Technical Specifications

Compact Antenna Test Range (CATR)

1. INDEX

2. INTRODUCTION 2
3. SPECIFICATION OF THE PROPOSED CATR 3
4. DESIGN AND INSTALLATION REQUIREMENTS OF THE PROPOSED CATR ASSEMBLY 4
5. MANUFACTURING TECHNOLOGY AND PERFORMANCE OF CATR MIRROR 6

2. Introduction

Compact Antenna Test Range (CATR) installed inside an Anechoic Chamber creates a section of Plane-Wave , known as "Quiet Zone". This Plane-Wave or "Quiet Zone" area is an excellent Test Environment either for Antennas or for RCS measurements.
Therefore, the Plane-Wave generated by CATR impinges the Device Under Test (DUT). CATR can be configured, using different arrangements of one, two or three reflectors :

- one-reflector CATR (Fig.1) is the simplest configuration and shows limited XPD (25dB) the "Quiet Zone" area is limited to 50% of the reflector aperture;

- two-reflector CATR (Fig.2) is more complex and performs excellent XPD (40dB) the "Quiet Zone" area is 70% of the main reflector aperture;

- three-reflector CATR is the most complex, expensive and flexible configuration, thus it was proposed only for special applications, where a relatively small "Quiet Zone" was concerned.

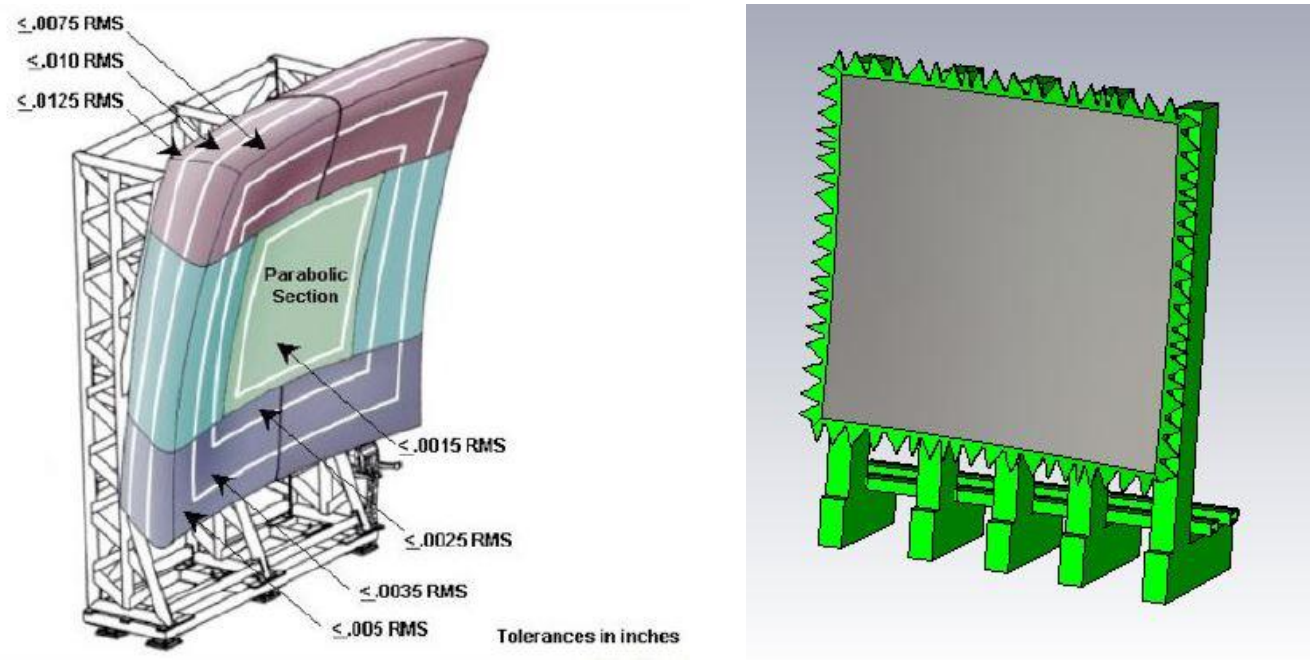

Fig. 1 Possible realizations of One-Reflector CATR configuration
(Left picture) (a) CATR with "rolled-edges" (Right picture) (b) CATR with "serrated-edges"

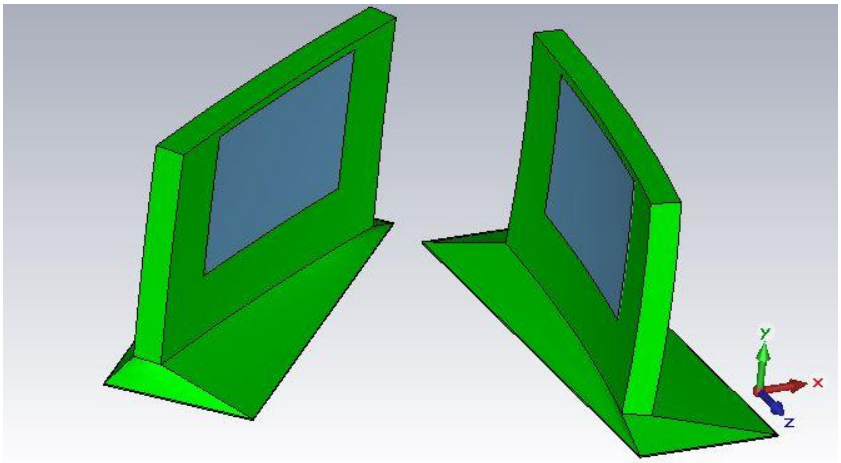

Fig. 2 Two-Reflector configuration of CATR

Manufacturing cost of mirrors is approximately the same either for one-reflector or for two-reflector configuration, having the same extension of their respective "Quiet Zone" CATR area, however vendors prefer to supply easy-to-install one-reflector CATR, with high F/D focal ratio and improved XPD. Furthermore, it's possible to take XPD performance over 45dB by means the optional implementation of a feeder array, that is a system capable of compensating in a specific band (e.g. 60-90 GHz) the cross-polarized field created by the offset mirror, constituting any type of one-reflector CATR.

Taking into account the last consideration, a one-reflector CATR is selected as preferred cost-effective environment for testing high performances mm-wave antennas inside an Anechoic Chamber.

3. Specification of the proposed CATR

The technical specification of the proposed CATR are listed below:

- mm-wave frequency band of operation : 60 – 200 [GHz];
- Quiet Zone area from 60 GHz to 90 GHz : Planar Wavefront on a square area of 70 cm x 70 cm;
- Quiet Zone area up to 200 GHz : Planar Wavefront on a square area of 20 cm x 20 cm;
- max.Phase Ripple in this Quiet Zone area : ± 6 [degs];
- max.Amplitude Ripple in this Quiet Zone : ± 0.4 [dB];
- max.Amplitude Taper in this Quiet Zone : < 1.0 [dB];
- crosspolar discrimination in this Quiet Zone area : XPD > 36 dB
  optionally, using Feed-Array compensation technique, > 45 dB;
- spurious reflections from Mirror Edges : < -63 dB;
- RMS surface accuracy of mirrors Ø1 m : ≤ 10 [microns]

4. Design and installation requirements of the proposed CATR assembly

The proposed CATR assembly, shown in Fig. 1 (b) and in the Anechoic Chamber plan of Fig. 3, is made of the following constitutive elements:

1. The **metal structure** of steel, for supporting the single-offset mirror.
2. The **single-offset mirror**, a section of Paraboloid with rectangular edges, milled from a solid block of Aluminum;
3. The **serrated edges** of the mirror, made of Aluminum metal sheet;
4. Two **absorbing structures**, made of standard absorbing panels.

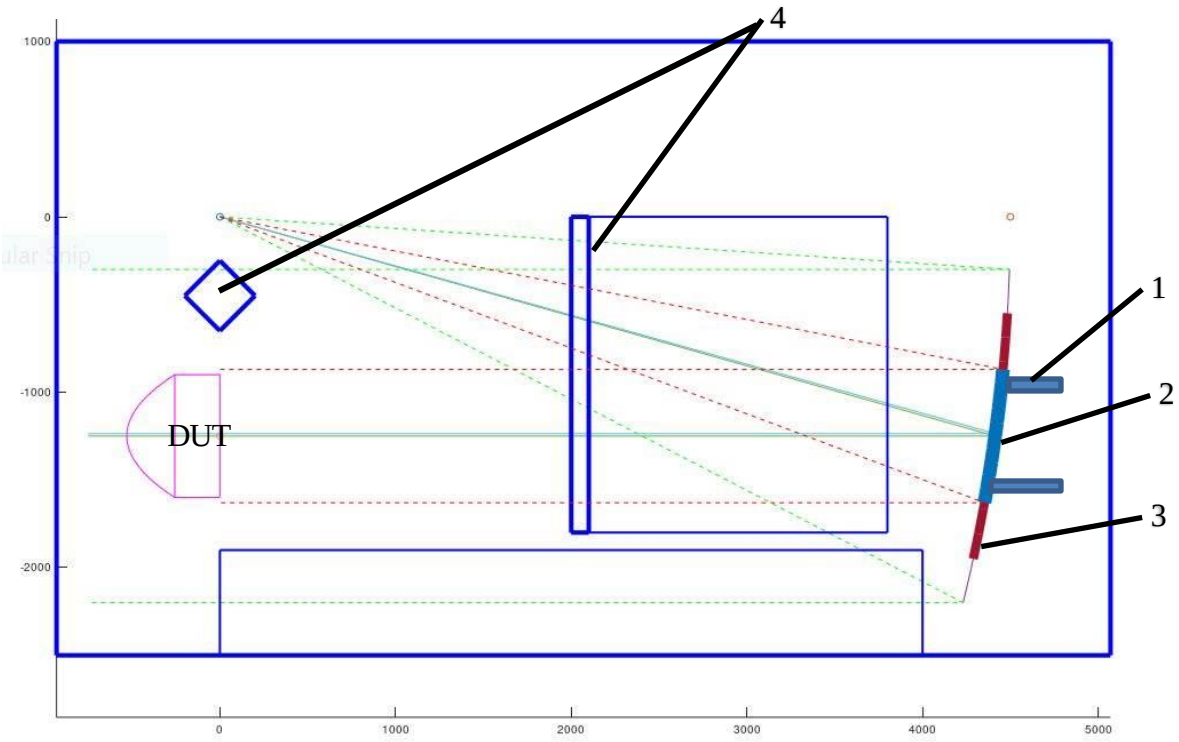

Fig. 3 Anechoic Chamber plan including DUT and One-Reflector CATR

A. All components of CATR shall be passed through the door of the Anechoic Chamber, having width of 90cm and height of 190cm. Therefore, the supporting structure (1) shall be composed of several parts to be easily passed through this door, to be assembled inside the Anechoic Chamber and to be finally fixed to the base-plate on the floor.
B. The dimensions of the mirror (2) shall be smaller than 1500mm x 1400 x 100 mm and the relevant weight should be minimized such that the mirror can be moved by hands inside the Chamber easily without the help of a trolley. After fixing the mirror (2) to the structure (1), the serrations (3) shall be fixed - by means of pins and screws - to the mirror edges.

C. The mechanical design of the mirror (2) shall include at least a complete CAD evaluation of the deformations due to the gravity (indeed, high precision machining would be performed with the mirror lying in horizontal position, while the final installation of mirror is in vertical position)
D. The geometric alignment of CATR assembly shall be performed by means of a Laser Tracker equipment; the alignment procedure shall require a reasonable positioning of the supporting structure (1) and the following more accurate positioning of the mirror (2); finally, it's very important to define with extremely high accuracy the position of its focal point, by merging the data provided by the Laser Tracker with the data known from the 3D model of the mirror (1). Therefore, suitable "Fiducial Points" are required on the border of the mirror.
E. At least two absorbing structures (4) are needed for minimizing spurious reflections inside the Anechoic Chamber; one planar structure, made using nine absorbing panels 60cm x 60cm, would have an overall dimension of 180cm x 180cm and should be mounted on a frame, which is tiltable from a horizontal position, in contact with floor to the vertical position, making the function of separation absorbing wall. Finally, near the focal point of the mirror (1) a TOTEM removable structure, made of smaller absorbing panels, should be provided.

5. Manufacturing Technology and Performance of CATR mirror

The reflector should be made of solid Aluminum material, following a special high precision process of numeric-controlled machining in order to guarantees an extreme accuracy of manufacturing with an RMS error ≤ 10 [microns].

In the frame of our preliminary CAD simulations, we have created a Computer Model of one-reflector CATR with the following characteristics:

- CATR (Single-Offset) Mirror with F/D > 2 and exemplary edge dimensions 1500x1400 mm;
- SERRATIONS with dimensions < 200mm added at the rectangular edges of this Mirror;

Further improved XPD > 45dB has been enabled, as demonstrated in Fig. 4 by computer simulation, provided that a "compensated Array of 3 Feeders" is deployed for a specific frequency band.

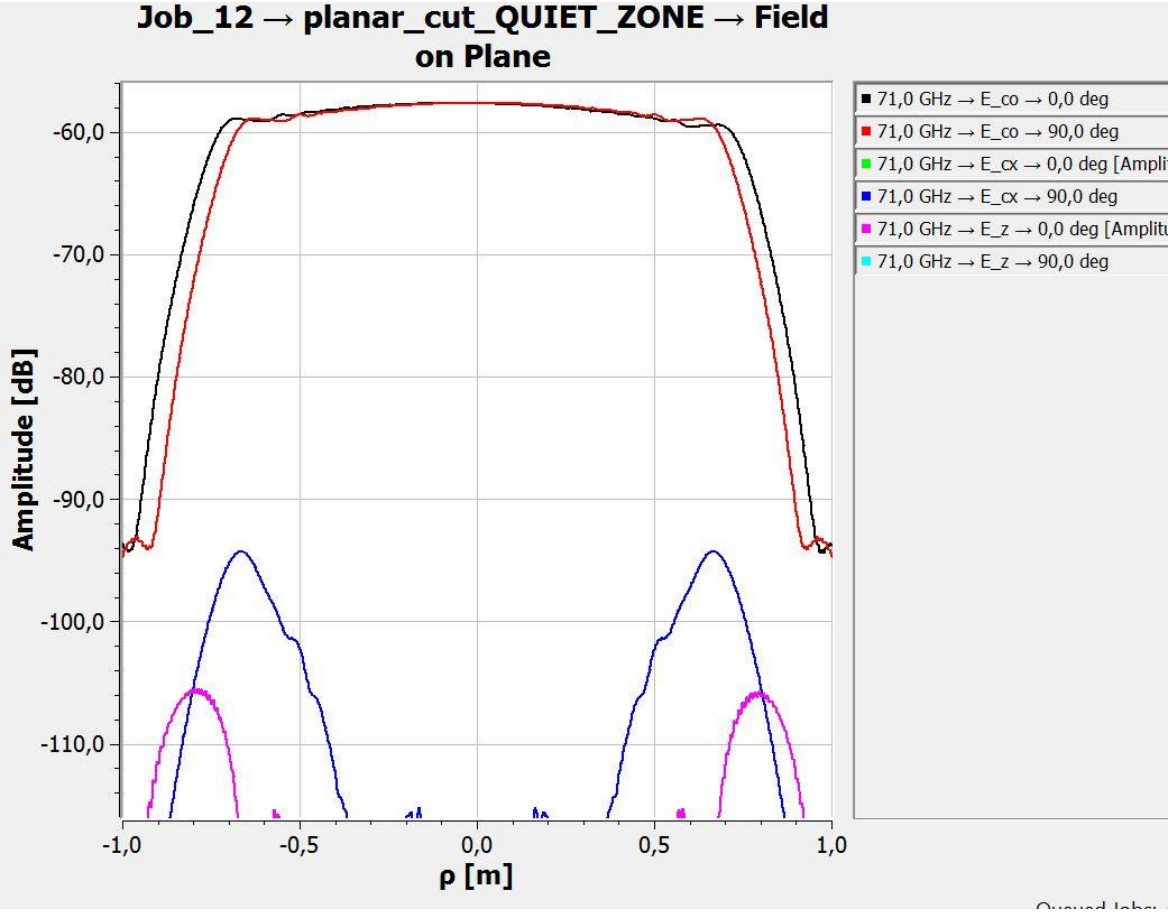

Fig. 4 Simulation result of the Quiet Zone of One-Reflector CATR @ 71 GHz