

# The Light Dark Matter eXperiment

PANIC 2021

Geoffrey Mullier on behalf of the LDMX collaboration

Lund University

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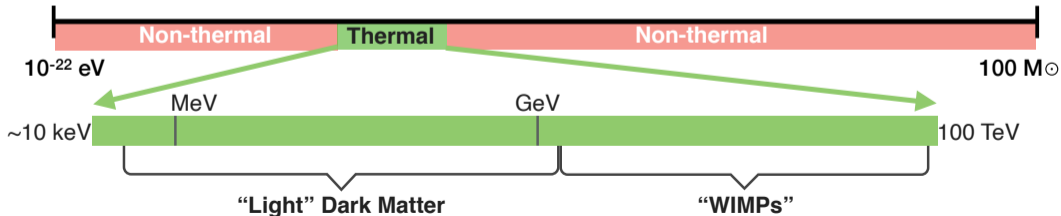
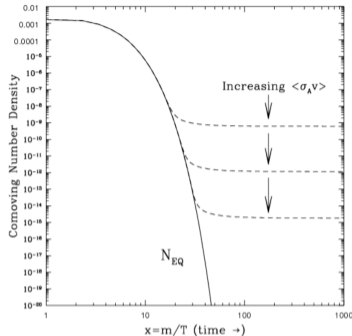
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# Light Dark Matter?

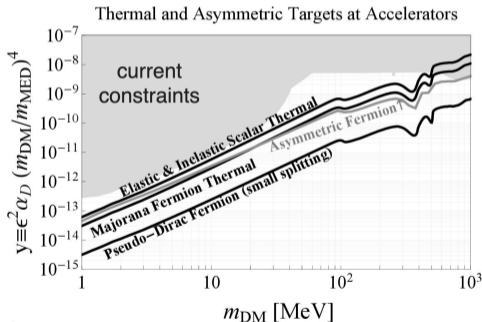
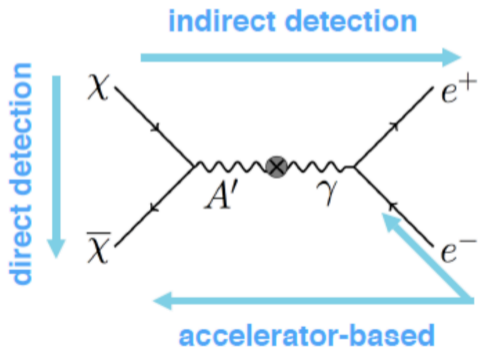
- Dark Matter could be a thermal relic
- WIMPs have been so far heavily investigated
- Effort from the community to expand research in the light regime



“Hidden sector” Dark Matter

# Dark sector mediator

- Simple dark sector extension
- Dark QED + kinetic mixing  $\epsilon \rightarrow$  "weak" interaction by construction
- Thermal targets in line with sensitivity obtainable at accelerators



# The **L**ight **D**ark **M**atter **eX**periment Fundamental concept

$e^-$   
\_\_\_\_\_

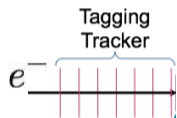
- $e^-$  beam on target
- Missing momentum experiment
- Tracking and tagging
- make "all" SM background appear in the detector
- Use  $P_T$  as a handle for signal discrimination

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<https://arxiv.org/abs/1808.05219>



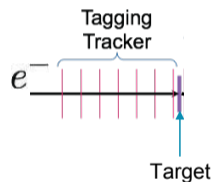
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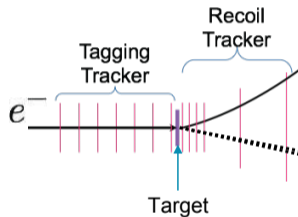
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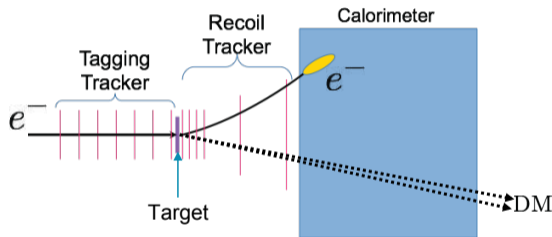
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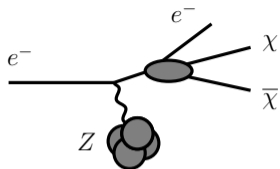
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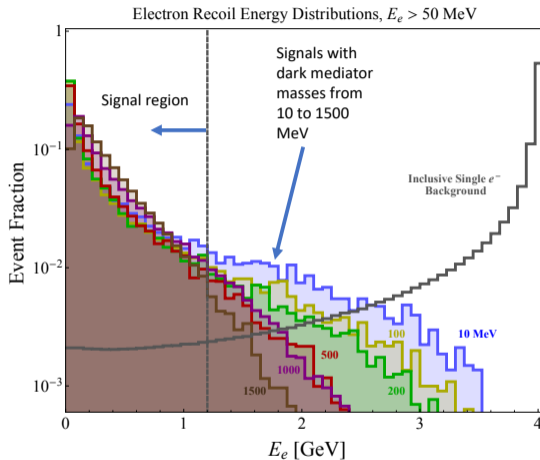
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# Kinematics

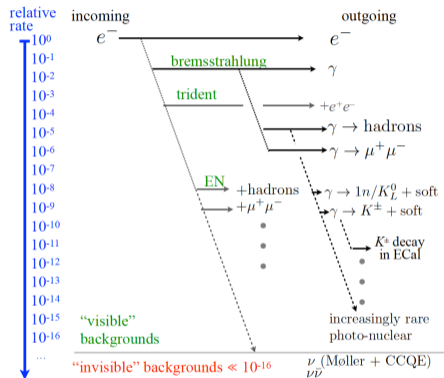


- Dark matter mediator and Dark matter takes the most of the momentum out
- Electron left with small momentum
- Signal is a low detector activity with low energy recoil electron



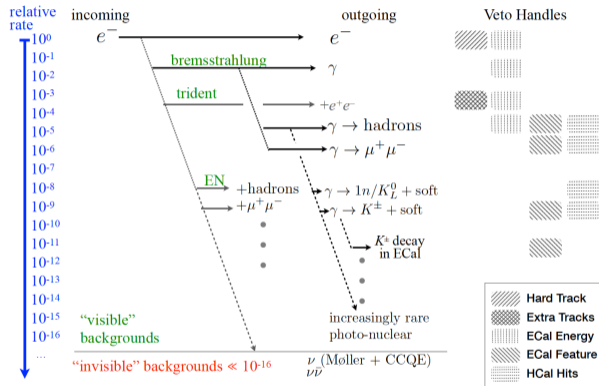
4GeV  $e^-$  beam on W target

# Backgrounds



- Numerous background contributing to potential signals
- Each of the backgrounds can be identified thanks to a combination of handles given by subsystems

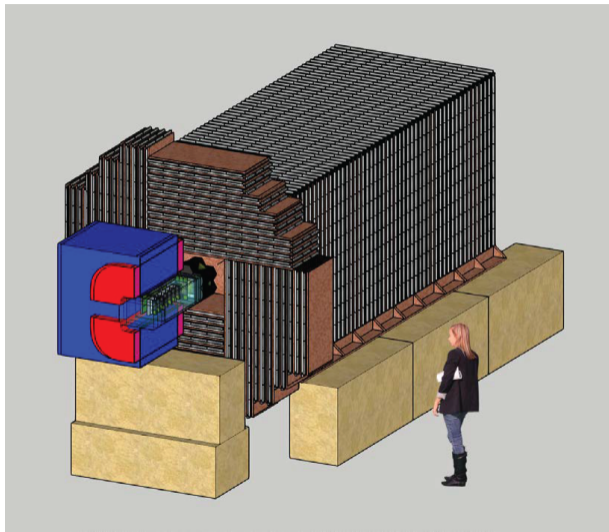
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# LDMX experimental setup overview

- Use of LCLS-II beam at SLAC via dedicated transfer line (LESA) first at 4 GeV, then to 8 GeV
- Individual tagging and Reconstruction of  $10^{16}$  electrons on target → low current, high repetition rate
- Detector that can sustain high rates and high radiation doses
- Tracking: Fast and, high momentum resolution
- EM calorimeter Fast, High granularity with good energy resolution
- HCAL Hermetic for vetoing

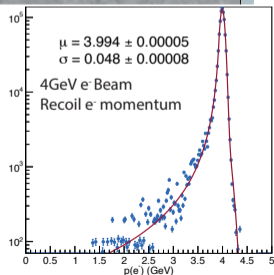
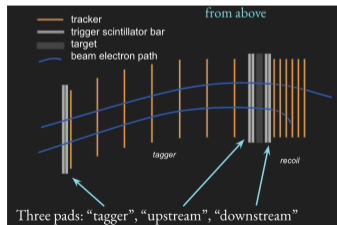
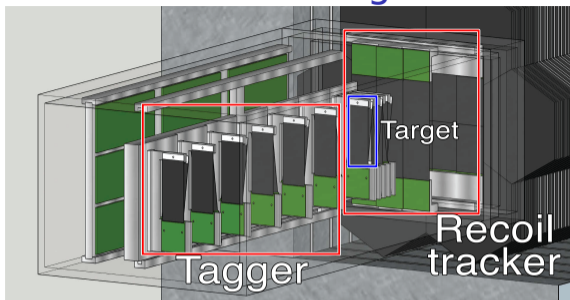


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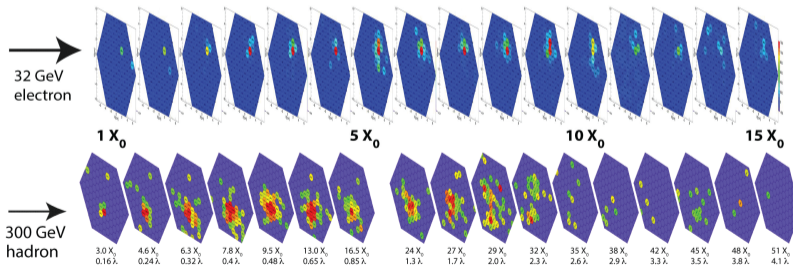
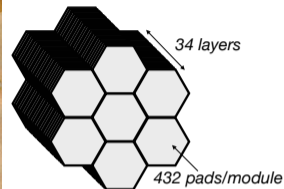
# LDMX experimental setup overview : Tracking

- Tagging tracker inside dipole field, tracks incoming  $e^-$
- Recoil tracker in fringe field, tracks recoil products
- Momentum resolution limited by multiple scattering in target
- Trigger scintillator array of scintillator bars for fast count of incoming electrons as input to missing-energy trigger



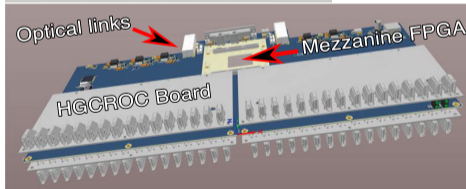
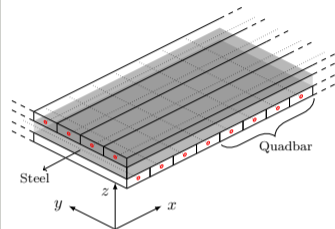
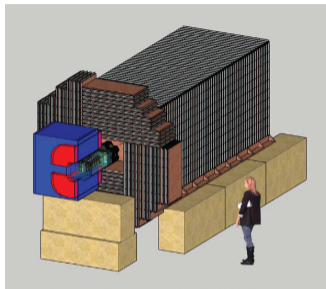
# LDMX experimental setup overview : ECal

- $40X_0$  silicon-tungsten sampling calorimeter
- CMS HGC hardware
- High granularity, fast, radiation hard with containment of EM showers
- Allows for tracking of showers and MIPs

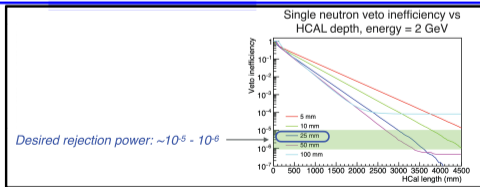
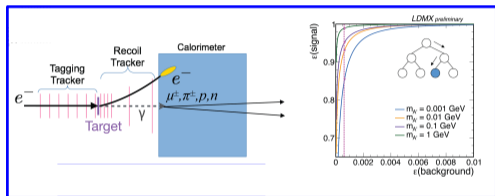
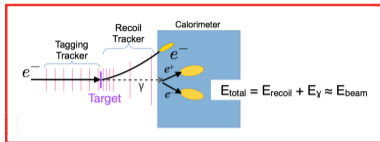
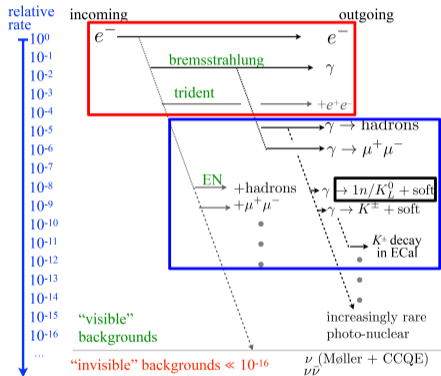


# LDMX experimental setup overview : HCal

- Modified hardware from  $\mu 2e$
- Extruded polystyrene scintillator bars with wavelength shifting fibers read out by SiPM, steel absorber
- Depth of main HCal  $\approx 16 \lambda_I$
- Side Calorimeter to ensure hermeticity
- Same Front End chips as the ECal (HGCROC)

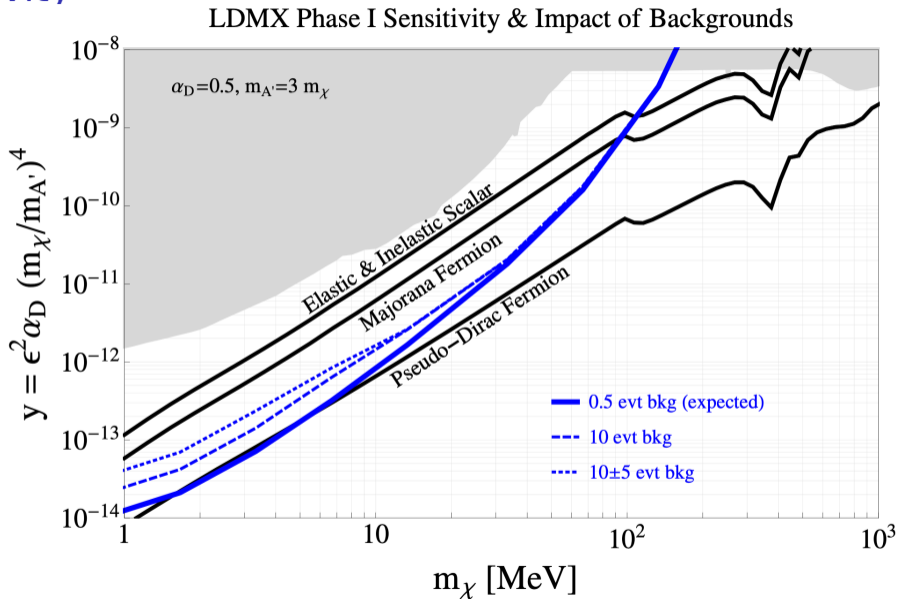


# Background rejection



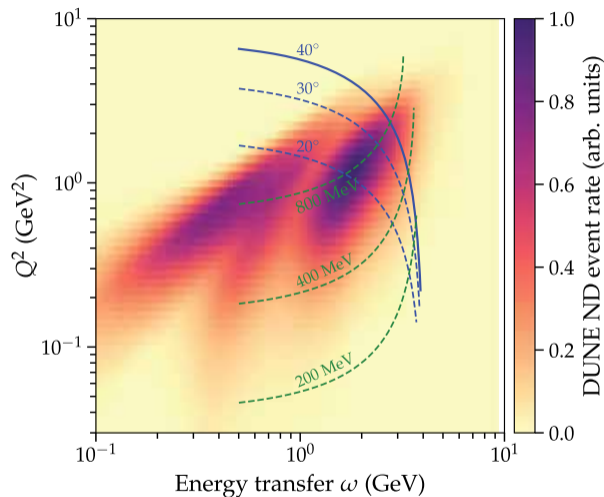
[https://link.springer.com/article/10.1007/JHEP04\(2020\)003](https://link.springer.com/article/10.1007/JHEP04(2020)003)

# Sensitivity



# LDMX Light Dark matter, but not only!

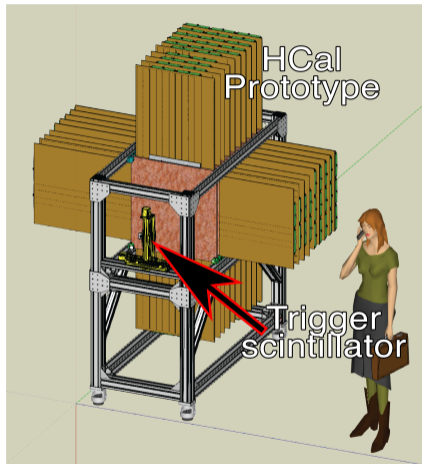
- In a nutshell LDMX is electrons on target
- Sensitive to not only Dark photons but a wide range of DM models
- Electro-nuclear events will occur at a high rate in the detector
- Kinematic range accessible by LDMX in the bulk of events of DUNE
- Dune would profit greatly of measurement from LDMX to reduce uncertainties



DOI: 10.1103/PhysRevD.101.053004 DOI:PhysRevD.99.075001

# Upcoming testbeam

- At CERN newly renovated East Area
- Calibration and validation of the readout for the Trigger Scintillator and Hadronic Calorimeters
- First test of the first iteration of the integration of the system



# Summary

- LDMX aims to explore the light dark matter regime via  $e^-$  beam on target of 4GeV/8GeV
- The design of LDMX makes it possible to measure critical phase space parameters of interest to DUNE as well as a wide range of other DM models
- First phase testing of the hardware has begun and first test beam will happen next month



Thank you for your attention!



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# Extended Sensitivity

