HOW TO APPLY EFC ON SPHERE ?

Introduction

There are two main files to apply EFC on SPHERE : a shell file and a python file. The python file does not have to be modified. Indeed, the different EFC parameters must be changed in the .sh file.

Trees and files

In the shell file, you can find *DATA_PATH* and *WORK_PATH0* . Ajust *DATA_PATH* to match the folder where the raw SPHERE datas are recorded.
Adjust *WORK_PATH0* to match the folder where you want the matrices, the data and the slopes at different iterations to be saved. In this path, you will need :
- The shell file *MainEFCBash*.sh to compile in order to launch an EFC iteration.
- A python file *PythonSphereEFC.py* which is compiled directly in *MainEFCBash.sh* : do not modify it.
- A directory called '*SlopesAndImages*'.
- A directory called '*MatricesAndModel*'.

A preliminary step to perform once a day when EFC is applied is to :
- Save the DTTS ref slopes *IRAcq.DET1.REFSLP.fits* in the directory '*SlopesAndImages*'.
- Save the Visible WFS ref slopes *VisAcq.DET1.REFSLP.fits* in the directory '*SlopesAndImages*'.
- Save the interaction matrix '*CLMatrixOptimiser.HO_IM.fits*' in the directory '*MatricesAndModel*' . The other matrix situated in that directory should not be deleted !!

Preparing of the NCPA compensation on the SPHERE machine

Switch on the lamp and set the CPI, AO system and IRDIS in a position ready to take internal calibrations.
This can be done by loading SAXO_tec_daily calib from BIB and executing the first templates called **SPHERE_gen_cal_preset**, **SPHERE_gen_cal_vwfs_background**, **SPHERE_gen_cal_dtts_backgnd** and **SPHERE_gen_cal_voffset** (see Fig. 1)

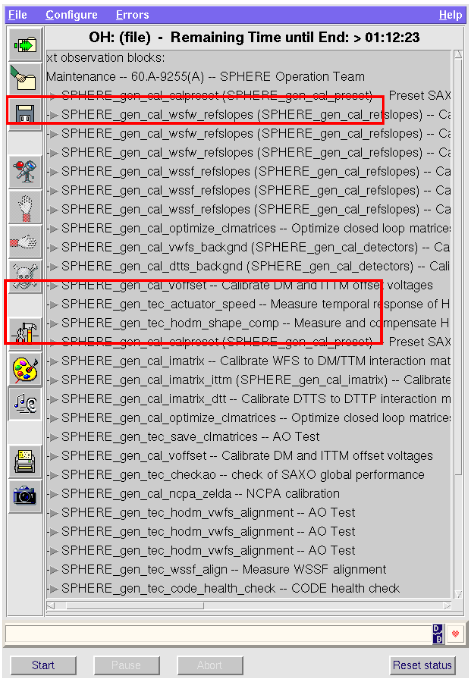

Figure 1. SAXO daily calibrations list of templates. The templates ensquared in red must be run.

The coronagraph configuration to apply EFC is APO1-ALC2:
- Insert the apodizer **APO1** (device called cpaw in the SPHERE ICS panel)
- Insert the Lyot Stop **ST_ALC2** (device called irlw located in the IRDIS ICS) and the Lyot mask (device **ALC2** in the filter wheel icw)

Check you have some flux on the WFS and close the loop by clicking on **CLOSE ALL** from the SPHERE SOS panel. Make sure the spatial filter is **MEDIUM** (SOS panel).

Check that in IRDIS you have the filter **B_ND-H** inserted in irfw1 and the filter **D_H23** is inserted in irfw2

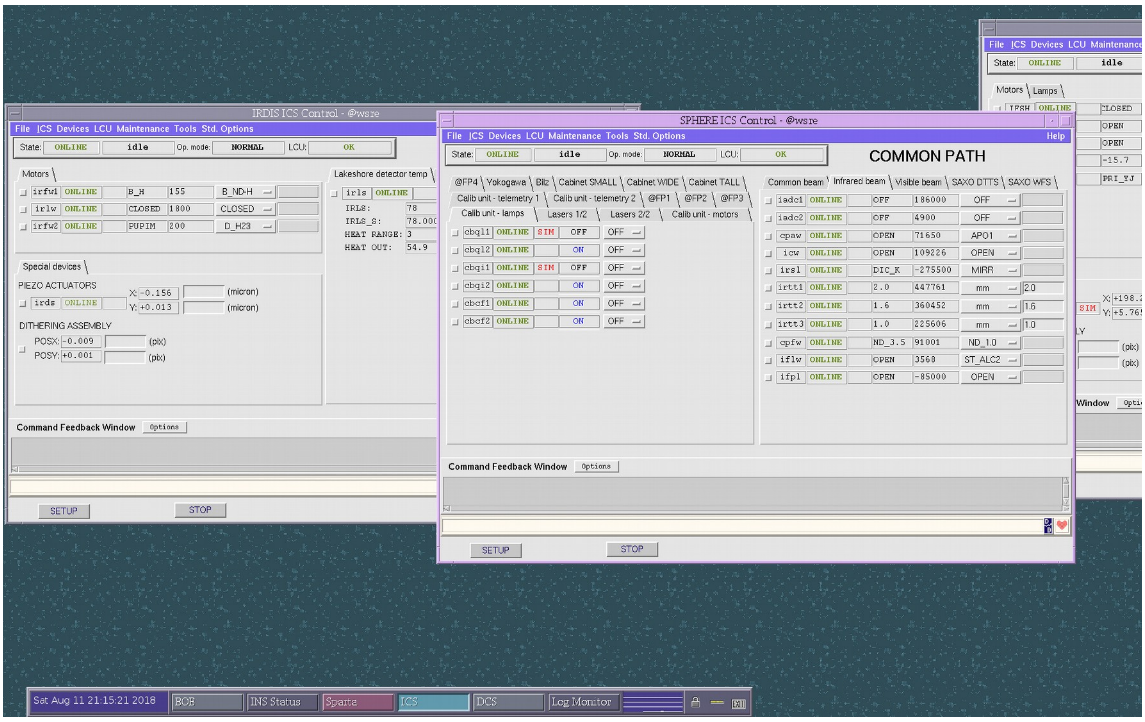

Figure 2. Check that the device cpfw is set to ND_3.5 under the infrared beam tab of the SCPHERE ICS

Start the **IRDIS** detector from the SOS panel (Figure 3).

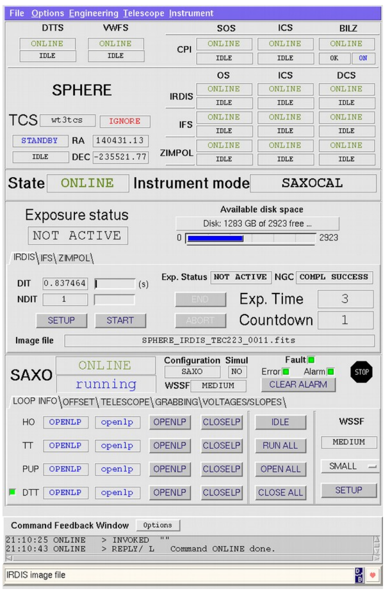

Figure 3. SPHERE SOS panel where the IRDIS detector can be started

Change the parameters in the file MainEFCBash.sh

Open the file *MainEFCBash.sh*.
Different parameters can be changed:

- nbiter represents the index of the iteration. When you start an EFC compensation, set nbiter=1 . If no previous EFC slopes are recorded in the directory 'SlopesAndImages', it will create the first slopes of the Experiment 0000 . Then, after each correction, increment nbiter.
After a few iterations in Experiment 0000, if you set back nbiter=1, then you start a new EFC experiment from scratch and you create Experiment0001 slopes and images.

- DHsize represents the size of the Dark Hole where the speckles will be minimized by EFC. 3 different dark holes are already defined in the system. Set:
    - DHsize = 0 for a half dark hole 188mas to 625mas x -625mas to 625mas
    - DHsize = 1 for a half dark hole 125mas to 625mas x -625mas to 625mas
    - DHsize = 2 for a full dark hole -625mas to 625mas x -625mas to 625mas

- corr_mode represents the strength of the minimization. Again, the properties of the corrections for each dark holes are already defined, and the astronomer can set:
    - corr_mode=0: stable correction but moderate contrast
    - corr_mode=1: less stable correction but better contrast
    - corr_mode=2: more aggressive correction (may be unstable)

- nbprobe represents the number of probes used to modulate the speckle field intensity in order to estimate the aberrations. The less probes you use, the faster it takes for one iteration. You can define nbprobe=2, 3 or 4 .

- DIT represents the exposure time for the coronagraphic images.

- NDIT represents the number of coronagraphic images to be acquired before averaging them.

- DIT_PSF represents the exposure time when acquiring an off-axis PSF at the beginning of each iteration. This acquisition is usefull to normalize properly the coronagraphic images. Be sure DIT_PSF is set not to saturate on the IRDIS detector.

- NDIT_PSF represents the number of off-axis PSF images to be acquired before averaging them.

- WHICH_ND represents the neutral density to use to prevent the off-axis PSF image to saturate. It can be 'ND_3.5' or 'ND_2.0' .

- ONSKY has to set to tell the algorithm if the EFC experiment is done on-sky or on the calibration source. Set ONSKY=0 for the internal source and ONSKY=1 for an on-sky correction.

- XOUP, YOUP, X1UP, Y1UP represent respectively the guess position of the x and y position of the upper PSF echo and the x and y position of the bottom PSF echo, created to estimate the center of the image at each experiment. It should not be changed except if the optimization algorithm to find the positions of these PSF echos does not converge.

- DATA_PATH. Adjust DATA_PATH to match the folder where the raw SPHERE data are recorded.

- WORK_PATH0. Adjust WORK_PATH0 to match the folder where you want the matrices, the data and the slopes at different iterations to be saved.

Launch the EFC correction

- Save MainEFCBash.sh after setting the good parameters.
- On the terminal, write ‘chmod +x MainEFCBash.sh’
- On the terminal, write ‘./MainEFCBash.sh’
- Follow the next instructions on the terminal.