ADVANCED PORT & PIPE
MANUAL

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1. INFO BEFORE USE

1.1 INTRODUCTION

The program is intended for both amateurs and professionals with basic knowledge about the 2-stroke cycle and its pulse dependency. It's possible to succeed quite well without any particular knowledge though, since the program contains a lot of recommended values for different tuning degrees. The novice tuner will therefore learn a lot by trying different ways to design the system within the limits. The parametric design approach updates the charts instantly and helps anyone to try new shapes and understand the changes. However, deep knowledge about 2-stroke tuning makes this program even more efficient and flexible. One thing is to calculate the shape; another is to do it on real hardware. Without correct machining tools, the result will be what the tools can admit and what they are forced to do by your hands.

The program is written for Microsoft Excel 2003, i.e. in order to run it you need to have at least MS Excel 2003 installed for full compatibility. **Without MS Excel installed, it will not work**.
Trial versions of Excel will not work either.
The units are in mm, m/s, cm^3, rpm, Celsius and degrees.
Pipe tables are defined in accordance to G.P. Blair's definitions, i.e. the dimensions can be transferred directly to his 2-stroke simulator programs for further work.

1.2 INSTALLING, OPEN / SAVE

The program is delivered as a internet download link, unique compiled to each user. No installation is needed, and different calculations can be stored in different file names.
Example: Save As…; MyEngine1.xls, MyEngine2.xls, etc.

When running the program, Excel may ask for acceptance to run macros dependent on the security settings in your PC. This program is reliable and free from virus so you should accept to run macros, otherwise the program will not work properly. If you have trouble with this setting then see the troubleshoot section at the end of this manual.

Information about the latest version be found in the programs 'About…' page or at www.bimotion.se under Port & Pipe; update info., where also the changes are described.

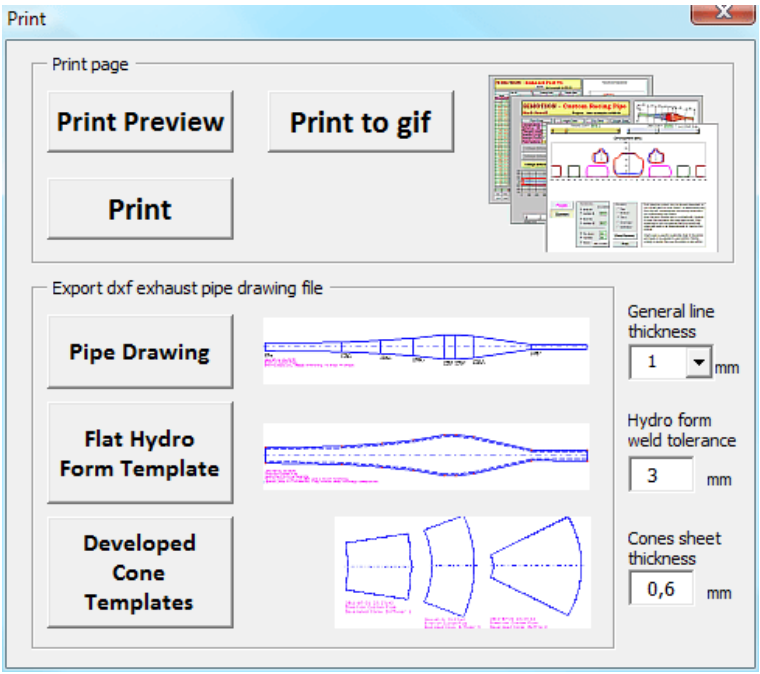
Picture 1

1.3 CHANGING LANGUAGE

The program language can be changed by importing a language file which is downloaded from the Bimotion site at the Port&Pipe page. (www.bimotion.se/Pipe/lang/). Change language simply from the 'About…' page and 'Import Language' button, see section 2.9. Available languages will increase in time as soon as they are translated. The. typical name of a language file is 'Bimotion_Port_Pipe_text_english.xls'. If your language is missing and you want to contribute with translation, please contact Bimotion and it will be added !

1.4 PRINT FUNCTION

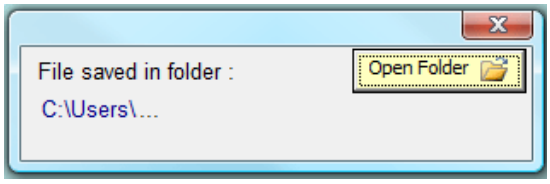
- The print function is divided into printing the pages and exporting drawings in cad dxf format for laser cut machines or manual cut. The cad files contain descriptive text in the plot.
- 'General line thicknesses apply to the pen thickness of continuous lines in drawings. 'Hydro form weld tolerance' is a measure to add for TIG welding when melting the edges together.
- 'Cones sheet thickness' is an ad for the sheet thickness since all dimensions refers to inside cones dimensions. See also the 'Cone Development' window (picture 20). Drawing entities are sorted in different layers and may then be filtered in a dxf viewer or cutting machine.



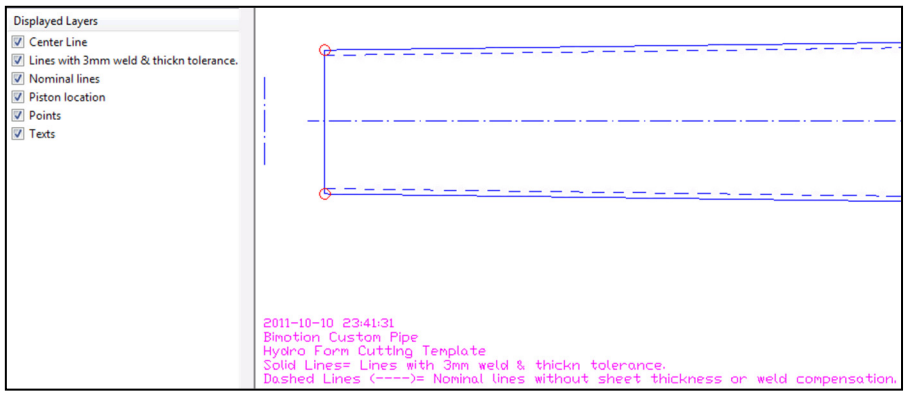
Picture 2

Print to GIF saves a picture file of the current sheet into a folder that is specified before saving if the 'Save to' check box in the "About…" page is checked. If it is not checked, then the files will be saved in the folder that the program was started from. The dxf file saving works the same way.

After saving, a window shows the chosen folder is shown in 3 seconds and the folder can be quickly accessed by clicking the 'Open Folder' button in that window.



Picture 3

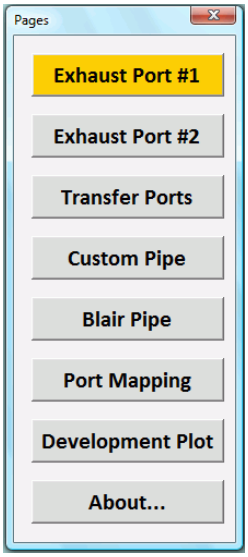


Picture 4. Example from a dxf viewer. (e-drawings)

2. PROGRAM MODULES

2.1 BASIC FEATURES

Green cells are input cells, and yellow are output. All cells except the green ones are locked for changes. The diagrams and the yellow cells are instantly updated when any green cell is changed. Cells with a red mark in upper corner (Vertical) will show a pop-up text with recommendations or explanations when the cursor is moved over them.



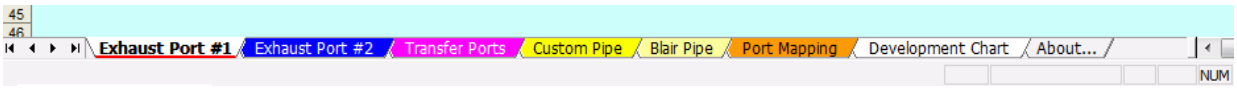
Picture 5

There are two screen modes, one full screen with hidden tool bars, menus etc. for cleanest possible view and one in normal window view. When full screen is enabled, other windows can not be shown at the same time, this is possible in normal window view only.

Screen

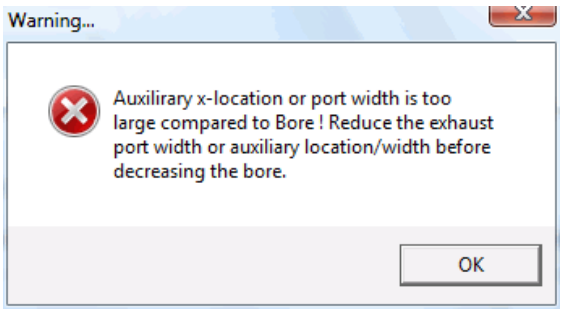
The different sections, or pages, are accessed from the 'Pages' button, or from the tabs at the bottom when the option checkbox is on in the 'About…' page.

Pages

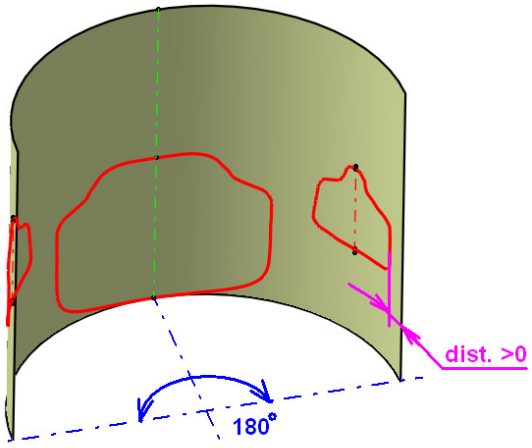


Picture 6

If any of the exhaust ports develops more than across half inside of the cylinder (over 180° referenced bore center axis) then a warning will pop up. The program will not compute such designs correct and is regarded as an error input. This may occur if the bore is decreased, port width increased or auxiliary ports are moved or enabled. Simply reduce the exhaust port width before decreasing the bore to overcome this !



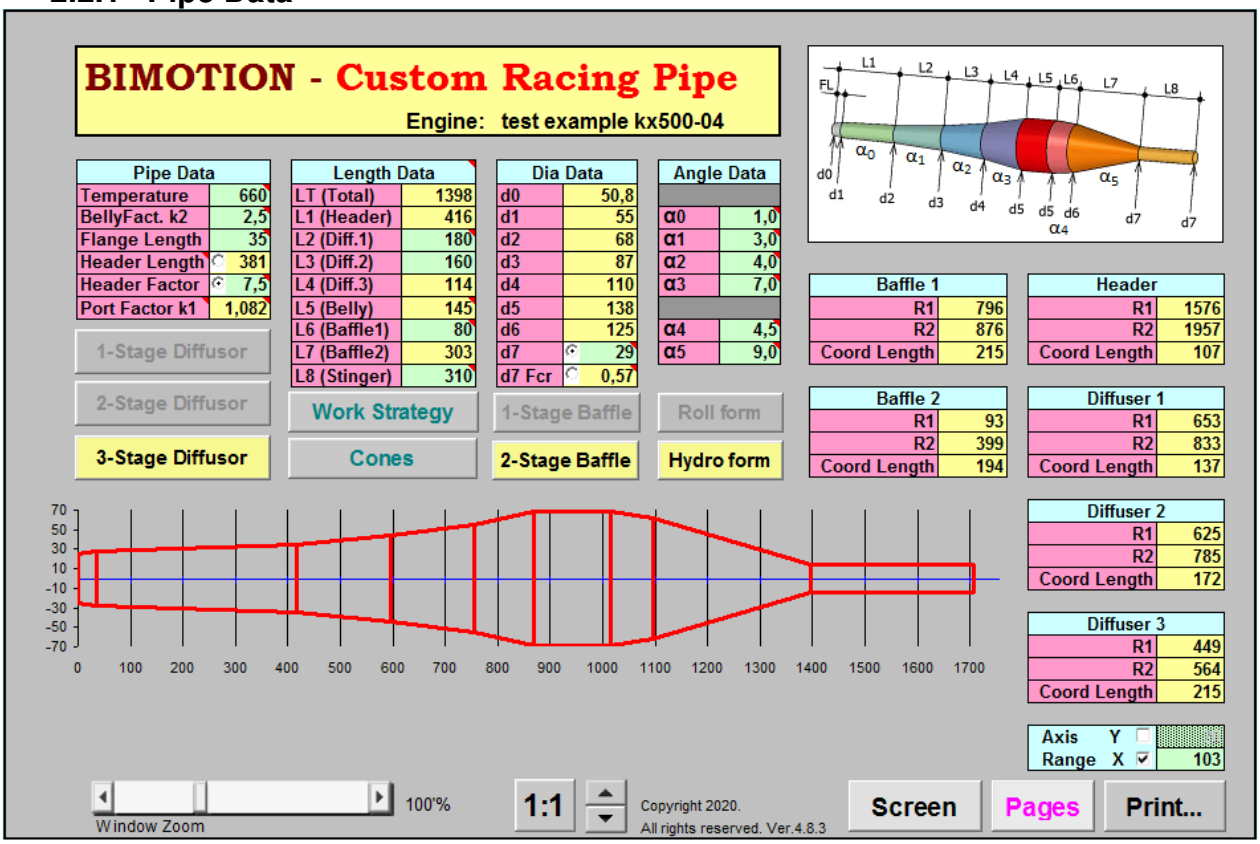
Picture 7



Picture 8

2.2 CUSTOM PIPE

2.2.1 Pipe Data



Picture 9. Custom Pipe Design page.

Pipe Data	
Temperature	500
BellyFact. k2	2,5
Flange Length	25
Header Length	357
Header Factor	8,0
Port Factor k1	1,098

Picture 10.

- The temperature usually varies between 400-600 deg Celsius, measured in the belly. A good recommendation for medium performance engines is to aim for a range of 400-500 deg C.
- A large Belly Factor widens the power band, but it also assumes an efficient designed exhaust port. If your tuning target is medium than keep the factors to a medium.
- 'Flange Length'+ 'Header Length' = 'L1 (Header)'
- Header length can be entered either as a length in mm or a factor of pipe dia. by selecting an option button. A wide range of recommended factors are given for different tuning degrees and engine sizes.
- The 'PortFact. k1' is very important. Getting this wrong will spoil the pipe. Any sudden area change from the piston to first diffusor will lower the pipe efficiency.

2.2.2 Length Data

Length Data	
LT (Total)	1237
L1 (Header)	382
L2 (Diff. 1)	180
L3 (Diff. 2)	150
L4 (Diff. 3)	118
L5 (Belly)	103
L6 (Baffle1)	90
L7 (Baffle2)	214
L8 (Stinger)	220

Picture 11.

- Total length 'LT (Total)' is measured from the piston to the end of 'L7 (Baffle2)'. Unless you do not know exactly what you are doing and why, dimension the diffusors so that L2 > L3 > L4.
- Using a 2-stage baffle will usually widen and sometimes suppress the top end power some. The configuration is most efficient on small engines with narrow power bands.

2.2.3 Dia Data

Dia Data	
d0	44,6
d1	49
d2	55
d3	74
d4	98
d5	123
d6	108
d7	29
d7 Fcr	0,65

Picture 12.

- The diameters are measured inside the pipe. Don't forget to add material for the thickness compensation when rolling the cones.

- Stinger diameter 'd7' is critical to heat buildup and power production. This parameter usually needs to be tested and carefully checked. The stinger length L8 is not critical below 9000 rpm. Above this speed, the stinger will produce a plunging wave that will improve the scavenging. If the transfer ports or intake tract are not properly designed then this extra energy will not be noticeable. Stinger dia can be entered as a dia or a factor of the header dia by clicking an option button. Recommended factors are given for different tuning degrees.

2.2.4 Angle Data

Angle Data	
alfa0	0,8
alfa1	3,0
alfa2	5,0
alfa3	7,0
alfa4	5,0
alfa5	11,0

Picture 13.

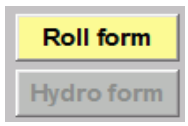
- The cone angles refer to divergent angle measured to the centerline in degrees.
- The header interacts a lot with the exhaust port shape, so this angle is dependent on the exhaust port configuration. Sometimes an engine can benefit from a non-divergent header, especially if the port is relatively large or not state of the art.

2.2.5 Diffusors

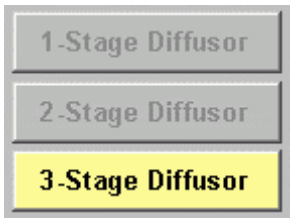
Diffusor 1	
R1	214
R2	354
Coord Length	116

Picture 14.

These dimensions apply to either roll developed cone templates or hydro form cone templates decided by two buttons. The cones button (picture 10a) displays the development map (10b) with the dimension definitions.



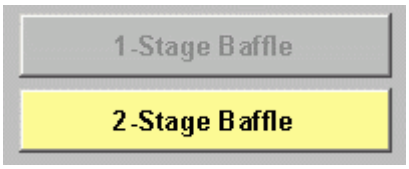
Picture 15



Picture 16

There are 3 pre-defined diffusor configurations available in the custom pipe. Multi stage diffusors are used with higher tuning degrees, when stronger pulses are present with bigger diffusor angles. Click desired configuration and the cells will configure for that input accordingly.

The 2 pre-defined baffle stage buttons work as the diffusor buttons. 2-Stage baffles are used with very steep baffle cones and may boost up peak power without too much midrange loss.



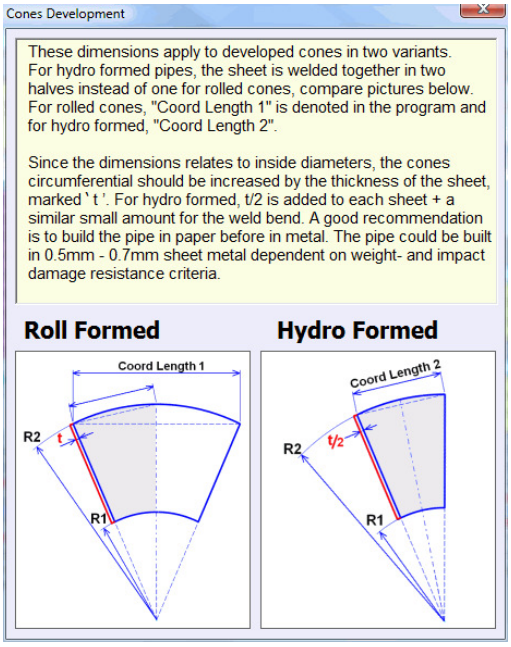
Picture 17.

Picture 18.

The Work Strategy button displays a text with explanations, definitions and design strategy of the different pipe sections.

Picture 19.

The cones button displays the cone development definition of rolled and hydro formed templates. All pipe dimensions are referred to inside measurement. The red line indicates the add to compensate for sheet thickness. (20)



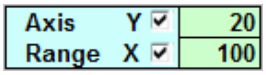
Picture 20.

2.2.6 Chart

The spin button adjusts the chart height. It will scale the chart to make the cone angles more obvious (21).

Picture 21.

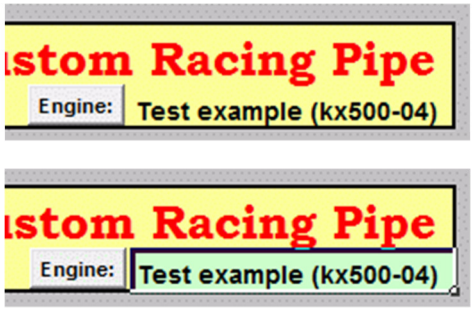
Y- and X- grid lines apply to the pipe plot; it can be switched off or on. When on, the range can be specified. (22)



Picture 22.

The 'Engine' button will open a cell for editing the project name. The Cell will be closed if the text is entered by return key of if a sheet tab is changed.

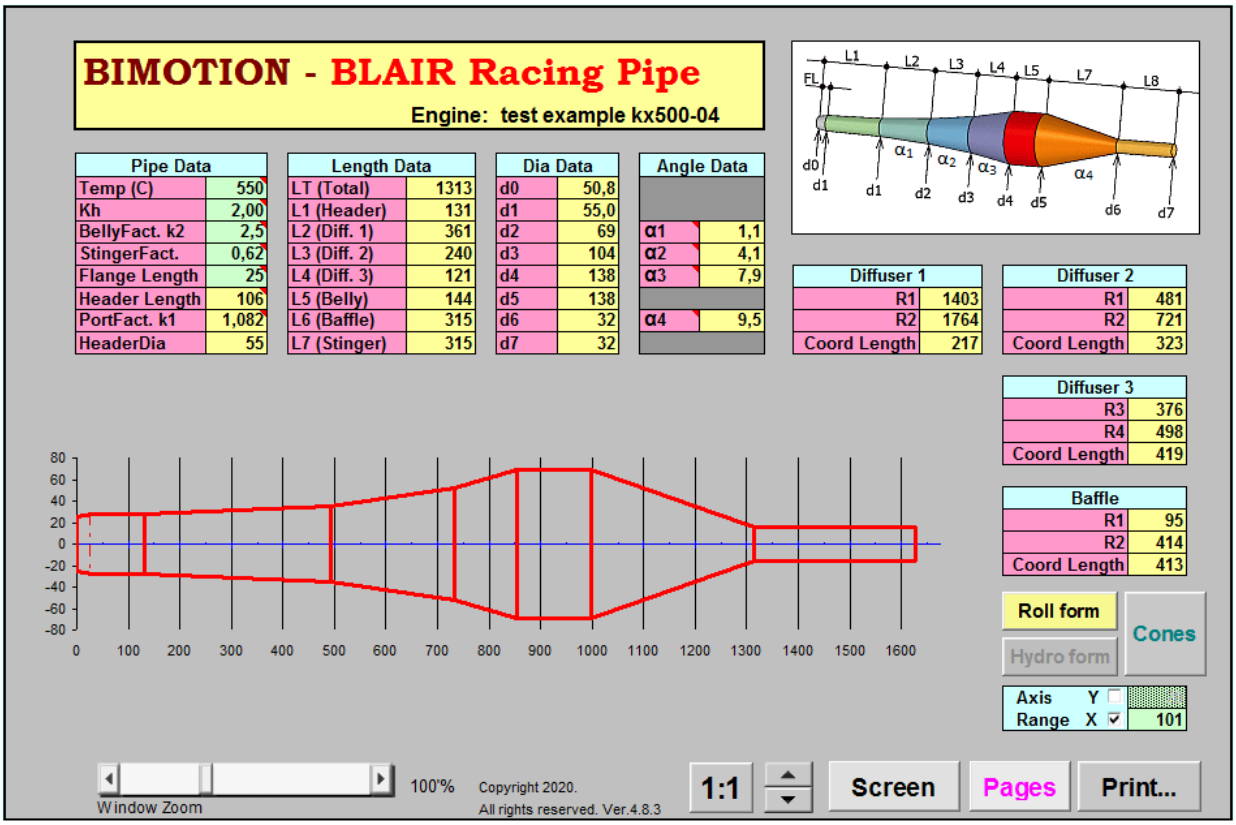
The project name propagates to all sheets. (23)



Picture 23

2.3 BLAIR RACING PIPE

2.3.1 Description



Picture 24

This pipe is prof. G.P. Blair's approach to an exponential controlled gas expansion through a horn factor 'Kh'. It assumes that the exhaust port is designed as 'state of the art' of a road-racing engine. The cone length ratios are deduced from practical tests and experience from road racing engines. The Blair Racing Pipe can easily be modeled and modified by the more flexible General Pipe.

2.3.2 Pipe Data

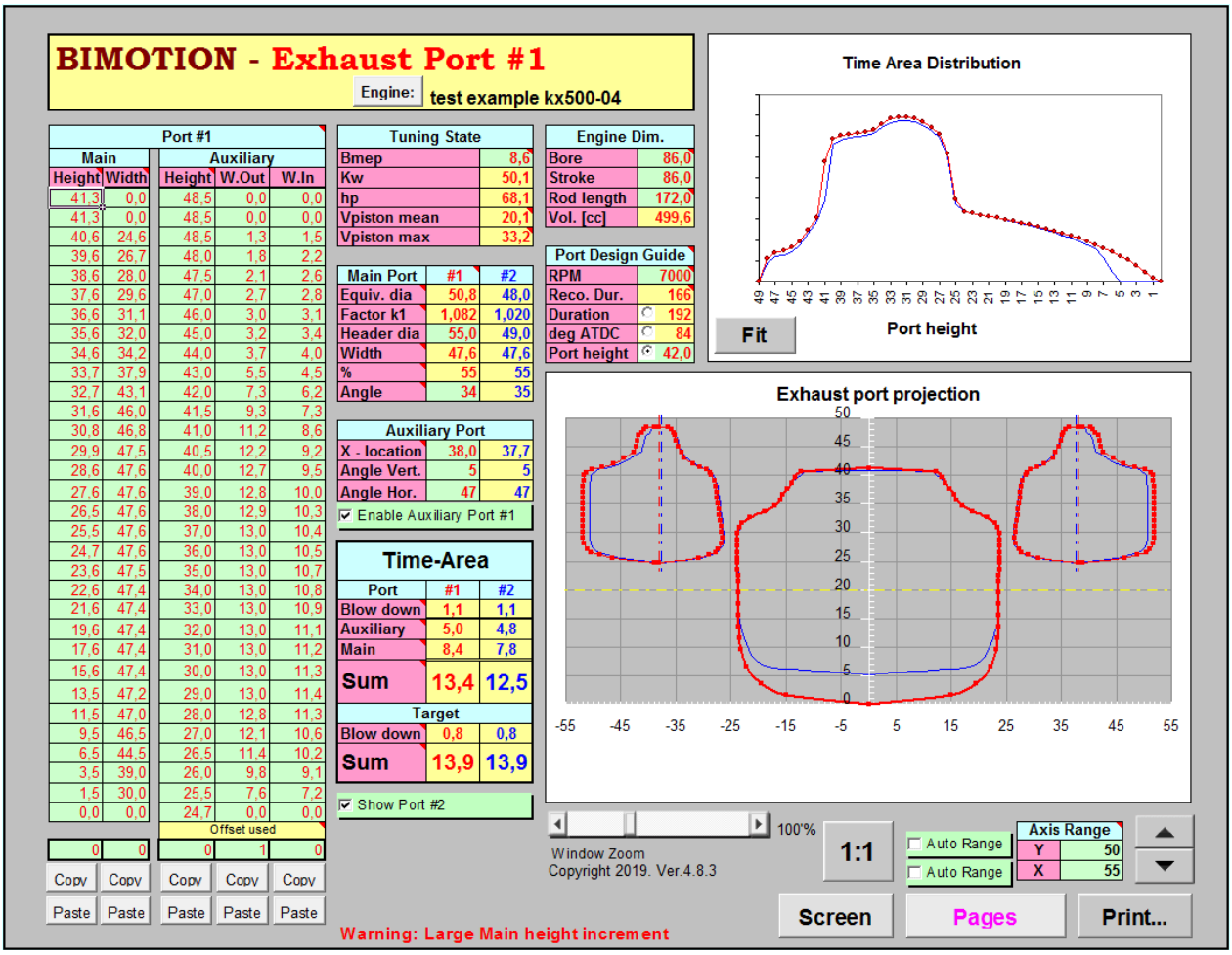
Pipe Data	
Temp (C)	500
Kh	1,50
BellyFact. k2	3
StingerFact.	0,6
Flange length	50
Header length	32
PortFact. k1	1,004
HeaderDia	32

Picture 25.

Increased 'Kh' factor makes the pipe more extreme, producing shorter and stronger pulses.
The other properties are described in the Custom Pipe section.

2.4 EXHAUST PORT #1

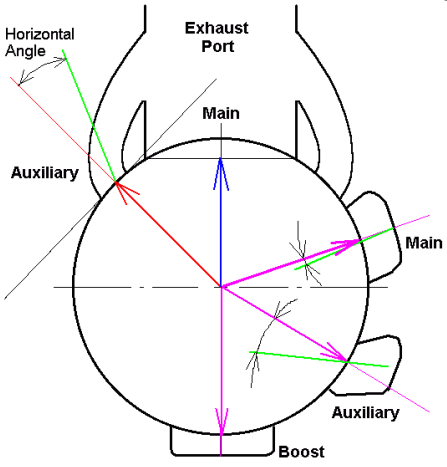
2.4.1 Flow Directions



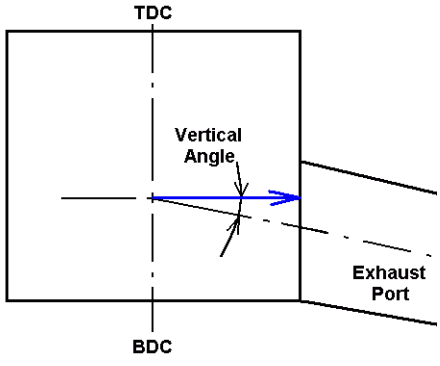
Picture 26.

The red ports and text apply to current view, Exhaust Port #1. The blue ports and text apply to next view, Exhaust Port #2, that is intended for an original design so the changes can be clearly visualized.

The exhaust- and transfer ports are displayed in a projection layout according to picture 28 and 29. See the different projections for different ports, blue and red arrows. The charts show the ports perpendicular to the aperture in the cylinder, i.e, without any projection (the arrows). **All width data is measured as the aperture width seen from the arrow's projection**. Bridged exhaust ports (dual ports) are made by using the auxiliary ports only, setting the main port width to zero, picture 16b & c.



Picture 27.



Picture 28.

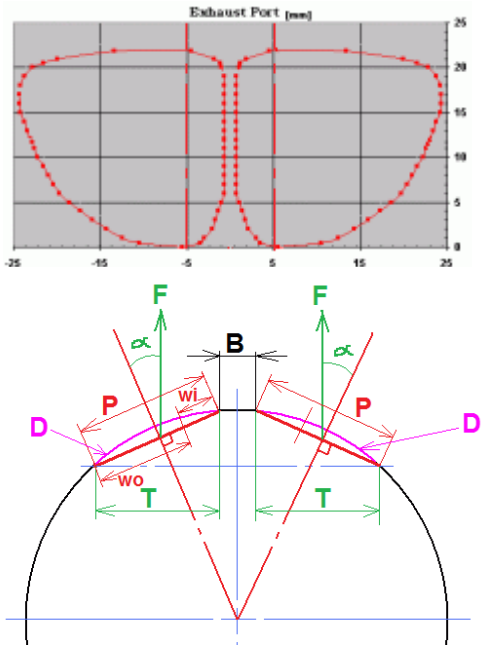
At this point, the normal projection is not in same direction as the main port. The red arrow in pic.27 applies to the vertical dot dashed lines in pic. 30.

The projected view is what the port *could* flow at the maximum, but the flow direction gives a true area restriction. The green line shows the flow direction of the auxiliary exhaust port which is defined as the horizontal angle, 'Angle Hor.' The transfer ports and vertical angles are measured accordingly.

When modelling dual ports, **wo**, **wi** and α (**alfa**) should be measured for time-area and then the ports should be located in the cylinder correctly in developed view in the development sheet according to picture 31.
The projected view in sheet Port#1 (and/or Port#2) will be a semi-projected help view shown in two different directions at the same time (along red center lines).

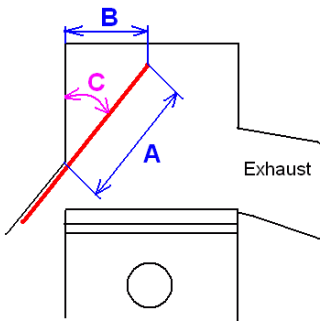
D= Developed width
P= Projected width

T= Flow width by using **F**low angle α
B= Bridge width
wo= outer width
wi= inner width



Picture 30, dual port.

Vertical angles may be measured according to pic. 32.
C= arcsin(B/A). The vertical port angle to enter into the program is then 90-C deg.
When the ports are shown in the design chart from these different projections, it will not represent a true perspective, true projection relative to each other or development. It's only for viewing and design. The true port layout is shown in the Development Chart sheet, see 3.8 below.



Picture 31.

2.4.2. Table Port #1

Port #1				
Main		Auxiliary		
Height	Width	Height	W.Out	W.In
25,2	0	25,2	0	0
25,2	0	25,2	0	0
25,2	0	25,2	0	0
25,2	0	25,2	0	0
1	27	14	0	0
0	25	14	0	0
0	0	0	0	0

Picture 32A.

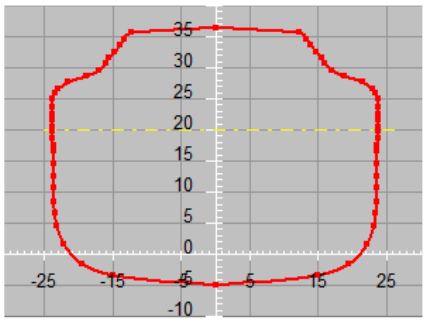
The port properties can be changed on each point or by a whole column, by an offset. This practical feature makes it easy to move the complete port in different directions to see the response for time-area and time-area distribution change. A reminder is lightened above the offset cell.

1	27	14	0	0
0	25	14	0	0
Offset used		Offset used		
5	0	5	0	0

Picture 32B.

The height column is normally filled up from the bottom, starting with zero height. When maximum height is reached, the column is rarely filled to the top.
It is important to give all remaining cells the maximum height value and the port width equal to zero, see picture 32A, blue mark. No height cells except the first one at the bottom must be zero or empty, see picture 32A, red mark, otherwise there will be a warning message shown. The height increment should in general be kept to 1 mm. If higher increment is needed for large ports, then the larger steps should be taken at the lower part of the port.

Not following this rule will decrease the time-area calculation precision. A warning is shown when the height increment is 2 mm or more.



Sometimes the ports are not aligned with Bottom Dead Center. The recommended method is then to model the ports as aligned to BDC and then use an offset, shown as a negative offset in picture 33. The yellow horizontal line marks out the transfer port height.

Picture 33.

2.4.3. Tuning State

Tuning State	
Bmep	11,5
Kw	24,9
hp	33,8
Vpiston mean	18,9
Vpiston max	30,4

Picture 34.

- The engine tuning degree decides the recommended targets.
- Bmep = Braked Mean Efficient Pressure, with other words, the main pressure in the cylinder from TDC to exhaust opens.
- Vpiston = piston velocity

2.4.4 Main Port

Main Port	#1	#2
Equiv. dia	31,9	32,6
Factor k1	1,004	1,011
Header dia	32	33,0
Width	32,0	32,0
%	59	59,26
Angle	15	0

Picture 35.

#1 applies to port #1 (this page). Port data from 'Exhaust Port #2' is shown to simplify compartment. 'Equivalent diameter' is the port area conformed to a diameter. 'Factor k1' changes with 'Header dia'. 'Angle' is the vertical direction change of the exhaust flange (picture 16).

2.4.5. Auxiliary Port

Auxiliary Port		
X - location	25	29
Angle Vert.	10	5
Angle Hor.	30	15
☑ Enable Auxiliary Port #1		

Picture 36.

- The port can be moved in horizontal direction by 'X-location'. This has no impact on the calculation but helps to locate the port on the chart to get a good view.
- 'Angle Vert.', see picture 16.
- 'Angle Hor.', see picture 15.

- The enable toggle is used to enable or disable the port. No data is deleted when disabled; only removed from charts and results.

2.4.6. Time-Area

Time-Area		
Port	#1	#2
Blow down	1,2	2,0
Auxiliary	4,4	5,3
Main	10,9	12,8
Sum	15,3	18,1
Target		
Blow down	1,2	1,2
Sum	16,6	16,6

Picture 37.

The time-area is to be compared with the flow capacity of the port. The unit is mm2 * s / cm3 *10-3, or in short s/m*10-3. Since the unit is per cm3, this value can be compared to an engine with same characteristics and tuning degree but with different cylinder capacity.
Another way could be to see how the port must be changed if the rpm is to be increased with the same flow (time-area). (The time-area decreases with increased rpm). The recommended targets are no law, but works as a good estimation if no other experience is at hand.
When dealing with port time area it's important to be aware of the validity of the calculations. The time area values are only valid for the port apertures, not the port channels. That is, it's a measure of what the port can flow not what is really does flow. Bad shaped port channels may need more port- and blowdown time-area than recommended, or truer, the port channels may need to be reworked to a state-of-the-art shape with smooth surfaces to fit with the recommendations. An exhaust port without auxiliary ports, with the same blowdown as a main port and with the same blowdown, will have a more efficient blowdown flow. This means that the auxiliary exhaust port design needs more blowdown time-area than the single main port design. The recommendations for the bmep's above 8 bars assume efficient blowdown flow of both kinds since it's based on high performance engines.

2.4.7. Engine Dimension

Engine Dim.	
Bore	54,0
Stroke	54,0
Rod length	108,0
Vol. [cc]	123,7

Picture 38.

If the rod length isn't known, then use 2 x Stroke.

2.4.8. Port Design Guide

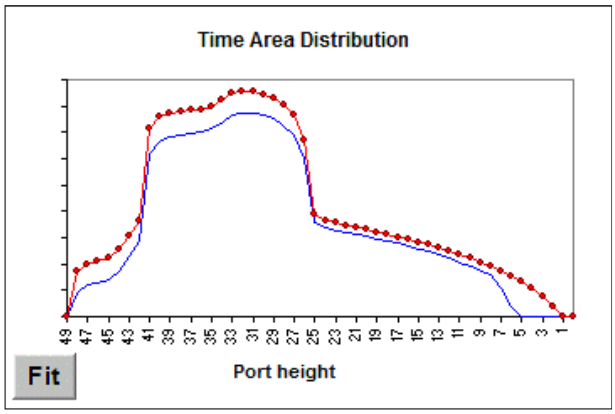
Port Design Guide	
RPM	6500
Reco. Dur.	163
Duration	173
deg ATDC	93
Port height	35,0

Picture 39.

The recommended duration should be regarded as an upper limit for gearbox engines. The normal approach is to keep the exhaust port as low as possible, but there are often exceptions dependent on ride ability and other matched components as pipe and intake.
Port opening data can be entered as duration, opening ATDC (After Top Dead Center) or port height BBDC (Before Bottom Dead Center) by clicking an option button. The cells with unchecked buttons are calculated accordingly.

2.4.9. Time-Area Distribution

This chart shows how the time-area is distributed over the port height. The absolute value is of no importance, but the interesting thing is at which height the flow capability is the highest. The distribution chart is limited to port heights up to 50mm. The Fit button will adjust the curves to the x-axis if they are not aligned.



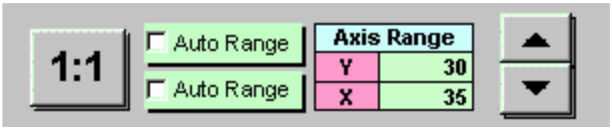
Picture 40.

2.4.10. Show Options

Picture 41.

With this option, port #2 can be turned on or off from the cells or charts. It's very handy to compare two different ports in the same chart (original and tuned for example). Turning it off could be less confusing if only one port is modeled.

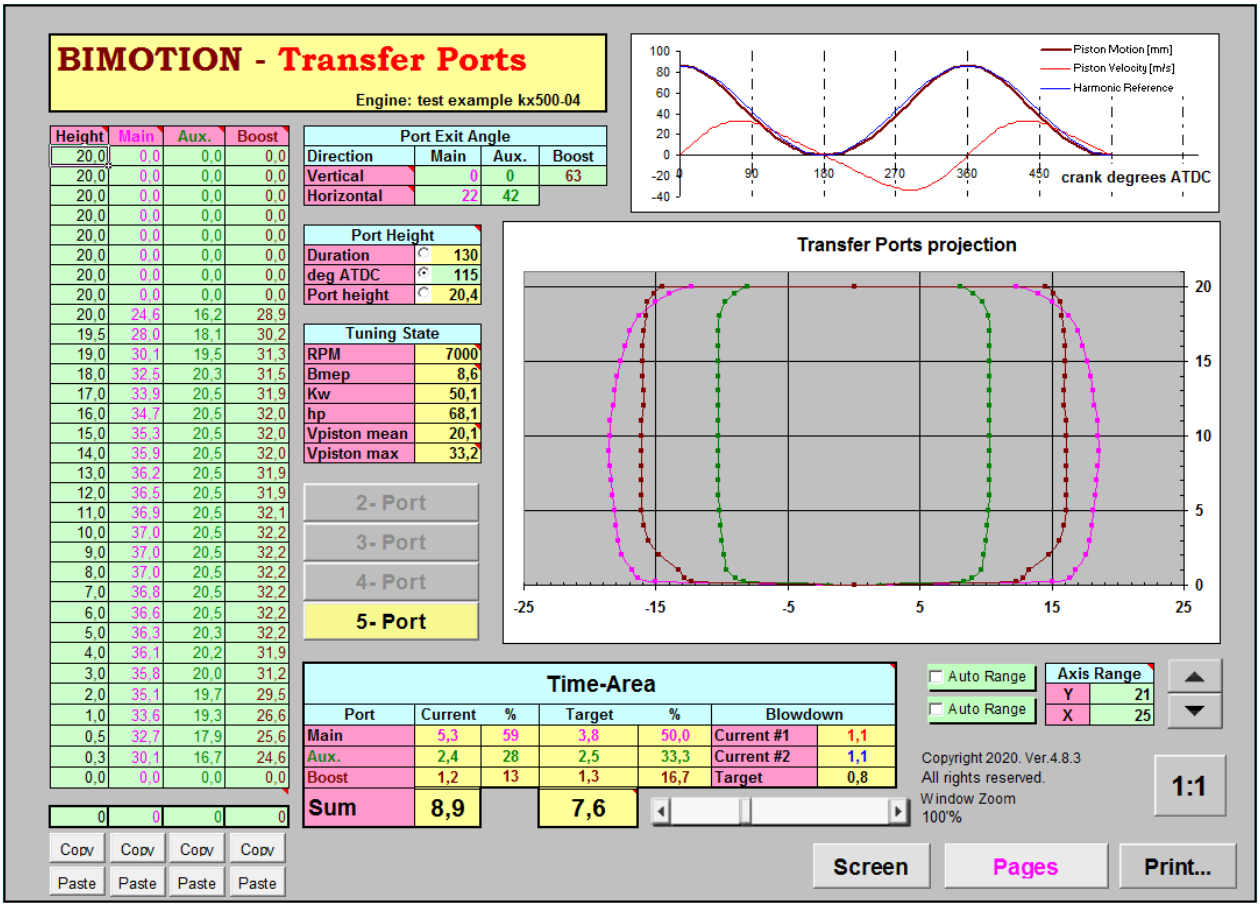
2.4.11. Chart Options



Picture 42.

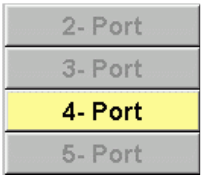
The exhaust port chart can be user scaled in different ways, self-instructive. The thin
EXHAUST PORT #2
This tab page works exactly the same as Exhaust Port #1 with the exception that is only used as an overlay to #1 and is not linked to any other sheet. It is intended for the original design so the changes in #1 can be seen in a relation. Se section 2.4 for description.

2.5 TRANSFER PORTS



Picture 43.

2.5.1 Port Configuration



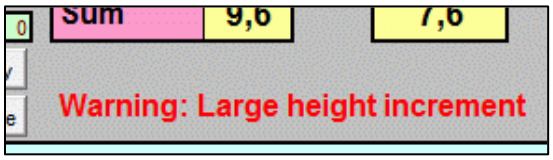
Picture 44.

Four scavenging port configurations can be modeled:

2-Port	(2 main)
3-Port	(2 main + boost)
4-Port	(2 main + 2 aux.)
5-Port	(2 main + 2 aux. + boost)

Click any button (picture 29) and the configuration is made automatically. If the 4-port configuration is used then the boost port will be disabled.
If the boost port is bridged, (2 ports) then add the 2 ports width into 1 port. Keep in mind that the flow loss is greater with a bridged port compared with a no bridged and therefore needs more time-area, about 10% more dependent on channel length.

The height column is normally filled up from the bottom, starting with zero height. When maximum height is reached, the column is rarely filled to the top. *It is important to give all remaining cells the maximum height value and the port width equal to zero*. See picture 44.



Picture 45.

The height column must not be set to zero and should not have an increment larger or equal to 2mm. If greater increment is used then the time-area precision will be lower. Warnings will notify this.
No other height cell than the first row at the bottom must be zero.

0,5	31	33	25
0	28	31	17
Offset used			
5	0	0	0

Picture 46.

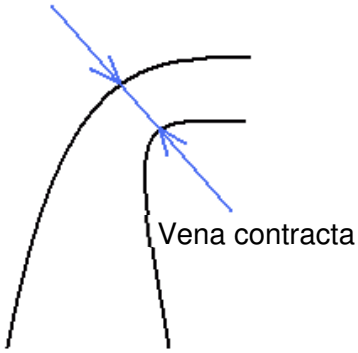
Just as described in section 2.4.2, the height and width data can have offsets for fast changes. The height data follows the same restrictions with increment and non-zero cells.

2.5.2 Port Exit Angle

Port Exit Angle			
Direction	Main	Aux.	Boost
Vertical	0	15	55
Horizontal	40	60	

Picture 47.

The angles apply to the port flow directions at the port aperture. This means that it is assumed that the port can flow this time-area amount at the aperture. If the port has a vena contracta in the channel, that could overestimate the flow capacity at the port aperture. In other words, increasing such a ports time-area by its width would not necessarily make it flow more. The vena contracta section would also need an increased width.



Picture 48

2.5.3 Port Height

Port Height		
Duration	○	129
deg ATDC	○	115
Port height	◉	20,1

Picture 49.

The duration is a universal measure independent of cylinder capacity or stroke. The specified stroke and rod length will give a port height at stated duration. This height can be used in the 'Height' column. The option buttons admits inputs of either duration, opening ATDC or port height. The cells with unchecked buttons are calculated accordingly.

2.5.4 Tuning State

This is a mirror table from 'Exhaust Port #1'.

Tuning State	
RPM	10500
Bmep	11,5
Kw	24,9
hp	33,8
Vpiston mean	18,9
Vpiston max	30,4

Picture 50.

2.5.5 Time-Area

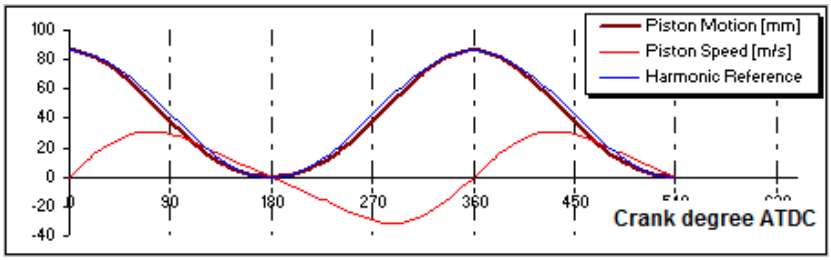
Time-Area						
Port	Current	%	Target	%	Blowdown	
Main	4,0	50	4,4	50,0	Current #1	1,2
Aux.	2,6	33	2,9	33,3	Current #2	2,0
Boost	1,3	16	1,5	16,7	Target	1,2
Sum	7,9		8,8			

Picture 51.

Current values are from the port design in [s/m] * 10-3. % is the ratio of the current 'Sum'.

The target value is a recommended level of time-area at the specified bmep and rpm for engines with multi gearbox. The % of the target is also a recommended ratio, independent of gearbox, fixed or regulator drive.
As mentioned in section 3.6.2, this time-area value applies to the port aperture flow capacity. Blow down is the time-are from exhaust port opens to transfer port opens. This is a very important measure and is dependent on exhaust pipe design. The target value assumes a well working exhaust pipe.

2.5.6 Motion Chart

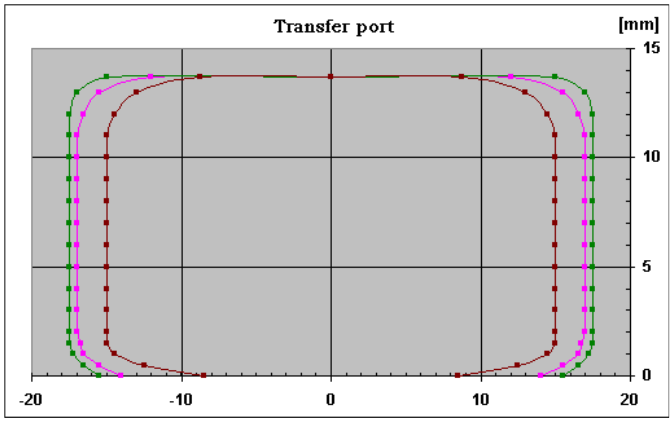


Picture 52.

The sinus curve shape is dependent on the rod length. A short connecting rod will make the piston spend more time in the BDC region. This is a benefit for high rpm engines. The drawback is a fast moving piston at the combustion phase.

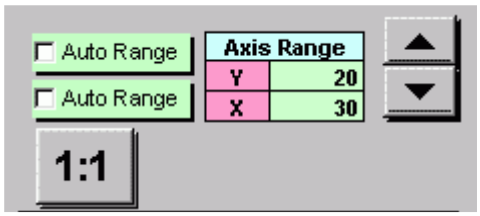
2.5.7 Transfer Port Chart

The ports are symmetrically designed from the width. If a port width is unsymmetrical then that will not affect the time-area. Therefore, the port is always symmetrically modeled simply by measuring the width and neglecting the asymmetry. (53)



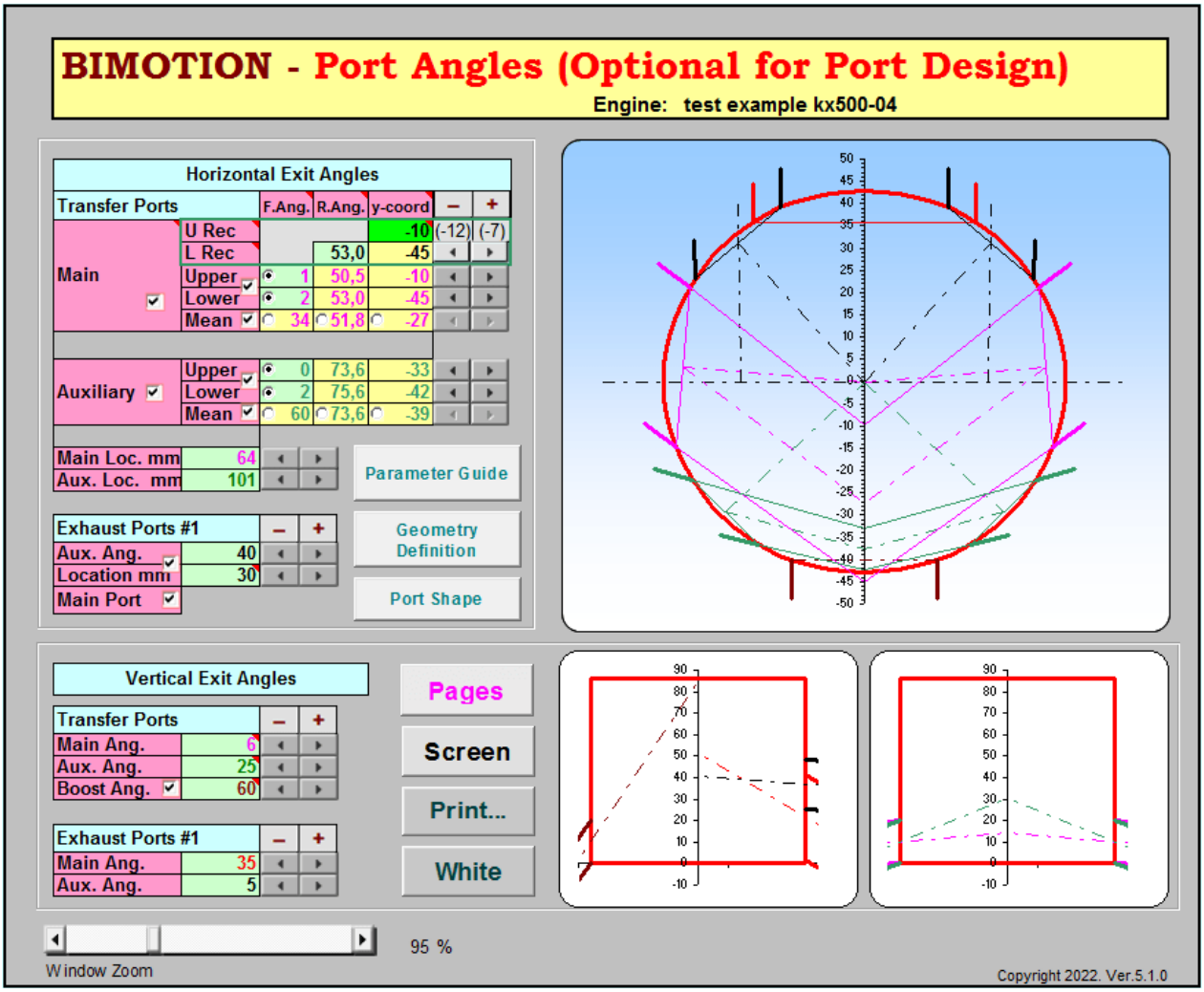
Picture 53.

The chart has different options for axis and scale customization. (54)



Picture 54.

2.6 PORT ANGLES DESIGN



Picture 55.

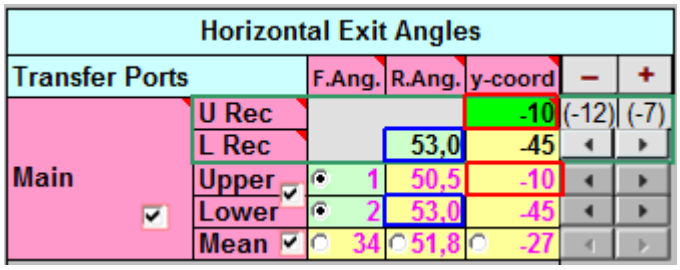
The *Port Angles* page is an option to manage and design port flow direction angles and is not needed for the time-area calculation or basic port design. It is recommended to use this option page as a design guide and make changes in small steps to avoid numeric- and geometric errors.
The upper chart shows the port flow horizontal directions for the chosen port configuration, also shown in *Transfer Ports* and *Exhaust Port* pages. Checkboxes may show or hide chart lines in order to simplify the view. The 2 charts at at the bottom shows side views of the cylinder with vertical angles. The left chart has boost and exhaust ports and the right chart has transfers.
The recommended design values in the cell comment text boxes are based on research and testing from many different states of the art racing configurations for multi geared engines. The angles are the same (linked) to the *Transfer Ports* and *Exhaust Port* pages.
The recommended relationships between the ports and angles are dependent on port location along the cylinder wall.
The spin buttons change the input variables in increments for easy changes and different alternative angles can be activated by option buttons dependent on which design angle that is the preferred one to change. Y-coord direction is vertical axis in the charts.

How to use the angle recommendation: The target flow angle is specified for the main transfer only and is the same for all transfer configurations (2-5 transfer ports). The direction is defined on the vertical axis (‘C’ in picture 58) for the Transfer Main Upper line (‘1’ in picture 58), in mm location. The upper (-10) and lower (-14) tolerance is shown in the gray cells in picture 58. The

green cell ('U Rec', 'y-coord') is the mean value of these that shall be reached when the angle 'A' is changed. 'A' will change when port location is moved or the 'L Rec, 'R Ang' angle is changed (Lower Recommendation (Line), Recommended Angle).
The target is also dependent on cylinder size. The cell changes between red and green when it's inside or outside the target.

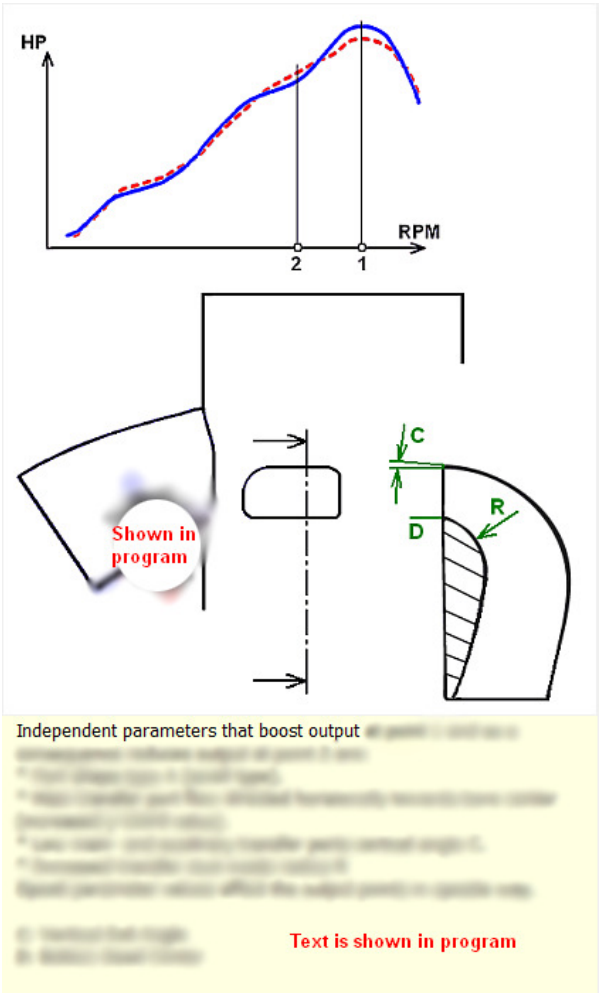
In this case (picture 56), the target values in the upper blue and red marked cells were met in the lower marked cells.

The other transfer ports (auxiliary and boost) have no specific targets but are chosen from experience and wanted engine characteristics. The boost port is however often directed to the spark plug or just behind.

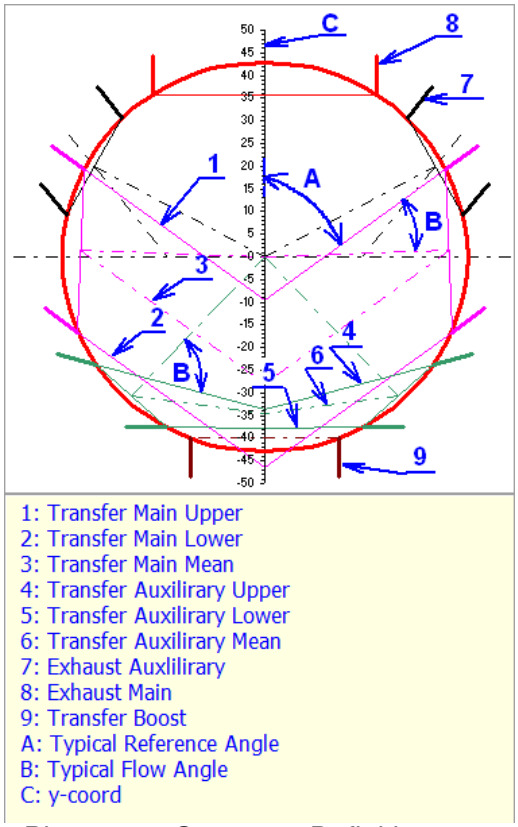


Picture 56. Port angle selection

Some independent porting parameters that influence the engine characteristics are described for design guidance purpose (picture 57).



Picture 57. Port Shape



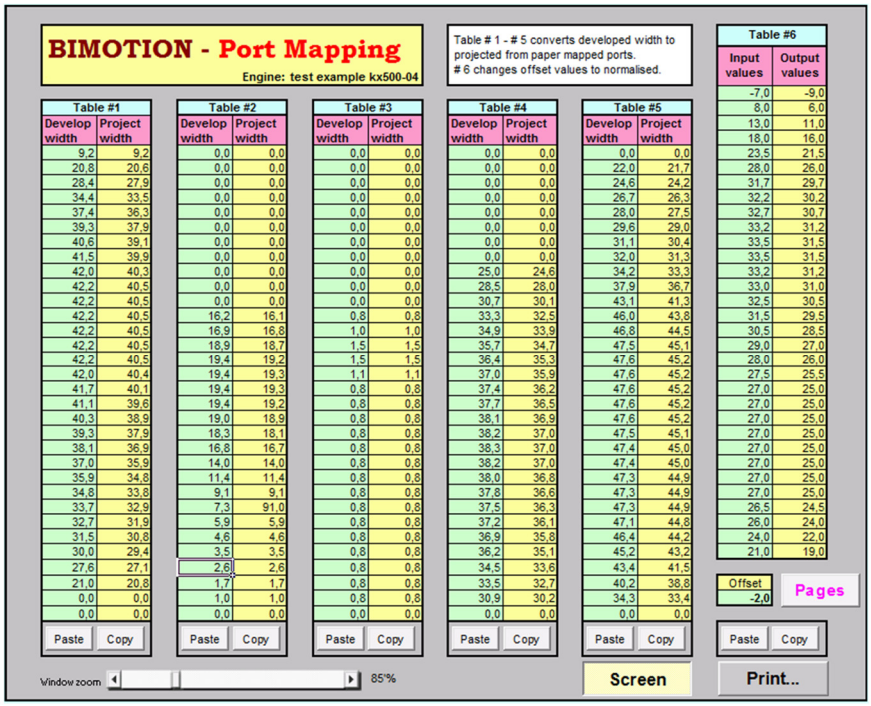
Picture 58. Geometry Definition.

Note that all time-area calculations in the program are based on the port aperture and flow angle in that section only, giving the time-area value of what it can flow, not the what is does flow since it depends on pressure differences.

2.7 PORT MAPPING

The first step to do when tuning an engine is to measure the original state. This is done by mapping the ports inside the cylinder with a thin paper. Simply press a finger to the port edges. The paper is then developed and measured. (Width and height).
If port mapping is done on regular basis, we recommend a free software to digitize the drawn port image: **Engauge Digitizer** from http://markummitchell.github.io/engauge-digitizer/

The developed width is inserted in any of the numbered tables in the 'Develop Width' column. The developed width is then converted to projected width and can then be copied and pasted to the port section with the buttons. Click the copy button here and the paste button in the port section.
There are several columns #1 - #5 so your developed port data is stored and it's easy to adjust afterwards.
Table #6 is used for changing any of your data when port offset has been used. In order to reduce/increase an offset to a nominal value (width or height), this column will do the simple work.
Using the buttons, copy the source column and paste into Table#6 Input. Add or subtract from the whole input column by 'Offset' and Copy the Output column. Paste back to the original source column.

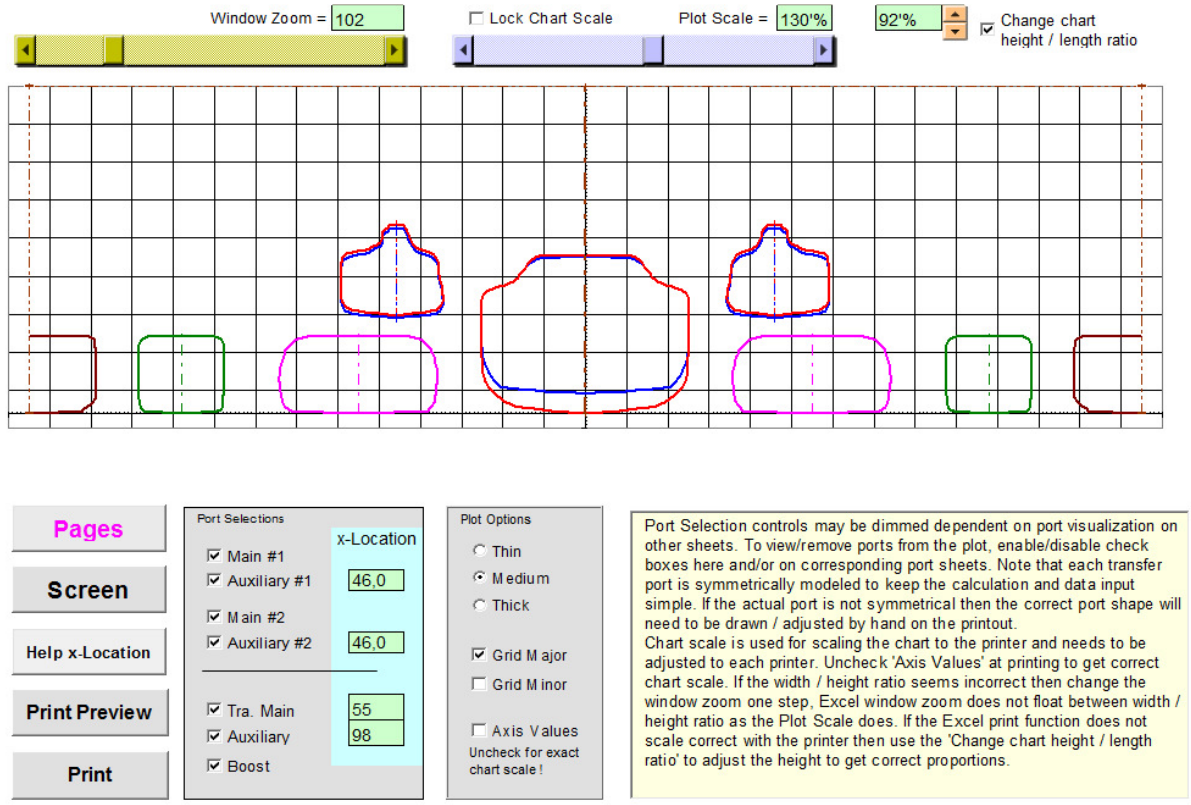


Picture 59

2.8 DEVELOPMENT PLOT

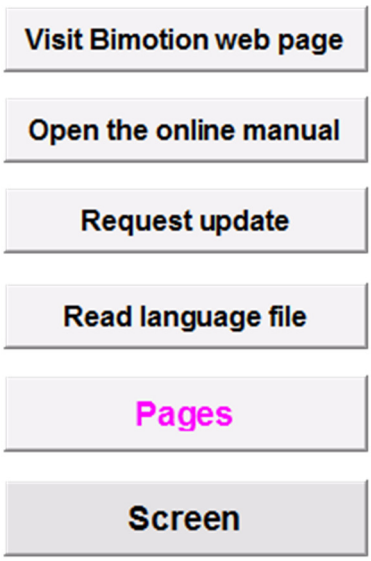
When the design is completed, the developed ports can be printed on paper in 1:1 scale. The developed plot can be taped/bonded inside the cylinder to be used as a grinding template.

The plot sheet allows the user to scale the plot to the printer by the Chart Scale variable. If the length/height ratio isn't perfect on screen then change the window zoom slightly, the ratio isn't floating perfect with Excel's window zoom. However, even when the length/height ratio is correct on the screen, Excel does not export the correct length/height ratio to printers so an additional ratio adjustment has been added.
Measurement on a printout is recommended with 'Grid Major' activated for verification. The "Lock Chart Scale" button locks the chart for changes so accidental changes will not be done once the printer scales have been set.
The 'Window Zoom' control bar only scales the view on the screen to fit different screen sizes. Any port can be hidden in the plot by checkboxes, but changing the plot thickness or leaving the sheet will reset the hidden port visualization. The x-Location cells will move the ports horizontally to get the correct layout.



Picture 60. Development Plot view.

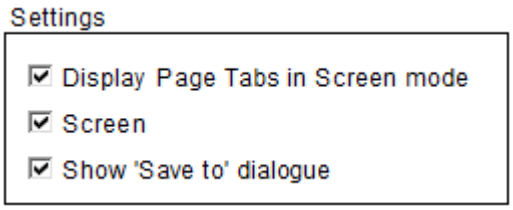
2.9 ABOUT…



Picture 61

The program automatically tries to connect to the Bimotion site when it is opened in order to check for new versions and notify important changes. If your security settings ask you about permission to connect, you should admit if you have an internet connection at the time and want online notifications. This online manual in pdf is available from a button click as well as a request for update button which calls for the mail program and writes a request.
Some language files in can be downloaded from www.bimotion.se/Pipe/lang/ and imported by reading the file from 'Read language file' button. If your language is missing and you want to contribute with translation, please contact Bimotion and it will be added !
There are 3 general settings accessed from the About page:

- Page Tabs at the bottom are visualized as default but can be toggled off in Screen Off mode which can be useful if a small screen is used and the all-page tabs do not fit the screen anyway. The 'Pages' button at each page is then an alternative.
- Maximize Window in Screen mode can be toggled off if other excel sheets should be used in parallel in Screen mode.
- Show 'Save to' dialogue enables GIF and dxf files to be saved in any other location than the default folder where the program is started from.



Picture 62

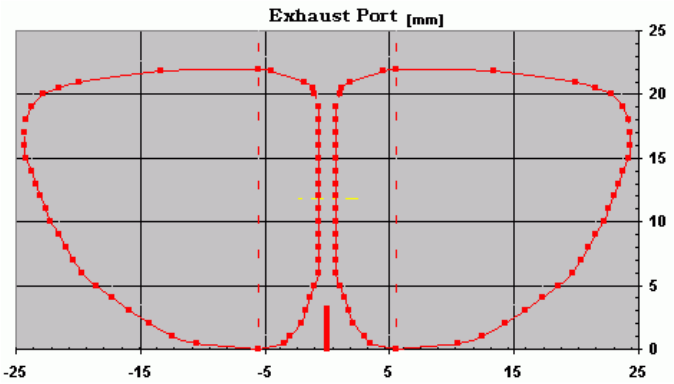
3. PORT MODELING, A CASE STUDY

It is recommended to first start with the exhaust port since that one is the most critical part. Usually, we need to map the original port configuration in order to see what to do or what have been done already. This is done by fitting a mm-paper inside the cylinder and carefully pressing the port edges to get a watermark on to the paper [1]. Next, fill in the marks with a pen and measure the port width starting from bottom (BDC) on the developed paper. Measure every width at each mm height.
Fill in the 'Port Mapping' table starting from the bottom with zero and ending at max. port height with zero width. Click the 'Copy' button under the 'Project with' table. In the port section, click 'Paste'.
If you by any reason copy /paste any cells manually (without the buttons) then always use 'Paste Special' and 'Paste Values', otherwise you may destroy the program ! That's why the buttons are there.

Table #1	
Develop width	Project width
0	0,0
15	14,9
20	19,7
25	24,4
33,5	32,0
33	31,6
31	29,8
28	27,1
Paste	Copy

Port #1				
Main		Auxiliary		
Height	Width	Height	W.Out	W.In
30,0	0,0	28,0	0,0	0,0
30,0	0,0	28,0	0,0	0,0
1,0	17,5	18,5	0,0	0,0
0,5	12,5	18,5	0,0	0,0
0,2	3,4	18,5	0,0	0,0
0,0	0,0	18,5	0,0	0,0
0	0	0	0	0
Copy	Copy	Copy	Copy	Copy
Paste	Paste	Paste	Paste	Paste

If we have an unbridged port without auxiliary exhaust ports then we disable the 'Auxiliary port' checkbox, otherwise we also measure the auxiliaries.



In this example we will model a bridged port and therefore we have to use only the auxiliary port table, not the main port. So we need to set the main port width to zero. If we set the main port height to '0.1' then the 'empty' curve will disappear from the chart, that's up to you. **If you do this then set zero at the bottom and 0.1 in all other 'height' cells. If all cells are zero then the blowdown calculation will fail !**

Now, each of the bridged port must be modeled in two halves. The dotted vertical line shows the split. The table is divided in this split, 'Width Out' and 'Width In'. The width starts and ends with zero with. (The dotted line is the zero line).
First, this looks confusing, but we then move the ports aside by the Auxiliary ports 'X-location' property. In this case we moved the zero-line 5.5 mm to get the correct port location. About the angle, see the port angle section.

Auxiliary Port		
X - location	5.5	
Angle Vert.	25	
Angle Hor.	0	
☑ Enable Auxiliary Port #1		

Tuning State	
Bmep	12.6
Kw	21.3
hp	29.0
Vpiston mean	19.1
Vpiston max	30.6

Engine Dim.	
Bore	47.5
Stroke	47.8
Rod length	95.6
Vol. [cc]	84.7

Main Port	#1	
Equiv. dia	22.1	
Factor k1	1.449	
Header dia	32.0	
Width	0.0	
%	0	
Angle	25	

Port Design Guide	
RPM	12000
Reco. Dur.	200
Duration	190
deg ATDC	85.0
Port height	23.0

Next, fill in the engine data and match the bmep value to get the known hp. The port time area will indicate if the port can deliver the expected power decided by the bmep (hp target) and it's predicted time area target.
Match the 'Duration' cell until you get your port height. The pipe calculation uses this duration value.
In this case we modeled a Yamaha YZ85 and got a matching time area to the target.
Well done Yamaha ☺

We can now test different methods to increase the hp. If we raise the cylinder foot 1mm with a thicker gasket we get more duration and time area. Simulate this with the height offset cell at the bottom of the table. The time area then becomes 18.9 at 12000 rpm. Increase the rpm until the previous value (17.9) is reached, in this case 12700 rpm. Since we predict the same time area (gas flow) at a higher rpm, we now see that the predicted hp is 30.7 compared to the original 29, i.e. 1.7 hp increase.

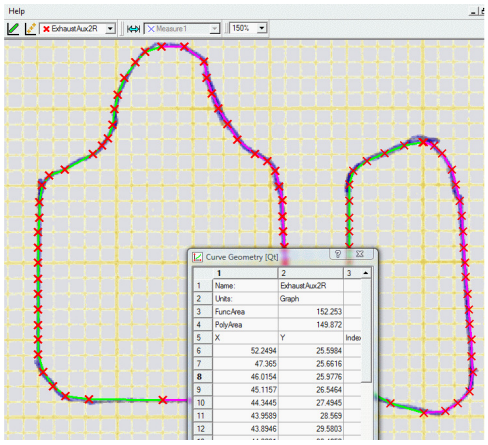
Time-Area		
Port	#1	
Blow down	0.5	
Auxiliary	17.9	
Main	0.0	
Sum	17.9	
Target		
Blow down	1.3	
Sum	17.7	

This is one way to do it, you could also offset the width and check that result.

The 'Exhaust Port #2' section is intended for the original configuration and 'Exhaust Port #1' for the modified. By this approach you can compare the two designs in the same chart and tables.

Now go ahead with the same procedure with the transfer ports. The short yellow line in the exhaust port chart marks the transfer port height, see above.

[1] Pre-printed mm-papers can usually be found in well sorted paper shops. Scan the paper in high resolution, zoom the view and count mm's.
We recommend the freeware program Engauge Digitizer for regular port mapping. The curves can be smooth adjusted and converted to coordinates in some clicks. More info at http://markummitchell.github.io/engauge-digitizer/



Picture of a mapped port on mm grid paper, scanned in high resolution and processed by digitizer.

For more examples about how to calculate the ports and use the program, see the 'Theory' section on www.bimotion.se and also the case study www.bimotion.se/Bimotion_2-Stroke_Case_Study.pdf

4. TROUBLE SHOOTING

Q: "I get a runtime error when I click a button or change a cell"

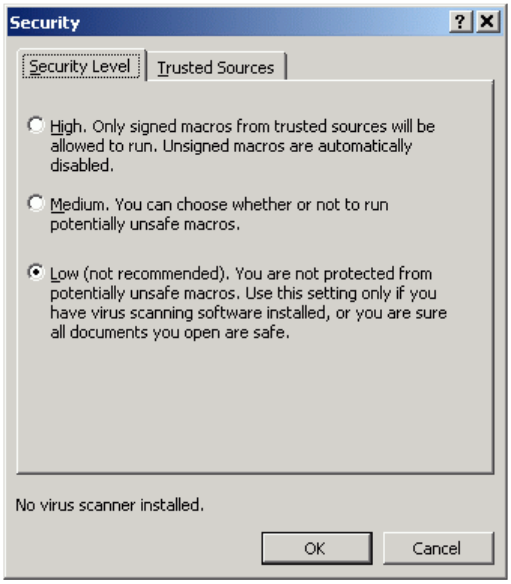
A: You probably need to change your security settings in excel.

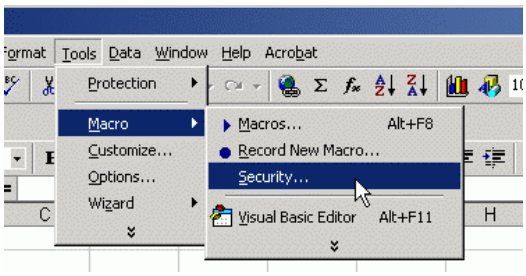
Do this in Excel 2003:
1) Select the non-full screen mode with the 'Screen' button to make the menu available.

2) On the **Tools** menu, click **Macro** and **Security...**

3) Set the security level to **Low**

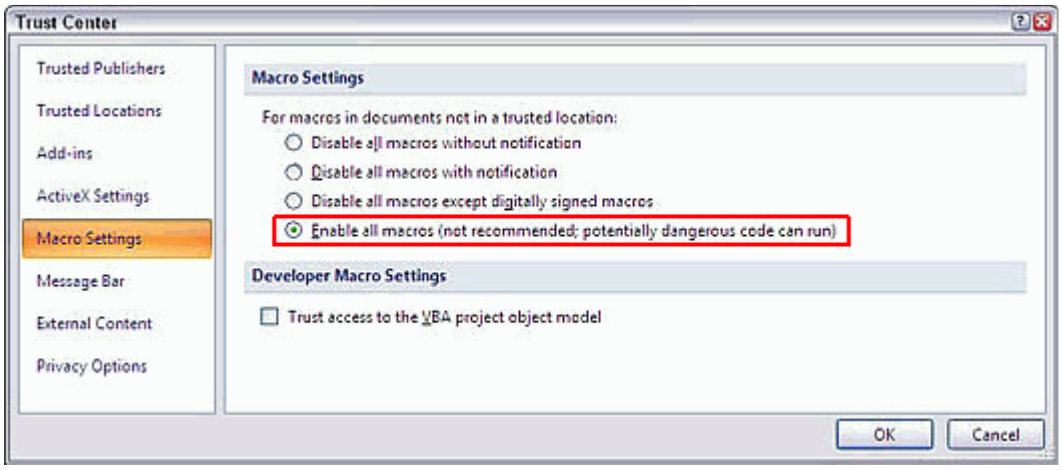
Open the Bimotion program again and check the result, this should cure the problem.
You were probably not allowed to run the necessary macros before.





If there still are problems (or not) it's recommended to use the latest updated Excel version. Updates are available at http://office.microsoft.com and select 'Check for Office updates'.

The menu in Excel 2007- :



Q: "I cannot input decimals, and when I do, strange things happen."

A : If your regional setting in Excel is set to (,) as decimal separator then always use comma (,) with decimals, not dots (.) Otherwise you may change your Excel's setting.

Q: In the "About…" page, "Latest available version" says "No internet connection"

A: If there is an internet connection and the message *"No internet connection"* is shown, then it might be an internal Excel conflict if you use Excel add-ins. If you use add-ins, close Excel and restart in "Safe Mode" by holding the Ctrl key down while starting Excel. Choose Safe Mode as start option in the appearing dialogue. This will disable add-ins and avoid such conflict.