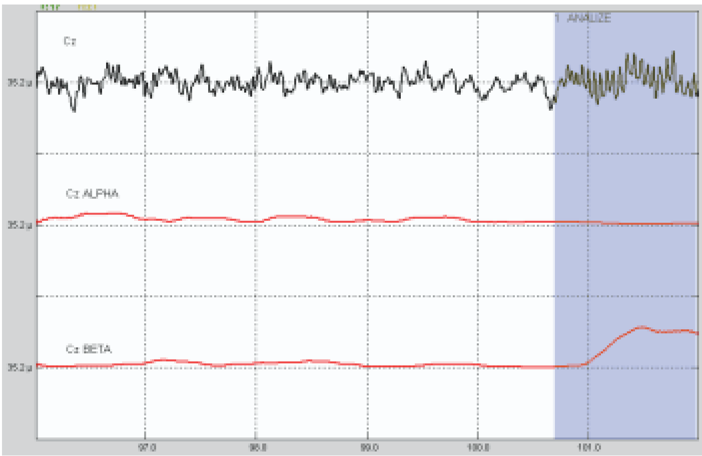
# Application example – Classification of EEG alpha and beta band patterns
# Classify toolbox

GUGER TECHNOLOGIES

## Feature extraction

EEG during **right** hand and **foot** movement imagery was recorded over electrode positions C3 and Cz. The type of movement imagery was given via experimental instructions on the computer screen. A total of 160 imaginations of movements were performed (80 hand and 80 foot movements).

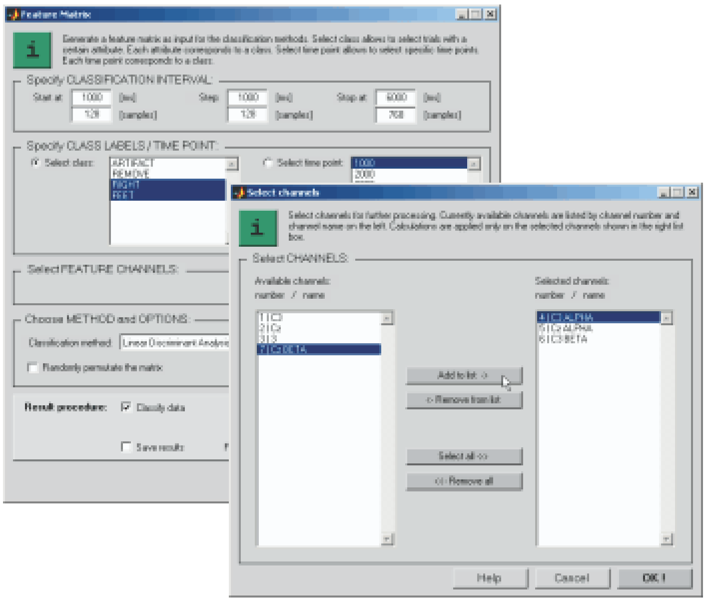
The **first step** in data set classification is to define features best describing the signal patterns. In this case, the band power features in the ALPHA and BETA bands are computed for the 2 EEG channels. The computation yields 2 feature channels per EEG channel.




## Feature matrix generation

The **second step** is to generate learning examples at certain time points for the training phase of the used classifier. The classifier also needs - in supervised learning - the class information, i.e. to which type of movement a certain EEG pattern is related. The following steps explain how to select the time points, the class information and an appropriate classifier.

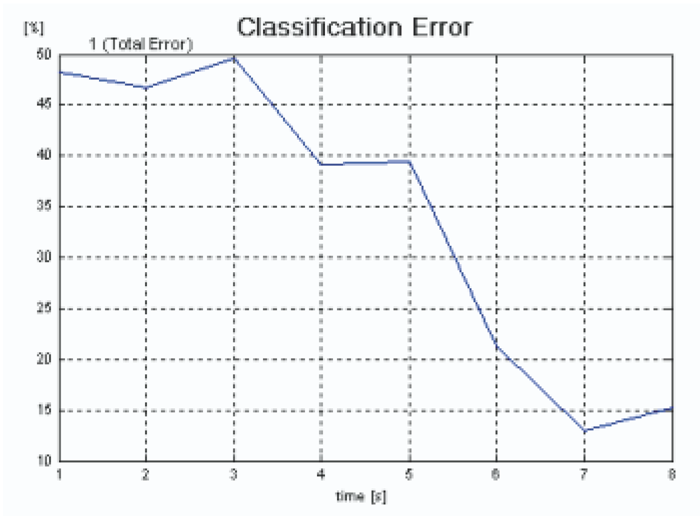
- The classification interval is specified between 1000 and 6000 ms
- EEG patterns for **RIGHT** and **FOOT** movement imagery classes are selected for classification
- The ALPHA and BETA band power are selected as feature channels
- The classification method **Linear discriminant analysis** is selected




## Classification results

The **third step** is to classify the features by the chosen classification method. As a result of the classification, an error curve is computed, yielding information about the successful or unsuccessful classification as function of time. The result below is based on a 10 times 10 cross-fold validation of the input data. This means that 90% of the input examples are chosen randomly for training of the classifier. The classification of the data is done on the remaining 10% of the examples. This yields the first classification results. In a second run, another 90% of the data are randomly selected, and a second classification on the remaining 10% of examples is performed. This procedure is repeated 10 times, yielding an average error curve.

The selected features and class information now define the feature matrix, which is the basis for classification via a selected classification method. The classification error (figure to the right) for the movement imagery experiment shows that the classification error at the beginning of the imagination is around 50 %. At second 7, the error drops down to about 13 %. Therefore, RIGHT and FOOT movement imagery patterns can be discriminated successfully.




## DSLVQ Feature weighting for most relevant feature identification

***g.CLASSIFYtoolbox*** can perfom a **fourth step** in data set classification! In order to identify the most relevant feature contributing to the discrimination task, the method of Distinction Sensitive Learning Vector Quantization (DSLVQ) can be applied. The linear vector quantizer classifier is initially trained on all features. Through implicit feature relevance analysis, the system finds non-relevant features and adapts the weighting of the features accordingly.

For the RIGHT and FOOT movement imagery experiment, a total of 4 feature channel were created. For channels C3 and Cz, the band power in the ALPHA and BETA bands were computed. The graphs to the right yield an overview about the contribution of the individual features to the classification result.

At second 1, feature 1 is the most important one, followed by 4, 2 and 3. But the classification error is 51,75 % and therefore the result is random.

At second 7 the error is 11,75 % and therefore the feature weighting can be considered reliable. Therefore, feature 4 (bandpower in the beta range of channel 2) is the most important one. The bar of feature 3 is much smaller, but the feature can still be considered as important for the classification task. Features 1 and 2 are not important and should not be considered for the discrimination.