HPS Update

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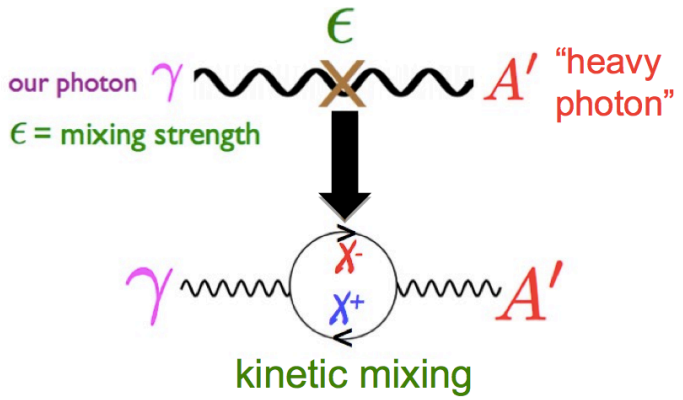
CLAS Collaboration Meeting

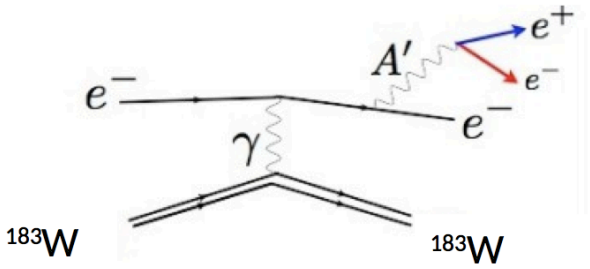
February 24, 2016

Searching for Dark Matter

- There must be dark matter made of something other than Standard Model particles
  - based on galactic rotation curves, cosmic microwave background, gravitational lensing, etc.
  - yet no direct observation yet

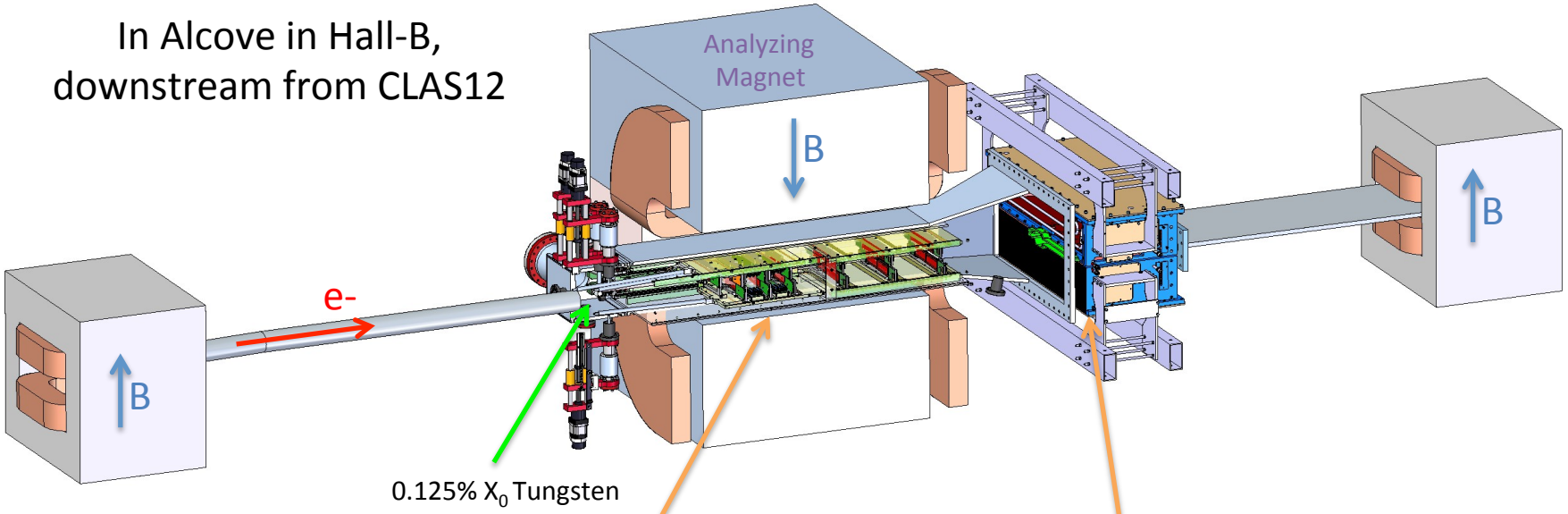


- HPS proposed to search for a heavy photon via kinetic mixing with SM photon, bremstrahlung off heavy nuclear target, and decay to e+e-
  - Requires a detector with good e^+e^- mass and vertex resolution
    - mass bump hunt sensitive to large mixing
    - displaced vertex search sensitive to small mixing
  - And small angle acceptance to get to low mass → close to beamline

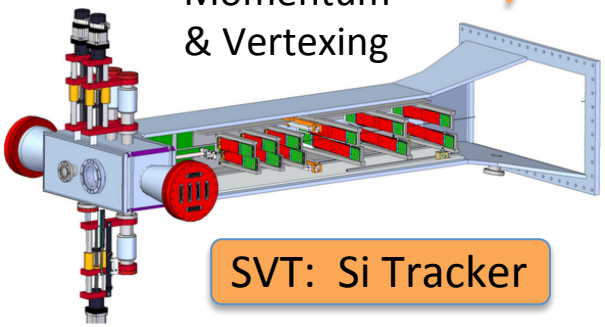


HPS Setup

In Alcove in Hall-B,
downstream from CLAS12

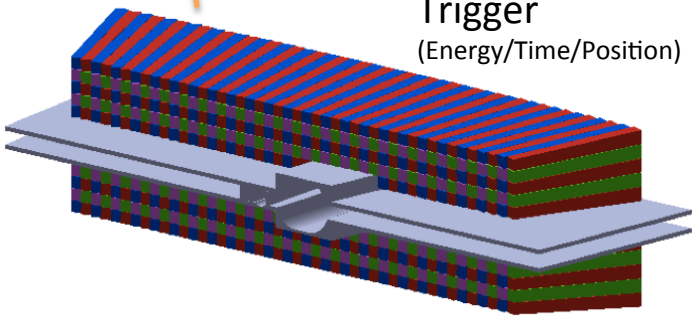


Momentum
& Vertexing



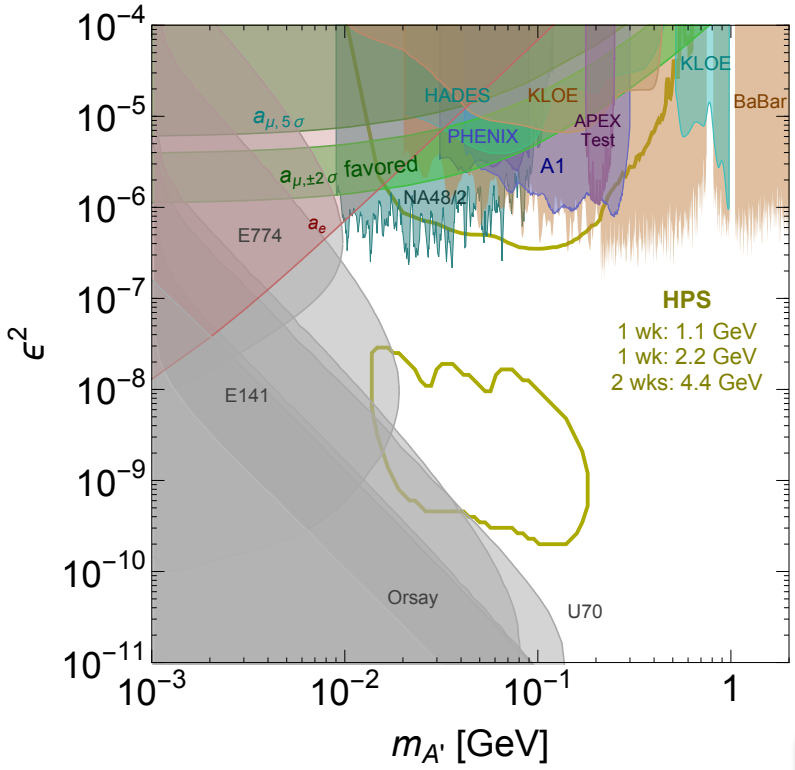
SVT: Si Tracker

Trigger
(Energy/Time/Position)

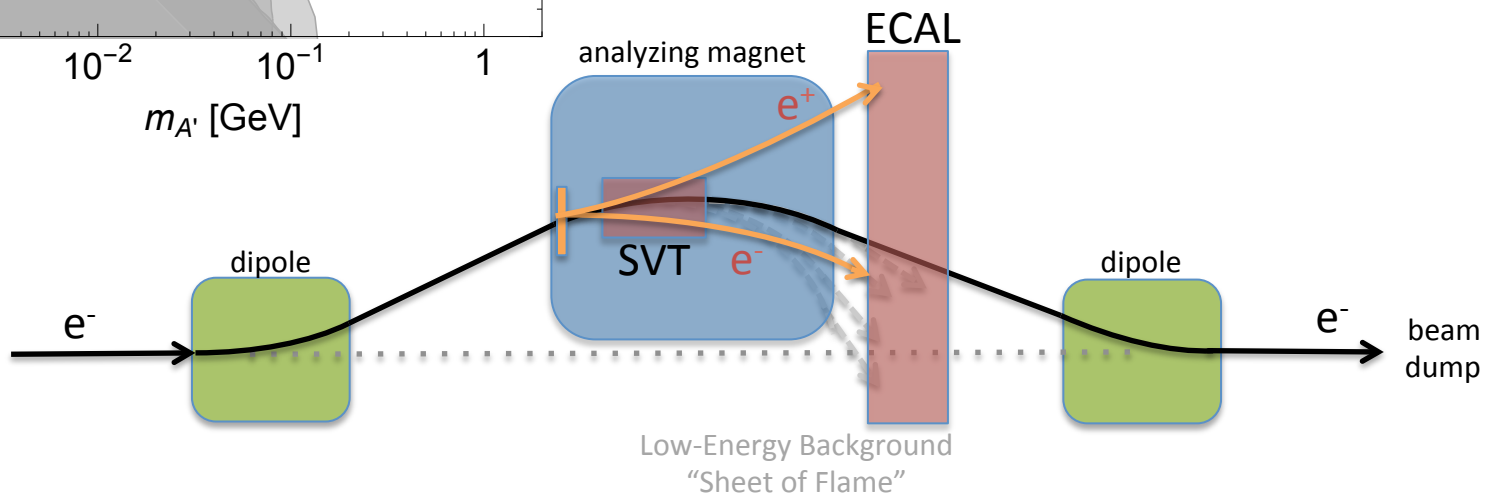


ECAL: $PbW0_4$ Calorimeter

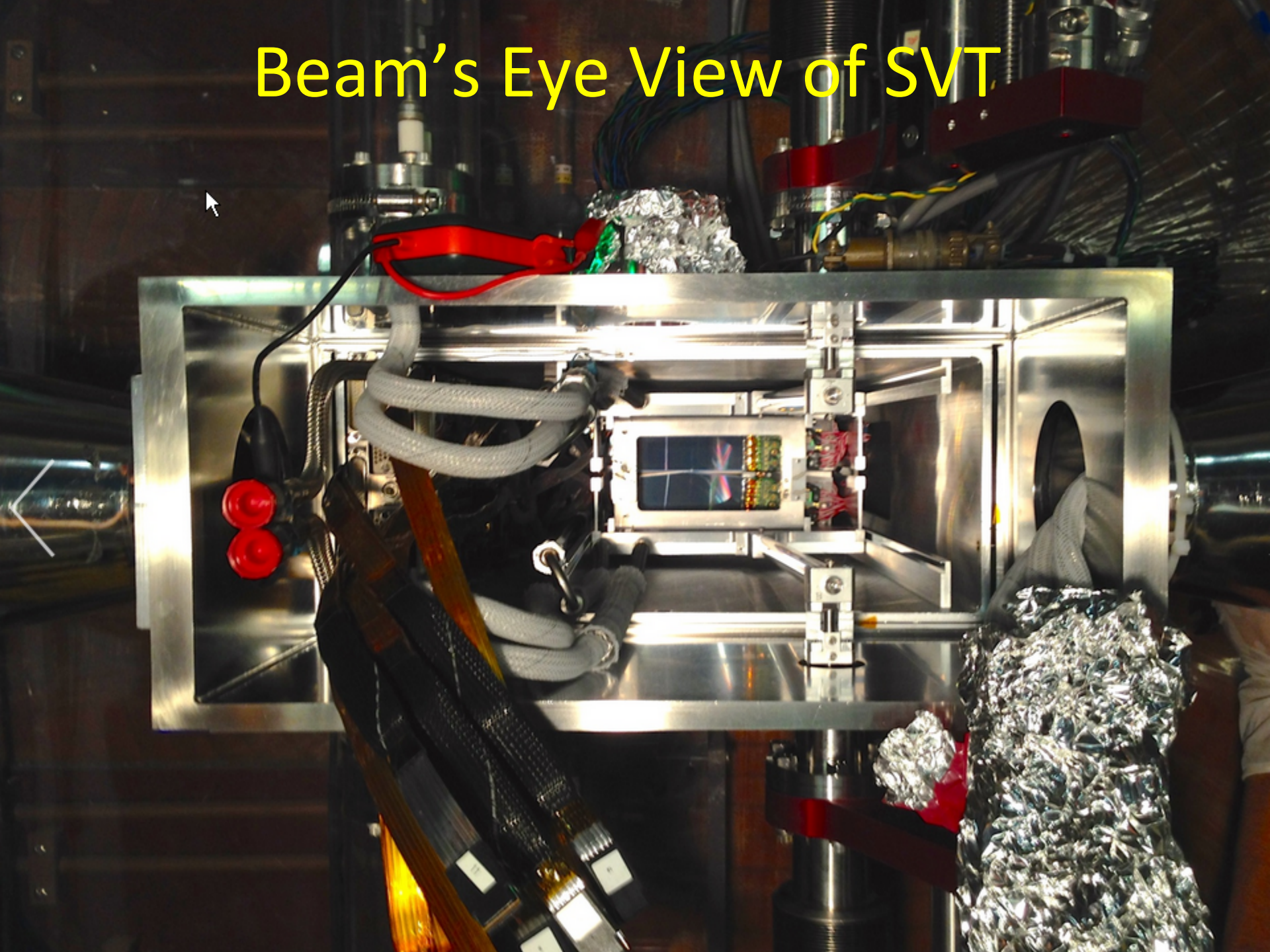
HPS Reach & Runs



- 2012 "Test" and 2014 "Commissioning" Runs
  - not for physics
- 2015 "Engineering" Run
  - 1.05 GeV (1-pass), 1st with full HPS setup
- 2016 "Physics" Run
  - 2.3 GeV (1-pass)



Beam's Eye View of SVT



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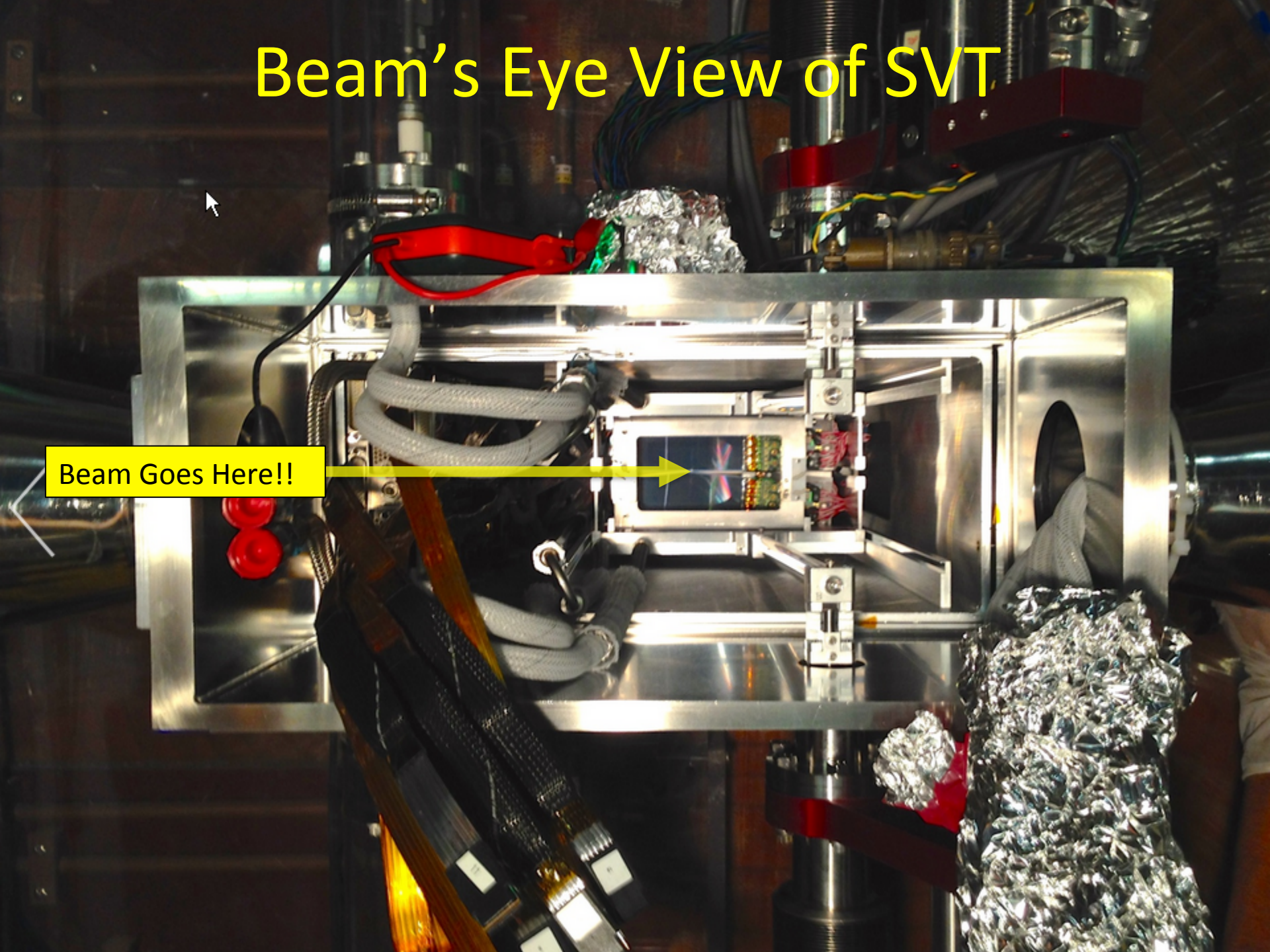
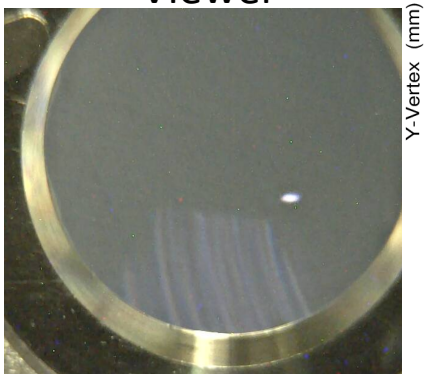


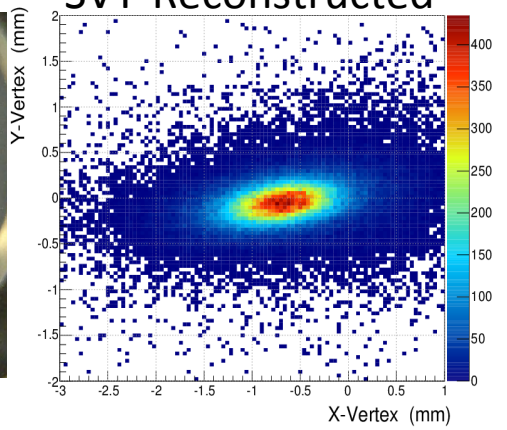
2015 Run: Beam

- Narrow in y for precise vertexing
  - σ_y < 50 μm
- Broader in x for target heat load
  - σ_x < 300-500 μm
- Small halo for SVT @ 0.5 mm

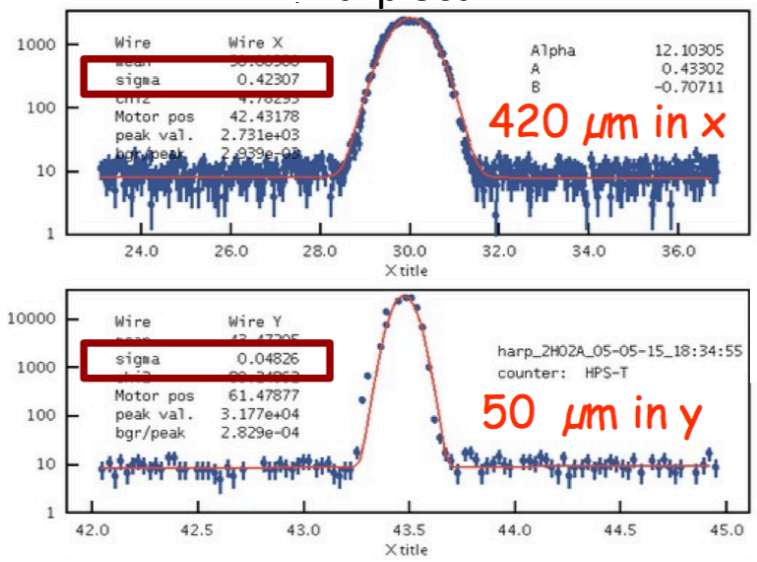
Viewer

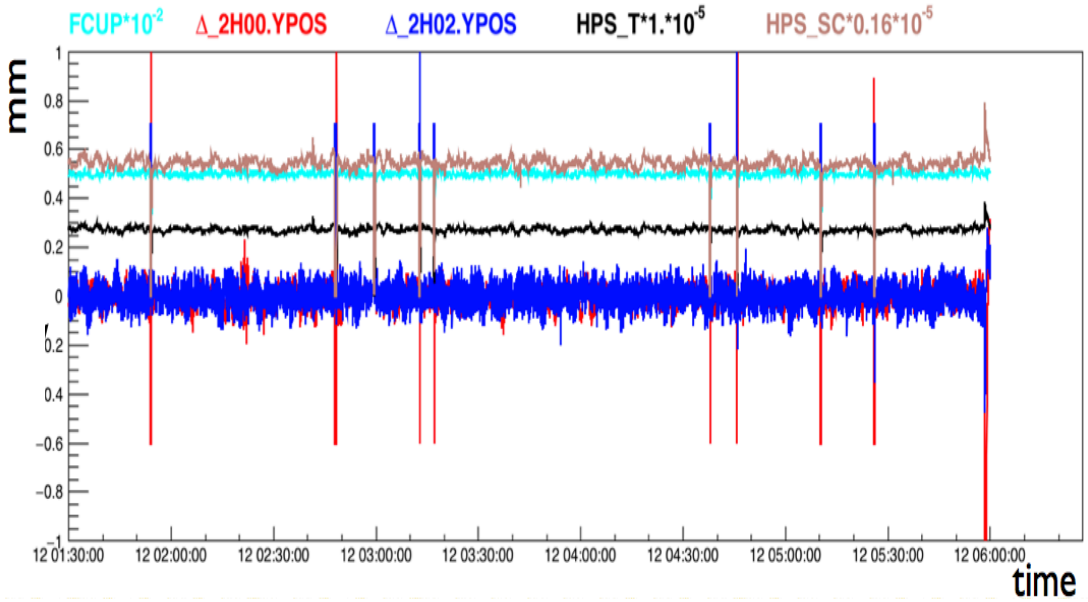


SVT-Reconstructed



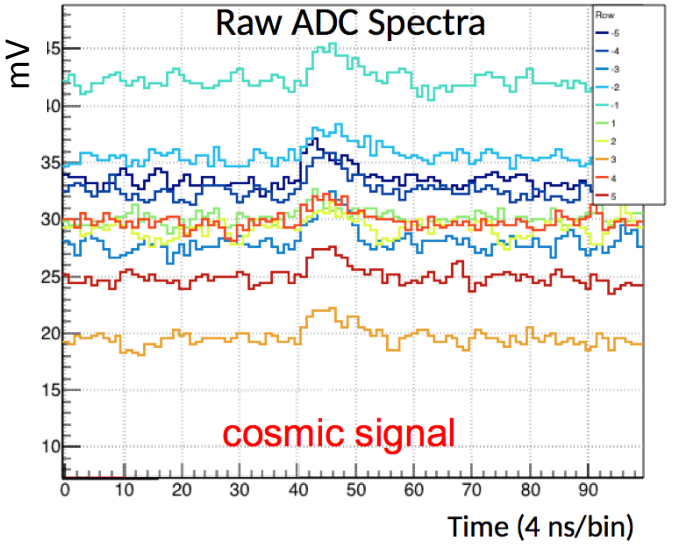
Harp Scan

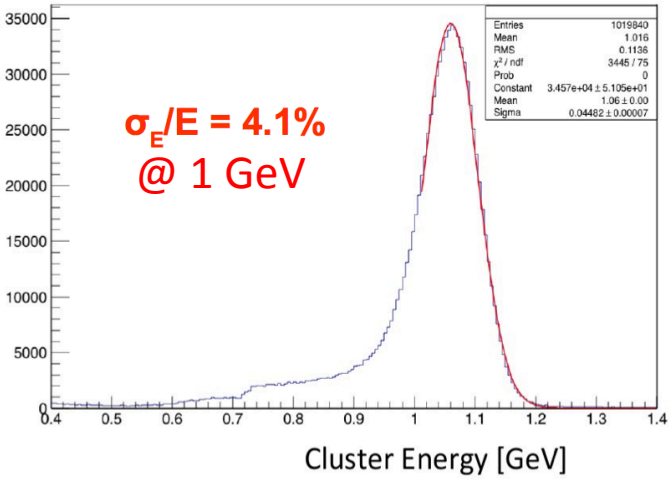


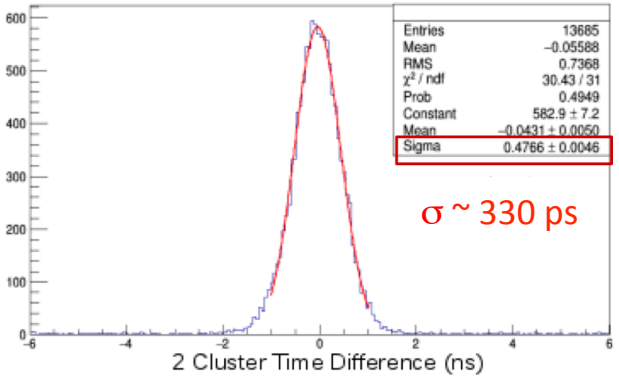


2015 Run: ECAL

- Gain calibration first with cosmic signals and finally 1 GeV electrons
- FADC time calibration against RF
- Achieved expected resolutions



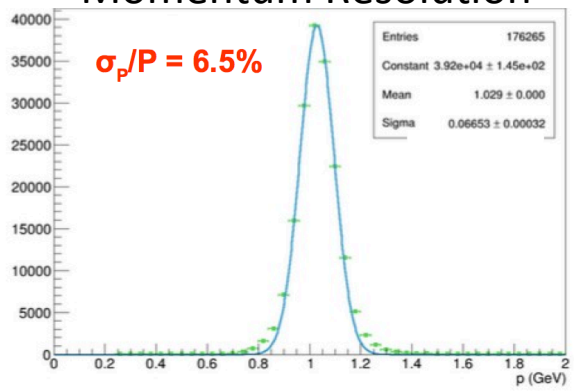




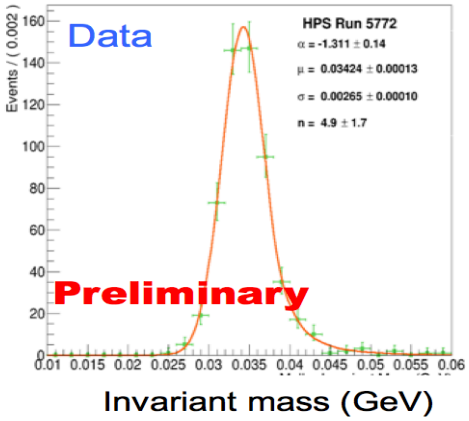
2015 Run: SVT

Expected momentum, mass, vertex resolutions achieved.

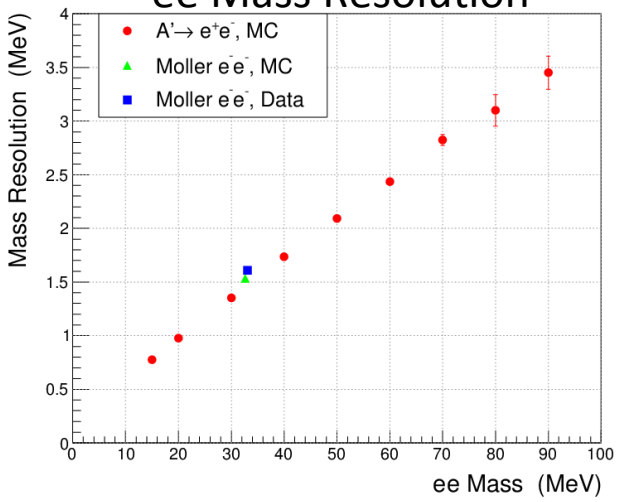
Momentum Resolution



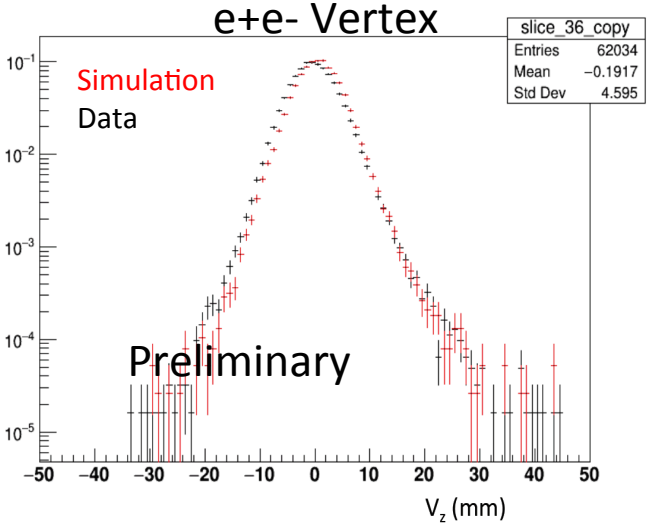
Möller e^-e^- events



ee Mass Resolution



e+e- Vertex



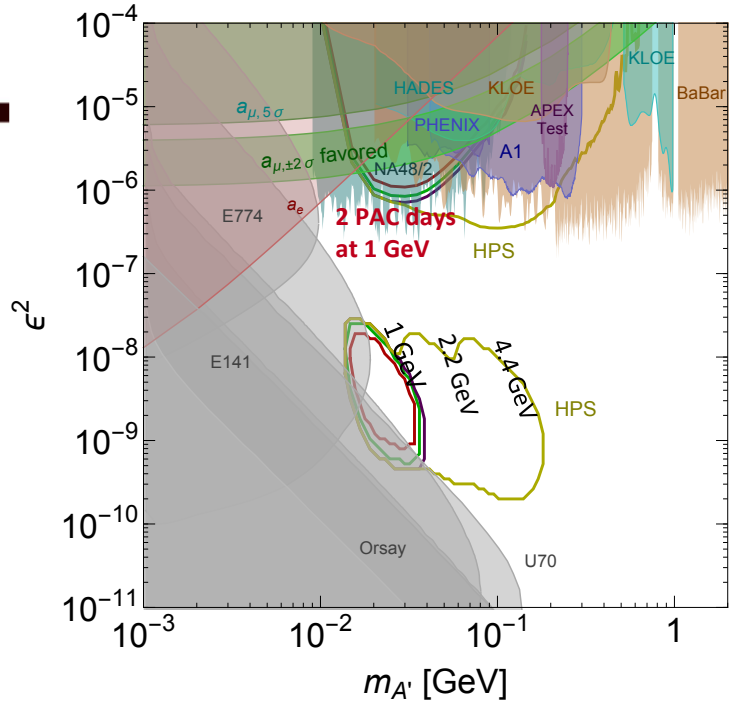
2015 Run: Summary

1st Physics Run, May 4-18, 2015
Nights and Weekends Only
1.05 GeV beam energy

- Collected 2 PAC-days of physics data with SVT Layer-I at 0.5 mm from the beam plane (θ_{min} = 15 mrad) at proposed run conditions:
  - 50 nA beam current and 0.125 r.l W-target

- Analysis of various benchmark reactions (e^-e^-, $e^-\gamma$, e^-e^+, e^-A) showed remarkable agreement with expected performance from simulations

- Final unblinded data processing started early February (4 weeks on batch farm)
- Physics results expected this Spring

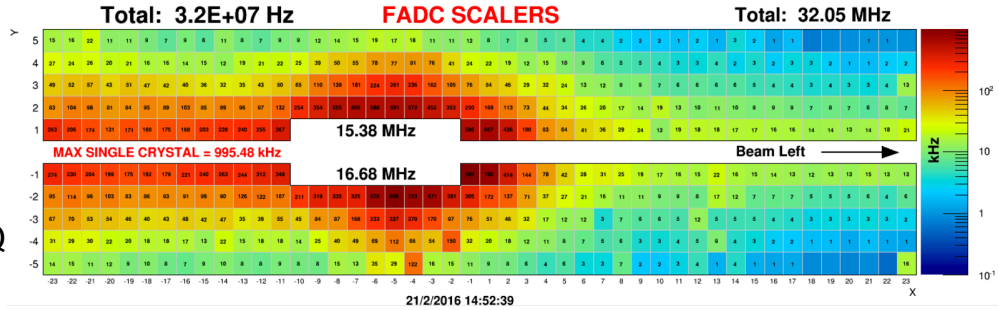


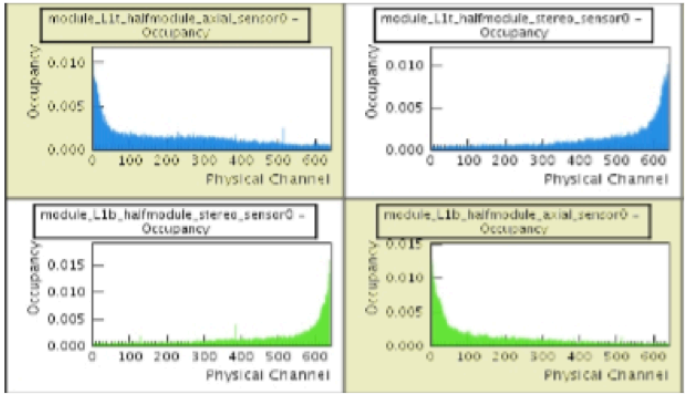
Parameter	Proposal value	Measured value
Beam current	50 nA	50 nA
SVT occupancy	<1%	1%
Ecal rates	0.5 MHz	1.2 MHz
DAQ/trigg. rate	18 kHz	19 kHz
Pair mass res.*	1.5 MeV	1.6 MeV
Pair vertex res.#	4.4 mm	4.6 mm

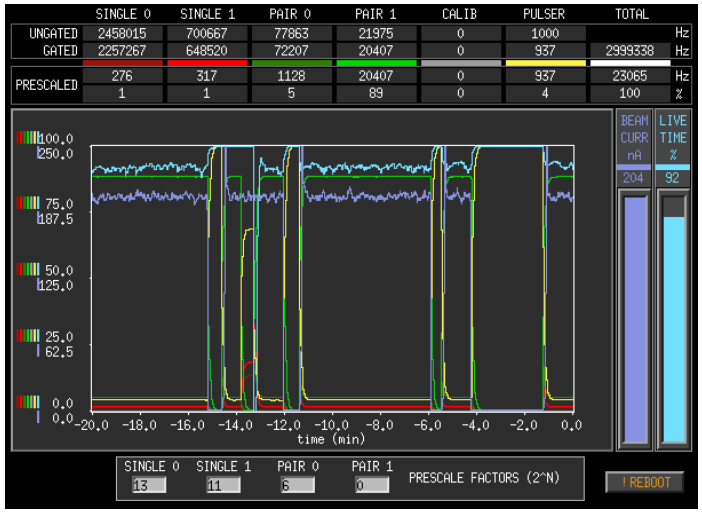
* At 34 MeV
# At 40 MeV

2016 Run

- 2.3 GeV beam energy
- ***Weekend Running Only***
- Accomplished in 1st three weekends:
  - beam optics tuned to σ_x/σ_y = 50/200 μm
  - commissioned beamline, FSD, ECAL, DAQ
  - tested trigger rates, deadtime
  - centered beam+collimator relative to SVT
  - SVT 3rd weekend: moved into 0.5 mm, studied occupancies, timed-in, calibrated thresholds, tuned pulse shaping





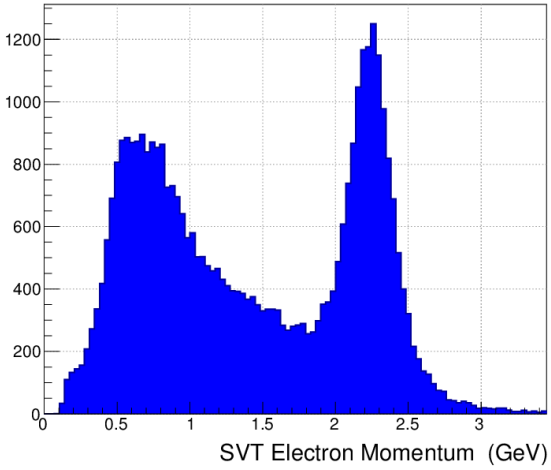


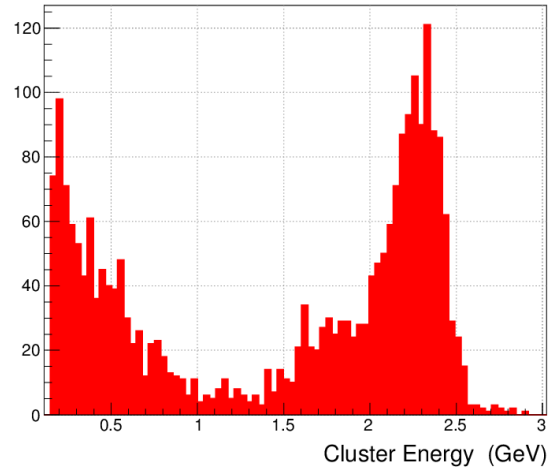
- Started production running at end of 3rd weekend
  - recorded 500M+ triggers at nominal settings
  - also took data at higher currents to study possibility of increasing luminosity (>200 nA)

- 3 weekends remain of production data taking

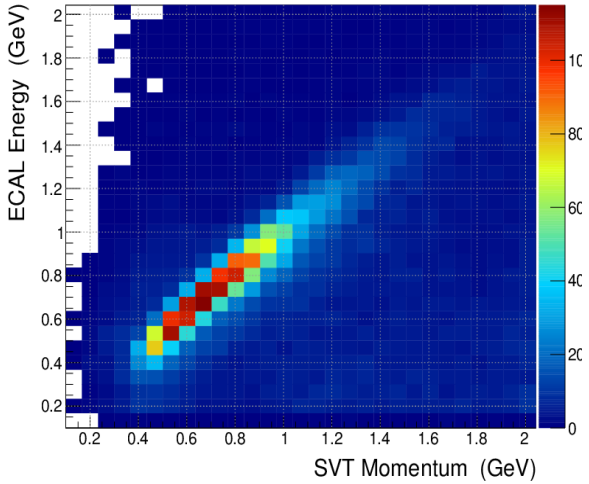
2016 Run: Data Quality Monitoring

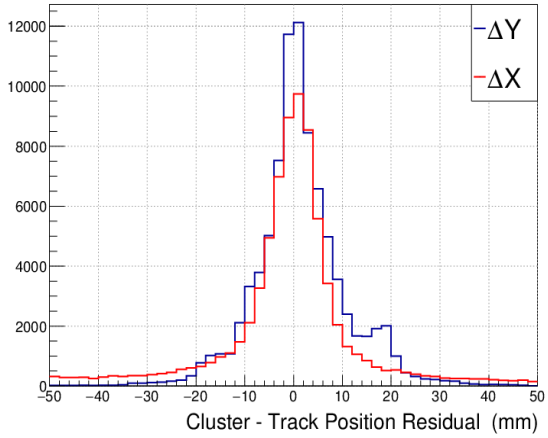
Energy & Momentum





Cluster-Track Matching





Summary

- Successful 2015 run at 1.05 GeV
  - 2 PAC days with SVT @ 0.5 mm
  - physics results expected this Spring
- 2016 run at 2.3 GeV moving into production mode after 3 weekends
  - In remaining 3 weekends hope to achieve 4 PAC days of production data