



# DarkLight: a new particle search at TRIUMF

Kate Pachal  
TRIUMF



DarkLight is a new experiment to **search for particles beyond the Standard Model**

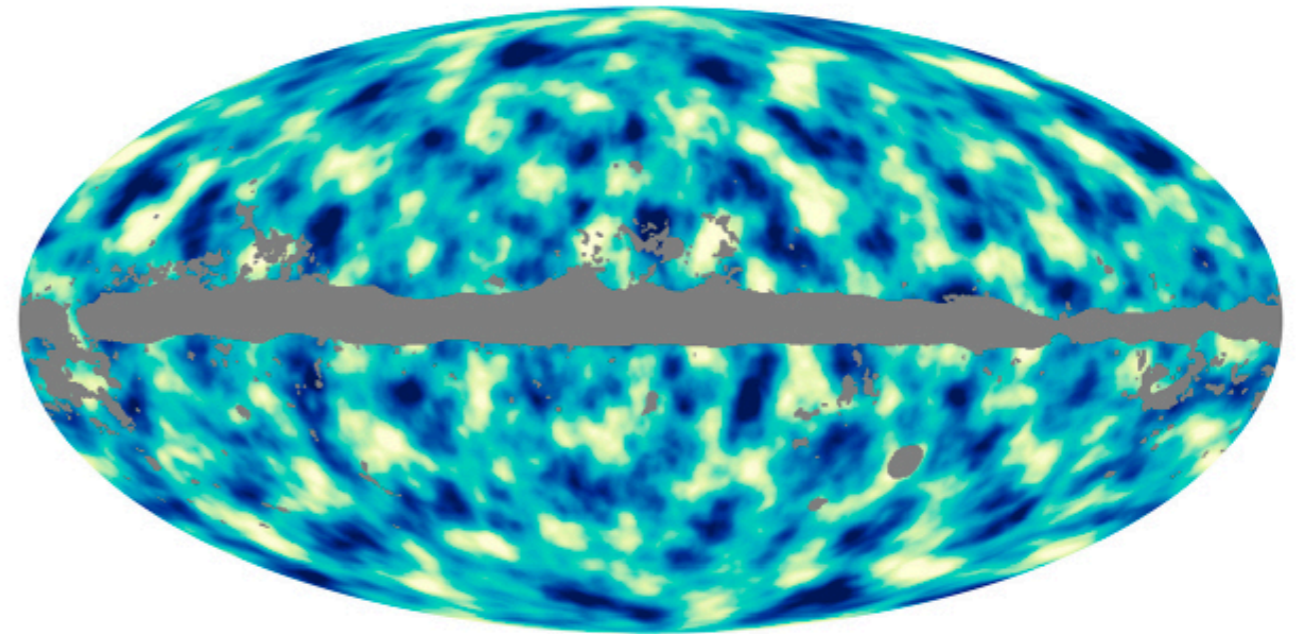
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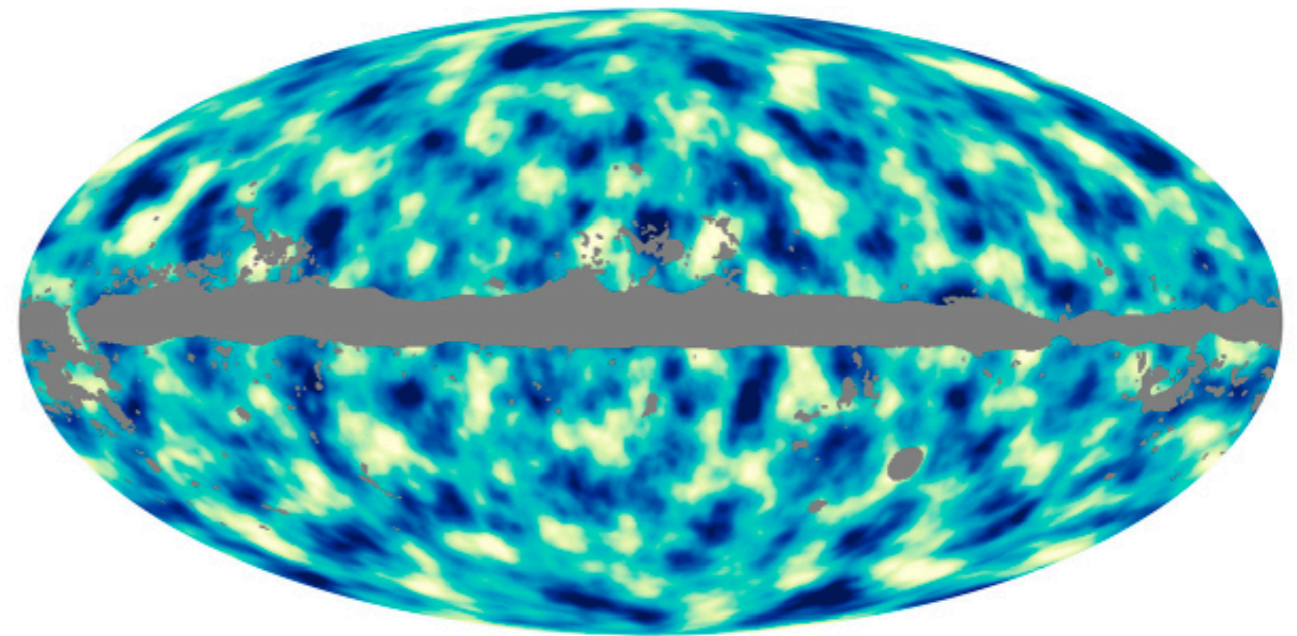
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- Some observed values seem suspiciously fine-tuned
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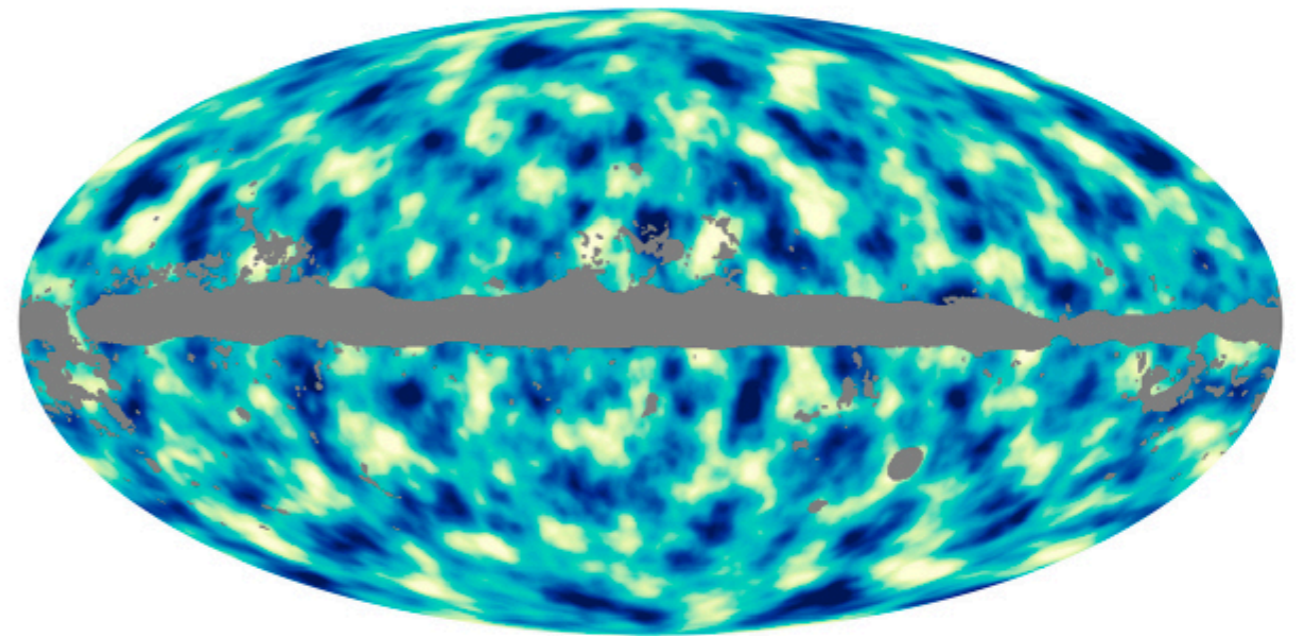


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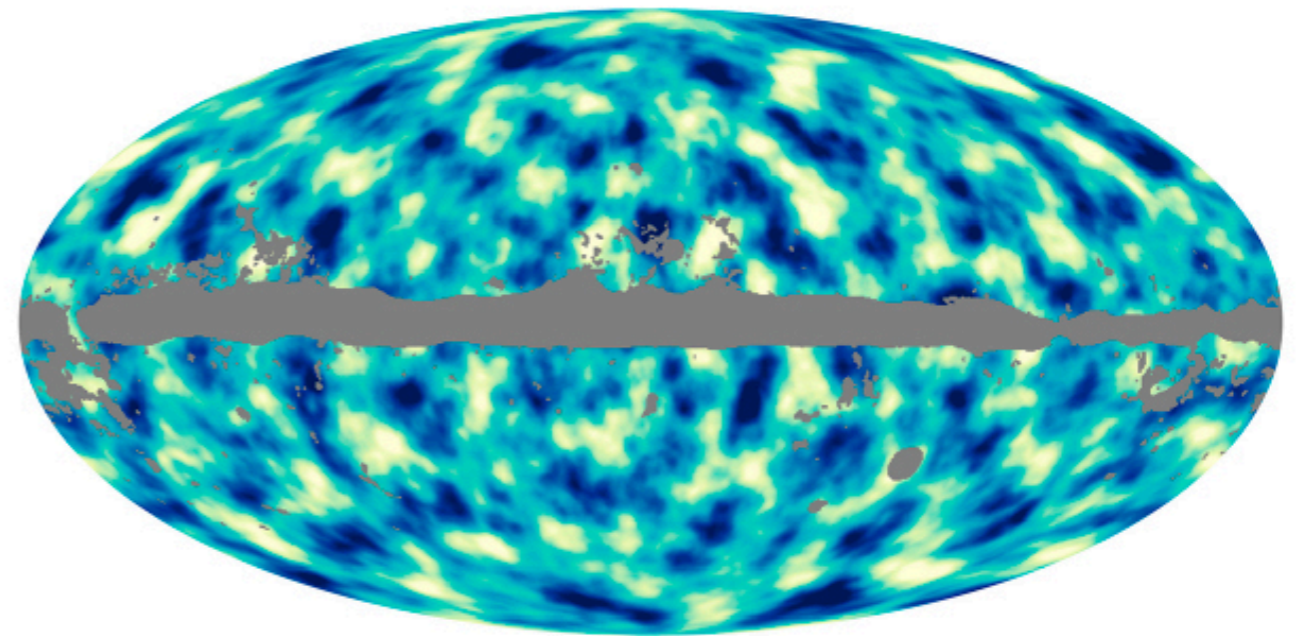
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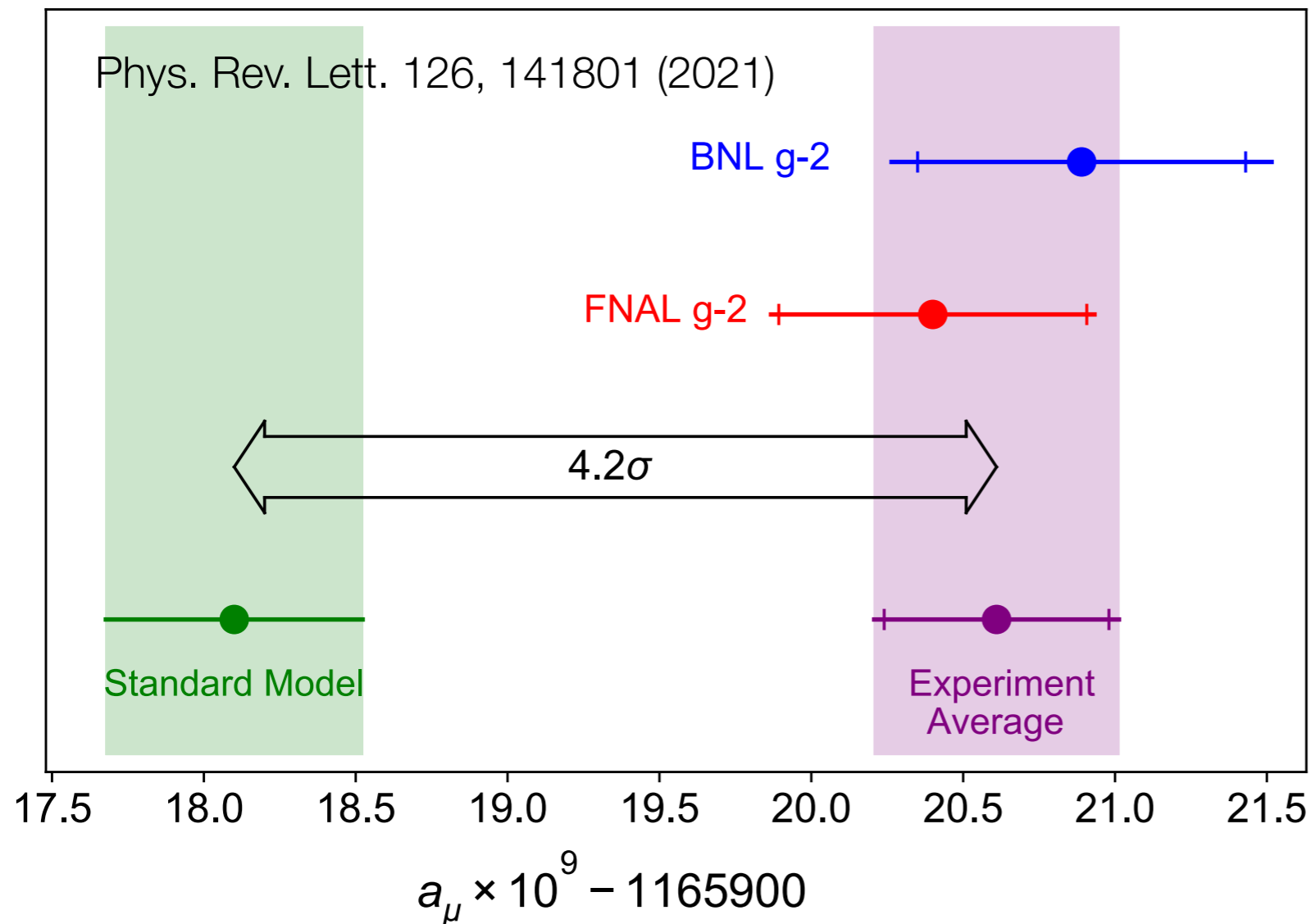
Complementary approaches - theory or experimentally driven

If we see something odd in an experiment, can probe where the **anomaly suggests interesting things**

# First anomaly: muon g-2

“Spin” of a muon in a magnetic field **very precisely predicted**

**Measured value** is significantly different

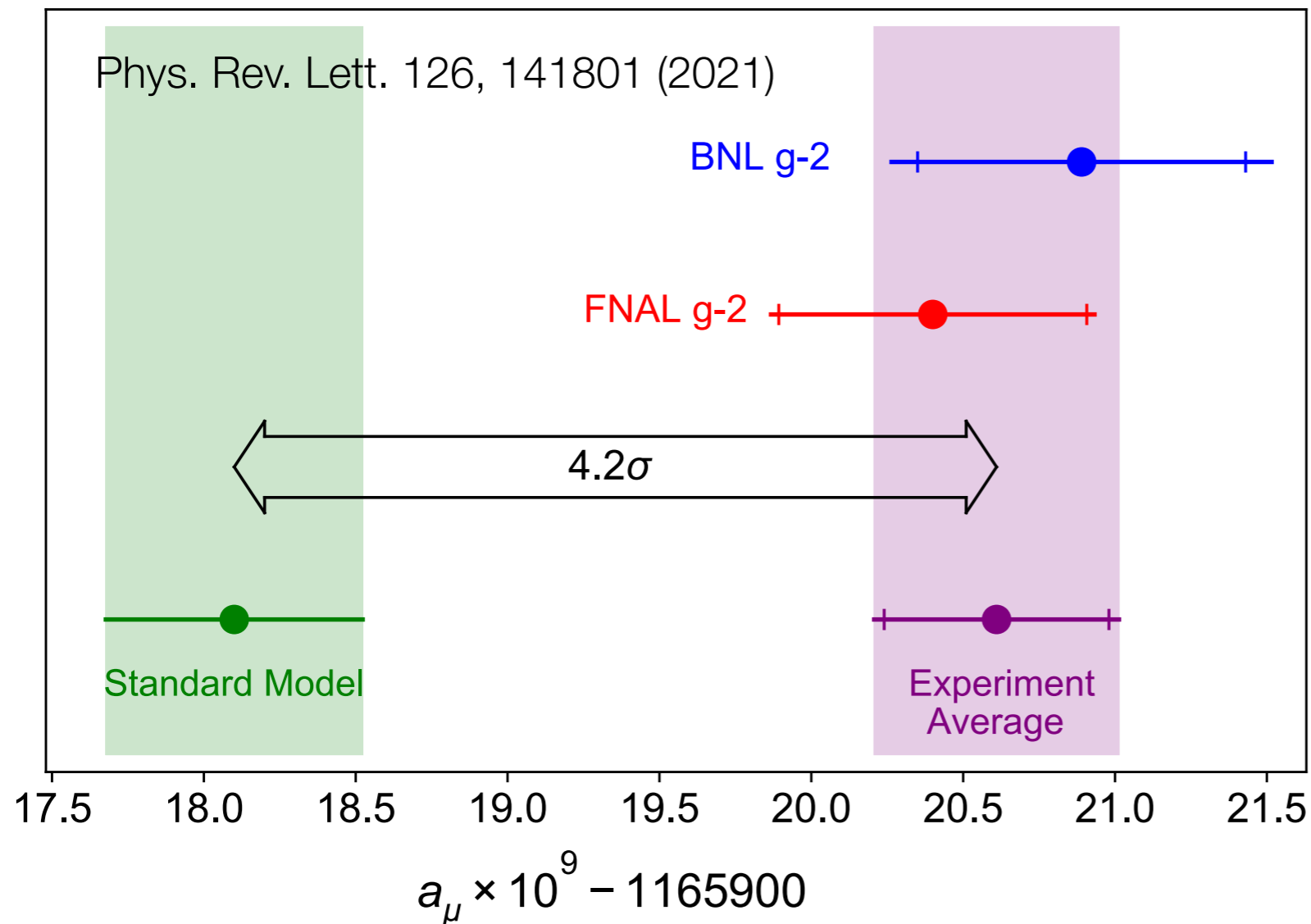




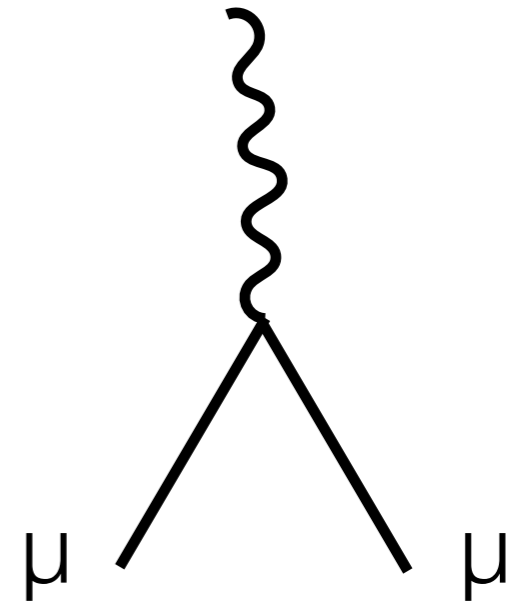
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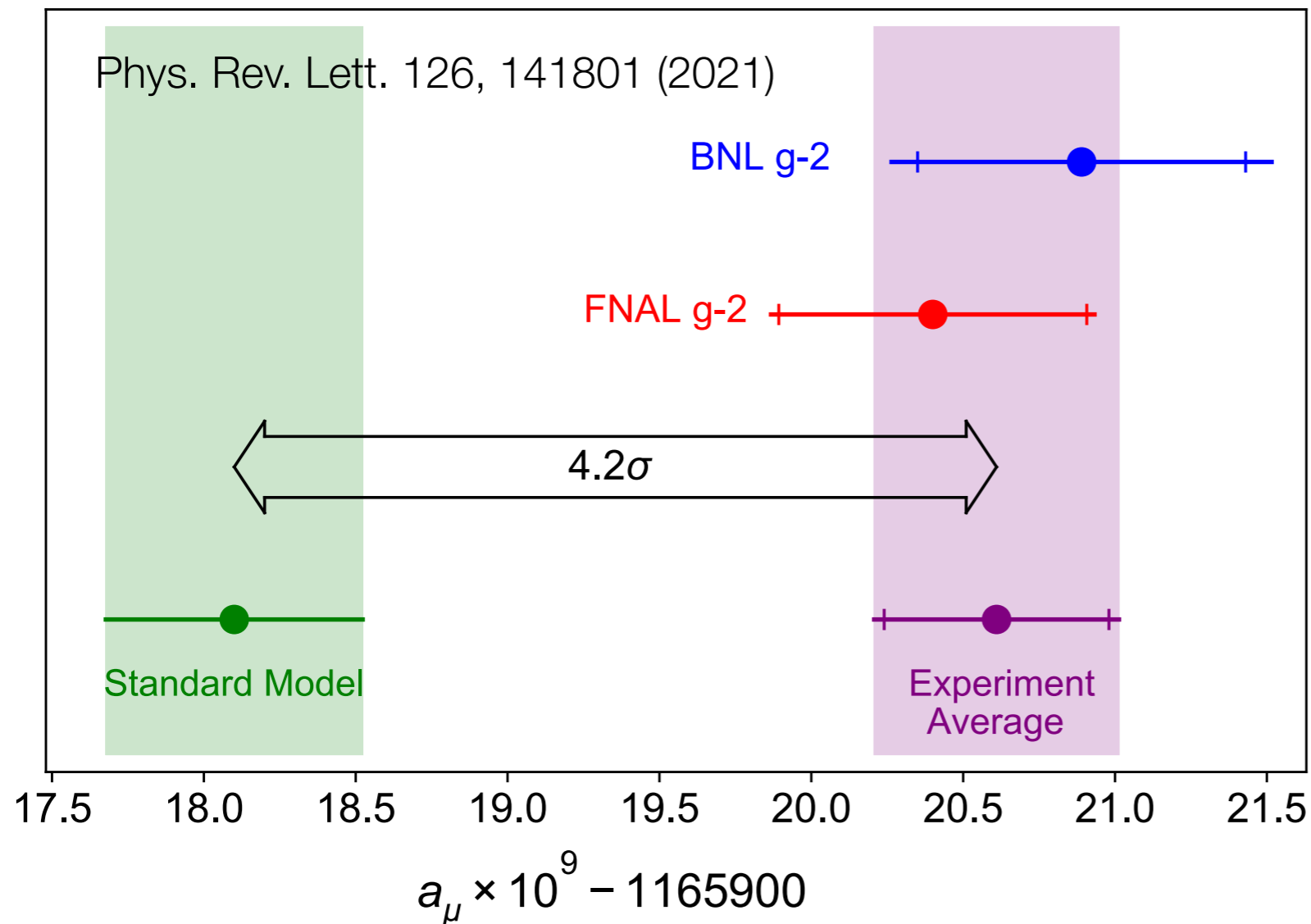
(magnetic field)



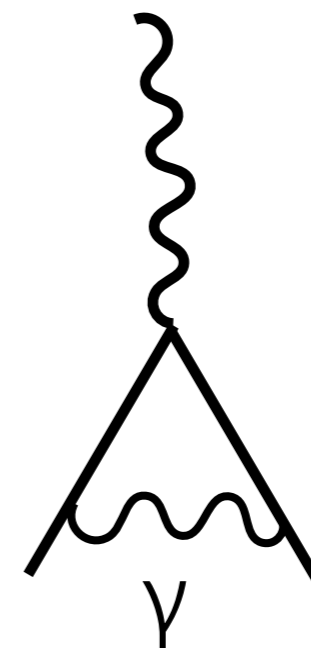
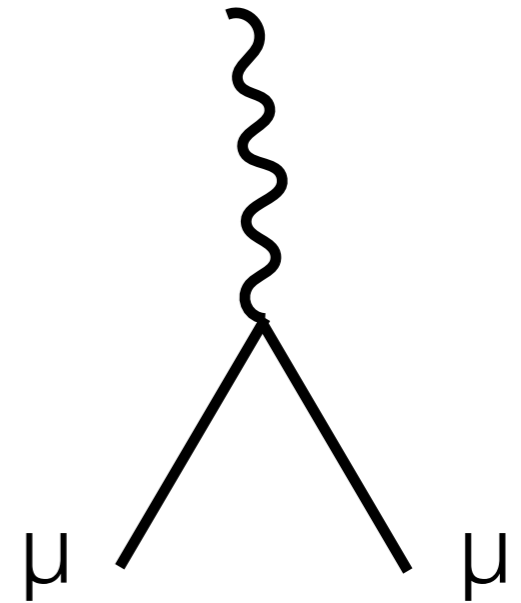
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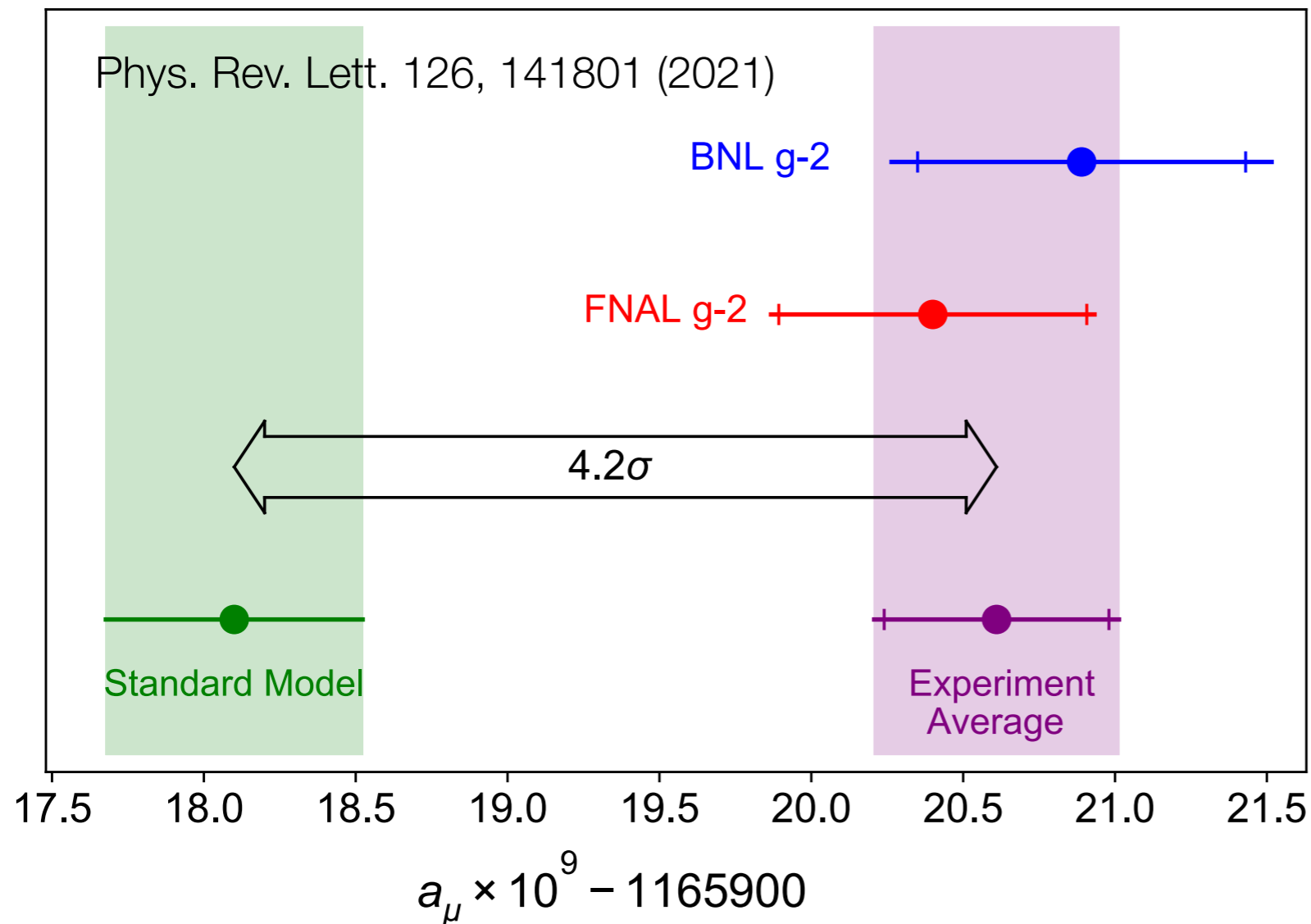
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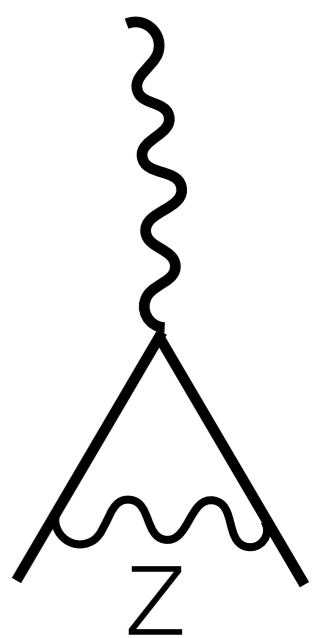
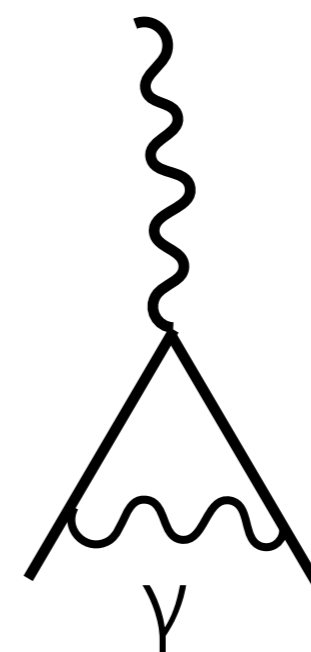
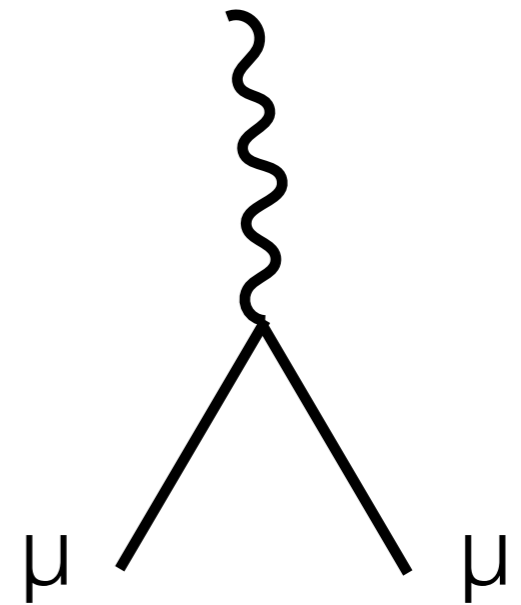
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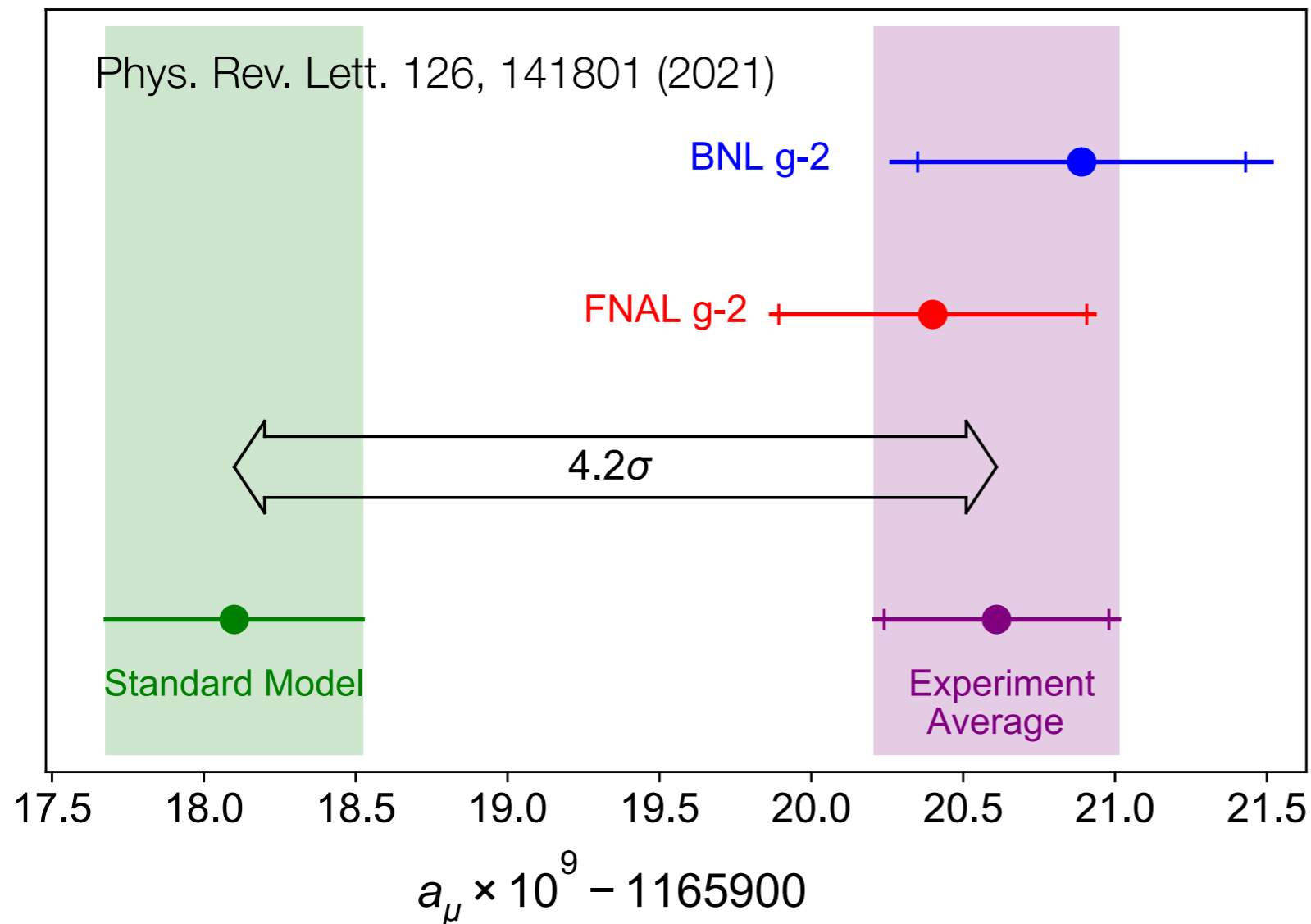
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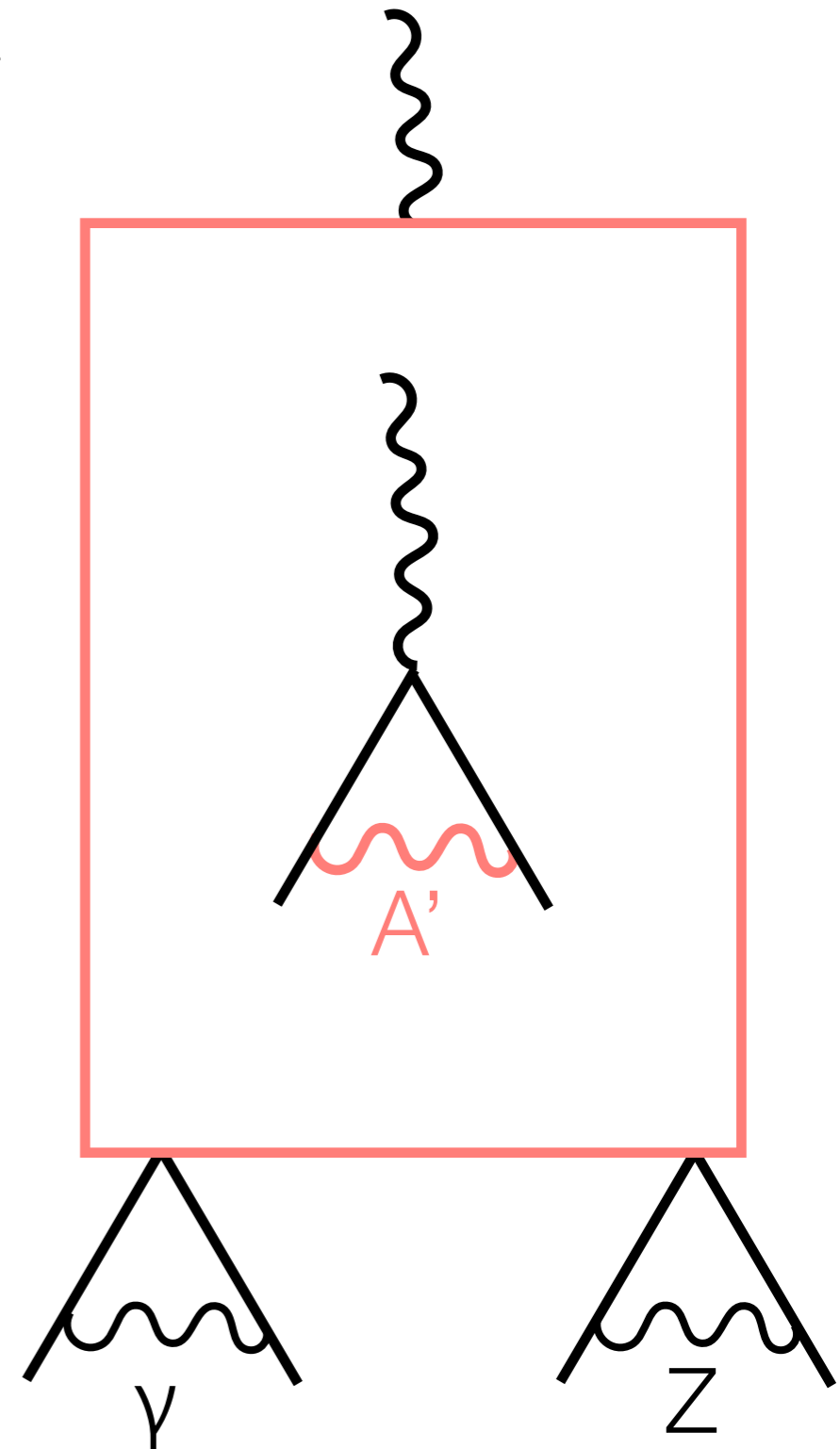
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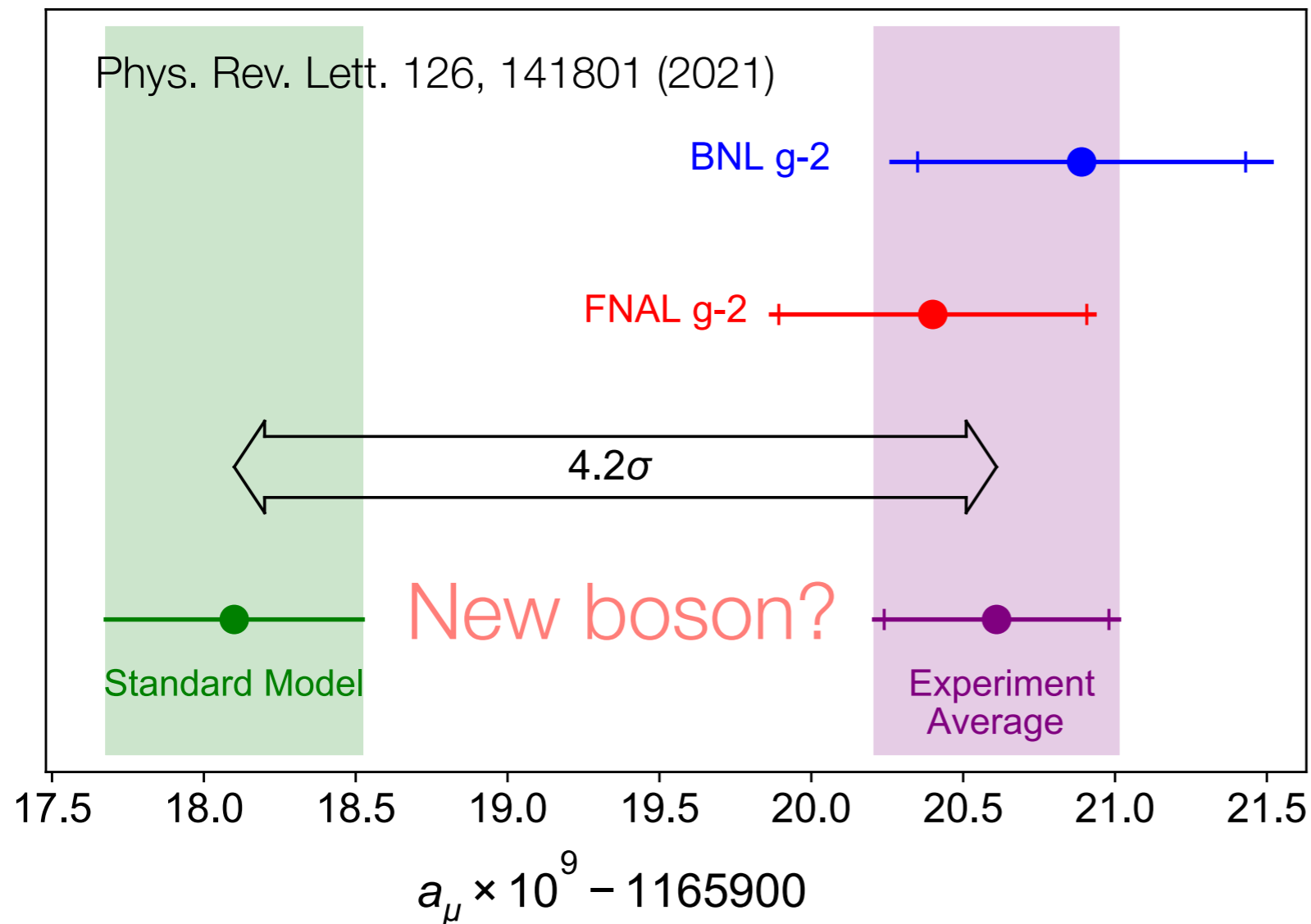
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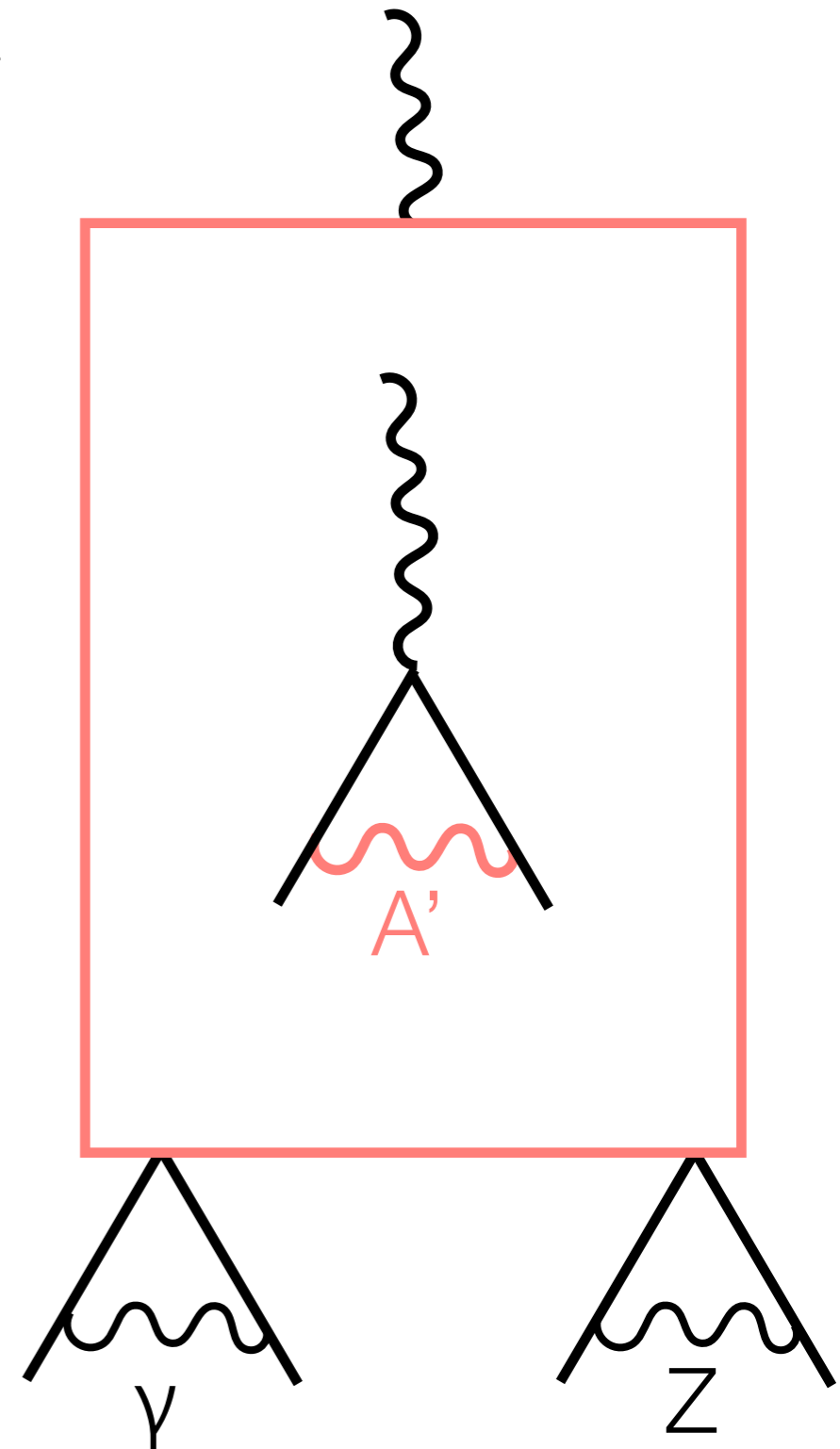
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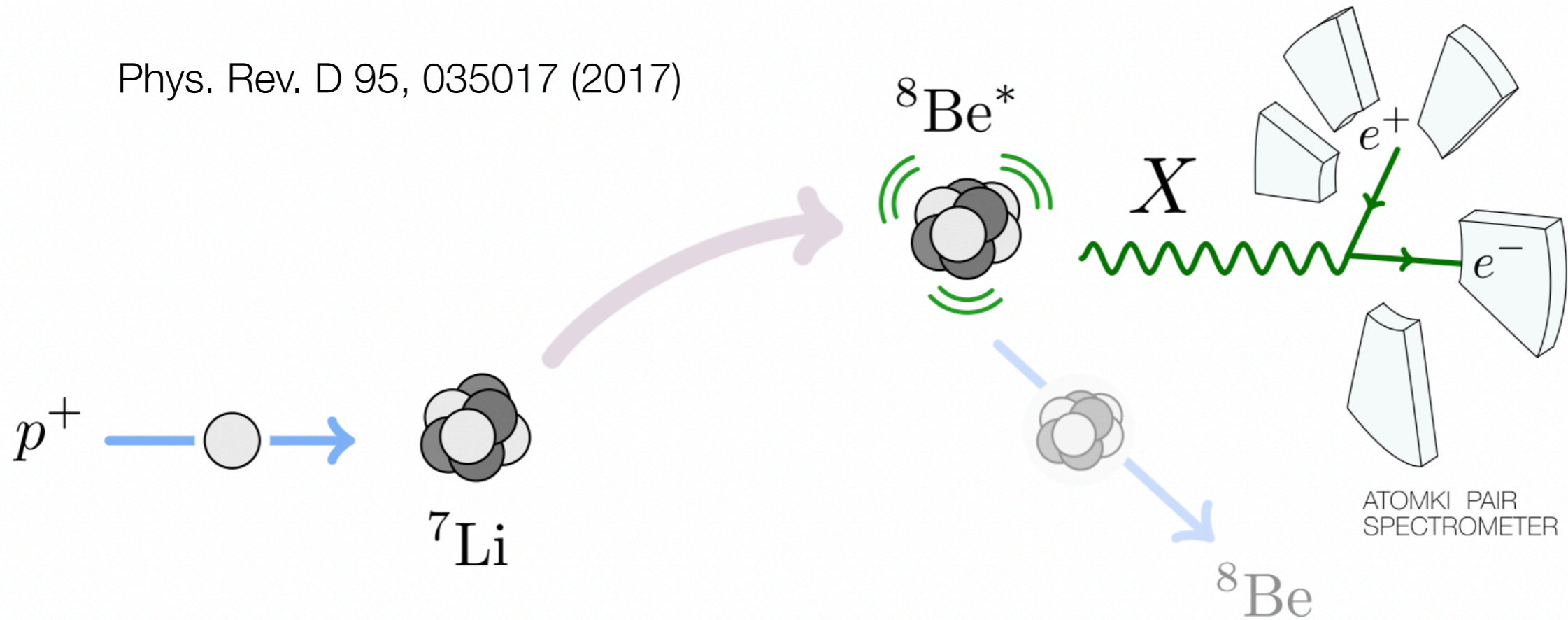


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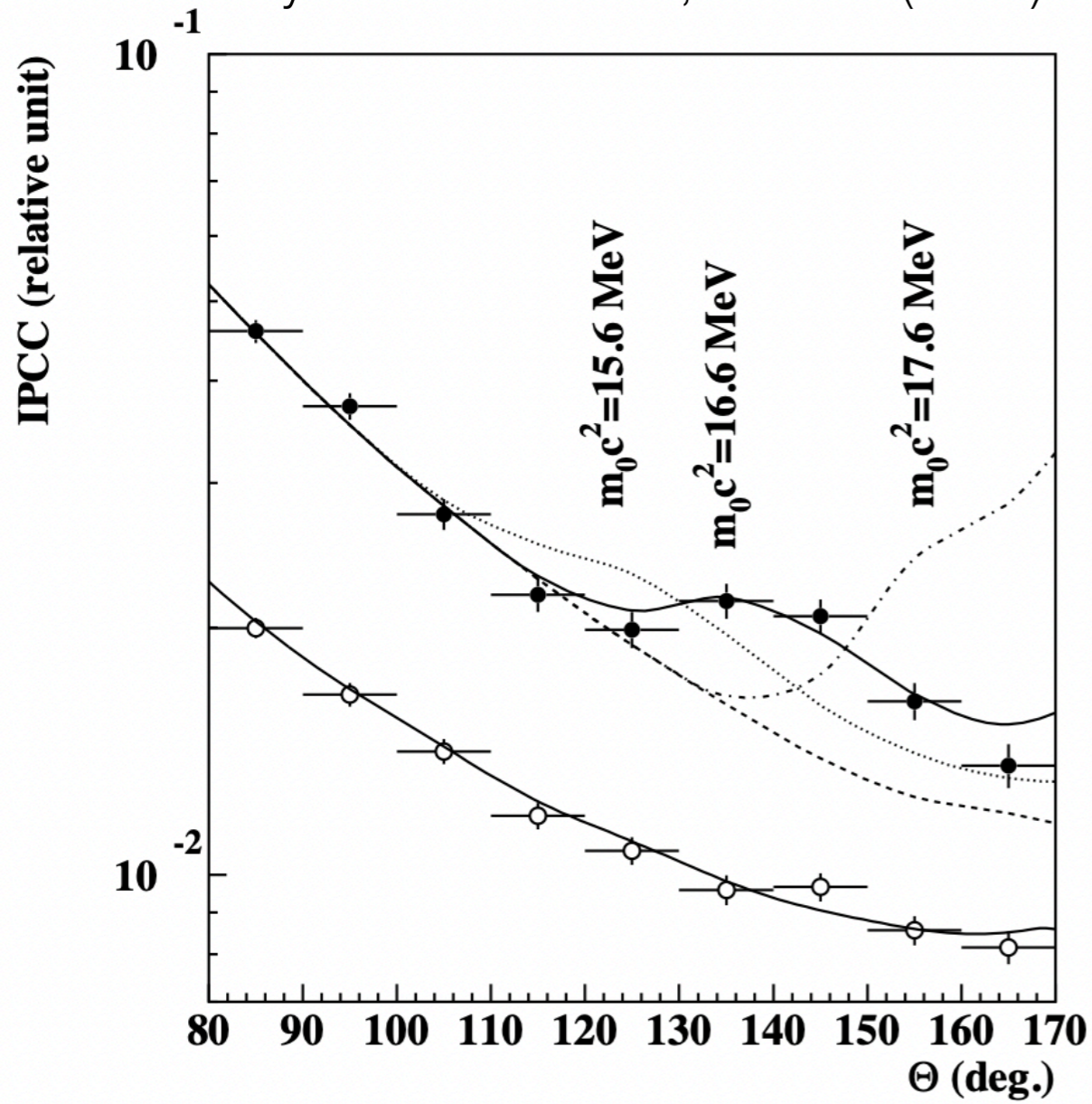
# Second anomaly: the “X17”

Phys. Rev. D 95, 035017 (2017)



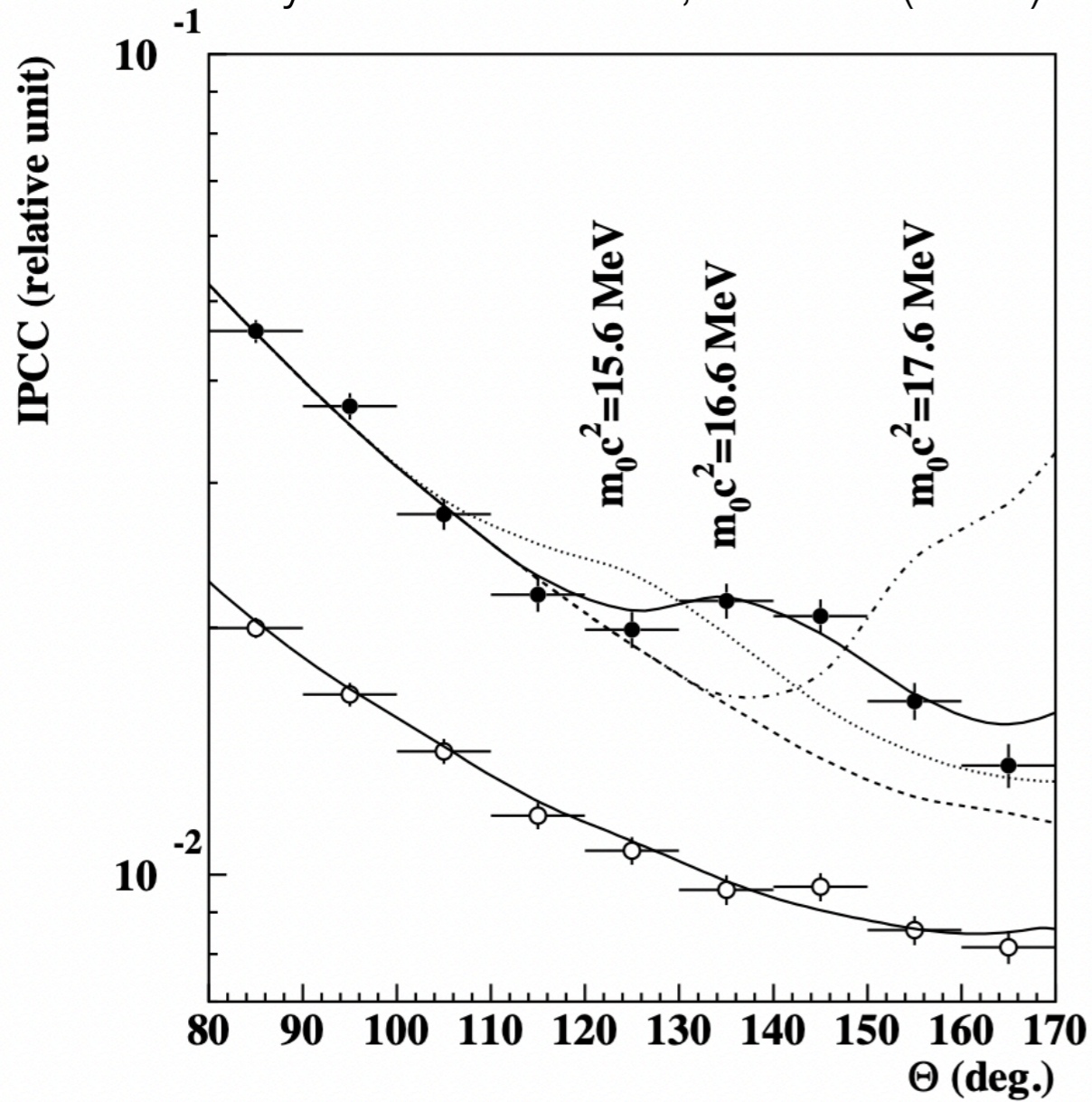
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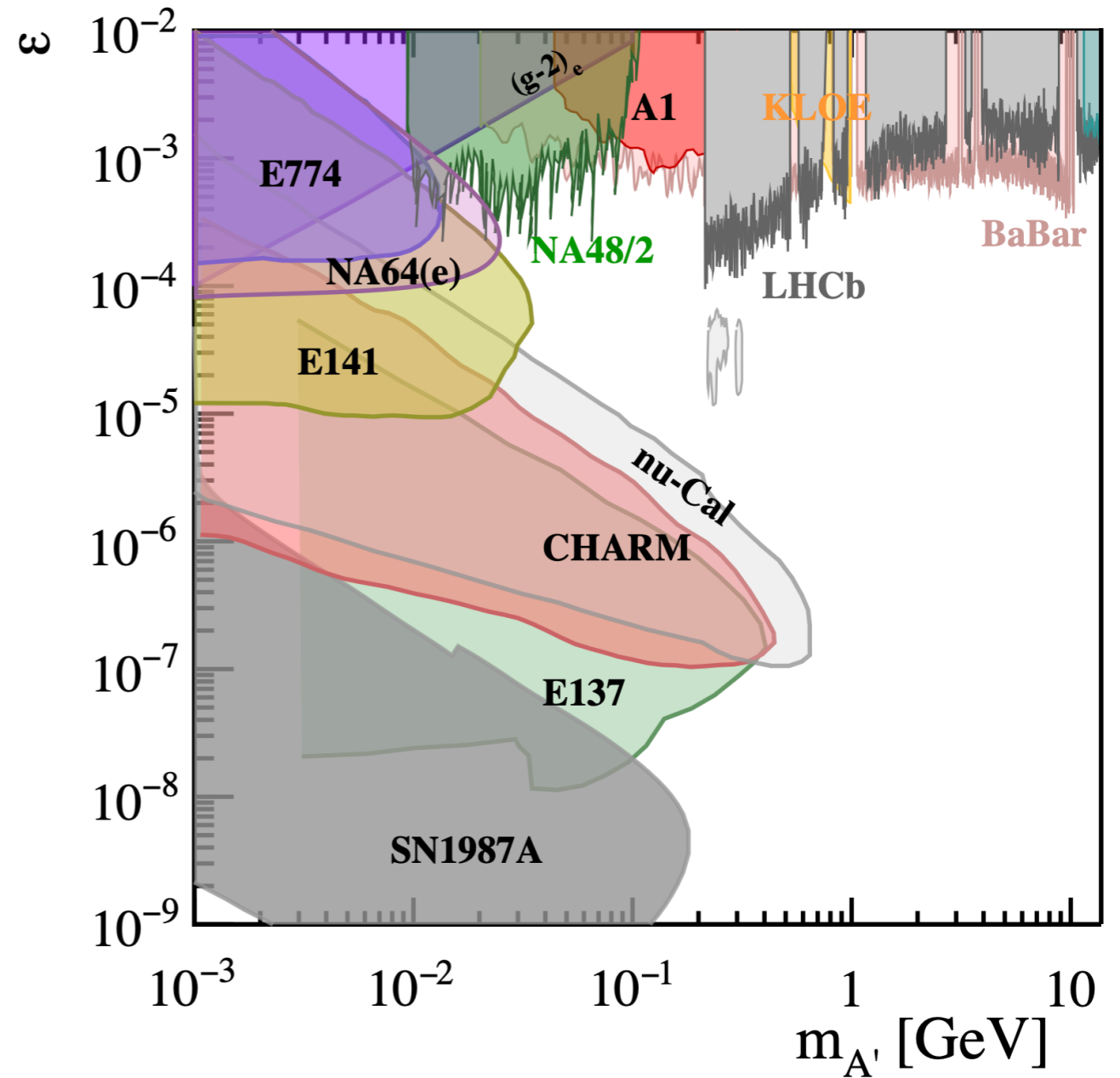


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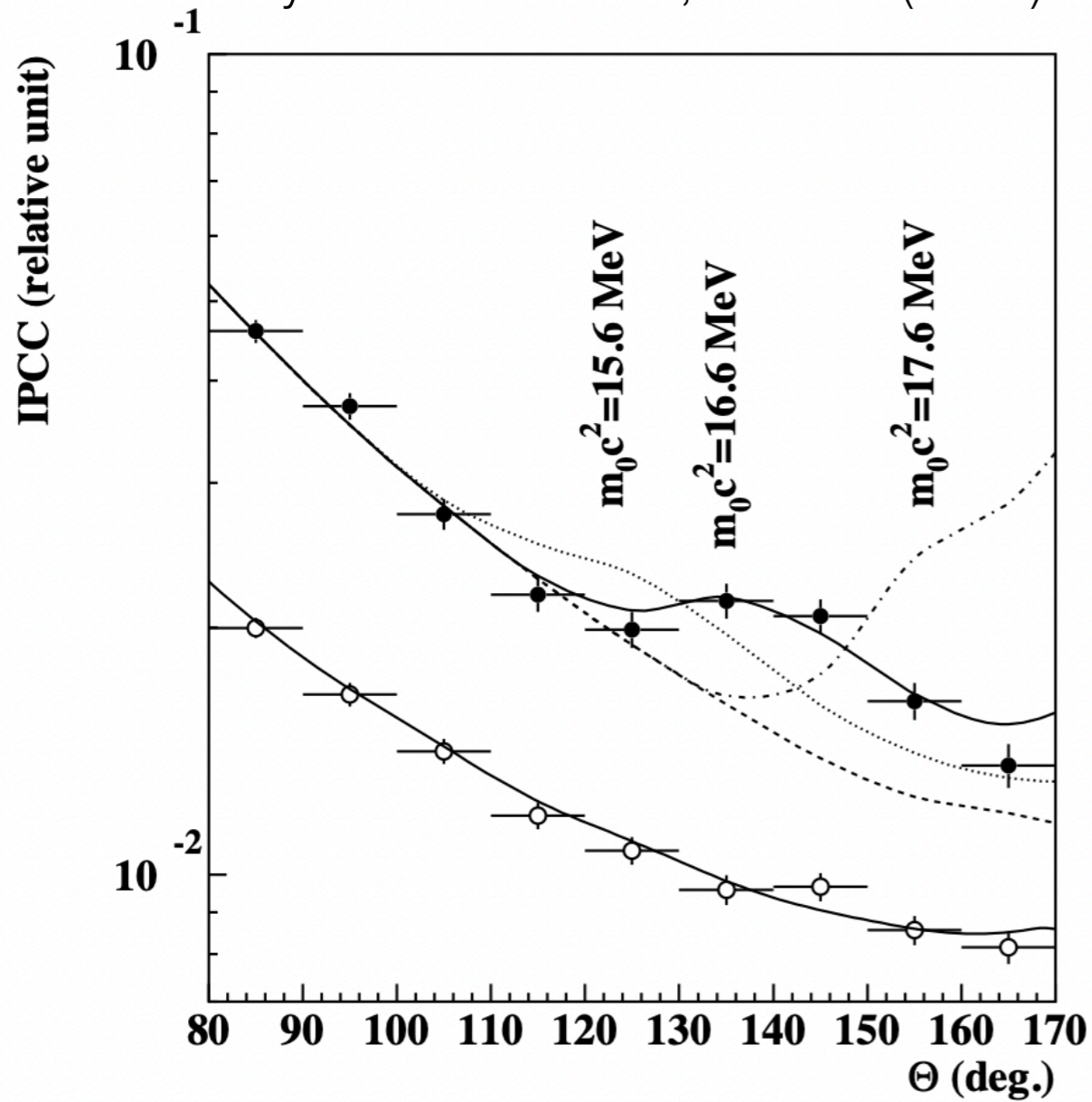
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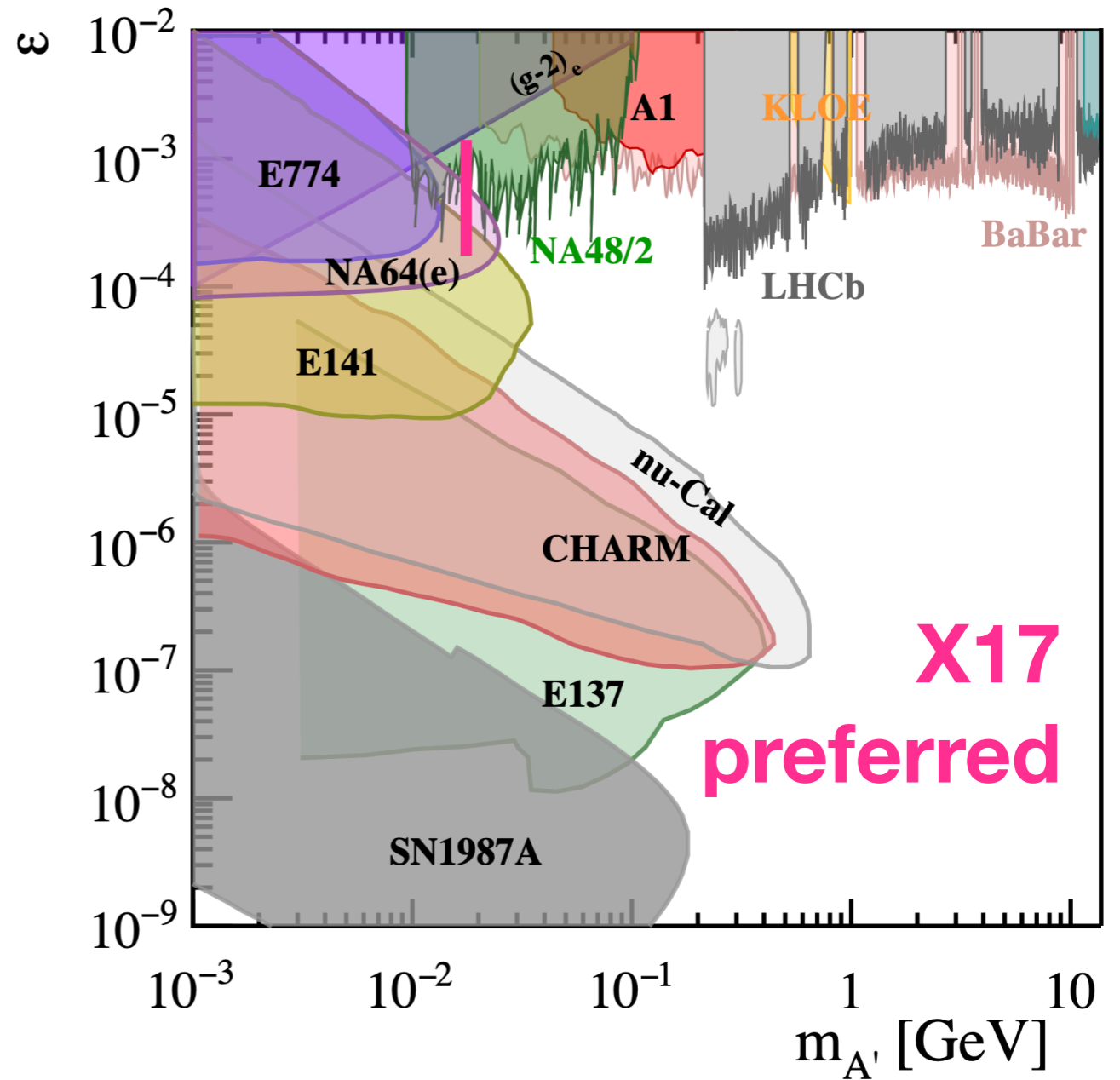


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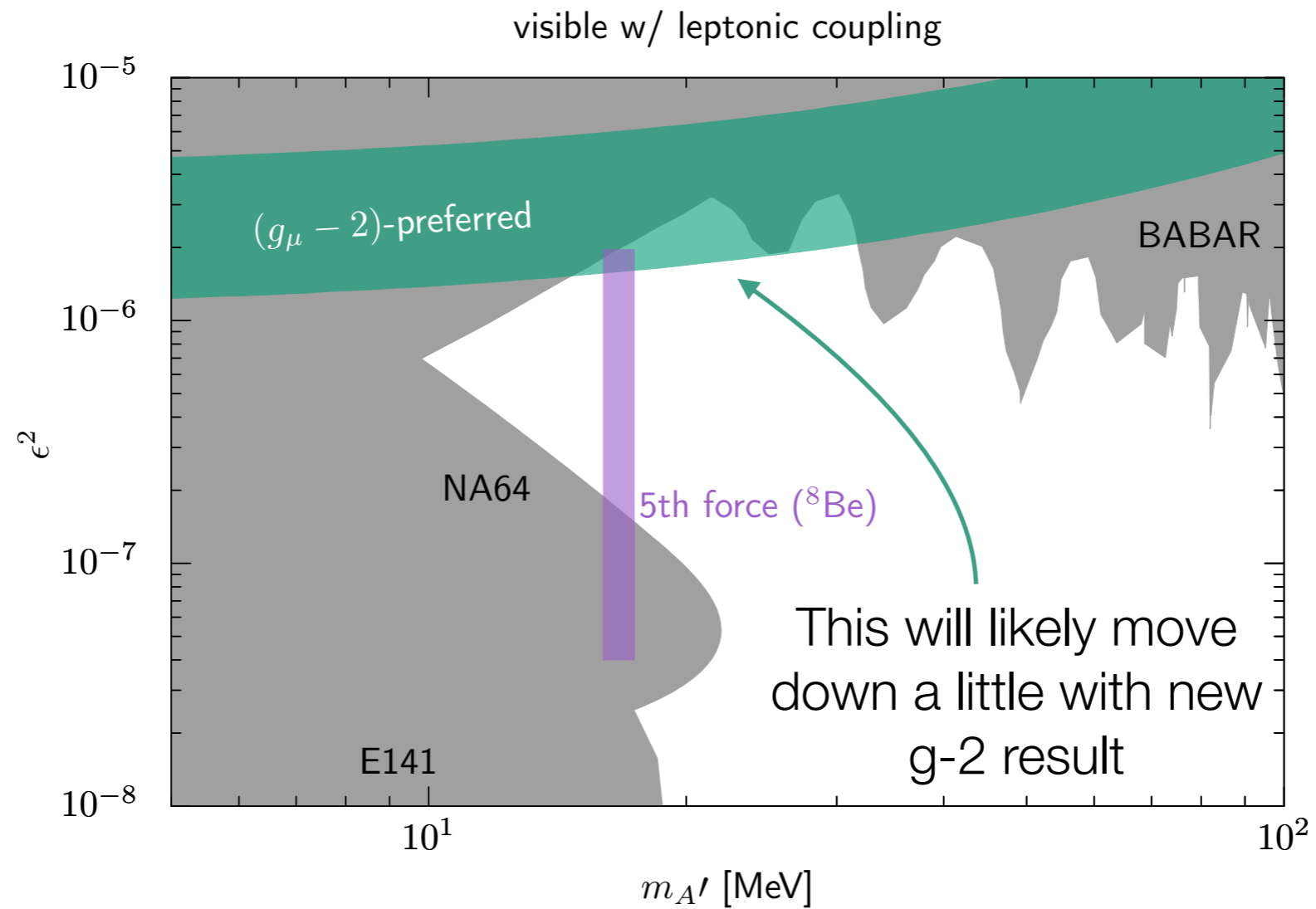


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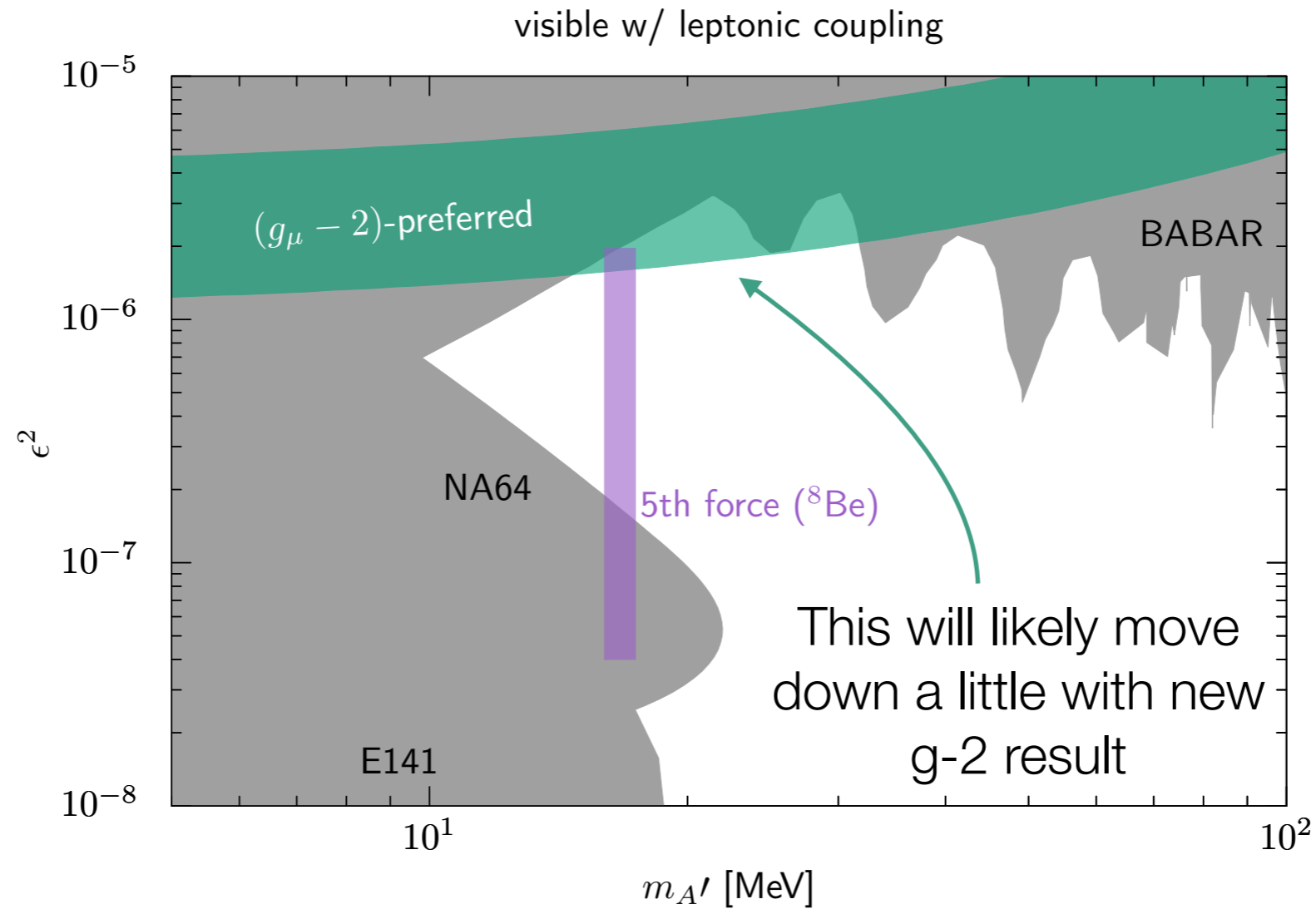
# What new boson would these motivate?

This plot: new boson limits from **e+e- interactions only**



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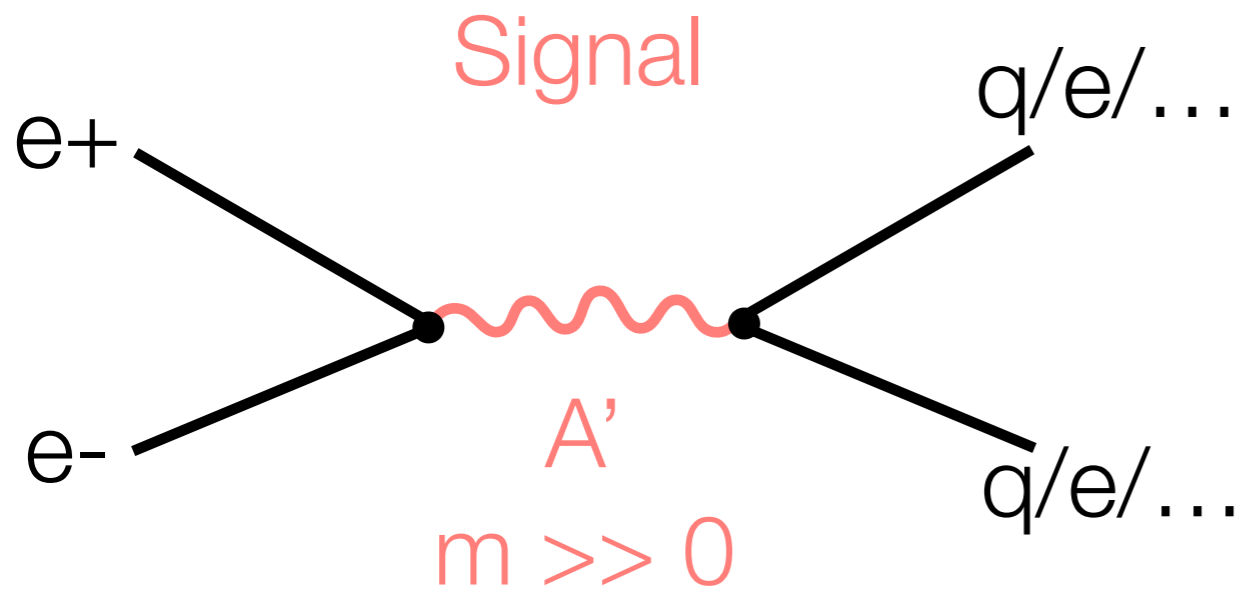
This plot: new boson limits from **e+e- interactions only**



X17 and muon  $g-2$  anomalies both appear in **lepton interactions**.  
“Protophobic” boson would avoid constraints from pion interactions  
but can be cleanly probed at e- machine.

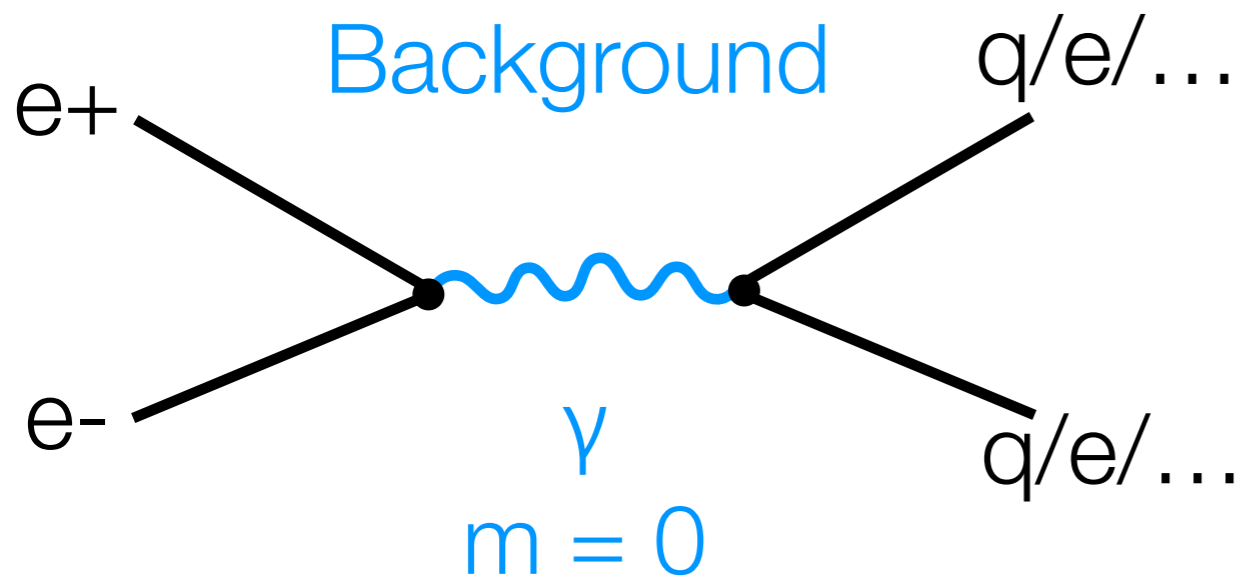
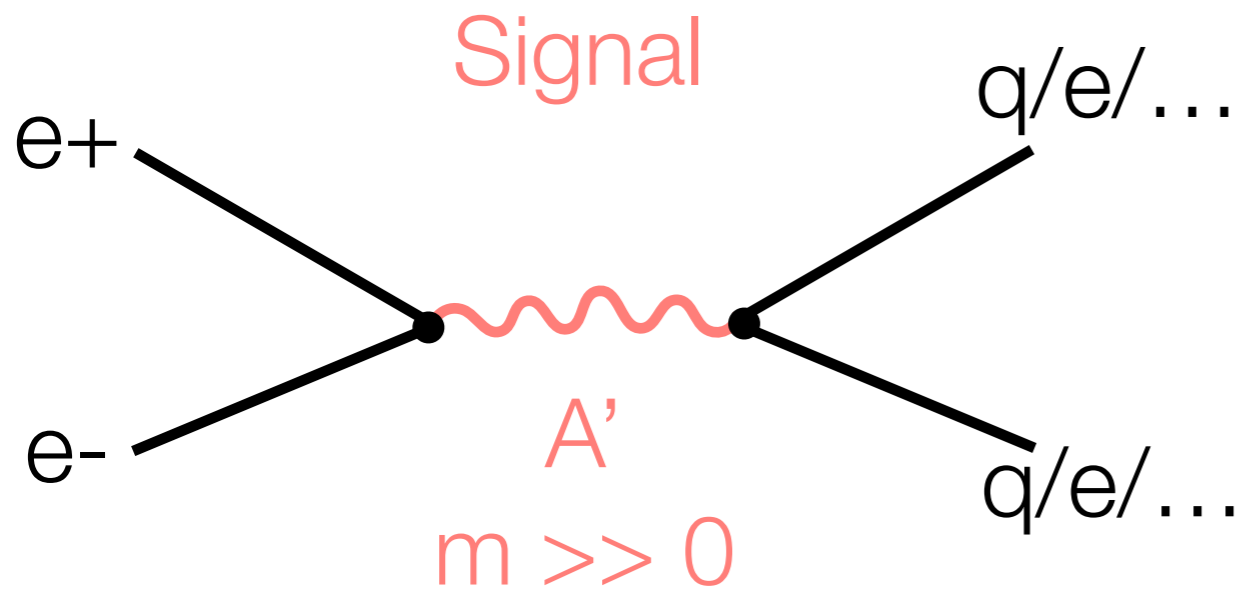
# Resonance searches for new particles

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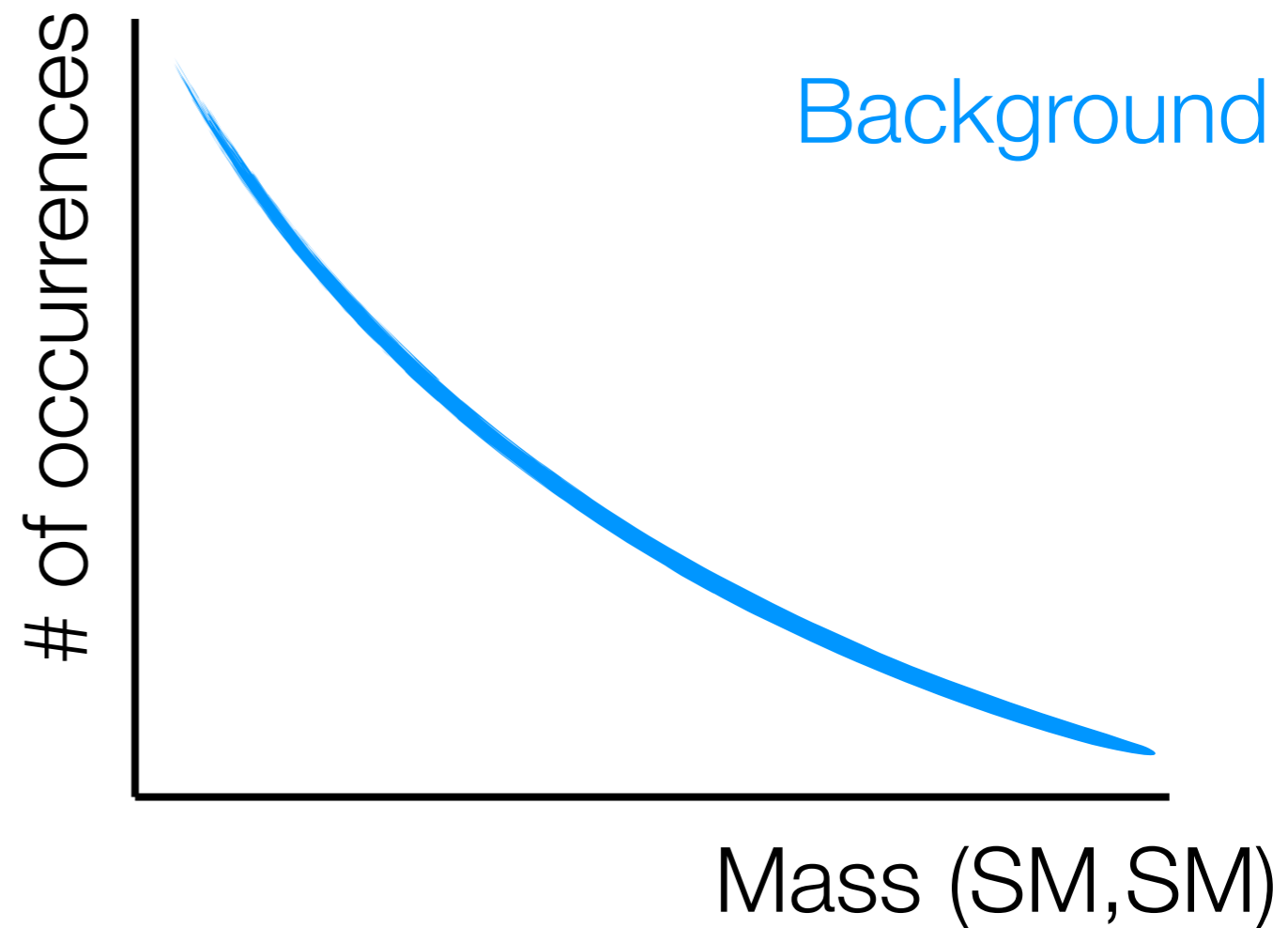
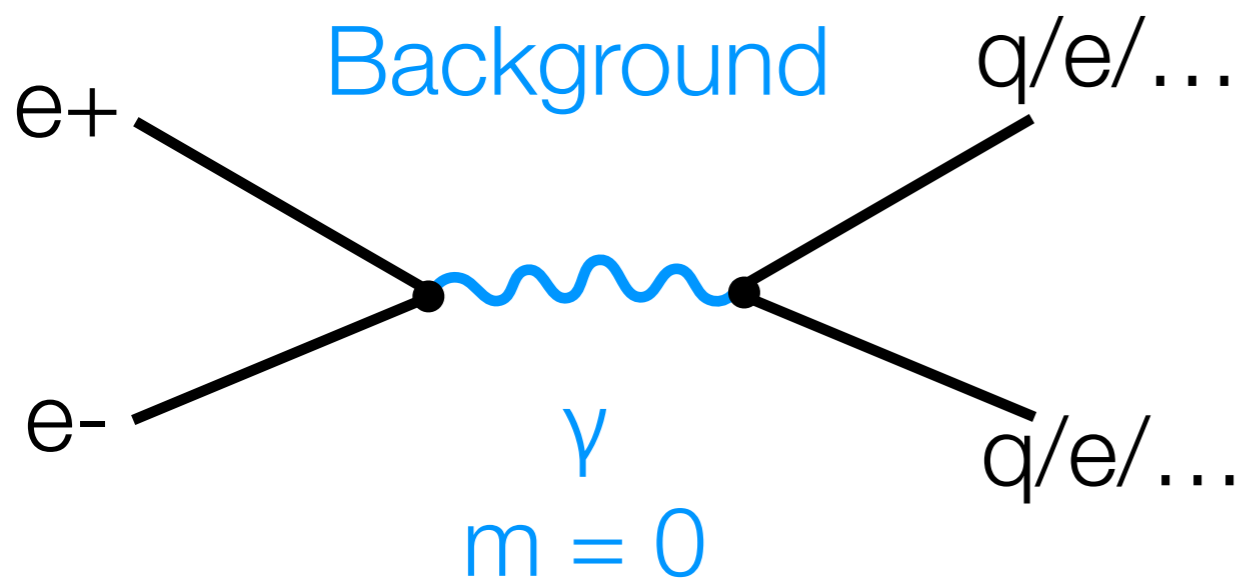
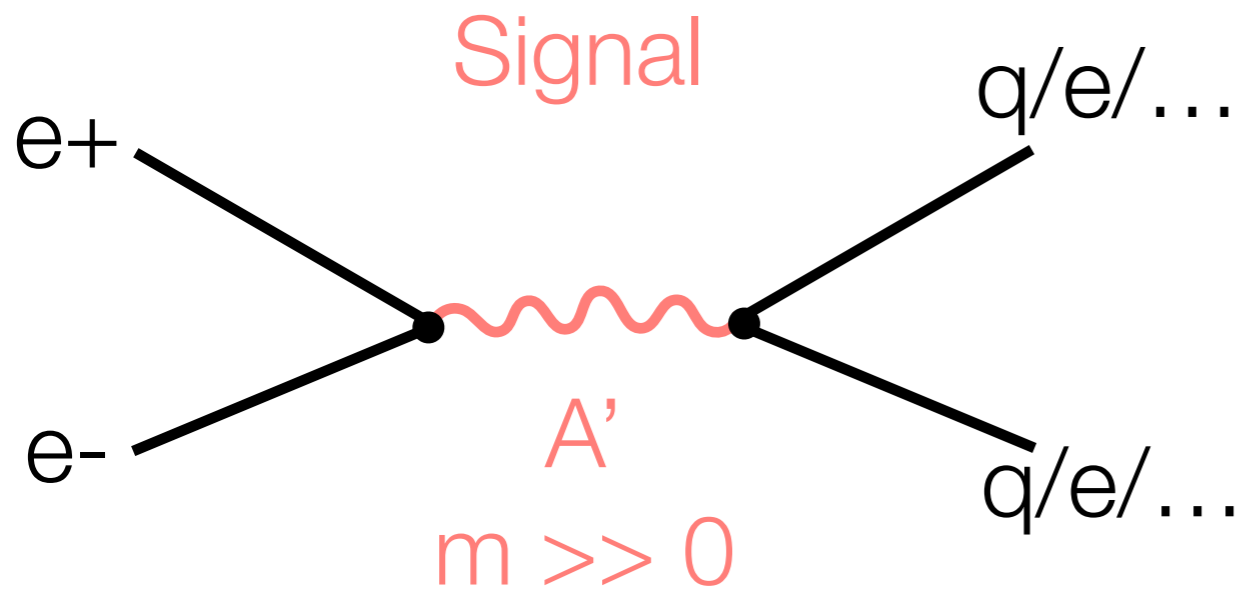


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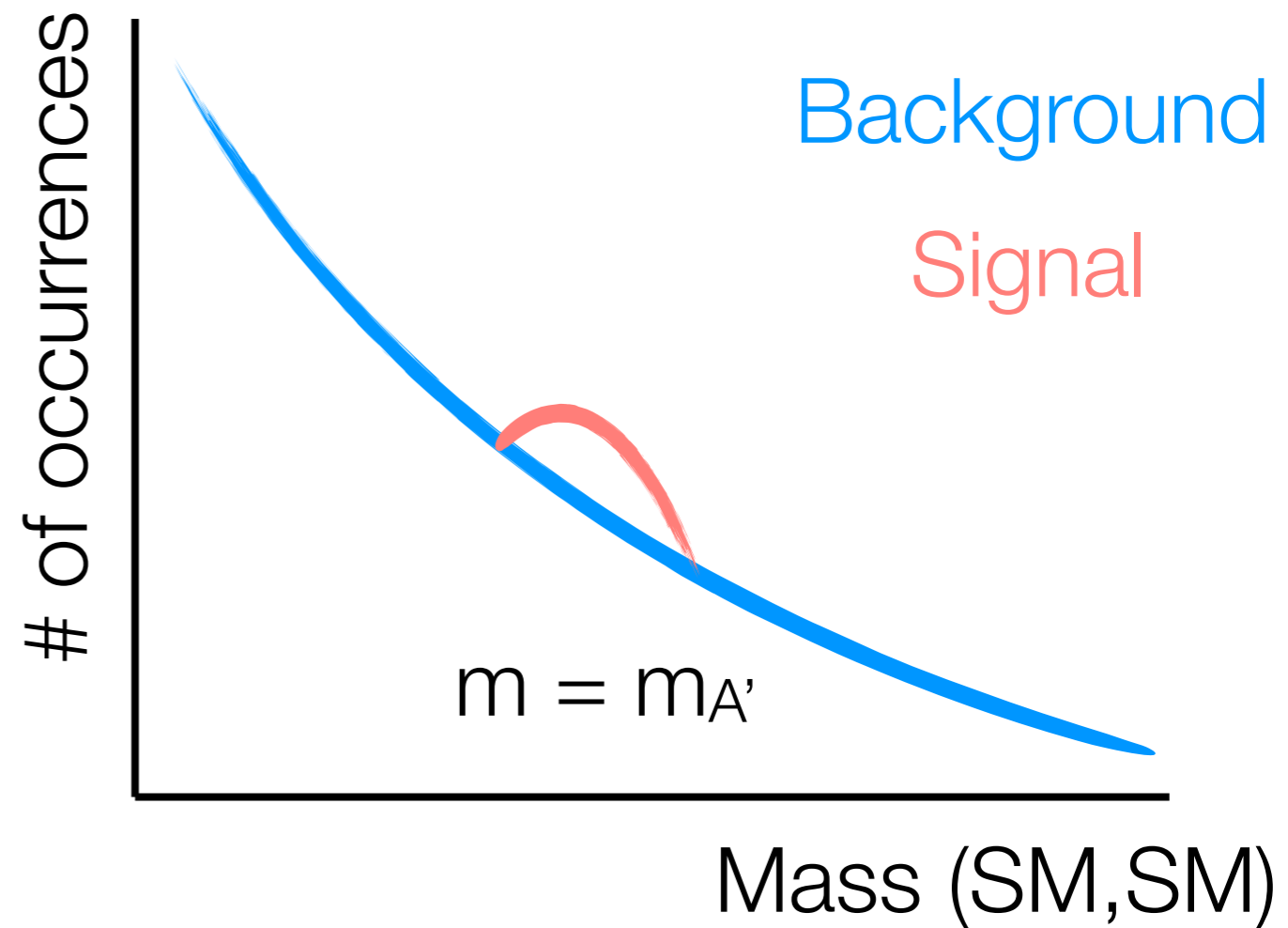
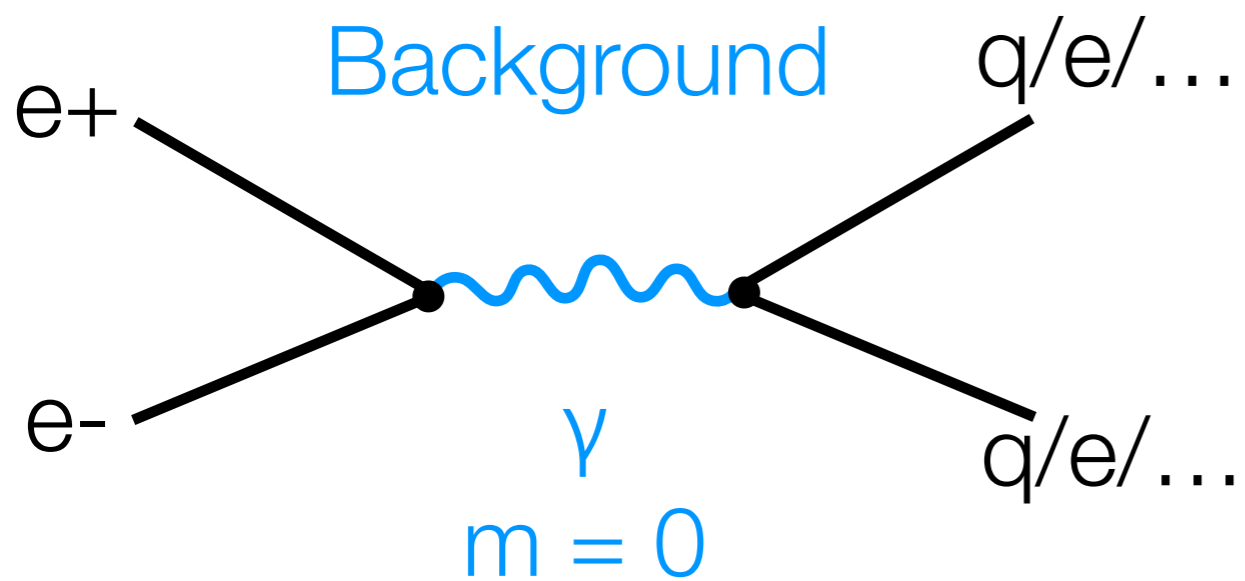
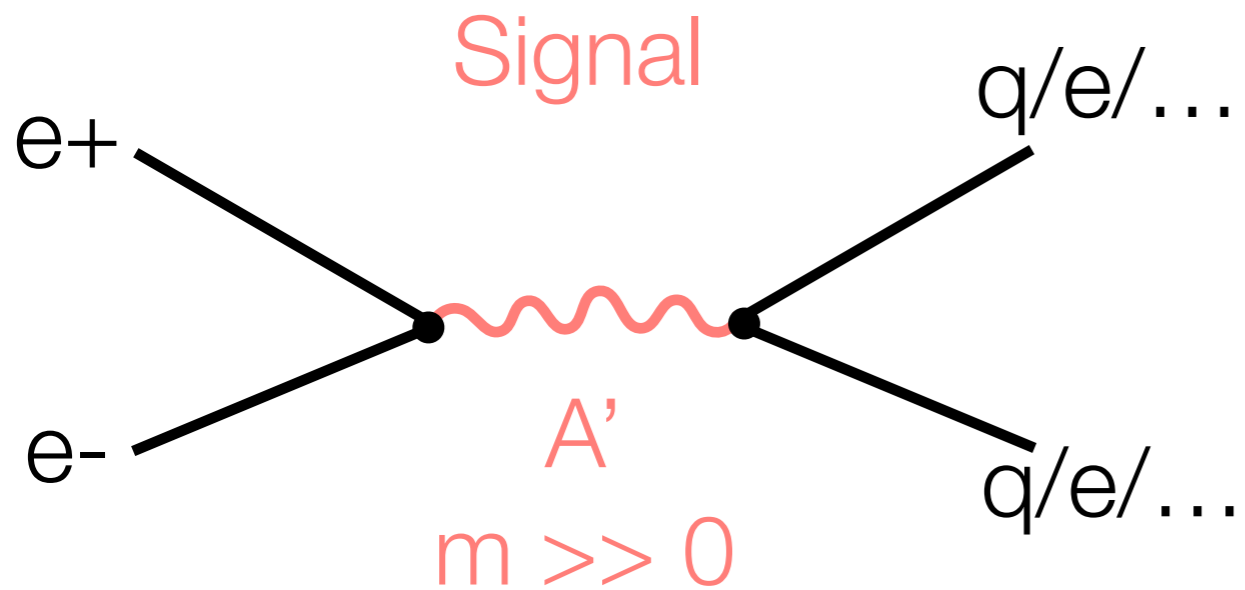
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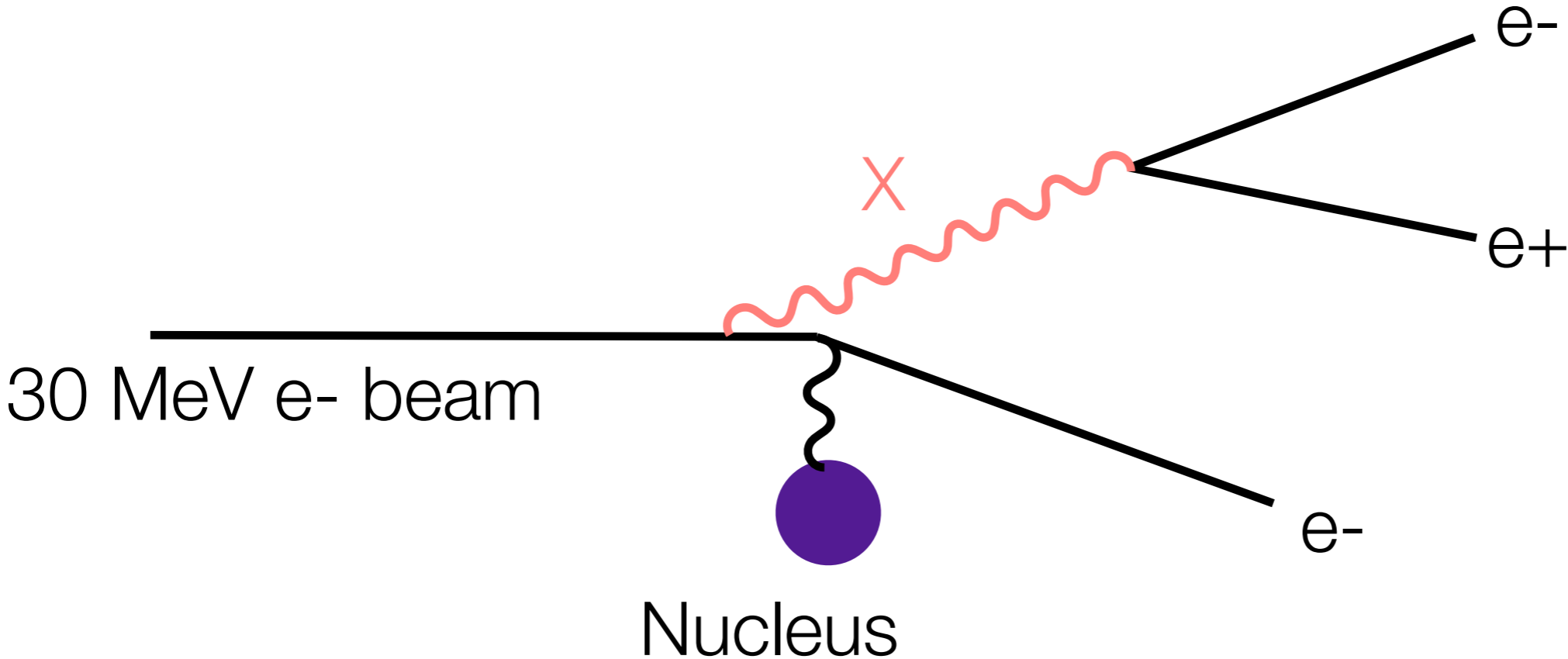


# Resonance searches for new particles



# The DarkLight @ ARIEL experiment

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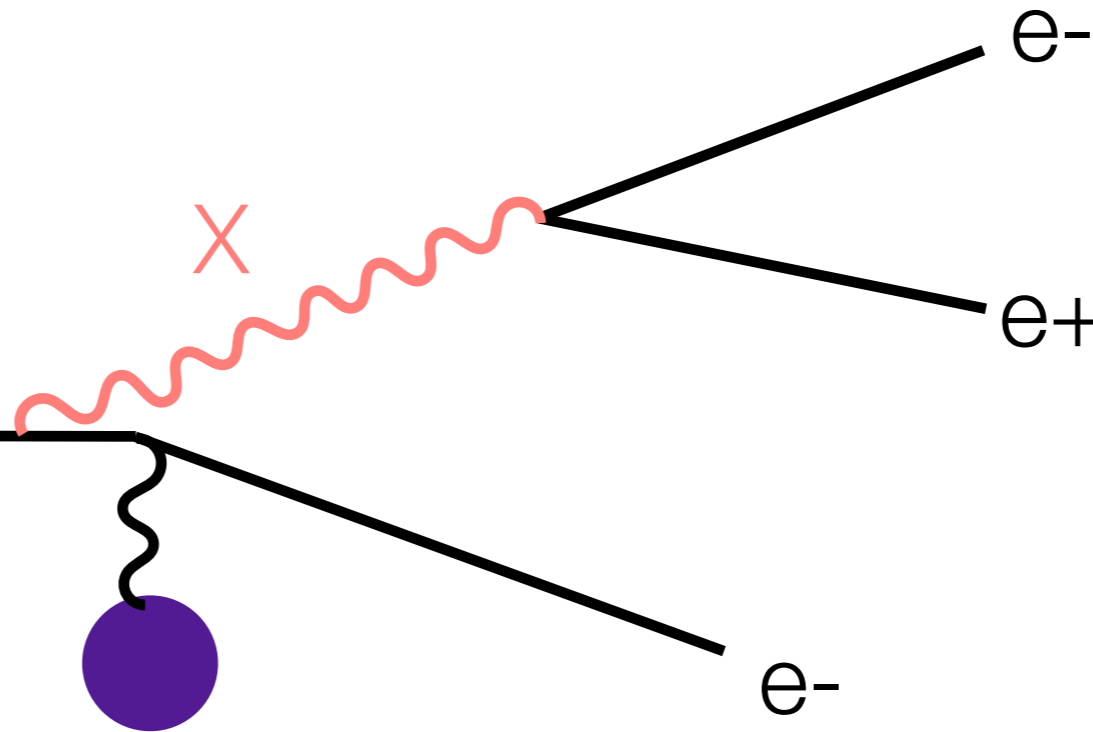
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Moderate energy,  
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from ARIEL e-linac

30 MeV  $e^-$  beam

Nucleus



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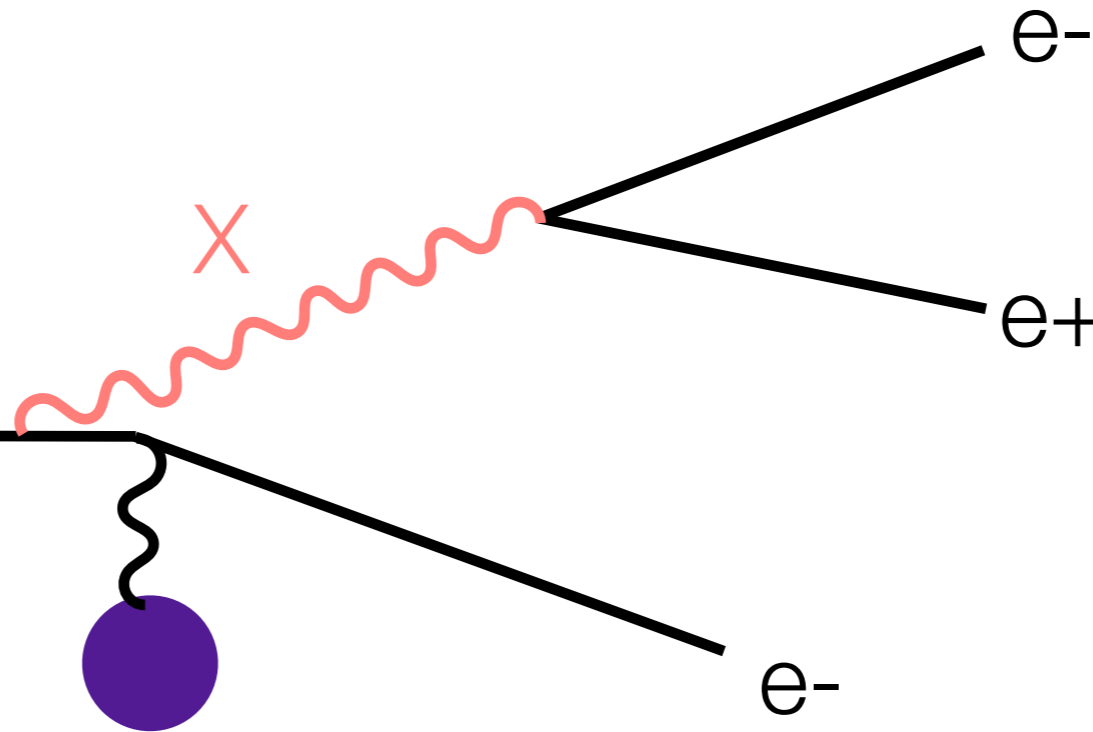
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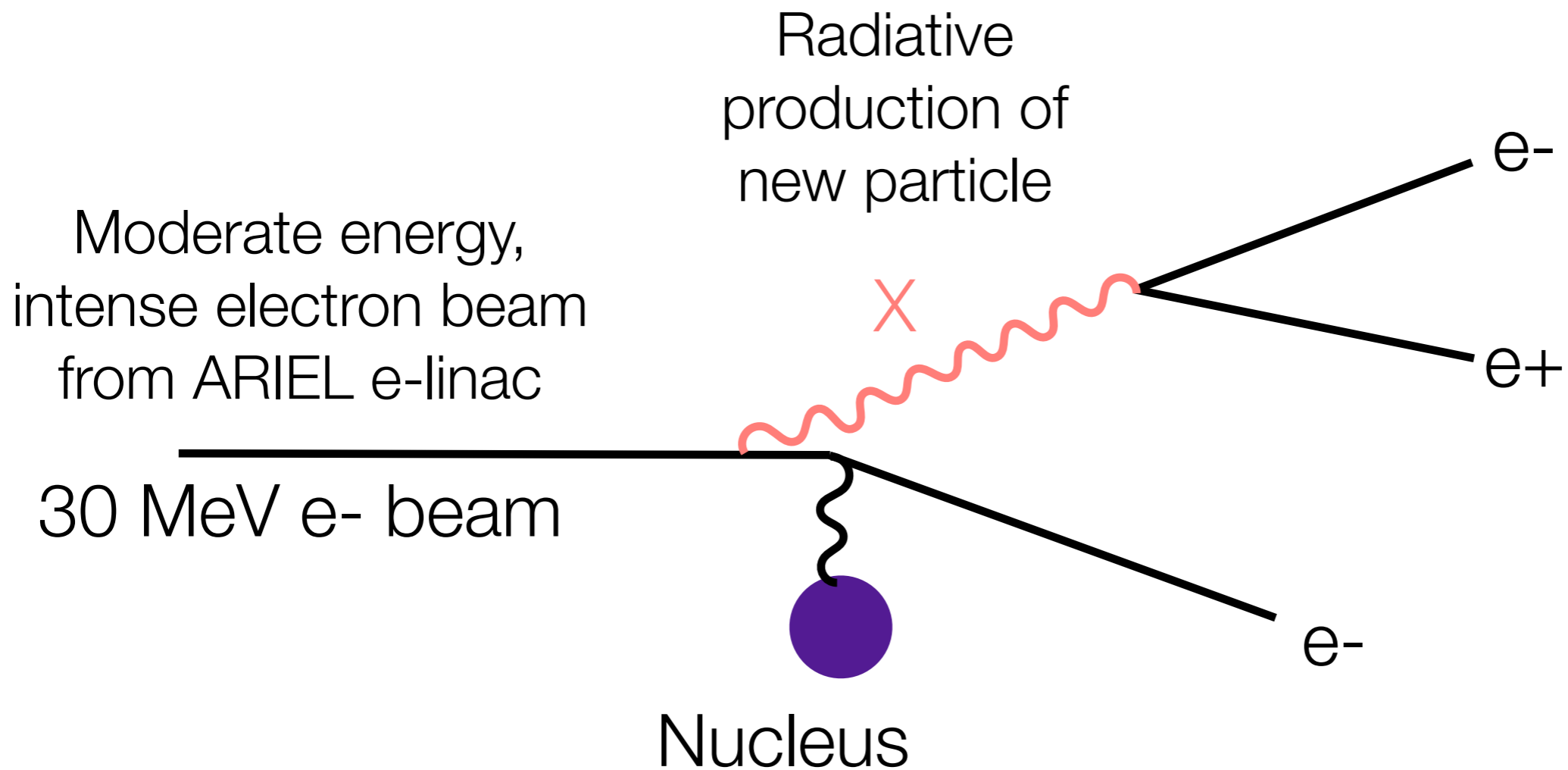
Nucleus

Dense target optimised  
for minimum multiple  
scattering



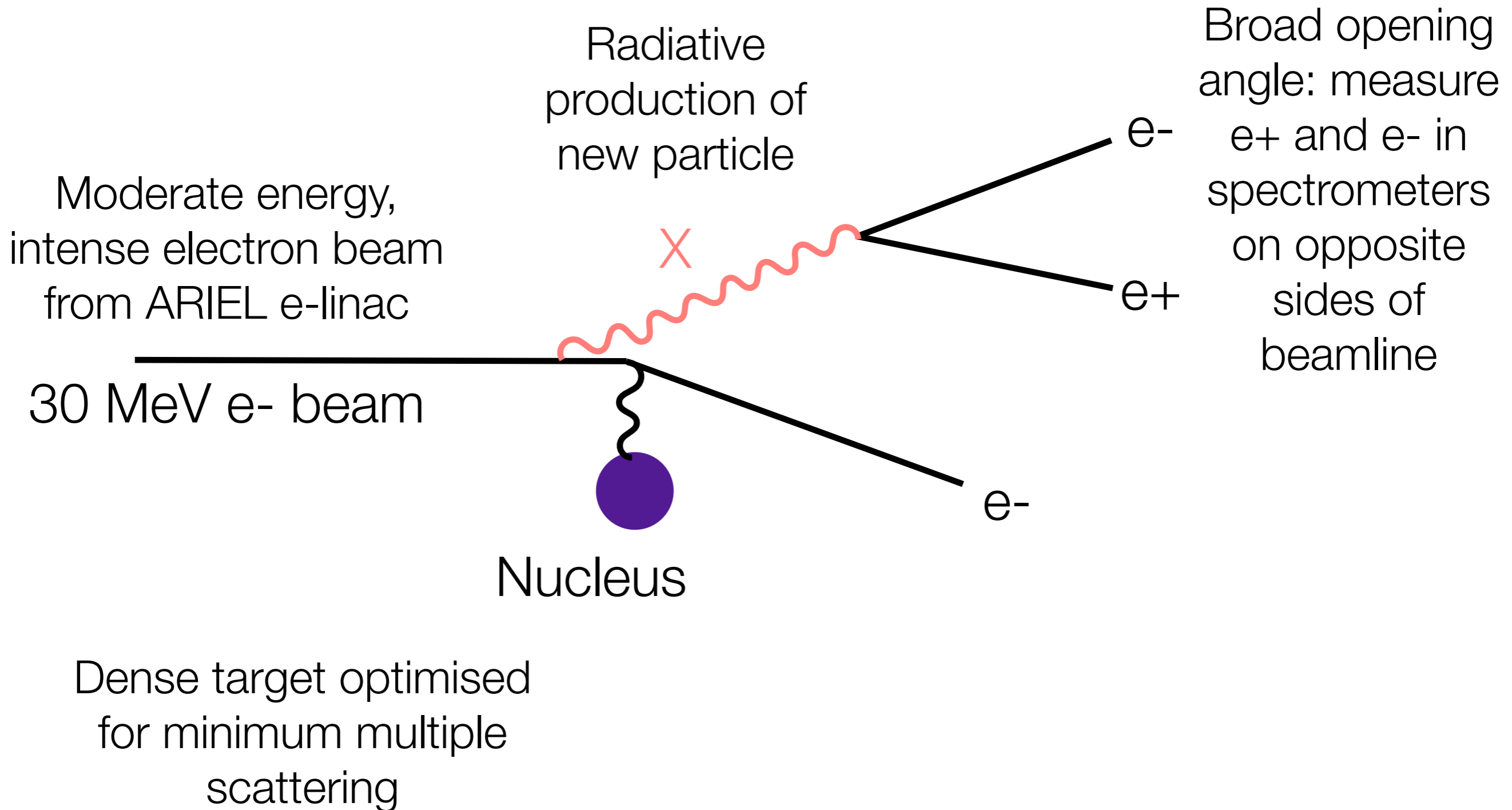
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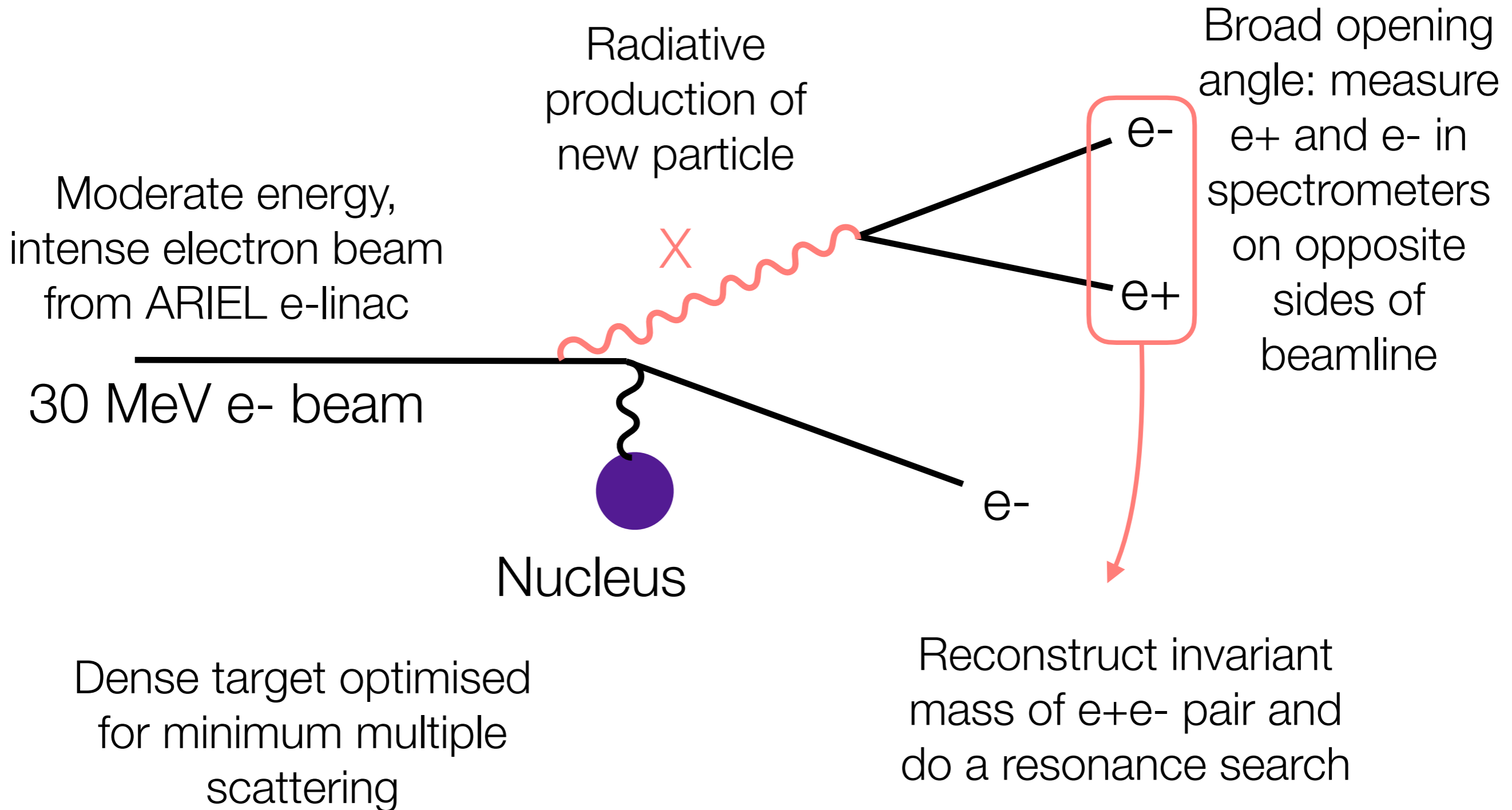


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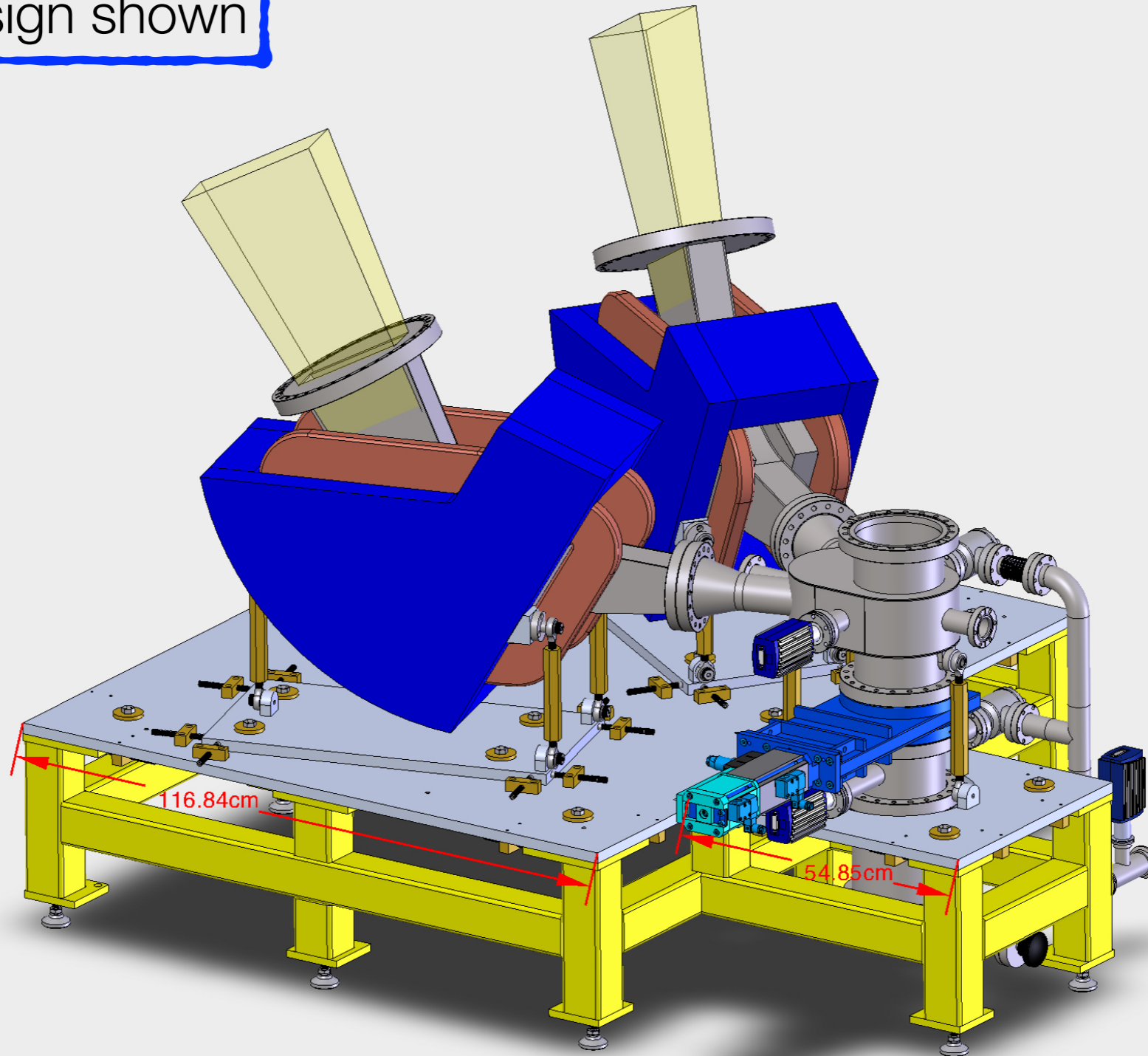


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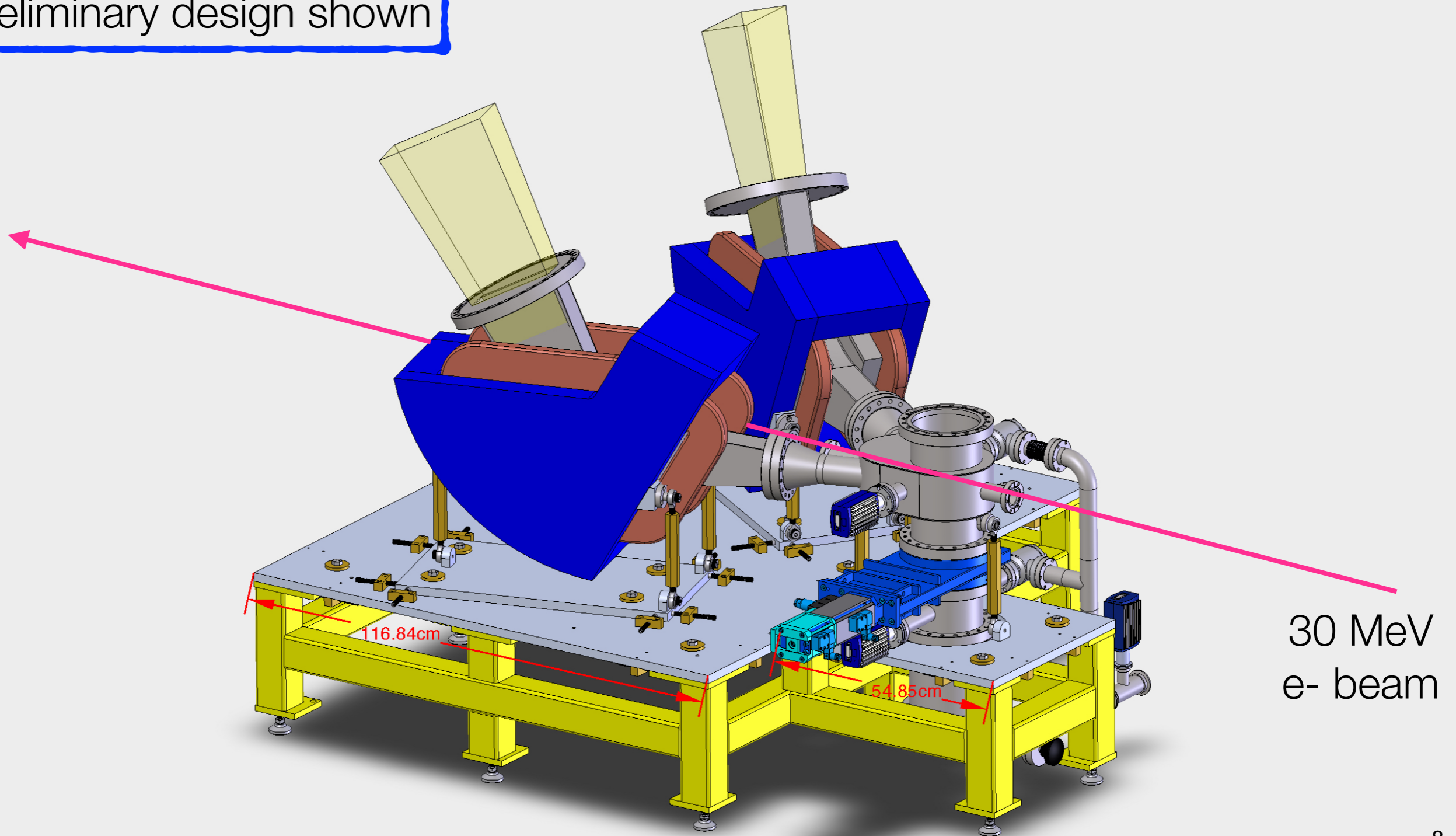
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Preliminary design shown



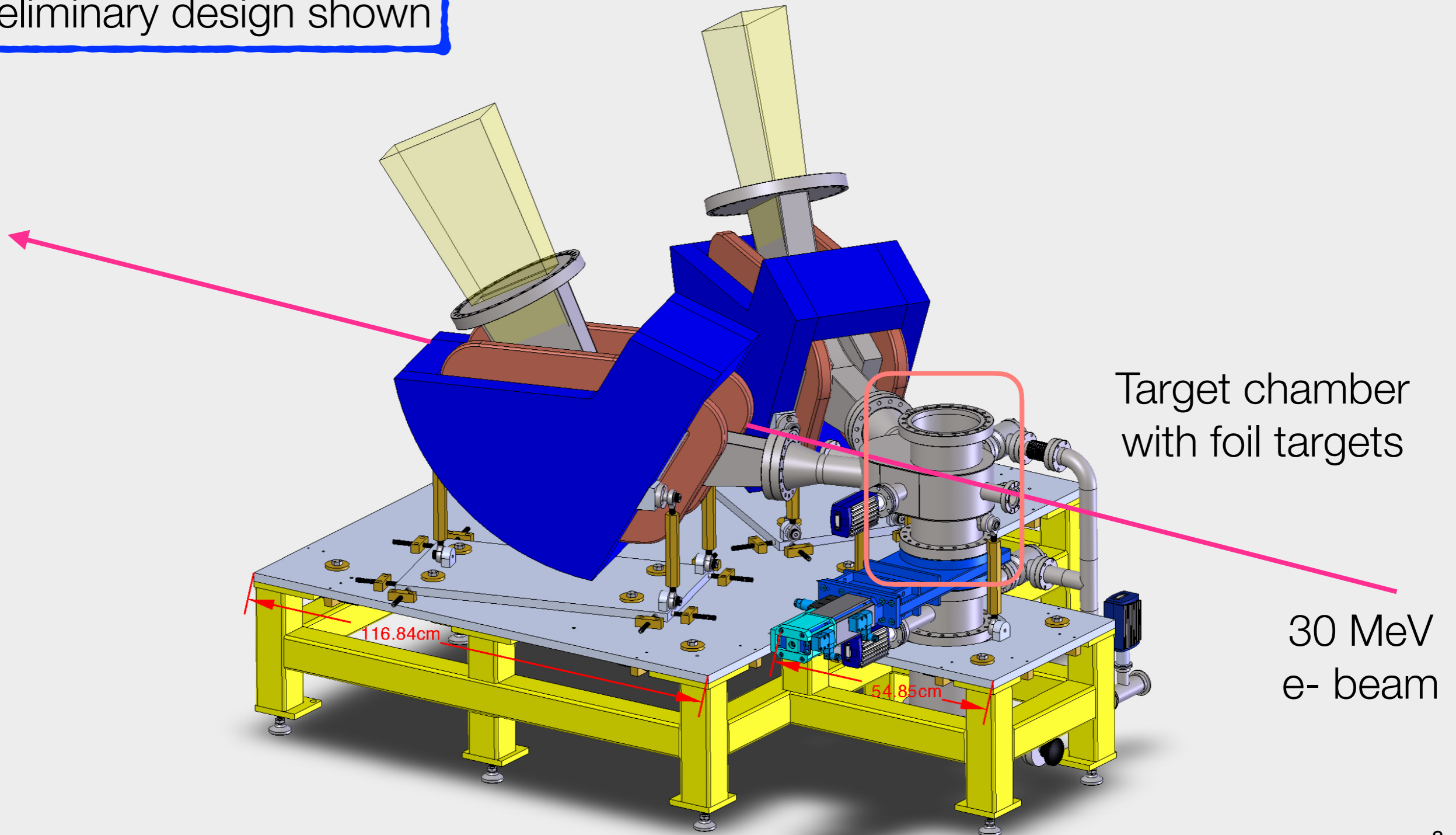
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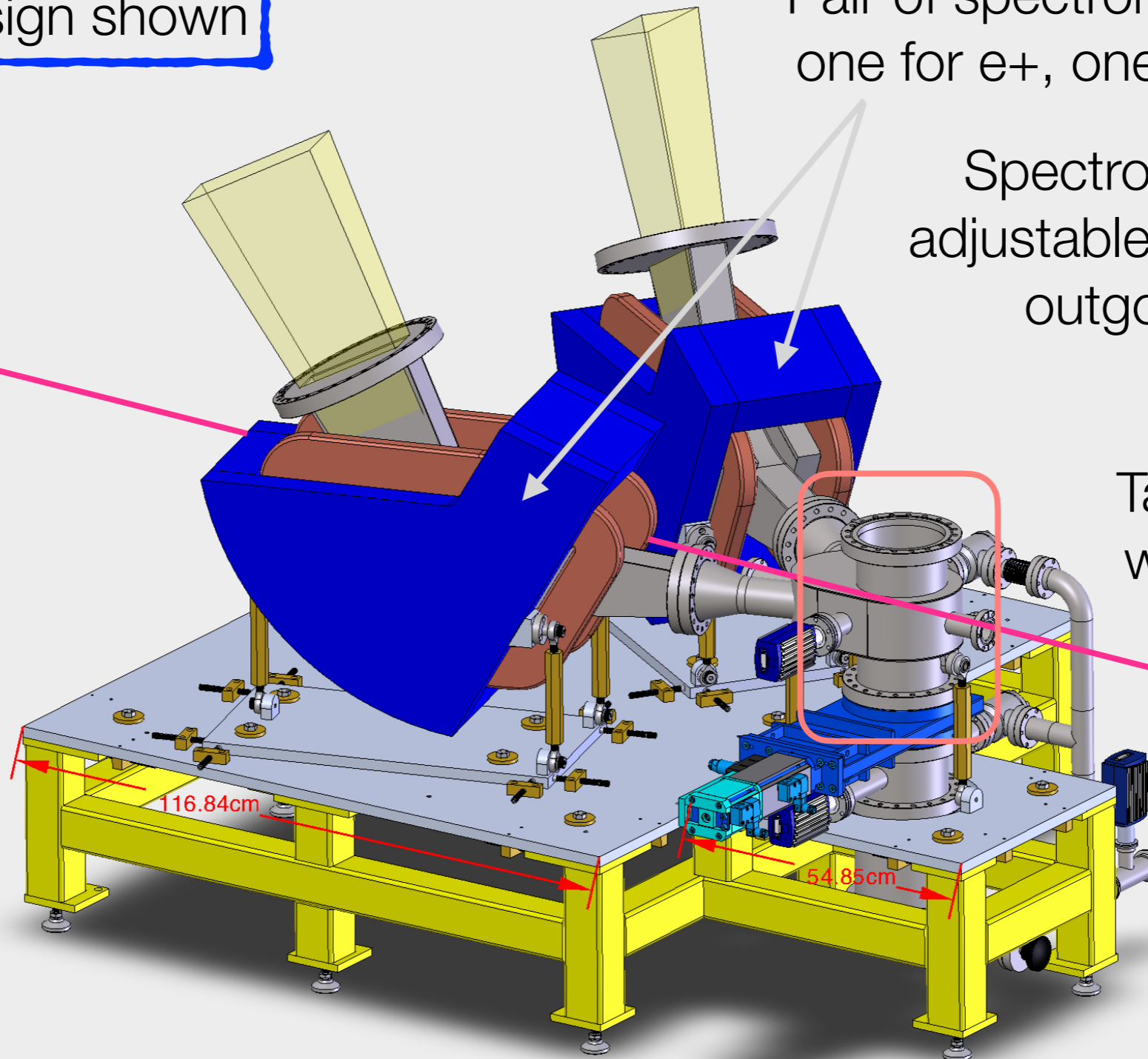
Preliminary design shown

Pair of spectrometers:  
one for  $e^+$ , one for  $e^-$

Spectrometer arms at  
adjustable angles to select  
outgoing leptons

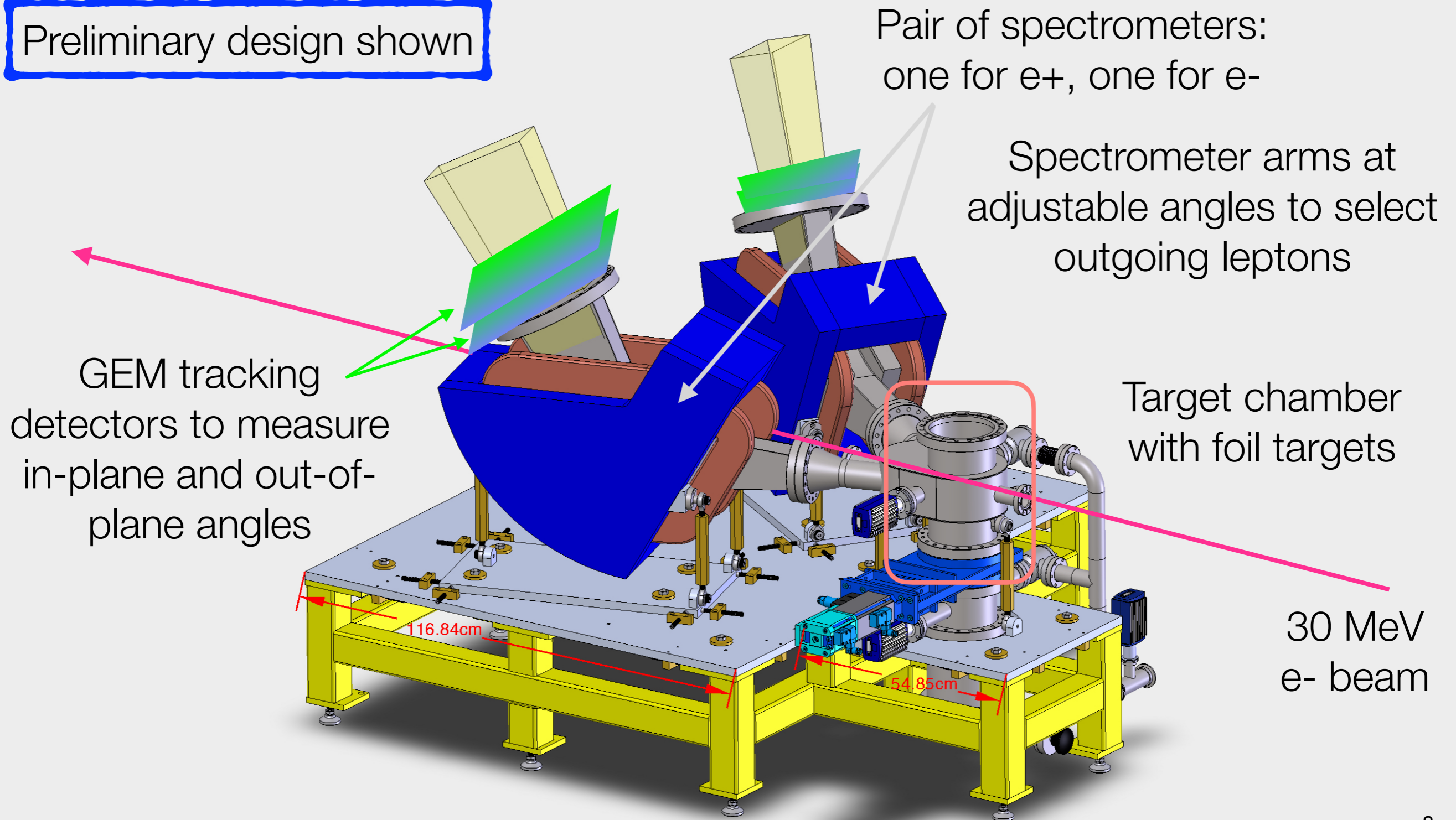
Target chamber  
with foil targets

30 MeV  
 $e^-$  beam



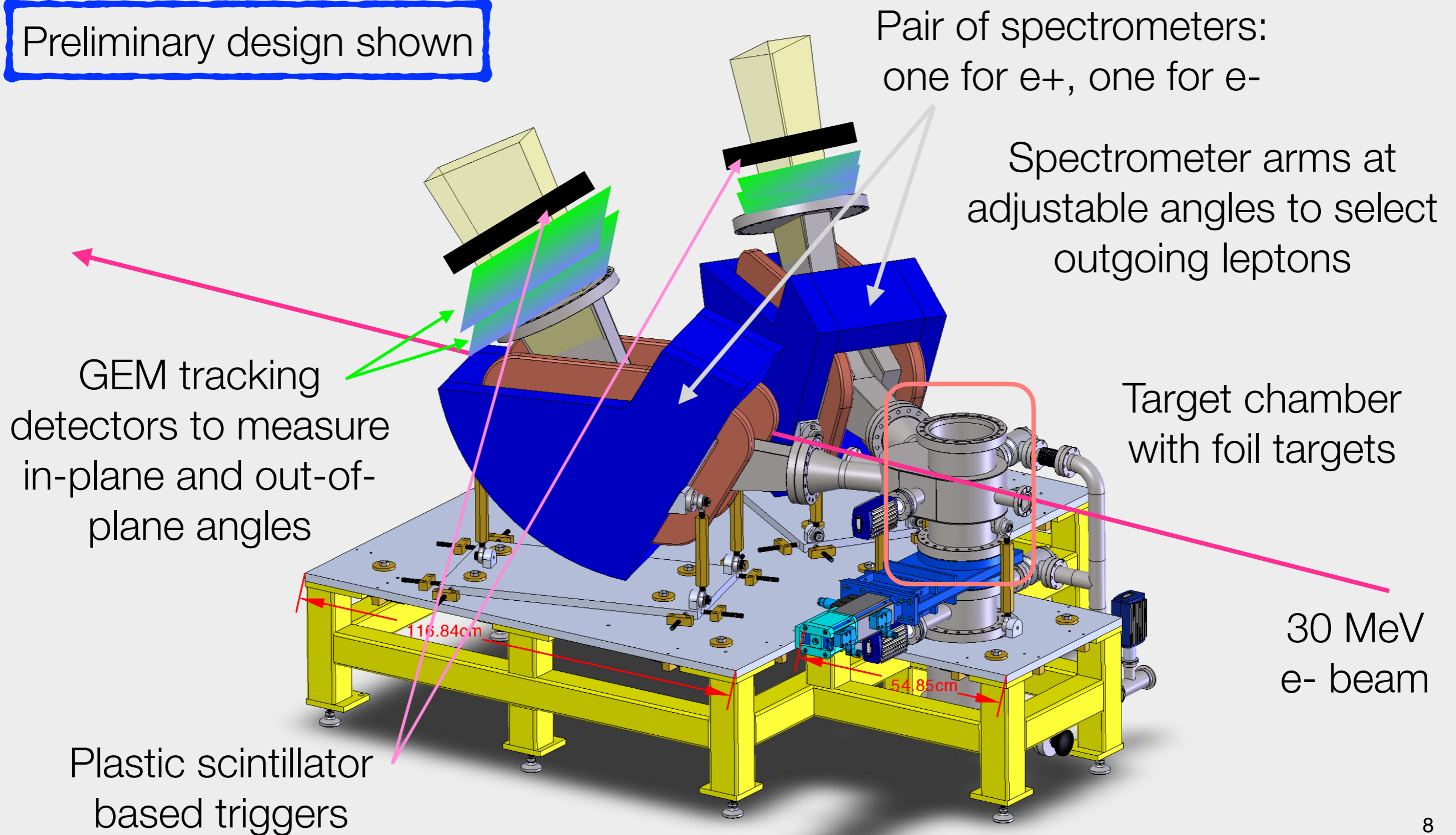
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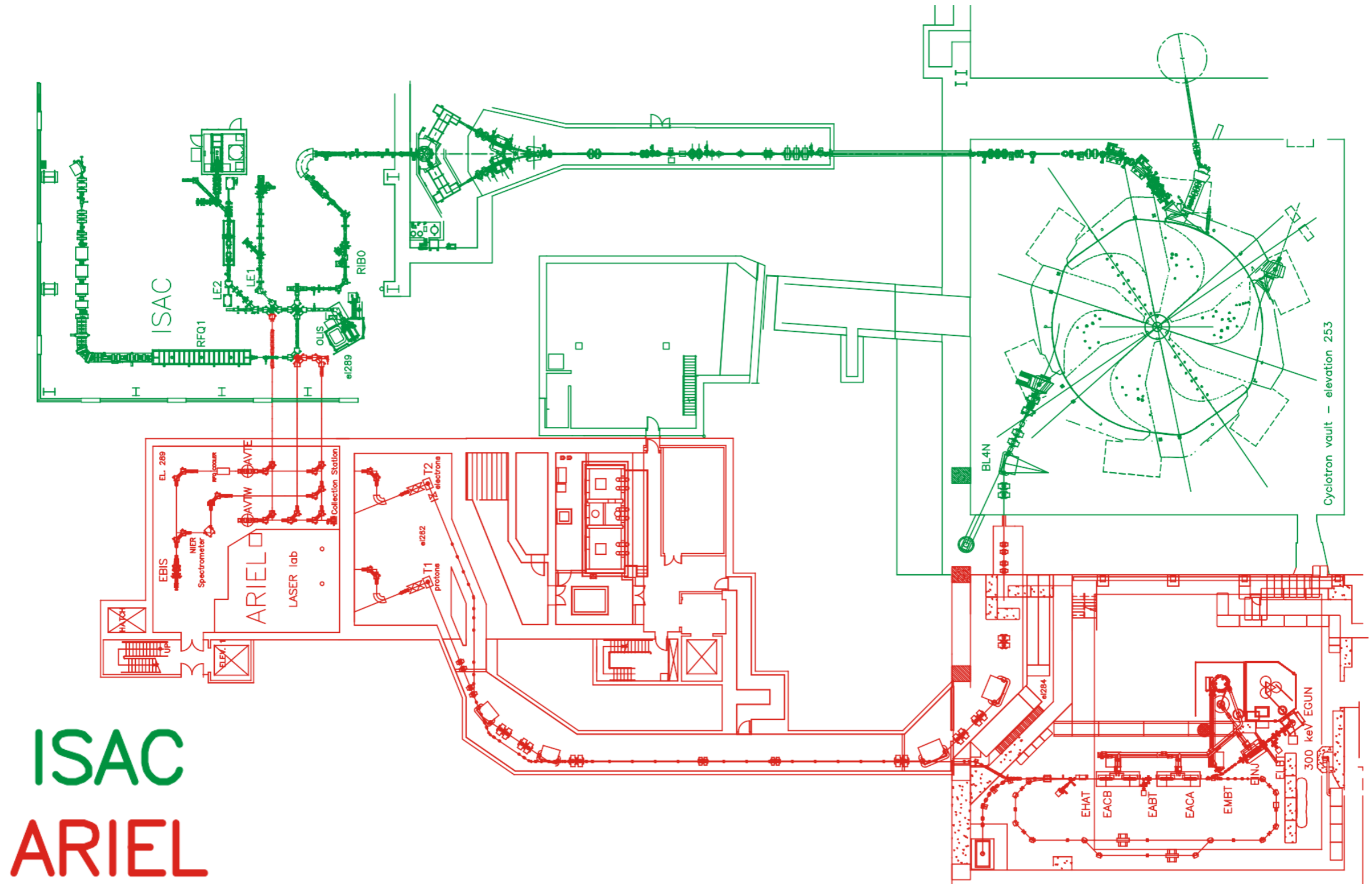


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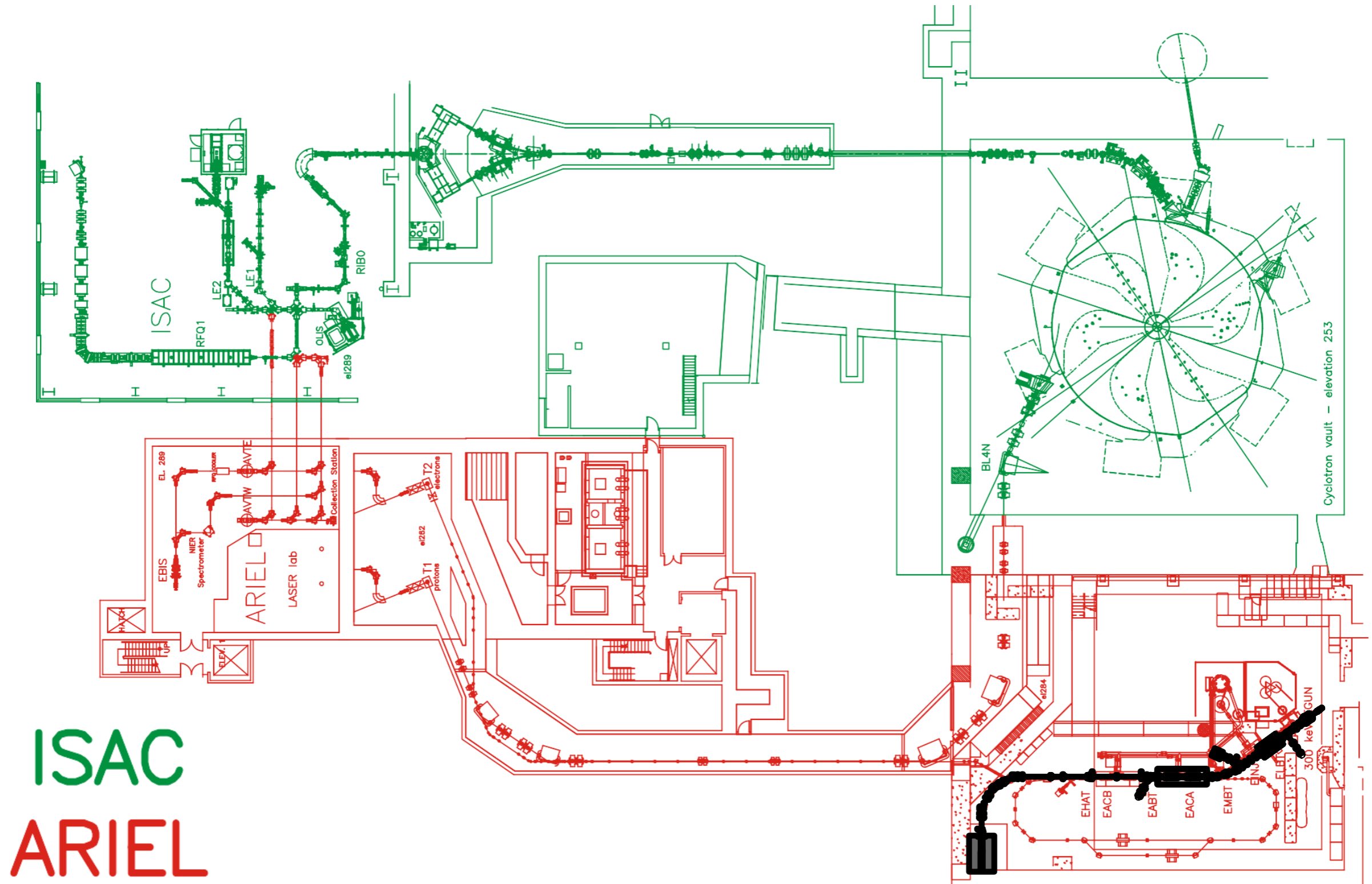
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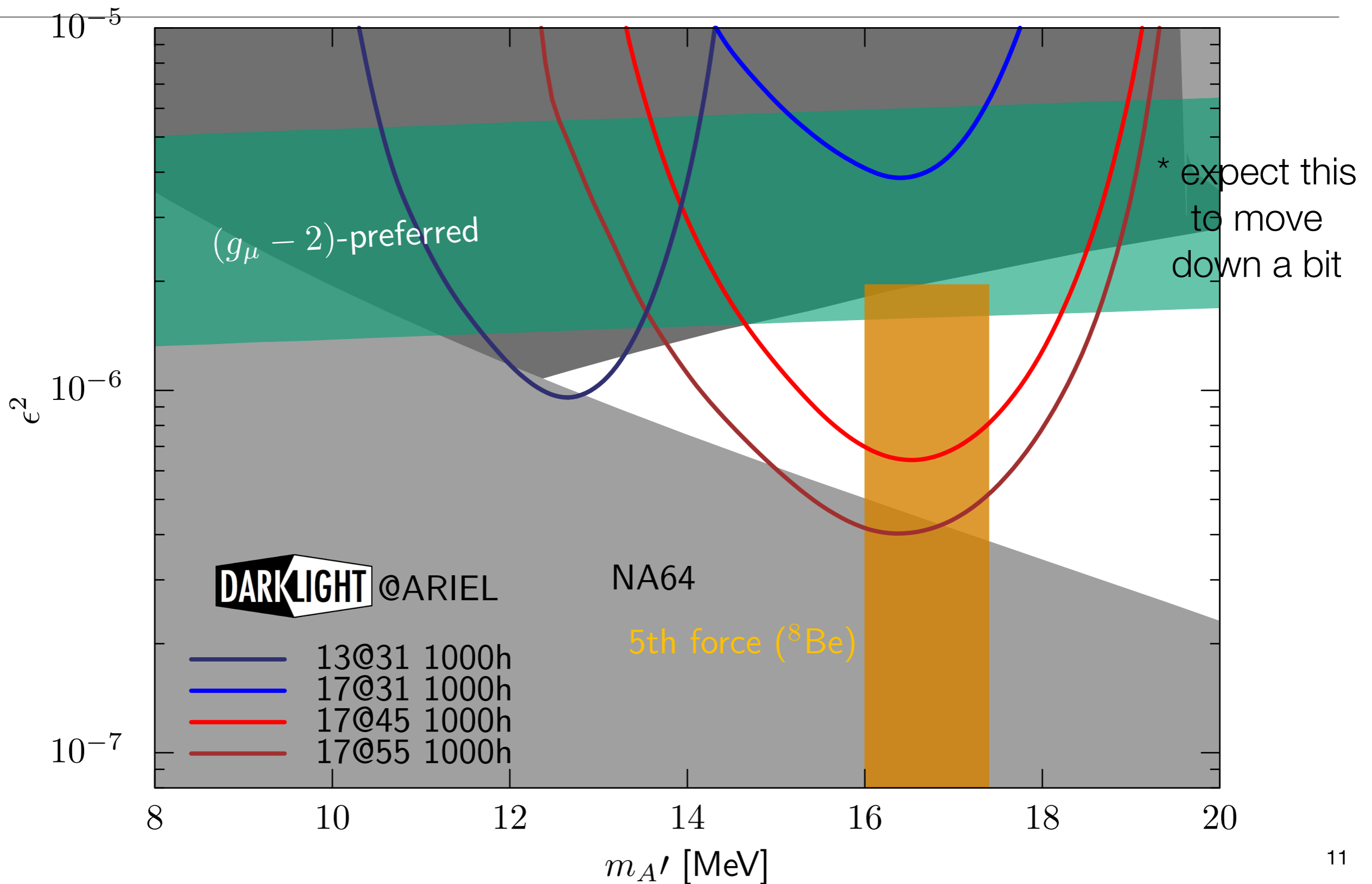
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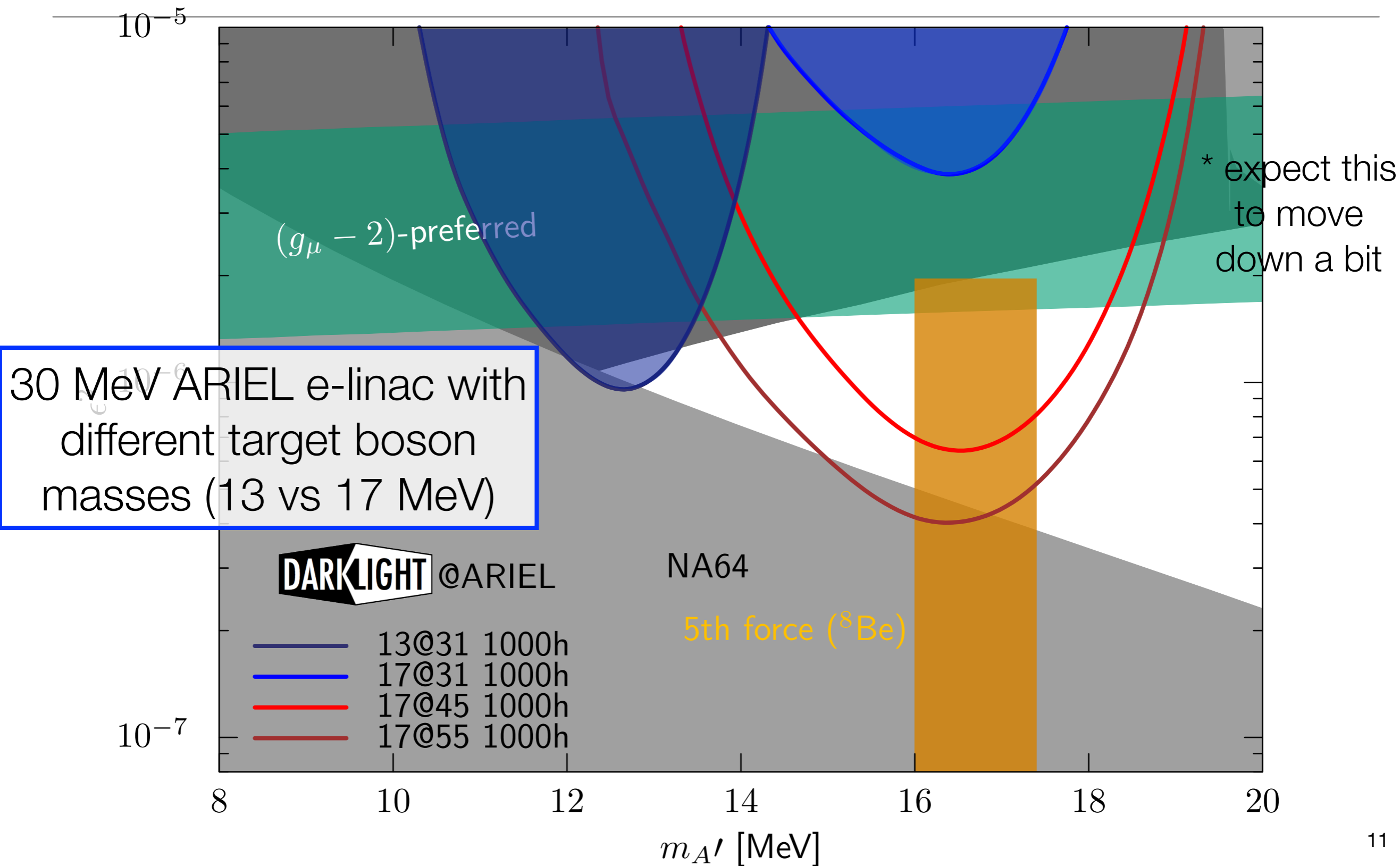
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Planning full experiment for fall/winter 2023!

# Sensitivity at 30 and 50 MeV accelerators

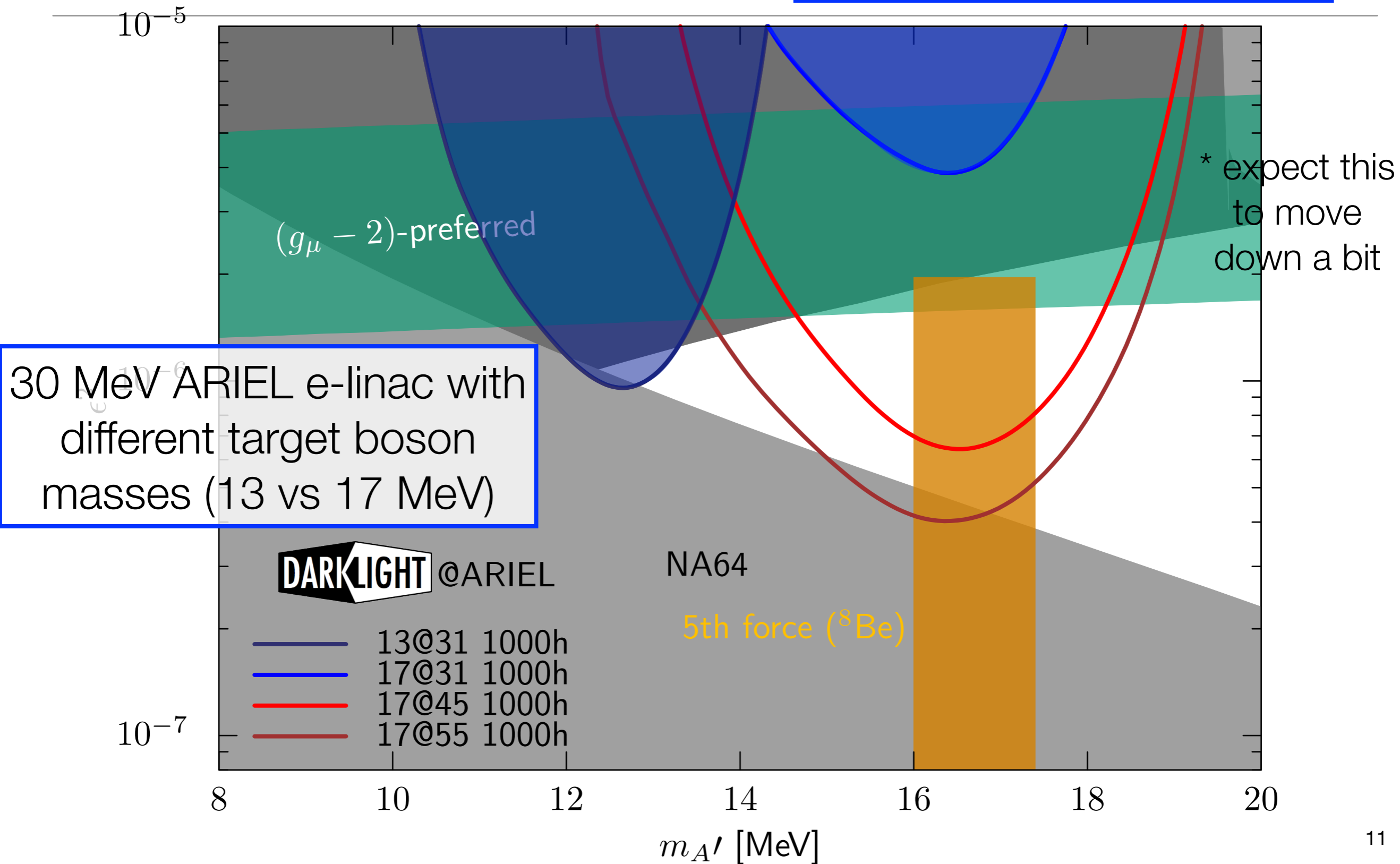


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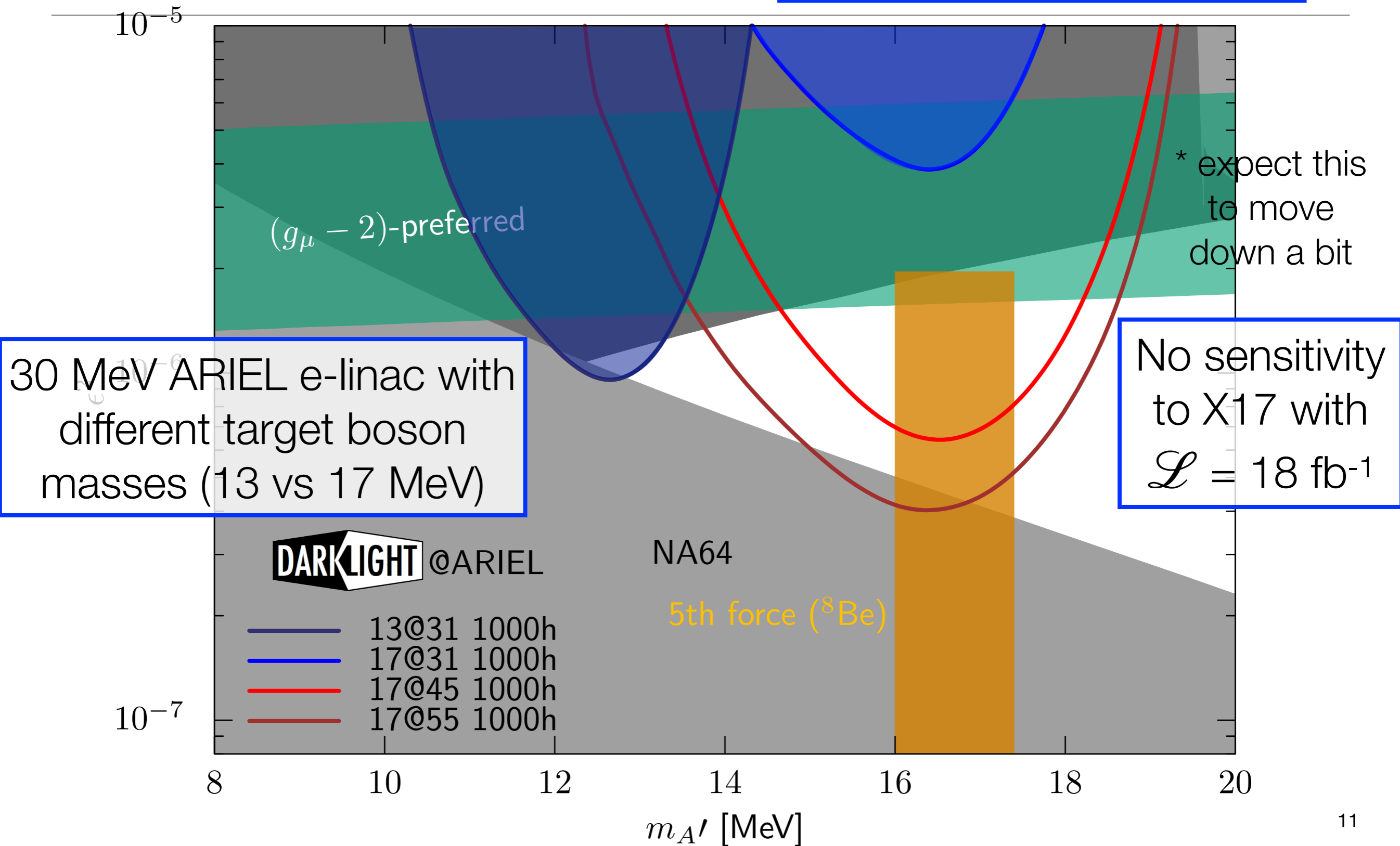
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Overlap with  $g-2$  favoured region is only in already-excluded areas



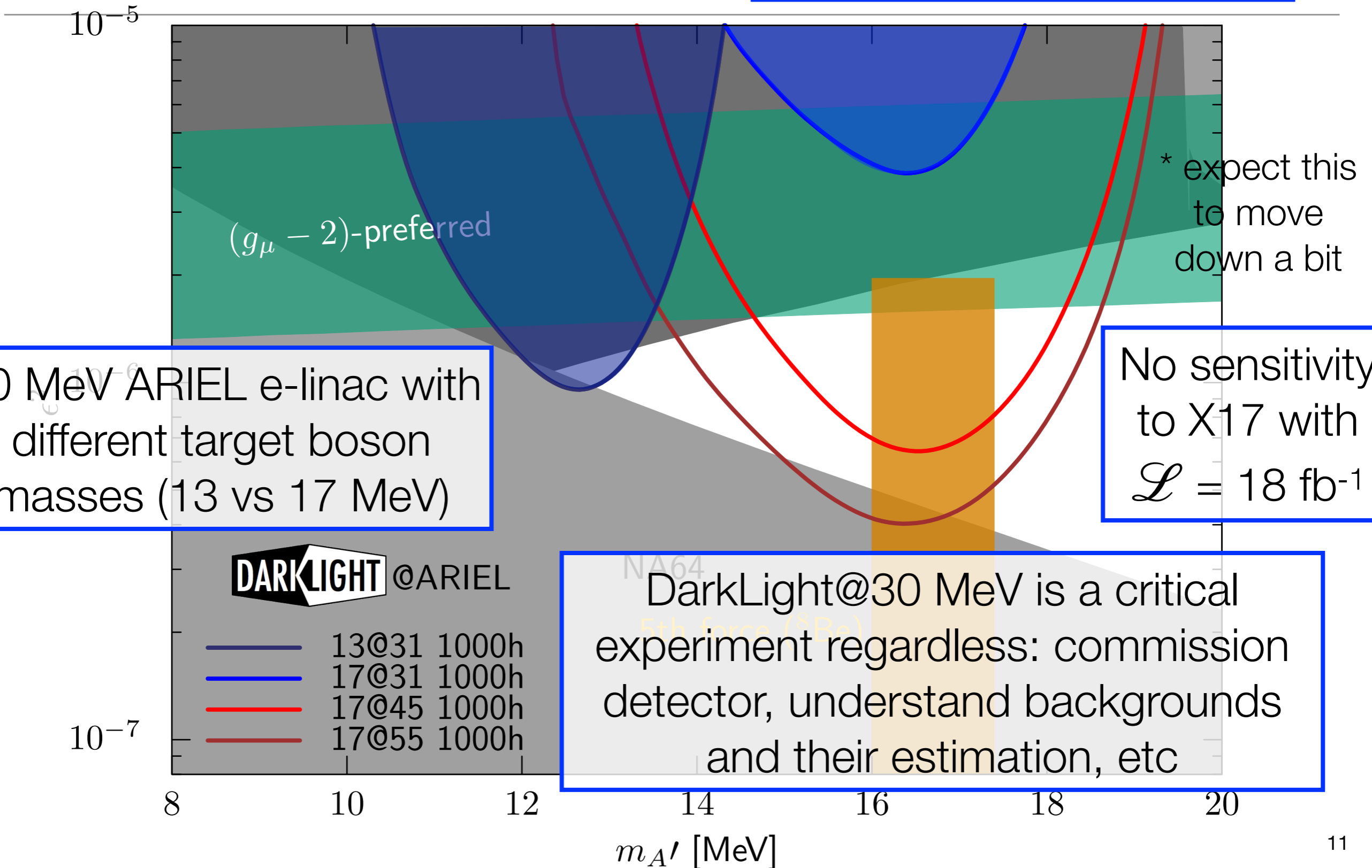
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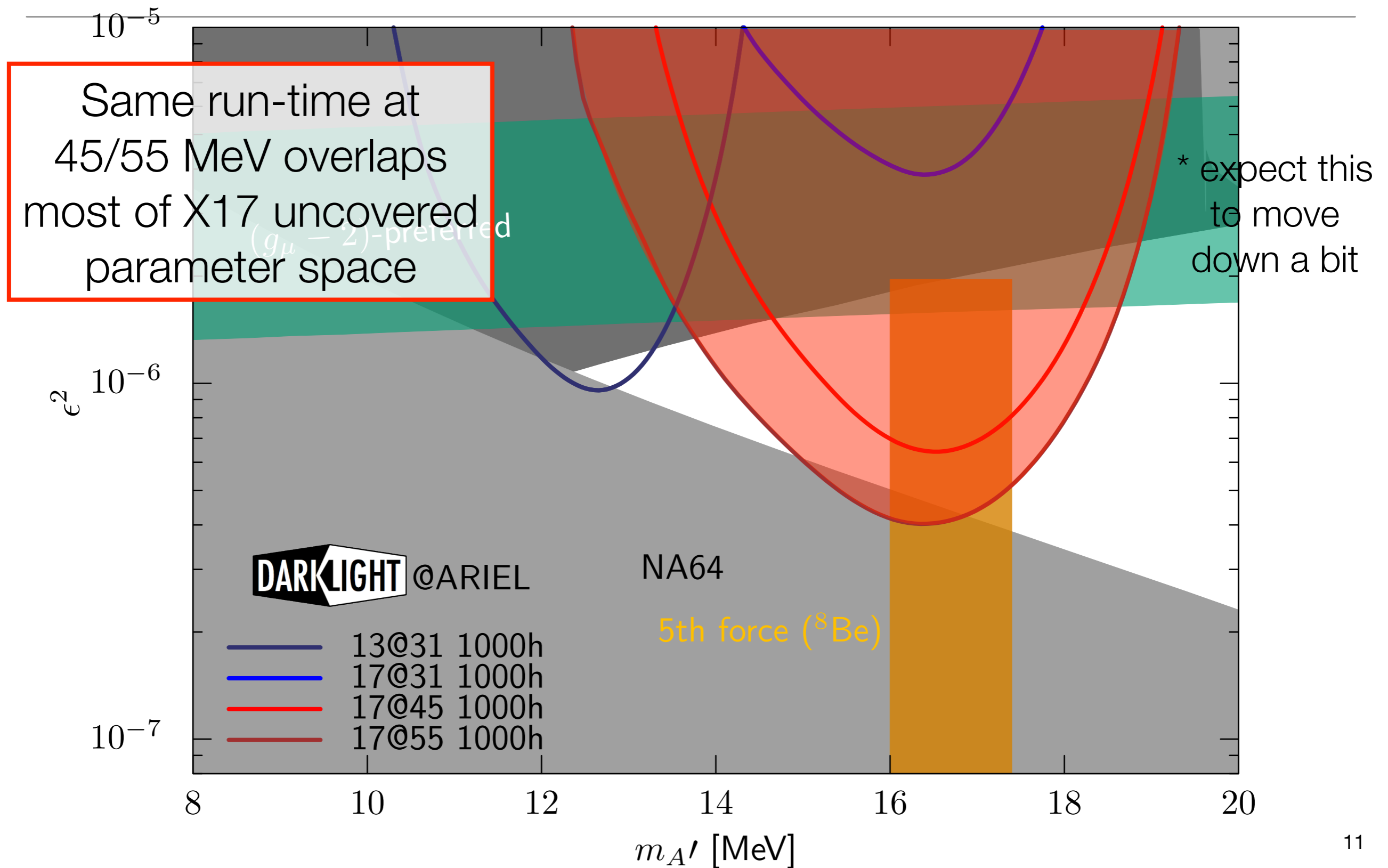


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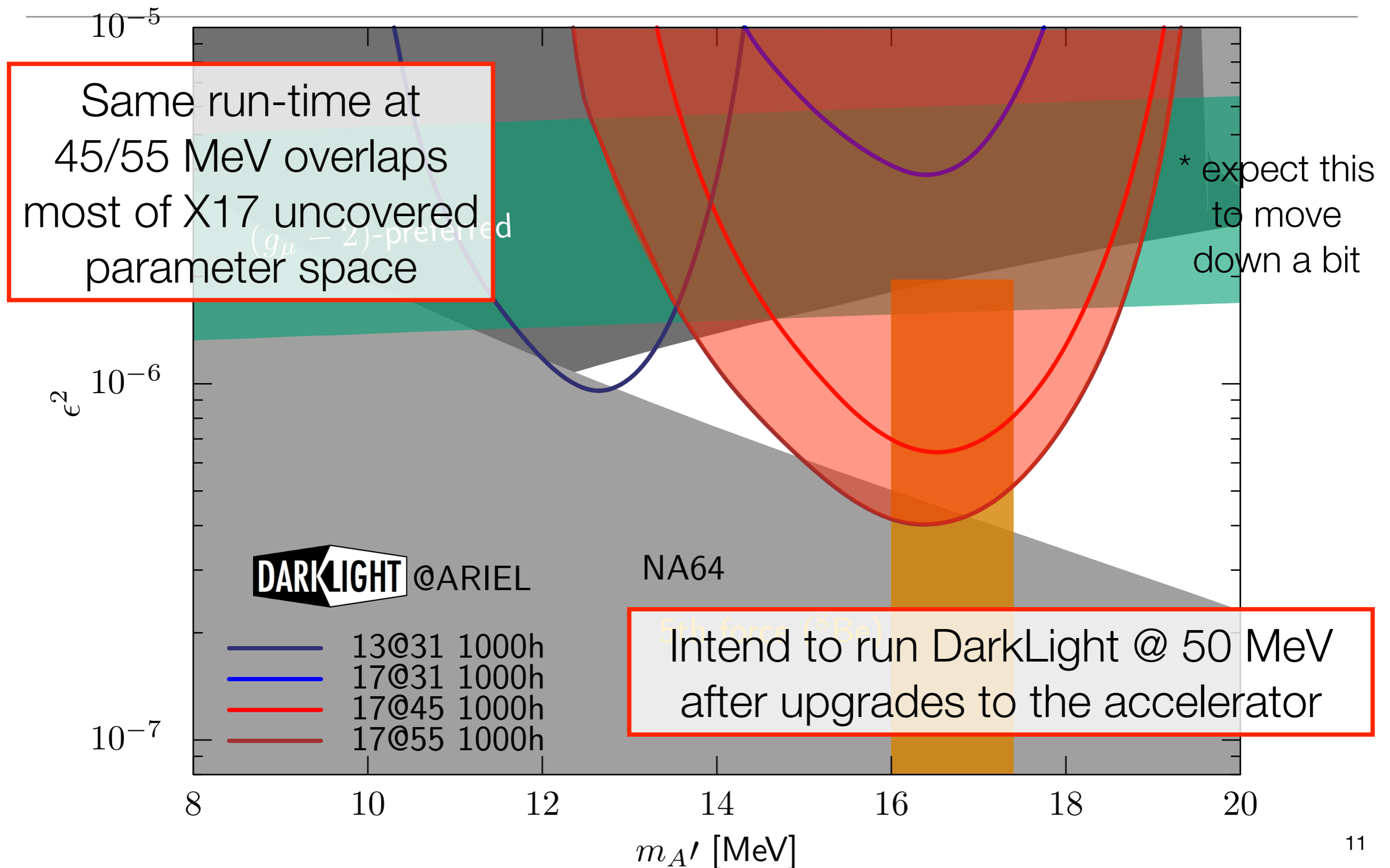
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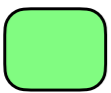


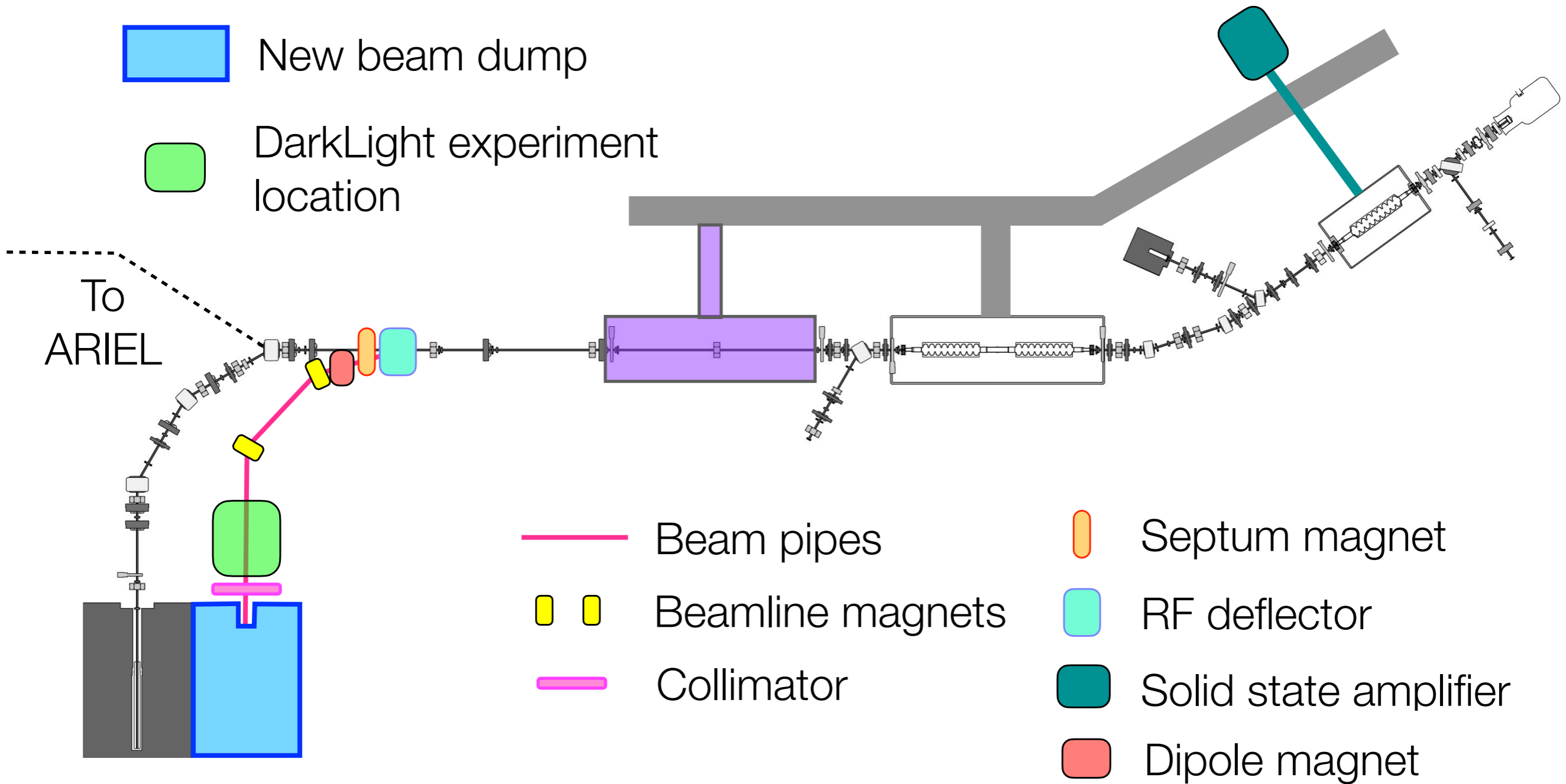
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# Running at 50 MeV

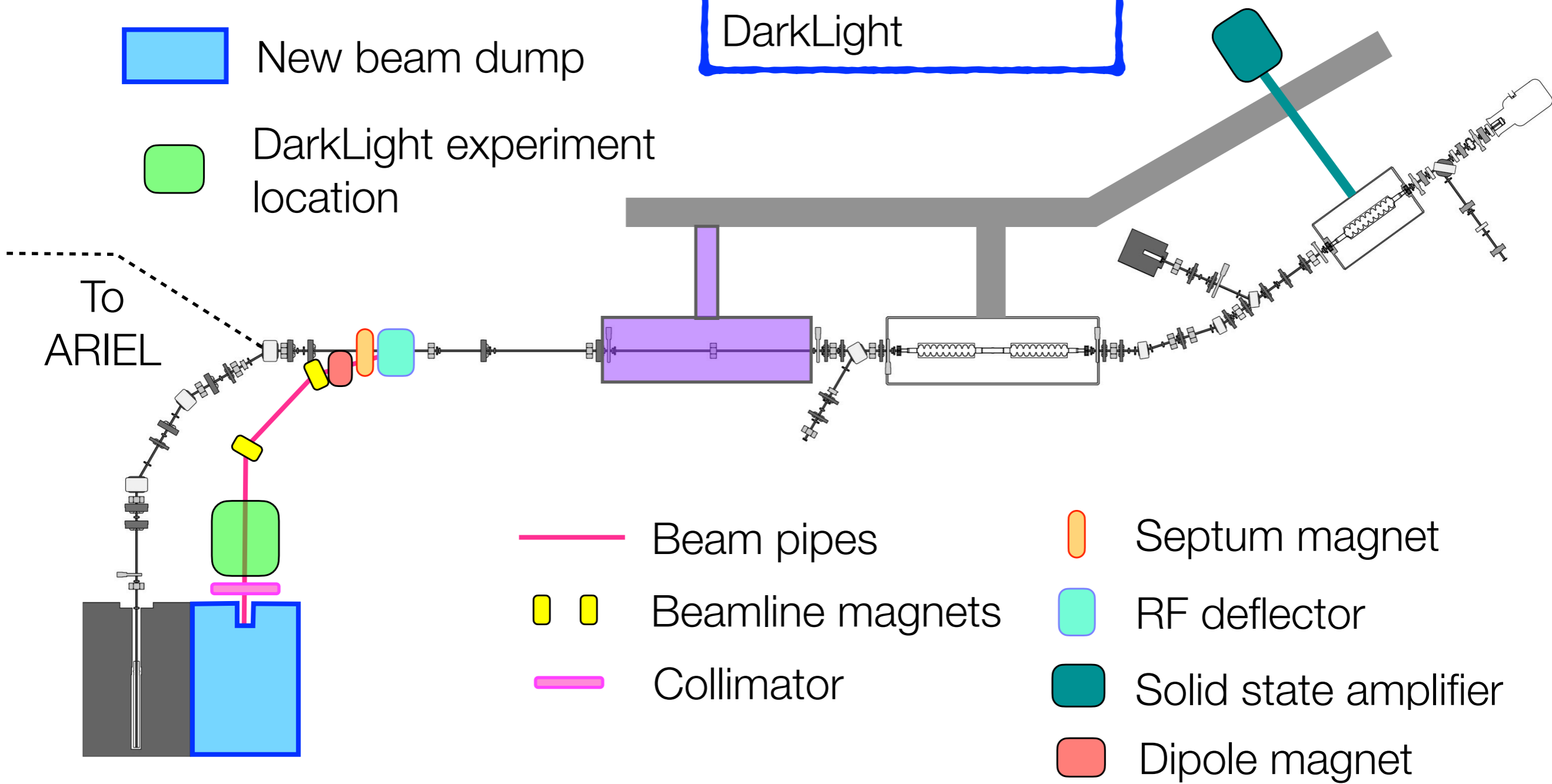
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-  New beam dump
-  DarkLight experiment location



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Alternating bunches sent to ARIEL, DarkLight

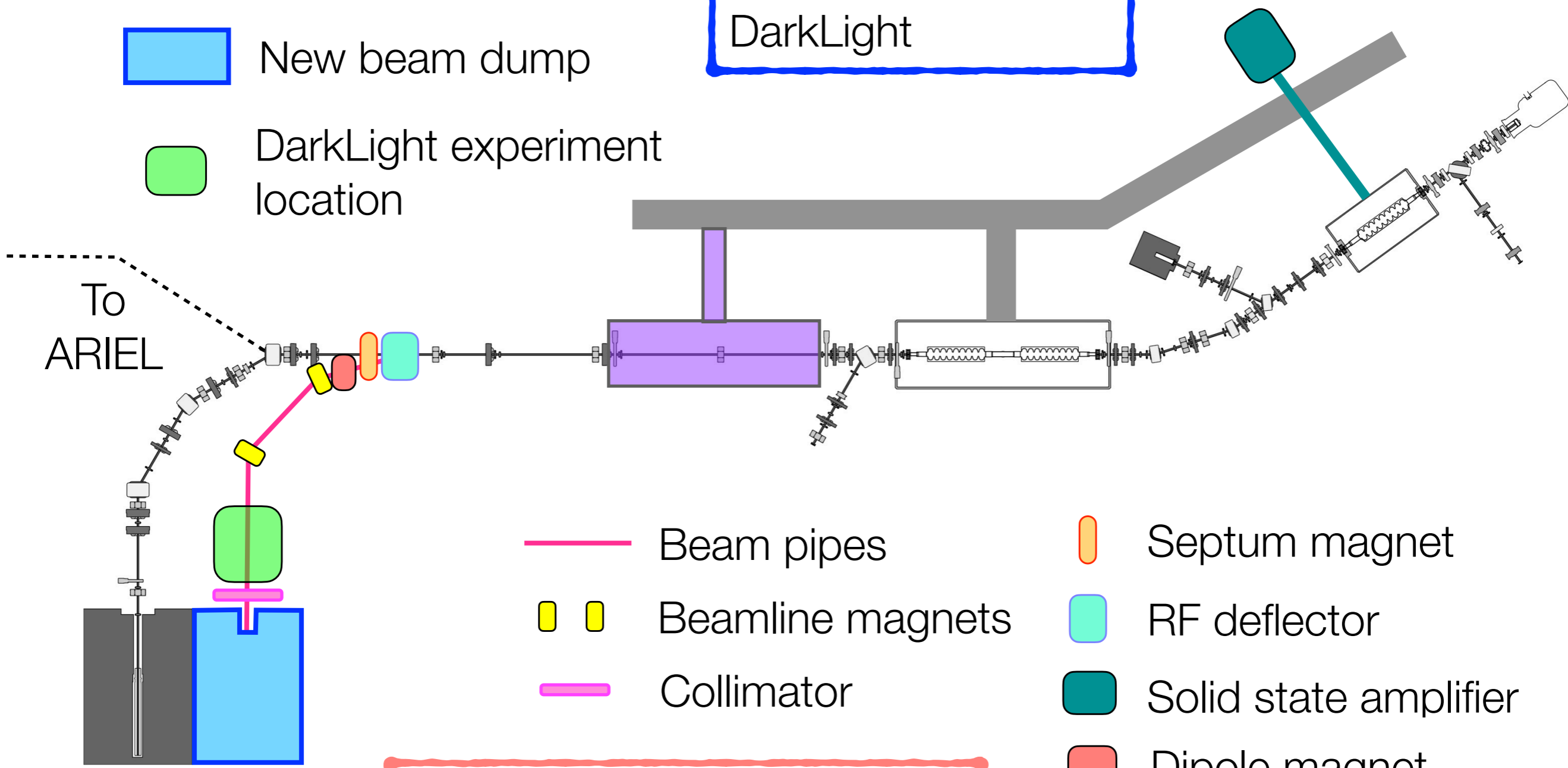


- Beam pipes
- Beamline magnets
- Collimator
- Septum magnet
- RF deflector
- Solid state amplifier
- Dipole magnet

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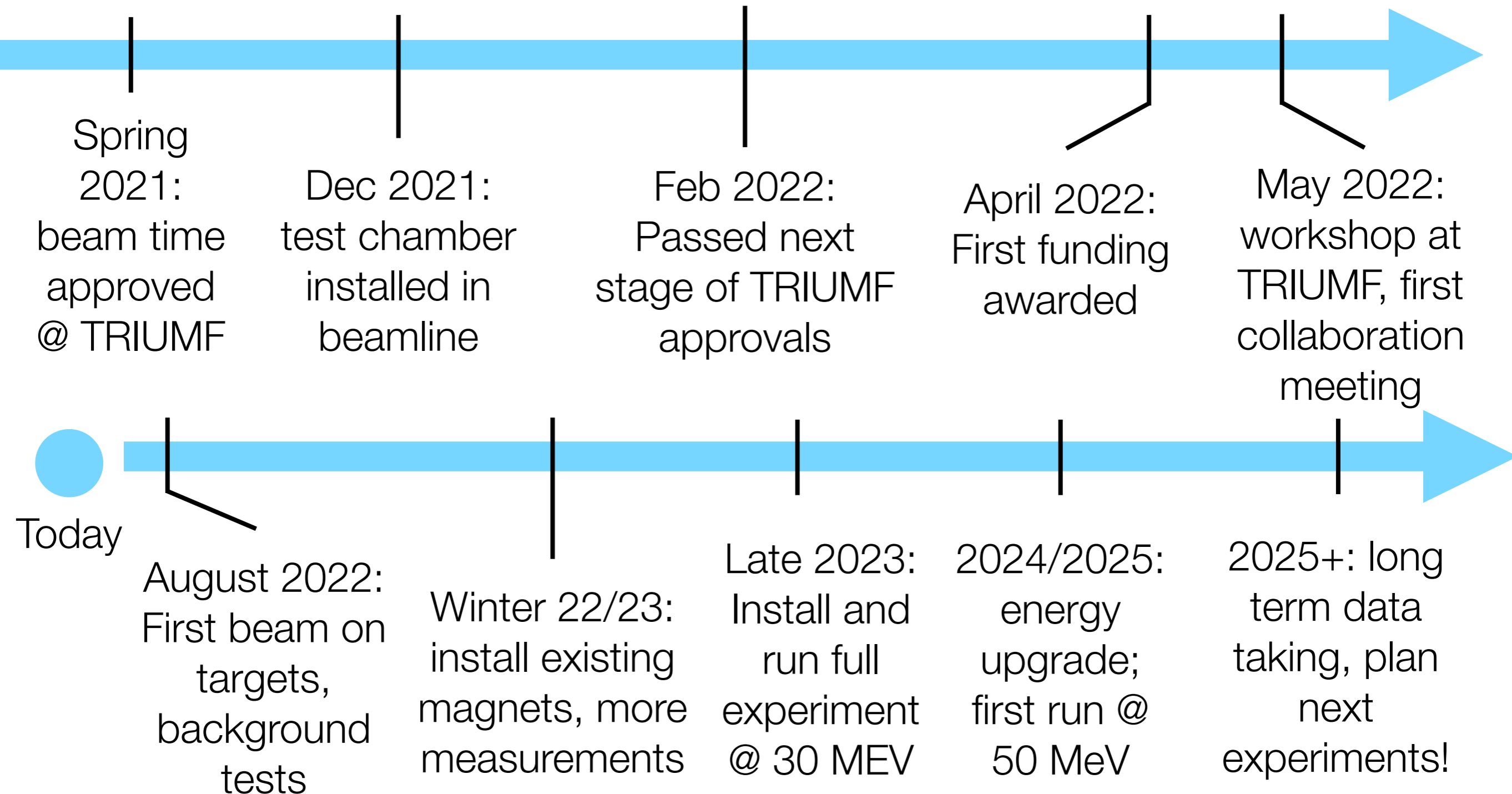
Alternating bunches sent to ARIEL, DarkLight



New experiments can run at dump after DarkLight ends

- Septum magnet
- RF deflector
- Solid state amplifier
- Dipole magnet

# Roadmap



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We're excited for new science results and  
opportunities **here at TRIUMF!**

Thank you!

# Collaboration

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**Arizona State University, Tempe, AZ, USA**

**University of British Columbia, Canada**

**Hampton University, Hampton, VA, USA**

**TJNAF, Newport News, VA, USA**

**Massachusetts Institute of Technology, Cambridge, MA, USA**

**St. Mary's University, Halifax, Nova Scotia, Canada**

**Stony Brook University, NY, USA**

**TRIUMF, Vancouver, British Columbia, Canada**

**University of Manitoba, Canada**

**University of Winnipeg, Manitoba, Canada**

