Collimator Design Meetings

Minutes of the meeting 40 (19/08/2004)

Present: Aberle, Assmann, Chiaveri, Hänni, Mayer, Sievers

As introduction E. Chiaveri congratulates the entire team for the great success of the installation of the 2 collimators on the 18.08 – which went without difficulty.
This was only possible due to the untiring effort over the last 8 month of all involved in the project as well as the excellent support of the TS-MME group during planning design and manufacturing.

WHAT IS THE FINAL NUMBER OF COLLIMATORS TO BE INCLUDED IN THE IT ? (Oliver, Ralph)

A detailed list for the call for tender has been prepared as a reference. Some positions still need clarification. The total amount of collimators for the tender is between 93 and 101.
See http://lhc-collimation-project.web.cern.ch/lhc-collimation-project/collimator_list.htm

Specification for IT:
Possible Scenario:

1: "ALL IN ONE" firm – this is the preferred solution. However, there is a certain risque due to the fact that one single company might have various difficulties (structure, finance, delivery-schedule etc.)
The specification and the commercial documents should be written such as to take into account that CERN should have some flexibility in case of such difficulties

2: Separation of manufacture of several components at Novosibirsk
Manufacture of some or most components, assembly (brazing, welding) and adjustments "close" to CERN
This solution has many drawbacks. CERN has to assess the technical competence AND THE REQUIRED EQUIPMENT (brazing under vacuum, measuring device for items over 1.5m length – better than 20µ), transport of assembled collimators over long distances and its effect to the required precision – in case of assembly at Novosibirsk - and many more. In case of assembly closer to CERN with components from Russia the question of quality control and supervision will be a mayor difficulty.

Number of spares to be included into the IT

This is included in the list

SPS test:
results from the bake-out attached Collimator Acceptance Test.pdf

debriefing of installation TT40 and LSS5 (Oliver) see above.
A difference of 10mm in height was found – (after the meeting: this seems to be a mistake by the survey people and need to be corrected on the next technical stop –on September 06.)

Russian "manufacturing scenario" preparation for the visit
No visit is planned for the moment as CERN did not get the essential invitation to start the travel planning (visa etc.) yet.

AOB:

The final report of the external review committee can be accessed at:
http://lhc-collimation-project.web.cern.ch/lhc-collimation-project/review-report04/report-complete.pdf

The ordering of the raw material for the series production becomes now high priority.
Concerning the jaw material it was **decided,** after discussion, that the order should be written as soon as possible for **CFC material at TATSUNO**. It was decided that Ma. should – after his private visit – discuss with the technical and commercial engineers of the company and clarify some remaining technical questions.

A list of all questions to Tatsuno should be prepared for the next meeting (04/09/02)

ACTION LIST to be followed up:

Radiation load on springs, (and fingers ?)	#30	Vasilis
Divisional request for motors MS	#31	Oliver, Fabrice, Stefano
Heat transfer – final report	#31	Sergio
"plug-in" position control unit	#32	Roger, Fabrice
Water quick connection	#32	Manfred
Drilling holes after phase one – grooves in tunnel floor	#33	Oliver
Designer for TCDI beginning of September	#33	TS-MME
Contact fingers – model for tests top and side	#34	Sergio, Roger
Play between motor spindle and jaw	#34	Roger
Non-symmetric heating of vacuum flanges	#34	Vasilis, Oliver, Miguel, C. Rathjen
"Remote control" collimator exchange	#35	Keith, Roger
Radiation issues – heat evacuation, air duct, space, shielding		Ralph
Electrical plug-in	#36	Oliver, Fabrice, Roger
Preparation of all raw-material list and order	#40	Oliver, Raymond

Manfred

PRELIMINARY RESULTS ON THE OUTGASSING ACCEPTANCE TESTS OF THE LHC PROTOTYPE COLLIMATOR

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AT Vacuum Group

1. Test conditions

TS activities

1. All parts of the collimator have been cleaned according to CERN procedures.
2. The graphite blocs have been heat treated in a furnace during 2 h at 1000 degrees under vacuum
3. After installation in the collimator tank, the cover is welded using the electron beam technique
4. The collimator stays opened to air during the metrology controls (> 1 day)

AT/VAC activities

1. Before being tested, two sector valves (SPS type DN100) have been installed one on the upstream flange and the second one on the downstream flanges. These valves will allow keeping the collimator under vacuum after the bake out in order to avoid an in situ bake out in the SPS tunnel (time constraints).
2. Connection to a turbo molecular pumping station equipped with gauges and residual gas analyzer. The pumping station is entirely bakeable, its ultimate pressure before the test was: 5.1×10^{-10} torr.

2. Acceptance procedure

1. Connection to the pumping station
2. Pump down and follow up of the pressure decay and leak detection
3. Residual gas analysis before starting the bake out
4. Bake out at 250 degrees during 24 hours (flat top) and with a heating slope of 20 degrees/h.
5. Cool down after bake out (20 degrees/hour) and follow up of the leak tightness using the residual gas analyzer. During the temperature decrease, outgassing of residual gas analyzer and gauges during the cool down at 150 degrees while the collimator was at 120 degrees.
6. Pressure and residual gas analysis at room temperature
7. Searching for virtual leaks in the RGA spectrum
8. Ultimate pressure and corresponding outgassing flux (pumping speed 25 l/s)
9. Heating to 50 degrees (20 degrees/h)
10. Pressure and residual gas analysis at 50 degrees / gas loads (torr.l/s)
11. Heating to 100 degrees (20 degrees/h)
12. Pressure and residual gas analysis at 100 degrees / gas loads (torr.l/s)
13. Heating to 150 degrees (20 degrees/h)
14. Pressure and residual gas analysis at 150 degrees / gas loads (torr.l/s)
15. Cool down to ambient temperature
16. Pressure and residual gas analysis at room temperature

3. Results

1. Connection to the pumping station
2. Pump down and follow up of the pressure decay / Leak detection

Leak detection: Collimator was tight (background <10^{-10} mbar.l/s)
Pump down: -1 slope characteristic of water outgassing

3. Residual gas analysis before starting the bake out

Pressure: 5.9 × 10^{-6} torr after 17 hours pumping
RGA: H_2O (50 %), H_2 (25%), N_2 (20%), CH species (~ 1%) t.b.c.

4. Bake out at 250 degrees during 24 hours (flat top) and with a heating slope of 20 degrees/h.

Pressure (end of the flat top): 1 × 10^{-5} torr

5. Cool down after bake out (20 degrees/hour) / Follow up of the leak tightness using the residual gas analyzer. During the temperature decrease, outgassing of residual gas analyzer and gauges during the cool down at 150 degrees, 120 degrees for the collimator.

No leak observed during the cool down of the collimator

6. Pressure and residual gas analysis at room temperature

Pression: 1.8 × 10^{-8} torr
RGA: H_2 (80%), N_2 (9%), CO (4%), CO_2 (3%), CH (2%), H_2O (~2%)

7. Searching for virtual leaks in the RGA spectrum

No indication of virtual leaks

8. Ultimate pressure and corresponding outgassing flux (pumping speed 25 l/s)

Pressure: 1.8 × 10^{-8} torr
Total outgassing flux: 4.5 × 10^{-7} torr.l/s (1.3 × 10^{-7} torr.l/s specified)

9. Heating to 50 degrees (20 degrees/h)
10. Pressure and residual gas analysis at 50 degrees / gas loads (torr.l/s)

Pressure: 2.1 × 10^{-8} torr
RGA: H_2O increased
H_2 (78%), N_2 (9%), CO (4%), H_2O (~4%), CO_2 (3%), CH (2%)

11. Heating to 100 degrees (20 degrees/h)
12. Pressure and residual gas analysis at 100 degrees / gas loads (torr.l/s)

Pressure: 5.2 × 10^{-8} torr @ the beginning of the flat top
9.5 × 10^{-8} torr @ the end of the flat top (3h after)
RGA: H_2O increased
H_2 (77%), H_2O (~10%), N_2 (5%), CO (4%), CO_2 (2%), CH (2%)

13. Heating to 150 degrees (20 degrees/h)
14. Pressure and residual gas analysis at 150 degrees / gas loads (torr.l/s)

Pressure: 2.7 × 10^{-7} torr
3.3 × 10^{-7} at the end of the flat top (3 hours after)
RGA: H_2 (74%), H_2O (~15%), N_2 (4%), CO (3%), CO_2 (2%), CH (2%)

15. Cool down to ambient temperature (20 degrees/h)
16. Pressure and residual gas analysis at room temperature

Pressure: **9.9×10^{-9} torr**
RGA: **H_2 (88%), H_2O (4%), N_2 (3%), CO (3%), CO_2 (1%), CH (1%)**

4. Preliminary conclusions

1. The mechanical assembly of the tank was made according to UHV standards
2. Before the bake out, the pressure decrease was dominated by the water vapour pressure as expected ☞ Efficient cleaning and working procedures
3. Bake out
   a. No leak appeared during the bake out cycle
   b. No traces of virtual leaks
   c. Total outgassing flux after 24 hours bake out at 250 degrees is low, only a factor of 3 above the specifications (see recommendations)
   d. H_2 is the dominant gas, CO/CO_2 represents about 6-7 %, CH about 1 %
4. The total outgassing flux increased less than expected with the temperature: 20 % at 50 °C, factor 5 and 18 at 100 °C and 150 °C respectively. This measurement is giving a pessimistic view since during operation, only the jaws temperature will increase.
5. Ratios of gas composition stayed constant except water which slightly increased with the temperature. CH species stayed at a 2 % level.
6. As expected, after the cycling in temperature and the additional pumping time, the total outgassing flux decreased by a factor of 2

5. Recommendation

The total outgassing flux measured at room temperature is above the specification (factor 2) and this can be solved by a longer bake out time (not recommended during operation) or by the use of an additional pumping like the NEG coating.

Since the partial pressure is dominated by hydrogen, the use of a NEG coating will decrease the pressures by at least a factor of 10.

An estimation of the saturation time of the NEG coating, assuming that the entire inner surface of the tank is NEG coated (10^4 cm^2) gives 50 and 140 hours equivalent assuming 2×10^{-5} or 7×10^{-6} torr.l/cm^2 for the CO and the CO/CO_2 outgassing flux at 150 °C .

At 50 °C (more realistic assumption), the estimations gives between 22 and 64 days equivalent before being saturated.

These duration before saturation, equivalent to the LHC working time with a beam lifetime of 1 hour, should be high enough not to require an intermediate reactivation of the NEG coatings between two successive shutdowns.

The use of NEG coatings inside the collimator tank will decrease the gas load to the upstream and downstream NEG coated copper chambers.