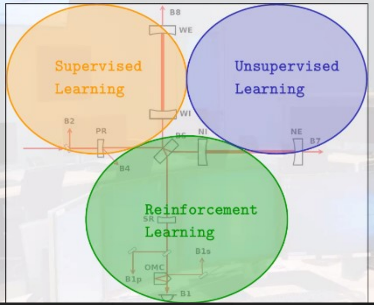
How to apply Machine Learning to Interferometer Controls?

- What has been presented so far is essentially based on classical approaches:
  - Classical control theory
  - Sequential algorithms
  - Transfer functions measurements
  - Human classification and interpretation
- What could be topics of interest for Machine Learning applications?



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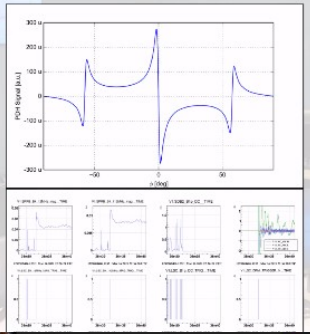
Machine Learning for Lock Acquisition (1)

- A big limitation for Lock Acquisition is the narrow linear range of the PDH signals
- This highly reduces the parameter space we can probe with classical controls and forces to sequential locking (*Variable Finesse*) or waiting for favorable conditions (*Coincidence Locking*)
- A proper MIMO approach for the sensing is also made difficult by the non-trivial coupling between DOFs



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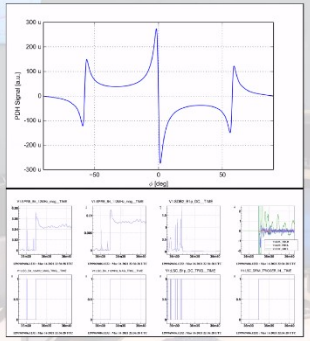
Machine Learning for Lock Acquisition (2)

- Could ML algorithms find different probes to read the status of an interferometer?
- Could it be possible to switch to a “cost function” approach?
- Could ML algorithm find a more complete sensing matrix for the interferometer DOFs?



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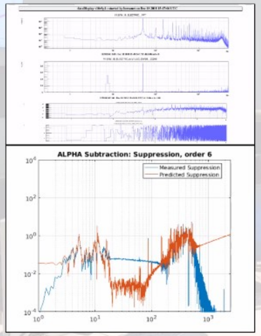
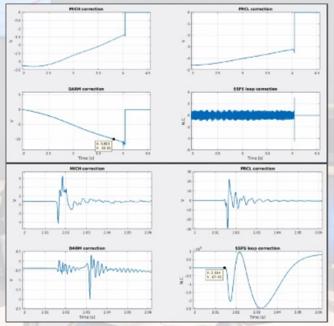
Machine Learning for Noise Subtraction

- Could ML help in finding the best witness (or a combination of) for a given disturbance?
- Online adaptation of couplings between DOFs?
- MIMO approach for the reduction of control noises?



Machine Learning for Lock Losses: Analysis and Classification

- Supervised classification of the unlocks seems the more intuitive use case for ML
- Could unsupervised learning detect rare and exotic unlocks?
- Automatic analysis would be a big time saver



Machine Learning for Lock Losses: Precursors and Prevention

- Could it be possible to *prevent* some unlocks by using ML?
- Unlikely for fast and abrupt events (e.g. fast unlocks), but it could be meaningful for slow drifts or other types of unlocks
- What about detection of earthquakes and automatic switch to more robust controls at the cost of sensitivity, but keeping the lock?