BEAM ABSORBER FOR TUNING ACCELERATOR IN THE BEAM LAYOUT OF THE EXPERIMENTAL COMPLEX

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Abstract

The absorber of a beam without moving parts in vacuum volume for tuning the high current linear accelerator is described.

INTRODUCTION

Since 2006 both the Linear accelerator and the Experimental complex at the INR have started operating with the proton beam of the current up to 100 μA [1]. The beam absorber for tuning of the accelerator, located at the beginning of the Experimental complex, was put through an upgrade. The old absorber contained by construction several moving absorbing elements in the vacuum (the copper cylinders the diameter of 20cm and the length 20cm), which required direct maintenance by people. A new beam absorber, without moving absorbing elements in vacuum, has been designed, mounted and set up in the beam tunnel.

BEAM ABSORBER

At the moment tuning of the parameters of the acceleration beam before its transport to the physical facilities in the Experimental complex is accomplished in the new beam absorption region (Fig.1). This region consists of a deflecting magnet and an absorbing part of vacuum cell, surrounded by biological shielding. The shielding decreases the level of radiation fields around the tunnel of the accelerator and surrounding rooms.

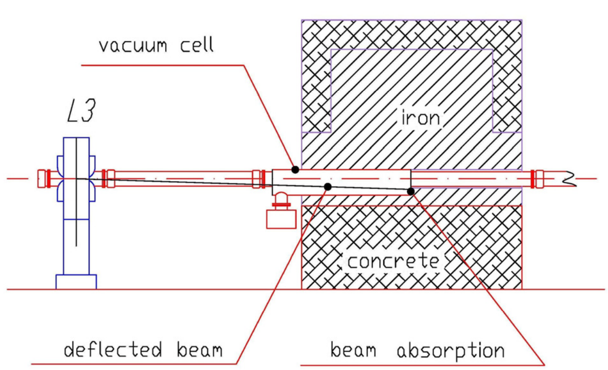

Figure 1: The beam absorber.

Beam of protons is deflected vertically downwards from the axis of the beam "red arrow" for the purpose of beam absorption during the tuning of the accelerator in the vacuum cell (as shown on Fig. 2).

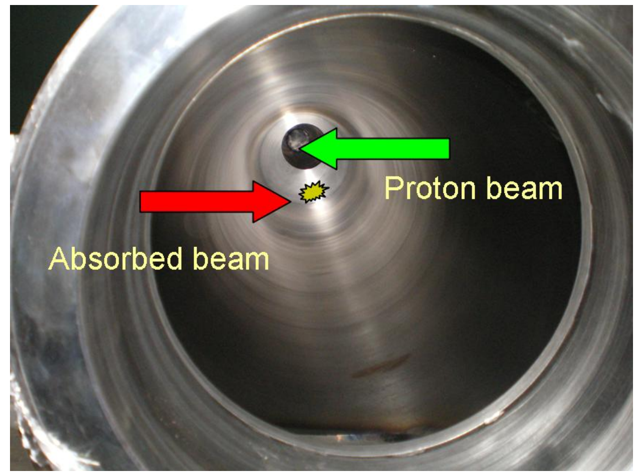

Figure 2: Inside view of the vacuum cell.

For the purposes of deflecting the beam some structural changes were made to the quadrupole lens L3 of the dipole magnet (in particular switching of lens's coils has been carried out). During the tuning of the accelerator lens L3 is used as a dipole magnet. The beam is absorbed inside a special vacuum cell, surrounded by shielding. Shielding consists of the blocks of iron and of concrete with the following dimensions: length of 4m x height 3m x width 2.5m. This ensures sufficient protection from the activation of the equipment and the air in the tunnel.

Design features of the magnetic core of this type of lens allow effective vertical deflection of the proton beam. The angle of deflection from the beam axis is 2 degrees.

Thermal calculations of absorption of the beam in the wall of the vacuum cell are implemented by JSC "N.A. Dollezal Research and Development Institute of Power Engineering" [2]. Maximum temperature of the region absorption of the beam in the vacuum cell after 16 hours of continuous work was 120C, while the maximum temperature of the near iron blocks – no more than 30C. Analysis of results of the calculations allows us to come to the conclusion of possibility of using the beam absorber without a water-cooling system.

The main factors of radiation hazard to people when the beam absorber is active are the beams of secondary photons and neutrons. These arise during interaction between proton beam and equipment of the beam absorber and channel of transportation of the beam in the Experimental complex.

Radiation safety while the beam absorber is in operation is provided by biological shielding, system of blocking doors of the Experimental complex, system of blocking of the beam of the Linear acceleration from the signal of readiness of the absorber of the proton beam of the Experimental complex and automated monitoring subsystem for dose fields in the area of the beam absorption.

In November 2009 the experimental data of neutron and photon (charged) components of radiation in the absorber have been acquired. Measurements were carried out on the proton beam with energy E_p=*160MeV*, frequency *1 Hz*, duration of an impulse of *30μs* and a current in an impulse of *9 mA*. Measurements of dozes of photon and neutron components of radiation field were collected by means of a passive dosimeter of an effective dose on the basis of a spherical polyethylene moderator with a diameter 10'' with individual dosimeters placed on its surface and a slide in the centre of a sphere [3].

CONCLUSIONS

Analysis and comparison of the received data with experimental data from the old absorber shows that the new one works more effectively as an absorber in the mode of beam absorption. Low levels of radiation are observed on the pathway of the beam after the beam absorber. During tuning of the accelerator with the beam absorber there is low activation of the equipment located in these areas and the absence of exceeding maximum permissible dose around the tunnel of the accelerator and surrounding rooms.

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