Heat flux width at the divertor plate

To understand or reliably predict λ_q, we need to know (at the least):

1) turbulent transport in SOL, $Q_{\perp,e} = n \langle \delta v_r \, \delta T_e \rangle + T_e \langle \delta v_r \, \delta n \rangle + \langle Q_{||} \, \delta B_r \rangle / B$
(e.g. electrostatic vs. EM, intermittency, poloidal angle dependence)

2) parallel heat and particle transport (e.g. neoclassical terms, effects of flows)

3) effects of neutrals and impurities (e.g. cx, viscosity, radiation)

4) possible effects of large-scale convective cells and/or magnetic error fields

5) effects of MHD (e.g. ELMs, locked modes, Alfven instabilities)

6) possible kinetic effects (e.g. fast electrons, neoclassical effects, ripple transport)

$\Rightarrow$ we also must know the plasma conditions at the separatrix, since all of these SOL processes will depend on the value of the SOL plasma parameters

Turbulent transport in SOL

1) measurements of <δv_r δn> were made in the early 1980's and showed that this flux was close (within x2-3) to 'explaining' ⊥ edge particle transport

2) measurements of <δv_r δT_e> were made in the 1990's and seemed to show a significant contribution to ⊥ edge heat transport

3) empirical scalings have been attempted since at least 1982 without success (in prediction) and without impact on the development of the physics

4) analytic models with 'mixing length' scalings are not reliable

5) dimensionless scaling arguments have not been useful in SOL

6) nonlinear edge turbulence simulations have developed since ~1983

7) none of these simulations are yet at the stage of being able to explain or predict SOL transport (e.g. BOUT, GEM, ESEL, 2DX, XGC, LLNL)

What can be done ?

1) attempt to make quantitative comparisons of SOL turbulence measurements with nonlinear simulations or simplified nonlinear models (e.g. ‘blob’ model). This is initially machine-specific and requires extensive collaboration with theorists / modelers who are willing to investigate specific cases.

2) attempt to test ‘active’ SOL control techniques which might succeed even without a detailed understanding of the physics, and which can be used to test and develop our understanding of the physics.

   - non-axisymmetric B fields, possibly time dependent (e.g. ‘RWM” coils)
   - electrostatic perturbations, e.g. divertor bias or non-axisymmetric bias
   - local effects of RF, e.g. on convective cell formation in SOL
   - heat pulse propagation experiments to test parallel transport

3) this type of research does not require any major upgrades to NSTX, but does require diagnostic upgrades, specific SOL control hardware upgrades, and active support for theorists/modelers.