# New Physics to be Addressed with the Fast Probe


By
J. Boedo
and
G. Tynan and H. Ji

For the UCSD and NSTX Teams

Acknowledge contributions/discussions with P. Diamond, S. Krashenninikov, M. Burin, C. Holland, R. Moyer, G. Antar

# Relevance of ST Edge Turbulence Studies

UC San Diego

- Edge Transport is linked to Global Confinement
- Current Drive coupling/physics depends on edge profiles
- ST probably has finite beta effects (E-M fluctuations, magnetic flutter induced transport)
- Bursty Edge Transport is important in tokamaks (ST?)
- ST provide astrophysically relevant plasmas (see Hantao Ji's talk)

# New Issues

UC San Diego

- Intermittency in the edge/SOL
- Reynolds Stress studies & turbulent energy cascade in 2-D Plasmas (Especially During L-H Transitions)
- Probe/gas puff imaging comparisons
- Finite Beta effects on transport
    - Coupling between density and magnetic fluctuations (ala Drift-Alfven waves)
    - Magnetic Reynolds Stress v. Electrostatic Reynolds Stress
- Helicity transport
- Edge current and edge current gradient

# Relevant Physical Quantities

UC San Diego

Particle Flux

$$\tilde{\mathbf{A}}_{\perp} = -\frac{\left\langle \tilde{n}\nabla\tilde{\phi}\right\rangle \times \overline{\mathbf{B}}}{B^2} + \frac{\overline{n}\left\langle \tilde{v}_{\parallel}\tilde{\mathbf{B}}\right\rangle}{\overline{B}}$$

Reynolds Stress (neglecting ion pressure fluctuations)

$$\vec{\mathbf{i}} = m\overline{n}\left\langle \left(-\frac{\nabla\tilde{\phi}\times\overline{\mathbf{B}}}{B^2}\right)\left(-\frac{\nabla\tilde{\phi}\times\overline{\mathbf{B}}}{B^2}\right)\right\rangle$$

Heat Flux

$$\tilde{\mathbf{Q}} \equiv \frac{3}{2}\left[\frac{\left\langle \tilde{p}\tilde{\mathbf{E}}\right\rangle \times \overline{\mathbf{B}}}{B^2} + \frac{\left\langle \tilde{q}_{\parallel}\tilde{\mathbf{B}}\right\rangle}{\overline{B}}\right]$$

Parallel Current Flux

$$\tilde{\mathbf{A}}_{J_{\parallel}} = -\frac{\left\langle \tilde{j}_{\parallel}\nabla\tilde{\phi}\right\rangle \times \overline{\mathbf{B}}}{B^2} + \frac{\left\langle \tilde{p}_{\parallel}\tilde{\mathbf{B}}_r\right\rangle}{\overline{B}}$$

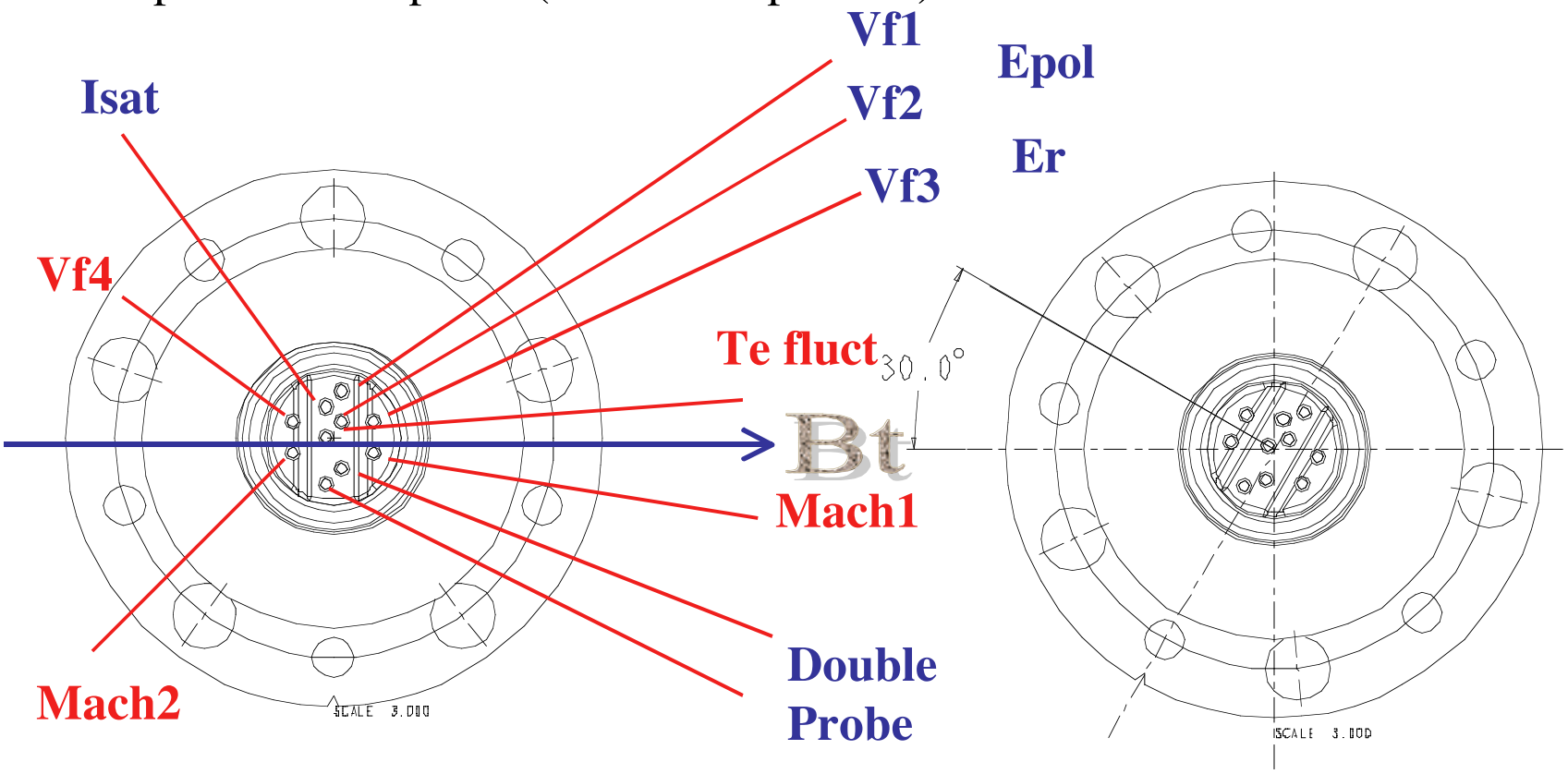
Helicity Flux

$$\tilde{\mathbf{A}}_K = \left\langle \tilde{\phi}\tilde{\mathbf{B}}_{\perp}\right\rangle$$

# Existing Probe Head has 10 Tips

UCSanDiego

- Tips in blue will be active on day one, the rest implemented as upgrades (not funded)
- Fluctuations to 1 MHz
- Two Vf tips used for Epol (and fluctuations)
- Two Vf tips used as Er (and fluctuations) >> Reynolds Stress
- One tip as Isat >> ne
- Two tips as double probe (Te and Ne profiles)



# Correlations to Measure/Calculate

UC San Diego

New Correlations. Need upgraded head with imbedded B coils

(1) MHD dynamo <E_theta B_theta>
(2) MHD dynamo <E_r B_r>
(3) diamagnetic dynamo <grad_theta Pe B_theta>
(4) diamagnetic dynamo <grad_r Pe B_r>
(5) Reynolds stress <E_theta E_r>
(6) Maxwell stress <B_theta B_r>

Intermittent Transport. Need sophisticated electronics hardware (not funded)

(1) Te fluctuations

# Physics Topics

- *Radial particle and heat transport (perpendicular and parallel, broadband and intermittent)*
- *Fundamental turbulence studies and scaling (aspect ratio dependence, Beta dependence, etc).*

- *Physics of L-H transition (energy cascading, Reynolds Stress)*

- *Direct studies of velocity shear stabilization*

- *Direct measurements of Zonal Flows*

- *Some measurement of energy cascades*

- *Parallel flow physics, poloidal asymmetries*

- *Edge particle and energy profiles and scaling*

- *Radial electric field and conductivity*

- *RF ponderomotive forces*