Hampton University Contributions

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Who am I ?

PhD Darmstadt (2001), postdoc at MIT 2003-2007
Joint appointment JLab/Hampton since 2008
Tenure since 2013

DOE Early Career Award 2009

OLYMPUS @ DESY (data in 2012, analysis close to final)
TREK/E36 @ J-PARC (data taken in 2015)
MUSE @ PSI (2016 approved for funding by NSF, 2016-2019)

JLab Physics:
SANE @ Hall-C (data in 2010, analysis close to final)
DarkLight @ LERF (phase 1a in 2016, phase 1b/c in 2017)
C-GEN @ Hall-C (~2019)

GEM detector development – OLYMPUS, MUSE, DarkLight

My group at Hampton University

Dr. Anusha Liyanage, postdoc since September 2013
Main activities:
- GEMs for MUSE and DarkLight
- Operation and handling, DAQ, analysis

Dr. Narbe Kalantarians, postdoc since August 2014
Main activities:
- TREK/E36 running and analysis
- Analysis of DIS cross sections
- Proposal development

Bishoy Dongwi, grad. student since fall 2011
- TREK/E36 construction, running, analysis, simulation
- Geant4

Jesmin Nazeer, grad. student since fall 2014
- DarkLight phase 1a (summer 2016)
- GEM lepton tracker for phase 1c

What we have been doing

Nine (9) GEM elements (10x10 cm^2) constructed and operated at OLYMPUS at DESY: two forward-angle tracking telescopes read out with INFN electronics (APV+MPD)
(flux & DAQ rate < few hundred Hz)

One telescope moved to PSI in 2013, now used for beam particle tracking at MUSE (Muon Scattering Experiment)
(flux < 5 MHz, density < 10 kHz/mm^2, DAQ rate few kHz)

The second telescope is now arranged as 4-GEM stack for DarkLight phase 1a @ LERF in a solenoidal magnetic field (expect similar rate environment)

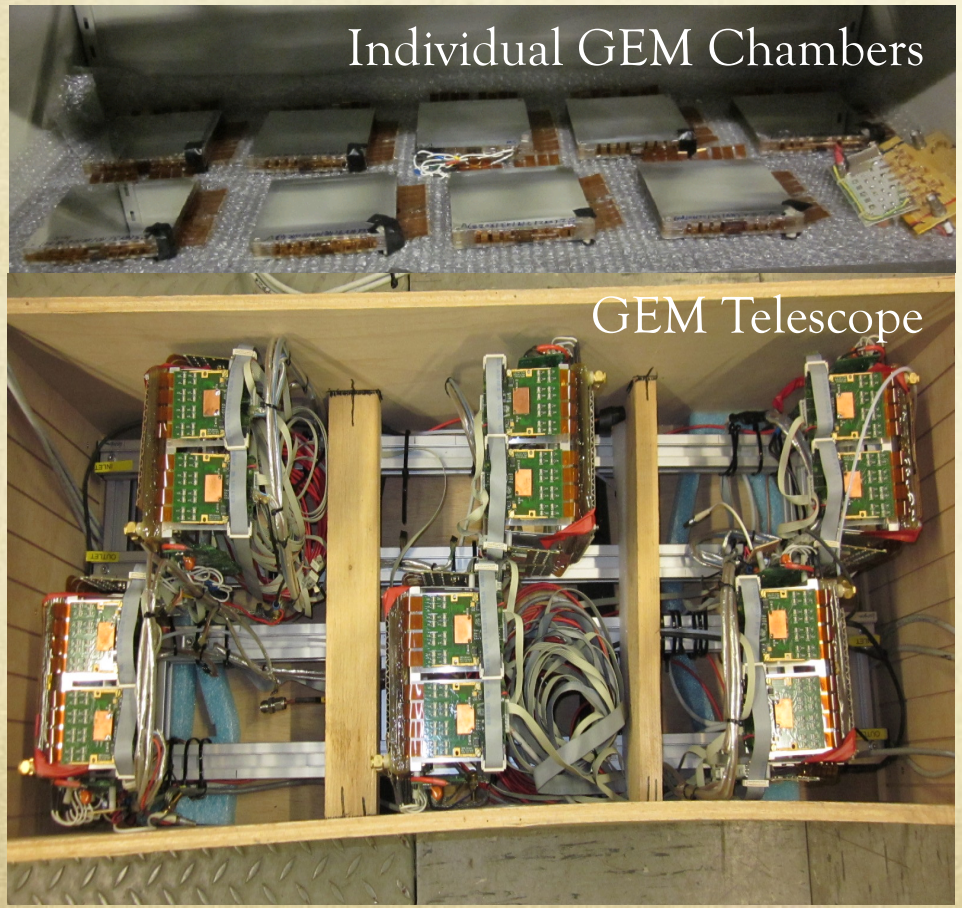
We are working on speedup of the DAQ, and on a robust tracking code to achieve high efficiency at high intensity

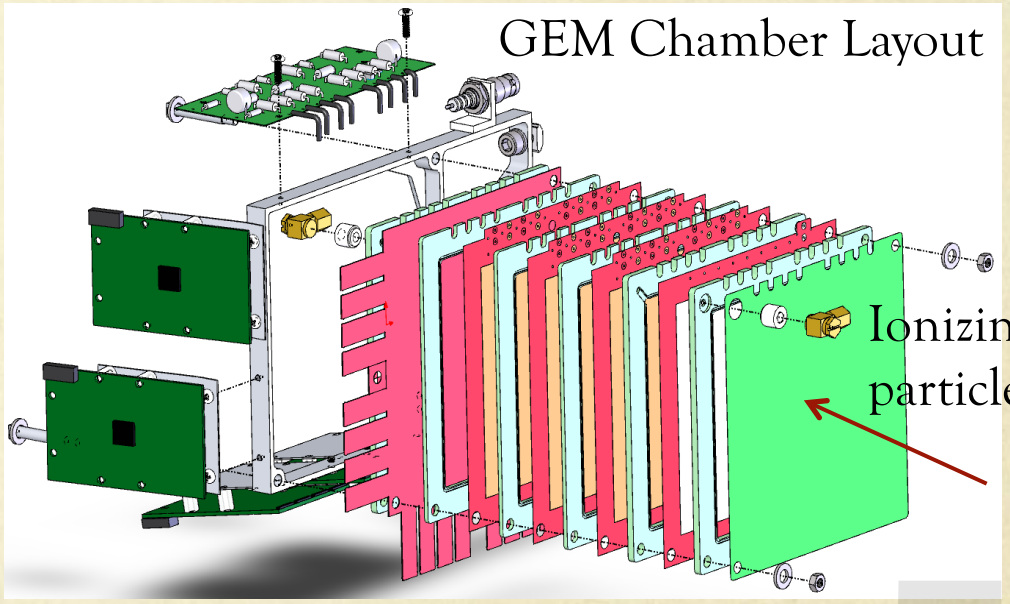
Hampton University GEMs

Two GEM telescopes,

- **Three 10x10 cm^2 triple-GEM chambers 30-40 cm apart. (70 cm long)**
- **1500 readout channels per telescope (INFN electronics)**

Were Built, Tested and Operated by Hampton University.





GAS SYSTEM:

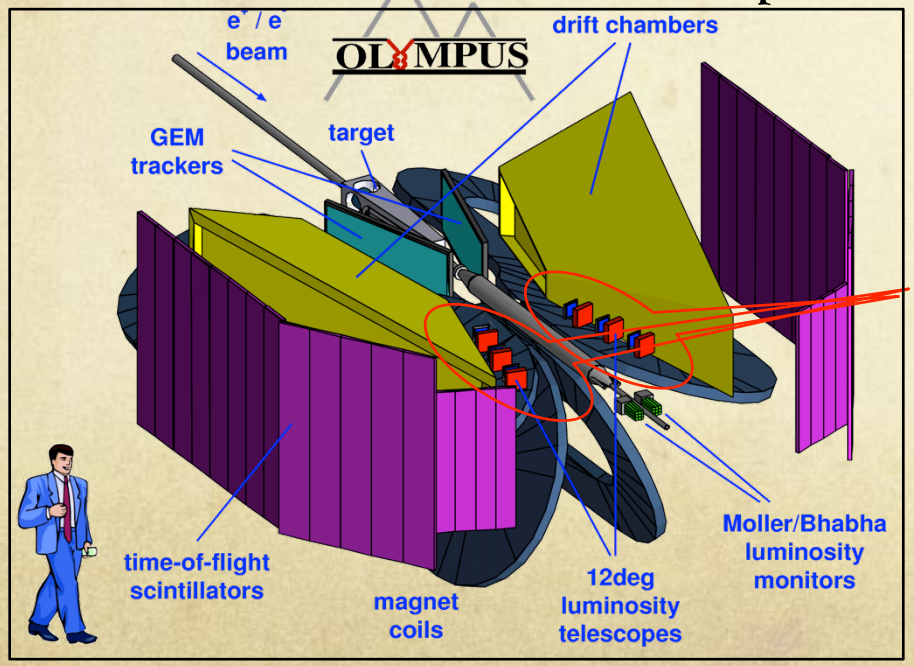
- ✓ Flowing $ArC0_2$ (70:30) at 1 liter/h.
- ✓ Rotameters and bubblers read the gas flows.

GEMs for OLYMPUS

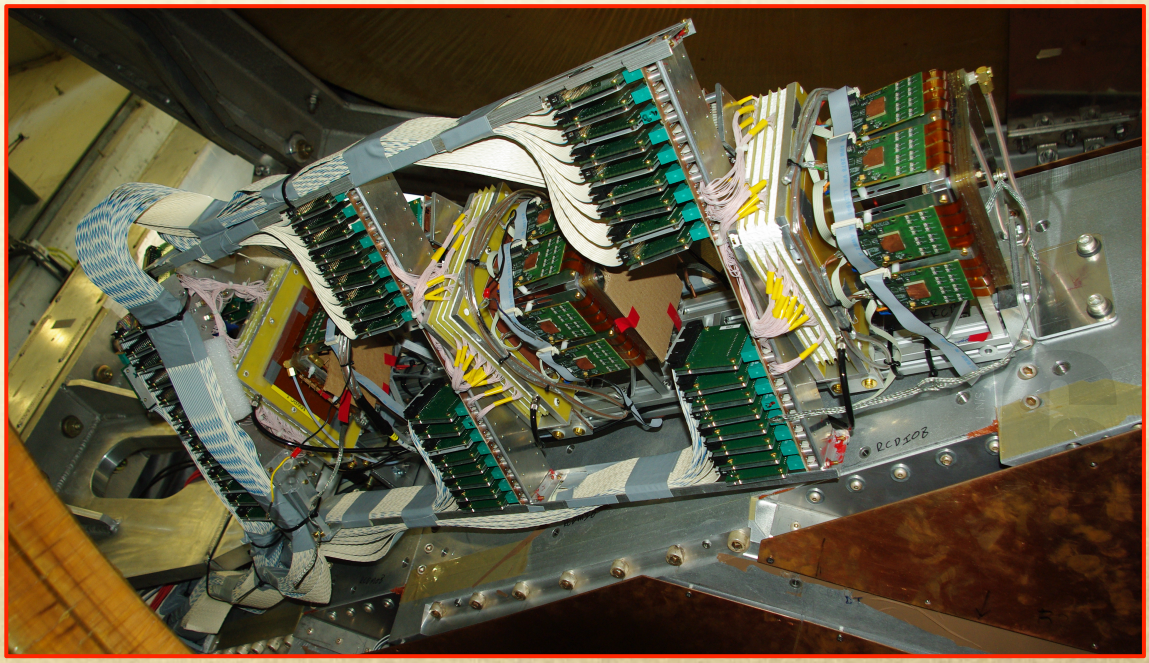
(e^-/e^+ (100 mA) in multi-GeV storage ring. DORIS at DESY, Hamburg, Germany)

- OLYMPUS is to study the effect of "Two Photon Exchange".
- GEMs were to measure elastic ep scattering at 12^0 where high particle flux was expected.
- Operated until Jan. 2013.
- Very stable operation, high efficiency ~95%, high spatial resolution ~70 μm

OLYMPUS Detector Setup



GEMs together with MWPCs

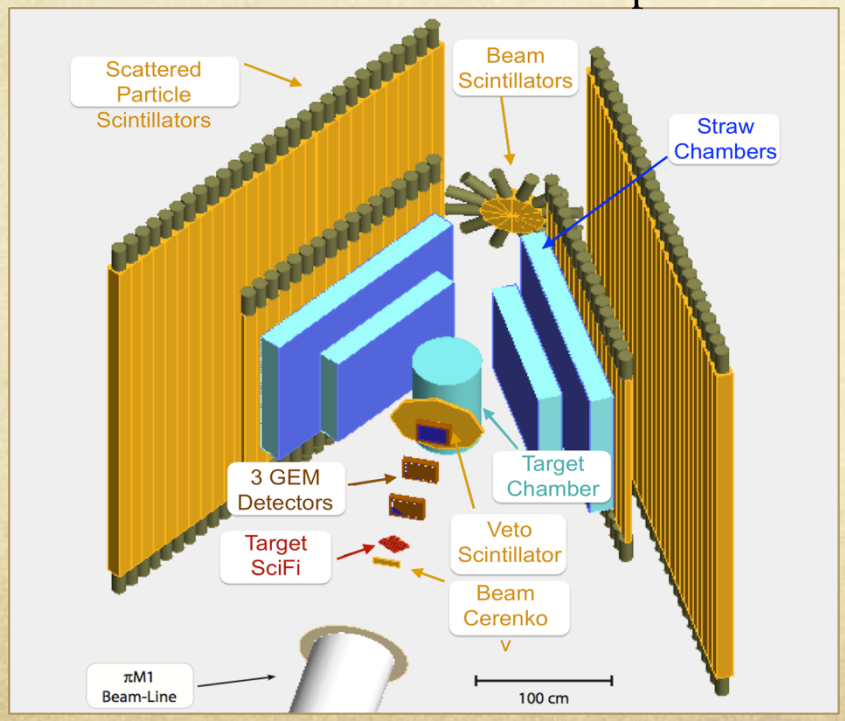


GEMs for MUSE

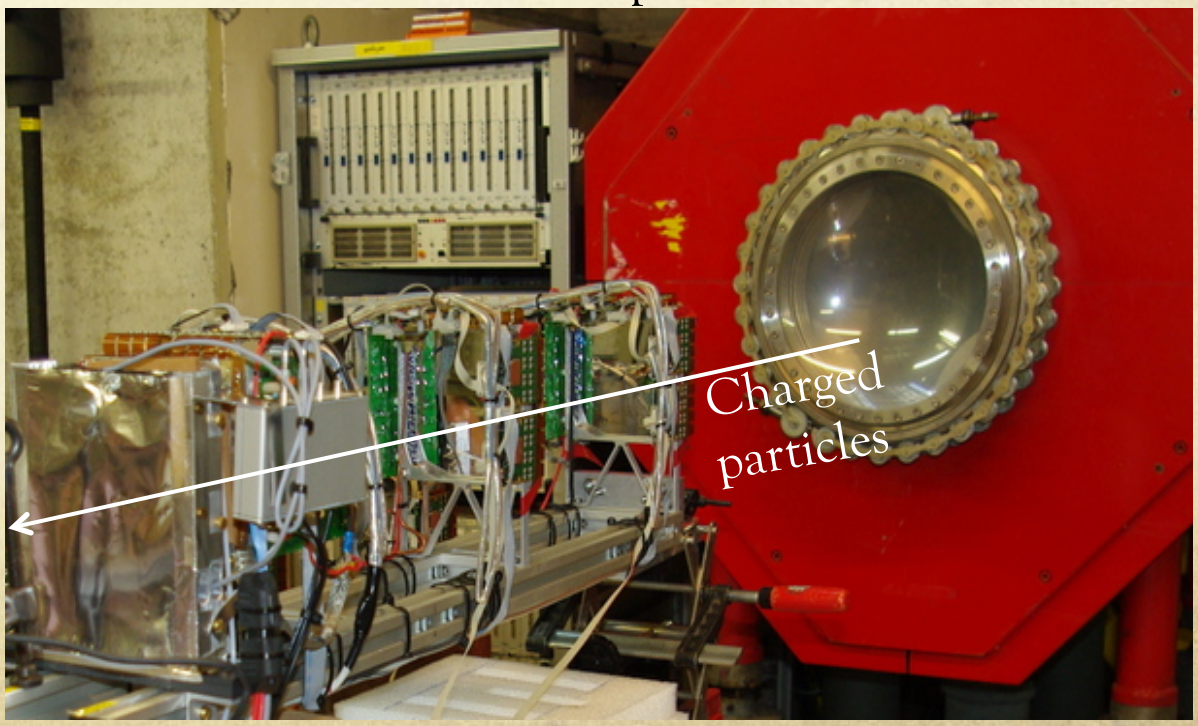
(low-energy separated e/π/μ beam, Paul Scherrer Institute, Switzerland.)

- MUSE is a direct test to study the "Proton Radius Puzzle".
- PSI πM1 beam line provides a beam with ~2 cm radius at the scattering target.
- Use GEM detectors as beam line elements to reconstruct the incoming particle track for a precise determination of the scattering angle.
- Expect ~100 μm spatial resolution.

MUSE Detector Setup



GEM telescope at PSI



GEM Efficiency

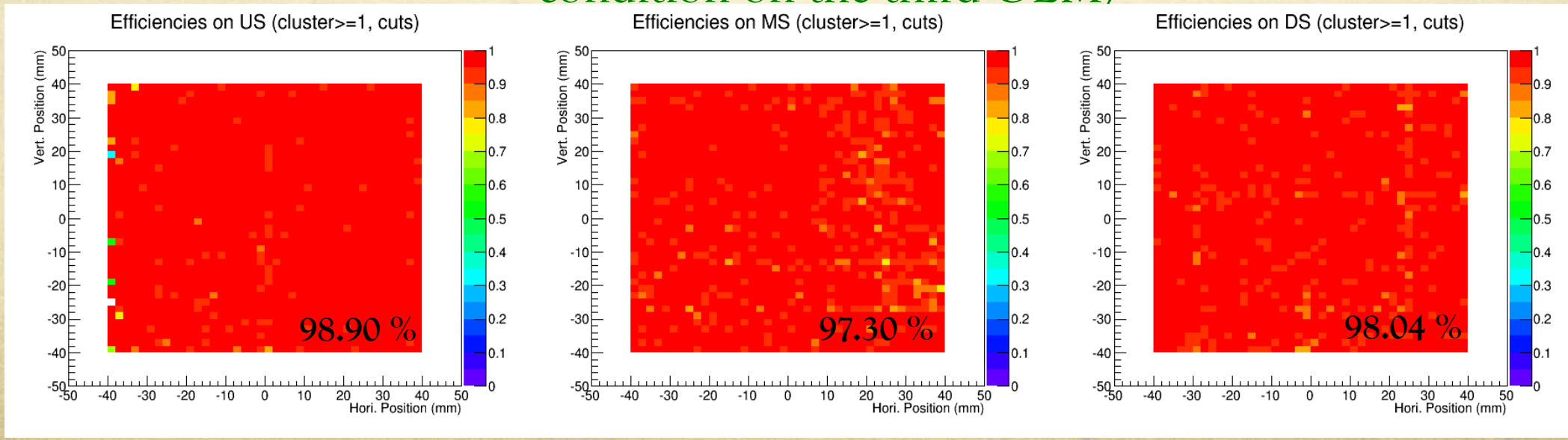
- Triggered with 12x12 cm^2 scintillator placed close to the third GEM.

The maximum charge cluster is selected on two of the three GEMs to form the track which is projected to the third GEM.

$Efficiency_{(max\ chg\ cluster,\ cuts)}$ = (Projected track positions on the third GEM only if the third GEM has at least one cluster in its vicinity) /

(Projected track positions on the third GEM, No condition on the third GEM)

Vicinity cut = ±1 cm



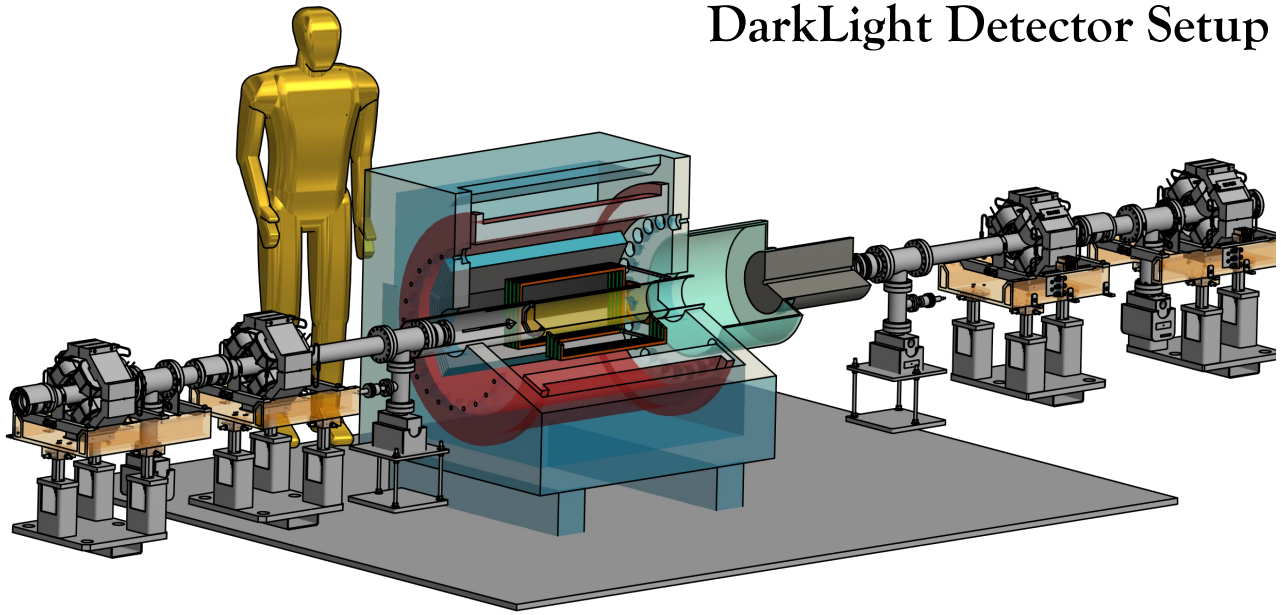
Future Experiments for our group

DarkLight at JLAB

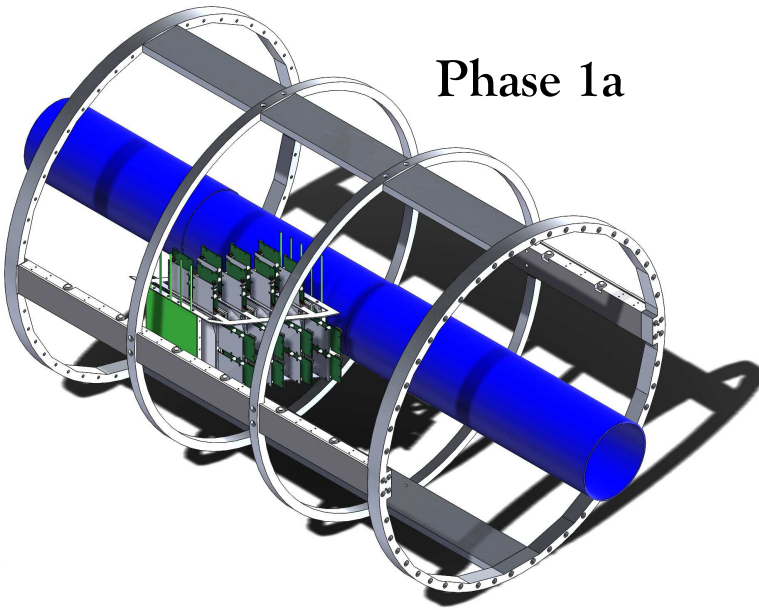
- Dark photons (universal coupling) well motivated by dark matter observations (astronomical, direct, positrons) in combination with g_μ-2 anomaly .
- To be run at the Low Energy Recirculator Facility (LERF) at Jefferson Lab.
- Search for visible decay modes of A' → e+e- in ep→epA' →epee
- Search for invisible decays A' → X in ep→epX

- DarkLight phase I:
  - ✓ Funded (NSF-MRI) in 2014, HU responsible for lepton tracker.
  - ✓ Prepare to run phase 1a/b in 2016 and phase 1c in 2017.

DarkLight Detector Setup



Phase 1a



What we can contribute to SBS

Help with commissioning of SBS GEMs with cosmic rays and Hall A beam

Help with DAQ, operate GEMs and assess data quality

Assess resolution and efficiency

Develop methods for tracking in high-rate environment

Take advantage of synergy with work on MUSE & DarkLight