Active steering system for the Neutral Beam Injector for ITER

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ITER requires an additional power of 33MWfrom neutral beam injection, depending on the operating scenario; such power can be provided by two injectors, each delivering 16.5MW; the ion current should be 40A and the accelerating voltage 1MV [1]; such particle energy implies the use of negative ions based on consideration of neutralisation efficiency [2].
It is required that the design allows both on-axis and off-axis injection into ITER; presently this is accomplished by mechanical tilting of the injector source. At the same time, on the horizontal plane, very tight misalignment is tolerable (±3 mrad), to preserve the integrity of the beam line components; such precision must be obtained by precise installation of the components.
Modifications of the alignment through these systems require breaking the vacuum and executing a long series of operations. It would be helpful if such alignments could be performed remotely.
A study has been conducted on the possibility of steering the negative ions by suitable magnetic fields, generated by dedicated coils located at the exit of the accelerator. It results that the magnetic system can meet the requirements in terms of beam alignment.
As a by-product, the steering system would heavily affect the trajectory of the electrons extracted from the accelerator and deflect them onto suitable electron dump plates.
Advantages of this system are the possibility of steering the ions and dumping the electrons in a controlled way, even in case of modulation of the acceleration voltage; aiming of the ions is provided without the need of moveable parts in vacuum and of flexible connections; active aiming can be helpful in modifying the power deposition profile in ITER following the characteristics of the plasma; active steering can provide a suitable way to control the power deposition with respect to the possibility of exciting Alfvén eigenmodes, which can reduce the performances of ITER plasmas [3].
The present contribution will review the preliminary design of the active steering system and provide an analysis of advantages and disadvantages.

[1] DDD 5.3 ITER documentation
[2] Gormezano C et al 2007, "Chapter 6: Steady state operation", Nucl. Fusion **47** S285
[3] Ishikawa M. et al., Nucl. Fusion **47** (2007) 849