Table of Contents

CCDTL 4th technical meeting for production of 7 CCDTL modules for Linac4 (ISTC contract #3888 and #3889), 15-17 June 2010 at CERN

Participants:

BINP Novosibirsk:
Alexey Tribendis (ISTC Projects 3888/89 manager, deputy RF group leader BINP), **Yaroslaw Kryuchkov** (design group leader)

VNIITF Snezhinsk:
Mikhail Naumenko (ISTC Projects 3888/89 sub-manager, design group leader VNIITF), **Dmitry Vavasov** (design engineer, VNIITF), **Vladimir Lomakin** (Production Supervisor)

CERN:
Jean-Pierre Corso (responsible for integration for Linac4), **Alessandro Dallocchio** (responsible mechanical engineer for Linac4), **Gilles Favre** (Workshop Supervisor, Coordination of Linac4 Prototyping), **Luca Gentini** (mechanical engineer), **Frank Gerigk** (ISTC Projects 3888/89 coordinator at CERN, responsible for accelerating structures in Linac4), **Jean-Michel Giguet** (testing and installation of Linac4 accelerating structures), **Mark Jones** (Large Scale Metrology Linac4), **Tadeusz Kurtyka** (Project Office, External Relations), **Luz Anastasia Lopez-Hernandez** (responsible for civil engineering Linac4), **Benoit Riffaud** (mechanical engineer), **Carlo Rossi** (responsible for RFQ construction and 3 MeV test stand), **Stefano Sgobba** (material science, deputy group leader MME), **Patricia Ugena** (RF simulations Linac4), **Maurizio Vretenar** (Linac4 Project Leader), **Rolf Wegner** (responsible for PIMS design & construction)

List of talks:

Indico Meeting 97706

Supporting documents in EDMS:

- results of first welding test at VNIITF, EDMS 1072458, restricted access
- proposal for revised welding procedure, EDMS 1080835, restricted access
- drawings with status June 2010, EDMS 1081009, restricted access

Technical Summary

1. Construction Status at VNIITF
2. Construction Status at BINP
3. Water Cooling
4. Welding Qualification
5. Support Frame
6. Integration and Metrology
7. Quality Assurance
8. Action List

The meeting was opened with a welcome by T. Kurtyka followed by a status report of the Linac4 project (M. Vretenar).

1. Construction Status at VNIITF

Presentation by M. Naumenko:

- Slides in Indico
- Approximately half of the modules are pre-machined,
- The grooves for the water channels of the 1st module are machined and the workshop is now waiting for the approval of the welding procedures by CERN,
- The SERTO fittings, which are connected to the cavity are bought by ISTC. This resolves the problem that these fittings cannot be bought in Russia directly. The purchase order has already been launched.
- A solution was presented to avoid the trapping of chemicals (during copper plating) in the hidden volume between cavities and coupling cells. A water channel has been added, which can be used to press water through the hidden volume and flush out any remaining chemicals. **This procedure was accepted by CERN**. It was suggested by S. Sgobba to measure the PH value of the water which is flushed out to judge whether all chemical remains have been removed. After the water cleaning the warm gas (e.g. Nitrogen) should be used to dry the hidden volume.

Planning for July visit at VNIITF

- The coupling cells and the half cells of the first tank will be machined. It was agreed that some of the half tanks and coupling cells will be copper plated for the visit.
- There was concern that the copper plating might be damaged when doing a metrology check (with a rigid bar inserted in the beam pipe along a module) on the assembled module. However, several solutions were discussed how to avoid any damage.
- A rough alignment check will have been done before the visit.

2. Construction Status at BINP

Presentation by A. Tribendis:

- Slides in Indico
- Altogether 50 drift tubes and stems will be prepared. This includes 8 spares, which will not be final machined, and the welding of drift tube to stem will not be done the spares to allow for final machining of the drift tubes on a turning machine.
- Several aluminum dummy drift tubes with different sizes have been prepared for the tuning. These will be used to determine the precise dimensions of the copper drift tubes to arrive at 352.2 MHz.
- Rough machining of drift tube bodies is ongoing.
- It was calculated that around 700 g of gold will be used for the brazings..

Further construction planning

- June/July: turning operations on drift tubes and stems.
- July: machining of cooling channels,
- August: brazing of drift tube bodies, rough machining of 50 drift tubes finished, machining operations of 50 stems finished,
- The remaining fine machining will be done after measurements with aluminum dummies on the actual cavities.

3. Water Cooling

- CERN announced that it does not want to install large manifolds, which can be used for the cooling for high duty-cycle (SPL type) operation. Instead a simplified cooling will be installed that only

covers the needs of Linac4 operation.
- CERN decided to reserve space for large manifolds on the ground close to the structures.
- CERN needs to verify which hoses to connect to the foreseen SERTO fittings (SO 51429-12 weld-on, and SO51121-12-3/8 screw-on), and which connectors to use.
- For the water pressure tests at BINP, BINP will use simple hoses and no special connectors are needed.
- The final hoses will be ordered by CERN after a first mounting at BINP. From this test the total amount of hoses will be estimated.
- BINP will calculate the pressure drop when connecting several channels of a module in series. Ideal would be 2 circuits for the 3 tanks and 2 circuits for the drift tubes. This would result in a "symmetric" heating pattern along the modules. The maximum pressure drop should not be more than 4 bars per circuit and the water flow speed should be ~1 m/s. At the PIMS CERN has calculated a pressure drop of 1.5 bar per circuit (4 discs) when assuming a flow speed of ~1 m/s.
- BINP will make a suggestion for the design of a 4 fold splitter (mini-manifold) that can be used for the modules.
- It was decided to place the 4-fold splitters on the ground, in order to block the space already for future, larger manifolds.
- CERN will bring a sample hose to the visit at VNIITF.

4. Welding Qualification

- After the tests of the welding samples EDMS 1072458, restricted access, which have been provided at the 3d technical meeting, new welding samples were presented according to the newly proposed welding procedure EDMS 1080835, restricted access.
- The quality of the weldings and the approach was considered as valid for production by G. Favre and S. Sgobba.
- For the qualification of the welders, however, it is necessary to obtain production drawings with specification of the welding depths. Only then can be judged if the welders actually did what they were asked to do. VNIITF will send these drawings and CERN will do the qualification of the pieces. It is foreseen to return the welding samples during the visit at VNIITF in July.
- In order to proceed with the work at VNIITF, it was agreed that VNIITF can start the weldings with the proposed procedure. Nevertheless, the qualification process for the welders (see above) has to be concluded.

5. Support Frame

The current status of the support frame was presented by D. Vavasov. It shows all elements needed to fix intertank supports and water manifolds.

- The maximum **deformation of the frame** will be in the range of 0.1 mm at one end of the frame. An effort should be made to reduce this deformation to ~0.05 mm. CERN will supply standard steel profiles, which can be used for the frame and VNIITF will make simulations to test the frame deformation with these profiles. Most gain is expected from profiles with more height (200 instead of 180) mm, while an increase in wall thickness will probably not have much effect (due to the simultaneous increase in weight).
- For **transport** all water channels will be closed with an aluminum disk,
- **Quadrupole supports** for quads between the cavities of a module can only be fixed on one side of the support, because a two-sided support would interfere with the coupling cells. At present these supports are screwed. It would be preferable to weld these supports to avoid any change in position over time. This however makes the dismounting of the modules difficult, because the longitudinal movement of the half tanks becomes restricted. A certain movement range, however, is needed to remove the cavity bodies from the coupling cells. VNIITF will check which beams can be welded, so

that it is still possible to dismount the cavities. In case a welded solution is impossible, CERN will accept the screwed solution.
- The **tilt surfaces** will have a distance of 310 -+ 0.5 mm from the axis. The exact distance and the position of the three holes for the laser-tracker target holders will be measured with a precision in the um range and given to CERN.
- Three guide rails will be welded to one side of the support. These provide horizontal and vertical guidance for the three cavities of each module. After welding the support has to undergo a stress relief procedure (at BINP for instance a vibration treatment was used but this procedure is not accepted by CERN; a stress relief with heat treatment is compulsory), and then the rails are precision machined. For the reference frame which was constructed at BINP for the test assembly of all modules, a precision of -+0.1 mm was achieved.
- The feet, which are used against the alignment surface must have a high precision with respect to the axis. The feet are precision machined only after they after are welded onto the cavities. Overall this should give a precision of 0.08 mm across the 3 cavities of a module.
- We need to understand the stresses on the coupling cell weldings, when the structure is "forced" into misalignment on the support. On one slide a stress of 168 MPa appears if a movement of 1 mm is enforced at one end. This is not acceptable.
- We need to understand possible deformations of the structure during transport at CERN (fully mounted modules).

Assembly procedure:

The module is relatively flexible, which means that it will "find" its own position once it is assembled on a surface and once all bolts are tightened. It is assumed that each cavity of a module will "sit" on 2-3 points (out of 4 supports). Free longitudinal expansion must be ensured to account for heating effects. For alignment there is a precision machined guide rail (see above).

1. The drift tubes are assembled in the half tanks,
2. The 2 half tanks of the central cavity are put onto the support and pressed against the guide rail.
3. Then the half tanks are bolted together and fixed transversally and longitudinally on the support. The possible small misalignment between the half tanks is taken by the tolerance on the Helicoflex joint between the cavities.
4. The coupling cells are attached either to the central cavity or to the outer half tanks.
5. The half tanks following the coupling cells slide into position and are fixed transversally on the guide rail.
6. The outer half tanks slide on the support into position.
7. The feet of the outer half tanks are pressed against the guide rail on the support and blocked into their transverse position.

6. Integration and Metrology

- It was found that the **water connections for the drift tubes**, which are on top the girder, penetrate into the space reserved for metrology. CERN will define how much penetration can be accepted, and BINP will reduce the penetration as far as possible by shortening the connections in the vertical direction and by using 90 degree bends so that water hoses can be connected in the horizontal direction (on the right side, when looking downstream). The optimised connections will probably extend 8-10 cm into the reserved space.
- The only length limitations for the support frames is given by handling and installation. This means that at least a few cm of space are needed between the frames in the longitudinal direction. The length of the first and last support frame has to start and end at the same level as the cavities, because spererate supports will be used for the areas between DTL/CCDTL and CCDTL/PIMS.
- The surfaces of the tilt pads and the feet of the cavities will be parallel within an envelope of 50 um.

7. Quality Assurance

A document has to be written, which specifies when CERN gives its official acceptance for the CCDTL modules. The following tests will be defined:

- vacuum: leak rate
- RF: field flatness, Q, frequency range,
- water pressure test, test pressure, operating pressure,
- each module will be delivered with a document that contains all test reports and measurement results, which were done at VNIITF and BINP, together with execution drawings in plt, in English and Russian,
- alignment: positions of laser tracker target holders will be given (agreed with Mark), BINP will do an alignment check on a reference table: report will be given, CERN will do an alignment check but the alignment on a modules will not be an acceptance criteria because modules are mounted on supports, which are fabricated by CERN,
- CERN reserves right for high-power test within 3 months after assembly (criteria for acceptance/rejection not so clear to define), after 2 weeks of conditioning with Linac4 duty cycle the structures must be able to maintain the nominal fields and duty cycle,
- see with vacuum group how to define the condition of the copper plated surfaces, transport is done under nitrogen,

Discussion items for visit at VNIITF

- Need to define the response by VNIITF in case there is a technical problem. Discuss with director that in case there is a problem caused by VNIITF, that VNIITF fixes the problem. This avoids the involvement of ISTC, which may close its operations during or shortly after the project is finished.

8. Action list:

action	institute/person	status/result	completed
welding samples			
send drawings of welding samples (including foreseen welding penetrations) to CERN	VNIITF, M. Naumenko	done visit requests sent from ISTC to VNIITF	2010-06-29
qualify VNIITF welding samples	CERN, F. Gerigk, S. Sgobba	done EDMS document 1083982 (restricted access)	2010-07-16
support structure			
check which quadrupole supports can be welded, so that it is still possible to dismount the modules	VNIITF, M. Naumenko	done	
provide standard steel profiles, which can be used for the support frame	CERN, Y. Cuvet	done profiles 1, profiles 2	2010-06-17
increase rigidity of the support	VNIITF, M. Naumenko	done see 5th technical meeting	2010-07-21
optimise position of the supports for increased rigidity, if possible		done see above	2010-07-21
provide drawings for alignment arms and specify where to fix them	CERN, M. Jones, F. Gerigk	done	
define maximum misalignment of the module, which can be accepted by the weldings of the coupling cells. This information is needed to work	VNIITF, M. Naumenko	in progress	

out handling instructions of the mounted modules.			
provide details on the foreseen supporting jacks	CERN, B. Riffaud	done see presentation	2010-06-16
provide assembly procedure for the cavities on the support (finalised only after assembly of first module at BINP)	BINP/VNIITF	in progress	
provide available drawings	BINP/VNIITF	done see EDMS 1081009	2010-06-017
Water cooling			
provide drawings for the support of PIMS water splitters, if available	CERN, L. Gentini	EDMS 1083973	
provide 3D model of the jacks will be used for CCDTL	CERN, B. Riffaud	done EDMS 1083986	2010-07-20
verify which hoses to connect to the foreseen SERTO fittings (SO 51429-12 weld-on, and SO51121-12-3/8 screw-on), and which connectors to use.	CERN, L. Gentini, J-M. Giguet, Y. Cuvet	done	
provide sample hose and connector	CERN, F. Gerigk, L. Gentini	done at 5th technical meeting	2010-7-20
calculate the pressure drop when connecting several channels of a module in series	VNIITF, M. Naumenko, D. Vavasov	in progress	
suggestion for the design of a 4 fold water splitter	BINP, A. Tribendis	in progress	
Integration and Metrology			
define volume above the girder, which can be used for cooling connections	CERN, J-P. Corso, M. Jones	in progress	
shorten water connections for drift tubes (above girder) and use 90 deg bends for horizontal connection (right hand side) & provide sketch of optimised layout	BINP, A. Tribendis	in progress	
preparation of sketch to define coordinate system to be used for the metrology of half cavities at VNIITF	CERN, M. Jones, Y. Cuvet	done presentation at 5th technical meeting	2010-07-20
Quality assurance			
write a document for the acceptance procedure at CERN	CERN, F. Gerigk	in progress	

-- FrankGerigk - 17-Jun-2010

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