BTR code Applications FOR ITER Neutral Beamlines Design [[1]](#footnote-1)\*)

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BTR code (*Beam Transmission with Re-ionization*) [1] is used for Neutral Beam Injection (NBI) design and studies - for many years. BTR was conceived in 1995, and finally released in 2005 (Born-To-Run), developed by means of MS Visual C++ for Windows. From the very beginning it is open and intended for *public usage*. BTR is fast and fully interactive - looks and feels like a real NB flight simulator, and even can be used for NBI training purposes. BTR is parallel, thus the best performance is achieved on multi-core systems. But even on moderate Windows machines it is still possible to trace up to 1010 particles within few hours. BTR models are *light*and straight-forward, self-replicable and verifiable analytically. They are used for cross-checking with other beam tracking models [2]. The simulation capacity (including geometry details, particles statistics and tracing steps), output data (power images) amount and resolution (meshing size) - can be flexibly adjusted to any task within NBI design purposes. Today BTR is a lively and evolving code, and free support is available to all the Users. The information on BTR upgrades and code manuals can be found online [1].

BTR *beam**model* starts from the ion beam source exit grid position, all the successive transforms and beam transmission along the beamline are simulated by a simple and comprehensive beam model**.** The sourceparticles are traced in electromagnetic fields, with their neutralization and downstream ionization accompanying the beam passage through gas or plasma targets. The beam tracingmodel is deterministic. BTR source beam is an array of beamlets (*cone*-beams); each single beamlet individual position, axis focusing and inner angular distribution can be set; the beam is reproduced with a high resolution: typically 1280 source beamlets are started with 103 - 105 primary particles per *each* beamlet.

The *injector geometry* inputapproachis flexible, it allows the combination of the *Standard* components input and *Free-Surfaces* input, the latter can be created manually or by means of CAD tools. The amount of input surfaces can be large enough to show the geometry details, refined to several millimeters. Power flux and power deposition maps are the main code *output*which can be obtained in any plane or solid surface along the injector. The images quantity and resolution are adjusted interactively by the User; typically BTR delivers 100-200 power maps for output, each resolved with ~100x100 meshing.

The general *scope* for BTR application is wide: basic simulation purposes include the detailed analysis of beam transport and power losses along the beamline, magnetic field effect studies and limit-setting, beam transformations in gas or plasma volumes, beam species tracking, power imprints and maps calculation, images processing, and other. The most important (conventional) BTR application *examples* for ITER Heating and Diagnostic neutral beams [3,4] are highlighted in this report. They include the summary of recent studies performed by ITER central team with the new version (BTR-5, *Multi-Run*), which was specially built for multi-parametric analysis.

References

1. E.D. Dlougach, BTR webpage (2010), URL: [**https://sites.google.com/site/btrcode/**](https://sites.google.com/site/btrcode/)
2. E. Sartori et al, “Benchmark of numerical tools simulating beam propagation and secondary particles in ITER NBI”, AIP Conference Proceedings, v.1655, 2015, p.050006
3. M.J. Singh et al, “Heat load estimation in the duct and blanket module region of the HNB during various operating scenarios of the ITER machine”, AIP Conference Proceedings, v.1515, 2013, p. 498
4. M.J. Singh et al, “Powerloads on the front end components and the duct of the heating and diagnostic neutral beam lines at ITER”, AIP Conference Proceedings, 1655(1), 2015, p.050011
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/E/ru/IK-Dlugach.docx) [↑](#footnote-ref-1)