DESIGN RELATIVISTIC CHARGED PARTICLE BEAM TRANSPORTATION CHANNELS

G. P. Averyanov, V. A. Budkin, I.O.Osadchuk, MEPhI, Moscow, Russia

Abstract

This paper contains results of development new version (2016) of program for channels design high-energy beams of charged particles. The program includes application package modeling the dynamics of charged particles in the channel, operational tools to change the channel parameters, channel optimization tools and processing output beam parameters with graphic and digital presentation of its key features. The MATLAB (Scilab) was used as programming tools, allows to make the source code modular, compact and scalable. New object-oriented graphical user interface provides an interactive assembly of new or modernization of previously developed channel - selection and arrangement of its elements, as well as the installation and the variation of their parameters. The relational database, which is part of the new version of program, providing additional functionality to the designer. It is intended for storage of the current development, and to preserve the previously completed projects, as well as other useful designer related information. A multi-output of all the main parameters of the beam at the output, as well as anywhere in the channel. In this case, the developer has the ability to interactively search and setting the optimum mode of operation channel.

INTRODUCTION

The effectiveness of the design on the stage of computer simulation is largely determined by the convenience of the user interface of the used software package and the time of adaptation of the user to that application [1-4].

This paper presents a new approach in the implementation of interface software package KATRAN, designed for the design of channels of transportation of a relativistic charged particle beams.

THE PACKAGE STRUCTURE AND ALGORITHM DESIGN

The package contains four main modules:

- graphical interface, consisting of the Builder module of the channel and the processing module results of the calculation;
- calculation module;
- database module.

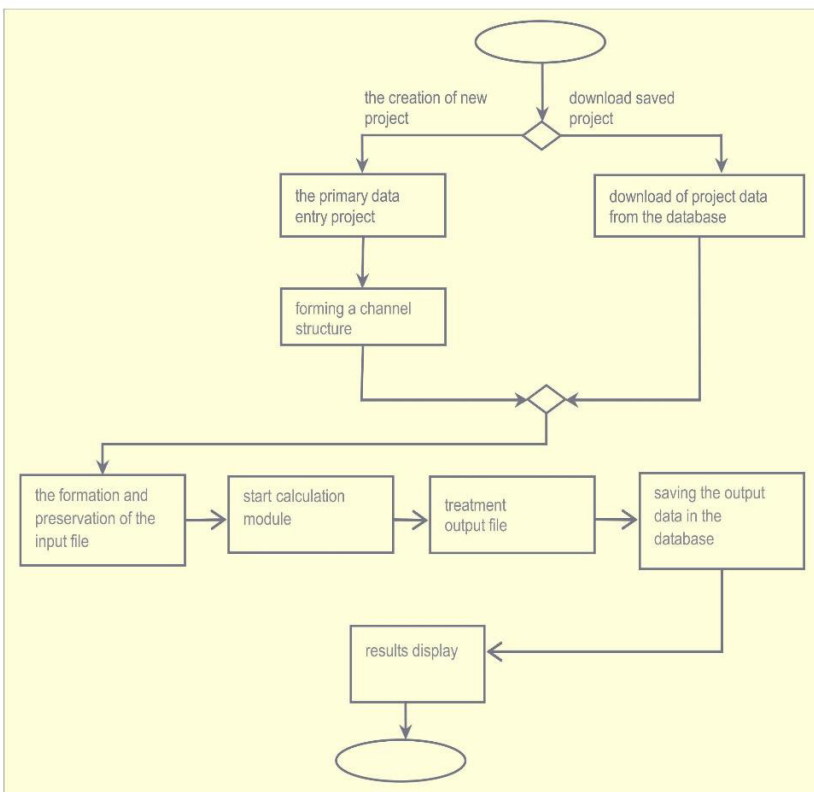

Figure 1: The package structure and algorithm design.

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At System startup, initializes database, and load elements of the graphical user interface. Once launched, the user can choose from the following scenarios with the System (Fig.1):

- Create a new calculation.
- Loading a saved calculation.

Scenario 2 ("loading a saved calculation") differs from Scenario ("Create a new calculation") the fact that the input data file is generated on the basis contained in the database System the calculation data (the primary data and the structure of the channel, including the parameters of each element of the channel).

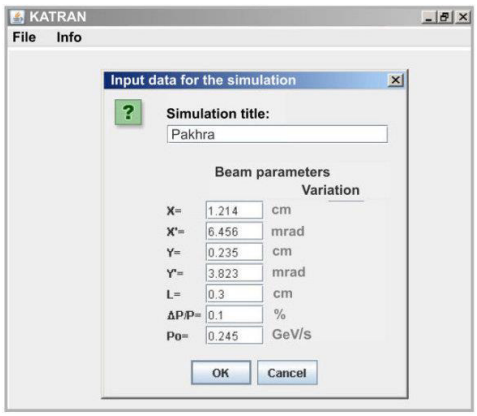

Figure 2: Setting beam parameters at the entrance of the channel.

This eliminates largely the need for immersion of the designer in the specific details of a computer environment, the features of the software package and mathematical methods of modeling channel. The generalized algorithm of the System shown in Fig. 1.

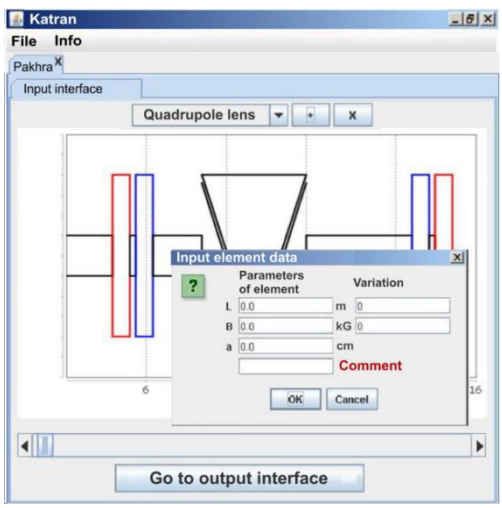

Figure 3: The visual assembly of elements of the transport channel

SIMULATION MODULE

The target feature Ft, which reflects the degree of achievement of the desired beam parameters for the experimental setup, can be written as:

$$Ft = \sqrt{\sum_{j=1}^{k} a_j \left(\varphi_j \frac{x}{x^{norm}} - \varphi_j{}^c\right)^2} \qquad (1)$$

where $\varphi_j{}^c$ – is the target value of the parameter; x^{norm} – vector of selection coefficients; parameter; a_j – weight coefficient of the parameter; x – vector space of search parameters; $\varphi_j(x)$ – the elements of the transformation matrix; k – is the number of optimized parameters. The Simplex method. (The Algorithm of Nelder-Mead) used to determine the optimal parameters of the transportation channel.

FEATURES OF THE GRAPHIC SHELL

Graphical user interface KATRAN provides high efficiency of user interaction with the program, because it implements a simple form of specifying parameters of the channel and construction of canal in General, as well as a clear presentation of the results of the calculation. The simplicity and convenience of working with KATRAN allows you to use it not only in science but also in the educational purposes, which is especially important for teaching students in specialties related to accelerator technology. The KATRAN software package includes following key interface functions:

- The design of the transport channel in visual form.
- Edit the parameters of the transport channel in the process of design.
- Displaying calculation results in visual form of the beam envelopes, and phase portraits, parameters of the elements of the channel and transformation matrix;
- Two-dimensional visualization of the canal with navigation.

The interface represents a sequence of actions of the designer for creating a virtual channel:

- Set beam parameters at the entrance of the channel (Fig. 2).
- The visual assembly of elements of the transport channel (Fig. 3).
- Parameters optimization for simulation algorithm procedure (Fig, 4).

CONCLUSION

The presented version of the environment is a continuation of earlier developments. The main advantages of this option are:

- The introduction of additional functions that extend the capabilities of study of the parameters of the transport channel and optimization of parameters;
- The accessibility to different hardware and software platforms;
- New simple multifunctional interface.

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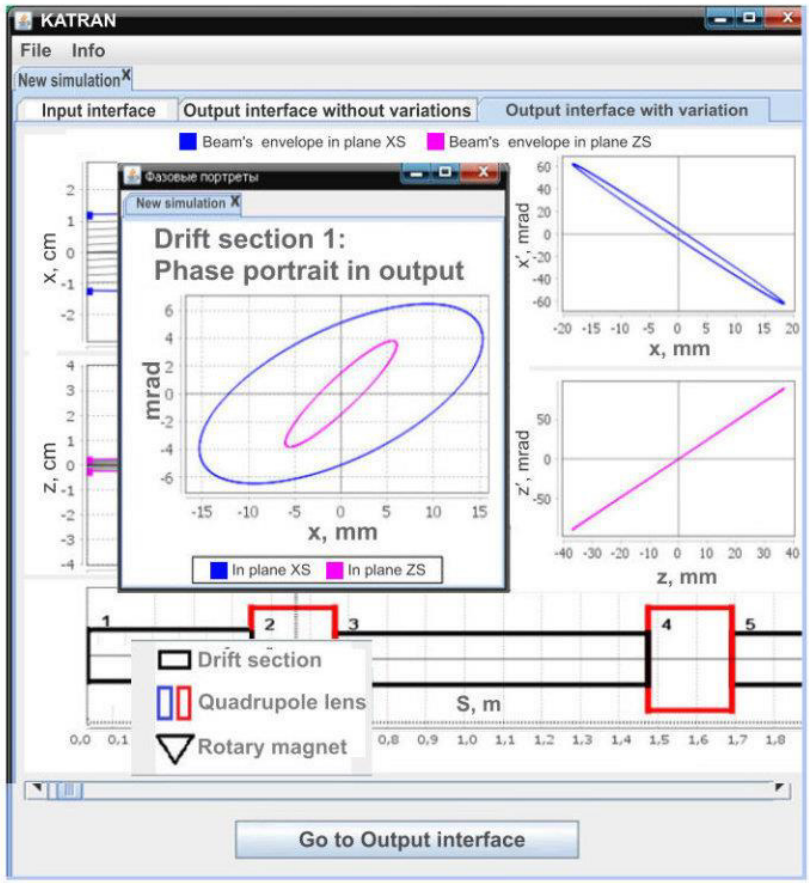

Figure 4: Parameters optimization for simulation algorithm procedure.

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