FielDrive in Fraunhofer
[NEO 13-049]
Testing Guide

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Introduction 1

The FielDFrive is a component widely used at CERN for the communication over the WorldFIP fieldbus. All along the LHC tunnel different equipment groups, such as cryogenics, power converters and radiation monitoring are using WorldFIP for the communication between their sensors and actuators in the tunnel and the control and supervision level in the control rooms. Figure 1 shows the typical architecture of a WorldFIP network. The FieldDrive chip is an active component that implements the physical layer of the WorldFIP protocol. It is housed in a PLCC 28 pins package.

The French company Alstom is CERN's provider of FielDrive chips. CERN has recently purchased 4'000 FielDrive chips, all coming from the exact same batch: 1132A. CERN is interested in validating the batch, by testing at the Fraunhofer facility.
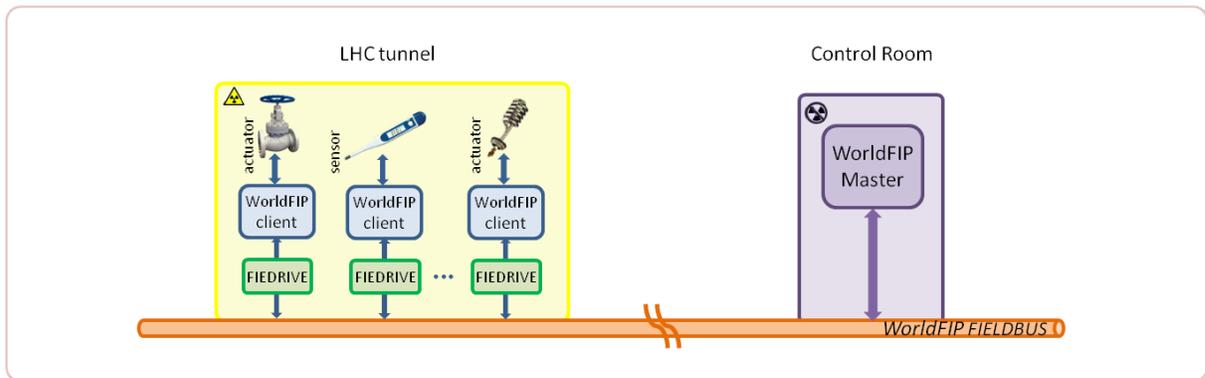

Figure 1: WorldFIP architecture

The different equipment groups have been testing FielDrives under radiation, always along with other components on their boards. Although so far there has been no suspicion for its vulnerability up to 400 Gy, because of its critical role it was recently decided to perform dedicated tests on the component alone.

For the tests CERN is providing 15 FielDrive chips, randomly selected amongst those 4'000. The target is confirming that the batch's TID limit is above 400 Gy.

Testing Procedure Overview 2

In the Fraunhofer facility, the FielDrive will be tested **passively,** which means not powered, at a **low dose rate**, following the "standard" irradiation steps: 0.5 kGy, 1.0 kGy, 2.5 kGy.

The Fraunhofer code for the project is "**NEO 13-049**".

1. Fraunhofer will receive **15** FieldDrive chips, randomly selected amongst the 4'000 chips of the 1132A batch. The components are grouped in **3 groups of 5** chips:
   - o all the components of group #1 will be tested up to **0.5 kGy**
   - o all the components of group #2 will be tested up to **1.0 kGy**
   - o all the components of group #3 will be tested up to **2.5 kGy**

2. Once the components of a group have reached the target TID, they are **removed** from the radioactive environment and **immediately after**, their functionality is **verified** using the provided system and a digital voltmeter.
   To avoid annealing effects it is important to verify the functionality immediately after the irradiation. Note that each one of the components of a group should be verified.

   In the case where drifts are observed from the expected values the **verification** procedure is **repeated every 12 hours for the next 168 hours** to check for annealing.

3. The results of the performance of each chip are reported to the CERN responsible.

System Setup Overview 3

Figure 2 shows the system we are providing for the validation of the irradiated FielDrive chips; Table 1 lists its main parts. It is important to stress that the system should be placed on a **radiation free** zone.
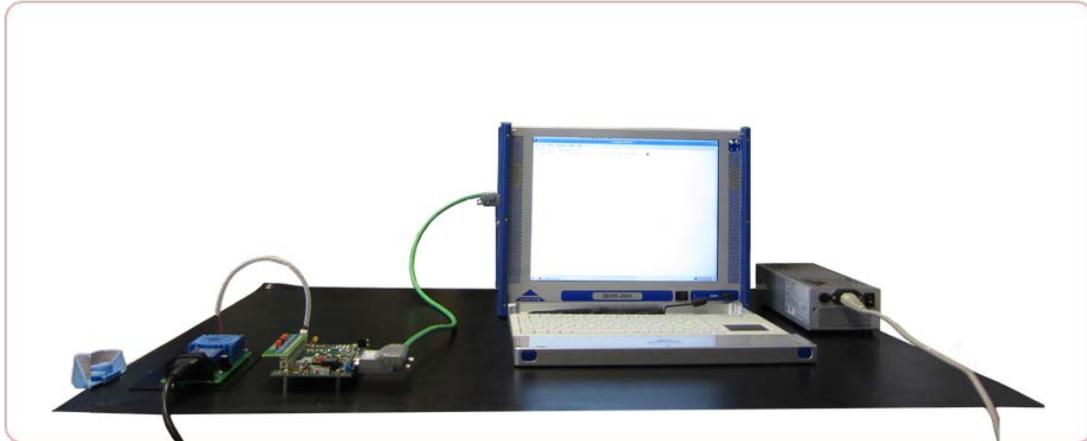

Figure 2: System for the FielDrive functionality validation

Item	Comments
1x transportable computer	includes monitor, keyboard, mouse; transformer and power cable also provided; WorldFIP master card installed; Software for automated validation installed
1x WorldFIP client board	transformer and power cable provided; the board provides a socket where the FielDrive DUT is placed board schematics available here
1x spare WorldFIP client board	identical to the one described above; to be used if the first one does not work properly
1x socket extraction tool	tool for the easy extraction of a DUT from the socket
1x WorldFIP green cable	1m cable that connects the board to the computer
1x FielDrive "reference chip"	chip for the validation of the system setup
1x voltmeter or oscilloscope	not provided; please inform us if there is none available
1x ESD mat with wrist strap	not provided; please inform us if there is none available
Documentation	this user guide plus a one-page testing procedure

First Time Setup

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Once the equipment is received, the system setup itself needs to be validated. For this purpose, a "reference FielDrive chip" is provided; this chip will not be irradiated, it is only used for the validation of the setup. The following steps describe the procedure for the validation of the system setup.

1. Place the **computer** along with its **transformer** on the antistatic mat.
    Confirm that the transformer's ON/OFF switch is ON and connect it to the 230V mains.
    Connect the transformer output to the corresponding plug of the computer.
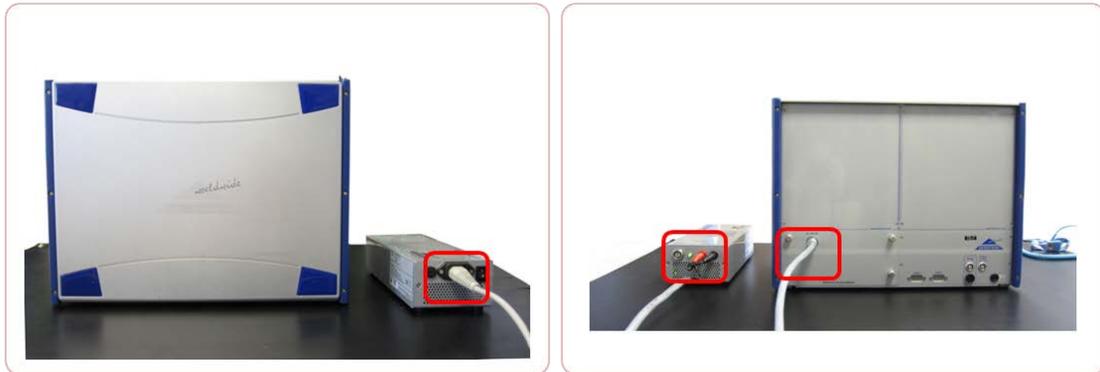   The green LED on the transformer should turn ON.

Figure 3: Computer-transformer-mains connections

2. Place the green **WorldFIP cable** on the corresponding connector on the side of the computer, as indicated in the figure that follows.
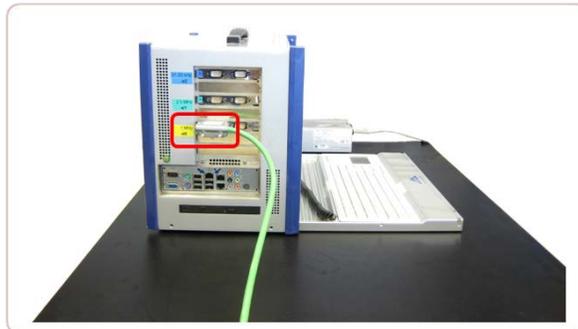

Figure 4: WorldFIP cable on hte computer side

3. Place the board along with its transformer on the ESD mat.
    Connect the board to its **transformer**, **without** plugging the 230V mains yet.
    Connect the other side of the green **WorldFIP** cable to the connector on the board.
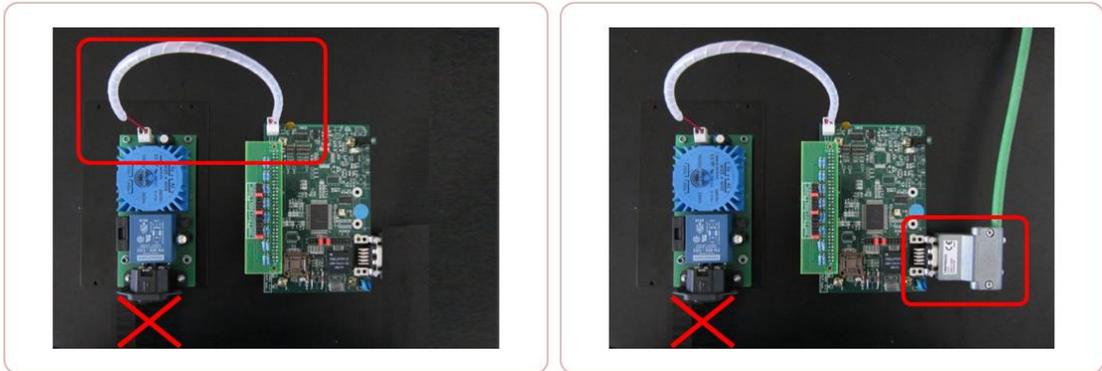

Figure 5: Board connections

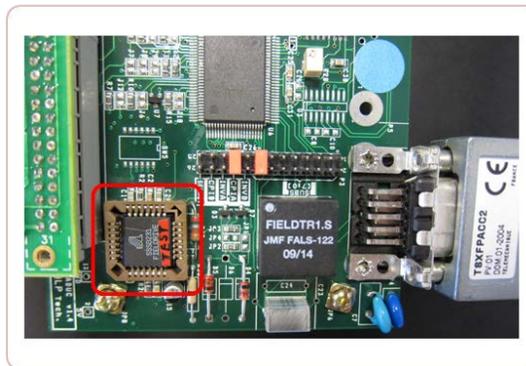4. Place the reference FielDrive chip inside the **socket** on the board.

Figure 6: Reference FielDrive chip into socket

5. Only now, connect the 230V mains to the **transformer**. The green LED on the board should now turn ON.
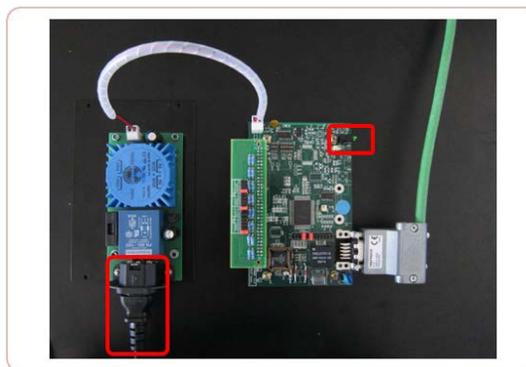

Figure 7: Board power-up

6. Switch the **computer ON** by pressing the corresponding switch under the screen.
   The "*Scientific Linux CERN SLC (2.6.24.7-rt27)*" operating system will automatically be loaded; at the end the user is prompted to provide the **username** and **password**.
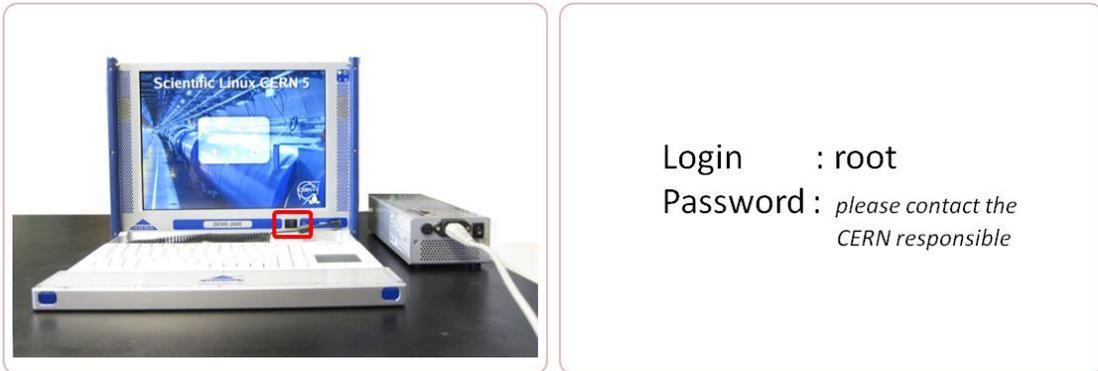

Login   : root
Password : *please contact the*
            CERN responsible

Figure 8: Computer start-up

7. A terminal opens automatically.
   Type *"cd ↵"*
   Type *"./test ↵ "* or use the keyboard arrows to bring the **last command** from the history.

Figure 9: Software start-up

8. The testing software starts. As the following figure shows, the user should be expecting NO ERRORS, i.e. the "**Last 10 errors**" section of the screen should remain empty.
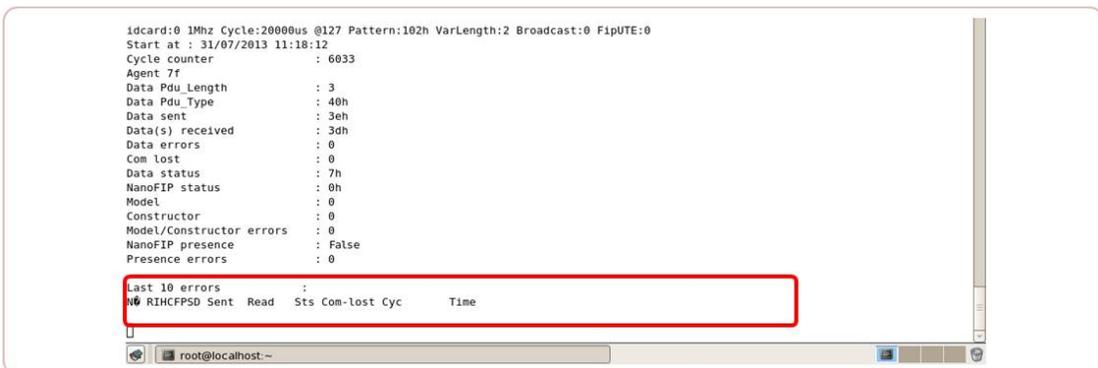

Figure 10: Software screenshot with no errors

If errors appear, as the following figure shows, please contact the CERN responsible. You will also be hearing a low volume beeping from the computer when errors appear.


```
idcard:0 1Mhz Cycle:20000us @127 Pattern:102h VarLength:2 Broadcast:0 FipUTE:0
Start at : 31/07/2013 11:20:44
Cycle counter          : 507
Agent 7f
Data Pdu_Length        : 3
Data Pdu_Type          : 40h
Data sent              : 7ch
Data(s) received       : 16h
Data errors            : 1
Com lost               : 100
Data status            : 0h
NanoFIP status         : 0h
Model                  : 0
Constructor            : 0
Model/Constructor errors   : 95
NanoFIP presence       : False
Presence errors        : 41

Last 10 errors        :
NO RIHCFPSD Sent  Read   Sts Com-lost Cyc      Time
7f 01110000 123   022    0   00000100 00000507  Wed Jul 31 11:20:55 2013
7f 01110000 122   022    0   00000099 00000506  Wed Jul 31 11:20:55 2013
7f 01110000 121   022    0   00000098 00000505  Wed Jul 31 11:20:55 2013
7f 01110000 120   022    0   00000097 00000504  Wed Jul 31 11:20:55 2013
7f 01110000 119   022    0   00000096 00000503  Wed Jul 31 11:20:55 2013
7f 01110000 118   022    0   00000095 00000502  Wed Jul 31 11:20:55 2013
7f 01110000 117   022    0   00000094 00000501  Wed Jul 31 11:20:55 2013
7f 01110000 116   022    0   00000093 00000500  Wed Jul 31 11:20:55 2013
7f 01110000 115   022    0   00000092 00000499  Wed Jul 31 11:20:55 2013
7f 01110000 114   022    0   00000091 00000498  Wed Jul 31 11:20:55 2013

root@localhost:~
```

Figure 11: System validation failed

9. While the testing software is running, take a measurement of the **current consumption**; place the voltmeter between the **GND** and the **Test Point 4** as the following figure shows. The relationship linking the current consumption (in Amperes) to the measured voltage (in Volts) is V = 5*I. In a typical measurement, the voltage is varying between 0.5 and 0.6 V DC.
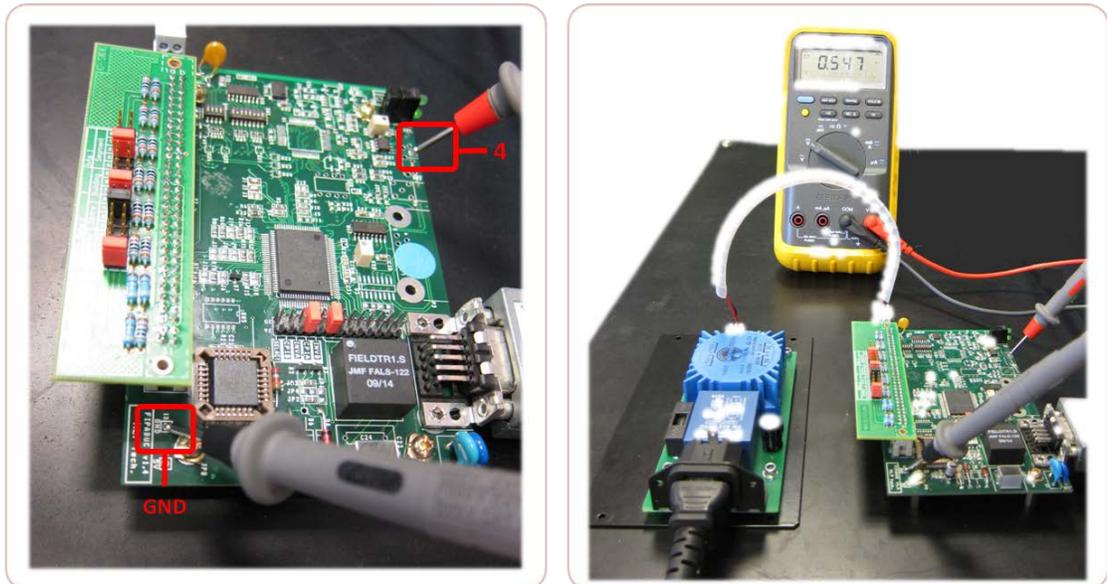

Figure 12: Current consumption measurement

10. Confirm that no errors appear even after around 2 min, i.e. until the "**Cycle Counter**" has reached > 6000 cycles.
You may now **stop the program** by pressing simultaneously the keys "*Ctrl*"+"*C*".
The system is validated!


```
idcard:0 1Mhz Cycle:20000us @127 Pattern:102h VarLength:2 Broadcast:0 FipUTE:0
Start at : 31/07/2013 11:10:13
Cycle counter            : 6033
Agent 71
Data Pdu_Length          : 3
Data Pdu_Type            : 40h
Data sent                : 3eh
Data(s) received         : 3dh
Data errors              : 0
Com lost                 : 0
Data status              : 7h
NanoFIP status           : 0h
Model                    : 0
Constructor              : 0
Model/Constructor errors : 0
NanoFIP presence         : False
Presence errors          : 0

Last 10 errors           :
N° RIHCFPSD Sent  Read   Sts Com-lost Cyc        Time


root@localhost:~
```

Figure 13: Wait until the Cycle counter has counted >6000

11. To remove the reference FieldDrive chip from the socket, first **unplug the 230V** mains from the board's transformer. The green LED on the board should turn OFF.
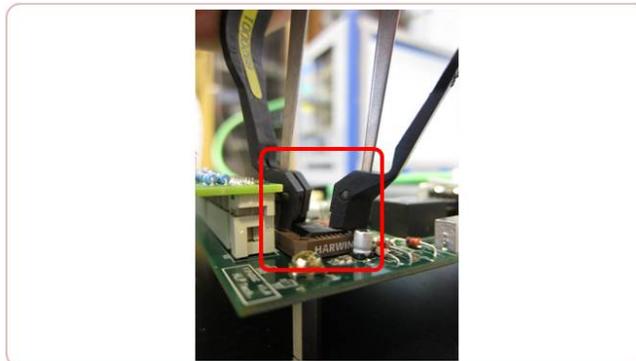Use the provided tool to grab and extract the component.

Figure 14: Chip extraction tool

12. Leave the **computer switched ON** and the **WorldFIP cable** between the board and the computer connected; the **230V** of the board's transformer should remain **unplugged**.
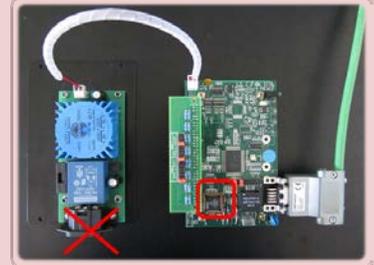
Testing Procedure

1) **Irradiate** the components up to the expected TID.

Group #1	0.5 kGy
Group #2	1.0 kGy
Group #3	2.5 kGy

2) Move the components to a **radiation-free zone**, where the system setup is located.
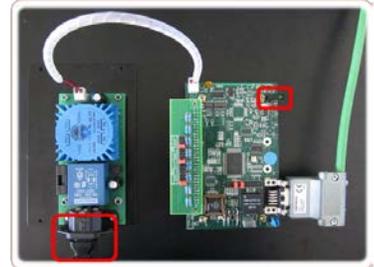
   Make sure the board is **not powered**.

   Place one of the irradiated components inside the board's **socket,** using the **ESD strap**.
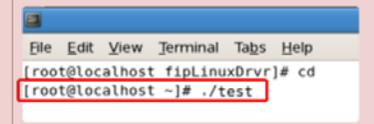

3) Connect the **230V** mains cable to the board's transformer.

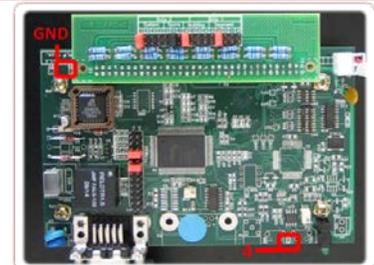   The green LED should now turn ON.

4) Launch the **software** on the computer by typing "*./test ↵*".

5) Take a measurement of the current consumption; place the voltmeter between: **GND** and the **test point 4**.

   Normally the measurements vary between 0.5 V and 0.6 V

5) Wait until the "***Cycle counter***" reaches more than 6000, checking the "***Last 10 errors***" section:
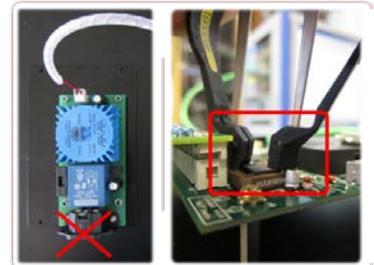
   o If the component is OK, the section will remain empty.
   o If the component is damaged, errors will be appearing.
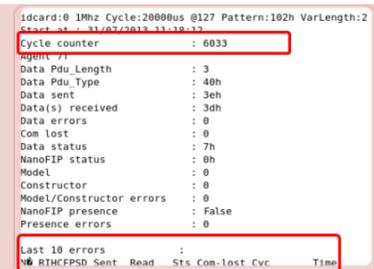
6) Press "*Ctrl*"+"*C*" to stop the program.

   Unplug the 230V from the board's transformer.

   Unmount the component using the provided tool.

7) **Report** all the acquired results; if **abnormal results** are reported for a component, **repeat** the same procedure **every 12 hours for the next 168 hours**.

CERN Contacts

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