# Study of the correlation between GAE activity and electron transport

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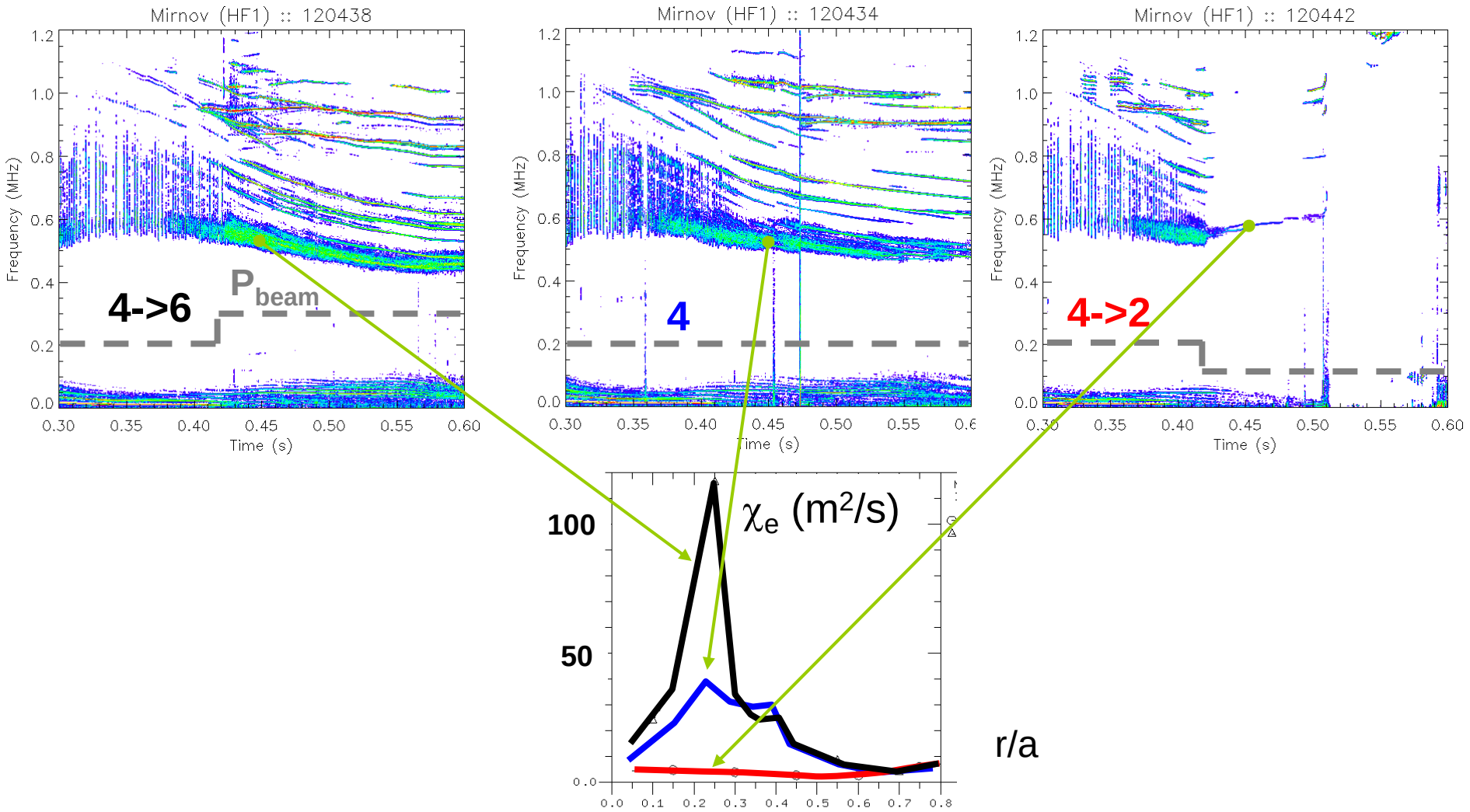
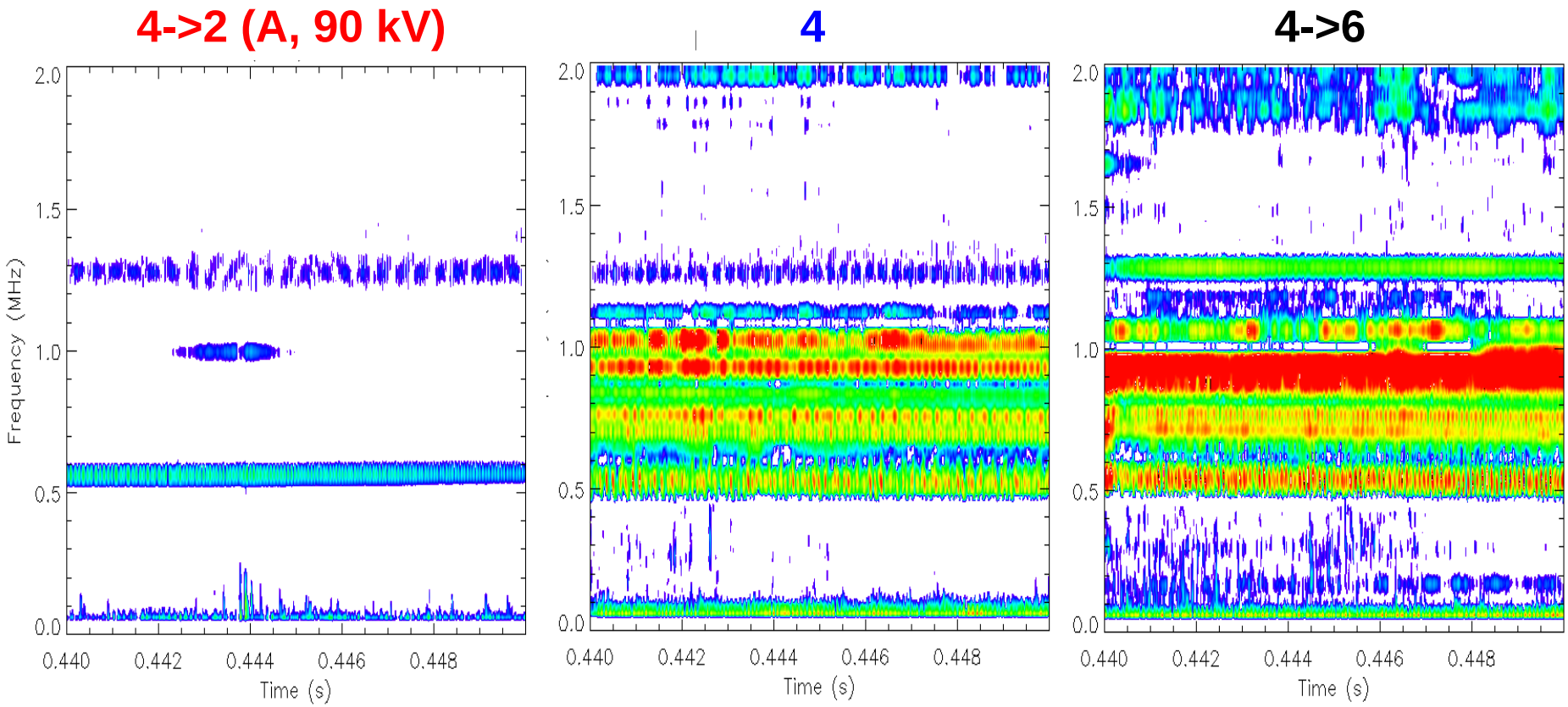
# Compelling signs for a GAE/electron transport connection

## $P_b$ changes in fixed-q, 1 MA, 90 kV, 4.5 kG H-modes




- Strong/weak GAEs appear to correlate with high/low $\chi_e$ in H- and L-modes
- Rapid $\chi_e$ increase at $P_b$ > 2 MW suggests threshold in transport mechanism

# Apparent threshold for GAE 'coalescence' at $P_b$ > 2 MW

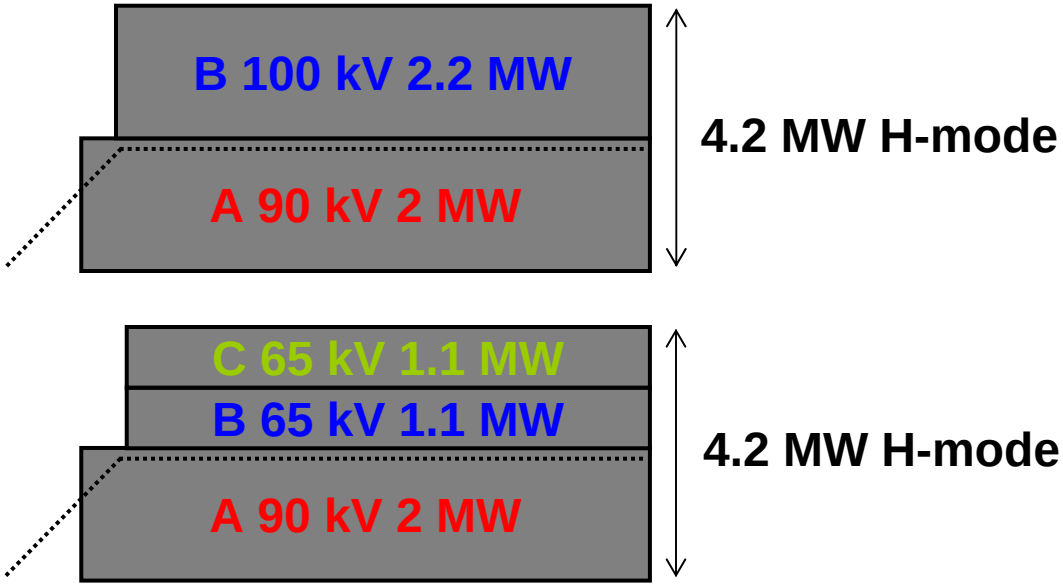



- Elevated q also appears to favor mode coalescence and high central $\chi_e$
- Possibly supported by theory (N. Gorelenkov)
- *Practical point*: single source at 90 kV does not make strong GAEs

# XP goals: Strengthen/document GAE/$e^-$ transport connection

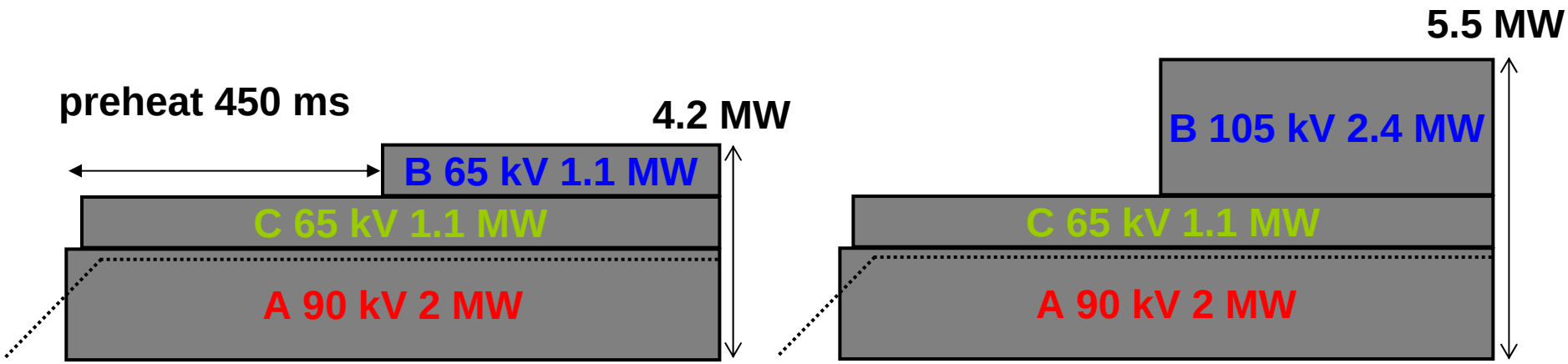
- Compare plasmas with/without GAEs in a few heating scenarios
- Same q-profile ($n_e$, rotation) as much as possible
- Document with MPTS, CHERS, MSE, high-k, reflectometry, Neon injection

**Part I: Compare plasmas with same $P_b$ but different $V_b$**




- GAEs 'turn-off' at low $V_{beam}$ (E. Fredrickson)
- If at low $V_b$ q reverses, reduce $I_p$ ramp rate to restore similar q
- H-mode preferred for stability, reproducibility, elevated central q

• **Part II:** $P_b$ step at increasing $V_b$




- Make MHD quiescent 3 MW H-mode (A+C)
- 'Freeze-in' q-profile by preheating
- Step source B at increasing $V_b$ (60, 75, 90, 105 kV)
- Compare differences in electron transport using TRANSP

• **Part III: Compare RF+NBI heating in plasmas with/w.o. GAEs**

- Apply RF to conditions evidencing largest difference in GAE content

# Proposed run plan

## Part I

1. High $V_b$: A/90 + B/100 (2 shots)
2. Low $V_b$: A/90 + B/65 + C/65 (2 shots)
3. Decrease $I_p$ ramp if q tends to reverse at low $V_b$ (2 shots)
4. Neon injection at high/low $V_b$ (2 shots)

Baseline
129902
0.9 MA
4.5 kG

## Part II

4. Establish baseline A/90 + C/65 (2 shots)
5. Step B at 450 ms: 60, 75, 90, 105 kV (8 shots)

## Part III

6. Apply 2 MW RF to GAE/no GAE plasmas (4 shots)

## Part IV (time permitting)

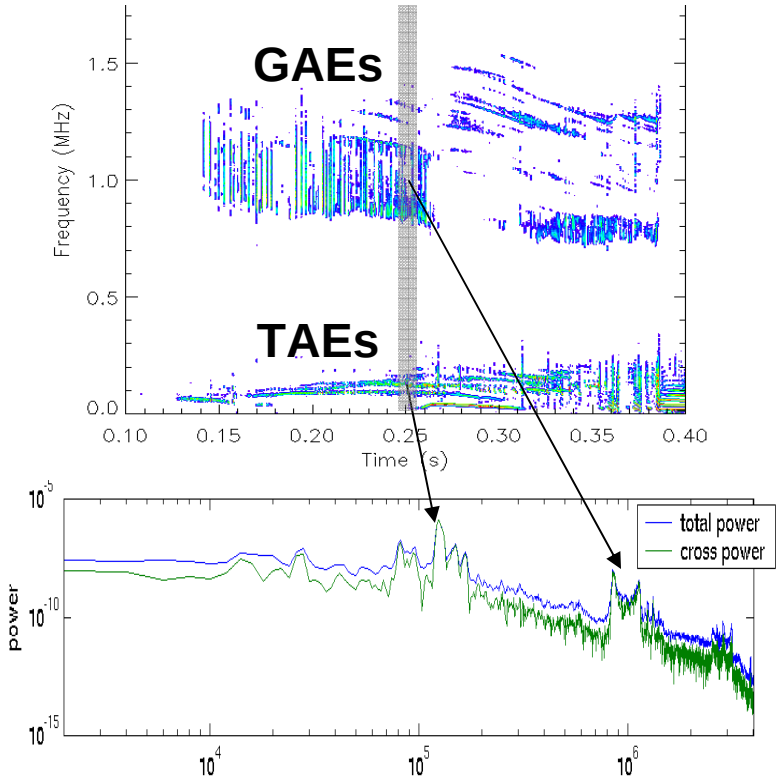
6. High $V_b$ slow-ramp L-mode for reflectometry (2 shots)

**Total 24 shots**

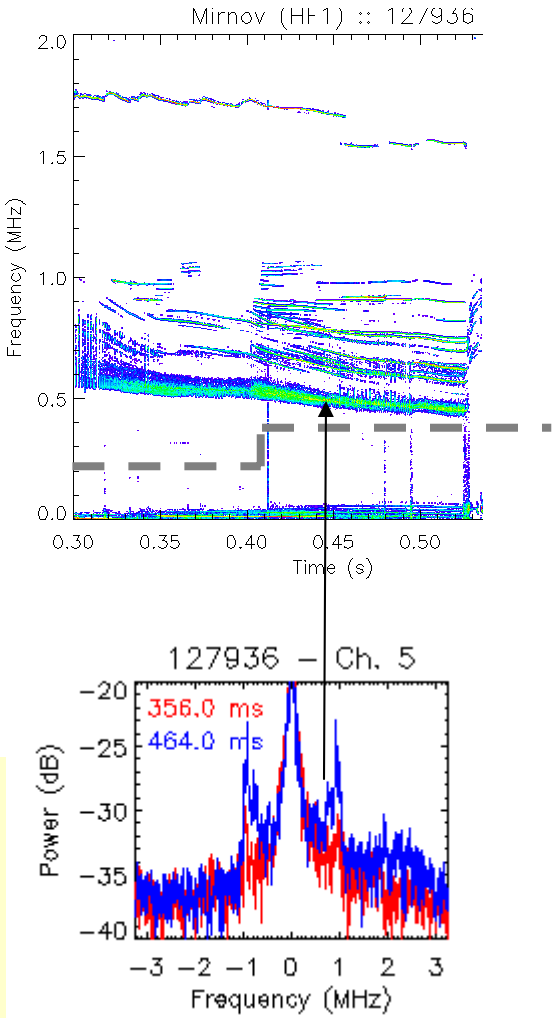
- Diagnostics: magnetics, MPTS, MSE, CHERS, high-k, TOSXR, reflectometry

# Reflectometry + high-k for GAE amplitude?

## ‘Slow-ramp’ low $n_e$ L-mode




## 4->6 H-mode

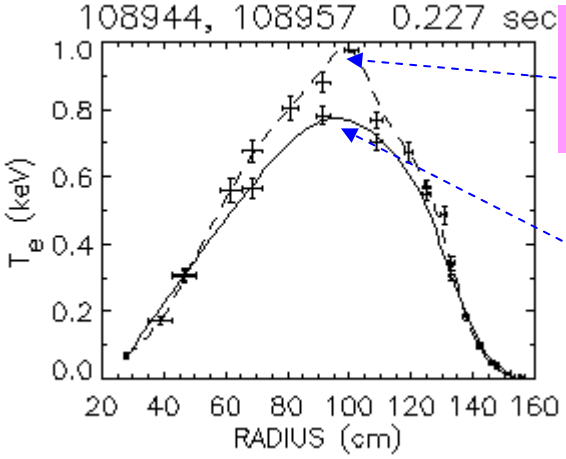



- Cross-calibrate high-k with reflectometry using slow-ramp L-mode
- Use high-k (‘interferometric mode’?) to assess GAE $\delta n$ in H-modes

# backup slides

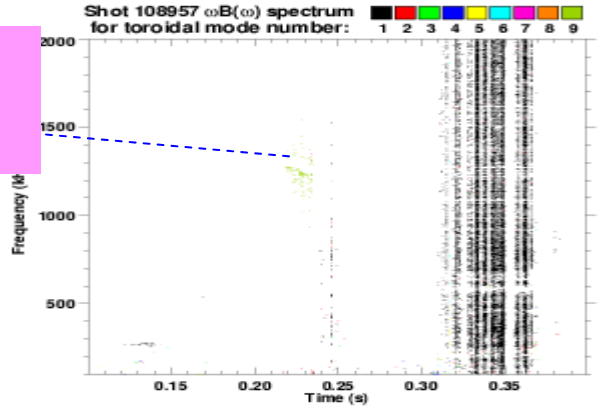
# Very similar plasmas without GAEs have higher central $T_e$

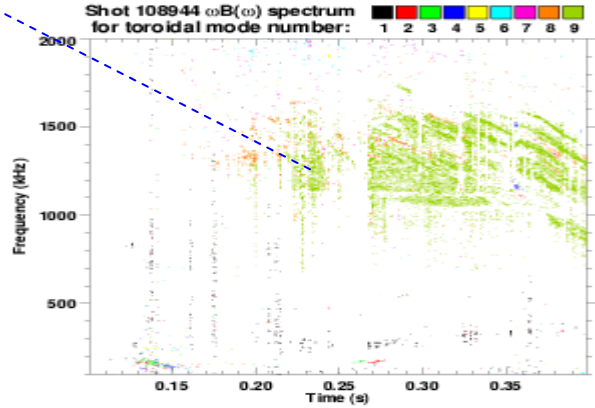
1 MA, 4.5 kG L-modes (2002)




A+B+C 60 kV
2.4 MW

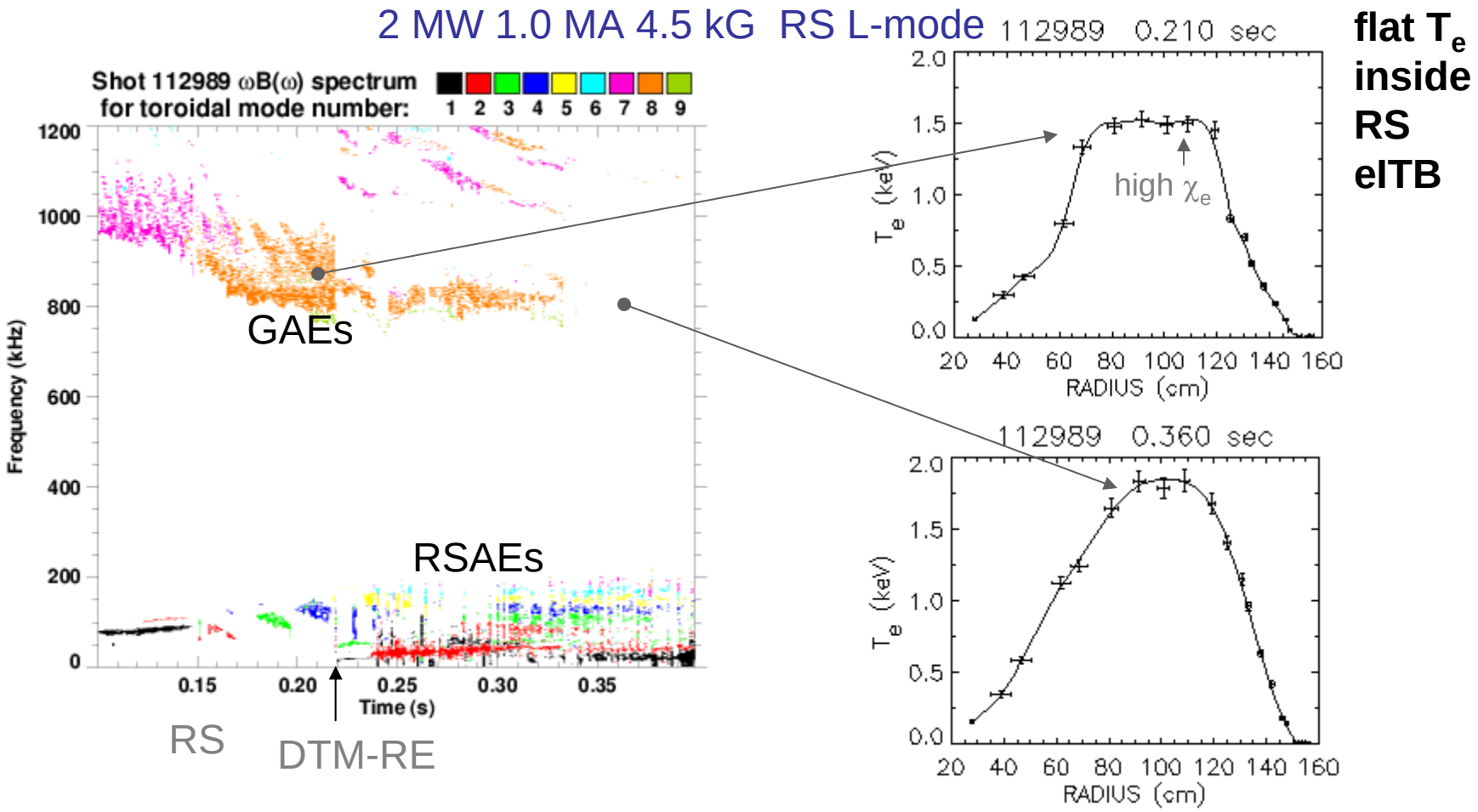
A 100 kV
2.2 MW




- μ-tearing possible link between GAEs and electrons (Stutman et al T&T/EP)
- GAE/trapped electron transport connection in ORBIT (N. Gorelenkov, prelim.)
- Possibly large implications for NHTX, beam-driven CTF, burning plasma

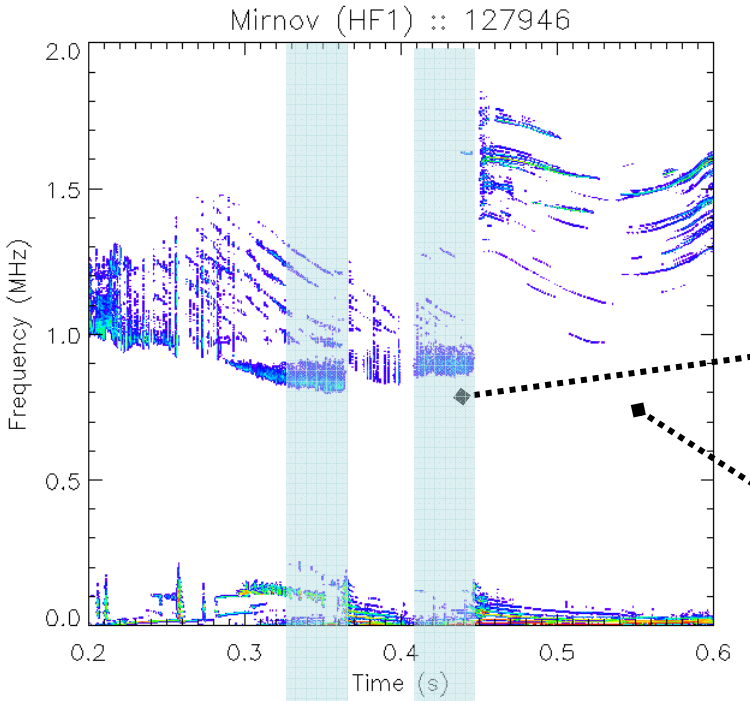
# GAE decrease/$T_e$ peaking correlate also in L-modes

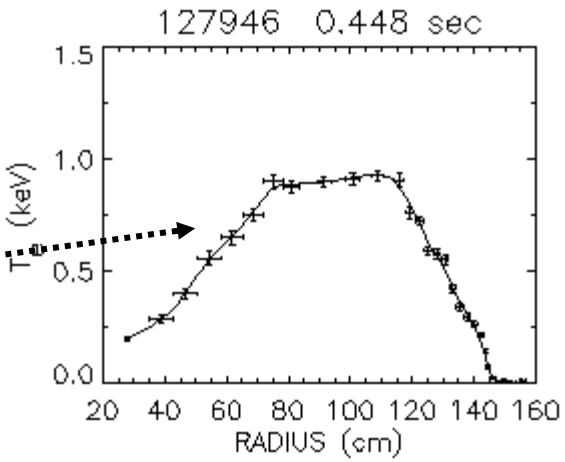


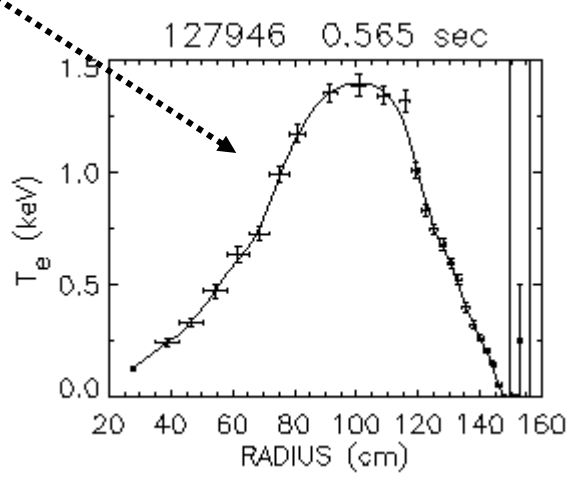

- RF appears to heat D-NBI plasmas only when no GAEs

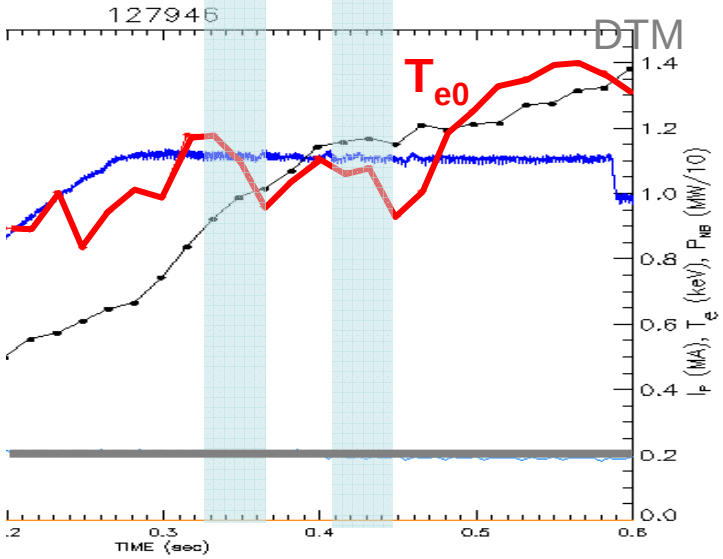
# Central $T_e$ spontaneously peaks when GAEs decrease

2 MW
1.1 MA
5.5 kG
H-mode



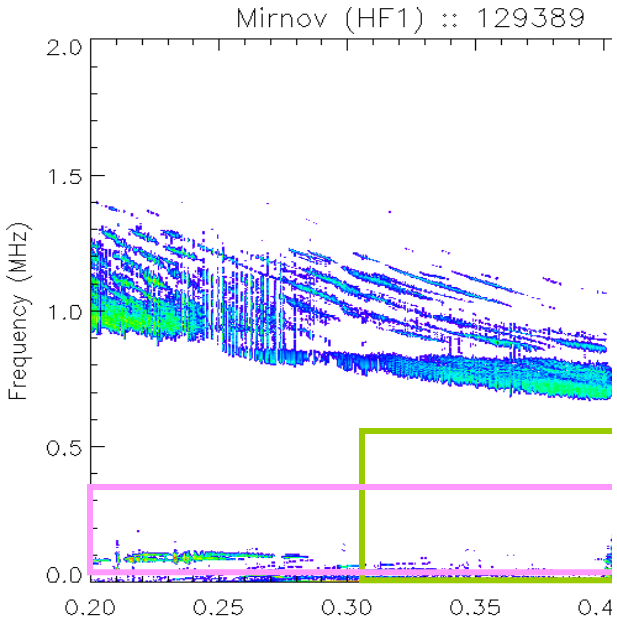



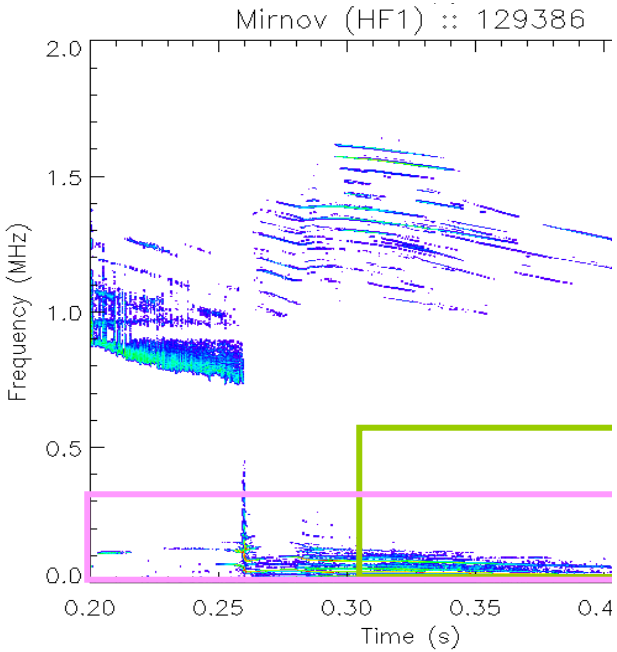

$P_{beam}$

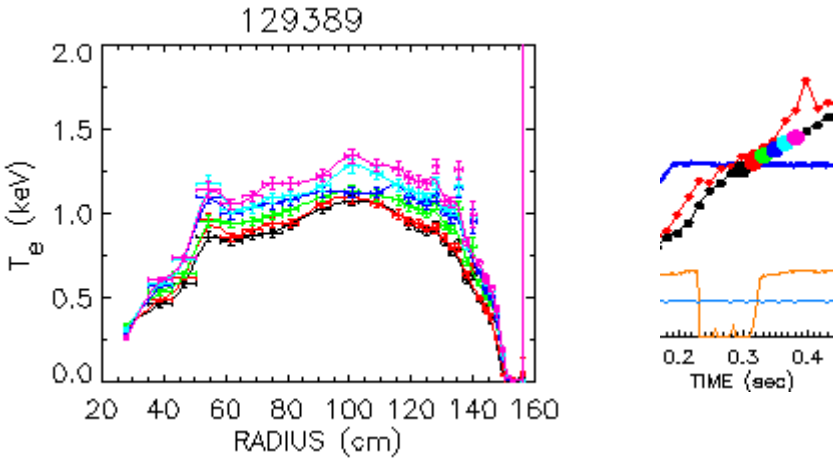
# RF increases central $T_e$ in NBI plasma only when no GAEs

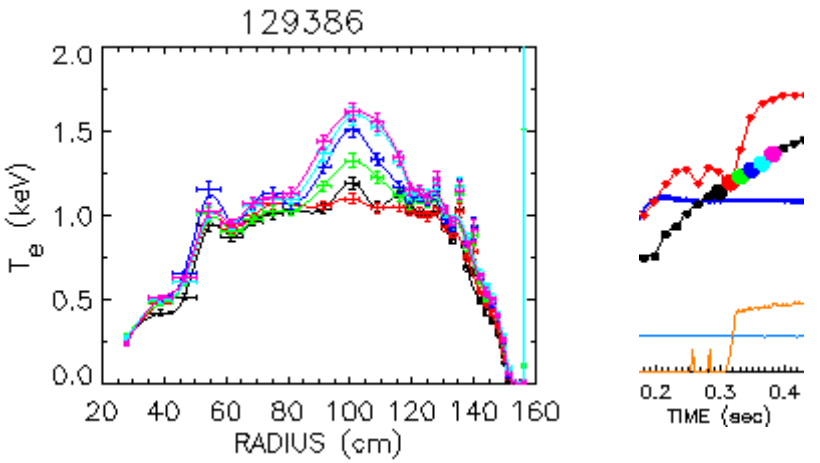



RF

NBI




- Metals after 0.4 s in both discharges