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BLVD IMPROVEMENTS

O. Dubois, A. Feschenko and C. J. B. Riviere

1. Introduction

The Bunch Length and Velocity Detector (BLVD) built by the Institute for Nuclear Research (INR) enables the measurements of the longitudinal bunch profile and the mean energy of the beam **[1]**. It is part of Linac 3 equipment.
In March 1994 the detector has been installed in the machine. After its use in the temporary measuring line at the output of the RFQ it has been shifted to its present position, downstream of the IH Tank 3.
In September 1994 the electronic equipment had been placed in the Linac control room. Despite proper operation of its experimental set up at machine commissioning, some improvements of the system and some corrections of the software were felt necessary to ease its daily use. So the operation of its Mechanical Phase Shifter (MPS) had to be controlled and re-adjusted. The displacement distances (mode of energy measurement) had to be carefully re-measured and calibrated.
The control software had to be checked and cleaned from several errors. Other mechanical and electronic hardware problems were encountered and solved. Finally new test measurements were performed to obtain handy references.
In this note all modifications to the system are described in details.

2. Brief Description of the BLVD Software

A *BLVD.EXE* code is used to control the detector. It is written in Borland® C++. The source code is composed of several *CPP* files (see the list in Annex 2 of ref. **[1]** and the "h" files). The main one called *BLVD.CPP* creates the Dos user interface where the mouse and unrolling menus are used to set the measurement conditions, to start measurements and view recorded data. Another example is the file *MOVEF.CPP* which performs one of the four kinds of measurements: the fast energy measurement. Some *CPP* files are made out of numerous functions. For instance, the function called *MOVEMECHDRIV* in the file *VME10.CPP* (devoted to the hardware interfacing) moves the BLVD mechanical glider to the assigned detector position corresponding to the expected nominal energy. Among the other subroutines of *VME10*, there are also two functions, *PHASHIFTMIN* and *PHASHIFTMAX* which are used to set up the trombone (the MPS) to its minimum or maximum position. The English commented modifications achieved in the software took place in the modules and functions described above. The **Appendix A** summarizes a brief description of these files and functions. The other files and functions used in the BLVD software are not described here. For more details see the reference **[1]**.

3. The Detection Device

3.1. Solution to a first displacement problem

The BLVD had a malfunction when displacing it from an upstream to a downstream position. When a distance of 37 mm, for instance, was set into the code, the detector moved only by a 23 mm distance. The BLVD motion is determined by two Optical Position Monitor (OPM) **[1]**. The OPM1 has a limited range of measurement; when the device has to move more than this distance, a second OPM does the measurement. The OPM1 range is 23 mm. That is why the BLVD moved from the zero position

(upstream) to the end of the OPM1 range and stopped. After checking in situ the OPM1 local controller seemed to be out of order or badly initialized. Its screen was blank. So probably an error signal from this controller was sent to the program which blocked the BLVD at the 23 mm position. This problem has been solved by deactivating the function *MOVEMECHDRIV* (utilization of the OPMs) and replacing it by the function *MOVEMECHDRIV1* (no utilization of the OPM measurements) in the *VME10.CPP* file. Then the BLVD displacement was true to the value fixed in the program.
Remark: The OPM controller still needs to be repaired or reset.

3.2. Displacement Calibration

In order to measure the energy of the particles, the BLVD is shifted along the direction of the beam. This displacement has been evaluated with a depth measurer. The detector is moved by using a mechanical glider assembly. The BLVD can be tilted from right to left sides when moving it. So in order to consider only the real displacement of the target (in the center of the detector) two measurements were done on each side of the device with the depth measurer. **Figure 1** gives an idea of the equipment and the way the distances were measured with a ±0.02 mm accuracy.

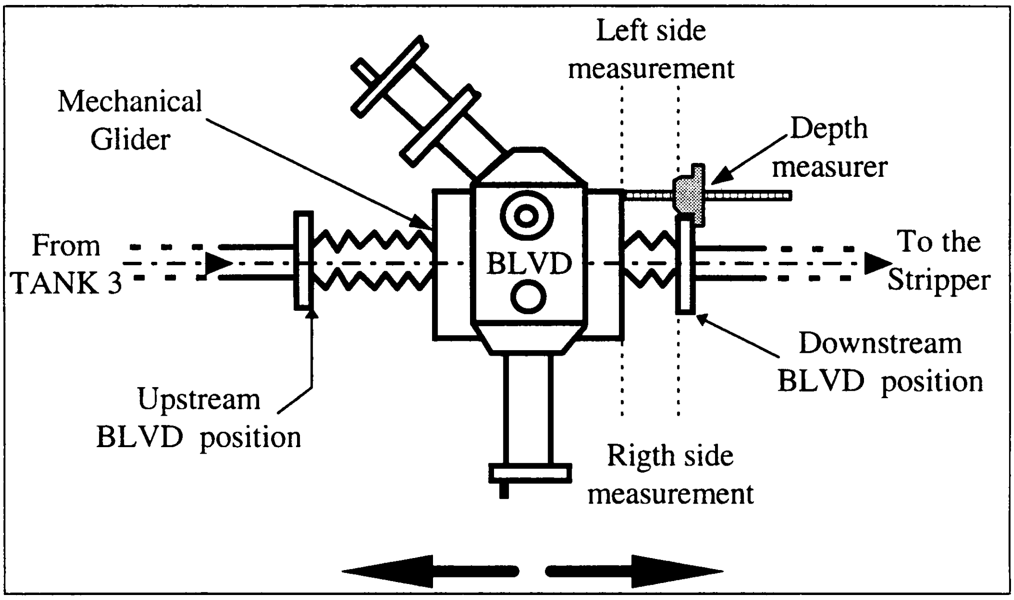

Fig. 1: Measurements of the BLVD displacement on its mechanical glider.

An average of the measurements achieved on each BLVD side gave a target displacement of:

$$\Delta D_{meas} = 34.74 \ mm \quad \textbf{(1)}$$

The value set in the program driving the BLVD was equal to 34.93 mm* (for an energy of 4.2 MeV/u). So there was a shift between the programmed and the measured value. Therefore a calibration of the detector motion was necessary. It has been done for the three different energies involved: i.e. 4.207 MeV/u when the three tanks are powered,

* This value has been calculated for a MPS displacement of 184.39 mm. This displacement has been found different (see the paragraph called ***The MPS - Displacement Calibration***)

3.047 MeV/u when Tank1 and 2 are powered and Tank 3 is unpowered and 1.862 MeV/u when only Tank1 is on. The result is given in the **Figure 2** for the three cases.

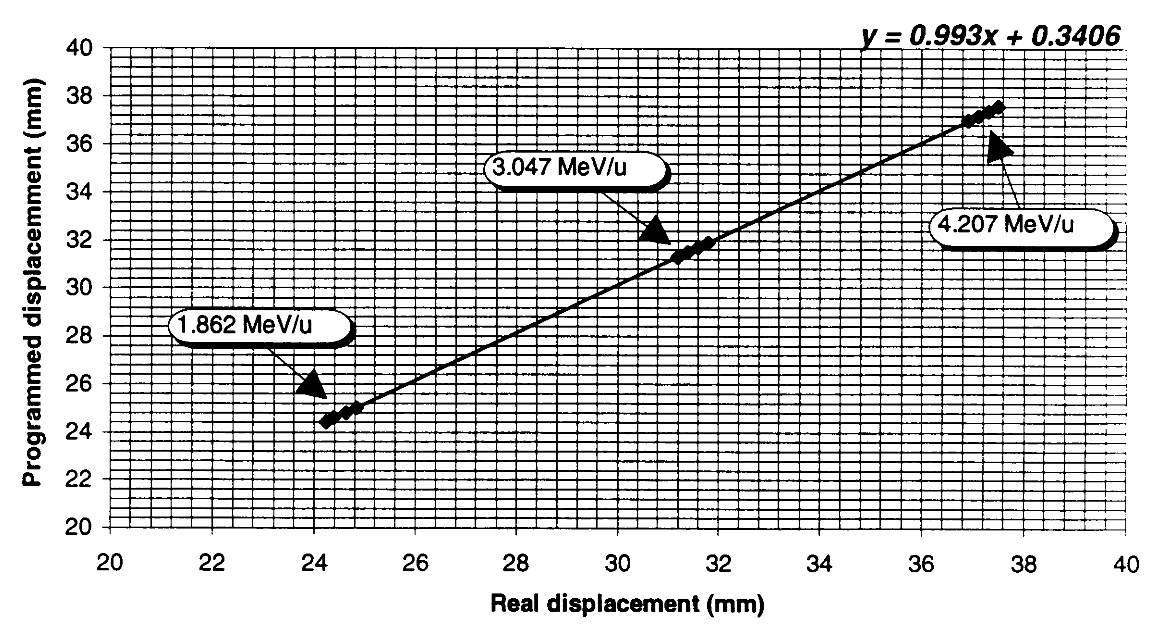

Fig. 2: BLVD displacement calibration for the three energies.

One can see that the displacement shift is linear. The calibration law found for the 4.207 MeV/u nominal energy has been inserted in the BLVD software (see the paragraph **5.3. Miscellaneous Modifications**).

4. The Mechanical Phase Shifter (MPS)

4.1. Solution to a second displacement problem

The mechanical phase shifter used in the bunch shape measurements **[1]** is driven by a stepping motor via the BLVD program. The MPS is a two arm trombone. Its elongation is limited by two micro-switches. The MPS elongated with difficulties at different positions of its path. Moreover it did not reach the end-switches. Firstly the maximum number of steps set in the code was thought to be too small. So it has been increased in the software (see paragraph **5.3**). The MPS worked properly but only temporarily. In fact the problem was due to a bad cleaning and oiling of the motor and the arms. This problem has been fixed and now the MPS can easily move all the way from one micro-switch to the other.

4.2. Displacement Calibration

In order to measure the mechanical phase shifter elongation, 500 mm Vernier calipers have been used. A set of measurements gave an average stroke of :

$$\Delta L_{meas} = 196.64\ mm^{*} \quad \textbf{(2)}$$

* This distance has been checked 3 months after this measurement and gave the same value at ± 0.06 mm.

This length corresponds to a phase shift of:

$$\varphi_t = \frac{360.f.(2\Delta L_{meas})}{c} = 95.59° \textbf{ (3)}$$

where f is the second harmonic of the free space frequency i.e. f = 202.56 MHz,
c is the velocity of light.

Note that the considered length is $2\Delta L_{meas}$ because the MPS is a two arm trombone (each arm measuring ΔL_{meas}). The MPS phase range has been updated in the BLVD software to 95.59° (see the paragraph **5.3.**).

Then the new BLVD displacement value can be worked out using the formula:

$$\Delta D_{nom} = \beta_{nom}(2.\Delta L_{meas}) \textbf{ (4)}$$

That is to say:

$$\Delta D_{nom} = 37.25 \text{ mm } \textbf{(5)}$$

So according to our measurements, the value of the nominal BLVD displacement distance has been set to the value found just above (see the paragraph **5.3.**).

5. Software Modifications

5.1. Verification of the Sign of the Phase Shift

When an energy measurement is realized two bunch shape measurements are done at two different detector positions. If the centers of the bunches coincide then the energy of the particles is the expected one (the one assigned to the given BLVD displacement distance). Else there is a phase shift, $\delta\varphi$, the particles have not the nominal energy and then the new energy is calculated with respect to this phase shift. The following formula is used:

$$W = 931.478\left[(1-\beta^2)^{-0.5} - 1\right] \textbf{ (6)}$$

$$\text{where } \beta = \frac{\Delta D_{nom}}{\frac{\lambda\varphi_t}{360}\left(1 - \frac{2\delta\varphi}{\varphi_t}\right)} \textbf{ (7)}$$

where W is the particle energy,
ΔD_{nom} is the BLVD displacement distance in mm,
λ is the wavelength of the deflecting rf field (202.56 MHz),
φ_t is the trombone phase range in degrees.

The comparison of velocity measurements and calculations done with the formula **(7)**, showed that the phase shift was not properly calculated: the sign of $\delta\varphi$ was reversed. So the software has been modified in consequence.

5.2. Correction of the External Magnetic Field

Due to the effect of the non-homogeneity of the external magnetic fields all around the detector, there was a different deflection of the secondary electron beam between the upstream and downstream BLVD positions. So during an energy measurement, the detected electrons during the second bunch shape measurement had an additional phase shift. This modified the energy calculation. In order to measure this shift, the thermal electrons emitted when heating the target have been used. The optics have been properly aligned for the upstream position. Then the mechanical glider has been moved 37.25 mm downstream to the nominal BLVD place. Then the image of the thermal electron beam on the phosphor screen was no more aligned with the SEM (Secondary Electron Multiplier) entrance slit. This shift has been estimated at around 0.5 ± 0.1 mm* in the downstream direction. On the second hand the displacement had to be calibrated. So a specific experiment has been done in the conditions described in **Table 1**. The correction brought to the energy calculation was then fixed by the chosen settings. That is to say that:

SINCE THIS MOMENT THE ENERGY MEASUREMENTS ARE RELIABLE ONLY WHEN WORKING WITH THE SETTINGS OF TABLE 1**.**

Phase range (°)	*Deflector voltage (V) on the scope*
180-250	**2**

__Tab. 1:__ The setting conditions for energy measurements.

Indeed the value of the correction depends on the deflector voltage and its sign depends on the slope of the sinusoidal function. In general the slope which is used. It changes for example if the electrical length of the BLVD (or the accelerator) power supply line is changed. But for fixed conditions the range 180-250 degrees gives the correct sign.

The calibration has been done as following. First of all the BLVD optics have been properly aligned for the upstream detector position. Then a velocity fast measurement has been started. The first bunch shape has been performed. The optics have been arbitrary misaligned and the measurement process continued. The thermal electron enabled to show a displacement of 5.5 mm in the upstream direction. It corresponded to a 1.95° phase shift between the two bunch profile centers. So the displacement 0.5 mm previously measured gave:

$$\Delta(\delta\varphi) = \frac{1.95 * 0.5}{5.5} = 0.177° \quad \textbf{(8)}$$

Using the formulae **(6)** and **(7)** the following approximation can be made:

$$\frac{\Delta W}{W} \approx \frac{4}{\varphi_l} \Delta(\delta\varphi) \quad \textbf{(9)}$$

Thus an error of 0.177° corresponds to a 30 keV/u error on a 4.207 MeV/u energy. So finally the phase shift has been corrected in the energy calculation formula in the software. The line `betta=betta+0.177` has been added in the file *MOVEF.CPP* (remember that the variable `betta` is used for the phase shift and then for the velocity).

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* The same displacement has been observed several months later.

** See also **Appendix C**.

5.3. Other Modifications

Apart from the two previous software modifications other ones have been performed.

As mentioned in the paragraph **3.1** The function *MOVEMECHDRIV* has been replaced by the already existing function *MOVEMECHDRIV1*. This last one drives the mechanical glider without using the OPM measurements. The error created from the OPM1 has thus been avoided but not solved. However another problem appeared when using *MOVEMECHDRIV1*. There was an error message when running the software and no measurements were possible. After checking the source code it has been found that the BLVD displacement was calculated in micrometers instead of millimeters. This value used in the velocity calculation (cf. **eq. (7)**) gave a β value bigger than 1. So when the energy was calculated with the **eq. (6)**, where the term $(1-\beta^2)^{-0.5}$ is present, an error appeared. Therefore a division factor of 1000 (to go from µm to mm) has been added to the corresponding code line in the function *MOVEMECHDRIV1*:
`qwe[149]=qwe[149]*15.78;` became `qwe[49]=qwe[49]*15.78/1000;`
After this correction there was no error anymore.

After the discussion of the paragraph **3.2** the BLVD displacement calibration law for a 4.207 MeV/u energy (see **Fig. 2**) has been added to the software. In the file *VME10.CPP* a new variable `dimens1` has been created. It is defined as:

```
float dimens1;
dimens1=0.993*dimens+0.3406
```

where `dimens` is the BLVD displacement length set in the program.
The calibration law used above gives the real BLVD displacement (`dimens1`) from the value (`dimens`) entered in the program by the user. So the real displacement value is utilized in a loop which moves the BLVD. The actual displacement is then calculated with respect to the calibration law found previously. In order to do that the following line has been added in the file *VME10.CPP*:

```
qwe[149]=1.0071*qwe[149]-0.3427;
```

As previously reported in **4.1**, the MPS did not elongate correctly. Firstly the maximum number of steps set in the code was thought to be too small. So it has been increased in the software from 3200 to 5000 in the functions *PHASHIFTMIN* and *PHASHIFTMAX* of *VME10.CPP*. This modification improved temporarily the MPS elongation but after few days the trombone was blocked again. Cleaning and the oiling the MPS mechanism solved the problem. Nevertheless the maximum step number has not been reset to the initial 3200 value.

Upon the calculations (see **eq. (3)**) made in the paragraph **4.2**, the MPS phase range has been changed from φ_t=95.8° to 95.59° in *MOVEF.CPP*. Moreover the default value of the BLVD displacement has been modified in the file *BLVD.CPP* from 34.93 mm to 37.25 mm with respect to the equations **(4)** and **(5)**. The energy formula in *MOVEF.CPP* has been corrected as regards of the equation **(6)**. The constant was 931.1 and it has been replaced by 931.478.

By looking the dates of creation of the files it has been found that the executable *BLVD.EXE* has been generated before the file *MOVEF.CPP*. It means that the previous version, *MOVEF.BAK*, was used. So BLVD.CPP has been recompiled in order to use the last version of *MOVEF.CPP* containing all the changes. Two compilation errors appeared. The first one was the presence of the unknown variable `bettal` in *MOVEF* instead of `betta`. The second error was due to the fact that a file called *FAST.CPP* was missing in the working directory (C:\ANDI\WORK\). So in order to clarify the situation, a new directory has been created. It is called C:\BLVD\ and it contains all the BLVD files required for a compilation of the main program (*BLVD.CPP*). A batch file has also been created in order to simplify the use of the BLVD software. So now in order to run the software under DOS just type the command:

```
C:\> BLVD
```

When the return key is pressed, the HpScreen (required for print outs when pressing the Print Screen key on the PC keyboard) and BLVD programs are automatically launched.

The last modification in the BLVD software was just a question of convenience. Indeed when a bunch profile measurement is required it is firstly interesting to select the bunch. So the first measurement has to be done in the 0° to 360° phase range. So the maximum value of 100° previously set in the "fast bunch shape inputs" menu of the file *BLVD.CPP* has been changed to the value 360°.

In order to facilitate the BLVD program debugging, a software called Norton PCANYWHERE® has been installed and properly configured on the BLVD dedicated PC. It enables the control of the BLVD PC (the "Eleve" or the server) from any PC (the "Maitre" or the client) connected to the network and which has been previously properly configured. After the BLVD PC is switched on, the control of the server is launched on the client PC by running the file AWSTART.BAT. The server called BLVD has to be contacted (the password is YURI) and then the screen of the BLVD PC appears on the PC "Maitre" screen. Since this moment the BLVD can be directly controlled: any action can be performed as if the user would be working on the BLVD PC.

6. Mechanical and Hardware Modifications

6.1. The MPV952

It has to be noticed that the *Burr Brown* VME module called MPV952, a high speed 12 bits analog to digital converter providing the BLVD data acquisition, needs a stabilization delay:

ROUGHLY 20 MINUTES ARE REQUIRED BEFORE SWITCHING ON AGAIN THE CRATES.

Remark: The MPV952 module does not exist anymore in *Pentland* catalog.
Nevertheless there is a spare one in CERN (see the acknowledgments).

6.2. The Target

The target used in the BLVD is a 100 μm diameter and 45 mm long tungsten wire. It is placed in the ion beam in order to create secondary electrons which are then detected. After a certain time this wire is deteriorate by the lead beam. Indeed one day there was no signal from the secondary electron multiplier. Moreover the heating of the target was not possible. So it has been deduced that the wire was cut. It has been verified by measuring the target impedance. During a Linac 3 shut down the wire has been replaced by a new one. The replacement was quite easy due to the wire support design (two fork arms hold by springs) and the wire itself which has blocking cylinders at each end. **Figure 3** shows the target device.

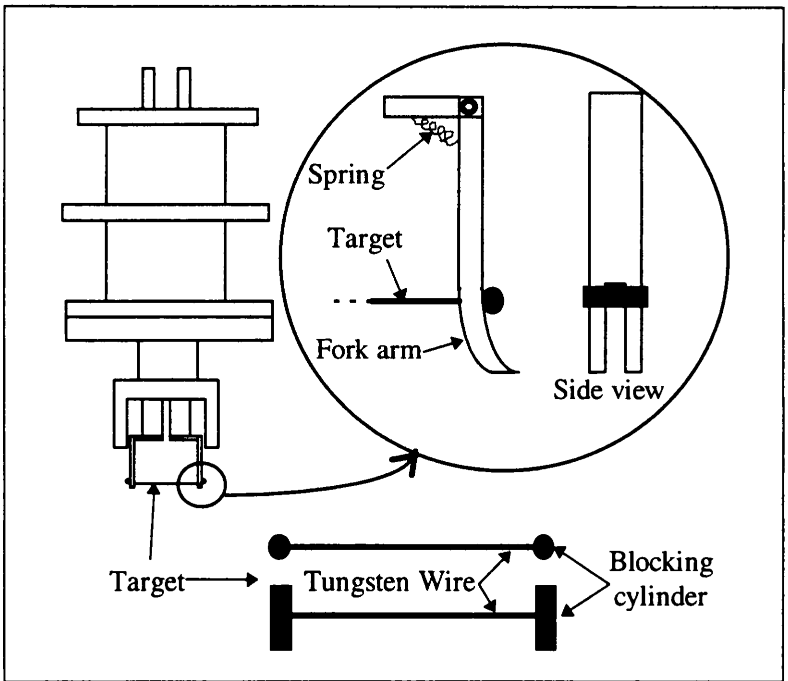


Fig. 3: The target unit. The inset shows details of the tungsten wire and its support.

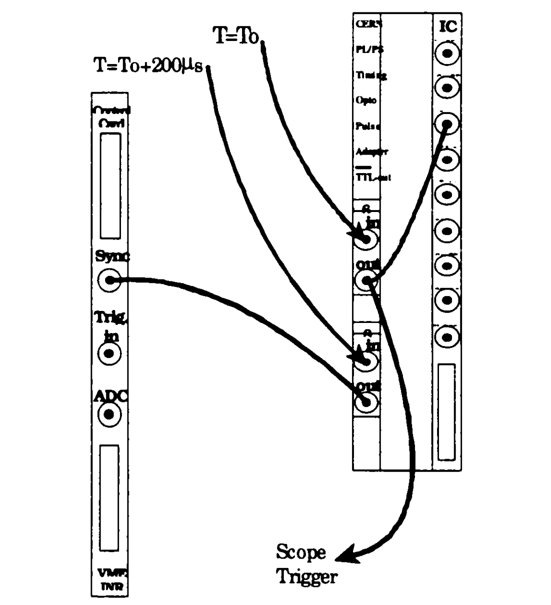
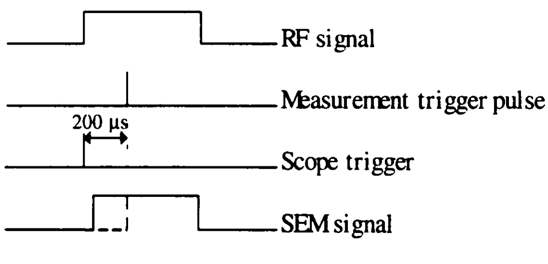
Remark: There are around ten spare tungsten wires in CERN (see the acknowledgment part).

So in order to increase the target life time it has been decided to:

TAKE THE WIRE OUT OF THE LEAD ION BEAM WHEN THE BLVD IS NOT USED AND PUT IT BACK TO THE REFERENCE POSITION WHEN OPERATION IS NEEDED.

6.3. Triggering

On an oscilloscope we observe two signals. The first one (on channel 1) comes from the deflector which converts the longitudinal secondary electron position to a transverse position through rf modulation. Whereas on channel 2 the signal from the electron detector (the SEM) can be observed. It has been observed that the leading edge of this signal was missing. The first 200 μs were not visible on the scope. So the cabling has been modified in order to trigger the scope at the beginning of the RF signal and then trigger the measurement 200 μs after. This change can be seen in **Tab. 2**.

Cabling set up (see **Appendix D** for more details)	
Timing diagram	

Tab. 2: Triggering cabling set up and the corresponding timing diagrams.

A trigger problem occurred after a short complete shutdown. It has been found that a NIM module in Linac 3 timing rack (CYT01) was malfunctioning. The BLVD is triggered on each PS cycle except the B and C supposed to perturbate strongly the energy measurements. The information about the PS cycles is given by the PS PLS. This telegram is sent to a decoder which sends signals to a driver when the A to H PS cycles are recognized. The B and C outputs of this driver are connected to a logic AND gate which enables the inhibition of the B and C cycles: the BLVD is not triggered during this time. The PS PLS decoder used in this gating is a NIM module containing two EPROMs programmed on the PS PLS. After testing the module itself (without the EPROMs) with the use of two new modules it has been concluded that the EPROMs were malfunctioning or deprogrammed. Spare parts were not available. Thus a new PLS decoder has been installed in the slot 3 of the CAMAC crate 11 of the Linac 3 timing rack (CYT01). It does not include EPROMs but it is driven by a software. Therefore a new device has been created for the Linac 3 control system and it is called ***IX.PD-BLVD***. The PS telegram contains several sequences. The one of interest is the following cycle type group:

PS PLS Line	*PS Cycle Name*	*Equivalent PSB PLS Name**
41	A	MDION
42	B	MDPRO
43	C	LEAPRO
44	D	LHC
45 .	E	ISOHRS
46	F	MEION
47	G	MDLHC
48	H	ZERO

Tab. 3: The PS cycle types and the corresponding lines in the PS/PLS telegram. The booster names are also present because the BLVD is part of a booster environment (see the footnote).

The PLS decoder has to be programmed with ***IX.PD-BLVD*** as follows. First of all on a Linac 3 console open the ***Linac 3 Console Manager***. Then in the menu ***Sequence*** choose the option ***PLS Decod2 Linac3***. Finally click on each channel to select a PLS line from the ***POWER*** group (using negative logic) as shown in **Tab. 4**.

Channel	*Name*
1	-A
2	-B
3	-C
4	-D
5	-E
6	-F
7	-G
8	-H

Tab. 4: The software channels and the corresponding PS names.

6.4. Optics Alignment

In order to transport the secondary electrons (emitted when the lead ion beam hits the tungsten wire) to the Secondary Electron Multiplier (SEM), some electron optics (steering and focusing) are used. When these elements are properly aligned the electron beam passes through the slit in front of the SEM. During a Linac 3 MD it was found that the BLVD optics were very difficult to align. This may be due to the strong perturbating external magnetic fields. First of all the correcting magnet of the registration unit (see ref [1]) has been correctly positioned. Then the optics have been aligned by optimizing the SEM signal on the scope (see the potentiometer on the Filament Heating Card). However the bunch shape had a non equal to zero base line. This constant level may be due to a bad optics alignment: some interferences could have been produced by the beam hitting the collimator edges. So the optics alignment has been done visually. Indeed when the target is heated some thermal electrons are

* The program Display Alarms on Linac 3 console refers to the PSB PLS database so one has to translate PSB line names to the equivalent PS names for the same PLS line number using the above table.

emitted and their image on a phosphor screen can be aligned with the image of the SEM slit. Then the base line of the bunch profiles was equal to zero again.

In conclusion the two ways of doing the optics alignment (with secondary electrons or with thermal ones) did not give the same result contrarily to a normal BLVD operation. So a third alignment method has been found. It uses the fact that when the secondary electron beam is correctly aligned, the bunches on the PC screen are equally spaced. When a bunch shape measurement is performed on a 0 to 360 degrees phase range, four bunches can be observed. In reality it is the same bunch seen four times. On one hand this is due to the fact that the BLVD works at the second harmonic (202.56 MHz) of the RFQ (ν_{RFQ}=101.28 MHz is the lead ion bunch frequency and also the secondary electron bunch frequency just after being emitted). On the other the position of the secondary electron beam with respect to the SEM slit is $x=x_o\sin(\phi-\phi_o)$ where ϕ is the BLVD phase. So when the sinus is equal to zero, the electrons enter the SEM through the slit. This event occurs two times during a BLVD period that is to say four times during an ion bunch period. Therefore when the optics are not misaligned the bunch profile measurement shows four bunches equally spaced as represented in **Fig. 4**.

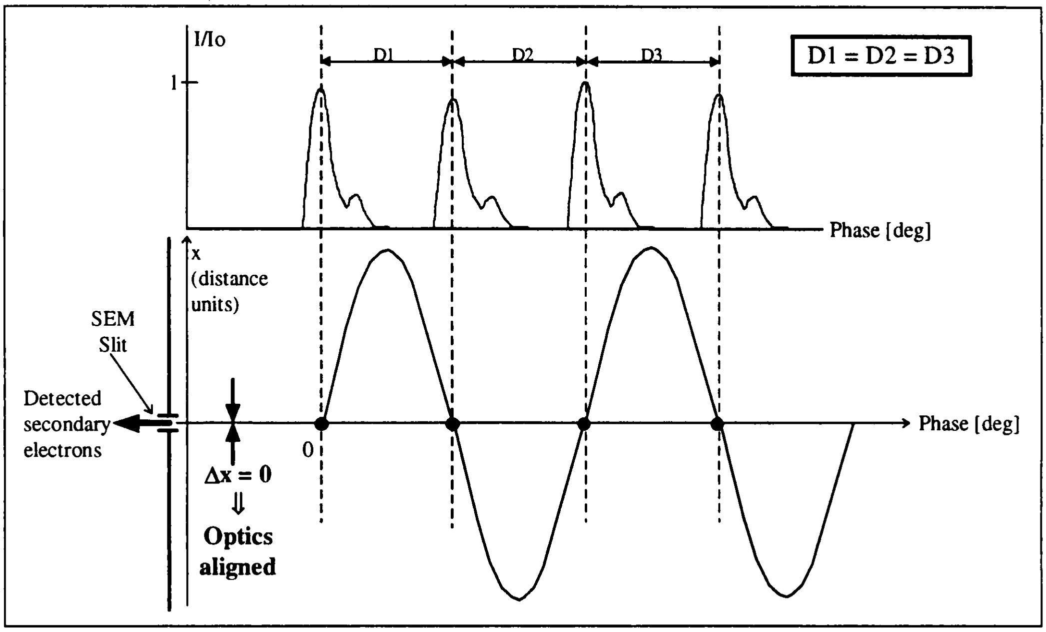


Fig. 4: BLVD optics alignment using the equidistance between the bunches (D1=D2=D3).

However if the BLVD optics are misaligned, the bunches are not anymore equidistant with respect to the BLVD phase as depicted in **Fig. 5**.

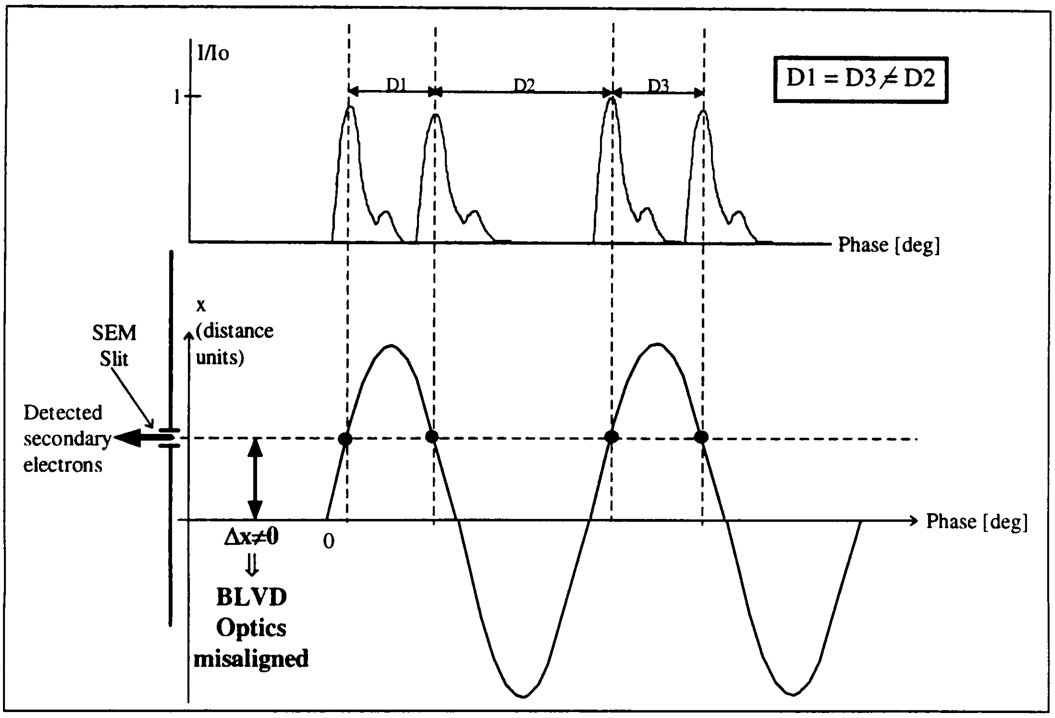


Fig. 5: The effect of the misalignment of the BLVD optics is visible on the distance between the bunches (D1=D3≠D2 if the perturbation is constant over the measuring time).

7. Measurements

After the target replacement some tests have been performed. The first one was the measurement of the bunch intensity and rms width with respect to the target transverse position. **Figure 6** shows the results of the measurements. The physical width of the lead beam in the horizontal direction perpendicular to the ion beam trajectory has been estimated to approximately *7 mm* at the BLVD position during that experiment.

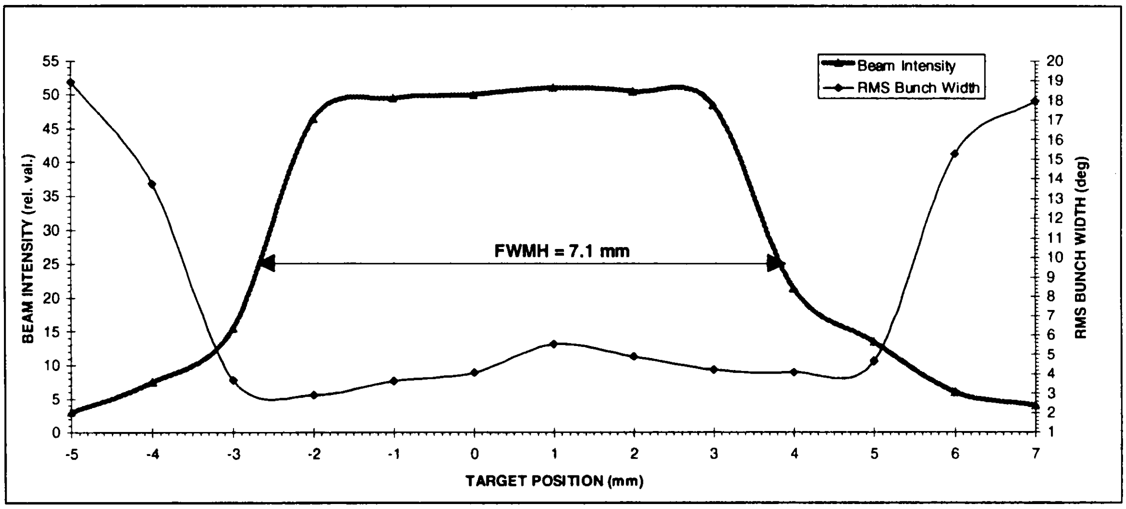


Fig. 6: Bunch intensity and rms width of the bunches with respect to the transverse target position (see the data file reference in **Appendix A**).

In the same picture the bunch rms width has been represented. From **Figure 6** one can see that the rms bunch length can vary by more than a factor 2 (2.5 to 5.4), only due to the change of position of the target wire. One can also note that in the center of the beam there is a saturation effect on the bunch length. So:

FOR PROPER OPERATION, THE TARGET HAS TO BE PLACED EACH TIME AT THE SAME POSITION, OFF-CENTER OF THE ION BEAM.

Remark: Be careful to place the target at a position where the absolute intensity of the ion beam is always the same.

Depending on the tuning of the IH tanks, rms bunch length of ***1.55 ± 0.15 degrees*** have been observed (which results in a 4-rms bunch length of ***171 ± 17 ps***).
The measurement of the absolute energy has been repeated at several occasions. The value ***4.03 ± 0.05 MeV/u*** was found, which differs from 4.207 MeV/u, the design value for the IH structure. This difference may be due to external magnet fields created by Linac 3 elements such as the quadrupoles or the steerer near the BLVD. This discrepancy is still under investigation.

8. Conclusion

The manipulation of the BLVD by non-experts has been eased. Some software errors could be fixed. Our degree of familiarity with this detector has been raised.
Very much care has to be taken in the measurement when absolute bunch length or energy are of interest. Many parameters (e.g. the dependance of the bunch length from the position of the target wire, **Fig. 6**) have to be set correctly (at specific values) to avoid any miss-interpretation.
The measurement of the absolute energy 4.03 ± 0.05 MeV/u several times repeated which differs so much from the nominal value 4.207 MeV/u will stay a puzzle untill a time-of-flight measurement with a device with a guaranteed higher precision than 1 % will be available.

Appendices

A) DATA FILE LIST:

DESCRIPTION	*FILENAME*
BLVD & MPS Displacement Curves	BLVDDISP.XLS
Detailed cabling of the BLVD crates (Appendix E)	BLVDCRAT.DS4
Measurements versus the target transverse position	BLVDTARG.XLS

B) MODIFIED FILE AND FUNCTION LIST:

NAME	*DESCRIPTION*
BLVD.EXE	controls the detector.
BLVD.CPP	creates the Dos user interface where the mouse and unrolling menus are used to set the measurement conditions, to start measurements and view recorded data.
MOVEF.CPP	performs one of the four kinds of measurements: the fast energy measurement.
VME10.CPP	is devoted to the hardware interfacing.
FAST.CPP	does a fast bunch profile measurement.
MOVEMECHDRIV (in VME10.CPP)	moves the BLVD mechanical glider to the assigned detector position corresponding to the expected nominal energy. The detector position is given by 2 Optical Position Monitors (OPM).
MOVEMECHDRIV1 (in VME10.CPP)	moves the BLVD mechanical glider to the assigned detector position corresponding to the expected nominal energy. The OPM are not used for the BLVD position.
PHASHIFTMIN (in VME10.CPP)	is used to set the trombone (the MPS) to its minimum position.
PHASHIFTMAX (in VME10.CPP)	is used to set the trombone to its maximum position.

The complete list can be found in Annex 2 of ref. [1] and in the “h” files.

C) IMPORTANT WARNINGS WHEN USING THE BLVD:

C.1) In order to run the BLVD software under DOS, **TYPE THE COMMAND `BLVD` WHEN THE `C:\>` PROMPT APPEARS ON THE PC SCREEN**. The HpScreen and BLVD programs are then automatically launched.

C.2) **When energy measurements are performed (around the 4.207 MeV/u nominal value) it is important that the settings have the following values** (the external magnetic field related correction has been done for these values):

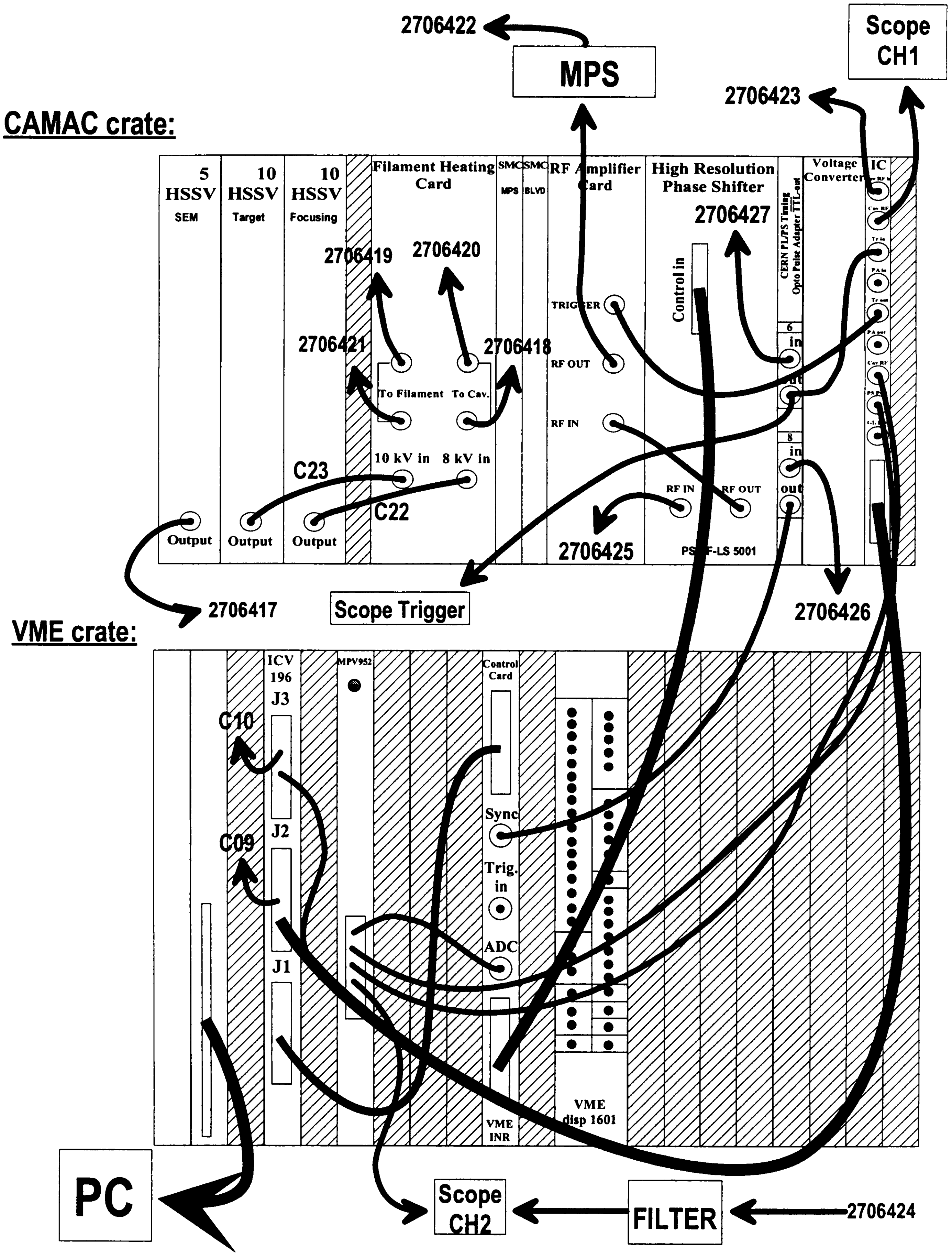
Energy Measurement Phase Range (°)	*Deflector Voltage (V) on the scope*
180-250	**2**

C.3) When the CAMAC and VME crates are powered and then switched off, **A *20 MN* DELAY IS REQUIRED BEFORE TURNING ON AGAIN**. Otherwise the 12 bits ADC module MPV952 does not work properly and no BLVD operation is possible.

C.4) **WHEN THE BLVD IS NOT USED THE TARGET HAS TO BE TAKEN OUT OF THE ION BEAM**. Thus the wire life time is increased.

C.5) Each time the BLVD is used, the intensity of the ion beam has to be determined with respect to the target position. Then **THE TARGET HAS TO BE PLACED AT THE CHOSEN REFERENCE POSITION: ALWAYS THE SAME ION BEAM INTENSITY AND OFF THE BEAM CENTER**.

D) DETAILED CABLING OF THE BLVD CRATES IN RACK C16T:



Reference

[1] **Bylinsky Y., Feschenko A., Liiou A., Men'shov A., Ostroumov P., Kugler H., Soby L., Williams D.,** *"Design and Performance Characteristics of the Bunch Length and Velocity Detector"*, 1994.

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