Initial Tests of TGLF Transport Model with Experimental H-mode Pedestal Data from DIII-D

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GENERAL ATOMICS

Introduction and motivation

- **Predictive capability for H-mode pedestal structure requires validated theory-based transport models**
- **Theory-based transport models are being developed to predict pedestal structure**
- **One such model is TGLF**
  - And TGLF is ready for initial testing of its linear stability calculations
- **This talk presents initial experimental study of TGLF**
  - Comparison of linear growth rates to ExB shearing rate
  - Results should be treated as ***preliminary!***

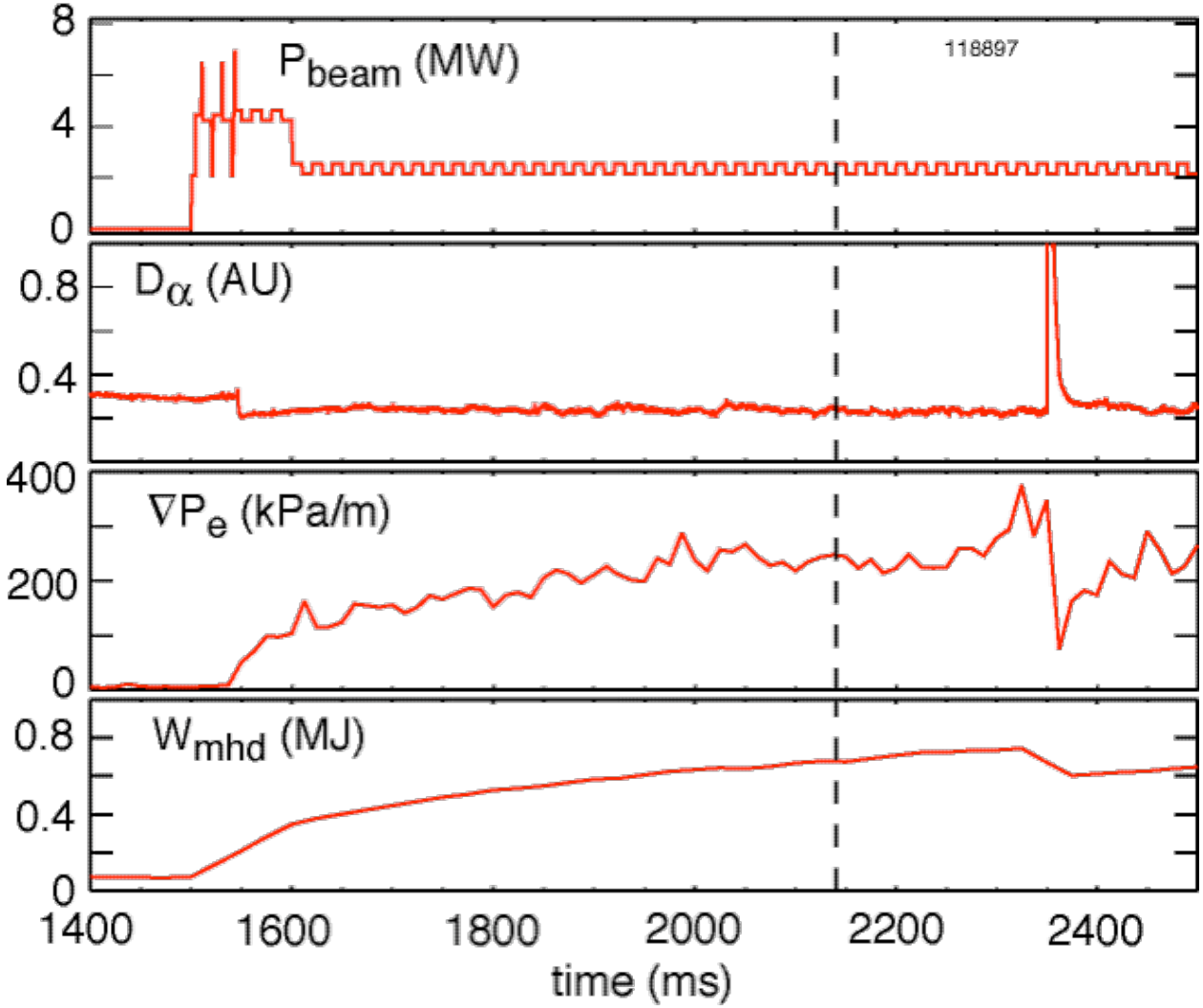
TGLF is an Accurate Model of Gyro-Kinetic Theory

- **Based on a set of Trapped Gyro-Landau Fluid (TGLF) system of equations**
  - STAEBLER, G.M., KINSEY, J.E., WALTZ, R.E., Phys. Plasmas 12 (2005) 102508
- **Yields a fast, accurate approximation to the linear eigenmodes of gyro-kinetic drift-wave instabilities**
  - ITG, ETG, TIM, TEM, kinetic ballooning
  - It predicts growth rates
- **Includes comprehensive physics**
  - Trapping, general toroidal geometry, electron-ion collisions, fully electromagnetic, impurity ions
  - Thus, it is suitable for conditions of H-mode pedestal
- **Theory-based: model is fit to first principles gyro-kinetic theory (GYRO)**
- **Linear stability predictions have been extensively benchmarked against GYRO and GKS**

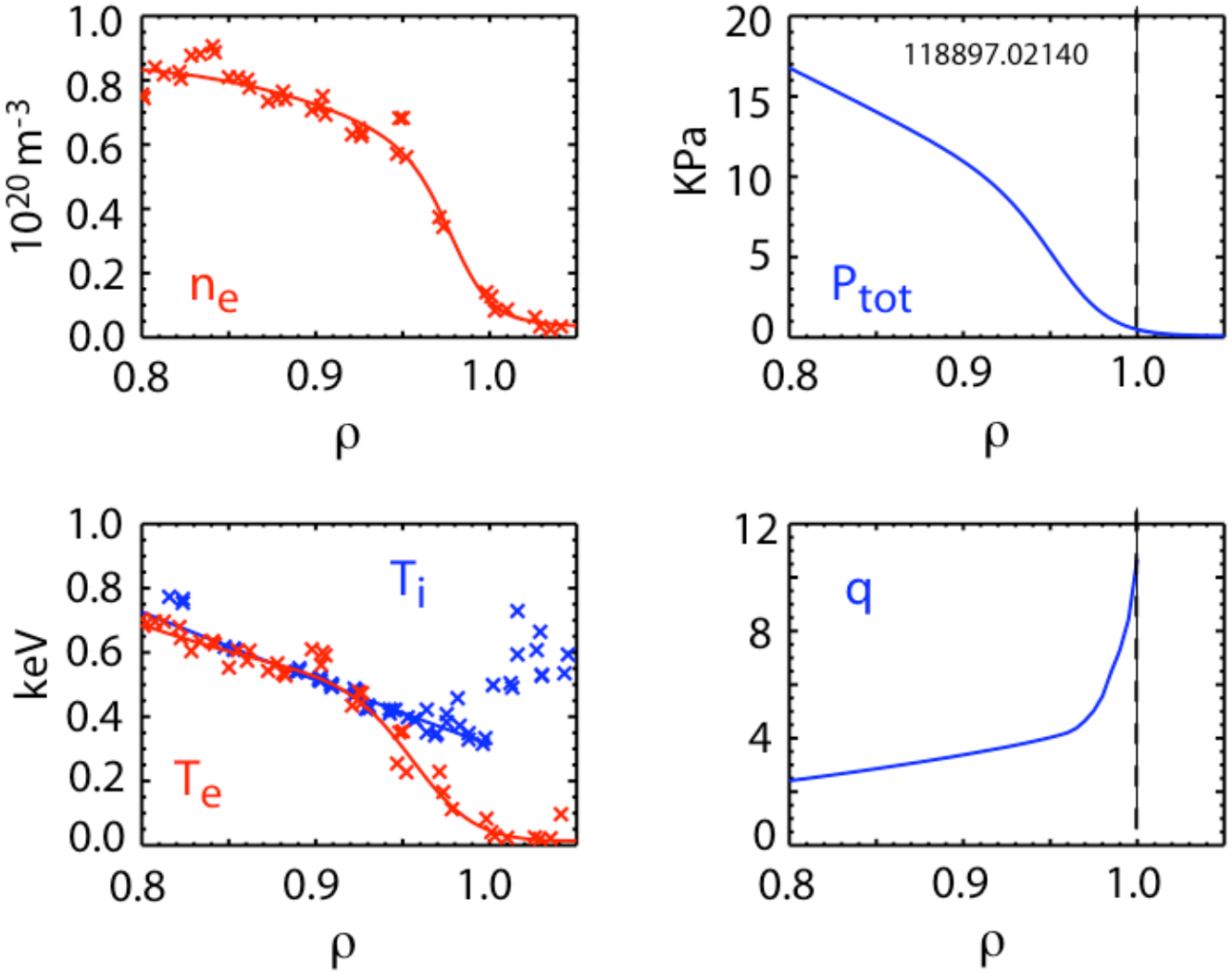
Methodology for performing initial comparisons of TGLF predictions to experimental data

- **Produce plasma with long ELM-free period to obtain pedestal profiles with MHD effects absent**
  - Measure profiles of T_e, n_e, T_i, n_I
- **Obtain composite profiles and fit with smooth analytic functions, which capture shape of the pedestal**
- **Perform ONETWO transport run with these profiles as input to generate an iterdb file**
  - Iterdb file is a mechanism to transfer profile fits from experiment to modeling codes
- **Use iterdb file as input to TGLF modeling code, run to obtain linear growth rates at various k values**
- **Compute ExB shearing rate from C VI force balance**

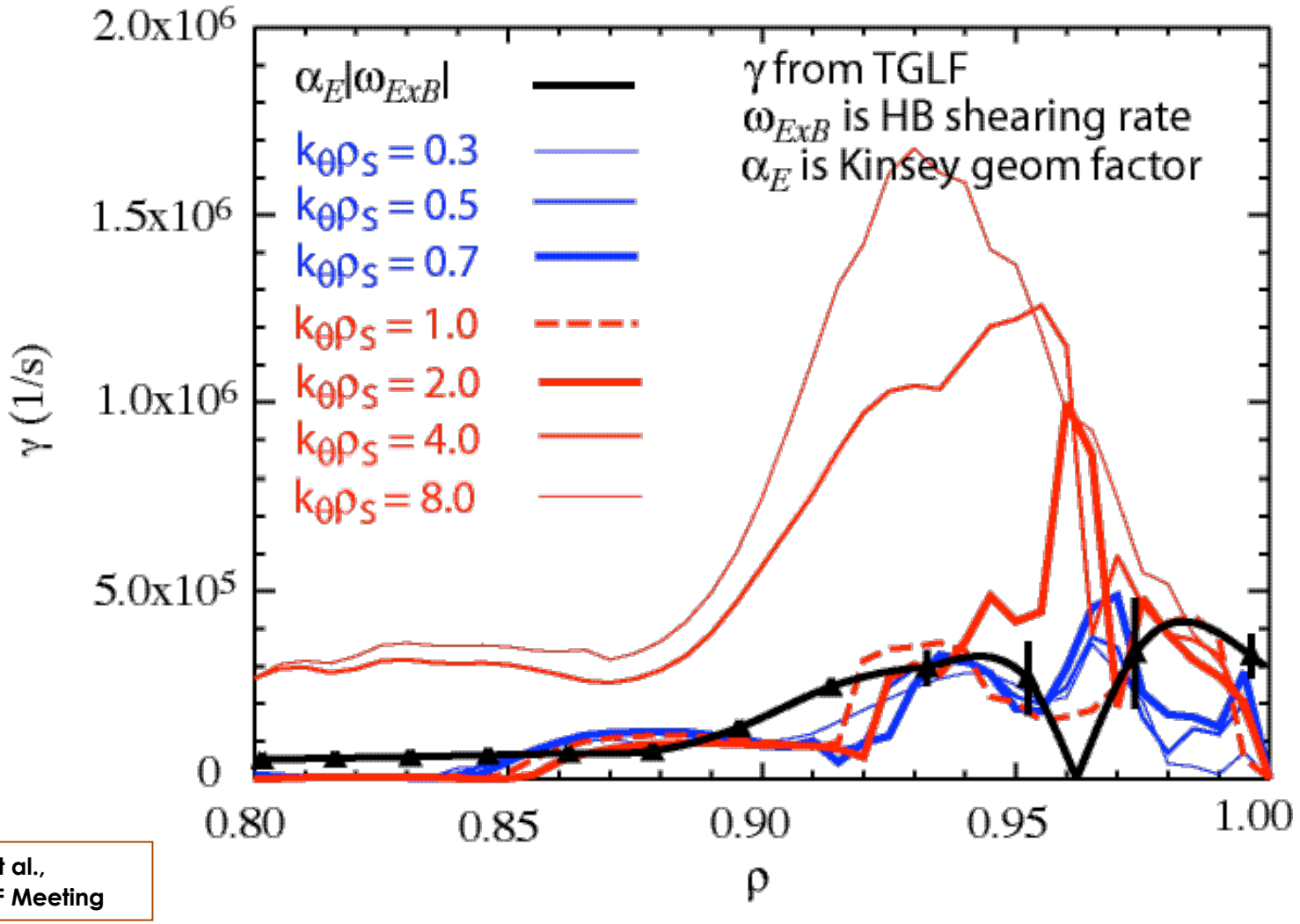
Pedestal data obtained from discharge with long ELM-free period (and no other edge MHD)



Composite profiles are fit from SOL into core

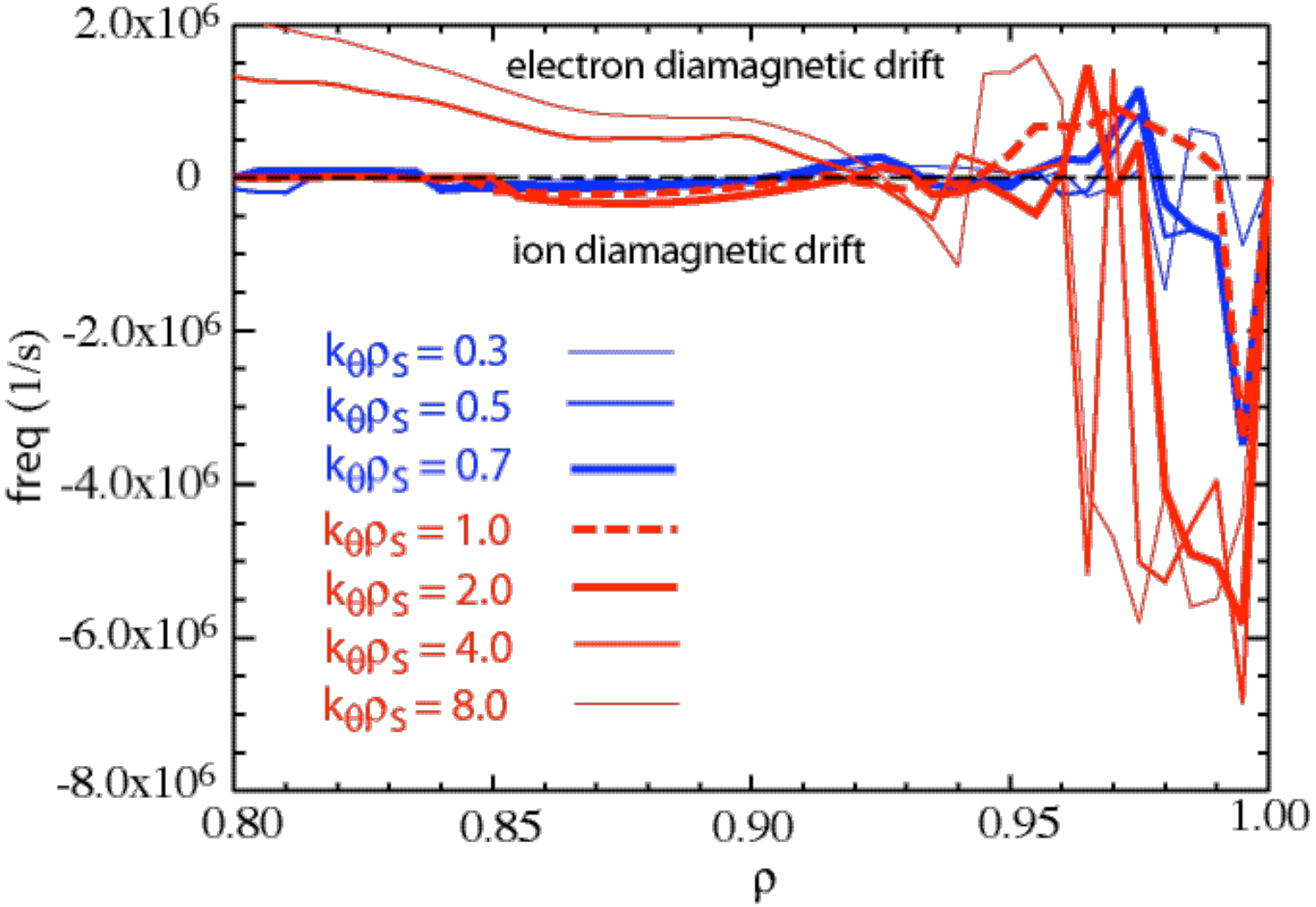


Growth rates for modes with $k_\theta \rho_s < 1$ are comparable to or less than ExB shearing rate

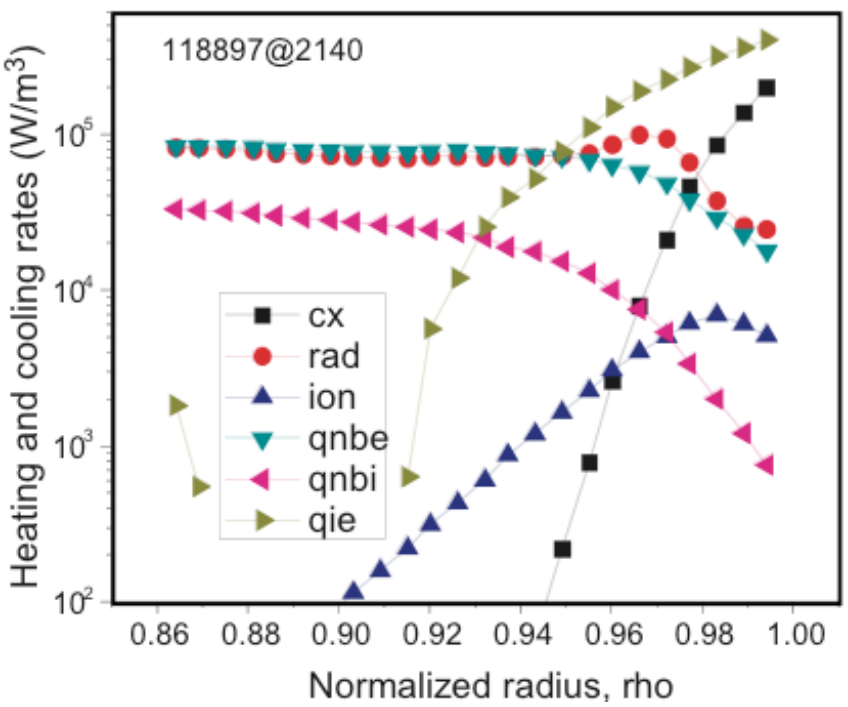


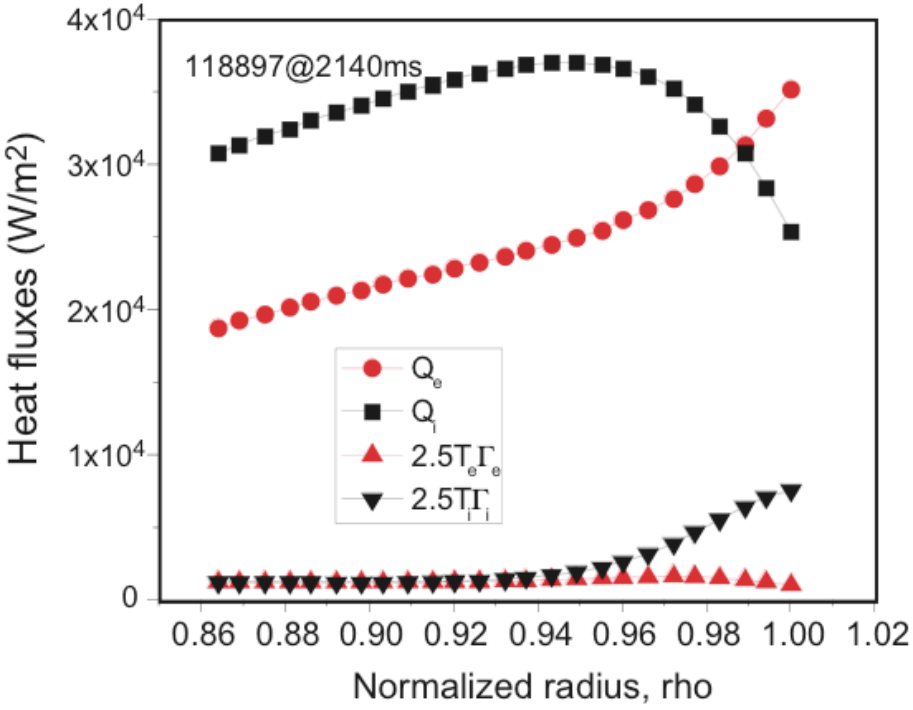
α_E from Kinsey et al., 2007 US-EU TTF Meeting

Large and negative frequencies predicted at high wave-number



Power balance (interpretive) transport analysis indicates that heat transport is dominant loss channel





Stacey and Groebner, Phys. Plasmas 14, 012501 (2007)

But, more work is needed to characterize sources, sinks and heat fluxes in pedestal

Summary and Conclusions

- **Initial comparison of experimental pedestal data with predictions of TGLF code has been made**
- **TGLF predicts large linear growth rates for gyrokinetic modes in pedestal**
- **Experimental ExB shearing rate is about right level to quench modes for $k_\theta \rho_s < 1$**
- **At high k, real frequencies predicted to be large and negative (in ion diamagnetic direction)**
  - In steep gradients, ion modes can exist at high k
- ***These results are very preliminary!!***
  - Much more analysis needed
  - Sensitivity studies needed - for instance, large values of Ti/Te have big effect in TLGF - will take some effort to make sure this analysis method is okay