

# Facilities on site for clean mechanical assembling .

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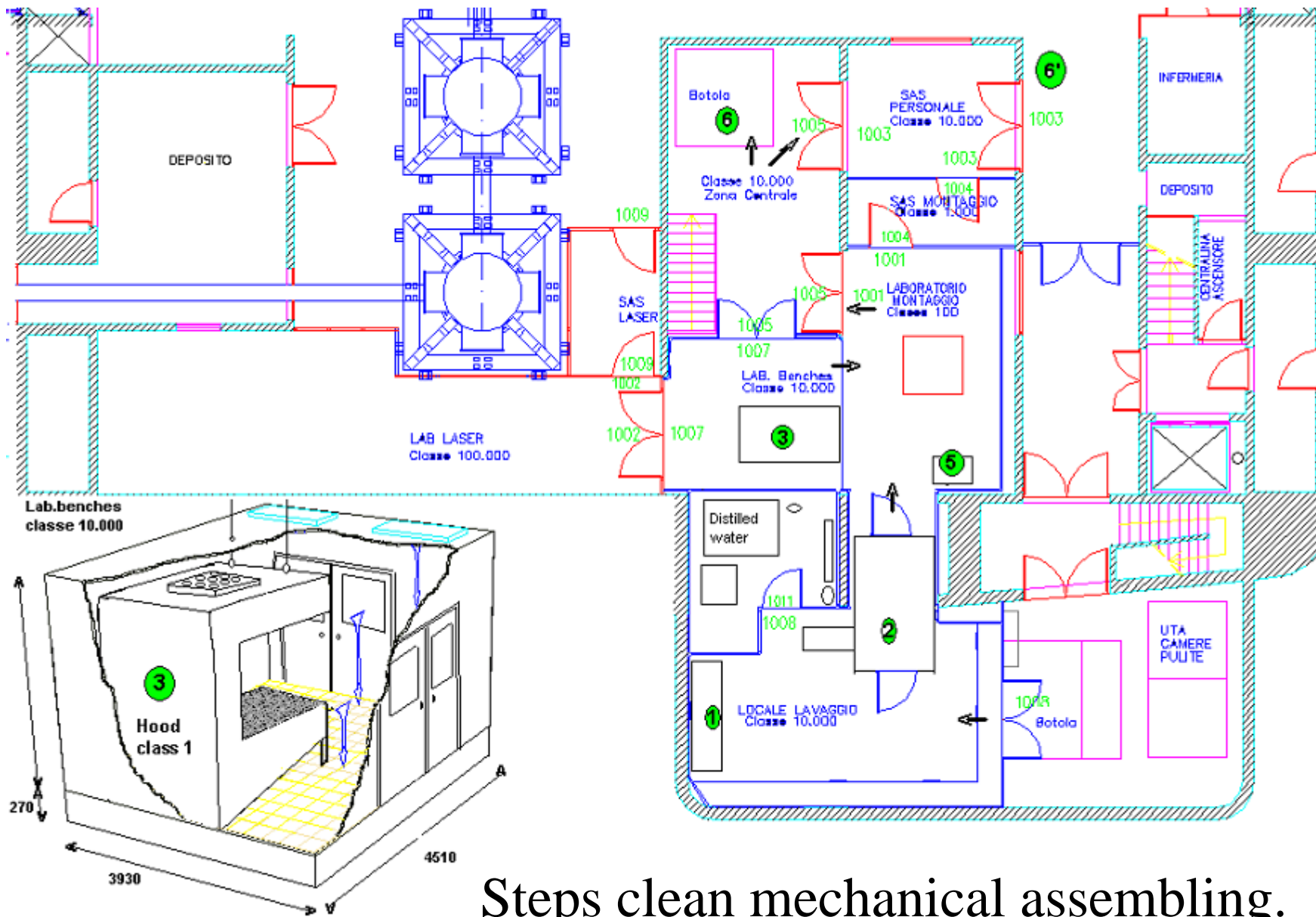
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The purpose of this document is to summarize the large facilities that Ego site puts at disposal for clean mechanical assembling.

A large facility has been developed for the Virgo experiment to make clean mechanical assembling; it can be used for any kind of clean mechanical mounting.

The essential of the activity is performed in clean room. First of all, all used mechanical parts must be cleaned in the cleaning room: we propose here an overview of the available facilities. After the cleaning operation, all mechanical parts are duly packed; then, we are able to proceed with their mounting, where necessary.

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Cleaning room → Assembling laboratory → Transport → Tower.

# Cleaning room.

The aim of this room is to allow the suitable cleaning of the mechanical parts which are introduced in the VIRGO optical towers; that is, the removal of dust or particle pollution.

The main cleaning philosophy is to wash, rinse and dry. So, all mechanics parts have to be cleaned, following the hereafter order:

- 1- in one of the ultrasonic bath (to take the grease off)
- 2- in the cleaning unit.





Giant **ultrasonic bath** to take the grease off.

We used a mixing water with an alkaline detergent solution:  
Henkel product: P3 permeta 161, Potassium hydroxide.

The ultrasonic treatment is started and continues for at least 20 minutes, keeping the water temperature at least 40 °C)

We have also 2 small ultrasonic bath, their size allowed to use a mixing alcohol-water.



Giant ultrasonic bath panel control

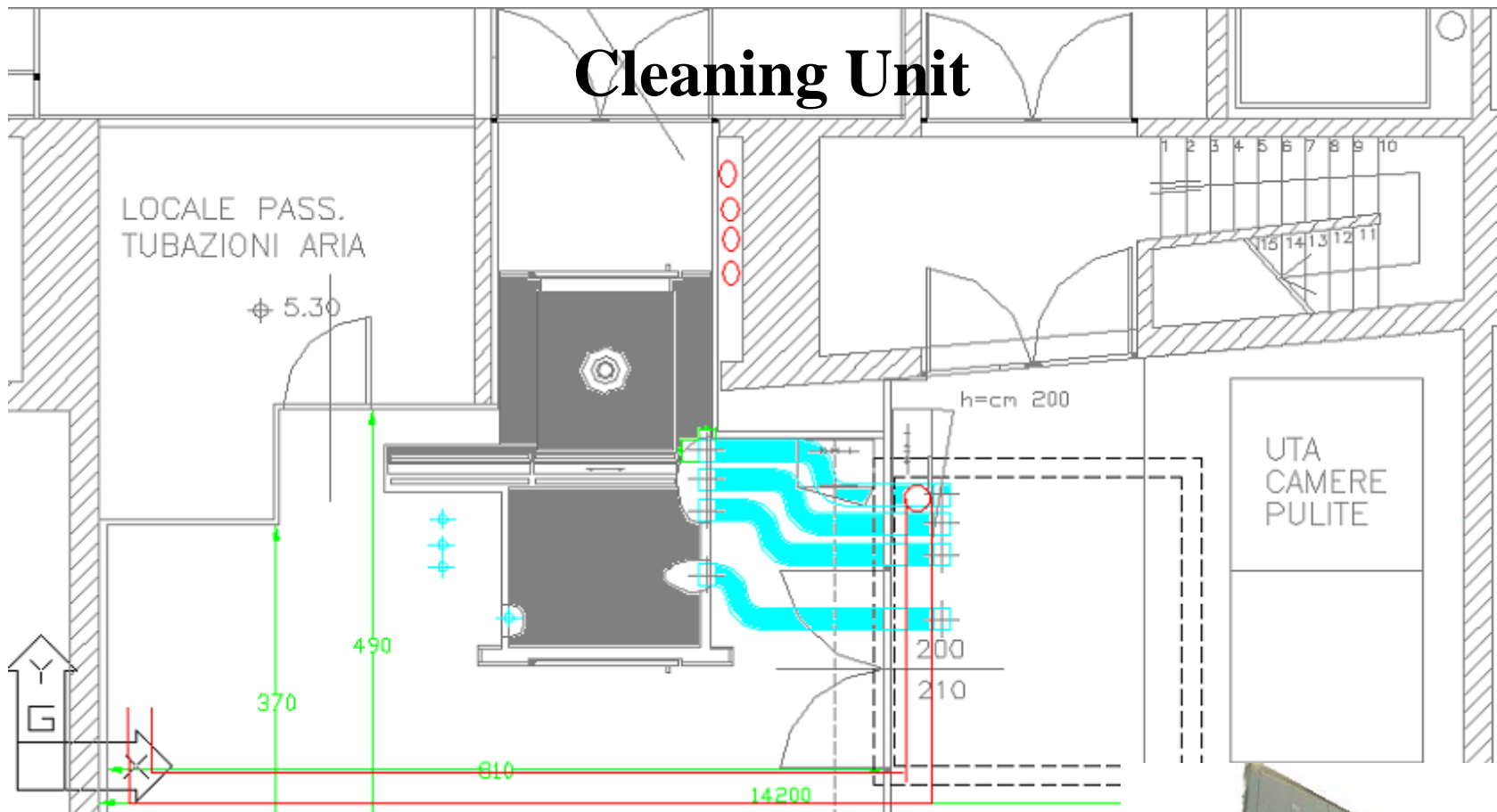


One of small ultrasonic bath. Expected consumption is 1,5 to 2 litres of pure alcohol per washing cycle.

Don't forget, to clean, there is not magic solution, it is needed to use yours hands!



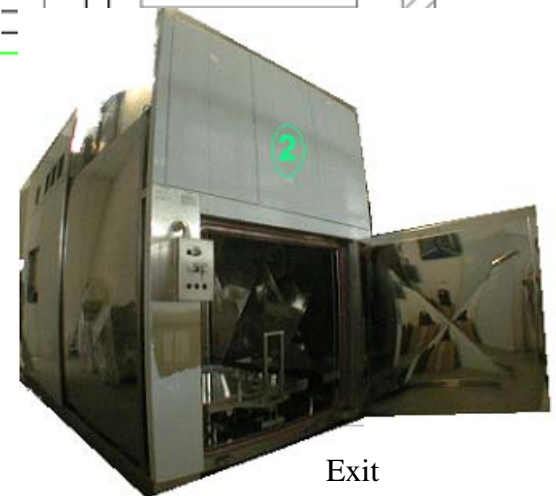
# Cleaning Unit



Entrance



Panel control



Exit

**ICOS-Impianti-s.r.l.**

Via della Fossa, 4

33080-Orcenico-di-Zoppola, Pordenone

Phone: (+39)-0434-979596 - Fax: (+39)-0434-574080

E-mail: [sales@icosimpianti.com](mailto:sales@icosimpianti.com)

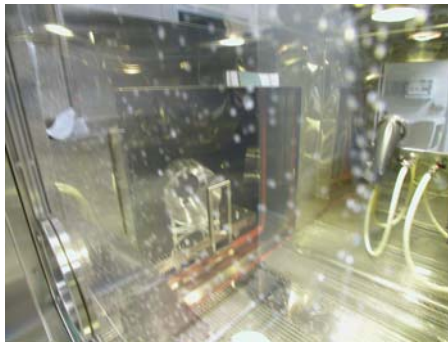
Website: <http://www.icosimpianti.com>



Washing unit  
entrance



Cleaning with ultra-pure  
water inside the washing  
unit



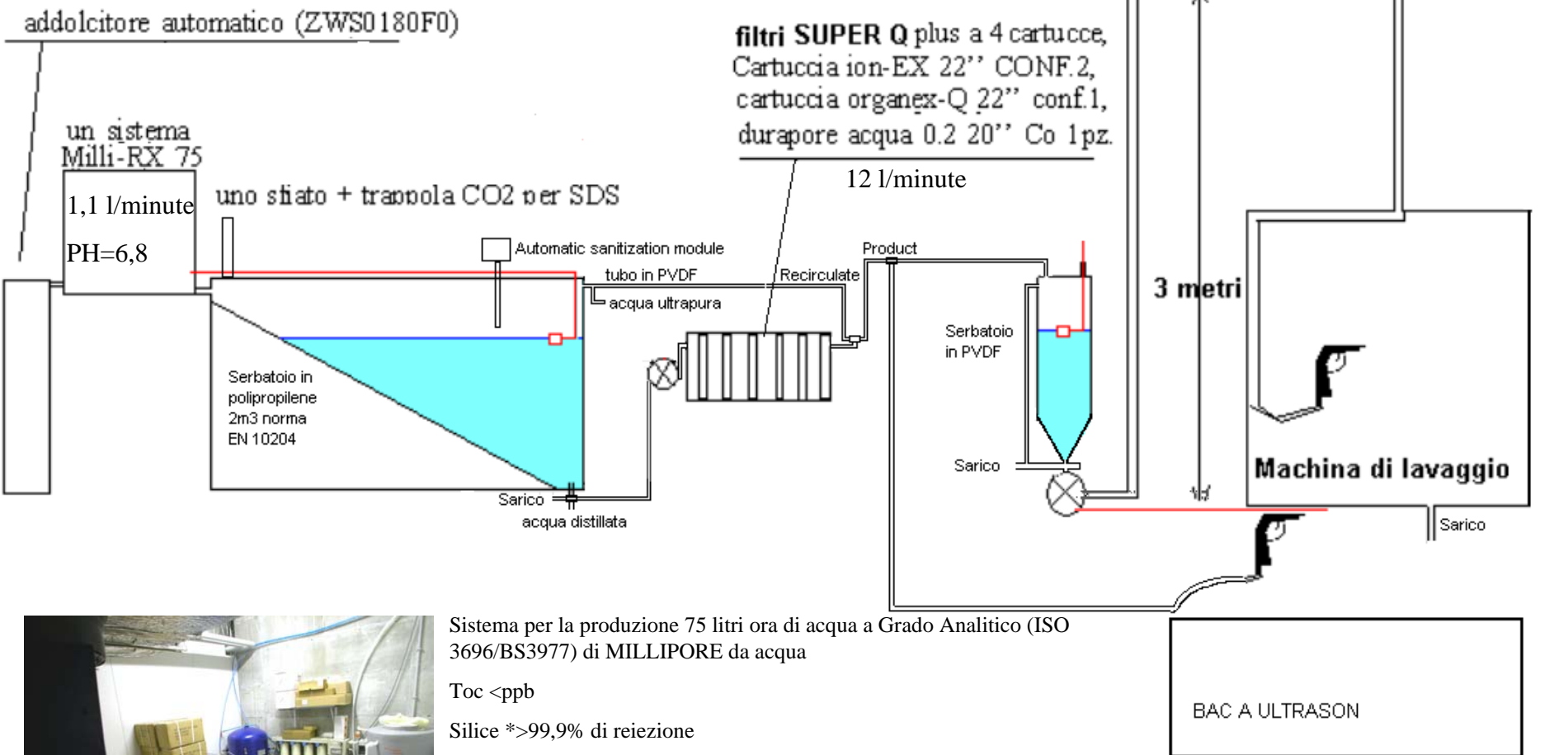
The reference mass goes to the Clean  
oven automatically.

Mechanic parts exit from the washing unit  
in the assembling laboratory.



# High purity water production facility

Free of ionic contamination up to  $18 \text{ M}\Omega \cdot \text{cm}^{-1}$  resistivity level, and free from particulate and microbiological to an absolute size level determined by the membrane filtration to particle retention levels ranging to  $0.22 \mu\text{m}$ .



Sistema per la produzione 75 litri ora di acqua a Grado Analitico (ISO 3696/BS3977) di MILLIPORE da acqua

Toc <ppb

Silice  $>99,9\%$  di reiezione

Resistività  $> 5 \text{ MW} \times \text{cm}$  a  $25^\circ\text{C}$  ( TIPICA  $10-15 \text{ MW} \times \text{cm}$ )

Conducibilità elettrica:  $1045 \text{ us/cm}$

pH=6,8

durezza totale  $39,2^\circ\text{F}$

silice:  $19\text{mg/l SiO}_2$

CO2 disciolta:  $137 \text{ mg/l CaCO}_3$ .

Ultra-Clean water, previously for the washing unit.  
Cartridge replacement: shorter life time if you don't use it.

Super-Q product water is intended for immediate use because such high quality water deteriorates when stored, or exposed to the environment.



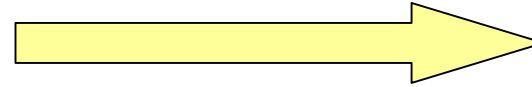
# Tools to clean

- Ionizing air gun, working with nitrogen. aerostat air blower to eliminate electrostatic charges [www.simco-static.com](http://www.simco-static.com)



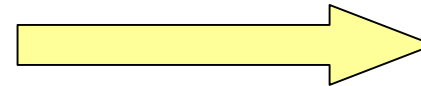
- The Simco-aerostat XC extended coverage Air Blower provides the best surface coverage and this is required for the inside a tower and in the Hoooh. 900 Euro

- The Sno-Gun Dry Ice Cleaning. Work with CO<sub>2</sub>. [www.vatran.com](http://www.vatran.com) (Cf. LIGO CO2 cleaning Procedures with Snogun) \$12,000.00



- Kit Cryoptique (Cryonic medical) 1200 Euro

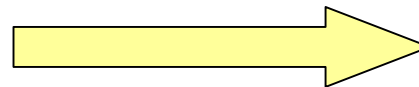
- Cleanroom vacuum cleaner systems (ulpa filter efficiency of 99.999% on 0.12 um



- The MV-1CR (GC) **Tiger-vac** clean room mini Vac is the smallest, and its optional tools and accessories will allow a better work in small environment (like a tower) 1800 Euro

- The Nilfisk GM80 dedicated to clean the clean room

- Baking outgasses by vacuum process. (V.Datillo)



# Entrance to the clean room

## The lock room

The aim of this room is to allow the suitable cleaning of the small mechanical parts and tool which are introduced in clean room (Wipers + pure alcohol), and it is a garment storage cabinet where the operator will wear a suitable overall, gloves, a face mask, cover shoes .

The bench is the borderline between the white area and the blue area.

We have also all tools to the cleaning crew for clean-build programs. Clean room maintenance kit includes: tacky mats, 2 roll mops, 2 sponge mops, wipers, 2 buckets and 1 vacuum cleaner, and all necessary consumables.



# Clean room consumables

	A.M. Instruments	ALSCO. LINEN SUPPLY	A.D.S. Laminaire	SNDI	Europa Euromicron
paio sovrascarpe in polietilene clorurati, colore azzurro 43 cm	0,05	0,084	0,08	0,125	0,125
sovrascarpe in polietilene clorurati, colore azzurro 36 cm	0,045		0,5	1,035	1
tappeti 1200*450		0,66	1,66	1,38	3,43
tappeti 1200*650	0,925	1	1,191		7
tappeti 1200*900	0,885				
tuta in TYVEK	5,72	4,2	5,8	5,96	4,13
paio sovrascarpe bianche XL	1,07	1,9		1,04	
paio sovrascarpe bianche L	1,02				
Mascherina 3 strati		0,103			
paio guanti vinyl, classe 100	0,33		0,5	0,194	0,14
Cleanroom wiper, berkshire (23cm x 23 cm)	0,0878		0,1305	0,188	0,14
ricarica di prodotto sostituendo l'alcololo.(3.78)	54,74				
prodotto per parete e pavimento (3.78)	80,44				
plastique salle blanche			396 (50 x 0.33)	116 (0.5 x 0.5)	
* 20 tute con cappuccio in tessuto per camere pulite colore verde		47,8	160		44,39
* 20 di taglia XXL					
* 20 di taglia XL					
* 20 di taglia L					
* 10 di taglia M					
* gambali singoli con suola antistatica e tessuto per camera pulite colore verde		13	23,92		9,3

# Budget

		Previsioni 2003	Previsioni 2004
<b>CONSUMABLES</b>		<b>25417</b>	<b>14450</b>
paio sovrascarpe in polietilene clorurati, colore azzurro 43 cm	0,05	1300	700
tappeti 1200*450			
tappeti 1200*650	0,925	1100	1100
tappeti 1200*900	0,885	3000	3000
tuta in TYVEK (XL, L, M, S)	5,72	5000	2000
paio sovrascarpe bianche XL	1,07	960	400
paio sovrascarpe bianche L	1,02	700	300
Mascherina 3 strati		539	300
paio guanti vinyl, classe 100 (XL, L, M, S)	0,33	960	500
Cleanroom wiper, berkshire (23cm x 23 cm)	0,0878	1300	600
clerpack Sterile bags 450x600	30,24	60	10
ricarica di prodotto sostituendo l'alcolico.(3.78)	54,74	300	200
prodotto per parete e pavimento (3.78)	80,44	600	300
plastique salles blanches		500	200
Buste		400	400
Camice		800	500
foglie di aluminium		50	50
pistole per alcolo		50	50
cuffie con elastico	0,02249	200	200
* tute con cappuccio in tessuto per camere pulite colore verde	47,8	0	0
* gambali singoli con suola antistatica e tessuto per camera pulite	13	0	0
Secchio acciaio inox	317	0	
Alphamop replacement heads		1700	1000
Cleanus, spugna di ricambio		220	100
Decontamination di una tuta	4,6	1518	700
Decontamination di una gambale	1,25	1012	500
Decontamination cappuccio	2	240	120
P3 per vasca a ultra sono		700	200
Alcolico isopropilico 2,5L	16,472	988	300
alcolico denaturato 1L	1,446	20	20
paio guanti blu (XL, L, M, S)	17,043	1200	700

## MAINTENANCE

		19847	15747
Filtri aqua ultra pura	1230	1230	1230
Pompa - ingranagi	217	217	217
Bombole CO2		800	100
Bombole N2		600	200
Wafers	100	0	0
Pulizia de camere pulite (imputato gruppo infrastruttura) e parte bassa	13000	13000	10000
Calibration compteur de particules - Lasair 210	200	2000	2000
Calibration compteur de particules - Vaculaz	2000	2000	2000

## INVESTMENT

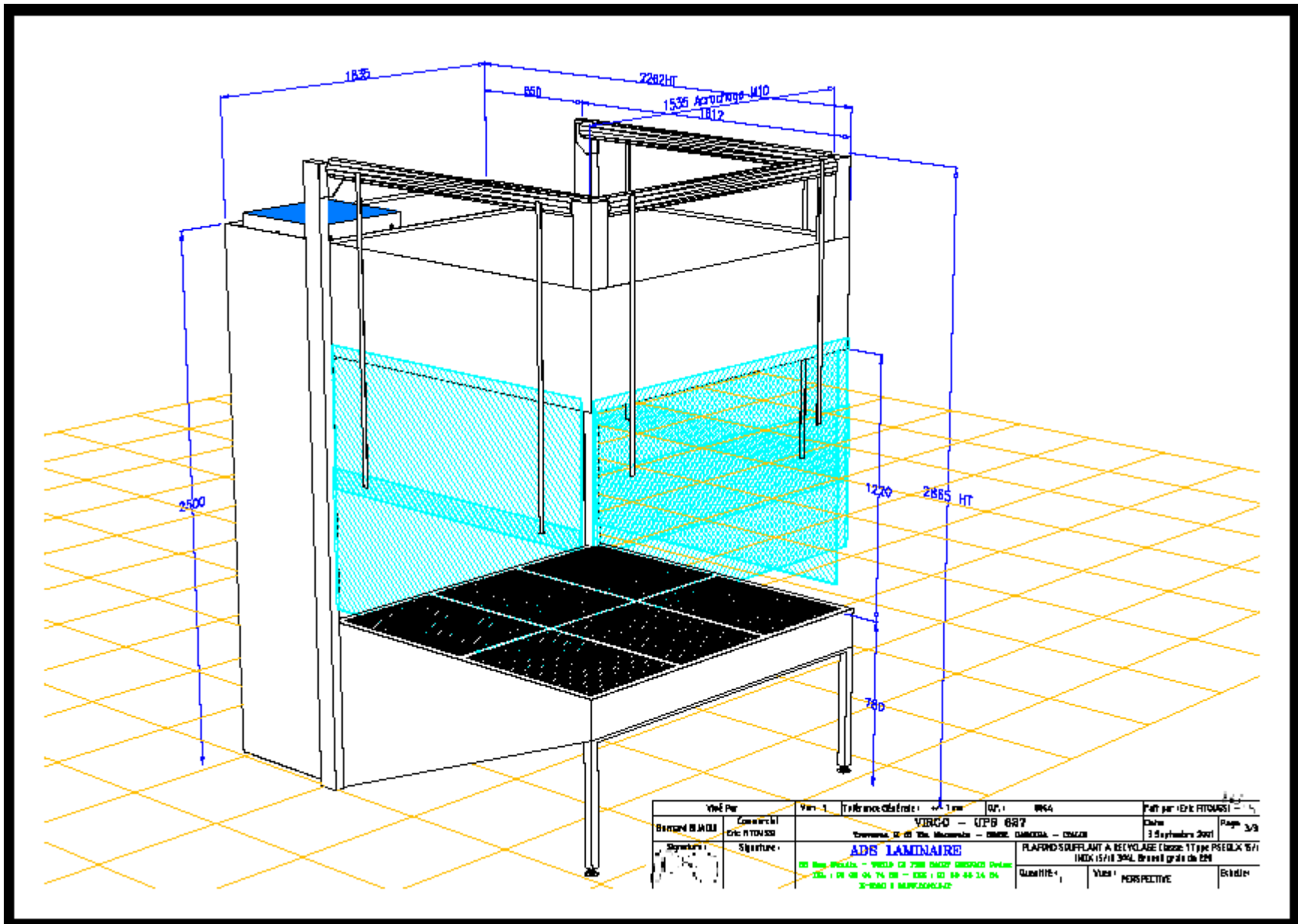
Achat compteur de particule II 110	25000	25000	
portata aria del tunnel di lavaggio (gruppo infrastruttura)	1000	1000	
filtri acqua tunnel di lavaggio	617	617	
Scarico alle sas - interventoidraulico	2000	2000	
Refection des sols du batiment central (Zone bleue) (groupe infrastruttura)	23000		
Aspiratore a polvere	250	250	
inquinamento di Virgo outside - inside (gaz, polvere,,)			
compteur de particules surfaciques			
maitriser les flux d'air, generateur de brouillard			
anemometre			
compteur de particules dans l'eau			
Bancs d'absorption PDS (Photothermal Deflection System)1064 nm			
Diffusomètre CASI (SMS, ex TMA)1064 nm, 10.6 µm			
microscopio			
MICROMAP			

# Laminar air flow

## Hood ISO 3 (class 1)

The aim of this room is to allow to have the cleanest area as possible. Its working is independent of the rest of the clean room. Its is a clean area in a clean room. This room was to allow the Virgo mirror preparation, which consists in the *gluing* through silicate bonding technology on the mirror of the lateral spacers and magnets, of the back face magnets and front face camera targets.





Manufacturing by ADS LAMINAIRE 35-37 Rue Baudin 93315 Le Pre St Gervais Cedex France . Cost 35500 Euros.

# Assembling laboratory.

The aim of this room is assembling the mechanical different parts. In the case of the payload, it consists in the positioning of the marionetta on the mounting frame, the positioning and suspension of the mirror under the marionetta and positioning and suspension of the reference mass around the mirror.

Inside the curtains, the area is classified ISO4 (class 10), around in ISO 6 (class 1000)

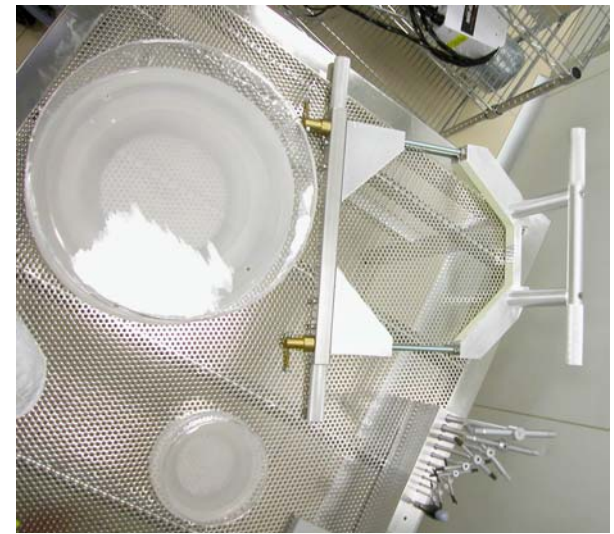




The assembling laboratory has its own lock room with garment storage and every own consumables.



This room has its own handling tools, and they must stay there.



For special tool like this pliers, we used Polyuréthane sheet FP3 (Format 21X29.7 cm) 10/10 42956, L'ingénierie de l'Elastomère. (Z.I. Roubaix est – BP 18, 59115 Leers – France, [www.pronal.com](http://www.pronal.com) ) to avoid any kind of contamination.

2 boxes for handling mirrors. Designed by L.M.A.. Heraeus buy to Wisag (deutsche firm): <http://www.wisag.ch> 10630 Euros



All main mechanical parts are taken out of the cleaning machine and are set on the suitable chariot.

We use the elevator chariot to hang the piece to the hook available at the center of the laminar flow ceiling by means of a cable of suitable length.

It is always better to use the giraffe, in order to stay less long as possible over the clean mechanical part, to avoid any kind of contamination.



The protected mirror is set on the chariot

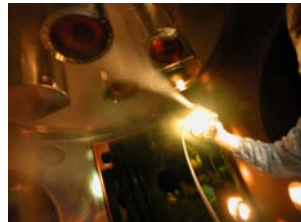


# Preparation and cleaning of the lower part of the tower



All preparation must be in compliance with the Contamination Control Plan, with the Procedure for using a clean room and with the Procedure for going in a tower.

- To be sure that the area around the tower is clean (Cleaning is done by the cleaning crew, at minimum one day before the opening)
- Opening of the tower.
- **Cleaning of the lower part** with the vacuum cleaner; particle and dust should be removed by mopping (wipe or mop) with clean water mixed with isopropyl alcohol (99,99%)
- **Startup of the air conditioning** of this tower. Check the clean air circulation in the tower: coordination with the vacuum group for the valve. The air blowing is also a cleaning phase.
- Blowing with the Snogun, and doing it each time it is necessary, until obtaining the suitable ambience.
- Stabilization of cleanliness, (class 10) ISO 4 must be obtained inside the area delimited by the curtains, checking by a particle counter LASAIR II 210. It can take 48 hours.



PR tower,  
13.11.2002



IB tower, October,  
14.2002

## Introduction of the operator

Source: Vir-Pro-Cas-2200-115 Procedure for going in a tower



**!!! The worst contamination source is the operator himself !!!**

**Be quiet and move slowly.**

Some rules : dress yourself in the synthetic overall (over the overall of tyvek)

- put on facemask.
- sit down on the circular plate, and wears synthetic over shoes.
- wear new gloves over those put in sas (lock chamber)

# Particles counting



\* Counting particles airborne .The **LASAIR 210** laser particle monitor from Particle Measuring Systems [www.pmeasuring.com](http://www.pmeasuring.com) is 1.0 CFM unit with the ability to count the size 0.2, 0.3, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0 micron particles. ( $\mu\text{m}/\text{ft}^3$ ). Calibration provider in Italia.A&LCO.Industries s.r.l . To be done each year (max 2 year). Purchased in 1993.

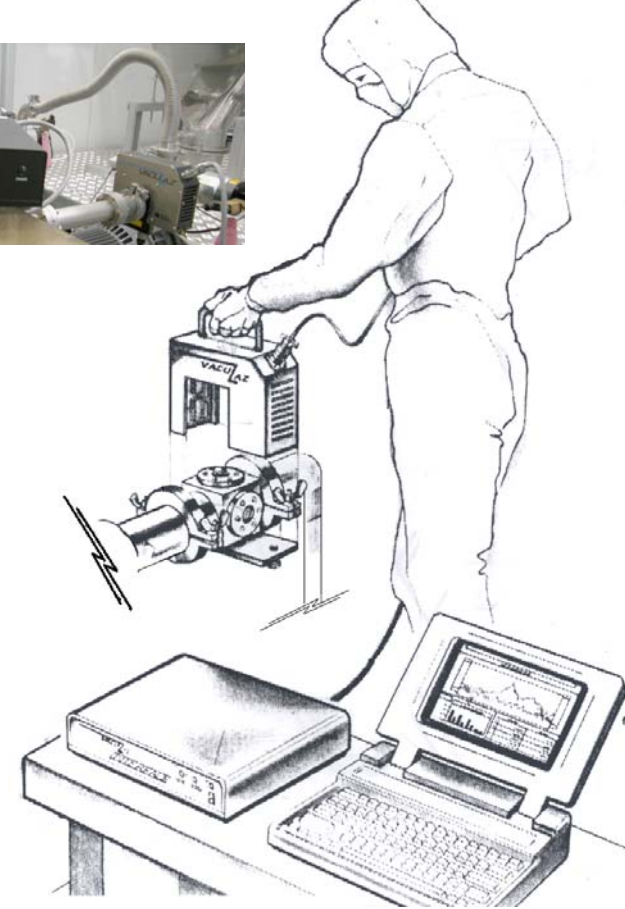
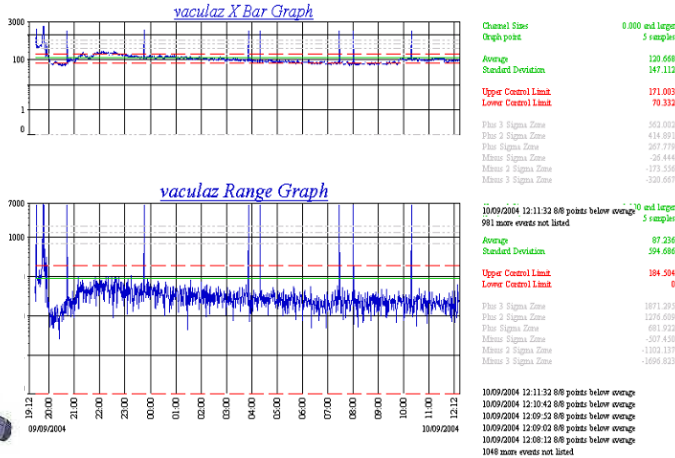


## \* Handheld Airborne Particle Counter

Model 227 B

- 0.3 or 0.5 micron sensitivity at 0.1 cfm
- Counts 2 sizes simultaneously

the facility Net version 2.9.4 software graphic results

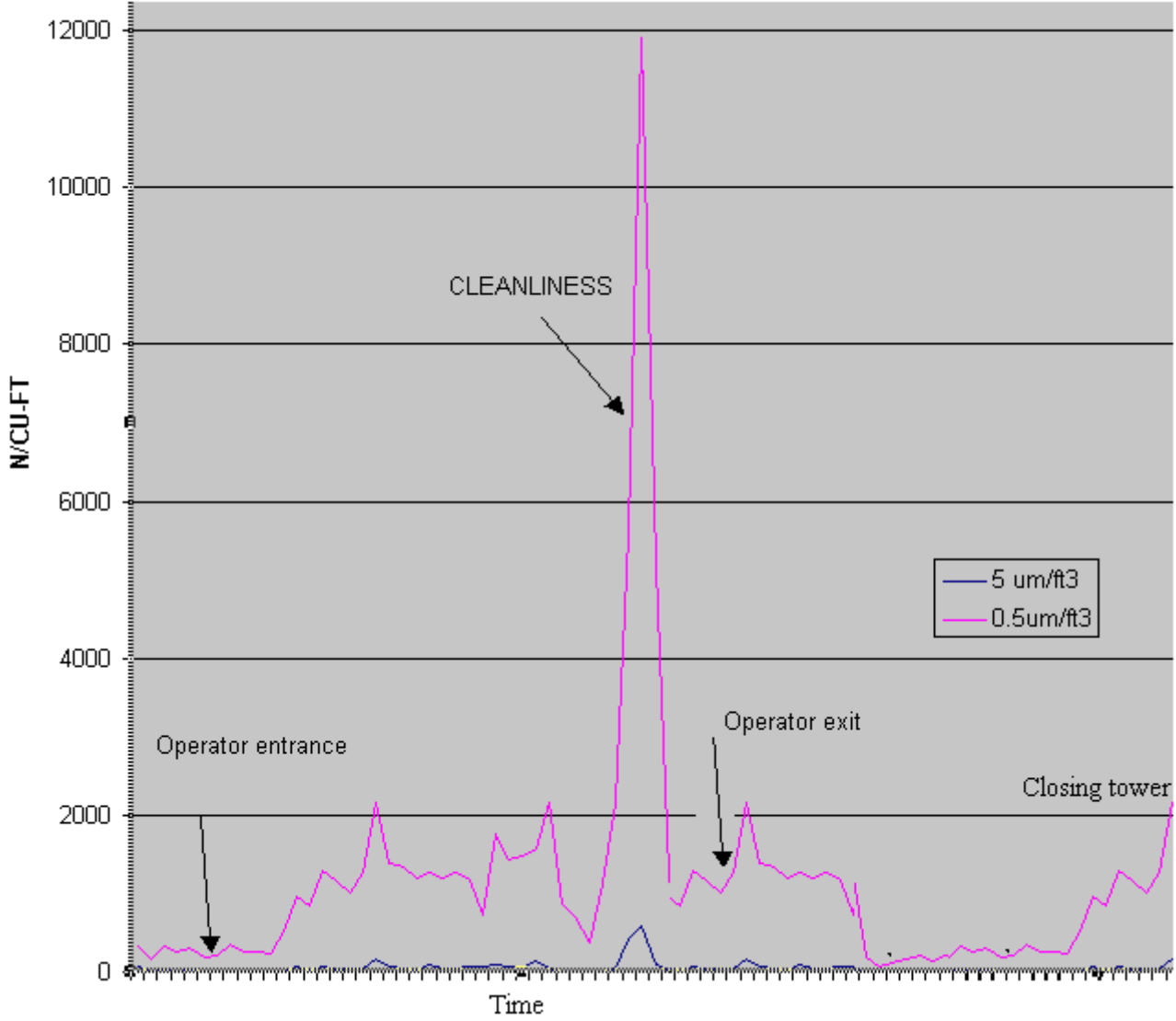


\* The **VacuLaz** vacuum process particle sensor from Particle Measuring Systems is an insitu device designed to measure particulates in vacuum process chambers and loadlocks during pumping. The system is installed on the exhaust line of vacuum process tools. The complete system consists of a viewing module, a sensor, and an electronics interface module. Repaired the 16.12.2003, the purchase of the facility Net version 2.9.4 software upgrade (OK for the lasair 210) \$ 3050,00.

\* wafers de silicium, wafers de 3 pouces, type P dopé BORE, orientation <111>, épaisseur 380  $\mu\text{m}$ . Dealer Siltronix



# Evolution of the concentrations of the contaminants during a cleaning tower cycle.



Source: Cleaning PR tower, CITF measure

# Transfer of the payload from assembly laboratory to the Virgo towers.

These steps are sensible, by the fact we must go across dirty area



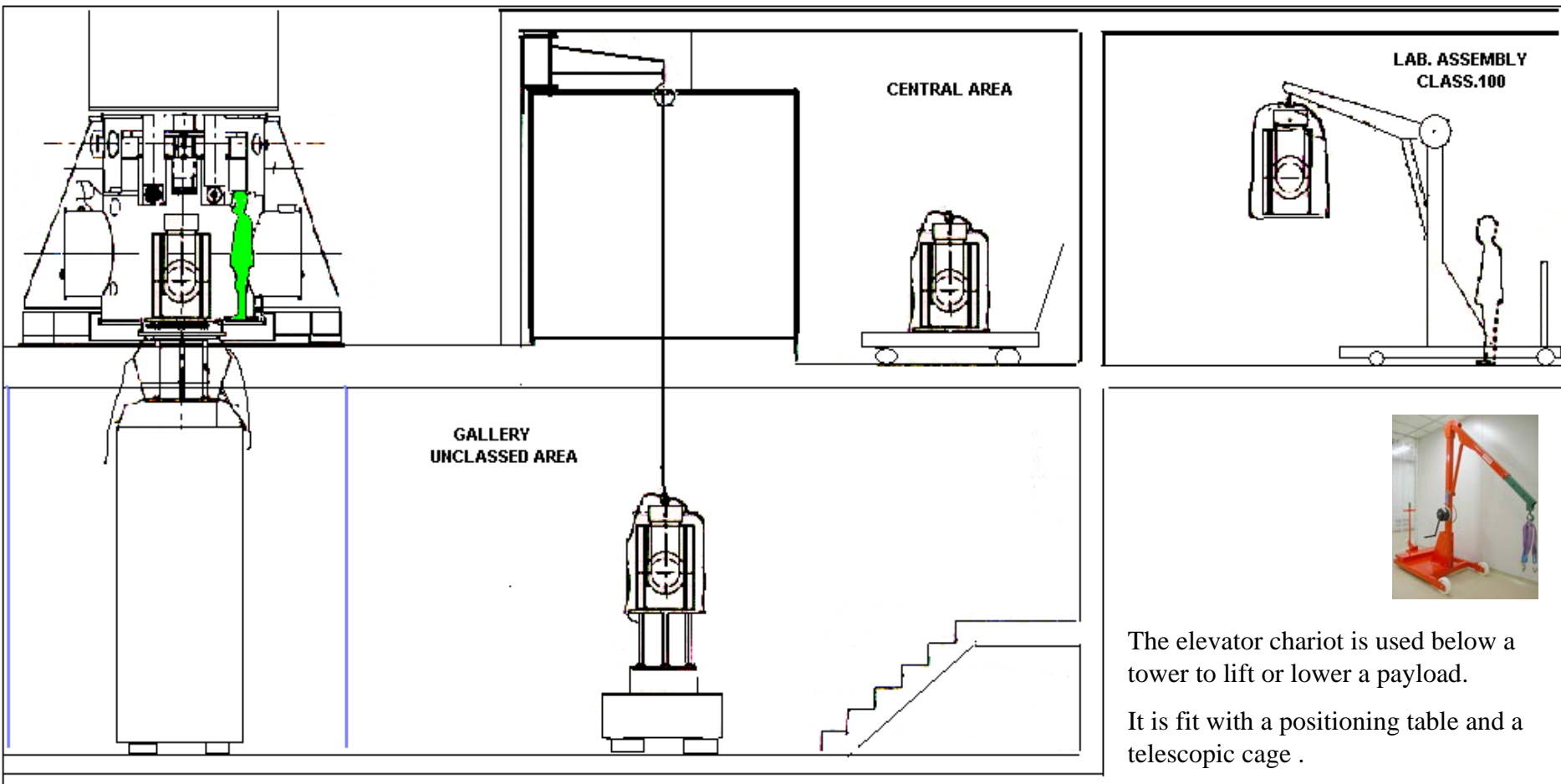
Exit from the assembly laboratory

Packing of the payload in Clean Room with 2 plastic layers



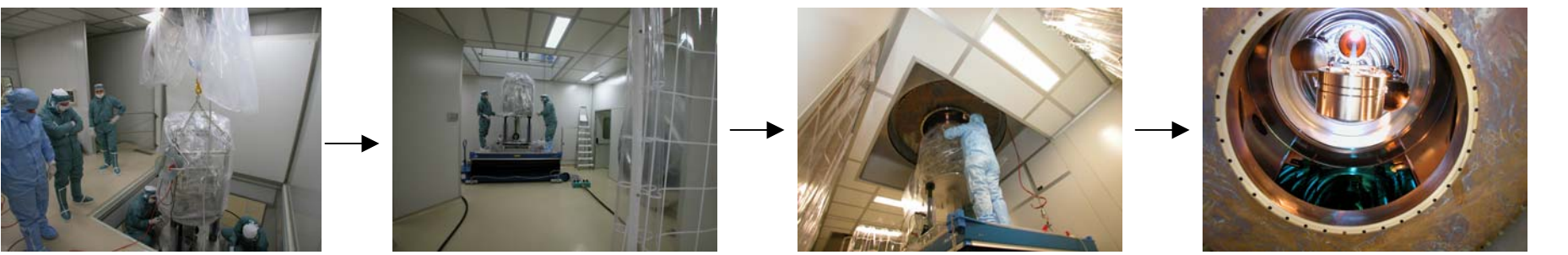
To exit from this room, we used either the elevating chariot, either the giraffe. The first choice is to go to the central building gallery, the second is to go the North end building.

# To the central building gallery



The elevator chariot is used below a tower to lift or lower a payload.

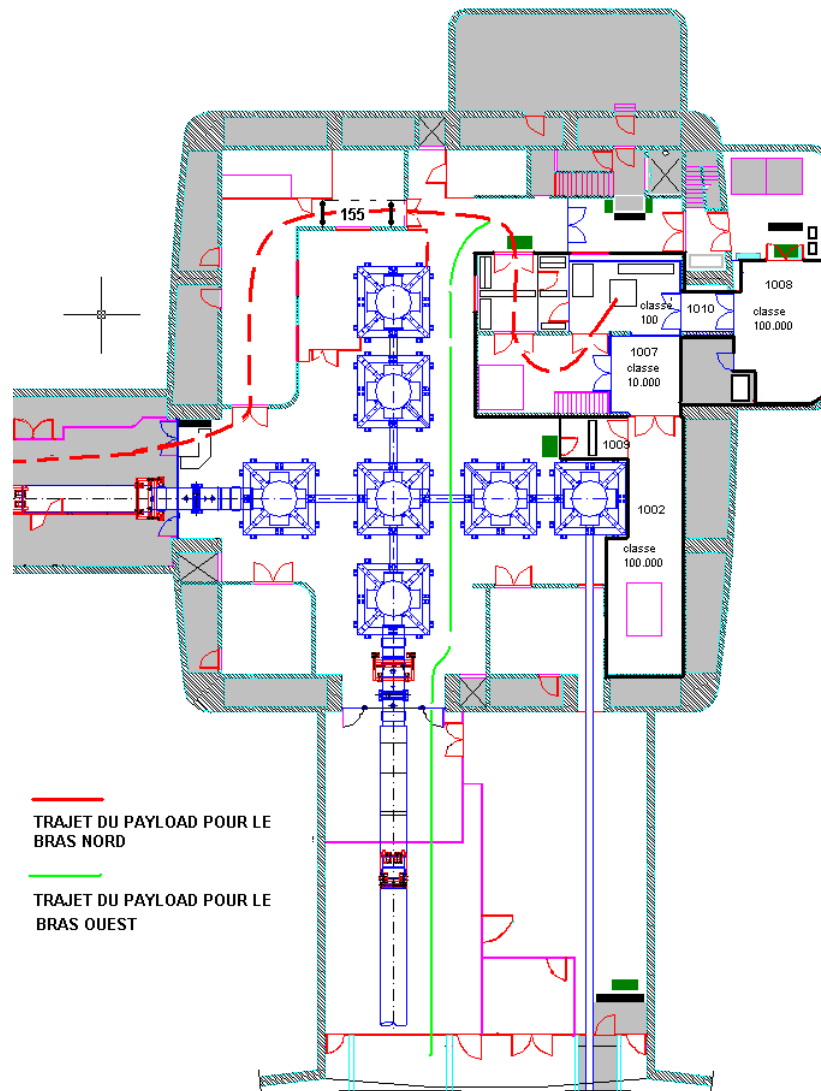
It is fit with a positioning table and a telescopic cage .



To the final buildings.



The payload is loaded on the box-trolley



To the west end building, it is necessary to cross the central building with the suitable binary.



Specially for the mounting west end mirror, we exited from the clean room with the elevator chariot. After that it must be cleaned perfectly.



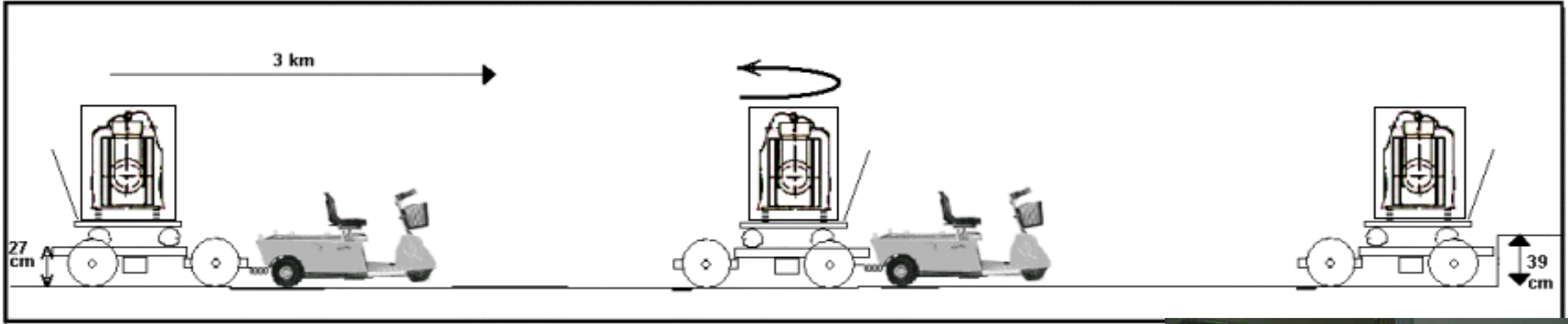
The 'varioreuil' has a speed remote controller.

The payload is loaded on the box-trolley





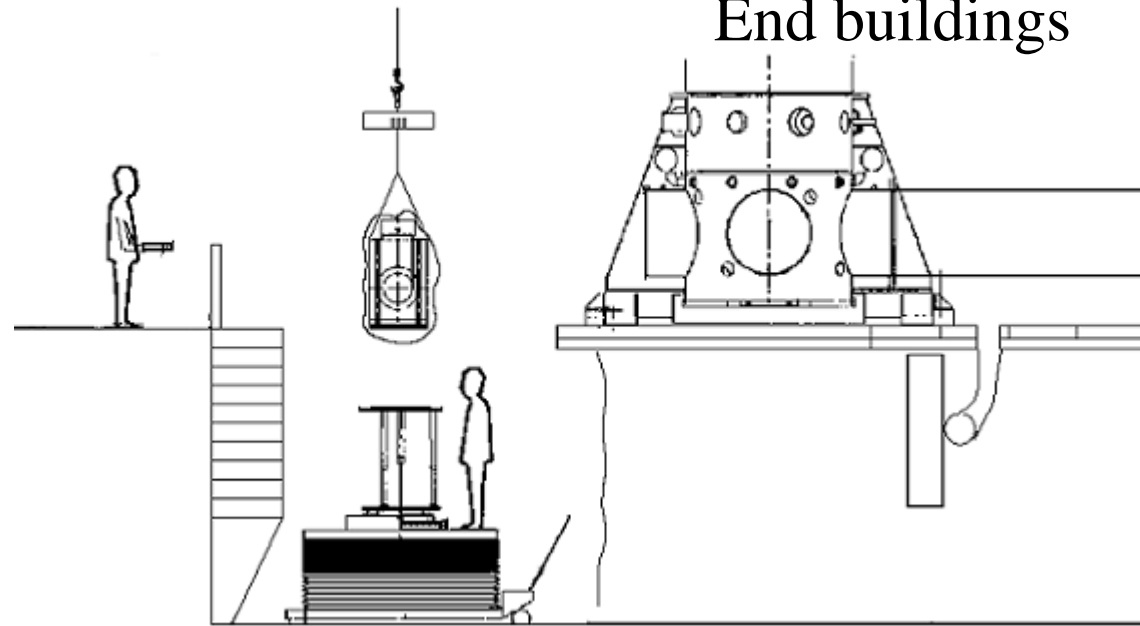
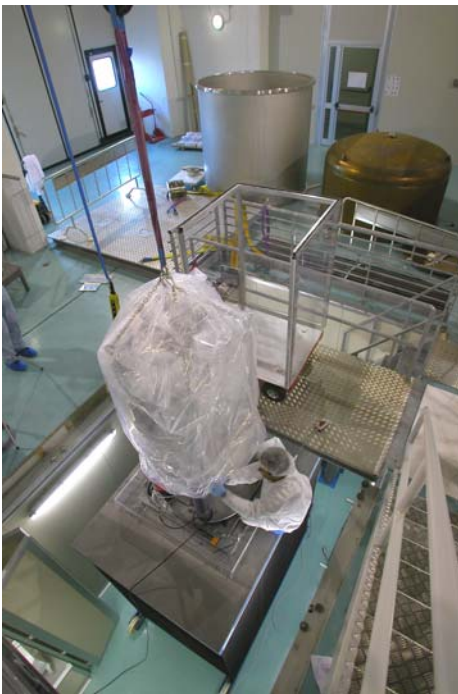
# To the end buildings



Vehicule electrique ST1-700 (Plateau 700x700)  
Chargeur embarque 24V – 10 A  
**STI industrie** 7000 Euro

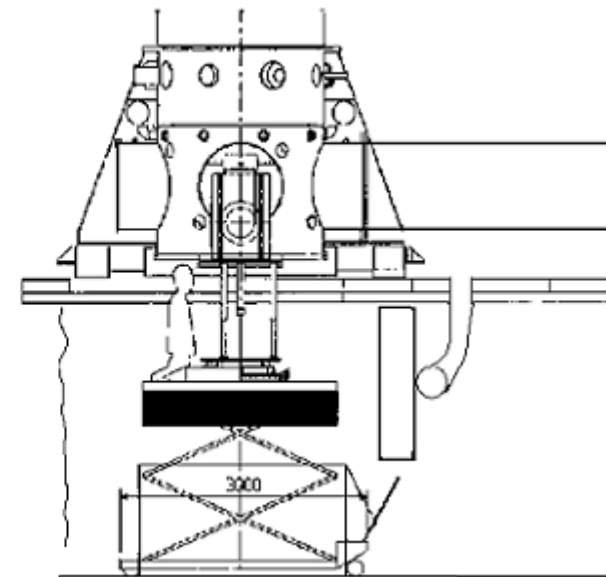
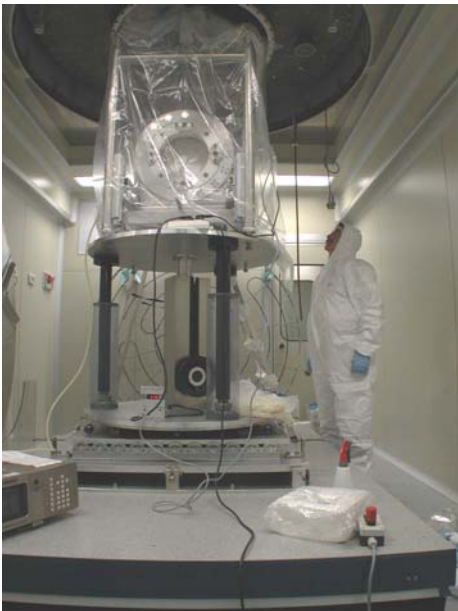
The electric car has a cruise control.





Note The 4 hymo, lift truck, on the site, are implemented with a skirt in order to confine its dusty parts as well as a possible oil leak in its hydraulic system The positioning table allows for smooth X/Y displacements and for rotation around its vertical axis. It is used to position smoothly the payload with respect to the bechers. The table is set up under a protection cover built to allow an easy wet cleaning. This protection cover is made with a transparent material to allow a visual control of its movements.

The telescopic cage has been built to provide a smooth vertical approach of the suspension point located between the stainless steel bechers. The cage is also used for a safe extraction of the operators. Sitting under the cage, an operator would be safe in case of any problem during the payload. The legs and the plates of the cage are designed with protections allowing an easy cleaning.



# Conclusion

Today, EGO site offers good facilities to work in “clean environment”, and to make good mechanical assembling.

Of course, one mistake during of one of these steps and all steps must be made again..

And one thing to keep in mind, all this is not valid for the mirror. Until now, here in Cascina, we don't know how to clean a mirror.

In the future, we could envisage to reinforce the links with Lyon to list/define the different problems met at the time of the assembly of the 1st generation Virgo mirrors and include/understand the pollution measured on the CITF mirrors, in order to foresee/adapt our future operations.

In order to make in situ tests of mirror cleaning, the return on Cascina site of the CITF mirrors, would be necessary.

Now Virgo staff must be made aware of the cleanliness problems, and an idea would be to create a “Quality Group”, which would be responsible to ensure the respect of all these rules, in order to guarantee their successful results in the future.

# References

- Air cleaning by CRC press LLC 2001
- Air sampling instrumentation options by CRC press LLC 2001
- cleaning procedures for ligo optics E000007
- Definition et mise en oeuvre du cahier des charges infrastructures des salles blanches de Virgo Morand
- E980035 large optics and coc's cleaning procedures
- E990190-01-D Viewports cleaning and baking procedure
- E990316-00 CO2 Cleaning procedures
- EGO-MEM-OPE-40 Contamination current status
- Ego-Mem-Ope-45 Panels Clean Room
- EGO-NOT-OPE-69 Minutes of the opening of mc mirror's box
- Ego-Pro-Ope-39 Procedura per la pulizia delle camere pulite di Virgo
- Ego-Pro-Ope-44 opening instruction for the mirror boxes
- Ego-Rep-OPE-47 Transportation of the BS mirror from the Class 1 hood (Iso3) room to the assembling laboratory (Iso5)
- EGO-REP-OPE-49 Transportation of the dummy mirror from the clean room to the northend building
- EGO-REP-OPE-50 Transportation of the westend mirror from 30.06 to 01.07.2003
- Ego-Rep-ope-51 Assembling of the dummy mirror in clean room 15.07.02
- Ego-Rep-ope-52 Pictures of the assembling PR payload in assembling laboratory 13.11.02
- Ego-Rep-ope-53 Transportation of the PR payload from the assembling laboratory to the PR tower 14.11.02
- Ego-Rep-ope-54 Portfolio of NI payload transportation 16.01.03
- Ego-Rep-ope-55 Portfolio of the NI lower part tower
- Ego-Rep-Ope-56 Portfolio of detection benches assembling 08.11.02
- Ego-Rep-ope-57 Portfolio of NE payload transportation 28.04.03
- Ego-Rep-Ope-59 Portfolio of Mode cleaner payload assembling 23.03.03
- Ego-Rep-Ope-60 Contamination measurement for Virgo towers
- Ego-Rep-Ope-61 Portfolio of BS lower part tower
- Ego-Rep-ope-62 Portfolio of WI payload assembling 15.02.03
- Ego-Rep-Ope-63 Portfolio of PR superattenuators 27.03.03
- Ego-Rep-Ope-64 Portfolio of WE payload assembling 15.07.03
- EGO-REP-OPE-66 Arrival of the Cleaning Unit
- EGO-REP-OPE-68 Mirrors receiving in presence of SMA and Perugia crews 18.06.02
- EGO-SPE-OPE-67 Hood Class1 Technical requirements
- VIR-CFT-PIS-2200-104 Disciplinary tecnico per la fornitura delle clean rooms
- Vir-Man-Cas-2200-113 Contamination control plan
- VIR-MEM-LAP-3300-108 Cleanliness requirements for the installation of the central building vacuum chamber
- VIR-MOM-CAS-2200-107 Cleanliness meeting 2001
- Vir-Mom-Pis-2200-105 Minutes of Review 26-05-98
- Vir-Mom-Pis-2200-107 Minutes of Review 14-07-98
- VIR-NOT-ESP-1390-77 Measurement on the beamsplitter substrate
- VIR-NOT-LAL-1380-41 Scattered light problem
- VIR-NOT-LAL-1380-48 Scattering light
- VIR-NOT-LAL-1380-58 Pumping technical document
- VIR-NOT-LAL-1380-59 Pumping technical document apperndice
- Vir-Not-Lal-1380-61 etude pompage eau
- VIR-NOT-LAL-1390-123 Baffles
- VIR-NOT-LAP-1380-54 Prototype bas de tour
- Vir-Not-Lap-1380-80 la proprete du blanc
- VIR-NOT-PCI-1380-63 Absolute surface testing
- Vir-Pro-Cas-2200-114 Procedure for using a clean room
- Vir-Pro-Cas-2200-115 Procedure for going in a tower
- Vir-Pro-Cas-2200-116 Procedure for cleaning a clean room (draft)
- VIR-PRO-LAP-3300-109 A summary of the optics introduction scenario
- VIR-PRO-LAP-3300-1PP A summary of the cleanliness tests performed on the lower tower
- VIR-SPE-LAP-2200-102 Clean optics installation, final proposal
- VIR-SPE-LAP-3300-110 Cleanliness of the lower prototype
- VIR-SPE-LAP-3300-116 Specifications of the gallery handling tools
- VIR-SPE-LYO-4340-0024 C03004 - Concave Mirror
- VIR-SPE-ROM-2200-103 Cleaning installation Specification concerning the cleaning system of the payload
- Vir-Tec-Cas-2200-117 Contamination current status
- VIR-TRE-LAP-3300-110 Historic of the cleanliness of the lower tower prototype Dic94-Jan97