BDX @ SLAC & JLab

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Fermilab

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PI

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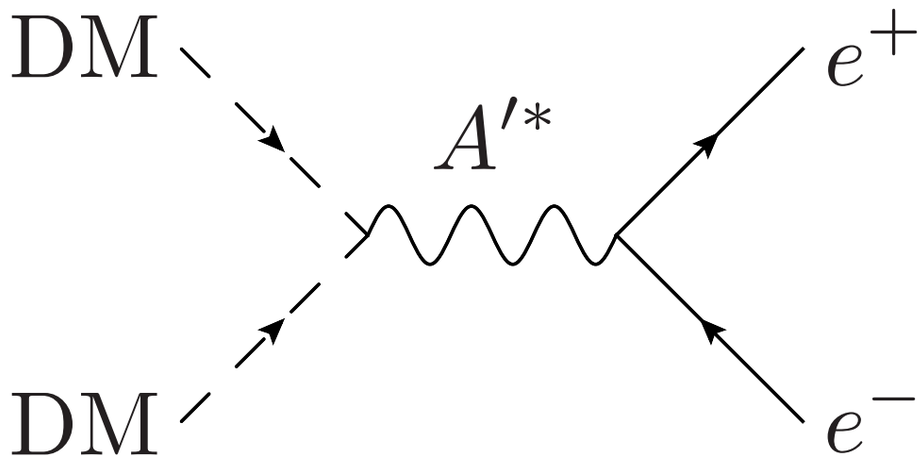
Overview

- Reminders & Context
- SLAC vs. JLAB (Majorana DM)
- SLAC vs. JLAB (Scalar DM)
- Biased Remarks

Recall Eder's talk

Light Thermal DM



gives an annihilation rate which goes as

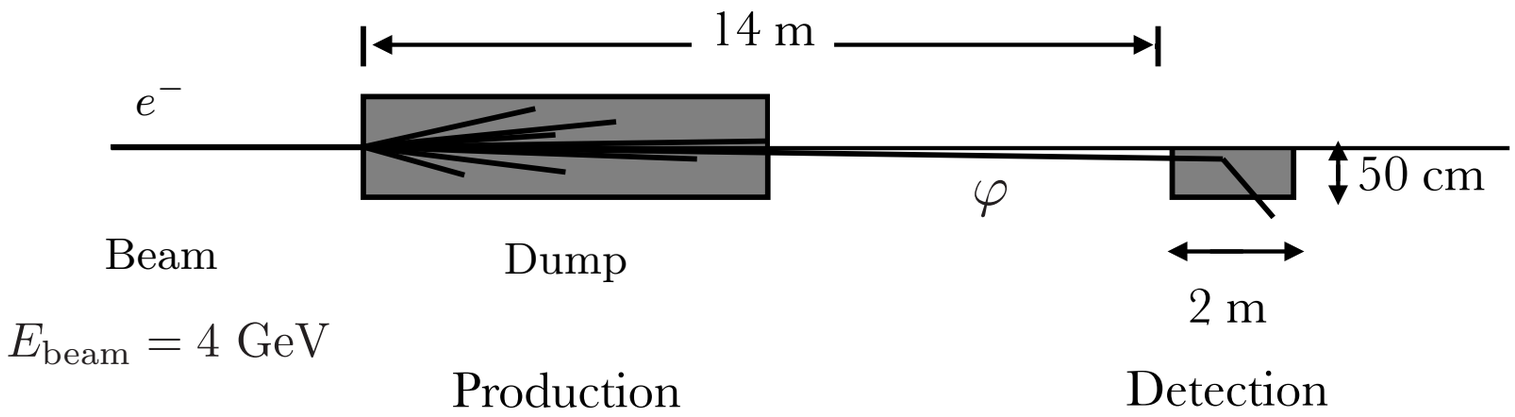
$$\langle \sigma v \rangle \propto \epsilon^2 \alpha_D \frac{m_\varphi^2}{m_{A'}^4} = \epsilon^2 \alpha_D \frac{m_\varphi^4}{m_{A'}^4} \frac{1}{m_\varphi^2} = \frac{y}{m_\varphi^2}$$

Then, for fixed DM mass
annihilation rate invariant
under the dimensionless combination

$$y = \epsilon^2 \alpha_D \frac{m_\varphi^4}{m_{A'}}$$

Recall Eder's talk

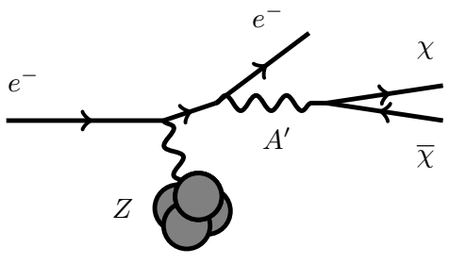
DM production at LCLS-II Beam Dump



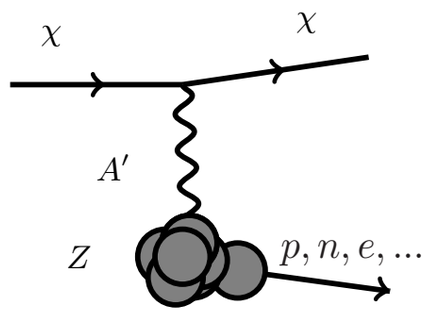
I'm assuming the dump is made out of aluminum

Detection takes place at a 50cm x 50 cm x 200 cm CsI prototype

Production

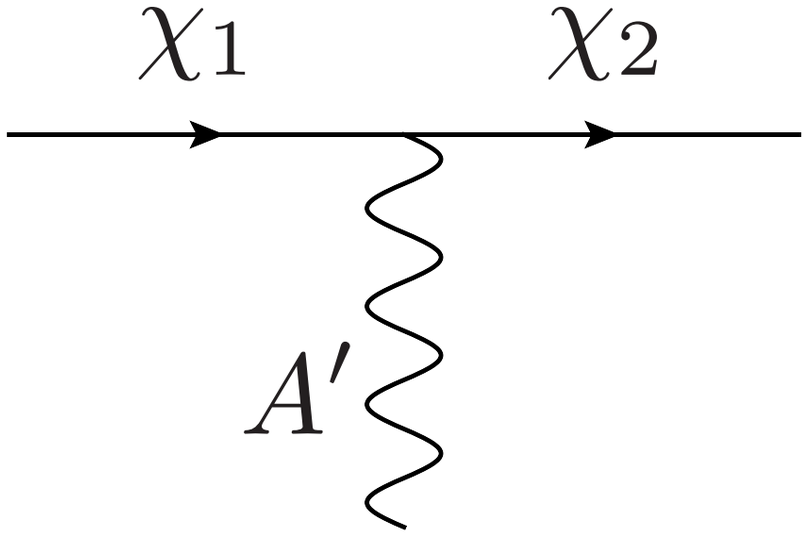


Detection

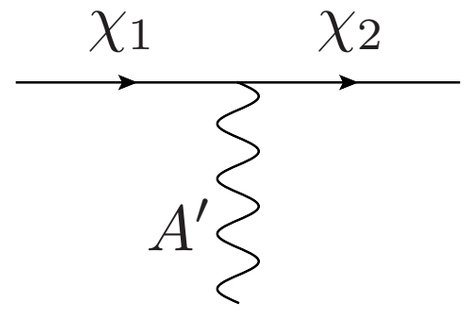


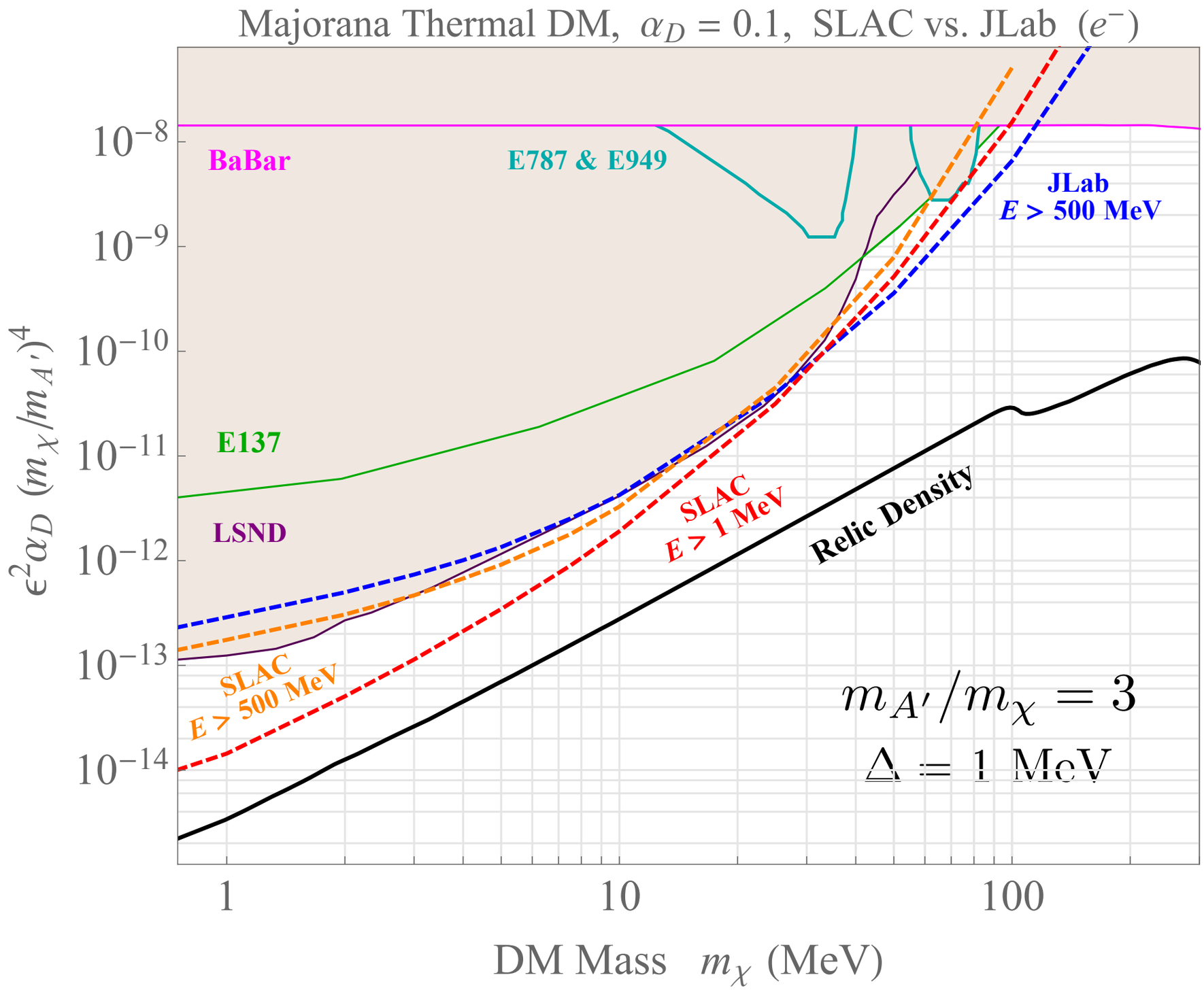
SLAC vs. JLab

Majorana DM



Majorana DM (electron)

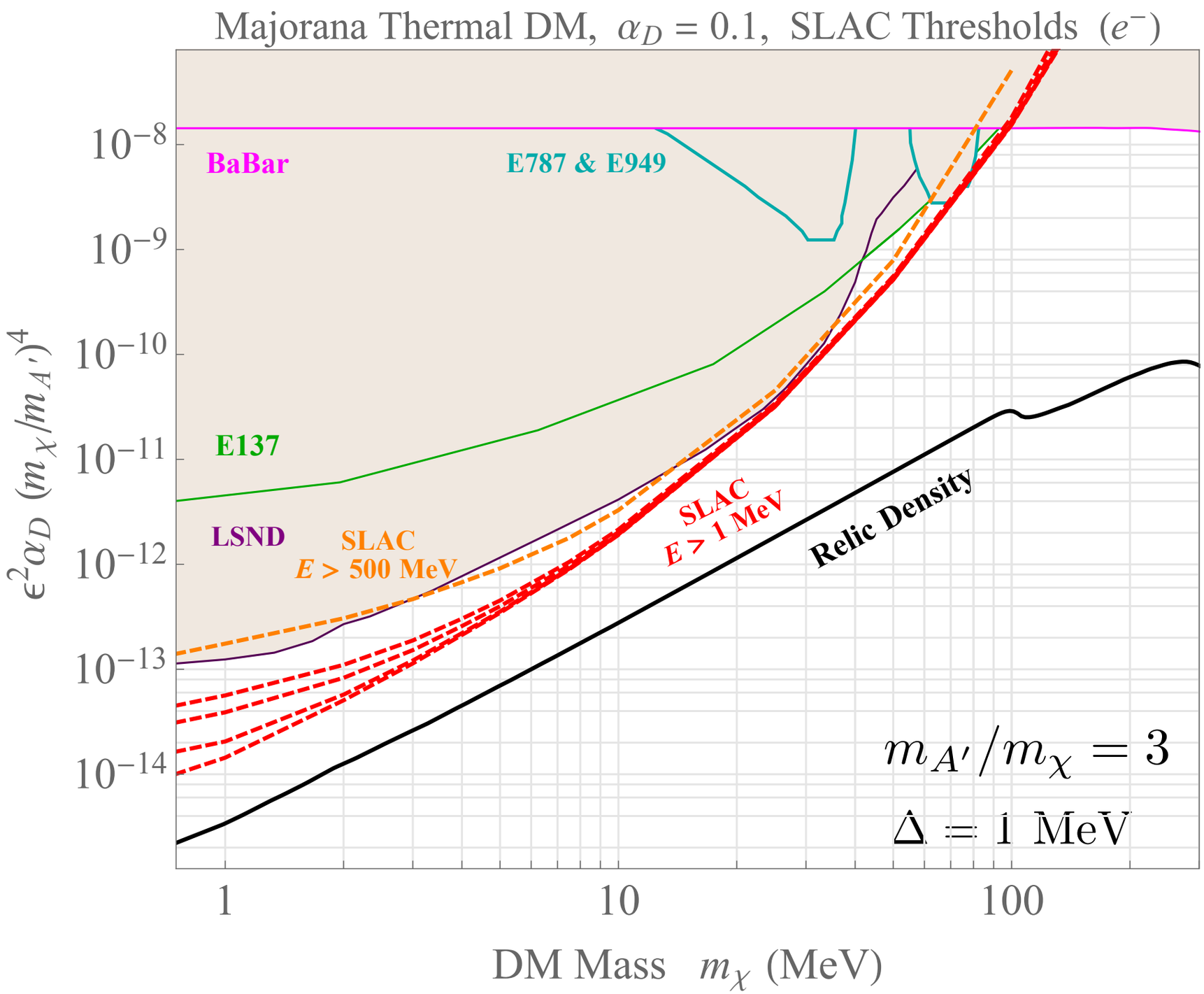


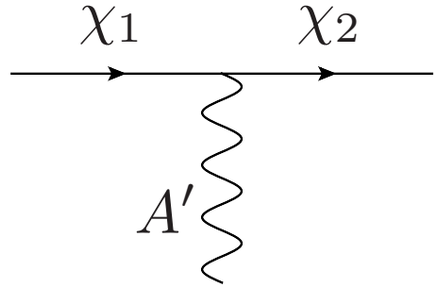


SLAC : 3×10^{21} EOT, 10 Events

JLab : 10^{22} EOT, 100 Events

Majorana DM (electron)

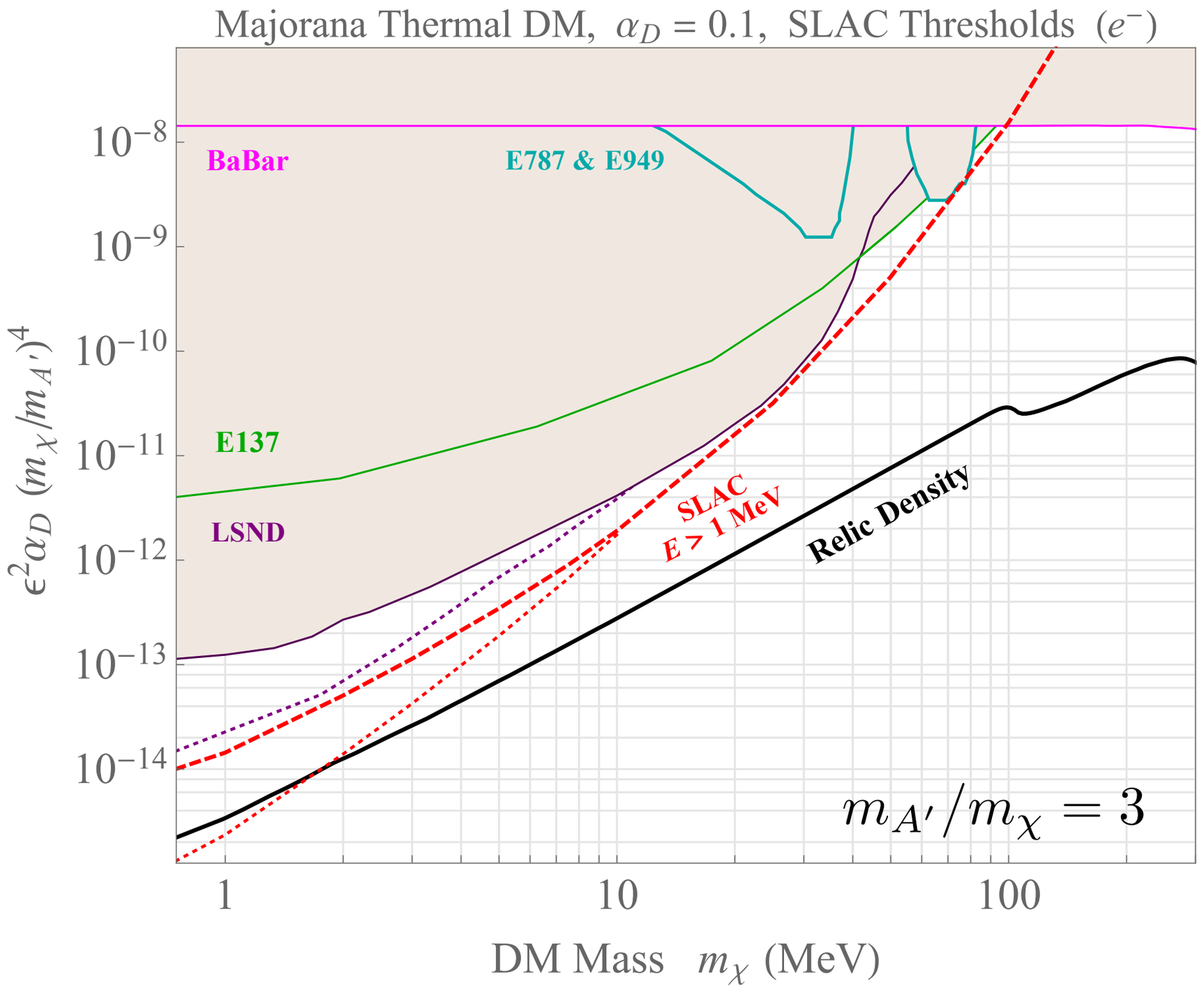


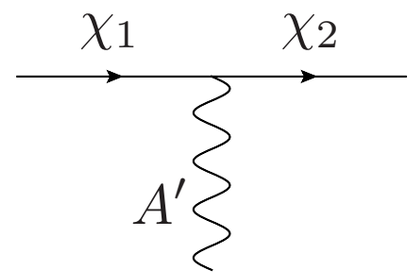


$$E_e > \{1, 10, 50, 100, 500\} \text{ MeV}$$

SLAC : 3×10^{21} EOT, 10 Events

Majorana DM (electron)

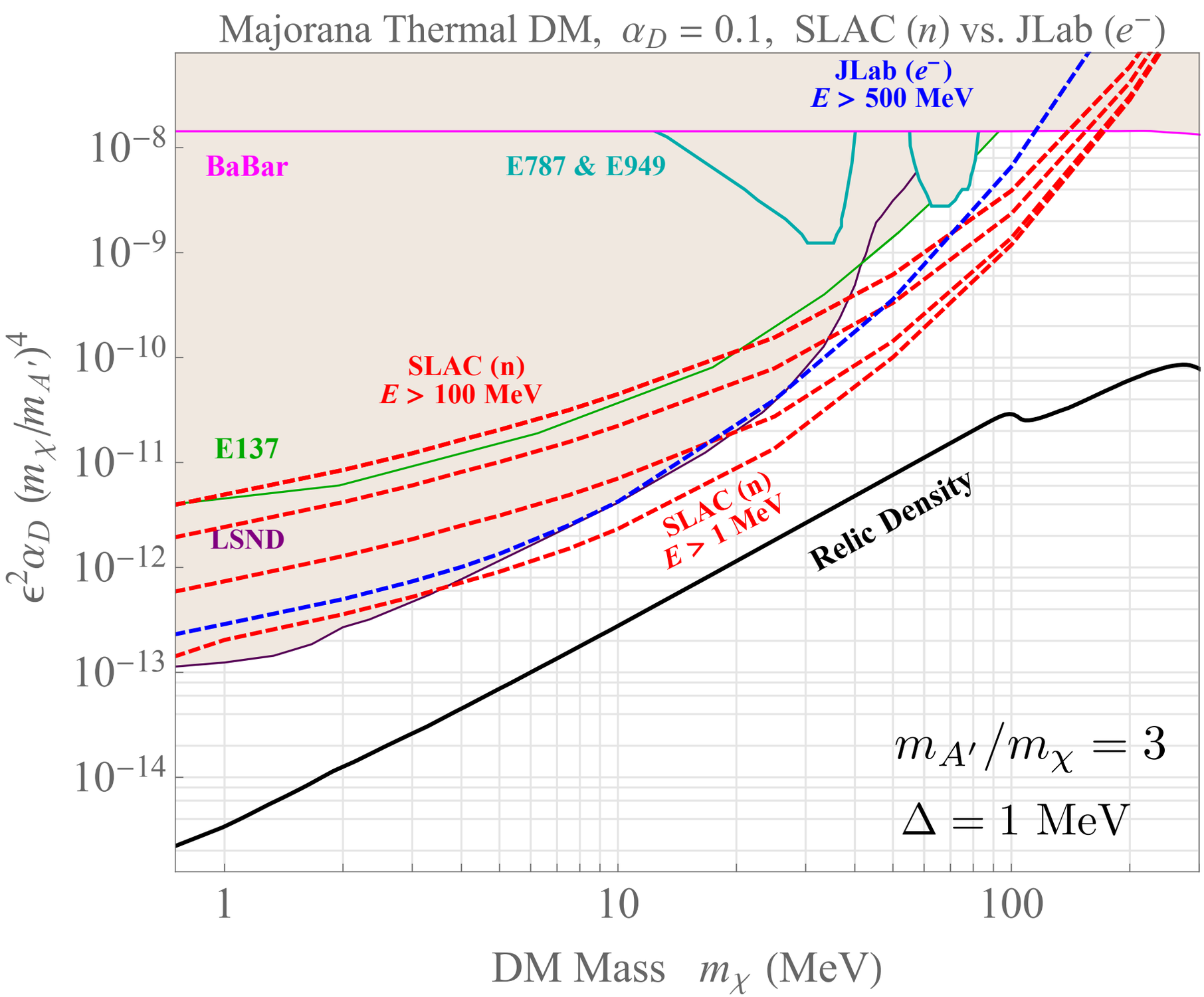


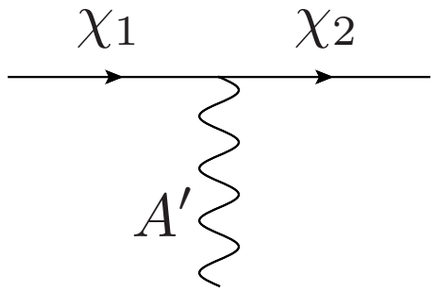


$$\frac{\sigma_{\chi\chi}}{m_\chi} < \frac{\mathrm{cm}^2}{\mathrm{g}}$$

Include DM self interaction constraints in choosing conservative α_D

Majorana DM (nucleon)

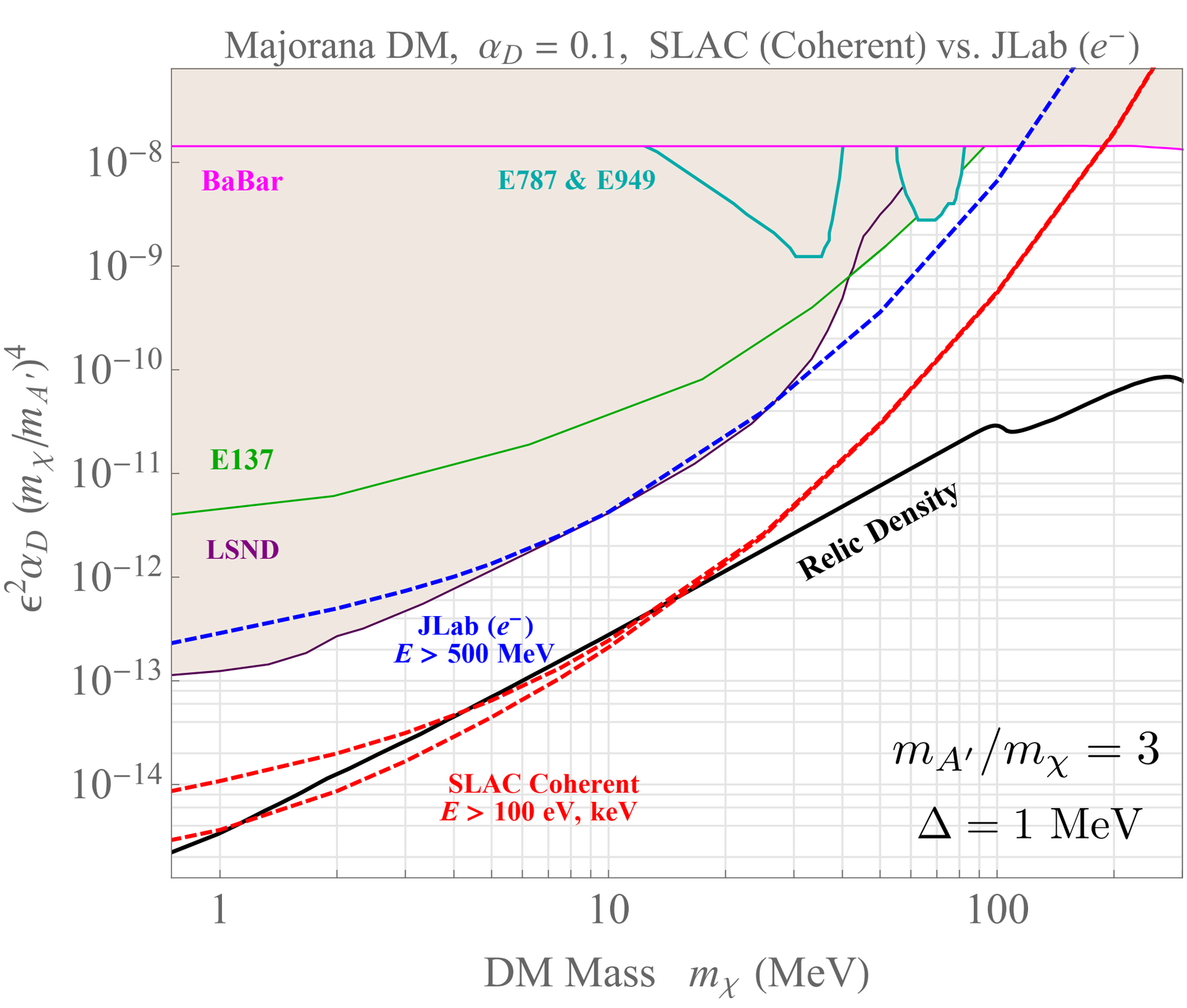


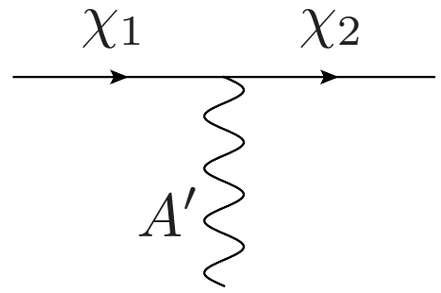


SLAC : 3×10^{21} EOT, 10 Events

JLab : 10^{22} EOT, 100 Events

Majorana DM (Coherent Nuclear)



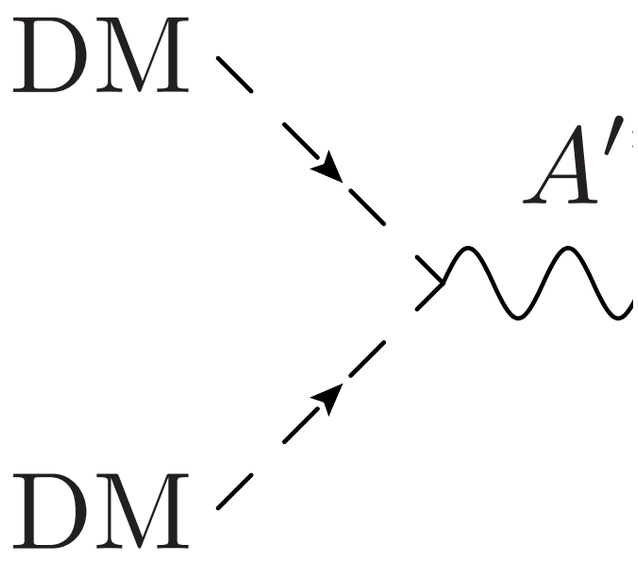


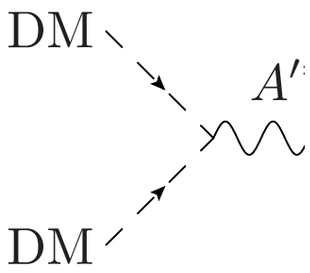
SLAC : 3×10^{21} EOT, 10 Events

JLab : 10^{22} EOT, 100 Events

SLAC vs. JLab

Scalar QED DM





Scalar QED DM (electron)

Scalar Thermal DM, $\alpha_D = 0.1$, SLAC

CMB
BaBar
XENON 10
LSND
JLab
$E > 500$ MeV
SLAC
$E > 500$ MeV
SLAC
$E > 1$ MeV
Relic Density
$m_{A'}/m_\chi = 3$

$\epsilon^2 \alpha_D \, (m_\varphi / m_{A'})^4$

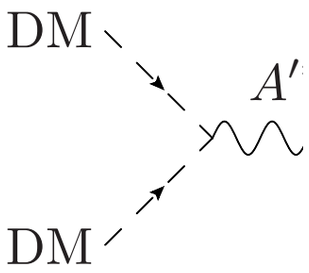
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-14}

1
10
10^2

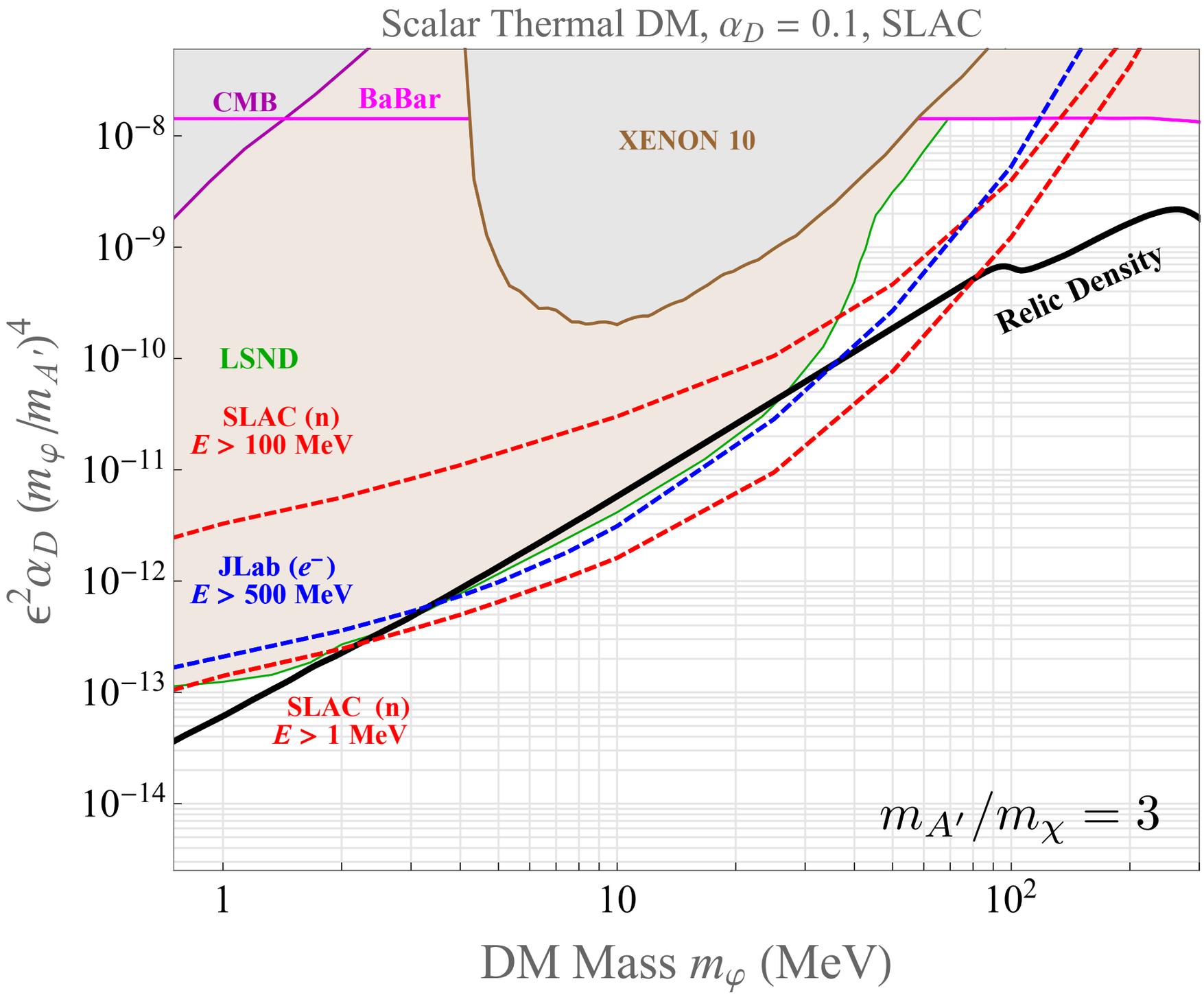
DM Mass m_φ (MeV)

SLAC : 3×10^{21} EOT, 10 Events

JLab : 10^{22} EOT, 100 Events

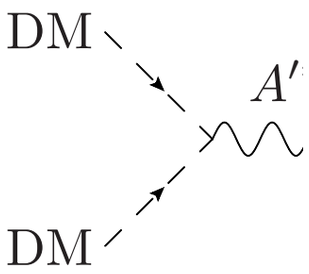


Scalar QED DM (nucleons)



SLAC : 3×10^{21} EOT, 10 Events

JLab : 10^{22} EOT, 100 Events



Scalar QED DM (Coherent)

Scalar Thermal DM, $\alpha_D = 0.1$, SLAC

CMB
BaBar
XENON 10
LSND
JLab (e^-)
$E > 500$ MeV
SLAC Coherent
$E > 100$ eV, keV
Relic Density
$m_{A'}/m_\chi = 3$

$\epsilon^2 \alpha_D \, (m_\varphi / m_{A'})^4$

10^{-8}, 10^{-9}, 10^{-10}, 10^{-11}, 10^{-12}, 10^{-13}, 10^{-14}

1, 10, 10^2

DM Mass m_φ (MeV)

SLAC : 3×10^{21} EOT, 10 Events

JLab : 10^{22} EOT, 100 Events

Remarks

- SLAC (JLab) generally wins at low (high) mass

  Tremendous potential gains w/ low thresholds

- Quasi-elastic nucleon channel potentially very useful

  (SLAC beats JLab at high mass if cuts can be low)

- If feasible, coherent channel wins across the board

- Possible to conservatively test light thermal DM