iQMetrix-CT software user manual

Contents

Recommendations for correct use of the software

- It is advisable to place the reconstructed images to be analyzed in several folders with explicit names beforehand, and to put them in a given directory.

- In this directory, it is better to have only reconstructed images with the same z-positions so that they can be analyzed in batch mode.

- It is also recommended to systematically add an acquisition with a high dose level (CTDIvol > 20 mGy for a standard phantom) to facilitate the detection of inserts for the calculation of the TTF.

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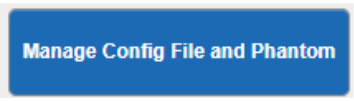
I. Creating a phantom

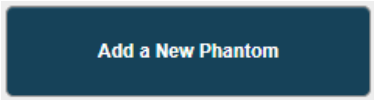
By default, the IQMetrix-CT software proposes two image quality phantoms among the most used in routine, the ACR CT 464 phantom and the Catphan 600 phantom.

However, any phantom can be created in the software if it has a homogeneous section for the calculation of Noise Power Spectrum (NPS) and/or a section with cylindrical inserts for the calculation of Task-based Transfer Function (TTF).

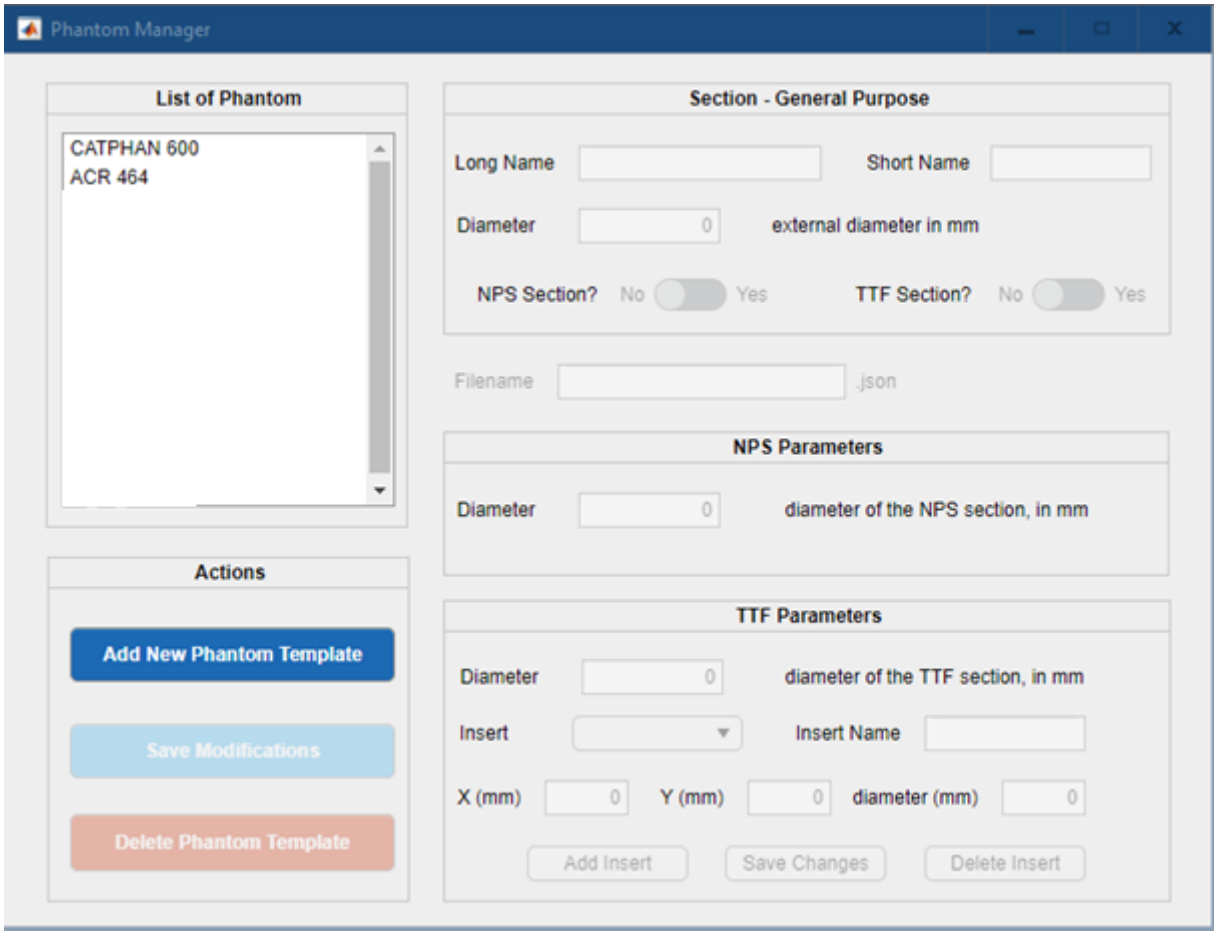
To create a phantom, click on the button below:

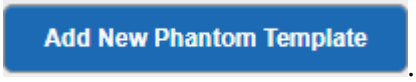


You must then click on the button below:



A new "***Phantom Manager***" window will open:

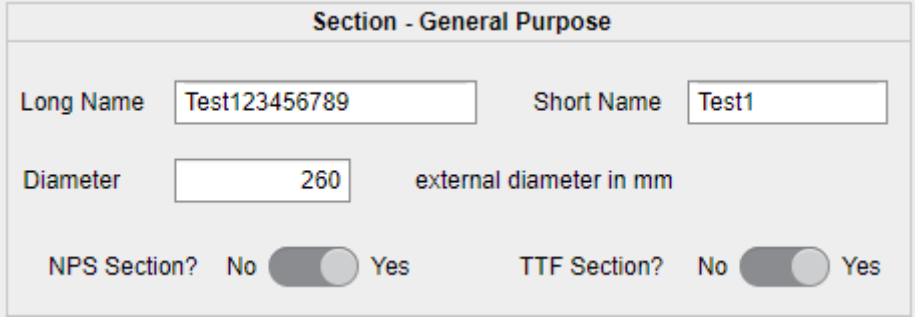


To create a new phantom, click on 

.

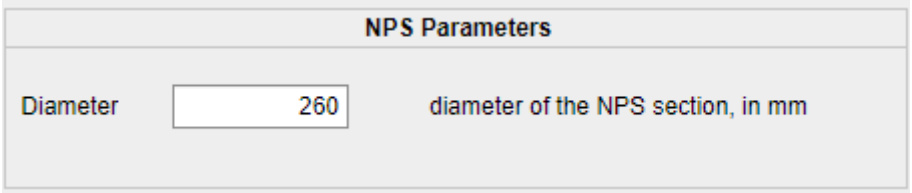
You must then:

- enter the long and short names of your phantom in the "**Long name**" and "**Short name**" boxes. The same name can be used for both boxes. The name entered in " **Short name** " will later go up into the " **List of Phantoms** " column.
- enter the external diameter (in mm) of your phantom in the " **Diameter** " box.
- define whether your phantom has sections for calculating the NPS and/or TTF.

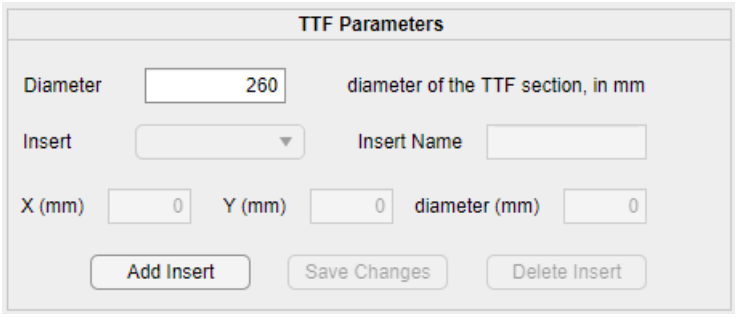


- enter the name of the phantom you want to see in your .json file in "**Filename**".

- If your phantom has a section for NPS calculation, you must enter the diameter of the section (in mm) where the NPS will be calculated (homogeneous section without the edges).



- If your phantom has a section for TTF calculation, you must enter the diameter of the section (in mm) where the TTF will be calculated.



Then click on "**Add Insert**" and enter the following information about the insert:

- the name of the insert in "**Insert Name**"
- the position of the center of the insert in X and Y (in mm),
- the diameter of the insert (in mm),

- once all the information has been entered, you must click on "***Save changes"*** to record your insert.

To find the X or Y positions of your inserts, you can use the user manual of the phantom (some manuals specify the positions), or find them directly on the phantom images with image processing software. The diameter of the inserts is usually available in the user manual of the phantom. You can measure it directly on the phantom images with image processing software.

You must then repeat these 5 steps for all the inserts you wish to add.

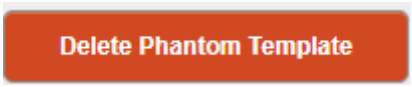
If you wish to delete an insert, you can also click on "**Delete Insert".**

Once you have completed all these steps, you must save your phantom by clicking on

The name entered in "**Short name**" will appear in the "**List of Phantoms**" column.

If you want to make changes to your phantom template, you can do so by selecting it in the "List of **Phantoms**" column.

If you wish to delete it, select the phantom template to be deleted in the "**List of Phantoms**" column. Then click on "Delete Phantom Template".

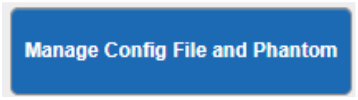


Once you have completed all these actions, you can close the "**Phantom Manager**" window.

II. Creating .json files for the calculation of NPS and TTF

To facilitate detection of the phantom, positioning of ROIs for NPS and search of inserts for TTF, it is essential to use a series of high quality images (high dose level and soft kernel). In particular, the inserts used to calculate the TTF must be perfectly visible

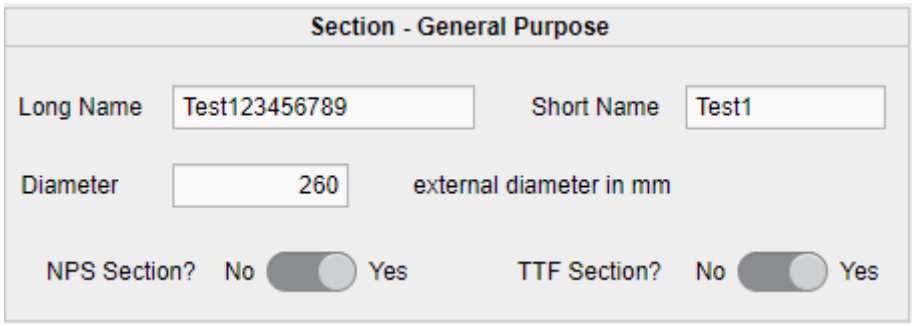
To create the .json file for the NPS and/or TTF calculation, you must click on



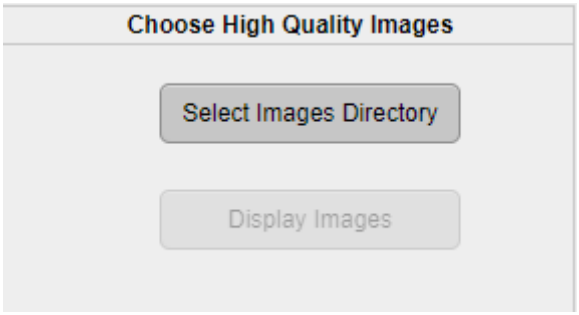
.

Then, in the " **List of Phantoms** " column, you must select the template of the phantom to be used.

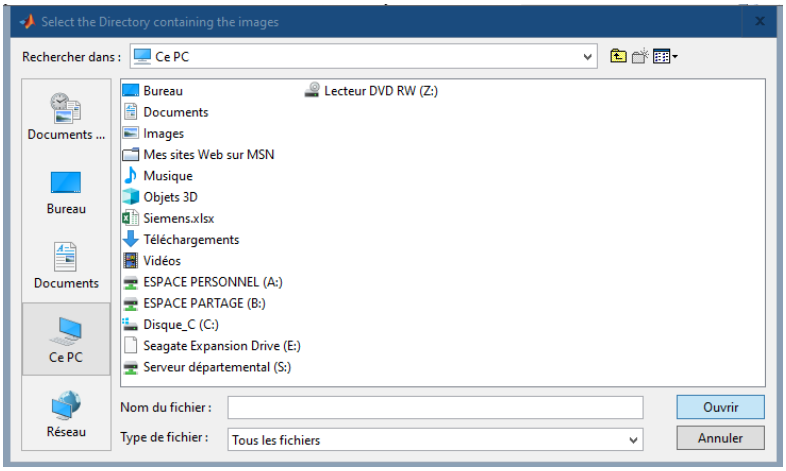
In the " **General Purpose** " section below, the main configuration elements of the selected phantom are shown again.



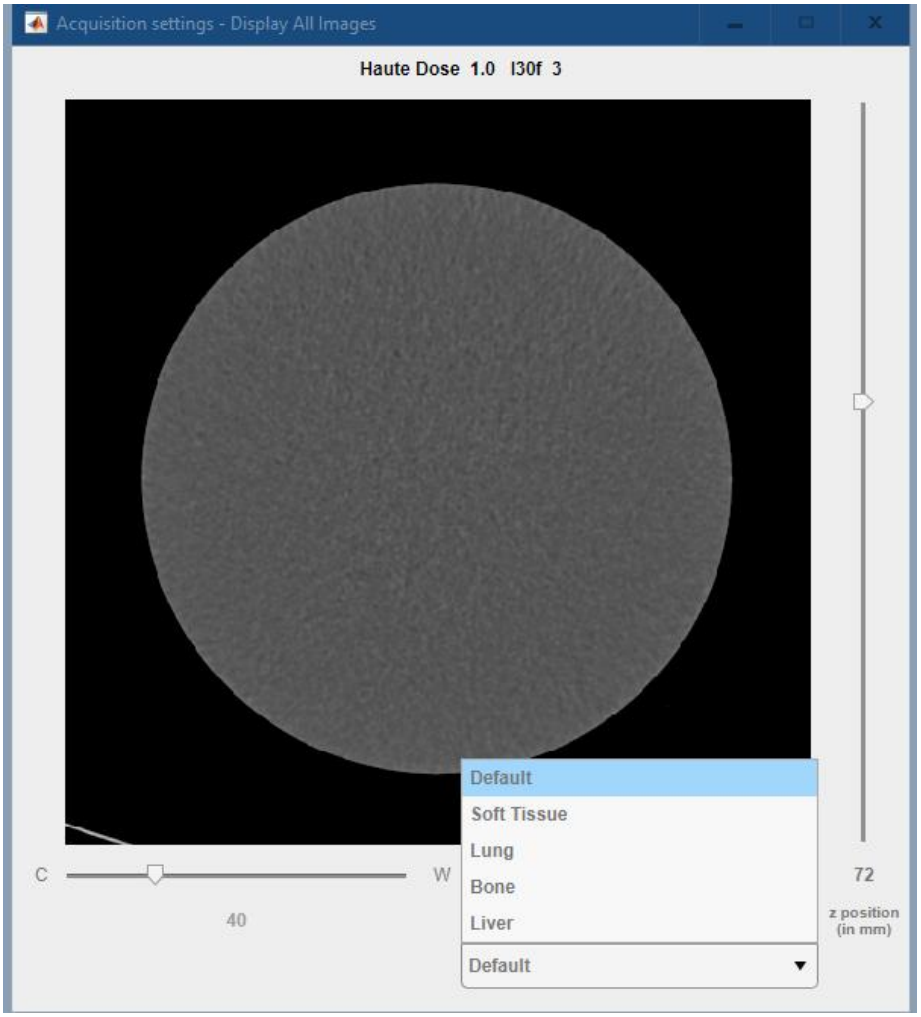
Finally, to choose the sections to be selected and positions of the ROIs useful for calculating NPS and/or TTF, you must select a series of images of the phantom by clicking on "**Select Images Directory**".



A window will then open. In it, select the **FOLDER** containing the images you wish to use **and not the images present in the FOLDER**.



By clicking on "**Display Images**", a new window will open, showing all the images in the selected folder.



In this window, you can scroll through the images with the sidebar and change the windowing of the images either manually or by using the 5 predefined windowing functions.

When an image viewing window is active, use the up/down arrows to scroll through the images; the q key will close the window.

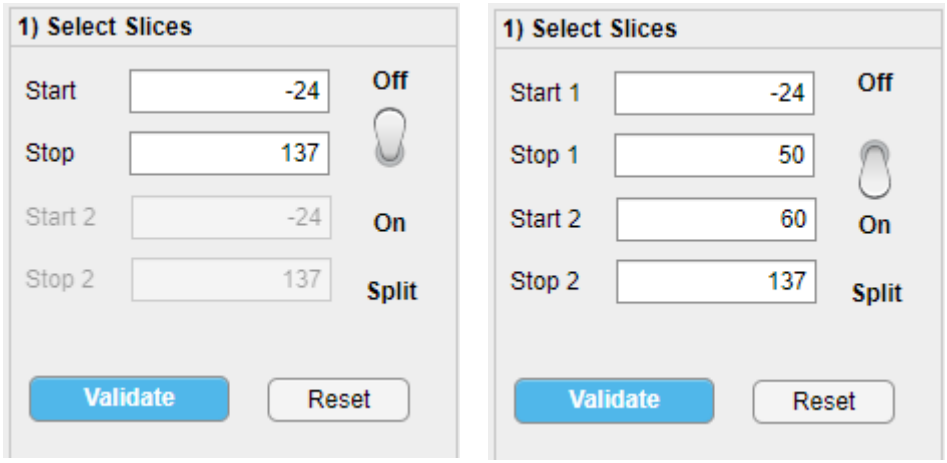
1. Creating the .json file for NPS calculation (default tab)

- **Slice selection**

In the "**Display images**" window, visually locate the z-position of the first and last slices covering the area where the NPS will be calculated.

If the slices you have selected are consecutive, enter the start position in **"Start"** and the end position in "**Stop**".

If the slices are not consecutive and you want to exclude some slices in your set of slices, you must select "**Split**" "**On**".

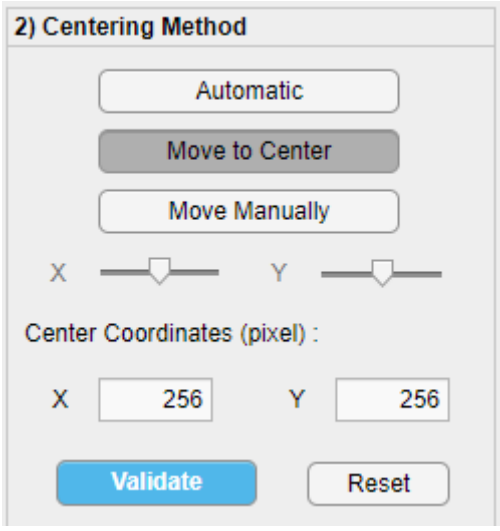


In all cases, the numerical value of the start position must be less than the numerical value of the end position. The values entered must correspond exactly to those available in the DICOM information.

Once you have entered the start and end positions, you can click on "**Validate**".

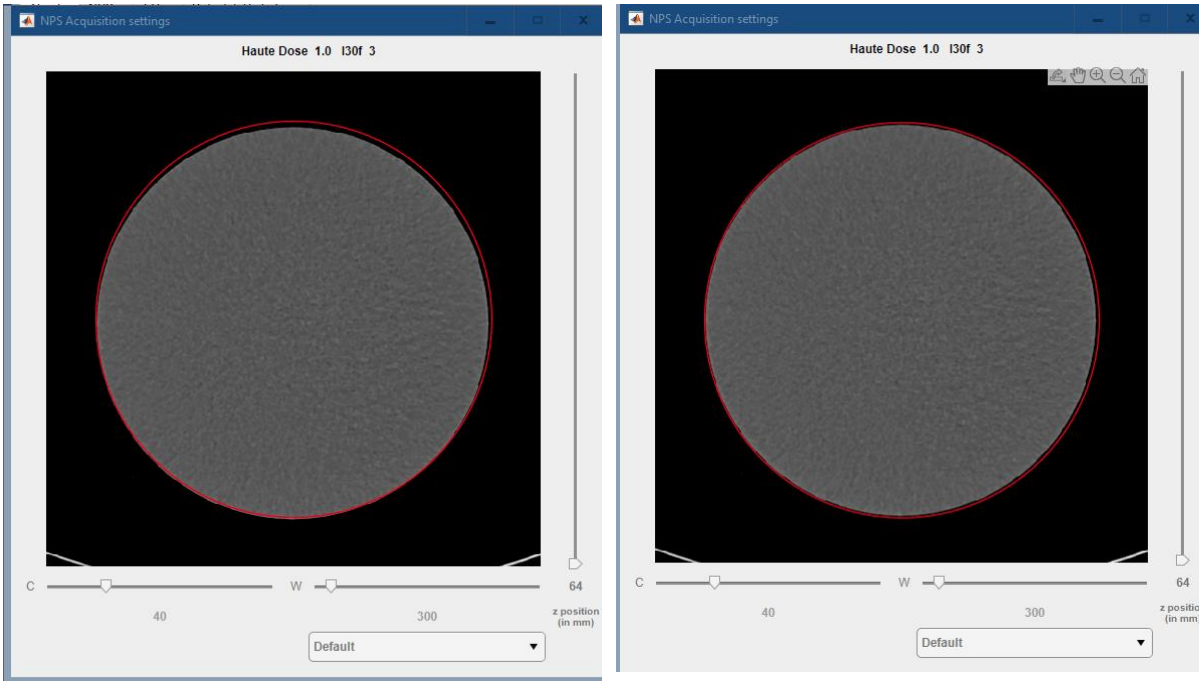
- **Centering methods**

A new window will open to center the phantom with the number of images selected at the previous stage.



A red circle, corresponding to the value of the external diameter defined while the phantom was being set up for the NPS section, will appear in the center of the image.

If the phantom is off-center, the offset will appear on the image.



You can still scroll through the images with the sidebar and change the windowing of the images either manually or by using the 5 predefined windowing functions.

You have the possibility:

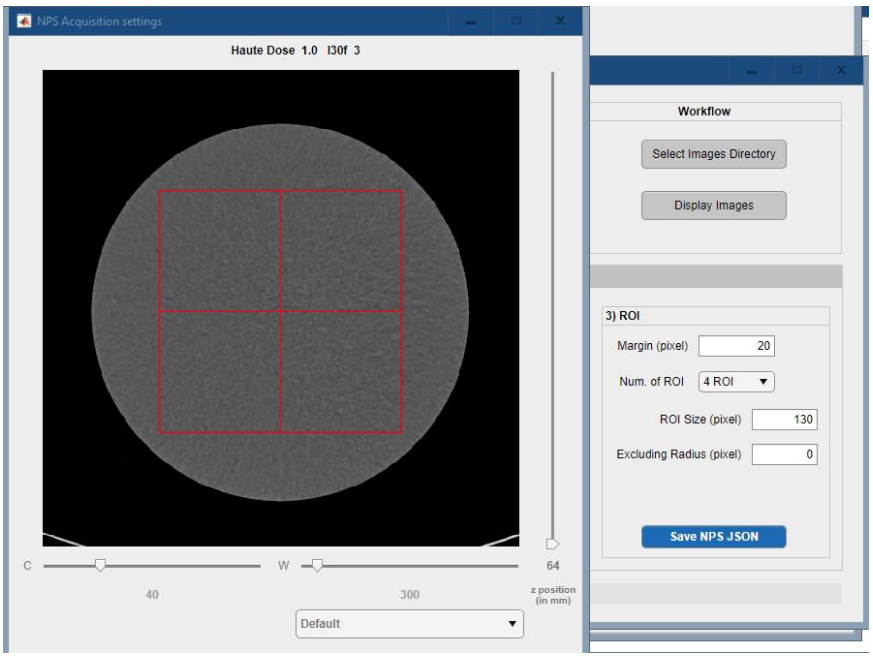
- Of either letting the software center the red circle on the phantom automatically by clicking on **"*Automatic*"** or
- moving the red circle manually in an X and/or Y direction by clicking on "**Move Manually**".

In any case you can return to the initial position by clicking on "**Move to Center**".

Once the centering of the red circle on the phantom seems correct, you can click "**Validate**".

- **Choosing the number of ROIs and positioning them**

A new window will open so that you can position the ROIs for the NPS calculation.



As specified in the GT SFPM report, the user can either select one ROI or 4 ROIs.

In all cases, you must enter a margin between the edge of the phantom and the ROI(s) by entering a pixel value in "**Margin (pixel)**". A minimum margin in pixels corresponding to a 10 mm margin is imposed by the software. The purpose of this margin is to avoid modifications to noise texture that might be encountered at the air/phantom interface.

- You must then select the number of ROI(s)
- If you have selected "4 ROIs", you must also enter the margin between the center of the phantom and your ROIs, in pixels, in "Excluding Radius (pixel)".

The value entered can be 0 if you want joint ROIs.

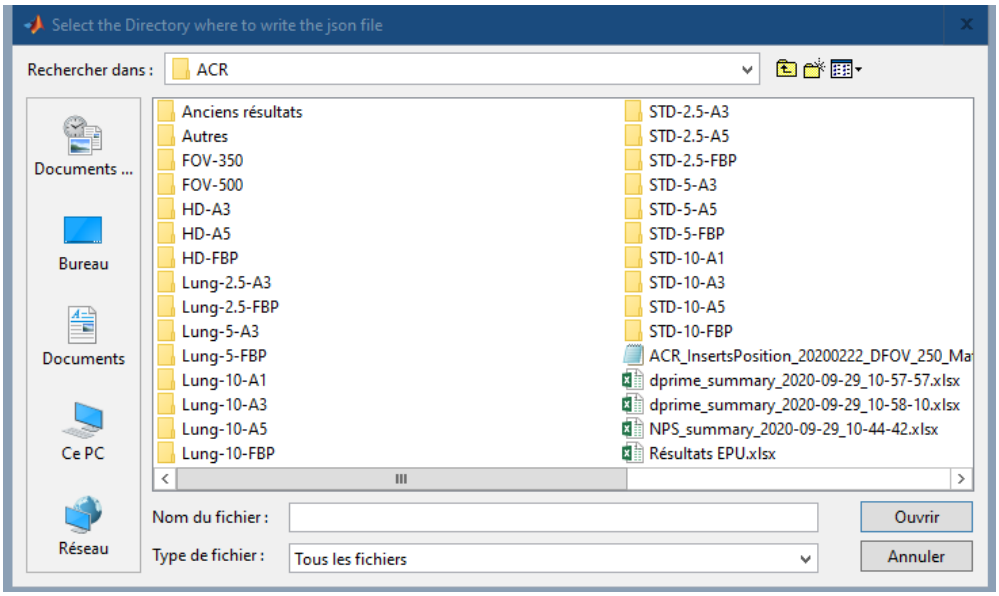
The ROI size is automatically calculated based on the two margin values entered. However, if you want to, you can enter a smaller ROI size in the "***ROI Size (pixel)***" box

- If you have selected "1ROI", the ROI size is automatically calculated based on the outer edge margin value entered.

- **Save the .json file**

Once you have completed all these steps you can click on 

A new window will open.



To save the NPS .json file, you must select the **FOLDER** in which you want the file to be saved and click on "**Open**".

The following message will thus appear

A .json file will then be saved in the selected folder, with the following name:

"***Phantom name***_NPS_ROIs_Position_***Date phantom created***_DFOV_DFOV size_***MatrixSize***_ "

2. Creating a .json file for TTF calculation (TTF tab)

The steps for "**Slice Selection**" and "**Centering Methods**" are similar to those described for creating the .json file for the NPS calculation.

- **Searching for inserts**

Once the slices have been selected and the red circle centered on the phantom, the software will automatically search for the inserts entered in the template configuration of the selected phantom.

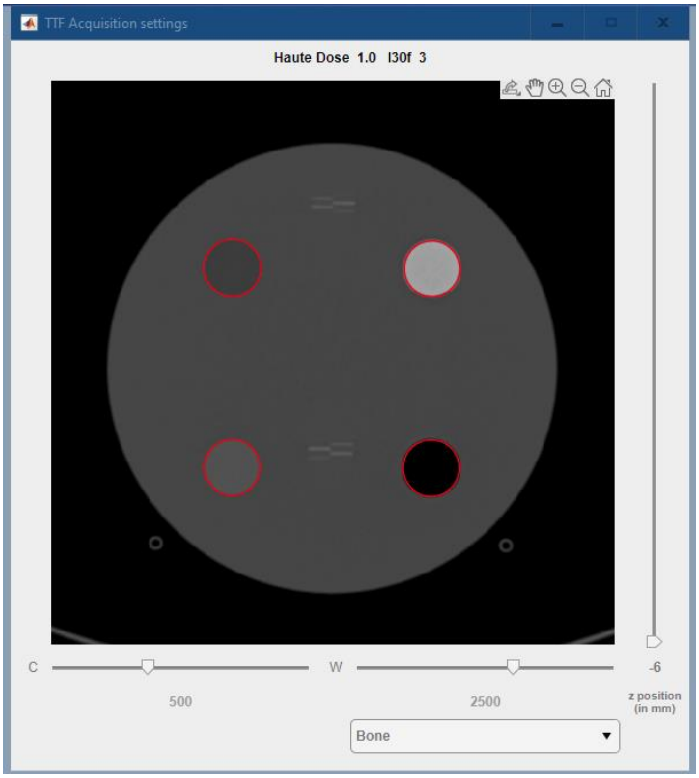
If the images used are of sufficient quality and the positions of the inserts correctly entered, the software is able to detect all the inserts entered in the phantom template.

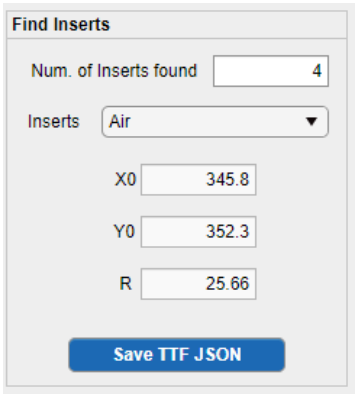
At the end of its automatic search, the software specifies the number of inserts detected in "**Number of inserts found**".

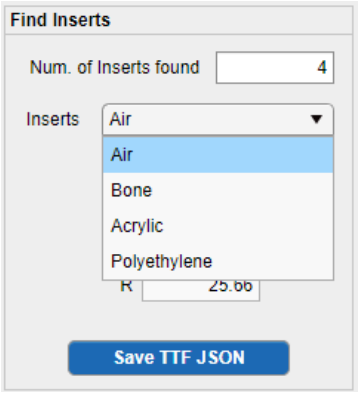
The different inserts are then marked in the " **TTF Acquisition settings** " window. The different red circles positioned on the inserts are there to show that the inserts have been correctly detected on the phantom.

In the "**Inserts**" section, the names of the different inserts detected are listed, corresponding to the names entered in the phantom template.

For each insert, the positions of the center of the insert " **X0** " and " **Y0** " as well as the radius " **R** " of the red circle are specified.



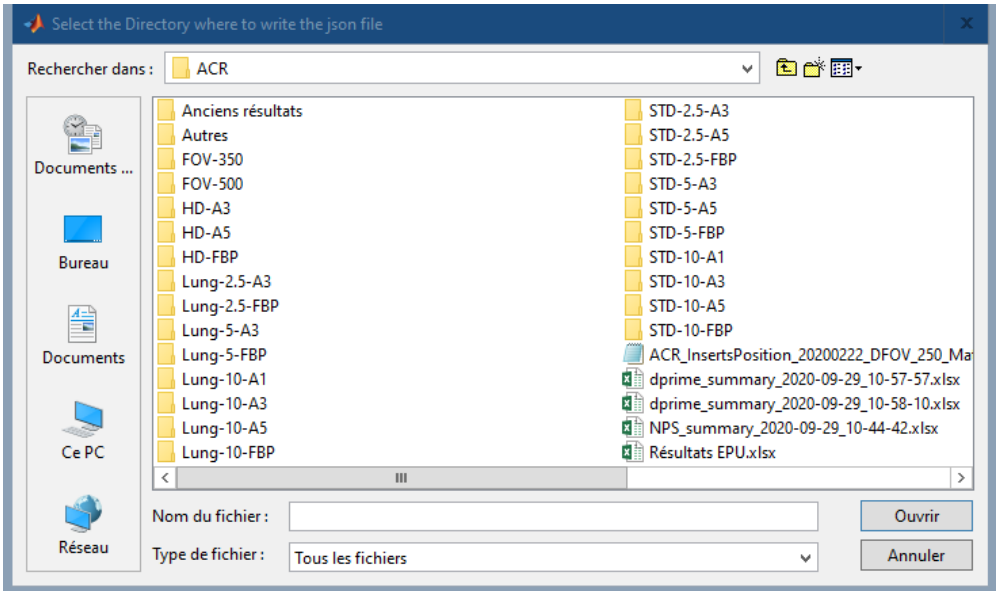




- **Save the .json file**

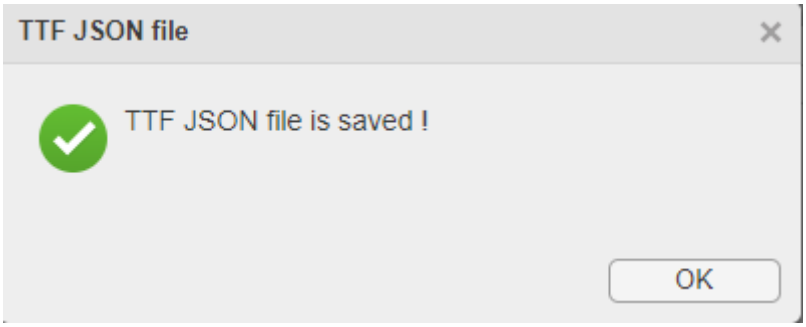
Once you have completed all these steps, you can click on 

A new window will open.



To save the .json file for TTF, you must select the **FOLDER** you want this file to be saved in and then click on "**Open**".

The following message will appear:

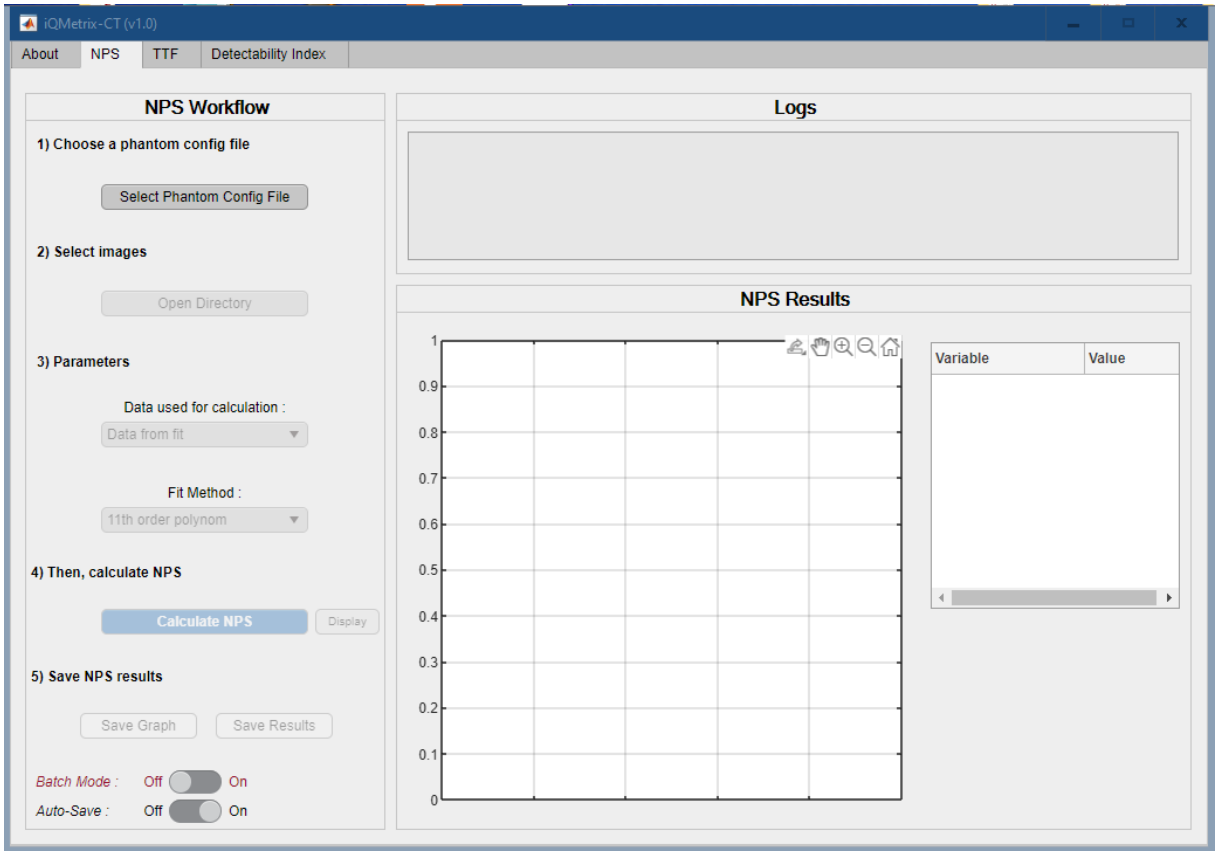


A .json file is then saved in the selected folder, with the following name:

"**Phantom Name**_TTF_Inserts_Position_**Date phantom was created**_DFOV_Size of DFOV_**MatrixSize**_"

III.Calculating the NPS

To calculate the NPS, you must click on the "NPS" tab located at the top left of the software's graphic interface.



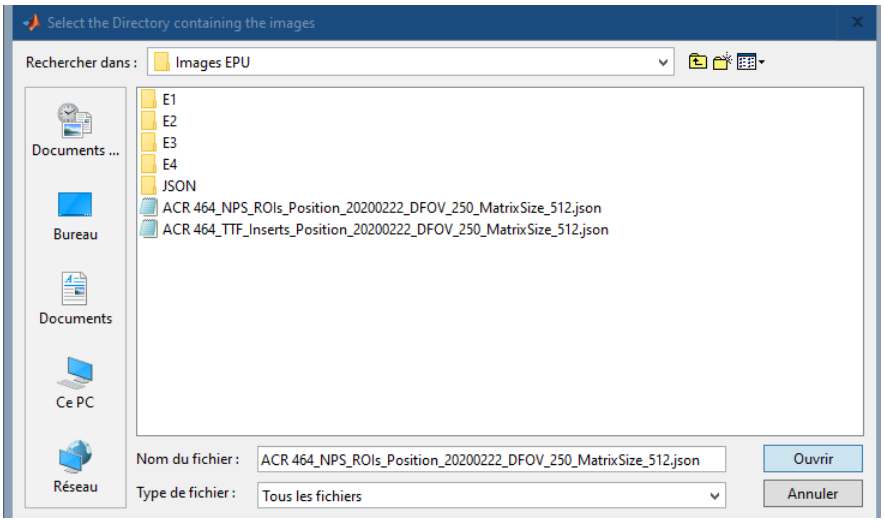
The software gives the user the choice of analyzing the images in a single folder with "**Batch Mode Off**" or of automatically analyzing the images in all the folders selected by the user with "**Batch Mode On**".

We advise you to select "Batch Mode Off" to ensure that the slices have been correctly selected and that the ROIs are correctly positioned and that the NPS curve obtained is relevant. In the event of difficulty, you will have to recreate the .json file for NPS calculation.

1. Batch Mode Off

- ***Selecting the configuration file***

You must click on "**Select Phantom Config File**" and select the saved .json file for the NPS calculation.



"**Name of phantom**_NPS_ROIs_Position_**Date of creation of phantom**_DFOV_Size of the DFOV_**Matrix Size** "

Once the correct file is selected, the following message will appear in the "**Logs**" window:

- ***Selecting the images on which the calculation will be made***

You must select the **FOLDER** containing the images to be analyzed by clicking on "***Open Directory***".

The z-positions of the slices on the images to be analyzed must be identical to those of the images used to create the .json file.

Once the images have been selected, 3 new lines will appear in the "**Logs**" window.

In Step 1, the software will read all the DICOM images present in the selected directory.

In Step 2, the software sorts the useful images thanks to the .json file and converts them into matrixes for calculation.

In Step 3, the software stores the parameters present in the relevant DICOM headers for the calculation.

If each step is done correctly, "**OK**" will be displayed. If not, an "**ERROR**" message will appear.

In the event of an error, you must check the images in the folder you have selected.

- ***Selecting the NPS curve adjustment parameters***

The user can either choose to have an NPS curve based on raw data, i.e. unadjusted (fitted) "**Data used for calculation: Raw Data**", or have an adjusted NPS curve "**Data used for calculation: Data from fit**".

If the user selects "**Data used for calculation**: **Data from fit**", two types of fit are proposed: either an "**11th order polynomial"** fit, or a "**smoothing splines"** filter.

*When the user selects "**Data used for calculation: Data from fit**", two NPS curves are proposed, the raw curve and the adjusted curve.*

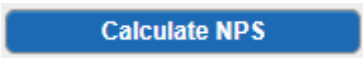
By default, the software proposes "**Data used for calculation: Data from fit**" and the "**11th order polynomial**" fit. Furthermore, the user must ensure that the NPS curves obtained do not present aberrant results. For example, the presence of artifacts can distort the calculation.

- ***Verification of ROI positioning and selected slices (optional)***

You can click on "**Display**" to visualize the positioning of the ROIs and the selected slice(s) for the NPS calculation.

As previously mentioned, in this window, you can scroll through the images with the sidebar and modify the image windowing either manually or by using the 5 predefined windowing functions.

- ***Calculating the NPS***

To calculate the NPS, you must then click on 

Two new lines appear in the "Logs" window corresponding to the calculation of the NPS and the saving of the NPS results.

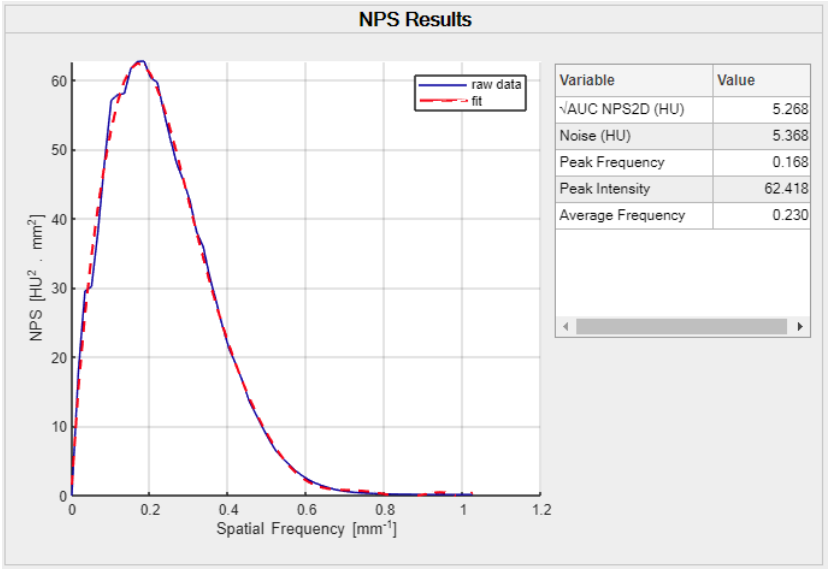
If both of these steps are correct, "**OK**" will be displayed. If not, an "**ERROR**" message will appear.

In the event of an error, you must check the images in the folder you selected.

Once the NPS is calculated, the software displays the 1D NPS curve (with the fit curve if applicable) and the main characterization data of the NPS curve:

- the square root of the area under the 2D NPS curve ($\sqrt{AUC}$ ***NPS2D*** (***HU***)) ;
- of the average noise in all ROIs (***Noise (HU)***) ;
- the amplitude of the NPS peak (***Peak intensity***) ;
- the spatial frequency of the NPS peak (***Peak intensity in mm^{-1}***) ;
- the average spatial frequency of the NPS curve (***Average frequency, in mm^{-1}***).

Ensure that the measurement of the NPS curve can be validated with $\sqrt{AUC}\ NPS2D\ (HU) \approx Noise(HU)$.

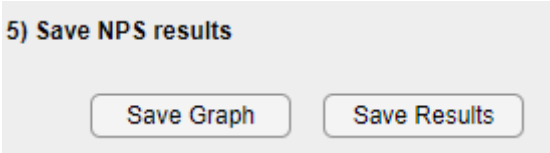


- ***Save the results***

The « ***Auto-Save*** » mode is activated by default. In this mode you can safeguard 4 files in the folder containing the images analyzed:

- ***NPS_parameters.txt*** => text file containing the calculation parameters
- ***NPS_results.txt*** => text file containing the values of the 5 results
- ***NPS1D.csv*** => 1D curve saved as a spreadsheet
- ***NPS2D.mat*** => Matlab file used for the calculation of the detectability index

If the "***Auto-Save***" mode is not activated, you can save these 5 files by clicking on "***Save Results***".



You can also save the NPS graph displayed in "**NPS Results**" as a .png or .pdf file by clicking on "**Save Graph**". A new window will open to select the place where you want to save this figure.

You can also save, zoom in/out or move this figure using the buttons at the top right of the figure

2. Batch Mode On

***/ !\ Essential prerequisite**: The images contained in all the folders to be analyzed must have exactly the same z-position and the same matrix size.*

- ***Selecting the configuration file***

You need to click on "**Select Phantom Config File**" and select the saved .json file for the NPS calculation

"Name of the phantom_NPS_ROIs_Position_**Date of creation of the phantom**_DFOV_Size of the DFOV_**Matrix Size"**

Once the right file is selected the following message will appear in the "**Logs**" window:

The z-positions of the slices on the images of the files to be analyzed must be identical to those of the images used to create the json file.

- ***Selecting the images on which the calculation will be performed***

You must select all the **FOLDERS** you want to analyze by clicking on "**Open Directories**".

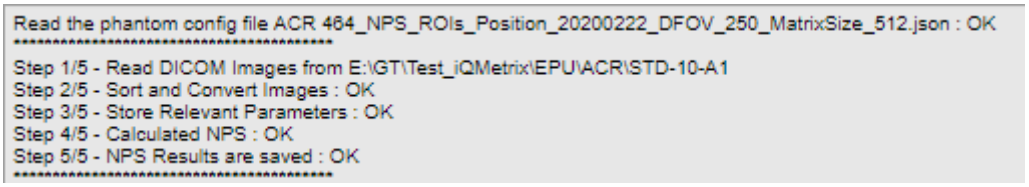
- **Selecting the NPS curve adjustment parameters**

The user must choose either "**Data used for calculation: Raw Data**" or "**Data used for calculation: Data from fit**" with one of the two fits.

- ***Calculating the NPS***

To calculate the NPS, you must then click on 

The 5 steps defined above appear in the "**Logs**" window for each folder analyzed.



If each of these 5 steps is done correctly, "**OK**" is written for each line otherwise "**ERROR**" appears.

At the end of the calculations, a new line appears in the "**Logs**" window.

In Batch mode, no figures or results appear in the software.

- ***Save the results***

In Batch mode, the "***Auto-Save"*** mode is activated and cannot be de-activated.

In each folder analyzed, the 4 previously defined files are saved.

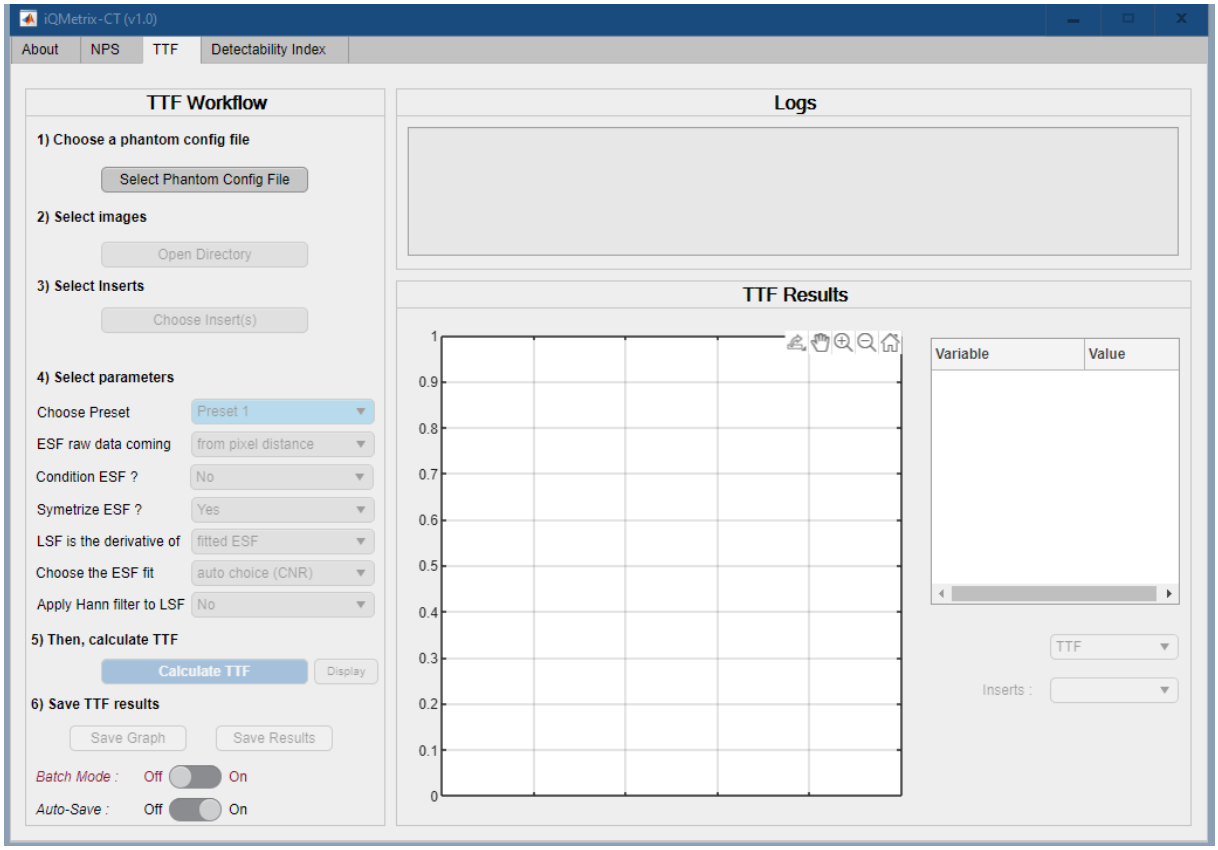
In addition, an additional Excel file is saved in the root of the analyzed folders. This file is called "**NPS_summary_Date of analysis_Time of analysis.xlsx**".

This file has three tabs:

- 1st tab with the values of the 5 parameters calculated per file analyzed
- 2nd tab with the **1D NPS Raw Data** curves calculated for each file analyzed
- 3rd tab with the **1D NPS Fit Data** curves calculated by analyzed folder

IV. Calculating the TTF

To calculate the TTF, you must click on the "TTF" tab located at the top left of the software's graphic interface



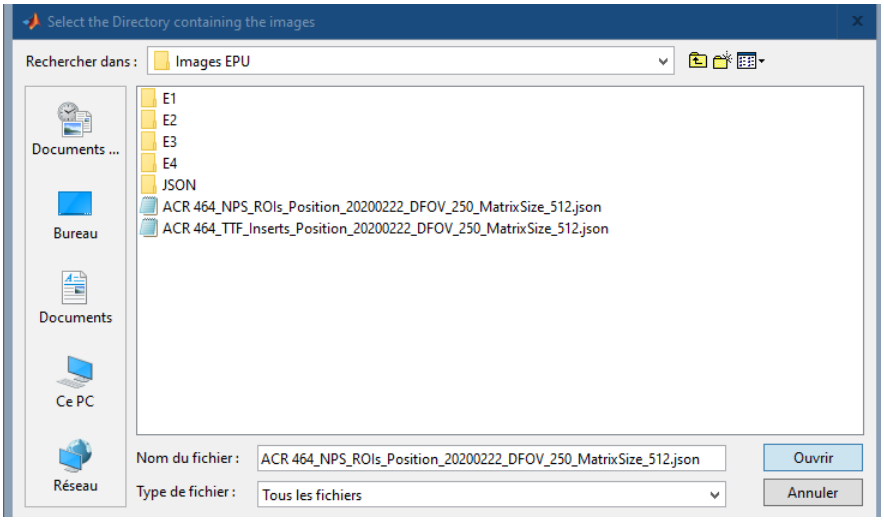
The software gives the user the option of analyzing the images in a single folder "**Batch Mode Off**" or analyzing the images in all the folders selected by the user "**Batch Mode On**".

We advise you to select first the "Batch Mode Off" to ensure that the slices have been correctly selected, that the ROIs are correctly positioned on the inserts and that the TTF curves obtained for each insert are relevant. If there is a problem, you will have to recreate the .json file for the TTF calculation.

1. Batch Mode Off

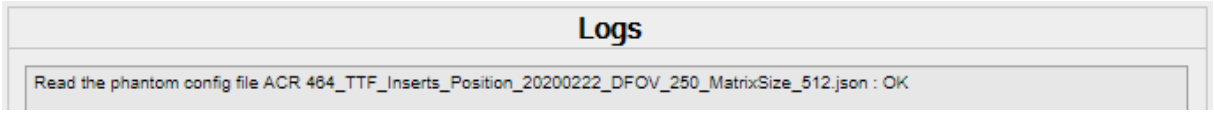
- ***Selecting the configuration file***

Click on « ***Select Phantom Config File*** » and select the .json file recorded for the TTF calculation.



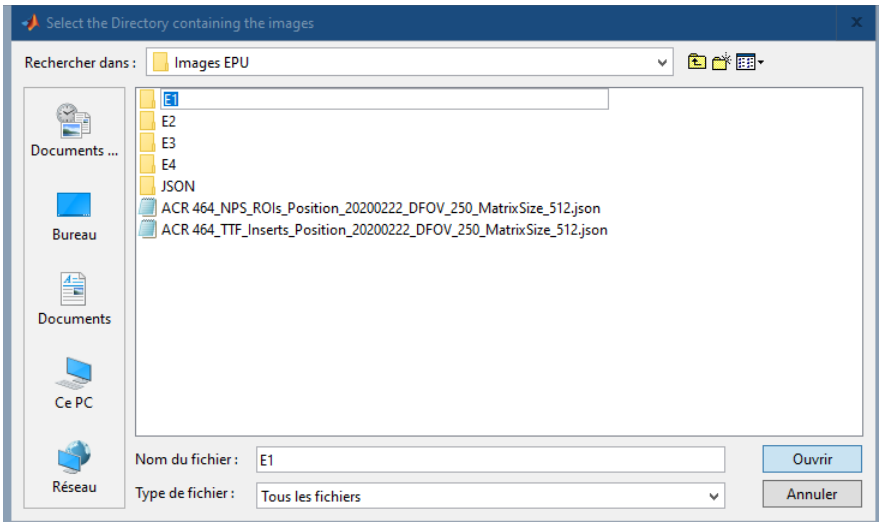
"Name of the phantom_TTF_Inserts_Position_**Date of creation of the phantom**_DFOV_Size of the DFOV_**MatrixSize** "

Once the correct file has been selected, the following message will appear in the "***Logs***" window:



- ***Selecting the images on which the calculation will be made***

You must select the **FOLDER** containing the images to be analyzed by clicking on "***Open Directory***".



The z-positions of the slices and the matrix size on the images to be analyzed must be identical to those of the images used to create the .json file.

Once the images are selected, 3 new lines appear in the "**Logs**" window

In Step 1, the software reads the selected DICOM images.

In Step 2, the software sorts and converts the images.

In Step 3, the software stores the relevant parameters.

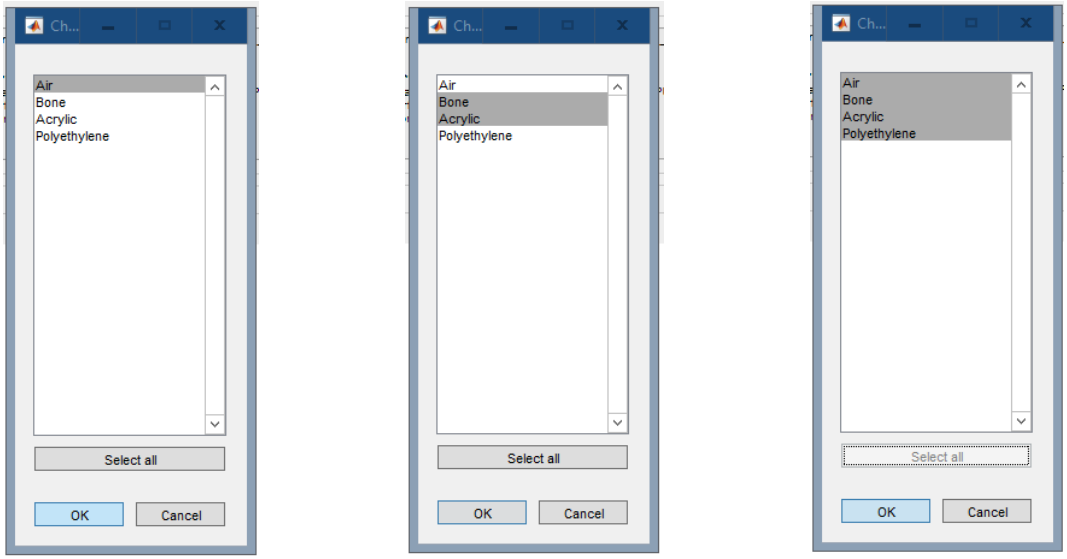
If these 3 steps are done correctly, "**OK**" will be displayed. If not, an "**ERROR**" message will appear.

In the event of an error, you must check the images in the folder you selected.

- ***Selecting the inserts***

By clicking on « ***Select Inserts*** », you can choose to calculate the TTF:

- for one insert => by clicking on one insert,
- for several inserts => by clicking on one insert then by clicking on another one by **pressing the Ctrl key**
- For all the inserts detected => by clicking on « ***Select all*** »



The selected inserts will then appear in **"*Logs*"**.

- ***Selecting the parameters for the TTF calculation***
  - *Choice of preset*

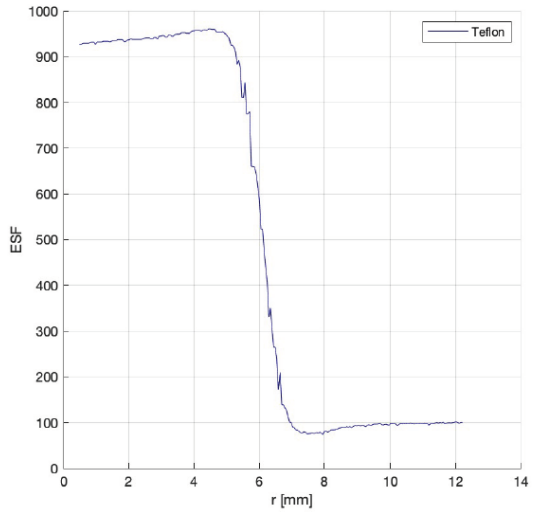
Two presets grouping coherent parameters have been defined to get closer to the parameters used in the literature to calculate the TTF. The user can select one of these two presets or choose the different parameters presented below.

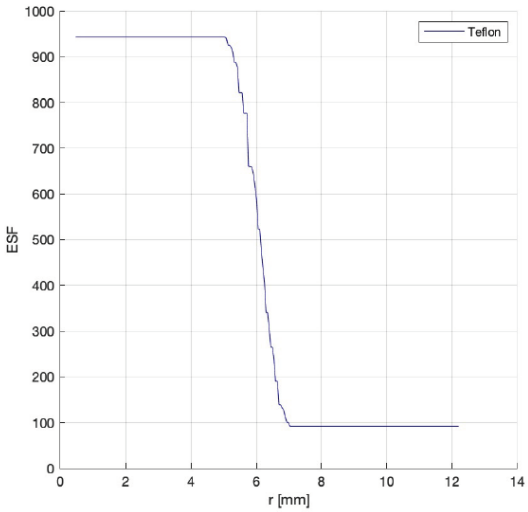
Depending on the quality of the images analyzed (noisy, with a hard kernel...), the ESF, LSF and TTF curves may be different. We therefore advise you to choose the preset or to adapt the parameters according to these different curves

- Conditioning the ESF

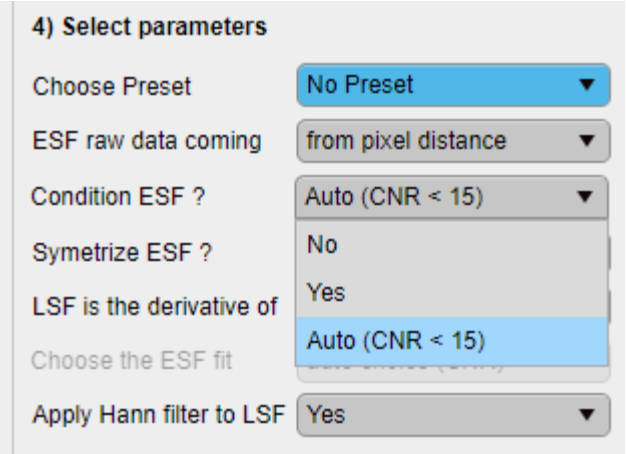
An overly noisy ESF curve can lead to an erroneous TTF curve. In the literature, we find a criterion on the CNR_{Total} that allows us to affirm that the ESF curve is too noisy ($CNR_{Total} < 15$). This criterion on the CNR_{Total} allows to take into account the influence of noise on a given contrast insert.

To limit the impact of noise, one solution is to eliminate it by conditioning the ESF. This conditioning of the curve is to make the curve for ESF strictly monotonic.





In the software, TTF conditioning can either be disabled "**No**", enabled "**Yes**" or automatically enabled when $CNR_{Total} < 15$ "Auto (CNR < 15)".

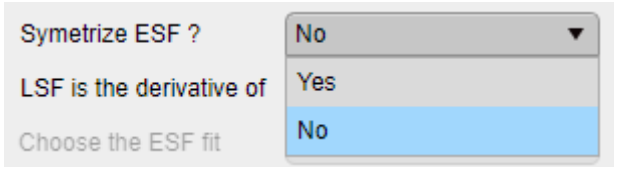


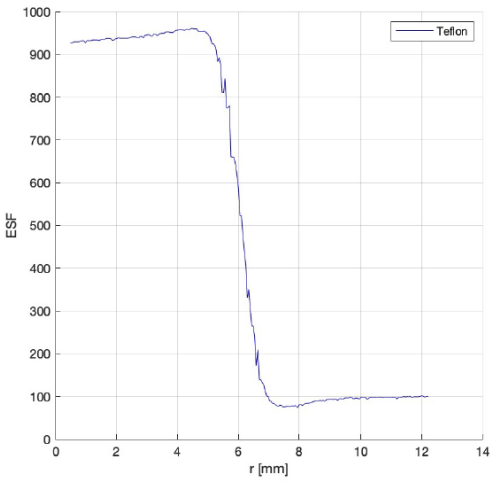
Conditioning must be handled with care because it modifies the ESF and therefore the resulting TTF. In case of CNR_{Total} < 15, it is recommended to increase the number of images to be analyzed either from the images already available or by repeating the number of acquisitions.

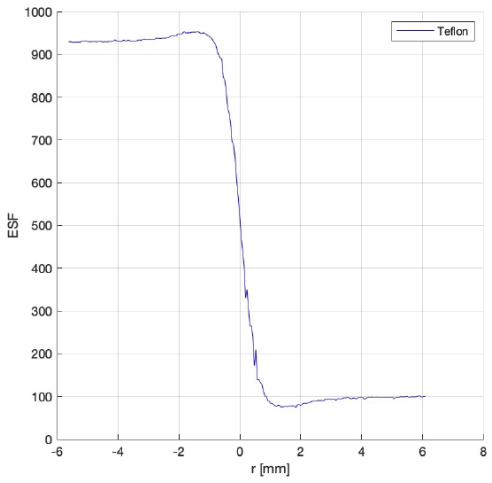
- *Symmetrization of the ESF curve*

Since the insert and the bottom of the phantom have different densities, the contribution of scattered radiation in these two elements will be different. This difference in contribution makes the ESF asymmetric.

Several studies show that for FBP algorithms, it makes sense to symmetrize the ESF curve to obtain an MTF curve identical to the one obtained from a high-density bead. The useful part of the ESF curve for the calculation of the TTF is the part from the bottom to the insert. In the literature, some authors recommend to continue to symmetrize the ESF curve for the calculation of the TTF as is done for the MTF.

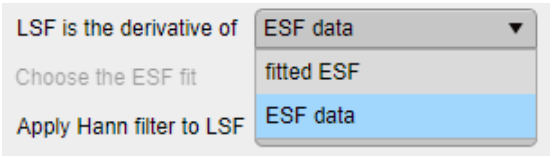


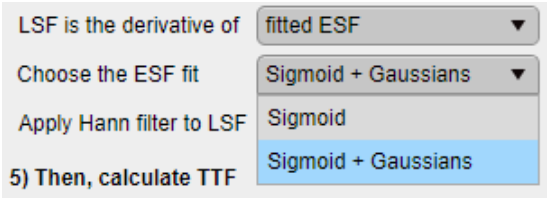




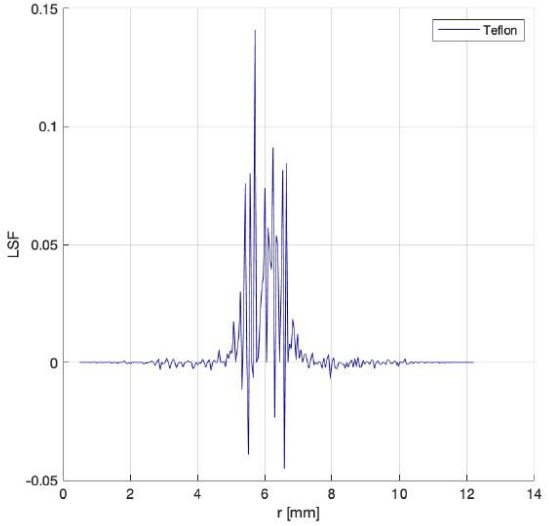
- *Selecting the ESF data to be derived to obtain the LSF*

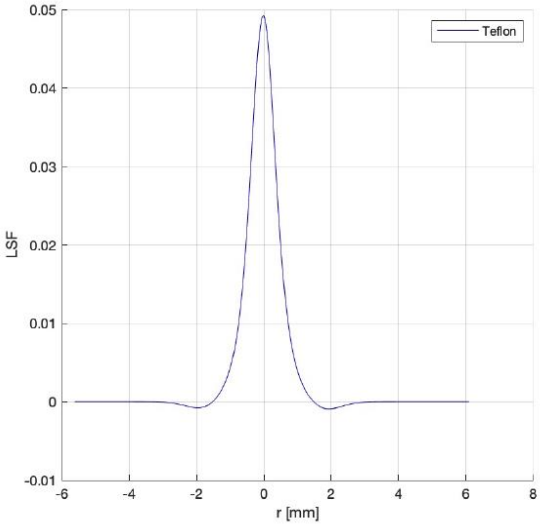
The LSF is obtained by deriving the ESF data.





The LSF can be obtained by deriving the raw **ESF data** or the **fitted ESF** data.





In the second case, the ESF can be adjusted, either by a "**Sigmoid**" function or a **Sigmoid + Gaussian** function.

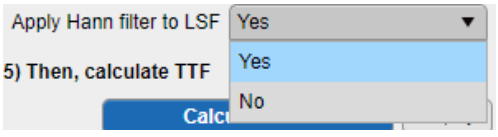
The first function corresponds to a sigmoid function and the second one corresponds to a sigmoid function to which two Gaussian functions modeling the reliefs or "overshoot" have been added to take the reinforcement filters of the contours into account. These two functions can be used in the software according to the value of the CNR_{Total} (CNR_{Total} < 15) and/or the reconstruction kernel.

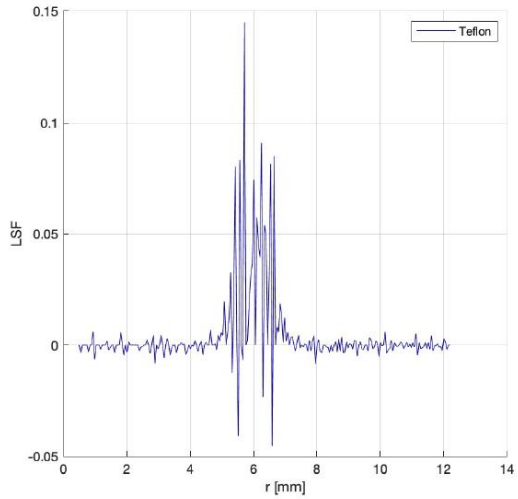
If the ESF is symmetrized, a single Gaussian is applied in the ESF fit, but if the ESF is not symmetrized, two independent Gaussians are applied

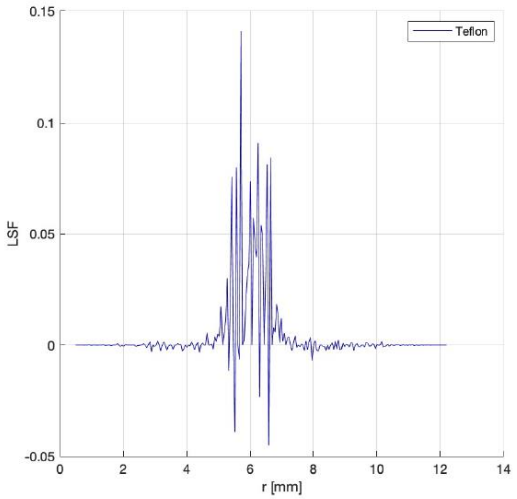
- *Application of a Hann filter on the LSF*

A Hann filter is a windowing filter that limits a signal over an observation window.

In some cases, a Hann filter can be used to remove noise in the LSF queues.







- *Complements*

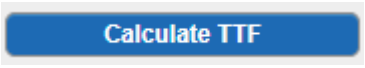
More details on the impact of these different parameters on the ESF, LSF and TTF curves are available in the GT SFPM report.

- ***Verification of ROI positioning and selected slices (optional)***

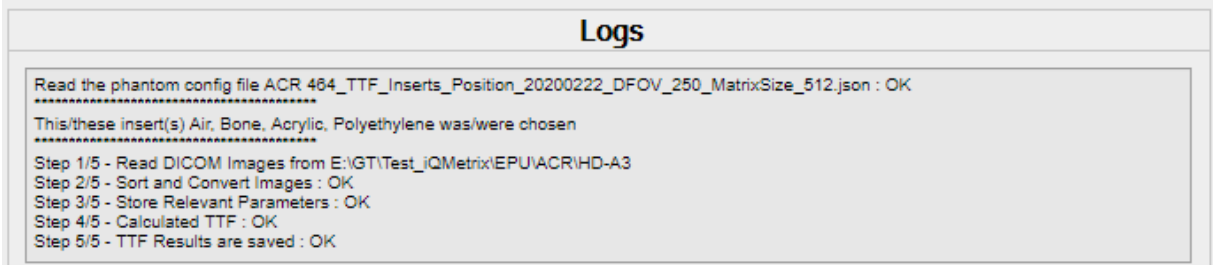
You can click on "**Display**" to visualize the positioning of the ROIs on the selected inserts and the selected slice for the TTF calculation.

As previously mentioned, in this window, you can scroll the images with the sidebar and modify the windowing of the images either manually or by using the 5 predefined windowing functions.

- ***Calculating the TTF***

To calculate the TTF, you must then click on 

Two new lines appear in the "Logs" window corresponding to the TTF calculation and the saved TTF results.



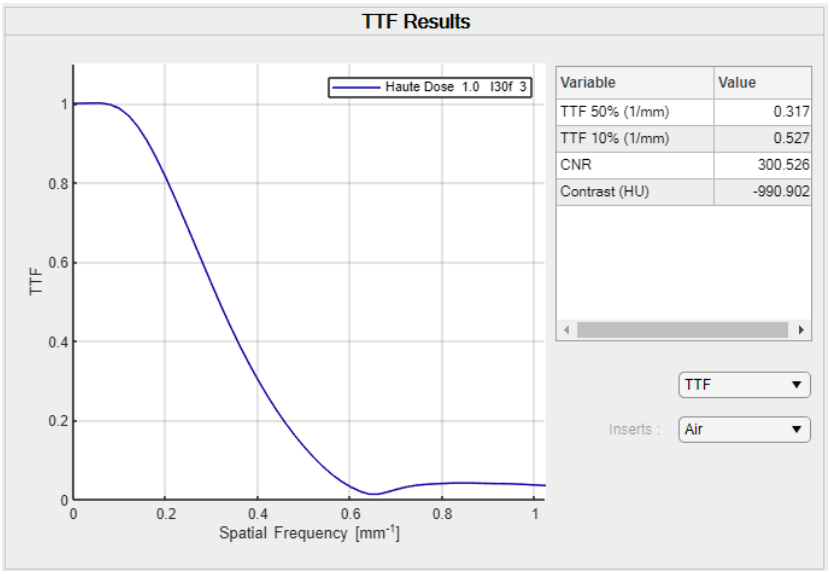
If each of these 2 steps is done correctly, " **OK** " is then written otherwise " **ERROR** " appears.

In the event of an error, you must check the images of the folder you have selected.

Once the calculation of the TTF is finished, the software displays in "**TTF Results**" the TTF curve of the first insert of the list and the main data of characterization of the TTF curve:

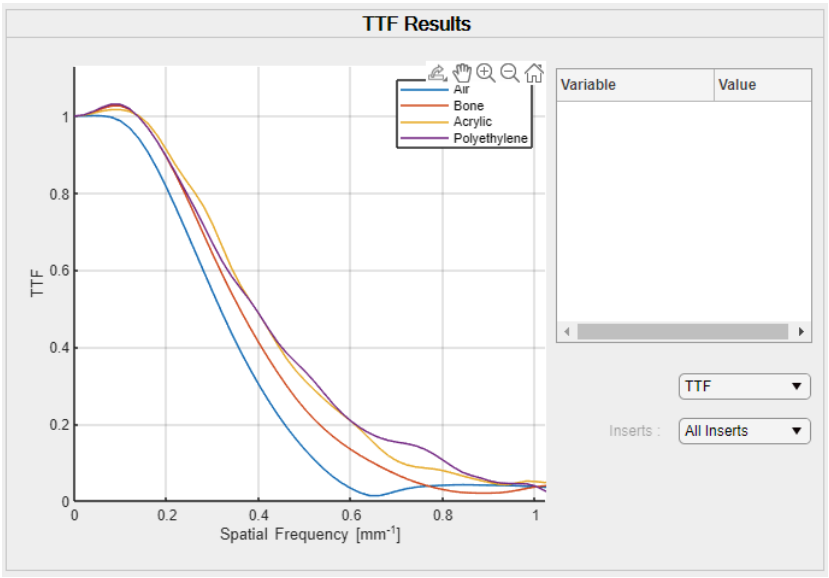
- the TTF value at 50% (***TTF 50% (1/mm)***),

- the TTF value at 10% (***TTF 10% (1/mm)***),
- the value of the total CNR calculated on all the slices analyzed (***CNR***),
- the value of the average contrast between the insert and the background of the phantom calculated on all the slices analyzed (***Contrast (HU)***)



For each insert, it is also possible to display the ESF and LSF curves used to calculate TTF.

It is also possible to display the TTF, ESF and LSF curves of each available insert and the TTF curves of all inserts.



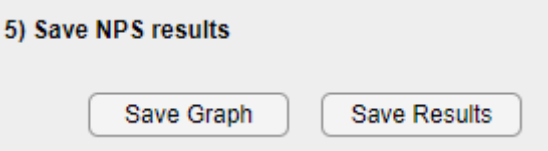
If all inserts are selected, the ESF and LSF curves will not be accessible and no results and no main TTF curve characterization data will appear

- ***Save the results***

The "***Auto-Save***" mode is activated by default. In this mode, 4 files can be saved in the folder containing the images analyzed:

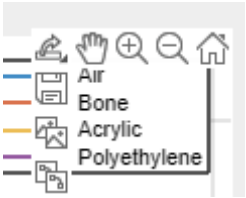
- ***TTF_parameters.txt*** => text file containing the calculation parameters
- ***TTf_results.txt*** => text file containing the values of 4 results
- ***TTF1D.csv*** => 1D curve saved as a spreadsheet
- ***TTF2D.mat*** => Matlab file used to calculate the detectability index

If the " **Auto-Save** " mode is not activated, you can save these 4 files by clicking on " ***Save Results*** ".



You can also save the figure for TTF (or TTFs) or ESF or LSF displayed in "**TTF Results**", as a png or pdf file by clicking on "**Save Graph**". A new window will then open so that you can select the place where you want to save the figure.

You can also save, zoom in/out or move this figure using the buttons at the top right corner of the figure



2. Batch Mode On

*/!\ **Essential pre-requisite**: The images contained in the set of folders to be analyzed must have exactly the same z positions and the same matrix size.*

- ***Selecting the configuration file***

You must click on « ***Select Phantom Config File*** » and select the .json file recorded to calculate the TTF.

"***Phantom name***_TTF_Inserts_Position_***phantom_creation_date***_DFOV_***DFOV_size***_MatrixSize_"

Once the correct file has been selected, the following message will appear in the **"Logs"** window:

The z-positions of the slices on the images of the files to be analyzed must be identical to those of the images used to create the json file.

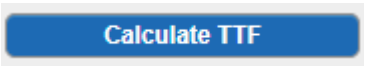
- ***Selecting the images on which the calculation is to be made***

You must select all the **FOLDERS** you want to analyze by clicking on « ***Open Directories*** ».

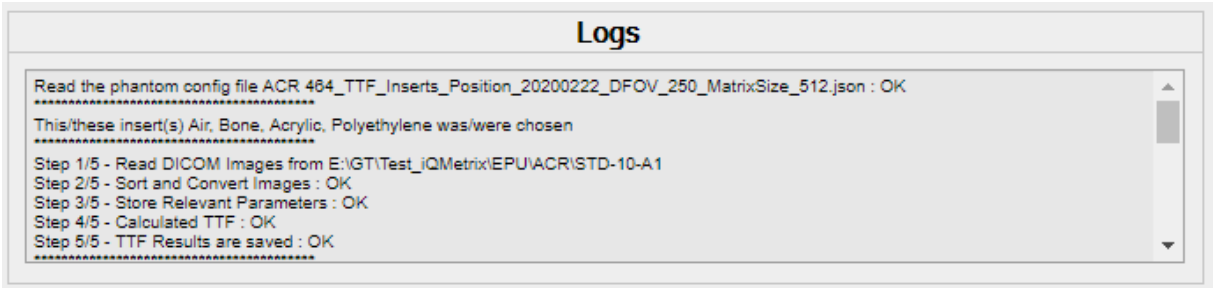
- ***Selecting the for TTF curve adjustment parameters***

The user must choose either to use a preset already defined or the different adjustment parameters.

- ***Calculating the TTF***

To calculate TTF, you must then click on 

The 5 steps previously defined will then appear grouped together in the « **Logs** » window for each file analyzed.



If each of these 5 steps has been completed successfully "***OK***" will be written for each line, or, failing that, "***ERROR***" *will appear*.

At the end of the calculations, a new line will appear in the "***Logs***" window

In Batch mode, no figures and results appear on the software.

- ***Save the results***

In Batch mode, the "***Auto-Save***" mode is enabled and cannot be disabled.

In each analyzed folder, the 4 previously defined files are saved.

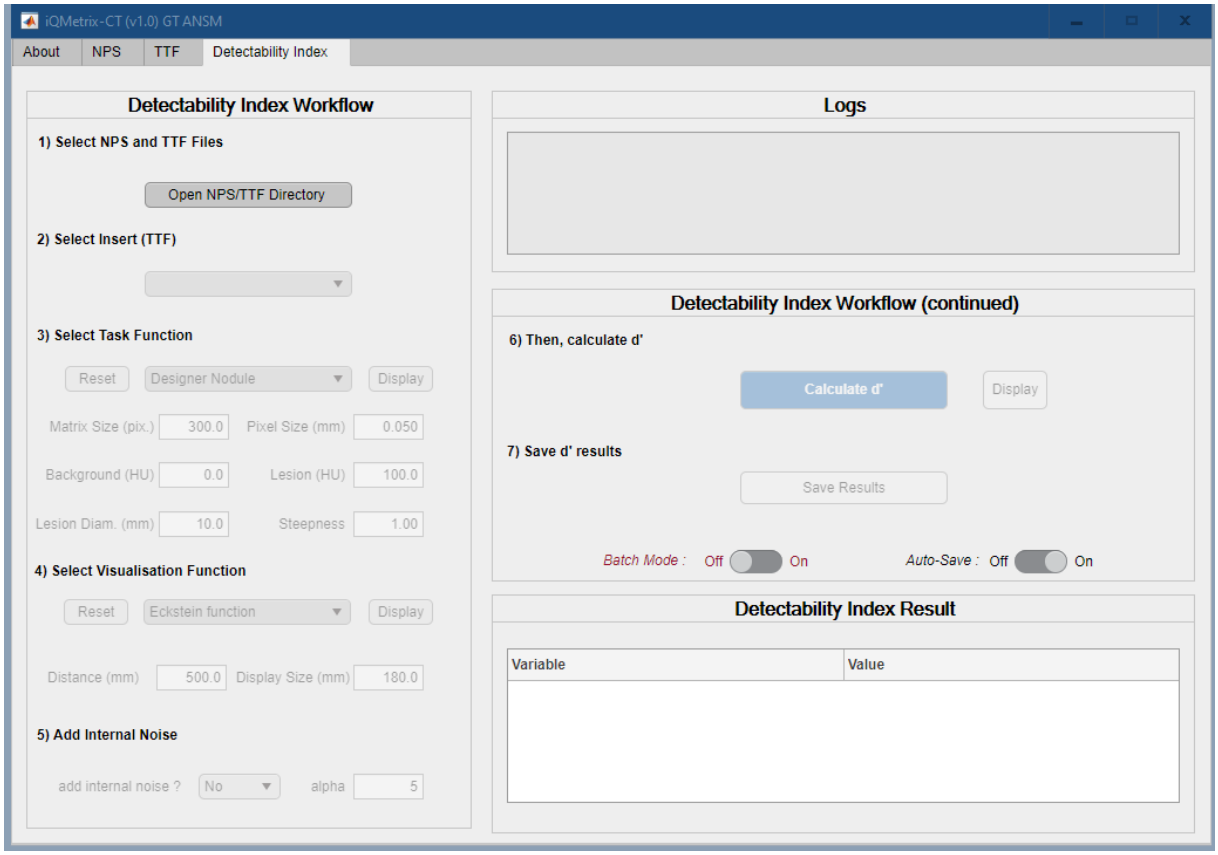
In addition, an additional Excel file is saved in the root of the analyzed folders. This file is called "***TTF_summary_Date of analysis_Time of analysis.xlsx***".

This file has a first tab with the values of the 4 parameters calculated per file analyzed but also the average CNR per section and the application or not of a conditioning on the ESF (CNR_{Total}<15).

This file then includes an additional tab per insert containing the calculated TTF curves.

V. Calculating the detectability index

To calculate the detectability index, you must click on the "***Detectability Index***" tab located at the top left of the software's graphic interface.



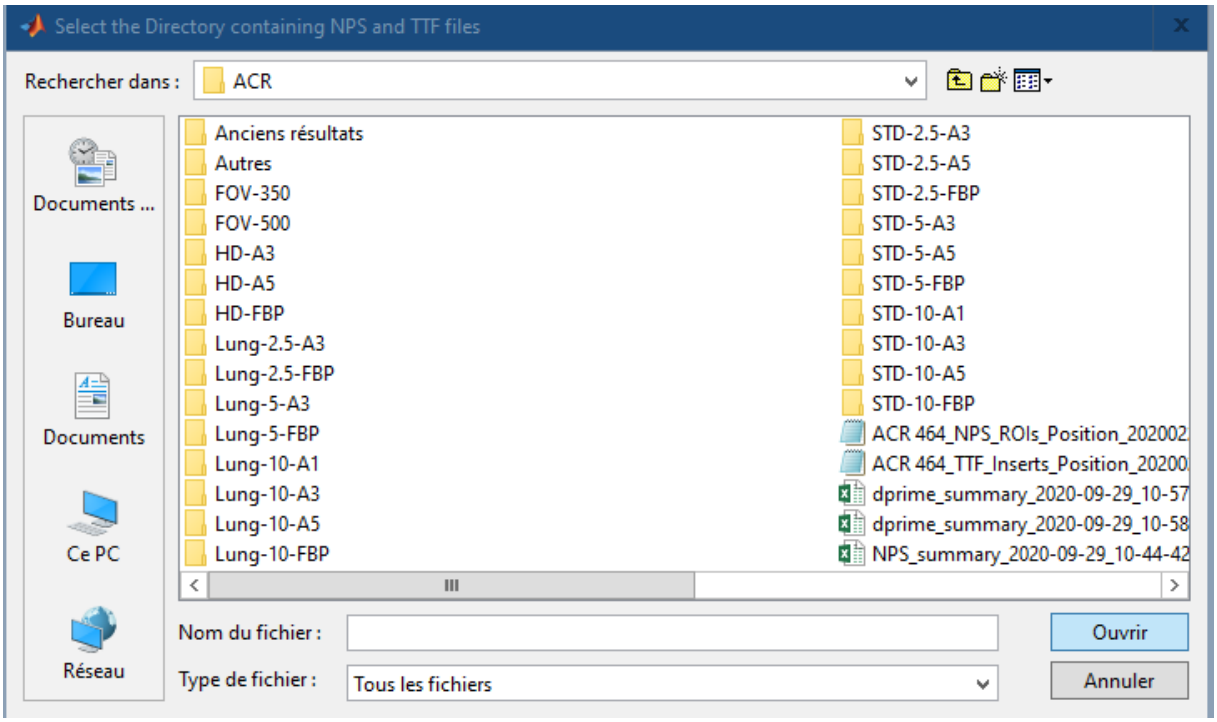
The software allows the user to choose to analyze the images in a single folder ***"Batch Mode Off"*** or to analyze the images in all the folders selected by the user ***"Batch Mode On"***.

We advise you to first select the "Batch Mode Off" to define the different parameters impacting the detectability index.

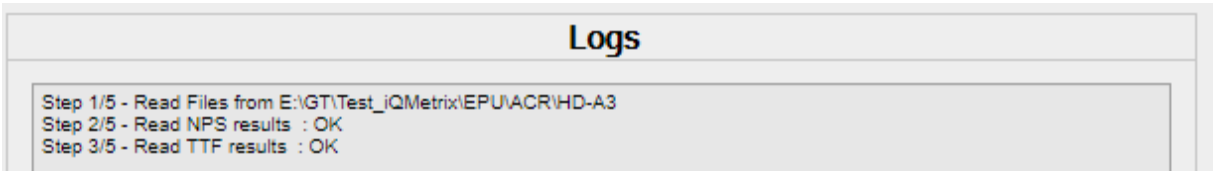
1. Batch Mode Off

- ***Selecting the NPS and TTF files***

You must select the **FOLDER** containing the ***NPS2D.mat*** and ***TTF2D.mat*** files by clicking on ***"Open NPS/TTF Directory"***.



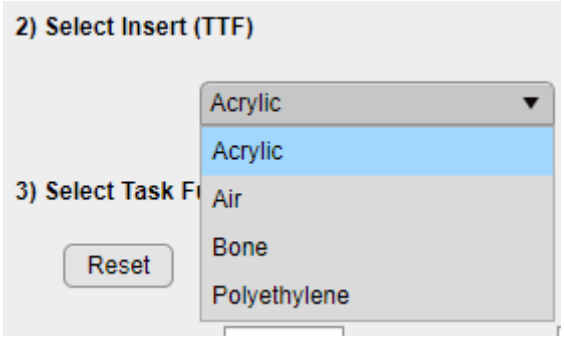
Once the images are selected, 3 lines appear in the ***"Logs"*** window to specify the selected folder and confirm the presence and conformity of the NPS and TTF files.



- ***Selecting the insert***

The user must choose an insert from the list of inserts where TTFs have been calculated.

From the choice made by the user, the TTF results obtained for this insert will be used for the calculation of the d'.

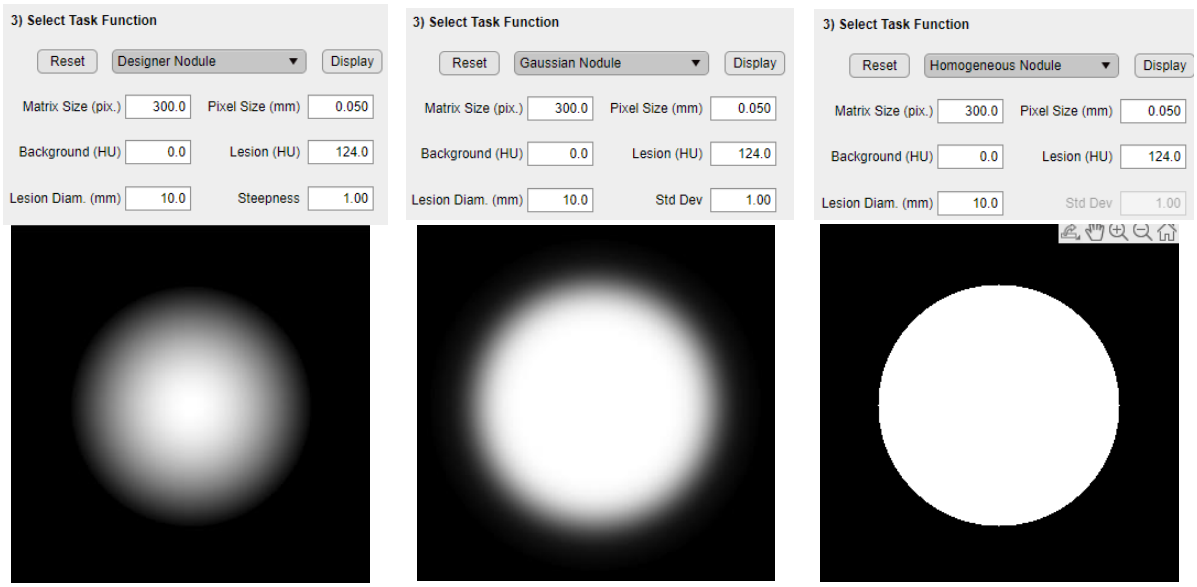


The insert is chosen according to its contrast value. It must be as close as possible to the contrast of the clinical task to be studied.

- ***Selection of clinical task parameters***
  - *Choice of the type of clinical task*

The user can choose three types of clinical tasks: « ***Designer*** », « ***Gaussian*** » and « ***Homogeneous*** ».

As specified in the SFPM report, the ***"Designer"*** task is used to simulate a non-spiculated pulmonary nodule, the ***"Gaussian"*** task to model a hepatic nodule and the ***"Homogeneous"*** task to characterize in the simplest way a circular homogeneous nodule.



- If the user selects the ***"Designer"*** task, he will be able to adjust the ***"Steepness"*** parameter which will play on the variation of the contrast between the center and the periphery of the clinical task.

- If the user selects the ***"Gaussian"*** task, he will be able to adjust the ***"Std Dev"*** parameter which will play the variation of the attenuation between the center and the periphery of the clinical task.

  - *Choosing the parameters for the clinical task*

First, the user must enter the matrix size and the pixel size. These parameters are defined to represent the ideal image of the simulated object.

- ***Pixel Size"*** must be defined to be strictly smaller than the ***"Pixel Size"*** of the scanner (e.g. 1/10th)
- ***Matrix Size"*** must be sufficient to include the lesion

Most of the time, the default parameters proposed by the software are adapted to represent clinical tasks of diameter ≤ 10 mm.

Next, the user must choose the contrast of the clinical task. He can either enter the HU value of ***"Background (HU)"*** and ***"Lesion (HU)"*** or enter the contrast value between the two directly in ***"Lesion (HU)"***.

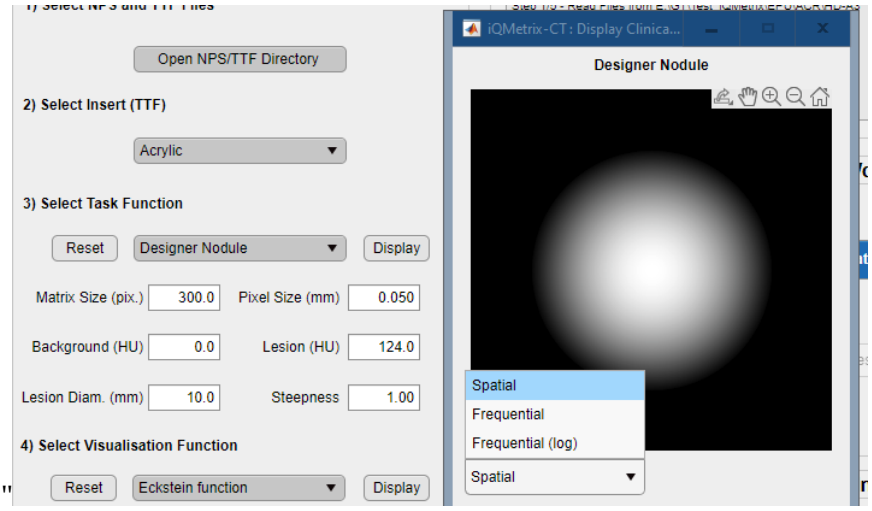
The contrast value measured during the TTF calculation of the selected insert is displayed by default in the *"**Lesion (HU)**"* box .

Finally, you must enter the diameter in mm of the clinical spot.

The contrast and size of the clinical spot entered must be representative of the lesion to be studied. Feel free to discuss with a radiologist beforehand to choose the right parameters.

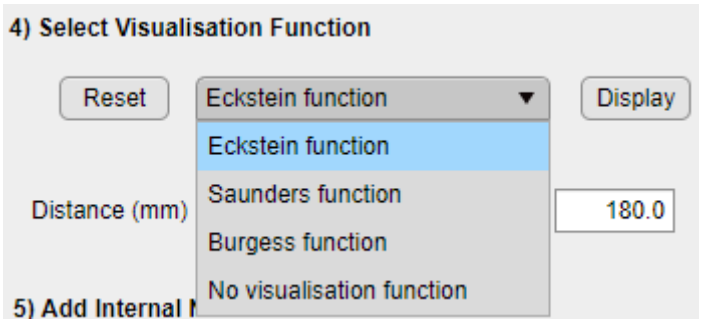
- *Visualizing the resulting clinical task*

To view the predefined clinical task in the spatial or frequency domain, you can click on *"**Display**"*.



- ***Selecting the visualization function***

The user can choose to select a visualization function or not to use one.



If you want to calculate the detectability index with a model observer of type NPW, without visualization function, you have to select *"**No visualization function**"*.

If you want to calculate the detectability index with a model observer of type NPWE or NPWEi, you must select a visualization function among the three proposed.

More details on these three visualization functions are provided in the GT SFPM report.

Regardless of the visualization function selected, the user must enter the visualization *"**Distance**"* which corresponds to the distance between the radiologist's eye and the screen and the image size of the object displayed on the screen *"**Display Size**"*.

$$Display\ Size = Matrix\ Size\ \times Size\ of\ the\ pixels\ of\ the\ visualisation\ screen\ \times display\ zoom$$

The choice of these parameters must be discussed with a radiologist.

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Each display function can be seen by clicking on ***"Display"***.

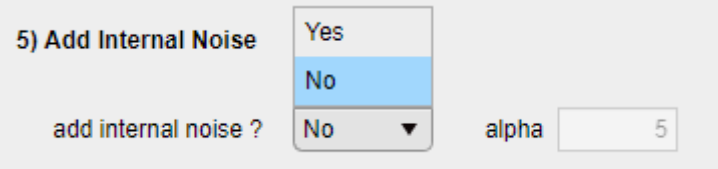
*The display of the visualization function depends on the choices of **"Matrix Size"**, **"Pixel Size"**, **"Distance"** and **"Display Size (mm)"**.*

- ***Adding internal noise***

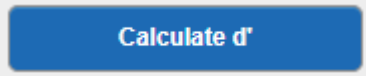
If you want to calculate the detectability index with a model observer of type NPWE, you must click on ***"No"***.

If you want to calculate the detectability index with a model observer of type NPWEi, you must click on ***"Yes"***.

The ***"alpha"*** coefficient must then be adjusted according to the amount of internal noise you wish to add. By default this value is 5.

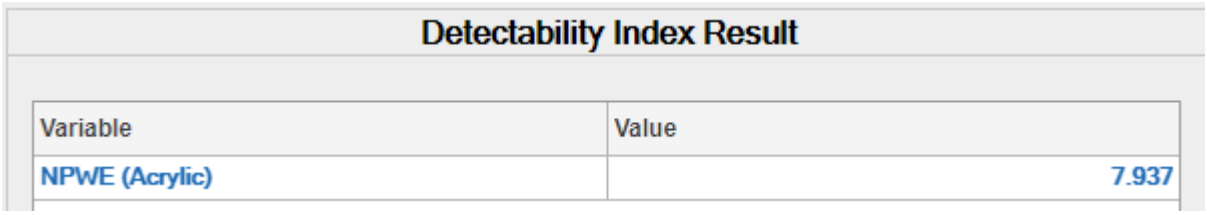


- ***Calculating d'***

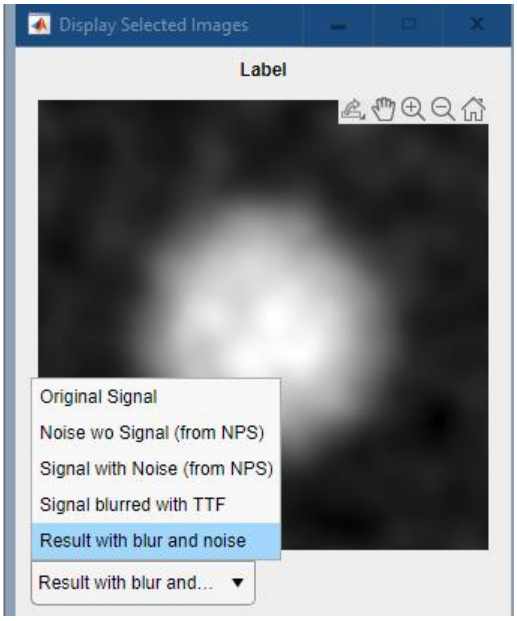
To calculate d', you must then click on 

Two new lines corresponding to the calculation of d' and the saved d' results will appear in the "Logs" window.

The value calculated for d' will then appear in the "***Detectability Index Result***" part



Once calculated, you have the possibility to see the representation of the original clinical task, with the NPS noise, the TTF blurring and with both added.



- ***Save the results***

The ***Auto-Save*** mode is activated by default. With this mode 2 files can be ssaved in the folder containing the images analyzed:

- ***dprime.csv*** => csv file containing the value of d' calculated
- ***dprime_Parameters.txt*** => text file containing the various parameters selections

If the "***Auto-Save"*** mode is not activated, you can safeguard these 2 files by clicking on "***Save Results"***

You can also save in .png or .pdf, all the figures available in " Display " by clicking on 

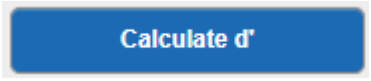
2. Batch Mode On

In Batch Mode On, you must click on "***Open NPS/TTF Directory"*** and select all the **FOLDERS** containing the results for NPS and TTF to be analyzed.

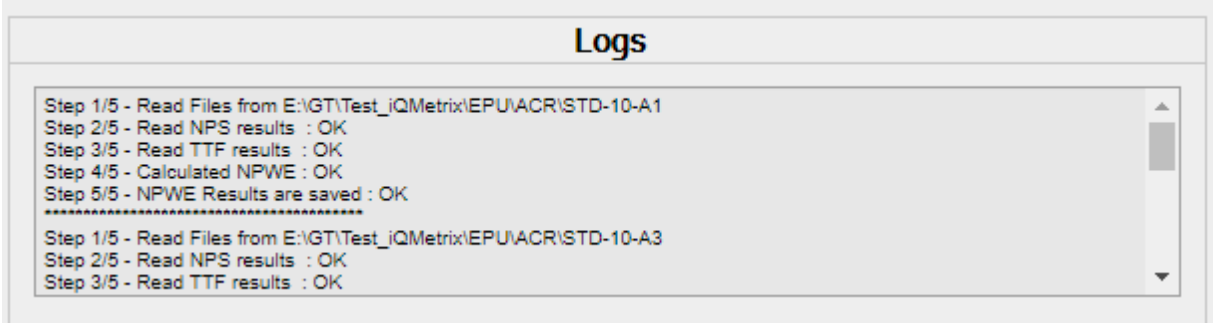
The steps for selecting the insert, choosing the clinical task, choosing the visualization function, and adding the internal noise are similar to those defined in Batch Mode Off.

The parameters selected for the calculation of the d' and in particular the contrast defined in the "Select Task Function" part will be the same for all the files analyzed.

- ***Calculating d'***

To calculate d', you must then click on 

The 5 steps defined above then appear in a packet in the "Logs" window for each folder analyzed.



If each of these 5 steps is done correctly, ***"OK"*** is written for each line, otherwise ***"ERROR"*** will appear.

At the end of the calculations, a new line appears in the ***"Logs"*** window

In Batch Mode, the software will not display any value for d'.

- ***Save the results***

In Batch mode, the **"*Auto-Save"*** » mode is activated and cannot be de-activated.

In each folder analyzed, the 2 files defined previously will be recorded.

In addition, an extra Excel file will be saved in the root of the folders analyzed. This file is called "***dprime_summary_Date of analysis_Time of analysis.xlsx***".

This file contains the calculated d' values as well as the main NPS and TTF results and the parameters selected for the d' calculation.