1er juin 2022

Mesure d’une vitesse de croissance cristalline

#NI Vision, #camera GigE, #platine de translation motorisée, #focus stacking

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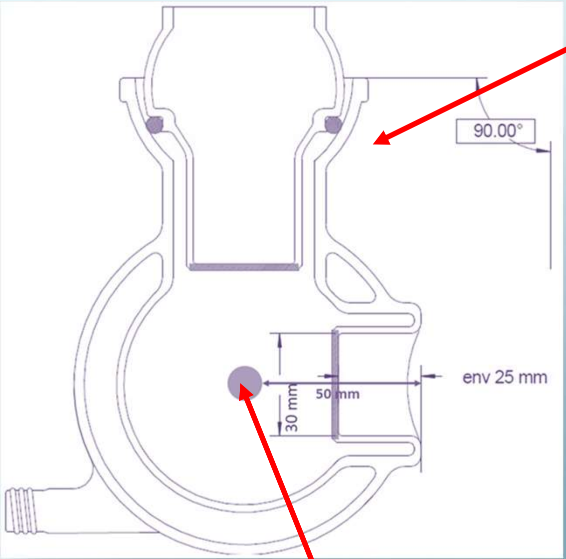
Problématique:

- On a un cristal (de KDP) plongé dans une solution & qui pousse très lentement (qqs microns/semaine)
- On veut suivre cette croissance (vitesse, morphologie)
- Comment ???

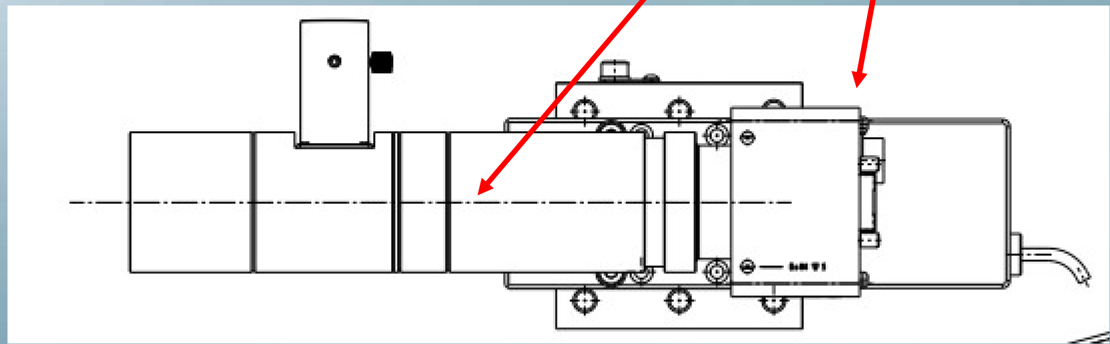
Avec des caméras…

Éclairage?



Cellule thermostatée

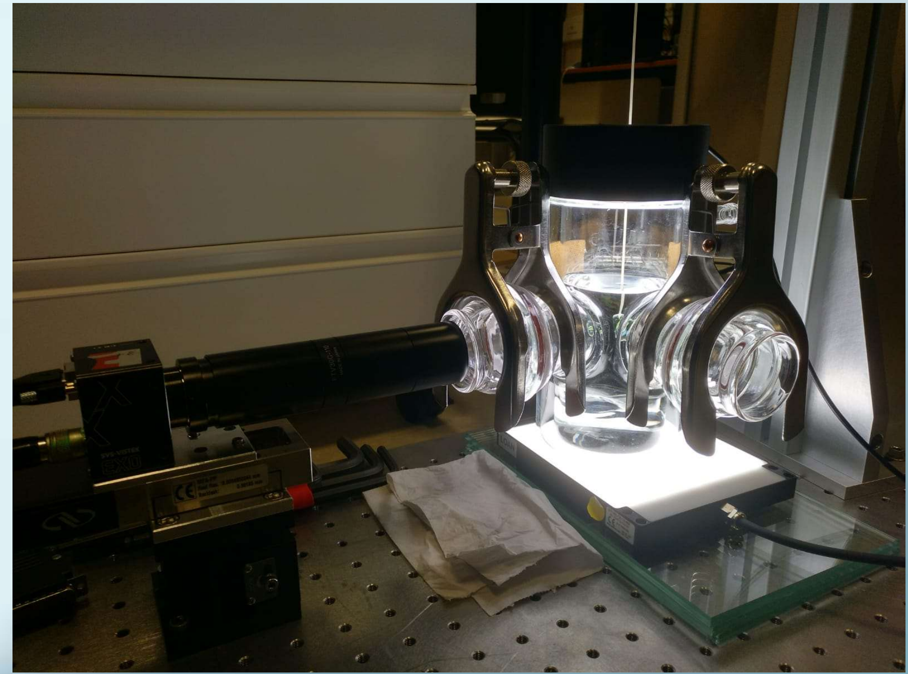
Caméra GigE SVS-Vistek
+ objectif ?

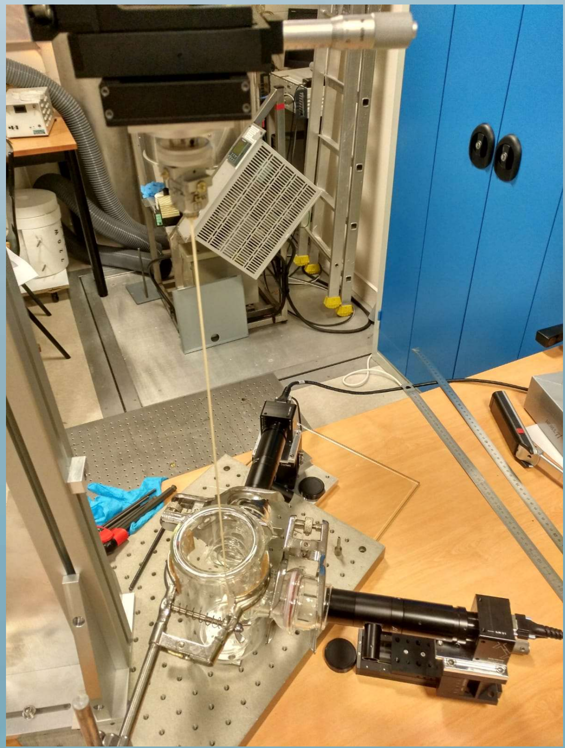


Platine de translation motorisée

Cristal KDP
(orienté, poli sous forme de bille Ø4 à 9mm)

AlpesView 2022





Vitesse de croissance estimée ~ µm /jour

Durée manip: Plusieurs mois

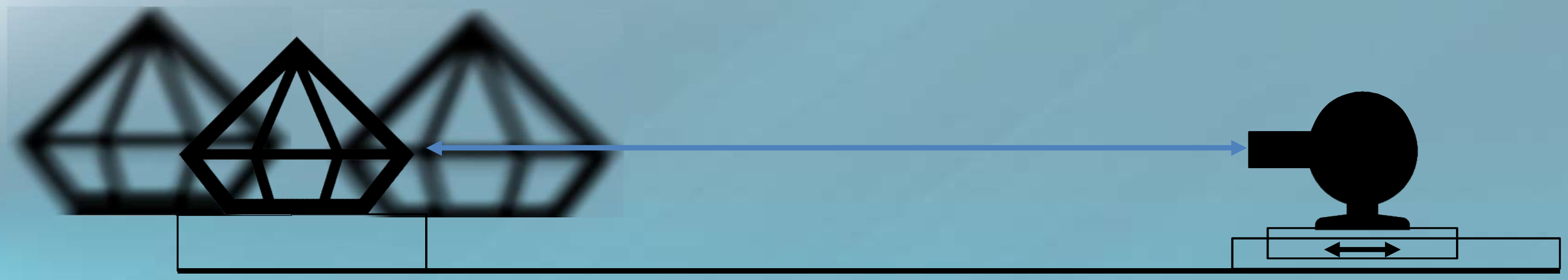
Champs de vision caméra: 4,11mmX4,11mm

Du fait de ces contraintes:

- Manip sur onduleur (comme toutes les manip de cristallogenèse)
- Capteur caméra 4504px X 4504px → 0.9micron/px
- Objectif caméra suffisamment petit pour rentrer dans les hublots
- Platine motorisée avec moteur pas à pas et contrôleur micro-pas (0.00757 µm/µpas), répétabilité 0.5 µm

Mesures de la vitesse de croissance

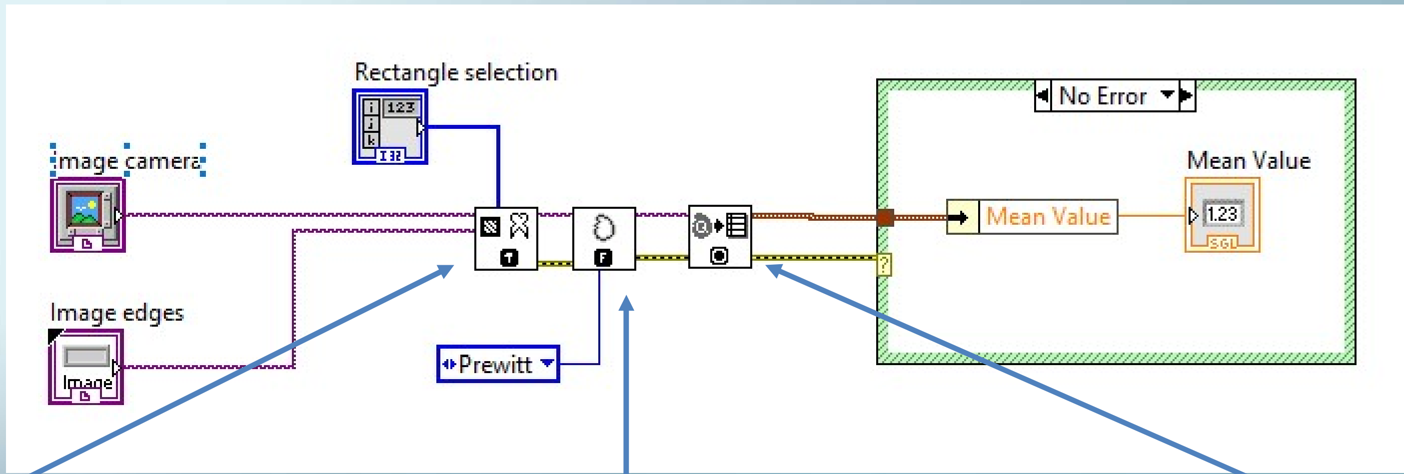
- La caméra n'est pas autofocus
- On va venir périodiquement faire le net sur la partie de l'image qui nous intéresse grâce à une platine motorisée sur laquelle est posée notre caméra.
- L'évolution dans le temps de la distance entre l'objectif et le cristal va nous donner la vitesse de croissance



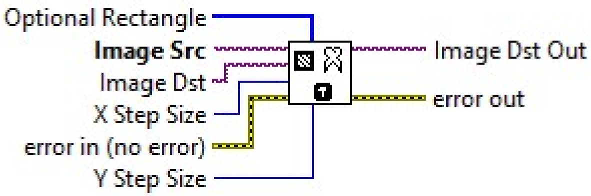
Comment déterminer la qualité du focus sur une cible?

- détection de contrastes (max du gradient de l'image)
  - La théorie est que **l'image est plus contrastée quand elle est nette**.
- mesure de la qualité des contours

Autofocus

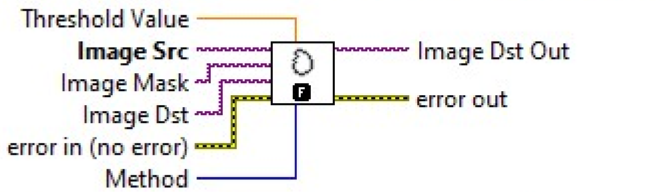


NI_Vision_Development_Module.lvlib:IMAQ Extract



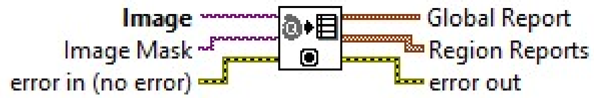
Extracts (reduces) an image or part of an image with adjustment of the horizontal and vertical resolution.

NI_Vision_Development_Module.lvlib:IMAQ EdgeDetection



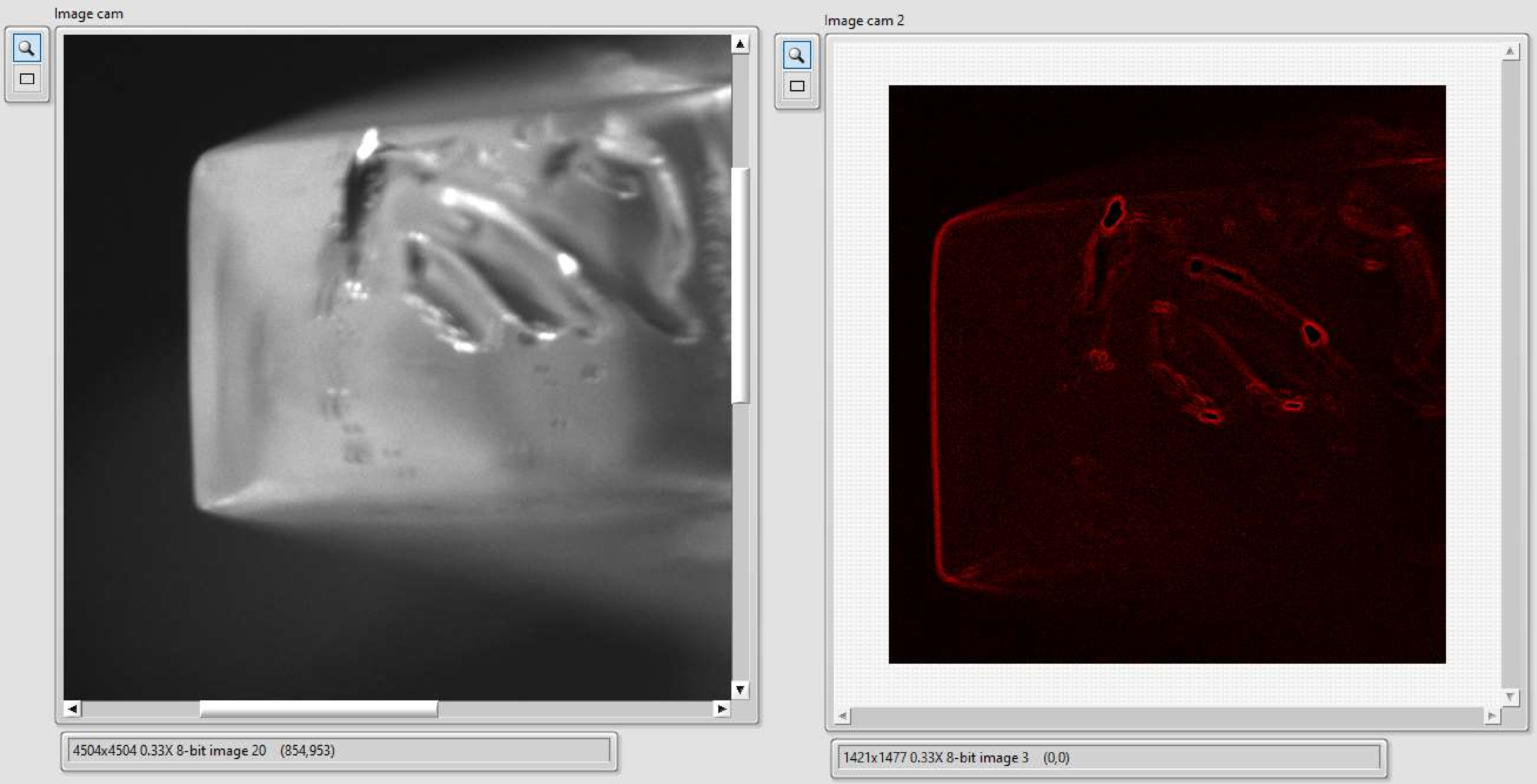
Extracts the contours (detects edges) in gray-level values.

NI_Vision_Development_Module.lvlib:IMAQ Quantify



Quantifies the contents of an image or the regions within an image. The region definition is performed with a labeled image mask. Each region of the mask has a single unique value.

AlpesView 2022



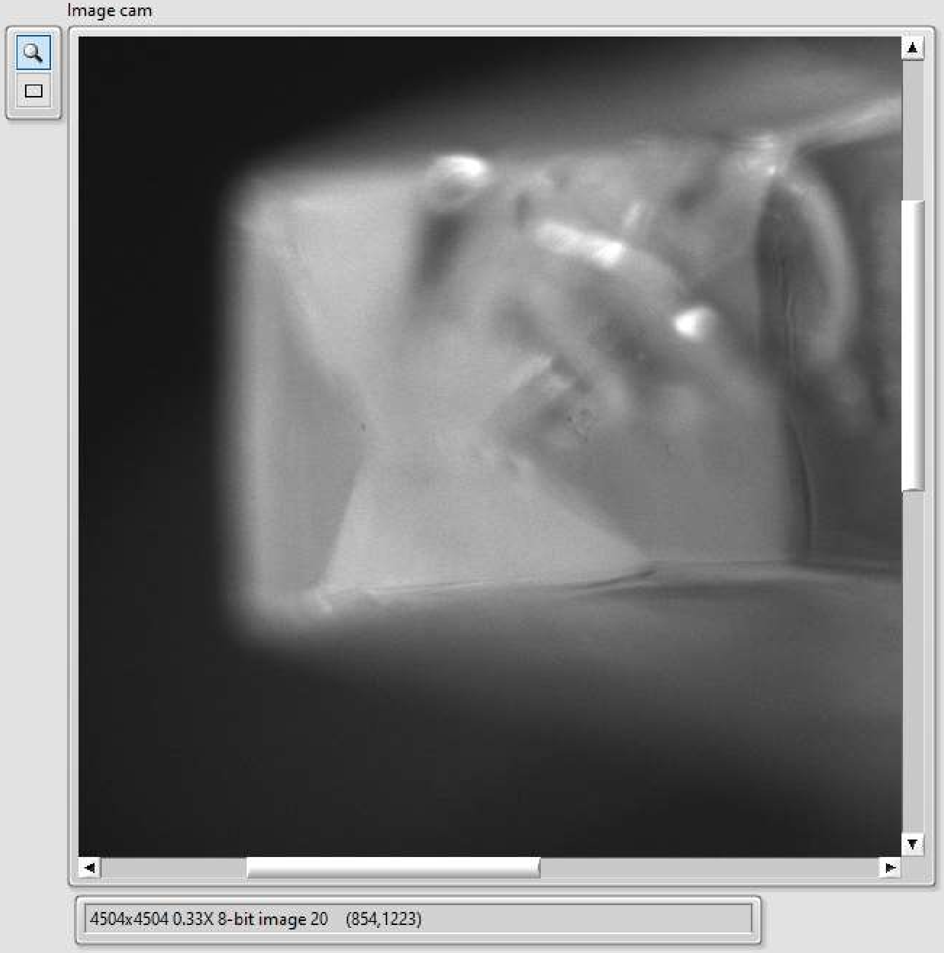


Image cam
4504x4504 0.33X 8-bit image 20 (854,1223)

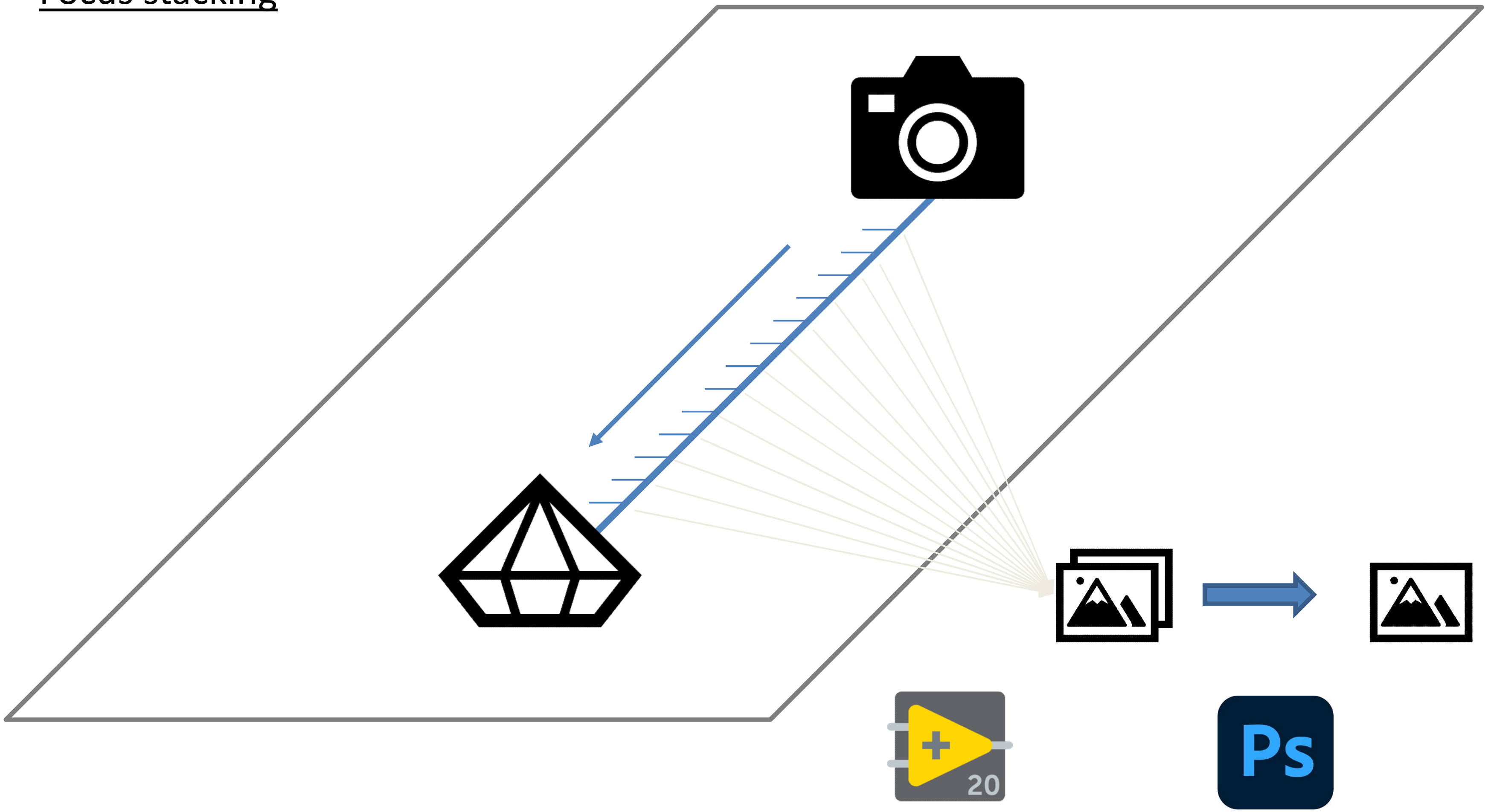

Image cam 2
1421x1477 0.33X 8-bit image 2 (35,1328)

Morphologie

Focus Stacking:

C'est une méthode qui consiste à augmenter la profondeur de champ en assemblant une série de photos dont la mise au point a été décalée à chaque prise de vue.

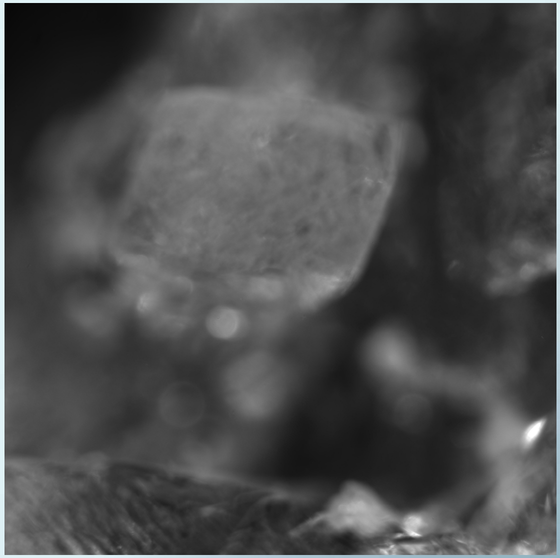
Focus stacking

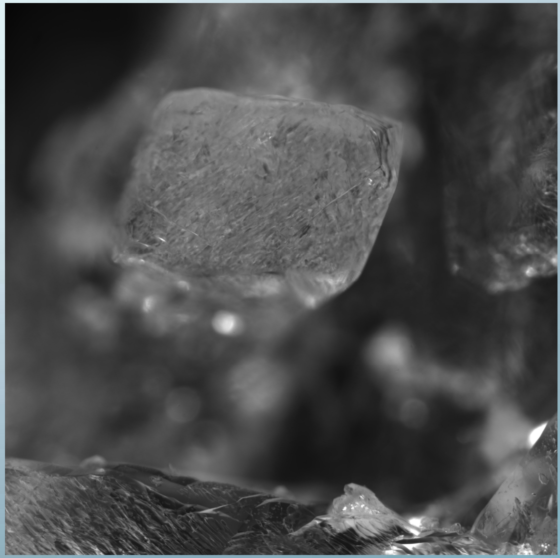


Le principe dans le traitement des images obtenues :

Récupérer les zones de netteté de chaque image et les assembler façon puzzle donnant une image unique, parfaitement nette sur toute la profondeur de champ choisie lors du paramétrage de la distance totale.

Quelques images de la pile…





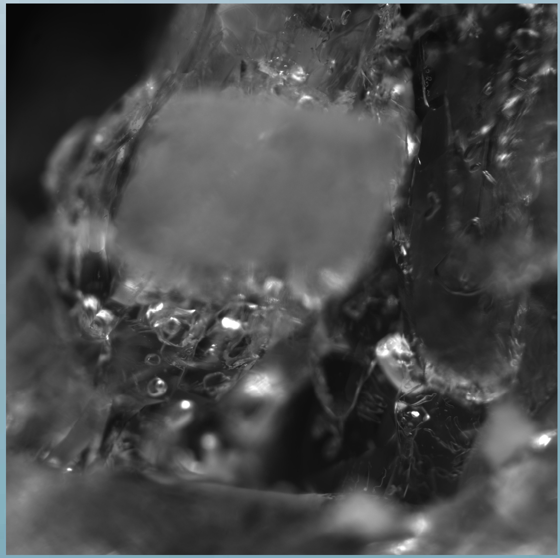
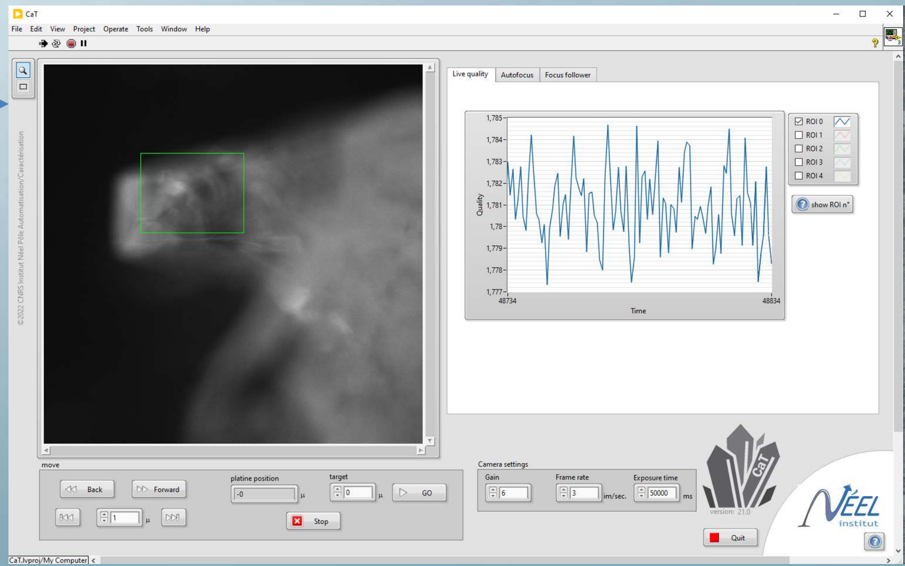


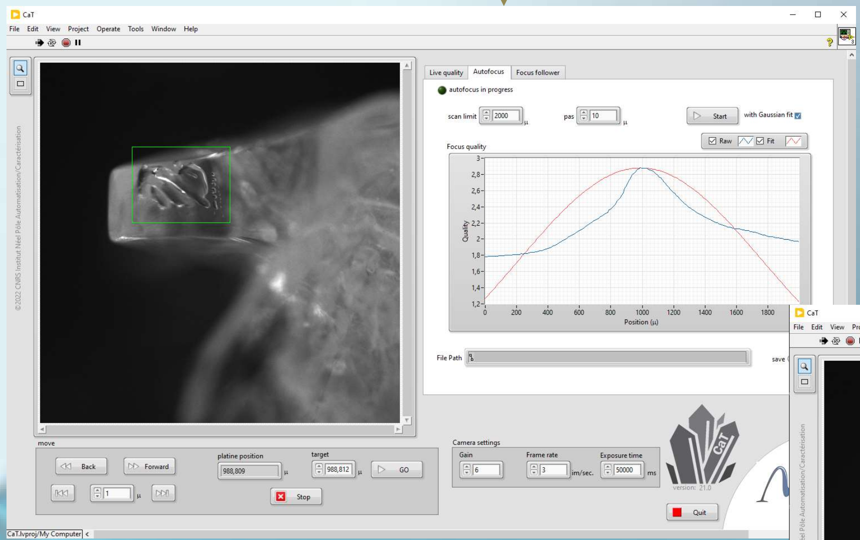
Image résultant du focus stacking (300 images) →

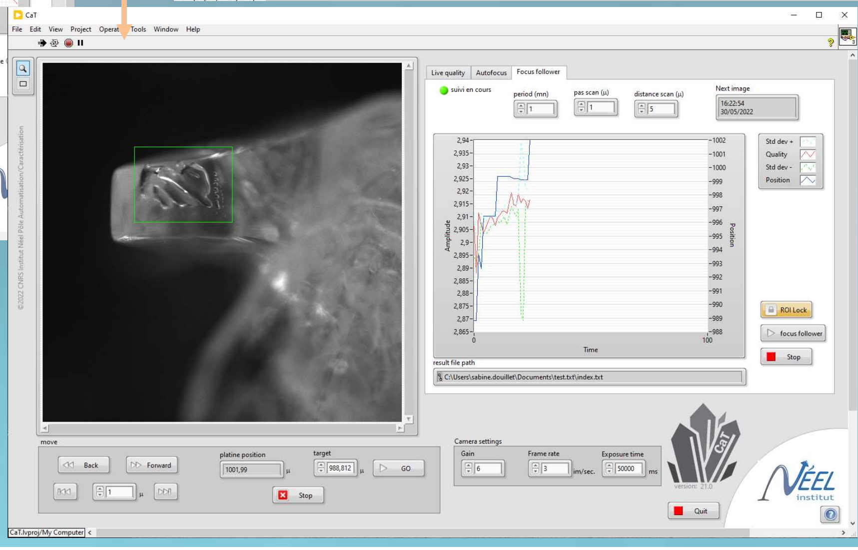
AlpesView 2022

3 modes:

- Live quality
- Focus follower
- Autofocus







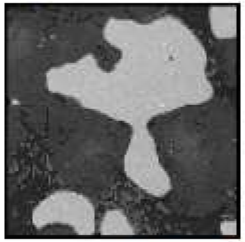
Problèmes rencontrés:

- Bruit
- Profondeur de champs
- Prise de vu à travers une paroi courbe -> déformation
- Le cristal est translucide, le liquide aussi, l'autofocus peux éventuellement se tromper et faire le focus sur qq chose qui n'est pas en 1^{er} plan
- Pour aller faire le focus, obligé de faire des allers/retours avec la platine de translation, on rajoute donc de l'imprécisions aux positionnements (jeu mécanique)
- …

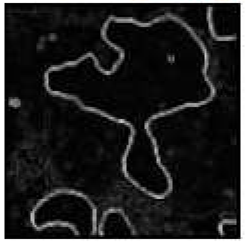
FIN

Nonlinear Prewitt and Nonlinear Sobel Example

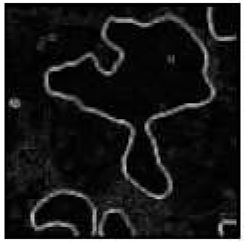
This example uses the following source image.



A nonlinear Prewitt filter produces the following image.



A nonlinear Sobel filter produces the following image.



Both filters outline the contours of the objects. Because of the different convolution kernels they combine, the nonlinear Prewitt has the tendency to outline curved contours while the nonlinear Sobel extracts square contours. This difference is noticeable when observing the outlines of isolated pixels.

Spatial Filtering

Filters are divided into two types: linear (also called *convolution*) and nonlinear.

A convolution is an algorithm that consists of recalculating the value of a pixel based on its own pixel value and the pixel values of its neighbors weighted by the coefficients of a convolution kernel. The sum of this calculation is divided by the sum of the elements in the kernel to obtain a new pixel value. The size of the convolution kernel does not have a theoretical limit and can be either square or rectangular (3 × 3, 5 × 5, 5 × 7, 9 × 3, 127 × 127, and so on). Convolutions are divided into four families: gradient, Laplacian, smoothing, and Gaussian. This grouping is determined by the convolution kernel contents or the weight assigned to each pixel, which depends on the geographical position of that pixel in relation to the central kernel pixel.

NI Vision features a set of standard convolution kernels for each family and for the usual sizes (3 × 3, 5 × 5, and 7 × 7). You also can create your own kernels and choose what to put into them. The size of the user-defined kernel is virtually unlimited. With this capability, you can create filters with specific characteristics.

When to Use

Spatial filters serve a variety of purposes, such as detecting edges along a specific direction, contouring patterns, reducing noise, and detail outlining or smoothing. Filters smooth, sharpen, transform, and remove noise from an image so that you can extract the information you need.

Nonlinear filters either extract the contours (edge detection) or remove the isolated pixels. NI Vision has six different methods you can use for contour extraction (Differentiation, Gradient, Prewitt, Roberts, Sigma, or Sobel). The Canny Edge Detection filter is a specialized edge detection method that locates edges accurately, even under low signal-to-noise conditions in an image.

To harmonize pixel values, choose between two filters, each of which uses a different method: NthOrder and LowPass. These functions require that either a kernel size and order number or percentage is specified on input.

Spatial filters alter pixel values with respect to variations in light intensity in their neighborhood. The neighborhood of a pixel is defined by the size of a matrix, or mask, centered on the pixel itself. These filters can be sensitive to the presence or absence of light-intensity variations.

Spatial filters fall into two categories:

- *Highpass filters* emphasize significant variations of the light intensity usually found at the boundary of objects. Highpass frequency filters help isolate abruptly varying patterns that correspond to sharp edges, details, and noise.
- *Lowpass filters* attenuate variations of the light intensity. Lowpass frequency filters help emphasize gradually varying patterns such as objects and the background. They have the tendency to smooth images by eliminating details and blurring edges.

Concepts

Spatial Filter Types Summary

The following table describes the different types of spatial filters.

Filter Type	Filters
Linear Highpass	Gradient, Laplacian
Linear Lowpass	Smoothing, Gaussian
Nonlinear Highpass	Gradient, Roberts, Sobel, Prewitt, Differentiation, Sigma
Nonlinear Lowpass	Median, Nth Order, Lowpass