USER'S   MANUAL
For Grape6-BLX64

1. Intruduction

GRAPE **(abbreviation of GRAvity PipelinE)** series is a special-purpose computer to accelerate the calculation of gravity or coulomb interaction between particles by using super parallel VLSI.

GRAPE calculates the following:

$$\mathbf{a}_i = \sum_j Gm_j \frac{\mathbf{r}_{ij}}{(r_{ij}^2 + \epsilon^2)^{3/2}} \tag{1}$$

$$\dot{\mathbf{a}}_i = \sum_j Gm_j \left[\frac{\mathbf{v}_{ij}}{(r_{ij}^2 + \epsilon^2)^{3/2}} - \frac{3(\mathbf{v}_{ij} \cdot \mathbf{r}_{ij})\mathbf{r}_{ij}}{(r_{ij}^2 + \epsilon^2)^{5/2}} \right], \tag{2}$$

$$\phi_i = \sum_j Gm_j \frac{1}{(r_{ij}^2 + \epsilon^2)^{1/2}}, \tag{3}$$

where

$$\mathbf{r}_{ij} = \mathbf{x}_{p,j} - \mathbf{x}_i, \tag{4}$$
$$\mathbf{v}_{ij} = \mathbf{v}_{p,j} - \mathbf{v}_i. \tag{5}$$

Here, $\mathbf{x}_i$, $\mathbf{v}_i$, $\mathbf{a}_i$, $\dot{\mathbf{a}}_i$, ϕ_i are the position, velocity, acceleration, time derivative of acceleration ,potential of particle i, G is the gravitational constant and m_j is the mass of particle j. With GRAPE-6, G is fixed to unity. The softening parameter ϵ is the usual plummer softening parameter. For a calculation of coulomb interaction,you just need replace the mass of particle with its charge.

It can be used in the filed of astronomy simulation, plasma simulation, molecular dynamics(MD) simulation,etc. It calculates force, time derivate of force and potential, and can also constructs the list of neighbor particles. It uses a personal computer with Linux pre-installed as a host computer. C and FORTRAN language interface library and sample program are supplied. The best thing about GRAPE series are **low cost , high speed , small size and easy to use.** It perfectly suit for **large scale and high accuracy N-body**(particle simulation**) simulation**. It is superior cost-effectiveness to a general-purpose super computer on simulation which consists of a lot of particles under gravity or coulomb interaction .

2. Specifications

- Speed: 131.3G flops (4× Grape6 VLSI Chips 6Pipeline per chip).
- Memory size: 262,144 particle. (18Mbit Burst-SRAM× 8)
- OS(prepared by users) : Linux Kernel 2.6.9
    *If you succeed in using other version , please inform us. Such information will help other users.
- Attached Application software:
    C and Fortran language sample program,interface library. (CD-ROM)
- Host computer: Intel Pentium4 and 865G chip set is suitable.
- Dimension : 33mm(w) x 313mm(d) x108mm (h)   2 PCI slot space occupied
- Interface : Standard **64bit/133MHz PCI-X**
    Note: You should set BIOS to make PCI-X bus works with 133MHz.
- Power consumption: DC12V 5A
- **Cooling fan** : 1.8m^3/min 65cfm (Please consult with the computer manufacturer.)
    *It is prepared by youself.Please make sure the surface temperature of heat sink **lower than 50** .

    NOTE: The breakdown caused by improper use will not be guaranteed.

3. Hardware installation

To install the Grape6-BLX64 on your system, you should do as following steps.

Step 1.

Insert the Grape6-BLX64 board on a 64bit/100MHz PCI-X slot of the PC which you want to be as a host computer.If the host computer only have 64bit/133MHz PCI-X slot,you should change BIOS to set it to 100MHz.

Fasten the Grape6-BLX64 on the host PC, be careful that the board with a heat sink is some heavy, so the PCI-X slot of computer will be damaged easily.

Step 2.

Connect the board to ATX power. Generally you can only connect the cable which the connecter can be inserted, but if you can confirm the voltage of the connecter which has the 12v, the connection will be safer.
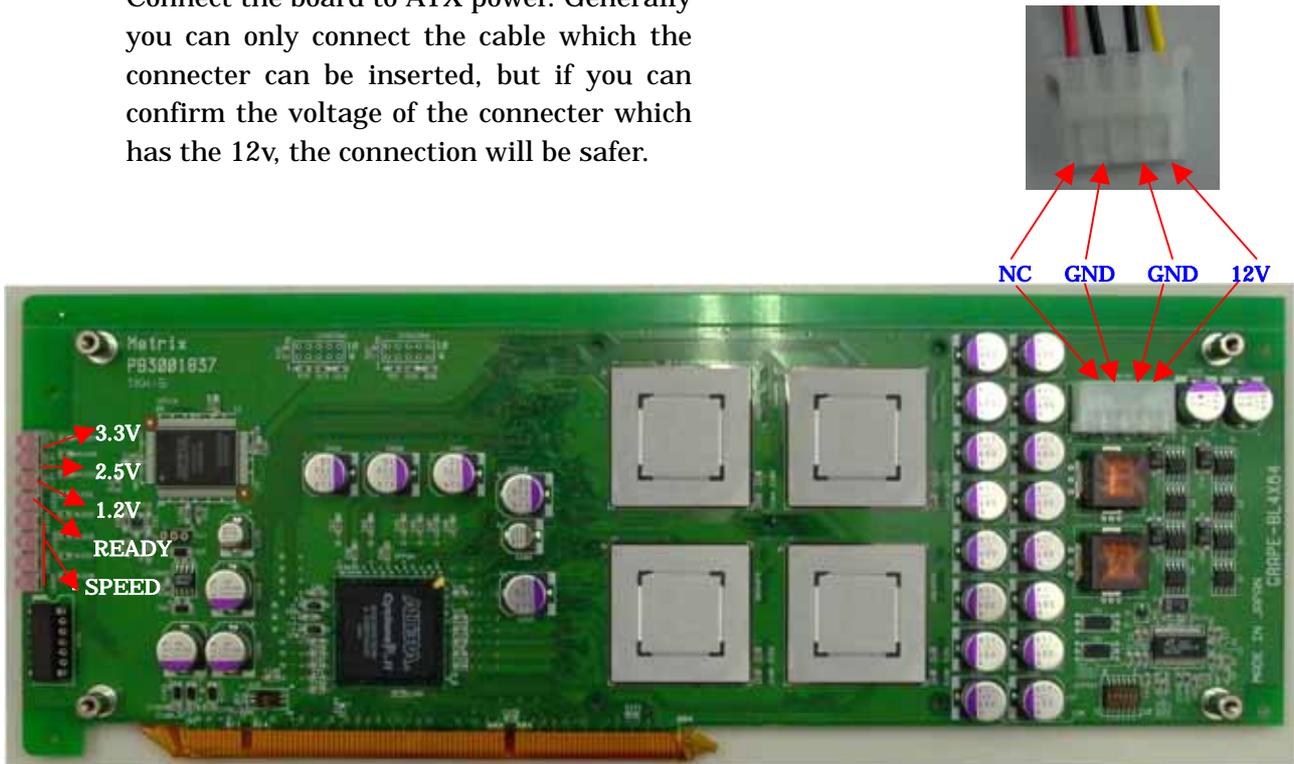

Figure 1. connecting the power cable

As shown in figure 1, the LED lamp from top to bottom indicate the power of 3.3v, 2.5v, 1.2v, READY and calculation speed. So, when you power on your computer the three voltage LED lamp will light up at once and the READY LED will light up after about one second. Please confirm the status of the LED and you can know whether the Grape6-BLX64 is installed successfully.

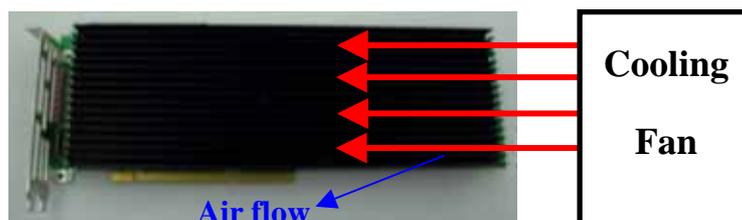**Step 3.**

Fix a cooling fan for the Grape6-BLX64

Figure 2. Grape6-BLX64 with cooling fan

4. Software installation

Power on your PC and login as a common user. For my PC, I login as **bgrape** with password of **bgrape1234** or login as **root** with password of **root1234**. You can just login as common user when you use the machine to calculate.

You can find Grape6-BLX64 library package in CD-ROM attached.You can copy it to your home directory and unpack it by inputting commend like following,

xx> tar zxvf g6bx0515.tar.gz

and you will get a directory called "g6bx". In the directory there are several files and directories, you can confirm them by inputting commend like following,

xx> cd g6bx

xx> ls -l

```
total 99
drwxrwxr-x   2 bgrape bgrape 4096 Apr 24 14:21 include
-rw-r--r--   1 bgrape bgrape 1102 May 15 00:31 install.csh
drwxrwxr-x   2 bgrape bgrape 4096 May 19 14:56 lib
drwxr-xr-x   3 bgrape bgrape 4096 May 19 14:51 pcixmem
drwxrwxr-x   2 bgrape bgrape 4096 May 22 15:22 s8
drwxr-xr-x   2 bgrape bgrape 4096 May 19 14:56 s8f
drwxrwxr-x   2 bgrape bgrape 4096 May 19 14:56 s9
drwxr-xr-x   2 bgrape bgrape 4096 May 19 14:56 tree
drwxr-xr-x   2 bgrape bgrape 4096 May 11 22:12 xhibutil
```

Figure 3. files and directories

Run the script "install.csh", you will be able to compile device driver, libraries, sample program and install the device driver.

xx> csh –f install.csh

You will see the Main Menu as following.

```
        "********** Main Menu ***********"
1. Compiling device driver
2. Compiling libraries and sample program
3. Installing device driver '(need to be a superuser)'
0. Exit
enter menu number '(1-3, or 0)':
```

Input '1' to compile the device driver.
Input '2' to compile libraries and sample program.
Input '3' to install the device driver, run this item you should be a superuser.
At present, device driver, libraries and sample program were confirmed under kernel 2.6.9.
You do not need to do item 1 and 2 every time when you use it unless you changed the source code.
If you don't set the device driver as auto-loaded at the boot time, you will have to run item 3 every time when you use it.

5. Try using the Grape6-BLX64

There are several sample programs in the library, if you are first to use the Grape6-BLX64, you can run the sample program to get a first imagination of the Grape6-BLX64. For example,you can run 's8 ' sample program which is in the directory of /s8, parameter file is 'inputpara',you can edit it as you like. There are two sample output results for pl1k and pl8k.log1k is for pl1k,log8k is for pl8k.

xx> cd s8

xx> ./s8>&mylog

When you run sample program s8 with pl1k like above,you will get output result 'mylog',you can open it with a text editer tool, and compare the contents with the file of log1k, if there are not any difference between the files except for time and speed, it means that the Grape6-BLX64 runs normally, there is no any hardware problem.

There are source files in the /s8, /s8f, /s9 and /tree, so you can read those source files to have a reference for your own programming.