Finite Orbit Monte-Carlo Simulations of FW Heating Discharges in DIII-D, NSTX and ITER

by

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in collaboration with

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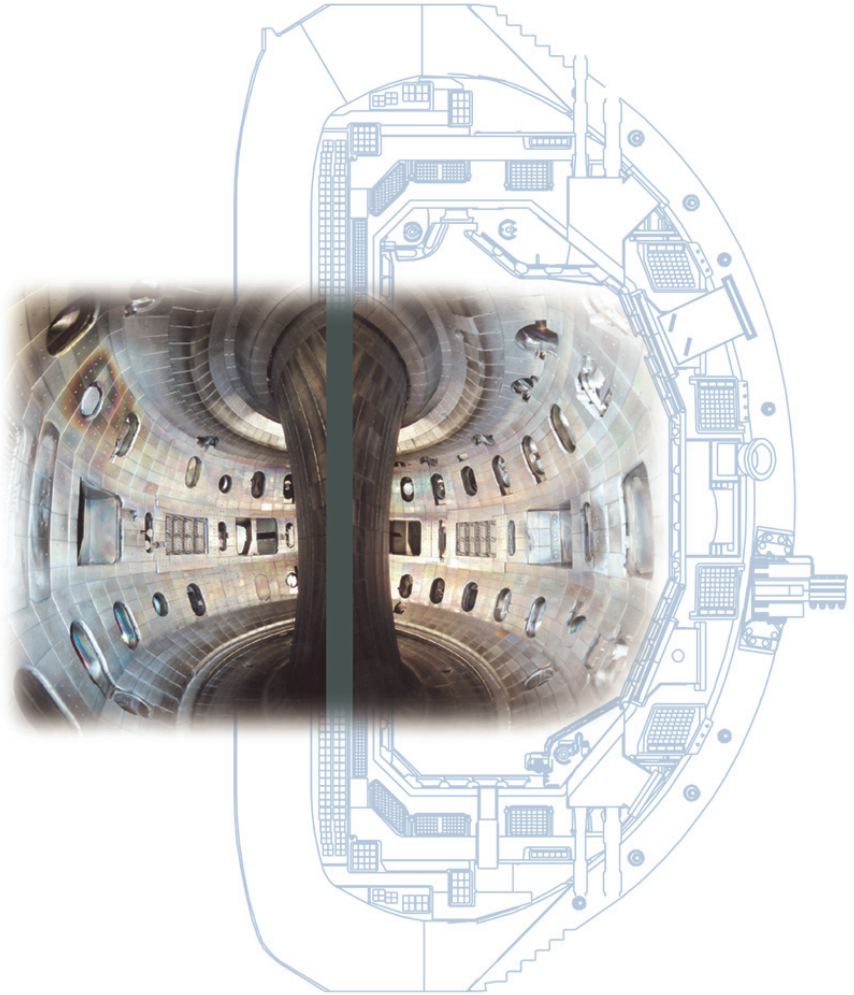

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Outline

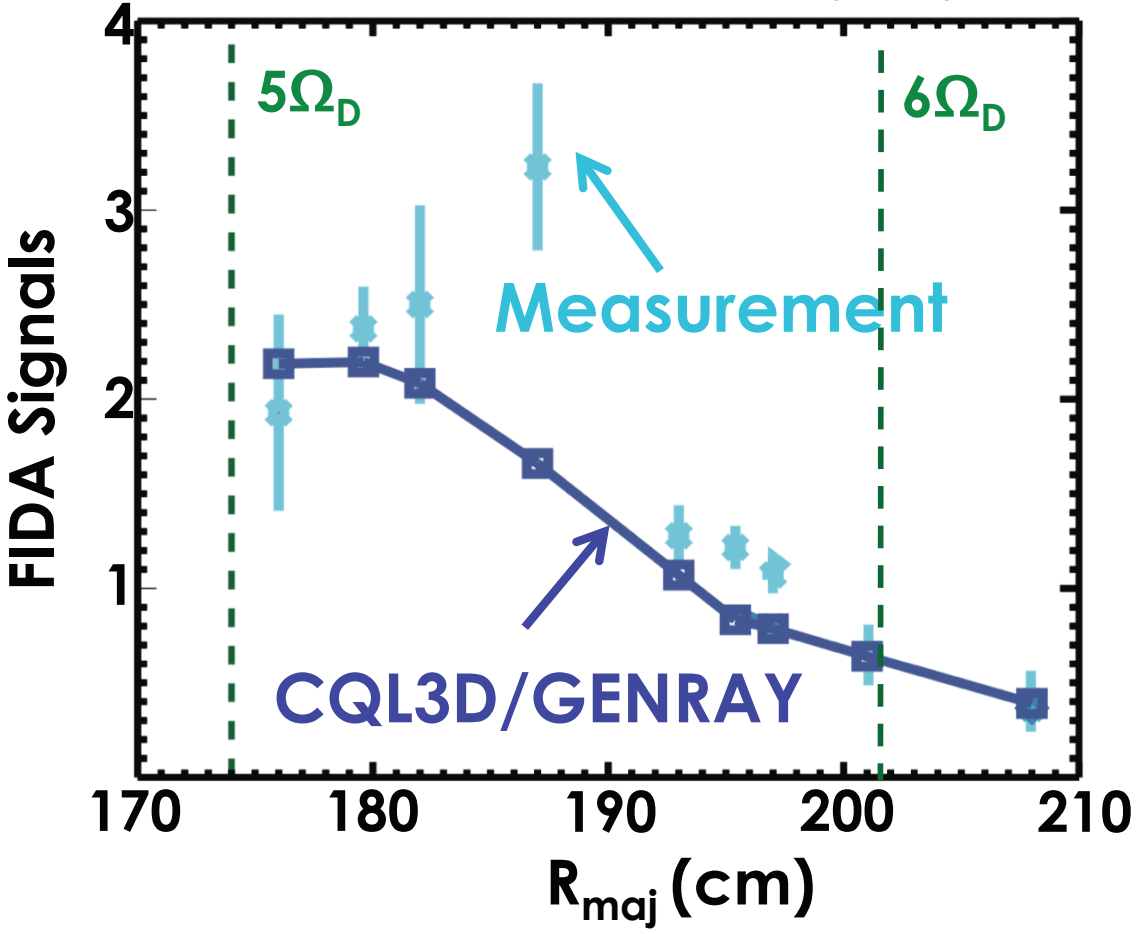
- **Synthetic diagnostic results of finite orbit Monte-Carlo coupled by full wave code in DIII-D and NSTX HHFW heating discharges reasonably reproduce measurements**
  - Outward radial shift
  - Fast ion spectra

- **Preliminary simulation in ITER suggests that finite orbit effect may also significantly modify fast ion distribution in velocity space**

Zero-Orbit Width Simulation Does Not Reproduce Outward Shift of Measured FIDA Signals in DIII-D

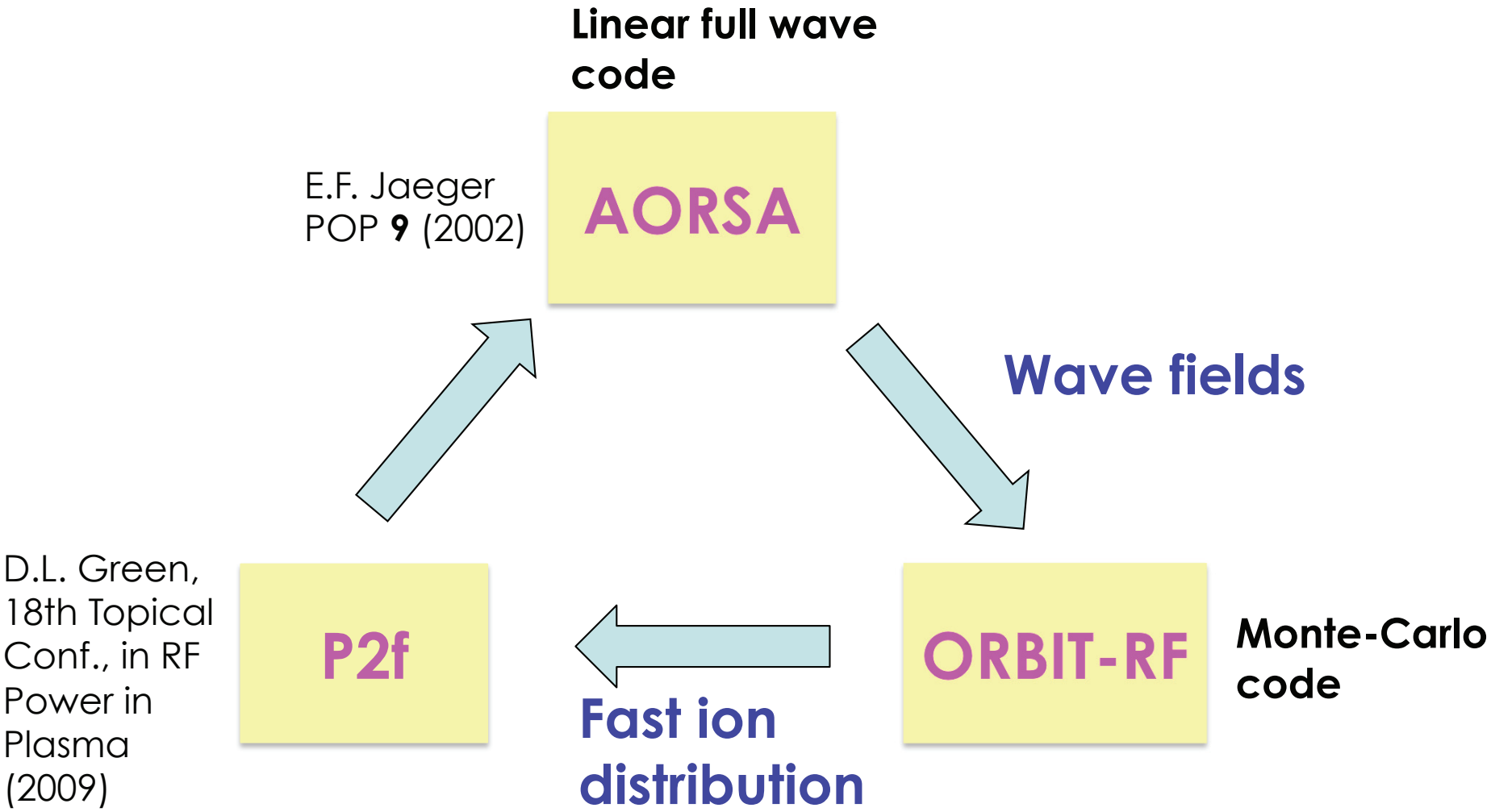
DIII-D FW discharge #122993

W.W. Heidbrink PPCF **49** (2007)

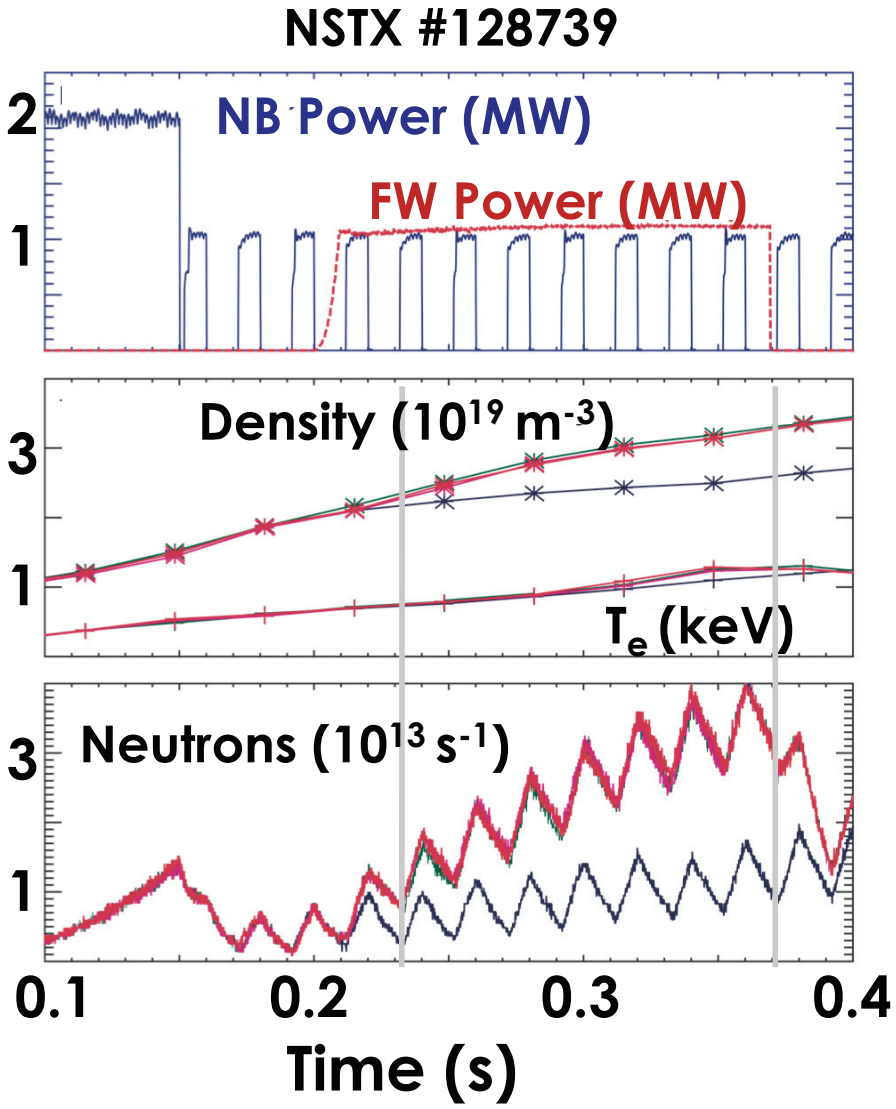


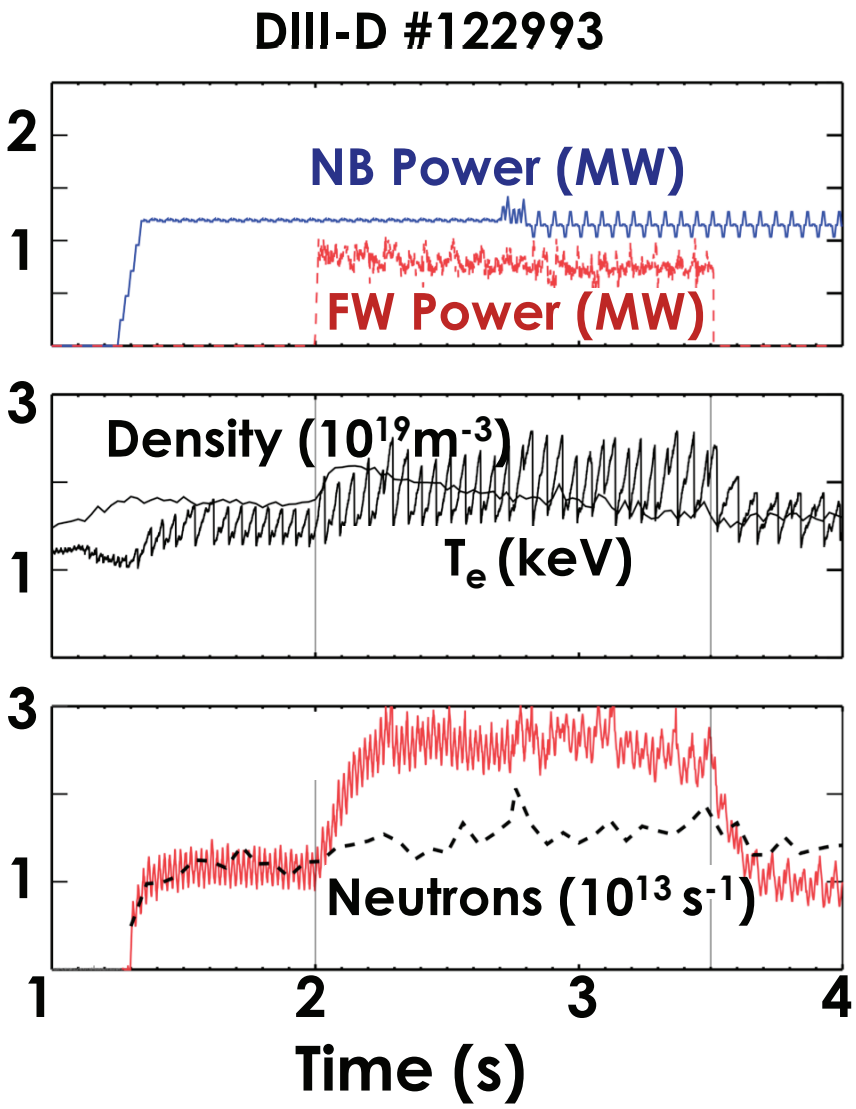
- **CQL3D to include finite orbit effect is underway**
- **Similar discrepancy in NSTX HHFW discharges (D. Liu, PPCF 52 (2010))**
- **This study is aimed at resolving this discrepancy with finite orbit width effect**

For This Purpose, ORBIT-RF is Coupled with AORSA in a Self-Consistent Way (RF SciDAC)



Increased Neutron Rates During FW Heating Indicate Absorption of FW By Beam Fast Ions

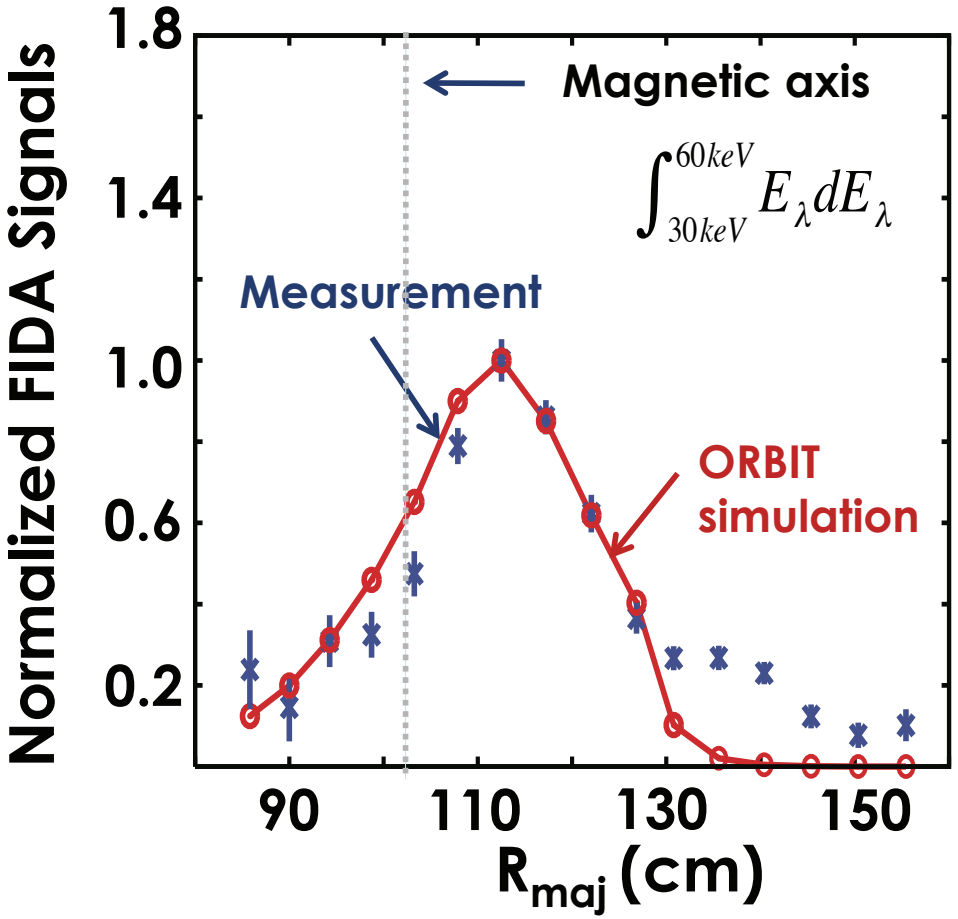


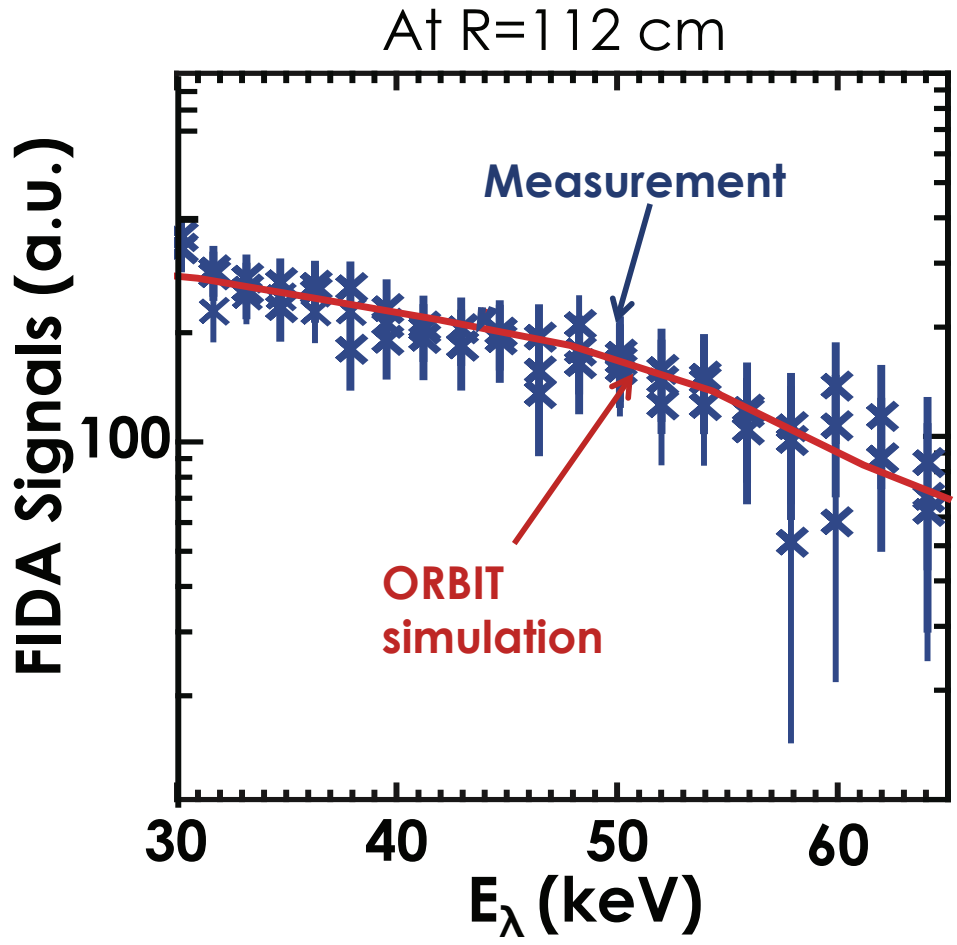


NSTX: Good Agreements Are Obtained in Spatial Profile and Spectra with No FW Heating

- **NSTX NB discharge #128742**

P_{NB}=2.0 MW, E_{inj} =65 keV

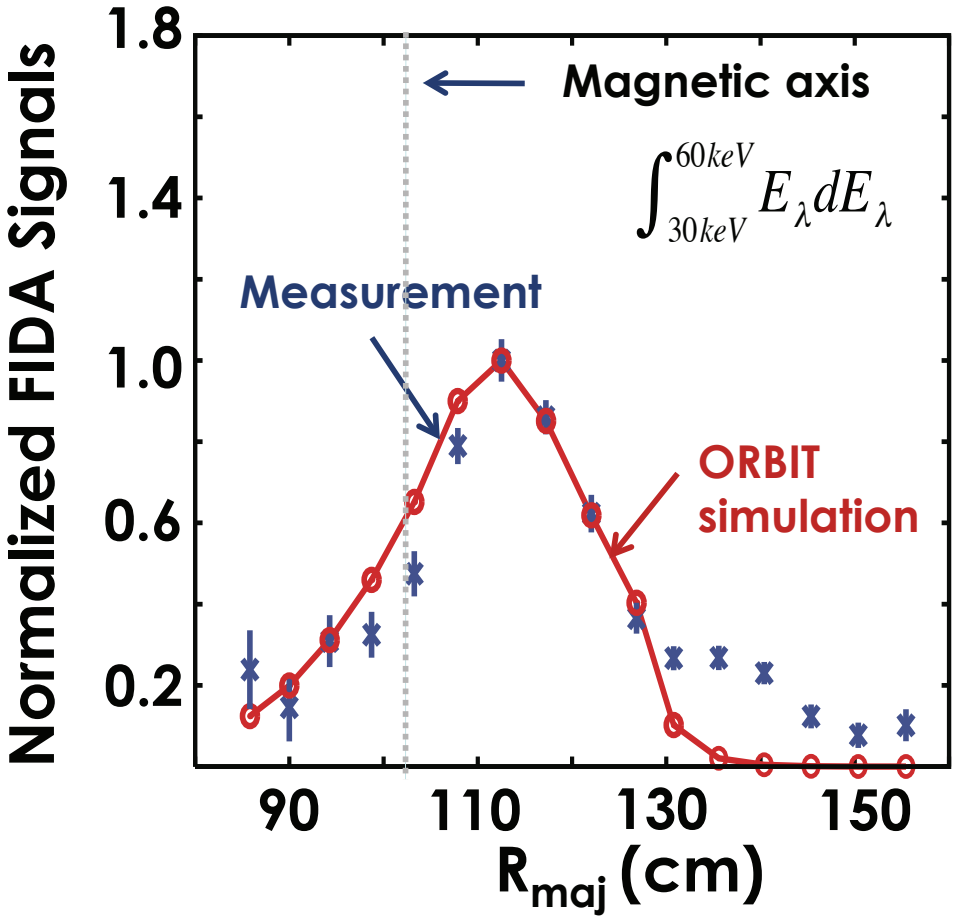




NSTX: FW Heating Simulation Predicts Enhanced Outward Shifts Compared to Measured Signals

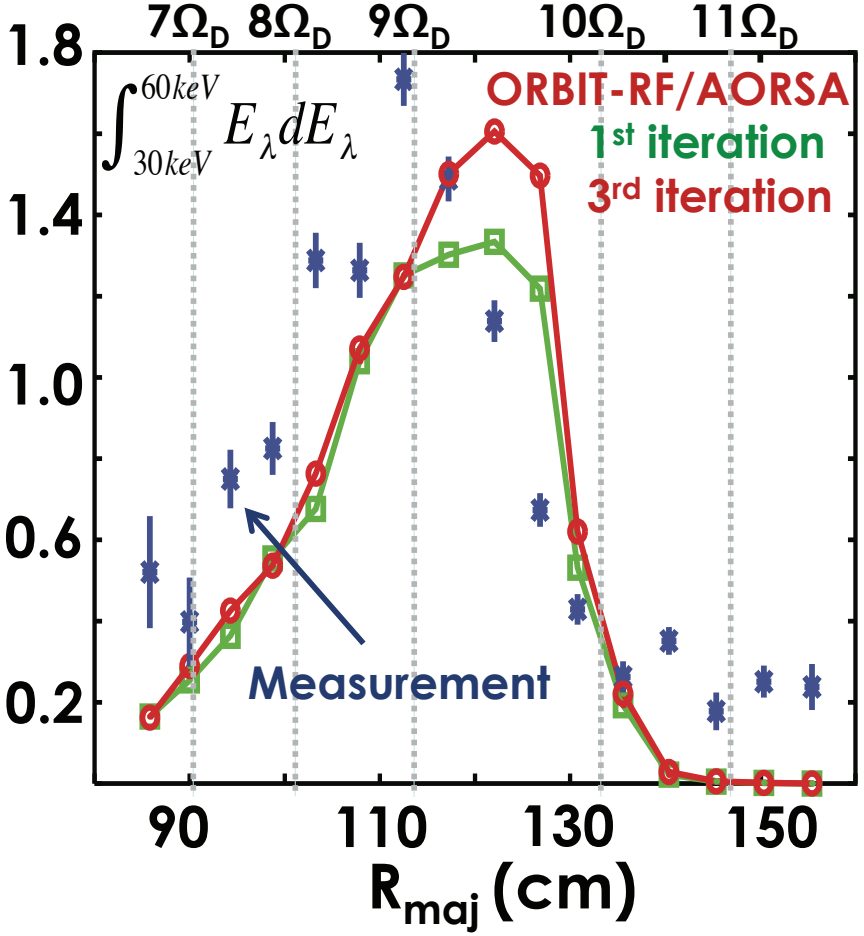
- **NSTX NB discharge #128742**

P_{NB}=2.0 MW, E_{inj} =65 keV



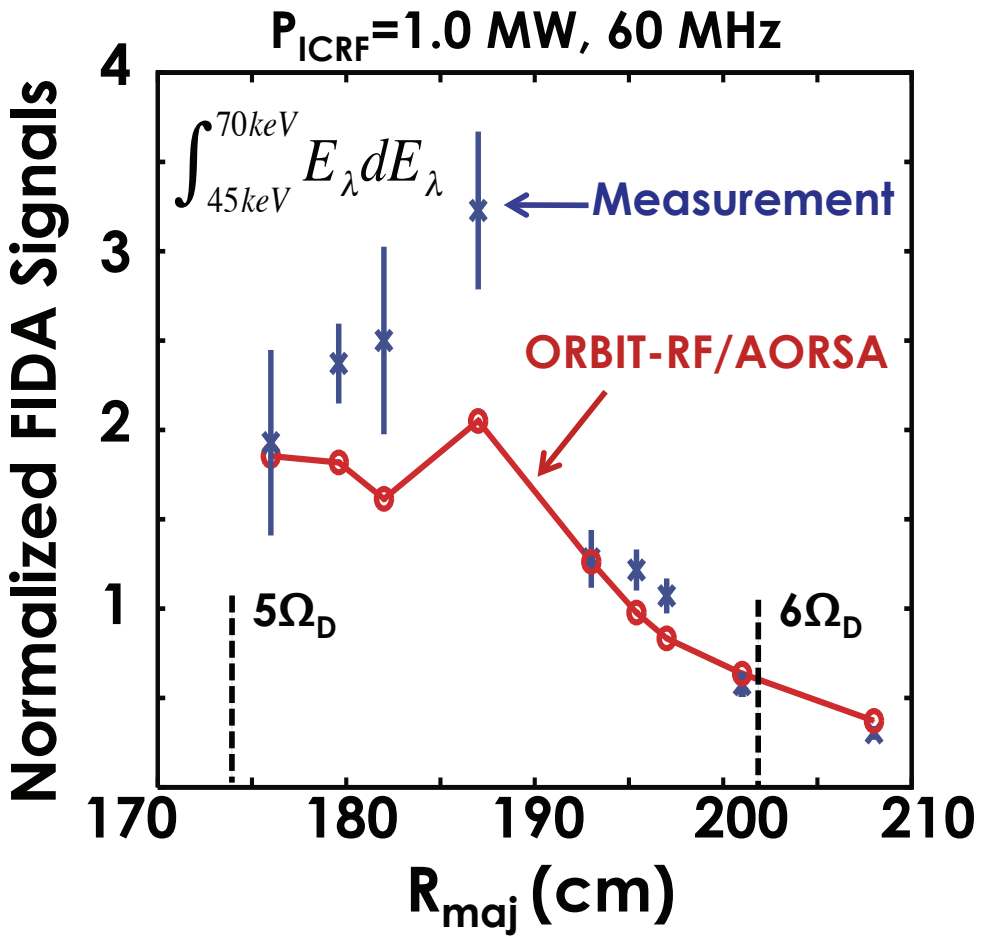
- **NSTX NB+HHFW #128739**

P_{FW}=1.0 MW, 30 MHz



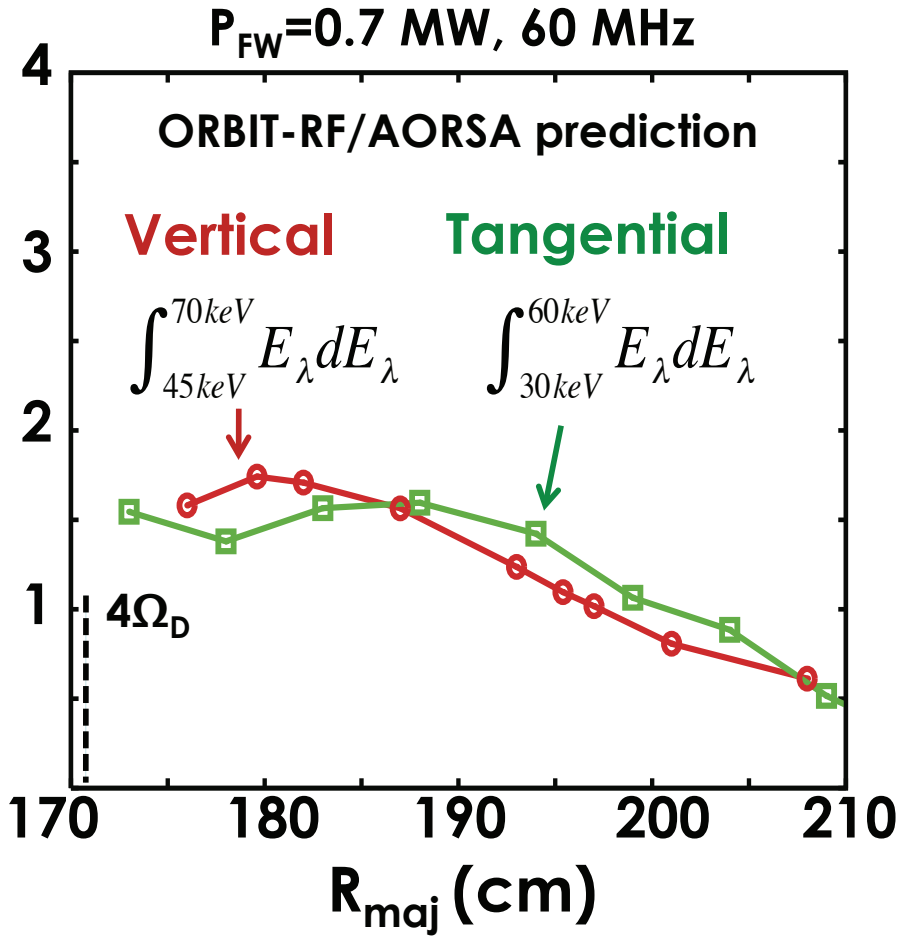
DIII-D: Qualitative Agreement is Obtained in Spatial Profile of FIDA Signals for #122993

DIII-D #122993



- Vertical view

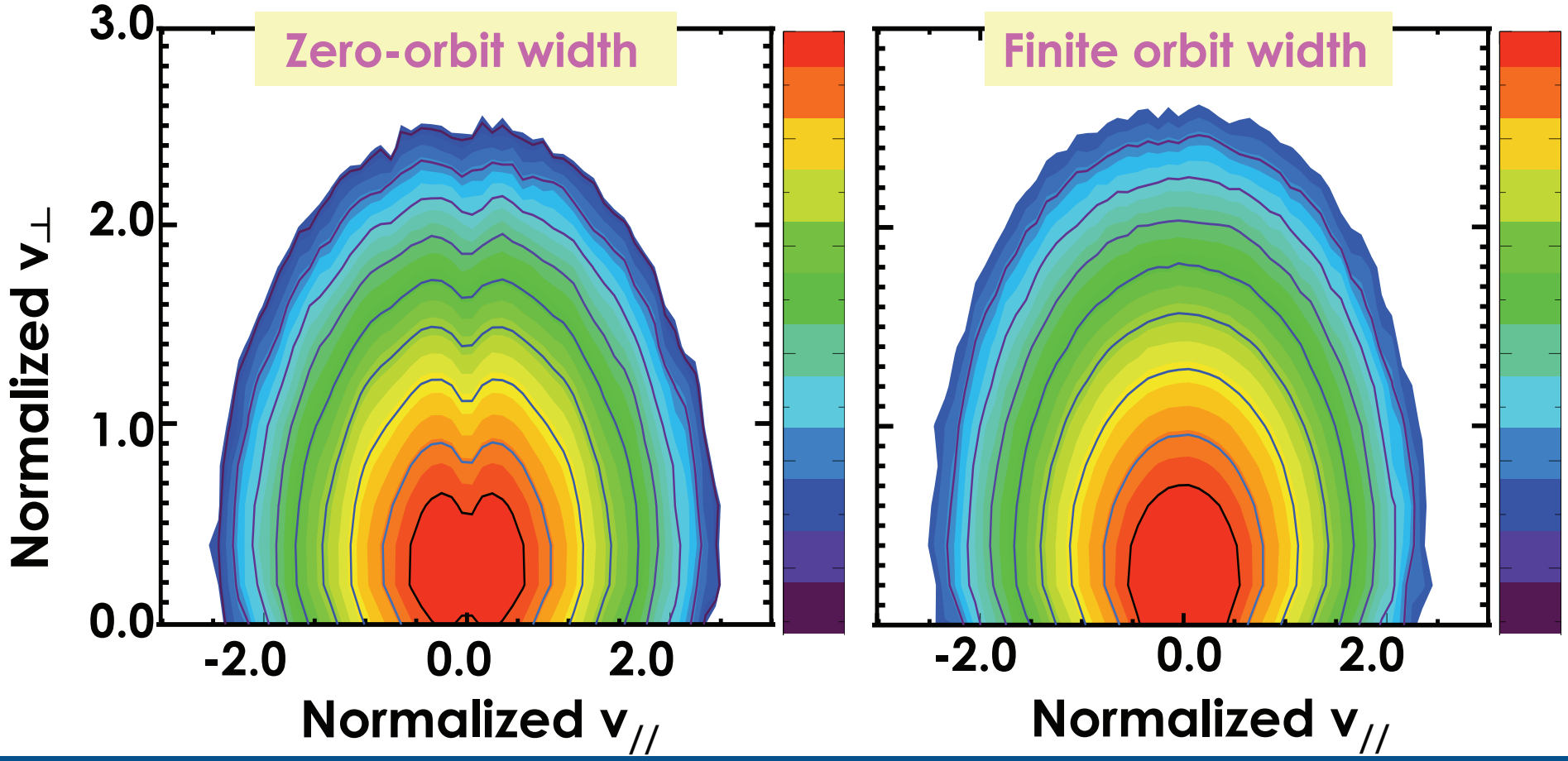
DIII-D #141187



- Comparison with FIDA is underway

ITER: Finite Orbit Effect Appears to Average Out Anisotropic Distribution

- **D(10%) minority fundamental harmonic heating scenario**
- $n_e(0)$: **7.3×10^{13} cm^{-3}**, $T_e(0)$: **24 keV**, $T_T(0)$: **25 keV**, $T_D(0)$: **25 keV**
- f_{ICRF}: **40 MHz** P_{ICRF}: **20 MW** n_φ : **-35**



Summary

- ORBIT-RF/AORSA provides a comprehensive tool to model FW heating scenarios with finite orbit width effects
- Simulations reasonably reproduce spectra and outward radial shifts of measured FIDA signals in DIII-D and NSTX FW heating experiments with NB injection
- Finite orbit width effect may significantly modify fast ion distribution in ITER