

September 2nd-9th, 2025, SARI, China



Hands-on Training with ELEGANT Code

- How to install/use ELEGANT on Fedora-36, 40 & 42, Ubuntu-24 & 25, and macOS -



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□ Appendix I, II, III - ELEGANT on Fedora-40 & 42, Ubuntu-24 & 25, and macOS-15

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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, ASTRA & ELEGANT Simulations, and AI for Accelerator Simulations** for **ISBA18 ~ ISBA25**.

You can obtain them by sending an email to Yujong Kim:

yjkim3488@gmail.com, yjkim@kaeri.re.kr or with facebook



Fedora vs. Ubuntu Linux



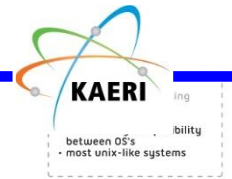
- ❑ Fedora is **the most advanced Linux distribution**, invariantly developed and maintained by the **Fedora Project**, sponsored by **Red Hat**. Starting in **2003**, Fedora gained a reputation for having **the best innovative capacities integrating new cutting-edge technologies** within the **Linux ecosystem**. It is a **playground for new features** that might later be included in **Red Hat Enterprise Linux (RHEL)**. Fedora is released about twice a year.
- ❑ **Ubuntu** has a very popular distribution maintained by **Canonical Ltd** and released in **2004**. Ubuntu has **user-friendliness and large community support**. The main purpose of **Ubuntu** is to be a **stable, secure, easy-to-use base**. Ubuntu is released about once a year.

For more details, please see
<https://ultahost.com/blog/fedora-vs-ubuntu/>



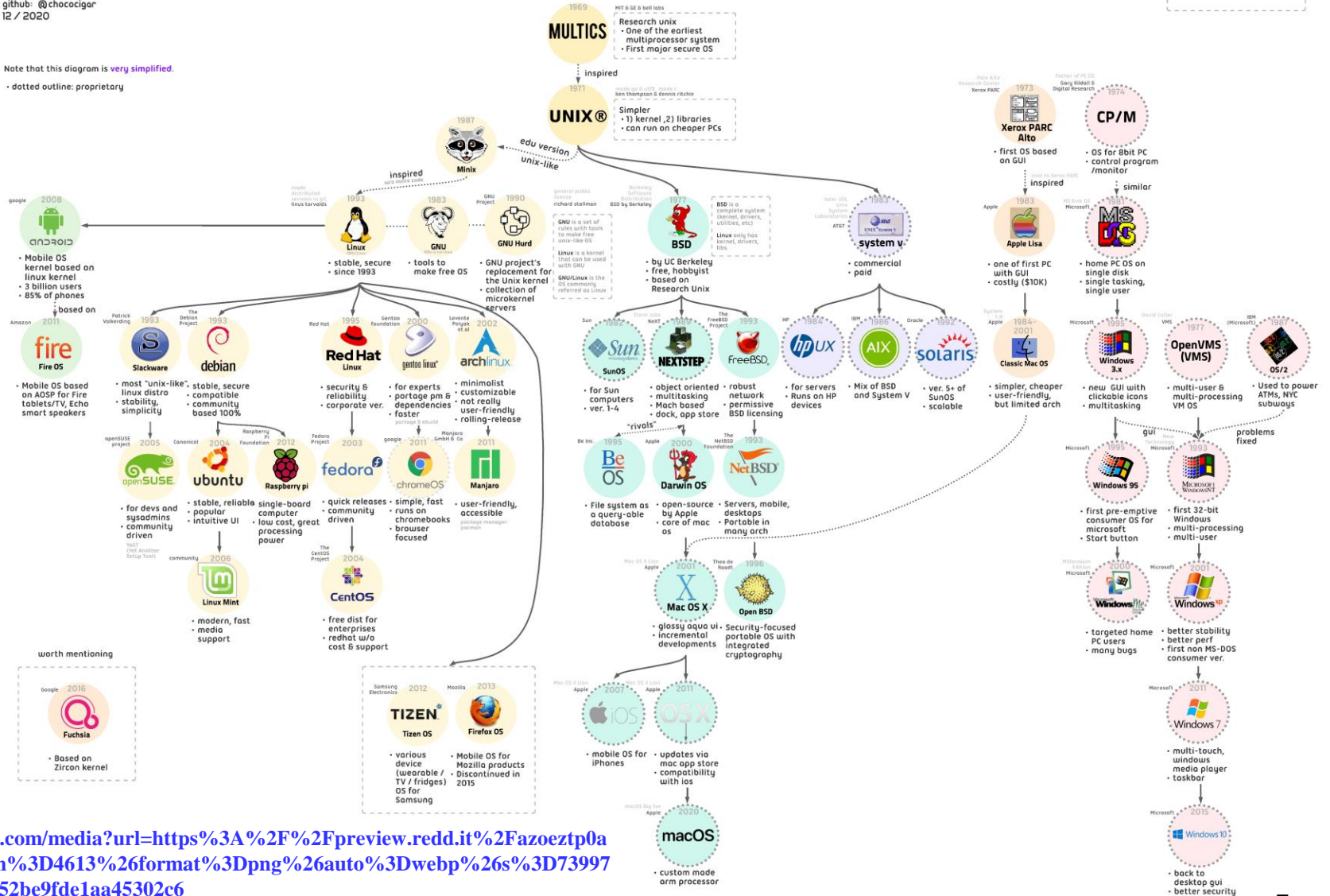
History of Various OS

SIMPLE HISTORY OF OS



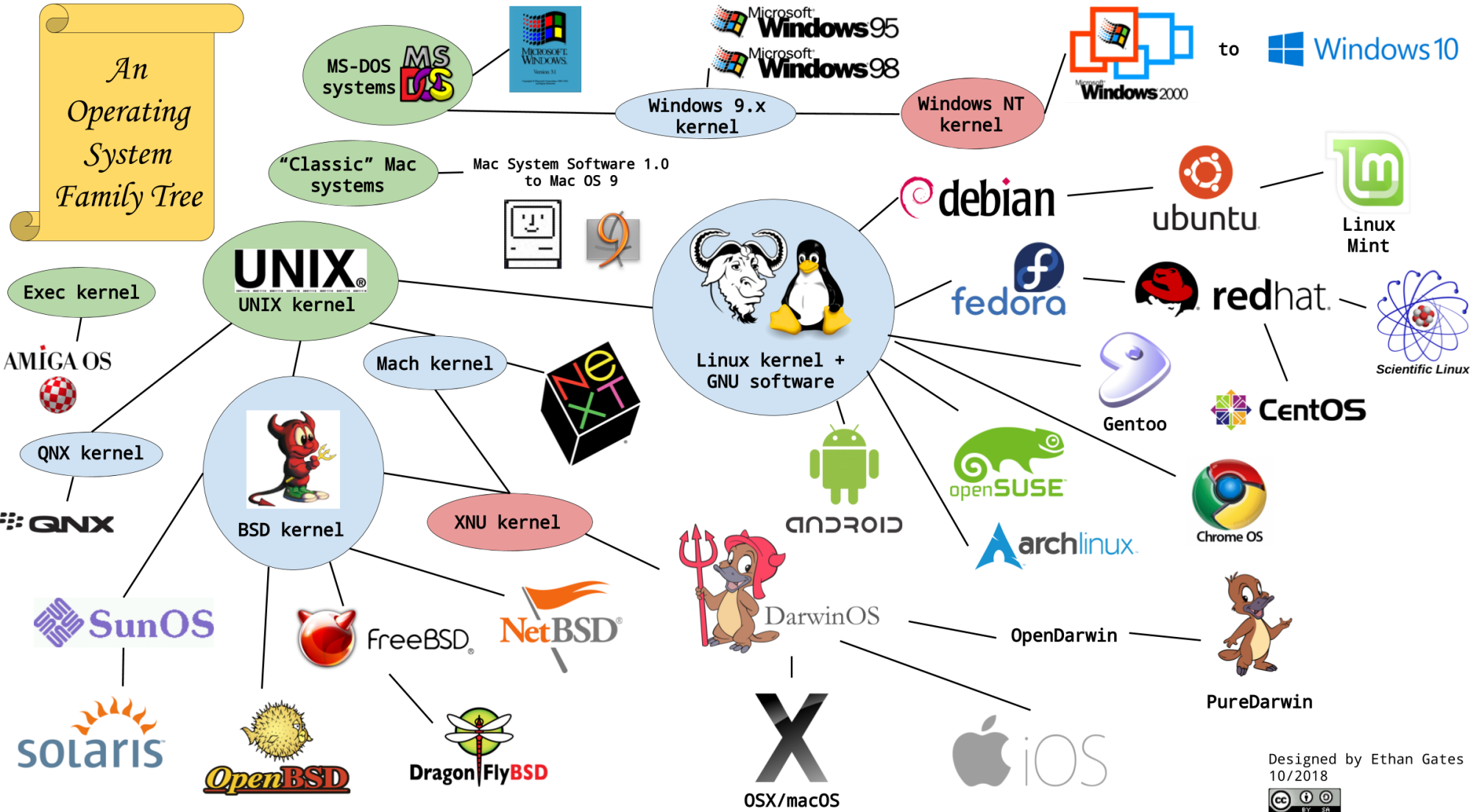
For any corrections, please contact
github: @chococigar
12 / 2020

Note that this diagram is very simplified.
- dotted outline: proprietary



<https://www.reddit.com/media?url=https%3A%2F%2Fpreview.redd.it%2Ffazoeztp0a2a81.png%3Fwidth%3D4613%26format%3Dpng%26auto%3Dwebp%26s%3D73997fe6f2b0467f73905452be9fde1aa45302c6>

OS Family Tree



https://github.com/EG-tech/digipres-posters/blob/master/OS_kernel_timeline.svg

Designed by Ethan Gates
10/2018



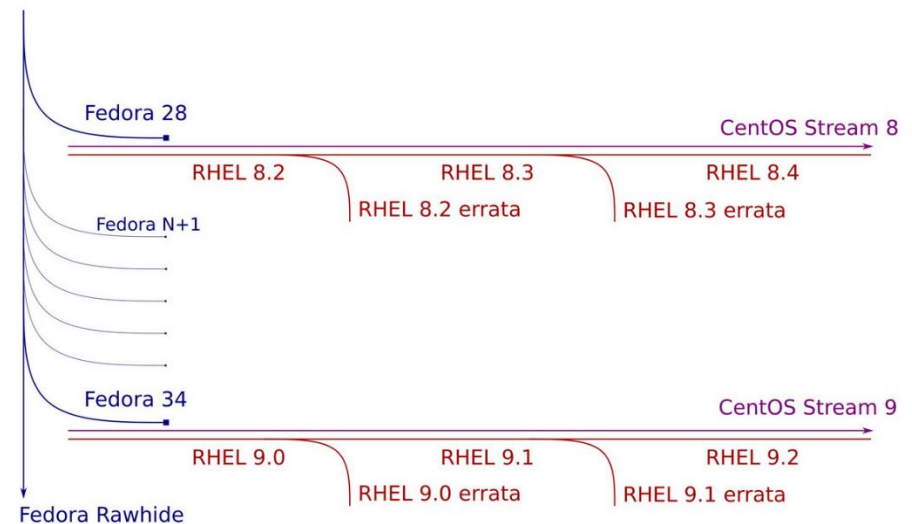
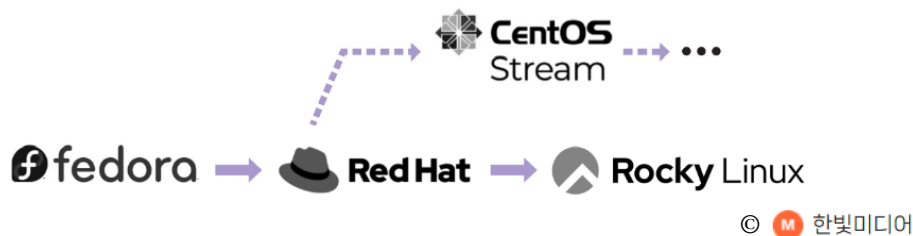
Relationship between Fedora, CentOS, & Red Hat



- **Fedora is the most advanced Linux distribution, having the best innovative capacities integrating new cutting-edge new technologies. Later, those new technologies are included in a commercial version of Red Hat Enterprise Linux (RHEL). CentOS is a free clone of RHEL but its released is stopped at CentOS-8 in 2020. CentOS Stream is a test version for the next RHEL version. Rocky Linux is a new free clone of RHEL after CentOS-8.**

<https://blog.while-true-do.io/linux-red-hat-family-in-2024/>

<https://github.com/mikeroyal/Fedora-Guide>



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. 64 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.**
- ❑ Our training will be based on Linux instead of Windows 10/11 due to bug.
- ❑ 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 64 GB.**
- ❑ We assume that students will use one of Fedora-36, Fedora-40, and Fedora-42 64 bit for the hands-on training with ELEGANT code, and **we may help you to solve any ELEGANT installation problem if you use iso image of Fedora-36, Fedora-40, or Fedora-42 64 bit network installation everything** (see next pages). **But 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. 22.

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. 64.

To install ELEGANT on Fedora-40, Fedora-42, Ubuntu-24, Ubuntu-25, and MAC OS, please see Appendix.

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 ~ Fedora-39** are not recommended due to several bugs.
 - But **Fedora-40 and Fedora-42** are stable. Their installations are described at Appendix at Page No. 80.
 - For download & installation details, please see:
https://docs.fedoraproject.org/en-US/fedora/f36/install-guide/install/Preparing_for_Installation/
<https://alt.fedoraproject.org/>
https://docs.fedoraproject.org/en-US/fedora/f36/install-guide/Downloading_Fedora/
- **[Important]** If you download Workstation or Server image instead of the network installation everything, you have to install many missing packages and libraries to install ELEGANT code later. Therefore, I strongly recommend you 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://github.com/FedoraQt/MediaWriter/releases/download/5.2.8/FedoraMediaWriter-win64-5.2.8.exe>
 - <https://github.com/ilikelinux69/Fedora-Media-Writer>
- ❑ Then, run its exe file to install **Fedora Media Writer** on the same Windows PC.
- ❑ Insert one **blank** USB flash memory card with a size bigger than 16 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/preparing-boot-media/>
 - https://docs.fedoraproject.org/en-US/fedora/f36/install-guide/install/Preparing_for_Installation/
 - https://youtu.be/jgCNwh_9zX4
 - <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 64 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 64 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



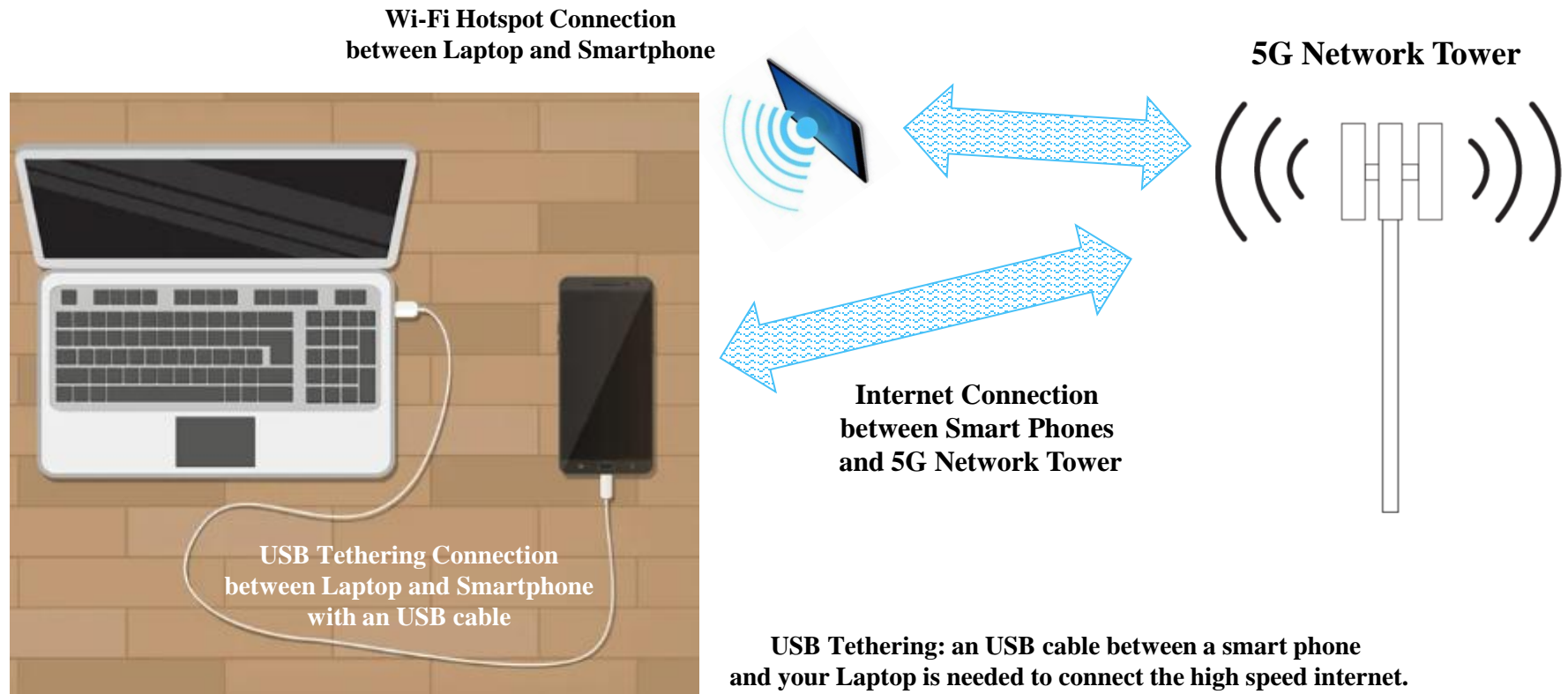
- ❑ For the dual boot installation, please install your two operating systems (Windows 7/10/11 and Linux) under the same firmware mode.
- ❑ Before Fedora installation, you may modify your BIOS or UEFI firmware if you want to do **by using a special button (ex, F2) during booting.**
 - For example, I 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.**

High Speed Internet for Fedora-36 Installation



□ 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 to 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.

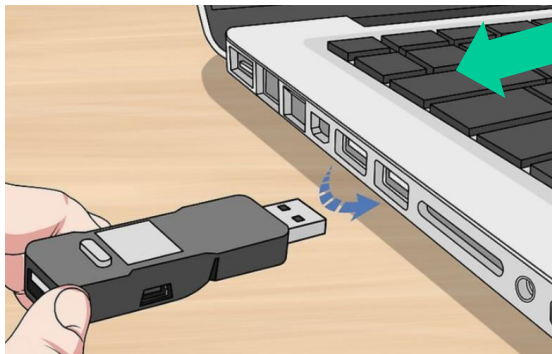
<https://www.samsung.com/in/support/mobile-devices/what-is-usb-tethering-in-samsung-smartphones/>

Installation of Fedora-36 & Single Boot Option



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

- <https://operavps.com/docs/install-fedora-36/>
- <https://www.youtube.com/watch?v=qcxnI9kUNko>
- <https://youtu.be/o9LmjJ-J3KA>
- <https://computingforgeeks.com/install-fedora-steps-with-screenshots/>
- <https://ostecnix.com/install-fedora/>
- <https://linuxhint.com/install-fedora-workstation-35-usb/>
- https://jfearn.fedorapeople.org/fdocs/en-US/Documentation/0.1/html/Fedora_Multiboot_Guide/BOOT-BIOS_or_UEFI.html



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

USB Card: Fedora Bootable Image

Fedora OS will be transferred from a Bootable USB card to an Internal SSD.

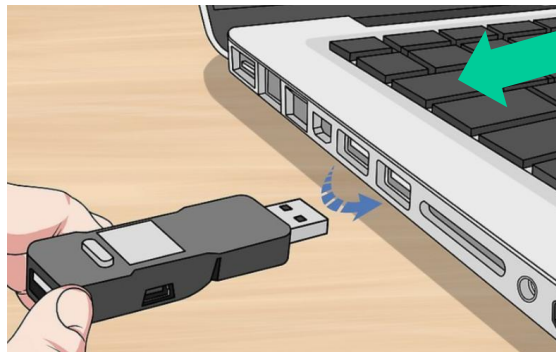
(All data in the internal SSD can be deleted if you install it with the single boot mode.)

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/>
- <https://ostechnix.com/dual-boot-fedora-and-windows/>



Windows 10
fedora

1st part of Internal SSD: Windows OS was installed

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

USB Card: Fedora Bootable Image

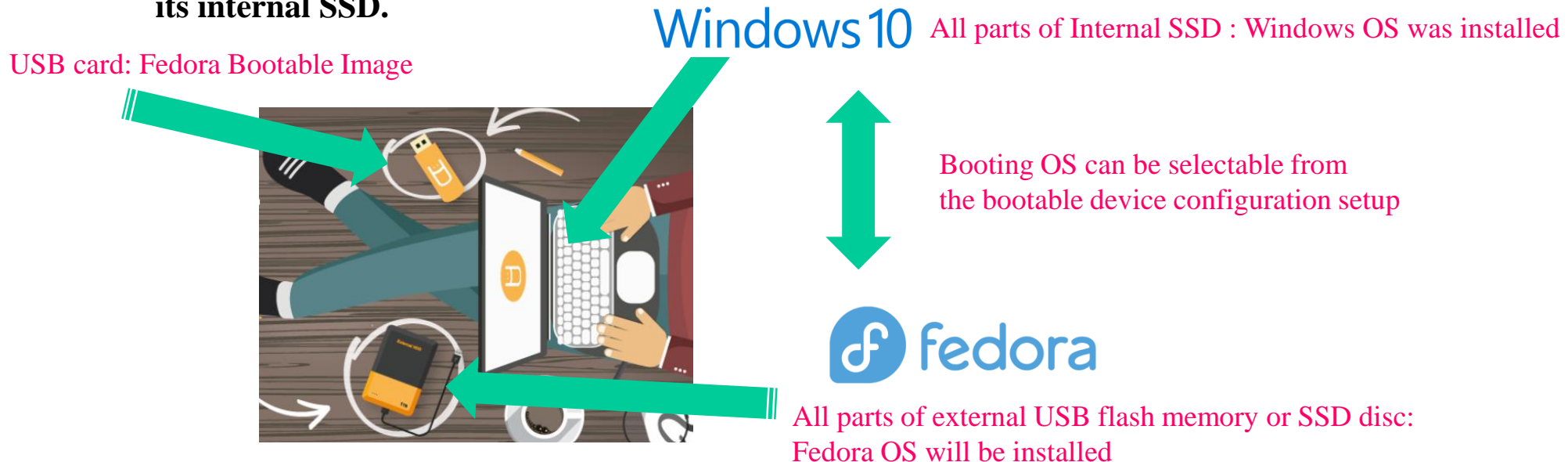
Windows 7/10/11 was already installed on the 1st partition of the internal SSD, and Fedora OS will be transferred from the bootable USB card to the 2nd partition of the internal SSD. **We need shrink (or readjust) of the Windows 7/10/11 SSD partition to make a new space for Fedora installation. During this installation, accidentally, 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 64 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 (≥ 64 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.

- 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/f36/install-guide/install/After_Installation/
 - <https://youtu.be/RrRpXs2pkzg>
 - <https://www.youtube.com/watch?v=lWcEHPwAIZk>
 - <https://www.hackingthehike.com/fedora36-guide/>
 - <https://www.youtube.com/watch?v=C3e-9JTONkA>
 - <https://www.howtogeek.com/things-you-should-do-right-after-installing-fedora-linux/>
 - <https://www.debugpoint.com/10-things-to-do-fedora-36-after-install/>
 - <https://fosspost.org/things-to-do-after-installing-fedora>

- 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. **You can also find similar post installations for Fedora-40 and Fedora-42 by doing Google (or YouTube) search or by using ChatGPT.**

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. 64.

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

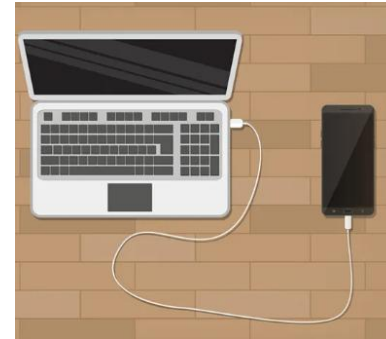
`dnf check-update`

- 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://youtu.be/9PLFEF5JEkc?si=_hsQpt6KhHXxxN8Z
- <https://docs.fedoraproject.org/en-US/fedora-coreos/sysconfig-enabling-wifi/>
- <https://wiki.archlinux.org/title/NetworkManager>

- ❑ 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"** **Please 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



- ❑ To install ELEGANT on Fedora (or RHEL), please install followings with dnf (or yum). Otherwise, it may generate errors during ELEGANT installation.

dnf install tcl wget subversion gzip tar make rpmdevtools rpm-build gcc gcc-c++ gcc-gfortran zlib-devel gd-devel libpng-devel libtiff-devel lapack-devel blas-devel gsl-devel fftw-devel openmotif-devel motif-devel libXaw-devel ncurses-devel readline-devel libXt-devel libXp-devel tcl-devel tk-devel tcsh python-devel hdf5-devel boost-devel ← This is a list of installed packages.



- ❑ To install ELEGANT on Ubuntu, please install following things with apt-get

apt-get install tcl wget subversion gzip tar make rpm alien gcc g++ gfortran zlib1g-dev libgd2-xpm-dev liblapack-dev libblas-dev libgsl0-dev libfftw3-dev libxaw7-dev libncurses5-dev libpng12-dev libxt-dev libxp-dev tcl-dev tk-dev tk-table csh python-dev libmotif-dev libtiff5-dev libreadline6-dev libhdf5-dev boost-dev ← This is a list of installed packages for Ubuntu.

Post Installation - TCP Wrapper Setting



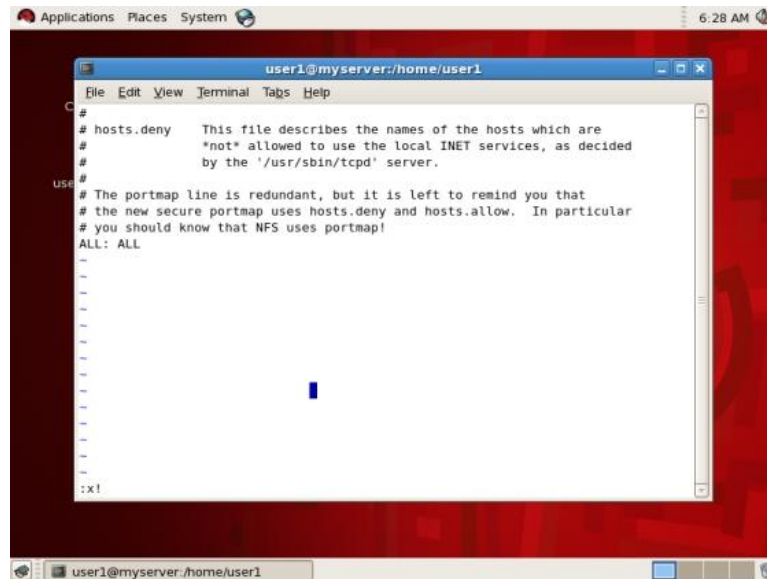
- To block any possible hacking from hackers, please block all services except **sshd service** from known computer by installing TCP Wrapper

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



```
user1@myserver:/home/user1
# hosts.deny This file describes the names of the hosts which are
# *not* allowed to use the local INET services, as decided
# by the '/usr/sbin/tcpd' server.
#
# The portmap line is redundant, but it is left to remind you that
# the new secure portmap uses hosts.deny and hosts.allow. In particular
# you should know that NFS uses portmap!
ALL: ALL
```

/etc/hosts.deny



```
user1@myserver:/home/user1
# hosts.allow This file describes the names of the hosts which are
# allowed to use the local INET services, as decided
# by the '/usr/sbin/tcpd' server.
#
sshd: 192.168.1.
```

/etc/hosts.allow

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

- 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 at **/usr/bin/tcsh**

After checking path of tcsh, modify your & root's shells to tcsh, located at /bin/tcsh:

su

chsh -s /bin/tcsh root ← to change root's default shell to /bin/tcsh

chsh -s /bin/tcsh yourID ← to change your default shell to /bin/tcsh

<https://www.tecmint.com/change-a-users-default-shell-in-linux/>

- 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 with your ID. Please do the same thing at root home directory (/root) under su by typing (Please see details at Pages No. 90 and 91):**
tar xvf env64.tar → **Then, restart computer to update the modifications.**

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

- ❑ **.cshrc** is the Linux/Unix shell (csh or tcsh) startup configuration file, which should be located at **your** and **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 new terminal.

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=1000
endif
```

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

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

setenv LD_LIBRARY_PATH /usr/local/lib:/lib64:/lib:/usr/lib64:/usr/lib:/usr/lib64/cernlib/2006/lib:/usr/lib/cernlib/2006-g77/lib:/usr/local/pgplot ← this is one long connected line without any space.

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

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
```

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-abssoft
```

```
# 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!

- **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_\(Unix\)](https://en.wikipedia.org/wiki/Modes_(Unix))

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'

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_basicle locale 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'
```

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=bbbox'
```

```
alias pdf2eps 'pdf2ps -sDEVICE=bbbox' -r600
```

```
alias ps2pdfa4 'ps2pdf14 -sPAPERSIZE=a4 -r600'
```

```
alias ps2pdfletter 'ps2pdf14 -sPAPERSIZE=letter -r600'
```

```
alias dvi2pdf 'dvi2pdf -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'
```

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'
```

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

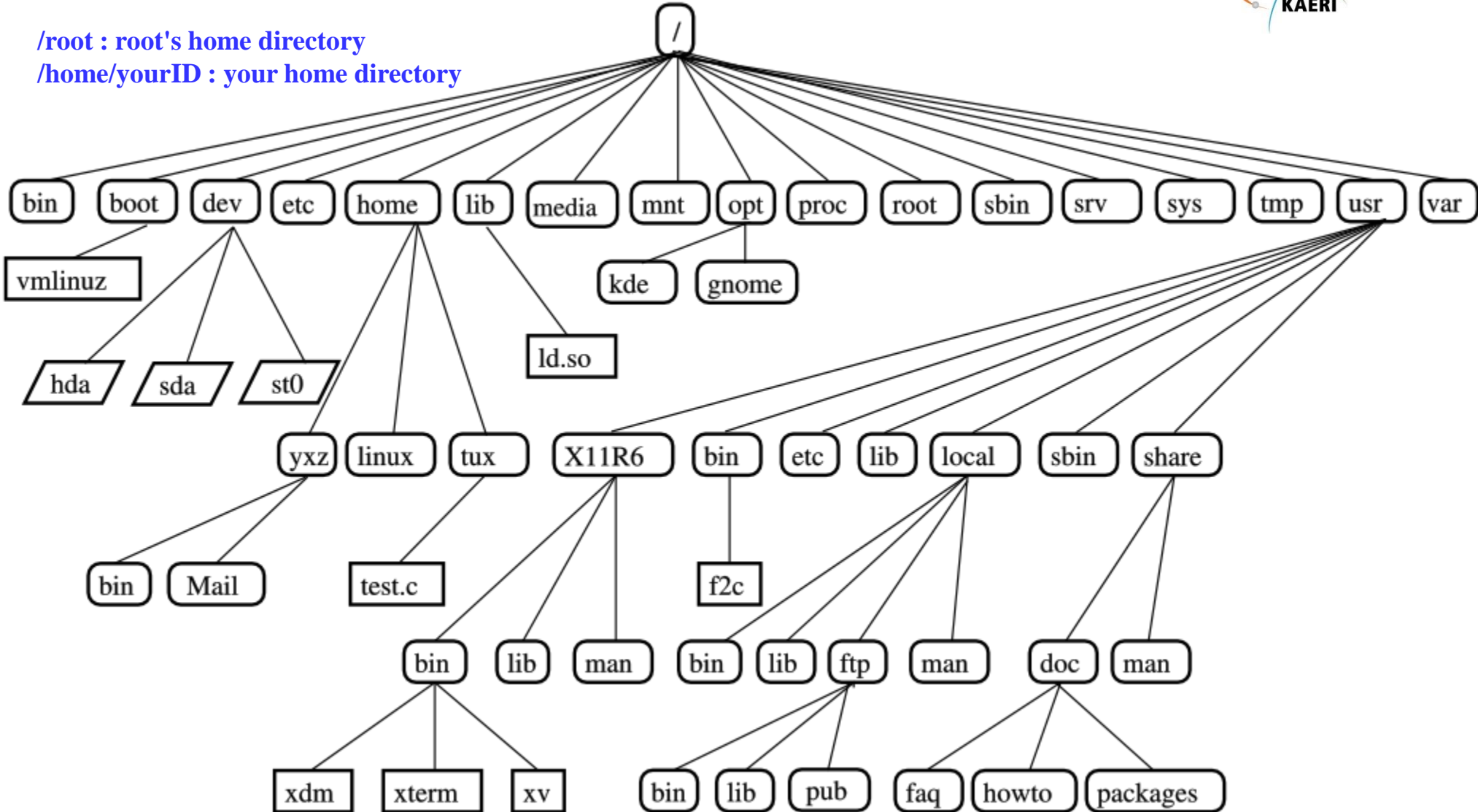
Please read this section even though you know well on Linux commands

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. 64.

Directories in Linux

/root : root's home directory

/home/yourID : your home directory



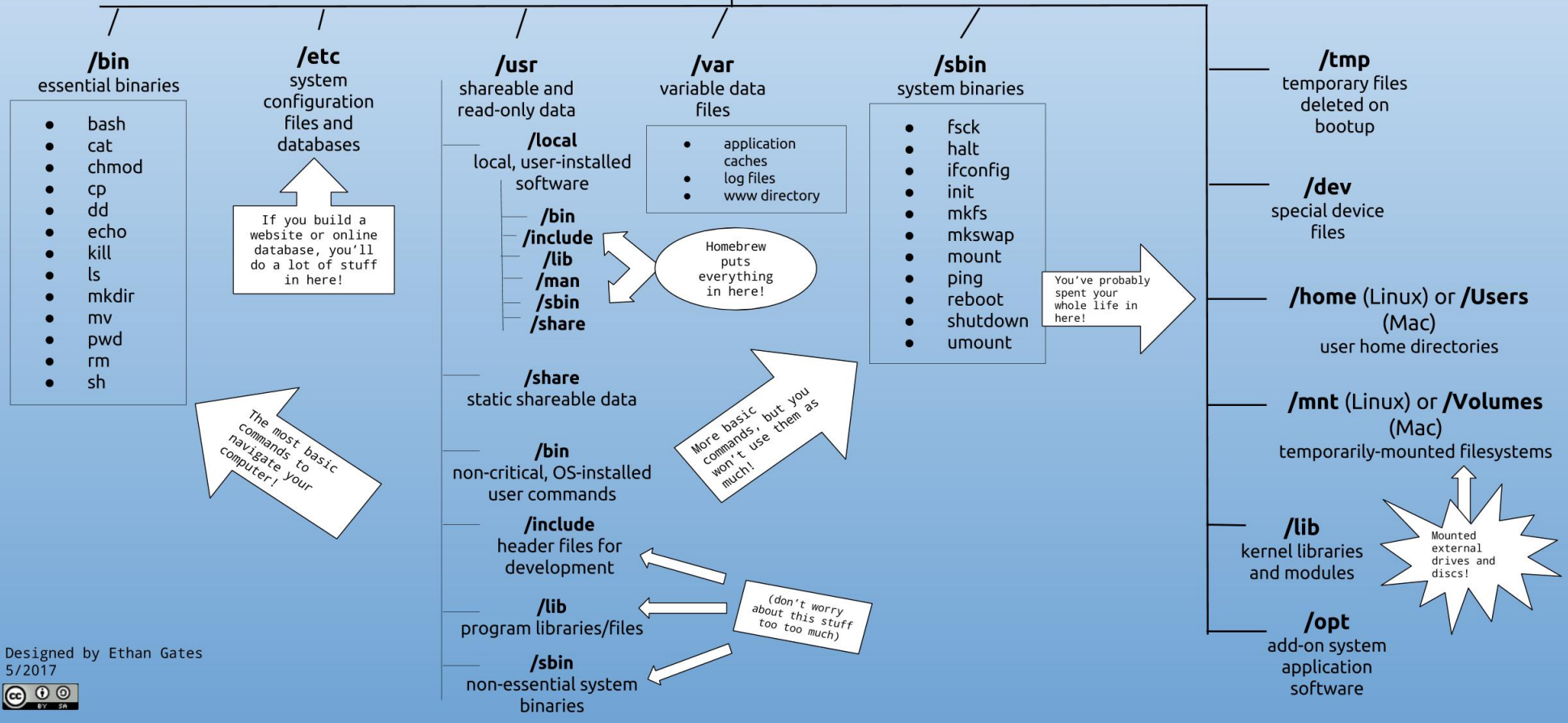
https://www.linuxtopia.org/online_books/suse_linux_guides/SLES10/suse_enterprise_linux_server_installation_admin/sec_bash.html

What's inside your Unix computer?

/root : root's home directory

/home/yourID : your home directory

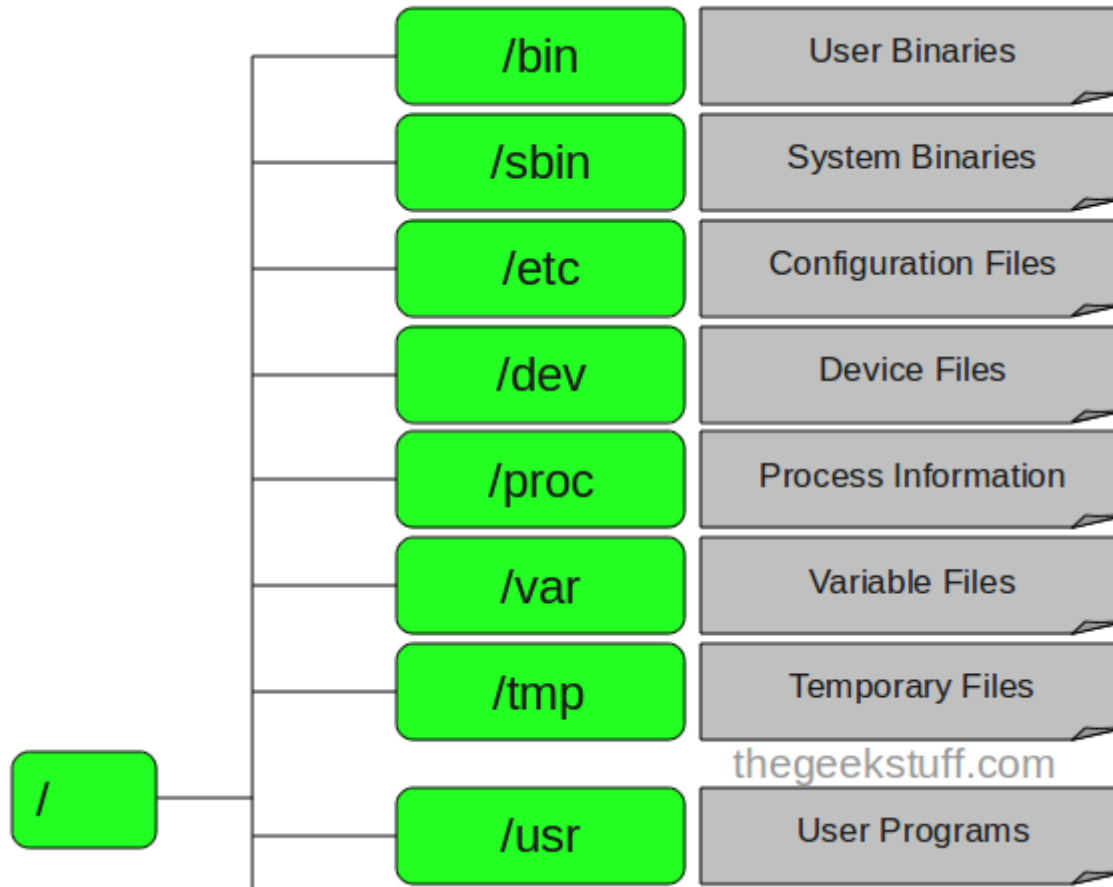
/ "root"



Designed by Ethan Gates
5/2017



Directories in Linux



/usr/local/bin

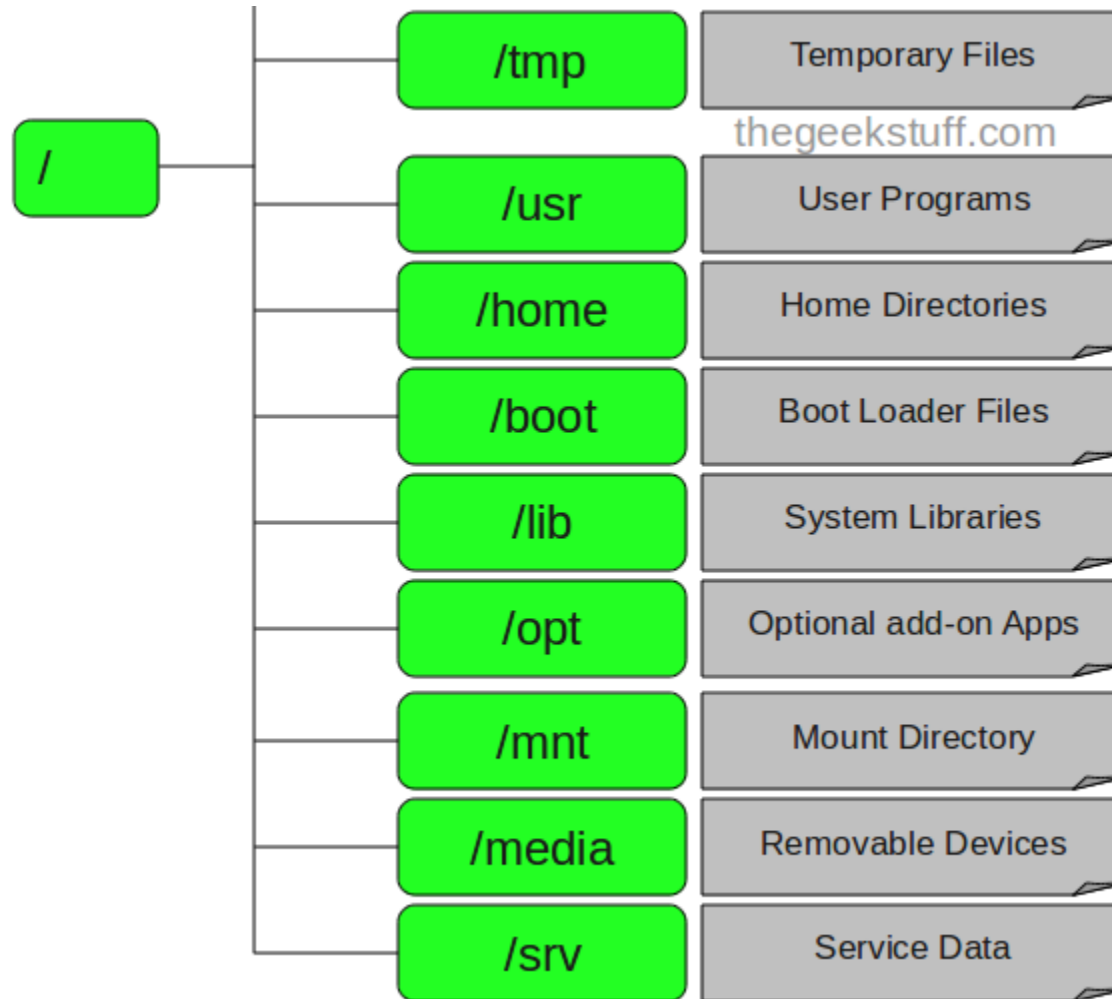
/usr/local/include

/usr/local/lib

← Software Installation Point

courtesy of thegeekstuff.com

directories - continued



thegeekstuff.com

/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

- **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 executable 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

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

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 → unzipped 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 forcibly

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 - shutdown computer now

reboot - rebooting your computer (shutdown -r now for rebooting)

su - switching to system administrator (root, super user) or other userID with su ID.

du -h - estimating HDD usage of file or directory in human readable 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 - unmounting /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 a job with a 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://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/html/doc/educational/shell_and_script.html

Installation of ELEGANT Code on Fedora-36 64 bit

If you already installed ELEGANT code on a Linux computer, 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. 64.**

- **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 ≥ 100 MeV for $Q \sim 1$ nC & $I_{\text{peak}} \sim 100$ 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 and SDDS Toolkit

- ELEGANT Website with **Installation Guide for Linux OS and macOS**

<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 & SDDS 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 as described at Page No. 57. Then the key will be delivered to your email.

- APS Software Documentation Website (PDF & HTML manuals of 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 Linux due to a plotting bug in Windows version.**

- **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 [Recommended]**

<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.

Please insert the delivered key for your downloading. Then, push Download button.

Please fill out the following form before downloading

Name:

Email:

Key:

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

From the website, you can download and save the pre-compiled ELEGANT related RPM binaries for Fedora-40, Fedora-42, Ubuntu-24, and Ubuntu-25 by using "save as link" function of the right mouse button. **But for those ELEGANT related binaries for Fedora-36, you can download them from following links (Courtesy of Dr. Robert Soliday and Dr. Michael Borland):**

https://ops.aps.anl.gov/downloads/elegant-2023.2.0-1.fedora.36.mpich.x86_64.rpm

https://ops.aps.anl.gov/downloads/elegant-2023.2.0-1.fedora.36.openmpi.x86_64.rpm

https://ops.aps.anl.gov/downloads/OAGTclTk-1.28-1.fedora.36.x86_64.rpm

https://ops.aps.anl.gov/downloads/SDDSEpicsToolKit-5.4-1.fedora.36.x86_64.rpm

https://ops.aps.anl.gov/downloads/SDDSJava-5.2.1-1.fedora.36.x86_64.rpm

https://ops.aps.anl.gov/downloads/SDDSPython3-5.2.1-1.fedora.36.x86_64.rpm

https://ops.aps.anl.gov/downloads/SDDSToolKit-5.4-1.fedora.36.x86_64.rpm

https://ops.aps.anl.gov/downloads/SDDSToolKit-devel-5.4-1.fedora.36.x86_64.rpm

https://ops.aps.anl.gov/downloads/shield-1.0-1.fedora.36.x86_64.rpm

https://ops.aps.anl.gov/downloads/shower-1.13-1.fedora.36.x86_64.rpm

https://ops.aps.anl.gov/downloads/spiff-e-4.8.2-1.fedora.36.x86_64.rpm

If the download key is requested, please obtain the key over email as described at previous Page No. 57. Recently, you may not need to insert the download key.

How to install ELEGANT on Fedora-36 64 bit



[Very Important!] After logging as the root, system administrator with `su` or `sudo` command, please do all post installations described from Page No. 22 to 28 before you start to install those RPMs.

If you do not follow them, you will meet an error at a certain step in the near future. You can find those downloaded RPM files at `/home/yourID/Downloads`.

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.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 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 follow all steps at Pages No. 22 ~ 28.)**

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

1. Updating Fedora-36 with its last version software (please see Page No. 22)
dnf upgrade and reboot your laptop for updating

2. Installation of development tools and libraries (please see Pages No. 24 and 25)
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 as well as all needed prerequired packages for Fedora, which are described at Pages No. 24 and 25.
dnf install gsl-devel atlas atlas-devel lapack-devel blas-devel motif-devel
dnf install dnf install tcl wget subversion boost-devel
← Please use its full list at Page No. 25. Then, **under su, do**
source ~root/.cshrc

Then, please try reinstallation of ELEGANT.

How to install ELEGANT on Fedora-36 64 bit



4. During running of ELEGANT, if you meet a following error about the FFT libraries:

"elegant: error while loading shared libraries: libfftw3.so.3"

Then, please install its libraries for 64 bit 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 a way to compile and build ELEGANT RPMs on your own Linux 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 pages (Page No. 58 ~ 59). Then, please cross-check whether your Linux has **tcsh** shell, and you already changed your shell and root's shell from bash to tcsh, and **untar env64.tar** file at your home and root's home directories (/home/yourID and /root).

Then relogin for updating the shell change (Please see details at Page No. 27 and 28).

Then, try to find elegant binary 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 and root's home. 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, 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. 65.**

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**.

A terminal window titled 'Terminal' showing the following commands and their output:

```
[yjkim@fedora ~/Downloads]# gzip -d ISBA2022_ELEGANT_sample.tar.gz
[yjkim@fedora ~/Downloads]# ls -al *.tar
-rwxrwxrwx. 1 yjkim yjkim 10240 Nov 14 16:02 ISBA2022_ELEGANT_sample.tar
[yjkim@fedora ~/Downloads]# tar xvf ISBA2022_ELEGANT_sample.tar
ISBA2022_ELEGANT_sample/
ISBA2022_ELEGANT_sample/CSR-1G.lte
ISBA2022_ELEGANT_sample/beta_eta_plot
ISBA2022_ELEGANT_sample/CSR-1.0GEV_DISP_TRACK.ele
[yjkim@fedora ~/Downloads]# cd ISBA2022_ELEGANT_sample
[yjkim@fedora ISBA2022_ELEGANT_sample]# pwd
/home/yjkim/Downloads/ISBA2022_ELEGANT_sample
[yjkim@fedora ISBA2022_ELEGANT_sample]# ls
beta_eta_plot  CSR-1.0GEV_DISP_TRACK.ele  CSR-1G.lte
[yjkim@fedora ISBA2022_ELEGANT_sample]#
```

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

```
Terminal
[yjkim@fedora ~/Downloads]# gzip -d ISBA2022_ELEGANT_sample.tar.gz
[yjkim@fedora ~/Downloads]# ls -al *.tar
-rwxrwxrwx. 1 yjkim yjkim 10240 Nov 14 16:02 ISBA2022_ELEGANT_sample.tar
[yjkim@fedora ~/Downloads]# tar xvf ISBA2022_ELEGANT_sample.tar
ISBA2022_ELEGANT_sample/
ISBA2022_ELEGANT_sample/CSR-1G.lte
ISBA2022_ELEGANT_sample/beta_eta_plot
ISBA2022_ELEGANT_sample/CSR-1.0GEV_DISP_TRACK.ele
[yjkim@fedora ~/Downloads]# cd ISBA2022_ELEGANT_sample
[yjkim@fedora ISBA2022_ELEGANT_sample]# pwd
/home/yjkim/Downloads/ISBA2022_ELEGANT_sample
[yjkim@fedora ISBA2022_ELEGANT_sample]# ls
beta_eta_plot CSR-1.0GEV_DISP_TRACK.ele CSR-1G.lte
[yjkim@fedora ISBA2022_ELEGANT_sample]# 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:

```
Terminal
18 Nov 22 14:35:56: Rf phases/references reset.
Dumping output beam data...done.
Dumping centroid data...done.
Dumping sigma data...done.
Dumping final properties data...done.
Post-tracking output completed.
Tracking step completed  ET:    00:00:00 CP:    0.03 BIO:0 DIO:0 PF:0 MEM:6756

Saving lattice parameters to csr-1.0gev.par...done.
Finished tracking.
End of input data encountered.
statistics:  ET:    00:00:00 CP:    0.03 BIO:0 DIO:0 PF:0 MEM:6907
=====
=====
Thanks for using elegant.  Please cite the following reference in your publications:
  M. Borland, "elegant: A Flexible SDDS-Compliant Code for Accelerator Simulation,"
  Advanced Photon Source LS-287, September 2000.
If you use a modified version, please indicate this in all publications.
=====
=====
[yjkim@fedora ISBA2022_ELEGANT_sample]#
```

How to use ELEGANT on Fedora-36 64 bit



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

```
Terminal
Dumping final properties data...done.
Post-tracking output completed.
Tracking step completed  ET:    00:00:00 CP:    0.03 BIO:0 DIO:0 PF:0 MEM:6756

Saving lattice parameters to csr-1.0gev.par...done.
Finished tracking.
End of input data encountered.
statistics:  ET:    00:00:00 CP:    0.03 BIO:0 DIO:0 PF:0 MEM:6907
=====
=====
Thanks for using elegant.  Please cite the following reference in your publications:
  M. Borland, "elegant: A Flexible SDDS-Compliant Code for Accelerator Simulation,"
  Advanced Photon Source LS-287, September 2000.
If you use a modified version, please indicate this in all publications.
=====
=====
[yjkim@fedora ISBA2022_ELEGANT_sample]# ls
beta_eta_plot          csr-1.0gev.fin  csr-1.0gev.par  CSR-1G.lte
csr-1.0gev.cen         csr-1.0gev.mag  csr-1.0gev.sig
CSR-1.0GEV_DISP_TRACK.ele  csr-1.0gev.out  csr-1.0gev.twi
[yjkim@fedora ISBA2022_ELEGANT_sample]#
```

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

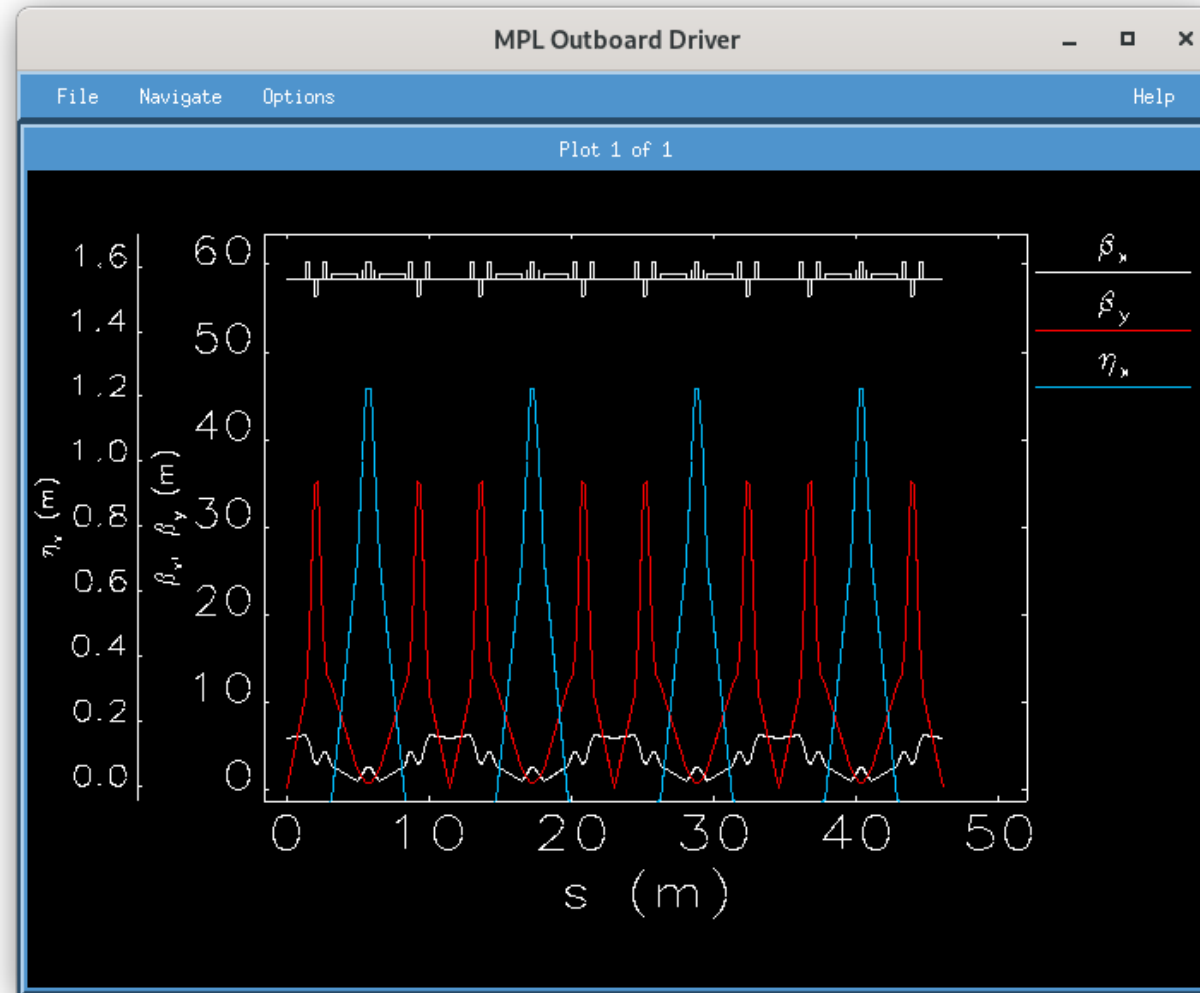
`./beta_eta_plot`

```
Terminal
Dumping final properties data...done.
Post-tracking output completed.
Tracking step completed ET: 00:00:00 CP: 0.03 BIO:0 DIO:0 PF:0 MEM:6756

Saving lattice parameters to csr-1.0gev.par...done.
Finished tracking.
End of input data encountered.
statistics: ET: 00:00:00 CP: 0.03 BIO:0 DIO:0 PF:0 MEM:6907
=====
=====
Thanks for using elegant. Please cite the following reference in your publications:
M. Borland, "elegant: A Flexible SDDS-Compliant Code for Accelerator Simulation,"
Advanced Photon Source LS-287, September 2000.
If you use a modified version, please indicate this in all publications.
=====
=====
[yjkim@fedora ISBA2022_ELEGANT_sample]# ls
beta_eta_plot      csr-1.0gev.fin  csr-1.0gev.par  CSR-1G.lte
csr-1.0gev.cen     csr-1.0gev.mag  csr-1.0gev.sig
CSR-1.0GEV_DISP_TRACK.ele  csr-1.0gev.out  csr-1.0gev.twi
[yjkim@fedora ISBA2022_ELEGANT_sample]# ./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:



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. 56 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
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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.

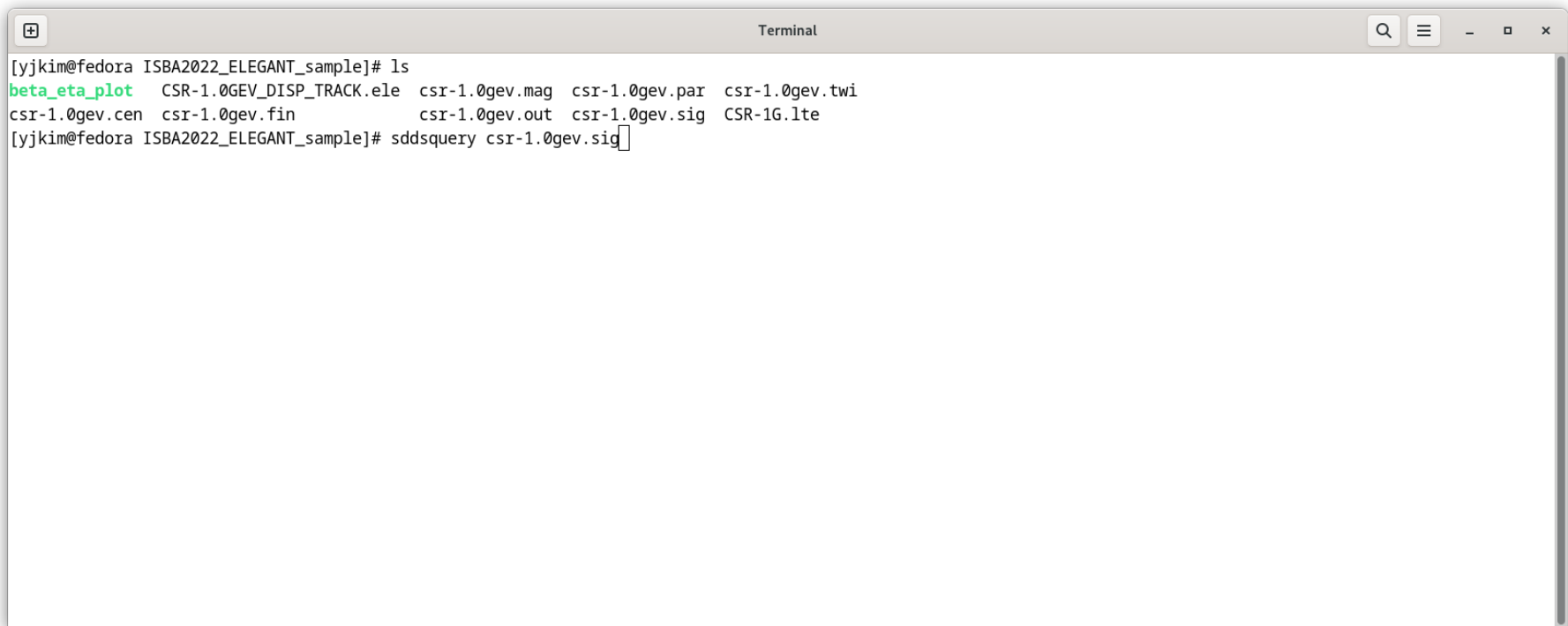
**Strongly
recommended
document
on SDDS!**

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`

A terminal window titled "Terminal" is shown. The prompt is [yjkim@fedora ISBA2022_ELEGANT_sample]#. The user enters 'ls' and the output is: 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. The user then enters 'sddsquery csr-1.0gev.sig' and the cursor is at the end of the command.

```
[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
```

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
              UNITS          SYMBOL          FORMAT          TYPE          FIELD          LENGTH
s             m             NULL           NULL           double        0             Distance
ElementName   NULL          NULL           %10s           string        0             Element name
ElementOccurrence NULL        NULL           %6ld           long         0             Occurrence 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      $gs$Ir$bx'$n  NULL      double  0      sqrt(<(x'-<x'>)^2>)
Sy       m         $gs$Ir$by$n  NULL      double  0      sqrt(<(y-<y>)^2>)
Syp      NULL     $gs$Ir$by'$n  NULL      double  0      sqrt(<(y'-<y'>)^2>)
Ss       m         $gs$Ir$bs$n  NULL      double  0      sqrt(<(s-<s>)^2>)
Sdelta   NULL     $gs$Ir$bd$n  NULL      double  0      sqrt(<(delta-<delta>)^2>)
St       s         $gs$Ir$bt$n  NULL      double  0      sqrt(<(t-<t>)^2>)
ex       m         $ge$Ir$bx$n  NULL      double  0      geometric horizontal emittance
enx      m         $ge$Ir$bx,n$n  NULL     double  0      normalized horizontal emittance
ecx      m         $ge$Ir$bx,c$n  NULL     double  0      geometric horizontal emittance less dispersive contributions
ecnx     m         $ge$Ir$bx,cn$n  NULL     double  0      normalized horizontal emittance less dispersive contributions
ey       m         $ge$Ir$by$n  NULL      double  0      geometric vertical emittance
eny      m         $ge$Ir$by,n$n  NULL     double  0      normalized vertical emittance
ecy      m         $ge$Ir$by,c$n  NULL     double  0      geometric vertical emittance less dispersive contributions
ecny     m         $ge$Ir$by,cn$n  NULL     double  0      normalized vertical emittance less dispersive contributions
betaxBeam  m         $gb$Ir$bx,beam$n  NULL     double  0      betax for the beam, excluding dispersive contributions
alphaxBeam NULL     $ga$Ir$bx,beam$n  NULL     double  0      alphax for the beam, excluding dispersive contributions
betayBeam  m         $gb$Ir$by,beam$n  NULL     double  0      betay for the beam, excluding dispersive contributions
alpayBeam  NULL     $ga$Ir$by,beam$n  NULL     double  0      alpay 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
              UNITS          SYMBOL          FORMAT          TYPE  FIELD  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$nc      p$bcnt$n     NULL           double 0      Initial central momentum
ElementName  NULL         NULL          %10s           string 0      Element name
ElementOccurrence NULL        NULL          %6ld           long   0      Occurrence of element
ElementType  NULL         NULL          %10s           string 0      Element-type name
ChamberShape NULL        NULL          NULL           string 0      NULL
dI1          m             NULL           NULL           double 0      Contribution to radiation integral 1
dI2          1/m           NULL           NULL           double 0      Contribution to radiation integral 2
dI3          1/m$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]

```
[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 m	betax m	betay m	etax 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 ISBA2024 school website:

[1] **env64.tar** : tcsh environmental configuring dot files for **Fedora and Ubuntu**

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

Downloading a tar file : https://conference-indico.kek.jp/event/186/sessions/1101/attachments/2511/3257/ISBA2022_ELEGANT_sample.tar

[3] You can also get *Getting Started SDDS sample data file*

Downloading a tar.gz file : <https://conference-indico.kek.jp/event/186/sessions/1111/attachments/2517/3256/GettingStartedData.tar.gz>

- 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 4th Generation Synchrotron Light Source
- Error Tolerance of MBA based 4th Generation Synchrotron Light Source
- Dynamic Aperture of MBA based 4th 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 Fedora-40 & Fedora-42 64 bit Linux OS

If you do not install Fedora-40 (or Fedora-42) yet, please see next pages. If you already have Fedora-40 (or Fedora-42) OS, please **do the similar Post Installation**, which is described at **Pages No. 22 ~ 28** for **Fedora-36**. **After the Post Installation**, please install **ELEGANT code on Fedora-40**, (or **Fedora-42**) which is described at this Appendix.

Here, we will focus on installation of ELEGANT on Fedora-40. To install ELEGANT on Fedora-42, with pre-compiled RPM binaries for Fedora-42 64 bit, please do the same steps described here.



Appendix I - Install Fedora-40 & 42 Network Everything



- ❑ On one Windows 7/10/11 PC, download the hybrid ISO image of Fedora-40 or 42 64 bit network installation everything from **Fedora Main Downloads site**:
 - **Fedora-40**: https://download.fedoraproject.org/pub/fedora/linux/releases/40/Everything/x86_64/iso/
 - **Fedora-42**: https://mirror.karneval.cz/pub/linux/fedora/linux/releases/42/Everything/x86_64/iso/
 - Please download Fedora-40 (or Fedora-42) Network Installation Everything: **Fedora-Everything-netinst-x86_64-40-1.14.iso** (about 812 MB)
 - You can also download Fedora-42 from <https://fedoraproject.org/everything/download>
- ❑ **[Important]** If you download Workstation or Server image instead of the network installation everything, you have to install many missing packages to install ELEGANT later. **Therefore, I strongly recommend you to download Fedora-Everything-netinst-x86_64-40-1.14.iso from the Fedora Downloads site.**
- ❑ After downloading the iso image, please follow similar steps for making a bootable USB card described at Page No. 13.
- ❑ Then, please follow similar steps for Firmware Configuration at Page No. 14, Priority of Bootable Device at Page No. 15, High Speed Internet at Page No. 16.
- ❑ Then, please follow steps for your boot option. Single Boot Installation Option is described at Page No. 17, Dual Boot Option is described at Page No. 18.
 - <https://www.youtube.com/watch?v=6Z9oG3E6M44> <https://www.youtube.com/watch?v=1z57nN5R5EU>
- ❑ **Then, please follow steps for Post Installation described at Pages No. 20 ~ 28.**

Appendix I - ELEGANT on Fedora-40 & 42 64 bit



Please download Fedora-40 (or Fedora-42) 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-40 (or Fedora-42) 64 bit such as below:



- SDDSToolKit-5.8-1.fedora.40.x86_64.rpm
- SDDSToolKit-devel-5.8-1.fedora.40.x86_64.rpm
- SDDSEpicsToolKit-5.6-1.fedora.40.x86_64.rpm
- OAGTclTk-1.28-1.fedora.40.x86_64.rpm
- elegant-2025.1.0-1.fedora.40.mpich.x86_64.rpm
- elegant-2025.1.0-1.fedora.40.openmpi.x86_64.rpm
- shower-1.13-1.fedora.40.x86_64.rpm
- spiffe-4.10.0-1.fedora.40.x86_64.rpm
- SDDSJava-5.2.1-1.fedora.40.x86_64.rpm
- clinchor-2.0-1.fedora.40.x86_64.rpm
- shield-1.0-1.fedora.40.x86_64.rpm



- SDDSToolKit-5.8-1.fedora.42.x86_64.rpm
- SDDSToolKit-devel-5.8-1.fedora.42.x86_64.rpm
- SDDSEpicsToolKit-5.8-1.fedora.42.x86_64.rpm
- OAGTclTk-1.30-1.fedora.42.x86_64.rpm
- elegant-2025.2.0-1.fedora.42.mpich.x86_64.rpm
- elegant-2025.2.0-1.fedora.42.openmpi.x86_64.rpm
- shower-1.14-1.fedora.42.x86_64.rpm
- spiffe-4.10.0-1.fedora.42.x86_64.rpm
- SDDSJava-5.2.1-1.fedora.42.x86_64.rpm
- clinchor-2.0-1.fedora.42.x86_64.rpm
- shield-1.1-1.fedora.42.x86_64.rpm

By using the "save as link" function of right mouse button, please download those RPM packages. If the download key is requested, please obtain the key over email as described at Page No. 57.

[Very Important!] After logging as the root, system administrator with **su** or **sudo** command, please do all post installations described from Page No. 20 to 28 before you start to install those RPMs.

If you do not follow them, you will meet an error at a certain step in the near future. You can find those downloaded RPM files at `/home/yourID/Downloads`.

Then, please move in the `Downloads` directory, and let's install ELEGANT under **su**:

su

cd /home/yourID/Downloads (Followings are for Fedora-40 case.)

rpm -Uvh SDDSToolKit-5.8-1.fedora.40.x86_64.rpm

rpm -Uvh SDDSToolKit-devel-5.8-1.fedora.40.x86_64.rpm

rpm -Uvh SDDSEpicsToolKit-5.6-1.fedora.40.x86_64.rpm

rpm -Uvh OAGTclTk-1.28-1.fedora.40.x86_64.rpm ← optional

rpm -Uvh elegant-2025.1.0-1.fedora.40.mpich.x86_64.rpm

rpm -Uvh elegant-2025.1.0-1.fedora.40.openmpi.x86_64.rpm ← optional

rpm -Uvh shower-1.13-1.fedora.40.x86_64.rpm ← optional

rpm -Uvh spiffe-4.10.0-1.fedora.40.x86_64.rpm ← optional

rpm -Uvh SDDSJava-5.2.1-1.fedora.40.x86_64.rpm ← optional

rpm -Uvh clinchor-2.0-1.fedora.40.x86_64.rpm ← optional

rpm -Uvh shield-1.0-1.fedora.40.x86_64.rpm ← optional

Optional is an optional installation, which you may skip its installation. To install ELEGANT on Fedora-42, please do same steps with pre-compiled RPM binaries for Fedora-42 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 follow all steps at Pages No. 22 ~ 28.)**

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

1. **Updating Fedora-40 or 42 with its last version software (please see Page No. 22)**
dnf upgrade and reboot your laptop for updating
2. **Installation of development tools and libraries (please see Pages No. 24 and 25)**
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 as well as all needed prerequired packages for Fedora, which are described at Pages No. 24 and 25.**
dnf install gsl-devel atlas atlas-devel lapack-devel blas-devel motif-devel
dnf install tcl wget subversion boost-devel
← Please use its full list at Page No. 25.

Then, **under su, let's reboot your Linux to update OS after installation of many new packages: shutdown -r now** after reboot, let's reinstall ELEGANT.

Appendix I - ELEGANT on Fedora-40 & 42 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 a way to compile and build ELEGANT RPMs on your own Linux by yourself. **Since we already downloaded pre-compiled RPMS for Fedora-40, 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 pages (Page No. 81 ~ 82). Then, please cross-check whether your Linux has **tcsh** shell, and you already changed your shell and root's shell from **bash** to **tcsh**, and **untar env64.tar** file at your home and root's home directories (**/home/yourID** and **/root**).

Then relogin for updating the shell change (Please see details at Page No. 27 and 28, and Pages at 90 and 91).

Then, try to find elegant binary just by typing a following thing in a terminal:
which elegant

→ **This will display `/usr/bin/elegant` if you have installed ELEGANT properly.**

Appendix I - ELEGANT on Fedora-40 & 42 64 bit



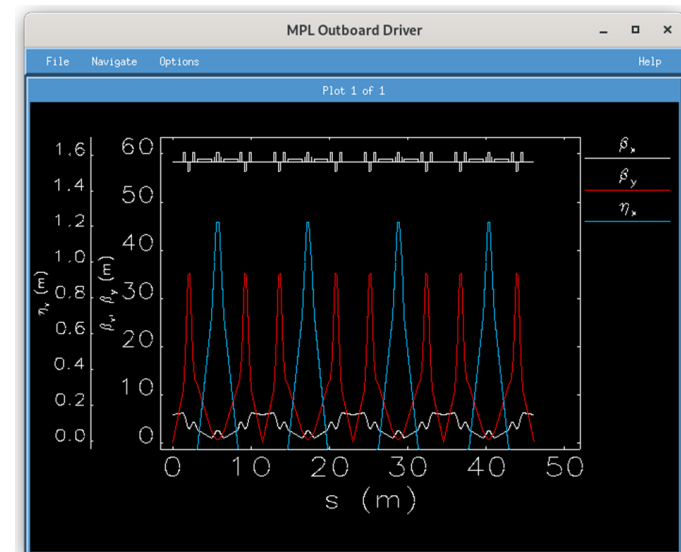
By untarring env64.tar file, which you can download from ISBA school website, several files (.cshrc, .alias, .env-apsoag, .env-epics64, .defns.rpn and so on) will be installed at your home and root's home. Therefore, you can skip Step 3 and Step 4, which are described on the above Linux Installation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

Congratulations!

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

To use ELEGANT and SDDS, please follow all steps described at Page No. 64 ~ 77. Specially, you have to make a Twiss parameter plot at Page No. 70 to check whether your ELEGANT is working properly or not:

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-40



Installation of ELEGANT on Ubuntu-24 & Ubuntu-25 64 bit Linux OS

If you do not install Ubuntu-24 (or Ubuntu-25) yet, please install it and do similar Post Installation at Pages No. 22 ~ 28 by using Google and YouTube searching. Here, we assume that you already finished installation and Post Installation of Ubuntu-24 (or Ubuntu-25), and we will focus on installation of ELEGANT on Ubuntu-24. To install ELEGANT on Ubuntu-25, with pre-compiled RPM binaries for Ubuntu-25 64 bit, please do the same steps described here.

After the Post Installation, please install ELEGANT code on Ubuntu-24 (or Ubuntu-25), which is described at this Appendix.



Appendix II - Install & Use ELEGANT on Ubuntu



Please **download Ubuntu-24 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 Ubuntu-24 (or Ubuntu-25) 64 bit** such as below:

+ Ubuntu 24.04 x86_64

- SDDSToolKit-5.8-1.ubuntu.24.04.x86_64.rpm
- SDDSToolKit-devel-5.8-1.ubuntu.24.04.x86_64.rpm
- SDDSEpicsToolKit-5.6-1.ubuntu.24.04.x86_64.rpm
- OAGTclTk-1.28-1.ubuntu.24.04.x86_64.rpm
- elegant-2025.2.0-1.ubuntu.24.04.mpich.x86_64.rpm
- elegant-2025.2.0-1.ubuntu.24.04.openmpi.x86_64.rpm
- shower-1.13-1.ubuntu.24.04.x86_64.rpm
- spiffe-4.10.0-1.ubuntu.24.04.x86_64.rpm
- SDDSJava-5.2.1-1.ubuntu.24.04.x86_64.rpm
- clinchor-2.0-1.ubuntu.24.04.x86_64.rpm
- shield-1.0-1.ubuntu.24.04.x86_64.rpm

+ Ubuntu 25.04 x86_64

- SDDSToolKit-5.8-1.ubuntu.25.04.x86_64.rpm
- SDDSToolKit-devel-5.8-1.ubuntu.25.04.x86_64.rpm
- SDDSEpicsToolKit-5.8-1.ubuntu.25.04.x86_64.rpm
- OAGTclTk-1.30-1.ubuntu.25.04.x86_64.rpm
- elegant-2025.2.0-1.ubuntu.25.04.mpich.x86_64.rpm
- elegant-2025.2.0-1.ubuntu.25.04.openmpi.x86_64.rpm
- shower-1.14-1.ubuntu.25.04.x86_64.rpm
- spiffe-4.10.0-1.ubuntu.25.04.x86_64.rpm
- SDDSJava-5.2.1-1.ubuntu.25.04.x86_64.rpm
- clinchor-2.0-1.ubuntu.25.04.x86_64.rpm
- shield-1.1-1.ubuntu.25.04.x86_64.rpm

By using the "**save as link**" function of **right mouse button**, please download those RPM packages. If the download key is requested, please obtain the key over email as described at Page No. 57.

Appendix II - Install & Use ELEGANT on Ubuntu



Before you install ELEGANT RPMs, please **do the Post Installations to update the software packages in Ubuntu-24** by looking into following websites:

<https://jumpcloud.com/blog/things-to-do-after-installing-ubuntu-24-04>

<https://www.linuxtechi.com/things-to-do-after-installing-ubuntu-24-04/>

<https://www.tecmint.com/things-to-do-after-installing-ubuntu/>

add-apt-repository universe

apt-get update -y

apt-get upgrade -y

shutdown -r now

Please note that the Post Installation described at Page No. 20 to 28 is Fedora-36 instead of Ubuntu-24. But you have to do similar things for Ubuntu-24 or Ubuntu-25.

Then, you have to **install all required packages to install ELEGANT on Ubuntu-24 (or Ubuntu-25)**, which is described at Page No. 25:

su

apt-get install tcl wget subversion gzip tar make rpm alien gcc g++ gfortran zlib1g-dev libgd2-xpm-dev liblapack-dev libblas-dev libgsl0-dev libfftw3-dev libxaw7-dev libncurses5-dev libpng12-dev libxt-dev libxp-dev tcl-dev tk-dev tk-table csh python-dev libmotif-dev libtiff5-dev libreadline6-dev libhdf5-dev boost-dev

Please note that this is a long line showing the list of all installed packages for Ubuntu.

Appendix II - Install & Use ELEGANT on Ubuntu



Then, you have to reboot your Linux to update OS after installation of many new packages:

shutdown -r now

We will use **alien** package to install RPMs on Ubuntu-24 and Ubuntu-25 :

<https://www.rosehosting.com/blog/how-to-install-rpm-packages-on-ubuntu-22-04/>

<https://phoenixnap.com/kb/install-rpm-packages-on-Ubuntu>

<https://saidulhaque.com/knowledgebase/tutorial-73/complete-guide-to-start-linux-os-and-install-essential-applications-in-linux/655-content-alien-installation-in-ubuntu#/>

Let's install ELEGANT RPMs on Ubuntu-24. Those downloaded RPMs are located at /home/yourID/Downloads.

su

cd /home/yourID/Download

alien -i SDDSToolKit-5.8-1.ubuntu.24.04.x86_64.rpm

alien -i SDDSToolKit-devel-5.8-1.ubuntu.24.04.x86_64.rpm

alien -i SDDSEpicsToolkit-5.6-1.ubuntu.24.04.x86_64.rpm

alien -i OAGTclTk-1.28-1.ubuntu.24.04.x86_64.rpm ← optional

alien -i elegant-2025.2.0-1.ubuntu.24.04.mpich.x86_64.rpm

alien -i elegant-2025.2.0-1.ubuntu.24.04.openmpi.x86_64.rpm ← optional

alien -i shower-1.13-1.ubuntu.24.04.x86_64.rpm ← optional

alien -i spiffe-4.10.0-1.ubuntu.24.04.x86_64.rpm ← optional

alien -i SDDSJava-5.2.1-1.ubuntu.24.04.x86_64.rpm ← optional

alien -i clinchor-2.0-1.ubuntu.24.04.x86_64.rpm ← optional

alien -i shield-1.0-1.ubuntu.24.04.x86_64.rpm ← optional

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

Similarly, you can also install ELEGANT on Ubuntu-25.04.

Appendix II - Install & Use ELEGANT on Ubuntu



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):

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 a way to compile and build ELEGANT RPMs on your own Linux by yourself. **Since we already downloaded pre-compiled RPMs for Ubuntu-24 (or 25), 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 pages (Page No. 87 ~ 89).

After reading details at Pages No. 27 and 28, please install tcsh if you do not have tcsh in your Ubuntu-24:

which tcsh

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

If your system does not have tcsh command, then, please install it with apt-get

su

apt-get install tcsh

which tcsh

→ Now, this will display a path (ex, /usr/bin/tcsh or /bin/tcsh)

Appendix II - Install & Use ELEGANT on Ubuntu



After reading details at Pages No. 27 and 28 carefully, please change your shell as well as root's shell from bash to tcsh by using chsh command. You can check its change by using grep command before/after the shell change:

```
grep root /etc/passwd  
grep yourID /etc/passwd
```

This will show that your and root's default shells are /bin/tcsh now.

Then relogin to update the shell changes.

Again, after reading details at Pages No. 27 and 28 carefully, let's untar env64.tar file at your home directory under yourID and at root's home directory under su (/home/yourID and /root).

at /home/yourID under login with yourID

```
tar xvf env64.tar
```

at /root under login with root, su

```
tar xvf env64.tar
```

Then, relogin to update changes in the tcsh environmental configuring dot files.

Then, try to find elegant binary just by typing a following thing in a terminal:

```
which elegant
```

→ This will display /usr/bin/elegant if you have installed ELEGANT properly.

Appendix II - Install & Use ELEGANT on Ubuntu



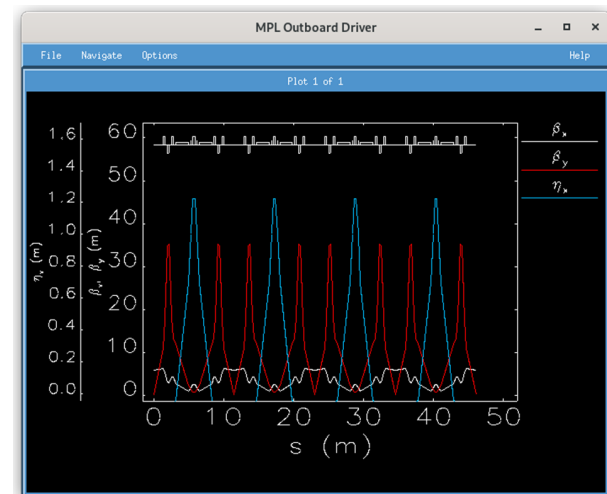
By untarring env64.tar file, which you can download from ISBA school website, several files (.cshrc, .alias, .env-apsoag, .env-epics64, .defns.rpn and so on) will be installed at your home and root's home. Therefore, you can skip Step 3 and Step 4, which are described on the above Linux Installation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

Congratulations!

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

To use ELEGANT and SDDS, please follow all steps described at Page No. 64 ~ 77. Specially, you have to make a Twiss parameter plot at Page No. 70 to check whether your ELEGANT is working properly on Ubuntu-24 or not:

If you have any problem during ELEGANT installation on Ubuntu, please send email to me (yjkim@kaeri.re.kr). We may solve it at ISBA school if we have available time at school.



Appendix III - Install & Use ELEGANT on macOS



Since macOS is not an officially supported OS for ISBA25, I will not describe its details. Since macOS is one of Unix/Linux OS, you may install ELEGANT on macOS by looking into APS ASD-AOP and ISBA22 websites:

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

<https://conference-indico.kek.jp/event/186/page/264-elegant>

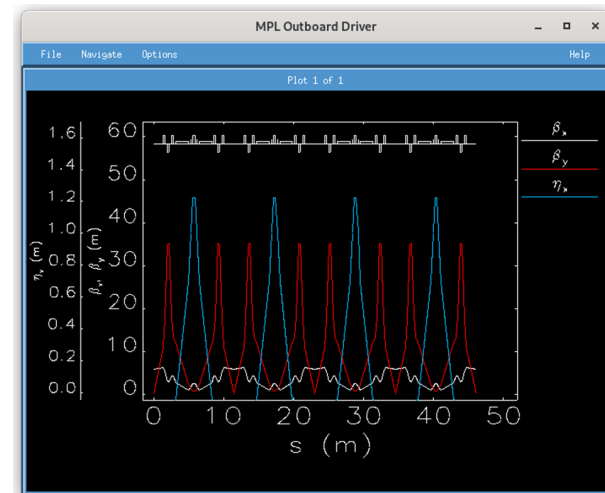
and ELEGANT users forum:

<https://www3.aps.anl.gov/forums/elegant/viewtopic.php?t=1138>

After install ELEGANT on macOS properly, please follow all steps described at Page No. 64 ~ 77 to use ELEGANT and SDDS. Specailly, you have to make a Twiss parameter plot at Page No. 70 to check whether your ELEGANT is working properly on macOS or not:

If you have any problem during ELEGANT installation on macOS, please send email to me (yjkim@kaeri.re.kr). We may try to solve it at ISBA school if we have available time at school.

macOS



[Important Notice]

During installation of Fedora-40 & Fedora-42 with everything netinst iso image, which is described at Appendix I, please do not choose following missing packages:

KDE

KDE Mobile

KDE Mobile Apps

LxQt

Electronic Lab

If you choose one of them, your installation will be stopped.

They can install later (if you want to do) after installation of Fedora-40 or Fedora-42 with the Fedora package installation command (dnf install) please see dnf package installation from Pages No. 22 ~ 25 and 83.

If you fail continuously in installation with everything netinst iso image, please try install with Desktop or Server iso image without choosing missing packages above. Then please try to install needed packages described at Pages No. 22 ~ 25 and 83.