ANL/ASD/CP-85048
CONF-950512--230

POSITRON FOCUSING IN THE ADVANCED PHOTON SOURCE (APS) LINEAR ACCELERATOR*

Y. L. Qian and M. White, Argonne National Laboratory, Argonne, IL, 60439 USA

Abstract

Positrons are created by a bremsstrahlung shower process, and are therefore produced with broad divergence and a large energy spread. The e^+/e^- conversion ratio is on the order of 1/200, so the positron focusing system is critical to ensure good positron capture and transport efficiency. The positron focusing system is described, and functions of the different magnetic elements are discussed. Some improvements to the focusing system are suggested, although the linac's design positron intensity of 8 mA has already been achieved [1].

I. INTRODUCTION

Positrons are used in the APS storage ring in order to avoid ion trapping. Electrons are accelerated to 200 MeV in the electron linac, and focused to a 3-mm to 5-mm-diameter spot on a 2-radiation-length-thick tungsten target. The energy spectrum of positrons emerging from the target is shown in Figure 1. The pair-produced positrons (and electrons) are then accelerated to 450 MeV by the remainder of the linac. Positrons are produced with divergent angles, a broad energy spectrum, and with a much larger emittance than that of the initial electron beam; thus the positron linac focusing system is different from the electron linac focusing system. A short pulsed solenoid serves as first part of the focusing system for the low energy positron beam, followed by 6 m of DC solenoids. Quadrupole magnets focus the positrons as they gain energy and contain them through the remainder of the linac.

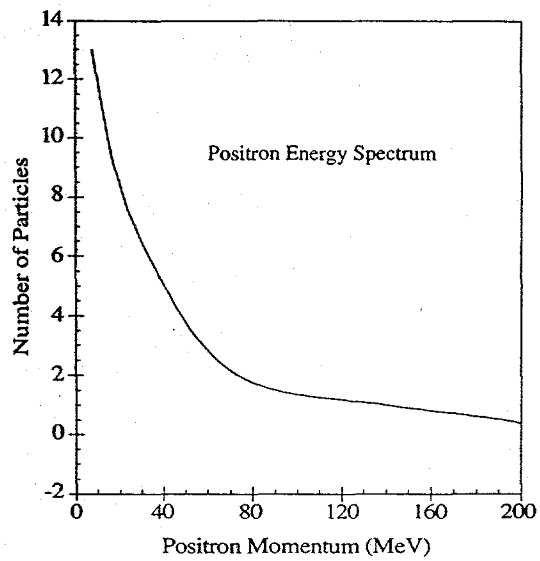

Figure 1: Momentum spectrum of positrons from the target.

II. SOLENOID FOCUSING

A 5-cm-long pulsed solenoidal coil is the first focusing element in the positron linac. The coil has an inner diameter of 25 mm and operates at its design peak current of 5000 A. It is fabricated from a single piece of water-cooled copper tubing that is wound around the inside and the outside of a cylindrical piece of ceramic. There are a total of 16 turns. The tube rests in grooves machined into the inside and outside of the ceramic. The ceramic support is located between the two coil layers to provide mechanical stability. A prototype made with machinable ceramic was used in the first tests, but the ceramic did not withstand the high radiation fields and was replaced with 99.5% pure ceramic [2]. The layout of the pulsed coil and target is shown in Figure 2.

The pulsed solenoid coil serves as a quarter-wave transformer (QWT) for the beam's phase space. It rotates the initial transverse phase space from a small radius and a large slope to a phase space with a larger radius and a smaller slope.

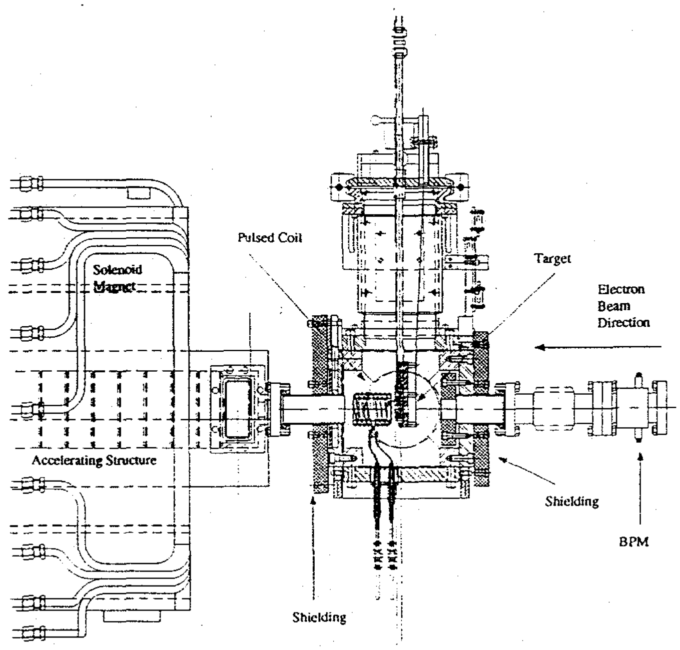

Figure 2: Layout of the pulsed coil and positron target.

The DC solenoidal field is generated by two 2.5-m-long solenoid magnets with a 0.2-m-long solenoid coil between them for matching. The long solenoids have 784 turns in four

* Work supported by the U. S. Department of Energy, Office of Basic Sciences under the Contract W-31-109-ENG-38.