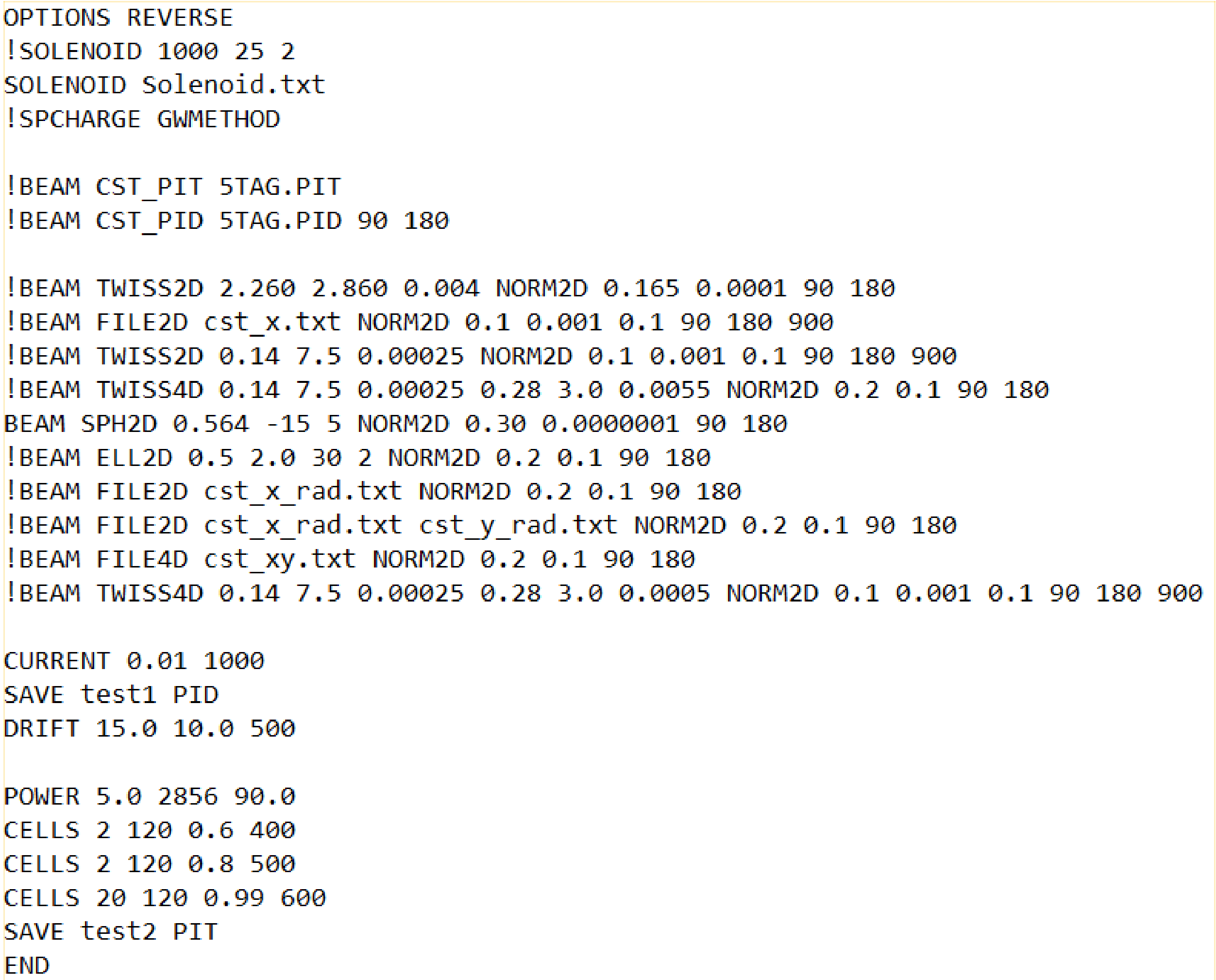
Hellweg2D Interface Guide

To calculate beam dynamics in TW linacs, you need to follow some simple steps, describing below.

1. INPUT file.

The program reads the initial data from text file «INPUT.txt» which must be in the same folder as the "Hellweg2D.exe" file. If the data was successfully read, you would see the correct numbers in the main window. If the data is not correct, you can look through the «PARSER.txt» file to see what lines were successfully read. The example of an input file is presented in Figure 1.



```
OPTIONS REVERSE
!SOLENOID 1000 25 2
SOLENOID Solenoid.txt
!SPCHARGE GWMETHOD

!BEAM CST_PIT 5TAG.PIT
!BEAM CST_PID 5TAG.PID 90 180

!BEAM TWISS2D 2.260 2.860 0.004 NORM2D 0.165 0.0001 90 180
!BEAM FILE2D cst_x.txt NORM2D 0.1 0.001 0.1 90 180 900
!BEAM TWISS2D 0.14 7.5 0.00025 NORM2D 0.1 0.001 0.1 90 180 900
!BEAM TWISS4D 0.14 7.5 0.00025 0.28 3.0 0.0055 NORM2D 0.2 0.1 90 180
BEAM SPH2D 0.564 -15 5 NORM2D 0.30 0.0000001 90 180
!BEAM ELL2D 0.5 2.0 30 2 NORM2D 0.2 0.1 90 180
!BEAM FILE2D cst_x_rad.txt NORM2D 0.2 0.1 90 180
!BEAM FILE2D cst_x_rad.txt cst_y_rad.txt NORM2D 0.2 0.1 90 180
!BEAM FILE4D cst_xy.txt NORM2D 0.2 0.1 90 180
!BEAM TWISS4D 0.14 7.5 0.00025 0.28 3.0 0.0005 NORM2D 0.1 0.001 0.1 90 180 900

CURRENT 0.01 1000
SAVE test1 PID
DRIFT 15.0 10.0 500

POWER 5.0 2856 90.0
CELLS 2 120 0.6 400
CELLS 2 120 0.8 500
CELLS 20 120 0.99 600
SAVE test2 PIT
END
```

Figure 1. INPUT.txt structure

Keywords description ("bold" parameters are optional)::

- OPTIONS <***Keyword***>

This keyword defines extra modes that will be used in calculations. Possible options:

- *REVERSE*

Backward travelling wave regime would be considered.

Ex. OPTIONS REVERSE

- ➢ SOLENOID *B[Gs] L[cm]* ***Z₀[cm]*** or SOLENOID *Filename*

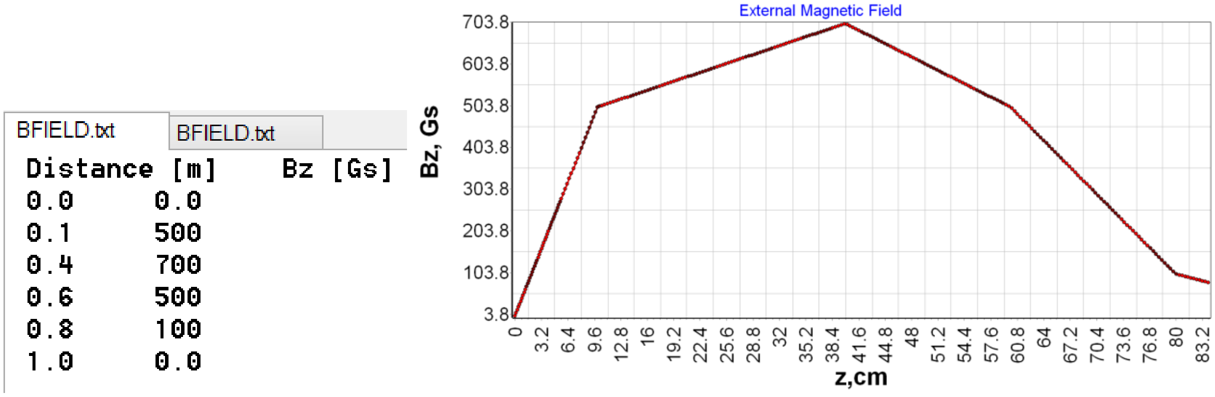
This keyword defines the source of the external uniform longitudinal magnetic field. There are three parameters to define solenoid specification: magnetic field strength B[Gs]; solenoid length L[cm]; longitudinal coordinate of the start of the solenoid Z_0[cm]

Ex. SOLENOID 1500 20 010

Custom magnetic field distribution can be imported from a file. In this case, you add the name of the file with magnetic field data after the keyword SOLENOID.

Ex. SOLENOID BFIELD.txt

The following input file format must be used: the first column is z coordinate in [cm], the second is a magnetic field in [Gs]. Z-coordinates can be outside the simulation domain.



```
Distance [m]    Bz [Gs]
0.0       0.0
0.1       500
0.4       700
0.6       500
0.8       100
1.0       0.0
```

Figure 2. *BFIELD.txt file structure and imported field*

- ➢ BEAM <***Set of Parameters***>

This line defines the parameters of the initial distribution or import of particles in transversal and longitudinal phase space. Currently, there is a possibility to input the whole particles phase space from one of the standard format files, or define/import the transversal and longitudinal distribution separately. In the latter case, the keyword for the longitudinal distribution should immediately follow the transverse distribution definition (see examples section).

Here is the list of the possible keywords

- *CST_PID FileName* ***φ0 [deg] Δφ [deg]*** ***σ_φ [deg]***

The code will import the initial distribution form CST PID file with “FileName” name. The normal phase distribution (see NORM2D) can be optionally defined by two parameters: mean phase (φ0), and phase length (±Δφ). Optionally, the RMS deviation (σ_φ) can be defined. If no phase distribution parameters are defined, the code will generate the uniform distribution from 0 to 360 deg. If the deviation is not defined, the code will assume a uniform distribution. The format of "pid" file is the following:

x [m], y [m], z [m], $(\beta\gamma)_x$ [], $(\beta\gamma)_y$ [], $(\beta\gamma)_z$ [], m_0 [kg], q_0 [C], I [A]

Ex. BEAM CST_PID cst_example.pid

Ex. BEAM CST_PID cst_example.pid 90 180

Ex. BEAM CST_PID cst_example.pid 90 180 50

- *CST_PIT FileName **COMPRESS***

The code will import the initial distribution from CST PIT file with "FileName" name. If the imported beam consists of multiple bunches, the keyword COMPRESS can be added to compress all particles into one bunch. The particle with time t will have the phase $\varphi=-t*c/\lambda$. The format of this file is the following:

x [m], y [m], z [m], $(\beta\gamma)_x$ [], $(\beta\gamma)_y$ [], $(\beta\gamma)_z$ [], m_0 [kg], q_0 [C], Q [C], t [s]

Ex. BEAM CST_PIT cst_example.pit

Ex. BEAM CST_PIT cst_example.pit COMPRESS

- *FILE2D FileName1 **FileName2***

The code will import 2D distribution from the file with *FileName1* name. In the case of longitudinal distribution, the file should have the following format: *φ [deg], W[MeV]*. In case of transversal distribution, the format must be: *r [cm], r' [rad]*. Optionally, the second file can be defined for transversal distribution only. In this case, the code will read *x [cm] x' [rad]* distribution from the first file, and *y[cm] y'[rad]* from the second file, and converts the distribution to cylindrical coordinates r, θ, p_r, and p_θ. The user must ensure that the number of particles from different files matches, as well as the order of the particles in the file.

Ex. BEAM FILE2D radius.txt FILE2D energy.txt

Ex. BEAM FILE2D particles_x.txt particles_y.txt FILE2D energy.txt

- *FILE1D FileName φ0 [deg] Δφ [deg]* ***σ_φ [deg]***

The code will import the energy distribution from the file with *FileName* name. The file should have the following column: *W[MeV]*. The normal phase distribution (see NORM2D) should be defined by two parameters: mean phase (φ0), and phase length (±Δφ). Optionally, the RMS deviation (σ_φ) can be defined. If the deviation is not defined, the code will assume a uniform distribution. In the case of multiple files are defined, the user must ensure that the number of particles from different files matches, as well as the order of the particles in the file. This type of distribution can only be used for longitudinal phase space

Ex. BEAM FILE2D radius.txt FILE1D energy.txt 90 180

Ex. BEAM FILE2D radius.txt FILE1D energy.txt 90 180 20

- *FILE4D FileName*

The code will import the 4D transversal phase space distribution from the file with *FileName* name. The file should have the following format: *x [cm] x' [rad] y[cm] y'[rad]*. In the case of multiple files are defined, the user must ensure that the number of particles from different files matches, as well as the order of the particles in the file. This type of distribution can only be used for transversal phase space

Ex. BEAM FILE4D phase_space.txt FILE1D energy.txt 90 180

- *TWISS2D* α_x, β_x *[cm/rad],* ε_x *[cm*rad]*

The code will generate the x-x' distribution with α_x, β_x [cm/rad], ε_x [cm*rad] Twiss parameters (Figure 3), and y-y' distribution for the same parameters. x-x' and y-y' distributions are independent. Then the code converts the distribution to cylindrical coordinates r, θ, p_r, and p_θ. This type of distribution can only be used for transversal phase space.

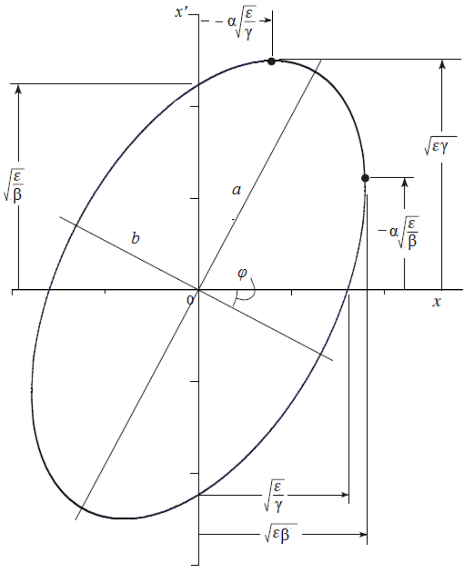

x'
$-\alpha\sqrt{\frac{\varepsilon}{\gamma}}$
$\sqrt{\varepsilon\gamma}$
$\sqrt{\frac{\varepsilon}{\beta}}$
a
b
$-\alpha\sqrt{\frac{\varepsilon}{\beta}}$
φ
0
x
$\sqrt{\frac{\varepsilon}{\gamma}}$
$\sqrt{\varepsilon\beta}$

Figure 3. Phase space defined by Twiss parameters.

Ex. BEAM TWISS2D 0.14 2.0 0.0005 FILE2D energy.txt

- *TWISS4D* α_x, β_x *[cm/rad],* ε_x *[cm*rad]* α_y, β_y *[cm/rad],* ε_y *[cm*rad]*

The code will generate the x-x' distribution with α_x, β_x [cm/rad], ε_x [cm*rad] Twiss parameters (Figure 3), and y-y' distribution with α_y, β_y [cm/rad], ε_y [cm*rad]. x-x' and y-y' distributions are independent. Then the code converts the distribution to cylindrical coordinates r, θ, and p_r. p_θ is assumed equal to zero to avoid particle magnetization. This type of distribution can only be used for transversal phase space.

Ex. BEAM TWISS4D 0.14 2.0 0.0005 0.28 4.0 0.0015 FILE2D energy.txt

- *NORM2D W0 [MeV] ΔW [MeV]* $\boldsymbol{\sigma_W}$ ***[MeV]*** *φ0 [deg] Δφ [deg]* $\boldsymbol{\sigma_\varphi}$ ***[deg]***

The code will independently generate the Gaussian energy and phase distribution with mean energy (W0), energy spread (±ΔW), mean phase (φ0), and phase length (±Δφ). Optionally, the rms deviations (σ_W, σ_φ) can be defined for both energy and phase distribution. It is impossible to define the RMS deviation for only one parameter! If deviations are not defined, the code will assume uniform distributions. If ΔW (or Δφ) is zero or negative, the code will generate the Gaussian distribution with no boundaries. If $\Delta W^2 < 12 \cdot \sigma_W^2$, the distribution will be uniform! Otherwise, the code generates Truncated Gaussian distribution with the limits W0- ΔW and W0+ΔW. The same for phase distribution. See Figure 4. This type if distribution can only be used for longitudinal phase space

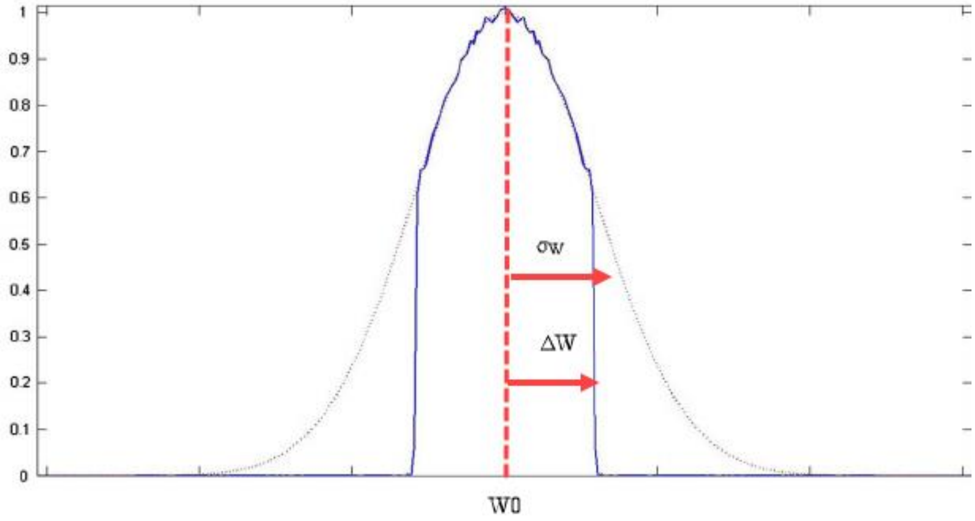


Figure 4. Example of Truncated Gaussian Distribution

Ex. BEAM TWISS2D 0.14 2.0 0.0005 NORM2D 1.0 0.5 0.25 90 180 20

Ex. BEAM FILE2D beam.txt NORM2D 1.0 0.5 90 180

- *SPH2D Rcath [cm]*, ***Rsph [cm], kT [eV]***

The code will generate radial distribution from the spherical cathode (see Figure 5). *Rcath [cm]* defines the radial limit of the particles. Rayleigh distributions with σ_R= Rcath will be modeled. *Rsph [cm]* is an optional parameter for cathode sphericity. If Rsph=0 or not defined, the cathode will be cylindrical (flat). If Rsph >0, the cathode is concave. If Rsph <0, the cathode is convex. The normal (to the cathode surface) component of r' is defined as r'=-sin(r/Rsph). Optional parameter kT [eV] defines the thermal emittance. This type of distribution can only be used for transversal phase space.

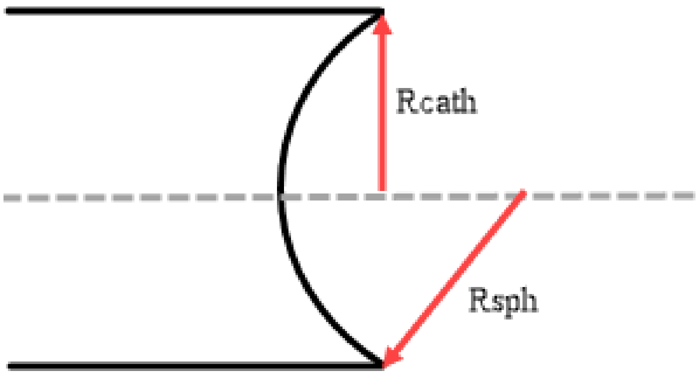


Figure 5. Example of spherical cathode distribution

Ex. BEAM SPH2D 0.564 1.0 10.0 NORM2D 1.0 0.5 90 180

Ex. BEAM SPH2D 0.564 1.0 FILE2D energy.txt

Ex. BEAM SPH2D 0.564 FILE1D energy.txt 90 180

- *ELL2D a_x [cm], b_y [cm],* φ ***[deg], h***

The code will generate a radial elliptical distribution with *a_x [cm] and b_y [cm]* half-axes. Optionally, the beam can be rotated in x-y space by an angle of φ[deg]. If phi is not defined, it is assumed zero. See Figure 6. Optional parameter h defines the RMS deviation of the Gaussian distribution as $\sigma_x= a_x/h$, $\sigma_y= a_y/h$. If not defined, h is assumed to equal to 1. No particles will be generated outside of the ellipse. Radial and azimuthal speeds assumed to be zero. This type of distribution can only be used for transversal phase space.

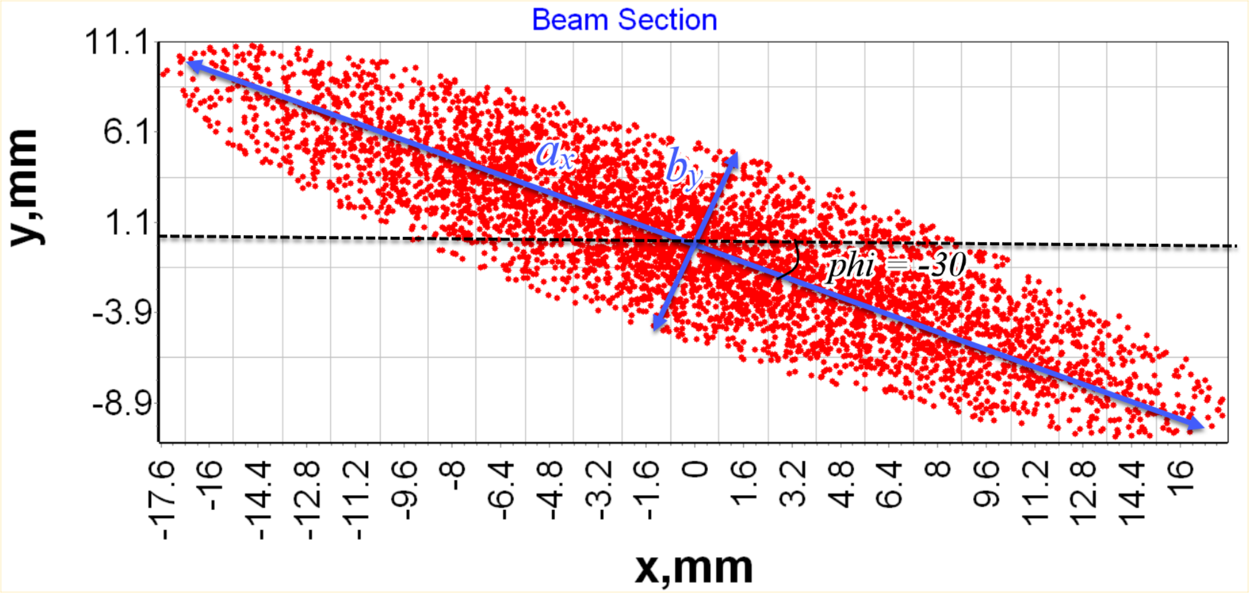


Figure 6. Example of Elliptical distribution

Ex. BEAM ELL2D 2.0 0.5 -30 2 NORM2D 1.0 0.5 90 180

Ex. BEAM ELL2D 2.0 0.5 -30 FILE2D energy.txt

Ex. BEAM ELL2D 2.0 0.5 FILE1D energy.txt 90 180

- CURRENT *I_0[A]* **Np**

This line defines the beam current *I_0[A]* during the RF pulse (*I_0=Q/Tpulse*), and a number of particles in beam *Np*. If the beam is generated randomly, the Np parameters must be defined. If the particles distribution is imported from the file, the Np parameter is optional. In this case, if Np is defined and less than number of imported particles, the code will consider only the first Np of the imported particles. If Np is greater than the number of imported particles, it will be ignored.

Ex. CURRENT 0.15 1000

- SPCHARGE ***Keyword Nslices TRAIN Lbunch [cm]***

This line defines if the space charge algorithm should be included in simulations. Two algorithms are available: ellipsoid bunch approximation per Lapostolle formula (COULOMB keyword), ellipsoid approximation with 3 elliptic integrals form-factors and the fields outside the bunch (ELLIPTIC) and Garnett-Wangler algorithm (GWMETHOD keyword). If the line is absent, the code will not include space charge in simulation. If no parameters are defined after the SPCHARGE keyword, the code will assume Lapostolle algorithm. For Lapostolle and Elliptic algorithms it is optionally possible to define the dimensions of the ellipsoid core in rms values. If no slices is defined, the code will define each dimension for ellipsoid as 3 rms. For Garnett-Wangler algorithm it is optionally possible to define the number of bunch slices with *Nslices* parameters. If no slices is defined, the code will assume 1 slice.

WARNING: As for now, Garnett-Wangler algorithm was disabled from simulations!

It is possible to define a keyword TRAIN, optionally followed by the parameter *Lbunch* [cm]. In this case, the code will assume that the simulated bunch is surrounded by two bunches, one is trabelling at Lbunch distance ahead of the simulated bunch, the other is travelling at Lbunch distance behind the simulated bunch. The code will then adjust the space charge forces according to this 3-bunches model. If Lbunch parameter is not defined, the code will assume the distance between bunches equal to the wavelength at the given position. Currently, only Elliptical space charge model supports this feature.

WARNING: If several bunches are simulated, the Lbunch should be multiplied by the number of bunches!

Ex. SPCHARGE

Ex. SPCHARGE COULOMB

Ex. SPCHARGE ELLIPTIC 1.5

Ex. SPCHARGE GWMETHOD 5

Ex. SPCHARGE ELLIPTIC 1.5 TRAIN 10.5

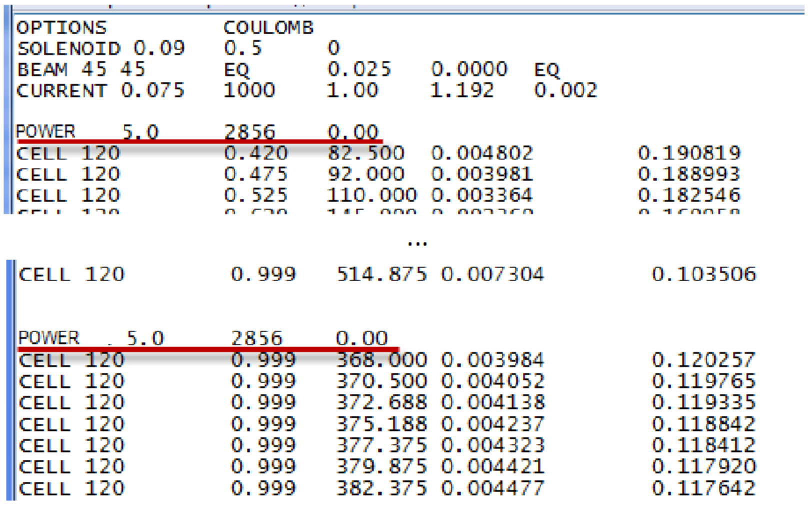
- POWER P_0[MW] F_0[MHz] **Δφ[deg]**

Defines RF power parameters for the accelerating section: pulsed input power P_0[MW]; operating frequency F_0[MHz]; phase shift from the reference phase Δφ[deg] (this parameter can be undefined – in this case it will be automatically assumed to be zero)

Ex. POWER 2.0 2856

Ex. POWER 4.5 5712 90

It possible to define several RF sections by using the keyword POWER before coupling CELL line (Figure 7). In this case all the power from the previous section will be assumed transferred to the load (Figure 8). If no power sources are defined, the system wavelength would be assumed to 1 meter!



```
OPTIONS           COULOMB
SOLENOID 0.09     0.5      0
BEAM 45 45        EQ       0.025    0.0000   EQ
CURRENT 0.075     1000     1.00     1.192    0.002

POWER     5.0     2856     0.00
CELL 120          0.420    82.500   0.004802          0.190819
CELL 120          0.475    92.000   0.003981          0.188993
CELL 120          0.525    110.000  0.003364          0.182546
```

...

```
CELL 120          0.999    514.875 0.007304           0.103506


POWER   . 5.0     2856     0.00
CELL 120          0.999    368.000 0.003984           0.120257
CELL 120          0.999    370.500 0.004052           0.119765
CELL 120          0.999    372.688 0.004138           0.119335
CELL 120          0.999    375.188 0.004237           0.118842
CELL 120          0.999    377.375 0.004323           0.118412
CELL 120          0.999    379.875 0.004421           0.117920
CELL 120          0.999    382.375 0.004477           0.117642
```

Figure 7. Example of extra RF section

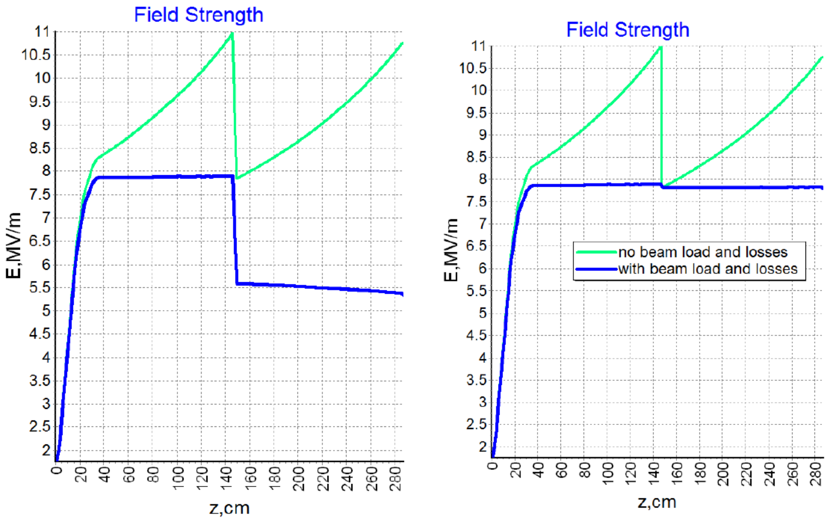


Figure 8. Longitudinal electrical field in linac (left – without extra POWER line; right- with extra POWER line)

- ➢ <u>CELL</u> θ [deg] β_{ph} [] Eλ/P$^{1/2}$ [$\Omega^{1/2}$] **$\alpha\lambda^{3/2}$ [m$^{1/2}$] a/λ []**
- ➢ <u>CELLS</u> N θ [deg] β_{ph} [] Eλ/P$^{1/2}$ [$\Omega^{1/2}$] **$\alpha\lambda^{3/2}$ [m$^{1/2}$] a/λ []**

The keyword CELL defines an accelerating cell by the following parameters: phase advance, relative phase velocity, accelerating field invariant $\frac{E_z\lambda}{\sqrt{P}} = \sqrt{\frac{2\pi\lambda r_{sh}}{Q\beta_{gr}}}$, normalized attenuation and normalized aperture. If last 2 parameters are not defined, program automatically recalculates it for DLS structure using tables. Currently, automatical calculation is only available for modes π/2 and 2π/3. To define multiple identical cells, the keyword CELLS followed by the number of cells should be used instead.

Ex. CELL 120 0.999 380.0 0.01 0.12

Ex. CELL 90 0.8 200.0

Ex. CELLS 6 120 0.999 380.0 0.01 0.12

- DRIFT L[cm] a[cm] **Nm**

This keyword defines a drift tube using 2 parameters: length L[cm]; radius a[cm]. Optionally, it is possible to add the number of mesh points for drift element after the radius that will override the global mesh settings.

Ex. DRIFT 10.0 2.0

Ex. DRIFT 10.0 2.0 100

Please, note that the DRIFT element will terminate any power used before.

- SAVE ***FileName Parameters***

If this line is present, the code will export the live particle parameters (phase, energy, radius, azimuth and radial velocity) at position define in the INPUT to the file with the defined name and .dat extension

Ex. CELLS 3 120 0.999 380.0

SAVE test

DRIFT 10.0 2.0

In this example, the particle parameters will be exported at the position between 3 cells and drift to the file *test.dat*. Multiple export commands are possible, but two SAVE lines at the same position will be overwritten.

It is possible to define the number of particles to be exported or the region of particles numbers after the name of file

Ex. SAVE test 500

Ex. SAVE test 1000 2000

In the first example, the first 500 particles will be exported. In the second one, only the particles with numbers from 1000 to 2000 will be exported. Lost particles are not exported.

Several flags are allowed to define the particular parameters to be exported. If no flags are defined, all parameters (except live status) will be exported. If at least one flag is set, only flagged parameters will be exported.

LOST – export the lost or live status of the particle

PHASE – export the phase of the particle

ENERGY – export the energy of the particle

RADIUS – export the radius of the particle

AZIMUTH – export the azimuth of the particle

DIVERGENCE – export the radial divergence r' of the particle

The flags must be defined in any combination after the number of elements region or after the file name if the region is not defined.

Special Formats. If a one of the following keywords is present, the code will ignore all other keywords, and save the beam in a special format.

PID –export the beam in CST PID format (see Beam keyword section) to the file with *.pid extension

PIT –export the beam in CST PIT format (see Beam keyword section) to the file with *.pit extension

ASTRA – export the beam in ASTRA format to the file with *.astra extension

x [m], y [m], z [m], p_x [eV/c], p_y [eV/c], p_z [eV/c], clock [ns], Q_0 [nC], index [], status []

To export the beam in the multiple format, it is necessary to define a line with SAVE keyword for each format.

Ex. SAVE test LOST ENERGY

Ex. SAVE test 500 ENERGY PHASE RADIUS

Ex. SAVE test ENERGY PHASE

Ex. SAVE cst_export PID

Ex. SAVE astra_export ASTRA

Ex. SAVE test 500 2000 LOST RADIUS VX

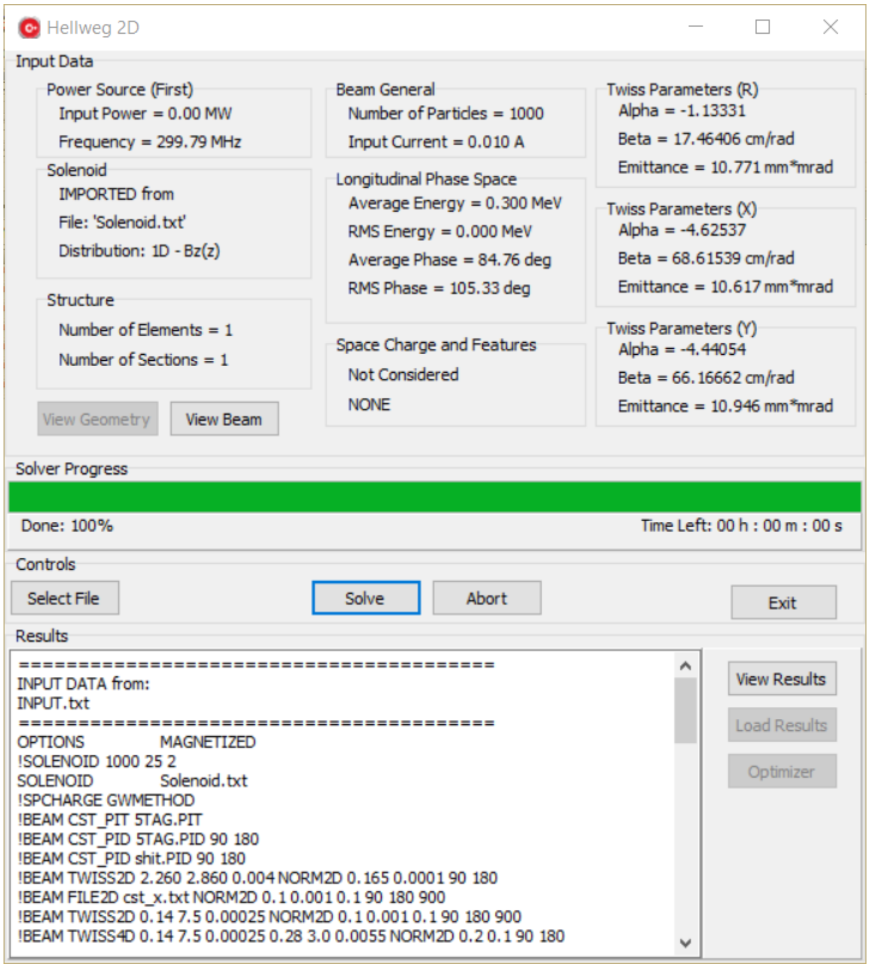
- !COMMENTS

Any line with improper format will be ignored and not copied into the output file. To make a comment use the '!' symbol at the beginning of the line

Ex. !This line is a comment

2. Simulation and post-processing results.

Program interface is presented in Figure 9



Input Data

Power Source (First)
Input Power = 0.00 MW
Frequency = 299.79 MHz

Solenoid
IMPORTED from
File: 'Solenoid.txt'
Distribution: 1D - Bz(z)

Structure
Number of Elements = 1
Number of Sections = 1

Beam General
Number of Particles = 1000
Input Current = 0.010 A

Longitudinal Phase Space
Average Energy = 0.300 MeV
RMS Energy = 0.000 MeV
Average Phase = 84.76 deg
RMS Phase = 105.33 deg

Space Charge and Features
Not Considered
NONE

Twiss Parameters (R)
Alpha = -1.13331
Beta = 17.46406 cm/rad
Emittance = 10.771 mm*mrad

Twiss Parameters (X)
Alpha = -4.62537
Beta = 68.61539 cm/rad
Emittance = 10.617 mm*mrad

Twiss Parameters (Y)
Alpha = -4.44054
Beta = 66.16662 cm/rad
Emittance = 10.946 mm*mrad

Solver Progress
Done: 100%
Time Left: 00 h : 00 m : 00 s

Controls

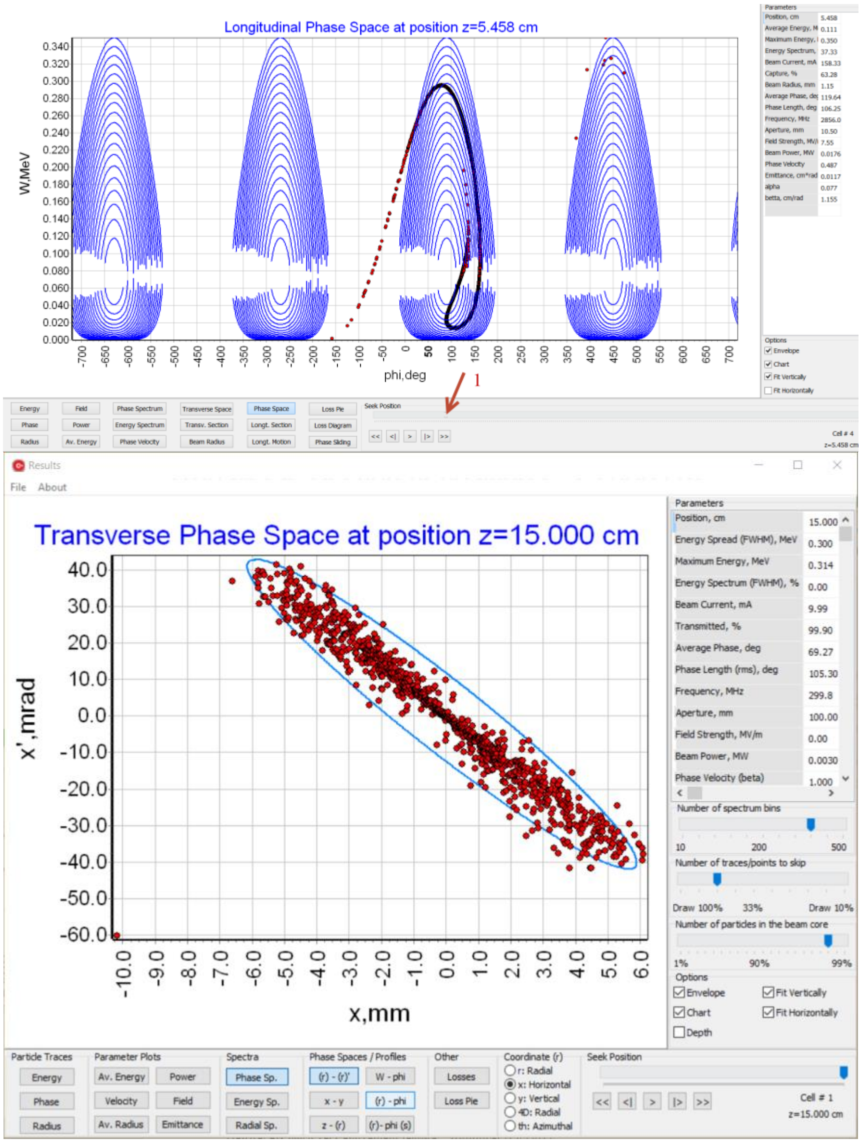
Results

```
========================================
INPUT DATA from:
INPUT.txt
========================================
OPTIONS          MAGNETIZED
!SOLENOID 1000 25 2
SOLENOID         Solenoid.txt
!SPCHARGE GWMETHOD
!BEAM CST_PIT 5TAG.PIT
!BEAM CST_PID 5TAG.PID 90 180
!BEAM CST_PID shit.PID 90 180
!BEAM TWISS2D 2.260 2.860 0.004 NORM2D 0.165 0.0001 90 180
!BEAM FILE2D cst_x.txt NORM2D 0.1 0.001 0.1 90 180 900
!BEAM TWISS2D 0.14 7.5 0.00025 NORM2D 0.1 0.001 0.1 90 180 900
!BEAM TWISS4D 0.14 7.5 0.00025 0.28 3.0 0.0055 NORM2D 0.2 0.1 90 180
```

Figure 9. Hellweg2D Interface

Hellweg2D automatically reads an input file (INPUT.TXT) from the folder with the executable file and displays user defined parameters. It is possible to select the other file. The input cells parameters ocan be visualized by pressing “View Geometry” button and the input beam parameters by pushing ”View Beam” button. After solving the problem (button “Solve”) «OUTPUT.txt» file is automatically generated. The results can be viewed either in the Hellweg2D window or in OUTPUT.TXT file in program folder.

Button “View Result” lets user to view graphical results such as Field vs. coordinate; phase space; energy spectrum, etc (Figure 10). The user can choose any longitudinal position of the beam to view the particles distribution. The radio buttons in “Coordinate” section allow to choose between cylindrical and Cartesian coordinates. There are three sliders that allow changing the number of bins for the spectrum visualization, reduce the number of output points to improve the speed, and the define the number of particles in the core for the envelope.



Parameters

Position, cm	5.458
Average Energy, M	0.111
Maximum Energy, I	0.350
Energy Spectrum,	37.33
Beam Current, mA	158.33
Capture, %	63.28
Beam Radius, mm	1.15
Average Phase, deg	119.64
Phase Length, deg	106.25
Frequency, MHz	2856.0
Aperture, mm	10.50
Field Strength, MV/	7.55
Beam Power, MW	0.0176
Phase Velocity	0.487
Emittance, cm*rad	0.0117
alpha	0.077
betta, cm/rad	1.155

Options
☑ Envelope
☑ Chart
☑ Fit Vertically
☐ Fit Horizontally

Cell # 4
z=5.458 cm

Parameters

Position, cm	15.000
Energy Spread (FWHM), MeV	0.300
Maximum Energy, MeV	0.314
Energy Spectrum (FWHM), %	0.00
Beam Current, mA	9.99
Transmitted, %	99.90
Average Phase, deg	69.27
Phase Length (rms), deg	105.30
Frequency, MHz	299.8
Aperture, mm	100.00
Field Strength, MV/m	0.00
Beam Power, MW	0.0030
Phase Velocity (beta)	1.000

Number of spectrum bins
10 200 500

Number of traces/points to skip
Draw 100% 33% Draw 10%

Number of particles in the beam core
1% 90% 99%

Options
☑ Envelope ☑ Fit Vertically
☑ Chart ☑ Fit Horizontally
☐ Depth

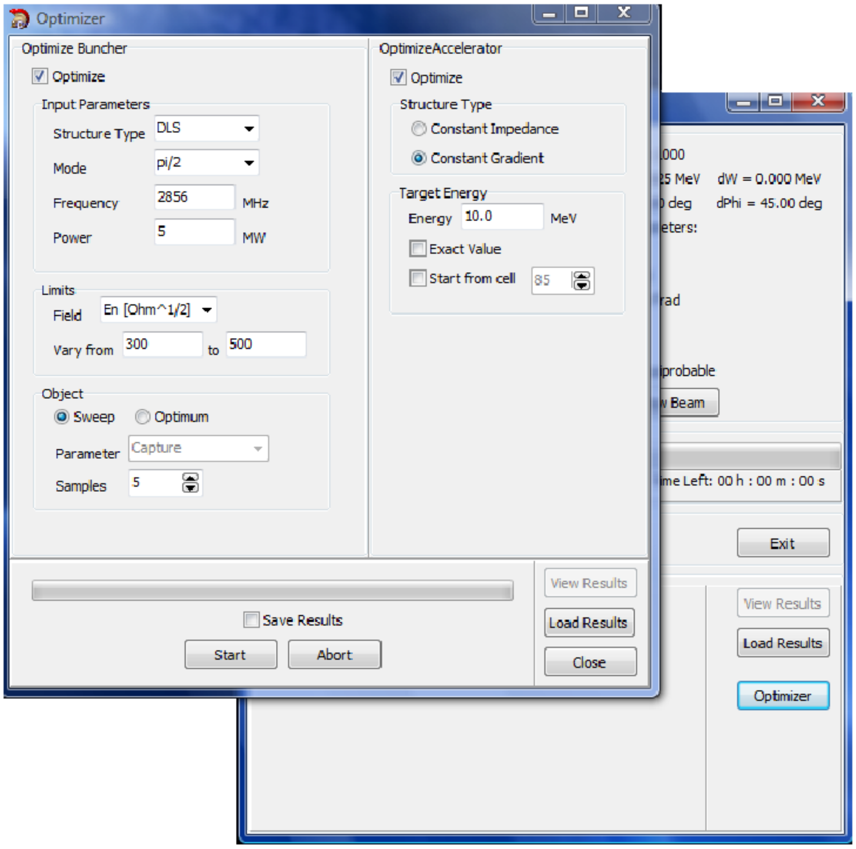
Coordinate (r)
○ r: Radial
● x: Horizontal
○ y: Vertical
○ 4D: Radial
○ th: Azimuthal

Cell # 1
z=15.000 cm

Figure 10. Results visualization interface

3. Optimizer.

Hellweg2D has a very convenient feature – Optimizer (Fig. 3.1)



Optimizer

Optimize Buncher

☑ Optimize

Input Parameters

Structure Type: DLS

Mode: pi/2

Frequency: 2856 MHz

Power: 5 MW

Limits

Field: En [Ohm^1/2]

Vary from 300 to 500

Object

● Sweep ○ Optimum

Parameter: Capture

Samples: 5

OptimizeAccelerator

☑ Optimize

Structure Type

○ Constant Impedance

● Constant Gradient

Target Energy

Energy: 10.0 MeV

□ Exact Value

□ Start from cell 85

□ Save Results

Fig. 3.1 Optimizer interface

This function can calculate DLS cells parameters (relative phase speed β_{phase}; normalized value of electrical accelerating field intensity ; normalized attenuation factor $\alpha\lambda_{3/2}[m_{1/2}]$; normalized aperture radius a/λ) using included tables to obtain the desired energy on the end of the accelerator without access to the INPUT file.

- Optimize Buncher. In this window user defines coupler parameters and desired buncher field parameters.

·*Input parameters:* Choice between π/2 and 2π/3 modes; operating frequency; input pulse power.

·*Limits:* It necessary to define allowable variations of the values of the accelerating electrical field on the end of the buncher. User can choose between 3 field dimensions: dimensionless field A; normalized electrical field ; absolute value of electrical field E [MV/m].

·*Object:* There are 2 algorithms to calculate buncher cells parameters: *Sweep* divides an interval defined in Limits for equal parts (Samples) and calculates field in them using table’s data; *Optimum* chooses the best field value to obtain the best capture coefficient/energy spectrum/phase spectrum (Parameter).

- Optimize Accelerator. In this window user defines desired output parameters.

·*Structure type:* The choice between Constant Gradient or Constant Impedance structures. In the first case the optimizer will add the cells identical to the last one. In second case, it will adjust the aperture radius in order to maintain the same electrical field gradient.

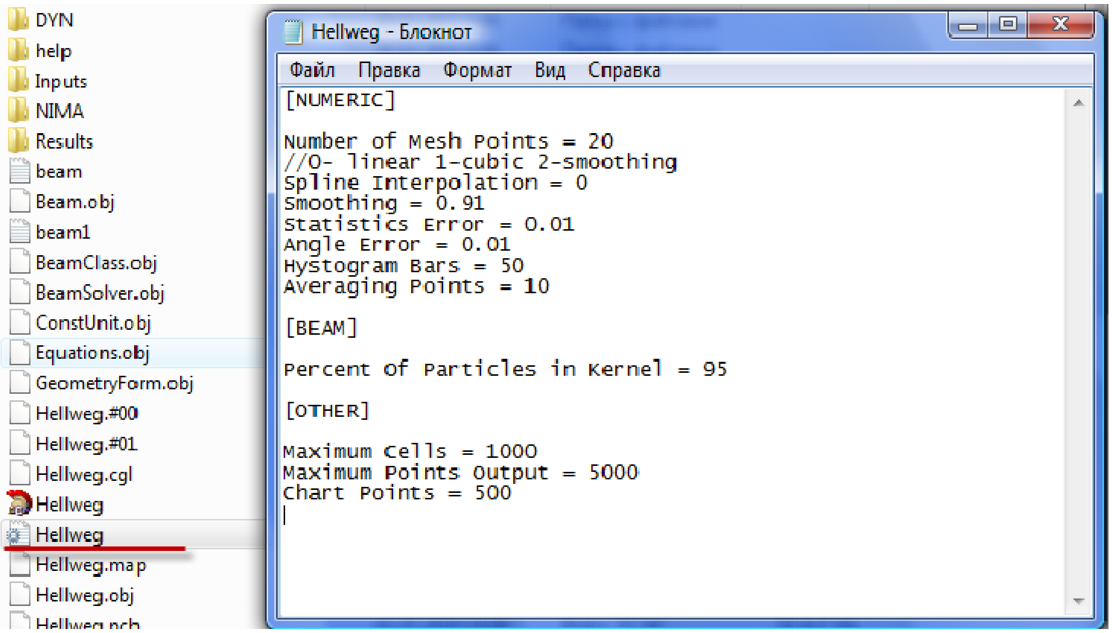
·*Target Energy:* It is necessary to define desired output energy. Marker "Exact Value" varies beam current to obtain exact value of average beam energy.

Marker "Start from cell" is used when it is necessary to modulate accelerating structure after the already defined cells parameters in INPUT file (Optimize Buncher marker is switched off)

- Get Results. You can find results in the OUTPUT file in the Results folder

4. Configuration file.

Mesh parameters and interpolation parameters are defined in file Hellweg.ini which placed in program folder (Fig. 4.1)

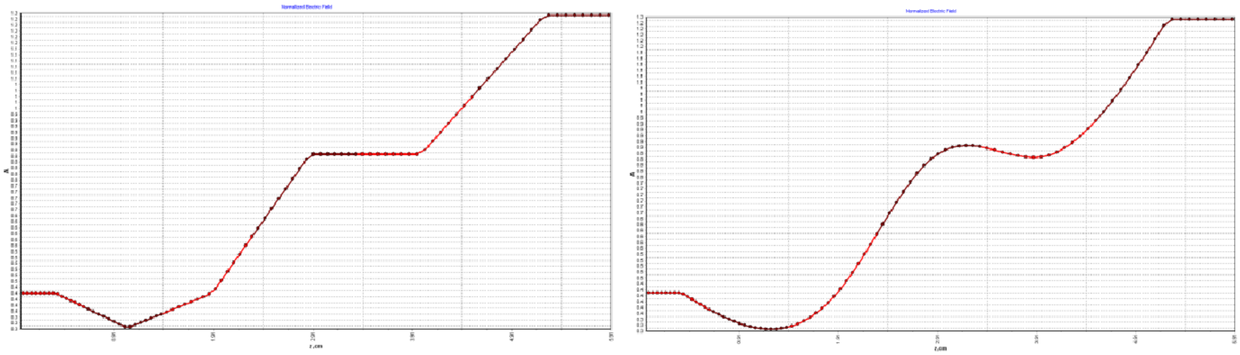


```
[NUMERIC]

Number of Mesh Points = 20
//0- linear 1-cubic 2-smoothing
Spline Interpolation = 0
Smoothing = 0.91
Statistics Error = 0.01
Angle Error = 0.01
Hystogram Bars = 50
Averaging Points = 10

[BEAM]

Percent of Particles in Kernel = 95

[OTHER]

Maximum Cells = 1000
Maximum Points Output = 5000
Chart Points = 500
```

Fig. 4.1 Hellweg2D configuration file

- Number of mesh points. This value of mesh points will be used for accelerating field interpolation in cell. Please, note that the same number of points will be used for a single DRIFT element.

- Interpolation. Relative phase speed and value of accelerating electrical field are defined in the centers of cells. Then these values are interpolated for other mesh cells (Number of mesh points). In Figure 4.2 are presented 2 kinds of interpolations (linear and cubic). It is recommended to use linear interpolation to avoid nonphysical field oscillations. Smoothing spline can be used for example to obtain spectrum envelope.



a b

Fig. 4.2 Interpolation types (a-linear; b-cubic)

Thank you for using our program!

Have a good simulation time with Hellweg2D!