

Beam Interlock System User Interface (CIBU) Overview



Front view of the CIBUS (single input version)

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Outline:

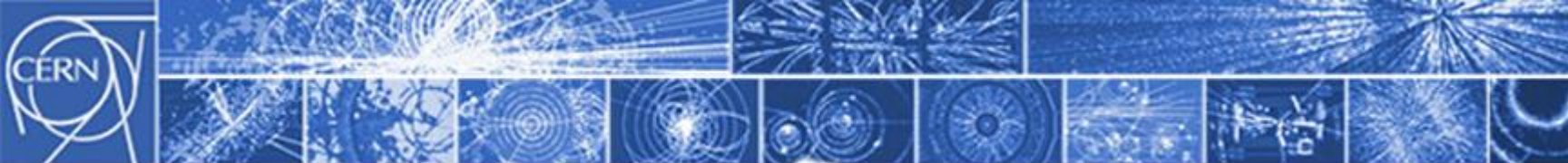
- Role of the CIBU
- CIBU key points
- CIBU block diagram
- CIBU power supply
- CIBU test benches



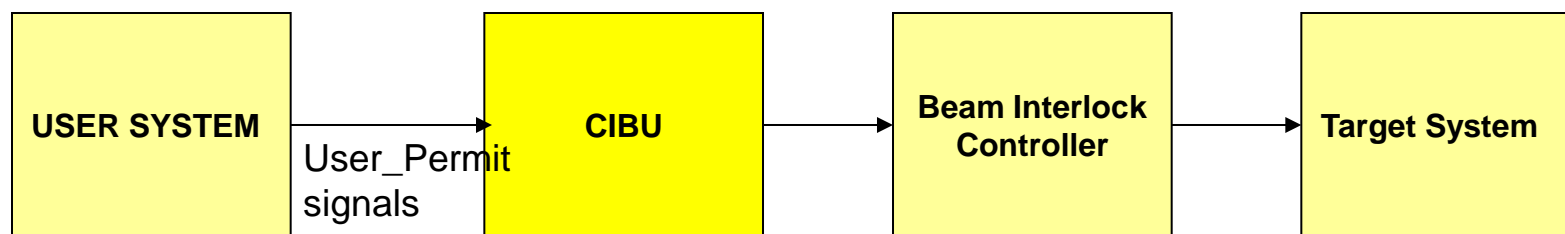
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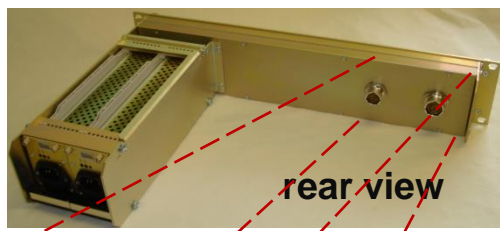
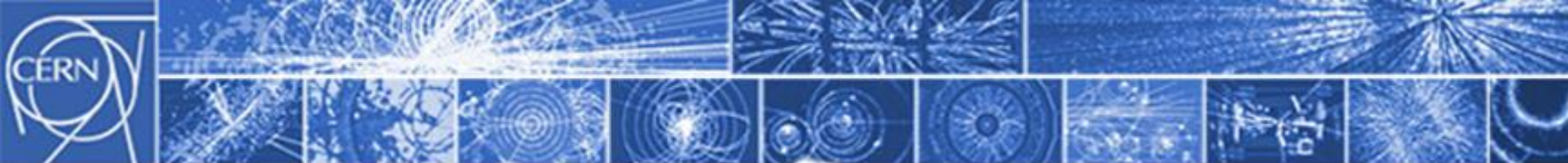


The CIBU (User interface) collects the USER_PERMIT signals from the *User System* and transmits them to the nearest BIC (Beam Interlock Controller) in a safe and reliable manner.



The role of the interlock system is to gather the status of the connected systems (named hereafter *User Systems*) and transmit these information up to a *Target system*, like Extraction Kicker, Choppers,...

The CIBU is certainly the most simple element of the Beam Interlock System, but also one of the most critical. If the CIBU unit fails to transmit correctly the USER_PERMIT signals, it will obviously lead to a blind failure of the BIS.



Unique HW solution for connecting any User System via a copper cable
[F.O. variant available for long link (>1.2km)]

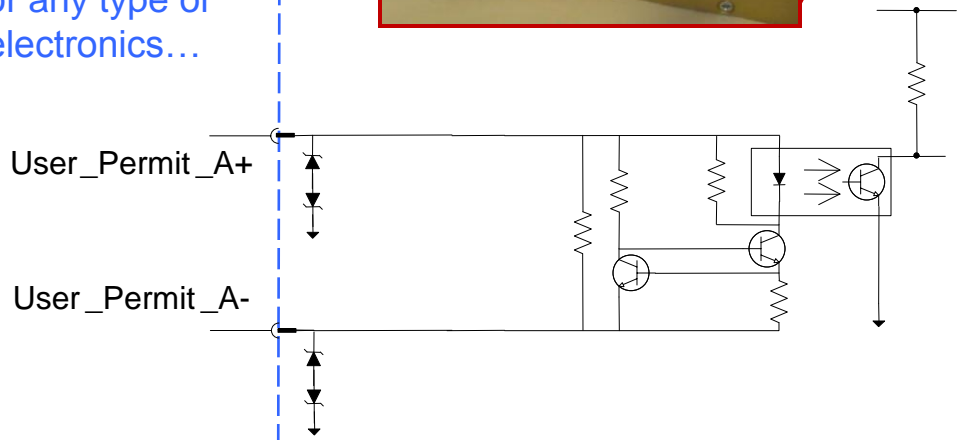
User System

Could be PLC based, or VME based, or any type of electronics...



User_Permit state transmitted in RS485 format

to Controller

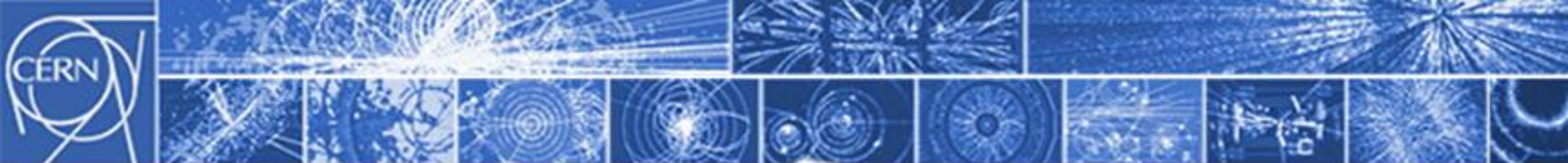


User_Permit = "FALSE" if Input current < ~10mA



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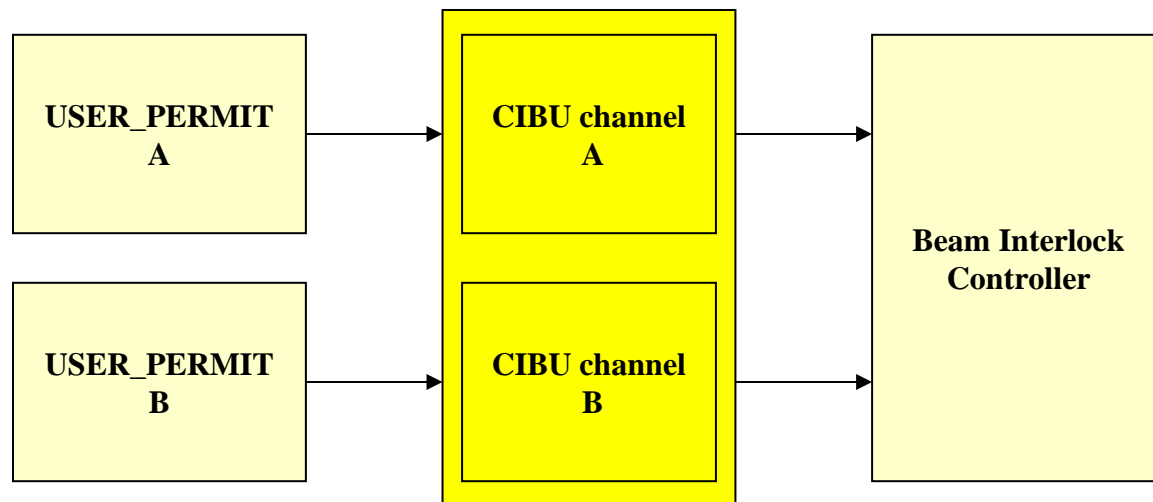
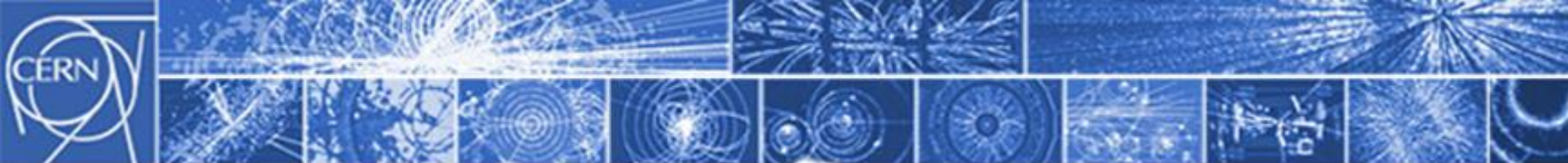


- The CIBU unit is installed in the *User System* rack, the size must be appropriate (2U), and the CIBU frame must be robust. The external connectors must also be robust and reliable (Burndy type)
- The input signal type must be versatile (3Vdc to 24Vdc for a “True” signal)
- The USER_PERMIT input voltage are converted inside the CIBU in a current loop, to be more reliable (EMC tolerant)
- The connection between the CIBU and the BIC must also be reliable on a distance up to 1Km (RS485 link + Manchester encoding)
- The CIBU must be simple; each User must read and understand the CIBU user manual to find the best way to connect its electronic. This electrical connection is under the User’s responsibility

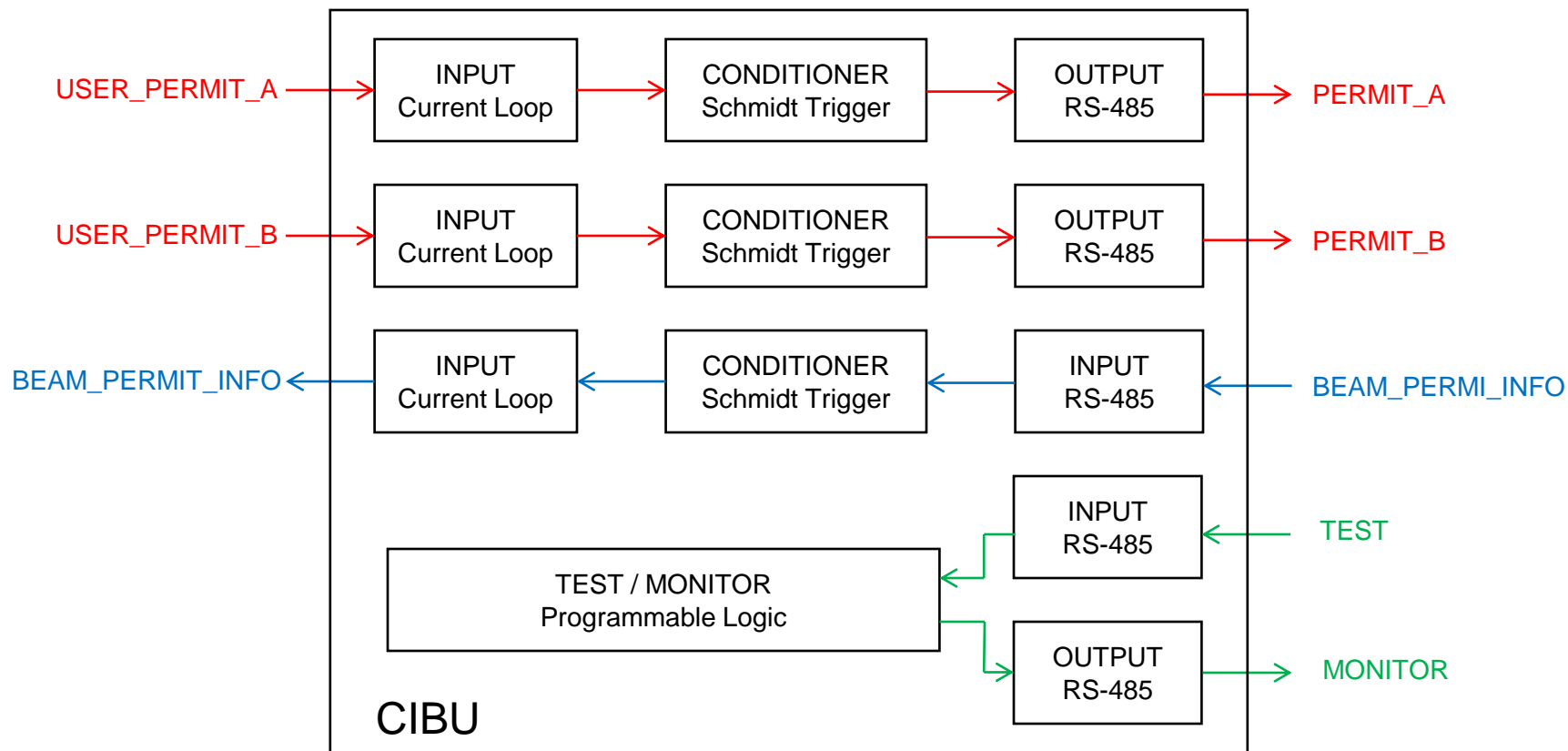
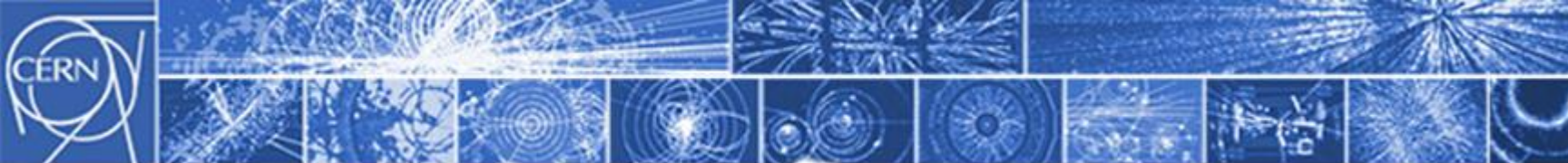


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The USER_PERMIT signals re-transmitted by the CIBU to the BIC must be highly safe and are fully redundant. The redundancy is ensured **via two separate channels A and B**.

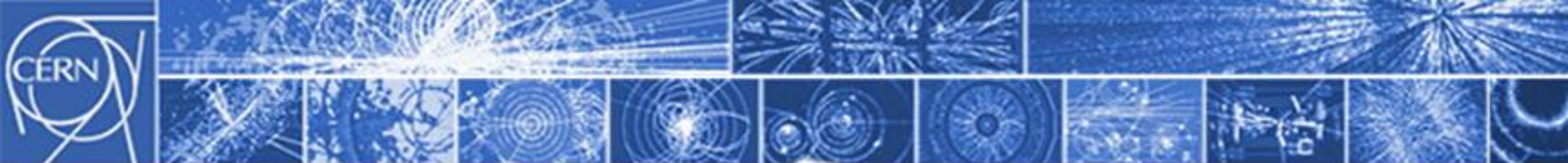


Internal Layout of CIBU Circuits

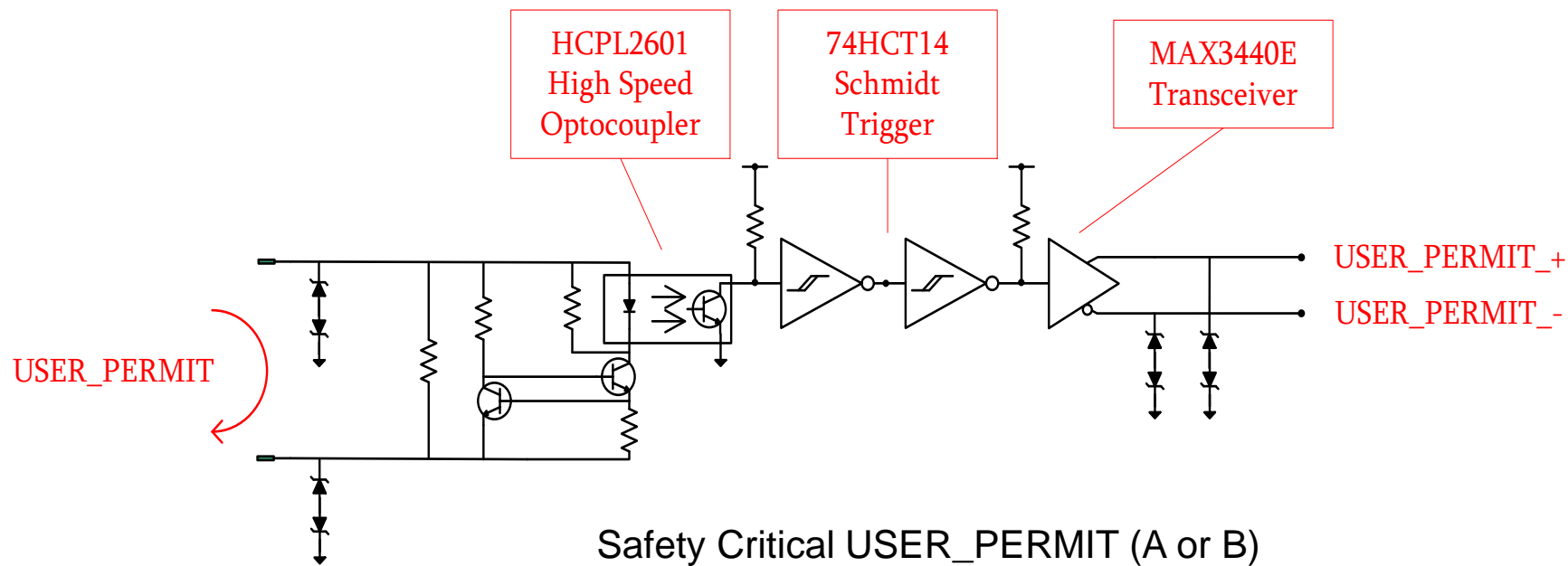
CRITICAL PATH

LESS CRITICAL INFO

NOT CRITICAL

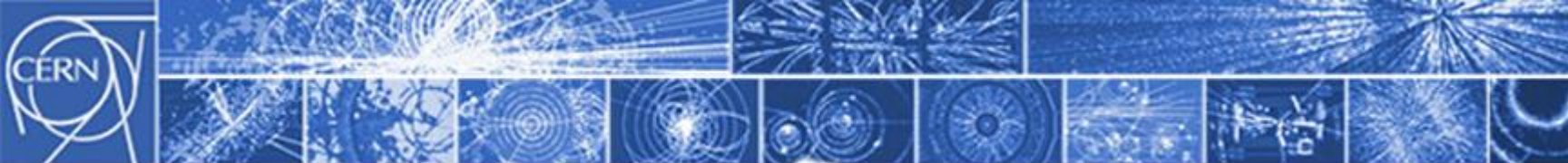


User Permit details (**critical path**)

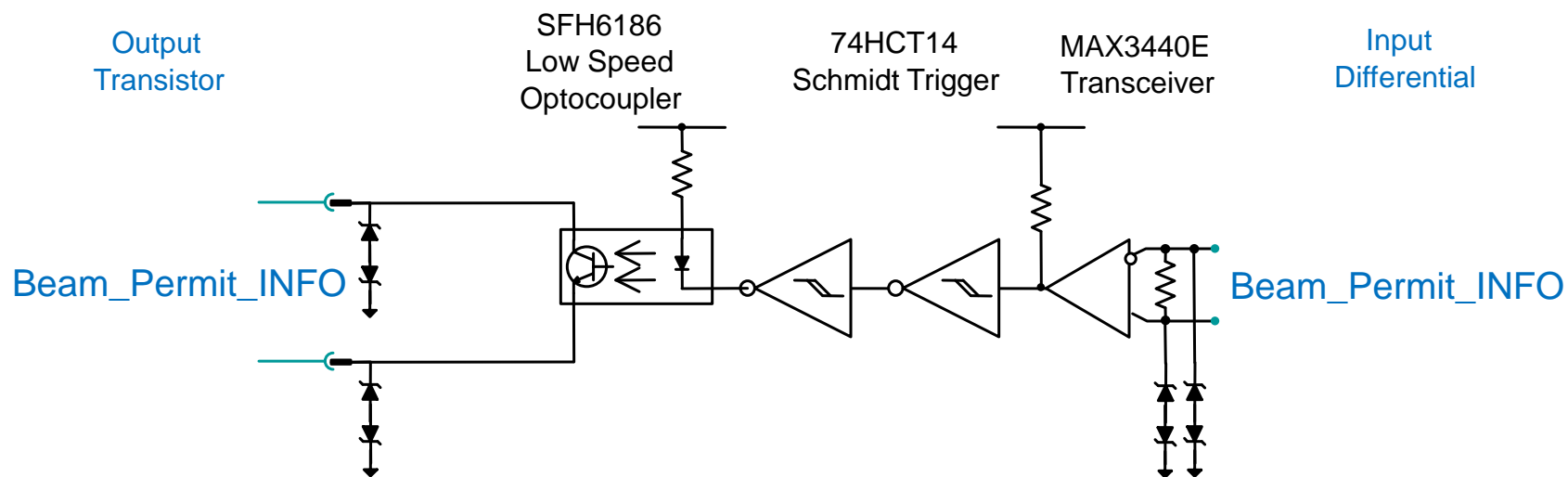


Safety Critical USER_PERMIT (A or B)

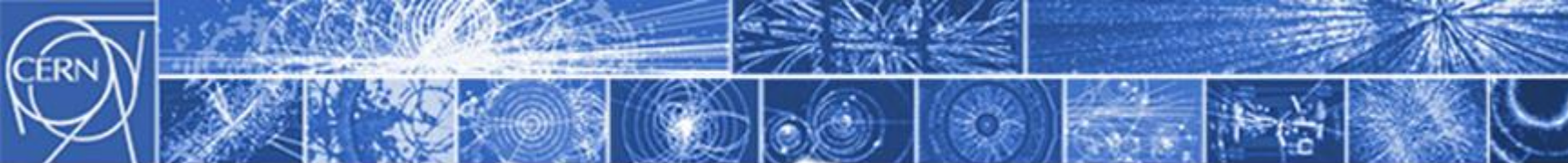
- ✓ Fast response time (2.6 μ S max)
- ✓ Large Input Voltage Range (3Vdc up to 25Vdc)
- ✓ Hysteresis, clean signal edges
- ✓ RS485 output, good EMC, long distance (up to 1000m)
- ✓ No programmable logic on the critical path



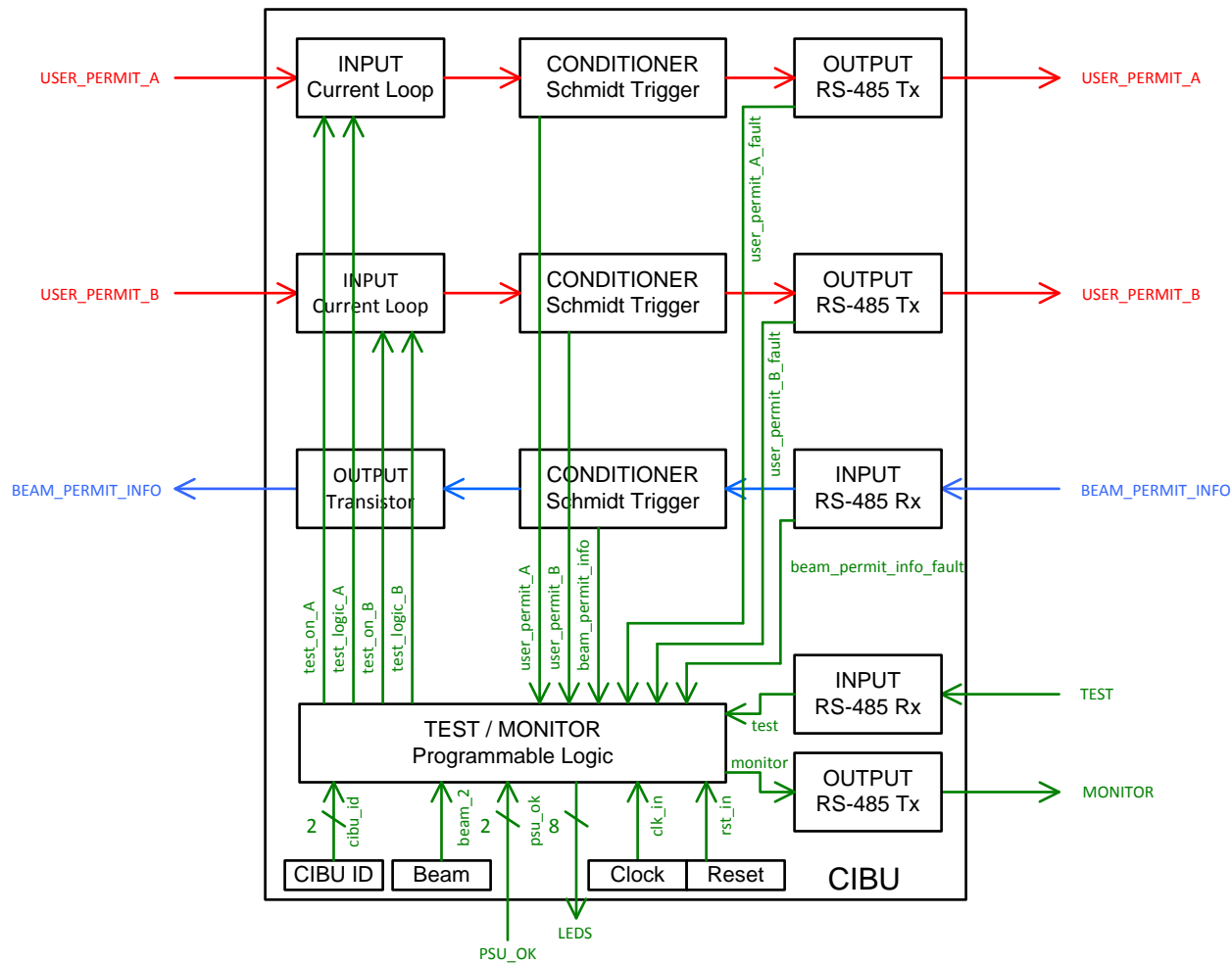
Beam Permit info details (less critical path)



Non-Safety Critical BEAM_PERMIT_INFO Channel



Test and Monitor (not critical path)



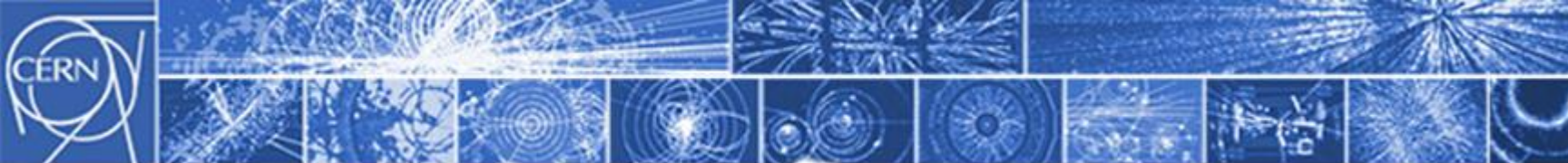
Non-Safety Critical BEAM_PERMIT_INFO Channel



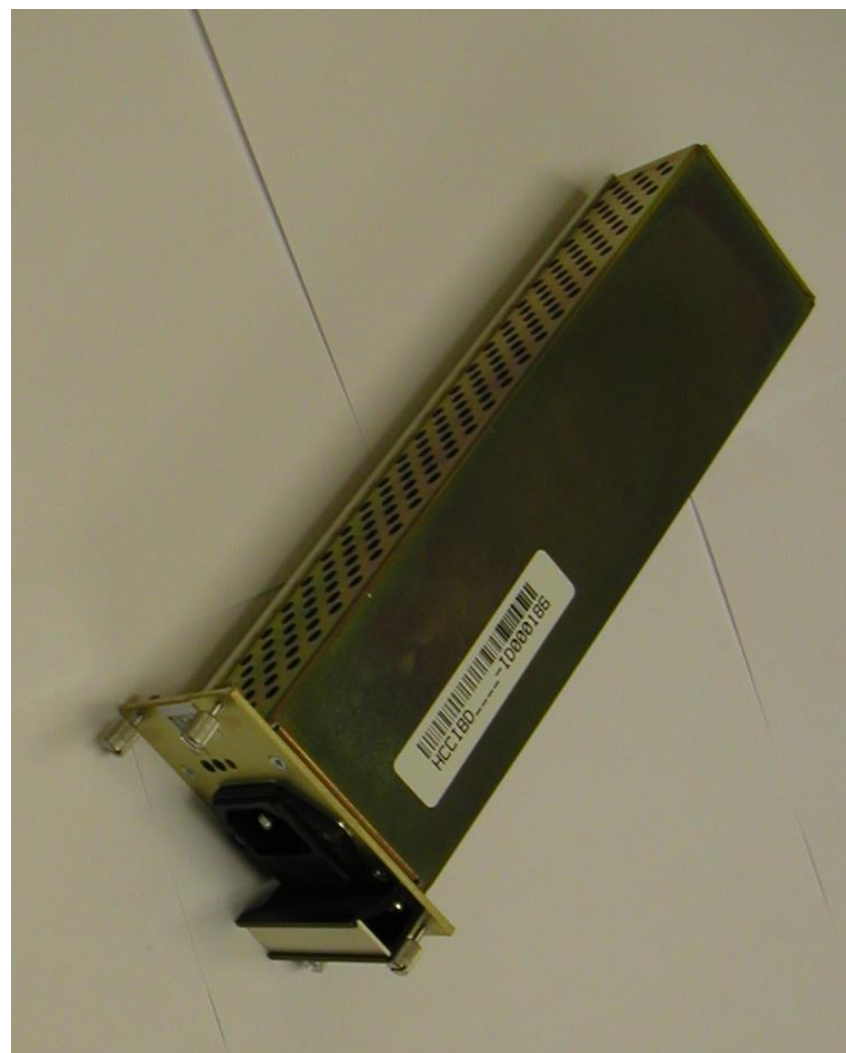
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- **CIBU power supply**
- CIBU test benches

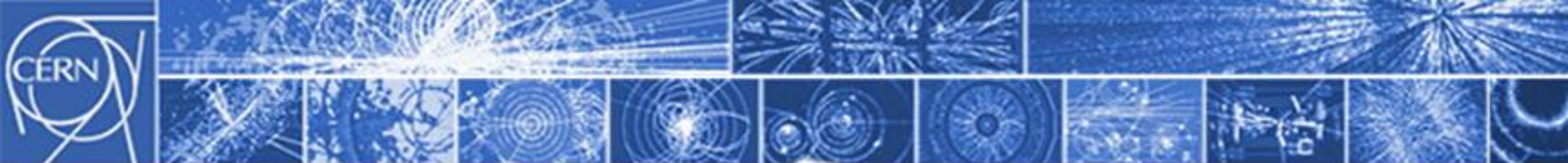




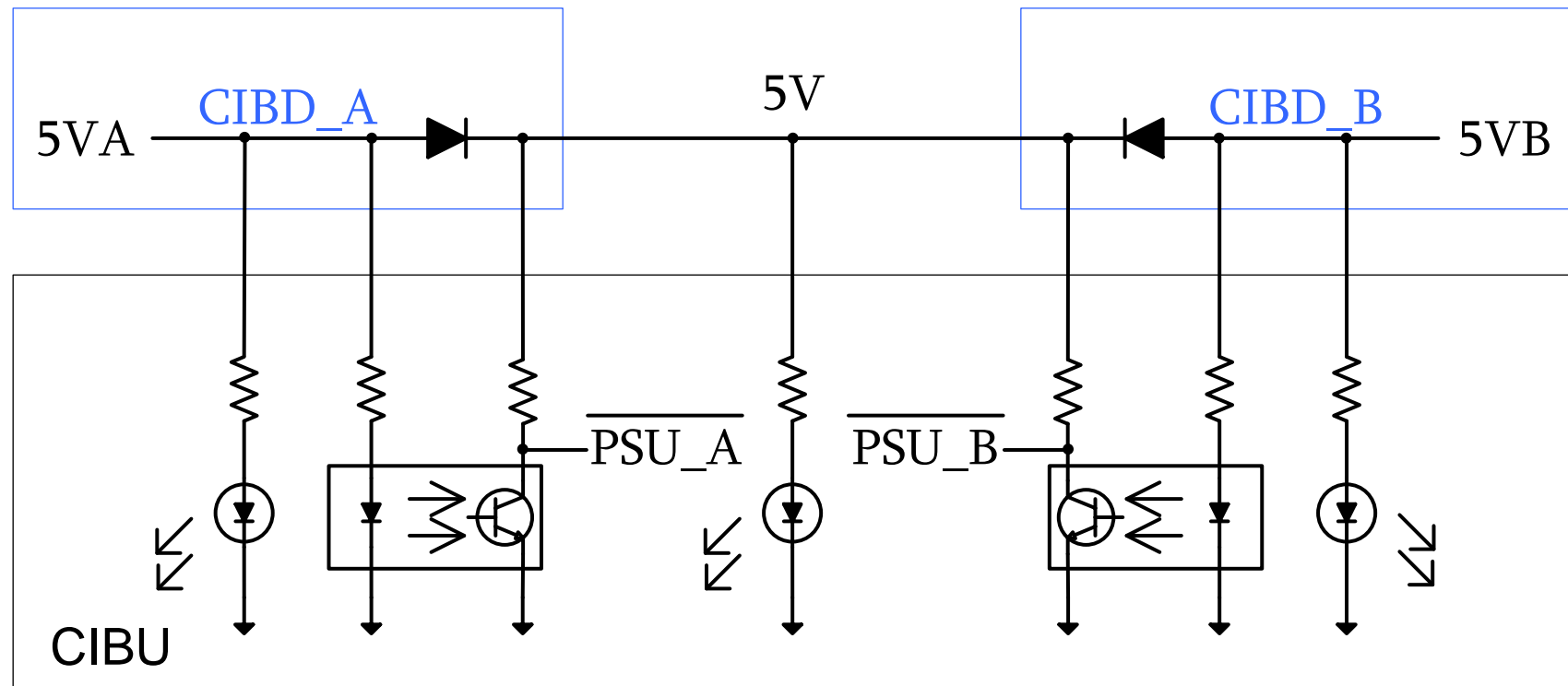
The “CIBD unit” is the power supply specially designed for the CIBU



In order to improve the overall CIBU availability, the PS units are redundant



Coupling of redundant CIBD power supplies



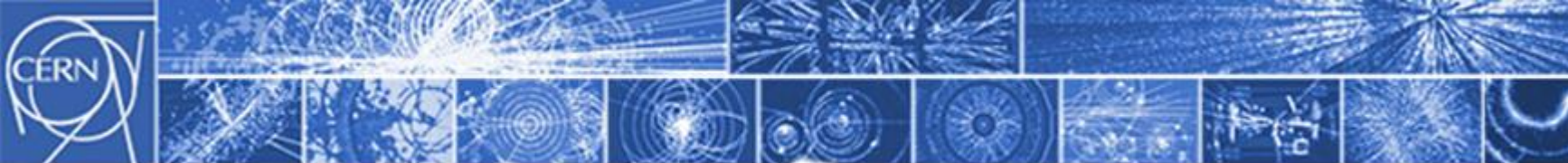
- ✓ No interaction between the two CIBD units
- ✓ Each individual CIBD unit has the capability to provide all the current required by the CIBU

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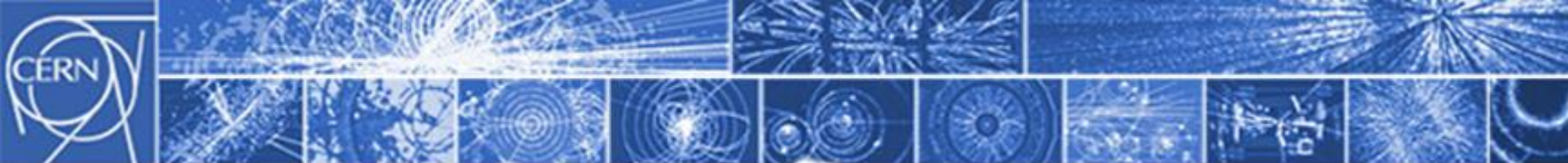


It is crucial to correctly test the CIBU units prior to its operational use.

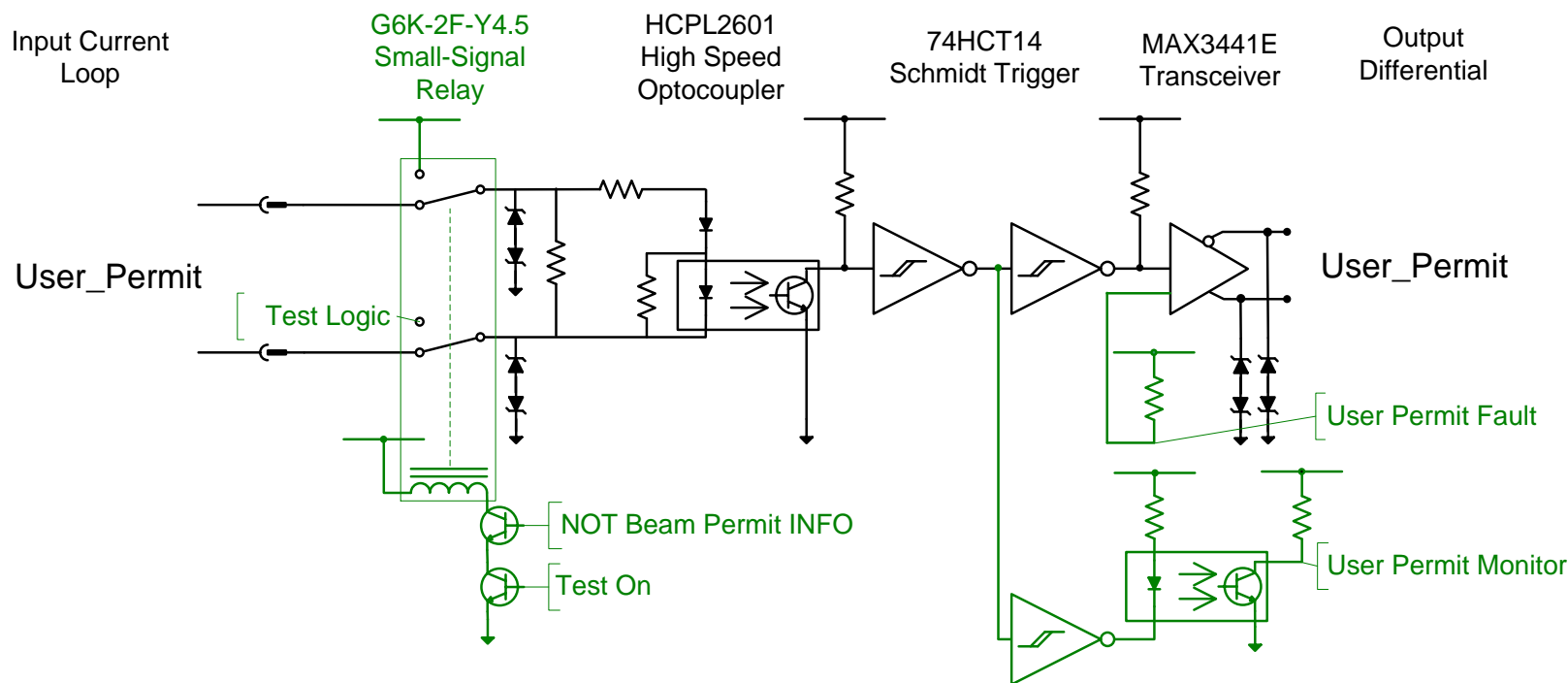
The different means to test such electronics must be foreseen during the conception of the module and not once the device is on the production line...

3 different types of hardware test are used to test a CIBU unit:

- A User input test mode embedded directly in the CIBU.
This test can be used to quickly checks the CIBU integrity or for diagnosis purpose in case of doubt with the *User System* connection.
- A test bench used during the manufacturing, generally after the assembling at the production plant.
This test validates the full CIBU functionality, and also the acceptance of the assembled module by the CERN.
- A special device used to validate the connection between the *User System* interface and the CIBU
This test checks if the User interface connection is in compliance with the CIBU requirement, mainly for the new connections or after a long “stop” of the accelerators.



The CIBU User input embedded test mode details

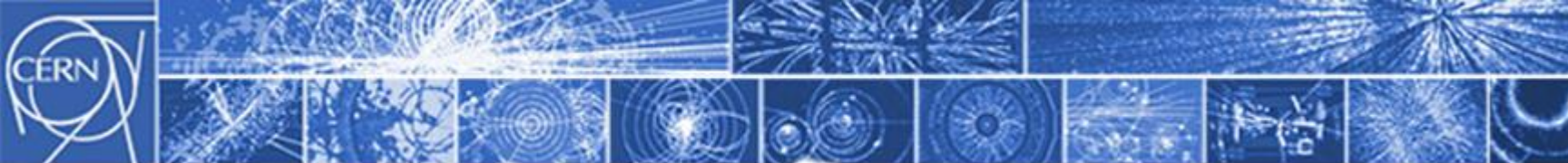


On demand, it's possible to replace the User input by a "true" level.

But, it's not possible to:

- Launch a test on the User permit A & B at the same time
- Enter in "test mode" when there is Operation with beam

The embedded test mode must be safe !



The “manufacturing” test bench details

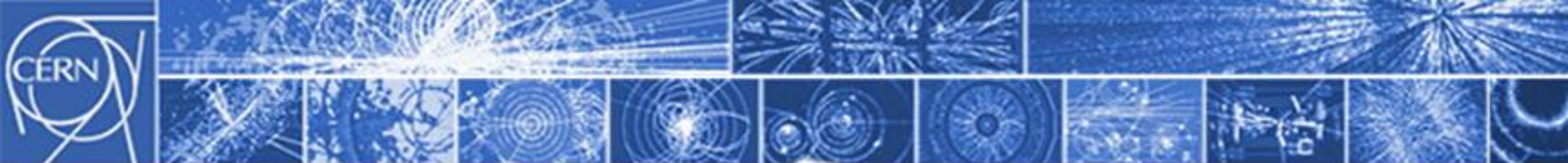


This test bench is used at the production plant
Its role is to fully verify the CIBU functionality.

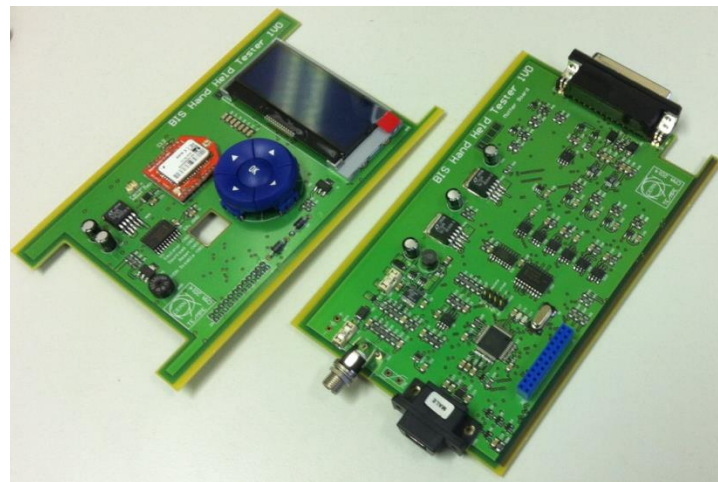
It is realised with an hybrid solution: a National Instrument PXI crate together with a “home made” TCC (Test Controller Card).
Labview software used to control the test bench.

On the front of the CIBU unit, a dedicated 10 pin connector is reserved for the test purpose:





The “BIS handheld tester” details



Home made hardware (mother + daughter board)

This test bench is used to validate the connection between the *User System* interface and the CIBU (currently, up to 364 connections with the different users are necessary for all CERN Facilities)

This test is used to qualify:

- ✓ The *User System* output voltage in open circuit (User_Permit A+ A- & User_Permit B+ B-)
- ✓ The *User System* output impedance for User_Permit A & B
- ✓ The *User System* output voltage and current for User_Permit A & B in closed-circuit
- ✓ The *User System* connection type (distinct, serial or parallel)



Thanks for your attention