

# Architect short tutorial

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This tutorial provides a short instruction on how to install the Architect on the Windows-PC and basic information on how to use it.

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## What You will need

In order to use Architect on Win You will need two things:

- CygWin
- GitHub

I do believe those programs can be substituted with something else. For example GitHub is needed only to down load the architect itself and keep up with updates. In addition to that You might want to install some kind of a .txt editor for work with input Architect files (e.g. PSPad).

## 1 CygWin

In order to install CygWin You will need a setup file - google it. At start of the setup You will be asked about the server from which will be download the CygWin itself - pick any, it does not matter. CygWin has a lot of packages (see. Fig.1) and You certainty don't need all of them. In order to make Architect work You will need to install only *Base* and *Devel*.

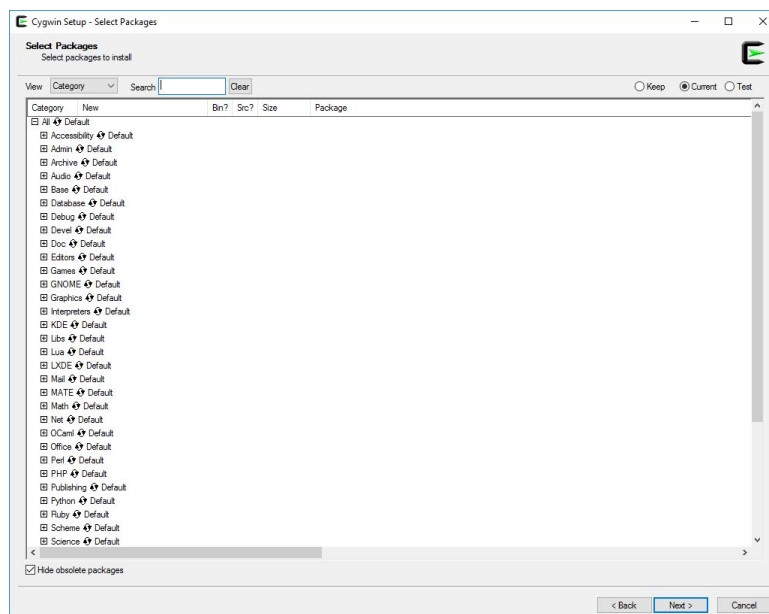


Figure 1: Cygwin packages. You will need only *Base* and *Devel*.

It will take some time to install everything, but this is it with CygWin installation.

## 2 GitHub

Now You will need to download the Architect files. It can be done from GitHub repository, so You will need GitHub itself. Again the GitHub setup file can be googled. After You will install the GitHub go to GitHub.com and register/sign up to Your account and find Architect repository (see Fig.2). Click "Clone or download" and clone Architect into Your CygWin installation folder "...\\cygwin64\\home". That is it, after that You will need only update from time to time Your Architect from GitHub.

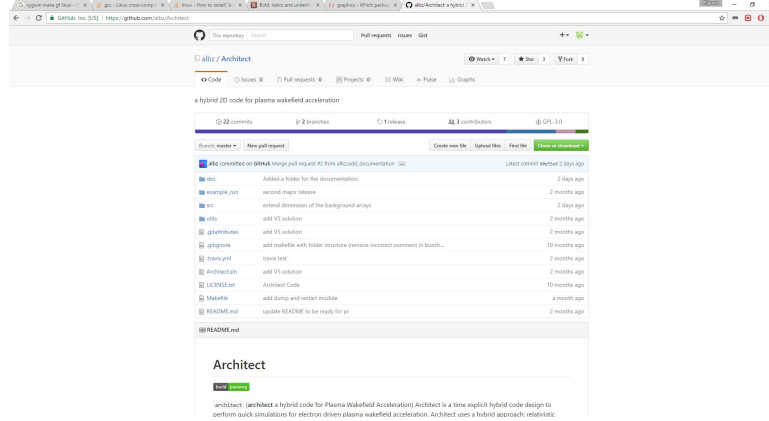


Figure 2: Architect at GitHub web cite.

## 3 How to actually run it

Well, start up the CygWin and go to Your home Architect folder (see Fig.3). Then using command *make gflinux* generate .exe file that will be stored in "...\\cygwin64\\home\\Architect\\bin". Now You can go to the folder in Architect directory that called "example\_run" where You will find file "architect.nml". This is a name list where You set the parameters of Your simulations. In order to run it You just need, being inside the folder with this file, indicate where is Your Architect.exe file, thus it will be something like: "...\\bin\\Architect.exe". This will start the simulation and create a number of output folders inside the "...\\example\_run". That it is, You started the Architect simulation.

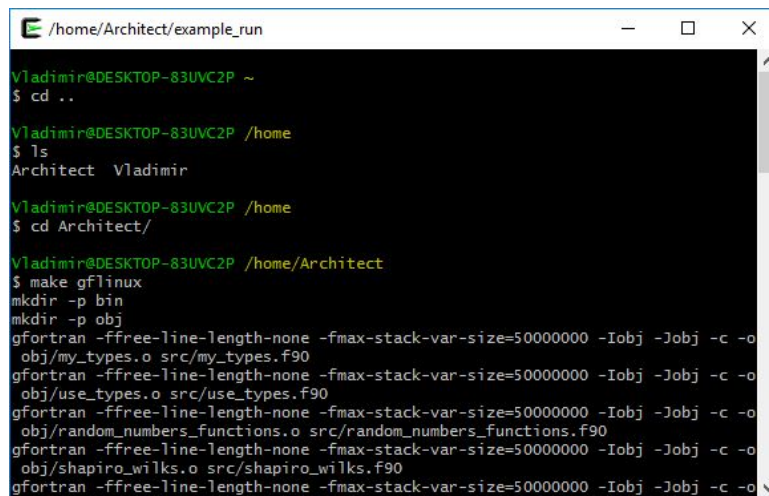


Figure 3: How to make .exe file for Architect.

## 4 Name List

Name list, as the name suggests, contains the parameters of the simulation (see Fig.5). Last time when I used Architect ( a couple of month ago) I had a different template for the name list, thus I will be able to give comments on very few lines in .nml file. Luckily a lot of strings have comments and lot of variables have transparent names.

```

1 1.architect.nml
2
3 1 &PLASMA_PARAMETERS
4 2 /Length of the accelerating stage, in um
5 3 plasma%l_acc=30050.0
6 4
7 5 /Plasma initial density, in cm^-3
8 6 plasma%n0=1.0e16
9 7
10 8
11 9 /=====
12 10 &SIMULATION_PARAMETERS
13 11
14 12 /CFL condition
15 13 sim_parameters%CFL=0.9
16 14
17 15 / DOMAIN BOUNDARIES AND CAPILLARY RAMP LENGTH
18 16
19 17 /Having window parameters
20 18 sim_parameters%window_mode = 1 (/0 = window moves with first bunch, 1 = window moves at constant speed)
21 19 sim_parameters%moving_window_speed = 1. / in units of c
22 20
23 21
24 22 / FLUID ADVANCE SCHEME
25 23
26 24 / Fluid Scheme (0 = Upwind, 1 = FCT, 2 = Upwind new centering )
27 25 sim_parameters%fluid_scheme=2
28 26
29 27 / BUNCH INTEGRATED DIAGNOSTICS
30 28
31 29 / Limit value for integrated bunch diagnostics with dcut (in initial sigma units)
32 30 / Diagnostics is performed on particles within a radius of sigma_cut*(max(sigma_z0,sigma_r0))
33 31 sim_parameters%sigma_cut=2.5
34 32
35 33 / Enable diagnostics with dcut (0 = No, 1 = Yes)
36 34 sim_parameters%diagnostics_with_dcut = 1
37 35
38 36
39 37 / OUTPUT OPTIONS
40 38 /Output format (0:ASCII, 1:Binary; Integrated parameters are always in ASCII)
41 39 sim_parameters%Output_format= 1
42 40
43 41 / Save reduced Phase Space (0: save the whole phase space, 1: save only the phase space with the cut of integrated a
44 42 sim_parameters%reduced_PS = 0
45 43
46 44 / Integrated Outputs (sigmas, emittance, energy spread etc.) every nn steps :
47 45 sim_parameters%Output_Integrated_params_nstep = 900000, /steps
48 46 sim_parameters%Output_Integrated_params_dist = 25., /mu
49 47
50 48 / OnGrid Output (set 0 for final results only):
51 49 sim_parameters%Output_grid_nstep = 900000, /steps
52 50 sim_parameters%Output_grid_dist = 250., /mu
53 51
54 52 / Phase Space output (set 0 for writing at the end):
55 53 sim_parameters%Output_PS_nstep = 900000, /steps
56 54 sim_parameters%Output_PS_dist = 10.e4, /mu
57 55
58 56 / Number of grid point to jump when saving
59 57 sim_parameters%jump_grid=1,
60 58
61 59 / Number of particles to jump when saving
62 60 sim_parameters%jump_PS=1,
63 61
64 62 / Shapiro-Wilks applied on bunches - diagnostic options:
65 63 sim_parameters%sk_test=.TRUE.,
66 64 sim_parameters%skl_sample_dimension=5000,
67 65 sim_parameters%skl_sub_iter=10,
68 66
69 67 / Lineout
70 68 sim_parameters%kl_lineout = .TRUE.,
71 69
72 70 / Bunch Reinitialization
73 71 sim_parameters%kl_Bunch_evolve=.FALSE.
74 72 sim_parameters%kl_BunchReinit=.FALSE.
75 73 sim_parameters%Bunch_reinit_distance_um=50.0
76 74 /
77 75
78 76 /=====
79 77 &MESH_PARAMETERS
80 78
81 79 / Transverse sampling points per units min(2* whole bunch lsigma_r, lambda_p/2, based on first bunch)
82 80 mesh_par%l_sample_r= 20
83 81 / Longitudinal sampling points per unit min(lsigma_z bunches, lambda_p, based on first bunch)
84 82 mesh_par%l_sample_z= 50
85 83
86 84
87 85 / Define resolution instead of number of points
88 86 mesh_par%dx=1.0
89 87 mesh_par%dx=0.4
90 88
91 89 / Having window/Domain boundaries in lambda_dap units
92 90 mesh_par%Left_Domain_boundary= 1.0
93 91 mesh_par%Right_Domain_boundary=1.5
94 92 / Domain Boundaries in mu
95 93 mesh_par%Left_mesh=250.00
96 94 mesh_par%Right_mesh=250.00
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1323 1321
1324 1322
1325 1323
1326 1324
1327 1325
1328 1326
1329 1327
1330 1328
1331 1329
1332 1330
1333 1331
1334 1332
1335 1333
1336 1334
1337 1335
1338 1336
1339 1337
1340 1338
1341 1339
1342 1340
1343 1341
1344 1342
1345 1343
1346 1344
1347 1345
1348 1346
1349 1347
1350 1348
1351 1349
1352 1350
1353 1351
1354 1352
1355 1
```

- *bunch\_initialization%db(1)=0.*,

String number 130. Point where the centroid of the first bunch is originally placed. If I am not mistaken this parameter always should be 0.

- *bunch\_initialization%db(2)=0.45*,

String number 131. Point where the centroid of the second bunch is originally placed. The position of the bunch is given in terms of plasma wavelength  $\lambda_p$ , meaning that every time when You change plasma density You change the absolute position of the second beam with respect to the first bunch.

- *bunch\_initialization%ChargeB(1)=0.200*,

*bunch\_initialization%ChargeB(2)=0.060*,

Strings number 133 and 134, correspondingly. Charge of the first and second bunches, can be more. The number of those bunches is defined by the "total\_bunches" parameter.

- *bunch\_initialization%shape(1)=1*,

*bunch\_initialization%shape(2)=1*,

Strings number 136 and 148, correspondingly. If remember this correctly this is the longitudinal profile of the bunches and "1" is the Gaussian distribution.

- *bunch\_initialization%n\_particles(1)=100000*,

*bunch\_initialization%n\_particles(2)=50000*,

Strings number 137 and 149, correspondingly. The number of (macro?)particles that considered inside the bunch. The more the better, but slower.

- *bunch\_initialization%bunch\_s\_x(1)=4.0*,

*bunch\_initialization%bunch\_s\_y(1)=4.0*,

*bunch\_initialization%bunch\_s\_z(1)=50.0*,

*bunch\_initialization%bunch\_s\_x(2)=4.0*,

*bunch\_initialization%bunch\_s\_y(2)=4.0*,

*bunch\_initialization%bunch\_s\_z(2)=50.0*,

Strings number 138-140 and 150-152, correspondingly. The size of the beam in x,y,z directions. I do believe that for normal distribution beam those are  $\sigma$ 's.

- *bunch\_initialization%bunch\_gamma\_m(1)=200.*,

*bunch\_initialization%bunch\_dgamma(1)=0.100*,

*bunch\_initialization%bunch\_gamma\_m(2)=200.*,

*bunch\_initialization%bunch\_dgamma(2)=0.100*,

Strings number 141,144 and 153,156, correspondingly. Initial energy of the bunches and energy spread. Energy is given in terms of Lorentz factor. The energy spread is given as  $\Delta\gamma/\gamma$ .

- `Osos%macwin=1`

String number 199. This parameter defines the OS You work with, since this tutorial mostly for Windows family, this parameter should be "1".

- `bck_plasma%order_radial(1)=0,`  
`bck_plasma%order_radial(2)=0,`

This parameter set the profile of the background plasma. Following values of this parameter can be applied:

- 0: Uniform density in  $r_z$
- 3: The profile starts from a fixed value at  $r=0$  and decays with a  $\cos^2$  shape reaching zero at  $r_z = \text{radius\_um}$ .
- 4: The profile has a  $\cos^2$  shape shrunk vertically by a factor  $\text{perturbation\_amplitude}$  and shifted upwards by a  $\text{certain value}$ . The profile drops to 0 with a step at  $r_z = \text{radius\_um}$
- 5: The profile has a flat-top with a  $\text{certain high}$  from  $r_z = 0$  to  $r_z = \text{radius\_internal\_um}$  then, from  $\text{radius\_internal\_um}$  to  $\text{radius\_um}$  the profile decays with a  $\cos^2$  shape.

## 5 Useful MatLab utilities

In order to process the Architect data there are several useful scripts that can be found in Architect files (something like `..\Architect\utils\MatLab_utils`). The easiest way to use those scripts is to add them into MatLab command library. Just click "Set\_folder" and choose the folder with Architect utilities.

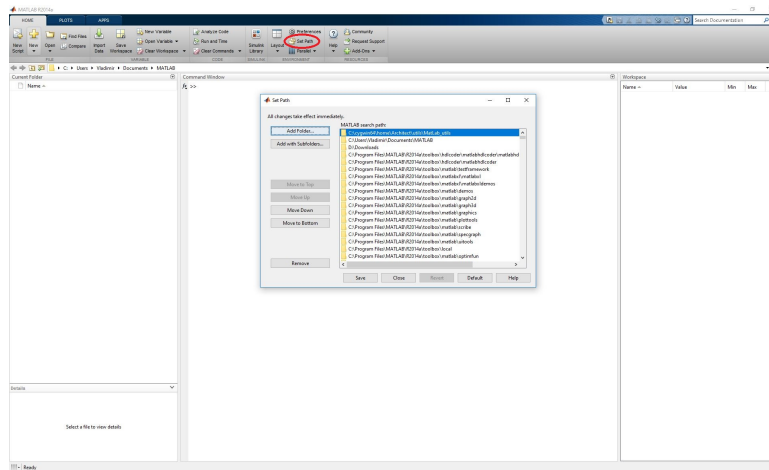


Figure 5: How to add Architect scripts to MatLab.

In order to use those utilities change the MatLab current folder to the folder where You did ran simulation. The description of those utilities can be found inside ".m" files.