Parametric investigation of CAE & GAE instability and effect on thermal confinement in NSTX

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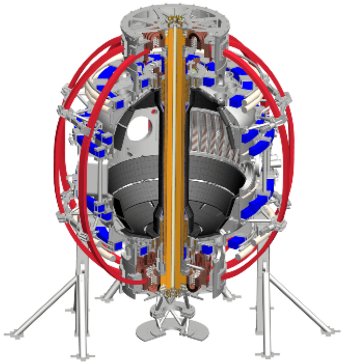
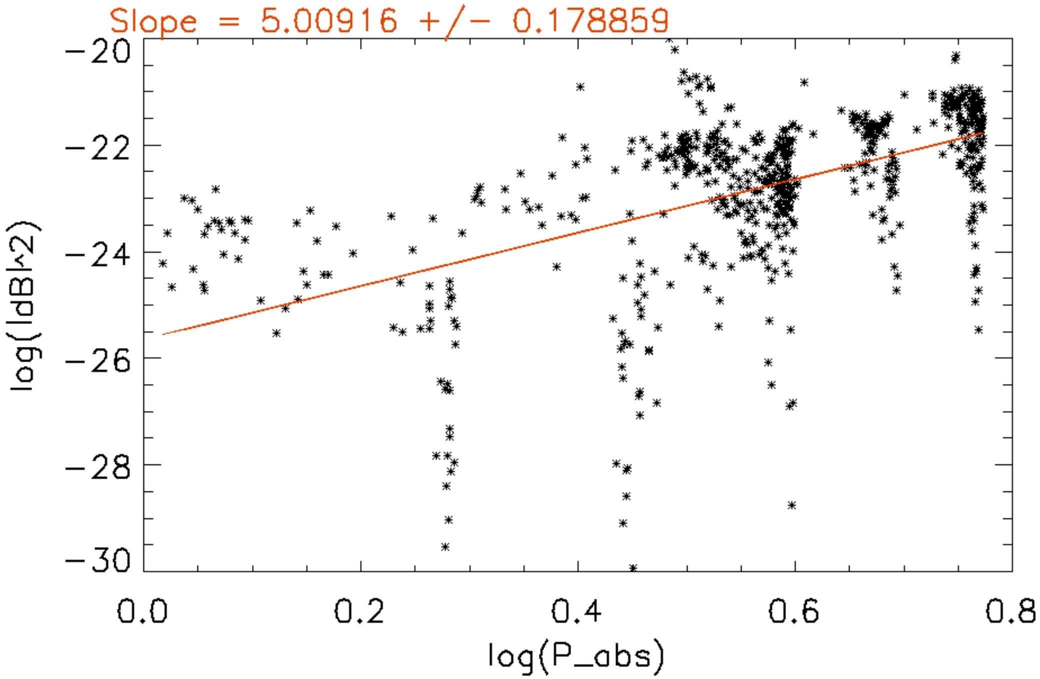


Database extended with spectral characteristics of CAEs and GAEs

- Existing database with plasma parameters from TRANSP extended to include characteristics of CAEs and GAEs [Fredrickson 2014]
  - Database spans 195 total shots and 1051 total times
- Frequency, mode power, and toroidal mode number calculated for each 50ms interval
  - Divide into 1ms records and FFT
  - Keep points (t,f) that are a good fit to single toroidal mode number
  - Power weight (dB^2) average f, n
- Investigate whether these modes play a role in anomalous electron transport, as well as understanding physics controlling the instability

[Stutman 2009]

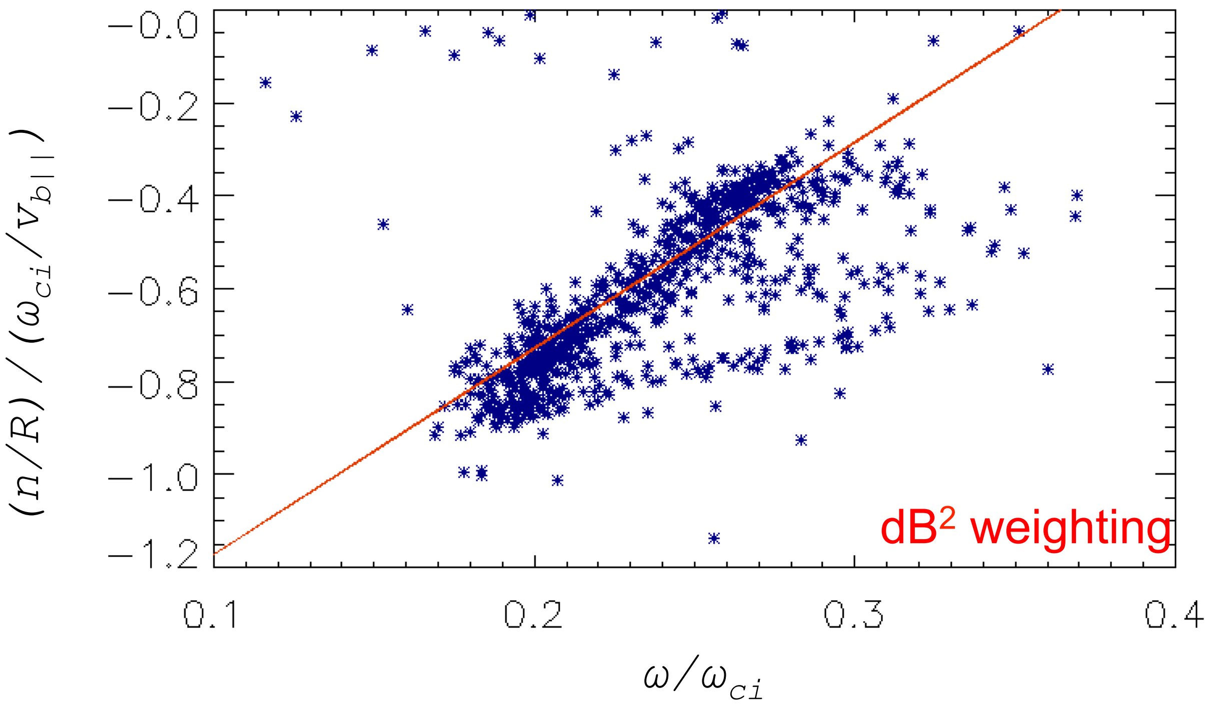
Beam power correlates with mode power



- Correlation found between total mode power (|db|^2) and TRANSP calculated absorbed beam power
- Power law found $|db| \sim P_{abs}^{2.5}$
- Roughly consistent with nonlinear simulations and analytic theory which have shown: $db \sim P_b^2$

[Lestz & Belova, 2016]

Toroidal mode number and frequency highly correlated

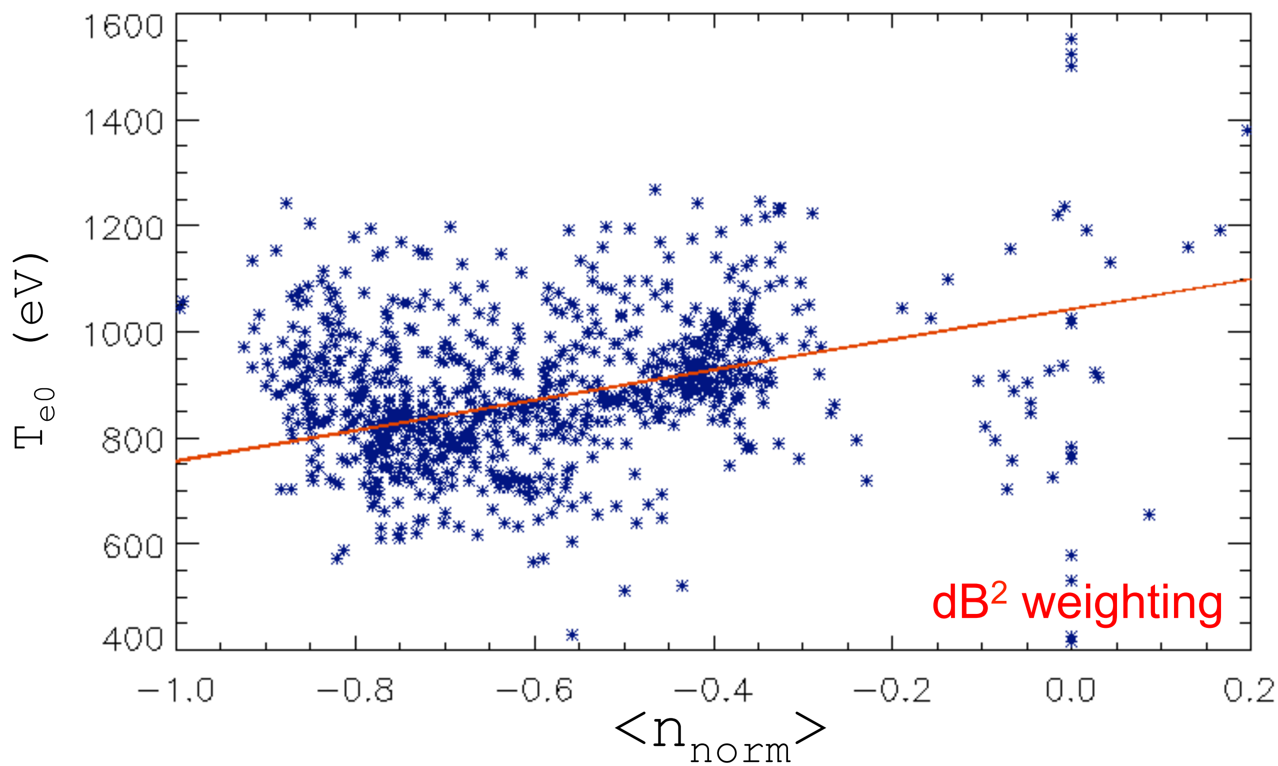


- Normalize ω and n as:
  - $\omega \rightarrow \omega/\omega_{ci}$
  - $k_{tor} \rightarrow k_{tor}/(\omega_{ci}/\max(v_{b||,inj}))$, $k_{tor} = n/R$
  - Motivated by parallel resonance condition
- Perform mode power (dB^2) weighted fit

Correlation improves with normalization motivated by parallel resonance condition

- Instability thought to be governed by Doppler shifted cyclotron parallel resonance condition
  - $\omega_{ci} = \omega - k v_{b||}$
- k and destablizing $v_{b||}$ not known → k_{tor} and $\max(v_{b||,inj})$ used
- Correlation coefficient improves from $\rho = 0.52$ +/- 0.05 to $\rho = 0.85$ +/- 0.05
  - ρ calculated using dB^2 weighted
- Suggests that resonance condition plays some role in governing instability

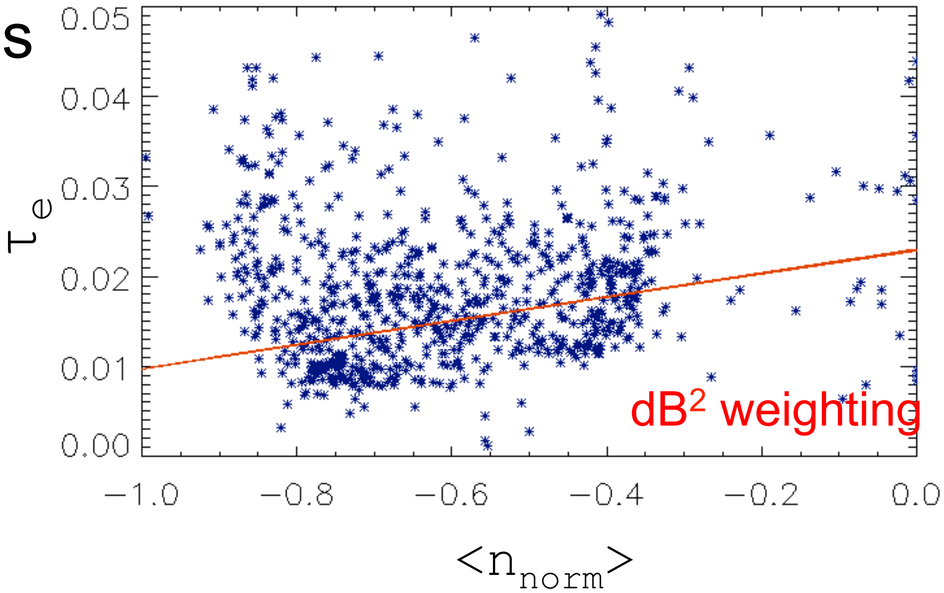
T_{e0} correlates with both <f_{norm}>, <n_{norm}>



- T_{e0} correlates with both <f_{norm}> and <n_{norm}> with statistical significance, with ρ = *0.32±0.05* and ρ = *0.45±0.05* respectively
- <f_{norm}>,<n_{norm}> control T_{e0}?

min(τ_e) in core correlates with <f_{norm}>,<n_{norm}>

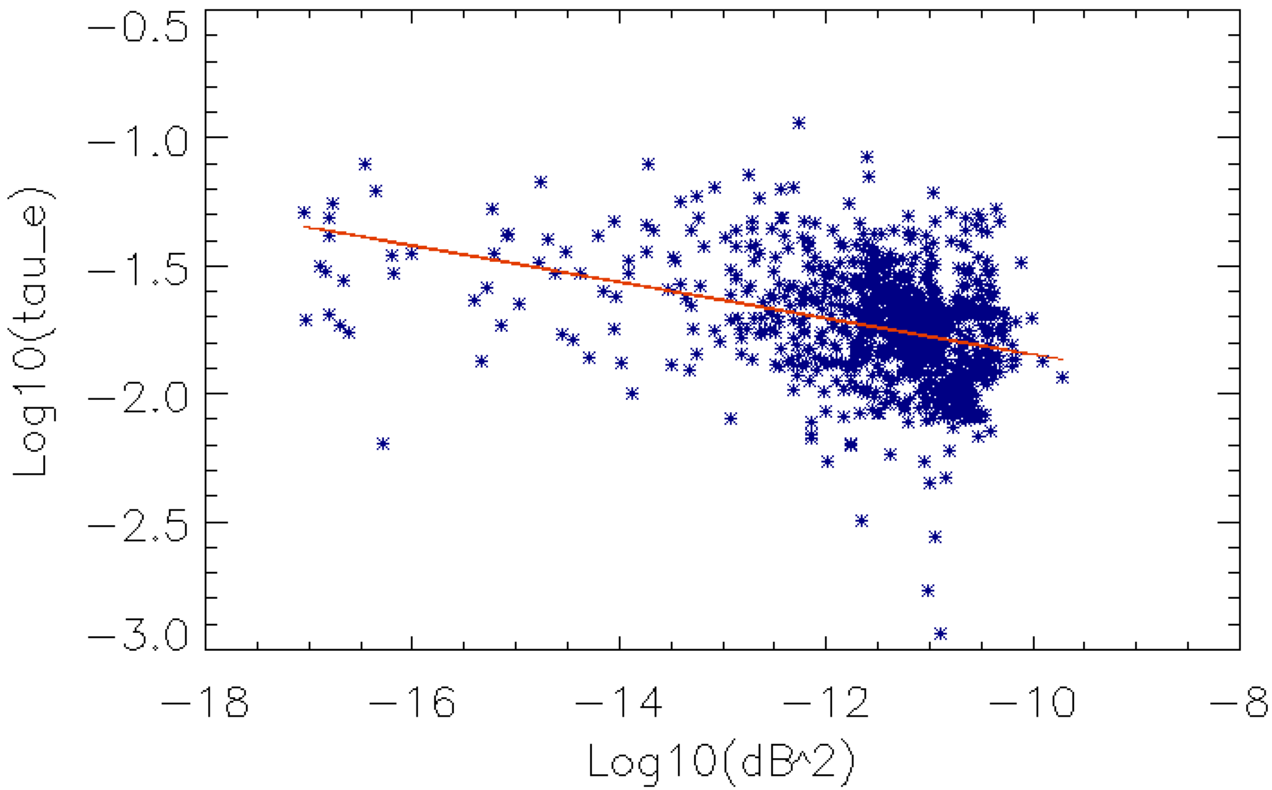
- χ_e ideal indicator of anomalous transport but very noisy
  – Connects to Stutman PRL 2009
- $\tau_e(\rho)$ integrated, low noise
  – Median smoothing to eliminate outliers
  – take minimum value between ρ = 0.1 and ρ = 0.5



- Correlation of <f_{norm}>, <n_{norm}> with τ_e gives ρ = 0.296 ± 0.05, 0.302 ± 0.05 respectively
- Modeling assume classical fast ion diffusivity → τ_e controlled by anomalous fast ion transport?
- Some f, n more effective at orbit stochastization?

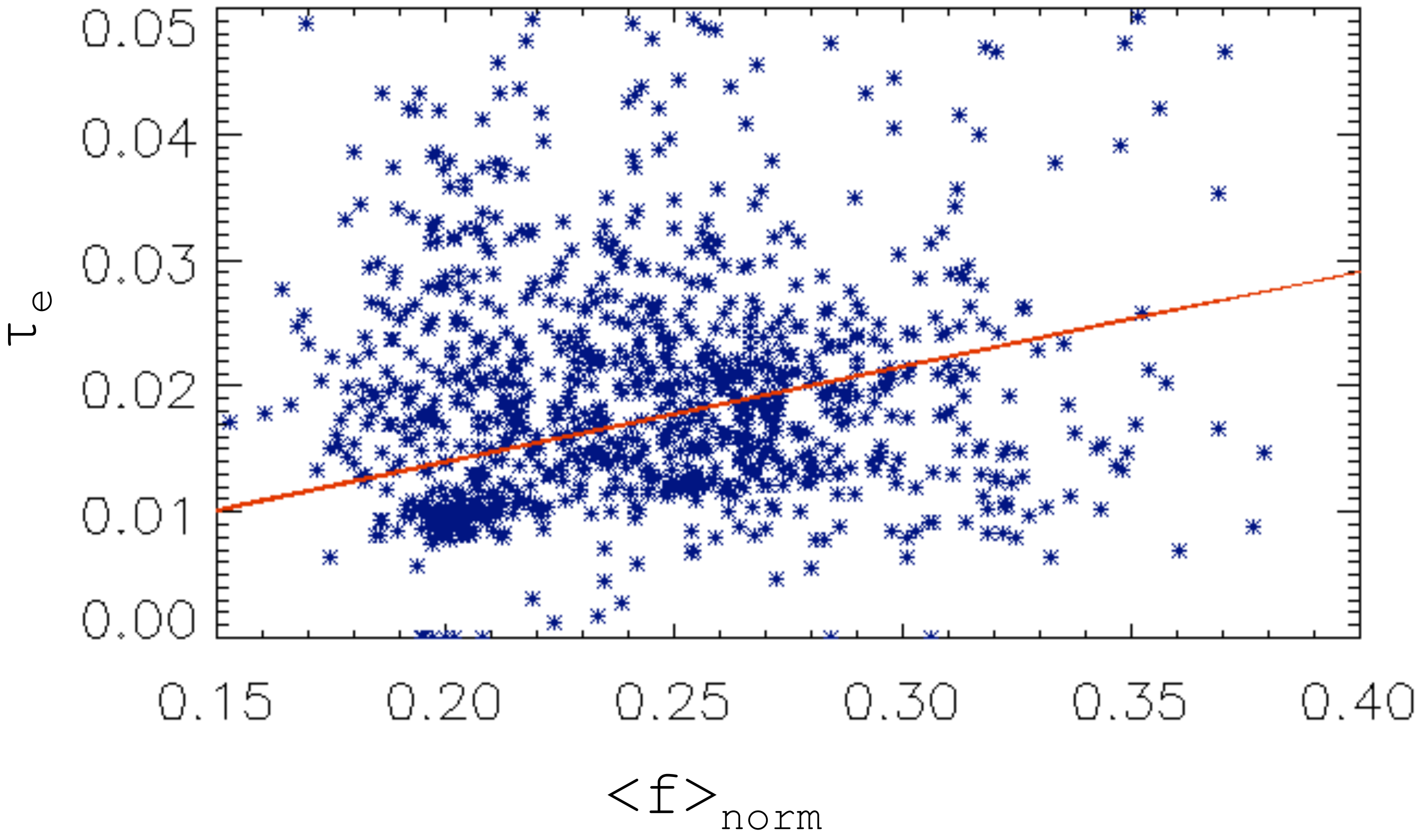
Backup Slides

Mode power vs τ_e



Rho = - 0.356 +/- 0.03
R^2 = 0.13

<f> vs τ_e



Rho = 0.296 +/- 0.05
R^2 = 0.09