XP 540: Transport of Fast Ions by Fishbones and TAEs

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

Experimental Goal:

Strong fishbone & TAE instabilities

Fast-ion profiles

Fluctuation profiles

Why fishbones?

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

Why TAEs?

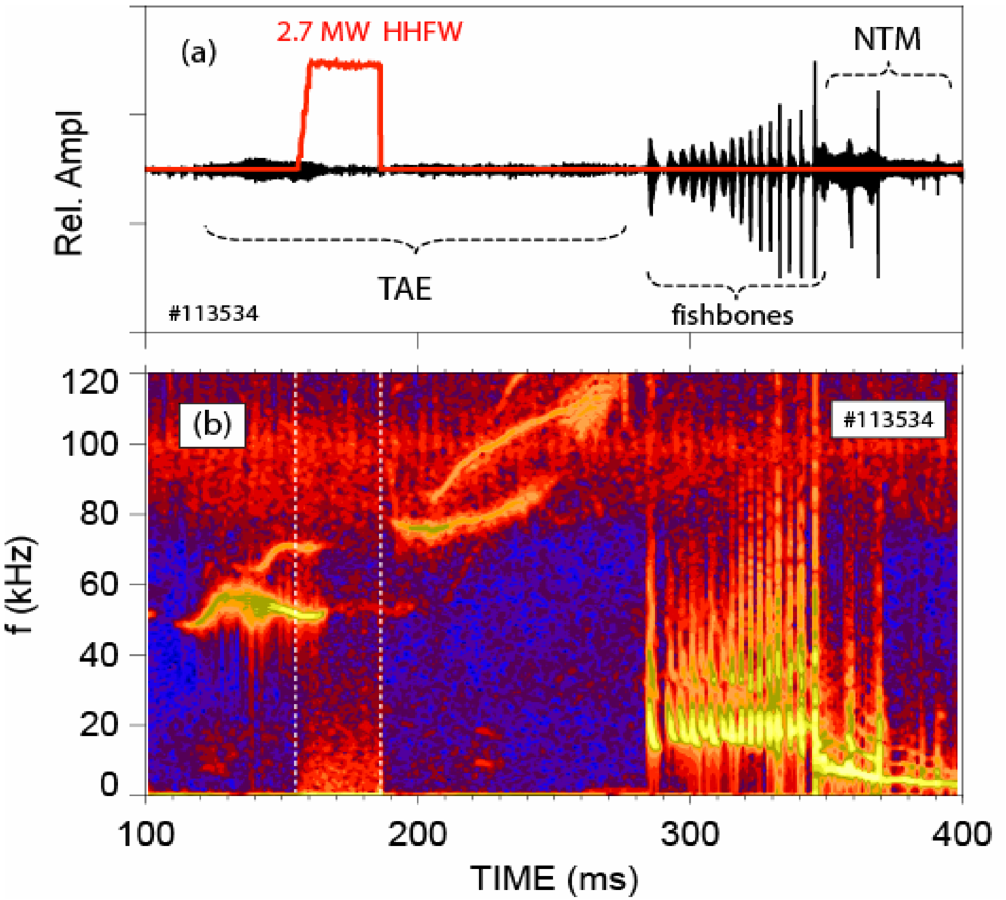
- Need to understand fast-ion transport by TAEs for ITER. (Published comparisons with theory disagree.)
- Efficient to study in same experiment (XP 449 had both fishbones and TAEs.
- Also a good discharge for 3-wave coupling between fishbones and TAEs.

Crucial Diagnostics

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

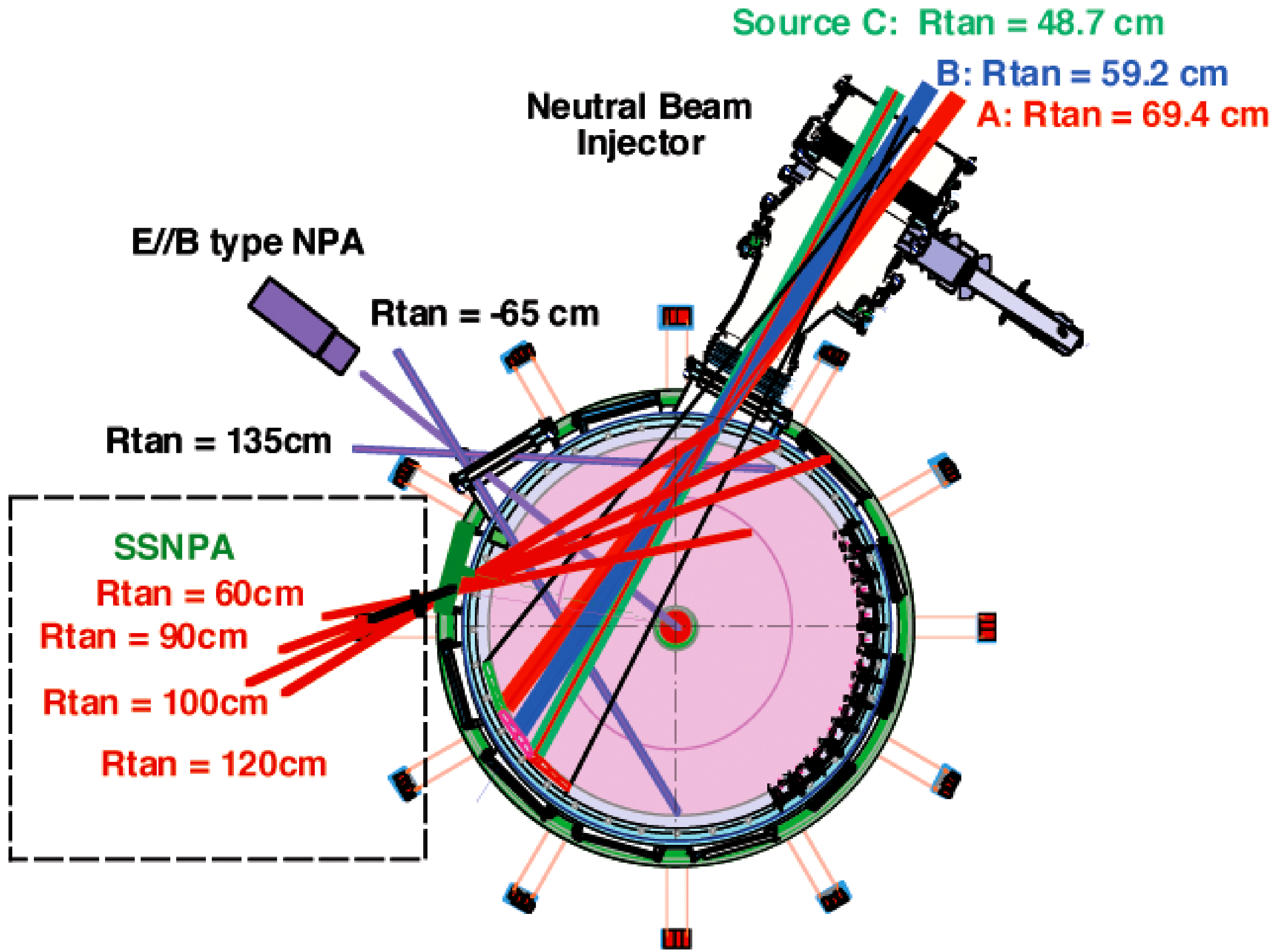
➔ L-mode

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

- Establish target: (2-8 shots) #113534 (4.5 kG, 0.8 MA, Source C at 90 keV, inner wall limiter, helium).
  - If the fishbones are weak, add Source B at the time of interest or lower the plasma current or lower the toroidal field.
- Document—NPA spatial scan (4 shots).
- Repeat with Source A (4 shots).
- Adjust discharge for strong TAEs (if not already acquired).
- Lower the beam voltage to 65 keV from the reference condition (4 shots).
- Options if time permits: seek stronger 3-wave coupling condition, lower toroidal field, or lower current.

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.