

Prepared by group 19

Non Invasive Glucose Tracking

Final Project

Problem Statement & Solution

Problem Statement

Invasive glucose monitoring devices, such as microneedle patches and continuous glucose monitors (CGMs), pose challenges like discomfort, high costs, and the need for frequent replacements. Microneedle patches, while effective, require skin penetration, while CGMs rely on sensors inserted under the skin that must be regularly replaced, adding expense and inconvenience for users.



Solution

These limitations highlight the need for a more accessible, non-invasive solution. By using light-based NIR technology, we aim to create a comfortable, reusable, and cost-effective device that continuously monitors glucose without skin penetration. This innovation would improve convenience and affordability, enhancing the quality of life for individuals requiring frequent glucose monitoring.

Data Source

- **Data Acquisition**

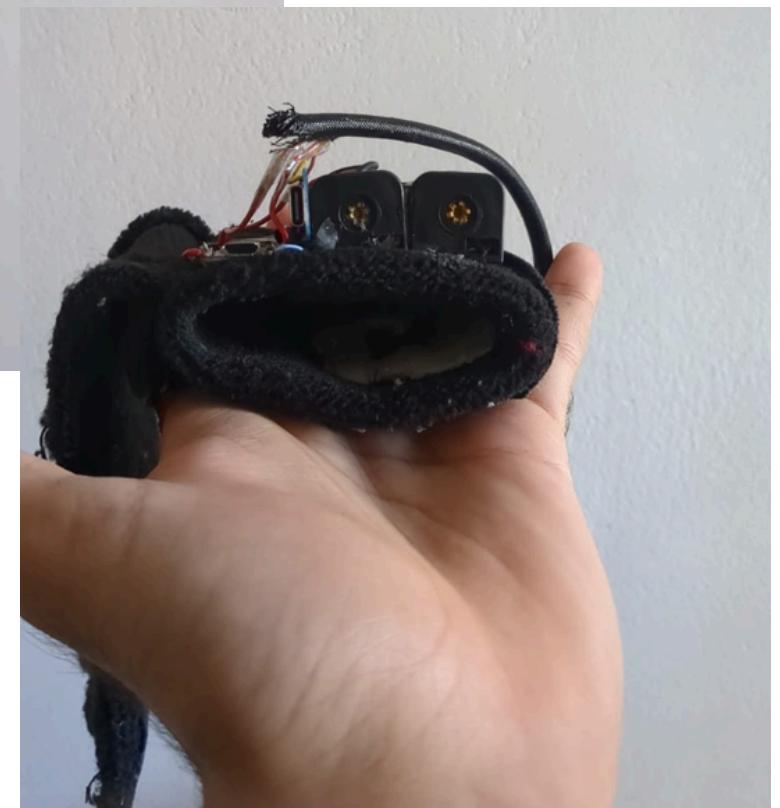
- Our device gathers data in real-time, following a prospective approach to continuously monitor glucose levels.
- The device uses NIR Spectrography technology with a 410 to 940 nm spectrum to capture glucose signature.

- **Sample Rate and Battery Life**

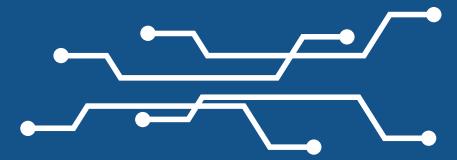
- Data is sampled every 5 minutes, capturing approximately 300 daily data points until the battery is depleted.
- Enhanced design includes a Samsung 18650 battery, offering 2 days of continuous operation.

- **Transmission**

- Data is transmitted via Bluetooth (the NRF Connect app) and UART, allowing easy real-time access and analysis.



Approach



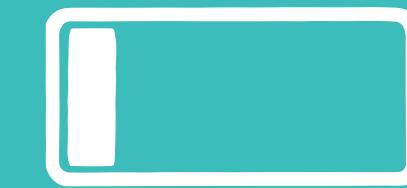
NIR
SPECTROGRAPHY
TECHNOLOGY



DATA
COLLECTION
AND
CORRELATION



CONNECTIVITY
AND
TRANSMISSION



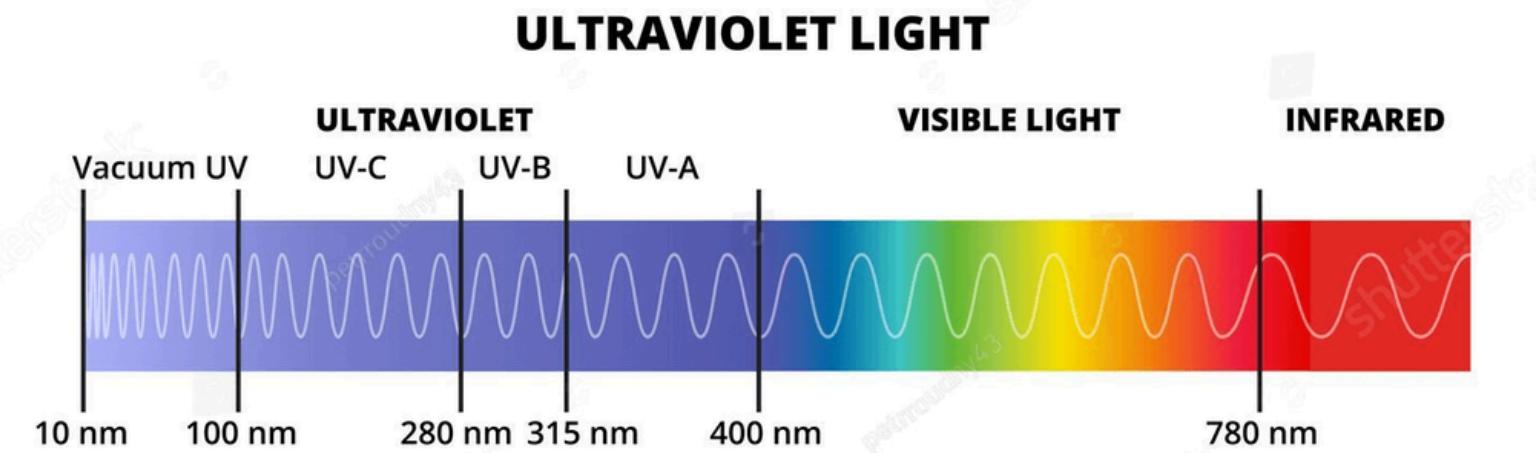
SAMPLING AND
BATTERY LIFE



LIGHT
SPECTRUM AND
SENSOR
VARIETY

Prototyping

- Our prototype, built on a tennis band, integrates sensors (NIR receivers and suitable LEDs for required spectrum) for versatility and comfort. It's designed for wrist-worn ease, making it ideal for daily use.
- **Hardware Integration:** Sensors are strategically positioned for maximum skin contact, ensuring reliable data collection. The compact design includes a rechargeable battery and a Bluetooth module for wireless connectivity to the NRF Connect app.
- **Data Transmission and App Interface:** With Bluetooth connectivity, data is transmitted to the NRF Connect app, where users can access glucose readings and trends. The app interface provides clear, real-time insights.
- **Charging and Usage:** The device supports continuous monitoring with a 5-minute sampling rate and requires a 2-hour charge for daily use, delivering a seamless experience with minimal intervention.



```
≡ Devices DISCONNECT :  
BONDED ADVERTISER GT TURBO F7:35:BA:AC:5B:81 X  
CONNECTED CLIENT SERVER :  
NOT BONDED 15:51:50.992 Services discovered  
15:51:51.080 Connection parameters updated  
(interval: 45.0ms, latency: 0, timeout:  
5000ms)  
15:51:53.879 Data written to descr. 00002902-0000  
-1000-8000-00805f9b34fb, value: (0x)  
01-00  
15:51:53.879 "Notifications enabled" sent  
15:51:56.750 Data written to 00002a56-0000-10  
00-8000-00805f9b34fb, value: (0x)  
01  
15:51:56.750 "(0x) 01" sent  
15:51:56.753 Notification received from 00002a56-00  
00-1000-8000-00805f9b34fb, value: (0x)  
D7-5F-00-00-D8-01-96-00-69-01-43-00-B1  
-00-5E-00-49-00-49-00  
15:51:56.753 "(0x) D7-5F-00-00-D8-01-96-00-69-  
01-43-00-B1-00-5E-00-49-00-49-00" received  
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Hypothesis



Main Hypothesis

Glucose levels can be measured using NIR spectroscopy.

Key Insight

At 940nm wavelength, the absorption is highest, making it the most effective channel for glucose monitoring.

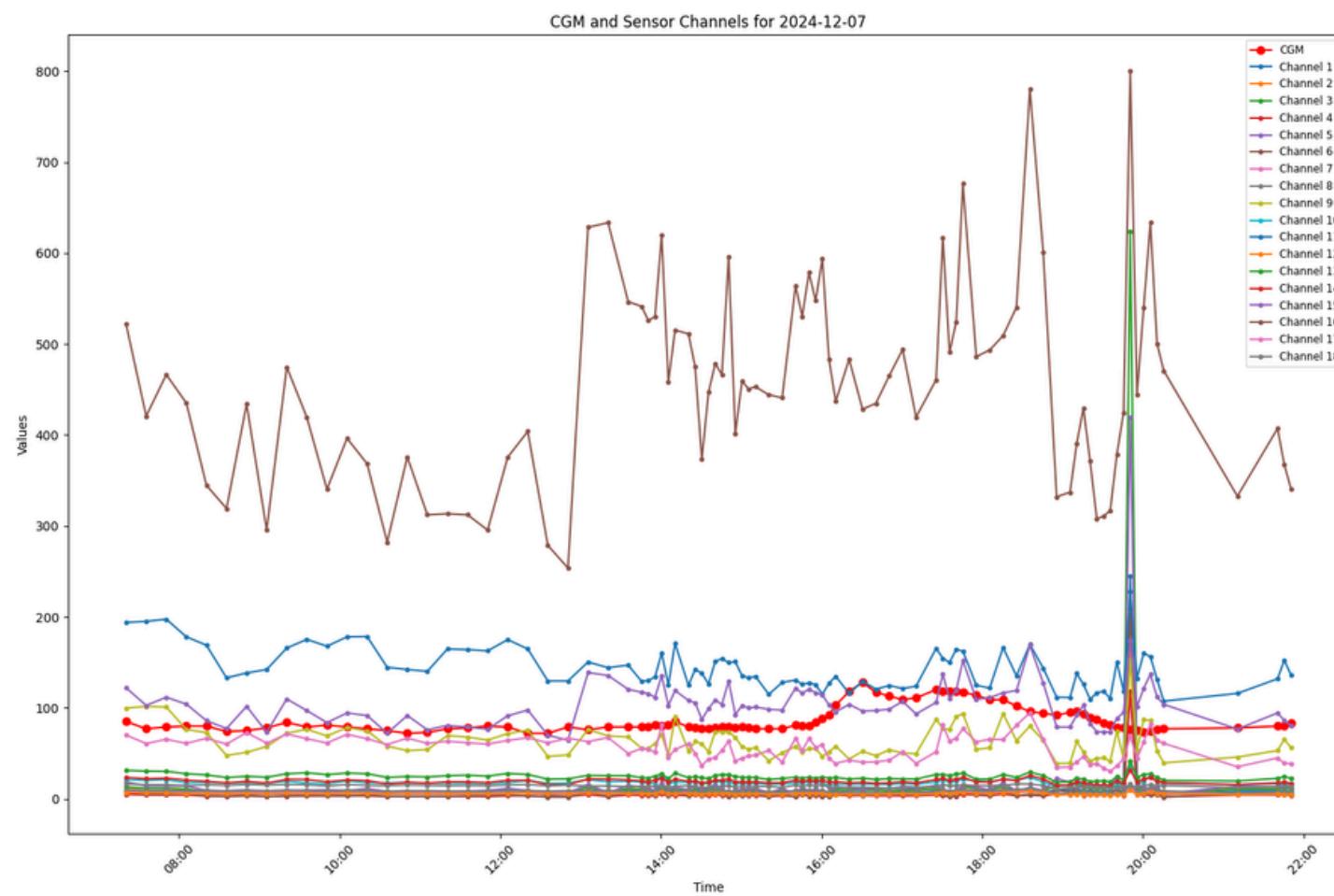


Light Absorption Concept

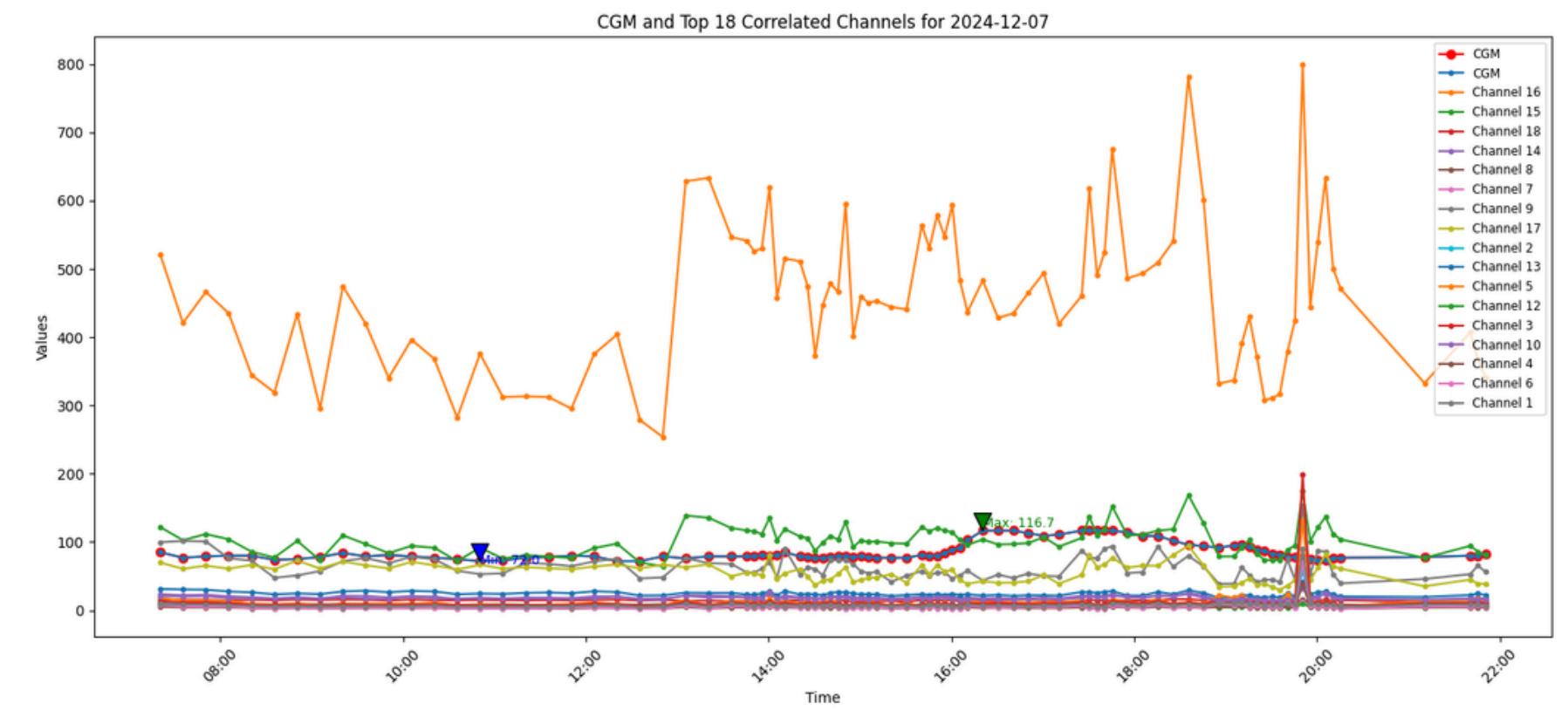
Higher glucose levels result in lower light intensity readings due to increased absorption of light.



Add Z score and detecting outliers and Normalising data



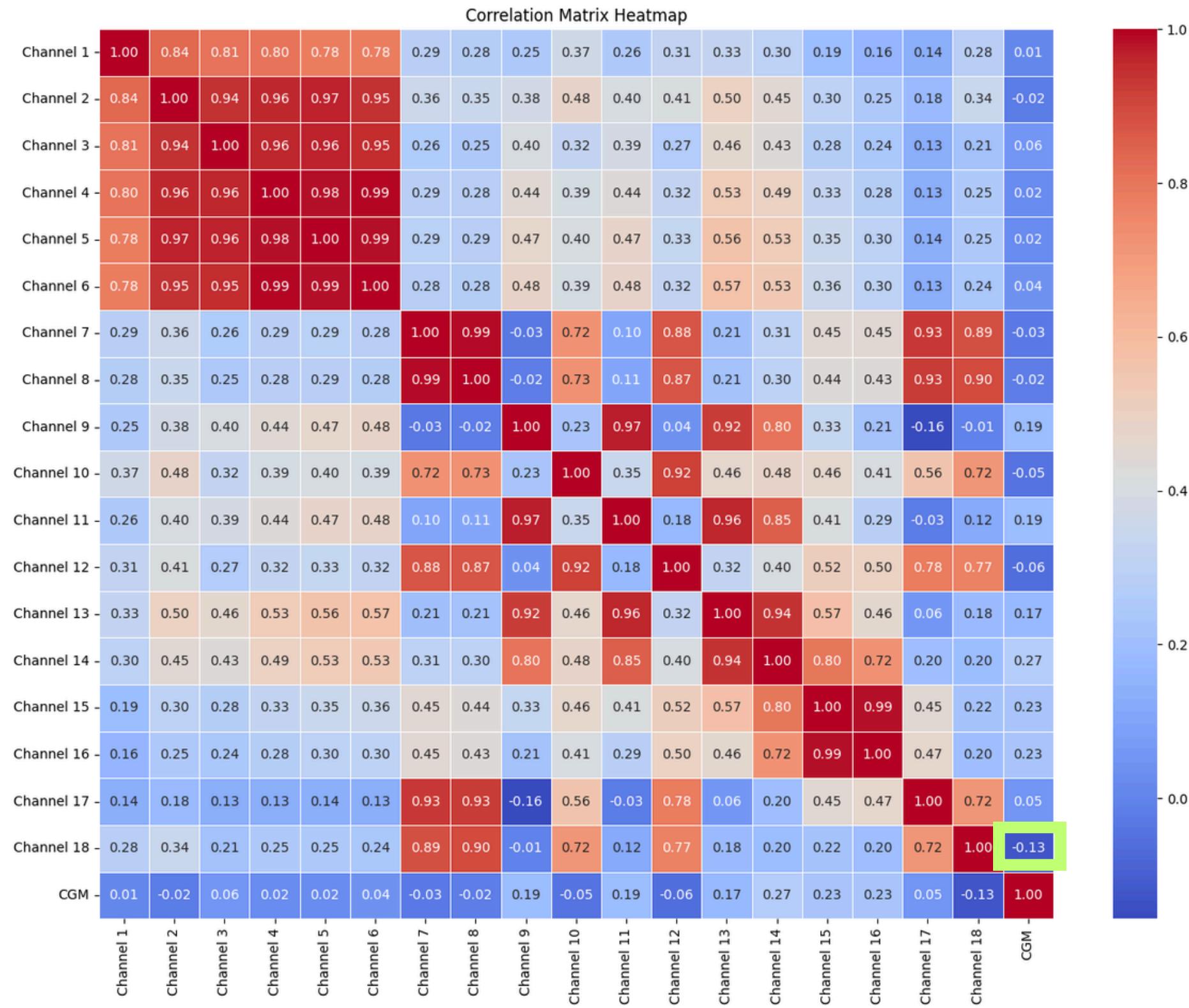
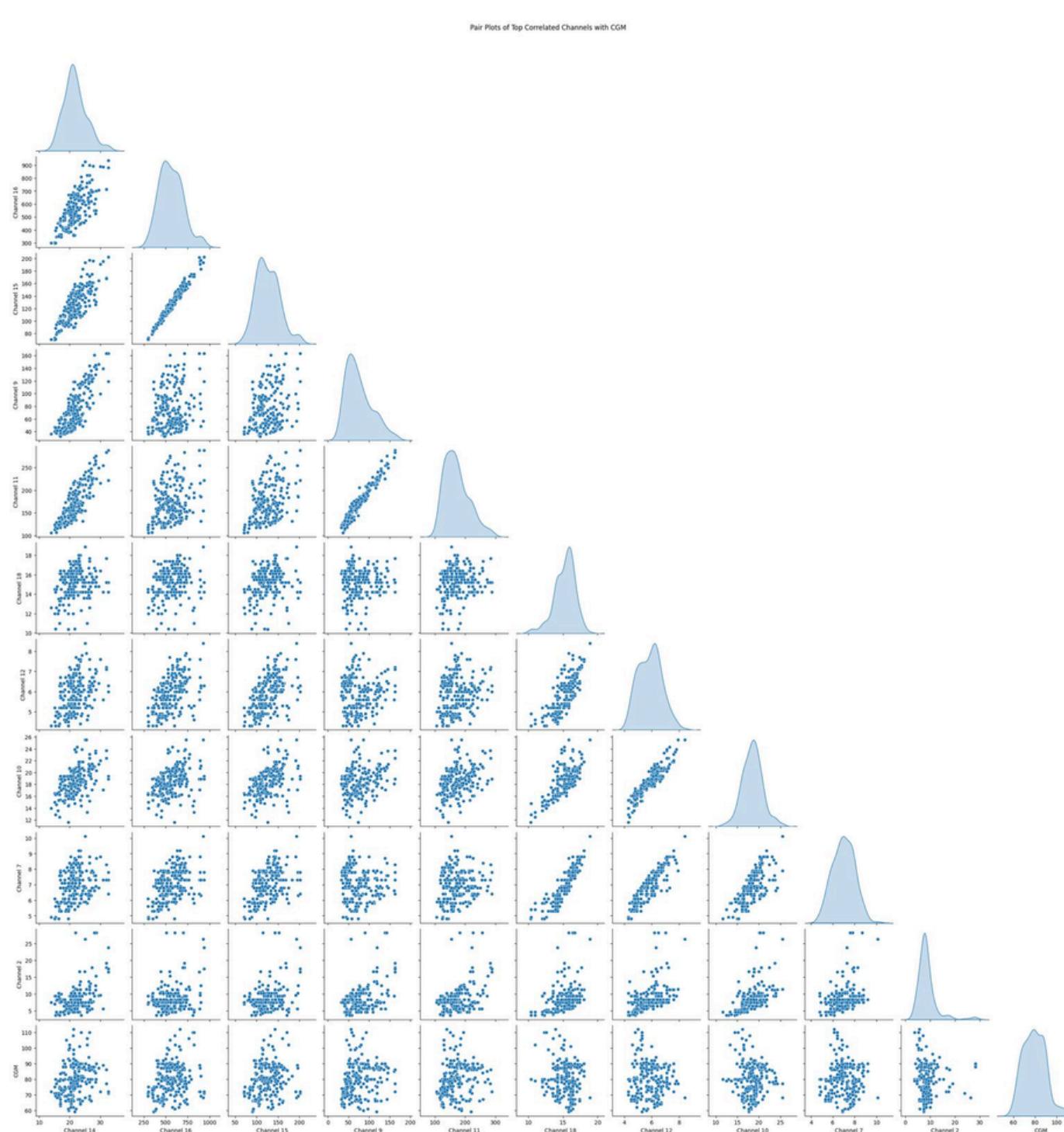
Before Processing



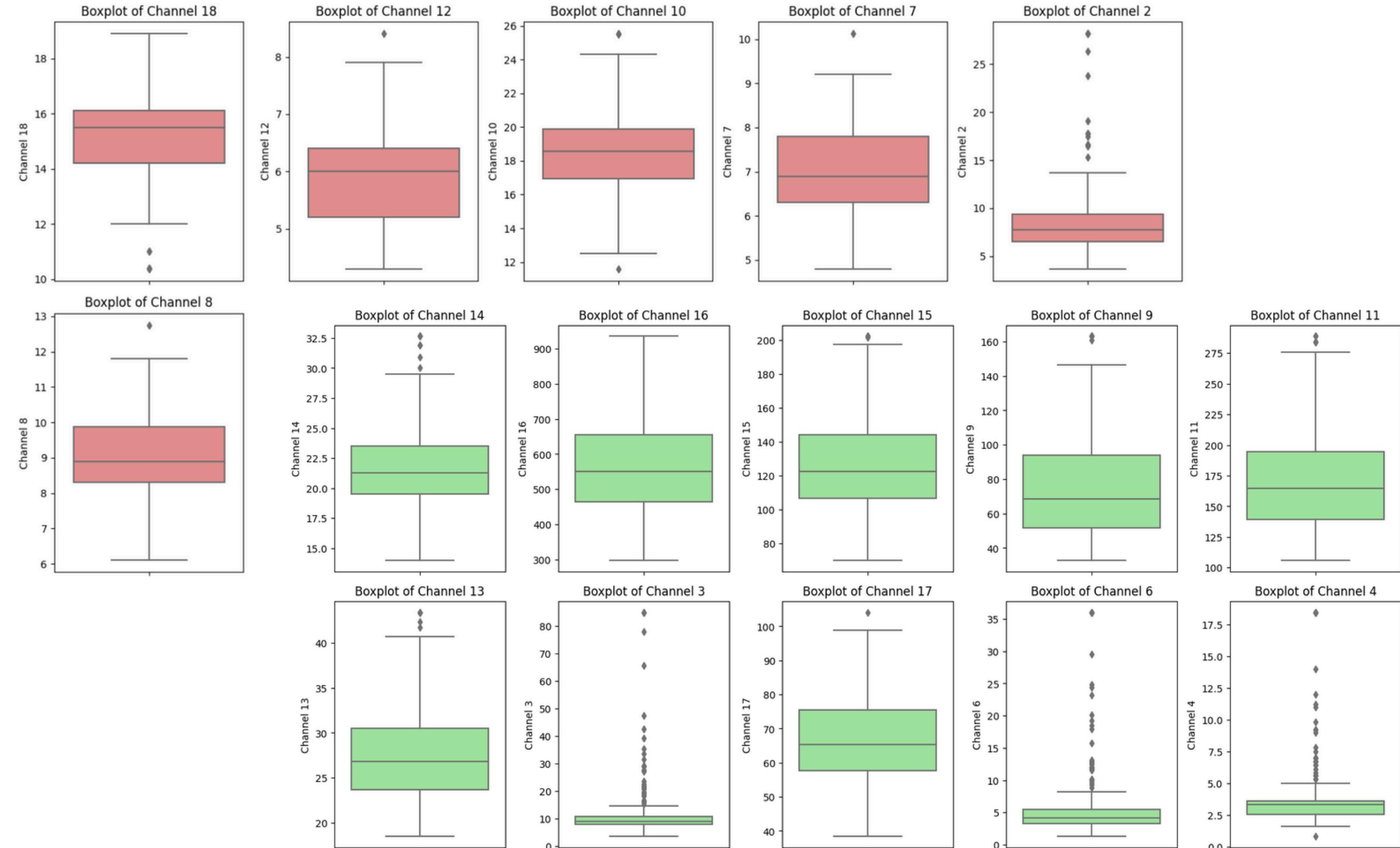
After Processing

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Channel 2	755.0	9.427658	4.996155	2.800000	7.50	8.4	10.30	58.020364
Channel 3	755.0	11.811418	17.340587	2.600000	8.00	8.9	11.30	198.284179
Channel 4	755.0	4.004136	3.761306	0.800000	2.50	3.3	4.20	38.937140
Channel 5	755.0	12.977278	12.369547	2.100000	8.20	10.6	13.80	130.986162
Channel 6	755.0	5.698372	7.343776	0.600000	3.30	4.2	6.00	70.628461
Channel 7	755.0	6.570203	1.237976	3.900000	5.80	6.4	7.30	12.850596
Channel 8	755.0	8.520505	1.491681	5.200000	7.60	8.4	9.30	15.780255
Channel 9	755.0	67.763188	28.915783	7.400000	47.75	61.6	81.05	190.453322
Channel 10	755.0	18.275679	2.932260	11.200000	16.50	17.9	19.60	32.587540
Channel 11	755.0	157.575741	38.835235	29.600000	129.60	154.5	177.90	280.836896
Channel 12	755.0	5.708144	0.970056	3.500000	5.00	5.6	6.30	9.368619
Channel 13	755.0	26.288612	5.395990	9.300000	22.70	25.8	28.70	44.425579
Channel 14	755.0	20.795415	4.034687	12.100000	17.80	20.5	22.90	33.527649
Channel 15	755.0	116.833103	30.641973	64.300000	94.40	109.2	136.90	206.527576
Channel 16	755.0	518.234034	151.978498	253.800000	399.30	475.8	618.65	948.943972
Channel 17	755.0	59.581846	14.824315	29.900000	49.50	59.1	68.30	109.249233
Channel 18	755.0	14.473103	1.523623	9.807635	13.40	14.5	15.50	19.127161
CGM	755.0	82.266743	10.247112	59.000000	76.00	80.0	87.00	116.673856

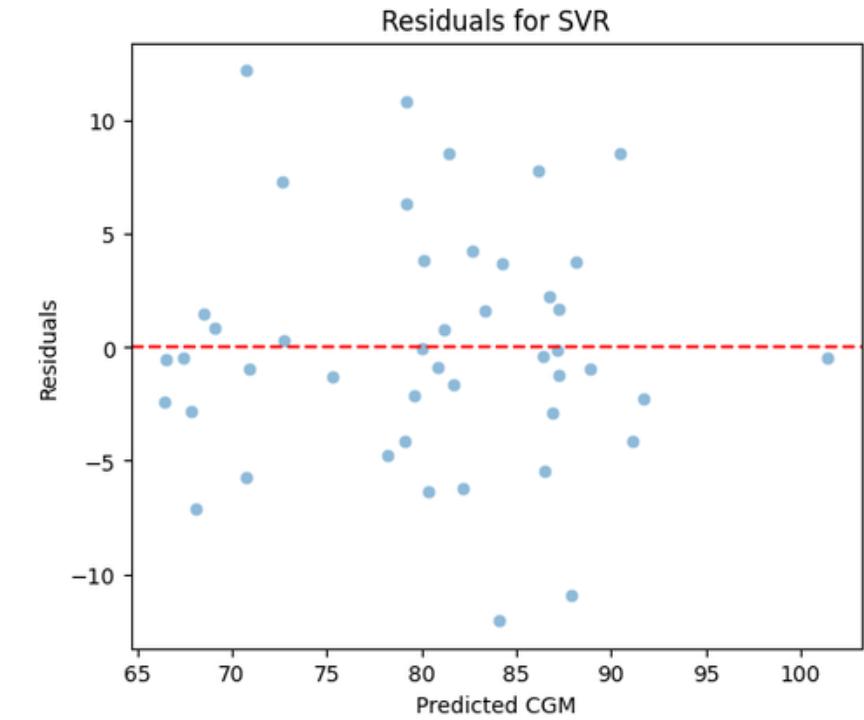
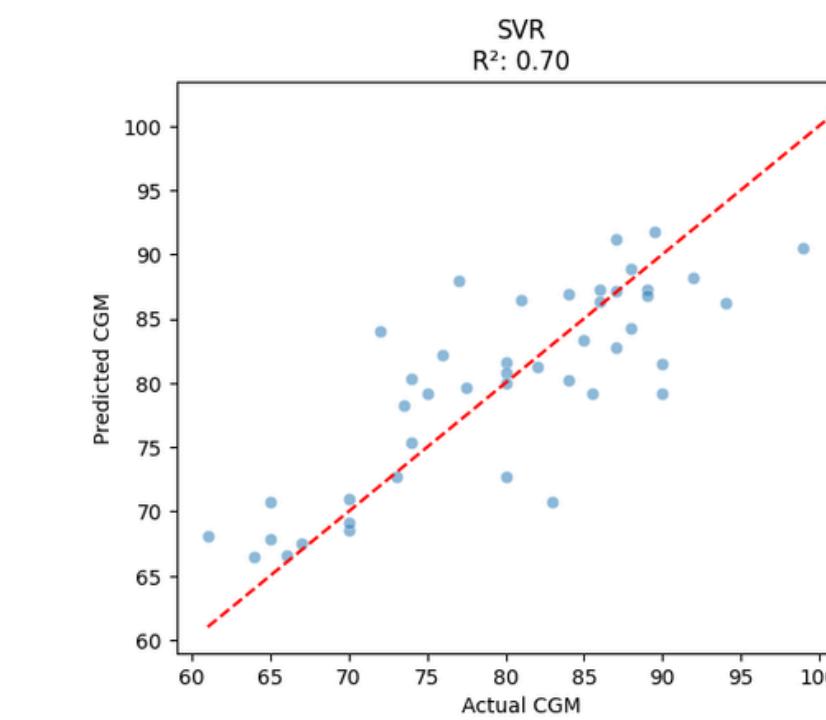
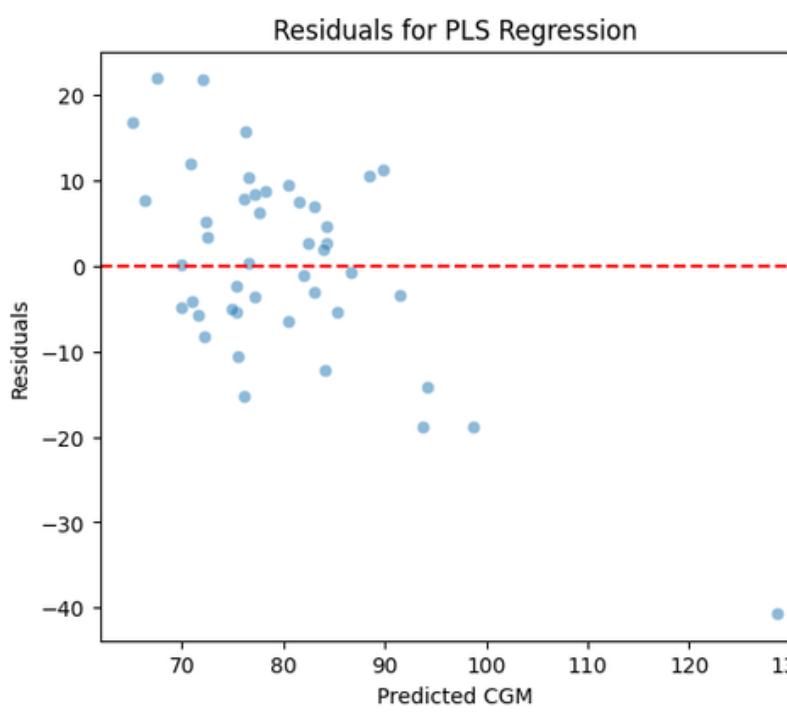
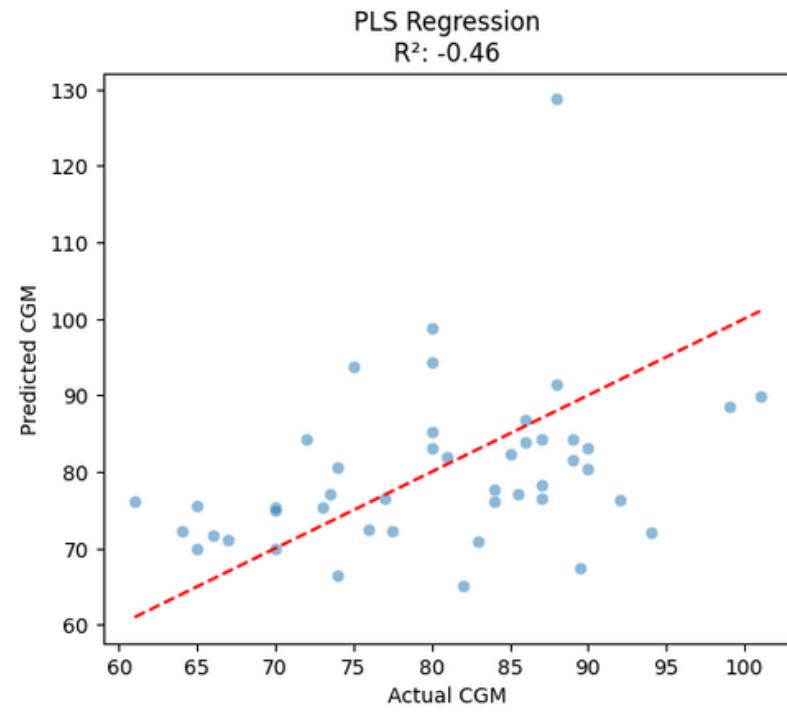
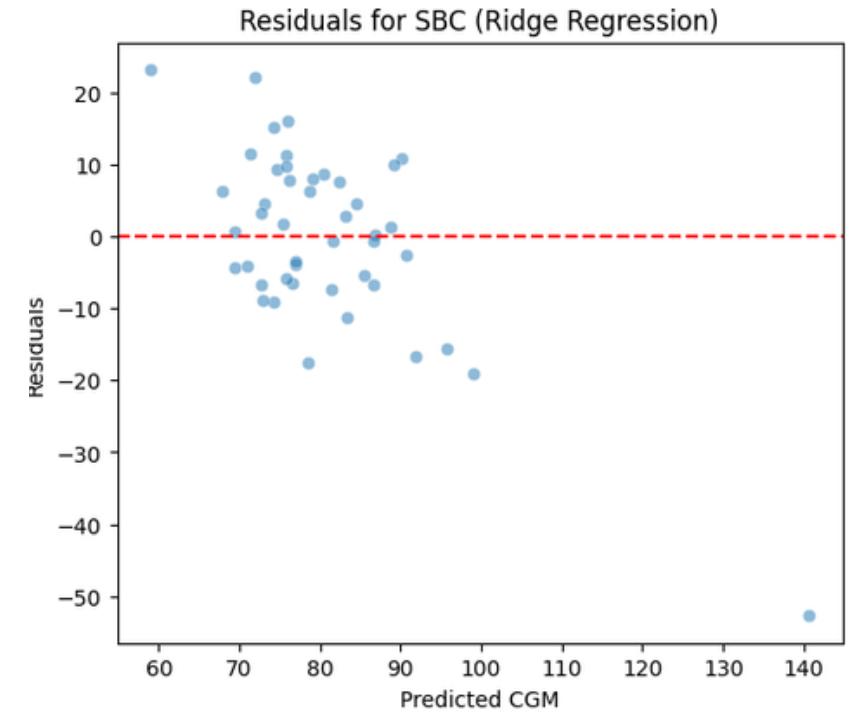
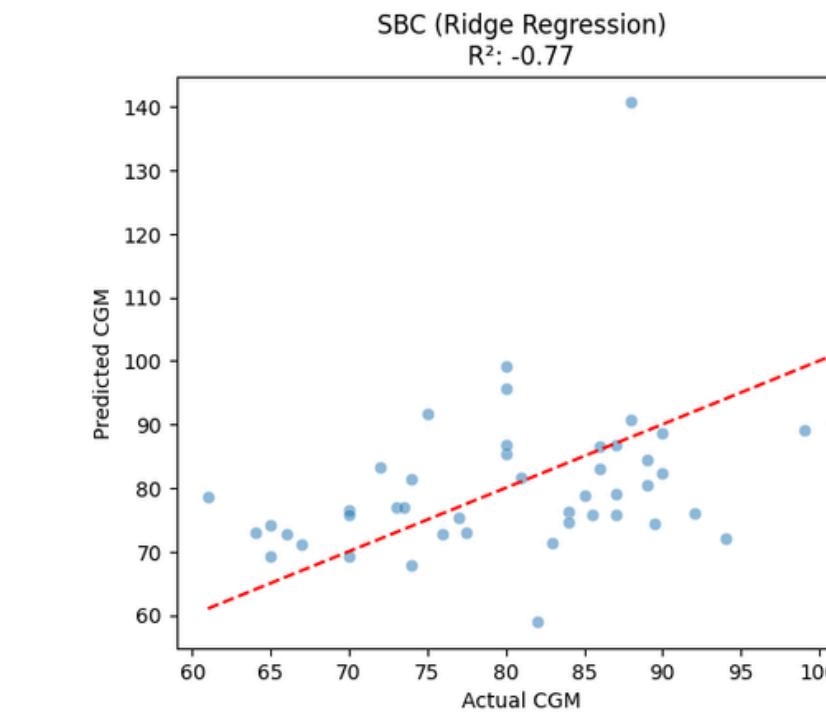
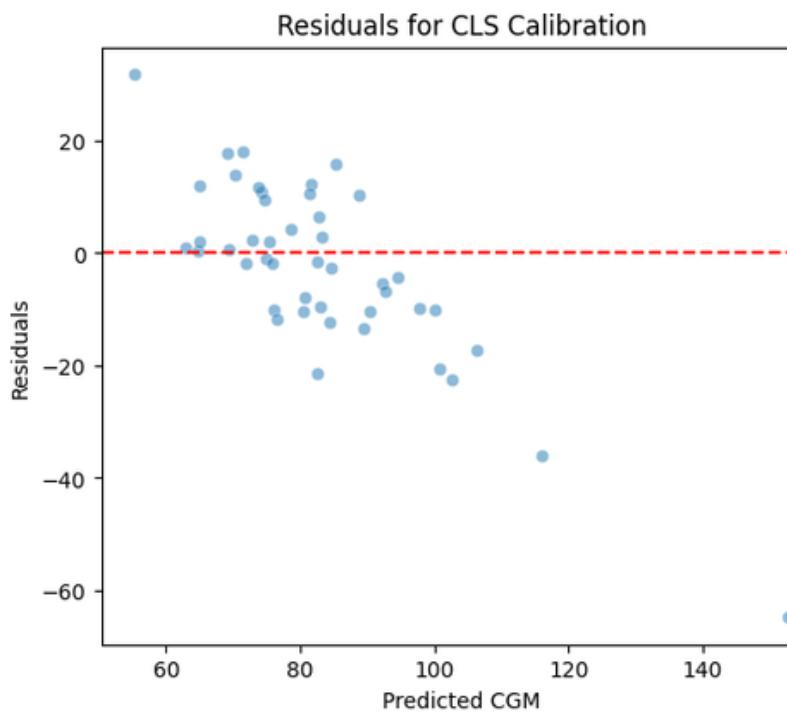
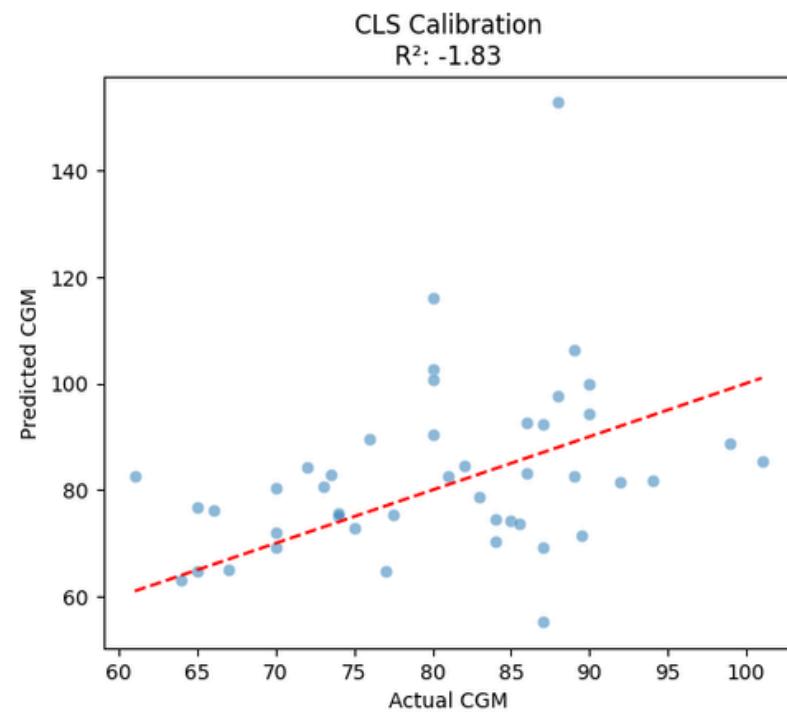
Data Visualisation



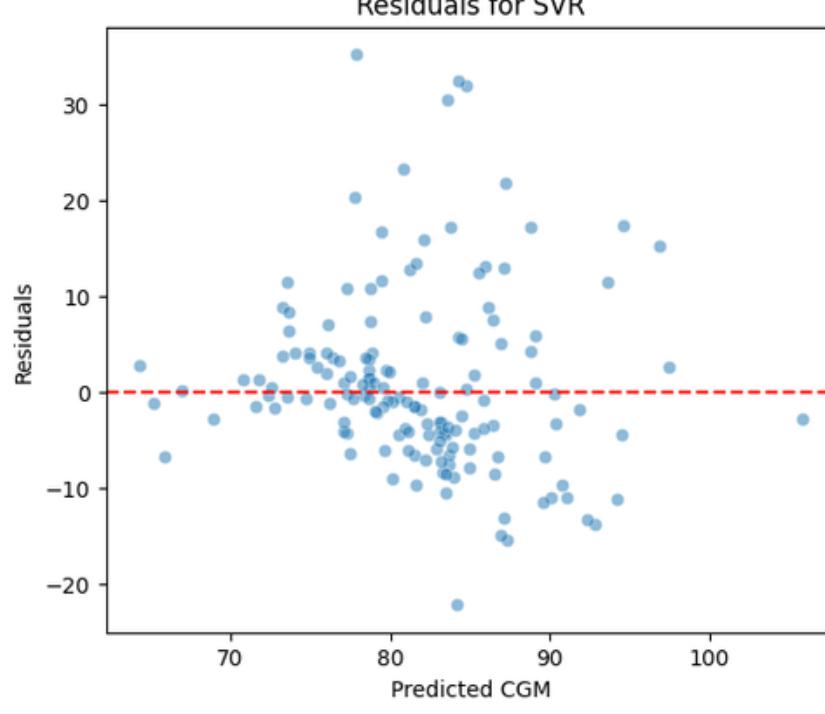
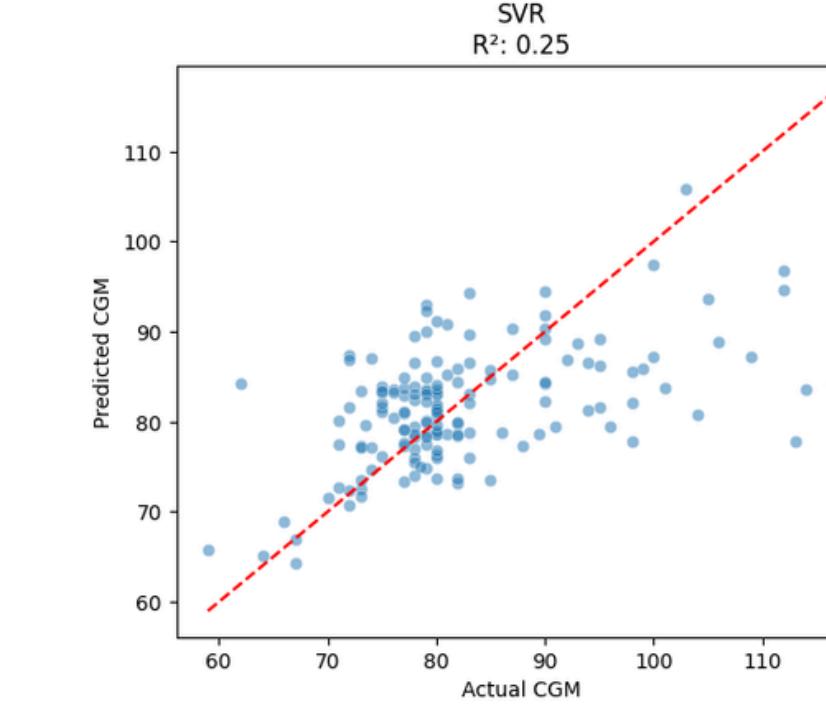
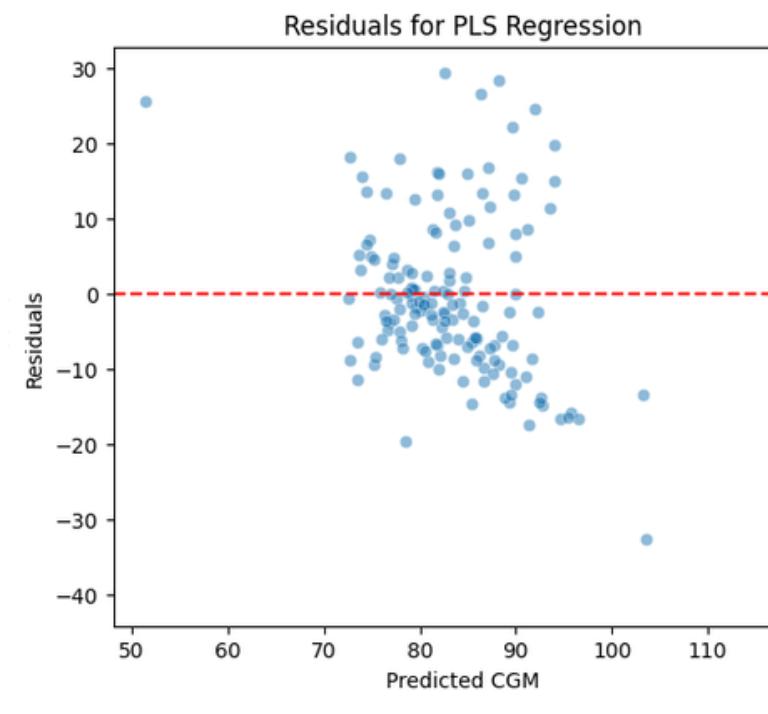
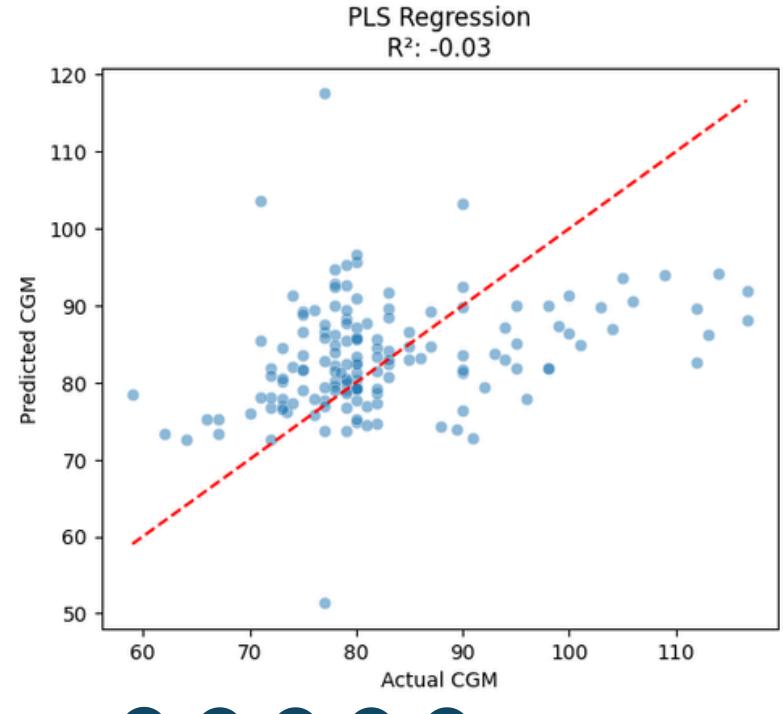
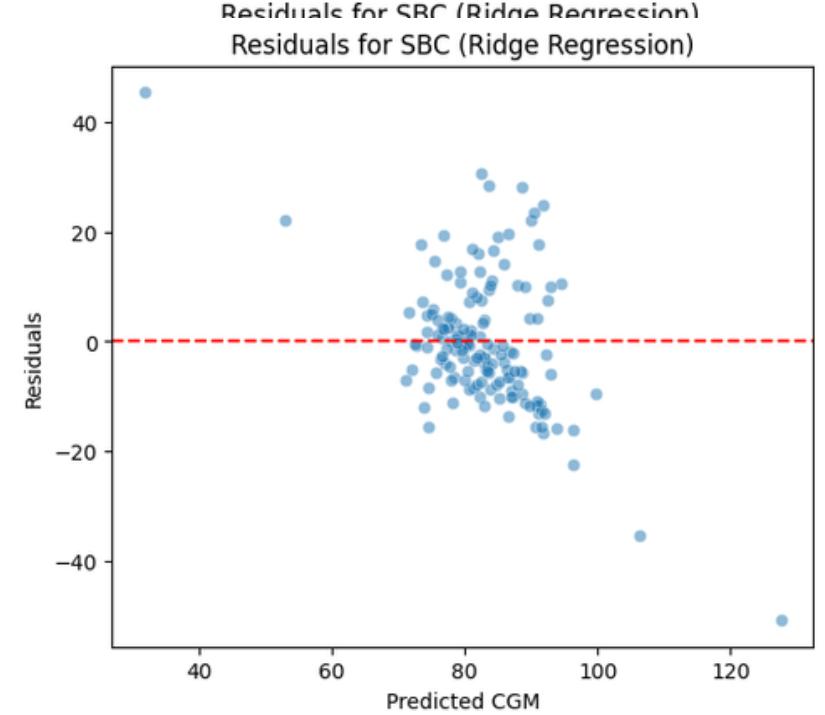
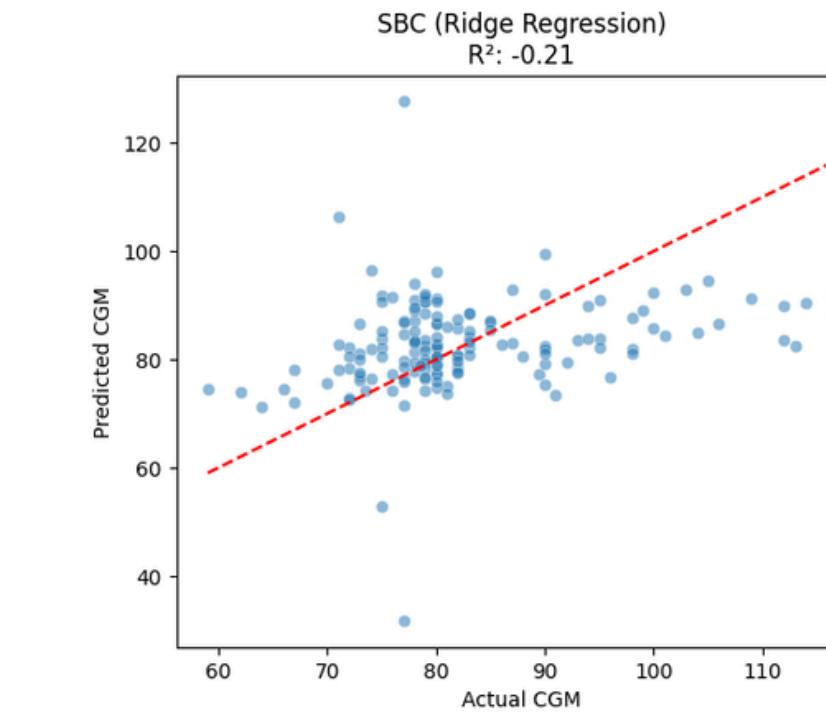
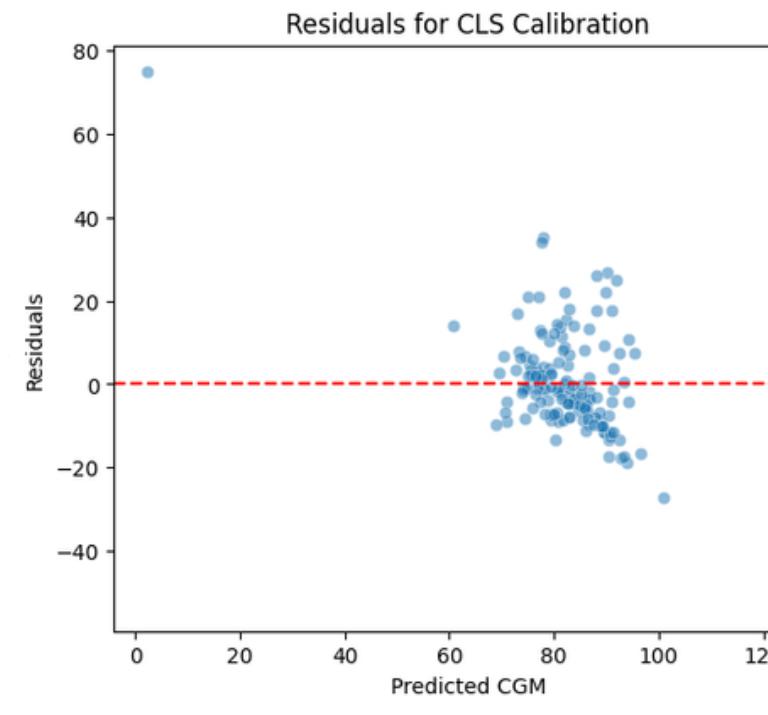
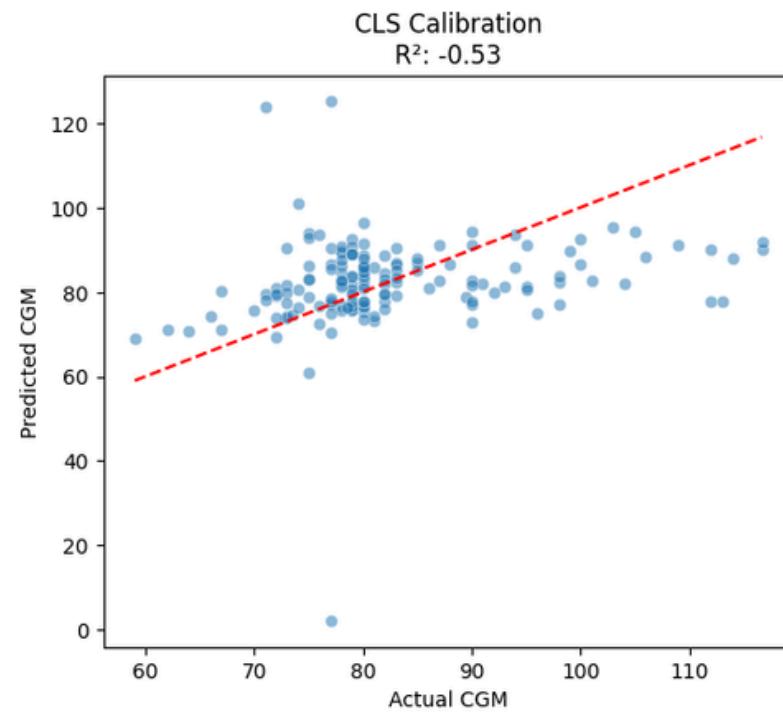
Box Blot and Feature Engineering



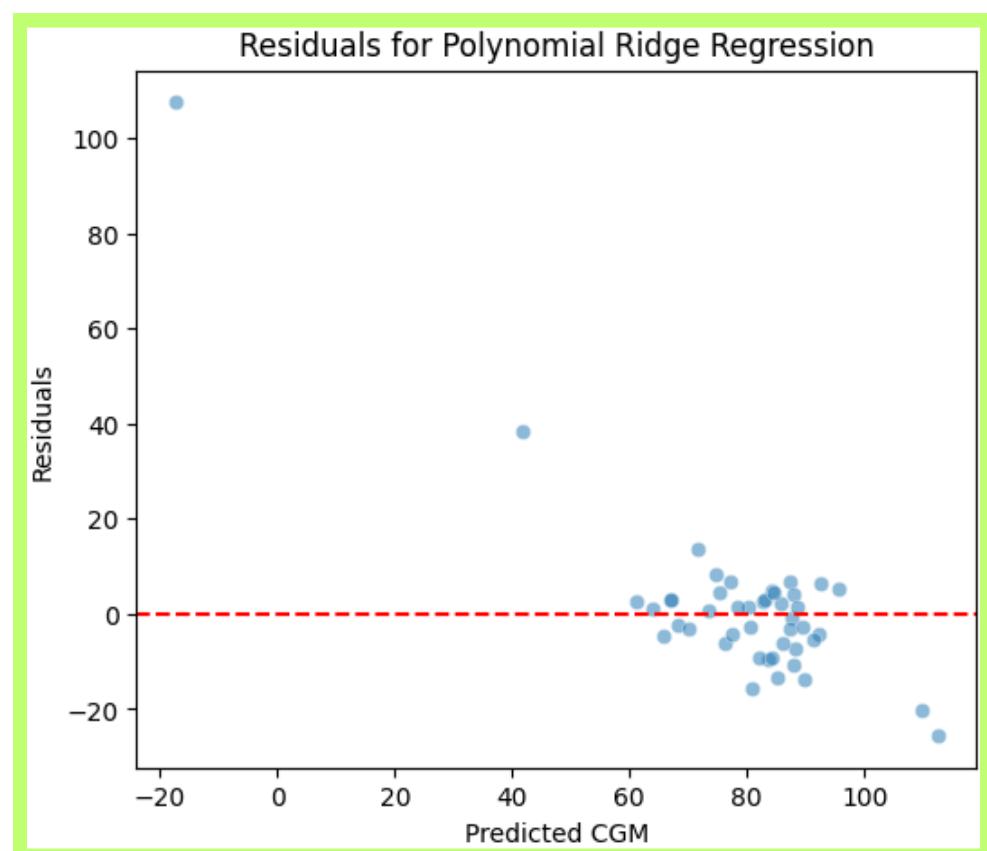
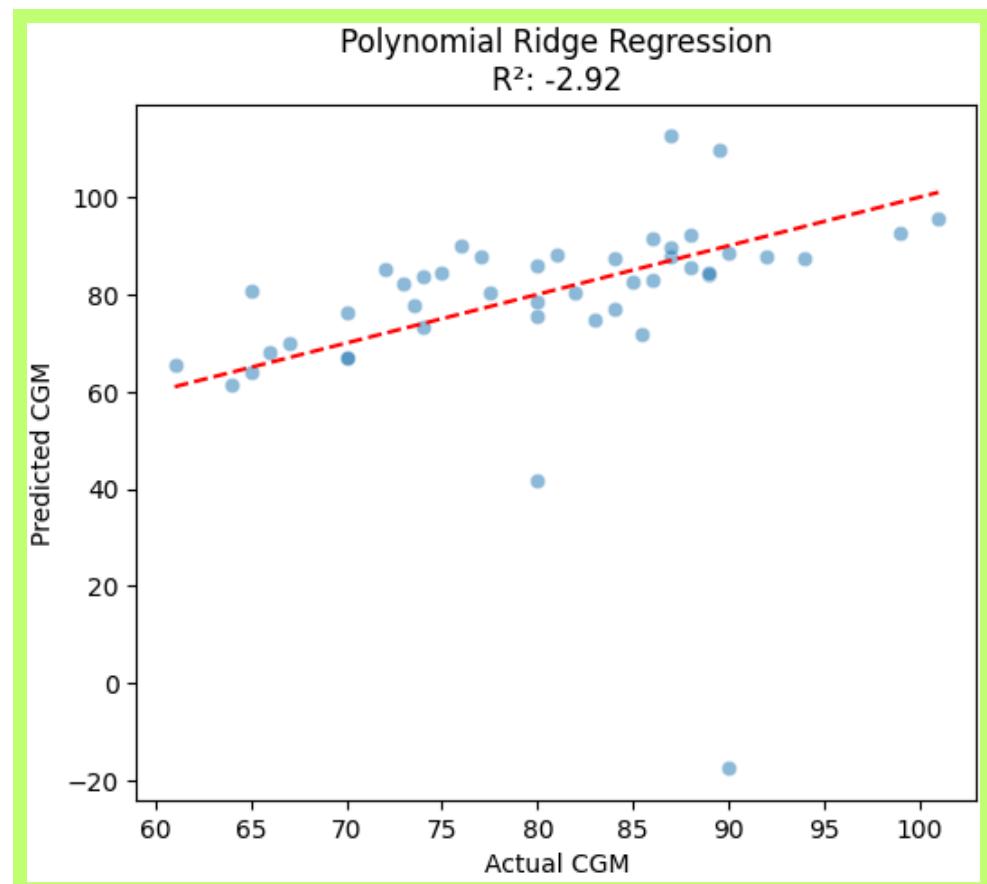
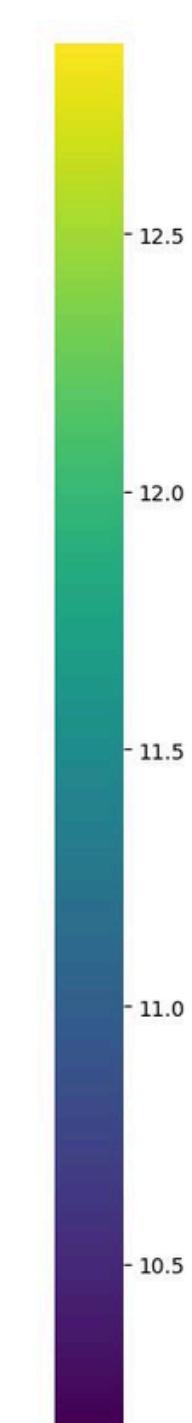
Analysis



Analysis with More Data



Analysis



Vision & Challenges



Vision

Our vision is to enhance the accuracy of our non-invasive device by continuously refining data models. By comparing our data against invasive device accuracy, we aim to create a reliable, user-friendly solution that provides consistent glucose monitoring without the need for skin penetration.



Technical Issues

- finding the right sensor.
 - increasing the battery life.
-

User Issues

- User has to avoid sweating.
 - It starts heating up at the beginning.
-



Citations



[Link1](#)

[Link2](#)

[Link3](#)



Individual Contribution

• • • •

Rudraksh & Sanjana:

- Hardware design and setup
- Real-time data extraction and integration with NRF Connect

Akshay, Vijay & Trilok:

- Database creation and management
- Ensured efficient storage and retrieval of data

Shubham, Aditya & Hardi:

- Data analysis and visualization
- Interpreted sensor readings and correlation with glucose levels

• • • •



Thank you

