

# Summary of lock loss study in O4c

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### Main problem to solve

We want to study the relation between lock loss events and the patterns in several channels, to find possible reasons for lock loss events to happen, e.g. earthquake.

Specified to this week, we want to study the pattern in `K1:VIS-ETMY_MN_OPLEV_TILT_VER_OUT_DQ` channel and its relation to the human-labeled `ETMY` lock loss events.

### Pipeline developed

We analyzed by human eyes that in most cases, `ETMY` lock loss events have a step-like feature in their temporal distribution.

The step-like feature requires both a jump and flat step surface before and after the jumping point (Can refer to the slides for plots). So we developed a pipeline to take into account both features to search for such a feature.

The pipeline would ask for the absolute jump of the step to be larger than a certain threshold to make sure there's a 'jump', and the maximum standard error, maximum range for distribution and the maximum drift of the step surface to be smaller than certain thresholds to make sure the step-surfaces are 'flat'

The flow chart of the pipeline is also presented in the slides.

### Results

#### Classification within the lock loss events

Using the pipeline to do the classification of lock loss event to be whether `ETMY` type or not and using certain hyperparameter sets, we can achieve TNR = 0.125 and FPR = 0.0048 (totally 8 `ETMY` )

Only two of the lock losses are mis-classified, with ID 159 to be not an `ETMY` labeled lock loss but has step-like feature and ID 174 to be a `ETMY` labeled lock loss but has no step-like feature.

#### O4c science segment study

We applied the pipeline to the data in science segment in O4c, to make sure no step-like feature will exist in science modes. Due to running time limit, we only perform the test for the first 10 days of O4c.

We didn't see any step-like feature in O4c science segment data.

We have to note here that at this stage we CANNOT say that such step-like feature is closely related to the `ETMY` lock loss events due to both existence of anomalies and total number of lock losses for O4c is highly limited to reach a concrete conclusion.

### Future plans

- A more careful fine-tuning of the threshold can be performed to further improve the classification.
- Other channels for OPLEV of MN of ETMY/ETMX/ITMY/ITMX in TILT/ROL HOR/VER is under investigation for possible patterns related to lock loss.

- More channels i.e. PEM channels should also be taken into account.
- Use unsupervised AI method to further do the lock loss study.