

PA² Software

The Intensity and Coverage Software from Peening Accessories

USER's MANUAL

1 Introduction

Thank you for choosing PA² Software that we wish very useful to you.

This product has been designed and tested by experienced users, making it very accurate and powerful. Advanced functionalities have been integrated to make it user friendly and to avoid any possible mistake, in particular for fresh operators in production and control phases of the shot peening process.

PA² Software meets SAE-J2597 requirements.

As it is always possible to make it better, your accurate user's comments and recommendations for improvements will be much appreciated.

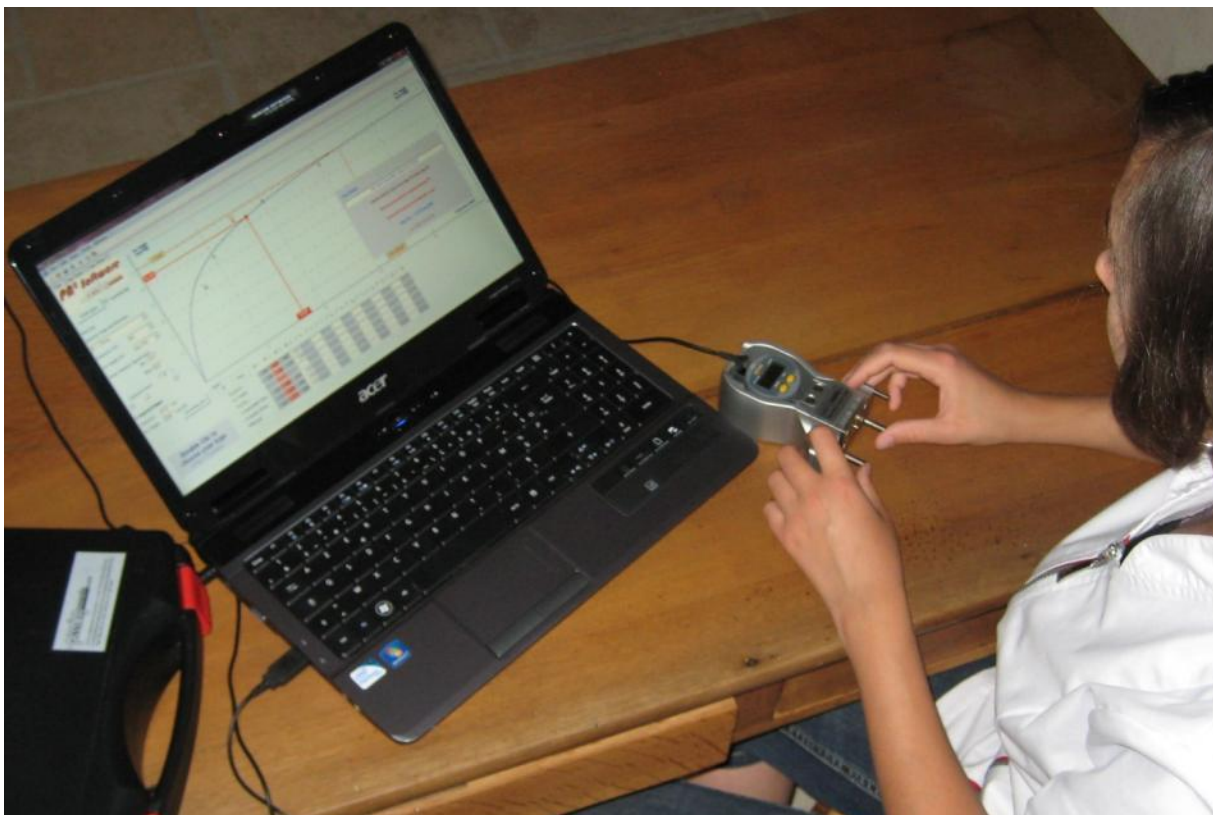


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2 Computer configuration

2.1 Computer environment

PA² software is designed to work in a PC environment, with Microsoft Windows XP-SP 2, or later operating system.

2.2 Equipment

PA² software is very light and does not require a lot of space in your hard disk. Nevertheless, the RAM memory and processor speed should be as high as possible to ensure comfortable use.

2.3 Display

PA² Software accepts automatically the following screen sizes: screen and graphic card with a resolution of 1024 x 768 pixels, or higher.

PA² Software is not suitable for narrow display types such as Netbook or Notebook formats.

2.4 Software development tools

Microsoft “.NET Framework 4” must be operational before starting PA² Software. Therefore, if it is not operational when installing PA Software, it is necessary to ask your Computer Administrator to install it. Free download from the following link (English, USA):

<http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=17851>

It is recommended to download the language version of your country in order to get all of PA² Software message boxes in your own language.

3 Software protection

WARNING!

- PA² software is protected by the mean of a serial number which is allowing the traceability, the updating of the original software files and preventing any use out of a related commercial contract.
 - Full permanent activation is granted only for one computer. For several computers a commercial contact for multi-computer use and dedicated serial numbers are required.
-

4 Installation procedure

Just after downloading, PA² Software is fully operational and free, but for a limited granted amount of use for testing. File recording will be disabled after 40 times saving or resaving. All the files saved during the test period will remain accessible either directly from windows explorer or from PA² menu after purchasing the full version.

In order to get full rights for permanent use, it is necessary to input the serial number that will be granted by PEENING ACCESSORIES (see 4.3).

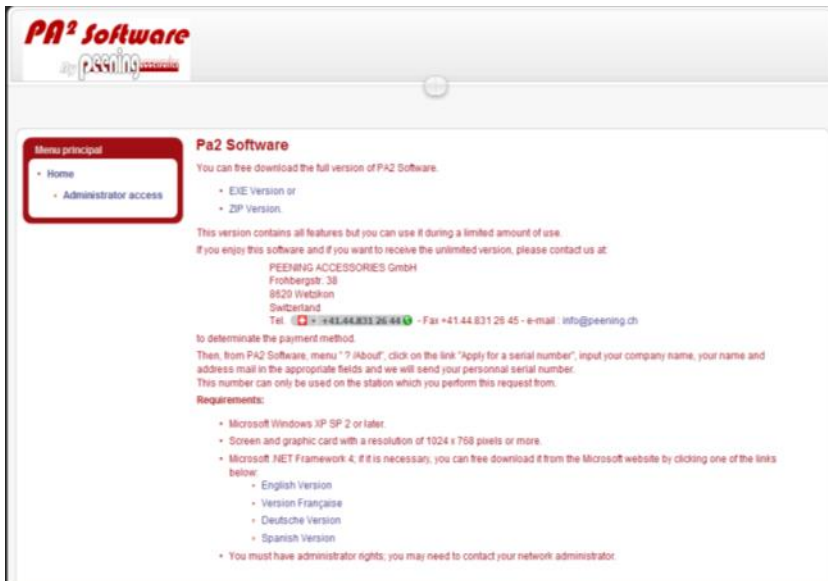
4.1 Downloading from PEENING ACCESSORIES Website

Before any tentative for downloading PA² Software, it is necessary to double check that you have all authorizations from your computer administrator. At least, check if “.NET Framework 4” is installed in the program files list through <Configuration panel>, <install uninstall program files> (XP) or <Programs, Programs and features> (Vista, Seven, W8, W10).

Step-1 downloading

Download link: <https://pa2.peening.ch/>

After reaching the server this window will welcome you.

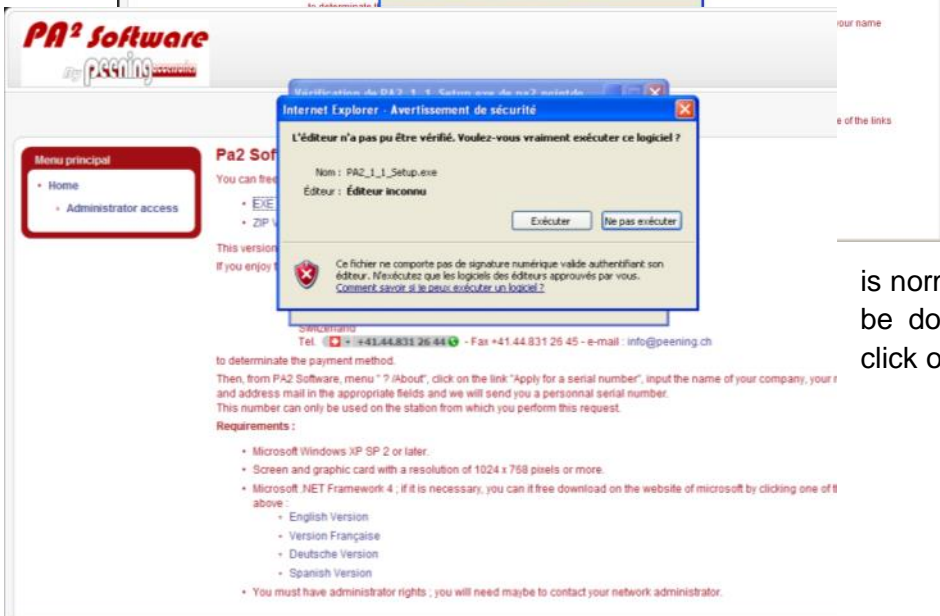
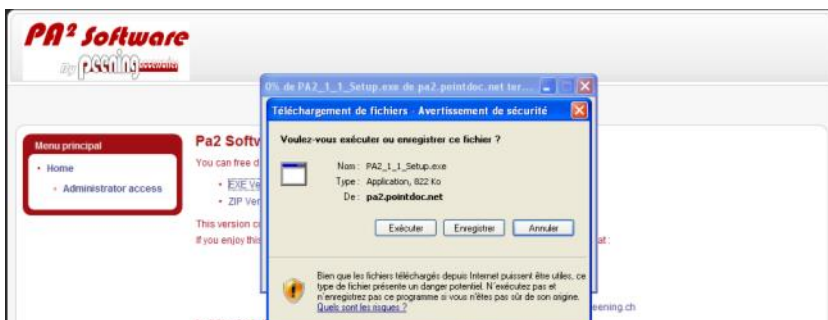


- **No need to Login** (free downloading)
- Click on the blue link of your choice: **EXE Version** if you have full rights from the administrator, Or **Zip Version** if you do not want to execute, but only after save, unzip and scan for virus, before installation.

Then follow the instructions...

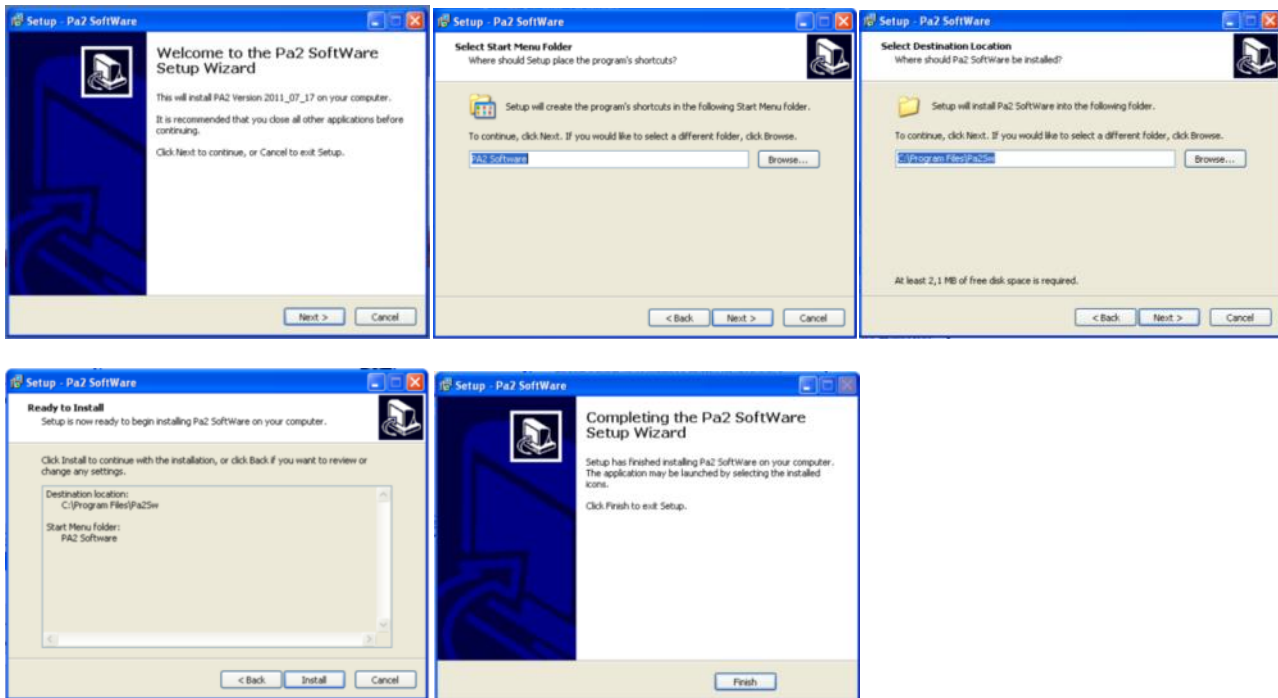
Note that at this step, for higher safety you can still choose saving instead of executing and then executing only after scanning for virus.

If downloading does not happen smoothly, you can still go back to the previous zip option.



At this step, the warning from Windows is normal. Just check that the program name to be downloaded looks like here beside. Then click on execute.

Step-2; Installing



Double check if the proposed

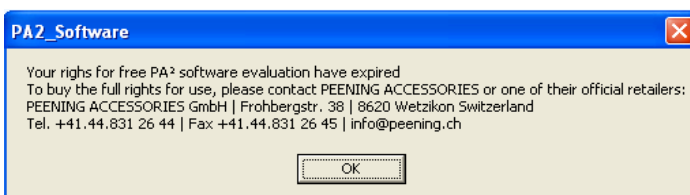
directories are suitable.

A PA² subfolder will be created in your [my] Documents folder, in which will be placed, by default, the graphics that you want to save and the provided example charts.

4.2 Extraction from a CD or DVD

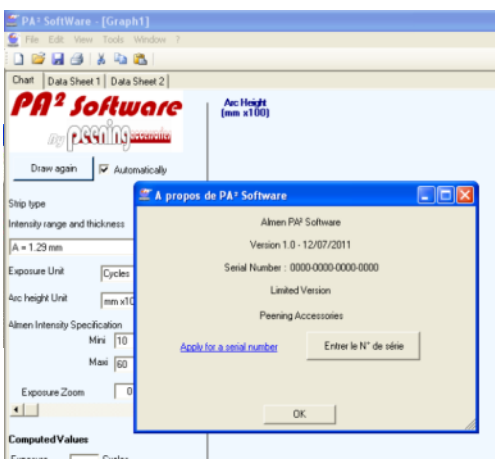
In order to guaranty updating and upgrading procedures, PA² Software is only available from downloading.

4.3 Asking for the serial number



At the installation step, an amount of free use is granted, allowing for testing the full functionalities of PA² Software.

At the end of this test period, the following message will show up and PA² Software will be usable only after you input the serial number to be automatically inquired to PEENING ACCESSORIES, following this procedure:



Click on the question mark <?> in the main menu at the top of PA² window.

Select <About>

Click on the link [apply for a serial number](#)

This will automatically connect with the PEENING ACCESSORIES server for subscribing procedure.

After reaching the server, this window will welcome you.

At this step, it is necessary to have already a commercial contract with PEENING ACCESSORIES that will receive automatically your serial number request and will check the commercial status before any serial number transmission.

- Fill the Identification fields with your company name, first name, last name and e-mail address.
- Click on <Submit>

When this message is displayed, PEENING ACCESSORIES will be automatically warned about your inquiry.

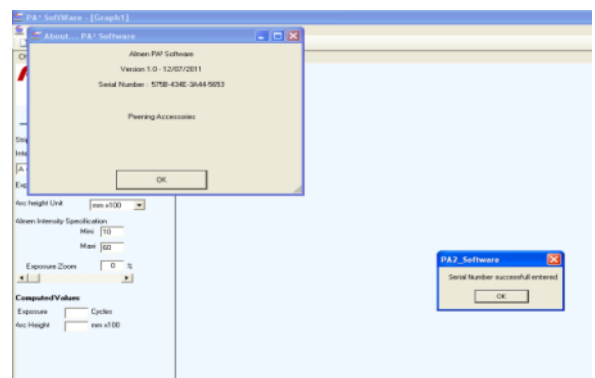
You can close the navigator and check the e-mail reply that will contain the serial number.

Here below, is the content of the e-mail return message:

Hello,
 Hereafter the serial number of your PA2 Software, which allows unlimited use:
35fc-99ab-ee36-2dc3
 To input your serial number, use the PA2 software menu "? / About". You can select and copy it (CTRL-C) out of this mail and then you can paste it. You can also enter it manually.
 Thank you for your confidence

4.4 Input the serial number received by e-mail return

- 1) Open the e-mail message from PEENING ACCESSORIES containing the serial number. Select the activation key, and copy it in the clipboard,
- 2) Restart PA² Software, Click on the question mark <?> in the main menu at the top of PA² window.
- 3) Select <About>>,
- 4) Click on <Paste Serial Number> to paste your activation key.
- 5) When the clipboard is empty or does not contain the proper data format, the button <Paste Serial Number > does not show up. You can then either click on < Input serial number > and manually input the serial number, or come back to your e-mail message and copy the serial number into the clipboard.
- 6) Click on the "OK" button to confirm.



PA² is now ready for use with permanent rights.

5 Almen Saturation

5.1 Almen Saturation Chart description

The 5 main areas are shown in the hereafter screen copy and described in the next sections:

The screenshot shows the PA² Software interface for Almen Saturation. It features a main menu at the top, a central graphic chart with a saturation curve and data points, a table for measurements data input at the bottom, and a message box for results and automatic comments display. Callouts point to these five main areas.

5.1.1 Measurements data format

The screenshot shows the settings panel for Almen Saturation. It includes options for Strip type (Intensity range and thickness), Arc height units (inch/1000 or mm/100), Exposure units (cycles, s, min, kg/m², Passes, min/m), Almen intensity specification range (Mini, Maxi), Saturation point definition (Saturation amplitude, Exposure Zoom), and Computed values (Exposure, Arc Height).

- **Almen strip type**

Select the Almen strip type you intend to use “N”; Thin type for low peening intensity range, “A”; standard type or “C”; Thick type for high peening intensity range,

- **Arc height units**

Select “inch/1000” (Imperial units) or “mm/100” (metric system) or input any “potatoes” units that will be used only for the active file,

- **Exposure units** (also used for coverage)

Select “cycles” or “s” or “min” or “kg/m²” or “Passes” or “min/m”,

- **Almen intensity specification range**

Input the maximum and minimum required limits for Almen intensity,

- **Saturation point definition**

Input the maximum arc height increase, in %, when exposure is doubled; generally 10%,

- **Exposure zoom**

Input a percentage of the maximum exposure input which will be added to it and used as the maximum abscissa value for graphic display (from 0% to 200%). The cursor can also be used,

- **Computed values**

The Almen saturation curve can be displayed as soon as 2 measurement points are set into the input table. When pointing anywhere at the curve, the exposure and corresponding computed arc height will be displayed in this frame,

5.1.2 Table for measurement data input

Description of the 6 input lines

Ascending Sort		Select	<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input checked="" type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/> 15																	
Exposure		<input type="radio"/> All <input type="radio"/> None	0'15"	0'30"	0'45"	1'00"	2'00"	4'00"												
Arc Height			10,8	12,9	13,7	14,4	15,7	16,4												
Pre Bow																				
Compensated Value			10,8	12,9	13,7	14,4	15,7	16,4												
Computed Values			10,5	12,9	14,0	14,6	15,6	16,2												
Difference			0,3	0,0	-0,3	-0,2	0,1	0,2												

Double Clic to choose your logo (219 x 73 pixels)

Notes:

- Each table column refers to one measurement point with the related inputs, selections and computed values,
- The orange highlighted columns contain measurement points out of maximum the allowed distance from the curve. The maximum allowed distance is defined inside the <Options> menu (see 5.1.3 & 5.1.4). These points are marked with a red triangle in the chart. If the triangle is pointing downside < >, the point is too high above the computed curve; positive distance. If the triangle is pointing upside < >, the point is too low underneath the computed curve; negative distance.

- Measurement point number**

Check marks will automatically appear as soon as starting to input data in each column. When removing some check marks, the input values remain in memory and table display, but they are no longer taken into account for calculation and graphic display. To take back the inputs into account for computation, just click in the check area at the top of the column.

This function is very useful for analysing and showing the influence of each of the measurement points on the final result. Charts with different combinations can be saved and printed separately or displayed in the same "Multigraph" chart (see section 5.3).

- Exposure**

Input here the exposure value to the peening stream. The exposure units selected in Almen measurements data format will automatically apply for calculation, display and memory inputs.

If you have selected "min" as "exposure units", 1.5 min will be accepted as 1min and 50 sec, 1.3 min will be accepted as 1min and 30 sec and 1.8 min will be accepted as 2min and 20 sec.

- Arc Height**

Input here the arc height value after peening either read on the Almen gage display or directly send by USB port to the computer (see section 6),

- Pre Bow**

Input here the arc height value before peening either read on the Almen gage display or directly send by USB port to the computer. Make sure that the pre bow does not exceed specified value.

- Compensated value**

No input there; the effective arc height after removing the pre-bow will be automatically calculated and used as actual input value for further calculation steps.

- Computed value**

No input there; the virtual arc height will be automatically displayed here after curve fitting using the square distance method.

- Distance (Deviation)**

No input there; the effective distance from the measurement point to the computed curve will be automatically calculated, taken into account and displayed here after computation.

- **"Draw again" button and "Automatically" checkbox (top left)**

When the "Automatically" box is checked each new input in the table causes recalculation and the immediate drawing of the curve; this can be unpleasant when lots of data are entered, especially with connected Almen gage. To avoid this drawback, uncheck this box. It is then needed to click on the "Draw again" button to update the chart. The "Automatically" box is selected by default when a graphic is loaded from the memory, but it is disabled when a new chart is created.

- **"Ascending sort" button**

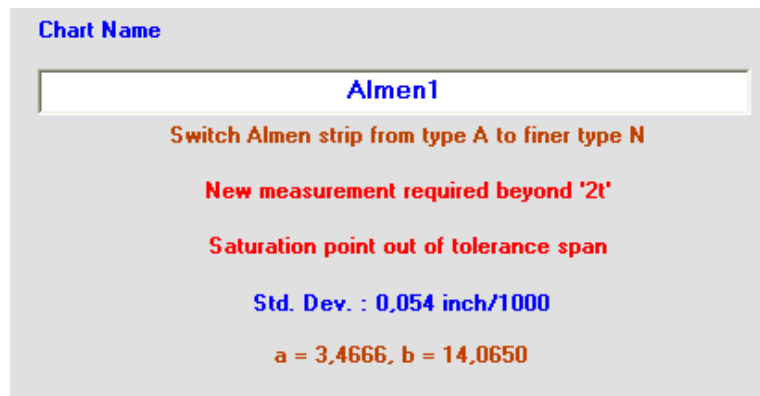
Since the software allows inputting values in any order, not necessarily growing, this function allows sorting values, after input, into the growing order of exposure time first, and then compensated values in case when several exposures are identical.

- **Select "all" or "none" option**

When the "All" option is selected, then all the measurement points with full data inputs will be taken into account for computation.

When the "None" option is selected, then no input will be taken into account for computation. This option is useful before re-selection of some measurement points.

5.1.3 Chart title and message box for results and automatic comments display



- **Chart name;** input here the chart title, as short and clear as possible i.e. "First test – Inside top – S110 - 40 psi"

Warning: If you do not change it until the file saving step, this chart name will be used as default file name for the 1st file save. Therefore the following signs are prohibited: "? , " , / , \ , < , > , * , | , :".

1st 2nd and 3rd lines of automatic comments; several messages can be displayed there. These messages are just advises and will not bring any automatic reaction from the software. Therefore, it is the user's choice of to follow or not follow the advice.

- The 1st line displays intensity range error messages in brown color:
 - "Almen intensity is too low to be measured with N type"
 - "Switch Almen strip from type N to thicker type A"
 - "Switch Almen strip from type A to finer type N"
 - "Switch Almen strip from type A to thicker type C"
 - "Switch Almen strip from type C to finer type A"
 - "Almen intensity is too high to be measured with C type"
- The 2nd line displays comments according to Almen saturation curve building method as described in Standards or peening manuals:

- “New measurement required beyond ‘2t’”

Means maximum exposure input is too low.

- “4 measurement points required at least”

This message is displayed as long as less than 4 measurement points are input or simply selected.

- “New measurement required lower than xx”

Means minimum exposure input is too high.

- The 3rd line of comments warns up when the Almen intensity is out of the specified tolerance span;

- “Saturation point out of tolerance span”

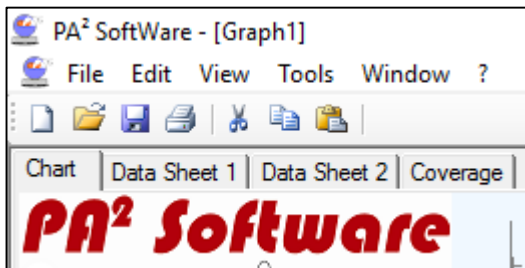
Minimum and maximum Almen intensity limits can be defined into the 2 input boxes at the left of the screen under the “Almen Intensity specifications” label. These limits will be displayed as green lines in the chart

- The 4th line displays in blue colour the standard deviation value in arc height units. This value will be used to define whether measurement points are close enough from the computed curve; see tools option in the main menu.

- The 5th line displays in brown colour the “a” and “b” values where:

- ✓ “a” is the arc height limit (horizontal asymptote value) expressed in arc height units,
- ✓ and “b” is a constant expressed in exposure units,
- ✓ The curve equation is: $y(x) = a \cdot x / (x + b)$.

5.1.4 Main PA² Software menu



The file name is displayed in the title bar of PA² Software window.

The tabs are leading to Almen chart, component and process datasheets and coverage simulation.

The menu works as any standard menu for PC software, with the following specificities:

- **Menu, File**

- File, Open

This option works on a single graphic chart which is linked with its own datasheet.

- File, Open Multigraph

This option gives direct access to a multi-chart file that has been previously built with several single graphic charts and saved as a Multigraph chart.

An error message could be displayed when several charts that were used to build the Multigraph were moved, renamed or deleted.

When opening a Multigraph, any other open Multigraph will be automatically closed as well as any other single chart that is not part of the Multigraph to be opened. A warning will show up if these files have been modified.

- File, Export (CSV)

This option will save the graphic chart and attached datasheet as a CSV file (Coma Separated Values) that can be handled to feed any software such as tabulator, text treatment or database...

- File, Print

This option allows to print either a single chart, or a Multigraph or two data sheets, based on the active page on the screen. To allow faster opening, the last registered graphics are displayed at the bottom of the file menu. By default, the simple graphics have the ".alm" extension and Multigraph have the ".amm" extension.

• **Menu, Tools**

- Tools, Multigraph

This option works on all graphic charts that are currently open (maximum 6). Multigraph (or <F5>) allows the compiling of several single charts on the same graphic chart and the saving of this as a new multi-chart file (see Multigraph).

- Tools, Options

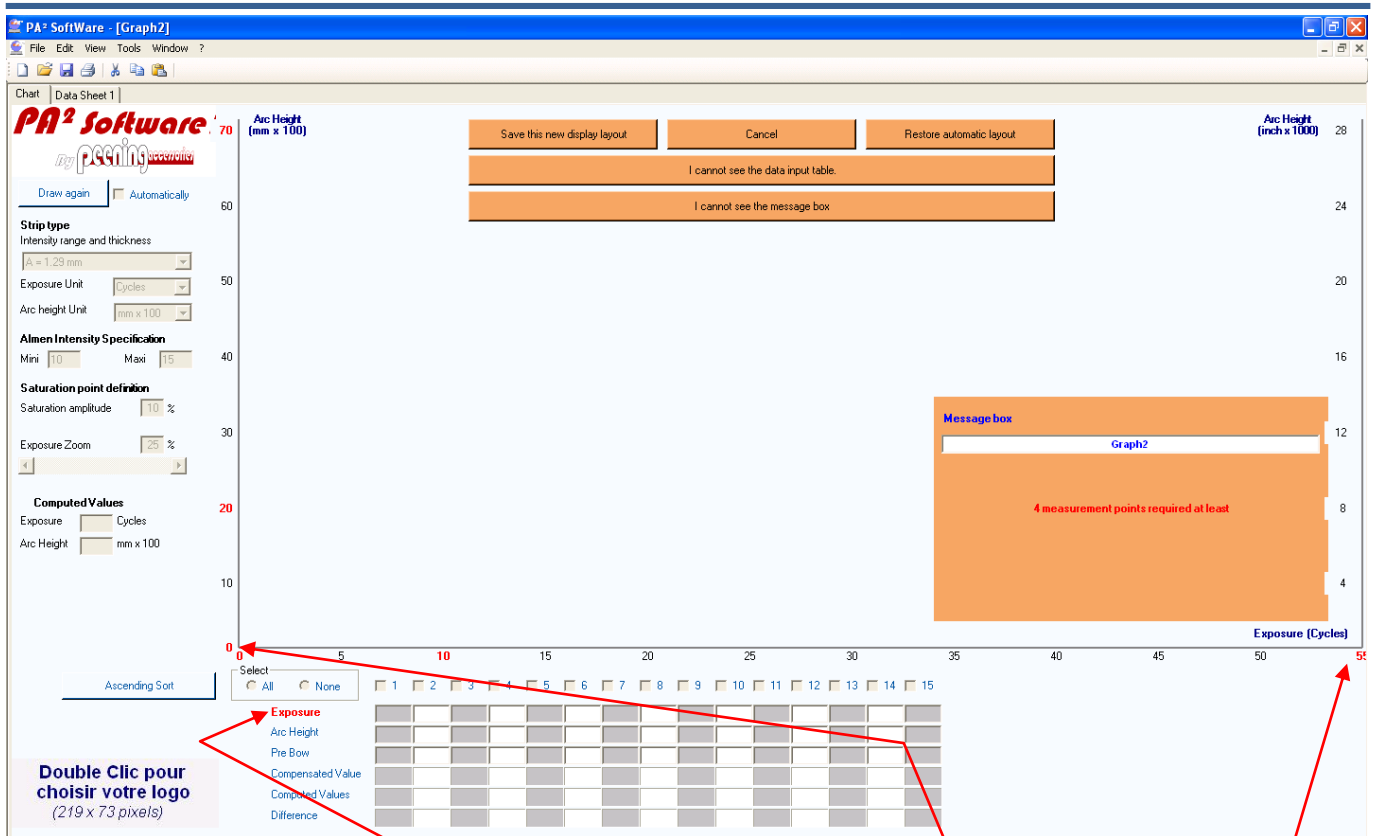
Options functionality will open the following window and give access to some software settings:

The screenshot shows the 'Options' dialog box with the following settings and callouts:

- Language:** Set to 'EN'. Callout: 'Language: Select here your language.'
- Point out of range:** 'distance > Std x by' set to 1.25. Callout: 'Points out of Range: Input here the maximum distance from the curve to a measurement point, measured in amplitude of standard deviation.'
- Metric archeight unit:** 'mm x100'. Callout: 'Metric/Imperial Units: Input here your own format description of arc height units.'
- Imperial archeight unit:** 'inch x1000'.
- Display 2T on the chart:** Checked. Callout: 'Display 2T: When activated, the coordinates of the "2T" theoretical point will be displayed.'
- Default Values:** A sub-dialog box containing:
 - Strip type: [Dropdown]
 - Intensity range and thickness: 'A = 1.25 mm'.
 - Exposure Unit: 'Cycles'.
 - Arc height Unit: 'mm x100'.
 - Almen Intensity Specification range: Mini '10', Maxi '60'.
 - Saturation point definition: Saturation amplitude '10 %'.
 - Exposure Zoom: '0 %'.
- Default Path:** 'C:\Documents and Settings\F\Xavier\Bureau\PA2 Examples'. Callout: 'Default Path: Input here the path to use in order to open or save any file if not changed at the saving or finding step. The browse button can be used to change the path.'

- Tools, Customize the display

Normally the software detects the screen resolution and optimizes the display accordingly. Nevertheless it may happen that the result is not effective, especially when using some 1920 x 1200 pixels graphic cards. This display customizing function will allow moving some objects.



At the display bottom the data input table which first line is entitled "Exposure" (in red) should be visible. If this is not the case, click on <I cannot see the data input table >. The data input table will then move automatically to a visible display area.

It is then possible to drag with the mouse the "Exposure" label; this will allow moving all together and where desired, the data input table, the "Ascending sort" button, the "All/None" and individual checks and the company logo.

The whole graphic chart can also be moved by dragging one of the two zeros "0,0", in red.

The height of the y-axis can be changed by moving the red labels 20 and 70 and the length of the x-axis can be changed by moving the labels 10 and 55.

If you do not see the orange message box rectangle, click on <I cannot see the message box>. The message box will then move automatically to a visible display area.

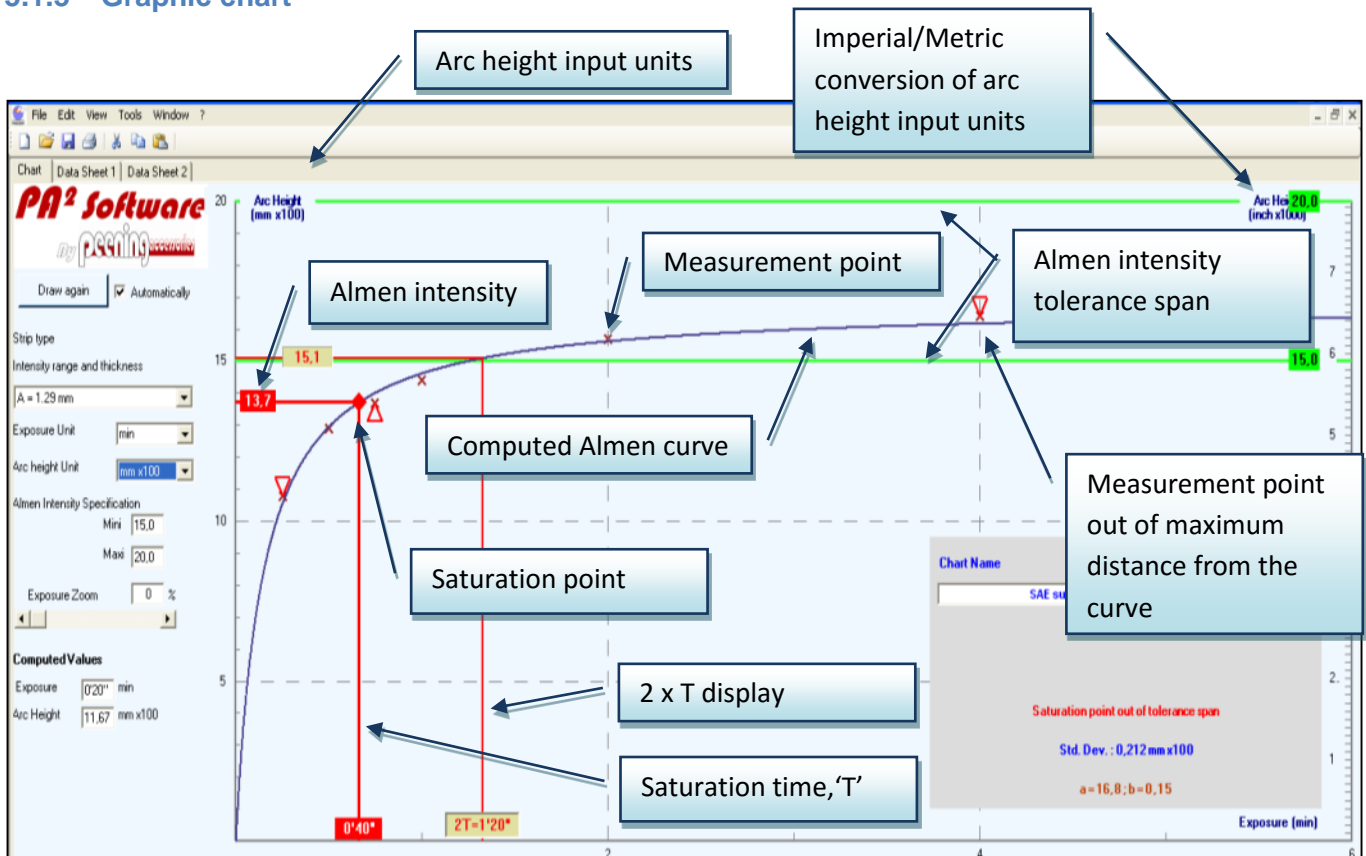
The message box can also be moved as desired, just by dragging with the mouse.

To cancel layout customization, click on <cancel>.

When all the elements are properly located, click on <Save this new display layout> to now freeze items as just arranged. PA² will then be closed automatically and modifications will be effective at next PA² session.

To come back to the original automatic layout, click on <Restore automatic layout>. PA² will then be closed automatically and modifications will be effective at next PA² session.

5.1.5 Graphic chart



5.2 Datasheets

All data related to the Almen and coverage curves building and the associated graphic chart can be saved here spread on 2 data sheets and sorted by topic of interest.

5.2.1 Navigation

To access to the data sheet from the graphic chart, select the tab "DataSheet1" or "DataSheet2" at the top of the graphic chart.

To go back to the graphic chart, select the tab "Chart" bottom at the top of the graphic chart.

5.2.2 Data input

White input boxes accept text data format with no restriction except the length. Grey boxes cannot receive data, depending on another input box content. Some boxes can only receive data from a selection list; click on the <▼> button at the right of the input box.

5.2.2.1 Customer, component and requirement data, Page-1/2

The data are dispatched through 4 areas

- Customer Data

Input here all information allowing defining clearly the company, organization or internal Department who is ordering the shot peening work.

- Work Part

Input here all information allowing defining clearly the work part name, location in the assembly, reference code, peening area, material and its main characteristics.

- **Specifications List**

Input here all standards and specifications references governing the shot-peening process, including customer and internal specifications and technical data sheets, purchase order...

- **Main requirements**

Input here the main requirements from the drawings, specifications, technical sheets, purchase order and any other contractual document.

Note: Almen strip type is a multi-choice input area where only N, A, C standard types can be selected. The Almen strip type input here is automatically copied in the graphic chart.

Chart name *

Customer Data

Company Location
 Contractor (end customer) Country
 Free Free

Work Part

Assembly Name Material
 Part Name Heat Treatment
 Reference Hardness
 Peening Zone Free

Specification List	AMS	SAE	Others
	<input type="text" value="NA"/>	<input type="text" value="NA"/>	<input type="text" value="XIK-2264 (PROCESS)"/>
			<input type="text" value="PLGR-B2 (SHOT)"/>
			<input type="text"/>

Main Requirements

Almen Strip Type * Coverage Rate
 Almen Strip Quality Maximum Roughness
 Minimum Almen Intensity *
 Maximum Almen Intensity *
 These labels can't be changed *

Residual Stress Profile

Compression Depth
 Depth of Compression Peak
 Compression Peak
 Surface Compressive Stress

Inside the datasheets, **any** label not marked with “ * “ can be changed; the modifications will apply to any existing and new files, except the 8 labels from the “Specific Data“ group in Datasheet 2 which will remain specific to each file if not changed.

Warning! The new labels will be effective for any other data sheet, including the ones already saved. I.e.; if the blue label of 3rd line on the right is “Date”, any new datasheet will have “Date” as label of the 3rd line at right.

5.2.2.2 Process parameters, Page-2/2

The screenshot shows a software window titled 'Chart' with a menu bar (File, Edit, View, Tools, Window, ?) and a toolbar. The main area is divided into three sections:

- Process Parameters:** Contains fields for Equipment Type (Wet peening), Machine Type (Direct pressure), Equipment (Wheel turbine), Number of nozzles (16), Nozzle Type (STRAIGHT), Nozzle Diametre (8), Air pressure (2 BARS), Shot Type (SCW), Shot Size (MM 0.8), Shot Hardness (HV 640), Shot Flow Rate (KG/MIN 10), Shot Concentration Water (%), Throwing Distance to Target (MM 125), Impingement Angle, and Shot Velocity (M/S 75).
- Movements:** Contains fields for Table Rpm, Spinner Rpm (65), Nozzle Speed (MMIN 0.25), and Scan Pitch (MM 25).
- Specific Data:** Contains eight input fields, each labeled '(Free)'.

At the bottom left of the form, there is a note: "These labels can't be changed *".

The data are dispatched through 3 areas

- **Process parameters**

Input here all information about the process, machinery and parameters. Some of the blue data box titles are interactive and will change according to your equipment and type selection.

- **Movements**

Input here all information about automatic work part or nozzle movement.

- **Specific data**

In this area, the 8 blue labels (Free) can be changed as well as well as the data content, up to your need. The label change will be effective only for the active data sheet.

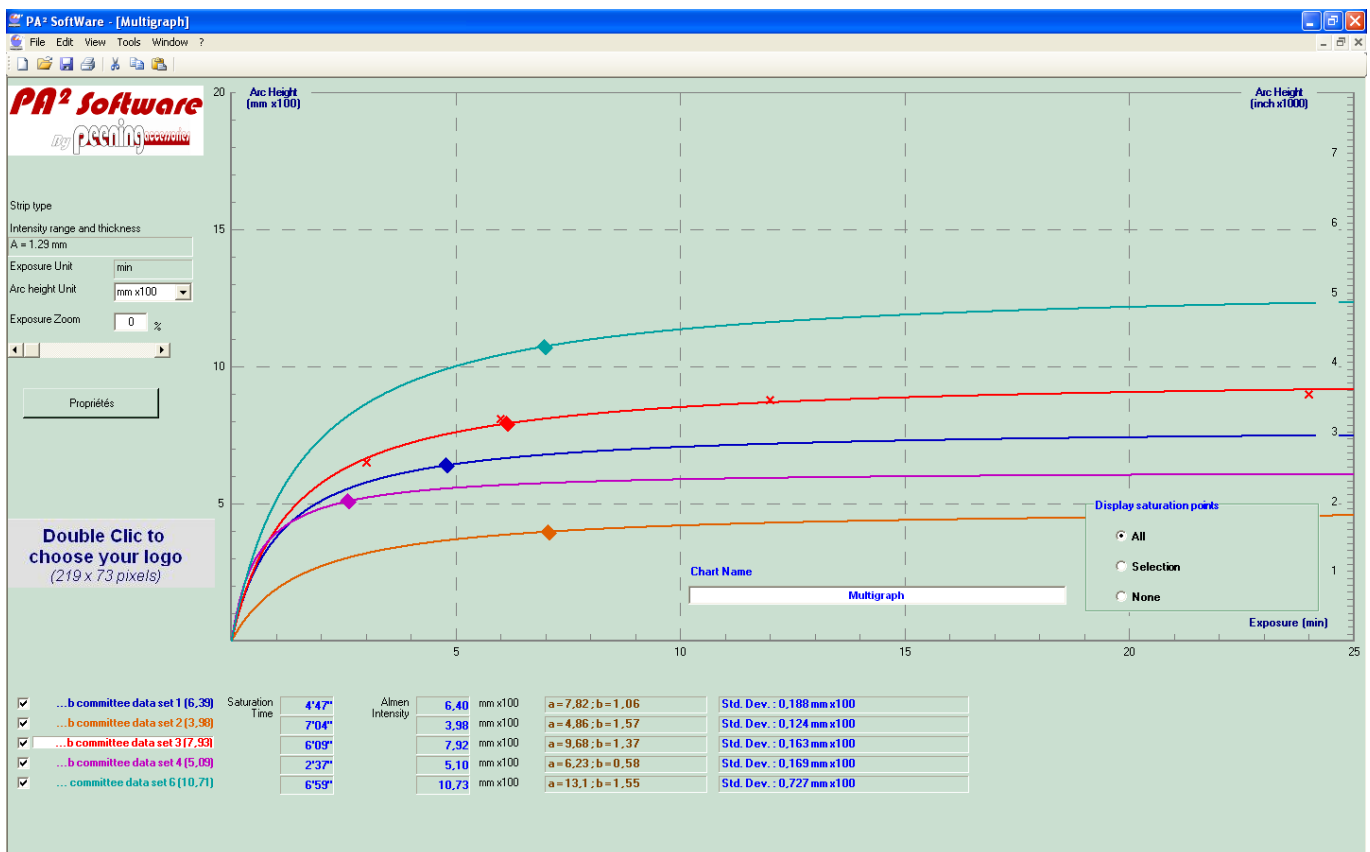
5.3 Multigraph chart

PA² Software offers the possibility to display up to 6 saturation curves together in the same graphic chart named "Multigraph".

5.3.1 What is the use of Multigraph?

The Multigraph functionality allows to:

- ✓ Display the different Almen curves for several Almen strip holders on the same component
- ✓ Compare several Almen curves from the same production campaign,
- ✓ Show the variation of Almen intensity versus air pressure, wheel turbine rpm, shot size and hardness...
- ✓ Represent the Almen curves (Max 4) in between the minimum and maximum tolerance limits,
- ✓ Check the influence of critical Almen measurement items such as different screw types used to mount the Almen strips, Almen strips pre-bow, re-use of Almen strips (forbidden)...



5.3.2 How building a Multigraph?

- 1 - Close any single chart that should not be included into the Multigraph,
- 2 - Open each of the single charts that will be included into the Multigraph,
- 3 - Select <Tools>, <Multigraph> or press <F5> which will automatically generate a new Multigraph chart.

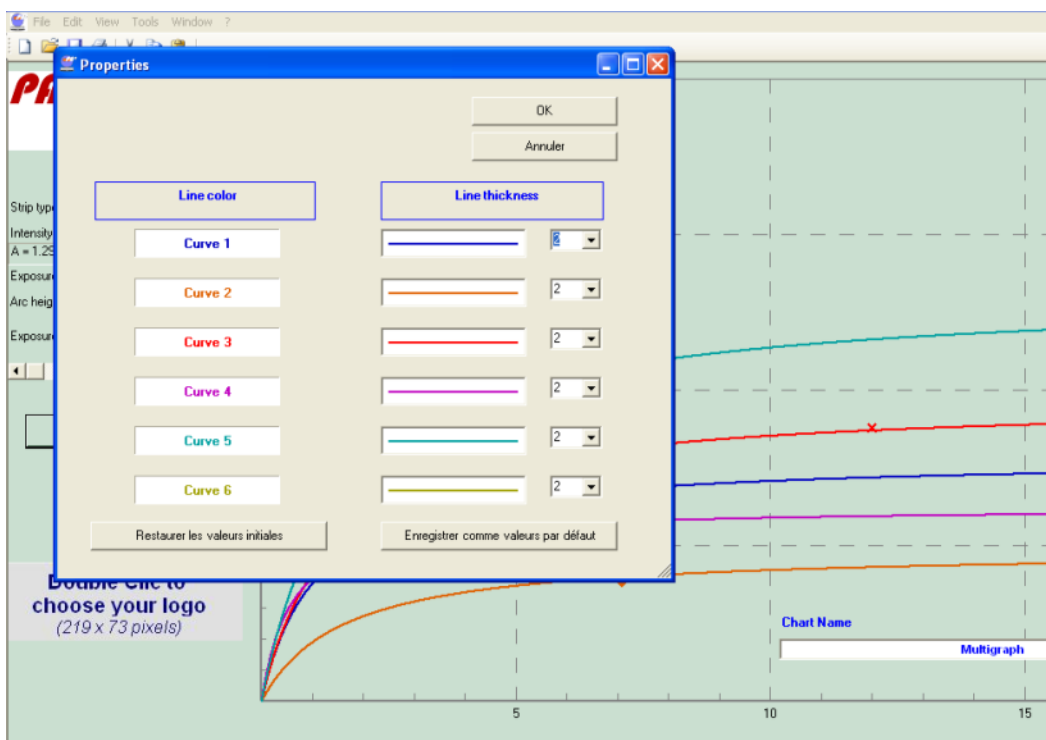
If the single charts use different types of Almen strips or different exposure units, a message will warn that only charts complying with the first chart will be selected.

5.3.3 Multigraph functionalities

- ✓ The active single chart is the one of which title is highlighted with a white background.
- ✓ In order to clarify the display, only the measurement points for the active single chart are displayed.
- ✓ To come back to a single chart, double click on its title or use <window> in the main menu.
- ✓ To remove a curve from the display but not from the Multigraph, just remove its check at the left. To display it back, click again in the check.
- ✓ To display the saturation points, select your option (all, selection or none) inside the control box titled "Display saturation points".

5.3.4 Display properties

Click on <Properties> to change the colour and thickness of the lines. The following window will open:



5.3.5 Multigraph Example

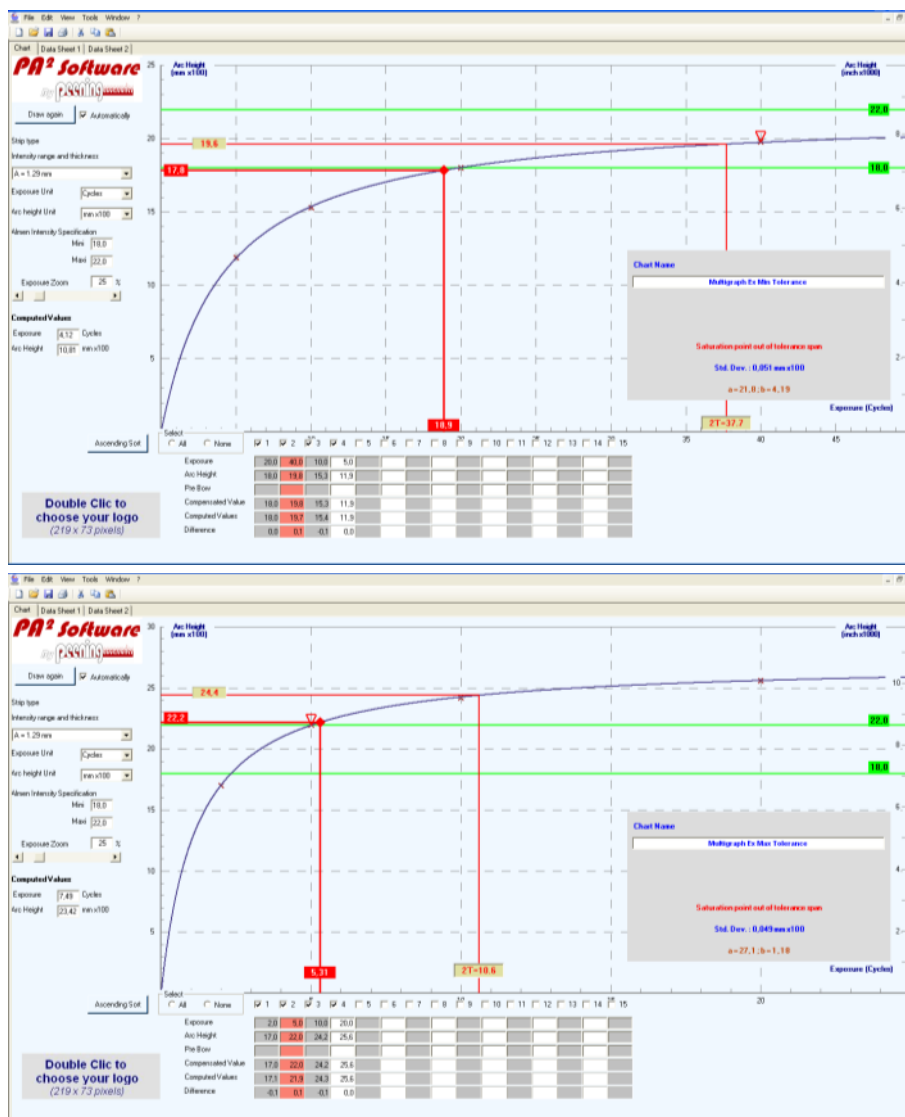
In this showcase, minimum and maximum tolerance Almen curves will be built for mm-A 0.18 and 0.22.

2 Almen measurements curves will be integrated into a Multigraph, together with the tolerance curves in order to check which one is acceptable for production and make a decision.

Recommendation: to ensure that any change in individual data set will be taken into account for the Multigraph building, do not save the Multigraph chart until all data of each chart are actually set.

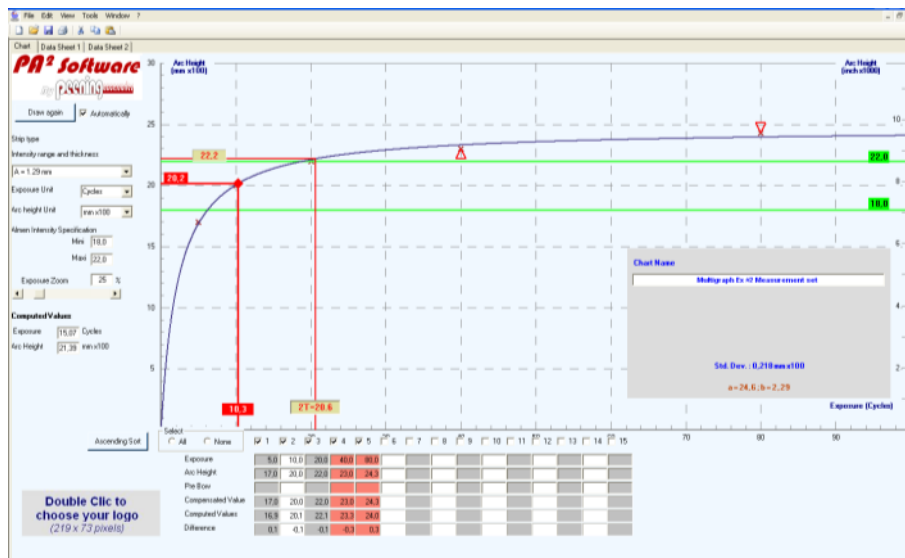
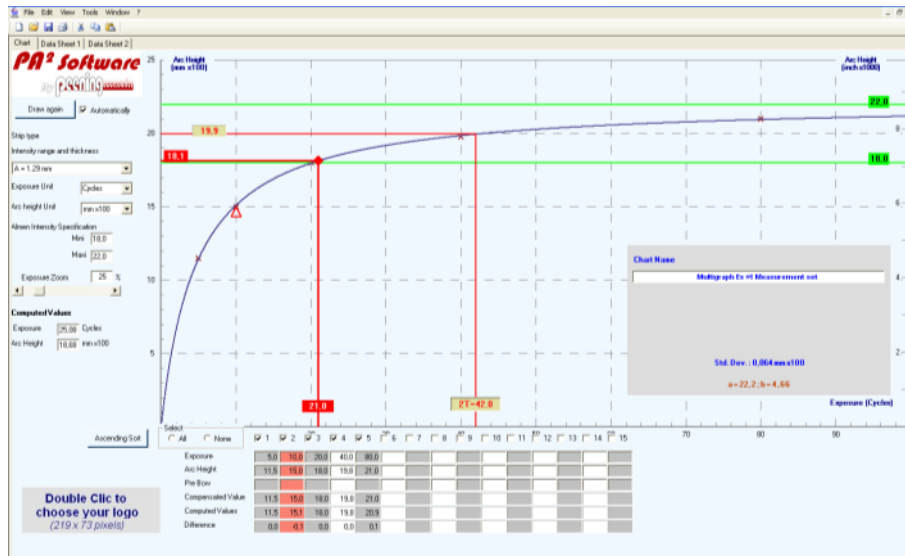
5.3.5.1 Building the tolerance curves

It is necessary to build the minimum and maximum tolerance curves just as any other Almen saturation curve, looking for a saturation point as close as possible from the tolerance values of mm-A 0.18 and 0.22.

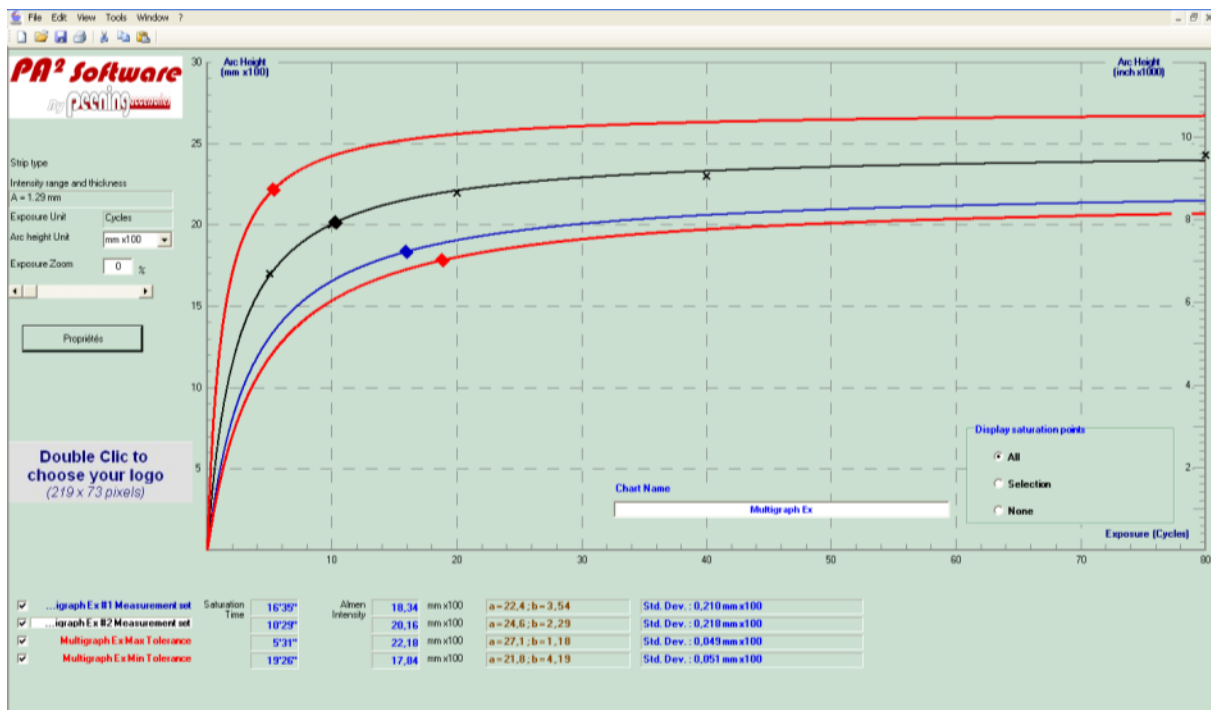


5.3.5.2 Building different curves in between the tolerance limits

Applying peening parameters in between the minimum and maximum amplitude of peening parameters defined at the previous step will produce Almen curves in between the 2 tolerance curves.



5.3.5.3 Multigraph and results exploitation



Here above, the Multigraph allows understanding the followings:

The lower is the Almen intensity, the longer is the saturation time,

Close to the lower Almen intensity tolerance limit, a given time variation induces low difference in arc height. Close to the upper Almen intensity tolerance limit, the same amount of time variation induces a much higher difference in arc height, but saturation time is much shorter.

This allows making decisions, depending on your own constraints in terms of industrial process, equipment capability and specification requirements...

5.4 Almen Gage Connection with the computer

The Almen gage can be connected through a USB port and simply used as data input device.

5.4.1 USB Gage-PC connection

Warning! The gage driver has to be installed, set up and active before any tentative to connect and use the gage. The PEENING ACCESSORIES' gage driver, is "GageWedge". GageWedge is supplied with the connexion cable (optional). GageWedge can also be downloaded for free following this link:



http://www.sylvac.ch/index.php?option=com_docman&task=doc_details&gid=159&Itemid=55&lang=en

5.4.2 Gage driver configuration

Before any tentative to download and install GageWedge, it is necessary to double check that you have all authorizations from your computer administrator.

GageWedge is designed as a very basic interface for Sylvac measuring tools. It allows feeding gage readings directly into Windows programs. GageWedge is designed to be extremely easy to use. Standard RS232 transmission Sylvac parameters: 4800 bauds, 7 data bits, even parity, 2 stop bits, For Windows OS and Windows7.

The screenshot shows the GageWedge (Inactive) window with the following settings and callouts:

- Callout 1:** "Choose the port which the Almen gage is connected to." points to the "Port:" dropdown menu set to "COM2".
- Callout 2:** "Select 'Use coma as decimal separator'." points to the checked checkbox "Use Comma As Decimal Separator".
- Callout 3:** "Select 'filter out non numeric characters'." points to the checked checkbox "Filter Out Non Numeric Characters".
- Callout 4:** "Post amble keystroke should always be selected." points to the "Postamble Keystroke:" dropdown menu set to "None".

The software window includes the following text:

STEP 1: Select a serial port and choose your preferences.

Port: COM2

Preferences:

- Gage Uses OptoRS Duplex Adapter
- Use Comma As Decimal Separator
- Beep Speaker On Input From Gage
- Filter Out Non Numeric Characters
- Load With Windows At Startup

Postamble Keystroke: None

STEP 2: Transmit a reading from your gage. If data does not appear correctly in the text box below, you may have to check that your gage is configured correctly or choose a different serial port.

Input Data From Gage:

STEP 3: If data appears correctly, keep Gage Wedge running and switch to another program. When you transmit data from your gage, it will appear in the other application as if it were being typed in.

Press Function Key F1 For Help

5.4.3 Automatic data transmission



Once GageWedge is active, PA² requires no other specific artifact to be used with the Almen gage. GageWedge will transmit the data from the Almen gage to the computer.

To input data from the Almen gage, place the Almen strip in the gage and press the <Set> button. To input the next measurement, it is necessary to press again the <Set> button.

At any time, data can be input indifferently through the computer keyboard or through the gage connection.

After configuration of the gage driver, it is then possible to allow the number of digits and the measurement sign, positive or negative (see gage software user's manual).

6 Coverage Simulation

6.1 Purpose

The purpose of this tool is helping in answering the complex and subjective question:

What is the optimal amount of craters for covering the component surface whilst meeting specifications and minimizing the surface damage and processing costs?

PEENING ACCESSORIES is using a scientific method based on Johnson-Mehl-Avrami-Kolmogorov equation, known since 1949 as “JMAK” Law, to produce artificial pictures, representing the surface after a given number of shots have randomly reached the target surface, each of them creating a single crater. The advantage of an artificial picture is that the quantification is easy and not subjective. In a few cases, the limitation is the difficulty for precisely fitting with reality.

These artificial pictures help then building the coverage curve and calculating the 98% physical and 100% practical coverage vs. amount of exposure. PA² Software also producing artificial pictures for comparing with reference pictures taken from the microscope on any other optical magnification tool.

6.2 Definitions

Crater: spherical print into the target surface, characterized with its size (diameter) and depth.

Developed craters area (mm²): sum of individual craters areas that are included inside the inspection area.

Overlapping: crater superposition. Following the random surface bombardment, the first shot has 100% chance hitting a virgin surface, the last one has 100% chance hitting in a crater.

Crater population density: ratio of the developed craters area over the inspection zone area.

Physical coverage rate (%): proportion of the inspection zone area that has been actually impacted.

Practical coverage rate (%): since 100% physical coverage rate is not achievable, 98% physical coverage rate is set as practical 100% coverage (industrial).

Time for 100% practical coverage rate: time for 98% physical coverage rate.

Coverage factor: Some specifications require practical coverage rate (specified) different from 100%, using a coverage factor applied to the peening exposure (time).

i.e., 118% practical coverage means: Practical peening time = (98% physical coverage time) . (practical coverage factor (=1.18)).

Notes:

1. In this case, physical coverage = 99%.
2. To reach 99.9% physical coverage, the coverage factor is 1.767.
3. Coverage specification lower than 98% means pure physical coverage and not using the coverage factor.
4. The actual peening time for the component production is based on the practical coverage time, multiplied by the area ratio (component area to operate / coverage testing area).

6.3 Picture and data table

This tab will produce an artificial coverage picture, depending on shot size distribution, peening intensity and exposure time.

Once the Almen intensity has been set up, and peening parameters have been “frozen”, then the coverage study can start.

Shot size distribution (mm)						Craters					
Control sieves	Mean size	Retained	Accumulation	Diameter (mm)	Depth (µm)	Population	Developed area				
d4	1,700	d > d4	-	(gr)	(%)	0 %					
d3	1,425	d3 < d <= d4	1,563	1	1 %	1 %	0,313	15,8	7	0,53	0,9 %
d2	1,250	d2 < d <= d3	1,338	12	12 %	13 %	0,268	13,6	137	6,67	10,7 %
d1	1,180	d1 < d <= d2	1,215	87	87 %	100 %	0,243	12,3	1326	54,94	88,4 %
Pan		0 < d <= d1	0,590	0	0 %	100 %	0,118	6,0	0	0,00	0,0 %
Effective shot size		1,233	100 gr			Total			1470	62,15	100,0 %
Intensity correction				20 %		Crater population density Dc = 3,88					
Shot flow rate				49 %		Approximate coverage rate C(%) = 97,9					
Picture size (mm)				4							
Picture area (mm²)				16							

NOTE: 1% Coverage = 16 graphic cells of 0.1 x 0.1 mm side

6.3.1 “Picture size” and “total number of impacts”

Except if the shot is too fine, use the “automatic” picture sizing. For fine shot, reduce the “Picture size” and/or increase the “total number of impacts”. The recommended standard “total number of impacts” is “3.200”.

6.3.2 Shot size distribution

For as new cast shot, or working mix of any type of shot, the shot size analysis is made by weighing the amount of shot retained on each standard test sieve (screen).

- 1- Input the sieve opening in mm in the “Control sieves” column. The largest sieve opening must be at the top and the finer at the bottom (pan).
- 2- Beside each sieve Input the weighing results, in the “Retained” column, in grams, that will be automatically converted into total mass percentage. If already known, the measurements can be input directly in %. Select “(gr)” or “(%)”. If less than 4 sieves are required, input zero in the sieve contents from the bottom (pan).

For as new or conditioned cut wire that have a tight size distribution, it is recommended to input the nominal shot size everywhere in the column “control sieves”, input “100%” in one of the “Retained” cells and “0%” in any of the remaining ones.

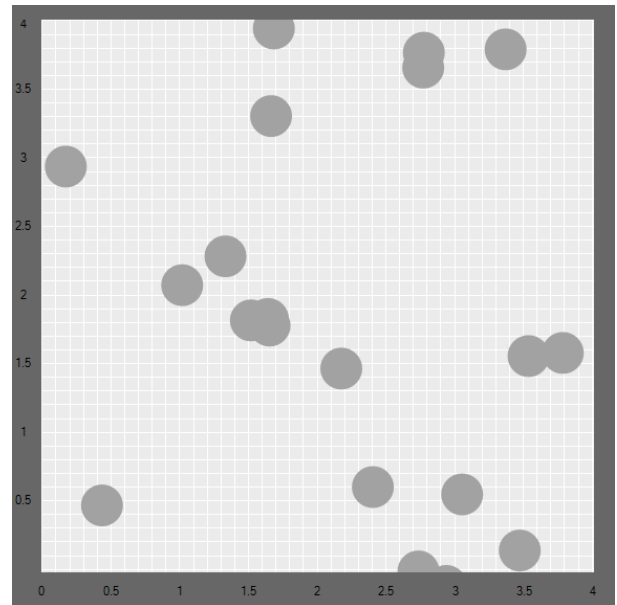
Note: The “JMAK” law used for PA² Software works with a constant individual crater size. Therefore, when the shot size, and subsequently the crater size is dispersed, the larger the dispersion is, the lower will be the accuracy of the coverage rate result. Nevertheless, the shot size requirements from shot peening standards are stringent enough to keep the PA² Software error on coverage rate low and acceptable for process control. PA² Software has been calibrated with an image analysis software, giving less than 0.25% difference with PA² Software coverage.

6.3.3 Crater sizing by “Intensity correction”

Each crater has a given diameter and depth that can be objectively taken into account:

At low coverage rates, i.e., 10%, the real diameter of isolated craters can be measured under a microscope. Then, the “Intensity correction” can be adjusted by simple proportional calculation to make the crater size calculation fit with the measured size.

The crater depth will be automatically calculated according to its diameter. This value is a good 1st Rmax roughness estimation (ISO 4287).

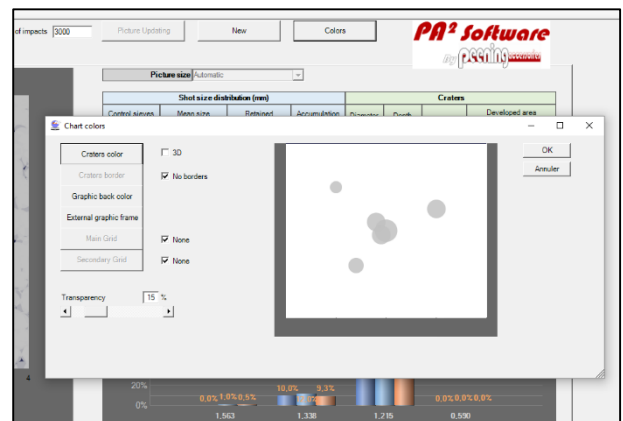


6.3.4 Picture settings

PA² Software offers several picture configurations in order to produce artificial pictures as close as possible from reality.

6.3.4.1 “Craters color”

Depending on the optical magnification properties real craters will appear with the color of the base metal with no oxidation. It is then possible testing and keeping in memory the base material “RGB” or “HSL” color. The “3D” check should be kept “off”. It helps representing very high surface roughness i.e., ductile alloy under high peening intensity.

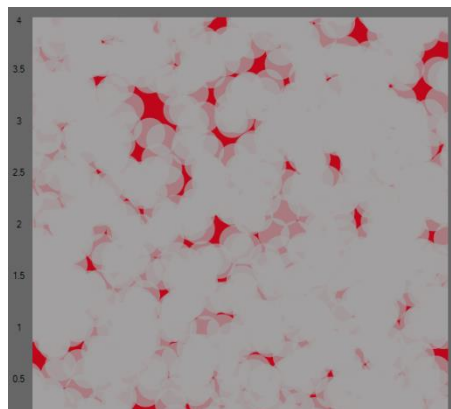


6.3.4.2 “Craters border”

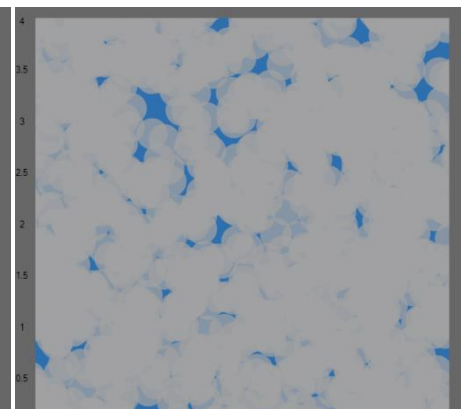
Since real craters are not marked with borders, this function should only be used on specific purpose; i.e., to make crater size measurement easier.

6.3.4.3 “Graphic back color”

The “graphic back color” will represent the virgin surface before peening. This can be the metal, or its oxide color, a varnish or a special coating for coverage check... It is then possible testing and keeping in memory the virgin material “RGB” or “HSL” color. See here beside some example: pictures:



Red marker for whiteboard



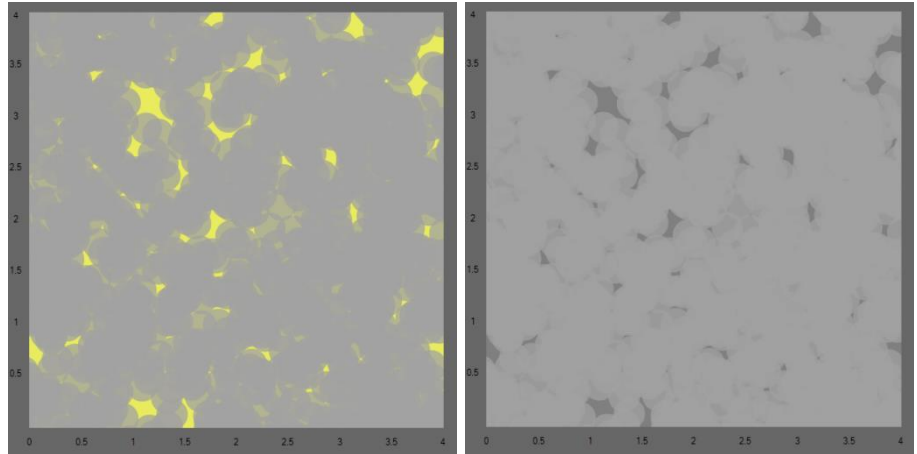
Blue ink

6.3.4.4 “Main grid” and “Secondary grid”

For easy scaling and sizing of craters and counting of virgin and impacted areas, the main and secondary grids can be, or not be displayed.

6.3.4.5 “Transparency”

To imitate real picture conditions, the craters can be made more or less transparent.



Yellow fluorescent tracer

Natural virgin material

6.4 Calculation grid

This tab allows detailed inspection of craters location, size and excluded area when partly or totally out of the picture frame. Each column can be sorted by a simple click for ascending and double click for descending order.

PA² SoftWare - [C:\Users\F-Xavier\Documents\Pa2\Graph1.alm]

File Edit View Tools Window ?

Back to Almen curve | Graph1 | Total number of impacts 3000 | Picture Updating | New | Colors

Picture and Data Table | Calculation Grid | Overlapping Map | Coverage Curve

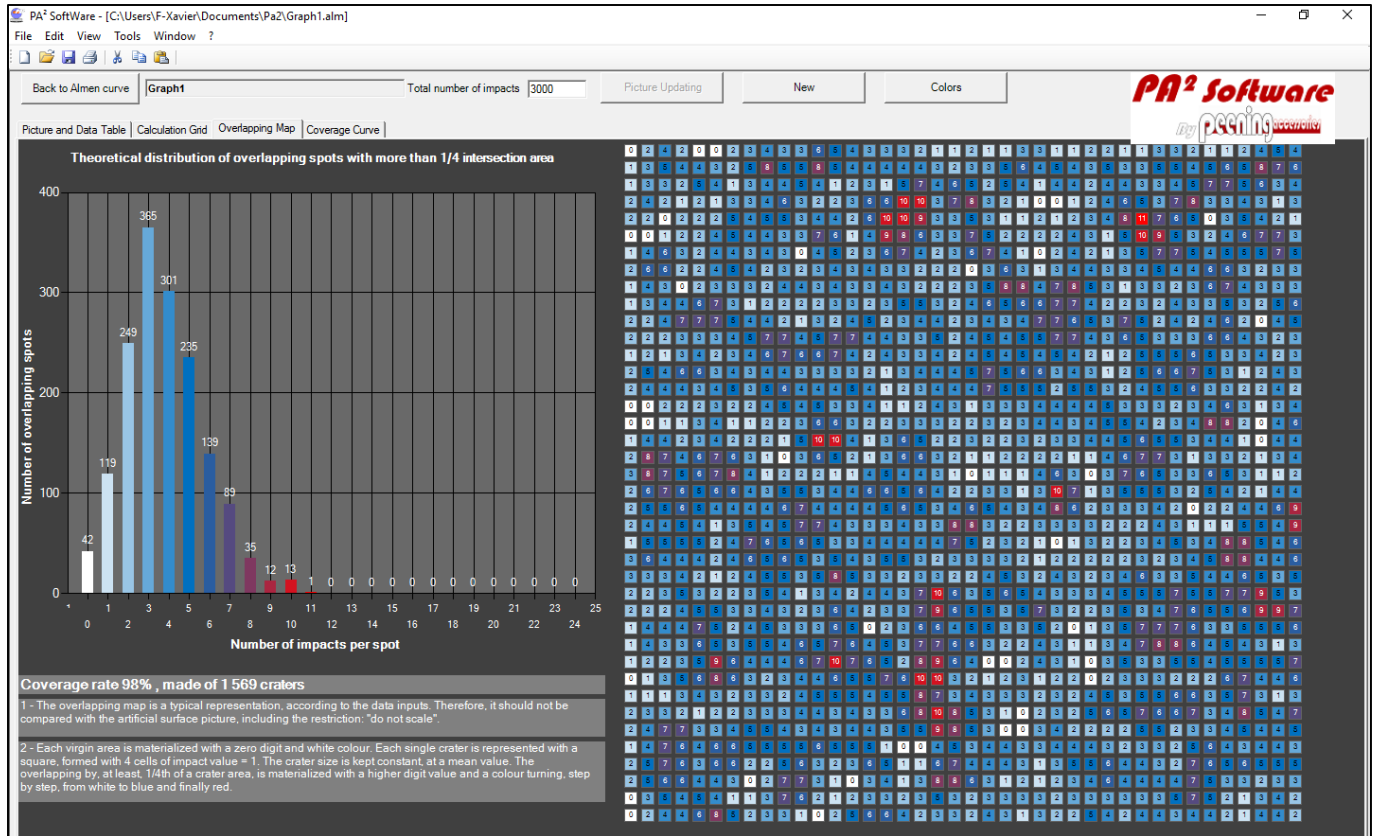
Cumulative excluded area 7.379

n	X	Y	Size	Radius out	Area out
0	3.246	2.932	0.313	0.000	0.000
1	3.416	0.638	0.313	0.000	0.000
2	1.855	0.052	0.313	0.104	0.022
3	0.816	0.155	0.313	0.001	0.000
4	0.549	3.836	0.313	0.000	0.000
5	0.669	1.784	0.313	0.000	0.000
6	2.901	0.264	0.313	0.000	0.000
7	2.134	2.344	0.268	0.000	0.000
8	1.952	2.114	0.268	0.000	0.000
9	0.776	1.584	0.268	0.000	0.000
10	4.038	3.340	0.268	0.172	0.038
11	1.944	0.698	0.268	0.000	0.000
12	1.236	0.524	0.268	0.000	0.000
13	2.053	2.586	0.268	0.000	0.000
14	3.358	1.506	0.268	0.000	0.000
15	3.849	3.975	0.268	0.109	0.022

6.5 Overlapping map

For a given coverage rate, this tab shows an estimation of the number of locations where a given amount of overlapping occurs. The data are presented as an “Overlapping map” and also as a Gaussian distribution bar graph.

No input can be made in this tab. Any modification in the “Picture and data table” tab will be translated automatically in the “Overlapping map”.



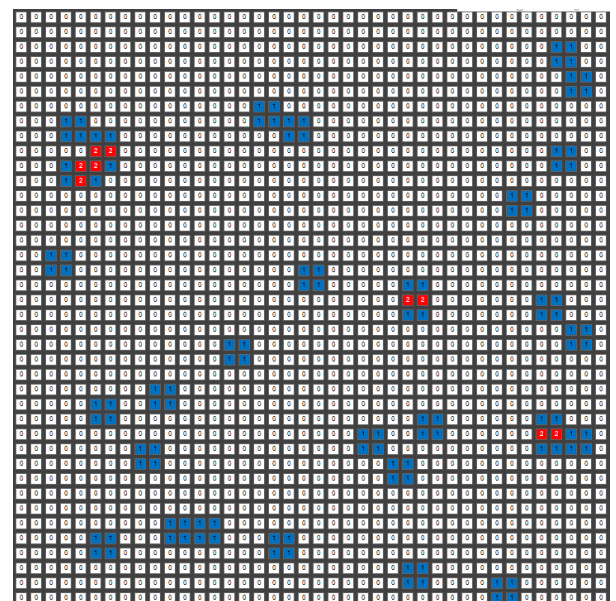
6.5.1 Map building

The area to be represented is gridded with $40 \times 40 = 1600$ cells (spots)

Each crater is randomly located and represented with 4 cells, each having a value of “1”

In reality, craters are nearly round and they can have intersections area from almost 0% to 100%. The square crater shape is a good approach, but minimum intersection is 25%. Therefore, intersection possibilities are 25, 50 or 100%.

When overlapping is happening, the craters having intersections with other ones, their cells values are added. This process is easy to understand when coverage is low. See the aside picture.

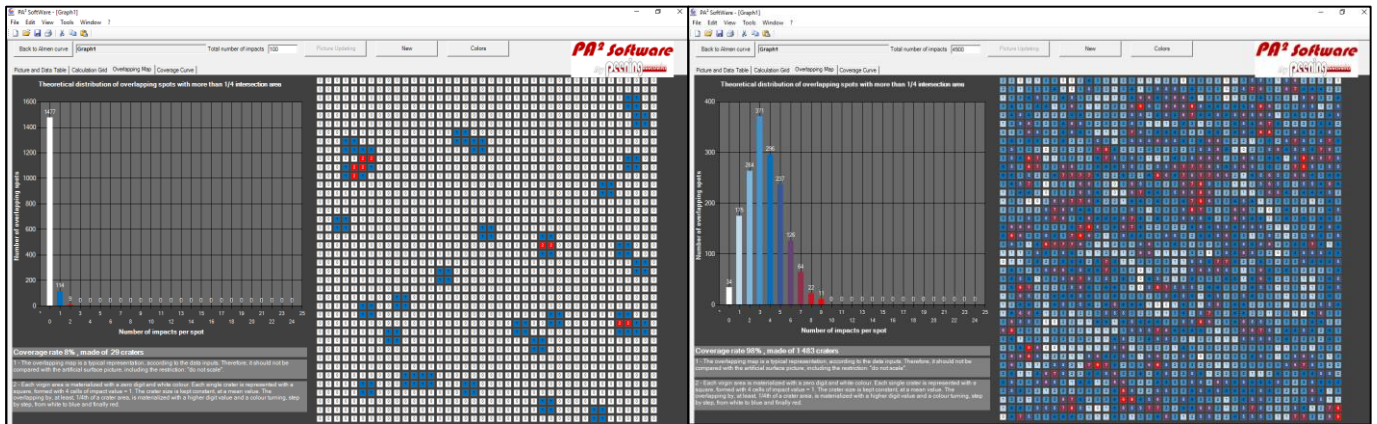


For a given amount of coverage, the number of cells among the 1600 total ones to be different from zero can be easily calculated by proportional law. Then, by random method, the individual craters are located and each of their

4 cells receive a value taking into account the intersections with the other ones. The cells are then colored from white for “0”, to blue for medium overlapping value and to red for “maximum overlapping value.”

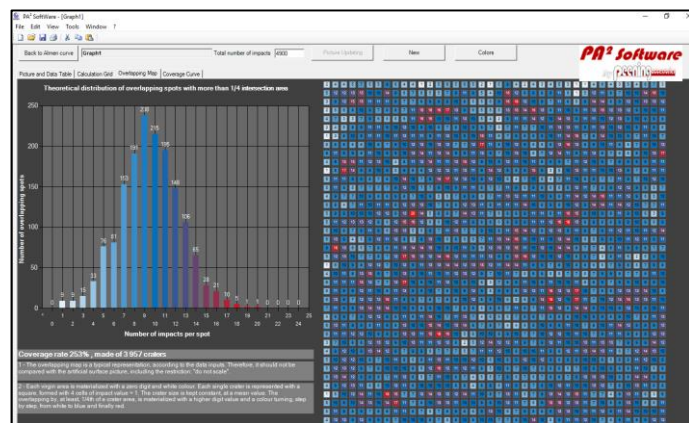
6.5.2 Theoretical distribution of overlapping spots with more than 1/4th intersection

No overlapping happens in the cells (spots) showing “0” or “1” impact.



Low coverage, the bar graph is squeezed to the left. Max number of impacts at the same spot is “2”.

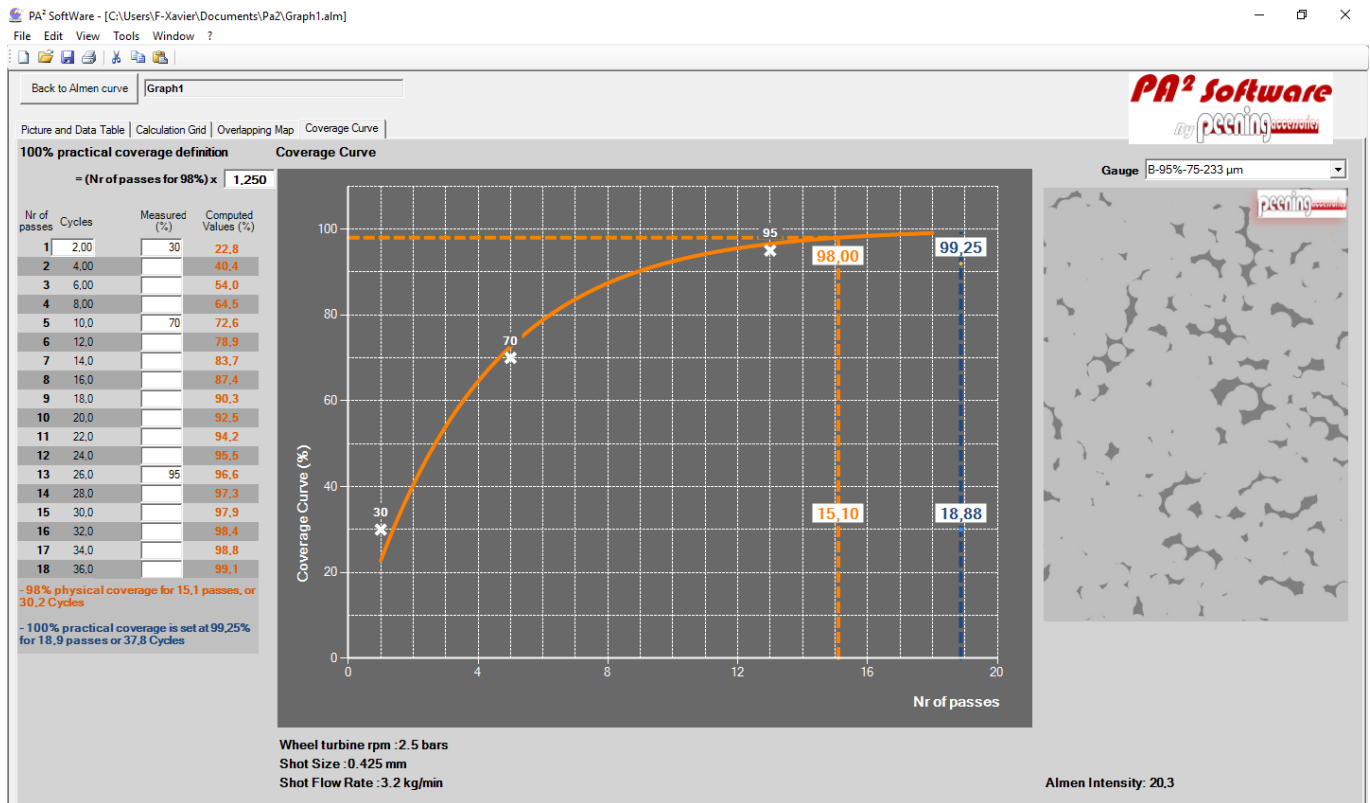
98% coverage, the bar graph is balanced, with a central peak. Max number of impacts at the same spot is “9”. 50% of the area showing, at least, “3” impacts at the same spot.



253% coverage, the bar graph is balanced, with a central peak. No virgin spot remaining. Max number of impacts at the same spot is “20”. 40% of the area showing, at least, “8” impacts at the same spot.

6.6 Coverage curve and physical coverage rate calculation

This tab allows building the physical coverage curve and determining the amount of exposure for 98% physical coverage rate and the amount of exposure (time) for practical (specified) coverage rate.



6.6.1 Measurements input

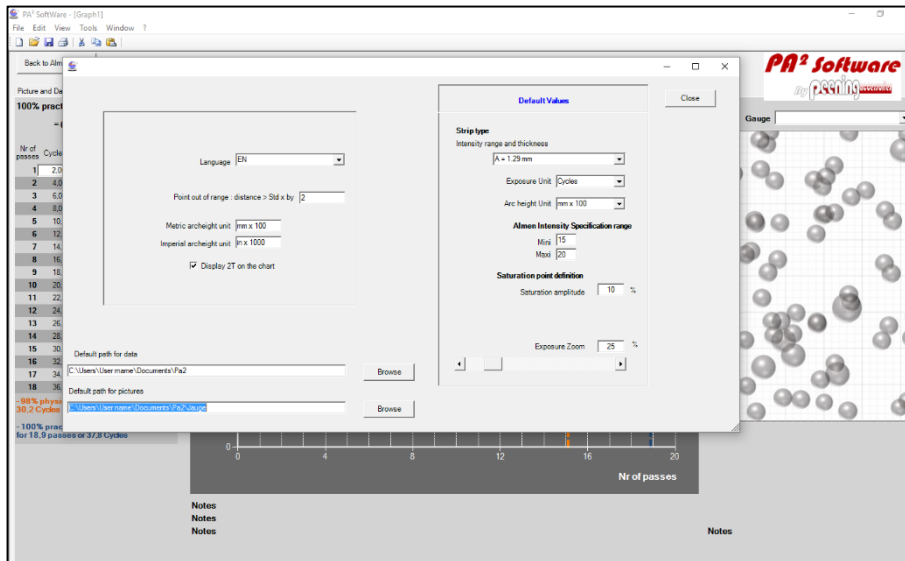
In the 1st column titled “Nr of passes”, no input is possible.

In the 2nd column titled with the same “exposure units” as input in the original “Almen curve”, only the first value can be input. This will set up how many “seconds” is lasting one pass or how may “cycles” per pass: i.e., “0.5” “cycle” per “pass”, which means: each cycle is made of “going”, first half cycle, and “going back”, second half cycle. The other values in the same column are automatically calculated from the first one.

Notes:

- 1- If the first measurement is too low, usually below 20%, the 98% physical and 100% practical values will be out of the graph.
- 2- It is not necessary to give very precise values. Usually +/- 2% is acceptable.
- 3- The automatic display of the computed coverage value should not disturb the operator. When it is too far from estimation, just invite somebody else to give his own input, or repeat this specific measurement or some of other ones.
- 4- Use both real reference pictures taken from the microscope and artificial reference pictures from PA² Software. These “Gauge” pictures can be kept in specific computer directories with direct access via PA² Software.

6.6.2 Gauge



At the screen right, a reference picture is displayed to help the operator determining the coverage by comparing the artificial picture rated by PA² Software with the actual observation with the microscope or lens.

At PA² Software installation, the directory where Reference picture are stored is

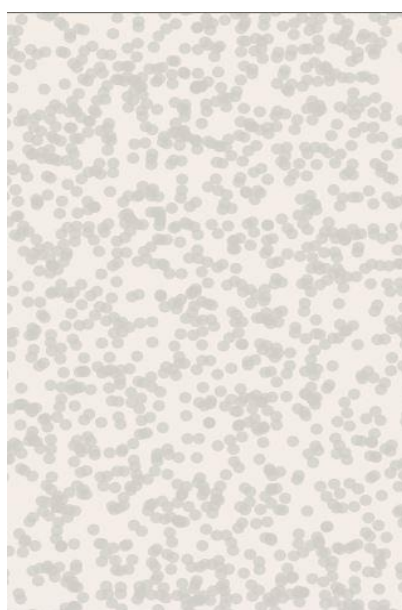
C:\Users\“Username”\Documents\Pa2\Jauge

PEENING ACCESSORIES recommends:

- 1- Creating subdirectories by picture type: real pictures from microscope, reference artificial pictures from PA² Software, pictures for different components, locations in the component, materials, coverage revelators, peening parameters...
- 2- Since the file names will appear in the choice list, to give very descriptive and short file names. I.e.:
 - “98%-blade root radius-SCCw24-10A”, if the media and peening parameters are versatile,
 - “50%-coil-inside-front-end” which is enough if the media and peening conditions are permanent.
- 3- Do not leave unapproved reference pictures accessible. Place them in a specific directory, different from the PA² default path.
- 4- Renew the reference pictures a.s.a.p. when improved ones are available.



Real picture 50% coverage on Aluminum component.



PA² Software 50% reference picture.