### 🧠 ****EEG Movement Task Analysis – Beta Power Extraction with EEGLAB & FieldTrip****

#### **Study Design**

* Participants perform ***N* self-paced movement trials**.
* EEG is recorded continuously during the task.
* Each trial includes 3 triggers:
  + **232**: Movement onset
  + **226**: Halfway through movement
  + **228**: Movement offset
* Movement duration varies across trials.

#### **Current Data Status**

* EEG data is already epoched in **EEGLAB** from **-3s to +8s** around **trigger 232**.
* **Preprocessing and ICA-based artifact rejection** have already been completed in EEGLAB.
* Data is saved as **.set files** with **equal-length epochs**.

### 🧪 ****Analysis Goal****

For each trial:

1. Extract a **new epoch** from **-1s before trigger 232** to **+1s after trigger 228** (variable-length per trial).
2. Calculate **beta power (13–30 Hz)** using **FFT**.
3. For each trial, compute average beta power in the following **5 time windows**:
   * preMov: -1s to 232 (movement onset)
   * earlyMov: 232 to 226 (first half of movement)
   * fullMov: 232 to 228 (entire movement)
   * lateMov: 226 to 228 (second half of movement)
   * postMov: 228 to +1s
4. Export results to Excel with columns:
   * MovDur (duration between 232 and 228)
   * preMov, earlyMov, halfMov, lateMov, postMov (average beta power)

### ❓****Key Questions****

1. Can **EEGLAB** handle **variable-length epochs** in a single .set file?
2. Should I create **one EEGLAB file per trial** with the appropriate epoch length?
3. Is there a **better way to reduce memory load**, e.g., by extracting new epochs in **FieldTrip**?
4. How do I **calculate beta power** using **FieldTrip** (e.g., which function to use, how to handle padding)?
5. How to **avoid artifacts** due to variable-length padding?
6. How to **export the results** (beta power averages + movement duration) to **Excel**?
7. Generate a complete MATLAB script for this workflow with trial window extraction and beta power computation included?

**✅ 1. Can EEGLAB handle variable-length epochs in a single .set file?**

**No**, EEGLAB expects all epochs in a dataset to be of equal length. Variable-length epochs would break assumptions in many EEGLAB functions.

**✅ 2. Should I create one EEGLAB file per trial with the appropriate epoch length?**

**Not recommended.** Managing hundreds of .set files is inefficient and error-prone. Instead:

* Use **FieldTrip**, which supports variable-length trials natively.
* You can import your preprocessed EEGLAB data into FieldTrip and extract custom epochs per trial.

**✅ 3. Is there a better way to reduce memory load, e.g., by extracting new epochs in FieldTrip?**

**Yes.** FieldTrip is designed for flexible trial definitions and memory-efficient processing. You can:

* Import your EEGLAB .set file using ft\_preprocessing.
* Define trials using ft\_definetrial with a custom trial function that reads triggers 232 and 228 and creates variable-length epochs.

**✅ 4. How do I calculate beta power using FieldTrip (e.g., which function to use, how to handle padding)?**

Here’s a suggested pipeline:

1. **Define trials** using ft\_definetrial with a custom trial function.
2. **Preprocess** with ft\_preprocessing (you can skip filtering if already done).
3. **FFT-based power**:
   * Use ft\_freqanalysis with method 'mtmfft' and frequency range [13 30].
   * Set cfg.pad = 'maxperlen' to avoid zero-padding artifacts.
   * Use cfg.output = 'pow' and cfg.foilim = [13 30].
4. **Extract time windows**:
   * Use ft\_selectdata or manually average power values over time windows using trial timing info.

**✅ 5. How to avoid artifacts due to variable-length padding?**

* Use **cfg.pad = 'maxperlen'** in ft\_freqanalysis to avoid artificial zero-padding.
* Alternatively, use **wavelet or multitaper time-frequency analysis** (ft\_freqanalysis with 'mtmconvol') if you want time-resolved beta power.

**✅ 6. How to export the results (beta power averages + movement duration) to Excel?**

You can:

* Store results in a MATLAB struct or table.
* Use MATLAB’s writetable() or xlswrite() to export to Excel.
* Columns: Trial, MovDur, preMov, earlyMov, fullMov, lateMov, postMov.