XP 607: Transport of Fast Ions by Fishbones and TAEs

Motivation: Exploit new diagnostic capabilities to achieve a quantitative understanding of fast-ion transport.

Primary Experimental Goals:

Strong fishbone & TAE instabilities

Fast-ion profiles

Fluctuation profiles

Secondary Experimental Goals: Three-wave coupling

Angelfish

Why Fishbones?

- Reproducible large neutron drops
- Condition compatible with key diagnostics
- Extensively studied in conventional tokamaks

Why TAEs?

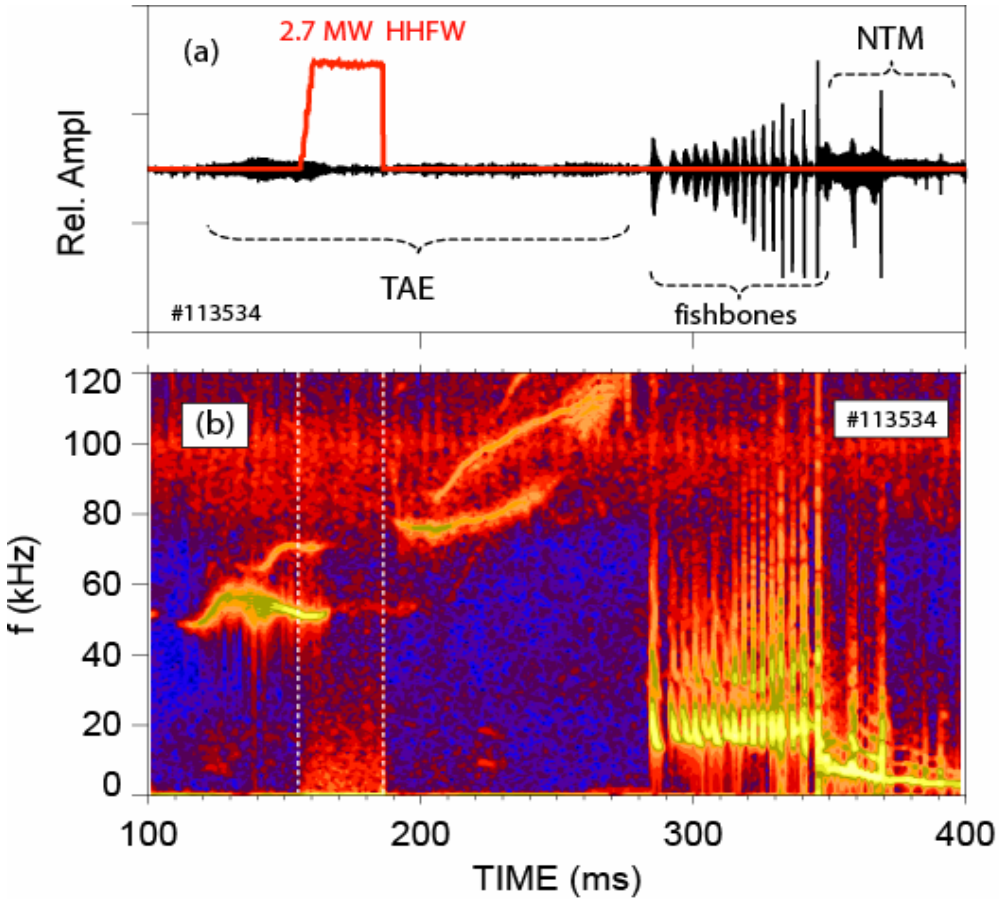
- Need to understand fast-ion transport by TAEs for ITER. (Published comparisons with theory disagree.)
- Efficient to study in same experiment (XP 449 had both fishbones and TAEs.
- Also a good discharge for 3-wave coupling between fishbones and TAEs.
- Also a good discharge for Angelfish

Crucial Diagnostics

- SSNPA
- EllB NPA
- Soft x-ray
- Reflectometer

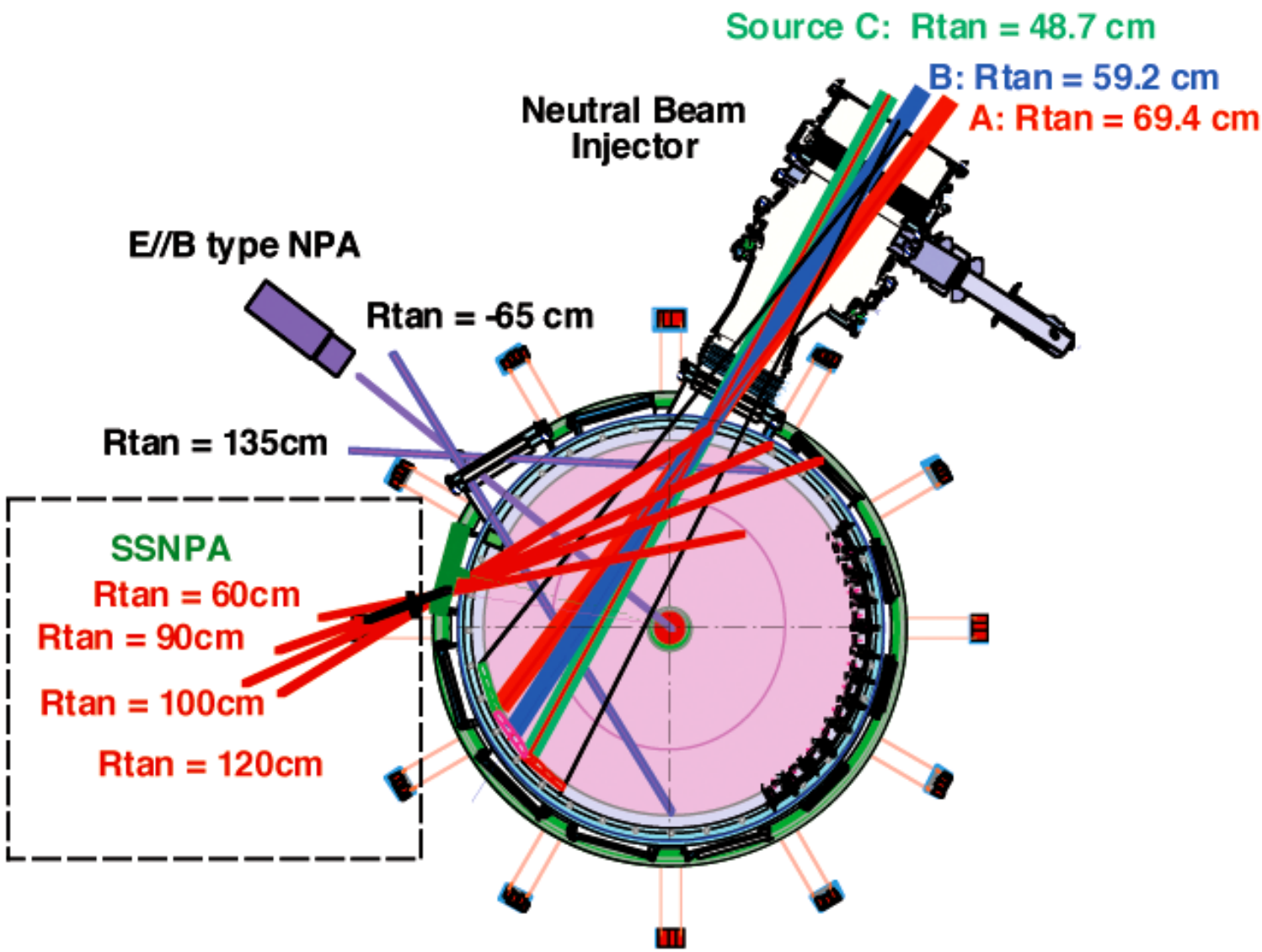
➔ L-mode

XP 449 Provides an Excellent Target for this Integrated Experiment



- "Effect of ion cyclotron acceleration on rapidly chirping beam-driven instabilities in NSTX" by Heidbrink *et al.*
- TAE eigenfunction measurements in Fredrickson's APS and IAEA Technical Meeting papers.
- Three-wave coupling paper by Crocker *et al.*

Diagnose Fast-ion Phase Space with SSNPA (Deyong Liu)



Experimental Run Plan

1. Establish the target condition: L-mode with strong fishbones that cause sudden drops in the neutron rate (2-8 shots). Initial target is #113534 (helium fill gas, 4.5 kG, 0.8 MA, Source C at 90 keV, inner wall limiter).
2. Document this condition (4 shots). Include NPA spatial scan at four midplane radii that match the SSNPA sightlines.
3. Repeat with Source A (4 shots).
4. One Source C shot with Source A at end of pulse for MSE q profile measurement.
5. One shot in deuterium for more accurate neutron determination of losses and better CHERS data.
6. One shot with shortened beam pulses to determine active/passive contributions to the SSNPA and NPA signals.
7. If the TAEs were not strong early in the discharge, adjust the plasma conditions to obtain stronger TAE activity. Possibilities include more beam power or a lower toroidal field (0-4 shots).
8. If a new condition was established with stronger TAE activity, document this condition with a NPA spatial scan (4 shots). If Source A was not already used, take one shot with Source A for MSE; also one shot in deuterium (0-2 shots).
9. Lower the beam voltage of Source C to 65 keV from the reference condition (4 shots for NPA scan and 1-2 shots with Source A pulse for MSE)….

Essential Resources

- Three neutral beam sources
- Fluctuation diagnostics: reflectometers, FIRETIP, SXR arrays, magnetics
- Fast-ion diagnostics: neutrons, NPA, SSNPA, sFLIP.
- Plasma diagnostics: Thomson scattering, MSE.

Desired: HHFW

Fishbone / TAE Analysis Plan

- Transp with *ad hoc* transport models—match to neutron & neutral particle data
- Models of MHD eigenfunction—match to fluctuation data
- ORBIT code: calculate fast-ion transport in model fields.