BTR 4.0 Free Geometry

List of upgrades versus BTR 3.3 (Jan 13 – July 13) E.Dlougach

*Most of the upgrades are requested by IO users*

Free Surfaces input & management

* *Free Geometry Input* option is added, allowing the user to create beamline surfaces directly or by preparing the text files, the latter can be easily generated by design codes. Almost all BTR interface tools for Free Surf operation are kept similar to the old Standard NBI concept, making the transfer to new input procedure as easy as possible.
* The *Calculation Area Limits* are adjusted (enlarged) automatically by BTR4 - to fit freely on the defined Surfaces dimensions.
* The user can feel free when *updating the Calculation Area* Limits by hands (directly via Green Panel) – as all the Free Surfaces will not disappear any more, like it was before in BTR 3.
* Free Surface can be modified directly via the command Pop-up Menu -> Modify Surf. In the dialog-box appeared the user can change the Corner-points positions of the selected Surface, the Comment-line, set Solid/Transparent property, and even the ID-number (although it’s recommended to keep the automatic value of ID).
* Every Surface selected (by left mouse click), even non-loaded, can be added or removed to the Loads Summary listing - by selecting the command Pop-up Menu->Add/Remove Load. This is done by user request – to facilitate the comparison of loads summary listings for different BTR runs.
* *Standard NBI geometry* input and the results of calculation for Standard input can be *converted to Free Surf* input format, upon that the NBI components are decomposed to Free Surfaces which are written to separate Surf-files with or without the load.
* When the user wants to select a Surface, in case when two or more Surfaces *overlap*, BTR asks to specify the Surf ID-number to select.

Results management

* Storing the *Summary of load results*: when the results PD summary is displayed in the Load-view, right mouse click on the view opens the system open-file dialog, where the filename for the summary should be specified. The load summary will be written in text format as displayed in the Load-view.
* *Colour bar* is added to Multi-colour map view, by user proposal. Its purpose is probably to make the colour maps more comprehensible for analysis, and maybe let BTR compete with other codes’ GUI (graph user interface).
* *Neutralization and Re-ionisation profiles* are plotted via Main Menu command Plot->Neutralization or Plot->Re-ionization, and the correspondent data arrays can be stored as a text files – when the user pushes the button “*Save*” in the Plot dialog-box.
* *2D gas profile* (X, Z, Density) is added as an optional format of gas data. So far it is useful for non-ITER NBI applications of BTR-code, but who knows what tomorrow holds :).
* *Additional gas profile for re-ionization* (with a cross-section relevant) can be defined. When the user selects the command Main Menu->Options->Fields/Gas, it invokes a Fields/Gas dialog-box, where the button (Gas)”*Advanced*” allows to set the input data file and appropriate cross-section for the new gas. The resulting Re-ionization rate and percentage will be calculated as a sum across the two gas profiles – basic and additional.
* The function of *Single beamlet* tracing is corrected.
* The possibility of to choose the *particles species* for power load display is added. The function is available via the command Main menu->Options->Beam. In the Beam dialog-box the user can make the choice (check/uncheck) to show atoms, negative ions, and positive ions.
* The *accuracy of peak* positions on the graphs is increased to more decimal places (up to 6). Before it was limited by 2 decimal places (1 cm).
* *Angular distribution* of power falling on a selected Surface can be obtained via the command Pop-up Menu->Angular Distr. The incidence angle (in degrees) is counted from the surface, 90 deg is for normal fall, the power is integrated with 1 degree step. The data can be written to a text-file: to do it in the plot dialog-box click on the button “Save”. Note: at present the angular data are kept while the beam is not restarted and BTR session is not closed.
* Some features are added to BTR graphical interface (e.g. Surf labels flashing).
* Several functions available in BTR 3.3 are switched-off until BTR 4.0 version is completely debugged and tested (beam- plasma, shine-through, ions reflection, etc.).

Directed Input (common)

* When running BTR the user makes a choice between:
  + New task
  + Results review
  + Demo
* According to the selection made, the user has to pass through the sequence of dialogs which make him put his preferences, and to read appropriate files. The user may choose to skip the Directed Input procedure any moment and to return back to the standard input procedure. Running Demo might be useful for the beginners – to see what the code is all about.

COMMENTS on the Upgrades BTR 3->4 (User’s Guide)

Free Surfaces input & management

Free Surfaces model in BTR 4.0 allows to set the beamline structure ad libitum – i.e. the number of surfaces and their positions are not limited. The only restriction is a quadrangle (but not necessarily rectangular) shape of a surface. Each surface is defined by its 4 corner-points coordinates in the NBI coordinate system and can be either “Solid” or “Transparent” with respect to the particles behavior at the surface.

Each Free Surf can be added, removed, and modified directly by BTR interface tools, as opposed to the Standard NBI surfaces which cannot be modified independently.

Free Surf approach offers more flexibility to geometry input than Standard mode, but it’s the user who has to mind the input data consistency, avoid the overlaps (they can occur when parallel surfaces are too close to each other) or leaks at the surfaces joints. BTR provides the input data checking only for Standard geometry.

BTR 4.0 has two modes of NBI geometry input – Standard NBI and Free Surf. The choice between them is made by the user at the beginning of BTR session. When *Standard NBI* is chosen, BTR screen displays a default NBI configuration with the NBI components and PDP-diaphragms indicated.

When *Free Surf mode* is selected, BTR shows the beam array (i.e. beamlets axes) in empty geometry. The only Free Surfaces defined by default are *Calculation Area Limits*.

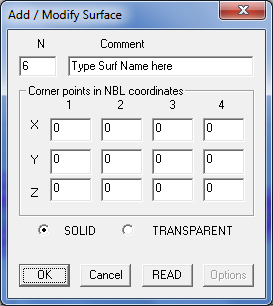
Free Input: Config-file format

In Free Surf mode the conventional BTR input file (Config.dat) has the same format as in Standard mode, but the data section *NBI Configuration* is not used (skipped by BTR). Only the *Beam Regular Array* and *Beam Tracing*, including the limits of Calculation Area are taken by BTR from Config-file in Free Surf mode. The beamline geometry should be created separately by adding the Free Surfaces.

Free Surf Direct Input and Modification

To add a Surface manually use the command Options->Surfaces->Add New. In the Surf Dialog (see below) define the corner-points, the Comment line and set Solid/Transparent property.

BTR 4.0 Dialog - for input or modification of Free Surf data



The newly created Free Surface is displayed on pushing OK.

To Modify a Free surface Select it (left mouse click on the hot-spot), then click the Pop-up menu (right mouse button) and choose Modify Surf command. The same Add/Modify dialog will reappear with the Surf actual data (old corner-points, ID-number and Comment). Set the new data and push OK – the Surface will be updated at once. (Note: Surf ID is assigned automatically, its manual change is not safe).

Read Free Surf from a file

You can read one or multiple Surfaces from external text files. Use the Menu command Data->Read Surf, then specify the path for the input Surf-file. You can repeat this operation as many times as needed and read as many Surf-files as you need. The text format of Surf-file is brought further.

Save Free Surfaces in a file

To Save the Free Surfaces in a text file go to Menu->Data->Save Surf. Set the path/name for the file in a standard open-file dialog.

The Surf-file has the following format (Fig. 1.8):

Comments:

Each Surface is defined by 4 Corner Points (X Y Z)

# Free Surf 1 Name (solid)

1.8 0 2.5

1.8 0 0.65

2.6 -0.1 0.65

2.6 -0.1 2.5

# Surface 2 (solid)

1.8 0 2.5

1.8 0 0.65

2.6 0.1 0.65

2.6 0.1 2.5

# Surface A (solid)

3.7 0.1 2.5

1.8 0.1 2.5

1.8 -0.1 2.5

3.7 -0.1 2.5

# Additional Surf (transpar)

0.5 -0.06 -0.6

0.5 0.06 -0.6

0.5 0.06 0.6

0.5 -0.06 0.6

...

...

Note: the Surf Name line begins with symbol #, the string contains (at the end) the substring “solid” or “transpar”, defining the Surf property. Next follow the Corner-points of the Surface defined as coordinates X Y Z in NBI frame. Their values should be separated by space characters.

Delete Free Surf

You may want to delete any Surf created (or all of them). Use the Pop-up menu command Delete Surf (or Delete All Free).

Save Results of calculation for Free Surfaces geometry

When you have configured your NBI (Free or Standard), next input steps are common for both input modes: you set the beam array and beam tracing options, define gas profile and MF-data. When the task is ready, you can run the beam in usual manner. When it’s finished you can Save the Results.

To Save the Results of calculations in Free mode use the same BTR command as for Standard NBI: Results->Save All. The configuration is written in Config-file, the Free Surfaces data and results are written in Load-files. The Load-file format is shown below.

The sample Load-file format for a Free Surf (non-zero load)

# Free Surf (transpar)

25.52 -0.52 -2.33561

25.52 0.52 -2.33561

25.52 0.52 -0.175613

25.52 -0.52 -0.175613

Duct Exit Cross-plane, X = 25.51 m PARAMETERS (Plate 96)

Nx = 20 Ny =20

StepX = 0.050 m StepY =0.100 m

Summa = 2.118674e+007 W

MaxLoad = 1.879000e+008 W/m2 at X = 0.500 m Y = 0.800 m

Origin at X = 25.520 m Y = -0.520 m Z = -2.336 m

OrtX X = 0.000 Y = 1.000 Z = 0.000

OrtY X = 0.000 Y = 0.000 Z = 1.000

Smoothing Degree = 0

Downstream Edge X = 0.75 m

POWER DEPOSITION on the Plate

X,m Y,m Load, W/m2

0.000 0.000 0.000e+000

0.000 0.100 0.000e+000

0.000 0.200 0.000e+000

0.000 0.300 0.000e+000

0.000 0.400 0.000e+000

... … ….

Read Free Surf geometry and Results

When the Free Surf results are written, they can be read via Menu command Results->Read All. The tool is similar to Standard NBI results reading – select and open “Config.dat” in the results folder. The geometry will be displayed with the existing power loads.

Converting the Standard NBI geometry to Free Surf format  
  
1. Run BTR in Standard mode, read Config-file via command Data->Read or optionally read the old results (Results->Read All).  
2. When you have the Standard geometry (and results) loaded - select Results -> Save All.  
3. BTR message asks you to choose how the geometry and results should be saved - as the Old or the New format (choose YES - for Free option).  
4. You get the message with the name of the folder created (i.e. subfolder in your active folder, from which you have read the Config-file).  
5. Exit BTR and restart it in Free mode.  
6. Choose Results->Read All ->Config.dat from the subfolder newly created.  
7. The NBI geometry and the results are displayed in the screen. Note: the NBI is now represented by free surfaces, with each surface data stored in a separate file (with or w/o load) – Load-file. The data contains the Corner-points positions and the Load array (for non-zero load). If the load is zero, the array is not written to the file. The Load-file format is shown above (see the item Save Results).

OTHER BTR4 MODIFICATIONS

Inclination and Tilting in Free input mode

In Standard input mode there existed 3 vertical steering angles applied to NBL axis and to the beam

.................. NBI CONFIGURATION ..................

Beam Axis Vert. Misalign Angle, rad BeamMisVert = 0

NBL Axis Vert. Inclination Angle, rad VertInclin = -0.0492

Beam Axis Vert. Tilting Angle, rad BeamVertTilt = -0.01

Parameter *VertInclin* refers to the NBI components (Neutralizer, RID, Calorimeter, Duct, etc.) which are shifted or rotated when the NBL axis is inclined from horizontal axis (X). *BeamVertTilt* is counted from the NBI inclined axis, this parameter means that the beam can be injected above (*BeamVertTilt* >0) or below (<0) the nominal injection point (defined by *VertInclin*). Besides there is a small misalignment (~2 mrad up or down) in the beam steering, which is typically included in the most critical calculations – *BeamMisVert.*

In Free mode there is no NBL in terms of Standard components set – therefore the parameter *VertInclin* can’t be applied to the entire system of Free Surfaces (now composing the NBI configuration). Otherwise the user would have to define the movement algorithm (or rule) for each NBI surface (up to ~300 surfaces). As the NBI inclination still plays an important role as nominal axis, and is used in other codes and design documents, it was proposed to transfer it somehow to BTR Free mode. After some discussions it was asked to change the meaning of the parameter *BeamVertTilt* (Beam Axis Inclination) for the Free mode and replace it by *VertInclin* value in it. Then the old value of *BeamVertTilt* is added to *BeamMisVert*, as tilting and misalignment are working together. This modification (a bit confusing though) concerns the Free mode only, in Standard geometry the steering parameters are kept conventional.

As a result the Green Panel the following parameters are used for beam vertical steering in the Free mode (with corresponding values):

.................. BEAM TRACING ..................

Beam Axis Vert. Tilt + Misalign Angle, rad BeamMisVert = -0.01

Beam Axis Vert. Inclination Angle, rad BeamVertTilt = -0.0492

Angular Distribution of Power

The angular distribution of power falling on a Surface can be calculated after the beam tracing is over. To get the angular profile after beam is finished:

1. Select the Surface (left mouse click on hot-point);
2. Call the Pop-up menu by right mouse button click and choose the command Angular distr;
3. The plot with the profile appears (falling angle is counted from the surface, power is integrated within each 1 degree step);
4. To Save the profile data as a txt-file press Save-button in the plot box.  
     
   Note. Angular profiles are not saved automatically with the power maps during Results->Save All procedure. It means if you have not saved the angular profile with the plot Save-button you'll not be able to see it after closing the session.