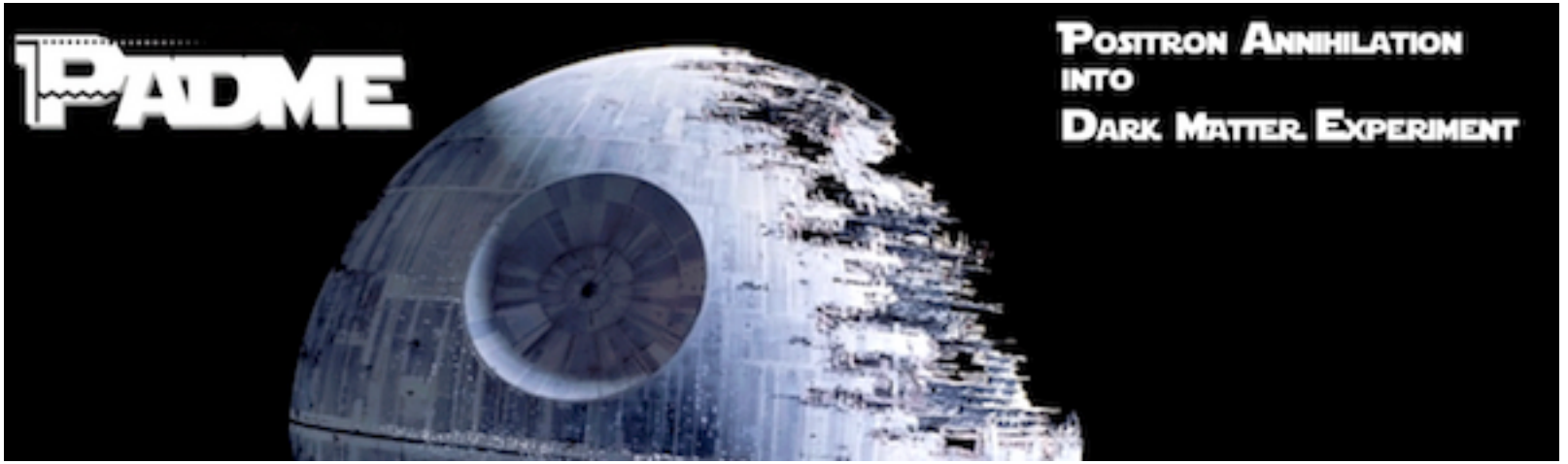

Expanded physics

In Search of ALPs

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A brief look at axions

- The strong CP-problem and it’s natural solution
- Interactions
- Good candidate for CDM
- A summary version of axions – ALPs, predicted in several BSM models
- The decay constant and ALP mass are two independent parameters

Axion model

Focusing on axion-electron coupling scenario

Simplified model to generate the events $\mathcal{L} = i\frac{g_{ae\bar{e}}}{2m_e}\partial_\mu a\bar{\psi}_e\gamma_5\gamma^\mu\psi$

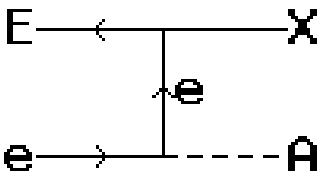
Lagrangian term implemented in CalcHEP

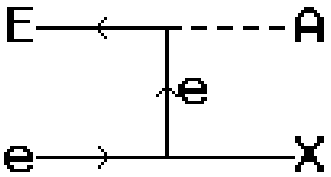
Parameters: mass M_X and coupling G_{aee}

$e^+ e^- \rightarrow X A$

X - Axion

A - Photon

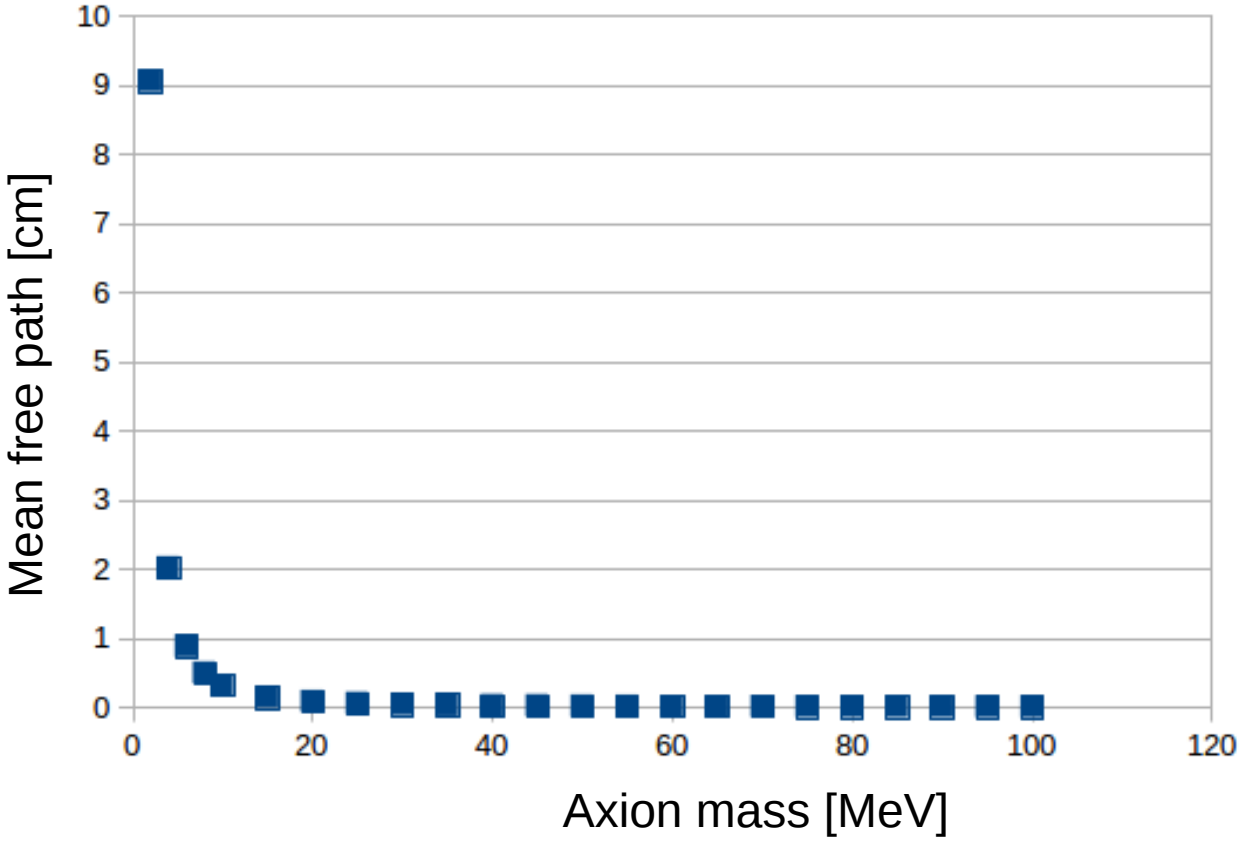




First calculations

Looking at axion lifetime, assuming it only decays: $X \rightarrow e^+e^-$

$G_{eex} = 1.\ 10^{-5}$



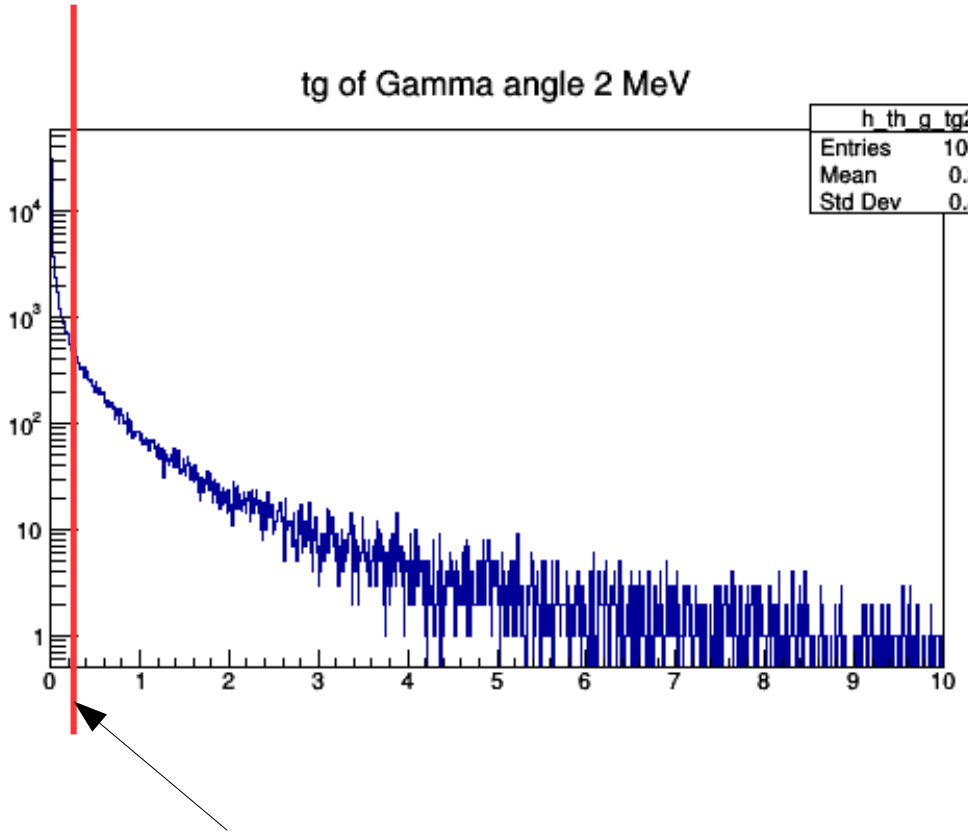
Axion production cross-section

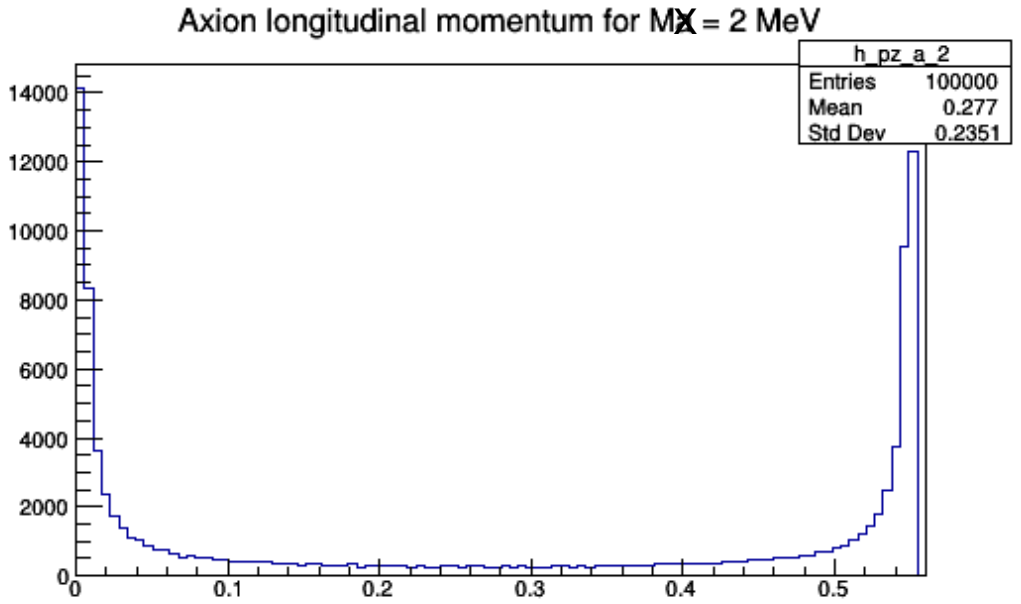
CS [pb]	M ix [MeV]
2.091039E+00,	2
2.105432E+00,	3
2.126593E+00,	4
2.155600E+00,	5
2.193944E+00,	6
2.307277E+00,	8
2.491561E+00,	10
2.790925E+00,	12
3.287698E+00,	14
4.151291E+00,	16
5.789884E+00,	18
9.49E+00	20

At $G_{aee} = 10^{-3}$ axions decay close to the production (inside the target)

Seem to scale as $1/M^2_X$, as expected

Event kinematics



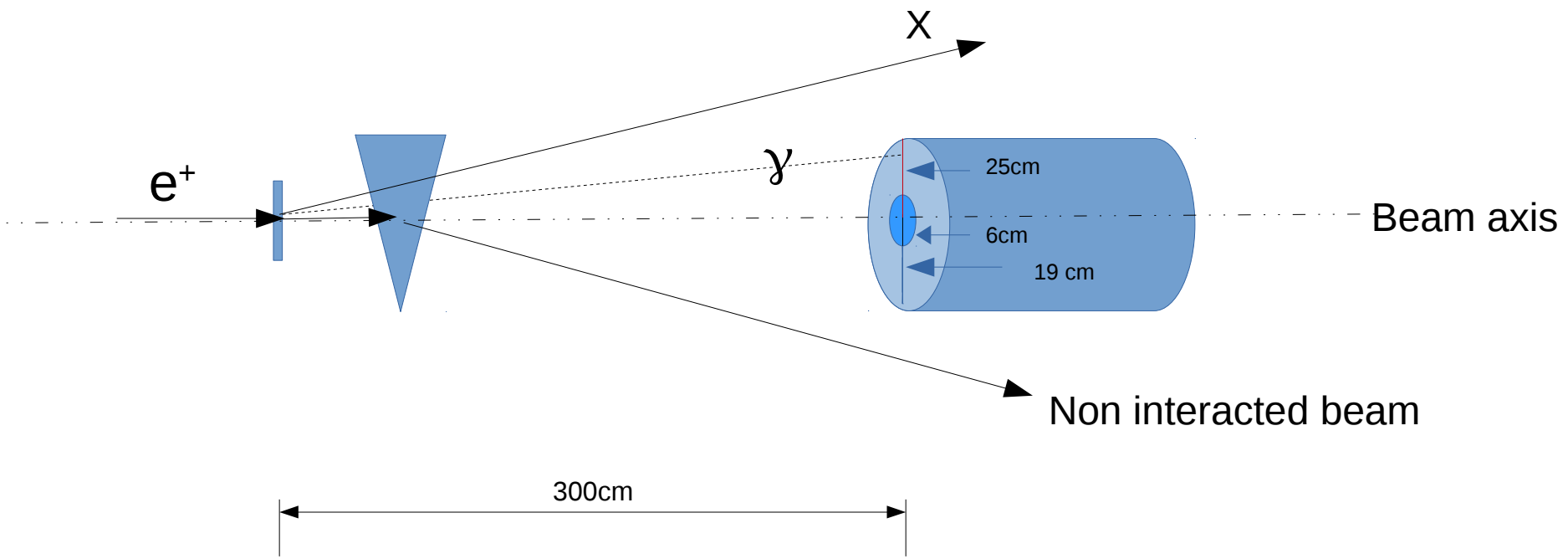


PADME acceptance region:
still catching the dominant fraction of the gammas

At low masses axions are either taking all or close to zero momentum (symmetric events)
Towards higher masses (MX → 20 MeV) the axion takes almost all the momentum

Constraints on the detector

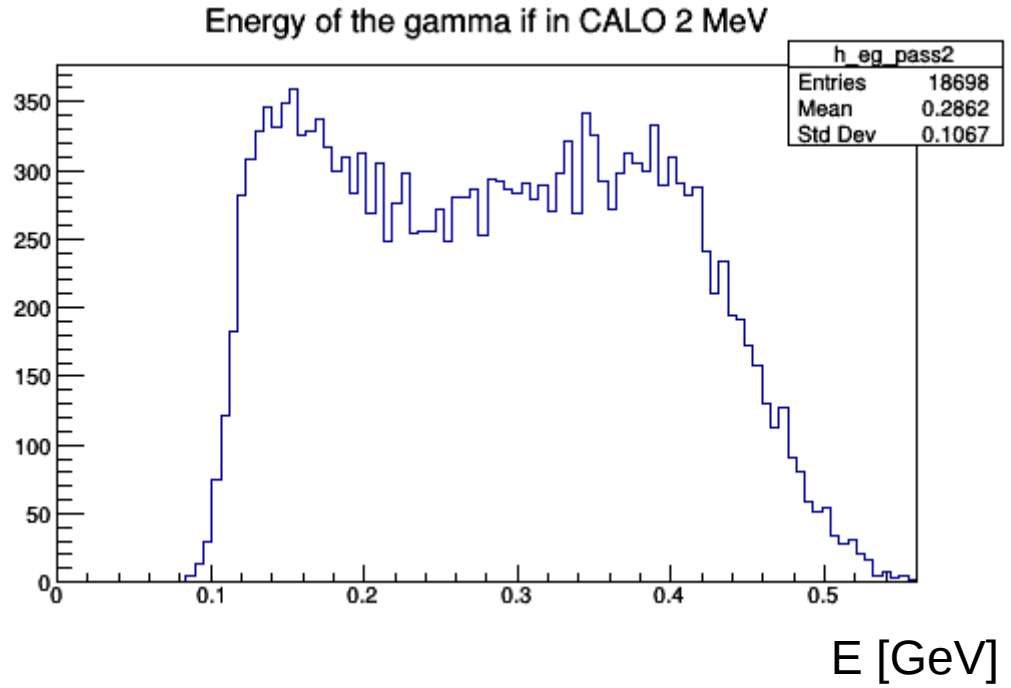
Only geometry considered, no pile-up of events, timing, etc…
Optimistic acceptance estimation



Recoil gamma energy distribution

E_{beam} = 550 MeV

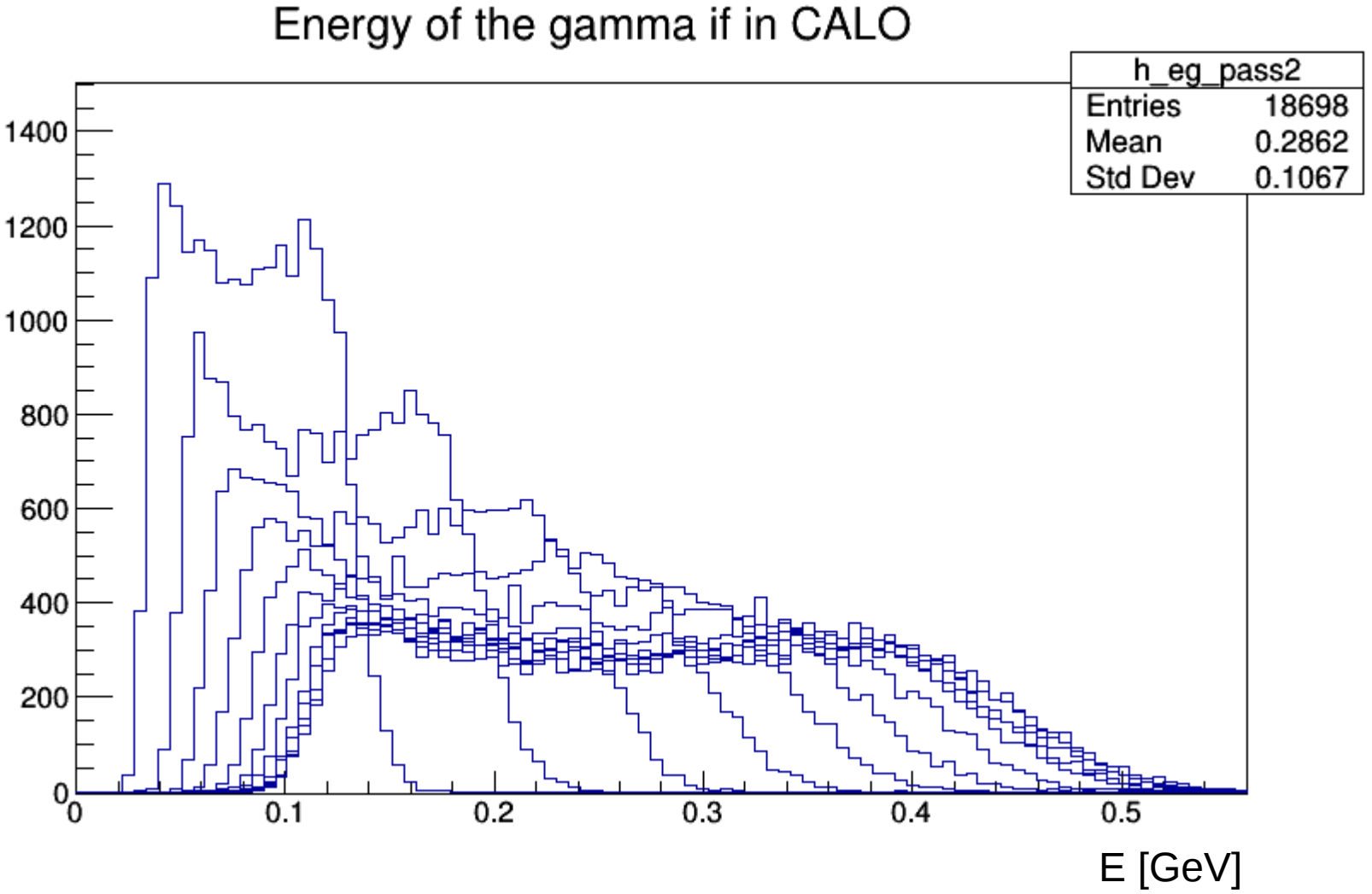
M_X = 2 MeV



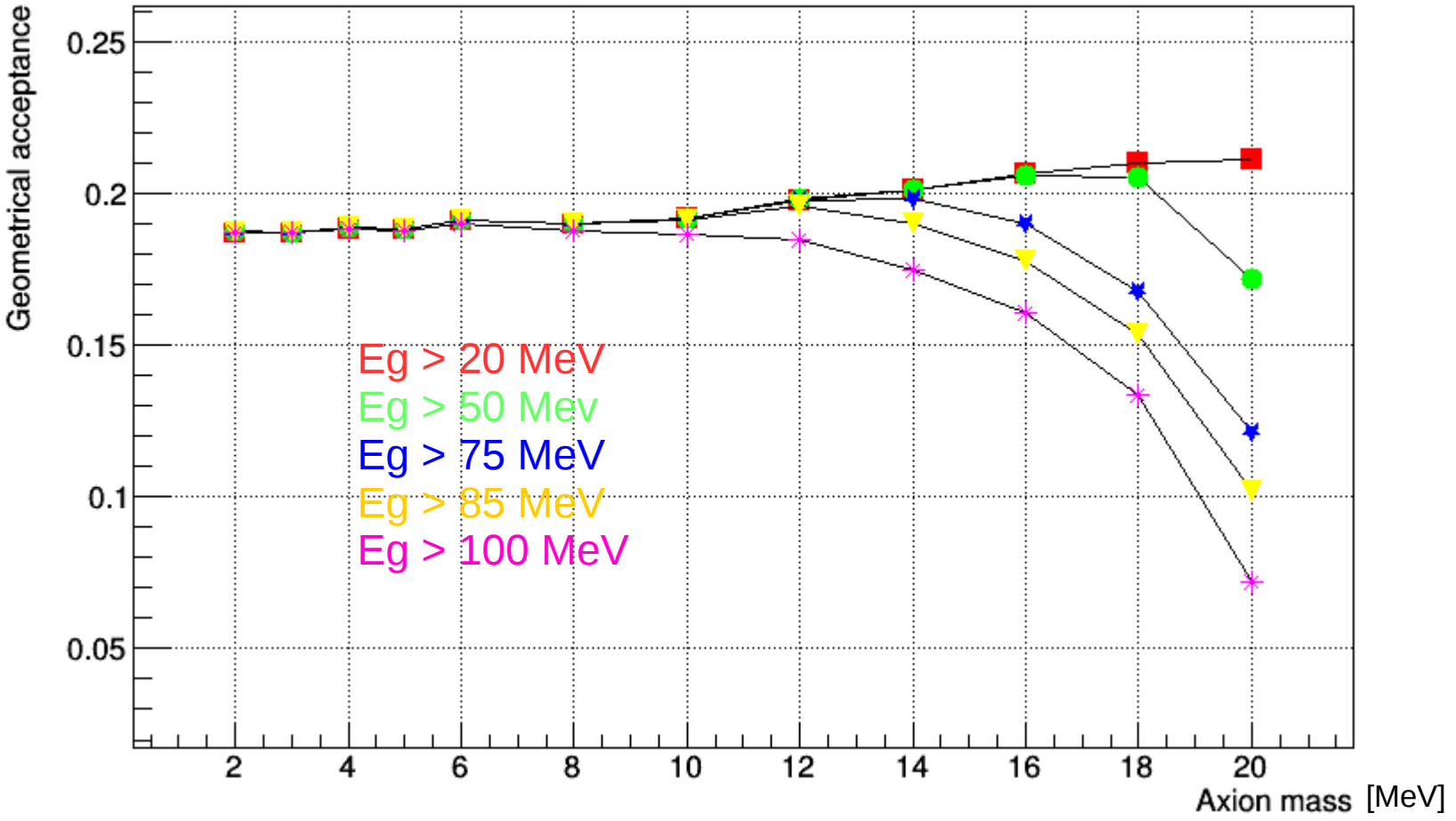
The calorimeter geometry naturally selects photons with energy in the sensitive detector range!

Energy dependence on the axion mass

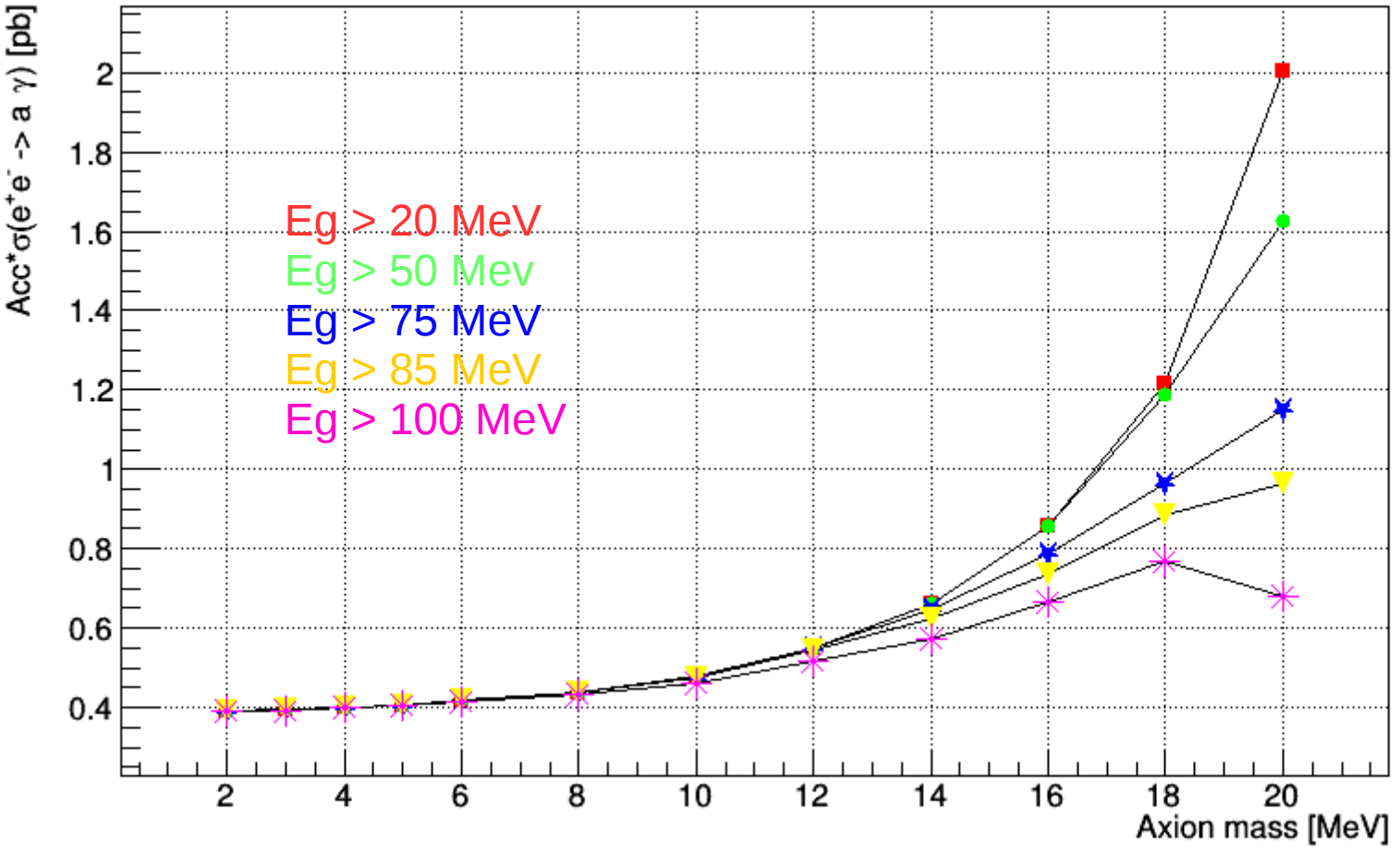
Axion mass: 2 – 20 MeV



Geometrical acceptance



Geometrical acceptance times cross-section



The last calculations – for now!

75 MeV cut	CS [pb]	M_x [MeV]	For 100 events	Ga / Me [GeV -1]
0.18697	2.09E+00	2	4.94E-04	9.87E-001
0.18686	2.11E+00	3	4.92E-04	9.84E-001
0.18823	2.13E+00	4	4.88E-04	9.76E-001
0.18806	2.16E+00	5	4.85E-04	9.69E-001
0.19081	2.19E+00	6	4.77E-04	9.54E-001
0.18976	2.31E+00	8	4.66E-04	9.33E-001
0.19147	2.49E+00	10	4.47E-04	8.94E-001
0.19736	2.79E+00	12	4.16E-04	8.32E-001
0.19751	3.29E+00	14	3.83E-04	7.66E-001
0.18969	4.15E+00	16	3.48E-04	6.96E-001
0.16686	5.79E+00	18	3.14E-04	6.28E-001
0.1212	9.49E+00	20	2.88E-04	5.75E-001

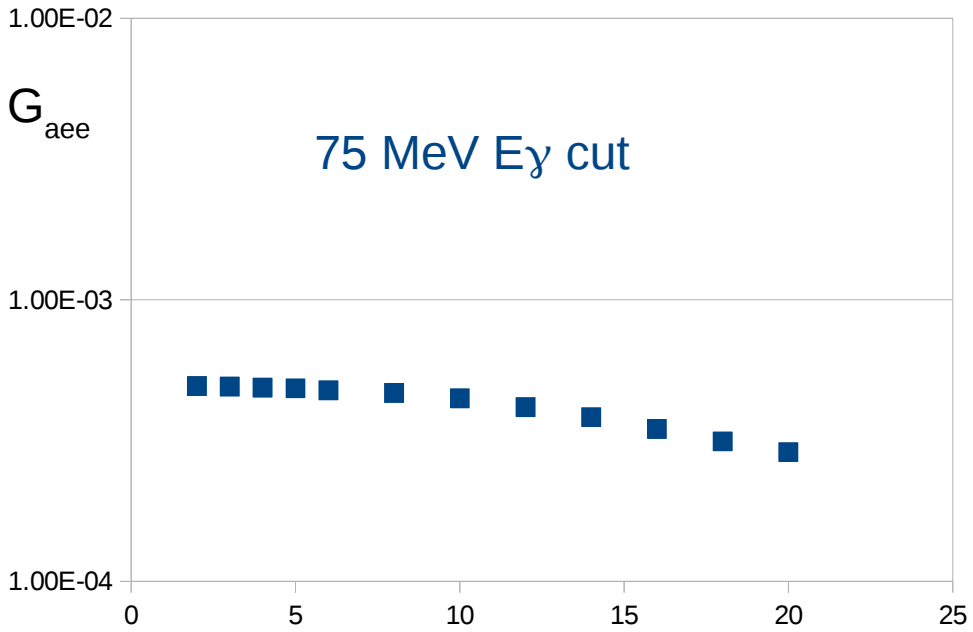
50 MeV cut	CS [pb]	M_x [MeV]	For 100 events	Ga / Me [GeV -1]
0.18698	2.09E+00	2	4.94E-004	9.87E-001
0.18686	2.11E+00	3	4.92E-004	9.84E-001
0.18824	2.13E+00	4	4.88E-004	9.76E-001
0.18806	2.16E+00	5	4.85E-004	9.69E-001
0.19081	2.19E+00	6	4.77E-004	9.54E-001
0.18977	2.31E+00	8	4.66E-004	9.33E-001
0.19154	2.49E+00	10	4.47E-004	8.93E-001
0.19767	2.79E+00	12	4.15E-004	8.31E-001
0.20096	3.29E+00	14	3.80E-004	7.59E-001
0.206	4.15E+00	16	3.34E-004	6.67E-001
0.2053	5.79E+00	18	2.83E-004	5.66E-001
0.17151	9.49E+00	20	2.42E-004	4.84E-001

@target, $G_{aee} = 10^{-5}$

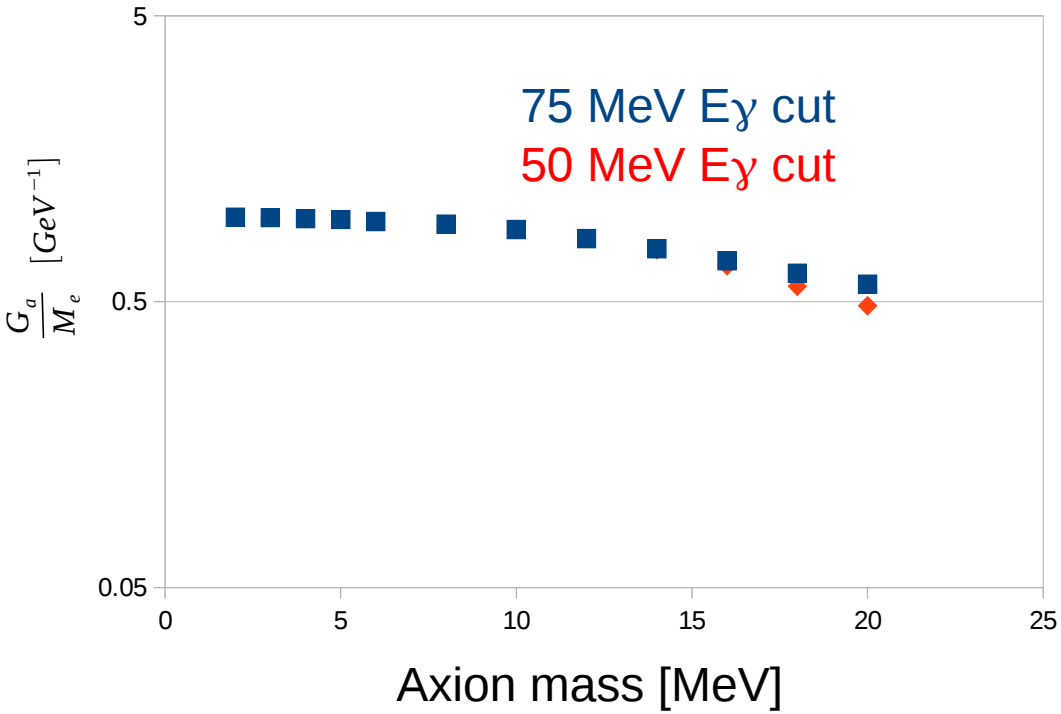
Number of produced events
2.20E-001
2.21E-001
2.23E-001
2.26E-001
2.30E-001
2.42E-001
2.62E-001
2.93E-001
3.45E-001
4.36E-001
6.08E-001
9.97E-001

PADME axion-electron coupling sensitivity

Dimensionless coupling



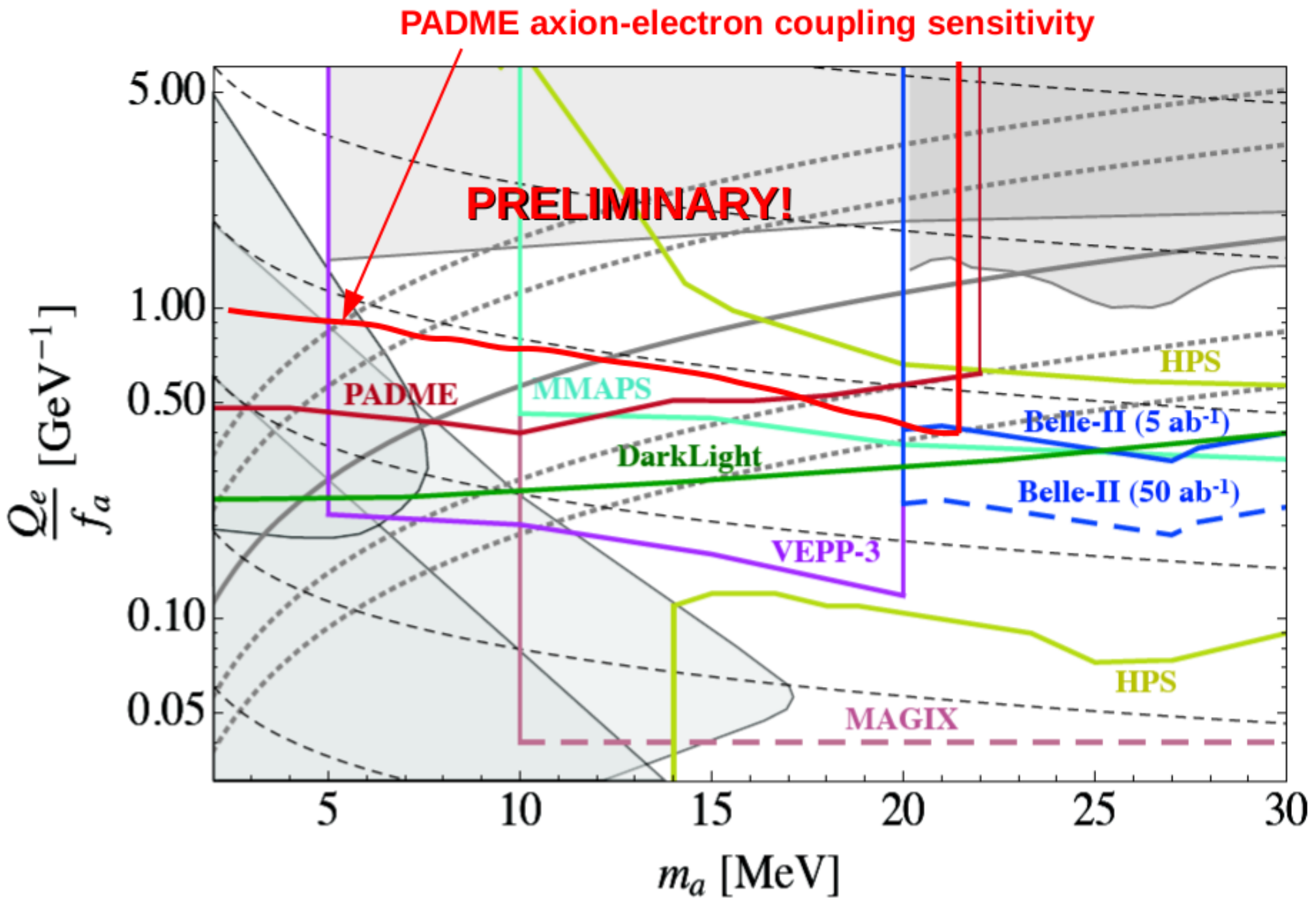
Rescaled with Me



Assumption: **10^{13} positrons on target**

100 events of e^+e^- → X A detectable (i.e. background of the level of 10^4)

Comparing to the theory



Conclusions!

- An initial study of the PADME sensitivity to axions coupling to electrons started
- Getting experience with toy MC and event generation
- Implemented simplified (but realistic) model in CalcHEP
- Preliminary results seem promising
- PADME may turn also to a Any-Light-Particle (ALP again :)) searching machine