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SOLAR CORONAL DOPPLEROMETER

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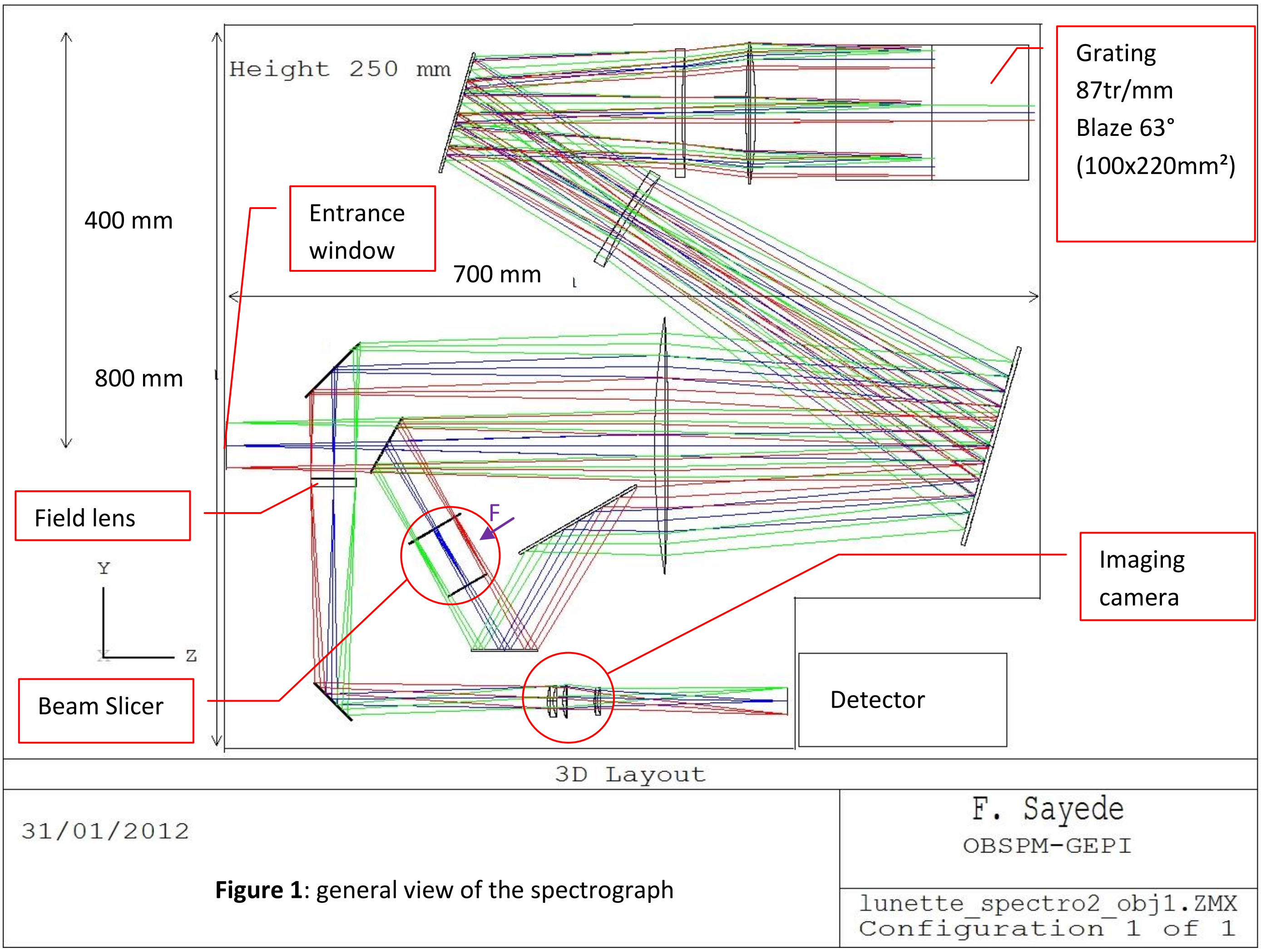


Figure 1: general view of the spectrograph

1. General description

The spectrograph is a MSDP system (figure1) optimized for the two spectral band 530.3nm and 637.4nm. The image quality is the same for both wavelengths. Around these bands, the image quality is acceptable but not diffraction limited (§3). The spectrograph collimator/camera is made of only four optical lenses; the other ones are plane mirrors and a filter.

The structure is made of aluminum honeycomb (15mm width) to lighten it with a high stiffness. The adjustments are reducing to the minimum; only two components are motorized: the grating and the focus on the detector via the imaging camera (TBC).

We image the Sun on the entrance window (2.6x34.4arcmin²) placed on the telescope focal plane. After a first pass into the spectrograph, the light is dispatched to the beam slicer by the fold mirror. We inject the sliced image into the spectrograph again. We image then the channels through a field lens and an imaging camera on the detector.

The figure 2 below is an example of a 8 channels slicer (the view is along the F arrow on the figure1)

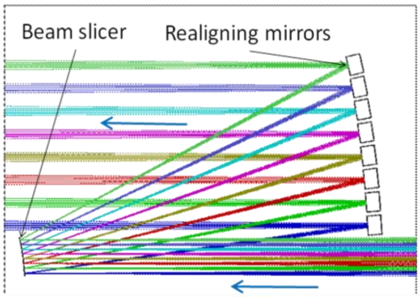


figure 2: example of a 8 channels slicer

The beam slicer is made of 18 slices that will give 18 channels on the detector. The slicer width is 300µm and the slicer height is 40mm.

The aperture of the spectrograph is F/20 with a pupil of about 100mm. The image reduction before the detector is between 2.2x and 2.7x. The image size on the detector is 24.6x24.6mm².

2. Global size and Mass evaluation

The above figure 1 gives the spectrograph size. We can adapt this global size if needed.

The total mass of the optics is about	6.1Kg
The total mass of the mechanics (without the structure) is about	8.5Kg
The total mass of the structure (without the positioning system on the telescope) is about	7.1Kg
The total mass of the electronics is about	1Kg

The total mass of the spectrograph (without margin) is about 22.7Kg

The total mass of the spectrograph (with a 10% margin) is about 25Kg

The total mass above is an evaluation. The goal is to reduce the total mass to 20Kg.

We have to compute the position of the mass center.

3. Image quality on the slicer

The figure 3 gives the spectral resolution: the two vertical black lines are the slice limits. The resolution is 0.2Å. To increase it, we can reduce the size of each slice and/or increase the angle of the grating.

The figure 4 gives the FFT PSF on the slicer. It is the image quality of the spectrograph after the first pass. We are diffraction limited.

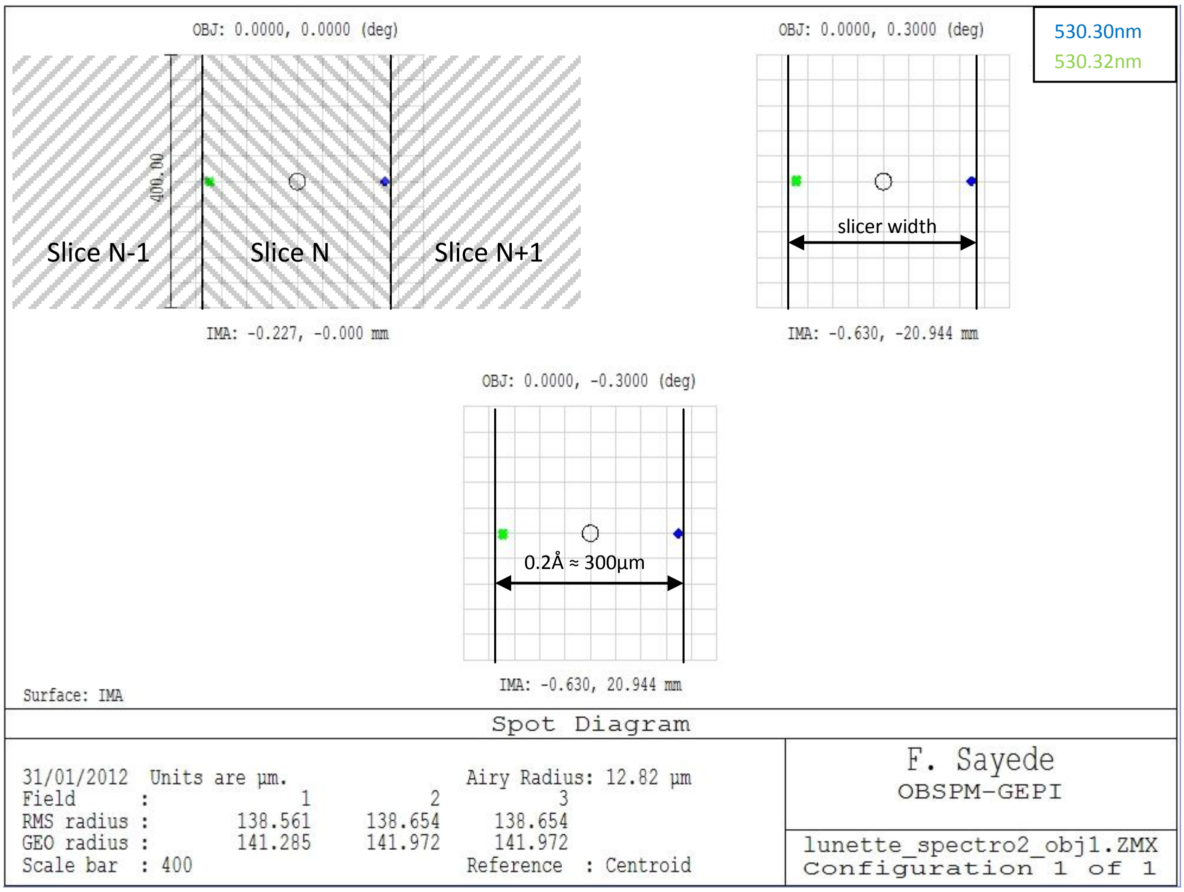


Figure 3: Two PSF on the slicer around 530.2nm separated of 0.2Å

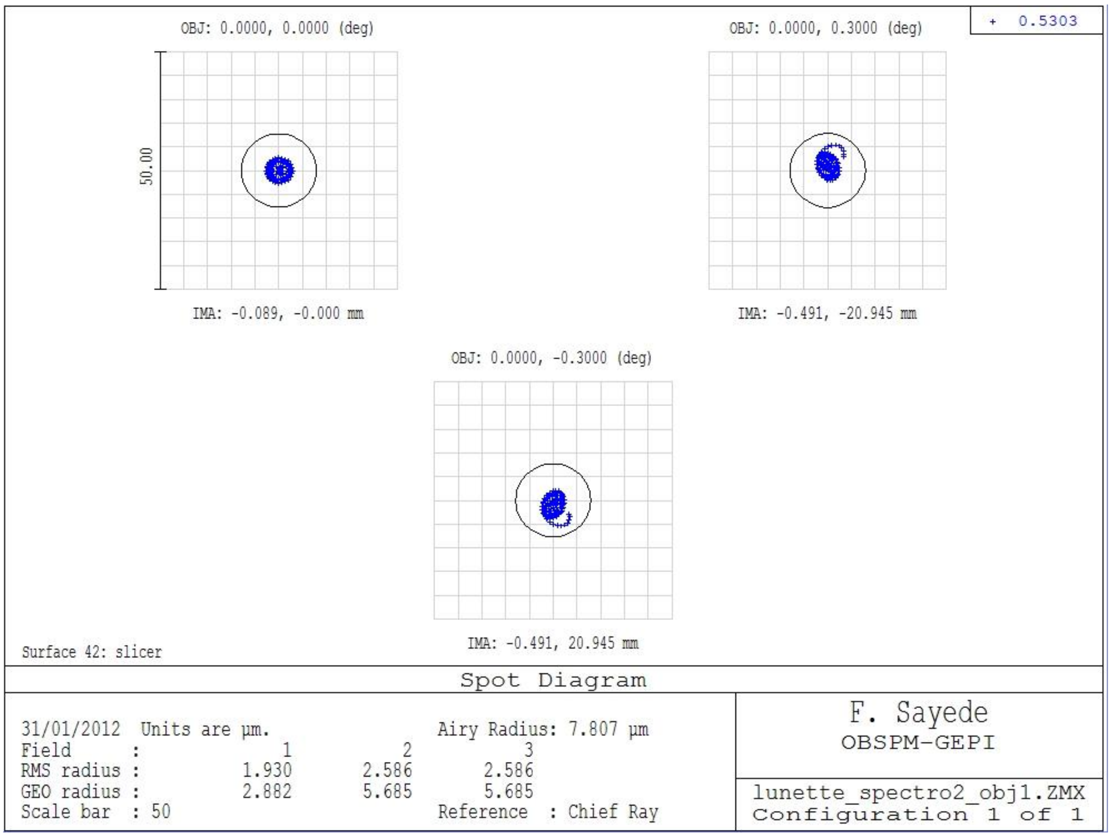
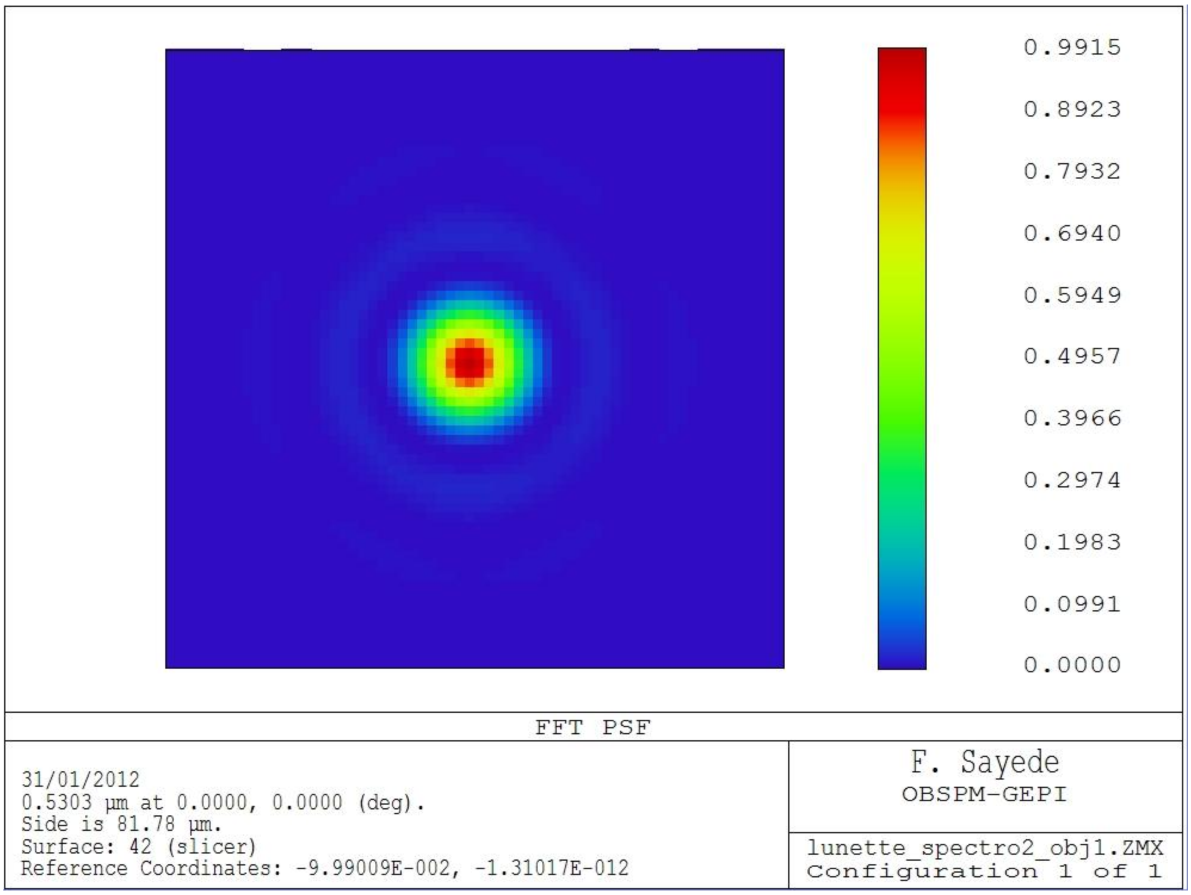


Figure 4: PSF on the slicer after the first pass (the black circle is the airy disk)



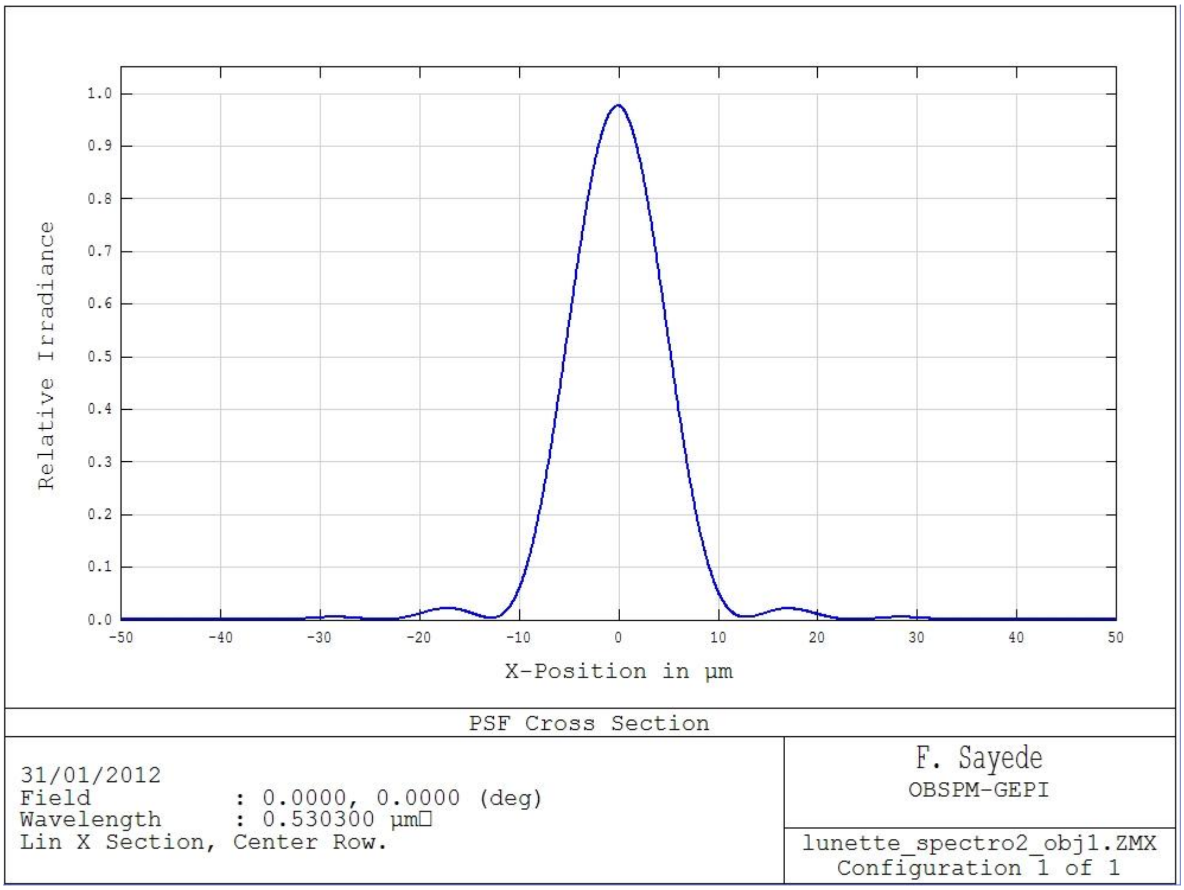


Figure 5: FFT PSF on the slicer after the first pass

4. Image quality on the detector

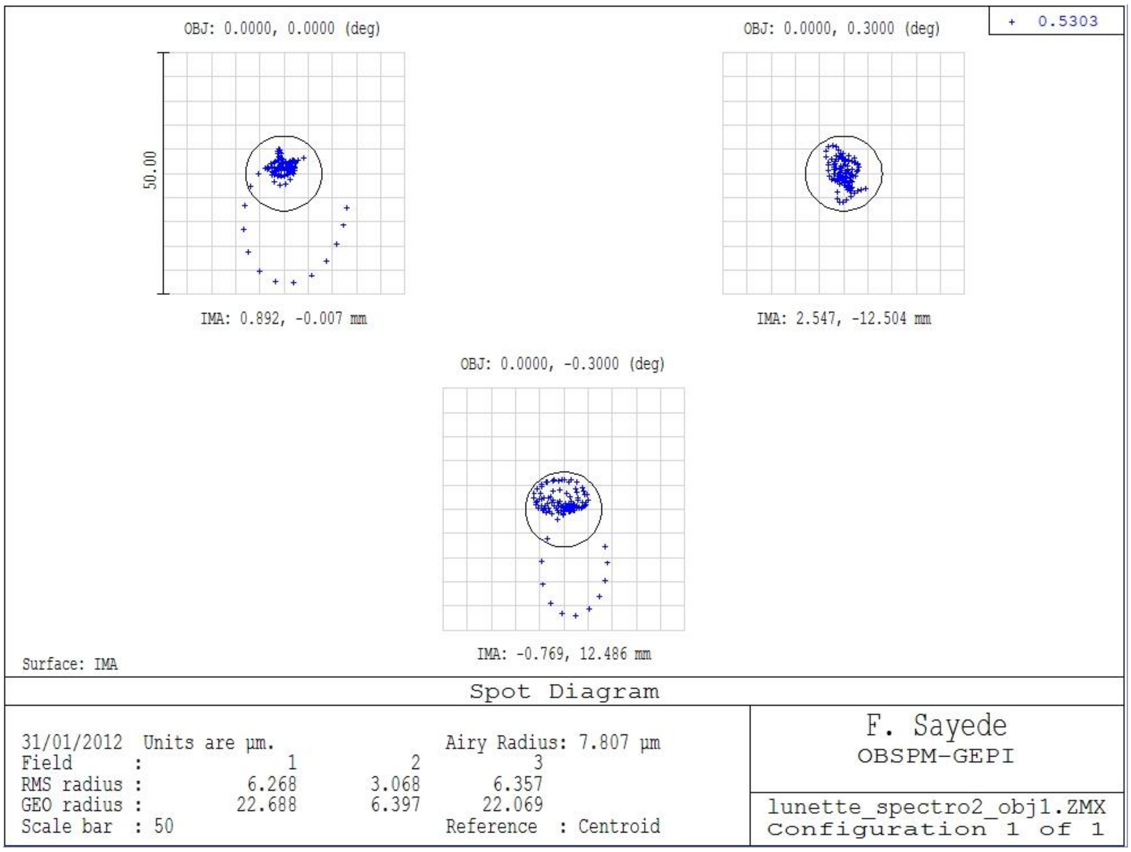


Figure 6: PSF on the detector after the beam slicer and the second pass (the black circle is the airy disk)

Before the detector, a field lens reduces the pupil and a camera resizes the image. These two elements are not homemade but bought from companies. The detector is a Silicon Imaging SI 4000M-CL with 12µm square pixel size ie about one airy diameter into each pixel.

Figure 8 and 9 gives the PSF on the detector after the beam slice and the second pass at the center of the detector and on the side of it (figure7).

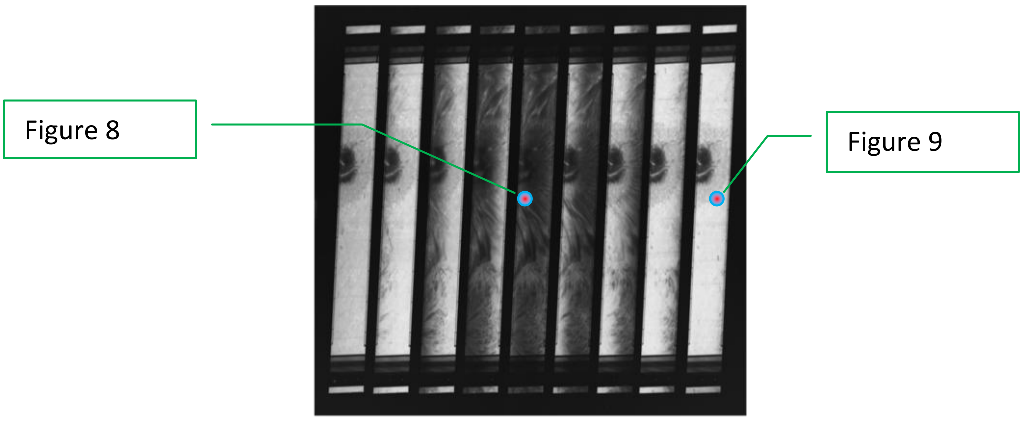


Figure 7: Example of data and positions of the calculated PSF on the detector

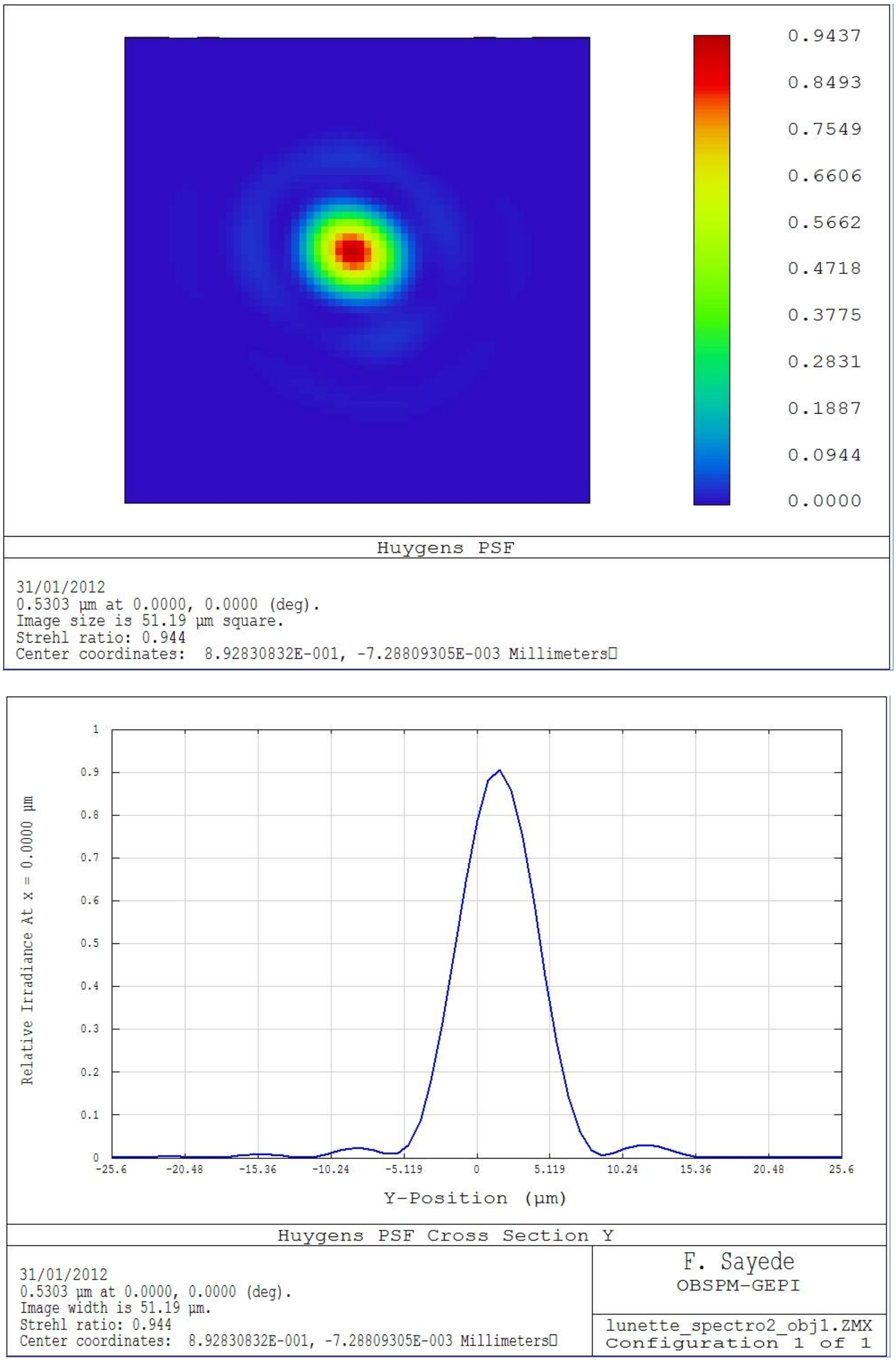
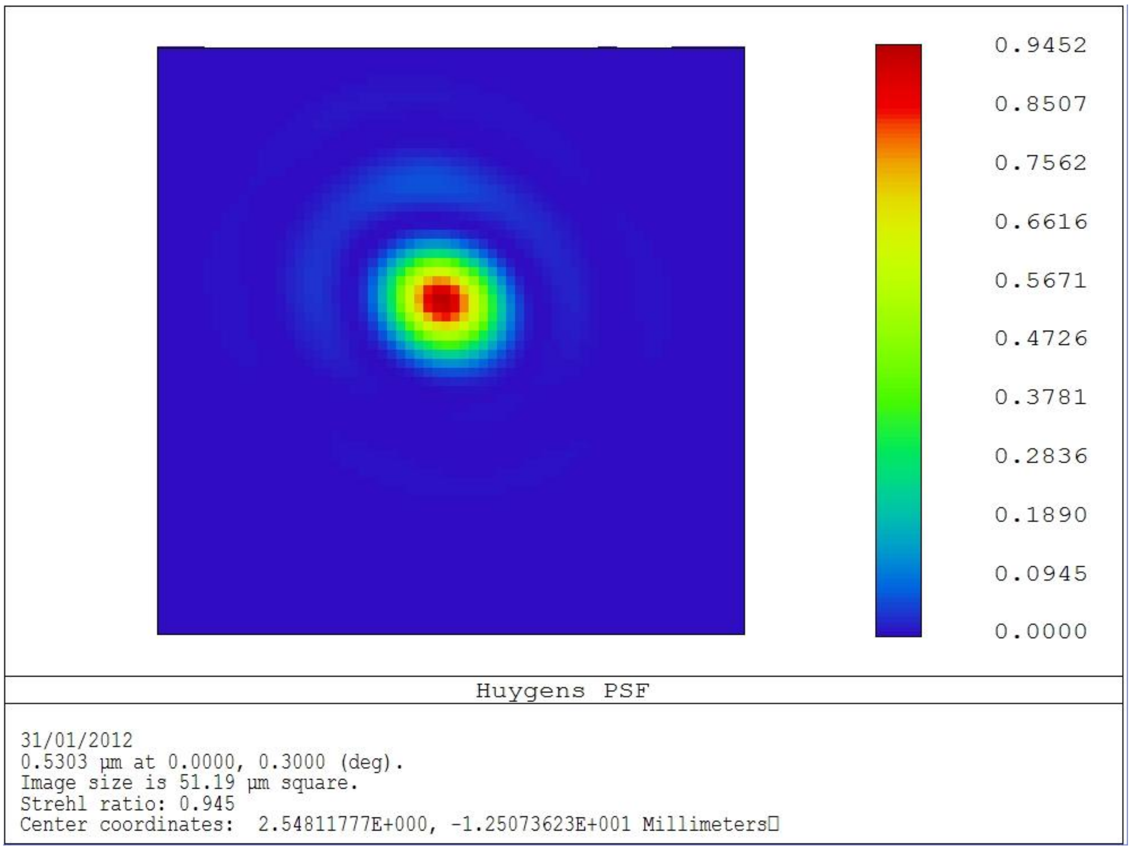


Figure 8: PSF on the detector after the beam slicer and the second pass at the center of the detector



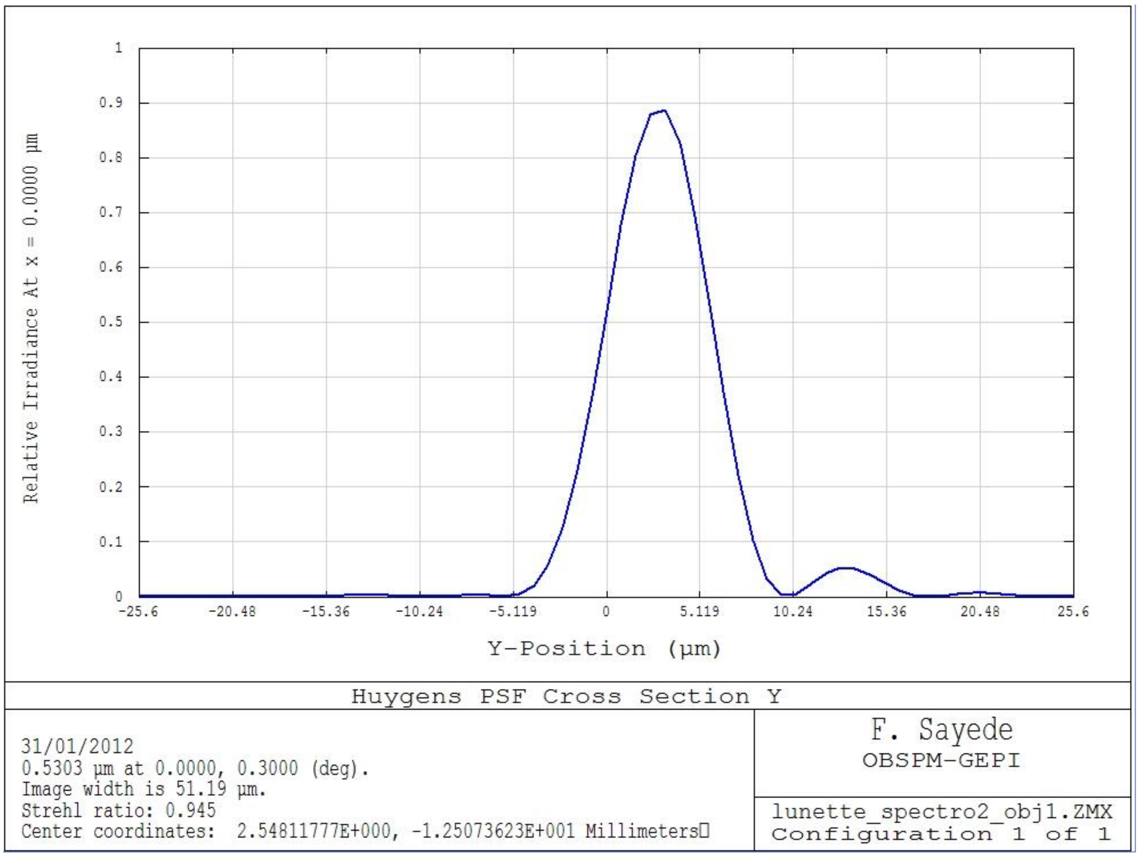
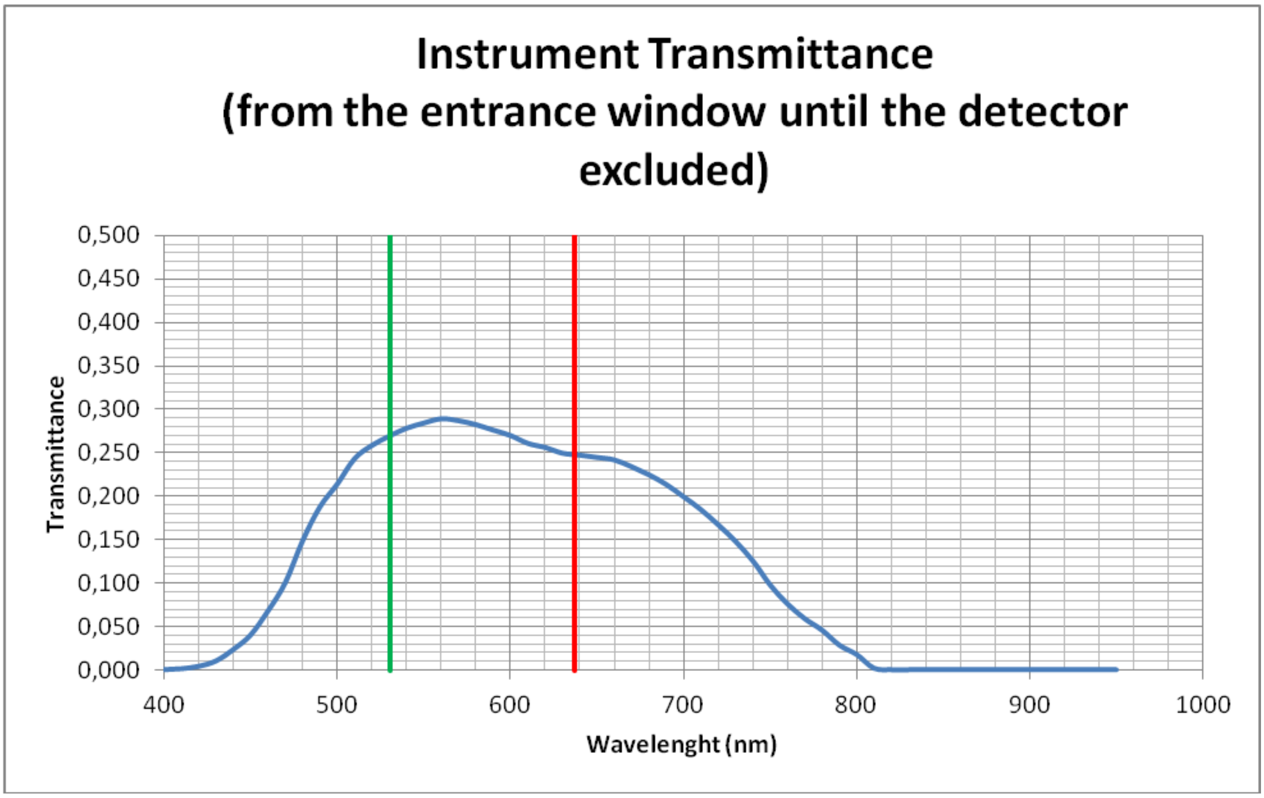


Figure 9: PSF on the detector after the beam slicer and the second pass at a side of the detector

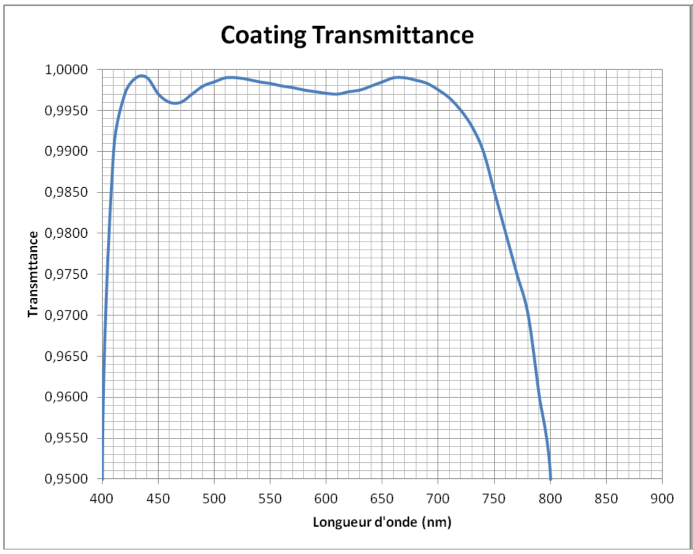
5. Transmittance

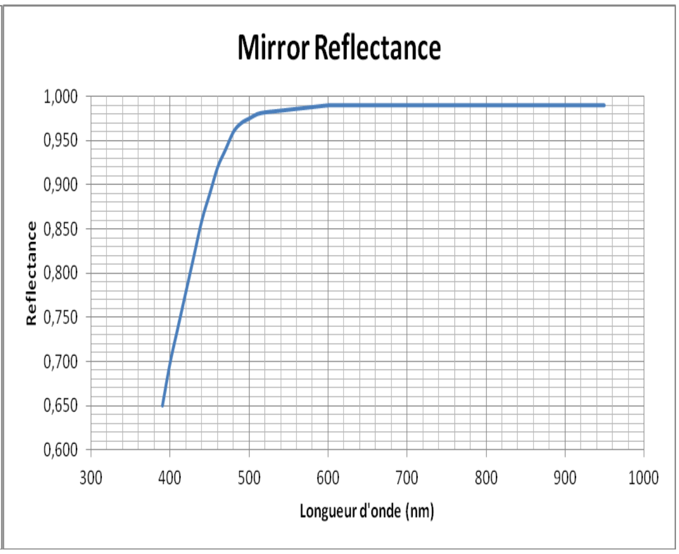
The following curve gives the overall transmittance of the MSDP from the entrance window until the detector (not included).



The calculation includes the transmittance or the reflectance of each optical face, the glass transmittance, the filter transmittance, the grating efficiency and the two-passage into the spectrograph.

The coating transmittance is the Vis 0° from Edmund Optic ®. The mirror reflectance is the protected silver from the same company.





The grating transmittance is between 60% and 70%. We are working with a 87g/mm 63°blazed grating. We have to compute if two orders permit an optimal transmittance at 530.3nm and 637.4nm.

6. Cost evaluation

The cost evaluation takes into account all the material but not the studies and the mechanical manufacture.

The cost of the optic is the following:

Type	Material	Size	Cost €
lense 1	SILICA	Φ240	3500
lense 2	SILICA	Φ100	2200
lense 3	F5	Φ120	1500
lense 4	FPL-53	Φ130	3800
mirror 1	Protected silver	100x150	420
mirror 2	Protected silver	150x200	500
mirror 3	Protected silver	50x15	100
mirror 4	Protected silver	80x80	250
mirror 5	Protected silver	100x100	380
mirror 6	Protected silver	80x80	250
mirror 7	Protected silver	60x60	240
camera	env. 2.5x		500
grating	87g/mm@63°	100x220	7000
Slicer	18 slices + mirrors		13000
		Total	**33640**

The cost of the mechanics is the following:

Designation	Quantity	Unit cost €	Cost€
Adjustement screws + nuts	42	20	840
Grating Mechanisum (Ball bearing,screw…)	1	150	150
Filter mechanisum	1	140	140
Material	1	500	500
Alu Honeycomb	2,5	320	800
Hardware	1	300	300
marging 10%	1		270
		Total	**3000**

The cost of the electronics is the following:

Designation	Quantity	Unit cost €	Cost€
Motor	2	20	40
Control card	2	75	150
Power adaptater	1	50	50
Hardware	1	100	100
marging 10%	1		30
		Total	**370**

An evaluation of the total cost of the project without contingencies is **37000€** ie about **40k€ with contingencies** (without studies and manufacture).