



**Particle Physics Division  
Mechanical Department Engineering Note**

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Project Internal Reference:

Project: FHEP Bookend

Title: FHEP Bookend flatness

Author(s): Mike Zuckerbrot

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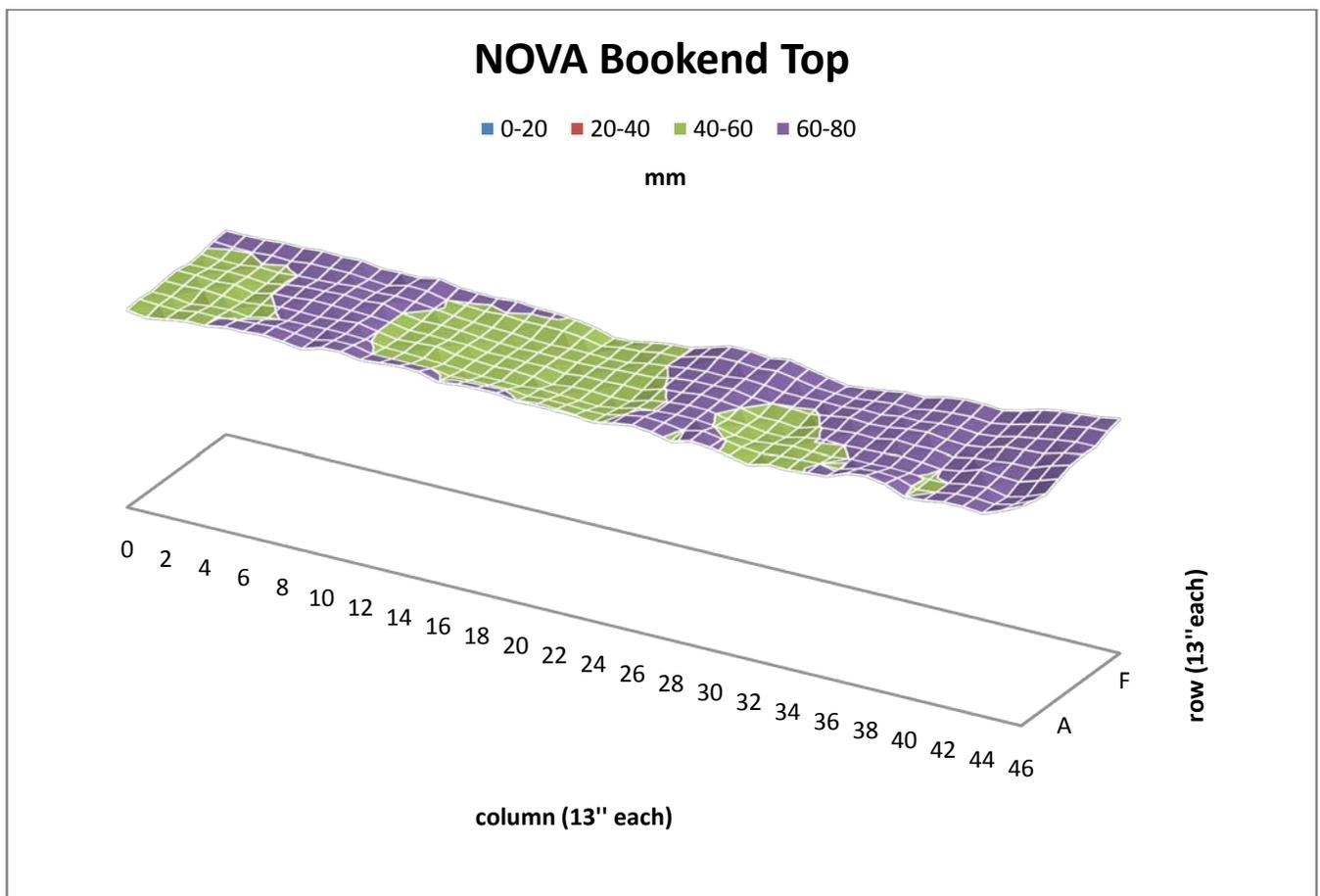
Applicable Codes:

Abstract Summary:

The following analyzes and plots the flatness of the FHEP bookend from several perspectives.

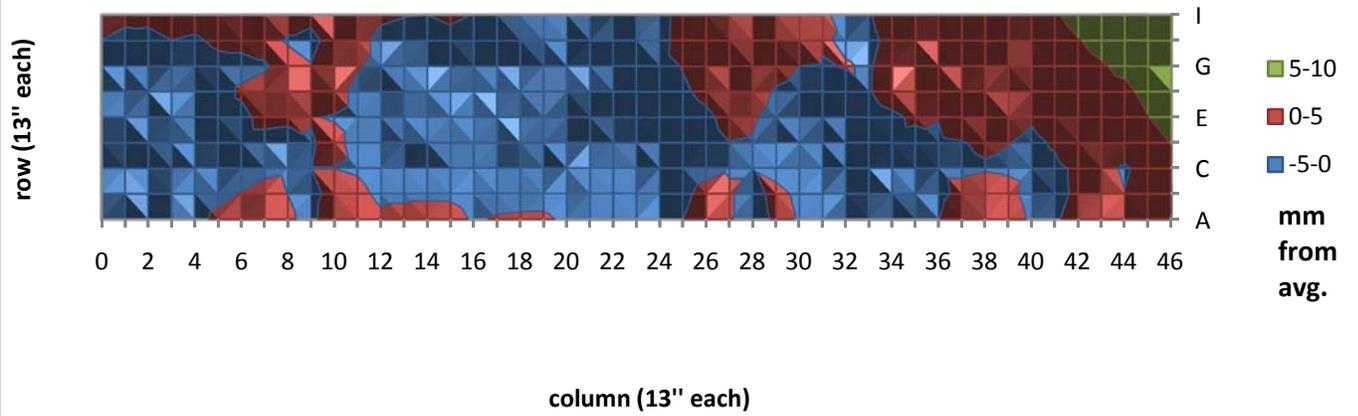
## Discussion/Summary

The FHEP bookend was split into a chalk line grid 47 columns wide (numbered 0-46) and 9 rows deep (labeled A-I) with each section 13 square inches, for a total of 423 vertices. These points' heights were measured with a fixed optical level and plotted as a whole surface, by row, and by column. The surface has shown to have its lowest sections around the origin corner (0, A), as well as in the center section. The surface peaks at the far right corner (46, I), and increases with height when approaching this end. A small portion of the difference between the elevations of the two far ends (about 59 mm – 65 mm from row 0 to row 46) may be due to the bookend sitting on a slightly uneven surface, but the average height of the surface was found to be 60.62104 mm.

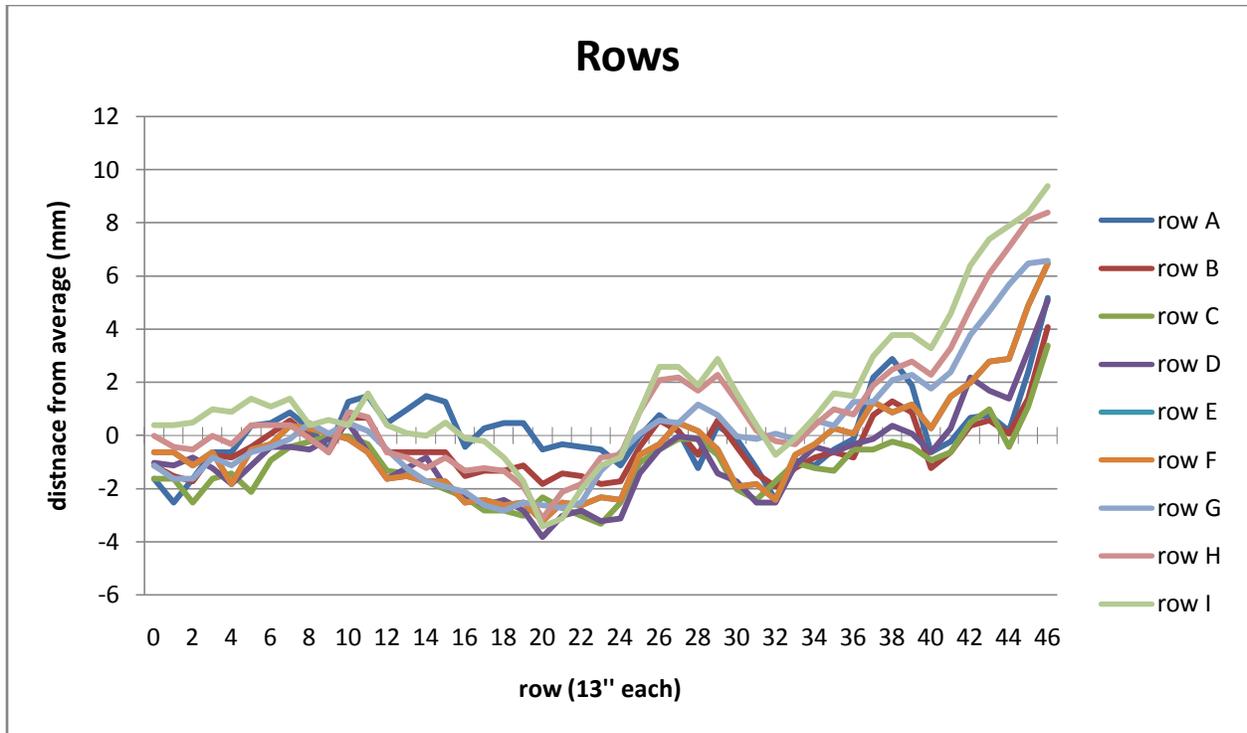


*3-D plot of the surface of the bookend with elevation varying from 56.8 mm close to the center up to 70 mm at the far corner (46, I).*

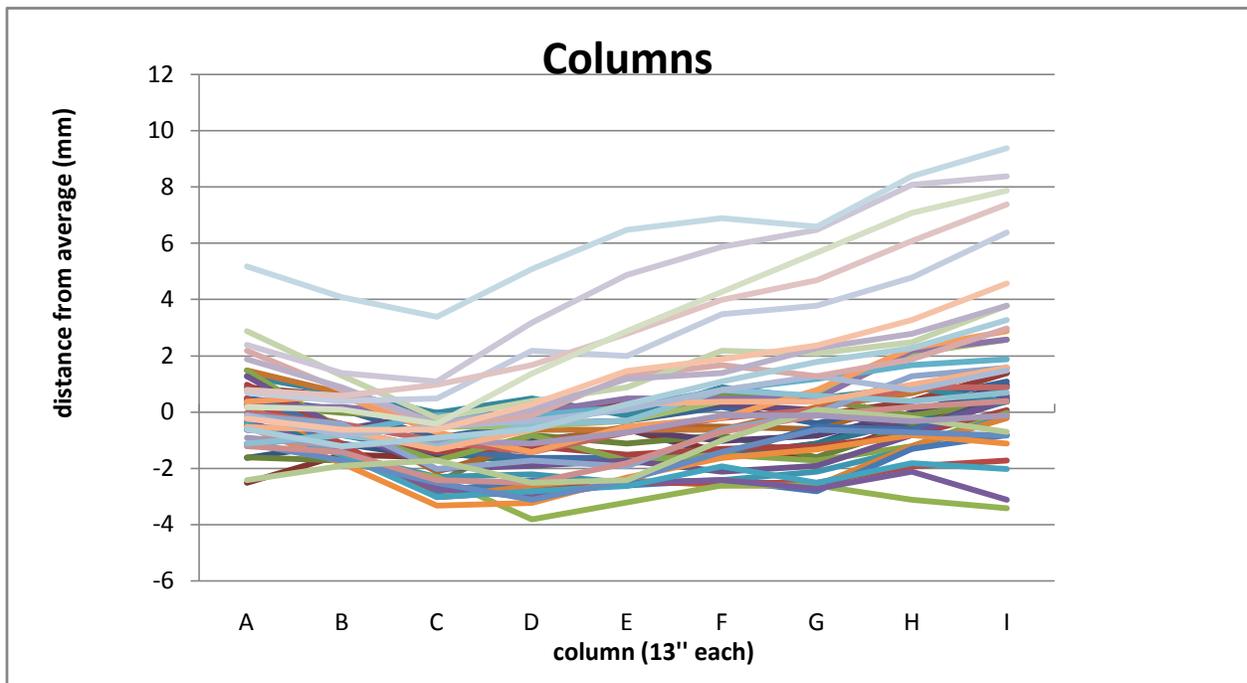
# Top View of Bookend



*Arial view of the surface.*



*This plot shows the trend in the elevation of the surface when looking at it by row against the distance from its average height of the bookend (60.62104 mm).*



*This plot shows the trend in elevation of the surface when looking at it by row against the distance from its average height (60.62104 mm).*

*Elevations recorded with optical level, all measurements in mm*

	A	B	C	D	E	F	G	H	I
0	59	59.5	59	59.6	60	59.1	59.5	60.6	61
1	58.1	59.1	59	59.5	60	59.2	59	60.2	61
2	59	58.9	58.1	59.8	59.5	59.8	59	60.1	61.1
3	60	59.9	59	59.4	60	59.6	59.8	60.6	61.6
4	60	59.8	59.2	58.8	58.8	59	59.5	60.3	61.5
5	61	60.2	58.5	59.5	60.1	60.1	60	61	62
6	61.1	60.7	59.7	60.2	60.3	60.8	60.2	61	61.7
7	61.5	61.2	60.2	60.2	61	61	60.5	61	62
8	60.9	60.6	60.4	60.1	60.9	61.3	61.1	60.5	61
9	60.1	60	60.6	60.5	60.7	60.9	60.7	60	61.2
10	61.9	61.3	60.6	61.1	60.5	61.5	61.1	61.5	61
11	62.1	61.3	60.3	60	60	60	60.8	61.3	62.2
12	61.1	60	59.3	59	59	59.1	60.1	60	61
13	61.6	60	59.2	59.4	59.1	59.3	59.4	59.8	60.7
14	62.1	60	58.9	59.8	58.9	59.1	58.9	59.4	60.6
15	61.9	60	58.6	58.7	58.9	58.5	58.7	59.8	61.1
16	60.2	59.1	58.3	58.4	58.1	58.2	58.5	59.3	60.5
17	60.9	59.3	57.8	58	58.2	58	58	59.4	60.4
18	61.1	59.3	57.8	58.2	58	58.2	57.8	59.3	59.8
19	61.1	59.5	57.6	57.8	58.1	58.1	58.1	58.7	58.9
20	60.1	58.8	58.3	56.8	57.4	58	58	57.5	57.2
21	60.3	59.2	57.9	57.6	58.1	58.2	57.9	58.5	57.5
22	60.2	59.1	57.6	57.8	58	58.7	58.1	58.8	58.6
23	60.1	58.8	57.3	57.4	58.3	59	59.3	59.8	59.5
24	59.5	58.9	58.1	57.5	58.2	59.2	60	59.9	59.8
25	60.6	60.2	59.6	59.2	59.9	60.4	60.7	61.5	61.5
26	61.4	61.2	60.1	60.1	60.3	61	61.2	62.7	63.2
27	60.8	60.8	60.5	60.6	61.1	61.1	61.1	62.8	63.2
28	59.4	59.9	60.5	60.5	60.8	61.4	61.8	62.3	62.5
29	61	61.2	59.9	59.2	60.1	60.4	61.4	62.9	63.5
30	60.5	60.2	58.6	58.9	58.7	60	60.6	61.9	62.2
31	59.4	59.2	58.2	58.1	58.8	59.9	60.5	60.8	61
32	58.2	58.7	58.9	58.1	58.2	59.6	60.7	60.4	59.9
33	59.7	59.4	59.6	59.5	59.9	60.5	60.5	60.3	60.5
34	59.5	59.8	59.4	60.2	60.3	61.4	61.2	61	61.3
35	60.1	60	59.3	60	60.9	61	61	61.6	62.2
36	60.5	59.8	60.1	60.3	60.7	61.4	61.9	61.4	62.1
37	62.8	61.4	60.1	60.5	61.9	62.3	61.9	62.5	63.6
38	63.5	61.9	60.4	61	61.5	62.8	62.7	63.1	64.4

39	62.5	61.5	60.2	60.7	61.8	62	62.9	63.4	64.4
40	60	59.4	59.7	60	60.9	61.7	62.4	62.9	63.9
41	60.4	60	60	60.9	62.1	62.5	63	63.9	65.2
42	61.3	61	61.1	62.8	62.6	64.1	64.4	65.4	67
43	61.4	61.2	61.6	62.3	63.4	64.6	65.3	66.7	68
44	60.8	60.7	60.2	62	63.5	64.9	66.3	67.7	68.5
45	63	62	61.7	63.8	65.5	66.5	67.1	68.7	69
46	65.8	64.7	64	65.7	67.1	67.5	67.2	69	70