

# Step by Step to Complete CP Simulation

This manual aims to give a detailed guide for the fresh hands in Dr. Lian's group to perform CP (Crystal Plasticity) simulation dealing with the influence of strain rates and orientations by the means of parameter fitting.

Four parts are in this tutorial material including the parameter edition, the usage of Putty, plotting load-displacement curves as well as plotting pile-ups.

## 1. Edit the Parameters (Grain Orientation and Model Parameters)

### 1.1 Grain Orientation

#### 1) Use Notepad to pen Grain Data

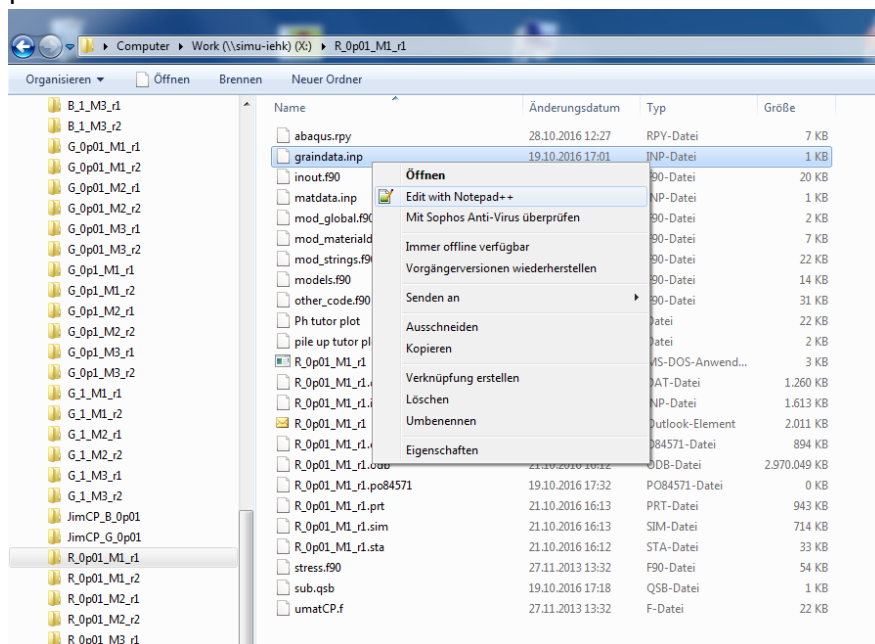


Fig. 1.1 open grain data to edit grain orientation

#### 2) Edit Euler angles

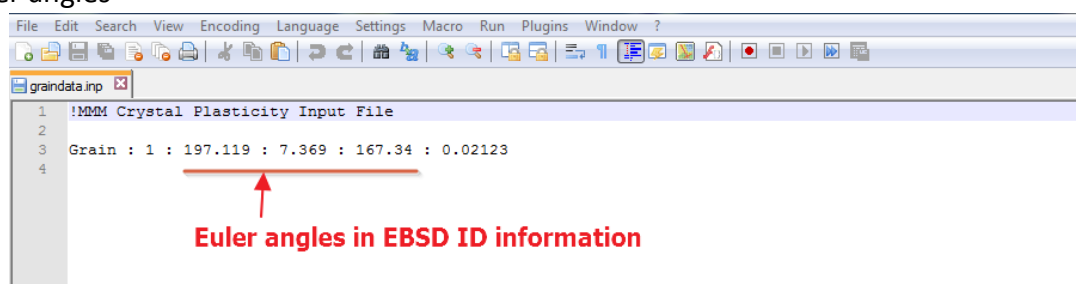


Fig. 1.2 change the three numbers marked according to the IQ map from EBSD package

These Euler angles are between 0~360°.

## 1.2 Model Parameters

There are 6 parameters to calibrate. These parameters may have different names as presented below. If the user has a different understanding about them, it is also acceptable.

$\tau_0$ : critical resolved shear stress (CRSS), in MPa

$\dot{\gamma}_0$ : initial strain rate, in /s

$1/m$ : m is strain rate sensitivity, in 1.

$h_0$ : initial hardening slope, in MPa

$\tau_c^S$ : CRSS for cross hardening, in MPa

a: hardening exponent

Complete the following procedures to edit the simulation parameters above used for ABAQUS simulation.

1) Open matdata as below.

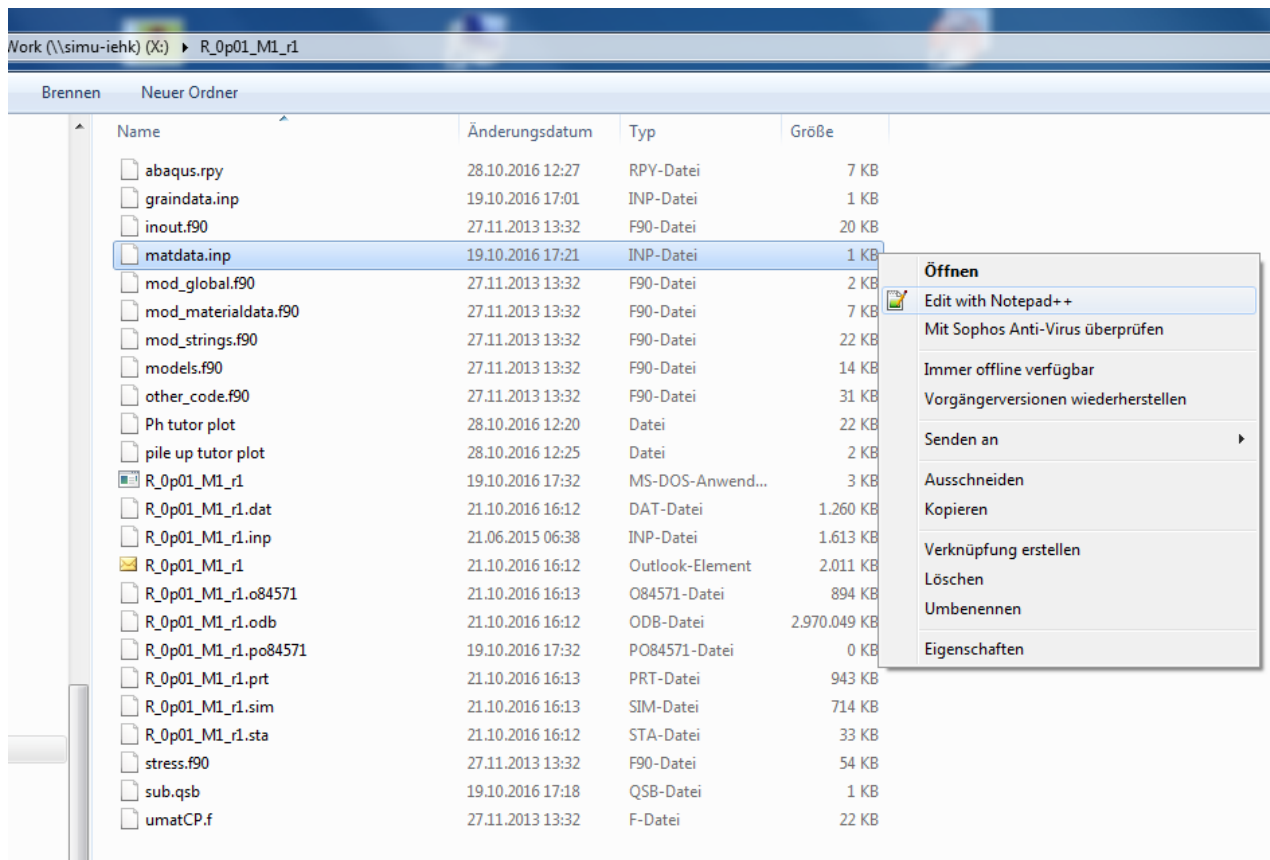


Fig. 1.3 open with Notepad

These parameters have different labels in matdata as shown below. **They are for BCC (ferrite simulation) mode.**

```

1 !Crystal Plasticity Input File
2 !DO NOT CHANGE THE ORDER OF THE MATERIAL PARAMETERS!
3 !Indicate new material definitions via <: Material: x :>
4
5 <: Material: 1 :>
6
7 !! FCC Dislocation density
8 C11 : 247.d3
9 C12 : 147.d3
10 C44 : 125.d3
11 nslip : 12
12 pw_fl : 20.0
13 brgvec: 2.86d-7
14 v0 : 5.0
15 rho_0 : 1.0d8
16 km1 : 349650.0
17 km2 : 10.0
18 c3 : 0.5
19
20 <: Material: 2 :>
21 ! FCC Phenomenological
22 C11 : 231.4d3
23 C12 : 134.7d3
24 C44 : 116.4d3
25 nslip : 12
26 pw_fl : 20.0
27 shrt_0 : 0.001
28 hdrt_0 : 180.0
29 crss_0 : 20.0
30 crss_s : 117.0
31 pw_hd : 2.25
32 Adir : 0.0
33 Adyn : 0.0
34 gam_c : 0.03
35 pw_irr : 6.0
36
37 <: Material: 3 :>
38 ! BCC Phenomenological with non-Schmidt effect
39 C11 : 230.1d3
40 C12 : 134.6d3
41 C44 : 116.6d3
42 nslip : 24
43 pw_fl : 20
44 shrt_0 : 0.001
45 hdrt_0 : 850
46 crss_0 : 105
47 k : 0.0
48 crss_s : 470
49 pw_hd : 1.5
50 Adir : 0.0
51 Adyn : 0.0
52 gam_c : 0.03
53 pw_irr : 1.0

```

Fig. 1.4 edit the parameter in matdata then save this file

Edit them correspondingly and then save the edited version

There are **12** files in the folder to submit which are marked blue in Fig. 1.5.

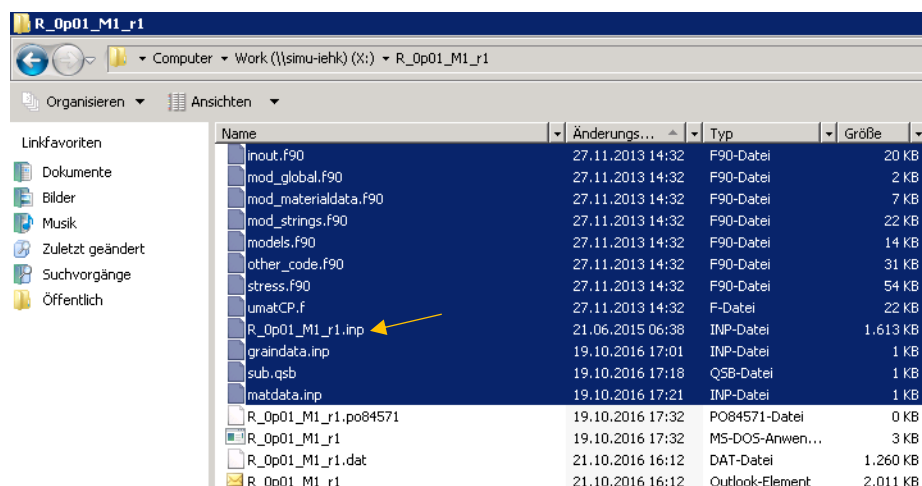
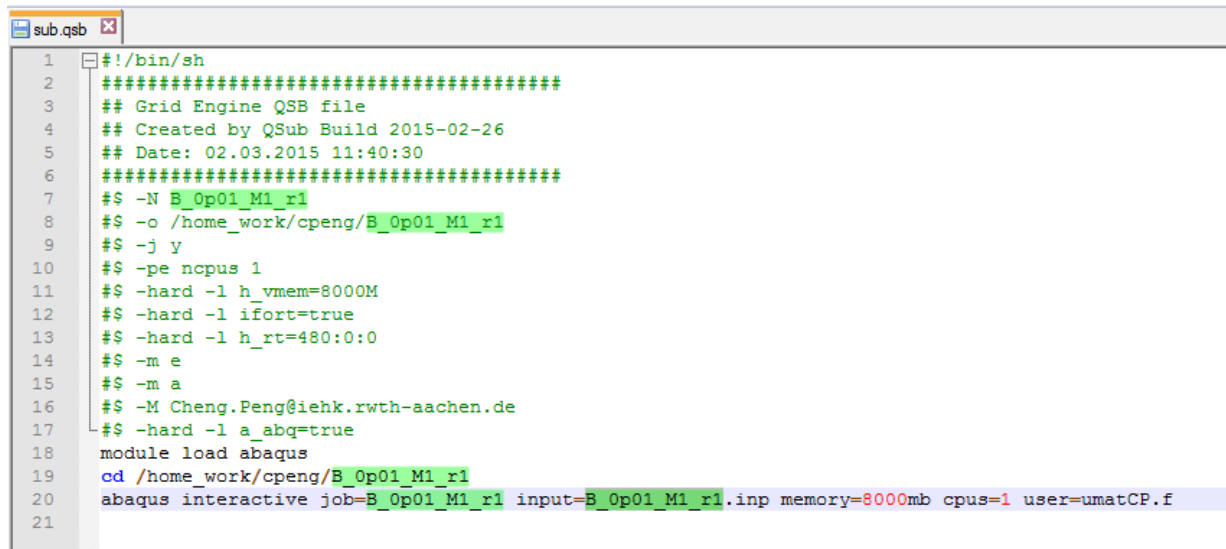


Fig. 1.5 Twelve files to submit in the folder in X disk

For the input files of different strain rates, the input file (.INP), as yellow arrow marked in Fig. 1.5, should be replaced. Here is the sample for 0.01/s (strain rate).

ABAQUS use the input files and the rest files of these 12 files including UMAT (user defined material), the codes etc. to carry on the simulation work simulation work.

### 3) Check the QSB file before the submitting



```
1 #!/bin/sh
2 #####
3 ## Grid Engine QSB file
4 ## Created by QSub Build 2015-02-26
5 ## Date: 02.03.2015 11:40:30
6 #####
7 #$ -N B_Op01_M1_r1
8 #$ -o /home_work/cpeng/B_Op01_M1_r1
9 #$ -j y
10 #$ -pe ncpus 1
11 #$ -hard -l h_vmem=8000M
12 #$ -hard -l ifort=true
13 #$ -hard -l h_rt=480:0:0
14 #$ -m e
15 #$ -m a
16 #$ -M Cheng.Peng@iehk.rwth-aachen.de
17 #$ -hard -l a_abq=true
18 module load abaqus
19 cd /home_work/cpeng/B_Op01_M1_r1
20 abaqus interactive job=B_Op01_M1_r1 input=B_Op01_M1_r1.inp memory=8000mb cpus=1 user=umatCP.f
21
```

Fig. 1.6 this is the recommended method to organize a QSB file which is quite effective

## 2. Use Putty to Perform Simulation

Complete the following procedures to submit the simulation work.

### 1) Open Putty



Fig. 2.1 click to start Putty

- 2) Put in "cluster-iehk" and press enter button, then click "open" button

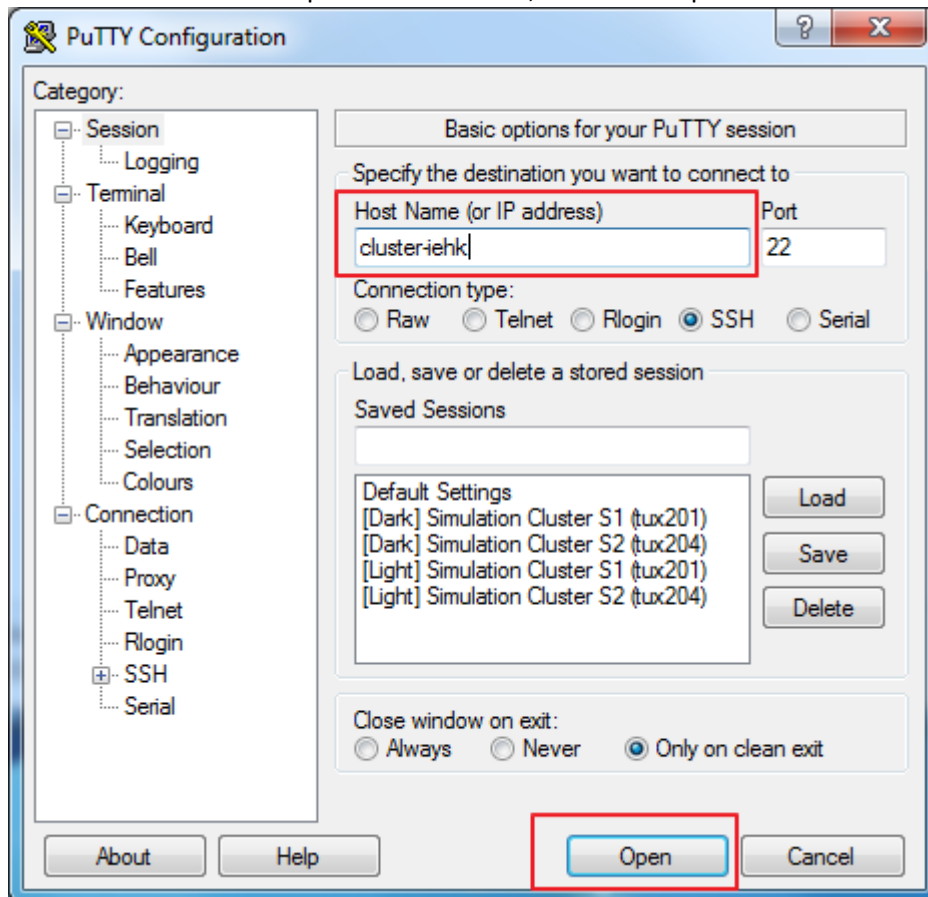


Fig. 2.2 start the DOS operation system

- 3) Log in with iehk ID

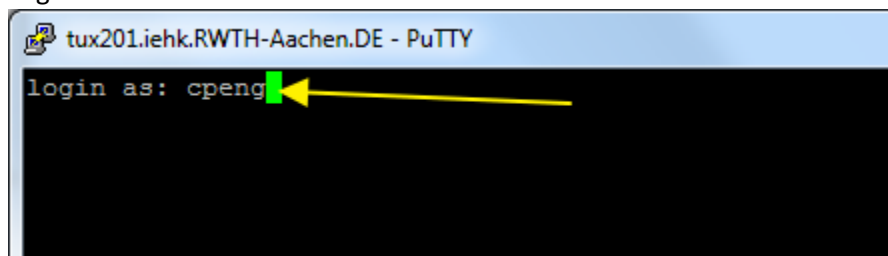


Fig. 2.3 Log in then press enter button

- 4) Type "cd \$WORK" to go to the work space

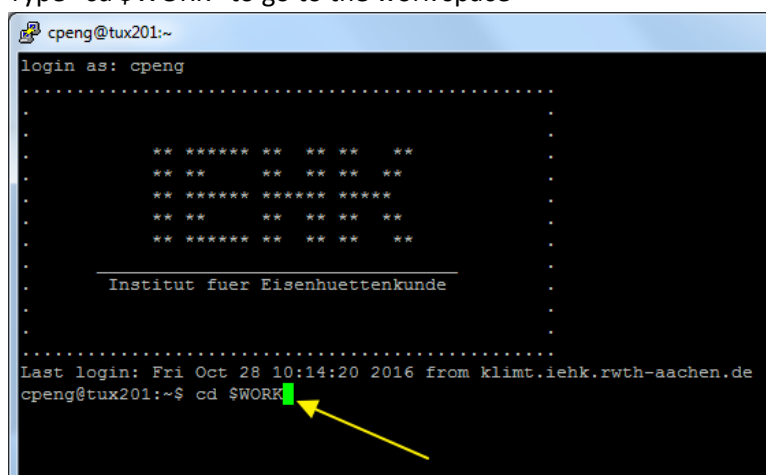
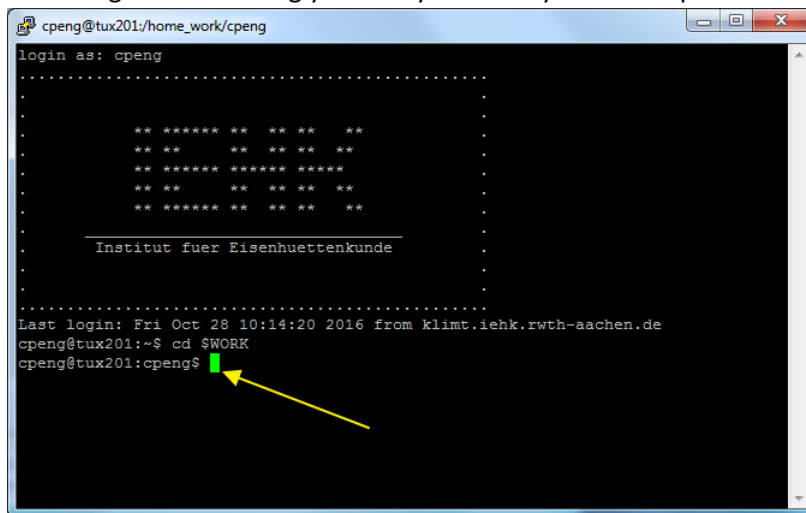


Fig. 2.4 there is a SPACE between d and \$

5) Following content telling you that you are in your work space

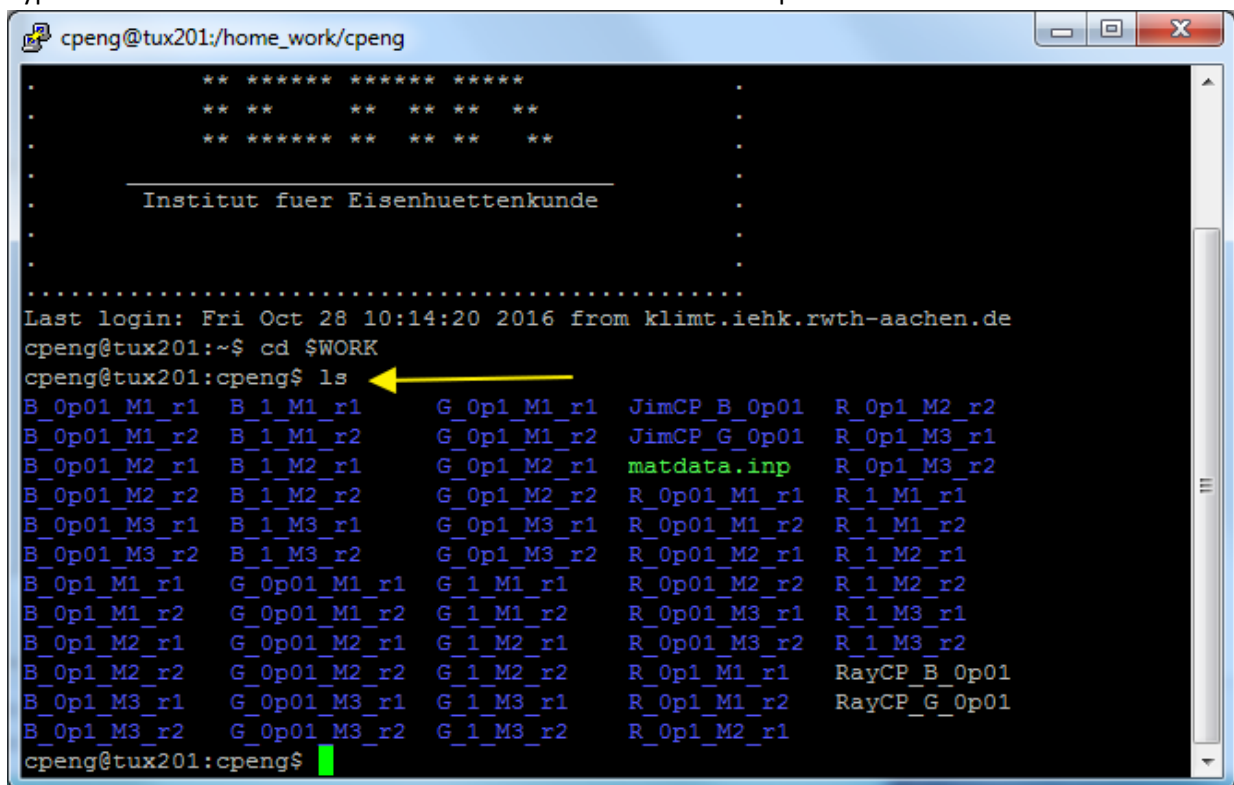


```
cpeng@tux201:/home_work/cpeng
login as: cpeng
.....
** ***** ** ** ** **
** **      ** ** ** **
** ***** ** ** **
** **      ** ** **
** ***** ** ** **
.....
Institut fuer Eisenhuettenkunde
.....
Last login: Fri Oct 28 10:14:20 2016 from klimt.iehk.rwth-aachen.de
cpeng@tux201:~$ cd $WORK
cpeng@tux201:cpeng$
```

A terminal window titled 'cpeng@tux201:/home\_work/cpeng'. It shows a login prompt 'login as: cpeng' followed by a series of asterisks forming a box around the text 'Institut fuer Eisenhuettenkunde'. Below this, it shows the last login information and the user changing the directory to '\$WORK' (which is 'cpeng'). The prompt now shows 'cpeng@tux201:cpeng\$'. A yellow arrow points to the green cursor at the end of the prompt.

Fig. 2.5 in the work space of cpeng

6) Type "ls" to view the content of the folder i.e. the current work space



```
cpeng@tux201:/home_work/cpeng
.....
Institut fuer Eisenhuettenkunde
.....
Last login: Fri Oct 28 10:14:20 2016 from klimt.iehk.rwth-aachen.de
cpeng@tux201:~$ cd $WORK
cpeng@tux201:cpeng$ ls
B_Op01_M1_r1  B_1_M1_r1      G_Op1_M1_r1    JimCP_B_Op01   R_Op1_M2_r2
B_Op01_M1_r2  B_1_M1_r2      G_Op1_M1_r2    JimCP_G_Op01   R_Op1_M3_r1
B_Op01_M2_r1  B_1_M2_r1      G_Op1_M2_r1    matdata.inp     R_Op1_M3_r2
B_Op01_M2_r2  B_1_M2_r2      G_Op1_M2_r2    R_Op01_M1_r1   R_1_M1_r1
B_Op01_M3_r1  B_1_M3_r1      G_Op1_M3_r1    R_Op01_M1_r2   R_1_M1_r2
B_Op01_M3_r2  B_1_M3_r2      G_Op1_M3_r2    R_Op01_M2_r1   R_1_M2_r1
B_Op1_M1_r1   G_Op01_M1_r1   G_1_M1_r1      R_Op01_M2_r2   R_1_M2_r2
B_Op1_M1_r2   G_Op01_M1_r2   G_1_M1_r2      R_Op01_M3_r1   R_1_M3_r1
B_Op1_M2_r1   G_Op01_M2_r1   G_1_M2_r1      R_Op01_M3_r2   R_1_M3_r2
B_Op1_M2_r2   G_Op01_M2_r2   G_1_M2_r2      R_Op1_M1_r1    RayCP_B_Op01
B_Op1_M3_r1   G_Op01_M3_r1   G_1_M3_r1      R_Op1_M1_r2    RayCP_G_Op01
B_Op1_M3_r2   G_Op01_M3_r2   G_1_M3_r2      R_Op1_M2_r1
cpeng@tux201:cpeng$
```

A terminal window titled 'cpeng@tux201:/home\_work/cpeng'. It shows the same login and directory change as Figure 2.5. Now, the user has typed 'ls' and the terminal displays a list of files and directories in the current directory. The files are arranged in a grid-like format. A yellow arrow points to the 'ls' command in the prompt.

Fig. 2.6 the content of the work space cpeng

- 7) Type "cd " (a SPACE after cd), then double click "G\_M2\_r2" (the folder you'd like to open), the item is then died blue, after this, right click. DOS will copy the name of the item "G\_M2\_r2" after "cd ".

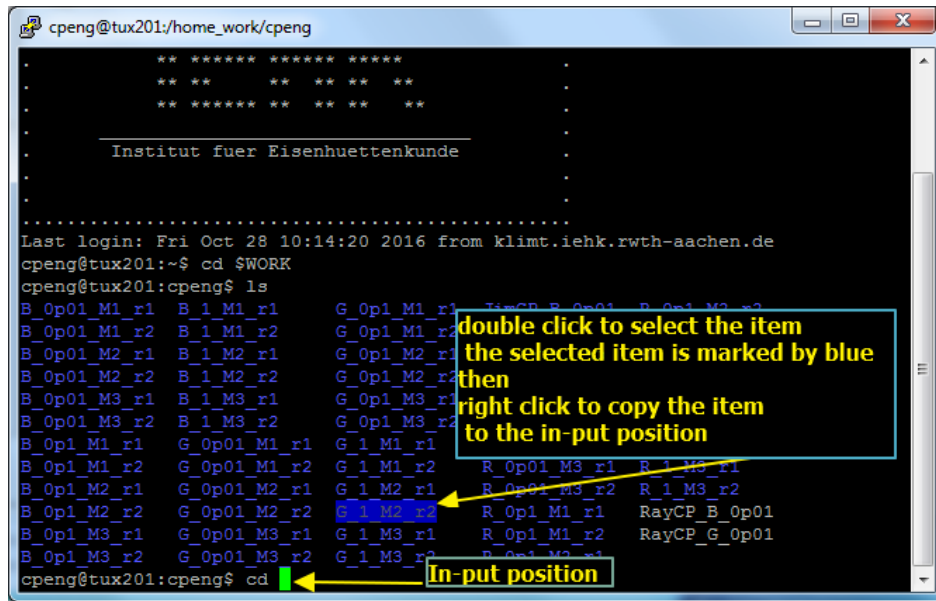


Fig. 2.7 open a folder in a fast way

- 8) The folder "G\_M2\_r2" is then open

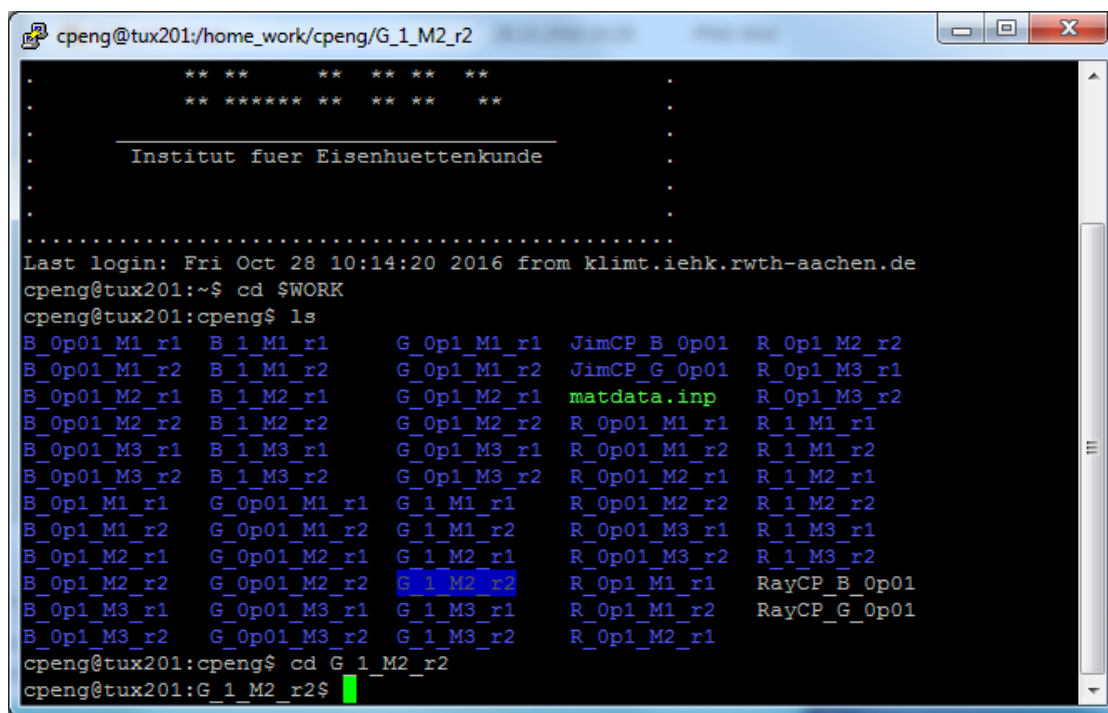


Fig. 2.8 open



9) Type "ls" to view the content of "G\_M2\_r2"

```
cpeng@tux201:/home_work/cpeng/G_1_M2_r2
.....
** **      ** **      **
** **      ** **      **
.....
Institut fuer Eisenhuettenkunde
.....
Last login: Fri Oct 28 10:14:20 2016 from klimt.iehk.rwth-aachen.de
cpeng@tux201:~$ cd $WORK
cpeng@tux201:cpeng$ ls
B_0p01_M1_r1  B_1_M1_r1      G_0p1_M1_r1  JimCP_B_0p01  R_0p1_M2_r2
B_0p01_M1_r2  B_1_M1_r2      G_0p1_M1_r2  JimCP_G_0p01  R_0p1_M3_r1
B_0p01_M2_r1  B_1_M2_r1      G_0p1_M2_r1  matdata.inp   R_0p1_M3_r2
B_0p01_M2_r2  B_1_M2_r2      G_0p1_M2_r2  R_0p01_M1_r1  R_1_M1_r1
B_0p01_M3_r1  B_1_M3_r1      G_0p1_M3_r1  R_0p01_M1_r2  R_1_M1_r2
B_0p01_M3_r2  B_1_M3_r2      G_0p1_M3_r2  R_0p01_M2_r1  R_1_M2_r1
B_0p1_M1_r1   G_0p01_M1_r1   G_1_M1_r1    R_0p01_M2_r2  R_1_M2_r2
B_0p1_M1_r2   G_0p01_M1_r2   G_1_M1_r2    R_0p01_M3_r1  R_1_M3_r1
B_0p1_M2_r1   G_0p01_M2_r1   G_1_M2_r1    R_0p01_M3_r2  R_1_M3_r2
B_0p1_M2_r2   G_0p01_M2_r2   G_1_M2_r2    R_0p1_M1_r1   RayCP_B_0p01
B_0p1_M3_r1   G_0p01_M3_r1   G_1_M3_r1    R_0p1_M1_r2   RayCP_G_0p01
B_0p1_M3_r2   G_0p01_M3_r2   G_1_M3_r2    R_0p1_M2_r1
cpeng@tux201:cpeng$ cd G_1_M2_r2
cpeng@tux201:G_1_M2_r2$ ls
```

10) Type "qsub " (a SPACE after b), then copy "" after "qsub ", then press enter button.

```
cpeng@tux201:/home_work/cpeng/G_1_M2_r2
.....
Last login: Fri Oct 28 10:14:20 2016 from klimt.iehk.rwth-aachen.de
cpeng@tux201:~$ cd $WORK
cpeng@tux201:cpeng$ ls
B_0p01_M1_r1  B_1_M1_r1      G_0p1_M1_r1  JimCP_B_0p01  R_0p1_M2_r2
B_0p01_M1_r2  B_1_M1_r2      G_0p1_M1_r2  JimCP_G_0p01  R_0p1_M3_r1
B_0p01_M2_r1  B_1_M2_r1      G_0p1_M2_r1  matdata.inp   R_0p1_M3_r2
B_0p01_M2_r2  B_1_M2_r2      G_0p1_M2_r2  R_0p01_M1_r1  R_1_M1_r1
B_0p01_M3_r1  B_1_M3_r1      G_0p1_M3_r1  R_0p01_M1_r2  R_1_M1_r2
B_0p01_M3_r2  B_1_M3_r2      G_0p1_M3_r2  R_0p01_M2_r1  R_1_M2_r1
B_0p1_M1_r1   G_0p01_M1_r1   G_1_M1_r1    R_0p01_M2_r2  R_1_M2_r2
B_0p1_M1_r2   G_0p01_M1_r2   G_1_M1_r2    R_0p01_M3_r1  R_1_M3_r1
B_0p1_M2_r1   G_0p01_M2_r1   G_1_M2_r1    R_0p01_M3_r2  R_1_M3_r2
B_0p1_M2_r2   G_0p01_M2_r2   G_1_M2_r2    R_0p1_M1_r1   RayCP_B_0p01
B_0p1_M3_r1   G_0p01_M3_r1   G_1_M3_r1    R_0p1_M1_r2   RayCP_G_0p01
B_0p1_M3_r2   G_0p01_M3_r2   G_1_M3_r2    R_0p1_M2_r1
cpeng@tux201:cpeng$ cd G_1_M2_r2
cpeng@tux201:G_1_M2_r2$ ls
G_1_M2_r2.inp  matdata.inp      mod_materialdata.f90  stress.f90
graindata.inp  models.f90       mod_strings.f90      sub.qsb
inout.f90      mod_global.f90   other_code.f90       umatCP.f
cpeng@tux201:G_1_M2_r2$ qsub sub.qsb
```

11) The work is submitted.

```
cpeng@tux201:/home_work/cpeng/G_1_M2_r2
.....
Last login: Fri Oct 28 10:14:20 2016 from klimt.iehk.rwth-aachen.de
cpeng@tux201:~$ cd $WORK
cpeng@tux201:cpeng$ ls
B_0p01_M1_r1  B_1_M1_r1      G_0p1_M1_r1  JimCP_B_0p01  R_0p1_M2_r2
B_0p01_M1_r2  B_1_M1_r2      G_0p1_M1_r2  JimCP_G_0p01  R_0p1_M3_r1
B_0p01_M2_r1  B_1_M2_r1      G_0p1_M2_r1  matdata.inp   R_0p1_M3_r2
B_0p01_M2_r2  B_1_M2_r2      G_0p1_M2_r2  R_0p01_M1_r1  R_1_M1_r1
B_0p01_M3_r1  B_1_M3_r1      G_0p1_M3_r1  R_0p01_M1_r2  R_1_M1_r2
B_0p01_M3_r2  B_1_M3_r2      G_0p1_M3_r2  R_0p01_M2_r1  R_1_M2_r1
B_0p1_M1_r1   G_0p01_M1_r1   G_1_M1_r1    R_0p01_M2_r2  R_1_M2_r2
B_0p1_M1_r2   G_0p01_M1_r2   G_1_M1_r2    R_0p01_M3_r1  R_1_M3_r1
B_0p1_M2_r1   G_0p01_M2_r1   G_1_M2_r1    R_0p01_M3_r2  R_1_M3_r2
B_0p1_M2_r2   G_0p01_M2_r2   G_1_M2_r2    R_0p1_M1_r1   RayCP_B_0p01
B_0p1_M3_r1   G_0p01_M3_r1   G_1_M3_r1    R_0p1_M1_r2   RayCP_G_0p01
B_0p1_M3_r2   G_0p01_M3_r2   G_1_M3_r2    R_0p1_M2_r1
cpeng@tux201:cpeng$ cd G_1_M2_r2
cpeng@tux201:G_1_M2_r2$ ls
G_1_M2_r2.inp  matdata.inp      mod_materialdata.f90  stress.f90
graindata.inp  models.f90       mod_strings.f90      sub.qsb
inout.f90      mod_global.f90   other_code.f90       umatCP.f
cpeng@tux201:G_1_M2_r2$ qsub sub.qsb
Your job 84980 ("G_1_M2_r2") has been submitted
cpeng@tux201:G_1_M2_r2$
```



- 12) Type “cd ..” (a SPACE between d and .) to go back to the mother folder of the current folder i.e. the work space. In this way, you can open other folders in the work space or in the mother folder.

```

cpeng@tux201:/home_work/cpeng
Last login: Fri Oct 28 10:14:20 2016 from klimt.iehk.rwth-aachen.de
cpeng@tux201:~$ cd $WORK
cpeng@tux201:cpeng$ ls
B_Op01_M1_r1  B_1_M1_r1      G_Op1_M1_r1    JimCP_B_Op01   R_Op1_M2_r2
B_Op01_M1_r2  B_1_M1_r2      G_Op1_M1_r2    JimCP_G_Op01   R_Op1_M3_r1
B_Op01_M2_r1  B_1_M2_r1      G_Op1_M2_r1    matdata.inp     R_Op1_M3_r2
B_Op01_M2_r2  B_1_M2_r2      G_Op1_M2_r2    R_Op01_M1_r1   R_1_M1_r1
B_Op01_M3_r1  B_1_M3_r1      G_Op1_M3_r1    R_Op01_M1_r2   R_1_M1_r2
B_Op01_M3_r2  B_1_M3_r2      G_Op1_M3_r2    R_Op01_M2_r1   R_1_M2_r1
B_Op1_M1_r1   G_Op01_M1_r1   G_1_M1_r1      R_Op01_M2_r2   R_1_M2_r2
B_Op1_M1_r2   G_Op01_M1_r2   G_1_M1_r2      R_Op01_M3_r1   R_1_M3_r1
B_Op1_M2_r1   G_Op01_M2_r1   G_1_M2_r1      R_Op01_M3_r2   R_1_M3_r2
B_Op1_M2_r2   G_Op01_M2_r2   G_1_M2_r2      R_Op1_M1_r1    RayCP_B_Op01
B_Op1_M3_r1   G_Op01_M3_r1   G_1_M3_r1      R_Op1_M1_r2    RayCP_G_Op01
B_Op1_M3_r2   G_Op01_M3_r2   G_1_M3_r2      R_Op1_M2_r1
cpeng@tux201:cpeng$ cd G_1_M2_r2
cpeng@tux201:G_1_M2_r2$ ls
G_1_M2_r2.inp  matdata.inp     mod_materialdata.f90  stress.f90
graindata.inp  models.f90      mod_strings.f90       sub.qsb
inout.f90      mod_global.f90  other_code.f90        umatCP.f
cpeng@tux201:G_1_M2_r2$ qsub sub.qsb
Your job 84980 ("G_1_M2_r2") has been submitted
cpeng@tux201:G_1_M2_r2$ cd ..
cpeng@tux201:cpeng$

```

- 13) Type “cd ” to open e.g. “G\_Op1\_M1\_r1” in the way as described since 7) in Fig. 2.7 above. Then submit and so on as described before to submit this work.

```

cpeng@tux201:/home_work/cpeng
Last login: Fri Oct 28 10:14:20 2016 from klimt.iehk.rwth-aachen.de
cpeng@tux201:~$ cd $WORK
cpeng@tux201:cpeng$ ls
B_Op01_M1_r1  B_1_M1_r1      G_Op1_M1_r1    JimCP_B_Op01   R_Op1_M2_r2
B_Op01_M1_r2  B_1_M1_r2      G_Op1_M1_r2    JimCP_G_Op01   R_Op1_M3_r1
B_Op01_M2_r1  B_1_M2_r1      G_Op1_M2_r1    matdata.inp     R_Op1_M3_r2
B_Op01_M2_r2  B_1_M2_r2      G_Op1_M2_r2    R_Op01_M1_r1   R_1_M1_r1
B_Op01_M3_r1  B_1_M3_r1      G_Op1_M3_r1    R_Op01_M1_r2   R_1_M1_r2
B_Op01_M3_r2  B_1_M3_r2      G_Op1_M3_r2    R_Op01_M2_r1   R_1_M2_r1
B_Op1_M1_r1   G_Op01_M1_r1   G_1_M1_r1      R_Op01_M2_r2   R_1_M2_r2
B_Op1_M1_r2   G_Op01_M1_r2   G_1_M1_r2      R_Op01_M3_r1   R_1_M3_r1
B_Op1_M2_r1   G_Op01_M2_r1   G_1_M2_r1      R_Op01_M3_r2   R_1_M3_r2
B_Op1_M2_r2   G_Op01_M2_r2   G_1_M2_r2      R_Op1_M1_r1    RayCP_B_Op01
B_Op1_M3_r1   G_Op01_M3_r1   G_1_M3_r1      R_Op1_M1_r2    RayCP_G_Op01
B_Op1_M3_r2   G_Op01_M3_r2   G_1_M3_r2      R_Op1_M2_r1
cpeng@tux201:cpeng$ cd G_1_M2_r2
cpeng@tux201:G_1_M2_r2$ ls
G_1_M2_r2.inp  matdata.inp     mod_materialdata.f90  stress.f90
graindata.inp  models.f90      mod_strings.f90       sub.qsb
inout.f90      mod_global.f90  other_code.f90        umatCP.f
cpeng@tux201:G_1_M2_r2$ qsub sub.qsb
Your job 84980 ("G_1_M2_r2") has been submitted
cpeng@tux201:G_1_M2_r2$ cd ..
cpeng@tux201:cpeng$ cd G_Op1_M1_r1

```

- 14) Type “qstat” to view the situation of the submitted work.

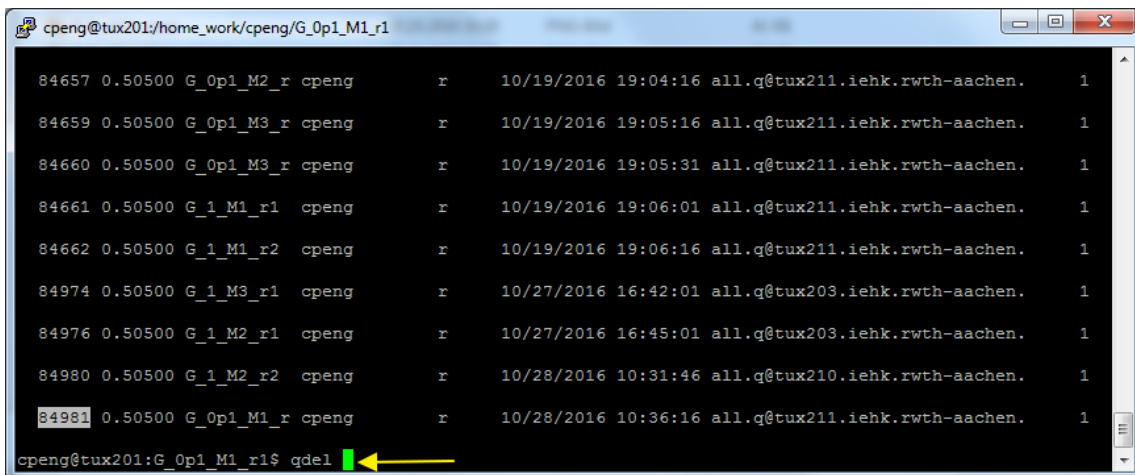
```

cpeng@tux201:/home_work/cpeng/G_Op1_M1_r1
cpeng@tux201:cpeng$ ls
B_Op01_M1_r1  B_1_M1_r1      G_Op1_M1_r1    JimCP_B_Op01   R_Op1_M2_r2
B_Op01_M1_r2  B_1_M1_r2      G_Op1_M1_r2    JimCP_G_Op01   R_Op1_M3_r1
B_Op01_M2_r1  B_1_M2_r1      G_Op1_M2_r1    matdata.inp     R_Op1_M3_r2
B_Op01_M2_r2  B_1_M2_r2      G_Op1_M2_r2    R_Op01_M1_r1   R_1_M1_r1
B_Op01_M3_r1  B_1_M3_r1      G_Op1_M3_r1    R_Op01_M1_r2   R_1_M1_r2
B_Op01_M3_r2  B_1_M3_r2      G_Op1_M3_r2    R_Op01_M2_r1   R_1_M2_r1
B_Op1_M1_r1   G_Op01_M1_r1   G_1_M1_r1      R_Op01_M2_r2   R_1_M2_r2
B_Op1_M1_r2   G_Op01_M1_r2   G_1_M1_r2      R_Op01_M3_r1   R_1_M3_r1
B_Op1_M2_r1   G_Op01_M2_r1   G_1_M2_r1      R_Op01_M3_r2   R_1_M3_r2
B_Op1_M2_r2   G_Op01_M2_r2   G_1_M2_r2      R_Op1_M1_r1    RayCP_B_Op01
B_Op1_M3_r1   G_Op01_M3_r1   G_1_M3_r1      R_Op1_M1_r2    RayCP_G_Op01
B_Op1_M3_r2   G_Op01_M3_r2   G_1_M3_r2      R_Op1_M2_r1
cpeng@tux201:cpeng$ cd G_1_M2_r2
cpeng@tux201:G_1_M2_r2$ ls
G_1_M2_r2.inp  matdata.inp     mod_materialdata.f90  stress.f90
graindata.inp  models.f90      mod_strings.f90       sub.qsb
inout.f90      mod_global.f90  other_code.f90        umatCP.f
cpeng@tux201:G_1_M2_r2$ qsub sub.qsb
Your job 84980 ("G_1_M2_r2") has been submitted
cpeng@tux201:G_1_M2_r2$ cd ..
cpeng@tux201:cpeng$ cd G_Op1_M1_r1
cpeng@tux201:G_Op1_M1_r1$ qstat

```

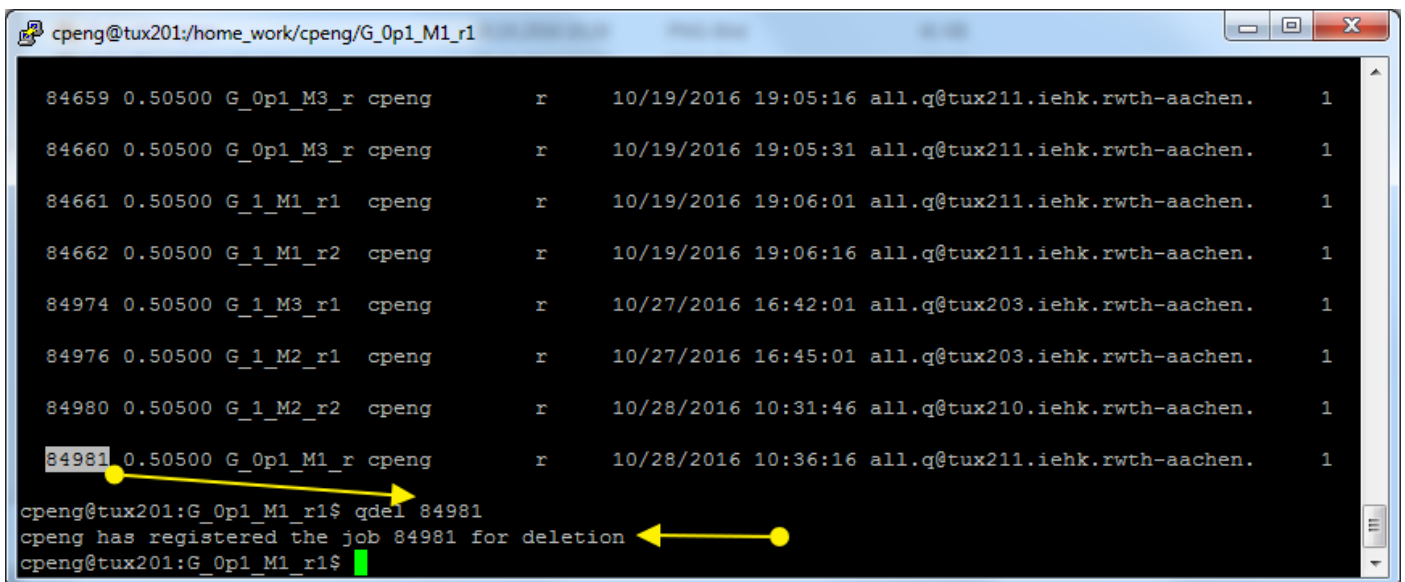
job-ID	prior	name	user	slots	ja-task-ID	state	submit/start at	queue
84383	0.50500	JimCP_B_Op	cpeng	1		r	10/27/2016 12:25:01	all.q@tux200.
84390	0.50500	JimCP_G_Op	cpeng	1		r	10/27/2016 12:25:34	all.q@tux200.
84581	0.50500	R_Op1_M2_r	cpeng	1		r	10/19/2016 17:58:46	all.q@tux211.

- 15) If you would like to stop the submitted work, type “qdel ” (a SPACE after l) and copy the work number e.g. 84981 of “G\_0p1\_M1\_r1” submitted above, then press enter. This submitted work will be deleted.



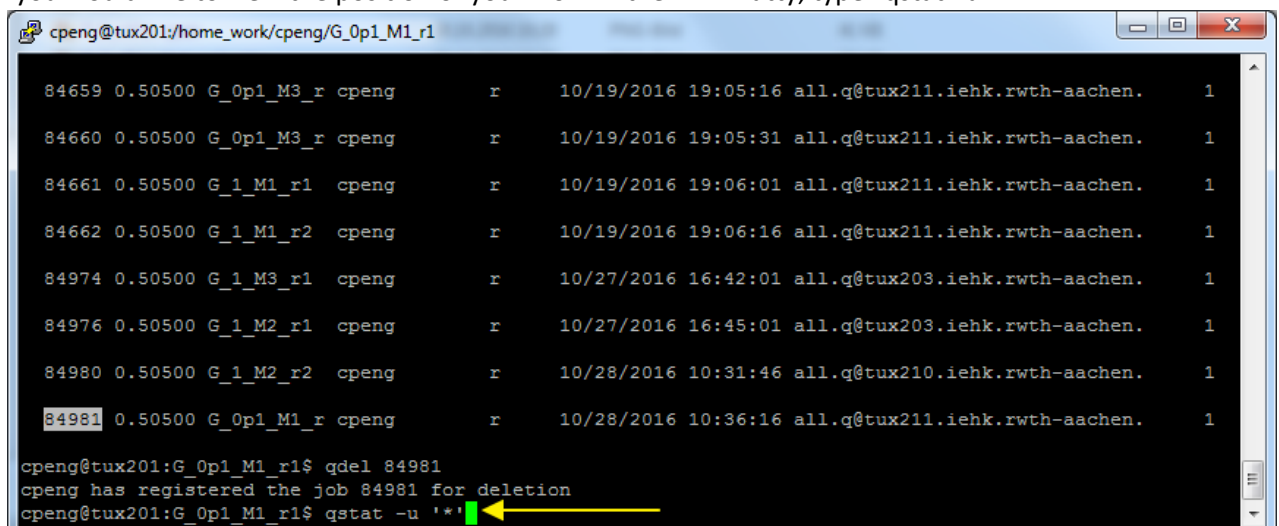
```
cpeng@tux201:/home_work/cpeng/G_0p1_M1_r1
84657 0.50500 G_0p1_M2_r cpeng      r    10/19/2016 19:04:16 all.q@tux211.iehk.rwth-aachen. 1
84659 0.50500 G_0p1_M3_r cpeng      r    10/19/2016 19:05:16 all.q@tux211.iehk.rwth-aachen. 1
84660 0.50500 G_0p1_M3_r cpeng      r    10/19/2016 19:05:31 all.q@tux211.iehk.rwth-aachen. 1
84661 0.50500 G_1_M1_r1 cpeng        r    10/19/2016 19:06:01 all.q@tux211.iehk.rwth-aachen. 1
84662 0.50500 G_1_M1_r2 cpeng        r    10/19/2016 19:06:16 all.q@tux211.iehk.rwth-aachen. 1
84974 0.50500 G_1_M3_r1 cpeng        r    10/27/2016 16:42:01 all.q@tux203.iehk.rwth-aachen. 1
84976 0.50500 G_1_M2_r1 cpeng        r    10/27/2016 16:45:01 all.q@tux203.iehk.rwth-aachen. 1
84980 0.50500 G_1_M2_r2 cpeng        r    10/28/2016 10:31:46 all.q@tux210.iehk.rwth-aachen. 1
84981 0.50500 G_0p1_M1_r cpeng        r    10/28/2016 10:36:16 all.q@tux211.iehk.rwth-aachen. 1
cpeng@tux201:G_0p1_M1_r1$ qdel
```

- 16) The work is deleted



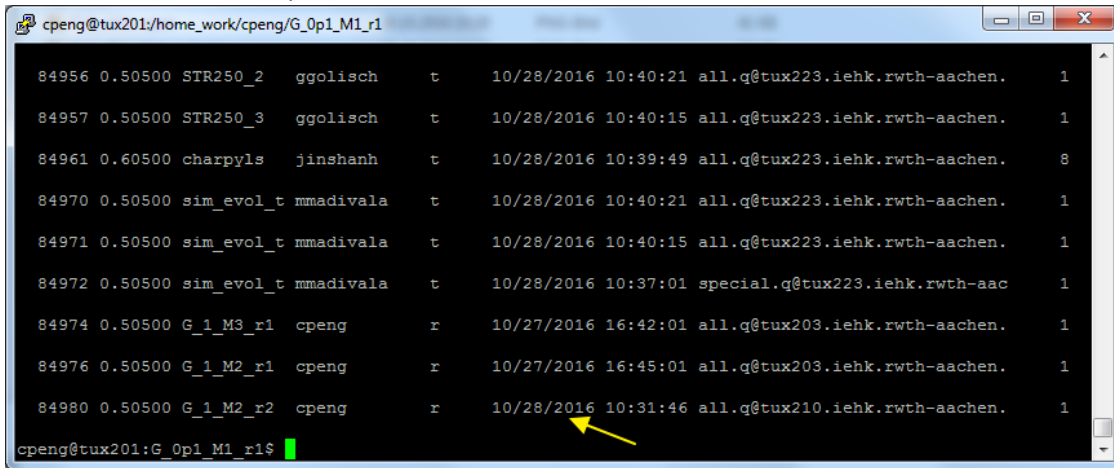
```
cpeng@tux201:/home_work/cpeng/G_0p1_M1_r1
84659 0.50500 G_0p1_M3_r cpeng      r    10/19/2016 19:05:16 all.q@tux211.iehk.rwth-aachen. 1
84660 0.50500 G_0p1_M3_r cpeng      r    10/19/2016 19:05:31 all.q@tux211.iehk.rwth-aachen. 1
84661 0.50500 G_1_M1_r1 cpeng        r    10/19/2016 19:06:01 all.q@tux211.iehk.rwth-aachen. 1
84662 0.50500 G_1_M1_r2 cpeng        r    10/19/2016 19:06:16 all.q@tux211.iehk.rwth-aachen. 1
84974 0.50500 G_1_M3_r1 cpeng        r    10/27/2016 16:42:01 all.q@tux203.iehk.rwth-aachen. 1
84976 0.50500 G_1_M2_r1 cpeng        r    10/27/2016 16:45:01 all.q@tux203.iehk.rwth-aachen. 1
84980 0.50500 G_1_M2_r2 cpeng        r    10/28/2016 10:31:46 all.q@tux210.iehk.rwth-aachen. 1
84981 0.50500 G_0p1_M1_r cpeng        r    10/28/2016 10:36:16 all.q@tux211.iehk.rwth-aachen. 1
cpeng@tux201:G_0p1_M1_r1$ qdel 84981
cpeng has registered the job 84981 for deletion
cpeng@tux201:G_0p1_M1_r1$
```

- 17) If you would like to view the position of your work in the IEHK Putty, type “qstat -u ‘\*’”



```
cpeng@tux201:/home_work/cpeng/G_0p1_M1_r1
84659 0.50500 G_0p1_M3_r cpeng      r    10/19/2016 19:05:16 all.q@tux211.iehk.rwth-aachen. 1
84660 0.50500 G_0p1_M3_r cpeng      r    10/19/2016 19:05:31 all.q@tux211.iehk.rwth-aachen. 1
84661 0.50500 G_1_M1_r1 cpeng        r    10/19/2016 19:06:01 all.q@tux211.iehk.rwth-aachen. 1
84662 0.50500 G_1_M1_r2 cpeng        r    10/19/2016 19:06:16 all.q@tux211.iehk.rwth-aachen. 1
84974 0.50500 G_1_M3_r1 cpeng        r    10/27/2016 16:42:01 all.q@tux203.iehk.rwth-aachen. 1
84976 0.50500 G_1_M2_r1 cpeng        r    10/27/2016 16:45:01 all.q@tux203.iehk.rwth-aachen. 1
84980 0.50500 G_1_M2_r2 cpeng        r    10/28/2016 10:31:46 all.q@tux210.iehk.rwth-aachen. 1
84981 0.50500 G_0p1_M1_r cpeng        r    10/28/2016 10:36:16 all.q@tux211.iehk.rwth-aachen. 1
cpeng@tux201:G_0p1_M1_r1$ qdel 84981
cpeng has registered the job 84981 for deletion
cpeng@tux201:G_0p1_M1_r1$ qstat -u '*'
```

18) Your submitted work is presented then



```
cpeng@tux201:/home_work/cpeng/G_0p1_M1_r1

84956 0.50500 STR250_2 ggolisch t 10/28/2016 10:40:21 all.q@tux223.iehk.rwth-aachen. 1
84957 0.50500 STR250_3 ggolisch t 10/28/2016 10:40:15 all.q@tux223.iehk.rwth-aachen. 1
84961 0.60500 charpyls jinshanh t 10/28/2016 10:39:49 all.q@tux223.iehk.rwth-aachen. 8
84970 0.50500 sim_evol_t mmadivala t 10/28/2016 10:40:21 all.q@tux223.iehk.rwth-aachen. 1
84971 0.50500 sim_evol_t mmadivala t 10/28/2016 10:40:15 all.q@tux223.iehk.rwth-aachen. 1
84972 0.50500 sim_evol_t mmadivala t 10/28/2016 10:37:01 special.q@tux223.iehk.rwth-aac 1
84974 0.50500 G_1_M3_r1 cpeng r 10/27/2016 16:42:01 all.q@tux203.iehk.rwth-aachen. 1
84976 0.50500 G_1_M2_r1 cpeng r 10/27/2016 16:45:01 all.q@tux203.iehk.rwth-aachen. 1
84980 0.50500 G_1_M2_r2 cpeng r 10/28/2016 10:31:46 all.q@tux210.iehk.rwth-aachen. 1

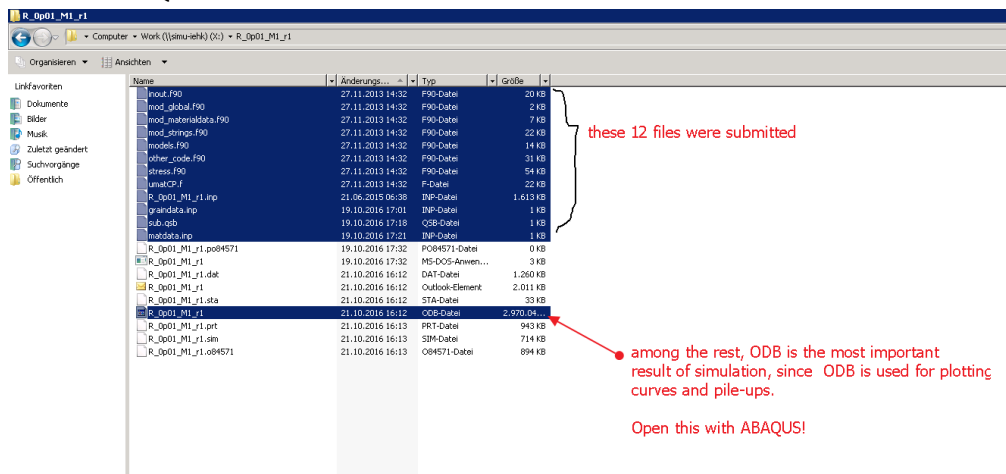
cpeng@tux201:G_0p1_M1_r1$
```

Forget about some skills in windows operation system, DOS is a whole new ball game.

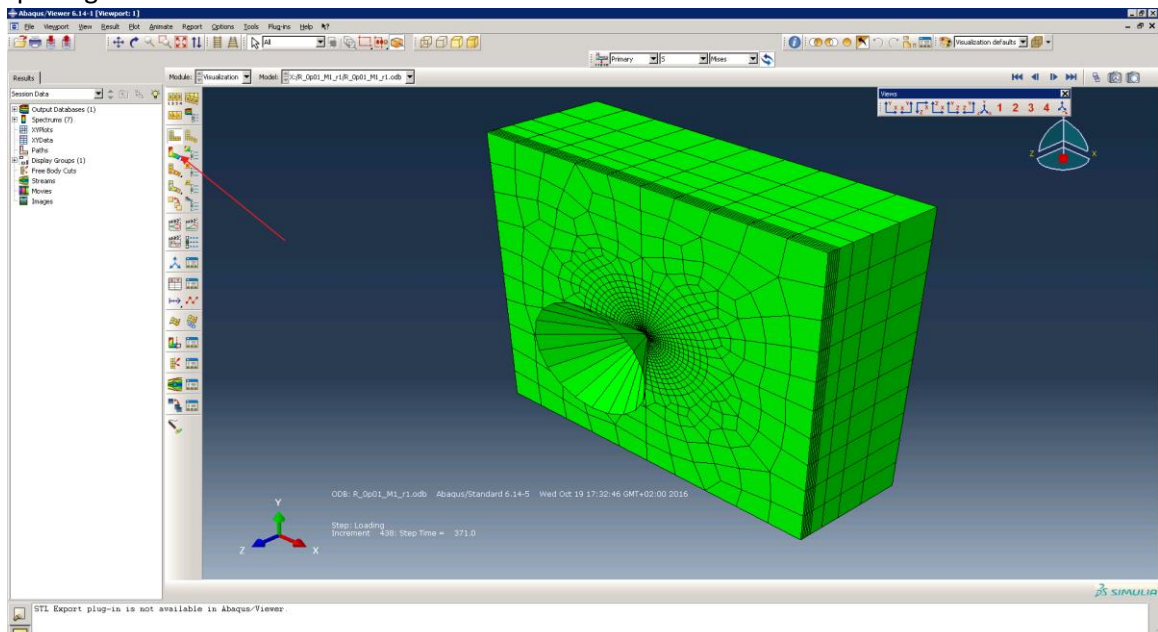
### 3. Plot Load-Displacement (P-h) Curves

Complete the following procedures to plot a load-displacement curve from the ODB data i.e. the completed simulation result.

1) Open the ODB with ABAQUS



2) After opening



- 3) Present the deformed shape to check whether the result is usable, because sometimes simulation provides useless result i.e. an ODB which could not present the deformed shape, even though it has taken much time to achieve this useless ODB. If it can deform, then open “creat XY data” by single click the button in Fig. 3.1 below.

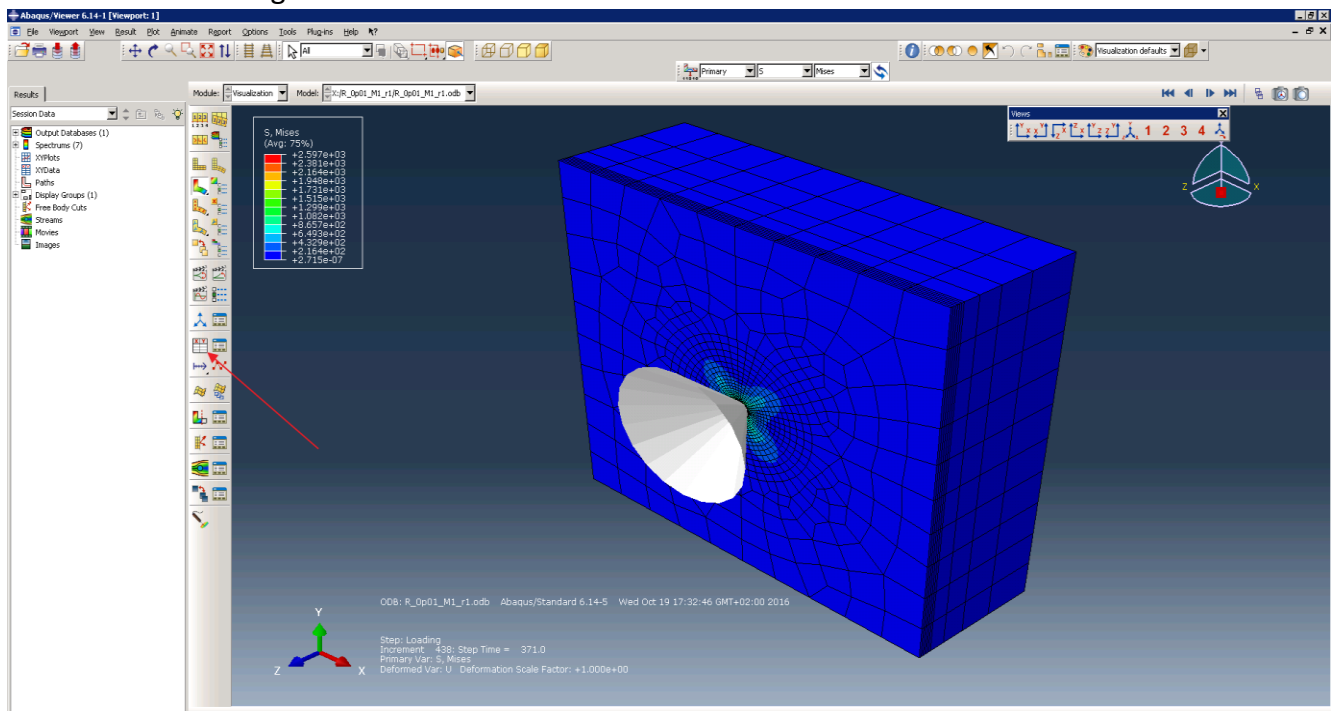
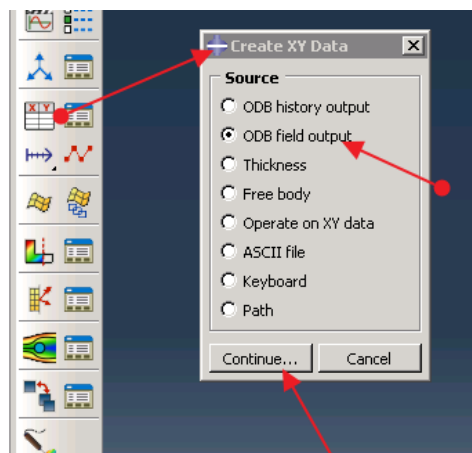
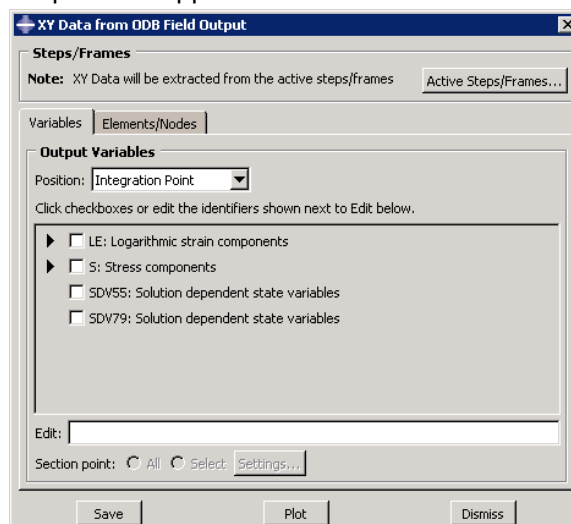


Fig. 3.1 make sure the block in ODB can be deformed, then deal with XY data

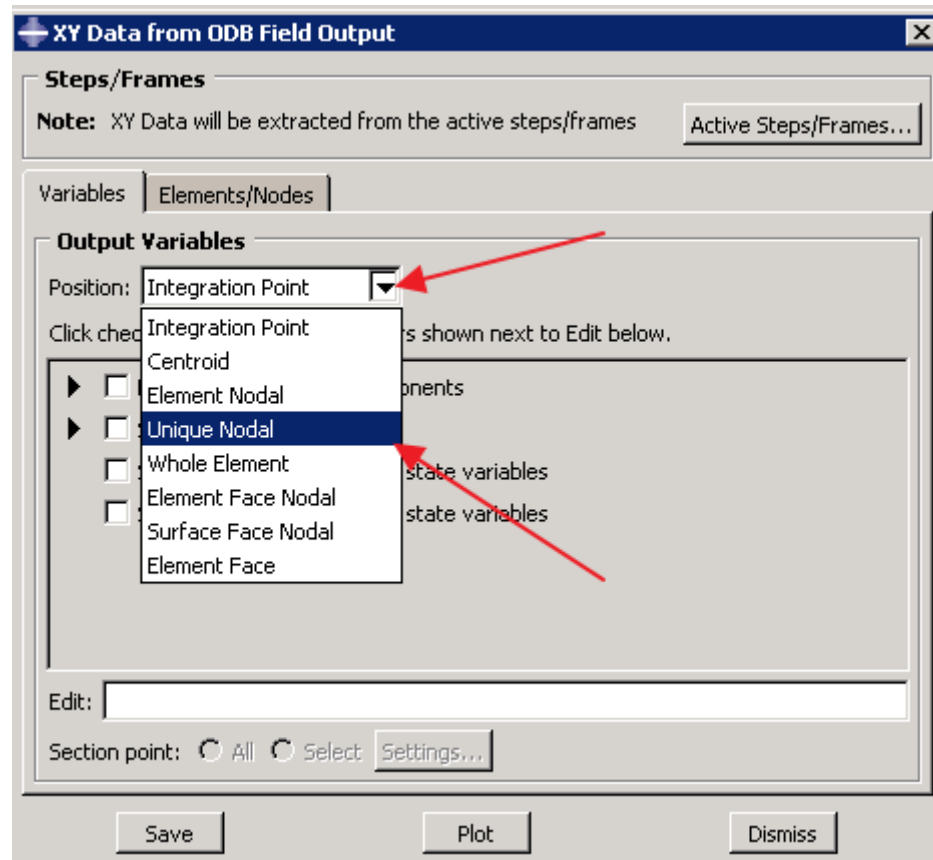
- 4) Click “continue” under “ODB field output”



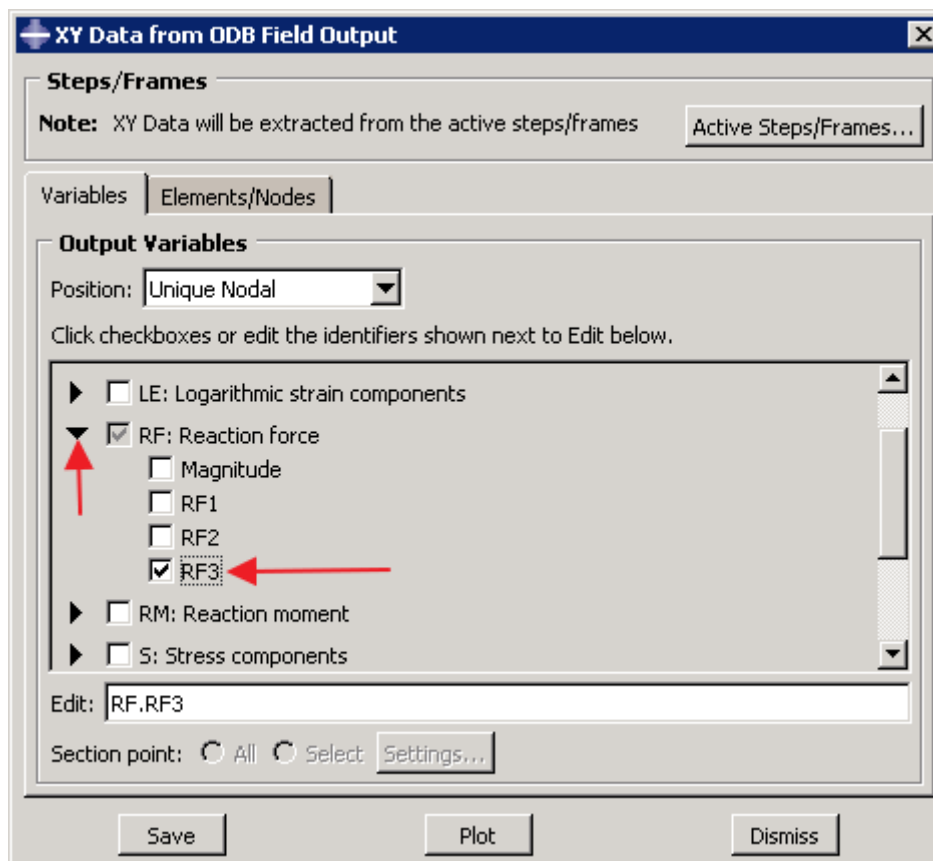
- 5) Then “XY Data from ODB Field Output” box appears



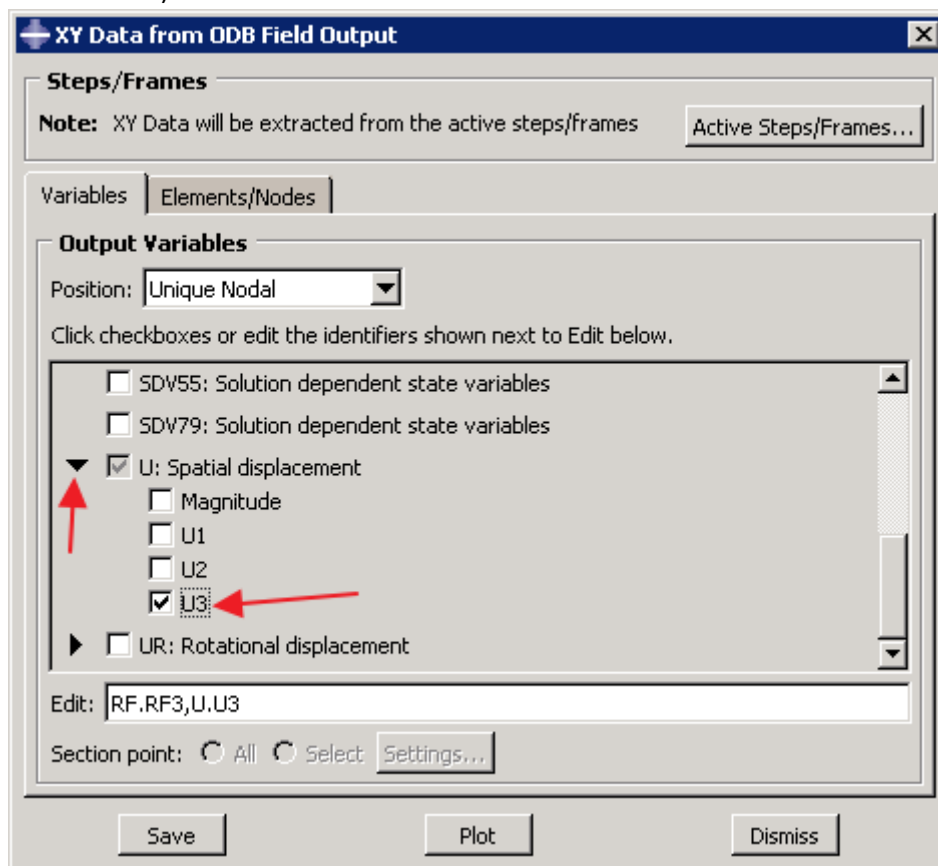
- 6) Click the black-downwards-arrow, then click "Unique Nodal". (chose the nodal)



- 7) Click the black-downwards-arrow, then click "RF", then click "RF3". (chose RF3 as the output item, the force in Z direction )



- 8) Click the black-downwards-arrow, then click “U”, then click “U3”. (chose U3 as the output item, the displacement in Z direction )



- 9) Click in the sequence in Fig. 3.2. This aims to choose the reference point, then save the data selected in 6), 7) and 8) above.

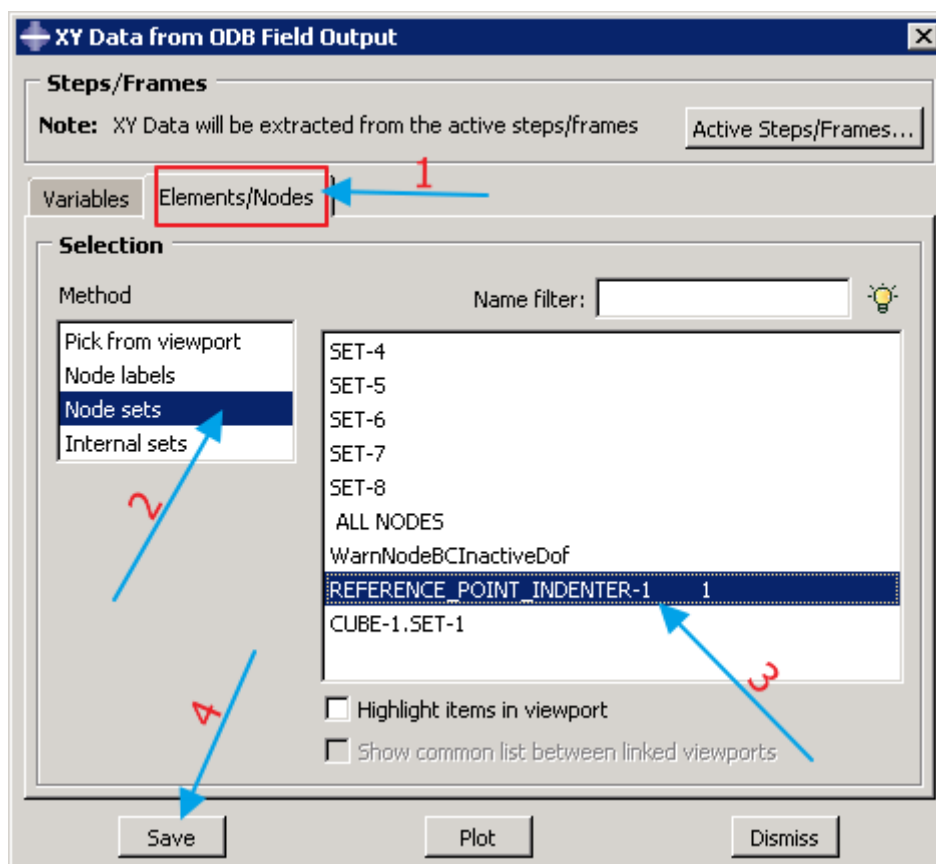
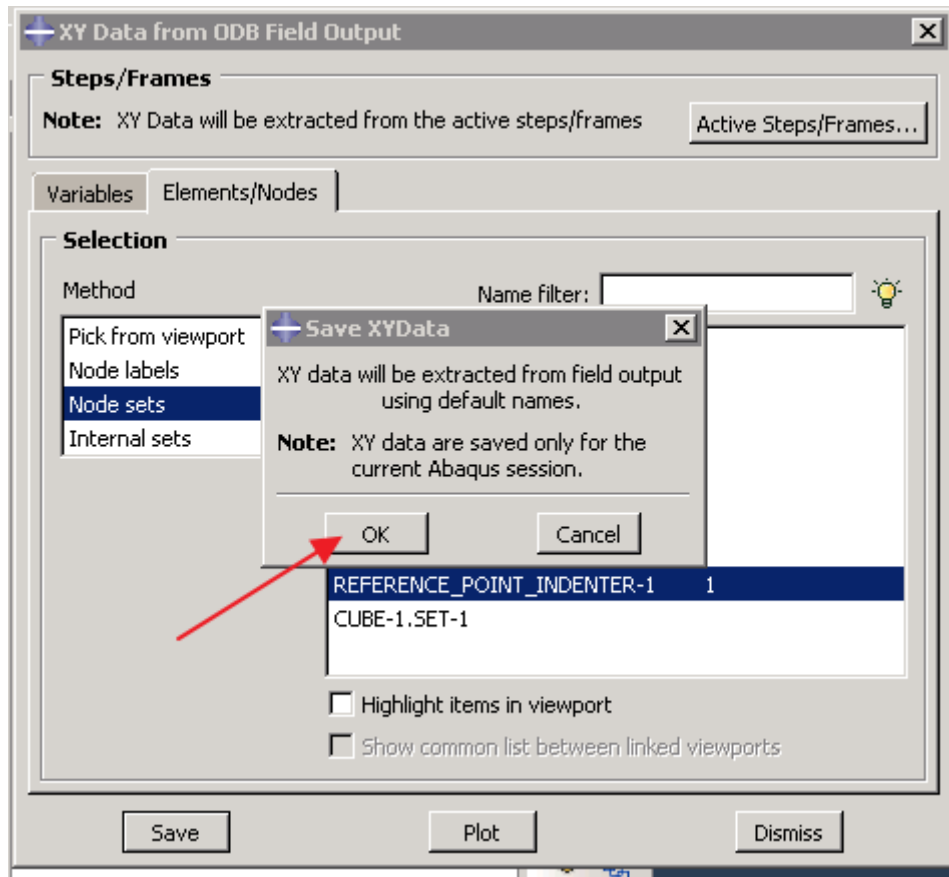
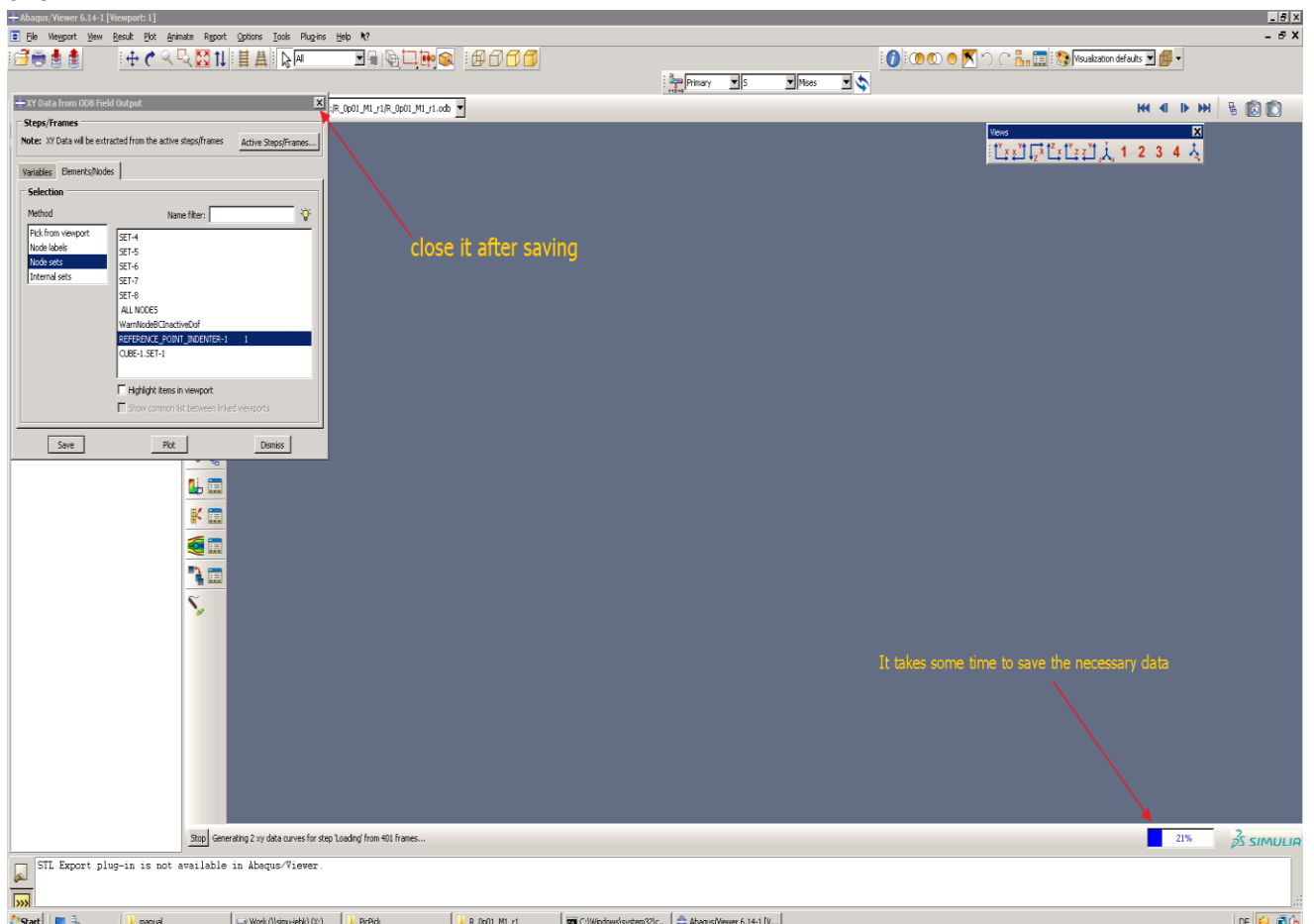


Fig. 3.2 choose the reference point and save

10) Click “OK”

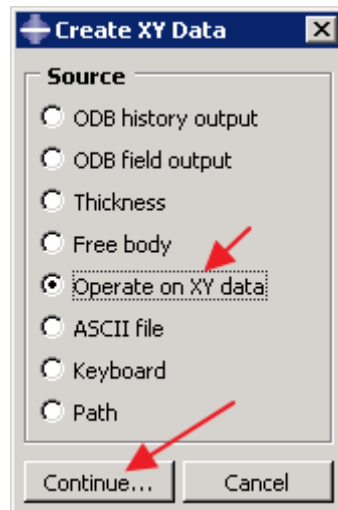


11) It can take several minutes to save the data. You can turn off the “XY Data from ODB Feld Output” box after this.

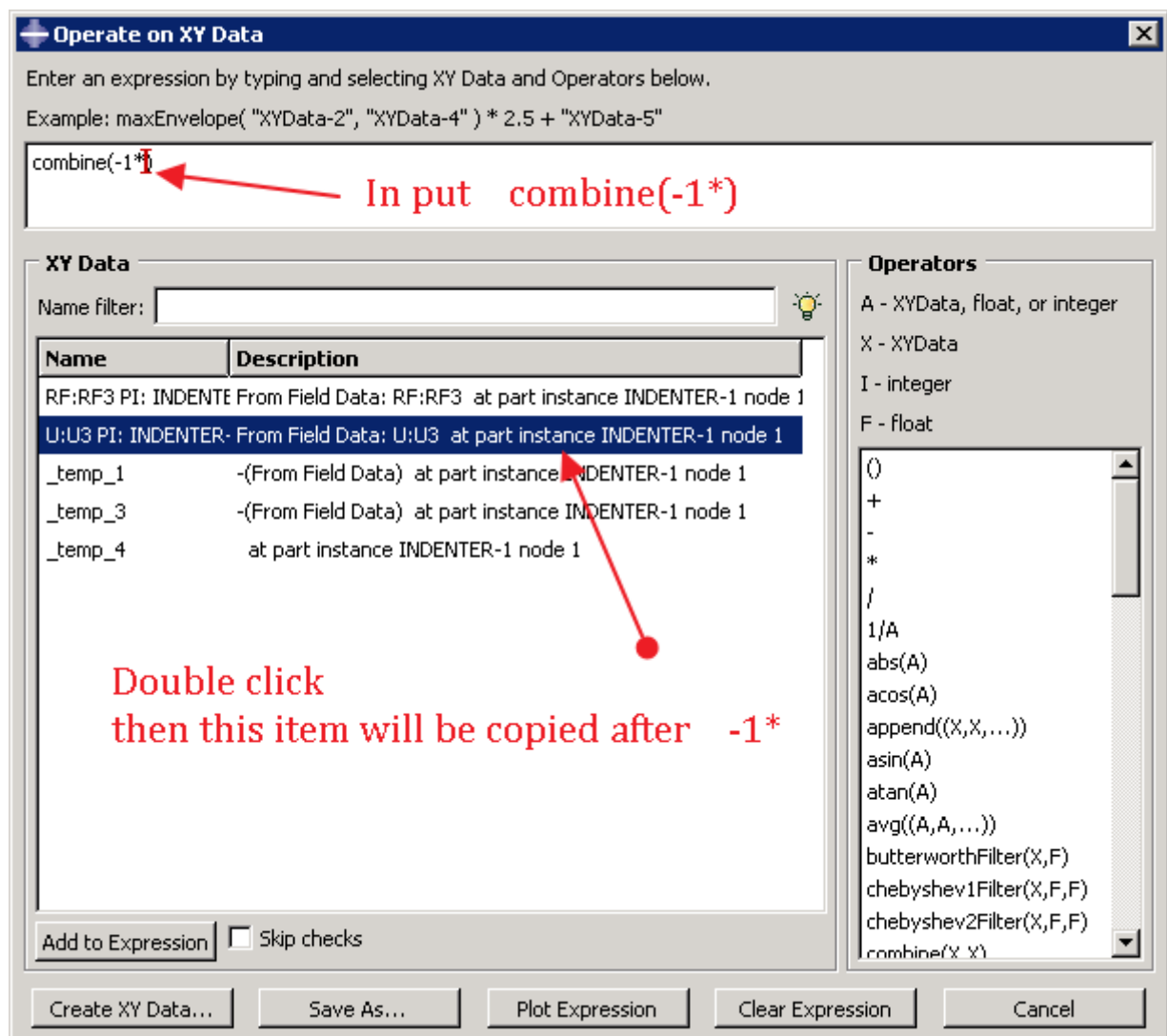




- 12) Click "Continue" after toggling on "Operate on XY data" to call up the data for plotting load-displacement curve



- 13) Type "comobine(-1\*)", then double click U item (the whole item is the marked blue) to copy this item after \*. This means set -U3 as X values.



- 14) Similarly put R3 in the expression in 13) above. This means to set -RF3 (reference force in Z direction) as the Y values. Use Komma "," (no SPACE neither before nor after Komma) to separate U3 and RF3. The whole expression is like that in Fig. 3.3. You can click "Plot Expression" to check whether the load-displacement curve is good enough

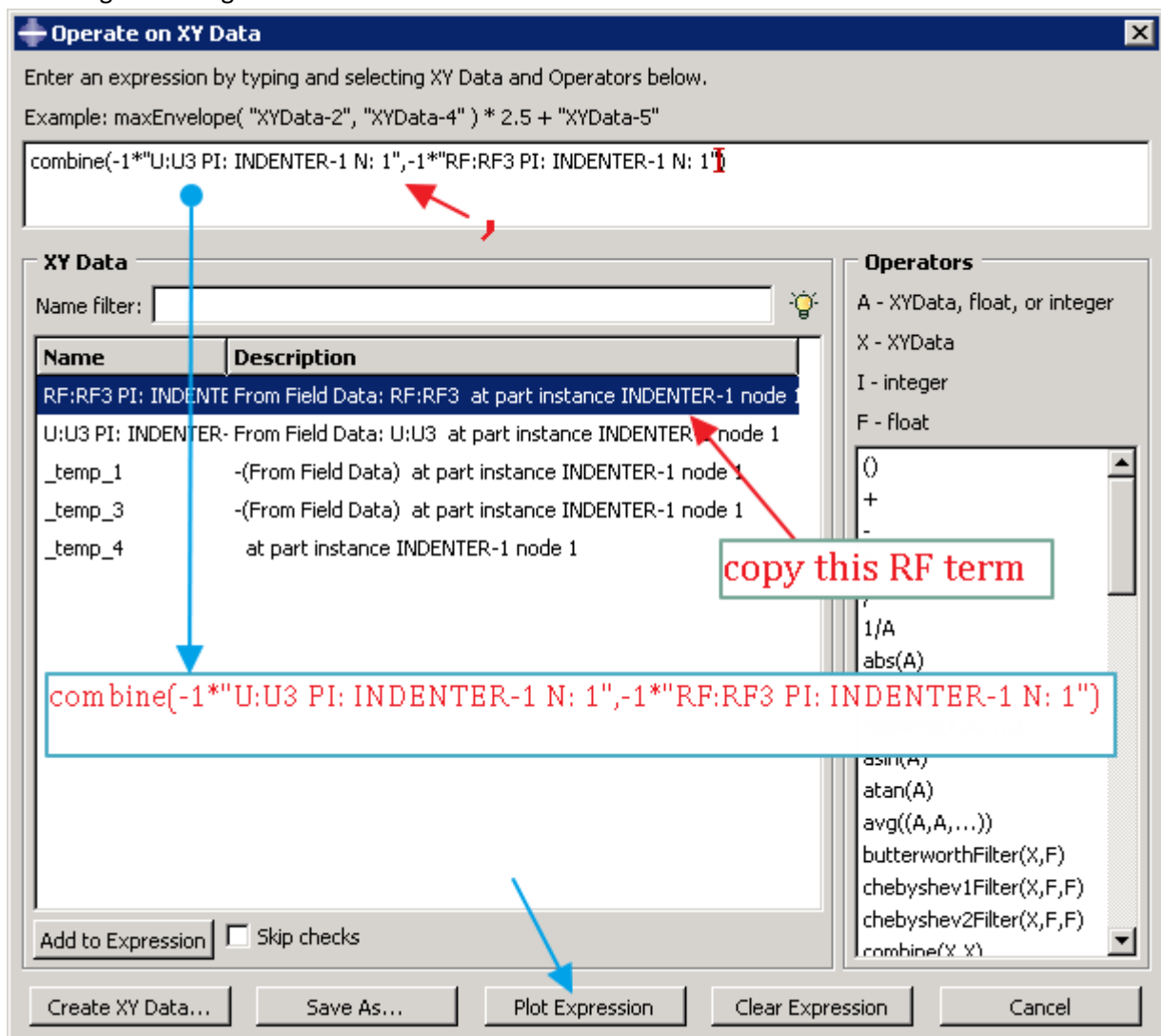
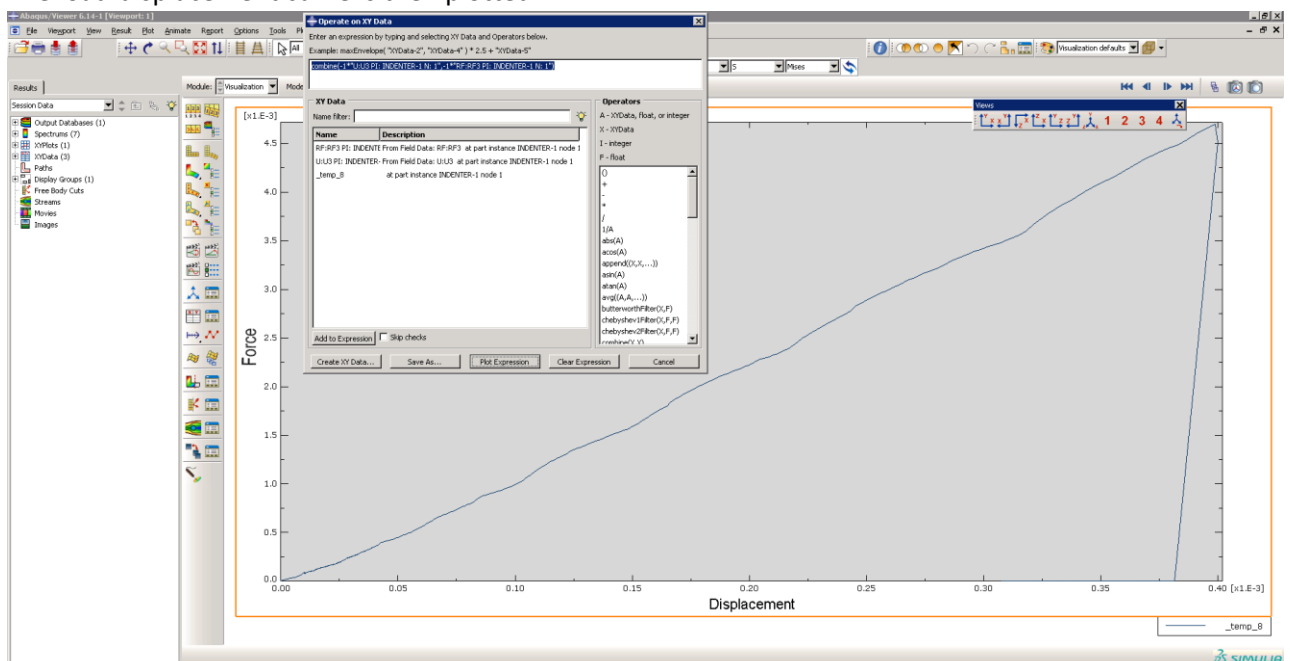


Fig. 3.3 expression

- 15) The load-displacement curve is then plotted



- 16) If you are pleased with the result, then save the data with a name you can identify e.g. "Ph\_tutor" as shown in Fig. 3.4.

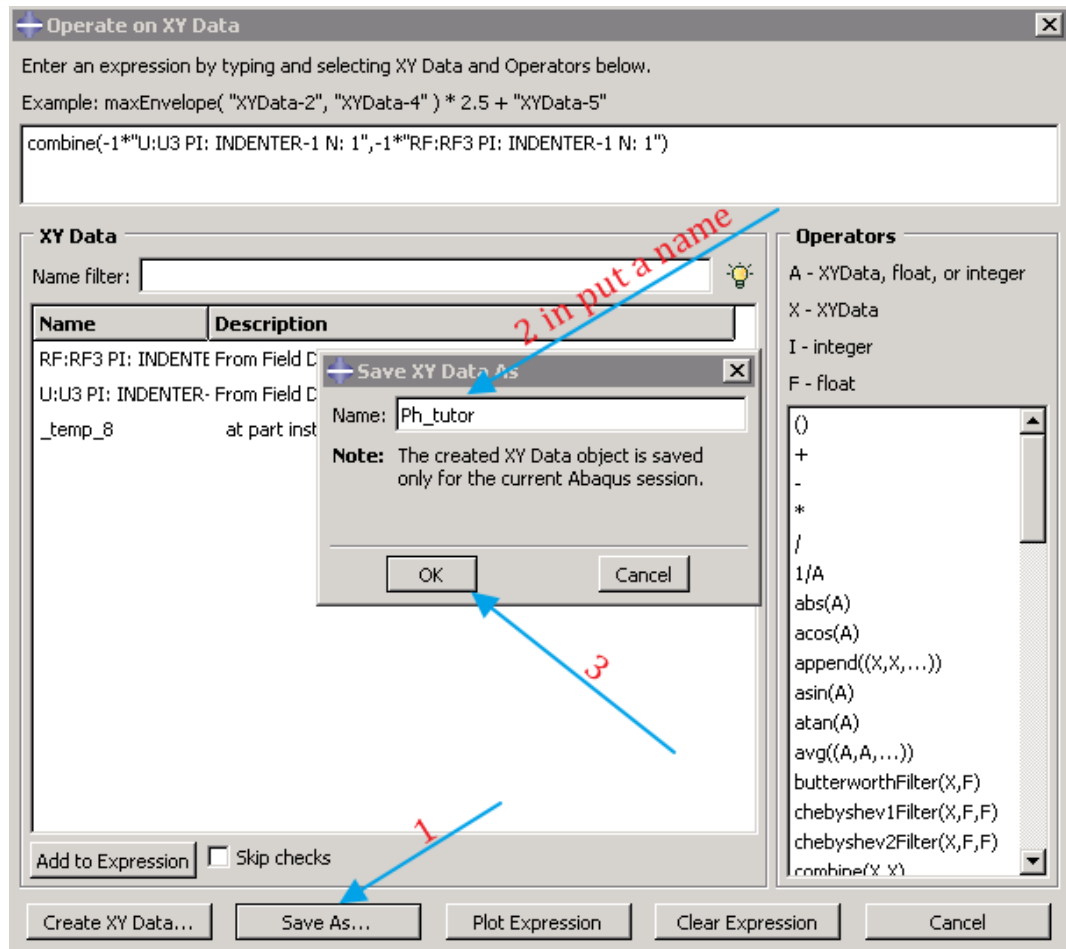
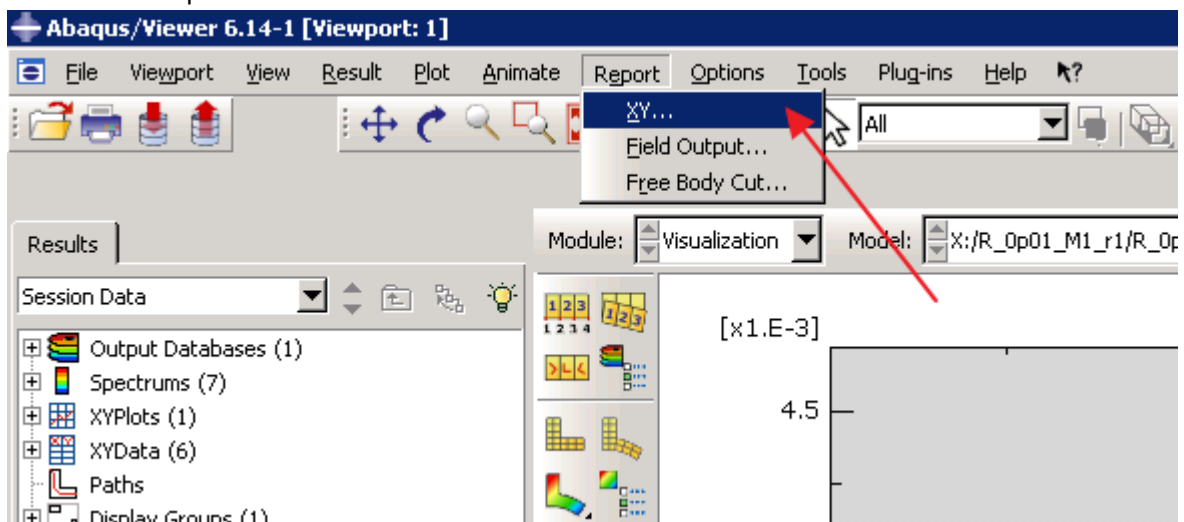
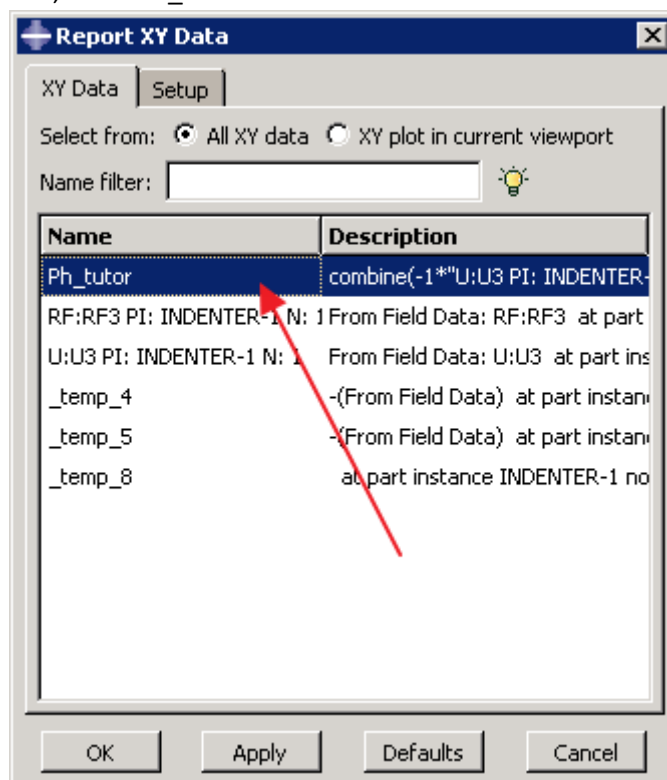


Fig. 3.4 click in this sequence to save the data you are pleased with.

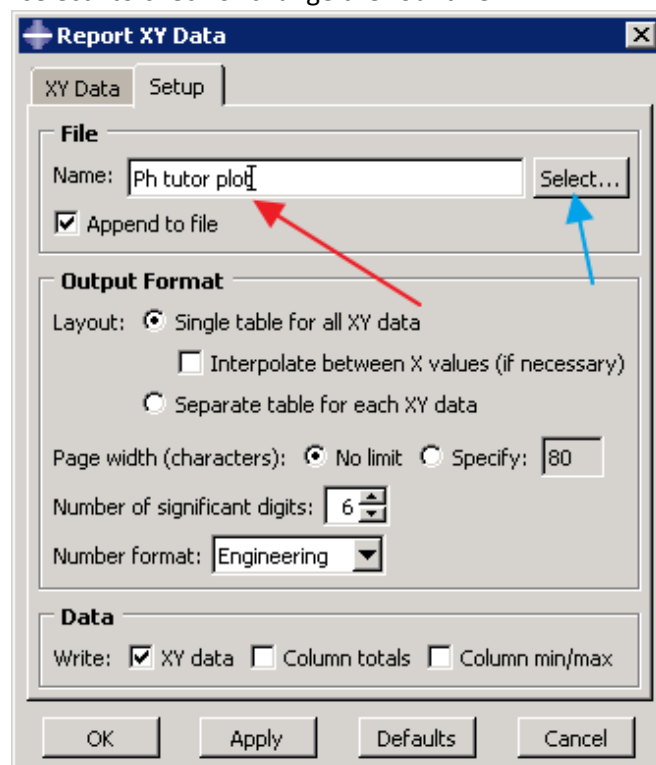
- 17) Click "XY" to report XY



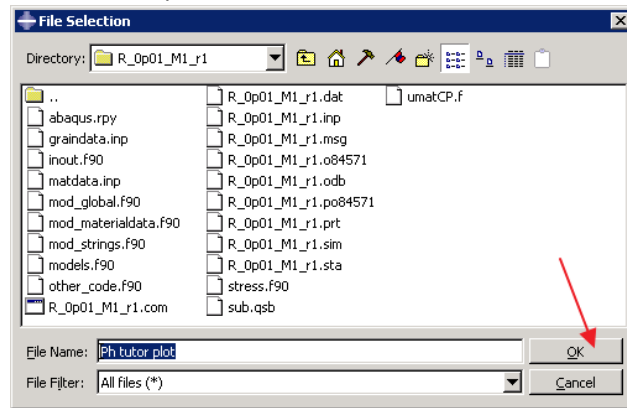
18) "Report XY Data" box appears, click "Ph\_tutor" to select this item under "XY Data".



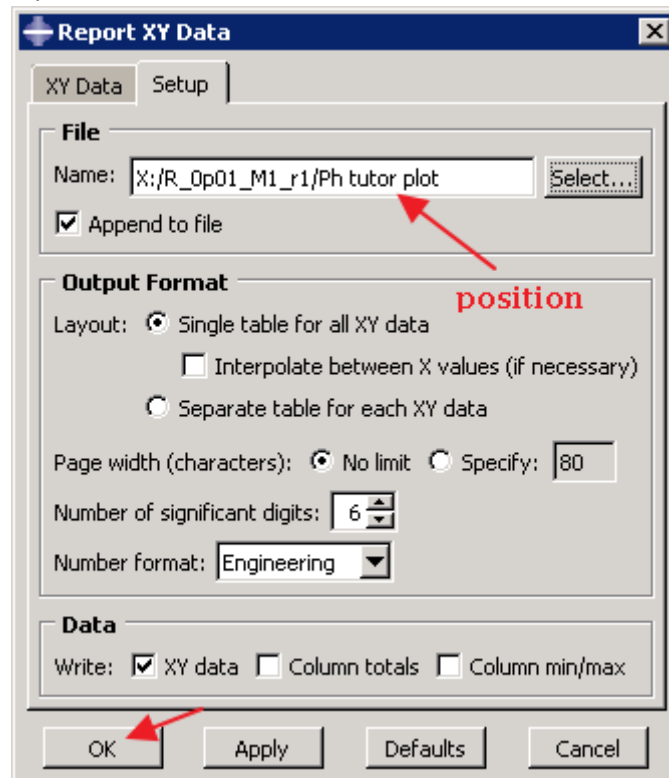
19) Give a name of the save file e.g. "Ph tutor plot", if you are not sure about the routine i.e. the folder where this file will be saved, click "select" to check or change the routine.



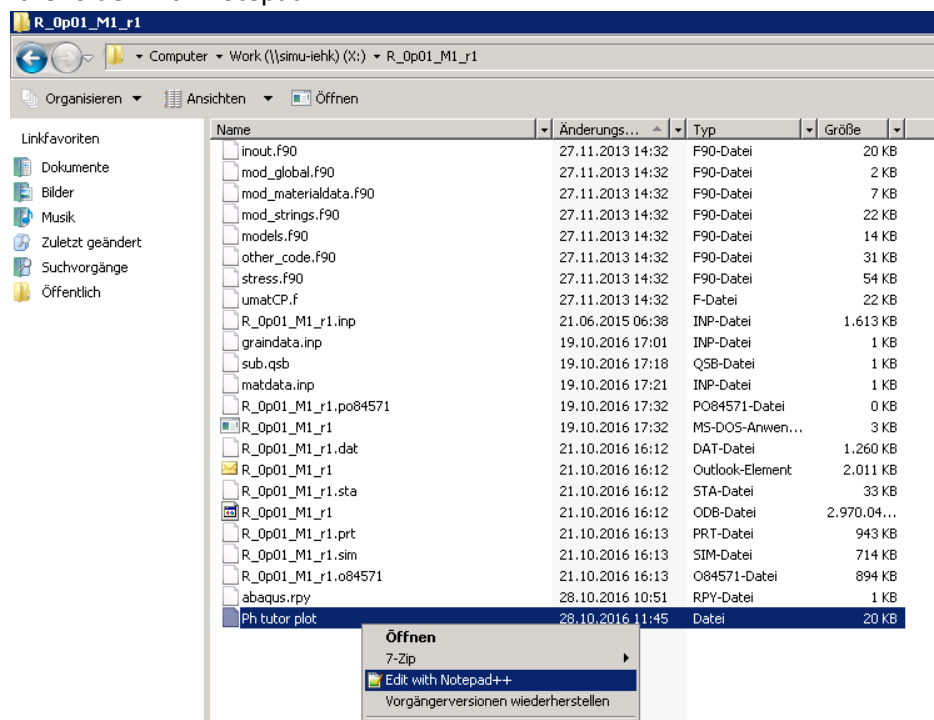
20) If you can find the file in which “Ph tutor plot” will be saved, click “OK”.



21) Click “OK” to save “Ph tutor plot”



22) Open the file in the folder with Notepad.



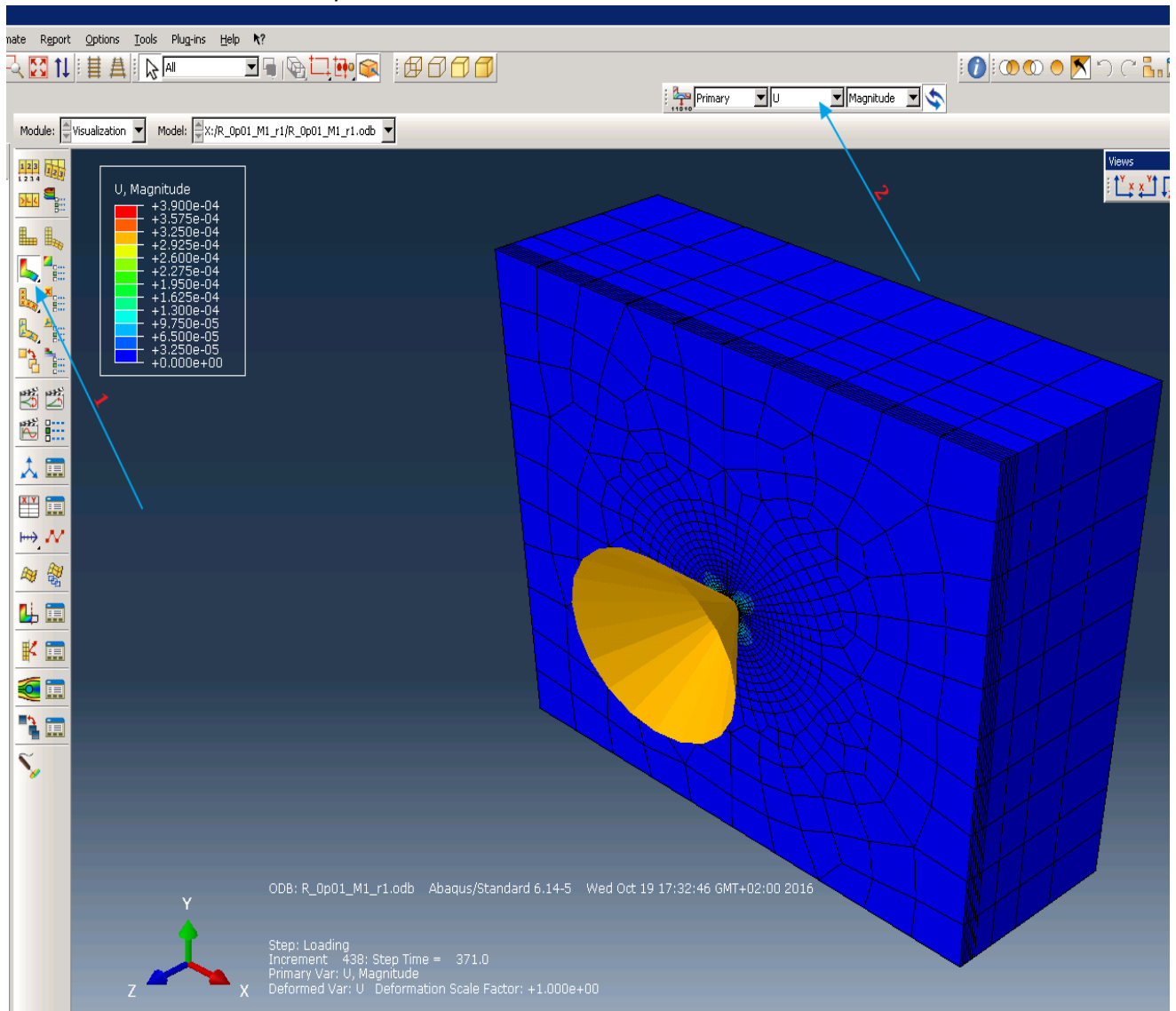
23) This is the content of “Ph tutor plot”

X:\R_Op01_M1_r1\Ph tutor plot - Notepad++			
File Edit Search View Encoding Language Settings Macro Run Plugins Window			
Ph tutor plot			
1			
2		X	Ph_tutor
3			
4		-0.	0.
5		2.E-06	12.6201E-06
6		4.E-06	29.726E-06
7		6.E-06	39.3776E-06
8		8.E-06	57.1902E-06
9		10.E-06	89.7284E-06
10		10.E-06	81.1768E-06
11		10.E-06	78.6591E-06
12		10.E-06	77.2722E-06
13		10.E-06	76.2783E-06
14		10.E-06	75.5121E-06
15		10.E-06	75.5121E-06
16		10.3917E-06	81.4878E-06
17		10.3917E-06	79.3205E-06
18		10.3917E-06	78.0752E-06
19		10.3917E-06	77.1495E-06
20		10.5703E-06	84.4957E-06
21		10.7785E-06	87.3691E-06
22		10.9868E-06	89.1134E-06
23		11.195E-06	90.7653E-06

## 4. Plot Pile-Ups

Complete the following steps to select, extract and plot pile-up

- 1) Present the deformed assembly under “U” mode



- 2) Click in the sequence in Fig. 4.1 to present the cube.

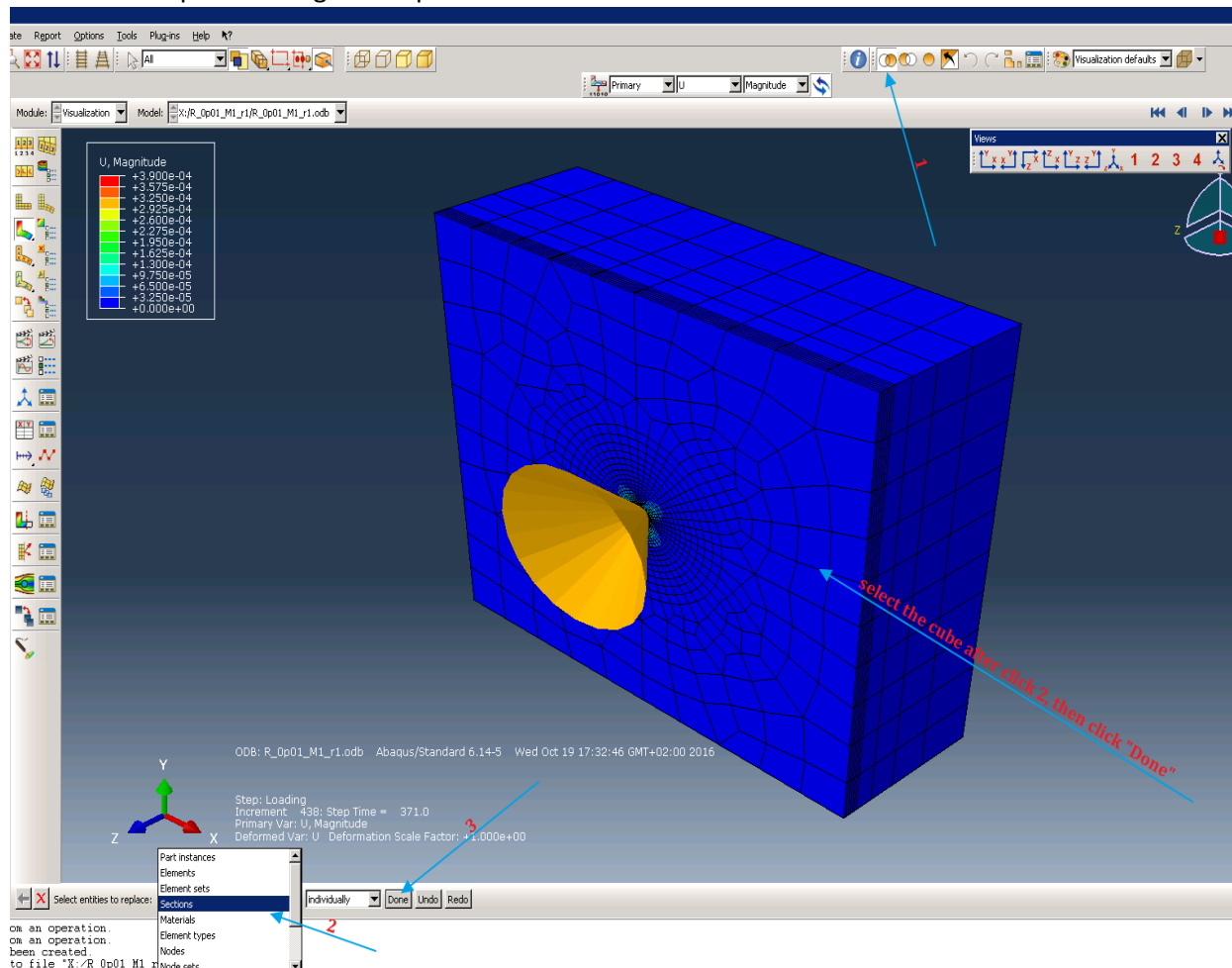
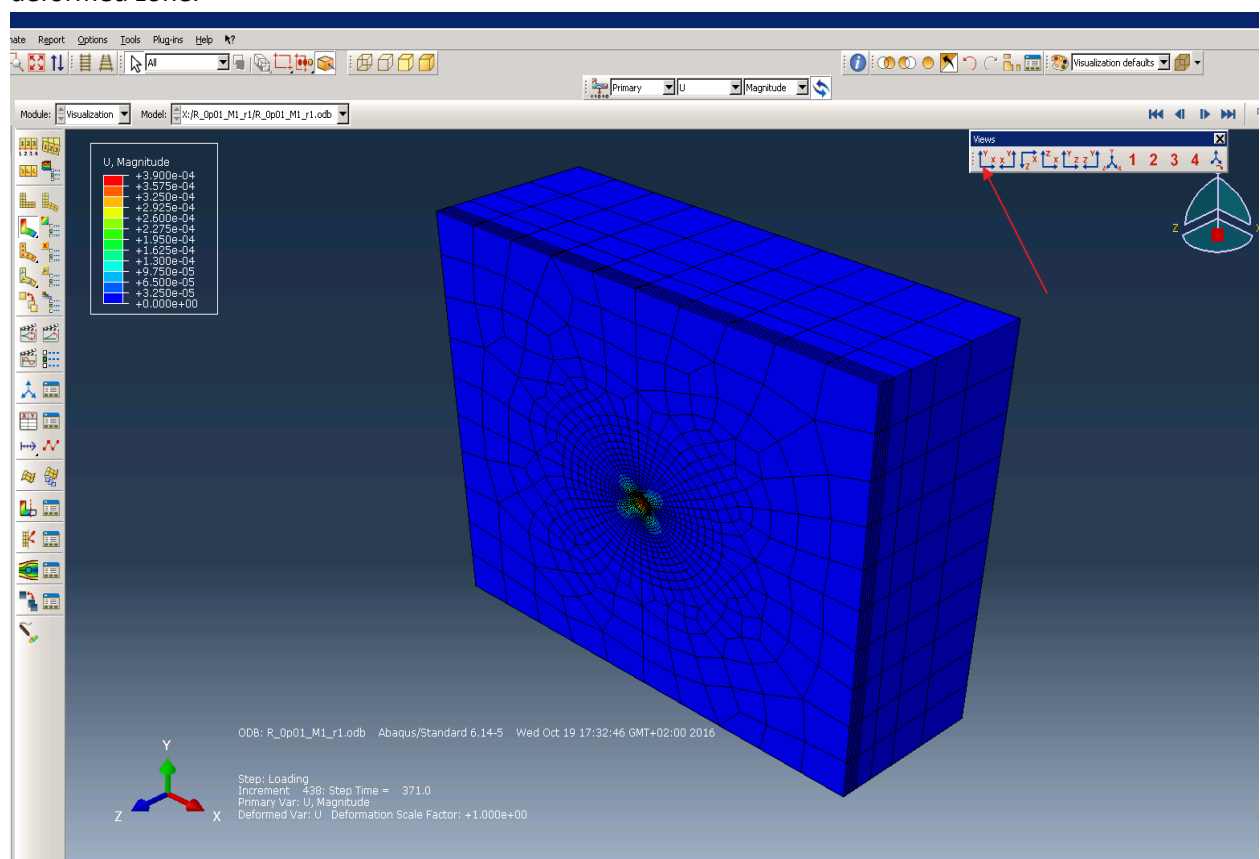


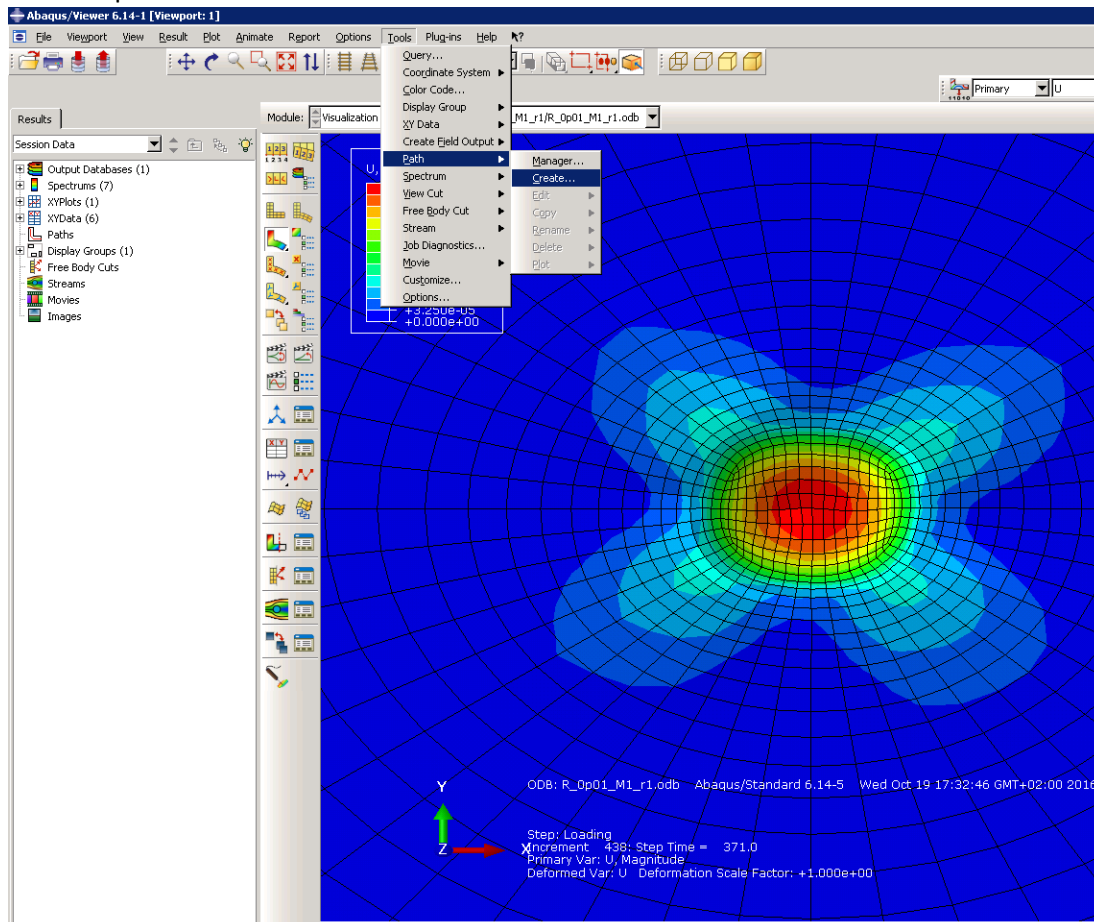
Fig. 4.1 attention: after click 2, click the tube (to select the cube), then perform click 3

- 3) The deformed cube is then presented. You can click xy view means and magnify to have a better view of the deformed zone.





#### 4) Create a path



#### 5) Do as in Fig. 4.2. Give a name you know e.g. "Pile up tutor".

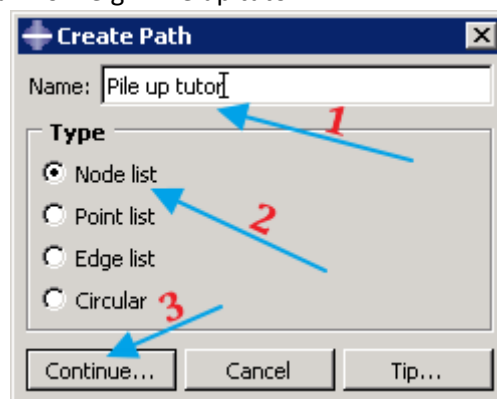
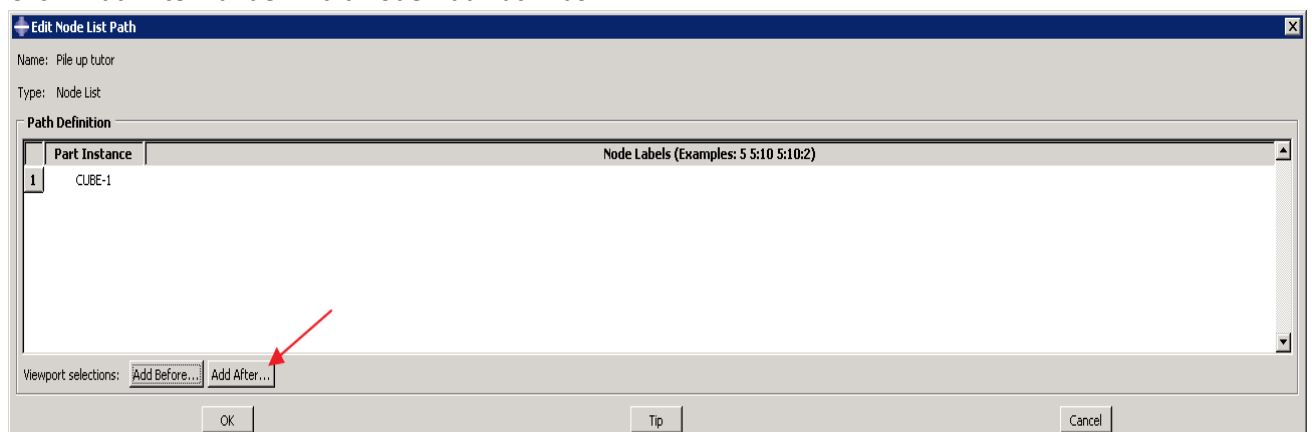


Fig. 4.2 give a name of the path, select node list, then continue

#### 6) Click "Add After" under "Edit Node List Path" box



- 7) Click the nodes one by one in one direction. These nodes will be saved in the path you have named in 6) above. ABAQUS generates the red line between the adjacent nodes you have clicked. As a result a red line in Fig. 4.3 is the path you would like to create. Click “done” when you think this path is good enough.

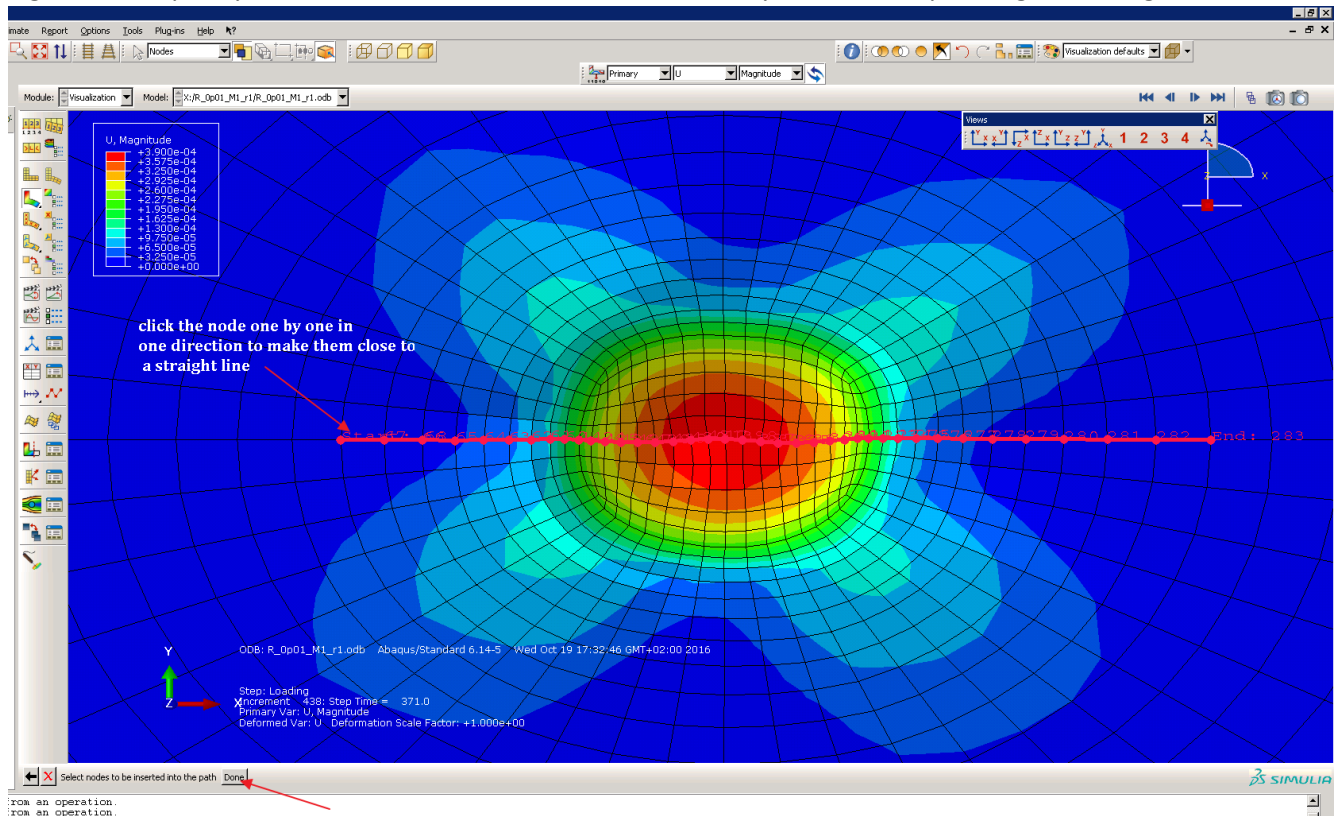
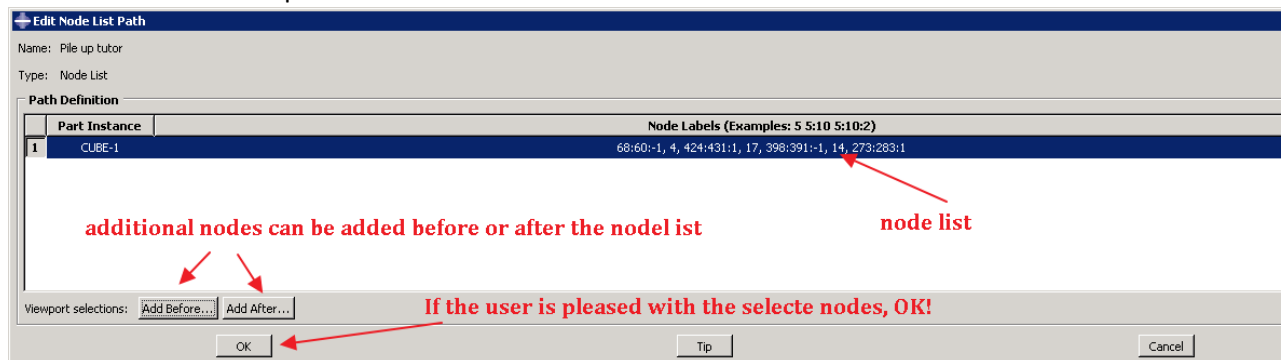
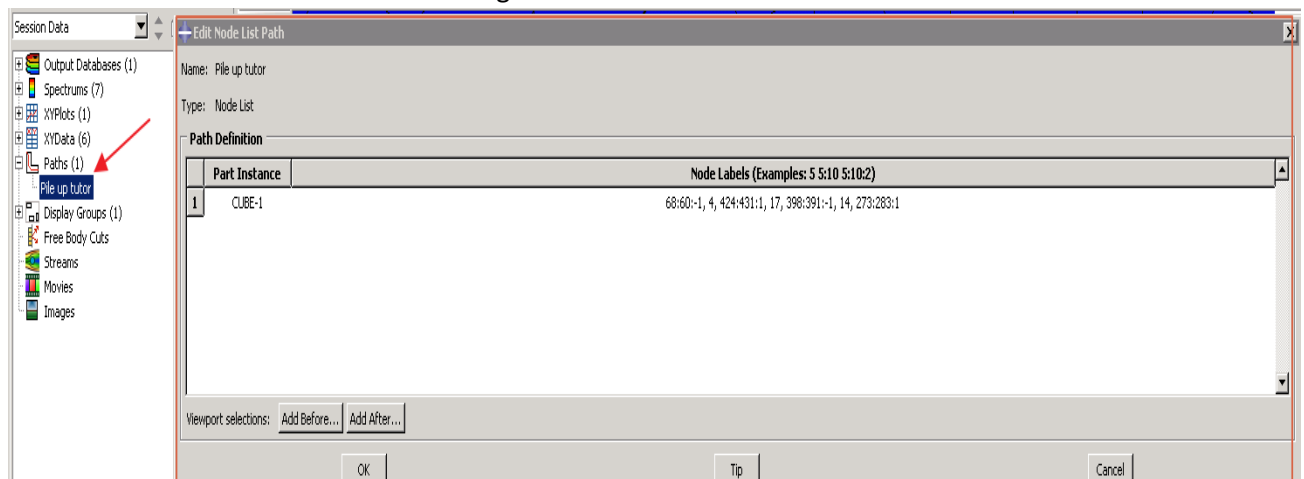


Fig. 4.3 click the nodes to create the path

- 8) This path could be further edited by adding additional nodes before or after this node list. Click “OK” after the edition to save the path.



- 9) Further edition could be done after saving



10) Click as in Fig. 4.4 to deal with the path

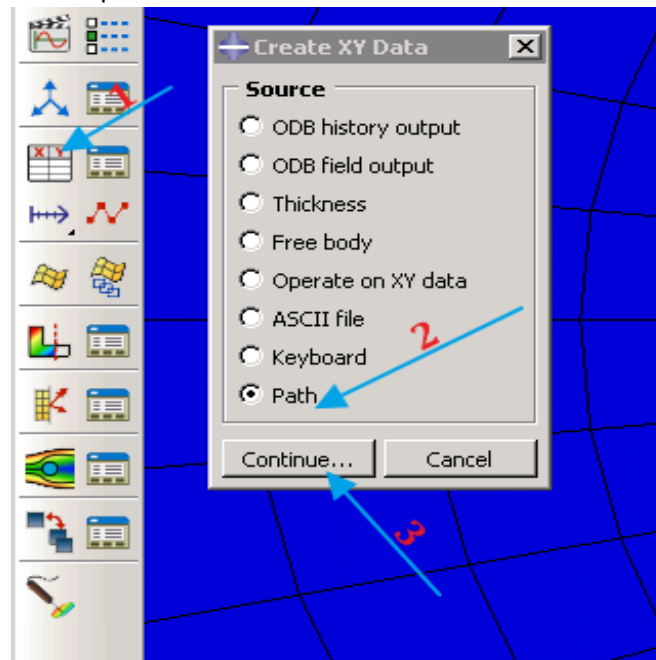
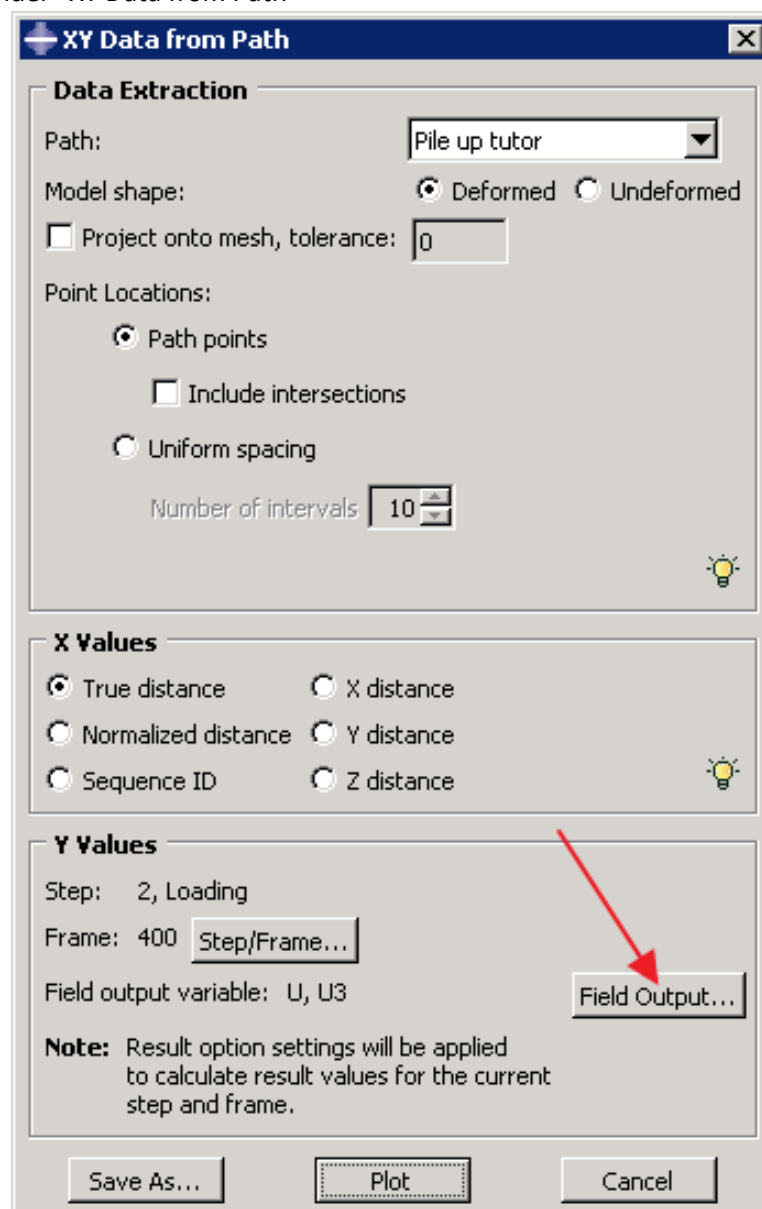


Fig. 4.4 click in sequence

11) Click “Feld Output” under “XY Data from Path”



12) Click in sequence as in Fig.

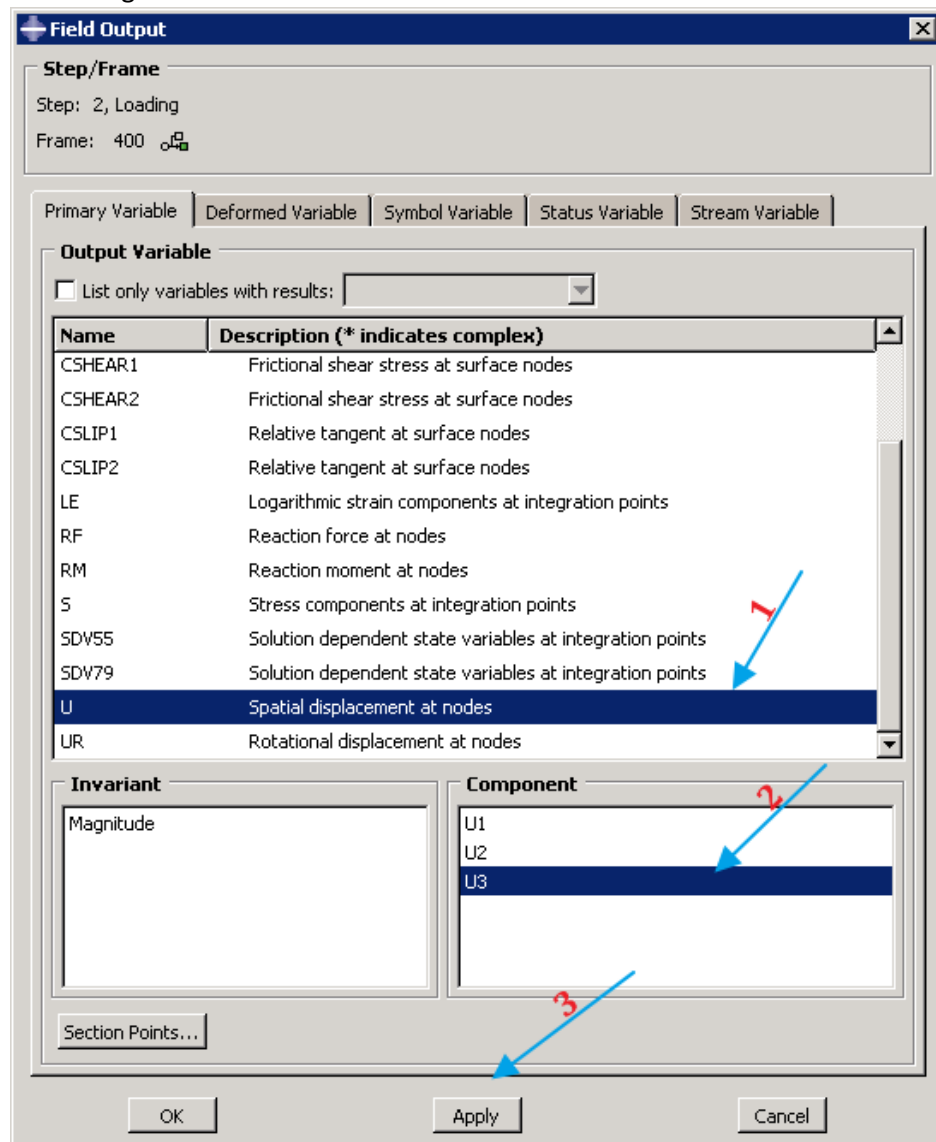
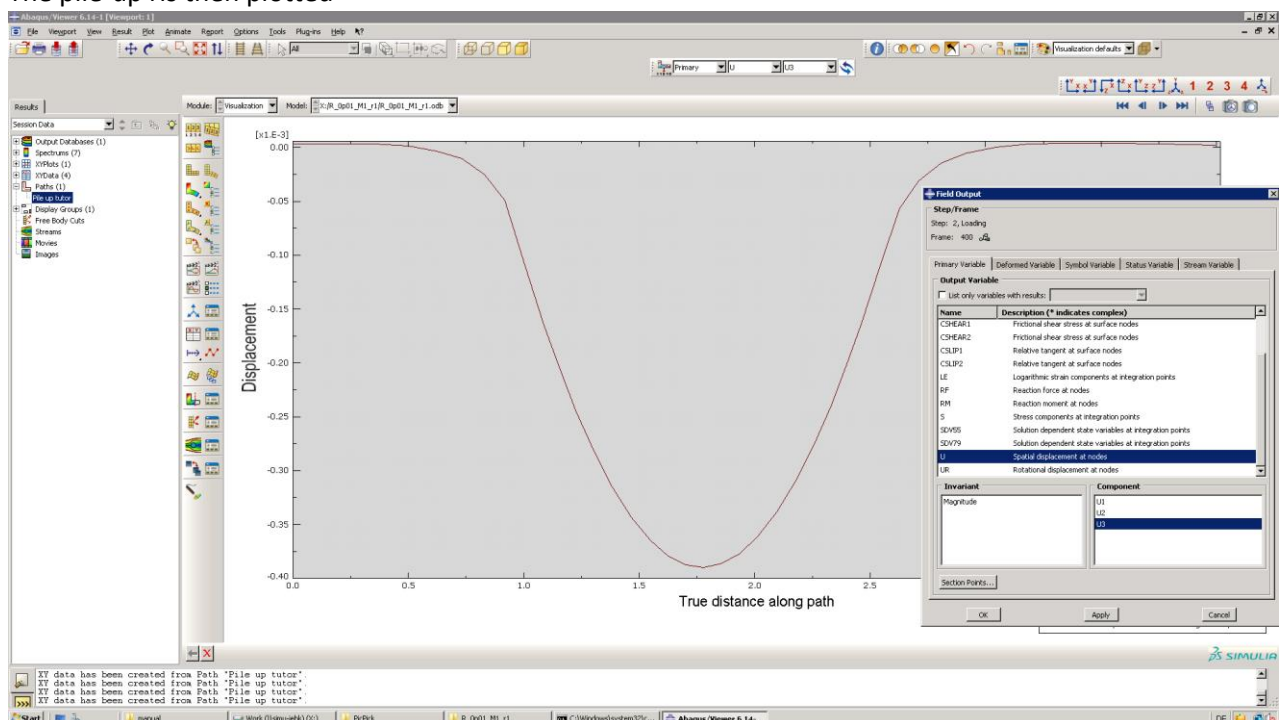
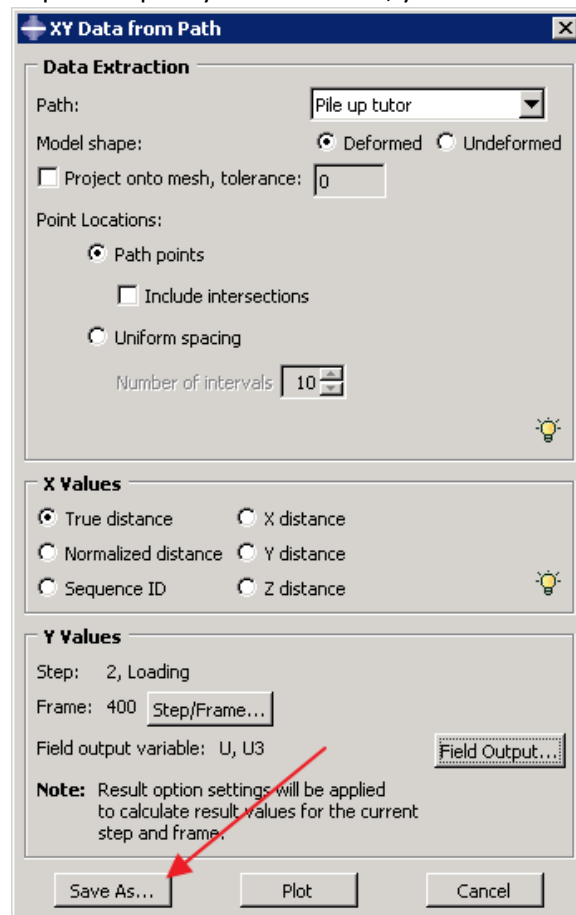


Fig. 4.5 click in sequence to select U3

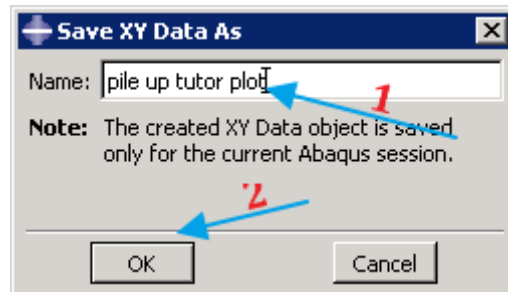
13) The pile-up ris then plotted



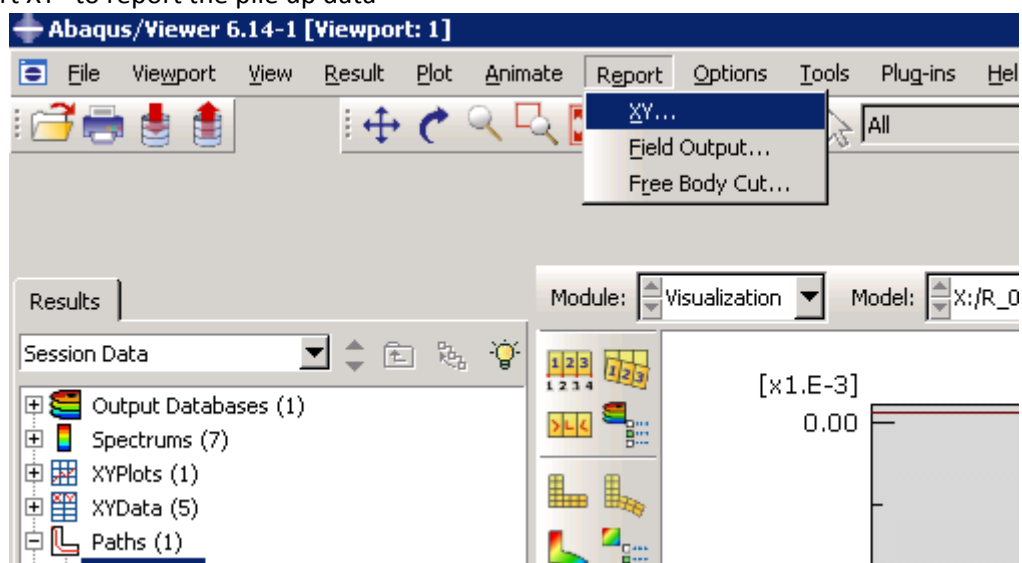
14) If you are pleased with the pile-up in the path you've selected, you can save this data by clicking "Save As"



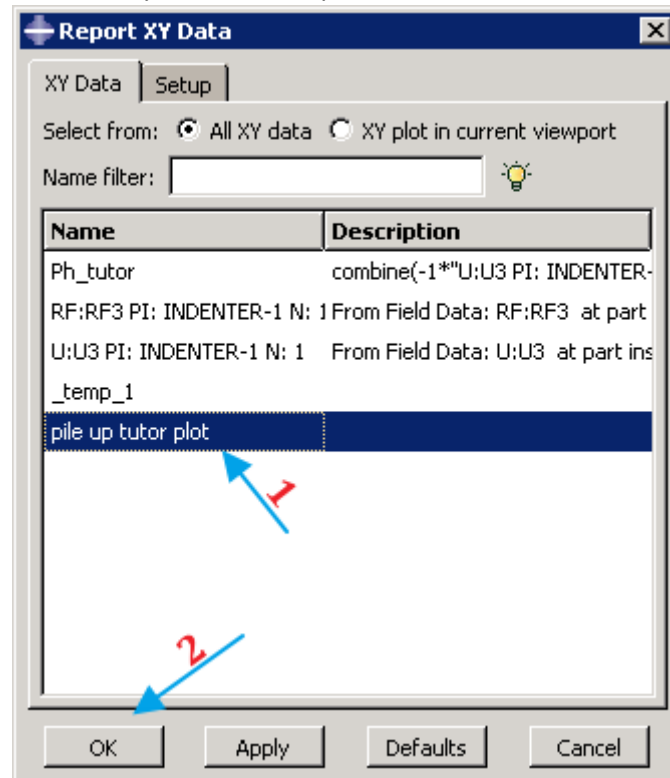
15) Give a name you can identify e.g. "pile up tutor plot", then click "OK".



16) Click "Report XY" to report the pile up data



17) Select “pile up tutor plot” as the one you’d like to report, click “OK”.



18) Click as in sequence as in Fig. 4.6

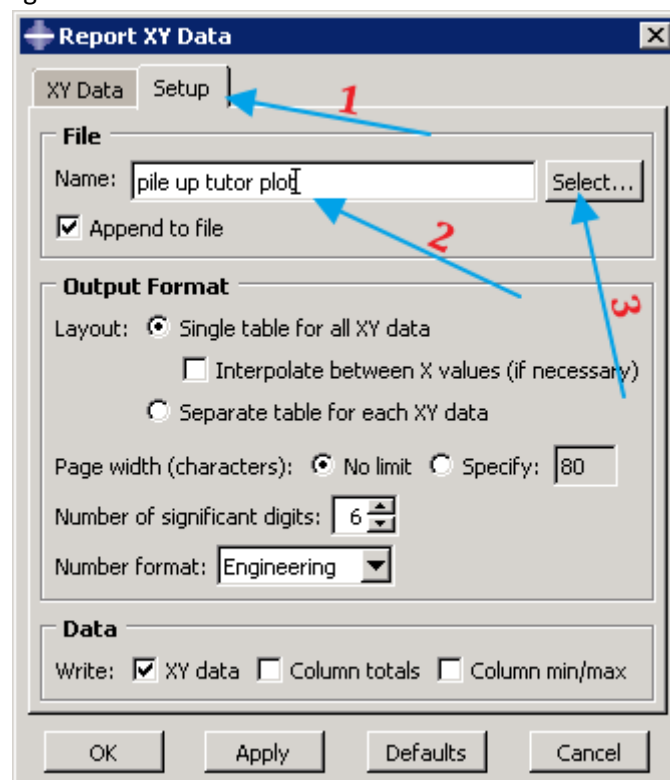
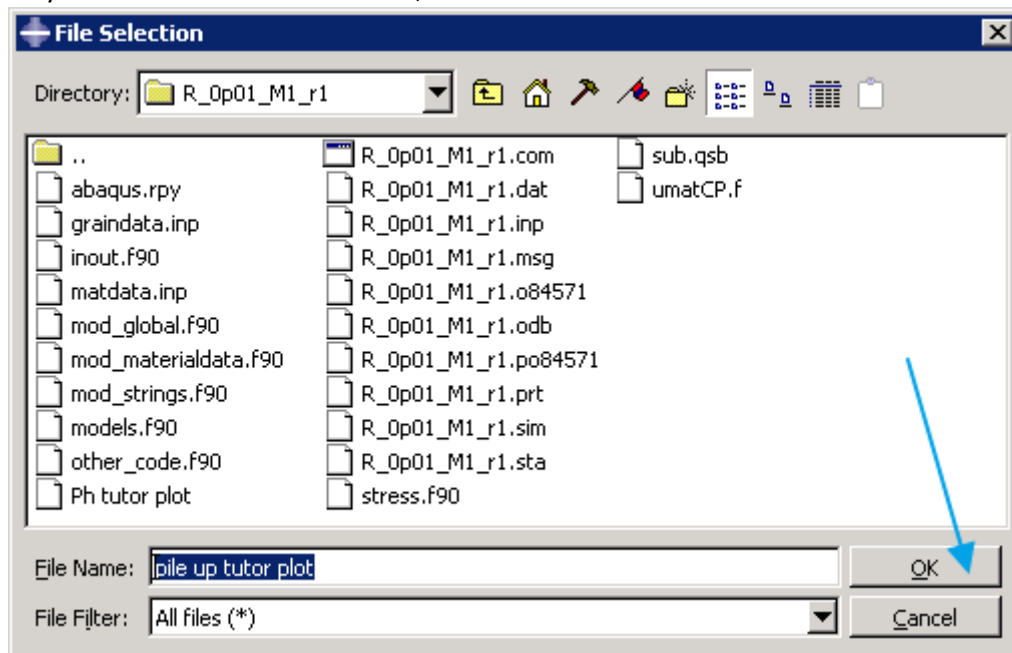
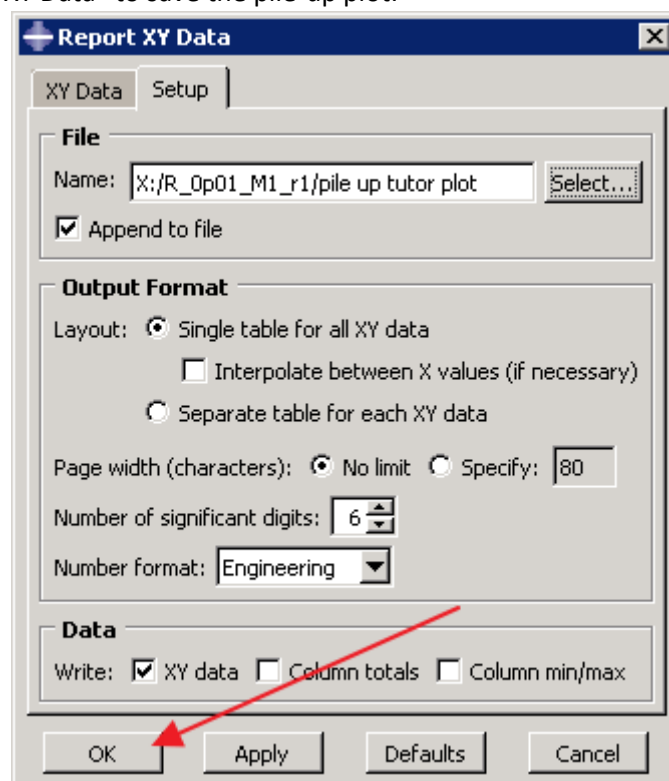


Fig. 4.6 click 3 is for checking the routine i.e. the file where this data is to be saved

19) If you are sure you can find the data in the file, click “OK” to exit.

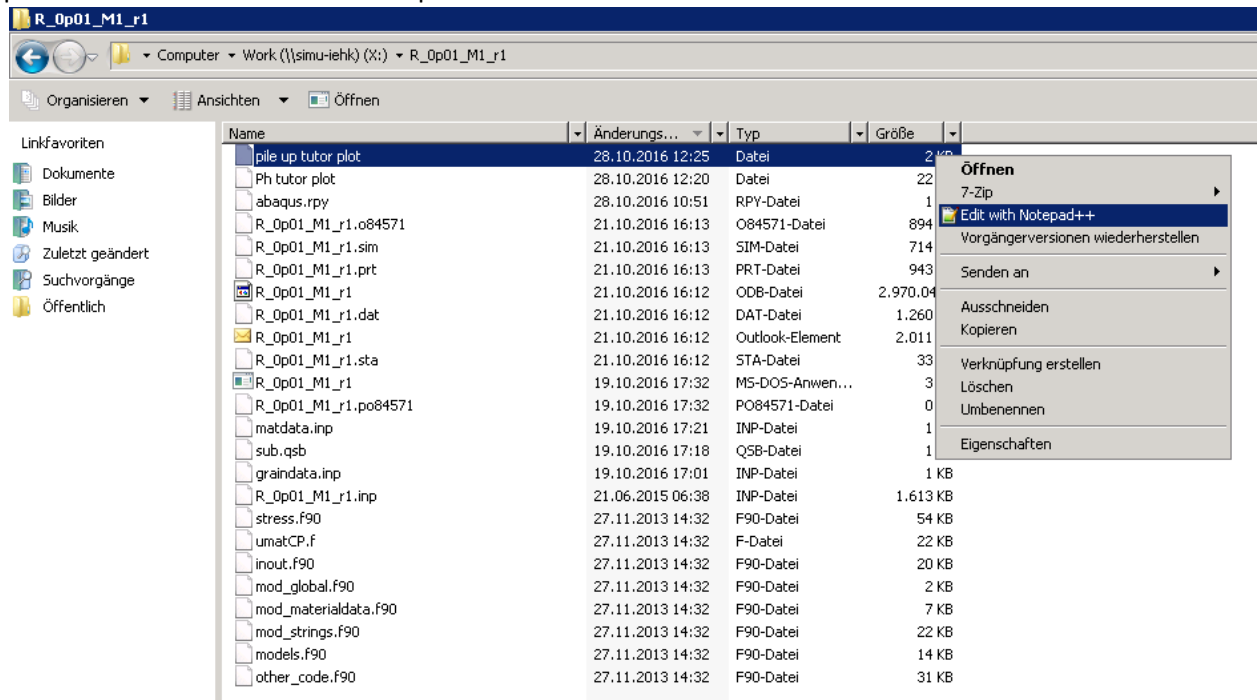


20) Click “OK” under “Report XY Data” to save the pile-up plot.





## 21) Open the file in the folder with Notepad



## 22) This is the pile-up plot you saved.

