Beyond the Standard Model
Research at Jefferson Lab:
The DarkLight Experiment Status

James R. Boyce
Jefferson Lab (JLab)
On behalf of the DarkLight Participants
July 18, 2012
8th Patras Workshop on Axions, WIMPs and WISPs
Chicago and Fermilab, USA

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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

Previously Explored Dark Matter Regions

Log_{10} (mass of Dark Matter particle in eV)

Log_{10} (coupling constant)

Atoms ~5%
Dark Matter ~23%
Dark Energy ~72%

Ref: Jaekel and Ringwald 1002;0329v1
DarkLight Participants

Spokespersons: Peter Fisher and Richard Milner


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

implies Luminosity: 1 ab^{-1}/month

“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 μm
FEL is TUNEABLE
Light is linearly polarized.
DarkLight Experiment: Schematic Layout
DarkLight Windowless Hydrogen Gas Target

DarkLight Silicon Detector Systems

Silicon Central Detector  Silicon Forward Detector (SFD)
Mainly interested in this region for Mollers
DarkLight – Modeling Moeller Events

10 events

200 events
DarkLight/FEL Layouts

Beam/Target Tests

Possible DarkLight Location

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

Everything on: rf, well tuned cw e-beam at 130 MeV

- rf only, no e-beam
- Injector gate valve closed
- Injector only
- e-beam only
- e-beam only

J.R. Boyce. 8th Patras Workshop. Chicago IL, July 18, 2012. Slide 15
FEL vault neutron radiation levels vs. total RF gradient
FEL Vault Beam-Target Tests & Rad Measurements
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<th>Major Focus</th>
<th>2012</th>
<th>2013</th>
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Coupling of photon to electron:

\[ a = \frac{e^2}{4\pi} \]
Acknowledgements

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References

2. www.jlab.org
3. PAC 37
4. PAC 39
5. Freytsis, Ovanesyan, JDT: arXiv:0909.2862 (JHEP 1001;111)