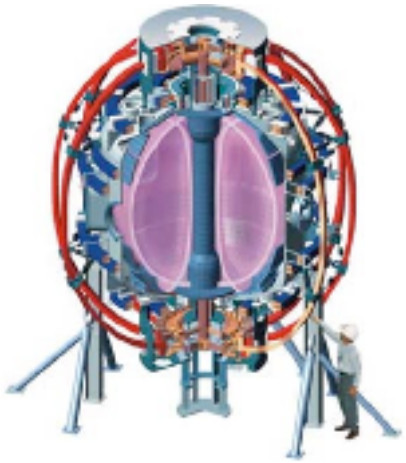


XP 808 - AC mode induced fast-ion transport and MHD spectroscopy

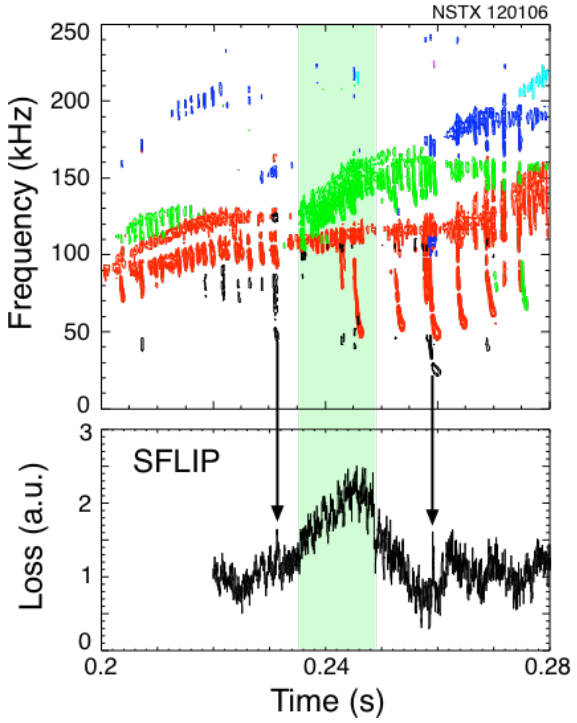
NA Crocker, ED Fredrickson, NN Gorelenkov
and many others …

NSTX Results and Theory Review

August, 2008

Goals of XP 808

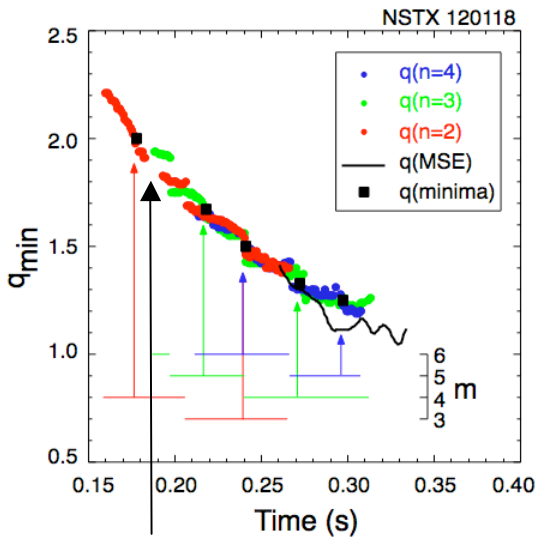
- **Assess role of Alfvén Cascade modes in fast-ion transport**
  - Identify mechanism for sustained fast-ion loss (sFLIP) associated with AC modes
  - Assess role in "avalanche" and "diffusive" transport



- **Test MHD spectroscopy (determination of q_{min} from f_{AC}) at high β and $\nabla\beta$**
  - $\nabla\beta$ dependence relatively unexplored experimentally
  - γ (adiabatic index): sort out roles of β_e, β_i and β_f in accoustic coupling (geodesic curvature)

$$\omega_{AC}^2 = k_{||}^2 v_A^2 + \omega^2_{geo} + \omega^2_{\nabla\beta}$$

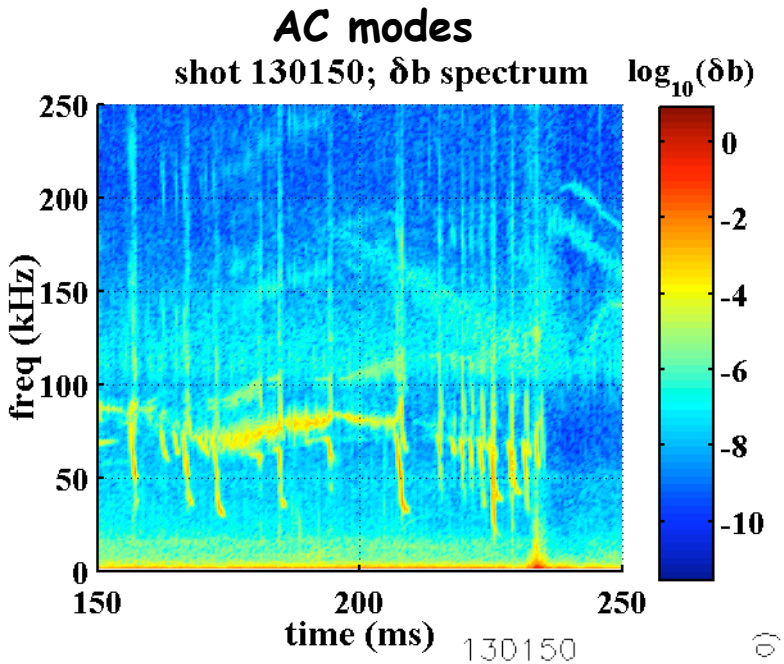
$$k_{||} = (m/q_{min} - n)/R \qquad \omega^2_{geo} = 2\gamma P/\rho$$

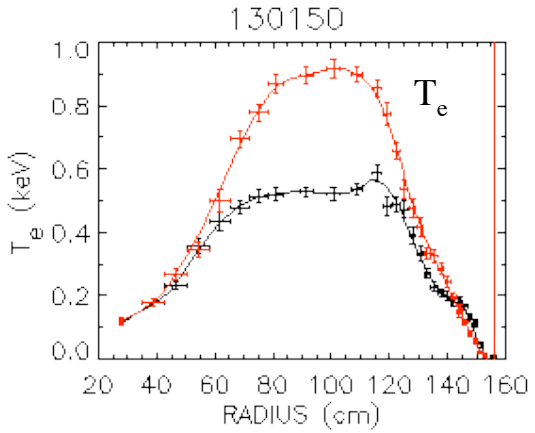


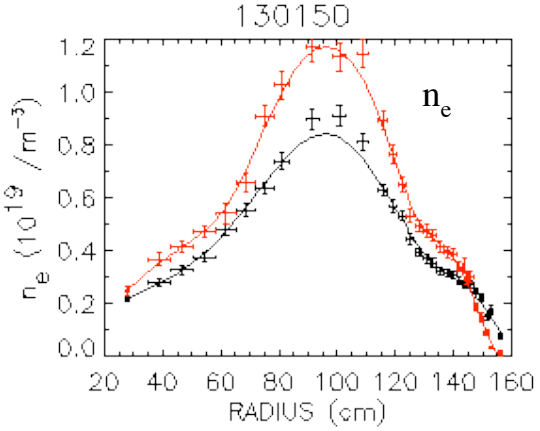
$$q_{min} = \frac{mV_{Alfvén}}{nV_{Alfvén} + R(\omega^2_{mode} - \omega^2_{min})^{1/2}}$$

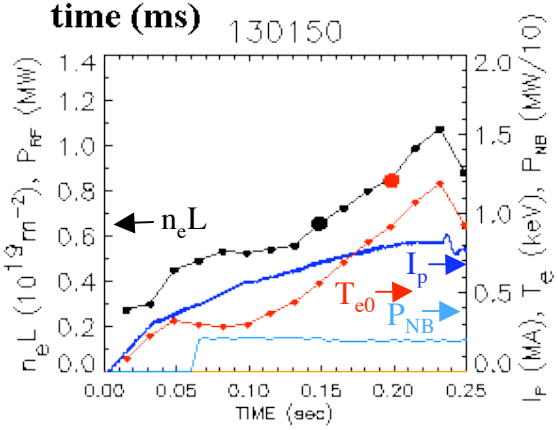
Results

- *AC mode spectra measured (edge δb, reflectometry, inteferometry)*
- *fast-ion population measurements obtained:*
  - sFLIP: energy+pitch resolved at 1 kHz; also, fast "total loss" measurement
  - 7-angle vertical NPA scan + ssNPA
  - FIDA spectra and total light profiles
- *Equilibrium variations to test MHD spectroscopy:*
  - n_e ~ 0.5 – 2.5 x 10^{19} m^{-3} ⇒ β and V_A variation
  - B = 0.45 and 0.55 T ⇒ β and V_A variation
  - Ion mass variation: D and He ⇒ β_i and ρ variation
  - Electron heating with HHFW ⇒ β_e and ρ variation









Planned Analysis

- **Two approaches to determine fast-ion transport (both "diffusive" and "avalanche")**

  1) Calculate fast-ion transport from mode structure

  - **Use NOVA-K + reflectometry and interferometry measurements to determine mode structure and amplitude**
  - **Use ORBIT to calculate perturbed fast-ion trajectories**

  2) Use transport modeling to identify impact on fast-ion population

  - **Use TRANSP to model expected population without modes**
  - **Determine "anomalous" transport consistent with NPA, ssNPA and FIDA**

- **Also use ORBIT calculations to identify direct loss mechanism**

- **To test MHD spectroscopy: compare mode spectra with NOVA-K calculations**

  - **Exploit variation of ion mass, B, n_e and T_e and $\nabla\beta$ to test predictions for γ.**

Improved mode structure measurements available in 2009

- By March 2009, 16 reflectometer channels covering 35 to 75 GHz
  - Better mode structure spatial resolution
  - 1.5 – 7.0 x 10^{19} m^{-3} in O-mode
  - Mode structure in high density plasmas (when H-mode evolves to monotonic density profile)