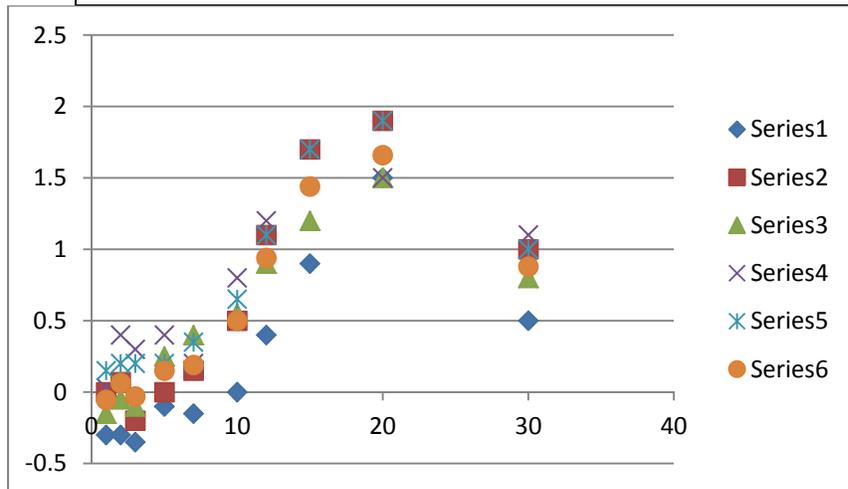


**Proposal for correcting the apparent centerline offsets in the 2015 flame profiles V3**  
**2017-03-05**

Before distributing the 2015 data, we need to agree on a strategy to correct the apparent problems with flame centering. With Shawn’s data, I had applied a linear correction based on the apparent centerline offset in his FA flame because this flame had the most symmetric exit profile of mixture fraction. That correction was applied to all flames and seemed to do a reasonable job.

Some time back, Hugh generated a table of the apparent centerline offsets for all of the 2015 flame profiles. Results showed a nonlinear behavior, which could not be easily explained by a fixed tilt of the flame or a fixed non-verticality of the traverse. At the time we decide not to apply any correction to the radial positions. Hugh’s results are tabulated and plotted below.

x/D	FA75_45	FJ75_57	FJ300_59	FJ75_80	FJ75_103	AVE
1	-0.3	0	-0.15	0.03	0.15	-0.054
2	-0.3	0.07	-0.05	0.4	0.2	0.064
3	-0.35	-0.2	-0.1	0.3	0.2	-0.03
5	-0.1	0	0.25	0.4	0.2	0.15
7	-0.15	0.15	0.4	0.2	0.35	0.19
10	0	0.5	0.55	0.8	0.65	0.5
12	0.4	1.1	0.9	1.2	1.1	0.94
15	0.9	1.7	1.2	1.7	1.7	1.44
20	1.5	1.9	1.5	1.5	1.9	1.66
30	0.5	1	0.8	1.1	1	0.88



Centerline offsets reported by Hugh. “Series 6” is the average of the five flames.

When gearing up for subsequent experiments on the TUD stratified burner, we had major problems with the traverse. In the process of repairing and debugging, we determined that there was a nonlinear shift in the laser-axis position. From the figure above, it appears that we are

seeing a reasonably repeatable pattern that the offset increases up to  $x/D=20$  then drops again at  $x/D=30$ . In addition, there is some spread in the initial alignment, such that the nominal  $r=0$  position is +/- up to 0.4 mm from the true centerline. I do not recall how we did the initial alignment each day, but the measured mean temperature profiles in the first 1-3 diameters should be symmetric.

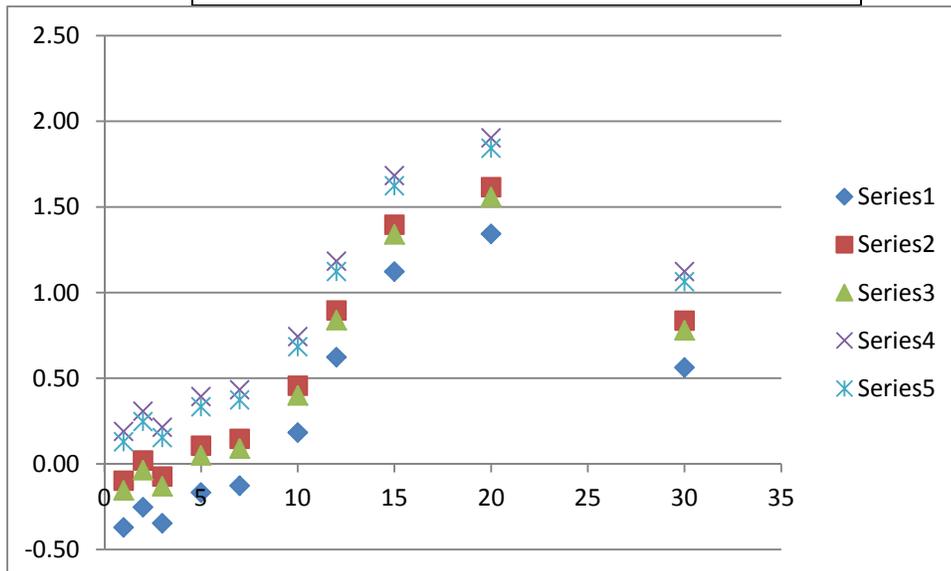
I have calculated the initial positioning error for each flame as the average offset for the first three points,  $x/D=1,2,3$ . I have also calculated the average offset for the five flames at each  $x/D$  position. I propose that we apply corrections that combine these two effects, an initial alignment offset for each flame and the nonlinear shift in  $r$  as the traverse moves down.

The initial offset values for each flame are:

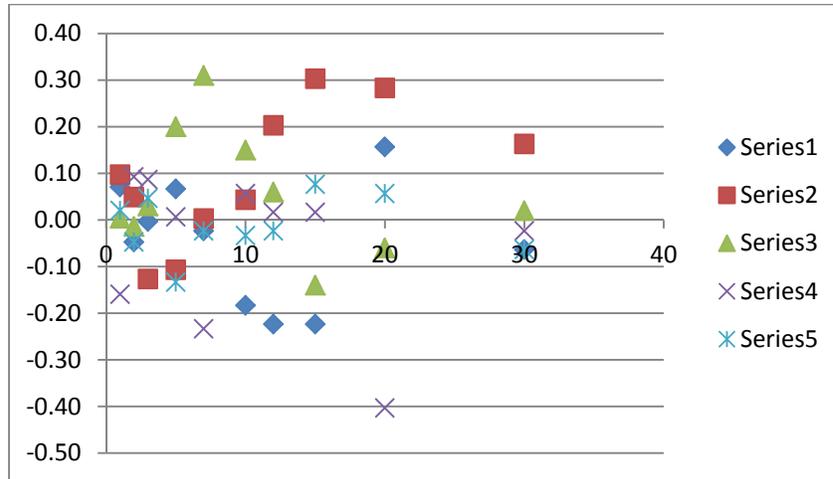
FA75_45	FJ75_57	FJ300_59	FJ75_80	FJ75_103
-0.32	-0.04	-0.10	0.24	0.18

The corrections for each flame are then the values in the AVE column above plus the corresponding initial offset for that flame, as tabulated and plotted below.

$x/D$	FA75_45	FJ75_57	FJ300_59	FJ75_80	FJ75_103
1	-0.37	-0.10	-0.15	0.19	0.13
2	-0.25	0.02	-0.04	0.31	0.25
3	-0.35	-0.07	-0.13	0.21	0.15
5	-0.17	0.11	0.05	0.39	0.33
7	-0.13	0.15	0.09	0.43	0.37
10	0.18	0.46	0.40	0.74	0.68
12	0.62	0.90	0.84	1.18	1.12
15	1.12	1.40	1.34	1.68	1.62
20	1.34	1.62	1.56	1.90	1.84
30	0.56	0.84	0.78	1.12	1.06



The residuals (Hugh's values minus the correction) are plotted below, and are mostly within  $\pm 0.1$  mm in the near field and within  $\pm 0.3$  mm farther downstream. The tabulated corrections would be added to the xmm values in the original data.



Residuals (Hugh's values for centerline offsets – the corresponding correction)

From H. Cutcher email (Nov 20, 2016) the FJ80 offset at  $x/D=1$  is an outlier. The measured offset of 0.03mm has been used. The offset for FJ80,  $x/D=20$  also looks odd but there was no delay between profiles at  $x/D=15, 20,$  and  $30$  (no gap attributable to moving the tunnel for OH alignment).

```
rShift =

      xD: [1 2 3 5 7 10 12 15 20 30]
    FJ75_57: [-0.1000 0.0200 -0.0700 0.1100 0.1500 0.4600 0.9000 1.4000 1.6200 0.8400]
    FJ75_80: [0.0300 0.3100 0.2100 0.3900 0.4300 0.7400 1.1800 1.6800 1.9000 1.1200]
    FJ75_103: [0.1300 0.2500 0.1500 0.3300 0.3700 0.6800 1.1200 1.6200 1.8400 1.0600]
    FJ300_59: [-0.1500 -0.0400 -0.1300 0.0500 0.0900 0.4000 0.8400 1.3400 1.5600 0.7800]
    FA75_45: [-0.3700 -0.2500 -0.3500 -0.1700 -0.1300 0.1800 0.6200 1.1200 1.3400 0.5600]

>> save('rShift.mat','rShift')
```