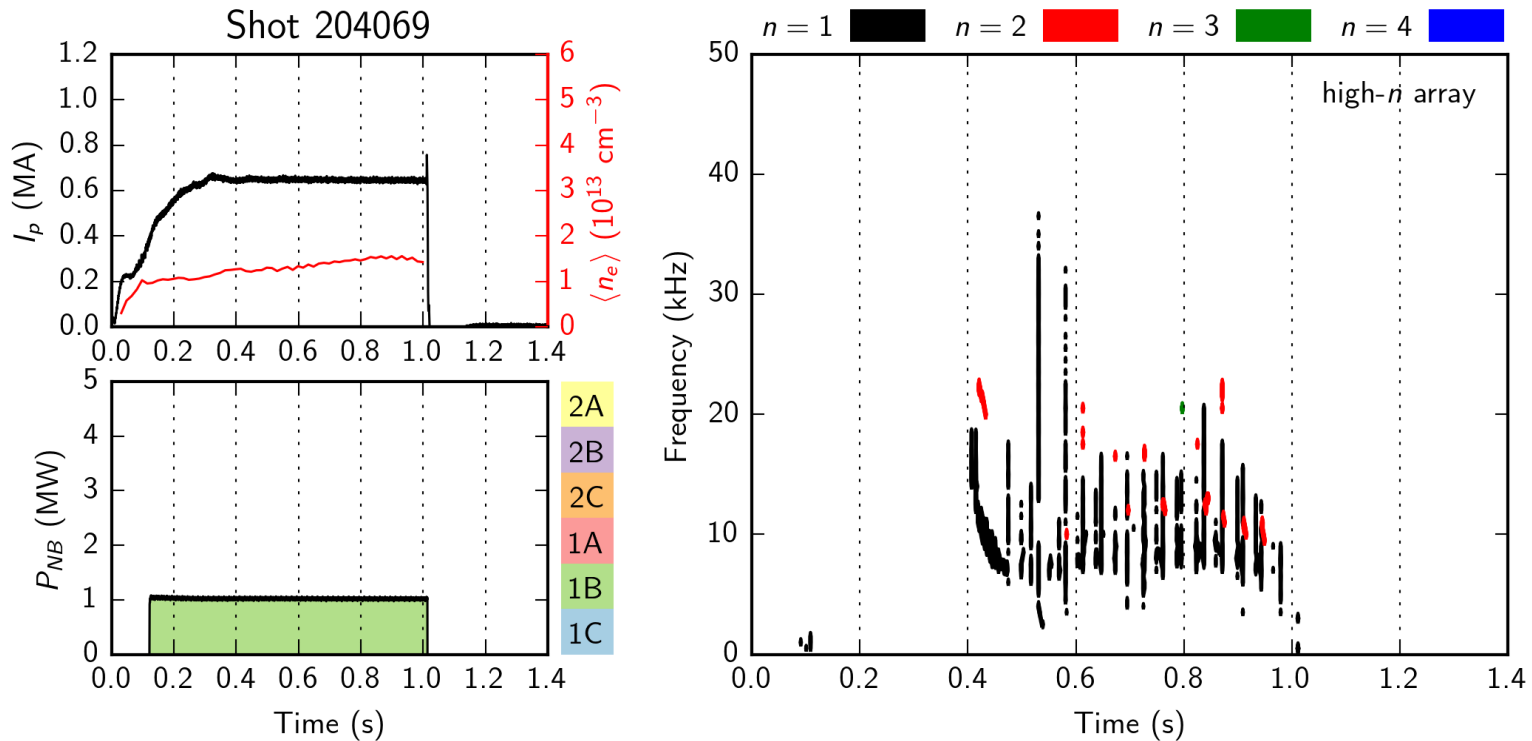
XP-1506 Phase Scan – 650 kA 1 MW L-mode – 5/11/16



Summary and plans

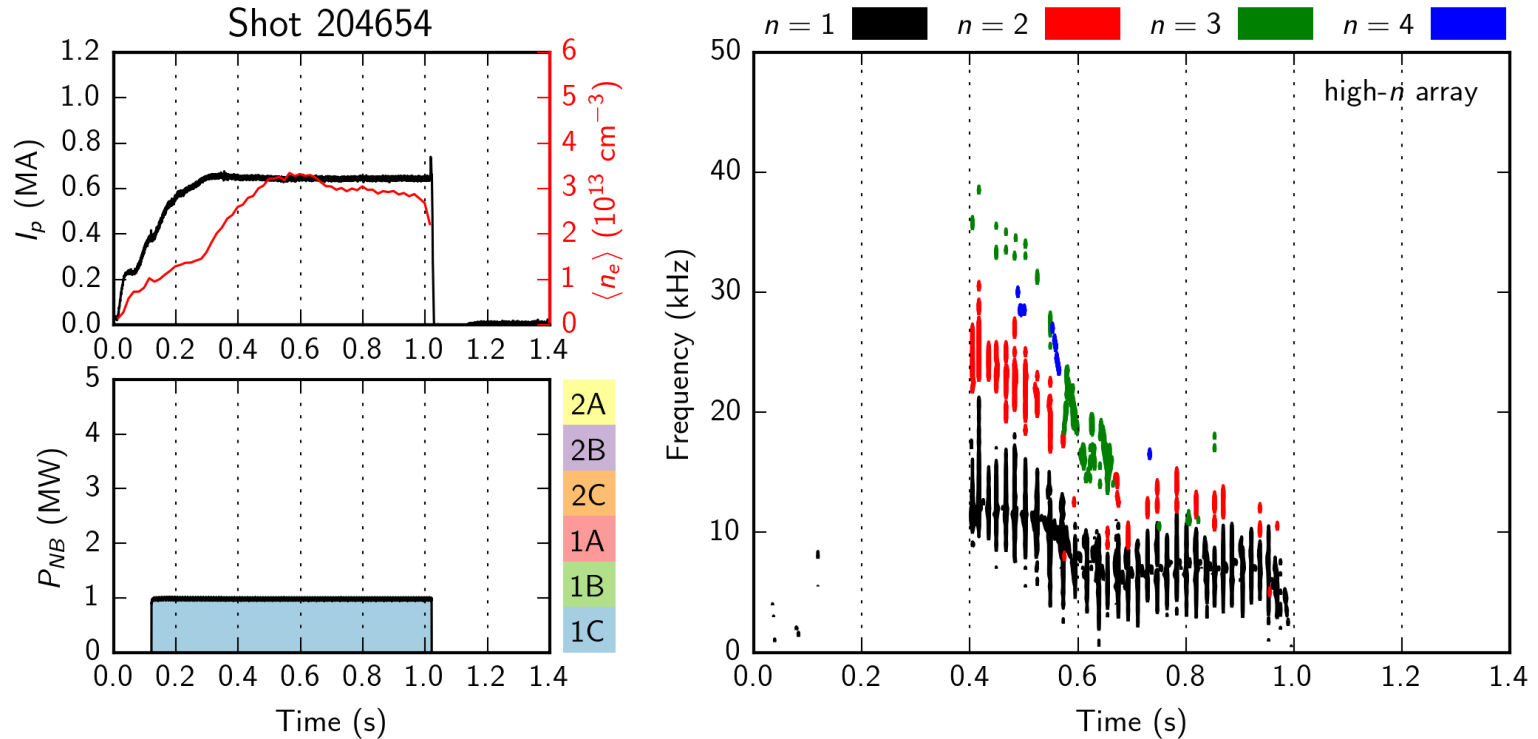
- Two compass scans confirm an optimized $n=1$ correction
 - RWM coil current amplitude ~ 600 kA
 - RWM coil current phase $\sim 15^\circ$
 - This correction presently used in all NSTX-U scenarios
- What is the error field source?
 - The XP-1506 correction doesn't agree with PF5 coil shape measurements
 - The required correction is several times too large and 90° out of phase
 - Confirmed by preliminary IPEC modeling
 - Need to continue the search for the error field source
- Path forward
 - How does the correction scale with plasma current?
 - Raise the plasma current in L-modes to say, 800 kA and 950 kA (if possible), to determine the I_p scaling of the required correction
- Implications of MHD activity
 - MHD spectrograms indicate that we are locking the 1/1 sawtooth core rather than a 2/1 mode at the $q=2$ surface
 - CHERS, etc. indicate that the $q=2$ surface may be locked in all of these discharges

MHD activity – Low-density compass scan



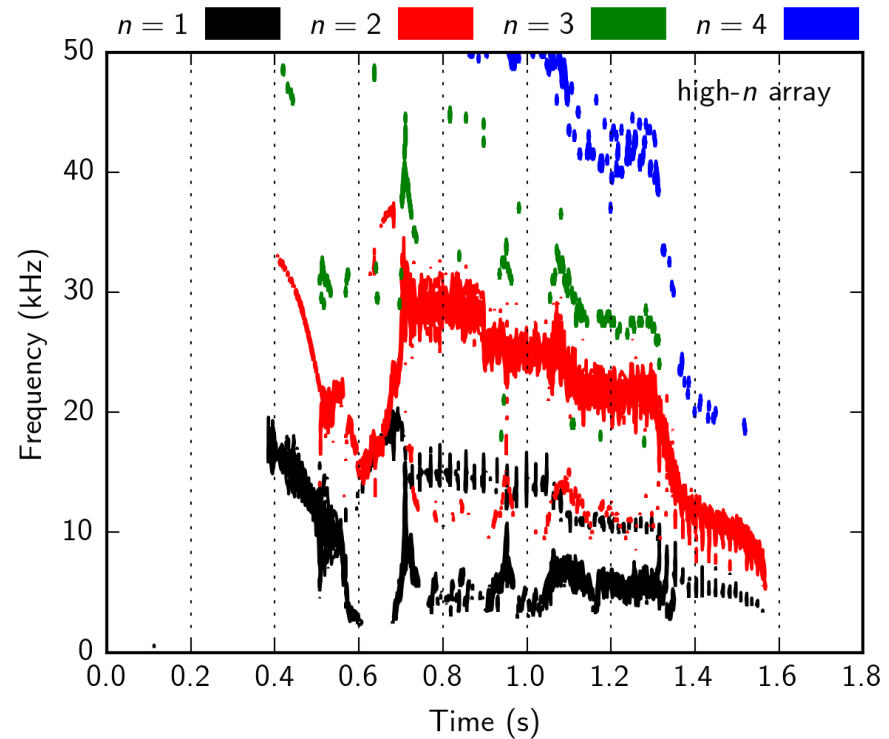
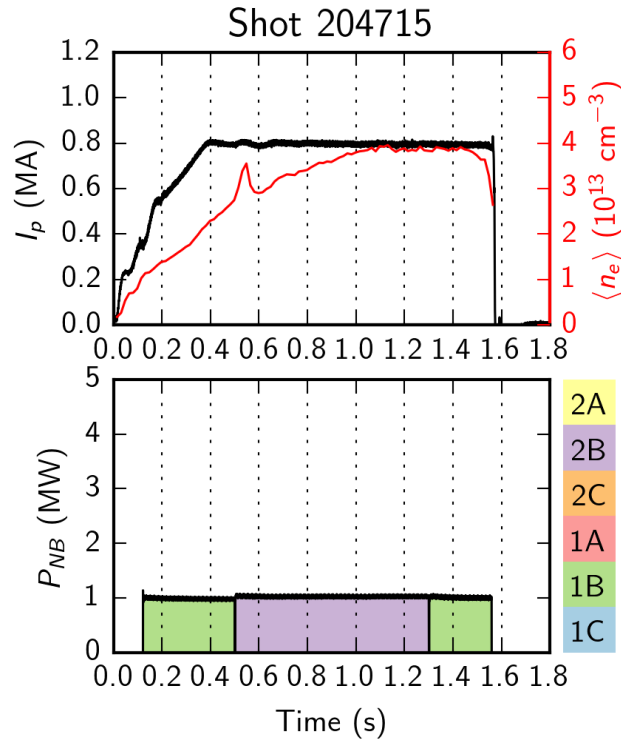
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MHD activity – High-density compass scan



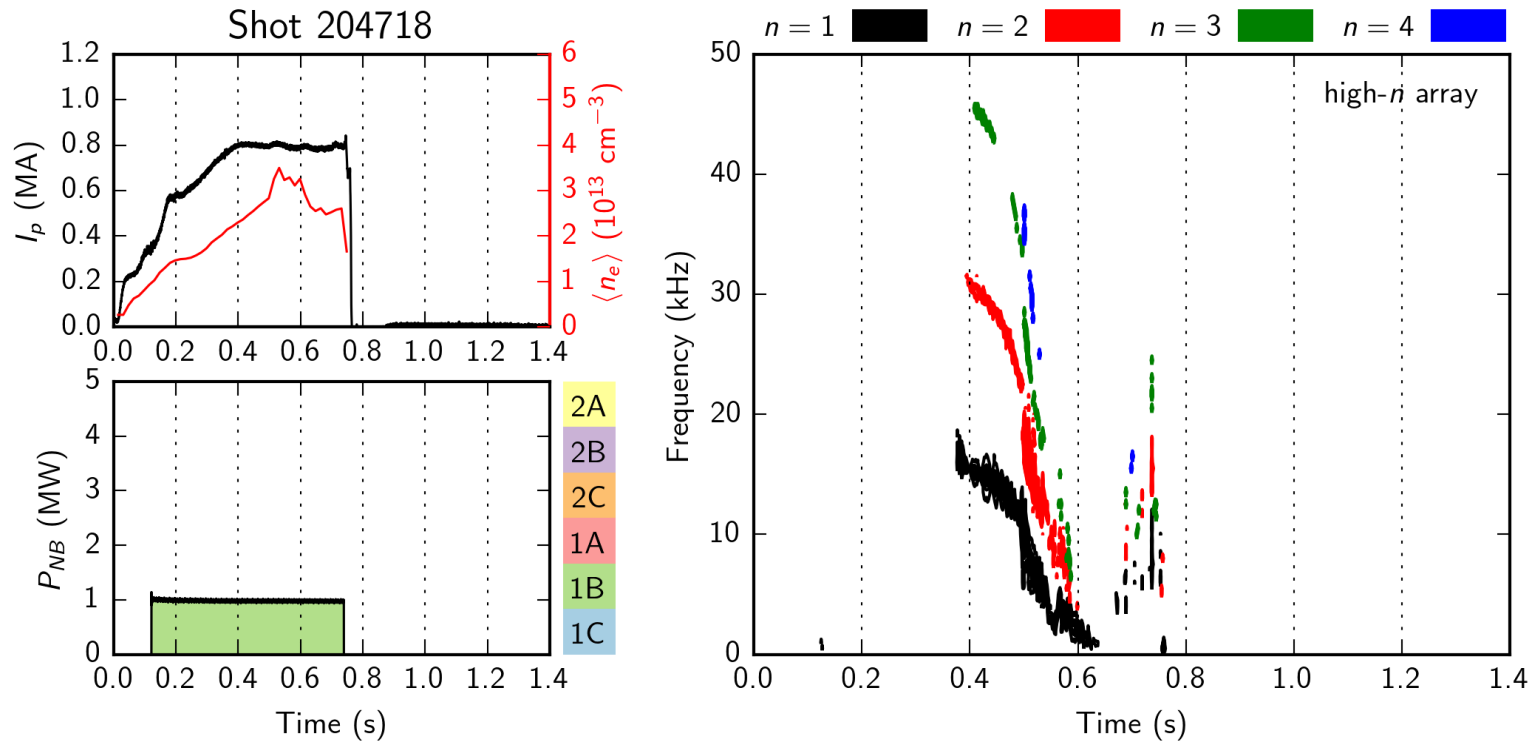
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MHD activity – High-torque XMP-151 shot



- Higher torque from 2B keeps the $q=2$ surface from locking
- Differential rotation between the core and $q=2$ clearly visible

MHD activity – Low-torque XMP-151 shot



- Without the high torque, get a straight lock of the $q=2$ surface