OPEN-HARDWARE KNOB SYSTEM FOR ACCELERATION CONTROL OPERATIONS

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Istituto Nazionale di Fisica Nucleare

ICALEPCS 2021

WHY A KNOB?

Context:
During accelerator setup, many functional systems are involved to deliver the beam to the target (RF, diagnostics, beam transport, etc.). When automatic procedures are not available, operators have to operate manually through the control system Human-Machine Interfaces (HMIs).

Many of these interactions are repetitive (ex.: correct a current, change slits position, change RF parameters and move into another page of the GUI) and they are commonly performed by mouse and keyboards connected to a common personal computer.
Sometimes these tools are not the best solution for the operator: the biggest problem observed is the eye-hand coordination between mouse/keyboard and the multi-screen monitor

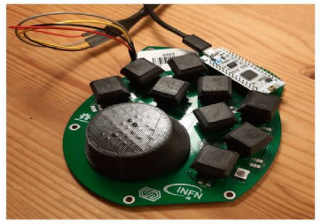
Is possible to improve something?

We observed the actions the operators perform in many experiments setup, and we noticed it is more intuitive and simpler to use a knob (related to old hardware configurations) to set up a parameter than to press on keyboard buttons or move a cursor.
Operators prefer the haptic feedback provided by old knob controllers and better eye-hand coordination and, as consequence, operations accuracy increases. Based on these assumptions, we investigated and studies different solutions available on the market.

WHY AN OPEN-SOURCE HARDWARE?

Something went hard:
based on the studies performed, we found several limitations using commercial solutions:

- operative systems compatibility,
- application compatibility
- missing drivers



The first prototype based on Kerry Sharfglass mechanical layout.

To overcome this limitation (in terms of drivers and OS interface), the need for a new technical solution would be suitable. According to this assumption and based on the talk of Kerry Scharfglass, exposed during the conference KiCon 2019, we started to study and design a new knob controller equipped with an encoder and buttons which has to achieve the following goals:

- Easy to configure
- Multi-platform
- Cost-optimized
- Adopt public licenses for both hardware and software

open source hardware

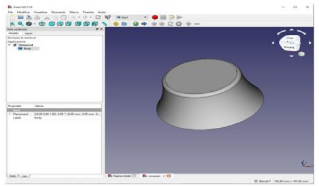
Unlike many proprietary solutions, this hardware can be recognized as a common USB keyboard from any kind of device that support USB HID, and is virtually compatible with any modern operating system. Key buttons and encoder can be programmable and dynamically reconfigurable by the user, if needed. There's also the possibility to send strings or character to an external device through a serial port interface.

HOW IS IT BUILT?

Tools are precious:
Development tools are very important. In order to provide the maximum degree of freedom for developers and makers in terms of software tools, we used open-source software KiCad EDA to design the PCB and FreeCAD for all mechanical parts.

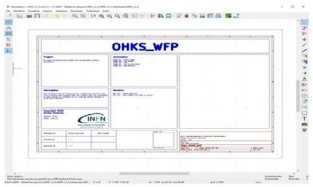
Easy to build :
One of the goal that this project wanted to achieve was to provide a complete system buildable from scratch, minimizing the cost in terms of components. For this reason, different parts have been designed to be realized through 3D printers and Fused Deposition Modeling (FDM) technology.

FreeCAD



The KNOB 3D model designed in FreeCAD.

KiCad



The project schematics designed in KiCad.

WHERE CAN I FIND IT?

https://github.com/Enri-com/OHKS

GitHub

enrico.munaron@lnl.infn.it

Conclusions:
The need for a simpler and more intuitive solution for beam transport and experimental control has been the starting point to design and develop a new controller for linear accelerators.
The prototype realized is a multi-platform, easy to configure solution where most of the costs have been minimized through the usage of fast prototyping technologies, such as 3D printing. In addition to that, the product follows the open-source philosophy, and all the design parts are freely available under OHL and GPLv3 licenses.
First feedbacks coming from the test are very promising and let us confirm the technology assumptions made during the design stage; at the same time, further development will be done to optimize different aspects (electronics, mechanics, performances) and realize a more efficient and comfortable control device.

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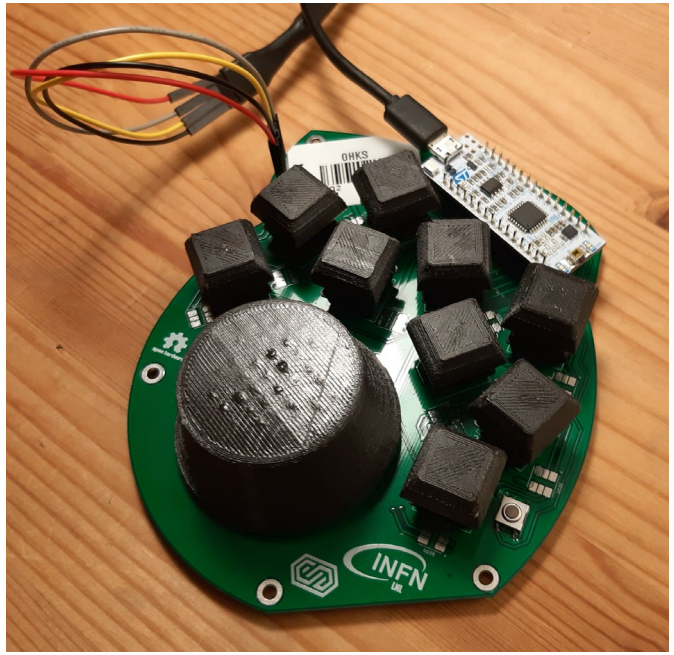

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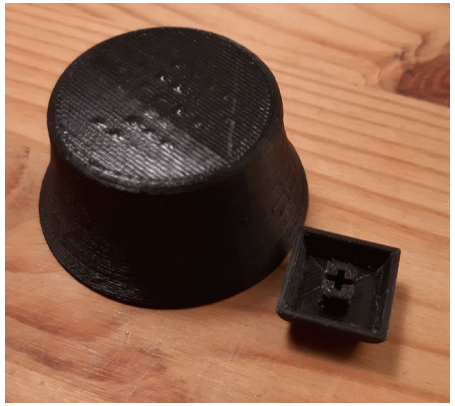

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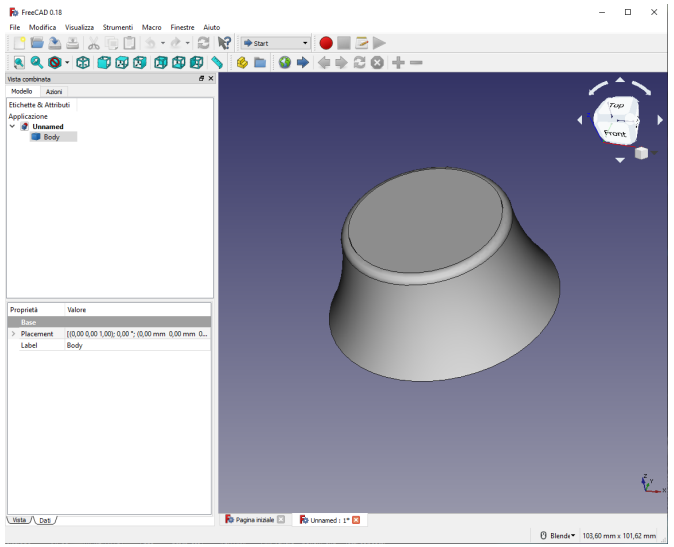

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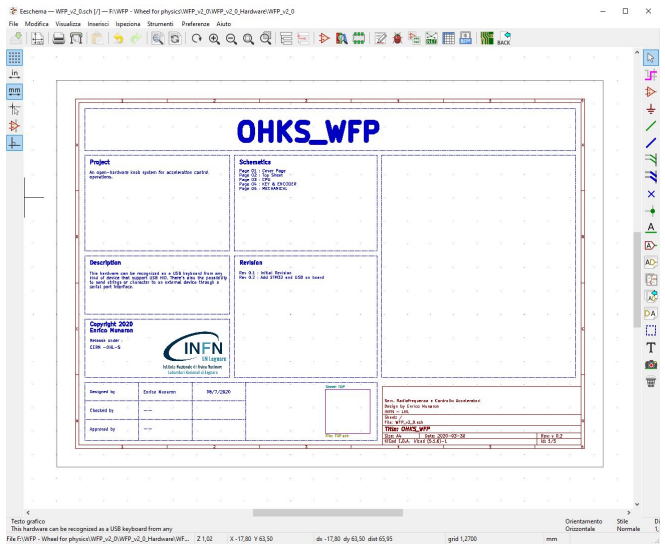

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