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Qualification of vacuum tests at NCBJ, short summary:

- vacuum tests of a PIMS standard disc and a pickup ring have been repeated at NCBJ
- the elements have been carefully handled and installed.
- vacuum tests have been performed according to the established procedure
<https://edms.cern.ch/document/1271614//>
- the tests and the equipment have been very well prepared
- the tests went smoothly, both PIMS elements are leak tight
- pictures can be found in the EDMS folder <https://edms.cern.ch/document/1286452//>
- **vacuum tests have been qualified at NCBJ**
- 3 points for improvement have been discussed:
 - ◆ a chart recorder is needed to record the Helium content displayed by the leak detector. During our visit, a chart recorder has been organised. It will be connected for the next tests.
 - ◆ in order to double-check the pressure applied to the cooling channels (evacuation of air followed by helium pressurisation in steps), a second manometer will be installed behind the last valve. This will facilitate to check the states of the 4 involved valves.
 - ◆ a lifting device will be organised to facilitate the installation of PIMS elements (for end discs in particular) and to reduce the risk of damaging completed PIMS elements

Discussion of production of first PIMS cavity (cavity M):

- the last schedule sent to CERN could be kept so far, the last elements of cavity M are foreseen to be finished at NCBJ mid June 2013. Details can be found here:
[https://edms.cern.ch/file/1286452//Schedule_cavity_M_\(29.04.2103\).pdf](https://edms.cern.ch/file/1286452//Schedule_cavity_M_(29.04.2103).pdf)
- it is not feasible to accelerate the completion of the waveguide ring
- the shipment of elements of cavity M will be done in 2 or 3 batches to allow metrology checks at CERN to take place from mid June onwards. The 1st batch will consist of 4 to 6 discs followed by a batch of rings and finally the remaining elements. The last batch is foreseen to arrive at CERN end of June.
- for the final machining of rings, the problems of coaxiality errors (~80 µm instead of allowed 20 µm) have been discussed. It was agreed to finish the remaining rings of cavity M with the technology used

(boring with Kaiser tool) for ring M_13-14 and gm_13-14. From the fully assembled cavity conclusions can be drawn if the technology needs to be changed. In the meantime, machining tests are carried out on a non-CNC milling machine by a skilled mechanic; the coaxiality seems to be well controlled but problems have been met in measuring the assembly diameter $524.720 \pm 0.075 \pm 0.050$ on the 1.7 mm short section directly on the machine. Turning promises to be quicker than boring.

- the 2 grooves for brazing wires for the waveguide ring of cavity M are asymmetrically placed. An option to place a 3rd brazing wire was discussed but will not be implemented as the brazing with 2 asymmetrical wires went very well for the brazing test carried out last year. From the next cavity onwards, the 2 grooves will be placed symmetrically.
- the waveguide ring has undergone the last thermal treatment, is cooling down and will be final machined in the coming week (week 21). The circularity will be checked and slight deformations might be needed if the error exceeds the remaining material allowance of 0.5 mm in diameter. Cleaning, brazing, metrology and vacuum tests are the following tasks.
- bottlenecks have been discussed, they have already been considered in the recent planning. In the metrology lab, 1 disc or 3 rings can be measured per day – discussions for simplification will take place after the completion of the 2nd cavity. 3 discs or 3 rings can be cleaned per day. Up to 2 discs or 2 rings are foreseen to be vacuum tested per day after a learning period.
- the production is done in 1 shift at the moment
- the collaboration with CPL developed positively since the last meeting, deadlines have been respected. Next goals are the delivery of discs M_8-9 in week 20 and the final machining of waveguide ring M_7-8 in week 21.

Particular problems:

- the knife edge of the CF tuner port flange of ring M_9-10 has been damaged (see https://edms.cern.ch/file/1286452/Ring_M_9-10_-_CF_flange_damaged.jpg). The repair and successive tests have been discussed:
 - ◆ the entire profile of the flange, the brazing and the copper tube of the port need to be re-machined (see sketch https://edms.cern.ch/file/1286452/Re-machining_of_CF_flange_DN_114-63.png) since the copper joint has an inside diameter of 63.6 ± 0.2 mm and an outside diameter of 82.4 ± 0.05 mm.
 - ◆ after the re-machining, the profile shall be checked in the metrology lab
 - ◆ the corresponding clamps of the flange need to be re-machined in height by the same amount to preserve the compression of the joint
 - ◆ the 2 corresponding clamps shall be **both** stamped with the label "ring M_9-10" in order to allow us to keep track of the modified flange-clamp combination
 - ◆ a vacuum test needs to be performed as validation (standard operation anyway)
- a scratch has been found on the CF flange of ring N_9-10. It was judged that this scratch can be removed with standard hand polishing methods. It needs to be repaired before vacuum testing.
- in order to avoid similar problems, protective plastic covers have been ordered and care will be taken in handling. CPL will be reminded of handling PIMS elements and in particular CF flanges with great care.
- the cooling channel threads of disc M_6-7 will be repaired by the following operations:
 - ◆ repulsing the threads again
 - ◆ re-cutting the flat top part to cut the burrs. Manual tools with cutting angles between 15° and 30° are being considered
 - ◆ after successful repair, a standard vacuum test for discs shall be performed
- disc M_8-9 is being finished by CPL, also here a repair of the cooling channels might be necessary
- in the future, all cooling channels will be machined by NCBJ. Drills can be used for 8 discs before re-sharpening or replacement

Further discussions:

- the metrological measurement procedure for perpendicularity has been followed up: Grzegorz sent details of the measurement procedure used at NCBJ (EDMS <https://edms.cern.ch/document/1284295//>), which were discussed with the CERN metrology (Lilian Remandet). The same procedure is used at CERN, only the number of measurement points and locations differ slightly which leads to the seen differences in perpendicularity.
- about 40 rings have been prepared for EB welding; the ports need to be nickel plated and brazed, which might take 3 to 5 weeks. Traveller documents for the weld order have been prepared and will be discussed with FZJ Julich. CERN will be included in the communication.
- 6 spare rings (4 standard and 2 pickup) are being prepared for welding in order to be able to replace rings quickly if needed. Standard rings can be opened to integrate a pickup port if needed.
- a list of additional flanges needed will be sent to CERN as the order at CERN will take a considerable amount of time due to requests for the Long Shutdown (LS1)
- the installation of the new Chiron turning/milling machine is scheduled for June 26th, the base is being prepared. More than 2 people will be trained for the new machine.
- tools for final machining are changed after completing 2 PIMS elements (degradation has been seen after machining 4 elements in a row)
- 11 fixed tuners have been delivered to CERN, the brazing did not fill the gap completely as only 1 brazing wire was used instead of 2 applied for the tuners of the PIMS prototype cavity. Ultrasound checks are being done at CERN to see if the tuners can be accepted. 5 fixed tuners are needed per cavity. It was agreed that for the remaining 54 fixed tuners, a 2nd brazing wire will be used even though this implies to remove the nickel plating from the already prepared flanges, the machining of a 2nd groove into the flanges and a new nickel plating.
- the machining of pinholes 6H7 for target supports into all standard discs has been discussed. The corresponding drawings have recently been modified by CERN (splacpm*0003-vAA, with * representing C to N corresponding to the cavity label).

EDMS-link: " target="_blank"><https://edms.cern.ch/document/1286452//>] Photos contained in EDMS link above
Twiki-link: <https://twiki.cern.ch/twiki/bin/view/SPL/PIMS14May13>]]

Action-list:

- NCBJ: install a chart recorder to record the leak detector readings
- NCBJ: organise a lifting device for vacuum tests to avoid risk of damaging completed PIMS elements
- NCBJ: organise and install a manometer on the pressure side for tests of cooling channels
- NCBJ: repair the CF tuner port flange of ring M_9-10 by re-machining, cut the corresponding clamps accordingly, stamp them both with "ring M_9-10" and document the changes clearly in the quality assurance documents
- NCBJ: repair the CF tuner port flange of ring N_9-10 by standard hand polishing methods before vacuum testing
- NCBJ: agree on traveller and quality assurance documents with FZJ Julich for the EB welding of rings
- NCBJ: prepare a list of additional flanges needed
- NCBJ: use silk paper to wrap cleaned copper elements before placing them into plastic bags to avoid carbon contamination of surfaces
- CERN: order additional flanges if needed
- CERN: send a reference of silk paper or silk paper itself to NCBJ
- CERN: send indium wire for vacuum tests of waveguide rings to NCBJ
- CERN: prepare an option to perform vacuum tests of waveguide rings with indium wire as seals in case Helium permeates the NBR 70 seals too quickly

We would like to thank our Polish colleagues for the excellent preparation and extraordinary hospitality!

Rolf Wegner, 17. May 2013

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