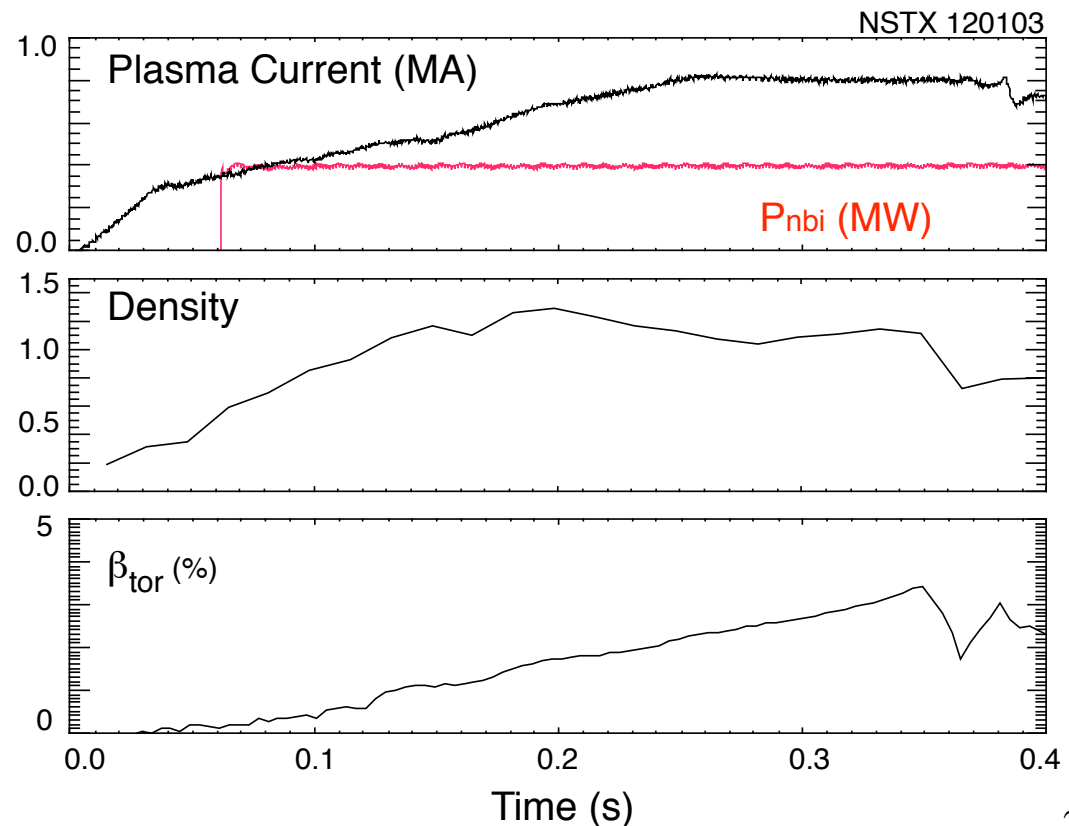


# “Missing” Cascade Modes are (were?) Mystery on STs

- Neither MAST nor NSTX has (had?) seen Cascade modes.
- Predicted for  $\beta < 4\%$  (Berk, Briezman, Van Dam).
- Recently, cascade-like modes have been seen at very low density, beta on NSTX
- No MSE data, so fundamental physical

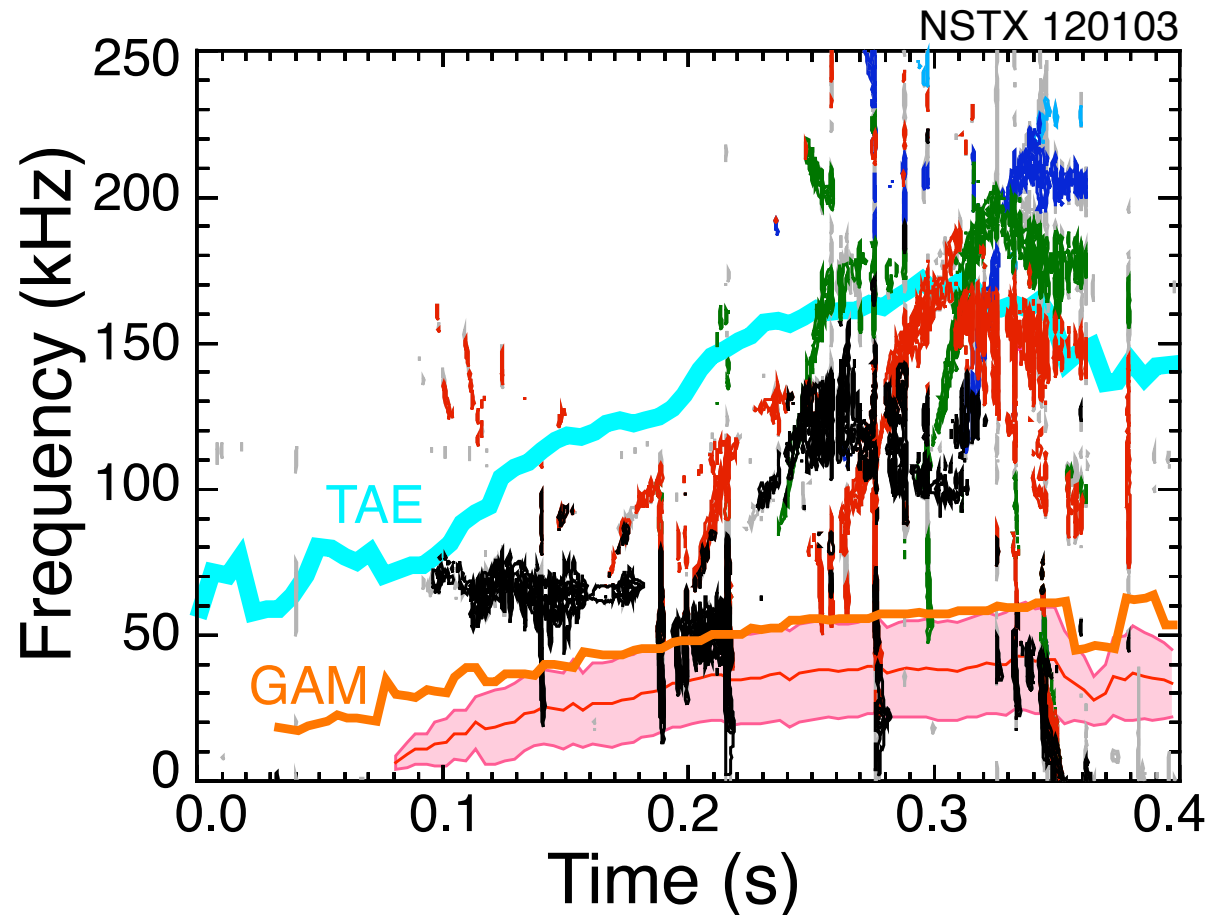
# “Cascades” were seen in very low density plasma

- Only a couple of shots, and with source “C”
- Central density  $\approx 1.2 \times 10^{13}/\text{cm}^3$
- $\beta_{\text{tor}} < 3\%$
- $V_{\text{beam}}/V_{\text{Alfvén}} \approx 1.3$
- $\rho_{\text{beam}} \approx 20 \text{ cm}$



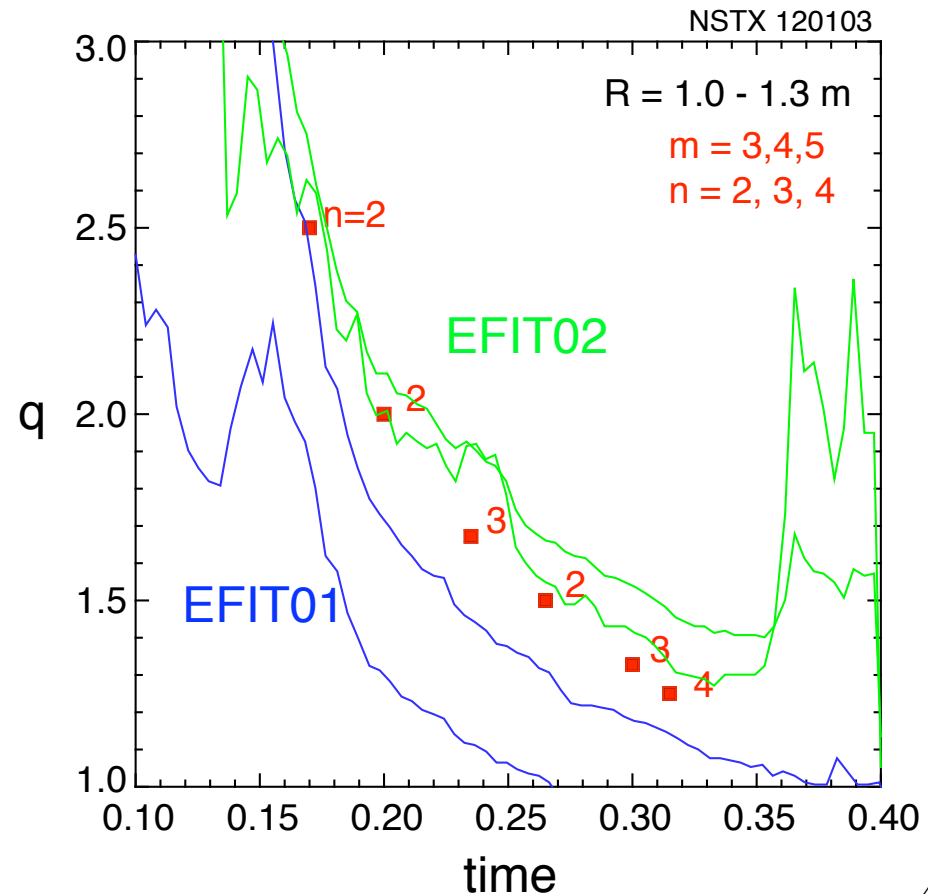
# Frequency spectrum is cascade-like.

- Sequence of toroidal mode numbers: 2, (1,2), 3, 2, 3, 4 is consistent with cascade.
- Unfortunately, no MSE data, so just speculation.
- CHERs finds very low rotation rate (no locked mode?)
- but  $n=2, 3, 4$  have significant frequency split



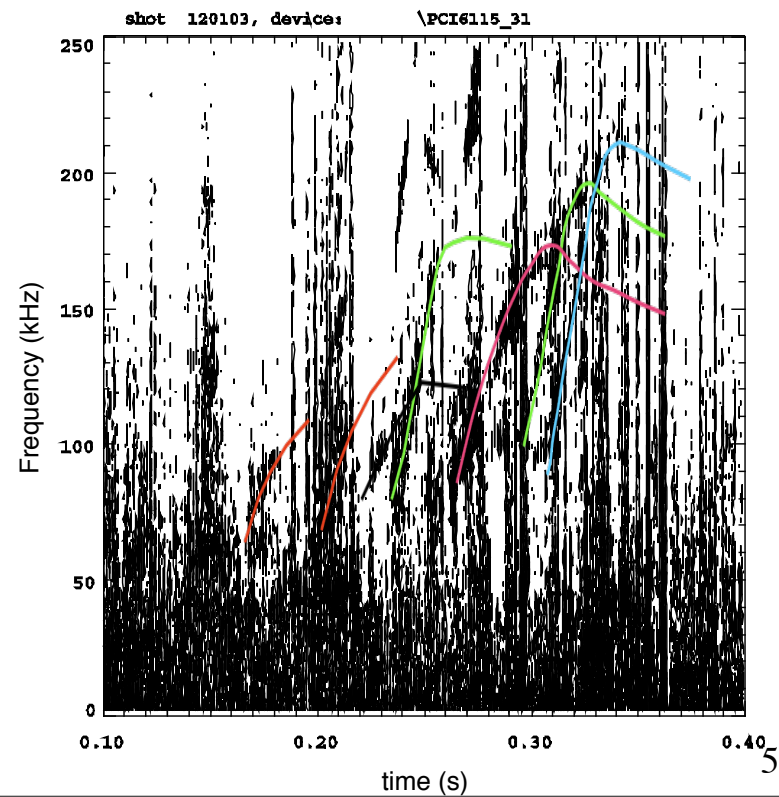
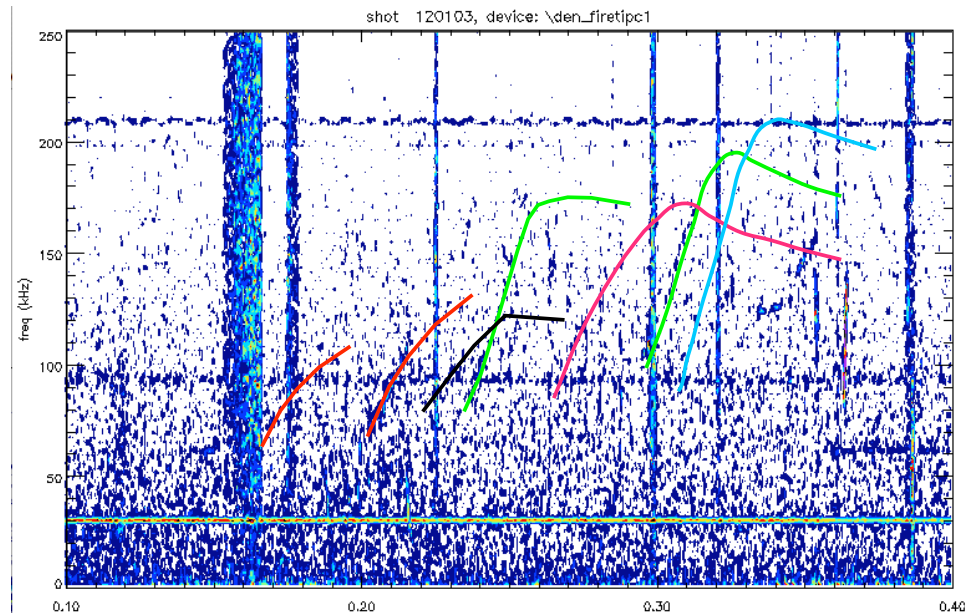
# Cascade structure “consistent” with EFIT02 q-profile

- The times of  $q_{\min} =$  rational can be inferred from Cascade structure (red points).
- These are consistent with EFIT02 q profile - although q is flattish, rather than inverted as expected for Cascades.



# Modes can be seen on Firetip channel, “reflectometer”

- Signals much weaker than on Mirnov coils.
- Frequency of modes detected with Mirnov coils overlaid.
- Density at or below cut-off for all channels - so more like interferometers.

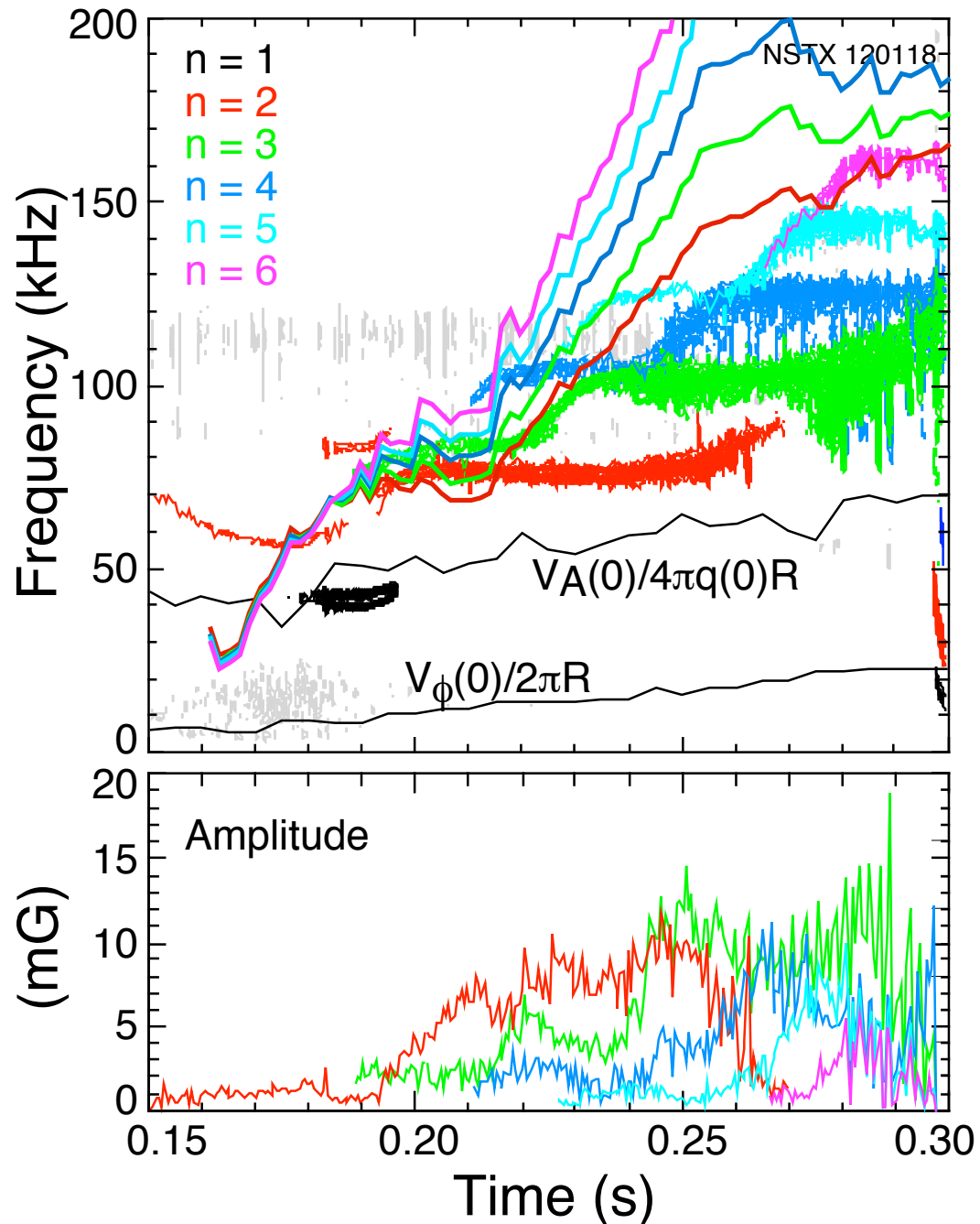


# Summary

- Strongly up-chirping modes, saturating at frequencies near TAE, are seen in very low density, low beta NSTX beam heated plasmas.
- Time sequence of toroidal mode numbers could be consistent with q-profile evolution.
- But MSE data never collected.
- High priority is to acquire such data early in next campaign.
- Also, try to get reflectometer data on structure

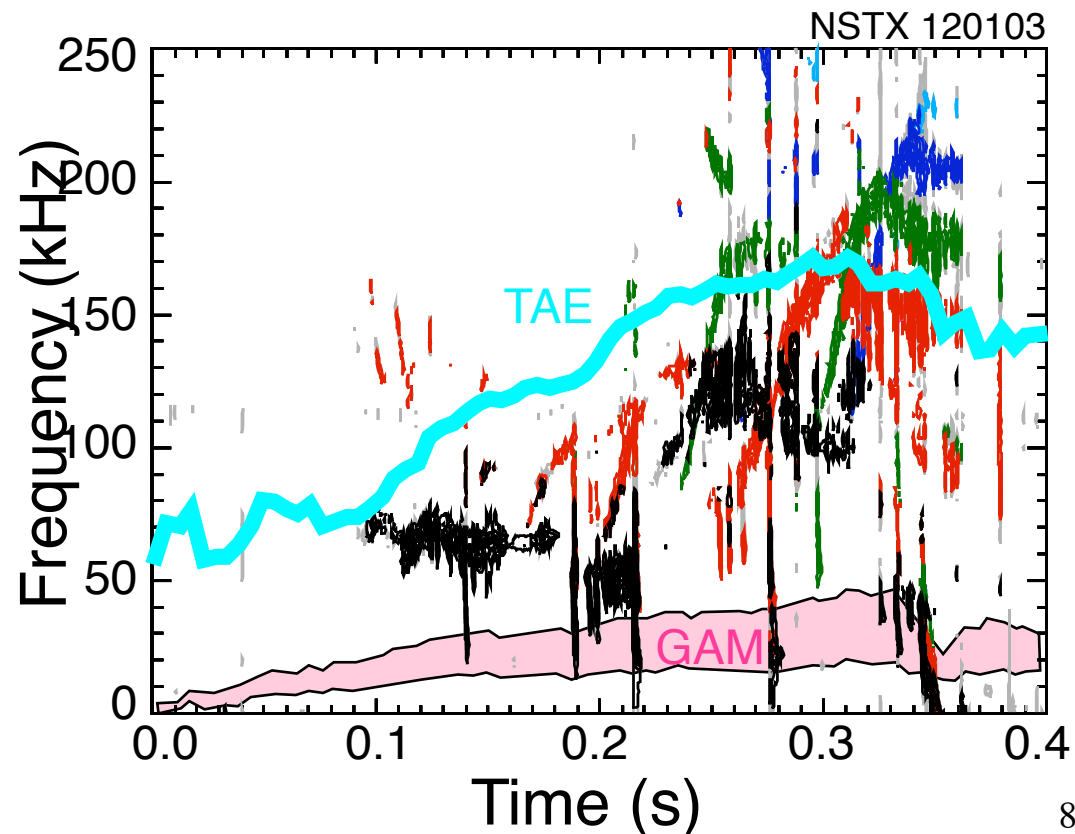
# At low density, “TAE” evolution still odd

- TAE show one or two slowish upward frequency chirps.
- Maybe evolution through different poloidal structures of TAE with same  $n$ ?



# Saturated cascade frequencies are roughly consistent with TAE frequency

- CHERs finds very low rotation rate (no locked mode?),
- but  $n=2, 3, 4$  saturated frequencies have significant split





# Signals also detected with “reflectometers”

- Density at or below cut-off for all channels - so more like interferometers.
- Possible additional modes seen in reflectometer data.

