Status of the CCDTL

(preparation for kick-off meeting)

F. Gerigk

pre-kick-off meeting for ISTC projects #3888 and #3889,
CERN, July 2009

Overview

- status of ISTC contract,
- RF port,
- vacuum,
- material orders,
- drift tube construction & cooling,
- support structure,
- follow up,

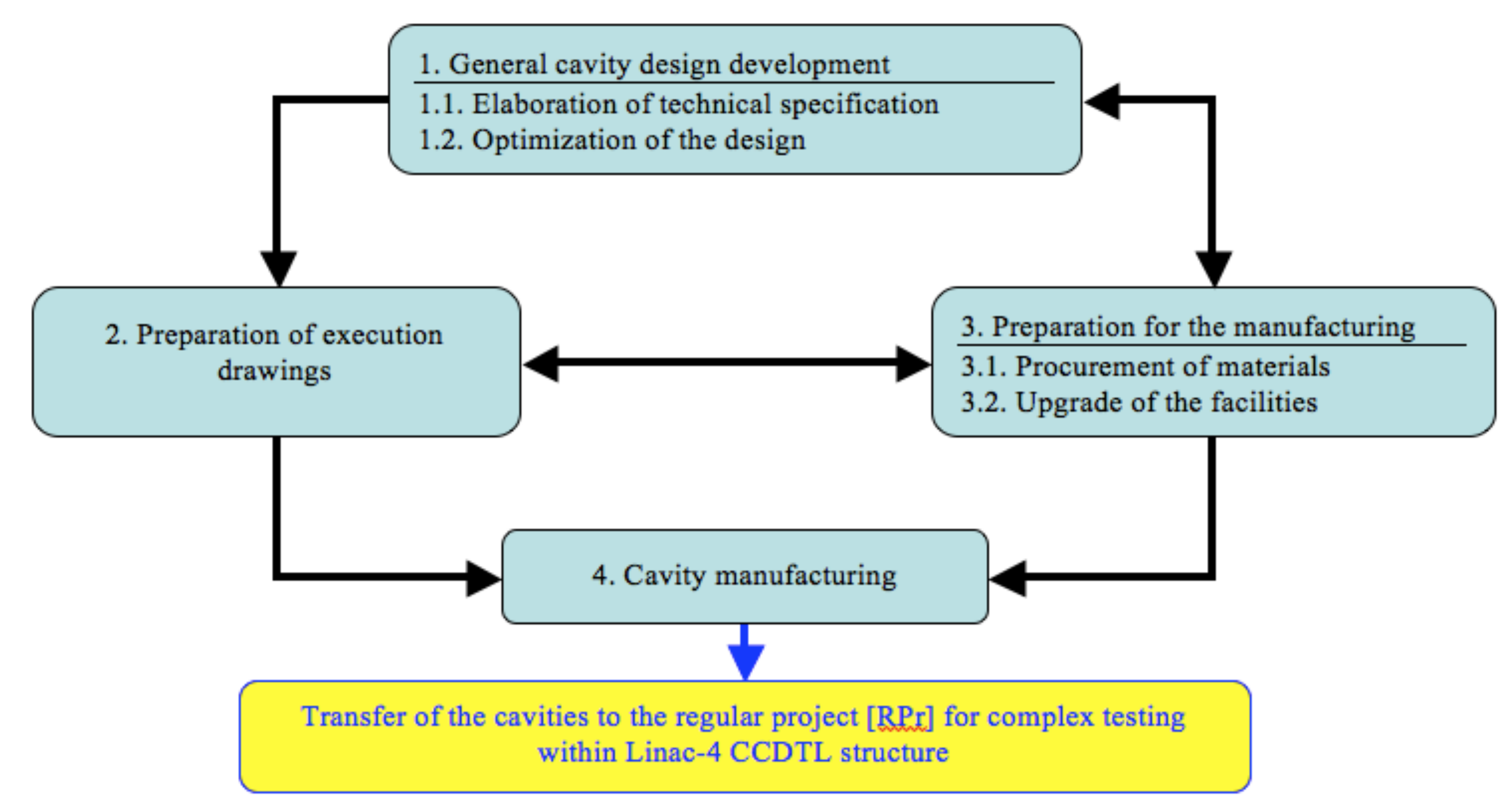
ISTC contract & budgets

#3888 (regular project),
#3889 (partner project)

status of ISTC contracts

original proposal	**#3888**	**#3889**
project type	**regular project**	**partner project**
funding	fully funded by ISTC	fully funded by CERN
content	structure design, drawings, construction of drift tubes, module assembly, RF tuning, support frames, testing at BINP and CERN, transport to CERN.	cavity design, drawings, preparation for construction, cavity construction
value	1.35 M$	1.35 m$

flow-chart partner project



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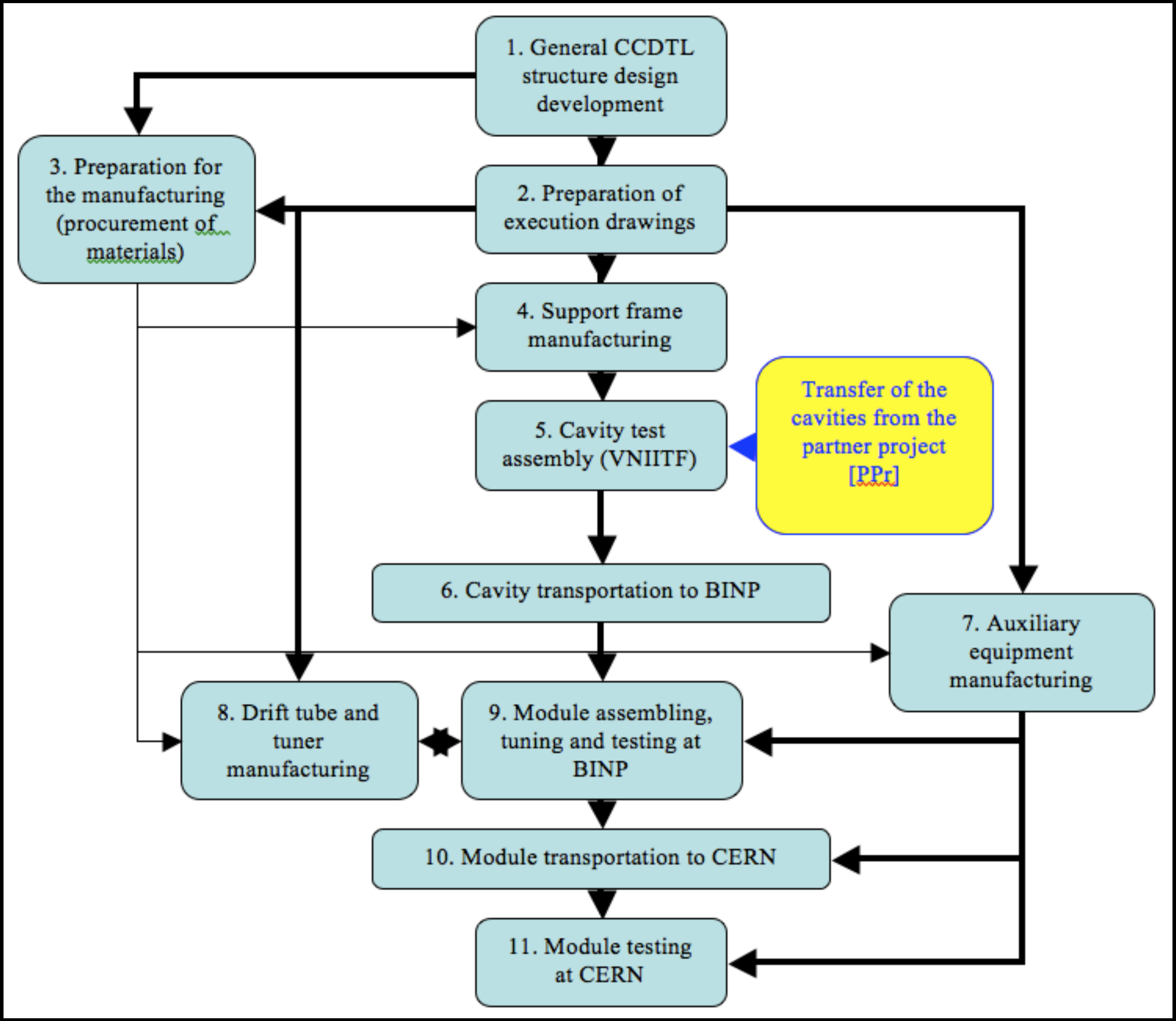
flow-chart regular project



budget cut by ISTC

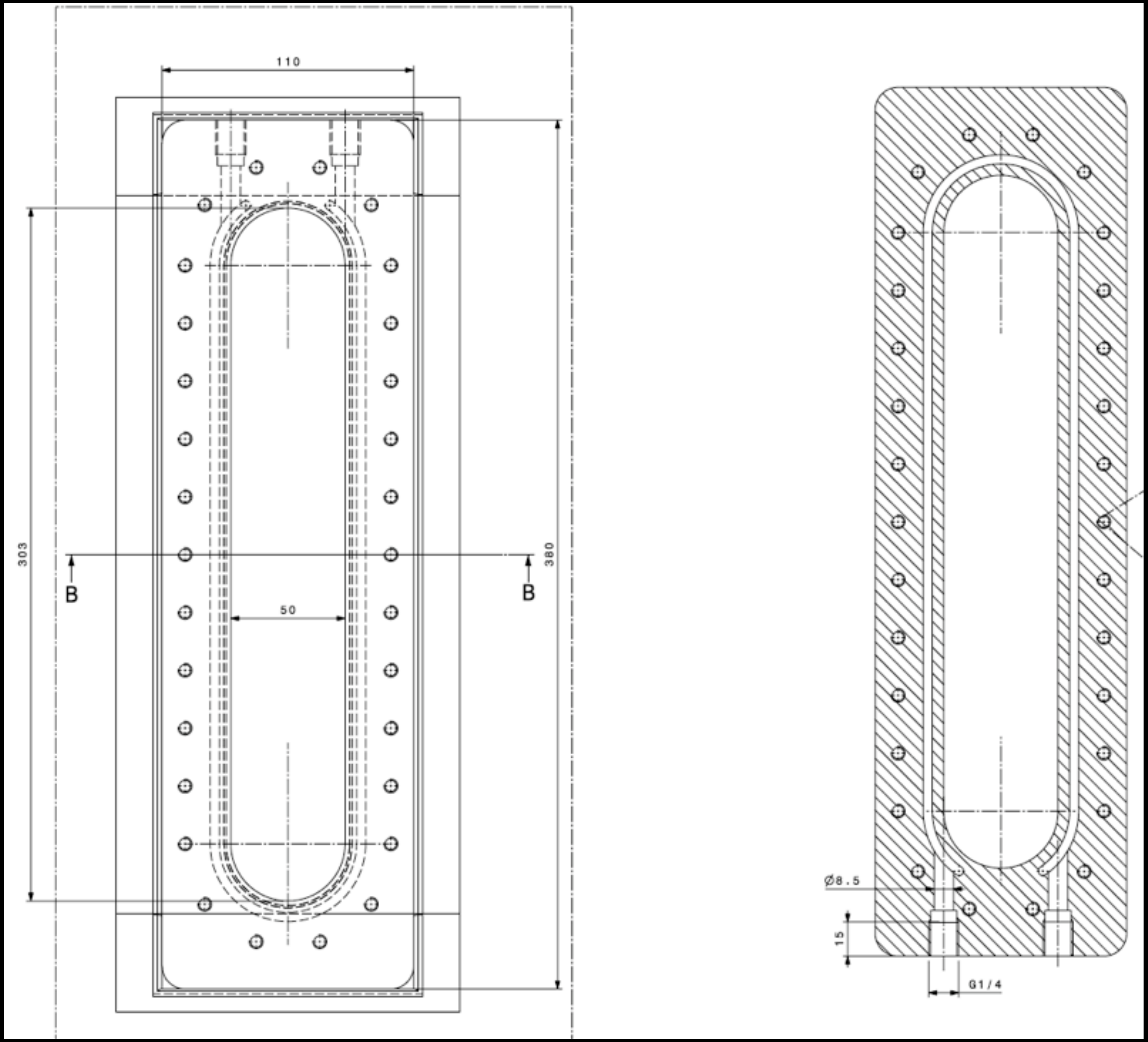
January 2009: ISTC approves both projects, but cuts the budget for #3888 from 1.35 M$ to 916 k$. In order to save the project the following steps were taken:

- **in 3889:** skip the baking of long half cells after copper plating, which means no extension of the baking oven is necessary (saves 50 k$)
  - ➡ during the prototype manufacturing no degrading of the plating was ever observed after baking,
  - ➡ for the series, the shorter tanks will be baked to verify the copper plating, but then the longer ones will not be baked.
- **in 3888:** remove the construction of the supporting frames and do the assembly and testing on simpler structures,
- CERN will pay an additional 185 k$

RF port

standardardisation with PIMS
and DTL

RF port (standardised)

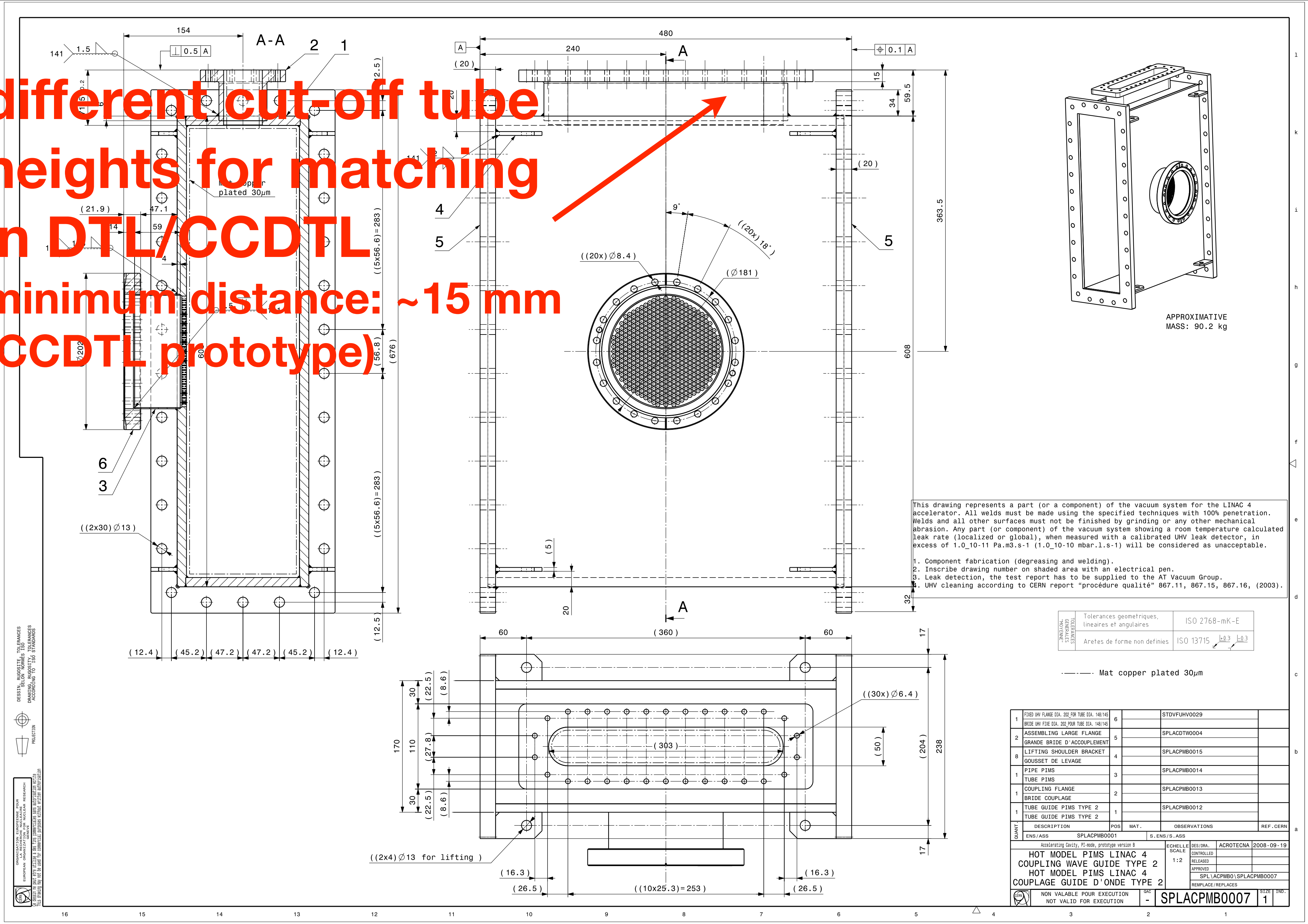


- same port opening for DTL, CCDTL, PIMS,
- 300 x 50 mm,
- different cut-off tube lengths to adapt to different Q-values,
- 10% duty cycle, 1 MW peak forward power,

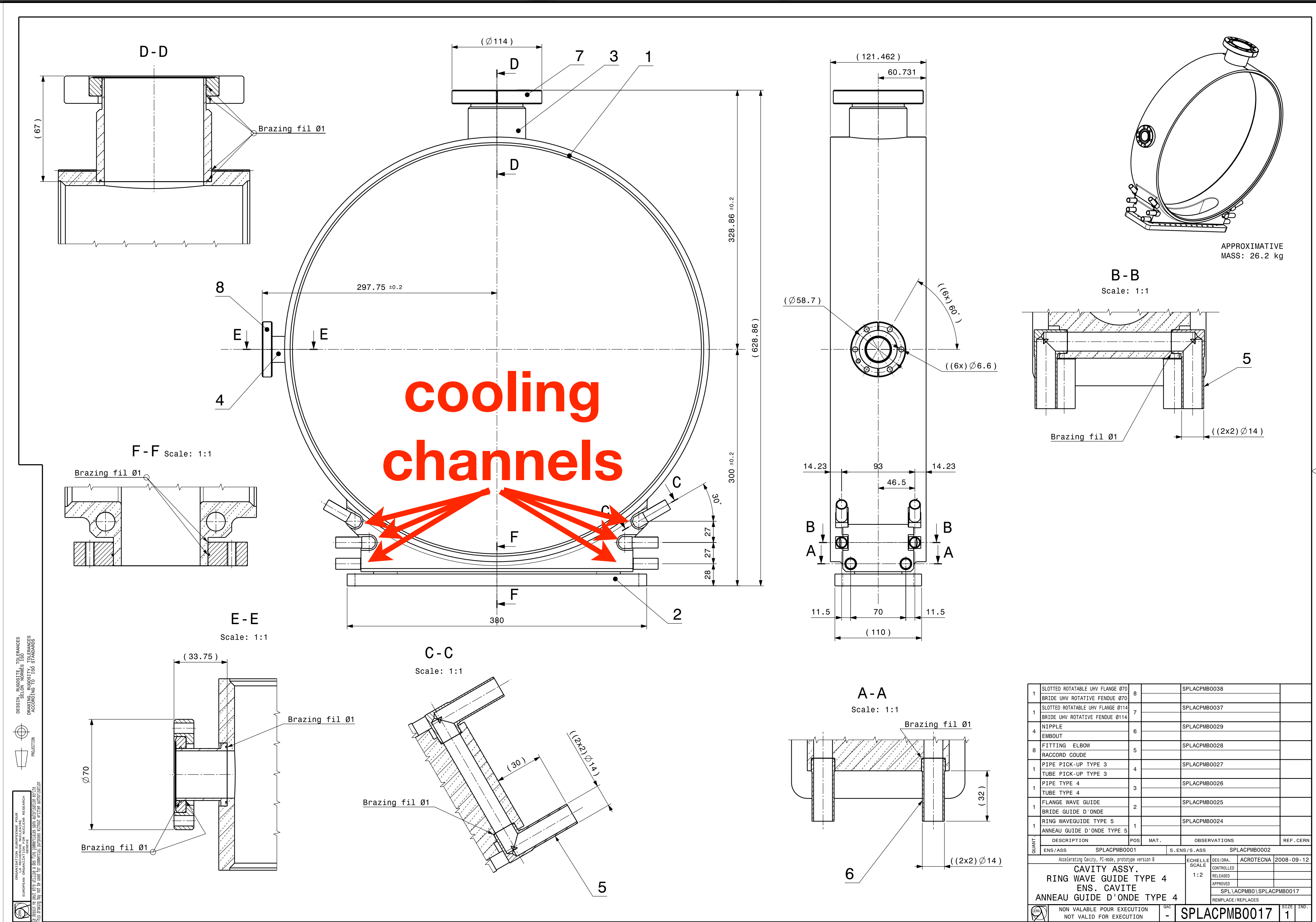
PIMS wave-guide coupler

different cut-off tube heights for matching in DTL/CCDTL

minimum distance: ~15 mm (CCDTL prototype)



PIMS wave-guide port



Vacuum tests on rectangular wave-guide flanges

goal: find a suitable surface preparation for the Helicoflex joints

rectangular vacuum flanges

the surfaces in contact with Helicoflex flanges were rectified to a roughness of Ra ≈ 0.3. After plating the roughness was 0.8 < Ra < 2.0.

most likely due to imperfect plating!

surface condition	gasket	gas leak
w/o plating	HNV 200	no
w/o plating	HN 200	no
after plating	HNV 200	no
after plating	HN 200	yes
after 2nd plating	HN 200	no

conclusion: avoid copper plating but rectify the surface and use an acid to clean the rectified surfaces

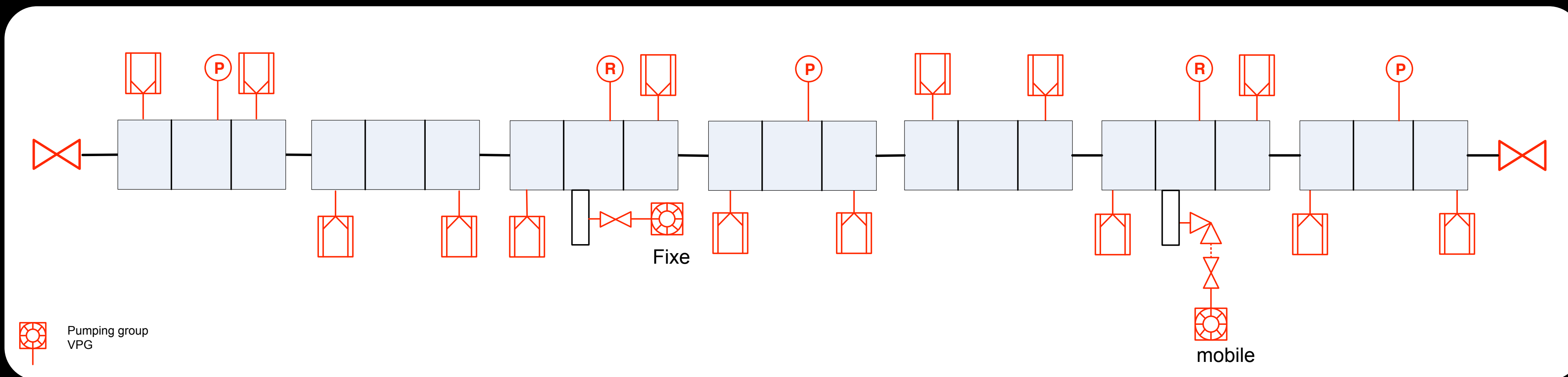
-> use HN 200

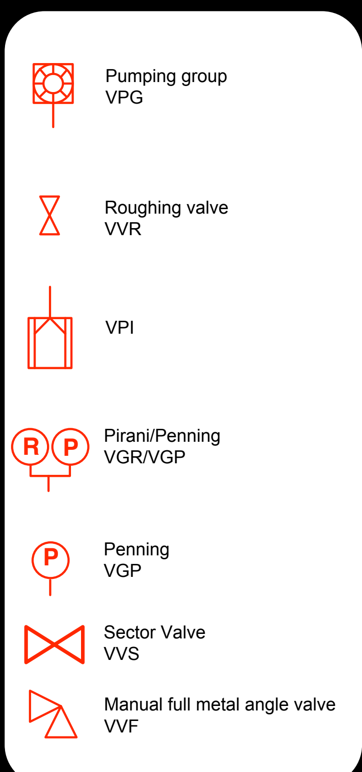
vacuum

ports and flanges

- keep same vacuum port grid as for prototype: (14x) **DN?? CF**,
- ports for RF pick-ups and vacuum gauges: (35x) **DN40 CF**,
- tuners coupling cells: **DN63 CF**,
- tuners accelerating cells: **DN 100 CF**,

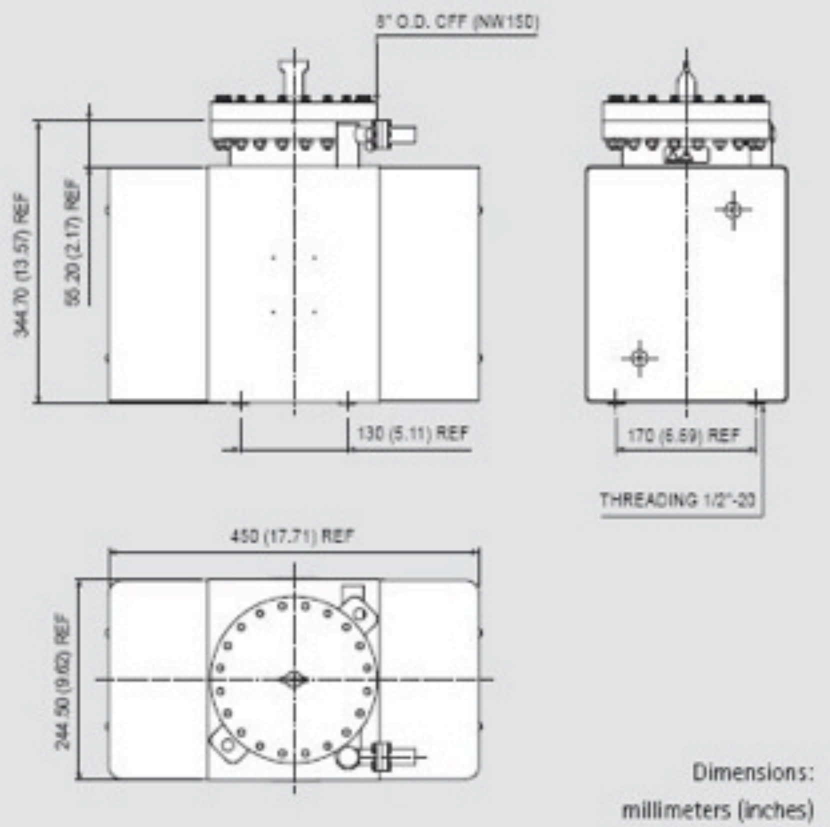
vacuum system





- 2 VPI pumps per module (VAC ION PLUS 300), cavity 1, 3,
- 2 roughing pumps, one fix & one mobile (VPG) on modules 3, 6,
- 5 gauges on coupling cell RF port (DN40CF ?),

Outline Drawing



Technical Specifications

	StarCell®	Noble Diode	Diode
Nominal pumping speed for Nitrogen (*) (l/s)	240	260	300
Operating life at 1×10^{-6} mbar (hours)	80,000	50,000	50,000
Maximum starting pressure (mbar)	$\leq 1 \times 10^{-2}$	$\leq 1 \times 10^{-3}$	
Ultimate pressure	Below 10^{-11}		
Inlet flange	8" CFF (NW 150) AISI 304 ESR		
Maximum baking temperature (°C)	350		
Weight, kg (lbs)	69 (149)		

number of ports

ports	ports p. module	total	flange	comment
vacuum gauge/RF pick-up	5	35	DN40 CF	
vacuum pumps	2	14	DN160 CF ??	NW150 pump flange
tuners coupling cells	2	14	DN63 CF	
tuners tanks	6	42	DN100 CF	
RF coupler	1	7	Helicoflex	custom made
beam pipe	6	42	?	

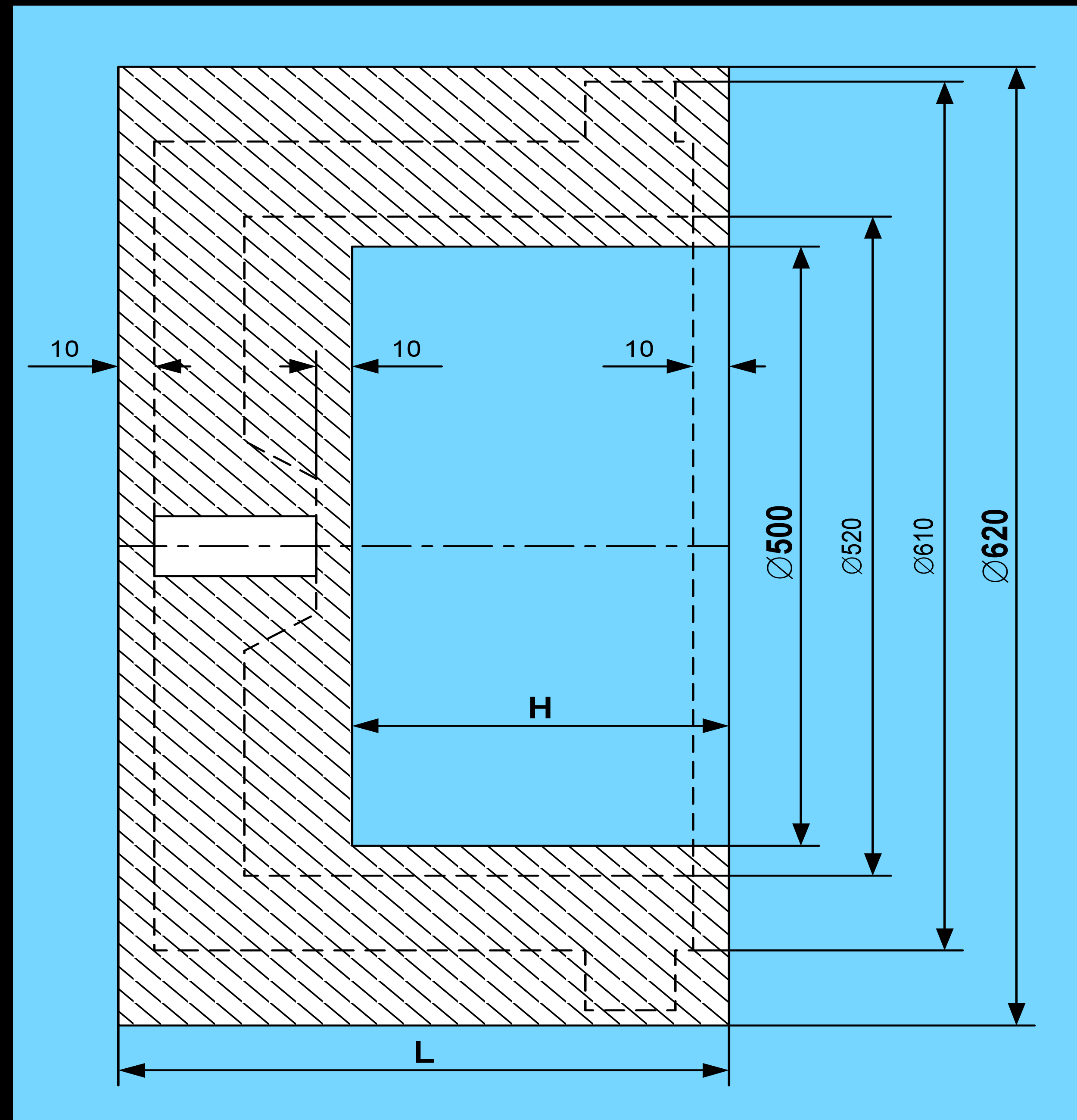
Materials

steel, copper, flanges, etc.

Simplified construction

The raw material will be supplied by CERN as forged pre-shaded buckets:

- simplified machining,
- no EB welds,
- better material properties,
- faster construction,



materials

copper	length [mm]	diam [mm]	wall thickness [mm]	weight [kg]	number of pieces	total weight [kg]	cost [kCHF]	ordered	delivery
rods	280	30	solid	1.77	50	88.47	3.91	06/03/2009	31/03/2009
tubes	200	15	1.5	0.11	50	5.69	1.84	06/03/2009	31/03/2009
drift tube body	250	120	solid	25.28	55	1390.25	83.70	03/03/2009	22/06/2009

st.steel	length [mm]	diam [mm]	wall thickness [mm]	weight [kg]	number of pieces	total weight [kg]	cost [kCHF]	ordered	delivery
half-cavities	405-575	610		480-70 0	46	28080	457.6	11/03/2009	03/08/2009
tubes	600	8	1	0.11	50	5.28		not yet	
coupling cell	170	300	50	107.43	16	1718.85	41.10	07/05/2009	09/07/2009
coupling cell noses	125	305	solid	81.65	32	2612.69	82.10	07/05/2009	09/07/2009

still to order (t.b.c)

conflat flanges	flanges	blanks	purpose	cost [kCHF]	ordered	delivery
DN40 CF (STDVFUHV0093)	35+5 spares	35 + 5 spares	RF pick-ups/vac. gauges		not yet	
DN63 CF (STDVFUHV0092)	28+4 spares	28+4 spares	tuners coupling cells		not yet	
DN100 CF (STDVFUHV0094)	42+6 spares	42+6 spares	tuners acc. cells		not yet	
DN150 CF (STDVFUHV0054) outer diam: 202 mm	21+3 spares	21+3 spares	VPI vacuum pumps		not yet	

SERTO fittings?	number of pieces	purpose	cost [kCHF]	ordered	delivery
				not yet	
				not yet	
				not yet	

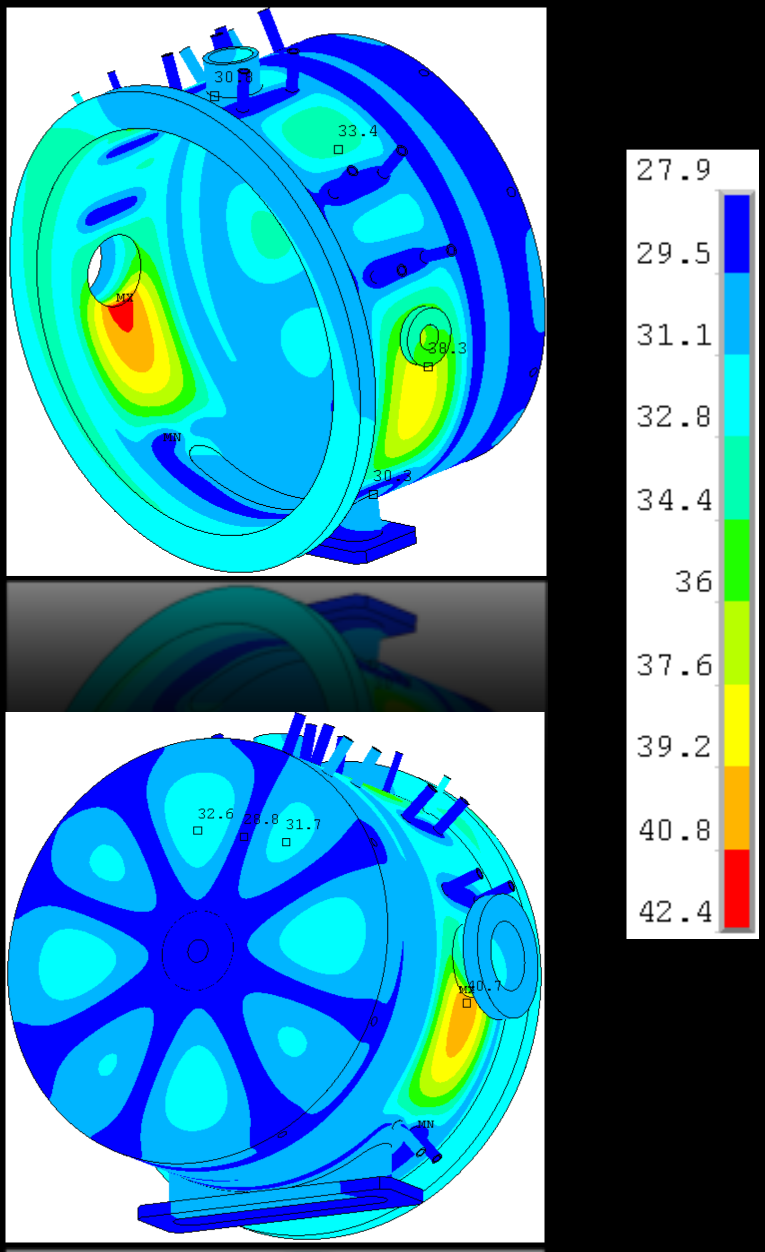
still to order (t.b.c.)

Helicoflex	number of pieces	purpose	cost [kCHF]	ordered	delivery
HN aluminum		RF port		not yet	
HNRV aluminum*		stem/tank		not yet	
HN aluminum		half tanks		not yet	
HN aluminum		coupling cells		not yet	

*applied forces must be adequate!

st. steel	length [mm]	outer diam. [mm]	inner diam. [mm]	number of pieces	cost [kCHF]	ordered	delivery
tubes (for DN100)	150	88.9	84.9	48			
tubes (for DN63)	150	63.5	60.5	32			
tubes (for DN40)	150	33.7	29.7	42			
tubes (for DN150)	150			24			

Construction & cooling



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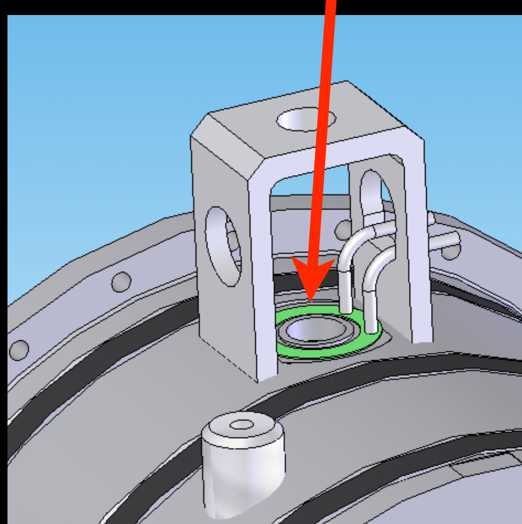
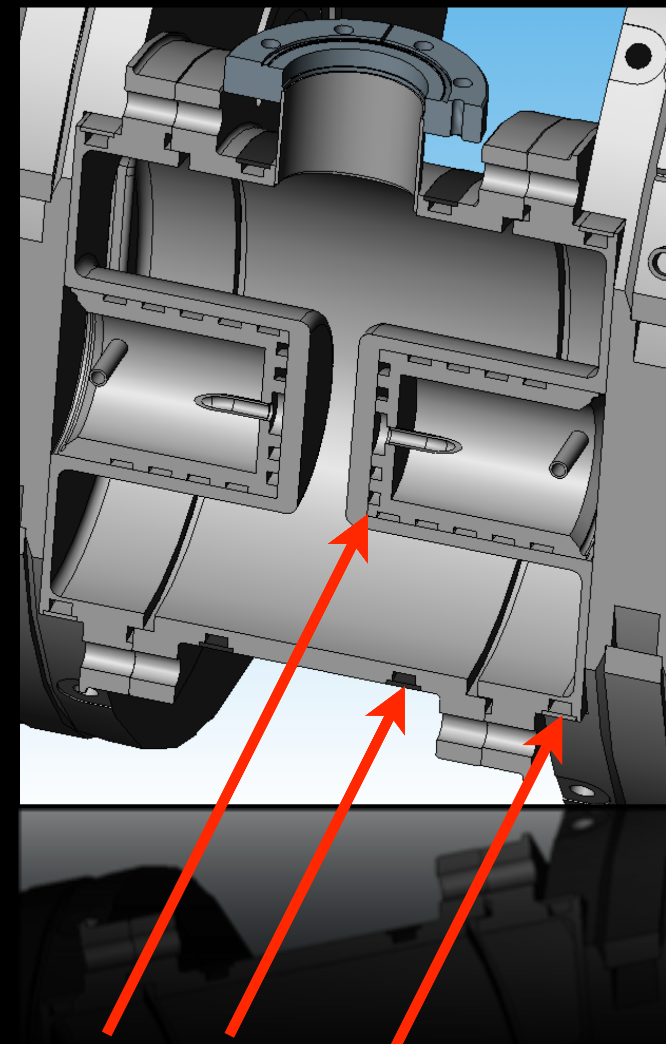
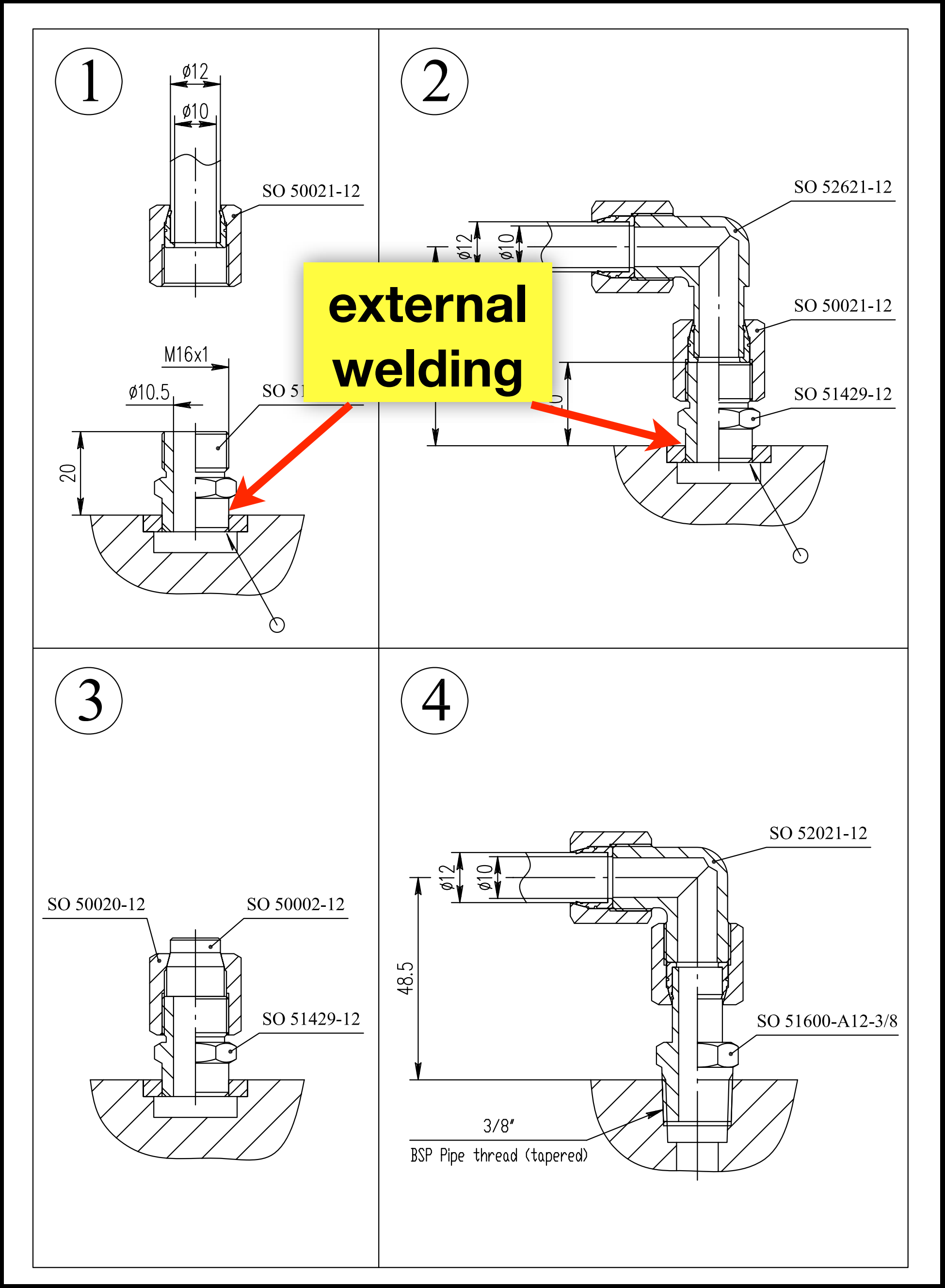
cooling channel optimisation

- channel 2 could be suppressed (minor influence on temperature),
- channel around drift tube was suppressed (increase of max. temp around stem by 15 deg to 61 deg),





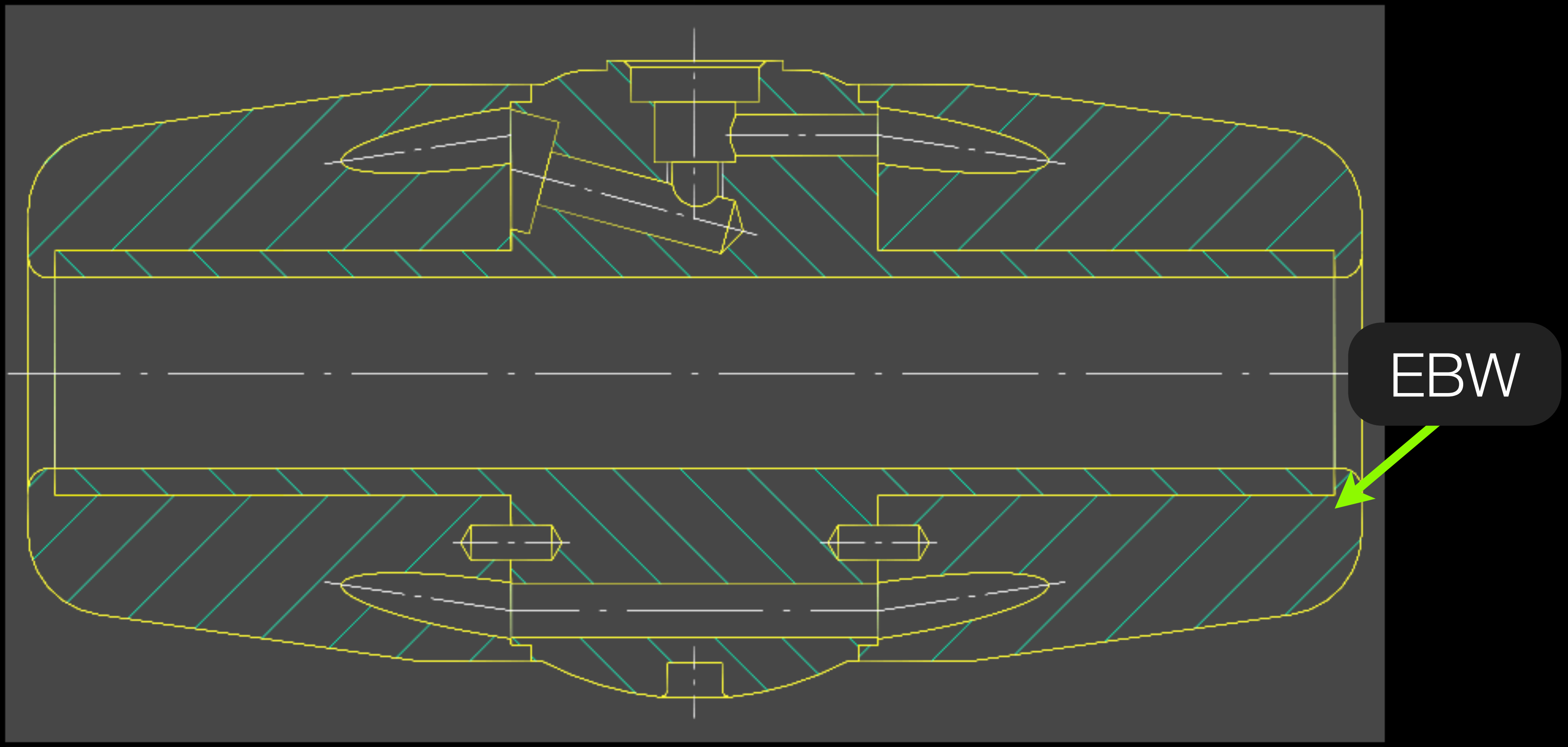
SERTO water fittings



- exchangeable water connections,
- nominally they will be welded, in places where welding is difficult: threaded cones,
- VNIITF prefers rigid external stainless steel tubes,
- do we need flexible radiation resistant hoses: not necessarily (to be discussed)
- list of SERTO fittings not yet received,

Option 1: used for prototype

- **disadvantage:** awkward welding angle, difficult for series production,
- **advantage:** worked successfully for prototype, no joint in high-field area



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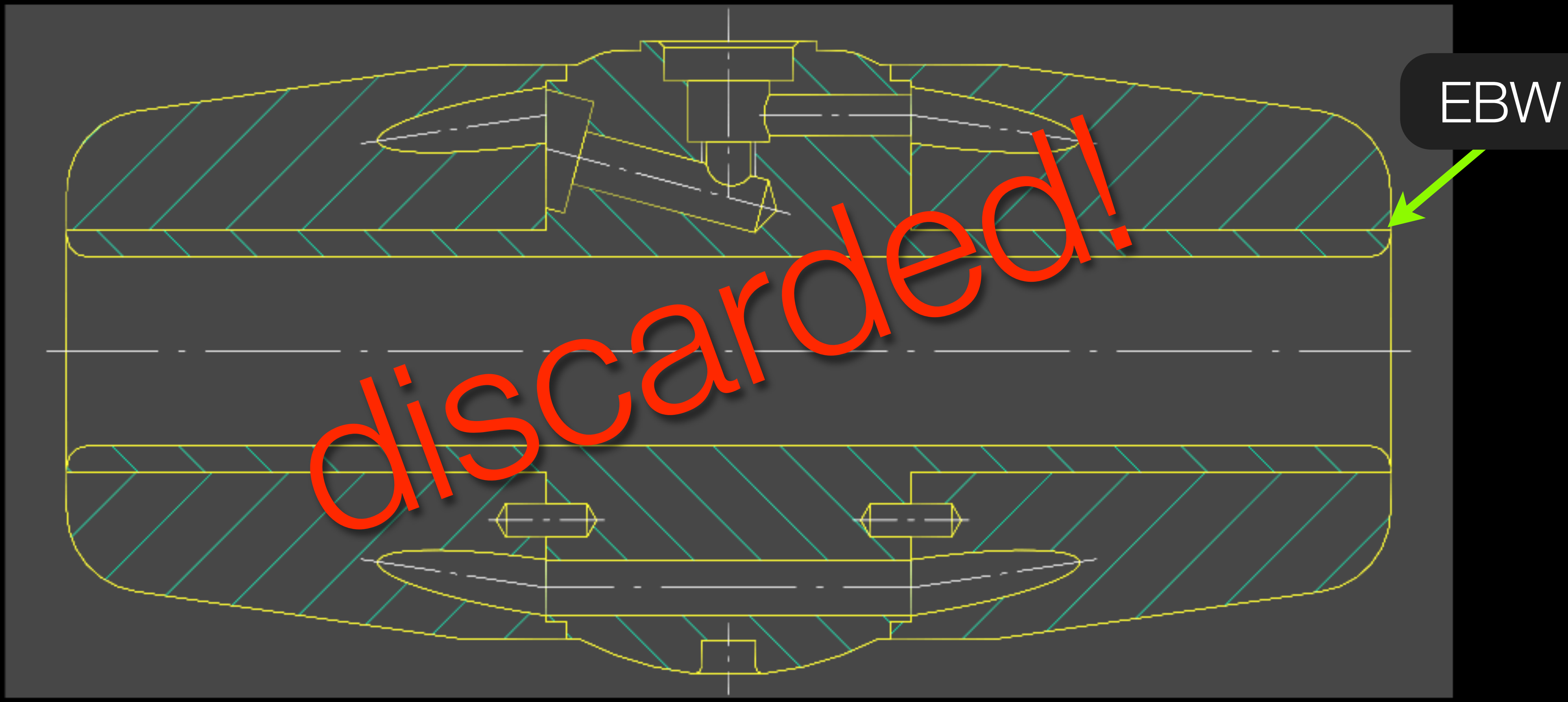
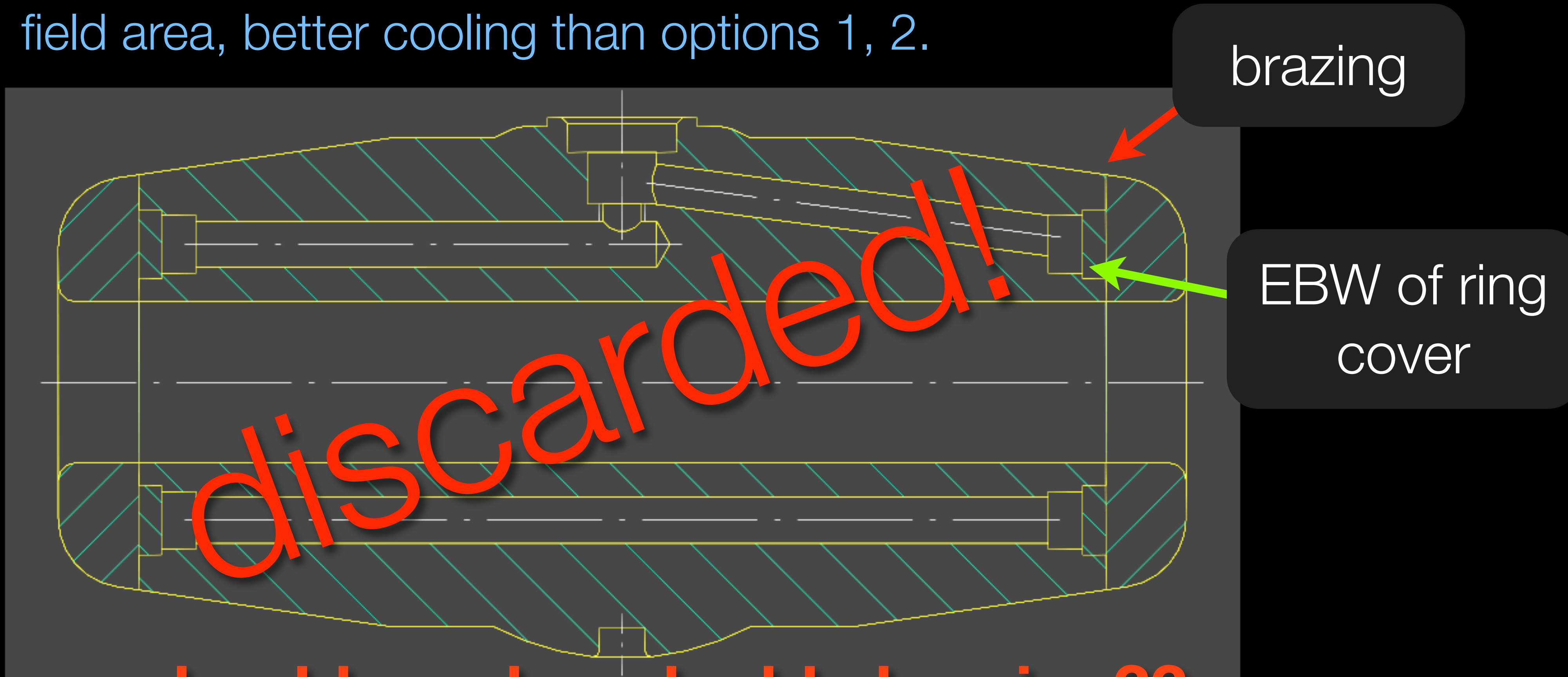
Option 2:

- **disadvantage:** joint in high field area, need machining over joint (bad SNS experience!),
- **advantage:** easier welding angle, deeper penetration



Option 3:

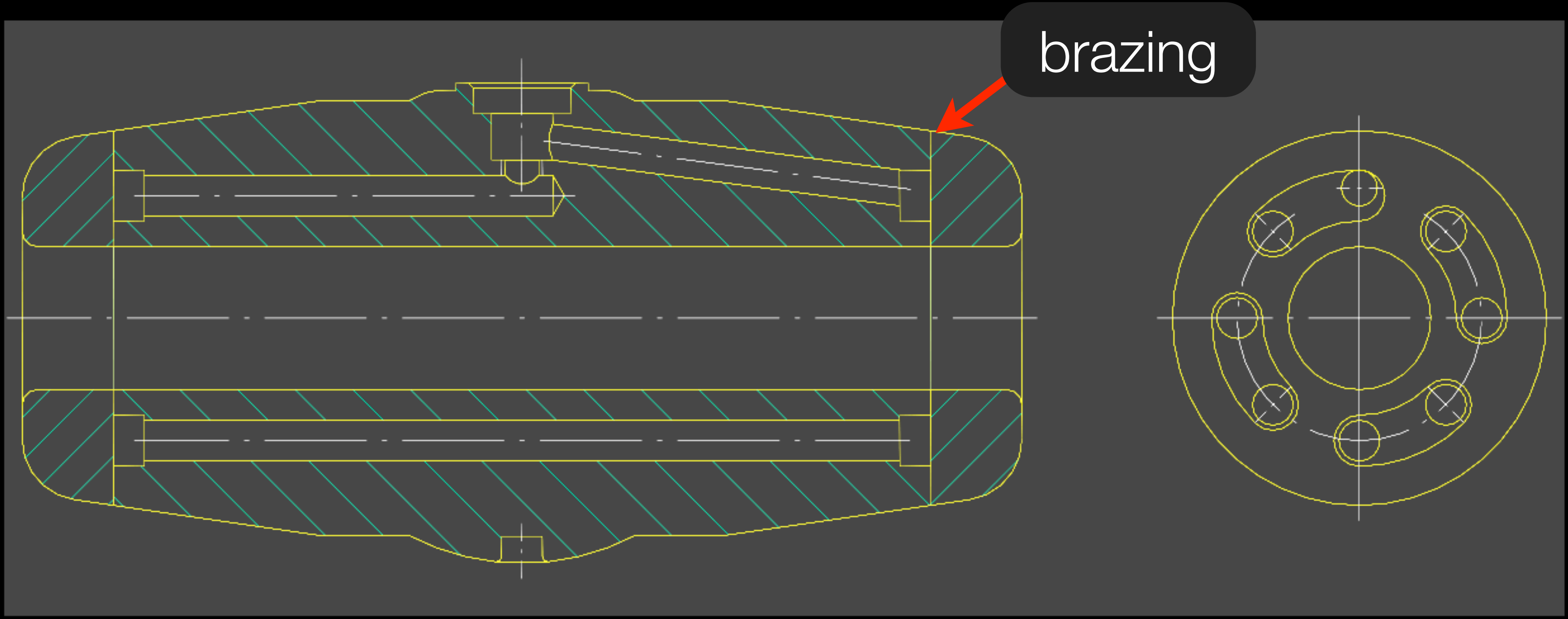
- **disadvantage:** brazing after welding may deteriorate the material in the area of the weld (depending on Cu quality),
- **disadvantage:** would require extensive testing,
- **advantage:** single piece DT, joint can be moved further into lower field area, better cooling than options 1, 2.



should we do a double brazing??

Option 4: preferred option

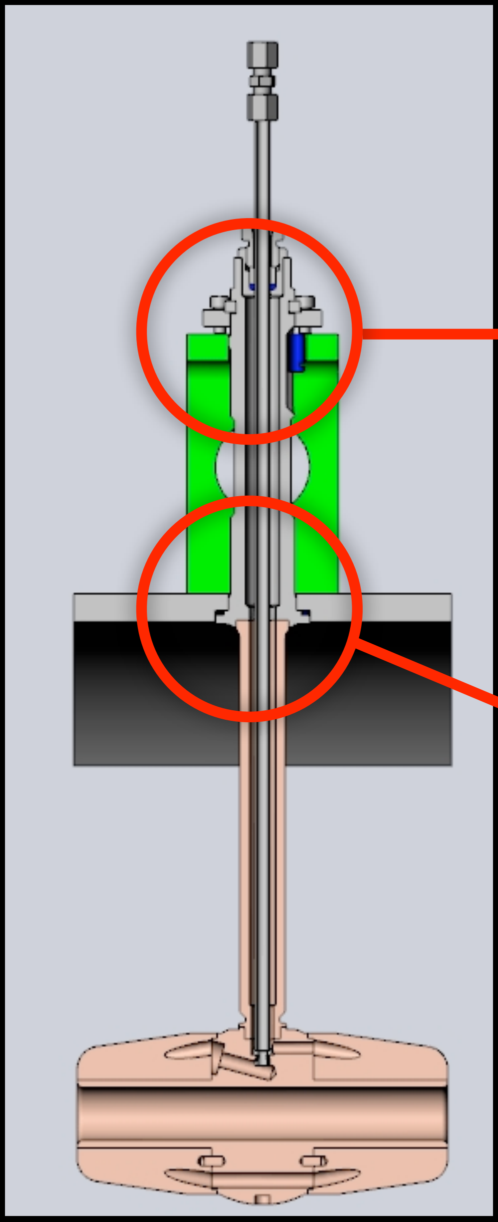
- **disadvantage:** only a brazing joint between vacuum and cooling channel, machining over brazed surface,
- **advantage:** technique has been used successfully at BINP and CERN (CLIC, RFQ), single piece DT, joint can be moved further into lower field area, still only one joint seen by RF current, better cooling than options 1, 2; in case of faulty brazing the nose tips can be re-machined.



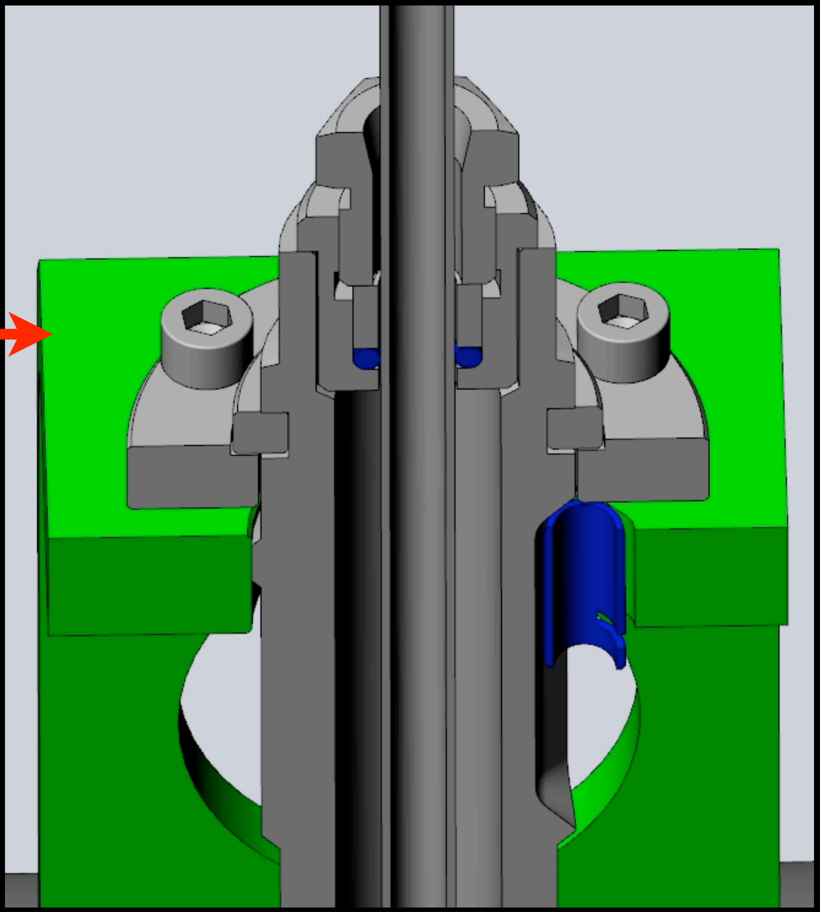
remarks

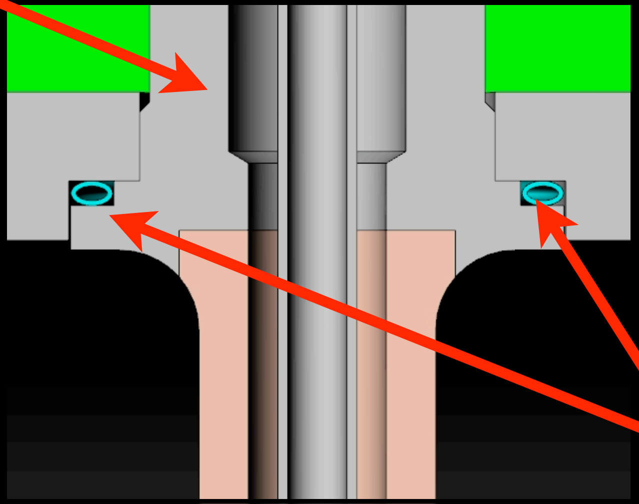
- a brazing canal should be used instead of a brazing foil,
- moving the joint further away from the nose:
    - ➡ silver alloys, which may come to the surface of the drift tube are further away from peak field region, silver tends to spark in areas of high fields,
    - ➡ easier machining of brazing grooves?
- water flow speed should not exceed 1.5 m/s in each canal,
- on the inside the diameter of the bore should be bigger: this prevents silver alloys from dripping towards the nose tips,
- need new thermal calculations for drift tubes!
- any new construction technique must be prototyped!!

adoptions from the CERN DTL



Welding of the stem to the tank changed to a girder-system, CERN type spring loaded system will be used.

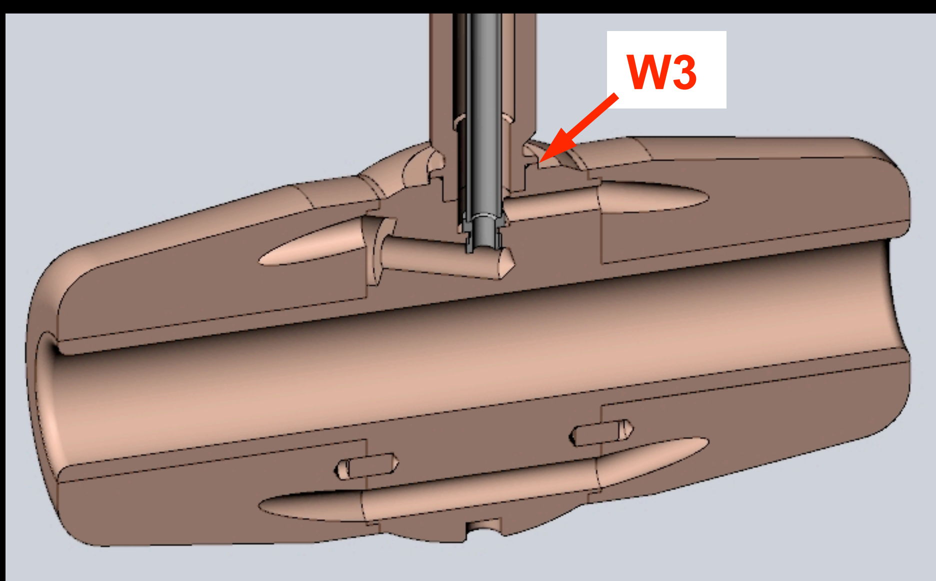


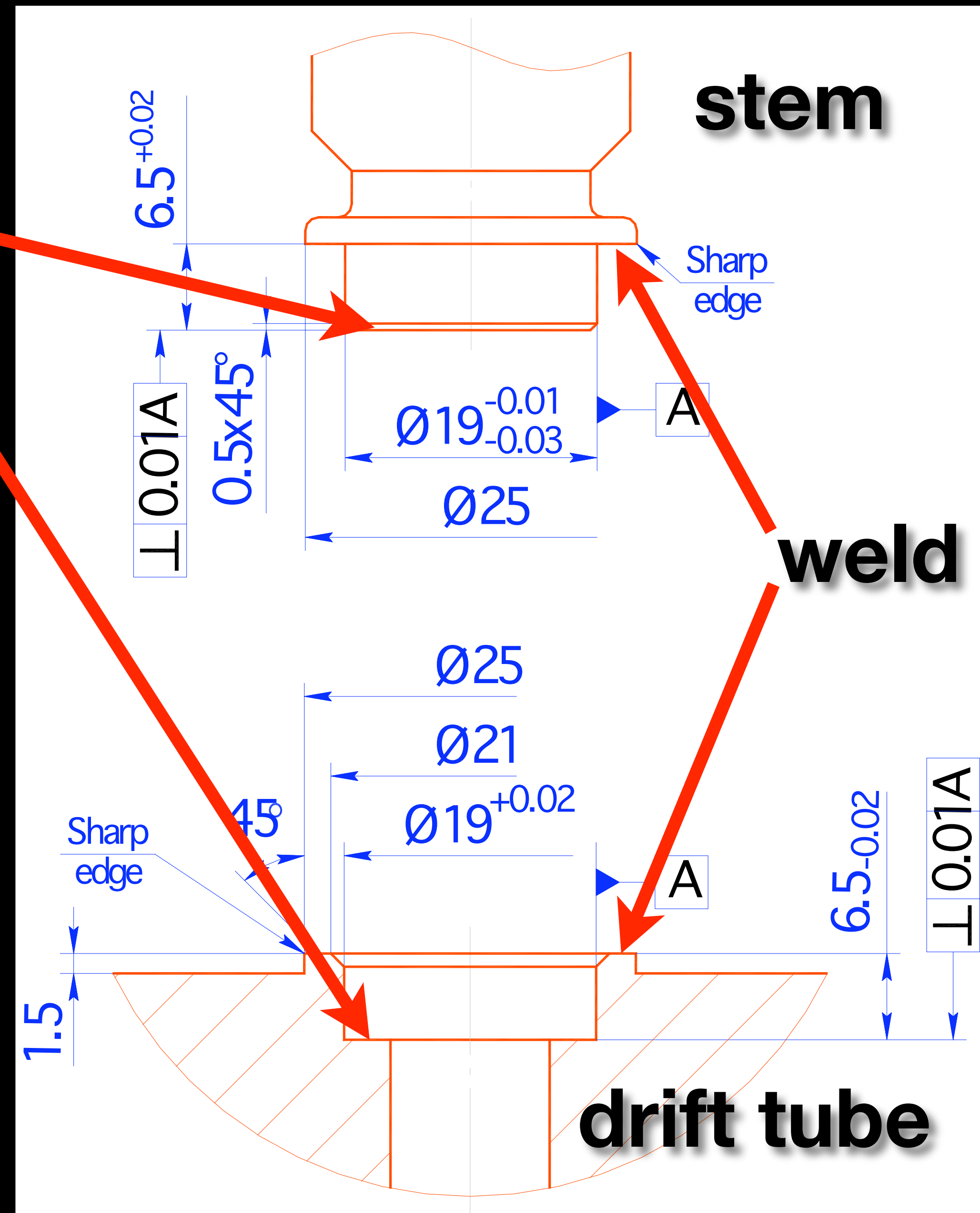


Vacuum & RF contact with Helicoflex joint

stem/drift tube perpendicularity

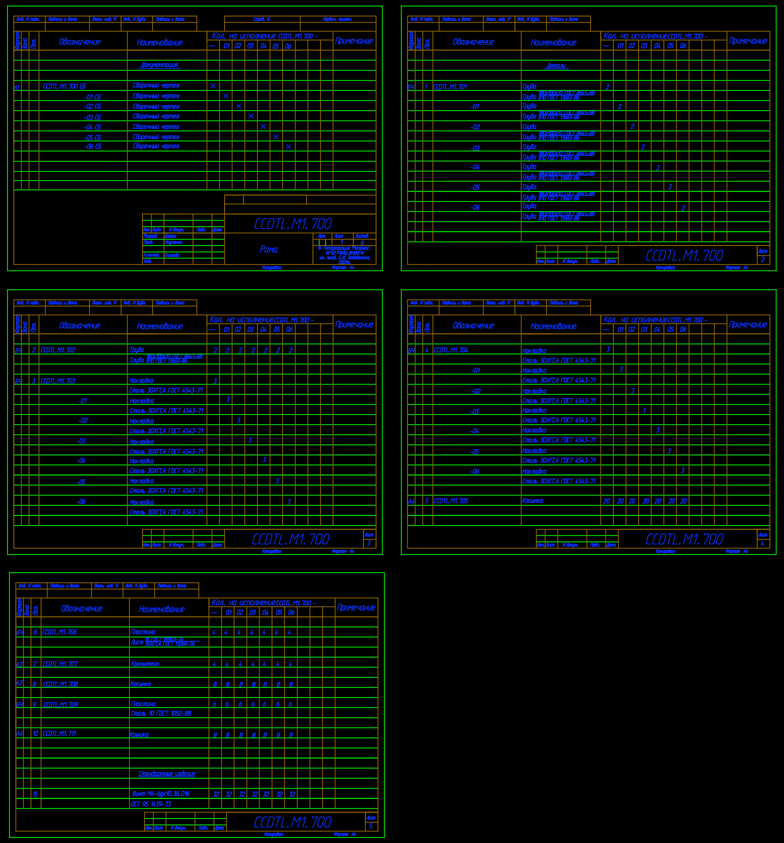
Position of the two parts is determined by these two surfaces and not by the welded surfaces!





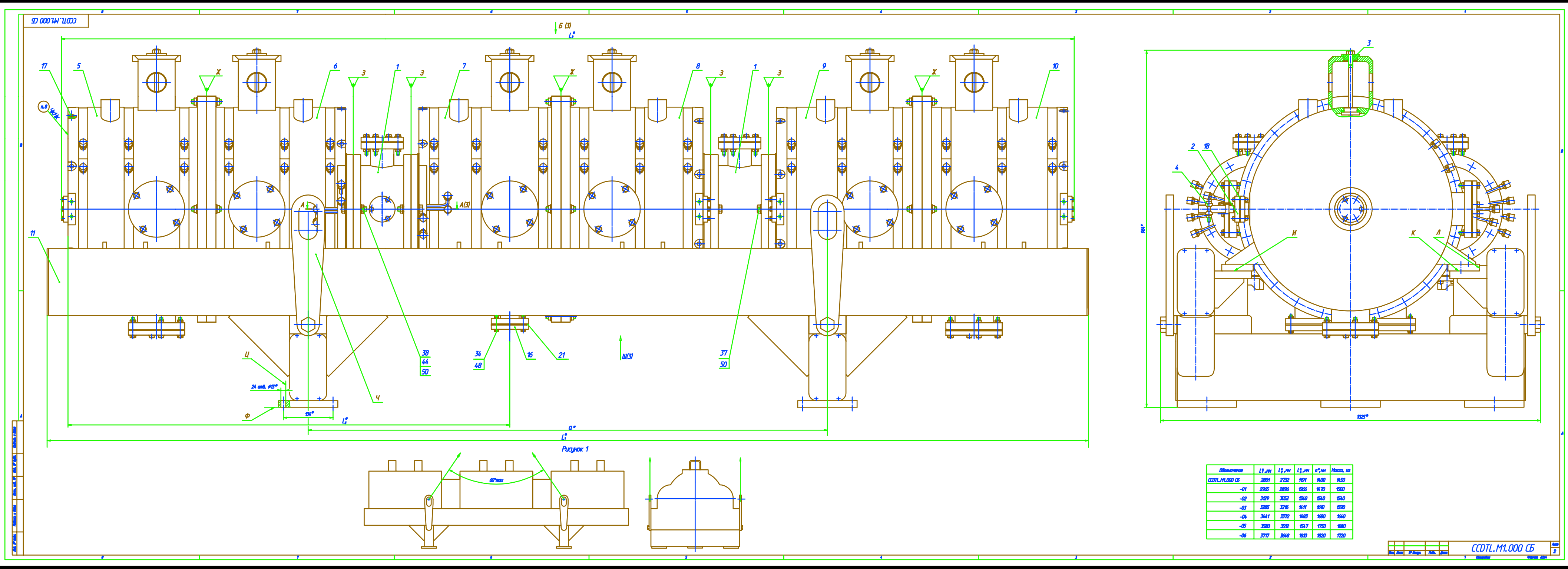
support structure

concept by BINP/ VNIITF, construction by CERN



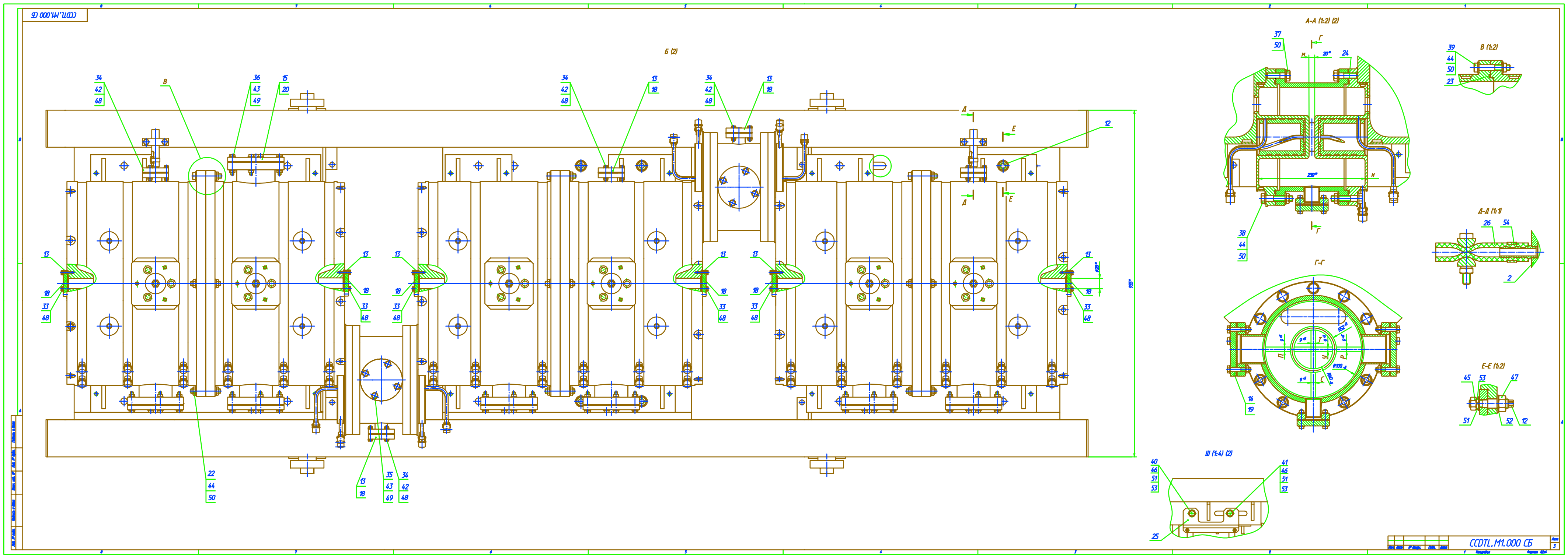
received some first drawings but need to discuss the details..

assembly: side view



Обозначение	L_1^*, мм	L_2^*, мм	L_3^*, мм	a^*, мм	Масса, кг
CCDTL.M1.000 СБ	2801	2732	1191	1400	1450
-01	2965	2896	1266	1470	1500
-02	3129	3052	1340	1540	1540
-03	3285	3216	1411	1610	1590
-04	3441	3372	1483	1680	1640
-05	3580	3512	1547	1750	1680
-06	3717	3648	1610	1820	1720

assembly: top view



Alignment

- cavities and coupling cells will be aligned on the support,
- 3 reference surfaces on each cavity (1 for tilt measurement, 2 for alignment),
- 2 alignment arms per module mounted on the supporting girders,
- alignment of drift tubes with reference inside of tubes,
- tilt measurement on support via ??
- line of sight respected?
- Only the middle tank will be fixed in position horizontally, the 2 other tanks can move on the support.
- The flexibility of the cavities must be used for the movement and not the flexibility of the Helicoflex gaskets.

structure dimensions

after re-matching for beam dynamics

change of last module?

- all dimensions have been double checked in January and the material has been ordered,
- change of the synchronous phase for matching into the PIMS section was not yet taken into account,

	gap 1 [mm]	gap 2 [mm]	gap 3 [mm]	cav. 1 [mm]	cav. 2 [mm]	cav. 3 [mm]	dt 1 [mm]	dt 2 [mm]	dt 3 [mm]
Jan 2009 design	124.07	127.04	130.25	1008.5	1021.5	1037.1	235.28	236.41	237.29
July 2009 design	122.84		128.59	992.4		1019.2	236.42		236.69

	synchr. ph. [deg]	E_{out} [MeV]	βλ 1 [mm]	βλ 2 [mm]	βλ 3 [mm]	min Δϕ/βλ [deg]	max Δϕ/βλ [deg]	max Δϕ total [deg]
Jan 2009 design	-20.8	103.4	358.69	362.78	366.86	0	0	0
July 2009 design	-28.7	103.0	358.61		366.35	0.0803	0.501	2.2552
delta			0.08		0.51			

Follow-up & milestones

production step	critical technolgy	time	done at:
compatibility check	▪ compatibility check of drawings for support, alignment, and integration (no detailed mechanical check)	t0	CERN
procedure check	▪ verification of key production & testing procedures (even in Russian),	t0+1 month	CERN
Cu plating 1st tank	▪ surface quality without baking, ▪ vacuum, water pressure & flow test,	t0+7 months	VNIITF
test of 1st drift tube	▪ vacuum tightness of brazing, ▪ water pressure & flow test,	t0+3/4 months	BINP
assembly 1st module	▪ vacuum tightness of stem/tank connection with Helicoflex gaskets, ▪ alignment of drift tubes, ▪ tuning,	t0+11 months	BINP

in general: minimum of 2 visits per year

meetings next week

1. welcome (all),
2. alignment (J. Stovall, G. DeMichele, P. Bourquin, Y. Cuvet),
3. vacuum (G. Vandoni, E. Page),
4. support structure (Y. Cuvet, P. Bourquin, J. Stovall, G. Favre),
5. material orders (C. Saint-Jal, S. Sgobba?),
6. cavity ports & geometry & drift tube construction (Y. Cuvet, P. Bourquin, J. Stovall, G. De Michele, G. Favre, S. Mathot),
7. intercavity & integration (R. Macaferri, S. Maury, J. Stovall)
8. test sequence, meeting schedule, monitoring (T. Kurtika, M. Savino, M. Vretenar)

copper
plating

copper plating revisited

in the first attempt the colouring of the copper was not very homogenous, even though the Q was as expected

explanation: removing the protective paint on the inside produced the colouring

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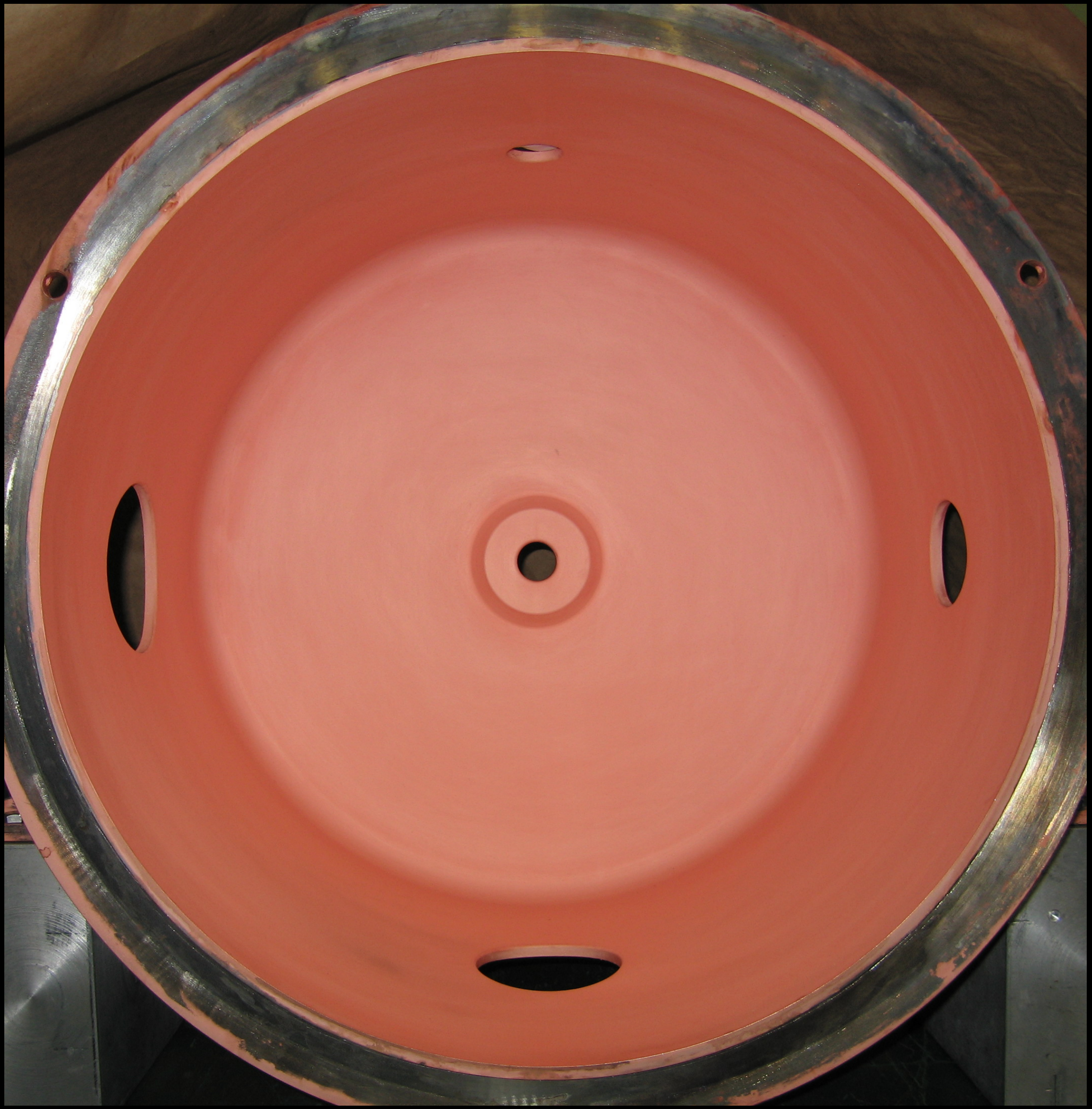
copper plating revisited

now the copper on the outside will be either i) removed mechanically, or ii) painted over

flanges must be copper plated!!



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