

# Heavy Photon Search

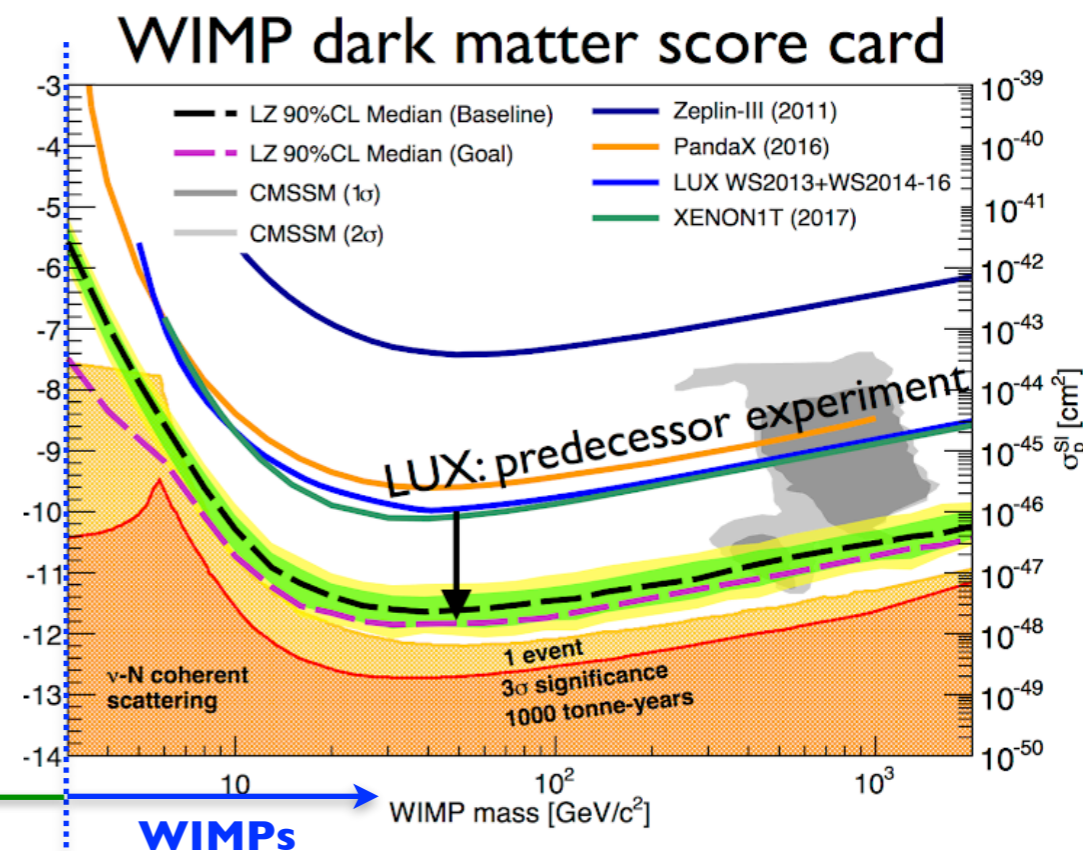
## A Search for Dark Force Carriers

*The particle nature of Dark Matter is a central puzzle in physics.*

Experiments searching for new particles with Weak Interactions (WIMPs) have nearly exhausted the accessible parameter space.

*Where haven't we looked?*

← "Light Dark Matter" →

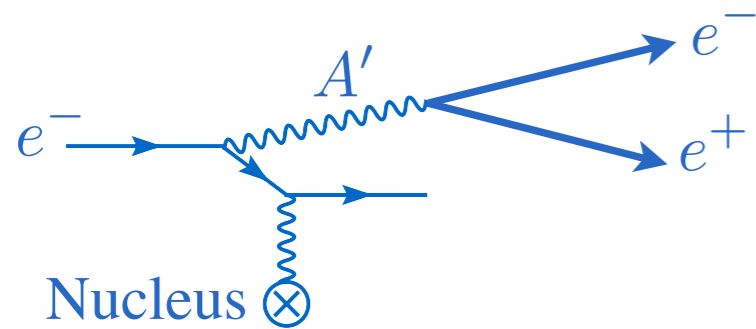


WIMP-like (thermal relic) DM can be as light as  $\sim 10$  KeV, but if lighter than  $\sim 2$  GeV, they aren't WIMPs because *they must interact with SM via a new light force carrier.*

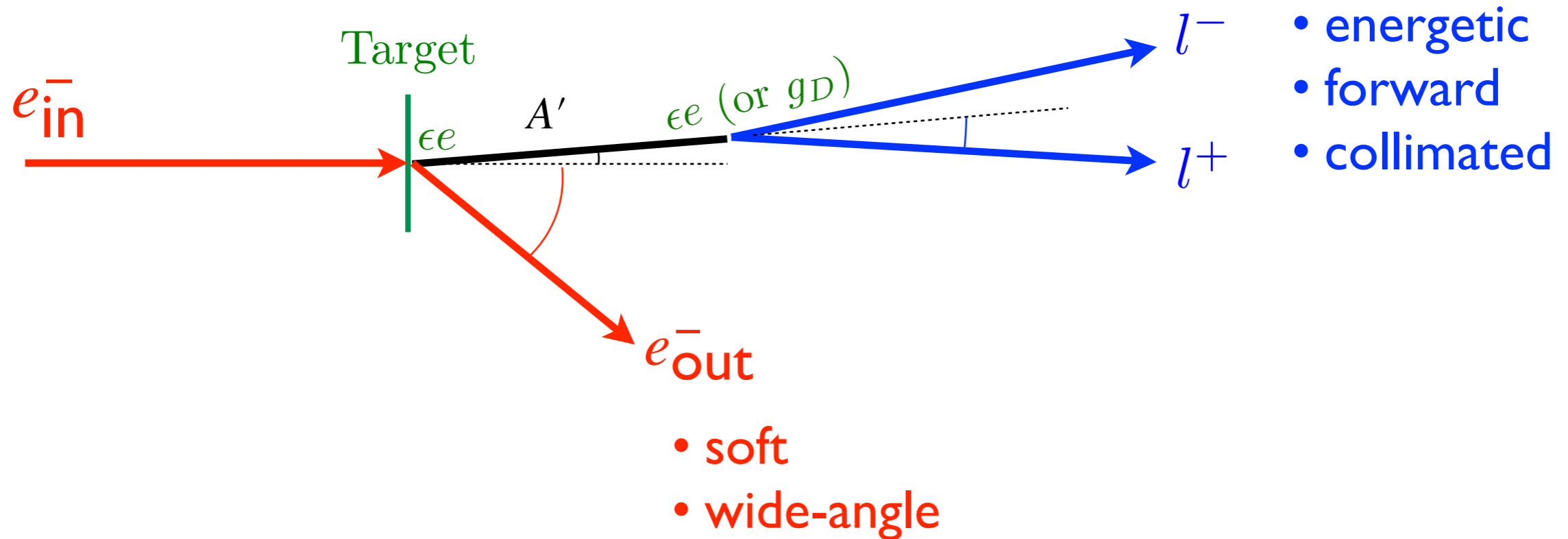
The **Heavy Photon Search** searches for this new mediator, a “dark photon” or  $A'$ .

$A'$  produced at heavily suppressed rate in any process producing energetic photons.

# Dark Bremsstrahlung

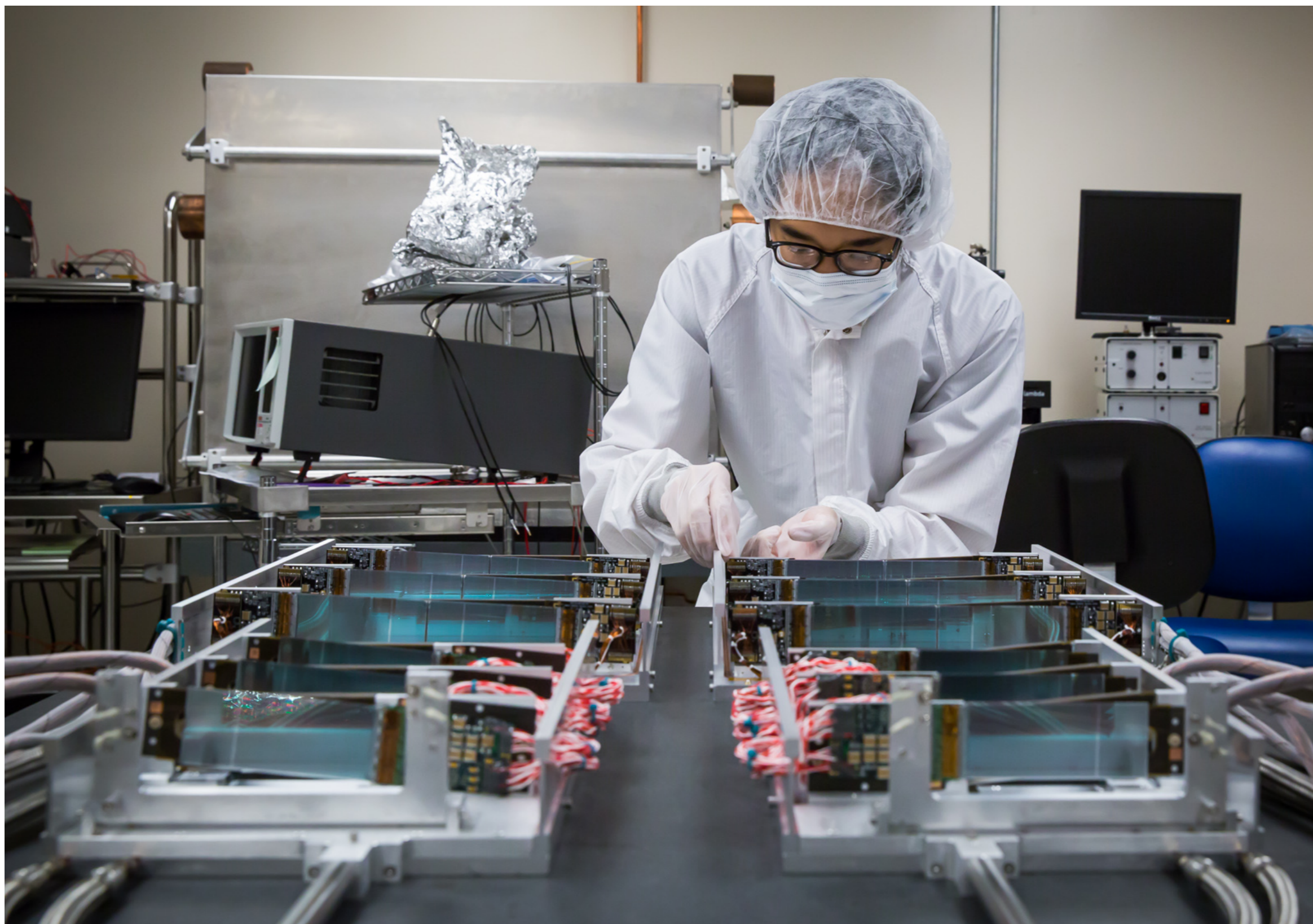


Heavier product (here  $A'$ ) takes most of beam energy

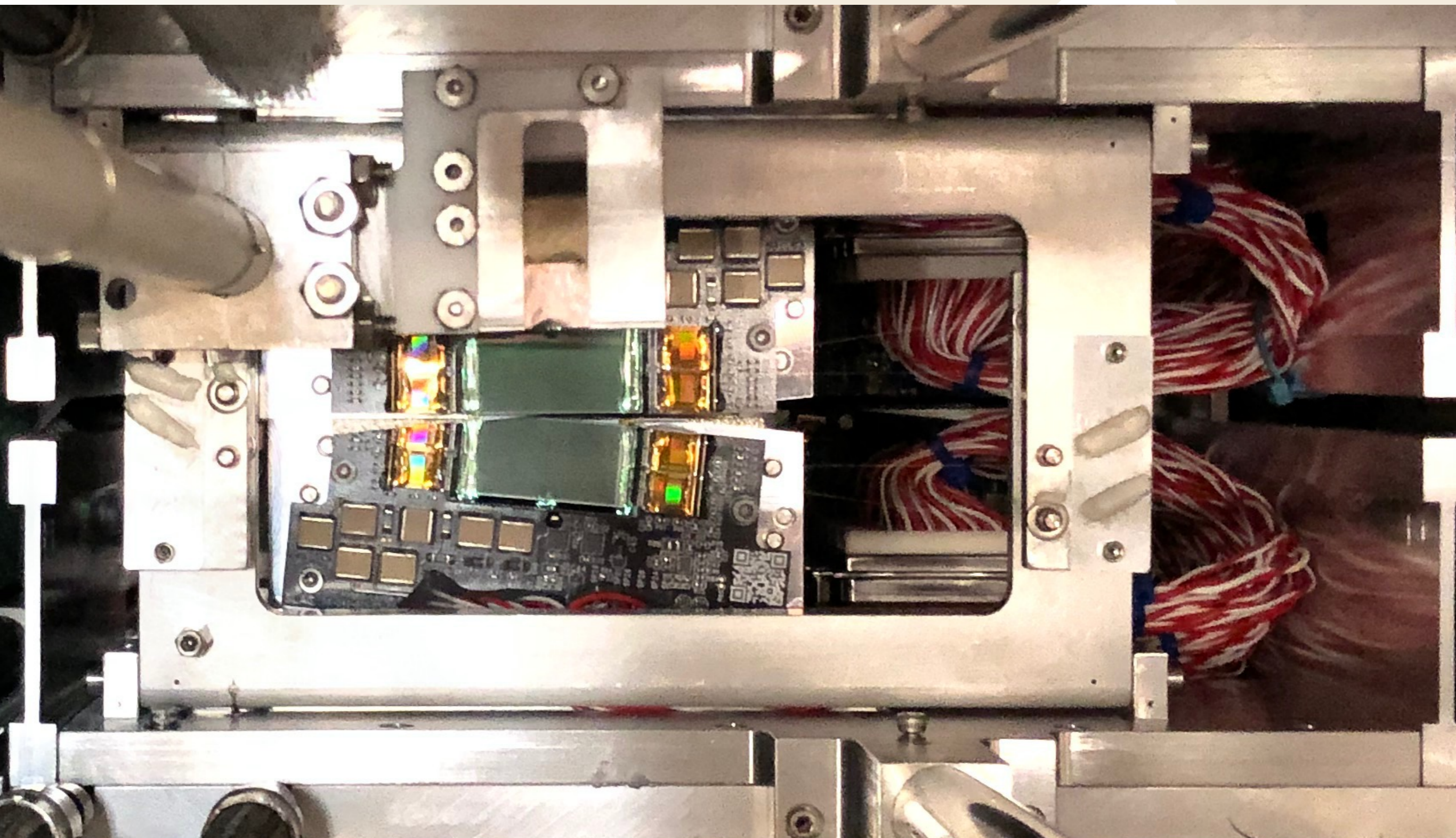


*In most of the unexplored parameter space,  $A'$  is long lived, and will have macroscopic decay length in HPS - mm to cm or longer.*

# The HPS Silicon Vertex Tracker

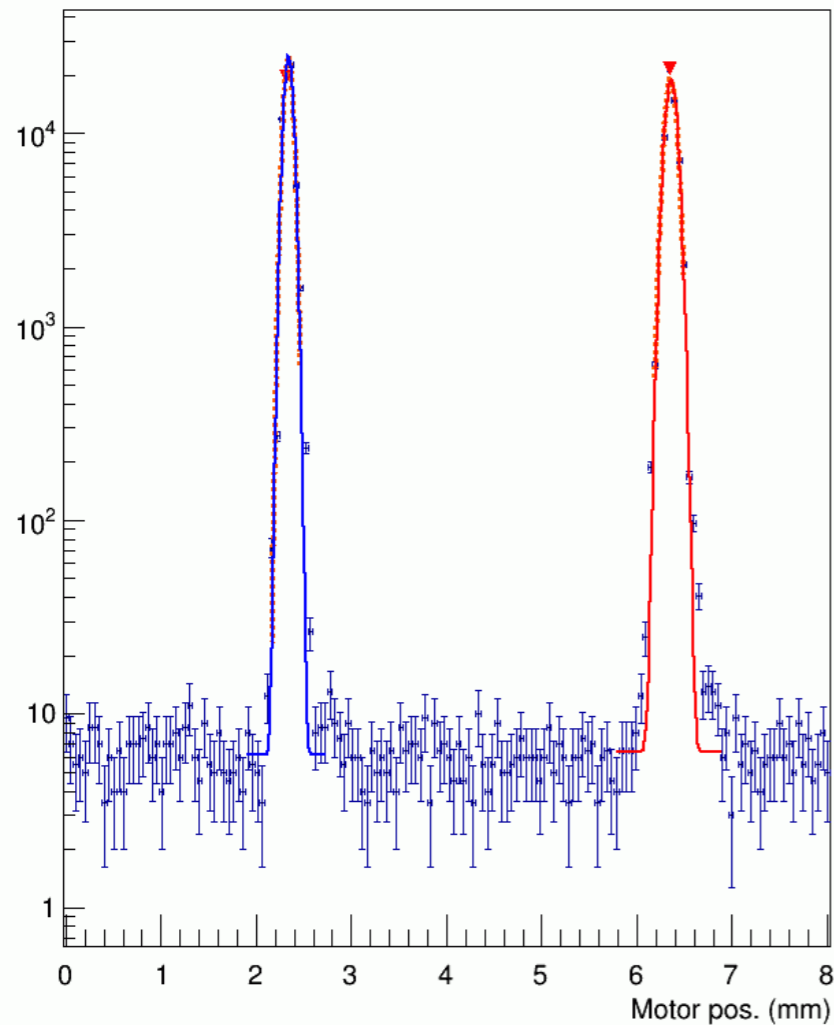


# The HPS Silicon Vertex Tracker

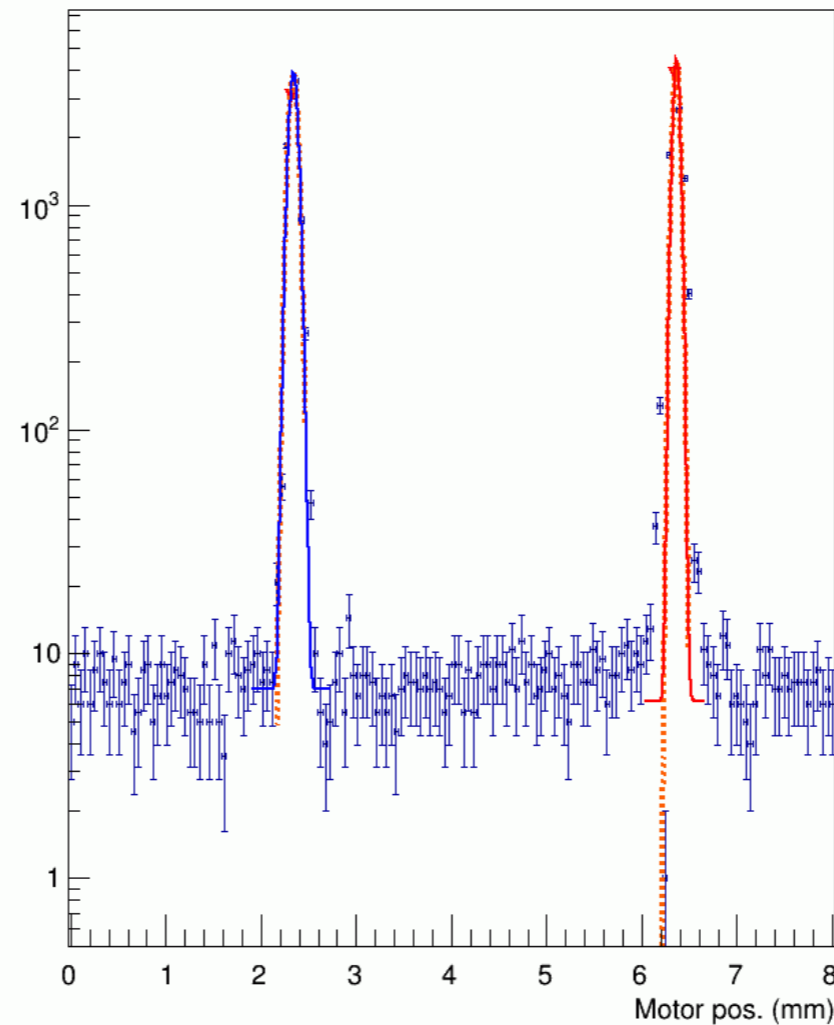


# Beam Conditions on Morning of 6/30 (after a long night!!)

HPS\_T



HPS\_SC



File: svt\_top\_scan\_0143.asc

Analyze from HPS\_t counter

top\_mot\_pos1 = 2.340 mm  
top\_mot\_pos2 = 6.357 mm  
top\_wire\_dist = 1.935 mm  
top\_beam\_Y = -0.075 mm  
top\_beam\_X = -0.099 mm  
top\_beam\_σ<sub>Y</sub> = 0.0221 mm



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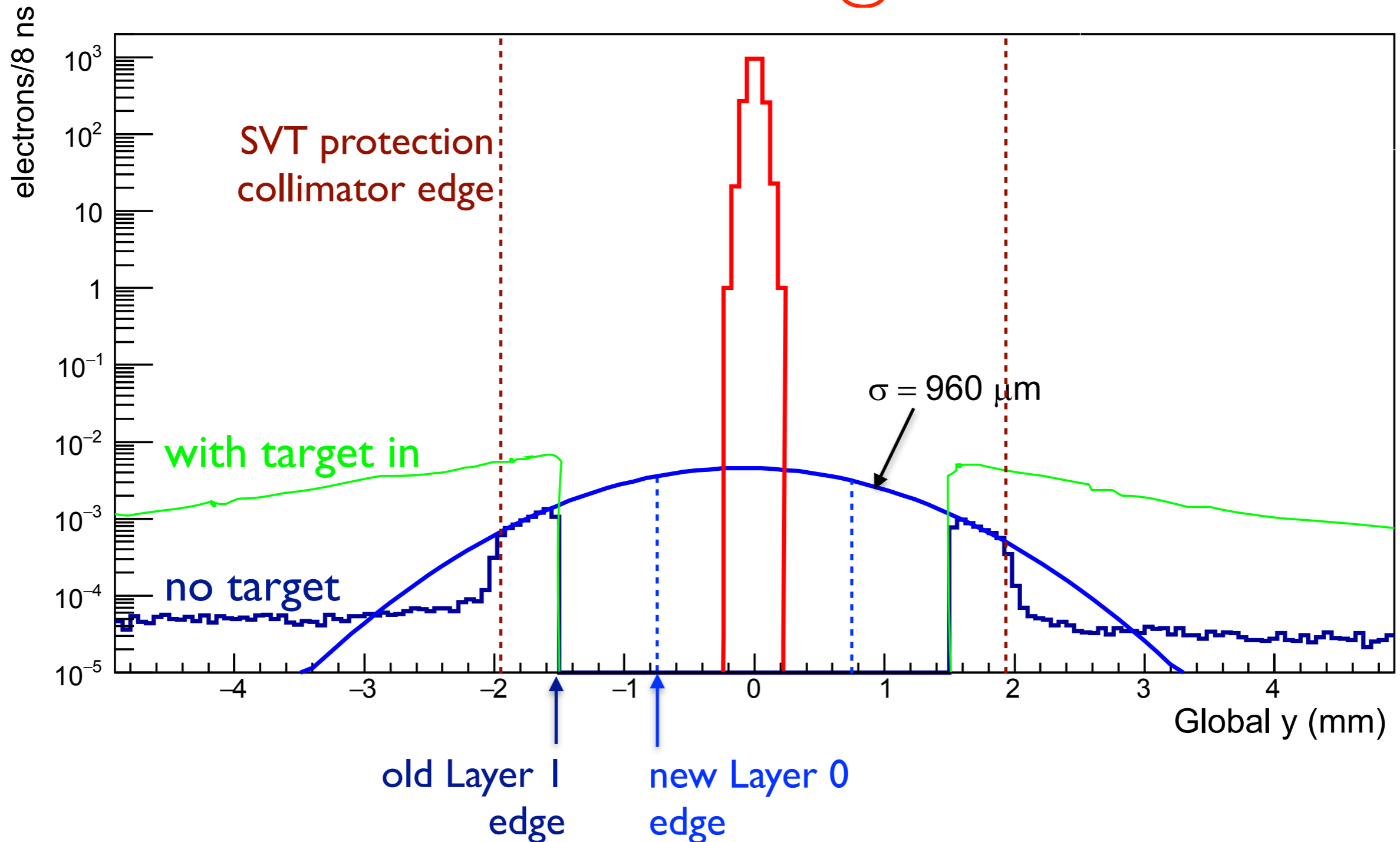
Analyze from HPS\_SC counter

top\_mot\_pos1 = 2.340 mm  
top\_mot\_pos2 = 6.363 mm  
top\_wire\_dist = 1.938 mm  
top\_beam\_Y = -0.075 mm  
top\_beam\_X = -0.078 mm  
top\_beam\_σ<sub>Y</sub> = 0.0224 mm

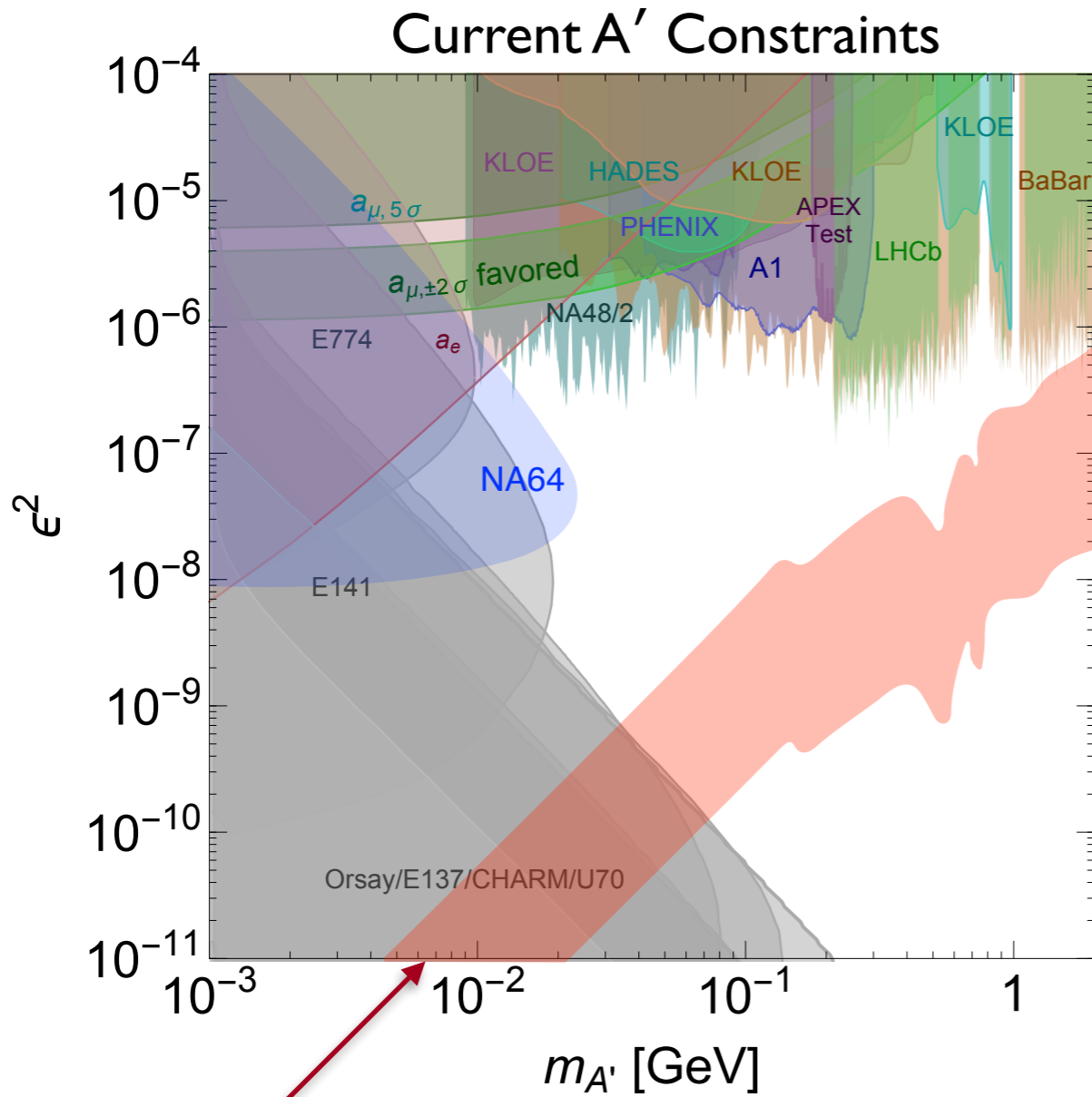
top\_mot\_pos1 = 2.339 mm  
top\_mot\_pos2 = 6.364 mm  
top\_wire\_dist = 1.938 mm  
top\_beam\_Y = -0.075 mm  
top\_beam\_X = -0.075 mm  
top\_beam\_σ<sub>Y</sub> = 0.0225 mm

# SVT can be overwhelmed with very low-level halo!

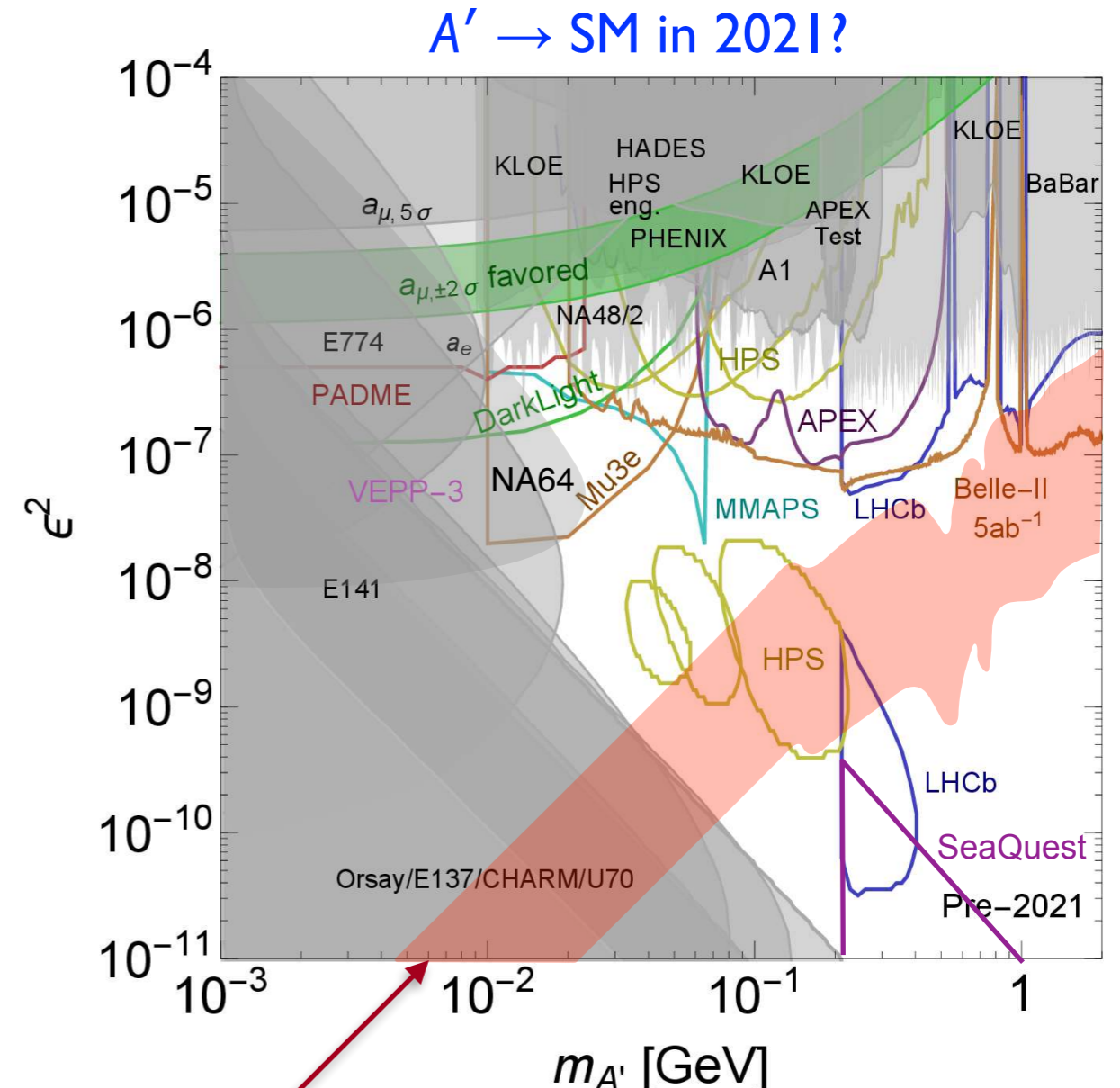
HPS 2015 run: 50 nA @ 1.056 GeV



# HPS is still ahead of the pack... *for now!*



**thermal targets**  
 $\alpha_D = 0.5, M_{A'}/M_\chi = 1.5$



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 $\alpha_D = 0.5, M_{A'}/M_\chi = 1.5$

*In ~2022, LHCb Run 3 can cover most of this!!*