

# **Thread Gage Measurement Inter-Laboratory Comparison (ILC)**

## **of Major Diameter, Pitch Diameter, Pitch and $\frac{1}{2}$ Angle Measurements**

June 2014

Norbert Solomonson, Boeing  
Joe Greenslade, IFI  
Al Barrows, ASME B1 Chairman

### **INTRODUCTION:**

An ILC study concerning thread plug gage measurements was initiated in the fourth quarter of 2010. Forty-eight labs participated in this study. One lab acted as a pivot lab and reported measurements at the beginning, middle and near the end of the study to check for any damage and to validate the stability of the artifacts. One National Measurement Institute (NMI) reported measurements near the beginning and at the end of the study. In all, 51 measurement reports were submitted.

This study is unique in that it required measurements of four gage attributes: Major Diameter, Pitch Diameter, Pitch (Lead) and  $\frac{1}{2}$  Angles. Other studies have only examined major and pitch diameter measurement variability.

Participant instructions were carefully written to minimize any variability associated with the gages themselves. This was done by defining the exact measurement location for each attribute.

The measurement results are described in this report. Participants have been kept anonymous as much as possible. The director of the ILC provided each participant with an identification number and received reports directly from each lab. Anonymous lab reports were then sent to another party for review and analysis.

One challenge with this type of study is to determine the best estimate of the “true, or reference value” of each gage’s attribute. Two approaches were taken. One method was to assign the reference value to be the calculated average of all the participant’s measurements after removing any outliers. The other method was to assign the reference value to be the value that was measured by the NMI. Any difference between these two methods would show up as an offset between the two results.

No attempt was made to employ a more sophisticated estimate of the reference value. Methods such as weighting the measurement results based on the lab’s estimated uncertainties did not work with this data set. The estimated uncertainties provided by the labs varied significantly and did not always correspond to the reported result’s being closer to, or farther away, from the group’s average. Additionally, some labs provided no uncertainty estimates; some labs provided no measurements on pitch, and or  $\frac{1}{2}$  angles. These facts indicate that many of the reporting labs do not have a realistic understanding of their reported uncertainties.

## GAGE DESCRIPTIONS:

Three thread gages were used in the study and are listed below.

Gage 1: ½-20 UNS 3B GO

Gage 2: ¼-28 UNJF 3A HI-LO

Gage 3: ½-13 UNS

## TERMS AND DEFINITIONS:

The following terms are introduced and defined in this section. Most of these terms are standard for ILC studies. However a new term is introduced here called the Compliance Value. It is related to the tolerance given in the ASME B1.2 1983 Thread Gage Standard for the particular attribute being measured.

### 1) Artifact Reference Values:

This is the best estimate value for the gage attribute, for example, Pitch Diameter.

Due to the metrological difficulty in making threaded measurements, the best estimate value is report by two methods as noted above.

$AT_{REF-AVE}$  This is the ATtribute value that is determined by calculating the ILC participants' average value, with outliers removed.

$AT_{REF-NMI}$  This is the average of the two ATtribute values reported by a National Measurement Institute (NMI).

AT This represents one of the following thread gage ATtributes: MD (Major Diameter), PD (Pitch Diameter), P (Pitch) and ANG (thread ½ ANGLE)

Note: Outliers are selected to be those data points which deviate from the average value of the initial filtered data set by more than 3 times the standard deviation. The process is repeated on the filtered data set until there are no more outliers. Plotting the raw data set provides a means to visually observe the outliers.

## 2) Reference Value Expanded Uncertainties:

This is the estimated expanded uncertainty of the reported  $AT_{REF}$  value at a 95% level of confidence.

$U_{REF-STD}$  This is the expanded uncertainty of an attribute's reference value, ( $AT_{REF-AVE}$ ) that is determined by calculating 2 times the standard deviation of the participant values with outliers removed.

$U_{REF-NMI}$  This is the expanded uncertainty of an attribute's reference value, ( $AT_{REF-NMI}$ ), that is reported by an NMI.

## 3) Reported Values:

$AT_{LAB}$  This is the Atribute value reported by a participating lab.

$U_{LAB}$  This is the expanded uncertainty reported by the participant lab for a particular attribute measurement. NOTE: if a lab did not report an uncertainty value then the lab uncertainty value it set equal to 0, i.e.,  $U_{LAB} = 0$ . This only affects the individual lab's En value and did not affect the overall uncertainties in the summary of results for the thread feature.

## 4) Performance Values:

$E_{n-XXX}$  The En value (normalized error) is defined as:

$$E_{n-XXX} = \frac{(AT_{LAB} - AT_{REF-XXX})}{\sqrt{U_{LAB}^2 + U_{REF-XXX}^2}}$$

where XXX corresponds to NMI, AVE or STD as appropriate.

z The z-score is defined as:

$$Z = \frac{AT_{LAB} - AT_{REF-AVE}}{\frac{U_{REF-STD}}{2}}$$

$C_{XXX}$  A new performance value is being introduced here called the Compliance Value and is defined as:

$$C_{XXX} = \frac{(AT_{LAB} - AT_{REF-XXX})}{\frac{TOL}{2}}$$

where XXX corresponds to NMI or AVE, and TOL is the tolerance of the attribute being measured as defined in ASME B1.2

5) Performance Evaluations:

$$|E_{n-xxx}| \leq 1 \equiv \text{satisfactory}$$

$$|E_{n-xxx}| > 1 \equiv \text{unsatisfactory}$$

$$|z| \leq 2 \equiv \text{satisfactory}$$

$$2 < |z| < 3 \equiv \text{questionable}$$

$$|z| \geq 3 \equiv \text{unsatisfactory}$$

$$|C_{xxx}| \leq 1 \equiv \text{satisfactory}$$

$$|C_{xxx}| > 1 \equiv \text{unsatisfactory}$$

Statistical definition reference: ISO GUIDE 43-1: 1997

**RESULTS:**

The results for each attribute measurement are shown in both tabular and graphical form. The lab reports are numbered 1 through 51.

**SUMMARY OF RESULTS:**

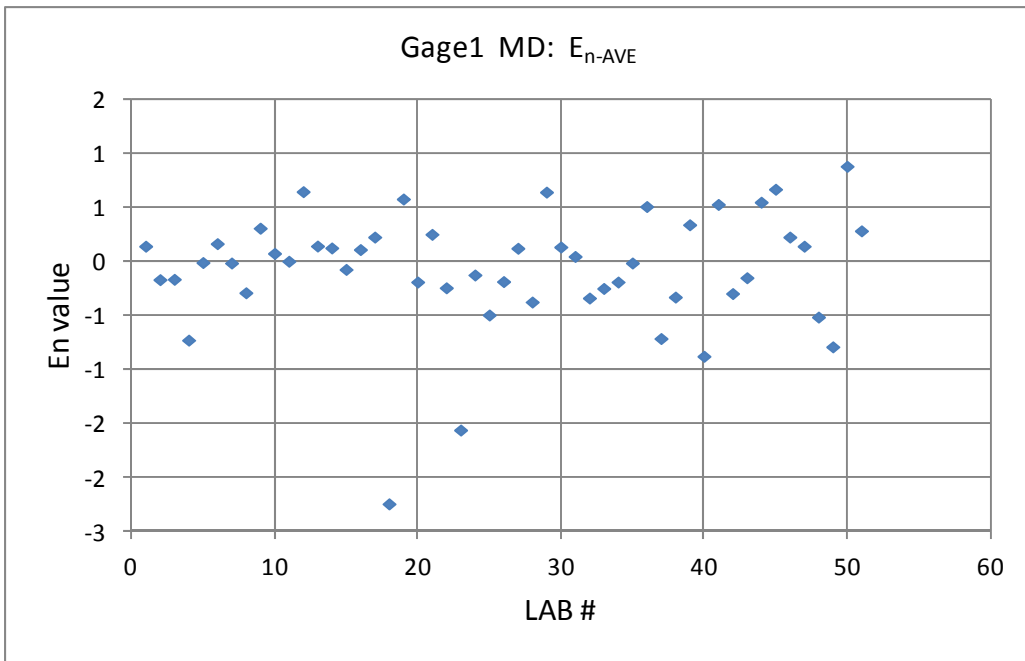
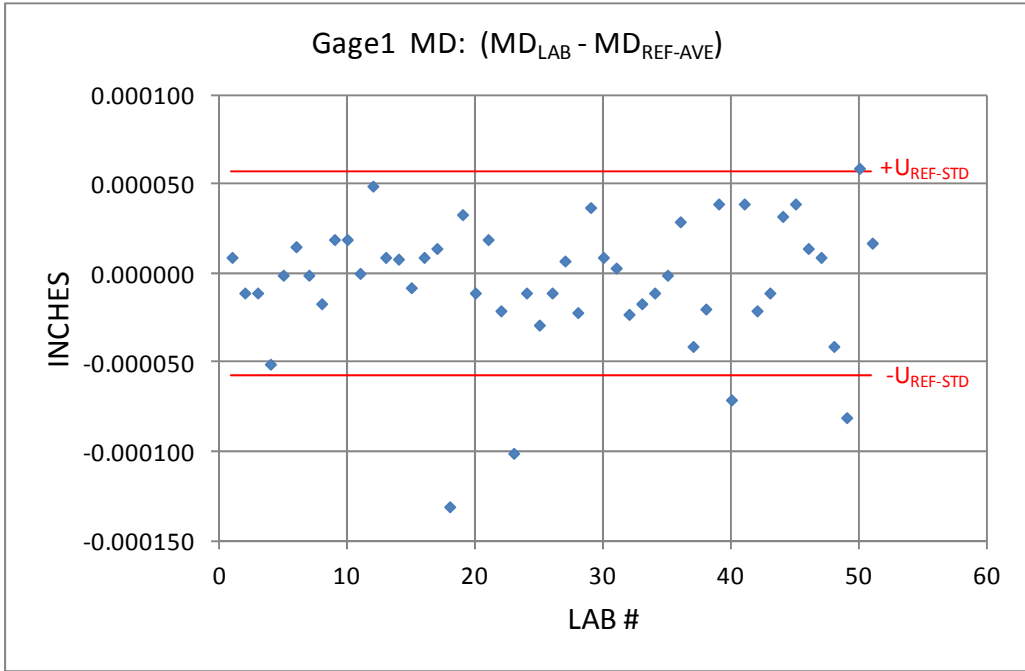
Based on the data this study collected, the following conclusions can be drawn, if measurement outliers are removed:

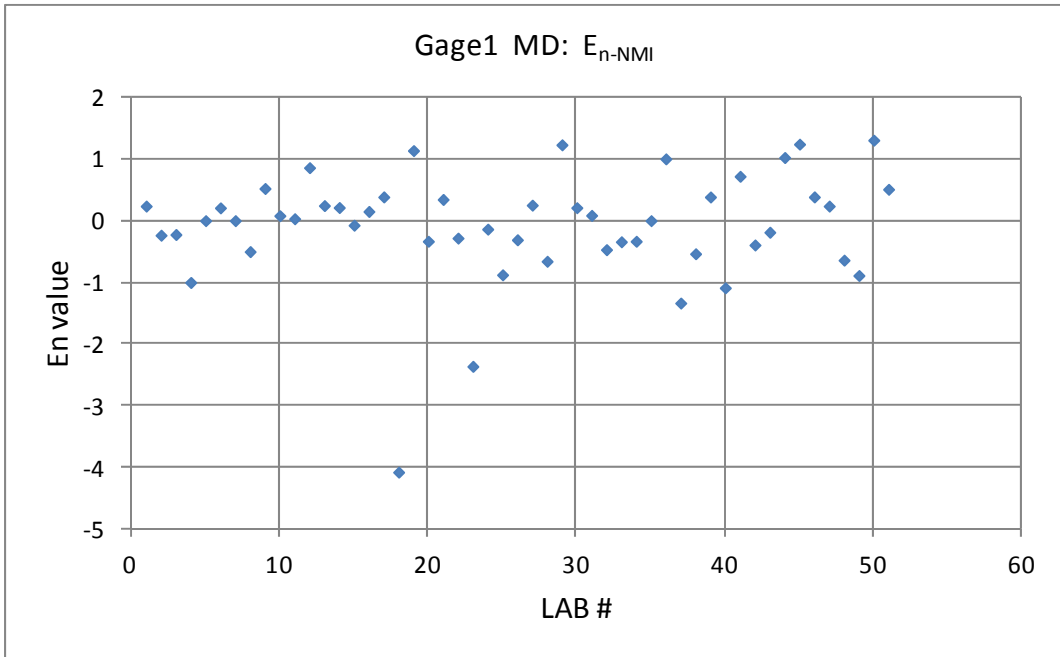
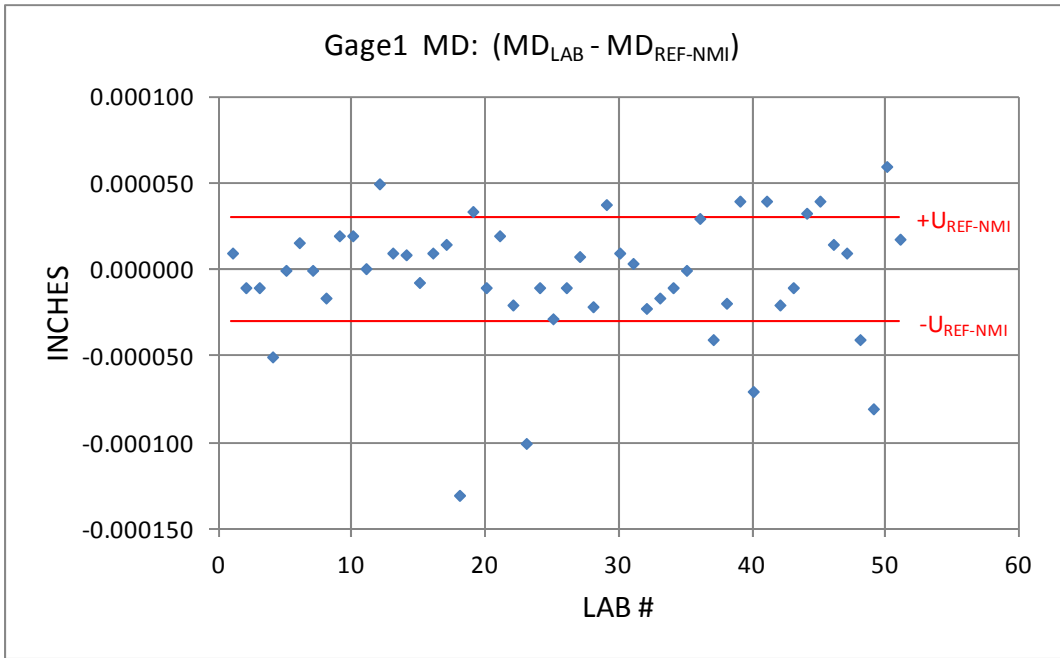
<b>Thread Characteristic</b>	<b>Approximate Measurement Uncertainty</b>	<b>Comments</b>
Major Diameter	±57 micro-inches	NA
Pitch Diameter	±98 micro-inches	NA
Pitch (Lead)	±199 micro-inches	over a 0.18" distance
Half Angle	±20 minutes	NA

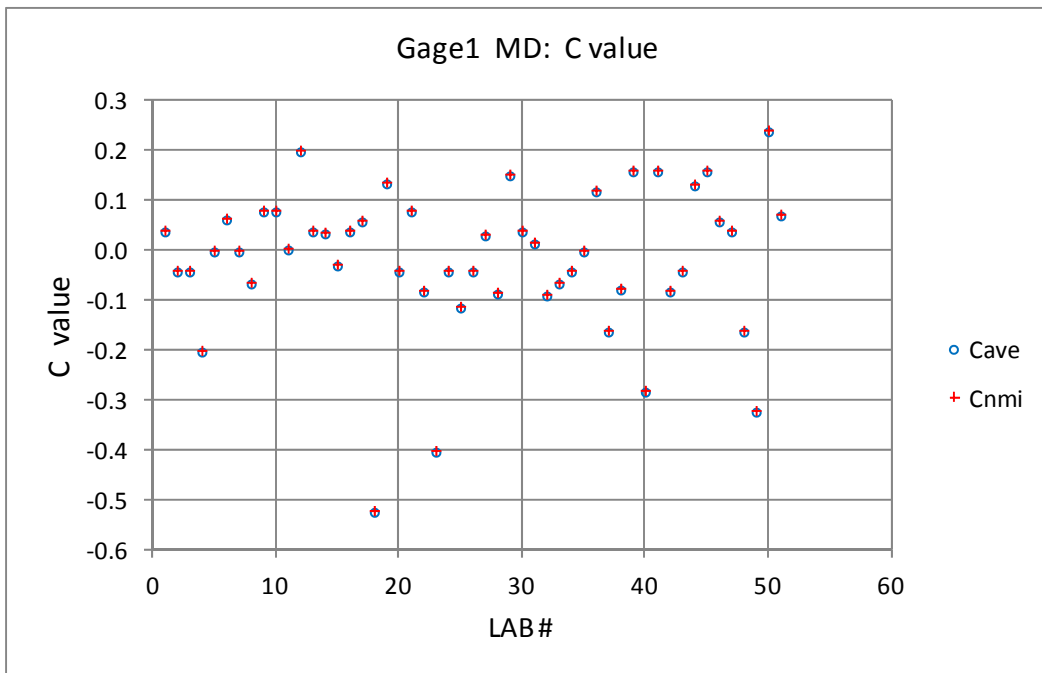
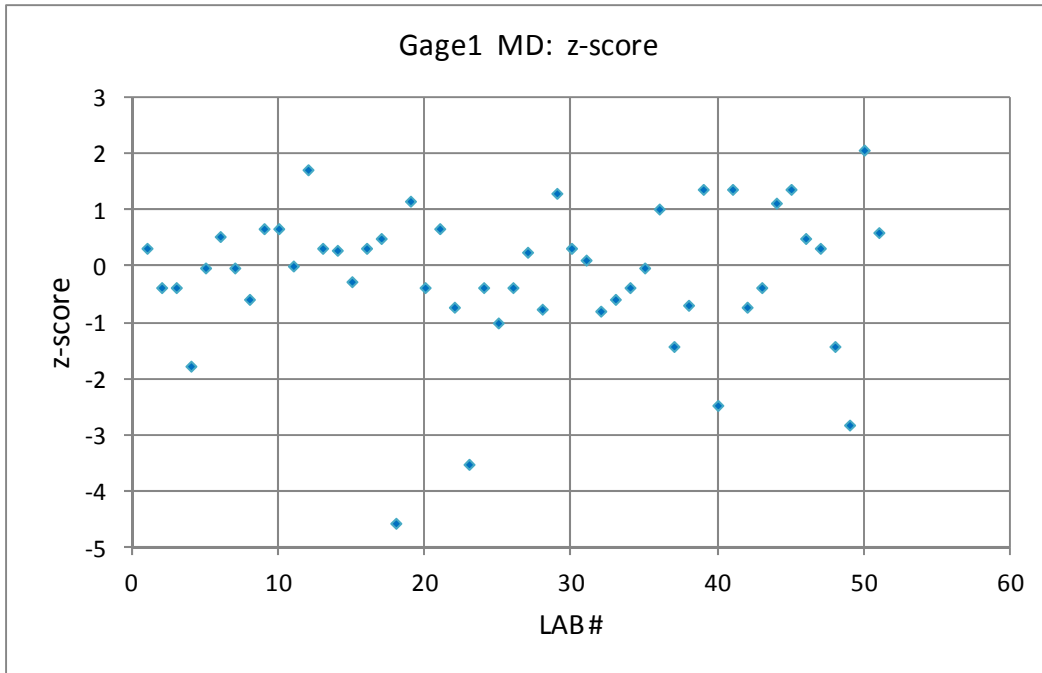
This study does not differentiate measurements by equipment. Further evaluation of the influence of equipment might be worthy of undertaking.

# Major Diameter Gage 1

Major Diameter		GAGE 1 1/2-20 UNS GO 3B: MD tolerance = 0.0005"					
Outliers:							
(#18, #23)		MD <sub>REF-AVE</sub> = 0.500341	MD <sub>REF-NM</sub> = 0.500340	MD tol. = 0.0005			
		U <sub>REF-STD</sub> = 0.000057	U <sub>REF-NM</sub> = 0.000030				
	Reported						
	Uncertainty						
	Reported	k = 2, 95%					
	Value	coverage					
Lab	MD	factor	E <sub>T-AVE</sub>	E <sub>T-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
#	[in]	+/- [in]					
1	0.500350	0.000030	0.141	0.236	0.319	0.037	0.040
2	0.500330	0.000030	-0.168	-0.236	-0.379	-0.043	-0.040
3	0.500330	0.000033	-0.164	-0.224	-0.379	-0.043	-0.040
4	0.500290	0.000040	-0.727	-1.000	-1.773	-0.203	-0.200
5	0.500340	0.000075	-0.009	0.000	-0.030	-0.003	0.000
6	0.500356	0.000072	0.165	0.206	0.528	0.061	0.064
7	0.500340	0.000016	-0.014	0.000	-0.030	-0.003	0.000
8	0.500324	0.000011	-0.289	-0.501	-0.588	-0.067	-0.064
9	0.500360	0.000024	0.308	0.521	0.668	0.077	0.080
10	0.500360	0.000250	0.075	0.079	0.668	0.077	0.080
11	0.500341	0.000012	0.002	0.031	0.005	0.001	0.004
12	0.500390	0.000050	0.646	0.857	1.714	0.197	0.200
13	0.500350	0.000028	0.143	0.244	0.319	0.037	0.040
14	0.500349	0.000030	0.126	0.212	0.284	0.033	0.036
15	0.500333	0.000090	-0.074	-0.074	-0.274	-0.031	-0.028
16	0.500350	0.000060	0.110	0.149	0.319	0.037	0.040
17	0.500355	0.000025	0.226	0.384	0.493	0.057	0.060
18	0.500210	0.000011	-2.241	-4.068	-4.563	-0.523	-0.520
19	0.500374	0.000000	0.578	1.133	1.156	0.133	0.136
20	0.500330	0.000000	-0.189	-0.333	-0.379	-0.043	-0.040
21	0.500360	0.000050	0.252	0.343	0.668	0.077	0.080
22	0.500320	0.000064	-0.243	-0.283	-0.727	-0.083	-0.080
23	0.500240	0.000030	-1.558	-2.357	-3.517	-0.403	-0.400
24	0.500330	0.000066	-0.124	-0.138	-0.379	-0.043	-0.040
25	0.500312	0.000011	-0.494	-0.876	-1.006	-0.115	-0.112
26	0.500330	0.000012	-0.185	-0.309	-0.379	-0.043	-0.040
27	0.500348	0.000011	0.122	0.250	0.249	0.029	0.032
28	0.500319	0.000011	-0.374	-0.657	-0.762	-0.087	-0.084
29	0.500378	0.000008	0.642	1.227	1.295	0.149	0.152
30	0.500350	0.000037	0.134	0.210	0.319	0.037	0.040
31	0.500344	0.000036	0.046	0.085	0.110	0.013	0.016
32	0.500318	0.000036	-0.338	-0.469	-0.797	-0.091	-0.088
33	0.500324	0.000036	-0.249	-0.341	-0.588	-0.067	-0.064
34	0.500330	0.000000	-0.189	-0.333	-0.379	-0.043	-0.040
35	0.500340	0.000020	-0.014	0.000	-0.030	-0.003	0.000
36	0.500370	0.000000	0.508	1.000	1.016	0.117	0.120
37	0.500300	0.000000	-0.712	-1.333	-1.425	-0.163	-0.160
38	0.500321	0.000019	-0.329	-0.535	-0.692	-0.079	-0.076
39	0.500380	0.000100	0.340	0.383	1.365	0.157	0.160
40	0.500270	0.000057	-0.876	-1.087	-2.471	-0.283	-0.280
41	0.500380	0.000047	0.528	0.717	1.365	0.157	0.160
42	0.500320	0.000041	-0.296	-0.394	-0.727	-0.083	-0.080
43	0.500330	0.000044	-0.150	-0.188	-0.379	-0.043	-0.040
44	0.500373	0.000012	0.549	1.021	1.121	0.129	0.132
45	0.500380	0.000012	0.668	1.238	1.365	0.157	0.160
46	0.500355	0.000025	0.226	0.384	0.493	0.057	0.060
47	0.500350	0.000030	0.141	0.236	0.319	0.037	0.040
48	0.500300	0.000055	-0.514	-0.638	-1.425	-0.163	-0.160
49	0.500260	0.000085	-0.789	-0.888	-2.820	-0.323	-0.320
50	0.500400	0.000035	0.880	1.302	2.062	0.237	0.240
51	0.500358	0.000019	0.284	0.507	0.598	0.069	0.072



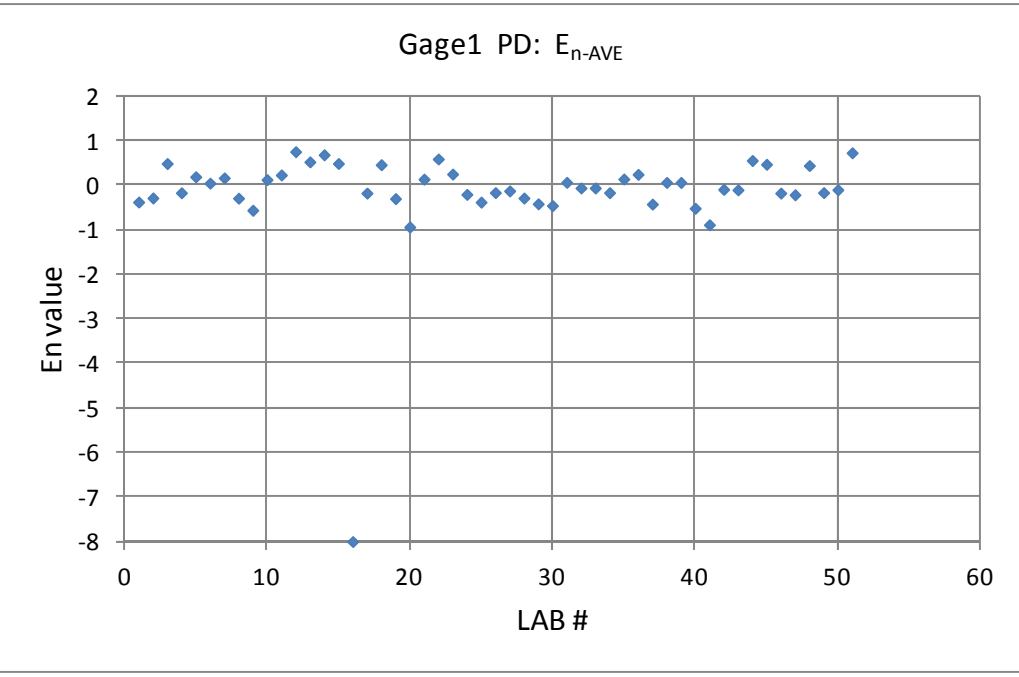
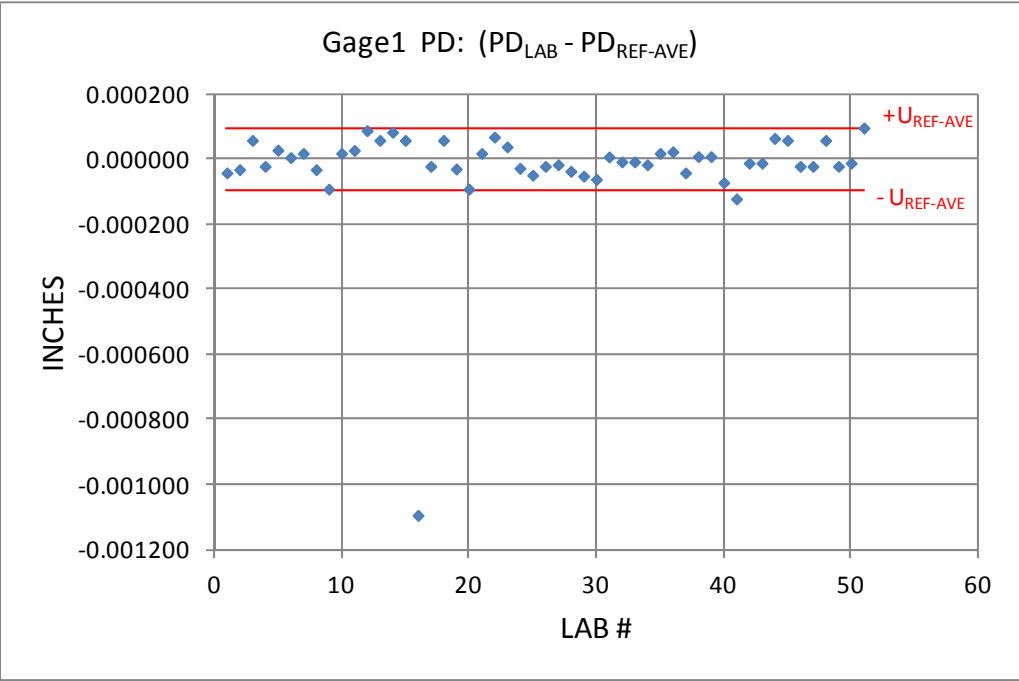


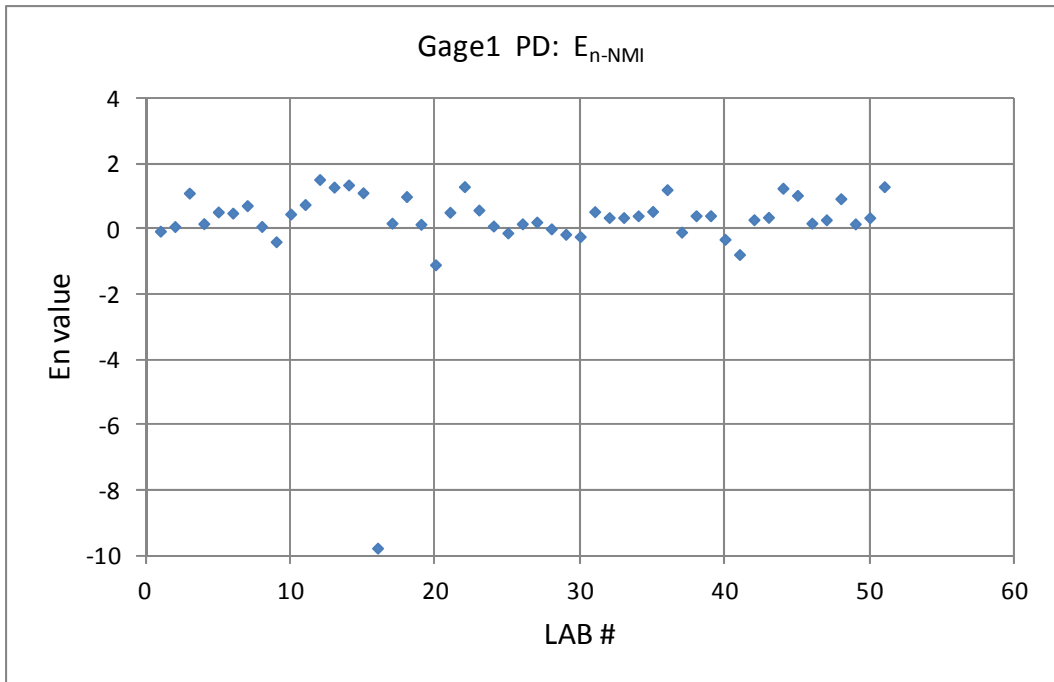
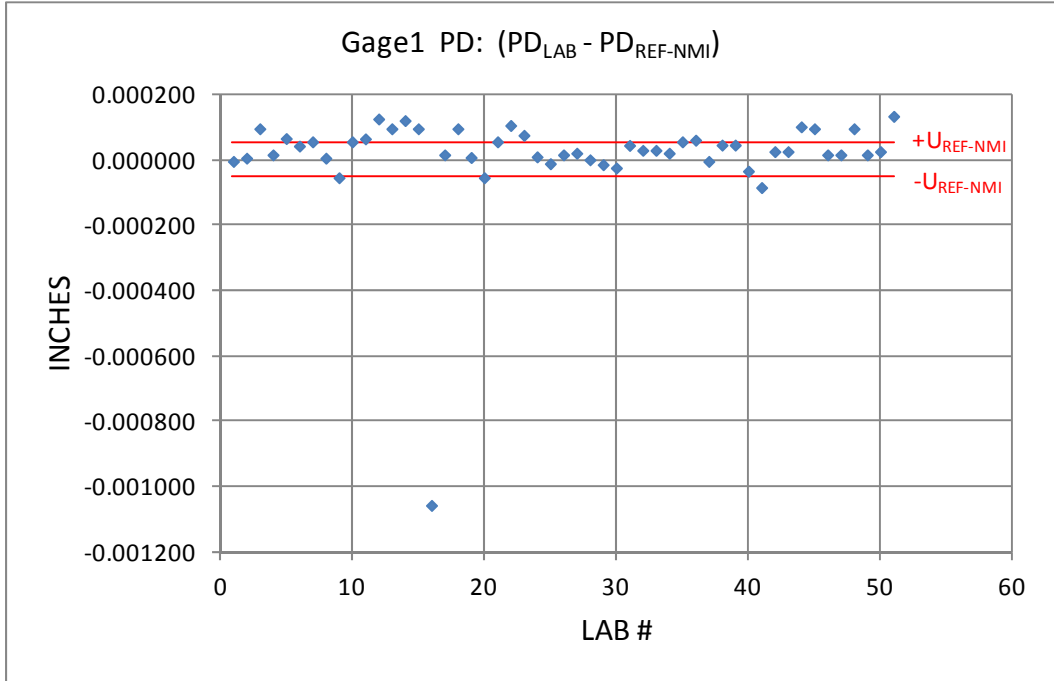


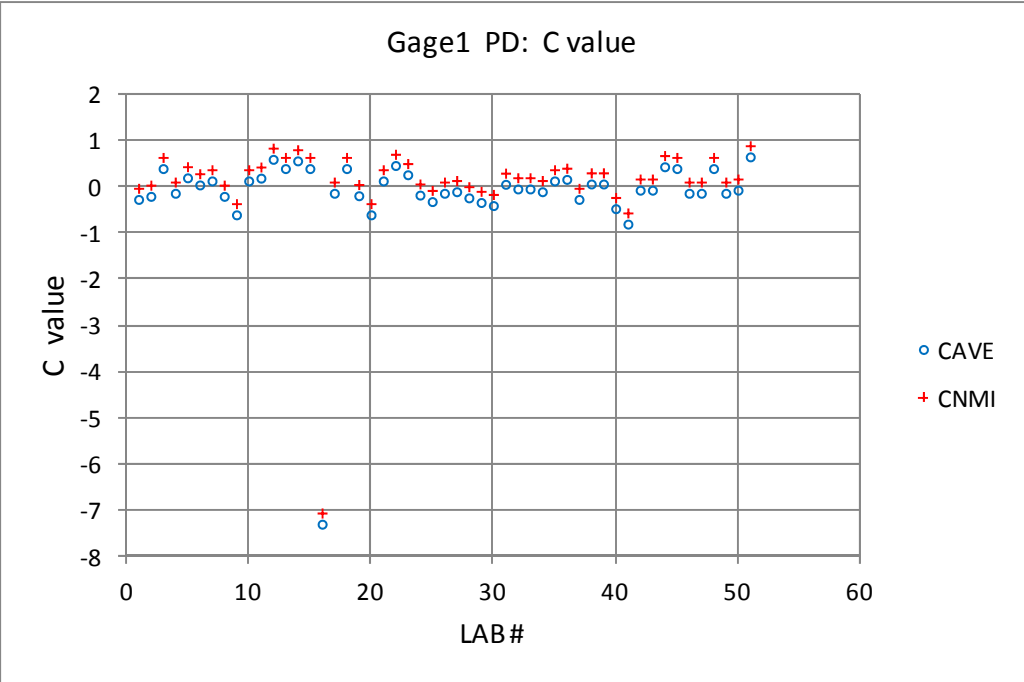
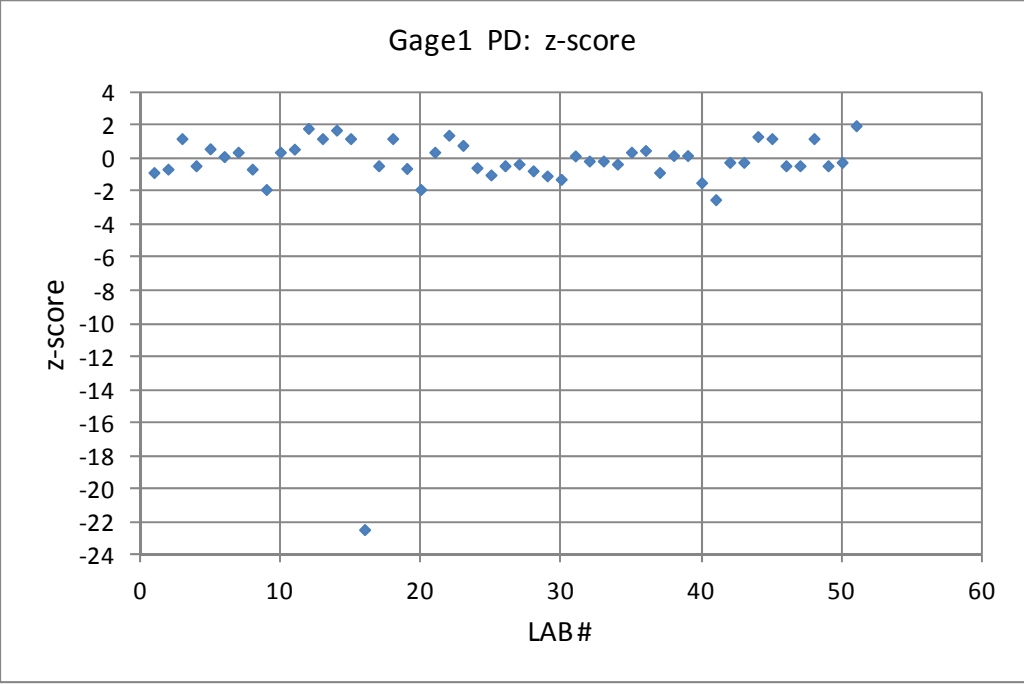


# Pitch Diameter Gage 1

Pitch Diameter		GAGE 1 1/2-20 UNS GO 3B: PD tolerance = 0.0003"					
Outliers:							
#16		PD <sub>REF-AVE</sub> = 0.468171	PD <sub>REF-NM</sub> = 0.468135			PD tol. = 0.0003	
		U <sub>REF-STD</sub> = 0.000097	U <sub>REF-NM</sub> = 0.000050				
		Reported					
		Uncertainty					
		Reported					
		k = 2, 95%					
		Value					
		coverage					
Lab #	PD [in]	factor +/- [in]	E <sub>n-AVE</sub>	E <sub>n-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
1	0.468130	0.000050	-0.376	-0.071	-0.846	-0.275	-0.033
2	0.468140	0.000050	-0.285	0.071	-0.641	-0.208	0.033
3	0.468230	0.000071	0.488	1.094	1.206	0.392	0.633
4	0.468150	0.000080	-0.168	0.159	-0.436	-0.141	0.100
5	0.468200	0.000115	0.191	0.518	0.591	0.192	0.433
6	0.468177	0.000072	0.048	0.481	0.119	0.039	0.280
7	0.468190	0.000059	0.165	0.711	0.385	0.125	0.367
8	0.468140	0.000046	-0.290	0.074	-0.641	-0.208	0.033
9	0.468080	0.000130	-0.561	-0.395	-1.872	-0.608	-0.367
10	0.468190	0.000111	0.127	0.452	0.385	0.125	0.367
11	0.468199	0.000070	0.232	0.744	0.570	0.185	0.427
12	0.468260	0.000066	0.754	1.510	1.822	0.592	0.833
13	0.468230	0.000055	0.525	1.278	1.206	0.392	0.633
14	0.468255	0.000074	0.685	1.344	1.720	0.559	0.800
15	0.468230	0.000070	0.490	1.104	1.206	0.392	0.633
16	0.467077	0.000096	-7.999	-9.775	-22.458	-7.295	-7.053
17	0.468150	0.000070	-0.177	0.174	-0.436	-0.141	0.100
18	0.468230	0.000082	0.462	0.989	1.206	0.392	0.633
19	0.468142	0.000000	-0.300	0.140	-0.600	-0.195	0.047
20	0.468080	0.000000	-0.936	-1.100	-1.872	-0.608	-0.367
21	0.468190	0.000096	0.137	0.508	0.385	0.125	0.367
22	0.468240	0.000064	0.590	1.293	1.412	0.459	0.700
23	0.468210	0.000120	0.251	0.577	0.796	0.259	0.500
24	0.468144	0.000090	-0.205	0.087	-0.559	-0.181	0.060
25	0.468123	0.000082	-0.379	-0.125	-0.990	-0.321	-0.080
26	0.468150	0.000083	-0.166	0.155	-0.436	-0.141	0.100
27	0.468155	0.000083	-0.127	0.206	-0.333	-0.108	0.133
28	0.468135	0.000080	-0.287	0.000	-0.743	-0.241	0.000
29	0.468120	0.000075	-0.417	-0.166	-1.051	-0.341	-0.100
30	0.468110	0.000092	-0.457	-0.239	-1.256	-0.408	-0.167
31	0.468179	0.000067	0.066	0.526	0.160	0.052	0.293
32	0.468164	0.000067	-0.061	0.347	-0.148	-0.048	0.193
33	0.468164	0.000067	-0.061	0.347	-0.148	-0.048	0.193
34	0.468155	0.000000	-0.166	0.400	-0.333	-0.108	0.133
35	0.468190	0.000090	0.142	0.534	0.385	0.125	0.367
36	0.468195	0.000000	0.244	1.200	0.488	0.159	0.400
37	0.468130	0.000000	-0.423	-0.100	-0.846	-0.275	-0.033
38	0.468180	0.000100	0.063	0.402	0.180	0.059	0.300
39	0.468180	0.000100	0.063	0.402	0.180	0.059	0.300
40	0.468100	0.000097	-0.518	-0.321	-1.462	-0.475	-0.233
41	0.468050	0.000096	-0.886	-0.785	-2.488	-0.808	-0.567
42	0.468160	0.000074	-0.092	0.280	-0.230	-0.075	0.167
43	0.468160	0.000050	-0.102	0.354	-0.230	-0.075	0.167
44	0.468236	0.000064	0.556	1.244	1.330	0.432	0.673
45	0.468230	0.000078	0.471	1.025	1.206	0.392	0.633
46	0.468150	0.000070	-0.177	0.174	-0.436	-0.141	0.100
47	0.468150	0.000020	-0.213	0.279	-0.436	-0.141	0.100
48	0.468230	0.000090	0.443	0.923	1.206	0.392	0.633
49	0.468150	0.000085	-0.164	0.152	-0.436	-0.141	0.100
50	0.468160	0.000054	-0.101	0.340	-0.230	-0.075	0.167
51	0.468268	0.000090	0.730	1.292	1.986	0.645	0.887

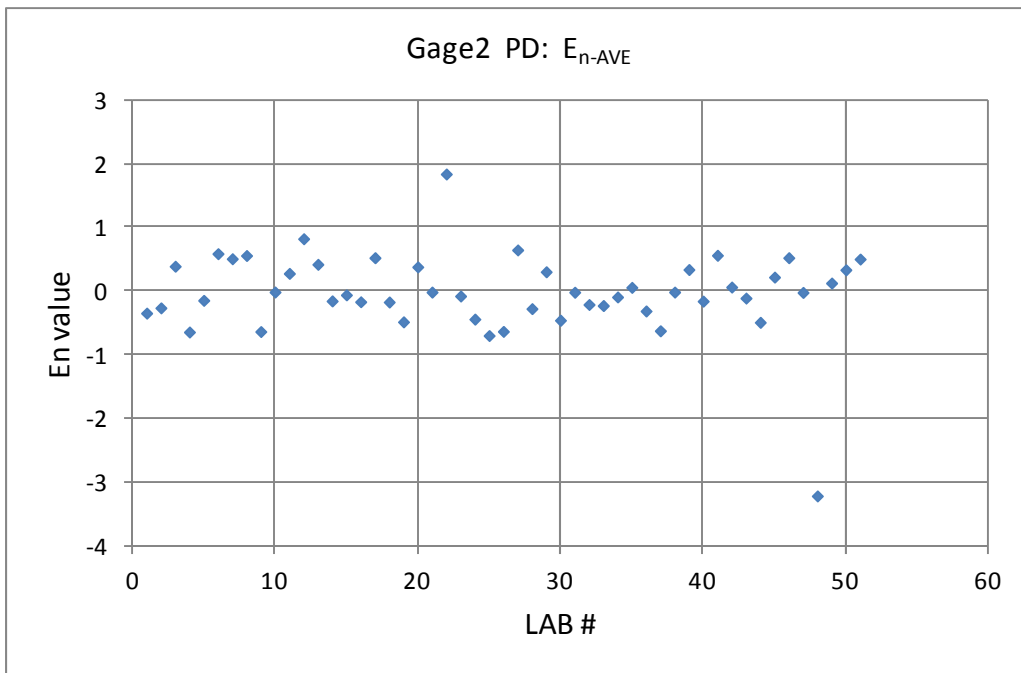
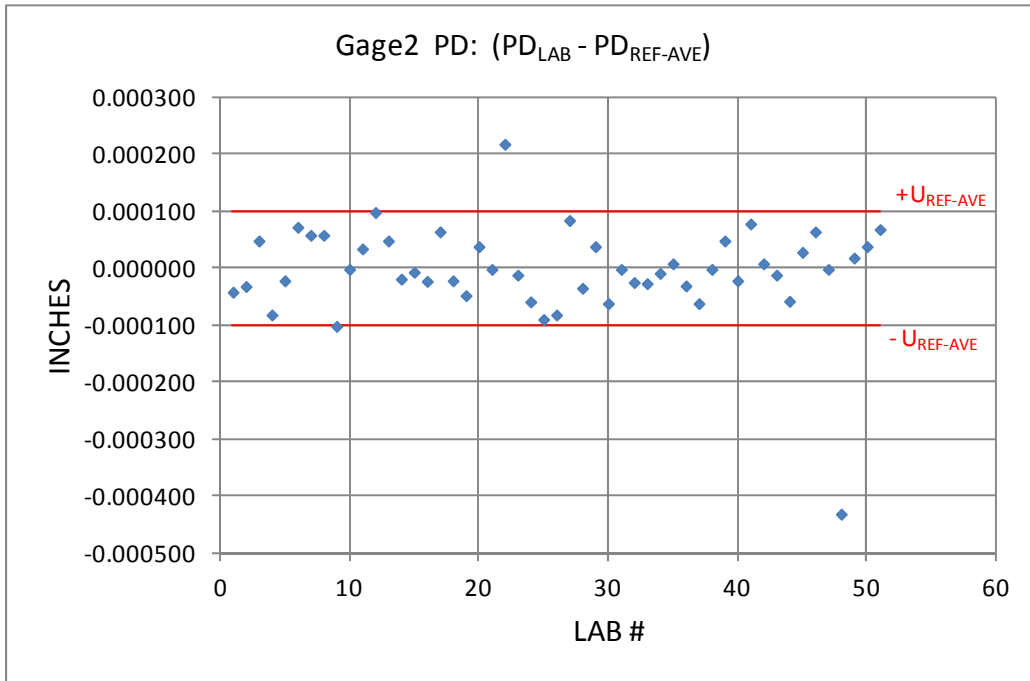


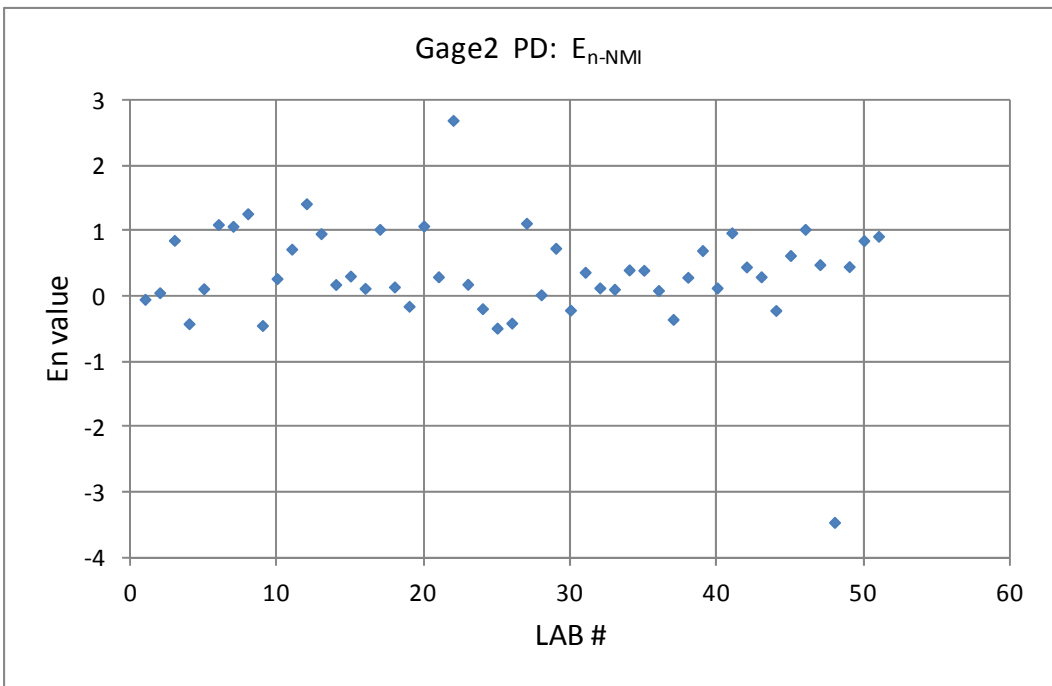
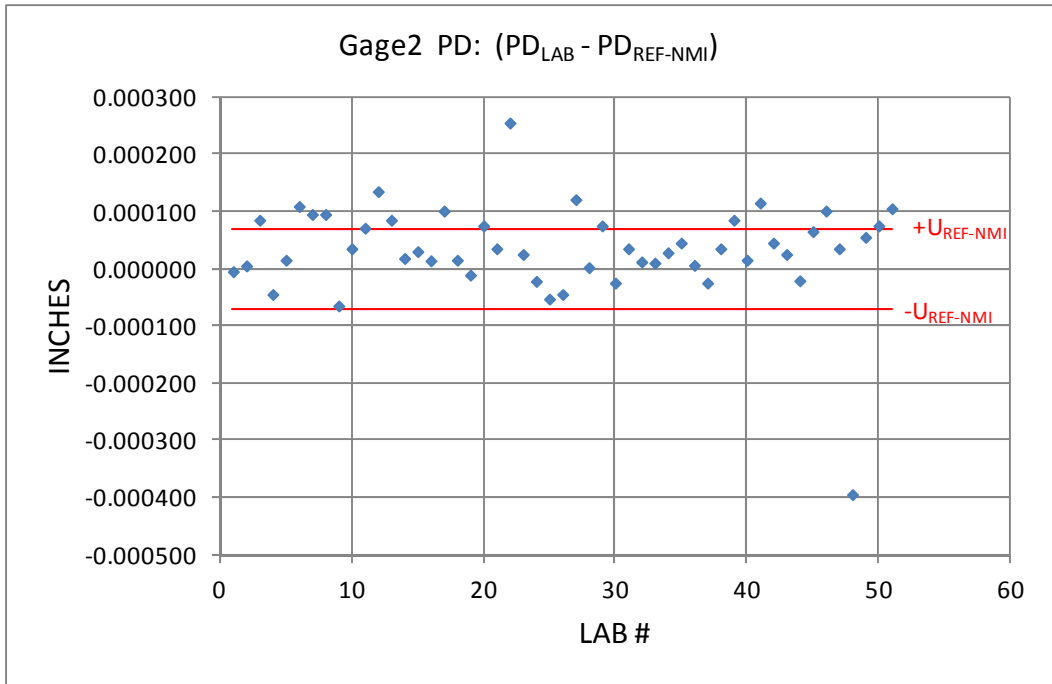


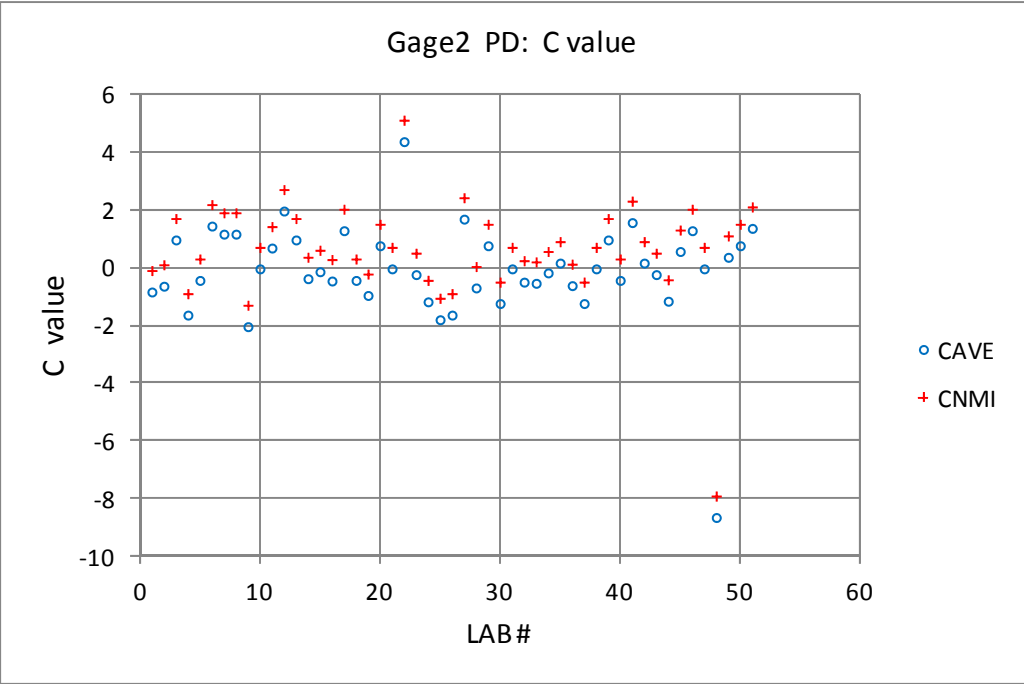
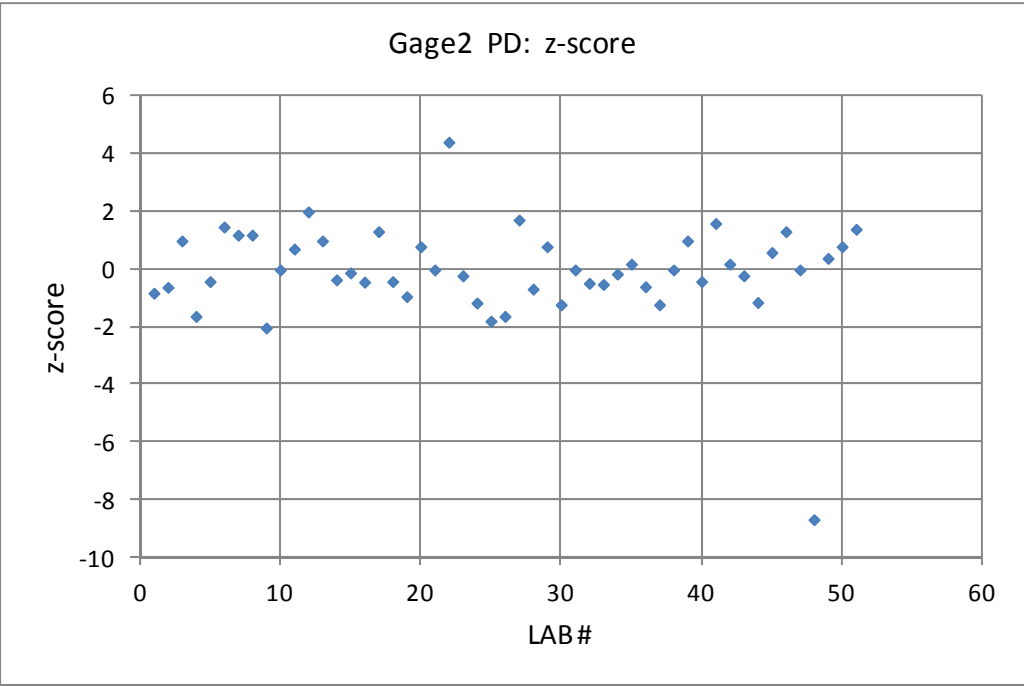


## Pitch Diameter Gage 2

Pitch Diameter		GAGE 2: 1/4-28 UNJF GO 3A: PD W tolerance = 0.0001"					
Outliers:							
(#22, 48)		PD <sub>REF-AVE</sub> = 0.226722	PD <sub>REF-NM</sub> = 0.226685	PD tol. = 0.0001			
		U <sub>REF-STD</sub> = 0.000100	U <sub>REF-NM</sub> = 0.000070				
		Reported					
		Uncertainty					
		Reported	k = 2, 95%				
		Value	coverage				
Lab #	PD [in]	factor +/- [in]	E <sub>AVE</sub>	E <sub>NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
1	0.226680	0.000070	-0.346	-0.051	-0.845	-0.841	-0.100
2	0.226690	0.000070	-0.263	0.051	-0.644	-0.641	0.100
3	0.226770	0.000071	0.392	0.853	0.963	0.959	1.700
4	0.226640	0.000080	-0.642	-0.423	-1.648	-1.641	-0.900
5	0.226700	0.000115	-0.145	0.111	-0.443	-0.441	0.300
6	0.226794	0.000071	0.589	1.095	1.445	1.439	2.180
7	0.226780	0.000055	0.509	1.067	1.164	1.159	1.900
8	0.226780	0.000028	0.560	1.260	1.164	1.159	1.900
9	0.226620	0.000126	-0.635	-0.451	-2.050	-2.041	-1.300
10	0.226720	0.000111	-0.014	0.267	-0.041	-0.041	0.700
11	0.226756	0.000070	0.279	0.717	0.682	0.679	1.420
12	0.226820	0.000065	0.824	1.413	1.967	1.959	2.700
13	0.226770	0.000055	0.421	0.955	0.963	0.959	1.700
14	0.226703	0.000074	-0.154	0.177	-0.383	-0.381	0.360
15	0.226715	0.000069	-0.058	0.305	-0.142	-0.141	0.600
16	0.226699	0.000096	-0.167	0.118	-0.463	-0.461	0.280
17	0.226786	0.000070	0.525	1.020	1.284	1.279	2.020
18	0.226700	0.000082	-0.171	0.139	-0.443	-0.441	0.300
19	0.226674	0.000000	-0.483	-0.157	-0.965	-0.961	-0.220
20	0.226760	0.000000	0.381	1.071	0.762	0.759	1.500
21	0.226720	0.000096	-0.015	0.295	-0.041	-0.041	0.700
22	0.226940	0.000064	1.841	2.689	4.377	4.359	5.100
23	0.226710	0.000120	-0.077	0.180	-0.242	-0.241	0.500
24	0.226663	0.000090	-0.440	-0.193	-1.186	-1.181	-0.440
25	0.226632	0.000082	-0.698	-0.492	-1.809	-1.801	-1.060
26	0.226640	0.000083	-0.633	-0.414	-1.648	-1.641	-0.900
27	0.226806	0.000083	0.647	1.114	1.686	1.679	2.420
28	0.226687	0.000080	-0.274	0.019	-0.704	-0.701	0.040
29	0.226760	0.000075	0.304	0.731	0.762	0.759	1.500
30	0.226660	0.000092	-0.458	-0.216	-1.246	-1.241	-0.500
31	0.226720	0.000066	-0.017	0.364	-0.041	-0.041	0.700
32	0.226697	0.000066	-0.210	0.125	-0.503	-0.501	0.240
33	0.226695	0.000066	-0.227	0.104	-0.543	-0.541	0.200
34	0.226713	0.000000	-0.091	0.400	-0.182	-0.181	0.560
35	0.226730	0.000090	0.059	0.395	0.159	0.159	0.900
36	0.226691	0.000000	-0.312	0.086	-0.624	-0.621	0.120
37	0.226660	0.000000	-0.623	-0.357	-1.246	-1.241	-0.500
38	0.226720	0.000100	-0.015	0.287	-0.041	-0.041	0.700
39	0.226770	0.000100	0.340	0.696	0.963	0.959	1.700
40	0.226700	0.000099	-0.157	0.124	-0.443	-0.441	0.300
41	0.226800	0.000096	0.563	0.968	1.565	1.559	2.300
42	0.226730	0.000073	0.064	0.445	0.159	0.159	0.900
43	0.226710	0.000048	-0.109	0.295	-0.242	-0.241	0.500
44	0.226664	0.000064	-0.490	-0.221	-1.166	-1.161	-0.420
45	0.226750	0.000078	0.221	0.620	0.561	0.559	1.300
46	0.226786	0.000070	0.525	1.020	1.284	1.279	2.020
47	0.226720	0.000020	-0.020	0.481	-0.041	-0.041	0.700
48	0.226290	0.000090	-3.219	-3.464	-8.677	-8.641	-7.900
49	0.226740	0.000100	0.127	0.451	0.360	0.359	1.100
50	0.226760	0.000054	0.335	0.848	0.762	0.759	1.500
51	0.226790	0.000091	0.504	0.915	1.364	1.359	2.100



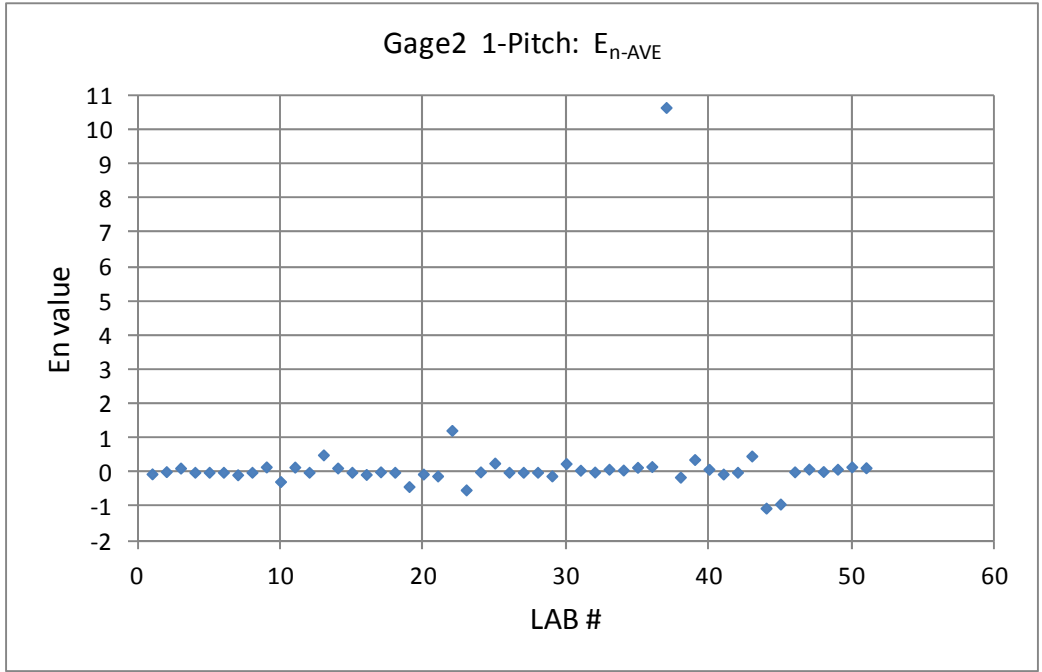
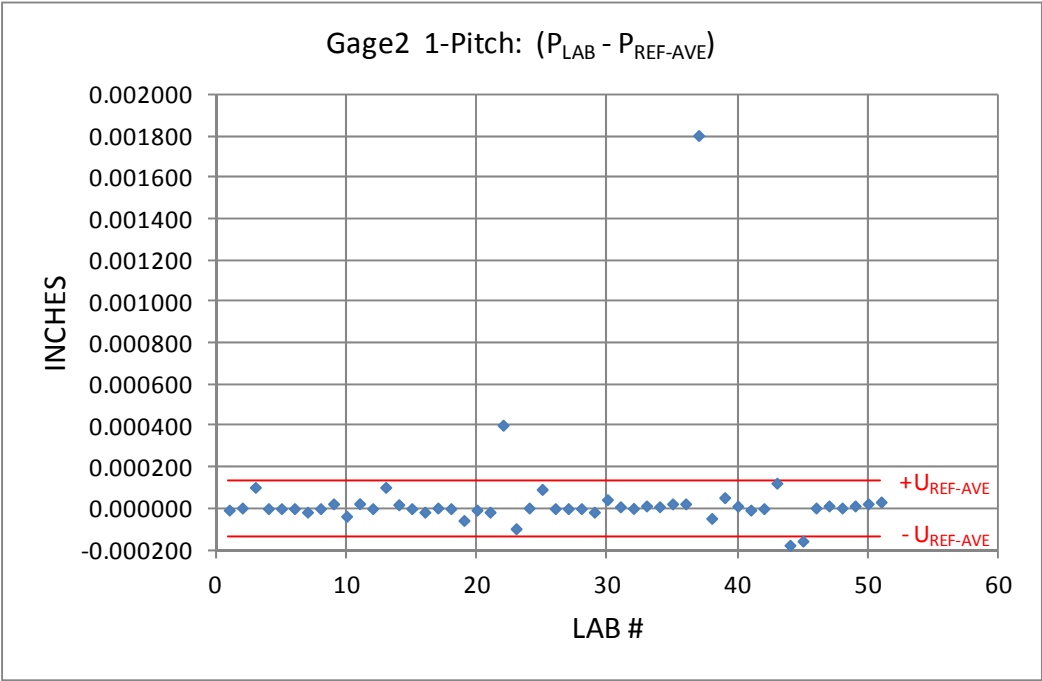


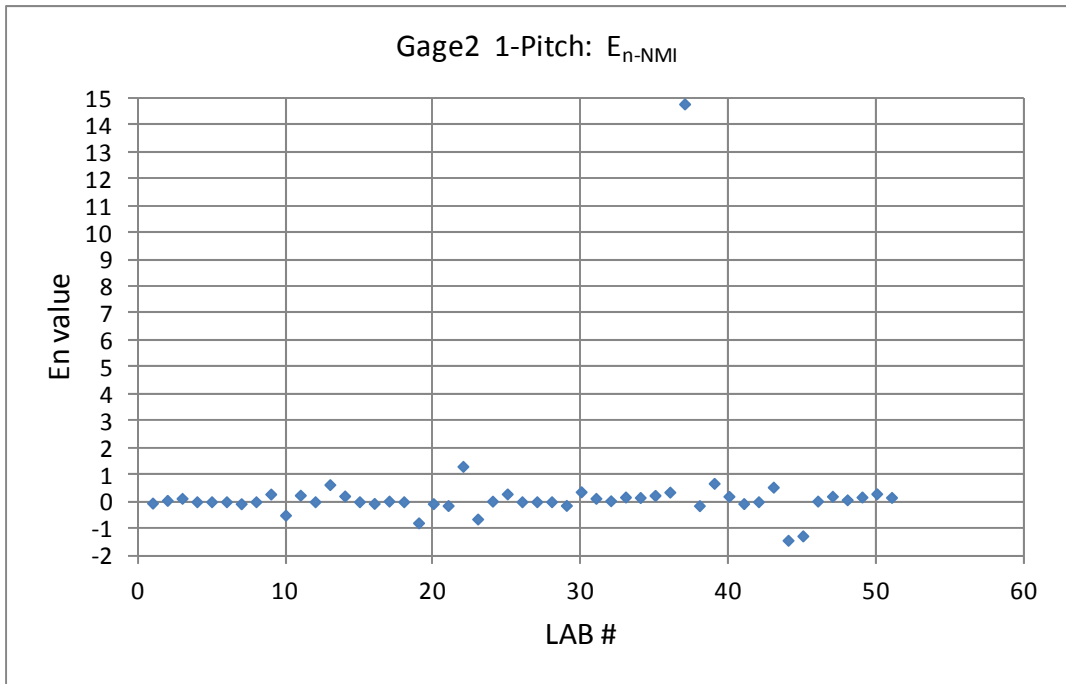
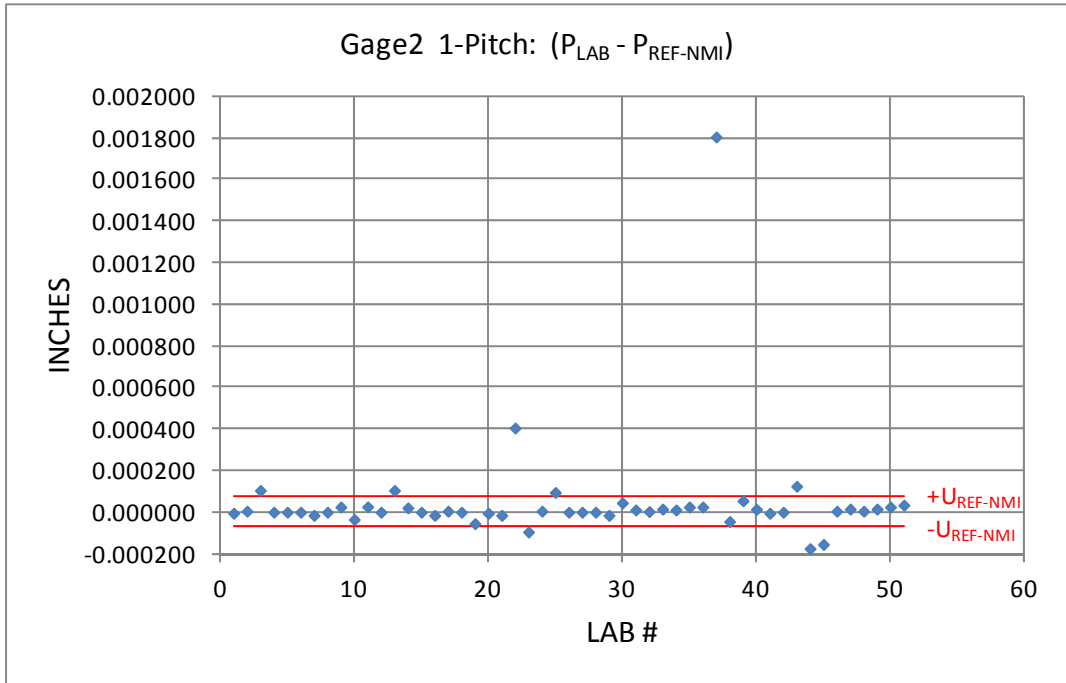


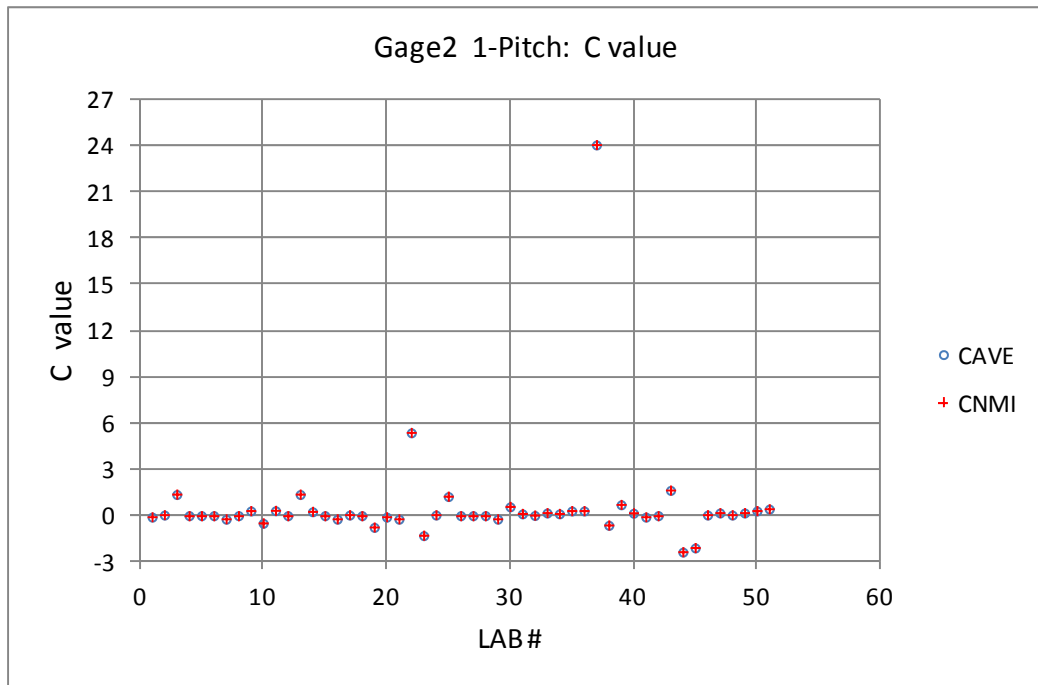
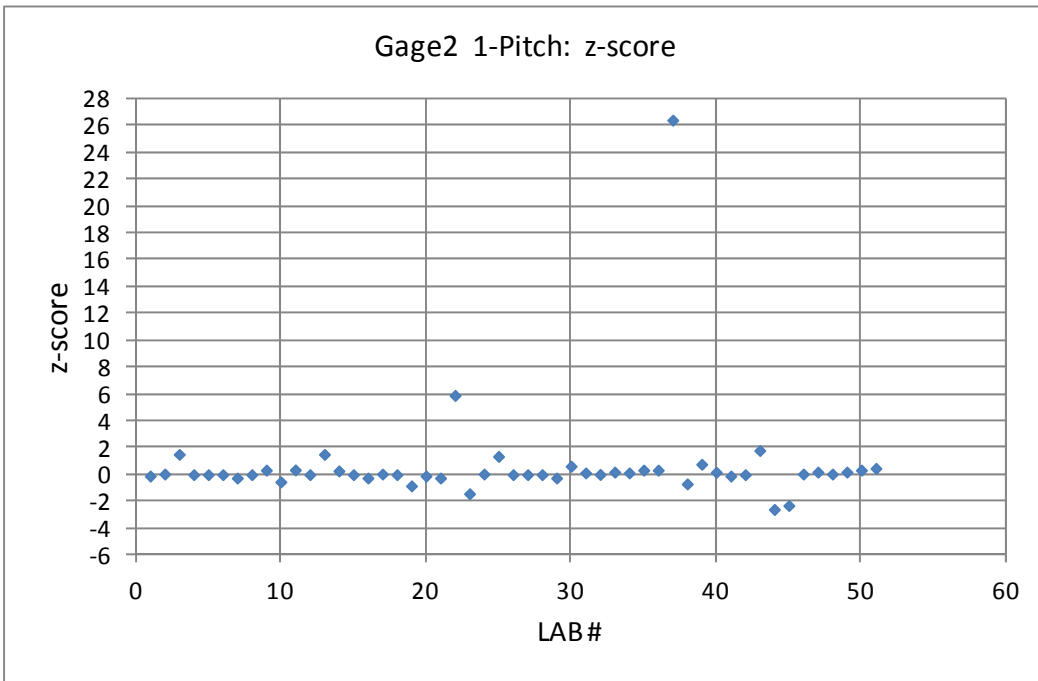


## Lead, 1 Pitch Gage 2

Lead		GAGE 2: 1/4-28 UNJF GO 3A: Lead tolerance = 0.00015"					
Outliers: (#22, 37)		$P_{REF-AVE} = 0.035697$	$P_{REF-NM} = 0.035695$	$P_{tol.} = 0.00015$			
		$U_{REF-STD} = 0.000137$	$U_{REF-NM} = 0.000070$	1 Pitch Measurement			
		Reported					
		Uncertainty					
		Reported	k = 2, 95%				
		Value					
	P	factor	$E_{T-AVE}$	$E_{T-NM}$	z-score	$C_{AVE}$	$C_{NM}$
Lab #	[in]	+/- [in]					
1	0.035690	0.000070	-0.046	-0.051	-0.104	-0.094	-0.067
2	0.035700	0.000070	0.019	0.051	0.043	0.039	0.067
3	0.035800	0.000830	0.122	0.126	1.507	1.372	1.400
4	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
5	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	0.035680	0.000190	-0.073	-0.074	-0.250	-0.228	-0.200
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	0.035720	0.000053	0.156	0.285	0.336	0.306	0.333
10	0.035660	0.000000	-0.271	-0.500	-0.543	-0.494	-0.467
11	0.035721	0.000080	0.151	0.245	0.350	0.319	0.347
12	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
13	0.035800	0.000150	0.507	0.634	1.507	1.372	1.400
14	0.035716	0.000068	0.124	0.215	0.277	0.252	0.280
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	0.035680	0.000230	-0.064	-0.062	-0.250	-0.228	-0.200
17	0.035700	0.000200	0.012	0.024	0.043	0.039	0.067
18	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
19	0.035640	0.000000	-0.418	-0.786	-0.836	-0.761	-0.733
20	0.035690	0.000000	-0.052	-0.071	-0.104	-0.094	-0.067
21	0.035680	0.000080	-0.108	-0.141	-0.250	-0.228	-0.200
22	0.036100	0.000300	1.222	1.315	5.899	5.372	5.400
23	0.035600	0.000130	-0.515	-0.643	-1.421	-1.294	-1.267
24	0.035700	0.000235	0.011	0.020	0.043	0.039	0.067
25	0.035790	0.000320	0.267	0.290	1.360	1.239	1.267
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	0.035680	0.000084	-0.106	-0.137	-0.250	-0.228	-0.200
30	0.035740	0.000100	0.254	0.369	0.628	0.572	0.600
31	0.035706	0.000050	0.060	0.126	0.128	0.117	0.144
32	0.035698	0.000050	0.006	0.035	0.013	0.012	0.040
33	0.035710	0.000050	0.089	0.174	0.189	0.172	0.200
34	0.035706	0.000000	0.065	0.157	0.131	0.119	0.147
35	0.035720	0.000080	0.145	0.235	0.336	0.306	0.333
36	0.035720	0.000000	0.168	0.357	0.336	0.306	0.333
37	0.037500	0.000100	10.649	14.787	26.395	24.039	24.067
38	0.035650	0.000300	-0.143	-0.146	-0.689	-0.628	-0.600
39	0.035750	0.000040	0.372	0.682	0.775	0.706	0.733
40	0.035709	0.000000	0.087	0.200	0.175	0.159	0.187
41	0.035690	0.000020	-0.051	-0.069	-0.104	-0.094	-0.067
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	0.035820	0.000220	0.475	0.541	1.800	1.639	1.667
44	0.035520	0.000100	-1.046	-1.434	-2.592	-2.361	-2.333
45	0.035540	0.000100	-0.928	-1.270	-2.300	-2.094	-2.067
46	0.035700	0.000200	0.012	0.024	0.043	0.039	0.067
47	0.035710	0.000025	0.093	0.202	0.189	0.172	0.200
48	0.035700	0.000000	0.021	0.071	0.043	0.039	0.067
49	0.035710	0.000050	0.089	0.174	0.189	0.172	0.200
50	0.035720	0.000047	0.159	0.297	0.336	0.306	0.333
51	0.035729	0.000200	0.132	0.160	0.467	0.426	0.453

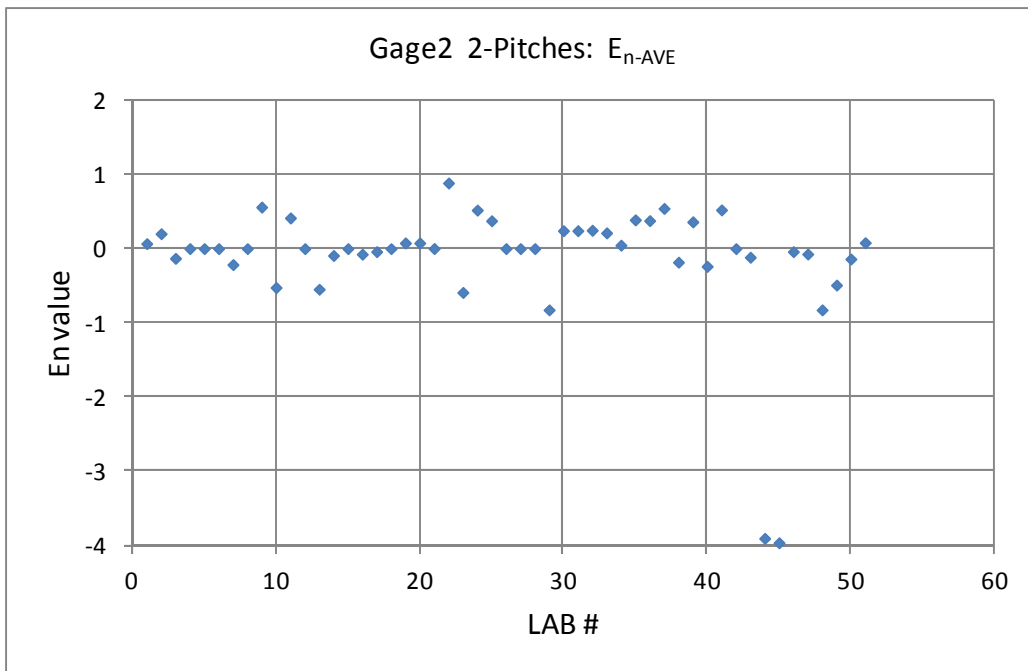
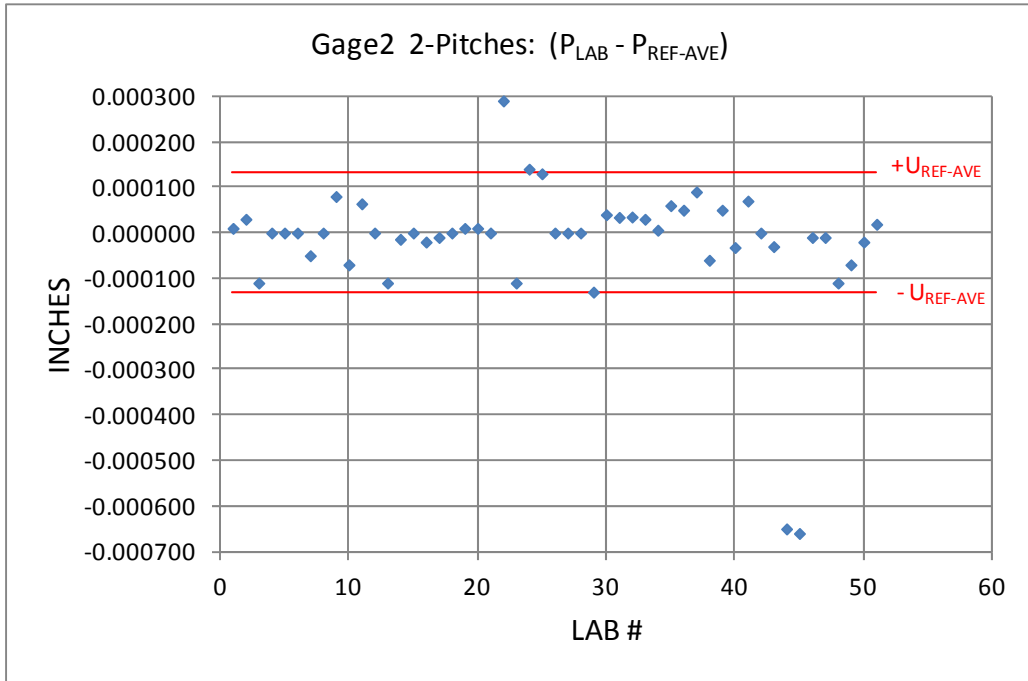


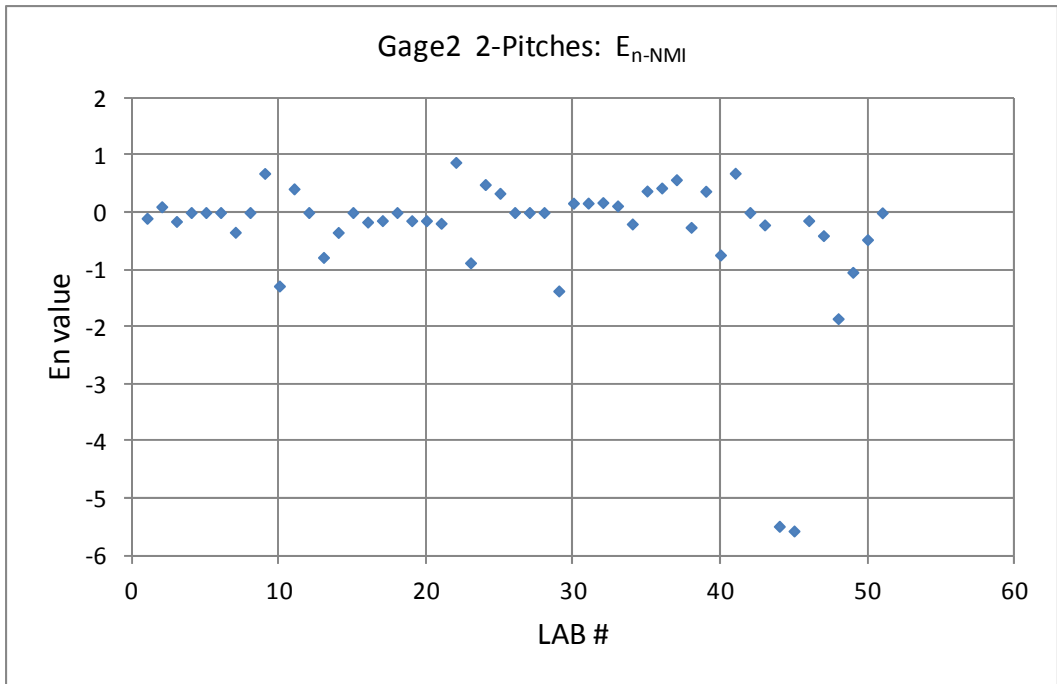
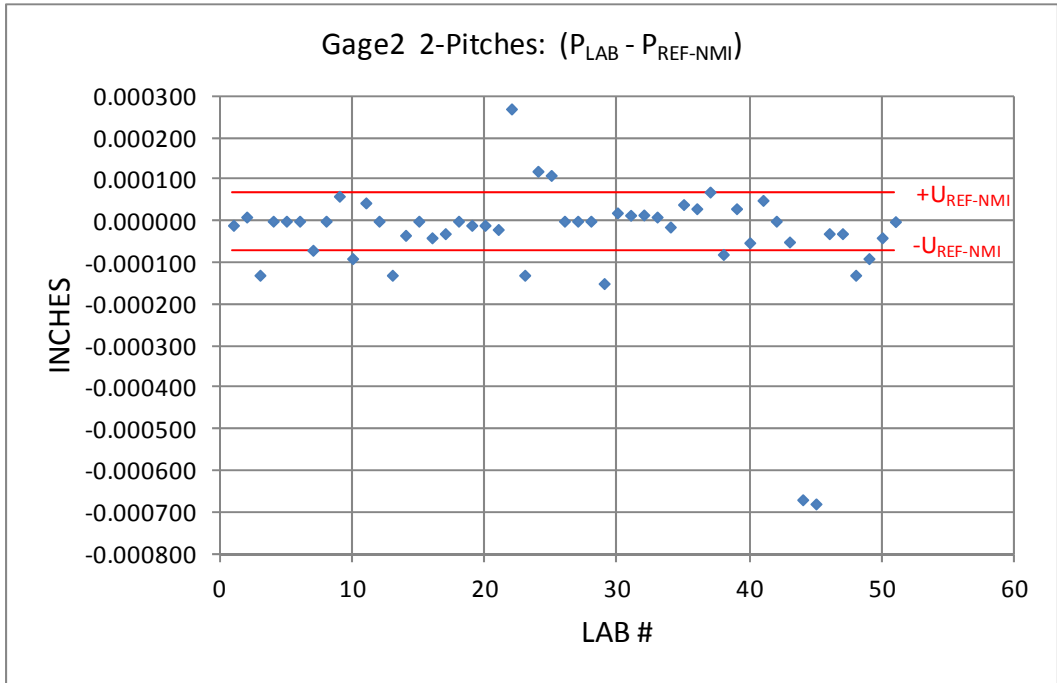


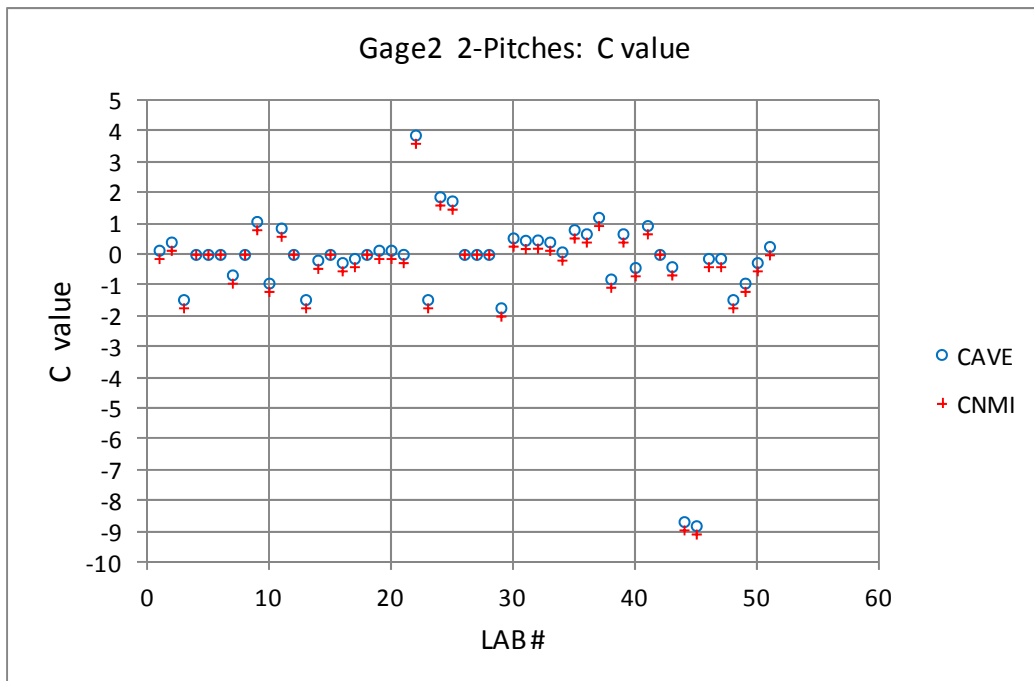
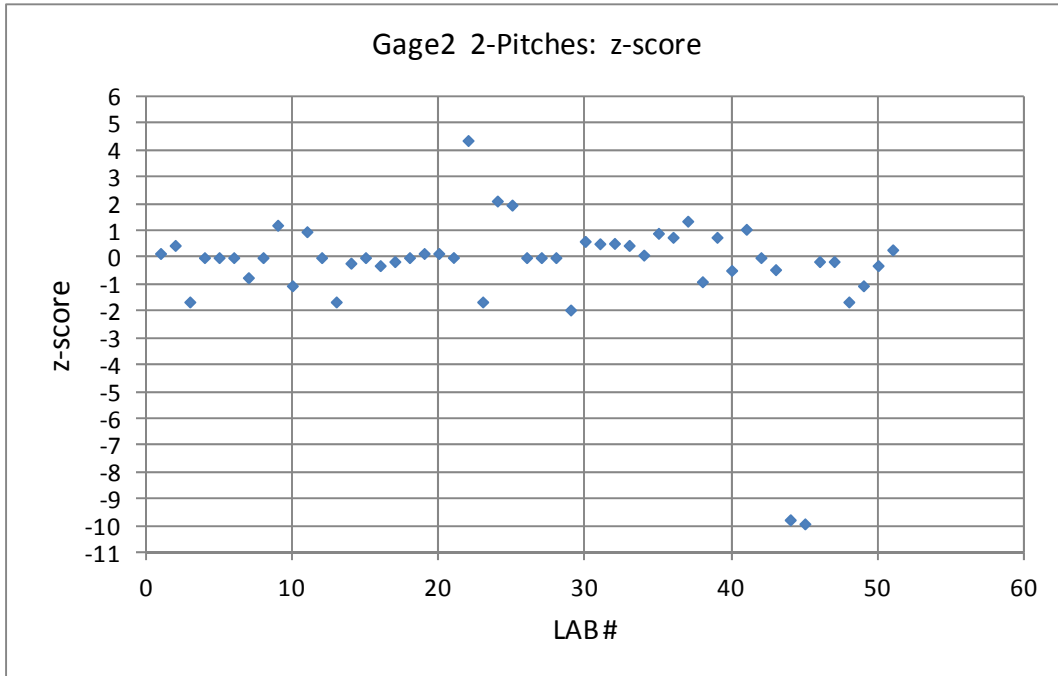


## Lead, 2 Pitches Gage 2

Lead		GAGE 2: 1/4-28 UNJF GO 3A: Lead tolerance = 0.00015"					
Outliers: (#22, 44, 45)		$P_{REF-AVE} = 0.071410$	$P_{REF-NM} = 0.071430$	$P_{tol.} = 0.00015$			
		$U_{REF-STD} = 0.000133$	$U_{REF-NM} = 0.000070$	2 pitch measurement			
		Reported Uncertainty					
		Reported Value	k = 2, 95% coverage				
Lab #	2-P [in]	factor +/- [in]	$E_{T-AVE}$	$E_{T-NM}$	z-score	$C_{AVE}$	$C_{NM}$
1	0.071420	0.000070	0.068	-0.101	0.153	0.136	-0.133
2	0.071440	0.000070	0.201	0.101	0.454	0.403	0.133
3	0.071300	0.000830	-0.131	-0.156	-1.649	-1.464	-1.733
4	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
5	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	0.071360	0.000190	-0.215	-0.346	-0.748	-0.664	-0.933
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	0.071490	0.000053	0.560	0.683	1.205	1.069	0.800
10	0.071340	0.000000	-0.524	-1.286	-1.048	-0.931	-1.200
11	0.071474	0.000080	0.413	0.414	0.965	0.856	0.587
12	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
13	0.071300	0.000150	-0.547	-0.785	-1.649	-1.464	-1.733
14	0.071396	0.000068	-0.092	-0.348	-0.207	-0.184	-0.453
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	0.071390	0.000230	-0.074	-0.166	-0.297	-0.264	-0.533
17	0.071400	0.000200	-0.041	-0.142	-0.147	-0.131	-0.400
18	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
19	0.071420	0.000000	0.077	-0.143	0.153	0.136	-0.133
20	0.071420	0.000000	0.077	-0.143	0.153	0.136	-0.133
21	0.071410	0.000080	0.001	-0.188	0.003	0.003	-0.267
22	0.071700	0.000300	0.884	0.876	4.360	3.869	3.600
23	0.071300	0.000130	-0.590	-0.880	-1.649	-1.464	-1.733
24	0.071550	0.000235	0.519	0.489	2.106	1.869	1.600
25	0.071540	0.000320	0.376	0.336	1.956	1.736	1.467
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	0.071280	0.000084	-0.825	-1.372	-1.950	-1.731	-2.000
30	0.071450	0.000100	0.242	0.164	0.604	0.536	0.267
31	0.071444	0.000050	0.242	0.165	0.516	0.458	0.189
32	0.071445	0.000050	0.248	0.174	0.529	0.469	0.200
33	0.071440	0.000050	0.212	0.116	0.454	0.403	0.133
34	0.071416	0.000000	0.047	-0.200	0.093	0.083	-0.187
35	0.071470	0.000080	0.388	0.376	0.905	0.803	0.533
36	0.071460	0.000000	0.377	0.429	0.754	0.669	0.400
37	0.071500	0.000100	0.542	0.573	1.355	1.203	0.933
38	0.071350	0.000300	-0.182	-0.260	-0.898	-0.797	-1.067
39	0.071460	0.000040	0.361	0.372	0.754	0.669	0.400
40	0.071378	0.000000	-0.239	-0.743	-0.478	-0.424	-0.693
41	0.071480	0.000020	0.522	0.687	1.055	0.936	0.667
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	0.071380	0.000220	-0.116	-0.217	-0.448	-0.397	-0.667
44	0.070760	0.000100	-3.903	-5.489	-9.762	-8.664	-8.933
45	0.070750	0.000100	-3.963	-5.571	-9.912	-8.797	-9.067
46	0.071400	0.000200	-0.041	-0.142	-0.147	-0.131	-0.400
47	0.071400	0.000025	-0.072	-0.404	-0.147	-0.131	-0.400
48	0.071300	0.000000	-0.825	-1.857	-1.649	-1.464	-1.733
49	0.071340	0.000050	-0.491	-1.046	-1.048	-0.931	-1.200
50	0.071390	0.000047	-0.140	-0.474	-0.297	-0.264	-0.533
51	0.071429	0.000200	0.080	-0.005	0.289	0.256	-0.013



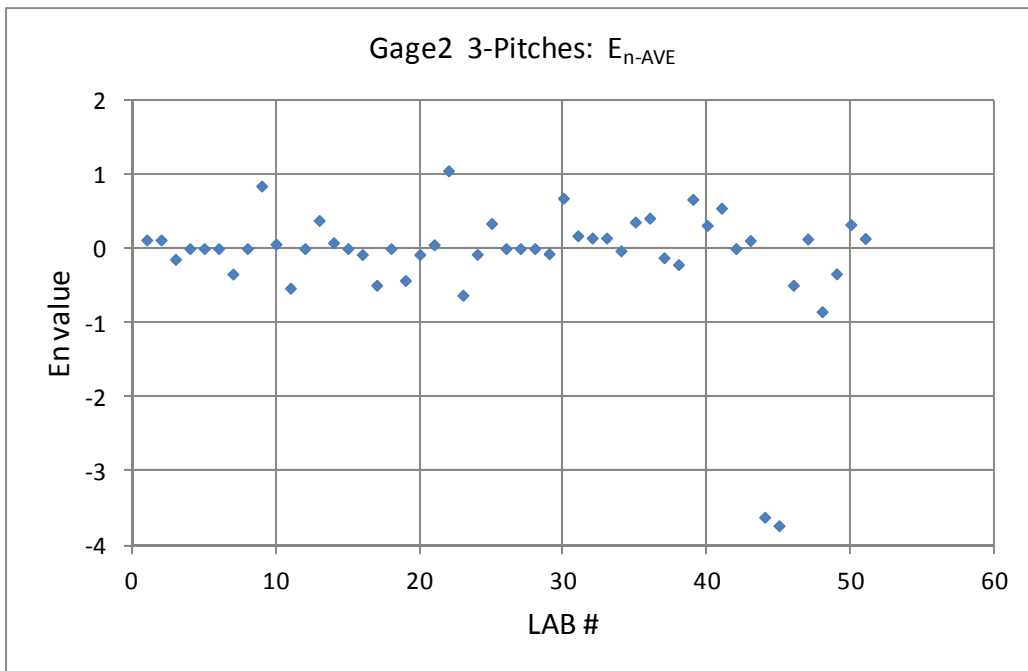
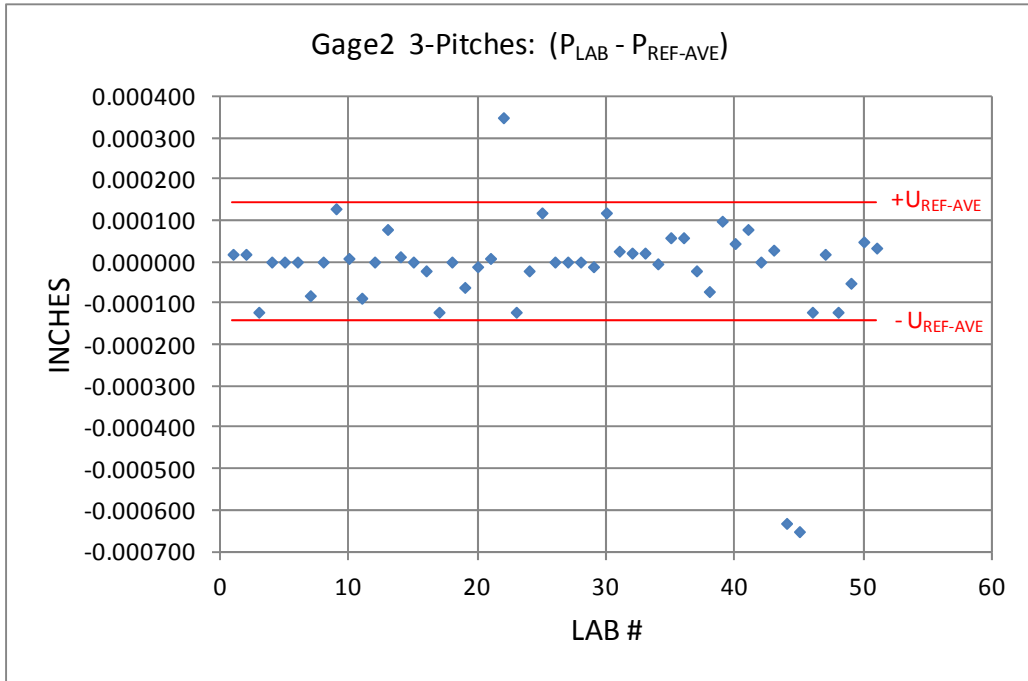


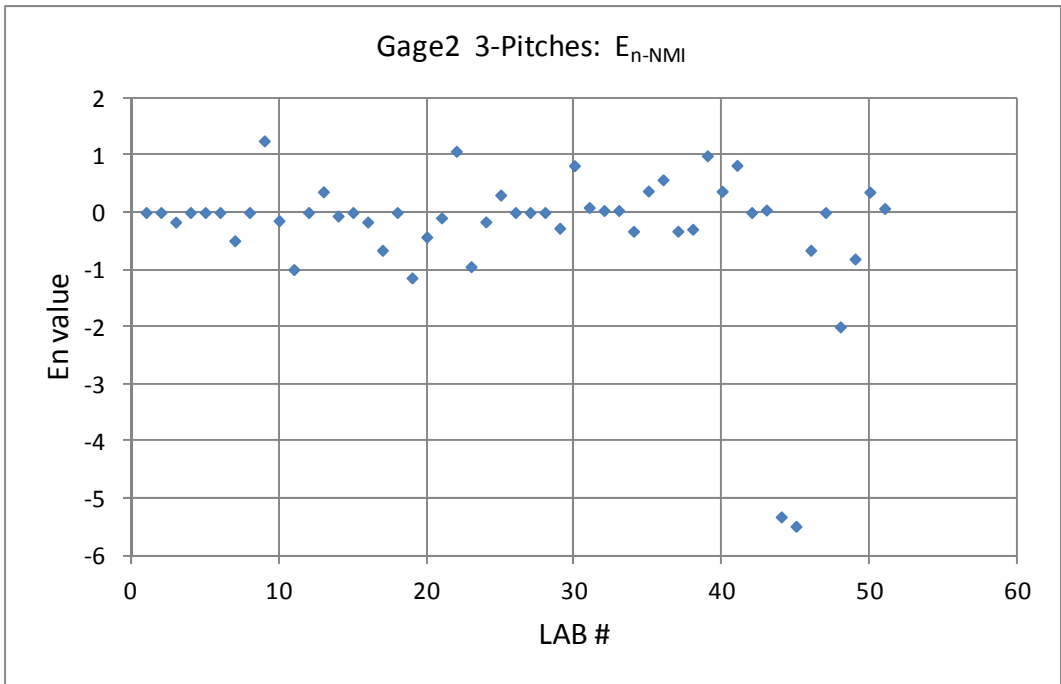
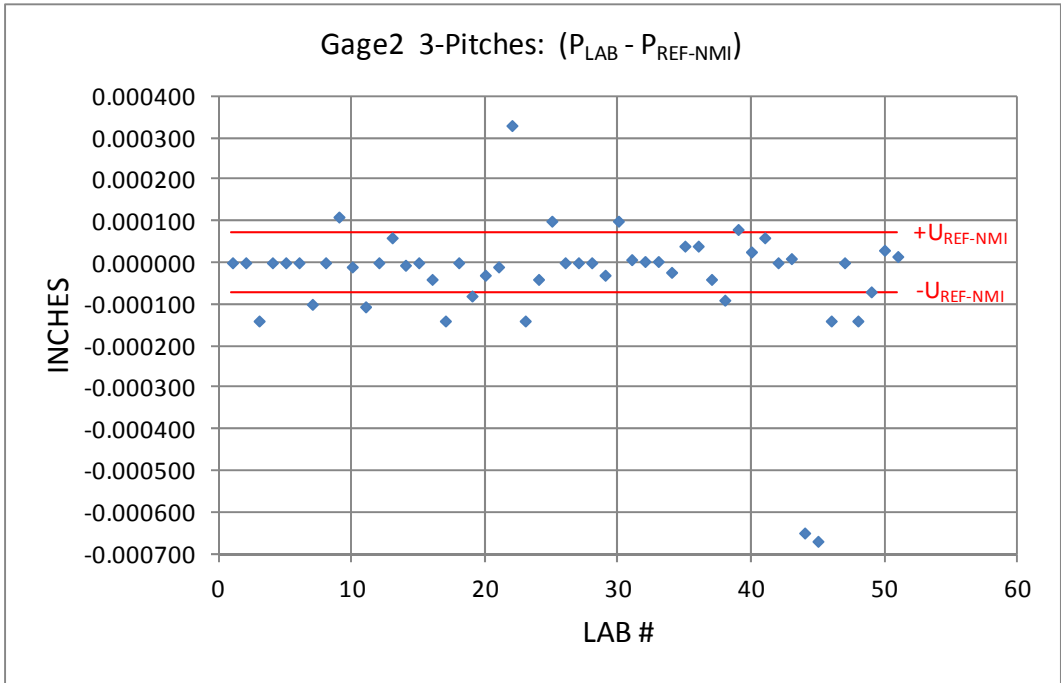


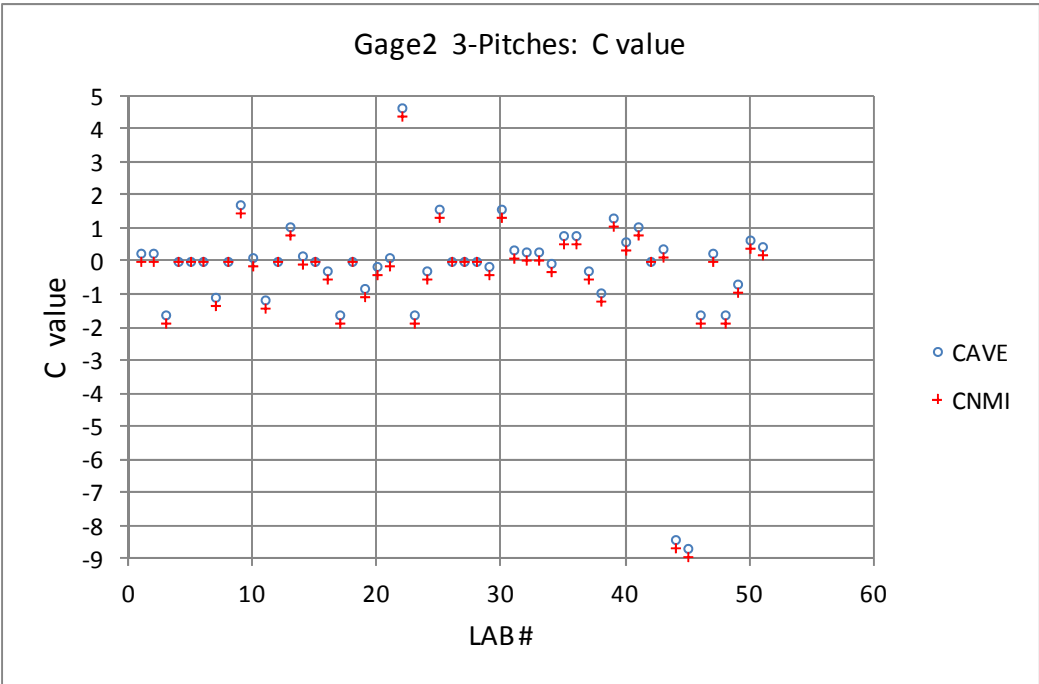
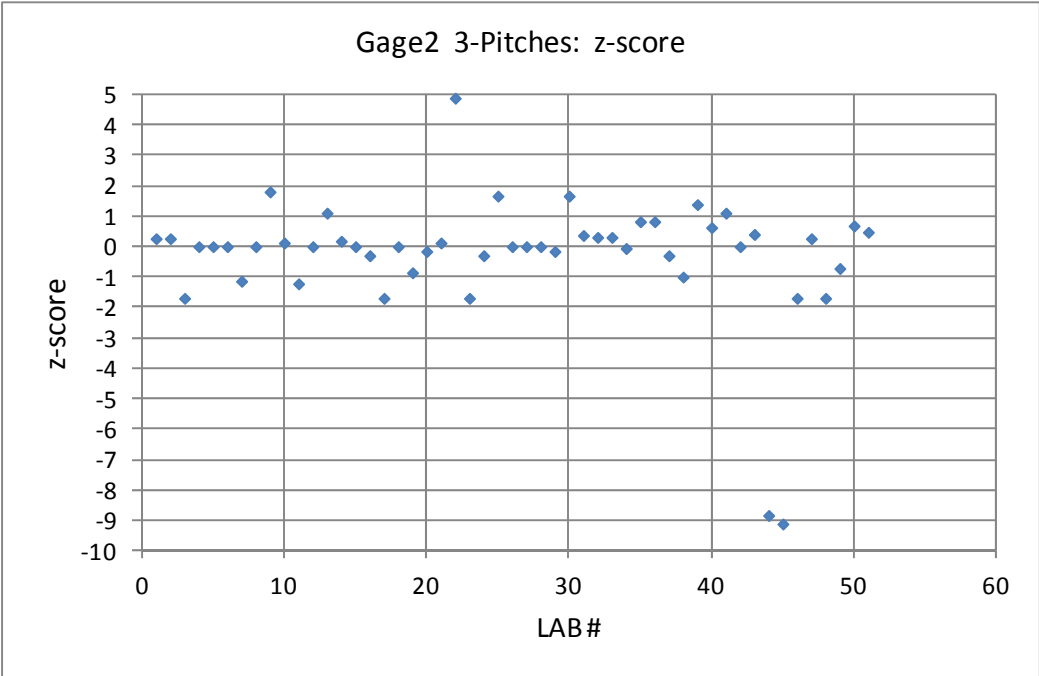


## Lead, 3 Pitches Gage 2

Lead		GAGE 2: 1/4-28 UNJF GO 3A: Lead tolerance = 0.00015"					
Outliers: (#22, 44, 45)		$P_{REF-AVE} = 0.107121$	$P_{REF-NM} = 0.107140$	$P\ tol. = 0.00015$			
		$U_{REF-STD} = 0.000143$	$U_{REF-NM} = 0.000070$	3 pitch measurement			
		Reported					
		Uncertainty					
		Reported					
		k = 2, 95%					
		Value					
Lab	3-P	factor	$E_{T-AVE}$	$E_{T-NM}$	z-score	$C_{AVE}$	$C_{NM}$
#	[in]	+/- [in]					
1	0.107140	0.000070	0.117	0.000	0.261	0.249	0.000
2	0.107140	0.000070	0.117	0.000	0.261	0.249	0.000
3	0.107000	0.000830	-0.144	-0.168	-1.697	-1.618	-1.867
4	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
5	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	0.107040	0.000190	-0.342	-0.494	-1.138	-1.085	-1.333
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	0.107250	0.000053	0.844	1.253	1.800	1.715	1.467
10	0.107130	0.000000	0.061	-0.143	0.121	0.115	-0.133
11	0.107034	0.000080	-0.533	-0.997	-1.222	-1.165	-1.413
12	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
13	0.107200	0.000150	0.380	0.362	1.100	1.049	0.800
14	0.107134	0.000068	0.080	-0.061	0.177	0.169	-0.080
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	0.107100	0.000230	-0.079	-0.166	-0.298	-0.285	-0.533
17	0.107000	0.000200	-0.494	-0.661	-1.697	-1.618	-1.867
18	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
19	0.107060	0.000000	-0.429	-1.143	-0.858	-0.818	-1.067
20	0.107110	0.000000	-0.079	-0.429	-0.159	-0.151	-0.400
21	0.107130	0.000080	0.053	-0.094	0.121	0.115	-0.133
22	0.107470	0.000300	1.049	1.071	4.877	4.649	4.400
23	0.107000	0.000130	-0.628	-0.948	-1.697	-1.618	-1.867
24	0.107100	0.000235	-0.078	-0.163	-0.298	-0.285	-0.533
25	0.107240	0.000320	0.339	0.305	1.660	1.582	1.333
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	0.107110	0.000084	-0.068	-0.274	-0.159	-0.151	-0.400
30	0.107240	0.000100	0.680	0.819	1.660	1.582	1.333
31	0.107148	0.000050	0.173	0.087	0.366	0.349	0.100
32	0.107143	0.000050	0.143	0.035	0.303	0.289	0.040
33	0.107143	0.000050	0.143	0.035	0.303	0.289	0.040
34	0.107117	0.000000	-0.030	-0.329	-0.061	-0.058	-0.307
35	0.107180	0.000080	0.358	0.376	0.821	0.782	0.533
36	0.107180	0.000000	0.410	0.571	0.821	0.782	0.533
37	0.107100	0.000100	-0.122	-0.328	-0.298	-0.285	-0.533
38	0.107050	0.000300	-0.215	-0.292	-0.998	-0.951	-1.200
39	0.107220	0.000040	0.665	0.992	1.380	1.315	1.067
40	0.107166	0.000000	0.312	0.371	0.625	0.595	0.347
41	0.107200	0.000020	0.545	0.824	1.100	1.049	0.800
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	0.107150	0.000220	0.109	0.043	0.401	0.382	0.133
44	0.106490	0.000100	-3.618	-5.325	-8.831	-8.418	-8.667
45	0.106470	0.000100	-3.733	-5.489	-9.111	-8.685	-8.933
46	0.107000	0.000200	-0.494	-0.661	-1.697	-1.618	-1.867
47	0.107140	0.000025	0.129	0.000	0.261	0.249	0.000
48	0.107000	0.000000	-0.849	-2.000	-1.697	-1.618	-1.867
49	0.107070	0.000050	-0.339	-0.814	-0.718	-0.685	-0.933
50	0.107170	0.000047	0.323	0.356	0.681	0.649	0.400
51	0.107155	0.000200	0.137	0.071	0.471	0.449	0.200

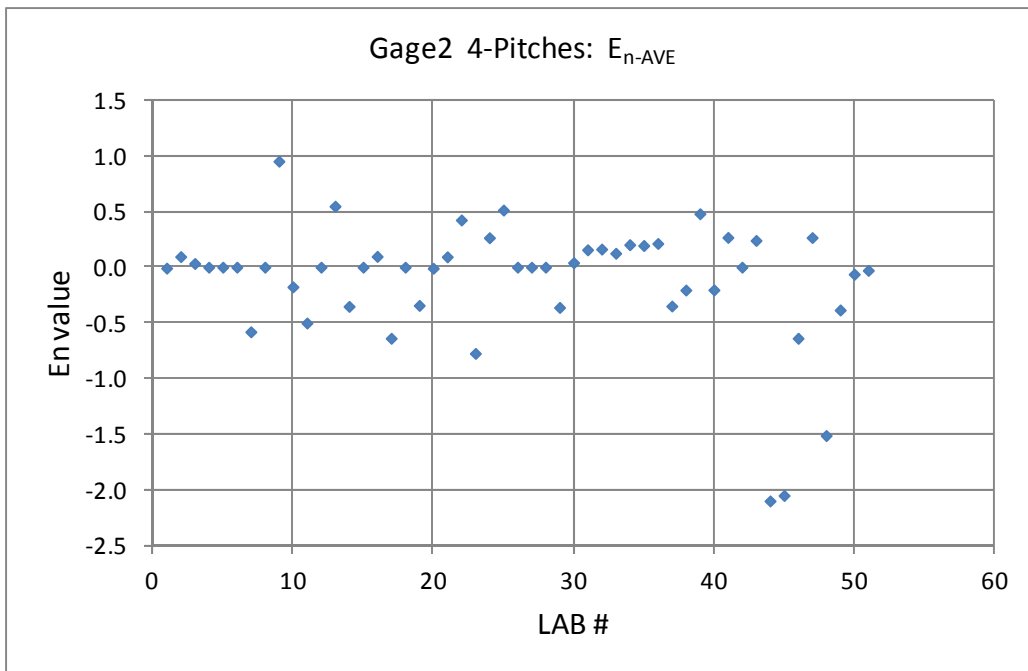
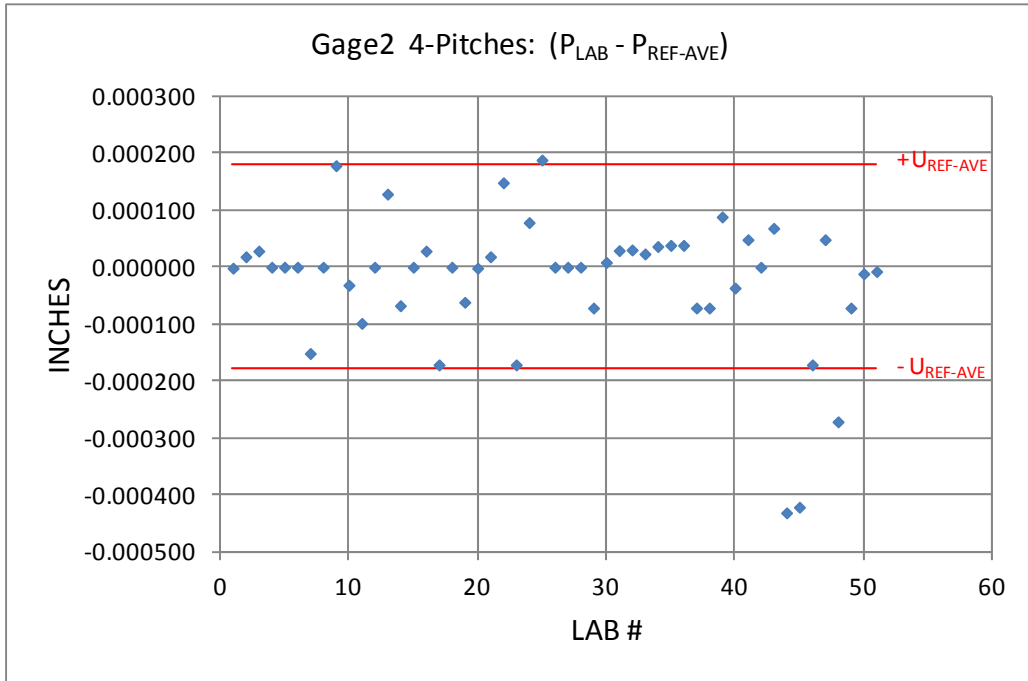


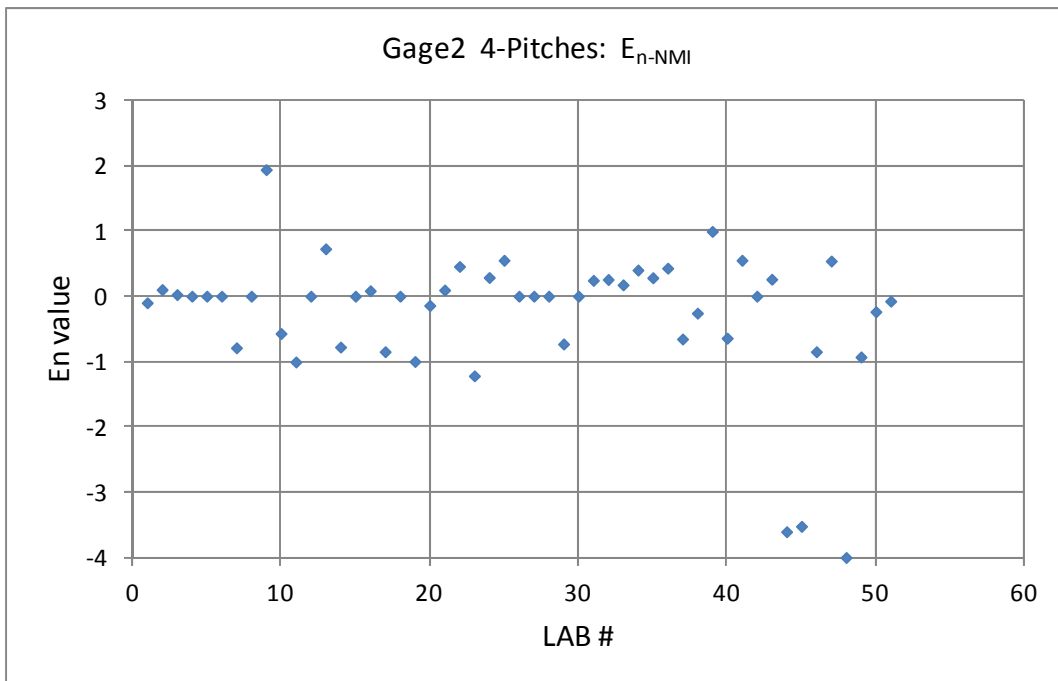
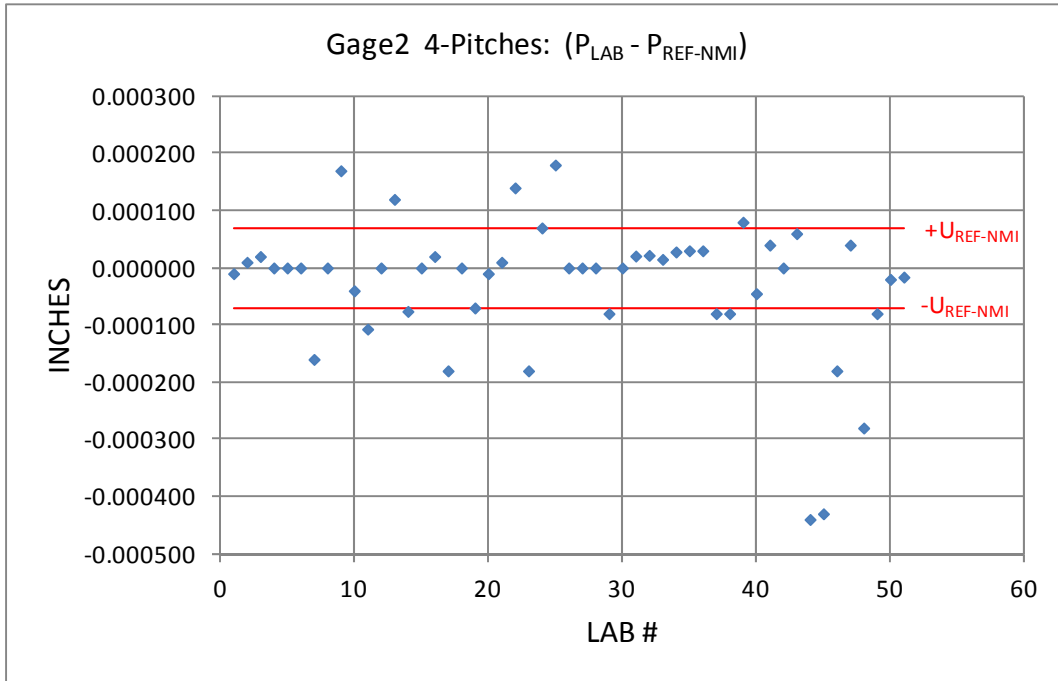


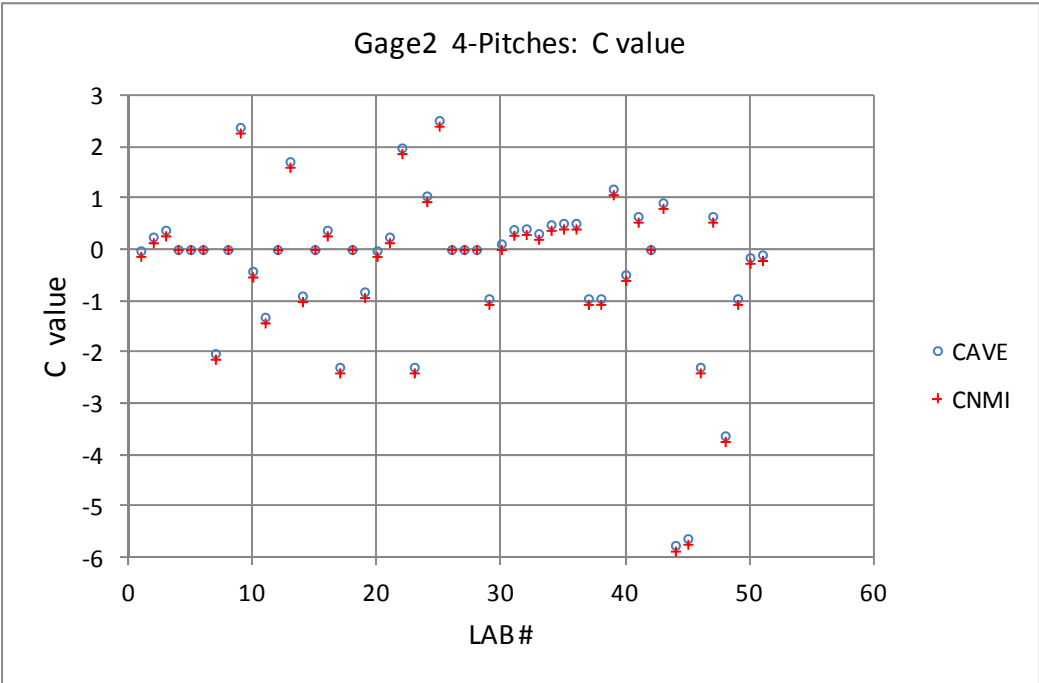
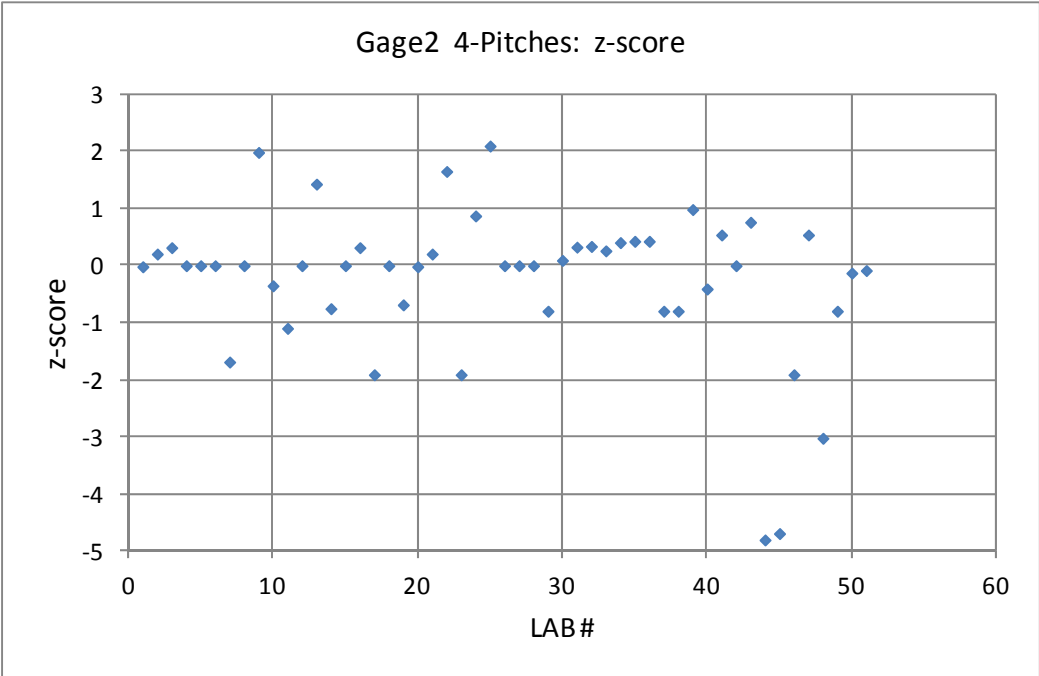


## Lead, 4 Pitches Gage 2

Lead		GAGE 2: 1/4-28 UNJF GO 3A: Lead tolerance = 0.00015"					
Outliers: (#44, 45, 48)		P <sub>REF-AVE</sub> = 0.142872	P <sub>REF-NM</sub> = 0.142880	P tol. = 0.00015			
		U <sub>REF-STD</sub> = 0.000180	U <sub>REF-NM</sub> = 0.000070	4 pitch measurement			
	Reported						
	Uncertainty						
	Reported	k = 2, 95%					
	Value	coverage					
Lab #	4-P [in]	factor +/- [in]	E <sub>T-AVE</sub>	E <sub>T-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
1	0.142870	0.000070	-0.009	-0.101	-0.019	-0.022	-0.133
2	0.142890	0.000070	0.095	0.101	0.204	0.244	0.133
3	0.142900	0.000830	0.033	0.024	0.315	0.378	0.267
4	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
5	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	0.142720	0.000190	-0.580	-0.790	-1.688	-2.022	-2.133
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	0.143050	0.000053	0.952	1.936	1.985	2.378	2.267
10	0.142840	0.000000	-0.176	-0.571	-0.353	-0.422	-0.533
11	0.142773	0.000080	-0.502	-1.007	-1.098	-1.316	-1.427
12	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
13	0.143000	0.000150	0.548	0.725	1.428	1.711	1.600
14	0.142804	0.000068	-0.352	-0.779	-0.753	-0.902	-1.013
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	0.142900	0.000230	0.097	0.083	0.315	0.378	0.267
17	0.142700	0.000200	-0.639	-0.849	-1.911	-2.289	-2.400
18	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
19	0.142810	0.000000	-0.343	-1.000	-0.686	-0.822	-0.933
20	0.142870	0.000000	-0.009	-0.143	-0.019	-0.022	-0.133
21	0.142890	0.000080	0.093	0.094	0.204	0.244	0.133
22	0.143020	0.000300	0.424	0.454	1.651	1.978	1.867
23	0.142700	0.000130	-0.774	-1.219	-1.911	-2.289	-2.400
24	0.142950	0.000235	0.265	0.285	0.872	1.044	0.933
25	0.143060	0.000320	0.513	0.550	2.096	2.511	2.400
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	0.142800	0.000084	-0.361	-0.732	-0.798	-0.956	-1.067
30	0.142880	0.000100	0.041	0.000	0.093	0.111	0.000
31	0.142901	0.000050	0.156	0.242	0.325	0.389	0.278
32	0.142902	0.000050	0.163	0.256	0.338	0.404	0.293
33	0.142895	0.000050	0.125	0.174	0.260	0.311	0.200
34	0.142908	0.000000	0.202	0.400	0.404	0.484	0.373
35	0.142910	0.000080	0.195	0.282	0.427	0.511	0.400
36	0.142910	0.000000	0.213	0.429	0.427	0.511	0.400
37	0.142800	0.000100	-0.349	-0.655	-0.798	-0.956	-1.067
38	0.142800	0.000300	-0.205	-0.260	-0.798	-0.956	-1.067
39	0.142960	0.000040	0.480	0.992	0.983	1.178	1.067
40	0.142835	0.000000	-0.204	-0.643	-0.408	-0.489	-0.600
41	0.142920	0.000020	0.267	0.549	0.538	0.644	0.533
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	0.142940	0.000220	0.241	0.260	0.761	0.911	0.800
44	0.142440	0.000100	-2.099	-3.605	-4.805	-5.756	-5.867
45	0.142450	0.000100	-2.051	-3.523	-4.694	-5.622	-5.733
46	0.142700	0.000200	-0.639	-0.849	-1.911	-2.289	-2.400
47	0.142920	0.000025	0.266	0.538	0.538	0.644	0.533
48	0.142600	0.000000	-1.512	-4.000	-3.024	-3.622	-3.733
49	0.142800	0.000050	-0.384	-0.930	-0.798	-0.956	-1.067
50	0.142860	0.000047	-0.063	-0.237	-0.130	-0.156	-0.267
51	0.142864	0.000200	-0.029	-0.076	-0.085	-0.102	-0.213



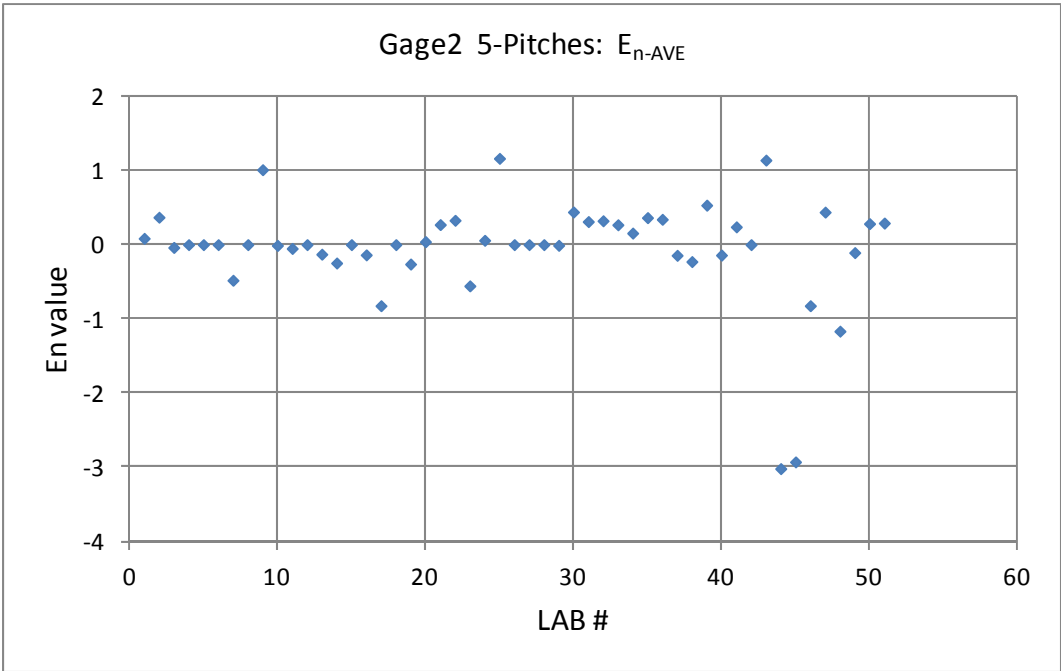
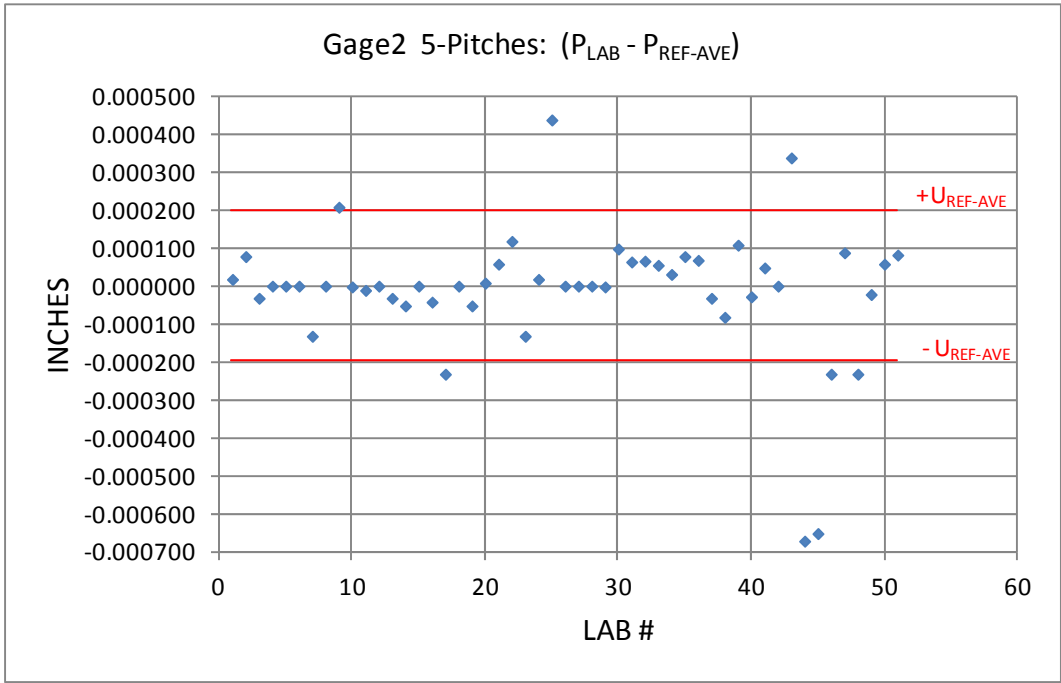


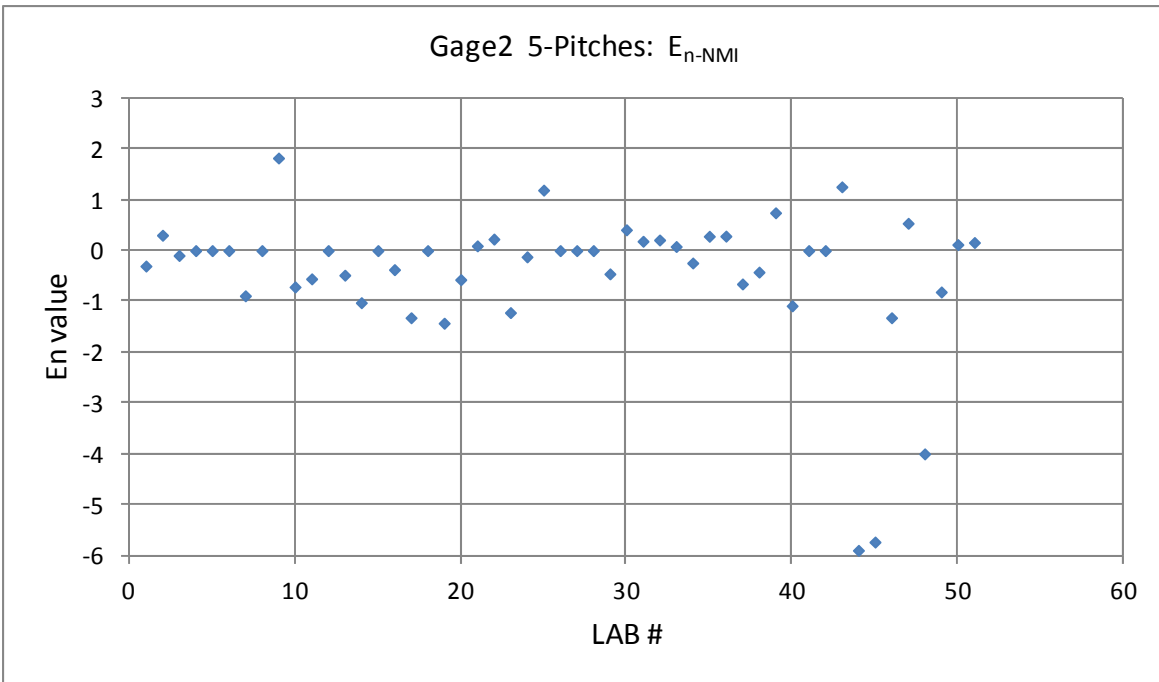
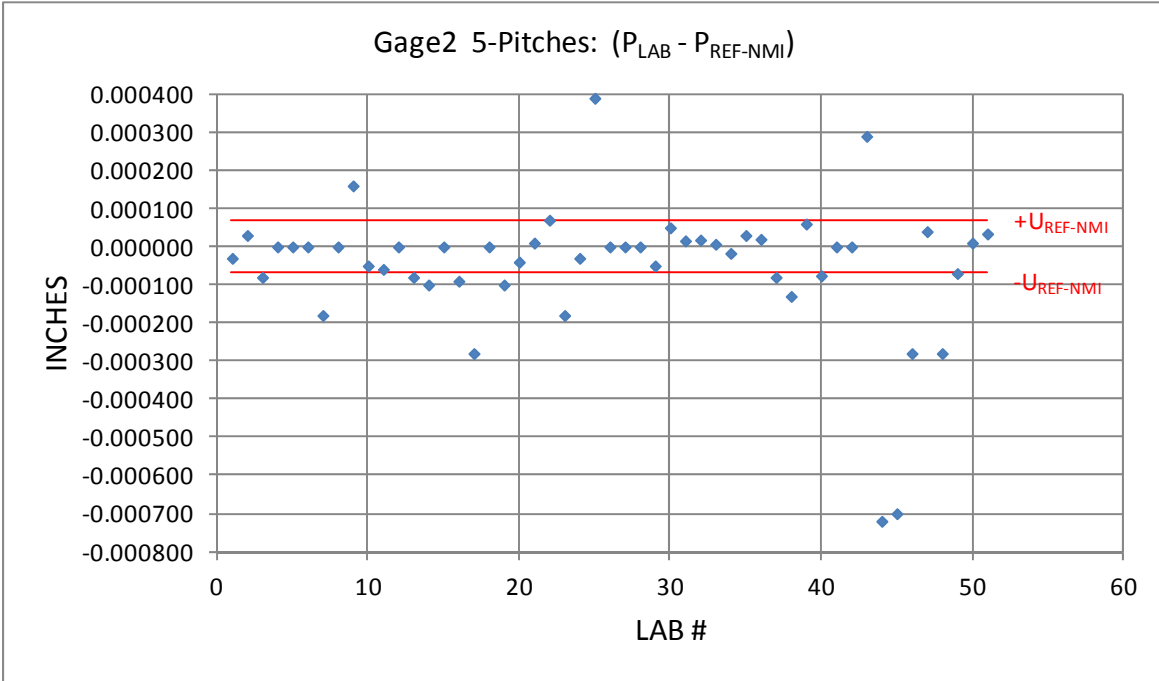


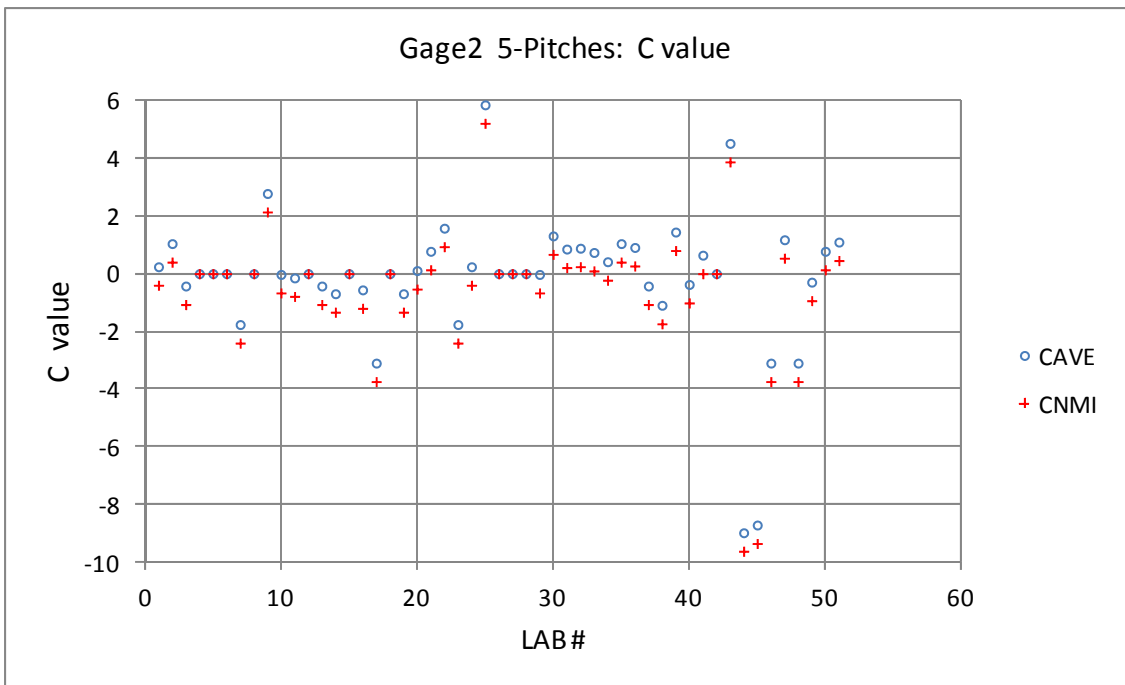
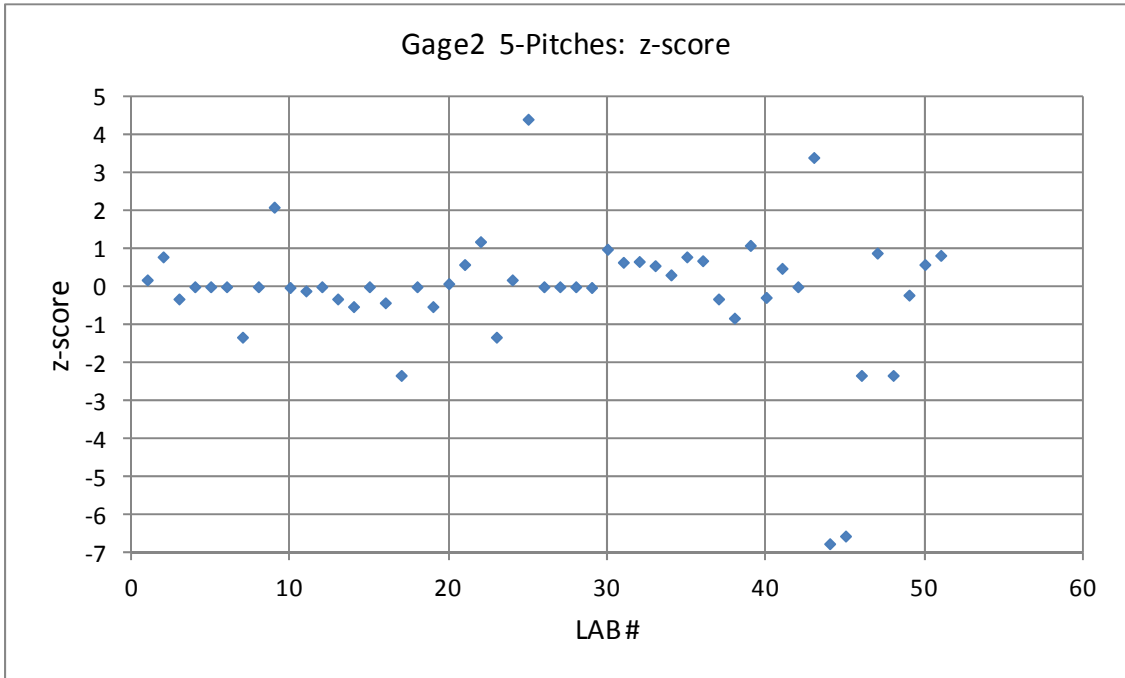


## Lead, 5 Pitches Gage 2

Lead		GAGE 2: 1/4-28 UNJF GO 3A: Lead tolerance = 0.00015"					
Outliers: (#25, 43, 44, 45)		$P_{REF-AVE} = 0.178532$	$P_{REF-NM} = 0.178580$	$P_{tol.} = 0.00015$			
		$U_{REF-STD} = 0.000199$	$U_{REF-NM} = 0.000070$	5 pitch measurement			
		Reported					
		Uncertainty					
		Reported					
		k = 2, 95%					
		Value					
		coverage					
Lab	5-P	factor	$E_{T-AVE}$	$E_{T-NM}$	z-score	$C_{AVE}$	$C_{NM}$
#	[in]	+/- [in]					
1	0.178550	0.000070	0.085	-0.303	0.181	0.240	-0.400
2	0.178610	0.000070	0.370	0.303	0.784	1.040	0.400
3	0.178500	0.000830	-0.038	-0.096	-0.322	-0.427	-1.067
4	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
5	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	0.178400	0.000190	-0.480	-0.889	-1.327	-1.760	-2.400
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	0.178740	0.000053	1.010	1.822	2.090	2.773	2.133
10	0.178530	0.000000	-0.010	-0.714	-0.020	-0.027	-0.667
11	0.178521	0.000080	-0.051	-0.555	-0.111	-0.147	-0.787
12	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
13	0.178500	0.000150	-0.128	-0.483	-0.322	-0.427	-1.067
14	0.178480	0.000068	-0.247	-1.025	-0.523	-0.694	-1.333
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	0.178490	0.000230	-0.138	-0.374	-0.422	-0.560	-1.200
17	0.178300	0.000200	-0.822	-1.321	-2.332	-3.094	-3.733
18	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
19	0.178480	0.000000	-0.261	-1.429	-0.523	-0.694	-1.333
20	0.178540	0.000000	0.040	-0.571	0.080	0.106	-0.533
21	0.178590	0.000080	0.270	0.094	0.583	0.773	0.133
22	0.178650	0.000300	0.328	0.227	1.186	1.573	0.933
23	0.178400	0.000130	-0.555	-1.219	-1.327	-1.760	-2.400
24	0.178550	0.000235	0.058	-0.122	0.181	0.240	-0.400
25	0.178970	0.000320	1.162	1.191	4.401	5.840	5.200
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	0.178530	0.000084	-0.009	-0.457	-0.020	-0.027	-0.667
30	0.178630	0.000100	0.440	0.410	0.985	1.306	0.667
31	0.178596	0.000050	0.311	0.184	0.641	0.851	0.211
32	0.178598	0.000050	0.322	0.209	0.663	0.880	0.240
33	0.178587	0.000050	0.268	0.081	0.552	0.733	0.093
34	0.178563	0.000000	0.156	-0.243	0.311	0.413	-0.227
35	0.178610	0.000080	0.364	0.282	0.784	1.040	0.400
36	0.178600	0.000000	0.342	0.286	0.683	0.906	0.267
37	0.178500	0.000100	-0.144	-0.655	-0.322	-0.427	-1.067
38	0.178450	0.000300	-0.228	-0.422	-0.824	-1.094	-1.733
39	0.178640	0.000040	0.532	0.744	1.085	1.440	0.800
40	0.178504	0.000000	-0.141	-1.086	-0.282	-0.374	-1.013
41	0.178580	0.000020	0.240	0.000	0.482	0.640	0.000
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	0.178870	0.000220	1.139	1.256	3.396	4.506	3.867
44	0.177860	0.000100	-3.017	-5.898	-6.753	-8.960	-9.600
45	0.177880	0.000100	-2.927	-5.735	-6.552	-8.694	-9.333
46	0.178300	0.000200	-0.822	-1.321	-2.332	-3.094	-3.733
47	0.178620	0.000025	0.439	0.538	0.884	1.173	0.533
48	0.178300	0.000000	-1.166	-4.000	-2.332	-3.094	-3.733
49	0.178510	0.000050	-0.107	-0.814	-0.221	-0.294	-0.933
50	0.178590	0.000047	0.284	0.119	0.583	0.773	0.133
51	0.178614	0.000200	0.291	0.160	0.824	1.093	0.453

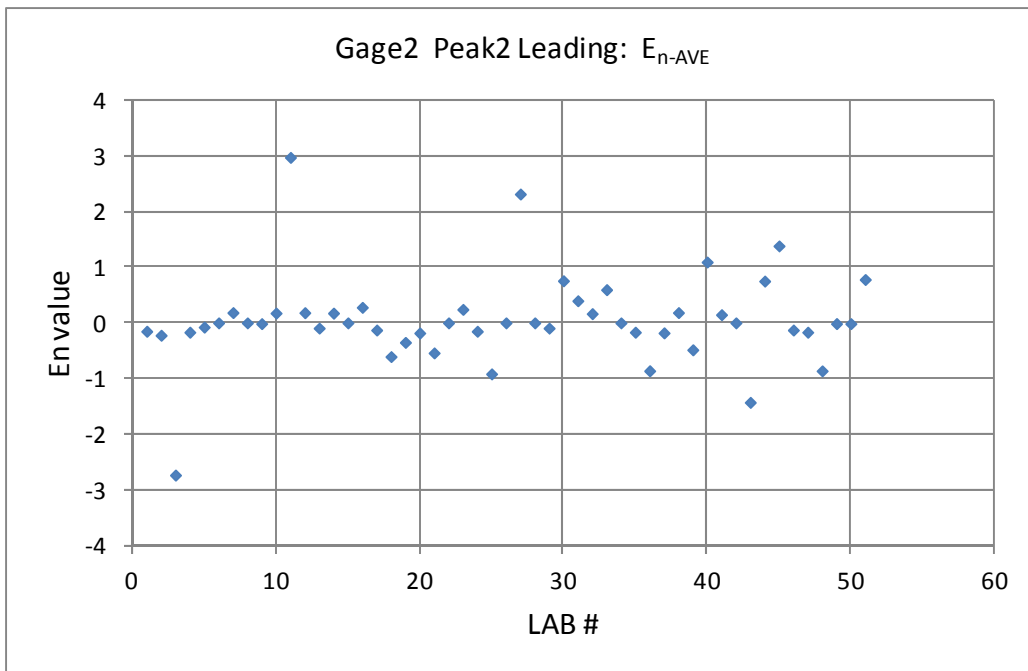
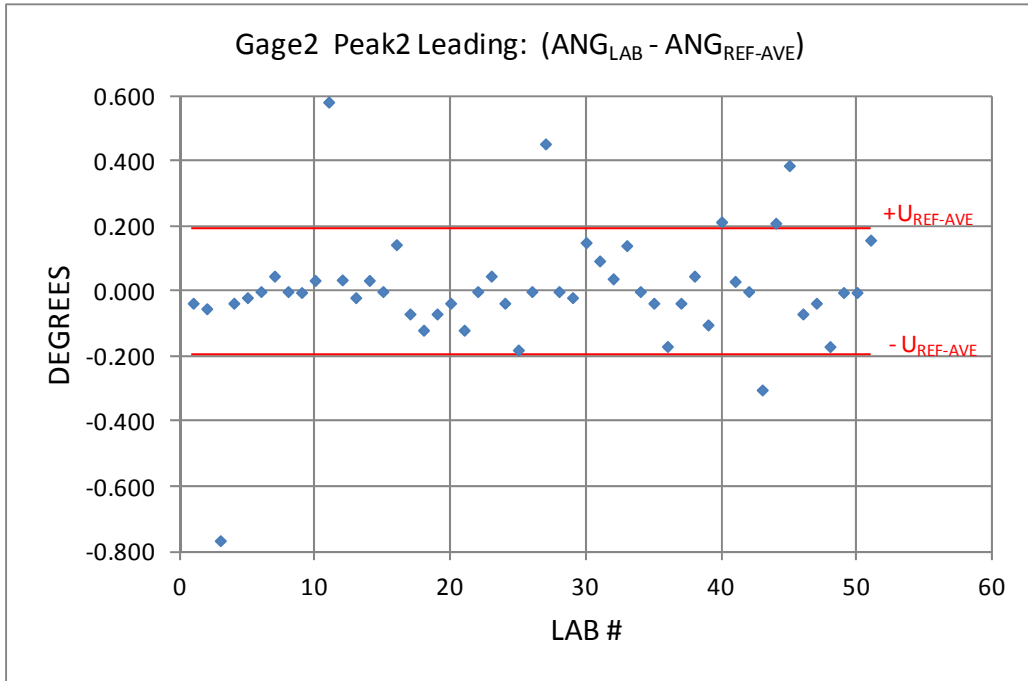


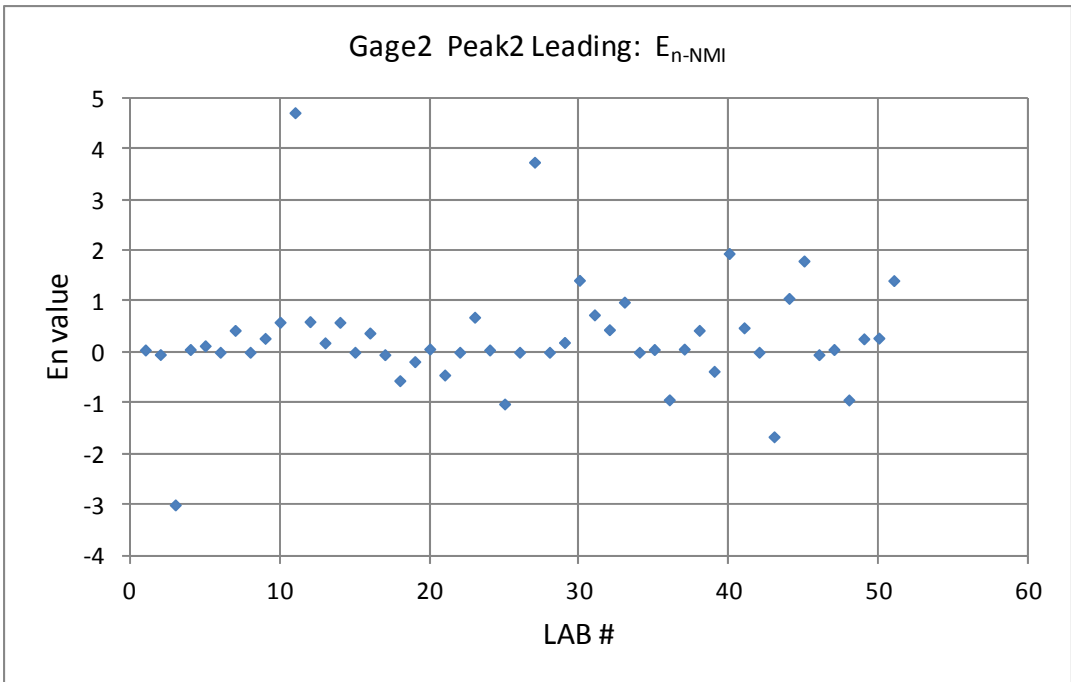
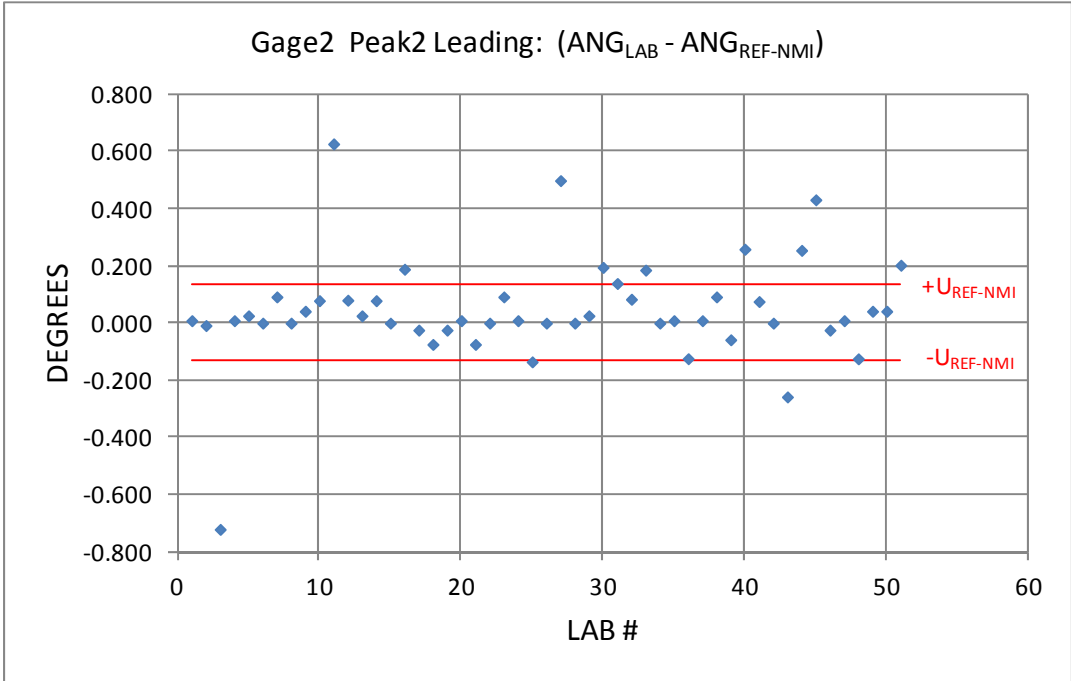


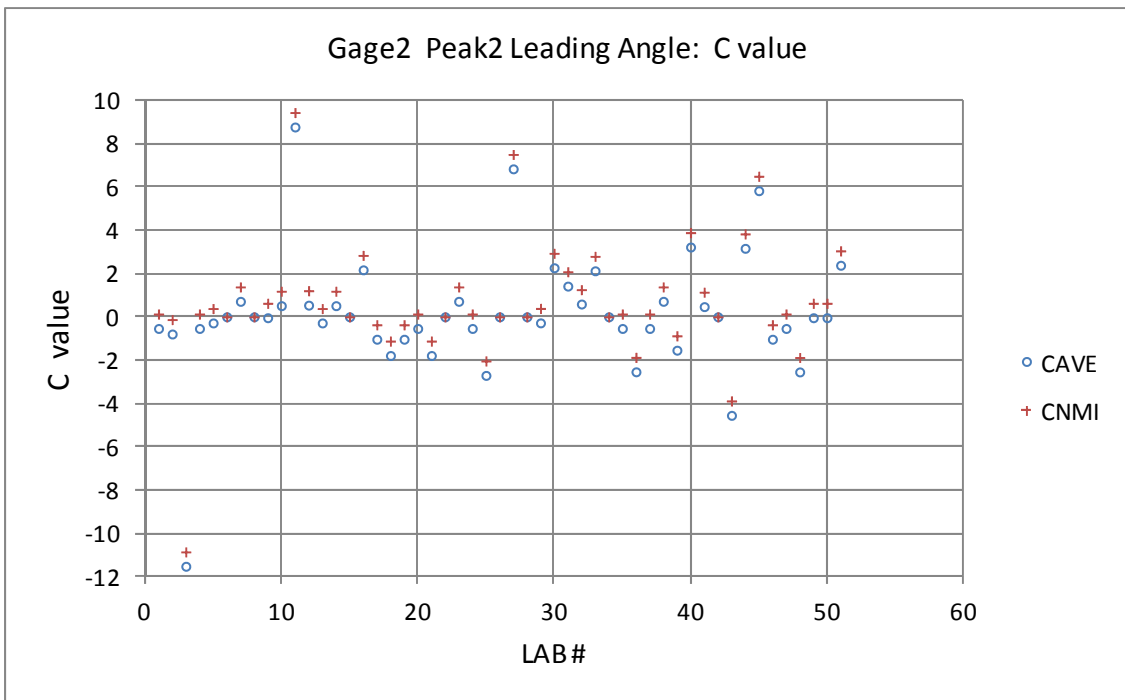
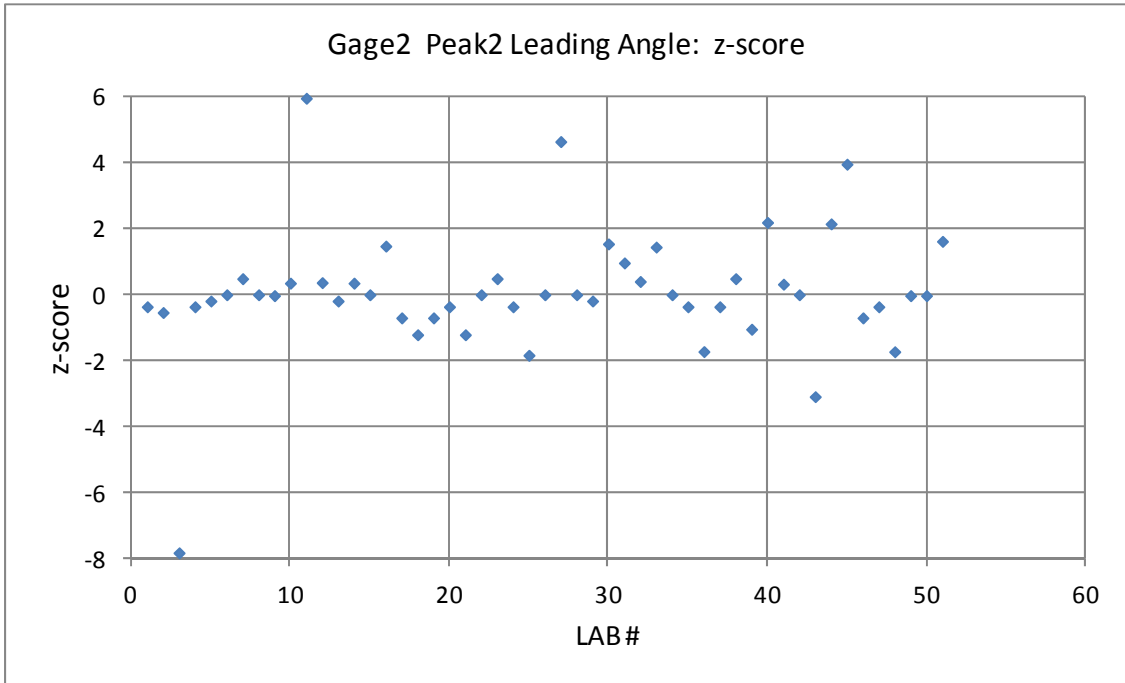


## ½ Angle, Leading Edge at Peak 2 Gage 2

		1/2 Angle	GAGE 2: 1/4-28 UNJF GO 3A: 1/2 angle tol. = 8' = 0.133 deg					
Outliers:								
(#3, 11, 27, 43, 45)		ANG <sub>REF-AVE</sub> =	30.036	ANG <sub>REF-NM</sub> =	29.992	ANG tol. = 0.133		
		U <sub>REF-STD</sub> =	0.196	U <sub>REF-NM</sub> =	0.133			
		Gage 2: Leading 1/2 angle @ peak 2						
		Reported						
		Uncertainty						
		Reported						
		k = 2, 95%						
		Value						
		coverage						
Lab	ANG	factor	E <sub>1-AVE</sub>	E <sub>1-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>	
#	[deg]	+/- [deg]						
1	30.000	0.133	-0.151	0.045	-0.365	-0.537	0.128	
2	29.983	0.133	-0.223	-0.045	-0.538	-0.793	-0.128	
3	29.270	0.200	-2.734	-3.004	-7.812	-11.515	-10.850	
4	30.000	0.083	-0.168	0.054	-0.365	-0.537	0.128	
5	30.017	0.150	-0.076	0.127	-0.191	-0.282	0.383	
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
7	30.083	0.167	0.185	0.430	0.485	0.715	1.380	
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
9	30.033	0.073	-0.013	0.274	-0.028	-0.041	0.624	
10	30.070	0.000	0.175	0.590	0.350	0.515	1.180	
11	30.619	0.000	2.973	4.714	5.945	8.763	9.429	
12	30.072	0.000	0.183	0.602	0.366	0.539	1.205	
13	30.017	0.036	-0.094	0.185	-0.191	-0.282	0.383	
14	30.070	0.008	0.175	0.589	0.350	0.515	1.180	
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
16	30.180	0.480	0.278	0.378	1.472	2.169	2.835	
17	29.967	0.500	-0.128	-0.047	-0.701	-1.034	-0.368	
18	29.917	0.008	-0.605	-0.559	-1.211	-1.786	-1.120	
19	29.967	0.000	-0.351	-0.184	-0.701	-1.034	-0.368	
20	30.000	0.000	-0.182	0.064	-0.365	-0.537	0.128	
21	29.917	0.100	-0.540	-0.448	-1.211	-1.786	-1.120	
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
23	30.083	0.006	0.243	0.690	0.486	0.716	1.381	
24	30.000	0.133	-0.151	0.045	-0.365	-0.537	0.128	
25	29.856	0.005	-0.916	-1.018	-1.834	-2.703	-2.038	
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
27	30.490	0.009	2.315	3.740	4.634	6.831	7.496	
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
29	30.017	0.005	-0.095	0.193	-0.189	-0.279	0.386	
30	30.186	0.036	0.756	1.416	1.537	2.266	2.931	
31	30.130	0.133	0.398	0.736	0.962	1.417	2.083	
32	30.075	0.133	0.166	0.444	0.401	0.590	1.256	
33	30.177	0.133	0.596	0.986	1.441	2.124	2.789	
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
35	30.000	0.083	-0.168	0.054	-0.365	-0.537	0.128	
36	29.867	0.000	-0.861	-0.936	-1.721	-2.537	-1.872	
37	30.000	0.033	-0.180	0.062	-0.365	-0.537	0.128	
38	30.083	0.167	0.185	0.431	0.486	0.716	1.381	
39	29.933	0.080	-0.484	-0.375	-1.045	-1.540	-0.875	
40	30.250	0.000	1.093	1.944	2.186	3.222	3.887	
41	30.067	0.083	0.147	0.482	0.319	0.470	1.135	
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
43	29.733	0.080	-1.428	-1.663	-3.085	-4.547	-3.882	
44	30.246	0.200	0.751	1.060	2.145	3.162	3.827	
45	30.423	0.200	1.382	1.796	3.950	5.822	6.487	
46	29.967	0.500	-0.128	-0.047	-0.701	-1.034	-0.368	
47	30.000	0.083	-0.168	0.054	-0.365	-0.537	0.128	
48	29.867	0.000	-0.863	-0.939	-1.726	-2.543	-1.878	
49	30.033	0.083	-0.013	0.264	-0.028	-0.041	0.624	
50	30.033	0.067	-0.013	0.279	-0.028	-0.041	0.624	
51	30.194	0.054	0.778	1.411	1.615	2.380	3.045	



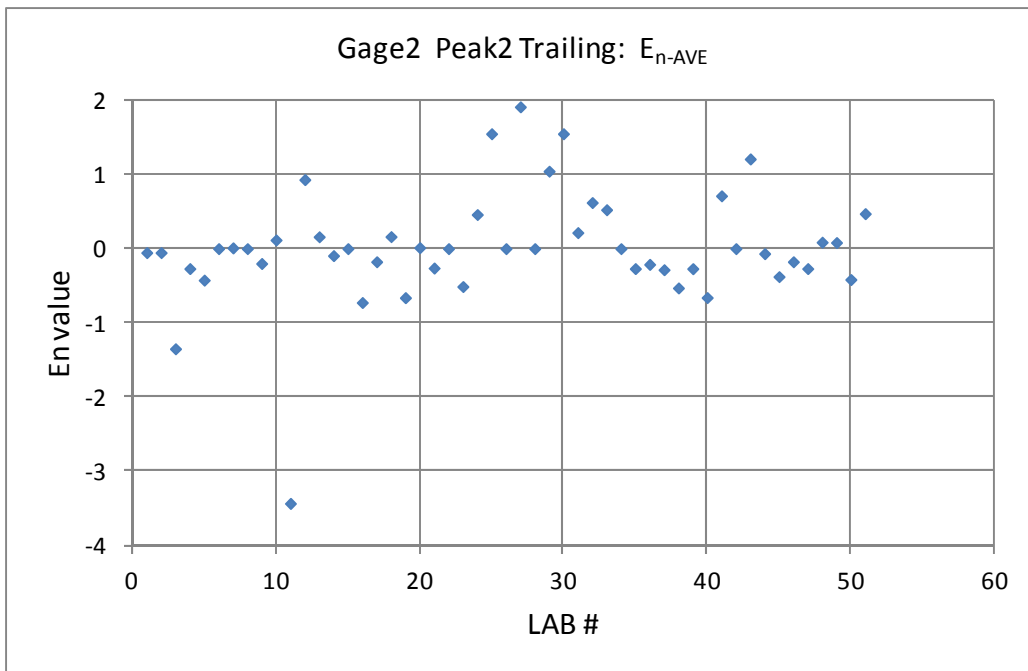
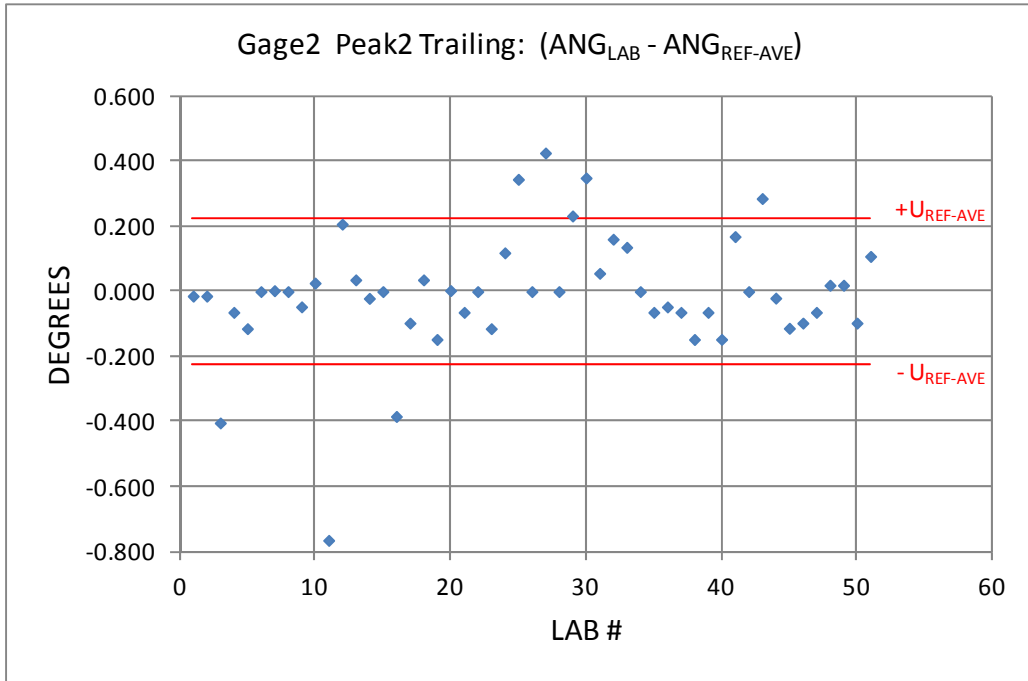


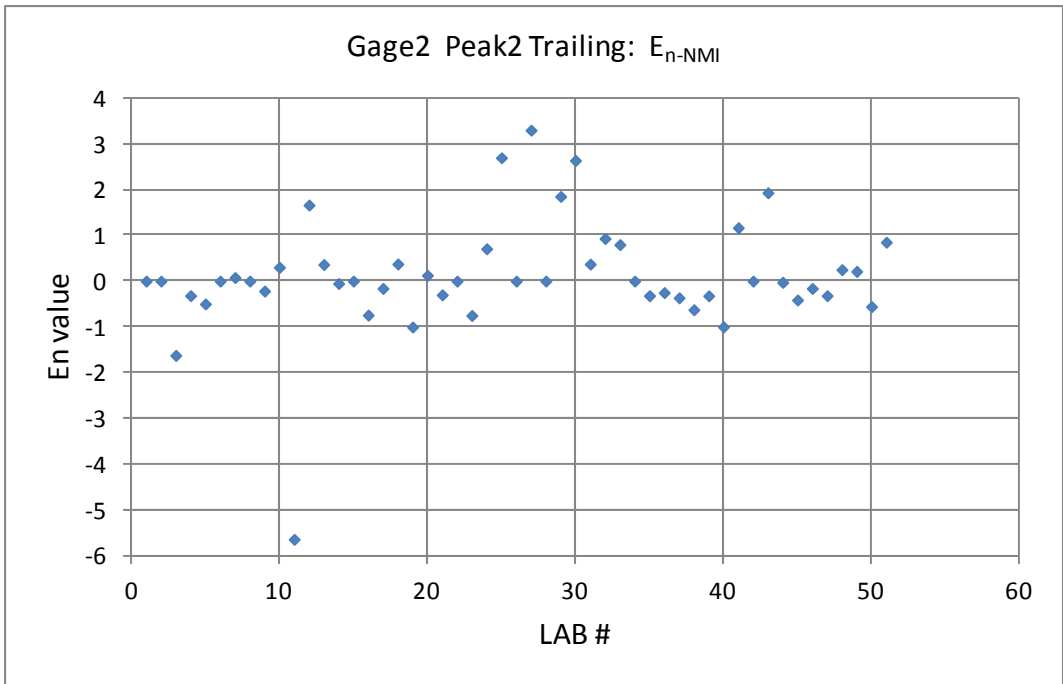
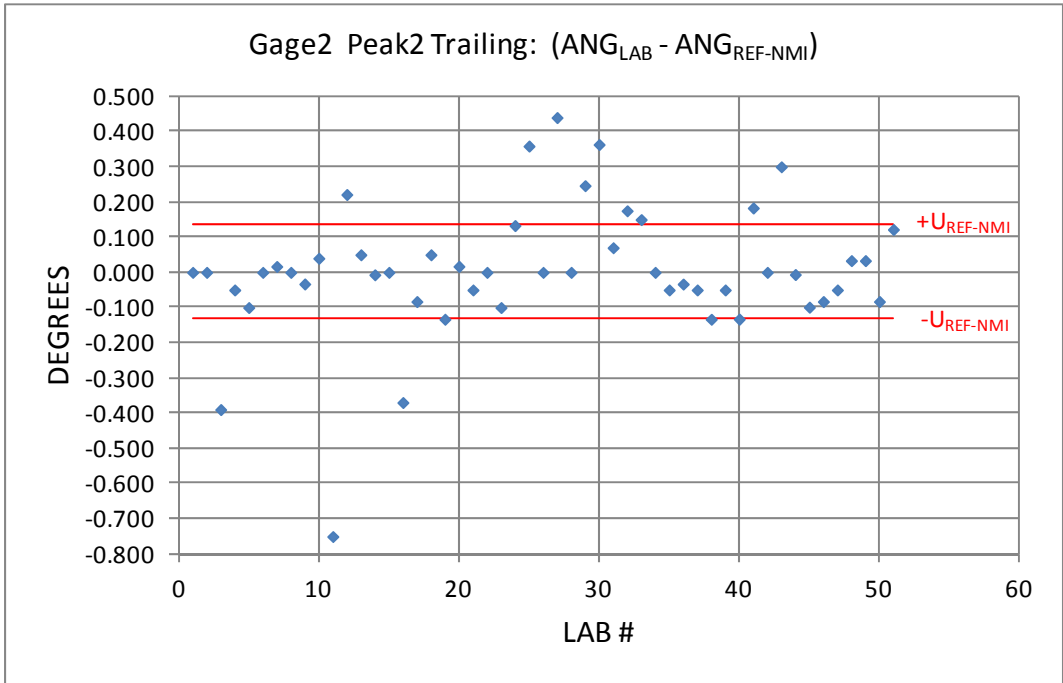


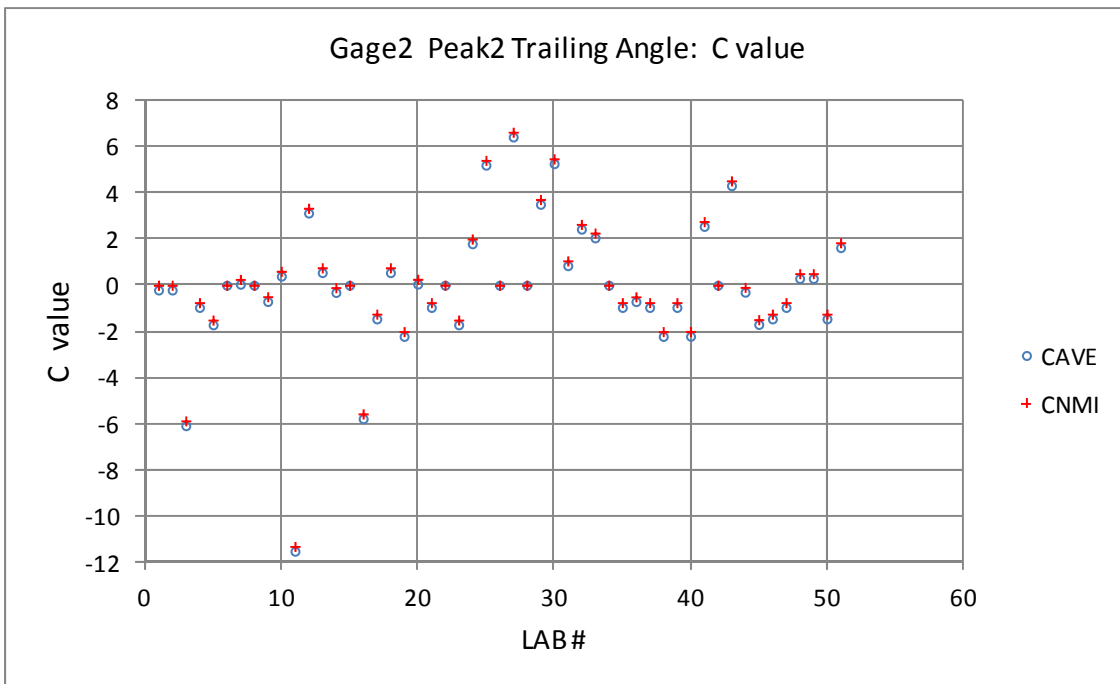
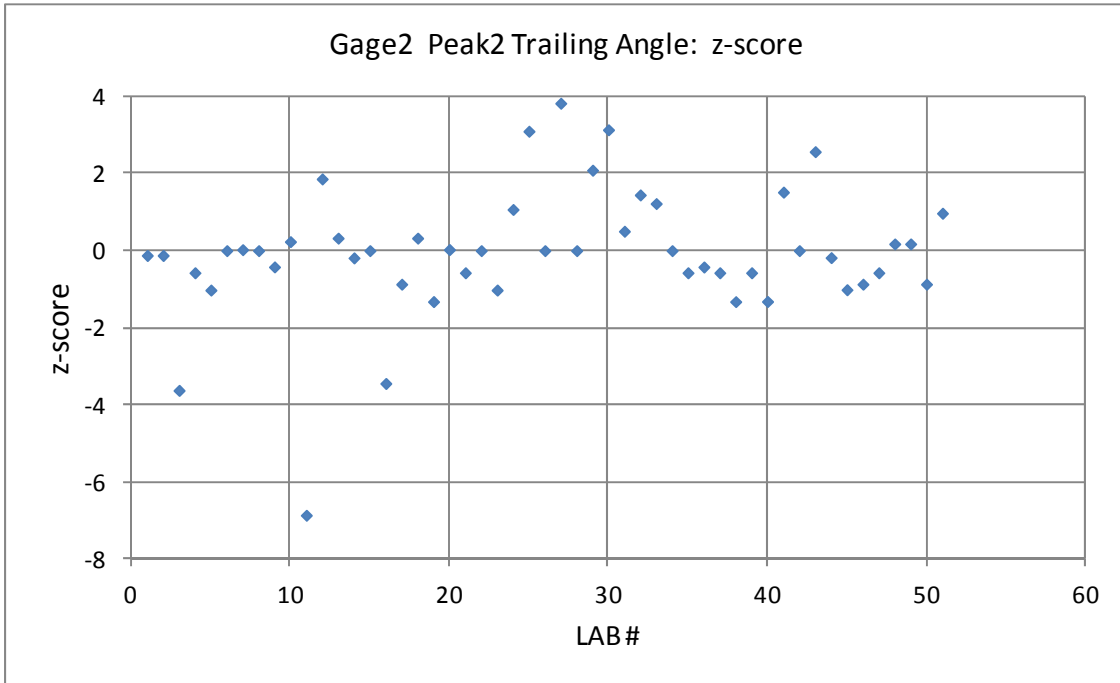


## ½ Angle, Trailing Edge at Peak 2 Gage 2

		1/2 Angle	GAGE 2: 1/4-28 UNJF GO 3A: 1/2 angle tol. = 8' = 0.133 deg				
Outliers:							
(#3, 11, 16, 25, 27, 30)		ANG <sub>REF-AVE</sub> =	30.064	ANG <sub>REF-NM</sub> =	30.050	ANG tol. =	0.133
		U <sub>REF-STD</sub> =	0.223	U <sub>REF-NM</sub> =	0.133		
							Gage 2: Trailing 1/2 angle @ peak 2
		Reported					
		Uncertainty					
		Reported					
		Value					
		k = 2, 95%					
		coverage					
Lab	ANG	factor	E <sub>n-AVE</sub>	E <sub>n-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
#	[deg]	+/- [deg]					
1	30.050	0.133	-0.054	0.000	-0.125	-0.209	0.000
2	30.050	0.133	-0.054	0.000	-0.125	-0.209	0.000
3	29.660	0.200	-1.349	-1.624	-3.625	-6.073	-5.865
4	30.000	0.083	-0.269	-0.319	-0.573	-0.961	-0.752
5	29.950	0.150	-0.424	-0.499	-1.022	-1.713	-1.504
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	30.067	0.167	0.010	0.078	0.025	0.042	0.251
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	30.017	0.073	-0.200	-0.218	-0.421	-0.705	-0.496
10	30.090	0.000	0.117	0.301	0.234	0.393	0.602
11	29.299	0.000	-3.432	-5.647	-6.864	-11.502	-11.293
12	30.271	0.000	0.930	1.663	1.861	3.117	3.326
13	30.100	0.036	0.160	0.363	0.324	0.543	0.752
14	30.043	0.008	-0.094	-0.053	-0.187	-0.314	-0.105
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	29.680	0.480	-0.725	-0.743	-3.445	-5.773	-5.564
17	29.967	0.500	-0.177	-0.160	-0.870	-1.457	-1.248
18	30.100	0.008	0.162	0.375	0.324	0.543	0.752
19	29.917	0.000	-0.660	-1.002	-1.321	-2.213	-2.005
20	30.067	0.000	0.014	0.128	0.028	0.047	0.256
21	30.000	0.100	-0.262	-0.300	-0.573	-0.961	-0.752
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23	29.950	0.006	-0.511	-0.751	-1.022	-1.713	-1.504
24	30.183	0.133	0.459	0.707	1.069	1.791	2.000
25	30.409	0.005	1.548	2.697	3.097	5.190	5.398
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	30.490	0.009	1.911	3.301	3.824	6.408	6.617
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	30.296	0.005	1.043	1.851	2.087	3.496	3.705
30	30.413	0.036	1.548	2.639	3.136	5.254	5.463
31	30.120	0.133	0.216	0.372	0.504	0.844	1.053
32	30.225	0.133	0.621	0.930	1.446	2.423	2.632
33	30.200	0.133	0.524	0.797	1.222	2.047	2.256
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
35	30.000	0.083	-0.269	-0.319	-0.573	-0.961	-0.752
36	30.017	0.000	-0.212	-0.250	-0.423	-0.710	-0.501
37	30.000	0.033	-0.284	-0.365	-0.573	-0.961	-0.752
38	29.917	0.167	-0.529	-0.625	-1.321	-2.214	-2.005
39	30.000	0.080	-0.270	-0.322	-0.573	-0.961	-0.752
40	29.917	0.000	-0.659	-1.000	-1.318	-2.209	-2.000
41	30.233	0.083	0.711	1.167	1.518	2.543	2.752
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	30.350	0.080	1.208	1.933	2.568	4.302	4.511
44	30.044	0.200	-0.067	-0.026	-0.180	-0.302	-0.093
45	29.951	0.200	-0.377	-0.412	-1.013	-1.698	-1.489
46	29.967	0.500	-0.177	-0.160	-0.870	-1.457	-1.248
47	30.000	0.083	-0.269	-0.319	-0.573	-0.961	-0.752
48	30.083	0.000	0.087	0.251	0.175	0.292	0.501
49	30.083	0.083	0.082	0.212	0.174	0.292	0.501
50	29.967	0.067	-0.416	-0.557	-0.870	-1.457	-1.248
51	30.172	0.054	0.471	0.850	0.970	1.626	1.835

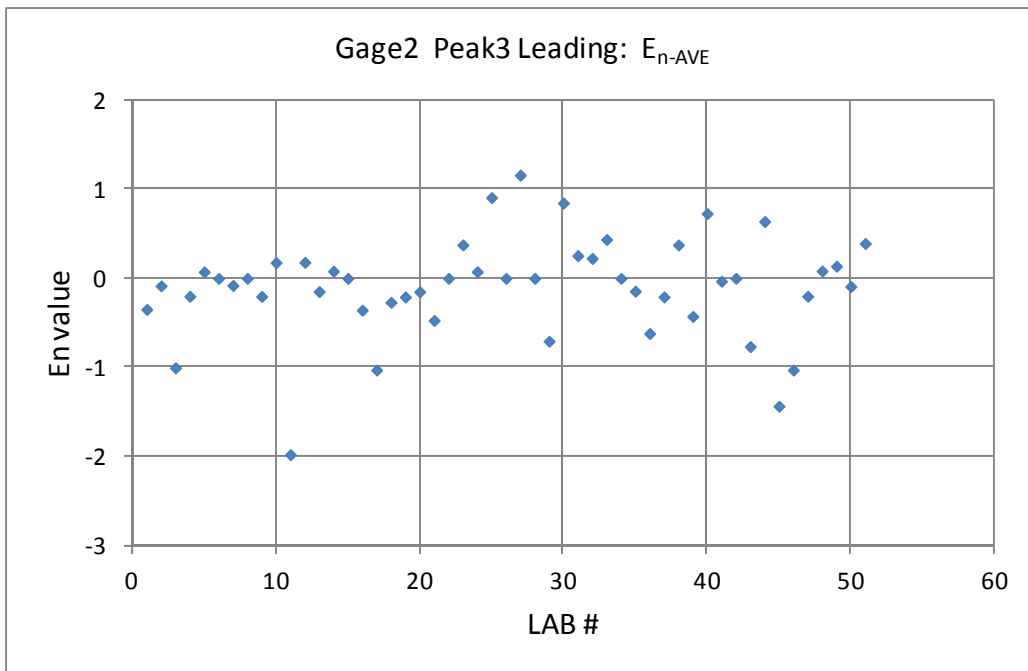
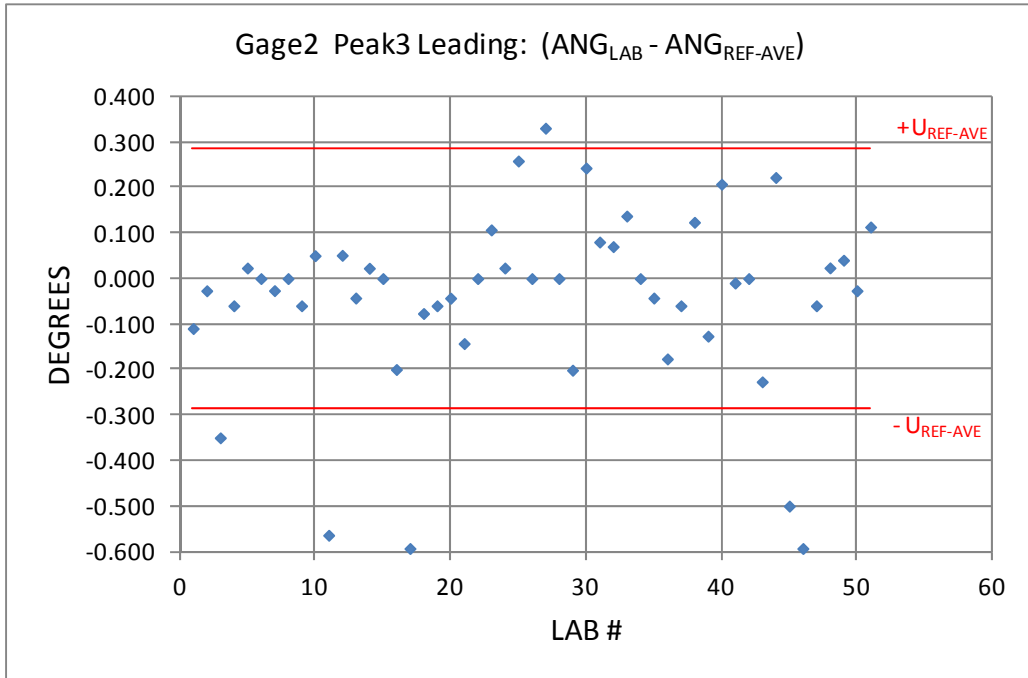


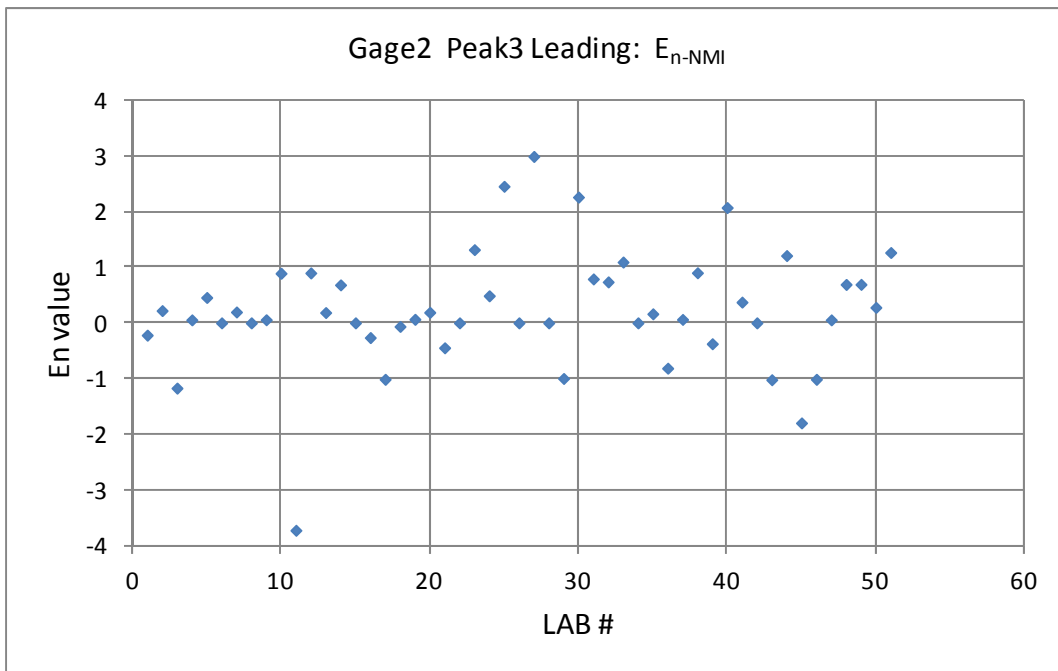
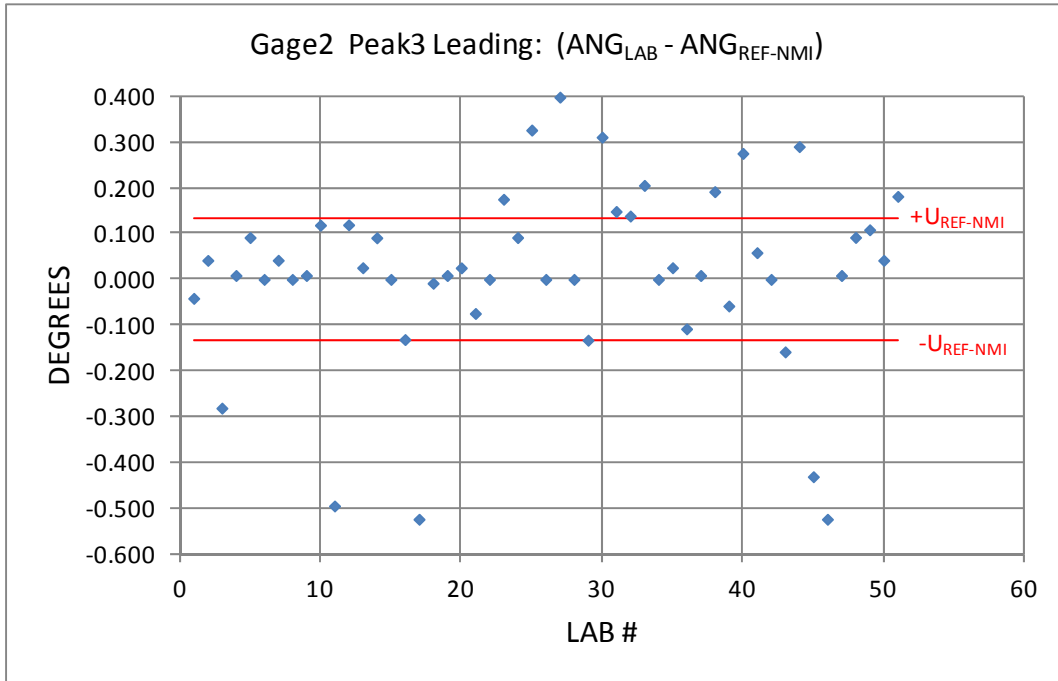


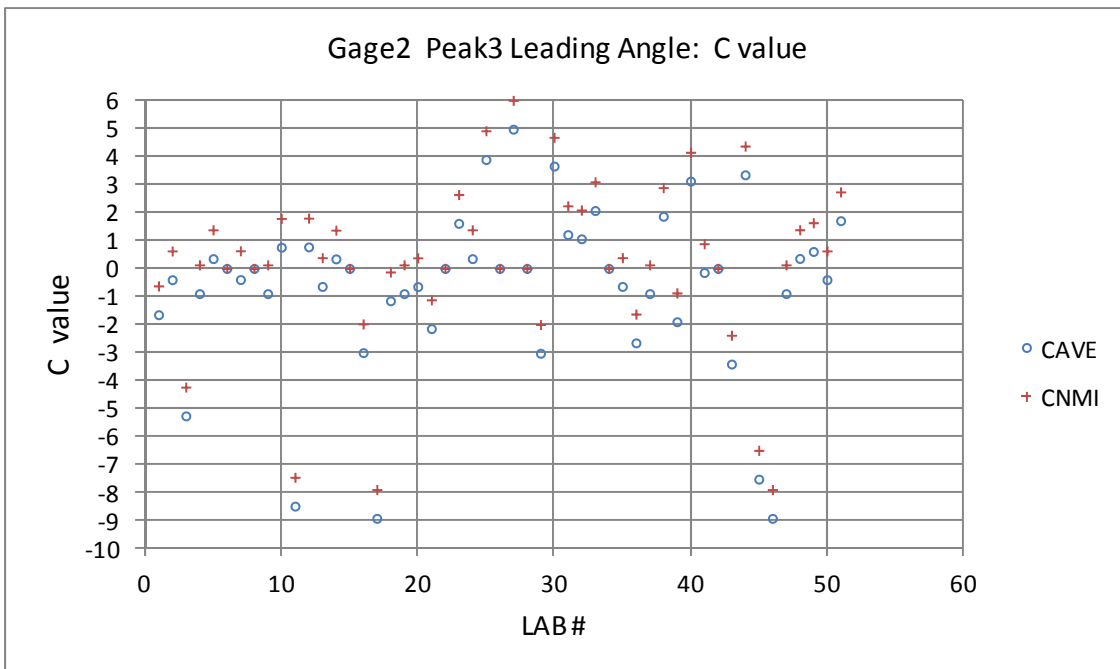
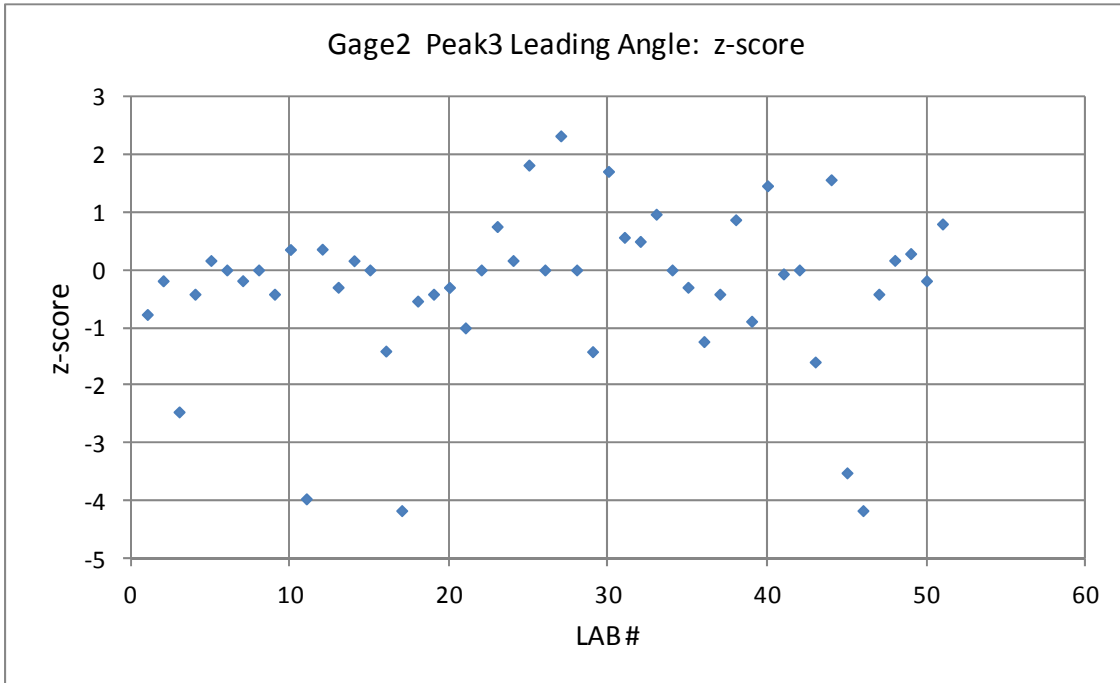


## ½ Angle, Leading Edge at Peak 3 Gage 2

1/2 Angle		GAGE 2: 1/4-28 UNJF GO 3A: 1/2 angle tol. = 8' = 0.133 deg					
Outliers:							
(#11, 17, 45, 46)		ANG <sub>REF-AVE</sub> = 30.060		ANG <sub>REF-NM</sub> = 29.992		ANG tol. = 0.133	
		U <sub>REF-STD</sub> = 0.285		U <sub>REF-NM</sub> = 0.133			
Gage 2: Leading 1/2 angle @ peak 3							
		Reported					
		Uncertainty					
		Reported					
		k = 2, 95%					
		Value					
		coverage					
Lab	ANG	factor	E <sub>T-AVE</sub>	E <sub>T-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
#	[deg]	+/- [deg]					
1	29.950	0.133	-0.349	-0.221	-0.771	-1.650	-0.624
2	30.033	0.133	-0.085	0.221	-0.188	-0.402	0.624
3	29.710	0.200	-1.005	-1.172	-2.456	-5.259	-4.233
4	30.000	0.083	-0.201	0.054	-0.419	-0.898	0.128
5	30.083	0.150	0.072	0.456	0.163	0.350	1.376
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	30.033	0.167	-0.080	0.196	-0.186	-0.398	0.629
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	30.000	0.073	-0.203	0.056	-0.419	-0.898	0.128
10	30.110	0.000	0.176	0.891	0.353	0.756	1.782
11	29.496	0.000	-1.979	-3.726	-3.958	-8.477	-7.451
12	30.111	0.000	0.179	0.897	0.359	0.768	1.794
13	30.017	0.036	-0.149	0.185	-0.300	-0.643	0.383
14	30.082	0.008	0.080	0.682	0.159	0.341	1.367
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	29.860	0.480	-0.358	-0.264	-1.403	-3.004	-1.977
17	29.467	0.500	-1.030	-1.014	-4.162	-8.913	-7.887
18	29.983	0.008	-0.269	-0.064	-0.539	-1.154	-0.128
19	30.000	0.000	-0.210	0.064	-0.419	-0.898	0.128
20	30.017	0.000	-0.151	0.189	-0.302	-0.647	0.379
21	29.917	0.100	-0.473	-0.448	-1.002	-2.146	-1.120
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23	30.167	0.006	0.375	1.316	0.751	1.608	2.634
24	30.083	0.133	0.074	0.486	0.163	0.350	1.376
25	30.318	0.005	0.907	2.453	1.813	3.884	4.910
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	30.390	0.009	1.159	2.989	2.319	4.966	5.992
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	29.859	0.005	-0.706	-0.999	-1.413	-3.026	-2.000
30	30.303	0.036	0.846	2.259	1.705	3.651	4.677
31	30.140	0.133	0.255	0.790	0.564	1.207	2.233
32	30.130	0.133	0.223	0.736	0.493	1.057	2.083
33	30.197	0.133	0.437	1.093	0.964	2.064	3.090
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
35	30.017	0.083	-0.144	0.163	-0.300	-0.643	0.383
36	29.883	0.000	-0.619	-0.814	-1.239	-2.653	-1.627
37	30.000	0.033	-0.208	0.062	-0.419	-0.898	0.128
38	30.183	0.167	0.375	0.900	0.868	1.858	2.885
39	29.933	0.080	-0.427	-0.375	-0.888	-1.901	-0.875
40	30.267	0.000	0.728	2.071	1.455	3.117	4.143
41	30.050	0.083	-0.033	0.373	-0.068	-0.146	0.880
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	29.833	0.080	-0.766	-1.021	-1.592	-3.410	-2.383
44	30.282	0.200	0.638	1.209	1.559	3.339	4.365
45	29.560	0.200	-1.436	-1.797	-3.509	-7.515	-6.489
46	29.467	0.500	-1.030	-1.014	-4.162	-8.913	-7.887
47	30.000	0.083	-0.201	0.054	-0.419	-0.898	0.128
48	30.083	0.000	0.083	0.690	0.166	0.355	1.381
49	30.100	0.083	0.136	0.691	0.283	0.605	1.632
50	30.033	0.067	-0.091	0.279	-0.188	-0.402	0.624
51	30.173	0.054	0.391	1.264	0.795	1.703	2.729



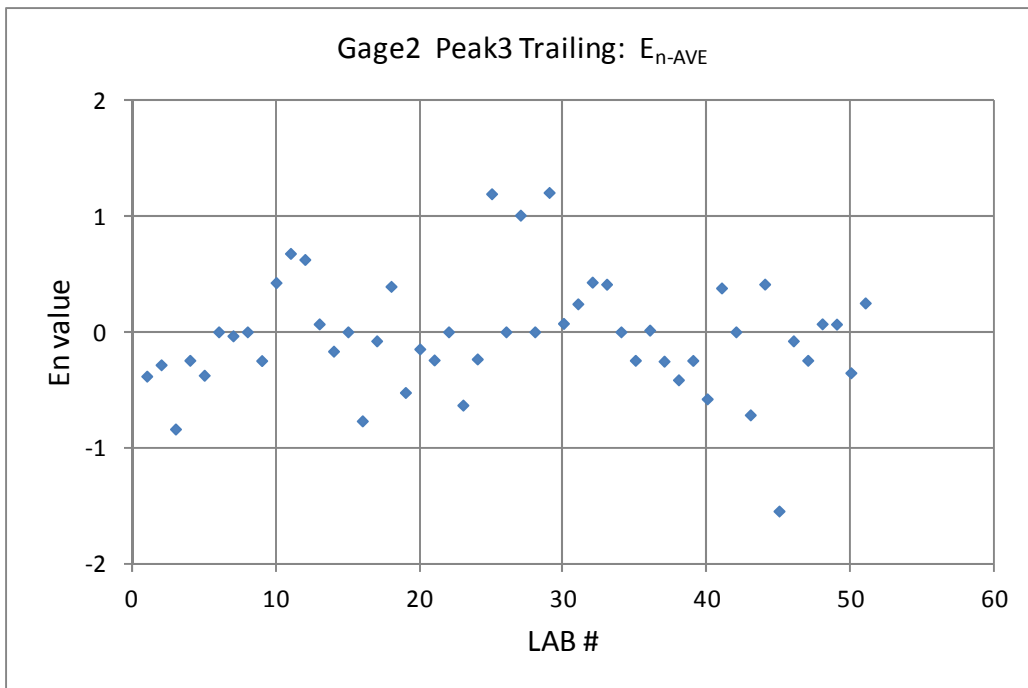
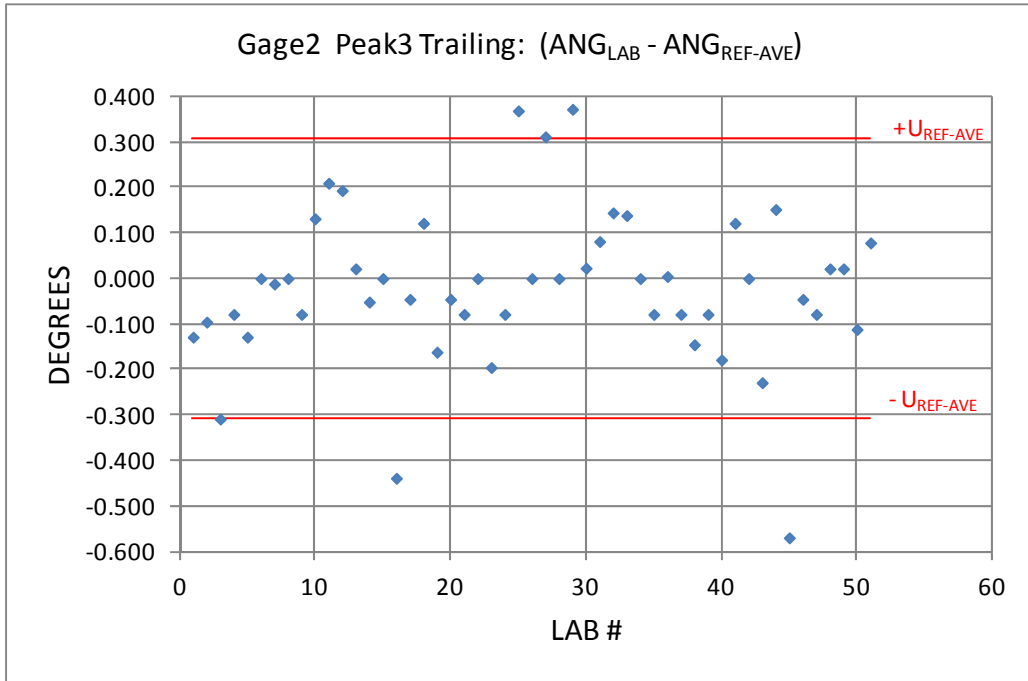


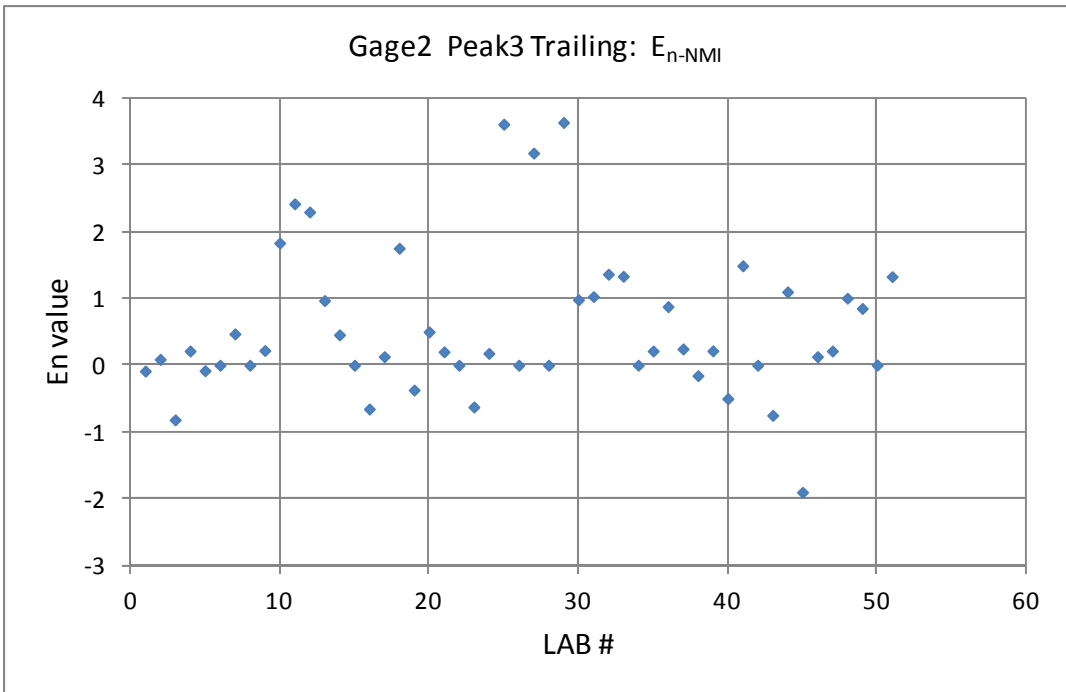
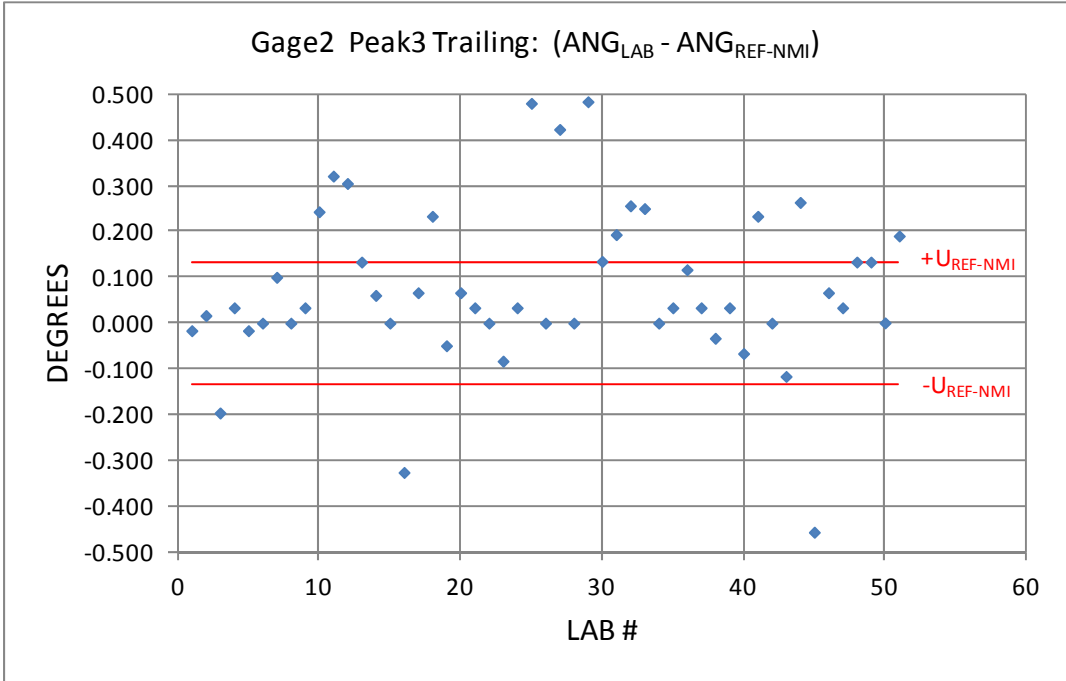


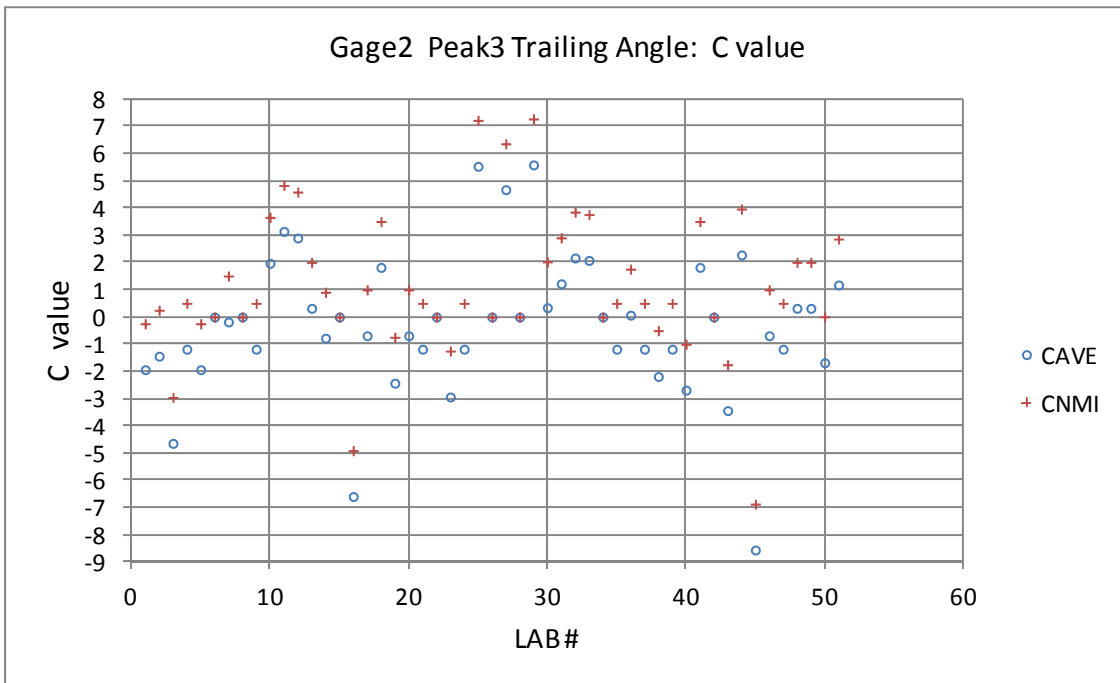
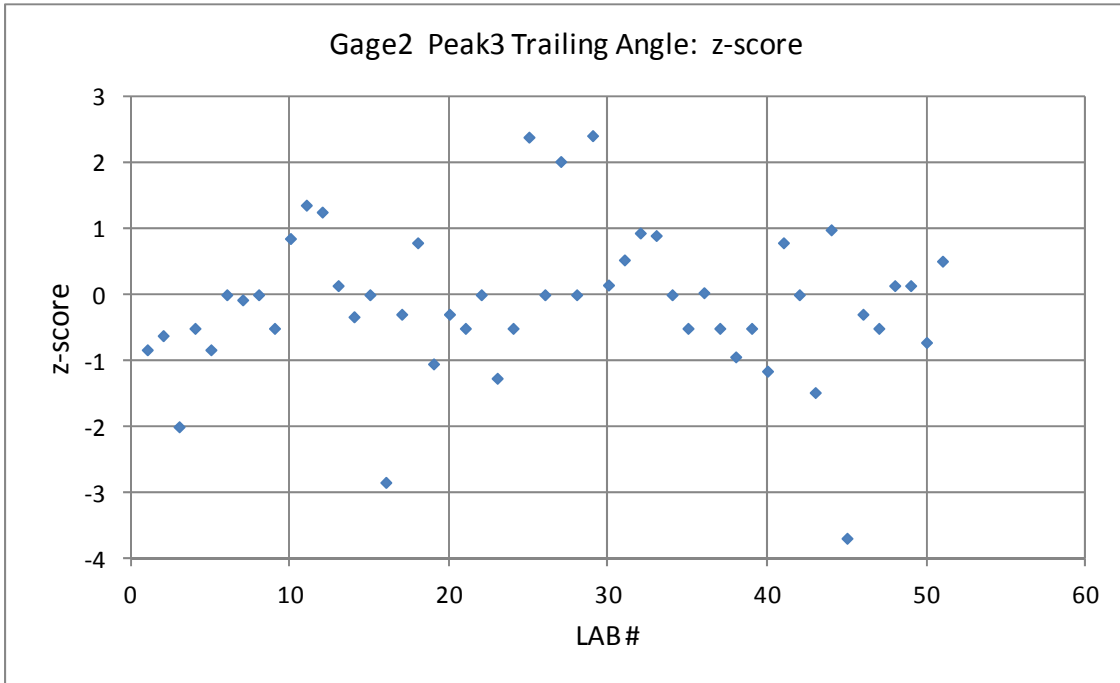


## ½ Angle, Trailing Edge at Peak 3 Gage 2

		1/2 Angle	GAGE 2: 1/4-28 UNJF GO 3A: 1/2 angle tol. = 8' = 0.133 deg				
Outliers:							
(#16, 45)		ANG <sub>REF-AVE</sub> =	30.079	ANG <sub>REF-NM</sub> =	29.967	ANG tol. =	0.133
		U <sub>REF-STD</sub> =	0.309	U <sub>REF-NM</sub> =	0.133		
		Gage 2: Trailing 1/2 angle @ peak 3					
		Reported					
		Uncertainty					
		Reported	k = 2, 95%				
		Value	coverage				
Lab	ANG	factor	E <sub>T-AVE</sub>	E <sub>T-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
#	[deg]	+/- [deg]					
1	29.950	0.133	-0.383	-0.088	-0.833	-1.935	-0.248
2	29.983	0.133	-0.284	0.088	-0.619	-1.439	0.248
3	29.770	0.200	-0.839	-0.818	-1.998	-4.642	-2.955
4	30.000	0.083	-0.246	0.213	-0.509	-1.183	0.504
5	29.950	0.150	-0.375	-0.082	-0.833	-1.935	-0.248
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	30.067	0.167	-0.034	0.470	-0.078	-0.180	1.507
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	30.000	0.073	-0.248	0.221	-0.509	-1.183	0.504
10	30.210	0.000	0.425	1.831	0.850	1.975	3.662
11	30.288	0.000	0.678	2.417	1.355	3.148	4.835
12	30.272	0.000	0.625	2.295	1.250	2.904	4.591
13	30.100	0.036	0.069	0.969	0.138	0.321	2.008
14	30.027	0.008	-0.167	0.455	-0.334	-0.776	0.911
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	29.640	0.480	-0.768	-0.656	-2.840	-6.597	-4.910
17	30.033	0.500	-0.078	0.129	-0.296	-0.687	1.000
18	30.200	0.008	0.393	1.752	0.785	1.824	3.511
19	29.917	0.000	-0.523	-0.372	-1.047	-2.431	-0.744
20	30.033	0.000	-0.148	0.500	-0.296	-0.687	1.000
21	30.000	0.100	-0.242	0.201	-0.509	-1.183	0.504
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23	29.883	0.006	-0.632	-0.625	-1.265	-2.938	-1.251
24	30.000	0.133	-0.234	0.178	-0.509	-1.183	0.504
25	30.447	0.005	1.192	3.610	2.384	5.539	7.226
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	30.390	0.009	1.007	3.177	2.015	4.682	6.368
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	30.451	0.005	1.203	3.637	2.407	5.591	7.278
30	30.101	0.036	0.073	0.980	0.147	0.342	2.029
31	30.160	0.133	0.242	1.029	0.526	1.223	2.910
32	30.223	0.133	0.429	1.364	0.934	2.170	3.857
33	30.217	0.133	0.411	1.332	0.895	2.080	3.767
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
35	30.000	0.083	-0.246	0.214	-0.509	-1.183	0.504
36	30.083	0.000	0.015	0.878	0.030	0.069	1.756
37	30.000	0.033	-0.253	0.244	-0.509	-1.183	0.504
38	29.933	0.167	-0.414	-0.156	-0.941	-2.186	-0.499
39	30.000	0.080	-0.247	0.216	-0.509	-1.183	0.504
40	29.900	0.000	-0.578	-0.500	-1.157	-2.687	-1.000
41	30.200	0.083	0.379	1.489	0.785	1.824	3.511
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	29.850	0.080	-0.717	-0.751	-1.480	-3.439	-1.752
44	30.230	0.200	0.412	1.099	0.982	2.282	3.968
45	29.509	0.200	-1.547	-1.904	-3.686	-8.562	-6.875
46	30.033	0.500	-0.078	0.129	-0.296	-0.687	1.000
47	30.000	0.083	-0.246	0.213	-0.509	-1.183	0.504
48	30.100	0.000	0.069	1.004	0.138	0.321	2.008
49	30.100	0.083	0.067	0.851	0.138	0.321	2.008
50	29.967	0.067	-0.353	0.003	-0.723	-1.679	0.008
51	30.157	0.054	0.250	1.327	0.507	1.178	2.865

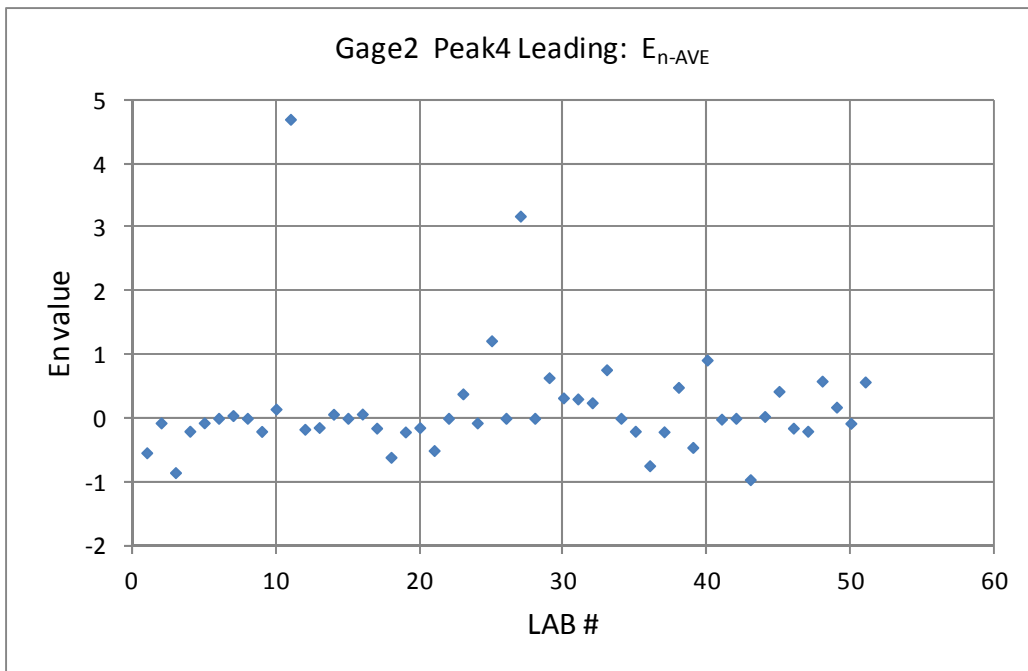
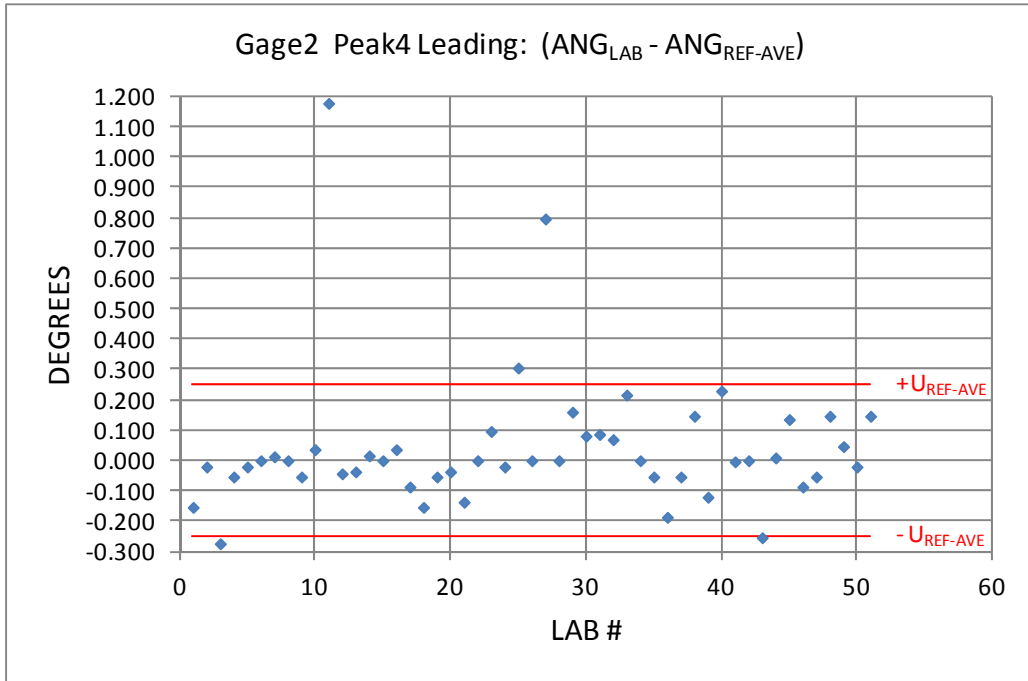


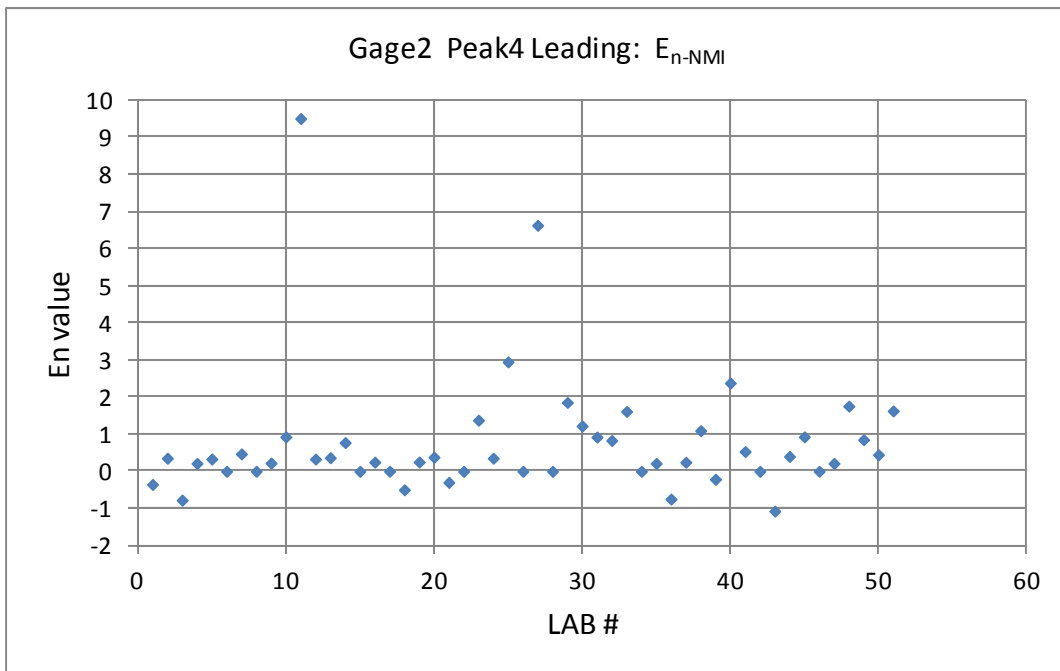
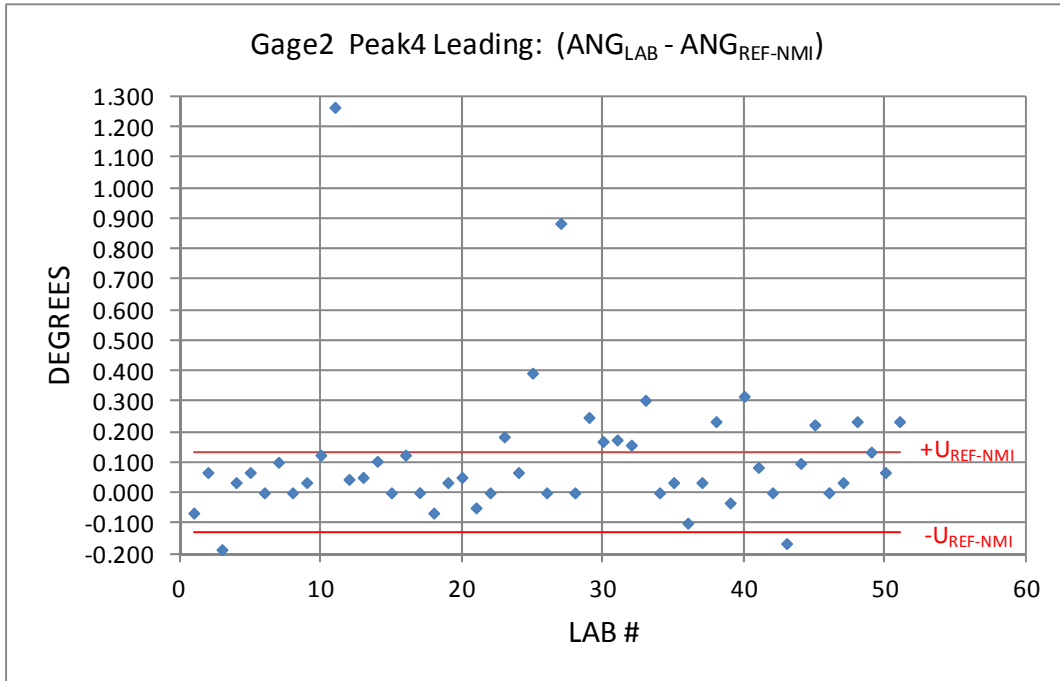


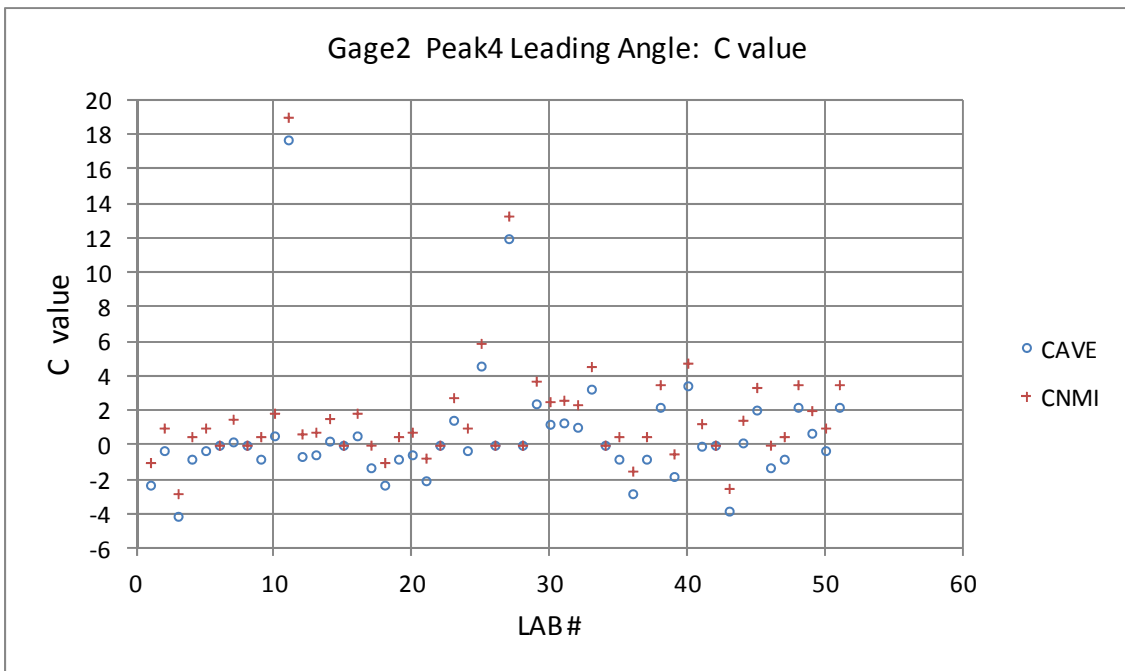
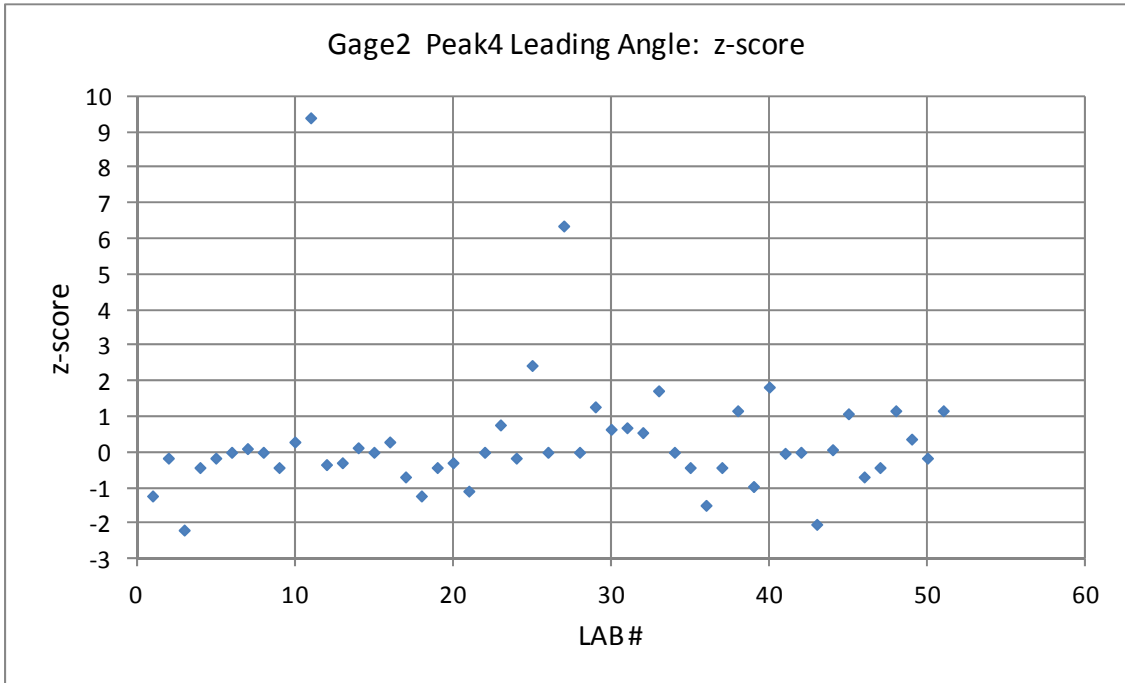


## ½ Angle, Leading Edge at Peak 4 Gage 2

		1/2 Angle	GAGE 2: 1/4-28 UNJF GO 3A: 1/2 angle tol. = 8' = 0.133 deg				
Outliers:							
(#11, 27)		ANG <sub>REF-AVE</sub> = 30.054	ANG <sub>REF-NM</sub> = 29.967	ANG tol. = 0.133			
		U <sub>REF-STD</sub> = 0.250	U <sub>REF-NM</sub> = 0.133				
Gage 2: Leading 1/2 angle @ peak 4							
		Reported					
		Uncertainty					
		Reported	k = 2, 95%				
		Value	coverage				
Lab	1/2 ANG	factor	E <sub>n-AVE</sub>	E <sub>n-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
#	[deg]	+/- [ideg]					
1	29.900	0.133	-0.542	-0.354	-1.227	-2.310	-1.000
2	30.033	0.133	-0.073	0.354	-0.165	-0.310	1.000
3	29.780	0.200	-0.854	-0.776	-2.185	-4.115	-2.805
4	30.000	0.083	-0.203	0.213	-0.428	-0.807	0.504
5	30.033	0.150	-0.071	0.332	-0.165	-0.310	1.000
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	30.067	0.167	0.043	0.470	0.104	0.196	1.507
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	30.000	0.073	-0.206	0.221	-0.428	-0.807	0.504
10	30.090	0.000	0.145	0.929	0.290	0.547	1.857
11	31.231	0.000	4.700	9.506	9.400	17.702	19.012
12	30.010	0.000	-0.173	0.330	-0.345	-0.650	0.660
13	30.017	0.036	-0.145	0.367	-0.293	-0.551	0.759
14	30.070	0.008	0.064	0.775	0.128	0.241	1.552
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	30.090	0.480	0.067	0.248	0.290	0.547	1.857
17	29.967	0.500	-0.155	0.001	-0.692	-1.303	0.008
18	29.900	0.008	-0.613	-0.499	-1.227	-2.310	-1.000
19	30.000	0.000	-0.214	0.252	-0.428	-0.807	0.504
20	30.017	0.000	-0.146	0.380	-0.293	-0.551	0.759
21	29.917	0.100	-0.507	-0.297	-1.091	-2.055	-0.744
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23	30.150	0.006	0.385	1.378	0.769	1.449	2.759
24	30.033	0.133	-0.073	0.354	-0.165	-0.310	1.000
25	30.359	0.005	1.219	2.949	2.438	4.592	5.902
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	30.850	0.009	3.178	6.628	6.359	11.975	13.286
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	30.214	0.005	0.639	1.857	1.277	2.405	3.716
30	30.135	0.036	0.320	1.222	0.647	1.219	2.529
31	30.140	0.133	0.305	0.922	0.690	1.299	2.609
32	30.123	0.133	0.245	0.832	0.554	1.043	2.353
33	30.270	0.133	0.763	1.614	1.728	3.253	4.564
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
35	30.000	0.083	-0.203	0.214	-0.428	-0.807	0.504
36	29.867	0.000	-0.745	-0.748	-1.490	-2.807	-1.496
37	30.000	0.033	-0.212	0.244	-0.428	-0.807	0.504
38	30.200	0.167	0.487	1.095	1.169	2.201	3.511
39	29.933	0.080	-0.458	-0.214	-0.961	-1.810	-0.499
40	30.283	0.000	0.916	2.380	1.831	3.449	4.759
41	30.050	0.083	-0.014	0.533	-0.029	-0.055	1.256
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	29.800	0.080	-0.965	-1.073	-2.025	-3.814	-2.504
44	30.063	0.200	0.029	0.401	0.073	0.138	1.448
45	30.189	0.200	0.423	0.928	1.083	2.040	3.350
46	29.967	0.500	-0.155	0.001	-0.692	-1.303	0.008
47	30.000	0.083	-0.203	0.213	-0.428	-0.807	0.504
48	30.200	0.000	0.584	1.756	1.169	2.201	3.511
49	30.100	0.083	0.176	0.851	0.370	0.697	2.008
50	30.033	0.067	-0.080	0.447	-0.165	-0.310	1.000
51	30.200	0.054	0.571	1.627	1.169	2.201	3.511



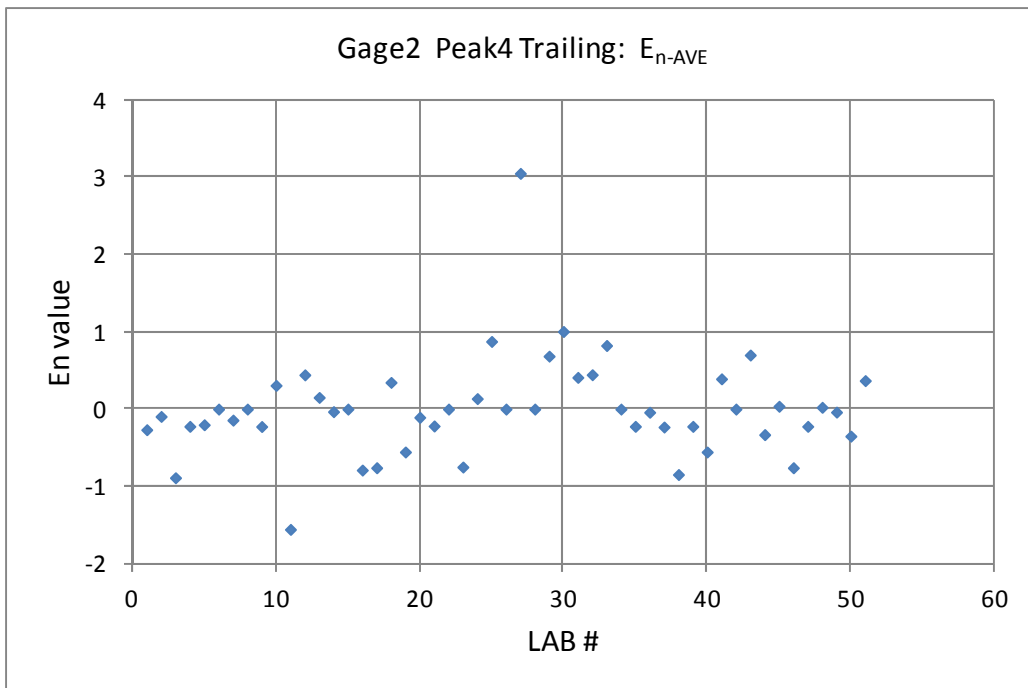
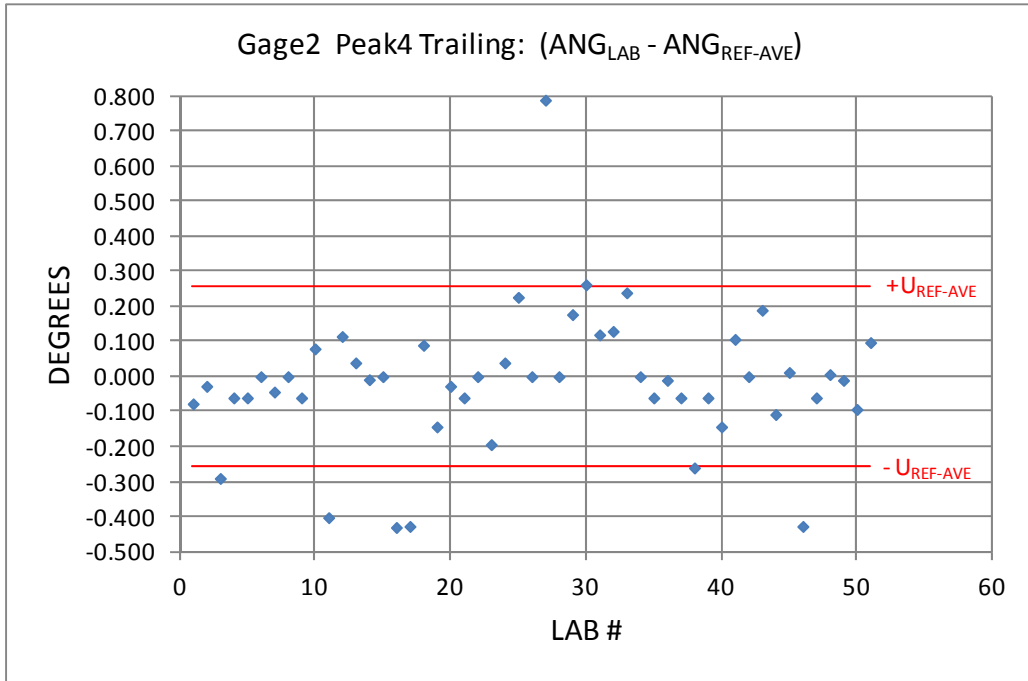


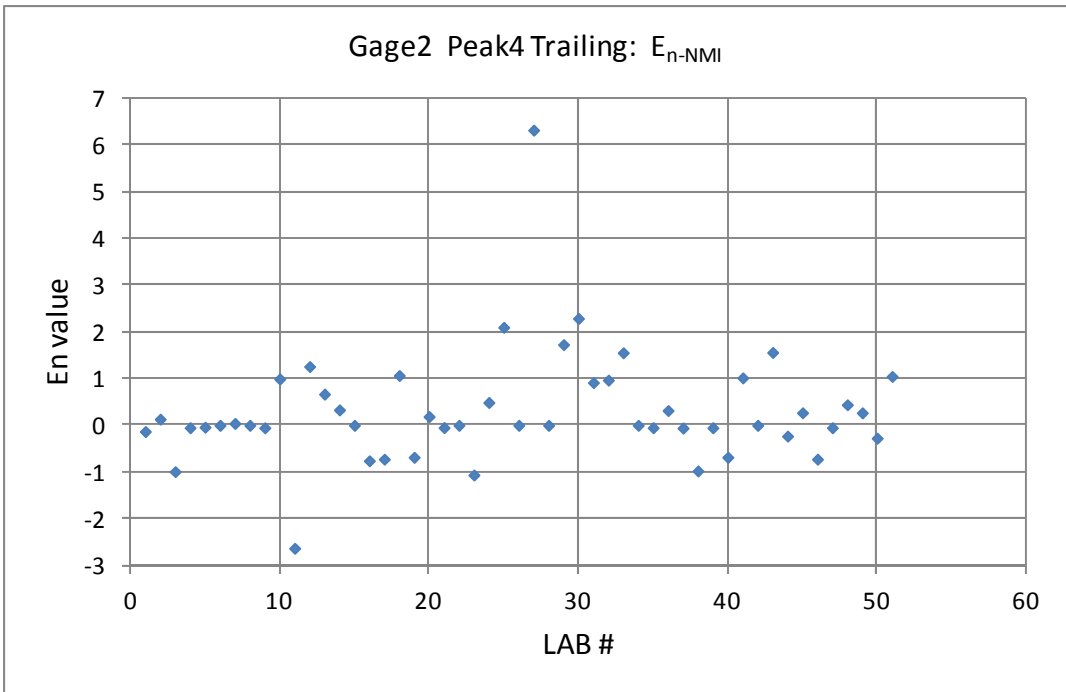
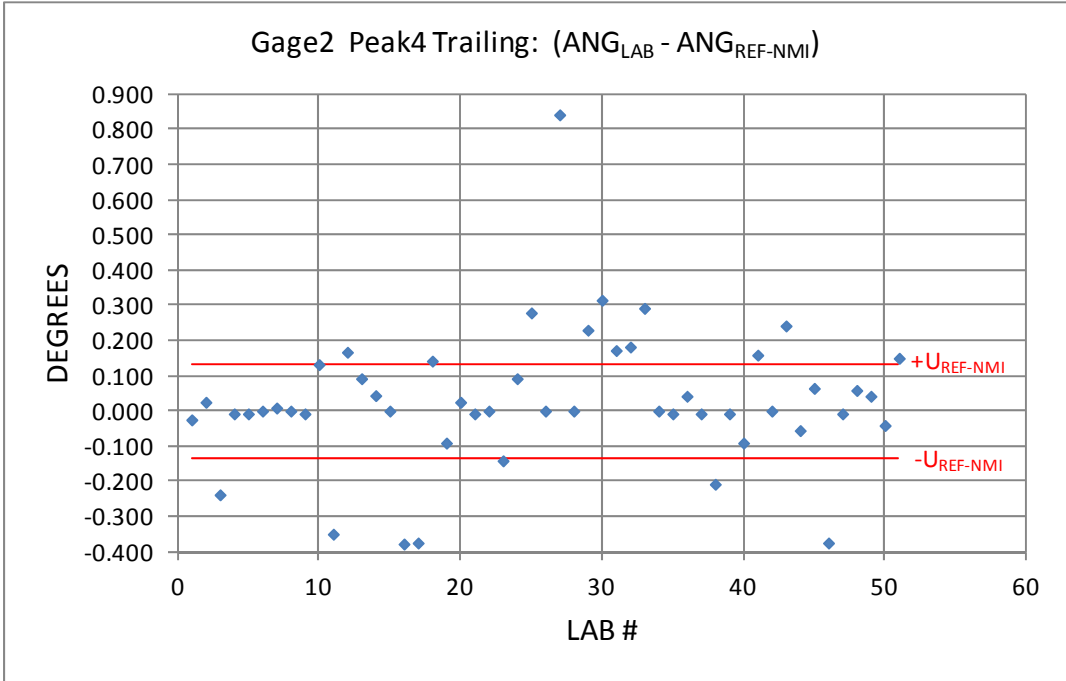


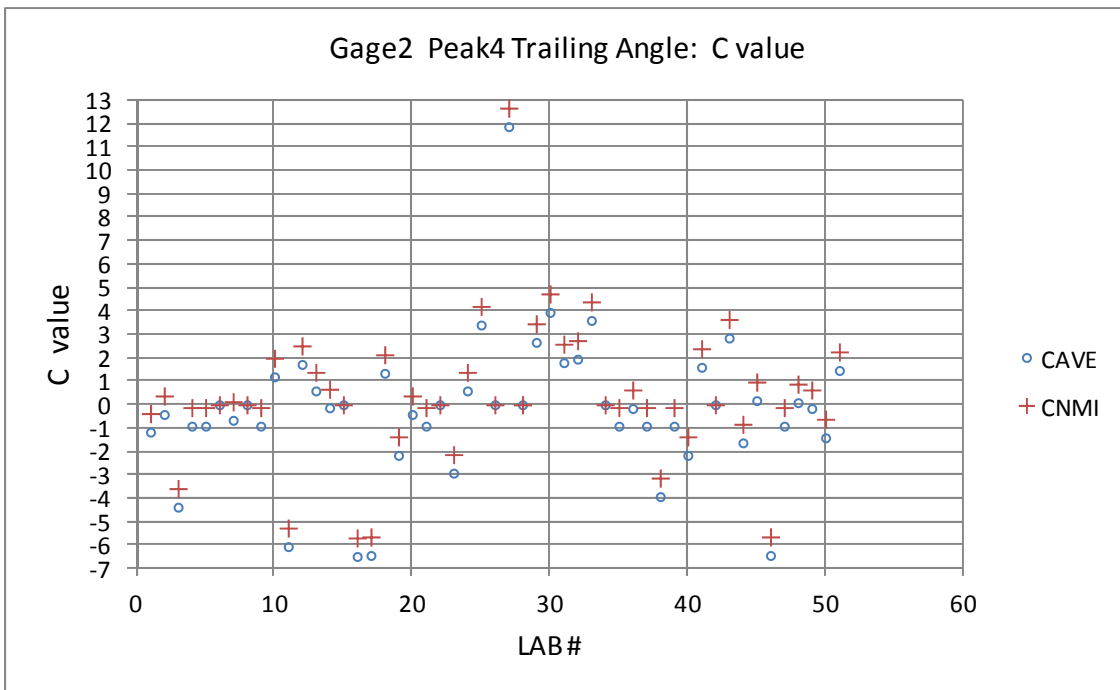
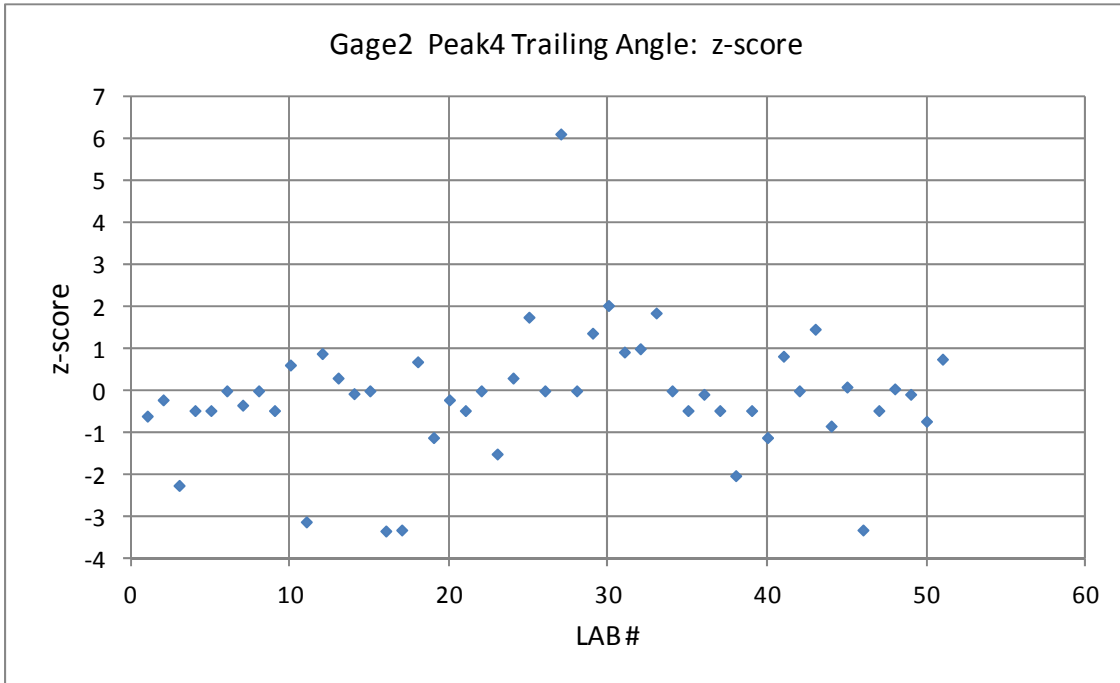


## ½ Angle, Trailing Edge at Peak 4 Gage 2

		1/2 Angle	GAGE 2: 1/4-28 UNJF GO 3A: 1/2 angle tol. = 8' = 0.133 deg					
Outliers:								
(# 16, 17, 27, 46)		ANG <sub>REF-AVE</sub> =	30.061	ANG <sub>REF-NM</sub> =	30.008	ANG tol. = 0.133		
		U <sub>REF-STD</sub> =	0.258	U <sub>REF-NM</sub> =	0.133			
		Gage 2: Trailing 1/2 angle @ peak 4						
		Reported						
		Uncertainty						
		Reported	k = 2, 95%					
		Value	coverage					
Lab	1/2 ANG	factor	E <sub>TR-AVE</sub>	E <sub>TR-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>	
#	[deg]	+/- [deg]						
1	29.983	0.133	-0.267	-0.133	-0.601	-1.168	-0.376	
2	30.033	0.133	-0.095	0.133	-0.214	-0.416	0.376	
3	29.770	0.200	-0.889	-0.991	-2.249	-4.371	-3.579	
4	30.000	0.083	-0.223	-0.051	-0.469	-0.912	-0.120	
5	30.000	0.150	-0.203	-0.040	-0.469	-0.912	-0.120	
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
7	30.017	0.167	-0.143	0.041	-0.340	-0.661	0.130	
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
9	30.000	0.073	-0.226	-0.053	-0.469	-0.912	-0.120	
10	30.140	0.000	0.307	0.992	0.614	1.193	1.985	
11	29.658	0.000	-1.558	-2.632	-3.116	-6.055	-5.263	
12	30.175	0.000	0.443	1.257	0.886	1.723	2.514	
13	30.100	0.036	0.151	0.668	0.304	0.592	1.383	
14	30.052	0.008	-0.033	0.330	-0.067	-0.130	0.662	
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
16	29.630	0.480	-0.790	-0.759	-3.332	-6.476	-5.684	
17	29.633	0.500	-0.760	-0.725	-3.309	-6.431	-5.639	
18	30.150	0.008	0.346	1.066	0.691	1.344	2.135	
19	29.917	0.000	-0.556	-0.684	-1.112	-2.160	-1.368	
20	30.033	0.000	-0.107	0.188	-0.214	-0.416	0.376	
21	30.000	0.100	-0.219	-0.048	-0.469	-0.912	-0.120	
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
23	29.867	0.006	-0.751	-1.062	-1.502	-2.918	-2.126	
24	30.100	0.133	0.135	0.489	0.304	0.592	1.383	
25	30.287	0.005	0.876	2.096	1.751	3.404	4.195	
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
27	30.850	0.009	3.052	6.316	6.108	11.870	12.662	
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
29	30.238	0.005	0.685	1.727	1.371	2.664	3.456	
30	30.323	0.036	1.005	2.287	2.028	3.942	4.734	
31	30.180	0.133	0.411	0.914	0.924	1.795	2.586	
32	30.190	0.133	0.445	0.968	1.001	1.945	2.737	
33	30.300	0.133	0.823	1.552	1.852	3.599	4.391	
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
35	30.000	0.083	-0.223	-0.051	-0.469	-0.912	-0.120	
36	30.050	0.000	-0.041	0.316	-0.082	-0.160	0.632	
37	30.000	0.033	-0.233	-0.058	-0.469	-0.912	-0.120	
38	29.800	0.167	-0.848	-0.976	-2.017	-3.920	-3.128	
39	30.000	0.080	-0.224	-0.052	-0.469	-0.912	-0.120	
40	29.917	0.000	-0.556	-0.684	-1.112	-2.160	-1.368	
41	30.167	0.083	0.392	1.014	0.823	1.599	2.391	
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
43	30.250	0.080	0.700	1.559	1.465	2.847	3.639	
44	29.953	0.200	-0.331	-0.231	-0.837	-1.626	-0.835	
45	30.073	0.200	0.036	0.269	0.092	0.178	0.970	
46	29.633	0.500	-0.760	-0.725	-3.309	-6.431	-5.639	
47	30.000	0.083	-0.223	-0.051	-0.469	-0.912	-0.120	
48	30.067	0.000	0.023	0.441	0.046	0.090	0.882	
49	30.050	0.083	-0.039	0.268	-0.082	-0.160	0.632	
50	29.967	0.067	-0.351	-0.275	-0.725	-1.408	-0.617	
51	30.158	0.054	0.369	1.045	0.753	1.464	2.256	

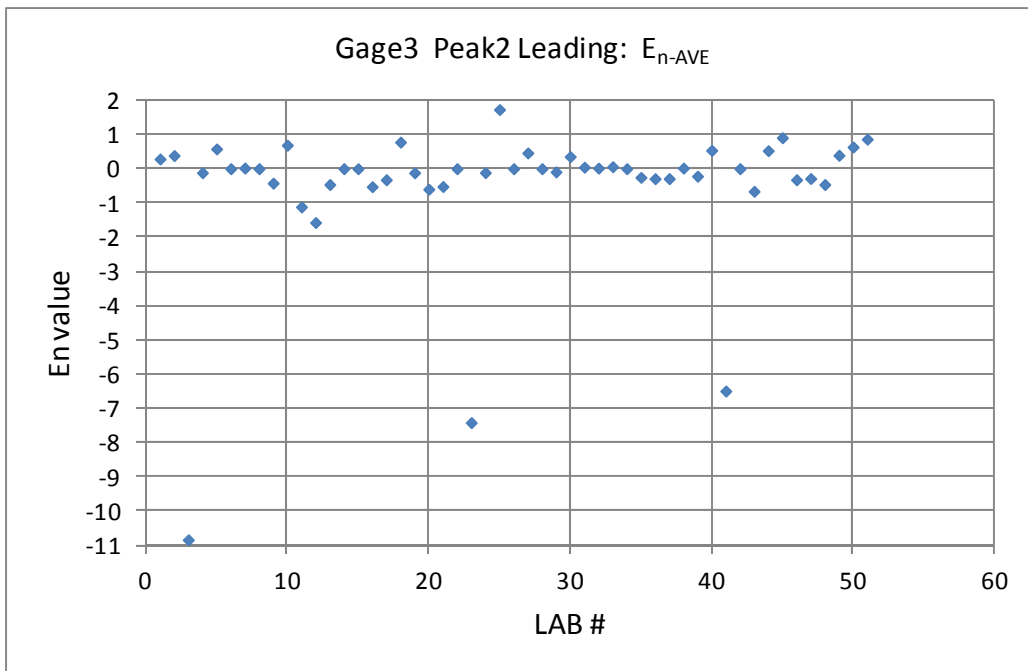
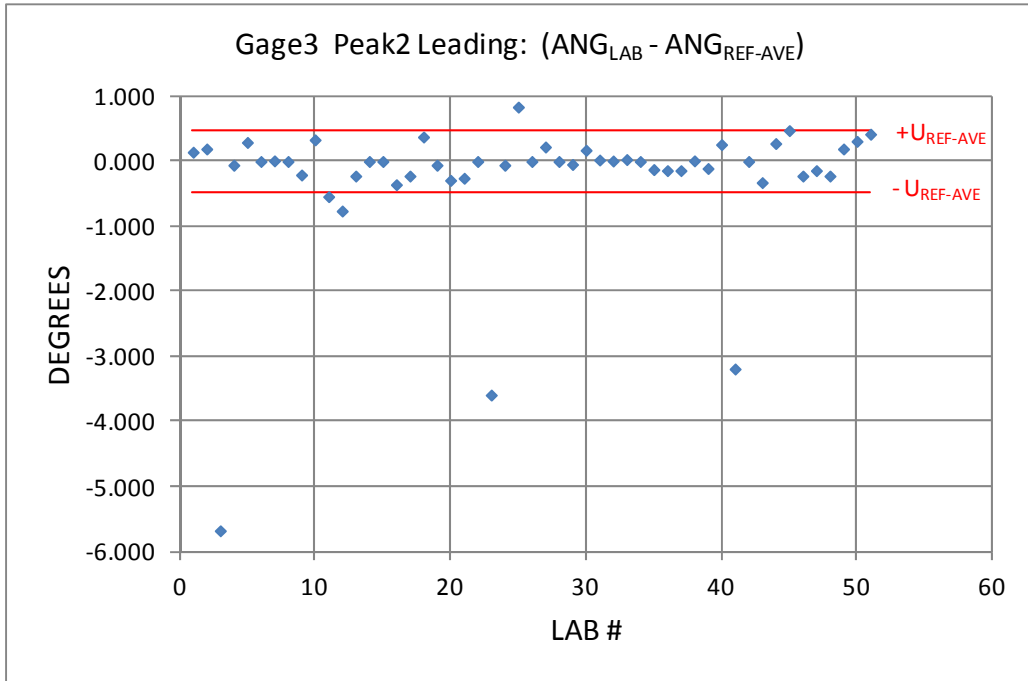


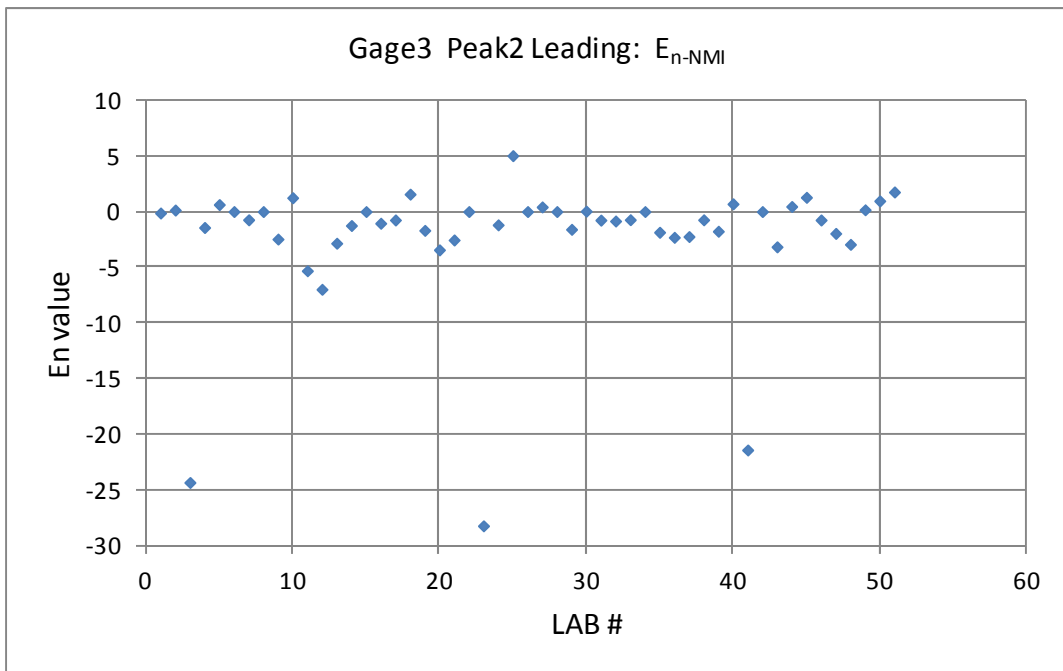
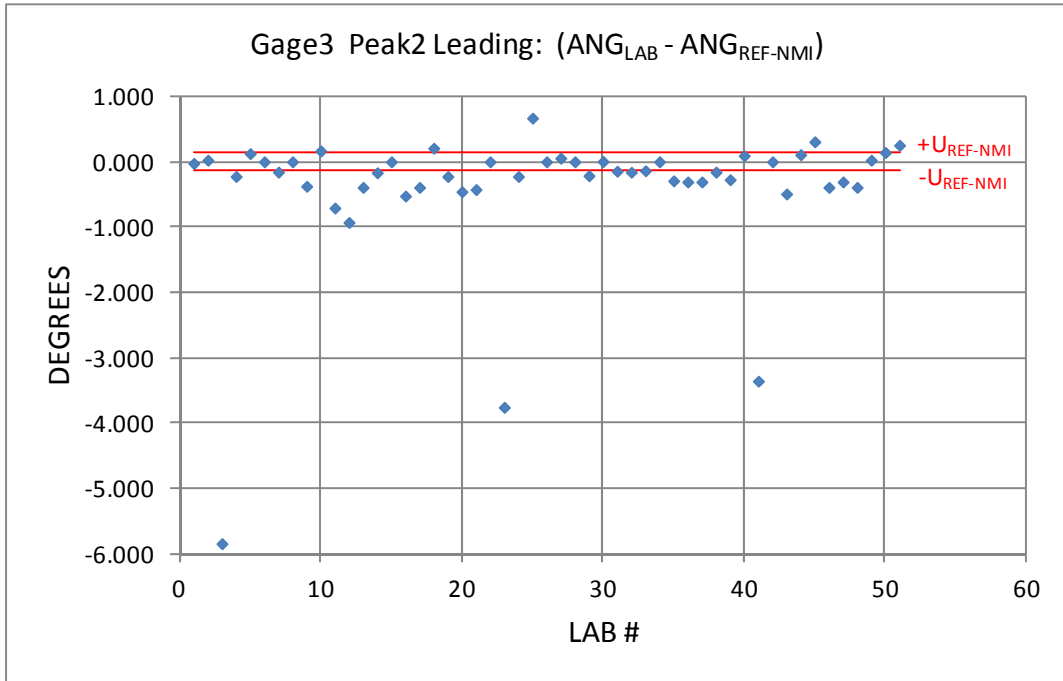


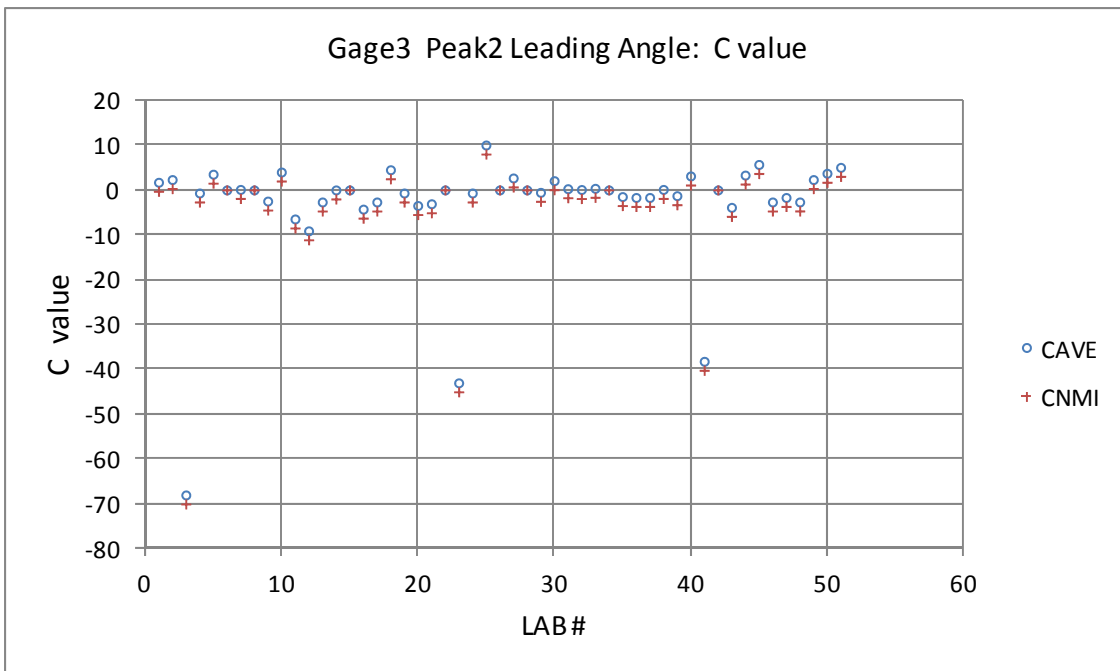
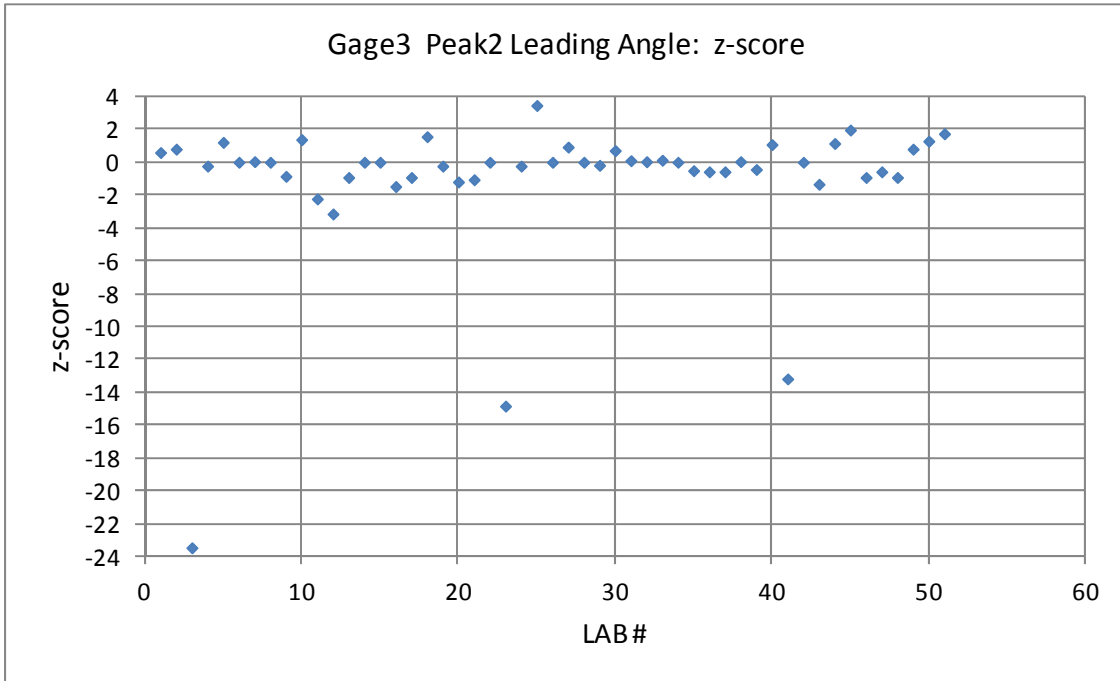


## ½ Angle, Leading Edge at Peak 2 Gage 3

		1/2 Angle	GAGE 3: 1/2-13 UNS: 1/2 angle tol. = 10' = 0.167 deg				
Outliers:							
(#3, 12, 23, 25, 41)		ANG <sub>REF-AVE</sub> = 33.757	ANG <sub>REF-NM</sub> = 33.925	ANG tol. = 0.167			
		U <sub>REF-STD</sub> = 0.484	U <sub>REF-NM</sub> = 0.133				
							Gage 3: Leading 1/2 angle @ peak 2
		Reported					
		Uncertainty					
		Reported					
		k = 2, 95%					
		Value					
		coverage					
Lab	1/2 ANG	factor	E <sub>T-AVE</sub>	E <sub>T-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
#	[deg]	+/- [deg]					
1	33.900	0.133	0.284	-0.133	0.589	1.710	-0.299
2	33.950	0.133	0.384	0.133	0.796	2.308	0.299
3	28.080	0.200	-10.832	-24.335	-23.437	-67.991	-70.000
4	33.700	0.083	-0.116	-1.434	-0.236	-0.686	-2.695
5	34.050	0.150	0.577	0.624	1.209	3.506	1.497
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	33.767	0.167	0.018	-0.742	0.039	0.113	-1.896
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	33.550	0.073	-0.423	-2.472	-0.856	-2.482	-4.491
10	34.090	0.000	0.687	1.241	1.374	3.985	1.976
11	33.217	0.000	-1.115	-5.323	-2.230	-6.470	-8.479
12	32.996	0.000	-1.572	-6.986	-3.143	-9.118	-11.127
13	33.533	0.036	-0.462	-2.845	-0.926	-2.686	-4.695
14	33.757	0.008	0.000	-1.258	0.001	0.002	-2.007
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	33.400	0.480	-0.524	-1.054	-1.475	-4.278	-6.287
17	33.533	0.500	-0.322	-0.758	-0.926	-2.686	-4.695
18	34.133	0.008	0.775	1.561	1.551	4.500	2.491
19	33.700	0.000	-0.118	-1.692	-0.236	-0.686	-2.695
20	33.467	0.000	-0.599	-3.444	-1.198	-3.476	-5.485
21	33.500	0.100	-0.520	-2.554	-1.062	-3.081	-5.090
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23	30.167	0.006	-7.411	-28.230	-14.823	-43.002	-45.011
24	33.700	0.133	-0.114	-1.196	-0.236	-0.686	-2.695
25	34.593	0.005	1.725	5.019	3.450	10.009	8.000
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	33.980	0.009	0.460	0.413	0.920	2.668	0.659
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	33.712	0.005	-0.093	-1.600	-0.186	-0.541	-2.550
30	33.929	0.036	0.354	0.032	0.711	2.062	0.053
31	33.780	0.133	0.045	-0.771	0.094	0.272	-1.737
32	33.765	0.133	0.015	-0.851	0.032	0.093	-1.916
33	33.787	0.133	0.059	-0.734	0.123	0.356	-1.653
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
35	33.633	0.083	-0.253	-1.863	-0.513	-1.488	-3.497
36	33.617	0.000	-0.290	-2.318	-0.580	-1.683	-3.692
37	33.617	0.033	-0.289	-2.249	-0.580	-1.683	-3.692
38	33.767	0.167	0.018	-0.743	0.039	0.112	-1.897
39	33.650	0.080	-0.218	-1.772	-0.443	-1.284	-3.293
40	34.017	0.000	0.536	0.692	1.072	3.111	1.102
41	30.567	0.083	-6.491	-21.419	-13.170	-38.207	-40.216
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	33.433	0.080	-0.660	-3.170	-1.339	-3.883	-5.892
44	34.034	0.200	0.527	0.452	1.140	3.308	1.299
45	34.231	0.200	0.905	1.276	1.957	5.678	3.669
46	33.533	0.500	-0.322	-0.758	-0.926	-2.686	-4.695
47	33.617	0.083	-0.286	-1.965	-0.580	-1.684	-3.693
48	33.533	0.000	-0.462	-2.945	-0.924	-2.682	-4.691
49	33.950	0.083	0.392	0.159	0.796	2.308	0.299
50	34.067	0.067	0.633	0.954	1.279	3.710	1.701
51	34.177	0.054	0.861	1.756	1.733	5.027	3.018



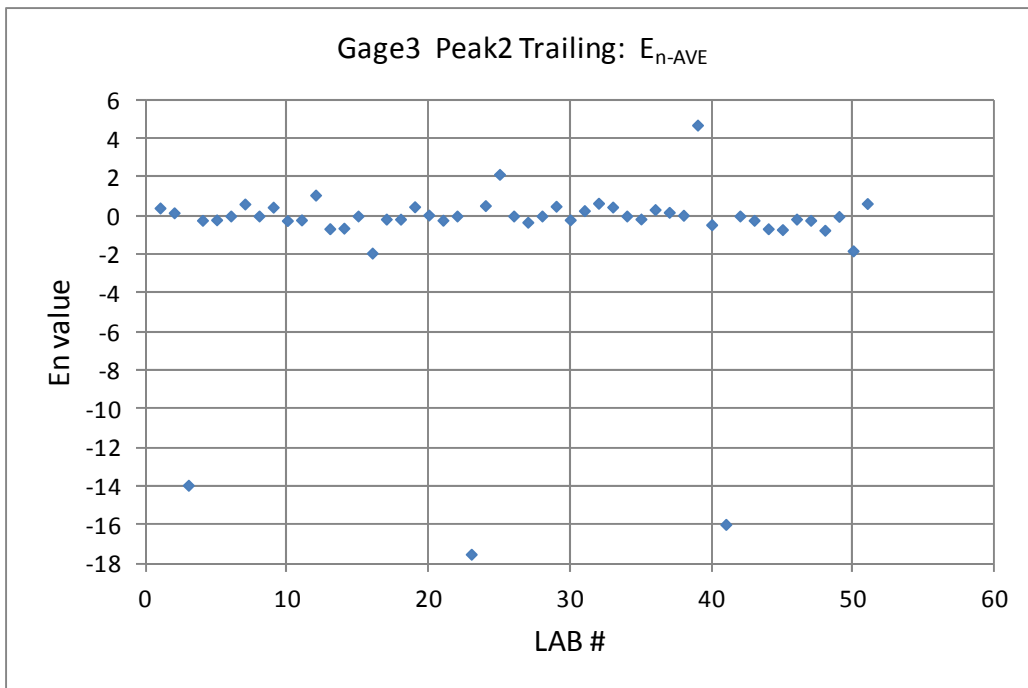
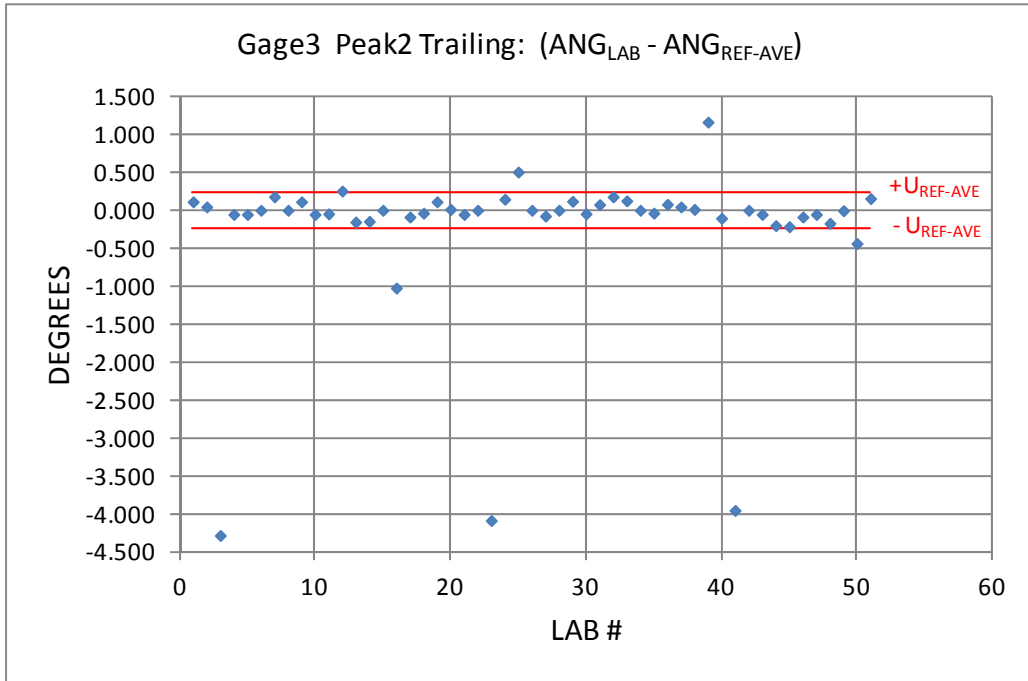


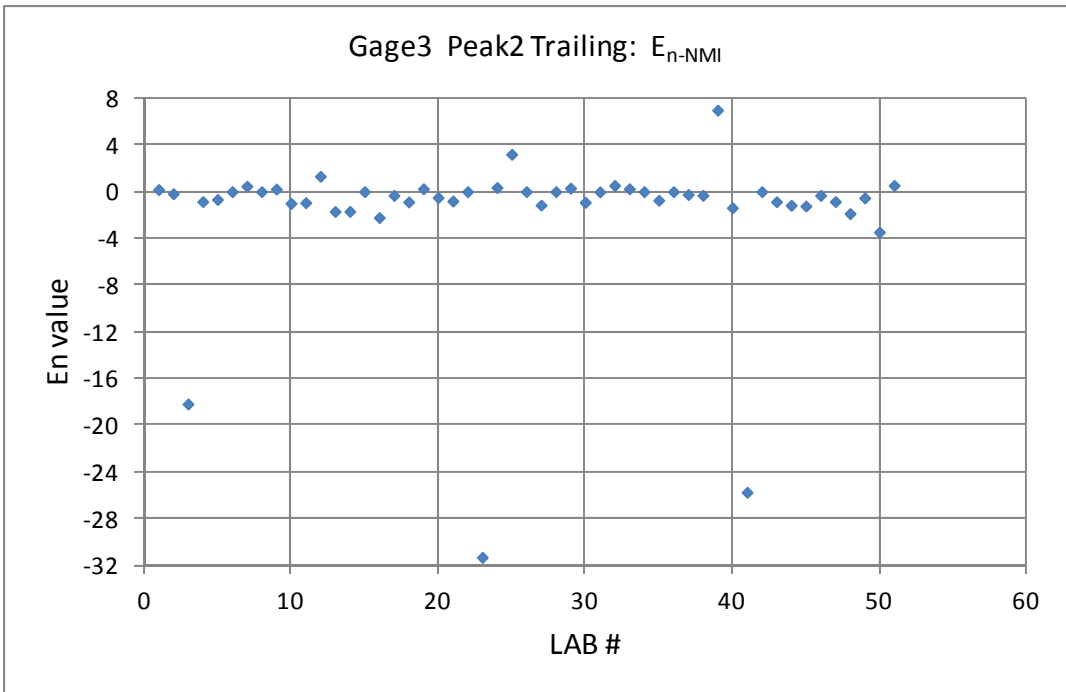
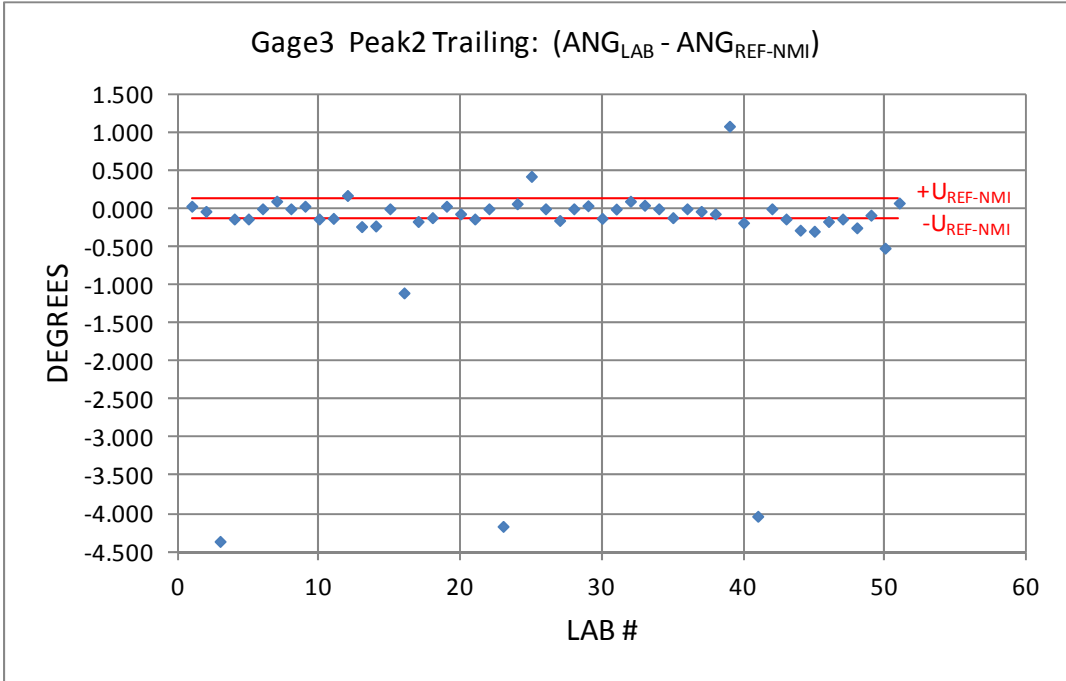


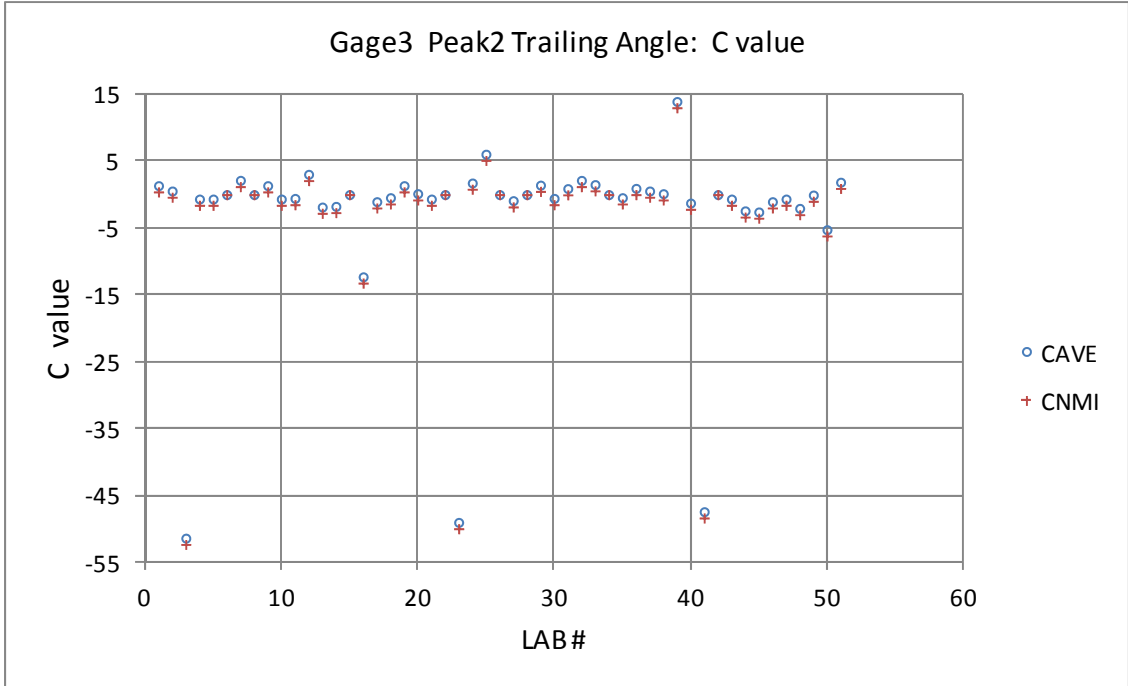
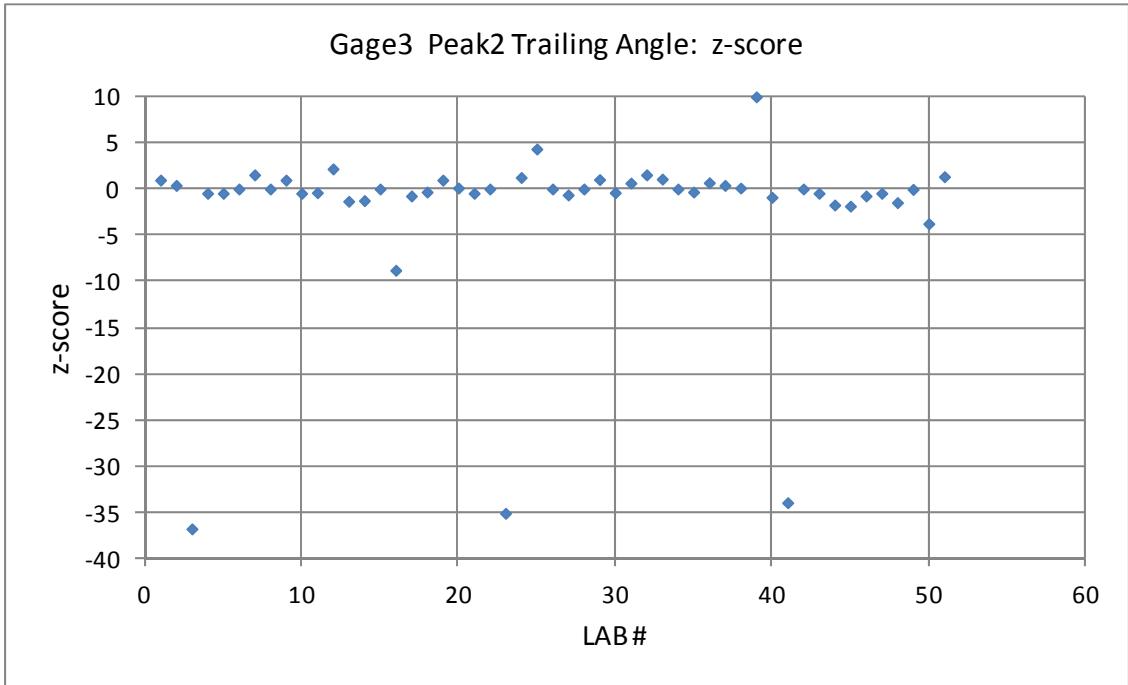


## ½ Angle, Trailing Edge at Peak 2 Gage 3

1/2 Angle		GAGE 3: 1/2-13 UNS: 1/2 angle tol. = 10' = 0.167 deg					
Outliers:		ANG <sub>REF-AVE</sub> = 34.055		ANG <sub>REF-NM</sub> = 34.134		ANG tol. = 0.167	
(#3, 16, 23, 25, 39, 41, 50)		U <sub>REF-STD</sub> = 0.233		U <sub>REF-NM</sub> = 0.133			
		Gage 3: Trailing 1/2 angle @ peak 2					
		Reported					
		Uncertainty					
		k = 2, 95%					
		Reported Value coverage					
Lab #	1/2 ANG [deg]	factor +/- [deg]	E <sub>h-AVE</sub>	E <sub>h-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
1	34.167	0.133	0.417	0.178	0.959	1.340	0.401
2	34.100	0.133	0.167	-0.178	0.385	0.538	-0.401
3	29.770	0.200	-13.945	-18.167	-36.738	-51.318	-52.257
4	34.000	0.083	-0.222	-0.851	-0.472	-0.660	-1.599
5	34.000	0.150	-0.199	-0.666	-0.472	-0.660	-1.599
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	34.233	0.167	0.622	0.468	1.528	2.134	1.195
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	34.167	0.073	0.458	0.221	0.959	1.340	0.401
10	34.000	0.000	-0.236	-1.004	-0.472	-0.660	-1.599
11	34.008	0.000	-0.202	-0.944	-0.404	-0.564	-1.503
12	34.308	0.000	1.085	1.313	2.169	3.030	2.091
13	33.900	0.036	-0.657	-1.695	-1.330	-1.857	-2.796
14	33.908	0.008	-0.628	-1.690	-1.258	-1.757	-2.696
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	33.030	0.480	-1.921	-2.215	-8.788	-12.276	-13.216
17	33.967	0.500	-0.160	-0.322	-0.755	-1.055	-1.994
18	34.017	0.008	-0.163	-0.874	-0.327	-0.456	-1.395
19	34.167	0.000	0.480	0.252	0.959	1.340	0.401
20	34.067	0.000	0.051	-0.500	0.102	0.143	-0.796
21	34.000	0.100	-0.217	-0.802	-0.472	-0.660	-1.599
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23	29.967	0.006	-17.520	-31.298	-35.052	-48.963	-49.902
24	34.200	0.133	0.540	0.354	1.242	1.735	0.796
25	34.559	0.005	2.160	3.197	4.320	6.035	5.096
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	33.980	0.009	-0.322	-1.152	-0.644	-0.899	-1.838
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	34.173	0.005	0.507	0.300	1.014	1.417	0.478
30	34.008	0.036	-0.199	-0.911	-0.403	-0.563	-1.502
31	34.130	0.133	0.279	-0.019	0.642	0.897	-0.042
32	34.233	0.133	0.663	0.529	1.525	2.131	1.192
33	34.180	0.133	0.465	0.247	1.071	1.496	0.557
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
35	34.017	0.083	-0.154	-0.743	-0.327	-0.456	-1.395
36	34.133	0.000	0.335	-0.002	0.671	0.937	-0.002
37	34.100	0.033	0.191	-0.244	0.385	0.538	-0.401
38	34.067	0.167	0.040	-0.314	0.099	0.138	-0.801
39	35.217	0.080	4.710	6.979	9.959	13.911	12.972
40	33.950	0.000	-0.450	-1.380	-0.901	-1.259	-2.198
41	30.100	0.083	-15.973	-25.728	-33.908	-47.366	-48.305
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	34.000	0.080	-0.223	-0.860	-0.472	-0.660	-1.599
44	33.853	0.200	-0.658	-1.168	-1.733	-2.421	-3.360
45	33.839	0.200	-0.704	-1.227	-1.855	-2.591	-3.531
46	33.967	0.500	-0.160	-0.322	-0.755	-1.055	-1.994
47	34.000	0.083	-0.222	-0.851	-0.472	-0.660	-1.599
48	33.883	0.000	-0.736	-1.881	-1.473	-2.057	-2.996
49	34.050	0.083	-0.021	-0.532	-0.044	-0.061	-1.000
50	33.617	0.067	-1.805	-3.468	-3.756	-5.247	-6.186
51	34.210	0.054	0.647	0.533	1.328	1.855	0.916

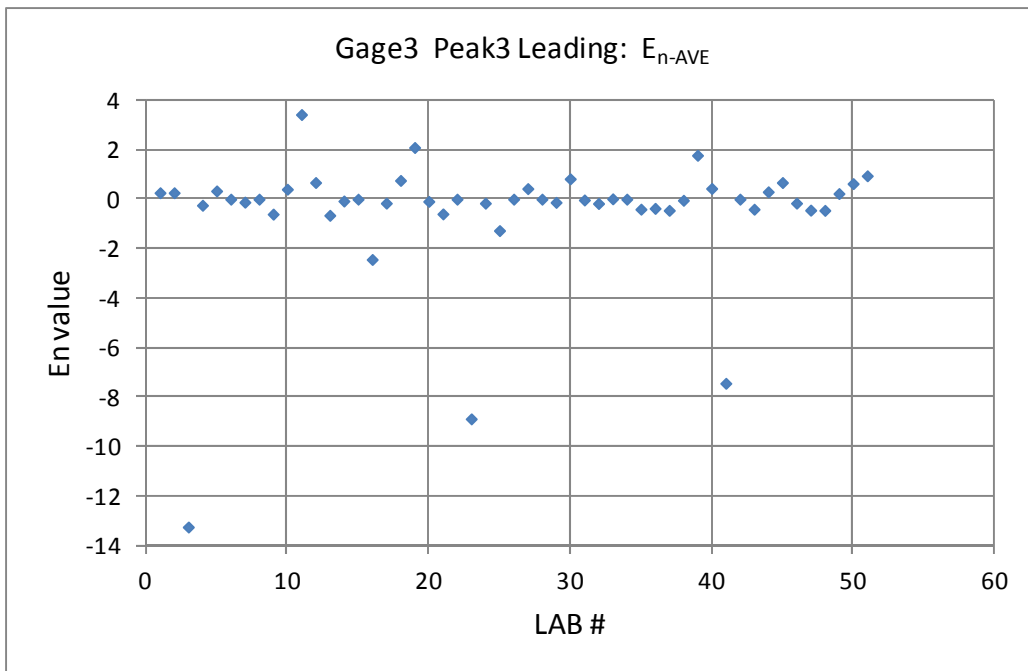
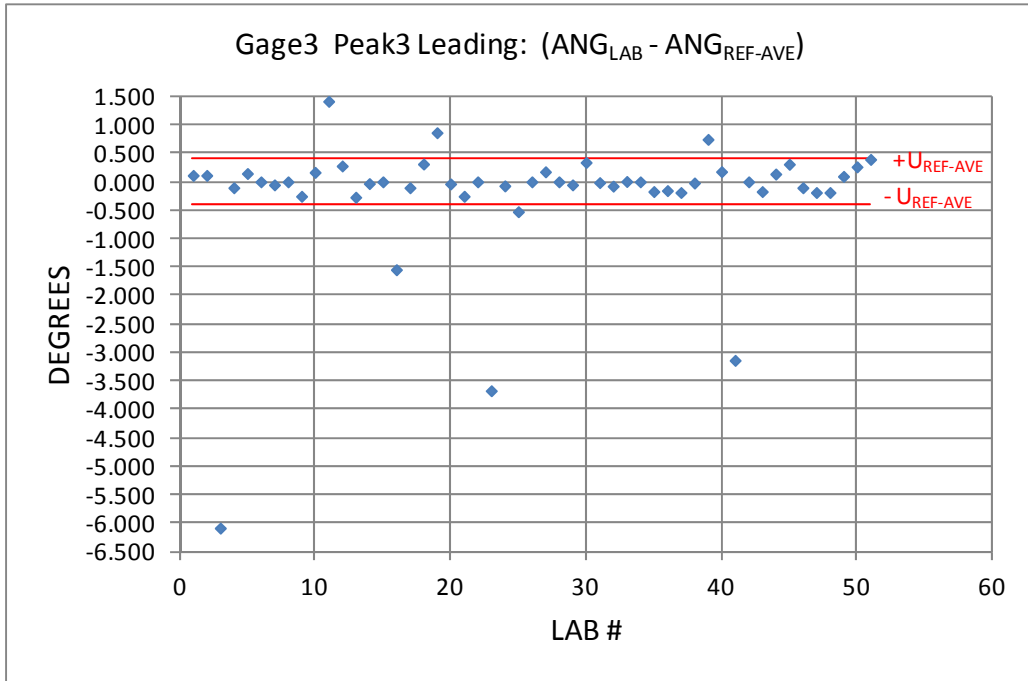


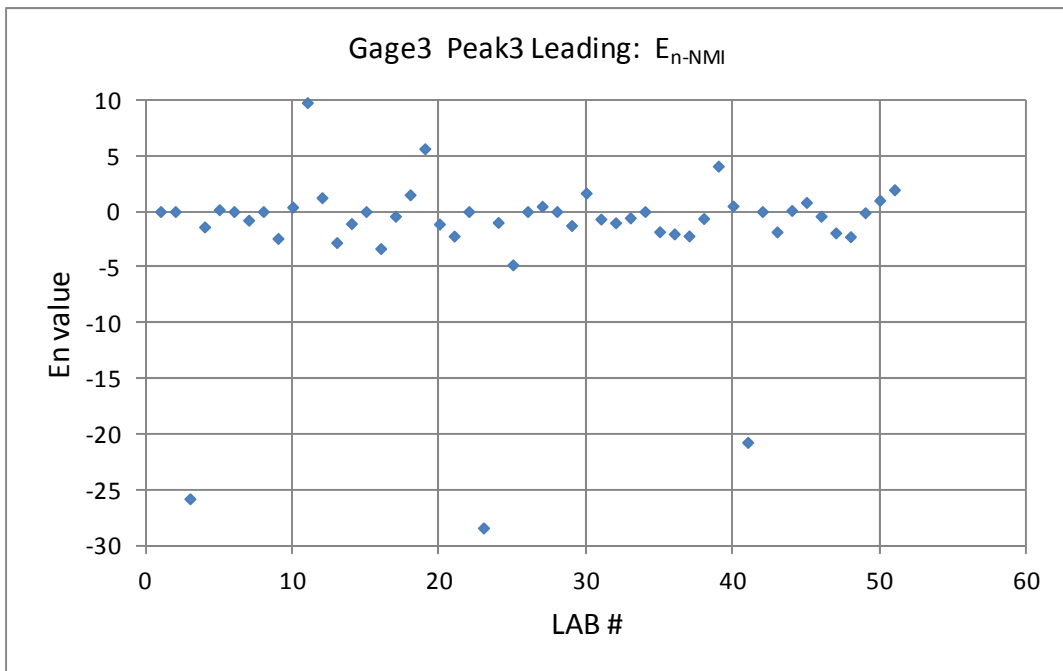
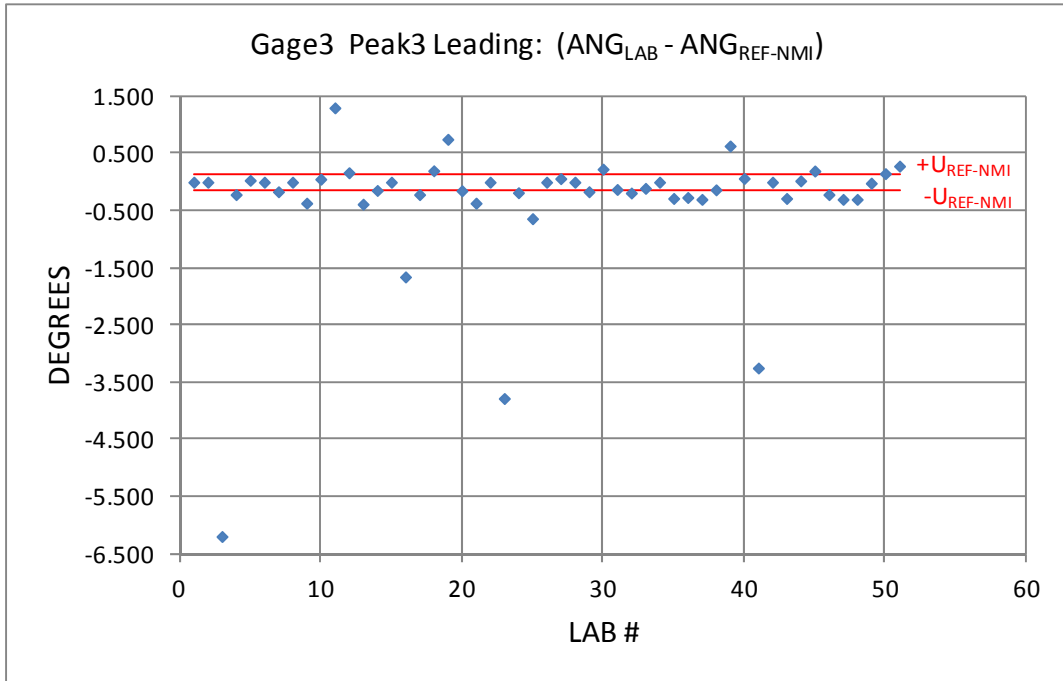


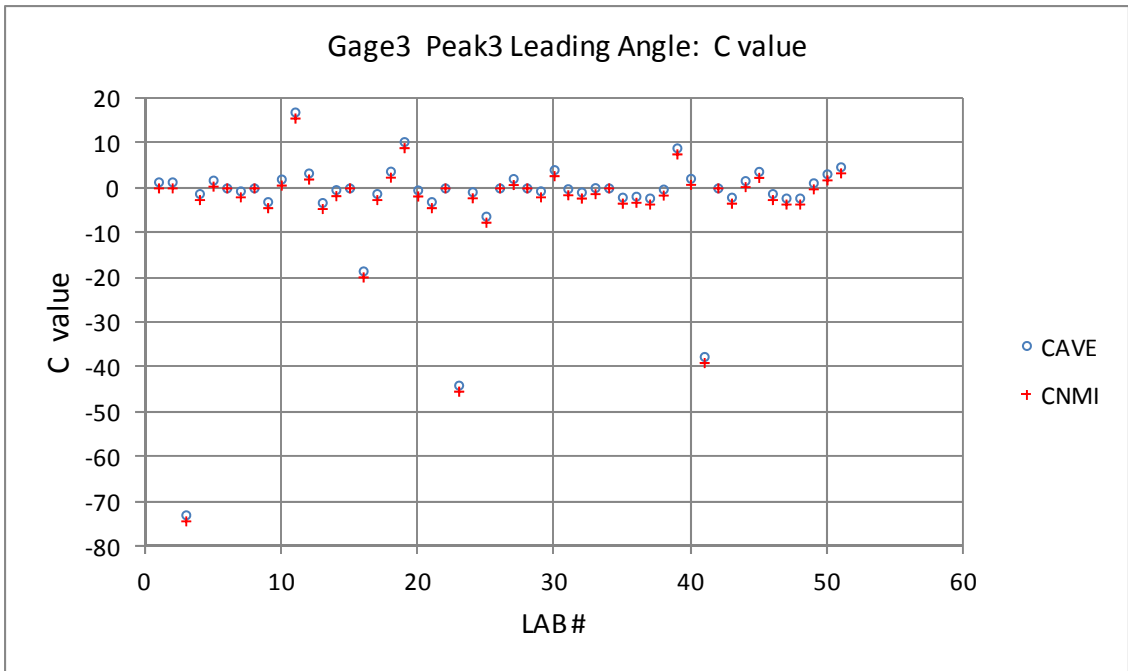
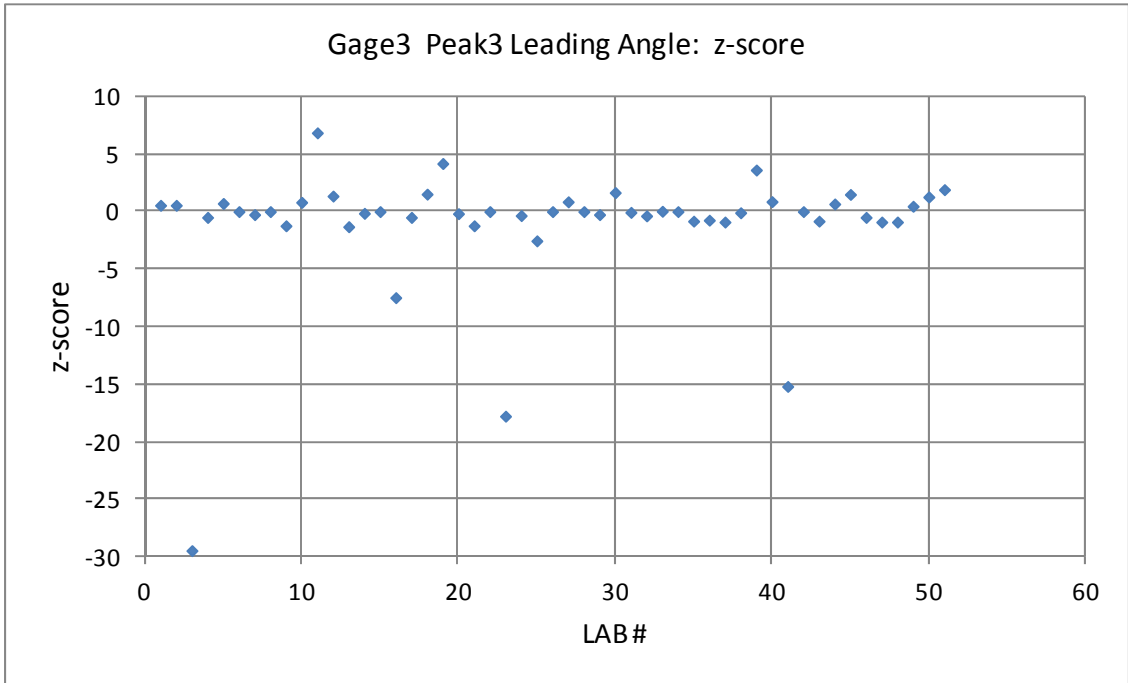


## ½ Angle, Leading Edge at Peak 3 Gage 3

		1/2 Angle	GAGE 3: 1/2-13 UNS: 1/2 angle tol. = 10' = 0.167 deg					
Outliers:								
(#3, 11, 16, 19, 23, 39, 41)		ANG <sub>REF-AVE</sub> = 33.804	ANG <sub>REF-NM</sub> = 33.917	ANG tol. = 0.167				
		U <sub>REF-STD</sub> = 0.413	U <sub>REF-NM</sub> = 0.133					
		Gage 3: Leading 1/2 angle @ peak 3						
		Reported						
		Uncertainty						
		Reported	k = 2, 95%					
		Value	coverage					
Lab	1/2 ANG	factor	E <sub>TR-AVE</sub>	E <sub>TR-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>	
#	[deg]	+/- [deg]						
1	33.917	0.133	0.260	0.000	0.547	1.354	0.000	
2	33.917	0.133	0.260	0.000	0.547	1.354	0.000	
3	27.720	0.200	-13.251	-25.801	-29.443	-72.862	-74.216	
4	33.700	0.083	-0.247	-1.383	-0.503	-1.245	-2.599	
5	33.950	0.150	0.332	0.165	0.707	1.749	0.395	
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
7	33.750	0.167	-0.121	-0.783	-0.261	-0.646	-2.000	
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
9	33.550	0.073	-0.605	-2.419	-1.229	-3.041	-4.395	
10	33.970	0.000	0.402	0.398	0.804	1.989	0.635	
11	35.218	0.000	3.420	9.778	6.841	16.929	15.575	
12	34.082	0.000	0.674	1.244	1.348	3.335	1.981	
13	33.533	0.036	-0.653	-2.787	-1.311	-3.245	-4.599	
14	33.773	0.008	-0.075	-1.082	-0.150	-0.372	-1.726	
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
16	32.260	0.480	-2.438	-3.327	-7.472	-18.491	-19.844	
17	33.700	0.500	-0.160	-0.419	-0.503	-1.245	-2.599	
18	34.117	0.008	0.757	1.501	1.515	3.749	2.395	
19	34.667	0.000	2.088	5.639	4.177	10.336	8.982	
20	33.767	0.000	-0.089	-1.128	-0.179	-0.443	-1.796	
21	33.550	0.100	-0.597	-2.206	-1.229	-3.041	-4.395	
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
23	30.133	0.006	-8.881	-28.420	-17.764	-43.960	-45.313	
24	33.733	0.133	-0.163	-0.978	-0.343	-0.850	-2.204	
25	33.279	0.005	-1.270	-4.793	-2.541	-6.287	-7.641	
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
27	33.980	0.009	0.426	0.473	0.852	2.108	0.754	
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
29	33.750	0.005	-0.130	-1.252	-0.260	-0.643	-1.996	
30	34.145	0.036	0.822	1.656	1.650	4.084	2.731	
31	33.790	0.133	-0.032	-0.675	-0.068	-0.167	-1.521	
32	33.728	0.133	-0.175	-1.005	-0.368	-0.910	-2.263	
33	33.810	0.133	0.014	-0.569	0.029	0.072	-1.281	
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
35	33.633	0.083	-0.406	-1.812	-0.827	-2.047	-3.401	
36	33.650	0.000	-0.373	-2.008	-0.745	-1.844	-3.198	
37	33.617	0.033	-0.452	-2.190	-0.906	-2.243	-3.596	
38	33.783	0.167	-0.046	-0.627	-0.100	-0.247	-1.601	
39	34.550	0.080	1.772	4.078	3.610	8.935	7.581	
40	33.983	0.000	0.433	0.496	0.866	2.144	0.790	
41	30.667	0.083	-7.442	-20.731	-15.181	-37.568	-38.922	
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
43	33.633	0.080	-0.406	-1.830	-0.827	-2.047	-3.401	
44	33.941	0.200	0.298	0.100	0.663	1.640	0.286	
45	34.113	0.200	0.672	0.814	1.494	3.696	2.343	
46	33.700	0.500	-0.160	-0.419	-0.503	-1.245	-2.599	
47	33.617	0.083	-0.444	-1.914	-0.906	-2.243	-3.597	
48	33.617	0.000	-0.453	-2.258	-0.906	-2.243	-3.597	
49	33.900	0.083	0.228	-0.108	0.465	1.150	-0.204	
50	34.067	0.067	0.628	1.007	1.273	3.150	1.796	
51	34.198	0.054	0.945	1.958	1.907	4.719	3.365	



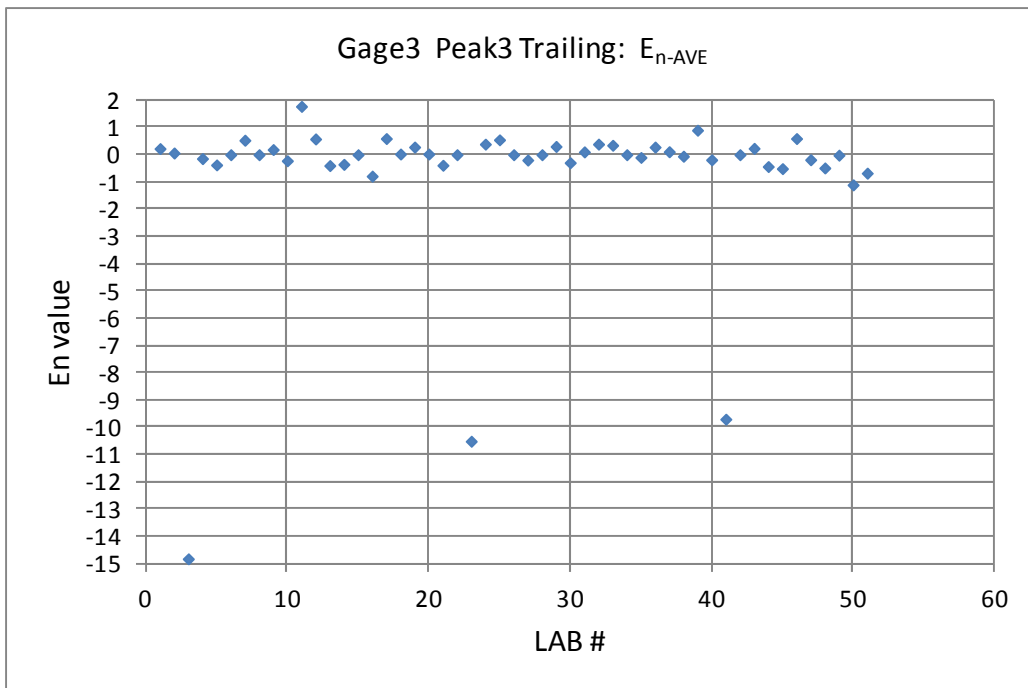
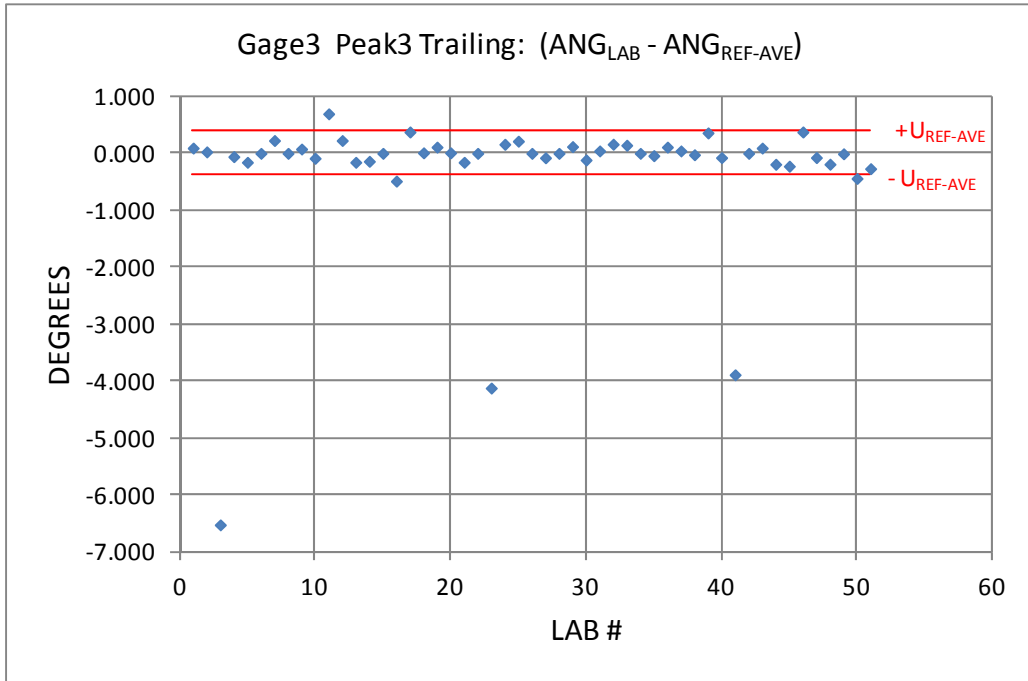


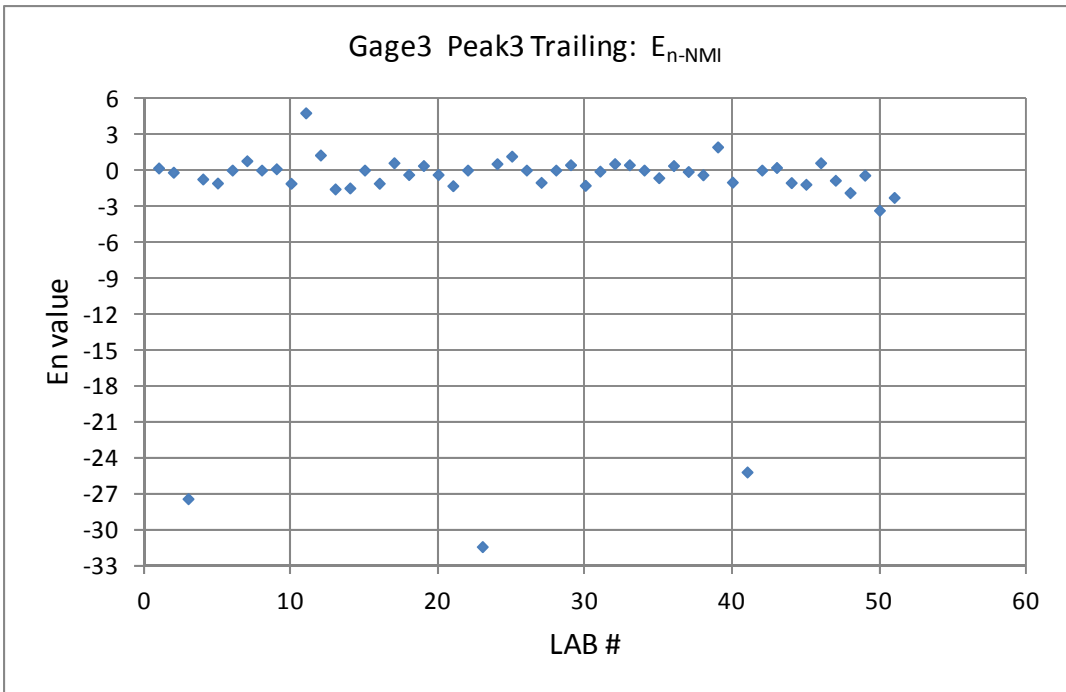
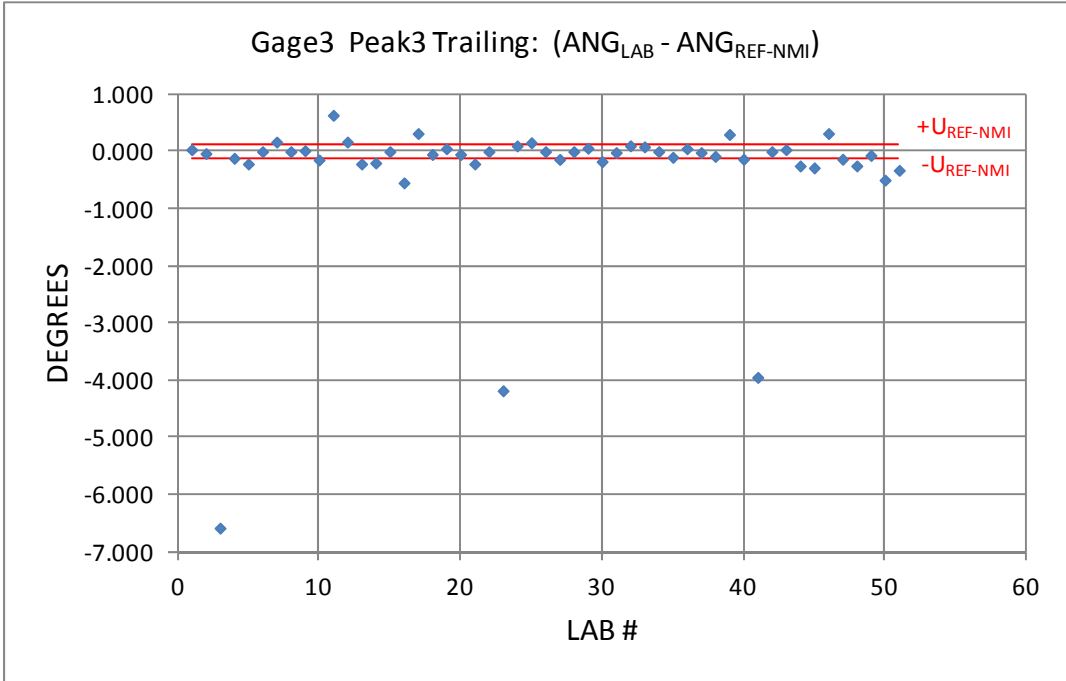


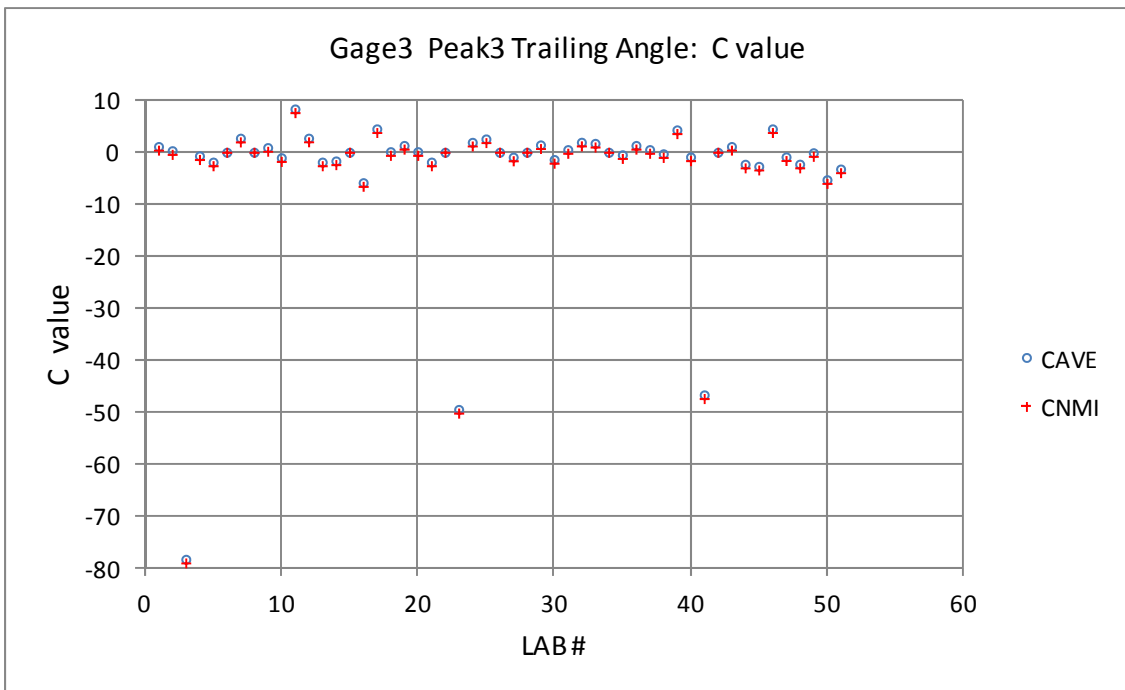
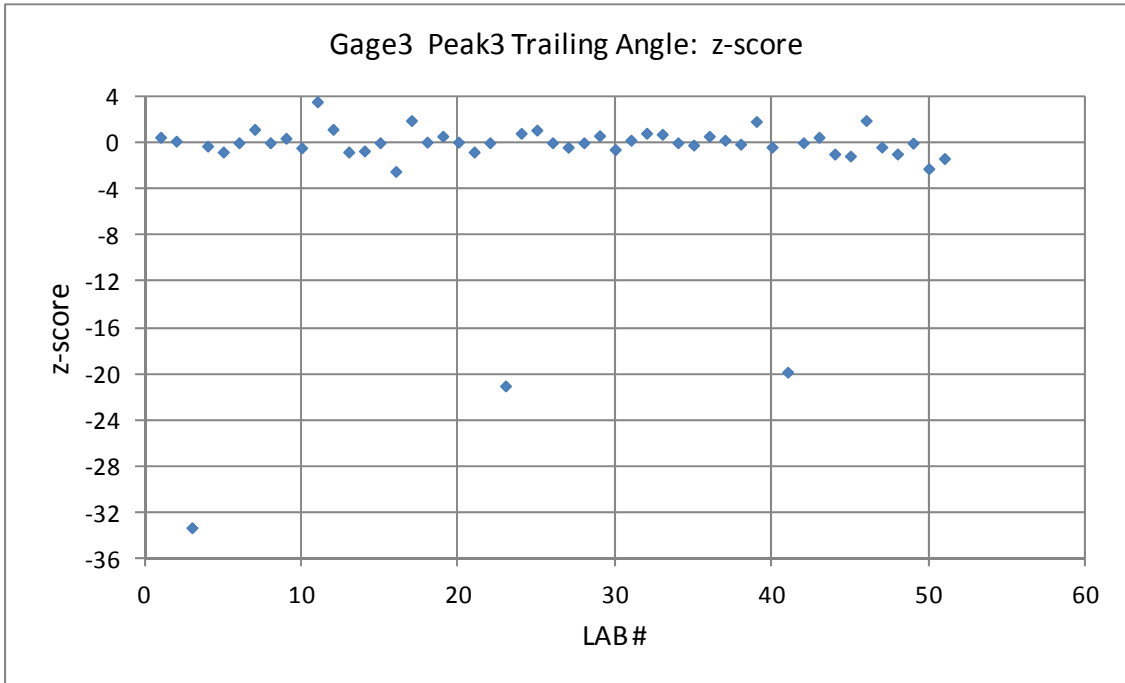


## ½ Angle, Trailing Edge at Peak 3 Gage 3

		1/2 Angle	GAGE 3: 1/2-13 UNS: 1/2 angle tol. = 10' = 0.167 deg					
Outliers:								
(#3, 11, 23, 41)		ANG <sub>REF-AVE</sub> =	34.057	ANG <sub>REF-NM</sub> =	34.117	ANG tol. =	0.167	
		U <sub>REF-STD</sub> =	0.392	U <sub>REF-NM</sub> =	0.133			
		Gage 3: Trailing 1/2 angle @ peak 3						
		Reported						
		Uncertainty						
		Reported	k = 2, 95%					
		Value	coverage					
Lab	1/2 ANG	factor	E <sub>T-AVE</sub>	E <sub>T-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>	
#	[deg]	+/- [deg]						
1	34.150	0.133	0.224	0.178	0.473	1.111	0.401	
2	34.083	0.133	0.062	-0.178	0.131	0.309	-0.401	
3	27.530	0.200	-14.827	-27.423	-33.288	-78.170	-78.880	
4	34.000	0.083	-0.143	-0.742	-0.292	-0.685	-1.395	
5	33.900	0.150	-0.374	-1.080	-0.802	-1.883	-2.593	
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
7	34.283	0.167	0.531	0.782	1.153	2.708	1.998	
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
9	34.133	0.073	0.190	0.109	0.386	0.908	0.198	
10	33.970	0.000	-0.222	-1.102	-0.445	-1.045	-1.754	
11	34.752	0.000	1.772	4.778	3.543	8.321	7.611	
12	34.284	0.000	0.578	1.258	1.156	2.714	2.004	
13	33.900	0.036	-0.399	-1.571	-0.802	-1.883	-2.593	
14	33.918	0.008	-0.354	-1.488	-0.708	-1.664	-2.374	
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
16	33.570	0.480	-0.786	-1.097	-2.485	-5.835	-6.545	
17	34.433	0.500	0.591	0.612	1.916	4.500	3.790	
18	34.067	0.008	0.025	-0.371	0.050	0.117	-0.593	
19	34.167	0.000	0.280	0.380	0.560	1.315	0.605	
20	34.067	0.000	0.025	-0.372	0.050	0.117	-0.593	
21	33.900	0.100	-0.388	-1.301	-0.802	-1.883	-2.593	
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
23	29.933	0.006	-10.514	-31.420	-21.031	-49.388	-50.098	
24	34.217	0.133	0.386	0.534	0.815	1.914	1.204	
25	34.271	0.005	0.545	1.161	1.090	2.560	1.850	
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
27	33.980	0.009	-0.197	-1.024	-0.394	-0.925	-1.635	
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
29	34.176	0.005	0.302	0.446	0.605	1.420	0.710	
30	33.941	0.036	-0.294	-1.272	-0.591	-1.387	-2.097	
31	34.100	0.133	0.103	-0.088	0.218	0.512	-0.198	
32	34.218	0.133	0.388	0.540	0.820	1.926	1.216	
33	34.200	0.133	0.345	0.444	0.728	1.710	1.000	
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
35	34.017	0.083	-0.100	-0.635	-0.205	-0.482	-1.192	
36	34.167	0.000	0.279	0.377	0.558	1.311	0.601	
37	34.100	0.033	0.109	-0.120	0.218	0.512	-0.198	
38	34.033	0.167	-0.056	-0.390	-0.122	-0.286	-0.996	
39	34.417	0.080	0.898	1.934	1.833	4.305	3.595	
40	33.983	0.000	-0.189	-1.004	-0.379	-0.889	-1.599	
41	30.167	0.083	-9.705	-25.192	-19.840	-46.589	-47.299	
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	
43	34.150	0.080	0.232	0.216	0.473	1.111	0.401	
44	33.865	0.200	-0.436	-1.045	-0.978	-2.297	-3.007	
45	33.832	0.200	-0.512	-1.185	-1.149	-2.698	-3.408	
46	34.433	0.500	0.591	0.612	1.916	4.500	3.790	
47	33.983	0.083	-0.184	-0.848	-0.377	-0.885	-1.595	
48	33.867	0.000	-0.486	-1.878	-0.972	-2.282	-2.992	
49	34.050	0.083	-0.018	-0.424	-0.037	-0.086	-0.796	
50	33.617	0.067	-1.107	-3.354	-2.245	-5.272	-5.982	
51	33.789	0.054	-0.678	-2.282	-1.368	-3.212	-3.922	

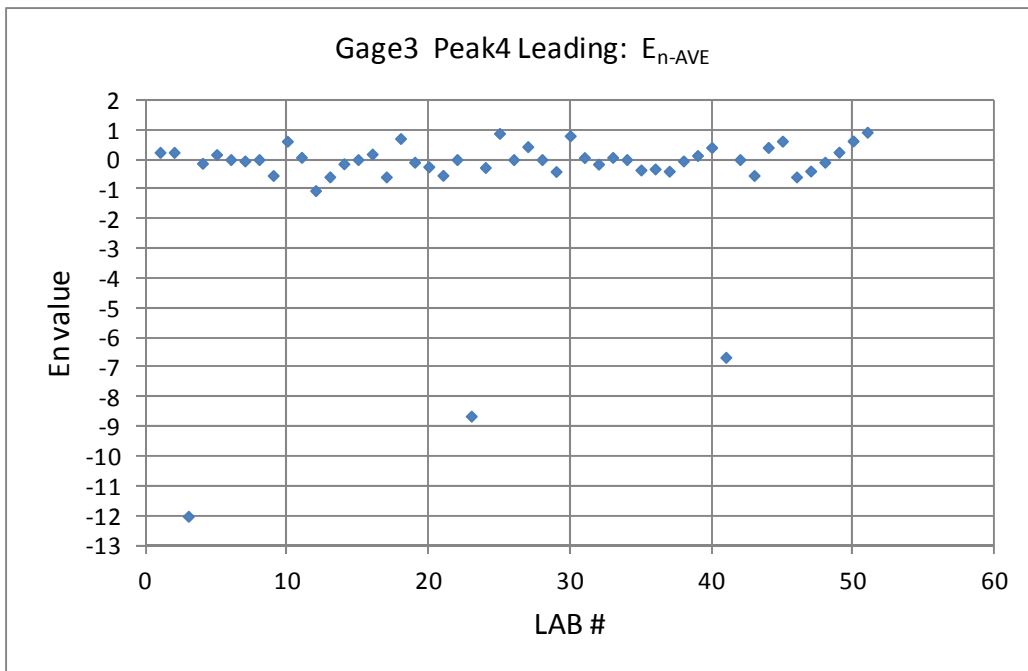
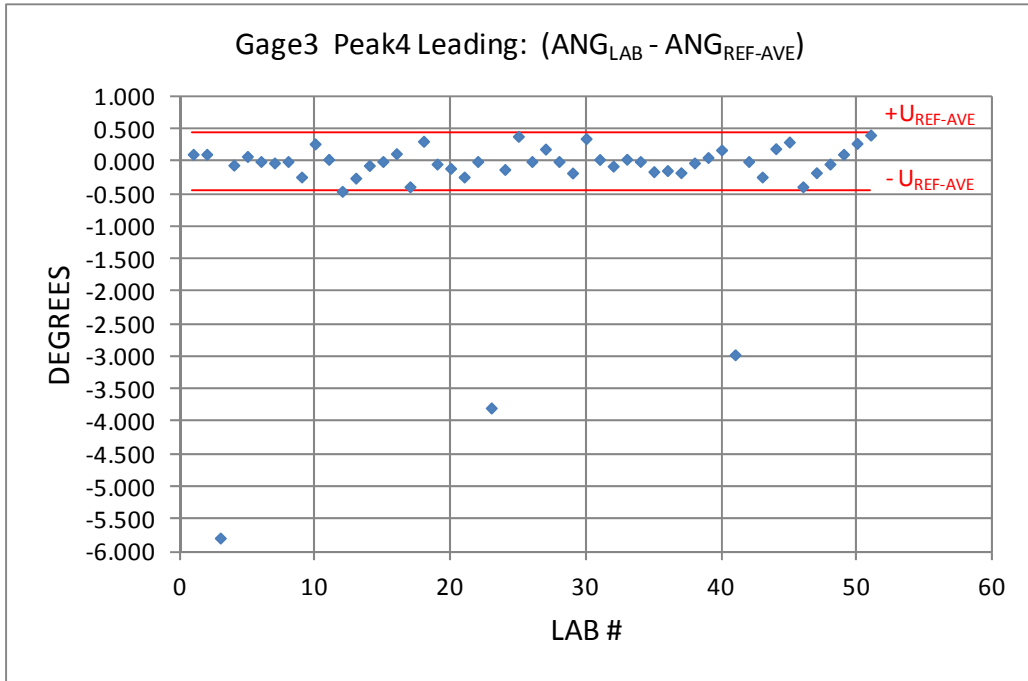


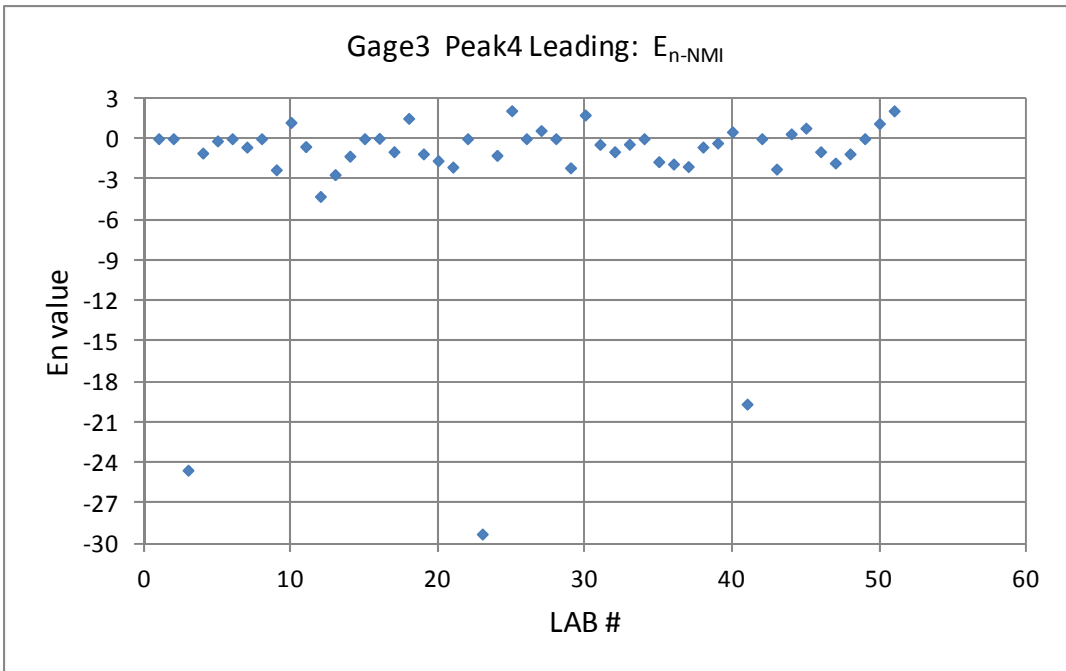
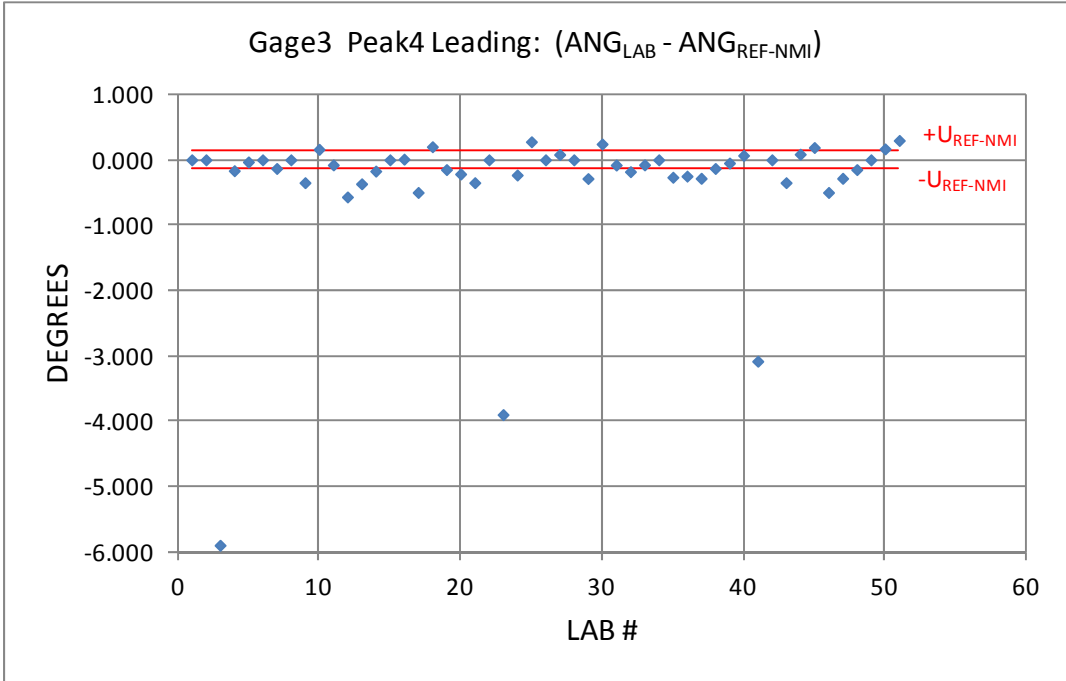


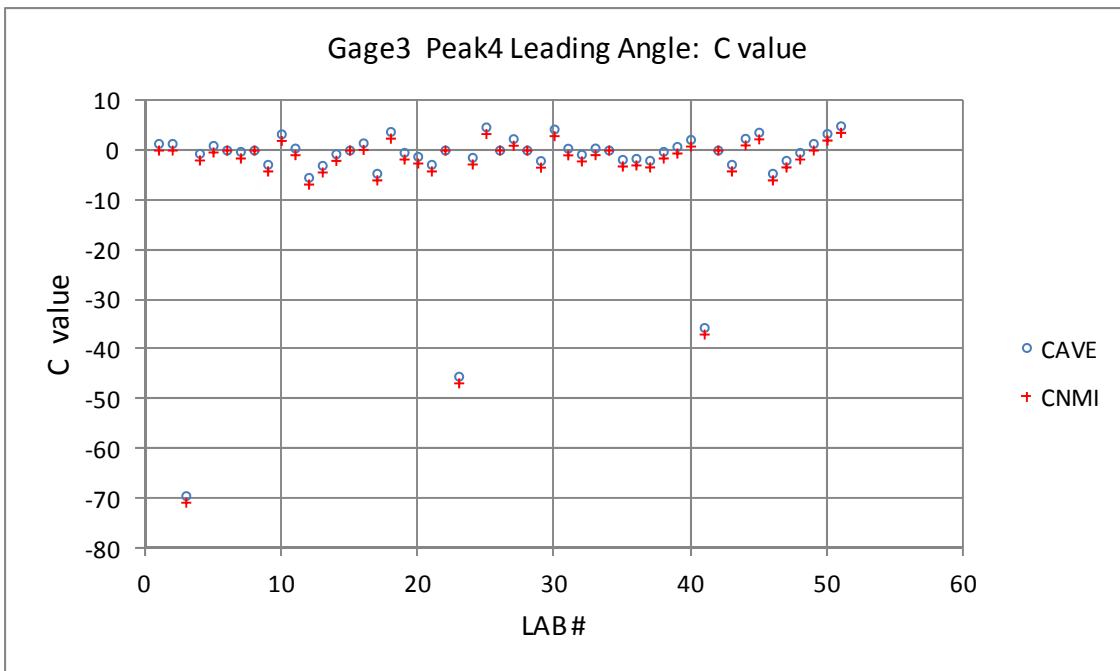
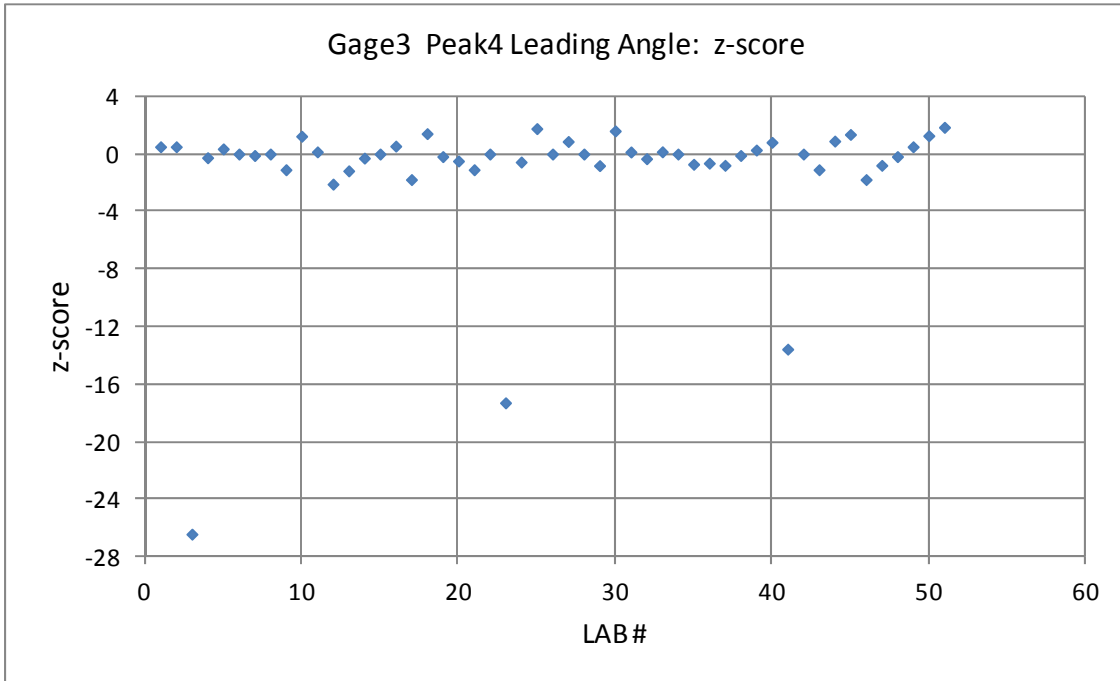


## ½ Angle, Leading Edge at Peak 4 Gage 3

		1/2 Angle	GAGE 3: 1/2-13 UNS: 1/2 angle tol. = 10' = 0.167 deg				
Outliers:							
(#3, 23, 41)		ANG <sub>REF-AVE</sub> = 33.789	ANG <sub>REF-NM</sub> = 33.900	ANG tol. = 0.167			
		U <sub>REF-STD</sub> = 0.438	U <sub>REF-NM</sub> = 0.133				
		Gage 3: Leading 1/2 angle @ peak 4					
		Reported					
		Uncertainty					
		Reported	k = 2, 95%				
		Value	coverage				
Lab	1/2 ANG	factor	E <sub>T-AVE</sub>	E <sub>T-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
#	[deg]	+/- [deg]					
1	33.900	0.133	0.242	0.000	0.507	1.330	0.000
2	33.900	0.133	0.242	0.000	0.507	1.330	0.000
3	28.000	0.200	-12.014	-24.564	-26.410	-69.329	-70.659
4	33.733	0.083	-0.125	-1.064	-0.255	-0.670	-2.000
5	33.867	0.150	0.168	-0.165	0.356	0.935	-0.395
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	33.767	0.167	-0.047	-0.625	-0.102	-0.267	-1.596
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	33.550	0.073	-0.538	-2.307	-1.090	-2.862	-4.192
10	34.060	0.000	0.618	1.203	1.237	3.246	1.916
11	33.822	0.000	0.075	-0.586	0.151	0.396	-0.934
12	33.331	0.000	-1.045	-4.280	-2.090	-5.487	-6.817
13	33.533	0.036	-0.582	-2.664	-1.168	-3.065	-4.395
14	33.727	0.008	-0.141	-1.298	-0.282	-0.741	-2.071
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	33.910	0.480	0.186	0.020	0.552	1.450	0.120
17	33.400	0.500	-0.585	-0.966	-1.774	-4.658	-5.988
18	34.100	0.008	0.709	1.501	1.419	3.725	2.395
19	33.750	0.000	-0.089	-1.128	-0.178	-0.467	-1.796
20	33.683	0.000	-0.242	-1.632	-0.483	-1.269	-2.599
21	33.550	0.100	-0.531	-2.103	-1.090	-2.862	-4.192
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23	30.000	0.006	-8.642	-29.294	-17.286	-45.377	-46.707
24	33.667	0.133	-0.266	-1.239	-0.556	-1.461	-2.790
25	34.176	0.005	0.883	2.074	1.766	4.635	3.305
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	33.980	0.009	0.436	0.600	0.872	2.288	0.958
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	33.613	0.005	-0.402	-2.159	-0.804	-2.111	-3.441
30	34.141	0.036	0.801	1.754	1.608	4.221	2.891
31	33.820	0.133	0.068	-0.425	0.142	0.372	-0.958
32	33.718	0.133	-0.155	-0.968	-0.324	-0.850	-2.180
33	33.823	0.133	0.074	-0.409	0.155	0.408	-0.922
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
35	33.633	0.083	-0.350	-1.703	-0.711	-1.868	-3.198
36	33.650	0.000	-0.317	-1.880	-0.634	-1.664	-2.994
37	33.617	0.033	-0.392	-2.066	-0.786	-2.063	-3.393
38	33.767	0.167	-0.047	-0.624	-0.100	-0.263	-1.593
39	33.850	0.080	0.137	-0.322	0.278	0.731	-0.599
40	33.967	0.000	0.406	0.504	0.812	2.132	0.802
41	30.817	0.083	-6.661	-19.665	-13.558	-35.592	-36.922
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	33.550	0.080	-0.536	-2.255	-1.090	-2.862	-4.192
44	33.986	0.200	0.409	0.358	0.899	2.361	1.031
45	34.088	0.200	0.621	0.783	1.364	3.581	2.251
46	33.400	0.500	-0.585	-0.966	-1.774	-4.658	-5.988
47	33.617	0.083	-0.386	-1.805	-0.786	-2.063	-3.393
48	33.750	0.000	-0.089	-1.128	-0.178	-0.467	-1.796
49	33.900	0.083	0.249	0.000	0.507	1.330	0.000
50	34.067	0.067	0.627	1.121	1.268	3.330	2.000
51	34.196	0.054	0.922	2.062	1.857	4.875	3.545



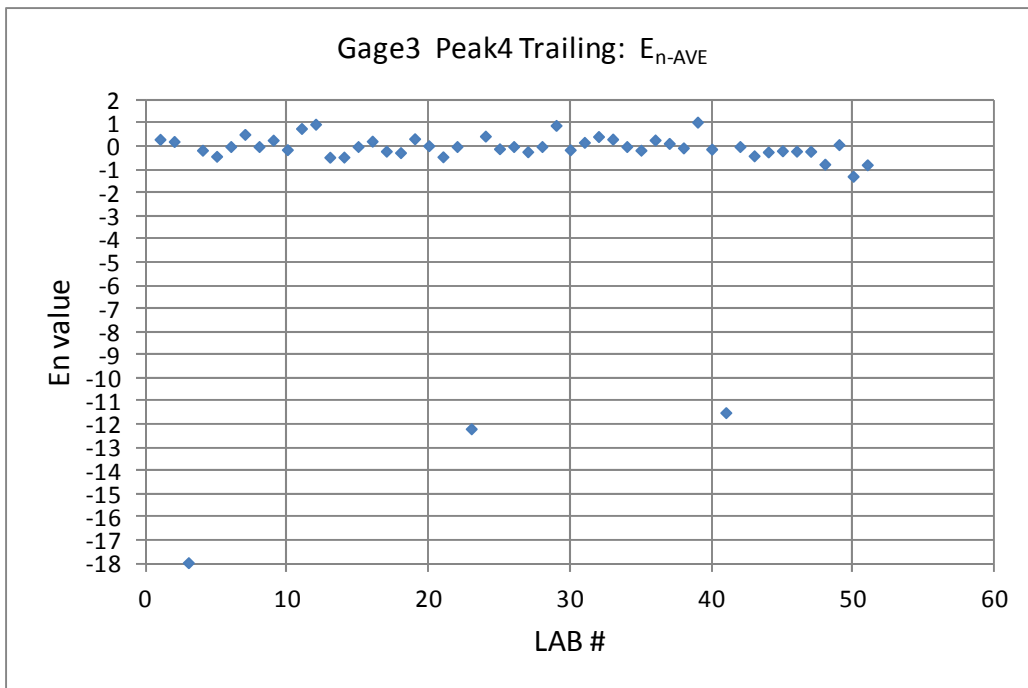
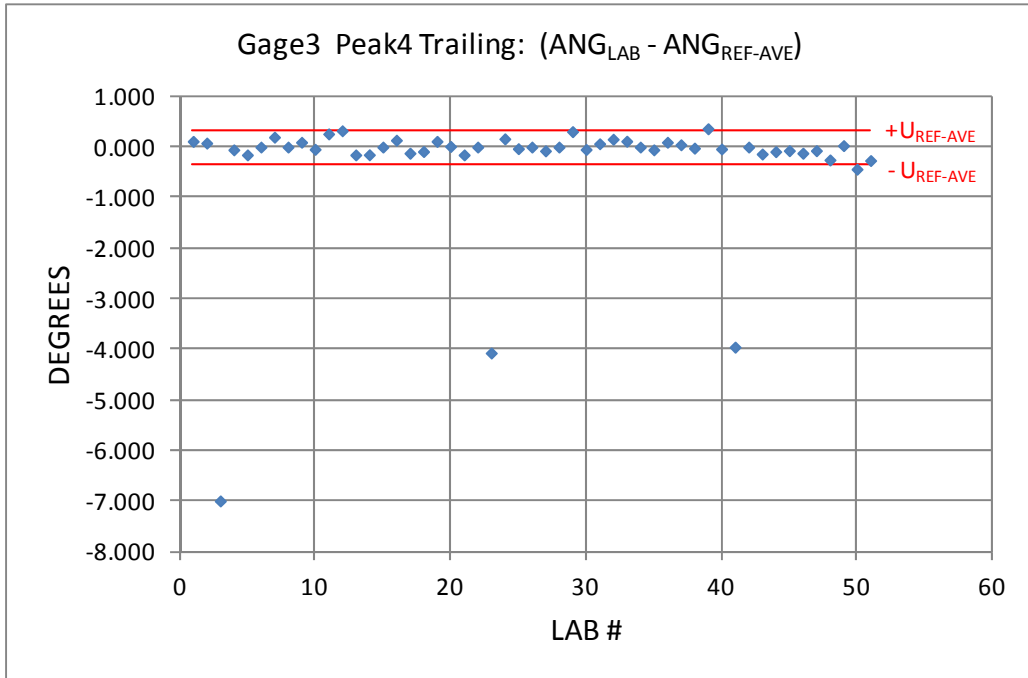


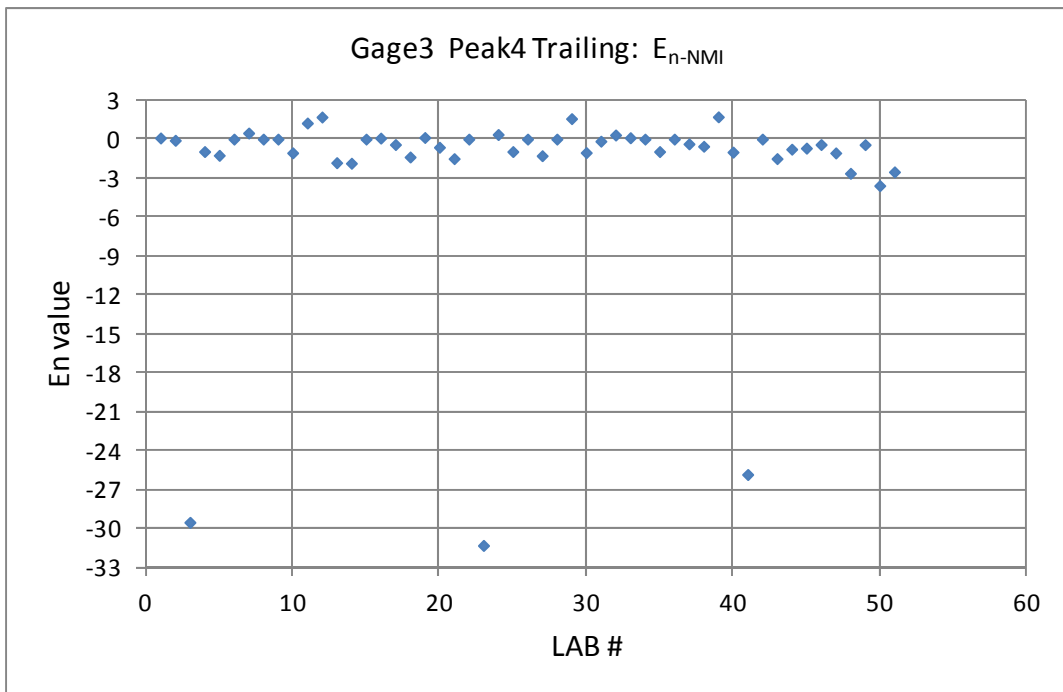
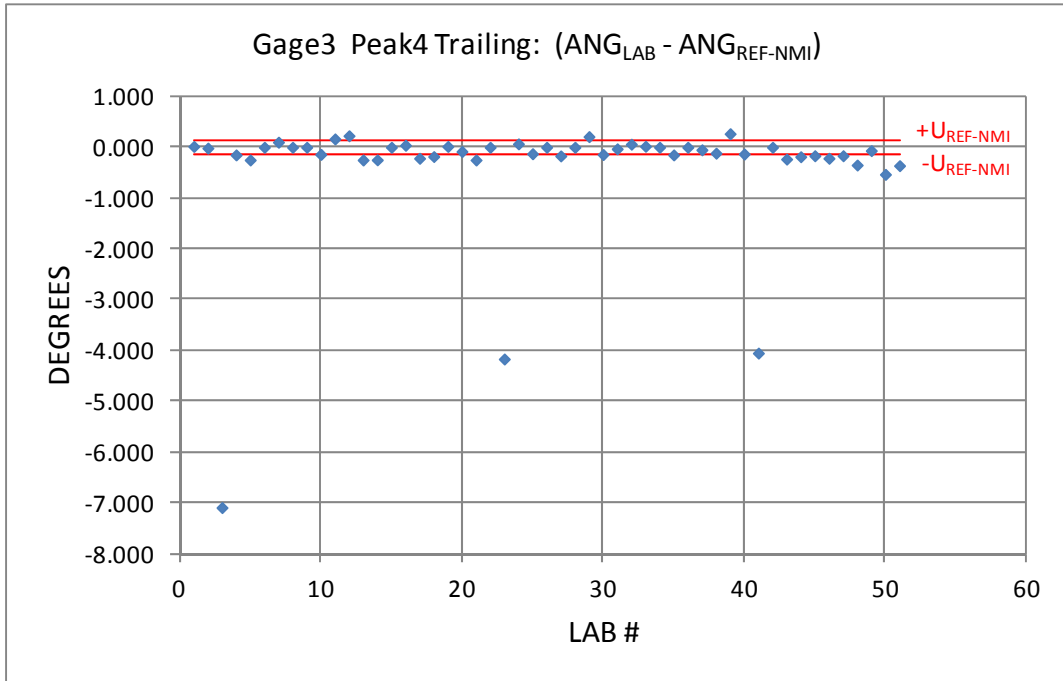


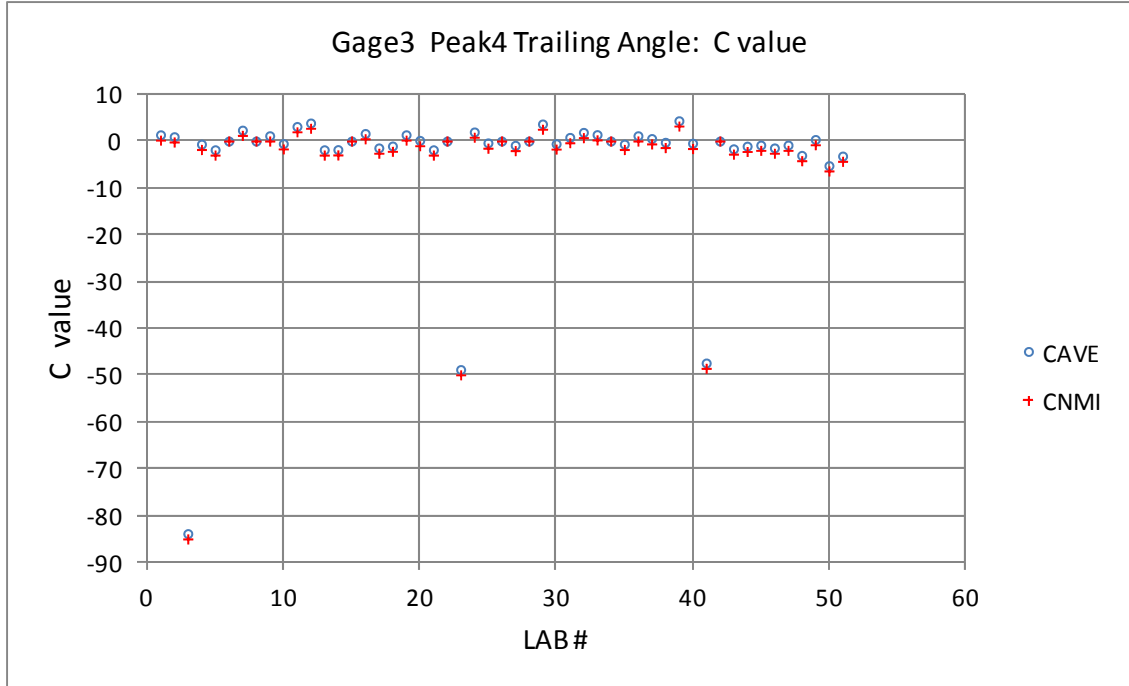
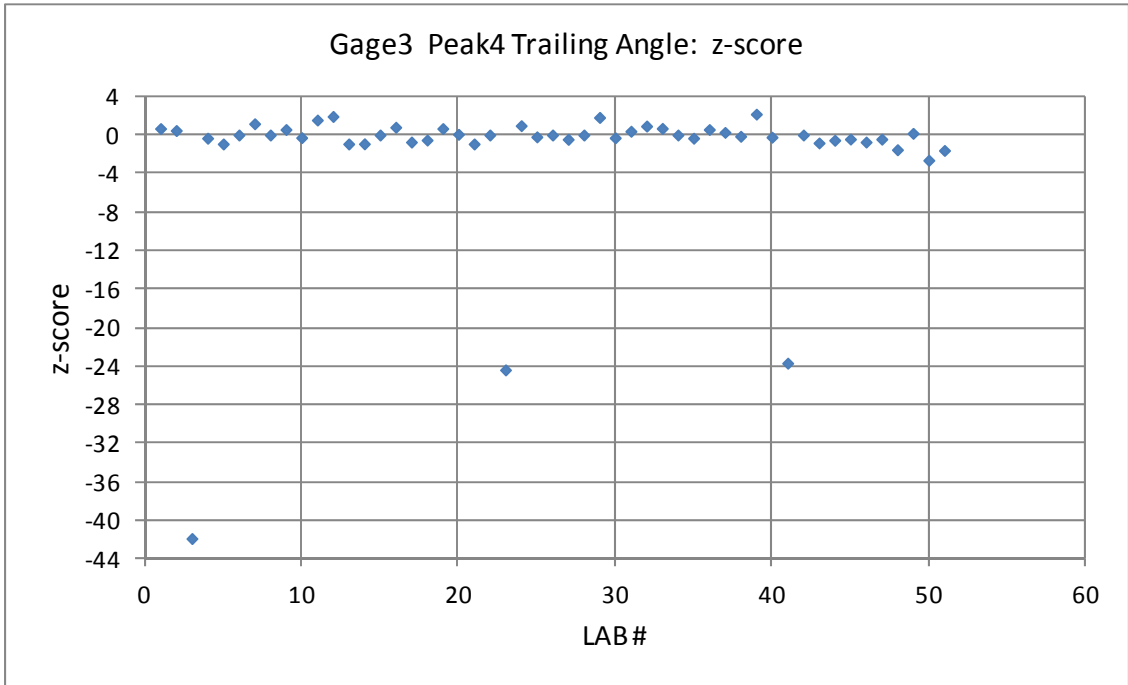


## ½ Angle, Trailing Edge at Peak 4 Gage 3

1/2 Angle		GAGE 3: 1/2-13 UNS: 1/2 angle tol. = 10' = 0.167 deg					
Outliers:							
(#3, 23,41)		ANG <sub>REF-AVE</sub> = 34.055		ANG <sub>REF-NM</sub> = 34.150		ANG tol. = 0.167	
		U <sub>REF-STD</sub> = 0.334		U <sub>REF-NM</sub> = 0.133			
Gage 3: Trailing 1/2 angle @ peak 4							
		Reported					
		Uncertainty					
		Reported					
		k = 2, 95%					
		Value					
		coverage					
Lab	1/2 ANG	factor	E <sub>D-AVE</sub>	E <sub>D-NM</sub>	z-score	C <sub>AVE</sub>	C <sub>NM</sub>
#	[deg]	+/- [deg]					
1	34.167	0.133	0.311	0.090	0.670	1.341	0.204
2	34.133	0.133	0.217	-0.090	0.467	0.934	-0.204
3	27.060	0.200	-17.963	-29.519	-41.870	-83.773	-84.910
4	34.000	0.083	-0.160	-0.956	-0.329	-0.659	-1.796
5	33.900	0.150	-0.423	-1.247	-0.928	-1.857	-2.994
6	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
7	34.250	0.167	0.522	0.469	1.167	2.335	1.198
8	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
9	34.150	0.073	0.278	0.000	0.568	1.137	0.000
10	34.010	0.000	-0.135	-1.053	-0.270	-0.539	-1.677
11	34.315	0.000	0.778	1.241	1.556	3.113	1.976
12	34.377	0.000	0.963	1.705	1.926	3.853	2.716
13	33.900	0.036	-0.461	-1.814	-0.928	-1.857	-2.994
14	33.903	0.008	-0.456	-1.857	-0.912	-1.826	-2.963
15	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
16	34.190	0.480	0.231	0.080	0.808	1.616	0.479
17	33.933	0.500	-0.203	-0.419	-0.730	-1.462	-2.599
18	33.967	0.008	-0.263	-1.373	-0.527	-1.054	-2.192
19	34.167	0.000	0.335	0.128	0.670	1.341	0.204
20	34.067	0.000	0.036	-0.624	0.072	0.143	-0.994
21	33.900	0.100	-0.445	-1.502	-0.928	-1.857	-2.994
22	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
23	29.983	0.006	-12.184	-31.297	-24.372	-48.763	-49.900
24	34.217	0.133	0.450	0.356	0.969	1.940	0.802
25	34.023	0.005	-0.096	-0.954	-0.192	-0.384	-1.521
26	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
27	33.980	0.009	-0.224	-1.275	-0.449	-0.899	-2.036
28	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
29	34.360	0.005	0.912	1.577	1.825	3.651	2.514
30	34.007	0.036	-0.142	-1.037	-0.286	-0.573	-1.710
31	34.120	0.133	0.181	-0.159	0.389	0.778	-0.359
32	34.210	0.133	0.431	0.319	0.928	1.856	0.719
33	34.170	0.133	0.320	0.106	0.688	1.377	0.240
34	error	error	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
35	34.000	0.083	-0.160	-0.957	-0.329	-0.659	-1.796
36	34.150	0.000	0.284	0.000	0.568	1.137	0.000
37	34.100	0.033	0.134	-0.365	0.269	0.538	-0.599
38	34.033	0.167	-0.058	-0.547	-0.130	-0.260	-1.398
39	34.417	0.080	1.053	1.718	2.165	4.331	3.194
40	34.017	0.000	-0.114	-1.000	-0.228	-0.456	-1.593
41	30.100	0.083	-11.488	-25.833	-23.673	-47.366	-48.503
42	na	na	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
43	33.917	0.080	-0.402	-1.501	-0.826	-1.653	-2.790
44	33.964	0.200	-0.234	-0.775	-0.546	-1.092	-2.229
45	33.984	0.200	-0.183	-0.693	-0.428	-0.856	-1.993
46	33.933	0.500	-0.203	-0.419	-0.730	-1.462	-2.599
47	33.983	0.083	-0.208	-1.062	-0.429	-0.859	-1.996
48	33.800	0.000	-0.763	-2.632	-1.527	-3.054	-4.192
49	34.083	0.083	0.082	-0.425	0.169	0.339	-0.798
50	33.617	0.067	-1.285	-3.579	-2.622	-5.246	-6.383
51	33.788	0.054	-0.789	-2.522	-1.598	-3.198	-4.335







## **APPENDIX A**

### **ILC Thread Gage Measurement Instructions**

#### **THREAD GAGE INTER-LABORATORY COMPARISON STUDY**

This study is designed to determine the variability in the measurement of thread plug gage attributes. The intent is to obtain a baseline snapshot of the current measurement capability across the industry. The participants will include calibration labs associated with gage manufacturing, certification labs and national certification labs.

It is understood that some locations may have better measurement controls than others. However, gages are sold and certified nationally and internationally and are used to accept or reject threaded product world wide. The data obtained in this Inter-Laboratory Comparison will help assess, quantitatively, the current consumer risk associated with accepting threaded product.

There are a variety of controlled studies that can be performed. The purpose of this study is to allow each lab to control their measurement variables, as they would, in their normal day to day operations. The typical variables include, but are not limited to, instrumentation accuracy, environmental controls, thread wire size, gaging force, technician experience, etc. The uniqueness of this study is that it looks not only at pitch diameter and major diameter, but also at the more challenging parameters of  $\frac{1}{2}$  angle and lead.

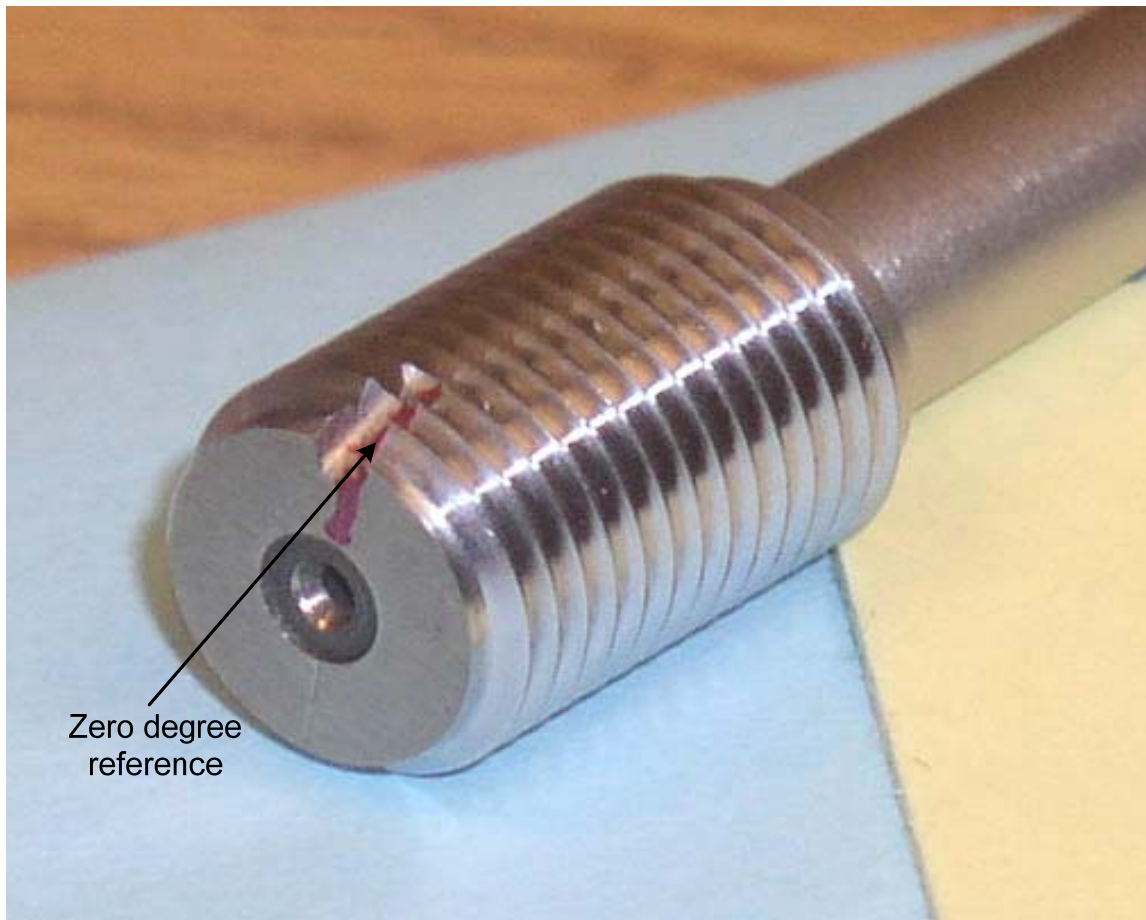
For this ILC, only threaded plug gages will be provided along with explicit instructions concerning which attributes are to be measured and where those attributes are to be measured on each gage. Best size thread wires and gage block standards will not be issued with the ILC gages.

The following sections describe the gages and the measurements that are to be performed on each gage. A rotational “zero degree” reference location for each gage is also described.

## SECTION 1: GAGE DESCRIPTIONS

Gage 1:  $\frac{1}{2}$ -20 UNS GO Gage.

**Zero degree reference:** Defined as the start of the first thread at the chip groove. See the picture below.



Picture of Gage 1,  $\frac{1}{2}$ -20 UNS GO Gage. Start of the first thread at the chip groove (red marking) shows the zero degree reference

Gage 2:  $\frac{1}{4}$ -28 UNJF – 3A HI-LO Gage

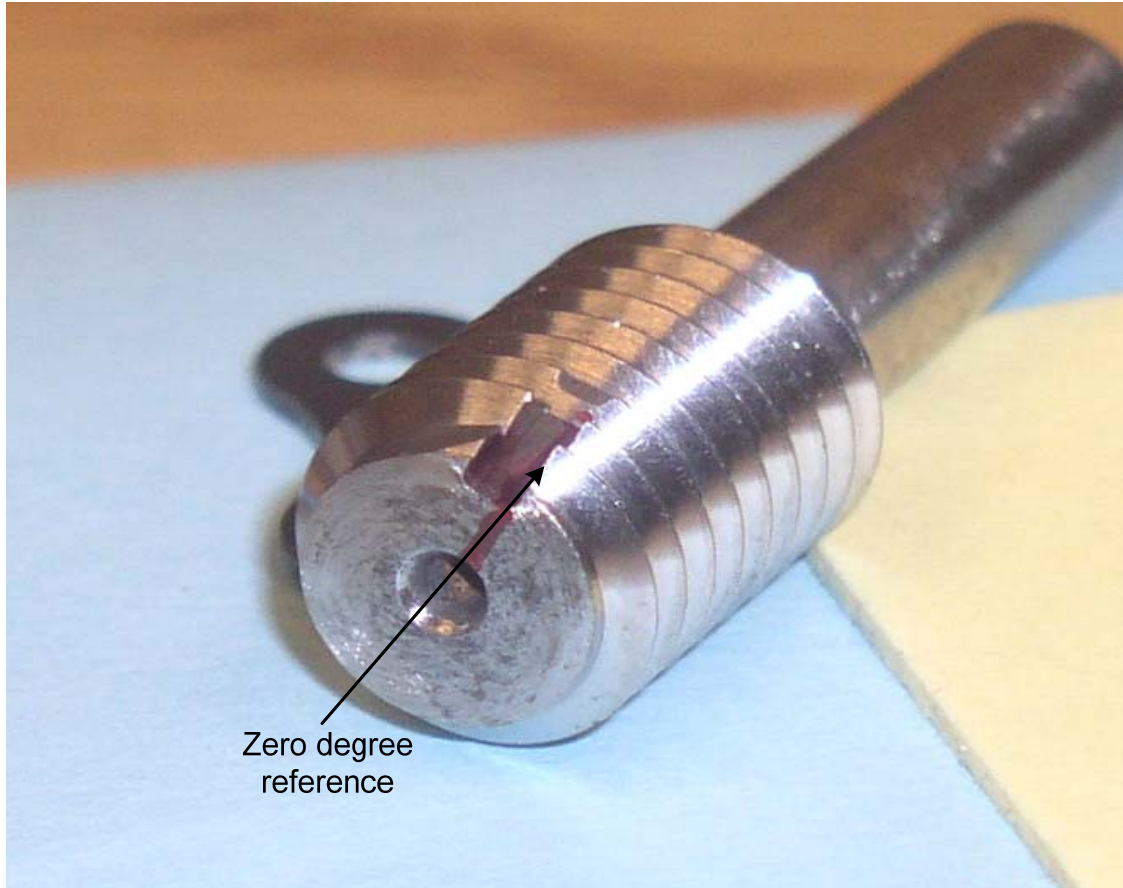
**Zero degree reference:** Defined as the start of the first thread on the GO member of the gage. See the picture below.



Picture of Gage 2,  $\frac{1}{4}$ -28 UNJF – 3A HI-LO Gage. Start of the first thread (red marking) shows the zero degree reference

Gage 3: ½-13 UN special #AA2

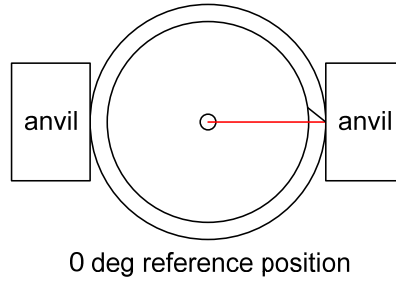
**Zero degree reference:** Defined as the start of the first thread at the chip groove. See the picture below.



Picture of Gage 3, ½-13 UN special #AA2. Start of the first thread at the chip groove (red marking) shows the zero degree reference



**NOTE:** The *zero degree reference POSITION* is the position in which a line from the center of the gage to the *zero degree reference* is horizontal, or parallel with the anvils on the measuring machine.



View showing the front of a threaded plug gage between anvils in the 0 degree reference position.

## SECTION 2: MEASUREMENTS

**NOTE:** As you work through each measurement section, record the data and information in the tables provided in this document.

### MAJOR DIAMETER

- (1) Using gage 1, measure the **major diameter** and record the data below. Measure the diameter in the 0 degree reference position at the middle of the gage. Record the measuring force and the estimated measurement uncertainty.

Orientation	Major Diameter [inches]	Force [lbs]	Estimated Uncertainty [inches]
0 deg. ref. position			±

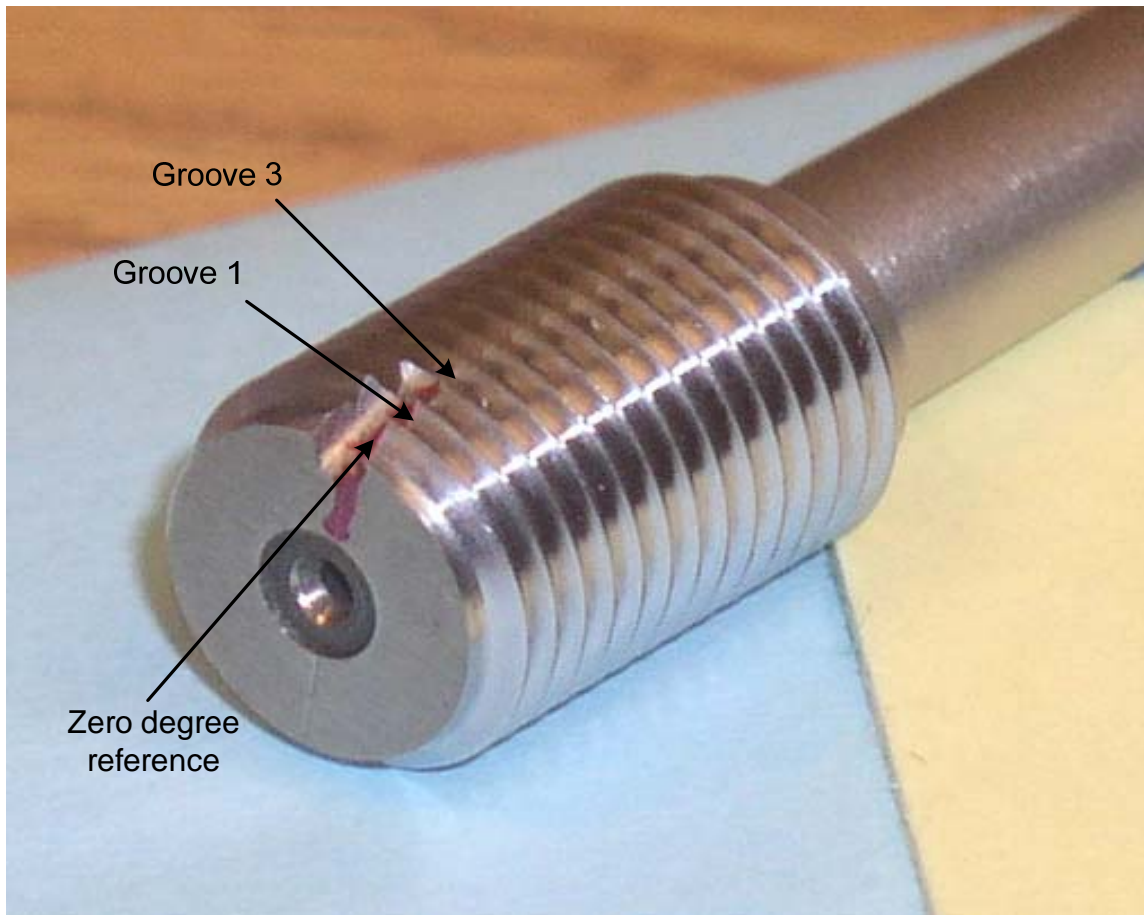
**Gage 1**

Instrument Used for Major Diameter Measurement	Anvil Diameter

## PITCH DIAMETERS -- MOW

### THREAD WIRE LOCATIONS:

The Measurement Over Wires measurement must be made with the thread wires located at particular groove locations to minimize variations caused by the gage itself. The zero degree reference defines the start of groove 1. The picture below shows the start of grooves 1 and 3.



Picture showing the locations of the start of grooves 1 and 3.

### **IMPORTANT**

The thread wires are to be located at the **start** of the listed grooves.

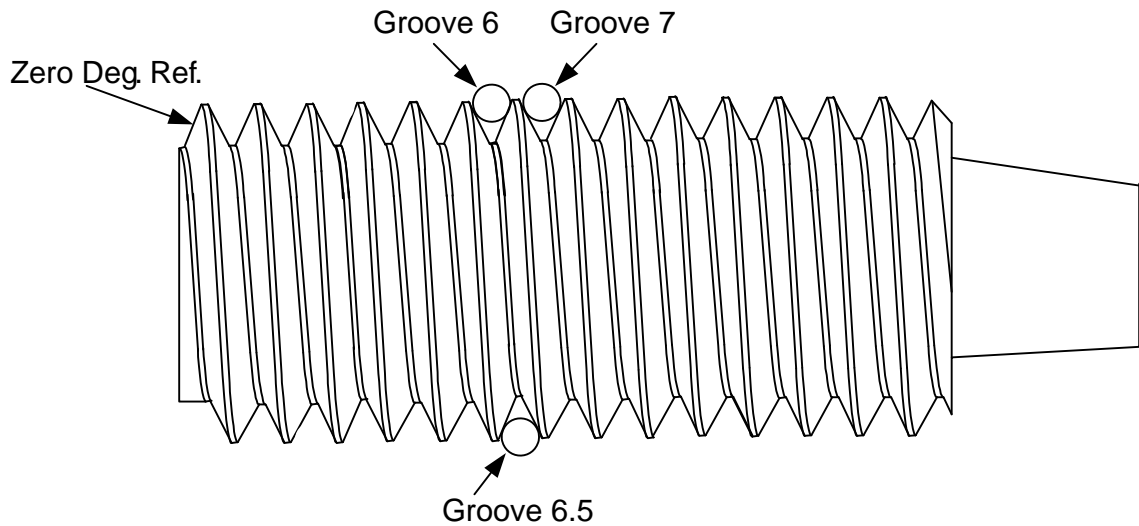
(2) Using gage 1, measure the **pitch (groove) diameter** and record the data in the table below.

Record the wire constant of the thread wire set, the gaging force used and the estimated uncertainty.

Perform a measurement over wire (MOW) on the gage in the 0 degree reference position.

Place the thread wires in the following grooves:

0 degree orientation: **wires in grooves 6, 6.5 and 7**



The illustration above shows the thread wire locations, with the gage in the 0 degree reference position.

Record the data below.

Orientation	MOW [inches]	Thread Wire Size	Thread Wire Constant, C [inches]	Gaging Force [lbs]	Estimated Uncertainty [inches]
0 deg. ref. position					±

**Gage 1**

(3) Using gage 2 measure the GO segment **pitch diameter** of the gage and record the data in the table below.

Record the wire constant of the thread wire set used, the gaging force used and the estimated uncertainty.

Perform a MOW on the gage in the 0 degree reference position.

Place the thread wires in the following grooves:

0 degree orientation: wires in **grooves 4, 4.5 and 5**

Record the data below.

Orientation	MOW [inches]	Thread Wire Size	Thread Wire Constant, C [inches]	Gaging Force [lbs]	Estimated Uncertainty [inches]
0 deg. ref. position					±

**Gage 2 GO**

Instrument Used for MOW Measurements

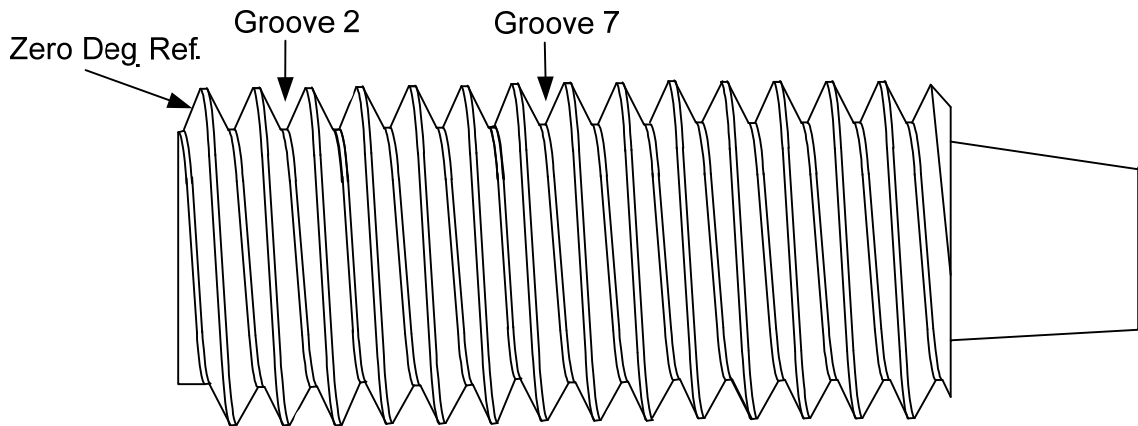
**PITCH**

(4) Using gage 2 measure the **pitch** on the GO segment. Orient the gage so that the pitch is measured along the zero degree reference position. Zero the lead readout in the 2<sup>nd</sup> thread groove. Continue measuring lead at each groove to complete the table below.

Ref. Position	Groove 2	Groove 3	Groove 4	Groove 5	Groove 6	Groove 7
0 deg	0					

**Gage 2 GO**

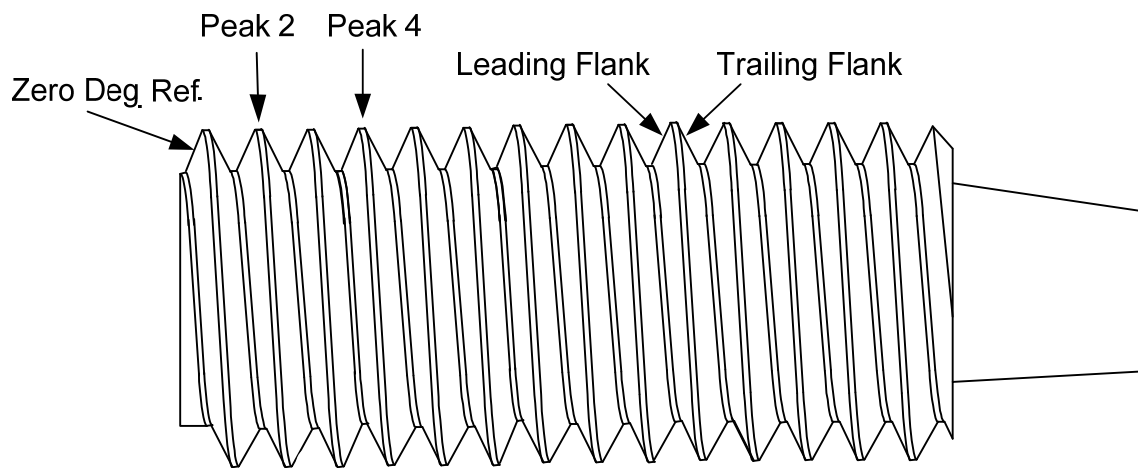
Estimated Lead Uncertainty [inches]	±
Instrument Used for Pitch Measurement	



## HALF ANGLES

- (5) Measure the  $\frac{1}{2}$  **angles** on the GO member of gage 2 and on gage 3. Orient the gage so that the angles are measured along the zero degree reference position as shown below.

Measure the leading and trailing flank angles and record the data for each peak listed in the tables below. The picture below depicts "Peaks" 2, and 4 on a typical thread member.



Measure Gage 2, (GO member) leading and trailing  $\frac{1}{2}$  angles at the specified peaks, and record the data in the table below.

Angle	Peak 2	Peak 3	Peak 4
Leading $\frac{1}{2}$			
Trailing $\frac{1}{2}$			

**Gage 2 GO Member, 0° reference position**

Estimated $\frac{1}{2}$ Angle Uncertainty [degrees]	±
Instrument Used for $\frac{1}{2}$ Angle Measurements	

Measure Gage 3 leading and trailing  $\frac{1}{2}$  angles at the specified peaks and record the data in the table below.

Angle	Peak 2	Peak 3	Peak 4
Leading $\frac{1}{2}$			
Trailing $\frac{1}{2}$			

**Gage 3, 0° reference position**

Estimated $\frac{1}{2}$ Angle Uncertainty [degrees]	±
Instrument Used for $\frac{1}{2}$ Angle Measurements	