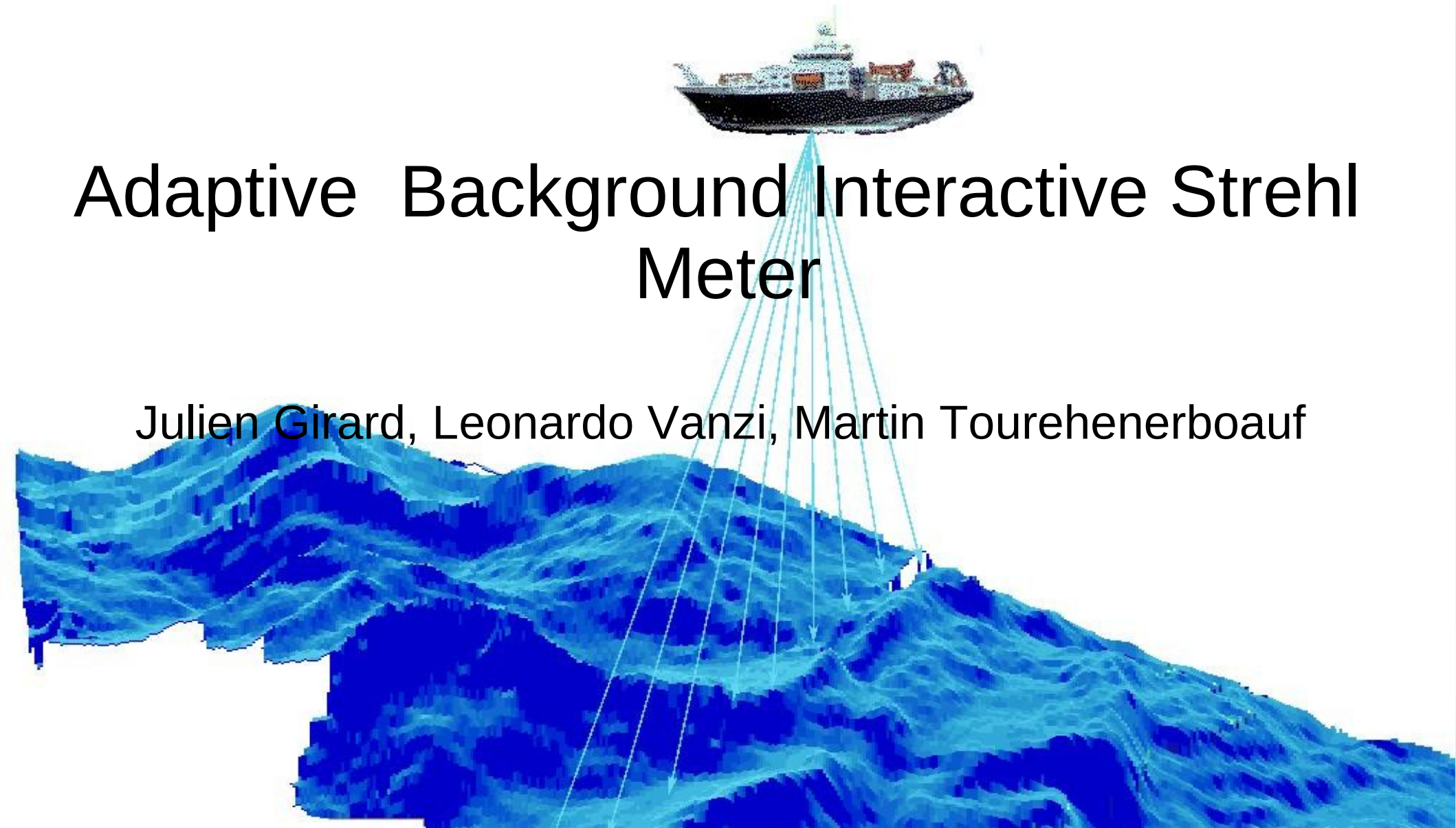
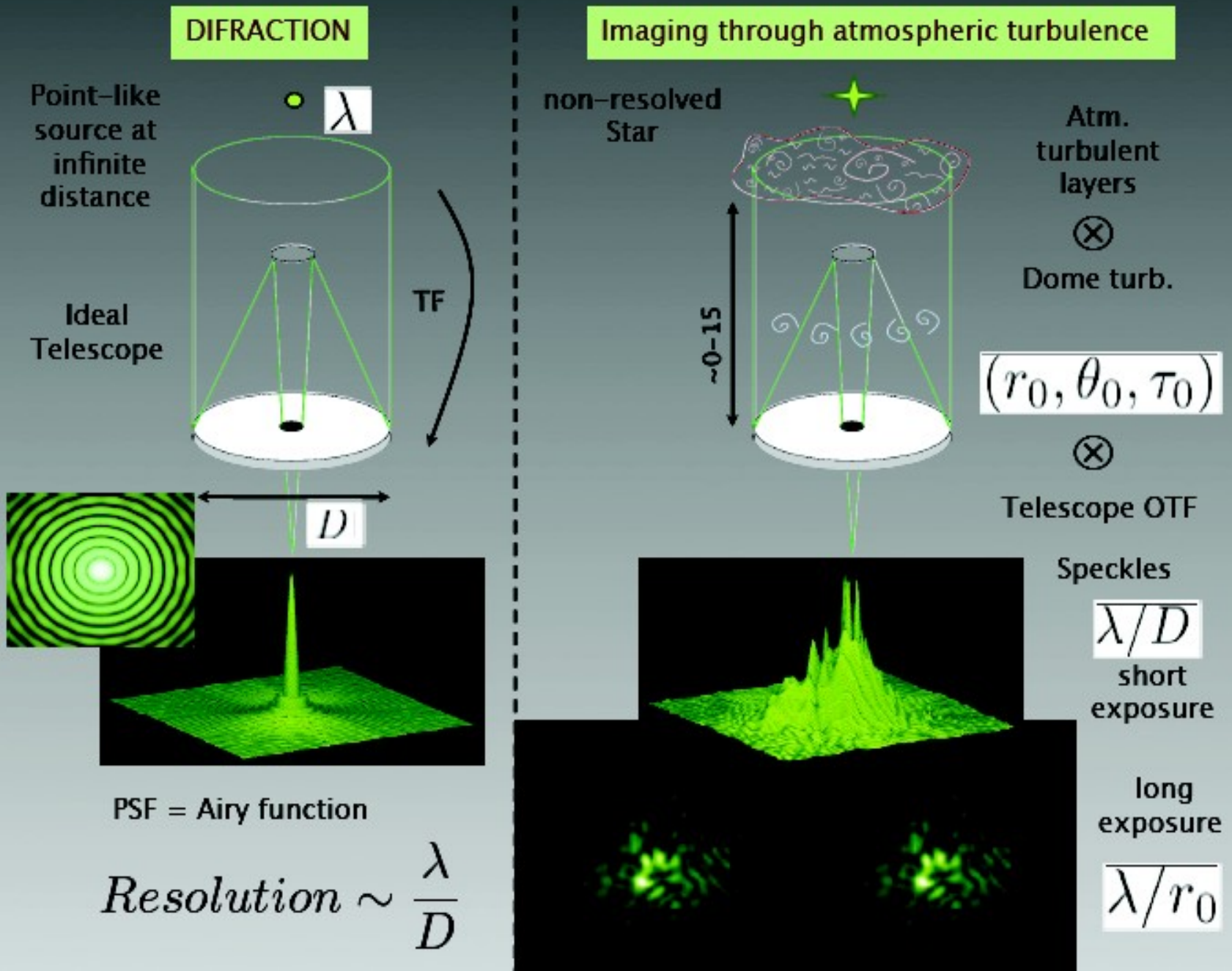
ABISM



Adaptive Background Interactive Strehl Meter

Julien Girard, Leonardo Vanzi, Martin Tourehenerboauf

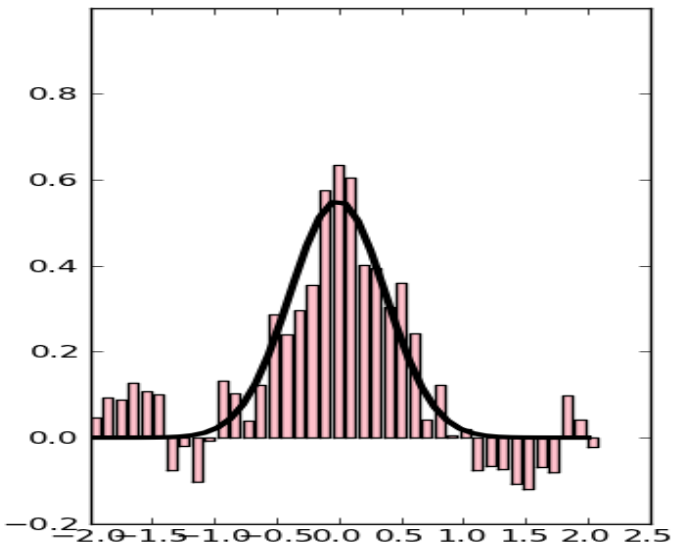
ABISM


DIFRACTION
Point–like source at infinite distance
λ
Ideal Telescope
TF
D
PSF = Airy function
$Resolution \sim \frac{\lambda}{D}$
Imaging through atmospheric turbulence
non–resolved Star
Atm. turbulent layers
⊗
Dome turb.
~0–15
(r_0, θ_0, τ_0)
⊗
Telescope OTF
Speckles
λ/D
short exposure
long exposure
λ/r_0

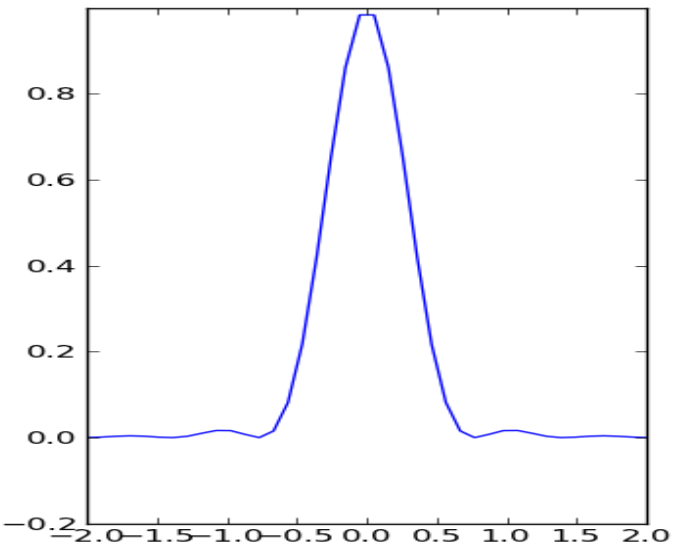
ABISM

The Strehl
is a mesure of the
quality of an image
used in
Adaptive Optic.

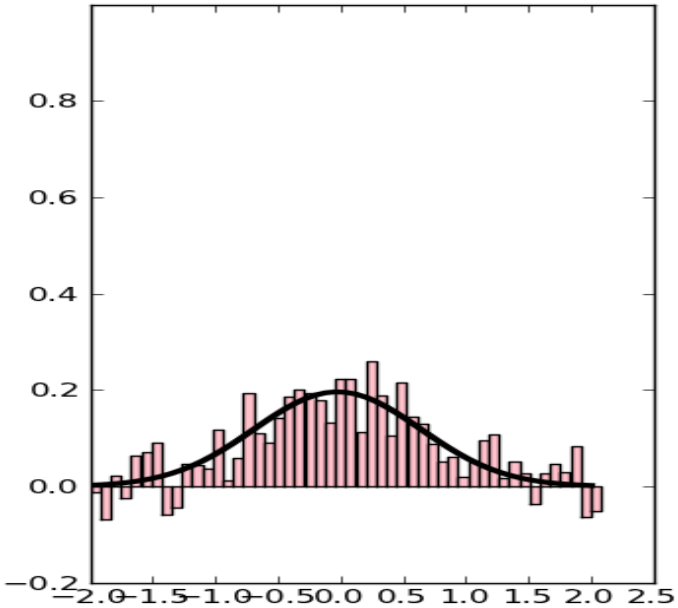
It is comparable to
the
Encircled Energy
Or the
FWHM

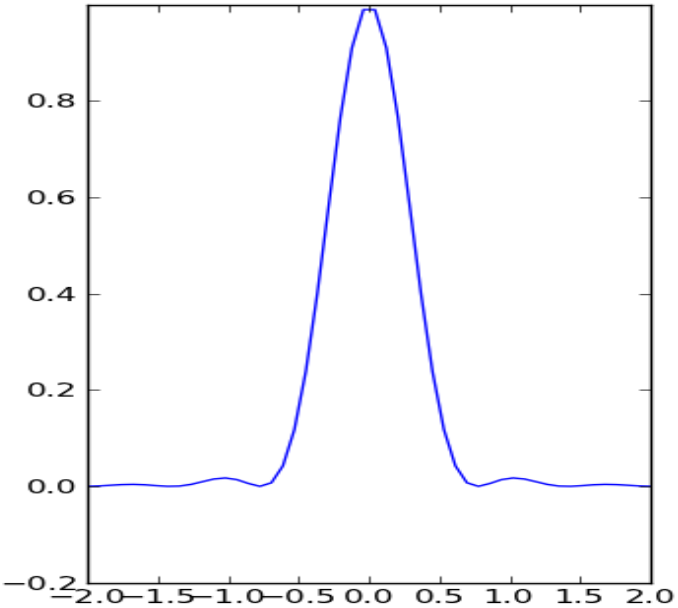


True Image



Diffraction Patern





Introduction

- We want to create a Strehl Meter
    - Easy to use (for visitors)
    - Independant
    - Fast
    - Robust (when it's 5am)
    - Can be installed on Paranal computers (old python versions (no wx)
    - Won't make everything bug (no crazy, dangerous loop)
    - Visual
    - Opened (can tell me all what he knows and can be used by everyone)

Summary

- 1/ Generalities
- 2/ Presentation of the Abism
- 3/ Photometry
- 4/ Difficulties

How to mesure the Strehl (1901)

$$S = \frac{I(\mathbf{x}=0)}{P(\mathbf{x}=0)}$$

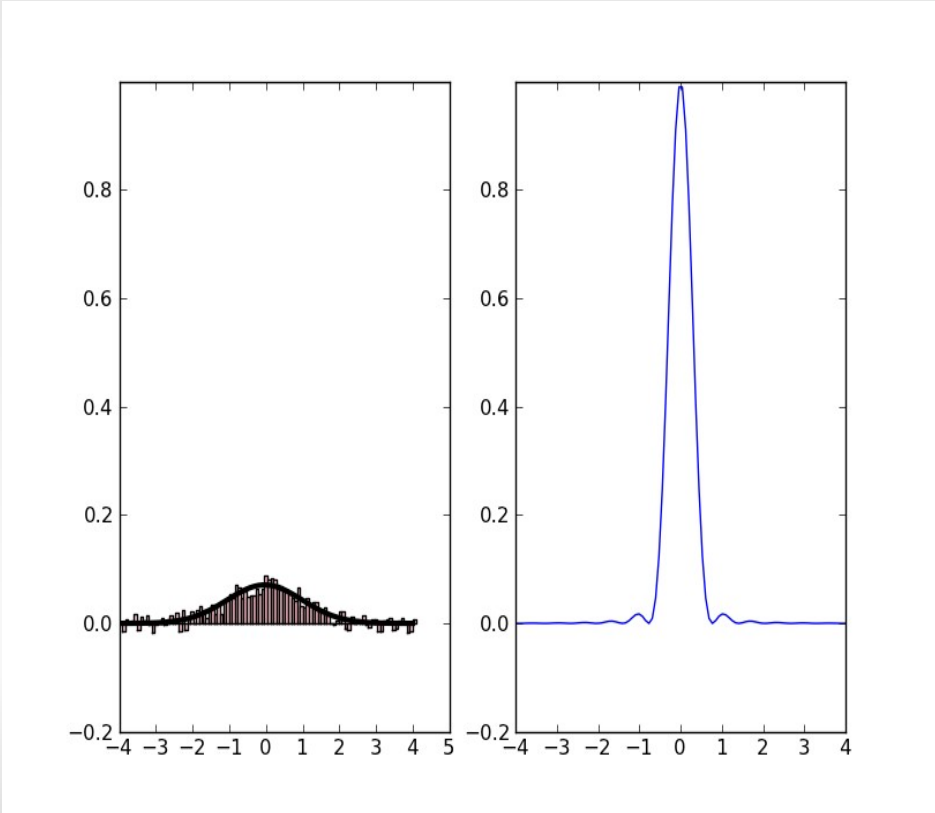
1/ Maximum
2/ Photometry
3/ Maximum of the diffraction pattern

$$S = \frac{\int OTF_{\mathrm{PSF}}(\mathbf{u})d\mathbf{u}}{\int OTF_{\mathrm{diff}}(\mathbf{u})d\mathbf{u}}$$

1/ Center
2/ Fourier transform
3/ Aperture
4/ Integration

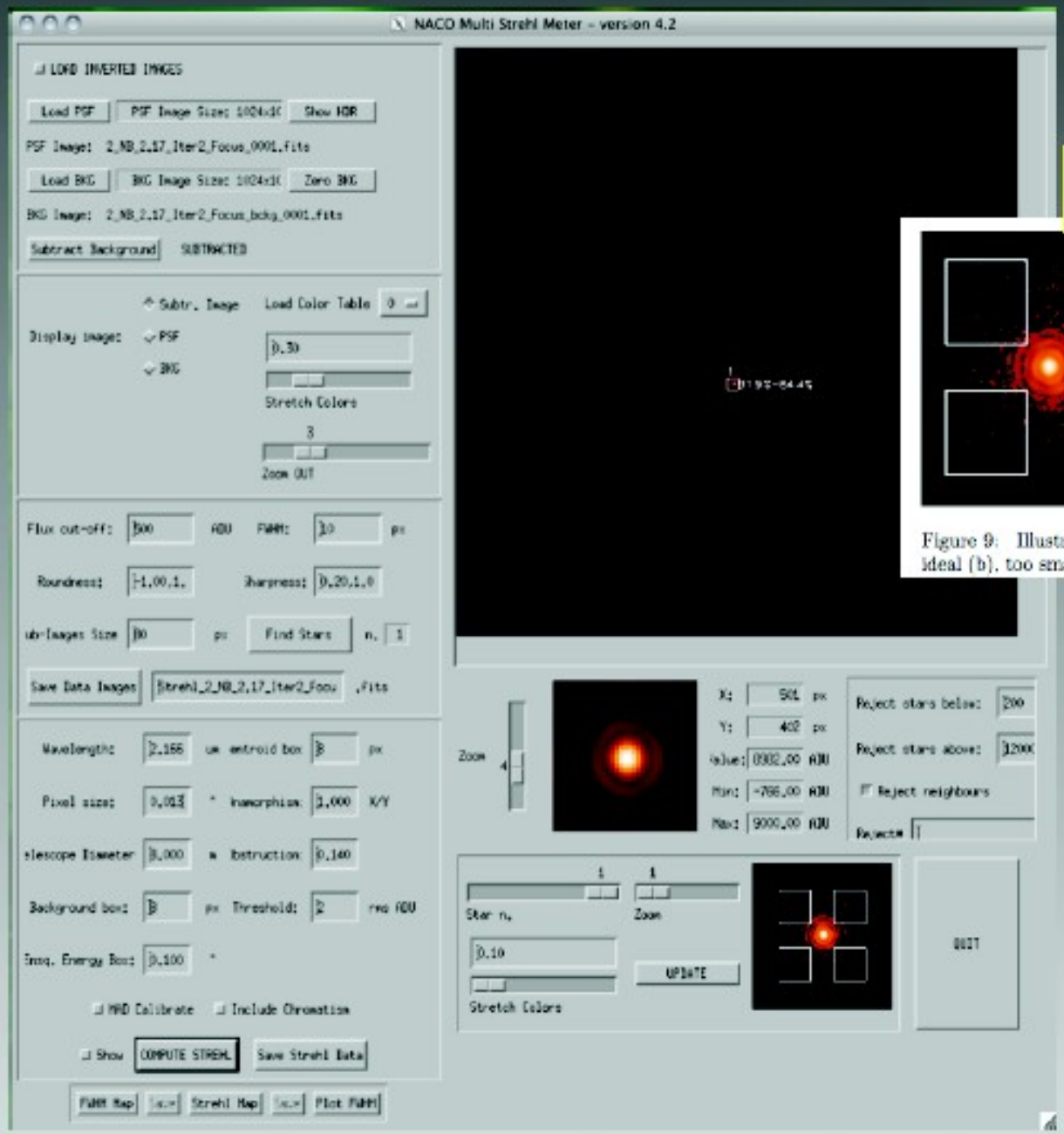
Generalities

- When the Strehl is too low, better to talk about encircled energy or FWHM. (Interferometry, spectroscopy)
- The Strehl is very dependant on the way to mesure it (Lewis 2004).
- Need to know
  - → wavelenght
  - → diameter & obstruction
  - → pixel scale



ESO current Strhel meter

MSM (good but not user friendly)



Background boxes

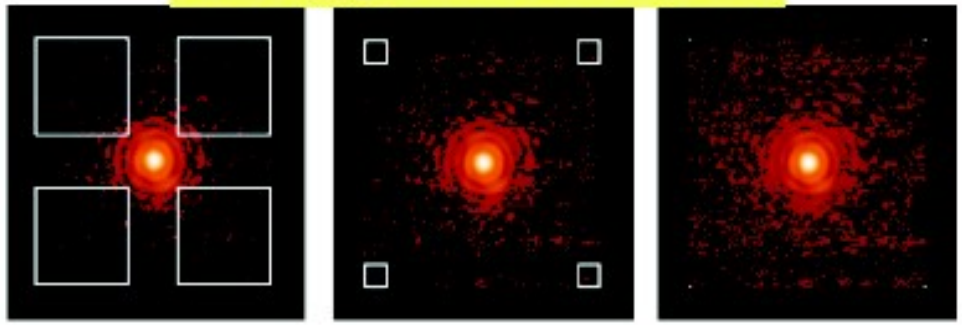


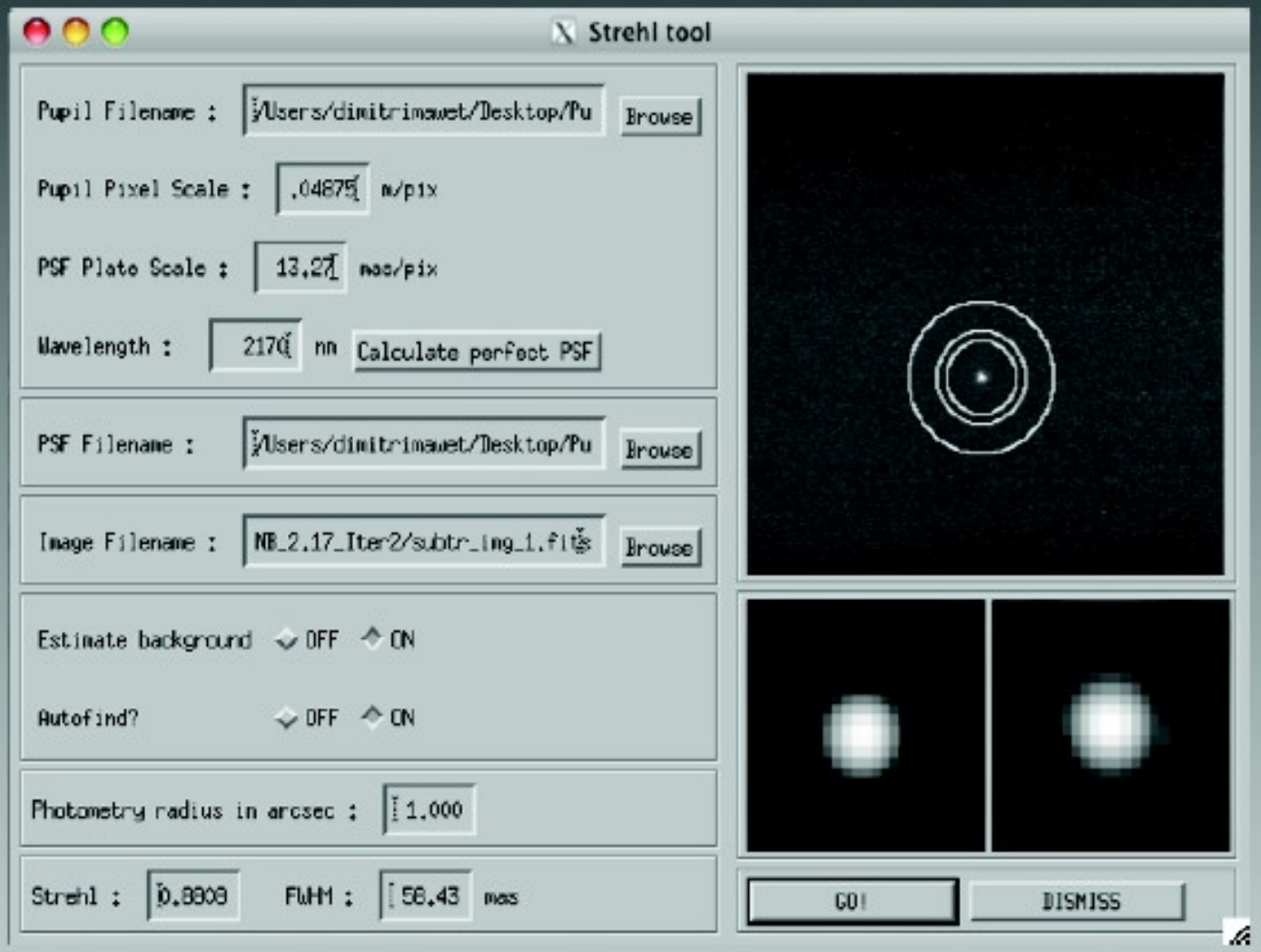
Figure 9: Illustration of three different background box sizes. From left to right: too large (a), ideal (b), too small (c).

MAD Multi Strehl Meter by E. Marchetti

Good for strehl maps

An other Strehl meter

goog but not user friendly either

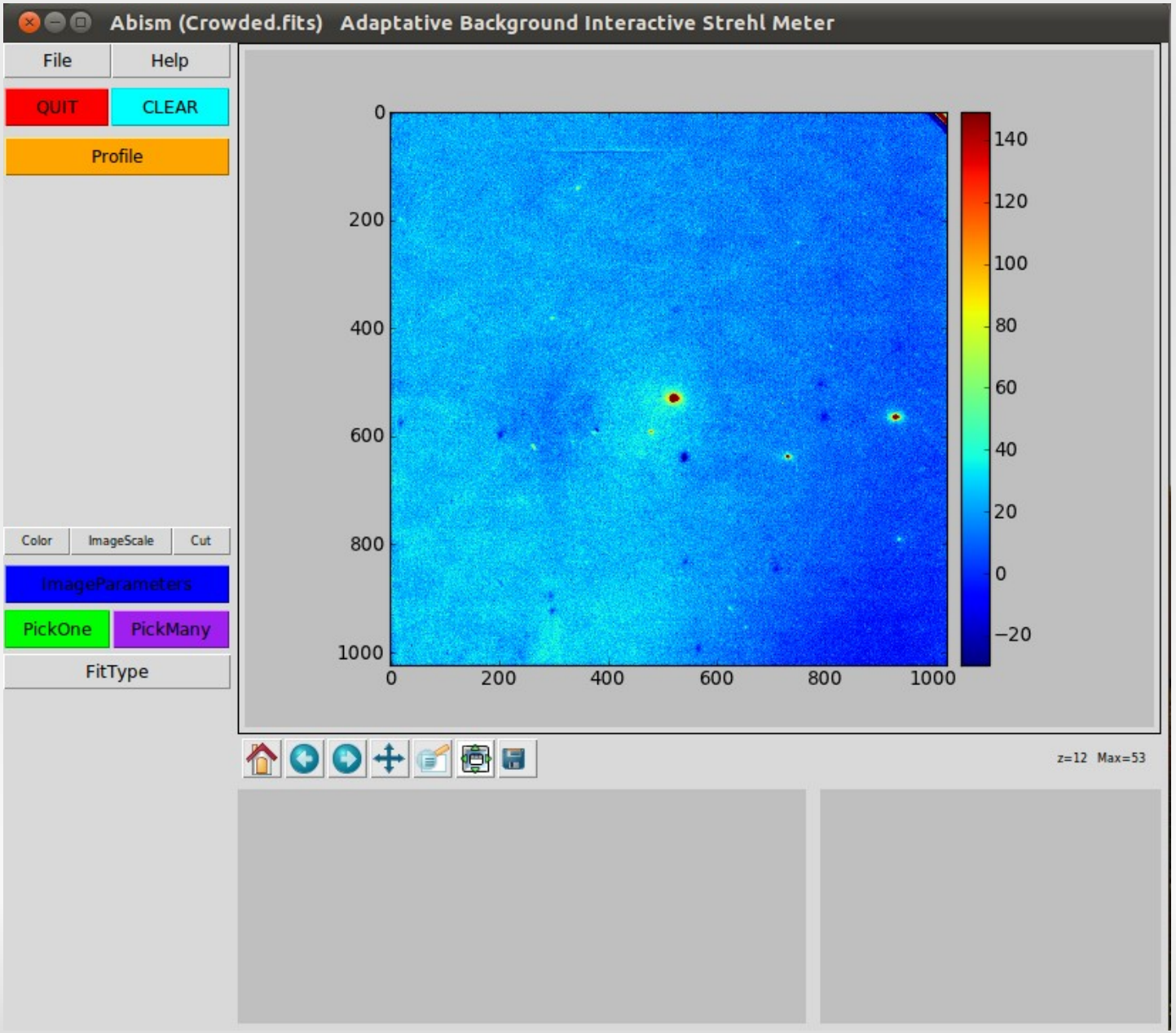


M. Van Dam

accurate but slow..
adapted to Keck's complex aperture

Our Strehl Meter

Just make a rectangle around your star



Summary

- 1/ Generalities
- 2/ Presentation of the Abism
- 3/ Photometry
- 4/ Difficulties

Presentation of ABISM

- Language : Python
- GUI package : Tkinter
- For : ESO : NaCo (can be used for every image.fits but won't read Header)
- Caracteristiques :

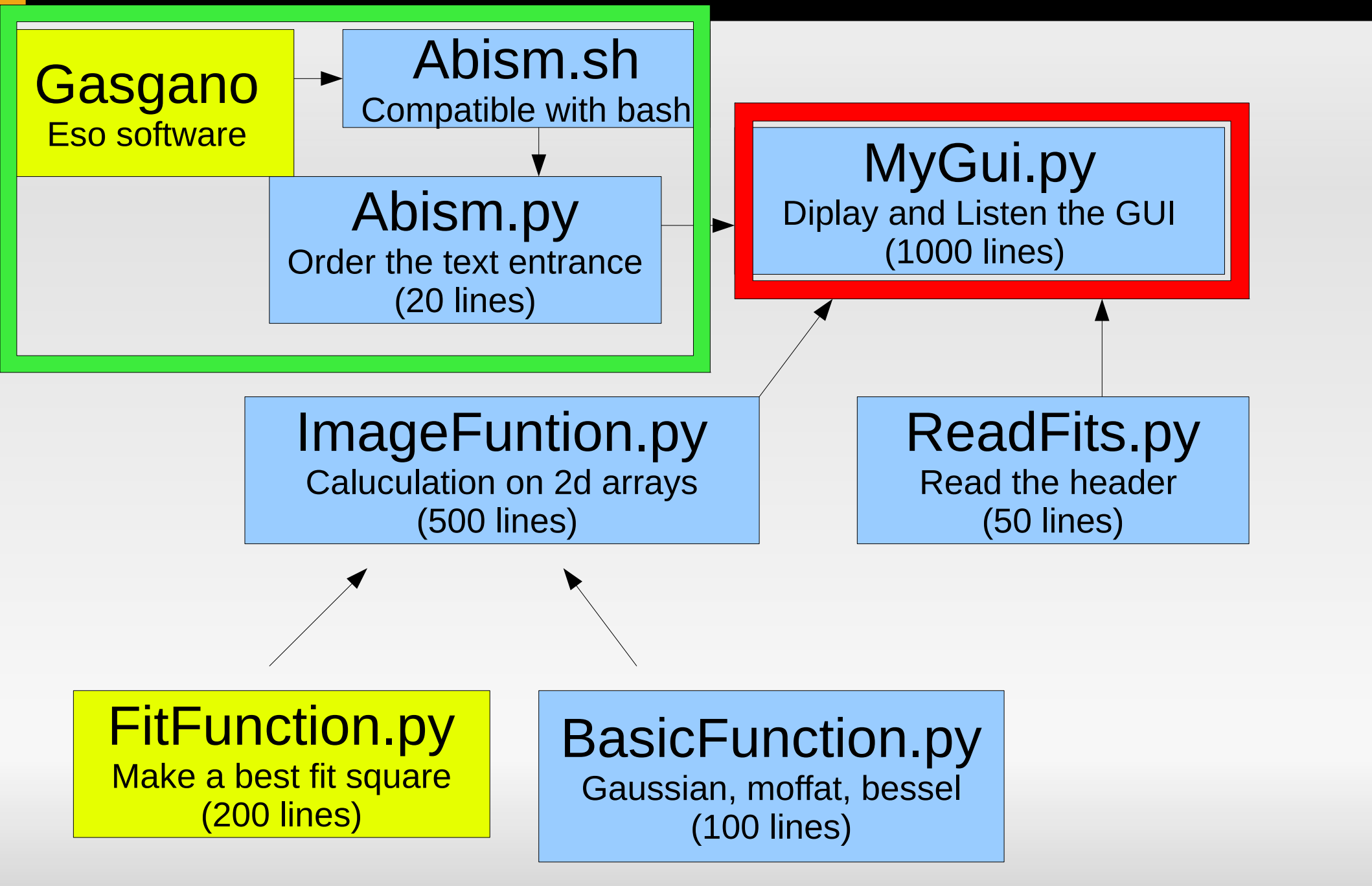
→ Can read data cube (by default take the last image)

→ Return an error and many easy way to compute the strehl

→ Return also : Strehl equivalent 2.2 um , FWHM, photometry, star center, background, Encircled energy (not implemented yet)

Presentation of ABISM

- Can be opened by command line :
  - → python Abism.py [image.fits]
  - → Or by a script (Gasgano)
- A GUI allows the user to check and adjust parameters
- The user choose one or many stars and get his strehl.


Gasgano
Eso software
Abism.sh
Compatible with bash
Abism.py
Order the text entrance
(20 lines)
MyGui.py
Diplay and Listen the GUI
(1000 lines)
ImageFuntion.py
Caluculation on 2d arrays
(500 lines)
ReadFits.py
Read the header
(50 lines)
FitFunction.py
Make a best fit square
(200 lines)
BasicFunction.py
Gaussian, moffat, bessel
(100 lines)

Summary

- 1/ Generalities
- 2/ Presentation of the Abism
- 3/ Photometry
- 4/ Difficulties

Photometry

- How to mesure an accurate photometry ?

PSF fit

- What is the form ?
- Fall in a local optimum ?
- Give initial parameters
- Where to stop

Aperture

- Where to stop ?
- Bad Pixels ?
- Circular ?
- How to interplolate ?
- What is the error ?

Astigatism ? Binary ? Stepped Background ?

How to find the star ?

Photometry

Photometry : Our Solution

PSF fit	Aperture
▪ What is the form ?	▪ Where to stop ?
▪ Fall in a local optimum ?	▪ Bad Pixels ?
▪ Give initial parameters	▪ Circular ?
	▪ How to interplolate ?
	▪ What is the error ?

Astigatism ? Binary ? Stepped Background ?

How to find the star ?

1/ Pre-Parameters

→ a) Center : User defined
→ b) FWHM : We parcurate the pixels

2/ Fit

→ a) Type : User defined (But we'll do Gaussian → Moffat → Bessel)
→ b) Local Optimum, to avoid it , we show the fit

3/ Aperture photometry

→ a) Rectangle stop at 99% encircled energy
→ b) Bad pixels destroyed by median filter

4/ Error

→ a) Difference between my photometry and the fit that has been done
→ b) Can be infered by S/N

Photometry (background)

- How to estimate background ?

Previous PSF fit

- Limits ?
- Degenerated ?

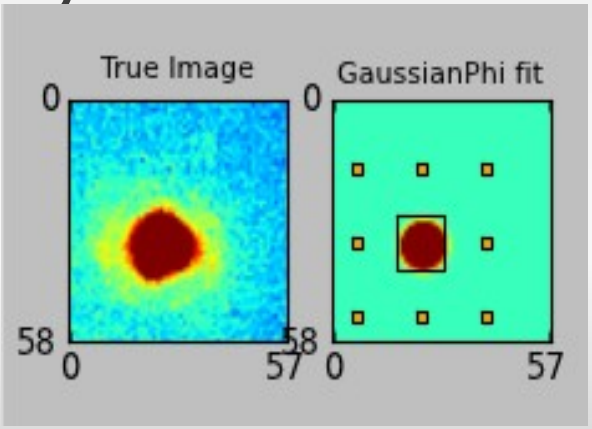
New, clever Aperture

- Where ?
- How ?

- We do a 8 rectangles phtotometry

:) And we take the median

:) In the futur we aim to give the slope of the background



Summary

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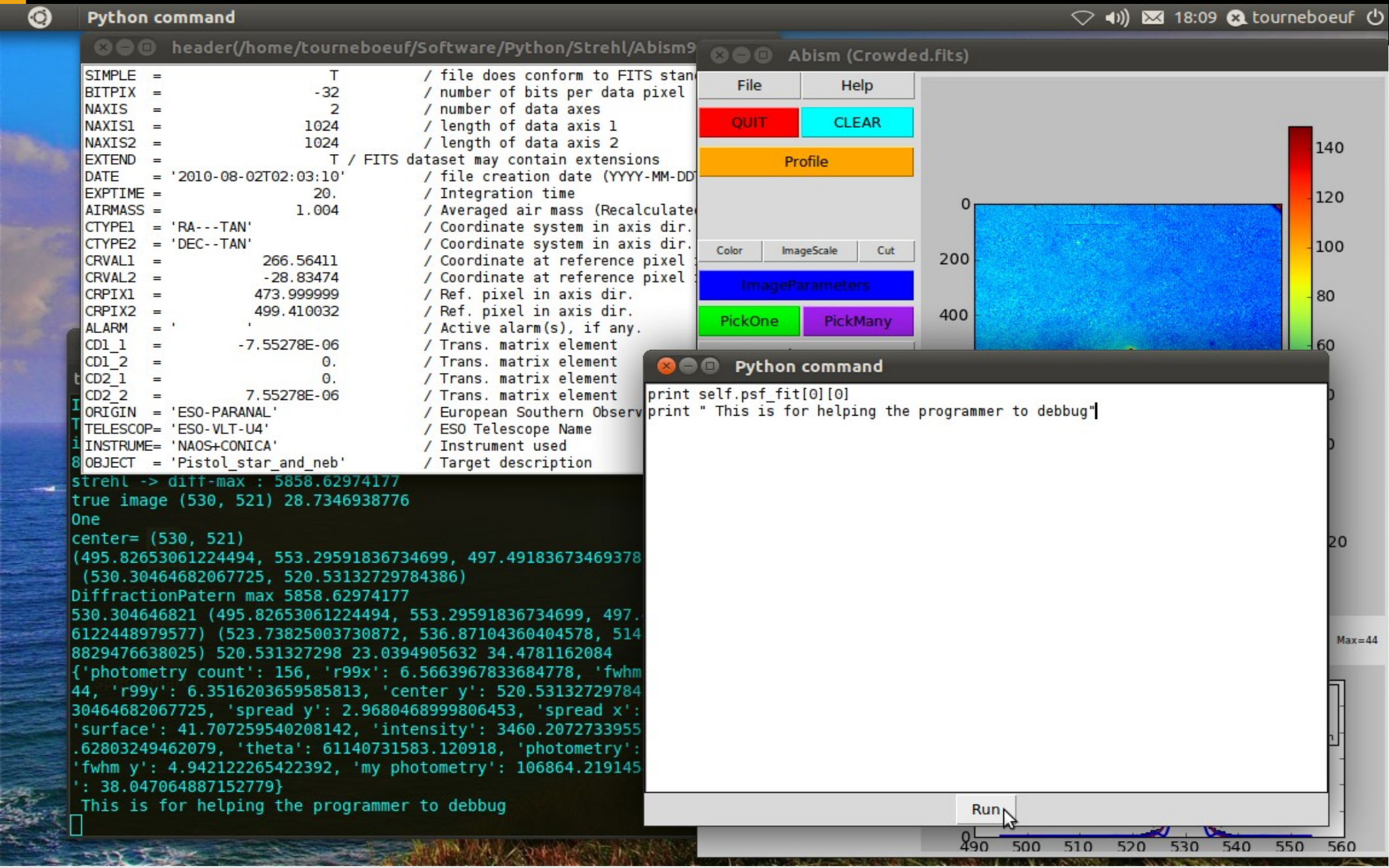
Dificulties



Dificulties

```
def Run(self,String):
        String = String.get("1.0",END)
        exec String in globals(),locals()
def RunPython(self):
  window_run = Tk()
  window_run.title('Python command')
  #window_run.geometry("+0+0")
  frame=Frame(window_run)
  frame.pack()
  text_user = Text(frame)
  text_user.insert(INSERT, 'print self.psf_fit[0][0]')
  text_user.pack()
  text_user.focus_force()
  button=Button(frame,text="Run", command=lambda : self.Run(text_user))
  button.pack()
  window_run.mainloop()
  return
```

Dificulties (Find the star)

- Histogram (brightest pixels)
- Near the center
- Iterative gravity center
- Human eye (Draw a rectangle)

→ Can change color, scale, (min,max)

→ Can substract the image of the noise

Dificulties

Science

- Noise
  - → Median Filter (when necessary)
- Error estimation
  - → (Strehl is in %)
- Moffat
  - → 2 degree of freedom
  - → 99% energy

Computer

- Compatibility
  - → from matplotlib.backends.backend_tkagg import FigureCanvasTkAgg as FigureCanvas
- Data cube
  - → automaticaly take the last
- Going fast with array
  - → od[d<0.25] = array[d<0.25]

Dificulties

Science

- Binary

  → (background, photometry)

- Cut in log scale

- Aperture Fourier transform

  → (Analitycal value but for Keck ?)

Computer

- Wich click do I want

  → Color of the buttons

- Destroy, clear

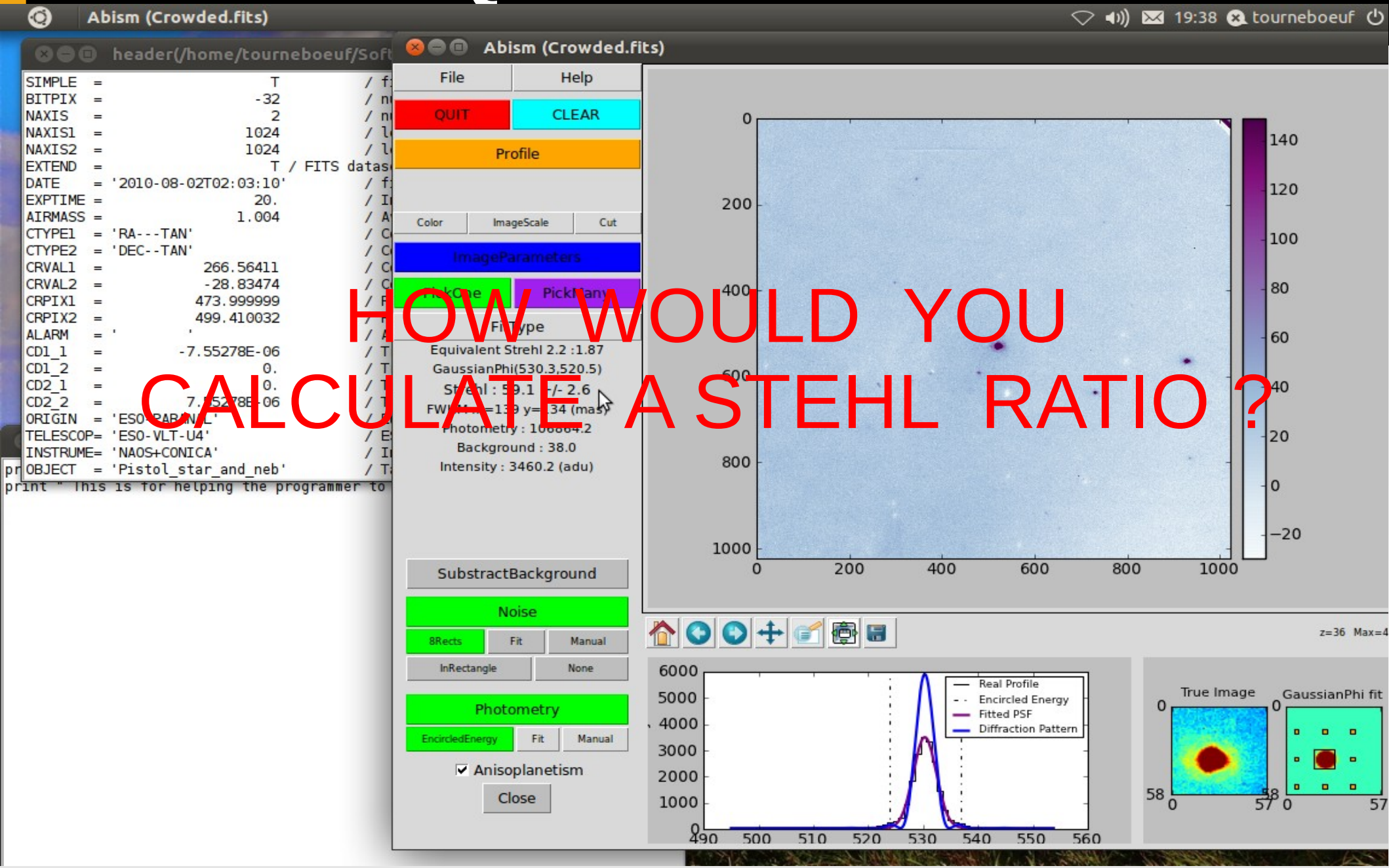
- Passing Variable

  → (class, dictionary)

Conclusion

- The error in strehl mesure (4%)
  - → we can do an automatic method
    - → phot, noise
    - → read header
    - → select star (ESO Eclipse)
- For low Strehl, better to speak about encircled energy, FWHM
- Return checks for the human.
  - → psf fit, global variables ...

Questions ?



HOW WOULD YOU CALCULATE A STEHL RATIO ?