



上海交通大学
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Feasibility Study for Dark Photon Visible Decay on BEPC

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March 8, 2022

Experiment Setup

BEPC electron beam line:

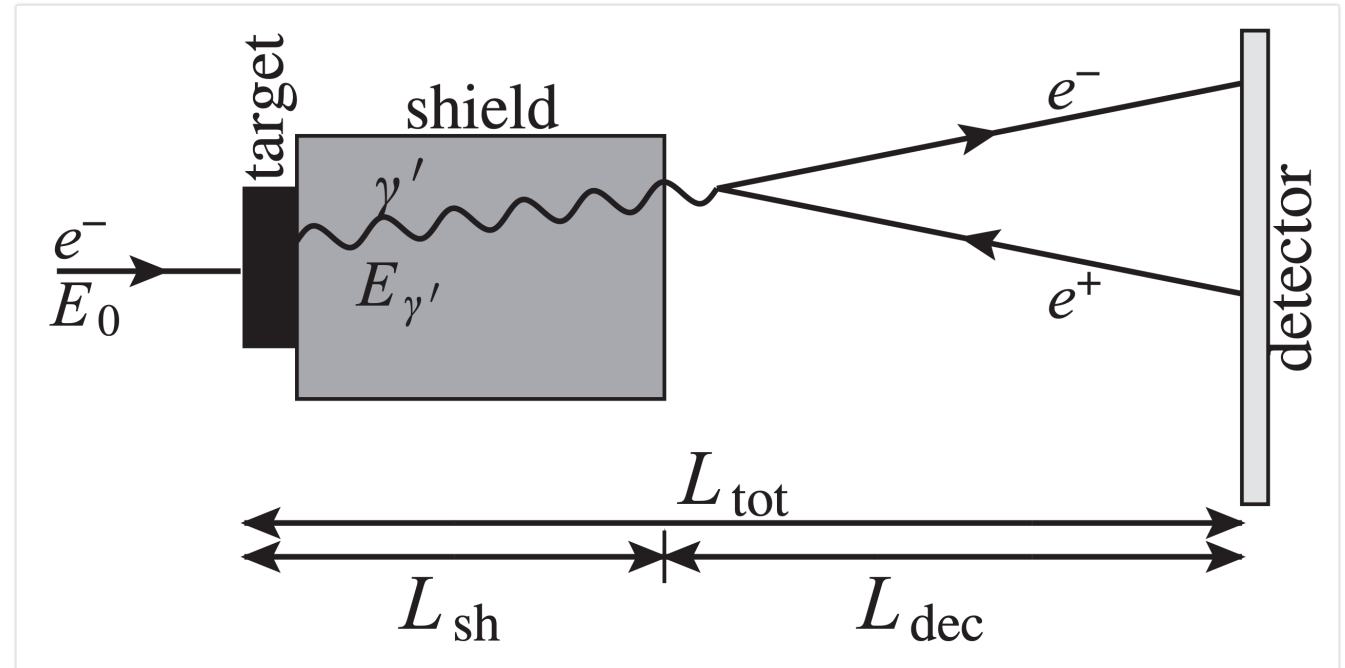
- Incident Energy (E_0): 2.9 GeV
- Target (Tungsten) : $0.1X_0$
- Shield Length (L_{sh}):
 - 0.05, 0.1, 0.2, 0.3, 0.4, 0.5 [m]

Simulation Assumption:

- 20 incident electrons per event
- Only one dark photon per event
- EOT: 10^{14}

Signal Model:

- [LDMX \(G4DarkBrem\)](#) - fully integrated
- CalcHep (DSS) – still under refactoring

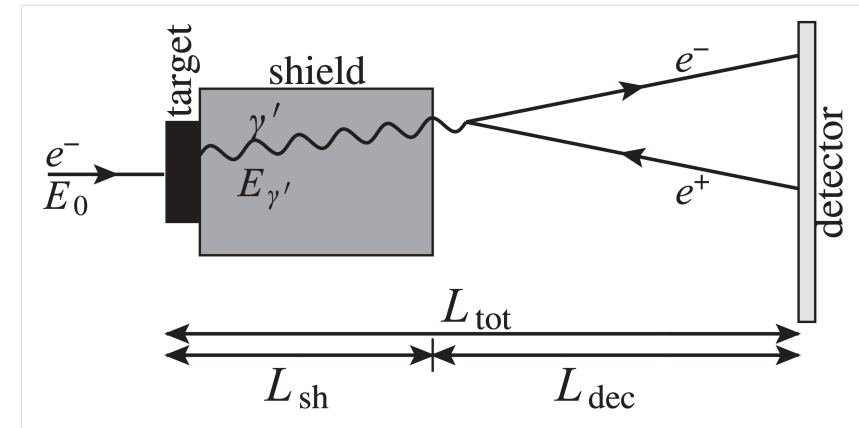


Experiment	Target	E_0 (GeV)	N_{el}	L_{sh} (m)	L_{dec} (m)
KEK [50]	W	2.5	$1.69 \cdot 10^{17}$	2.4	2.2
E141 [51]	W	9	$2 \cdot 10^{15}$	0.12	35
E137 [52]	Al	20	$1.87 \cdot 10^{20}$	179	204
E774 [53]	W	275	$5.2 \cdot 10^9$	0.3	2
Orsay [54]	W	1.6	$2 \cdot 10^{16}$	1	2

[Results and perspectives in dark photon physics \(2015\)](#)

Sensitivity Estimation

- Calculate $\Gamma_{A' \rightarrow \ell^+ \ell^-}$ for each mass point
- Generate random lifetime (**exponential decay**)
- Boost to lab frame and give L
- Calculate L_Z w.r.t the beamline (compared with L_{sh})



- $$\Gamma_{A' \rightarrow \ell^+ \ell^-} = \frac{1}{3} \alpha \epsilon^2 M_{A'} \sqrt{1 - \frac{4m_\ell^2}{M_{A'}^2}} \left(1 + \frac{2m_\ell^2}{M_{A'}^2}\right)$$
- $$L = \beta c \times \text{Exp}\left(\frac{\hbar c}{\Gamma c}\right)$$

Consistent with Xiang's results

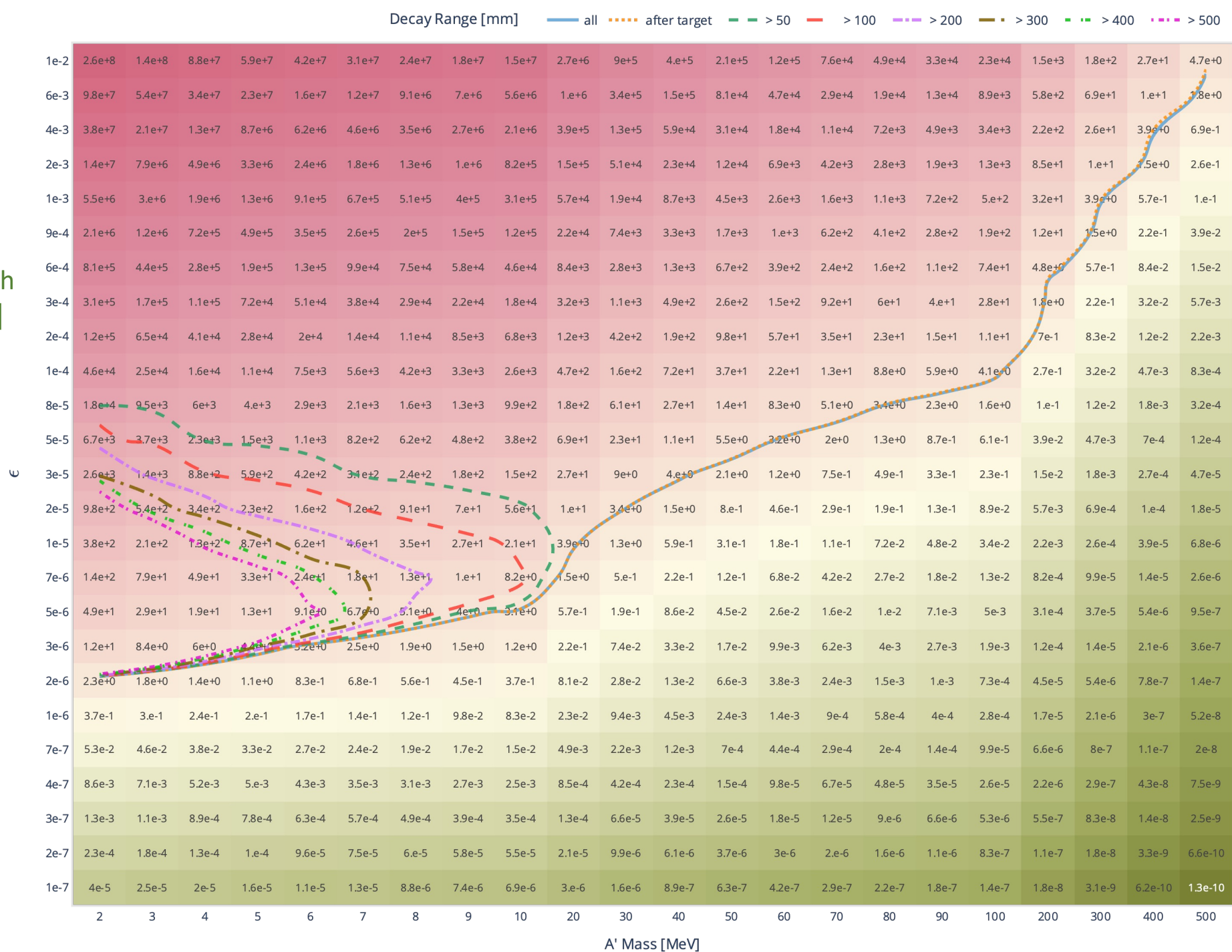
EOT estimation:

- $$N_{\text{sig}} = \sigma_{A'} \times 0.1 X_0 \times \mathcal{L} \times \frac{N_A}{M_W} \times 10^{-36} \times \epsilon^2$$

$\sigma_{A'}$ calculated from LDMX

Get quick estimation of limit suppose signal eff ~ 100% with 0.5 bkg

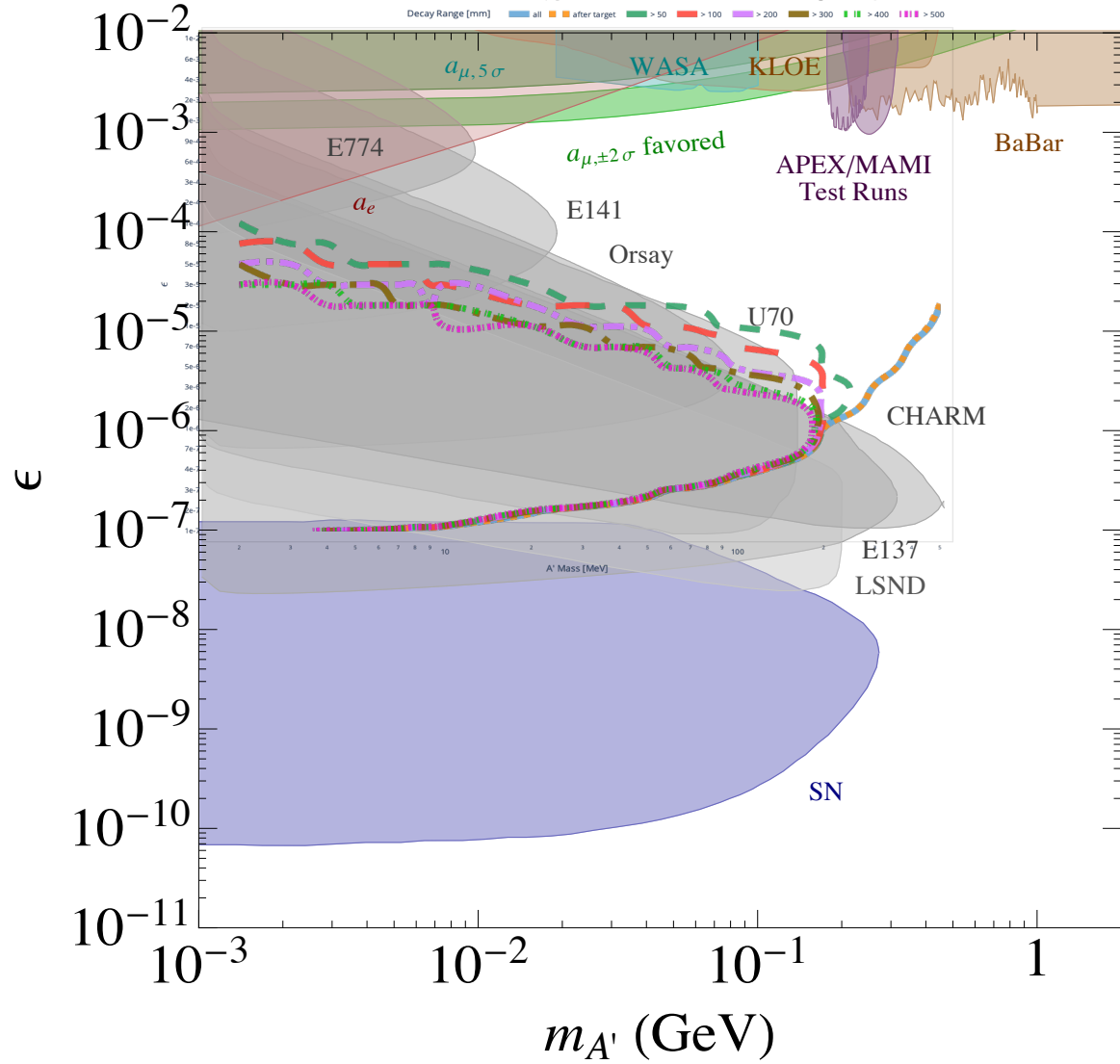
Sensitivity:
Should focus on
small masses with
 $\epsilon \in [10^{-6}, 10^{-4}]$



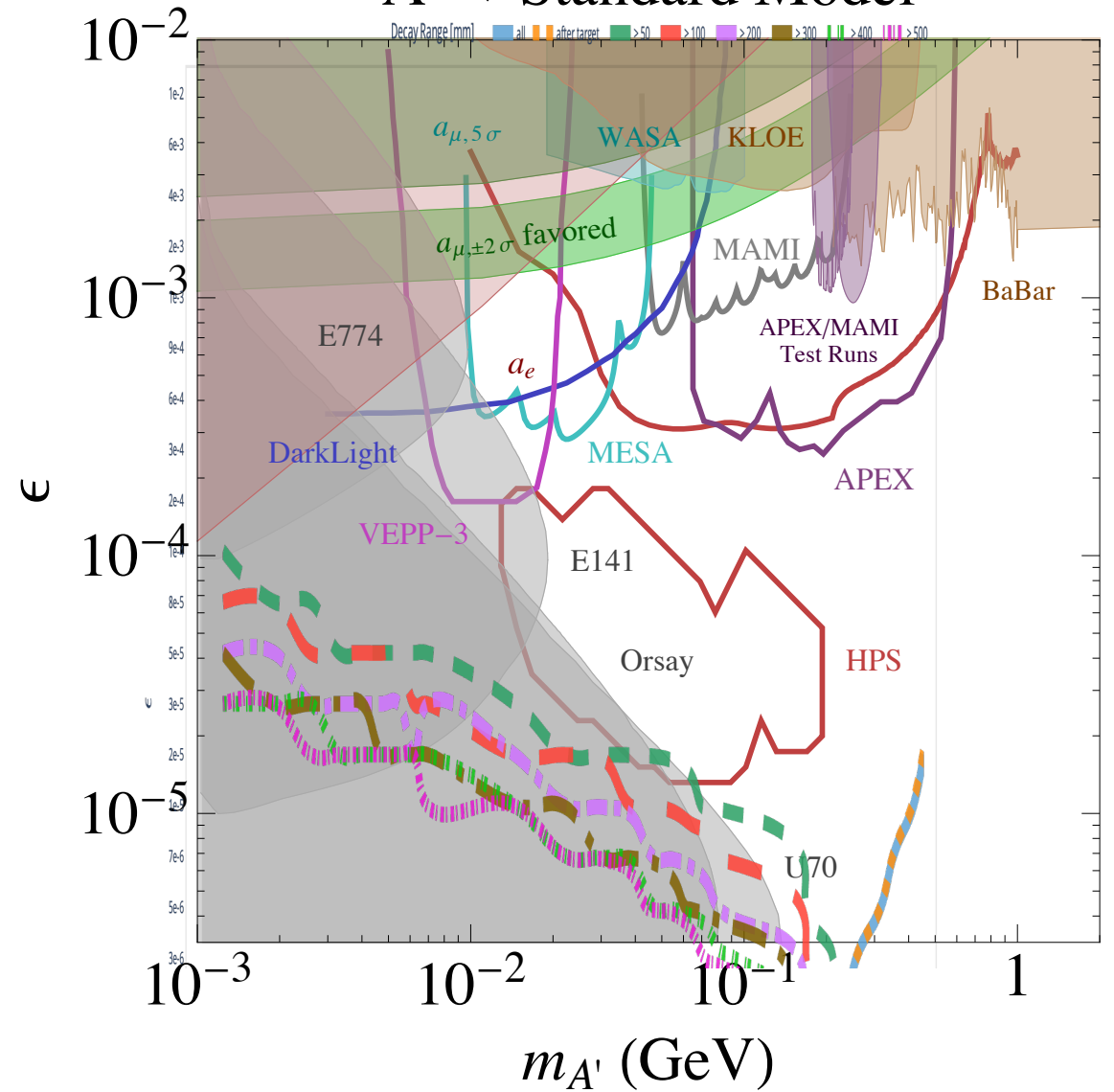
Some beam parameters

Particle Accelerator	Kinetic Energy (GeV)	Electrons per Bunch	Repetition Rate (Hz)	EOT/year ($\times 10^{19}$)
CEPC linac	20	1.88E10	100	6E19
BEPCII linac	2.9	1.25E10	50	2E19
EicC	3.5	1.7E11	0.588	0.3E19

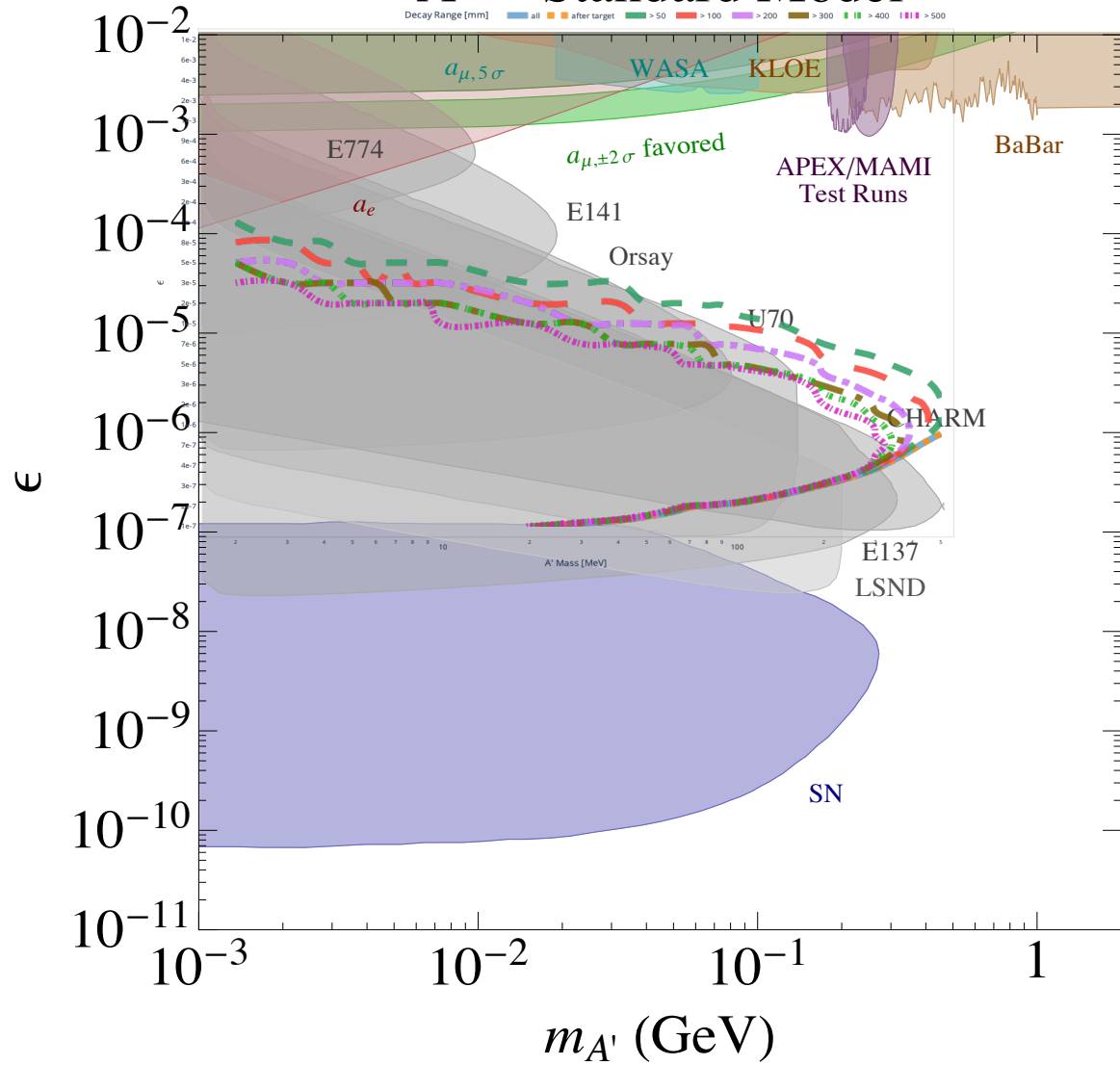
$A' \rightarrow \text{Standard Model}$



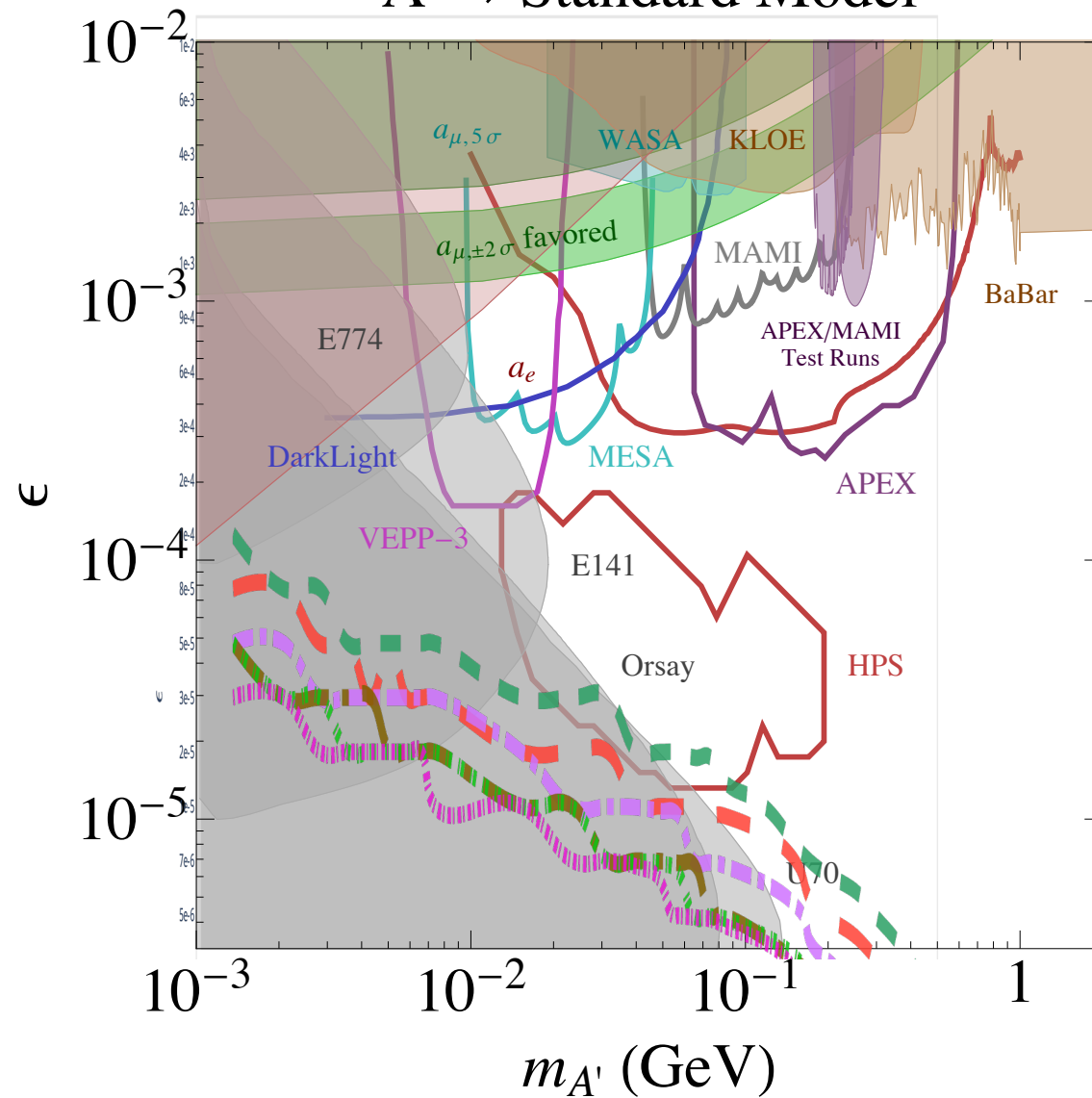
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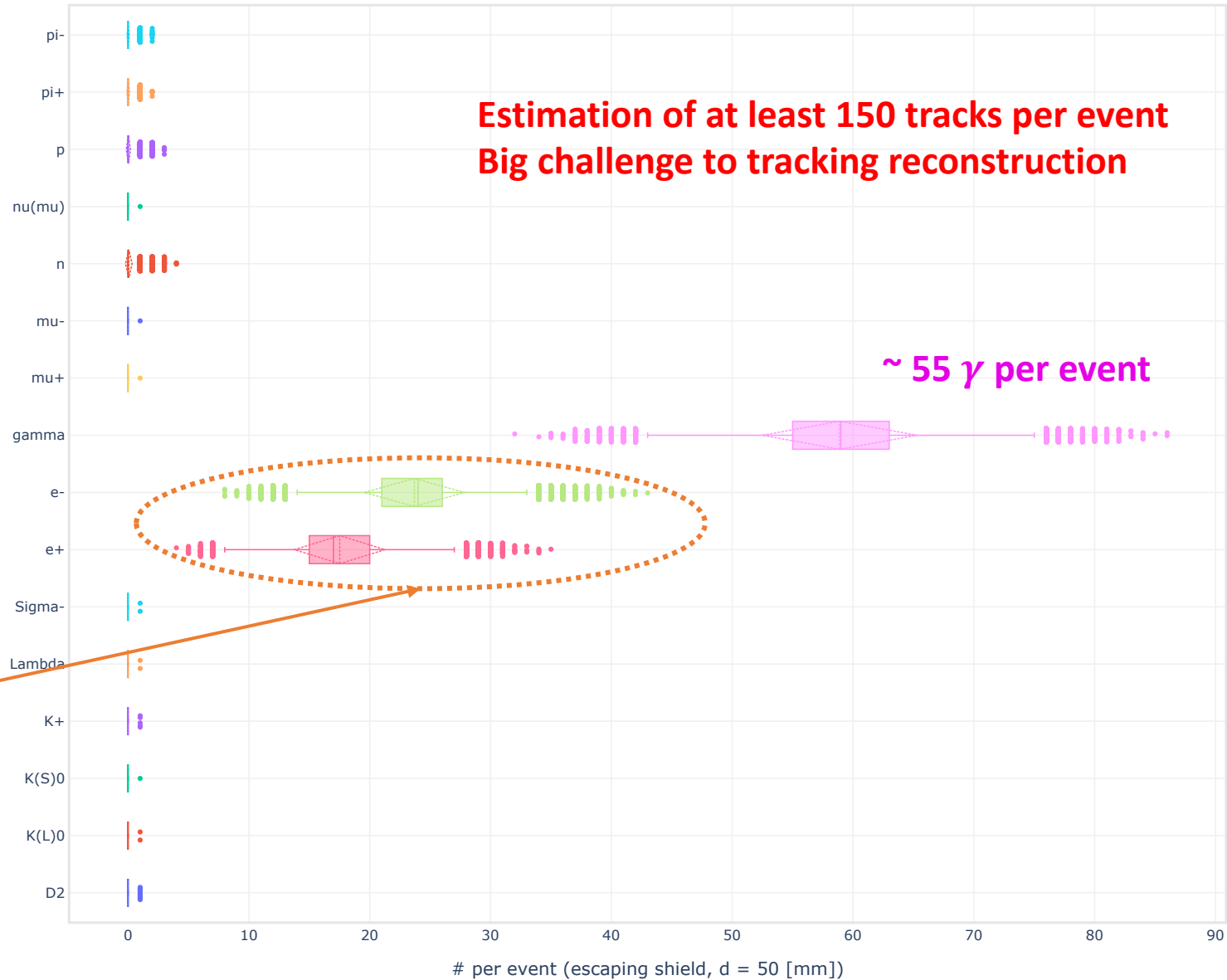


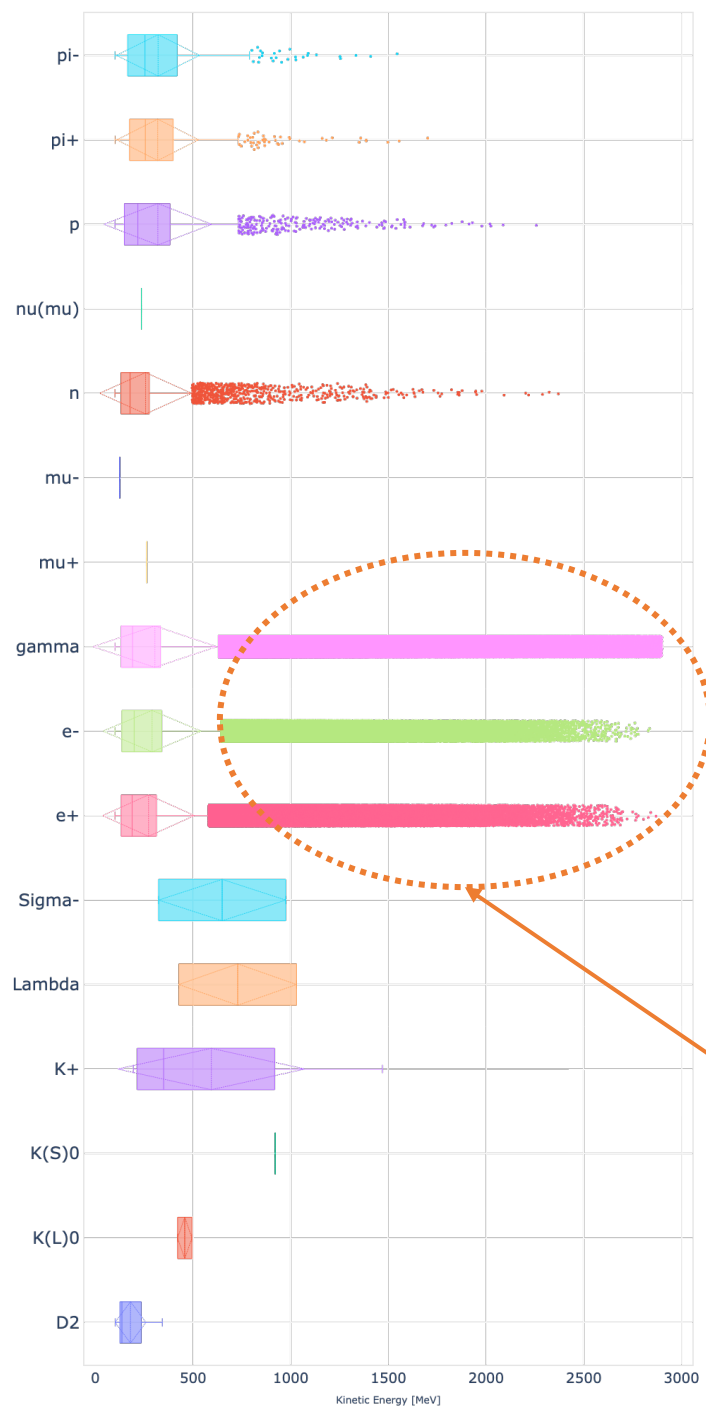
$A' \rightarrow \text{Standard Model}$



Background Simulation with Depth: 50 mm

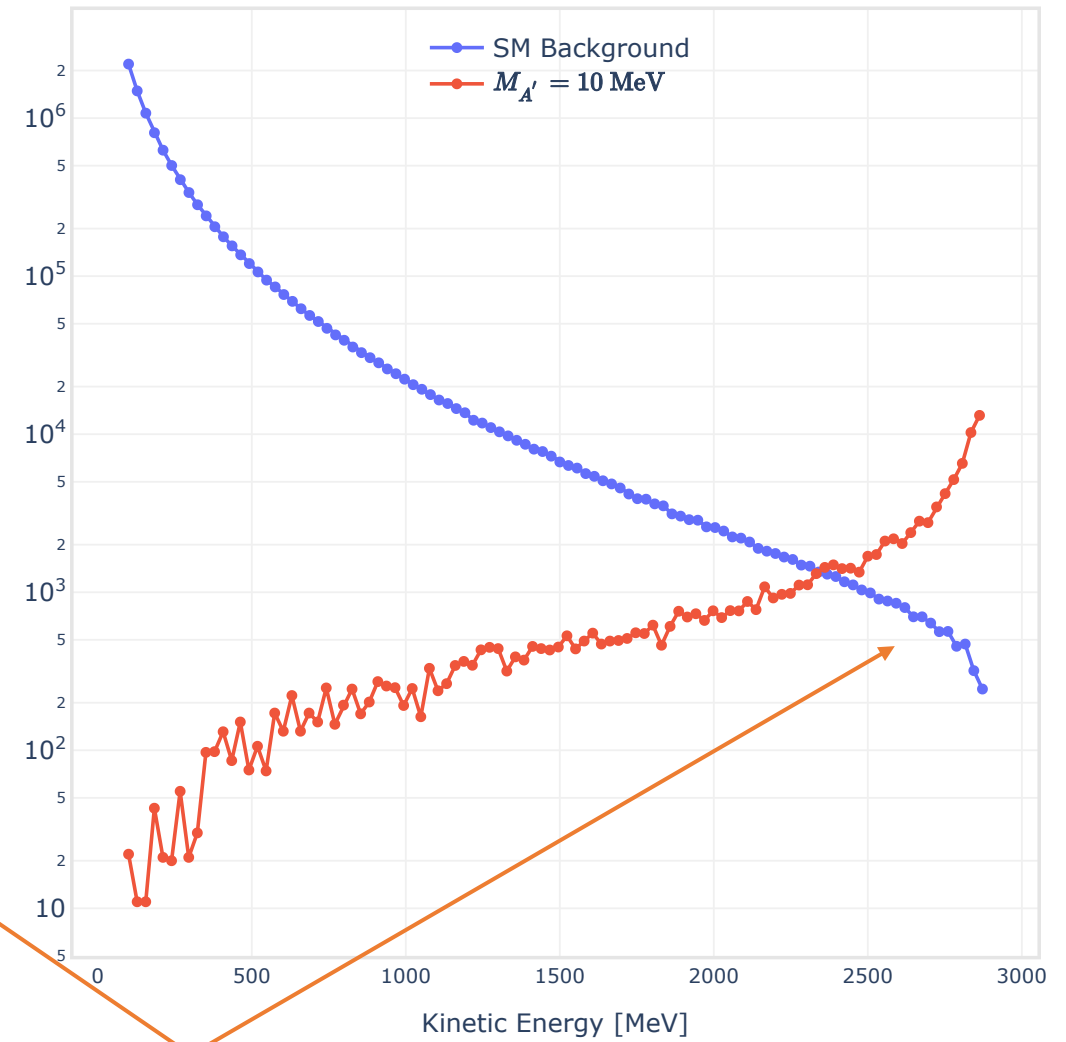
- Count: Number of particles per event





Background Simulation with Depth: 50 mm

- Kinetic Energy distribution [MeV]



Large kinetic energy