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Towards **MALESS**
*(**MA**chine **L**earning for accelerator and target diagnostics at **ESS**)*

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ML for Physics - *just the two extremes*

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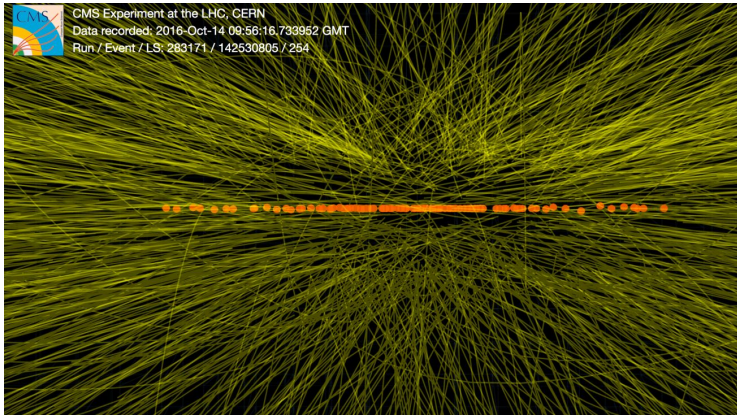
Dark matter or new physics



[1]

Achieving 100 ns Inference Latency on 150 Terabytes/Second Data Rates

Multi-messenger astronomy

[2]

Numerical relativity simulations of MMA sources, DL + HPC

ML for ESS

Very few algorithms are used for accelerator or target control systems. Main **drawbacks**:

- Limited data sets
- Simplified simulation tools

Challenges at ESS (with unprecedented linac power and neutron brightness):

- It's a large scale facility, complex and data-intensive
- Monitor a multitude of independent sub-systems
- Predict all the possible dangerous beam and target conditions
- ...

⟶ Outperform **time**-consuming simulation tools i.e. reduce the time spent for tuning
⟶ Identify **subtle changes** in key variables prior to devastating events
⟶ Allow for **automated correction** procedures

Proposed MALESS project

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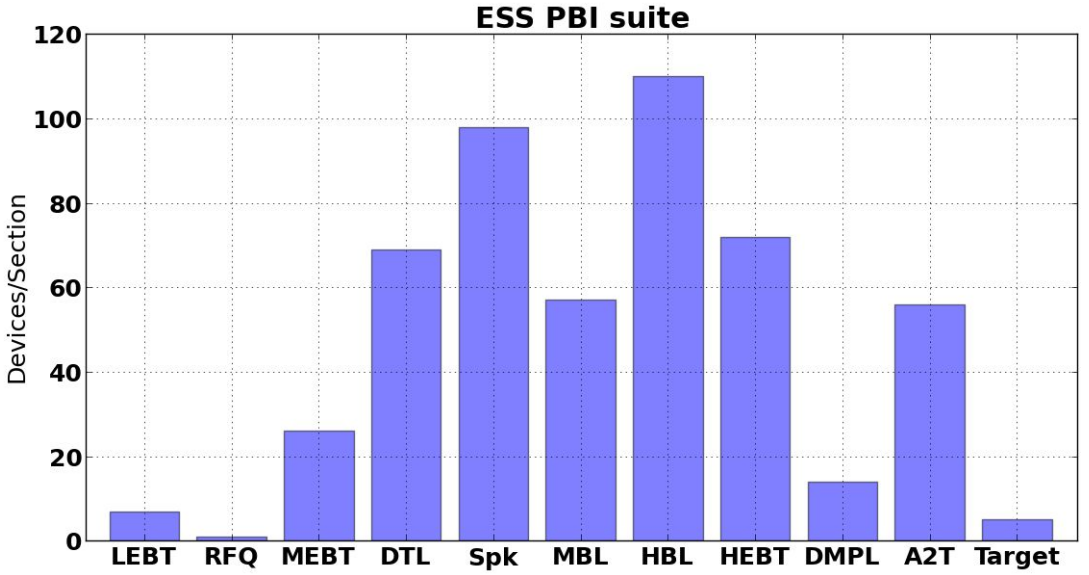
"Learn by looking at BD data"

1 Methodology

2 Schedule

3 Risks

4 Impact



Submitted in August-2019

TIARA ACCELERATING KNOWLEDGE AND INNOVATION

ARIES

Methodology

1) Identify relevant diagnostics data

- From SNS database and newly deployed systems at ESS (e.g. BLM, BPM, ΔI)
- Include information from MC simulations (e.g. Geant4 and MCNP)

2) Explore software tools from Xilinx and Struck

- To maximize the amount of processed diagnostics data
- To minimize the time to test algorithms

3) Evaluate ML tools and select the most promising one:

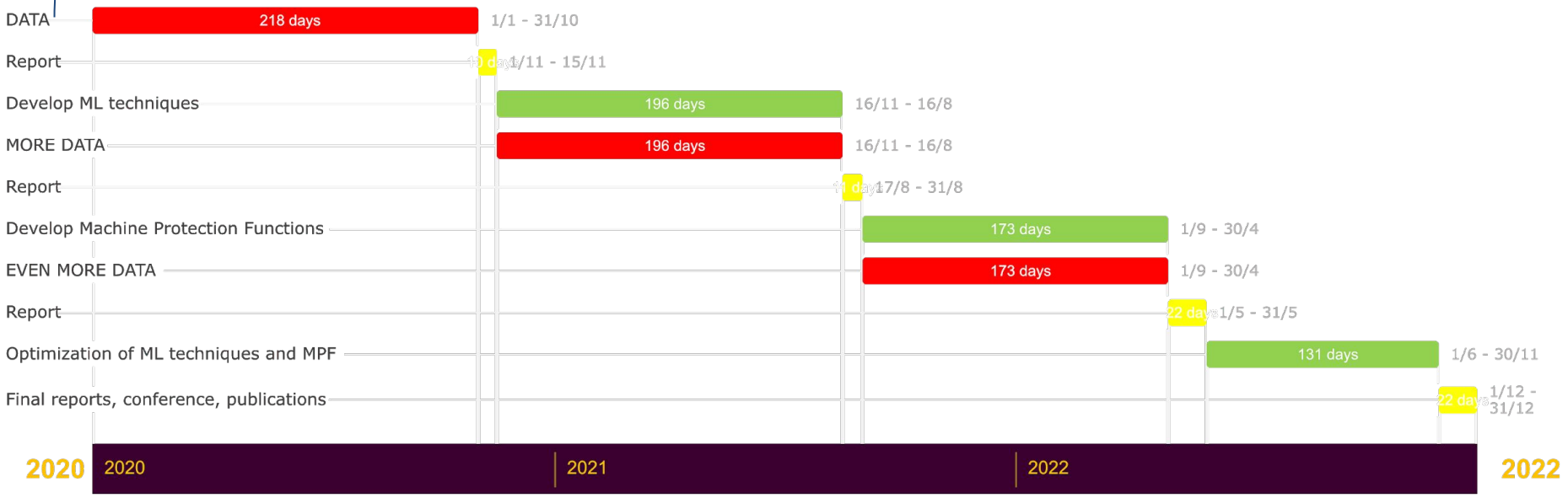
- Capability of modelling the desired functionality
- Practicality as control system

4) Verify the algorithm, as implemented on a low-latency network of FPGAs

5) Monitor the performance under controlled studies

Schedule

from key ESS BD systems
in addition to SNS data



Risks

	Potential Risk	Mitigation
1	Beam diagnostics systems not ready for deployment	Plan testing and bug fixing ahead. In addition, focus on training with simulation results and deploy in laboratory systems
2	Failure of critical beam diagnostics systems	Spares
3	Scope creep	Incremental development practices

Conclusions

MALESS = MAchine Learning for accelerator and target diagnostics at ESS

Assess diagnostics data to work out **predictive techniques** in order to:

- Predict errant beam conditions
- Minimize damage to high power linac and target station
- Maximize the overall ESS availability → minimize reparation
- Improve beam dynamics modelling

Ideas:

- Start with **SNS** operation data (13 y+)
- Collect data and perform tests at **ESS**
- Improve the design of **future** accelerators, targets, ADS, ESSvSB

References

[1] https://cms.cern/detector

[2] Deep Learning for Multi-Messenger Astrophysics: a Gateway for Discovery in the Big Data Era https://arxiv.org/pdf/1902.00522.pdf