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CERN - PS DIVISION

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TECHNICAL SPECIFICATION FOR THE MANUFACTURING OF TWO S-BAND TW ACCELERATING SECTIONS

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1. INTRODUCTION

CERN is extending its Compact Linear Collider (CLIC) Test Facility (CTF) with two accelerating sections. A high charge bunched electron beam will be accelerated up to 55 MeV by them.

Each section consists of 12 regular cells *(Fig. 1)* and 2 symmetric RF in/output couplers with connections to the beam vacuum chambers and to the 2 RF waveguides *(Fig. 2)*.

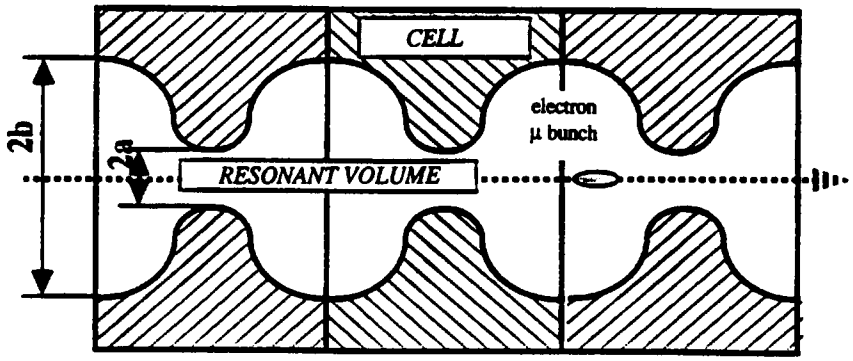


Fig. 1

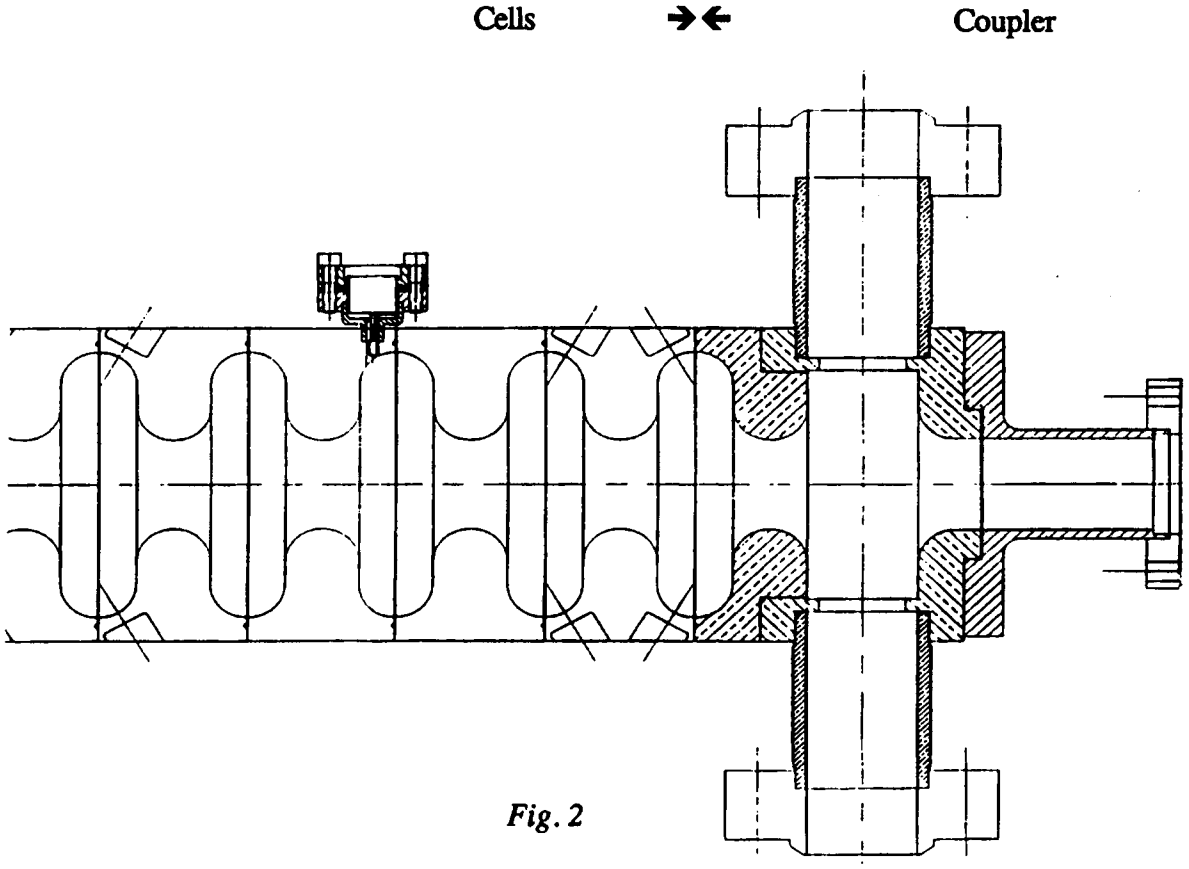


Fig. 2

The section HCS-1 will be operated at 2998.55 +7.8087 MHz,

The other, HCS-2, will be operated at 2998.55 -7.8087 MHz.

The frequencies are defined at 30°C and with the section under vacuum.

The scope of the call for tenders is the machining of 12 prototype cells and the machining and the brazing of one complete section HCS 1 and one complete section HCS 2.

2. DRAWINGS SUPPLIED BY CERN / LAL

2.1 List of Drawings

IC-2D-4409	CLIC Cell for Section HCS1
IC-2D-4410	CLIC Cell on the coupler
IC-4D-4411	CLIC Special cell
IC-3D-4412	CLIC Flange matched to the cell
IC-2D-4413	CLIC Cell 1
IC-2D-4414	CLIC Cell 2
IC-1S-4415	CLIC Celle for RF Measurement
IC-3D-4416	CLIC Connecting flange
IC-2D-4417	CLIC Coupler body
IC-3D-4418	CLIC Waveguide for Couplers
IC-3D-4419	CLIC LIL Type Flange
IC-4D-4420	CLIC Centering pin
IC-4D-4420	CLIC Positioning pin
IC-5E-4421	CLIC HCSI RF Structure
VW-31-1209 4C	LIL Waveguide
VW-31-1240 2E	LIL Flange

2.2 With the exception of the drawing of the test piece, the drawings are for the definition of the requirement only, the contractor shall be responsible for preparing the final manufacturing drawings.

The transverse flanges for the RF measurement loops shown on a number of cells are not yet worked out and can be ignored for this tender (IC-3D-4412).

The prototype cells serve to find the final cell dimensions. However, the final dimensions will be close to those shown on the drawing and the likely dimension **2b** shown on Fig. 1 needs to be changed only by a few 1/100 mm.

3. MATERIAL SUPPLIED BY CERN

3.1 CERN will supply, free of charge, copper bars with a diameter of 150 mm. The copper is oxygen free with a minimum copper content of 99.99%

The copper is defined by standards NF: A 53 100 Cu C2 or ISO: 1337 Cu OFE.

Mechanical properties of the copper supplied by CERN:

Brinell hardness: 45 - 55 HB
Ultimate tensile stress: 20 - 30 daN/mm^2
Elastic limit: 5 - 10 daN/mm^2

3.2 CERN will supply the wave guide pieces (drawing VW31-1209-4C) to be brazed to the RF couplers and the flanges (drawing VW31-1240-2E or IC-3D-4419) to be brazed to these wave guides.

3.3 CERN will supply the end flanges of the sections : DN 35 CF.

4. MACHINING

4.1 Clamping and positioning jigs

The contractor will prepare suitable manufacturing jigs. The study and manufacture of this equipment is the responsibility of the manufacturer who will submit the drawings to LAL/CERN.

4.2 Cutting tools

The contractor shall be responsible for supplying the cutting tools. Nevertheless only diamond tools are acceptable for the machining of the inner surfaces of cells and couplers, (natural diamond without defects which can be seen under a magnification of X 12 or polycrystalline synthetic diamonds are suitable).

4.3 Lubricants

The contractor shall provide a copy of the record of the chemical composition of the lubricant as obtained from its manufacturer. The lubricants shall not contain sulphur, graphite, silicone or chlorinated products.

4.4 Numbering and marking

Each cell or coupler part shall be allotted an individual number, ball-marked in the specified area.

This marking does not affects the shape of the pieces.

Cells

Three digits are required : The first for the number of the section and the two other for the machining order

For example 1-0-3

Couplers:

The body of the coupler will be marked with the machining order.

For example 2

4.5 Cleaning, handling and storage.

The cleaning procedure shall be made after the last machining. It consists of two phases:

Vapour phase degreasing

Liquid phase degreasing

Other more modern proceses can be proposed.

The contractor shall propose a precise specification for the cleaning process for CERN's approval.

Consumable gloves adapted to the cleaning procedure and the solvents are obligatory. After the cleaning cotton gloves will be used.

The copper pieces are very sensitive to shocks and must be manipulated very carefully. No scratches can be accepted on the working surfaces.

Immediately after cleaning, the cells shall be wrapped in new and clean cellular Kraft-polyethylene-type bags. These bags shall under no condition be sealed.

4.6 Final machining

The dimensions on the drawings are given for a temperature of 20°C.

The linear expansion coefficient of the copper is between 0 and 100°C : ALPHA = 16.5 10^{-6} /°C.

Considering the precision required, it is recommended to have the finishing machine installed in a shop maintained at 20± 3 °C.

5. FINAL SURFACE CONDITION

The internal surfaces of the cells and couplers must support very high electric fields. These fields can exceed 120 MVm^{-1} at the intersection between the straight part and the radiused iris (2a) To avoid field breakdown it is necessary to have an excellent surface quality.

The quality of the final machining must give

Ra=0.1 µm

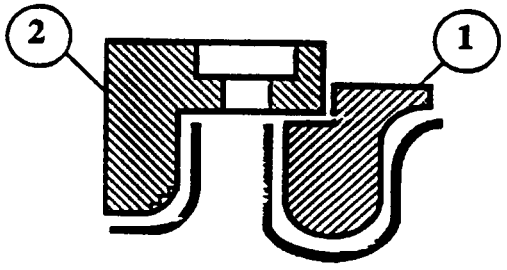
and must be obtained, over all the internal surfaces, solely by diamond machining.

6. PRODUCTION CONTROL AND TEST CERTIFICATES OF ALL PIECES

The contractor shall measure the dimensions of the machined pieces and establish test certificates. The inner radius of the cells being difficult to measure, LAL developed a technique to check the cell volume with a resonant frequency method. LAL can make this technique available to the contractor.

The surface roughness Ra at the cell inside surfaces shall be 0.1 micron. The total surface roughness Rt shall be <1.2 micron for an assessment length of 0.8 mm.

The same surface finish is needed for the inner part of the coupler underlined on figure 3. Round the coupling slots, machining will be made at LAL for the fine tuning of the frequency.



1 COUPLING CELL

2 COUPLER BODY

Fig. 3

7. BRAZING

7.1 The contractor shall be responsible for preparing the pieces to be brazed, to design and manufacture the brazing fixtures, to braze the assembled section in a high vacuum oven. CERN/LAL are ready to discuss with the contractor the different aspects associated with the brazing of the section. Prior to brazing , the contractor shall submit to CERN, for approval, the procedure he proposes to follow.

He will have demonstrated on a test sample that the proposed brazing procedure is successful.

7.2 Inspection prior to brazing.

At this stage LAL/CERN verifies whether the structure conforms to the RF specifications and is ready for brazing. The structure shall, under no condition, be brazed unless LAL/CERN has given formal approval in writing.

In order to be declared ready for brazing the structure shall satisfy the following conditions :

A) The mechanical tolerances must meet the requirements specified;

B) The good contact of the mating surfaces shall be tested with a light source moved along the structure axis; the contact shall be perfect if no light is detectable through the joints;

C) The radio-frequency measurements will concern the resonant frequency, Q, voltage standing wave ratio, electric field amplitude and phase, and coupler field asymmetry.

These measurements have to be carried out by the LAL in the manufacturer's premises. LAL/CERN reserves the right of additional measurements which should not last more than one day.

7.3 Measurement on finished section

Repeat RF measurements specified at 8.2

Check section for leak tightness and degassing rate

Visual inspection:

A visual inspection of the structure shall be carried out with particular attention to the surface finish and the cooling pipe brazing. Runs or drops of brazing material shall not be visible neither on the inner surfaces (using an endoscope) nor on the outer cell surfaces

8. TRANSPORT

The contractor shall provide a transport container which will prevent any damage to the section during shipment.

The section shall be sealed and pumped to a pressure of less than 1 mbar and then filled with dry nitrogen to atm. pressure.