Ionization Chamber
Refillable
Radiation hard

R2D-BLM500

Ar-Gas filled Beam Loss Monitor

Highlights

- **Operates in air and high vacuum**
- **Radiation hard by design**
- **Stainless steel vessel, 500 cm^3, active volume**
- **Ar-gas filling at 1.0 bar pressure**
- **Sensitivity: 91 pA/(Rad/hr)**
- **Outer to inner electrode diameter ratio: 4:1**

Features

- This radiation sensor is a custom-built prototype detector for operation as a beam loss monitor in high radiation fields.
- It is an argon-filled ionization chamber. It's current is proportional to the dose rate.
- The device can be re-filled on site.
- All materials used are know to be radiation hard.

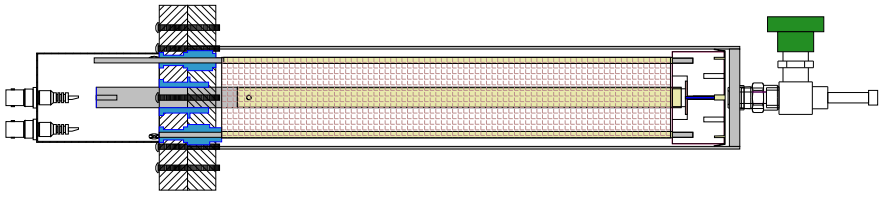


Figure 1: Outline of the R2D-BLM500. The main vessel contains a mesh electrode, which should be powered with negative HV and the center electrode, which serves as the signal electrode. The valve on the right is used to fill and refill the BLM, and its outlet on the right is sealed with a Swagelock stainless steel plug.

The active volume is the space between the center electrode and the mesh electrode.

Specifications

Parameter	*Symbol*	*Min*	*Typ.*	*Max*	*Comment*
Mechanical					
Center electrode diam.	ID		12.4 mm		
Mesh electrode diam.	OD		50.0 mm		
Diameter ratio	OD/ID		4.02		
Electrode length	L		283.5 mm		
Gas volume, total	Vtot		767 cm^3		
Gas volume, active	Vact		522 cm^3		
Fill pressure,	p		1.0 bar		absolute
Fill pressure, max allowed	p_max			2.0 bar	absolute
Max outer diameter			114 mm		without shroud
Overall length			541 mm		without shroud
Detector Operation					
HV			-1000 V	-1500 V	
Sensitivity			91.3 pA / (Rad/hr)		
Leakage current	I_leak			10 pA	at room-temperature

Radiation hardness: The chamber and all seals are made of metal and are radiation hard. Internal insulation uses Kapton. Note that the R2D-BLM500-001 is a prototype and uses one component made of polypropylene, which limits it radiation hardness.

Pressure: The chamber is designed for operation in air at standard pressure and in vacuum.

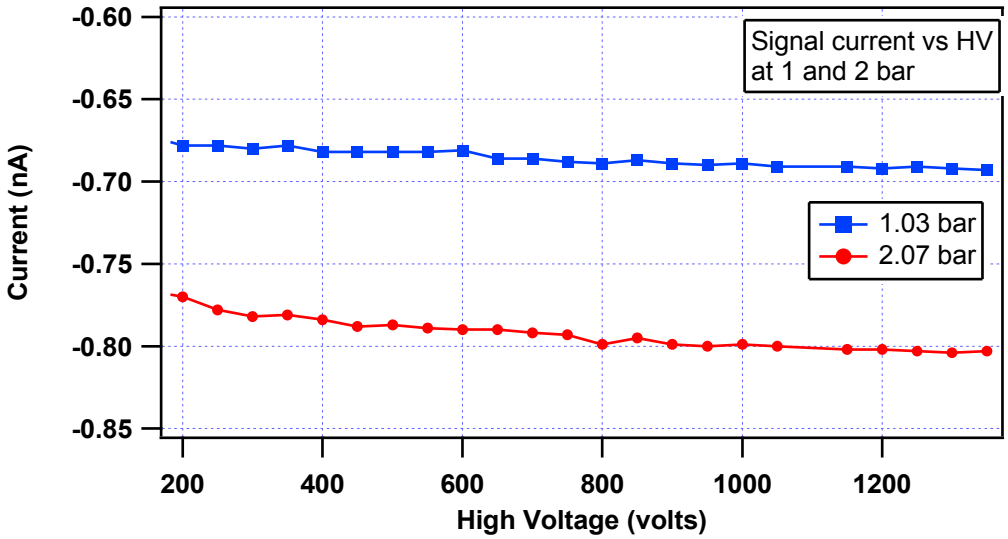


Figure 2: Response of the dose rate monitor to a chamber loaded with a set of Am-241 sources. The sources were mounted such that the majority of the alpha particles could not hit the mesh electrode.

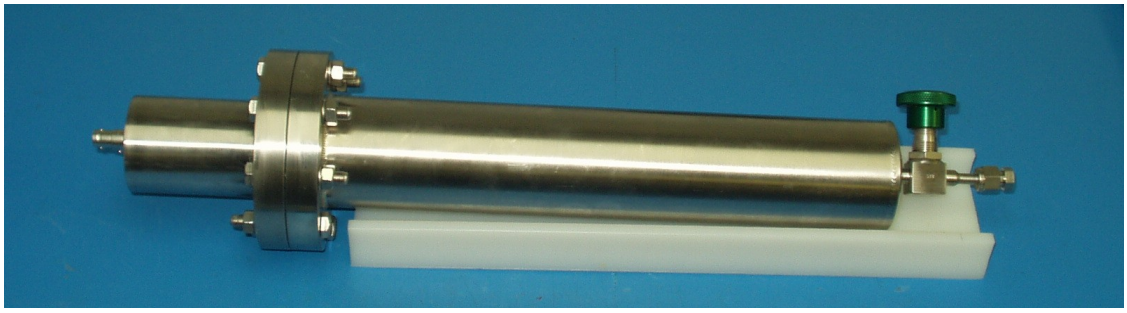


Figure 3: Photograph of the R2D-BLM500

Detector components

This R2D-BLM500 dose rate monitor uses an ionization chamber filled with Ar-gas. The active volume is confined between a center electrode and a mesh electrode, which is biased at negative HV. Guard rings ensure that the leakage current measured on the center electrode remains below 10 pA.

An attached valve is used to fill the detector volume. It's outlet is sealed, but the sealing plug can be removed to refill the detector when necessary.

Operation

The response of the detector to a deposited dose rate can be computed as follows:

$$I = \dot{D} \cdot \rho \cdot V \cdot \frac{1}{W} \cdot e$$

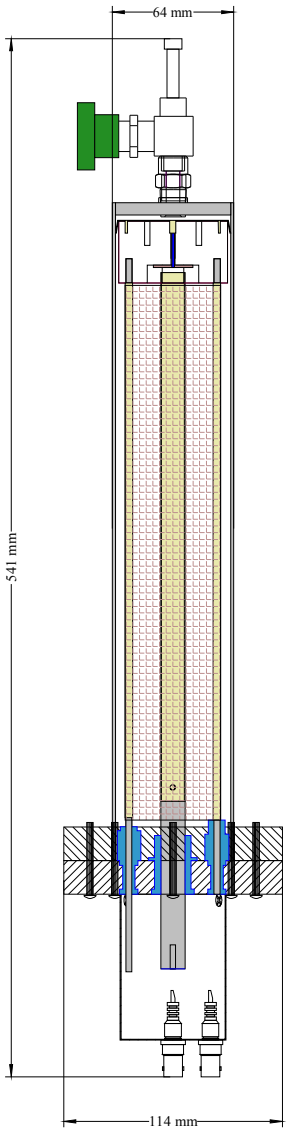
Symbol	*Meaning*	*Unit*
I	Detector current	A
$\dot{D}$	Deposited dose rate	Gy/s
ρ	Gas density	kg/m^3
V	Active gas volume	m^3
W	Average energy to ionize Ar	J
e	Electron charge	C

Symbol	*S.I. Units*	*Convenient Units*
I	91.3 E-12 A	91.3 pA
$\dot{D}$	2.78 E-6 Gy/s	1 Rad/hr
ρ	1.66 kg/m^3	1.66 g/l
V	522 E-6 m^3	0.522 l
W	4.22 E-18 J	26.4 eV
e	1.602 E-19 C	

Table 1: Computation of the detector response for a nominal dose rate of 1 Rad/hr.

The unit receives HV via a radiation-hard SHV connector. The signal current can be measured at the radiation-hard BNC connector.

Revision history:
R1 Nov 2008 Initial document



Drawing 1: Dimensions of the ionization detector.