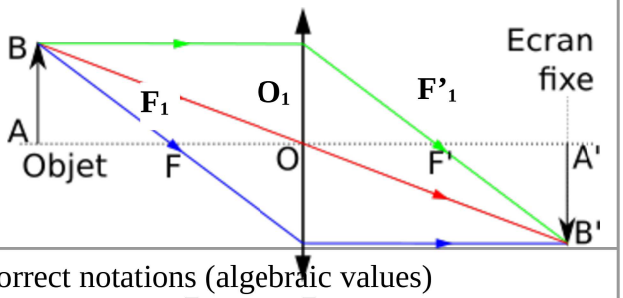
Correction IE1 – 15 October, 2021

Exercise 1 : Focimetry
Part 1 : Silbermann's method (10 points)

Q1 / 4 / 3 (1 point for each ray) / 0,5 Justification O, F and F' / 0,5 Conclusion	* previse ray-diagram, using pencil and ruler. * Ray crossing O_1 not deviated ; O_1 is at the intersection between the ray and the optical axis. As AB = -A'B', we get $O_1A=-O_1A'$ therefore O_1 is the middle of [AA']. * Similarly, we find that F is the middle of [AO_1] and F' the middle of [O_1A']. * Conclusion : $D=A\bar{A}'=4O_1\bar{F}'=4f_1'$ 
Q2 / 3 (1 point each equation)	* correct method, with explanations and correct notations (algebraic values) * Reversed image, same size as the object : $\gamma=-1\Rightarrow\bar{O_1A}=-\bar{O_1A}'$ * Descartes' conjugate equation $1/\bar{O_1A}'-1/\bar{O_1A}=1/f_1'\Rightarrow 2f_1'=\bar{O_1A}'$ * Object-screen distance $D=A\bar{O}_1+\bar{O_1A}'=4f_1'$
Q3 / 1	The object and the image should be real. This is possible only with a converging lens.

Part 2 : Badal's method (8 points)

Q1 / 2 (1 point for the explanation, 1 point for the scheme)	• Autocollimation method • or use of an eyepiece previously set to infinity
Q2 / 2	• Accurate ray-diagram, using pencil and ruler (see figure 3 in appendix), with a clear difference between solid and dashed lines.

Q3 and Q4 / 6	This open-ended question is assessed by 4 skills listed below. For each skill, examples of possible answers are presented. Correctors are invited to value any relevant element, even if it does not work or does not correspond to the examples. The resolution can be carried out at the choice of the student, either by the graphic method (see tfigure 4 in appendix), or by the analytical method.
Skills	
/ 1	**Analyse** : identify the simple tasks that will need to be done. • *As the screen is shifted to the right, the lens L_2 is a diverging lens (the image A_2 of A_1*

	given by L_2 is in its image focal plane since A_1 is at infinity). Then, as L_b is a converging lens, A' is real if and only if the object A_2 is located before $O_2 = F_b$). • *Find the positions of the points A_1, A_2 et A' (using a ray-diagram or by calculation)* • *Deduce the focal length f'_2 of the lens L_2.*
/ 3	**Perform** simple tasks. • *Simple or complete scheme, and/or identification of conjugated points : $A \rightarrow A_1 \rightarrow A_2 \rightarrow A'$ (A_1, image of A by L_a, is at infinity ; A_2, image of A_1 by L_2, is in the image of cal plane of L_2 and A', image of A_2 by L_b, eis on the screen) ; that is to say:* $$A_{1\infty} \xrightarrow[O_2 ; f'_2<0]{L_2} A_2 \equiv F_2 \xrightarrow[O_b ; f'_b>0]{L_b} A'$$ • *Draw ray paths to find the points A_1, A_2 and A' (graphical method, see figure 4 in appendix).* • *Use Chasles relation and (Descartes' or Newton's) conjugate equation to find :* $$f'_2 = -\frac{f'^2_b}{d}$$ *For instance :* $$\frac{1}{\overline{O_bA'}} - \frac{1}{\overline{O_bA_2}} = \frac{1}{f'_b}$$ $$\overline{O_bA'} = \overline{O_bF'_b} + \overline{F'_bA'} = f'_b + d$$ $$\frac{1}{\overline{O_bA_2}} = \frac{1}{\overline{O_bA'}} - \frac{1}{f'_b} = \frac{1}{f'_b + d} - \frac{1}{f'_b}$$ $$\overline{O_bA_2} = \frac{f'^2_b + f'_b \times d}{-d}$$ $$\overline{O_2O_b} = \overline{O_2A_2} - \overline{O_bA_2} = f'_b$$ $$f'_2 + \frac{f'^2_b + f'_b \times d}{d} = f'_b$$ $$f'_2 = -\frac{f'^2_b}{d}$$ • *Find the value of f'_2 (measurement on the ray diagram or by calculation) : .* $\boldsymbol{f'_2 \approx -33\ \text{cm}}$
/ 1	Take a **critical look** at the necessary assumptions and the results obtained. • *A negative focal length is obtained: the lens is clearly divergent.* • *One places oneself in the conditions of Gauss and in the case of thin lenses.*
/ 1	**Communicate** • *Clear and concise writing or clear and accurate ray diagram.* • *Structured reasoning: introduction, link between the parts, conclusion (value of the focal length of L_2).*

<u>Exercise 2</u> : Micro-lens and optoelectronics (7 points)

This open-ended question is assessed by 4 skills listed below. For each skill, examples of possible answers are presented. Correctors are invited to value any relevant element, even if it does not work or does not correspond to the examples.

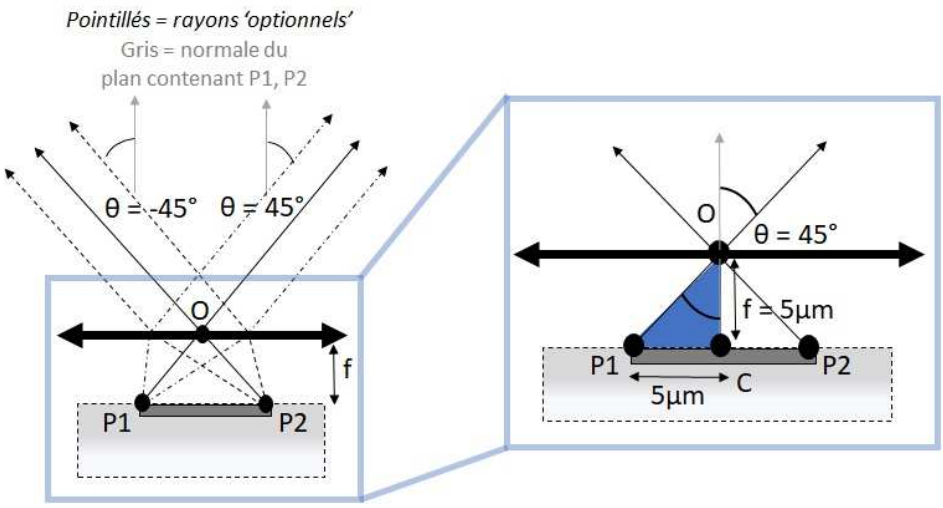
	Skills
/ 1	**Analyse** : identify the simple tasks that will need to be done. - *Determine the relative positions of the optical center O and the focal point* - *Understand where the rays emerging with an angle of 45° come from* - *Find a relation between P_1P_2 and the focal length*
/ 3	**Perform simple tasks.** - *Simple and complete scheme.* - *No eye accommodation ⇒ image at infinity ⇒ object in the object focal plane* - *The rays emerging at 45° come from P_1 and P_2 in the object focal plane*  - *The triangle CP_1O being isosceles in C, $CO = P_1C$* - *The focal length is therefore $f' = \bar{CO} = P_1P_2/2 = 5\,\mu m$*
/ 2	Take a critical look at the necessary assumptions and the results obtained. - *The focal length is positive (converging lens)* - *The micrometer size is well suited to the system requirements* - *The assumption is very (too much?) optimistic as we are far away from paraxial approximation…*
/ 1	**Communicate**. - *Clear and concise writing* - *Structured reasoning: introduction, link between the parts, conclusion*

Figure 3

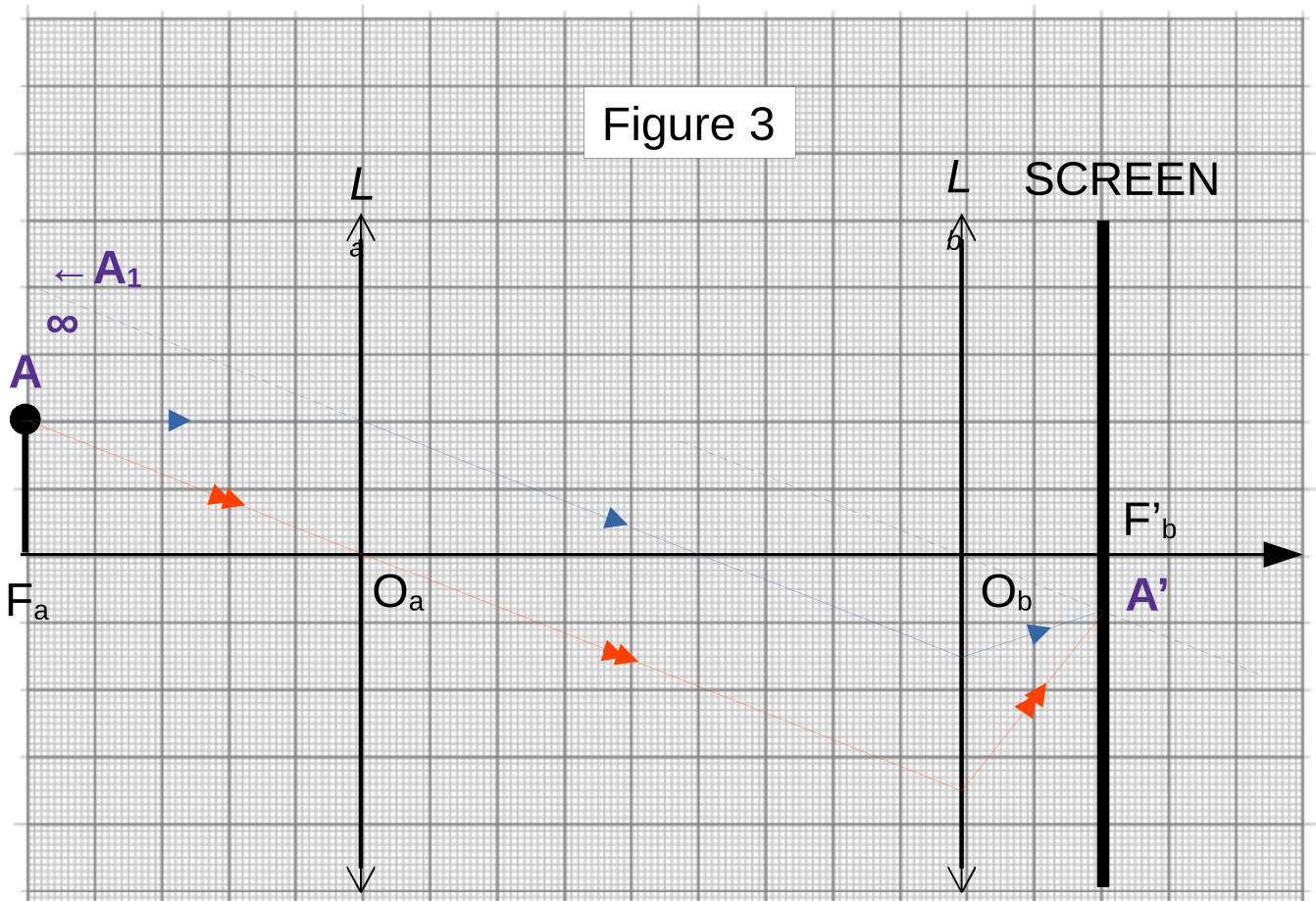


Figure 4