Fabrication of accelerator structures for CLIC study

CLIC Workshop
Oct. 16-18, CERN

T. Higo, KEK

Accelerator structures being made

- T18_VG2.4_disk
  - Start with the same quality as GLC
    - #1, #2: Fab. disks by KEK and bonding by SLAC, then test at SLAC and KEK
    - #3: All made and test by KEK
- TD18_VG2.4_quad
  - Learn about quadrant
    - Test cutting by 5 companies
    - Select one to make a quadrant
    - Make one full structure next JFY

T18_VG2.4_disk fabrication flow

We make three. C=CERN, S=SLAC, K=KEK

- Electrical design (C,C,C)
- Mechanical design (K,K,K)
- Fabrication of copper parts by a vendor (K,K,K)
  - Disks with diamond turning by the vendor (for the first time)
  - Couplers with end mill by the vendor (as GLC era)
- Chemical etching 2~3 microns(?) (S,S,K)
- Diffusion bonding of disks >1000C for 1hr (S,S,K)
- Brazing couplers and whole assembly CuAu (S,S,K)
- Tuning push/pull (S,S/K,K)
- Wet and dry hydrogen furnace treatment (S) this time skip?
- Vacuum baking ~650C (S) this time skip?
- In-situ bake (S/K?)
- High field test (S,K,K)

Let us confirm whether this flow is reasonable?

Work partition and schedule

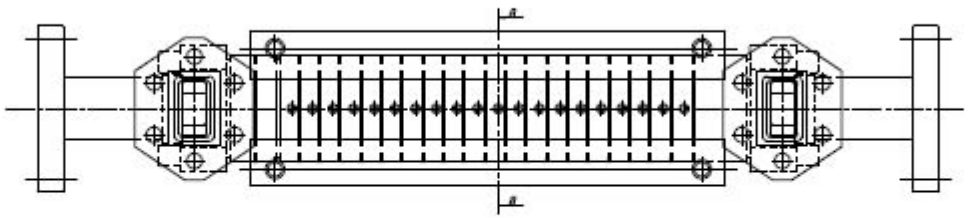
T18_VG2.4_disk (CLIC-VG1) Program Work partition and schedule v1

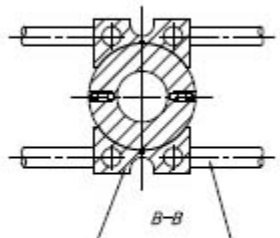
Aim: Make disk-based CLIC-parameter structures
to be tested to get the reference in a series of high-power tests for CLIC

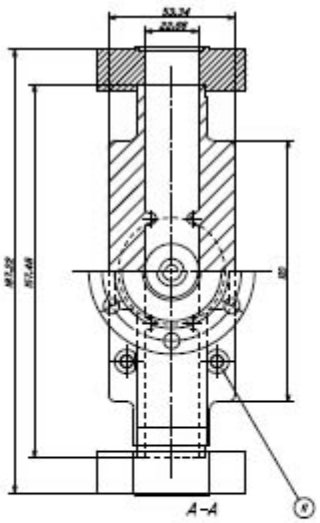
		#1		#2		#3		#4	
Purpose									
	High power test by	S		K		K		Spare **	
		Who	By when	Who	By when	Who	By when	Who	By when
Parts fabrication			11/2		11/2		12/M		12/M
	Disk	K		K		K		K	
	Coupler	K		K		K		K	
	Waveguide frange	S		K		K		K	
	Beam pipe & flange	K		K		K		K	
	Tuning pins	K		K		K		K	
	Cooling body etc.	K		K		K		K	
Parts evaluation									
	Mechanical	V	11/2	V	11/2	V	12/M	V	12/M
	Electrical (*)	K	11/9	K	11/9	K	1/11	K	1/11
Shipping									
	from KEK	K	11/16	K	11/16				
	to SLAC	S	11/23	S	11/23				
Cleaning									
	Chemical etching	S		S		K	2/B	K	
Bonding									
	Braze shim	K ?		K ?		K	2/E	K	
	Braze wire	S		S		K		K	
	Disk DB	S		S		K		K	
	Coupler assembly	S		S		K		K	
	Coupler add. Cut	S		S		K		K	
	Whole assembly	S	12/E	S	12/M	K		K	
Tuning									
		S ?		S ?		Non	3/B		
After-assembly treatment									
	Wet hydrogen ?	S ?		S ?		Non			
	Dry hydrogen ?	S ?		S ?		Non			
	Vacuum bake ?	S ?		S ?		Non			
Shipping									
	from SLAC			S	12/M				
	to KEK			K	12/E				
Tuning									
		S		K	1/B	K	3/M		
High power test									
	by, from	S		K	1/M	K	4/B		

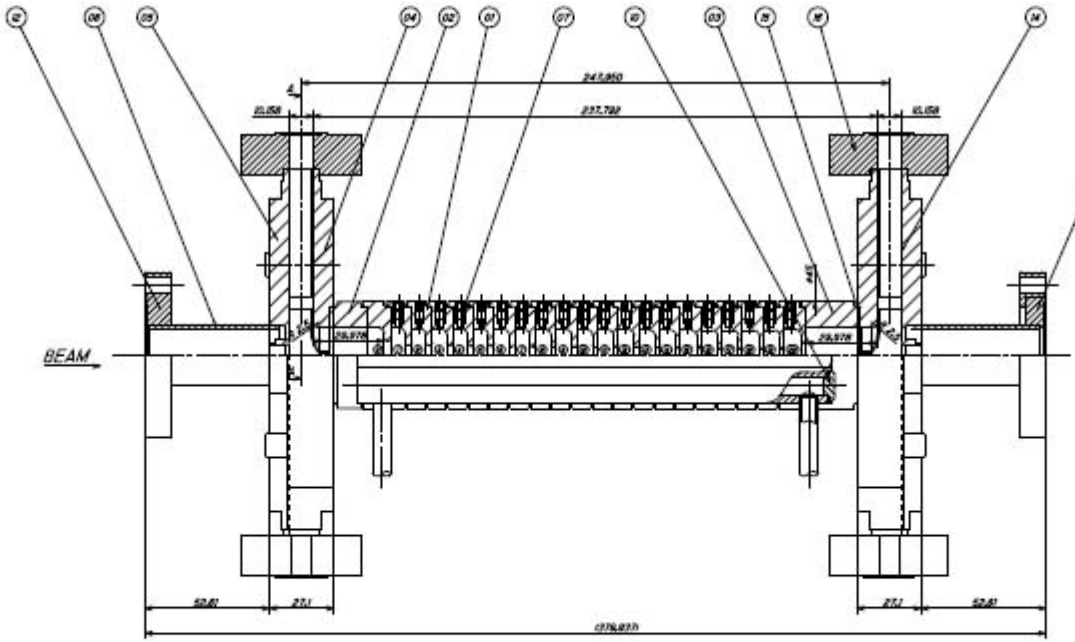
(*) S-para check with cramped assembly
V to be performed by vendor
** Spare but if possible, it can be used for any trial

No	Part Name	Material	Quantity	Remarks
01	STD CELL	CX011	21	
02	INPUT RING CELL	CX011	1	
03	OUTPUT RING CELL	CX011	1	
04	COUPLER BODY	CX011	2	
05	COUPLER COVER	CX011	2	
06	BEAM PIPE	SUS316L	2	
07	TUNING PIN	SUS316L	40	
08	COOLING BLOCK	CX011	2	
09	COOLING PIPE	CX011	8	
10	COOLING CAP	CX011	8	
11	BUSHING	SUS304	8	
12	ICF70FIXED FLANGE	SUS316L	1	
13	ICF70ROTATION FLANGE	SUS316L	1	
14	BRAZE SHIM-A	BAu	4	25mm×75mm×t=0.025mm
15	BRAZE SHIM-B	BAu	2	35mm×65mm×t=0.025mm
16	WG FLANG(FORMALE)	SUS316L	4	NOTE-1





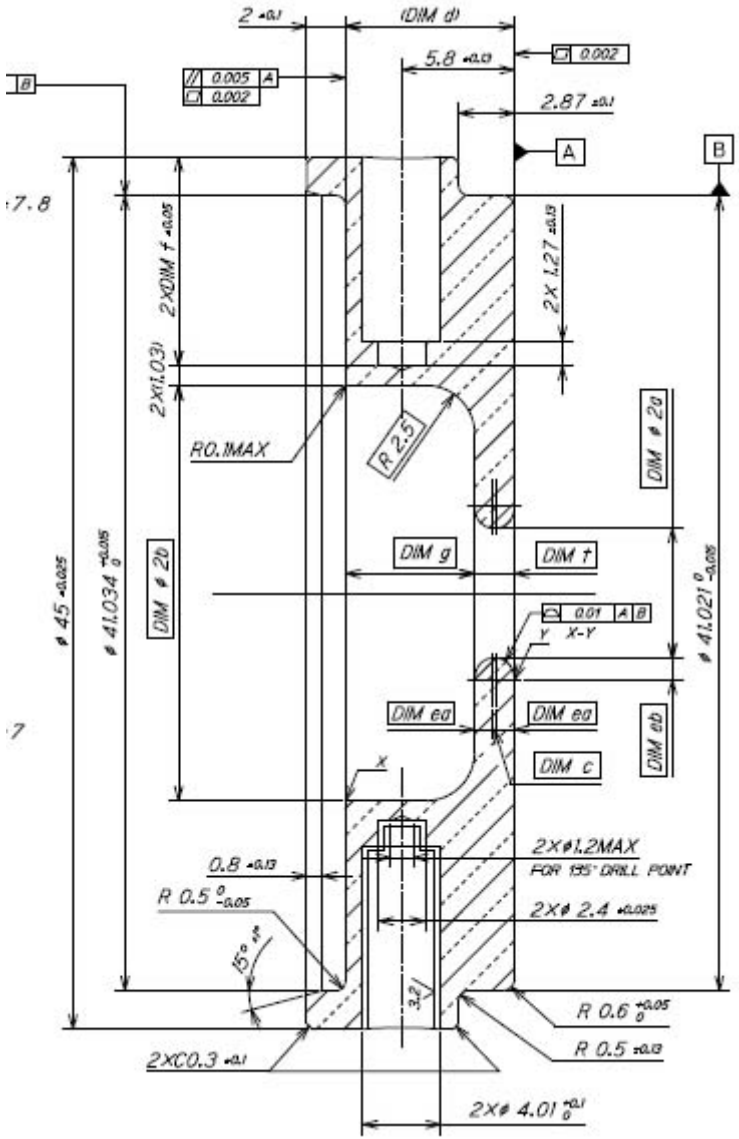


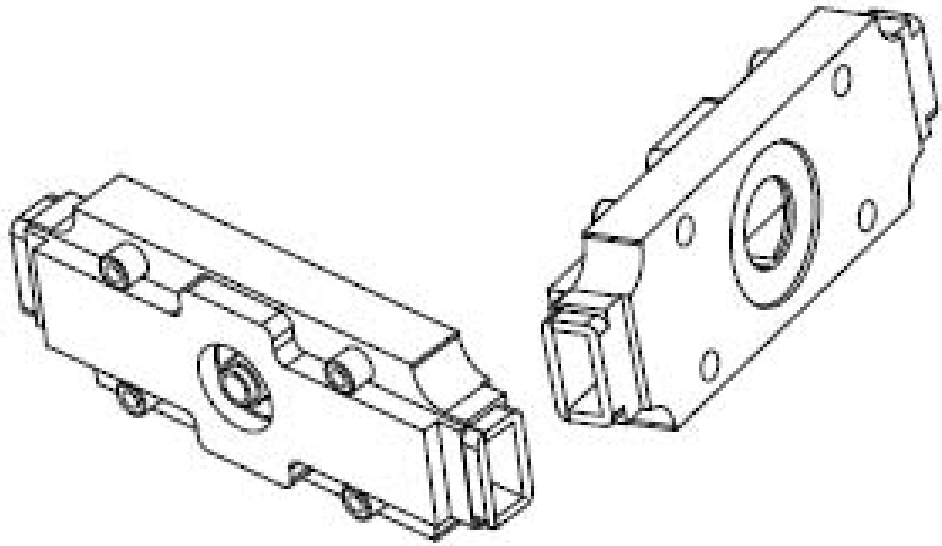


NOTES:
1. DIMENSIONS IN THIS DRAWING ARE AT 20℃ WHILE OPERATION TEMPERATURE IS 30℃
2. FLANGES ARE EITHER KEK FEMALE FLANGE SPECIAL FOR STRUCTURE PORT (Wave Guide FLANGE-KEK-B-A) OR SLAC FEMALE FLANGE(FF700-882-38)

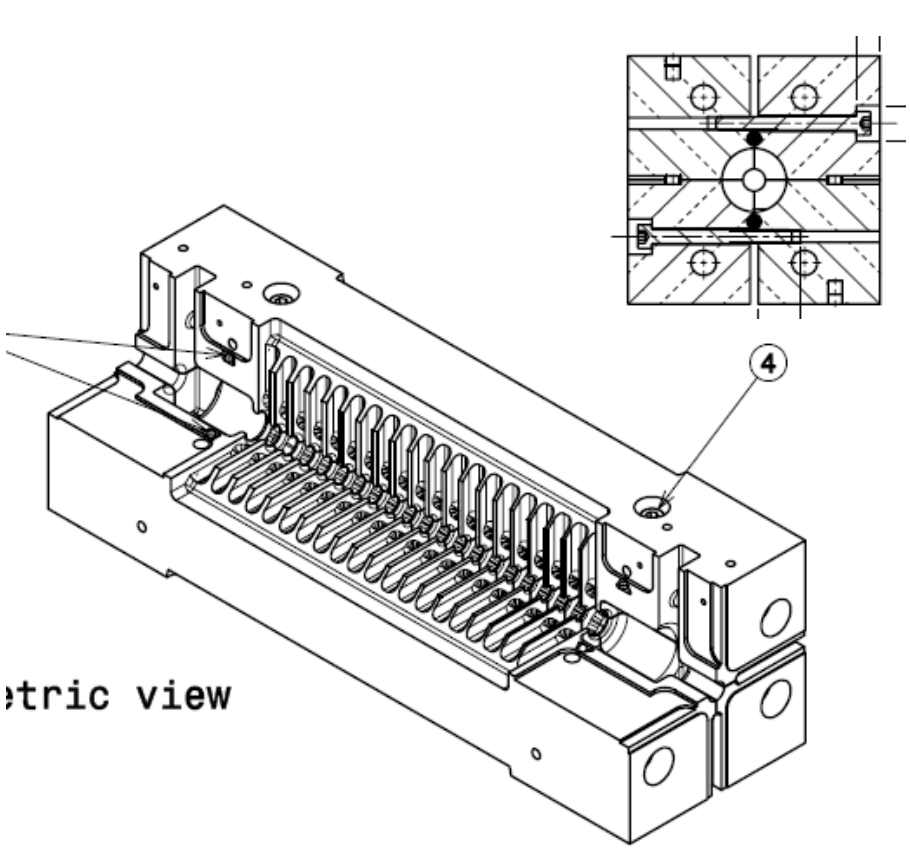
Rev.2		Designed	Drawn	Checked	Approved	Date	Drawing Name	CLIC TW16SDvg1 ASSEMBLY
Rev.1								
Date	2007/10/12					1:1		
		High Energy Accelerator Research Organization					Drawing Number	CLICVG1-01-00
								Rev. A

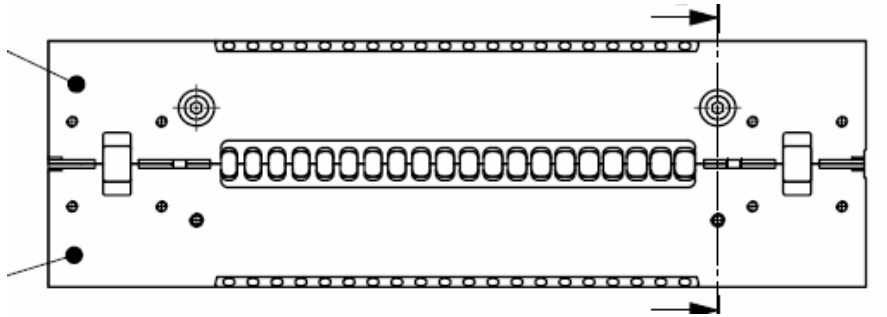
Disk and coupler

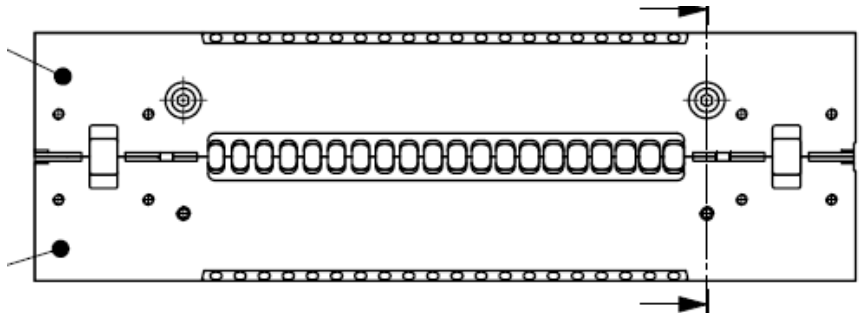




Quadrant design by CERN



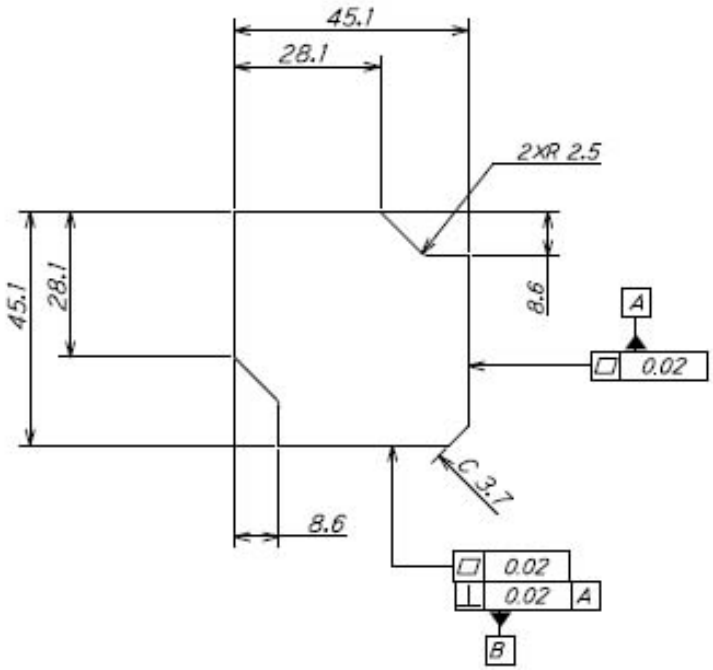


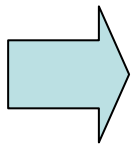


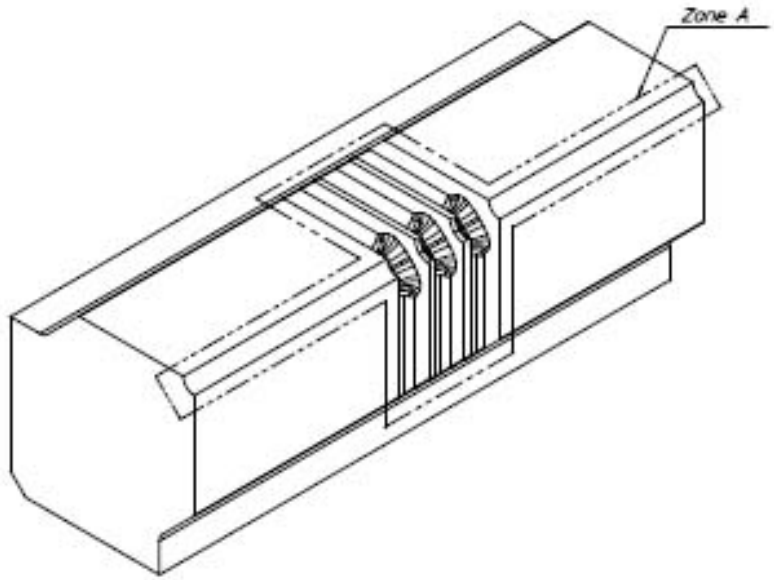
TD18_VG2.4_quad

- Aim
  - Acquire quadrant design and practice experience of quadrant fabrication
- Plan
  - Test cutting by mid. Nov.
  - Fab. one quadrant by the end of the year
  - Evaluation by vendor, KEK and CERN
- Status
  - Test cuttings are on-going.

Test cutting







Vendors

- HITACHI
  - Medical/nuclear (accelerator) group
- I I C
  - Use experience as of IHI and ask Costem co.
- YASDA
  - Excellent multi-axis milling machine maker
- Morikawa
  - Vendor which served most X-band disks for GLC
- U-corporation
  - Vendor of various precise machining parts for KEK

Want to see how to attack the problem to select one for the fabrication of one quadrant.

Some questions

- How to process a sharp edge in the drawing, burr, rounding, etc.?
- Which machine: 3-axis, 4-axis, 5-axis?
  - Surface roughness or geometrical precision?
  - Required surface roughness reasonable?
  - Zero cutting speed at the center of the ball end mill should be avoided or tolerated?
- Alignment tolerance between quadrants and how to realize it?
- Effect of following surface treatment on edges, dimensions, etc.?

Conclusion

- KEK want to
  - acquire experience of quadrant, in fabrication and high field operation
  - proceed study work starting with GLC-based to CLIC structure
- KEK also want basic studies on
  - breakdown mechanism
  - surface treatment method
  - material choice