VIRGO

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Memorandum : Cleanness requirements for the installation of the central building vacuum chamber.

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Abstract : This is a proposal for a cleaning procedure to be followed for the central building vacuum chamber installation. No satisfactory procedure has been discussed yet. Historically, the foregoing technical management was strongly in favor of a lower tower baking to be performed at SDMS. The proposed procedure aims to bypass that step as early as possible..

Learnings of the lower tower prototype

i)-Vacuum cleanness

Successive bakings of the lower tower prototype demonstrated that the VIRGO vacuum specifications can be reached in a lower tower: 10^{-9}mbar hydrogen, 10^{-10}mbar for other gazes. For hydrocarbons we measured 10^{-13}mbar at the limits of the possibilities of our gaz analyser. These results were obtained after several bakings at 200^{o}C, despite the low performances measured at tower reception.

After these vacuum tests, the tower was opened to play the mirror introduction scenario. During these operations the lower tower was permanently flushed with clean air. Once the tower was closed and returned to vacuum conditions, we measured an increase by a factor 100 of the last measured hydrocarbon residual partial pressure! A new baking restored the initial partial pressure pattern. Later, we installed the separating roof and we found again the same level of pollution which was cured by the same methods.

Since then we installed new windows, a new lower cover and we found again a high hydrocarbon pollution. The oven being dismounted, we live with a high hydrocarbon pollution.

Many cleaning procedures are available on the market : Tower, tube big valves on VIRGO, others at SDMS, ZANON, SEIV etc, CERN, ESRF, etc...They all produce different spectra on the analyser. After a 150^{o}C baking, they all (we tested many) produce the same good result! Baking is thus mandatory to reach VIRGO hydrocarbon partial pressure specifications.

ii)- Dust cleanness

After the vacuum and mechanical tests, we resumed cleanness conditions and found dust pollution in the tower. It happened that the upper compartment was full of « dirty » air whereas the lower compartment was flushed with clean air: pollution occured from the dirty air leaking in the lower tower through the suspension hole of the separating roof. Furthermore, dust particles were found inside the tower.

The lower compartment was washed to remove the visible dust. The lower tower was evacuated and filled with clean air, i.e. with air filtered at the venting access. After a few cycles, both compartments are finally filled with clean air. After restoring of the air flushing particle counting returned to zero. To go further, we decided to perform a complete introduction with Si wafers followed by another with real small size mirrors. Both were successfull.

3. Summary:

1.- Vacuum cleanness is best achieved on the VIRGO site by a >150 ^{o}C baking

2.- Clean venting and roughing is mandatory before optics introduction. Clean air flushing during payload introduction provides then the appropriate conditions for the optics introduction.

Installation at Cascina:

The central building vacuum chamber is build with many different components: lower towers, links, vacuum instrumentation, windows, valves, intermediate vacuum chamber, payloads, baffles.. All these parts have to be cleaned as vacuum components and if possible, baked at factory for hydrogen outgassing. They are assembled in a vacuum clean environment and present most probably some hydrocarbon pollution, even their assembly in the VIRGO hall may generate a hydrocarbon pollution. A final baking at high temperature, say below 200^{o}C, would produce the adequate hydrocarbon partial pressure.

The same reasoning applies to dust pollution. The production and assembly of the various components cannot be performed in a dustfree environment, but the vacuum chamber can be processed to be finally dustfree. To that purpose, the tank is evacuated and refilled with clean air. Several cycles are necessary. Once the tower is full of clean air, the mirror vicinity is washed and cleaned and ready for introduction. The payload is assembled in a clean environment and installed « clean ». Once installed, the optics will stay dustfree provided the tank evacuation is slow enough to let dust particles in place! There is no big worry about the ultimate dust cleanness of the links or of the suspensions: dust moves only during pressure drops.

However, any leak may seriously pollute the tank! Operation of valves which could lead to pressure drops are thus also prohibited.

The proposed strategy is simple. Oil or dust cleanness requested by VIRGO are quite difficult to keep over from construction to installation. As long as possible, one tries to work under normal conditions. Extreme conditions are applied only at the end of a procedure, once the result is easy to preserve, i.e.once one operates under standard VIRGO conditions. The only exception to the rule is the payload assembly, which takes place in a clean room and which has to be kept clean until operation in the tower vacuum.

The procedure actually planned for the lower tower:

A 200^{o}C baking under vacuum is foreseen on each mirror tower on the SDMS site.

This procedure is heavy to implement and heavy to manage outside a laboratory. A complete tower pumping bench (roughing, turbo, titanium pots and associated intsruments) has to be set up on the tower sitting in the so called SDMS oven. A baking takes a week and has to be followed round the clock by a qualified technician. A minimum of data acquisition has to be performed on the site. Today, the necessary instrumentation is provisionned.

As the tower is already baked at 400^{o}C for hydrogen outgassing, one may question about the usefulness of the 200^{o}C baking under vacuum, any hydrocarbon is eliminated for sure! Between the hydrogen outgassing and the baking, new components are added. Regardless of their chemical cleaning proccedure, these components may still outgass some hydrocarbons. Baking gets ride of that and thetowers will thus be delivered clean. But what about the other pieces of the vacuum chamber like the links, the intermediate vacuum chamber, the associated instrumentation etc..? All these parts will be assembled in the VIRGO hall where it will be anyway difficult to master the final hydrocarbon partial pressure, i.e. at a point which could avoid a final thorough baking.

We propose to minimise the SDMS procedure and to program a baking of the whole vacuum chamber once assembled at Cascina. This baking should take place after the intermediate vacuum chamber installation and before the suspension implementation. At that time, the baking can be total and can also be performed at 200^{o}C.

If we agree on such a procedure, we reduce clearly the load on the oven (usefull for SDMS) and on our technicians (usefull for the setting up at Pisa).