LDMX: The Light Dark Matter eXperiment

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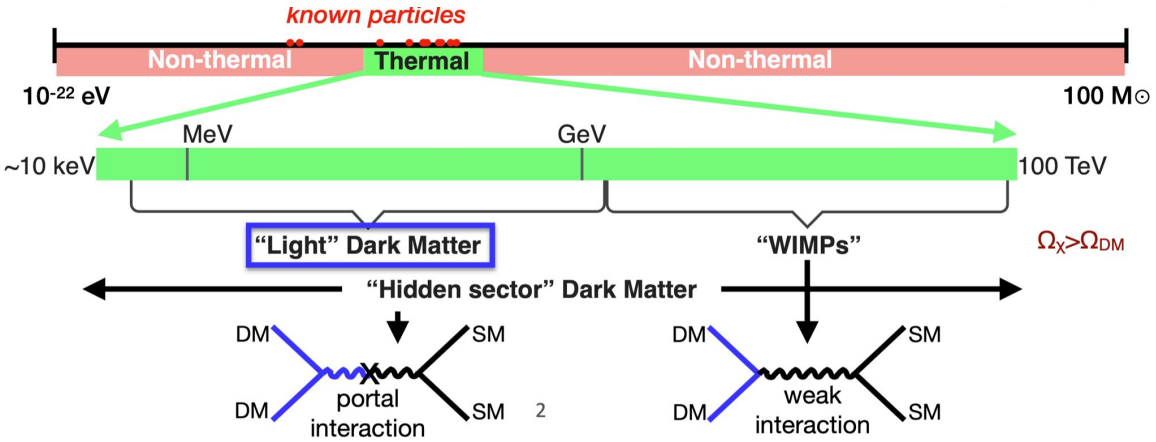
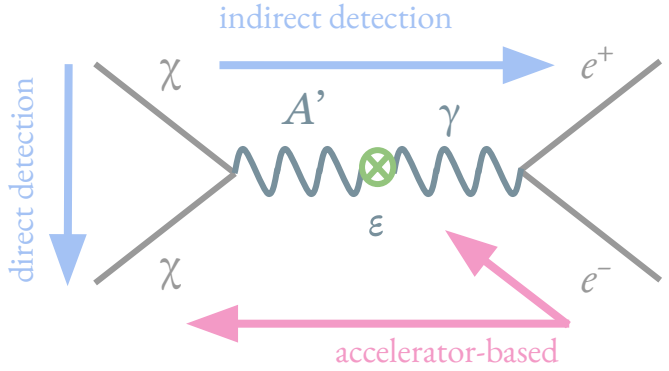
NuFACT 2022

A Thermal Relic & Light Dark Matter

- A thermal relic - simple and predictive model of dark matter (DM)
- Increasing interest in expanding the thermal DM search to “Light” DM in the MeV-GeV mass range
- Simplest prediction includes a dark photon (heavy photon or A’) that undergoes kinetic mixing with the SM photon

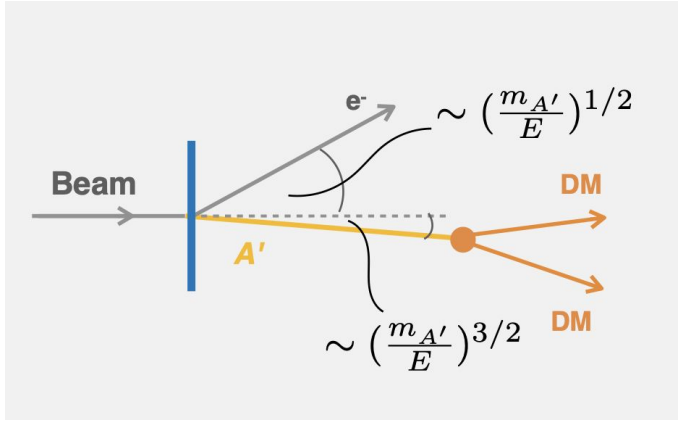


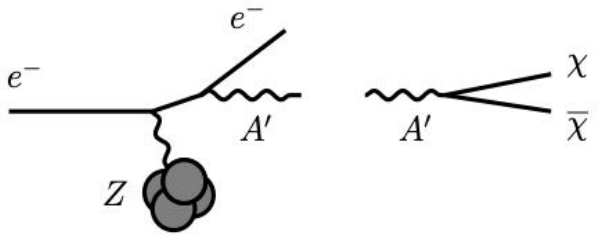


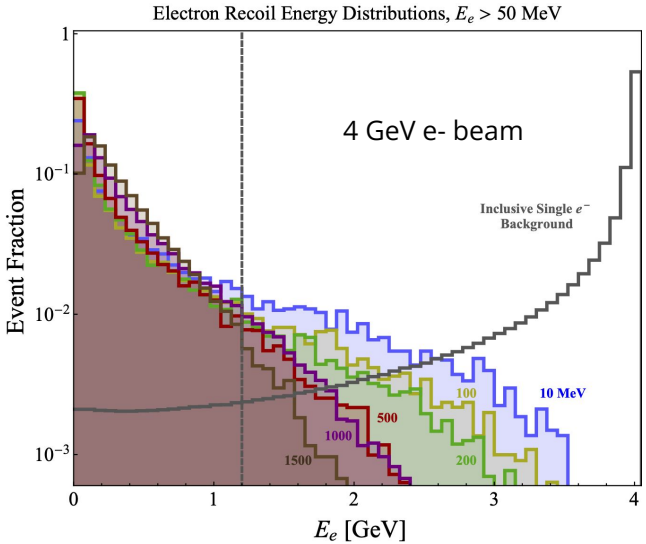
Kinetic Mixing $\epsilon F^{\mu\nu} F'_{\mu\nu}$

Dark Photon with a Fixed Target

- Fixed Target Signal Characteristics:
  - Dark bremsstrahlung A′ production, invisible decay
  - **A's take most of the beam energy; only visible final state particle is a soft recoil electron**





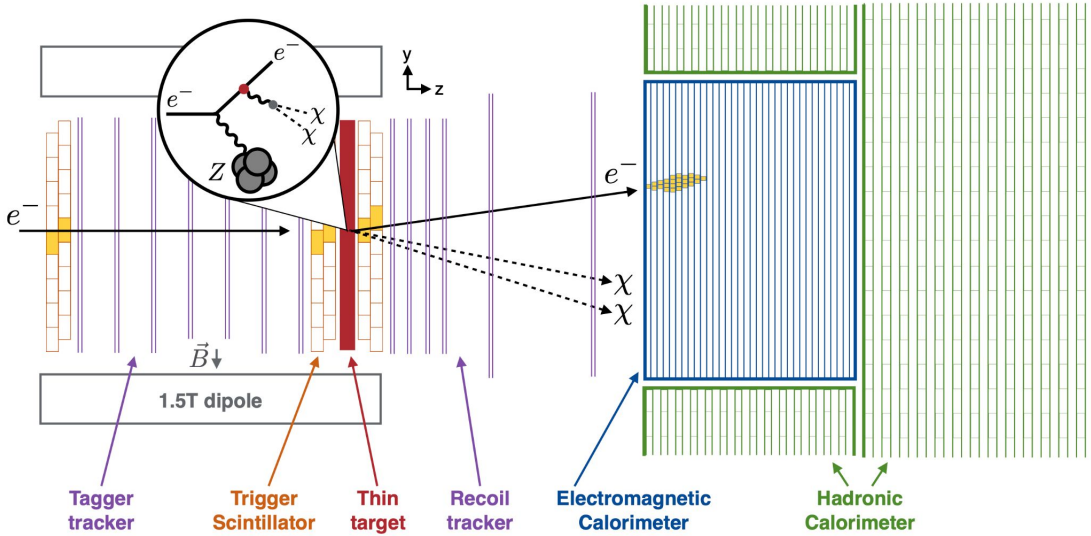


- Can probe this mechanism through a missing momentum search. We need…
  - High momentum resolution
  - High veto efficiency of SM backgrounds

LDMX Concept & Design

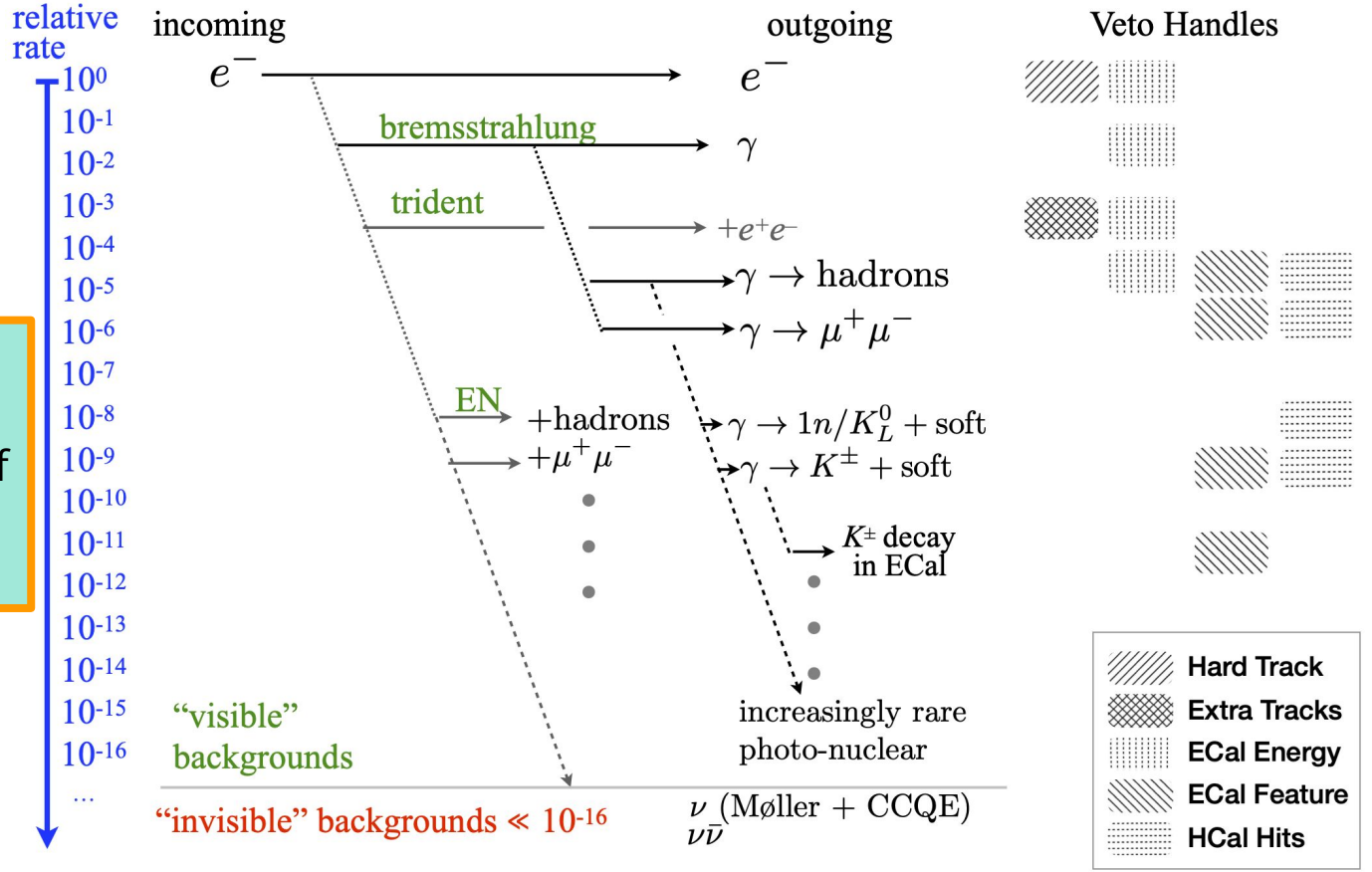
- Need hermetic detector designed for high rates and high radiation doses
  - **Tagging/recoil tracker**: fast with high momentum resolution and large acceptance
  - **Electromagnetic calorimeter**: fast, good energy resolution, and high granularity
  - **Hadronic calorimeter**: high veto efficiency of neutral hadrons

Matt Solt on Thursday WG4



Backgrounds

All systems combined: < 1 background event with signal efficiency of ~30-50% for O(1e14) EoT!



arXiv:1912.05535

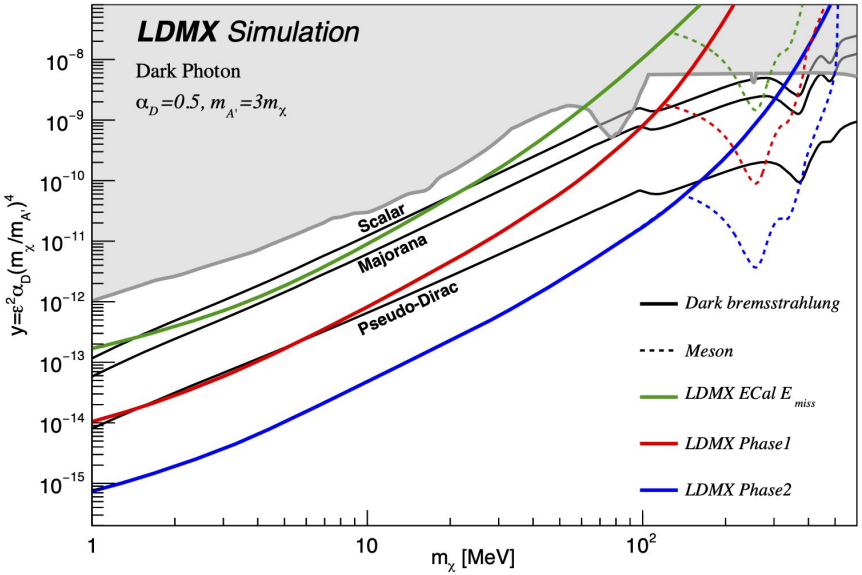
LDMX Sensitivity

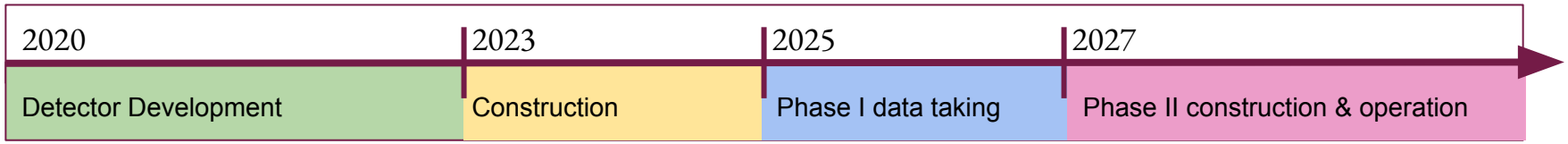
$$2m_{DM} < m_{A'}$$

Phase 1: 4 GeV,
10^{14} electrons
Phase 2: 8 GeV,
10^{16} electrons

arXiv:1808.05219

Planned at SLAC to run parasitically to LCLS-II

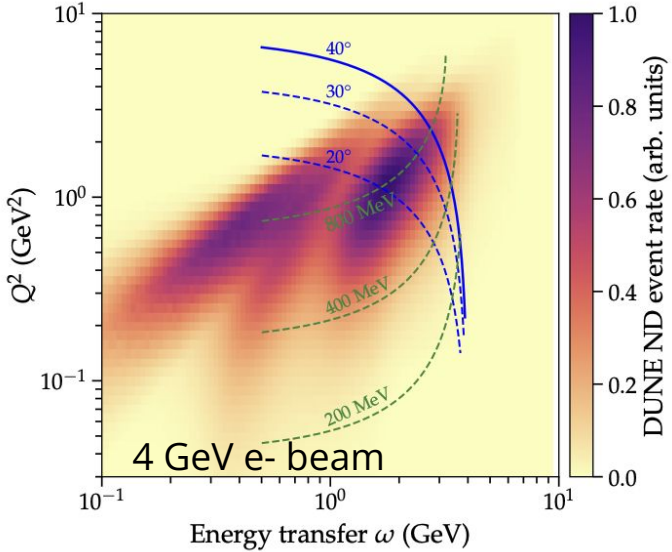


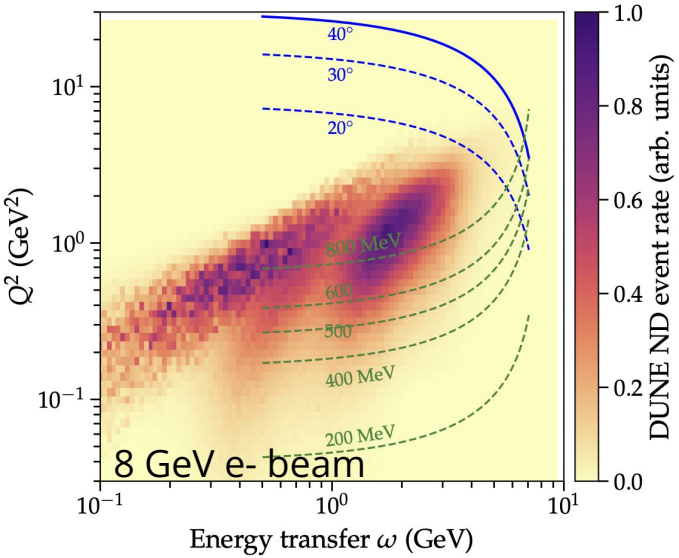


Proposed LDMX baseline schedule

LDMX Electro-nuclear Scattering Measurements

- Small angle acceptance and individual particle reconstruction (initial and final states) allows for electro-nuclear measurements of interest to neutrino experiments (such as DUNE)

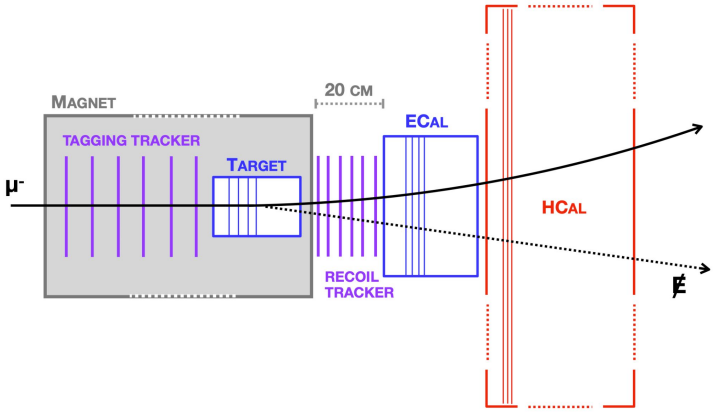


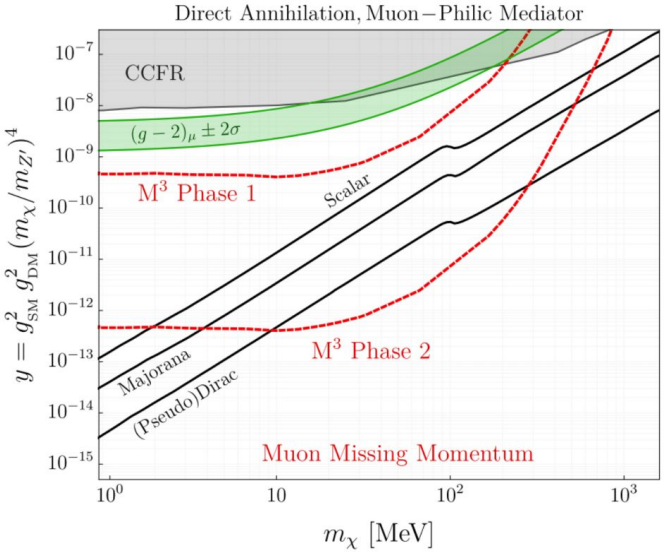


Wes Ketchum on [Tuesday WG2]

Muon Missing Momentum Experiment (M^3)

- Proposed missing momentum search for muon-philic invisibly decaying particles- scalars (S) and vectors (V)
- Utilizes LDMX-like detector with a thick active target and 15 GeV muon beam (Fermilab)





Phase I = 1e10 MOT:
g-2 anomaly
Phase 2 = 1e13 MOT:
dark matter

arXiv:1804.03144v1