Machine-learning assisted cavity quench identification at the European XFEL.

THPOPA26

LINAC 2022, Oral poster

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LINAC2022
LIVERPOOL

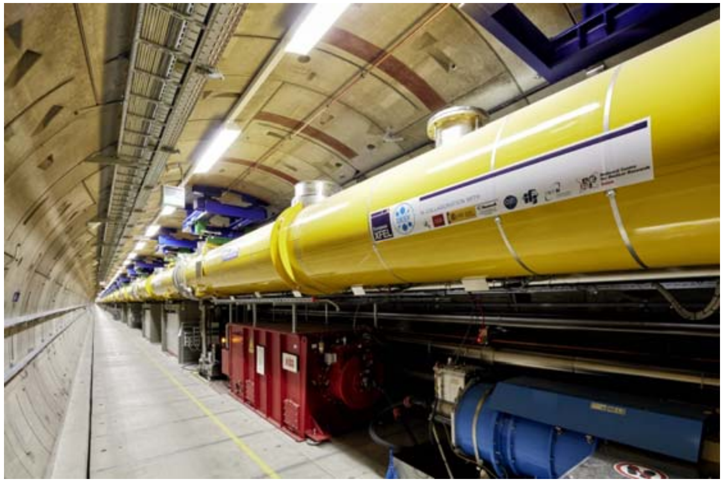
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

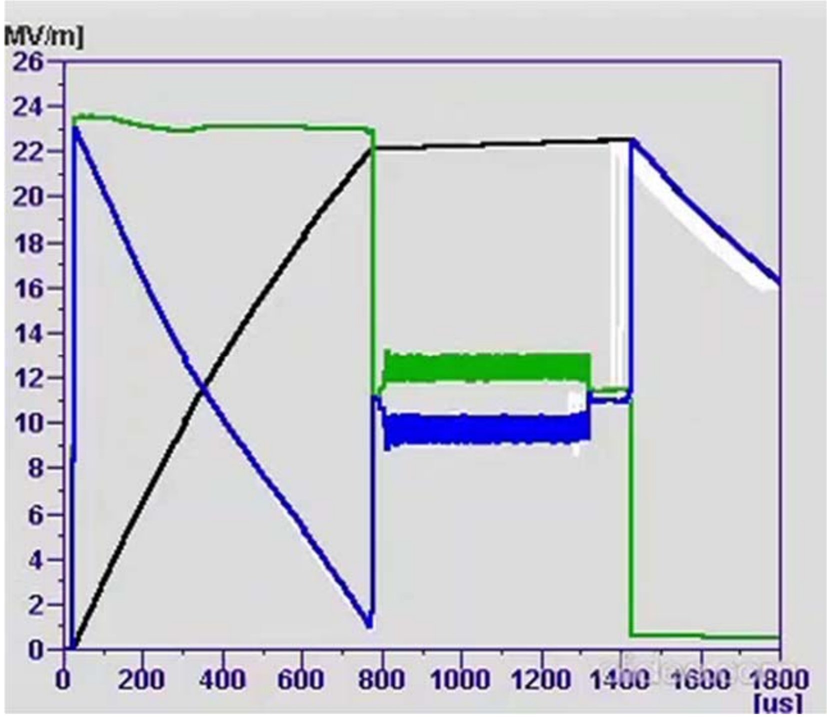
MOTIVATION

Can we lower false positive rates of quench detection at European XFEL?

European XFEL
- 17.5 GeV pulsed electron FEL
- 800x 1.3 GHz SRF cavities
- In operation since 2017
- Hamburg Germany



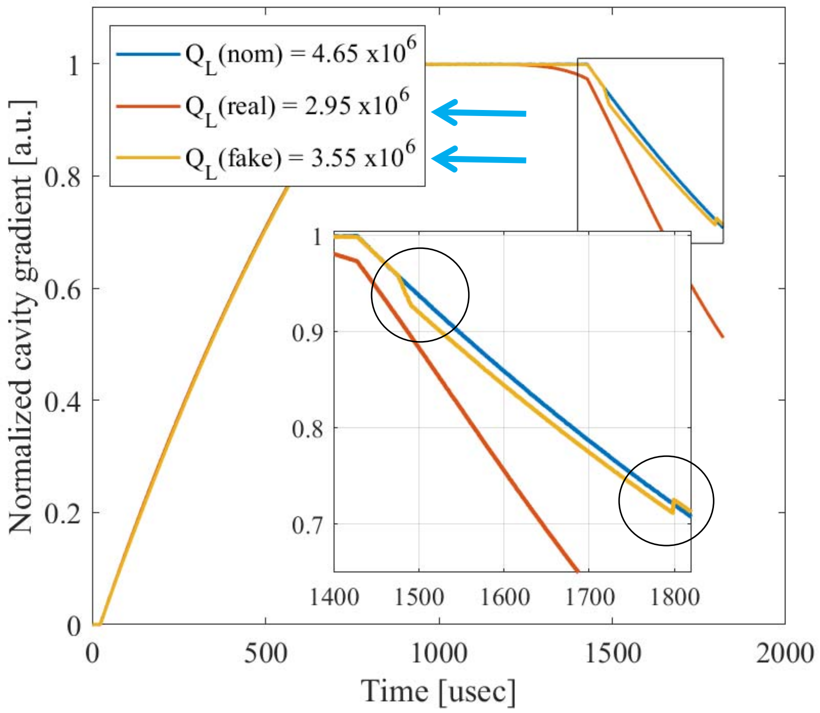
Data from August 2022



MOTIVATION

Can we lower false positive rates of quench detection at European XFEL?

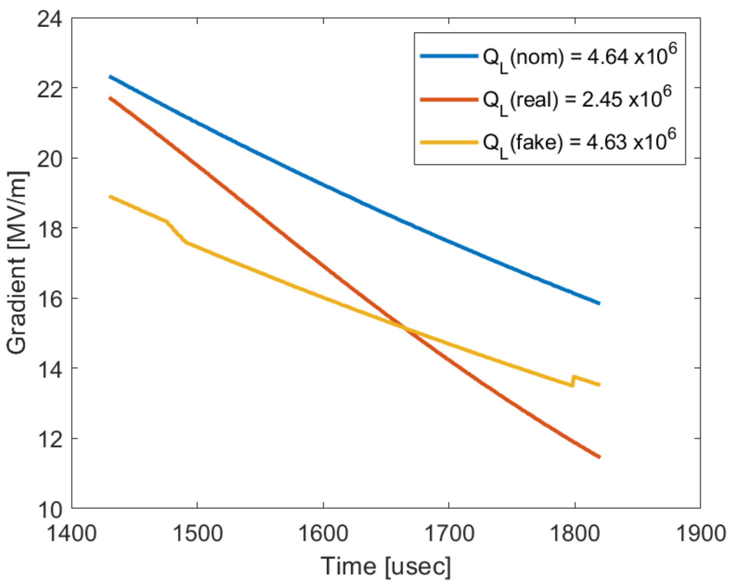
- Software-based **quench detection is successful** at catching SRF cavity quenches **but** also **triggers for other faults**
- Can we make use of **machine learning** techniques to help identify **REAL** and "**FAKE**" quenches ?
- Make **use of data snapshots** generated at each trip
  - ➡ build up on existing datasets
- Make use of well-known **cavity model** to compare measured probe and model prediction
  - ➡ no need for large training data sets

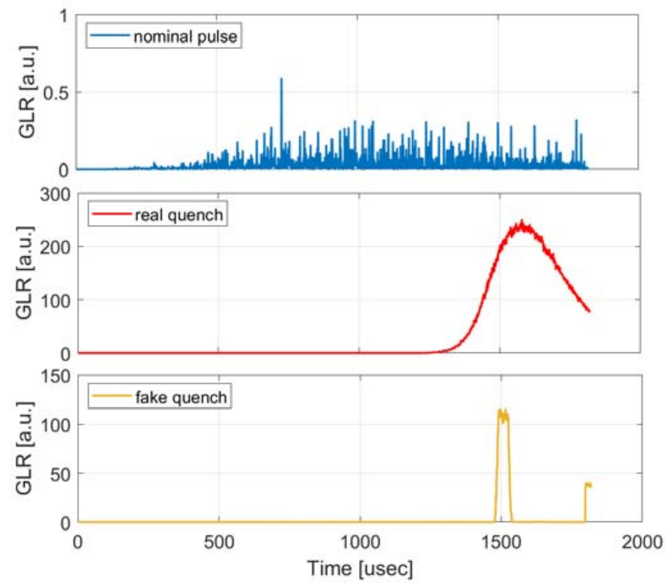


1. Introduce a new metric

Residual and Generalized Likelihood Ratio

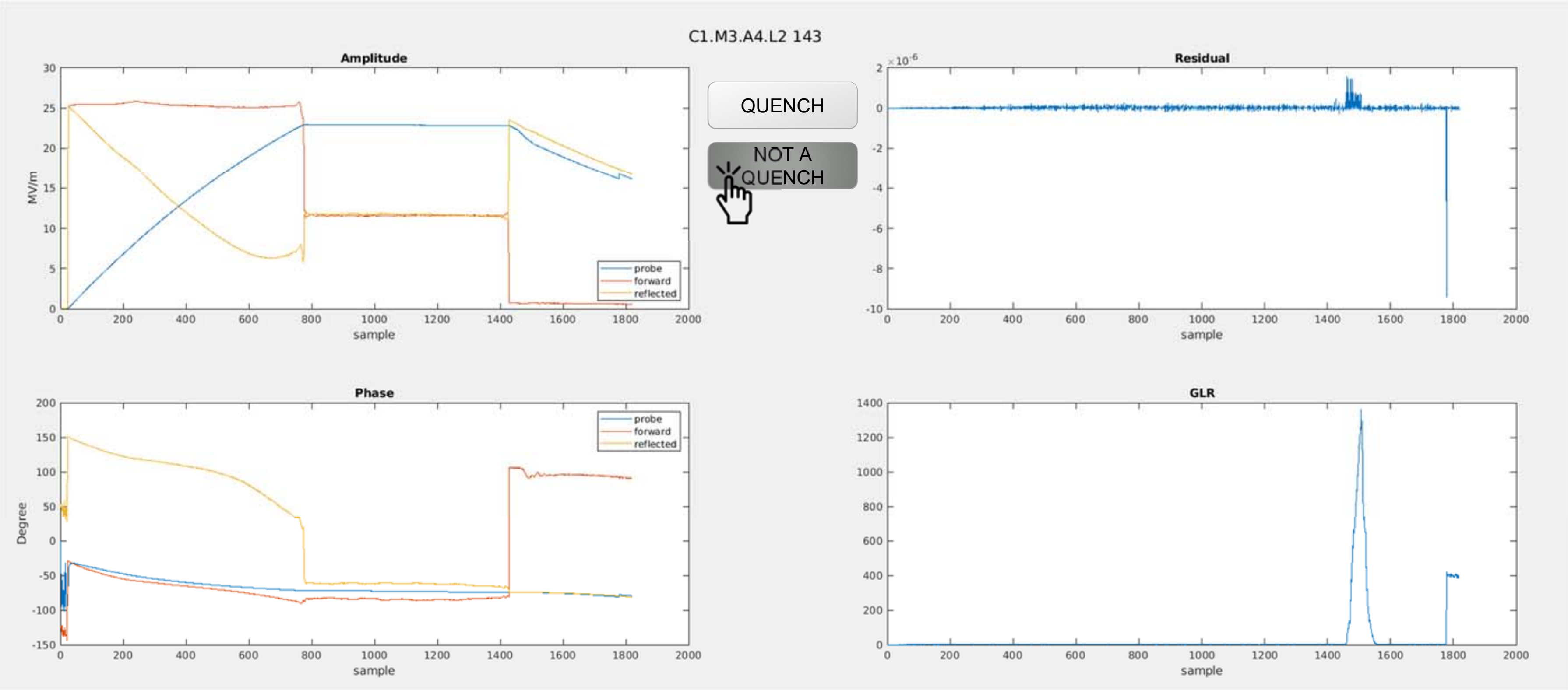
- Quantifies **deviation of the cavity probe from model**
- GLR provides very **distinct signatures** for **different kinds of trips**





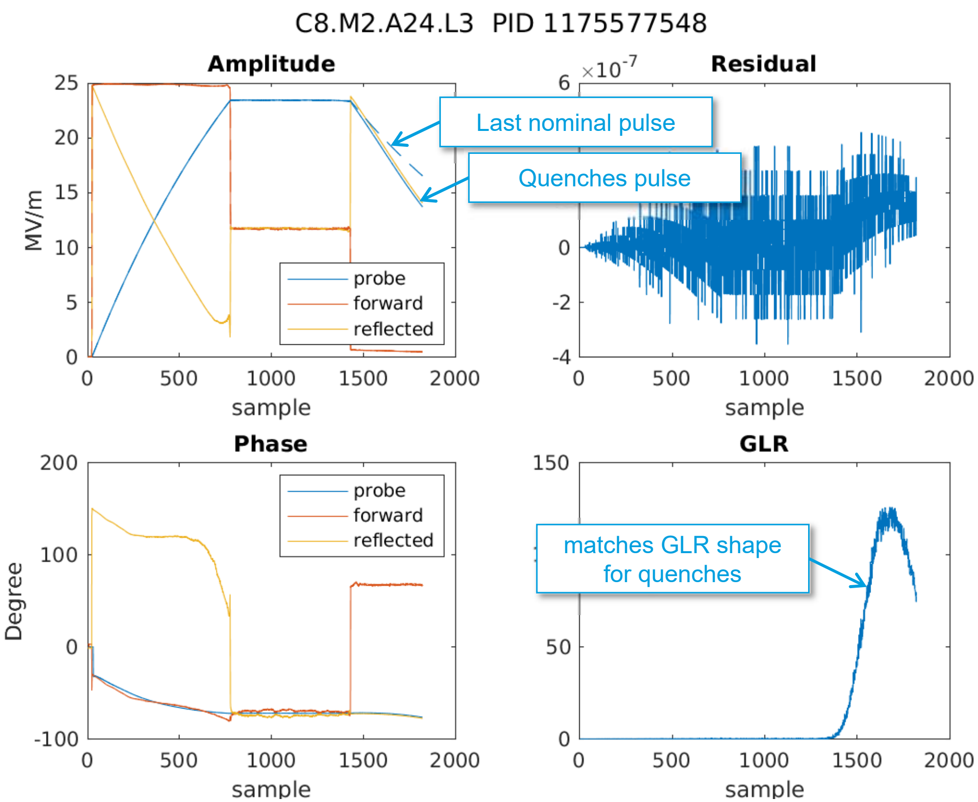
2. Training set on QUENCH – NOT QUENCH

453 trips reviewed by RF expert



3. Run the GLR analysis on all new trip data snapshot

Daily cron job since September 2021



Algorithm accuracy

$$a = \frac{TP + TN}{TP + TN + FP + FN}$$

TP : true positive (accurately detected a quench)

TN : true negative (accurately recognized a trip was not a quench)

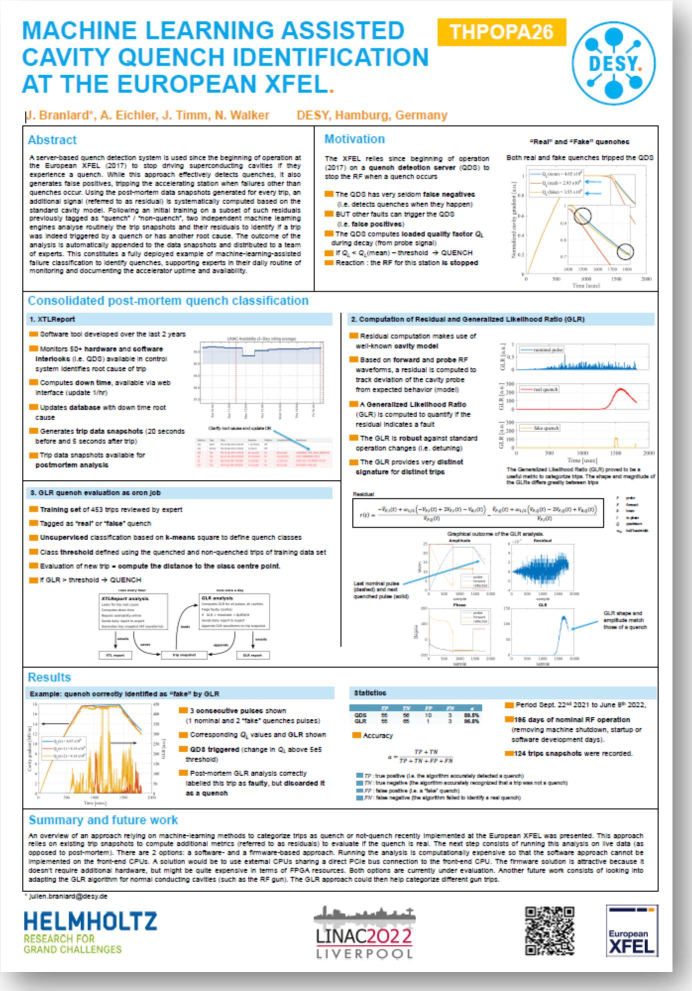
FP : false positive (a "fake" quench)

FN : false negative (algorithm failed to identify a real quench)

	TP	TN	FP	FN	a
QDS	55	56	10	3	**~90%**
GLR	55	65	1	3	**~97%**

improved accuracy

See you at poster THPOPA26



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