Efficient Design of the SHiP's Muon Shield

Through Machine Learning and High Performance Computing

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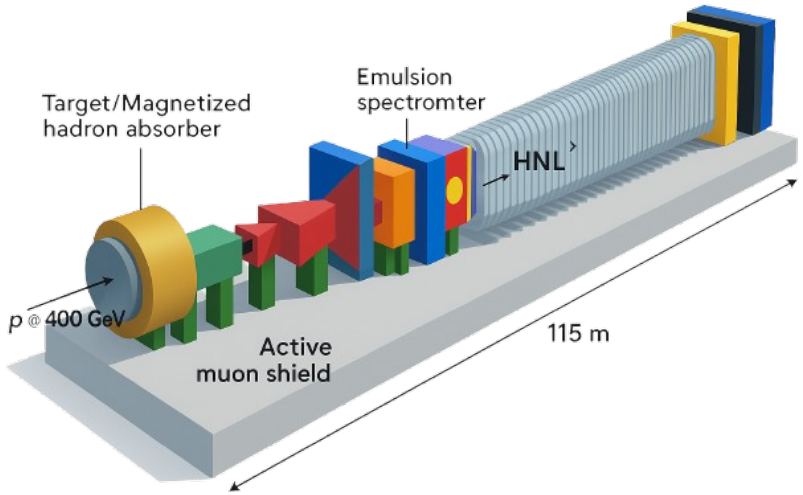
SHiP and the Muon Shield

SHiP: Search for Hidden Particles at CERN

Muon Shield: Blocks muons from reaching the detector.

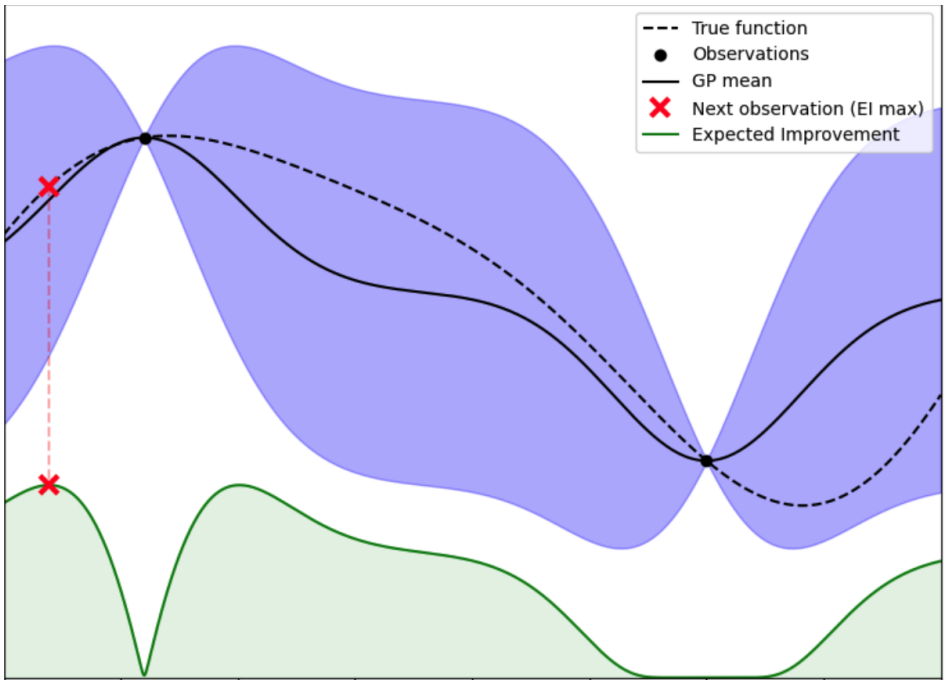
Challenge:

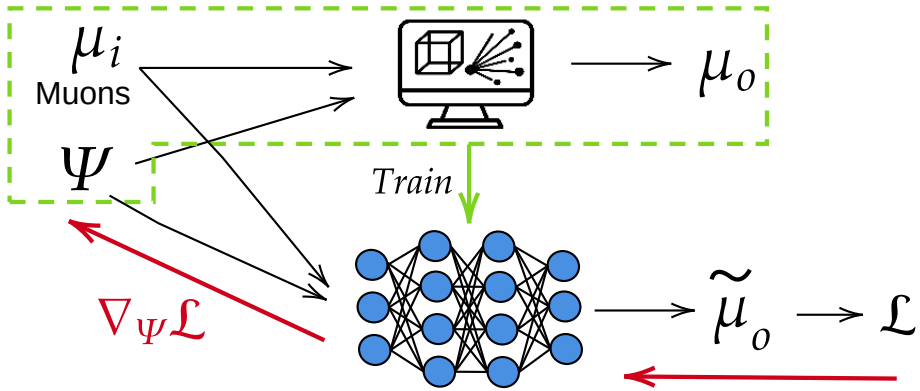
- Complex, high-dimensional design
- Expensive simulations
- Non-differentiable, stochastic



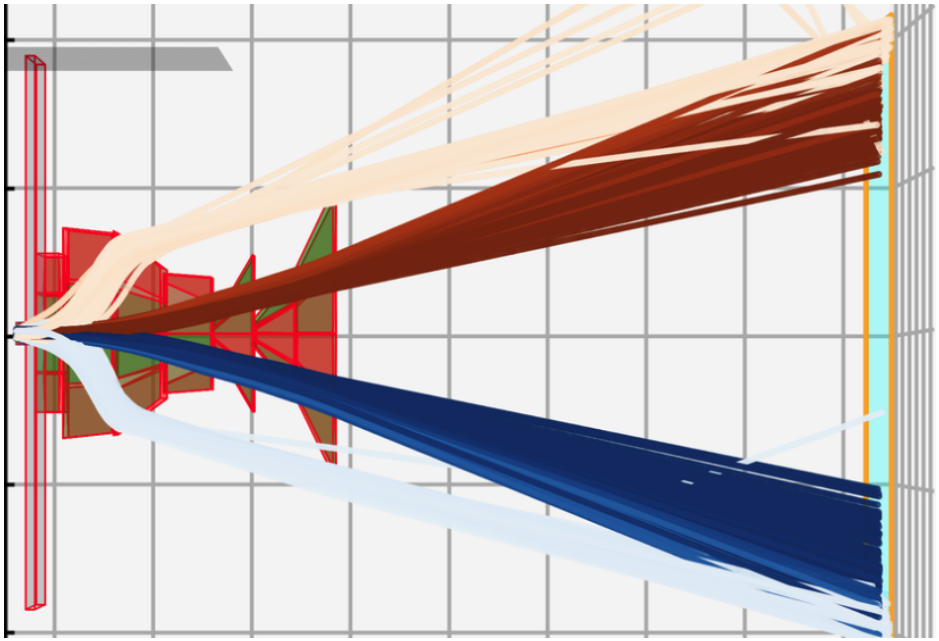
Machine Learning and HPC

- **HPC:** GPUs and distributed computing
- **Bayesian optimization:** Smart parameter search
- **Surrogate models:** Fast, differentiable approximations





Results



- **Muon flux:** $10^{10} \rightarrow 10^{4}$
- **Optimization time:** months $\rightarrow$ days
- Engineering constraints included
- More realistic simulations
- Refined cost estimation

HPC + ML successfully addressed Muon Shield design challenge!

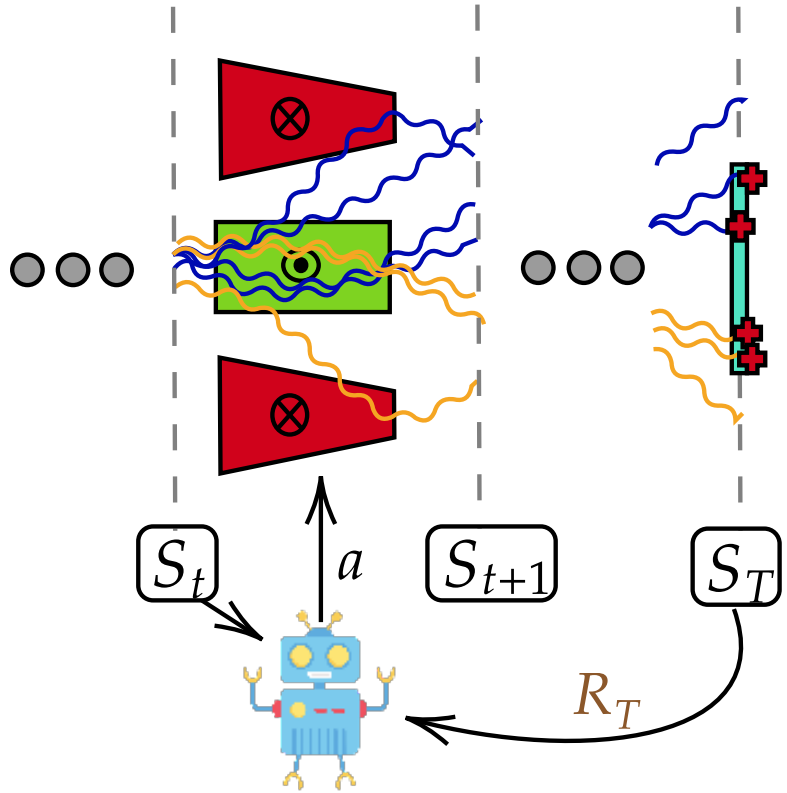
Next Steps: Reinforcement Learning

Why RL?

- Discrete, sequential design
- Joint optimization of sub-systems
- Non-differentiable, flexible

Framework:

- State: muon flux, layout
- Action: place/configure component
- Reward: suppression − cost



Thank you!

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