Quantitative evaluation of the wall heat load by lost fast ions in the Large Helical Device

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Background
1. Heat load by lost fast ions is critical issue for fusion reactors.
   - Damage the device
   - Limit operational conditions.

   ➔ Prediction and evaluation of heat load by lost fast ions is required to design fusion reactors by means of orbit following simulation.

2. Magnetic field structure changes with plasma beta.
   ➔ The effect of plasma beta should be included to evaluate heat load.

Purpose of Research
- Development of a simulation code to evaluate heat load by lost fast ions.
  (Including 3D magnetic configuration and the effect of plasma beta.)
- Validation of the simulation code with experimental results. (Future)
- Investigation of the effect of plasma beta on fast ion loss and heat load.

The Large Helical Device
- Superconducting Heliotron device in Toki, Gifu, Japan
- L=2/M=10 Heliotron configuration.
- Maximum magnetic field: 2.75 T
- Reactor relevant high beta plasma (<β=5%) is achieved.
- Design activity of LHD type reactor (FFHR) has been conducted.

Results and discussion
- Heat load concentration on vacuum vessel
  - Vacuum: Shift from footprints (-)
  - Finite Beta: Inside to upper region. Shift from footprints (+)

Calculation Method
- Guiding Center orbit following in real coordinate (GCR code)
- Heat load evaluation.
  ➔ Calculation of lost point and energy by orbit following
  ➔ Weighing
  ➔ Number of generated in real device
  ➔ Number of followed particles
  ➔ Calculation of lost power on the polygon.
  ➔ Calculation of heat load on each polygon.

  ➔ Characteristic of the code.
  ➔ High beta equilibrium field by HINT.
  ➔ Orbit following until vacuum vessel.
  ➔ Lost point detection.
  ➔ Velocity change by Coulomb collision.

Calculation Conditions
- To consider the geometry of injector and distribution of fast ions, FIT3D code is used.

Fast ion loss
- Co-injection
- Counter-injection

Heat load
- Co-injection
- Counter-injection

Conclusion
- Heat load distribution is affected by plasma beta
  - Counter, Vacuum: Torus inside to upper region
  - Counter, Finite Beta: Torus inside to lower region

- Because of the drift, fast ion loss is shifted from thick footprints of magnetic field lines.
  - Quantitatively more reliable data is required.