USER MANUAL

BLM

Beam Loss Monitor

Rev. 4.0

www.bergoz.com

bergoz INSTRUMENTATION

More than 40 years of experience recognized in the world of particle accelerators

Record of updates

Version	Date	Updates performed
2.0	06/2017	New release including BLM-DIF
3.0	03/2018	Review of the full manual. Obsoletes all previous versions
3.1	12/2019	Modification of the cover page and creation of the distributors' page
4.0	07/2024	Manual layout update

DISTRIBUTORS

U.S.A.

GMW Associates
www.gmw.com
sales@gmw.com

Japan

Hayashi-Repic Co., Ltd.
www.h-repic.co.jp
sales@h-repic.co.jp

India

GEEBEE International
www.geebeeinternational.com
info@geebeeinternational.com

China

Beijing Conveyi Limited
www.conveyi.com
sales@conveyi.com

South Korea

Seyoung Co., Ltd
www.seyoungsys.com
apark@seyoungsys.com

TABLE OF CONTENTS

INITIAL INSPECTION

It is recommended that the shipment be inspected immediately upon delivery. If it is damaged in any way, contact Bergoz Instrumentation or your local distributor. The content of the shipment should be compared to the items listed on the invoice. Any discrepancy should be notified to Bergoz Instrumentation or its local distributor immediately. Unless promptly notified, Bergoz Instrumentation will not be responsible for such discrepancies.

WARRANTY

Bergoz Instrumentation warrants its beam current monitors to operate within specifications under normal use for a period of 12 months from the date of shipment. Spares, repairs and replacement parts are warranted for 90 days. In exercising this warranty, Bergoz Instrumentation will repair, or at its option, replace any product returned to Bergoz Instrumentation or its local distributor within the warranty period, provided that the warrantor's examination discloses that the product is defective due to workmanship or materials and that the defect has not been caused by misuse, disassembly, neglect, use of faulty part, accident or abnormal conditions, repair made by the customer, or operations. Damages caused by ionizing radiations are specifically excluded from the warranty. Bergoz Instrumentation and its local distributors shall not be responsible for any consequential, incidental or special damages.

ASSISTANCE

Assistance in installation, use or calibration of Bergoz Instrumentation beam current monitors is available from Bergoz Instrumentation, 01630 Saint Genis Pouilly, France. It is recommended to send a detailed description of the problem by email to info@bergoz.com.

SERVICE PROCEDURE

Products requiring maintenance should be returned to Bergoz Instrumentation or its local distributor: The purchaser/customer must ask for a RMA (Return Material Authorization) number to Bergoz Instrumentation or its local distributor before return of goods. Bergoz Instrumentation will repair or replace any product under warranty at no charge.

For products in need of repair after the warranty period, Bergoz Instrumentation will assess the technical issue and send a quote to the purchaser/customer. The purchaser/customer must provide a purchase order before repairs can be initiated. Bergoz Instrumentation can issue fixed price quotations for most repairs.

RETURN PROCEDURE

All products returned for repair should include a detailed description of the defect or failure as well as name, phone number and email of a contact person to allow further inquiry. Contact Bergoz Instrumentation or your local distributor to determine where to return the product. Returns must be notified by email prior to shipment.

The shipment of a product under warranty or out of warranty back to the factory is paid by the user/customer, including the customs fees. The return of this repaired product under warranty back to the customer is paid by Bergoz Instrumentation.

Return of product out of warranty should be made prepaid or will be invoiced. Bergoz Instrumentation will not accept freight-collect shipments. Shipments should be made via UPS, FedEx or DHL. Within Europe, the transportation services offered by the national Post Offices can be used. The delivery charges or customs clearance charges arising from the use of other carriers will be charged to the customer.

SCOPE OF USE

Beam Loss Monitors based on PIN-photodiode signal coincidence detection can be used to evaluate beam loss of CW beam, long macropulses from synchrotrons, cyclotrons and high-repetition rate linacs. PIN-Photodiodes-based BLMs are of no use on beam with single pulses, e.g. laser-plasma accelerators, single bunch injection, low repetition rate linacs.

Why? Because PIN-photodiode-based BLM outputs a single pulse whether it is hit by one secondary electron or 1000 such electrons and requires 100ns to recover before the next hit.
Thus, it is not an integrating loss monitor.
It relies on the statistical probability of being hit by secondary electrons.

BLM-SE

Identify whether the model is BLM-SE has a unipolar single-ended output.

It is equipped with two 7.34 mm2 BPW34 PIN-diodes.

Note: BLM-DIF, with differential 100-ohm output, and BLM-XL with 150 mm2 S2662 are older models no longer manufactured.
Older denomination BLM-XS is now known as BLM-SE.

QUICK CHECK

You can check immediately that your BLM is working.

To check the spurious count rate in each channel, this is what you need:

- BLM-SE
- Oscilloscope ≥100 MHz bandwidth
- Power supplies: +5V, −5V, +24…25V
- Resistor 4.7 kΩ ≥1/8W

To check the actual count rate from secondary MIP electrons (minimum ionizing particles), a source decaying in beta- >900 keV is needed, e.g., Americium. These sources are not commonly available.

Identify the connections

HE10 Pin#............................Function

1...Ground
2...+ 5V
3...n/c
4...− 5V
5...Enable/Disable B
6...+24…25V
7...n/c
8...Ground
9...Enable/Disable A
10.......................................Output

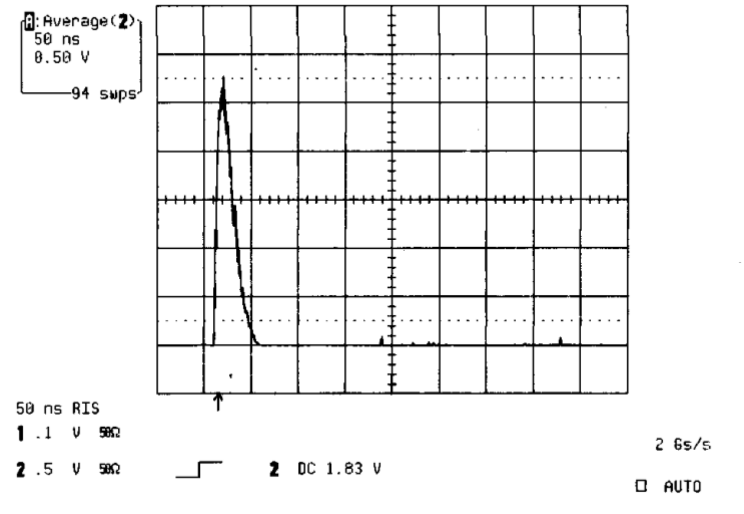
Connect the power supplies to BLM-SE:
Ground .... Pin 1
+5V..................................... Pin 2
−5V .... Pin 4
+24…25V .... Pin 6

Connect the oscilloscope:
Output .... Pin 10
Ground Pin 8

Check #1

- Display the spurious counts of channel A:
- Channel B must be enabled (as if it had received a hit at the same time):
  - Connect Enable/Disable channel B to +5V thru the 4.7kΩ resistor.
  - The oscilloscope displays the spurious counts in channel A.
- To display the spurious counts of channel B:
  - Connect Enable/Disable channel A to +5V thru the 4.7kΩ resistor.
  - The oscilloscope displays the spurious counts in channel B.

Waveforms look like this:



Check #2

If a beta- source with E>900 keV is available, display the counts from MIP secondary electrons (minimum ionizing particles); do not pull-up Enable/Disable A nor B. Bring the high-energy beta- source and the BLM closer to each other, observe the increase in the count rate.

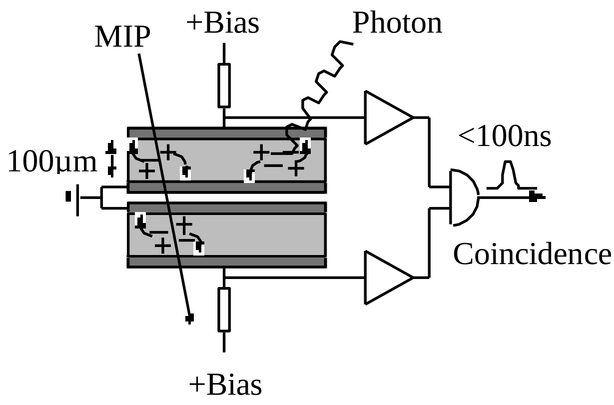
OPERATING PRINCIPLE

Detector Type

The detector is sensitive to MIPs (minimum ionizing particles) produced when an accelerated particle hits the wall of the vacuum chamber.

Refer to Annex I: “Electron Beam Loss Monitor” by W. Bialowons, F. Ridoutt and K. Wittenburg for the mechanism of beam loss in FODO structures due to accelerated particles scattering on residual gas molecules nuclei or vacuum chamber walls.

The detector is composed of two PIN-diodes mounted face to face to form a 2-channel coincidence detector.



Signal processing

When an ionizing particle hits a PIN-diode, an electric charge is produced. A bias voltage allows collection of this charge. It is amplified to a level high enough for conventional logic. An AND-gate detects the coincidence of pulses from the two PIN-diodes.

MIPs cause ionizations in both PIN-diodes, a coincidence occurs and an output pulse is generated. Photons do not cause ionization in both PIN-diodes. So, the coincidence circuit does not produce a pulse for photons.
The amplification gain of each channel is
adjusted with a potentiometer.

Efficiency of the detector

Overall, MIPs are detected with an efficiency > 30 %. See Annex III: “Radiation Resistance of Beam Loss Monitor” by K. Wehrheim and K. Wittenburg.
The size of the PIN-diodes mounted on the circuit determines the detector’s solid angle.
The coincidence scheme rejects very effectively the spurious noise from each channel to a figure well below 1 count/s.

The channel gains can be adjusted to obtain negligible spurious count rates: < 0.1 count/min. See Annex II “A Beam Loss Monitor for HERA” by S. Schlögl and K. Wittenburg.
It rejects equally effectively the X-ray background typical of electron/positron storage rings.

Dynamic range

It is determined by the spurious noise of the detector and the maximum count rate. It exceeds 108. The spurious noise, in the absence of any background, is well below 1 count/s. In the presence of an intense X-ray background, the BLM must be shielded by 3 cm of lead to maintain the spurious count rate below 1 count/s. Without a lead shield, the spurious count rate has been observed on HERA to reach 100 counts/s.
The detector recovers 100 ns after a hit, leading to 10 MHz maximum count rate.

Radiation resistance

Prototypes similar to production units were tested at DESY for radiation hardness. The unit under test was still working after 108 Rads dose (!). See Annex III: "Radiation Resistance of Beam Loss Monitor" by K. Wehrheim and K. Wittenburg.

CALIBRATION

BLM circuits are calibrated ex-factory for a spurious count rate of 10 kHz ±800 Hz.
Discriminator readjustment on P1 and P2 is needed when the PIN-diodes are changed for another type (larger, smaller). Background count can be performed on line.

On-the-bench verification / discriminator readjustment

To adjust the spurious count rate, power up the BLM. Connect a frequency counter on the output.

To readjust channel A, apply +5V via a 4.7kΩ resistor to "Enable/Disable B". Adjust potentiometer P1 till 9.6~10.4 kHz output.

To calibrate channel B, apply +5V via a 4.7kΩ resistor to "Enable/Disable A". Adjust potentiometer P2 till 9.6~10.4 kHz output.

On-line check

Apply ≥ +1V alternately to Enable/Disable A and Enable/Disable B. Observe the count rate to be in range 9.6~10.4 kHz.

Enable/Disable A resp. Enable/Disable B draws 120 µA from +1 V.

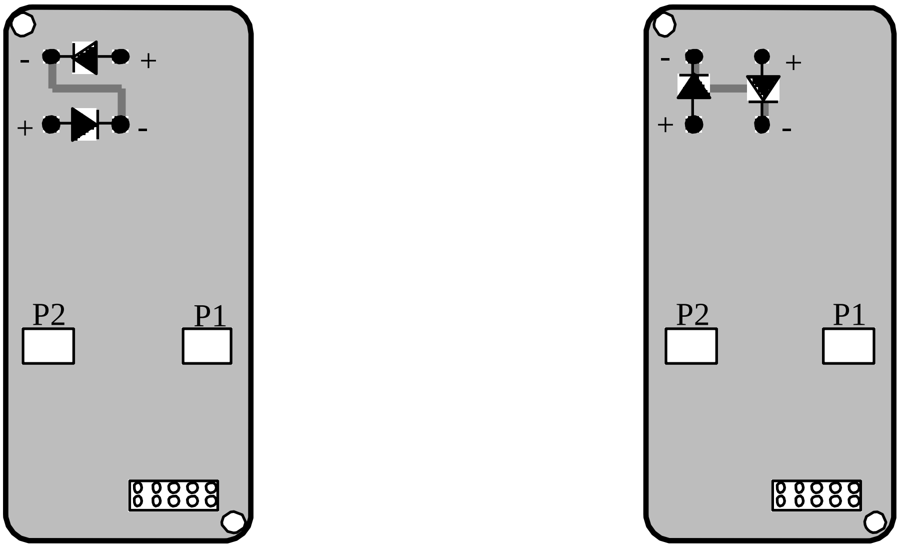
CHANGING THE PIN-PHOTODIODES

PIN-photodiodes can be changed by the user for a larger-area model. Two similar diodes per BLM are required.

Instructions

- Make sure the BLM works properly before modification: See QUICK CHECK, in this manual.
- Remove the printed circuit from its enclosure:
- Pull gently on the copper shield, the PCB is glued to the bucket.
- Desolder the copper shield and remove it.
- Desolder the PIN-diodes and remove them.
- Install the new PIN-diodes. They should be facing each other. Their active areas should overlap each other.!

Beware of the PIN diodes polarity. There are two possible configurations with the correct polarity:



Note the common cathodes

WARNING: Installing PIN-diodes with the wrong polarity voids the warranty.

- Execute a QUICK CHECK before the copper shield is re-soldered.
- Re-solder the copper shield. Make sure the copper shield does not touch the PIN-diodes leads! If needed, use polyvinyl adhesive tape to isolate the inside of the shield.
- Re-adjust the BLM discriminator levels P1 and P3. See CALIBRATION in this manual.
- Please note: large area PIN-photodiodes have more dark current, so the span of P1 and P2 covers a wider range and their adjustment on 10±0.4 kHz dark current is more “touchy”.

COMPTON ELECTRONS SHIELD

Production of Compton electrons in the BLM PIN-photodiodes has been observed on very-high energy leptons accelerators (HERA-e, LEP).

The consequence of Compton electrons production in one PIN-photodiode is that it may cause ionization in the other PIN-diode. As a result, the PIN-photodiodes produce pulses which are coincident and the BLM gives an output pulse. On very high energy leptons accelerators, these Compton electrons increase the background noise significantly[1].

The increase in background noise reduces the BLM useful dynamic range. A way to avoid this problem was sought. It was proposed[2] to install a shield between the two PIN-photodiodes.

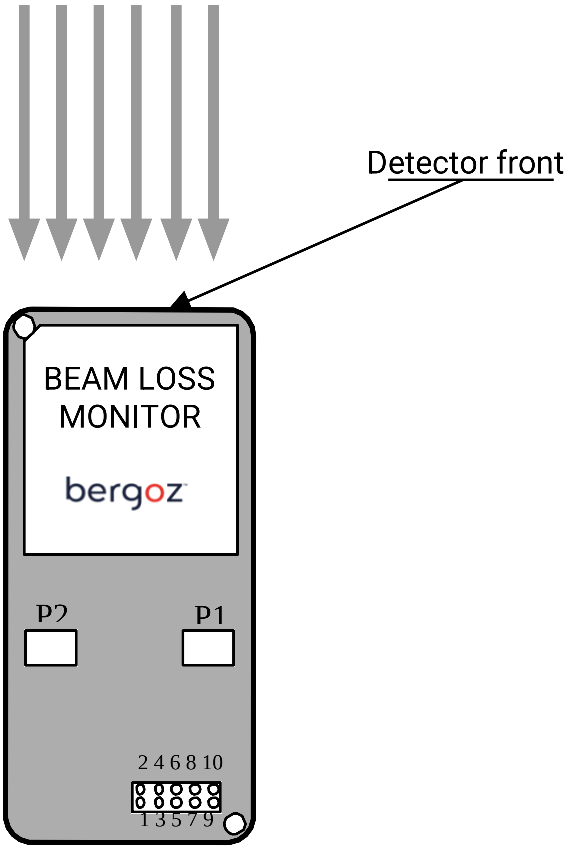
This proposed improvement was successfully tested at both LEP and HERA:
It reduces the Compton electron-induced noise significantly. The shield is made out of 200 µm thick copper foil. It is grounded via a high value resistor to prevent static charge build-up.

[1] Improvement in the useful dynamic range of the LEP Beam Loss Monitor, T.Spickermann, CERN, and K.Wittenburg, DESY, to be published
[2] Private communication, K.Wittenburg.

INSTALLATION

Mechanical mounting

The BLM must be oriented facing the particles to be detected:

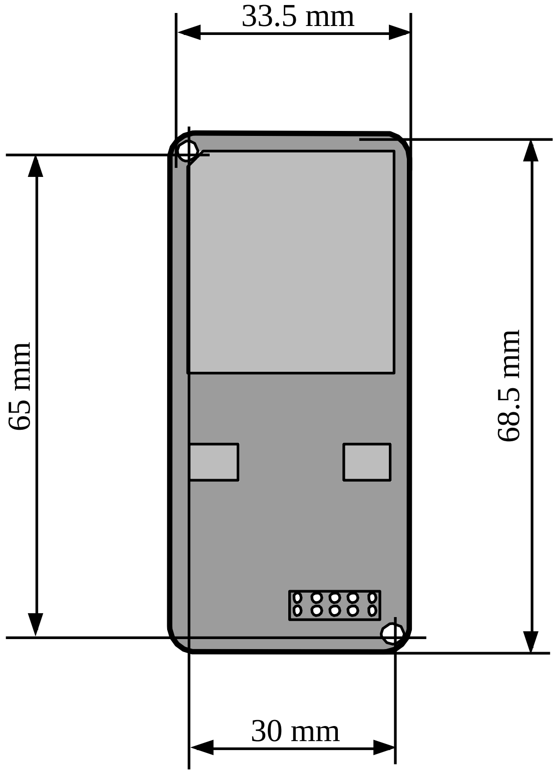


Mathematical simulation would indicate where beam loss is most likely to occur. BLMs will generally be placed with the front applied against the magnets.

BLM-SE can be screwed on brackets with two M3 screws. M3 screws will gently make their way into the Ø2.8mm holes of the ABS plastic.

Yet, it is preferable to attach the BLM with Velcro tape.

Mounting holes



BLM CONNECTIONS

BLM-SE connects with a female HE10 connector e.g., 3M, type 3473-6000.
Output with a 50-ohm coaxial cable connects to pin 10, ground on Pin 8.
At DESY, RG-59 75-ohm coax cables are used for distances up to 100 meters without problems (K. Wittenburg, private communication, Febr. 9, 1995). For cables longer than 100 meters, a small amplifier is added in front of the scaler.

F/UTP aka FTP, S/UTP and SF/UTP are suitable. UTP must be avoided.
STP is a generic name to describe S/UPT or SF-UTP. It is suitable.

For long runs of cable, an overall shield and individual shielding of each pair is preferable for RFI rejection: S/FTP or F/FTP are recommended for long runs or high-noise areas.
For acronyms, see:
http://www.belden.com/blog/datacenters/STP-UTP-FTP-Cable-More-7-Types-When-to-Use-Them.cfm

OUTPUT SIGNAL PROCESS

Controls would use scalers with single-ended input or 100-ohm differential input.
Laboratory tests can be made using a frequency counter.

SPECIFICATIONS

MIP detection efficiency	> 30%
PIN-photodiode surface	7,34 mm2
Spurious count rate	< 0.1 Hz
	Up to 100Hz under 6e3 Grey/yr SR background
	< 1Hz under 6e3 Grey/yr SR background with 3cm lead shield
Maximum count rate	10 MHz
Enable/Disable A control	≥+1V, 120 µA
Enable/Disable B control	≥+1V, 120 µA
Power supplies	
+5V	< 50mA, typ. 45mA
-5V	< 80mA, typ. 72mA
+24…25V	< 10mA, typ. 4 mA with BPW34B PIN-diodes
Output	positive TTL 50 ohms
Cable driving capability	> 200m RG213
Connector	10-pin HE10 male
Mating connector	10-pin HE10 female
Size	69 x 34 x 18 mm

More information and latest manuals revisions can be found on our website

www.bergoz.com

If you have any questions, feel free to contact us by e-mail

info@bergoz.com

Bergoz Instrumentation – 156, rue du Mont Rond – Espace Allondon Ouest – 01630 SAINT GENIS POUILLY – France
Tél. : +33 (0) 459 42 66 42 Fax : +33 (0) 450 42 66 43 – bergoz@bergoz.com

www.bergoz.com
S.A.S. capital 152K€ - APE 2651B – TVA-VAT-IVA-USt. N° FR88414997130 – Siren 414 997 130 R.C.S. Bourg-en-Bresse