SSC-N-288
SSC-MAG-115

1/28/87

SSC ARC-QUAD END DESIGN*

S. Caspi and M. Helm
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720

We outline two types of end design for the SSC arc-quad. The first design is a "dog bone end" where the end pole pieces bulge out azimuthally to ease the bend on the cable turnaround. This design has been implemented into magnet AQ-1. The second design is a "straight end," and will be used in magnet AQ-2.

In both cases we have constrained the end to produce a lower field than the straight section and to have its first allowed harmonic integrate to zero axially.

We anticipate the "straight end" configuration to be superior to the "dog bone end" both mechanically and magnetically. It is our plan to make adjustments after the magnets have been tested and measured.

General Features

Both ends have been computed without iron. We have assumed that the iron in the straight section terminates prior to the end or has a somewhat larger inner diameter when covering the end. In any case the effect of iron on field intensity and quality is expected to be small. (This has been shown to be true in the dipole end.) A second assumption was made regarding the conductor radial dimension. We assumed that each current line is placed at the center of each layer. Finally we benefited from the magnetic characteristics of the straight section design. In the straight section each layer by itself produces a good quality quadrupole. Therefore it is easier to separate the

*This work was supported by the Director, Office of Energy Research, Office of High Energy and Nuclear Physics, High Energy Physics Division, U.S. Dept. of Energy, under Contract No. DE-AC03-76SF00098.

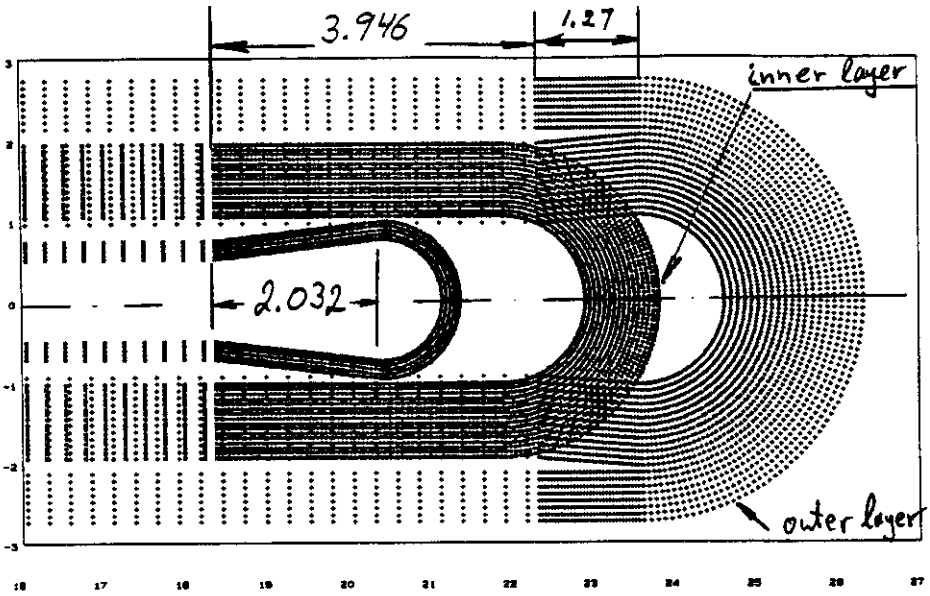
maximum field condition from the field quality at the magnet end. Field quality is not effected by relative displacement of the two layers -- which effects the maximum field -- but is only by an axial displacement of the blocks within a layer.

Results

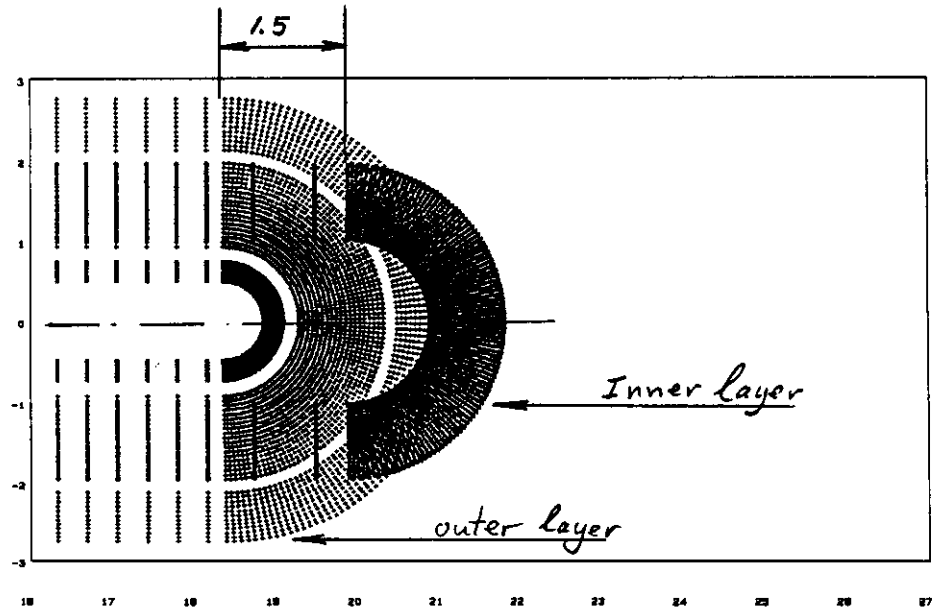
The two designs are shown in Fig. 1. The overall length of the "straight end" is shorter than the "dog bone end," with its inner layer extending beyond the outer layer. The corresponding field computed along a path adjacent to the inner layer pole is plotted in Fig. 2. It turns out that the overall maximum field is located along that path.

The local quadrupole and the first allowed harmonic b_5 are plotted in Figs. 3 and 4. The integrated value of b_5 along Z has been minimized. Note that in all figures the Z dimension carries only relative values.

Included are the computer input for both ends.



(a)



(b)

Figure 1. Develop view of the "dog bone end"-(a), and "straight end"-(b) (dimension in cm).

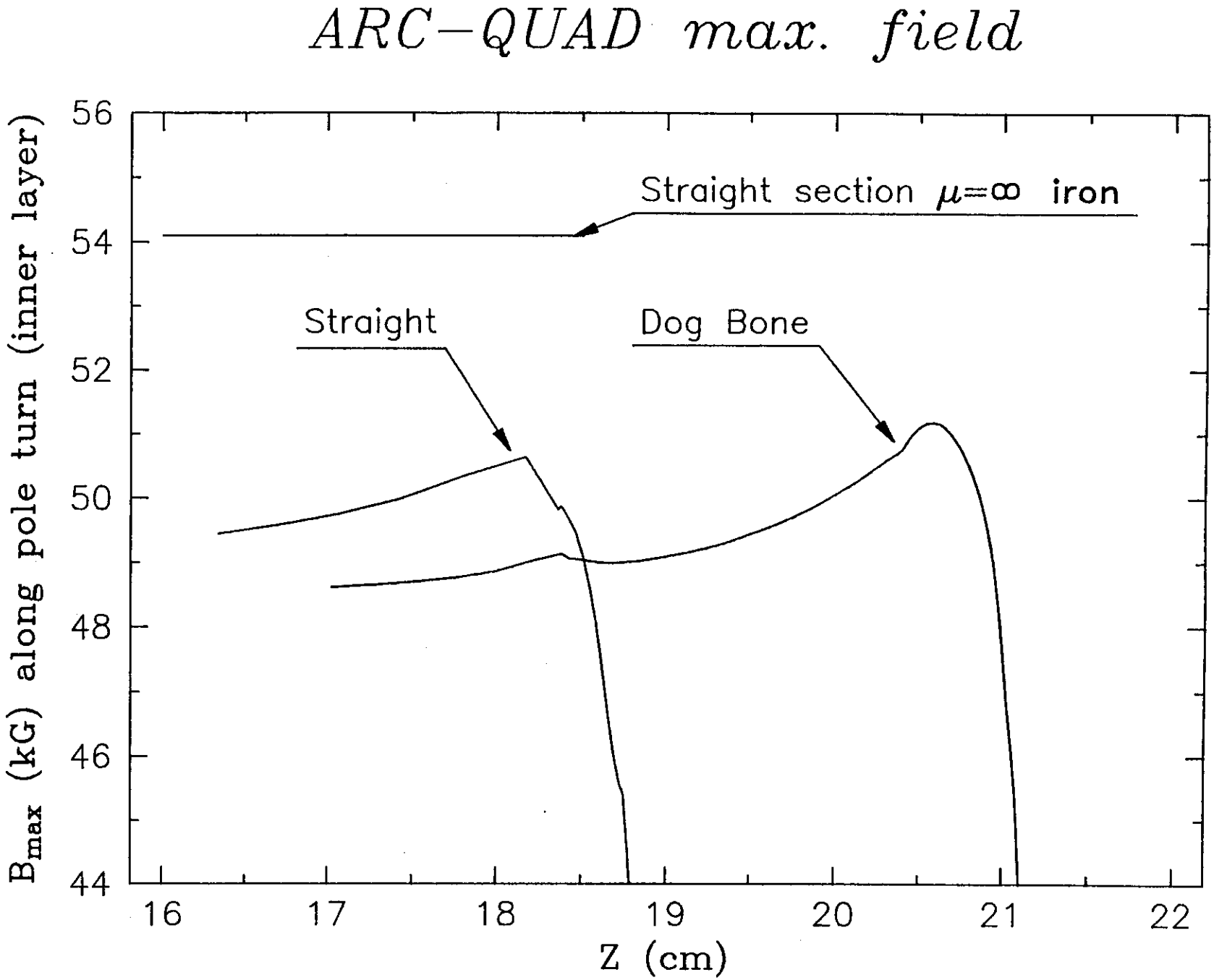


Figure 2. Field values along a path adjacent to the pole (inner layer).

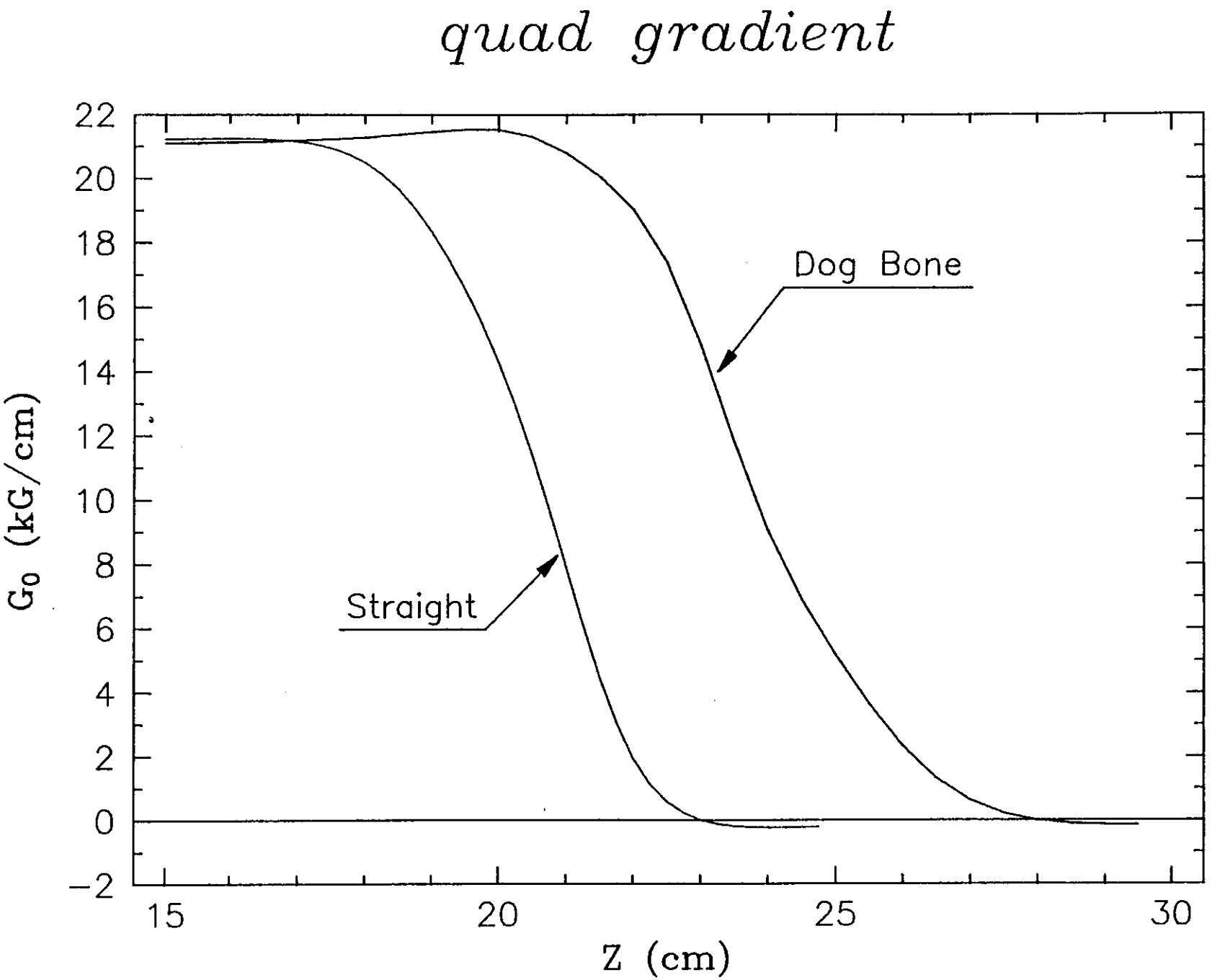


Figure 3. Quadrupole gradient along the end.

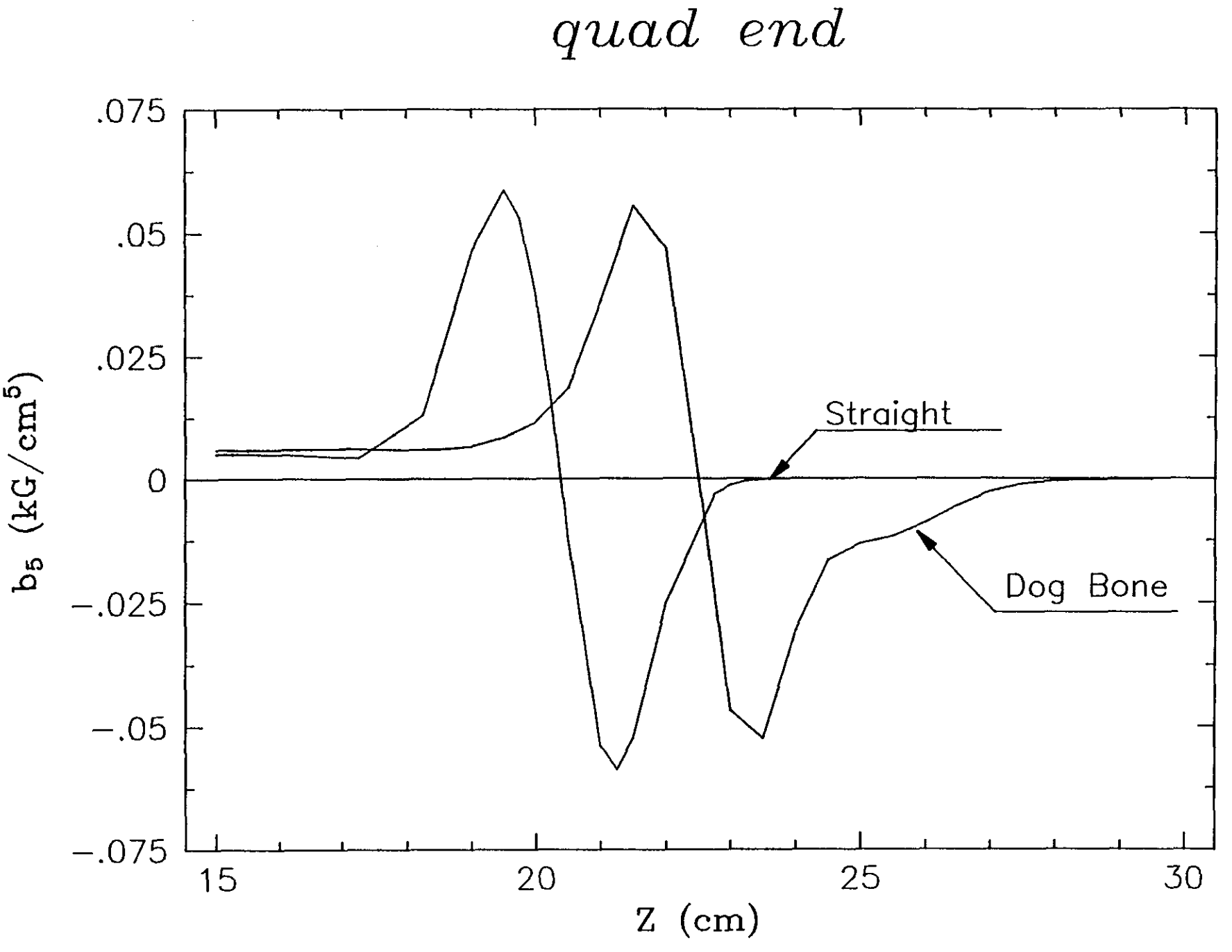


Figure 4. First allowed harmonic along the end integrates to ~ 0.

```
Case 3 - Layer 1 INTER-BLOCK SPACER
quad
cyl
$jdata bone = t jprint = 0
thick = 0.1346
nnx = 2 nny = 2 nnz = 2
zl(1) = 18.354 zl(2) = 22.3
mph(1) = 40 nl(1) = 76 nzb(1) = 40 nzs(1) = 0 ncs(1) = 50
mph(2) = 40 nl(2) = 84 nzb(2) = 32 nzs(2) = 0 ncs(2) = 50
dbone(1) = 2.032 db2(1) = 2.032 lsp(1) = 1 acone(1) = 0.0 acone(2) = 0.0
dbsp(1) = 0.0 dbsp(2) = 0.0
dbone(2) = 1.27  db2(2) = 1.27  lsp(2) = 1 $
4,2
  .240   22.015 2.0244 3.001  0.0 6.50 0.0 0.0
27.895    6.24  2.0244 3.001  0.0 6.50 0.0 0.0
  .165   11.115 3.062  4.0442 0.0  6.50 0.0 0.0
12.99    17.535 3.062  4.0442 0.0  6.50 0.0 0.0
1 25.0 1.5
```

```
Case 4 - Layer 2 on layer 1 ; no dbone
quad
cyl
$jdata bone = f jprint = 0
thick = 0.1346
nnx = 2 nny = 2 nnz = 2
zl(1) = 18.354 zl(2) = 18.354
mph(1) = 60 nl(1) = 50 nzb(1) =  0 nzs(1) = 0 ncs(1) = 50
mph(2) = 60 nl(2) = 50 nzb(2) =  0 nzs(2) = 0 ncs(2) = 50
dbone(1) = 2.032 db2(1) = 2.032 lsp(1) = 1 acone(1) = 0.0 acone(2) = 0.0
dbsp(1) = 0.0 dbsp(2) = 0.0
dbone(2) = 1.27  db2(2) = 1.27  lsp(2) = 1 $
4,2
  .240   22.015 2.0244 3.001  0.0 6.50 0.0 0.0
27.895    6.24  2.0244 3.001  0.0 6.50 0.0 0.0
  .165   11.115 3.062  4.0442 0.0  6.50 0.0 0.0
12.99    17.535 3.062  4.0442 0.0  6.50 0.0 0.0
1 25.0 1.5
```

Computer input to "dog bone end"-top, and "straight end"-bottom.