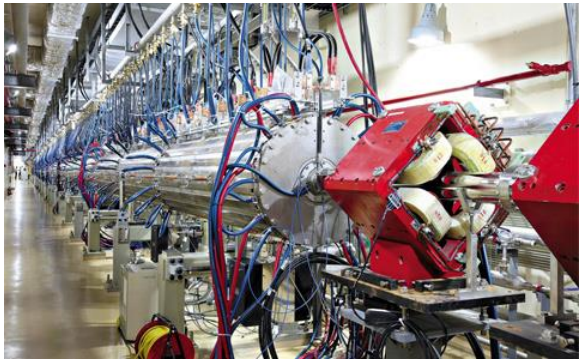
August 4th - 10th, 2023, PAL, Korea



한국원자력연구원 Korea Atomic Energy Research Institute

과학기술연합대학원대학교 UNIVERSITY OF SCIENCE & TECHNOLOGY

Hands-on Training with ELEGANT Code

- How to install/use ELEGANT on Fedora-36 Linux -

The 6th International School on Beam Dynamics and Accelerator Technology (ISBA23)

August 3rd to 12th, 2023
Pohang Korea
Hosted by KAERI & KAPRA
Co-organized by Hiroshima Univ.

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Outline

- ☐ Acknowledgements & Y. Kim's Other Notes
- ☐ Important Note before Fedora Linux Installation
- ☐ How to Install Fedora-36 Network Installation Everything
  - Downloading Hybrid ISO Image of Fedora-36
  - Fedora Media Writer and Burning Bootable USB
  - Installation of Fedora-36 Linux
- ☐ Fedora-36 Post Installations
  - Update Fedora to get the last Software
  - MATE Desktops
  - TCP Wrapper
  - TCSH Shell
  - Initial Configuration dot Files (.cshrc /umask.alia .env-XXX)
- ☐ Linux Directory Structure and Basic Linux Commands
  - Linux directory structure
  - chmod/setuid, setgud, sticky bit
  - chown and chgrp
  - vi editor

Outline

☐ Installation of ELEGANT Code on Fedora-36 Linux

- Downloading ELEGANT Linux RPM Binaries
- Installation of ELEGANT on Fedora-36 Linux
- Configuration dot Files for ELEGANT Code

☐ How to use ELEGANT Code and SDDS files

- Running ELEGANT Code with a Sample Input
- How to use SDDS Toolkit

☐ Covering Topics during Hands-on Training with ELEGANT Code

- Basic Linux Commands and Installation of ELEGANT Code on Fedora-36
- How to use ELEGANT Code and SDDS files
- Design of Bunch Compressors under Coherent Synchrotron Radiations (CSR)
- Design of FODO Lattices for Beam Diagnostics and Beam Transportation
- Design of XFEL Driving Linacs under the Short-range Wakefields
- Design of Compact Storage Ring
- Design of MBA based 4th Generation Synchrotron Light Source
- Design of Booster and Rapid Cycling Synchrotron (RCS)
- Study on Jitter and Tolerance with ELEGANT Code

☐ Appendix - Installation of ELEGANT with Cygwin on Windows 7/10/11

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My Other Lecture Notes

Yujong Kim's Other Lecture Notes at Idaho State University, KAERI WCI, POSTECH, KAIST, UST, VITZRONEXTech, Korea-Japan Joint Summer School, KAERI-KBSI Accelerator School, and ISBA.

☐ **Basic Accelerator Physics**
- **Magnets and Transverse Motion in Accelerators**
- **RF System and Longitudinal Motion in Accelerators**

☐ **Advanced Accelerator Physics Tutorial for XFEL Projects**
☐ **Accelerator Beam Diagnostics**
☐ **Linux Basic for Physicists**
☐ **Laser Compton Scattering (LCS)**
☐ **RF Technology and Electron Linear Accelerators**

There are my lecture notes on beam dynamics for KoPAS2015. There are also my lecture notes on RF system, Linac, Beam Dynamics, Accelerator Simulation for ISBA18 ~ ISBA23.

You can obtain them by sending an email to Yujong Kim: yjkim3488@gmail.com, yjkim@kaeri.re.kr or with facebook

Important Note before Fedora Linux Installation

- For the hands-on training with ELEGANT code, we will use Fedora Linux.
- If you have already installed ELEGANT code on your Linux laptop, please move to Page No. 59 to run sample files of ELEGANT on your laptop.
- If you do not have any experience on Linux installation, first of all, please ask Fedora Linux installation to your friends, who know Linux installation well.
- You may use Windows 10/11 for the hands-on training with ELEGANT code. However, our training will be based on Fedora Linux instead of Windows 10/11.
- If you want to install Fedora Linux on an SSD in your laptop with the dual boot option, you have to backup your data on Windows 10/11 before your installation. Or you may also install Fedora Linux on an external SSD or flash memory card with a size bigger than 32 GB.
- We assume that students will use Fedora-36 64 bit for the hands-on training with ELEGANT code, and we may help any ELEGANT installation problem if you use iso image of Fedora-36 64 bit network installation everything (see next pages). We can't support to solve ELEGANT installation problem if you use other OSs due to the limited time during the ISBA school period.

Installation of Fedora-36 64 bit Linux OS

If you already have Linux OS, please skip here and move to Post Installation at Page No. 16.

If you use other OS, please check whether your ELEGANT code works properly with the sample input files without any problem before the ISBA school. On the sample input files, please see Page No. 59.

Downloading of Fedora-36 Linux Everything

☐ **On one Windows 7/10/11 PC, download the hybrid ISO image of Fedora-36 64 bit network installation everything from Fedora Alternative Downloads site:**

- From a following Fedora-36 Download Site:
- https://archives.fedoraproject.org/pub/archive/fedora/linux/releases/36/Everything/x86_64/iso/
- Please download Fedora-36 Network Installation Everything:
  Fedora-Everything-netinst-x86_64-36-1.5.iso (about 670 MB)

- For other versions, you can find them from
- https://archives.fedoraproject.org/pub/archive/fedora/linux/releases/
  Then, go /Your Version No/Everything/X86_64/iso/ directory

- Please note that Fedora-37 is not pre-built by ELEGANT yet (2022.11.20)
- For download details, please see:
  https://docs.fedoraproject.org/en-US/fedora/latest/install-guide/Downloading_Fedora/
  https://docs.fedoraproject.org/en-US/docs/

☐ **If you download other image instead of the network installation everything, later, you have to install many missing packages and libraries to install ELEGANT code. To avoid those additional installations, we strongly recommend to download Fedora-Everything- netinst-x86_64-36-1.5.iso from the alternative downloads site.**

☐ **Note that you will need a high speed internet connection during the installation.**

Preparing USB Fedora Bootable Media

- ☐ On the same Windows PC, download the latest Windows Installer file from
  - https://getfedora.org/fmw/FedoraMediaWriter-win32-latest.exe
- ☐ Then, run FedoraMediaWriter-win32-latest.exe to install Fedora Media Writer on the same Windows 7/10/11 PC.
- ☐ Insert one blank USB flash memory card with a size bigger than 4 GB into the same Windows 7/10/11 PC
- ☐ Then, run Fedora Media Writer from the same Windows PC.
- ☐ Then, select the proper location of your pre-downloaded Fedora iso image; Fedora-Everything-netinst-x86_64-36-1.5.iso and your USB memory card.
- ☐ Then, start writing of Fedora boot image on the USB card.
- ☐ Now, you have the Fedora Bootable USB card, which can not be readable on the Windows PC.
- ☐ On above processes, you can see more details from following sites:
  - https://docs.fedoraproject.org/en-US/fedora/latest/install-guide/
  - https://docs.fedoraproject.org/en-US/fedora/latest/install-guide/install/Preparing_for_Installation/
  - https://www.debugpoint.com/fedora-media-writer/
  - https://www.addictivetips.com/ubuntu-linux-tips/fedora-media-writer-fedora-install-usb/
  - https://computingforgeeks.com/install-fedora-steps-with-screenshots/

Firmware Configuration to install Fedora-36

☐ Please choose a laptop with a sufficient specification to install Fedora Linux and ELEGANT code:

- Fedora recommends 32 GB disk space and 4 GB RAM for installation and running successfully.
- It is possible to install on an external USB flash memory or SSD with a size bigger than 32 GB.
- Normally, Fedora Linux works well even though your laptop is somewhat old one, which will be sufficient for Fedora-36 Linux installation.

☐ Before installation, please update your UEFI (or BIOS) firmware to avoid any booting issues.

- All laptop manufactured in 2012 or later have a Unified Extensive Firmware Interface (UEFI).
- Before 2012, it has BIOS firmware instead of UEFI.
- Please make sure your UEFI firmware is updated to the latest version before attempting to install Fedora 36 to resolve some common Boot Issues.
- If your laptop is not so old, it will work well without the UEFI firmware update.
- If you do not know how to update UEFI, please ask PC engineers or your friends who know it well. Or just do Google search.
- Warning: Once you install Fedora under one firmware mode (UEFI or BIOS), you can not switch your mode between UEFI and BIOS system after Fedora installation. The system must run on the same firmware mode, which it was installed on.
- For example, if you perform the Fedora installation on an UEFI system in UEFI mode, and then switch it to BIOS compatibility mode, Fedora will no longer boot and will require a reinstallation in order to be booted.

Priority of Bootable Devices

☐ For the dual boot installation, please install your two operating systems (Windows 7/10/11 and Linux) under the same firmware mode.

☐ Before Fedora installation, you may modify your BIOS or UEFI firmware if you want to do by using a special button (ex, F2) during booting.

- For example, I chose a following configuration for the single boot installation on an internal SSD with a SAMSUNG laptop, which is made in 2015.
  Under Boot menu:
  - Secure Boot Control: Off
  - OS Mode Selection: CSM and UEFI OS

☐ Before Fedora installation, please reboot your laptop after plugging in the Fedora-36 bootable USB to your laptop. Please re-enter BIOS or UEFI configuration setup during the booting by pushing a special key (ex, F2).

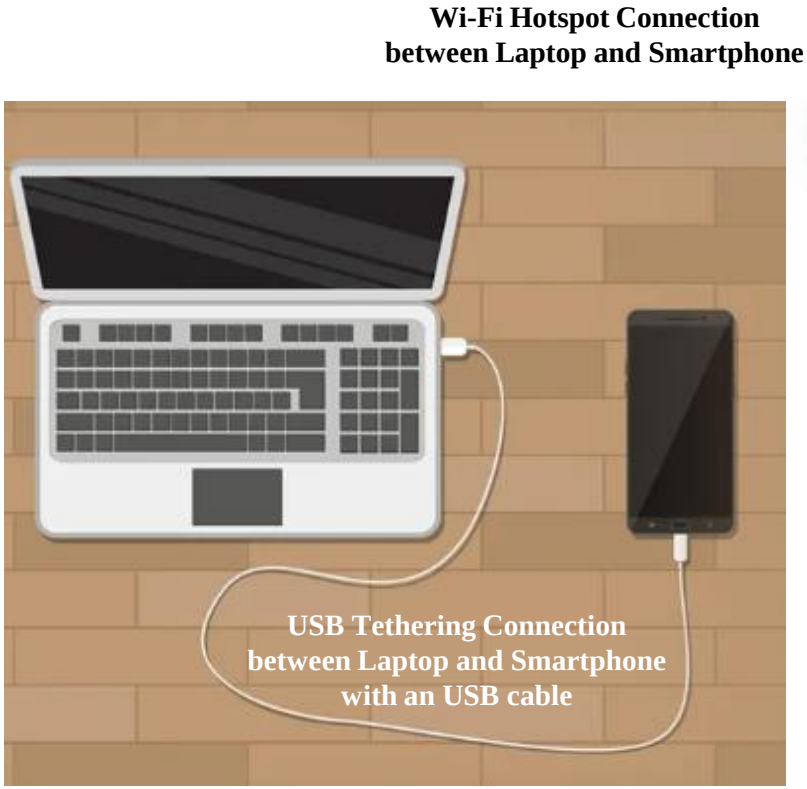
☐ Then, now, you can see your bootable USB card in the list of bootable device option in the configuration. Please note that your laptop can not detect the USB card until you reboot your laptop even though you plugged in the USB card.

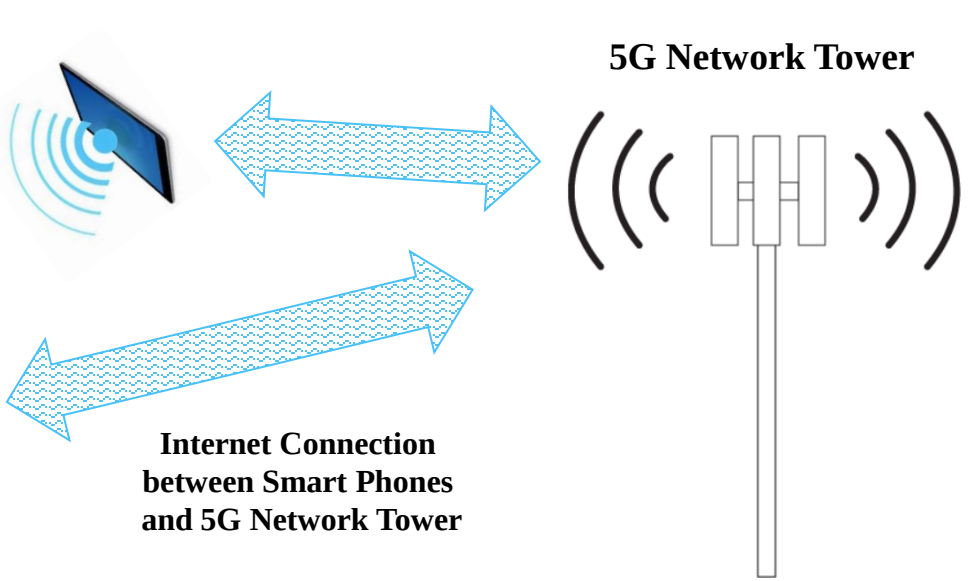
☐ Please move your bootable USB to the top priority bootable device in the booting device options.

Installation of Fedora-36 & Dual Boot Option

☐ Then, reboot the laptop to install Fedora

- **When it is rebooted, choose a proper USB card with the bootable Fedora-36 image**
- **During installation, you may use Wi-Fi hotspot (or USB cable) Tethering function in your smart phone to connect your laptop to a high speed internet. You need turn on Wi-Fi Ethernet card and USB cable connection for USB Tethering.**





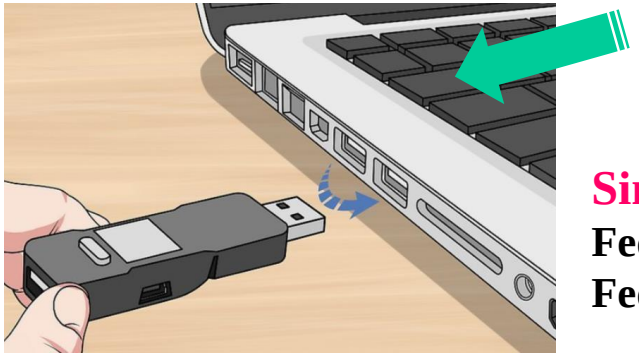
USB Tethering: an USB cable between a smart phone and your Laptop is needed to connect the high speed internet.

https://how2do.org/how-to-activate-the-hotspot-on-android-to-share-internet-in-wifi-bluetooth-or-usb/

Installation of Fedora-36 & Single Boot Option

☐ **To install Fedora-36 step-by-step, please visit following sites:**

- https://docs.fedoraproject.org/en-US/fedora/latest/install-guide/install/Installing_Using_Anaconda/
- https://computingforgeeks.com/install-fedora-steps-with-screenshots/
- https://dellwindowsreinstallationguide.com/fedora-36/
- https://dellwindowsreinstallationguide.com/fedora-34/
- https://youtu.be/o9Lmjj-J3KA
- https://jfearn.fedorapeople.org/fdocs/en-US/Documentation/0.1/html/Fedora_Multiboot_Guide/BOOT-BIOS_or_UEFI.html
- https://ostechnix.com/install-fedora/
- https://linuxhint.com/install-fedora-workstation-35-usb/



USB Card: Fedora Bootable Image

All parts of Internal SSD: Fedora OS will be installed

Single Boot Mode Installation with an Internal SSD

Fedora Bootable Image Source: USB flash memory card

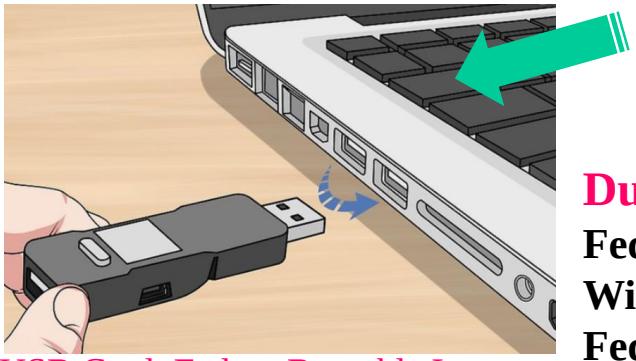
Fedora OS Installation Site: Internal SSD

Fedora OS will be transferred from a Bootable USB card to an Internal SSD.
(All data in the internal SSD can be deleted if you install it with the single boot mode.

Installation of Fedora-36 & Dual Boot Option

☐ **To install the dual (Fedora-36 & Windows 7/10/11) boot installation, you can find more details from following sites:**

- **https://youtu.be/GCWXNAAB4f0**
- **https://youtu.be/Cwr3nNiQ2To**
- **https://www.xda-developers.com/dual-boot-windows-11-linux/**
- **https://itsfoss.com/install-ubuntu-1404-dual-boot-mode-windows-8-81-uefi/**



USB Card: Fedora Bootable Image

Windows 10 — 1st part of Internal SSD: Windows OS was installed

fedora — 2nd part of Internal SSD: Fedora OS will be installed

Dual Boot Mode Fedora Installation with an Internal SSD

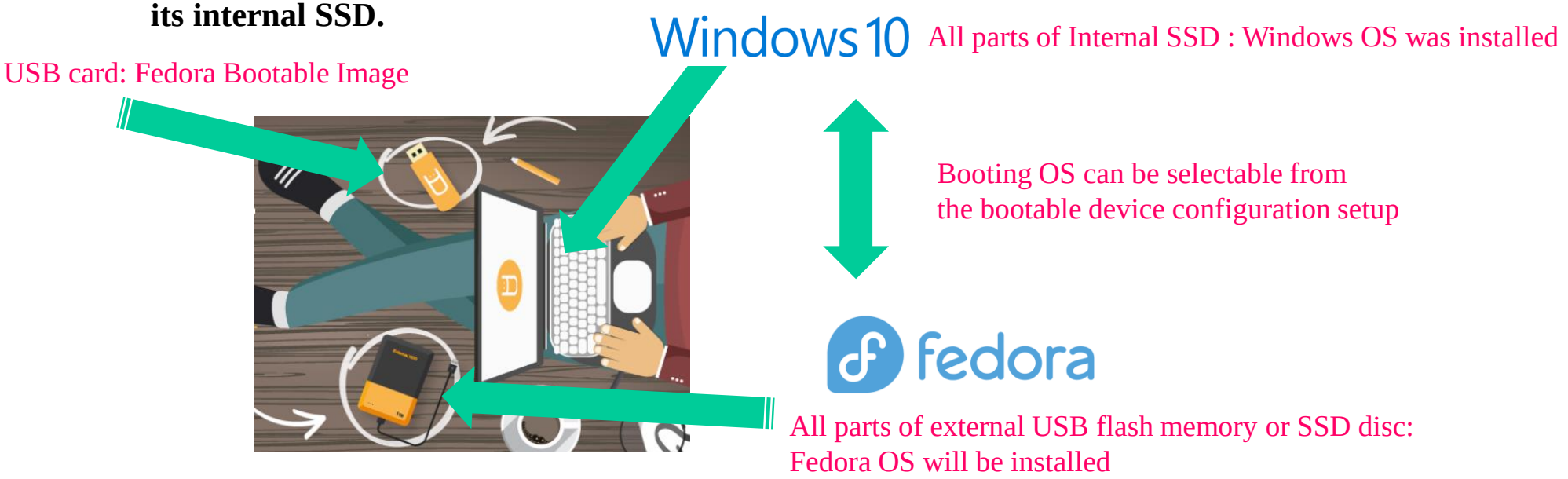
Fedora Bootable Image Source: USB flash memory card
Windows 7/10/11 Installed Site: 1st Partition of the Internal SSD
Fedora OS Installation Site: 2nd Partition of the Internal SSD

Windows 7/10/11 was already installed on the 1st partition of the internal SSD, and Fedora OS will be transferred from the bootable USB card to the 2nd partition of the internal SSD. We need shrink (or readjust) of the Windows 7/10/11 SSD partition to make a new space for Fedora installation. During this installation, accidently, all data in the internal SSD may be lost. Therefore, you have to backup all data in Windows OS in advance to avoid any data loss.

Recommended Safe Way for the Dual Boot

☐ **Instead of complicated dual boot installation, the most simple way to use dual boot OS is can be obtainable by installing Fedora-36 on an external USB flash memory card or SSD disc with a size of bigger than 32 GB, while Windows 7/10/11 is installed on an internal SSD disc. Windows 7/10/11 or Fedora can be selectable by changing the top priority bootable device in the booting device options in BIOS or UEFI configuration setup.**

- **Windows 7/10/11: Internal SSD Disc**
- **Fedora-36 Linux: External USB Interfaced Flash Memory or SSD Disc (≥ 32 GB)**
- **If you have an old second laptop, you may install Fedora with the single boot option on its internal SSD.**



What should be done after installation of Fedora-36

If you already have Linux OS, please check what you already did Post Installation actions after installation of your Linux.

Post Installation Actions

- There are various post installation actions after Fedora-36 installation, you can see more details from following sites:
  - https://docs.fedoraproject.org/en-US/fedora/latest/install-guide/install/After_Installation/
  - https://youtu.be/RrRpXs2pkzg
  - https://youtu.be/a3ePEjpg3lU
  - https://www.hackingthehike.com/fedora36-guide/
  - https://fosspost.org/things-to-do-after-installing-fedora-36/
  - https://www.debugpoint.com/10-things-to-do-fedora-36-after-install/

- By using Google search (search keyword: Fedora-36 post installation, Fedora-35 post installation, or Fedora 36 After install), you can find various helpful post installation actions such as OS updating, RPM Fusion, printer setup, media player, additional desktops, and so on.

Post Installation of Fedora-36 64 bit Linux OS

If you already have other Linux OS, please do same (or similar) things at this section for your Linux OS.

If you use other OS, please check whether your ELEGANT code works properly with the sample input files without any problem before the ISBA school. On the sample input files, please see Page No. 59.

Post Installation – Update Fedora Software

☐ After checking network connection, please update all installed Fedora OS packages with their last versions by following steps in one terminal:

- Login as the root, system administrator by typing su in a terminal. You need root password.
  su
- Checking software update
  dnf check-update
- Install software update
  dnf upgrade
- Then, reboot laptop to update change
  shutdown -r now

The most easy way for Internet Connection

Smart Phone
USB or Wi-Fi Hotspot Tethering

☐ You can also use Software application in System Tools of Gnome Desktop

- Applications → System Tools → Software → Updates
- Then, reboot laptop to update change
  shutdown -r now

☐ You can find more details by visiting a following site:

- https://linuxopsys.com/topics/update-fedora-linux-to-get-latest-software

☐ For network connection, please find details from following sites:

- https://certsimple.com/how-to-connect-fedora-to-wifi/
- https://www.makeuseof.com/tag/3-self-hosted-dropbox-alternatives-tested/

Post Installation - Desktops and Useful Tools

☐ To install group packages, please use dnf group under root login

☐ To check and search list of available package group

su

→ this needs root password to login as the root, system administrator.

dnf group list To list group packages

dnf list To list all packages

→ they will display available package group or single packages, which you can install additionally.

dnf search keyword

→ this can do package search with a keyword

☐ To install various other Desktops, which you can choose them when you login

dnf group install "MATE Desktop"

dnf group install GNOME

dnf group install "Xfce Desktop" "LXDE Desktop" "LXQt Desktop"

☐ To install various System Administration Tools

dnf group install "System Tools"

☐ To install compression tools and gimp, which is a powerful graph application

dnf install -y unzip p7zip p7zip-plugins unrar

dnf install -y gimp

Post Installation – Development Tools & Libraries

☐ To install development tools and libraries

dnf group install "Development Tools" "Development Libraries“
dnf group install "C Development Tools and Libraries"
dnf group install "D Development Tools and Libraries”

☐ To install GNU Scientific, Linear Algebra, and X-Windows related Libraries

dnf install gsl-devel
dnf install atlas atlas-devel lapack-devel blas-devel
dnf install motif-devel

Post Installation - TCP Wrapper Setting

☐ To block any possible hacking from hackers, please block all services except sshd service from known computer by installing TCP Wrapper

su

dnf install tcp_wrappers

By using an editor (gedit, vi, emacs), please edit /etc/hosts.deny and /etc/hosts.allow files as follow screens:

sshd: 1.1.1. ← for a wild card to allow all computers from 1.1.1.0 to 1.1.1.255

/etc/hosts.deny

/etc/hosts.allow

https://en.wikipedia.org/wiki/TCP_Wrappers

Post Installation - tcsh Shell and dot files

☐ To use the tcsh, which is an enhanced version of csh shell (= command-line-interpreter), we can install tcsh from dnf package installation method:

which tcsh

→ this will display a path (ex, /usr/bin/tcsh (= /bin/tcsh), where tcsh command is installed)

If your system does not have tcsh command, then, please install it

su

dnf install tcsh

→ tcsh will be installed at /bin/tcsh, which is the same linked thing with /usr/bin/tcsh

☐ edit /etc/passwd and modify bash into tcsh in yourID to use tcsh

Be careful not to generating any typing error in editing /etc/passwd, which may induce login failure later.

☐ Download tcsh environmental configuring dot files (env64.tar file) from ISBA school ELEGANT related download website [1]

☐ Launch a new terminal with yourID (instead of the root)

☐ Then, in the new terminal, extract the tar file at your home directory by typing

tar xvf env64.tar

→ Then, logout and relogin with yourID to update the modifications

☐ Let's see details on dot files (.cshrc, .alias, .env-xxx) at the next pages

chsh command can also change your shell: https://explorelinux.com/how-to-setup-csh-tcsh-on-fedora-linux/

Post Installation - .cshrc

- .cshrc is the Linux/Unix shell (csh or tcsh) startup configuration file, which should be located at your or root's home directory (/home/yourID or /root).
- .cshrc file contains or performs such functions as set variables, define aliases, perform initializations and various other tasks.
- .cshrc is similar to autoexec.bat and config.sys files in MS Windows and DOS OS.
- After modification of .cshrc, users should perform [Important Thing]
  source .cshrc at his home directory to update the modification at one terminal
  or logout, then relogin to update the modification at all terminals
  or open a new terminal to update the modification only at the terminal.

Post Installation - .cshrc

Example of one .cshrc

```
umask 022 ← controlling of file permission.
set path=(/usr/local/bin /usr/local/include /usr/bin /usr/sbin /bin /sbin /usr/share /etc /usr/X11R6/bin /usr/X11R6/include /home/userID/bin .)

if ( $?prompt ) then
        set history=150
endif

set filec ← substitute directory name to be completed when Tab key is pushed

set prompt = ("`uname -n`[\!]# ")
set cdpath = ( ~ )
limit coredumpsize    0

setenv  LD_LIBRARY_PATH  /usr/local/lib:/lib:/usr/lib:/usr/lib/cernlib/2006/lib:/usr/lib/cernlib/2006-g77/lib:/usr/local/pgplot:/usr/lib/dri

setenv MANPATH /usr/man:/usr/local/man:/usr/share/man
setenv INFOPATH /usr/local/info:/usr/share/info
```

Post Installation - .cshrc

Example of one .cshrc - continued

```
setenv MOZILLA_HOME /usr/dt/appconfig/netscape
setenv CLASSPATH /usr/dt/appconfig/netscape/java
setenv JAVAHOME /usr/local/jre-1.5.0.06

# PGPLOT Setting for ASTRA Plotting
setenv PGPLOT_DIR /usr/local/pgplot
setenv PGPLOT_DEV /xwin
setenv PGPLOT_BUFFER yes
setenv PGPLOT_BACKGROUND white
setenv PGPLOT_FOREGROUND black
setenv PGPLOT_FONT /usr/local/pgplot/grfont.dat

# IDL & Xgenesis Setting
source /usr/local/itt/idl/bin/idl_setup

# MATLAB Setting
setenv MATLAB /opt/matlab/2007b

# MATHEMATICA Setting
setenv MATHEMATICA /opt/mathematica/5.2
```

Post Installation - .cshrc

Example of one .cshrc - continued

```
# KDEHOME
setenv KDEHOME /home/yjkim/.kde

# SIMPLEX HOME
setenv SIMPLEX /usr/local/simplex-1.3.0

# Printer Setting
setenv PRINTER Ricoh-MP-C5000  ← default printer for userID

source ~/.alias                 # Aliases
source ~/.env-adobe9            # Acrobat
source ~/.env-epics64           # EPICS
source ~/.env-apsoag            # APS SDDS, ELEGANT
source ~/.env-psfish            # POISSION & SUPERFISH
source ~/.env-absoft            # ABSOFT Pro Fortran
```

Note that we have to add paths of binaries (ex, executable commands) and head files (ex, *.h) in path and libraries (*.so or *.a) in LD_LIBRARY path after installing a new software package!

Post Installation - .cshrc/umask

- umask is a command that determines the settings of a mask that controls how file permissions are set for newly created files. In other words, the mask acts as a last-stage filter that strips away permissions as a file is created.
- Four numbers means mask of permissions for (setuid, setgid, sticky bit), user, group, others

Octal Umask values : Permission (← opposite of chmod modes)
0: read, write and execute
1: read and write
2: read and execute
3: read only
4: write and execute
5: write only
6: execute only
7: no permissions

umask 022 : user = read, write, and execute, group and others = read and execute
umask 077: user= read, write, and execute, group and others = no permission

https://www.cyberciti.biz/tips/understanding-linux-unix-umask-value-usage.html
https://en.wikipedia.org/wiki/Umask
https://en.wikipedia.org/wiki/File_permissions
https://en.wikipedia.org/wiki/Modes_(Unix)

Post Installation - .alias

alias is a helpful way to predefine or to redefine commands. To run a command without the pre-defined alias, \ should be located in front of the command.

ex) \cp

Example of one .alias, which has lots of aliases.

```
# aliases for various commands
alias ll     'ls -l'
alias ls     'ls --color=auto'
alias su     'su -l'
alias top    'top -n 18'
alias h      'history'
alias c      'clear'
alias rm     'rm -i'
alias mv     'mv -i'
alias df     'df -k'
alias dusort 'ls |xargs -n1 du -sk |sort -nr'
alias cx     'gcc -I/usr/X11R6.3/include -lX11 -lsocket -lgen -lXm -lXt -lXext'
alias cp     'cp -i'
alias ssh    'ssh -X'
alias mad    '/usr/local/mad-8.23.06/mad -accel'
```

Post Installation - .alias

alias is a helpful way to predefine or to redefine commands.

Example of one .alias, which has lots of aliases - continued.

```
# aliases for distiller and ghostscripts
alias gslp  'gs -dNOPAUSE -sDEVICE=pswrite -r600 -sPAPERSIZE=a4 -sOutputFile=\|lp -d hp8550n'
alias htt    '/usr/openwin/bin/htt -lc_basiclocale ko'
alias xmmsen   'setenv LANG C:xmms'
# alias acroread3 'setenv LC_CTYPE en_US;/usr/local/bin/acroread -xrm /usr/local/adobe/acrobat-3.01/Exchange/sparcsolaris/app-defaults/AcroExch'
#alias acroread 'setenv LANG en_US;/usr/local/adobe/acroread-5.10/bin/acroread -xrm /usr/local/adobe/acroread-5.10/Reader/intellinux/app-defaults/AcroRead'
alias txt2pdf 'txt2pdf -c /usr/local/txt2pdf-1.1/Tests/test.cfg'
alias lyx     'setenv LANG C;/usr/bin/lyx -geometry 1200x1000'

alias distills 'distill -pagesize 590 890 pts -v'
alias distillr 'distill -resolution 600 -colordownsample off -v'
alias  'distill -resolution 600 -colordownsample off -pagesize 600 840 pts -v'
alias distill_pac 'distill -resolution 600 -colordownsample off -graydownsample off -monodownsample off -colorres 600 -grayres 600 -monores 600 -encodecolor off -coloracs off -compresstext off -pagesize 595 845 pts -v'
```

Post Installation - .alias

alias is a helpful way to predefine or to redefine commands.

Example of one .alias, which has lots of aliases - continued.

```
# aliases for distiller and ghostscript
alias gs2eps 'gs -sDEVICE=bbox'
alias pdf2eps 'pdf2ps -sDEVICE=bbox' -r600
alias ps2pdfa4 'ps2pdf14 -sPAPERSIZE=a4 -r600'
alias ps2pdfletter 'ps2pdf14 -sPAPERSIZE=letter -r600'
alias dvi2pdf  'dvipdf -sPAPERSIZE=letter -r600'
alias tiff2eps 'tiff2ps -a -e'
alias eps2png 'convert -density 600x600'
alias eps2fig 'pstoedit -f fig'

# commands for display
alias dis    'set display=\!*\:0;setenv DISPLAY $display'
alias ndis   'set display=141.xxx.yyy.\!*\:0;setenv DISPLAY $display'
alias vt100  'setenv TERM vt100'

# command for from DOS to UNIX file conversion
alias dos2unix'set file=\!*;tr -d '\r' < $file > ttmp;mv ttmp $file'
```

Post Installation - .alias

alias is a helpful way to predefine or to redefine commands.

Example of one .alias, which has lots of aliases - continued.

```
# commands for printing
#alias a2psp    'a2ps -ns -nP -R -1 -nn -nB -l80'
#alias a2psl    'a2ps -ns -nP -r -1 -nn -nu -nB -l55'
alias a2psl'a2ps -r -f7.78'
alias a2pslzoom         'a2ps -r -f5.78'
alias a2pspmad          'a2ps -s2 --rows=2 --columns=1 -R -l 160'
alias a2pslmad          'a2ps -s2 --rows=1 --columns=1 -r -l 160'
alias a2psp1            'a2ps -s2 -1'
alias a2psp2            'a2ps -s2 -4'
alias a2pspunch         'a2ps --medium=Punched'
alias xa2psl   'xa2ps -l -nP'
alias xa2psp   'xa2ps -p -nP'
```

Post Installation - .alias

alias is a helpful way to predefine or to redefine commands.

Example of one .alias, which has lots of aliases - continued.

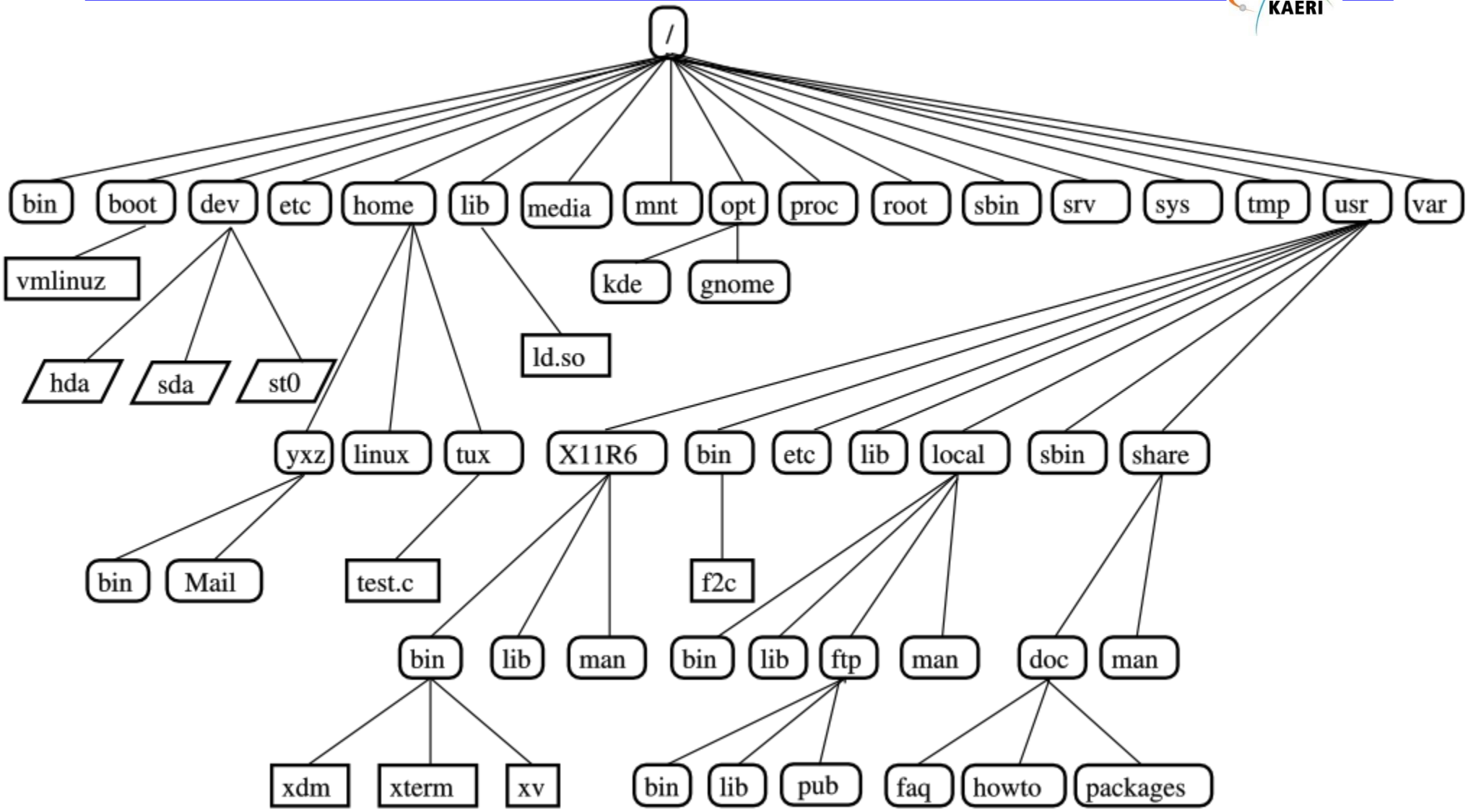
```
alias gsview 'ghostview -a4 -magstep -2 -color -portrait -resolution 100 -bg ivory'
alias lprm   'lprm -PHP-LaserJet-4050'
alias lpq    'lpq -PHP-LaserJet-4050'

# commands for Terminal fonts
alias pilgi   'hanterm -T "HANTERM(pilgi)"  -bg white -hfn -kaist-philgi-bold-r-normal--16-160-75-75-c-160-johabs-1 -ls -sb +rv&'
alias gothic 'hanterm -T "HANTERM(gothic)" -cr black -bg ivory -fg black -hfn -kaist-gothic-medium-r-normal--16-160-75-75-c-160-johabs-1 -ls -sb &'

# commands for networking
alias xxx 'ssh userID@xxx.isu.edu'
alias sun 'ssh userID@123.123.3.14'
alias zzz 'sftp  userID@zzz.desy.de'
```

Linux Directory Structure and Basic Commands

Please read this section even though you know well on Linux commands

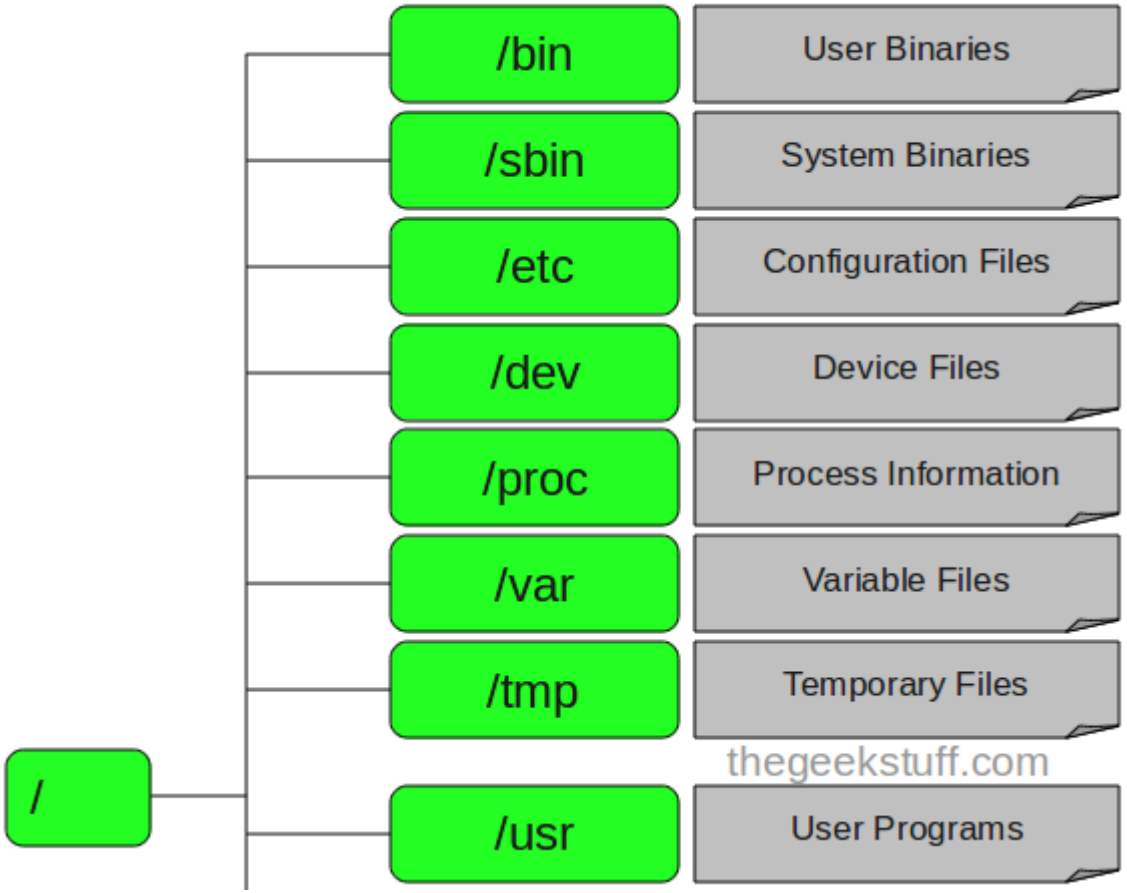
If you use other OS, please check whether your ELEGANT code works properly with the sample input files without any problem before the ISBA school. **On the sample input files, please see Page No. 59.**

Directories in Linux



https://www.linuxtopia.org/online_books/suse_linux_guides/SLES10/suse_enterprise_linux_server_installation_admin/sec_bash.html

Directories in Linux

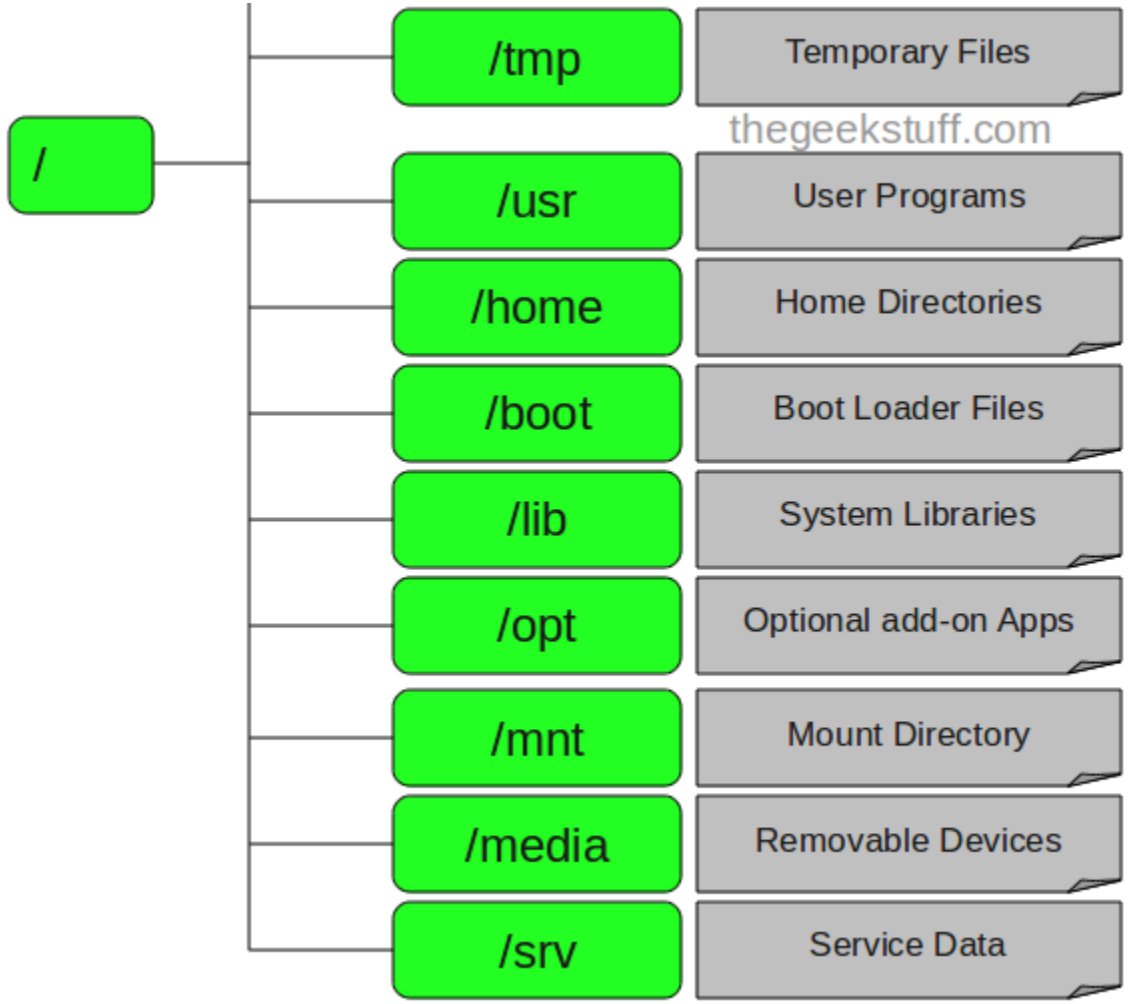


/usr/local/bin
/usr/local/include ← **Software Installation Point**
/usr/local/lib

courtesy of thegeekstuff.com

Directories in Linux

directories - continued



/home/yourID

***.so and *.a /lib/modules for 64-bit see /lib64 too!**

Commercial Software

HDD mounting point

old USB mounting point new: /run/media/yourID

courtesy of thegeekstuff.com

Basic Linux Commands - chmod modes

☐ chmod (change mode) is the name of a Unix shell command to change the access to file system objects (including files and directories).

chmod [options] mode (file or directory name)

options:

-R recursive, i.e. include objects in subdirectories
-f force, forge ahead with all objects even if errors occur
-v verbose, show objects processed

Octal chmod values : Permission (← opposite of umask)

7: read, write and execute	(+rwx)
6: read and write	(+rw)
5: read and execute	(+rx)
4: read only	(+r)
3: write and execute	(+wx)
2: write only	(+w)
1: execute only	(+x)
0: no permissions	(-rwx) or (=)

chmod -R 755 directory : user = read, write, and execute, group and others = read and execute
chmod 400 file : user= read, group and others = no permission
or chmod a+rwx file / chmod go-rwx file / chmod u-wx file ↔ chmod a+rwx,go-rwx,u-wx file ↔ chmod u=r,go-rwx

Here, a: all, u: user, g: group, o: others, +: adding, -:subtraction, =: having

https://en.wikipedia.org/wiki/Chmod

Basic Linux Commands - chmod / setuid & setgid

If there are four digits in chmod, the first number means setuid (4 or s), setgid (2 or s), or sticky bit (1 or t).

setuid (chmod u+s or chmod 4xxx) setgid (chmod g+s or chmod 2xxx)

When an executable file has the setuid or setgid, normal users on the system with the setuid of setgid permission can run the excutable file and create processes even though they are not the owner of the file. In this case, normally, root is the owner of the executable file.

ex) cd /bin

ls –al su

-rwsr-xr-x root root su

chmod 4xxx command ↔ chmod u+s command

chmod 6xxx command ↔ chmod ug+s command

a: all
u: user
g: group
o: others
+: adding a new permission
-: subtraction an existing permission
=: having the permission

https://en.wikipedia.org/wiki/Setuid
https://en.wikipedia.org/wiki/Sticky_bit

Basic Linux Commands - chmod / Sticky bit

If there are four digits in chmod, the first number means setuid (4 or s), setgid (2 or s), or sticky bit (1 or t).

Sticky bit (chmod u+t or chmod 1xxxx)

When the sticky bit is set, only the item's owner, the directory's owner, or the superuser can rename or delete files. Without the sticky bit set, any user with write and execute permissions for the directory can rename or delete contained files, regardless of owner. Typically this is set on the /tmp directory to prevent ordinary users from deleting or moving other users' files.

ex) cd /
ls -al
drwxrwxrwt root root /tmp
cd /tmp
ls -al
chmod 1755 /home/userID/tmp

https://en.wikipedia.org/wiki/Setuid
https://en.wikipedia.org/wiki/Sticky_bit

Basic Linux Commands - chown & chgrp

To change ownership and group of file or directory, we can use chown and chgrp

chown [options] owner FSO
chgrp [options] group FSO

options:
-R recursive through subdirectories
-v verbosely output names of objects changed. Most useful when "FSO" is a list.
-f force or forge ahead with other objects even if an error is encountered.

ex) chown userID file
chgrp groupID file

To change down to sub-directories, we can add -R option

ex) chown -R userID directory
chgrp -R groupID directory

https://en.wikipedia.org/wiki/Chown
https://en.wikipedia.org/wiki/Chgrp

Basic Linux Commands - vi editor

The vi (visual editor) editor is the default editor that comes with the Linux/Unix OS. There are also alternate editors such as gedit, pico, and emacs.

There are two operational modes (command and insert modes) of the vi editor. The vi always starts with the command mode. In the command mode, letters of your key board will be interpreted as commands, but in the insert mode, the same letters of keyboard will be typed the characters. To enter insert mode, please type in "i" on your key board. Then, "INSERT" will be displayed on the bottom of your terminal. To return to the command mode from the insert mode, hit ESC (Escape) key on your key board.

vi filename (ex, vi testfile.txt)

Please note that both Linux/Unix commands and vi are case-sensitive. The vi editor does not need Enter key after typing a command, the command is not displayed on screen (except with :). For details. see distributed hard copies and following websites:

https://www.cs.colostate.edu/helpdocs/vi.html
https://en.wikipedia.org/wiki/Vi

Basic Linux Commands - Directory or File Related

cd directory name - changing directory or return to your home
cd .. - moving to one upper tree directory
pwd - printing current/working directory
cd ~userID - moving to userID's home directory
mkdir directory name - making a new directory
rmdir directory name - removing an empty directory
\rm -r -f directory name - removing un-empty directory + all subdirectories
tar cvf list of directory or file names - saving files or directories into one tar ball
gzip A.tar or bzip2 - compression of the tar file with *.gz or *.bz2 format
tar xvf B.tar - restoring original files or directories
tar xvf C.tar.gz - restoring original gzip-compressed files or directories
ex) tar cvf PDFfiles.tar *.PDF ← Here * is a wild card
gzip PDFfiles.tar → PDFfiles.tar.gz will be created
cd /home, sudo tar cvf yourIDbackup.tar yourID
→ all files and directories in your home directory will be saved into one tar ball file (yourIDbackup.tar)
gzip yourIDbackup.tar → gzipped yourIDbackup.tar.gz will be created
gzip -d PDFfiles.tar.gz → ungzipped PDFfiles.tar will be created
tar xvf PDFfiles.tar.gz or tar xvf PDFfiles.tar → untarring

Basic Linux Commands - Directory or File Related

ls - listing of files and directories
ls -al - listing with detailed information to see hidden . files
ls -al --sort=time - listing with creating time (recent ones are displayed at top)
ls --color=auto - listing with colorized output
cat filename - showing content of the file without any scrolling
less filename or more filename - scrolling of content of the file
touch filename - creating an empty file
head filename - showing head part of the file
tail filename - showing tail part of the file
cp A B - copying file A into B
cp -R A B - copying directory A into B with sub directories together
cp A B/. - copying file A into a directory B with a same file name A
cp A B/C - copying file A into a directory B with a new file name C
mv A B - renaming file or directory A into B
mv A B/. - moving file or directory A into a directory B with a same name A
mv A B/C - moving file or directory A into a directory B with a new name C
mv * ../. - moving all files + directories to a upper tree directory with a same name
rm A - removing file A
rm -R A - removing directory A

Basic Linux Commands - Useful Others

diff A B - displaying differences in two files A and B
ln A B - linking an existing file A to a new B linked file.
source .file - updating the .file to run the file in current shell
find . -name "*.txt" -print - find all file names with .txt extension by search from current directory to sub directories. Here, * is a wild card meaning all or any.
which A - displaying directory information of the command A
man A - printing manual on command A
grep A - printing lines matching a pattern A
top - displaying or killing running processes
ps - printing all processes running foreground or background
ps -ef | grep A - displaying process ID and so on of a running command A
A & - adding ampersand (&) to run a job A with the background mode.
kill -9 PID - killing a job with PID forcely
nohup A & - keeping running a command or job even after logout
lp -dPRINTER A.ps - printing postscript file (A.ps) to a printer name (PRINTER)
lpq -PPRINTER - showing printer queue status of a printer (PRINTER)
cancel PQUEUE - canceling printer jobs with a queue (PQUEUE)
a2psl A.txt -o A.ps - converting ASCII text file to PS file (see .alias)
ps2pdfletter A.ps A.pdf - converting PS file to PDF file (see .alias)

Basic Linux Commands - Useful Others

ssh A - Secure Shell (SSH) to connect a hostname A
sftp A - Secure file transfer program to connect a hostname A
put filename or get filename
ifconfig - display information on network setting such as IP address and net mask
telnet - login another machine (unsecure)
ftp - file transfer program (unsecure)
rlogin hostname - remote login, add hostname and username (unsecure)
in /home/userID/.rhosts (ex, XXX.physics.isu.edu smartguy)
nslookup hostname - finding registered hostname and IP address from DNS
ping hostname - checking network connection
uname -a - displaying information of the machine
rpm - RPM package manager
dnf - new package manager of RPM based Linux distribution (old: yum)
env - displaying all shell environments
setenv - setting of tcsh and csh environmental variable
echo $ENVNAME - displaying values of environmental variable
who - listing of login users in a server
finger USERID - displaying user's information
last - listing login information

Basic Linux Commands - Useful Others

talk userID - talking with userID
whoami - checking userID
whereis A - finding and listing of location of command A
passwd - change of passwd
exit - exit a terminal
logout - logout
shutdown -h now - showdown computer now
reboot - rebooting your computer (shutdown -r now for rebooting)
su - switching to other userID or system administrator
du -h - estimating HDD usage of file or directory in human readble size (MB, GB)
df -h - reporting free HDD disk space in human readable size (GB)
fdisk -l - listing connected HDDs in your computer
fdisk /dev/sdb - Creating a new Linux partition on the second HDD (/dev/sdb)
mkfs.ext4 /dev/sdb1- format first partition (/dev/sdb1) with ext4 Linux file format
mount - displaying information on HDD mounting or mounting HDDs
mount -t ext4 /dev/sdb1 /mnt/data - mounting /dev/sdb1 partition on /mnt/data
or add its mounting information in /etc/fstab for continuous mounting
umount /dev/sdb1 - umounting /dev/sdb1
fsck.ext4 -cDfty -C 0 /dev/sdb1 - file system checking & scanning bad blocks

Basic Linux Commands - Useful Others

dos2unix - converting DOS text file to Unix text file format to remove \r\n symbol
sed - streaming editor for filtering and transforming text (ex, sed 's/.$//' A B)
sed -i 's/old-text/new-text/g' input.txt for replacing old-text with new-text
cat A > B - generating output of cat A to a new file B
Ctrl + Z - suspending the current foreground job
jobs - listing jobs
bg or fg %A - bring a job number A in to background or foreground running
kill %A - killing job number A
Ctrl + c - killing a current running job

See more Linux/Unix commands and shell script from following websites:
https://opensource.com/article/22/5/essential-linux-commands
https://www.thegeekstuff.com/2010/11/50-linux-commands/
https://comptechdoc.org/
https://www.thegeekstuff.com/2010/05/unix-background-job/
https://www.hostinger.com/tutorials/linux-commands
https://linuxcommand.org/lc3_writing_shell_scripts.php
https://www.computerhope.com/unix/tcsh.htm
https://afni.nimh.nih.gov/pub/dist/doc/htmldoc/educational/shell_and_script.html

Installation of ELEGANT Code on Fedora-36 64 bit

If you already installed ELEGANT code on Linux or Windows /10/11, please check whether your ELEGANT code works properly with the sample input files without any problem before the ISBA school. **On the sample input files, please see Page No. 59.**

Short Introduction of ELEGANT Code

☐ **ELEGANT (ELEctron Generation ANd Tracking) is one of the most powerful accelerator design and simulation codes, which was mainly developed by Dr. Michael Borland of APS.**

☐ **We may use ELEGANT code for various accelerator projects:**

- **Accelerator region at a somewhat higher energy where the space charge force is ignorable.**
- **For electrons, roughly energy $\geq$ 100 MeV for Q ~ 1 nC & I_{peak} ~ 100 A.**
- **If charge is lower, we can use ELEGANT code at a lower energy region.**
- **Specially, it is very useful when we consider geometrical wakefields in linac, incoherent synchrotron radiation, and coherent synchrotron radiation in bunch compressors and dog-leg.**
- **Generally, we can use ELEGANT code to design accelerators for X-ray Free Electron Laser (XFEL) driving linac, MBA based 4th generation synchrotron light source, linear magnet lattice for booster and Rapid Cycling Synchrotron (RCS), beamlines for beam diagnostics and transportation, and so on.**
- **It was designed to use particle tracking with macro-particles.**
- **It also has MPI parallel version (Pelegant).**
- **SDDS Toolkit is required for its postprocessor.**

Websites and Manuals of ELEGANT & SDDS

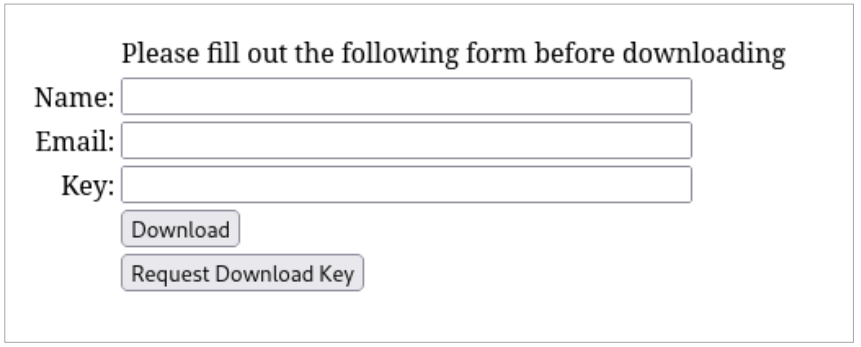
☐ Websites and Manuals of ELEGANT and SDDS Toolkit

- **ELEGANT Website:**
  https://www.aps.anl.gov/Accelerator-Operations-Physics/Software
- **ELEGANT Manual (PDF and HTML):**
  https://ops.aps.anl.gov/manuals/elegant_latest/elegant.pdf
  https://ops.aps.anl.gov/manuals/elegant_latest/elegant.html
- **ELEGANT Overview [Recommended]**
  https://ops.aps.anl.gov/elegant.html
- **ELEGANT Users Forum [Recommended]**
  https://www3.aps.anl.gov/forums/elegant/
- **SDDS Toolkit Manuals (PDF and HTML)**
  https://ops.aps.anl.gov/manuals/SDDStoolkit/SDDStoolkit.pdf
  https://ops.aps.anl.gov/manuals/SDDStoolkit/SDDStoolkit.html
- **SDDS Toolkit Quick Manual and Sample Data - Getting Started with SDDS [Recommended]**
  https://ops.aps.anl.gov/manuals/GettingStartedWithSDDS/HTML/GettingStartedWithSDDS.html
  https://ops.aps.anl.gov/manuals/GettingStartedWithSDDS/GettingStartedWithSDDS.pdf
  https://ops.aps.anl.gov/cgi-bin/oagLog4.cgi?name=GettingStartedData.tar.gz
  → You can get a download key by typing your email address and requesting. Then the key will be delivered to your email.
- **APS Software Documentation Website (ELEGANT and SDDS)**
  https://ops.aps.anl.gov/oagSoftware.shtml

Downloading & Installation of ELEGANT Code

☐ Installation Guides and Downloading Sites

- **Windows Version Installation Guide of ELEGANT and SDDS Toolkit [Optional]**
  https://www.aps.anl.gov/Accelerator-Operations-Physics/Software/installationGuide_WIN32
  → If you want to install windows version, please follow the installation guide there.
  → However, at ISBA school, we will focus on installation on Fedora-36 64 bit Linux.
- **Pelegant Installation Guide of ELEGANT for multi-CPU-core computers [Optional]**
  https://www.aps.anl.gov/Accelerator-Operations-Physics/Software/installationGuide_Pelegant
- **Linux Version Installation Guide of ELEGANT and SDDS Toolkit**
  https://www.aps.anl.gov/Accelerator-Operations-Physics/Software/installationGuide_Linux
  → For ISBA school, we will follow this installation guide.
- **ELEGANT Examples and Scripts**
  https://ops.aps.anl.gov/cgi-bin/oagLog4.cgi?name=elegantExamples.tar.gz
  → You can get a download key by typing your email address and requesting. Then the key will be delivered to your email.



1. Type in Your Name
2. Type in Your Email Address
3. Then, Push Request Download Key
4. Check your email from APS OAG
5. Then, Type in Key
6. Then, Push Download

How to install ELEGANT on Fedora-36 64 bit

Please download Fedora-36 64 bit pre-compiled Linux RPM binaries of ELEGANT codes and SDDS Toolkit from:

https://www.aps.anl.gov/Accelerator-Operations-Physics/Software/installationGuide_Linux

You can find various pre-compiled RPM binaries on the website.
Please scroll down until you can meet the pre-compiled RPM binaries for Fedora-36 64 bit such as below:

- Fedora 36 64bit
  - SDDSToolKit-5.4-1.fedora.36.x86_64.rpm
  - SDDSToolKit-devel-5.4-1.fedora.36.x86_64.rpm
  - SDDSEpicsToolKit-5.4-1.fedora.36.x86_64.rpm
  - OAGTclTk-1.28.1-1.fedora.36.x86_64.rpm
  - elegant-2023.2.0-1.fedora.36.mpich.x86_64.rpm
  - elegant-2023.2.0-1.fedora.36.openmpi.x86_64.rpm
  - shower-1.13-1.fedora.36.x86_64.rpm
  - spiffe-4.8.2-1.fedora.36.x86_64.rpm
  - SDDSPython3-5.2.1-1.fedora.36.x86_64.rpm
  - SDDSJava-5.2.1-1.fedora.36.x86_64.rpm
  - clinchor-2.0-1.fedora.36.x86_64.rpm
  - shield-1.0-1.fedora.36.x86_64.rpm

By clicking one of installation RPM packages, please obtain its download key over email as described at previous page No. 52. Then, please download 12 RPM binaries for Fedora-36 64 bit.

How to install ELEGANT on Fedora-36 64 bit

You can find those downloaded RPM binaries at /home/yourID/Downloads.
After logging as the root, system administrator with su or sudo command, then, please move in the Downloads directory, and let's install ELEGANT code:

```
su
cd /home/yourID/Downloads

rpm -Uvh SDDSToolKit-5.4-1.fedora.36.x86_64.rpm
rpm -Uvh SDDSToolKit-devel-5.4-1.fedora.36.x86_64.rpm
rpm -Uvh SDDSEpicsToolKit-5.4-1.fedora.36.x86_64.rpm
rpm -Uvh OAGTclTk-1.28.1-1.fedora.36.x86_64.rpm  ← optional
rpm -Uvh elegant-2023.2.0-1.fedora.36.mpich.x86_64.rpm
rpm -Uvh elegant-2023.2.0-1.fedora.36.openmpi.x86_64.rpm ← optional
rpm -Uvh shower-1.13-1.fedora.36.x86_64.rpm ← optional
rpm -Uvh spiffe-4.8.2-1.fedora.36.x86_64.rpm ← optional
rpm -Uvh SDDSPython3-5.2.1-1.fedora.36.x86_64.rpm ← optional
rpm -Uvh SDDSJava-5.2.1-1.fedora.36.x86_64.rpm ← optional
rpm -Uvh clinchor-2.0-1.fedora.36.x86_64.rpm ← optional
rpm -Uvh shield-1.0-1.fedora.36.x86_64.rpm ← optional
```

Optional is an optional installation, which you may skip its installation.

How to install ELEGANT on Fedora-36 64 bit

If there is errors during installation, please see info and install required pre-installation-packages first, which you have to pre-install them by using dnf search and dnf install (please see Page No. 19 ~ 21.)

Specially, if errors are generated, please check whether you already did following things before your ELEGANT installation.

1. **Updating Fedora-36 with its last version software (please see Page No. 19)**
   dnf upgrade and reboot your laptop for updating
2. **Installation of development tools and libraries (please see Page No. 21)**
   dnf group install "Development Tools" "Development Libraries“
   dnf group install "C Development Tools and Libraries"
   dnf group install "D Development Tools and Libraries”
3. **Installation of GNU Scientific, Linear Algebra, and X-Windows related Libraries (please see Page No. 21)**
   dnf install gsl-devel
   dnf install atlas atlas-devel lapack-devel blas-devel
   dnf install motif-devel

Then, try reinstallation of ELEGANT

How to install ELEGANT on Fedora-36 64 bit

4. During running of ELEGANT, if you meet an error about the libraries of FFT. "elegant: error while loading shared libraries: libfftw3.so.3"

Then, please install its libraries for 64bit systems:

rpm -Uvh fftw-libs-double-3.3.10-2.fc36.x86_64.rpm

Then, try re-run ELEGANT

How to install ELEGANT on Fedora-36 64 bit

Then, after installation of all pre-compiled RPMs for ELEGANT and SDDS Toolkit successfully, please follow steps described on the Linux Installation Guide website:

https://www.aps.anl.gov/Accelerator-Operations-Physics/Software/installationGuide_Linux

From the website, you can find descriptions on Build-AOP-RPMs script at Step 1. That is the way to compile and build ELEGANT RPMs on your computer by yourself. Since we already downloaded pre-compiled RPMS for Fedora-36, you do not need to use Build-AOP-RPMs script, which requires a long compiling time and lots of pre-installation packages to build RPMs on your laptop.

Just skip Step 1 and Step 2. They are the same things, which we already did at previous page (Page No. 55).

Then, please check whether your Linux has tcsh shell, and you already changed your shell from bash to tcsh, and untar env64.tar file at your home directory (/home/yourID). Then relogin for updating the shell change (Please see details at Page No. 23).

Then, try to find elegant just by typing a following thing in a terminal:
which elegant
→ this will display /usr/bin/elegant if you have installed ELEGANT properly.

How to install ELEGANT on Fedora-36 64 bit

By untarring env64.tar file, which you can download from ISBA school website, several files (.cshrc, .alias, .env-apsoag, .env-epics64, .defns.rpn and so on) will be installed at your home directory. Therefore, you can skip Step 3 and Step 4, which are described on the above Linux Installation website.

Congratulations!

If you did all things successfully, now you are ready to use ELEGANT code.

This congratulations typography lettering decorative text card design. Vector illustration

If you have any problem during ELEGANT installation, please send email to me (yjkim@kaeri.re.kr). We may solve it at ISBA school if you have Fedora-36.

How to use ELEGANT Code and SDDS Toolkit

If you already installed ELEGANT code on Linux or Windows /10/11, please check whether your ELEGANT code works properly with the sample input files without any problem before the ISBA school. **On the sample input files, please see Page No. 59.**

How to use ELEGANT on Fedora-36 64 bit

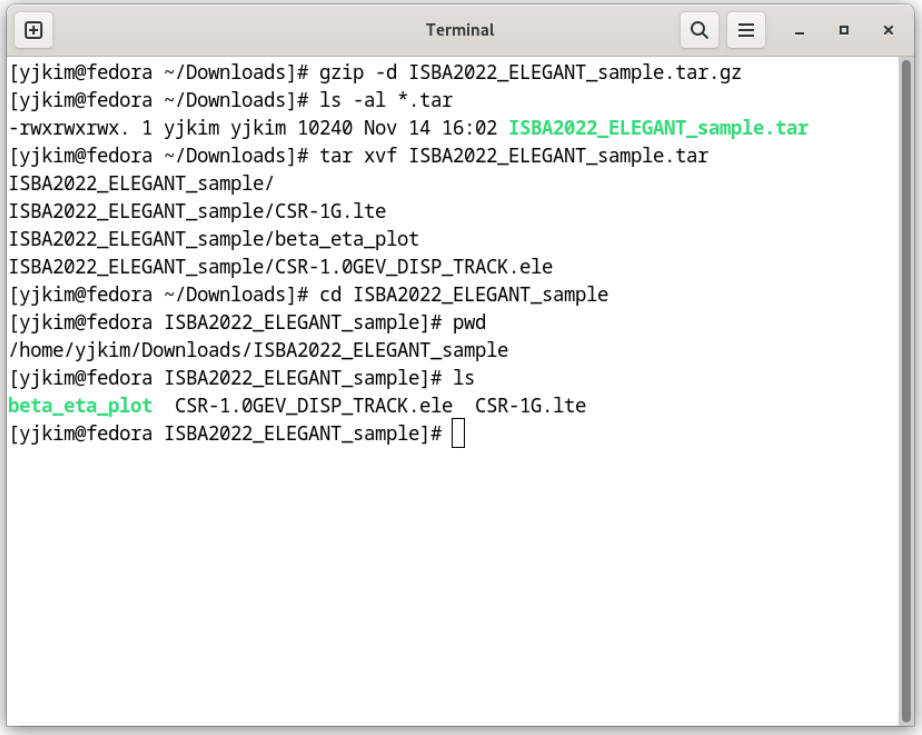
First of all, please download an ELEGANT sample input file from ISBA school website: ISBA2022_ELEGANT_sample.tar.gz [2]

After download it in /home/yourID/Downloads
Then, ungzip and untar the file by doing following things:

gzip -d ISBA2022_ELEGANT_sample.tar.gz
→ this will generate ISBA2022_ELEGANT_sample.tar

tar xvf ISBA2022_ELEGANT_sample.tar
→ this will generate ISBA2022_ELEGANT_sample directory in /home/yourID/Downloads

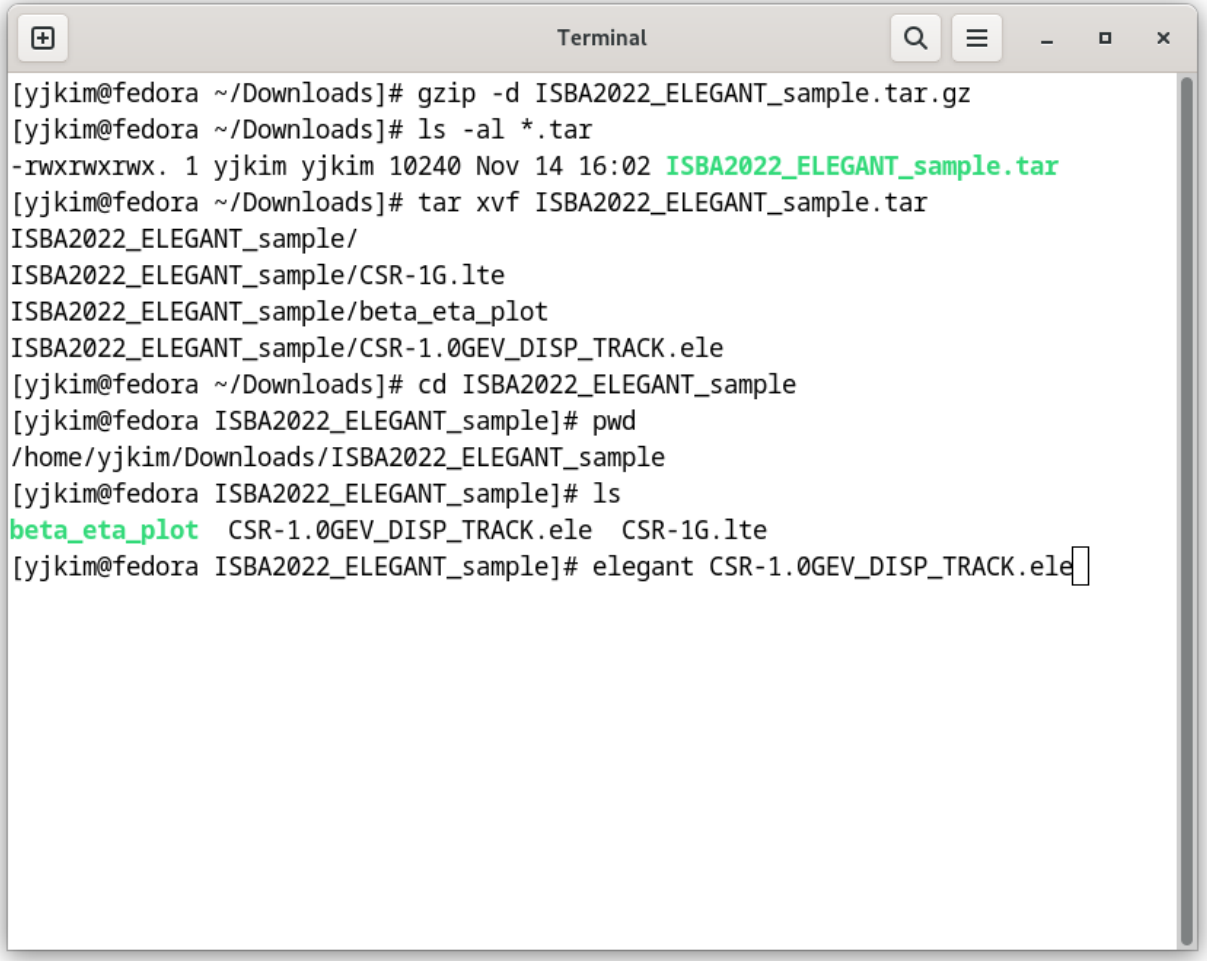
cd ISBA2022_ELEGANT_sample
ls
→ this will display three files such as a right picture:
Here, beta_eta_plot is an executable script for plotting.
CSR-1.0GEV_DISP_TRACK.ele is an ELEGANT simulation setup file, which define initial simulation conditions, simulation ways, and output generating way.
CSR-1G.lte is a lattice file on accelerator components.



How to use ELEGANT on Fedora-36 64 bit

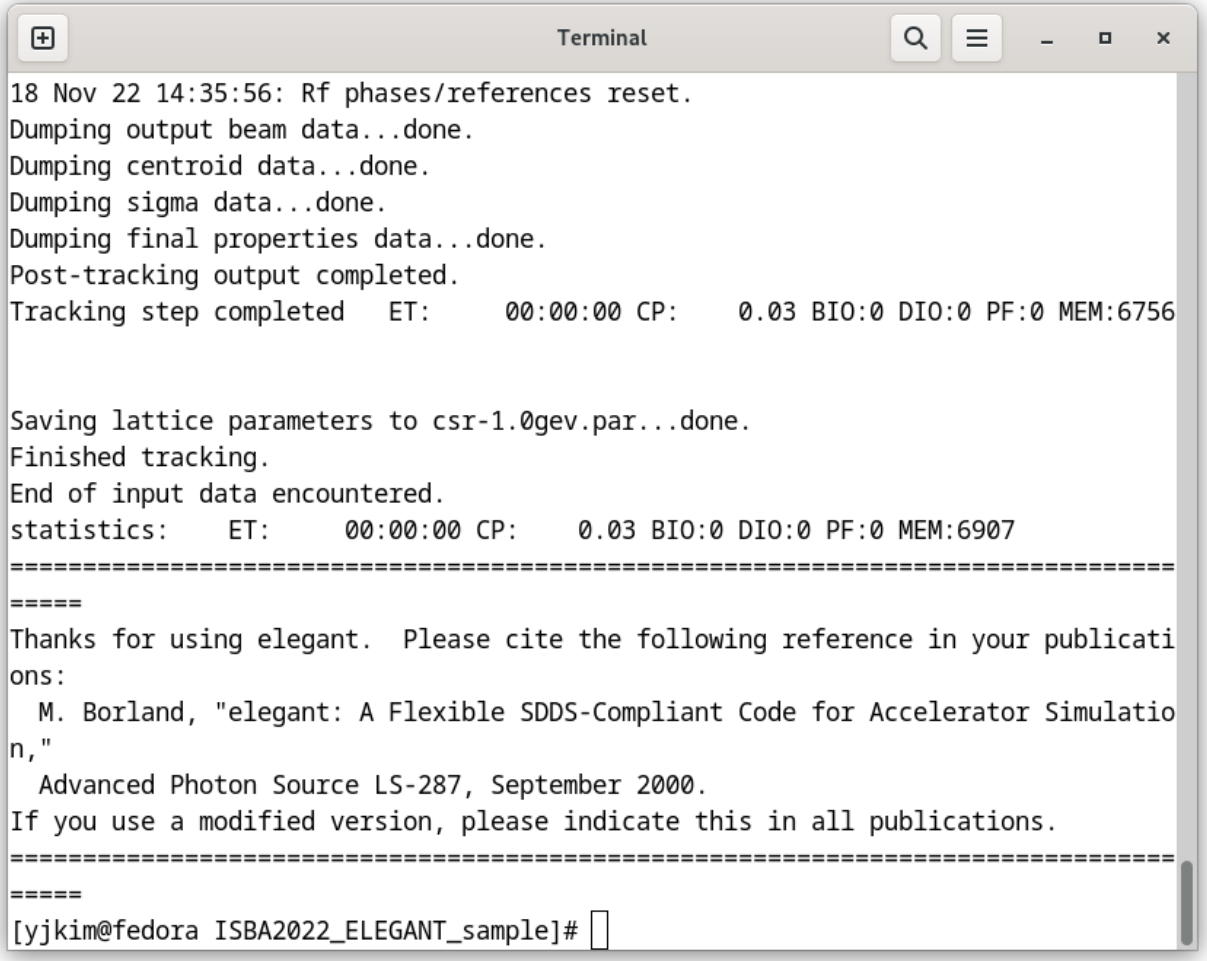
Now let's run ELEGANT by typing a following line such as below:

elegant CSR-1.0GEV_DISP_TRACK.ele



How to use ELEGANT on Fedora-36 64 bit

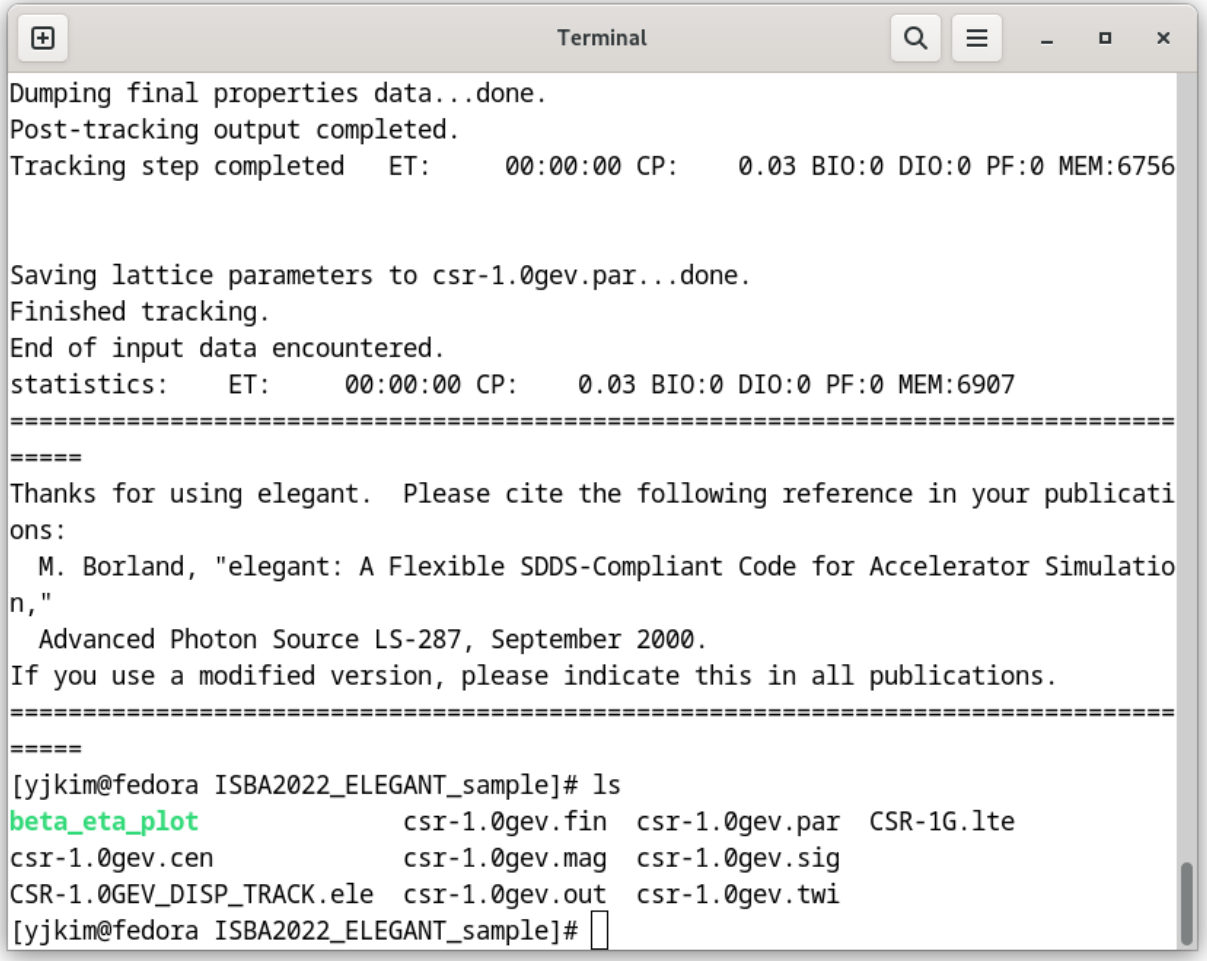
After running ELEGANT, simulation will be finished such as below:



How to use ELEGANT on Fedora-36 64 bit

Let's see newly generated files after ELEGANT simulation, by typing ls

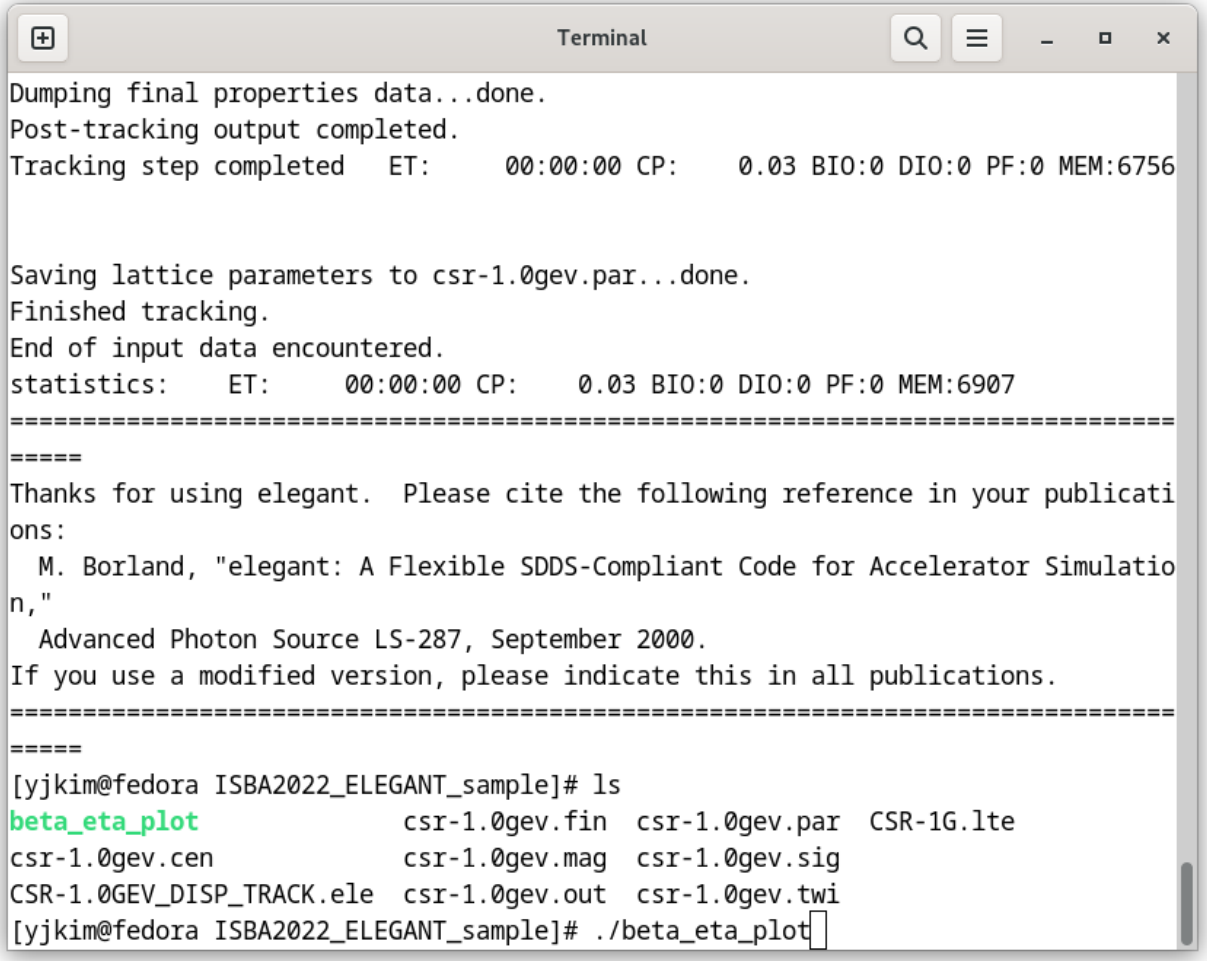
ls



How to use ELEGANT on Fedora-36 64 bit

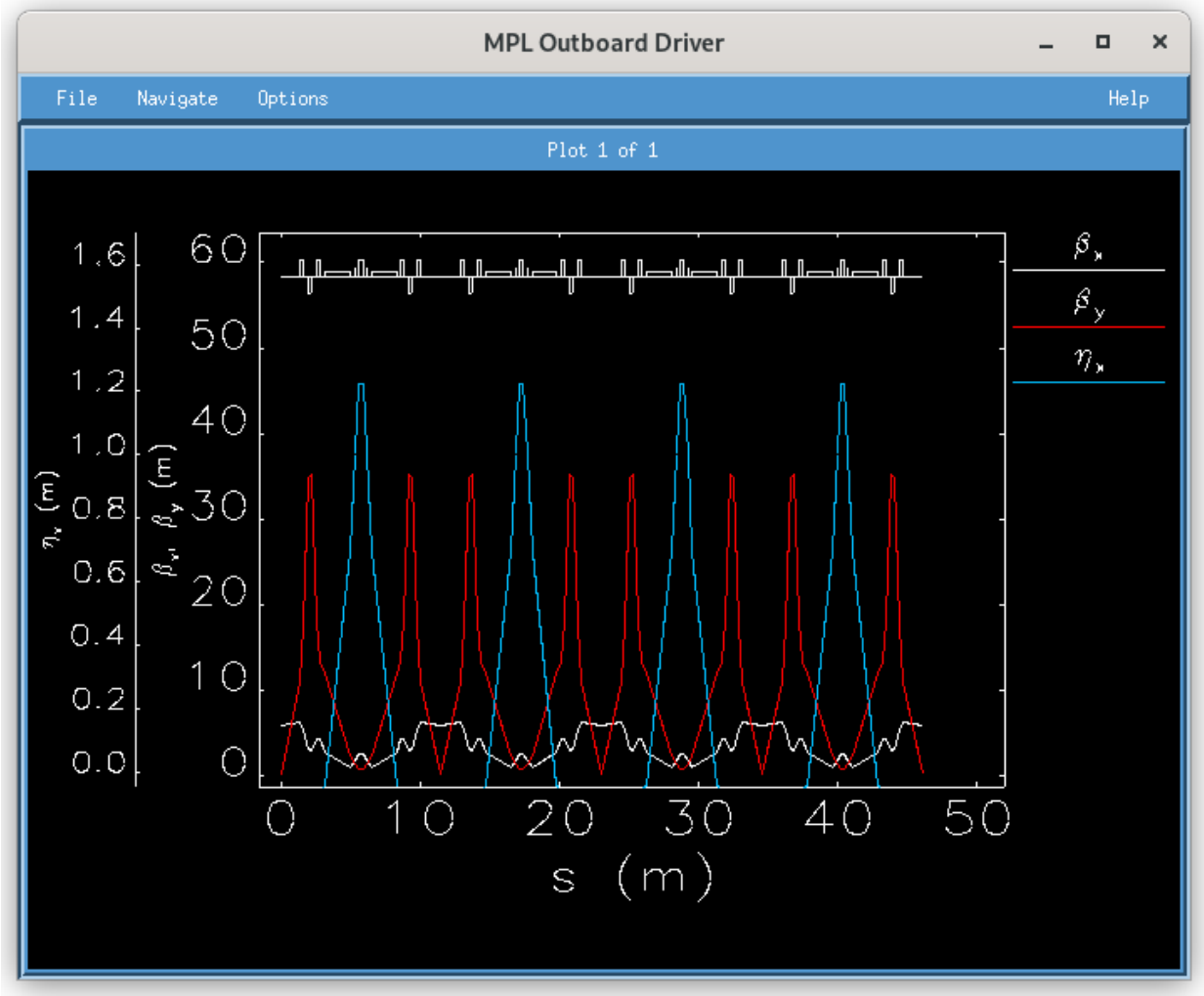
Now, let's plot beta and eta functions along the accelerator beamline by running the plotting script

./beta_eta_plot



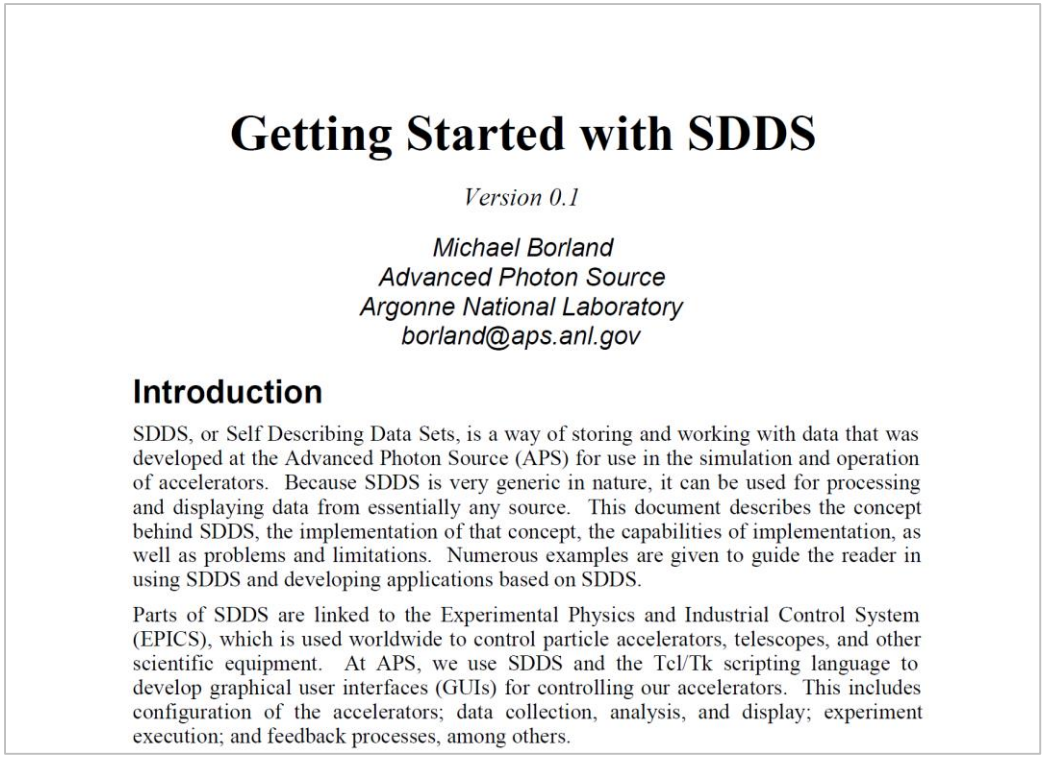
How to use ELEGANT on Fedora-36 64 bit

Then, a new plot showing beta and eta functions along accelerator will be displayed such as below:



How to use SDDS Toolkit on Fedora-36 64 bit

After running ELEGANT code, many output files with the Self Describing Data Sets (SDDS) format (*.sig, *.out, *.cen, *.fin, and so on) are generated. We have to understand files with the SDDS format and SDDS Toolkit such as sddsquery, sddsprintout, and sddsplot. To understand SDDS quickly, please look into SDDS Toolkit manual and very helpful Getting Started with SDDS and its data. Please see Page No. 51 and download its data file together to understand files with the SDDS format quickly.



Getting Started with SDDS

Version 0.1

Michael Borland
Advanced Photon Source
Argonne National Laboratory
borland@aps.anl.gov

Introduction

SDDS, or Self Describing Data Sets, is a way of storing and working with data that was developed at the Advanced Photon Source (APS) for use in the simulation and operation of accelerators. Because SDDS is very generic in nature, it can be used for processing and displaying data from essentially any source. This document describes the concept behind SDDS, the implementation of that concept, the capabilities of implementation, as well as problems and limitations. Numerous examples are given to guide the reader in using SDDS and developing applications based on SDDS.

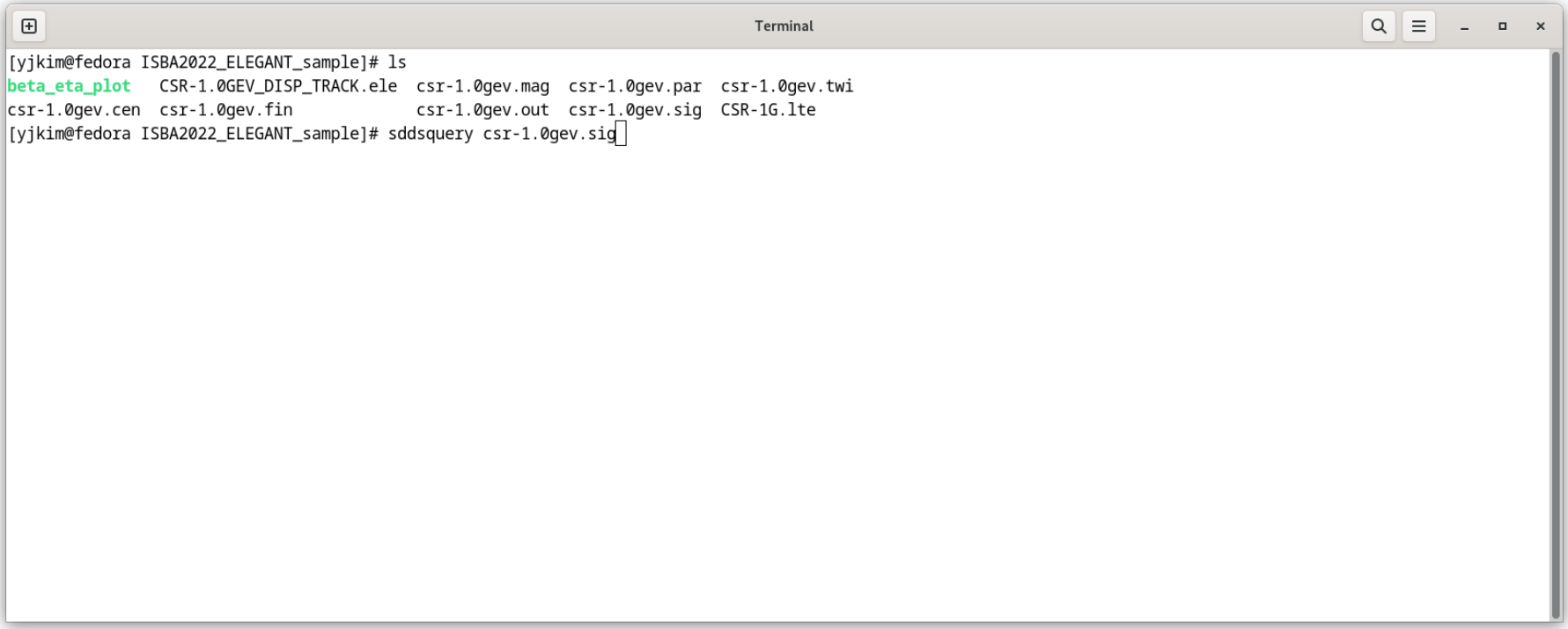
Parts of SDDS are linked to the Experimental Physics and Industrial Control System (EPICS), which is used worldwide to control particle accelerators, telescopes, and other scientific equipment. At APS, we use SDDS and the Tcl/Tk scripting language to develop graphical user interfaces (GUIs) for controlling our accelerators. This includes configuration of the accelerators; data collection, analysis, and display; experiment execution; and feedback processes, among others.

Strongly recommended document on SDDS!

How to use SDDS Toolkit on Fedora-36 64 bit

To know which kind parameters are included in an SDDS file, we can use sddsquery:

sddsquery csr-1.0gev.sig



How to use SDDS Toolkit on Fedora-36 64 bit

To know which kind parameters are included in an SDDS file, we can use sddsquery:

sddsquery csr-1.0gev.sig

→ This shows the fact that the file has 72 columns and 2 parameters in it:

Terminal

```
[yjkim@fedora ISBA2022_ELEGANT_sample]# ls
beta_eta_plot   CSR-1.0GEV_DISP_TRACK.ele  csr-1.0gev.mag  csr-1.0gev.par  csr-1.0gev.twi
csr-1.0gev.cen  csr-1.0gev.fin             csr-1.0gev.out  csr-1.0gev.sig  CSR-1G.lte
[yjkim@fedora ISBA2022_ELEGANT_sample]# sddsquery csr-1.0gev.sig

file csr-1.0gev.sig is in SDDS protocol version 1
description: sigma matrix--input: CSR-1.0GEV_DISP_TRACK.ele  lattice: CSR-1G.lte
contents: sigma matrix
data is little-endian binary

72 columns of data:
NAME            UNITS          SYMBOL         FORMAT         TYPE    FIELD  DESCRIPTION
                                                                      LENGTH
s               m              NULL           NULL           double  0       Distance
ElementName     NULL           NULL           %10s           string  0       Element name
ElementOccurence NULL           NULL           %6ld           long    0       Occurence of element
ElementType     NULL           NULL           %10s           string  0       Element-type name
s1              m              $gs$r$b1$n     NULL           double  0       sqrt(<x*x>)
s12             m              $gs$r$b12$n    NULL           double  0       <x*xp'>
s13             m$a2$n         $gs$r$b13$n    NULL           double  0       <x*y>
s14             m              $gs$r$b14$n    NULL           double  0       <x*y'>
s15             m$a2$n         $gs$r$b15$n    NULL           double  0       <x*s>
s16             m              $gs$r$b16$n    NULL           double  0       <x*delta>
s17             m*s            $gs$r$b17$n    NULL           double  0       <x*t>
```

This shows the head region of the sddsquery output.

How to use SDDS Toolkit on Fedora-36 64 bit

To know which kind parameters are included in an SDDS file, we can use sddsquery:

sddsquery csr-1.0gev.sig

→ This shows the fact that the file has 72 columns and 2 parameters in it:

Terminal

```
Sxp             NULL            $gs$r$bx'$n     NULL            double  0       sqrt(<(x'-<x'>)^2>)
Sy              m               $gs$r$by$n      NULL            double  0       sqrt(<(y-<y>)^2>)
Syp             NULL            $gs$r$by'$n     NULL            double  0       sqrt(<(y'-<y'>)^2>)
Ss              m               $gs$r$bs$n      NULL            double  0       sqrt(<(s-<s>)^2>)
Sdelta          NULL            $gs$bd$n$r      NULL            double  0       sqrt(<(delta-<delta>)^2>)
St              s               $gs$r$bt$n      NULL            double  0       sqrt(<(t-<t>)^2>)
ex              m               $ge$r$bx$n      NULL            double  0       geometric horizontal emittance
enx             m               $ge$r$bx,n$n    NULL            double  0       normalized horizontal emittance
ecx             m               $ge$r$bx,c$n    NULL            double  0       geometric horizontal emittance less dispersive contributions
ecnx            m               $ge$r$bx,cn$n   NULL            double  0       normalized horizontal emittance less dispersive contributions
ey              m               $ge$r$by$n      NULL            double  0       geometric vertical emittance
eny             m               $ge$r$by,n$n    NULL            double  0       normalized vertical emittance
ecy             m               $ge$r$by,c$n    NULL            double  0       geometric vertical emittance less dispersive contributions
ecny            m               $ge$r$by,cn$n   NULL            double  0       normalized vertical emittance less dispersive contributions
betaxBeam       m               $gb$r$bx,beam$n NULL            double  0       betax for the beam, excluding dispersive contributions
alphaxBeam      NULL            $ga$r$bx,beam$n NULL            double  0       alphax for the beam, excluding dispersive contributions
betayBeam       m               $gb$r$by,beam$n NULL            double  0       betay for the beam, excluding dispersive contributions
alphayBeam      NULL            $ga$r$by,beam$n NULL            double  0       alphay for the beam, excluding dispersive contributions

2 parameters:
NAME                UNITS               SYMBOL              TYPE                DESCRIPTION
Step                NULL                NULL                long                Simulation step
SVNVersion          NULL                NULL                string              SVN version number
[yjkim@fedora ISBA2022_ELEGANT_sample]#
```

This shows the tail region of the sddsquery output.

How to use SDDS Toolkit on Fedora-36 64 bit

To print some parameters in an SDDS file, first, we can use sddsquery to find out which parameters in it, then we can use sddsprintout to print:

sddsquery csr-1.0gev.twi

→ This shows that the file has 23 columns in it:

Terminal

```
[yjkim@fedora ISBA2022_ELEGANT_sample]# ls
beta_eta_plot   CSR-1.0GEV_DISP_TRACK.ele  csr-1.0gev.mag  csr-1.0gev.par  csr-1.0gev.twi
csr-1.0gev.cen  csr-1.0gev.fin             csr-1.0gev.out  csr-1.0gev.sig  CSR-1G.lte
[yjkim@fedora ISBA2022_ELEGANT_sample]# sddsquery csr-1.0gev.twi

file csr-1.0gev.twi is in SDDS protocol version 1
description: Twiss parameters--input: CSR-1.0GEV_DISP_TRACK.ele  lattice: CSR-1G.lte
contents: Twiss parameters
data is little-endian binary

23 columns of data:
NAME            UNITS           SYMBOL          FORMAT          TYPE    FIELD  DESCRIPTION
                                                                        LENGTH
s               m               NULL            NULL            double  0       Distance
betax           m               $gb$r$bx$n      NULL            double  0       Horizontal beta-function
alphax          NULL            $ga$r$bx$n      NULL            double  0       Horizontal alpha-function
psix            rad             $gy$r$bx$n      NULL            double  0       Horizontal phase advance
etax            m               $gc$r$bx$n      NULL            double  0       Horizontal dispersion
etaxp           NULL            $gc$r$bx$n$a'$n NULL            double  0       Slope of horizontal dispersion
xAperture       m               a$bx,eff$n      NULL            double  0       Effective horizontal aperture
betay           m               $gb$r$by$n      NULL            double  0       Vertical beta-function
alphay          NULL            $ga$r$by$n      NULL            double  0       Vertical alpha-function
psiy            rad             $gy$r$by$n      NULL            double  0       Vertical phase advance
etay            m               $gc$r$by$n      NULL            double  0       Vertical dispersion
etayp           NULL            $gc$r$by$n$a'$n NULL            double  0       Slope of vertical dispersion
yAperture       m               a$by,eff$n      NULL            double  0       Effective vertical aperture
pCentral0       m$be$nc         p$bcent$n       NULL            double  0       Initial central momentum
ElementName     NULL            NULL            %10s            string  0       Element name
ElementOccurence NULL            NULL            %6ld            long    0       Occurence of element
ElementType     NULL            NULL            %10s            string  0       Element-type name
ChamberShape    NULL            NULL            NULL            string  0       NULL
dI1             m               NULL            NULL            double  0       Contribution to radiation integral 1
dI2             1/m             NULL            NULL            double  0       Contribution to radiation integral 2
dI3             1/m$a2$n        NULL            NULL            double  0       Contribution to radiation integral 3
dI4             1/m             NULL            NULL            double  0       Contribution to radiation integral 4
```

How to use SDDS Toolkit on Fedora-36 64 bit

To print some parameters in an SDDS file, first, we can use sddsquery to find out which parameters in it, then we can use sddsprintout to print:

sddsquery csr-1.0gev.twi

sddsprintout -col=s -col=betax -col=betay -col=etax sddsquery csr-1.0gev.twi

→ This printout betax [m], betay [m], etax [m] along beamline travelling distance s [m]

Terminal

```
[yjkim@fedora ISBA2022_ELEGANT_sample]# ls
beta_eta_plot   CSR-1.0GEV_DISP_TRACK.ele  csr-1.0gev.mag  csr-1.0gev.par  csr-1.0gev.twi
csr-1.0gev.cen  csr-1.0gev.fin             csr-1.0gev.out  csr-1.0gev.sig  CSR-1G.lte
[yjkim@fedora ISBA2022_ELEGANT_sample]# sddsprintout -col=s -col=betax -col=betay -col=etax csr-1.0gev.twi
Printout for SDDS file csr-1.0gev.twi

      s             betax          betay           etax
      m               m              m              m
-------------------------------------------------------------
  0.000000e+00   5.906943e+00   1.913340e-01  -8.100253e-02
  0.000000e+00   5.906943e+00   1.913340e-01  -8.100253e-02
  1.430000e+00   6.253129e+00   1.087893e+01  -8.100253e-02
  1.680000e+00   5.312222e+00   1.750136e+01  -7.383312e-02
  1.680000e+00   5.312222e+00   1.750136e+01  -7.383312e-02
  2.030000e+00   3.020067e+00   3.488269e+01  -5.406026e-02
  2.280000e+00   2.801489e+00   3.516719e+01  -5.001146e-02
  2.280000e+00   2.801489e+00   3.516719e+01  -5.001146e-02
  2.630000e+00   4.234103e+00   1.825476e+01  -5.807730e-02
  2.880000e+00   4.219590e+00   1.318895e+01  -5.582828e-02
  2.880000e+00   4.219590e+00   1.318895e+01  -5.582828e-02
  3.230000e+00   2.757877e+00   1.193717e+01  -4.160918e-02
  5.030000e+00   9.645924e-01   2.315937e+00   6.954899e-01
  5.380000e+00   1.651701e+00   1.241534e+00   9.996585e-01
  5.390000e+00   1.676941e+00   1.217865e+00   1.008349e+00
  5.640000e+00   2.409192e+00   7.530314e-01   1.225612e+00
  5.890000e+00   2.409192e+00   7.530314e-01   1.225612e+00
  5.890000e+00   2.409192e+00   7.530314e-01   1.225612e+00
  6.140000e+00   1.676941e+00   1.217865e+00   1.008349e+00
  6.150000e+00   1.651701e+00   1.241534e+00   9.996585e-01
  6.500000e+00   9.645924e-01   2.315937e+00   6.954899e-01
  8.300000e+00   2.757877e+00   1.193717e+01  -4.160918e-02
  8.650000e+00   4.219590e+00   1.318895e+01  -5.582828e-02
  8.650000e+00   4.219590e+00   1.318895e+01  -5.582828e-02
  8.900000e+00   4.234103e+00   1.825476e+01  -5.807730e-02
  9.250000e+00   2.801489e+00   3.516719e+01  -5.001146e-02
```

File Downloading from ISBA School Website

For this lecture, please download following two files from ISBA2022 school website:

[1] env64.tar : tcsh environmental configuring dot files for Fedora-36

[2] ISBA2022_ELEGANT_sample.tar.gz : ELEGANT Sample Input files

Topics for Hands-on Training with ELEGANT

- ☐ Basic Linux Commands and Installation of ELEGANT Code on Fedora-36
- ☐ How to use ELEGANT Code and SDDS files
- ☐ Design of Bunch Compressors with consideration of CSR
- ☐ Design of FODO Lattices for Beam Diagnostics and Beam Transportation
- ☐ Design of XFEL Linacs with consideration of the Short-range Wakefields
- ☐ Design of Compact Storage Ring
- ☐ Design of MBA based 4^{th} Generation Synchrotron Light Source
- ☐ Design of Booster and Rapid Cycling Synchrotron (RCS)
- ☐ Study on Jitter and Tolerance with ELEGANT Code

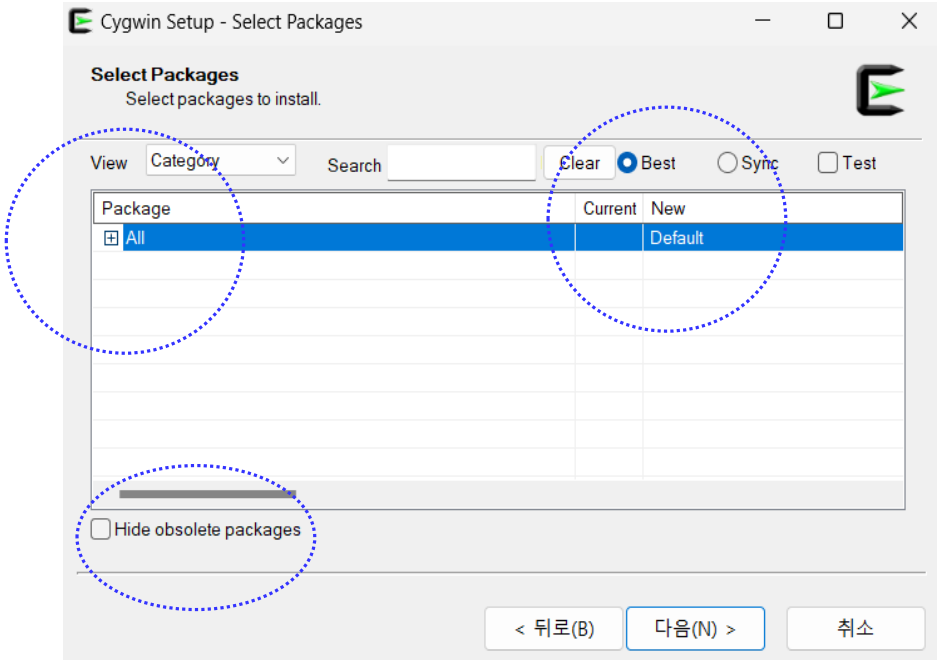
We will do our best to cover all those topics for various accelerator projects!

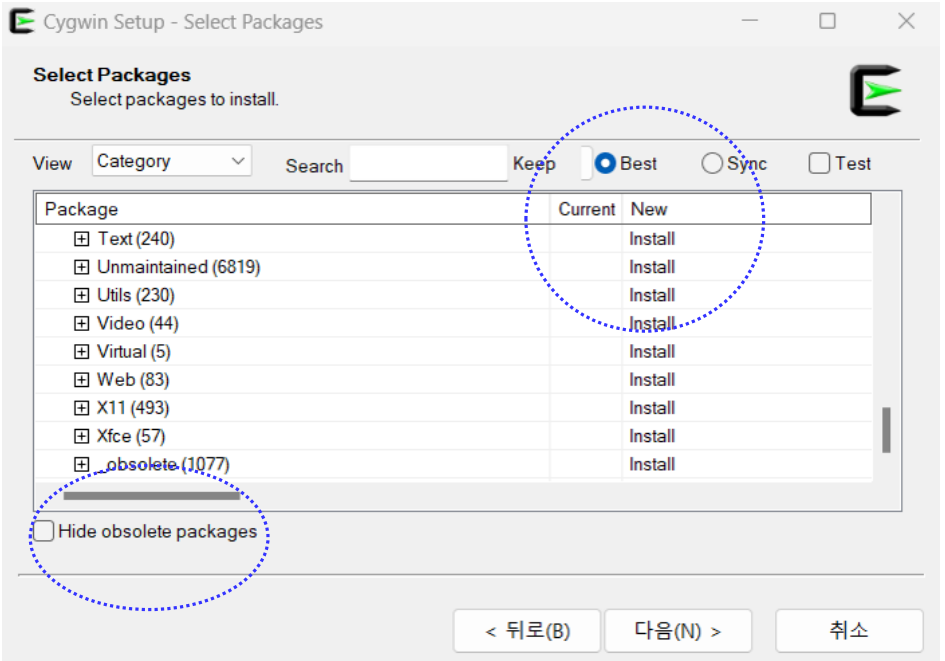
Installation of ELEGANT with Cygwin on Windows 7/10/11

If you want to install/use ELEGANT on Windows 7/10/11, please install Cygwin on your Windows 7/10/11, which is a large collection of GNU and Open Source tools which provide functionality similar to a Linux distribution on Windows. Then, you can install ELEGANT with the Cygwin on Windows 7/10/11.

Appendix: ELEGANT with Cygwin on Windows

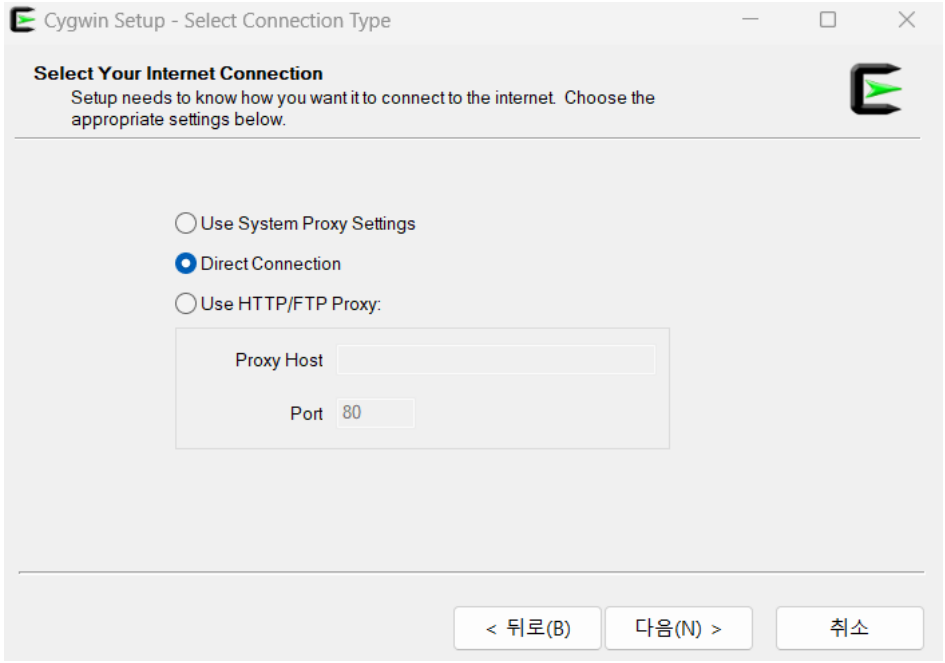
- To install Cygwin on Windows 7/10/11, please visit Cygwin website:
  - https://cygwin.com/index.html
- Move to Install Cygwin site and run setup-x86_64.exe
- Important - please install Cygwin packages by clicking All and by changing Default into Install in New Tab.
- Important - please remove a check on Hide obsolete packages at bottom such as below:

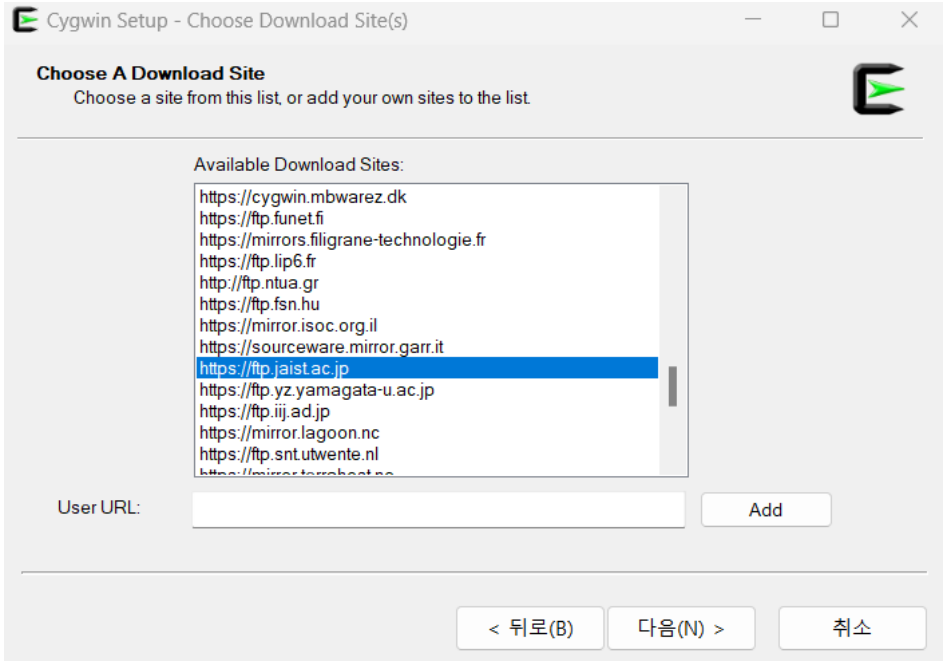




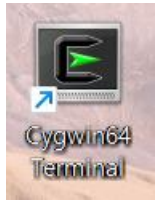
Appendix: ELEGANT with Cygwin on Windows

☐ Select direct connection, and choose a ftp site near you such as below:



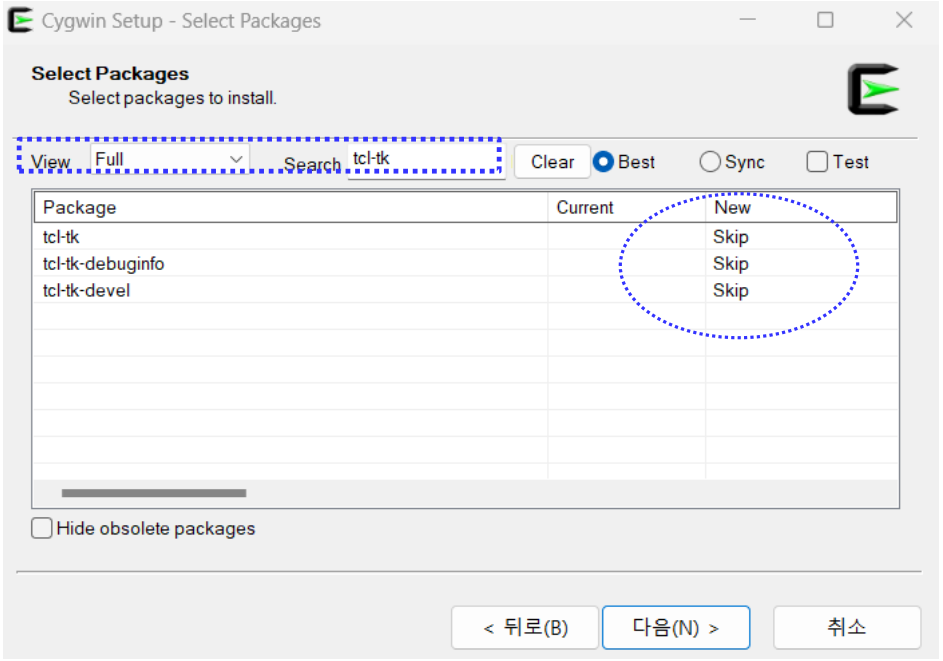


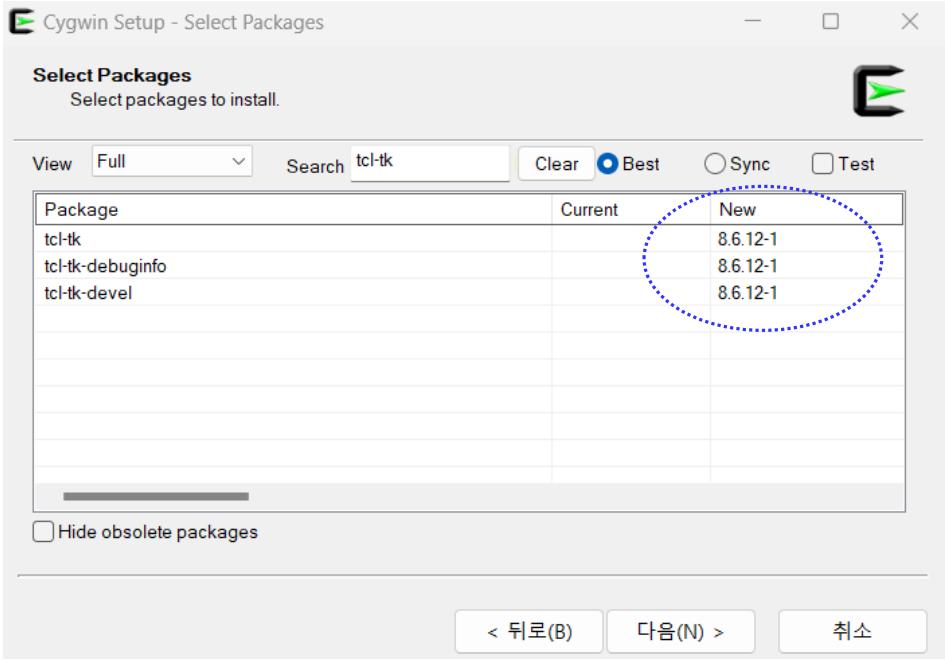
☐ Then downloading and installation will be started. After all installation, please make a Cygwin terminal icon on desktop and an icon on starting bar. By clicking the terminal icon, you can get a working terminal, which you can type Linux commands directly.



Appendix: ELEGANT with Cygwin on Windows

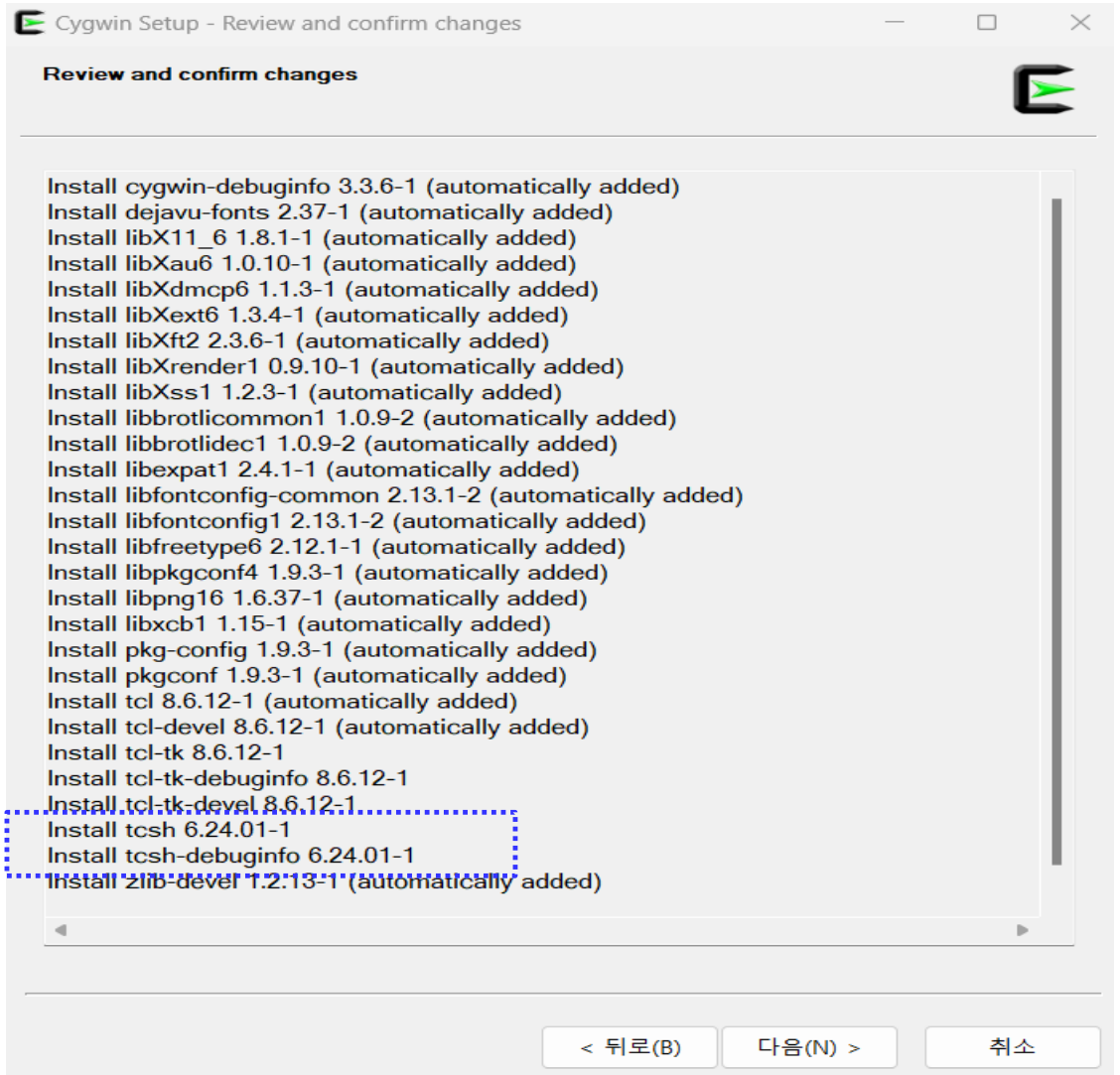
- For ELEGANT installation, let's install Tcl/Tk additionally by running setup-x86_64.exe again.
- Select View: Full, Search: tcl-tk
- Then, change Skip in New tap to its newly installed version (8.6.12-1).





Appendix: ELEGANT with Cygwin on Windows

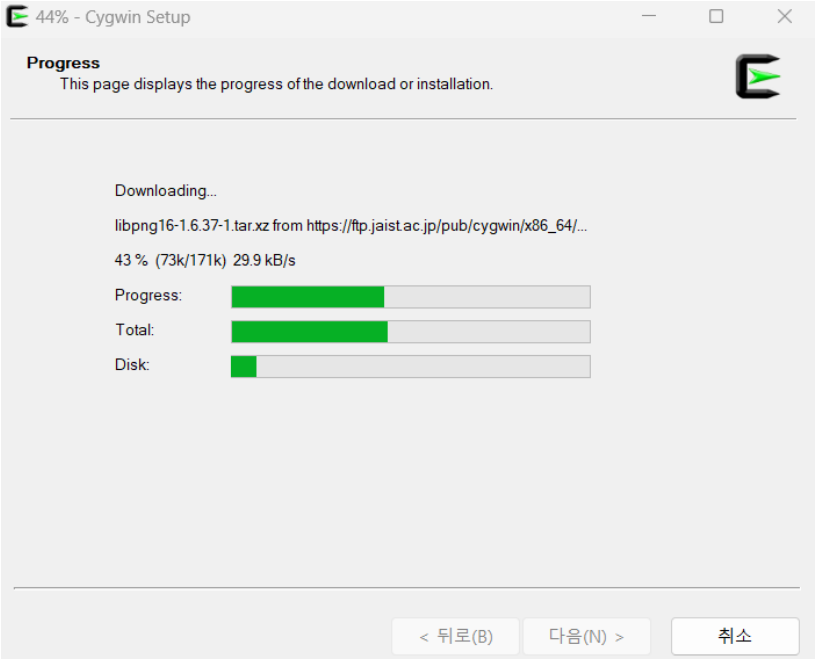
☐ **Then, Cygwin will review its installation and recommend installations of needed other packages:**



tcsh is also included additionally.

Appendix: ELEGANT with Cygwin on Windows

☐ Now, Cygwin will start installation of Tcl/Tk and recommended other packages:



☐ Now let's install ELEGANT with Cygwin on Windows 7/10/11 by looking into an APS website on ELEGANT Windows Install Guide:

- https://www.aps.anl.gov/Accelerator-Operations-Physics/Software/installationGuide_WIN32

Appendix: ELEGANT with Cygwin on Windows

☐ **To use ELEGANT on Windows 7/10/11 properly, Visual C++ 2015 Redistributable is required.**

- **From Microsoft Download Center, please download Visual C++ 2015 Redistributable (For Windows 7/10/11 64 bit, vc_redist.x64.exe) and install it.**
  https://www.microsoft.com/en-us/download/details.aspx?id=52685
  It takes somewhat long time due to the slow network speed.

☐ **Then, from the website, please download Windows version of ELEGANT, SDDS Toolkit, SDDS EPICS Toolkit by typing in the download key (See, Page No. 52):**

- 64bit
  - SDDS Toolkit-x64.msi REQUIRED
  - Visual C++ 2015 Redistributable for Visual Studio 2015 REQUIRED if not already installed
  - SDDS Epics Toolkit-x64.msi optional (control system programs)
  - Elegant-x64.msi optional (accelerator simulation)

☐ **Please install those downloaded software step by step:**

- **SDDS Toolkit**
- **SDDS EPICS Toolkit**
- **ELEGANT**

Appendix: ELEGANT with Cygwin on Windows

☐ **Please note that there are links between Windows drive and Cygwin drive:**

Open a Cygwin64 Terminal and type following commands:

$ cd c:/
→ You will move to /cygdrive/c
→ This indicates that c:/ is linked with /cygdrive/c
$ ls
cygwin64 and other directories will be displayed

$ cd cygwin64/bin
→ You will move to /cygdrive/c/cygwin64/bin

$ ls
sh.exe and tclsh.exe, tcsh.exe and many commands will be displayed.

☐ **Please note that you do not need to copy .defns.rpn or untar env64.tar in your home directory for Windows version ELEGANT code with Cygwin.**

☐ **Please check whether Windows version ELEGANT and SDDS work properly on with the sample input files, which are described at Pages No. 59-70.**