GYRO simulations of recent JET plasmas

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- **Motivation: Increased understanding of transport can help achieve successful fusion power**
- **Gyrokinetic simulations offer the possibility of predicting turbulent-driven energy, momentum, and species transport, and fluctuations**
- **Question: Can gyrokinetic codes predict transport with sufficient accuracy?**
- **This talk discusses GYRO simulations of the first pair of JET plasmas with reflectometry measurements**

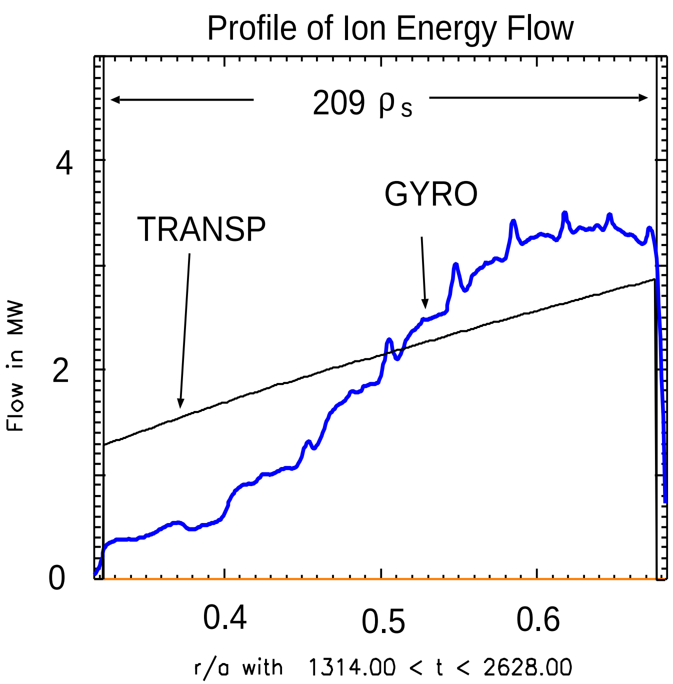
  1. **$\Rightarrow$ Approximate agreement with measured energy, momentum, and species flows**
  2. **$\Rightarrow$ Consistency with measured n_e fluctuations and radial correlations**

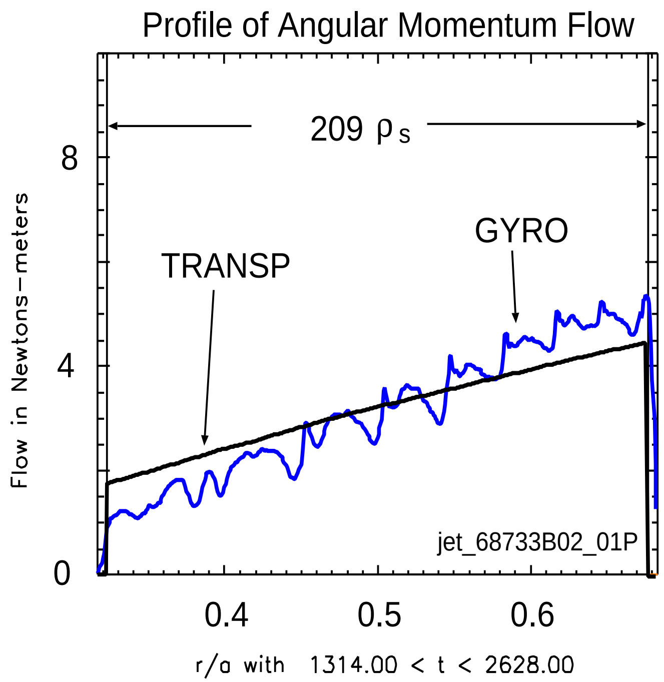
Methods

- TRANSP to extract transport from measurements
- TRGYRO to generate GYRO inputs from TRANSP and NCLASS
- Linear GYRO runs
  1. scan in $k_\theta \rho_s$ (up to about 1.0) for maximum growth rate γ_{lin} and mode frequency ω_{lin}
- Nonlinear GYRO runs
  1. kinetic electrons with trapping
  2. two kinetic ion species (main ion and lumped impurities)
  3. electron-ion collisions, but ignore ion-ion collisions
  4. use electrostatic approximation
  5. runs on Seaborg, Jacquard, Phoenix, Kestrel

Agreement with Energy and Angular Momentum Flows

- **Can't quantify uncertainties in energy flow (especially with fundamental D-ICRH)**

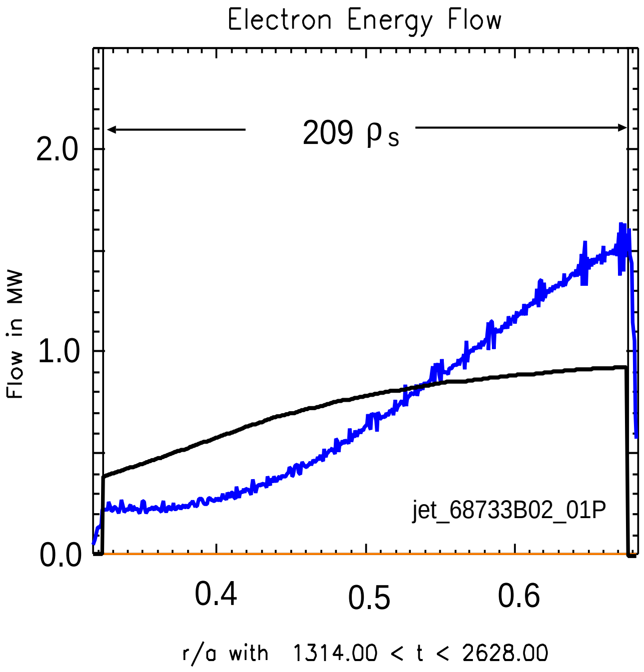


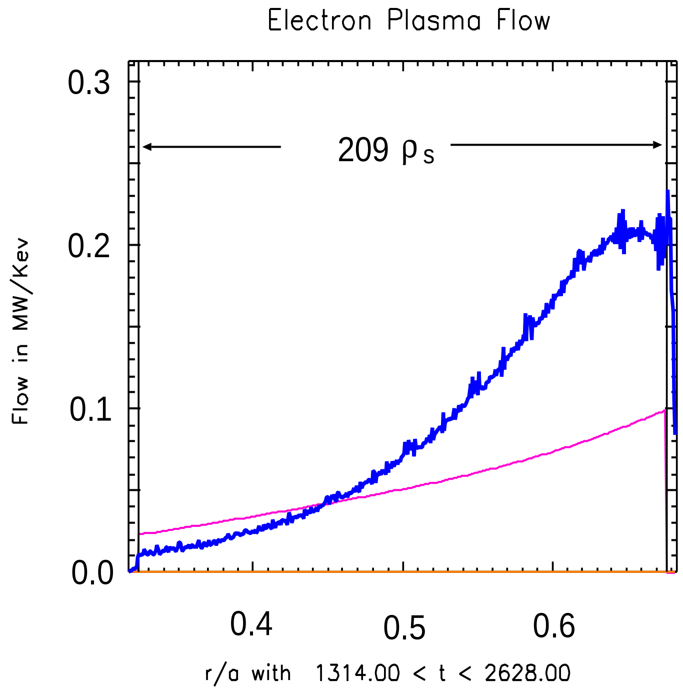


- **Comparable agreement for 68734 with $B_T = 3.7T$**

Agreement with Electron energy and species Flows

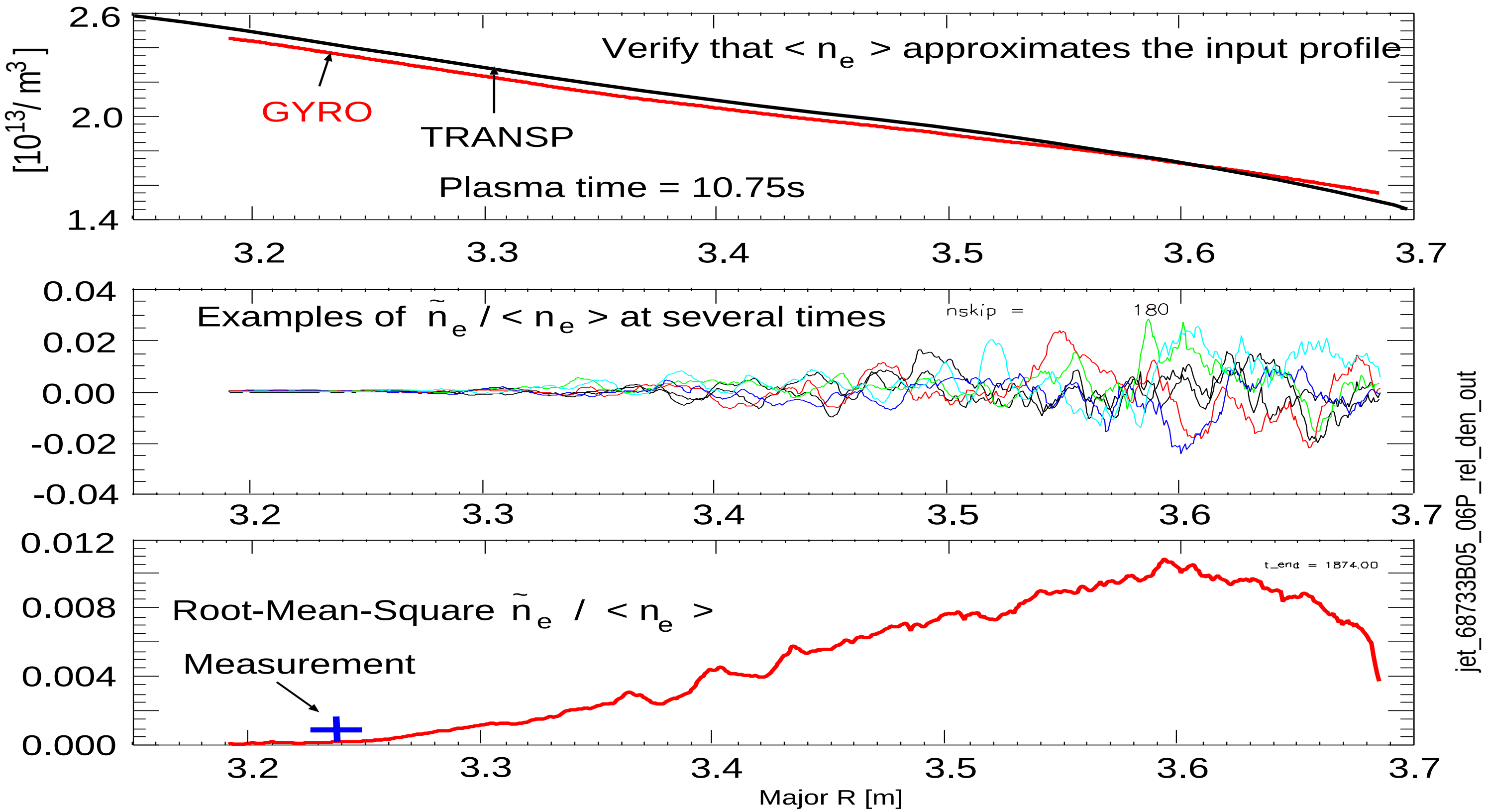
- **TORIC ICRH package in TRANSP predicts centrally-deposited direct el heating**





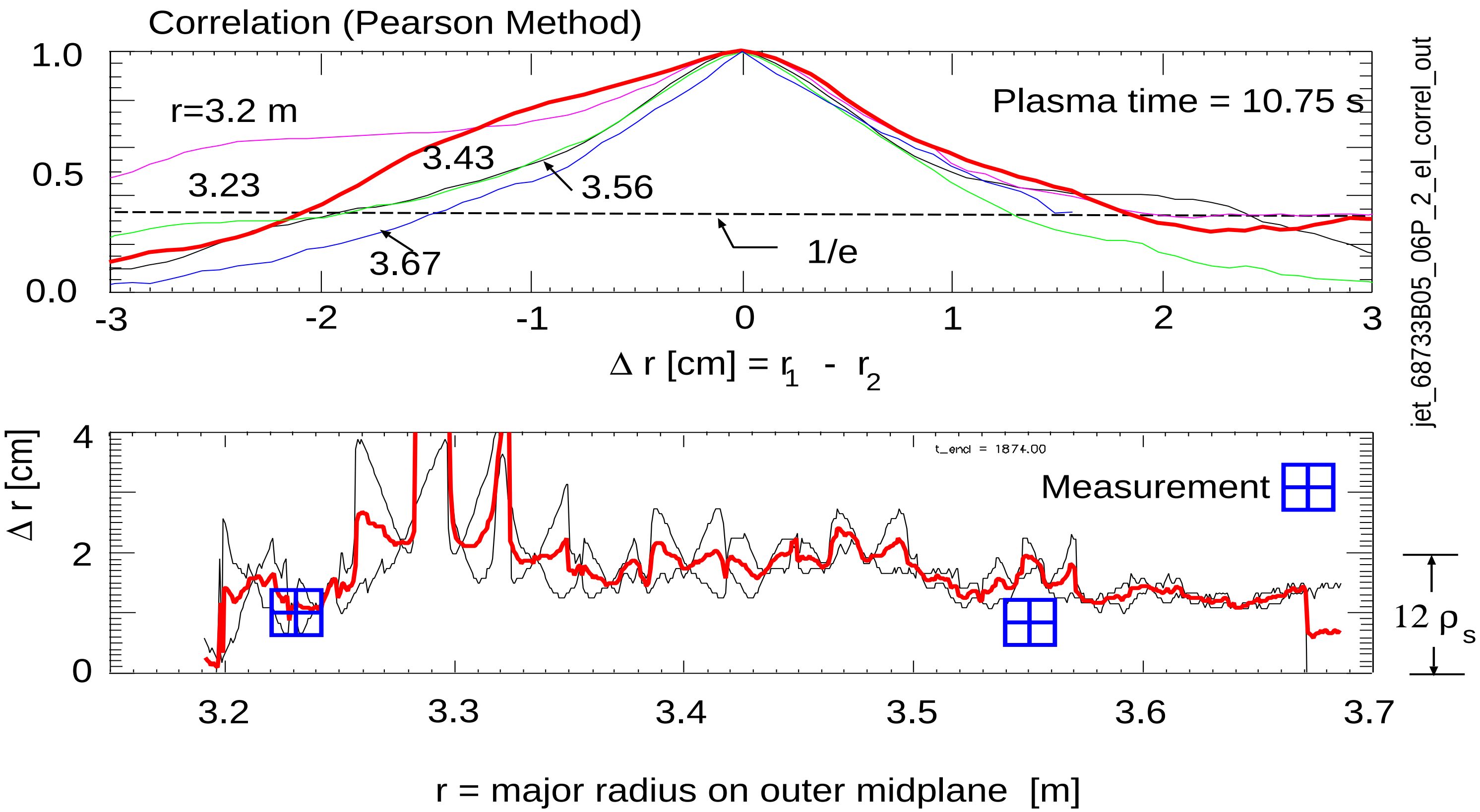
Simulated el fluctuations consistent with reflectometry

- **GYRO integrates f_{el} to get n_e in 3D and time**
- **We use Bravenec's postprocessor to get $n_e(r, \theta, \phi = 0, t)$**
- **Compute Root-Mean-Square along outer mid-plane ($\theta = 0$)**



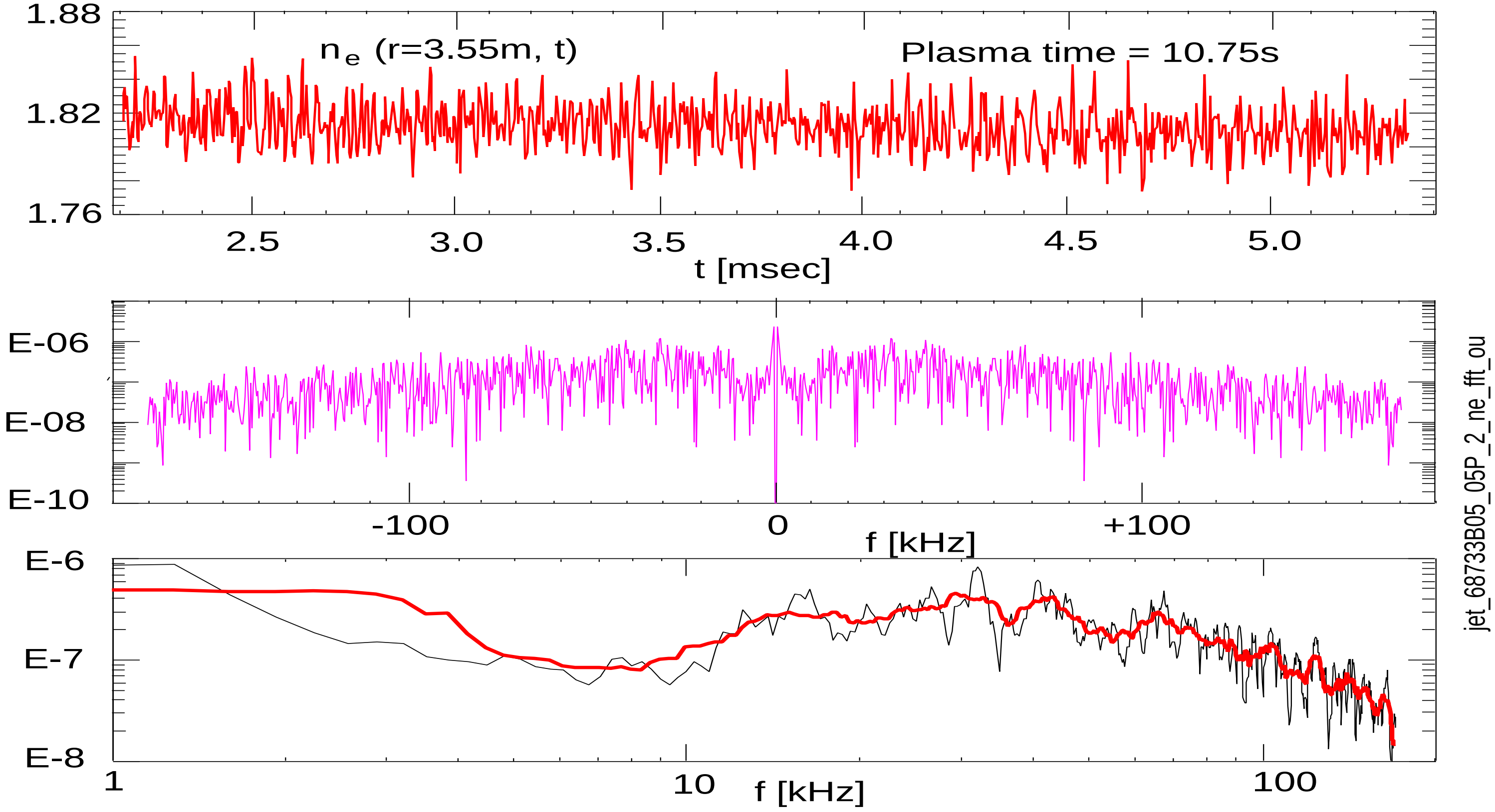
Radial correlation consistent with reflectometry

- Correlation of $n_e(r_1, t)$ and $n_e(r_2, t)$
- Δr defined where correlation decreases below 1/e



Relatively broad n_e power spectra simulated by GYRO

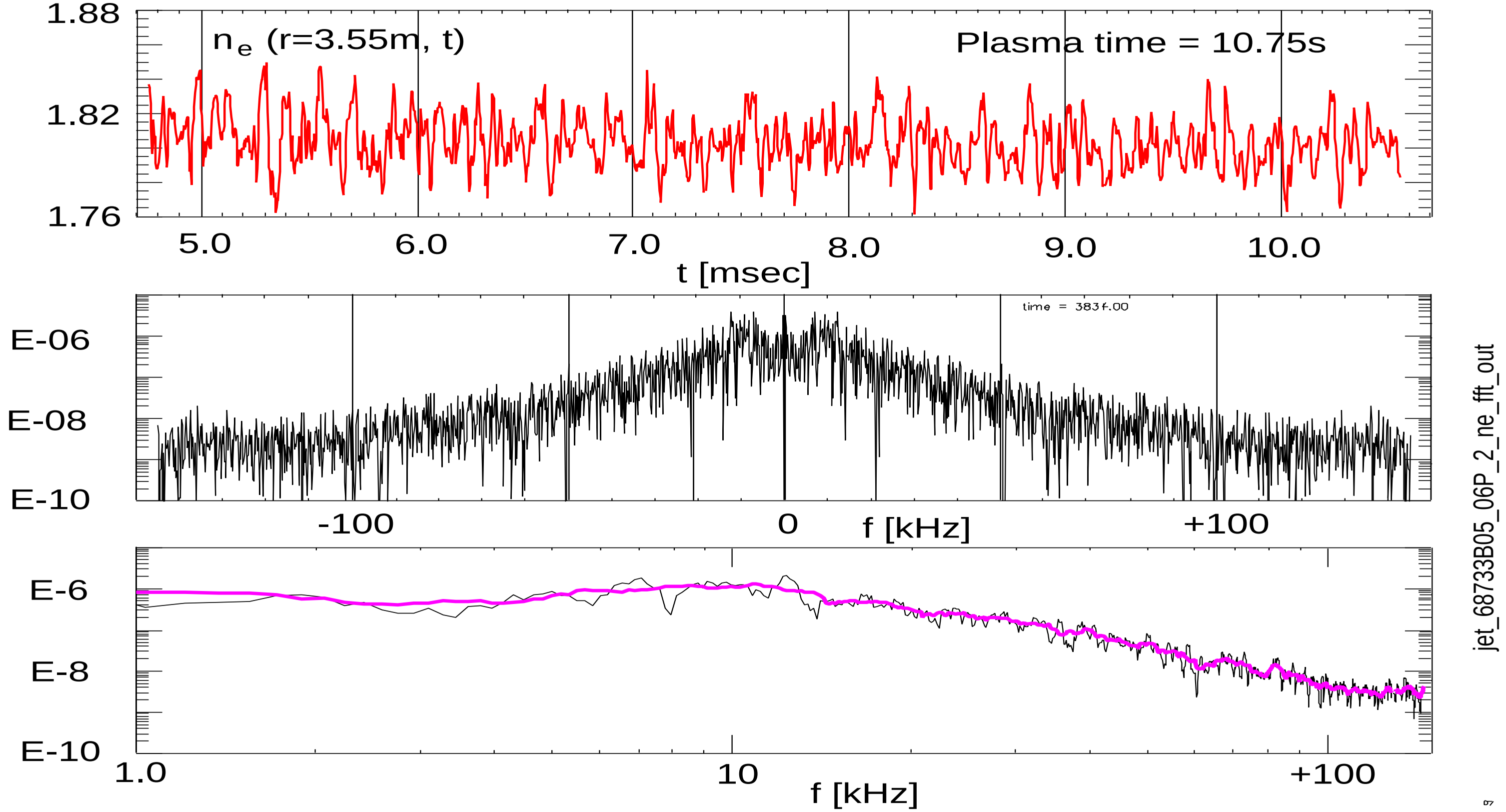
- **Fast Fourier transform $n_e(r,t)$**



- **Baseline rotation rotation was subtracted out in GYRO**

More peaked power spectra if $E_r' \rightarrow 0.1E_r'$

- **Fast Fourier transform $n_e(r,t)$**



- **If baseline rotation is added in GYRO, comparison with reflectometry power spectra can indicate value of E'**

Discussion and conclusions

- GYRO simulations of turbulence in two low β_n plasmas are in approximate agreement with measurements:
  1. energy, angular momentum, and species flows compared with TRANSP
  2. electron density fluctuations compared with reflectometry
- But simulations depend sensitively on input profiles;
  1. E_r flow shear
  2. q profile
  3. temperature and densities and their gradients
- But uncertainties in measurements for comparison/validation
  1. v_{Pol} contribution to E_r
  2. heating profile
  3. reflectometry