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2015 M8 Pitot Survey

Basore

July 20, 2015

Contents

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1 Tristan Nozzle Exit - Bad Rake and Bad Throat

The following figures(1-3) are for the July-2014 throats(both upstream and downstream). The sensors in this shot were not optimized and the output was initially taken at face value, the result of which can be seen in figure 2.

The bad rake tag line in the heading was because the wings of the rake had not been tightened properly. This resulted in a larger than expected variance in the core flow for some reason.

Taking the results in figure 1 with some scepticism, there is still a growth in the uncertainty of the throat versus the flat level of 0.007 that is expected.

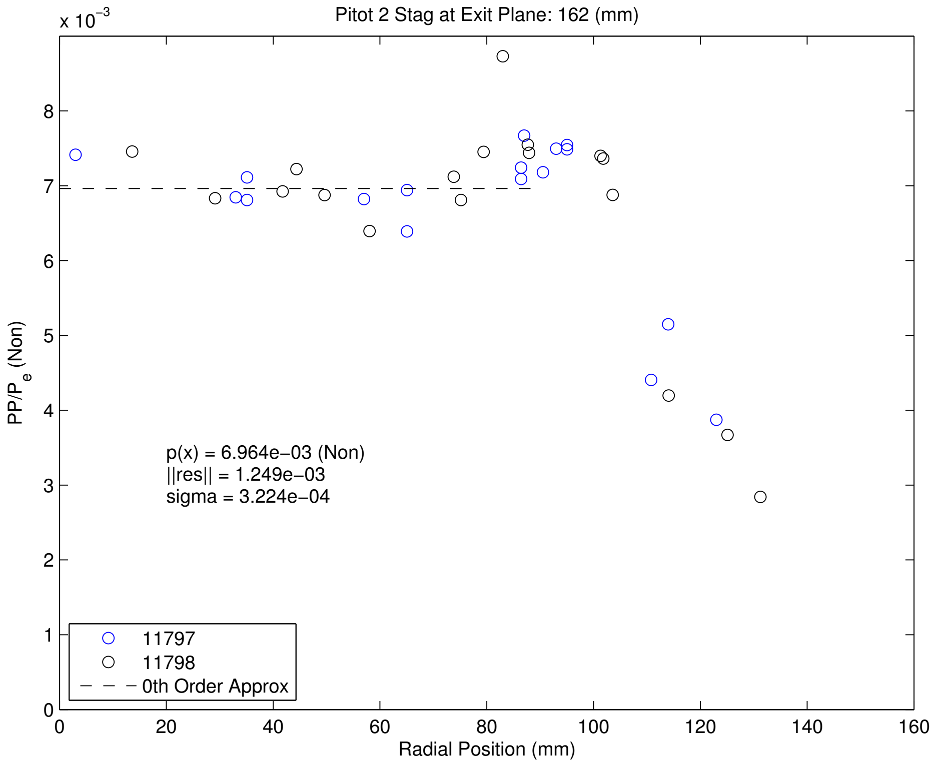

Figure 1: July 2014 Throat Good Gauges

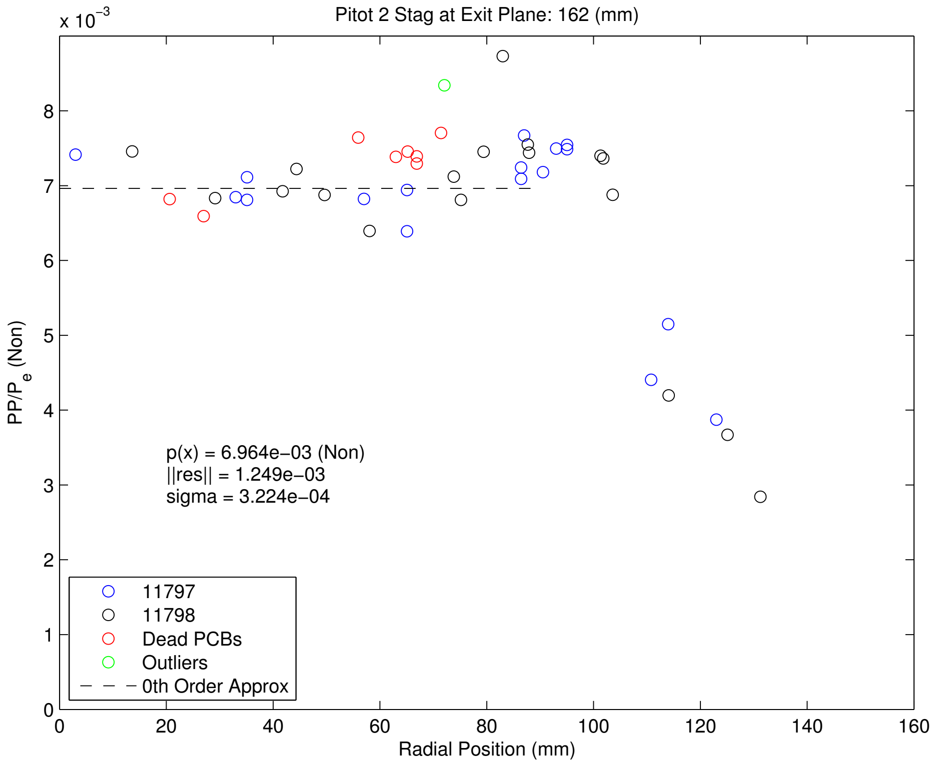

Figure 2: July 2014 Throat Bad Gauges

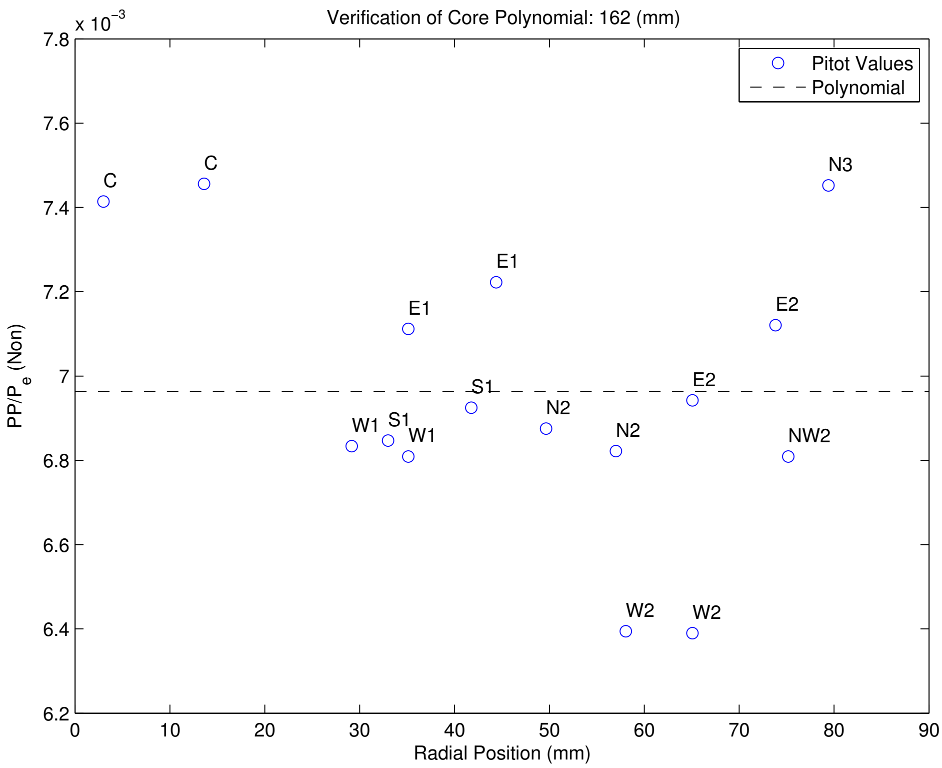

Figure 3: July 2014 Throat Core Variance

2 Denman Nozzle Exit- Bad Rake

Both the upstream and downstream throats were replaced with new copper machined throats. The 2015 throats presented an unacceptable level of variance in the core flow which lead to the investigation of the sensors in the rake in order to see if the erroneous readings were from sensors or a physical artefact. The original readings taken from the rake can be seen in figure 5. The data presented here was from non-optimized sensors and also from before the rake wings were tightened. These figures show the difference, using the same rake configuration, between the old throat and the brand new throat being used in the nozzle which is why the variance from the first set of results for the 2014 throat can be determined to be larger than permissible to be used on multiple upcoming campaigns. Figure 4 shows the resultant core removing the bad sensors but not accounting for the wings being loose.

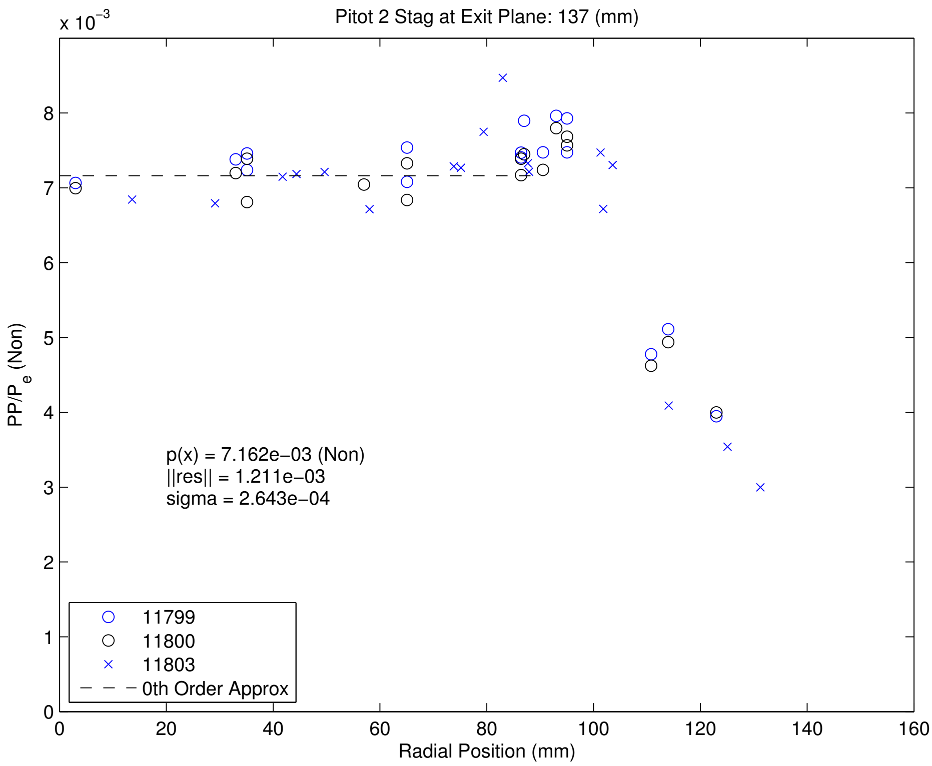

Figure 4: July 2015 Throat - Bad Rake, Good Gauges

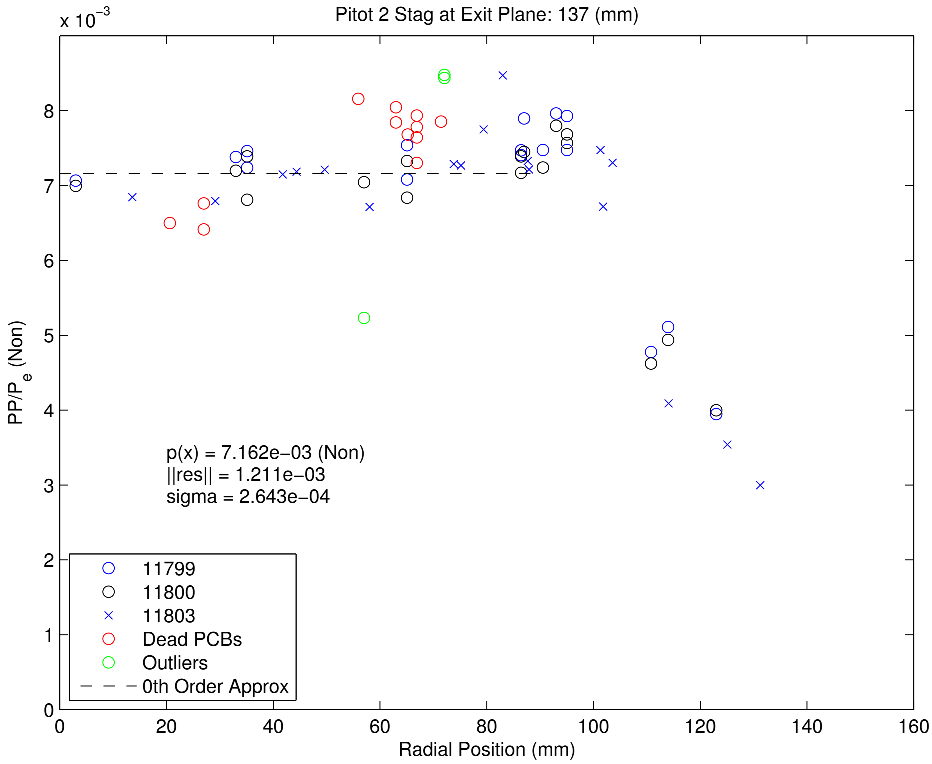

Figure 5: July 2015 Throat - Bad Rake, Bad Gauges

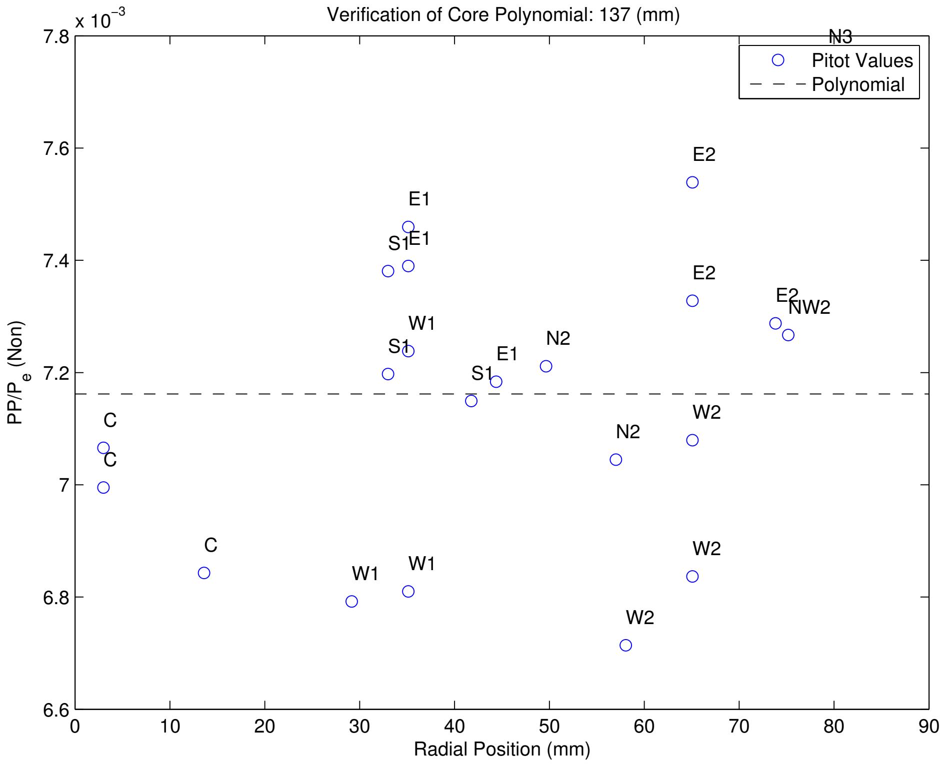

Figure 6: July 2015 Throat - Bad Rake, Core Variance

3 Zac Second Nozzle Exit - Good Rake

Following on from the first Denman plane(figure 5) a second nozzle exit plane was shot to verify the sensors in the rake. It was here that the wings were tightened and the remaining mechanical fasteners were verified on the pitot rake. Shot 11806 was a verification of tightening the rake and shot 11807 was the offset of this verification to create a better density in the core to prove that the tightening worked. Shot 11808 was the sensor optimization movement to show that it was sensors and not cabling or any other electrical fault responsible for the bad PCB readings.

The sensors that were moved to verify were:

C	(10637)	$<->$	N1	(9596)
W1	(19122)	$<->$	S2	(2536)
S1	(11076)	$<->$	NE1	(7942)
E1	(19126)	$<->$	W2	(14533)

Using this proof plus previous documentation from the sensor database, the data for some of the PCBs was thrown out as dead gauges to give the "good gauges" plots. The removal of this data was applied retroactively and not just following this analysis.

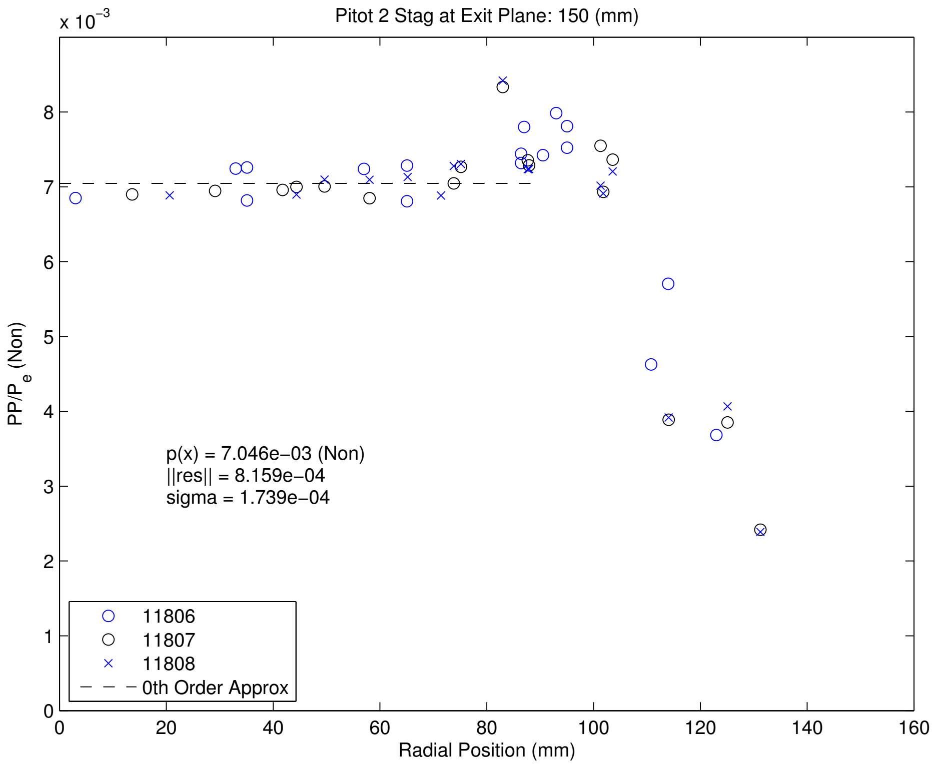

Figure 7: Denman Nozzle Exit - Good Rake, Good Gauges

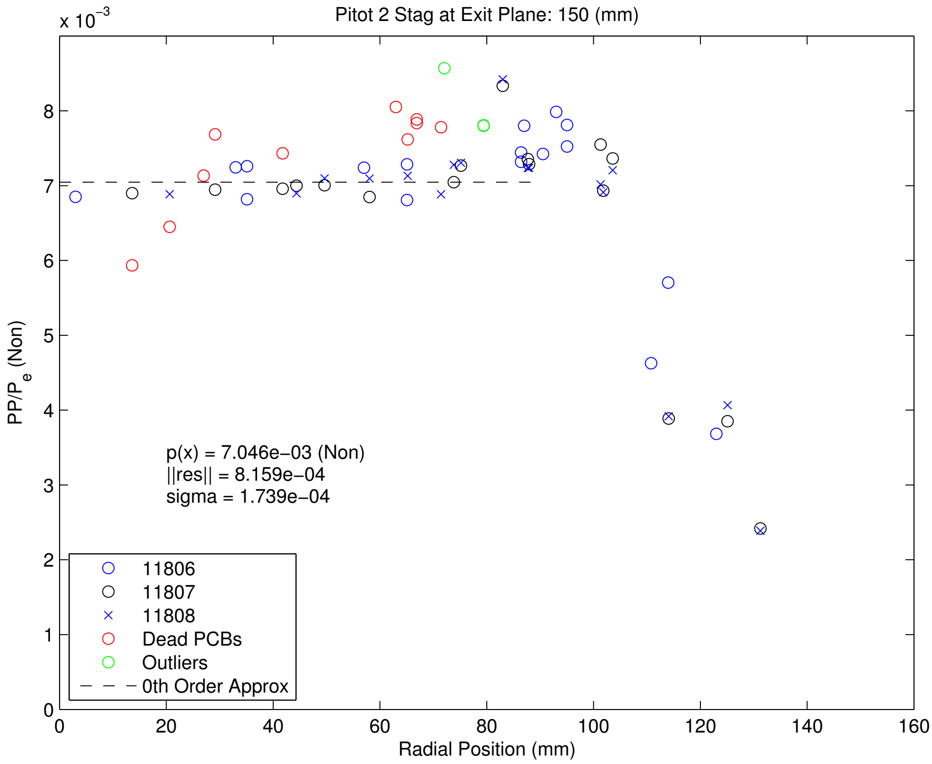

Figure 8: Denman Nozzle Exit - Good Rake, Bad Gauges

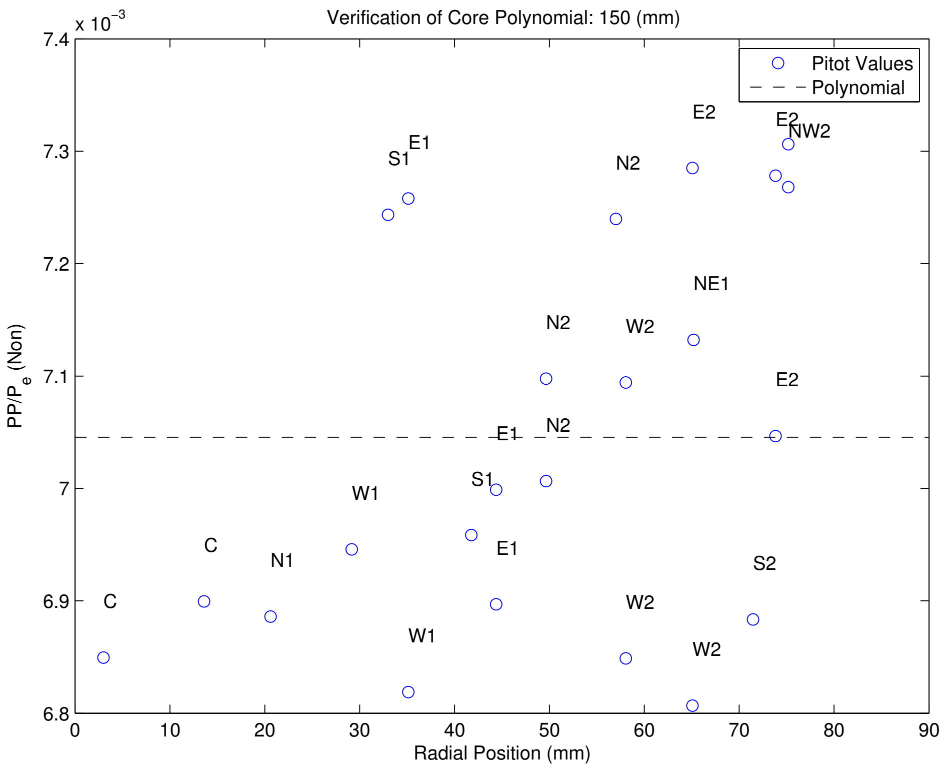

Figure 9: Denman Nozzle Exit - Good Rake, Core Variance

4 Basore Inj Plane Combined - Mixed Rake

Following the verification of the bad sensors, the injection plane offset for Basore was shot. As the core density looked fine after removing the faulty sensor data, the zero offset condition was not reshot. This is the reason that this section is called a mixed rake.

Besides proving the core flow at this nozzle exit location, the second objective for this analysis was to show that the condition, when normalized, was within acceptable error bounds to allow for cross-condition comparison in Basore's following campaign.

Figures 10 - 12 following show the results for this injection plane at both a 6mm and 3mm diaphragm condition.

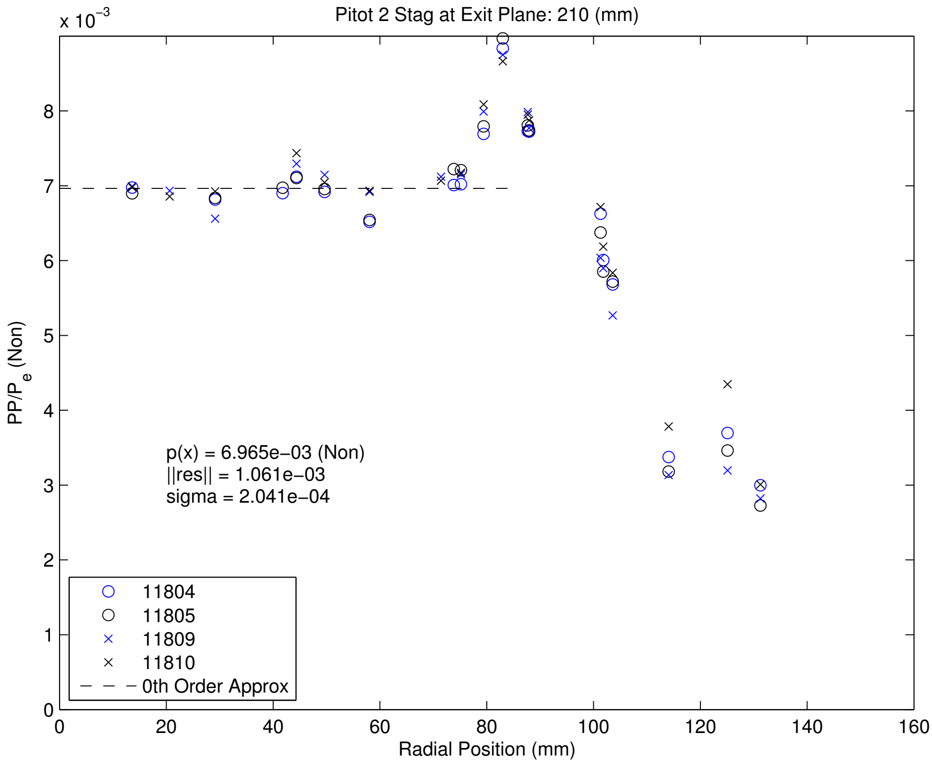

Figure 10: Basore Injection Plane - Mixed Rake, Good Gauges

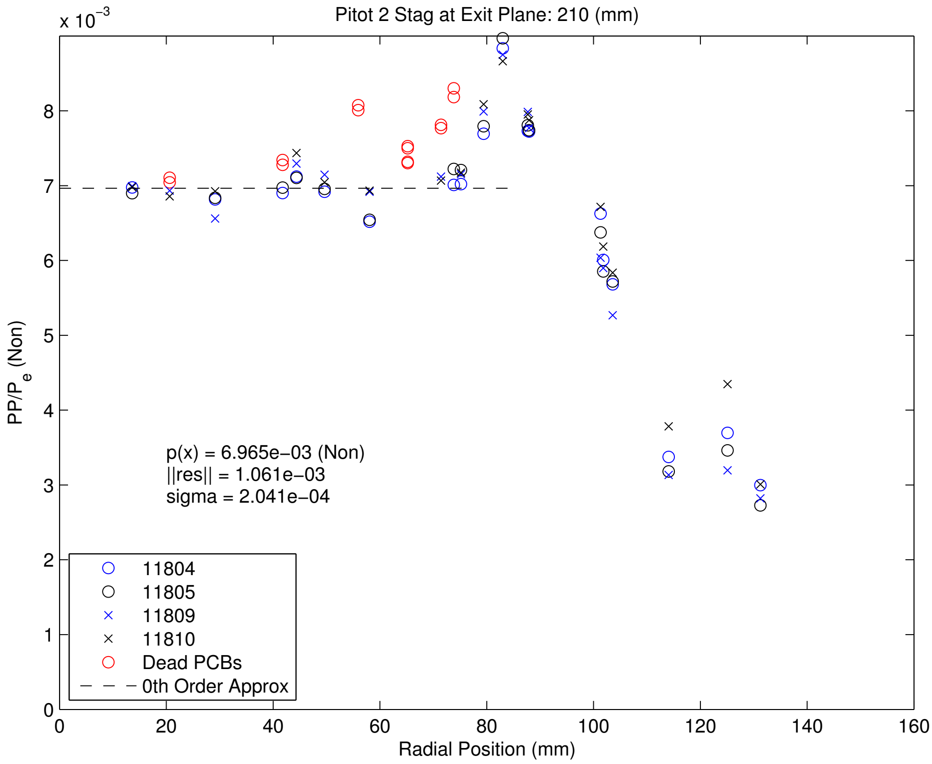

Figure 11: Basore Injection Plane - Mixed Rake, Bad Gauges

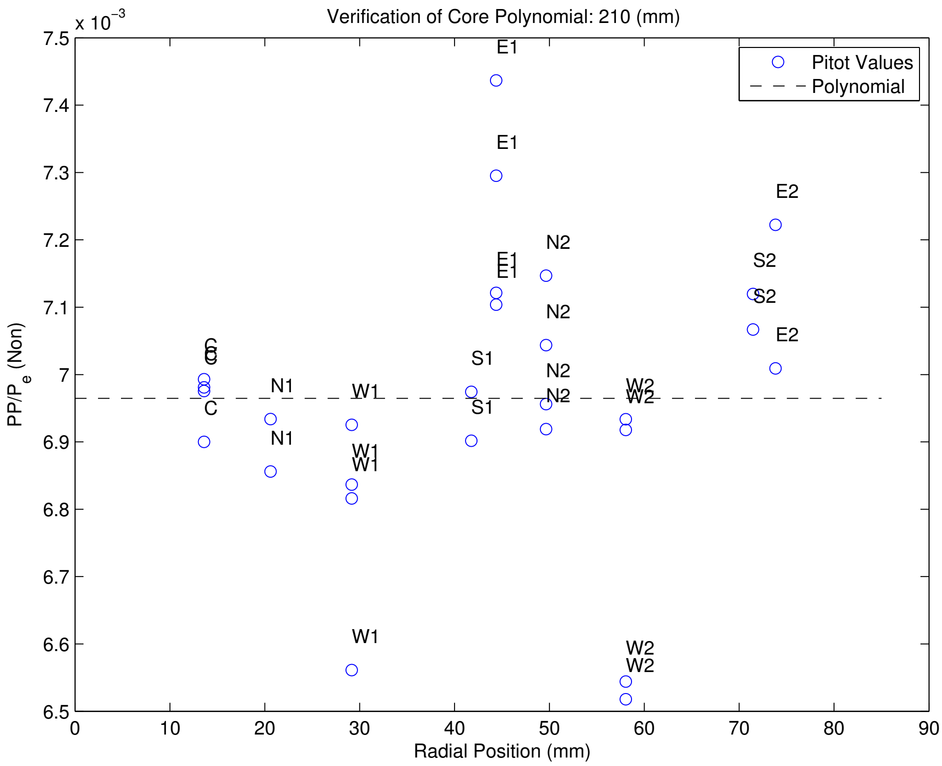

Figure 12: Basore Injection Plane - Mixed Rake, Core Variance

5 Basore Inj Plane 3 mm -Mixed Rake

To complement the combined output each individual condition was analysed for later comparison if necessary when post-processing Basore's campaign data.

Figure 13 - 15 shows the output for the 3mm condition that will be used during Basore's campaign. Please reference Basore's thesis if you wish to examine what each of the conditions/nozzle outflow were.

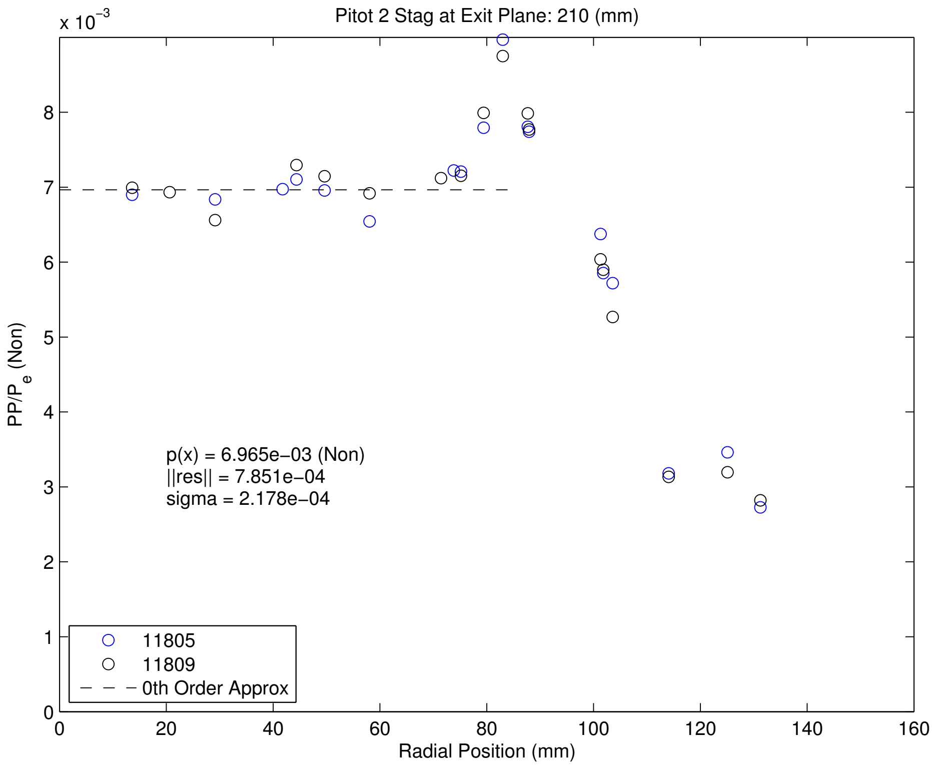

Figure 13: Basore Injection Plane - Mixed Rake, Good Gauges, 3 mm condition

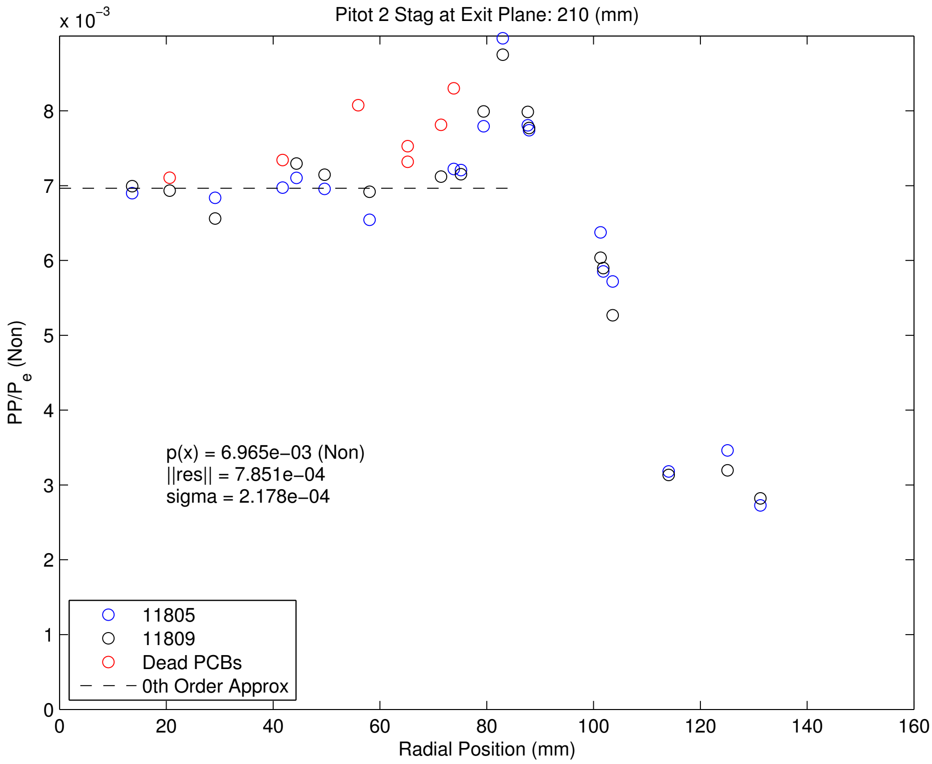

Figure 14: Basore Injection Plane - Mixed Rake, Bad Gauges, 3 mm condition

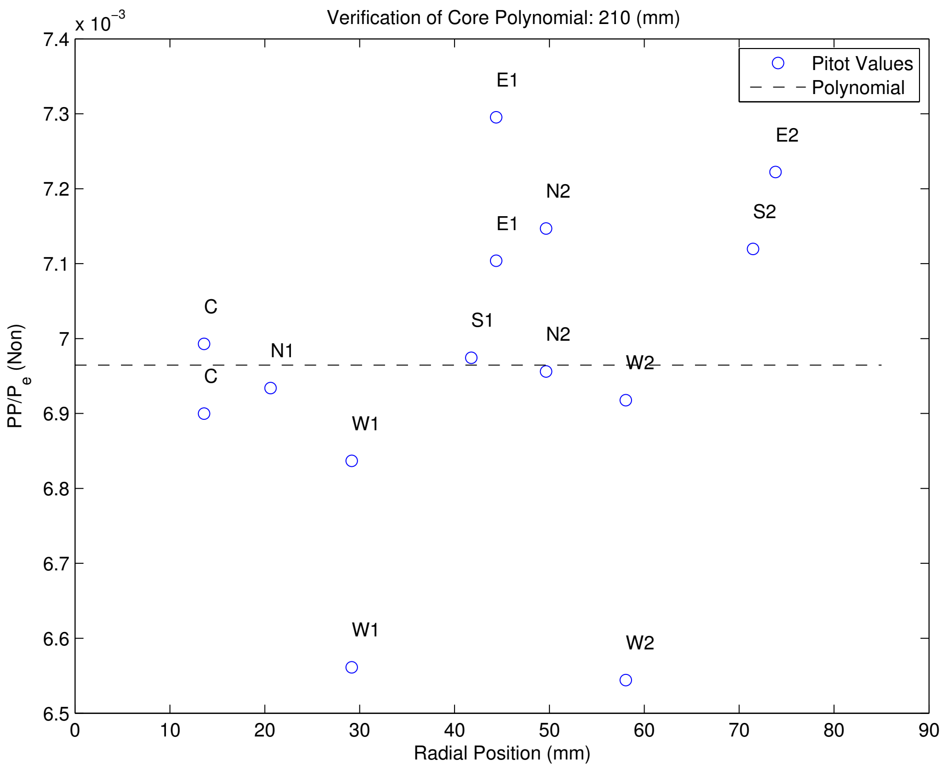

Figure 15: Basore Injection Plane - Mixed Rake, Core Variance, 3 mm condition

6 Basore Injection Plane 6 mm - Mixed Rake

Similar to Section 5, the 6mm Basore condition is presented in figures 16 to 18. It is interesting to note that the core average between these two conditions(3mm and 6 mm) are exactly the same. This shows that when accounting for the normalization of the pressure differential and the rake tightening, the condition was/is very repeatable.

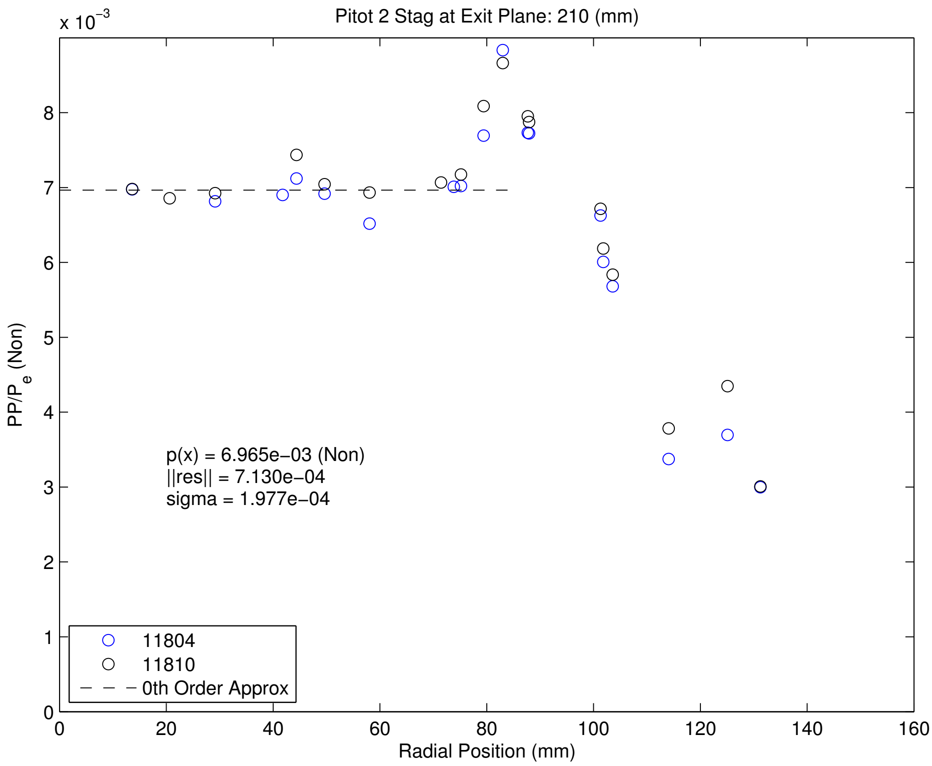

Figure 16: Basore Injection Plane - Mixed Rake, Good Gauges, 6 mm condition

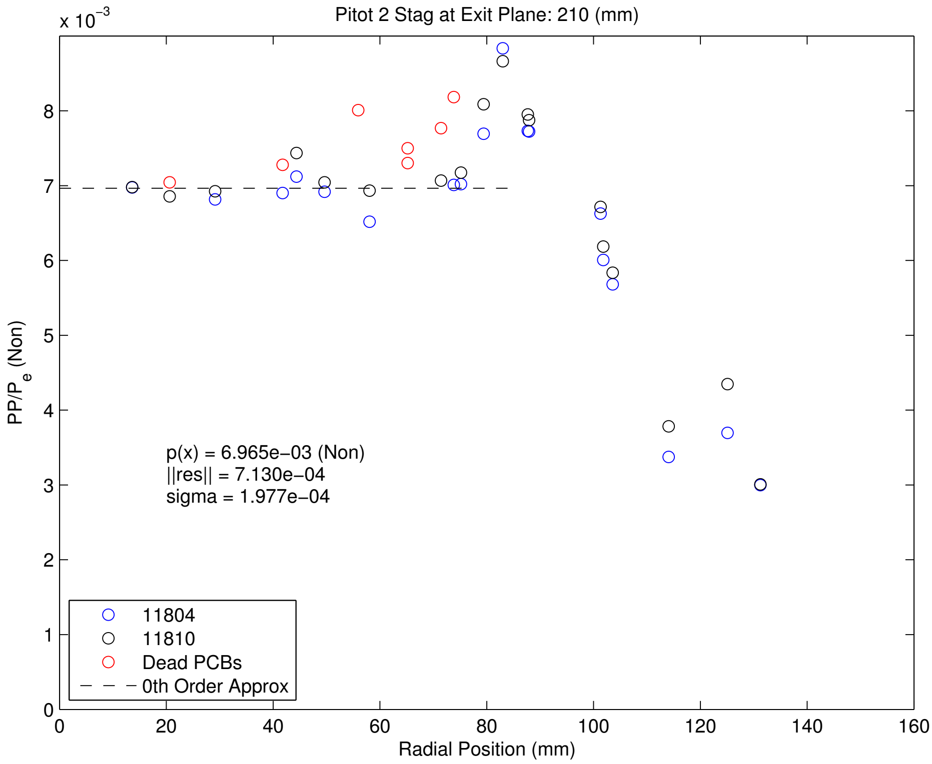

Figure 17: Basore Injection Plane - Mixed Rake, Bad Gauges, 6 mm condition

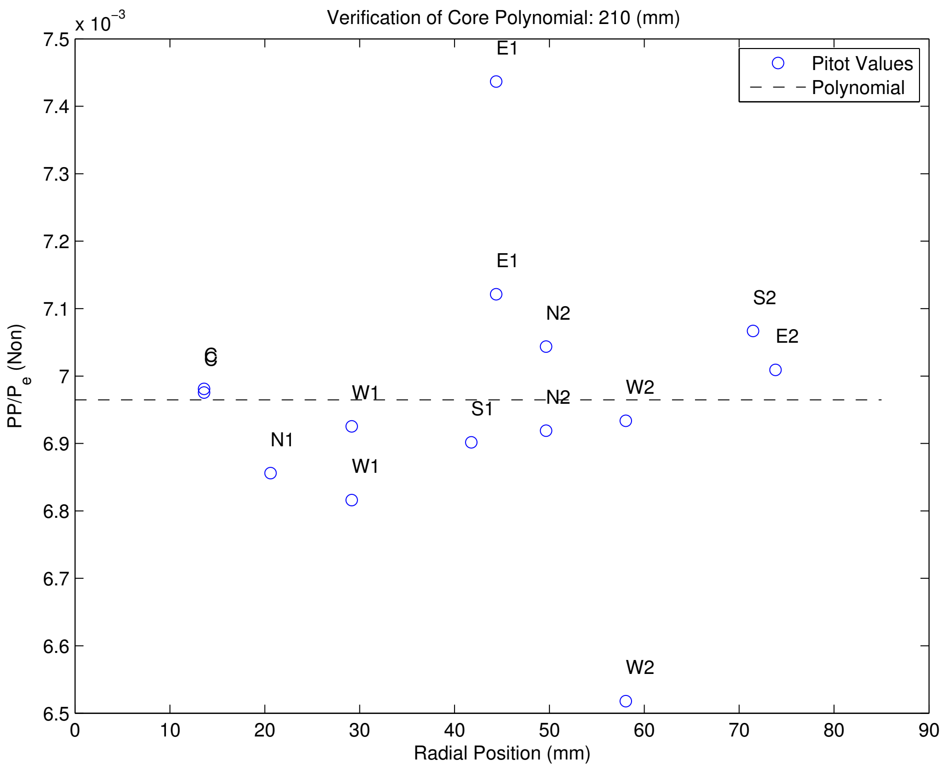

Figure 18: Basore Injection Plane - Mixed Rake, Core Variance, 6 mm condition

7 Basore End Sensor Field - Good Rake

Figures 19 - 21 show the plane that was shot at the end of Basore's sensor field. This plane was shot to prove the quality of the core flow at the end of the sensor field as during the first campaign a wave interaction was present that could not be accounted for. The quality and measured core radius disproved that this interaction was due to a collapsing core.

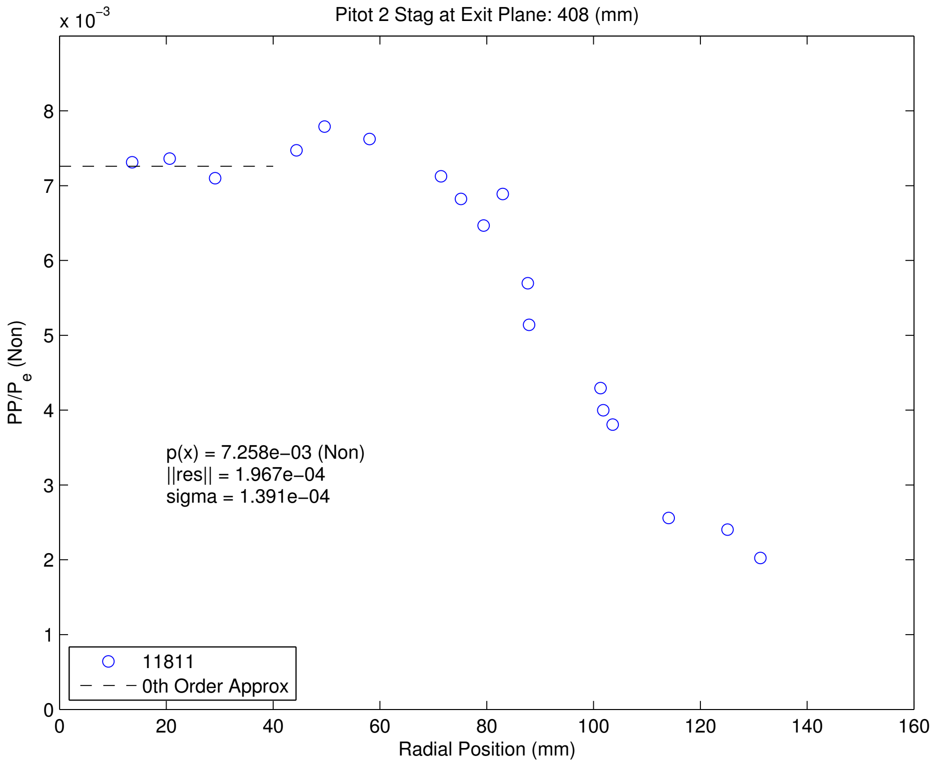

Figure 19: Basore End Sensor Field - Good Rake,Good Gauges

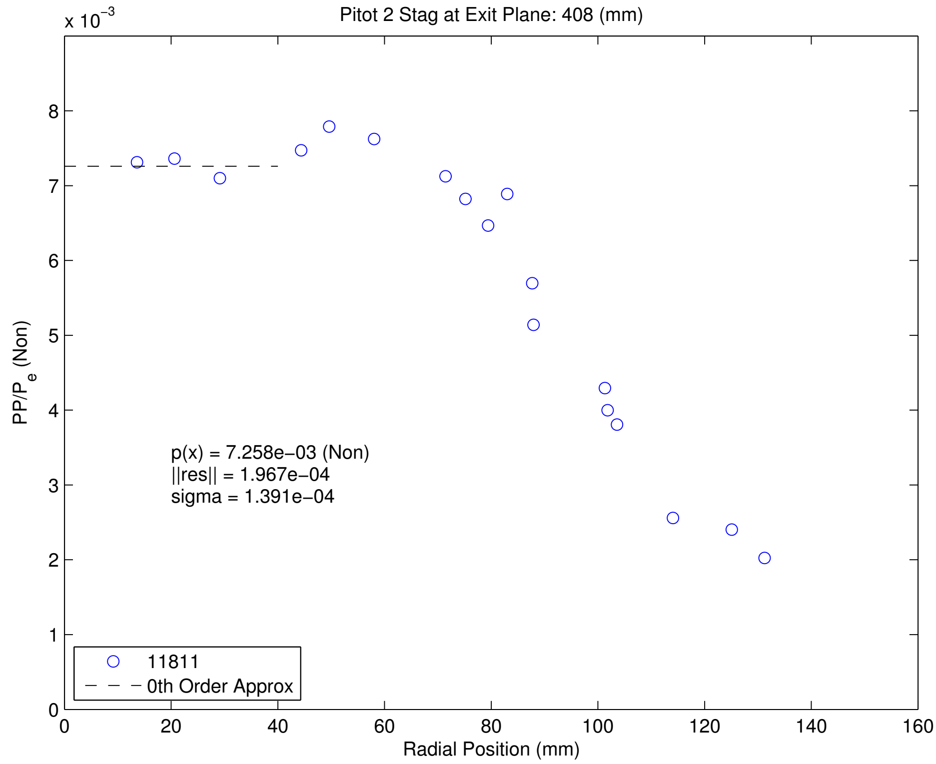

Figure 20: Basore End Sensor Field - Good Rake,Bad Gauges

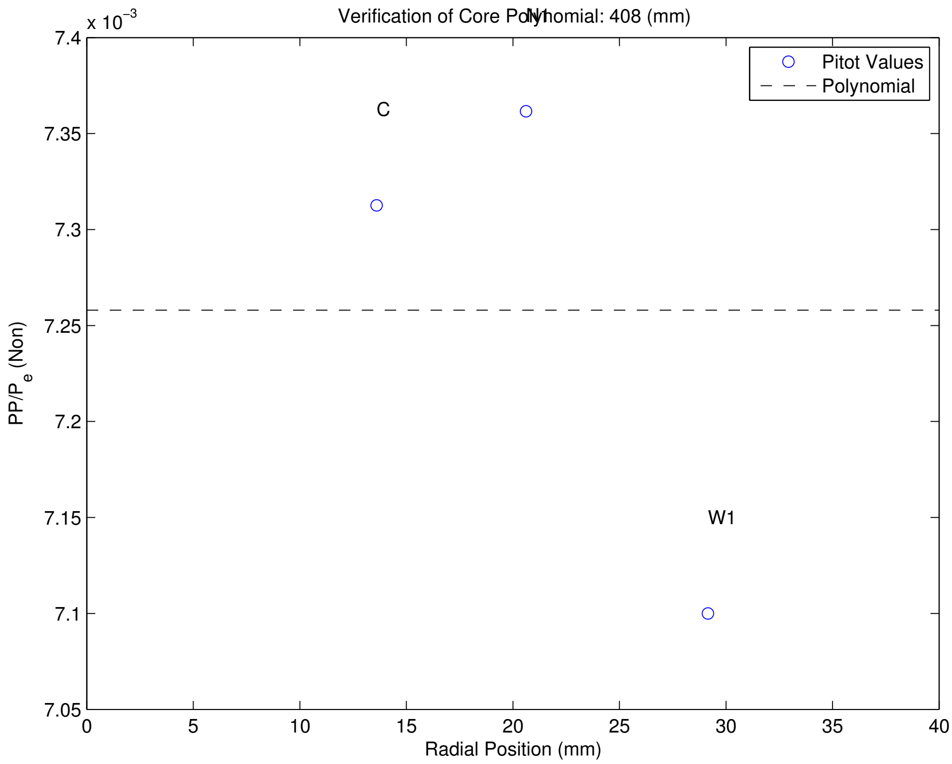

Figure 21: Basore End Sensor Field - Good Rake,Core Variance

8 Denman Cowl Closure - Good Rake

Similar to Section 7, Denman shot the cowl closure point of his model to verify that the core is larger than the capture area of the REST engine at this location.

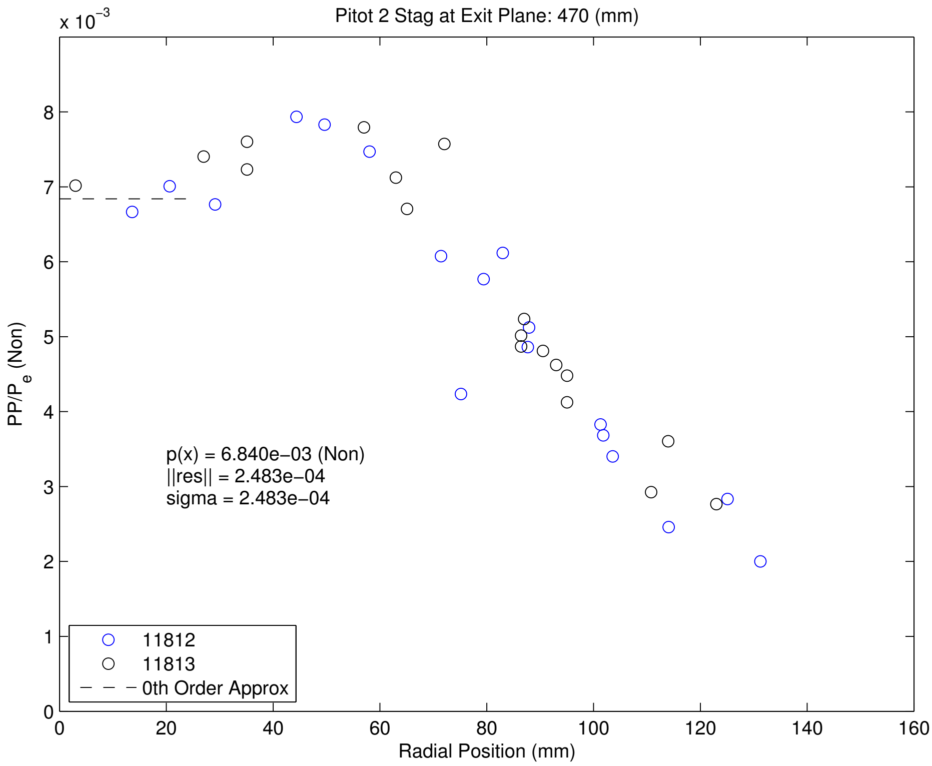

Figure 22: Denman Cowl Closure - Good Rake,Good Gauges

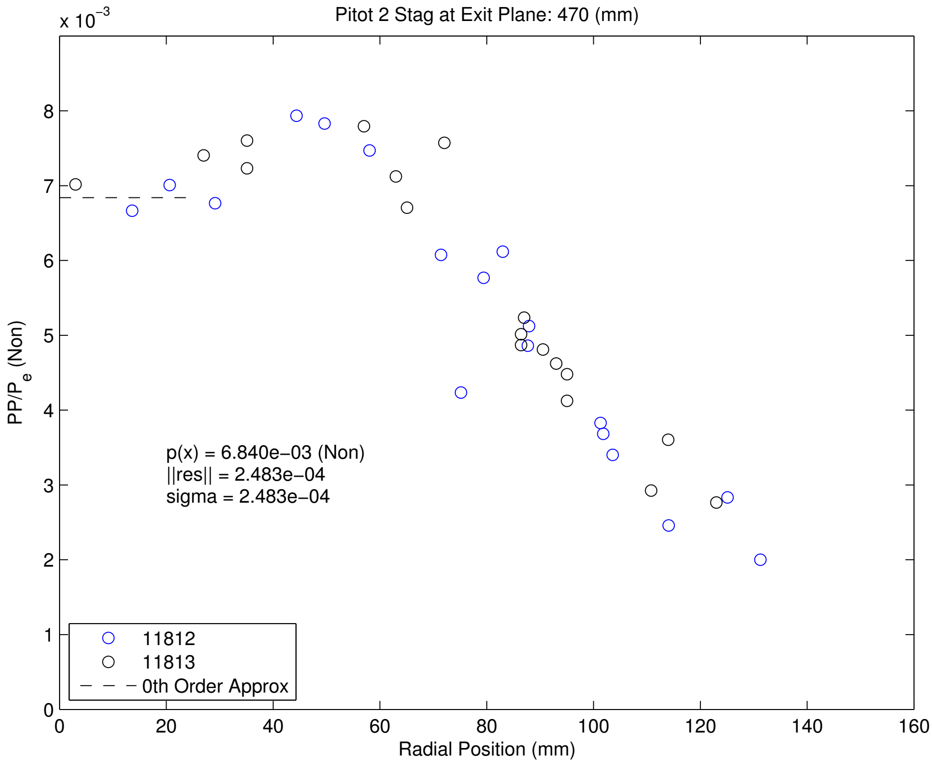

Figure 23: Denman Cowl Closure - Good Rake,Bad Gauges

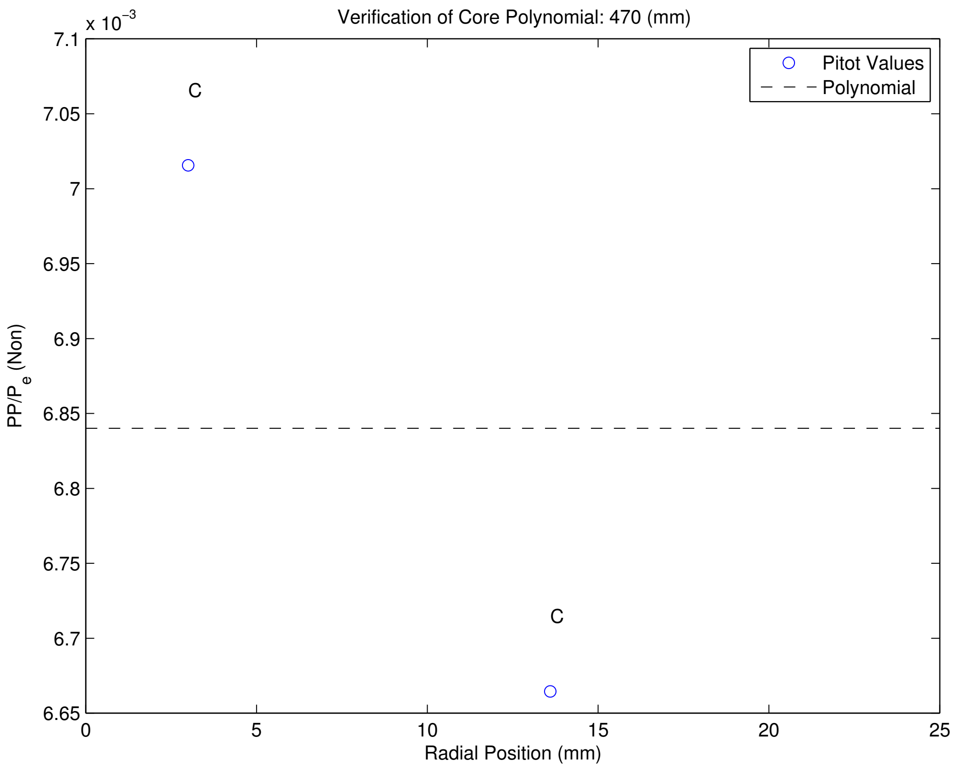

Figure 24: Denman Cowl Closure - Good Rake,Core Variance

9 Basore Nozzle Exit 5 mm - Bad Rake

Finally, to showcase all of Basore's results, this nozzle exit condition and the following nozzle exit condition(Section 10) are presented. Both of these conditions were shot on the non-tightened rake which is why the data was not used. After removing the faulty PCB data the average was close to what was expected but due to the data in Section 3 these planes were not used.

Figures 25 - 27 show the data for the 5mm exit condition.

Figures 28 - 30 show the data for the 3mm exit condition.

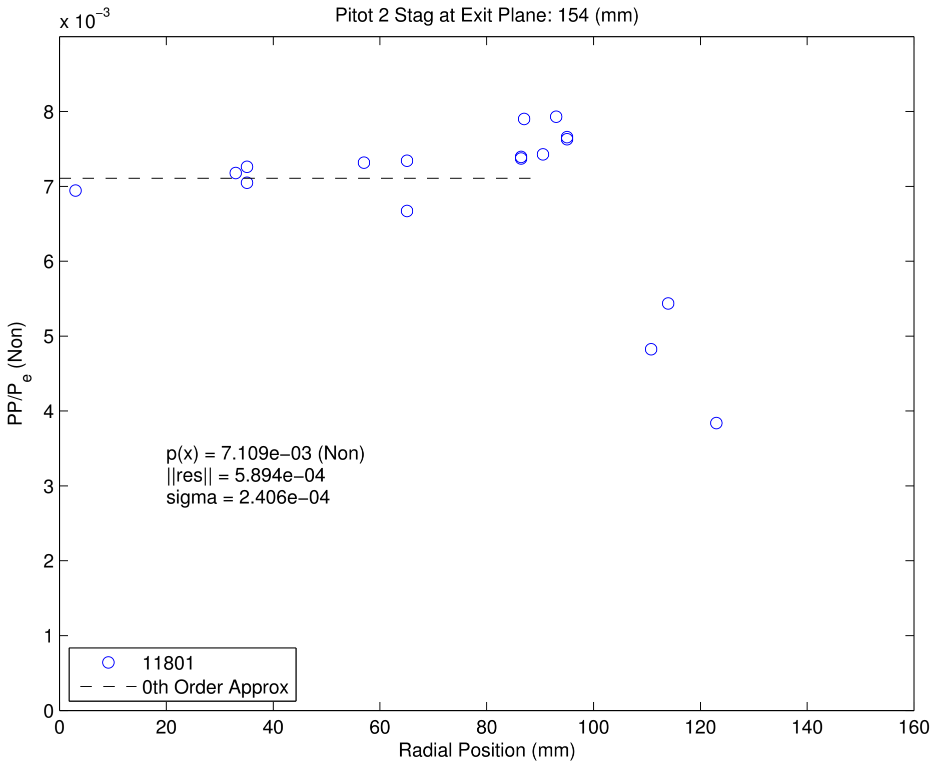

Figure 25: Basore Nozzle Exit 5mm - Bad Rake, Not Used, Good Gauges

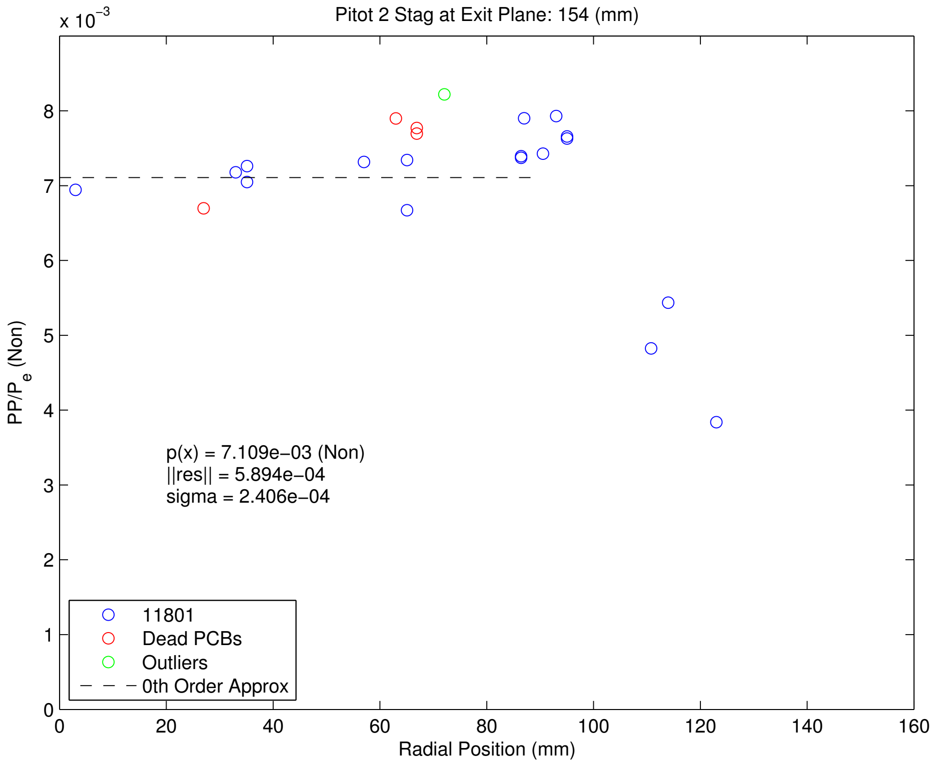

Figure 26: Basore Nozzle Exit 5mm - Bad Rake, Not Used, Bad Gauges

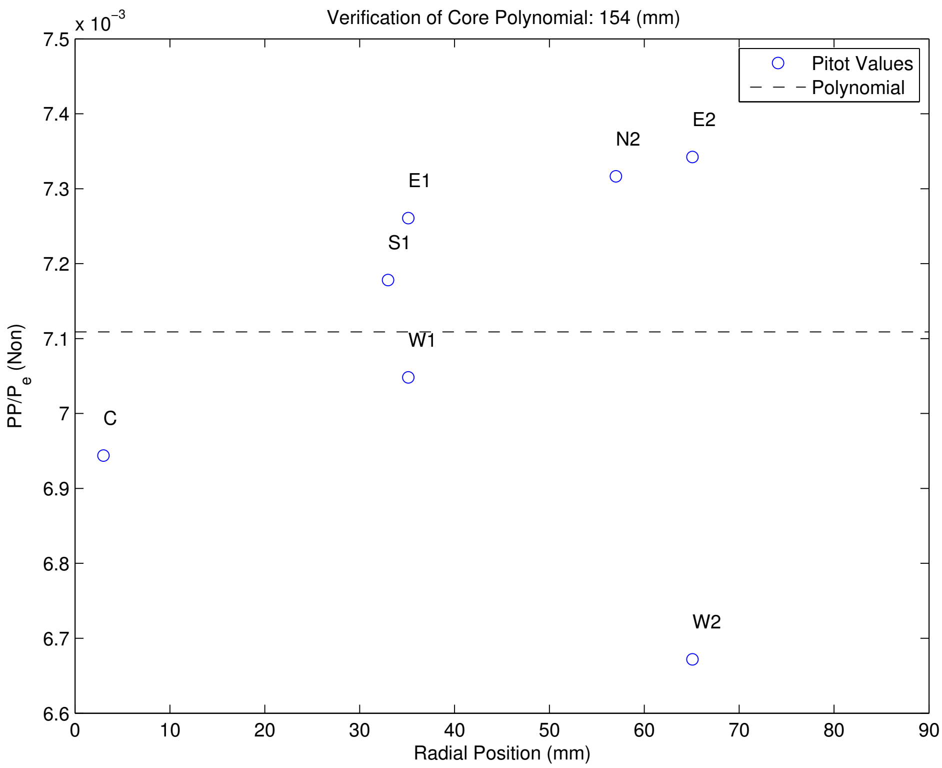

Figure 27: Basore Nozzle Exit 5mm - Bad Rake, Not Used, Core Variance

10 Basore Nozzle Exit 3 mm - Bad Rake

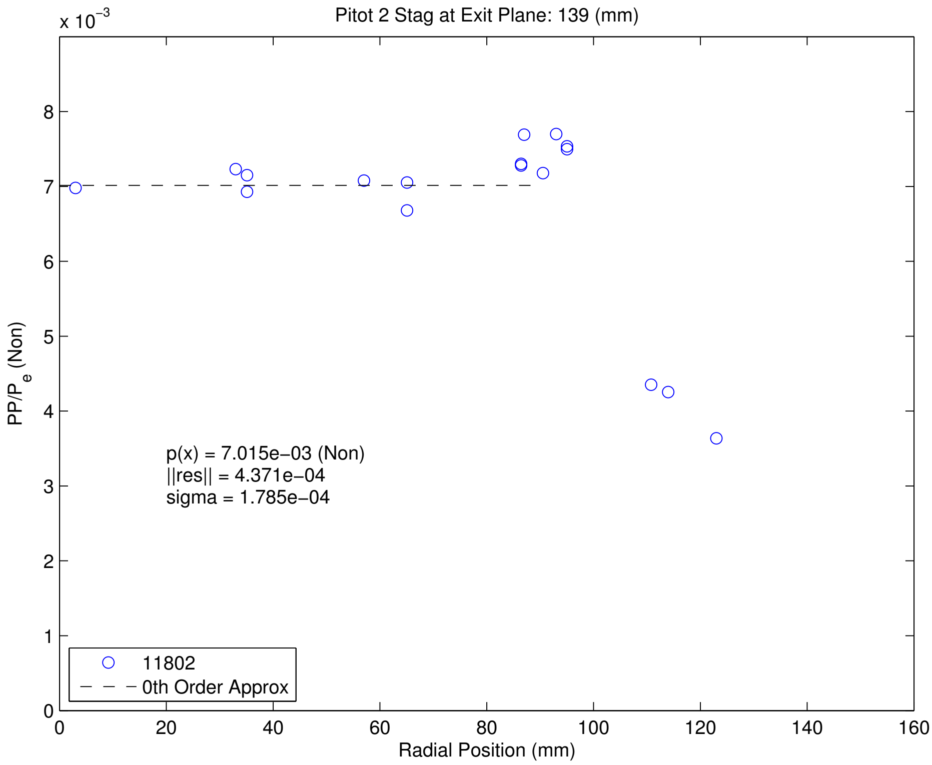

Figure 28: Basore Nozzle Exit 3mm - Bad Rake, Not Used, Good Gauges

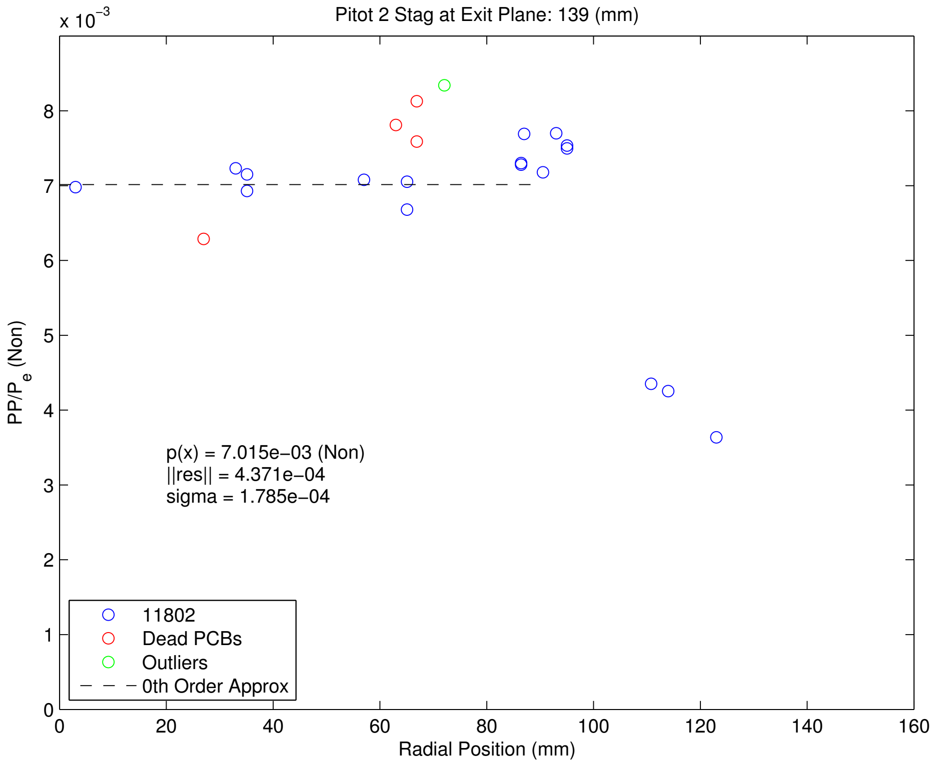

Figure 29: Basore Nozzle Exit 3mm - Bad Rake, Not Used, Bad Gauges

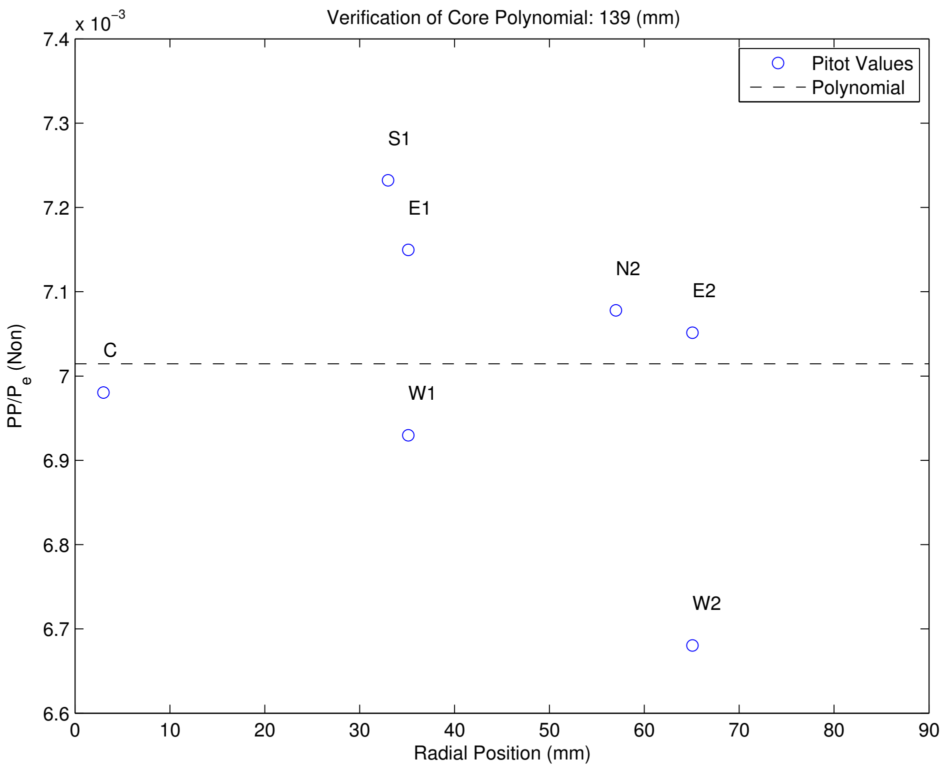

Figure 30: Basore Nozzle Exit 3mm - Bad Rake, Not Used, Core Variance