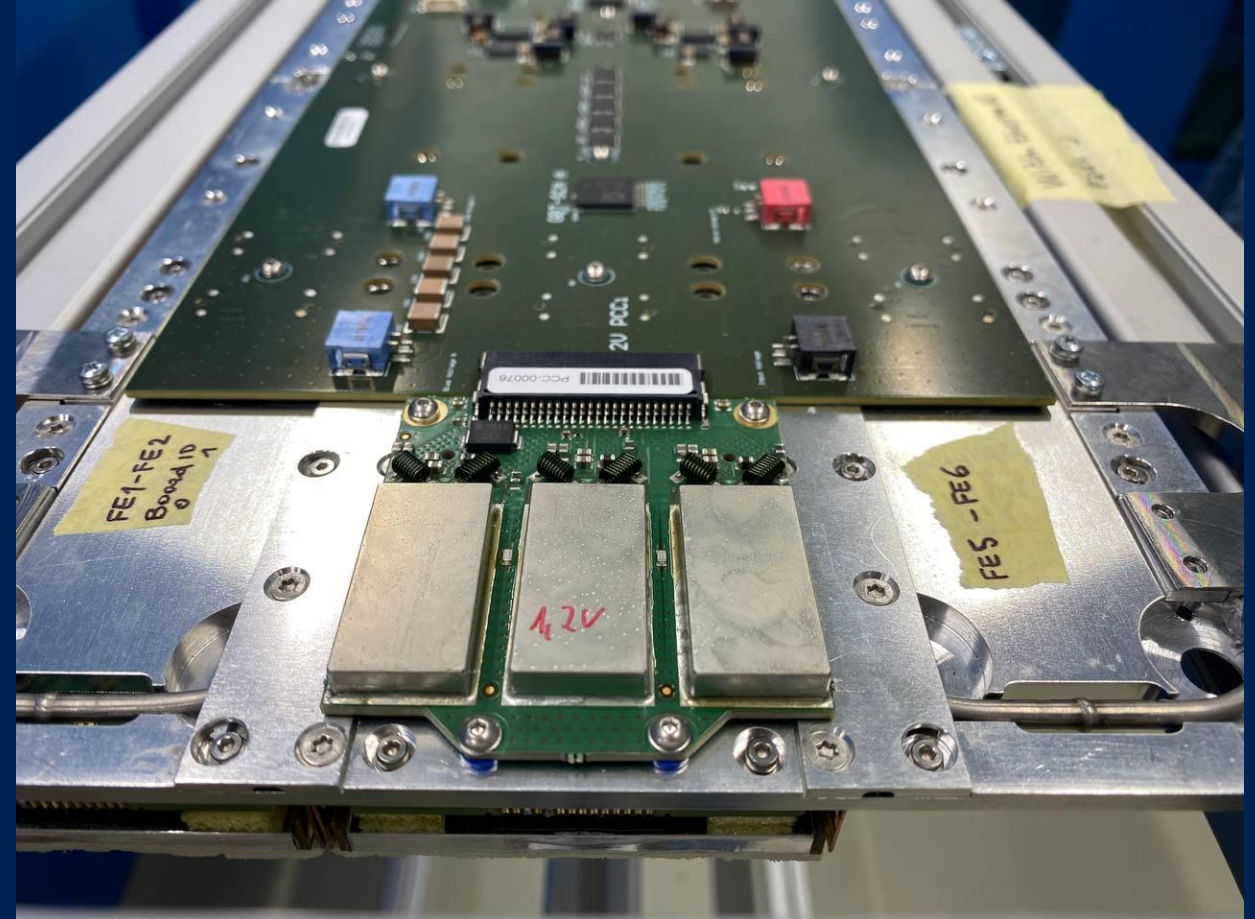


My work in CERN (in pictures)

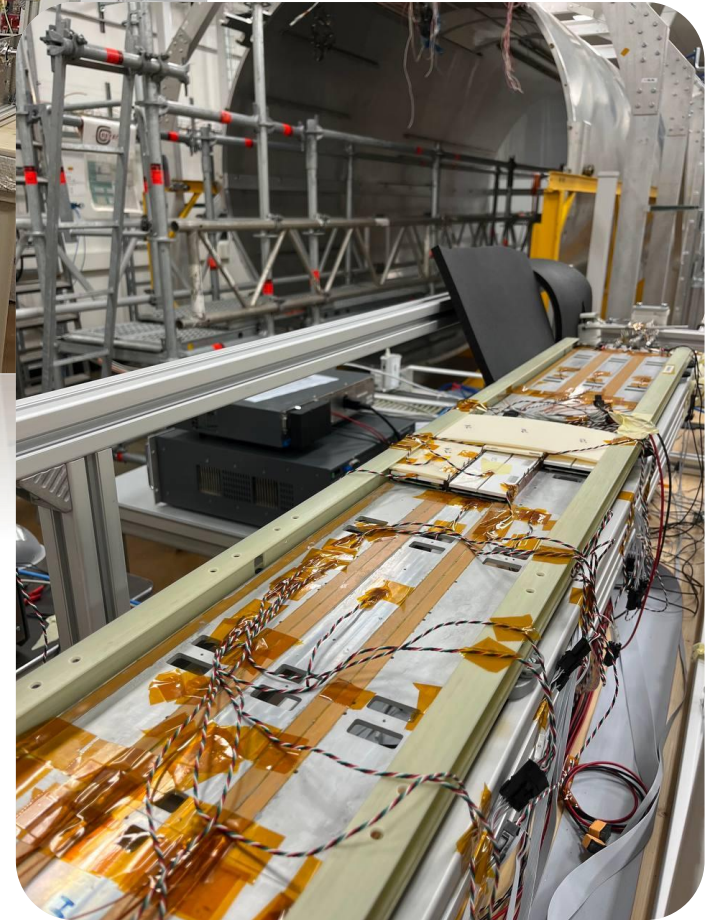
Iryna Kapran

Mentor: Chris Neu

Team: Braden Allmond, Giulia Sorrentino



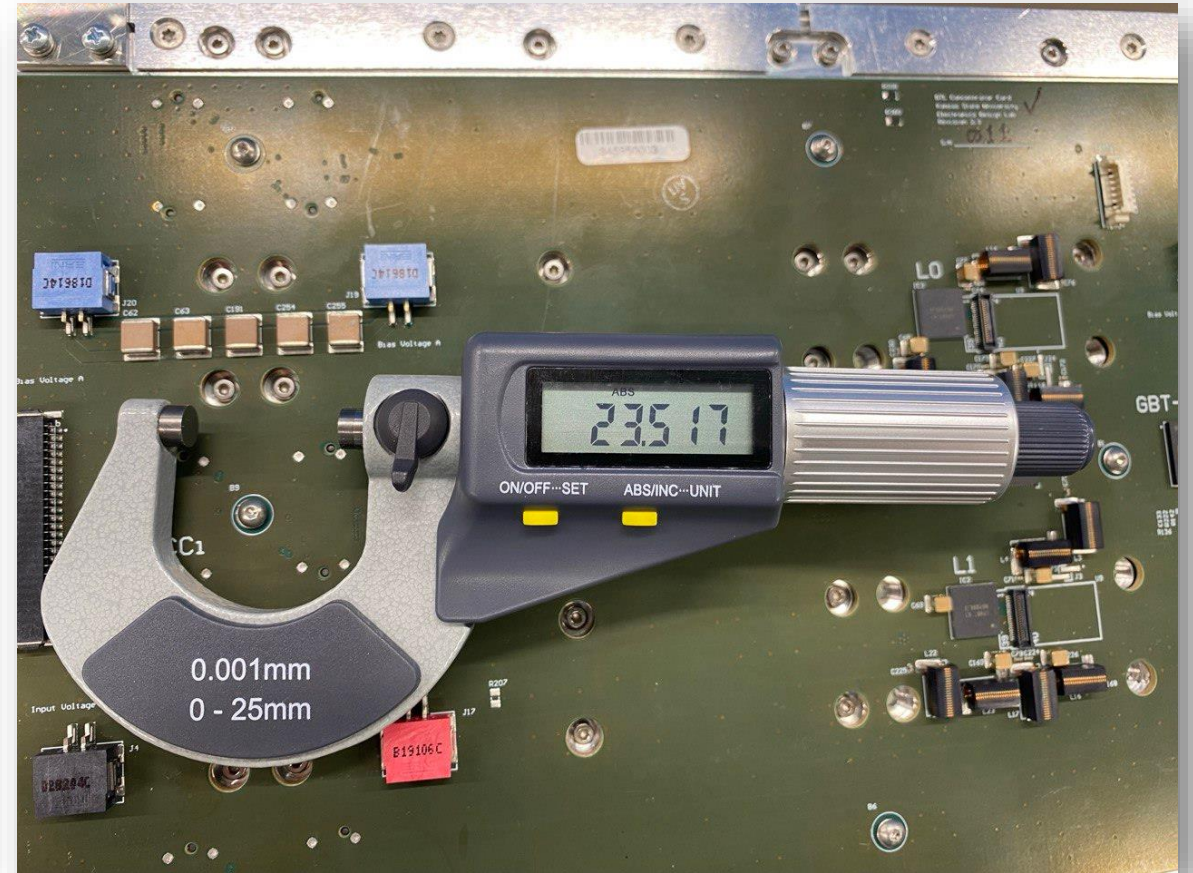
BTL



Measuring instruments



Caliper



Micrometer

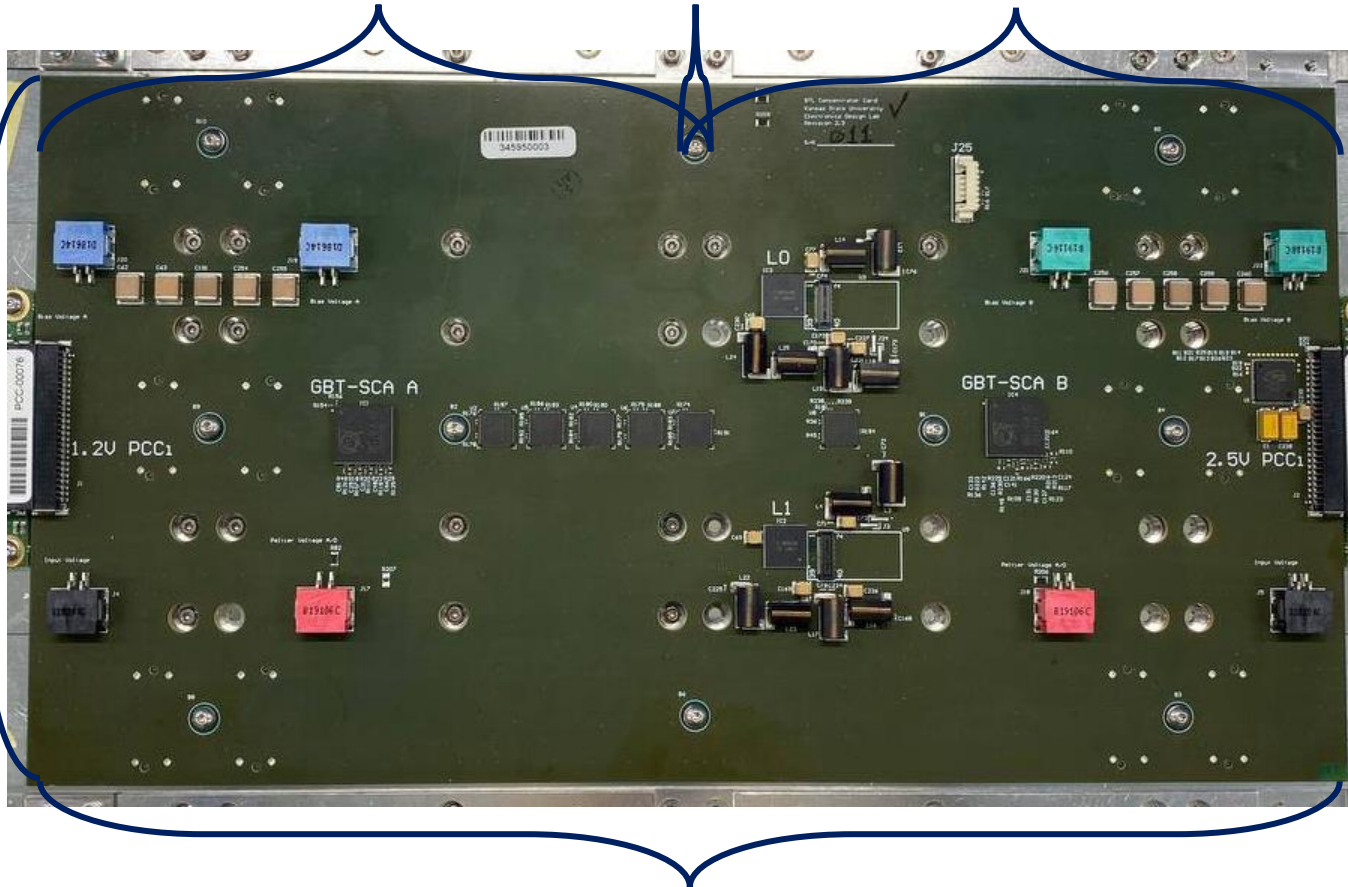
CC Measurements

CC Length
Left

CC central
screw

CC Length
Right

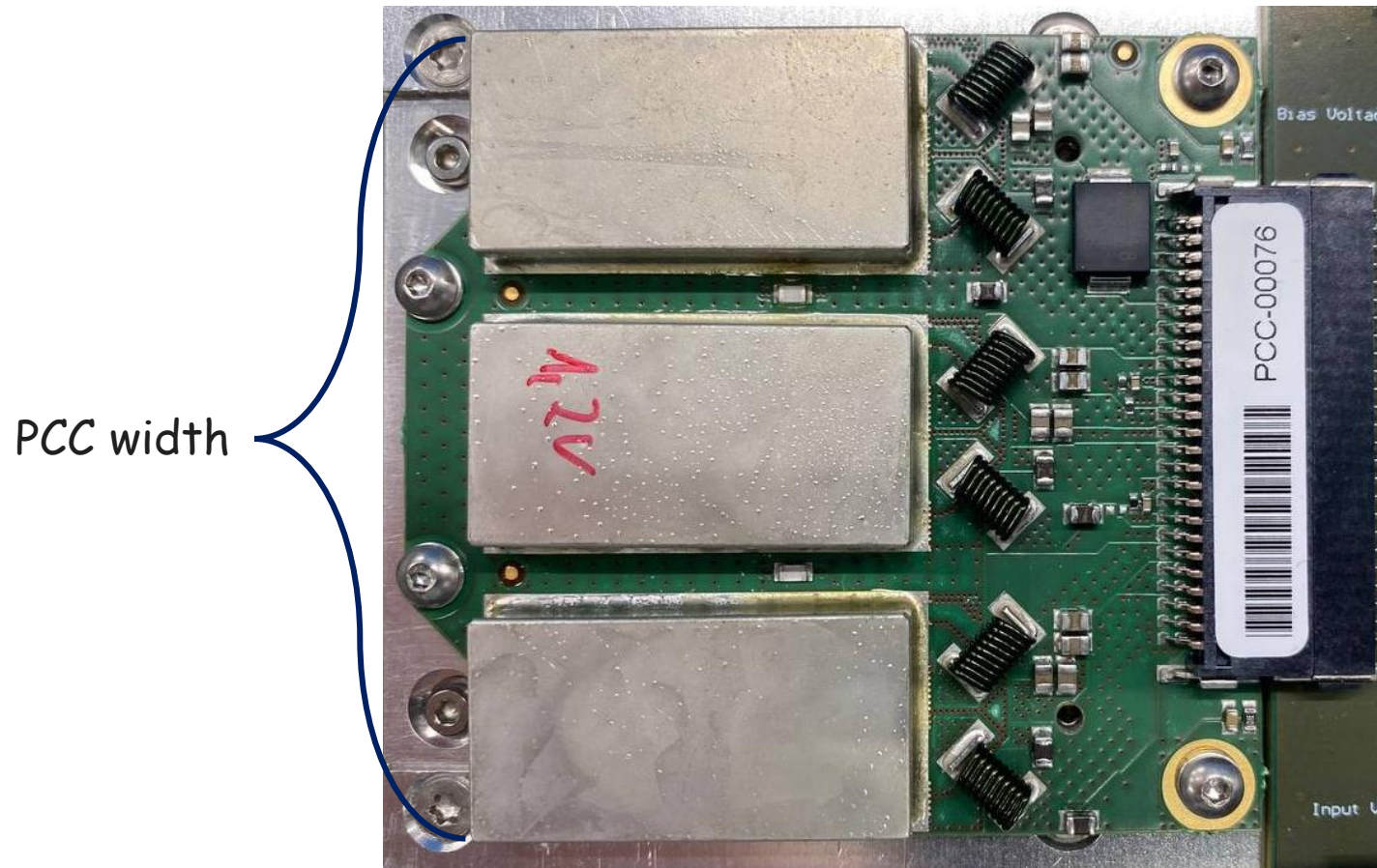
CC Width



CC Total
Length

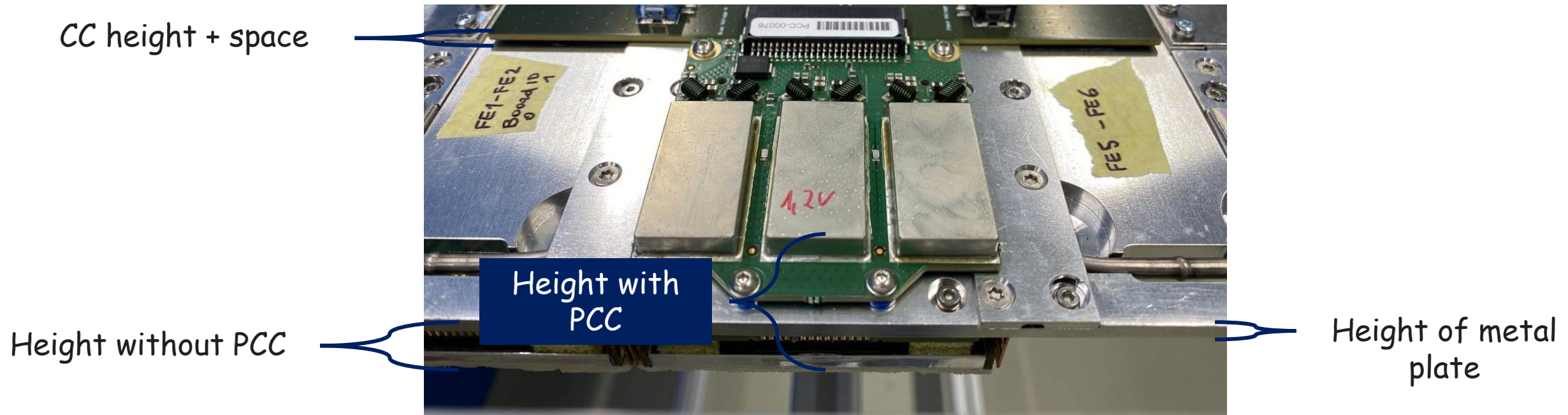
CC Width = $(149,99 \pm 0,01)$ mm
CC Total Length = $(279,90 \pm 0,06)$ mm

PCC Measurement



PCC width = $(58,96 \pm 0,01)$ mm

PCC-CC-PCC Measurements



Caliper:

CC height + space = $(2,77 \pm 0,04)$ mm

Height without PCC = $(17,37 \pm 0,05)$ mm

Height with PCC = $(26,17 \pm 0,03)$ mm

Height of metal plate = $(4,32 \pm 0,02)$ mm

Micrometer:

CC height = $(1,771 \pm 0,009)$ mm

Height without PCC = $(17,229 \pm 0,075)$ mm

Height with PCC = $(24,587 \pm 0,188)$ mm

Height of metal plate = $(4,026 \pm 0,001)$ mm

PCC-CC-PCC Measurements

Caliper:

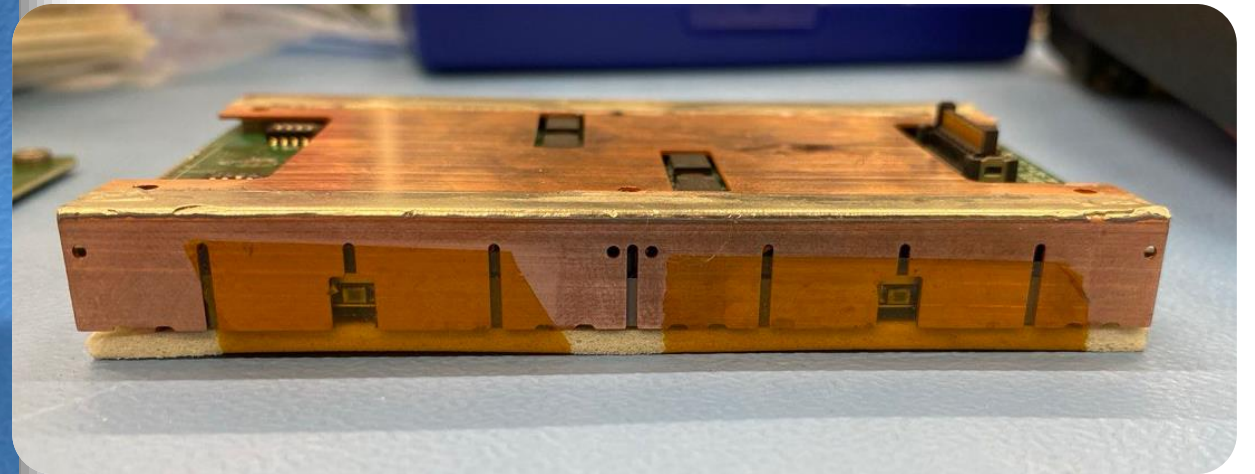
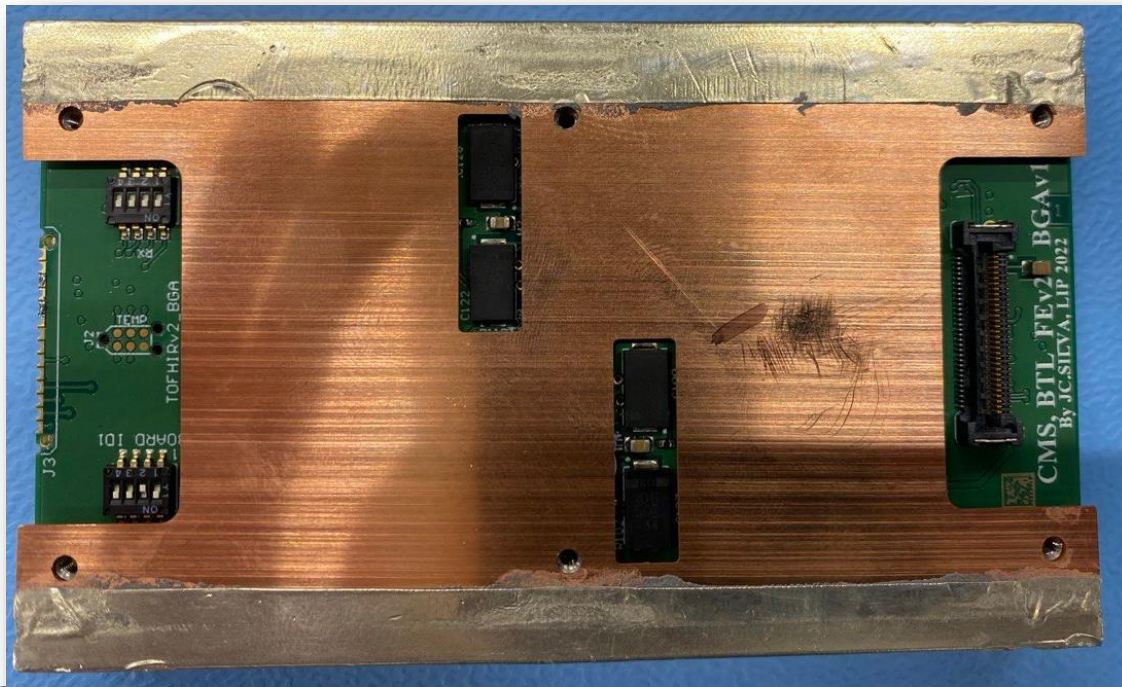
Copper Housing center = $(0,51 \pm 0,04)$ mm

All in one = $(13,86 \pm 0,11)$ mm

Micrometer:

Copper Housing center = $(0,551 \pm 0,018)$ mm

All in one = $(13,134 \pm 0,079)$ mm



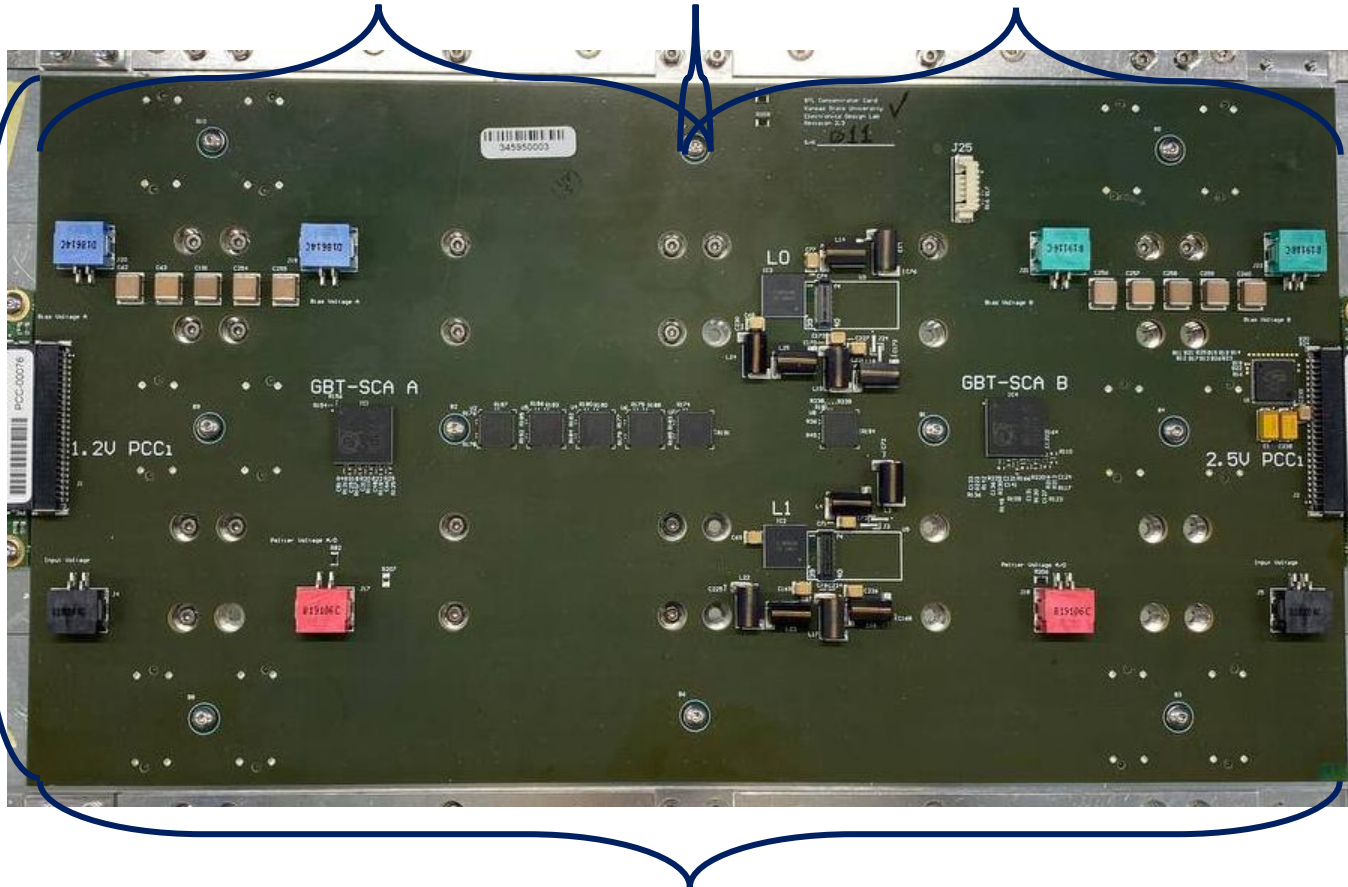
CC repeated measurements

CC Length
Left

CC central
screw

CC Length
Right

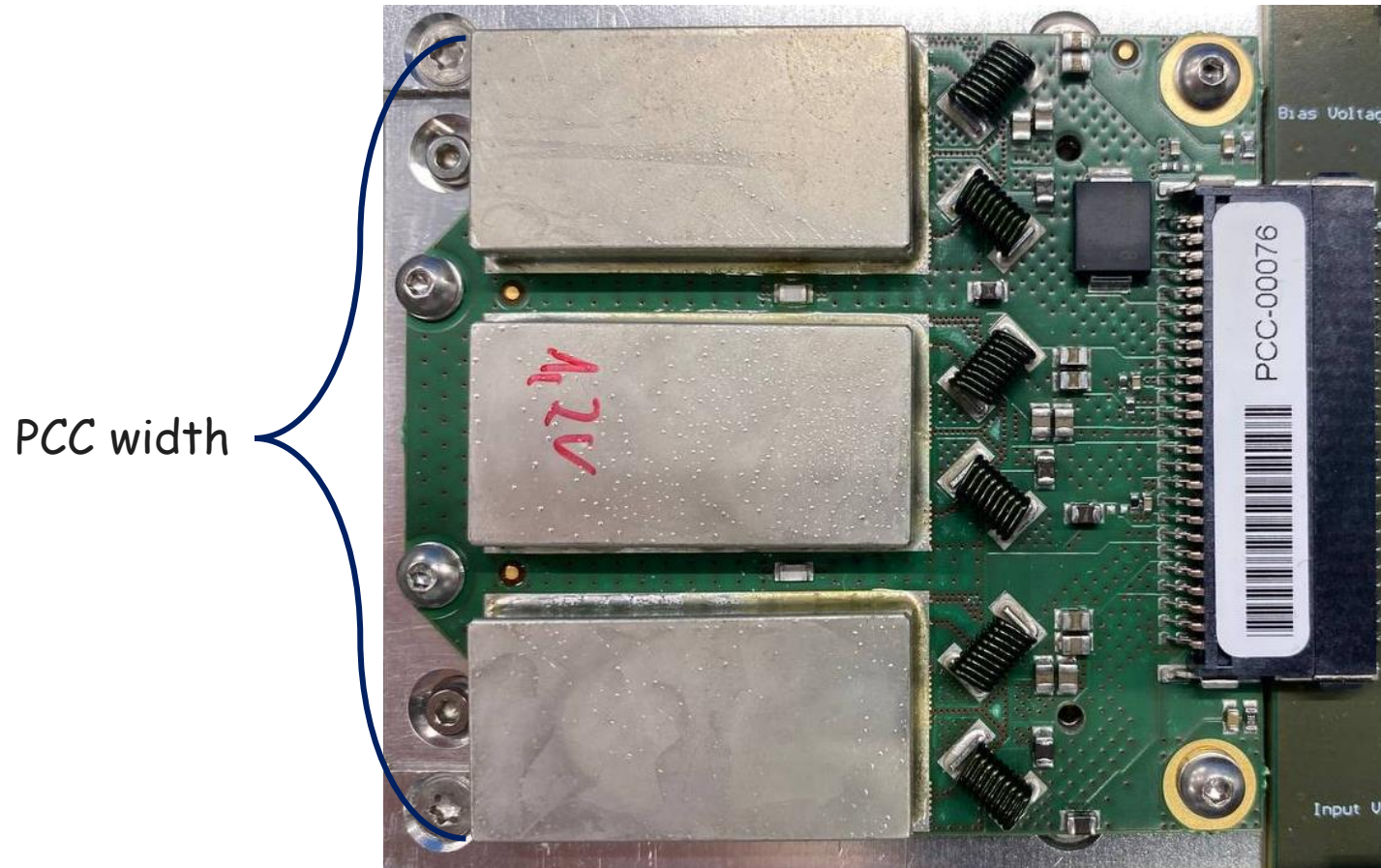
CC Width



CC Total
Length

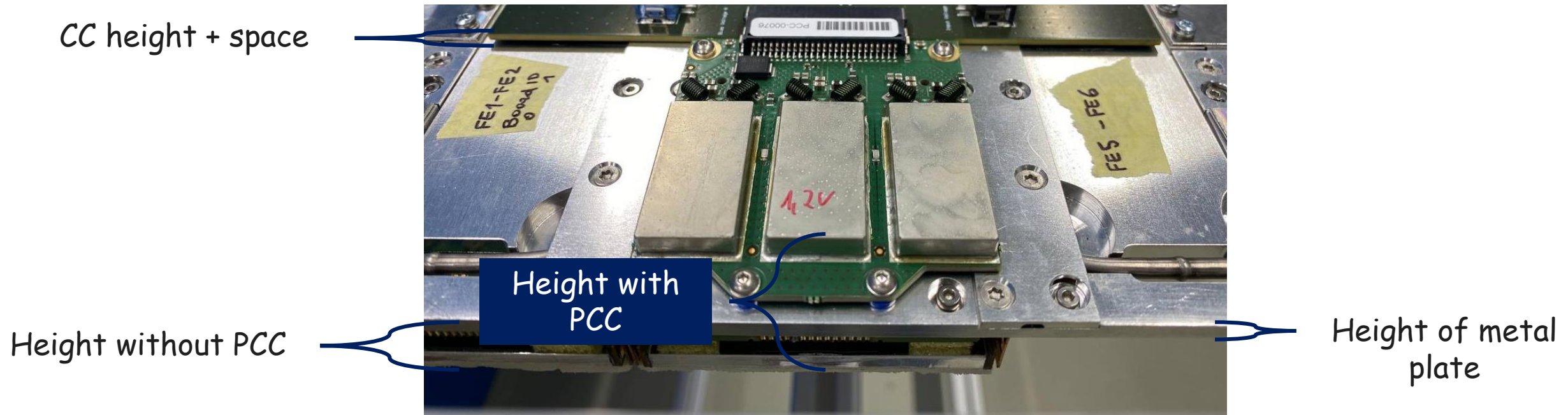
CC Width = $(149,95 \pm 0,05)$ mm
CC Total Length = $(279,92 \pm 0,01)$ mm

PCC repeated measurements



PCC width = $(58,97 \pm 0,01)$ mm

PCC-CC-PCC repeated measurements



Caliper:

CC height + space = $(2,80 \pm 0,01)$ mm

Height without PCC = $(17,27 \pm 0,01)$ mm

Height with PCC = $(26,02 \pm 0,02)$ mm

Height of metal plate = $(4,31 \pm 0,01)$ mm

Micrometer:

CC height = $(1,765 \pm 0,002)$ mm

Height without PCC = $(17,278 \pm 0,011)$ mm

Height with PCC = $(24,724 \pm 0,076)$ mm

Height of metal plate = $(4,080 \pm 0,018)$ mm

PCC-CC-PCC repeated measurements

Caliper:

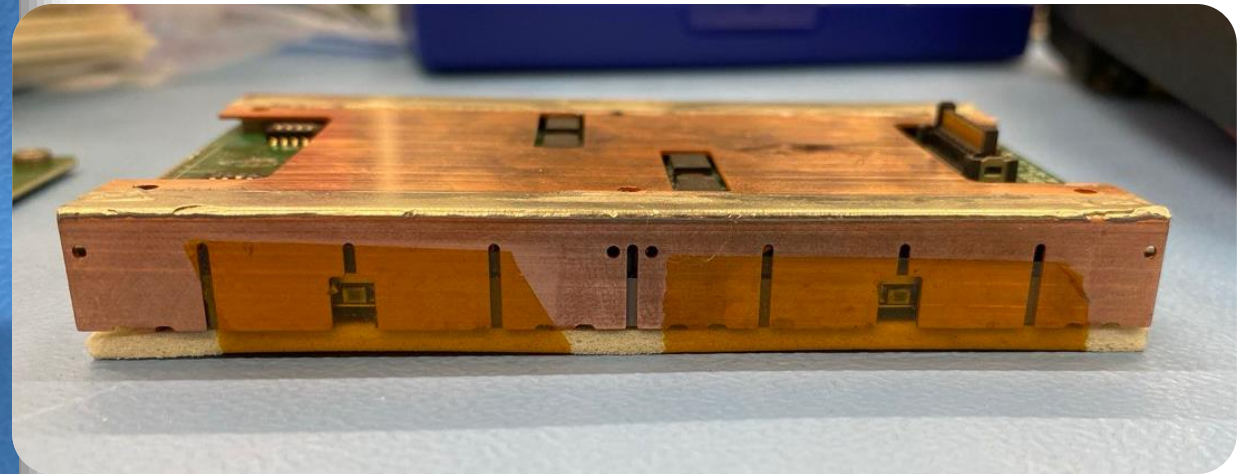
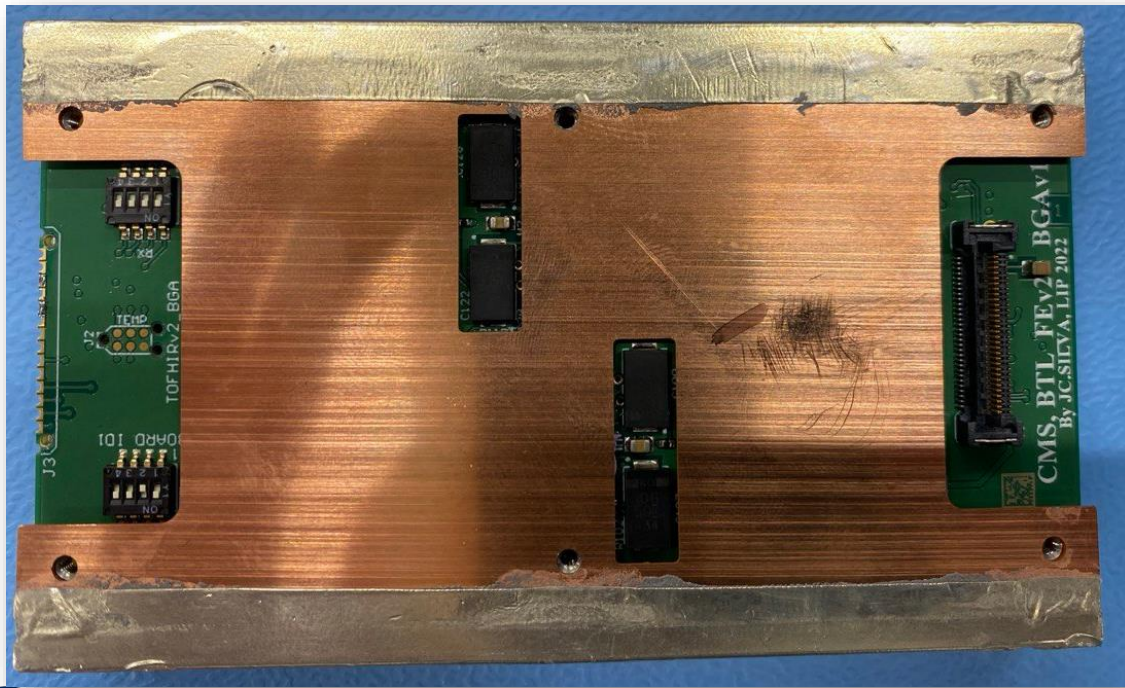
Copper Housing center = $(0,51 \pm 0,01)$ mm

All in one = $(13,11 \pm 0,06)$ mm

Micrometer:

Copper Housing center = $(0,547 \pm 0,008)$ mm

All in one = $(13,230 \pm 0,050)$ mm



PCC-CC-PCC Measurements

Mass [g]

Front End Card = (28 ± 2) g

Front End Card w Thermal Pads = (29 ± 2) g

Copper Housing = (32 ± 2) g

Airex Pad with Size of Front End Card = $(1,15 \pm 0,15)$ g

All in one = (221 ± 2) g

LYSO c25-2-T1 = (77 ± 2) g

LYSO c30-3-T2 = (62 ± 2) g

LYSO c25-2-T3 = (51 ± 2) g

LYSO Hpk-2-30 = (64 ± 2) g

CC = (215 ± 2) g

PCC-CC-PCC Measurements

		CC Length Left	CC Length Right	CC central screw	CC Total Length	CC Width
		142,08	142,38	4,78	279,68	149,97
		142,43	142,25	4,85	279,83	149,98
		142,43	142,26	4,85	279,84	149,98
		142,44	142,38	4,85	279,95	150,02
other side		142,41	142,38	4,87	279,90	150,05
		142,44	142,38	4,59	280,23	149,98
		142,38	142,39	4,88	279,87	149,98
Final		142,37	142,34	4,81	279,90	149,99
Standard Error		0,05	0,02	0,04	0,06	0,01
w Caliper						
		CC height+space	PCC width	Height without PCC	Height with PCC	Height of metal plate
		2,75	58,88	17,53	26,28	4,38
		2,70	58,96	17,23	26,07	4,31
		2,88	58,94	17,32	26,14	4,32
		2,88	58,95	17,38	26,15	4,28
		2,70	59,04	17,43	26,20	4,34
			59,01			
			58,96			
			58,96			
			58,91			
			58,96			
Final	#DIV/0!	2,77	58,96	17,37	26,17	4,32
Standard Error	#DIV/0!	0,04	0,01	0,05	0,03	0,02
w Micrometer						
		CC height				
		1,800		17,387	24,927	4,024
		1,778		17,338	24,732	4,027
		1,773		17,332	24,573	4,028
		1,747		17,125	24,829	4,022
		1,748		16,983	23,872	4,027
		1,781				
Final		1,771		17,229	24,587	4,026
Standard Error		0,009		0,075	0,188	0,001

All in one	Copper Housing center
13,95	0,52
13,92	0,52
14,11	0,52
14,25	0,50
13,67	0,51
14,10	0,51
13,52	0,004
13,17	
14,01	
13,86	
0,11	

Mass [g]	
	28 Front End Card
	29,00 Front End Card w Thermal Pads
	32,00 Copper Housing
	1,15 Airex Pad with Size of Front End Card
	221,00 All in one
	77,00 LYSO c25-2-T1
	62,00 LYSO c30-3-T2
	51,00 LYSO c25-2-T3
	64,00 LYSO Hpk-2-30
	215,00 CC

All in one	Copper Housing center
12,796	0,517
13,123	0,643
13,623	0,581
12,973	0,562
13,017	0,520
13,359	0,516
13,105	0,515
13,136	0,551
13,078	0,018
13,134	
0,079	

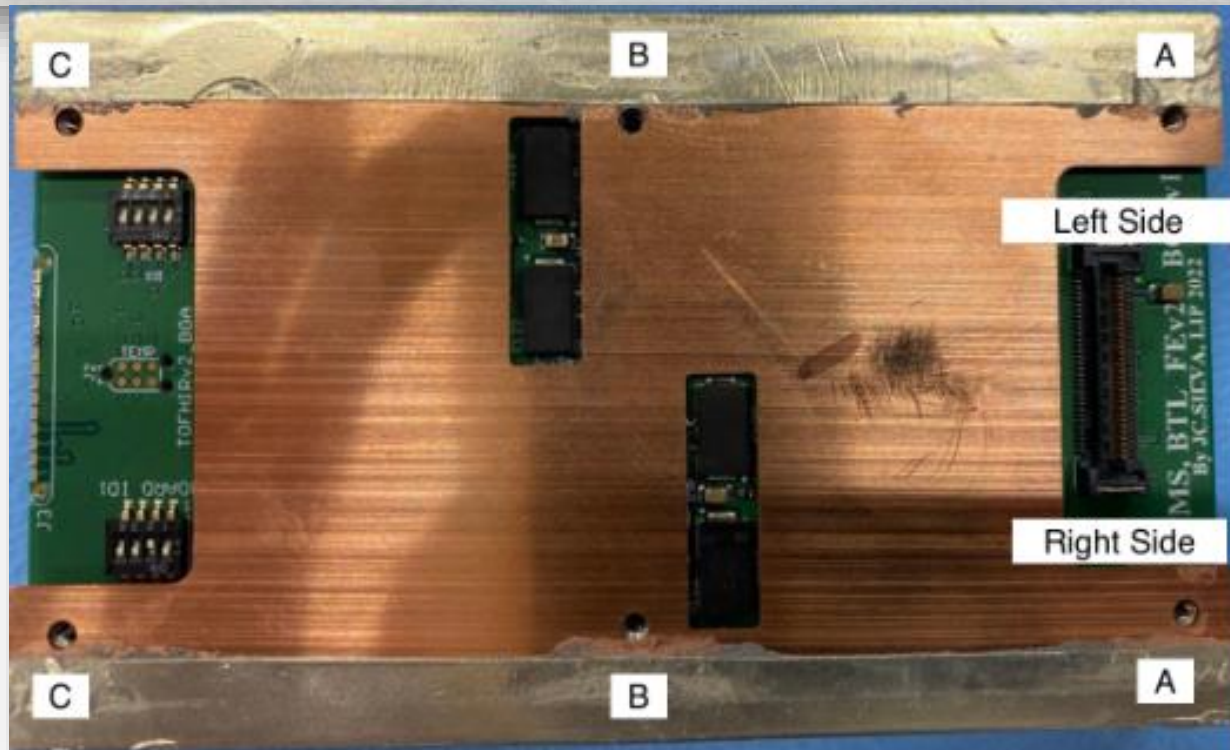
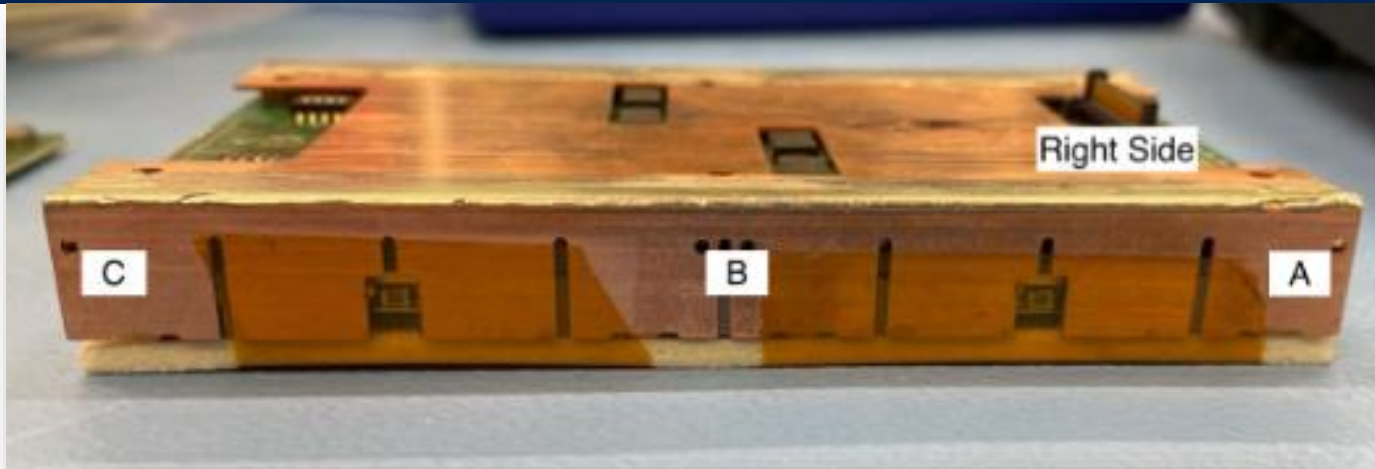
PCC-CC-PCC repeated measurements

w Caliper	CC Length Left	CC Length Right	CC central screw	CC Total Length	CC Width	CC height+space	PCC width	Height without P	Height with PCC	Height of metal plate	All in one	Copper Housing center
	142,23	142,35	4,84	279,74	150,03	2,83	58,97	17,31	26,15	4,38	13,42	0,52
	142,43	142,33	4,86	279,90	148,98	2,82	58,96	17,34	26,13	4,31	12,95	0,54
	142,39	142,37	4,78	279,98	150,01	2,85	59,01	17,28	26,06	4,35	12,99	0,57
	142,46	142,34	4,85	279,95	149,98	2,83	58,99	17,25	26,11	4,29	13,25	0,30
	142,44	142,30	4,87	279,87	149,98	2,83	58,96	17,29	26,05	4,29	12,94	0,56
	142,41	142,33	4,87	279,87	150,01	2,84	59,03	17,24	25,86	4,28	13,26	0,53
	142,46	142,37	4,83	280,00	150,03	2,82	58,88	17,26	26,09	4,32	12,86	0,51
	142,42	142,34	4,85	279,91	149,99	2,80	58,96	17,23	26,04	4,28	13,06	0,51
	142,40	142,36	4,87	279,89	150,00	2,76	59,00	17,26	26,02	4,31	12,91	0,52
	142,44	142,38	4,85	279,97	149,97	2,74	58,99	17,22	25,86	4,31	13,21	0,53
	142,43	142,38	4,81	280,00	149,97	2,76	58,97	17,29	26,01	4,26	12,95	0,40
	142,37	142,35	4,87	279,85	150,04	2,78	58,98	17,26	26,04	4,32	14,02	0,52
	142,41	142,37	4,85	279,93	149,99	2,74	59,01	17,25	25,96	4,29	13,02	0,54
	142,41	142,31	4,84	279,88	149,98	2,72	58,99	17,31	26,02	4,35	12,98	0,53
	142,45	142,37	4,81	280,01	149,98	2,76	58,87	17,24	25,94	4,29	12,92	0,53
	142,39	142,35	4,83	279,91	149,99	2,80	59,02	17,28	26,08	4,34	13,11	0,53
	142,42	142,32	4,83	279,91	149,98	2,83	58,86	17,34	26,01	4,34	13,28	0,56
	142,43	142,36	4,80	279,99	150,05	2,82	58,86	17,23	25,97	4,28	13,16	0,51
	142,40	142,36	4,82	279,94	149,99	2,82	59,02	17,26	25,91	4,32	12,97	0,49
	142,45	142,36	4,85	279,96	150,01	2,84	59,01	17,32	26,00	4,31	13,03	0,52
Final	142,41	142,35	4,84	279,92	149,95	2,80	58,97	17,27	26,02	4,31	13,11	0,51
Standard Error	0,01	0,01	0,01	0,01	0,05	0,01	0,01	0,01	0,02	0,01	0,06	0,01

PCC-CC-PCC repeated measurements

w Micrometer	CC height	Height without P	Height with PCC	Height of metal plate	All in one	Copper Housing center
	1,75	17,215	24,843	4,027	13,359	0,643
	1,77	17,286	25,103	4,028	13,123	0,548
	1,77	17,238	24,514	4,023	13,256	0,529
	1,77	17,346	24,432	4,146	13,093	0,532
	1,75	17,323	23,872	4,027	13,017	0,586
	1,76	17,268	25,158	4,028	13,027	0,516
	1,76	17,311	24,769	4,025	13,253	0,527
	1,77	17,292	24,829	4,198	13,123	0,587
	1,78	17,327	24,476	4,028	13,078	0,521
	1,76	17,324	24,698	4,149	13,367	0,581
	1,77	17,324	24,573	4,027	13,387	0,524
	1,77	17,183	24,527	4,149	12,973	0,520
	1,77	17,243	25,257	4,027	13,105	0,538
	1,75	17,302	24,361	4,267	13,648	0,557
	1,76	17,318	24,732	4,136	13,387	0,517
	1,75	17,310	25,312	4,028	13,136	0,539
	1,79	17,261	24,869	4,022	13,359	0,601
	1,76	17,213	24,927	4,207	13,623	0,515
	1,76	17,209	24,679	4,028	13,498	0,503
	1,76	17,263	24,543	4,024	12,796	0,562
Final	1,77	17,28	24,72	4,08	13,23	0,55
Standard Error	0,002	0,011	0,076	0,018	0,050	0,008

Module measurements



Height = $(14,06 \pm 0,34)$ mm
Width = $(61,18 \pm 0,03)$ mm
Length = $(103,20 \pm 0,02)$ mm

Module measurements

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	13.78	14.51	14.72	14.337	0.243
B	13.77	14.45	13.79	14.003	0.150
C	14.42	13.48	13.83	13.910	0.226
Average	13.990	14.147	14.113		
Std Dev (sample)	0.372	0.578	0.526		
Std Error	0.263	0.409	0.372		

Location	Width
A	61.24
B	61.2
C	61.11
Average	61.183
Std Dev (sample)	0.067
Std Error	0.047

Location	Length
Left	103.16
Center	103.24
Right	103.14
Average	103.180
Std Dev (sample)	0.053
Std Error	0.037

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	14.14	14.78	14.37	14.43	0.105
B	14.62	13.40	14.46	14.16	0.440
C	14.09	14.24	14.09	14.14	0.008
Average	14.28	14.14	14.31		
Std Dev (sample)	0.293	0.695	0.193		
Std Error	0.207	0.492	0.136		

Location	Width
A	61.09
B	61.22
C	61.09
Average	61.13
Std Dev (sample)	0.075
Std Error	0.053

Location	Length
Left	103.38
Center	103.32
Right	103.31
Average	103.337
Std Dev (sample)	0.038
Std Error	0.027

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	13.90	13.78	14.24	13.97	0.057
B	14.22	13.86	14.20	14.09	0.041
C	14.66	13.84	14.37	14.29	0.173
Average	14.260	13.827	14.270		
Std Dev (sample)	0.382	0.042	0.089		
Std Error	0.270	0.029	0.063		

Location	Width
A	61.07
B	61.16
C	61.08
Average	61.10
Std Dev (sample)	0.0493
Std Error	0.0349

Location	Length
Left	103.25
Center	103.26
Right	103.20
Average	103.24
Std Dev (sample)	0.0321
Std Error	0.0227

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	14.18	13.96	14.13	14.09	0.0133
B	14.29	13.74	14.05	14.03	0.0760
C	14.36	13.52	14.09	13.99	0.1839
Average	14.28	13.74	14.09		
Std Dev (sample)	0.09	0.22	0.04		
Std Error	0.06	0.16	0.03		

Location	Width
A	61.07
B	61.16
C	61.08
Average	61.10
Std Dev (sample)	0.05
Std Error	0.03

Location	Length
Left	103.25
Center	103.26
Right	103.20
Average	103.24
Std Dev (sample)	0.03
Std Error	0.02

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	14.27	13.68	14.36	14.10	0.14
B	14.26	14.33	14.45	14.35	0.01
C	14.24	13.52	14.25	14.00	0.18
Average	14.26	13.84	14.35		
Std Dev (sample)	0.02	0.43	0.10		
Std Error	0.01	0.30	0.07		

Location	Width
A	61.16
B	61.10
C	61.07
Average	61.11
Std Dev (sample)	0.05
Std Error	0.03

Location	Length
Left	103.21
Center	103.26
Right	103.24
Average	103.24
Std Dev (sample)	0.03
Std Error	0.02

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	13.97	13.59	14.08	13.88	0.07
B	14.29	13.86	14.13	14.09	0.05
C	14.18	13.71	13.79	13.89	0.06
Average	14.15	13.72	14.00		
Std Dev (sample)	0.16	0.14	0.18		
Std Error	0.11	0.10	0.13		

Location	Width
A	61.17
B	61.14
C	61.47
Average	61.26
Std Dev (sample)	0.18
Std Error	0.13

Location	Length
Left	103.19
Center	103.21
Right	103.23
Average	103.21
Std Dev (sample)	0.02
Std Error	0.01

Module measurements

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	13.94	14.48	14.78	14.400	0.181
B	13.93	14.42	13.89	14.080	0.087
C	14.37	13.51	14.32	14.067	0.233
Average	14.080	14.137	14.330		
Std Dev (sample)	0.251	0.544	0.445		
Std Error	0.178	0.384	0.315		

Location	Width
A	61.21
B	61.16
C	61.19
Average	61.187
Std Dev (sample)	0.025
Std Error	0.018

Location	Length
Left	103.21
Center	103.19
Right	103.17
Average	103.190
Std Dev (sample)	0.020
Std Error	0.014

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	13.72	14.46	14.64	14.273	0.238
B	13.78	14.32	13.89	13.997	0.081
C	13.64	14.38	13.96	13.993	0.138
Average	13.713	14.387	14.163		
Std Dev (sample)	0.070	0.070	0.414		
Std Error	0.050	0.050	0.293		

Location	Width
A	61.21
B	61.19
C	61.23
Average	61.210
Std Dev (sample)	0.020
Std Error	0.014

Location	Length
Left	103.25
Center	103.19
Right	103.22
Average	103.220
Std Dev (sample)	0.030
Std Error	0.021

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	13.98	14.34	14.12	14.147	0.033
B	13.89	14.51	14.25	14.217	0.097
C	13.9	14.23	14.31	14.147	0.047
Average	13.923	14.360	14.227		
Std Dev (sample)	0.049	0.141	0.097		
Std Error	0.035	0.100	0.069		

Location	Width
A	61.12
B	61.31
C	61.24
Average	61.223
Std Dev (sample)	0.096
Std Error	0.068

Location	Length
Left	103.14
Center	103.19
Right	103.21
Average	103.180
Std Dev (sample)	0.036
Std Error	0.025

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	13.78	14.34	13.82	13.980	0.098
B	13.72	14.43	13.79	13.980	0.153
C	14.02	13.47	13.93	13.807	0.087
Average	13.840	14.080	13.847		
Std Dev (sample)	0.159	0.530	0.074		
Std Error	0.112	0.375	0.052		

Location	Width
A	61.16
B	61.19
C	61.14
Average	61.163
Std Dev (sample)	0.025
Std Error	0.018

Location	Length
Left	103.21
Center	103.18
Right	103.17
Average	103.187
Std Dev (sample)	0.021
Std Error	0.015

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	13.65	14.32	13.86	13.943	0.117
B	13.69	14.41	13.83	13.977	0.146
C	13.76	14.39	13.89	14.013	0.111
Average	13.700	14.373	13.860		
Std Dev (sample)	0.056	0.047	0.030		
Std Error	0.039	0.033	0.021		

Location	Width
A	61.21
B	61.31
C	61.29
Average	61.270
Std Dev (sample)	0.053
Std Error	0.037

Location	Length
Left	103.11
Center	103.17
Right	103.15
Average	103.143
Std Dev (sample)	0.031
Std Error	0.022

Location	Thickness			Average	Variance
	Left Side	Center	Right Side		
A	13.68	14.53	14.63	14.280	0.272
B	13.73	14.47	13.89	14.030	0.152
C	13.64	13.42	13.86	13.640	0.048
Average	13.683	14.140	14.127		
Std Dev (sample)	0.045	0.624	0.436		
Std Error	0.032	0.441	0.308		

Location	Width
A	61.21
B	61.24
C	61.19
Average	61.213
Std Dev (sample)	0.025
Std Error	0.018

Location	Length
Left	103.19
Center	103.23
Right	103.17
Average	103.197
Std Dev (sample)	0.031
Std Error	0.022

Module measurements

Thickness					
Location	Left Side	Center	Right Side	Average	Variance
A	13.68	14.46	14.68	14.273	0.276
B	13.72	14.41	13.79	13.973	0.144
C	13.57	13.97	13.82	13.787	0.041
Average	13.657	14.280	14.097		
Std Dev (sample)	0.078	0.270	0.505		
Std Error	0.055	0.191	0.357		

Location	Width
A	61.18
B	61.23
C	61.17
Average	61.193
Std Dev (sample)	0.032
Std Error	0.023

Location	Length
Left	103.14
Center	103.21
Right	103.18
Average	103.177
Std Dev (sample)	0.035
Std Error	0.025

Thickness					
Location	Left Side	Center	Right Side	Average	Variance
A	13.63	14.62	14.68	14.310	0.348
B	13.66	14.53	13.79	13.993	0.220
C	13.79	13.98	13.75	13.840	0.015
Average	13.693	14.377	14.073		
Std Dev (sample)	0.085	0.346	0.526		
Std Error	0.060	0.245	0.372		

Location	Width
A	61.21
B	61.25
C	61.13
Average	61.197
Std Dev (sample)	0.061
Std Error	0.043

Location	Length
Left	103.17
Center	103.23
Right	103.15
Average	103.183
Std Dev (sample)	0.042
Std Error	0.029

Thickness					
Location	Left Side	Center	Right Side	Average	Variance
A	13.64	14.32	14.64	14.200	0.261
B	13.71	14.51	13.76	13.993	0.201
C	13.83	13.86	13.99	13.893	0.007
Average	13.727	14.230	14.130		
Std Dev (sample)	0.096	0.334	0.456		
Std Error	0.068	0.236	0.323		

Location	Width
A	61.11
B	61.17
C	61.23
Average	61.170
Std Dev (sample)	0.060
Std Error	0.042

Location	Length
Left	103.13
Center	103.18
Right	103.14
Average	103.150
Std Dev (sample)	0.026
Std Error	0.019

Thickness					
Location	Left Side	Center	Right Side	Average	Variance
A	13.79	14.52	14.74	14.350	0.247
B	13.76	14.41	13.67	13.947	0.163
C	14.44	13.51	13.73	13.893	0.236
Average	13.997	14.147	14.047		
Std Dev (sample)	0.384	0.554	0.601		
Std Error	0.272	0.392	0.425		

Location	Width
A	61.25
B	61.21
C	61.24
Average	61.233
Std Dev (sample)	0.021
Std Error	0.015

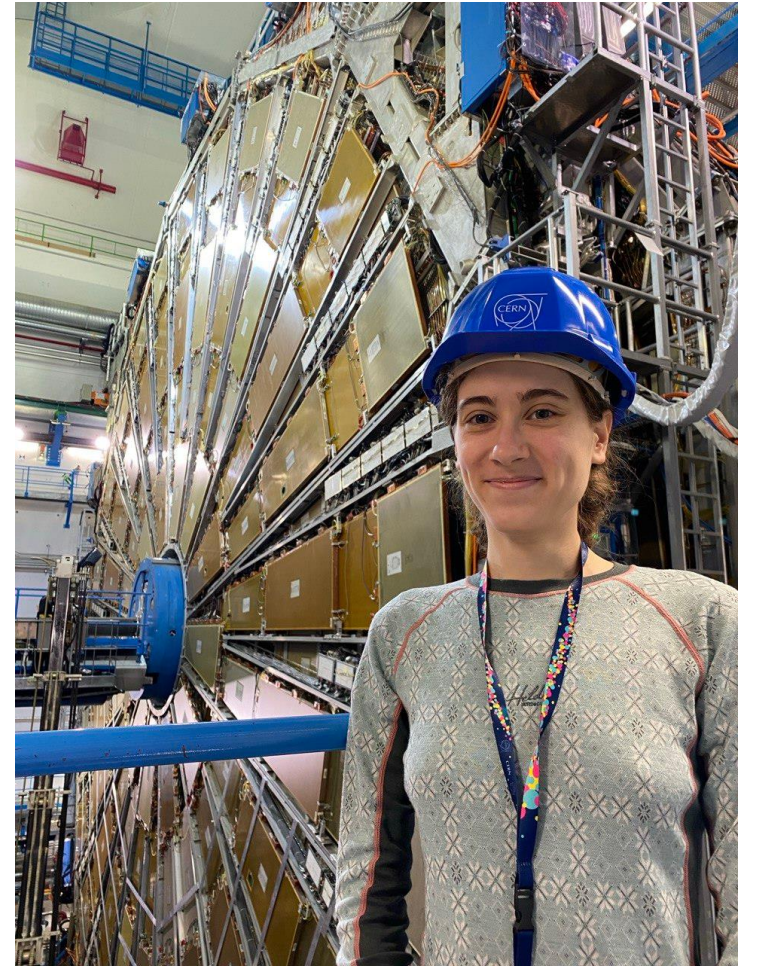
Location	Length
Left	103.13
Center	103.19
Right	103.17
Average	103.163
Std Dev (sample)	0.031
Std Error	0.022

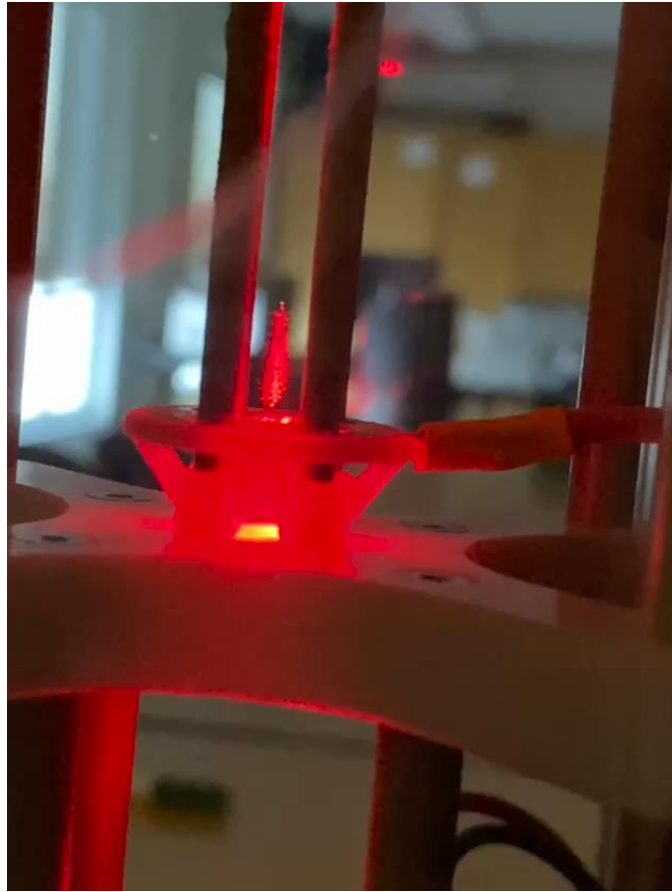
Conclusions

During the first measurements, we took an average of 6-7 data per value. The small number of experiments and the human factor influenced the fact that the results of caliber and micromoment measurements differ in some places. Next, we took twenty data per value. As a result, the final data has less divergence. We have big differences in the Height with PCC measurement. This is due to the Airex Pad, because it is quite soft and this distorts the results. All other data is quite accurate, which is confirmed by our final calculations.



Thank you
for your
attention





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