FIRST EXPERIENCE OF WORKS WITH COMPACT INJECTORS FOR TRIALS AND DRILLS OF RF LINAC STRUCTURES

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Abstract

The problem of gas loading on vacuum conditions in RF linac structures from traditional ion injectors based on duoplasmatron type source is well known. At the stage of starting high power linac trials and drills it often requires significant increase of pumping capacity to maintain the working vacuum level in resonators. The problem is mostly vital at development of multiple aperture linac structures. To simplify the problem new compact test injectors based on spark ion sources are discussed.

1 INTRODUCTION

Recently there has been a great deal of interest in studying of possible methods of remote non-destructive object composition testing by means of nuclear detection of targets irradiated by accelerated beams of light ions.

The approach known as pulsed fast neutron analysis (PFNA) is based on measuring of gamma ray spectra from remote target after its irradiation with extremely short neutron pulses produced by RF linac [1]. The obtained time and energy gamma spectra are used for material interrogation. The information is stored by means of time-of-flight analysis between the accelerator pulse and the arrival of γ-rays to *NaI* detectors located far enough from an examining object [2]. On the other hand, pretty low angular divergence of accelerated beam is required to transport it to remote target with minimal losses. The method of simultaneous acceleration of many short pulse ion beams in the same RF accelerator structure is expected to be the most promising for this purpose. Two approaches of multiple beam injection are under consideration. The first approach is based on the ion injector with multiple individual channels. The other way is based on generation of wide common ion beam with low angular divergence within ion source placed in the nearest close to multiple aperture RF structure with beam multiple channel collimating before the structure.

A compact injector of deuterium ions based on spark ion source is one of possible decision for the second approach. On the other hand, such kind of injectors may be used as test equipment for any RF structures trials and drills due to its feature to avoid the problem of gas loading on accelerator cavity.

2 MULTIPLE BEAM SYSTEMS

2.1 General comparison of single and multiple channel accelerator systems

It is well known requirements of simultaneous high intensity and small divergence of charged beams are in contradiction because of space charge loading, and only multiple beam accelerator systems are principally able to resolve the problem [3]. Let us compare properties of single and multiple channel systems with strong focusing.

If every the channel with aperture radius of *a* which is among multiple $(M\cdot N)$ beam system is able to accelerate maximum beam current of i_{Mm} then total current of the system is

$$I_M=(M\cdot N)\, i_{Mm},$$

And for traditional single channel linac with aperture radius of *R* and the same channel characteristics, maximum beam current is I_1 and it is easy to see that

$$I_M / I_1 = (a/R)^2 (M\cdot N). \qquad (1)$$

At analogous comparison of angular divergence α at the output of single and multiple beam linac systems their relationship may be estimate as

$$\alpha_1 / \alpha_M = R / a.$$

So taking into account (1) we have

$$\alpha_M = \alpha_1 \, [I_M / (M\cdot N \cdot I_1)]^{0,5}.$$

It is easy to see that at the same value of total current beam angular divergence at the output of multiple channel system is by factor of $(M\cdot N)^{0,5}$ times less than it is in a single channel system. It means that at given value of beam current its output angular divergence may be decreased by increasing of number of channels.

2.2 Multiple aperture RF accelerator system with space lattice focusing

Design features of multiple channel accelerator systems with alternating phase focusing (APF) as well as with some multiple channel RFQ modification [4] considered below are promised to be adequate decision for simultaneous acceleration of some hundred beams.