theory-informed classification of proton-proton collisions with quantum machine learning tools

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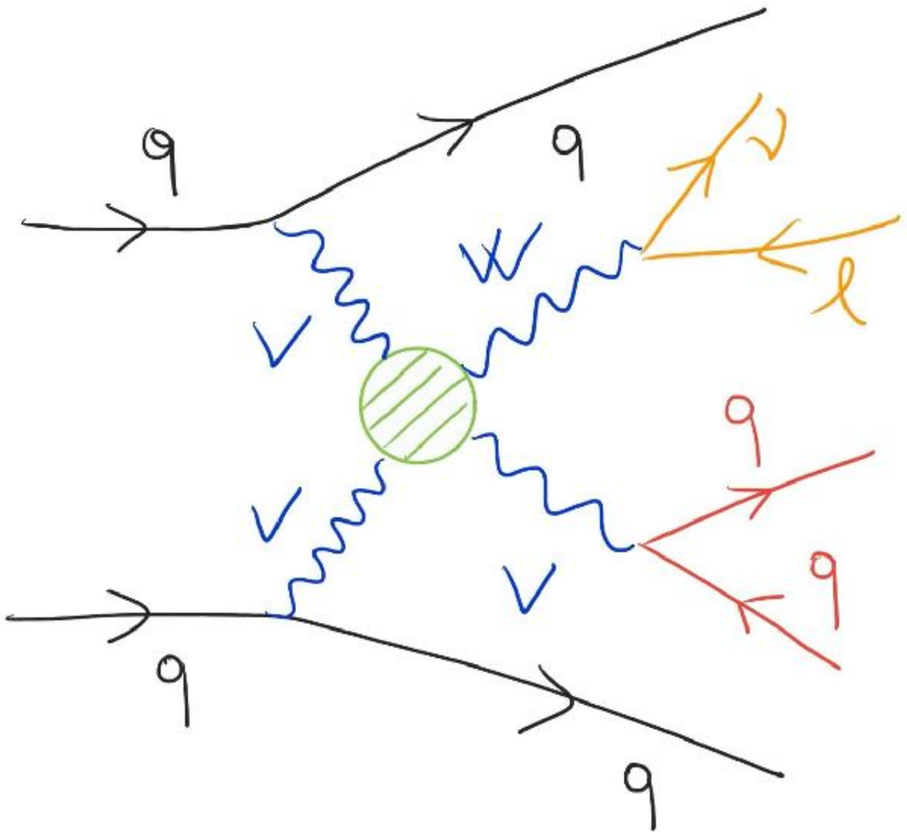
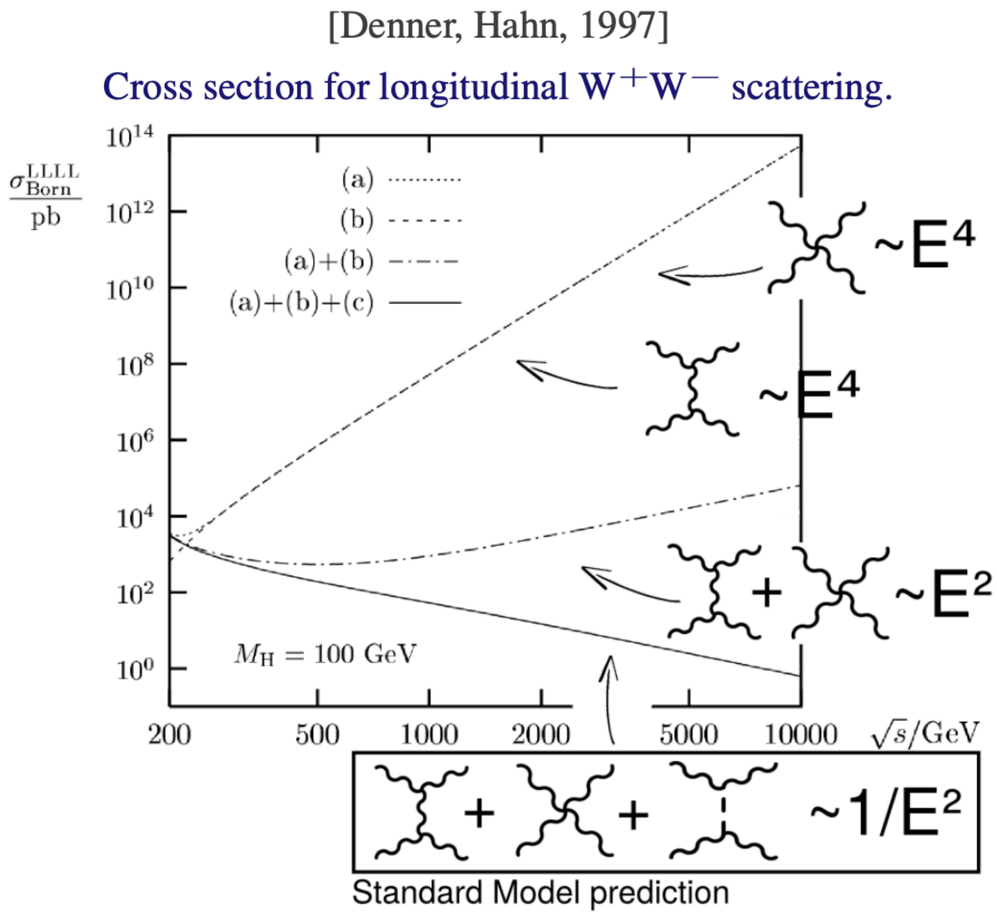
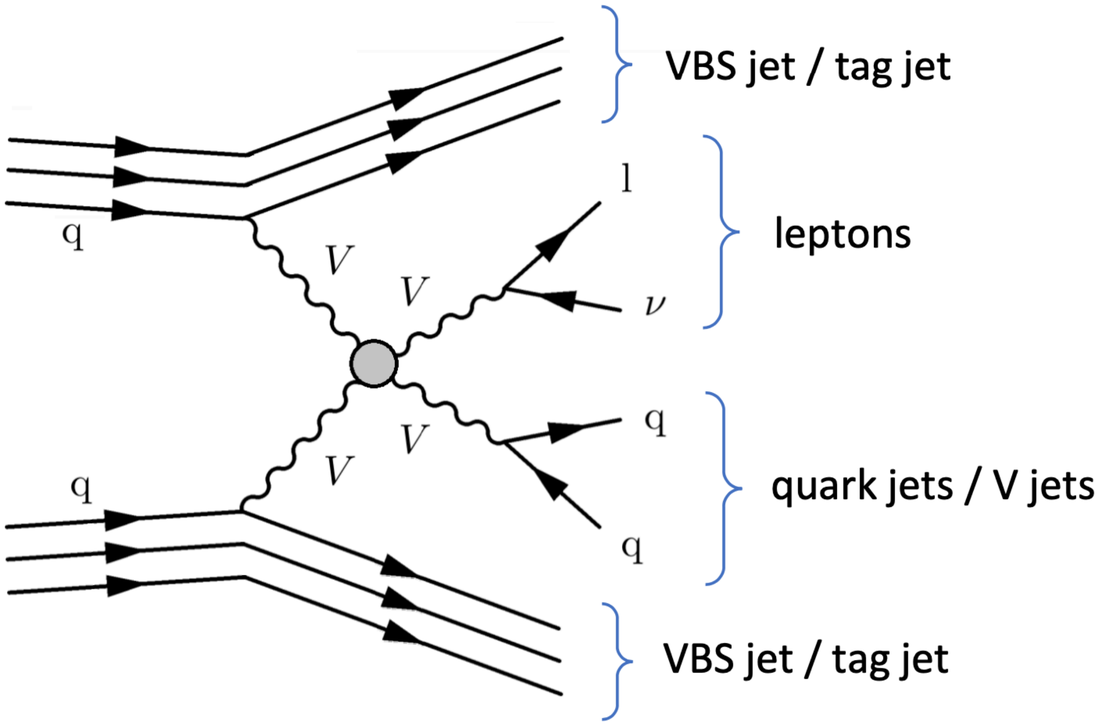
the use case: vector boson scattering at LHC

(longitudinal) VBS: active research field and one of the main benchmarks for HL-LHC and future colliders





the physics problem



	Process	Cross section (pb)
Signal	VBS	2.2
Principal backgrounds	W+jets	$6.1 \cdot 10^4$
	Top	974
	WW	114.7
	ZZ	16.5

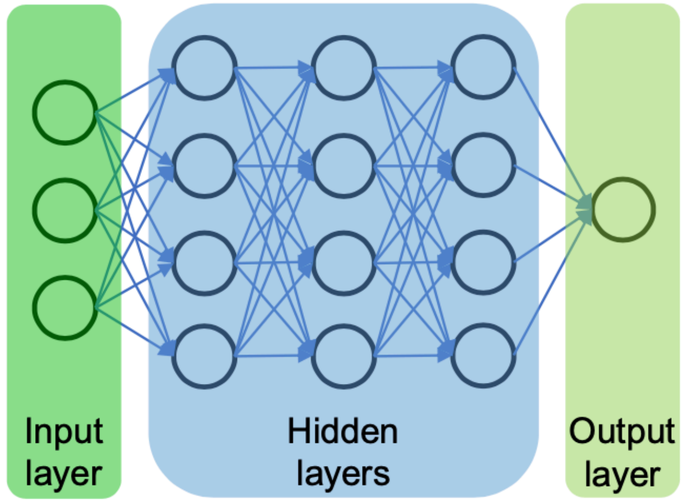
sophisticated final state with specific quantum-mechanical characteristics

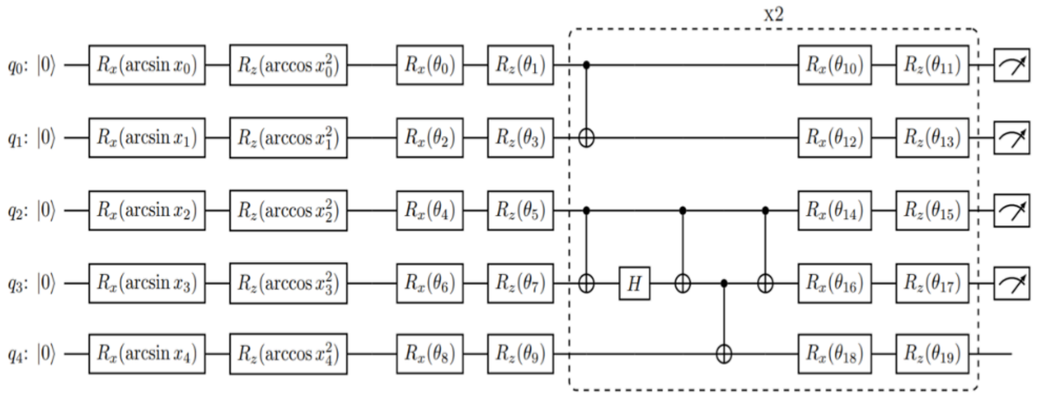
harsh environment with overwhelming backgrounds

aim of the study

Perform a **fully blown comparative study between classical and quantum machine learning (QML)** in the proton collisions case, in order to quantify the differences in performances between the two techniques.

Implement **context-aware architectures searching for significative improvements** in quantum circuit performances with respect to agnostic learning and classical learning.

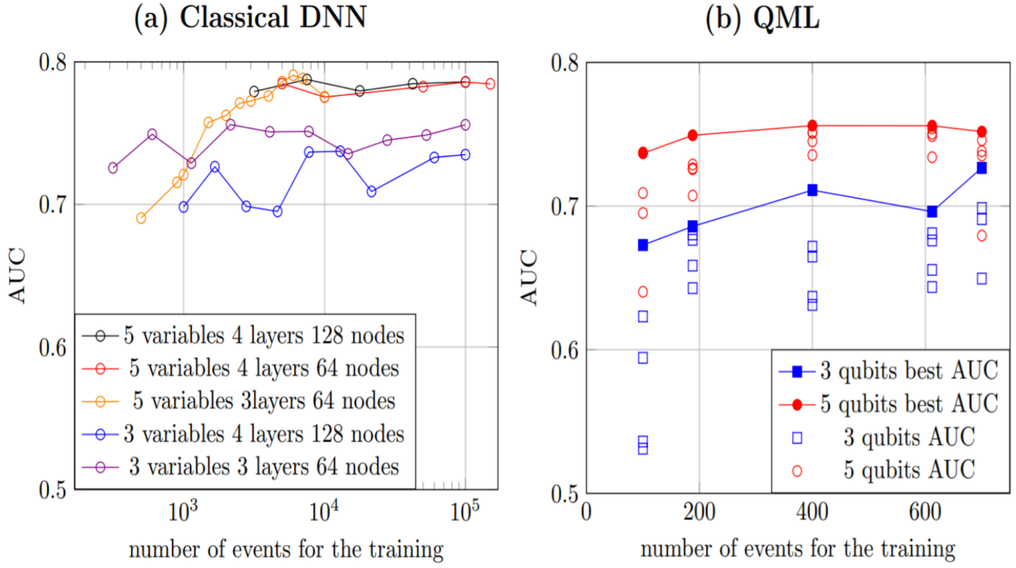




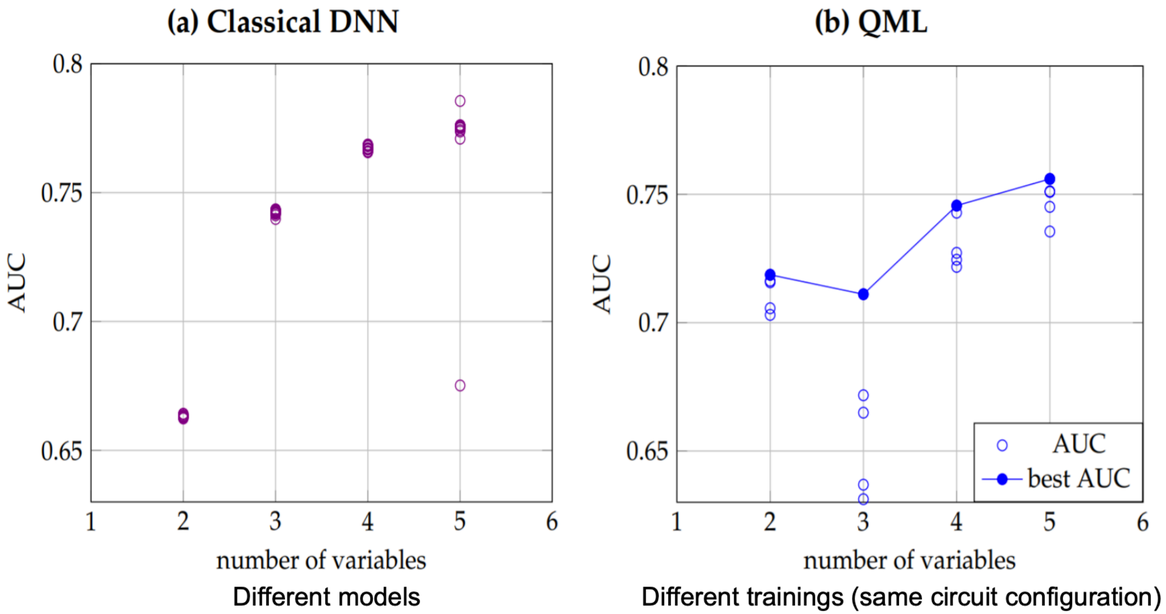
preliminary studies

starting point: bachelor theses (Davide Cugini, Aurora Perego) in Milano - Bicocca, performed in collaboration with D. Gerace from Pavia and by making use of publicly-available IBM Quantum Computers

1 Varying the number of training events



2 Varying the number of variables



Different models

Different trainings (same circuit configuration)

in summary

use case

LHC data analysis is the sophisticated and relevant use-case of vector boson scattering

resources

existing **solid theory process understanding** (MC simulations and calculations for signal and backgrounds) and, possibly, actual **LHC data** available

objectives

apple-to-apple comparison of quantum machine learning to classical data analysis
investigation of **advantages coming from context-aware quantum circuit design**