A new fast ion source and detector for investigating the interaction of turbulence with supra-thermal ions in a single magnetized toroidal plasma.

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Partly funded by the "Fonds National Suisse de la Recherche Scientifique"

**Motivations**

- Fast ions present in many tokamaks (even with ECRH).
- The anomalous transport in tokamak could be explained by turbulence.
- Poor knowledge in fast ions – turbulence interaction in toroidal devices.
- Turbulent transport (diffusion).
- Inhomogeneous poloidal electric field from plasma;
- Classical interaction with the main plasma
- Divergence due to space charge is negligible (very small current).

**Objectives of investigation**

1. Turbulent plasma influence on fast ions beam.
2. Fast ions beam influence on plasma turbulence.
3. Fast ions beam influence on coherent waves in regimes with closed magnetic flux surfaces.

**TORoidal Plasma Experiment (TORPEX)**

- Fast ions: 100eV-1keV ions energy;
- Low gas load; aluminosilicate Li-6 ion emmiter;
- Not sensitive to magnetic field;
- High voltage modulable power supply;
- Light ions to facilitate the ion-electron interactions; Li-6;
- Small size to minimize perturbations;
- Screen grid at plasma floating potential;
- Focusing.

**Main diagnostics of TORPEX**

- High-frequency Langmuir probes
- 3D Mirnov coils
- Gridded energy analyser
- Moving Langmuir probes
- Moving 2D Langmuir probe
- Moving Rogowski coil
- Gridded energy analyser

**Scheme of the experiment**

- Toroidal cross-section of TORPEX vacuum vessel:
- Fast ions source and gridded energy analyser will be installed on 2D poloidally moving system to change fast ions deposition and to measure beam current profile from shot to shot.

**Divergence of ion beam**

- Five possible mechanisms:
  1. Space charge of the beam ions;
  2. Drift motion + cyclotron motion;
  3. Classical transport;
  4. Inhomogeneous poloidal electric field from plasma;
  5. Turbulent transport (diffusion).

**Space charge**

Divergence due to space charge:

\[
\frac{d}{dr} = \frac{eU_{eff}^2}{2m_1^2 \sqrt{n_1 x}} \left( 1 - \frac{r}{b_1} \right) \left( 1 - \frac{r}{b_2} \right)
\]

Divergence due to space charge is negligible (very small current).

**2D poloidally moving system**

- Based on sliding seal feedthroughs with differential pumping:
- Coverage area
- Angular feedthrough
- Ceramic tube
- Remote linear motion
- Arm for remote angular motion

**Particle trajectories**

- Single particle approximation:
  - Toroidal cross-section:
  - Poloidal cross-section:

**Fast ions source**

- Scheme of fast ion source.

**Gridded energy analyser**

- * 2 grids;
- * Screen grid;
- * Biased with sweeping voltage (f=1kHz);
- * Spatial resolution ~5mm;
- * Energy resolution ~0.1V.