

Instruction Manual

**Users Guide
Transient Recorder
Type 2519A...**

Software
TR Control

KISTLER

measure. analyze. innovate.



Instruction Manual

**Users Guide Transient
Recorder
Type 2519A...**

Software
TR Control

Foreword

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Kistler Group
Eulachstrasse 22
8408 Winterthur
Switzerland
Tel. +41 52 224 11 11
Fax +41 52 224 14 14
info@kistler.com
www.kistler.com

Contents

1.	Introduction	3
2.	Important Information.....	4
2.1	Disposal Instructions for Electrical and Electronic Equipment	4
2.2	Software Upgrades and Updates.....	4
3.	Basic Characteristic of TR 2519	5
3.1	Structural Design of Transient Recorder	6
3.2	Mobility and Power Supply Possibilities	7
3.3	Transient Recorder 2519 Control.....	7
3.4	Graphical and Numerical Data Evaluation and Output Protocol Format	8
3.5	Calibration.....	8
4.	User Manual	9
4.1	List of Used Abbreviations and Terms	9
4.2	TR 2519 Installation	10
4.2.1	Safety Precautions for Working with TR 2519 Instrument:	10
4.2.2	Installation of Transient Recorder	12
4.2.3	Installation of Control Software TR 2519 Control.....	13
4.2.4	Problems During the Installation and Their Solution	17
4.3	Preparing TR 2519 for Measurement	18
4.3.1	Typical Connection of Sensors to TR 2519	18
4.3.2	Connecting Cables and Connectors.....	19
4.3.3	Recommendations for Choosing and Using Single Channels (Inputs)	19
4.3.4	What Data Will Be for Given Arrangement.....	20
4.3.5	Preparing TR 2519 for Measurement	21
4.4	Measuring Procedure, Method and Protocol Building.....	25
4.4.1	Entering of Name of Measured Series and Filling of Form	25
4.4.2	Setting of Main TR 2519 Parameters.....	28
4.4.3	Shooting of First Round.....	36
4.4.4	Building of Data Evaluation Method.....	39
4.4.5	Shooting of the Whole Rounds of Series	59
4.5	Work with Measured Data	60
4.5.1	Group Organizer, Displaying and Printing of Results	60
4.5.2	Selection of Single Round and Delete of Selected Round.....	62
4.5.3	Modification of Measured Data Evaluation.....	63
4.5.4	Filtering of Data (Built-in Running Average Filter)	64
4.5.5	Aborting of Shooting and Finishing of Shooting of Other Rounds of the Loaded Data	65
4.5.6	Function READ and BREAK.....	66
4.6	Working with Electronic Target WTS03.....	67
4.6.1	Connecting Target to TR 2519	67
4.6.2	How to Measure and Target Data Evaluation	68

Total pages 77

1. Introduction

Please take the time to thoroughly read this instruction manual. It will help you with the installation, maintenance, and use of this product.

To the extent permitted by law Kistler does not accept any liability if this instruction manual is not followed or products other than those listed under *Accessories* are used.

Kistler offers a wide range of products for use in measuring technology:

- Piezoelectric sensors for measuring force, torque, strain, pressure, acceleration, shock, vibration and acoustic-emission
- Strain gage sensor systems for measuring force and torque
- Piezoresistive pressure sensors and transmitters
- Signal conditioners, indicators and calibrators
- Electronic control and monitoring systems as well as software for specific measurement applications
- Data transmission modules (telemetry)

Kistler also develops and produces measuring solutions for the application fields of engines, vehicles, manufacturing, plastics and biomechanics sectors.

Our product and application brochures will provide you with an overview of our product range. Detailed data sheets are available for almost all products.

If you need additional help beyond what can be found either on-line or in this manual, please contact Kistler's extensive support organization.

2. Important Information

2.1 Disposal Instructions for Electrical and Electronic Equipment



Do not discard old electronic instruments in municipal trash. For disposal at end of life, please return this product to an authorized local electronic waste disposal service or contact the nearest Kistler Instrument sales office for return instructions.

2.2 Software Upgrades and Updates

Kistler may from time to time supply upgrades or updates for embedded software. Such upgrades or updates must always be installed.

Kistler declines any liability whatsoever for any direct or consequential damage caused by products running on embedded software which has not been upgraded or updated with the latest software supplied.

3. Basic Characteristic of TR 2519

Kistlers' measurement and data evaluation philosophy are the difference between ours and other ballistic analyzers on the market.

Standard analyzers are produced with rigid input configurations and limited measurement capabilities, which creates a high expense for any changes needed.

The Kistler analyzer, is fully customizable and has no fixed input configuration, making it easily adaptable for current and future applications. A nearly unlimited number of ballistics applications are possible, thanks to the Windows® based evaluation method.



Fig. 1: Transient recorder Type 2519A...

The Transient Recorder Type 2519 was developed to fill the need for an energy efficient compact unit that provides maximum flexibility.

The following comparison chart points on the considerable differences in construction from the limited conventional ballistic analyzers and the Kistler Type 2519:

Microsoft Windows® is a registered trade mark of Microsoft Corporation.

3.1 Structural Design of Transient Recorder

- The standard conventional BA's are formed from the special PC card (this using requires desktop PC). This card is connected with external block of charge amplifiers and with the next adaptors. The pressure measuring is performed by means of two channel AD converter with memory, the velocity measuring is performed by means of start/stop counter. The signal processing for start/stop signal generating (mostly impulses from optical gates) and for initiating of measuring by means of accelerometer make the trouble, because the input modules are sensitive for signal quality and for correct threshold adjusting. The diagnostics is complicated because BA do not make course of signal viewing possible from digital inputs and that is why it is necessary using a digital oscilloscope. This increase the costs of BA operation and through-going check during firing is problematical. The number, type and channels using is fixed by instrument design and this will make only standard measuring possible (designated by producer)
- This TR 2519 is compact small instrument, which is built from block of power supplies and from industry computer of miniature dimensions, from eight identical AD converters (next only ADC) and from eight removable input cards. The instrument control is provided via Ethernet connection from PC compatible (desktop, notebook, panel PC). The measuring of up to four pressure courses is performed by means of first quad of ADC and charge amplifiers. The next four ADC are used for connecting of miscellaneous voltage signals (accelerometer, muzzle sensor) or for measuring of velocity/accuracy by means of up to six gates. The gates may have digital or analog output (this can be used for display of bullet pass through the gate). Every TR 2519 channels saving input courses of digital and analog signals and that is why TR 2519 replacing diagnostic instruments incl. digital oscilloscope and make more easy failure localization possible during working operation. Channel using is not given sternly and this provides for user higher variability in method connection and used sensors

3.2 Mobility and Power Supply Possibilities

- Standard BA is usually a large instrument (incl. desktop PC) and so the mobility and terrain using is problematical. Excessive shock proof is also usually bad. Power supply is possible only from electricity line and power consumption reduces instrument using in terrain
- TR 2519 is designed for mobile using - small dimensions, resistance against the shocks, internal air circulation and so resistance against the dust, small power consumption 30 W at 12 V (24 V version is possible according to customer request). Notebook is best way for mobile using as control computer, but thanks to Ethernet connection (galvanic isolated connection) it is possible to use any computer with Ethernet card

3.3 Transient Recorder 2519 Control

- The functions are controlled partial manually and partial from control program. So it is impossible instrument adjustment according to method, which is stored on the control computer disc. The requirements for operating personnel are higher and possibility making mistake during measuring or during instrument configuring is also high
- All functions in TR 2519 are called from virtual machine in MS Windows® environment. User friendly environment make possible several ways for saving complete TR 2519 configuration including data evaluation method and output protocol format

3.4 Graphical and Numerical Data Evaluation and Output Protocol Format

- The software does not provide many ways for performing alternative data evaluations than standard thanks to fixed hardware configuration and output protocol about shooting is also given
- A different approach has been chosen for this instrument thanks to its connection variability to the system. The first there are configured basic parameters (sampling rate, triggering conditions, charge amplifiers ranges) and the single round is fired out. According this shot it is performed the setting of required calculations between any channels and final method is stored on the disc for future measuring. It is also possible shooting the whole shot series during continuous numerical outputs checking. The correction of calculations setting is possible during shooting, after shooting and in the future. The difference between standard process and this process is in the possibility to correct conditions for shot calculation, when the threshold setting for velocity measuring was incorrect. The shot is lost in conventional system. The data in output protocol about shooting are changed in dependence on the calculation settings. The protocol is available in three forms - full and short for all shots and short for current shot. The truncated protocol is generating directly in Microsoft® Word format

3.5 Calibration

- The manufacturers are not usually interesting in production of calibration instruments for charge amplifiers or they are making devices for manual calibration. So the calibration process is exacting for control and takes a several hours of work
- The TR 2519 has implemented manual calibration of charge amplifiers and automatic offset calibration of all inputs. Thanks to connection with 6-channel charge calibrator QC04 it is able calibrating automatically all charge amplifiers during 30 minutes. The protocol is generating about every calibration process and it is stored on the control computer disk

4. User Manual

4.1 List of Used Abbreviations and Terms

TR 2519	Transient Recorder Type 2519
BA	Ballistic Analyze
AD	Analog to Digital
ADC	Analog to Digital Converter
IM	Input Module (charge amplifier etc.)
A, B, ...	Channel 0, Channel 1,
Channel	one of eight strings built from input unit and ADC with memory
Input	input BNC connector, one IM can have several inputs
Record	data from single channel within single round (single shooting)
Round	one shot, which is stored on the disk as single data file under the name BADatNNN.dat (where NNN= 000 - 250) and it contains all eight records from single channels
Series	more shots, which are stored in single directory with user's defined name of series

4.2 TR 2519 Installation

4.2.1 Safety Precautions for Working with TR 2519 Instrument

- Only qualified personnel may work with TR 2519. Producer is not responsible for any accidents caused by unqualified personnel
- If the TR 2519 or its equipment works improperly or if the instrument indicates any failure symptoms, do not use it! Replace the cable or power supply, send TR 2519 for repairing to repair service!
- The TR 2519 is assigned for DC power supply with nominal voltage 12V (or 24V DC for the relevant instrument modification, see the label on the rear panel). This voltage is not allowed to exceed the maximum value assigned in the chapter C2 Technical parameters of TR 2519. TR 2519 is permanently protected against incorrect voltage polarity, it is not protected against the overvoltage. It is necessary keeping safety precautions, which are assigned in standalone manual for this unit, if this one is used for current supply. Working personnel must keep valid safety precautions for handling with electro-technical devices
- Cooling of internal electronic components is ensured by means of heat conducting through the case of the instrument. It is necessary to ensure free air circulation around this instrument. Do not place anything on the instrument case!!!
- Respect working temperature range (see chapter C2 Technical parameters of TR 2519)
- Never connect higher voltage than nominal to the input connectors (see chapter C2 Technical parameters of TR 2519)
- In case of installation and TR 2519 operation keep the instructions for handling with ESD (Electrostatic Sensitive Devices). Protect it against static electricity, because the instrument contains sensitive integrated circuits. Never touch the connector pins and discharge yourself from static electricity before connecting/disconnecting connectors
- The instrument must be protected against the moisture, rain, temperature extremes (storage temperatures below -20°C and above 40°C) and temperature and mechanical shocks. The instrument is not allowed placing to direct sunlight, near thermal sources and heavy electromagnetic field sources, to the environment with aggressive chemicals, flammable and explosive vapors and gasses. Keep appropriate instructions against the fire
- If the TR 2519 is moved to another environment with different temperature than 5°C , it is necessary to adapt the temperature difference sufficient time. Do not turn instrument on, if condensation is appears!

- Turn instrument off, if you will not make the measurement for the current day! Do not let the instrument turning on without checking, especially at night!
- Disassembling or modification of the instrument is not allowed without previous permission of producer. If you violate these conditions, you lose the warranty. Producer is not responsible for any due accidents!
- Use only original equipment and spare parts
- The instrument can be used only for purpose, for which it was made. Producer is not responsible for any interpretation of measured results and for any accidents caused by their applications in practice. Producer is not responsible for any changes of instrument properties caused with usage or aging
- The cleaning of TR 2519 is allowed only if the instrument is turned off and disconnected from power line. The instrument is allowed cleaning only with dry lint-free cloth. If the instrument is heavy dirty use damp lint-free cloth with few drops of mild detergent or use pure isopropanol. Never use alkalies, acids and organic solvents except pure isopropanol or ethanol! Especially it is dangerous using the solvents, which erode the polystyrene
- Clean the connectors only with pure isopropanol and let them drying before measuring!



Pay attention to maximum input voltage of all input modules – see reference manual/technical specifications. Exceeding of maximum values could destroy this instrument.

4.2.2 Installation of Transient Recorder

- Before removing from transport cover the TR 2519 must be acclimated by reason of the temperature equalization and minimizing the possibility of humidity condensation inside the instrument. After that it is possible removing the TR 2519 from the cover and placing it to a working place. Check, if the main switch on the rear panel is on the position 0 (off). If not, switch it to off
- Install power supply for TR 2519 (see the proper manual) and connect it with original cable with the TR 2519. Screw up optimize the nut of connector
- Connect the TR 2519 (connector Cannon 9 pin) with network card (connector RJ45) by means of delivered nonstandard communication cable. Screw up the screws on the Cannon connector
- Turn the TR 2519 on by means of the main switch which is located on the rear panel to position 1 (on). This will be indicated by means of green light POWER on the TR 2519 front panel in the section STATUS. After 5 minutes the other lights will be flash (READY, DATA), which indicates correct TR 2519 function. The instrument is ready for use
- Connect outputs from relevant sensors to the BNC inputs. TR 2519 installation is finished. Now the installation of TR 2519 Control software for transient recorder control to the control computer is remained. See the next chapter
- Turning TR 2519 off is possible by switching the main switch to the position 0 (off). If the TR 2519 will not be used for a longer time, disconnect it from the power line (see the proper manual for the power supply)

4.2.3 Installation of Control Software TR 2519 Control

- The control computer have to fulfill minimal requirements assigned in the chapter “C6 Requirements for the control computer”
- Insert install CD into the CD drive of control computer, easy copy the folder with file BAControl.exe to disc C:\ and make shortcut to BAControl.exe
- Check, if the TR 2519 is turned on and ready for measuring (see previous chapter)
- Check properly installation of the network card hardware and drivers (see manual for computer or network card)
- Now it is necessary to set up TCP/IP network communication protocol, which is very important for correct function of TR 2519 Control software. For Windows 7 environment it is step-by-step described in the pictures Fig. 2 and Fig. 3. In Fig. 4 it is setting of section Advanced (usually let default settings)
- Then run TR 2519 Control software. Activate access to other parts of menu Calibration by means of password KIWAG in Calibration > Activate Calibration. Then in calibration menu choose part Calibration > Network and fill the table in accord with table - see Fig. 5 (set IP Address to 10.10.10.11, Port to 222)
- Restart computer and try communication. Run program TR 2519 Control (shortcut or file BAControl.exe). The option File > New is enabled
- For the correct communication turn on control computer first and after booting operating system (and after network card initiating) turn the TR 2519 on. If you have a problem, the trouble is probably in the network cards autoconfiguration and with plug and play technology, when the two computers are started at the same time. The communication could be corrupted, when some programs are started with the program TR 2519 Control at the same time (antivirus program or firewall)

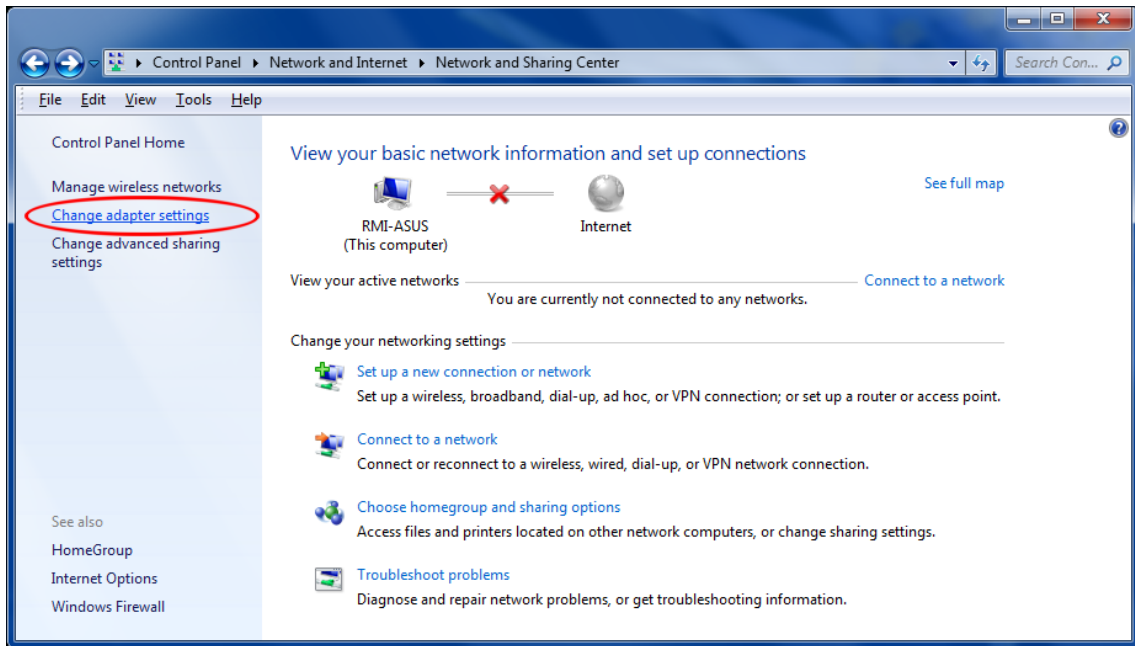
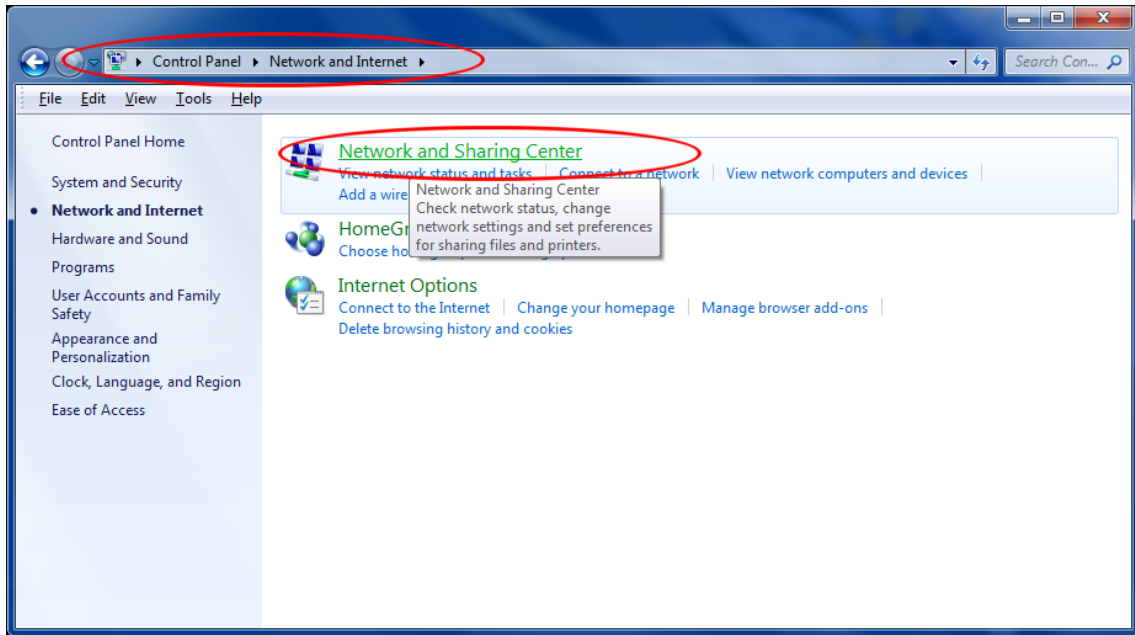


Fig. 2: Network and sharing center

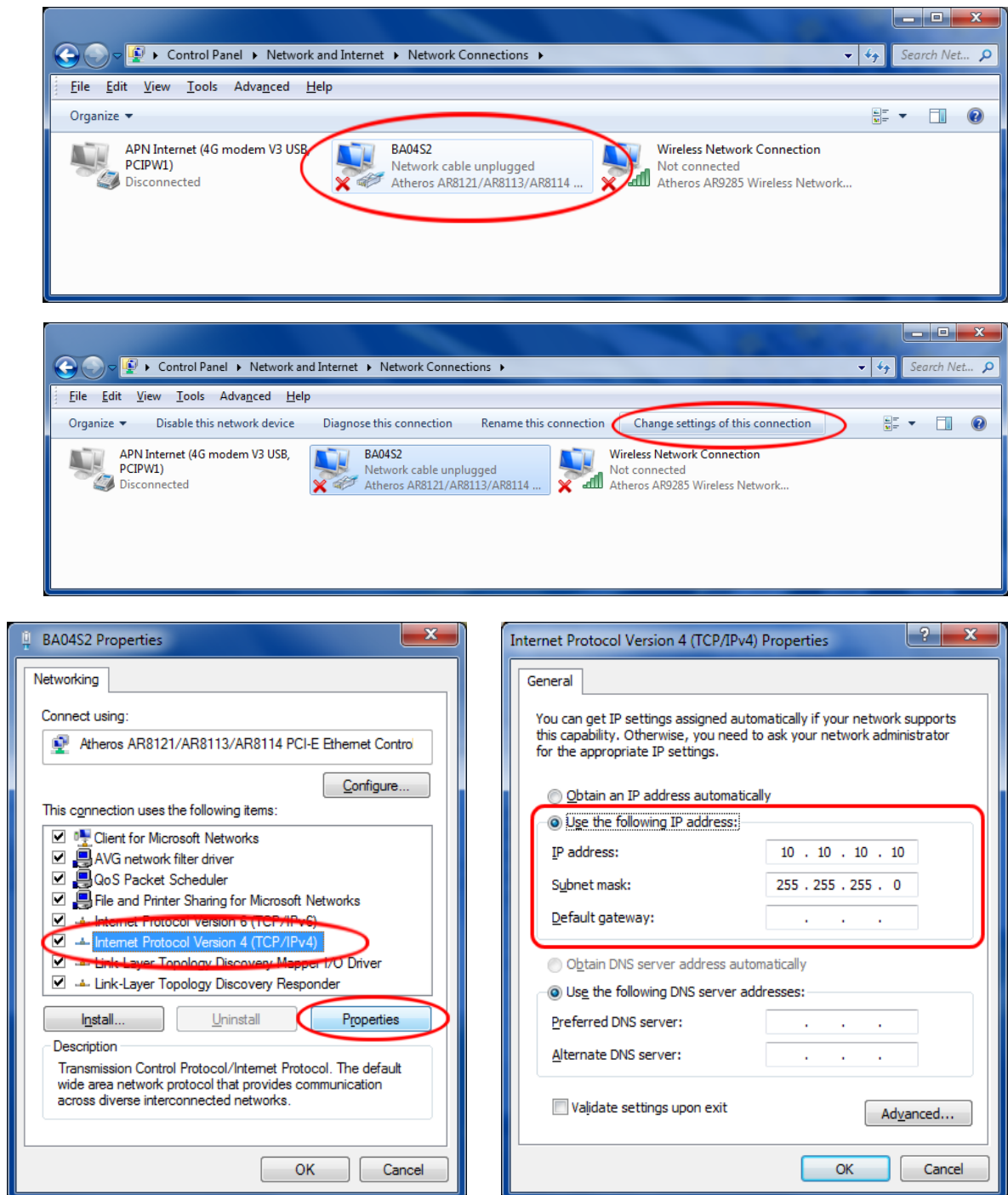


Fig. 3: Network connection

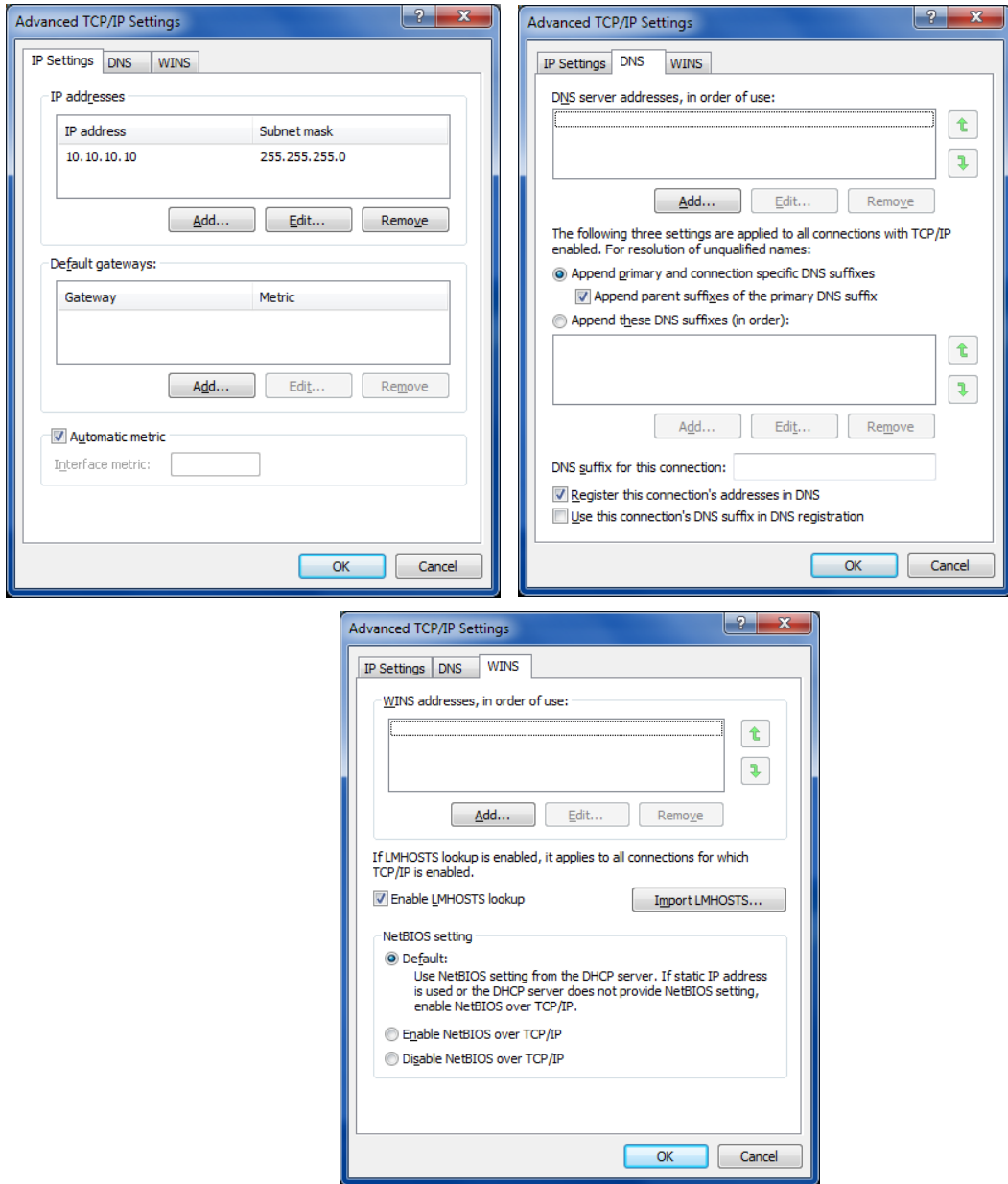


Fig. 4: Network settings

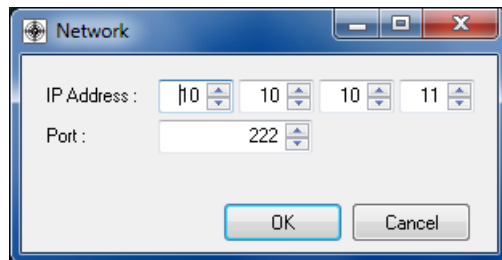


Fig. 5: Network settings

4.2.4 Problems During the Installation and Their Solution

- The green light POWER on the front panel does not light
- Check power supply and cables. In case of the failure replace these parts. If TR 2519 still not works, contact maintenance service
- The TR 2519 is turned on, the green light POWER lights, but after the five minutes the lights READY and DATA do not flash, the communication with the TR 2519 could not be established try turn off the TR 2519 and after one minute turn the TR 2519 on. If the problem persists, contact maintenance service
- The TR 2519 is turned on, the green light PWR ON lights and the light READY, DCOMP and DATA flash, but the communication with the TR 2519 could not be established
- check network card configuration (see chapter B2.3 Installation of control program TR 2519 Control) and restart control computer and TR 2519. (turn off and after one minute turn on control computer first and after booting operating system turn the TR 2519 on). Beware of the conflict with another network card or with some other programs (remove, disable problematical software/hardware). If the TR 2519 still not works, contact maintenance service
- The communication is lost during measuring process (data transport from the TR 2519 to control computer “freeze”) the solution is as same as for point 3
- The option File > New is inaccessible after starting TR 2519 Control program or the whole panel of the virtual TR 2519 is not appeared (the panel is missing or panel of input modules are missing) after inserting name of the directory for data saving and after filling initial form
- if some module misses, the firmware could not established connection with it. If the problem cannot be resolved according to point 3, the module is probably damaged and must be replaced, call service. If all modules are missing or the option File > New is inaccessible, the communication between TR 2519 and control computer was not established and the solution is as same as for point 3

4.3 Preparing TR 2519 for Measurement

The whole philosophy about TR 2519 control will be now explained on the following typical ballistic example (from sensors connection to establishment and printing numerical results). If the user will try the measuring according this example, he will be able working independently.

4.3.1 Typical Connection of Sensors to TR 2519

The basic EPVAT & Accuracy measurement is in the following picture (Fig. 6):

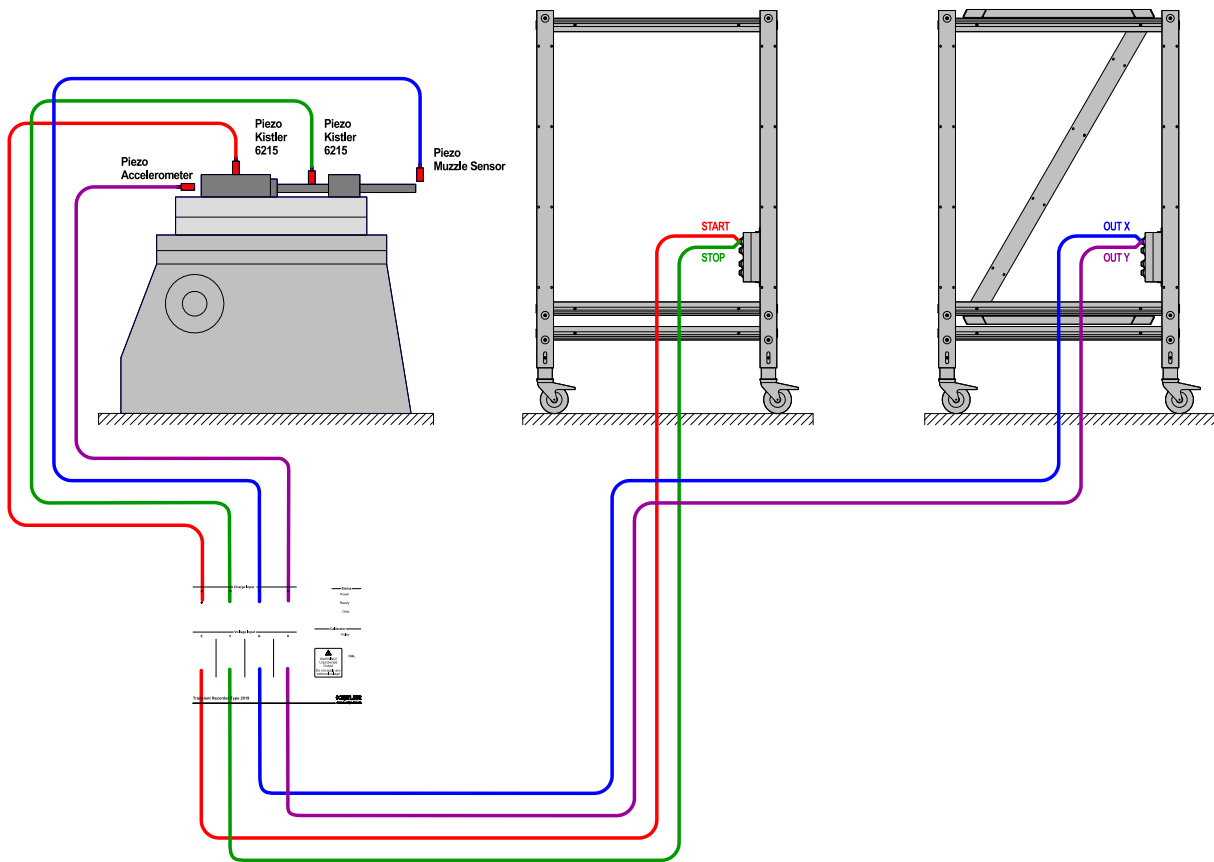


Fig. 6: Connection scheme

EPVAT & Target System Results

- Graph and max value of chamber pressure
- Graph and max value of port pressure
- Graph and max value of muzzle pressure
- Velocity (any combination of muzzle, two gates and target)
- Action time
- XY position of shot at target system
- Target velocity and energy of bullet

4.3.2 Connecting Cables and Connectors

The sensors are connected to TR 2519 by means of coaxial cables with BNC connectors. It is recommended to use only original cables from manufacturer for signal transfer from piezoelectric pressure sensors. Although this TR 2519 has circuits for compensation of cable leakage, it is necessary to keep all connectors clean and never touch the pins with the finger. The connectors should have only Fluoropolymer insulation and the cables high-quality dielectric with respect to used temperature range.

4.3.3 Recommendations for Choosing and Using Single Channels (Inputs)

The channels A – D CHARGE AMPLIFIERS have always single input and serve for piezoelectric pressure sensors connection. The channels E – H VOLTAGE INPUTS have either two inputs and they are used for common using for measuring of voltage signals in the range ± 10 V. Signal of all two inputs of one channel is added and digitized by one ADC. These inputs are mostly used for connection of accelerometer or flash detector and for measuring of velocity and accuracy by means of optical gates. You can connect the gates with digital or analog output (displays the pass of bullet through the gate). You can use other sensors for example electromagnetic rings if meets voltage inputs range (the sum within the two inputs is max. ± 10 V, in detail see technical parameters). These inputs can be used for connecting the other sensors, for example impact board (for signal recording during the shot impact on the target).

There exists three groups of processes in dependence on time duration. The first group is relatively short (Internal Ballistics) – it is the time interval from the ignition to the time, when the bullet leaves the barrel. The second two groups are considerably longer – it records the flight (External Ballistics 1) and impact of the bullet on the target (External Ballistics 2).

Transient Recorder always records all 400 000 points into internal high-speed memory. TR 2519 Control software allows adjust the interval of transferred data separately for the every pair of channels A+B, C+D, E+F, G+H and user can assign every channel into corresponding graph of Internal Ballistics, External Ballistics 1 or External Ballistics 2. The time intervals are fully independent to each other, overlapping is not necessary. This considerably improves speed of TR 2519 Control software and reduces a quantity of transferred data, because software transfers only data with true measured impulses.



Pay attention to maximum input voltage of all input modules- see reference manual/technical specifications. Exceeding of maximum values could destroy this instrument.

4.3.4 What Data Will Be for Given Arrangement

Standard TR 2519 is usually connected in the way that Chamber Pressure (Pc) signal starts the measurement (most reliable triggering).

Optical gate for measuring of velocity V10 is placed in distance 10m from muzzle (distance 10m is between muzzle and center of optical gate base). Optical target system for measuring of velocity V25 and accuracy T25 is placed in distance 25m from muzzle (distance 25m is between muzzle and center of optical target base).

This TR 2519 works on differently than other analyzers. It does not give any numerical readings directly, but it measures the real dependencies of all type of signals first. By means of the method, which is created in the program TR 2519 Control, it calculates from those dependencies needed numerical readings for any combinations of input signals. The following output data can be directly acquired for assigned TR 2519 connection:

- waveform of chamber pressure Pc
- waveform of port pressure Pp
- waveform of accelerometer signal
- waveforms of velocity gate signals (Start a Stop)
- waveforms of target system signals (X a Y)

By means of created method TR 2519 control calculates these numerical results:

- value and time of maximum chamber pressure Pc
- value and time of maximum port pressure Pp
- velocity V10
- velocity V25
- coordinates and statistical evaluation of every shot T25

It is acquired the review about velocity in dependence on the trajectory (it is possible to calculate drop of velocity and V0). Besides, it can be continuously checked the signal quality from all sensors and in case of some anomaly it is possible determining the cause of anomaly. If the numerical outputs are false, the round need not be repeated, but you can only modify the method.

4.3.5 Preparing TR 2519 for Measurement

- Connect all cables from sensors with relevant TR 2519 inputs (see previous chapters)
- Check if TR 2519 is connected with control computer network card. If not, connect TR 2519 and control computer with this cable (9-pin Cannon – RJ45 connector). Screw the Canon connector screws
- Turn control computer on and wait while operating system is loaded
- Turn TR 2519 on with the switch (rear panel). This will be indicated on the section STATUS DISPLAY by POWER light. After a max. 5 minutes the other lights will be flashing (READY, and DATA), which indicates correct function
- Run program TR 2519 Control. It appears the main program window and if program is started for the first time, it is necessary to adjust its working directories. This is possible in Settings > Directories (Fig. 7) by assigning the whole path or by listing existing directory. The content of single directories is following:

- Data	- measured data
- ASCII export	- data output in ASCII form
- Settings (Methods)	- TR 2519 setting (methods)
- Reports	- measured results in the protocol forms
- XLS Reports	- measured results in the XLS protocol forms
- Calibrations	- calibration protocols
- References	- reference curves
- Report Forms	- C.I.P. forms
- Sensors	- sensors for TR 2519
- Data Backup	- directory for data backup
- Temporary	- temporary files

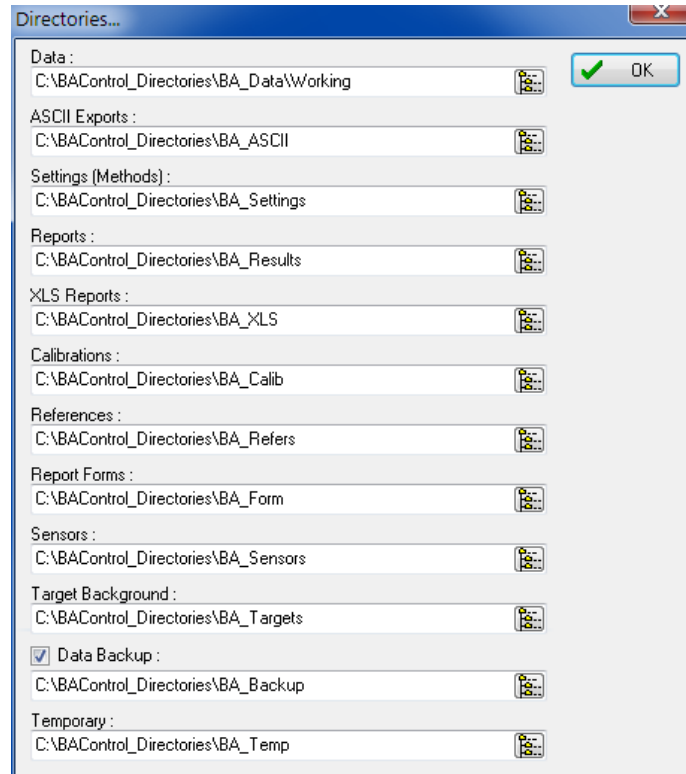


Fig. 7: Directories settings

- Check Settings > Colors, Preferences (Fig. 8 and 9). The reason of single items will be explained later, the setting should be according the picture. Grey (inactive) items has noeffect and their adjustment does not matter. Then it is necessary to assign channels A - H into relevant graphs by means of button according to picture Fig. 10

Now the preparations for measuring are done.

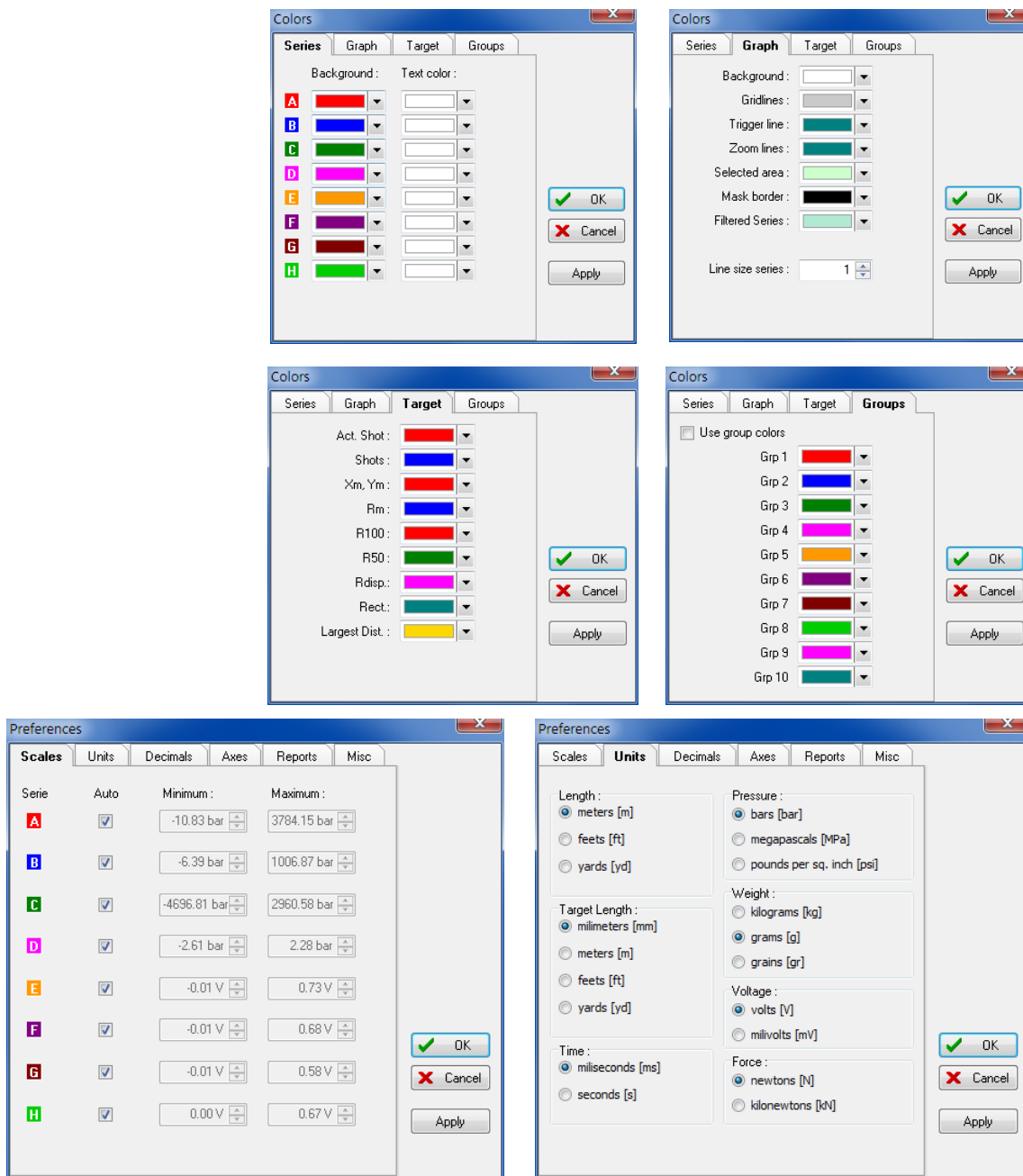


Fig. 8: Basic settings

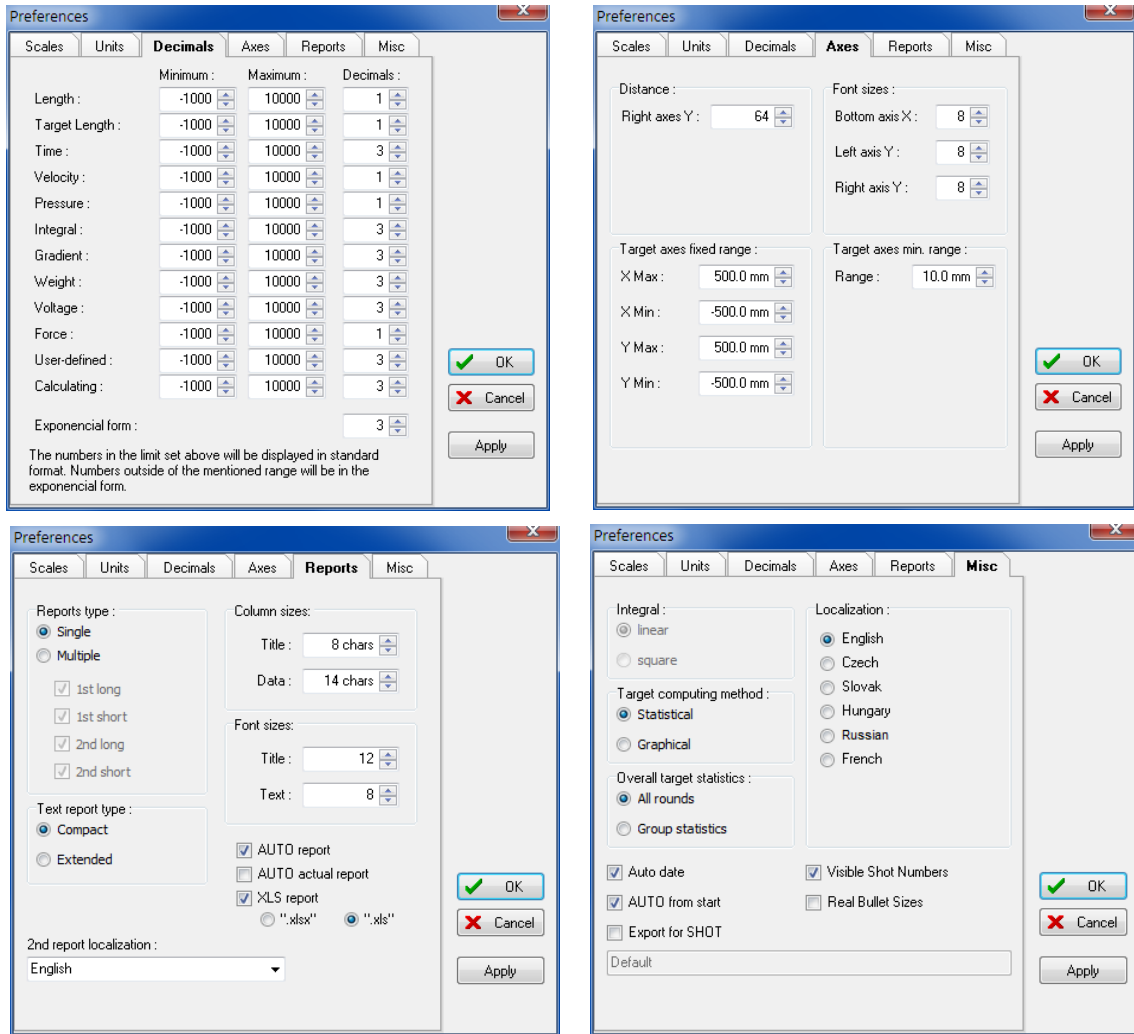


Fig. 9: Basic settings

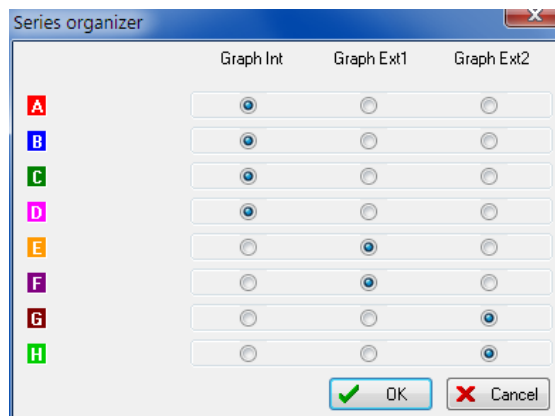



Fig. 10: Graph organizer

4.4 Measuring Procedure, Method and Protocol Building

If TR 2519 is ready (see previous chapter), it is possible to start measuring. It is recommended keeping the following method :

- Entering of name of measured series and filling of form
- Setting of main TR 2519 parameters
- Shooting of first round
- Building of data evaluation method
- Shooting of the whole rounds of series

4.4.1 Entering of Name of Measured Series and Filling of Form

For each new series it is necessary to enter the name of series and also select directory for saving of data (if directory is different from default directory). In the main window of program TR 2519 Control select File > New or use the button  and type required name of series (or use Browse... for different directory).

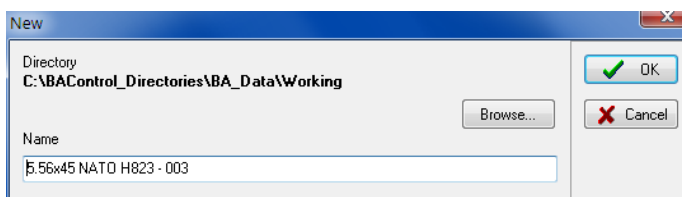


Fig. 11: Directory and name setting

The single data files will be stored in the directory :
 C:\BA_Data\2009-12-02_5.56x45 NATO H823 – 003

where: C:\BA_Data ... directory (see Settings > Directories)

- 2009-12-02_5.56x45 NATO H823 - 003 ... name of series (min. 4 characters!).



Attention!

MAXIMUM NUMBER OF SHOTS IS LIMITED TO 250.

Browse... serves for changing of data storage directory.

If you choose the name of existing series, after prompting and confirming with Yes answer, the existing data will be replaced with the new data.

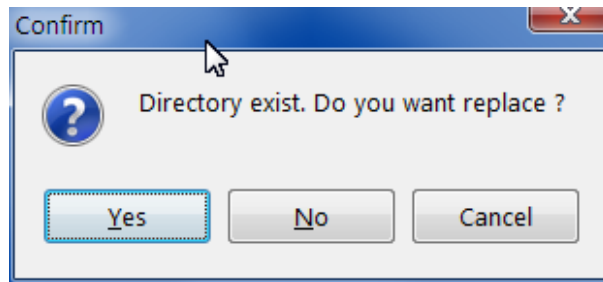


Fig. 12: Confirmation

After the new name of series setting it appears the configurable form (Fig. 13 and 14). Its filling is not required and can be completed later (see standalone chapter for detailed description). After confirming Yes, the configuration file is loaded from the instrument and TR 2519 virtual panel appears.

The figure displays two screenshots of the 'Report Form' dialog box, illustrating the configuration of report groups.

Top Screenshot (Group 1 selected):

- Group 1:**
 - <Title>** Ballistic Laboratory
 - Project No.: Acceptance test
 - Place: Ballistic Laboratory
 - Technician:
 - Test Manager:
- Group 2:** (disabled)
- Group 3:** (disabled)
- Customer:**
 - <Title>** Customer
 - Name:
 - Place:
 - Date: 28.12.2011
 - Time: 14:23

Bottom Screenshot (Group 2 selected):

- Group 1:** (disabled)
- Group 2:**
 - <Title>** Testing Equipment
 - Test barrel: 5.56x45 NATO
 - Test barrel length [mm]: 508.000
 - Transducer Pc (SNo): Kistler 6215
 - Transducer Pp (SNo): Kistler 6215
 - Velocity meas. system: WLS03
 - Accuracy meas. system: WTS03
 - Notes: Transient Recorder BA06S
- Group 3:** (disabled)
- Ammunition:**
 - <Title>** Ammunition
 - Ammunition: SS109
 - Testing conditions:
 - NSN ammunition:
 - Calibre [mm]: 5.560
 - Bullet diameter [mm]: 5.560
 - Bullet weight [g]: 3.600 g
 - Notes:

Fig. 13: Definition of report

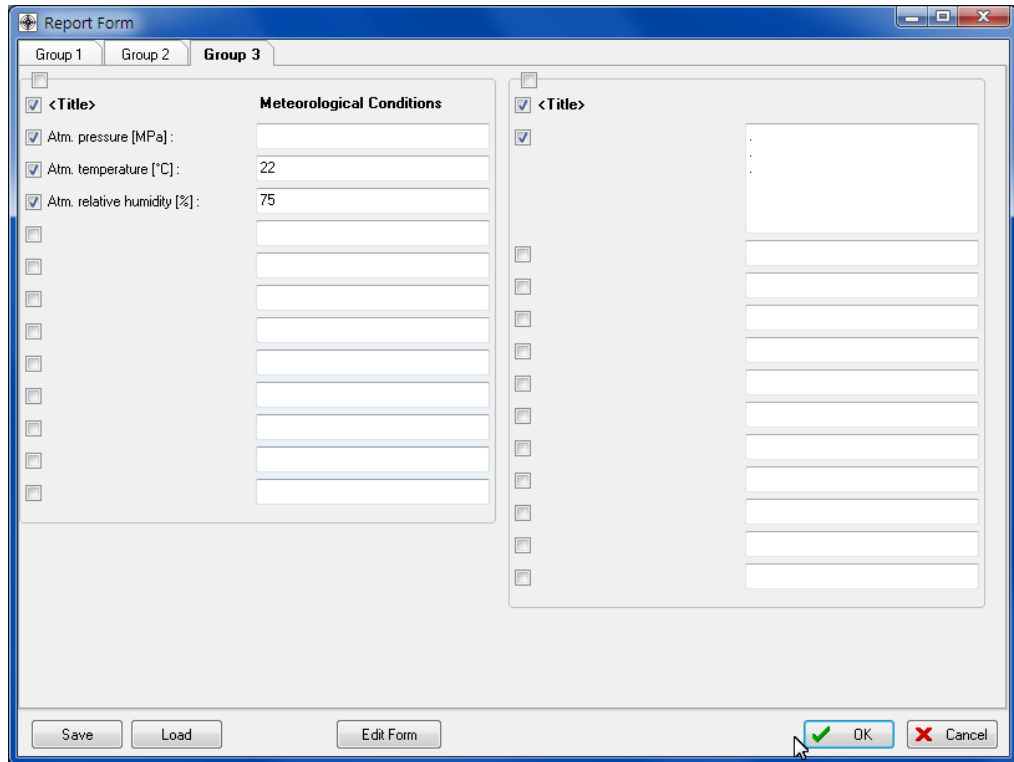


Fig. 14: Definition of report

4.4.2 Setting of Main TR 2519 Parameters

Setting of all TR 2519 parameters and its measuring control is made by means of virtual TR 2519 panel.

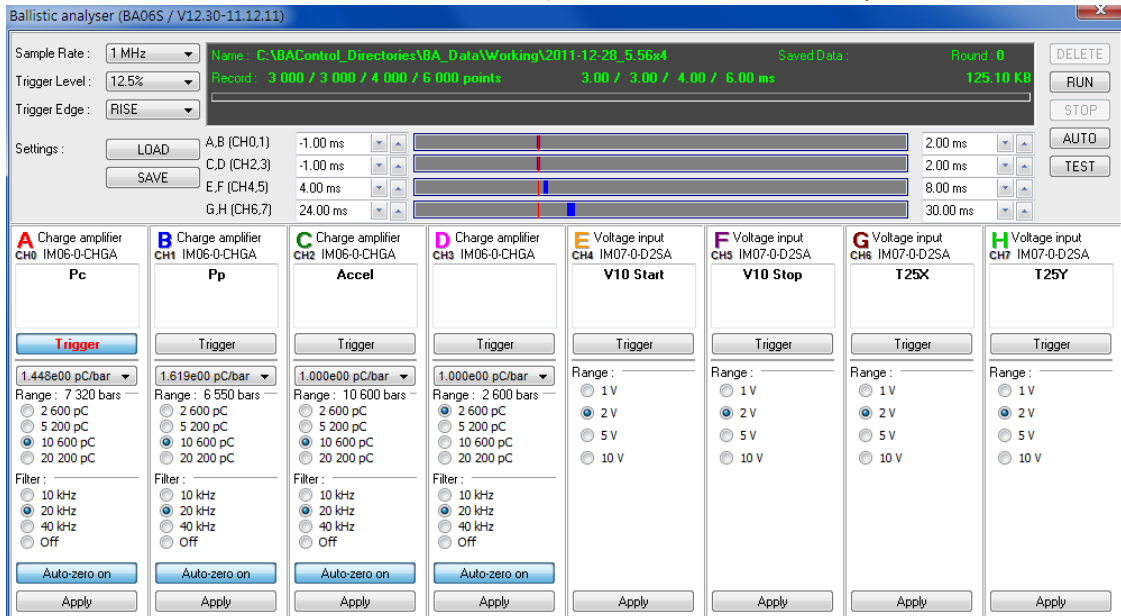
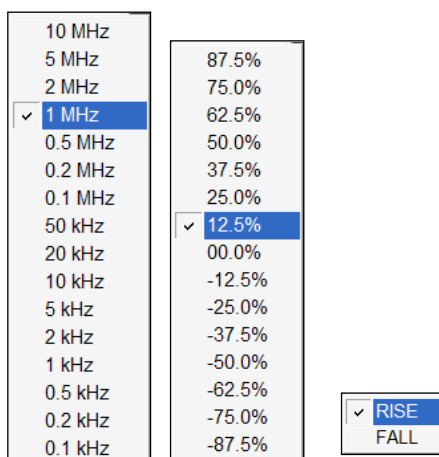


Fig. 15: Virtual panel

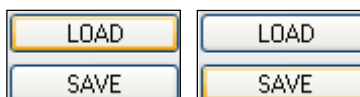
Before first round it is necessary adjusting following TR 2519 parameters:



Sampling rate (Sample Rate) determines the number of points of input signal (pressure etc.), which are recorded for every second. Its setting has effect for density of points on the final graph. Too high density made data processing slower and the large files are created on the disk. According to C.I.P. specifies the minimal sampling rate 1MHz, which is usually used method in practice for pressure measuring of powder gases.

Trigger level (Trigger Level) is the specific value. After exceeding this value the TR 2519 data recording is initiated. This value is pictured in percent of given range. For negative values has blue color, for positive values has red color and for zero value has green color. Set optimal trigger value for secure triggering without possibility of false triggering caused by noise and interference (and that is why the level 0.00% is not used during pressure triggering). Recommended value for typical measuring is 12.5%.

Trigger edge (Trigger Edge) determines, while data recording initialization will be followed after trigger level exceeding (Trigger Level) during signal increasing (RISE) or during signal decreasing (FALL).



This buttons serve for Transient Recorder setting (Settings) and make loading possible (LOAD) and saving (SAVE) on the control computer disk. Detailed description – see relevant text.

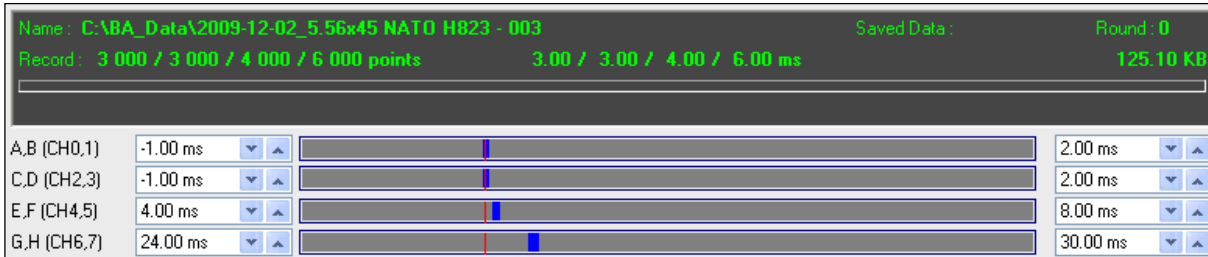


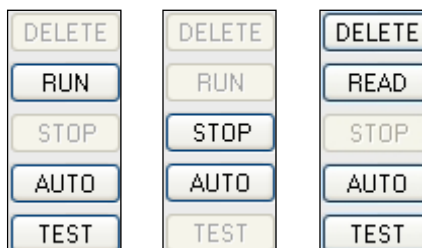
Fig. 16: Saved data

Virtual TR 2519 display provides important information about the setting and TR 2519 measuring procedure. There is the name of directory on the left topside in the first row (Name, Series), where the data will be stored, and the volume of total saved data in this series (Saved Data). There is the round counter on the right topside (Round), the number 0 means, that neither round was recorded so far.

For understanding of function of other settings it is necessary explaining TR 2519 operation with the memory of AD converters. This memory is always filled with data in the range -100 000 to +300 000 points. The negative numbers are the so-called pre-trigger, i.e. the data which are recorded before recording initiation, zero is the time of triggering and positive numbers are data after recording initiation. For typical work are 400 000 points too many and that is why only required part of data are transferred to control computer. This part is set-up separately for every pair of channels A+B, C+D, E+F and G+H (see chapter B 3.3 Recommendations for choosing and using single channels (inputs)) The beginning of memory reading is located on the left part of display, the end is on the right. The adjusted data are displayed for checking by bar graph form. The vertical red line indicates time of triggering (Trigger point).

In the second line of display are written calculations of transported points and lengths of time intervals for every pair of channels (Record) and total volume of data for the one round.

Free horizontal line in the center of display is used for bar graph displaying with data transport process from TR 2519 to control computer.



There are the buttons for TR 2519 measuring control in the right part of virtual TR 2519 panel. Their functions are : delete last round (DELETE), run measuring (RUN), stop measuring (STOP), automatic measuring of the whole series (AUTO) and testing of inputs (TEST). The button RUN has a second function READ (for reread of TR 2519 data after modification of time intervals at first round of series) and the button STOP has a second function BREAK (interrupt of long measurement by using low sample rate). The function of those buttons will be described later during measuring.

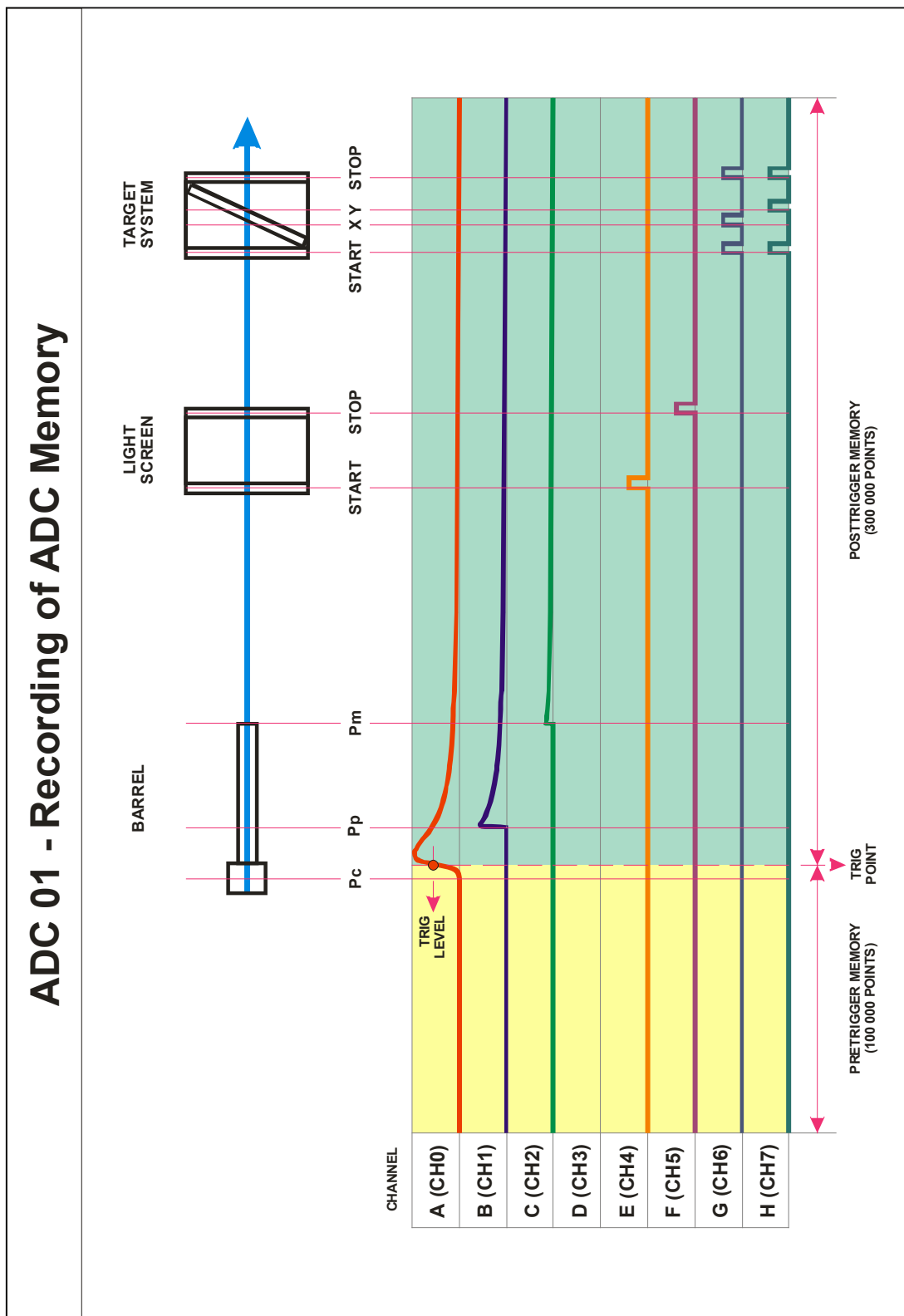


Fig. 17: Scheme of recording

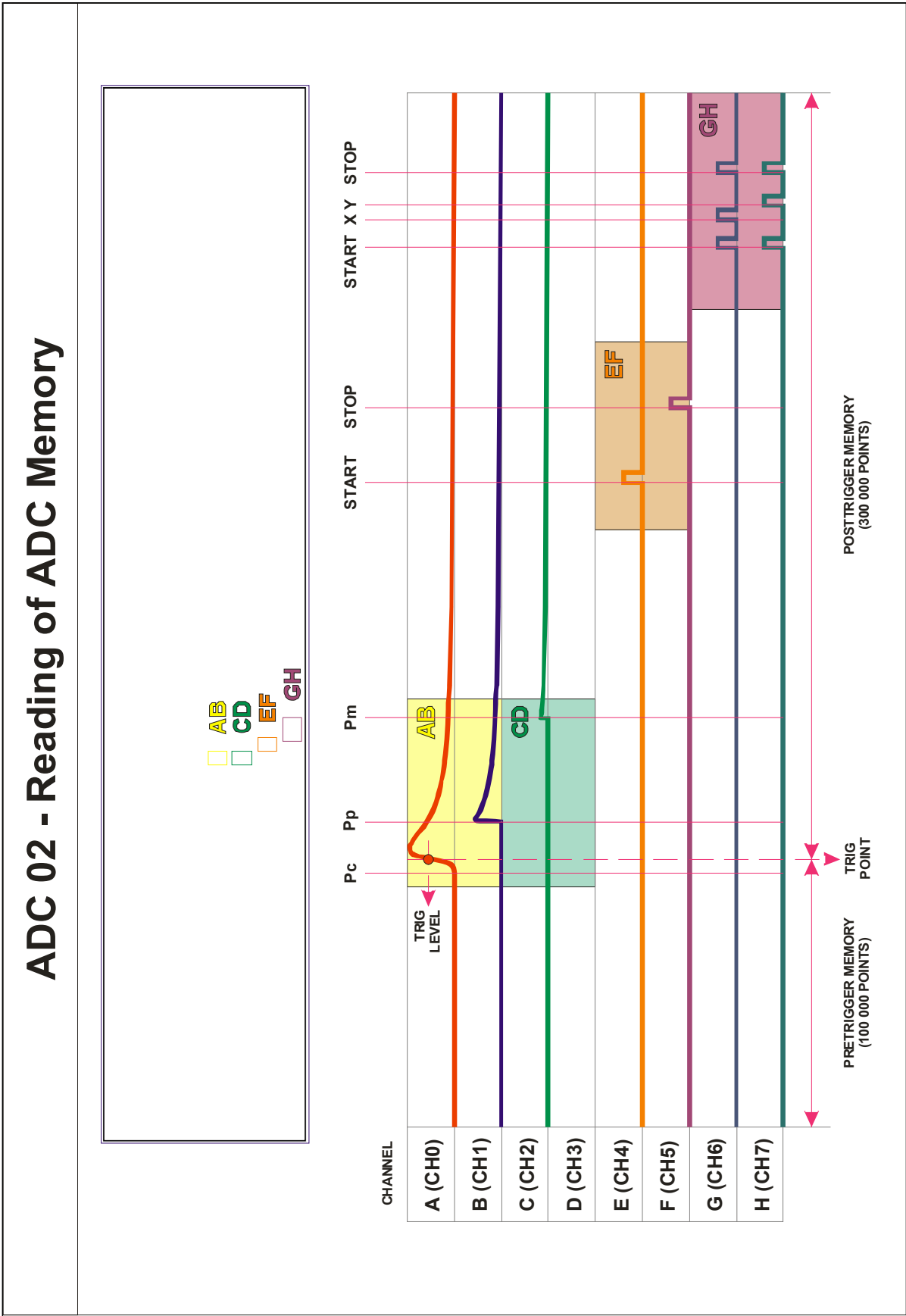


Fig. 18: Scheme of reading

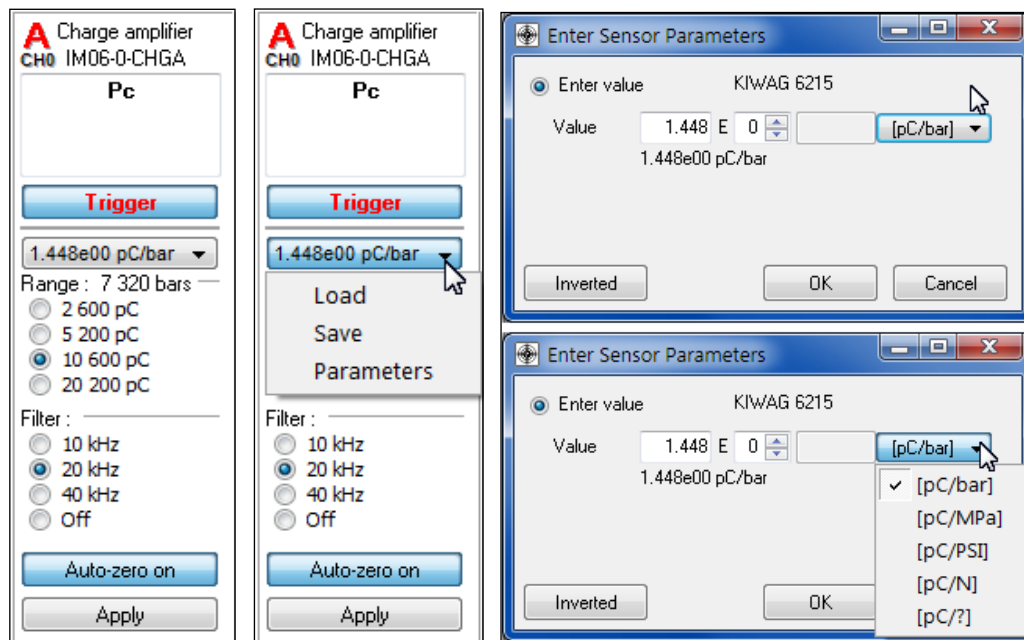


Fig. 19: Parameter setting

The panel of input module – charge amplifier.

A CHO - the marking of channel, color is the same as color of curve in graph.

Charge amplifier IM06-0-CHGA - the name of module.

Four lines of free text - text field for placing description of relevant channel for better orientation of user (sensor type, its using, location on the weapon i.e.).

Trigger - the switch for the trigger channel selection. Selected channel is highlighted with the red color. We recommend to choose the pressure channel as the triggering source, because by contrast to accelerometer it provides clear course with defined and almost constant shape and it is very resistive against the false triggering.

Setting of calibration constant of sensor - button for setting of the pressure sensor calibration coefficient. For entering of sensor coefficient press this button and select item from menu :

- Load is for loading of saved sensor parameters
- Save is for saving of actual sensor parameters
- Parameters serves for direct entering of sensor parameters in exponential form

(button Inverted inverts the sensor polarity - for sensors with negative calibration coefficient let this button inactive). [pC/?] means user defined unit (different from previously defined).

Range 2 600 pC, 5 200 pC, 10 600 pC, 20 200 pC - the selection of measuring range. Beside the title Range is displayed calculated value of measuring range in bar units (depends on the selection of measuring range and on the sensor calibration coefficient - provides information about true maximum pressure).

Filter 10 kHz, 20 kHz, 40 kHz, Off - the filter selection.
Auto-zero on, Auto-zero off - the switch of automatic compensation of the offset and the cable leakage. Normally use only Auto-zero on, do not set this switch to Auto-zero off. This provides maximum measuring accuracy by changing of temperature and other ambient conditions. Only for measuring of pressure process which are longer than 100 ms it is necessary to disable this function (Auto-zero off), because compensation causes distortion of measurement.

Apply - serves to send of actual settings into TR 2519.

The image shows a vertical configuration panel for a voltage input module. At the top, it displays 'E Voltage input' and 'CH4 IM07-0-D2SA'. Below this is a text field containing 'V10 Start'. A 'Trigger' button is positioned below the text field. Underneath is a 'Range:' label followed by four radio button options: '1 V', '2 V' (which is selected and highlighted with a blue dot), '5 V', and '10 V'. At the bottom of the panel is an 'Apply' button.

The panel of input module - universal voltage input.

E CH4 - the marking of channel, color is the same as color of curve in graph.

Voltage input IM07-0-D2SA - the name of module.

Four lines of free text - text field for placing description of relevant channel for better orientation of user (sensor type, its using, location on the weapon i.e.).

Trigger - the switch for the trigger channel selection. Selected channel is highlighted with the red color.

Range 1 V, 2 V, 5 V, 10 V - the selection of measuring range. Because this module has three summing inputs, the range means sum of three input voltages.

Apply - serves to send of actual settings into TR 2519.

4.4.3 Shooting of First Round

If basic TR 2519 parameters are adjusted, it is possible running measuring. If the measuring is new, it usually does not contain the method for data evaluation. You have to shot first round and make setting of those data evaluation for the whole series. If the testing weapon is ready for first shoot, click on the button RUN, which is located to the right topside. The button AUTO is not allowed to be pressed.

At first the control computer sends the information for setting of TR 2519 and then TR 2519 reads data for pretrigger (Fig. 20 and 21). After a several second it is displayed the information about waiting for trigger (Waiting for trigger, Fig. 22). The button RUN is now disabled, the measuring (waiting for trigger) can be aborted by enabled button STOP.

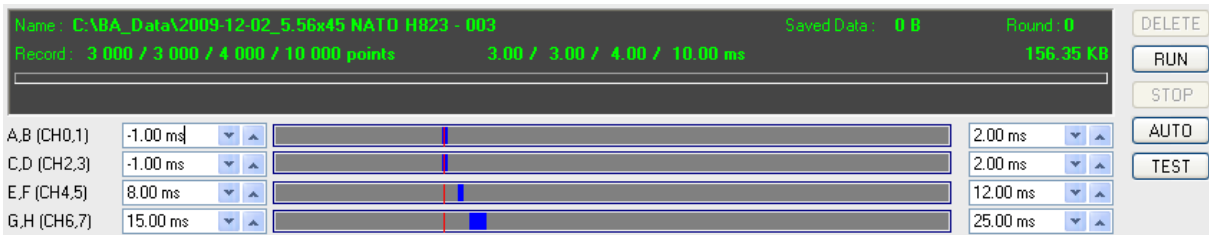


Fig. 20: Run first round

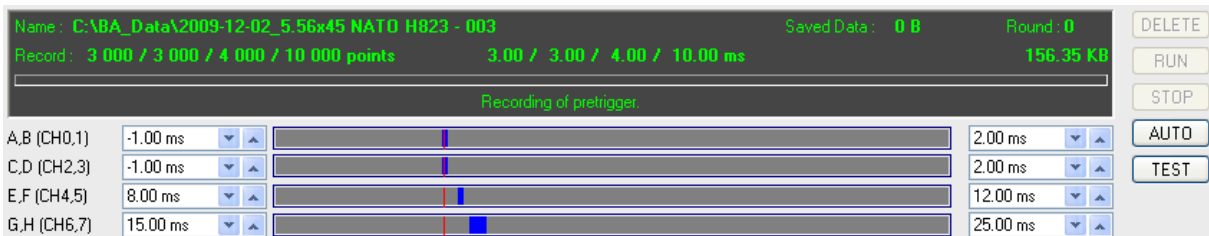


Fig. 21: Reading data for pretriggering

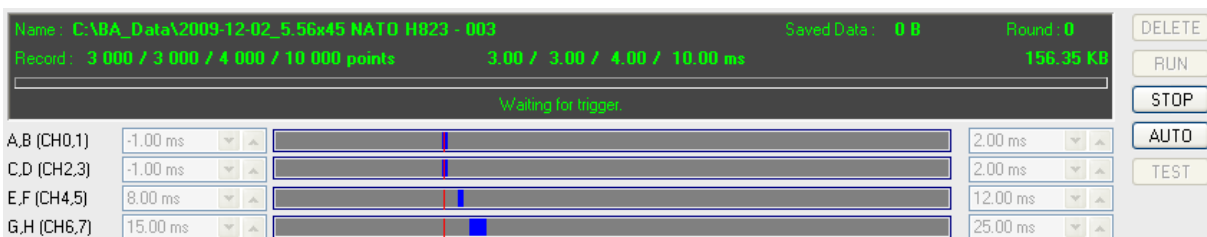


Fig. 22: After pretriggering: stop

On the front panel of TR 2519 lights the red light READY. This indicates finish recording of pre-trigger and TR 2519 is ready for recording of round. When the light is on, you can shot the first round. Correct capturing of triggering is indicated by the lettering Trigger OK.

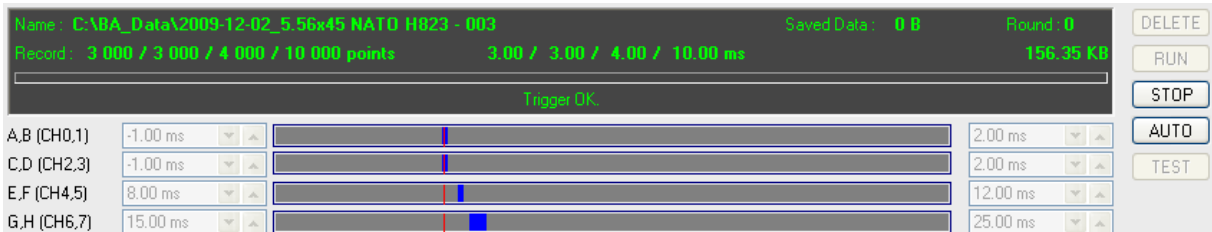


Fig. 23: Shoot of first round

The transport of data to the control computer is indicated by green light DATA. Data are sent separately for each pair of channels (see green bar graph).

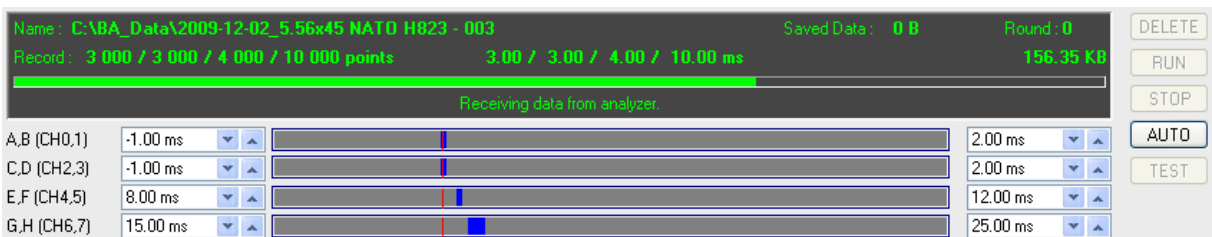


Fig. 24: Saving data

Successful transport and graphs drawing are indicated with the round counter incrimination (Round) and with the counter of saving data volume (Saved Data). The button RUN is enabled at the same moment for next shot of series and DELETE for deleting of the last round of series.

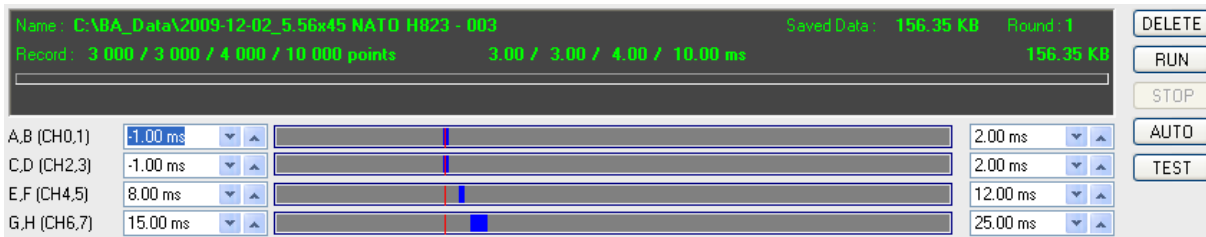


Fig. 25: Saved round

In this phase the data are stored on the control computer disk and it is possible to create the method for numerical evaluation of curves. It is necessary to create the method after the first round of series, because creating or modifying of method is disabled from the second round and it is possible to edit some parameters only. The method can be changed after finishing of measurement.

Description of functions is simplified and special functions (correction of time interval with rereading of data, interrupting of measurement with low sampling frequency etc.) are described in reference part of TR 2519 manual.

4.4.4 Building of Data Evaluation Method

Display of control computer now includes virtual TR 2519 panel and main program TR 2519 Control window.

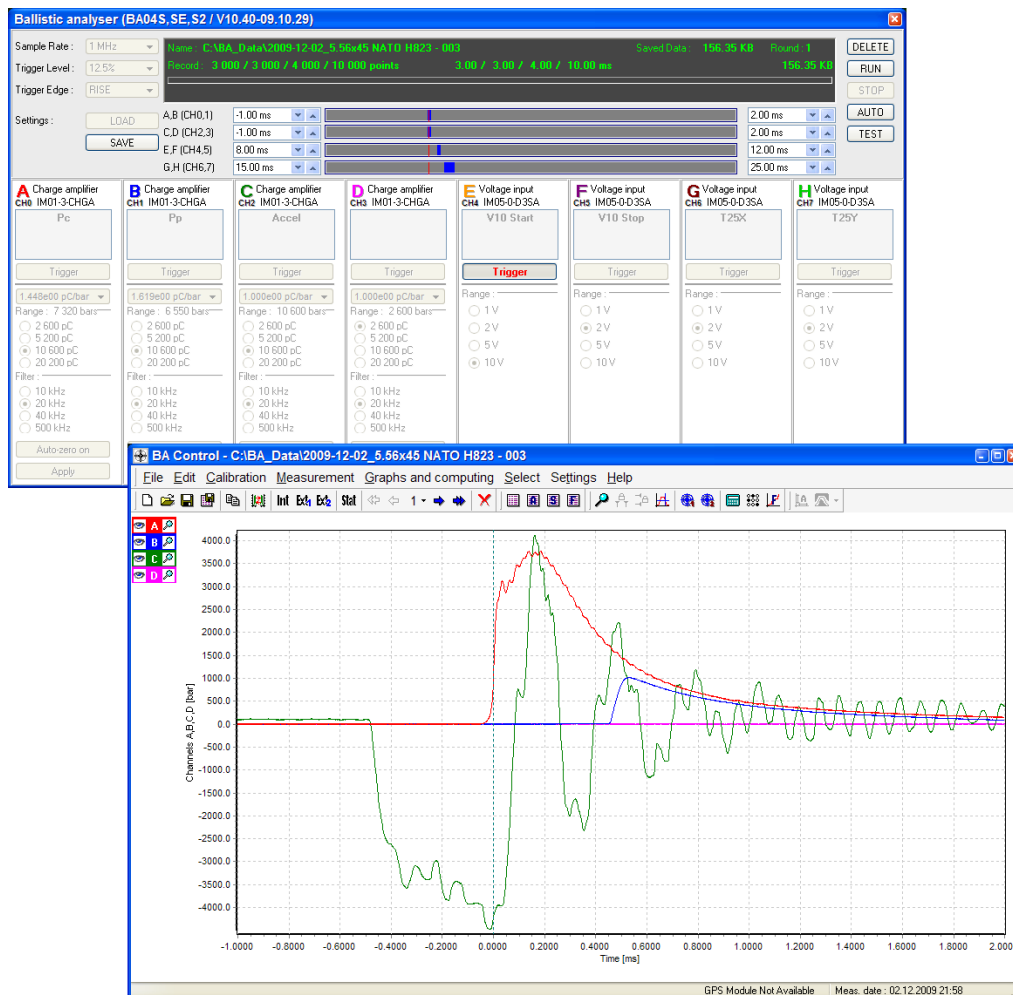


Fig. 26: Measuring graph

While TR 2519 virtual panel controls the instrument during measuring, the main window of TR 2519 Control program integrates all functions of program (measuring, data displaying and processing) to single complex. Creation of method for data evaluation is also performed in this window.

It is necessary to know several actions for successful creation of method - setting of graph (axis and colors), displaying and hiding of curves, switching of graphs and zoom function (Zoom). These functions are called from the main window of TR 2519 Control program.

Setting of graph scales is accessible in Preferences > Scales and contains setting of scales of all Y-axes (Fig. 27). The option Auto sizes axes according to founded curves minimum and maximum.

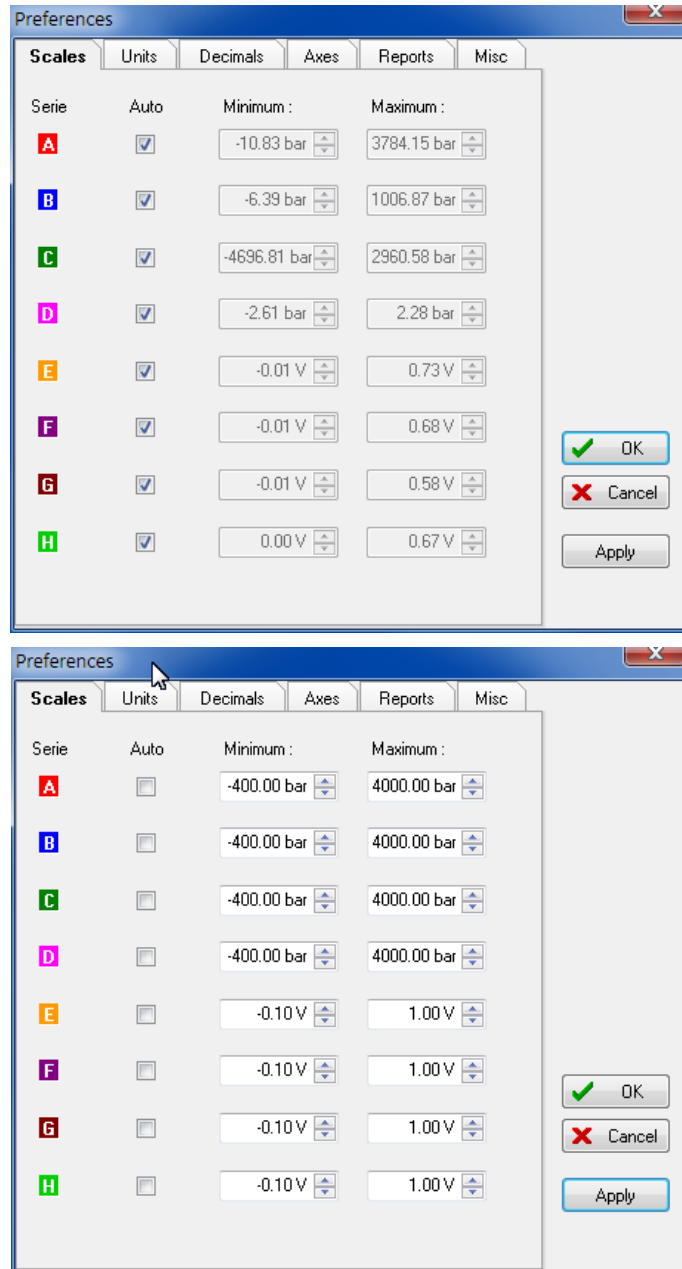



Fig. 27: Settings of graph scales

If you want to choose fixed axis scale, uncheck option Auto and type chosen value of curves minimum and maximum. The possible result is displayed on the Fig. 28. Automatic scaling of axes can be temporarily enabled by means of button .

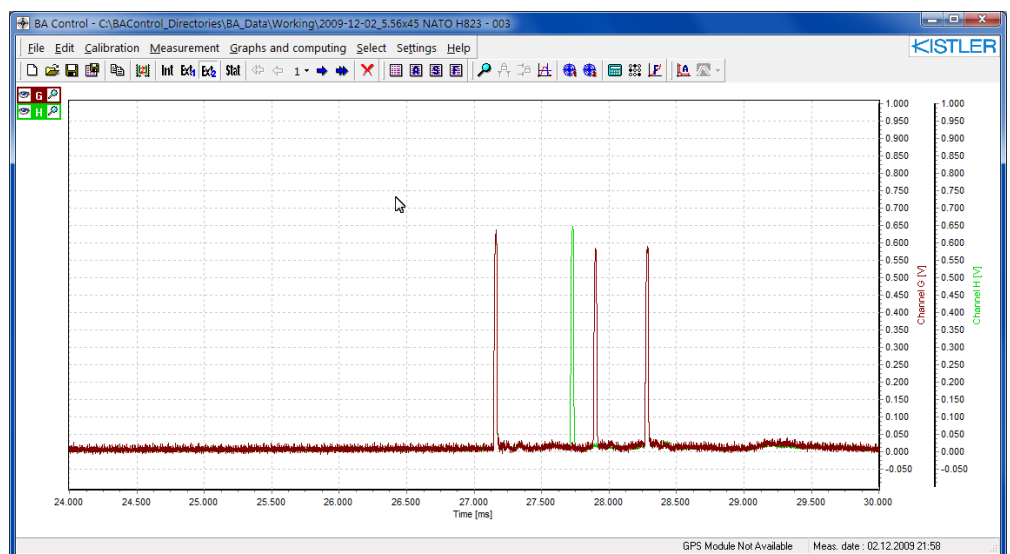
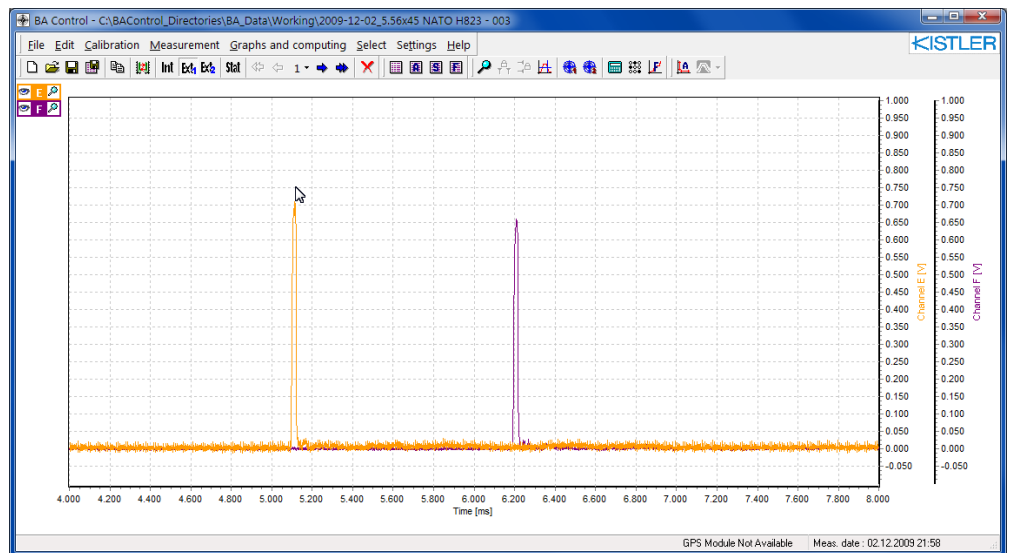
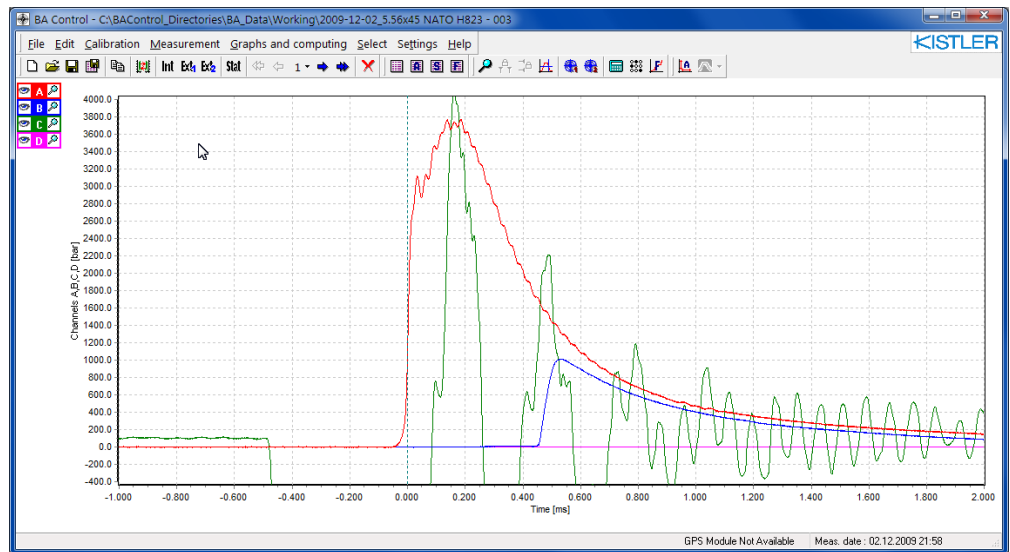


Fig. 28: Graphs A – D/E – F/G – H

Other possible settings are on the picture Fig. 29, 30 and 31 (during measurement are accessible only some options - for detailed description see TR 2519 reference manual).

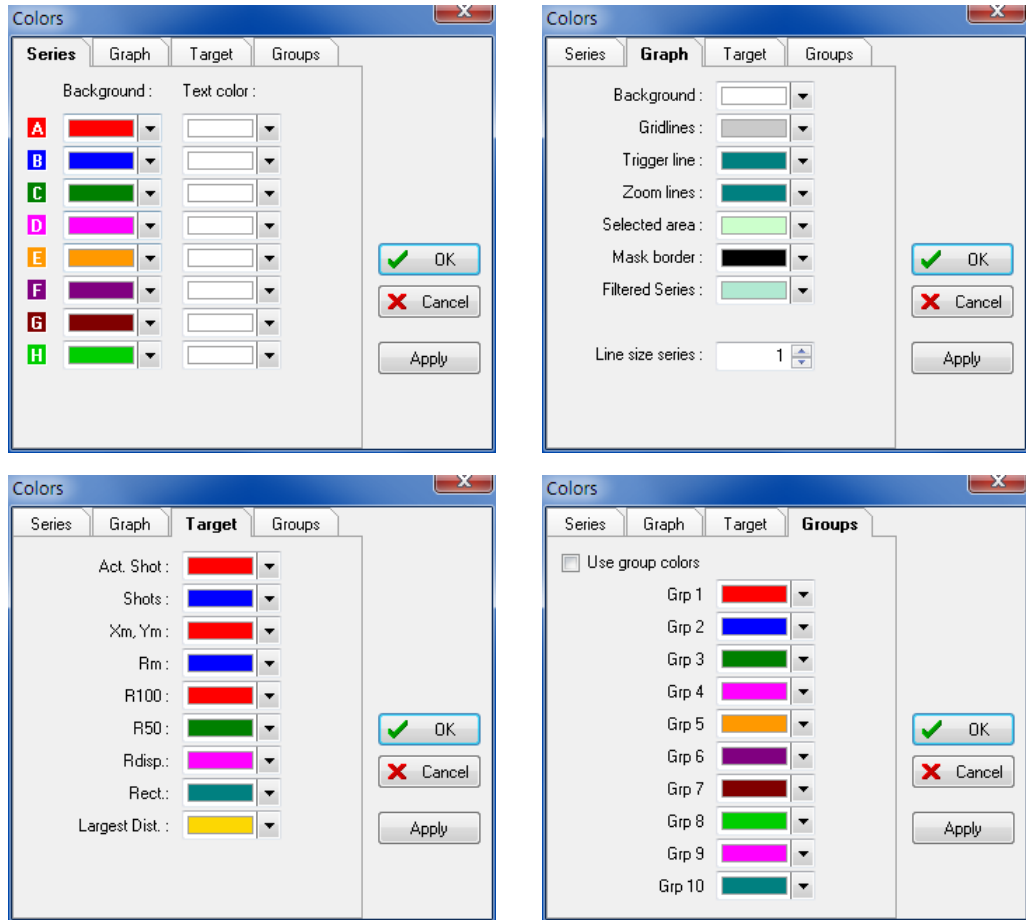


Fig. 29: Graph settings

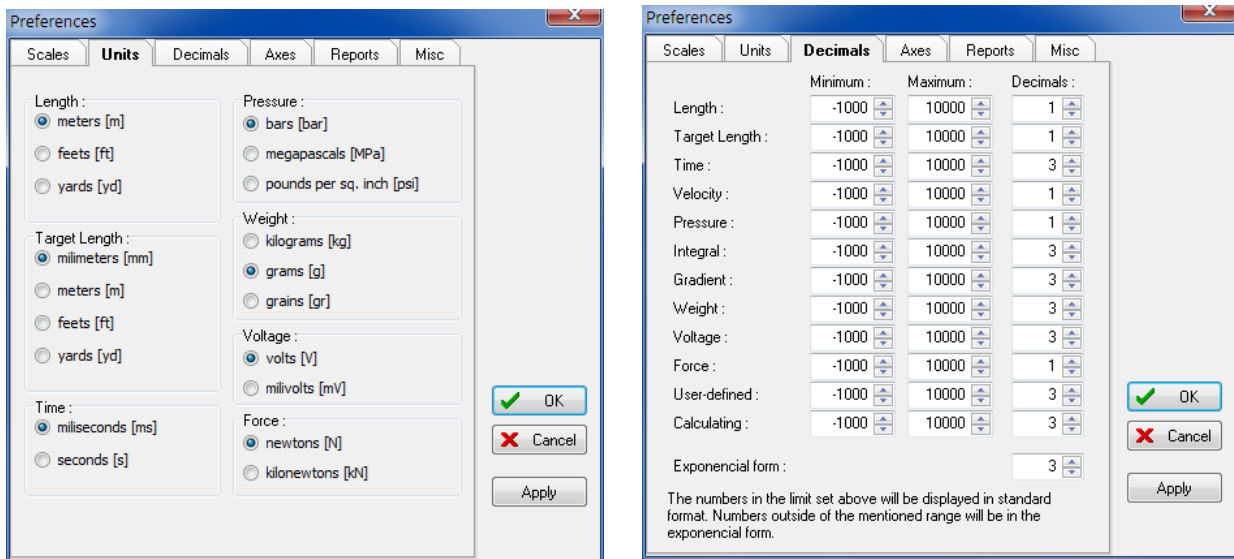


Fig. 30: Graph settings

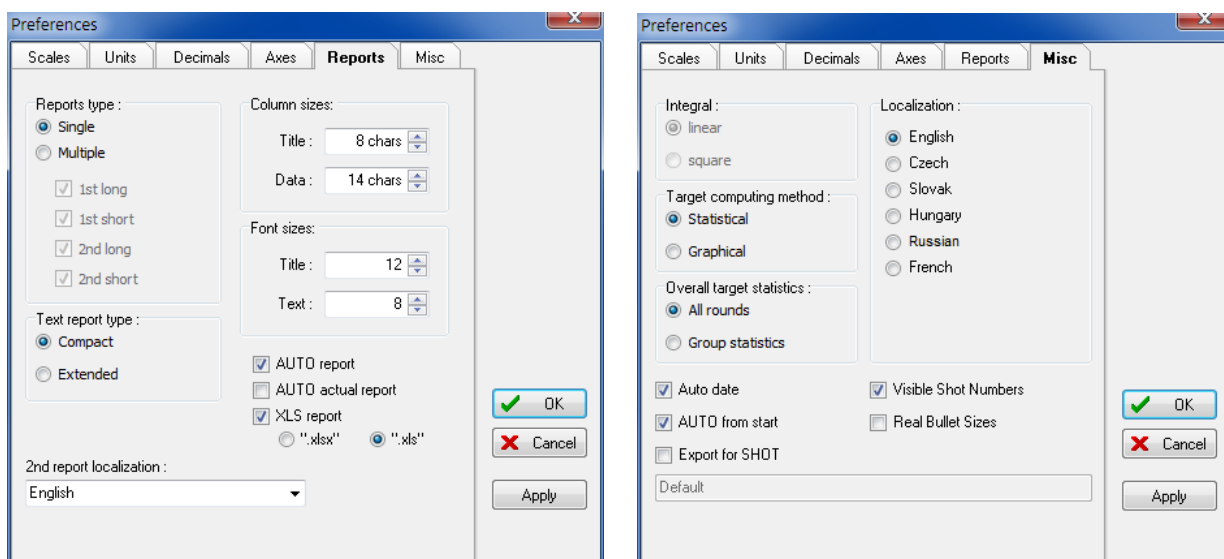


Fig. 31: Graph settings

Displaying and hiding of curves



- by means of buttons with the symbol of eye, which are located at the left topside margin of main program window (beside the graph).




If eye button has highlighted color, the curve is displayed. If you press this button, the color has to be dull and the curve is hidden. When you click on the button again, the curve will be displayed.

Graph switching is possible by means of switch in tools panel of main program window :



- Int** • graph of Internal Ballistics
- Ext₁** • graph of External Ballistics 1
- Ext₂** • graph of External Ballistics 2
- Stat** • graph of Internal Ballistics - Statistics (inaccessible during measuring)

Zoom is the next function of program. Selection of the curve, which is displayed in separate window Zoom, is made by means of zoom switches beside the buttons for curve displaying and hiding. The function Zoom is allowed

only for displayed curves   , it is prohibited for hidden curves. Active function Zoom is indicated with

change (activating) of zoom button in tools panel , after its deactivating the function Zoom is deactivated.

After Zoom activating it is opened in a separate window (Fig. 32) with the selected part of the curve. This part of selected curve is terminated with horizontal and vertical cursors and highlighted with color in the main program window (color setting see Settings > Preferences > Graph colours > Selected area). It is possible to drag&drop the cursors by means of mouse and changing magnification of relevant part of curve in the window Zoom.

The buttons   serves for locking and unlocking of relative cursor position for easy examination of curve details (it is possible moving with the pair of locked cursors at the same time).

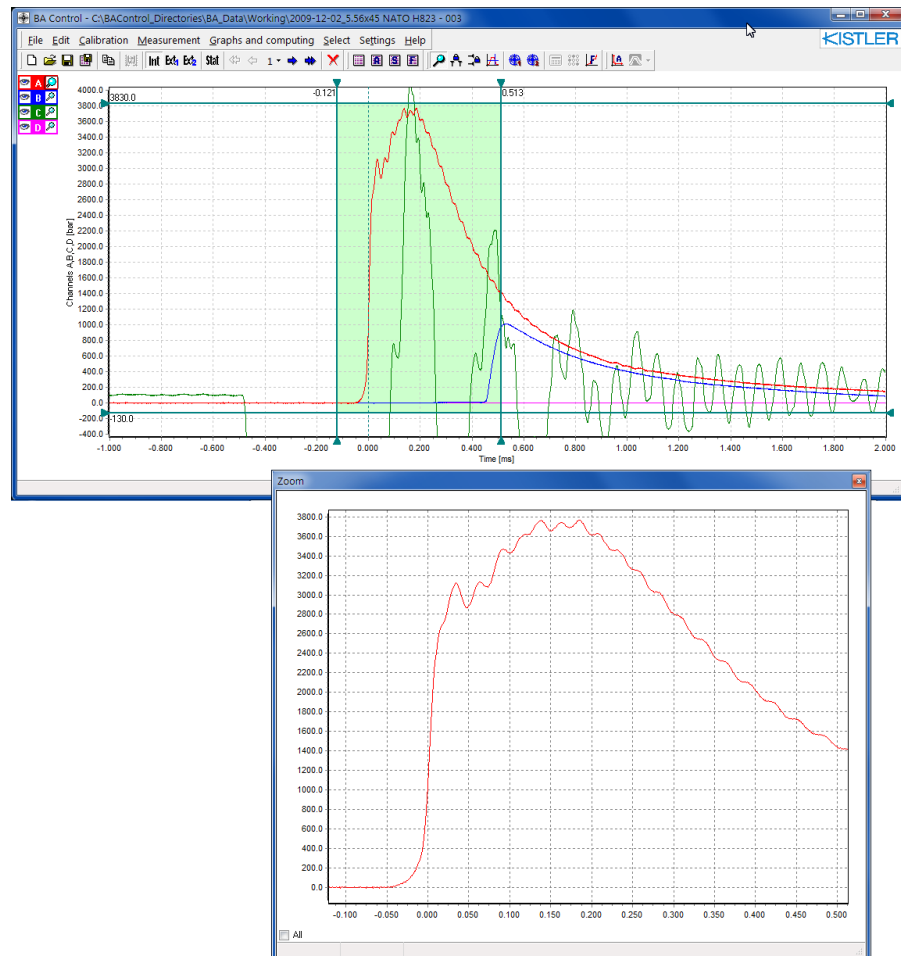




Fig. 32: Zoom function

Creation of method for data evaluation is activated and deactivated by means of button  Computing, which is located at the panel of tools of main program window. Make all required curve displayed on all graphs by means of previously described functions and adjust their imaging according to your requirements. Then press the button of function Computing. It appears empty window for creation of method for data evaluation. It contains group of control buttons (Fig. 33). If the window is not empty it is possible to delete all lines by means of button  Delete all. Delete all.

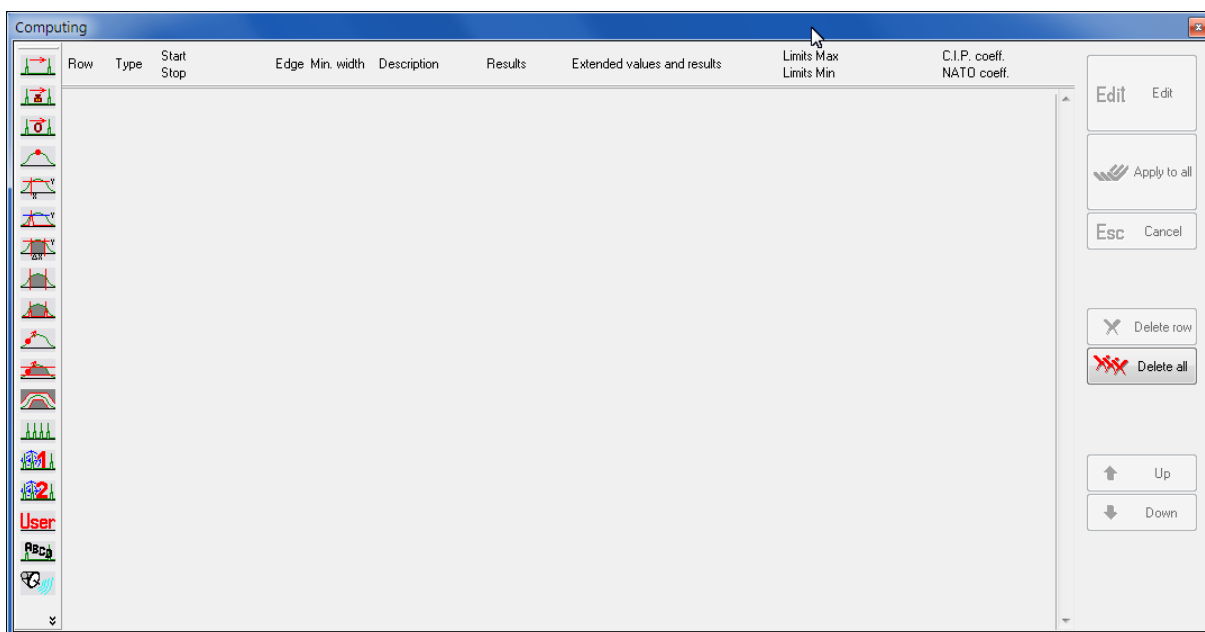


Fig. 33: Creation of method

The first line of method will be maximum pressure determination on the A curve (red). Press the button Add pressure, which serve for addition of single line with calculation of pressure maximum and relevant data times.

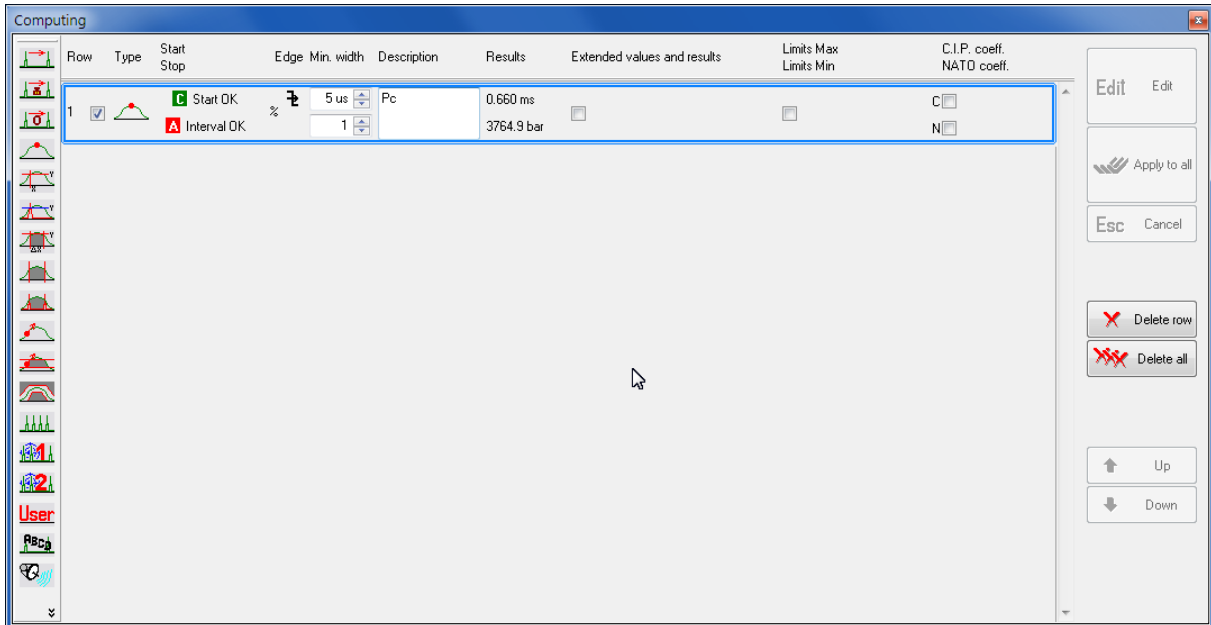


Fig. 34: Definition of method

Meaning of single line items :

Row: line number. **Checkbox** determines addition of results to reports.

Type: icon for identification of function of line (Pmax)

Start / Interval: up - button for setting of beginning of Pmax time admeasurement
down - button for setting of interval for calculation of Pmax

Edge: setting of evaluation from rise or fall edge of impulse

Min. width: setting of minimal accepted width of impulse

Description: naming of this line (any text)





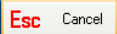

Results: time to Pmax and value of Pmax

Extended values and results: calculation of time to adjusted pressure level (%Pmax)

Limits (Max/Min): settings of limit values of Max(Pmax) and Min(Pmax)

C.I.P. coeff.: calculation of C.I.P.correction (setting of correction coefficient)

NATO coeff.: calculation of NATO correction (setting of value for correction of result)

Press button Start OK and for transition to  edit mode press the button  Edit. This opens the window Zoom, where it is displayed highlighted area of selected curve, which is limited with vertical cursors. The button on the number and its color is corresponding to color of selected curve. Choose required curve by means of button with symbol of magnifying glass . Because the beginning of time admeasurement for maximum pressure is given with accelerometer, choose the curve C. Then choose by means of vertical cursors required area and by means of single horizontal cursor, which represents threshold level, set its point of intersection with the curve. This cursor is drawn also in the window Zoom and founded point is highlighted. The relevant computed value of time is inserted to the window Computing. For accept of this setting press the button  Apply to all - edit mode is cancelled and setting is stored. If edit mode is left with other way, the setting is ignored! For cancel of edit mode without saving press the button  Esc Cancel . Next choose appropriate edge of impulse (Edge) and press the button . Similar is setting of minimal width of impulse (Min. width).

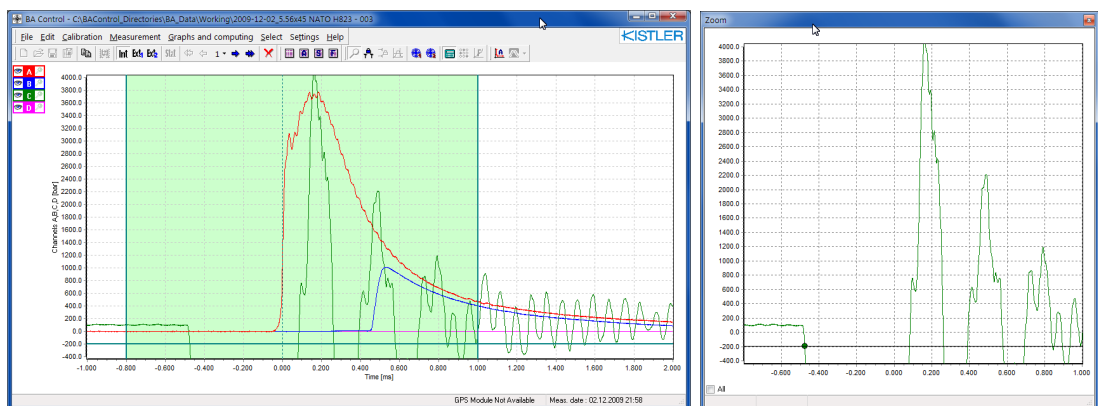
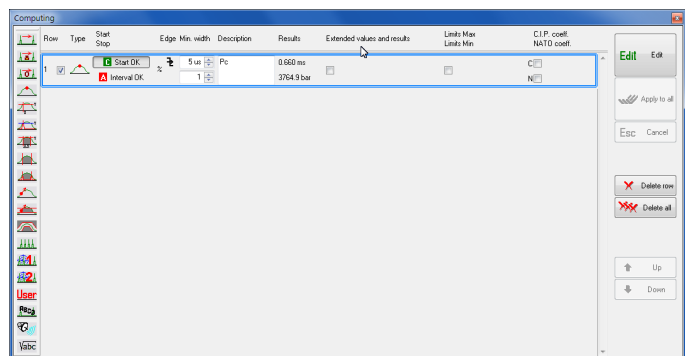






Fig. 35: Window zoom

The next point in sequence is setting of interval for calculation of maximum pressure Pmax. Press the button Interval OK to choose setting of this interval and by

pressing button  Edit go to edit mode. At first select appropriate curve of channel A by pressing button  and select the area for searching of maximum pressure with vertical cursors Horizontal cursor is not presented here. Founded maximum is highlighted at the window Zoom. Into the area Results are written time of maximum Pmax from beginning (here impulse of accelerometer) and value of maximum pressure Pmax.

For accept of this setting press the button  Apply to all (edit mode is cancelled and setting is stored).

Next select length of filter for noise suppression by searching of maximum value of pressure in column Min. width (maximum value is calculated as average value of preset area - default value is 1, zero means Filter Off). For

accept of this setting press the button  Apply to all.

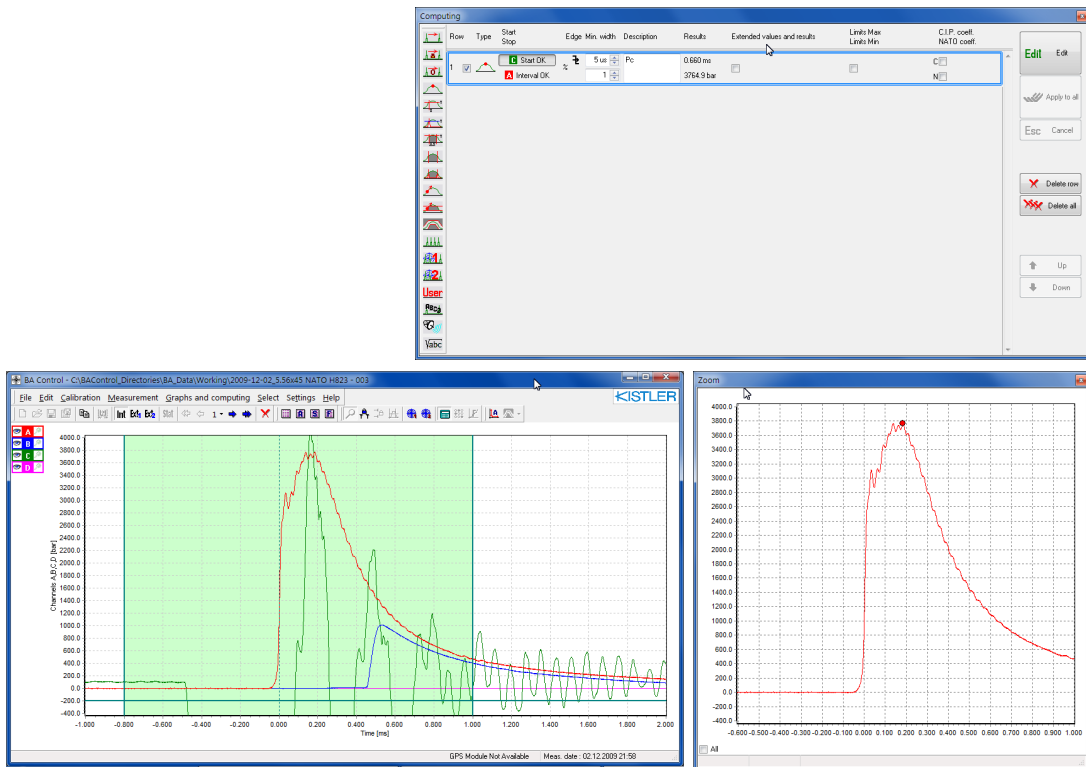




Fig. 36: Calculation of maximum pressure

Type any text to the field for naming of line, which characters measured quantities and will serve for their

identification (Fig. 37). Accept with the button  Apply to all .

The next point is calculation of the time, which is needed for reach of adjusted level of pressure (in percent of found maximum pressure). For activation of this function check the box and adjust required pressure level. In results area appears calculated time. For accept of this setting press the

button  Apply to all. The work with C.I.P. / NATO corrections is activated and filled with the same way as the previous items.

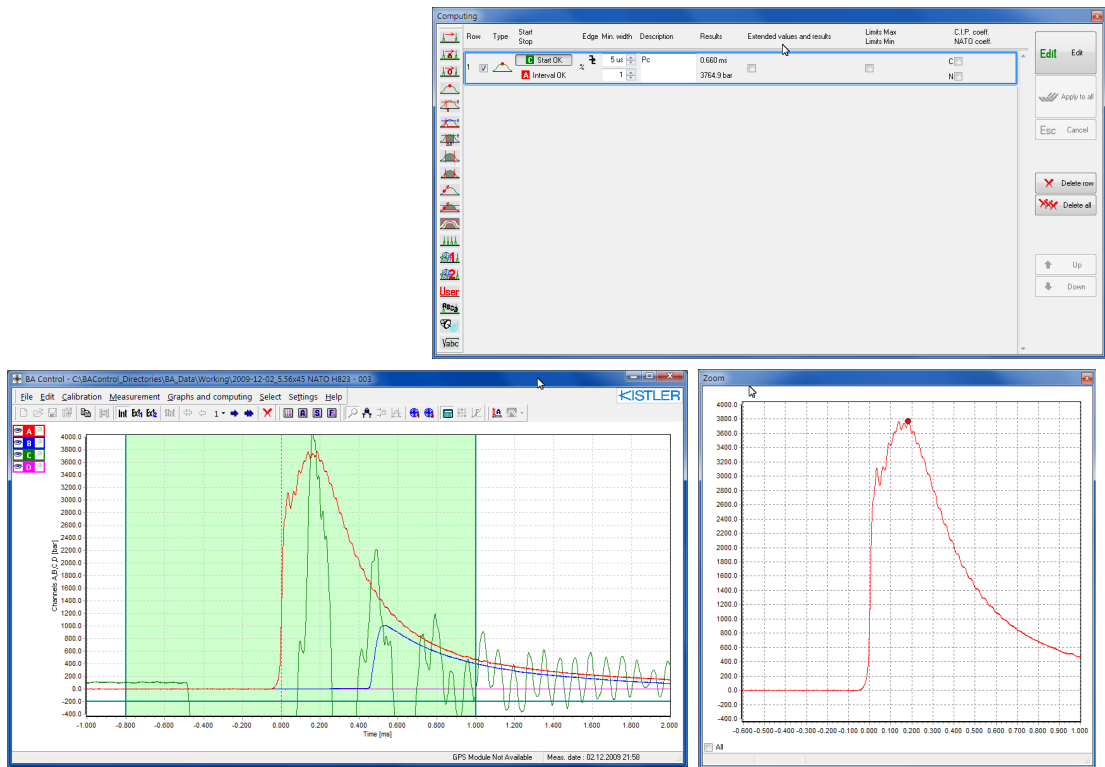


Fig. 37: Calculation of time

The first line building for pressure curve evaluation is finished.

If you want to edit setting, choose it the appropriate item, then by means of Edit go to edit mode, correct cursors setting and for finishing of edit mode use button Apply to all for saving of changes or Escape for keeping of previous setting. For editing of other setting the edit mode is not needed, but after inserting of new value use always the button Apply to all or Escape.

Analogical to the first line is filled the second line for the curve B (blue).

Third line of method will be contain assignment of time interval, the so-called Action time. Press button



Add time/velocity, which serves for addition of single line with calculation of time interval and after set of base size also for calculation of velocity.

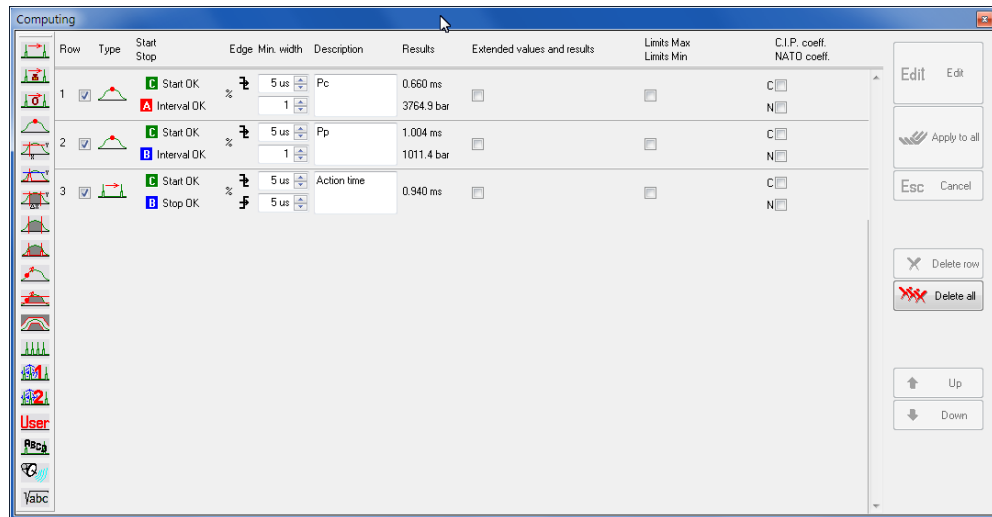


Fig. 38: Calculation methods

Meaning of single line items :

Row: line number. Checkbox determines addition of results to reports.

Type: icon for identification of function of line

Start/Stop: up - button for setting of time admeasurement start

down - button for setting of time admeasurement stop

%: button for selection of horizontal cursor mode (absolute position in units according to axe or relative position in percent of maximum value in selected interval)

Edge: setting of evaluation from rise or fall edge of impulse

Min. width: setting of minimal accepted width of impulse

Description: naming of this line (any text)

Results: calculated time interval

Extended values and results: option for calculation of velocity by entering:

- up - distance of first gate of given pair from muzzle
- down - size of base for measuring of velocity (distance between pair of gates)

Limits (Max/Min): settings of limit values of Max(time, velocity) and Min(time, velocity)

C.I.P. coeff.: calculation of C.I.P.correction (setting of correction coefficient)

NATO coeff.: calculation of NATO correction (setting of value for correction of result)

Press button Start OK and for going to edit mode also the



button Edit. At first choose required curve of channel A by pressing button with symbol of magnifying



glass. Because the beginning of time admeasurement for Action time is given with accelerometer, select curve C. Then select required area by means of vertical cursors and by means of single horizontal cursor, which represents threshold level, adjust its point of intersection with the curve. This cursor is drawn also at the window *Zoom* and founded point is highlighted. The relevant calculated value of time is inserted to the window *Computing*. For accept of this setting press the button



Apply to all - edit mode is cancelled and setting is stored. If edit mode is leaved with other way, the setting is ignored! For cancel of edit mode without saving press the



button Escape.

Next choose appropriate edge of impulse (Edge) and press



the button. Similar is setting of minimal width of impulse (Min. width).

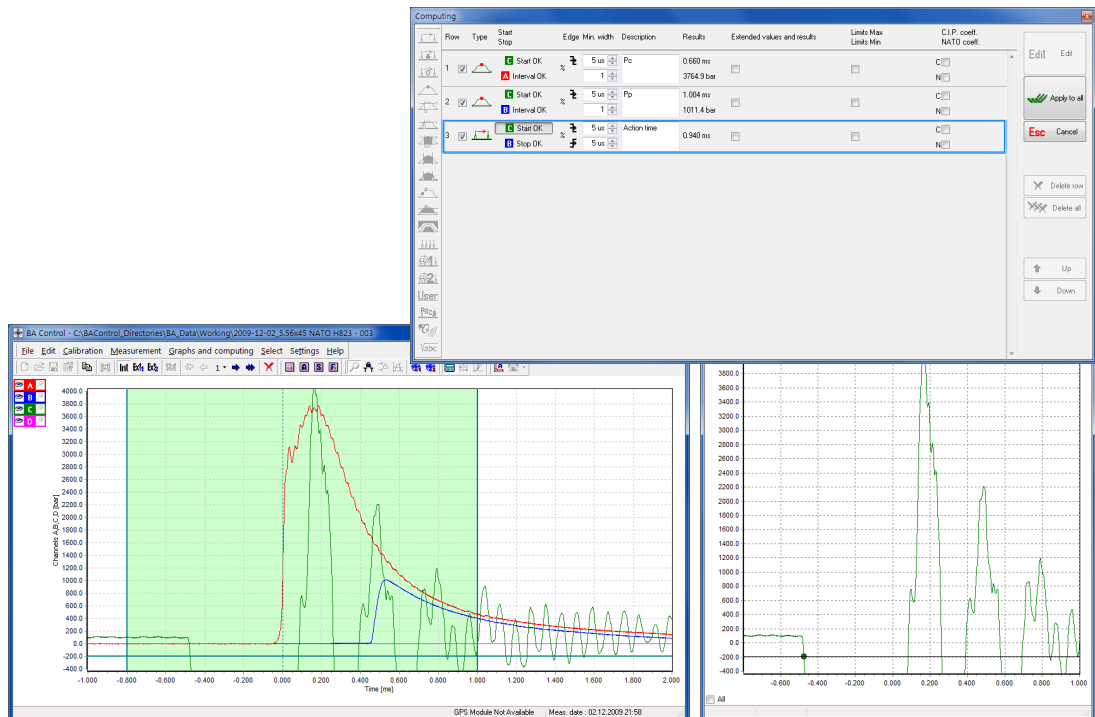


Fig. 39: Action time

Continue with setting end of time of the measurement. The setting process is as analogical as at previous point. After setting of begin and end of time interval is written the result – calculated time interval.

The next point is filling of naming of this this line. After finishing this procedure it is necessary to use the button Apply to all.

Then it is possible to continue in calculation of velocity from measured time interval (this function is not used here). For activation of this function check the box and adjust required distance of first gate of relevant pair from the muzzle and the size of measuring base. In results area appears calculated velocity. For acceptance of this setting it is necessary to use button Apply to all.

Similarly it is possible to enter limits and C.I.P. / NATO corrections.

Final building of first three lines you can see at the Fig. 40.

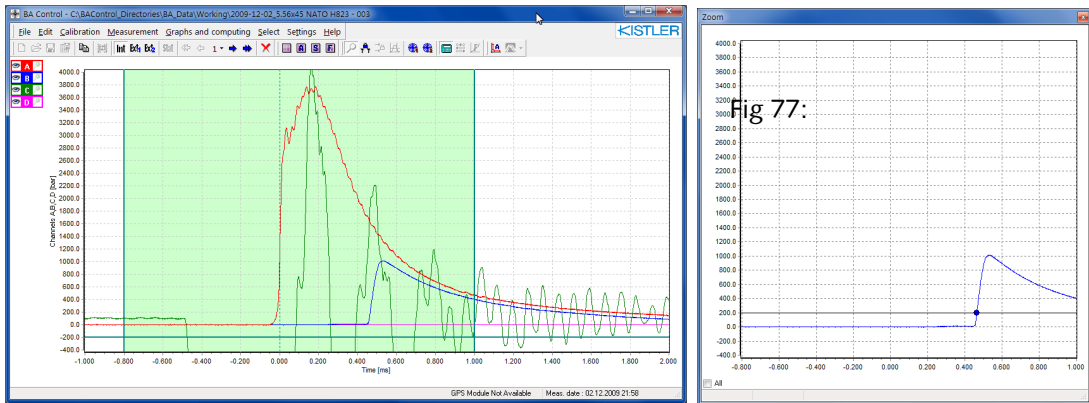
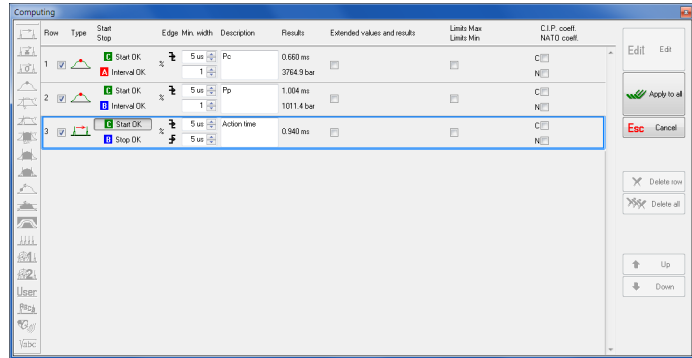


Fig. 40: Time interval

Building of the next lines at the window Computing is analogical to the procedure, which has been explained for the first three lines. Small change is only in fact, that this is measuring of velocity and that is why this function is always activated together with set of relevant entries.

The following pictures show also the signals from optical gates. Pay attention to setting of relevant intervals for single gates - it is accepted always only the first exceeding of horizontal cursor in adjusted interval in selected direction: first rise edge from right or left side or first fall edge from right or left side.

Line No. 4 – velocity measurement (optical gates – first gate start, second gate stop).

Row	Type	Start Stop	Edge	Min. width	Description	Results	Extended values and results	Limits Max	Limits Min	C.I.P. coeff.	NATO coeff.
1	Start OK		%	5 us	Pc	0.660 ms				C	
	Interval OK		%	1		3764.9 bar				N	
2	Start OK		%	5 us	Pp	1.004 ms				C	
	Interval OK		%	1		1011.4 bar				N	
3	Start OK		%	5 us	Action time	0.940 ms				C	
	Stop OK		%	5 us						N	
4	Start OK		%	5 us	V10	1.036 ms	10.0 m	912.5 m/s		C	
	Stop OK		%	5 us			1.0 m			N	

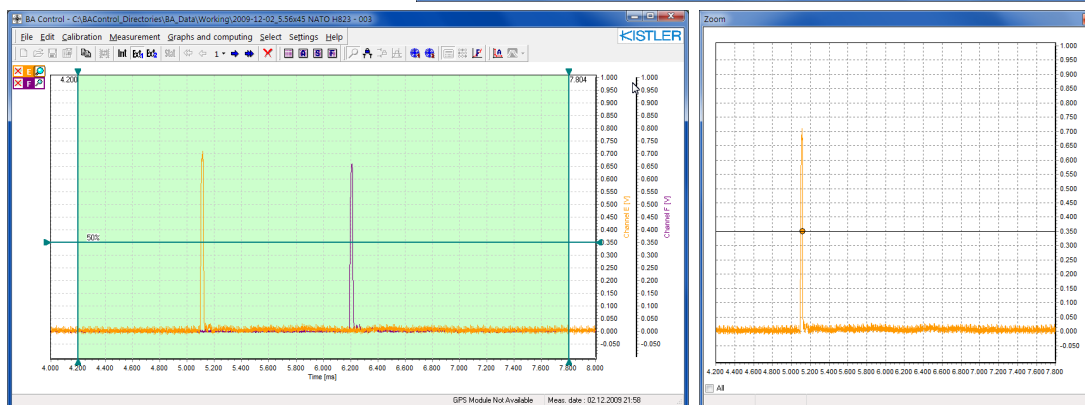


Fig. 41: Velocity measurement

Row	Type	Start Stop	Edge	Min. width	Description	Results	Extended values and results	Limits Max	Limits Min	C.I.P. coeff.	NATO coeff.
1	Start OK		%	5 us	Pc	0.660 ms				C	
	Interval OK		%	1		3764.9 bar				N	
2	Start OK		%	5 us	Pp	1.004 ms				C	
	Interval OK		%	1		1011.4 bar				N	
3	Start OK		%	5 us	Action time	0.940 ms				C	
	Stop OK		%	5 us						N	
4	Start OK		%	5 us	V10	1.036 ms	10.0 m	912.5 m/s		C	
	Stop OK		%	5 us			1.0 m			N	

Fig 83:

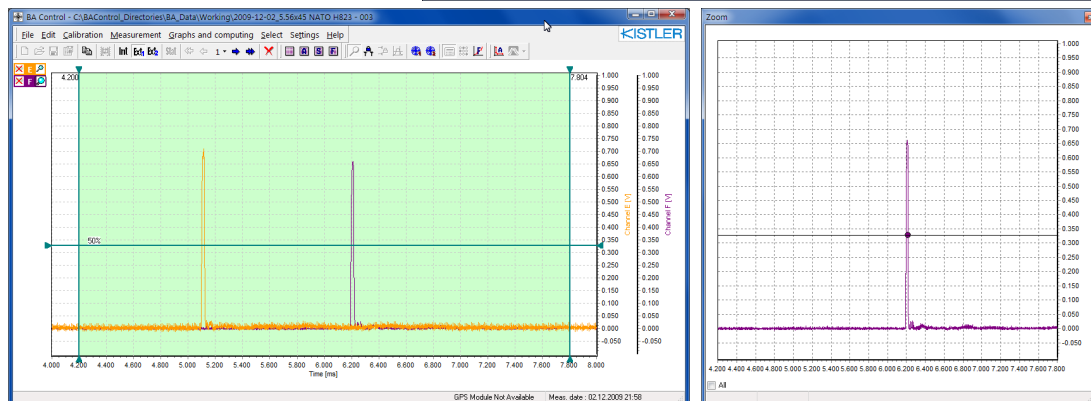


Fig. 42: Velocity measurement

Line No.5 – measurement of accuracy and velocity by means of electronic target system. Detailed description is in separate chapter.

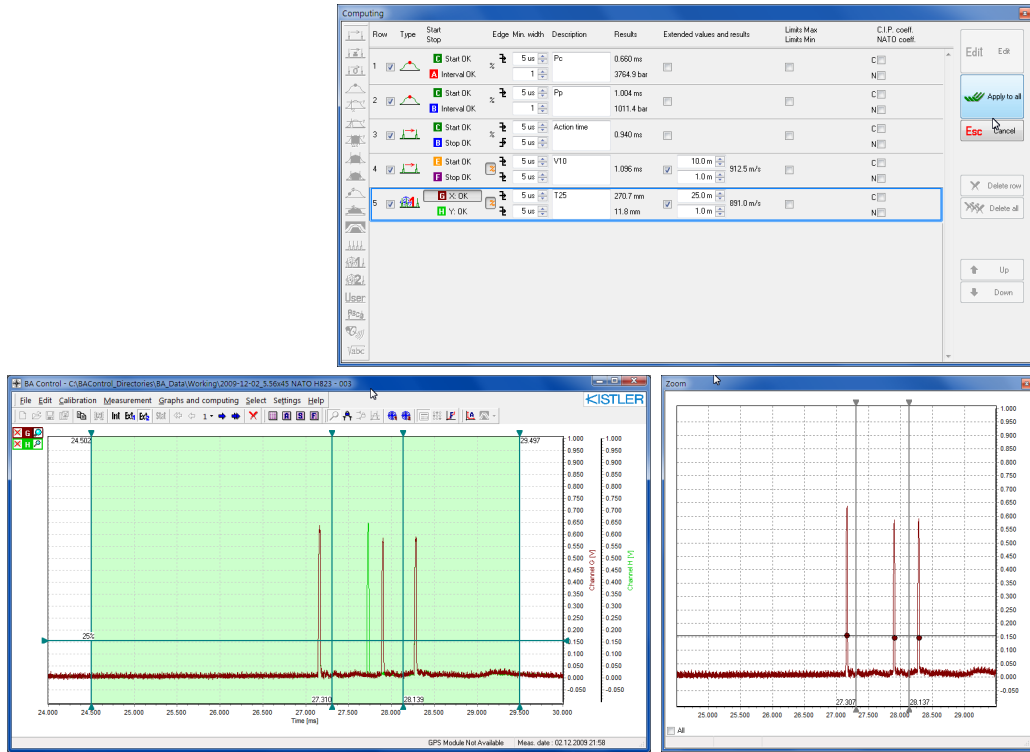


Fig. 43: Accuracy and velocity

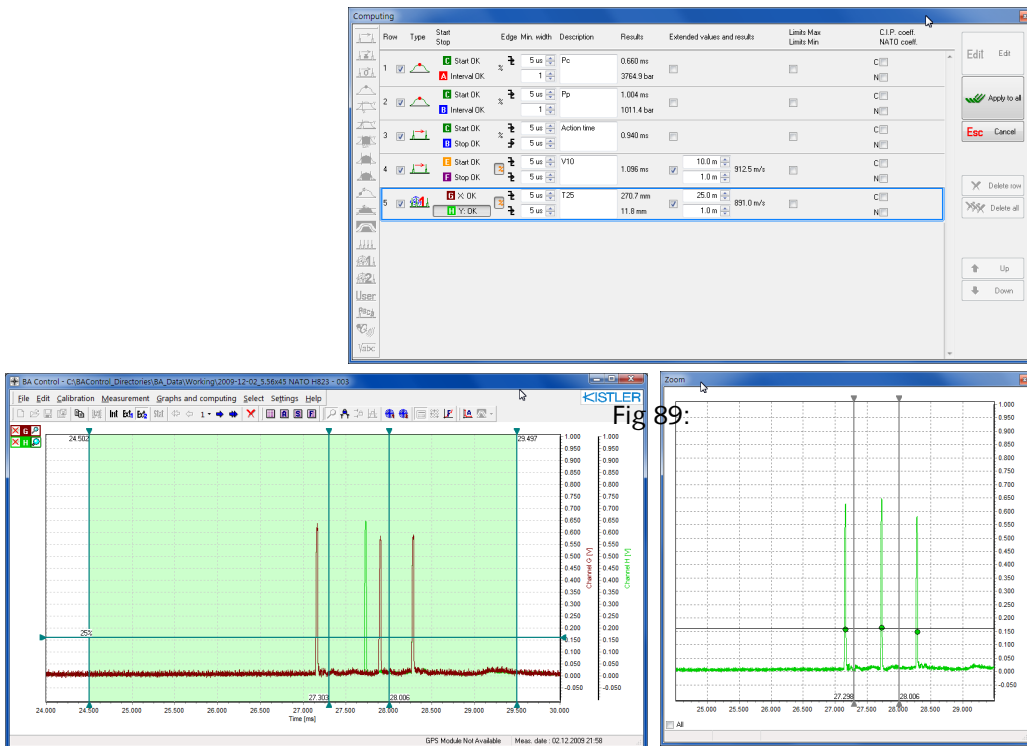


Fig. 44: Accuracy and velocity

Summary of functions at the window Computing :



- (1) Add Time/Velocity - calculation of time and velocity



- (1) Add t/v integral - calculation of time and velocity by means of integral (it requires special analog gates)



- (1) Add t/v zero - calculation of velocity from zero crossing (derivative sensors, as a AC light gates and electromagnetic rings)



- (1) Add pressure - calculation of the maximum pressure



- (1) Add Y=f(X) - computing of function value for predefined value of X (time)



- (1) Add adv. Y=f(X) - computing of function value at start impulse



- (1) Add Average - computing of average Y value in selected X interval (time)



- (1) Add integral - calculation of integral (between cursors)



- (1) Add adv. integral - calculation of integral (between start/stop impulse)



- (1) Add gradient - calculation of rate of rise (rate of fall) of the curve



- (1) Add Rise/Fall - computing of parameters of impulse edge



- (1) Add Mask - mask for checking of shape of curve



- (1) Add Rate Of Fire - calculation of Rate of Fire



- (1) Add target - calculation of target



- (1) Add user - input of any numeric value



- (1) Add Start-Stop Counter - computing of time/velocity by means of counters (BA04SE only)



- (1) Add GPS - reading of GPS (UTC Time and Coordinates) (GPS Garmin, special accessory)



- (1) Add Calculation - computing between result of rows



- (1) Delete row - delete selected row



- (1) Delete all - delete all rows



- (A) Edit - switching of selected row to edit mode



- (1) Apply to all - exit from edit mode and saving changes (for all round of series)



- (A-1) Apply - exit from edit mode and saving changes only for current round



- (A) Escape - exit without saving



- (1) Up, Down - selected line feed up/down

- (1) = accessible only for the round No.1 of relevant series
- (A-1) = accessible for all round of relevant series except the round No.1
- (A) = accessible for all round of relevant series

Important advices for building method for data evaluation:

- During searching of maximum pressure is always founded the point with maximum value in the interval selected with cursors. In the neighborhood of this point (adjusted, default ± 5 points) is determined medium value, which represents founded maximum. This filtration is necessary for noise elimination
- Program approximates measured curve with line in vicinity of intersection with horizontal cursor (which represents threshold level)
- It is convenient to place threshold level with respect to maximum interference elimination (see Fig. 42 ... 47)
- **It is possible to filtrate off undesired interference and fault impulses by setting of time interval for searching of threshold level intersection with the curve, by moving of threshold level cursor, by setting of rise/fall edge and by setting of minimal acceptable width of impulse.** This operation is not possible to make at conventional BA and causes false results. By contrast to common threshold setting with trial-and-error method, here it is provided lucid and easy setting in GUI (Graphic User Interface). It is possible to determine all signal anomalous and effectively to intervene - see next pictures:

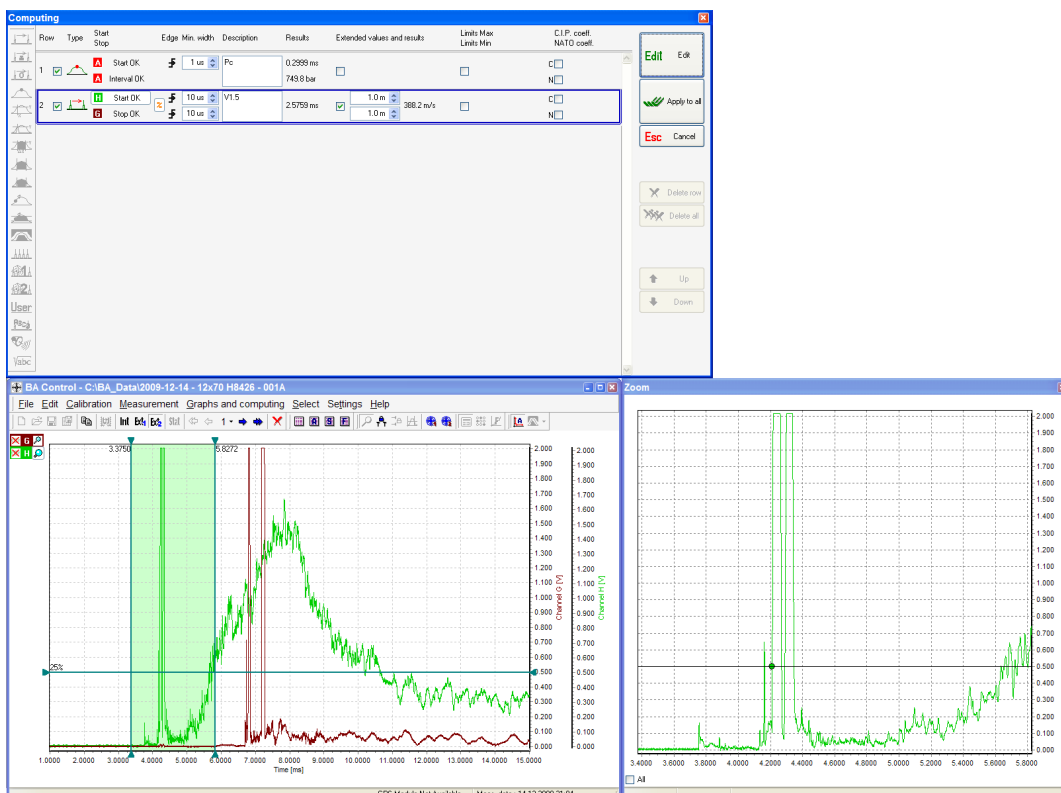


Fig. 45: Determination of signal anomalous

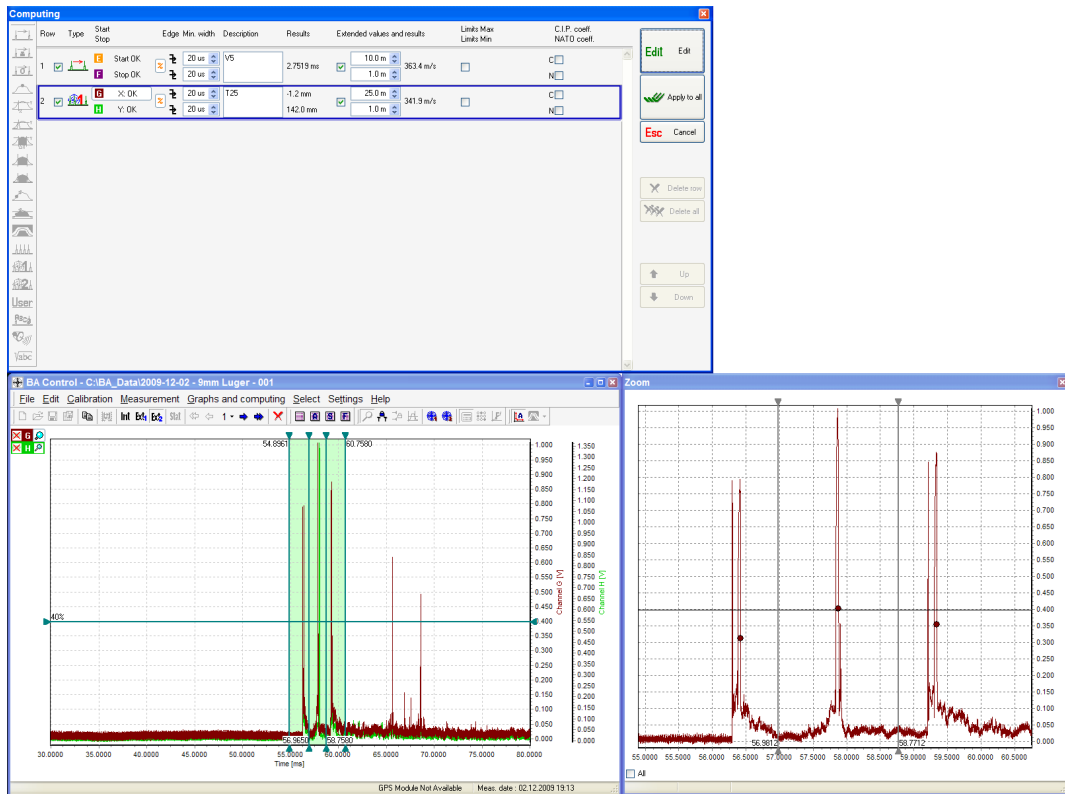


Fig. 46: Determination of signal anomalous

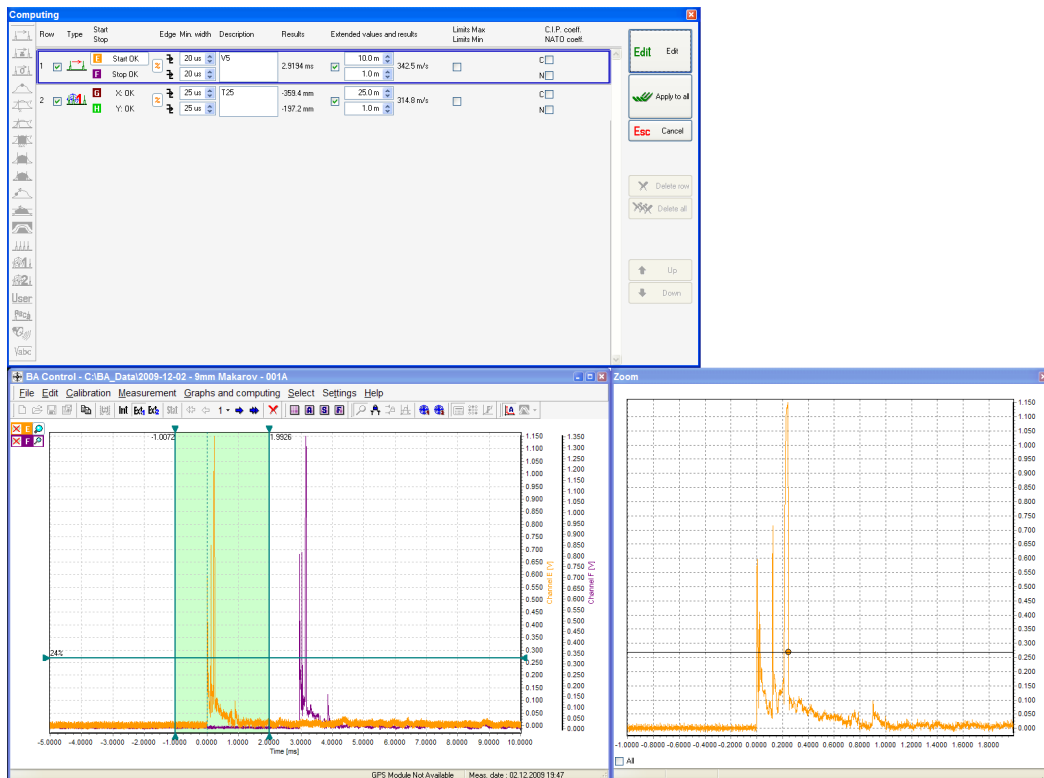


Fig. 47: Determination of signal anomalous

4.4.5 Shooting of the Whole Rounds of Series

After assembling of data evaluating method it is possible to continue in measurement of next rounds of relevant series. There are two options, which can be arbitrarily combined during measuring process:

- Manual mode (switch AUTO is not pressed) - before every round it is necessary by pressing of button RUN adjust TR 2519 to mode of waiting for trigger impulse. This waiting for trigger impulse is indicated by lettering Waiting for trigger (see Fig. 22) and by lighting of red light READY on front panel of TR 2519. Then it is possible to shot one round
- Automatic mode (switch AUTO is pressed) - before first round it is necessary by pressing of button RUN adjust TR 2519 to mode of waiting for trigger impulse. This waiting for trigger impulse is indicated by lettering Waiting for trigger (see Fig. 22) and by lighting of red (older versions orange) light READY on front panel of TR 2519. Then it is possible to shot one round. Always if the reading of data is finished, the TR 2519 is automatically set after every round to mode of waiting for trigger impulse and it is possible to shot next round

Measurement (waiting for trigger impulse) can be aborted by button STOP.


Last round can be deleted by means of button DELETE, if button is accessible.

Numerical results can be watched during measurement. This is possible at opened window Computing, where the values are updated after each round including the window Zoom (if window is opened by means of button for setting of some limit - see Fig. 34 and 38).


The next option is watching of report of measured series



(File > Report measured series), which provides summary information about all rounds of relevant series including statistic calculations.

Last option is the report of current round  (File > Report actual round), which contains key results about pictured round.


After shooting of the whole round series it is necessary to abort mode waiting for trigger impulse by means of button STOP (if button is activated) and closing TR 2519 panel

means of button  in right topside corner. Measured data will be automatically stored at this moment (data are stored to temporary directory during measuring process and will be copied to predefined data directory after closing of TR 2519 panel) and selected output reports are exported.

4.5 Work with Measured Data

4.5.1 Group Organizer, Displaying and Printing of Results

Program allows dividing of data up to ten groups for interlaced shooting or for comparison of groups of ammunition. Each group is separately statistically processed and the results are again processed to overall report.

Dividing is allowed by the function Group Organizer, accessible by button :

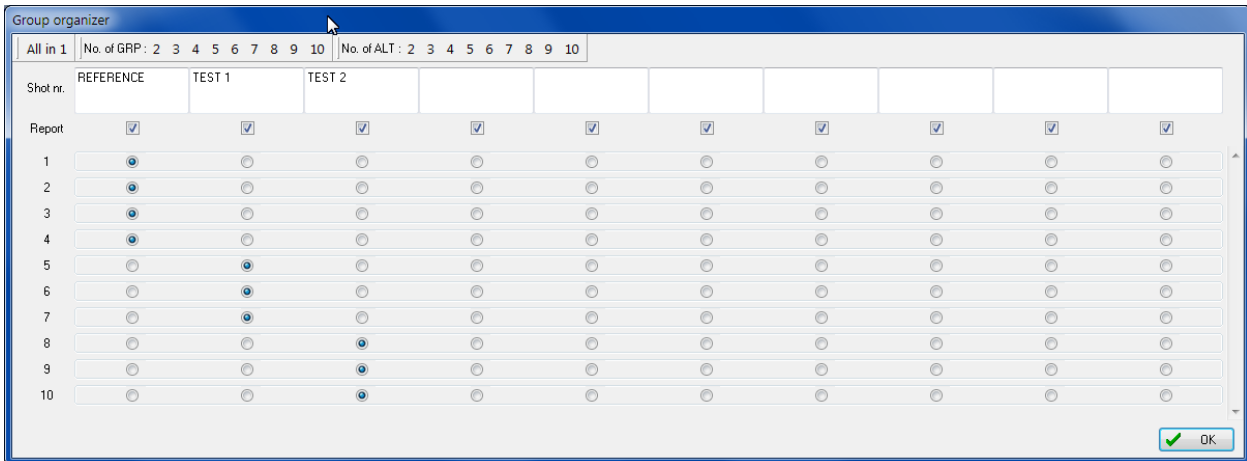


Fig. 48: Group organizer

In the left column are numbers of rounds and up are names of groups (any text, it will be appeared in title of report). On the top are buttons for quick dividing of rounds to groups:

All in 1 (all to first group)

No. of GRP: 2 (one half to 1st group and one half to 2nd group)

No. of GRP: 3 (first third to 1st group ... third third to 3rd group)

etc.

No. of ALT: 2 (alternate to 1st and 2nd group)

No. of ALT: 3 (alternate to 1st, 2nd and 3rd group)

etc.








It is possible to modify allocation by means of array of buttons. After closing the window it is automatically performed data recalculation according to actual allocation. Checkbox Report determines group, which is put into reports and statistic calculations (unchecked groups are hidden in all reports).


The results of measurement are:

- a) four graphs
 - 1. Internal Ballistics
 - 2. External Ballistics 1
 - 3. External Ballistics 2
 - 4. Internal Ballistics - Statistics


- b) computed values
 - 1. Target System 1
 - 2. Target System 2
 - 3. Reports (pictured and saved on the disc)


The work with the first three graphs has been described during the measuring process.


Fourth graph **Internal Ballistics - Statistics** is not accessible during measurement and contains the data from channels which were placed into graph Internal Ballistics. Software calculates average (AVG), minimum (MIN) and maximum (MAX) curve ("minimum" and "maximum" curve are envelope curves of all rounds, "average" curve is mean value of all rounds). Their displaying or hiding is possible by means of button   . It is also possible to show all rounds by means of button . The reference curve can be pictured by means of the button , if this one is loaded. It is possible to choose graph of specific group by means of the buttons  - . If only single group is chosen (pictured), it is possible to save its curve AVG as reference (File > Save ref...) for visual comparison with other measured curves. The other functions are the same as in previous both graphs. It is possible to show report for this statistic graph (File >

Report statistics) by means of the button .

For each graph exists the list of relevant numerical results according to setting of data evaluation method at the

window Computing. The report of current round  (File > Report actual round) is determined for first three

graphs and report of statistics  (File > Report statistics) for the fourth graph.

Report of measured series  (File > Report measured series) contains summary information about all rounds of relevant series including statistic calculations. The data are allocated to the groups, each includes basic statistic calculations (arithmetic average (Avg), standard deviation (SD), maximal and minimal value (Max, Min) and dispersion (Delta)). The summary statistic including corrections of CIP coefficient is placed in the end of report.

$$Avg = \bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$


$$SD = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$


$$Max = \underset{i=1}{\overset{n}{Max}}(x_i)$$

$$Min = \underset{i=1}{\overset{n}{Min}}(x_i)$$

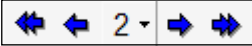
$$Delta = |Max - Min|$$

Preselected reports in Settings > Preferences > Misc (are always stored after finishing of measurement or by data saving on the disc to preset directory - Settings > Directories (Fig. 7). These reports can be easy printed or processed in programs as a MS Word etc.


Final Report  (File > Final Report...) serves for comfortable direct printing of results (see Reference Manual).

Each graph can be transferred to another program through the Clipboard (by means of , Edit > Copy or Ctrl+C), printing of graph is possible by File > Print or Ctrl+P.

4.5.2 Selection of Single Round and Delete of Selected Round

It is possible to list between the rounds by means of buttons  or Select > First, Previous, Next, Last). Their function is (from the left) : first round, previous round, direct selection, following round and last round. Selected round can be deleted by means of button



or Edit > Delete. For permanent delete it is necessary to save data on the disc by means of the button  or File > Save, because the program by reason of original data protection works only with their copy.

4.5.3 Modification of Measured Data Evaluation

It is necessary to remind basic rules:

- it is possible changing method setting of data evaluation by means of Computing, i.e. addition and erasing line, text and numerical values changing only during first round of relevant series and this fact has effect for all round of relevant series
- for second and next rounds it is possible to modify only cursors setting (intervals and thresholds), it is not possible to add or delete line, change the text and numerical values. The changes in setting have influence only for this round

It follows two consequences:

- if it is necessary to change the whole method setting, choose round number one and make required modifications as during measurement
- if you find out, that some numerical value for other than first round in report is not quite correct, choose it and in Computing try to determinate the cause of fault evaluation from the graphs and try to get correct result with cursors moving. This change of setting has not effect for other round series


If the changes may have permanent character, it is necessary to save data on the disc by means of button



or File > Save, because the program by reason of original data protection works only with their copy.

4.5.4 Filtering of Data (Built-in Running Average Filter)

These filters serve to suppression of noise. It is possible to use this filter immediately during measurement or late after measurement. Original data is always retained and data is automatically restored after switch-off filter.

Filter is activated by use of button  or in menu Graphs and computing > Filters. It appears the window (Fig. 49), which contains setting of running average filter for each channel:

- checkbox of filter activation
- setting of filter parameters (number of points for computing of average value - higher number increases efficacy of filtering, but increases distortion of curve). Maximum number of points for computing of average value is limited to 1% of all measured points of relevant curve.

Channels filtered during measurement are color marked.

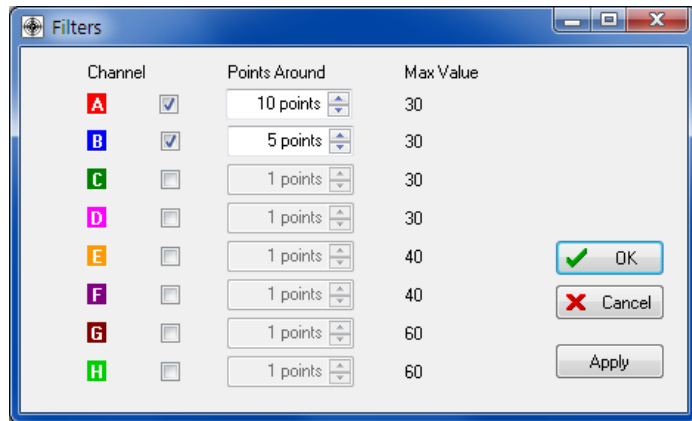


Fig. 49: Filter settings

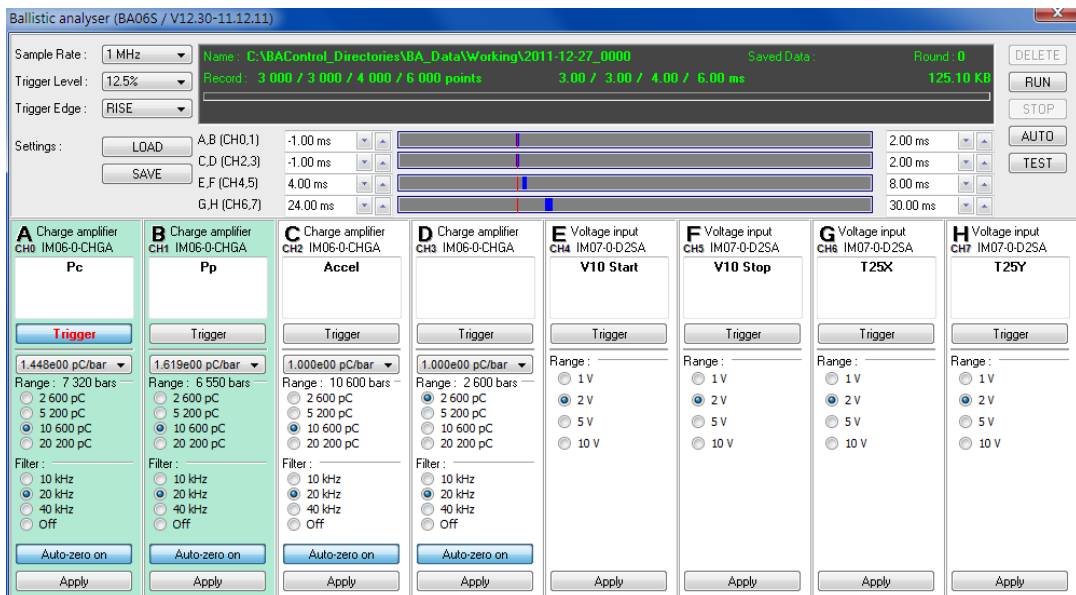


Fig. 50: Virtual panel

4.5.5 Aborting of Shooting and Finishing of Shooting of Other Rounds of the Loaded Data

Program allows breaking of shooting and finishing of shooting of remained rounds later. The condition is the necessity to use the same method for data evaluation (this is automatically provided). Let's suppose that data are stored on the disc. They can be loaded by means of button



or File > Open and activate measuring mode by means of Measurement > TR 2519. It is opened TR 2519 panel, which is set according to used method. It is possible to continue with measuring with typical way. When you finish the shot, it necessary to break waiting for trigger impulse by means of button STOP, if button is activated,



and close TR 2519 panel by means of button in right topside corner. It appears the window for data saving with predefined name of current series. You can overwrite previous data with new data (= previous+ new) or save these data under different name. If you choose Cancel, previous data will be kept without change and new data will be stored on the disc only in temporary copy. If you terminate program or you start new measurement (File >



New or you use the button), the new data will be lost. Do not forget to save the data on the disc by means



of button or File > Save.

4.5.6 Function READ and BREAK

Function READ is accessible only for first round of series. Function READ is accessible after changing of time intervals for reading of data of first round (it substitutes the button RUN in right part of virtual TR 2519 panel).

Memory of AD converters is always filled with data in the range -100 000 to +300 000 points. The negative numbers are the so-called pre-trigger, i.e. the data which are recorded before recording initiation, zero is the time of triggering and positive numbers are data after recording initiation. For typical work are 400 000 points too many and that is why only required part of data are transferred to control computer. This required part of data you have to set-up separately for every pair of channels A+B, C+D, E+F and G+H before first round by means of your experiences. After shooting of first round of series you can find out, that your guess of required data was incorrect, because required signal is not present (signal is out of time window) or amount of data is too big (time for transfer of data from TR 2519 to control computer is very long). Usually you have to delete this round, to correct of time intervals and to shot next "first" round etc. This TR 2519 presents new method for solving of this problem. You have to correct only the time intervals for reading of data and to reread the same data by using of command READ without shooting of new "first" round. It is possible to repeat this action until the settings is acceptable. Then you can continue with shooting of next rounds, but without possibility of other corrections of time intervals.

Function BREAK serves for necessary manual breaking of measurement and reading of data from TR 2519 for sample rates 50 kHz and less (it substitutes the button STOP).

After triggering the TR 2519 measures input signals and stores data on internal memory. Because the memory is very deep (300 000 points) and TR 2519 fills always all the memory, by using of sample rate 100 Hz you have to wait 3000s for next measurement! TR 2519 solves this problem by use of function BREAK. After exceeding the longest time interval for reading of data this function could be used for breaking of measurement and for reading of data. This time is also maximum value for correction of time intervals by means of function READ.

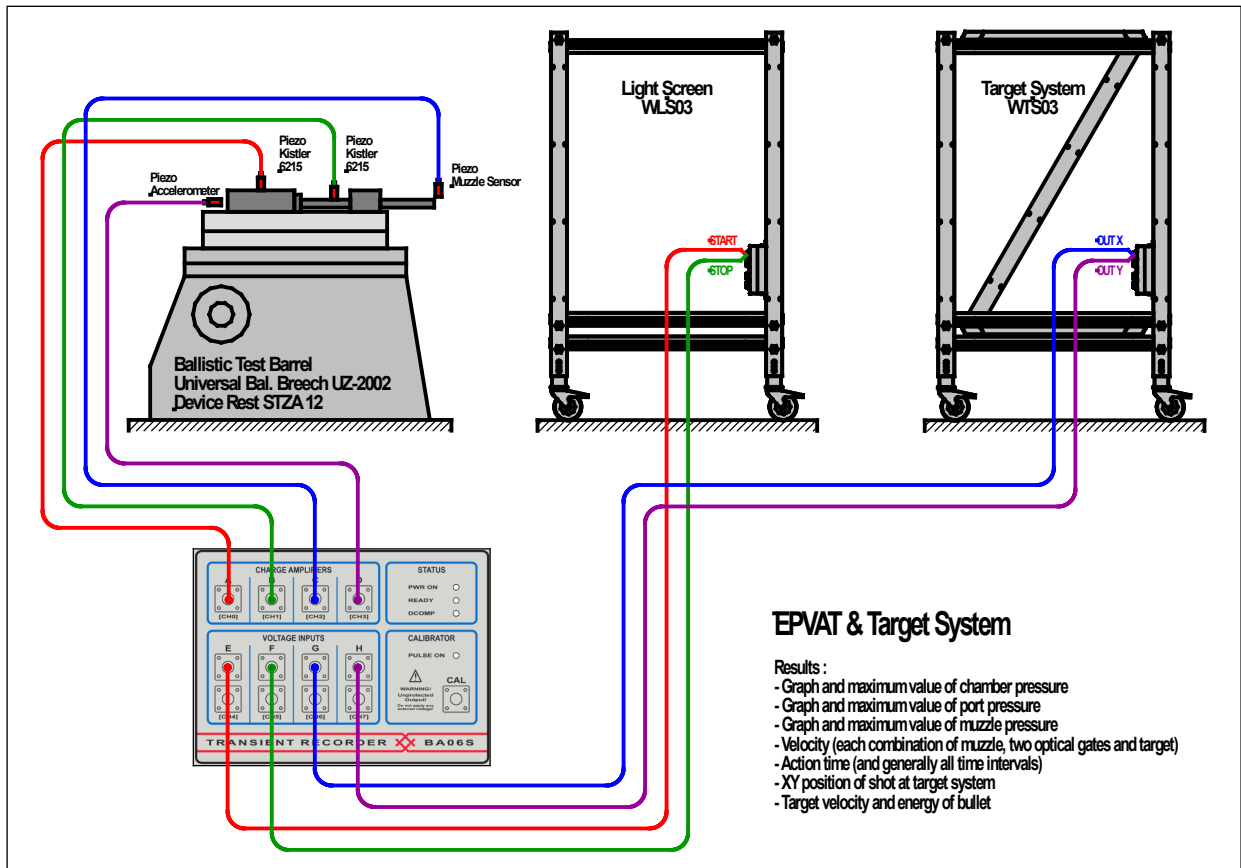
Function BREAK is accessible only for sampling frequency 50 kHz and less, because filling of all RAM by 100 kHz takes only 4s (1 MHz – 0,4 s).



4.6 Working with Electronic Target WTS03


4.6.1 Connecting Target to TR 2519

The program allows connection up to two electronic targets WTS03 to single Transient Recorder TR 2519. Recommended connection to TR 2519:



4.6.2 How to Measure and Target Data Evaluation

The knowledge of basic measurements on TR 2519 are supposed and that is why only some specific properties will be explained in details. Everything will be described on the example of EPVAT measurement with single target system. At first set required method of data evaluation in Settings > Preferences > Misc (Statistical or Graphical). Setting can be changed also for measured data and than all values are recalculated.

Run measurement File > New or use the button , type required name of series and fill out CIP blank form (if you will use graphical method of target evaluation, do not forget enter the bullet diameter). The panel of virtual instrument appears. Set it according to following picture:

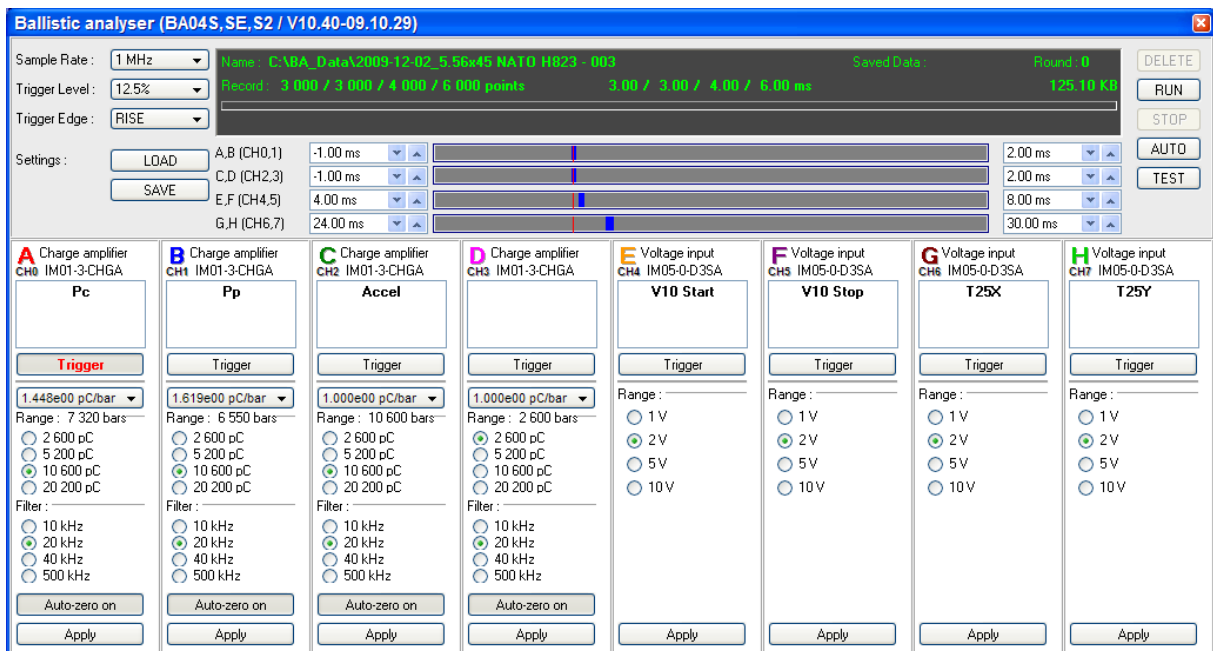


Fig. 51: Virtual panel

Optical gates of target have response time for about 1-2 μ s and sample rate 1 MHz is usually sufficient. Using rate higher than 5 MHz usually does not provide better accuracy of measurement. We strongly do not recommend to use lower value than 1 MHz !!! The other adjustment (input voltage range, trigger level etc.) should be chosen according to concrete conditions (ammunition type, distance and interference). The setting from the picture can be thought as default for most measurement, but serviceman should recommend concrete suitable setting during installation of target at customer.

If TR 2519 setting is done, the first round of series can be shot. This is example of record from channel G and H:

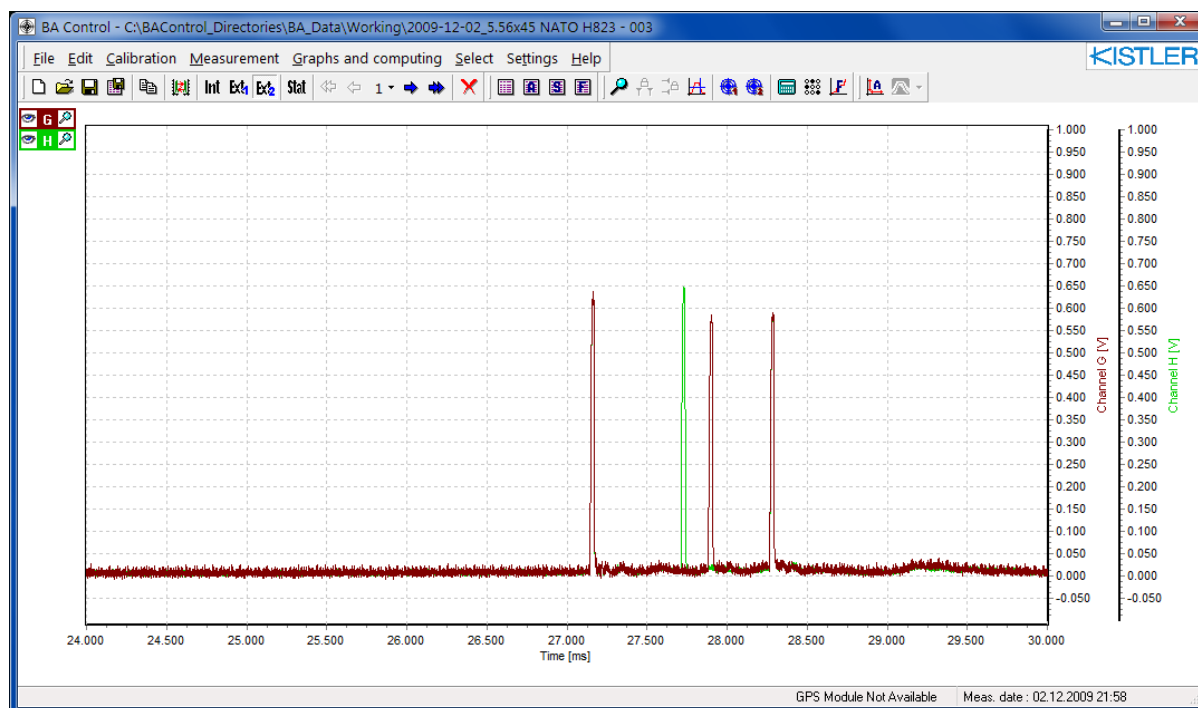



Fig. 52: Graph of target system

Target system converts coordinates by means of oblique gates to time interval. The first pair of overlapping impulses are given by pass of bullet through first normal gate, the last pair of overlapping impulses are given by second normal gate. These gates form the pair at once for measuring of velocity on the base 0.6 m. The middle two impulses are created by pass of bullet through oblique gate X (brown color, G) and Y (green color, H) and their position against the impulses from the normal gates contains information about the position of bullet. The method for evaluation of position X and Y is built on this process. Open the window for computing by means of the

button  Computing, which is in the panel of tools in main program window.

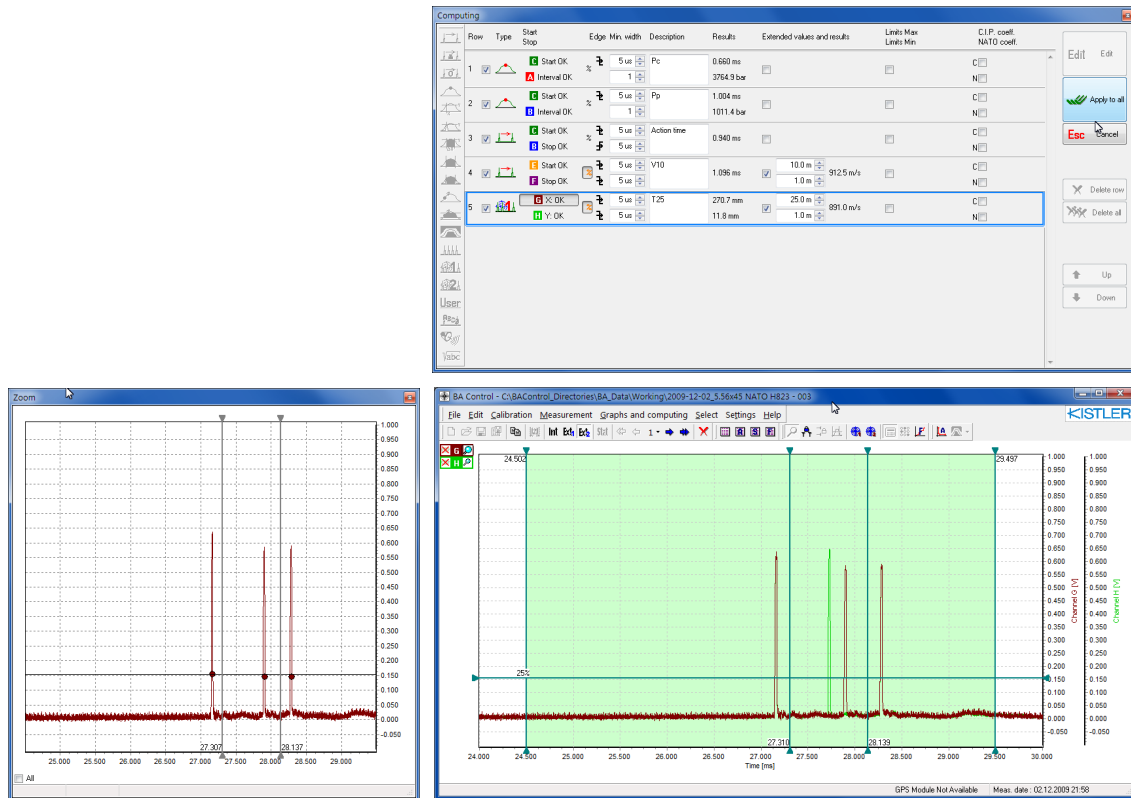





Fig. 53: Data analysis of target system

The cursors can be adjusted as usually (see previous chapters) by means of buttons  Edit,  Apply to all and  Esc Cancel. The difference is in the fact, that there are four vertical cursors instead of two common cursors. Cursor 1 and 2 determinates the interval for impulse searching from the first orthogonal gate, cursor 2 and 3 determinates the interval for impulse searching from the oblique gate X (or Y) and cursor 3 and 4 is for impulse searching from the second orthogonal gate. Set threshold level so as reading of point from the curve has been reliable and interference has been minimal. **We recommend to work with falling edge of impulse** (the impulse has higher edge slope and reading will be more accurate). Setting of minimum acceptable impulse length you can reach better interference rejection (shock waves etc.).

The whole building of method is viewed from previous picture for calculation of X axis and from following picture for calculation of Y axis :

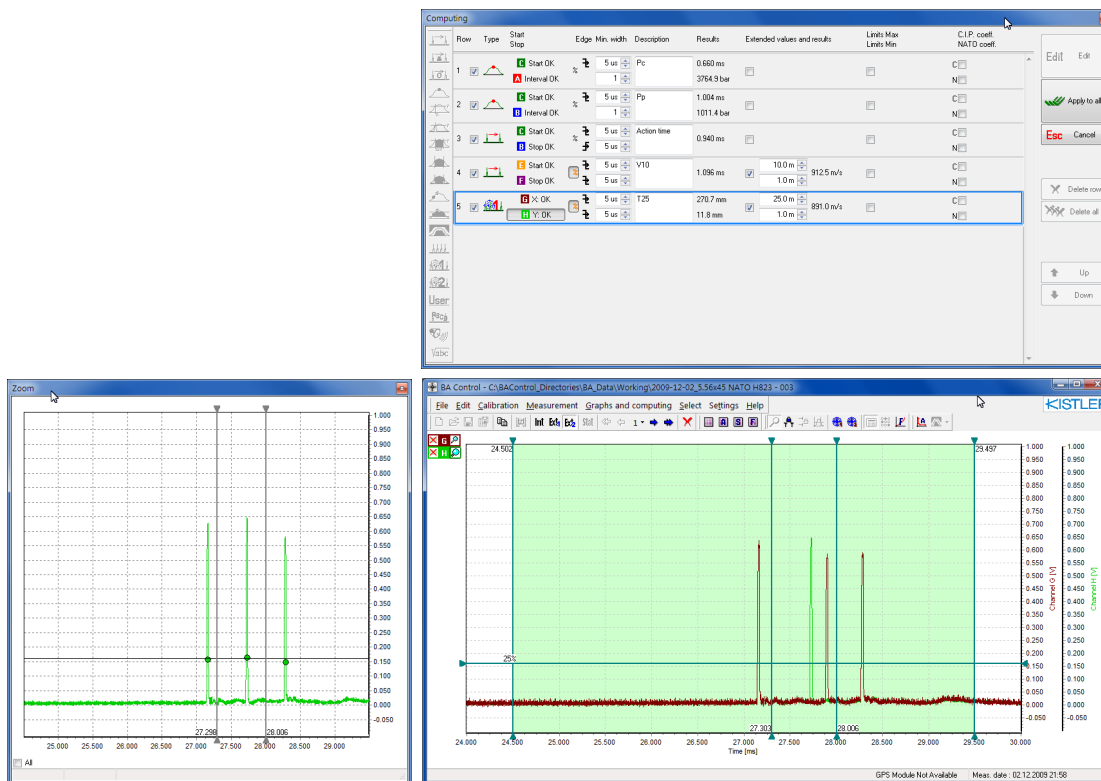


Fig. 54: Building method

The next rounds are shot with common way (see chapter B 4.5 Shooting of remained rounds of relevant series).

It is possible to watch also picture of target 1 and 2 in shooting process.

It can be activated/deactivated by pressing the button



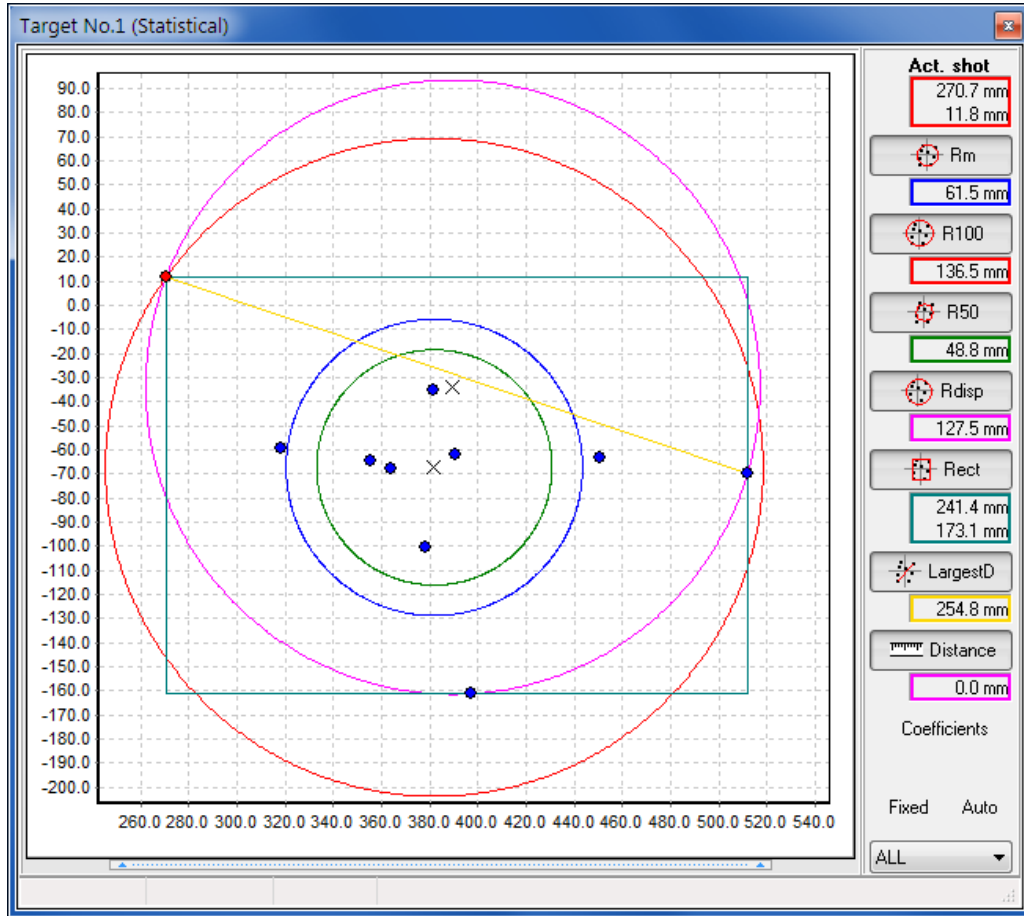



Fig. 55: Graph of target

Selected method for target evaluation is pictured in the bracket of upper left bar. Active hit is highlighted by red color and its measured course is also pictured in main program window. It is possible to make switching active hit by means of the selection of pictured round in main program window. You have to click on the relevant hit. The coordinates of active hit are pictured upper right.

It is possible to switch representation of relevant group by means of the buttons if the round are allocated to the


groups by means of the function Group Organizer  after measurement process - see Fig. 56.

The set of buttons (to the right) serves for switching on/off the relevant calculations, which are pictured on the target and for listing of numeric values. The last button Distance can admeasure distance between active point and next any point.

The function Zoom can be activated with mouse left click, by cursor moving (drag & drop, it appears zoom rectangle) and button release. The other option is in the picture Fig. 57. The function is activated by clicking on the left or bottom border of target. It is possible to set numerically the scale of axes or choose the function Auto Scale (button Auto).

Button Coefficients serves for calibration of target system (see WTS03 User's Guide).

Button *Fixed* serves for setting of target scale to predefined values (see setting of axes in menu *Settings*), button *Auto* sets Auto Scale of X and Y axe.

It is possible to transfer picture of target through clipboard (by means of , *Edit > Copy* or Ctrl+C) to any Windows application - all rounds on the target are enumerated.

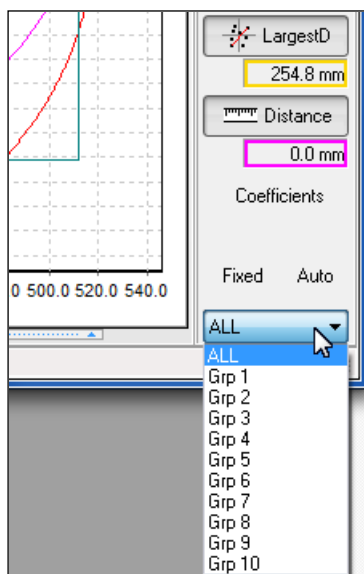


Fig. 56: Selection of group

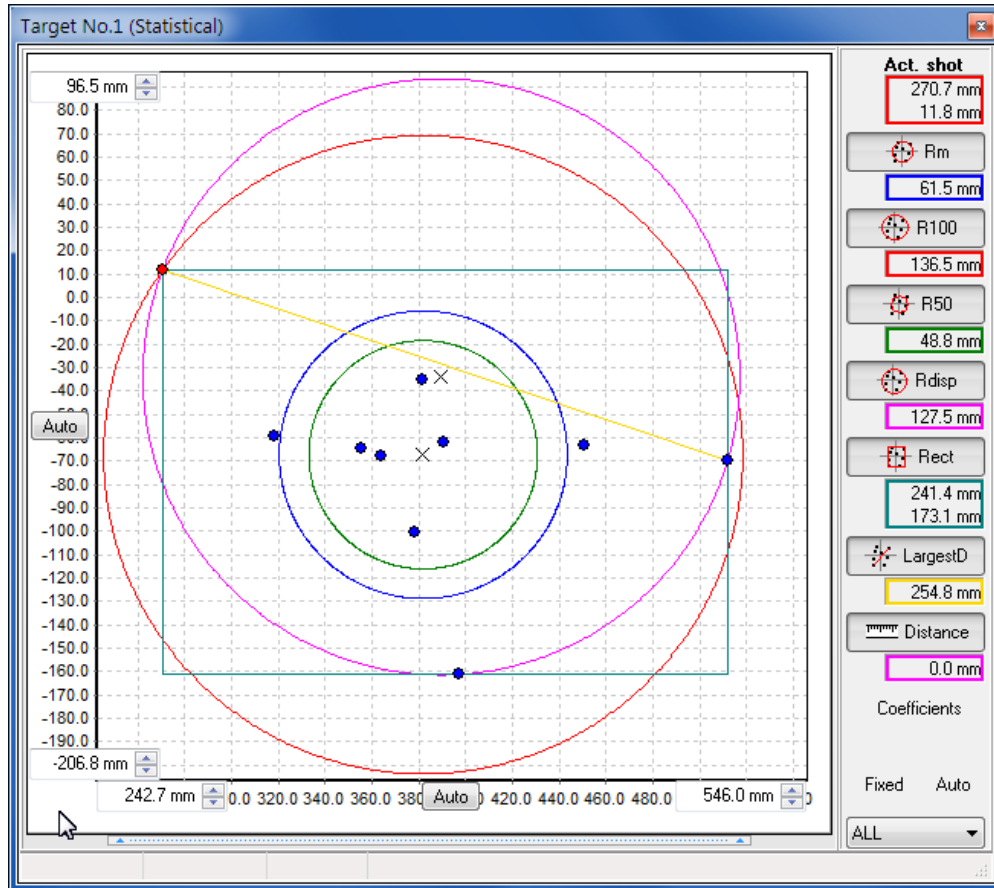



Fig. 57: Distance evaluation

If some rounds cannot be evaluated (for example by reason of signal exceeding from the limitations, which are set in the calculations), their numbers appear in the list below the target. The list of not evaluated rounds can be displayed or hidden by means of the bar



, see Fig. 58. If the round from this list is chosen, relevant course of signal is displayed in main program window and it is possible to make correction of evaluation by means of the

button  Computing. The round is then automatically aligned to the target.

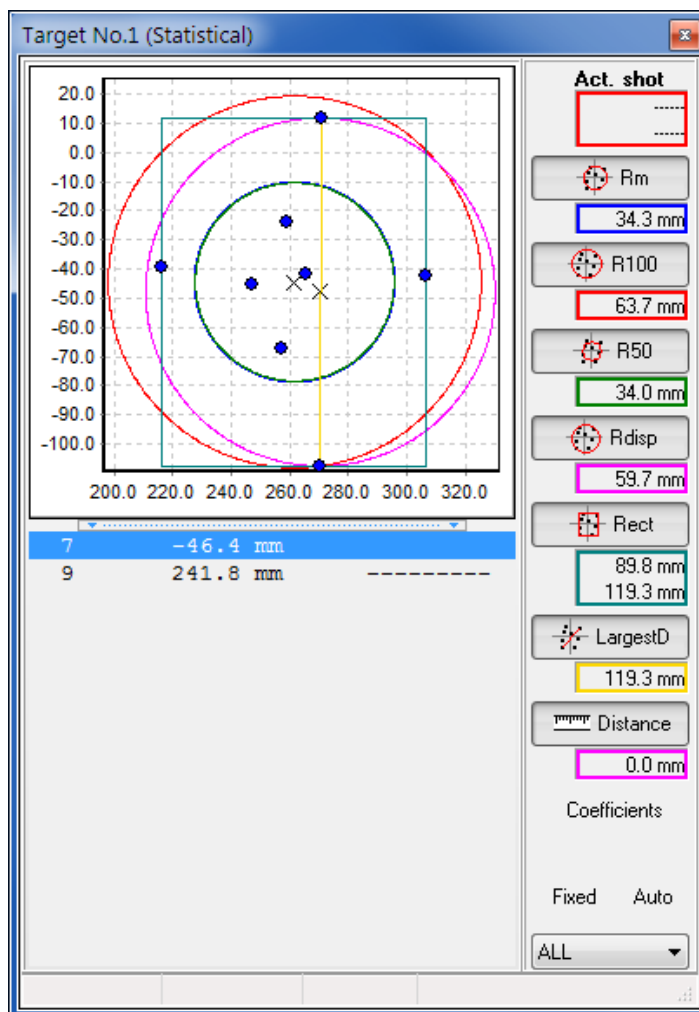



Fig. 58: Distance evaluation

The result of measurement is picture of target (see above) and report, which is accessible by means of the button .

If the rounds are allocated to the groups, they are also allocated in report. Each part has partial statistic and Overall statistic is released in the end. The meaning of single items (results) will be explained on the following sample of report. The report is not complete, but only the end part (partial statistics are quite analogical).

Overall statistic									
=====									
	1 (Target)	2 (Velocity UP)	3 (Velocity ->)	4 (Velocity <-)	5 (Velocity DN)				
Round	X [mm]	Y [mm]	Speed [m/s]	Speed [m/s]	Speed [m/s]	Speed [m/s]			

Avg	-58	-38	685.2	684.1	687.6	685.7			
SD	4	24	3.4	3.0	3.0	3.2			
Max	-53	-8	687.9	686.6	690.0	688.3			
Min	-63	-67	680.7	680.1	683.7	681.4			
Delta	10	59	7.3	6.5	6.3	6.9			
Wk[J]			0.000E+00	0.000E+00	0.000E+00	0.000E+00			

CIP K	2	2	2.0	2.0	2.0	2.0			
Avg +	-50	10	691.9	690.1	693.6	692.2			
Avg -	-66	-86	678.4	678.1	681.6	679.2			
Overall target statistic									
=====									
CIP K =	2	Avg	SD	Max	Min	Delta	Avg +		

Impact Mean Point Xm	-58	4	-53	-63	10				
Impact Mean Point Ym	-38	24	-8	-67	59				
Radius Rm	23	7	34	16	17	38 mm			
Radius R100	55	32	101	28	73	119 mm			
Radius R50	20	8	31	14	17	35 mm			
Radius Rdisp	42	20	71	24	47	83 mm			
Diameter 2R100	84	41	142	48	93	165 mm			
Group Rect. Width (W)	50	13	63	38	26	75 mm			
Group Rect. Height (H)	76	41	134	44	90	159 mm			
Group Rect. Sum W + H	126	47	192	44	148	220 mm			
Largest Distance	83	41	142	45	96	166 mm			

There is **Overall statistic** , on the top part. It is built from results in Computing window. These variable are in the single columns:

- Avg:** average value of measured variable
- SD:** standard deviation
- Max:** maximal value
- Min:** minimal value
- Delta:** dispersion (= |Max – Min|)
- Wk [J]:** energy of the round (only for velocity)
- CIP K:** value of C.I.P. coefficient
- Avg +:** corrected value ([Avg +] = [Avg] + [CIP K] x [SD])
- Avg -:** corrected value ([Avg -] = [Avg] – [CIP K] x [SD])

There is **Overall target statistic** on the bottom part. The rows represent final values, statistically processed according to previous paragraph:

Impact Mean Point Xm: mean point of hit – X coordinate (for statistical method it is calculated as normal (mean) value of X coordinates, for graphical method then for example for 10 hits it lies in half of distance between 5th. and 6th. hit, resp. for 11 hits it lies in 6th hit, calculated in direction of X axis).

Impact Mean Point Ym: mean point of hit – Y coordinate (for statistical method it is calculated as normal (mean) value of Y coordinates, for graphical method then for example for 10 hits it lies in half of distance between 5th. and 6th. hit, resp. for 11 hits it lies in 6th hit, calculated in direction of Y axis).

Radius Rm: radius of mean circle (i.e. circle with the center (Xm,Ym) and radius which is equal to mean value from distance of each hit from the point (Xm,Ym)). It is not generated for graphical method.

Radius R100: radius of smallest circle with the center (Xm,Ym), containing all hits.

Radius R50: radius of circle with the center (Xm,Ym), containing one half of hits (if it is for example 10 shots, the circle has radius of mean value of distance of 5th and 6th hit from center, resp. for 11 hits it passes directly by 6th hit).

Radius Rdisp: radius of smallest circle, containing all hits.

Diameter 2R100: diameter of smallest circle, containing all hits.

Group Rect. Width (W): distance of outer hits in direction of X axis

Group Rect. Height (H): distance of outer hits in direction of Y axis .

Group Rect. Sum W + H: sum of previous both results (one half of perimeter of smallest rectangle, which contains all hits and it is oriented in direction of X and Y axis).

Largest Distance: largest distance between any two hits.

The difference between statistical method and graphical method.

Statistical method calculates with the center of hits, while graphical method calculates with internal / external contact of penetrations (when caliber is positive / negative number) - calculated values are corrected by caliber (diameters and distances), resp. one half of caliber (radiuses).