COLUMBUS - A SIMPLE ION SOURCE

M. Frank, Ch. Wolf, E. Held, Gymnasium Ernestinum, Coburg, Germany

Abstract

A simple ion source had to be designed for a cyclotron for school- and teaching purposes. It is adjustable to find the ideal position of the ion source.

The hydrogen gas is stored in a hydro-stick and controlled by a mass-flow-controller.

INTRODUCTION

The protons for our cyclotron are produced in the ion source which was built after the pattern of Tim Koeth [1], which he used first in his cyclotron.

This paper is about the conception of a simple ion source, COLUMBUS, for a school project [2].

A specific design of the ion source was required due to the cyclotron's small size and the low number of revolutions, cf. Figure 1. It was designed for adjusting the position of the ion source itself and the proton's angel of emission.

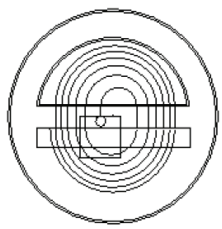

Figure 1: Revolutions of the protons.

FUNCTION & DESIGN

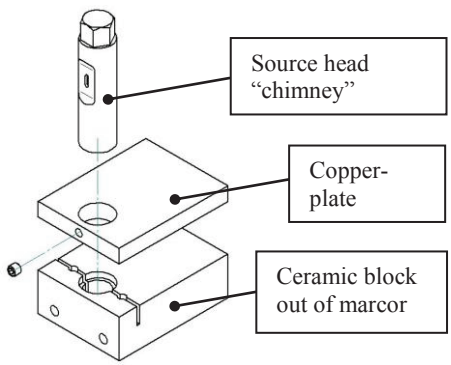

Figure 2: The basic setup of our ion source.

An ion source supplies the cyclotron with charged particles – in our case with protons accelerated by an electric field.

The protons are produced by collision ionization. Electrons emitted from a glowing tungsten filament showered by hydrogen gas are accelerated by a DC voltage of 100...200V. They are forced on a helical orbit by the uniform magnetic field. On their path they ionize the hydrogen gas.

The housing block of the ion source consists of a ceramic block out of macor and contains a filament of tungsten in an ionization-room. The macor block is covered by a copper plate, which holds the source-head – the so-called "chimney" – and is used as an acceleration-electrode for the electrons emitted from the glowing filament, cf. Figure 2.

Gas Feed

The ionized hydrogen-atoms, i.e. the protons rise into the chimney and exit through a tiny slit into the gap between the dee and the dummy-dee.

The hydrogen gas is stored in a hydro-stick, a small tank containing 10 litre of hydrogen gas at a pressure of 10 bar. After reducing the pressure to 0.3 bar the hydrogen gas is introduced into the housing-block by a mass-flow-controller (MFC) which allows a precise dosage of the hydrogen gas. The MFC will control the total pressure to approximately 10^{-4} mbar.

Positioning

For the setup of the ion source, it is considered that the ion source remains adjustable in direction of the gap, so that the ideal position can be found by experiments.

Normally the ion source is centred in the cyclotron. However, in our case – with our small cyclotron and such a small amount of revolutions ($\leq$ 10) - it is better to optimize the starting position of the first path. Due to this fact the ion source will not be fixed mounted but it will be stuck under the dummy-dee instead, cf. Figure 3.

Because of the low energy of the protons emitted from the ion source the angle of emission shall be adjustable for a better acceleration and to prevent that the protons remain in the gap between the dees.

This possibility is given by a rotatable source-head. The ideal angle of emission will be found by experiments.

ISBN 978-3-95450-128-1

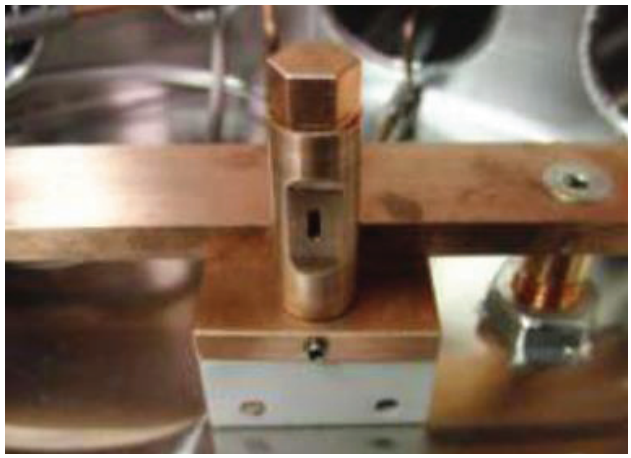

Figure 3: The Ion Source stuck under the dummy-dee.

REFERENCES

[1] Tim Koeth, "The Rutgers 12-Inch Cyclotron Ion Source Studies Part I" http:// www.rutgers.edu/cyclotron, 2006

[2] Christian Wolf, “COLUMBUS – A small cyclotron for school and teaching purposes”, 2013

ISBN 978-3-95450-128-1