Chung-Yao Fellowship 2016

Sho Uemura

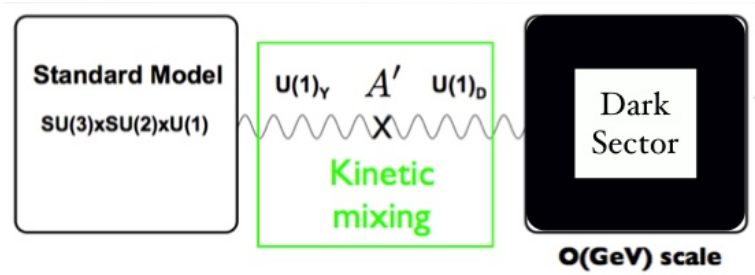
SLAC

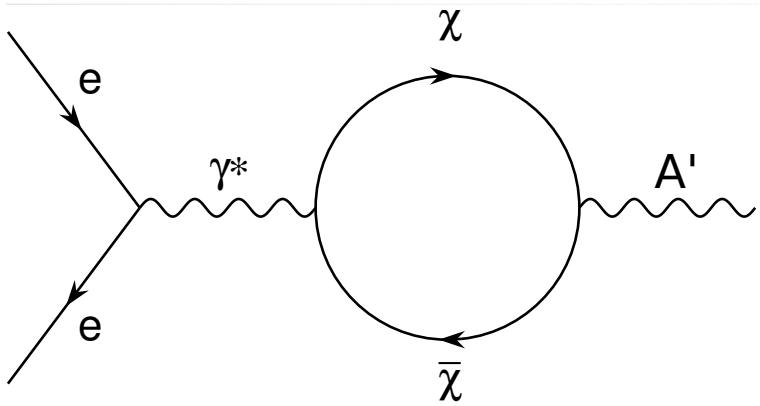
Summary of CV

- 2006–2010: S.B., Massachusetts Institute of Technology (Physics, Mathematics)
  - Thesis: *Differential Cross Section Measurement for the d(n,np) Reaction*, with Prof. June Matthews
- 2010–2016: Ph.D., Stanford University (Physics)
  - Degree expected September 2016
  - Thesis: *Searching for Heavy Photons with Separated Decay Vertices in the HPS Experiment*, with Prof. John Jaros

Current research: dark forces and the heavy photon

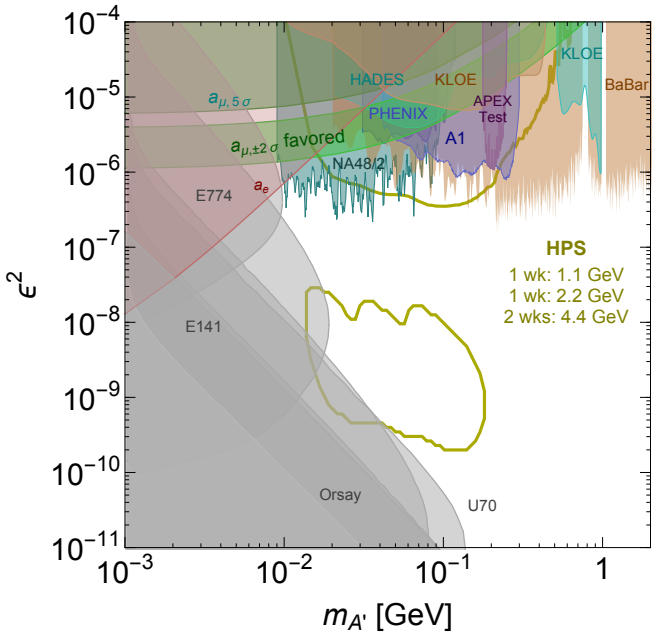
- "Dark sector" emerging as a picture of dark matter that allows for self-scattering, collisional excitation, annihilation
  - Standard Model forces don't couple to the dark sector
  - Dark forces don't couple to Standard Model matter
  - "Portals" create weak effective couplings between the sectors
- Vector portal: dark force is a massive $U(1)$ boson (heavy photon)
  - Kinetic mixing with the photon $\rightarrow$ weak coupling to electric charge
- Two relevant parameters: mass $m_{A'}$, relative coupling strength $\epsilon^2 = \alpha'/\alpha$

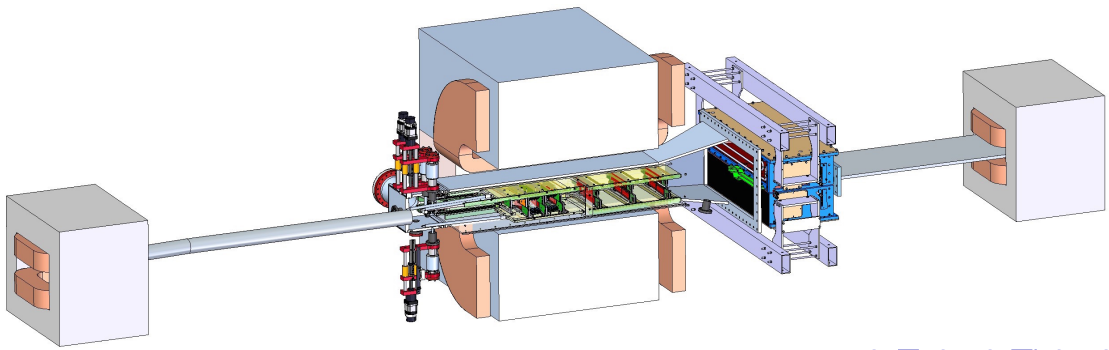




The Heavy Photon Search

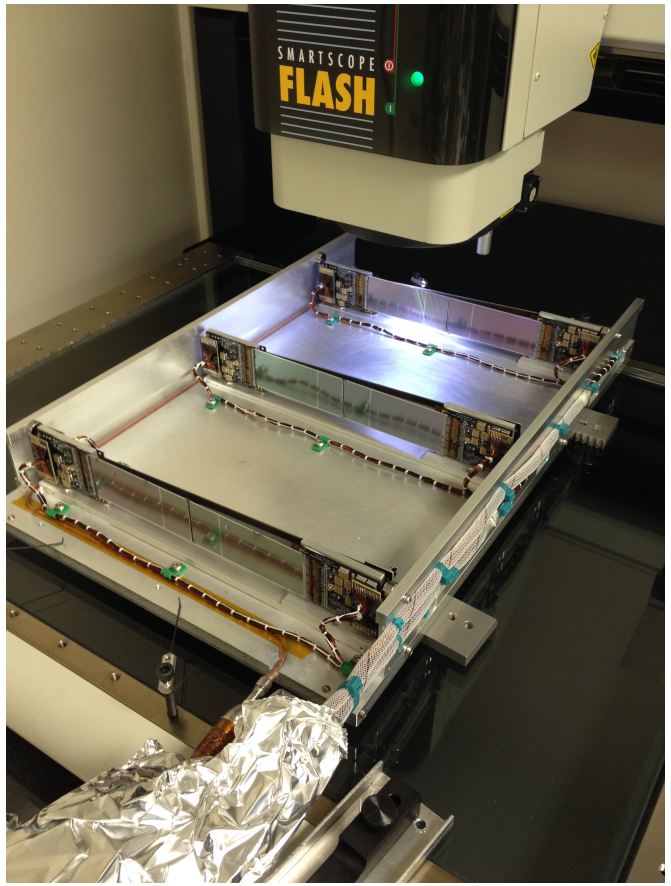
- HPS is a dedicated experiment looking for heavy photons
- Production: virtual bremsstrahlung from e^- on a fixed target
- Signature: e^+e^- mass resonance or displaced vertex
- Apparatus: silicon microstrips in dipole (measurement), $PbWO_4$ calorimeter (trigger)
- Facility: CEBAF linac at Jefferson Lab, Hall B beamline

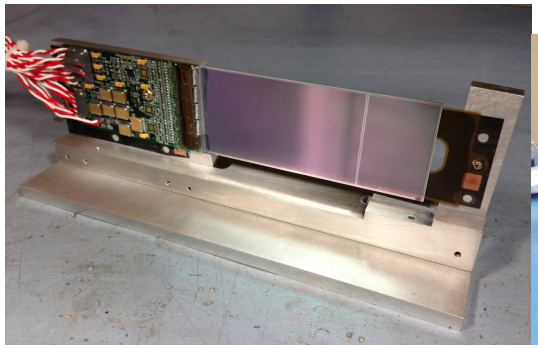


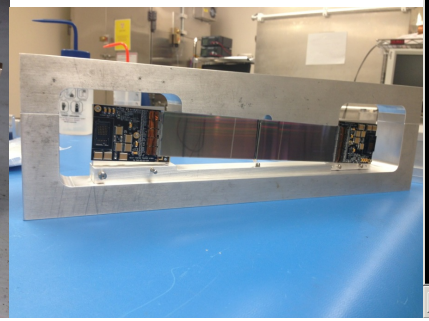


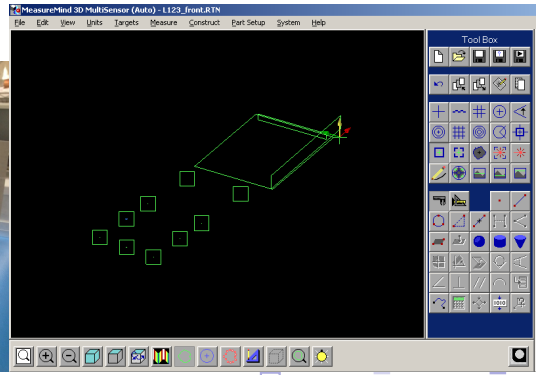
Assembly and survey of SVT

- Pair half-modules onto support structure at 50/100 mrad stereo angle
- Survey assembled modules using optical/touch-probe CMM: get sensor positions and curvature
- Modules (in sets of 3) mount onto U-channels; survey U-channels to relate sensors to each other and beamline survey



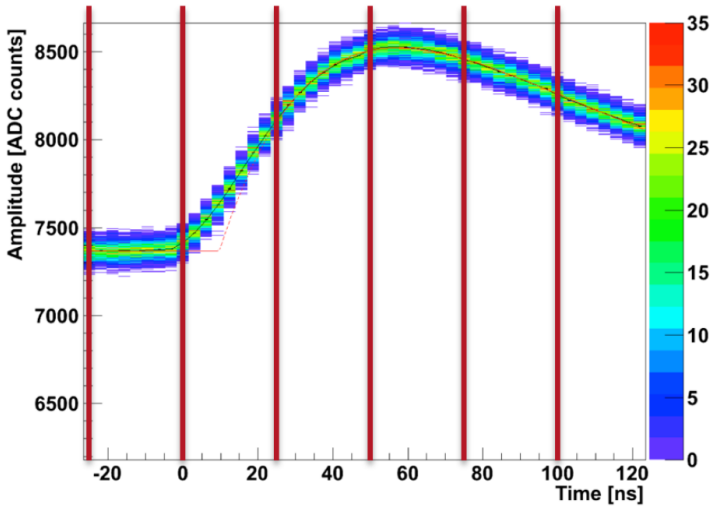


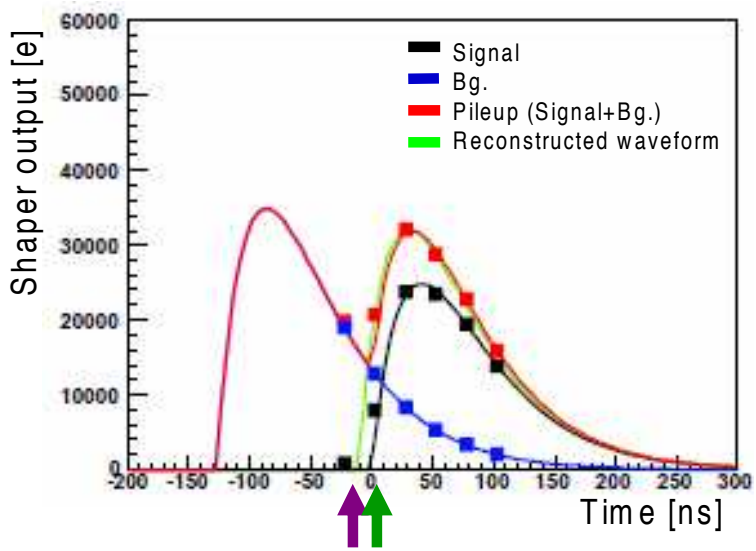




SVT hit time reconstruction

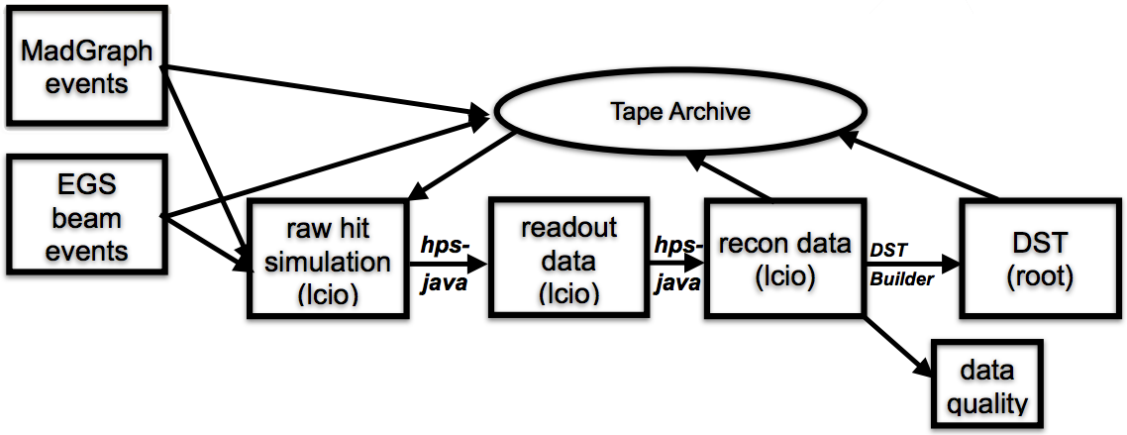
- SVT hit occupancies are very high; reject hits outside a time window defined by the ECal event time
- HPS is designed for a maximum occupancy of 1% (L1 next to the beam gap) in 8 ns window; to run at planned current with good tracking efficiency, hit time recon must be good within 8 ns
- Use APV25 readout chip to take 6 samples at 24 ns spacing; fit the pulse coming out of the preamp to get hit time resolution $\sim$2 ns
  - Minimize effect of pulse pileup on the time fit
- Use fitted hit times in track finding





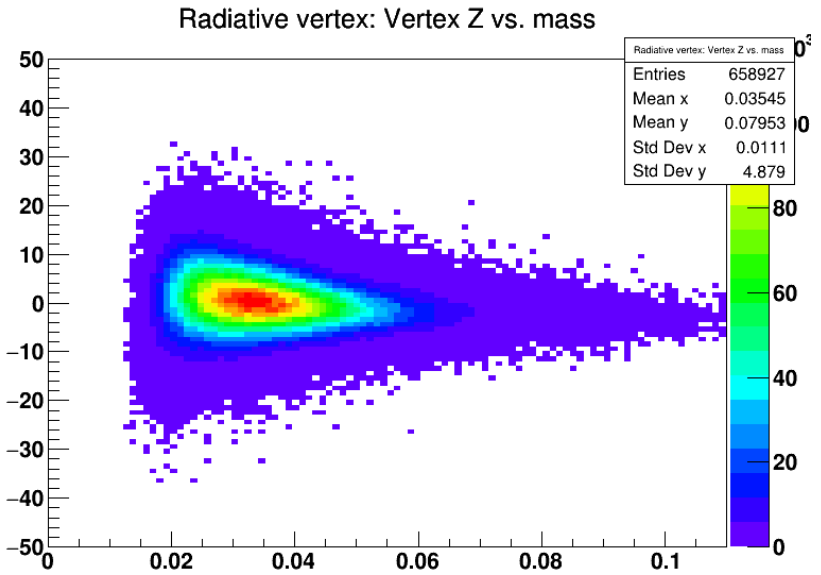
Monte Carlo

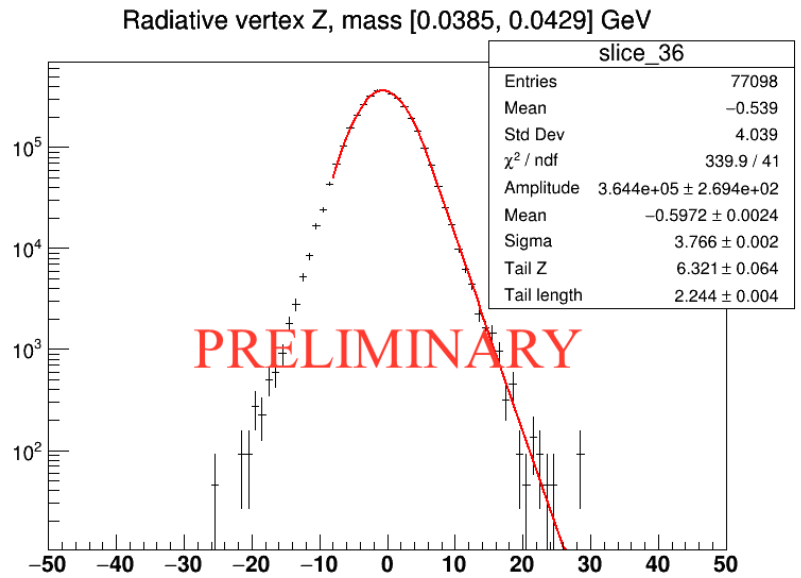
- Full simulation of pileup, time evolution, triggers and readout
- Mock data challenge: 1 week equivalent of simulated data with secret A' signals mixed in
- Set up and exercise all our MC, data handling and recon tools on Jefferson Lab compute farm



Vertexing search

- Looking for a tail in $+Z$ at a single mass
- Multiple scattering distribution leads to Gaussian core and non-Gaussian tail: fit the tail and do a cut-and-count analysis
- Blinded analysis; currently using 10% of the data
- Pushing for publication this year





Research plan

- 50% ATLAS, 50% CEPC
- ATLAS: Higgs analysis, Phase II inner tracker
- CEPC: tracker studies and development