

Controlling software for Materials Science Beamline

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Architecture

There are two computers Pentium CELERON 300 A dedicated for control of the MSB. The first computer Master communicates with Beamline Control System (BCS) by the serial link RS-232, the second one (Slave) communicates with the Master by the serial link RS-232 as well. The Master serves for direct input data and visualization etc., while the Slave should operate as a regulator of motors - "black box" without a keyboard and a monitor. However, the program Beamline Control Manager running on the both computers is the same one; different identity and services are distinguished by means of the initialisation file.

Commands can be given to the controlling system from three levels:

- from a BCS converted to the ASCII command, going to the Master, "translated" to coordinates of the particular axis, then going to the Slave and to motors,
- from the direct input at the Master, "translated" to coordinates of the particular axis, then going to the Slave and to motors, or
- from the Slave itself, in the extraordinary cases (service, troubleshooting etc.).

Beamline Control Manager

The program Beamline Control Manager consists of four layers:

	normally in operation at
visualisation of commands, data and coordinates etc., help	Master
communication	Master and Slave
parser of the commands and physical engine	Master
regulators	Slave

Protocol of communication between the Master and BCS

Communication is carried out on the serial link RS-232. Commands are case insensitive. Separators are space or comma. Commands as well as the answers to BCS must end with CarriageReturn LineFeed(CRLF) on the tail. i.e. CR=0x0D, LF=0x0A. CRLF must not to be added from the direct input at the Master.

Commands

Commands for MSB control are only ASCII commands. Complexity of ASCII commands ranges from low-level to high-level ones. The high-level commands allow simple control of energy at monochromator and other function while low-level ones enable direct control of regulators and hardware settings.

This paper covers the high-level commands and their description.

High-level commands should be used by users from BCS or from the Master via direct command input.

The high-level commands could be divided in three groups:

- physical engine setting commands
- inquiring commands
- specific action commands

The parser accepts commands with the syntax the described in the following tables Table 1, 2, 3 and 4.

The answer that goes to BCS starts always with characters 'T' or 'F', where 'T' means that a certain command has been successful while 'F' denotes a failure of this command or an error that has to be treated somehow. After this character describing what has been done, the space ' ' follows. Then the command is echoed. If the command did not require any return value and the command was successful, "CRLF" are added. If the same command was not successful, the string containing error message and CRLF are added.

Tab 1 List of physical engine setting commands

Command	Answer to BCS	Description	Units
SETCONST CENBETA X CRLF	T SETCONST CENBETA X CRLF F SETCONST CENBETA X ERRSTRING CRLF	Sets the angle of the radiusvector CENR.	rad
SETCONST CENR X CRLF	T SETCONST CENR X CRLF F SETCONST CENR X ERRSTRING CRLF	Sets the radiusvector of the pole of the toroidal mirror to the axis of rotation at Z1	mm
SETCONST DD X CRLF	T SETCONST DD X CRLF F SETCONST DD X ERRSTRING CRLF	Sets the line density of the grating	1/m
SETCONST DELTA X CRLF	T SETCONST DELTA X CRLF F SETCONST DELTA X ERRSTRING CRLF	Sets the angle between the surface of the plane grating and the plane grating lever	rad
SETCONST DISTENSPG X CRLF	T SETCONST DISTENSPG X CRLF F SETCONST DISTENSPG X ERRSTRING CRLF	Sets the distance between the entrance slit and the plane	mm

		grating	
SETCONST DISTPGSM X CRLF	T SETCONST DISTENSPG X CRLF F SETCONST DISTENSPG X ERRSTRING CRLF	Sets the distance between the plane grating and the spherical mirror	mm
SETCONST DISTSMEXS X CRLF	T SETCONST DISTSMEXS X CRLF F SETCONST DISTSMEXS X ERRSTRING CRLF	Sets the distance between the spherical mirror and the exit slit	mm
SETCONST EPSILON X CRLF	T SETCONST EPSILON X CRLF F SETCONST EPSILON X ERRSTRING CRLF	Sets the output angle after the plane grating in respect to the horizontal plane	rad
SETCONST GAMA X CRLF	T SETCONST GAMA X CRLF F SETCONST GAMA X ERRSTRING CRLF	Sets the angle of the linear cam in respect to the horizontal plane	rad
SETCONST H X CRLF	T SETCONST H X CRLF F SETCONST H X ERRSTRING CRLF	Sets the height of the grating above the optical axis	mm
SETCONST LEVERPG X CRLF	T SETCONST LEVERPG X CRLF F SETCONST LEVERPG X ERRSTRING CRLF	Sets the length of the plane grating lever	mm
SETCONST LJOY X CRLF	T SETCONST LJOY X CRLF F SETCONST LJOY X ERRSTRING CRLF	Sets the length of the lever of the joystick.	mm
SETCONST MAXENERGY X CRLF	T SETCONST MAXENERGY X CRLF F SETCONST MAXENERGY X ERRSTRING CRLF	Sets the minimum energy for the whole beamline, i.e. monochromator and prefocus mirror chamber	eV
SETCONST MAXJ1 X CRLF	T SETCONST MAXJ1 X CRLF F SETCONST MAXJ1 X ERRSTRING CRLF	Sets the maximum position of the J1 axis	mm
SETCONST MAXJ2 X CRLF	T SETCONST MAXJ2 X CRLF F SETCONST MAXJ2 X ERRSTRING CRLF	Sets the maximum position of the J2 axis	mm
SETCONST MAXPAL X CRLF	T SETCONST MAXPAL X CRLF F SETCONST MAXPAL X ERRSTRING CRLF	Sets the maximum position of the PAL axis	mm
SETCONST MAXPAU X CRLF	T SETCONST MAXPAU X CRLF F SETCONST MAXPAU X ERRSTRING CRLF	Sets the maximum position of the PAU axis	mm
SETCONST MAXPM X CRLF	T SETCONST MAXPM X CRLF F SETCONST MAXPM X ERRSTRING CRLF	Sets the maximum position of the plane mirror carriage	mm
SETCONST MAXXPG X CRLF	T SETCONST MAXPG X CRLF F SETCONST MAXPG X ERRSTRING CRLF	Sets the maximum position of the plane grating cam carriage	mm
SETCONST MAXZ1 X CRLF	T SETCONST MAXZ1 X CRLF F SETCONST MAXZ1 X ERRSTRING CRLF	Sets the maximum position of the Z1 axis	mm
SETCONST MAXZ2 X CRLF	T SETCONST MAXZ2 X CRLF F SETCONST MAXZ2 X ERRSTRING CRLF	Sets the maximum position of the Z2 axis	mm
SETCONST MINENERGY X CRLF	T SETCONST MINENERGY X CRLF F SETCONST MINENERGY X ERRSTRING CRLF	Sets the minimum energy for the whole beamline, i.e. monochromator and prefocus mirror chamber	eV
SETCONST MINJ1 X CRLF	T SETCONST MINJ1 X CRLF F SETCONST MINJ1 X ERRSTRING CRLF	Sets the minimum position of the J1 axis	mm
SETCONST MINJ2 X CRLF	T SETCONST MINJ2 X CRLF F SETCONST MINJ2 X ERRSTRING CRLF	Sets the minimum position of the J2 axis	mm
SETCONST MINPAL X CRLF	T SETCONST MINPAL X CRLF F SETCONST MINPAL X ERRSTRING CRLF	Sets the minimum position of the PAL axis	mm
SETCONST MINPAU X CRLF	T SETCONST MINPAU X CRLF F SETCONST MINPAU X ERRSTRING CRLF	Sets the minimum position of the PAU axis	mm
SETCONST MINPM X CRLF	T SETCONST MINXPM X CRLF F SETCONST MINXPM X ERRSTRING CRLF	Sets the minimum position of the plane mirror carriage	mm
SETCONST MINXPG X CRLF	T SETCONST MINXPG X CRLF F SETCONST MINXPG X ERRSTRING CRLF	Sets the minimum position of the plane grating cam carriage	mm
SETCONST MINZ1 X CRLF	T SETCONST MINZ1 X CRLF F SETCONST MINZ1 X ERRSTRING CRLF	Sets the minimum position of the Z1 axis	mm
SETCONST MINZ2 X CRLF	T SETCONST MINZ2 X CRLF F SETCONST MINZ2 X ERRSTRING CRLF	Sets the minimum position of the Z2 axis	mm
SETCONST RSM X CRLF	T SETCONST RSM X CRLF F SETCONST RSM X ERRSTRING CRLF	Sets the radius of the spherical mirror	mm
SETCONST RWHEEL X CRLF	T SETCONST RWHEEL X CRLF F SETCONST RWHEEL X ERRSTRING CRLF	Sets the diameter of the ball bearing on the plane grating lever	mm
SETCONST SPANZZ X CRLF	T SETCONST SPANZZ X CRLF F SETCONST SPANZZ X ERRSTRING CRLF	Sets the span of the kinematical mounting of the prefocus mirror chamber	mm
SETCONST THSM X CRLF	T SETCONST THSM X CRLF F SETCONST THSM X ERRSTRING CRLF	Sets the incidence graying angle of the spherical mirror	rad
SETDIFF X CRLF	T SETDIFF X CRLF F SETDIFF X ERRSTRING CRLF	Sets the actual diffraction order in which the monochromator should work	-

Notes:

- X denotes the float number, CRLF means the stop sequention, everything else are strings that have specific meaning.
- The column Answer contains success message and failure message

Tab 2 List of inquiring commands

Command	Answer to BCS	Description	Units
GETCONST CENBETA CRLF	T GETCONST CENBETA X CRLF F GETCONST CENBETA X ERRSTRING CRLF	Gets the angle of the radiusvector CENR.	Rad
GETCONST CENR RLF	T GETCONST CENR X CRLF F GETCONST CENR X ERRSTRING CRLF	Gets the radiusvector of the pole of the toroidal mirror to the axis of rotation at Z1	mm
GETCONST DD CRLF	T GETCONST DD X CRLF F GETCONST DD ERRSTRING CRLF	Gets the line density of the grating	1/m
GETCONST DELTA CRLF	T GETCONST DELTA X CRLF F GETCONST DELTA ERRSTRING CRLF	Gets the angle between the surface of the plane grating and the plane grating lever	rad
GETCONST DISTENSPG CRLF	T GETCONST DISTENSPG CRLF F GETCONST DISTENSPG ERRSTRING CRLF	Gets the distance between the entrance slit and the plane grating	mm
GETCONST DISTPGSM CRLF	T GETCONST DISTENSPG CRLF F GETCONST DISTENSPG ERRSTRING CRLF	Gets the distance between the plane grating and the spherical mirror	mm

GETCONST DISTSMEXS CRLF	T GETCONST DISTSMEXS X CRLF F GETCONST DISTSMEXS ERRSTRING CRLF	Gets the distance between the spherical mirror and the exit slit	mm
GETCONST EPSILON CRLF	T GETCONST EPSILON X CRLF F GETCONST EPSILON ERRSTRING CRLF	Gets the output angle of the optical axis after the plane grating in respect to the horizontal plane	rad
GETCONST GAMA CRLF	T GETCONST GAMA X CRLF F GETCONST GAMA ERRSTRING CRLF	Gets the angle of the linear cam in respect to the horizontal plane	rad
GETCONST H CRLF	T GETCONST H X CRLF F GETCONST H ERRSTRING CRLF	Gets the height of the grating above the optical axis	mm
GETCONST LEVERPG CRLF	T GETCONST LEVERPG CRLF F GETCONST LEVERPG ERRSTRING CRLF	Gets the length of the plane grating lever	mm
GETCONST LJOY CRLF	T GETCONST LJOY X CRLF F GETCONST LJOY X ERRSTRING CRLF	Gets the length of the lever of the joystick.	mm
GETCONST MAXENERGY CRLF	T GETCONST MAXENERGY X CRLF F GETCONST MAXENERGY ERRSTRING CRLF	Gets the minimum energy for the whole beamline, i.e. monochromator and prefocus mirror chamber	eV
GETCONST MAXJ1 CRLF	T GETCONST MAXJ1 X CRLF F GETCONST MAXJ1 ERRSTRING CRLF	Gets the maximum position of the J1 axis	mm
GETCONST MAXJ2 CRLF	T GETCONST MAXJ2 X CRLF F GETCONST MAXJ2 ERRSTRING CRLF	Gets the maximum position of the J2 axis	mm
GETCONST MAXPAL CRLF	T GETCONST MAXPAL X CRLF F GETCONST MAXPAL ERRSTRING CRLF	Gets the maximum position of the PAL axis	mm
GETCONST MAXPAU CRLF	T GETCONST MAXPAU X CRLF F GETCONST MAXPAU ERRSTRING CRLF	Gets the maximum position of the PAU axis	mm
GETCONST MAXPM CRLF	T GETCONST MAXPM X CRLF F GETCONST MAXPM ERRSTRING CRLF	Gets the maximum position of the plane mirror carriage	mm
GETCONST MAXXPG CRLF	T GETCONST MAXPG CRLF F GETCONST MAXPG ERRSTRING CRLF	Gets the maximum position of the plane grating cam carriage	mm
GETCONST MAXZ1 CRLF	T GETCONST MAXZ1 X CRLF F GETCONST MAXZ1 ERRSTRING CRLF	Gets the maximum position of the Z1 axis	mm
GETCONST MAXZ2 CRLF	T GETCONST MAXZ2 X CRLF F GETCONST MAXZ2 ERRSTRING CRLF	Gets the maximum position of the Z2 axis	mm
GETCONST MINENERGY CRLF	T GETCONST MINENERGY X CRLF F GETCONST MINENERGY ERRSTRING CRLF	Gets the minimum energy for the whole beamline, i.e. monochromator and prefocus mirror chamber	eV
GETCONST MINJ1 CRLF	T GETCONST MINJ1 X CRLF F GETCONST MINJ1 ERRSTRING CRLF	Gets the minimum position of the J1 axis	mm
GETCONST MINJ2 CRLF	T GETCONST MINJ2 X CRLF F GETCONST MINJ2 ERRSTRING CRLF	Gets the minimum position of the J2 axis	mm
GETCONST MINPAL CRLF	T GETCONST MINPAL X CRLF F GETCONST MINPAL ERRSTRING CRLF	Gets the minimum position of the PAL axis	mm
GETCONST MINPAU CRLF	T GETCONST MINPAU X CRLF F GETCONST MINPAU ERRSTRING CRLF	Gets the minimum position of the PAU axis	mm
GETCONST MINPM CRLF	T GETCONST MINXPM X CRLF F GETCONST MINXPM ERRSTRING CRLF	Gets the minimum position of the plane mirror carriage	mm
GETCONST MINXPG CRLF	T GETCONST MINXPG CRLF F GETCONST MINXPG ERRSTRING CRLF	Gets the minimum position of the plane grating cam carriage	mm
GETCONST MINZ1 CRLF	T GETCONST MINZ1 X CRLF F GETCONST MINZ1 ERRSTRING CRLF	Gets the minimum position of the Z1 axis	mm
GETCONST MINZ2 CRLF	T GETCONST MINZ2 X CRLF F GETCONST MINZ2 ERRSTRING CRLF	Gets the minimum position of the Z2 axis	mm
GETCONST RSM CRLF	T GETCONST RSM X CRLF F GETCONST RSM ERRSTRING CRLF	Gets the radius of the spherical mirror	mm
GETCONST RWHEEL CRLF	T GETCONST RWHEEL X CRLF F GETCONST RWHEEL ERRSTRING CRLF	Gets the diameter of the ball bearing on the plane grating lever	mm
GETCONST SPANZZ CRLF	T GETCONST SPANZZ X CRLF F GETCONST SPANZZ X ERRSTRING CRLF	Gets the span of the kinematical mounting of the prefocus mirror chamber	mm
GETCONST THSM CRLF	T GETCONST THSM X CRLF F GETCONST THSM ERRSTRING CRLF	Gets the incidence graying angle of the spherical mirror	rad
GETDEFOCUS CRLF	T GETDEFOCUS X CRLF F GETDEFOCUS ERRSTRING CRLF	Gets the current defocus calculated from the current positions of the PM and PG and engine constants	mm
GETDIFF CRLF	T GETDIFF X CRLF	Gets the current diffraction order in which the monochromator should work	-
GETENERGY CRLF	T GETENERGY X CRLF F GETENERGY ERRSTRING CRLF	Gets the current energy calculated from the current positions of the PM and PG	eV
GETHEIGHT CRLF	T GETHEIGHT X CRLF	Gets the heights of the prefocusing mirror	mm
GETPITCH CRLF	T GETPITCH X CRLF	Gets the pitch of the prefocusing mirror	rad
GETPOL CRLF	T GETPOL X CRLF	Gets degree of polarization	-
GETROLL CRLF	T GETROLL X CRLF	Gets the roll of the prefocusing mirror	rad
GETYAW CRLF	T GETYAW X CRLF	Gets the yaw of the prefocusing mirror	rad

Notes:

- X denotes the float number, CRLF means the stop sequention, everything else are strings that have specific meaning.
- The column Answer contains success message and failure message

Table 3 List of specific actions commands

Command	Answer to BCS	Description
FIND AXIS A CRLF	T FIND AXIS A CRLF F FIND AXIS A ERRSTRING CRLF	Finds the reference switch and sets to this point the coordinate A
MOVE AXIS A CRLF	T MOVE A CRLF F MOVE A ERRSTRING CRLF	Moves the axis AXIS to the absolute position A .
MOVEREL AXIS A CRLF	T MOVEREL A B CRLF F MOVEREL A ERRSTRING CRLF	Moves the axis AXIS from the current position by A. B is the resulting coordinate.
SCAN A B C D CRLF	T SCAN A B C D CRLF	Scans energy from energy A [eV] to B[eV] with step C[eV] with

	F SCAN A B C D ERRSTRING CRLF	dwelt time D[s]
SETENERGY A [D] [C] CRLF	T SET_ENERGY A [D] [C] CRLF E SET_ENERGY A [D] [C] ERRSTRING CRLF	Sets energy of the monochromator A= energy [eV], D= diffraction order [-], C= Cff constant, parameters D and C are optional
SETOFFSET AXIS A CRLF	T SET_OFFSET AXIS A CRLF F SET_OFFSET AXIS A ERRSTRING CRLF	Sets the current coordinate to A without movement
SETHEIGHT A CRLF	T SETHEIGHT A CRLF F SETHEIGHT A ERRSTRING CRLF	Sets the heights of the prefocusing mirror
SETPITCH A CRLF	T SETPITCH A CRLF F SETPITCH A ERRSTRING CRLF	Sets the pitch of the prefocusing mirror
SETPOL A CRLF	T SETPOL A CRLF F SETPOL A ERRSTRING CRLF	Sets degree of polarization to A
SETROLL A CRLF	T SETROLL A CRLF F SETROLL A ERRSTRING CRLF	Sets the roll of the prefocusing mirror
SETYAW A CRLF	T SETYAW A CRLF F SETYAW A ERRSTRING CRLF	Sets the yaw of the prefocusing mirror
SET_Z_PG A CRLF	T SET_Z_PG A B CRLF T SET_Z_PG A ERRSTRING CRLF	Sets the position of the plane grating to A and the plane mirror to B in order to get zero order light from the monochromator
SET_Z_PM A CRLF	T SET_Z_PM A B CRLF T SET_Z_PM A ERRSTRING CRLF	Sets the position of the plane mirror to A and the plane grating to B in order to get zero order light from the monochromator
STOP [AXIS]	T STOP [AXIS] CRLF	Stops the axis AXIS, optionally without parameter AXIS, this command stops all the axis

Notes:

- A, B, C, D denote the float numbers
- AXIS denote a symbolic name for an axis or an integer number (see the following Table 4)
- CRLF means the stop sequention, everything else are strings that have specific meaning.
- A parameter that is bracketed in [] means that it is optional, however, the parameters should be taken away one by one from the right side.

For instance: SETENERGY 45 1 2.25 CRLF means that an user wants photon energy 45 eV with the monochromator operated in the first diffraction order with the constant C_{ff} equal to 2.25. But if we omit the second parameter, the default value will be assigned to the third parameter: the command SETENERGY 45 2.25 CRLF means that energy 45 eV will be set with the set with the second diffraction order since $2=\text{int}(2.25)$

Table 4 Symbolic names for axes

Symbolic name of the <i>AXIS</i>	value	Description of the axis
PAU	0	Upper polarization aperture
PAL	1	Lower polarization aperture
J1	2	Prefocus mirror roll actuator
J2	3	Prefocus mirror pitch actuator
Z1	4	Prefocus mirror height and yaw actuator
Z2	5	Prefocus mirror height and yaw actuator
PM	6	Plane mirror carriage axis
PG	7	Plane grating cam carriage axis