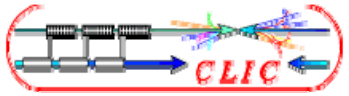


CLIC08 workshop

Structure production: CERN activities and Master Schedule

G. Riddone, W. Wuensch, R. Zennaro,

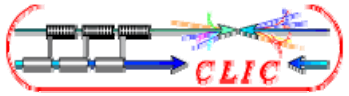
Contributions from C. Achard, S. Atieh, V. Dolgashev, D. Glaude, S. Heikkinen, A. Samoshkin, I. Syratchev
+ KEK/SLAC collaborations

15.10.2008

Content

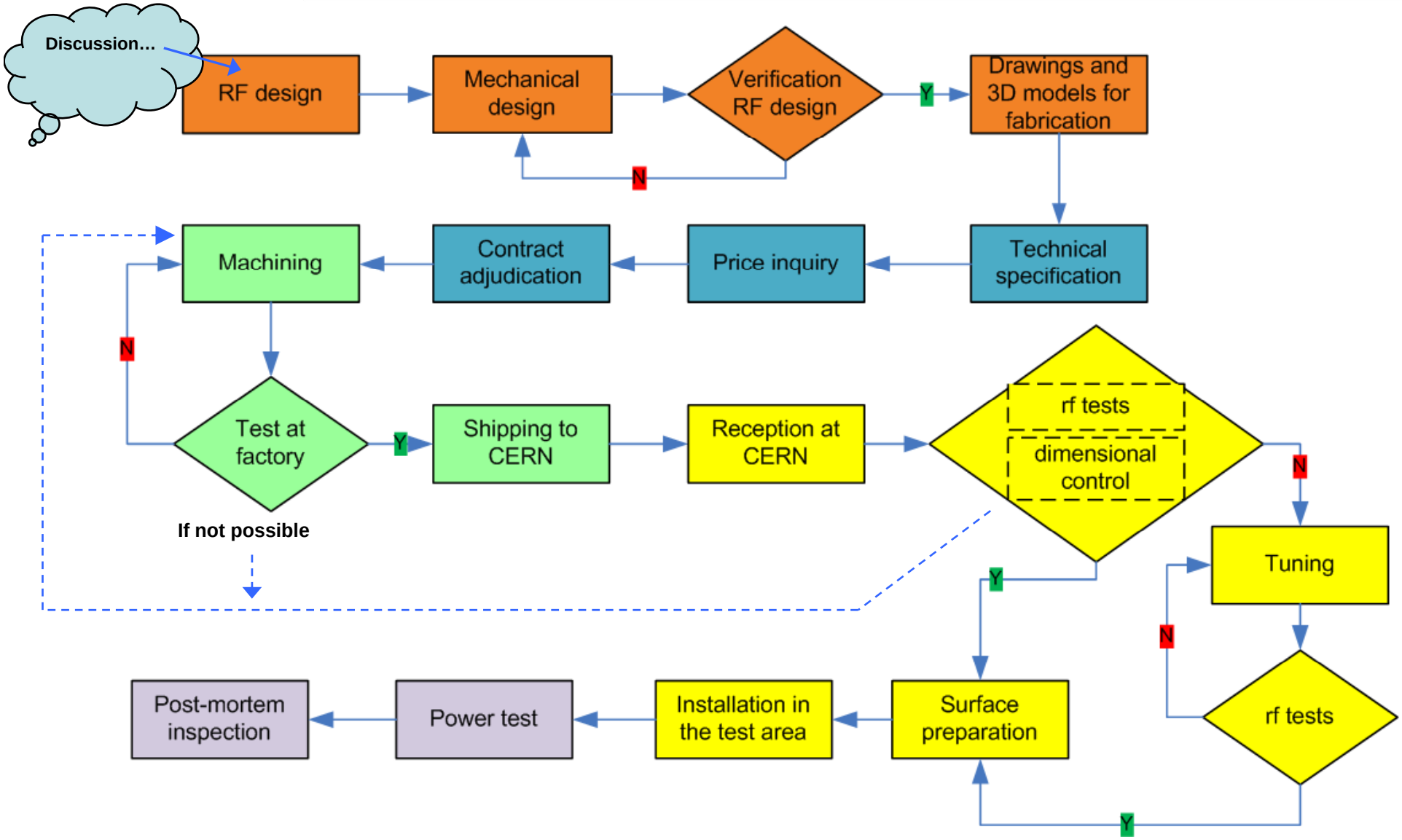
- Accelerating structures
- PETS
- RF components

- Structure Master Schedule



ACCELERATING STRUCTURES

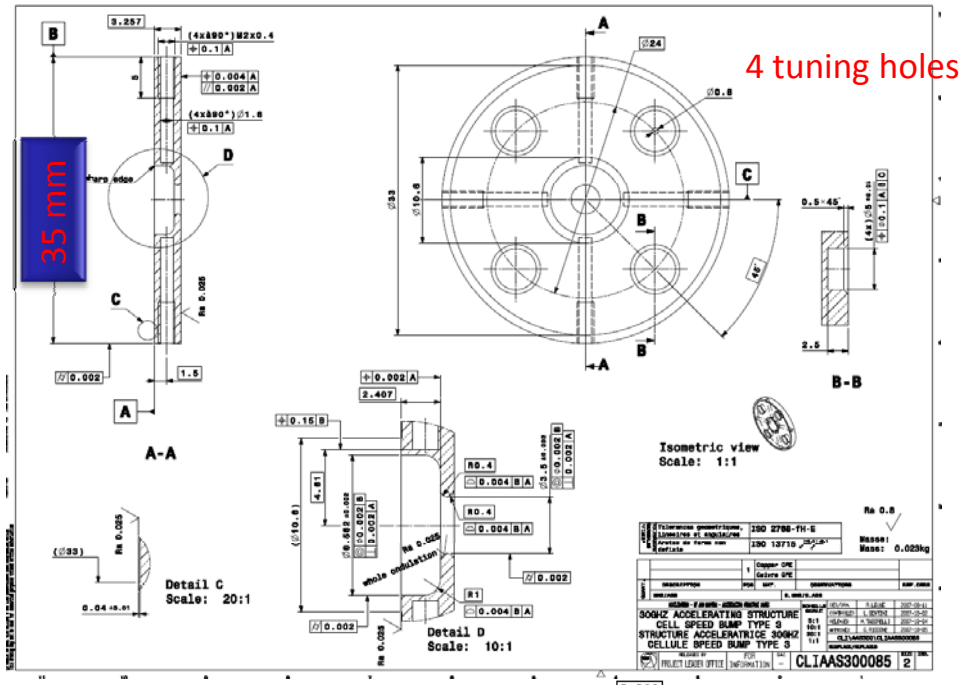
Production cycle for acc. structures



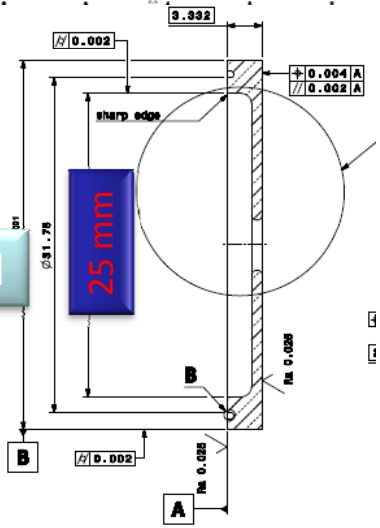
30 GHz – Speed bump, TM02, vg2.6

Speed bump

TM02 before brazing

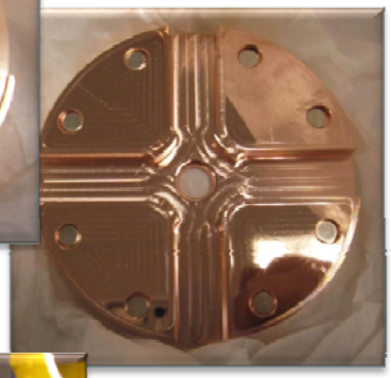


Speed bump cell



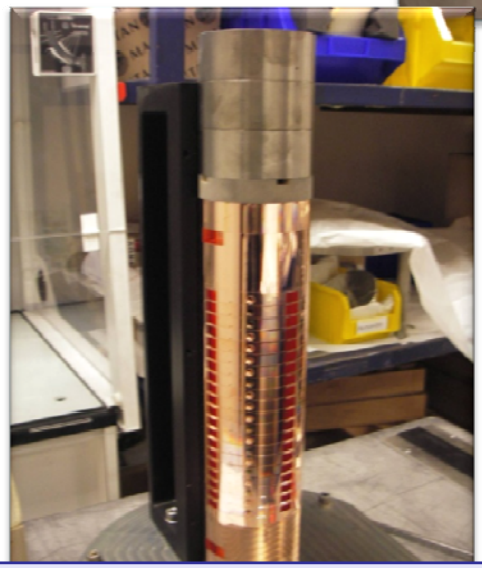
11.4 GHz - CLIC vg1, T18

Damped disks



QUADRANTS
2 damped structures (1 from KEK and 1 from CERN)

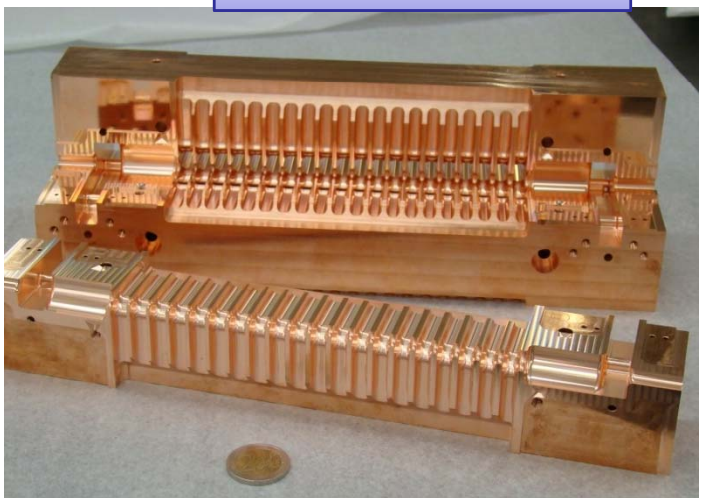
DISKS
5 undamped structures (4 from KEK/SLAC and 1 from CERN)
3 damped structures (2 from KEK/SLAC and 1 from CERN)



Damped structure#1 ready for brazing (CERN)

Undamped disk

Damped quadrants



11.4 GHz - CLIC G and C10

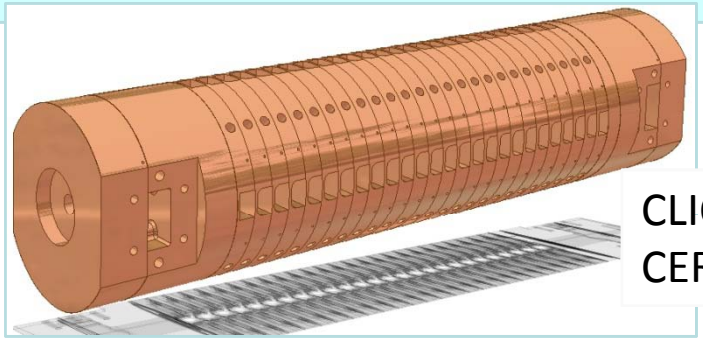
CLIC G - T24
11.4 GHz (tank and sealed configurations possible)
- 2 undamped structures from CERN
- 1 damped structure from CERN

12 GHz (tank)
- 1 undamped structure
- 1 damped structure

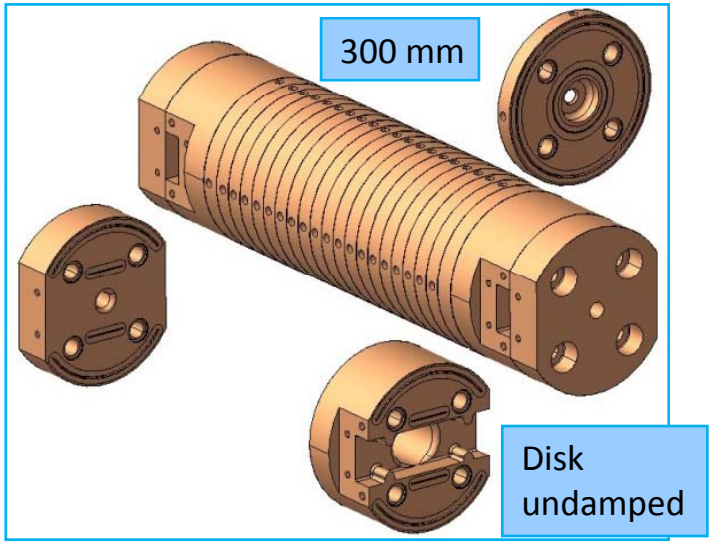
C10 (sealed configuration, tuning as SLAC design)
- 10 undamped structures
(2 from KEK/SLAC and 8 from SLAC)

- 4 damped structures
(2 from KEK/SLAC and 2 from CERN)

CLIC G under procurement



CLIC G 12 GHz:
CERN 3D models



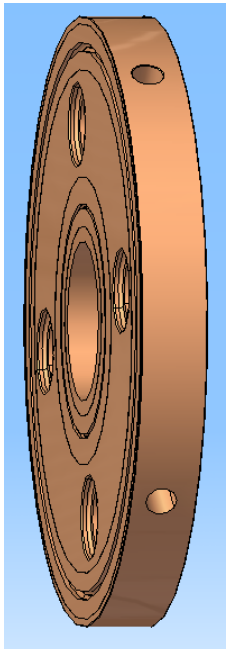
Mechanical design –Parameterization

Alexandre.Samochkine @ cern.ch

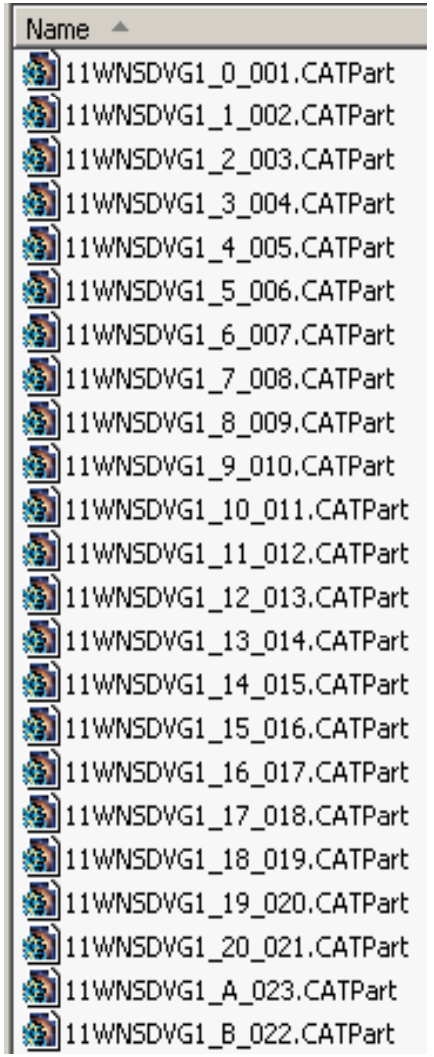
RF INPUT

No	b' (mm)	a' (mm)	t' (mm)	rdw' (mm)	C' (mm)	c_iris' (mm)	eb' (mm)	adw' (mm)	idw' (mm)	g' (mm)	Item'	t_pr (mm)
0	11.5	5.917	2.897			0.290	1.304	11.8	9.2		Match.Iris A	
1	9.575	4.060	2.794	3.364	0.592	0.279	1.517	11.8	9.2	5.976	Match.Cell A	
2	9.178	4.019	2.750	4.118	0.33	0.275	1.492	11.8	9.2	5.976	Cell 1	2.794
3	9.125	3.936	2.663	4.121	0.33	0.266	1.442	11.8	9.2	6.041	Cell 2	2.750
4	9.073	3.854	2.576	4.123	0.33	0.258	1.392	11.8	9.2	6.128	Cell 3	2.663
5	9.023	3.772	2.489	4.125	0.33	0.249	1.342	11.8	9.2	6.215	Cell 4	2.576
6	8.974	3.689	2.402	4.127	0.33	0.240	1.292	11.8	9.2	6.302	Cell 5	2.489
7	8.927	3.607	2.315	4.129	0.33	0.232	1.242	11.8	9.2	6.389	Cell 6	2.402
8	8.882	3.525	2.228	4.131	0.33	0.223	1.193	11.8	9.2	6.476	Cell 7	2.315
9	8.838	3.442	2.141	4.133	0.33	0.214	1.143	11.8	9.2	6.563	Cell 8	2.228
10	8.796	3.360	2.054	4.134	0.33	0.205	1.094	11.8	9.2	6.650	Cell 9	2.141
11	8.755	3.278	1.967	4.135	0.33	0.197	1.045	11.8	9.2	6.738	Cell 10	2.054
12	8.716	3.195	1.880	4.137	0.33	0.188	0.995	11.8	9.2	6.825	Cell 11	1.967
13	8.678	3.113	1.793	4.138	0.33	0.179	0.946	11.8	9.2	6.912	Cell 12	1.880
14	8.642	3.031	1.706	4.138	0.33	0.171	0.897	11.8	9.2	6.999	Cell 13	1.793
15	8.608	2.948	1.619	4.139	0.33	0.162	0.848	11.8	9.2	7.086	Cell 14	1.706
16	8.576	2.866	1.532	4.139	0.33	0.153	0.800	11.8	9.2	7.173	Cell 15	1.619
17	8.544	2.784	1.445	4.140	0.33	0.144	0.751	11.8	9.2	7.260	Cell 16	1.532
18	8.515	2.701	1.358	4.140	0.33	0.136	0.703	11.8	9.2	7.347	Cell 17	1.445
19	8.487	2.660	1.314	4.139	0.33	0.131	0.679	11.8	9.2	7.412	Cell 18	1.358
20	8.925	5.224	2.157	4.066	0.33	0.257	0.95	11.8	9.2	7.013	Match.Cell B	1.314
						t/10		adw & idw = Const values		g=P-t/2-t_pr/2		

3D Part



Generated 3D Parts



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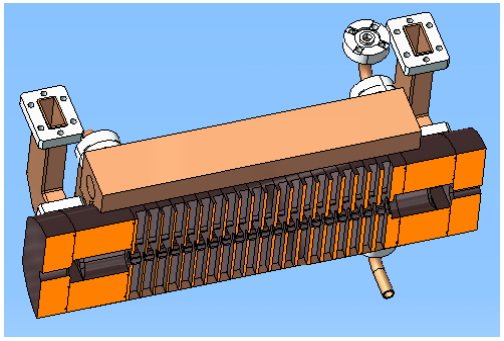
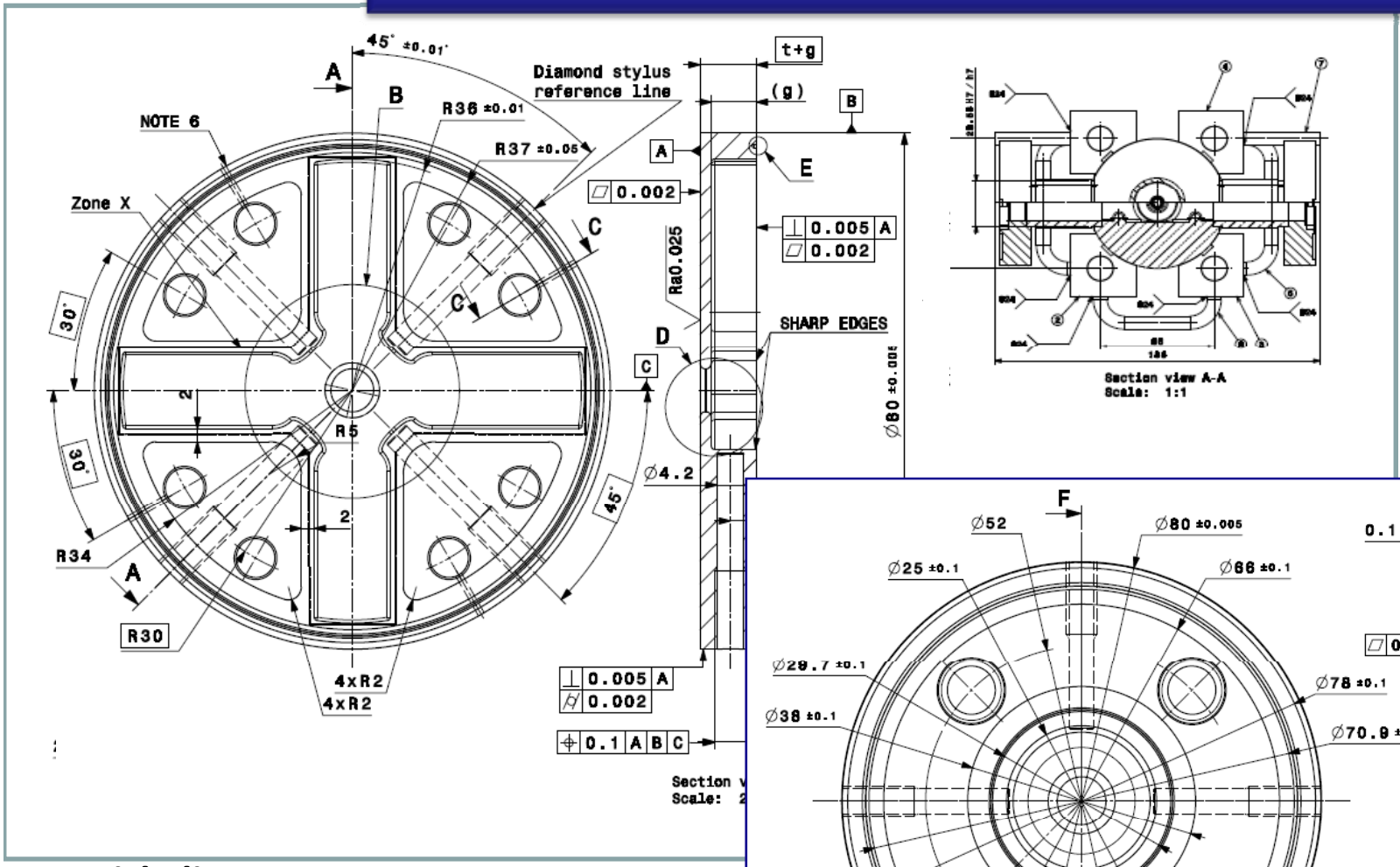
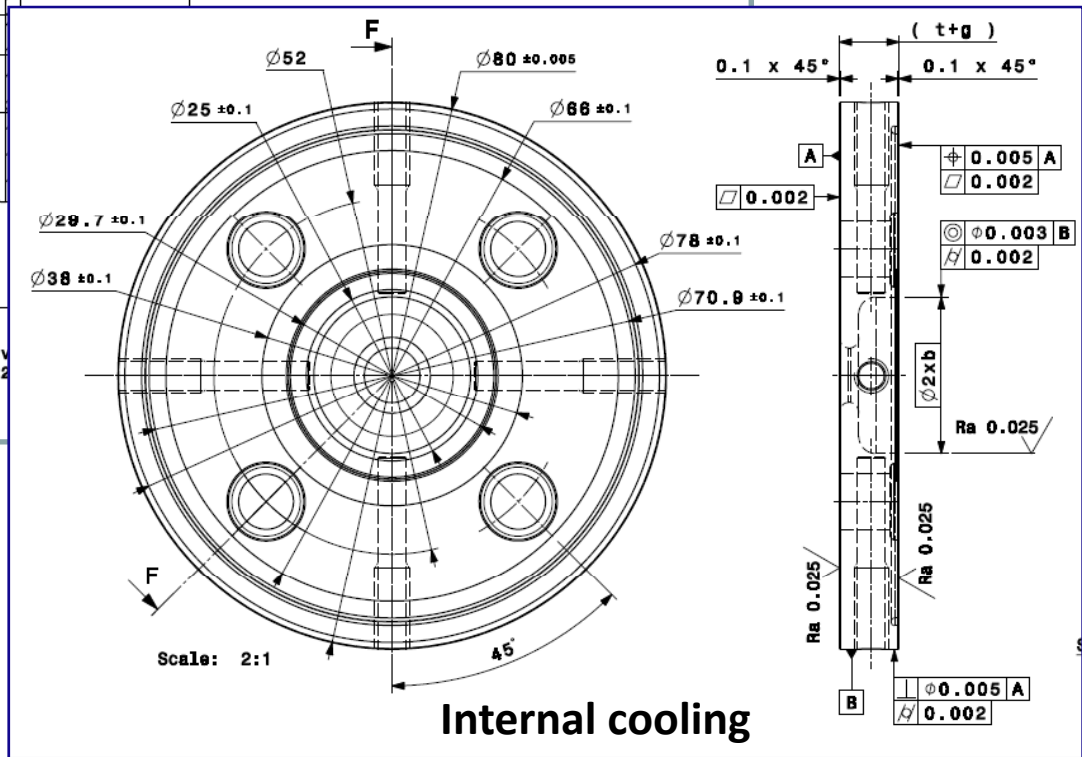


Assembly Design

Mechanical design - disks



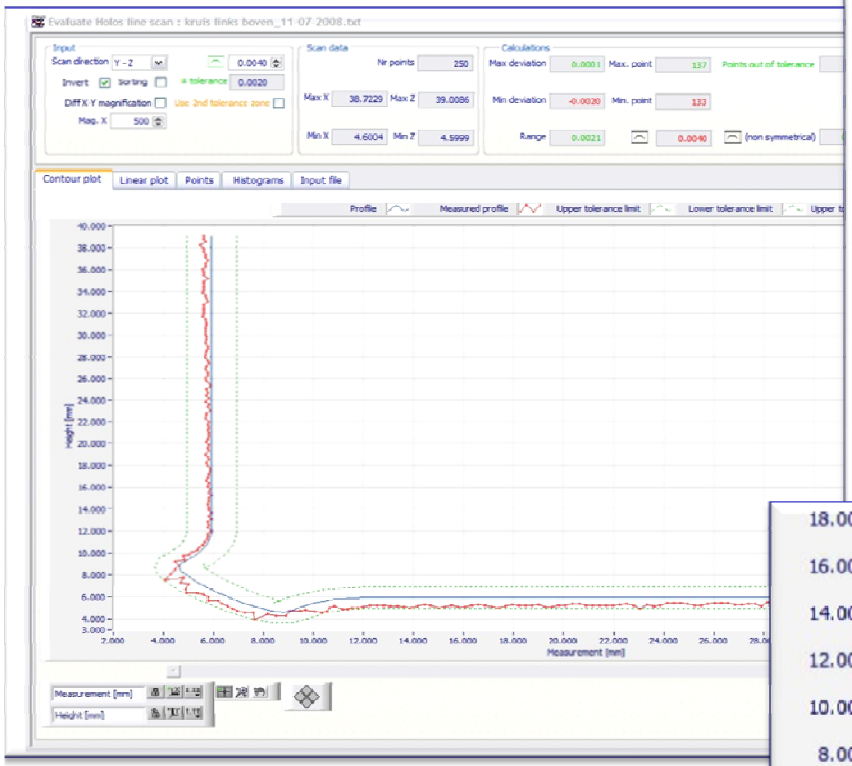


Disk diameter: 80 mm
4 tuning holes (push-pull possible)
Assembly by brazing

Internal cooling

Dimensional control

TD18 (VDL)

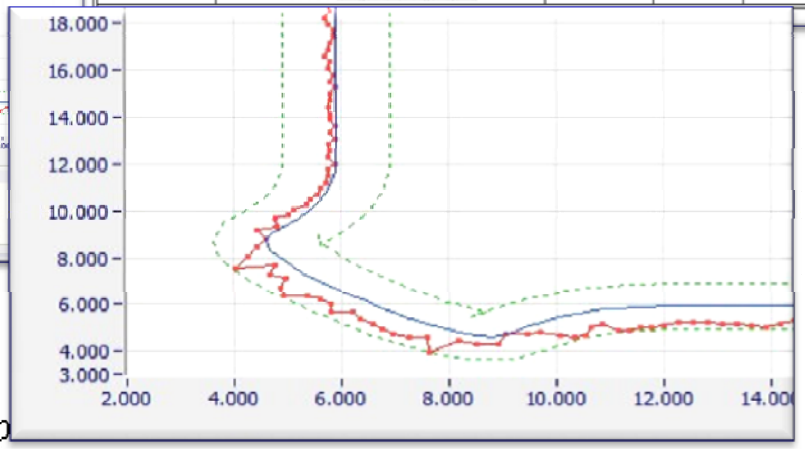


Enabling Technologies Group — **Inspection Report**

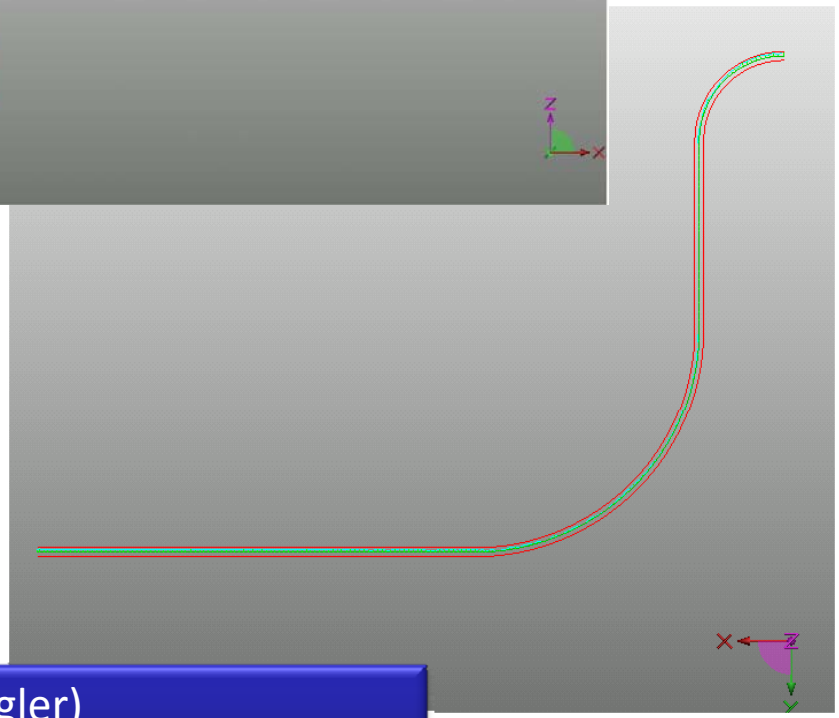
Drawing no.	CLIAAS110069					Prod. Nr.	1
Description	11 GHZ ACCELLERATING STRUCTURE CELL 07 - 11WDSDVG1CU					Meas. Date	14

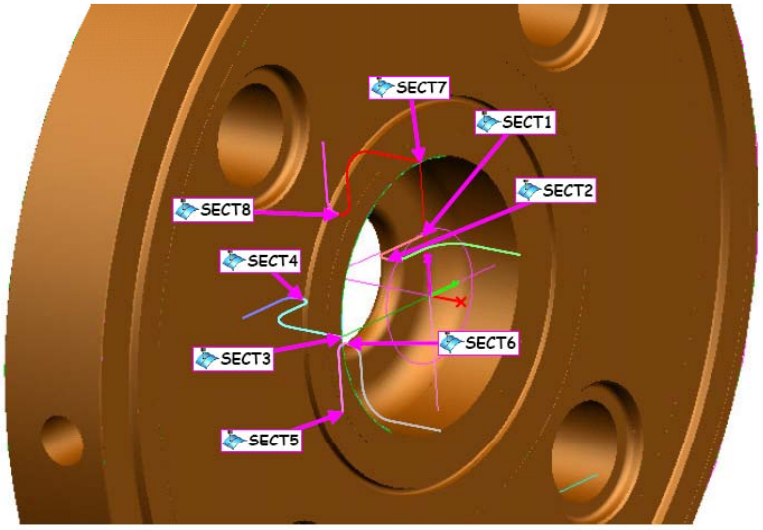
Dimensions

Measurand	Description	Nominal	Upper	Lower	Actual	Deviation	Pass	Fail
1	Ref A ⏥ 0.002	0.000	0.0020	0.0000	0.0012	0.0012	√	
2	Outer diameter Ref B	80.000	0.0050	-0.0050	79.9998	-0.0002	√	
3	⏥ 0.002	0.000	0.0020	0.0000	0.0010	0.0010	√	
4	⏥ 0.005 A	0.000	0.0050	0.0000	0.0002	0.0002	√	
5	Width of cross Z+	11.800	0.0040	-0.0040	11.7999	-0.0001	√	
6	Width of cross Z-	11.800	0.0040	-0.0040	11.7999	-0.0001	√	
7	Width of cross Y-	11.800	0.0040	-0.0040	11.7999	-0.0001	√	
8	Width of cross Y+	11.800	0.0040	-0.0040	11.8006	0.0006	√	
9	⌖ 0.005 A	8.7045	0.0025	-0.0025	8.7056	0.0011	√	
10	Plane opposite Ref A ⏥ 0.002	0.000	0.0020	0.0000	0.0012	0.0012	√	
11	⌖ 0.005 A	6.4765	0.0025	-0.0025	6.4767	0.0002	√	
12	Bottom plane cross ⏥ 0.002	0.000	0.0020	0.0000	0.0016	0.0016	√	
13	Depth of recess for solder foil	0.040	0.0100	-0.0100	0.0375	-0.0025	√	
14	Diameter undulation	7.050	0.0040	-0.0040	7.0525	0.0025	√	
15	○ 0.002	0.000	0.0020	0.0000	0.0011	0.0011	√	
18	Undulation ⌓ 0.004 A B	0.000	0.0040	0.0000	0.0040	0.0040	√	
19	Cross ⌓ 0.004 A B	0.000	0.0040	0.0000	0.0040	0.0040	√	



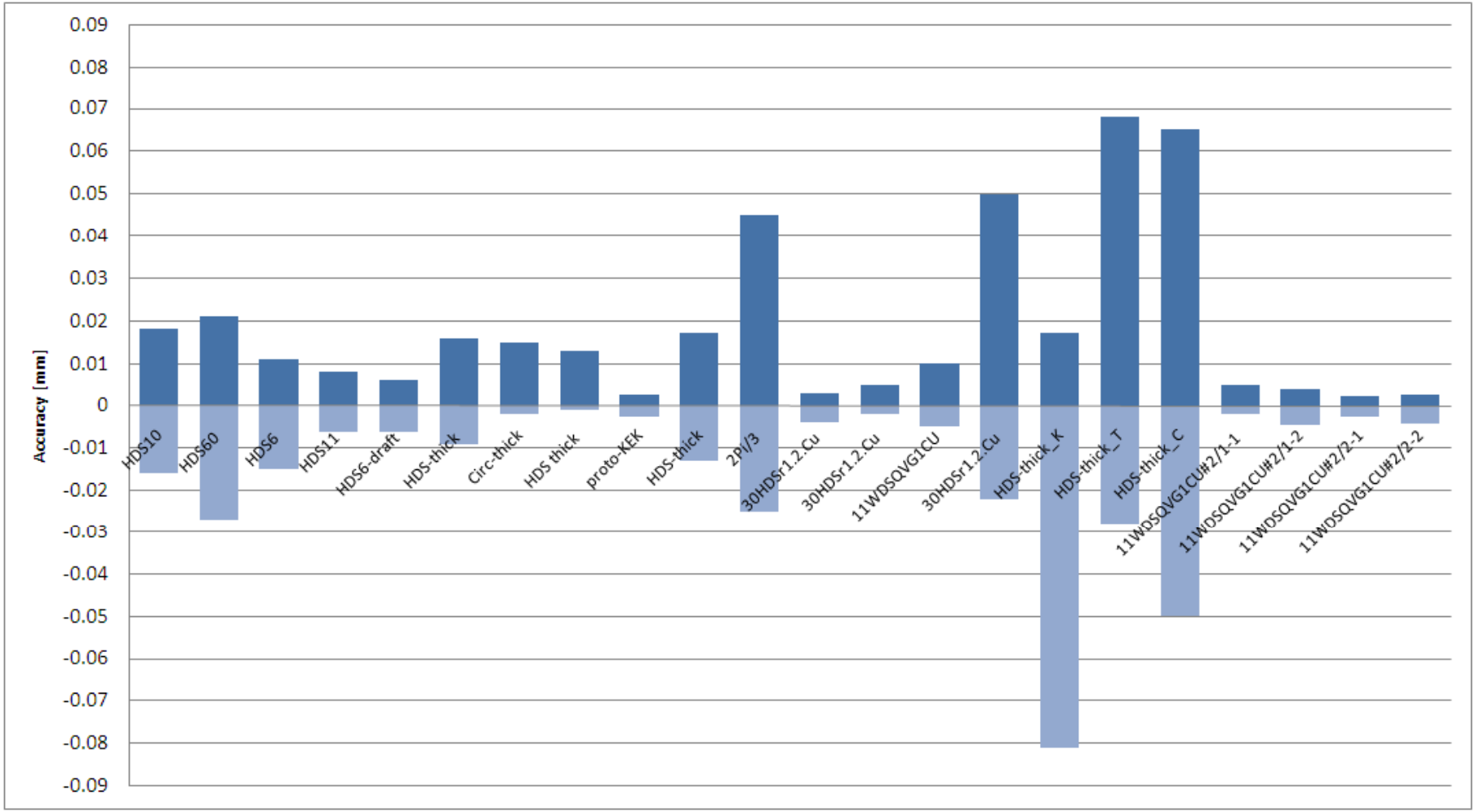
Dimensional control





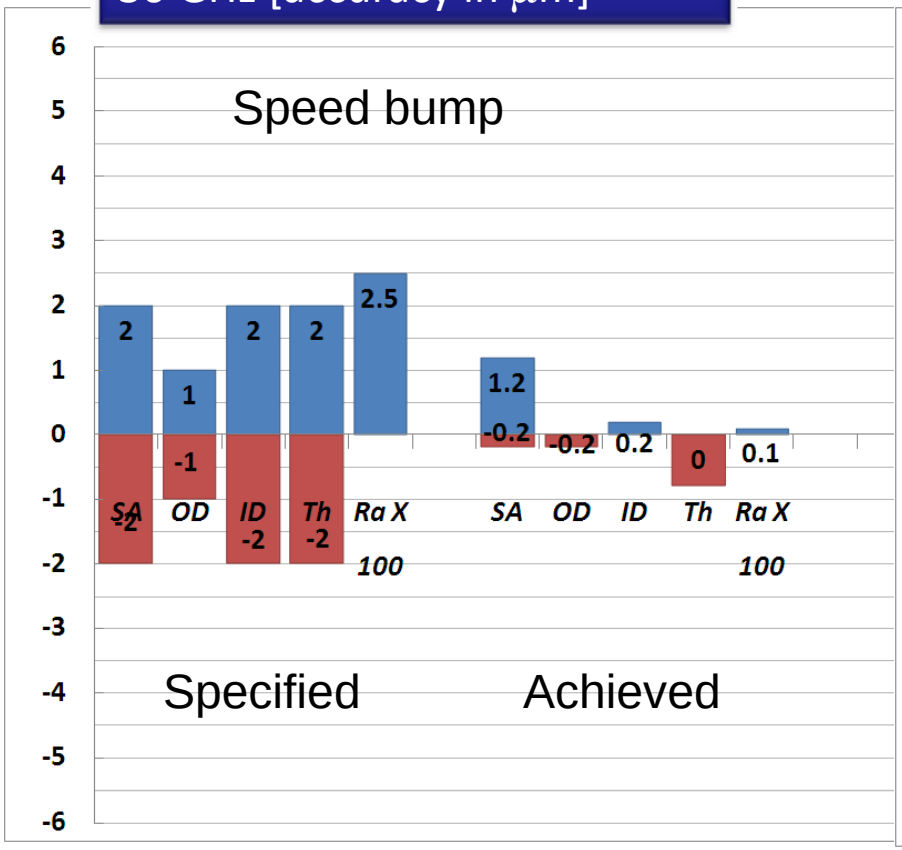
T18 (Kugler)
Requirements: +/- 5 micro

Achieved shape accuracy (quadrant)

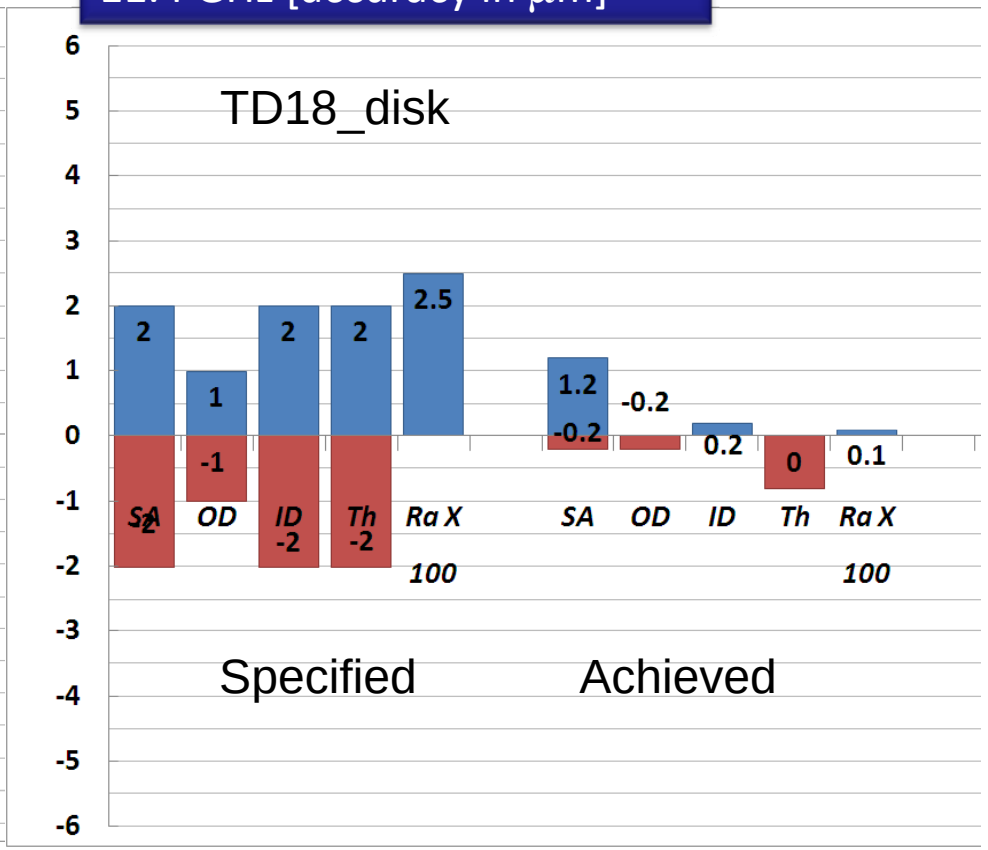


Achieved accuracy (disk)

30 GHz [accuracy in µm]

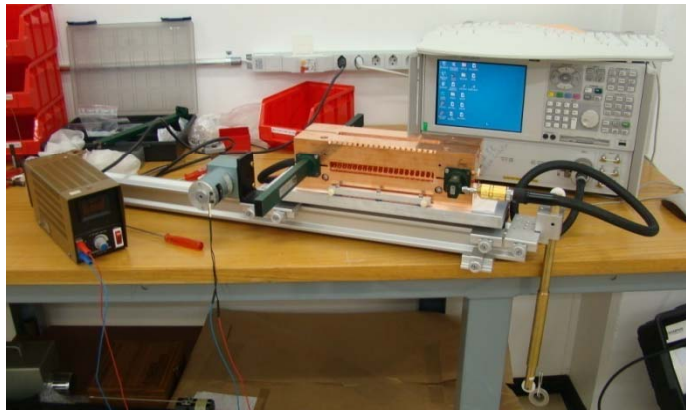


11.4 GHz [accuracy in µm]

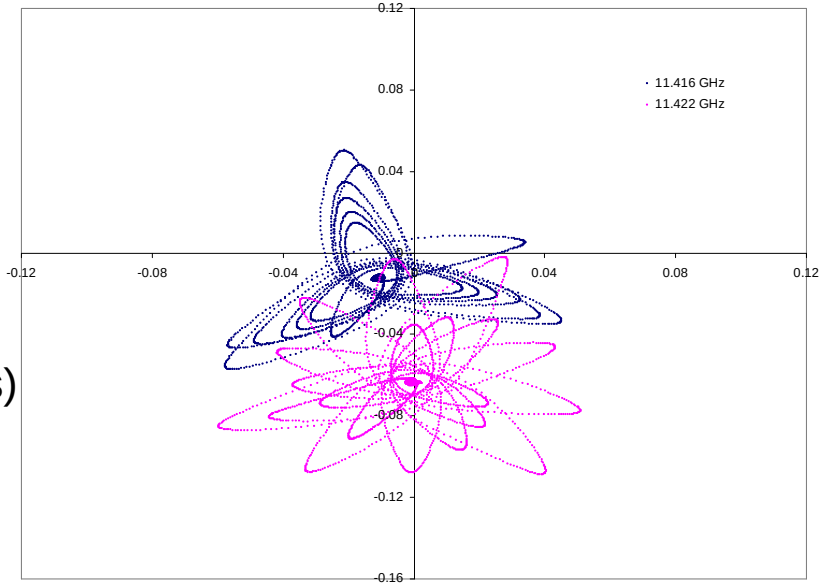


SA: iris shape accuracy
OD: outer diameter
ID: inner diameter
Th: iris thickness
Ra: roughness

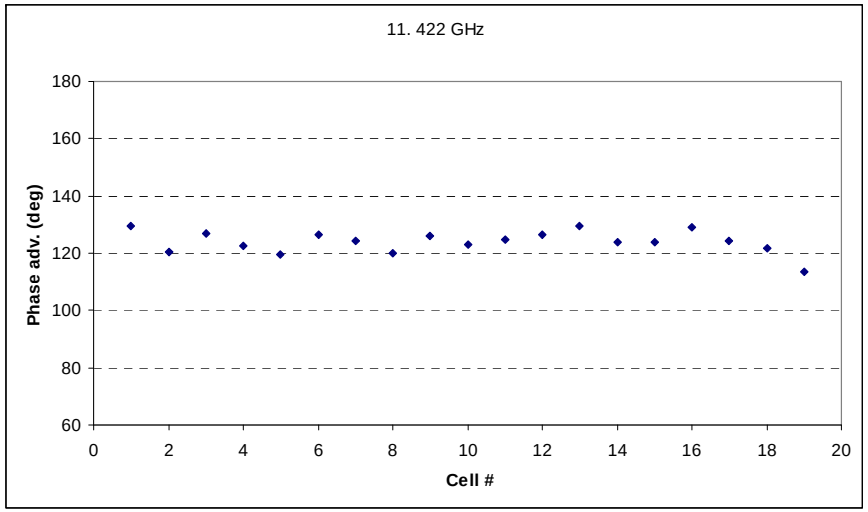
RF measurements – TD18 quadrant



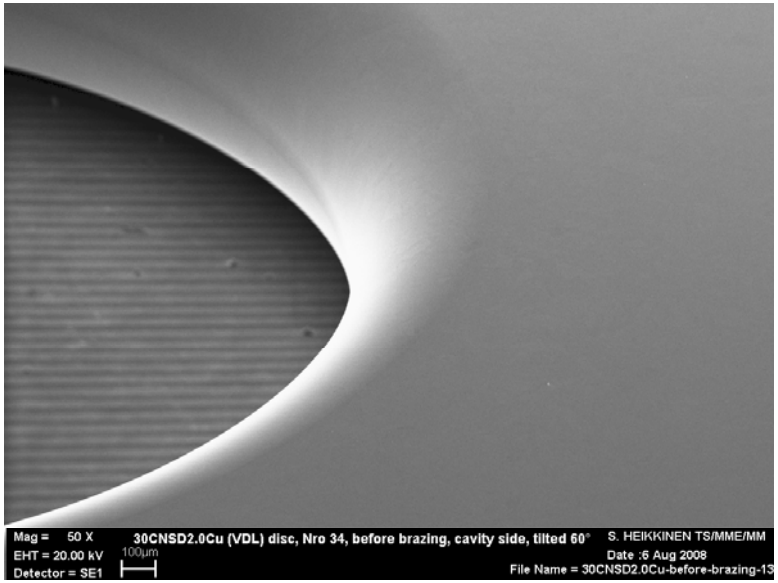
S11+S21 (240 deg phase advance)

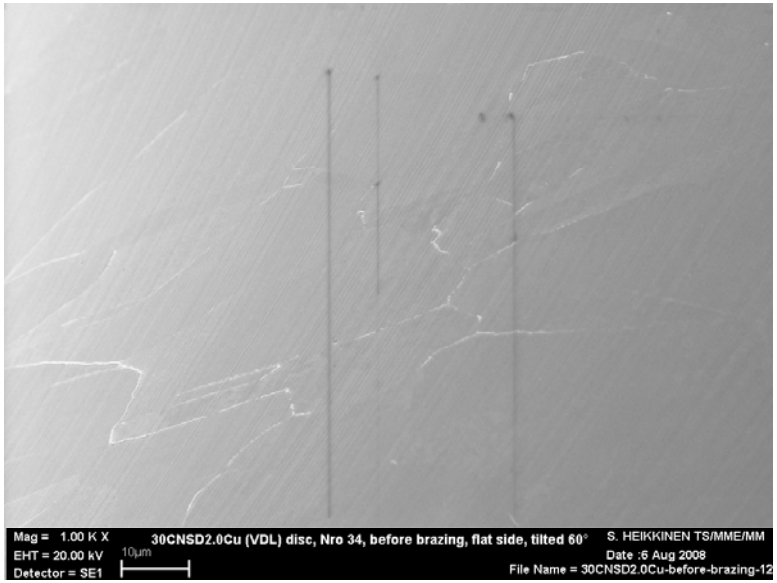


11.422 GHz: average phase advance/cell~
124.3 deg/cell (average only for the regular cells)

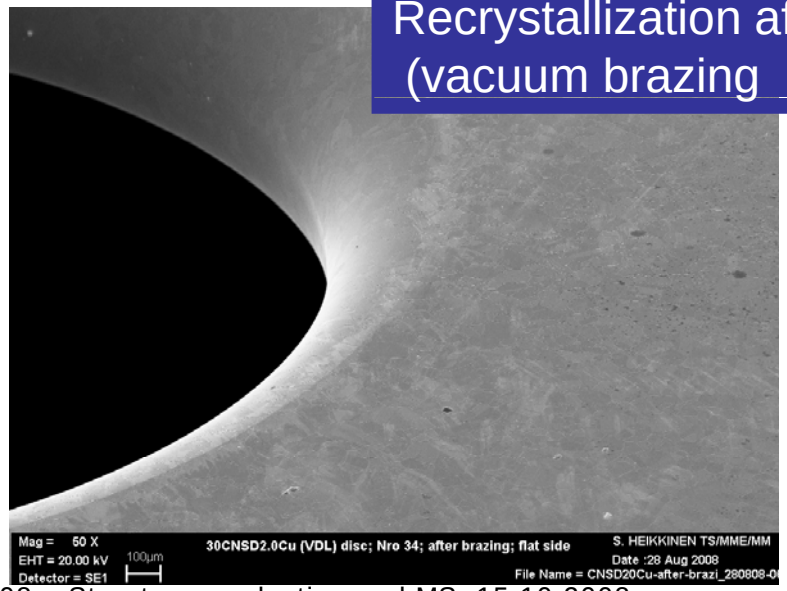


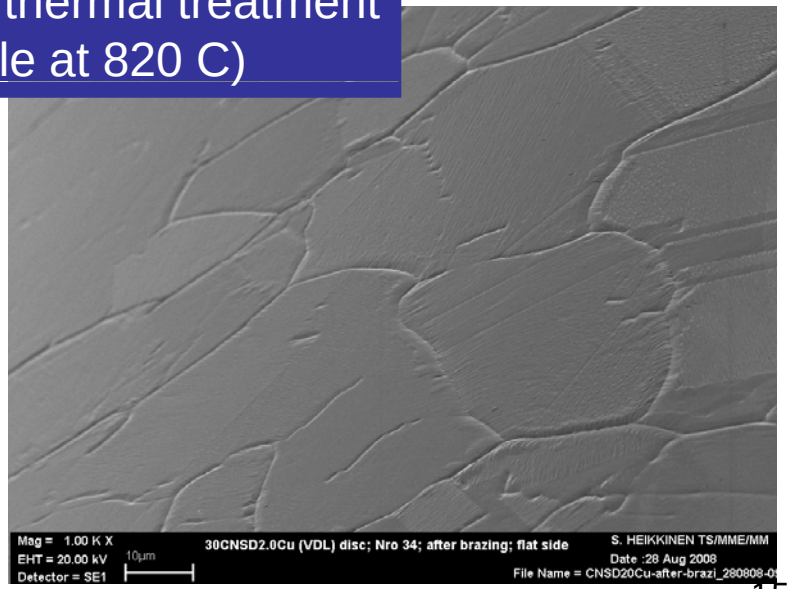
SEM – disk #34 speed bump





Recrystallization after thermal treatment (vacuum brazing cycle at 820 C)





Single Cell Accelerator Structures

Goals

- Study rf breakdown in practical accelerating structures: dependence on circuit parameters, materials, cell shapes and surface processing techniques

Difficulties

- Full scale structures are long, complex, and expensive

Solution

- *Single cell Traveling wave (TW)* and *single cell standing wave (SW)* structures with properties close to that of full scale structures
- **Reusable couplers**

We want to predict breakdown behavior for practical structures

V. Dolgashev

High Power Tests of Single Cell Standing Wave Structures

Tested

- Low shunt impedance, *a/lambda* = 0.215, *1C-SW-A5.65-T4.6-Cu*, 4 tested
- Low shunt impedance, TiN coated, *1C-SW-A5.65-T4.6-Cu-TiN*, 1 tested
- Three high gradient cells, low shunt impedance, *3C-SW-A5.65-T4.6-Cu*, 2 tested
- High shunt impedance, elliptical iris, *a/lambda* = 0.143, *1C-SW-A3.75-T2.6-Cu*, 1 tested
- High shunt impedance, round iris, *a/lambda* = 0.143, *1C-SW-A3.75-T1.66-Cu*, 1 tested
- Choke in high gradient cell, *1C-SW-A5.65-T4.6-Choke-Cu*, 2 tested
- Low shunt impedance, made of CuZr, *1C-SW-A5.65-T4.6-CuZr*, 1 tested

Now 13th test under way,
low shunt impedance cupper structure
1C-SW-A5.65-T4.6-Cu-Frascati-#2

V. Dolgashev

Next experiments, as for 13 October 2008

Reproducibility tests:

High shunt impedance, elliptical iris, *1C-SW-A3.75-T2.6-Cu*
High shunt impedance, round iris, *1C-SW-A3.75-T1.66-Cu*
Low shunt impedance, made of CuZr, *1C-SW-A5.65-T4.6-CuZr*
Three high gradient cells, low shunt impedance, *3C-SW-A5.65-T4.6-Cu*

Geometry tests:

Photonic-Band-Gap in high gradient cell, *1C-SW-A5.65-T4.6-Cu-PBG*
Highest shunt impedance, *a/lambda = 0.105*, *1C-SW-A2.75-T2.0-Cu*
Three cells, WR90 coupling to power source, *3C-SW-A5.65-T4.6-Cu-WR90*
High shunt impedance, choke with 4mm gap, *1C-SW-A3.75-T2.6-Choke-Cu*

Materials:

High shunt impedance, elliptical iris, 6N copper, *1C-SW-A3.75-T2.6-6N-Cu*
High shunt impedance, made of CuZr, *1C-SW-A3.75-T2.6-CuZr*
Low shunt impedance, made of CuCr, *1C-SW-A5.65-T4.6-CuCr*
High shunt impedance, made of CuAg, *1C-SW-A3.75-T2.6-CuAg*
Low shunt impedance, made of CuAg, *1C-SW-A5.65-T4.6-CuAg*

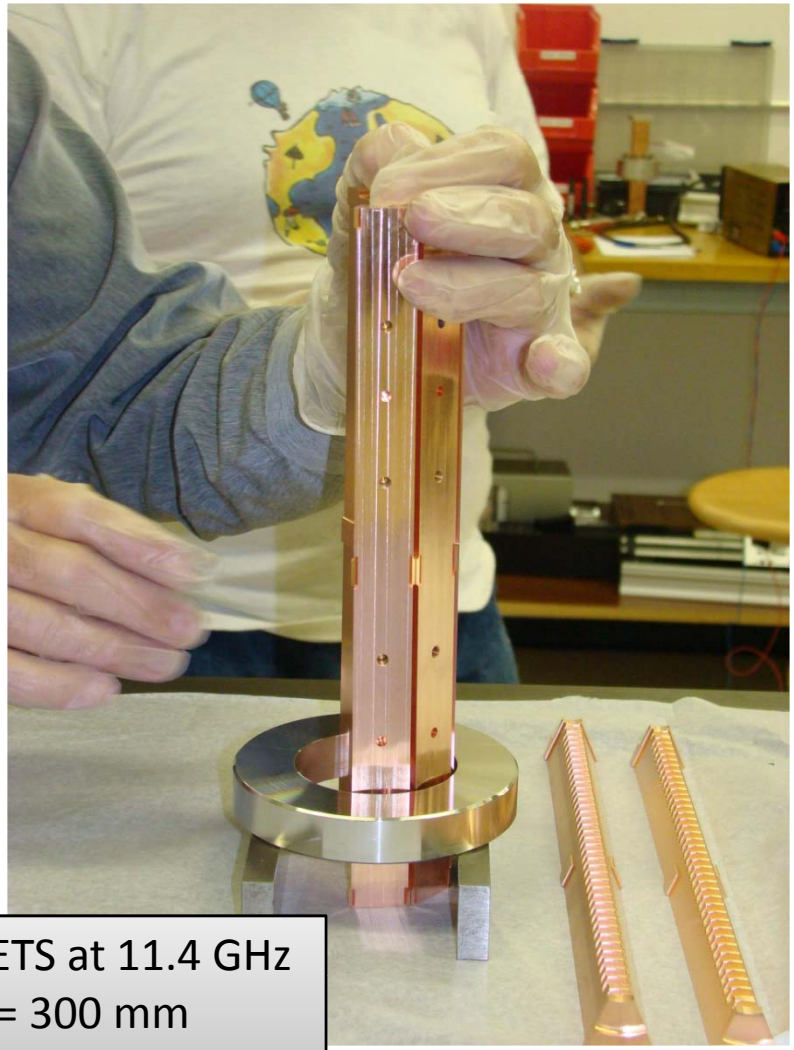
Traveling Wave structures, different materials

T53MC first cell:
Copper, 1C-TW-A3.88-T1.66-Cu
Stainless steel, 1C-TW-A3.88-T1.66-SS
Copper-Molybdenum, 1C-TW-A3.88-T1.66-CuMo

V. Dolgashev

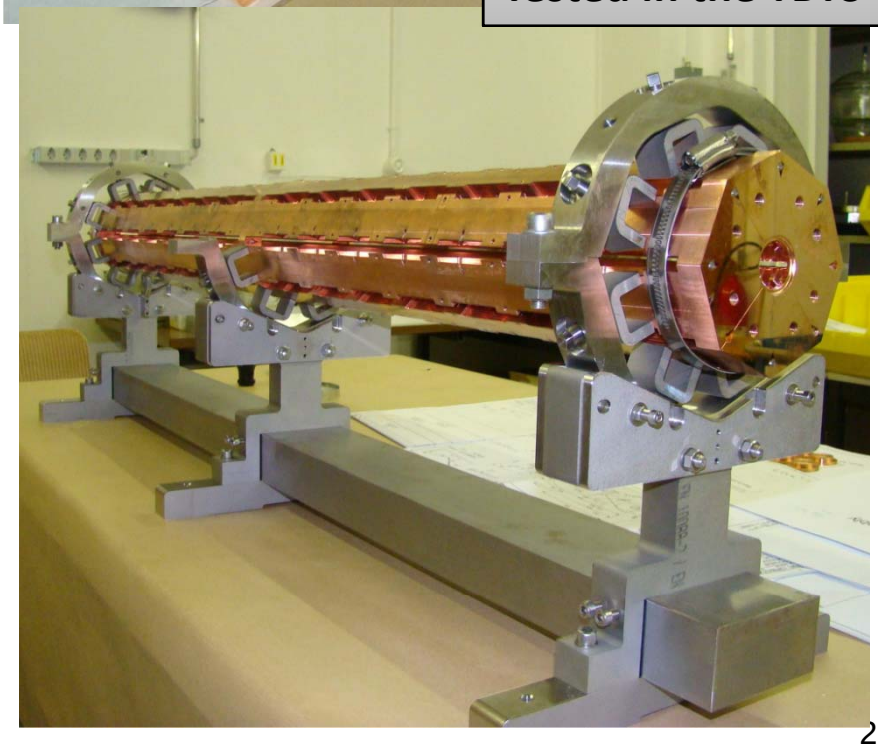
PETS

PETS

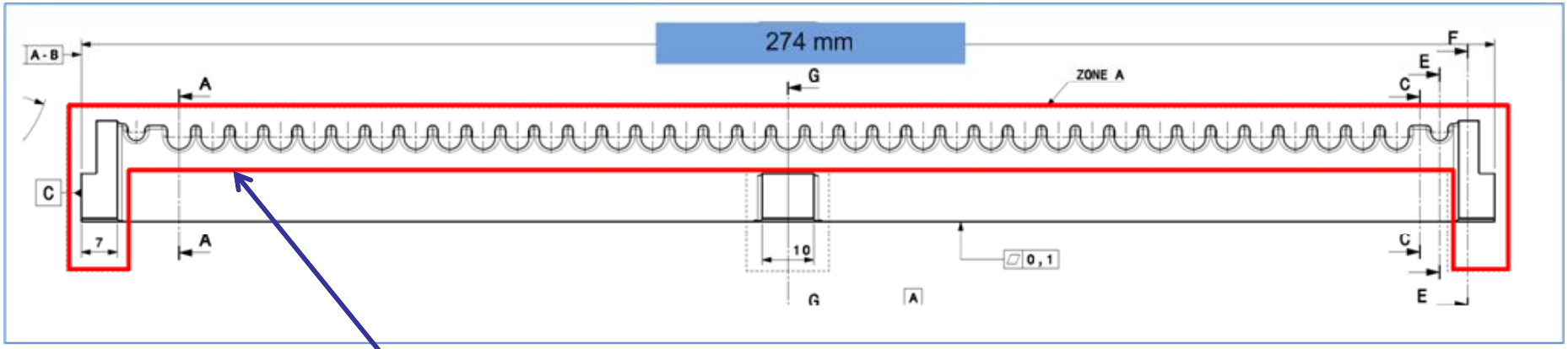


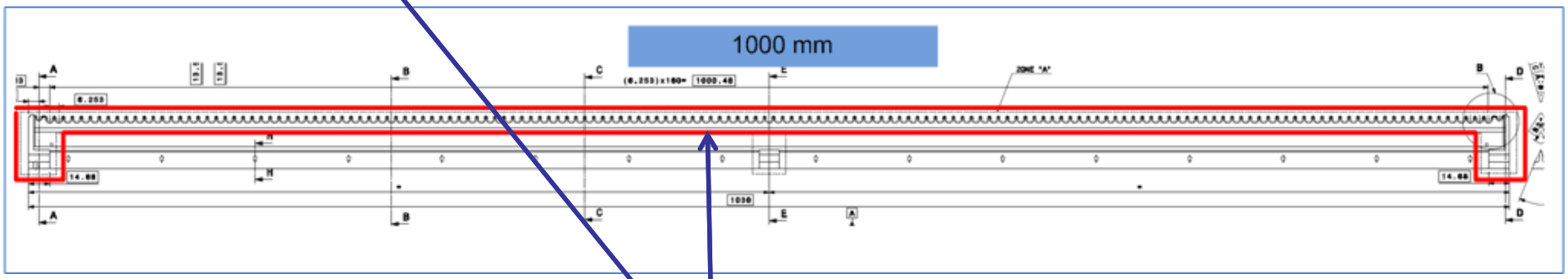
PETS at 11.4 GHz
L = 300 mm
Tested at SLAC

PETS at 12 GHz
L = 1000 mm
Tested in the TBTS



Mechanical design

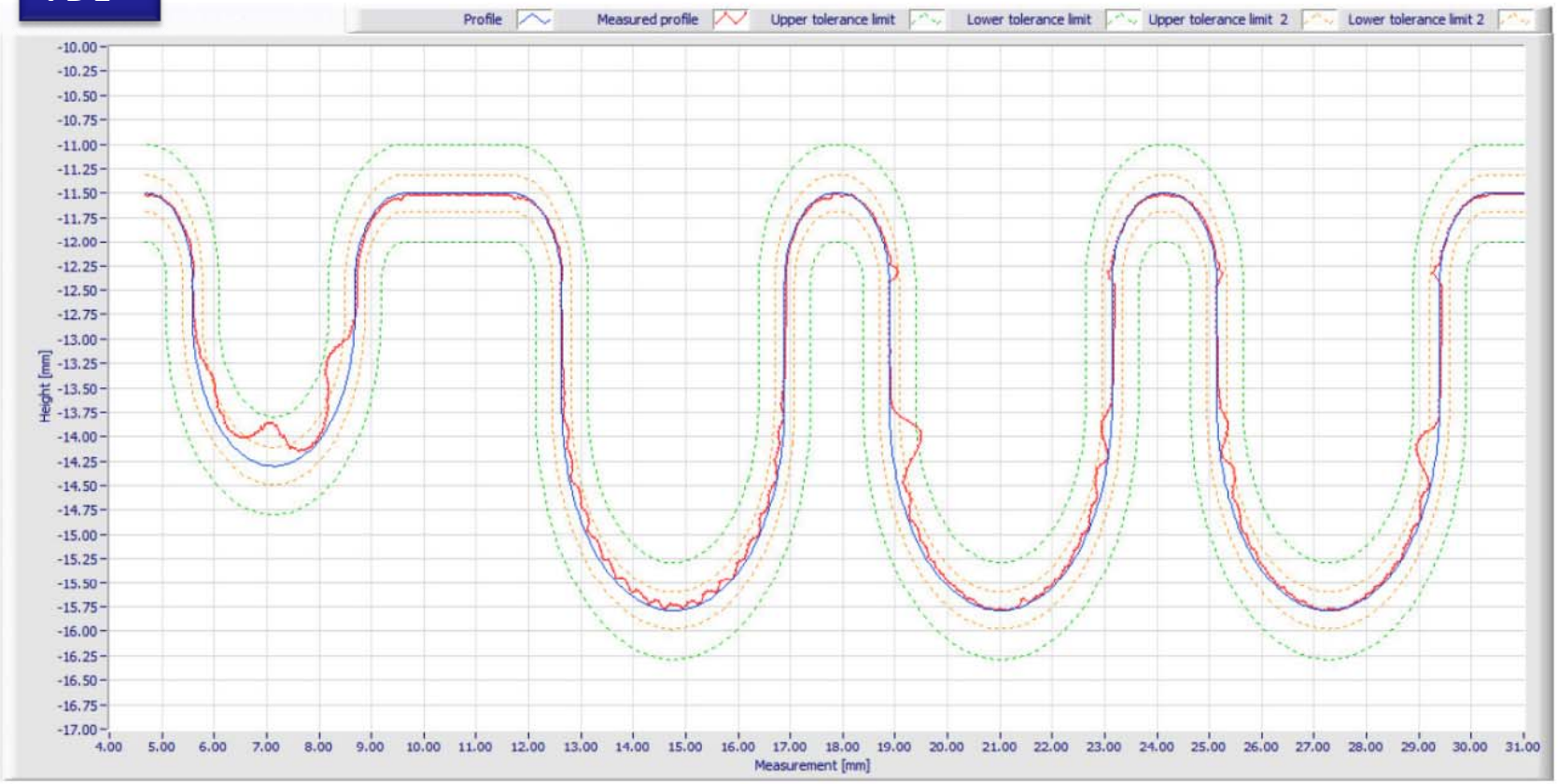




INSIDE ZONE A: ⌓ 0.015 A B C OUTSIDE ZONE A: ⌓ 0.05

Dimensional control – 1-m long PETS

VDL



During fabrication decision to enlarge the shape tolerance to +/- 25 µm

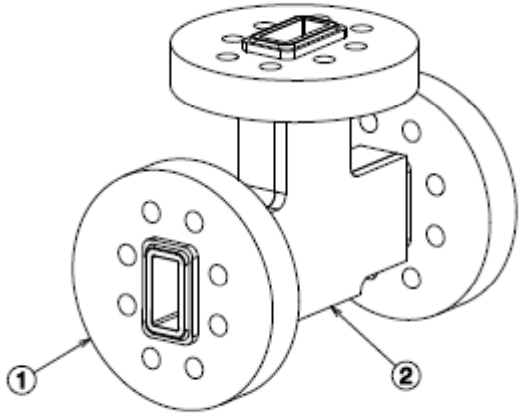
RF Components

RF components

Directional couplers

GYCOM, Russia
10 units, all available at CERN

Splitters



RF and mechanical design, CERN
Under fabrication VDL, Holland
10 units

Hybrids

RF and mechanical design, CERN
Fabrication CINEL, Italy
5 units , 2 available at CERN

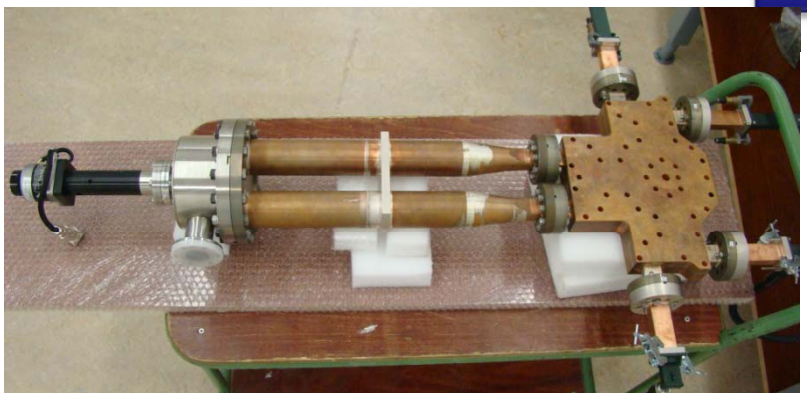
Choke mode flanges

RF and mechanical design, CERN
Fabrication Fluckiger, CH
2 units shipped to SLAC

RF components

Attenuator/phase shifter

Scaled from 30 GHz CERN version. GYCOM Russia.
5 units: 2 available at CERN



(stainless steel) RF load

12 GHz
RF and mechanical design, CERN
Fabrication CINEL, Italy and VDL, Holland
10 units: 6 available at CERN (AISI316LN)

11.4 GHz
RF and mechanical design, CERN
Under fabrication CINEL
4 units (SS430)

STRUCTURE MASTER SCHEDULE

Structure status

CLIC accelerating structures (from 2007) — EDMS# 844300, Last update: 30.09.08

Freq.		Structure		Cat.	Status	Supplier
11.424 GHz		C30_vg1.1	old vg1.1	ES	available at KEK	
	VG1	TD18_vg2.4_quad#1	11WDSQvg1Cu.1	FS	available at CERN, not conform (damage on last iris)	CERN (VDL)
		TD18_vg2.4_quad#3	11WDSQvg1Cu.3	FS	shipped to SLAC in CW26/08	CERN (VDL)
		TD18_vg2.4_quad#4	11WDSQvg1Cu.4	PS	quadrant delivered at KEK in CW18/08	KEK (U-Coorporation)
		TD18_vg2.4_quad#2	11WDSQvg1Cu.2	PS	quadrant delivered at KEK in CW18/08	KEK (Hitachi)
		TD18_vg2.4_quad#5	11WDSQvg1Cu.5	FS	mechanical design finished	KEK
		T18_vg2.4_disk#2	11WNSDvg1Cu.2	TU	under testing at KEK	KEK, tested at KEK
		T18_vg2.4_disk#1	11WNSDvg1Cu.1	TU	tested at SLAC	KEK, tested at SLAC
		T18_vg2.4_disk#3	11WNSDvg1Cu.3	TU	available at SLAC, bonded	KEK
		T18_vg2.4_disk#4	11WNSDvg1Cu.4	TU	available at SLAC, under bonding	KEK
		T18_vg2.4_disk#5	11WNSDvg1Cu.5	TU	cells available at CERN, brazed finished, tuning?	CERN (Kugler)
		TD18_vg2.4_disk#1	11WDSDvg1Cu.1	FS	cells available at CERN, under brazing	CERN (VDL)
		TD18_vg2.4_disk#2	11WDSDvg1Cu.2	FS	being machined	KEK
		TD18_vg2.4_disk#3	11WDSDvg1Cu.3	FS	being machined	KEK
		T28_vg2.9	11T26vg3DCu	TU	under testing at SLAC	SLAC
		T18_vg2.4_quad	11WNSQvg1Cu	TU	on hold	
	C10	C10_vg2.25_thick#1	11CNSD2.3Cu.1	ES	postponed by CERN to 2009	SLAC
		C10_vg2.25_thick#2	11CNSD2.3Cu.2	ES	postponed by CERN to 2009	SLAC
		C10_vg0.7#1	11CNSD0.7Cu.1	ES	being machined pieces ready CW43	SLAC
		C10_vg0.7#2	11CNSD0.7Cu.2	ES	being machined pieces ready CW43	SLAC
		C10_vg3.3#1	11CNSD3.3Cu.1	ES	postponed by CERN to 2009	SLAC
		C10_vg3.3#2	11CNSD3.3Cu.2	ES	postponed by CERN to 2009	SLAC
		C10_vg1.35#1	11CNSD1.4Cu.1	ES	being machined pieces ready CW43	SLAC
		C10_vg1.35#2	11CNSD1.4Cu.2	ES	being machined pieces ready CW43	SLAC
		C10_vg1.35#3	11CNSD1.4Cu.3	ES	being machined	KEK
		C10_vg1.35#4	11CNSD1.4Cu.4	ES	being machined	KEK
		CD10_vg1.35#1	11CDSD1.4Cu.1	FS	being machined	KEK
		CD10_vg1.35#2	11CDSD1.4Cu.2	FS	being machined	KEK
		CD10_vg1.35#3	11CDSD1.4Cu.3	FS	under mechanical design	CERN
		CD10_vg1.35#4	11CDSD1.4Cu.4	FS	under mechanical design	CERN
		CD10_choke damped			under conceptual design	
	G	T24_vg1.8_disk	11WNSDCGCu	TU	being machined	CERN
		TD24_vg1.8_disk	11WDSDCGCu	FS	mechanical design finished	CERN
		TD24_vg1.8_disk_CuZr				
	500	T 500 GeV				
	Coupler	New coupler design				
12 GHz	G	T24_vg1.8_disk	12WNSDCGCu	TU	being machined	CERN
		TD24_vg1.8_disk	12WDSDCGCu	FS	mechanical design finished	CERN

30 GHz in the pipeline
- Speed bump
- TM02
- Vg2.6

30 GHz		C40_vg4.x_π/2	30CNSD1p2Cu	FS	tested in 2007	
		C30_vg4.7_W	W 2π/3 clamped	FS	available at CERN	
		Pulse heating cavity		ES	available at CERN	
		HDS11_vgx_Cu	30HDS11S_Cu	FS	available at CERN	CERN (IMTEC)
		HDS11_vgx_Mo	30HDS11S_Mo	FS	available at CERN	CERN (IMTEC)
		HDS11_vgx_Ti	30HDS11S_Ti	FS	available at CERN	CERN (IMTEC)
		HDS4_vg2.6_thick#2	30HDS__TkCu.2	FS	Tested in 2007 ==> 2008	CERN (GREENFOX)
		HDS4_vg2.6_thick#1	30HDS__TkCu.1	FS	available at CERN (Saclay)	CERN (GREENFOX)
		NDS4_vg2.5_thick#1	30CNSQ_TkCu.1	TU	available at CERN (damage on mid cell iris)	CERN (VDL)
		NDS4_vg2.5_thick#2	30CNSQ_TkCu.2	TU	tested in 2007	CERN (VDL)
		NDS4_vg3.6_thin	30CNSQ_ThCu	TU	available at CERN (damage on a cell iris)	CERN (Megic)
		HDS11_vg2#1	30HDSR12_Cu.1	FS	available at CERN	CERN (VDL)
		HDS11_vg2#2	30HDSR12_Cu.2	FS	available at CERN	CERN (Unitek)
		C30_vg4.7_quad	30CNSQ2p3Cu	TU	available at CERN (shape error)	CERN (Micron-Cluny)
		C30_vg4.7_sb	30CNSDsbCu	ES	under testing [SB reverse]	CERN (VDL)
		C30_vg4.7_Cu iris				CERN
		C30_vg2.6	30CNSD2.6Cu	ES	being machined, cells ready CW42	CERN (Kugler)
		C30_vg8.2	30CNSD8.2Cu	ES	RF design finished	CERN
		C30_vg2_TM02	30CNSD2.0Cu	ES	available at CERN	CERN (VDL)
		HDS11_vgx_CuSS	30HDS11SCu.SS	ES	available at CERN	CERN
		T28_vg2.9				CERN
		HDS4_vg2.6_thick_Mo	30HDS__TkMo	FS	on hold	CERN (GREENFOX)
		NDS4_vg2.5_thick	30CNSQ_TkMo	TU	on hold	
		Bi-metal structure		FS	on hold	

CLIC PETS

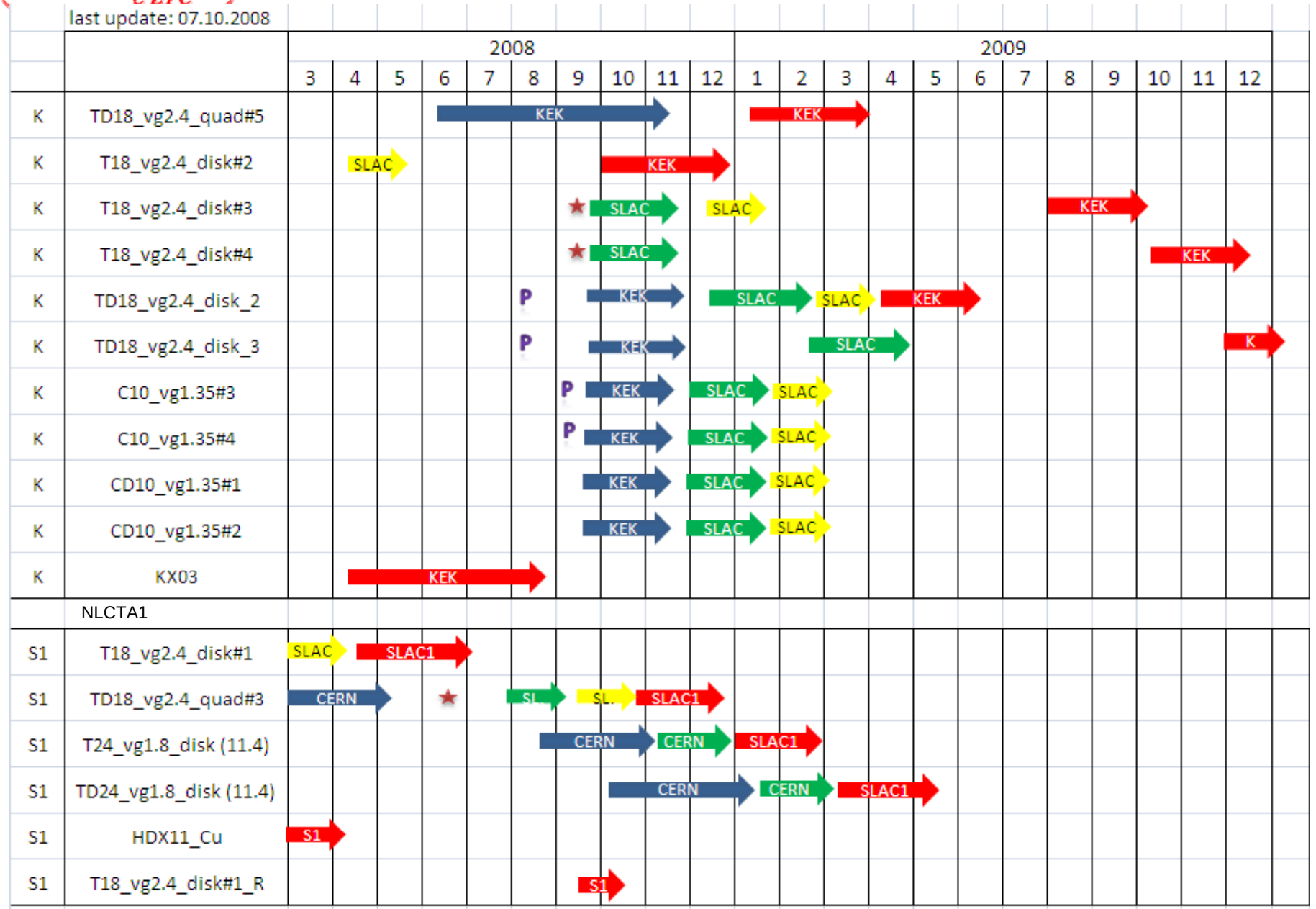
Frequency	Type	Name	Cat.	Status	Supplier
11.4 GHz	Couplers	11PETSC.1 -2	FS	available at CERN	CERN (G&P vacuum; Unitek)
	PETS (no damp. mat.)	11PETS.1	FS	available at CERN	CERN (Unitek)
	PETS (with damp.mat.)	11PETS.2	FS	mechanical design finished, fabrication on hold	CERN
12 GHz	Prototype bar	12PETS122.P1	PS	available at CERN	CERN (IMP)
	Couplers	12PETS122C.1-2	FS	available at CERN	CERN (G&P vacuum)
	PETS (no damp. mat.)	12PETS122.1	FS	mechanical design finished, fabrication on hold	CERN (CINEL)
	PETS (with damp.mat.)	12PETS122.2	FS	available at CERN	CERN (VDL)
	PETS (on/off mech.)	12PETS122.3	FS	on hold	
30 GHz	replacement PETS	30PETS	FS	available at CERN	CERN (IMTEC)

LEGEND
FS: Full structure, including HDS — ES: Experimental structure
TU: Tapered undamped structure — PS: Prototype structure

X-band structures in the pipeline
- CLIC vg1
- CLIC G (11.4 and 12 GHz)
- C10
- CLIC 500 GeV structure
- C10 choke mode
- CLIC structures with compact coupler
- PETS

X-band Structure Master Schedule 1/2

last update: 07.10.2008



X-band Structure Master Schedule 2/2