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XP510: Solenoid-free inductive start-up with an outboard field-null and HHFW

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NSTX Results Review
December 12-13, 2005
PPPL – Princeton, NJ

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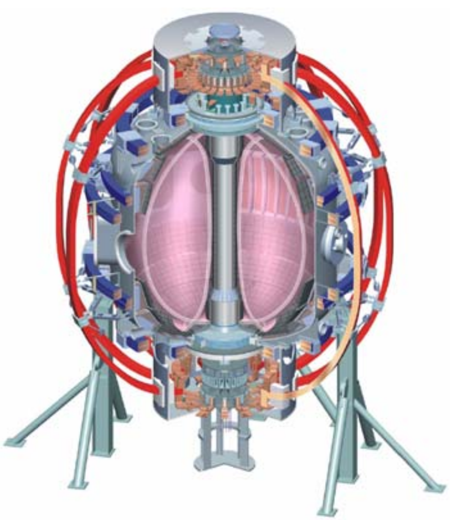

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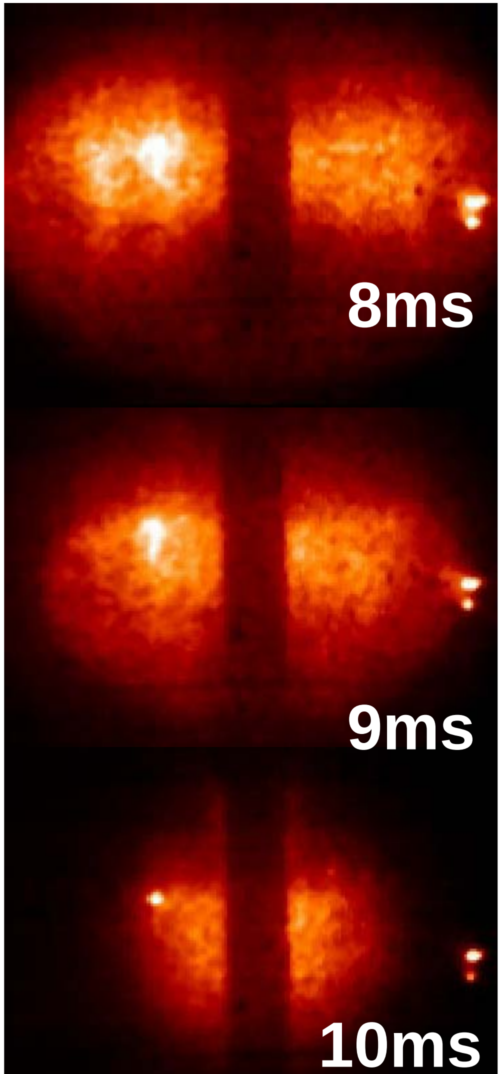
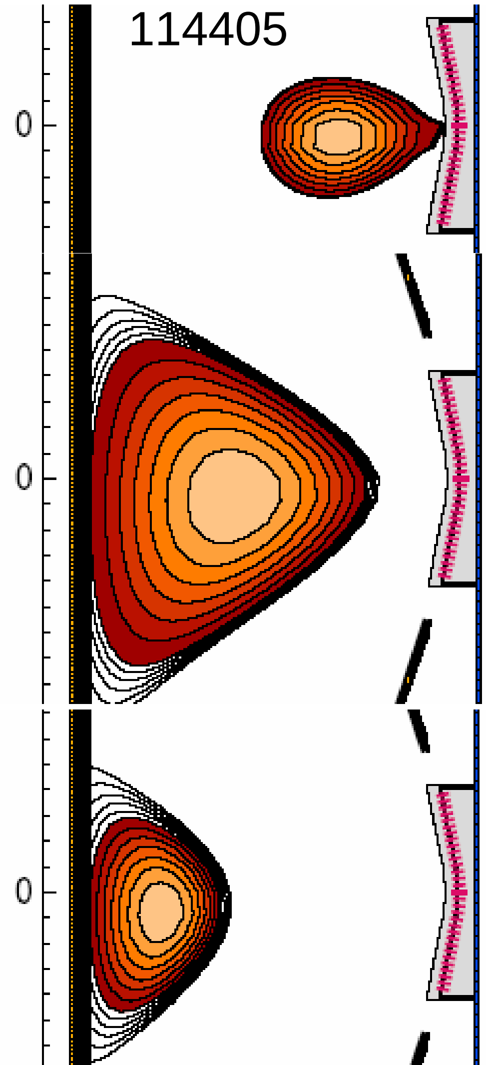
2004 camera images and reconstructions showed plasmas born on LFS with inward radial trajectory

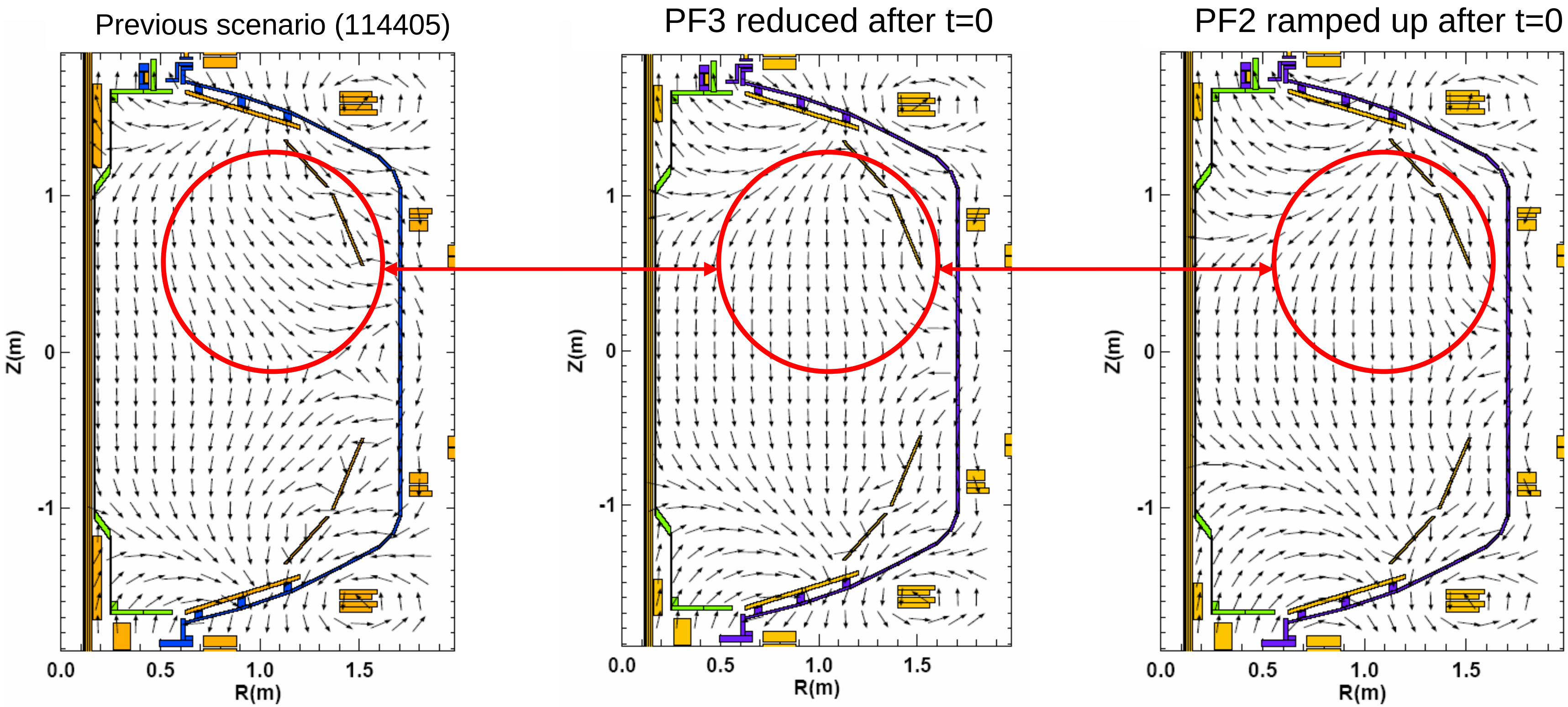




- LRDFIT code used for reconstructions
  - $I_{Vessel} \approx 10 \times I_P$
- Careful control of B_Z after breakdown helped raise I_P from 10kA to 20kA
- More B_Z evolution optimization possible

GOAL: test PF coil programming changes

Systematically scan field index after breakdown phase:



1. Decrease PF3 after t=0
   - Elongates plasma and reduces dB_z/dR → enhanced radial stability
   - Modest reduction in V_{LOOP}
2. If radial position evolution improves, increase PF5 ramp-rate after t=3ms
   - Assess trade-off between higher V_{LOOP} and larger B_Z
3. Increase PF2 after t=0
   - Maintains reduced dB_z/dR profile while further increasing elongation and B_Z

Received ¾ run day - shot plan was for 1.5 days

First run day – goals and progress

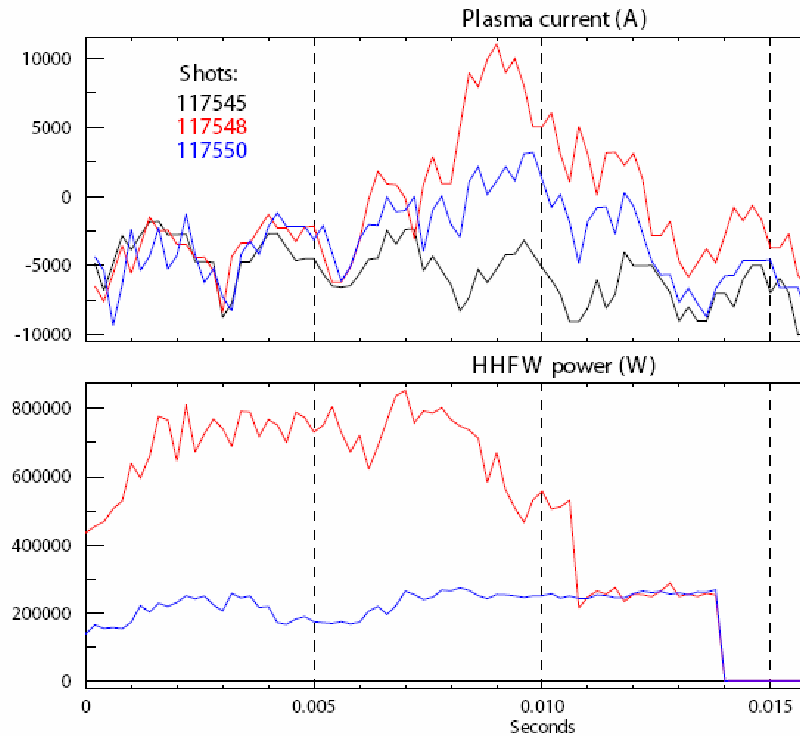
- Reproduce shot 114405 which achieved 20kA plasma current
  - **Got to 15kA reproducibly**
- Decrease PF3 current after t=-3ms to reduce dB_Z/dR and increase κ
  - **This worked - increased current and duration at low RF power = 200kW**
- Increase HHFW power incrementally to measure plasma response to higher P_{RF}
  - Try 750kW, 1MW, 1.25MW, 1.5MW
  - **rt-ACQ fault trips shot above 300kW for most shots → scan not done**
- Scan VF ramp-rate following improved position control/heating.
  - **This also helped increase current and duration following PF3 scan**
- Assess impact of higher elongation by adding PF2 current ramp
  - **Not done**

Second ½ run day – not done

- Study the field null quality requirements for successful breakdown
  - Start from most successful (highest IP) discharge achieved above:
  - Scan TF in 0.25kG decrements below 3kG until plasma initiation fails
  - Increase DC PF2U and 2L currents in 0.5kA increments until plasma initiation fails

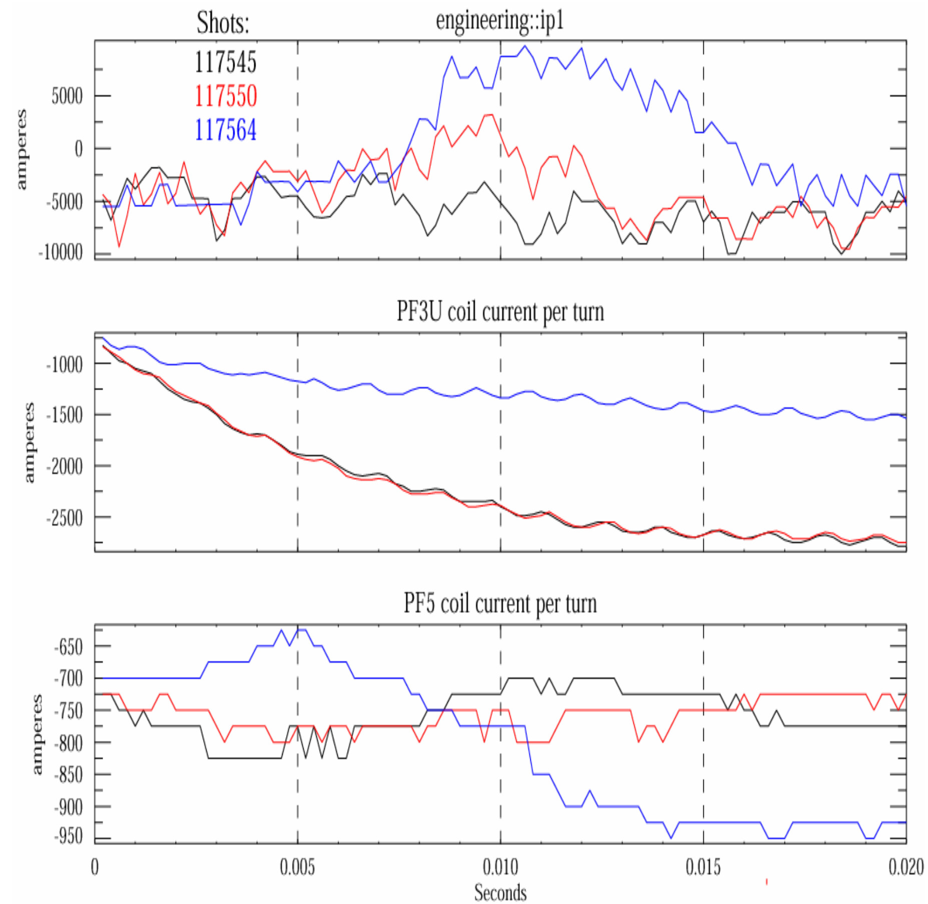
Need more HHFW pre-ionization power and further PF3 & 5 ramp-rate scans to increase I_P

- <u>This year:</u> using more HHFW straps for pre-ionization → up to 800kW



- Max. plasma current increases with pre-ionization power
- Unfortunately, HHFW trips rt-DAQ module in NTC for P_{RF} > 300kW

- Goal of XP: Adjust PF3 & 5 to increase/extend I_P - *progress made:*



- These waveforms project to I_P = approx. 25-30kA with higher P_{RF}