0. User account

This document uses lvc as the user name. If you are instructed to use other user name, use appropriate password and home directory name, like
user name lcgt, password c*******c and home directory /Users/lcgt/

1. Introduction : how to use SIS remotely

SIS is installed on rigel1.ligo.caltech.edu, which is a MacPro running OSX 10.6.
If you don't know Macintosh, it is a unix system, and the rest of the document "how to SIS" does not require any knowledge about Mac.
This machine is maintained by Prof. Rana Adhikari <rana@ligo.caltech.edu>.

To run the simulation, ssh login to rigel1 as user "lvc" with the LCV standard password "2**********t"

```
unix> ssh lvc@rigel1.ligo.caltech.edu
unix> Password:
```

When logged in for the first time, create directories /Users/lvc/yourname and /Volumes/HD15/yourname, and keep your stuff in these directories.

```
unix> mkdir /Users/lvc/yourname
unix> mkdir /Volumes/HD15/yourname
```

The main HD is fast (two WD VelociRaptor in RAID0) but small, 300GB, so don't keep large files in /Users/lvc/yourname.

When you generate large output files, either move to your computer or to /Volumes/HD15/yourname, which is 1.5TB.

2. How to run SIS

To run SIS, type as you do usually after cd to your directory, cd /Users/lvc/yourname

```
unix> cd /Users/lvc/yourname
unix> SIS -db dbname -par parameter=value < infile (-db, -par and infile are all optional)
```

When a long job starts, you use "screen" (see below) to free your computer, and come back later.

3. Examples

I prepared three examples. Copy sisDB_FP_0_xxx.mcr from /Users/hiro/3Samples/ to your directory.

```
unix> cp /Users/hiro/3Samples/sisDB_FP_0*.mar /Users/lvc/yourname/
```

sisDB_FP_0.mcr defines a simple FP.
sisDB_FP_0_randomMap.mcr defines a FP cavity with mirrors with aberration.
sisDB_FP_0_Thermal.mcr difines a FP cavity with thermal deformation and ring heater correction.

To test run these programs, type

```
unix> SIS -db sisDB_FP_0_Thermal.mcr (or other mar file name)
```

Example run is shown at the end of this document.

/Users/hiro/SISSamples contains more examples how to use SIS. Exmaples.txt in that directory explains how to use each example.

unix> cp -r /Users/hiro/SISSamples /Users/lvc/yourname/

4. How to use "screen" to free your computer

screen is a unix program which allows you to detach a process from your computer and you can turn off your computer even when the program is running on remote computers.

This is a quick tour to use screen program to detach your computer so that you don't need to keep your computer open running overnight.
Your inputs are shown in red, and green texts explain those inputs.

4.1 Tutorial of using screen

```
[gwave-83:~] hiro% ssh lvc@rigel1.ligo.caltech.edu <<<
login to rigel1 with user name lvc
Password: 2**********t <<< usual LVC long password
staring with 2 and ending with t
[rigel1:~] lvc% cd yourname <<< when you login for the
first time, make your working directory by "mkdir
yourname"
[rigel1:~/hiro] lvc% screen <<< start screen so that
you can detach once a long run starts
[ Start the SIS run explained above. When you are
```

```
conformable to keep it running and want to turn off
your computer,
  control-A followed by d
  the process is detached from your terminal, and keep
running.
]
[detached]
[rigel1:~/hiro] lvc% screen -ls <<< see what is your
detached process name
There is a screen on:
    928.ttys000.rigel1    (Detached) <<< you need to
remember this session number
1 Socket in /var/folders/fp/fpKKVADnFIa+U3FL-5y-hU++
+TQ/-Tmp-/.screen.

[rigel1:~/hiro] lvc% exit <<< exit the ssh session
logout
Connection to rigel1 closed.
[ close your computer and go to dinner and sleep ]
[gwave-83:~] hiro% ssh lvc@rigel1.ligo.caltech.edu <<<
login to rigel1 to resume the work. Job has been
running.
Password: 2**********t <<< the long lvc password
Last login: Thu Dec  9 13:51:24 2010
[rigel1:~] lvc% screen -ls <<< check the detached
screens
There is a screen on:
    928.ttys000.rigel1    (Detached)
1 Socket in /var/folders/fp/fpKKVADnFIa+U3FL-5y-hU++
+TQ/-Tmp-/.screen.

[rigel1:~] lvc% screen -r 928.ttys000.rigel1 <<< resume
the screen session you detached
[ you will see a terminal window of the SIS run as if
```

```
you had kept the computer open whole night.
  do whatever you want to do.
  When big files are created, copy back to your
computer or copy to /Volumes/HD15/yourname directory.
  When all are done, type exit to end the screen
session.
]
[rigel1:~] lvc% exit <<< end the screen session
[screen is terminating]
[rigel1:~] lvc% exit <<< end the ssh session
logout
Connection to rigel1 closed.
[gwave-83:~] hiro%
```

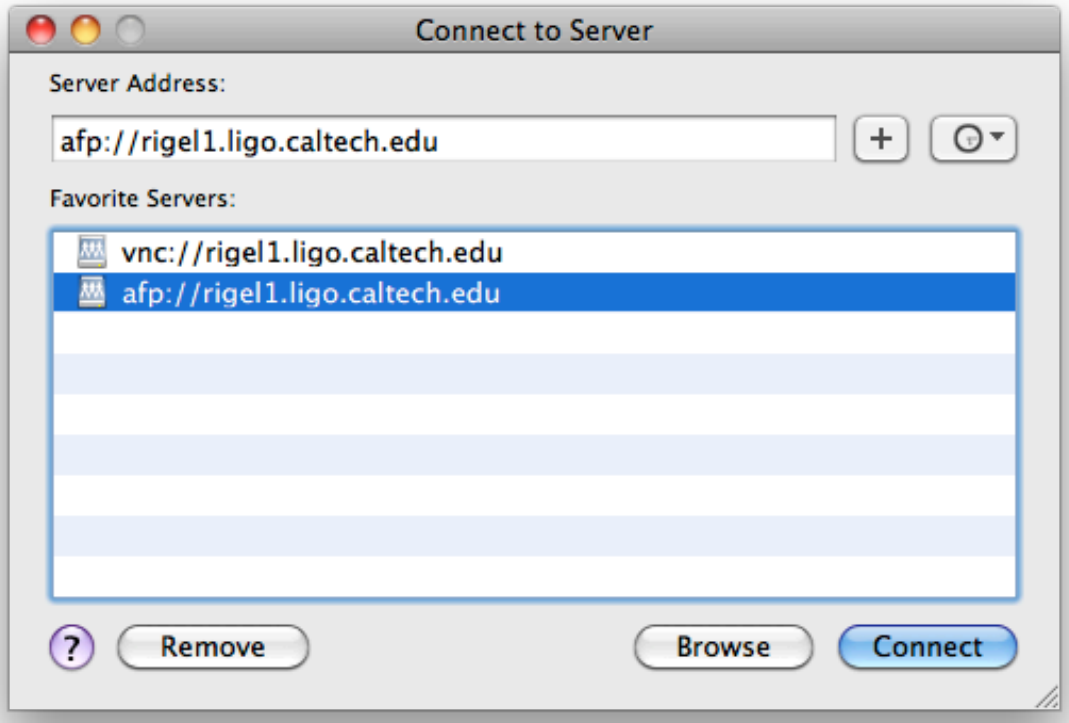
5. For Macintosh User

If you use Macintosh OSX10.6 (Snow Leopard) or OSX10.7 (Lion), you can do in the following Mac-way to simplify operations, instead of using unix commands like scp.

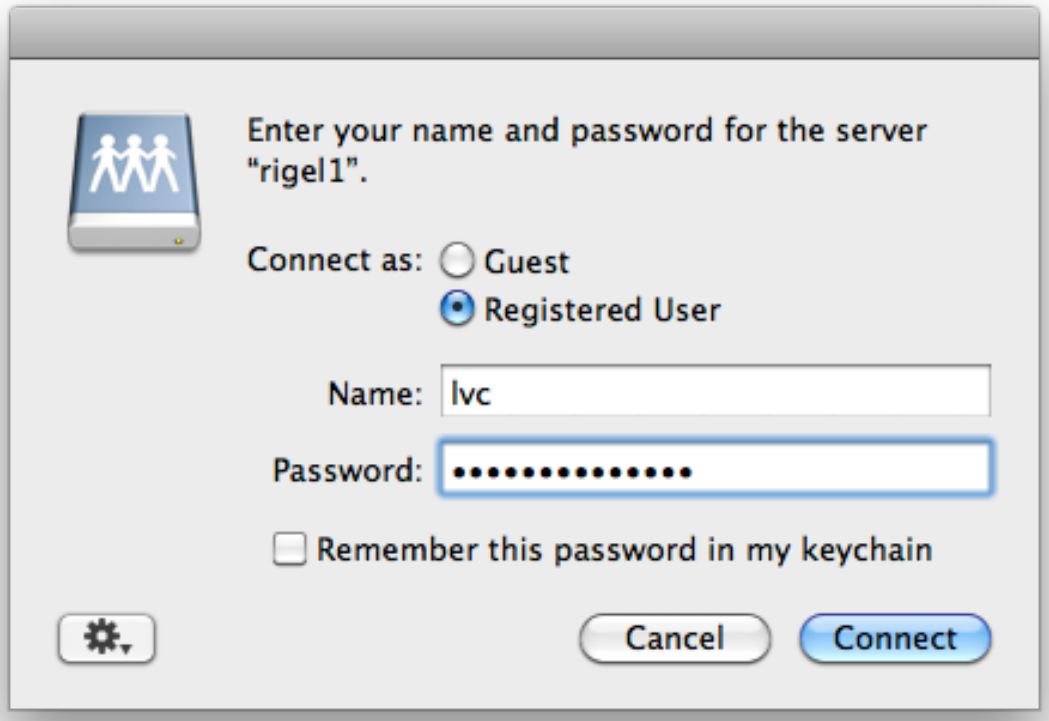
In the Finder, select "Connect to Server ..." menu item in "Go" menu and enter

afp://rigel1.ligo.caltech.edu

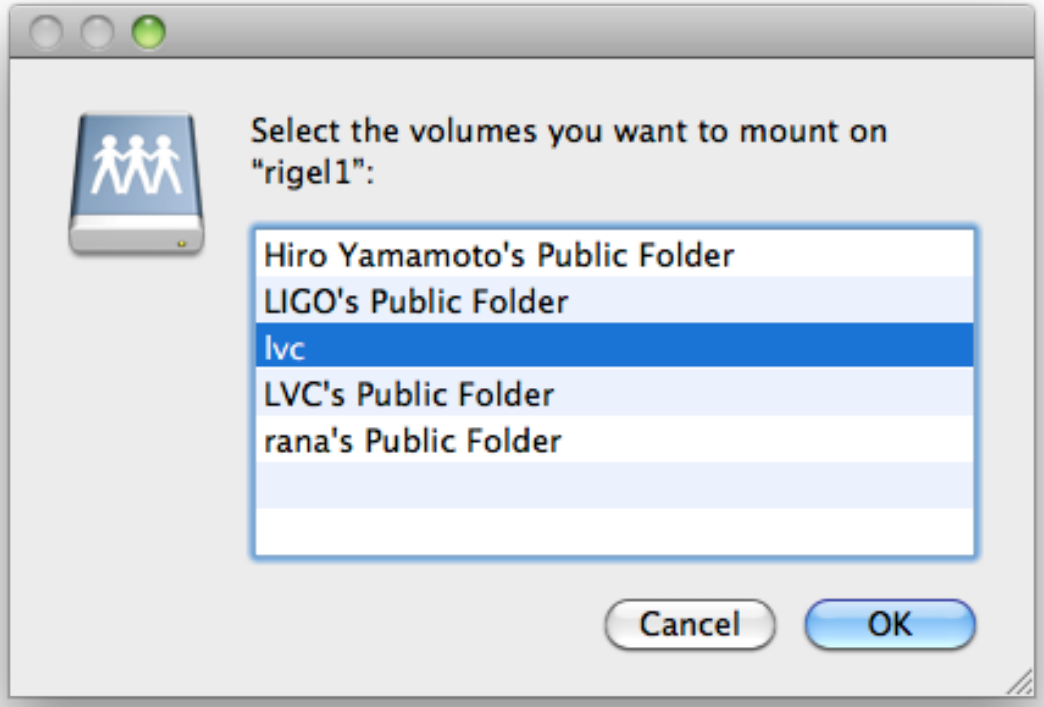
Choose server



Enter user name and password



Choose volume, i.e., lvc



Then rigel1 disk can be mounted, I.e., its directory can be accessed as one of your local disks. You can drag files between that disk and your local disks.

When you connect the server using vnc:: protocol by selecting "Connect to Server ..." menu item in "Go" menu by entering

vnc:://rigel1.ligo.caltech.edu

a screen of rigel1 shows up on your computer using VNC, and you can do anything just as if you are sitting in front of rigel1. The speed depends on the network.
If you cannot access the vnc session because someone is already using it and cannot access, like someone's screen saver blocks your access and the user is not lvc, switch user to "lvc" and login.

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Appendix

Red is what you type.

FP << choose the cavity type
lock << lock the cavity and find stationary state
sum << print summary information. Base means analytic prediction, fit is a result of the fit of the FFT simulation result
mode << print modal mode fit of FFT simulation result. In this example, you find that LG(1,0) and LG(2,0) are excited. This is because the thermal bump is not fully compensated by the ring heater, which makes the average curvature OK.

```
SISRelease -db sisDB_FP_0_Thermal.mcr
SIS>
SIS> Choose configuration to simulation
SIS>
SIS>       MIRROR     BS          FP          FPBS
MSCC       SCC        cancel
SIS>
SIS> Select 1 item(s)
SIS> Type "name" to choose item(s)  >> FP

>>>
<<<
>>>              Stationary IFO Simulation
<<<
>>>                   by H.Yamamoto / LIGO lab
<<<
>>>
<<<
>>>   v 101109
<<<
>>>
<<<
```

```
>>>   new fetuere
<<<
>>>   (0) new functions to generate random maps
<<<
>>>         RANDOMMAP, RANDOM1D, RANDOM2D
<<<
>>>   (1) Virgo optics data file format ".col"
supported <<<
>>>   (2) stable long cavity simulated
<<<
>>>   (3) signalGen command does not mess up inputField
<<<
>>>
<<<
>>>   previous features
<<<
>>>   (1) tag name in signalGen can contain @@@, ***
<<<
>>>
<<<
>>>   memorandom
<<<
>>>   (1) telescope can be defined
<<<
>>>       outField = TELESCOPE( inField, {}, ... )
<<<
>>>         { TELE_LENS, f_number, radius }
<<<
>>>         { TELE_MIRROR, ROC,
<<<
>>>           thetaAOI, phiAOI, radius, x0, y0 }
<<<
>>>         { TELE_SPACE, distance/-gouyPhase, x0, y0 }
<<<
```

```
>>>   (2) operator "^" added. x^y returns pow(x,y)
<<<
>>>   (3) input beam can be specified by data file
<<<
>>>          inputBeam.fldAmp   = amplitude
<<<
>>>          inputBeam.fldPhase = phase (in radian)
<<<
>>>          inputBeam.power = -Power : scale to Power
<<<
>>>   (4) data file name can specify the data window
<<<
>>>       with units, cm, mm, um, like N256_W600um.dat
<<<
>>>
<<<
>>>
<<<
>>>                      FP version
<<<
>>>
<<<
>>>              version 071113
<<<
>>>
<<<
>>>      Latest revision
<<<
>>>        (1) better locking
<<<
>>>
<<<

4 threads used for fftw_plan
```

```
* Baic FP cavity simulation with thermal deformation
and Ring heter correction
* "beamWidthITM" = 0.0529939093174
* "beamWidthETM" = 0.0619633988736
* "cavPower" = 770000
* "rcPower" = 2695
* "PabsVal" = 0.385
* "PsubValITM" = 0.01078
* "PsubValETM" = 1.54e-05
SIS>
SIS> next action
SIS>
SIS>       lock            calcField       signalGen
timeTrace       telescope
SIS>       dellL           modeAmp         saveField
mirrorInfo      storeMap
SIS>       summary         simSpec         loadSimSpec
runSpec         help
SIS>       exit
SIS>
SIS> Select 1 item(s)
SIS> Type "name" to choose item(s)  >> lock
Loading setup ...
"inputBeamInstance_firstLoad" retrieved
"ITM" retrieved
---> Mirror "FPcav.ITM" : thermal effect in
"THERMOELASTIC( beamWidthITM, PsubValITM, PabsVal ) +
rr/(2*ITM_RH)" at 14 added
"ETM" retrieved
---> Mirror "FPcav.ETM" : thermal effect in
"THERMOELASTIC( beamWidthETM, PsubValETM, PabsVal ) +
rr/(2*ETM_RH)" at 14 added
"FPcav" retrieved
    SISFP + Effective ITM ROC = 1913.427007192, ETM ROC
```

```
= 2226.5595752622 for effective optics
    SISFP + delL( 5.2965299261956e-07 ) =
              dlGouy( 4.6793962150771e-07 ) +
dz_ITM( 3.1854465211316e-08 ) +
dz_ETM( 2.9858905900532e-08 )
    SISFP + FP mode base calculated using cold optics
    SISFP + Effective ITM ROC = 1934, ETM ROC = 2245
for cold optics
"inputBeamInstance" retrieved
... checkinng mirror size, FFT window and beam size ...
... size check done
Loading completed ...
    SISFP : => lockFP starting <==
    .... fftw measurement starting
    .... fftw measurement finished
    .... fftw measurement starting
    .... fftw measurement finished


.........................................
... many lines of progress information ...
.........................................

                power = 283.37861816495, loss =
3.2892984335176 ppm, diffraction loss =
0.91960893544574 ppm
    SISFP :     ...         delL,       errSig,
power (length accuracy = 2.3883756270794e-14)
                    old : 8.6799140037339e-09,
-1.672444761466e-15, 283.3785135044
                    new : 8.6799173610106e-09,
1.1404377072913e-16, 283.37861816495
    SISFP + ++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++
              locked, exiting...
```

```
                  power(ITM->ETM) = 283.37861816495,
TEM00(ITM<=ETM) = 283.31848314974
                  diffr. loss = 0.91960893544574 ppm,
total loss = 3.2892984335176 ppm

-------------------------------------------------------
-----
lock succeeded
SIS>
SIS> next action
SIS>
SIS>       lock            calcField       signalGen
timeTrace       telescope
SIS>       dellL           modeAmp         saveField
mirrorInfo      storeMap
SIS>       summary         simSpec         loadSimSpec
runSpec         help
SIS>       exit
SIS>
SIS> Select 1 item(s)
SIS> Type "name" to choose item(s)  >> sum

Summary of FP cavity "FPcav"

cavity length = 5.3833290998057e-07 =
5.2965299261956e-07(dellL) - 0(ITMz) -
-8.6799173610106e-09(ETMz)
power in cavity = 283.37861816495, reflected power =
0.99832345206927, leakPower / Power00 =
0.99832345206927 / 0.99794105163134
Diffractive loss = 0.91960893544574, total loss =
3.2892984335176

++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   FP cavity modal analysis using cold optics
parameters

ROC(ITM) = 1934, ROC(ETM) = 2245, Cavity lenggth =
3994.499999672, total Gouy = 2.716949130603
Fval(ITM) = -4247.7862651981, OPL(ITM) =
0.13793033055886, Fval(ETM) = -4943.3509816417
waist size = 0.012037040731039, waist position from ITM
= 1834.2198819996, Rayleigh range = 427.80682119921

Mode parameters of cavity fields
ETM AR (out base) : w = 0.0619634      R = 1548.276
z  = 1519.925       z0 = 207.583        w0 =
0.008384783
       (out fit ) : w = 0.06173832     R = 1547.908
(x0,y0)=( 0         ,  0         )  power / HMfrac =
0.001416892 / 0.0003218
ETM HR (in  base) : w = 0.0619634      R = 2245
z  = 2160.28        z0 = 427.8068       w0 = 0.01203704
       (in  fit ) : w = 0.06173832     R = 2244.415
(x0,y0)=( 0         ,  0         )  power / HMfrac =
283.3786 / 0.0002056
       (out fit ) : w = 0.06173832     R = -2244.75
(x0,y0)=( 0         ,  0         )  power / HMfrac =
283.3771 / 0.0002067
ITM HR (in  base) : w = 0.05299391     R = 1934
z  = 1834.22        z0 = 427.8068       w0 = 0.01203704
       (in  fit ) : w = 0.05289762     R = 1934.588
(x0,y0)=( 0         ,  0         )  power / HMfrac =
283.3771 / 0.0002067
       (out fit ) : w = 0.05289824     R = -1934.818
(x0,y0)=( 0         ,  0         )  power / HMfrac =
283.3786 / 0.0002056
```

```
ITM AR (in  base) : w = 0.05299391     R = -1333.793
z  = -1300.153      z0 = 209.1332       w0 =
0.008416031
       (in  fit ) : w = 0.05299391     R = -1333.793
(x0,y0)=( 0         ,  0         )  power / HMfrac =
1 / 8.105e-14
       (out fit ) : w = 0.05280232     R = 1333.683
(x0,y0)=( 0         ,  0         )  power / HMfrac =
0.9983235 / 0.000383
------------------------------------------------------
------------------------------------------------------
SIS>
SIS> next action
SIS>
SIS>       lock            calcField       signalGen
timeTrace       telescope
SIS>       dellL           modeAmp         saveField
mirrorInfo      storeMap
SIS>       summary         simSpec         loadSimSpec
runSpec         help
SIS>       exit
SIS>
SIS> Select 1 item(s)
SIS> Type "name" to choose item(s)  >> mode
SIS>
SIS> Select a field to do mode expansion
SIS>
SIS>       0.inputField        1.fromITM
2.toETM             3.fromETM
SIS>       4.toITM             5.promptRefl
6.leakRefl          7.totalRefl
SIS>       all                 exit
SIS>
SIS> Select 1 item(s)
```

```
SIS> Type "name" to choose item(s)  >> 1
+++ Field "fromITM" +++
Mode base  : z = -1834.22       z0 = 427.8068
           : w = 0.05299391     R = -1934
Fit result : w = 0.05289824     R = -1934.818
(x0,y0)=( 0         ,  0         )  power / HMfrac =
283.3786 / 0.0002056
SIS>
SIS> Which function set to use for mode expansion
SIS>
SIS>       LaguerreGauss       HermiteGauss
nextField           fractionLimit
SIS>       exit
SIS>
SIS> Select 1 item(s)
SIS> Type "name" to choose item(s)  >> L
SIS> Max mode for expansion (def=7,[1:INF])  >> 10
+++ Field "fromITM" +++

 Amplitude = ( Re, Im ) [ subPower, fraction ]
     only those modes are listed whose powers > 1e-05
of the total power
LG( 0 , 0 ) = ( 16.731511445663, -1.8376288167909 )
[ 283.32035492467, 0.99979439789543 ]
LG( 1 , 0 ) = ( 0.060508336271747, 0.036427393665672 )
[ 0.0049882137676487, 1.7602646946161e-05 ]
LG( 2 , 0 ) = ( 0.16272127810836, 0.15153124614581 )
[ 0.04943993290772, 0.00017446599615692 ]

Total power = 283.37861816495
     Tabulated Power fraction   = 0.99998646653853
     Low power mode fraction    = 1.2667308436106e-05
     Higher order mode fraction = 8.6615303129811e-07
```

```
SIS>
SIS> next action
SIS>
SIS>       lock            calcField       signalGen
timeTrace       telescope
SIS>       delL            modeAmp         saveField
mirrorInfo      storeMap
SIS>       summary         simSpec         loadSimSpec
runSpec         help
SIS>       exit
SIS>
SIS> Select 1 item(s)
SIS> Type "name" to choose item(s)  >> exit
```