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Napoly, O (CEA)

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DELIVERABLE REPORT

TEST AND OPERATION OF THE COUPLER CLEANING PROCEDURES

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Abstract:

As far as the Task 10.8.1 is concerned the activity was to define the process of the automatic couplers cleaning, to have a full review of the different phases and to establish the necessary hardware components. After this the design of the machine and of its components has been realised. This has provided the faisability study and the costing of the automatic couplers cleaning machine. Hereafter we give a short summary of the main apects of the two phases: the definition of the automatic cleaning procedure and the study of the washing machine.

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Delivery Slip

	Name	**Partner**	**Date**
Authored by	Olivier Napoly	CEA	20/07/2013
Reviewed by	Jean Pierre Koutchouk	CERN	20/08/2013
Approved by WP Coordinator	Olivier Napoly	CEA	22/08/2013
Approved by Project coordinator	Jean-Pierre Koutchouk		01/09/2013

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1. DEFINITION OF THE NEED

1.1. THE HANDMADE PROCESS

To understand the interest of an automatic cleaning maching, we started by analyzing the handmade process of the TTF3 and XFEL Copleurs.

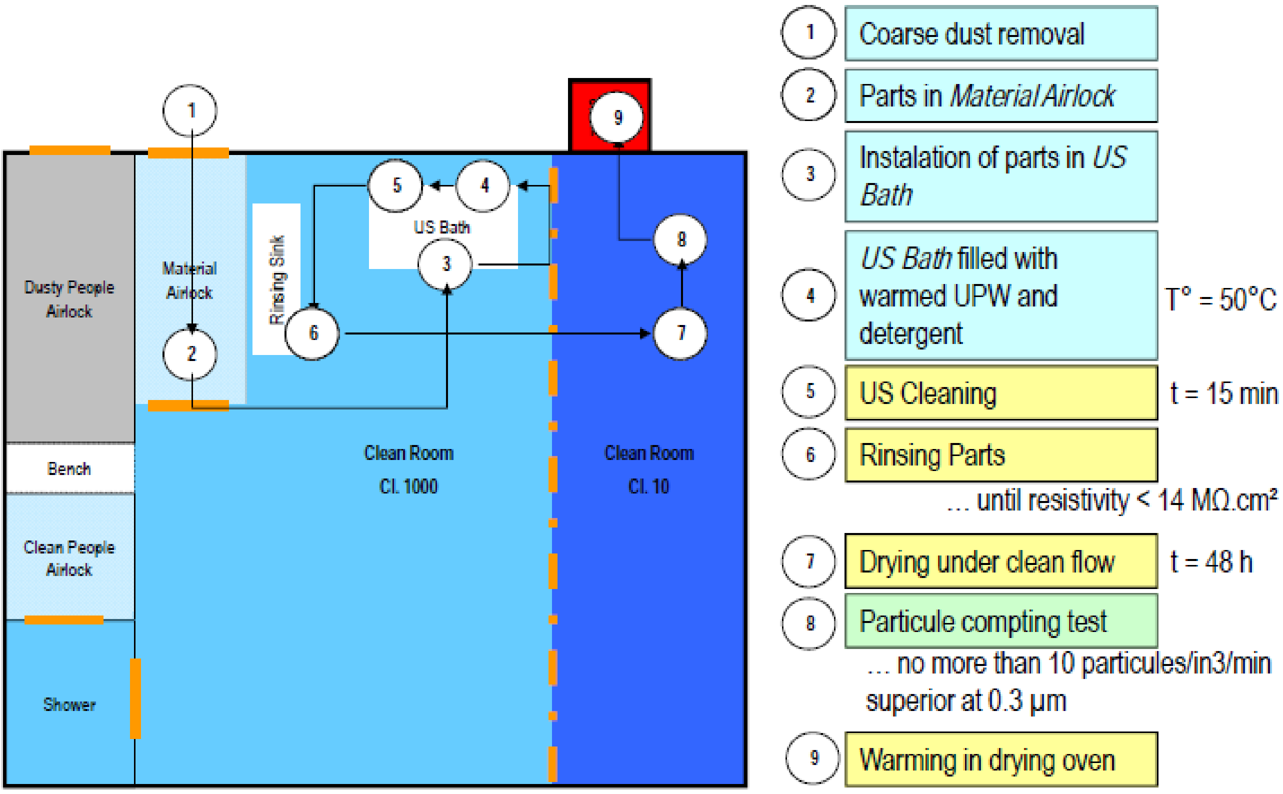

Figure 1: The handmade process drawing

The handmade process take place in a *class 1000* and *class 10* clean rooms, separated by a plastic curtain.

The process begins outside by a coarse dust removal. Next, the parts are introduced in a class 1000 clean room, trough the material airlock. Inside the clean room, the parts are cleaned is a ultrasound bath filled with warmed UPW at 50°C and detergent (Ticopur R33®). It's only now that the effective cleaning begins. Then, the parts are rinsed.This process is worked out by continuously checking the ultrapure water resistivity. The part is considered as clean when the measurements shows a resistivity below 14 MΩ.cm². After this phase the parts are dried. The drying is realized in the class 10 clean room, under a clean flow for 48h. A particule count test is done to check the quality of the cleaning. If the particule number is below 10 part./in³/min and smaller than 0.3 µm, we estimate that the cleaning has been efficient. Otherwise, the parts go back for the ultrasound cleaning. Finally, to exit the parts, they are warmed in a drying oven.

Summarizing the handmade process consists of more than 72h with 6 handmade steps (so 6 steps where the repeatability is not guaranteed) and 8 moves in the clean rooms (so 8 possibilities of contamination).

This process allows cleaning in a reliable way, a low number of Couplers on a long time what is insufficient in an industrial context. So, the goal of this project is to design an automatic washing system in order to:

- Bring together and automatize the manipulation operations needed for the preparation process in clean room of the TTF3 and XFEL Couplers sets.
- Guarantee the Coupleur integrity
- To assure and to act the quality, the repeatability and the reproducibility of the cleaning process.
- To optimize the cleaning parameters.

1.2. THE AUTOMATIC PROCESS

From the previous considerations we estimate that the full cleaning process can be divided in 4 different technical functions:

1) the Airlock function that takes into account the transition between the external environment and the clean room,
2) The Ultrasound cleaning function, providing the cleaning procedure
3) The rinsing function. In this phase the monitoring of the water resistivity assure the complete Ticopure removal
4) The drying function. The particle counting diagnostics validate the class 10 environment and assure the quality of the couplers to be integrated in a SC cavity

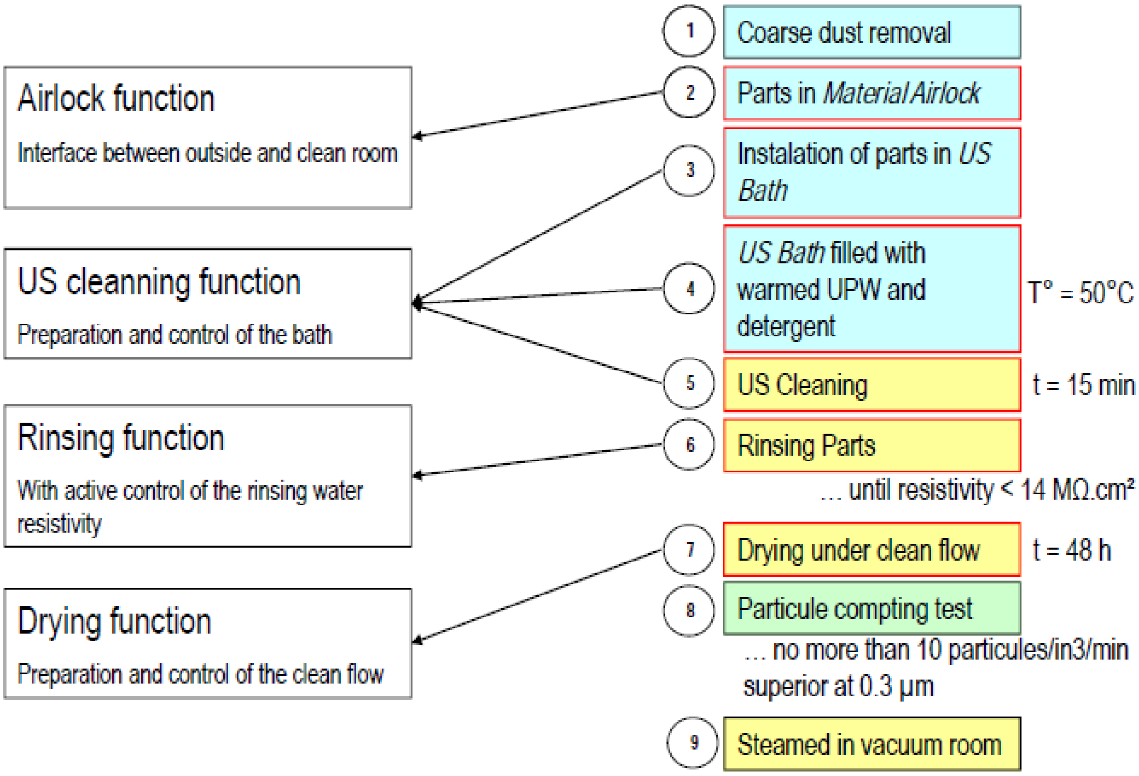

Figure 2 - The handmade process types

Nb : The fourth first steps are only preparation and don't concern directly the parts cleaning.

As a consequence of the partition of the different function process we produced a flow chart diagram that illustrates all the different phases that have to be taken into account by the couplers cleaning machine. In the next figure this process is illustrated. It is possible to notice that we start from the uncleaned parts. After this the parts are inserted horizontally in the machine. Once that the machine is closed the parts are rotated and the ultrasound bath starts. At the end the water is discarded and the rinsing starts after a system rotation. After the drying the system is rotating to allow the extraction of the parts form the machine.

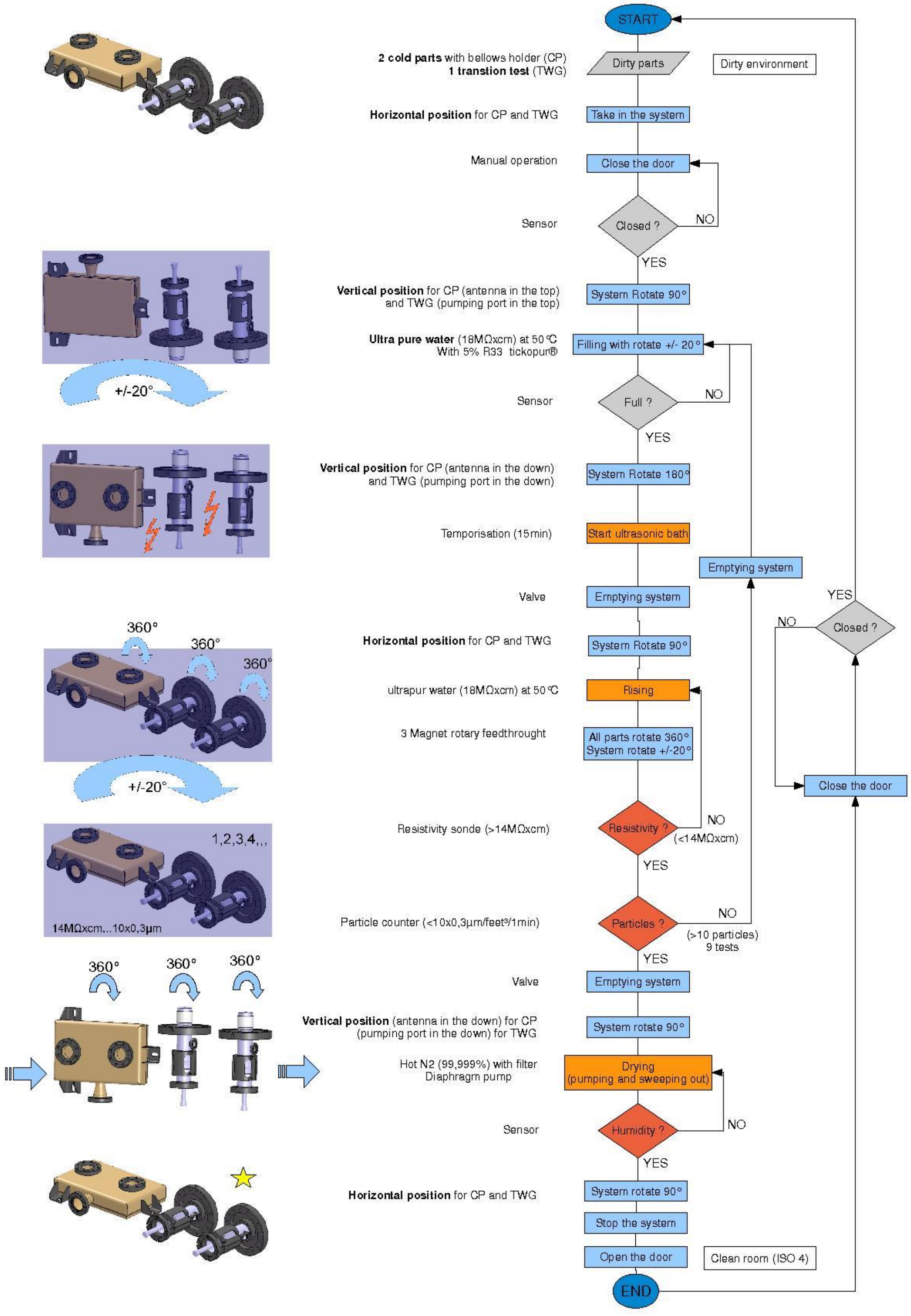

Figure 3 - The automatic process

2. THE AUTOMATIC CLEANING MACHINE A.L.I.C.E.

(Automate de Lavage Intégré pour Coupleur Electromagnétique)

The definition of the automatic process allowed providing a detailed study of the automatic cleaning machine. This is summarized in the following mechanical designs. At the beginning a first study provided the basic function of the machine and all the components necessary for the cleaning process. A further analysis of the system produced the study for the complete assembly of the machine and the individuation of all the components. The development design takes into account all the functional aspects of the ALICE machine, from all the procedures for the cleaning/rinsing to the support and the integration between the transition of the class 10 clean room.

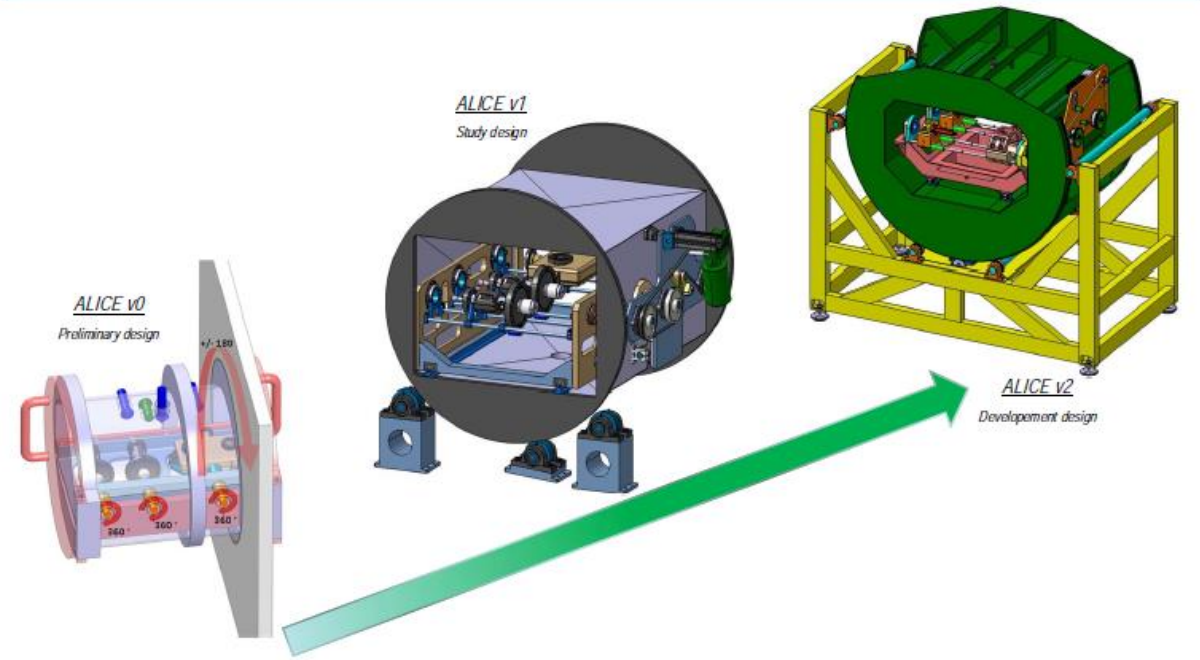

Figure 4 - A.L.I.C.E. evolution

2.1. THE INTERNAL MECHANIC

The trolley

The Coupler sets (TTF3 or XFEL) are locked on rotation axes to move them on themselves, inside the tub during the process. They are only maintained by their half-capsule (mechanical part that lock the bellows). There are specific locking tools for the cold and the warm parts, the push-rod and the gear. These tools can slide on the rotation axes according to the part to clean.

The rotation axes are leaded with specific ball-bearing and activated with magnetic pulley to avoid corrosion and minimize dust production during the rotation. The whole is put on a trolley to slide it from the outside into the tub to begin the process.

The study is completed

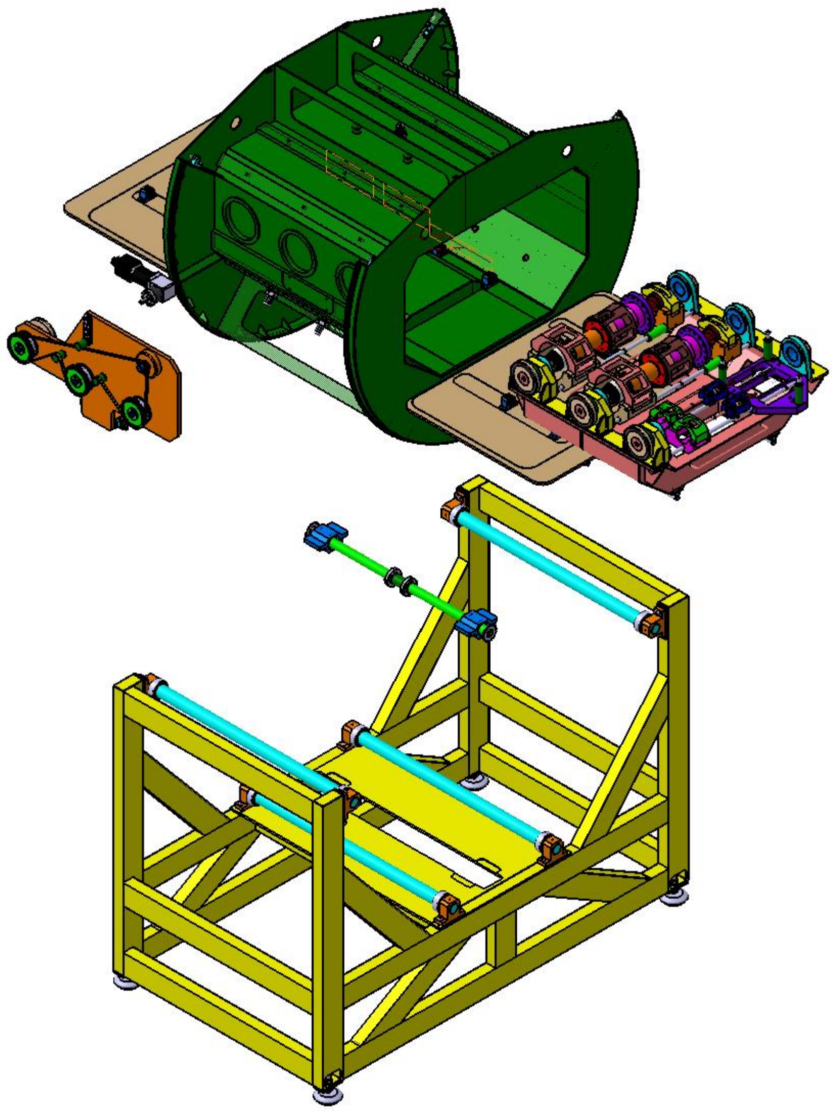

Figure 5 - A.L.I.C.E. design v2

<u>The tub</u>

The main dimensions are established, in function of the trolley and the ultrasonic transductors.

Some interfaces are defined with the hydraulic and retreatment air networks. Moreover, it was decided to electro-polish the inside to optimize the contaminated water flow during the emptying and the rinsing.

The design is quasi completed.

2.2. THE EXTERNAL MECHANIC

The motors

The machine need of two motors to assure the internal movement of the Couplers and the tub rotation. To preserve the Couplers integrity, the minimum and maximum engine torques were calculated, in order to apply an acceleration no more than one time the weight of the Couplers.

The motor for the internal movement (the lateral one) is defined and buyed. The study is quasi completed and the cost is estimated at 3.5 k€.

The lateral transmissions

The lateral transmission allows distributing the engine power from the lateral motor to the three internal rotation axes by the magnetic pulley.

The study is completed and the cost is estimated at 2 to 2.5 k€.

The clutch

The disadvantage to use the magnetic pulley is to disconnect them to allow the slide of the trolley. The choice was made to put up the lateral transmission on a removable panel, actioned by an actuator. The force and the course are known and frozen.

The study is to be completed and the cost is estimated at 5 to 6 k€.

The general transmission

The tub is connected to the general motor by a chain. Indeed, it is a simple way to control the position of the tub after the rotation for a low price.

The study is quasi completed and estimated at 5 to 6 k€.

1. The cleaning elements : the ultrasounds

To clean the Couplers, ultrasonic waves are needed. There are chosen to deliver 10 W/L of UPW to a frequency of 40 kHz. After a benchmark, the solution with two sontrodes Push-Pull was preferred. It allows diffusing uniformly the ultrasound in each direction with minimum variations of the frequency. The sonotrodes are not integrated.

The study is completed and estimated at 15 to 20 k€.

2. The hydraulic network

The needs are known and the global network is drawn.

The study is ongoing and cost 20 to 25 k€.

3. The retreatment air network

The needs are known and the global network is drawn.

The study is ongoing and cost 20 to 25 k€.

3. CONCLUSION

In conclusion, the cost of such a machine as A.L.I.C.E. is estimated at 119 ± 27.5 k€. Its technical interest was confirmed during the ultrasounds benchmark. Indeed, it exist some machine that already clean technical parts in an industrial way, but never with as much of technical functions as A.L.I.C.E.. Otherwise it is a full production line with many machines and a human operator during the process.

The studies are complete enough to give us a complete overview and estimation of the feasibility, the process and the costs: the efficiency of the porcess, as far as the large mass production is concerned, is undoubted. All the technical functions can be respected to clean automatically and correctly a Coupler, without any damage for them.