Modeling of turbulent transport in the SOL: status & plans

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- **SOLT code, goals & relation to FY2010 JRT**
- **recent work**
- **modeling of XP952 (J-W. Ahn)**
- **summary & ongoing work**

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SOLT code, research goals & FY2010 JRT

- **SOLT code**
  - **2D fluid turbulence code: model SOL in outer midplane**
    - classical parallel + turbulent cross-field
  - evolves n_e, T_e, Φ with parallel sheath closure relations
  - **strongly nonlinear: $\delta n/n \sim 1 \Rightarrow$ blobs**
  - model supports drift waves, curvature-driven modes, sheath instabilities …
  - **synthetic GPI diagnostic**
- **Goals**
  - **simulation of SOL profiles of $n_e(r)$, $T_e(r)$, $\Gamma(r)$, and $q_{||}(r)$**
  - **not fully predictive** ($\Rightarrow$ use for interpretation); need
    - profile information inside LCS; effective core BCs
    - E_r (model has incomplete physics for plasma rotation) – or fit
    - constrain by data (e.g. dissipation, viscosity)
  - **study cross-field energy transport**
    - near SOL profiles , SOL width, P scaling
    - far SOL blob transport

FY2010 JRT

Recent work

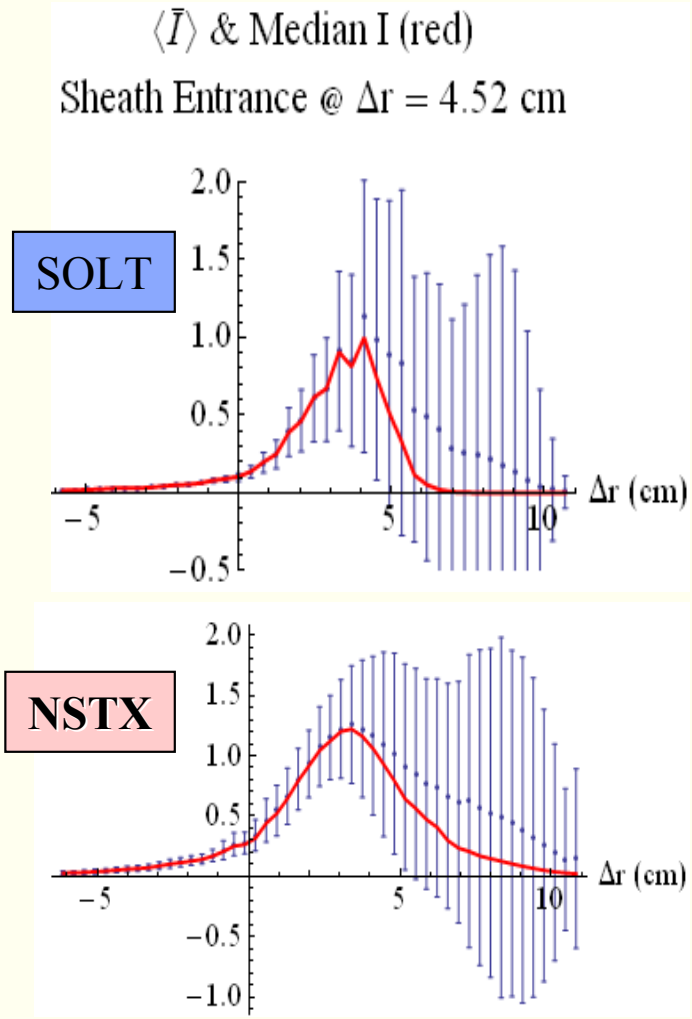
Completed blob simulations of a well diagnosed and analyzed shot #112825

- **He-puff** GPI, low power **L-mode**

Conclusions from that study:

- The simulated turbulence is sensitive to the parameters that control the stability of the system: drives and dissipations, some of which are poorly known, but can be constrained indirectly by data.
  - **"Successful" simulation of GPI profiles occurs close to marginality: balance instability drive ↔ sheared flows, dissipation**
- 2D fluid simulations with the SOLT code yield a reasonable match to GPI data for SOL blob/turbulence.
  - GPI statistics; blob size PDF
  - blob velocity PDF off by factor 2

GPI fluctuations radial dependence



Modeling of XP952 (J-W. Ahn)
July 17, 2009

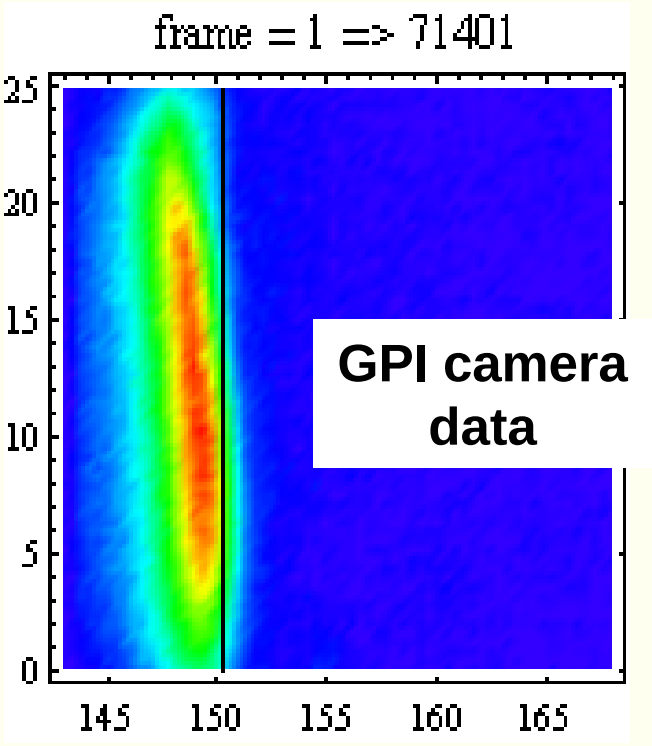
- Shot selection
  - ELM-free **H-modes** at 0.8 MW and 1.3 MW NBI with **GPI-D puff**
  - shots 135009, 135011 and 135038
- Shot modeling tasks
  - ✓ – TS profile fit (in core region)
  - ✓ – GPI data extraction
  - – geometry: camera view; magnetic geometry: R_{sep}, connection lengths, B_θ …
  - – power across LCS = P_{sep}
  - ✓ – synthetic GPI for D-puff: $D_0(r)$, atomic physics for D_α emission
- Simulations (underway)
  - sensitivity studies
- Comparisons
  - profile comparison with probes: $n_e(r)$, $T_e(r)$
  - mapped divertor heat flux comparison with $q_{||}(r)$ – near SOL
  - blob velocity and size distributions with GPI – far SOL

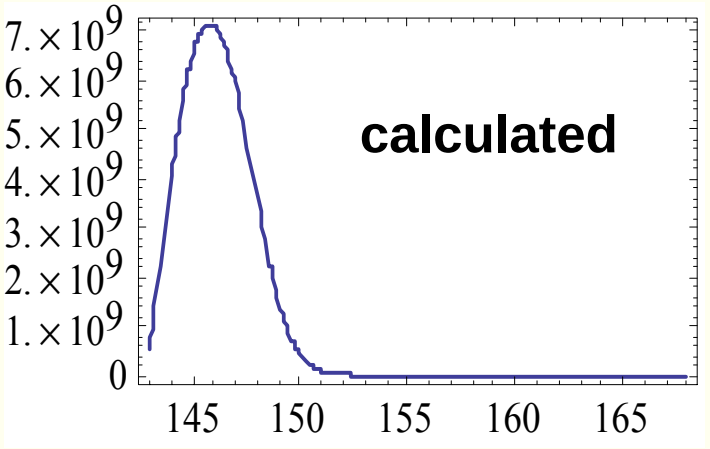
Preliminary results for XP952 modeling

Testing synthetic GPI for D-puff

- input n_e, T_e
  - here from TS data
  - later from SOLT code
- output D-puff emission

- achieved a good match to data for a quiescent frame
- calculated =>
  - Lundberg & Stotler fits for $D_0(R)$
  - fits to TS profiles for n_e, T_e
  - D_0 emissivity $I(n_e,T_e)$





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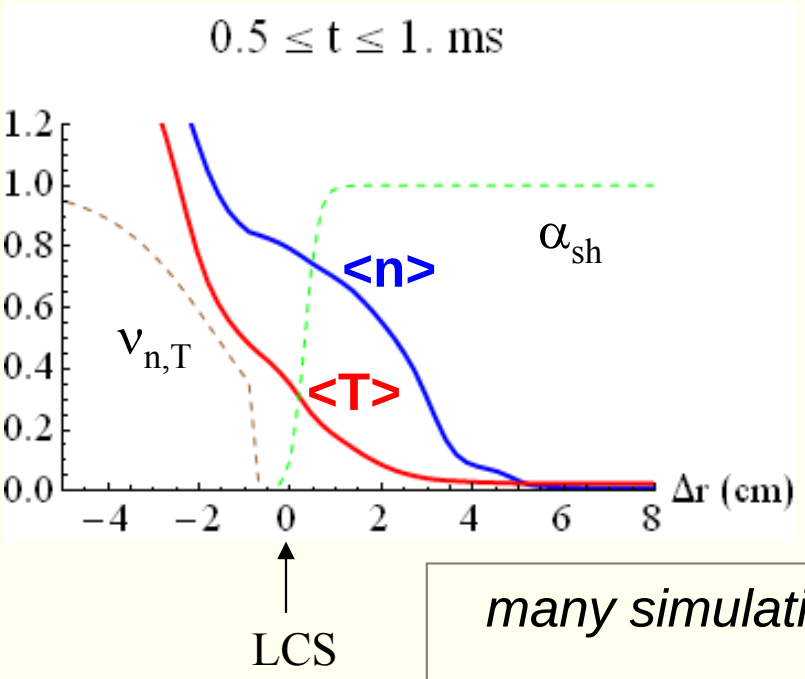
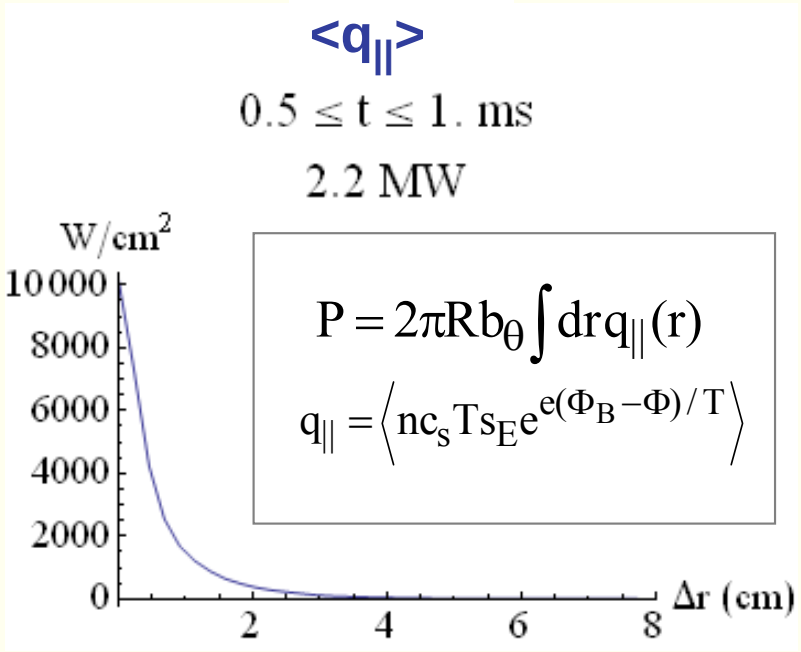
Preliminary results for XP952 modeling (cont'd)

H-mode edge turbulence

- may need to impose E_r well to suppress transport
- balance drives : E_r shear : dissipation to match P

SOLT (avg over blobs)





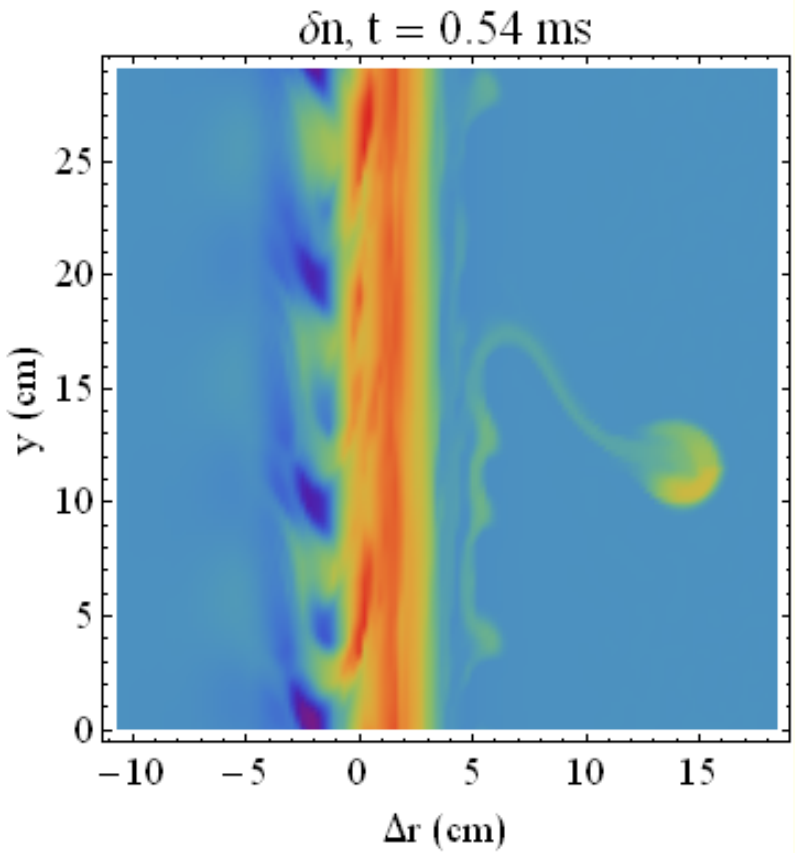
many simulation inputs need to be improved:

R_{sep}, $L_{||}$, E_r, P_{LCS}

and more SOLT sensitivity exploration needed

Preliminary results for XP952 modeling (cont'd)

- isolated blob ejection event



Summary & ongoing work

- Previous work with the SOLT code has modeled some features of edge SOL turbulence and blob transport but questions remain.
  - Can we resolve the factor of 2 discrepancy in the blob velocity?
  - Are the simulations consistent with observed scalings for different shots?
- Ongoing work is addressing these questions, plus
  - power (P) scaling studies of SOL width for the three shots (Ahn XP952)
  - extend to connection length ($L_{||}$) scaling studies as time permits
- Results will contribute to the FY2010 JRT
  - understanding SOL transport of heat, SOL width, and blob transport