

E13-2017-83

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## SLOW CONTROL OF VARIABLE-ENERGY POSITRON BEAM'S POWER SUPPLY

Submitted to "Particles and Nuclei, Letters"

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## Медленный контроль источника питания позитронного пучка переменной энергии

Целью данного проекта является разработка системы управления для блока питания позитронного пучка с переменной энергией. Для решения этой задачи выбрано соответствующее оборудование. Для управления данным оборудованием разрабатывается программное обеспечение (ПО) в виде двух отдельных программ. В статье объясняется, какие функциональные возможности предоставляет данное ПО, почему использовался LabVIEW, а также почему ПО представлено в виде двух отдельных программ.

Работа выполнена в Лаборатории физики высоких энергий им. В. И. Векслера и А. М. Балдина ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна, 2017

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## Slow Control of Variable-Energy Positron Beam's Power Supply

The purpose of this project is to develop a control system for variable-energy positron beam's power supply unit. To solve this problem, proper hardware is chosen. In order to control the hardware, the software, divided into two separate programs, is developed. The paper explains what features the software delivers, why LabVIEW was used, and why the programs are divided.

The investigation has been performed at the Veksler and Baldin Laboratory of High Energy Physics, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna, 2017

## **INTRODUCTION**

Variable-energy positron (VEP) beams are small accelerators generating a flux of monoenergetic positrons with energies in the range between a few dozen eV up to a few dozen keV [1]. They are used in the field of positron annihilation spectroscopy for detection of open-volume defects in the studied materials [2]. This kind of experiments requires a precise control of the energy of primary implanted positrons. In the case of VEP operating at the Dzhelapov Laboratory of Nuclear Problems (JINR, Dubna) the energy of implanted positrons depends strongly on the voltage applied to the investigated sample [3]. The profile of the measured annihilation feature versus the energy of positrons is commonly determined during the experimental session. Today the energy range for mentioned VEP beam is from 50 eV up to 36 keV with possibility to obtain 60 keV in the future. The voltage on the sample is given manually by Spellman PCM Series HVPSU HV source. This is not an effective way and should be replaced by automatized control system proposed in this paper.

### **1. PHYSICAL LAYER**

In order to adjust power supply voltage, input of voltage in the range from 0 to 10 V is required. Output voltage is linearly proportional to input voltage. Power supply unit interface provides feedback with voltage linearly proportional to output voltage.

These features of power supply unit interface match analogue interface of the National Instrument myDAQ. NI myDAQ provides 16-bit digital-to-analogue and analogue-to-digital converters, both of which operate within voltage range of the power supply unit interface. Digital-to-analogue converter with 16-bit resolution may control the output voltage with precision of circa 1.07 V, which is more precise than required.

### **2. PROGRAMMING**

Chosen device (myDAQ) input and output may be controlled with a PC, if a computer is supplied with NI LabVIEW runtime and proper drivers. This leads to the usage of LabVIEW language, as it is the most suitable for this task.

LabVIEW allows a programmer to create legible user interface and easily operate with myDAQ.

For user's convenience we decided that the best solution would be to use separate programs to prepare the experiment procedure and to supervise it. This way, while authorized personnel may prepare plan of experiment, designated operator could supervise it, but could not interfere with experiment parameters (still being able to stop it in case of emergency).

**2.1. Engineer's Input Panel.** The Engineer's Input Panel (Fig. 1) allows user to prepare a script that will be realized by runtime. User may set a desired voltage change (in a single step) and delay between the changes. Saved steps may be browsed and removed if are unnecessary or wrong.

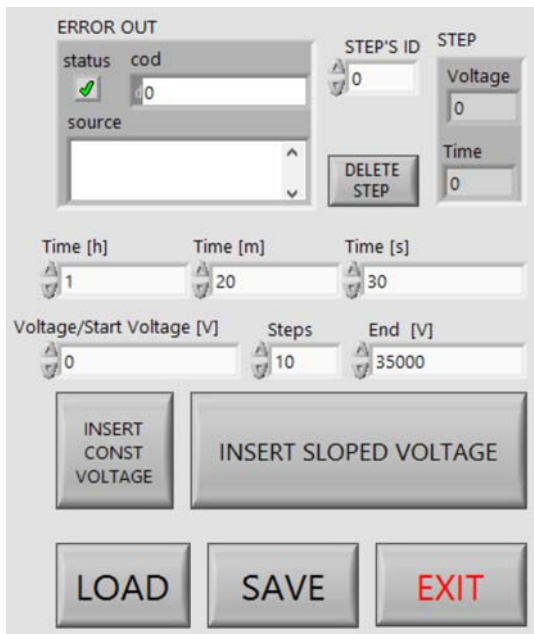


Fig. 1. Engineer's Input Panel

User may save the script at any moment. If it is required previous script may be loaded and then modified.

For user's convenience feature of sloped voltage change emulation is provided. It is realized by automatically inserting the user-defined number of steps, which are equally distributed at the scheduled time.

In case of any error, user would receive the feedback in ERROR OUT field.

**2.2. The Operator's Runtime Panel.** The Operator's Runtime Panel (Fig. 2) allows user to load scripts created with the Engineer's Input Panel. After the script was loaded, it is immediately executed. User may choose a desired device (as there may be more than one device connected to PC).

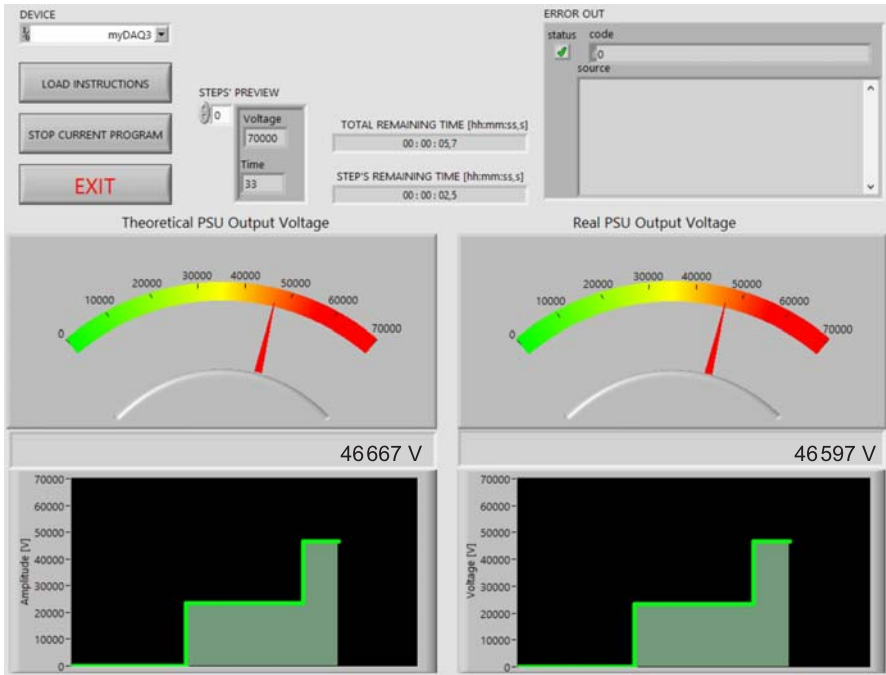


Fig. 2. Operator's Runtime Panel

Panel provides user with two sets of indicators for both theoretical (desired) output voltage and for real (measured at Supply Unit's feedback output and scaled to proper range). Both sets consist of analogue meter, digital display, and chart. Analogue meter allows user to quickly check in which range the voltage is, as it is more convenient representation if approximate value is required. Digital display shows user the exact value of voltage (theoretical and read from feedback). Chart shows data gathered during the experiment, user may apply them to monitor sudden changes and tendencies.

User is informed about remaining time of both the whole experiment and current step. It is possible to preview each step voltage and duration (if user wants to check the remaining steps).

Operator may stop script execution at any time by either clicking STOP CURRENT PROGRAM button or EXIT button. Both buttons would set voltage

to zero volts and stop executing the script. In case of EXIT button the Operator's Runtime Panel is terminated afterwards.

## CONCLUSIONS

National Instruments myDAQ controlled by LabVIEW software may be easily used to develop automatization systems. While myDAQ provides universal hardware (both digital and analogue inputs and outputs) and may be conveniently controlled with a PC, the LabVIEW language may be used to quickly develop the functional interface. By separation of functionalities between different programs, stability of their operation is increased (as simpler programs are easier to debug), and access to certain features may be easily restricted.

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Received on November 24, 2017.

Редактор *Е. И. Крупко*

Подписано в печать 12.02.2018.

Формат 60 × 90/16. Бумага офсетная. Печать офсетная.

Усл. печ. л. 0,44. Уч.-изд. л. 0,59. Тираж 215 экз. Заказ № 59337.

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