

SETUP OF THE ABSORBER AT BEAMLINE P08

Summerstudent Program 2009, DESY

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Abstract

Absorption is the process whereby the intensity of a beam of electromagnetic radiation is attenuated in passing through a material medium. The energy of the radiation is converted to an equivalent amount of energy appearing within the medium. The capacity of a medium to absorb radiation depends on a number of factors, mainly the electronic and nuclear constitution of the atoms and molecules of the medium, the thickness of the absorbing layer, the wavelength of the radiation, and the variables which determine the state of the medium, of which the most important are the temperature and the concentration of the absorbing agent.

This report comprises theoretical introduction to the absorption, the explanation of the principle of operation of the absorber and the description of the task in which I was taking part in DESY.

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1. INTRODUCTION

Absorption is a physical phenomenon associated with the passage of the electromagnetic radiation through matter. It is the way by which the energy of a photon is taken up by matter and transformed to other forms of energy. Usually photoelectrons are produced as a result of atomic excitations. Since photoelectron can be transmitted in any direction, the transition probability becomes lower as the thickness becomes bigger. The measured intensity I of transmitted through a layer of material with thickness x is related to the incident intensity I_0 according to the inverse exponential power law:

$$I = I_0 e^{-\mu x}$$

where x denotes the path length. The absorption coefficient is μ .

From this equation one can calculate the thickness of material required to reduce the intensity of the transmitted radiation to half its incident magnitude. It is a very important issue refers to protection from potentially harmful radiation.

2. PRINCIPLE OF OPERATION OF ABSORBER

Absorber is a device which diminish X-ray beam by different quantities of the energy. Its application is to protect detector from too high beam intensity. It consists of several absorbing plates of different thicknesses, made of different materials, which can be moved by pressure system, aided by sequence of magnets. Every plate has four magnets mounted in its cover and the same amount of magnets occurs in each valve. Plates with moving system are kept under vacuum.

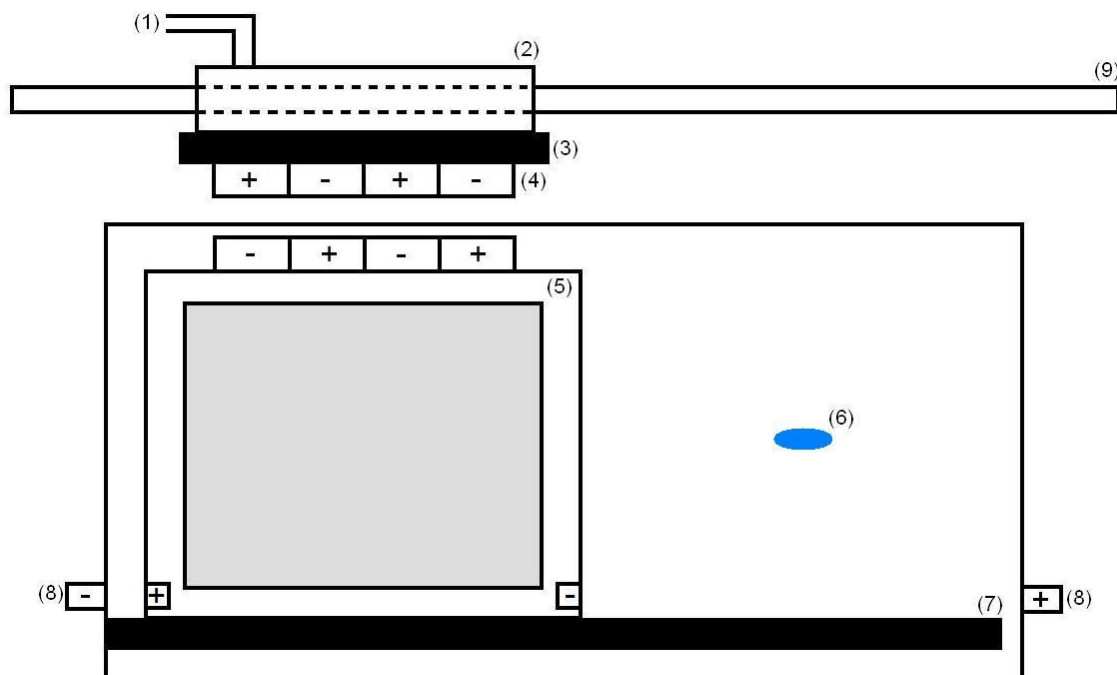


Fig. 1. Cutaway view of absorber: (1) air access, (2) valve, (3) piece of metal, (4) magnets, (5) absorbing plate, (6) X-ray beam, (7) internal slide, (8) Reed Relays, (9), external slide.

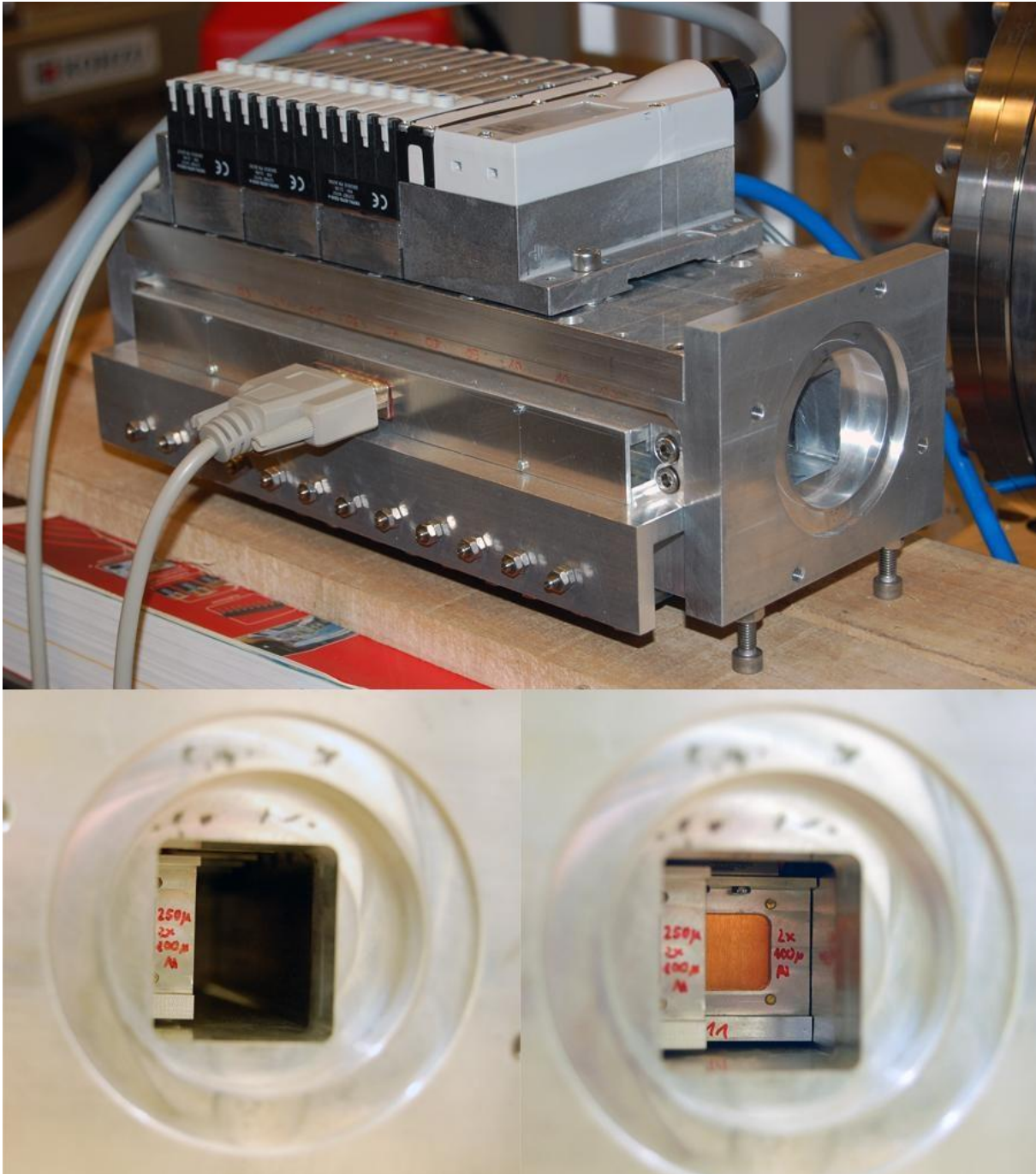


Fig. 2. Picture of the absorber and absorbing plates in two different positions. This absorber consists of twelve absorbing plates.

The valve is used to move the absorbing plate along the internal slide. It is controlled by two logical value of input signal – one refers to 24 V and zero refers to 0 V.

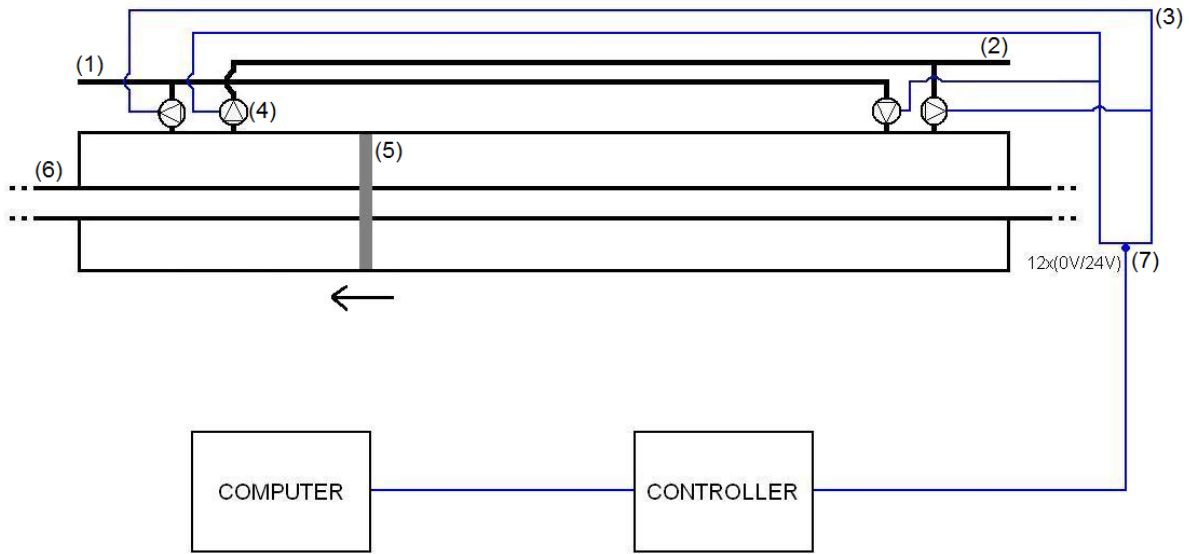


Fig. 3. Schematic diagram of the left-moved valve: (1) air access moving piston-like plate to the right, (2) air access moving piston-like plate to the left, (3) cables, (4) switch, (5) piston-like plate, (6) external slide, (7) input signal.

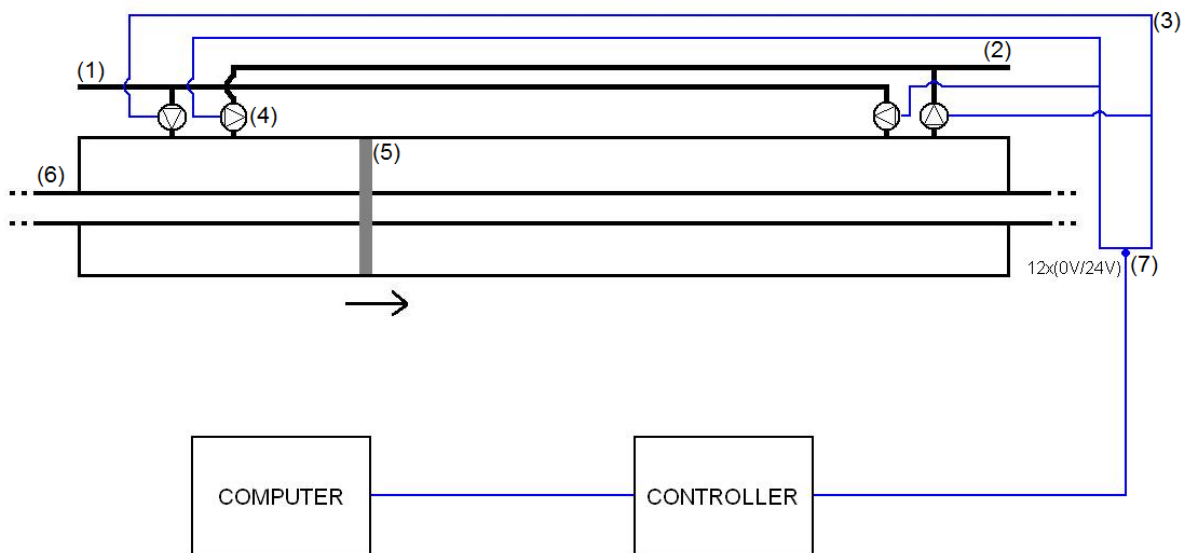


Fig. 4. Schematic diagram of the right-moved valve: (1) air access moving piston-like plate to the right, (2) air access moving piston-like plate to the left, (3) cables, (4) switch, (5) piston, (6) external slide, (7) input signal.

When 0V is applied, switches stay in previous positions and the piston is not moving. When the voltage is switched on 24 V, switches change their positions and incident air causes piston's movement in opposite direction, resulting in magnets' and absorbing plates' motion in the same way. Every voltage change is controlled by computer.

Since absorption, among other things, depends on the material which absorbing plate is made of and thickness of the absorbing plate, different types of plates are occurred.

Number	Thickness Al (μm)	Thickness Ti (μm)	Thickness Cu (μm)	Components
0	25			Al_25
1	50			Al_50
2	100			Al_100
3	200			Al_100 + Al_100
4	400			Al_250 + Al_100 + Al_50
5	800			Al_500 + Al_250 + Al_50
6	1600	234.1		Ti_125 + Ti_50 + Ti_50 + 9.1μm_Ti = Ti_125 + Ti_50 + Ti_50 + 62.2μm_Al = Ti_125 + Ti_50 + Ti_50 + Al_50 + Al_10
7	3200	468.2		Ti_125 + Ti_125 + Ti_125 + Ti_50 + 43.2μm_Ti = Ti_125 + Ti_50 + Ti_50 + 295μm_Al = Ti_125 + Ti_125 + Ti_125 + Ti_50 + Al_250 + Al_50
8	6400	936.4		7 x Ti_125 + 47.4_μm_Ti = 7 x Ti_125 + 324μm_Al = Ti_125 + Ti_125 + Ti_125 + Ti_125 + Ti_125 + Ti_125 + Ti_125 + Al_250 + Al_50 + Al_25
9	12800	1873	403.4	4 x Cu_100 + 3.4μm_Cu = 4 x Cu_100 + 108μm_Al = Cu_100 + Cu_100 + Cu_100 + Cu_100 + Al_100
10	25600	3746	806.8	2 x Cu_250 + 3 x Cu_100 + 6.8μm_Cu = 2 x Cu_250 + 3 x Cu_100 + 216μm_Al = Cu_250 + Cu_250 + Cu_100 + Cu_100 + Cu_100 + Al_100 + Al_100
11	51200	7491	1614	Cu_1000 + 2 x Cu_250 + Cu_100 + 14μm_Cu = Cu_1000 + 2 x Cu_250 + Cu_100 + 444μm_Al = Cu_1000 + Cu_250 + Cu_250 + Cu_100 + Al_250 + Al_100 + Al_100

Table 1. Thicknesses of the absorbing plates for different materials applied in absorber.

Thickness of absorbing plate should not be bigger than 1mm. That is why plate number 6 made of aluminium is replaced by thinner plate made of titanium, which can absorb much more radiation instead of aluminium plate of the same thickness. However, it is technical impossible to obtain 234.1 μm thickness. In that case combinations of different thicknesses and different materials are needed, as one can see in last column of the table 1.

3. TASK AND RESULTS

During this Summer Student Program I was taking part in preparation of absorber which was supposed to work with electronic devices, such as controller. My task was to arrange and build setup for two controllers what include production of aluminium plates for plug-ins, to fix them to steel slides on which controllers are placed and to connect pins with proper controllers' connectors. The results of my work are shown on the picture below.

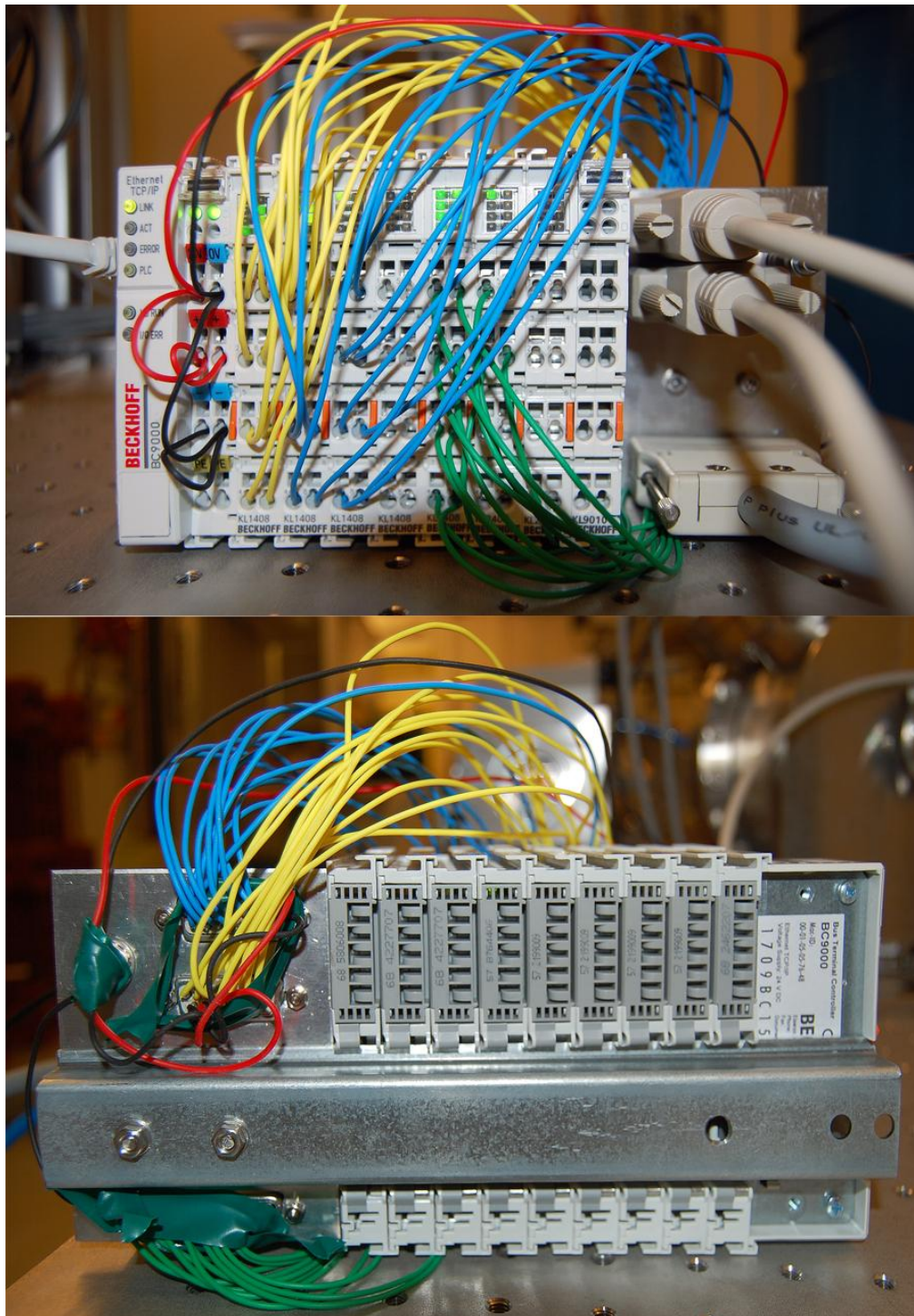


Fig. 5. Controller, front and back view.

4. CONCLUSIONS

Summer Student Program gave me an opportunity to extend my knowledge about synchrotron radiation and to familiarize myself with scientific issues which occur with every research facility. I have learnt how to solve problems and how to manage my work by myself. I succeed in preparing controller, which now is being mounted in Beamline P08 in PETRA III.

5. ACKNOWLEDGEMENTS

I would like to thank my supervisor Mr. Oliver Seeck for patience and taking care of me. I would also like to express my appreciation for all people involved with organization this project. It was a pleasure being here.