MEG Data Analysis

1 What is MEG?

Magnetoencephalography (MEG) is a neuroimaging method used to track and record the magnetic fields produced by the brain during various activities. These magnetic signals are extremely weak, requiring highly sensitive sensors such as **SQUIDs** (Superconducting Quantum Interference Devices) to detect them accurately. These sensors are placed within a helmet-like device that sits over the head and records the brain's magnetic activity.

Due to the weak nature of MEG signals, MEG systems are typically housed in **magnetically shielded rooms** to minimize interference from external magnetic sources such as power lines, electronic devices, and vehicles. This shielding ensures a high signal-to-noise ratio, allowing for more precise data collection and analysis.

MEG is widely used in **neuroscience, clinical diagnostics, and brain-computer interface research** to study brain function, identify epileptic activity, and analyze cognitive processes.

2 Tools Used

To analyze and manipulate the MEG dataset, we used **MNE-Python**, a Python module designed for processing, analyzing, and visualizing functional neuroimaging data. MNE-Python supports multiple neuroimaging data, such as **EEG, MEG, ECoG, fNIRS, and sEEG**.

2.1 Python Packages Used

- `os` → Used to handle file paths
- `mne` → The package used for MEG data processing and visualization
- `matplotlib.pyplot` → For plotting MEG signal

2.2 Functions Used

- `raw.info` → Displays metadata about the dataset (e.g., sampling rate, channel names, bad channels, etc.)
- `raw_meg = raw.pick(['meg'])` → Extracts only the MEG channels from the given dataset
- `raw_meg.drop_channels(raw_meg.info['bads'])` → Removes bad channels from the dataset for cleaner analysis

- `raw_meg.plot(duration=10, n_channels=5)` → Plots 5 MEG channels over a 10-second window

These tools and functions allowed are used to preprocess and visualize the MEG signals effectively.

3 Understanding the Graph

When plotting MEG signals, the **X-axis** and **Y-axis** represent key aspects of the brain's magnetic activity.

3.1 X-axis: Time

The X-axis represents **time** in seconds, showing how the MEG signals change over time. This helps in tracking neural responses to different stimuli or events.

3.2 Y-axis: Magnetic Field Strength

The Y-axis represents **the strength of the recorded magnetic fields**. MEG signals are typically in the femtoTesla ((ft)) range because the brain's magnetic fields are incredibly small.

3.3 Graph Interpretation

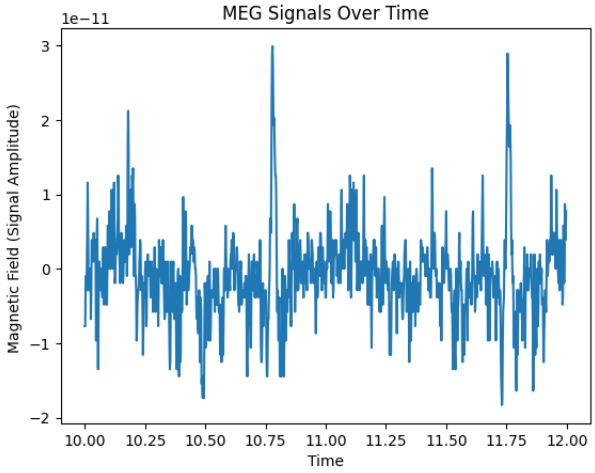

Figure 1: MEG Signal

- Each line in the plot represents the activity recorded by a different MEG sensor over time.
- Peaks and dips in the signals correspond to neural activity fluctuations.
- The plotted data can be analyzed further using filtering techniques to remove noise and highlight brain responses to specific tasks or stimuli.

By understanding these elements, we can interpret brain activity patterns and gain insights into neural processes.