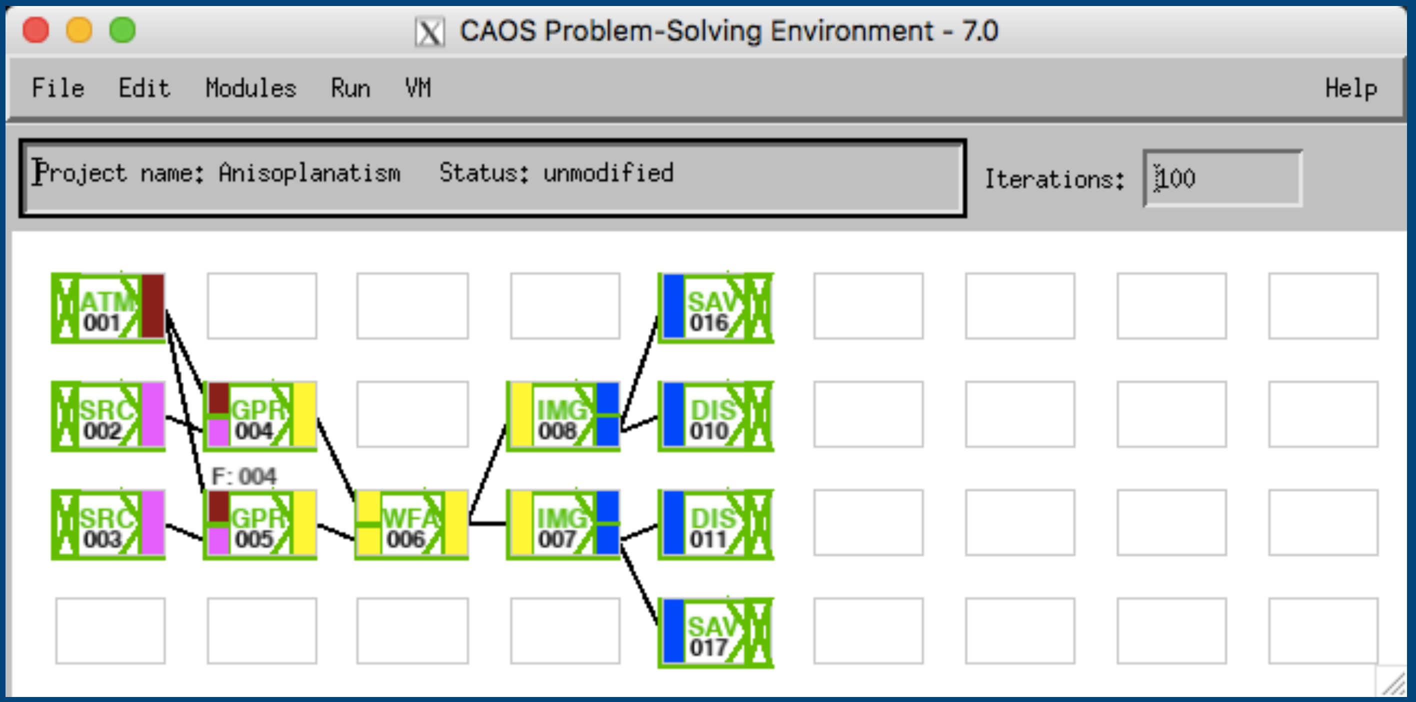
Build project for anisoplanatism…

0- COMPLETELY FINALISE INSTALLATION OF THE CAOS PSE AND THE SOFTWARE PACKAGE CAOS (POSSIBLY THE LITE VERSION OF IT) BEFORE GOING ON !!

Then, within the CAOS interface…

1- Reproduce the project ``Anisoplanatism” here beside.

2- Click on the ATM module, its graphical user interface (GUI) opens, then change its parameters into your own ones (r_0, L_0, altitude of the layers, mainly), and finally save them with button ``Save”.



3- Choose a value for the off-axis angle (typically in between 0” and 60”) within second occurence of module SRC and, as a consequence, adapt the name of the saved PSFs within the two modules SAV (one for each module IMG, i.e. one for each considered wavelength: for example 500nm and 1650nm).

4- Fix the parameters of the other modules.

5- Run the simulation project by using button ``Run” within the CAOS interface (or with the IDL-CAOS command ``.rn ./Projects/Anisoplanatism/project.pro” for a project called ``Anisoplanatism”).

6- Repeat steps 3 to 5 for each chosen value of the off-axis angle.

7- Compute the rms of the corrected wavefront and the FWHM for each resulting PSFs (two for each off-axis angle value) with routine ``dataprocessing.pro”.

(routine dataprocessing.pro — 1)

```
; dataprocessing.pro, revised in June 2023
; use: .rn ./Projects/Anisoplanatism/dataprocessing (for a project named "Anisoplanatism")


; parameters to be fixed for each case
THETA    = '10'                    ; off-axis angle ["]
diam_tel = 1.                      ; telescope diameter [m]
n_real   = 100L                    ; nb of realizations
np       = 64L                     ; nb of x- and y-pixels for the wf
np1      = 64L                     ; nb of x- and y-pixels for img#1
np2      = 64L                     ; nb of x- and y-pixels for img#2

; wf data processing
wf=fltarr(np,np,n_real)            ; cube of wf
for i=1,n_real do begin
   restore, "./Projects/Anisoplanatism/wf_"+strtrim(THETA,2)+"as/wf"+strtrim(i,2)+".sav"
   wf[*,*,i-1]=data.screen
endfor
pupil=data.pupil                   ; telescope pupil

rms=fltarr(n_real)                 ; vector of rms [m]
idx=where(pupil gt 0.5)            ; indexes of valid pixels in which calculate the rms
for i=0,n_real-1 do begin
   dummy=wf[*,*,i]
   dummy=moment(dummy[idx], SDEV=sigma)
   rms[i]=sigma
endfor
print, "mean rms=", mean(rms)*1E9, " nm"
```

(routine dataprocessing.pro — 2)

```
; 500-nm images processing
img500nm=fltarr(np1,np1,n_real)      ; cube of 500-nm PSFs
for i=1,n_real do begin
   restore, "./Projects/Anisoplanatism/img500nm_"+strtrim(THETA,2)+"as/img500nm"+strtrim(i,2)+".sav"
   img500nm[*,*,i-1]=data.image
endfor

PSF_LE = total(img500nm,3)          ; long-exposure PSF
LAMBDA = data.lambda                ; wavelength [m]
RES    = data.resolution            ; pixel size ["]
dummy  = gauss2dfit(PSF_LE,a) & sig = (a[3]+a[2])/2.
fwhm   = 2*sig*sqrt(2*alog(2))*RES ; FWHM ["]
print, "FWHM = ", fwhm, '" = ', fwhm/(LAMBDA/diam_tel*!RADEG*3600), " lambda/D"

; H-band images processing
imgHband=fltarr(np2,np2,n_real)      ; cube of H-band PSFs
for i=1,n_real do begin
   restore, "./Projects/Anisoplanatism/imgHband_"+strtrim(THETA,2)+"as/imgHband"+strtrim(i,2)+".sav"
   imgHband[*,*,i-1]=data.image
endfor

PSF_LE = total(imgHband,3)          ; long-exposure PSF
LAMBDA = data.lambda                ; wavelength [m]
RES    = data.resolution            ; pixel size ["]
dummy  = gauss2dfit(PSF_LE,a) & sig = (a[3]+a[2])/2.
fwhm   = 2*sig*sqrt(2*alog(2))*RES ; FWHM ["]
print, "FWHM = ", fwhm, '" = ', fwhm/(LAMBDA/diam_tel*!RADEG*3600), " lambda/D"

; end of routine
end
```

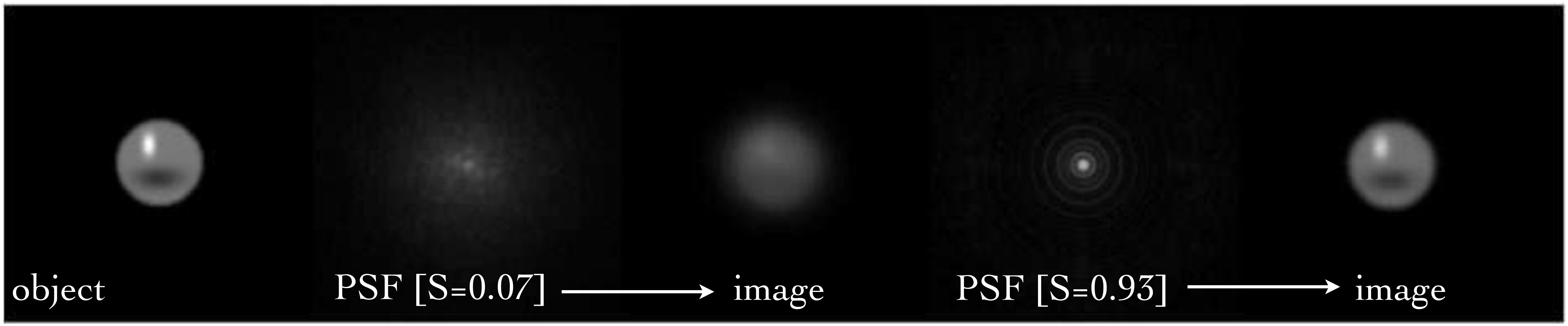
(Another useful metrics: the Strehl ratio)

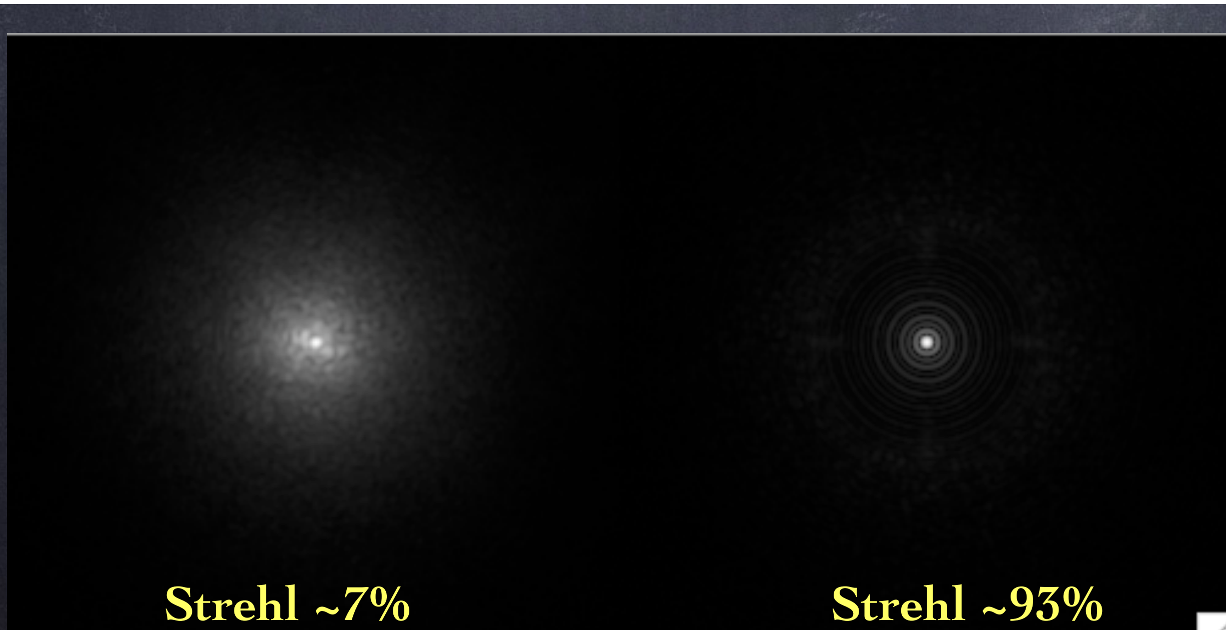
$$S = \frac{I_{\text{post AO}}[0,0]}{I_{\text{perfect}}[0,0]}$$

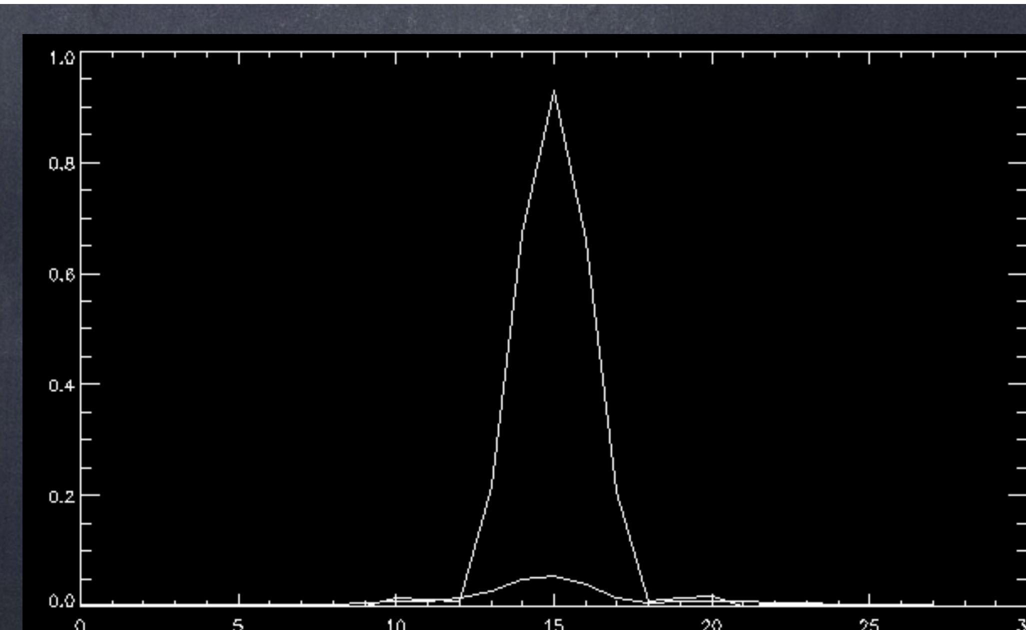
where *I[0,0]* is the intensity of the PSF at the optical center of the field (K. Strehl, Zeit. Instrumenkde 22, 213 (1902)).

$$S \simeq \exp\{-\sigma^2_{\text{post AO}}\}$$

in the framework of the Maréchal's approximation, where the variance (in radians²) is supposed to be small enough…







```
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REPORT
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[redacted]

- Preliminary measures
+ introduction/context
+ PSD(r0, L0)
+ => influence of r0 and L0
+ rms(r0, L0)
+ => influence of r0 and L0
+ FWHM(r0 or lambda=>r0, L0)
+ => influence of r0 and L0
+ => comparison with the "seeing" lambda/r0
+ noisy images
+ personal development ?

- Anisoplanatic error study
+ introduction on anisoplanatism (problem, schema)
+ CAOS modeling brief description (+theta_max+Δx)
+ wf measures: rms(theta)
+ => var_aniso proportional to theta^(5/3) ?
+ => Strehl(theta, lambda)
+ => ccl on the influence of theta and lambda
+ image measures: FWHM(theta, lambda)
+ => ccl on the influence of theta and lambda
+ personal development ?
```