

# xAI-assisted Machine Protection for Particle Accelerators

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## Machine protection

- Particle accelerators are highly complex system consisting of many cross-linked subsystems
- Malfunction of a single subsystem can lead to significant downtime or even severe damage
- Machine protection is an essential “mesh and double bottom” for safe operations

## Motivation for machine learning

- Accelerator operation generates vast amounts of data – most not directly related to the actual particle physics experiment
- Machine protection is a highly sophisticated “experience business”
- Machine Learning and xAI provide a promising toolbox for analysis of patterns, trends and correlations in big data

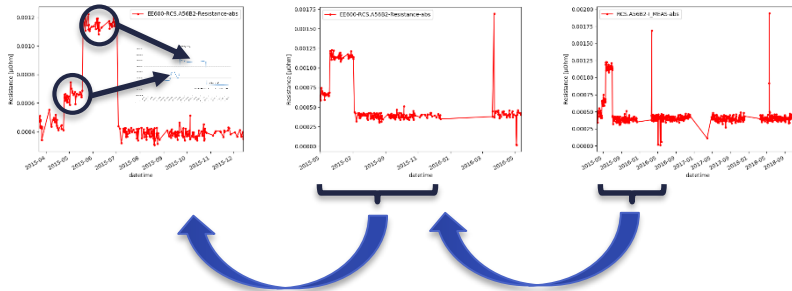
## Challenges

- Data typically imbalanced and error data scarce
- Long stable runs with change of operating parameters on the way
- Learning in the few data limit on dynamic systems

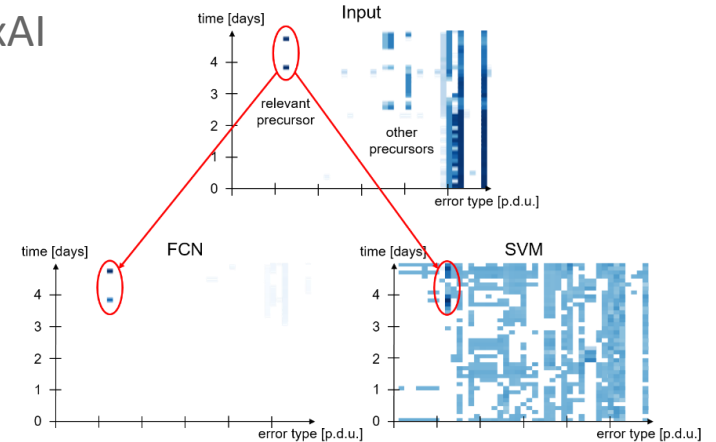
# xAI-assisted Machine Protection for Particle Accelerators

## Previous Work

- Machine Learning on resistance data of 600A Energy Extraction Switches



- Time series analysis of errors in LaserDB with xAI



## Suggested Methodology

- Time series analysis, pattern recognition and classification with Machine Learning and Xplainable AI for in-vivo and post-mortem detection

## Value Add

- Tool and algorithm development for accelerator independent machine protection

## Resources

- 1 FTE 24 months (Postdoc), 1 FTE 36 months (PhD student), 30 k€ equip./travel

## Collaboration partners

- In discussion with CERN and GSI