# Chapter 7.
# The Experimental Hall

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## 7.1. Introduction and Overview

The former 80$''$ bubble chamber building will house the muon $(g-2)$ storage ring. Its position is ideal for the experiment, allowing either pion or muon injection options. The high bay is $73' \times 62'$, which is large enough for the ring which has a $54'$ outside diameter. The floor is constructed in three sections. The central $20'$ wide strip is $5'$ concrete thickness, with the two outer sections being $1'$ thick. There was concern that the floor might need to be augmented for stability, however loading and survey studies have been carried out which indicated sufficient stability. The floor level is $6'$ below grade, so that the pion/muon beam will be pitched down to about $3'$ below grade. The ground will then provide useful shielding for radiation. The building includes a 40 ton overhead crane, an adjacent control room and work areas, and an adjacent compressor room, all of which will be used for the experiment.

The hall is not large enough to allow for both coil construction and the construction of the ring. These will therefore be phased. The three coil packages (4 coils total) will be each wound in the hall, then stored outside adjacent to the hall. To do this, a slot was built into the south wall of the hall to pass the 14 $m$ diameter coils to and from storage.

Fig. 7.1.1 shows the hall with the $(g-2)$ ring in position. the ring will be placed to the south end to allow for a $12'$ high wall of concrete shielding to protect people in control room area ($6'$ light concrete equivalent, 335 tons, will be sufficient for this). The building will be fenced on the other sides to limit access for radiation protection.

The building and control room are now being used by the $(g-2)$ engineering and physicist staff for design, construction, R&D work on the magnet shimming and measurements, and on the development of the quadrupole and ring vacuum design.

**Figure 7.1.1:** A plan view of the beamline and experimental hall.

## 7.2. Building Foundation Study

The floor of the $(g-2)$ building was loaded on 1 August 1988 to match the ring loading, with survey measurements of elevation and floor expansion taken each week until 12 April 1989. [1] Fig. 7.2.1 shows the distribution of several of the elevations and Fig. 7.2.2 shows the distribution of the measurements across the diameter of the storage ring. Accuracy was estimated by considering the spread of several measurements taken at the same time. We have observed a $0.010''$ maximum fluctuation in elevation and a $0.060''$ maximum spread in the diameter.

The elevation tolerance is set by effects on the muon population which would change the storage volume or the effective field integral seen by the muons, as well as by mechanical considerations. Tilts of the field are more important for the muon populations than displacements. A tilted field creates a vertical force which must be offset by the much weaker quadrupole field. For example, a 0.2 $mrad$ radial tilt of the entire ring (0.5 $mm$ relative to the center) results in a 1 $cm$ displacement of the muon population. This would reduce the effective storage region by 40%. There is a negligible effect on the spin motion and a small additional uncertainty (0.1 $ppm$) in the correction for the average orbit circumference in determining the total field integral seen by the muons. The effect is considerably less if the tilts are randomly distributed. Thus a $\pm 0.5$ $mm$ tolerance ($\pm 0.020''$) has been adopted relative to the reference plane. The floor stability, Fig. 7.2.1, is better than this. It is also planned to monitor tilts with electronic bubble levels and elevations with periodic surveys.

The observed diameter variations have let to a base design which is not tied to the floor, see Chapter 8 for details.

## 7.3. Radiation Shielding

Radiation estimates from the ring have been made assuming pion injection (for muon injection the radiation levels are much less), with $10^8$ $pions/fill$ and three fills per AGS cycle of 1.2 seconds. Pions (and protons for positive beam injection) are 2% higher momentum than the ring setting, and will hit one or more constrictions in the storage aperture (quadrupoles, collimators and vacuum tank walls) after about one turn. Most will then lose energy and spiral to the inside of the ring, ultimately striking one of the 24 electron calorimeters. Approximately 20% of the pions will have decayed before striking material. We assume that $10^7$ $\pi/fill$ strike each calorimeter. We consider 24 sources of radiation (the calorimeters) which are partially shielded vertically and radially to the outside of the ring by the iron return yoke.

**Figure 7.2.1:** Elevation change for for a 4.5 month period.

**Figure 7.2.2:** Diameter variations over 14 $m$ for a 4.5 month period.

An empirical formula for estimating side shielding gives about 16 $mrem/hr$ just outside the iron at the midplane. At the control room area, which is not shielded by the yoke for radiation from across the ring, we estimate 0.4 $mrem/hr$ just outside $6'$ of light concrete.

It is important to realize that the weight of the shielding will affect the floor settling. It will be intolerable to adjust the shielding empirically since a year of careful shimming will have preceded the first beam. A $6'$ thick wall represents a very conservative plan, compared to the AGS experience in the C1 line for example. Muon injection would require no shielding.

The other three sides of the $(g-2)$ building will be fenced at an appropriate distance.

## 7.4. Refrigerator Building

The R&D refrigerator has been moved to a concrete pad on the east side of the $(g-2)$ building, housed in existing temporary buildings.

## 7.5. Ring Thermal Enclosure

The ring iron must be held at a constant temperature, to within $\pm 1^o C$. We plan an inner thermal box of height $10'$ above the floor. Removable insulated panels will be installed on an aluminum frame which will span the width of the $(g-2)$ building. Sides will include three building walls and a wall on the control room side. Access from the control room, which is about $6'$ above the experimental floor, will be from a platform above the ring, with a stairs into the ring center. Sketches of the plan are shown in Fig. 7.5.1. We plan to build the thermal enclosure with a heating/cooling system after the first pion injection run in 1996.

**Figure 7.5.1:** The thermal enclosure.

## 7.6. References

1. A. Pendzick, F. Karl, J. Mills, J. Sullivan, $(g-2)$ *Building Floor Stability*, *Muon* $(g-2)$ *Note No. 39*, May 1989.