

Detailed Specifications of Open Tender Notice No: 01/2015

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| Required items with detailed specification | Quantity |
|---|----------|
| Capsule SPRTs | 5 |
| Capsule type Standard Platinum Resistance Thermometer (SPRT) | |
| Specifications : | |
| Nominal Resistance at TPW : 25.5 Ω | |
| Temperature Range : -260 °C to 230 °C | |
| Resistance Ratio : W(Ga) > 1.11807 and W(Hg) < 0.844235 as per ITS-90 | |
| Heating Effect at TPW for 1 mA current : ≤ 1.5 m°C | |
| Drift in R_{TPW} after thermal cycling : ≤ 0.001 °C | |
| Sheath of capsule SPRT : Quartz Glass or Platinum | |
| Sheath Length : 50 mm \pm 10 mm | |
| Sheath Diameter : 5.4 mm \pm 0.5 mm | |
| Connection leads for capsule SPRTs: 4 conductor lead with plated terminals, length ≥ 2 m. for above capsule SPRTs, each. | |

Tender No: 14-VII/HRM(2475)15-PB/T-22

| Sr. No. | Required items with detailed specification | Quantity |
|---------|--|----------|
| 1 | Water Triple Point Cell (TPW Cell) with Maintenance Bath | |
| | Water Triple Point Cell (TPW Cell) | |
| | Specifications : | 3 |
| | Cell made of Quartz-glass envelope | |
| | Dimensions : ID of inner well = 12 ± 1 mm; OD of the cell = $65 \text{ mm} \pm 5 \text{ mm}$ | |
| | Immersion Depth (water surface to well bottom) = $265 \text{ mm} \pm 5 \text{ mm}$ | |
| | Height of the cell = $420 \text{ mm} \pm 30 \text{ mm}$ | |
| | Expanded uncertainty at $k = 2$: $< \pm 0.1 \text{ m}^\circ\text{C}$; Reproducibility : $\leq \pm 0.02 \text{ m}^\circ\text{C}$ | |
| | Water : Vienna Standard Mean Ocean Water (V-SMOW) | |
| | Isotopic Content : As recommended by BIPM in 2005 | |
| | With conformity Certificate from supplier. | |
| | Isotopic Analysis for water used in Water Triple Point Cell | 1 |
| | Impurity Analysis of water used in Water Triple Point Cell | 1 |
| | Maintenance Bath for Water Triple Point Cells: For the realization of above TPW cells given in Sr. No. 1. Bath Stability $\leq \pm 0.001 \text{ }^\circ\text{C}$. Power $230 \text{ V} \pm 10 \text{ V} / 50 \text{ Hz}$ | 1 |
| | Ice Mantle Maker : To prepare the Ice Mantle in the above TPW Cells at Sr. No. 1 | 1 |

Tender No: 14-VII/DDS(2480)15-PB/T-23

| Sr. No. | Required items with detailed specification | Quantity |
|---------|---|----------|
| 1 | <p>High Precision Digital Thermometer</p> <p>Specifications : Accuracy in the whole range (-200 °C to 962 °C) : 0.2 ppm or better Measurement Probes : 4-wire PRT, Resistance, Thermistor Measurement Current : 0 to 10 mA selective Input Resistance Range (Rx) : 0 Ω to ≥ 100 k Ω Accepted external resistance Range (Rs) : 1 Ω to 10 k Ω, Ratio Range : 0 – 10 Internal Resistors Rs : 1 Ω, 10 Ω, 25 Ω, 100 Ω and 10 k Ω Stability of Internal Resistors (Rs) : Kept in a temperature controlled oven with stability 20 m°C or better Display units : Resistance (Ω), Ratio (Rx/Rs), K, °C Temperature Conversions : ITS-90, Pt-100, Polynomial, etc Display resolution : 0.001 m°C. Display Type : Full VGA/LCD PC Interface : Rs-232, USB, IEEE-488, Ethernet; Language : English Power : 230 V/ 50 Hz</p> <p>Calibration certificate to meet the above specifications</p> | 1 |

| High Precision Analyzer | |
|---|--|
| Parameters | Required Specifications |
| Frequency | |
| Frequency Range | 25 Hz $\geq f$ to $f \geq 25$ GHz |
| Aging per year | $\leq \pm 1 \times 10^{-5}$ |
| Achievable initial calibration accuracy | $\leq \pm 1 \times 10^{-6}$ Or Better |
| Display range for frequency axis | 0 Hz, 10 Hz to max. frequency |
| SSB phase noise (CF = 1 GHz) | |
| 1 kHz | < -100 dBc (1 Hz) |
| 10 kHz | < -100 dBc (1 Hz) |
| Resolution bandwidths | 1 Hz to 10 MHz |
| Level | |
| Max. input level | |
| CW RF power | 30 dBm (RF attenuation ≥ 10 dB) Or Better |
| 1 dB compression of input mixer | +5 dBm Or Better |
| Third-order intercept point | > 15 dBm at more than 25 GHz |
| Logarithmic level axis | 1 dB to 200 dB Or Better |
| Total measurement uncertainty | $\leq \pm 0.50$ dB at $f < 10$ GHz |
| Measurement | |
| Marker for peak search | |
| | Within 2 ms |
| Trigger source | free run, video, external, IF power, RF power |
| Min. trigger offset resolution | 5 ns |
| Inputs and outputs | |
| Setting range of attenuator | 0 dB to 50 dB with step ≤ 2 dB |
| Interfaces | Multiple port USB plugs, LAN, GPIB Interface for Connection of RF Power Sensor. |
| Reference output | 1 MHz to 20 MHz, 100 MHz, 640 MHz |
| IF output | Should be provided. |
| Video output | log, linear |
| Display | color touchscreen |
| Operating System | Windows 7, 64 bit or higher |

Detailed Specifications

Laser Wavelength Meter

- Measurement range: 350-1120 nm
- Absolute accuracy: better than 100 MHz
- Quick coupling accuracy with multimode fiber: 150 MHz
- Measurement Resolution: 10 MHz
- Linewidth option:
 - Accuracy: 20 MHz
 - Max. bandwidth: 10 GHz
- Measurement speed in Hz
 - Data acquisition: > 250
 - Wavelength calculation > 100
 - Linewidth calculation > 80
 - Pattern display > 30
- Coupling fiber : single mode and multimode with FC/APC connectors converging the optical range 350 nm to 1100 nm. Length at least 2 m.
- Interface: High-speed USB 2.0 connection
- Should be insensitive to intensity fluctuations and side modes.
- A static wave meter based on rugged Fizeau interferometer setup without any moving components
- Device should have advanced program interface with PC
- Device should work as PID controller for frequency locking of the laser.
- Software for interfacing with PC
- Compatible with 220 V-50 Hz Indian standard

Fabrication and Assembly of Copper Spherical Cavity Resonator Unit and Accessories as per the design supplied by CSIR-NPL

Specifications :

(A) Spherical Cavity Resonator :

Material : Oxygen Free High Conductivity (OFHC) Copper

Resonator Shape : (Quasi-) Spherical Cavity (Two hemisphere joined together)

(a) Initial machining : Five-axis CNC lathe machine

(b) Dimensions of Resonator :

Nominal Radius : $r = 50$ mm,

Quasi-sphere- $r_x = 49.950$, $r_y = 49.975$ and $r_z = 50.000$ mm

Inner quasi-spherical shape design with CNC machine Programme for triaxial ellipsoid defined by,

$$\frac{x^2}{r^2} + \frac{y^2}{r^2(1+\epsilon_2)^2} + \frac{z^2}{r^2(1+\epsilon_1)^2} = 1$$

With $r = 49.950$ mm, $\epsilon_1 = 0.001$ and $\epsilon_2 = 0.0005$.

- (c) Final Machining : Inner cavity using multi-axis Diamond turning lathe machine to achieve above quasi-sphere.
- (d) Inner Surface finishing of resonator : better than ± 50 nm
- (e) Equatorial Radius Tolerance : ± 0.003 mm
- (f) Critical thickness of resonator wall : minimum 10 mm
- (g) Collar width = 20 mm ± 0.003 mm , height = 30 mm + 30 mm ± 0.005 mm
- (h) Outer diameter at collar ends = 160 mm
- (i) O-ring groove on both side at ID=110 mm OD= 120 mm, tolerance ± 1 mm
- (j) Collar inner and outer surfaces : diamond turned better than ± 50 nm and ± 100 nm, respectively.
- (k) Collar nut-bolts = M5, 12 nos *; all the threaded holes equipped with Helicoil inserts.
- (l) Silicone O-ring at the interface of two hemispheres, leak proof for 10 bar Argon pressure. Screws tight at 0.45 N.m.
- (m) Two pins on equatorial plane of hemispheres, for assembly of two hemispheres, with Radius Tolerance : ± 0.003 mm.
- (n) Supply of required jigs and fixtures for Resonator Assembly/mounting at CSIR-NPL.
- (o) Embossing of the letters "CSIR-NPL" (front of upper collar) and "BOLTZMANN PROJECT" (front of lower collar)

(B) Ports and plugs

Material : Oxygen Free High Conductivity (OFHC) Copper

Positions of plugs and thermometers: As given in the drawings and Table.

Inner surface finish: diamond turned ± 50 nm. Curvatures: matching to inner surface of sphere with ± 0.002 mm.

Axial Angle between M1 to M2 = 90° and A1 to A2 = 39.2° , tolerance $\pm 1'$ (0.015°), tapered surfaces diamond turned.

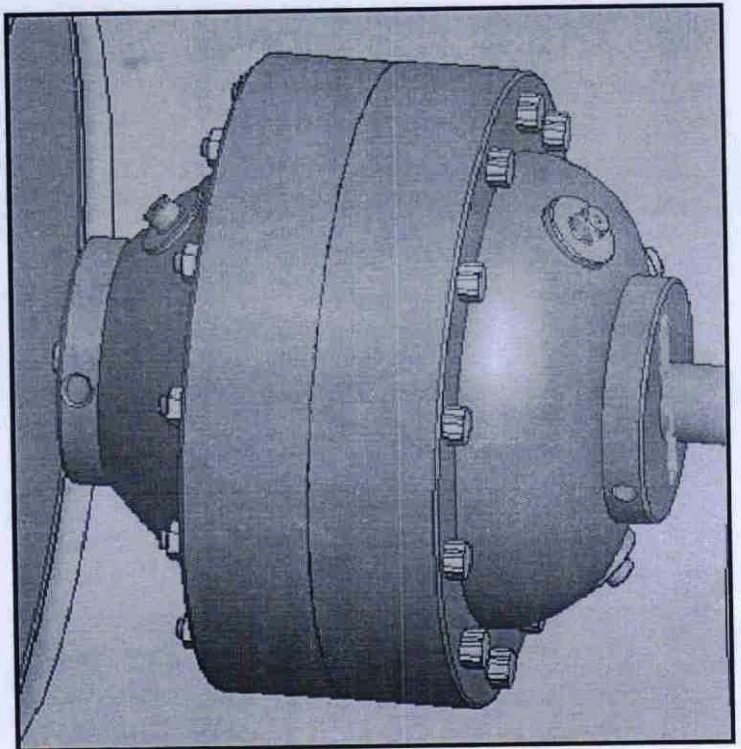
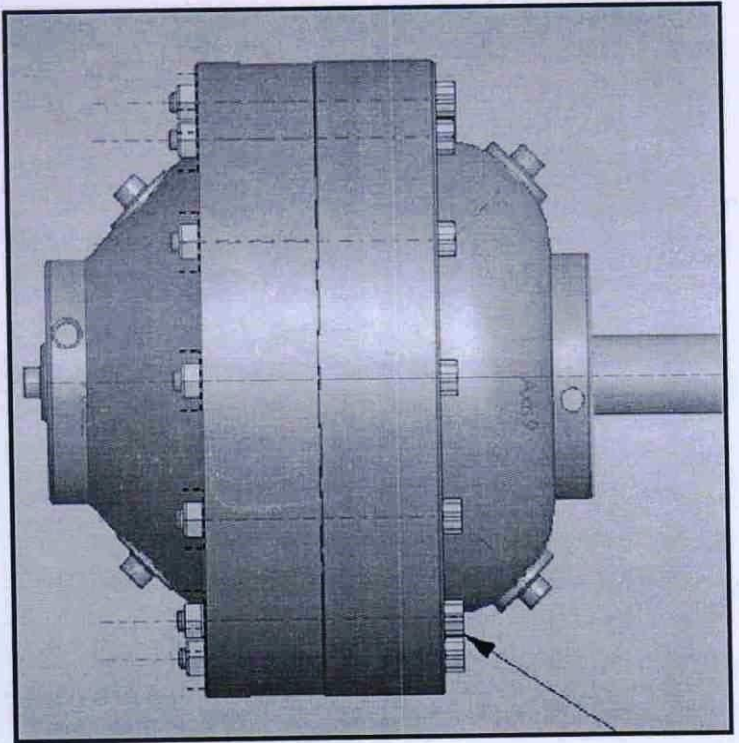
- (a) Gas In : G1; 4 mm to 20 mm tapered plug (Blank – one), with 0.6 mm drill (one)**.
- (b) Gas Out : G2 : 4 mm to 20 mm tapered plug (Blank – one), with 0.9 mm drill (one)**.
- (c) Microwave in : M1: 6 mm to 20 mm tapered plug (Blank – one), with 3 mm drill for sensor (one)**.
- (d) Microwave out : M2: 6 mm to 20 mm tapered plug (Blank – one), with 3 mm drill for sensor (one)**.
- (e) Acoustic in : A1: 8 mm to 20 mm tapered plug (Blank – one), with 7 mm drill for microphone (one)**.
- (f) Acoustic out: A2: 8 mm to 20 mm tapered plug (Blank– one, Dummy-one), with 7 mm drill for microphone (one)**
- (g) All plugs taper surfaces by diamond turning finish.
- (h) All probes attaché with four M3 screws, each*.
- (i) Thermometer 1 : T1 : drill of $\Phi 6$ mm, length 6 cm, tolerance in Diameter ± 0.5 mm
- (j) Thermometer 2 : T2 : drill of $\Phi 6$ mm, length 6 cm, tolerance in Diameter ± 0.5 mm
- (k) Thermometer 3 : T3 : drill of $\Phi 6$ mm, length 6 cm (in the collar), tolerance in Diameter ± 0.5 mm
- (l) Thermometer 4 : T4 : drill of $\Phi 6$ mm, length 6 cm (in the collar), tolerance in Diameter ± 0.5 mm
- (m) Embossing of the letters "A1, A2, M1, M2, G1, and G2" on respective ports.

* - All nut bolts should be made up of SS 316L,

** - All the connector probes will be supplied by CSIR-NPL for fixing at your end

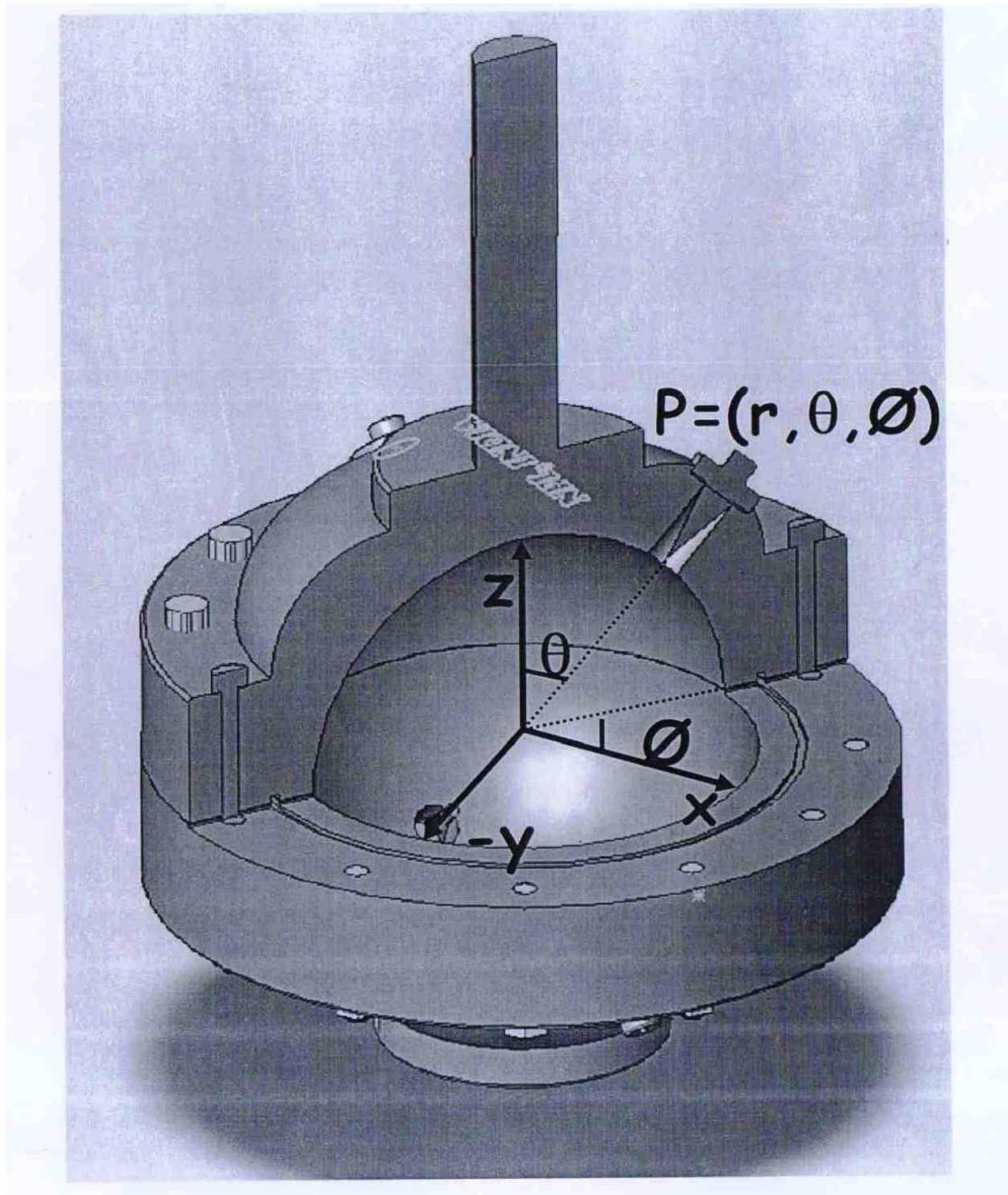
(C) Critical Requirements and Measurement Certifications :

- (a) Resonator Cavity inner surface roughness = better than ± 50 nm - measurement certificate.
- (b) Equatorial radius = better than ± 0.003 mm by CMM – measurement certificate.
- (c) Resonator Cavity Shape and Volume by CMM machine – measurement certificate.
- (d) Angle between M1 to M2 = 90° and A1 to A2 = 39.2° , tolerance $\pm 1'$ (0.015°) -- measurement certificate.
- (e) **The system should be assembled and tested by the party at CSIR-NPL site.**
- (f) Pressure (10 bar) and Vacuum Test (10^{-6} torr) to be shown at CSIR-NPL site.
- (g) Certificate from Supplier for material purity and Thermal Conductivity of Copper, etc.
- (h) Final Engineering Drawings – component and assembly wise.
- (i) Warranty : 1 Year warranty of the fabricated parts and apparatus.



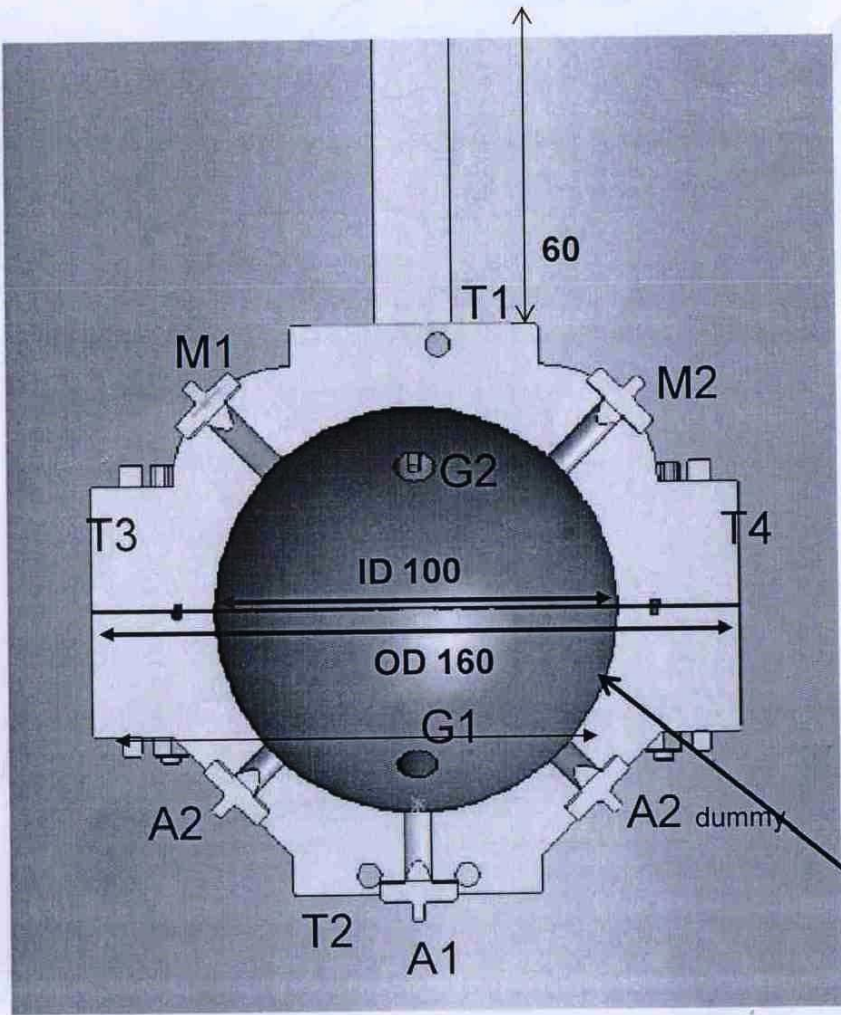
| Probe | Function | θ ($^{\circ}$) | ϕ ($^{\circ}$) | Remark |
|-------|---------------------------|-------------------------|-----------------------|-----------------|
| M1 | Microwave in | -45 | 180 | M1 to M2 |
| M2 | Microwave out | 45 | 0 | $\theta = 90$ |
| A1 | Acoustic in | 180 | 0 | A1 to A2 |
| A2 | Acoustic out | 140.8 | 0 | $\theta = 39.2$ |
| A2* | Acoustic out (* dummy) | 219.2 | 180 | |
| G1 | Gas in | 45 | 90 | |
| G2 | Gas out | 135 | 90 | |
| | Radius | 50 : 49.950 : 49.975 mm | | |

**Copper Cavity Resonator
Inside Pressure Vessel**



Sectional View

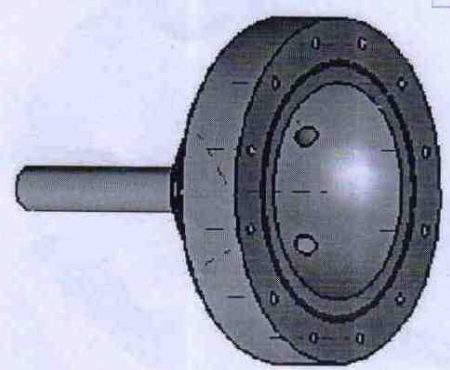
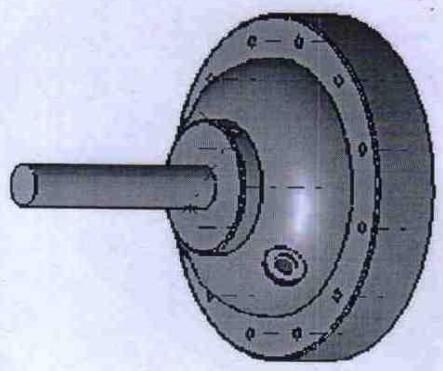
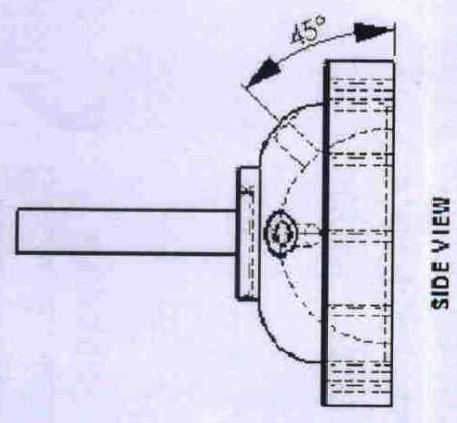
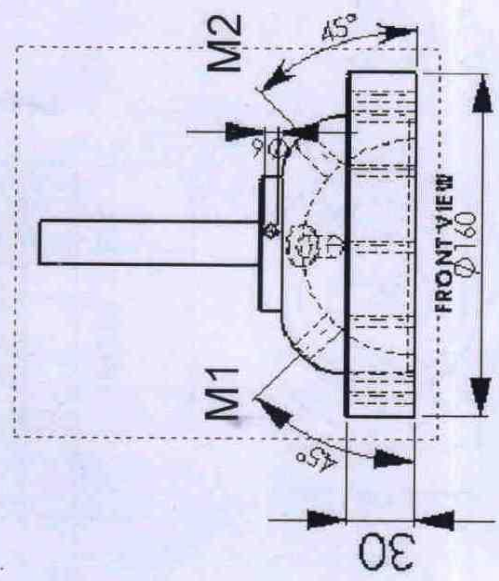
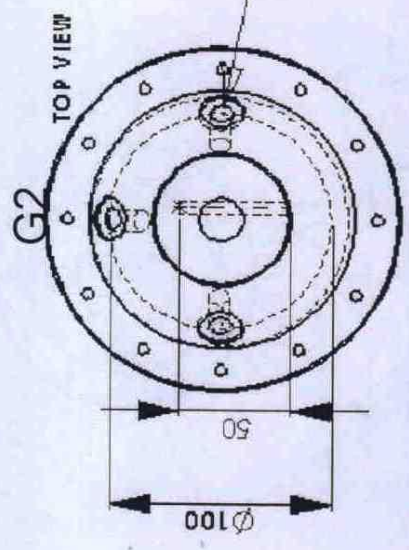
Dimensions in 'mm'



Inner surface (Diamond turned)

Blisscon

M1 = Microwave Probe 1
M2 = Microwave Probe 2
G2 = Gas Out



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| DATE | BY | APP | REV | COMMENTS |
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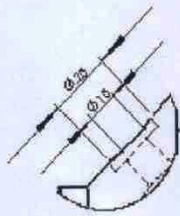
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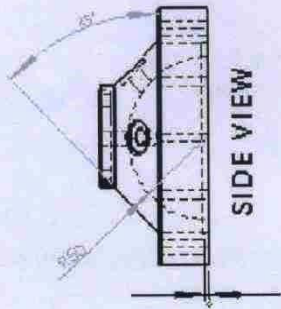
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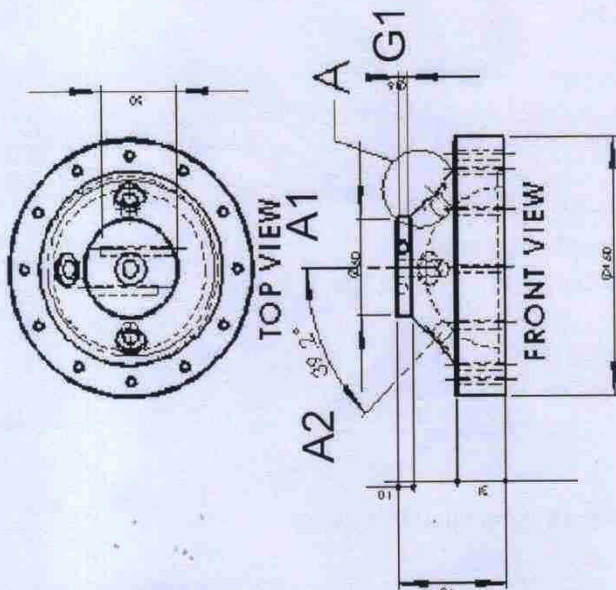
CSIR-NPL, NEW DELHI
**RESONATOR
TOP PART**



DETAIL A



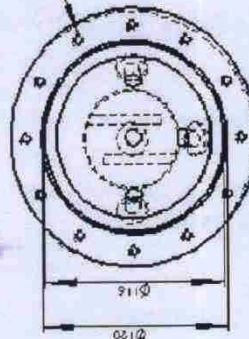
SIDE VIEW



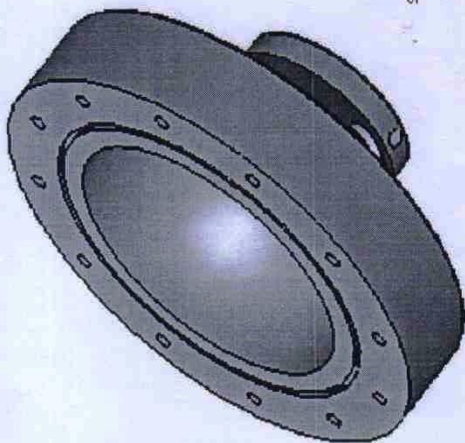
TOP VIEW

FRONT VIEW

Ø5, 12 HOLES, AT 140 PCD



BOTTOM VIEW



ISOMETRIC VIEW



A1 = Acoustic Probe 1
 A2 = Acoustic Probe 2
 A2* = Acoustic Probe 2 Dummy
 G1 = Gas In

| | |
|--------------------------|----------|
| CSIR-NPL, NEW DELHI | |
| RESONATOR BOTTOM PART | |
| WT (GMS) | 0 |
| SR (NO) | A |
| REV. NO | 001002 |
| DATE | 15/11/11 |
| BY | AS/04 |
| BY | AS/04 |

| | | |
|-------------------|----------------------|-------|
| DESIGNER/ENGINEER | DR/01 | DR/01 |
| DRAWN | CA/04 | DR/01 |
| CHECKED | | |
| VERIFIED | | |
| APPROVED | | |
| PROJECT NO. | | |
| UNIT | | |
| DATE | | |
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Fabrication and Assembly of Pressure Vessel, Vacuum Vessel and Accessories as per the design supplied by CSIR-NPL

Specifications :

(A) Pressure Vessel :

Material : Oxygen Free High Conductivity (OFHC) Copper

Shape : Cylinder

- (a) Dimensions of Pressure vessel :
Diameter ID = 225 mm, OD = 245 mm, thickness 10 mm, height = 300 mm, bottom plate brazed.
- (b) Top Plate : 25 mm thickness, OD = 285 mm, as shown in design. Fixed with Silicone O-ring and M5 screws *.
- (c) O-ring groove on both side at ID=235 mm OD= 245 mm, tolerance ± 2 mm
- (d) Resonator attached to Top plate of Pressure vessel : with Φ 25 mm and 100 mm long OFHC copper rod
- (e) Two Ducts to Top plate of Pressure Vessel : Gas-in, gas out tube connectors (Swagelok), multi-pin connector for cSPRTs, microwave and acoustic sensors.
- (f) Copper rod attachment to top plate and resonator, as shown in design.
- (g) Anchoring of the OFHC copper (Gas-in) tube (3 m long thick walls for 10 bar pressure) to pressure vessel top plate, by brazing
- (h) Embossing of the letters "CSIR-NPL" (first line) and "BOLTZMANN PROJECT" (second line) on front of Pressure Vessel.

(B) Vacuum Vessel :

Material : Vacuum Grade Stainless Steel 316L

Shape : Cylinder

- (a) Dimensions of vacuum vessel :
Diameter ID = 350 mm, OD = 360 mm, thickness 5 mm, height = 500 mm, bottom plate brazed.
- (b) Top Plate : 15 mm thickness, OD = 400 mm, as shown in design. Fixed with Silicone O-ring and M5 screws*.
- (c) O-ring groove on both side at ID=360 mm OD= 370 mm, tolerance ± 2 mm
- (d) Pressure Vessel attached to Vacuum Vessel : with Φ 25 mm and 150 mm long three OFHC rods
- (e) Three Ducts to Top plate of vacuum Vessel : Gas-in, gas out, connector for temperature, microwave and acoustic sensors. One duct with Vacuum gauges and pump connection.
- (f) OFHC Copper rods attachment to top plate and pressure vessel, as shown in design. Top joining by brazing, bottom to copper plate by nut-bolts.
- (g) Anchoring of the Gas-in OFHC copper thick wall tube, gas out copper tube from pressure vessel.
- (h) Embossing or metal plaque of the letters "CSIR-NPL" (first line) and "BOLTZMANN PROJECT" (second line) on front of Vacuum Vessel.

(C) Critical Requirements and Measurement Certifications :

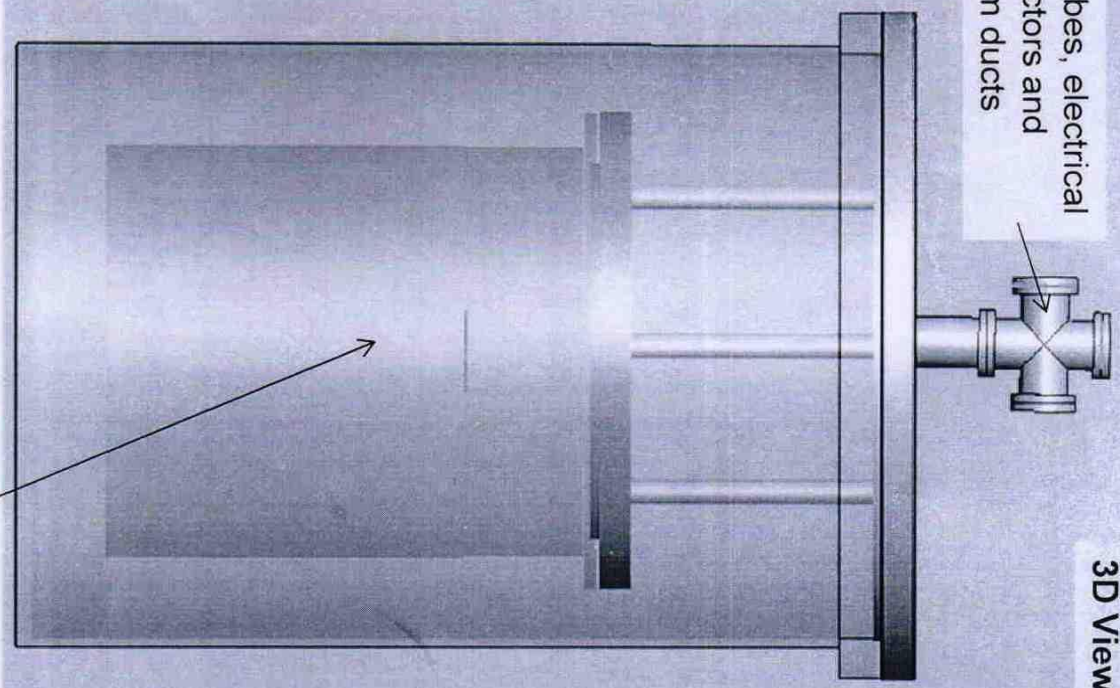
- (a) **The system should be assembled and tested by the party at CSIR-NPL site.**
- (b) Pressure (10 bar) and Vacuum Test (10^{-6} torr) to be shown at CSIR-NPL site.
- (c) Certificate from Supplier for material purity and Thermal Conductivity of Copper, etc.
- (d) Final Engineering Drawings – component and assembly wise.
- (e) Warranty : 1 Year warranty of the fabricated parts and apparatus.

* - All nut bolts should be made up of SS 316L. All materials and accessories to be arranged by party.

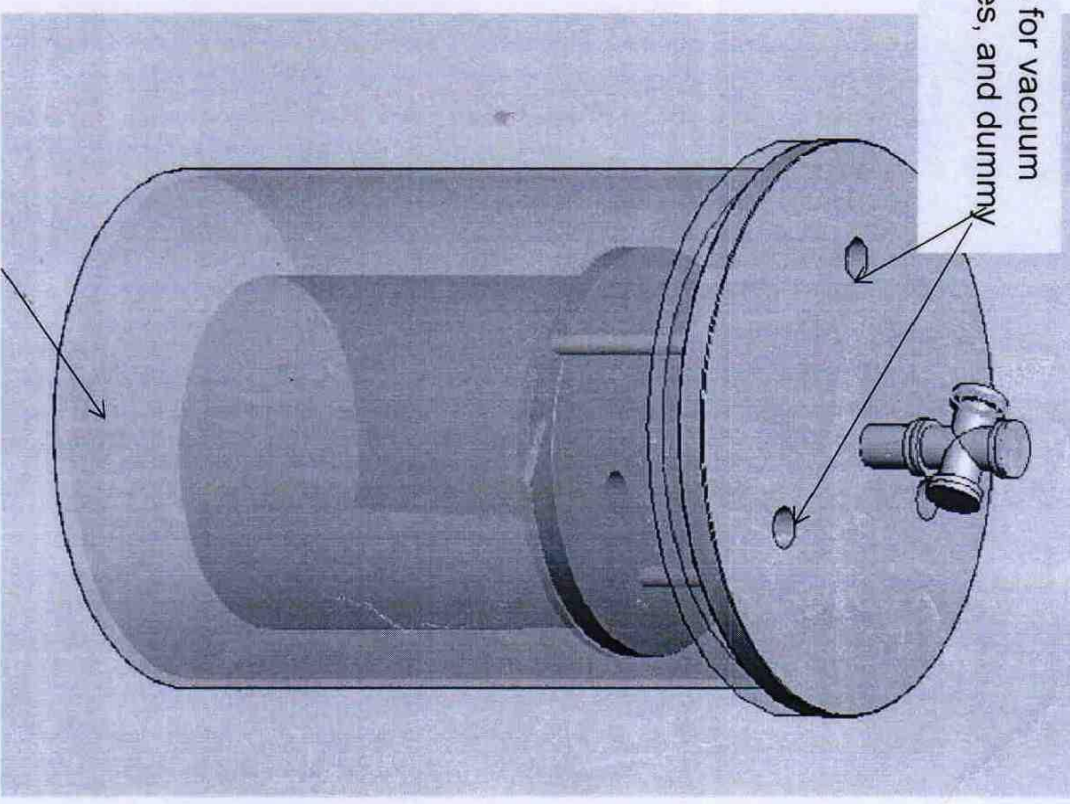
** - All the connector probes for resonator inside pressure vessel will be supplied by CSIR-NPL for fixing at your end.

3D View of Complete Unit: Pressure Vessel and Vacuum Vessel

Gas tubes, electrical connectors and vacuum ducts

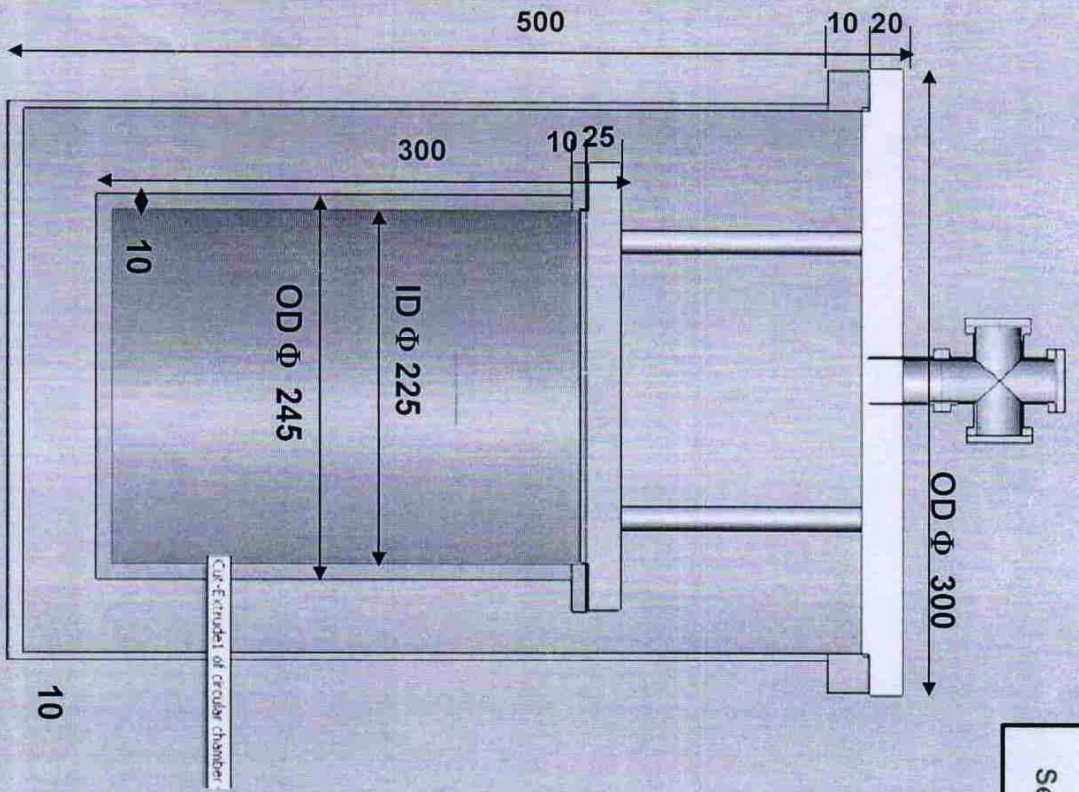


Ducts for vacuum gauges, and dummy duct

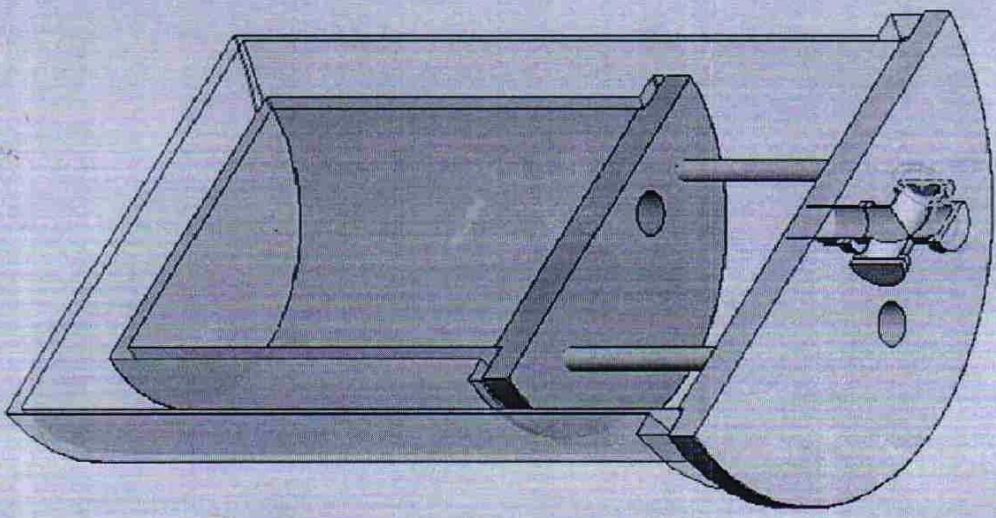


OFHC Copper Pressure Vessel
ID= 225 mm, OD= 245 mm, height 300 mm, top plate = 25 mm thick, with Cu rod

Stainless Steel 316L Vacuum Vessel
ID= 350 mm, OD= 360 mm, height 500 mm, top plate = 15 mm thick, attached with 3 Copper rods



Sectional View



Dimensions in 'mm'

OFHC Copper Pressure Vessel
 ID= 225 mm, OD= 245 mm, height 300 mm, top plate = 25 mm thick, with Cu rod

Stainless Steel 316L Vacuum Vessel
 ID= 350 mm, OD= 360 mm, height 500 mm, top plate = 15 mm thick, attached with 3 Copper rods

