Computational Study of Neoclassical Transport in NSTX using GTC-NEO

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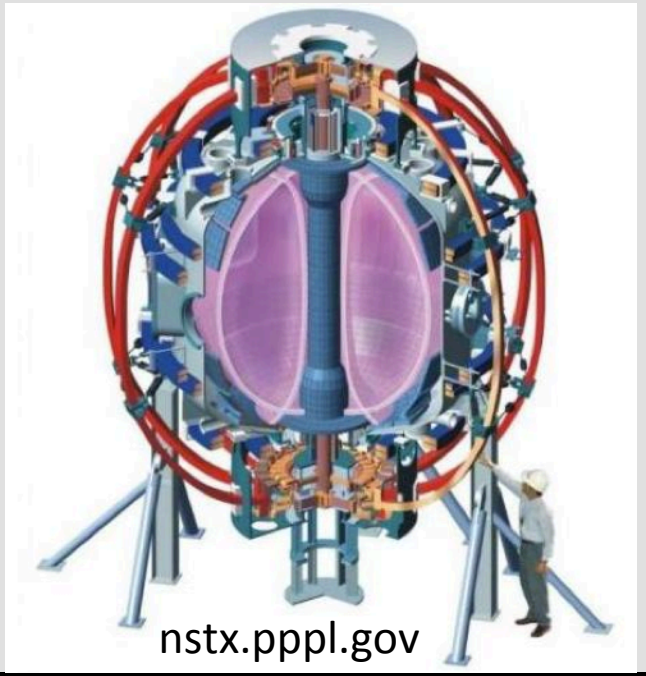
Outline

- The National Spherical Torus Experiment
- Plasma Transport in NSTX
- GTC-NEO Simulation Results
- Conclusions / Future Work

National Spherical Torus Experiment*

- Magnetic Confinement fusion device
- Low aspect ratio ("spherical") $R_0/a > 1.26$
- Deuterium plasma with up to:
  - 1.3 MA plasma current
  - 7 MW Neutral Beam Heating
  - 6 MW Radio Frequency heating
  - ~ 100 million degrees C


nstx.pppl.gov

Plasma Transport in NSTX

- Transport = motion of particles and energy
  - Classical = uniform E, B
  - Neoclassical = nonuniform E, B
    - Irreducible minimum
    - Gives curvature drifts, banana orbits, etc.
- In NSTX:
  - Ion thermal transport shows trend of increasing anomalous transport at lower collisionality*

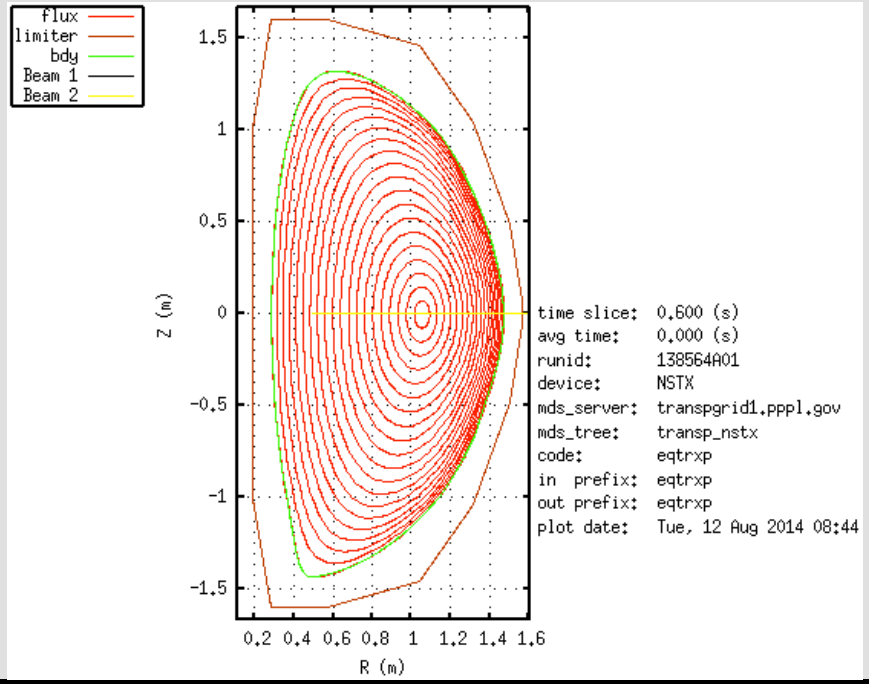
$$q = -\underline{\text{Chi}}\ n\ \text{grad}\ T$$

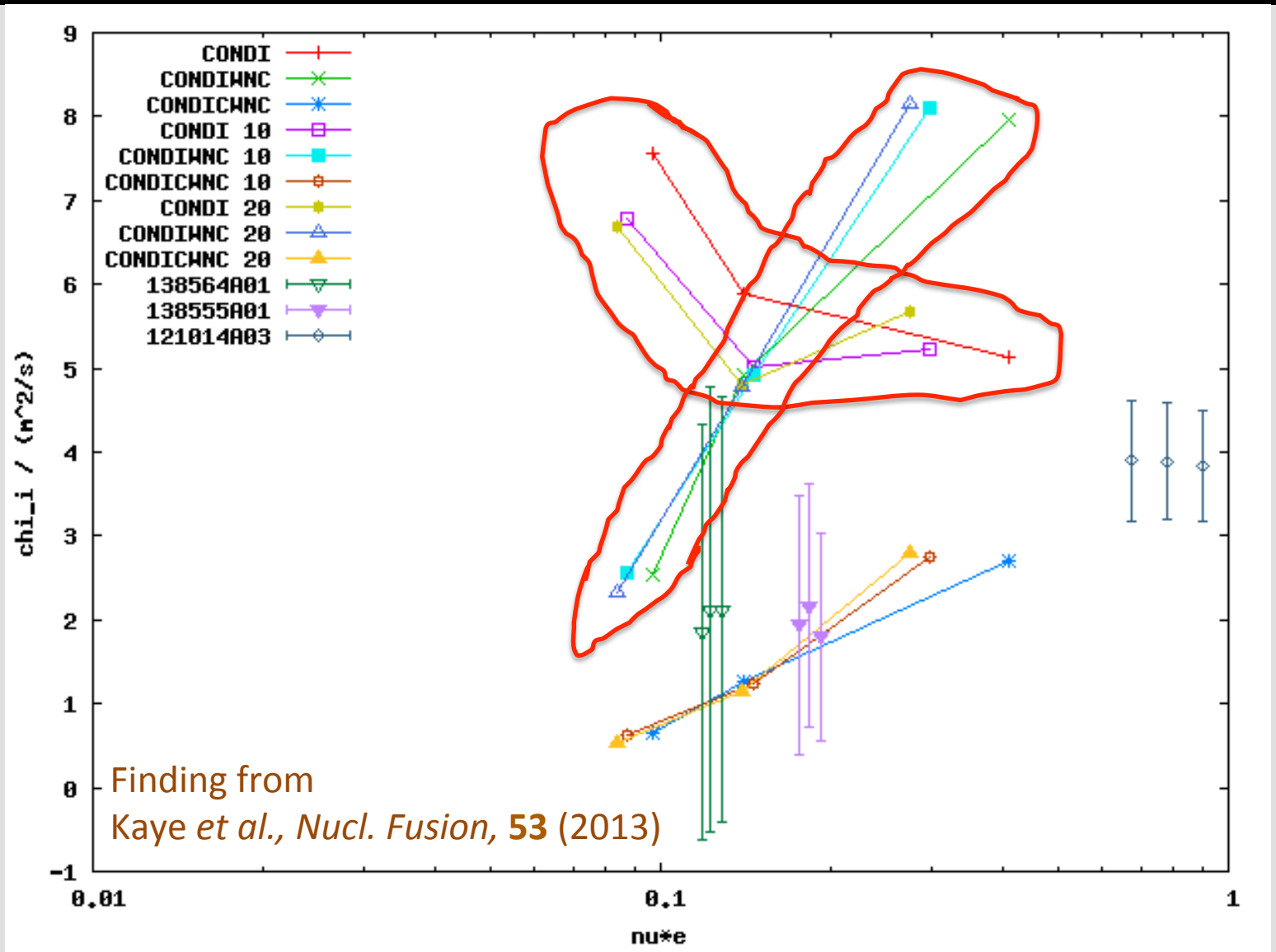
Why GTC-NEO?

- Ion thermal transport trend identified by comparison to NCLASS* model
  - Neoclassical models assume small orbit widths for trapped particles, paths bound to flux surfaces
- **GTC-NEO simulates the motion of a plasma to calculate transport quantities
  - Intrinsically includes finite orbit effects

Simulation Results of GTC-NEO

- Three H-mode shots, similar *q* and <beta_t>
- Data taken from TRANSP*

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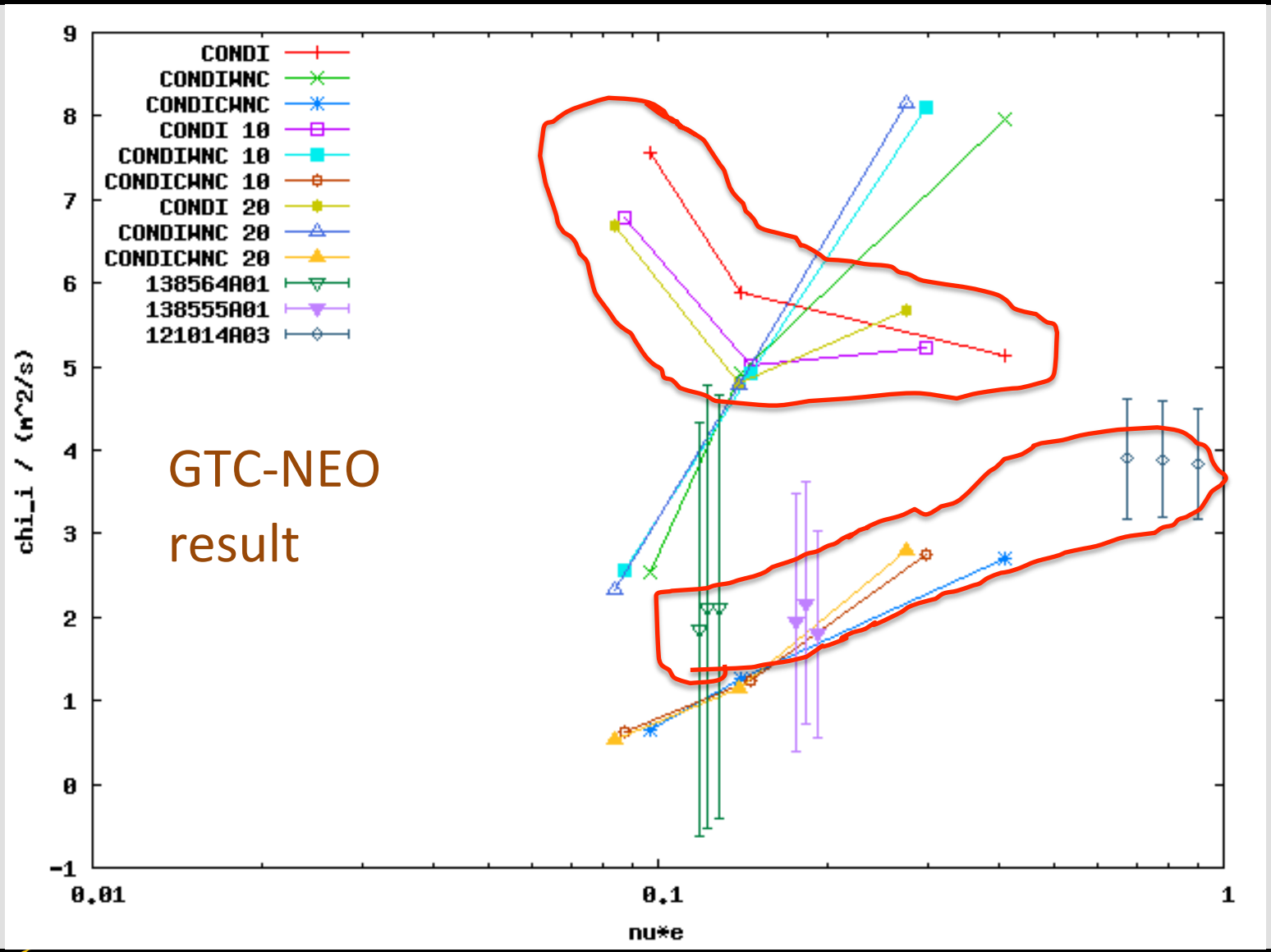
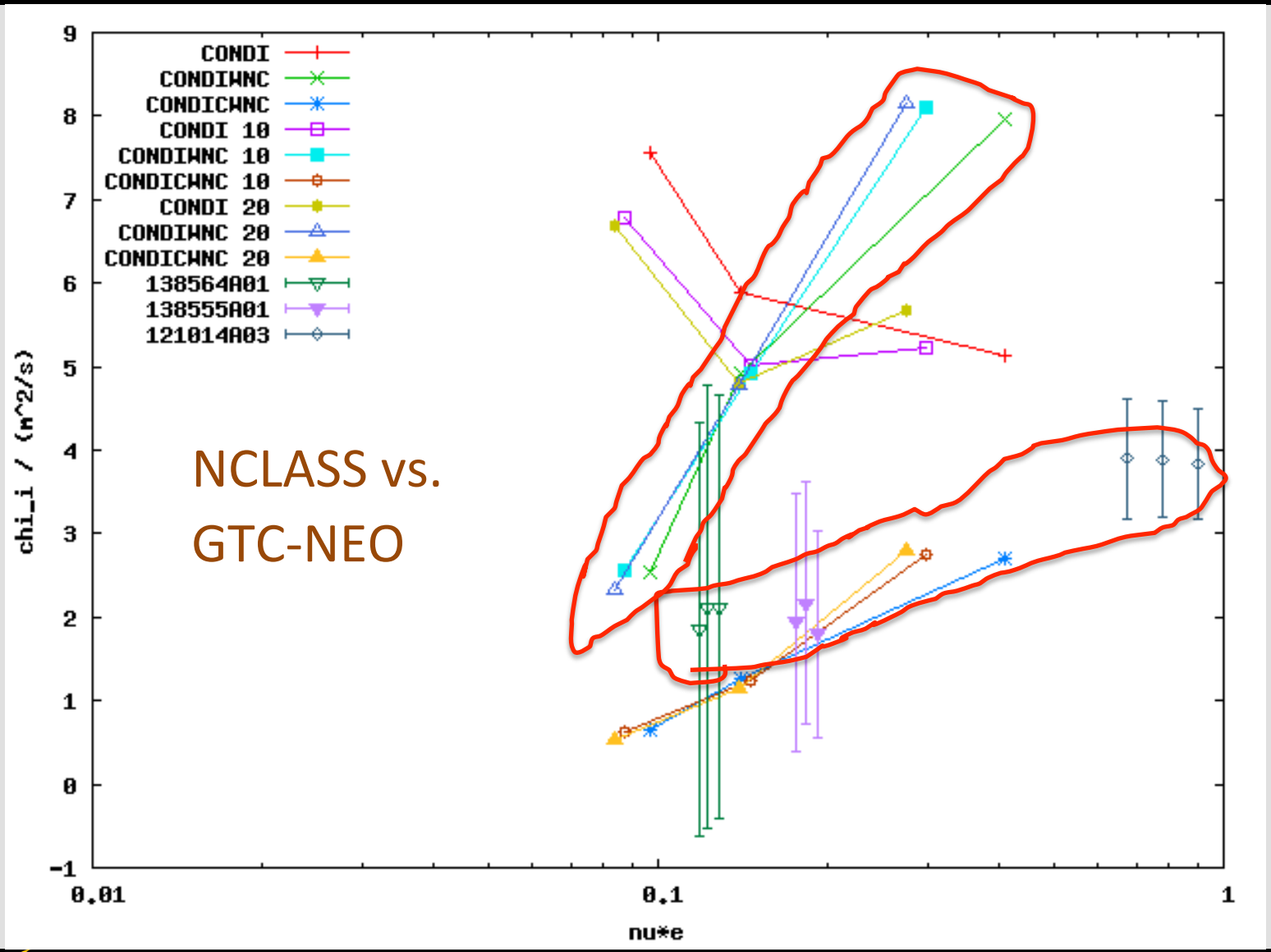
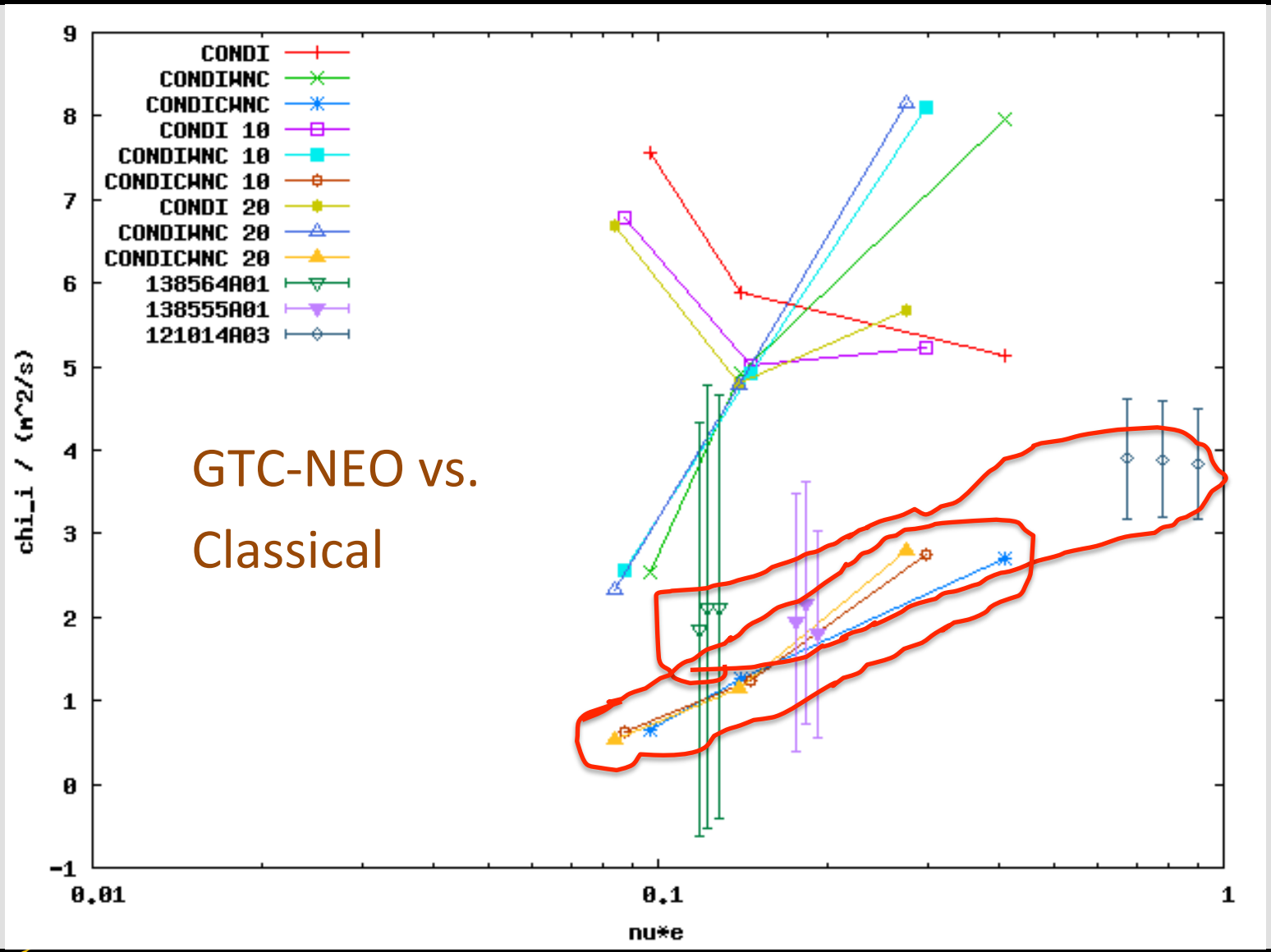
Finding from
Kaye *et al., Nucl. Fusion,* **53** (2013)



GTC-NEO result



NCLASS vs.
GTC-NEO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GTC-NEO vs.
Classical

Conclusions / Future Work

- Confirmed existence of anomalous ion thermal transport at low collisionality in NSTX

- Identified further questions regarding how close to classical levels the neoclassical transport is
- Run a turbulence code (e.g. GTS) to try to identify possible modes causing this transport
- Validation of bootstrap current models