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X17: Interpretations and Other Searches

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X17

- Seen in 8Be and 4He
- Persists in original 5-fold and new 6-fold geometry (but most detector angles are the same)
- Heavily incompatible with simple kinetic mixing model
  - would have been seen in pion decay etc

X17 in 4He and 8Be

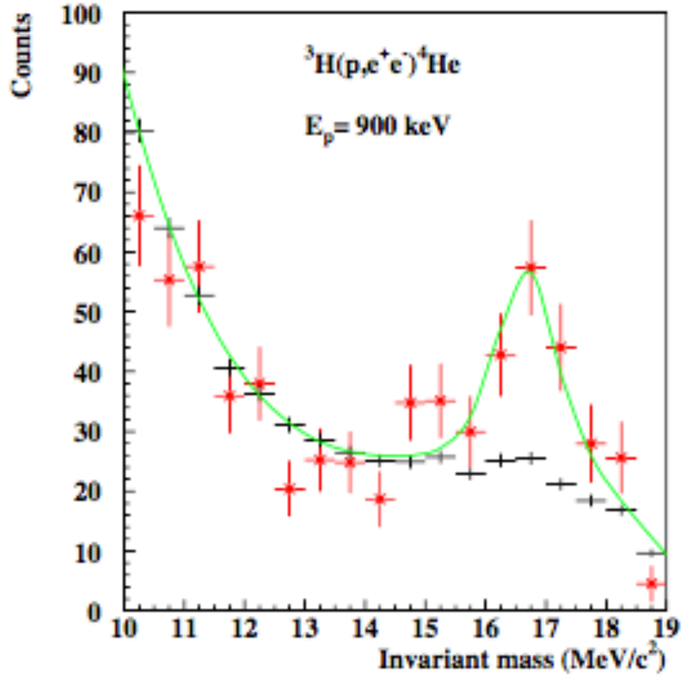

FIG. 3. *Invariant mass distribution derived for the 20.49 MeV transition in ^{4}He.*

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Survey of Experiments

- Beryllium:
  - 8BeP@Purdue - proposed, did not proceed
  - ??@**Toronto** - rumored...
- General-Purpose Accelerator:
  - **LHCb - stats by ~2023**
  - Belle II - stats in 2025 or later
- Dark-Photon Specific:
  - **MAGIX - operates 2023+**
  - LDMX - operates 2024+. data hungry
  - NA64 - probably can't close the gap. data hungry
  - APEX - can't reach
  - HPS - probably can't reach
  - PADME - studying visibles reach, needs modifications
  - *et al.*

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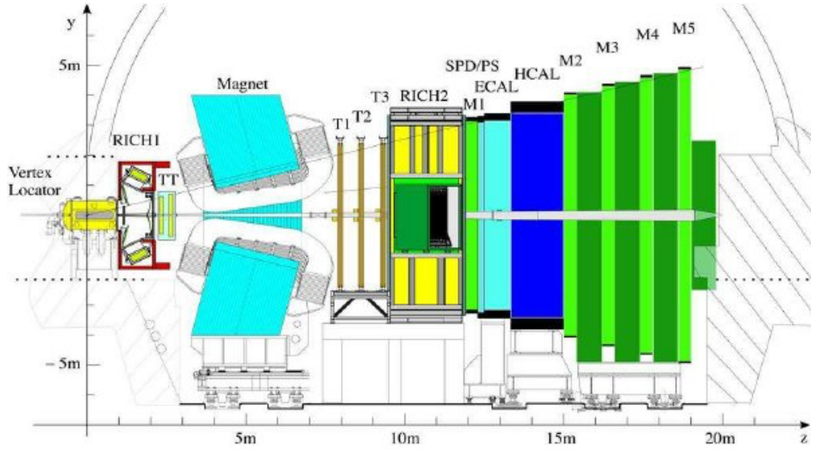
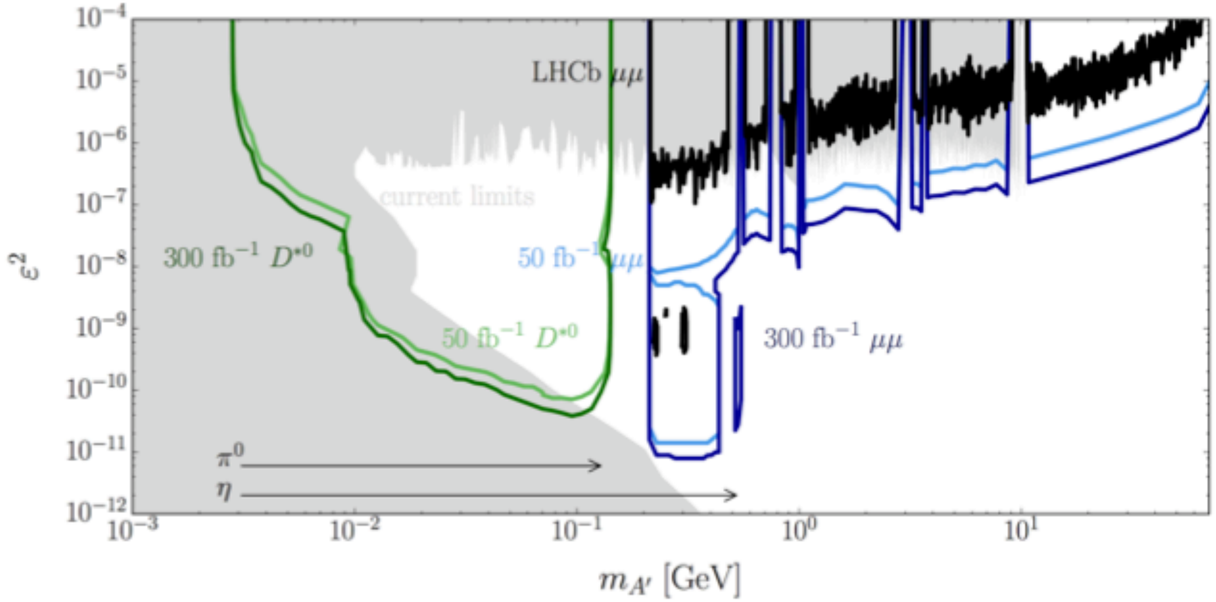
LHCb



- Upgrade for next run allows softer final states to be recorded
- Can exhaust parameter space even with protophobic with sufficient data, ~2023? (green bands)



arXiv:1808.08865

(P. Ilten paper (arXiv:1801.04847) allows to recast simple dark photon measurements in more complex models)

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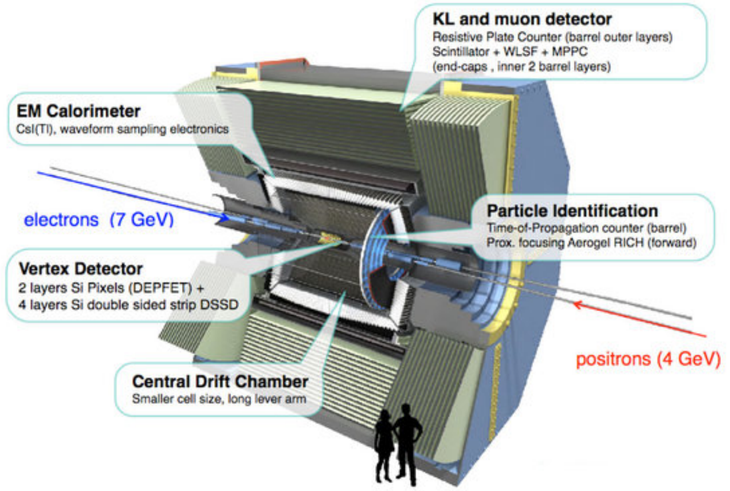
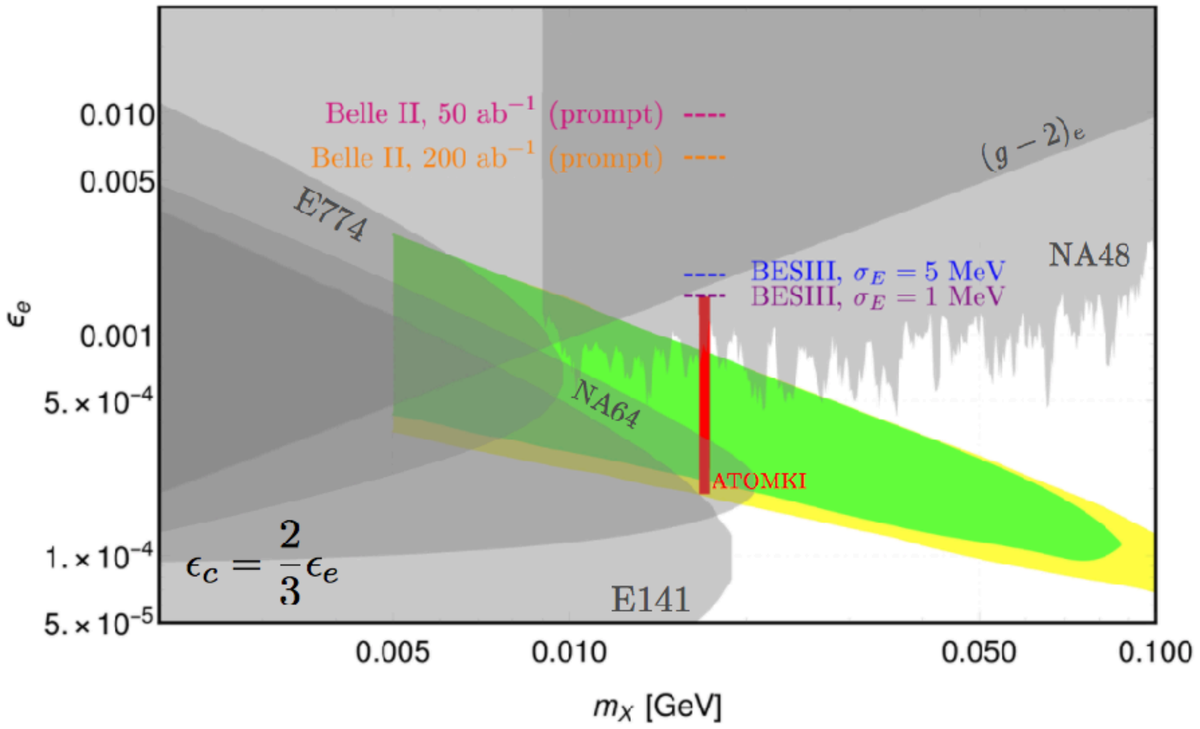
Belle-II





- First results expected soon, but direct measurements won't reach down far enough (horizontal lines) even with full dataset.
- X17-specific search uses displaced vertices in J/Ψ decay, 50ab-1, expected by ~**2025**
- Won't exhaust X17 even so.

arxiv.:2012.04190

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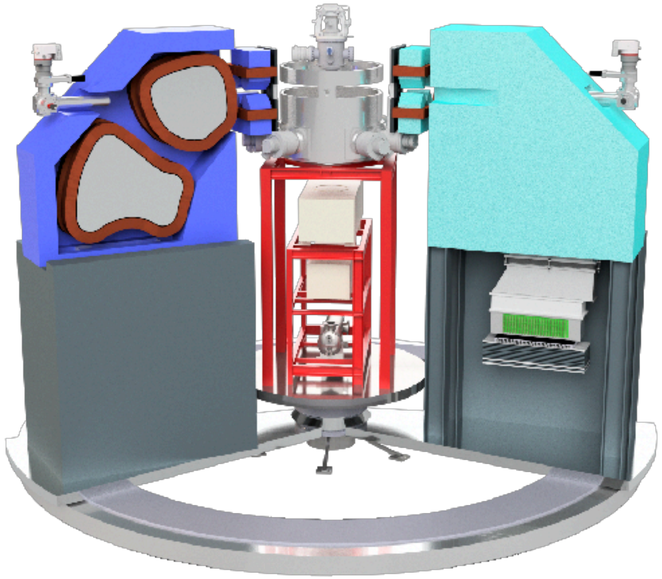
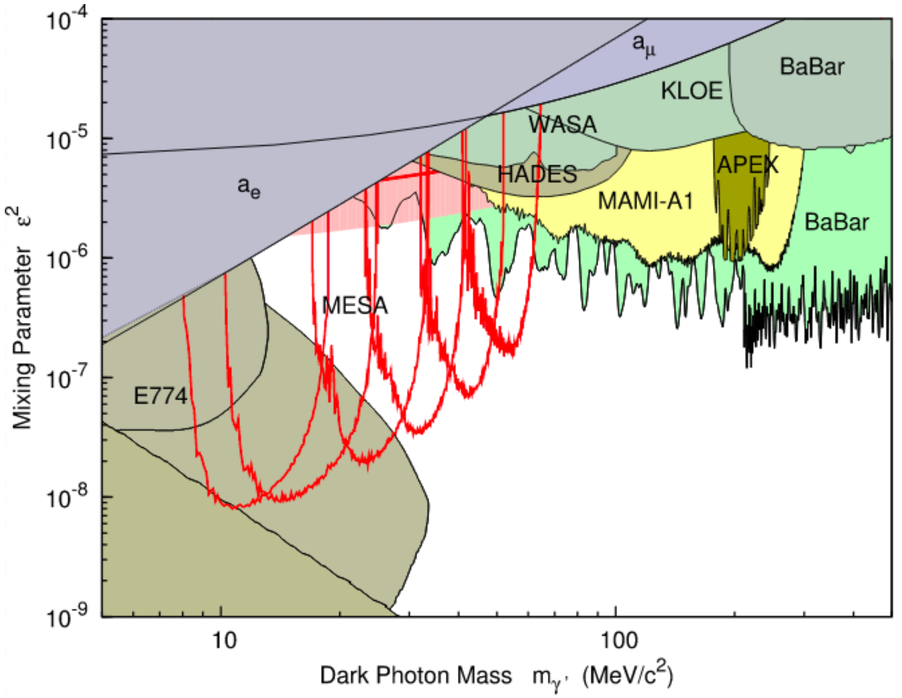
MAGIX



- Twin spectrometer, gas target
- Projects to reach X17 anomaly region w/ ~6mo at design luminosity
- MESA first beam ~2023, MAGIX start-up "shortly after"



https://magix.uni-mainz.de/physics.php

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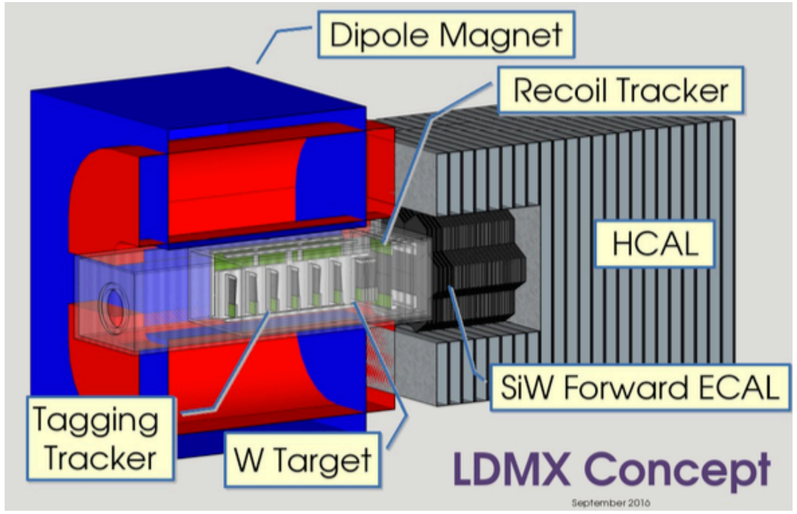
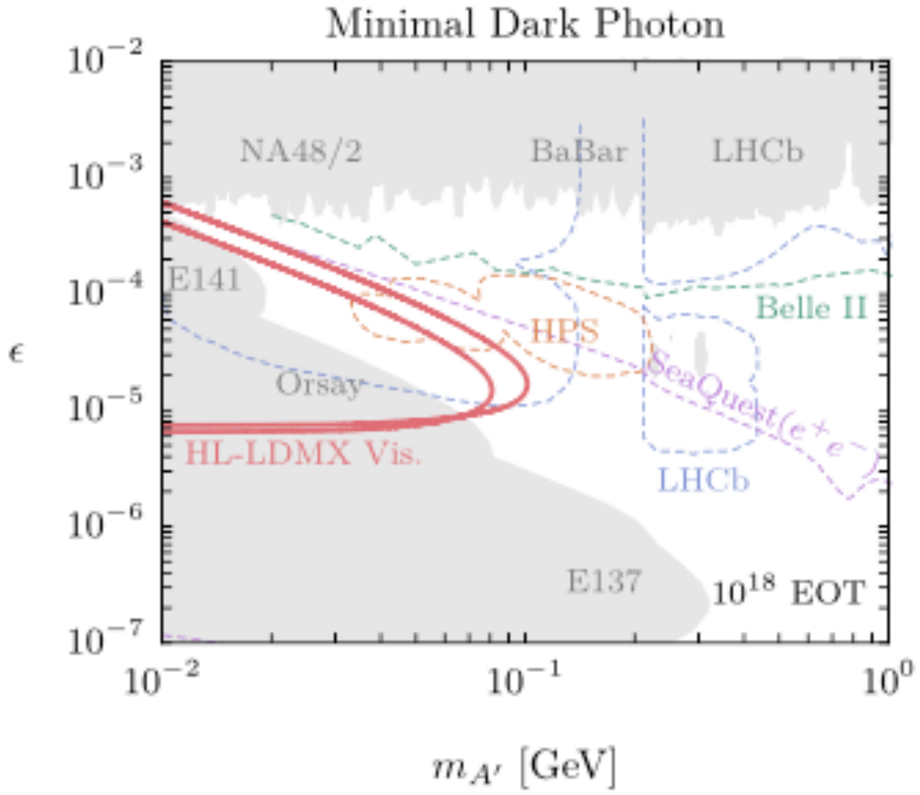
LDMX



- Primarily missing-momentum experiment.
- Model-dependent search via invisibles.
- Can do displaced vertices, but doesn't expect to reach useful range -- even in high integrated luminosity assumption
- Potentially runs in 2024



arxiv:1807.01730

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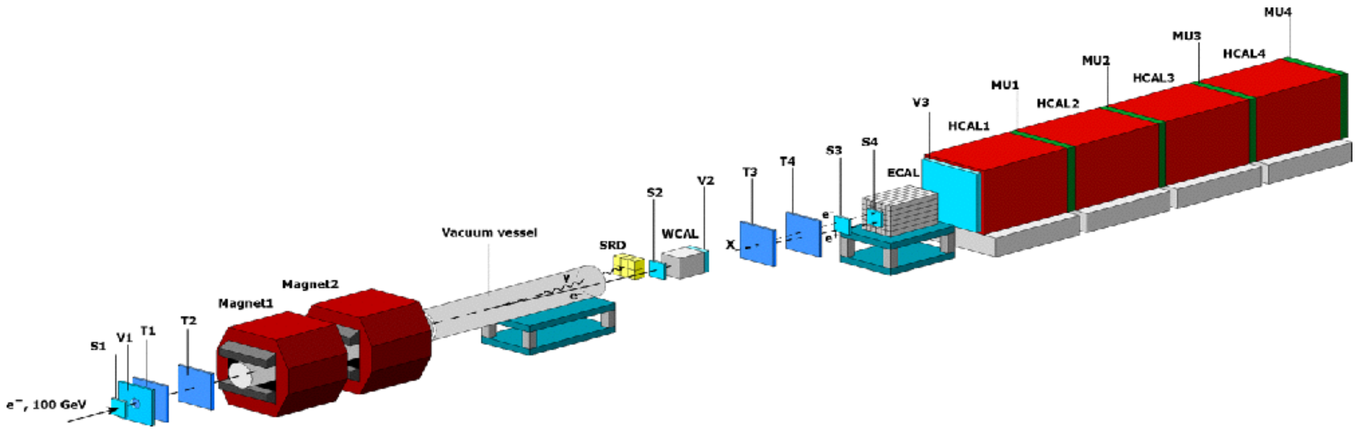
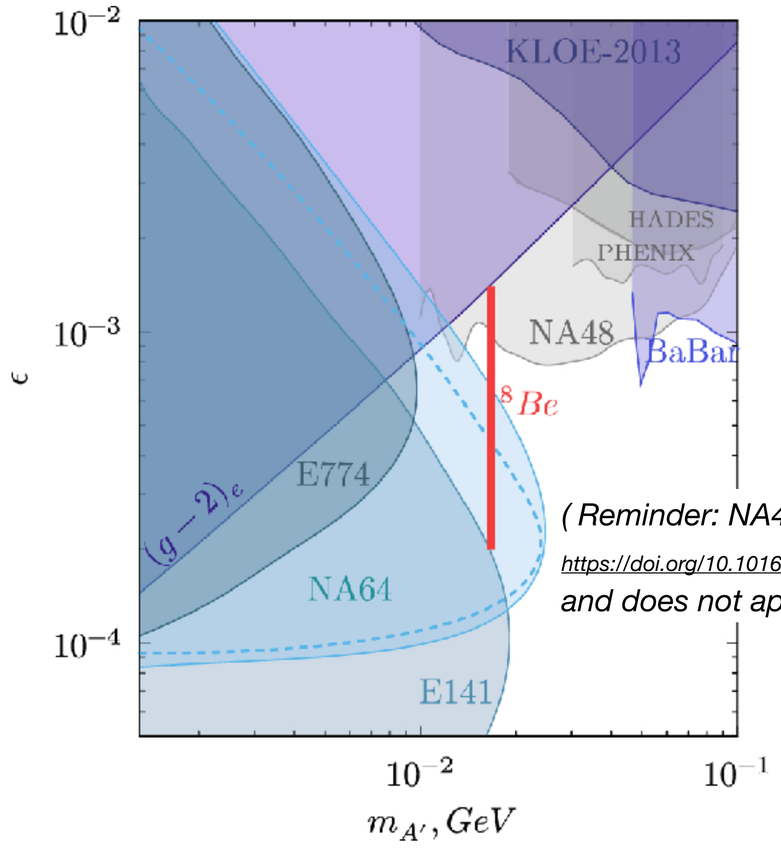
NA64



- 2020 combined analysis covers much of original 8Be coupling range
- Remaining space "very challenging", requires detector upgrade. Timeline unclear



(Reminder: NA48 is pion-based

https://doi.org/10.1016/j.physletb.2015.04.068

and does not apply in X17)

https://doi.org/10.1103/PhysRevD.101.071101

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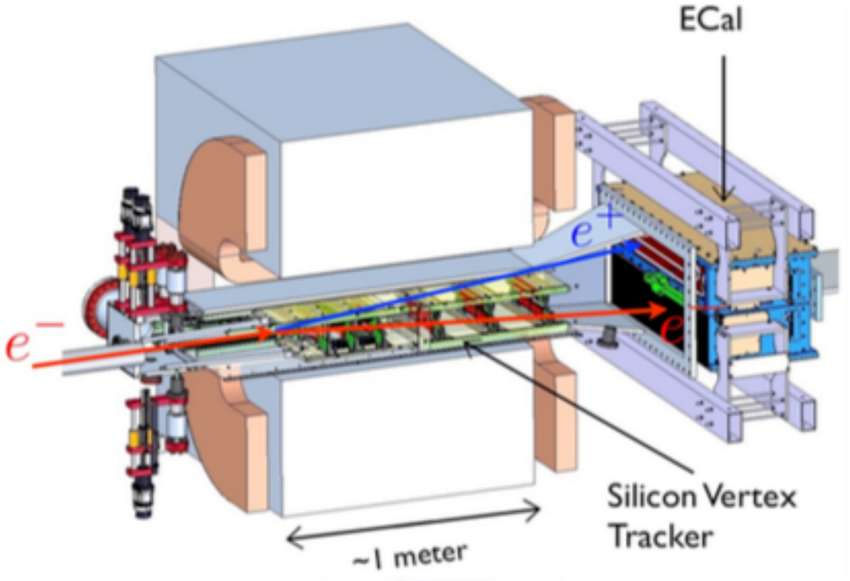
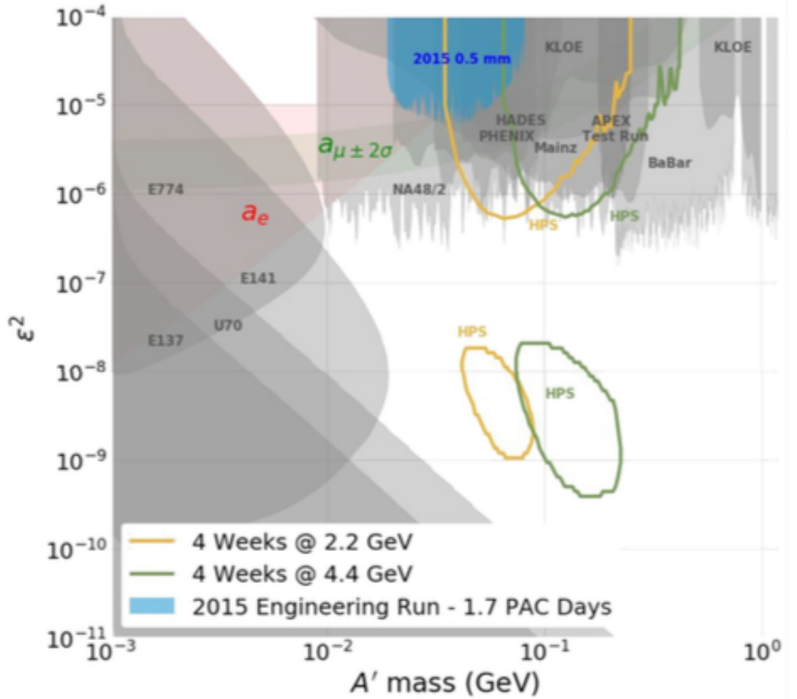
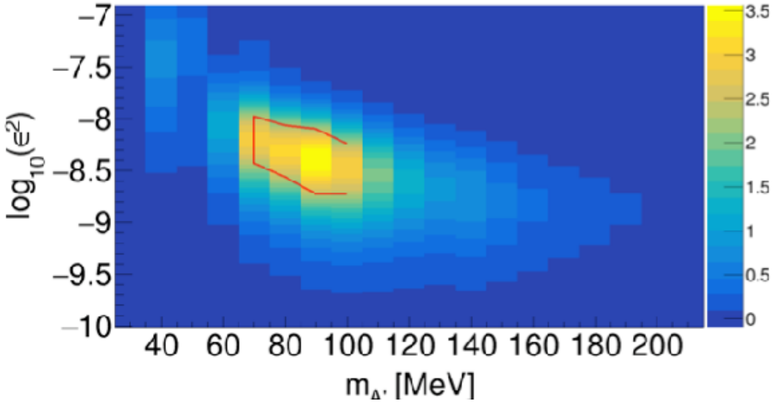
HPS







- Tracking very close to target+beam
- Prompt and displaced vertices for SM decay
- Can't reach <20 MeV without modification.
- Lower energy? Haven't seen this proposed

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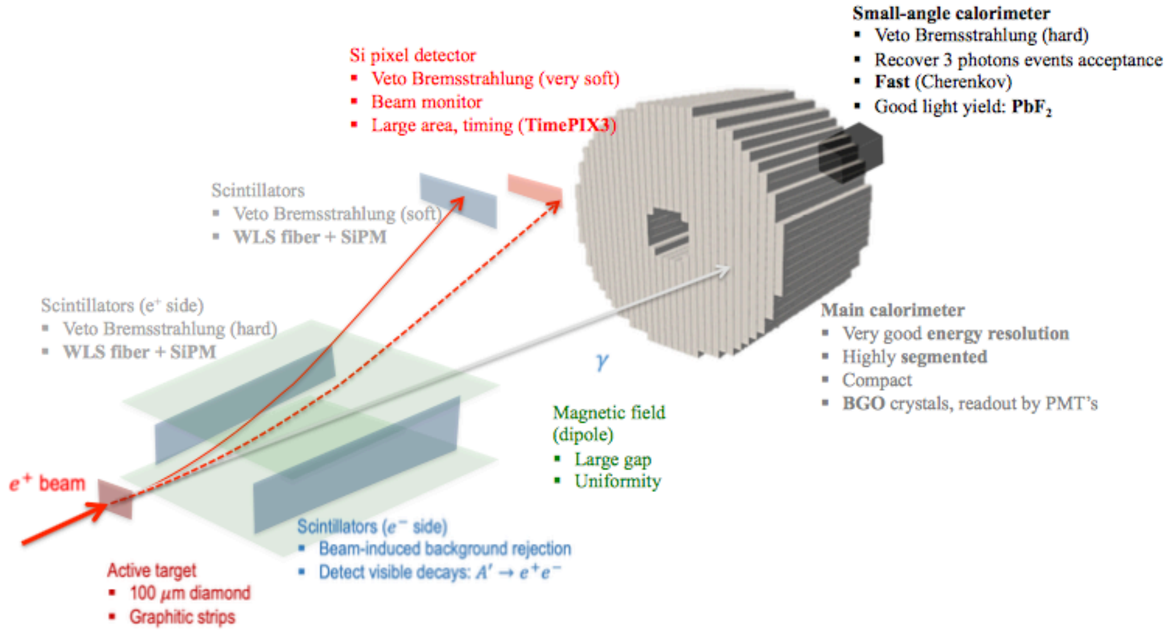
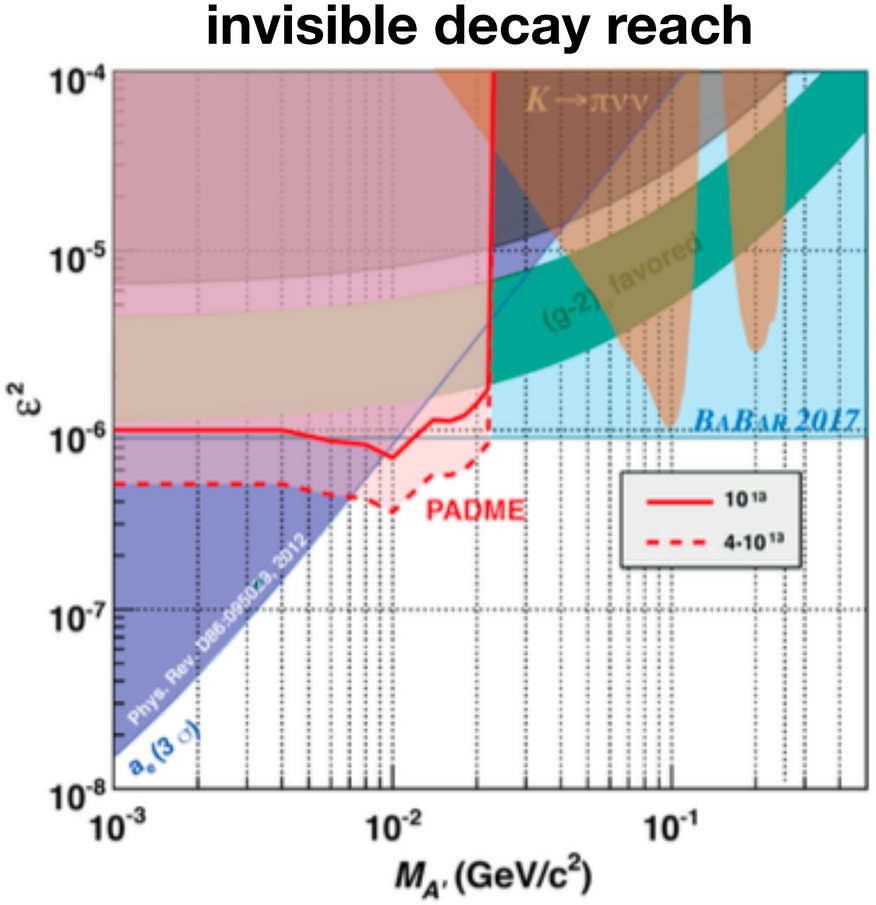
PADME





- Positron beam, missing mass technique
- **Studying visible decays, but requires modification to reach X17**

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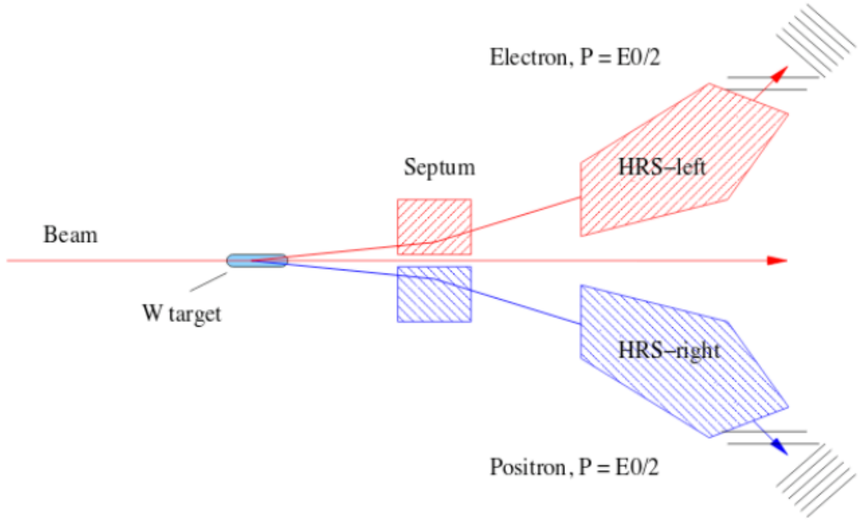
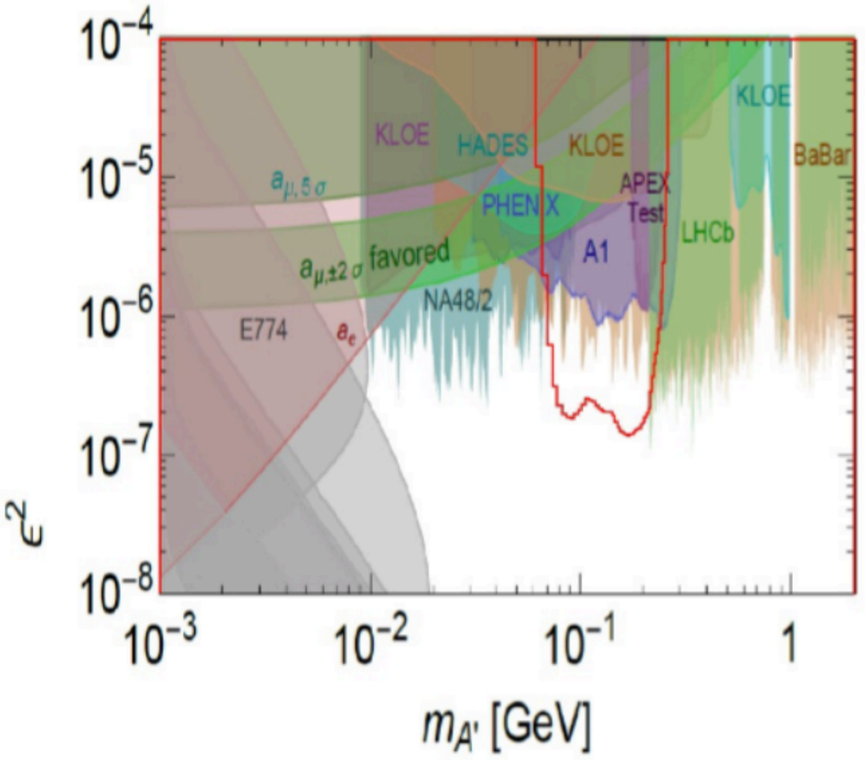
APEX





- e+e- mass resonance, very low opening angles
- Plot includes 2020 data and future proposed settings -- current design can't reach X17

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Summary

- Lots of interest, but difficult region to reach
-
- On similar time scale, mixed-hadronic (LHCb etc) + pure-leptonic (DL@ARIEL, MAGIX) would be complementary coverage for broad model-independence
- Most aggressive reach/schedule from LHCb, data taking done in 2023
- Opportunity exists if we move quickly!

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