Proposal to Improve Modeling of the Neutral Beam Ion Phase Space and Loss Cones in NSTX

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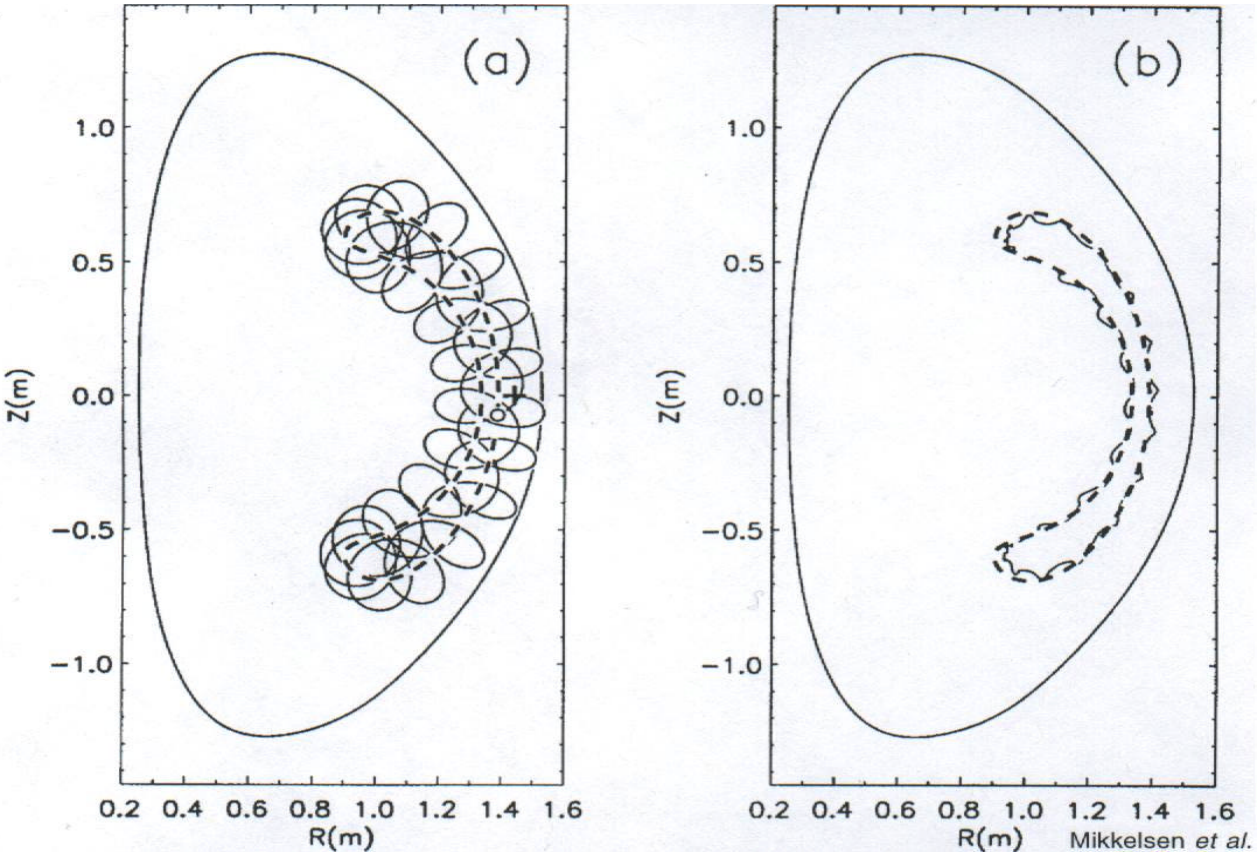
The Guiding center approximation

- Mikkelsen et.al (1997) showed that particle orbits in NSTX are well represented in the guiding center approximation.

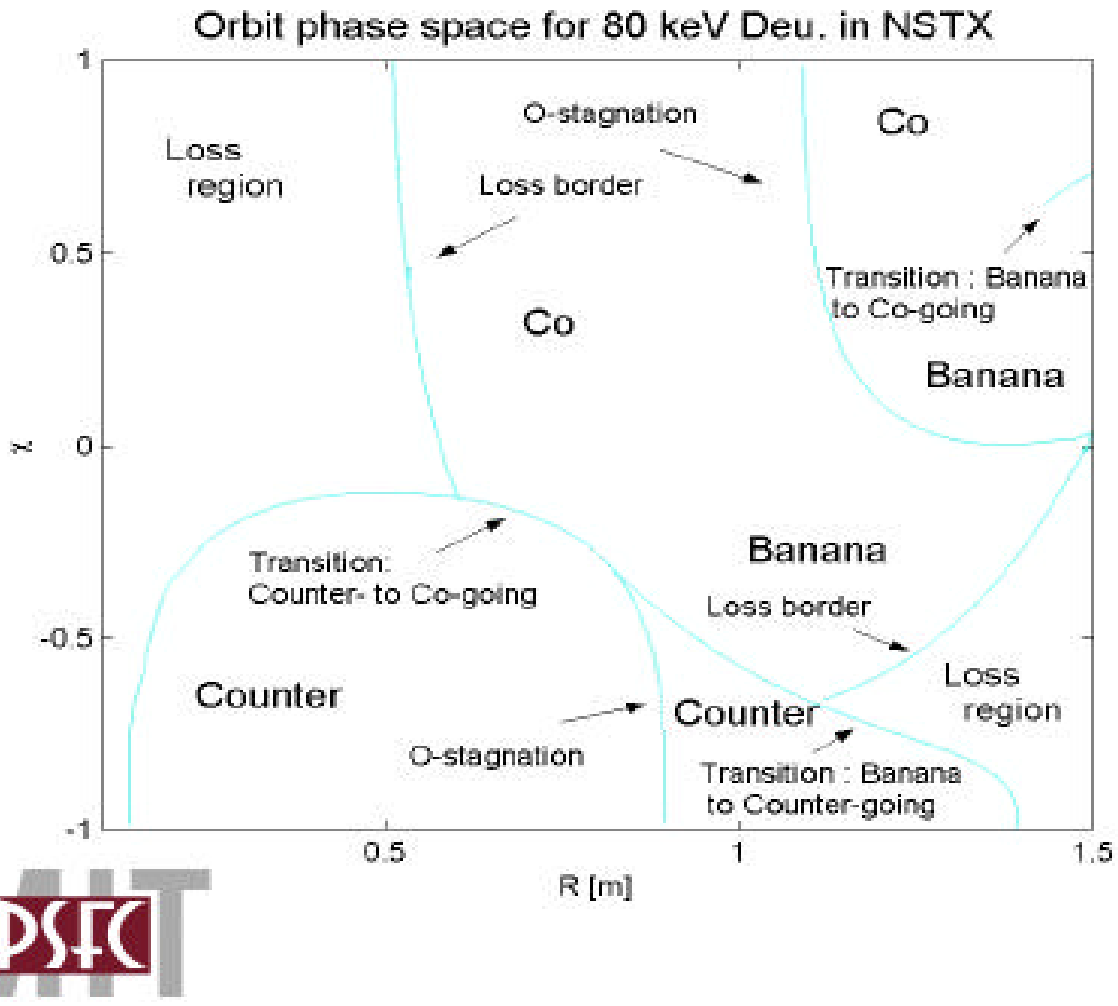
- Essential for this approximation is the conservation of
  - Canonical angular momentum, p_ϕ
  - Kinetic energy, E
  - Magnetic moment, μ



The phase space diagram of NSTX

- Recently [Egedal 2000], new methods have been developed by which the phase space diagrams of fast ions in tokamaks are obtained as a function of (R,χ)
  - Here R=Major radius, χ=cosine of pitch angle.

- The methods are numerically efficient:
  - At a given energy, phase space diagrams for all orbits (including lost orbits) are obtained in less than 60 CPU seconds.



The loss fraction of NBI ions

- Due to the relatively high momentum of the beam ions they do not strictly follow the magnetic field lines, but execute a variety of orbits that cross a range of magnetic flux surfaces.

- Full orbit simulations have revealed that a significant fraction (typically ~20%) of the possible beam ion orbits are not confined in the NSTX plasmas.

- Efficient beam heating requires that the main part of the beam ion population be launched onto the sub class of trajectories that are well confined in the plasma.

- Using the full orbit code EIGOL, at present it takes more than 30 CPU **hours** to calculate the beam loss fraction for a given magnetic equilibrium.

- The deposition profile of the NBI ions can be mapped directly onto to the orbit phase space of Egedal (2000). Using these methods the beam loss fraction may be estimated in less than 60 CPU **seconds.**

Initial goals of collaboration

- The orbit phase space diagrams will also be useful in displaying and interpreting the results of fast ion measurements on NSTX.

- The near term (2001) goals of the proposed collaboration are to:
  1. Write a routine to be able to read EFIT equilibria directly.
  2. Adapt existing code to calculated beam loss fraction on the basis of given EFIT equilibrium and beam deposition package.
  3. Show beam ion deposition density in the applied orbit phase space.
  4. Compare loss fraction against result from EIGOL full orbit code.
  5. Translate the line of sight of NPA into orbit phase space.
  6. Translate the line of sight of Fast Lost Ion Probe into orbit phase space.