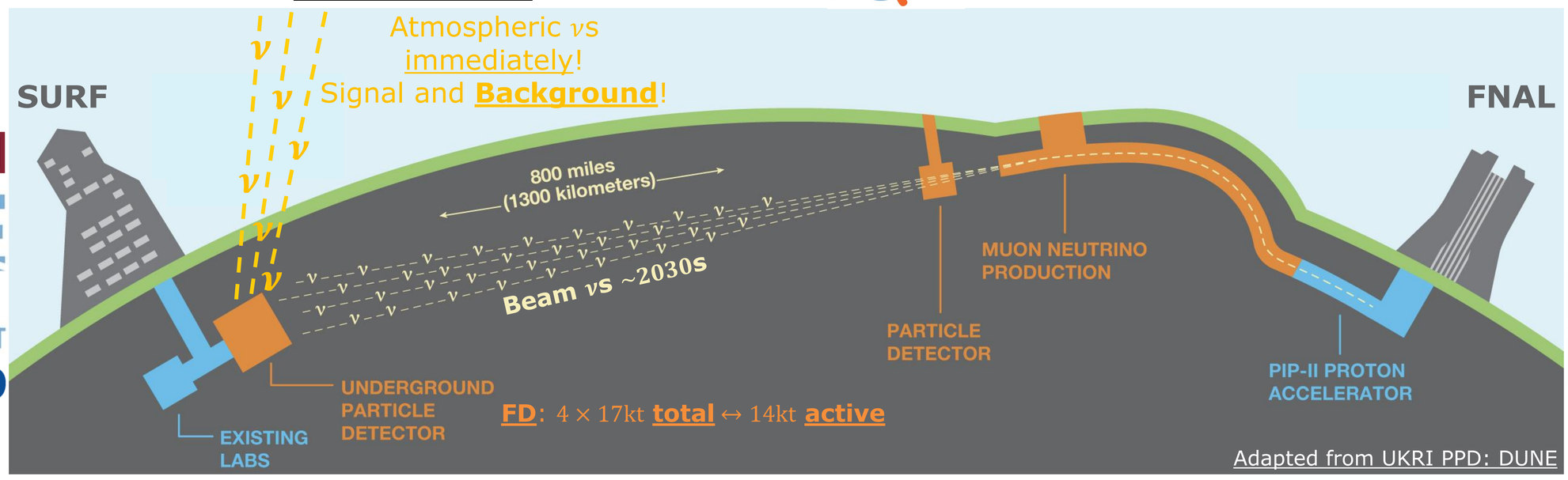
Baryon Number Violation Searches Using the DUNE Far Detectors

Josh Barrow on behalf of the DUNE Collaboration



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DEEP UNDERGROUND NEUTRINO EXPERIMENT

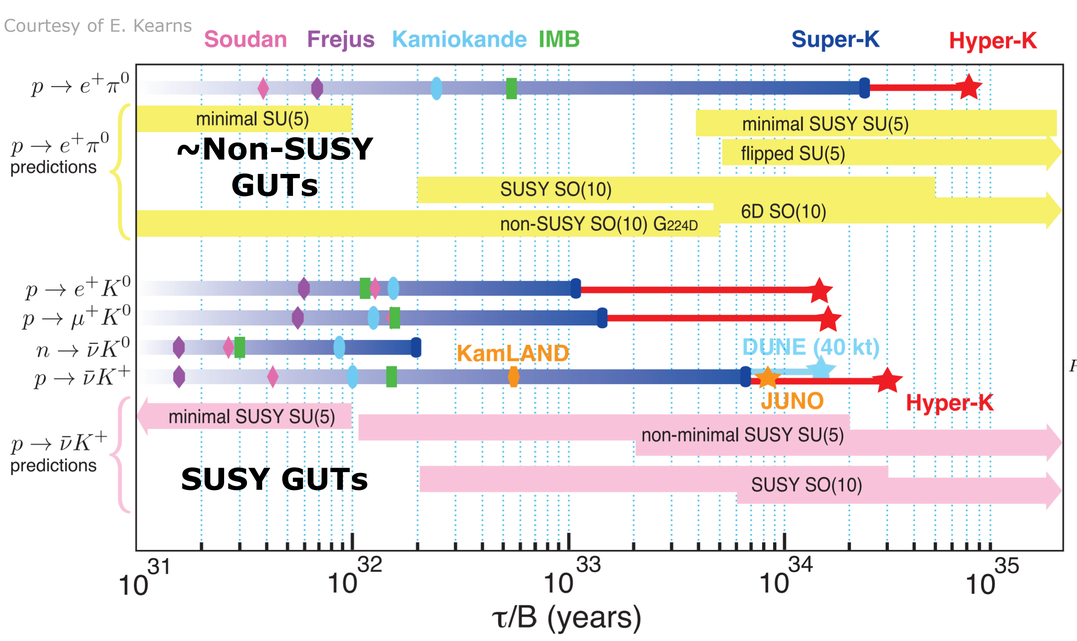
Fermilab

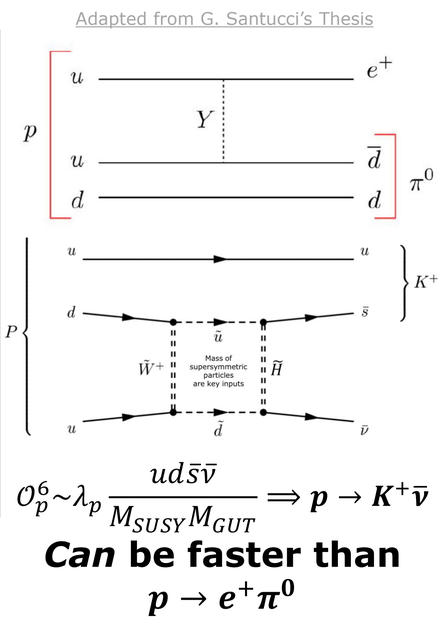
FERMILAB-POSTER
24-0093-LBNF-V

Two Current Flagship Intranuclear Baryon Number Violating Analyses in DUNE

Proton Decay ($p \to K^+\bar{\nu}$) "Golden Channel"

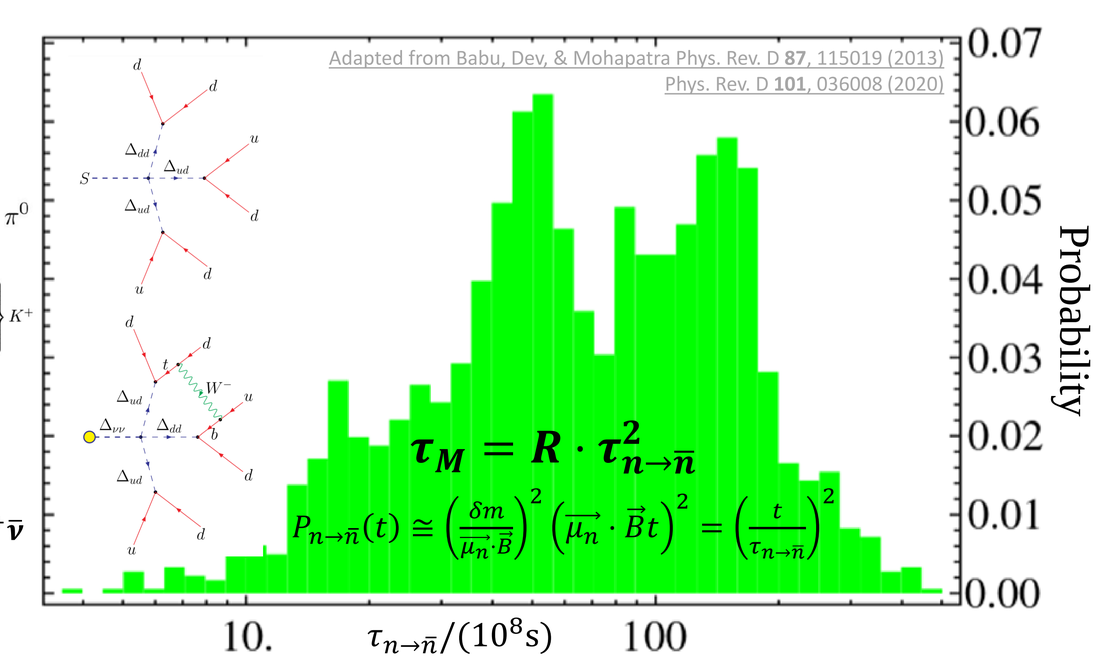
Tests for unification of fundamental forces at highest energy scales via $\mathcal{B}$ violation





Neutron-Antineutron Transformation ($n \to \bar{n}$)

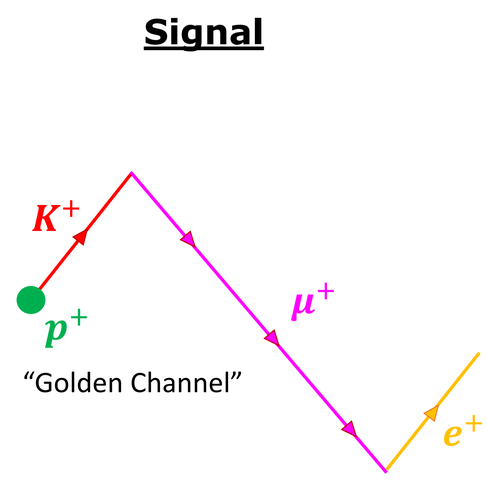
Tests for low energy theories of post-sphaleron baryogenesis via $\mathcal{B}-\mathcal{L}$ violation

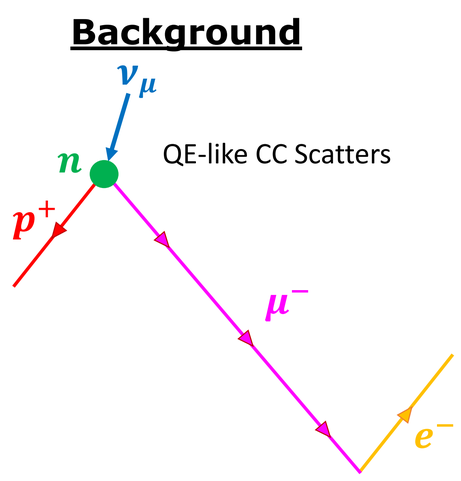


Both rare process signals will suffer from persistent atmospheric neutrino backgrounds

Signal & backgrounds must be *well modeled* (w/*uncertainties*) to understand expectations in LArTPCs with low hadron thresholds

See poster from Henrique Souza for more on atmospheric neutrinos in the DUNE Far Detectors!



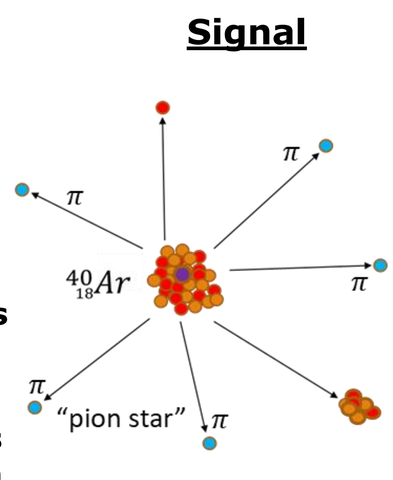


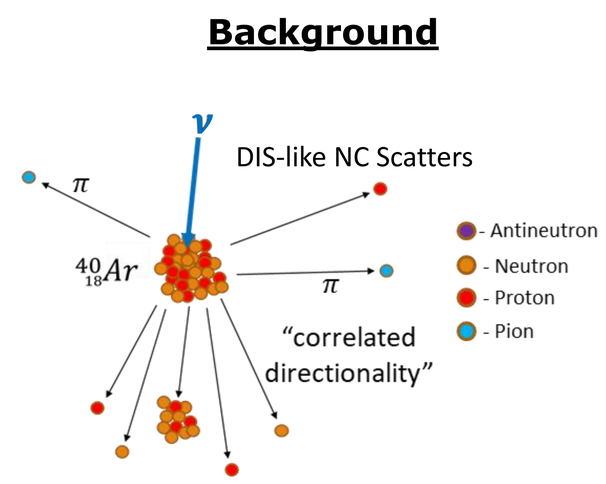
$p \to K^+\bar{\nu}$ **&** $n \to \bar{n}$ show powerful **topological**, **particle content**, **& kinematic characteristics** which can be uniquely exploited by LArTPCs

Exceptional Topological Signatures

≡

fertile grounds for **(Deep) Machine Learning Methods** for signal & background discrimination



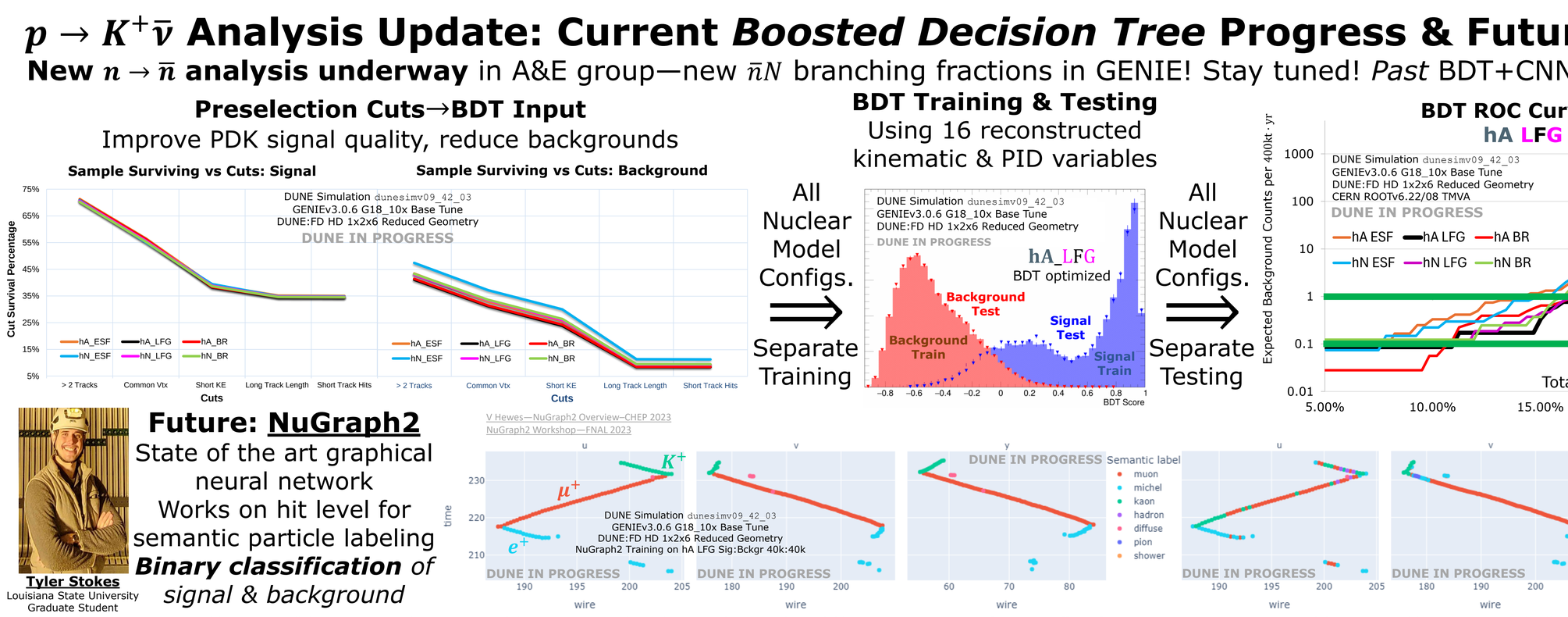


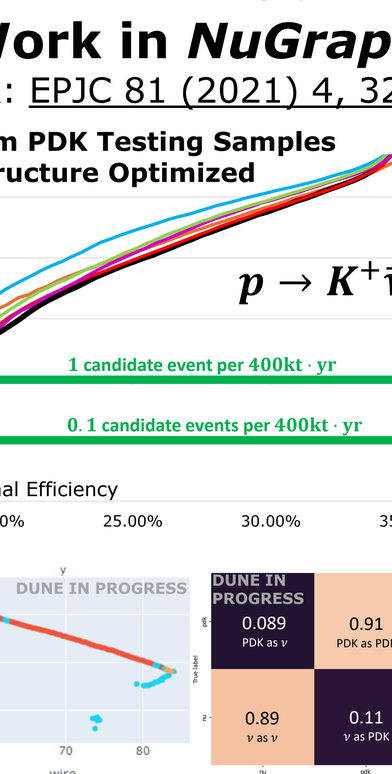
ML analysis methods can be biased by our *models* of Nature—Analysis tools must maintain performance

Need to be especially careful in the context of *unknown* BSM physics, remaining relatively agnostic to a central value model

Can conservatively estimate our ignorance by iterating over many potential *nuclear model configurations* which Nature *might* take

Robust testing requires that any analysis method remains relatively stable across these iterations—hopefully will be able to understand Nature's behavior





Lower final state K^+ KE can adversely affect signal efficiencies

Must understand modeling systematics!

$p \to K^+\bar{\nu}$ Analysis Update: Current *Boosted Decision Tree* Progress & Future Work in *NuGraph*

New $n \to \bar{n}$ analysis underway in A&E group—new $\bar{n}N$ branching fractions in GENIE! Stay tuned! *Past* BDT+CNN Work: EPJC 81 (2021) 4, 322

Preselection Cuts→BDT Input

Improve PDK signal quality, reduce backgrounds

BDT Training & Testing

Using 16 reconstructed kinematic & PID variables

All Nuclear Model Configs. ⟹ Separate Training

All Nuclear Model Configs. ⟹ Separate Testing

Future: NuGraph2

Tyler Stokes
Louisiana State University
Graduate Student

State of the art graphical neural network

Works on hit level for semantic particle labeling

Binary classification *of signal & background*

V Hewes—NuGraph2 Overview–CHEP 2023
NuGraph2 Workshop—FNAL 2023

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