**CRIS GEOMETRY AND GLOBAL COORDINATE SYSTEM**

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To: CRIS/SIS Data Analysis Teams

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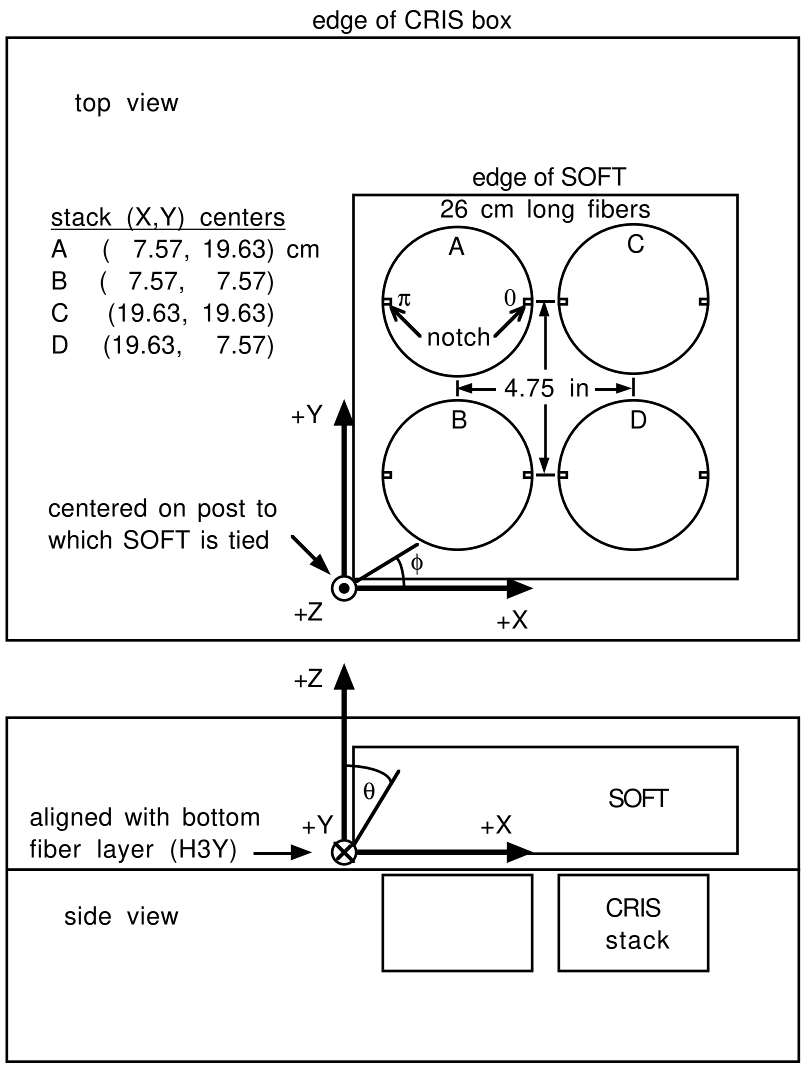
inre: The geometry of CRIS is reviewed for the purposes of data analysis, including:

- a standardized coordinate system placed on the entire instrument
- nominal locations and orientations of detector elements
- estimated tolerances for these locations

In Figure 1 the Si(Li) detector stacks A, B, C, and D are shown as they would appear when looking down on the instrument. As agreed at the Data Analysis meeting in St. Louis last November, the Z = 0 origin coincides with the bottom plane of the SOFT hodoscope; i.e. aligned with the bottom surface of the H3Y fiber plane. The positive Z direction points generally in the opposite sense from incoming particles.

The (X,Y) = (0,0) origin is now aligned with a post to which SOFT is anchored. This post is centered 0.6 cm from the nearest edges of the 26 cm long SOFT scintillating fibers, and SOFT is symmerically positioned over the Si(Li) stacks.

Each Si(Li) detector has a keyway notch cut into its perimeter that disallows rotations with respect to the module/mount. These notches are oriented as noted in the side table. Generally, a detector with its grooved side up (down) has a notch in the $\pi$ (0) position.




notch orientations

| | |
|---|---|
| E1 | π |
| E2 | 0 |
| E3-1 | π |
| E3-2 | 0 |
| E4-1 | π |
| E4-2 | 0 |
| E5-1 | π |
| E5-2 | 0 |
| E6-1 | π |
| E6-2 | 0 |
| E7-1 | π |
| E7-2 | 0 |
| E8-1 | π |
| E8-2 | 0 |
| E9 | 0 |

Figure 1.

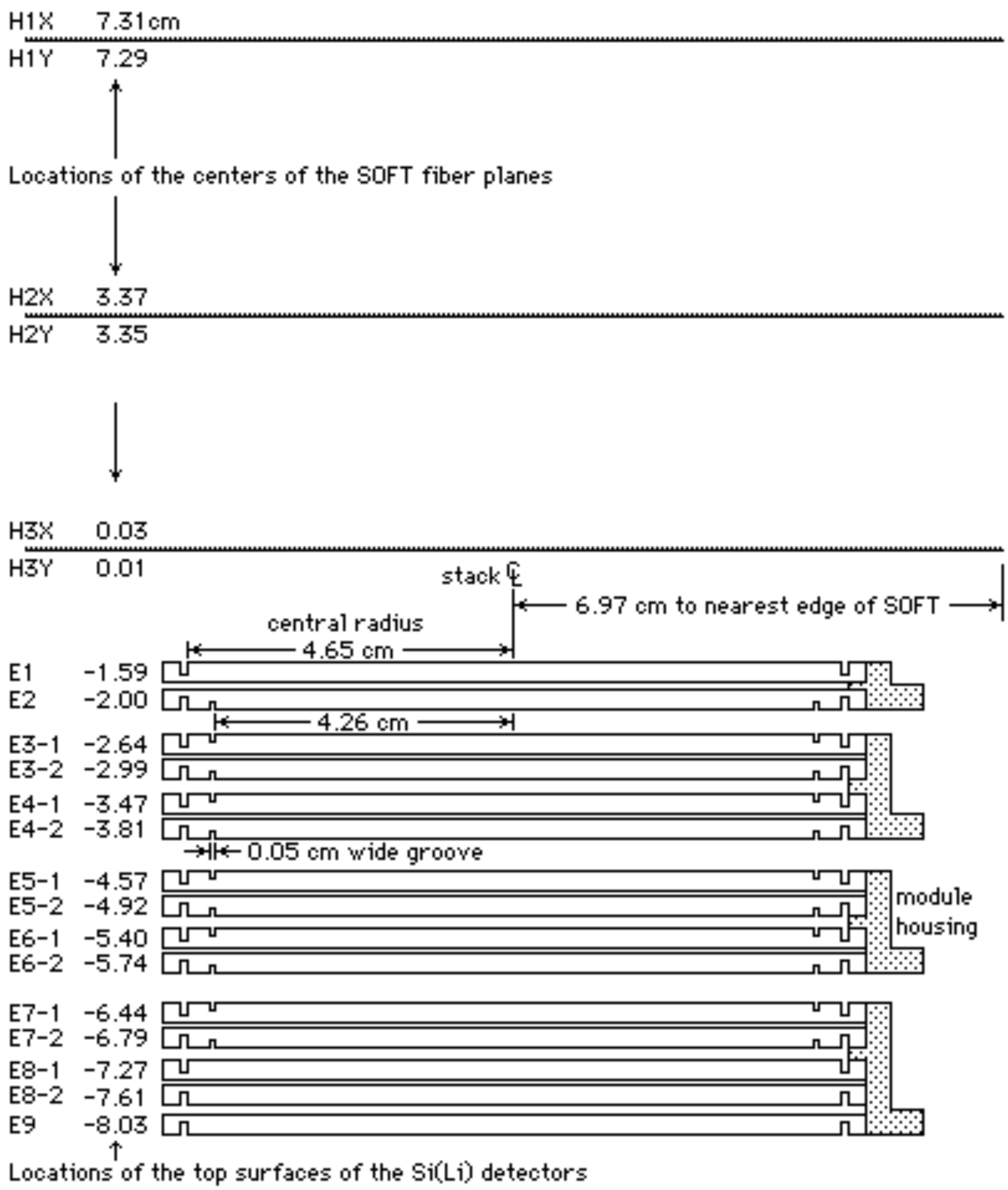
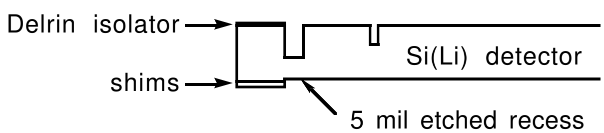



Figure 2.

Figure 2 shows which Si(Li) detectors are single and double grooved, and how they are oriented. Also shown are the locations of the uppermost surfaces of each detector, as well as the locations of the SOFT fiber planes. These coordinates are to be treated as nominal values, derived from the latest design drawings and assembly notes. The details of how such values were obtained are included in the following digression.

When CRIS was assembled for the last time in early April 1996, shims were inserted against the high voltage contacts on the ungrooved sides of each Si(Li) detector. These were needed to insure a snug fit of detectors within their modules. In the table below, columns D, I, and M indicate the amount of shims needed to make up for the difference between the expected and measured detector thickness, Delrin isolator thickness, and module depth, respectively. Values were taken from the final reports of late April and early May 1996, prepared by Nelson Silva: "CRIS Instructions", ACE Library document #36. Units are mils. Note that all detectors and isolators were thinner than the nominal thicknesses called for in the original CRIS design. Column T indicates the total amount of shims actually used.




Typical arrangement of shims and Delrin isolators

| telescope → | A | | | | B | | | | C | | | | D | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D | I | M | T | D | I | M | T | D | I | M | T | D | I | M | T |
| E1 | 7.0 | 2.5 | -1 | 8 | 6.0 | 1.5 | -2 | 5 | 5.0 | 0.5 | -1 | 4 | 5.0 | 2.5 | 2 | 9 |
| E2 | 5.0 | 1.5 | 0 | 6 | 5.5 | 1.0 | 1 | 7 | 5.0 | 2.0 | -1 | 6 | 6.0 | 0.5 | 2 | 8 |
| E3-1 | 2.0 | 1.0 | 1 | 4 | 2.0 | 2.5 | -1 | 3 | 1.5 | 0.5 | 1 | 3 | 1.0 | 1.5 | 0 | 2 |
| E3-2 | 5.0 | 1.5 | 1 | 7 | 4.0 | 2.0 | -1 | 5 | 4.5 | 1.0 | 1 | 6 | 4.5 | 2.0 | 0 | 6 |
| E4-1 | 4.5 | 1.0 | 2 | 7 | 6.0 | 1.0 | -1 | 6 | 6.0 | 1.0 | 1 | 8 | 4.5 | 2.5 | -2 | 5 |
| E4-2 | 1.5 | 1.0 | 2 | 4 | 1.5 | 1.0 | -1 | 2 | 1.5 | 1.5 | 1 | 4 | 1.5 | 2.5 | -2 | 2 |
| E5-1 | 1.5 | 2.5 | 1 | 5 | 1.5 | 1.0 | -1 | 2 | 2.5 | 2.0 | 1 | 5 | 2.0 | 0.5 | 1 | 3 |
| E5-2 | 4.5 | 2.0 | 1 | 7 | 4.5 | 1.5 | -1 | 5 | 5.0 | 1.0 | 1 | 7 | 6.5 | 1.0 | 1 | 8 |
| E6-1 | 5.0 | 2.0 | 1 | 8 | 4.0 | 0.5 | .5 | 5 | 7.5 | 2.0 | -1 | 8 | 4.5 | 2.5 | 0 | 7 |
| E6-2 | 2.5 | 2.0 | 1 | 5 | 2.0 | 1.5 | .5 | 4 | 2.0 | 1.0 | -1 | 2 | 1.5 | 2.5 | 0 | 4 |
| E7-1 | 2.5 | 2.0 | -1 | 3 | 1.5 | 1.0 | -1 | 2 | 1.5 | 2.5 | 1 | 5 | 1.0 | 0.5 | 0 | 2 |
| E7-2 | 6.5 | 1.5 | -1 | 7 | 5.0 | 2.5 | -1 | 6 | 5.0 | 2.5 | 1 | 8 | 6.5 | 2.5 | 0 | 9 |
| E8-1 | 3.5 | 2.5 | -3 | 3 | 5.5 | 1.5 | 1 | 8 | 8.0 | 1.0 | 0 | 9 | 4.5 | 0.5 | 0 | 5 |
| E8-2 | 3.0 | 2.5 | -3 | 2 | 3.5 | 1.0 | 1 | 5 | 2.0 | 1.5 | 0 | 3 | 1.5 | 1.0 | 0 | 2 |
| E9 | 2.0 | 1.0 | 0 | 3 | 3.0 | 0.5 | 1 | 4 | 2.5 | 1.5 | 0 | 4 | 2.5 | 2.0 | 0 | 4 |

D = shims needed for detector thickness deviations (measured around the detector edge)
I = shims needed for Delrin isolator thickness deviations
M = shims needed for module depth deviations
T = total shims used

There are "ledges" in the module housings below detectors E1, E3-2, E5-2, and E7-2 which fix the positions of every detector at their nominal locations according to the design drawings. After adjusting for the necessary shims, the top (grooved) surfaces of detectors E1, E3-1, E4-1, E5-1, E6-1, E7-1, and E8-1 are higher than expected by the amount (I). The top (ungrooved) surfaces of E2, E3-2, E4-2, E5-2, E6-2, E7-2, E8-2, and E9 are lower than expected by the amount (D + I + 5 mils); where 5 mils are added to account for the etched recess of that ohmic surface relative to the detector edge. Columns 2 through 4 of the following table list the required adjustments, in mils. These adjustments are equal to withn a few mils for each telescope; i.e. well within the uncertainty required for good resolution in measurements of cosmic ray particle masses. Therefore a single "typical" telescope may be reported here, including only the average positions of each detector. Accordingly, the next column ("design") lists the nominal positions of the top surfaces of all detectors, taken from Sandy Shuman's drawing of late November 1996. The last column lists the calculated average positions after taking account of the adjustments.

| det. | ΔA | ΔB | ΔC | ΔD | design | Typical |
|---|---|---|---|---|---|---|
| E1 | 2.5 | 1.5 | 0.5 | 2.5 mils | -1.59 cm | -1.59 cm |
| E2 | -11.5 | -11.5 | -12.0 | -11.5 | -1.97 | -2.00 |
| E3-1 | 1.0 | 2.5 | 0.5 | 1.5 | -2.64 | -2.64 |
| E3-2 | -11.5 | -11.0 | -10.5 | -11.5 | -2.96 | -2.99 |
| E4-1 | 1.0 | 1.0 | 1.0 | 2.5 | -3.47 | -3.47 |
| E4-2 | -7.5 | -7.5 | -8.0 | -9.0 | -3.79 | -3.81 |
| E5-1 | 2.5 | 1.0 | 2.0 | 0.5 | -4.57 | -4.57 |
| E5-2 | -11.5 | -11.0 | -11.0 | -12.5 | -4.89 | -4.92 |
| E6-1 | 2.0 | 0.5 | 2.0 | 2.5 | -5.40 | -5.40 |
| E6-2 | -9.5 | -8.5 | -8.0 | -9.0 | -5.72 | -5.74 |
| E7-1 | 2.0 | 1.0 | 2.5 | 0.5 | -6.44 | -6.44 |
| E7-2 | -13.0 | -12.5 | -12.5 | -14.0 | -6.76 | -6.79 |
| E8-1 | 2.5 | 1.5 | 1.0 | 0.5 | -7.27 | -7.27 |
| E8-2 | -10.5 | -9.5 | -8.5 | -7.5 | -7.59 | -7.61 |
| E9 | -8.0 | -8.5 | -9.0 | -9.5 | -8.01 | -8.03 |

## TOLERANCES

Sandy Shuman estimates that the X and Y coordinates for any Si(Li) detector could be out by as much as 0.5 mm, while the Z locations could be out by 0.25 mm at most. He also estimates that a detector could be rotated by 0.1° beyond its nominal postion, and that it could be tilted in its mount by 0.1° at most with respect to normal.