4-year overview

Daniel Cebra, UC Davis

January 10, 2025

Groups members: current and past

Graduate students

current: Zach Sweger, Mathias Labonte, Saeahram Yoo, Ziyuan Zeng, Andrew Liggett

previous (& current location): Sam Hepplemann (LLNL)

Postdocs

current: none

previous: none

Undergrads

current: none on project

previous (& current location):

Staff: Daniel Cebra and Manuel Calderon

Zach

Sam

Saeahram

Mathias

Ziyuan

Andrew

Daniel

Manuel

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List main accomplishments in past 4 years

- **UCD has had GS resident at LBNL (Sam ➔ Zach ➔ Mathias).**

- **Zach completed and published work started by Sam and supervised by LBNL Staff Spencer Klein.** Phys.Rev.C 106 (2022) 1, 015204

- **Zach has completed the DVCS project, paper published (supervised by Spencer Klein).** Phys.Rev.C 108 (2023) 5, 055205

- **Zach has worked on studies on ZDC requirements for backward physics channels to inform the ZDC design.**

- **Zach completed work with the Exclusive/Diffractive/Tagging group on far-forward benchmarks for B0 and ZDC development.**

- **Zach developed tutorial for developing benchmarks (https://eic.github.io/tutorial-developing-benchmarks/)**

- **Saeahram with LBNL PD Minjung Kim in produced TDR plots for resolution of the three upsilon states.**

- **Mathias has started a study of the nuclear excitations in order to determine if we could tag incoherent events.**

- **Mathias, Saeahram, Andrew, and Ziyuan have assisted the hardware effort at LBNL (led by Nikki Apadula).**

- The UC Davis plan is to provide students to assist LBNL/UCB with construction of the silicon tracker.

Key roles in ePIC

- None

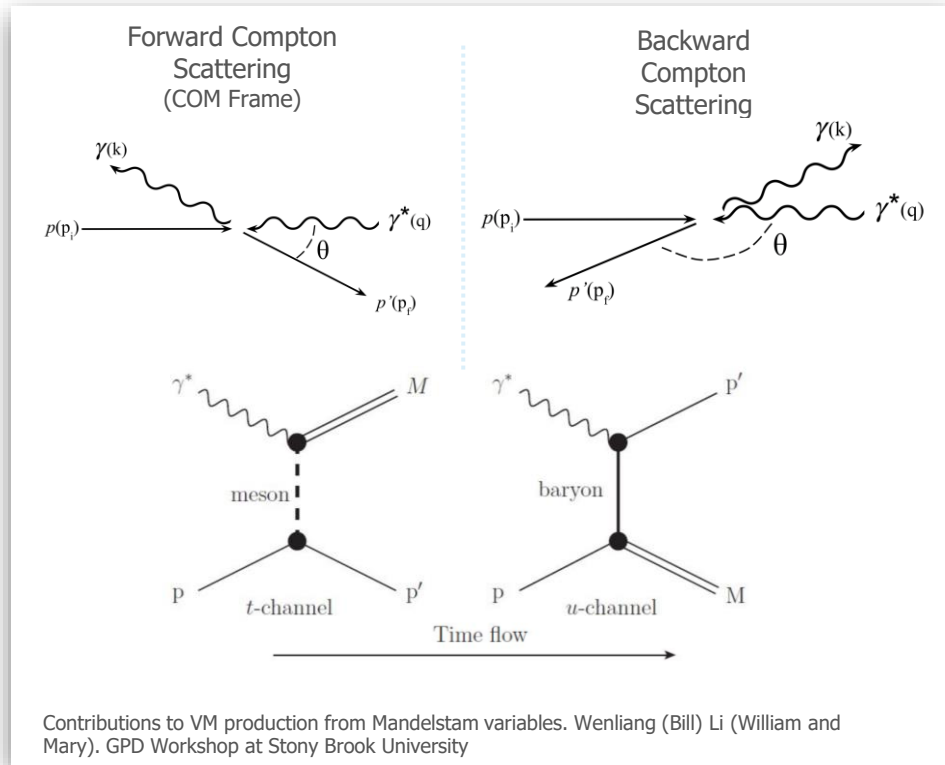# Key non-EIC accomplishments

Broader
Impacts

Highlighted in LRP

- Cebra – Developed and led RHIC BES II/FXT Program
- Cebra – Developed Space Radiation Program at RHIC
- Cebra – Developed Astatine production at UC Davis cyclotron
- Calderon – Made IMAX movie *Secrets of the Universe*
- Hepplemann/Sweger – Lead critical point search FXT energies
- Ota Kukral – Completed study of χ_C states at CMS
- Matt Harasty/Labonte – p/K/p spectra at BES II/FXT
- Santona Tuli/Graham Waegel – CMS suppression of Υ states.

DOE
PEMP
Notable

Highlighted in LRP

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3-4 EIC highlights with pictures (multiple slides)

Backwards (u-channel) Compton Scattering

electron beam → ← p/A beam

Forward region   Backward region

Forward Compton Scattering (COM Frame)

Backward Compton Scattering

Contributions to VM production from Mandelstam variables. Wenliang (Bill) Li (William and Mary). GPD Workshop at Stony Brook University

### Forward vs Backward Scattering
- Forward Production
  - t-channel: low Mandelstam t, high u
  - Momentum transfer to target is small
  - γ is produced in backwards (e⁻-going) direction
  - Proton continues in forward direction
- Backwards Production
  - u-channel: low Mandelstam u, high t
  - Momentum transfer to target is large
  - γ produced in forwards (p-going) direction
  - **Proton shifted many units in rapidity**

Backward scattering results in a large rapidity shift of the incident proton and probes the question of whether the baryon number is carried by the valence quarks of by the gluon junction.

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3-4 EIC highlights with pictures (multiple slides)

- Zach completed studies on ZDC requirements for backward physics channels to inform the ZDC design and led to far-forward benchmarks for Bo and ZDC development and figures for the TDR.
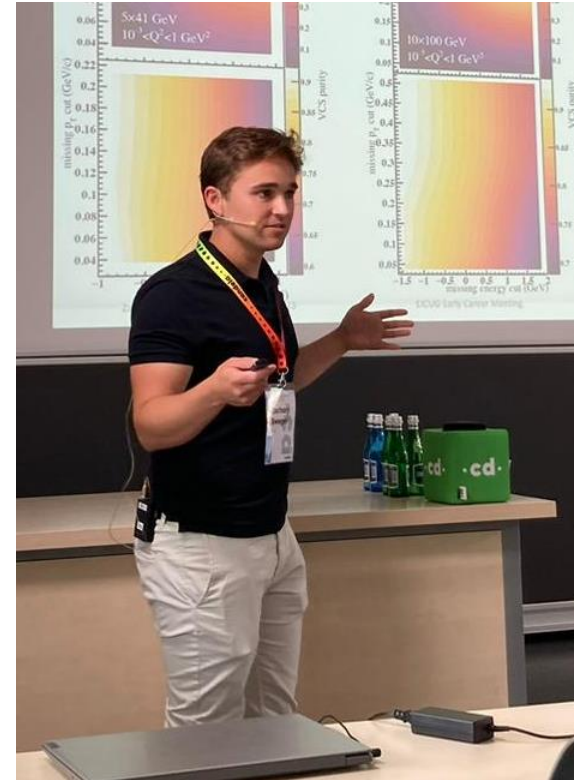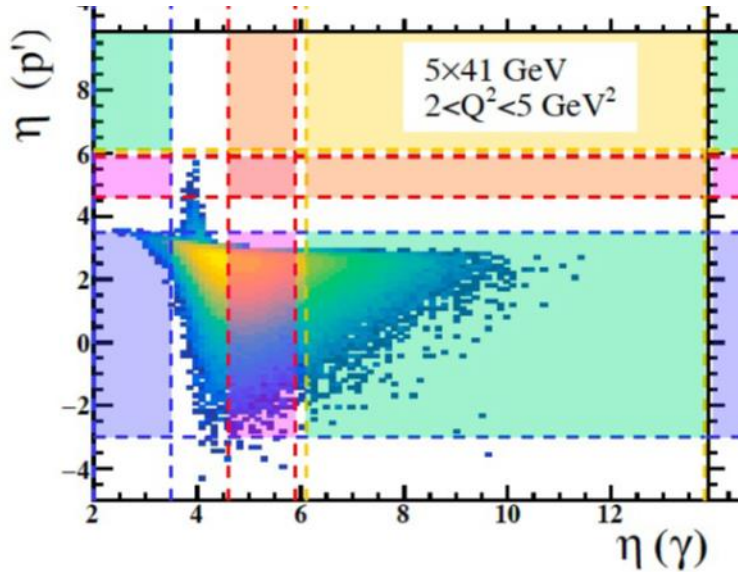
3-4 EIC highlights with pictures (multiple slides)

• Saeahram, with LBNL PD Minjung Kim, has completed a study the tracker resolution of the EPIC detector using three Upsilon states in the electron decay channel. She has prepared a plot for the TDR.
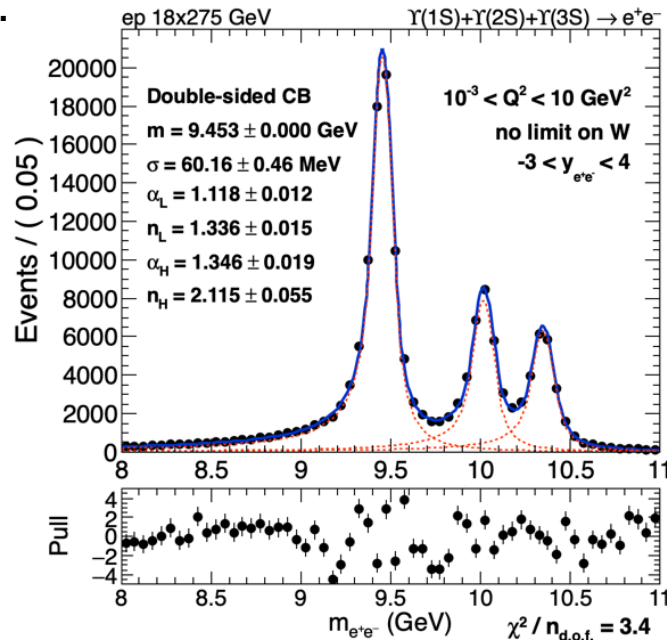
3-4 EIC highlights with pictures (multiple slides)

Mathias is using BeAGLE (an eA event generator) to look at how well we can parse coherent vs. incoherent events. In incoherent events, the nucleus excites, then de-excites, and semitting a gamma into the ZDC.
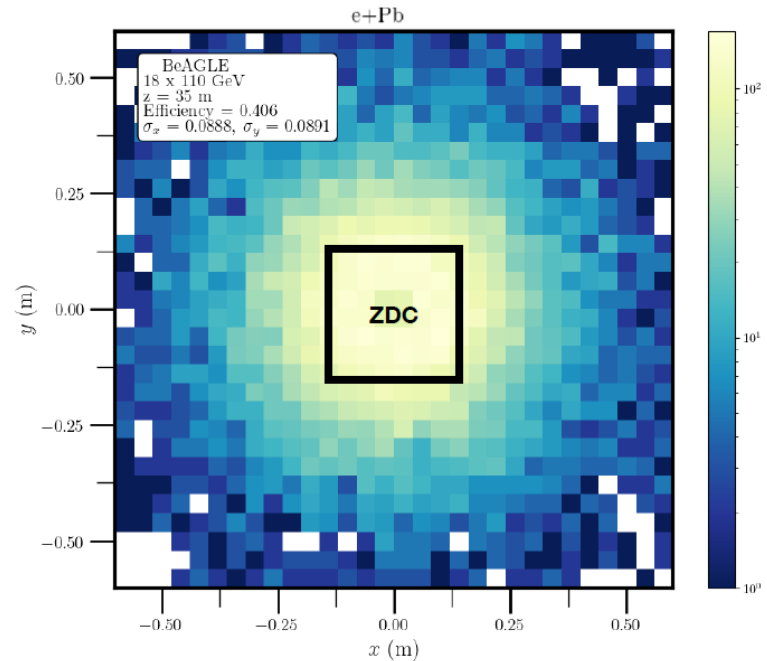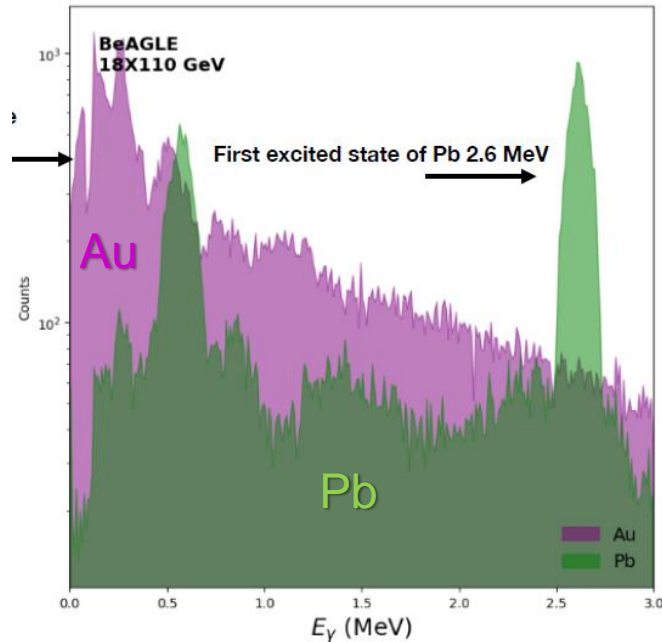
Leveraged funding (grants due to MRPI project)

- In some sense the core UC Davis grant was leveraged due to the MRPI project. We did mention this connection in our renewal in 2021, and were funded in full.

Publications in past 4 years

- Phys.Rev.C 106 (2022) 1, 015204

- Phys.Rev.C 108 (2023) 5, 055205

Future plans in the EIC program

- **Faculty hire likely in the 2026 timeframe.**

- **Continue studying backward vector meson production and it's connection to stopping in heavy ion collisions.**

- **Continue UCD efforts in heavy flavor production and polarization.**

Backup

Plans - Overview

Physics Goals: Heavy quarkonia production in DIS and in photon-nucleus collisions

Building on the expertise of Calderon, who has studied upsilon production at RHIC and at the LHC in p+p, p+A, and A+A collisions, and the theoretical work of our colleague, Ramona Vogt, we would like to continue this research into the EIC era.

Photonuclear collisions involving the exclusive production of light vector mesons (ρ, ω, Φ) and of heavy quarkonia (J/ψ and Υ particles) provide an excellent tool to probe gluon distributions at low x. Tagging the outgoing electron and is necessary to fully constrain the kinematics. Tracking is essential for the measurement of the leptons from the decays of the vector mesons and heavy quarkonia – this stimulates our interest in tracking simulations and performance.