Heavy Photon Search 2015 Engineering Run and Experiment Update

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Santa Fe, NM

OLD DOMINION
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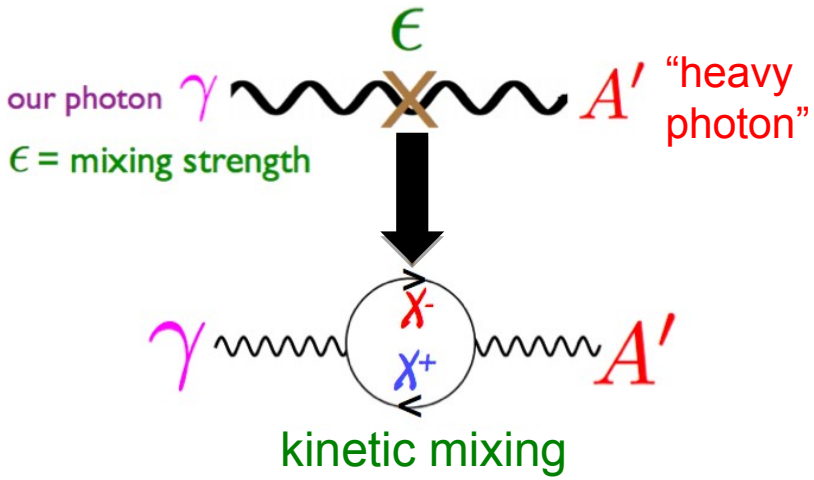
Heavy Photons

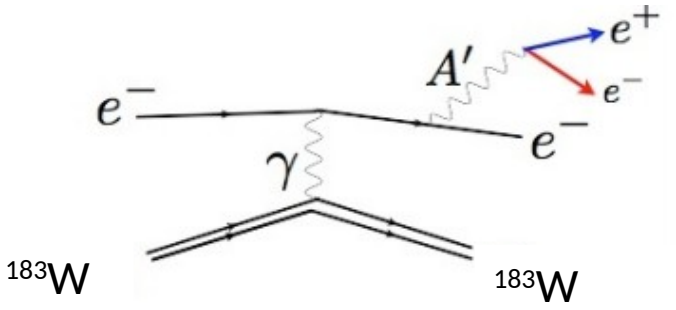
Additional U(1) symmetry in nature
-> new gauge boson!



kinetic mixing

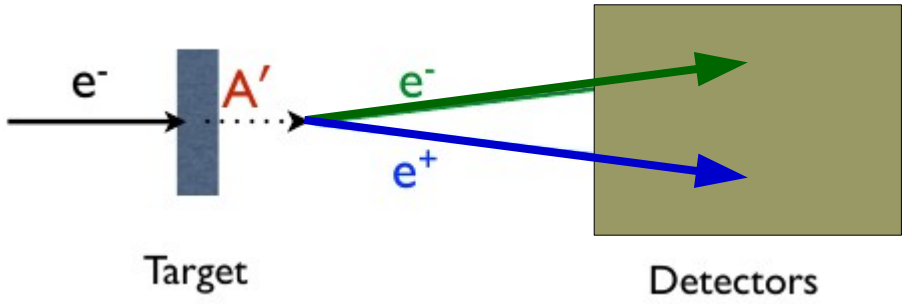
Kinetic mixing could be the leading interaction between the Standard Model and Dark Sector!

Experimental Signature



$e^- + {}^{183}W \rightarrow A' + X \rightarrow e^+ + e^- + X$

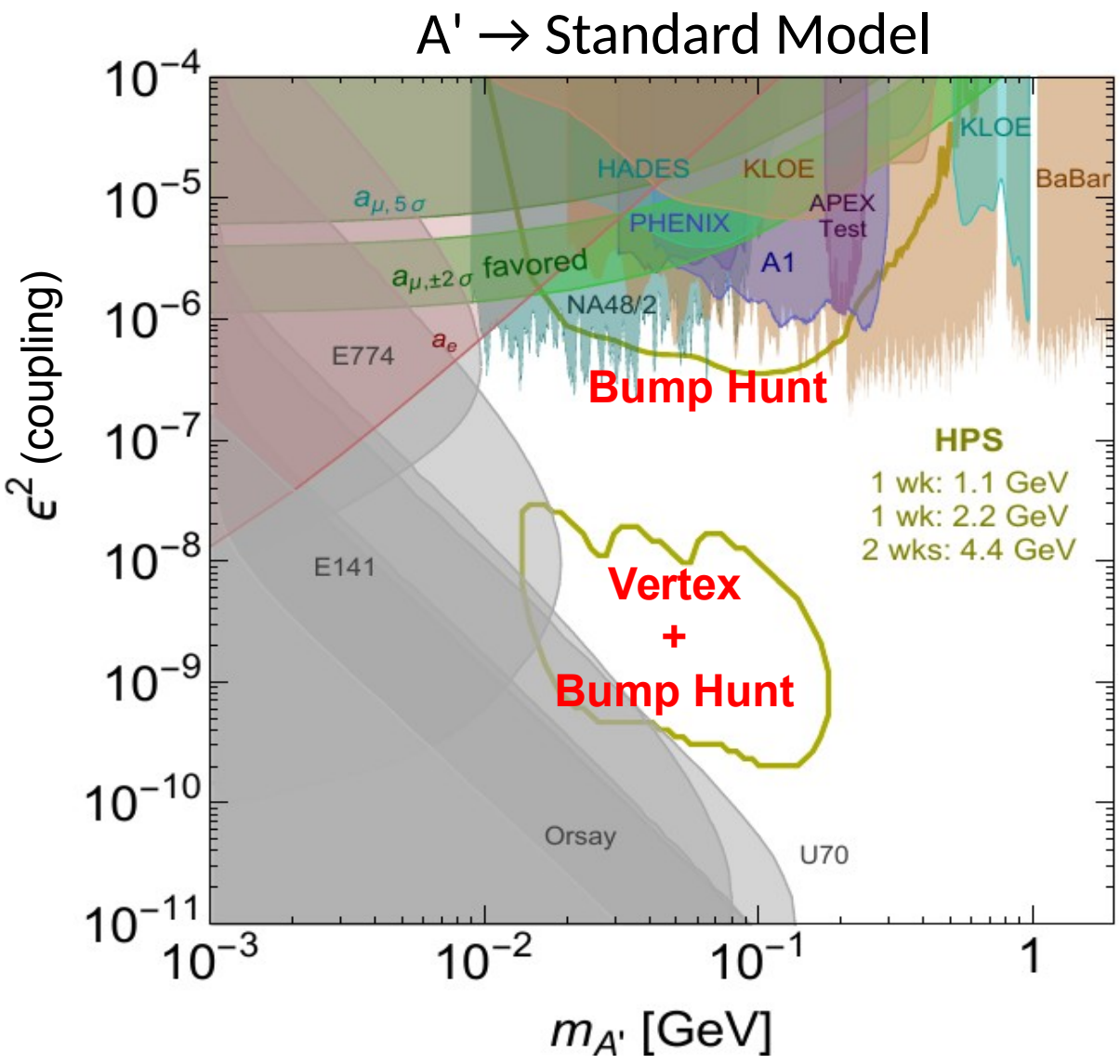
A' → Standard Model particles

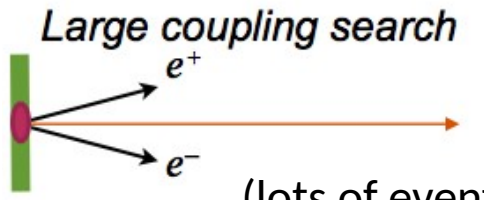


Heavy Photon?

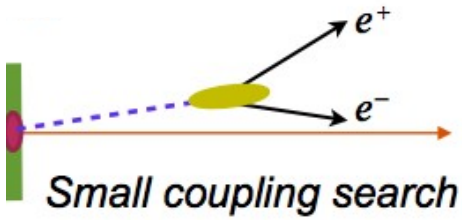
Standard Model		Dark Sector
g $W^\pm, Z$ γ	⟷	forces + particles dark matter?

HPS Proposed Running





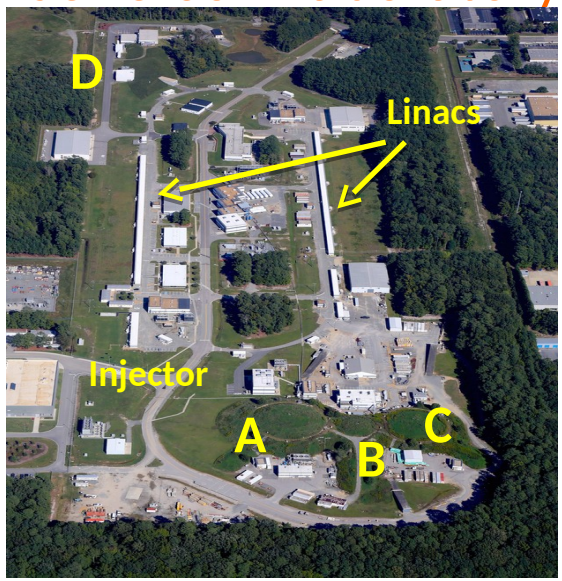
(lots of events)



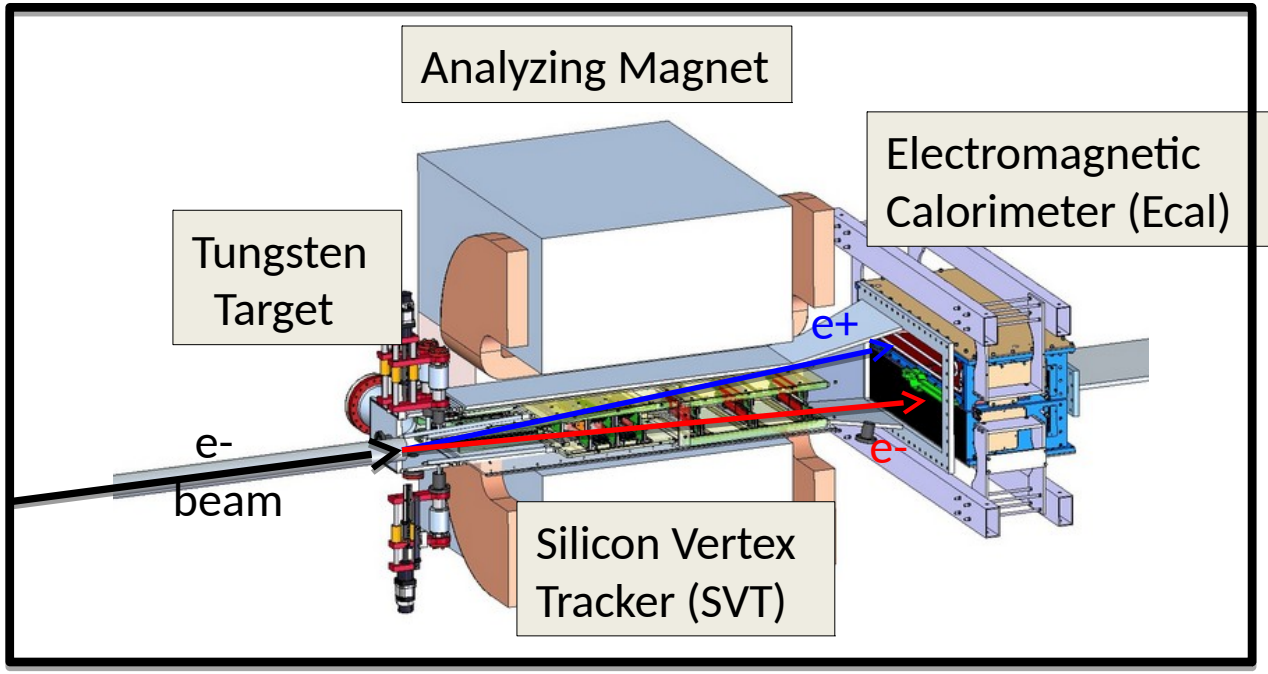
(fewer events)

HPS Experiment

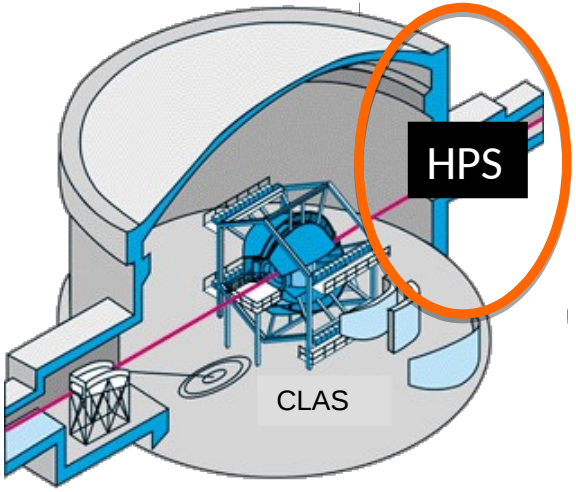
Jefferson Laboratory



HPS in Hall B alcove



Hall B



Detectors:

- SVT: tracks particles, measures momentum and vertex
- ECal: triggers events, measures energy

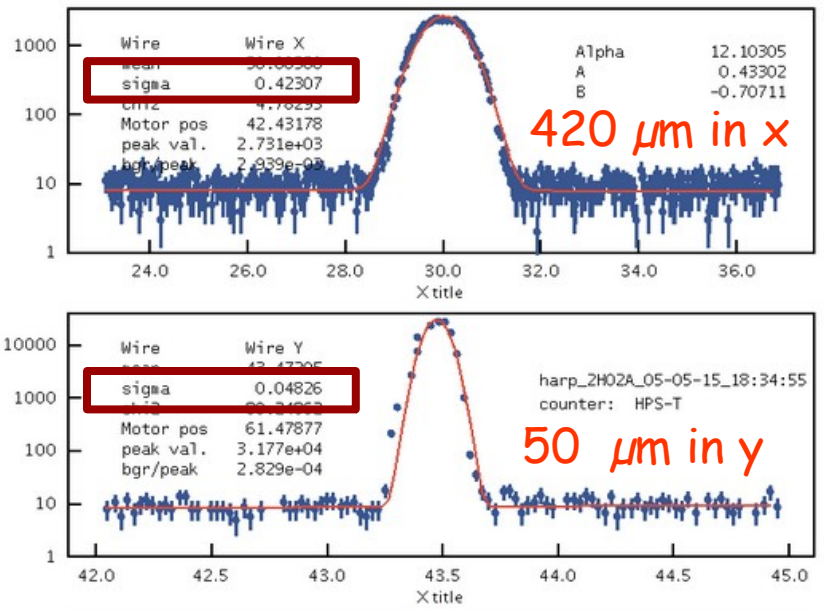
- Magnetic fields bend particles horizontally
- Each detector is separated vertically to avoid "sheet of flame"

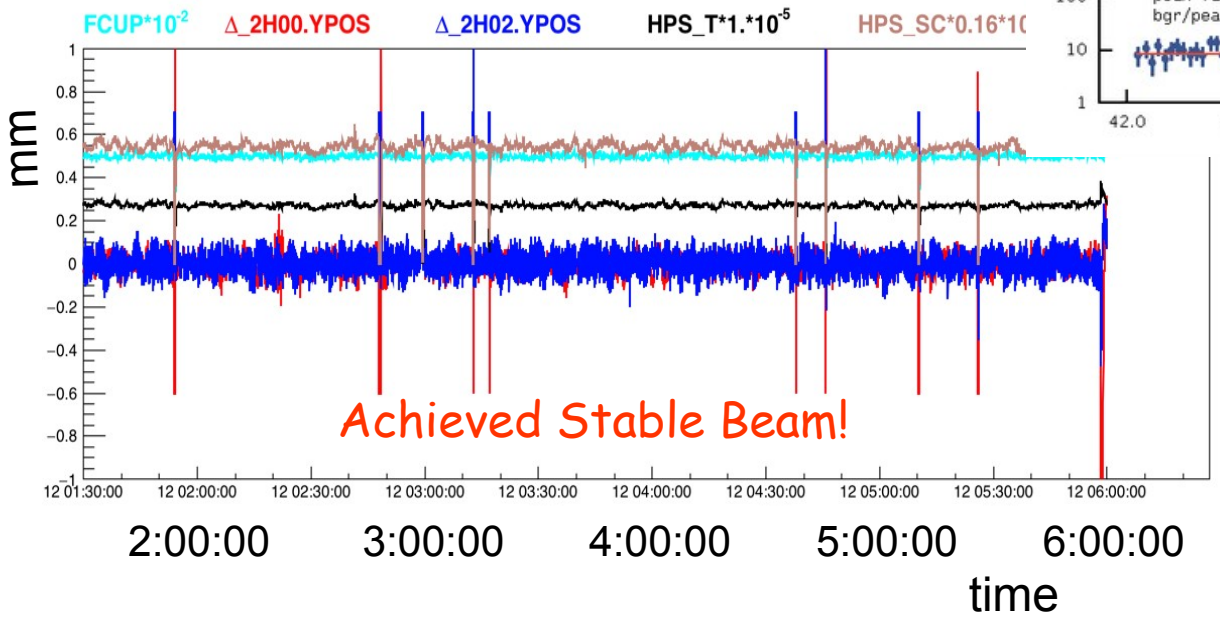
Beam Characteristics

HPS requires a stable, asymmetric beam profile:

- -Precise vertex reconstruction
  - σ_y = 10-50 μm
- -Distribute heat load on target
  - σ_x = 300-500 μm
- -SVT at 0.5 mm from the beam
  - No beam tails

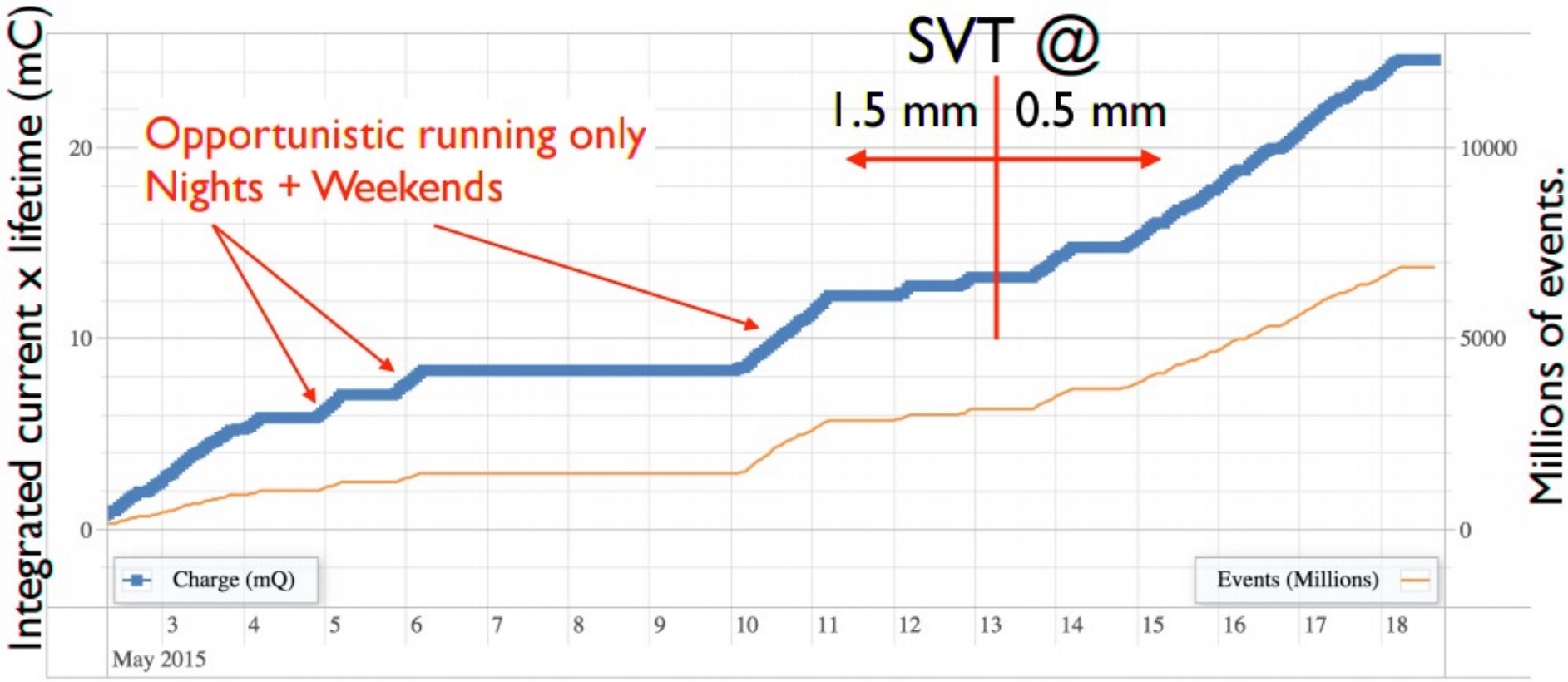
X, Y Beam Profile



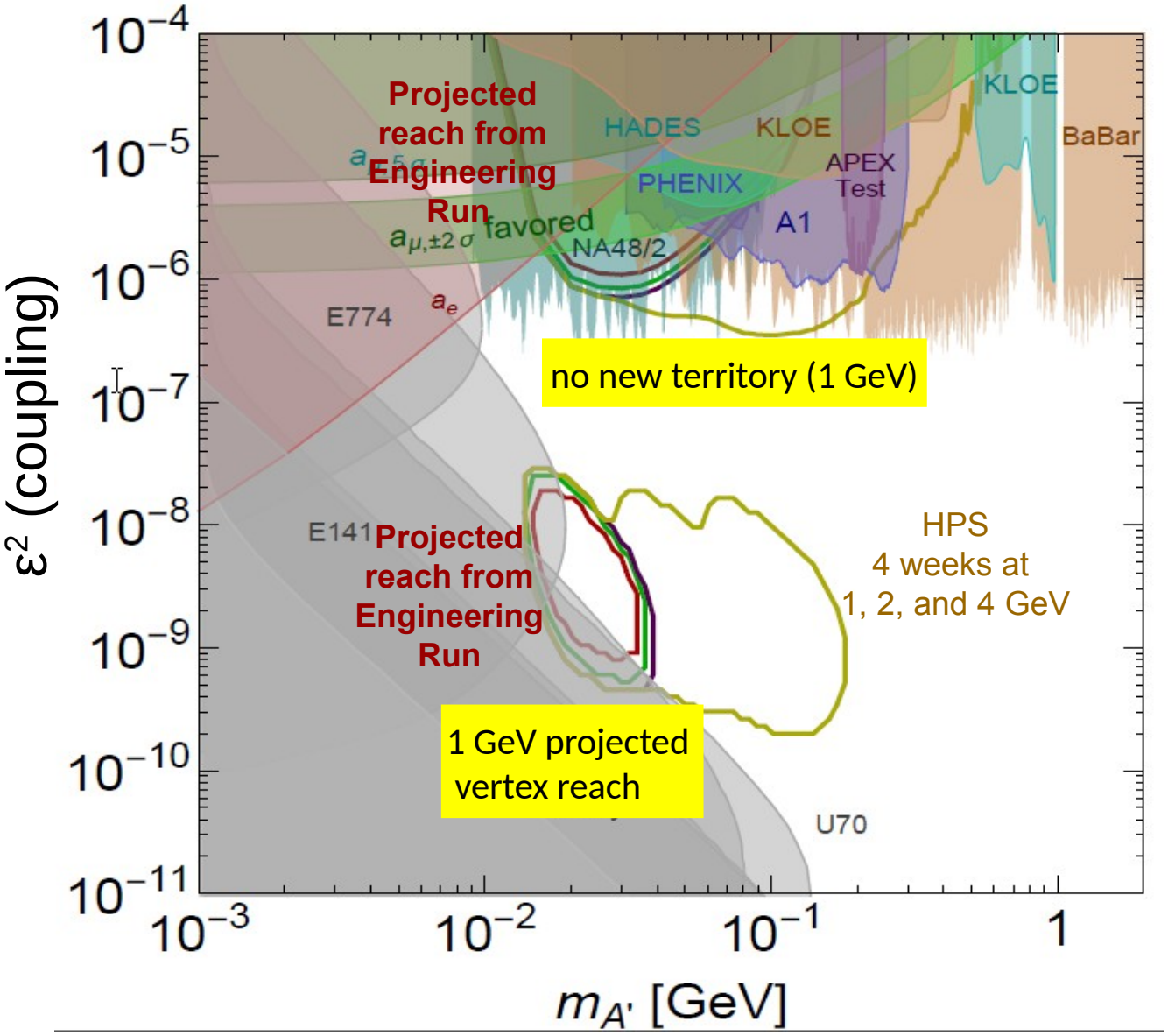


Spring 2015: 1 GeV Beam

Proposal: 30 mC (1 week at 50 nA)
Achieved: ~10 mC with SVT at +/- 1.5 mm,
10 mC with SVT at +/- 0.5 mm

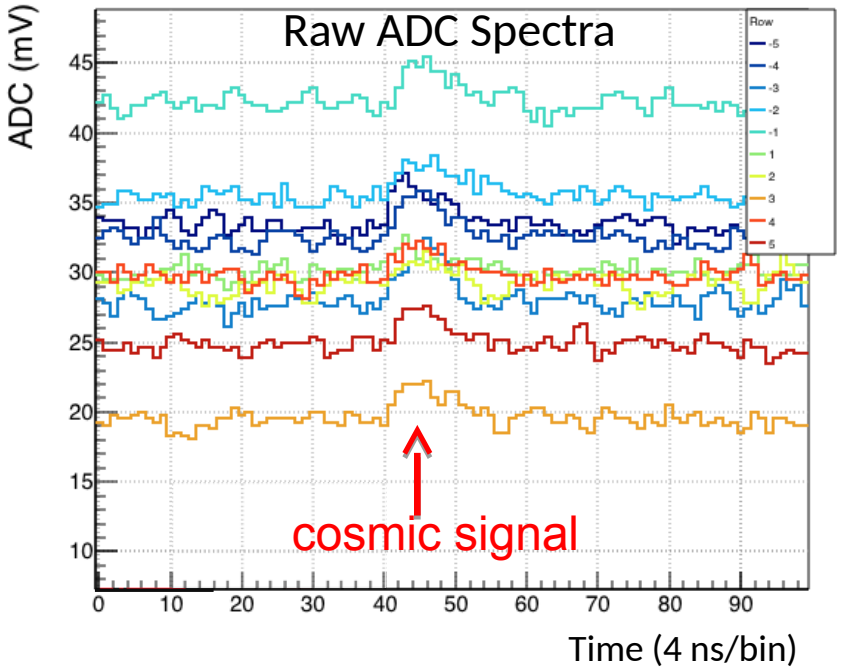


Projected HPS Reach

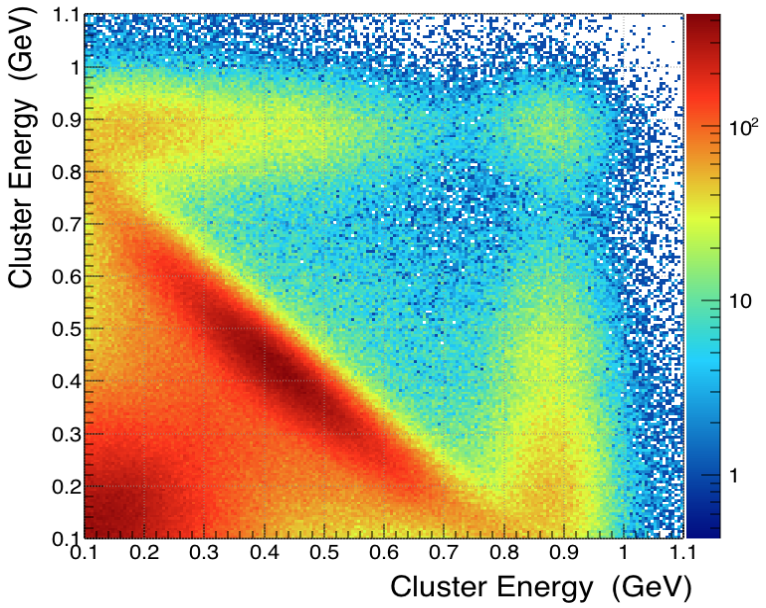


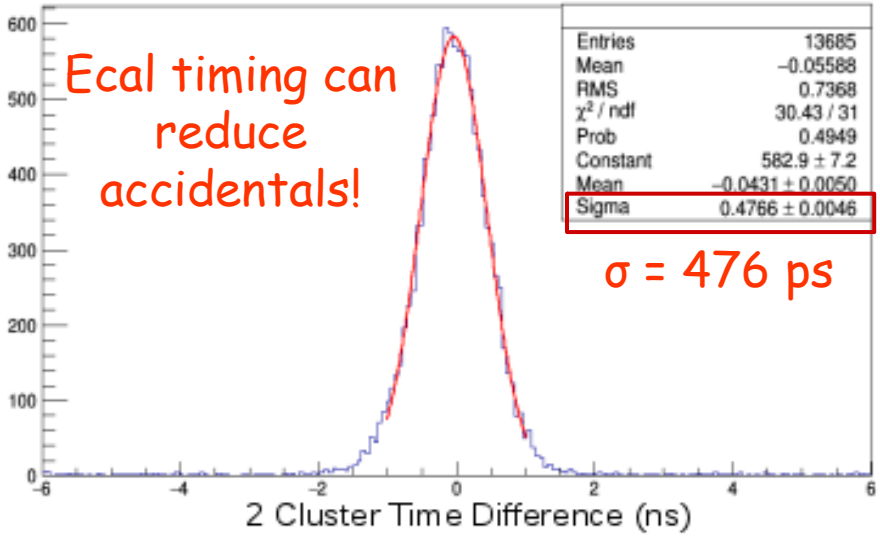
Ecal Calibration

- Ecal provides fast trigger for experiment
- At 1 GeV beam, Ecal and SVT energy resolution comparable



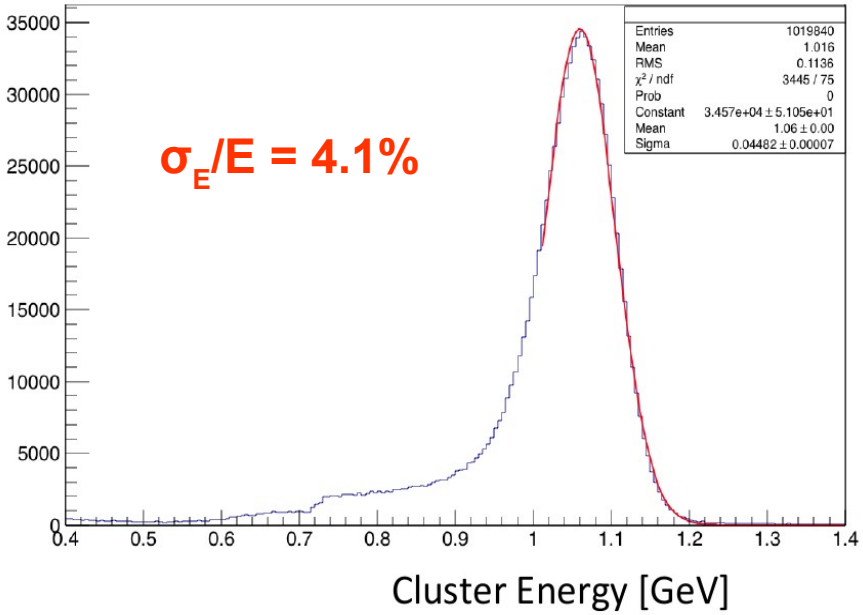
Cosmic ray muon passing vertically through 10 crystals in the Ecal



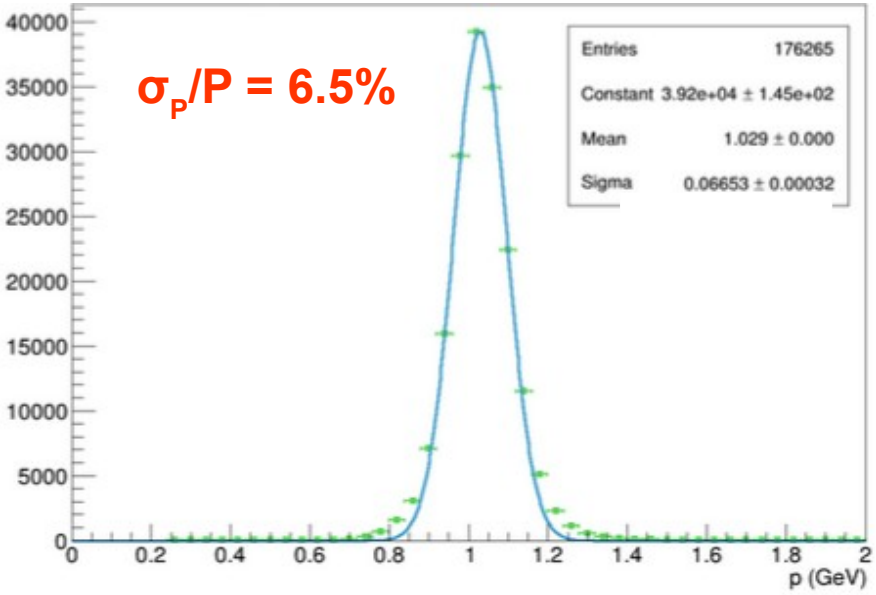


Elastically Scattered Electrons

Ecal Cluster resolution:



SVT Track resolution:



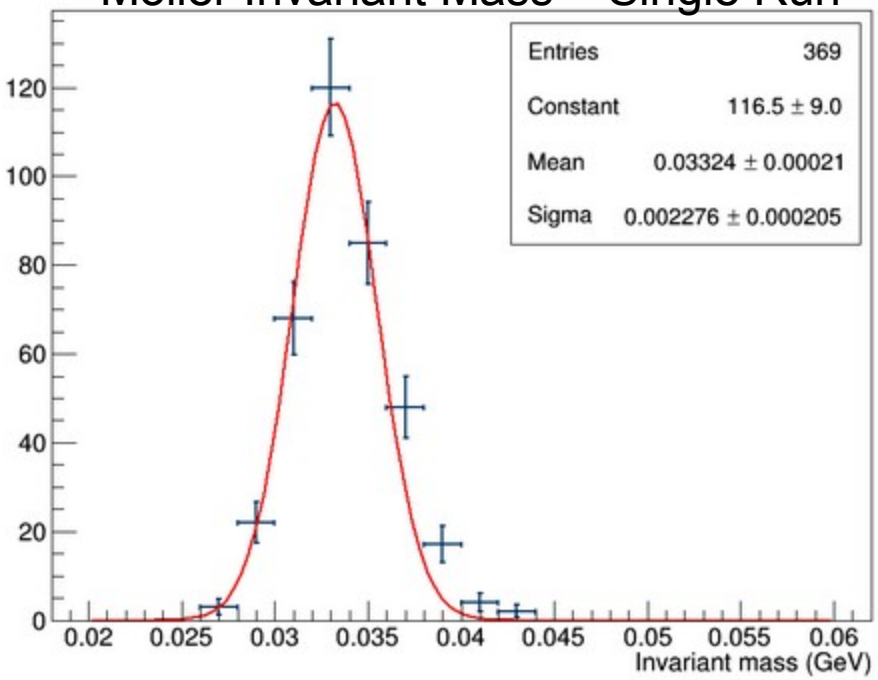
Plot from O. Moreno

Moller Invariant Mass

- Mollers are accidentals to HPS primary triggers
- Useful for calibration using e^-e^- correlated pairs

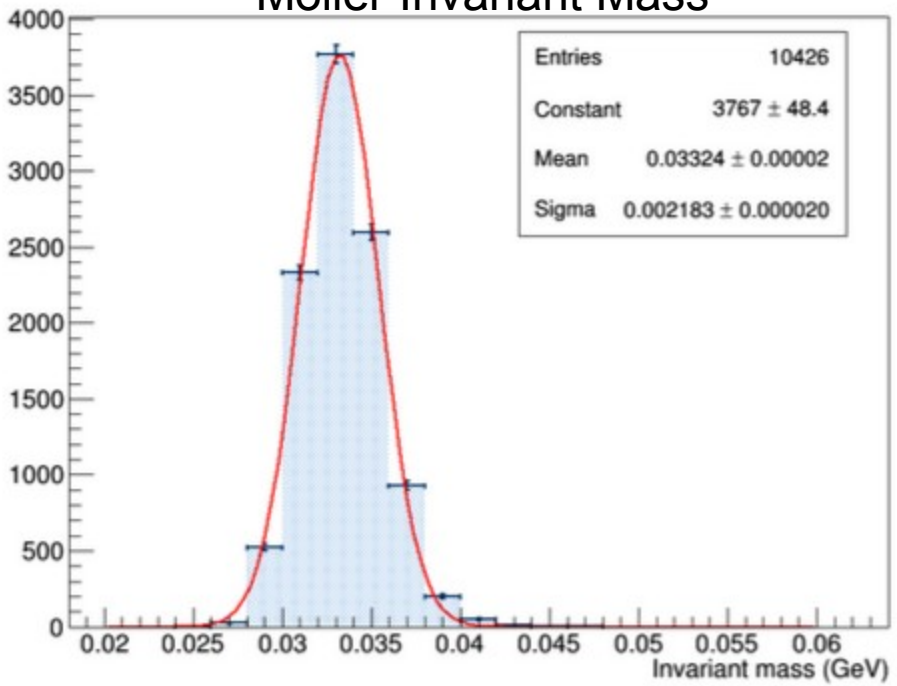
Data

Moller Invariant Mass – Single Run



Monte Carlo

Moller Invariant Mass

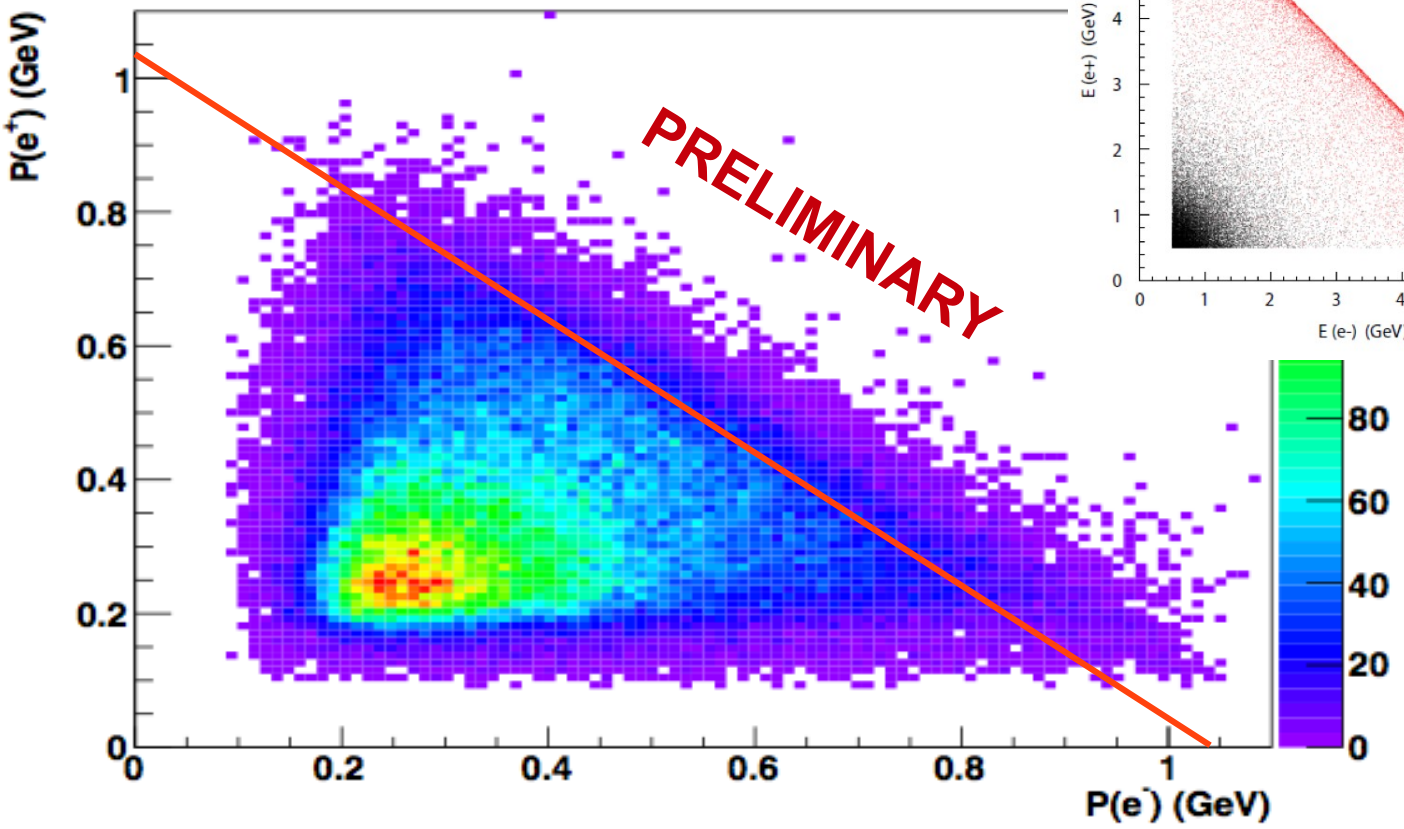


Plots from O. Moreno

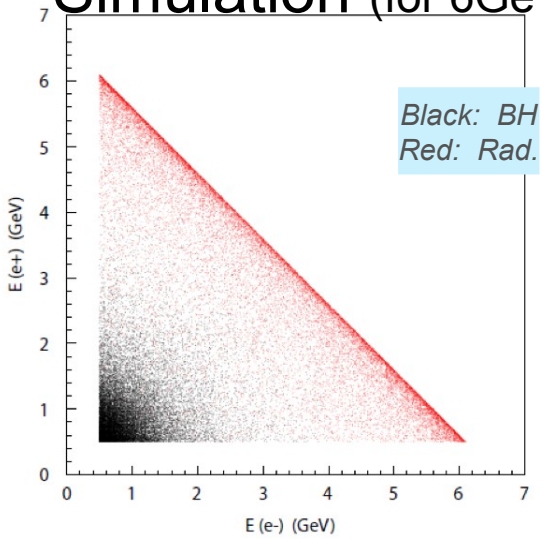
Tracked e^+e^- Pairs

Candidate A' pairs have a momentum sum of the beam energy (1.05 GeV)

From data:

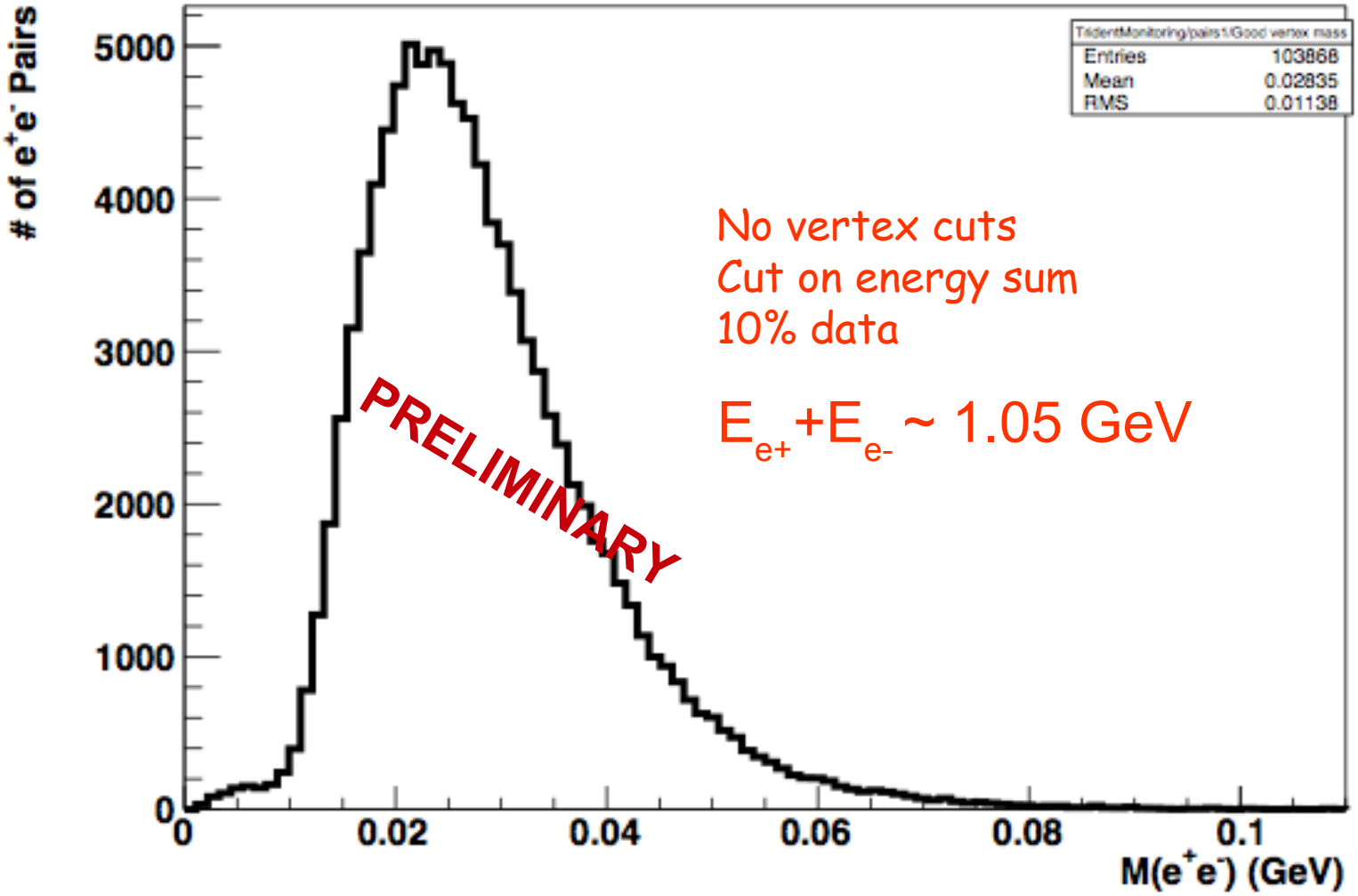


Simulation (for 6GeV)



Plot from M. Graham

e^+e^- Pairs Mass Distribution



Conclusions

- HPS Engineering Run successful
  - SVT and Ecal commissioned
  - Beamline commissioned
  - Successfully ran with SVT at 0.5 mm from the beam!
  - First physics data, 3 Beam Days at 1 GeV
- Calibrations almost final
- Blinded data analysis:
  - Analyze 10%
  - Freeze cuts
  - Unblind

Stay Tuned!