# CIBD power supply overview

- Beam Interlock System (BIS) overview
- User Permit Interface (CIBU)
- CIBD power supply
- CIBD issues
- CIBD electrical failures analyse
  - *Yves presentation*
- Conclusion / proposal

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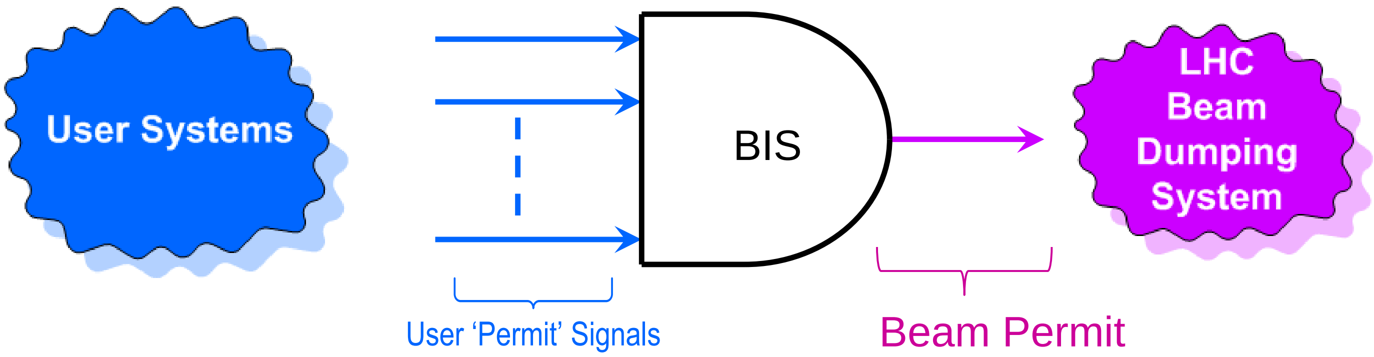
The Beam Interlock System (BIS) has been deployed on all the CERN accelerators with the exception of the PS

The function of the BIS is to collect the "User Permit" signals from the different users and to provide an unique "Beam Permit" signal (per accelerator) to the actuators for dumping the Beam (LHC or SPS) or to inhibit the next injection/extraction




User Systems connected to the BIS

Linac4: ~95

PSB Ejection: ~14

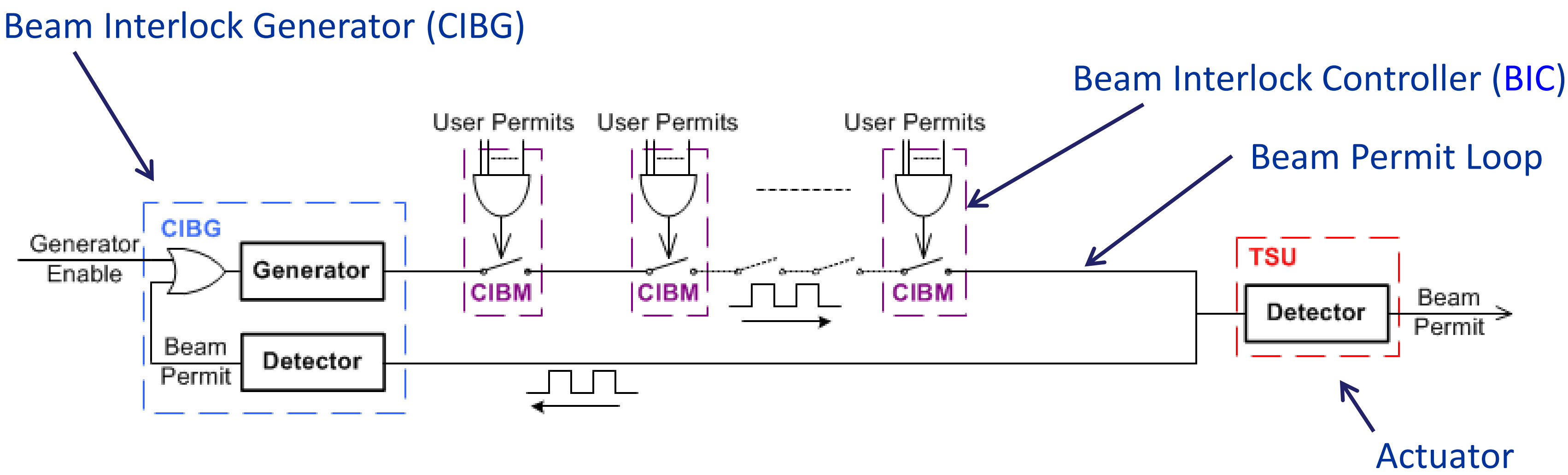
SPS: ~50

SPS Extraction: ~100

LHC Injection: ~40

LHC: ~150

**Total connection on the BIS ~450**

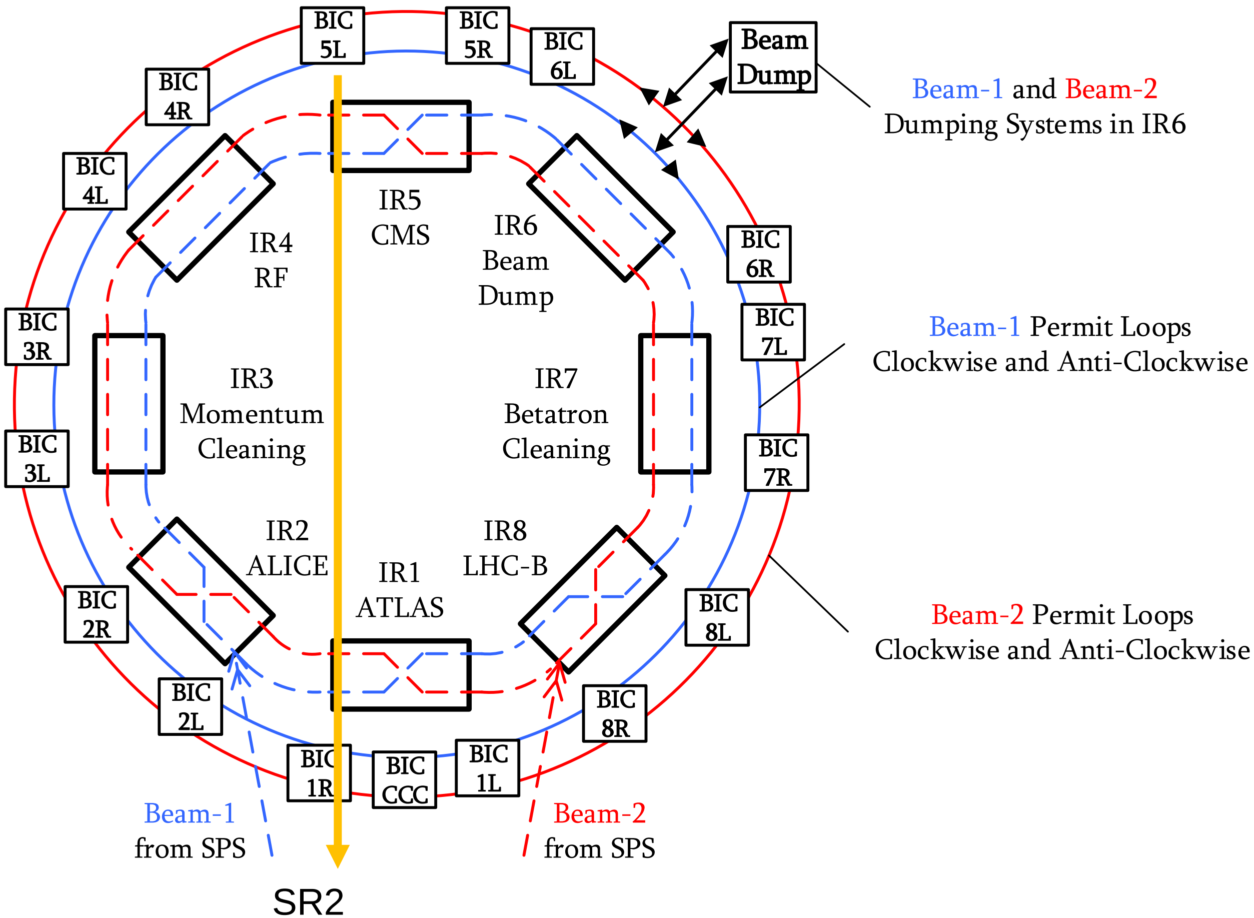


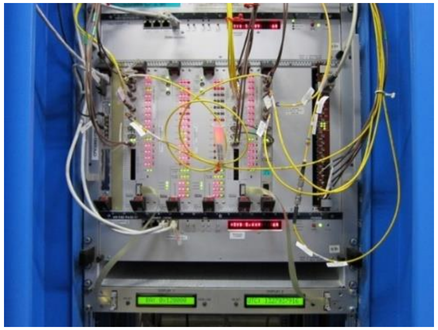

An optical frequency is generated by the generator (CIBG) and is propagated all around the accelerator

Each “User Permit” is connected to a Beam Interlock Controller (BIC)

Each “User Permit” can open the “Beam Permit” loop if required

At the end of the optical loop is connected the actuator in charge of dumping the beam or inhibiting the next pulse (the TSU in the LHC case). If no frequency is received by the TSU, the beam is removed from the LHC



*LHC BIC in UA63*

In the LHC, 17 BICs for each Beam are distributed all over the 27 km of the accelerator

Some connections between the “User System” and the BIC have a length higher than 10 km
*(CMS Users (USC55) to LHC Beam 1 injection (SR2) for example)*

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# Beam Interlock System, CIBU overview

All of the 450 “User Connections” on the different BICs are realised thanks to a standard User Connection Interface, the CIBU. This latter is always installed in the User System rack

Depending on the connection type and length between the CIBU and the BIC, different CIBU type can be used


<u>CIBU**S**</u>: distance to the BIC up to 1.2 km, single connection, differential link, power consumption 400 mA

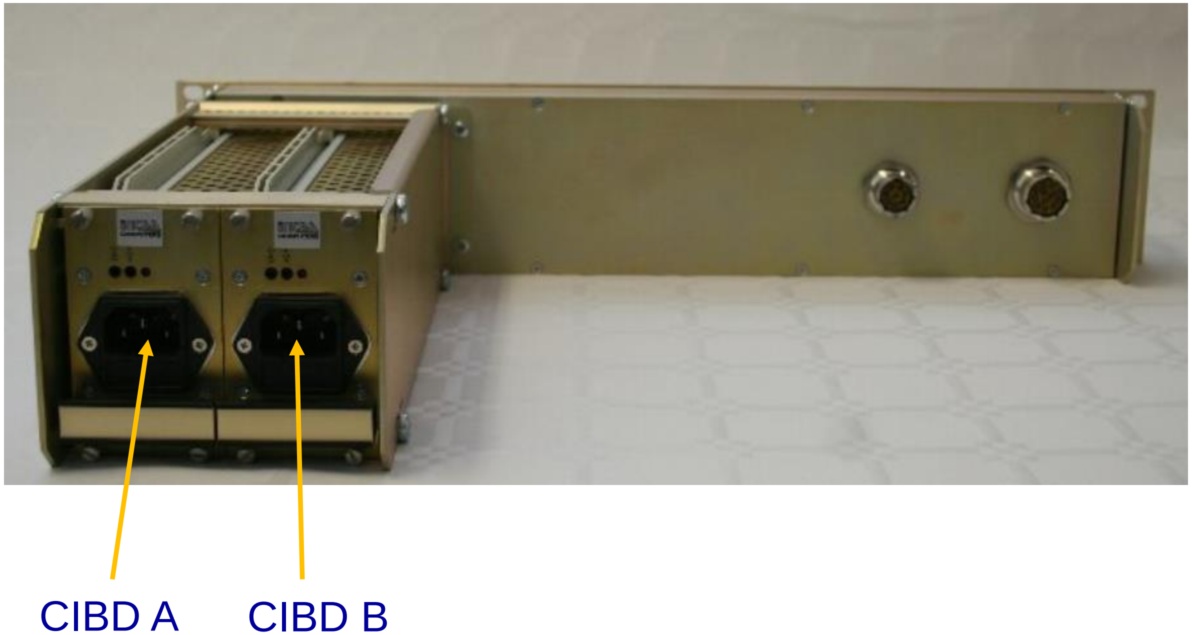

<u>CIBU**D**</u>: distance to the BIC up to 1.2 km, twin independent connections, two differential links, power consumption 900 mA


<u>CIBF**x**</u>: The CIBFx is composed of one CIBF**c** (controller side) and on CIBF**u** (user side)

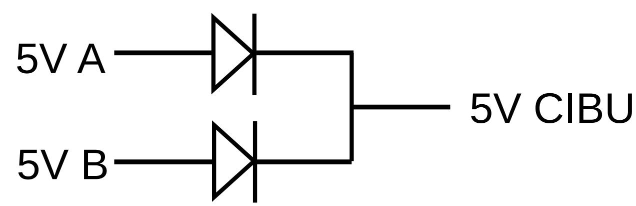
Distance to the BIC up to 15 km, single connection, optical link between the CIBFx modules, and differential connection between the CIBFc and the BIC. The CIBFc and the CIBFu have each a power consumption of 2.4A

# Beam Interlock System, CIBU overview

All CIBUs are powered by two independent power supply, the CIBDs (HCCIBD official name), for a redundancy reason (availability)




Each of the both power supply can withstand the full CIBU power consumption.




The current provided in the previous slide are the worst case where only one CIBD is “alive”. In normal situation (two CIBD alive) this current is less than the worst case.

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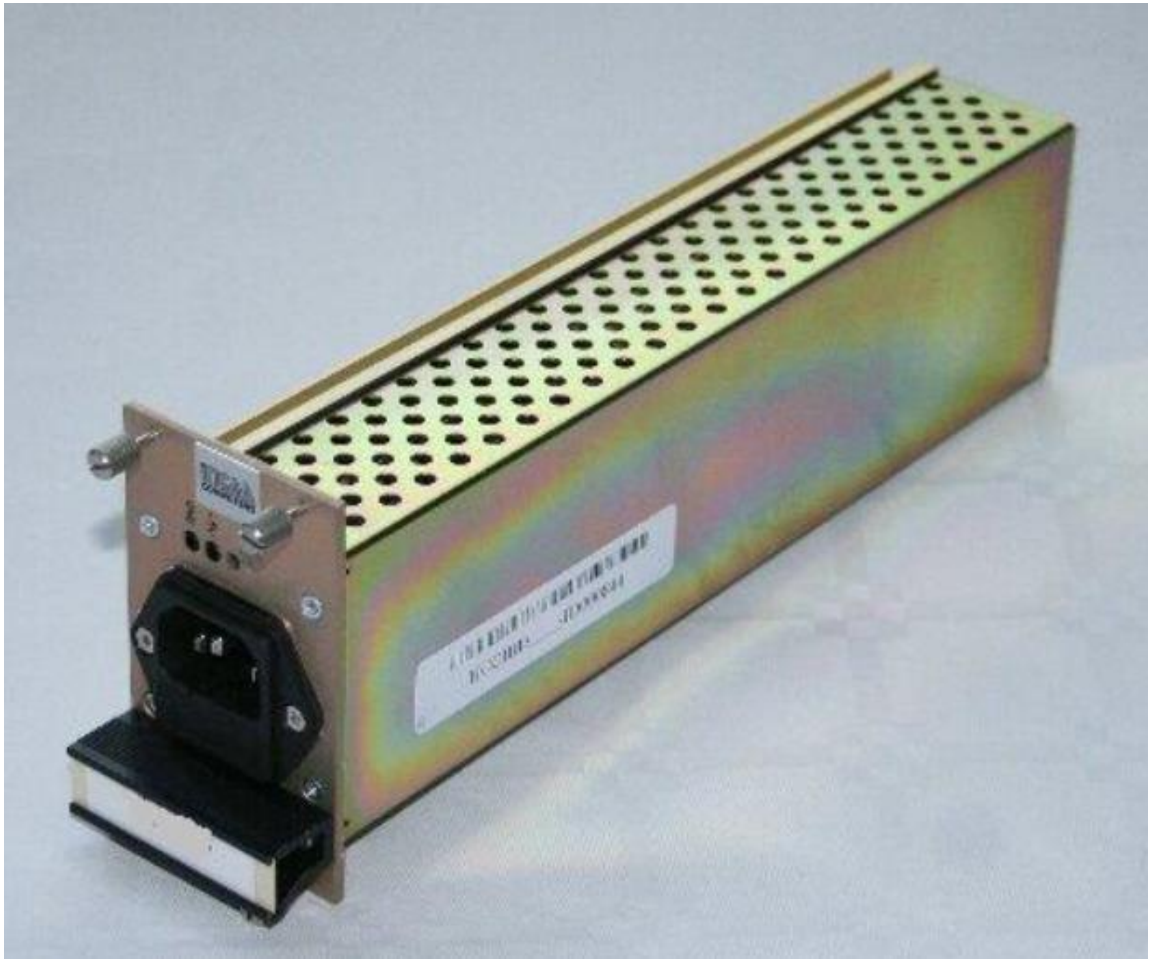
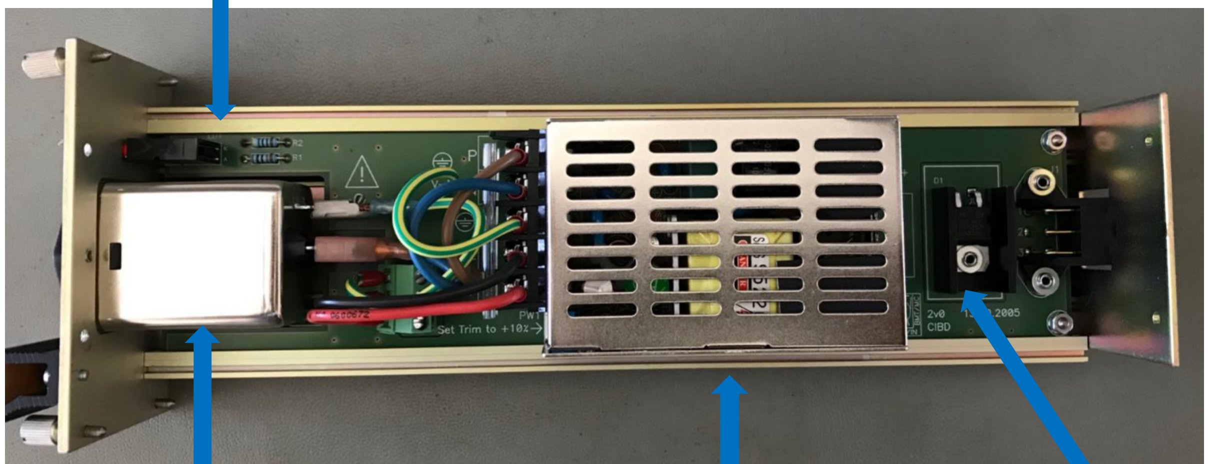


# Inside the CIBD power supply

Status LED
(+ resistors)




Schaffner
Mains filter + fuse
holder

Schottky
power diode


AC/DC converter
In 220VAC Out 5VDC

All components are “passive” components with the exception of the on the shelves AC/DC converter

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Since the beginning of the BIS operation (2007), we have encountered 38 fusible blown, 12 AC/DC converter HS and 1 main filter HS, among the 845 CIBD in operation.

**09/03/2018** => CIBD ID803 mounted on CIBF Totem in USC55 HS. During the exchange we seen the red power light flickering (*first occurrence, nothing captured my attention*)

**22/05/2018** => CIBD ID877 mounted on CIBF Beam Presence Flag in CCR HS. During the exchange we seen the red power light flickering (*second occurrence, strange behaviors for the second time …*)

**23/05/2018** => CIBD ID865 mounted one of the CIBF SMP in CCR HS. During the exchange we seen the red power light flickering (*third occurrence, I ask an internal investigation; no real conclusion …)*

**01/06/2018** => CIBDs ID817, ID714, ID647, ID769 mounted on CIBF in the CRR all HS after a main power fault of BIS CCR racks ( *this last event has trigged an emergency plan*)

Now it's clear that this problem is not a normal end of life of our electronics. Only the CIBDs with the higher current consumption (2.4 A) are affected by this problem.

During the TS1 (18 => 21 June 2018) the 138 CIBDs mounted on the CIBFx have been exchanged.

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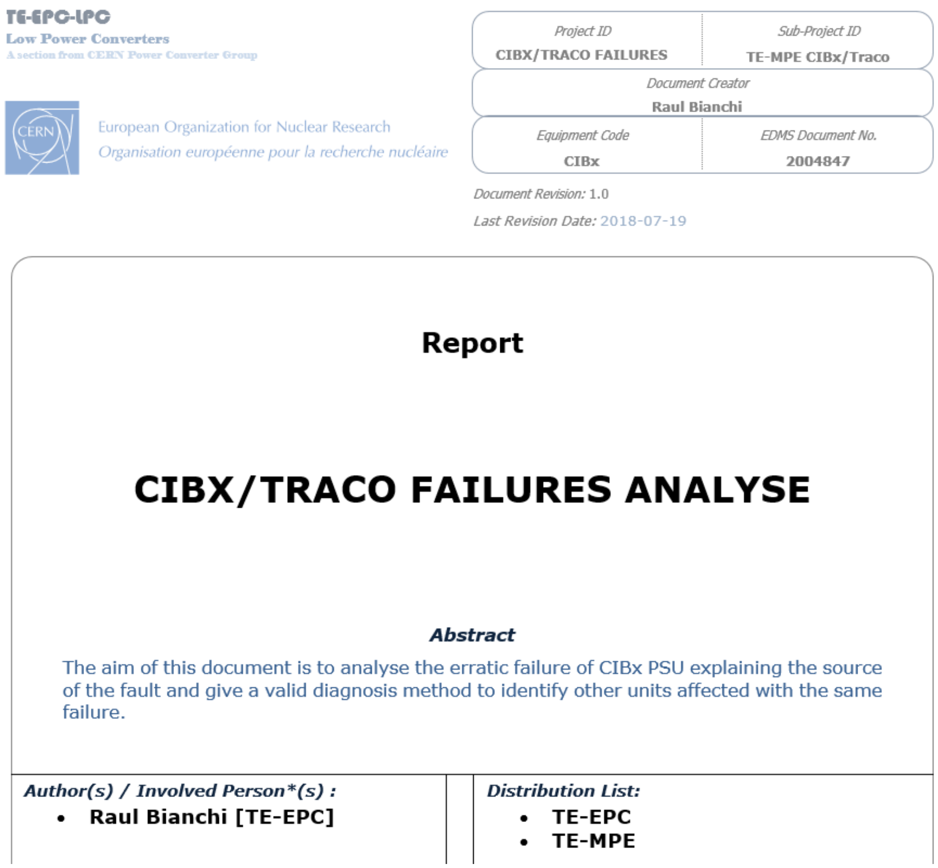
In July the Machine Interlock section has asked the Low Power Converters section to performed an investigation on the CIBD module and more particularly on the AC/DC Traco Power converter.

Thanks to their expertise, the LPC section was able to produce the following report:



TE-EPC-LPC
Low Power Converters
A section from CERN Power Converter Group

European Organization for Nuclear Research
Organisation européenne pour la recherche nucléaire

| Project ID | Sub-Project ID |
| --- | --- |
| CIBX/TRACO FAILURES | TE-MPE CIBx/Traco |

| Document Creator |
| --- |
| Raul Bianchi |

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| CIBx | 2004847 |

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**Report**

**CIBX/TRACO FAILURES ANALYSE**


***Abstract***

The aim of this document is to analyse the erratic failure of CIBx PSU explaining the source of the fault and give a valid diagnosis method to identify other units affected with the same failure.


| ***Author(s) / Involved Person*(s) :*** | ***Distribution List:*** |
| --- | --- |
| • **Raul Bianchi [TE-EPC]** | • **TE-EPC**<br>• **TE-MPE** |

tps://edms.cern.ch/document/2004847/1

Based on the previous report, the following reliability analyze has been performed:

# HCCIBD reliability analyse

## Failure case

*https://edms.cern.ch/document/2000852*

**Yves Thurel presentation**

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# External elements to keep in account before any conclusion:

1) The end of life of BIS V1.0 (and the CIBDs) is foreseen at the end of Run3 (2023)
    - *All the CIBD has to be exchange during LS3*

2) The price to refurbished one CIBD:

| CIBD 2V0 Liste de matériel / Material List | | | | | | | | prix materiel pour remise en etat |
|---|---|---|---|---|---|---|---|---|
| Ref. | Qty | SCEM | Description | Value | Fournisseur/Supplier | | Boitier/Outline | Prix CHF |
| D1 | 1 | | 45V 10A POWER SCHOTTKY RECTIFIER DIODE | | ST MICROELECTRONICS | STPS1045D/F | TO-220AC-H | |
| R1 | 1 | 11.22.10.510.5 | 0.6W ± 1% METAL-FILM RESISTOR | 10k | Bccomponents | MRS25 2322 156 10103 | | |
| R2 | 1 | 11.22.10.347.8 | 0.6W ± 1% METAL-FILM RESISTOR | 470 | Bccomponents | MRS25 2322 156 14701 | | |
| PW1 | 1 | | POWER CONVERTER 100-240 VAC INPUT 5VDC 5A OUTPUT | | TRACO POWER | TXL 025-05S | | **21.90** |
| LD1 | 1 | | 2 x TEST JACK 2mm + 1 x LED 3mm | | MENTOR | 1880 2011 | | |
| J1 | 1 | | 6 PINS RIGHT ANGLE BOARDMOUNT FEMALE CONNECTOR | | SMS | SMS6GE5 | | |
| J2 | 1 | 07.88.25.500.5 | CONNECTING TERMINAL FOR 1.5mm CABLE DIAMETER | | THOMAS BETTS | WKB01-03 AWP | | |
| Heat Sink | 1 | 08.61.10.311.1 | Heat Sink | | FISCHER | SK 431-1 | | |
| Mains Socket | 1 | 08.21.10.260.3 | PRISE SECT.EUR.+FILT.+PTE-F.4A | | SCHAFFNER | FN-261-4-06 | | **15.50** |
| Fuse | 1 | 06.73.51.332.9 | FUSIBLES MINIATURES 5 x 20 mm | 400 mA Slow | SCHURTER | | | |
| | | | | | | | **Total** | **37.40** |

Electronic components = 38 CHF
Manpower (FSU) ½ hour = 50 CHF
Handling (FSU) ½ hour = 50 CHF
Total = **138** CHF

For the 700 CIBD (CIBUS + CIBUD, CIBF yet exchanged) = **100 KCHF**

3) The CIBD are redundant (2xCIBD / CIBUx); to stop the operation, the two CIBD of the same CIBUx have to be defective at the same time …

# CONCLUSION

| Year | 2018 | 2021 | 2022 | 2023 | 2024 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|
| Failures / year | ≈ 1 | ≈ 2 | ≈ 3 | ≈ 5 | ≈ 8 | ≈ 13 | ≈ 20 |
| Cumulative | ≈ 1 | ≈ 2 | ≈ 5 | ≈ 9 | ≈ 18 | ≈ 30 | ≈ 50 |

The previous table doesn't take into account the fact that all CIBD's will be switched off during LS2 to extend their lifetime

In these conditions we will gain at lest two years of operation

**Assuming that the BIS v2.0 will be put in operation during LS3, I propose not to exchange preventively the remaining CIBD during LS2**