MODELING CODES FOR RFQ DESIGN

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Abstract

It is known, that the designing of high-frequency accelerators requires large volume of calculations the most part of which is conducted on a computer. At a stage of numerical designing of accelerating device the large number of codes is used a part from which can decide a problem as a whole and another part of ones either complement each other or serve for refining of the early computed results. The most part of the codes have been written in language FORTRAN and was oriented to run in operating systems similar DOS or UNIX. Today there are operating systems, for example such as WINDOWS, which are enough reliable and have a number of advantages attracting by new opportunities to develop the tools facilitating the computer designing of the devices. This paper reports on the progress of the development of the tool for a RFQ design. The results of numerical simulations of 433 MHz RFQ for D^{+} are presented.

INTRODUCTION

The numerical designing of the RFQ linac usually includes the following sequence of steps:
- estimated calculations (in result of which choice of initial design data is carried out);
- tentative estimations of beam dynamics on the basis of scale models (including analytical calculation of geometry of accelerating cells);
- calculation of beam dynamics by the particle-particle/particle-in-cell 3D methods;
- refinement of geometry of the accelerating cells by 3D electrostatic methods;
- calculation of beam dynamics with allowance for refined geometry of the accelerating cells;
- calculation of geometry of resonator volume.
Often there is the necessity in recurrence to separate phases of development as inside one step and in a kind of a sequence of several steps. In order to practically carry out the considered sequence of the steps using of variety codes is need. The large part of these codes have been written in language FORTRAN and was oriented to run in operating systems similar DOS or UNIX. At the same time the appearance in computer engineering of operating systems similar WINDOWS

makes attractive development of the tool which integrates all set of applications used for the decision of the design problem as a whole, putting at disposal the more convenient forms of work both with separate applications and in organization of intertask communication. One of the most attractive advantage of such tool is availability of a specialized graphic interface letting to the designer to display details of researched process in the forms convenient not only for screen supervision but also easily fixed and moved in the documents of the reporting stored as in an electronic kind and in a kind of hard copies. To develop the graphic interface it is most conveniently to use the elements of object-oriented programming; in this case a joint functioning of the object-oriented interface and the non-object-oriented codes of FORTRAN-applications should be provided by special program means. The question of organization of such joint functioning will become less urgent as the applications deciding the same design problems, but on the basis of the object-oriented approach, will appear.
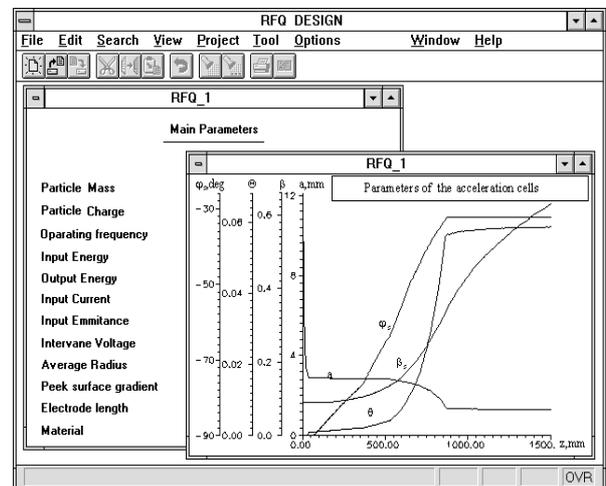

Figure 1. View of main window.

1 REVIEW of SEPARATE ELEMENTS of the RFQ DESIGN TOOL

The efficiency of labor of the designer much grows at unification of the visual forms accompanying the most frequently executed operations during working with

applications. It first of all the operations connected to the data input/output, and also operation of run of applications.

1.1 Forms of the data input

Realization of two main forms of data input is provided: tabular form and graphic form. Each of these forms can be either specialized form (in this case the form includes data only for one application) or extended form (in this case the form allow to include the initial data used by several applications).

1.2 Forms of the data output

The output forms of representation of the data cover the whole spectrum of the forms of display of the information generated by applications as directly during their running and stored on various types of data medium; here also the tabular and graphic forms provided by the graphic interface are widely used.

1.3 Organization of access to applications and run of applications

The means of operating system WINDOWS and language C++ give at disposal of the developer a rather wide set of means for convenient organization of access to applications as at a level of the screen forms ("button", "key", "control panel ") and on a code level, letting to take into account features of realization that or other application. It lets without the special complexities to run the codes compiled for work in operating system of the type DOS. The necessity of updating of such codes arises in case of joint functioning with the object-oriented graphic interface.

1.4 Data exchange between the DOS-codes and graphic interface under WINDOWS

The most attractive advantage of the specialized object-oriented graphic interface is an opportunity of fixing of the information generated by applications in various phases of their running as wall as save of this information in kinds convenient for use in various accounting documents stored as in an electronic kind and in a kind of hard copies. Organization of information flow by two methods is here possible. The first method assumes exchange by the information through given sites of main memory; in this case enough qualified approach is required. The second method is more universal and uses services of file system; here the information is periodically dumped

in files by an application and is read out from them by means of the graphic interface. The choice that or other method is decided individually concerning each application.

2 The RESULTS of NUMERICAL SIMULATIONS of 433 MHz RFQ for $D^{\pm}$

Last time interest to $D^{\pm}$ compact RFQ has grown. The structure of such type can be used as an independent accelerating element in radiation technologies and as an initial part of acceleration in accelerating complexes on higher energy. Some results of numerical research of dynamics of particles in the similar accelerator are below represented. In table 1 main design parameters of the accelerator are reflected. Figures 2 and 3 show input and output emittances of beam. The figure 4 presents parameters of accelerating cells depending on length of the accelerator. Since one of presented requirements included absence of loss of particles on transverse movement, length of electrodes was received rather large. Manufacturing and assembly of the accelerator of such length represent a serious problem and will require special design study.

Table 1   Main parameters of RFQ

Design ion	$D^{\pm}$
Operating frequency, MHz	433
Input energy, keV	60
Output energy, MeV	2
Electrode length, mm	4030
Total no. of cells	842
Average radius, mm	3.5
Input current, mA	25
Output peek current, mA	21
Input emittance ($\pi\beta\gamma$rr'), m·rad	5×10^{-7}
Intervane voltage, kV	98
Peek surface gradient, MV/m	37

SUMMARY

The tool facilitating the computer designing of RFQ linacs has been described. Review of separate elements of the RFQ design tool is given. The work on further perfection of this tool will be continued. The results of numerical simulations of 433 MHz RFQ for $D^{\pm}$ are considered. The results show that manufacturing, assembly and tuning of the accelerator represent a serious problem and special design study will be required.
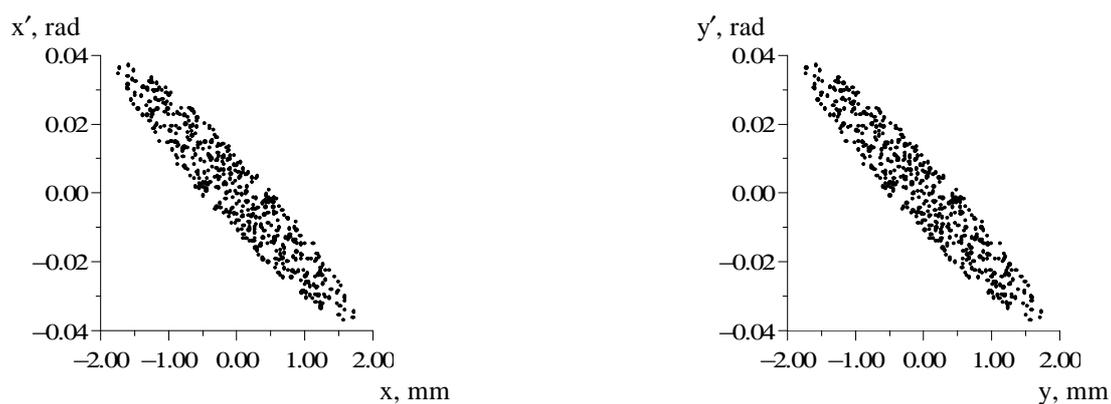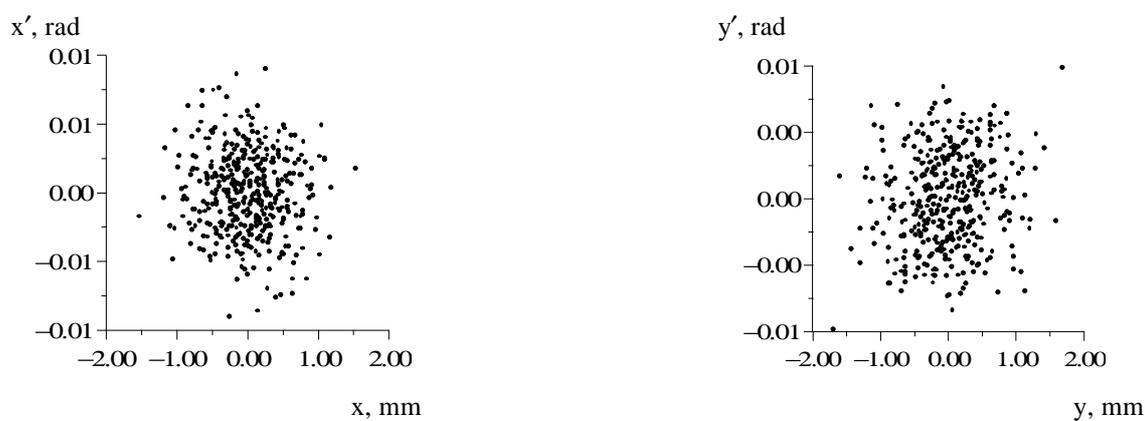
Figure 2. Input emittances of beam
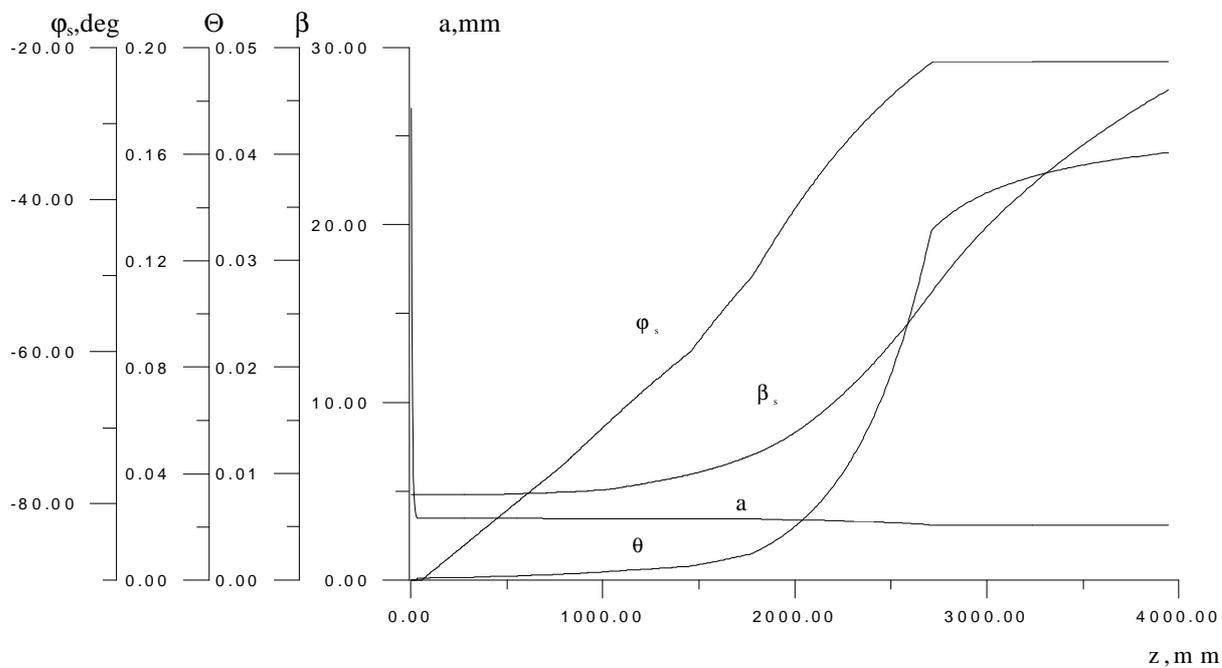

Figure 3. Output emittances of beam

Figure 4. Parameters of the acceleration cells (φ_s is the equilibrium phase, a is the aperture, β_s is the relative velocity, Θ is the acceleration parameter)