# Mini-SNO Geometry

*M.E. Moorhead, M.C. Isaac, K.T. Lesko*

SNO-STR-95-041

The purpose of this report is to describe the geometry of the mini-SNO detector which was dry-assembled in Berkeley and which is now implemented in SNOMAN. This document will serve the dual purposes of i) assuring that the Seattle construction matches the description in SNOMAN (there is a handedness) and ii) defining the PMT locations for the data acquisition and for SNOMAN users.

Mini-SNO is a 2.2 m diameter sphere made with 128 PMT hexes arranged in 20 panels, see Fig. 1. Eight of these panels are S7's and twelve are T6's. Both panel types are shown in Fig. 2 which shows the view of a panel looking from the *outside* of mini-SNO, i.e. the back-side of a panel. The equator of mini-SNO is comprised of six vertical S7 panels arranged in a circle at 60 degree intervals, see Fig. 3. The twelve T6's are located directly above and below the equatorial S7's at 45 degrees inclination to the vertical, see Fig. 4. They are joined together through an S7 placed at each pole (top and bottom).

The global coordinate frame used to describe this geometry will be a right-handed cartesian system with the z-axis vertical ($\theta = 0$) and the origin at the center of mini-SNO. Looking down from above, the y-axis is at $\phi = 90°$ and the x-axis at $\phi = 0°$, with $\phi$ rotating in an anti-clockwise direction. The relationship between this coordinate system and the Seattle water room is yet to be decided, i.e. where in the room is mini-SNO located and where does North point in the x-y plane.

Each hexagon is assigned a unique number from 1 to 128 which defines its location. It may or may not be equipped with a PMT, depending on the number of PMTs (and reflectors) available for mini-SNO. This information will be recorded in SNOMAN. There are currently two versions of mini-SNO available in SNOMAN: 90 PMTs or 128 PMTs, but any number of PMTs ($\leq$ 128) can be easily accommodated. It is important to remember that it is the Hexagons which carry the location number and *not* the PMTs. The panels will also be numbered from 1 to 20, starting with the upper hemisphere T6's, then the lower hemisphere T6's, the equatorial S7's and finally the polar S7's. The Hexagon numbering will start in Panel 1, and then continue incrementally through the rest of the panels. Within each panel the Hex number sequence will follow the order that is prescribed in Fig. 2.

To define the geometry uniquely all that is required is the position and orientation of each panel. This can be achieved by determining two vectors for each panel. The first vector, $V_{pos}$, gives the position (in global coordinates) of the center of the front face of Hex #4 (the central Hex) and the second vector, $V_{dir}$, gives the direction (in global coordinates) from Hex #4 to Hex #6. Normally, one would require a further vector to determine the orientation of a panel since it could be rotated about $V_{dir}$, but in mini-SNO all panels are pointing directly at the center of the detector, so the normal to the front face of each panel is given by $-|V_{pos}|$. The vectors $V_{pos}$ and $V_{dir}$ are given in Table 1 for all panels. Notice that $V_{dir}$ points *upwards* for the upper hemisphere T6's (and the equatorial S7's) and *downwards* for the lower hemisphere T6's. This determines the handedness of mini-SNO, i.e. where the 'missing Hex' is in the T6 panels.

The information in Table 1, and lots more stuff such as the bit which says whether the Hexagon cell has a PMT or not, is fed into SNOMAN by using the command file select_seattle_tank.cmd which loads the titles file pmt_positions_seattle_90.dat (or pmt_positions_seattle_128.dat if you want all 128 PMTs active). The information from these titles files is processed at initialization and stored in the common blocks GE_PANELS and GE_PMTS, where the position and location of every panel and every Hexagon is stored.

Table 1: $V_{pos}$ gives the location, in cm, of the center of the front face of Hex #4 and $V_{dir}$ the unit vector from the center of Hex #4 to the center of Hex #6, (see Fig. 2). In all cases $|V_{pos}| = 110$ cm and $V_{pos}.V_{dir} = 0$.

| Panel # | Panel Type | $V_{pos}$(x) | $V_{pos}$(y) | $V_{pos}$(z) | $V_{dir}$(x) | $V_{dir}$(y) | $V_{dir}$(z) |
|---|---|---|---|---|---|---|---|
| 1 | T6 | 77.78 | 0.00 | 77.78 | -0.7071 | 0.0000 | 0.7071 |
| 2 | T6 | 38.89 | 67.36 | 77.78 | -0.3536 | -0.6123 | 0.7071 |
| 3 | T6 | -38.89 | 67.36 | 77.78 | 0.3536 | -0.6123 | 0.7071 |
| 4 | T6 | -77.78 | 0.00 | 77.78 | 0.7071 | 0.0000 | 0.7071 |
| 5 | T6 | -38.89 | -67.36 | 77.78 | 0.3536 | 0.6123 | 0.7071 |
| 6 | T6 | 38.89 | -67.36 | 77.78 | -0.3536 | 0.6123 | 0.7071 |
| 7 | T6 | 77.78 | 0.00 | -77.78 | -0.7071 | 0.0000 | -0.7071 |
| 8 | T6 | 38.89 | 67.36 | -77.78 | -0.3536 | -0.6123 | -0.7071 |
| 9 | T6 | -38.89 | 67.36 | -77.78 | 0.3536 | -0.6123 | -0.7071 |
| 10 | T6 | -77.78 | 0.00 | -77.78 | 0.7071 | 0.0000 | -0.7071 |
| 11 | T6 | -38.89 | -67.36 | -77.78 | 0.3536 | 0.6123 | -0.7071 |
| 12 | T6 | 38.89 | -67.36 | -77.78 | -0.3536 | 0.6123 | -0.7071 |
| 13 | S7 | 110.00 | 0.00 | 0.00 | 0.0000 | 0.0000 | 1.0000 |
| 14 | S7 | 55.00 | 95.26 | 0.00 | 0.0000 | 0.0000 | 1.0000 |
| 15 | S7 | -55.00 | 95.26 | 0.00 | 0.0000 | 0.0000 | 1.0000 |
| 16 | S7 | -110.00 | 0.00 | 0.00 | 0.0000 | 0.0000 | 1.0000 |
| 17 | S7 | -55.00 | -95.26 | 0.00 | 0.0000 | 0.0000 | 1.0000 |
| 18 | S7 | 55.00 | -95.26 | 0.00 | 0.0000 | 0.0000 | 1.0000 |
| 19 | S7 | 0.00 | 0.00 | 110.00 | -1.0000 | 0.0000 | 0.0000 |
| 20 | S7 | 0.00 | 0.00 | -110.00 | 1.0000 | 0.0000 | 0.0000 |

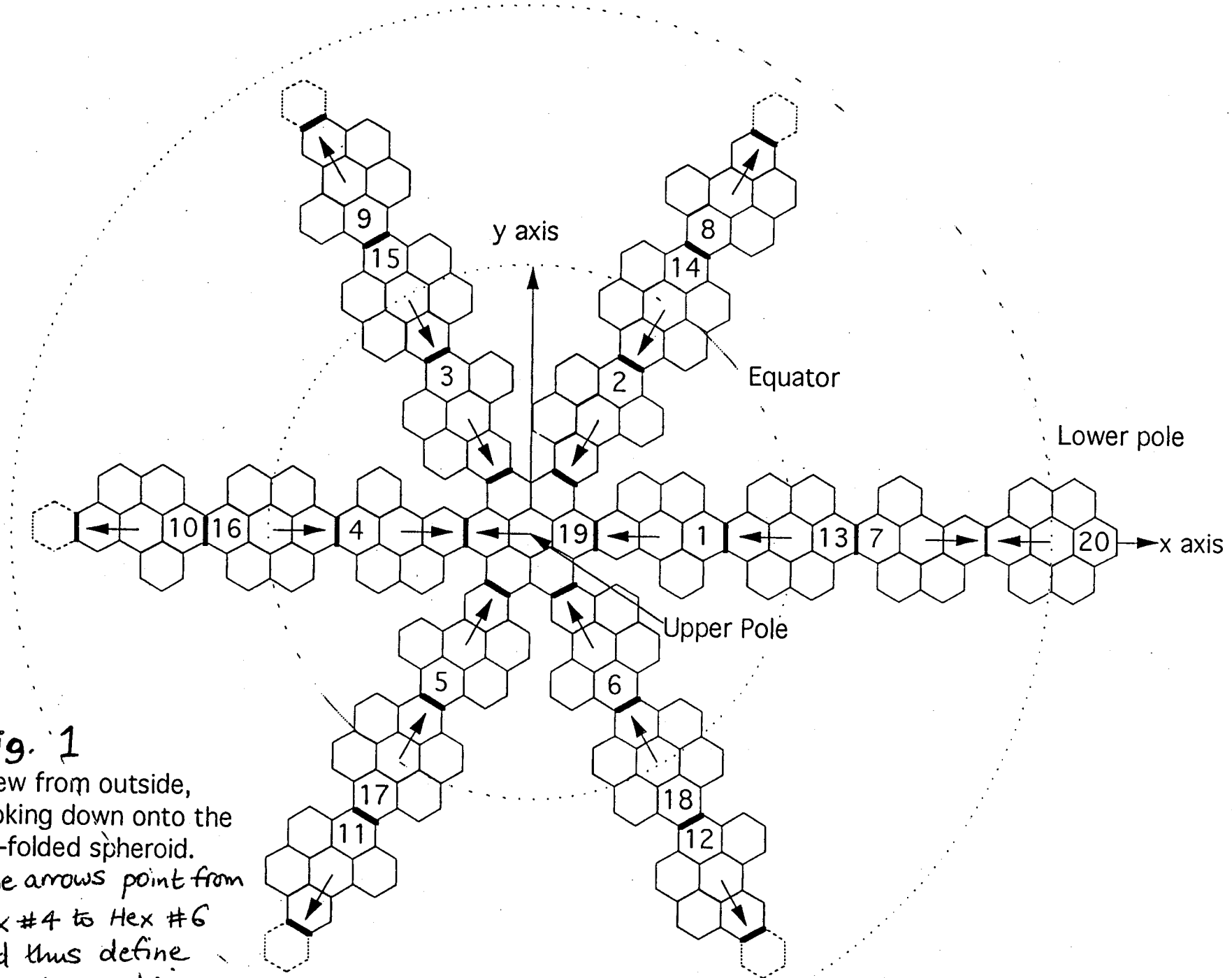


Fig. 1
View from outside, looking down onto the un-folded spheroid. The arrows point from Hex #4 to Hex #6 and thus define the Hex numbering inside each panel, see Fig. 2

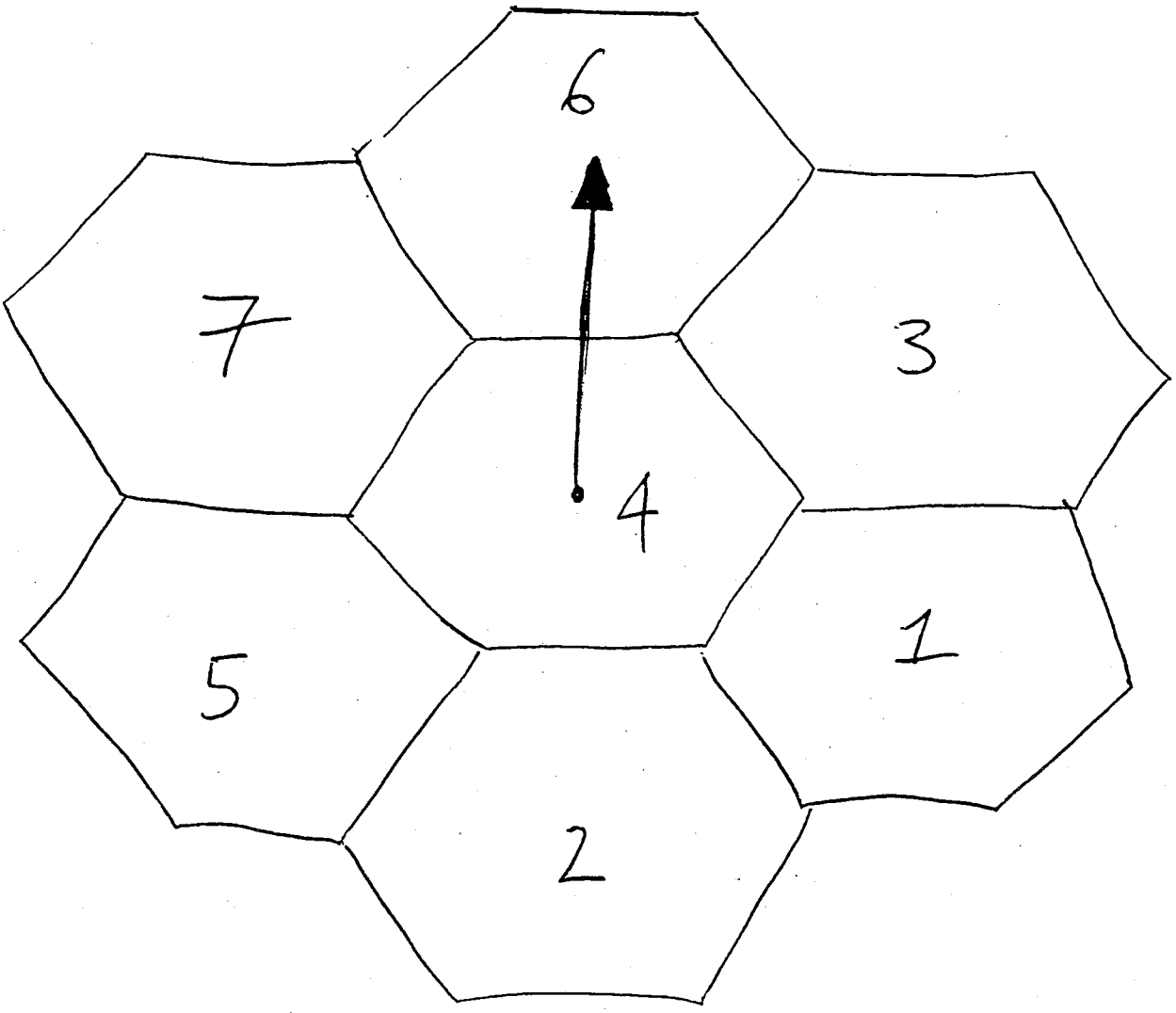


Fig. 2 View of a S7 panel from Outside Mini-SNO. A T6 panel is exactly the same except it has no Hex at location #7. The arrow from Hex #4 to Hex #6 is called $V_{dir}$.

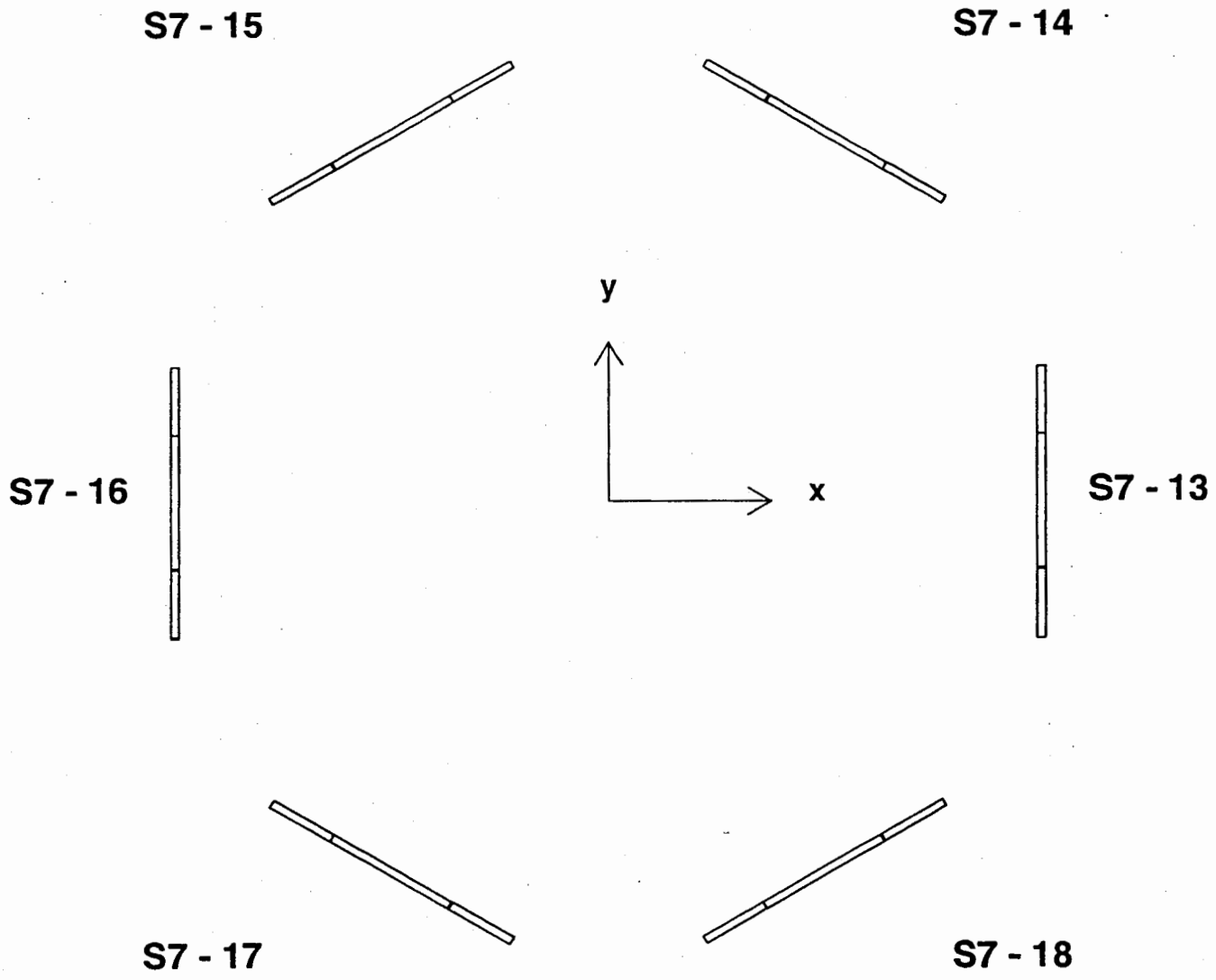


Fig. 3

Horizontal cross-section ($z = 0$) viewed from the top, showing the 6 S7 panels that make-up the equator.

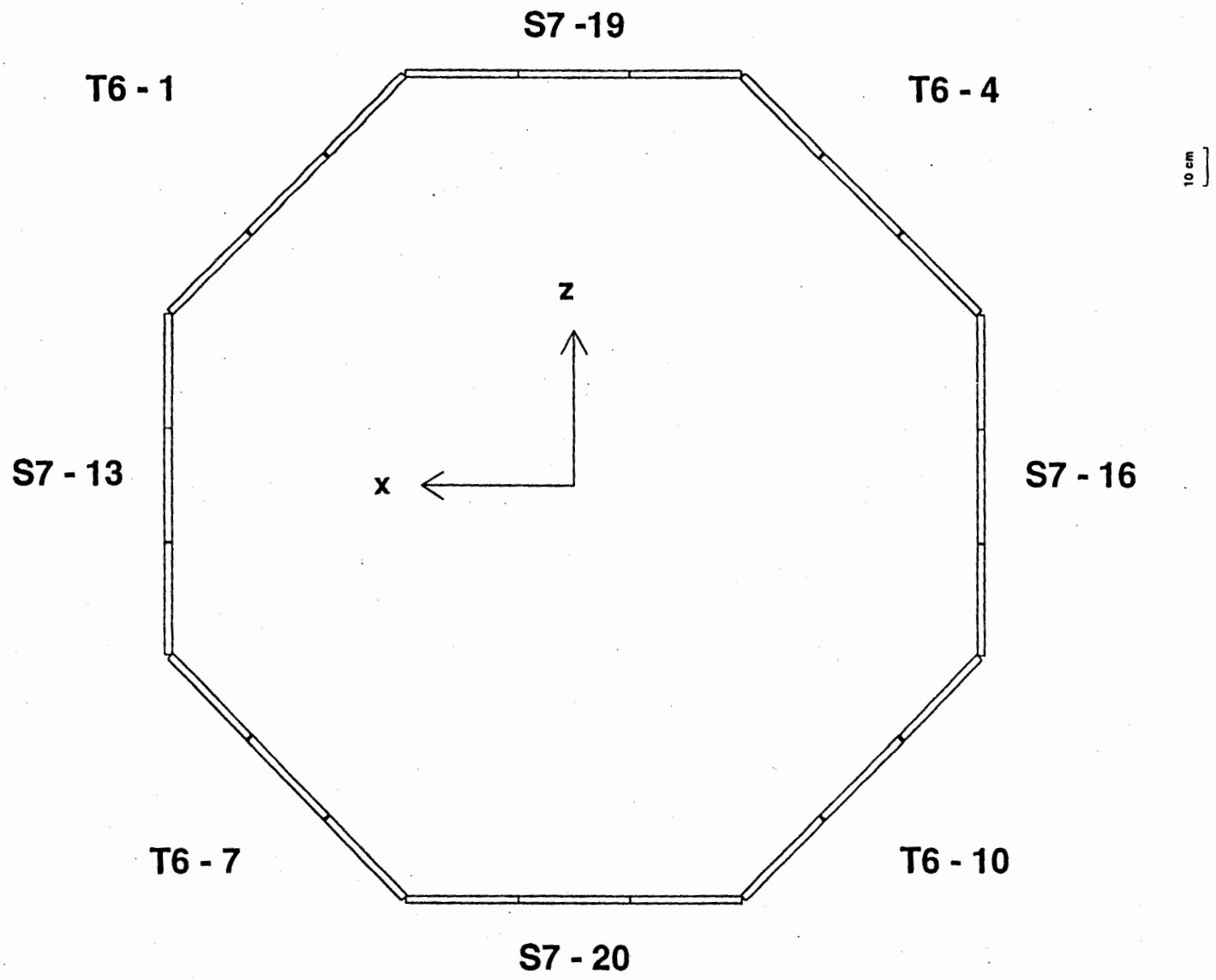


Fig. 4 vertical cross-section ($y=0$) viewed from $y=+\infty$