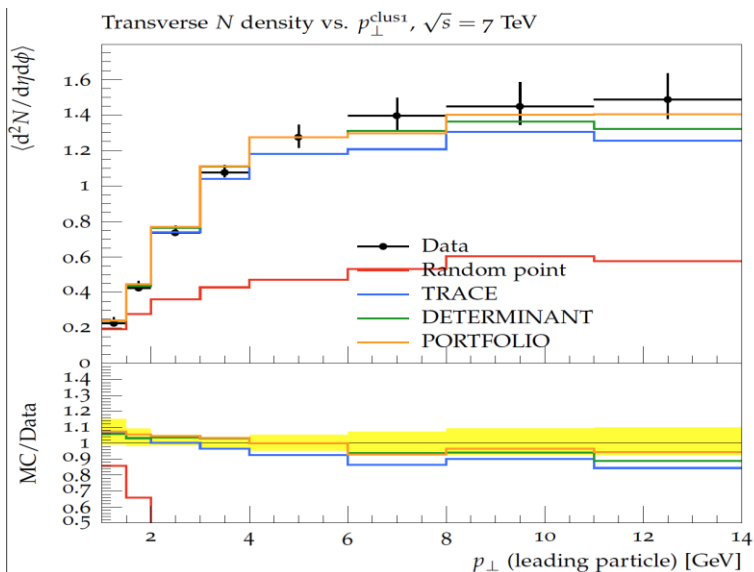# Automatic physics event generator tuning with bilevel and surrogate optimization

Scientific Achievement

Automatic tuning of physics event generators: Formulation as bilevel optimization with equality constraints. Solved the problem with surrogate model based optimization approach.

Optimization outcome: shown is the observation data (black) and the simulation model predictions (solid lines) when using three different outer optimization objective function models (portfolio, trace, determinant) and a randomly chosen solution (upper graphs). The lower graph shows how well the simulation predictions fall within the uncertainty band of the observations (ideally, the colored graphs lie within the yellow area). (Image Credit: Holger Schulz, U Cincinnati)

Significance and Impact

The bilevel optimization approach allows to automatically adjust the weights for each observable that enters and therefore influences the tune. Previously, the selection of these weights was done by hand, which was inefficient and potentially leads to bias in the tune.

Research Details

– Formulation of an outer optimization problem to *automatically* assign weights to observables used in the tune.

– Outer optimization by surrogate model approach with equality constraint to achieve good solutions efficiently.

– Modeling of the outer optimization problem: design of experiments (trace, determinant), and portfolio optimization (minimize the mean and variance of errors over all observables simultaneously)

– Inner optimization done with PROFESSOR tool

– Better tunes are obtained more efficiently