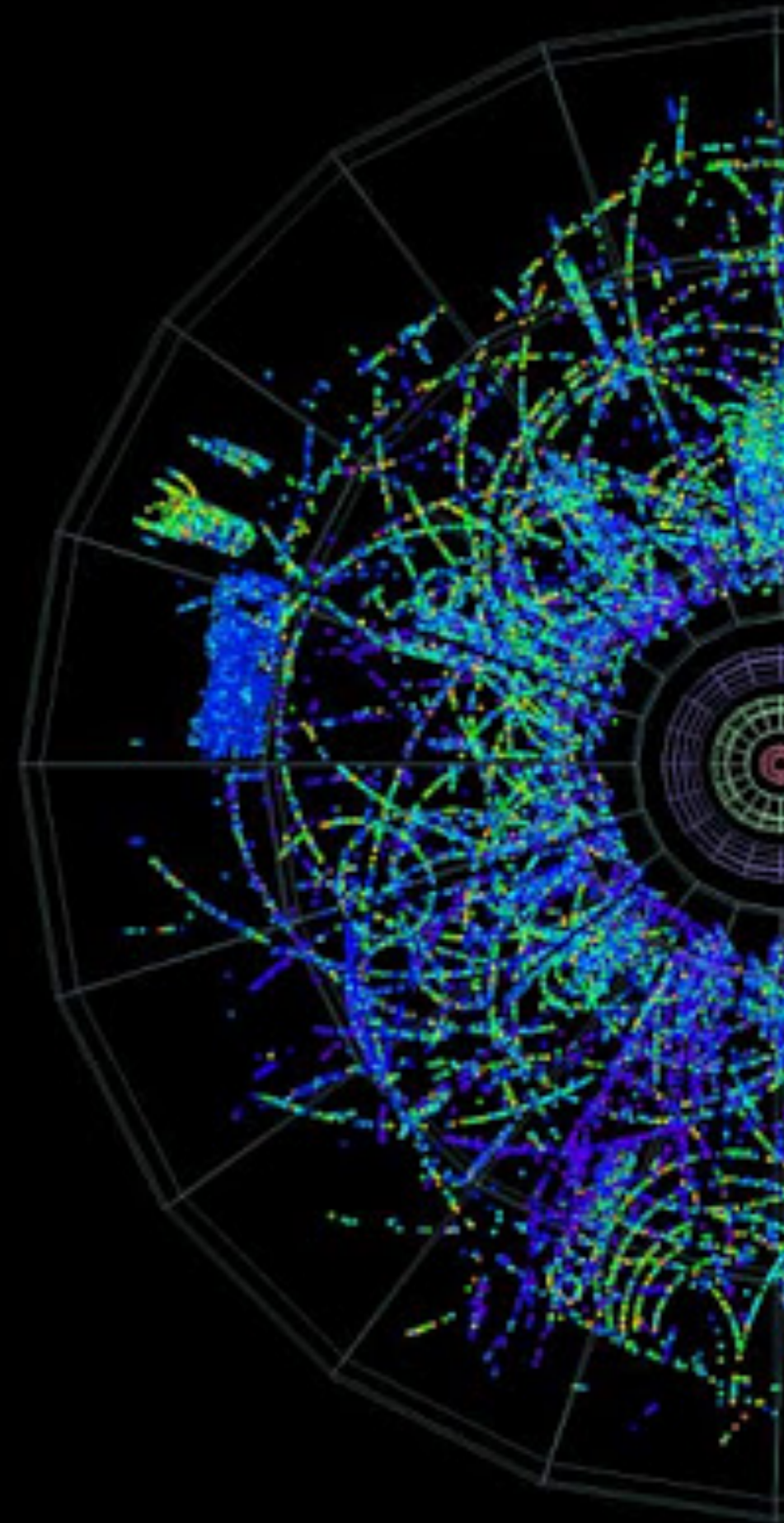


BENCHMARK MODELS FOR INCLUSIVE DARK SHOWER SEARCHES

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PROPOSAL: LOW-MASS DARK SHOWER SEARCH PROGRAM

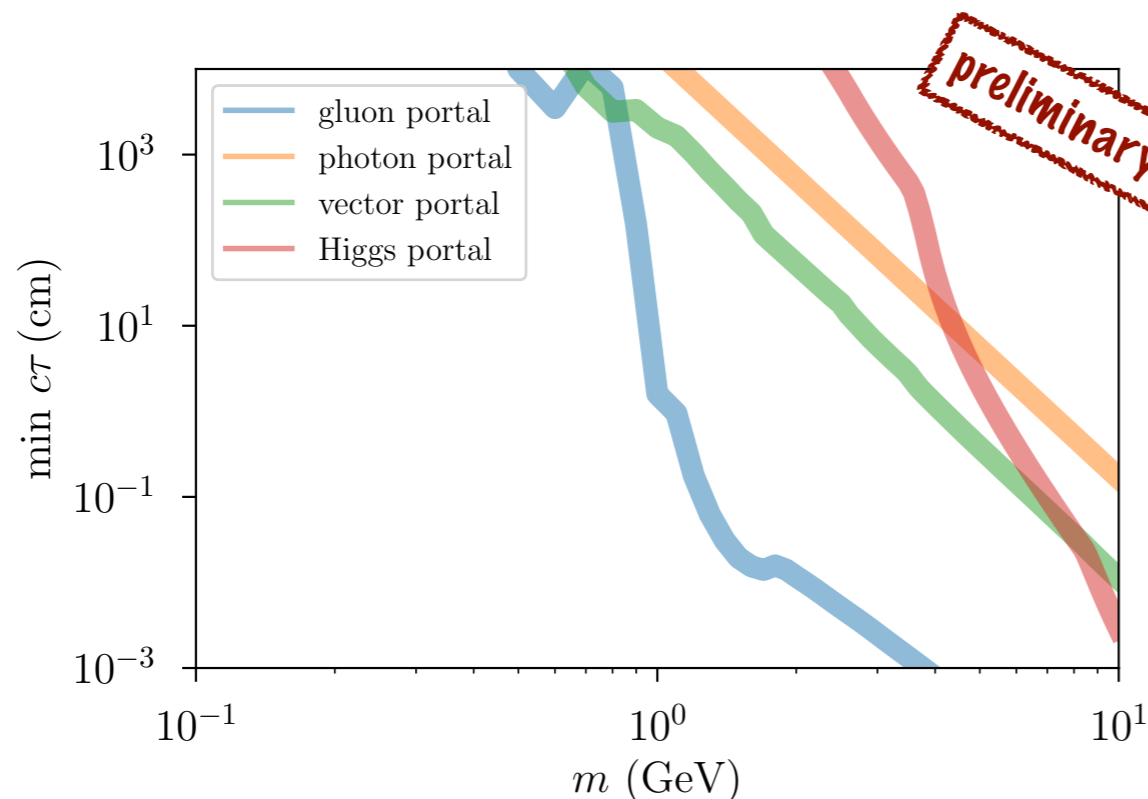
- Primary focus: dark showers produced in decays of **SM Higgs**
 - minimal; well-motivated
 - low mass final states: challenging benchmark for trigger development
- High multiplicity final states $\Rightarrow \lesssim 10$ GeV-scale dark hadrons
 - but then generically SM-decaying dark hadron is **long-lived**
- “Dark showers”: $\gtrsim 3$ **displaced objects/event**
 - Clean signature; enables **inclusive** searches
 - Strategy: use QCD-esque benchmarks, prioritize inclusivity
 - (see: dark showers chapter of LHC LLP white paper, arXiv:1903.04497)

LIGHT DARK HADRON DECAYS

- Decay portal operators: different visible signatures

Decay portal	decay operator	features
gluon portal	$aG^{\mu\nu}\tilde{G}_{\mu\nu}$ or $\phi G^{\mu\nu}G_{\mu\nu}$	hadron-rich
photon portal	$aF^{\mu\nu}\tilde{F}_{\mu\nu}$ or $\phi F^{\mu\nu}F_{\mu\nu}$	photon shower
vector portal	$\rho'^{\mu\nu}F_{\mu\nu}$	semi-visible jet
Higgs portal	$\phi H^\dagger H$	heavy flavor-rich
dark photon portal	$aF'^{\mu\nu}\tilde{F}'_{\mu\nu} + \epsilon F'^{\mu\nu}F_{\mu\nu}$	hadrons + leptons

- Light dark mesons are generically long-lived*



- Choices to minimize allowable CT
- * Theory prejudices apply: e.g.
 - small anomalous dimensions
 - avoiding tree-level fine-tunings

BENCHMARKS AND MONTE CARLO TOOLS

- Dark hadron multiplicities: **highly model-dependent**, not calculable
- Benchmark models using these decay portals implemented using Pythia HV module
 - default production through SM Higgs; other options possible
 - simplified hadron sector (ω, η); two choices of meson mass hierarchy to toggle visible multiplicities
 - user can set free parameters, e.g.: meson mass scale, N_f (invisible)

Will make associated tools for driving Pythia HV available in a public repository

DARK HADRON MULTIPLICITIES

► Multiplicities per event:

