Design and development of Geodesic structure and scattering chamber for NAND at IUAC

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Introduction

This report presents the design and fabrication concepts of geodesic mechanical structure and target chamber for National Array of Neutron Detectors (NAND) at IUAC. NAND is an array of 100 neutron detectors. Each detector is a 5"x 5" liquid scintillator cell coupled to a photo multiplier tube. The detectors are mounted on a hemi-spherical structure (Fig.1). The radial distance from the center of the array to the face of each detector is 1.75 meters. One main point kept in mind while designing the structure was to use minimum material and achieve maximum mechanical strength. Material needs to be minimised to reduce the chances of neutron scattering. It was found that a geodesic dome Structure is the most suitable for our application.

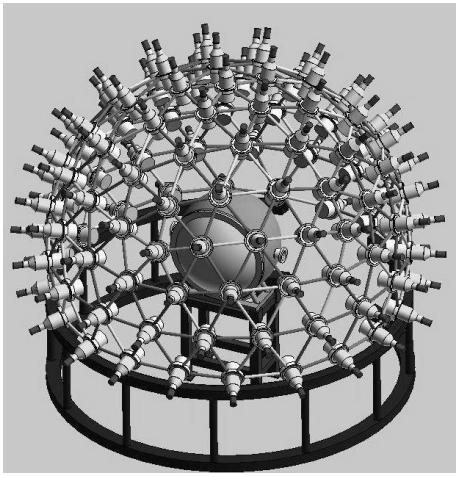

Fig.1 Solid works model of NAND.

Geodesic dome.

A geodesic dome can be built using different shapes. The simplest is to make from an icosahedron (a solid figure with 20 interlocking sides made of equilateral triangles). We had selected a four frequency geodesic dome for the structure. This frequency has 162 vertices in a complete sphere. Out of the 111 possible vertices (Table-1) in the truncated dome, we decided to use 100 vertices.

Table.1 No. of detectors on the ring

Ring No.	Approximate angle of each ring (degree)	No. of vertices in the ring
01	90	1
02	75	5
03	60	10
04	45	15
05	30	20
06	15	20
07	0	20
08	-15	20
	Total	111

Fabrication of Geodesic dome

Fabrication of the 1.75 metre radius dome structure with required tolerance (positioning of detectors within ± 5 mm and 0.5 degree) was a challenging task. A careful study showed that there exists a pattern existing in the dome. There are six large pentagons in the dome. These large pentagons are connected to each other by three struts at each joining point. The single large pentagon is called a module in the dome. The dome structure was fabricated by making six modules of large pentagons and assembling them together by welding.

One metre diameter target chamber

The scattering chamber for NAND is a one meter inner diameter, high vacuum chamber made of S.S-304 sheet of 4mm thickness (Fig.2). The

shell thickness of this chamber had to be as minimum as possible to reduce the neutron scattering from the chamber wall. At the same time it had to withstand the atmospheric pressure without using any additional strengthening ribs.

Fig. 2. One meter diameter target chamber.

Inside the chamber the fission fragment detectors Such as multi wire proportional counters (MWPC) can be positioned at different angles in the central plane according to the experimental requirements. Vacuum compatible, precision linear motion slides placed on four radial arms gives the radial movement for detectors. For the angular movement there is a circular (curved) track at the center on which the radial arms are fixed. The bigger size of this chamber helps the user to put the MWPC detectors at a radial distance of around 450 mm from the target site.

There are monitor detector mounts inside the chamber near exit port. Two monitor detectors look towards the center of the chamber near exit port. Provision to mount detectors near the entrance port is given for other purposes. All materials inside the chamber are made from Aluminum. There are linear scales on radial arms to measure the linear movement.

The chamber is made by "orange peel" technique. Petals and crowns were pressed to form the spherical shape. Full penetration TIG welding used to join the petals and crowns.

Fig. 3 The NAND facility in the beam hall.

Conclusion.

A truncated geodesic dome has been designed, fabricated and commissioned for mounting hundred neutron detectors at 1.75 meters in NAND facility .A one meter diameter scattering chamber has been designed, fabricated and installed after leak checking. Provision for target and detector mounts and their movements are provided. .These are shown in fig.3.

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