Development of Finite Orbit Width features in the CQL3D code.

Yuri Petrov, Bob Harvey, *CompX, Del Mar, CA*

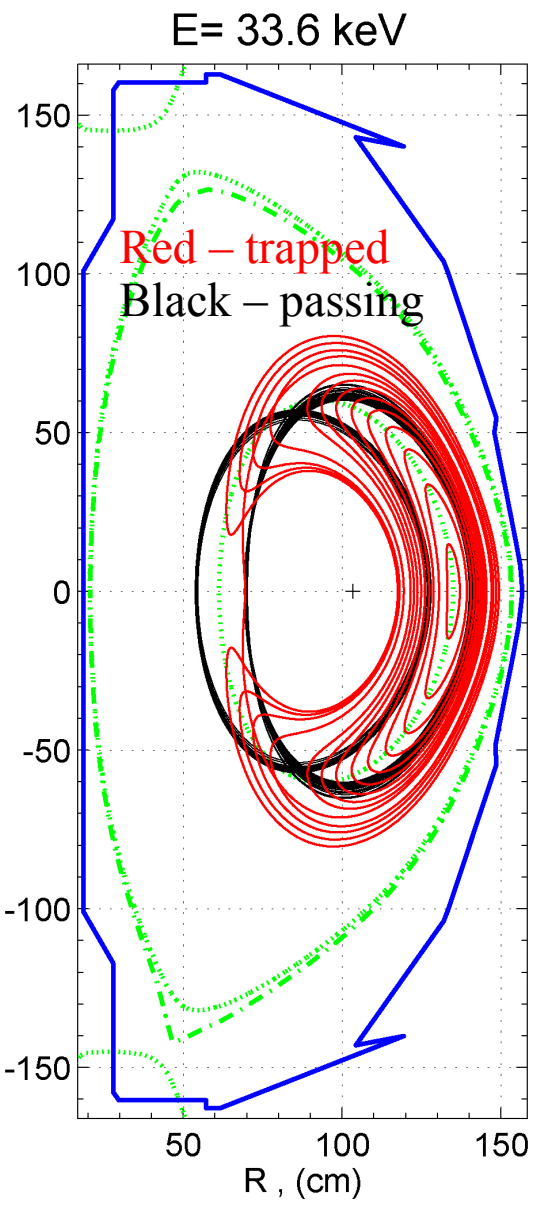
FOW features had been implemented for:

1. Neutral beam source.
2. RF quasilinear diffusion operator.
3. Diagnostics (neutrons/NPA so far).
4. Collisional operator (MPI in v-grid).

Together these capabilities will provide for a finite-orbit-width neoclassical transport in the banana regime, including very important losses to the plasma facing components, and transfer of particles, momentum, and heat to the scrape-off layer.

We emphasize that this is a full-orbit width neoclassical calculation, not the usual first-order in banana width neoclassical calculations.

So far, the FOW modifications were based on a $<\Psi_{pol}>$-model, as shown in Fig.1 ⇒



Distr.function for a given Ψ_{pol} consists of all orbits that have same $<\Psi_{pol}> = \Psi_{pol}$.

<u>Advantages:</u>

- Symmetrical t-p bndry in $\mathbf{u}$-space;
- Similar to 1st order correction.

<u>Main problem:</u>

Not directly interpretable: e.g. missing high-energy orbits at Ψ_{pol} near m.axis (with size > diameter of flux surface)

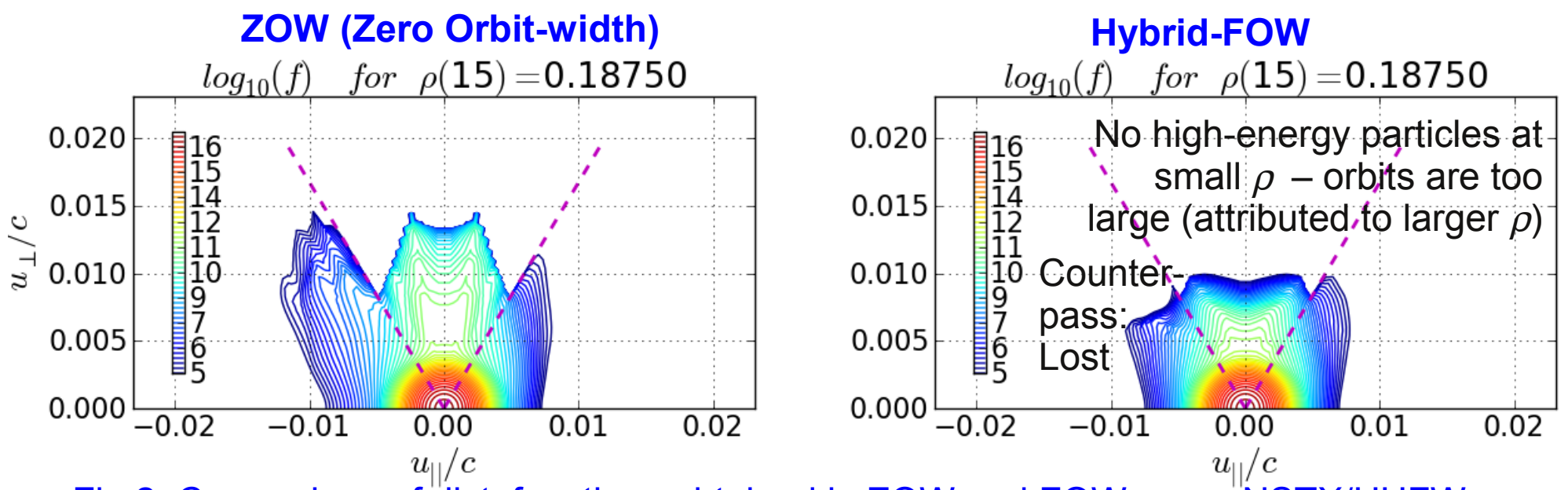


Fig.2. Comparison of distr.functions obtained in ZOW and FOW runs. NSTX/HHFW case.

1. $<\Psi_{pol}>$-based "Hybrid-FOW" model is ready for NBI applications, ICRH, and particle diagnostics. The model is not accurate near m. axis: High-energy particles cannot have small ρ. But, orbit loss model improved.

2. Initial tests: In general, the FOW modifications result in a broader profiles of power absorption and RF-driven current. In ZOW approximation, a given ray-element contributes power to a single flux surface; therefore – a very localized power profile and *J* profile. In FOW, the ray-element power is "spread" over many surfaces. Hence, a broader profile of current density.

3. Work is beginning on internal boundary conditions, which should link different radial coordinates and provide the "natural" neoclassical transport.

ALSO: (1) CompX carrying out CQL3D/AORSA/GENRAY/DC calcs pertinent to NSTX; (2) General parameter survey of HHFW in NSTX-U.