

Status of the CCDDL

(preparation for kick-off meeting)

F. Gerigk

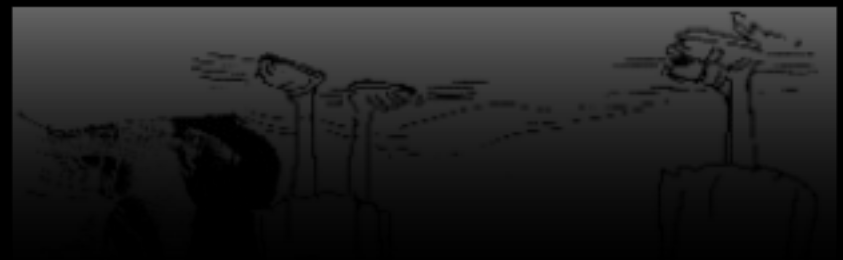
pre-kick-off meeting for ISTC projects #3888 and #3889,
CERN, July 2009

Overview

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

ISTC contract & budgets

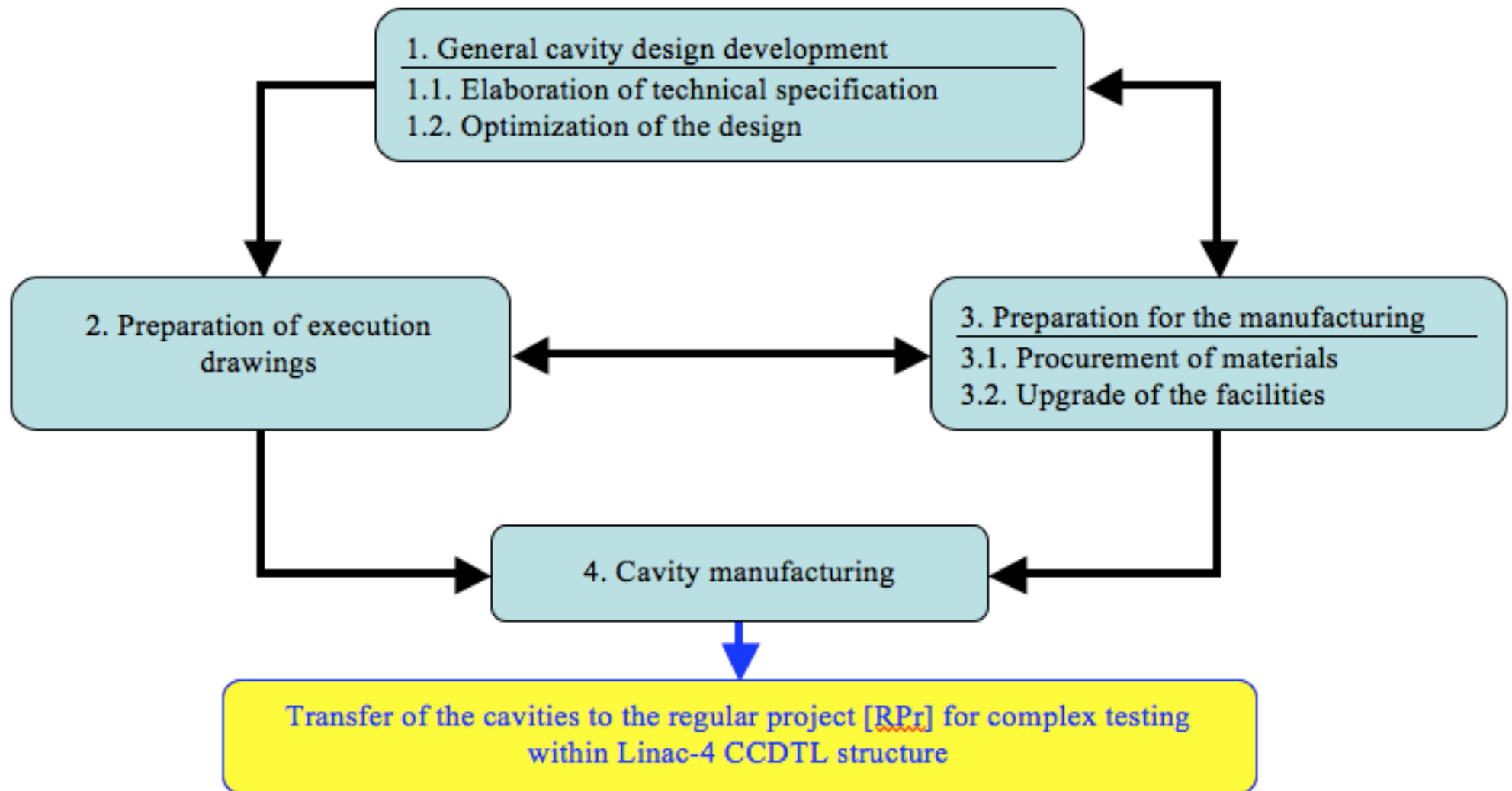
#3888 (regular project),
#3889 (partner project)



status of ISTC contracts

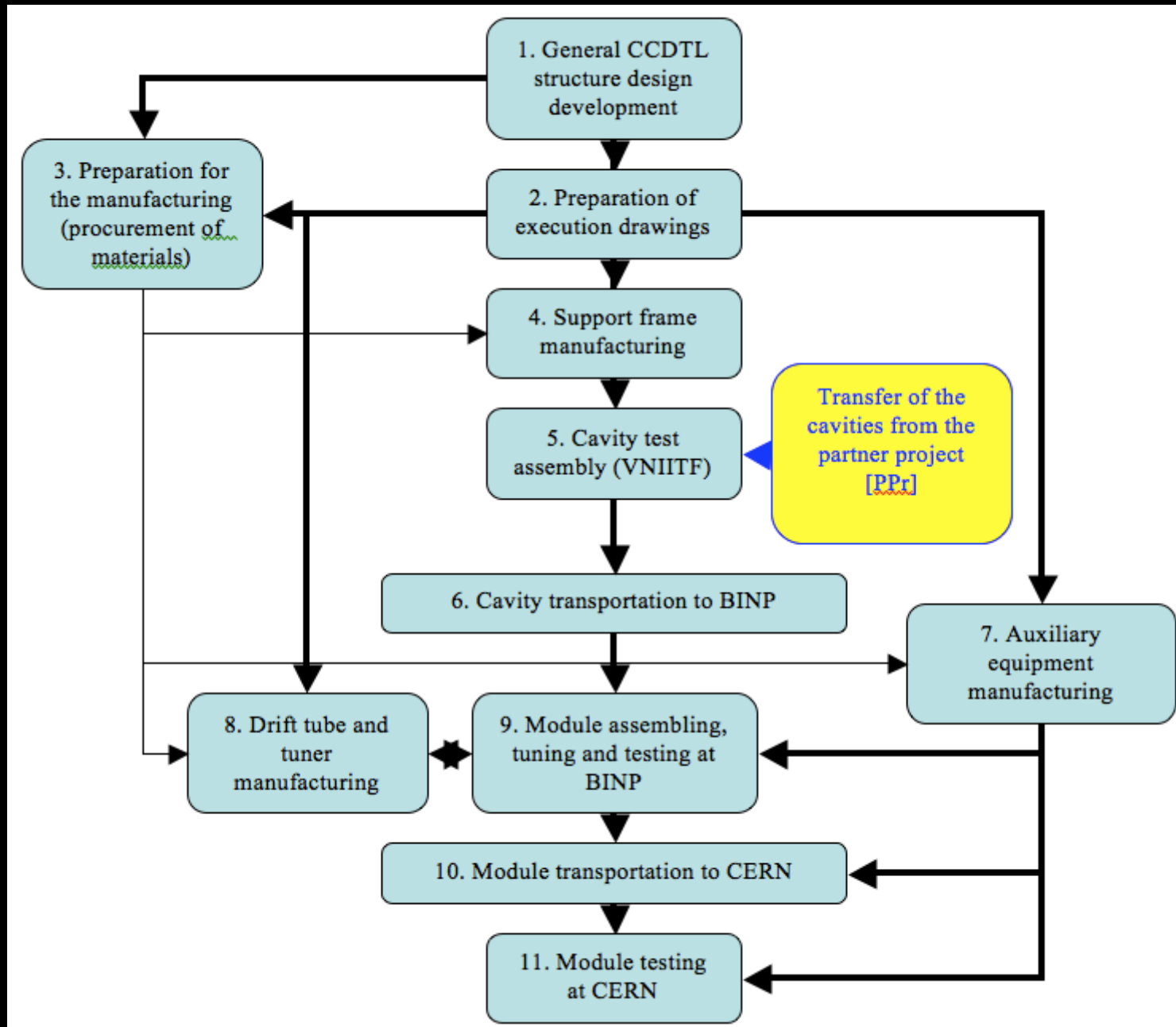
| original proposal | #3888 | #3889 |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| project 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



within Linac-4 CCDTL structure
Transfer of the cavities to the regular project [RPr] for complex testing
“CCDTL status”, pre-CCDTL-kick-off meeting, 9. July 2009, F. Gerigk,

flow-chart regular project



budget cut by ISTC

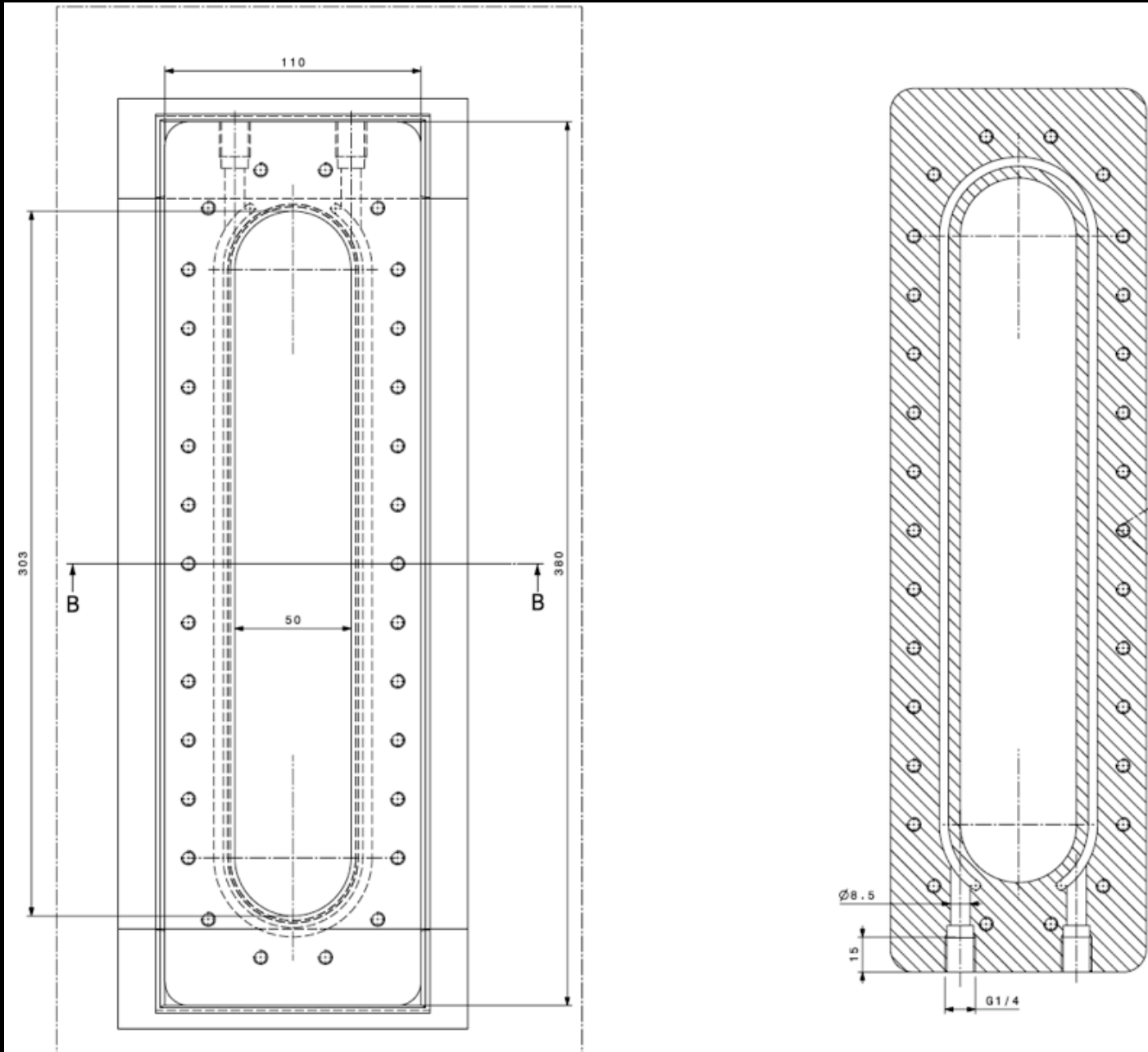
January 2009: ISTC approves both projects, but cuts the budget for #3888 from 1.35 M\$ to 916 k\$. In order to save the project the following steps were taken:

- ✦ **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

standardisation with PIMS
and DTL

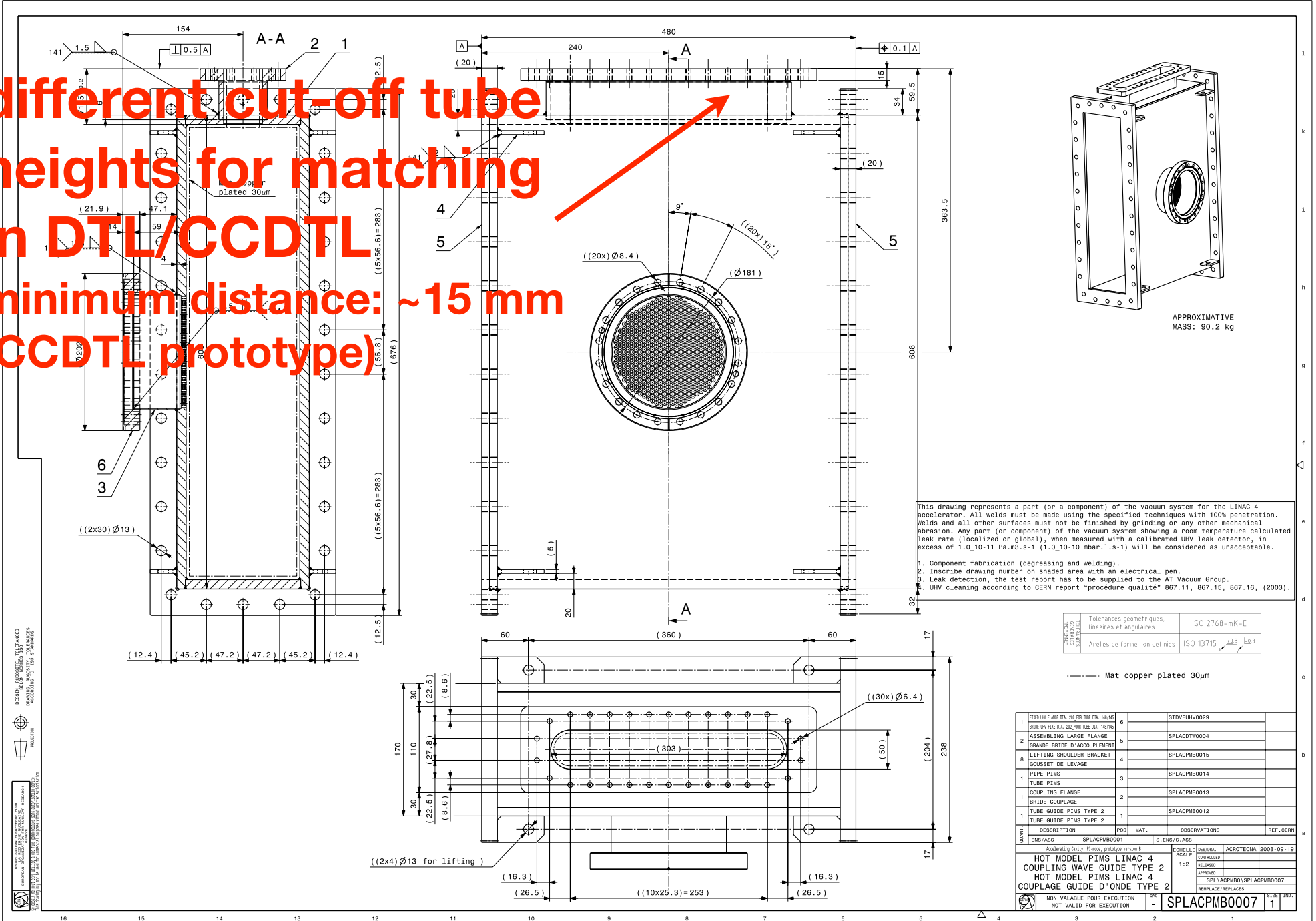
RF port (standardised)



- ✦ 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)

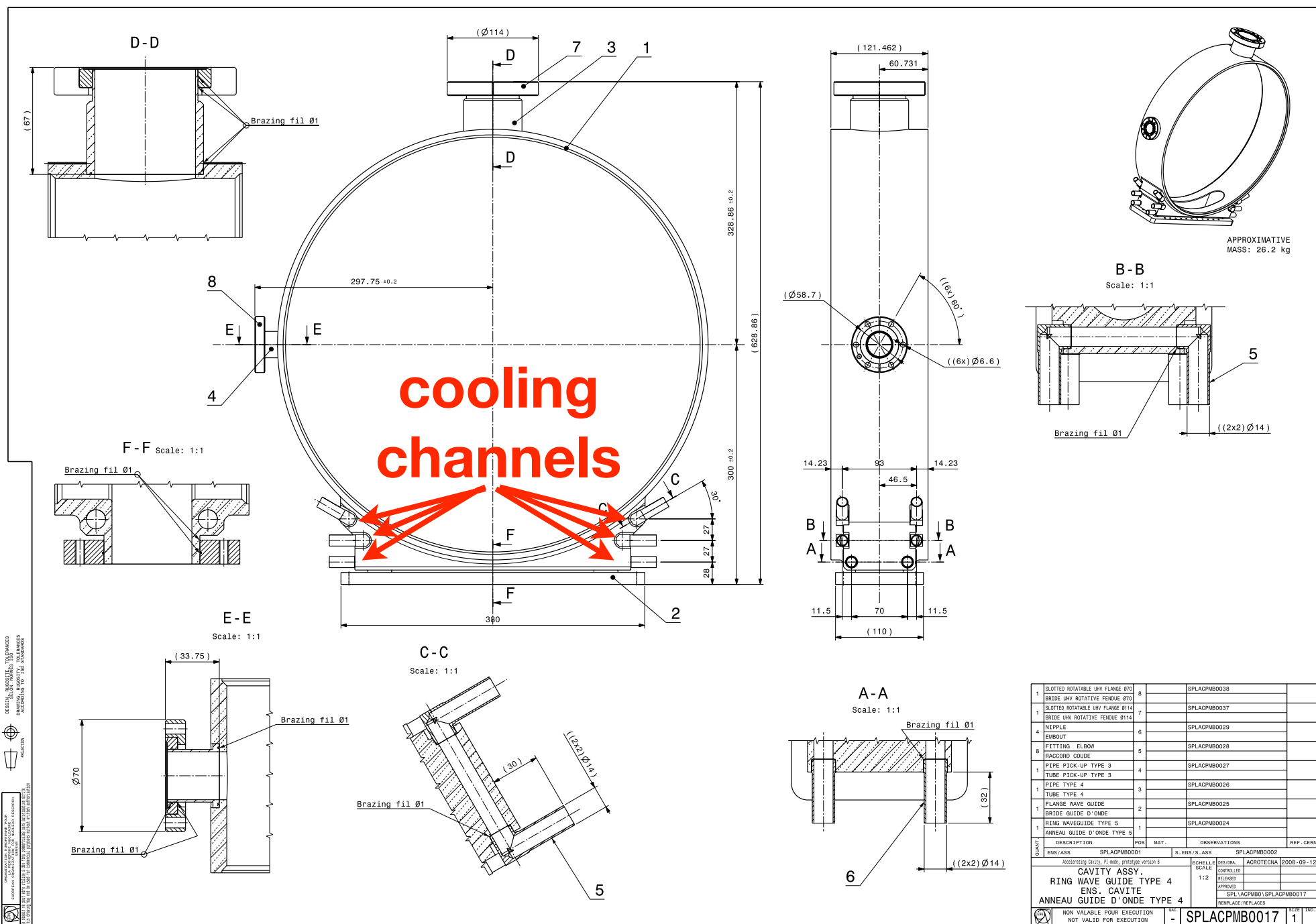


| | |
|-----------------------------------------------------|-------------------------------------|
| Tolerances géométriques, linéaires et angulaires | ISO 2768-mK-E |
| Arêtes de forme non définies | ISO 13715 $\sqrt{R.3}$ $\sqrt{R.3}$ |

Mat copper plated 30 μ m

| | | | | | |
|---------------------------------------|------------------------------------------------|-------------|------|-------------------------|------------|
| 1 | 1700 UHV FLANGE DIA. 300 FOR TUBE DIA. 181/186 | 8 | | STDVUHV00229 | |
| | GRANDE BRIDE D'ACCOUPLEMENT | 5 | | SPLACDTHW004 | |
| 2 | ASSEMBLING LARGE FLANGE | 5 | | SPLACDTHW004 | |
| | LIFTING SHOULDER BRACKET | 4 | | SPLACPMB0015 | |
| 3 | GOUSSET DE LEVAGE | 4 | | SPLACPMB0015 | |
| | PIPE PIMS | 3 | | SPLACPMB0014 | |
| 4 | TUBE PIMS | 3 | | SPLACPMB0014 | |
| | COUPLING FLANGE | 2 | | SPLACPMB0013 | |
| 5 | BRIDE COUPLAGE | 2 | | SPLACPMB0013 | |
| | TUBE GUIDE PIMS TYPE 2 | 1 | | SPLACPMB0012 | |
| 6 | TUBE GUIDE PIMS TYPE 2 | 1 | | SPLACPMB0012 | |
| DESCRIPTION | | POS | MAT. | OBSERVATIONS | REF. CERN |
| QTY | END/ASS | SPLACPMB000 | | S. ENDS. ASS | |
| ACROTECH ONLY, 1:2-ND, PREVIEW ONLY 1 | | | | | |
| HOT MODEL PIMS LINAC 4 | | | | ROULETTE SCALE | 2008-09-19 |
| COUPLING WAVE GUIDE TYPE 2 | | | | 1:2 | |
| HOT MODEL PIMS LINAC 4 | | | | RELEASED | |
| COUPLING GUIDE D'ONDE TYPE 2 | | | | APPROVED | |
| | | | | SPLACPMB00/SPLACPMB0007 | |
| | | | | REPLACE/REPLACES | |
| NON VALABLE POUR EXECUTION | | | | SPLACPMB0007 | SIZE 1 1ND |
| NOT VALID FOR EXECUTION | | | | | |

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 $Ra \approx 0.3$. 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

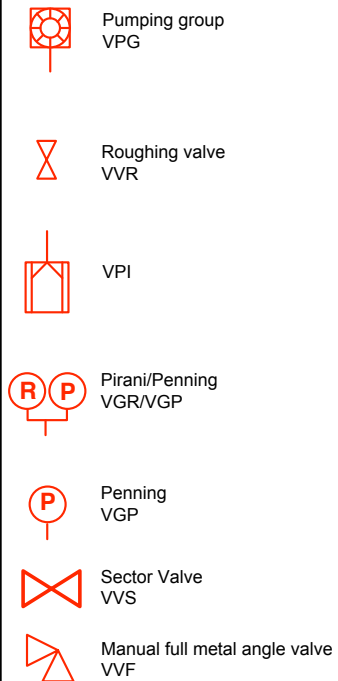
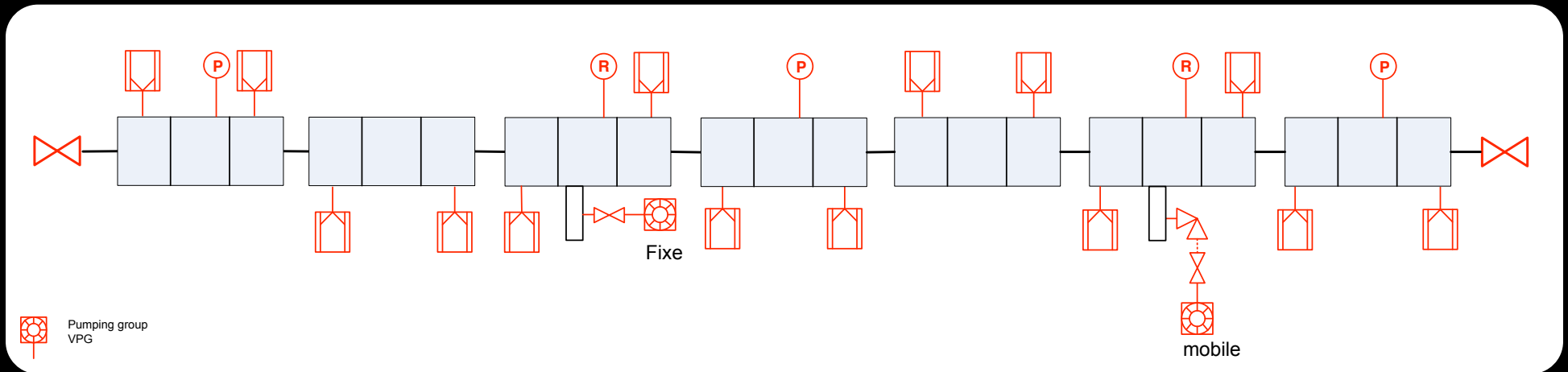
-> use HN 200

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

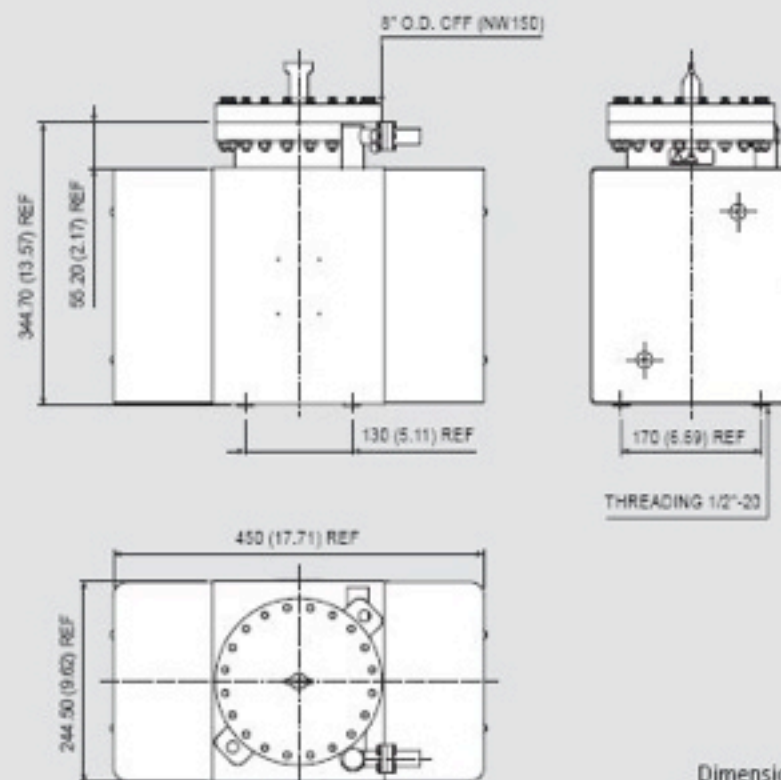


- ✦ 2 VPI pumps per module (VAC ION PLUS 300), cavity 1, 3,
- ✦ 2 roughing pumps, one fix & one mobile (VPG) on modules 3, 6,
- ✦ 5 gauges on coupling cell RF port (DN40CF ?),

Vaclon Plus 300



Outline Drawing



Dimensions:
millimeters (inches)

Technical Specifications

| | StarCell® | Noble Diode | Diode |
|---------------------------------------------------|------------------------------|----------------------|--------|
| Nominal pumping speed for Nitrogen (*) (l/s) | 240 | 260 | 300 |
| Operating life at 1x10 ⁻⁶ mbar (hours) | 80,000 | 50,000 | 50,000 |
| Maximum starting pressure (mbar) | ≤ 1x10 ⁻² | ≤ 1x10 ⁻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

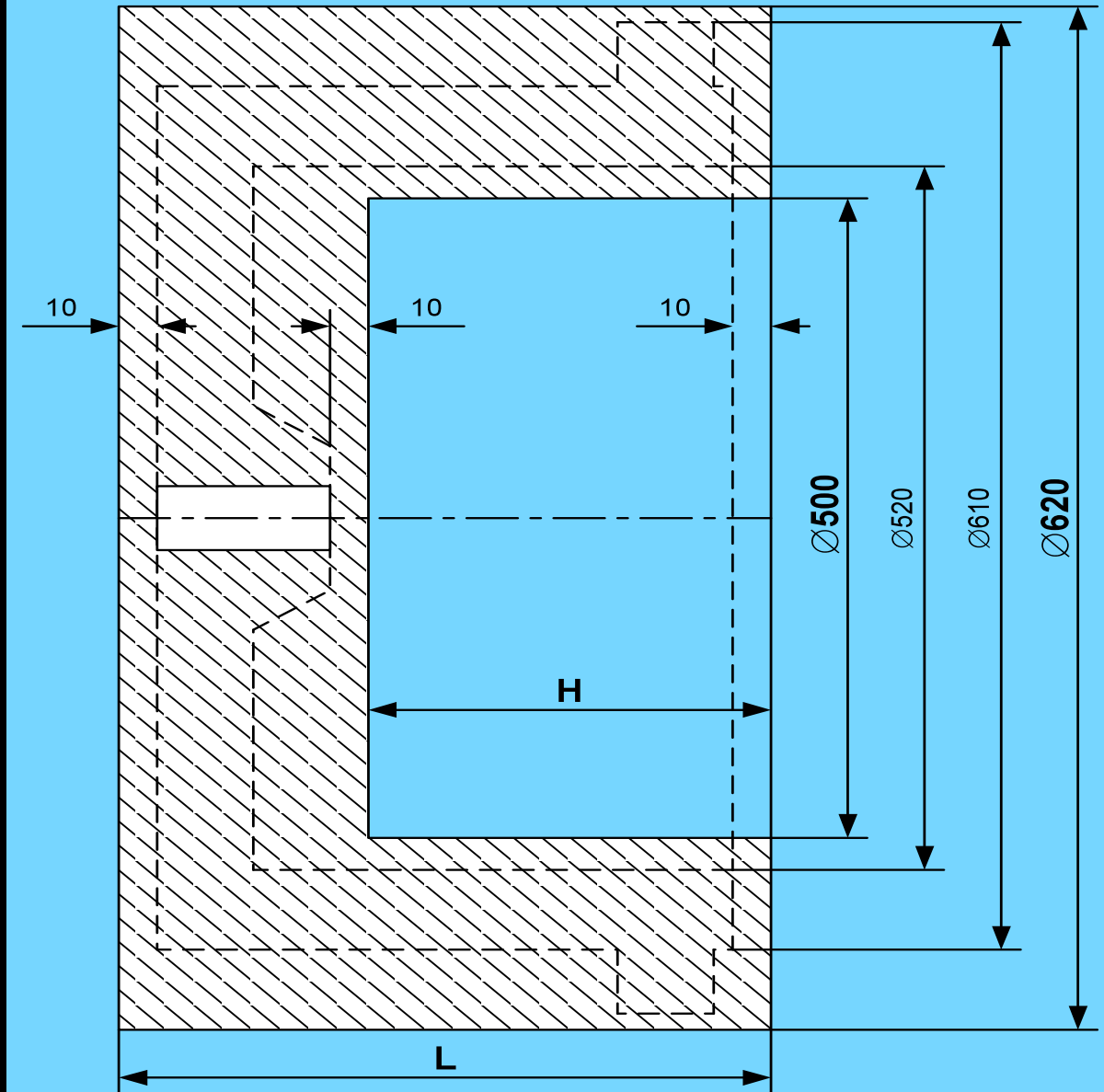
steel, copper, flanges,
etc.



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 | | 480-700 | 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 | |

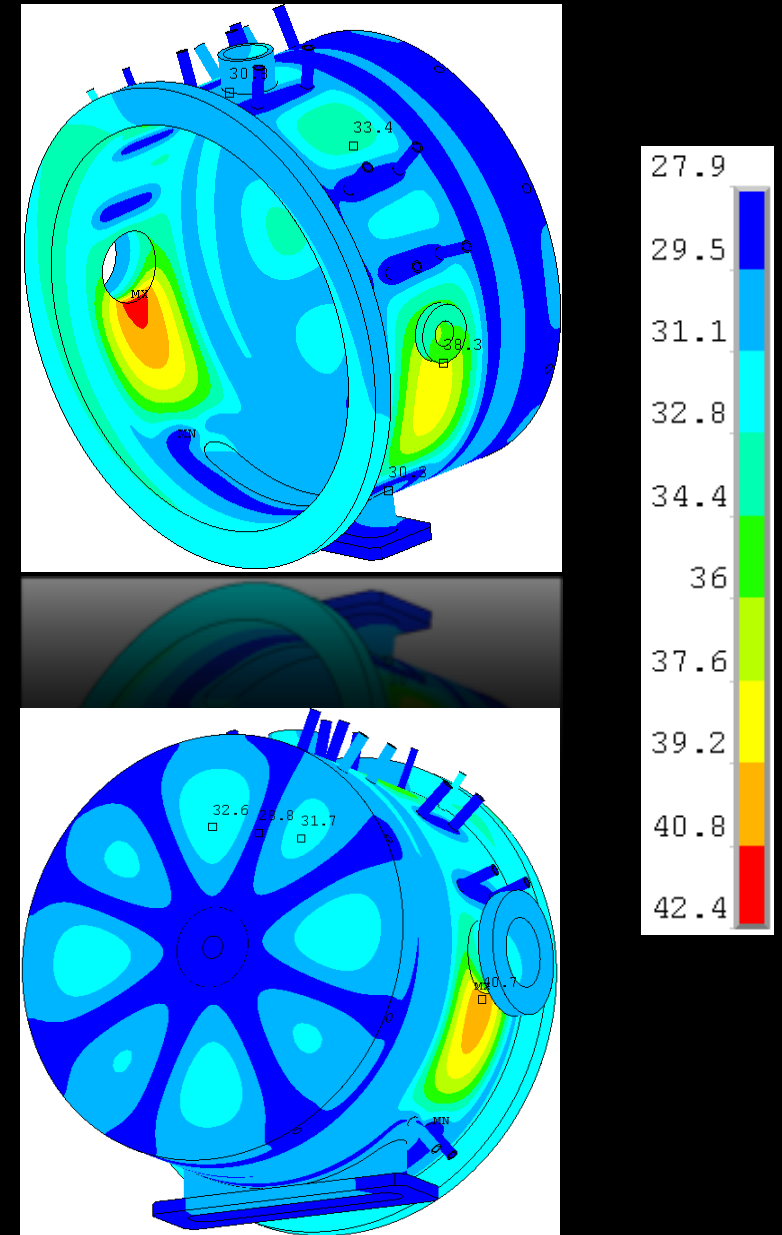
still to order (t.b.c.)

| 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!

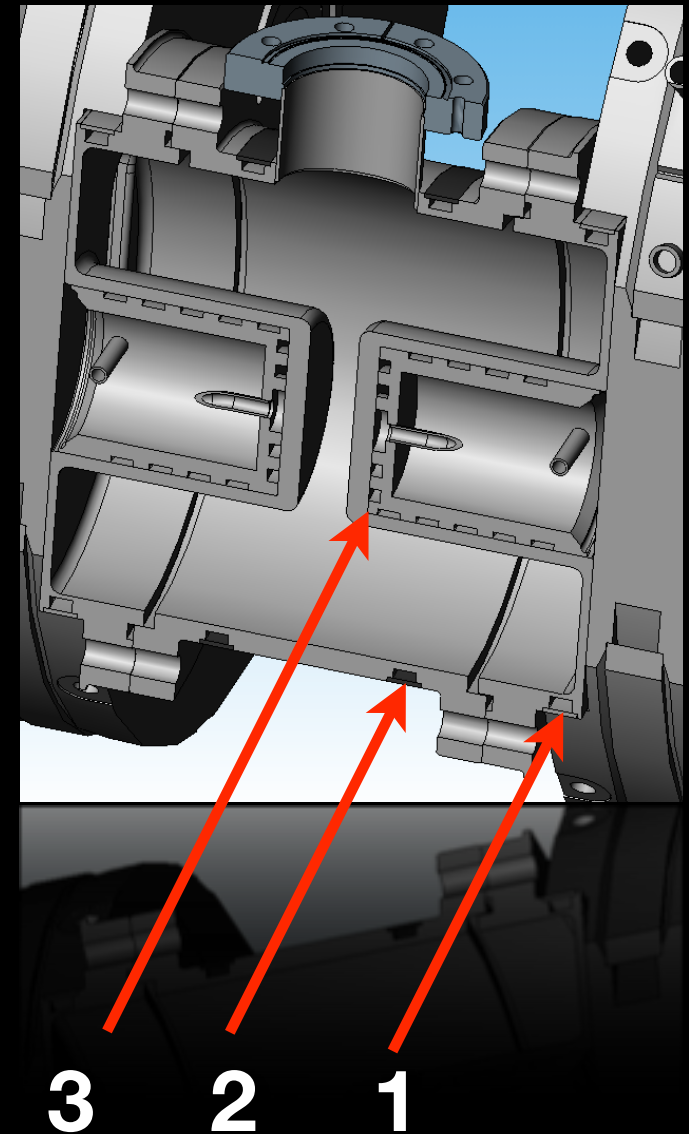
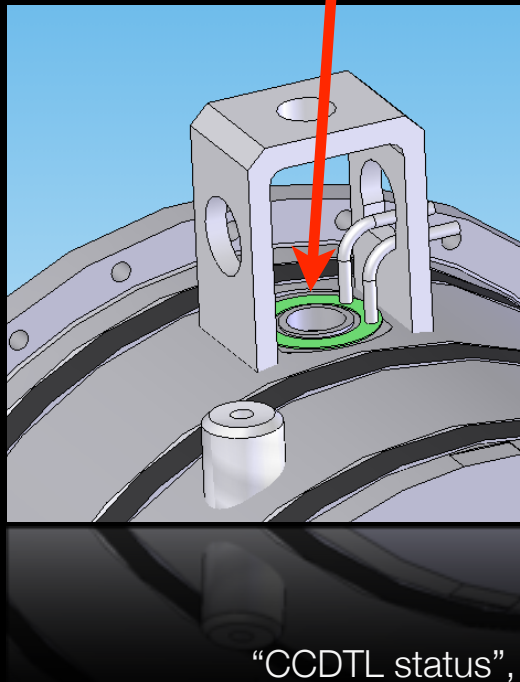
| st. steel | length [mm] | outer diam. [mm] | inner diam. [mm] | number of pieces | cost [kCHF] | ordered | delivery |
|-------------------|-------------|------------------|------------------|------------------|-------------|---------|----------|
| tubes (for DN100) | 150 | 88.9 | 84.9 | 48 | | | |
| 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

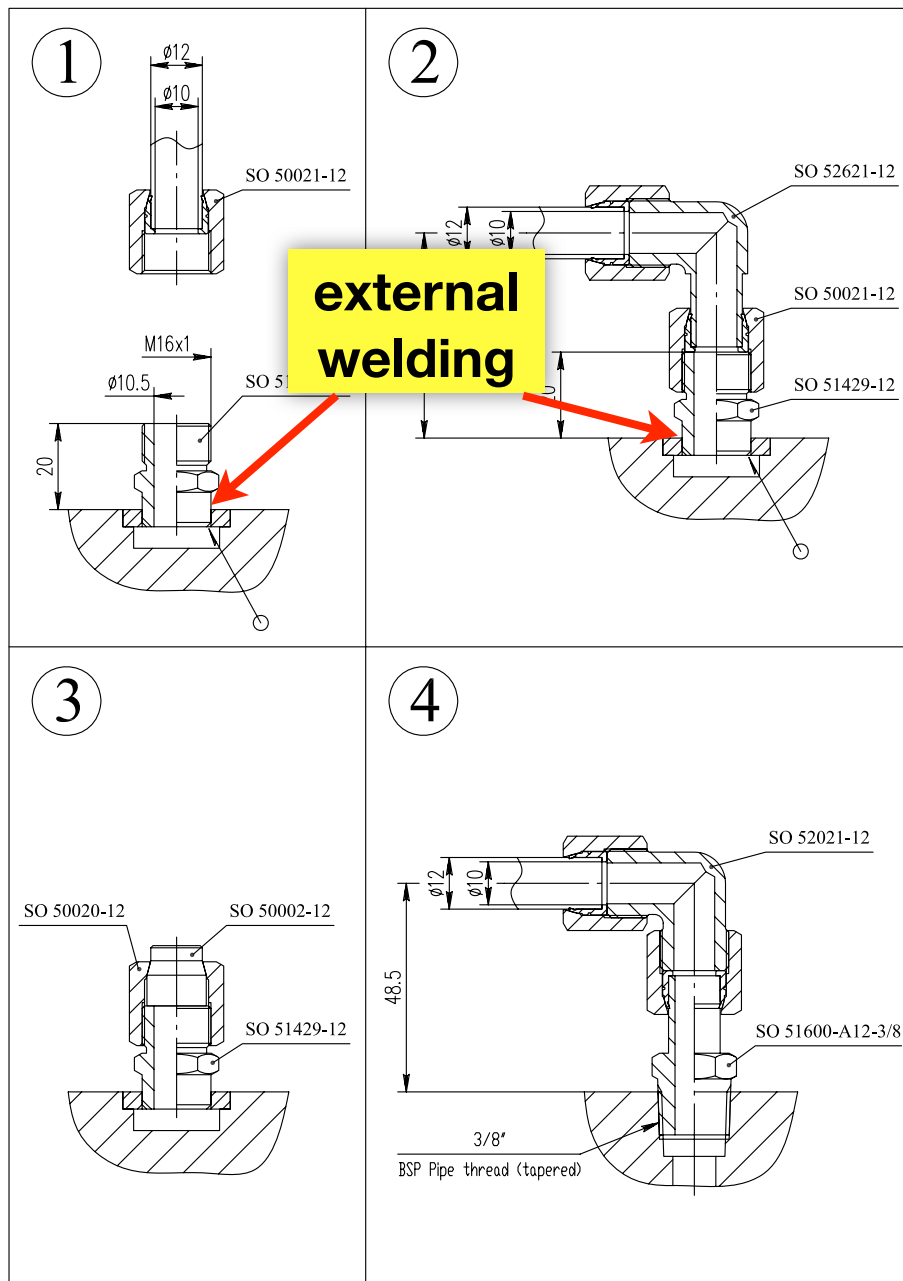


cooling channel optimisation

- 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),



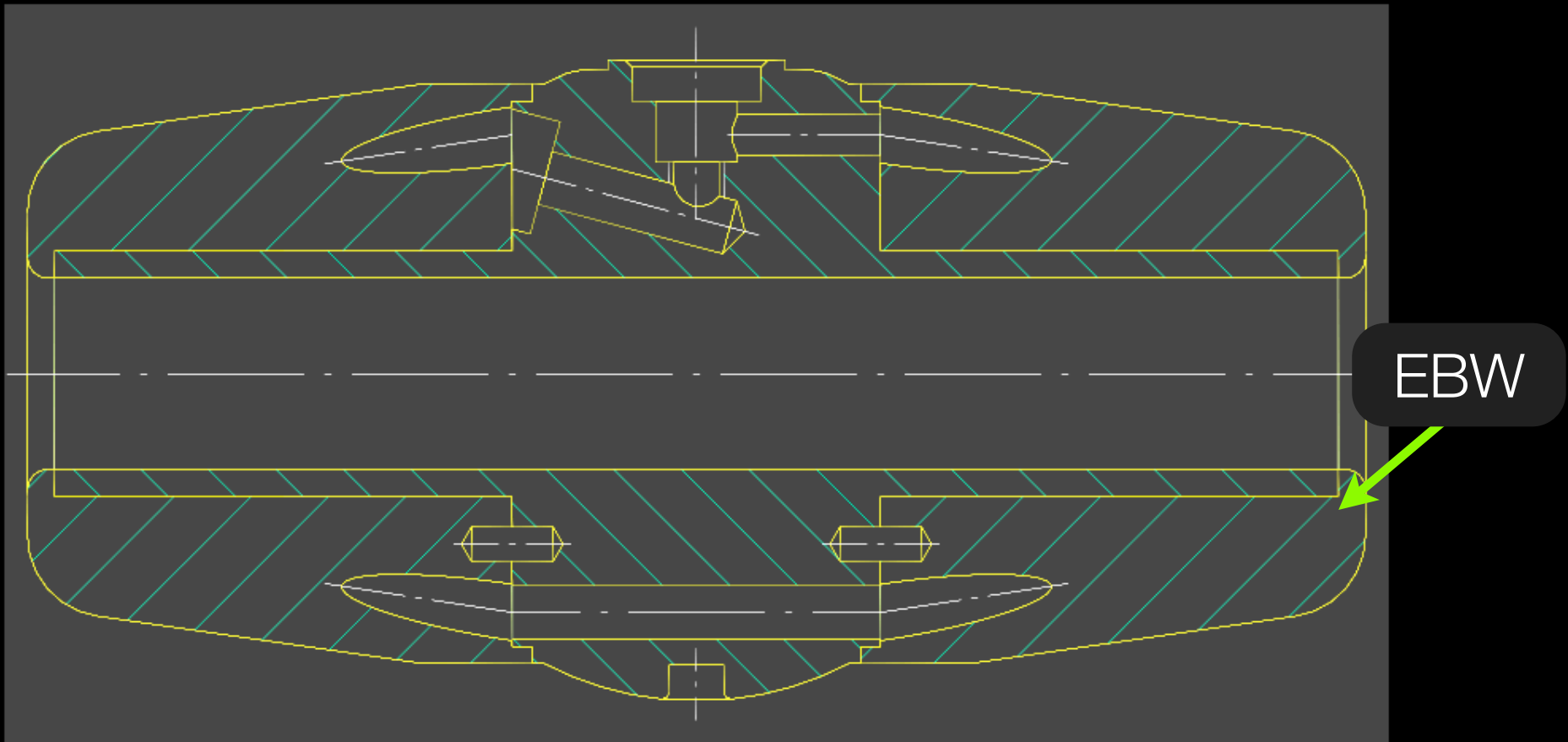
SERTO water fittings



- ✦ 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,

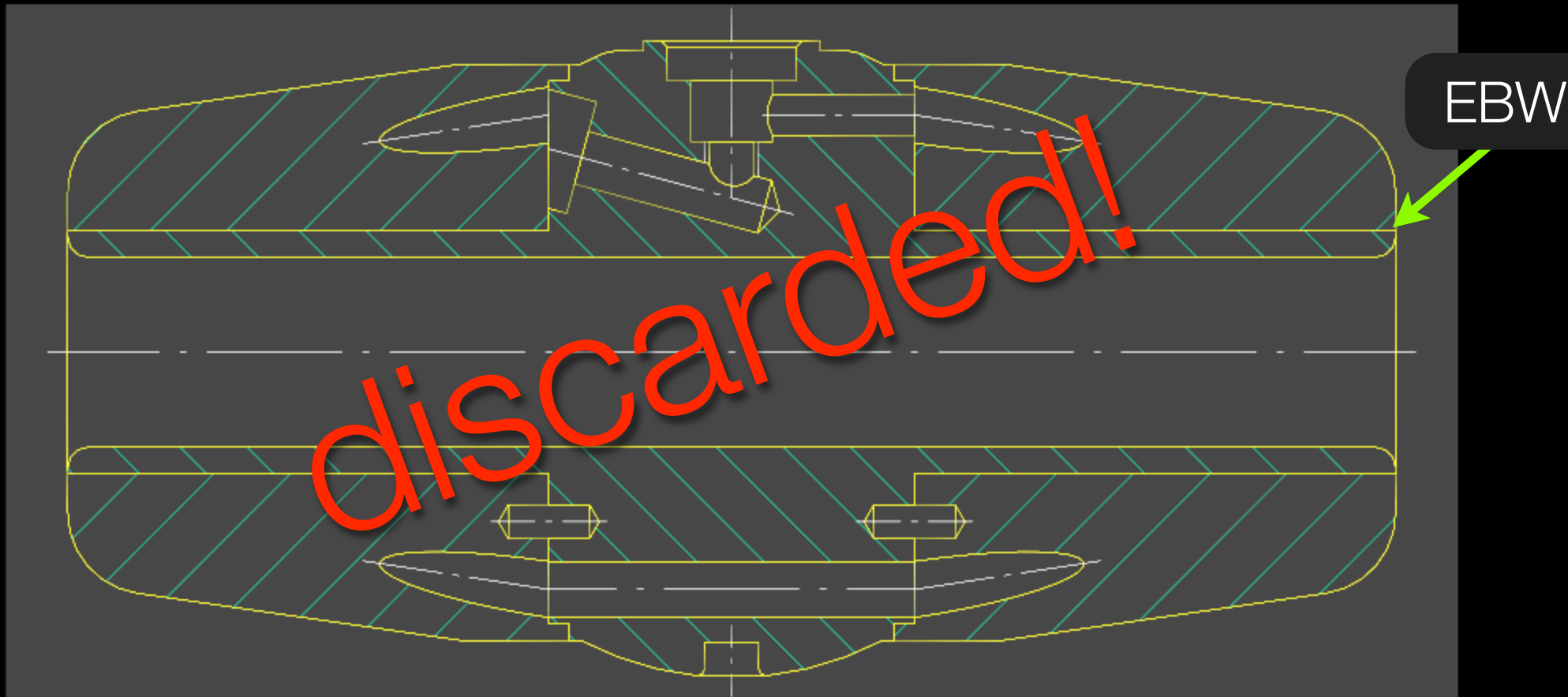
Option 1: used for prototype

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



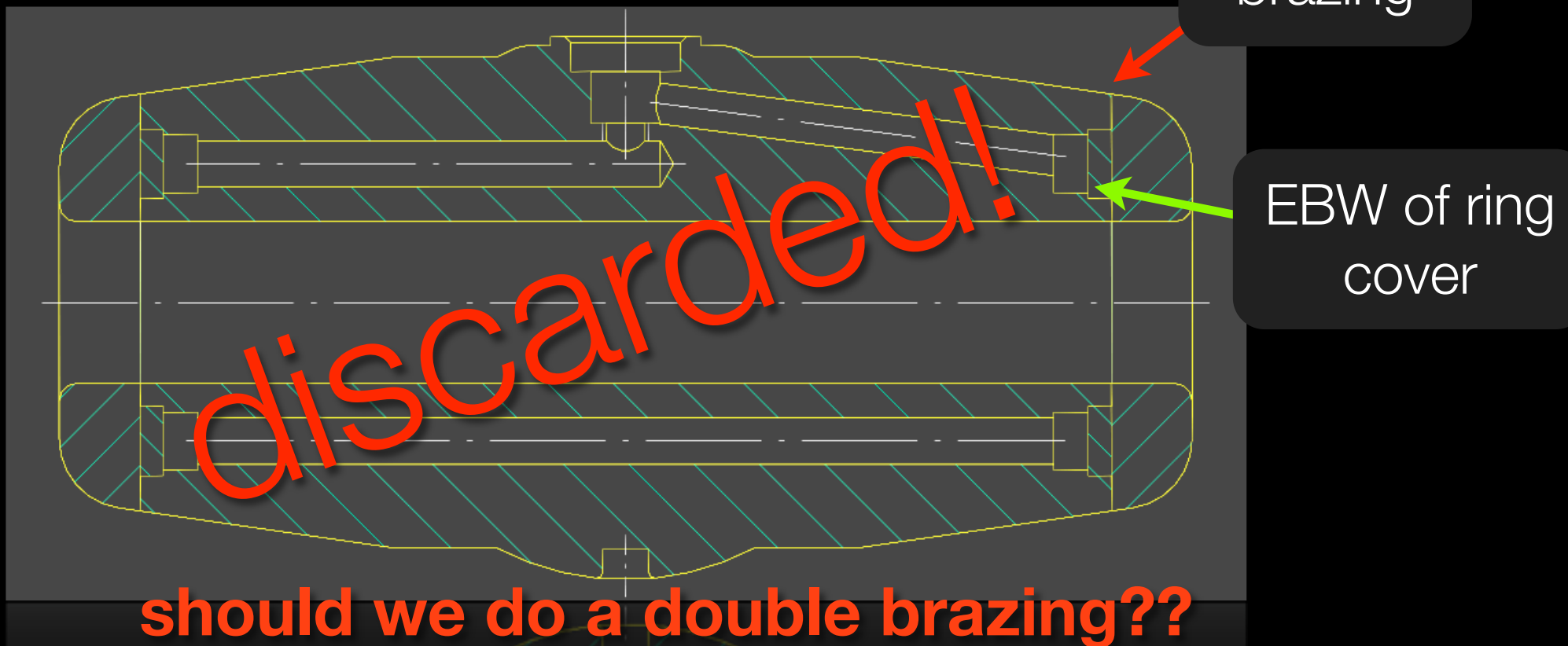
Option 2:

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



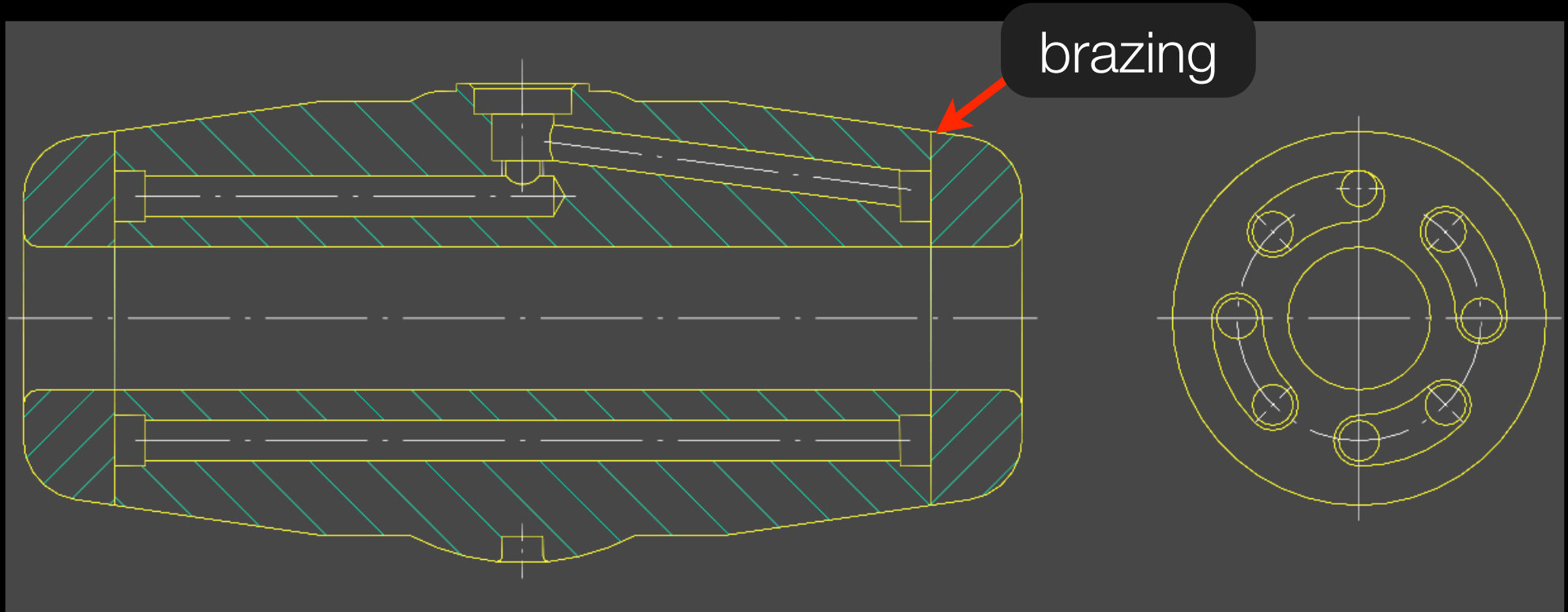
Option 3:

- ✦ **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.



Option 4: preferred option

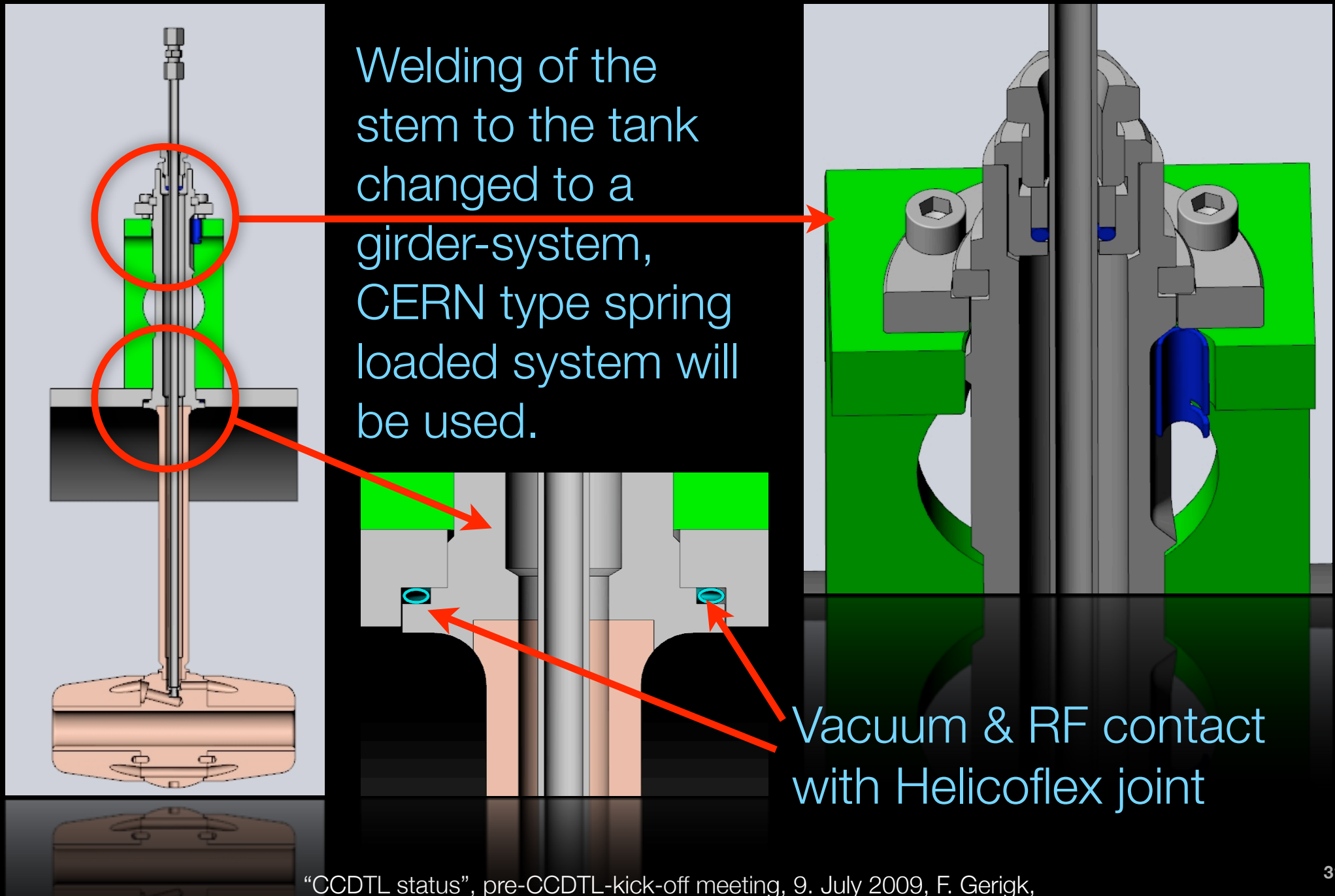
- **disadvantage:** only a brazing joint between vacuum and cooling channel, machining over brazed surface,
- **advantage:** technique has been used successfully at BINP and CERN (CLIC, RFQ), single piece DT, joint can be moved further into lower field area, still only one joint seen by RF current, better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



remarks

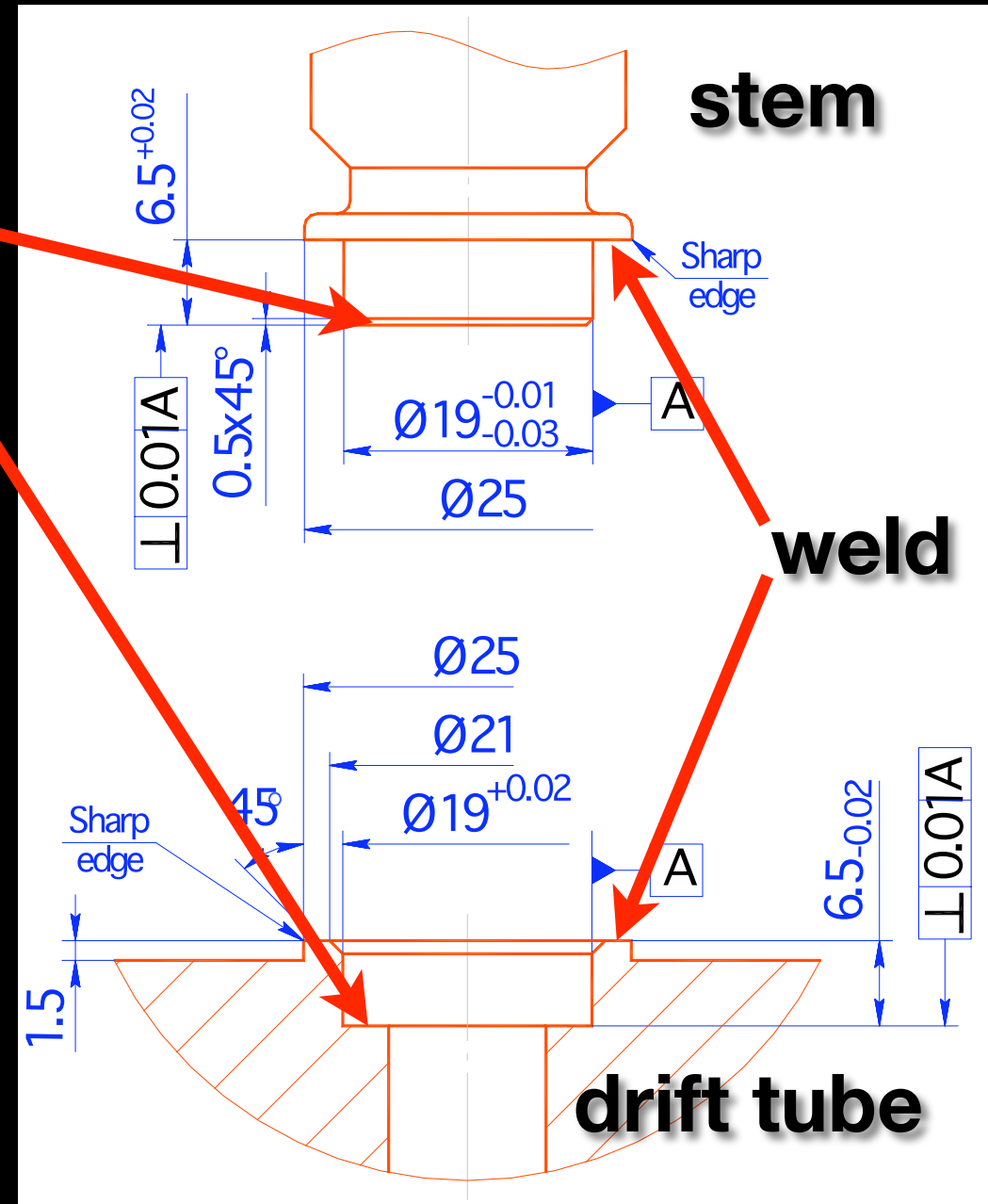
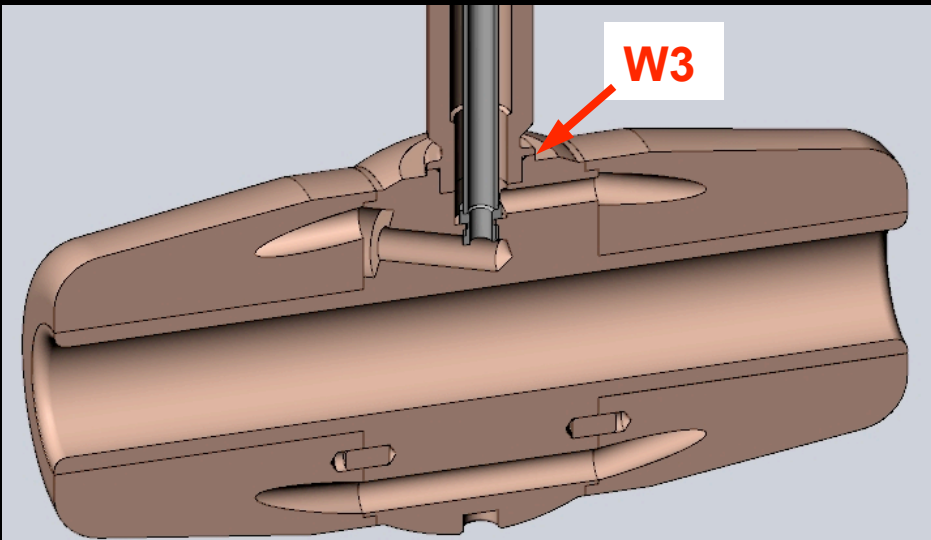
- ✦ a brazing canal should be used instead of a brazing foil,
- ✦ moving the joint further away from the nose:
 - ➡ silver alloys, which may come to the surface of the drift tube are further away from peak field region, silver tends to spark in areas of high fields,
 - ➡ easier machining of brazing grooves?
- ✦ 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



stem/drift tube perpendicularity

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



support structure

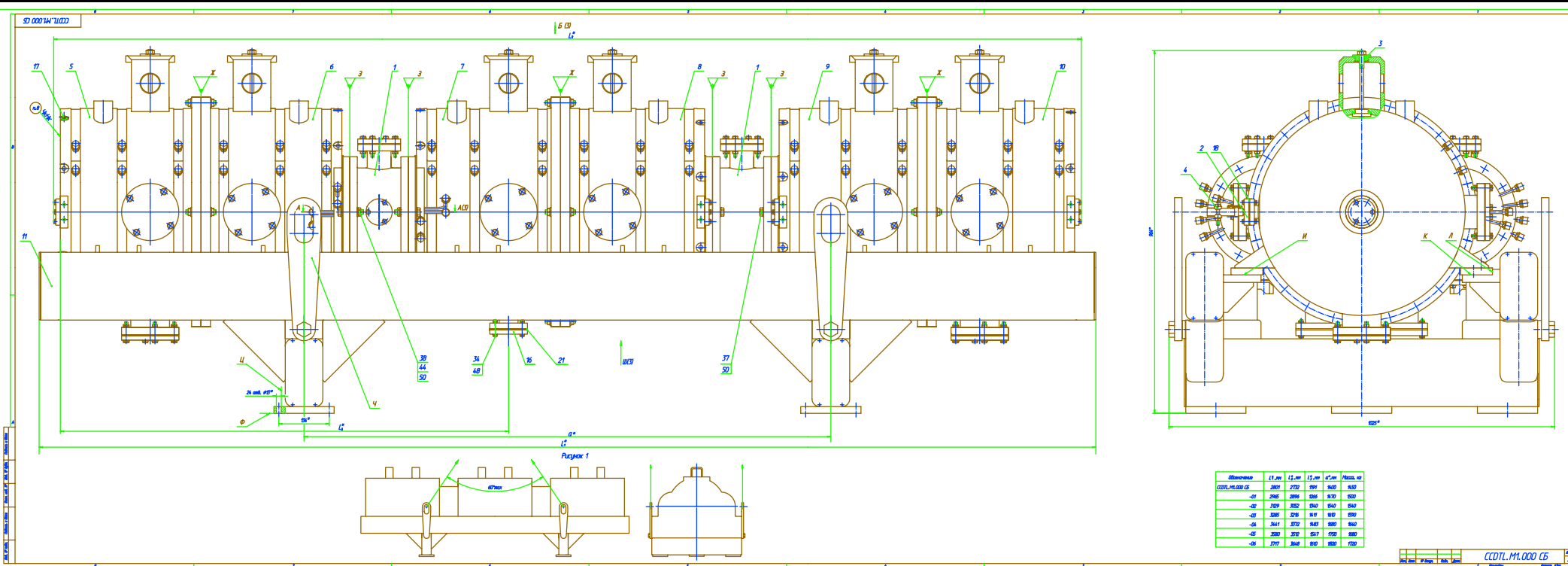
concept by BINP/
VNIITF, construction
by CERN

The image displays five technical drawings of the support structure for the CCDTL-M1.700 detector. Each drawing is a table with columns for 'Наименование' (Name), 'Код. на использование' (Code for use), and 'Примечание' (Remarks). The drawings are arranged in a 2x3 grid, with the bottom-right cell empty. The drawings show various components and their codes, including 'CCDTL-M1.700' and 'CCDTL-M1.700-1'.

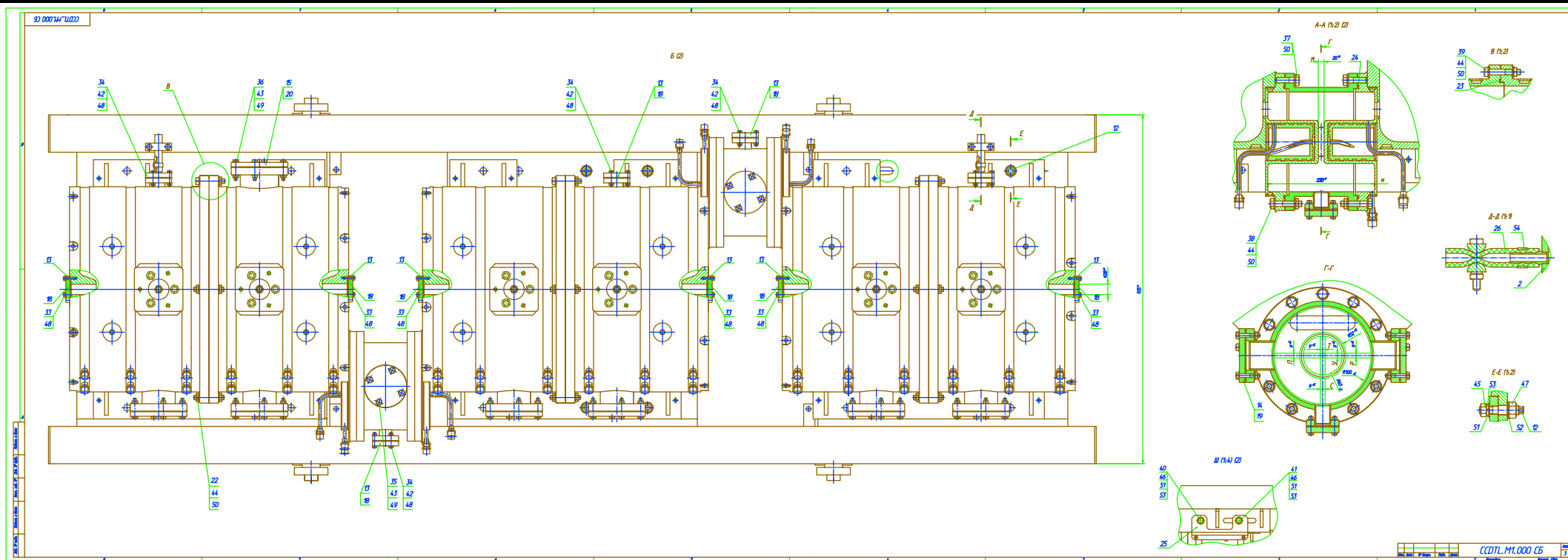
| Наименование | Код. на использование | Примечание |
|-----------------|-----------------------|------------|
| CCDTL-M1.700 | 1 | |
| CCDTL-M1.700-1 | 2 | |
| CCDTL-M1.700-2 | 3 | |
| CCDTL-M1.700-3 | 4 | |
| CCDTL-M1.700-4 | 5 | |
| CCDTL-M1.700-5 | 6 | |
| CCDTL-M1.700-6 | 7 | |
| CCDTL-M1.700-7 | 8 | |
| CCDTL-M1.700-8 | 9 | |
| CCDTL-M1.700-9 | 10 | |
| CCDTL-M1.700-10 | 11 | |
| CCDTL-M1.700-11 | 12 | |
| CCDTL-M1.700-12 | 13 | |
| CCDTL-M1.700-13 | 14 | |
| CCDTL-M1.700-14 | 15 | |
| CCDTL-M1.700-15 | 16 | |
| CCDTL-M1.700-16 | 17 | |
| CCDTL-M1.700-17 | 18 | |
| CCDTL-M1.700-18 | 19 | |
| CCDTL-M1.700-19 | 20 | |
| CCDTL-M1.700-20 | 21 | |
| CCDTL-M1.700-21 | 22 | |
| CCDTL-M1.700-22 | 23 | |
| CCDTL-M1.700-23 | 24 | |
| CCDTL-M1.700-24 | 25 | |
| CCDTL-M1.700-25 | 26 | |
| CCDTL-M1.700-26 | 27 | |
| CCDTL-M1.700-27 | 28 | |
| CCDTL-M1.700-28 | 29 | |
| CCDTL-M1.700-29 | 30 | |
| CCDTL-M1.700-30 | 31 | |
| CCDTL-M1.700-31 | 32 | |
| CCDTL-M1.700-32 | 33 | |
| CCDTL-M1.700-33 | 34 | |
| CCDTL-M1.700-34 | 35 | |
| CCDTL-M1.700-35 | 36 | |
| CCDTL-M1.700-36 | 37 | |
| CCDTL-M1.700-37 | 38 | |
| CCDTL-M1.700-38 | 39 | |
| CCDTL-M1.700-39 | 40 | |
| CCDTL-M1.700-40 | 41 | |
| CCDTL-M1.700-41 | 42 | |
| CCDTL-M1.700-42 | 43 | |
| CCDTL-M1.700-43 | 44 | |
| CCDTL-M1.700-44 | 45 | |
| CCDTL-M1.700-45 | 46 | |
| CCDTL-M1.700-46 | 47 | |
| CCDTL-M1.700-47 | 48 | |
| CCDTL-M1.700-48 | 49 | |
| CCDTL-M1.700-49 | 50 | |
| CCDTL-M1.700-50 | 51 | |
| CCDTL-M1.700-51 | 52 | |
| CCDTL-M1.700-52 | 53 | |
| CCDTL-M1.700-53 | 54 | |
| CCDTL-M1.700-54 | 55 | |
| CCDTL-M1.700-55 | 56 | |
| CCDTL-M1.700-56 | 57 | |
| CCDTL-M1.700-57 | 58 | |
| CCDTL-M1.700-58 | 59 | |
| CCDTL-M1.700-59 | 60 | |
| CCDTL-M1.700-60 | 61 | |
| CCDTL-M1.700-61 | 62 | |
| CCDTL-M1.700-62 | 63 | |
| CCDTL-M1.700-63 | 64 | |
| CCDTL-M1.700-64 | 65 | |
| CCDTL-M1.700-65 | 66 | |
| CCDTL-M1.700-66 | 67 | |
| CCDTL-M1.700-67 | 68 | |
| CCDTL-M1.700-68 | 69 | |
| CCDTL-M1.700-69 | 70 | |
| CCDTL-M1.700-70 | 71 | |
| CCDTL-M1.700-71 | 72 | |
| CCDTL-M1.700-72 | 73 | |
| CCDTL-M1.700-73 | 74 | |
| CCDTL-M1.700-74 | 75 | |
| CCDTL-M1.700-75 | 76 | |
| CCDTL-M1.700-76 | 77 | |
| CCDTL-M1.700-77 | 78 | |
| CCDTL-M1.700-78 | 79 | |
| CCDTL-M1.700-79 | 80 | |
| CCDTL-M1.700-80 | 81 | |
| CCDTL-M1.700-81 | 82 | |
| CCDTL-M1.700-82 | 83 | |
| CCDTL-M1.700-83 | 84 | |
| CCDTL-M1.700-84 | 85 | |
| CCDTL-M1.700-85 | 86 | |
| CCDTL-M1.700-86 | 87 | |
| CCDTL-M1.700-87 | 88 | |
| CCDTL-M1.700-88 | 89 | |
| CCDTL-M1.700-89 | 90 | |
| CCDTL-M1.700-90 | 91 | |
| CCDTL-M1.700-91 | 92 | |
| CCDTL-M1.700-92 | 93 | |
| CCDTL-M1.700-93 | 94 | |
| CCDTL-M1.700-94 | 95 | |
| CCDTL-M1.700-95 | 96 | |
| CCDTL-M1.700-96 | 97 | |
| CCDTL-M1.700-97 | 98 | |
| CCDTL-M1.700-98 | 99 | |
| CCDTL-M1.700-99 | 100 | |

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

assembly: side view



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] | $\beta\lambda$ 1 [mm] | $\beta\lambda$ 2 [mm] | $\beta\lambda$ 3 [mm] | min $\Delta\phi$ / $\beta\lambda$ [deg] | max $\Delta\phi$ / $\beta\lambda$ [deg] | max $\Delta\phi$ 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 technology | 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)

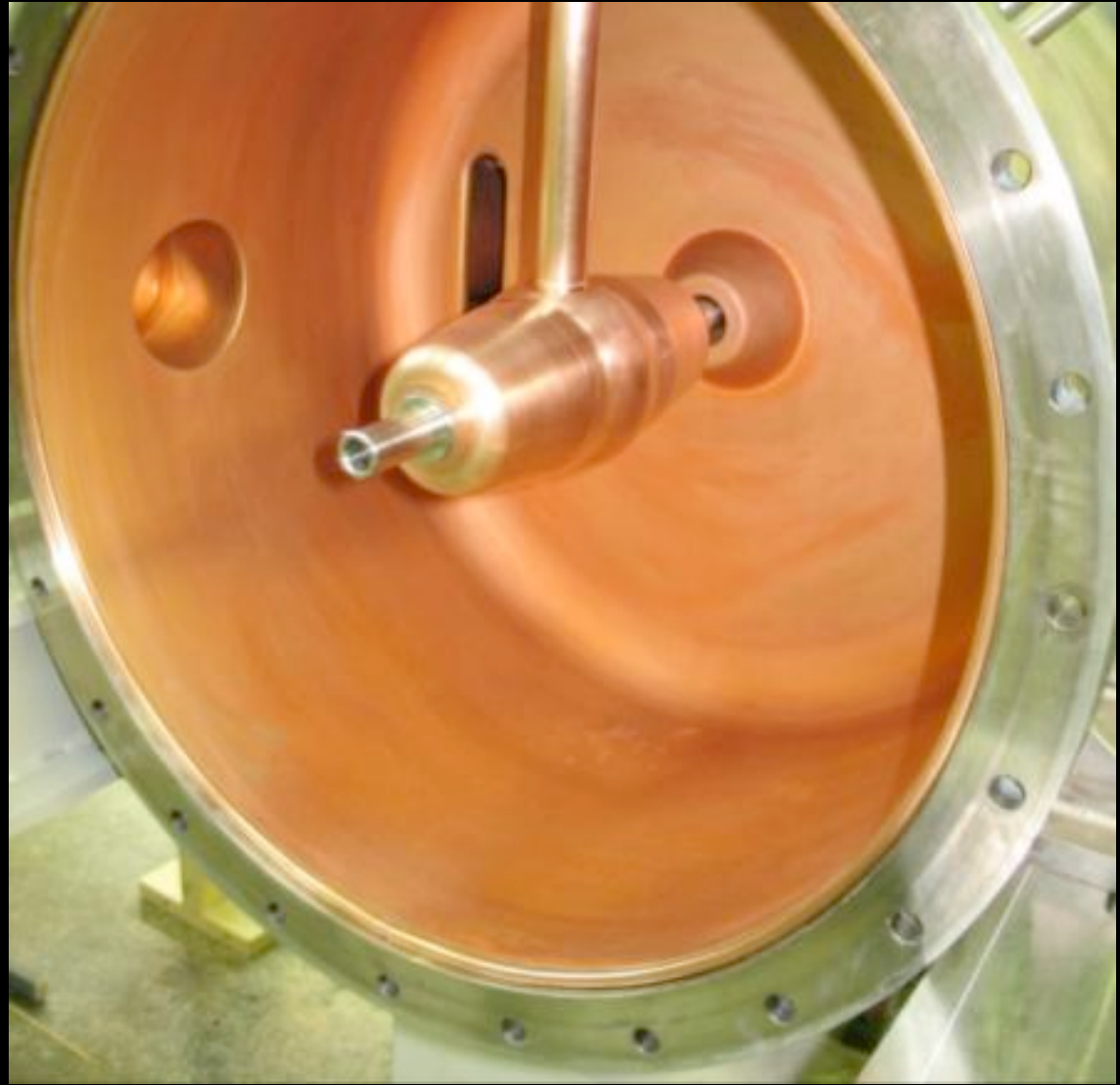
copper
plating

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



copper plating revisited

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

flanges must be copper plated!!

