CCDTL: kick-off meeting for production of 7 CCDTL modules for Linac4 (#3888, #3889), July 13 - 16, 2009

Participants:

BINP, Novosibirsk: A. Tribendis, Y. Kryuchkov
VNIITF, Snezhinsk: M. Naumenko, D. Vavasov
CERN: M.Vretenar, M.Pasini, F.Gerigk, R.Wegner, P.Bourquin, T. Kurtyka, E. Page, S. Sgobba, C. Saint-Jal, M. Savino, G. DeMichele, G. Favre, J. Stovall, R. Maccaferri, L. Evans, A. Lombardi, L. Soby, E. Bravin, T. Zickler

list of talks:

Indico meeting 64194

supporting documents for this meeting

- ion pump specification for a port diameter of 100 mm
- revised coupling slot shape for improved coupling 2nd view
- dimensions of vacuum equipment for rough pumping
- illustration of work distribution between institutes
- CCDTL design, lengths & RF parameters
- consideration about vacuum conductance of gridded vacuum ports
- metrology test of coupling cell of ISTC prototype (results indicated on drawings of CERN prototype!))
- preliminary drawings for intercavity integration (EDMS, restricted access)

Technical summary (F. Gerigk)

1. ISTC contract situation
2. Construction and cooling
3. Support structure and alignment
4. RF simulations and structure dimensions
5. Vacuum and ports
6. Material orders
7. Quality assurance and future meetings
8. Intercavity sections
9. List of actions

Main results:

1. ISTC contract situation

After the welcome address by L. Evans M. Vretenar started the session with a presentation on the construction status of Linace.Then T. Kurtyka gave an overview of the preparation for contracts #3888 and #3889, which started approximately one year ago. The regular project #3888 is supported by the ISTC with 916 k$ and includes the structure design, construction of drift tubes, RF tuning, design of support frames, testing and assembly at BINP and CERN, and the transport to CERN. The partner project #3889, which is fully funded by CERN includes the design of the cavities, drawings, prepration for construction and the construction of the cavities. One of the important points for CERN was to establish a strong contractual link between the projects so that it is clear that CERN will only engage itself if both contracts go ahead. T.

Kurtyka also stressed that this is probably one of the last big projects, which the ISTC can support with a significant financial contribution. This was followed by a presentation of A. Tribendis on the details of the contracts, which has been ratified recently. After the cut in funding all parties had to make an effort to save the project. The measures were:

- CERN pays an additional 185 k$ to project #3888, but reduces the amount for project #3889 by 50 k$. The additional sum of 135 k$ paid into the project was the maximum allowed by CERN rules (10% of the originally foreseen 1 350 k$)
- It was decided not to upgrade the baking oven at VNIITF, which would be necessary to bake the longest CCDTL structures. The baking was intended to uncover problems with the copper plating of the tanks. During a number of tests, however, no difficulties were found with the copper plating procedures. It was agreed that the first CCDTL modules shall be baked, and if there is no problem it should be safe not to bake the longer modules, which do not fit into the existing oven. This measure safes 50 k$ in project 3889.
- The construction of support strucures was removed from project #3888, while the design of the support structure is still in the contract. CERN will now construct the support structures. BINP will construct a test frame, which will be used for the test assemblies of all modules at BINP.

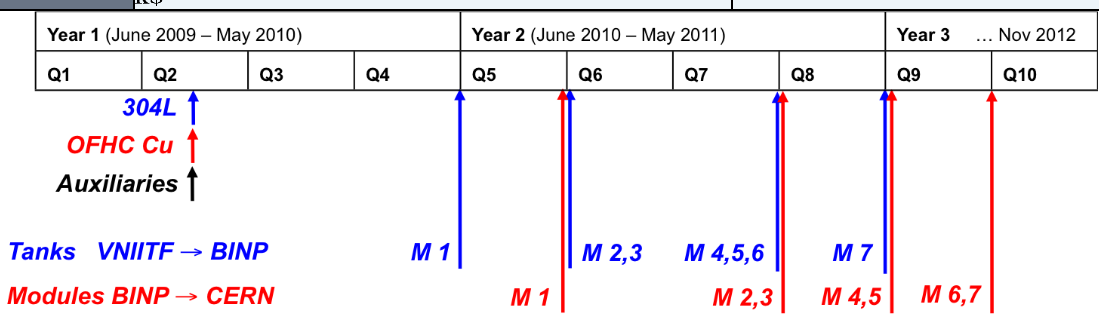
The total funding can be summarised as follows:

ISTC contribution to #3888 (regular project)	$ 915 884
CERN contribution to #3888	$ 185 000
CERN funding of #3889	$ 1 300 000
total budget for both projects (excluding material deliveries by CERN)	$ 2 400 884

out of this total budget 600 k$ are allocated for BINP and 1 800.884 k$ are allocated to VNIITF.

Payment schedule for CERN:

	#3889	#3888
imminent payment	650 k$	37 k$
2nd payment	after completion of 3d module by VNIITF: 390 k$	after reception of 3d module at CERN: 148 k$
3d payment	after completion of 5th module by VNIITF: 260 k$	



Planning:
Figure 1: Overall project planning.

The work distribution is shown in Figure 2.

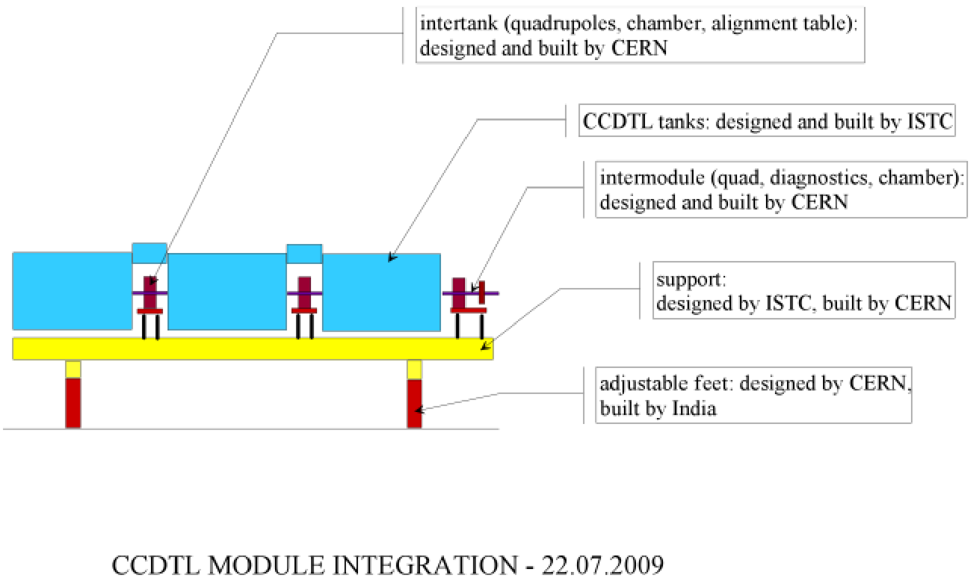


Figure 2: work distribution between the institutes.

2. Construction and cooling

Drift tube construction:

- It was agreed to braze the end tips onto the drift tube body, rather than to use EBW as originally foreseen.
- The drift tubes are brazed with oversized pieces and then machined to the desired dimensions.
- A brazing foil will be used to ensure good leak tightness. Any silver alloys coming to the surface will be machined off, when the drift tubes are machined to the final dimensions.
- It was agreed that the drift tubes will have 3 target holders each (on the circumference) to be used with a laser tracker.
- The construction of the drift tube is illustrated in Figure 3.

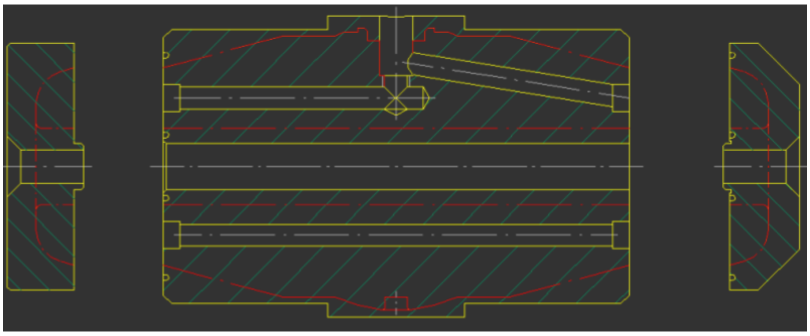


Figure 3: drift tube construction

Stem-drift tube joint and stem-tank joint:

- there are 2 options for joining the stem to the drift tube:

    - ♦ EBW (3 mm penetration). This option has the risk that the EBW will introduce a certain non-perpendicularity.
    - ♦ Brazing: this seems attractive because it is easier to fix both pieces into position when they are put into the brazing oven. The copper of the stem will annealed in any case because of the top part of the stem (made out of steel) will be brazed to the stem.
- A Helicoflex joint (HNRV) will make the vacuum/RF contact between the drift tube and the stem as indicated in Figure 4.

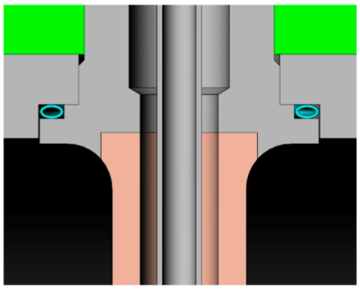


Figure 4: connection of stem to tank body.

Prototyping:

- BINP will construct 2 prototype drift tubes including a dummy volume and the alignment girder to verify the construction approach. CERN will deliver the necessary materials.

Water connections

- It was agreed to connect several water circuits in series. The limitation is a maximum temperature difference of 50 deg, a maximum flow speed of 1.5 m/s, and a maximum pressure drop of 5 bars.
- It was agreed to use SERTO fittings with self-sealing conical screws where ever possible (see Figure 5). In case the material is not thick enough to allow cutting the threads, the material thickness should be increased so that a thread can be made. If access conditions forbid this technique, SERTO fittings will be welded into position.
- Pressure tests of all cooling circuits will be made at 16 bars.
- If available the SERTO fittings will be bought in Russia. If not the fittings can be ordered via CERN. The SERTO fittings will be paid for by VNIITF/BINP.
- Looking downstream, the water manifolds will be mounted on the right hand side.

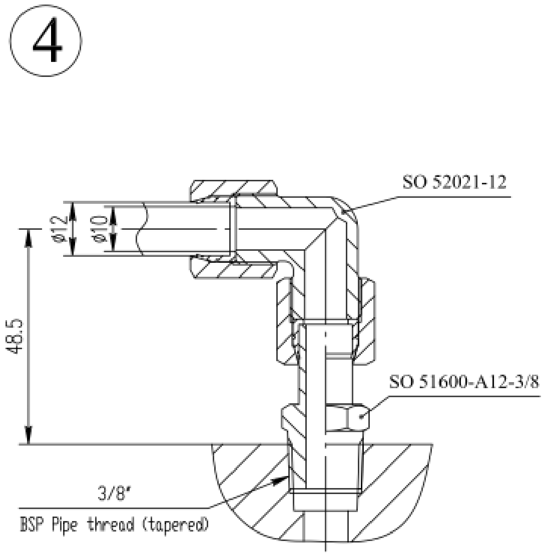


Figure 5: SERTO fittings with concial self sealing threads.

3. Support structure and alignment

The alignment of drift tubes inside the tank was presented by A. Tribendis. The concept uses a mechanical alignment, which was considered as suitable but work intensive. Instead it was suggested to make use of the laser tracker, which is available at BINP and to include 3 target holders on each drift tube. Whether these target holders will be used by BINP or not, it was agreed to include them in the drift tube design, so that a laser tracker can be used if needed.

Summary of the discussion on the support structure:

- VNIITF and BINP are developing the design for the support. They will provide intermediate drawings (in Russian) for integration checks. The construction drawings will be provided in English and will have to be adapted by CERN for production in Western industry. The design of the support also includes the support of the quadrupoles between the cavities. However, CERN will provide details of the alignment tables, which are foreseen to adjust the position of the quadrupoles.
- BINP/VNIITF will write an alignment procedure, which explains the concept.
- It was agreed to relax the tolerances for the alignment of the drift tubes with respect to the ideal beam axis from -+ 0.1 mm to -+ 0.3 mm. The precision for the alignment of the quadrupoles stays at -+ 0.1 mm.
- For the test assembly at BINP, a test frame is under construction, which is bolted to the floor for rigidity and then levelled to provide an ideal assembly frame.
- The middle tank is bolted to the support, while the end tanks are free to move longitudinally and vertically on rails. It is assumed that once the module is screwed together that it will actually sit on 3 points. The other points will be shimmed or supported with adjustable screws to avoid any tension in the system and to avoid vertical movement when the structure settles. Longitudinal movement due to temperature changes is possible.
- It needs to be understood how the alignment procedure affects the tuning of the coupling cell.

4. Simulation work

- The shape of the drift tubes was changed by BINP. RF simulations where made with MWS to correct the gap frequencies.
- It was found that the RF simulations of BINP and CERN agree in terms of power consumption.
- CERN changed the dimensions of the last module (using -28 degrees as synchronous phase instead -20 degrees). The changed dimensions were given to BINP and accepted link to parameter list.
- There is a bit of doubt on the simulation results of the coupling cells. CERN will measure the dimensions of the ISTC prototype coupling cell and give the values to BINP, where measurements of the untuned cell are available.
- G. DeMichele showed a new coupling cell geometry, which increases the cell to cell coupling by 12% (checked at 50 MeV and for the last module). In the last module the coupling is increased from 0.52% to 0.59%. This geometry shall be used for the last few modules.

5. Vacuum and ports

A. Tribendis showed the concept for the vacuum system as it was discussed via emails during the last months. The basic concept is shown in Fig. 6

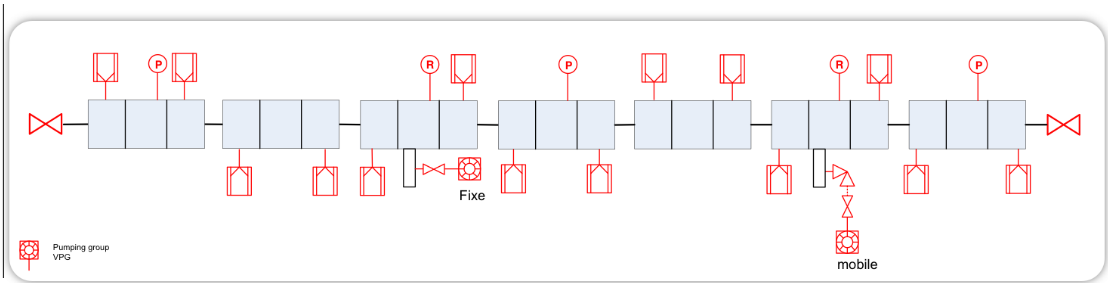


Figure 6: Layout of vacuum pumps and gauges on the CCDTL.

- It was agreed that all tuning ports are located on the right upper quadrant of the cavities (45 degrees from 12'o clock, looking downstream) if necessary. If they fit within the outline of the coupling cells they can also be located at 90 degrees on the right hand side. RF pick-up ports are located on the left hand side of the modules with the exception of one pick-up port, which is on the coupling cell that is on the right-hand side of the module.
- It was agreed to use the same ports for RF pick-ups and vacuum gauges (DN 40 CF, interior port diameter: 29 mm). There is one such port on each cell. During high-power testing all 5 ports will be used for RF monitoring and there will be a vacuum gauge on the waveguide port (together with a pump). In operation only 2 ports are used for LLRF and in total 5 ports out of 14 free coupling cell ports will be used for vacuum gauges.
- RF coupler port: using the standard port size of Linac4 (inside: 303x50 mm) gives a longer cut-off wave-guide (between cavity and T waveguide) than for the CCDTL prototypes, which leaves more space for mounting the coupler with screws.
- Half cavity flanges plus flanges of coupling cells will be copper plated.
- Rectangular wave-guide flanges and the surfaces around the stem/tank Helicoflex gaskets will not be copper plated.
- There are 2 ion pumps per module, and 2 roughing pumps on 2 waveguide couplers for the whole CCDTL section.
- Someone from the CERN vacuum group will be present during assembly and first vacuum test (with Helicoflex gaskets) of 1st module at BINP.
- It was found that there was a misunderstanding concerning the inner diameter of the ports for the ion pumps. CERN had assumed 150 mm to get sufficient pumping speed, while BINP/VNIITF had assumed 100 mm as for the ISTC prototype. 150 mm in diameter is too big to fit between the cooling channels. In order to have sufficient pumping speed one of the following 3 options has to be applied:
    - use a 100 mm diameter with an increased conductance (EP will check if Varian ion pumps are available for that port size, AT will try to increase the conductance),
    - use a "racetrack" shaped port on the cavity, which then transforms into a DN 150 CF flange (inner diameter 150 mm, outer: 202 mm),
    - use a 150 mm port and connect cooling channels "above" and "below" the port instead of having them surround the cavity (this way they are in fact closer to the hot spots than in the old approach).

List of ports on the CCDTL modules:

ports	ports p. module	total number	flange type	drawing	inner	outer	comment
vacuum gauge/RF pick-up	5	35	DN40 CF	STDVFUHV0093	29.7	70	
tuners coupling cells	4	28	DN63 CF	STDVFUHV0092	60	114	
tuners accelerating cells	6	42	DN100 CF	STDVFUHV0094	84.9	152	
vacuum pumps	2	14	DN150 CF	STDVFUHV0049	150	202	
RF coupler	1	7	Helicoflex			xx	

					303 x 50		custom made
beam pipe	6	42	Helicoflex		xx	xx	

6. Material orders

The following points were discussed:

- CERN will provide certificates for the steel and copper pieces, which are delivered to Russia.
- CERN will prepare the delivery of all pieces (to BINP) needed to make 2 drift tube prototypes (including Helicoflex joints for stem/tank: HNRV 100 diamT=3.4, alum, 47.1x53.9 c opening at inside), BINP will enquire how to ease the customs procedure,
- FG will send drawings of all needed conflat flanges together with preliminary amounts to CSJ, so that these pieces can be reserved for the CCDTL,
- The first CCDTL module will be tested with Helicoflex gaskets at BINP, these gaskets must be ordered 4 months in advance, CERN will order all CCDTL gaskets (+ wave-guide gaskets of all structures) as soon as the number and size of all gaskets is known,
- Steel tubes for ports will most likely come out of CERN stocks (either 304 or 316), bulk steel pieces for RF ports most likely from solid cylinders available at CERN,
- delivery of all material should be foreseen for the middle of October. We assume that ISTC can remove all customs procedures, so that the transport (CERN-VNIITF-BINP) should not take more than one week.
- Bolts for test assembly are provided by BINP, CERN will buy bolts for final assembly at CERN,
- VNIITF prefers to use M8 screws for the coupler port, CERN will check if M8 screws can be used for all RF ports instead of M6,

The following list of materials was agreed:

stainless steel	length	outer diameter	wall thickness	number	delivery status	comment
	[mm]	[mm]	[mm]			
rods	280	30	solid	50	ready for delivery	
tubes	200	15	1.5	50	ready for delivery	
drift tube body	250	120	solid	55	ready for delivery	

stainless steel	length	outer diameter	wall thickness	number	delivery status	comment
	[mm]	[mm]	[mm]			
half cavities	405-575	610	buckets	46	ready for delivery	agreed with manufacturer and VNIITF that the sizes for positions 19 and 20 can be reduced to 550/415 and 560/425
cooling tubes	600	8	1	50	ready for delivery	cooling tubes inside of stems
coupling cells	170	300	50	16	ready for delivery	
	125	305	solid	32		

coupling cell noses					ready for delivery	
tubes for DN100 CF	150	88.9	2	48	delivery	
tubes for DN63 CF	150	63	1.5	32	ready for delivery	
tubes for DN40 CF	150	33.7	2	40	ready for delivery	
bulk cylinders for DN150 CF	80	??	solid	16	t.b.c.	pumping ports

stainless steel	length [mm]	width [mm]	height [mm]	number	delivery status
blocks for RF ports	~400	~80	~100	9	probably from bulk cylinders available at CERN

conflat flanges	blanks	purpose	drawings	drawings of blanks	tube inner/outer diameter	delivery status
DN40 CF	80	RF pick-ups/vacuum gauges	STDVFUHV0093	STDVFUHV0005	29.7/33.7	ready for delivery
DN63 CF	64	tuners coupling cells	STDVFUHV0092	STDVFUHV0007	60/63	ready for delivery
DN100 CF	96	tuners accelerating cells	STDVFUHV0094	STDVFUHV0009	84.9/88.9	ready for delivery
DN150 CF	32	vacuum pumps (size t.b.c.)	STDVFUHV0049			-

7. Quality assurance and meeting schedule

- After the production of the modules CERN will receive "as built" 3D models in Solid Works and execution drawings in Autocad (in English) using the GOST standard for tolerances.
- For the frames CERN will receive a 3D model in Solid Works and CERN will then produce execution drawings.
- Each cavity will be accompanied by paper containing all quality assurance tests (metrology, leak tests, surface quality, flow rate, pressure test, temperature history of heat treatments, RF measurements)
- Another document will be provided to CERN that describes the test procedure (where/how pumps are connected, how leak tests are done, procedure for metrology),
- We should foresee the participation of BINP at high-power tests of 1st module (or more),

Meeting schedule:

subject	location	time
ISTC/VNIITF/CERN management + technical meeting	CERN	October 2009
results of drift tube mock-up	BINP	January 2010
technical meeting	CERN	March 2010
first module ready and partly copper plated	VNIITF	June 2010
technical meeting	CERN	October 2010

8. Intercavity sections

R. Maccaferri presented a sketch on the intercavity sections. The following points were discussed:

- There were some uncertainties about the available space between the cavities. This will be verified.
- CERN needs to decide whether to extend the supports so that inter-module elements can be placed there.
- Flanges between cavities and modules use Helicoflex joints.
- The pipes between the cavities and modules are CERNs responsibility.
- Alignment arms on the support frame are CERNs responsibilities.
- Figure 7 shows the available space for magnets between the cavities.

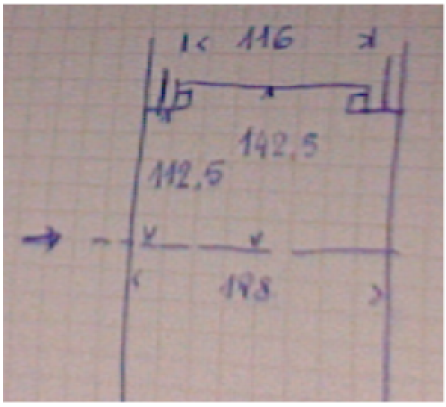


Figure 7: intercavity space for magnets

9. Action list:

action	institute/person	status/result	completed
complete first payment to ISTC	CERN, T. Kurtyka, M. Vretenar	done	13 August 2009
provide size and shape of target holders on the drift tubes for laser tracking system	CERN, Y. Cuvet	done: extract from drawing of DTL drift tubes	
include target holders for laser tracker target on the drift tubes	BINP, A. Tribendis	done	
provide power loss estimation for the Helicoflex connection of stem and tank, where the joint sits on non-copper plated steel surfaces	BINP, A. Tribendis	done: 1 - 1.7% in Q0 (if Cu instead of steel)	12 August 2009
construction and testing (in dummy vacuum volume: vacuum tightness of all joints, pressure test, flow test, alignment principle) of 2 prototype drift tubes (one with EBW between stem and drift tube, and one with brazing)	BINP, A. Tribendis	done see meeting March 2010	2010-03-10
material delivery to BINP for drift tube prototypes	CERN, F. Gerigk	items shipped w/o Helicoflex gasket list of items shipping request in EDH	2 September 2009
cooling simulations for the case when several cooling channels are connected in series	BINP/VNIITF	dropped	

find out which kind of water hoses (connection of cooling circuits) are generally used/accepted at CERN	CERN, R. Maccaferri	done: reference from CERN stores link to CERN stores	
suggestion for high-pressure, radiation hard, semi-flexible hoses for cooling water connections	BINP, A. Tribendis	done: picture 1, picture 2	2009-10-09
provide drawings of an alignment table suitable for the quadrupoles between the cavities	CERN, F. Gerigk, P. Bourquin, M. Jones	pending	
provide written procedure for the alignment of the modules on their support	BINP/VNIITF	open	
provide a 3D volume that can be used for the CCDTL volumes	CERN, J-P. Corso	done 2D cross-section in CCDTL section	2009-10-22
provide intermediate drawings of CCDTL moduls for integration check	BINP/VNIITF	done drawings in EDMS (restricted access)	3 September 2009
check with intermediate drawings of CCDTL modules integration into the Linac4 tunnel (with pumps, tuners, pick-ups, cables	CERN, J-P. Corso	pending	
metrology check of the ISCT CCDTL coupling cell dimensions (results are indicated on the drawings for the CERN prototype)	CERN, F. Gerigk	done: report, drawing 1, drawing 2	2009-08-20
use new coupling hole geometry for the last few modules to increase cell to cell coupling	BINP	pending	
confirm the size of the pumping port after selecting one of the possible options (see vacuum)	BINP/VNIITF/CERN	done Vacuum port geometry	2009-11-16
check if the vacuum conductance through the pumping ports can be increased	BINP, A. Tribendis	done presentation	2009-08-20
check if there is VARIAN ion pump with an inner port diameter of 100 mm	CERN, E. Page	solved: VacIon Plus_150	17 July 2009
provide information on roughing pumps to VNIITF (size, size including T piece needed during high-power testing for the gauges)	CERN, E. Page	done: dimensions of vacuum equipment	22 July 2009
provide a short written description of vacuum testing procedure at BINP	BINP, A. Tribendis	done: procedure	2009-10-16
define size of stainless steel blocks for RF ports	BINP/VNIITF	done Vacuum port geometry	
reserve conflat flanges for vacuum ports	CERN, F. Gerigk, C. Saint-Jal	done most pieces are delivered	2009-10-21
define size of port tubes and order them	F. Gerigk, A. Tribendis	done	
provide testing standards, which are used in material certificates	CERN, S. Sgobba	done	17 July 2009
	CERN, S. Sgobba	done	17 July 2009

provide standards for qualification of electron beam welding			
discuss how/if the qualification of welders is mandatory for this contract	CERN, S. Sgobba, G. Favre	done Meeting October 2009	
provide dimensions and type of all needed Helicoflex gaskets 4 months before assembly of the drift tube mock-up	BINP/VNIITF	pending	
VNIITF will send a welding test sample to CERN according to the EU welding standards	VNIITF, M. Naumenko	done	2010-03-10
qualify the VNIITF welding sample	CERN, S. Sgobba	pending	
provide list of bolts for assembly (to be bought by CERN)	BINP/VNIITF	pending	
check if M8 screws can be used for all RF ports instead of M6	CERN, P. Bourquin, F. Gerigk	done agreed to use M8, which enables us to use HN 200 gaskets instead of HNV 200: preliminary drawing DTL waveguide port	
We need to decide on ownership of tooling and type of tooling which might be interesting for CERN	CERN, F. Gerigk, P. Bourquin, T. Kurtyka	done CERN will receive the tools it wants	
decide whether to put inter-module elements on the same support as the modules	CERN, F. Gerigk, R. Maccaferri	done yes, elements will be put on same support SupportAlignment0809	2009-08-24
define additional support length to house the intermodule elements	CERN, R. Maccaferri	pending	
define the type of tables, which will be used to support the quadrupoles between the cavities of one module	CERN, F. Gerigk, P. Bourquin, M. Jones	pending	
calculate the increase in cell-to-cell coupling for the last module, when the new coupling slot shape is used	CERN, G. DeMichele	done: 13% increase from 0.52 to 0.59%	2009-07-22
provide peak electric field in center gap of each tank	CERN, G. DeMichele	done: table	2009-08-13
provide information on CERN EBW machine	CERN, F. Gerigk, T. Tardy	done: CERN EBW machine	2009-08-28
provide drawings of rectangular PIMS waveguide flange & Helicoflex joint	CERN, F. Gerigk	done: SPLACPMB0025, SPLACPMB0024, SPLACPMB0017, joint	2009-08-28

10. Appendix

List of items for drift tube mock-up

item	material	length	outer diameter	wall thickness	quantity
drift tube bodies	copper	250	120	solid	2
tubes	copper	200	15	1.5	3
rods	copper	280	30	solid	3
tubes	stainless steel	600	8	1	3
rods	stainless steel	200	60	solid	2

spring washers	outer diameter: 70 mm	inner diameter: 40.5 mm	thickness: 4 mm	uncompressed height: 5.6 mm	8 pieces
Helicoflex joints	t.b.d				
SERTO weld-on union	type: SO51429-15	2 pieces			
SERTO nut connection	type: SO50021-15	2 pieces			

List of Helicoflex joints

joint	type	size	torus diameter	groove dimensions	groove thickness	number	comment
half tanks	HN 200	522x534	6	520x535	5		same size as for DTL sections

-- FrankGerigk - 16 Jul 2009

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