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fenix

WP3 – PILOT PLANTS RECONFIGURATION/ IMPLEMENTATION

T 3.2 – Development, testing and optimization of an assembly-disassembly pilot station

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ABSTRACT

The main aim of the FENIX project is the development of new business models and industrial strategies for three novel supply chains in order to enable value-added product-services. Through a set of success stories coming from the application of circular economy principles in different industrial sectors, FENIX wants to demonstrate in practice the real benefits coming from its adoption. In addition, Key Enabling Technologies (KETs) will be integrated within the selected processes to improve the efficient recovery of secondary resources. In this sense, among the available KETs, the adoption of digital and advanced automated solutions allows companies to re-thinking their business strategies, trying to cope with even more severe environmental requirements. Among these technological solutions, the paradigm of Industry 4.0 (I4.0) is the most popular. I4.0 entails the development of a new concept of economic policy based on high-tech strategies and internet-connected technologies allowing the creation of added-value for organizations and society. Unlike the activities developed in T3.1, related to the development and implementation of simulation tools and models for the smartphones' disassembly process optimization, here the attention has been spent in managing and optimizing the new semi-automated PCBs disassembly station. The disassembly of products is a key process in the treatment of Waste Electrical and Electronic Equipment. When performed efficiently, it enables the maximization of resources re-usage and a minimization of pollution. Within the I4.0 paradigm, collaborative robots (co-bots in short) can safely interact with humans and learn from them. This flexibility makes them suitable for supporting current CE practices, especially during disassembly and remanufacturing operations. D3.2 focuses on describing the video of the semi-automated PCB disassembly process implemented at the POLIMI's Industry 4.0 Lab, aiming to demonstrate in practice the benefits of exploiting I4.0 technologies in PCB disassembly processes. Results highlight how a semi-automated cell where operators and cobots works together can allow a better management of both repetitive and specific activities, the safe interaction of cobots with operators and the simple management of the high variability related with different kinds of PCBs.

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Abbreviations and Acronyms:	
I4.0	Industry 4.0
PCB	Printed Circuit Board
WEEE	Waste from Electrical and Electronic Equipment

1. INTRODUCTION

1.1. D3.2 scope

The intent of D3.2 is presenting the real implementation of a semi-automated PCB disassembly station at the POLIMI's Industry 4.0 Lab. This way, a video has been produced and this document will describe some screenshots gathered from it. Considering what already defined in D3.1, the intent of POLIMI's work was the disassembly of wasted Printed Circuit Boards (PCBs) and their preparation for further recycling (done by UNIVAQ). Specifically, these activities:

- Were performed on a completely new semi-automated PCBs disassembly station (implemented in M21), constituted by a cobot and dedicated unsoldering tools
- Partially replicated the simulation tools and models described in D3.1, but managing and optimizing the new semi-automated PCBs disassembly station
- Tested both ergonomics and integrability with other FENIX pilots
- Started from wasted PCBs manually extracted from WEEEs by GREEN operators.

1.2. D3.2 structure

D3.2 structure follows the PCB disassembly process, constituted by six steps:

1. Environment setup: the table, tools and PCB holder are put in place
2. Front setup: the PCB is placed in the PCB holder and the cobot is placed in the starting position (a reference position respect to the PCB)
3. Front de-soldering: the PCB's front side is unsoldered and chipsets are removed from the board
4. Back setup: the PCB is placed in the PCB holder and the cobot is placed in the starting position
5. Back de-soldering: the PCB's back side is unsoldered and chipsets are removed from the board
6. Environment reset: the PCB holder is removed, tools are cleaned from residues and the PCB is stored in a dedicated warehouse

Steps 4 and 5 can be optional, depending on the structure of the PCB.

We assumed that operations start and end with a cleaned worktop. If this is not the case, step 1 and 6 might not be performed.

Each step has been briefly described in a dedicated section. Finally, section 7 provides some concluding remarks.

2. ENVIRONMENT SETUP

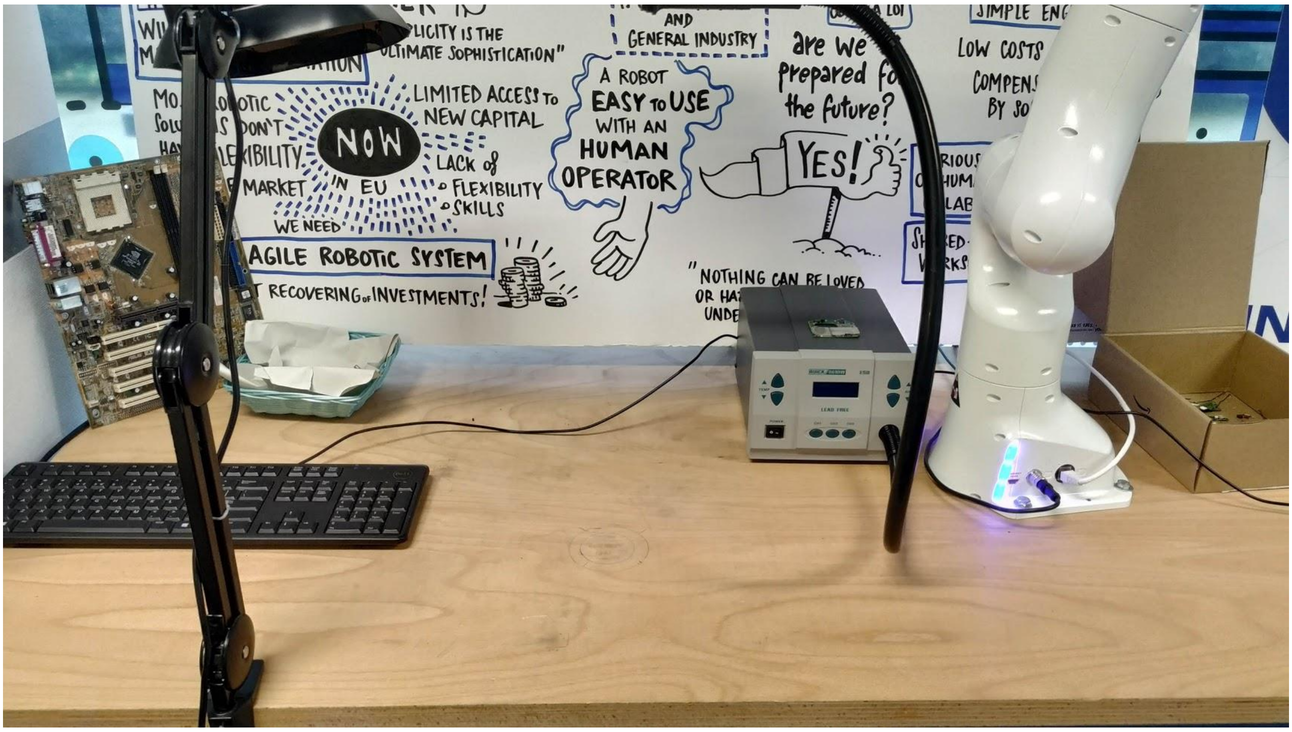

Figure 1: Environment setup (clean worktop)

Starting from a clean worktop, we gathered and placed all the tools required for the operation.

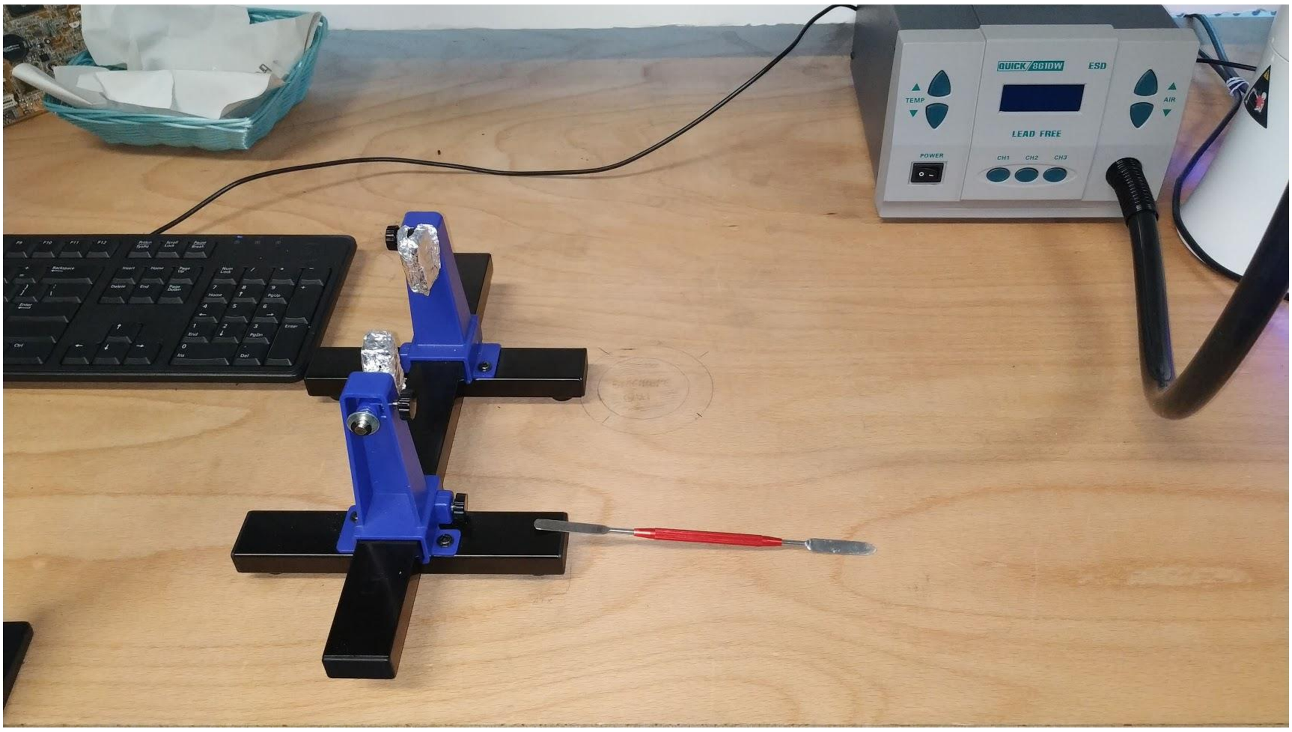

Figure 2: Environment setup (tools positioning)

Then, we select the PCB.

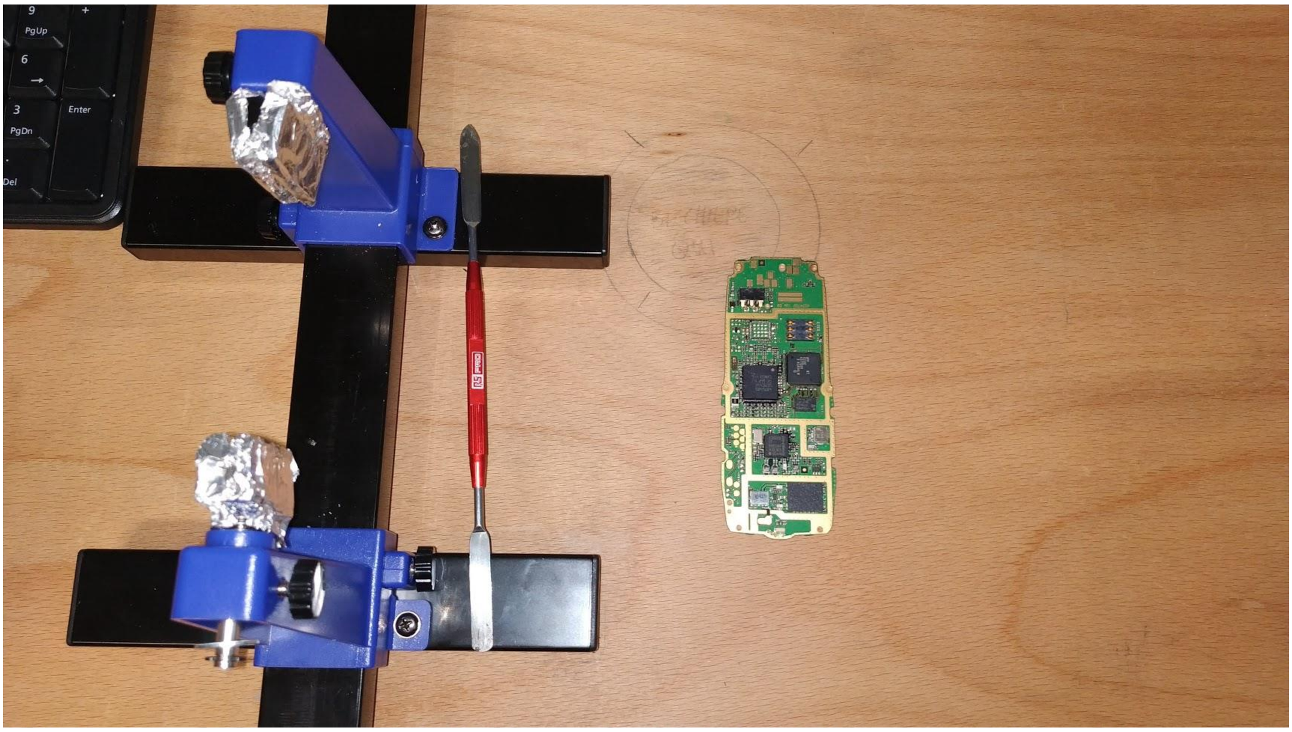

Figure 3: Environment setup (PCB selection)

Now, we are ready to start with the front setup.

3. FRONT SETUP

We first insert the PCB into the PCB holder, with its front face towards the cobot.

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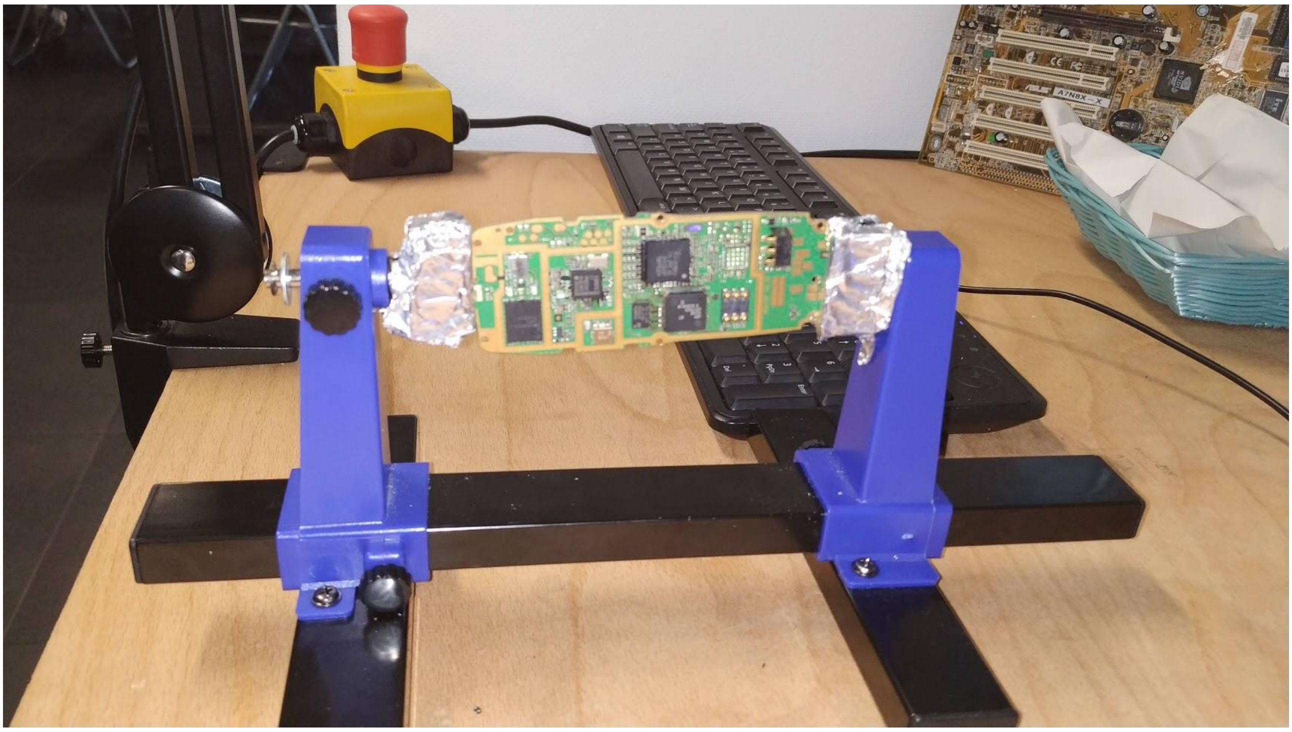

Figure 4: Front setup (PCB positioning)

Then, the cobot arm is put in the starting position in front of the PCB.

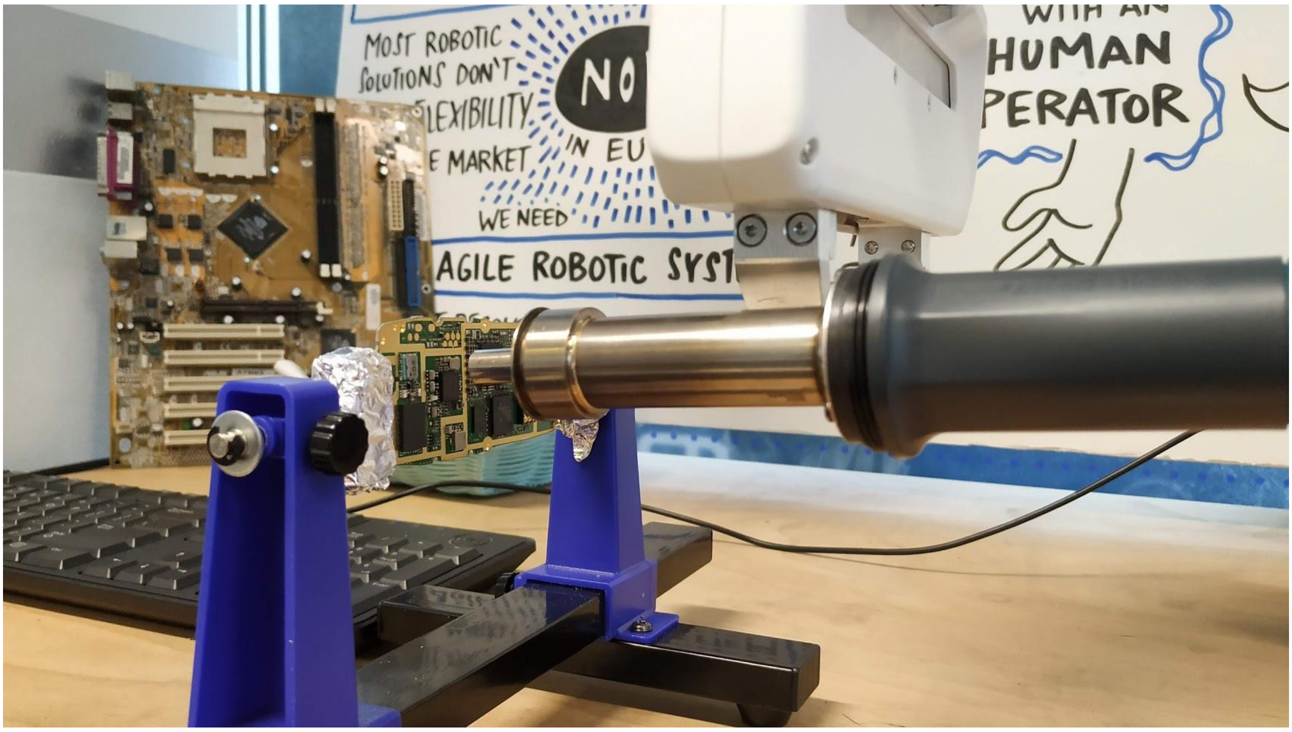

Figure 5: Front setup (cobot positioning)

Then, the operator can turn on the unsoldering tool and the PCB unsoldering process can start.

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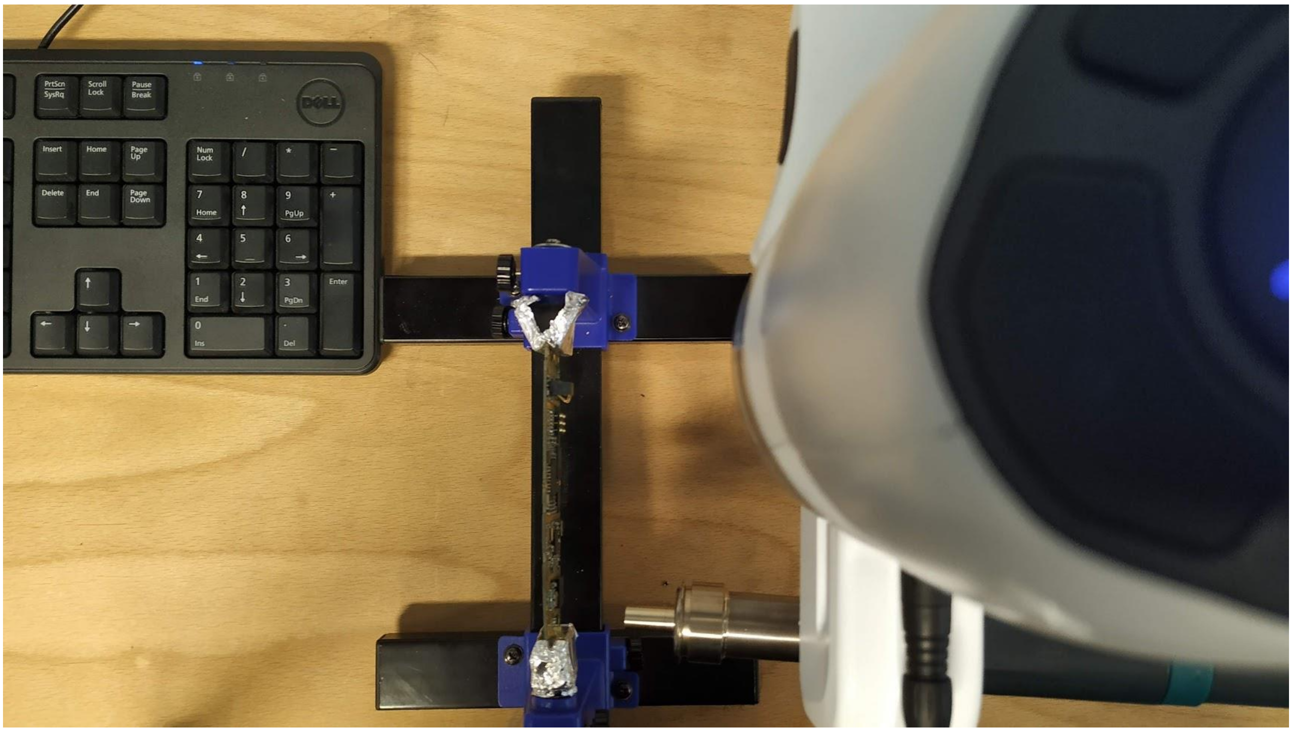

Figure 6: Front setup (front PCB unsoldering process start)

4. FRONT UNSOLDERING

The operator, once fitted with the necessary personal protective equipment, the self-protecting devices, can start working on the PCB. First, the hot air flow is directed to the area of interest. Then, with a metal spatula, the operator can remove all the chipsets, whose pins are already loosened by the unsoldering process.

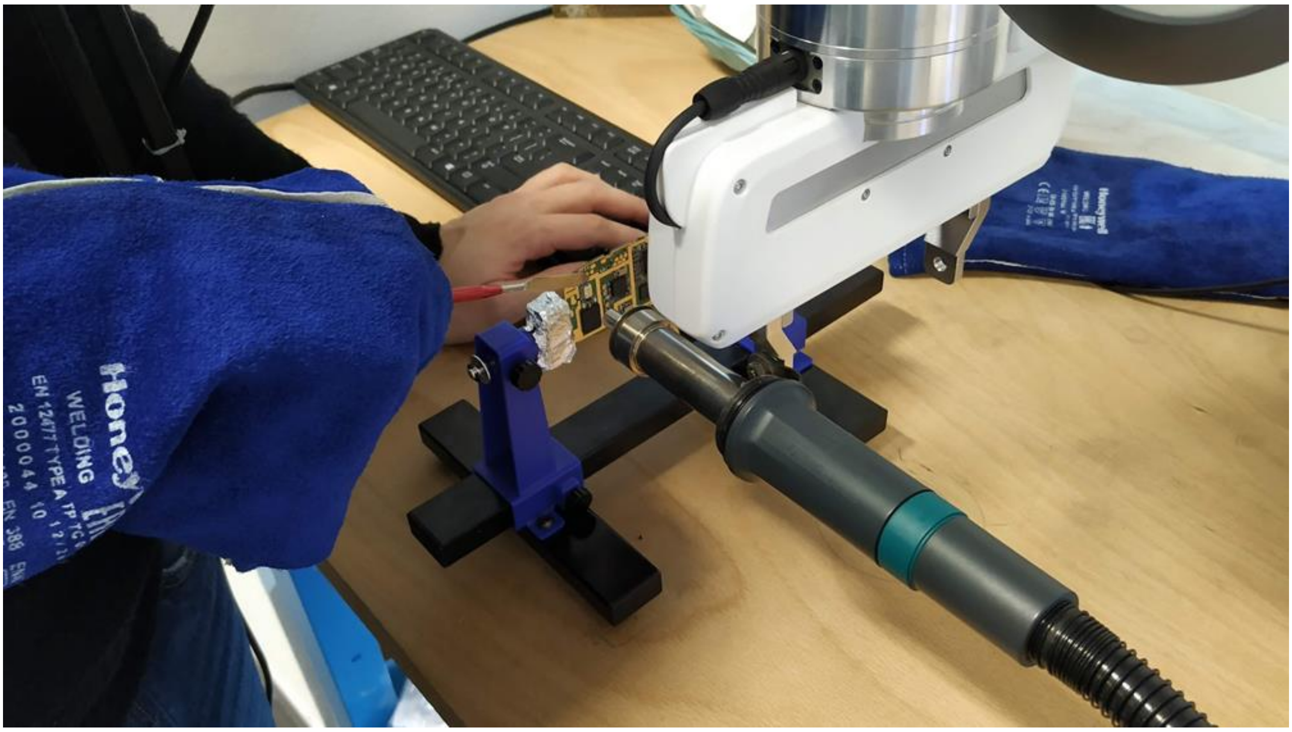

Figure 7: Front unsoldering (initialization)

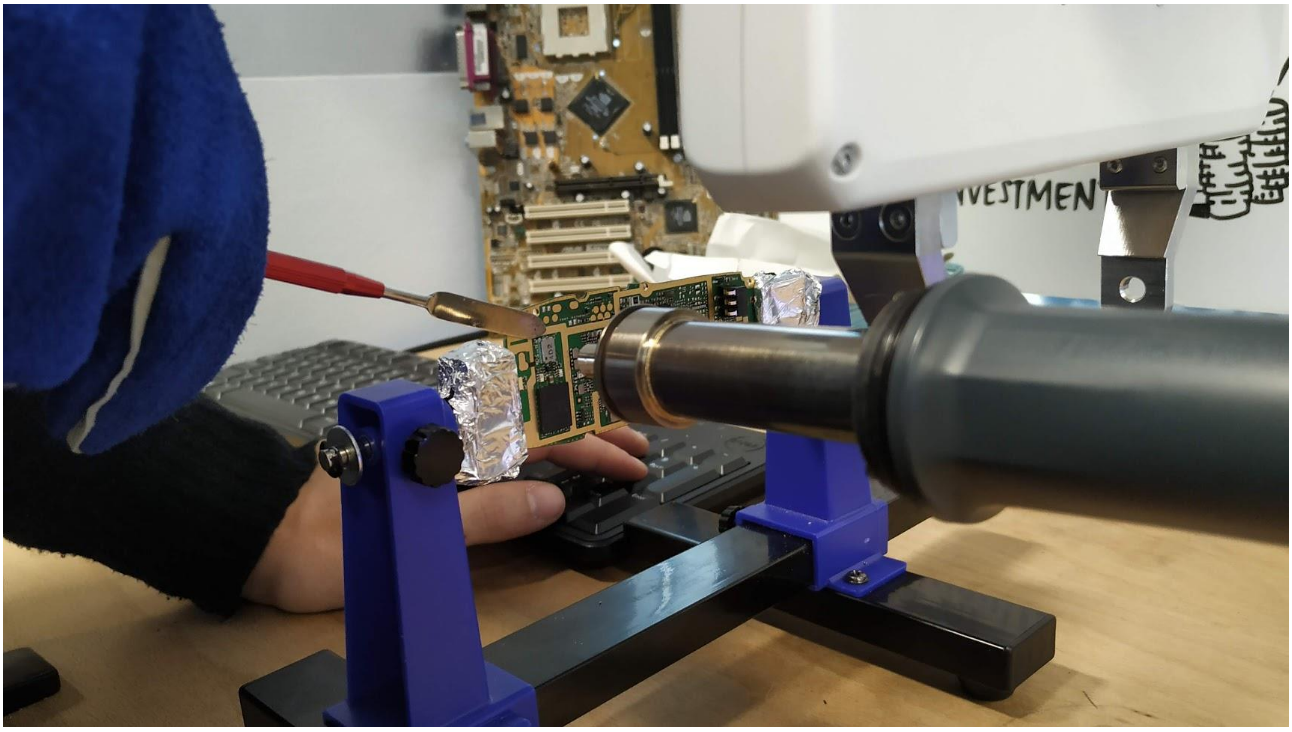

Figure 8: Front unsoldering (chipset disassembly 1)

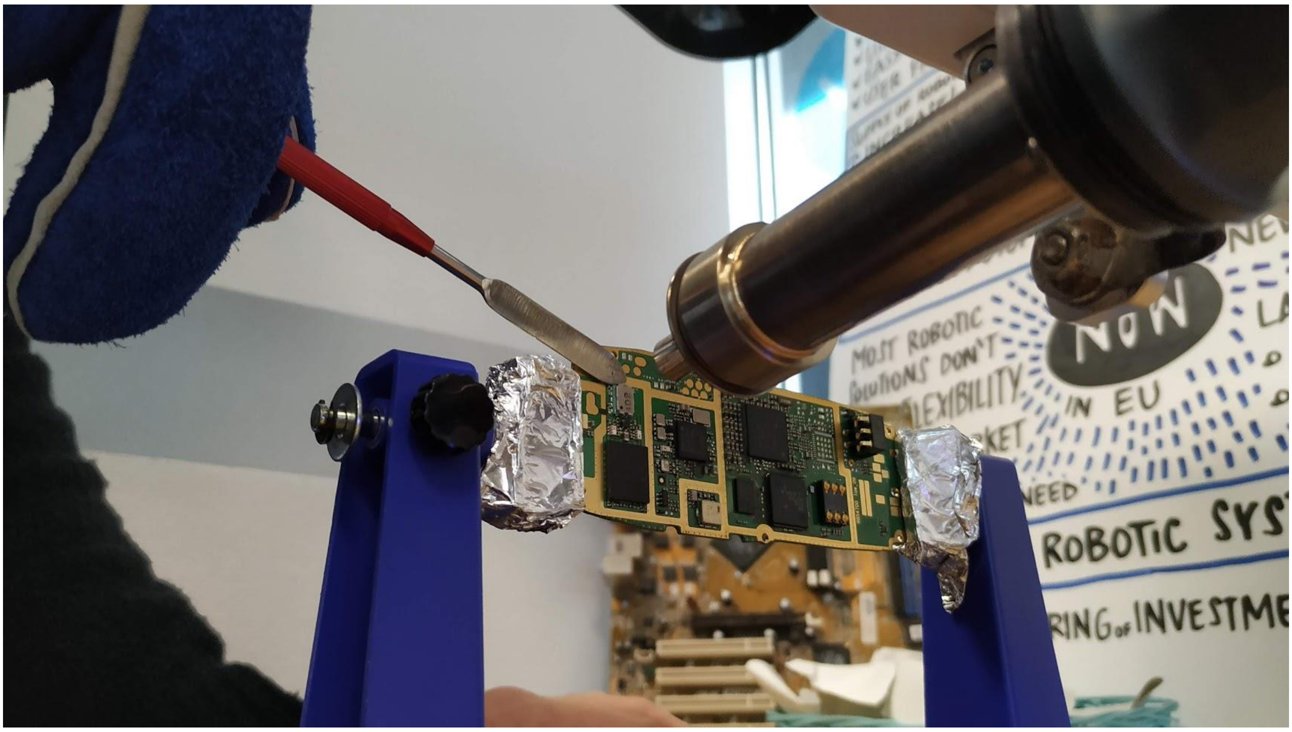

Figure 9: Front unsoldering (chipset disassembly 2)

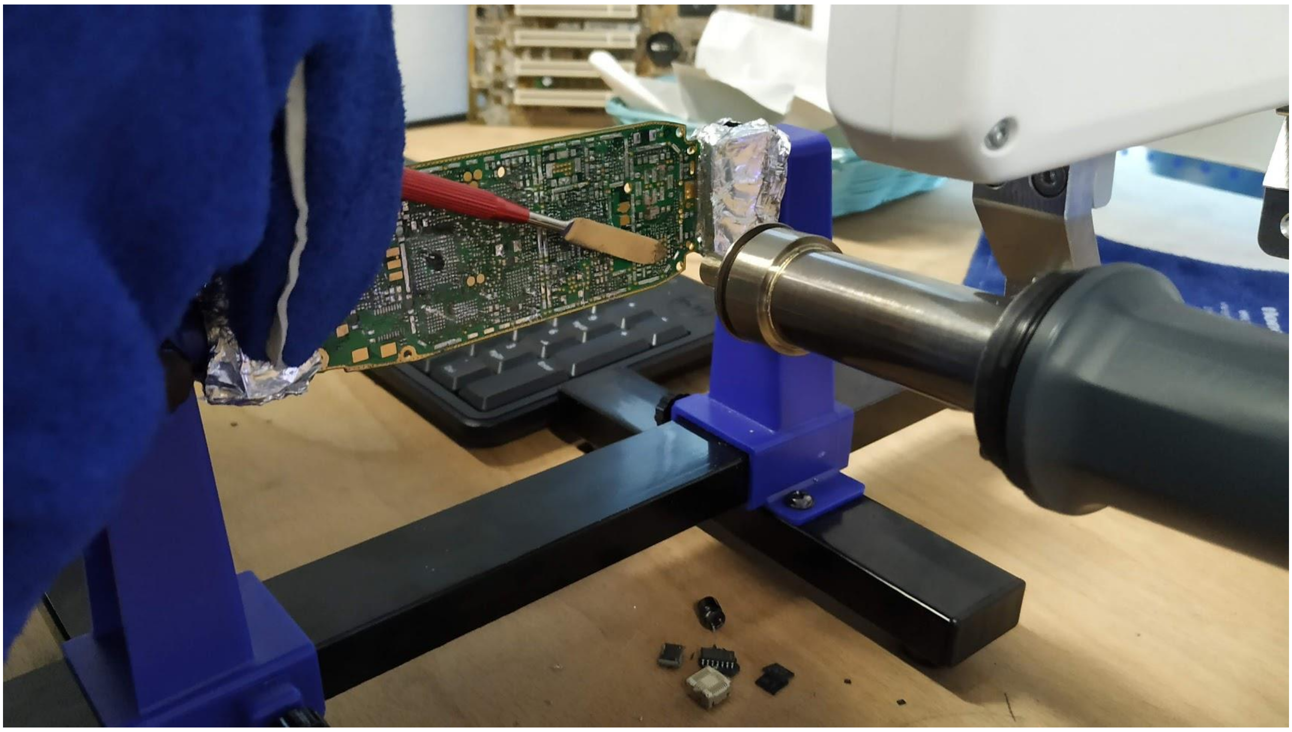

Figure 10: Front unsoldering (chipset disassembly 3)

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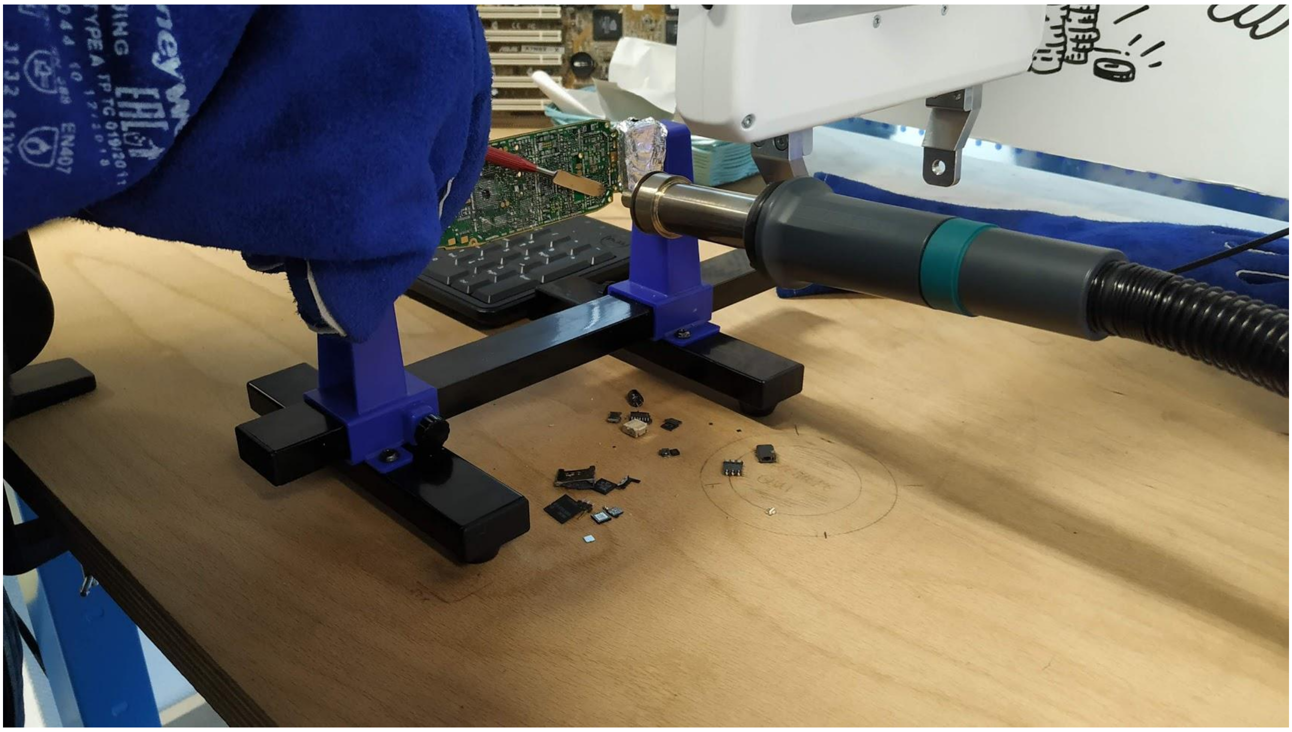

Figure 11: Front unsoldering (chipset disassembly 4)

Once all the chipsets have been unsoldered, the unsoldering tool is turned off.

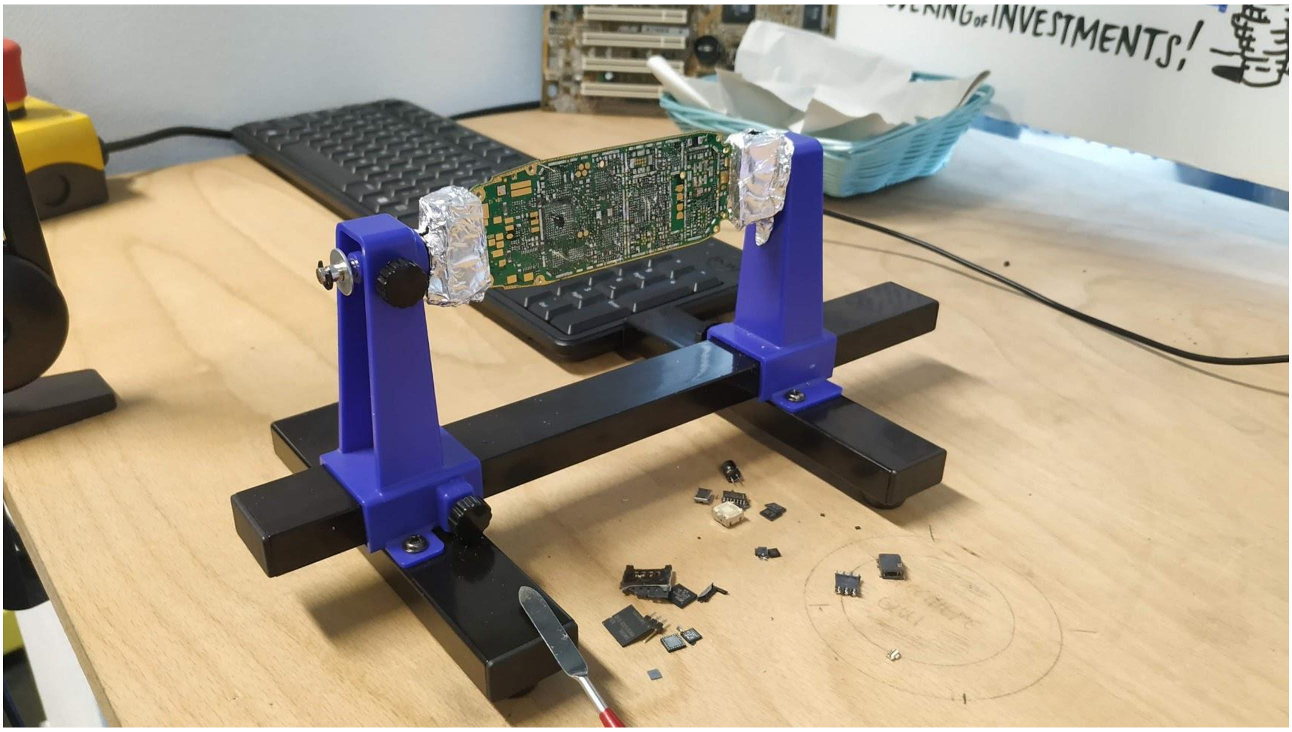

Figure 12: Front unsoldering (finalization)

5. BACK SETUP

The PCB is, then, reversed on the PCB holder, and the cobot is put again in the starting position.

6. BACK UNSOLDERING

The same process defined for the front unsoldering applies here.

7. ENVIRONMENT RESET

The table is cleaned from all the unsoldering tools.

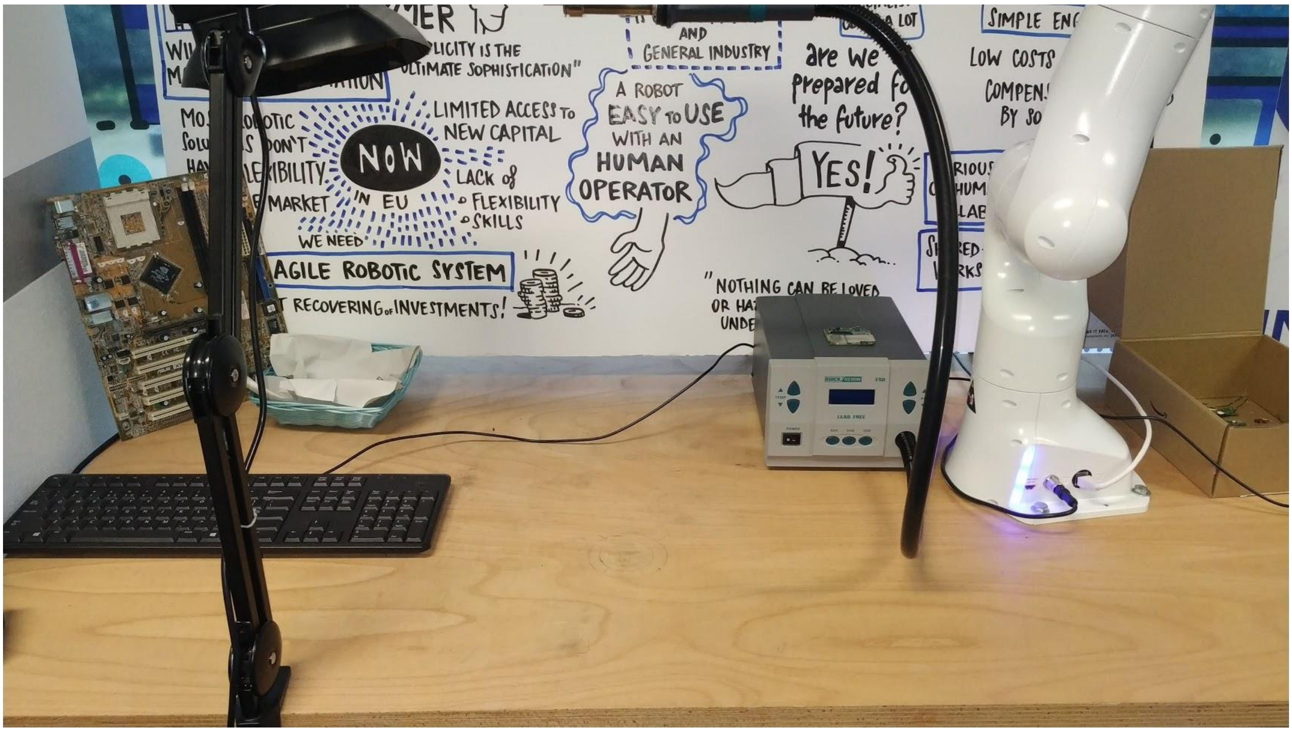

Figure 13: Environment reset (clean worktop)

This is the resulting PCB, cleaned from all the chipsets.

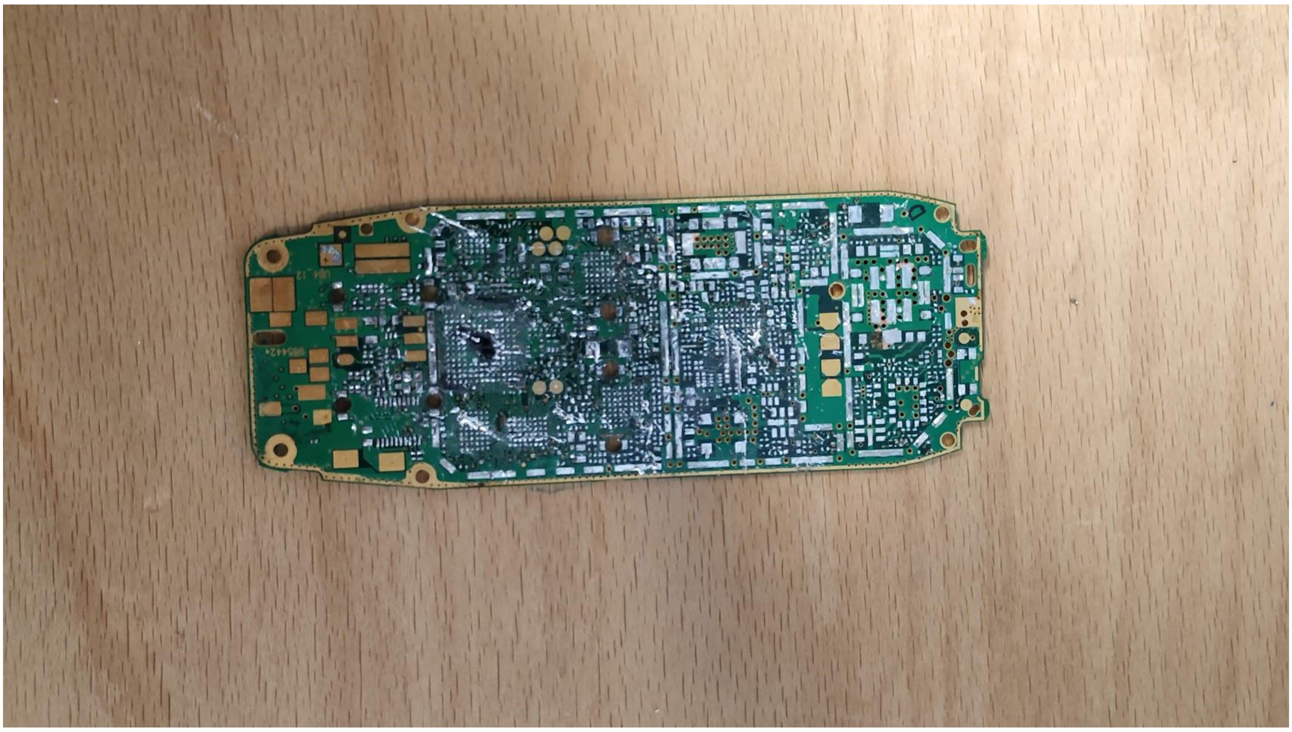

Figure 14: Environment reset (final PCB unsoldering process result)

8. CONCLUSIONS

D3.2 described the implementation a semi-automated PCB disassembly process carried out at the POLIMI's Industry 4.0 Lab. Considering the result (see the previous Figure 13), the cobot-assisted unsoldering process allows to completely and easily unsolder PCBs from cell/smartphones in about 9 minutes/unit. However, after some preliminar estimates, the full operation time could be furtherly reduced in about 4 minutes/unit. As already discussed in other deliverables, this demonstration experiment allowed to demonstrate in practice what can be the benefits and performances reachable through the introduction of I4.0 technologies in current WEEE management processes.