

# Beyond the Standard Model Research at Jefferson Lab: The DarkLight Experiment Status<sup>1</sup>

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Jefferson Lab (JLab)

On behalf of the DarkLight Participants

July 18, 2012

8<sup>th</sup> Patras Workshop on Axions, WIMPs and WISPs

Chicago and Fermilab, USA

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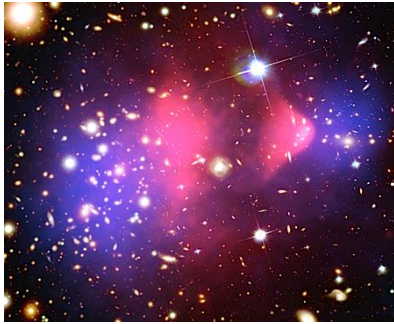
[www.jlab.org](http://www.jlab.org)

J.R. Boyce. 8<sup>th</sup> Patras Workshop. Chicago IL, July 18, 2012. Slide 1

[boyce@jlab.org](mailto:boyce@jlab.org)

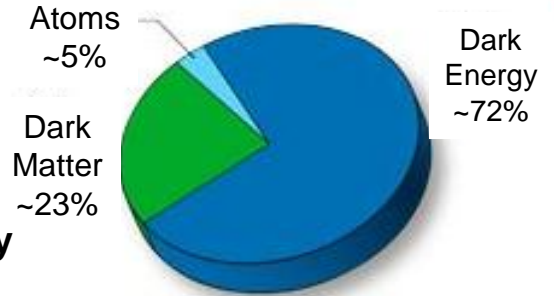
# Outline

- Background
- DarkLight – The Basic Concept
- Participants
- Proposals – PAC 37, PAC 39
- Detector/Experiment System
- Background Radiation Measurements
- e-beam/target Test Experiments
- Possible Timeline
- Acknowledgements
- References



# Astronomical Observations:

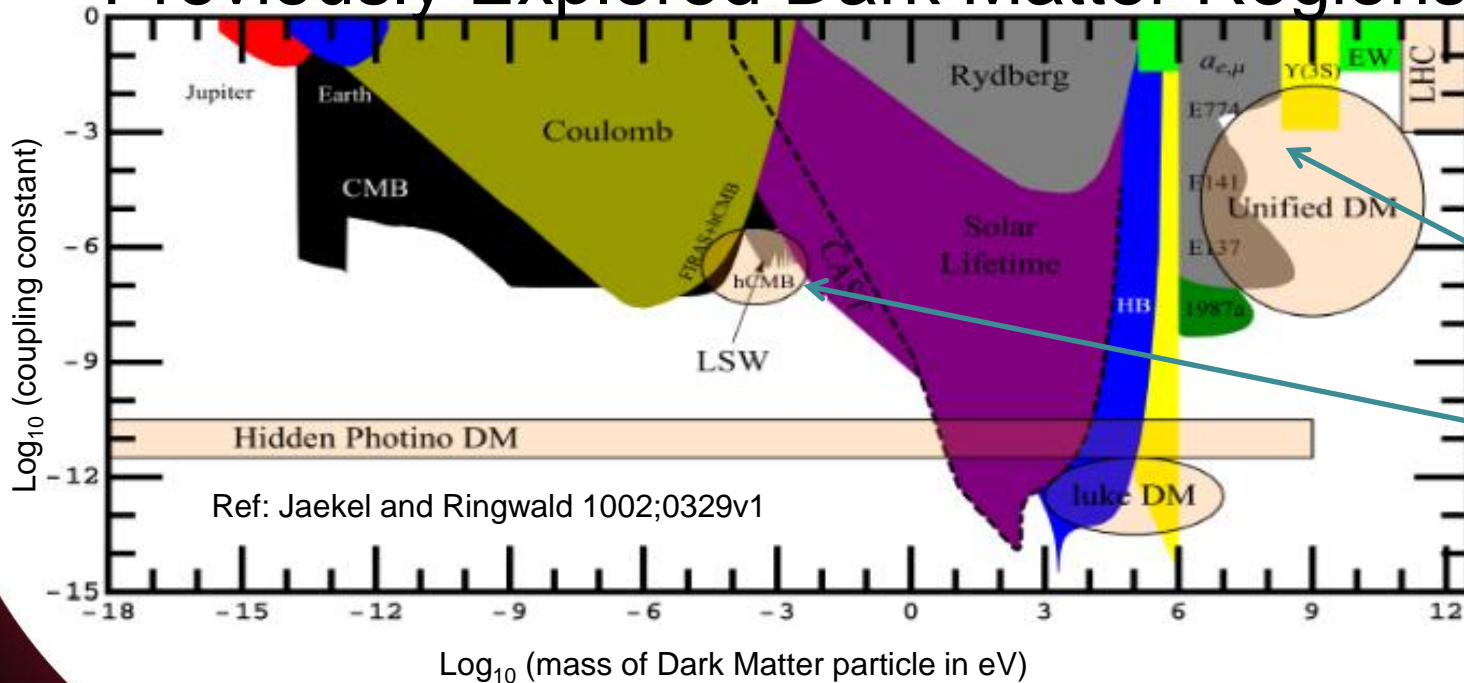
Galaxy rotation implies **Dark Matter**  
 Universe expansion rate implies **Dark Energy**



Bullet Nebula: blue is Dark Matter

Our Universe's composition

## Previously Explored Dark Matter Regions

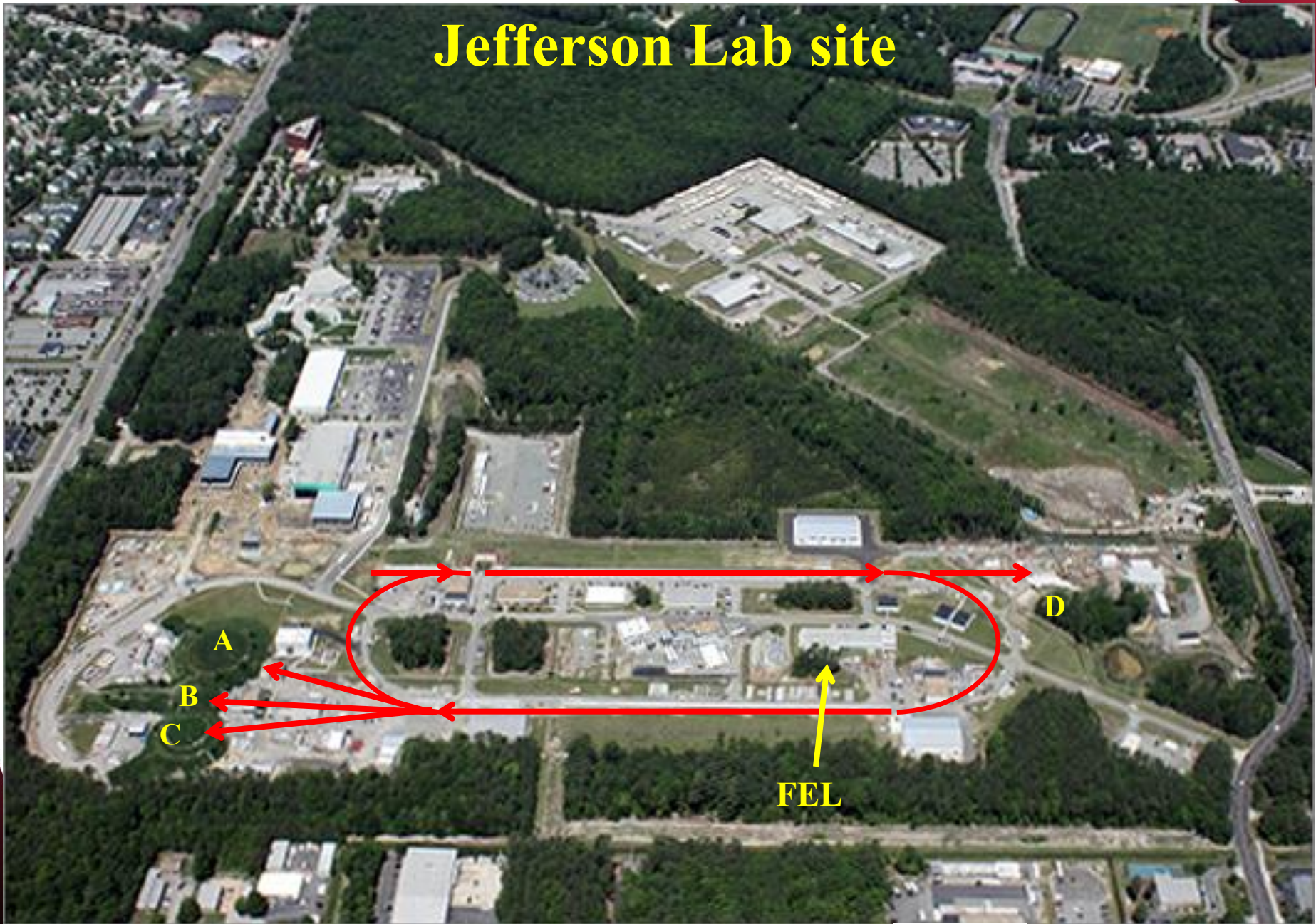


**JLAB FEL  
 Dark Matter  
 Experiments**

**DARKLIGHT**

**LIPSS**

# Jefferson Lab site



# DarkLight Participants

Spokespersons: Peter Fisher and Richard Milner

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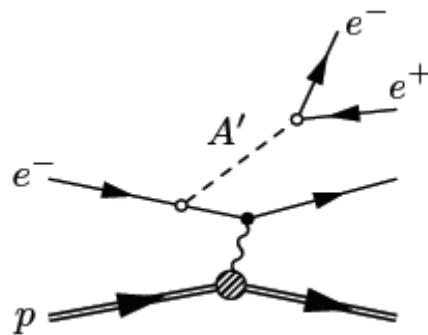
W.J.Kossler

*Physics Dept., College of William and Mary, Williamsburg VA 23185*



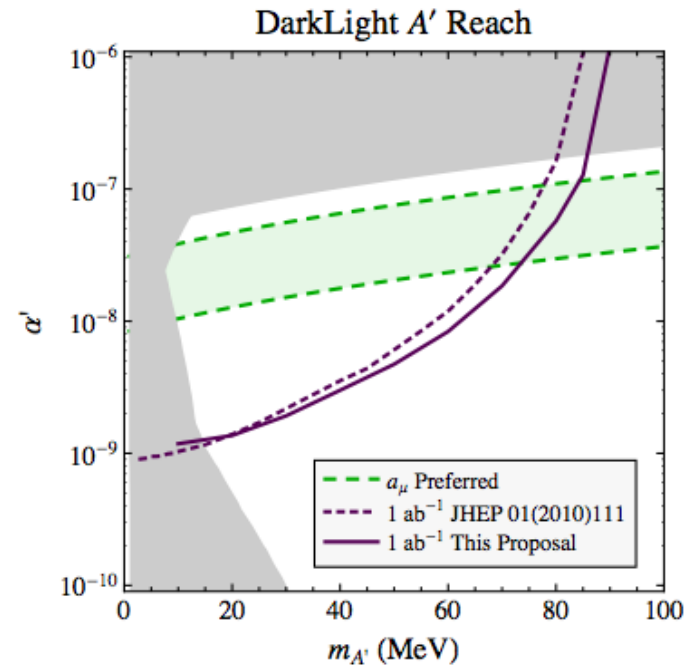
# Detecting **A** Resonance **K**inematically with **e**lectrons Incident on a **G**aseous **H**ydrogen **T**arget

A Search for new light bosons using the Jefferson Lab FEL facility.



High Intensity, Low Energy Electron Beam  
Using JLab's FEL on  
Diffuse Hydrogen Gas Target

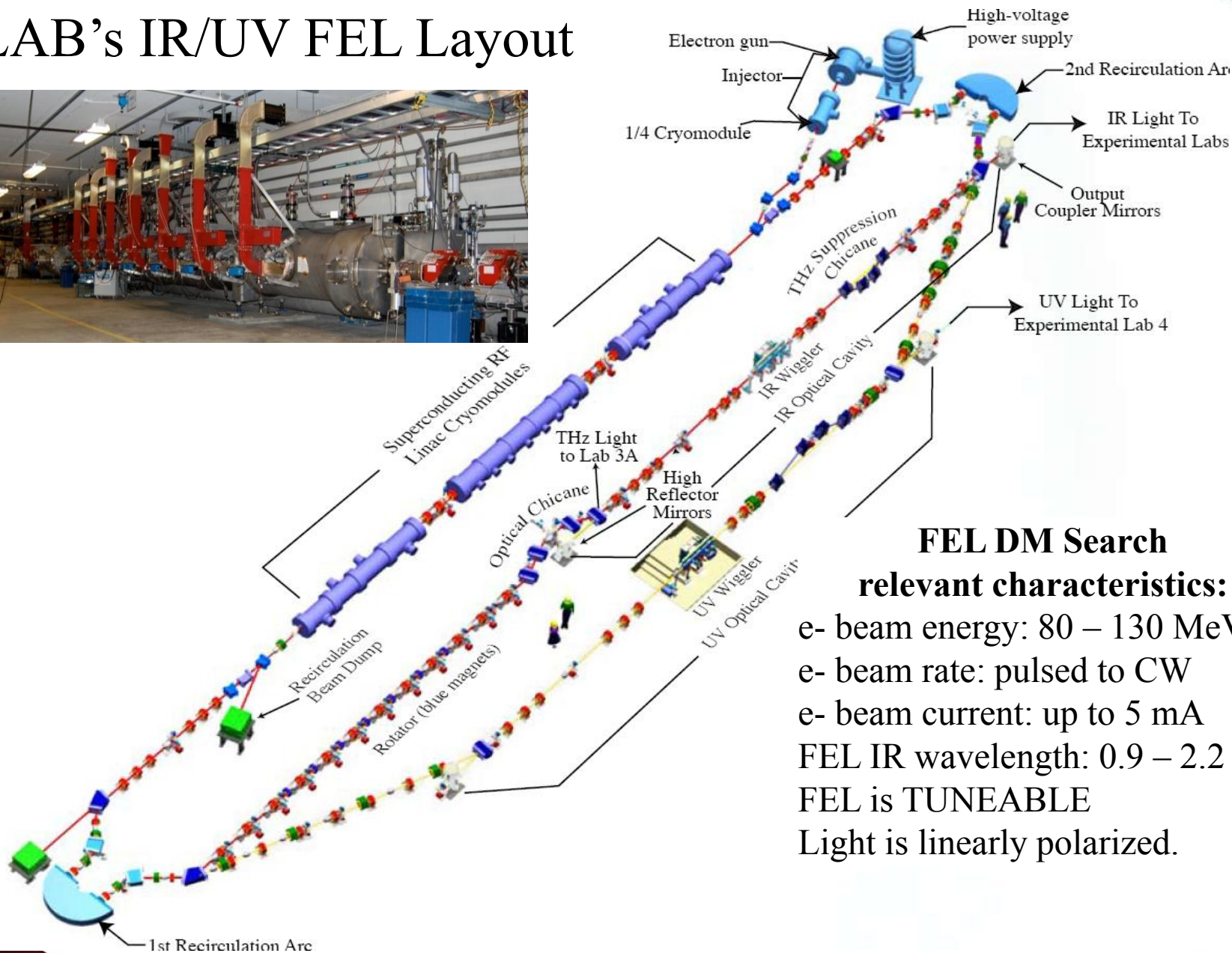
**==> Luminosity: 1 ab<sup>-1</sup>/month**



$$\alpha' \propto e^2 a, \quad (a = e^2 / 4p)$$

“Dark Force Detection in Low Energy e-p Collisions”  
[Freytsis, Ovanesyan, JDT: arXiv:0909.2862 (JHEP 1001;111)]

# JLAB's IR/UV FEL Layout

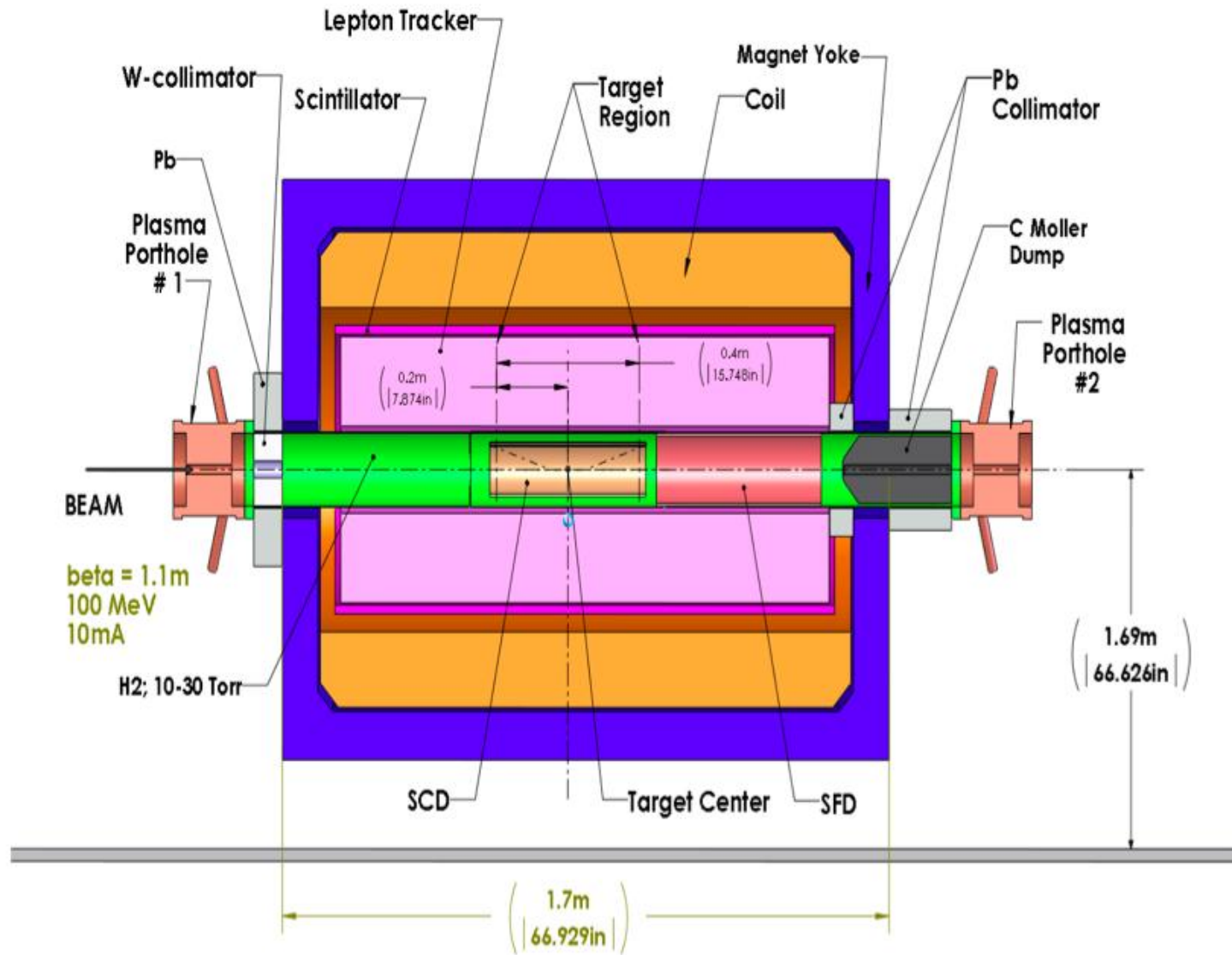


## FEL DM Search

### relevant characteristics:

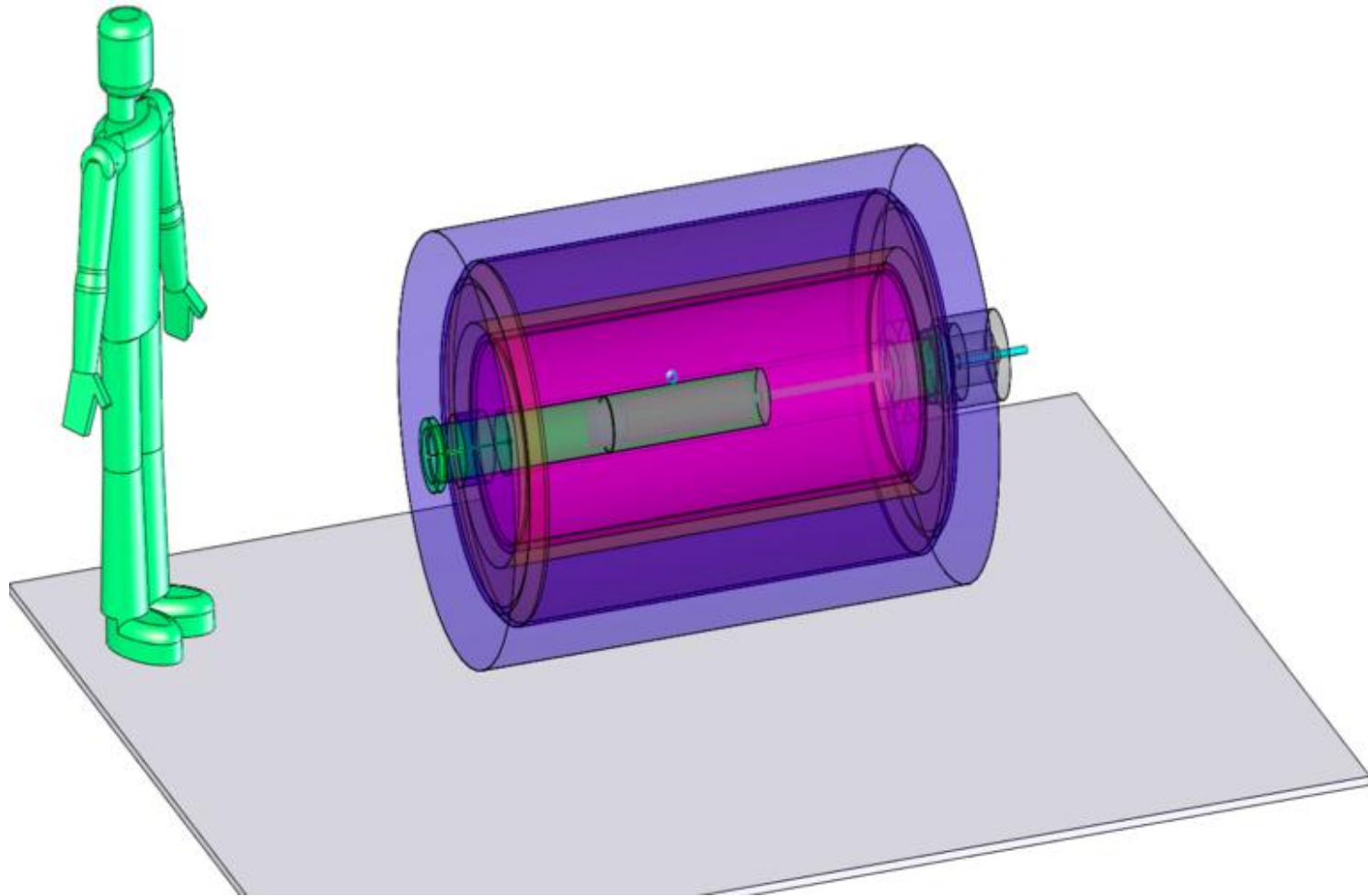
- e- beam energy: 80 – 130 MeV
- e- beam rate: pulsed to CW
- e- beam current: up to 5 mA
- FEL IR wavelength: 0.9 – 2.2  $\mu$ m
- FEL is TUNEABLE
- Light is linearly polarized.

# DarkLight Experiment: Schematic Layout

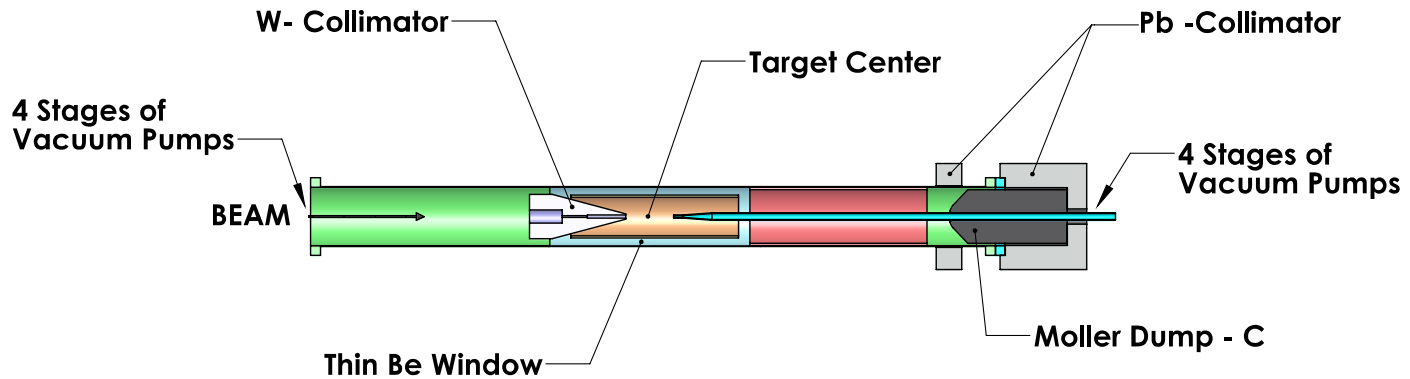




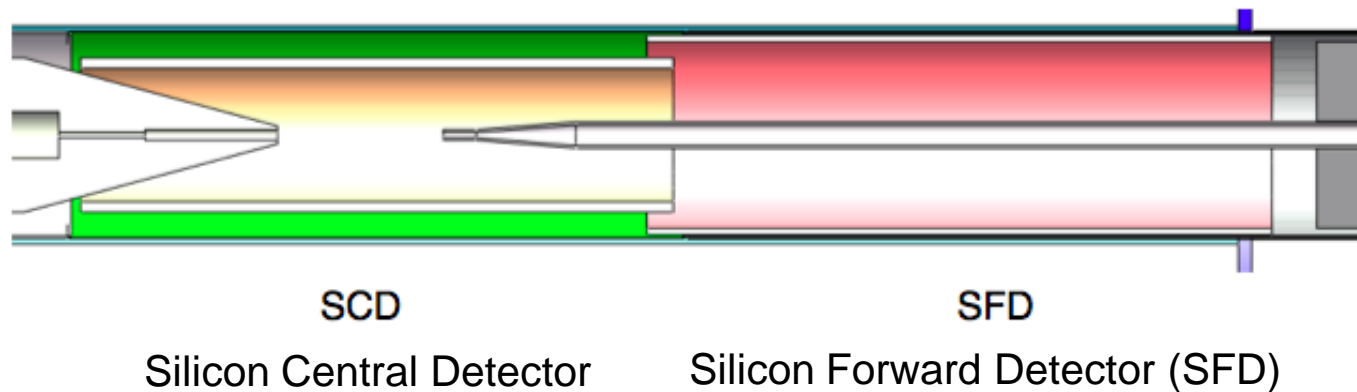
# DarkLight Detector System Scale



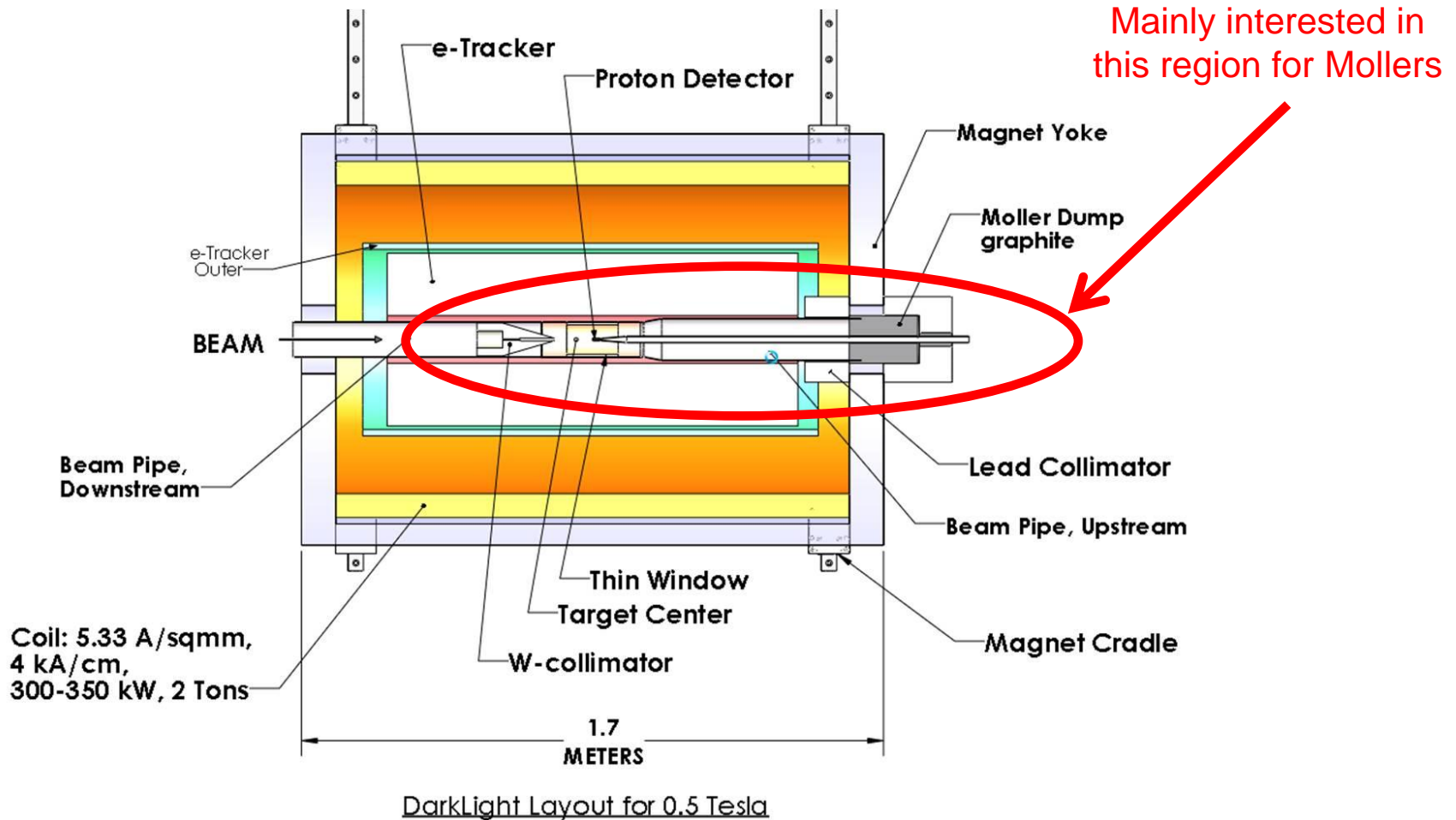
# DarkLight Windowless Hydrogen Gas Target



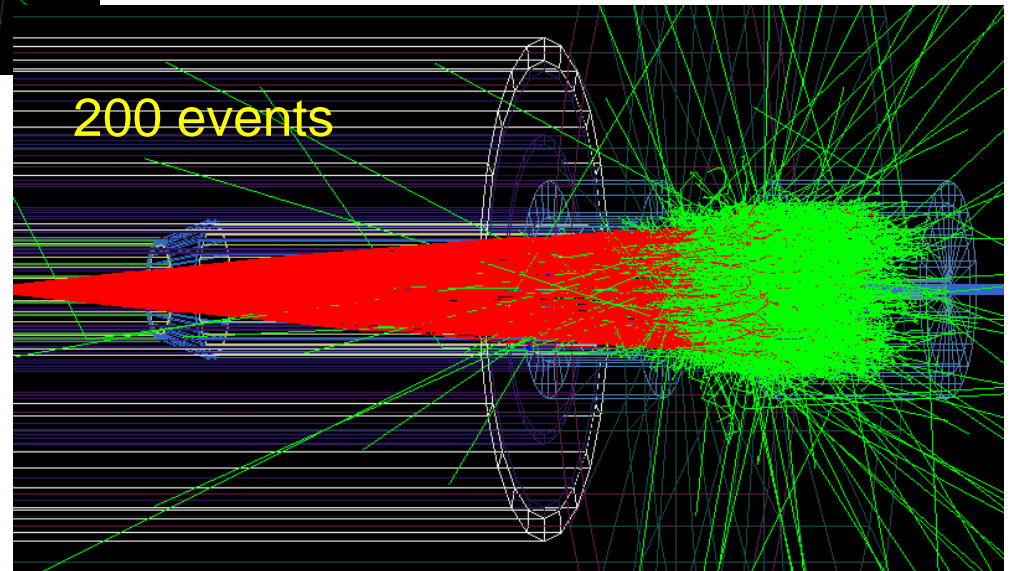
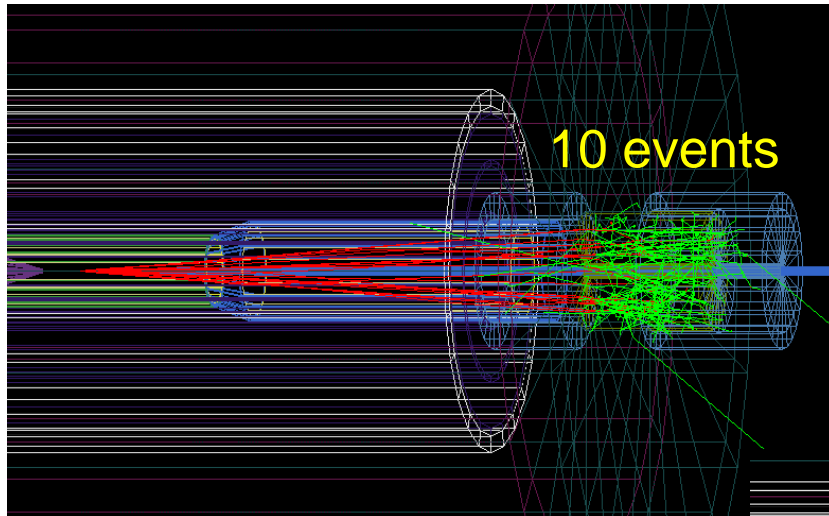
## DarkLight Silicon Detector Systems



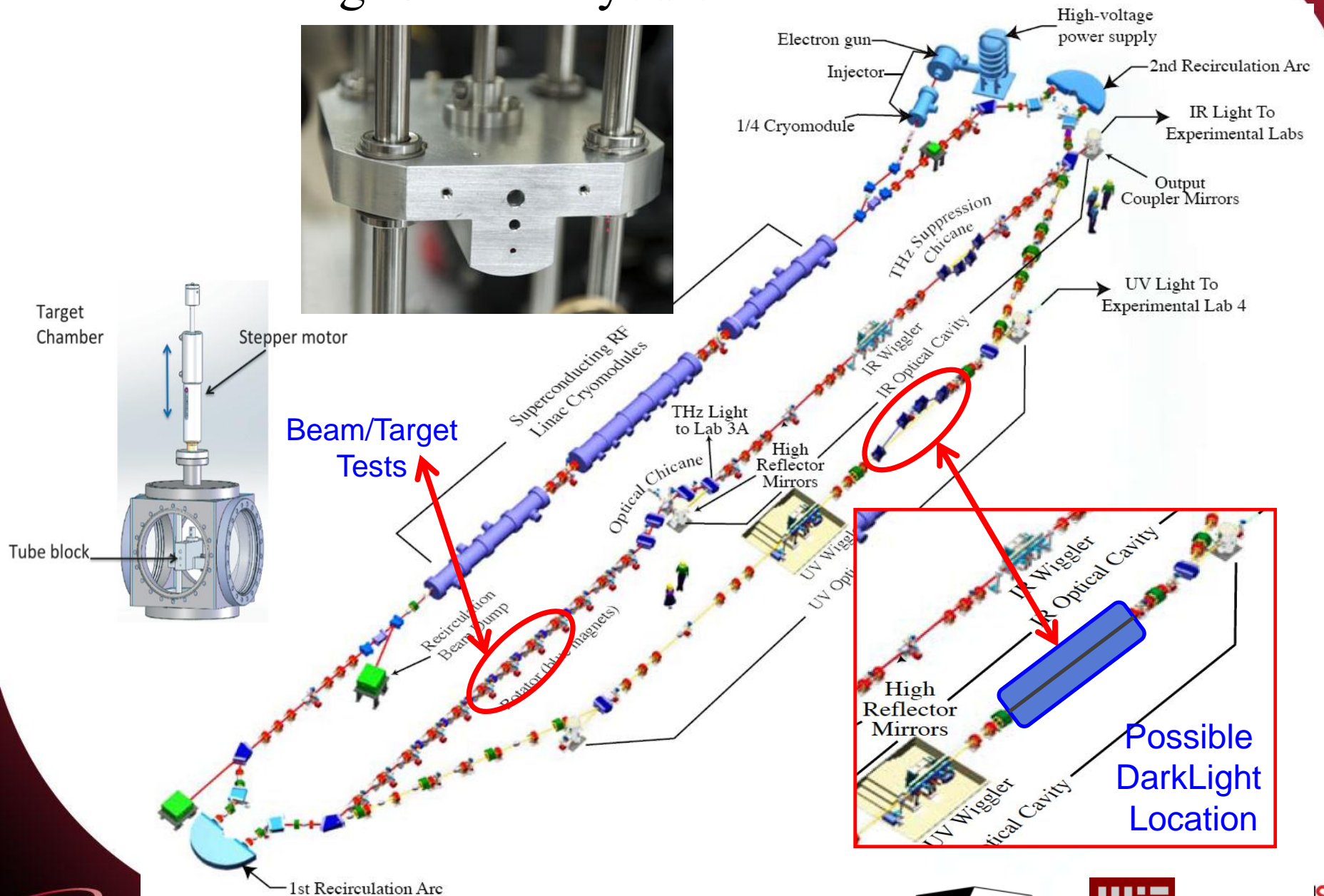
# DarkLight – Example of modeling effort



# DarkLight – Modeling Moeller Events



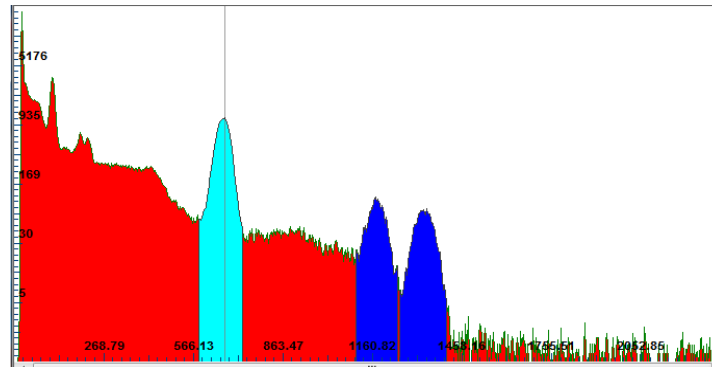
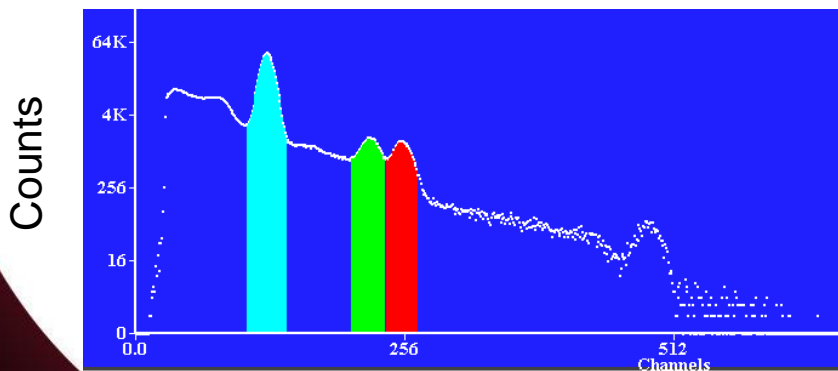
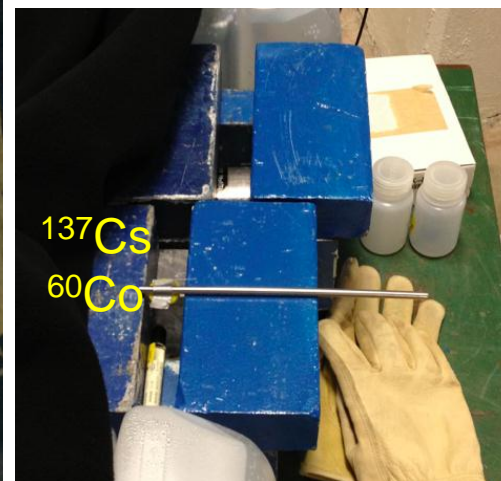
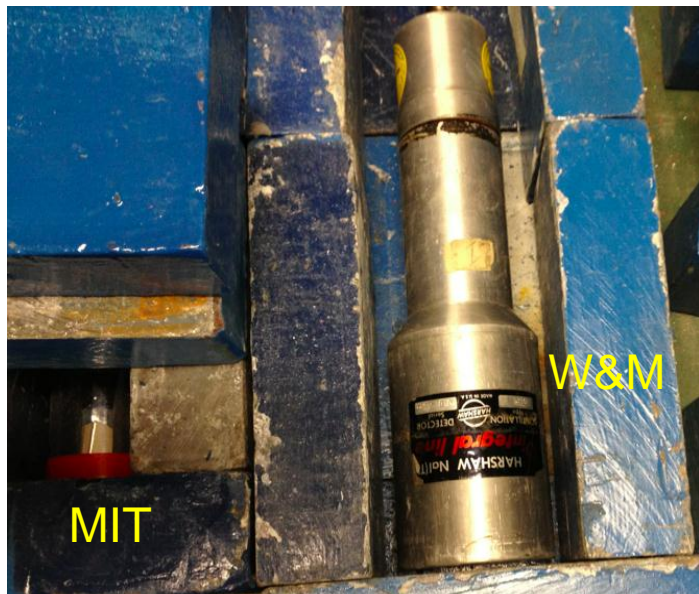
# DarkLight/FEL Layouts



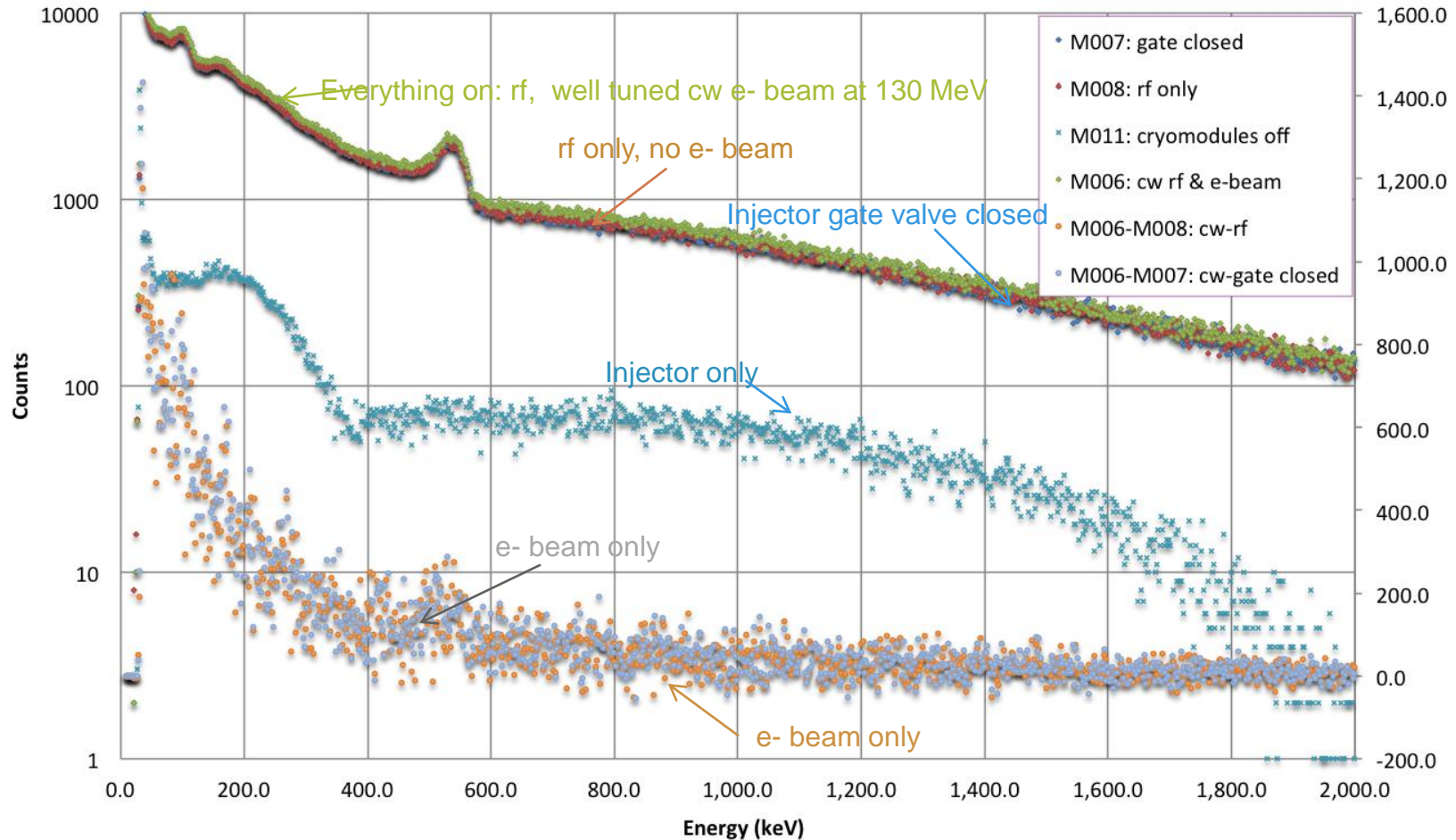
# NaI/PMT detectors & calibration sources

$^{137}\text{Cs}$ : 661.7 keV

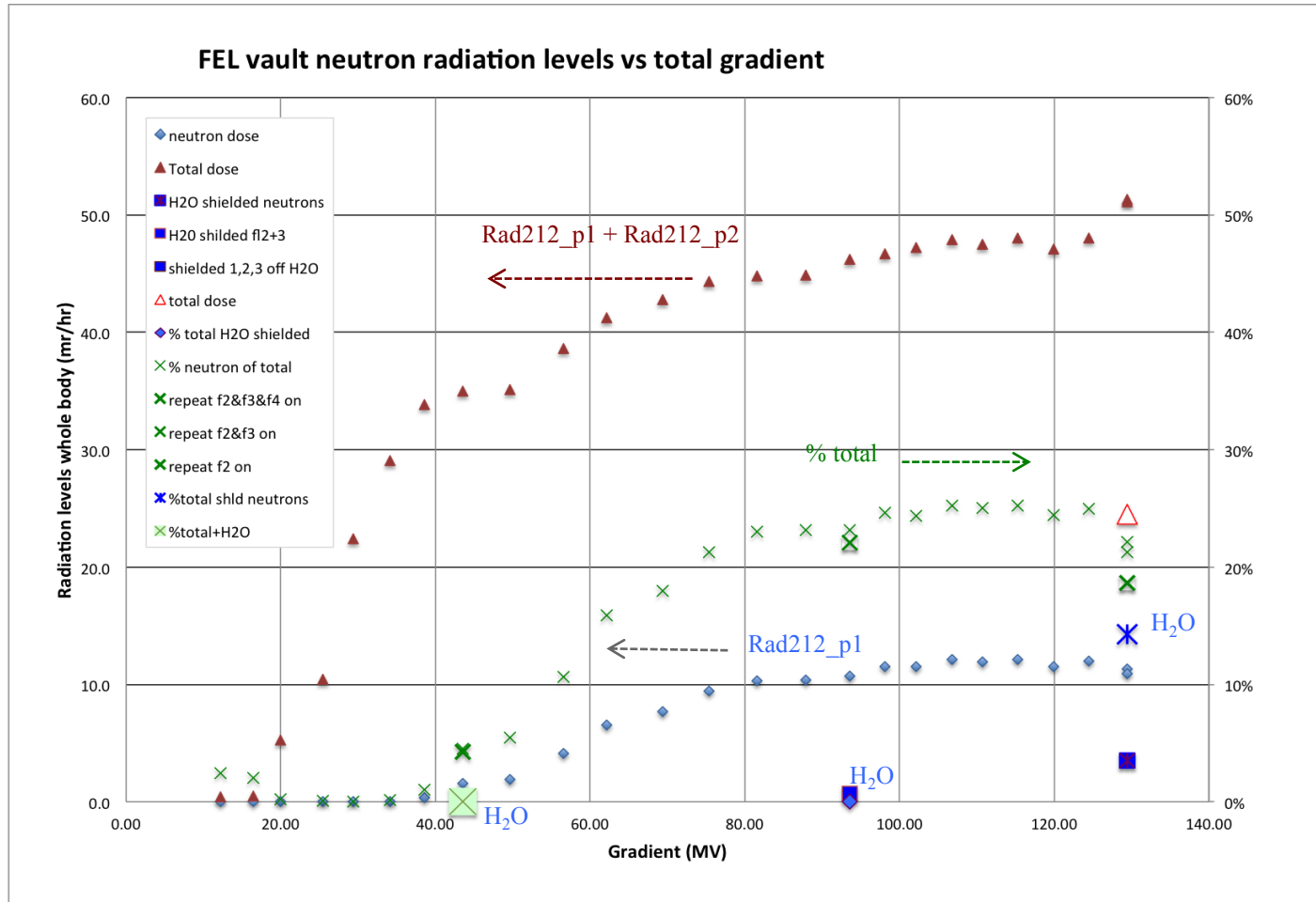
$^{60}\text{Co}$ : 1170.0 keV & 1330.0 keV



# Vault photon radiation – Good e- beam & lasing

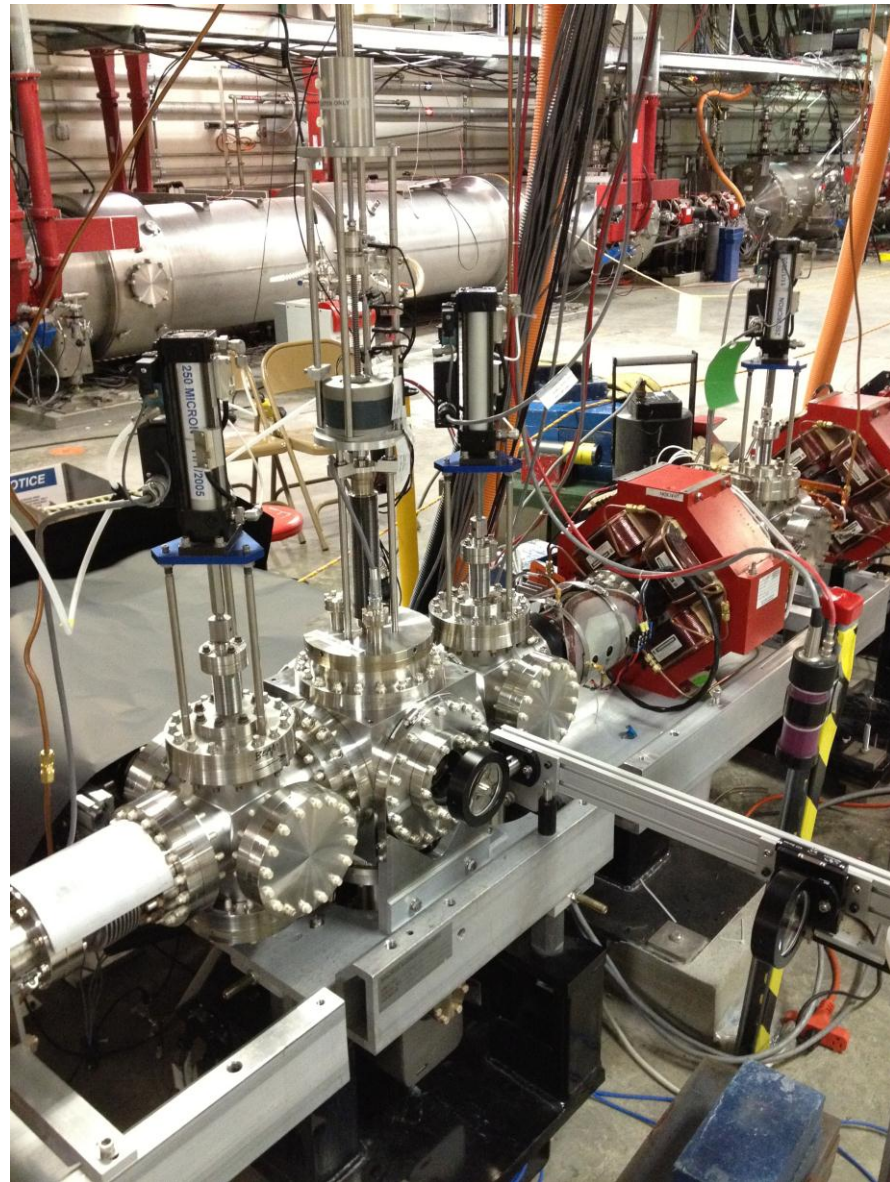


# FEL vault neutron radiation levels vs. total RF gradient





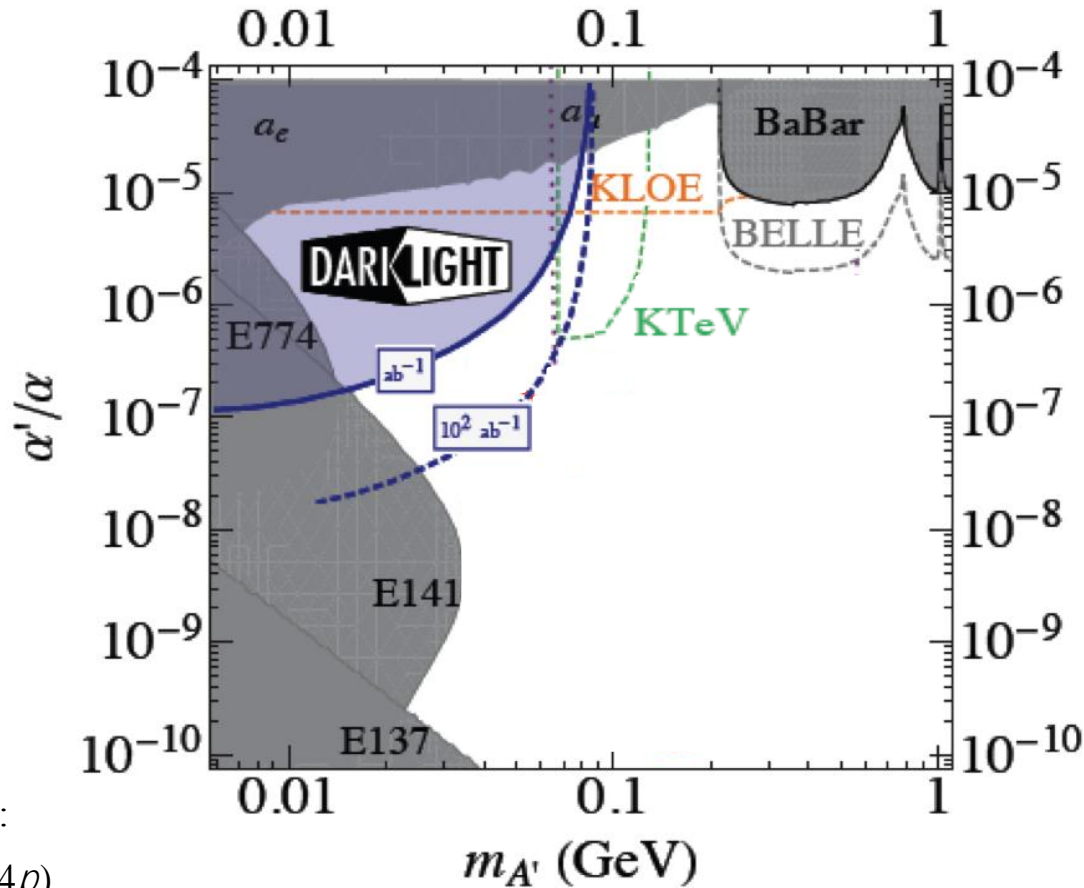
# FEL Vault Beam-Target Tests & Rad Measurements



# Possible Timeline

Major Focus \ Year	2012	2013	2014	2015	2016
FEL beam & Radiation limits					
Finalize Design Secure funding					
Technical Review Start Construction					
Detector Commissioning					
DarkLight data taking begins					

# DarkLight Projected Results



Coupling of photon to electron:  
 $\alpha' \propto e^2 a$ , ( $a = e^2/4p$ )

(DarkLight projected  $5\sigma$  vs. other projected  $2\sigma$ )

# Acknowledgements

The speaker would like to express grateful appreciation to the DarkLight Participants and the 8<sup>th</sup> Patras Workshop on Axions, WIMPs, WISPs Organizing Committees for the opportunity to share and discuss the DarkLight Effort.

## References

1. Jaekel and Ringwald [arXiv:1002.0329v1](https://arxiv.org/abs/1002.0329v1) [hep-ph].
2. [www.jlab.org](http://www.jlab.org)
3. PAC 37
4. PAC 39
5. Freytsis, Ovanesyan, JDT: arXiv:0909.2862 (JHEP 1001;111)
6. G. Neil, C. Bohn, S. Benson, G. Biallas, D. Douglas, et al., Phys.Rev.Lett. 84, 662 (2000)