How to run the QACITS script

**1. Initialization: qacits\_control\_ini.py**

Prior to run the script, there are parameters to be tuned in the config file (qacits\_control.ini):

- l**ambdaoverd\_arc**: angular size of the PSF (300mas when using the sub-aperture, 90mas when using the whole aperture)

- The **background image file name** should be given in the config file (qacits\_control.ini) and will be subtracted of every image.

We need to determine:

- the position of the center

- the angle of rotation between the image and the tip-tilt directions of the AO mirror

- the image scale (in other words the number of pixels per lambda/D)

Once the vortex is centered, run the script qacits\_control\_init.py

What it does:

**step1:**

it takes an image → can be used as the reference image later on: to do so, put the name of the file in the config file (ref\_file\_name). If this entry is left blank (empty string ''), the reference image will be the first of the acquired sequence of images

**step2:**

- it applies a waffle on the DM (thanks to 2 sinewaves), takes an image and remove the waffle

- it asks you to click on the 4 spots to determine the position of the center

**step3:**

- it offsets the PSF by 5 arcsec thanks to the tiptilt mirror → it should be in the 'up' direction (means 'south' for the manual steering of the mirror in the AO gui) (p3k.sci\_offset\_up) to be consistent with how it is used afterwards

- it waits till the AO system is ready again

- it takes an image

- it looks for the PSF in the image, fits a Gaussian to retrieve the position

- it determines the angle and the image scale

- it computes the total flux of the PSF for normalization of the differential intensities later on

→ be careful to which ND filters are used (when offset, the PSF can saturate the detector)

In the end, it modifies the following entries of the config file (qacits\_control.ini):

- centerx, centery: position of the center in pixels

- lambdaoverd: nb of pixels per lambda/D

- Itot\_off: the total flux of the offset PSF (in counts)

- rotang: the angle between the image and the axes of the tip-tilt mirror (should be around 62°)

**2. Run the script: qacits\_control\_v2.py**

Parameters to be tuned prior to run the script

In the config file (qacits\_control.ini):

- **ref\_file\_name**: if you want to use an image already acquired as reference

- the model parameters (**beta, gam\_in, gam\_out**)

Note: in my notations, beta usually refers to the factor for the cube component, while gamma refers to the linear component (relevant when the pupil is obstructed)

- the **type** of the image you want to use:

stand → the whole image

inner → the central lobe only

outer → the external part only (except the central circle)

both → inner and outer, the final tiptilt is the mean of the two estimations

- the **pupil** type: obstructed of unobstructed pupil (needed for the estimation of tiptilt using a cube model (unobstructed) or a linear model (obstructed))

- **quad\_width**: the quadrant width in lambda/D. Defines the quadrants in the standard mode and the external boundaries for the outer mode. 3 lbd/D sounds good.

- **inner\_rad**: the radius of the central lobe in lambda/D. It should be 1.6 lbd/D, and has to be adjusted with respect to the Lyot outer diameter (1.6/0.80=2 lbd/D for a 80% Lyot outer diameter)

- **Gain**: the gain of the proportionnal loop.

- **deadband**: the minimal value for the tip-tilt to send a command to the tiptilt mirror.

First, check the values of the variables: home=1 means working on acquired images (after the run for instance), onsky=1 means on-sky!

When running the loop, it will display the sub-image where you can see:

- the axes of the tip-tilt mirror (dashed white lines)

- a circle is drawn to help checking the centering of the subimage (its radius is 1 inner\_rad)

- the direction of the estimated tip-tilt (cyan line)

- its length is proportionnal to the amplitude of the tip-tilt (when it is as long as the circle radius, it means a tip-tilt of 0.1 lbd/D).

Note: a lot of text files should be saved when running the script. It should help me keeping the parameter values and estimated tip-tilt. They will be stored in a folder qacits\_save\_files inside the current folder (has to be created prior to running the script).