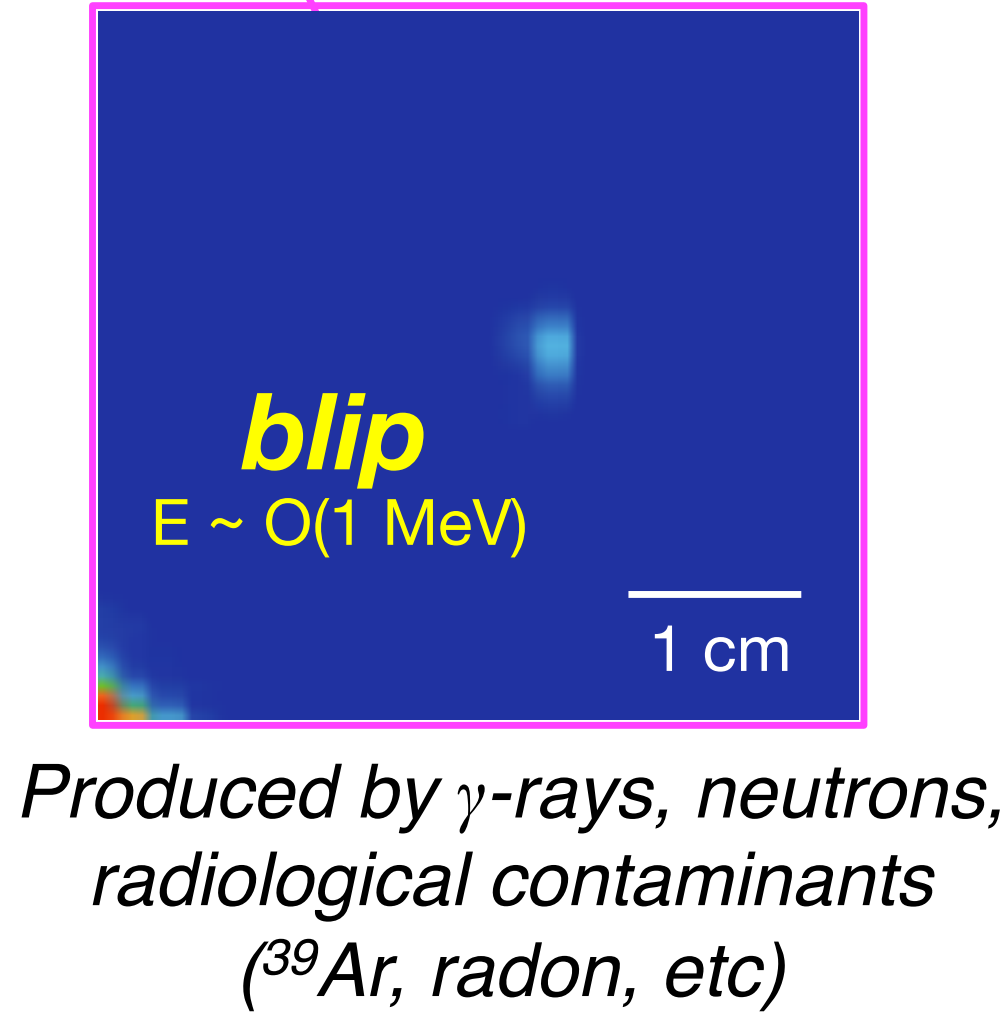
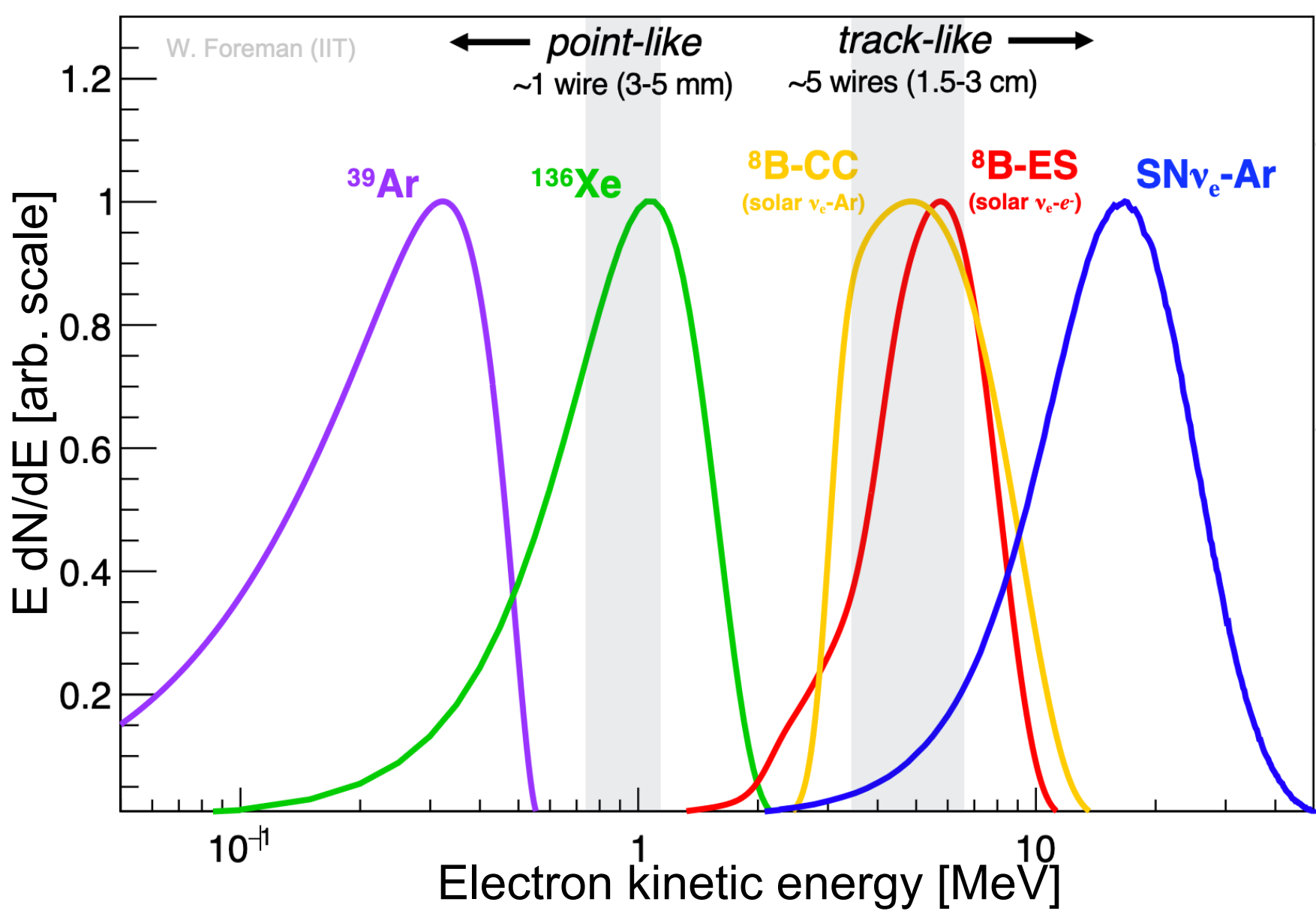


MeV-Scale Blip Reconstruction and Measurements of Radon Progeny in the MicroBooNE Liquid Argon TPC

Bryce Littlejohn, Will Foreman (Illinois Institute of Technology) representing the MicroBooNE Collaboration

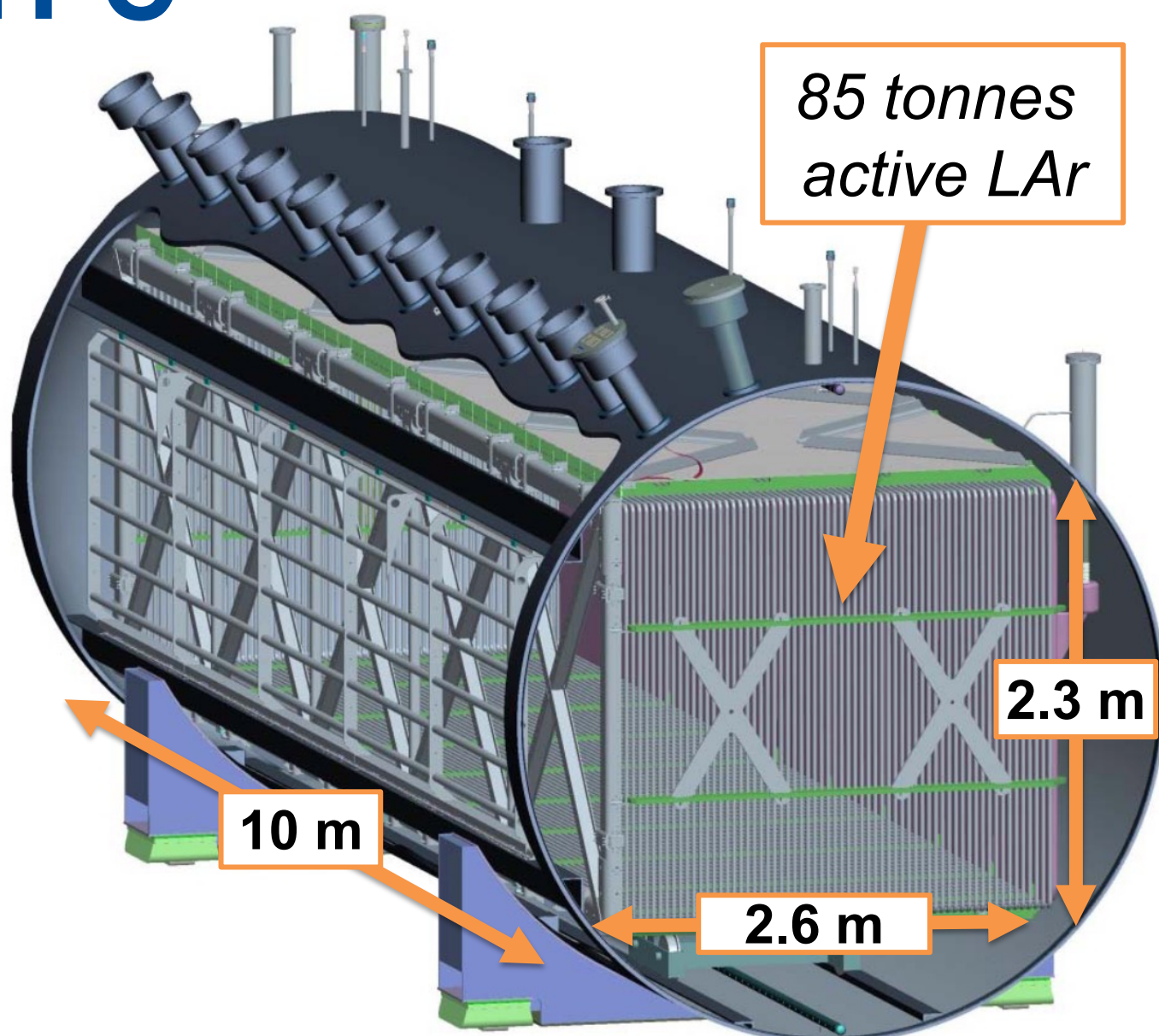
1) Energy Scales in LArTPCs

- Benefits to MeV-scale blip reconstruction:
- Tagging neutrons & γ -rays from ν -Ar hadronic final-states for calorimetry
- PID for μ/π capture-at-rest
- Supernovae & solar ν detection
- 'Beyond Standard Model' searches



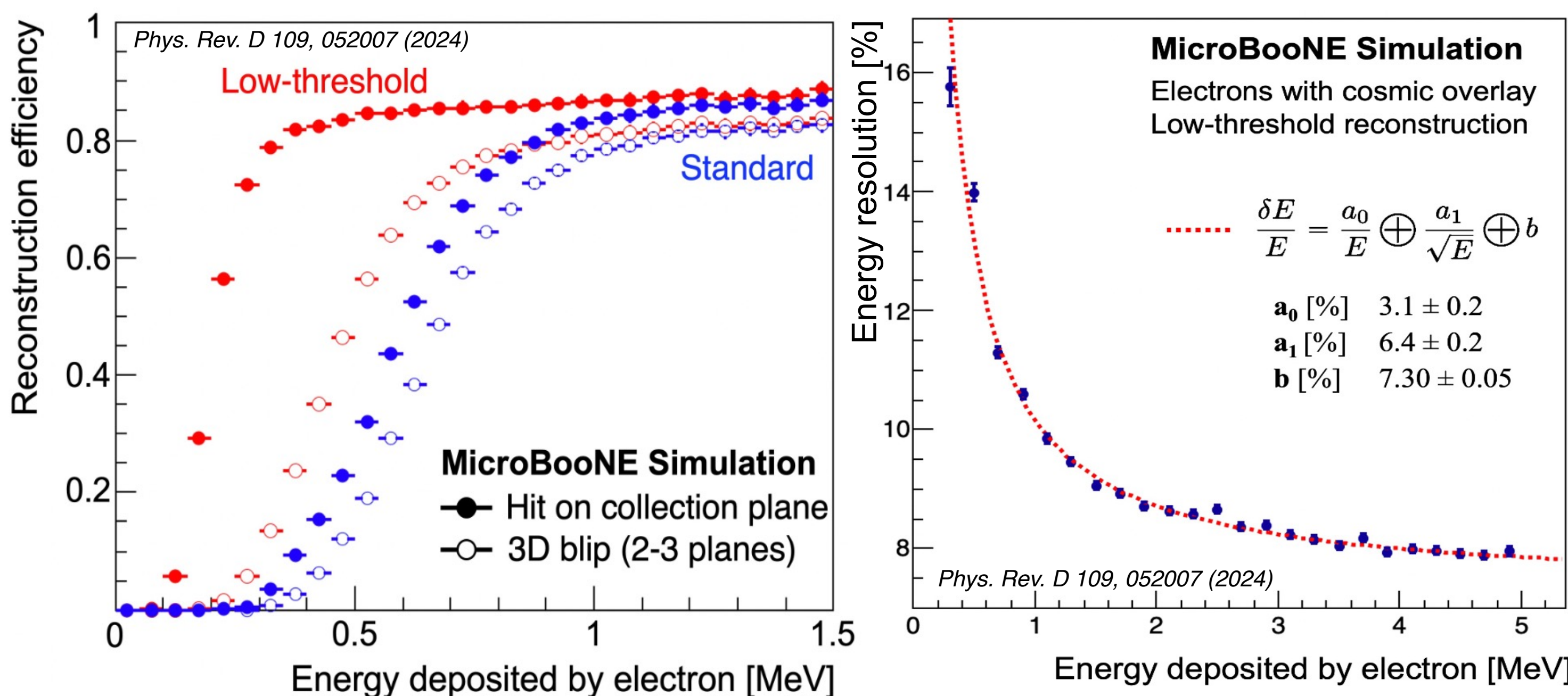
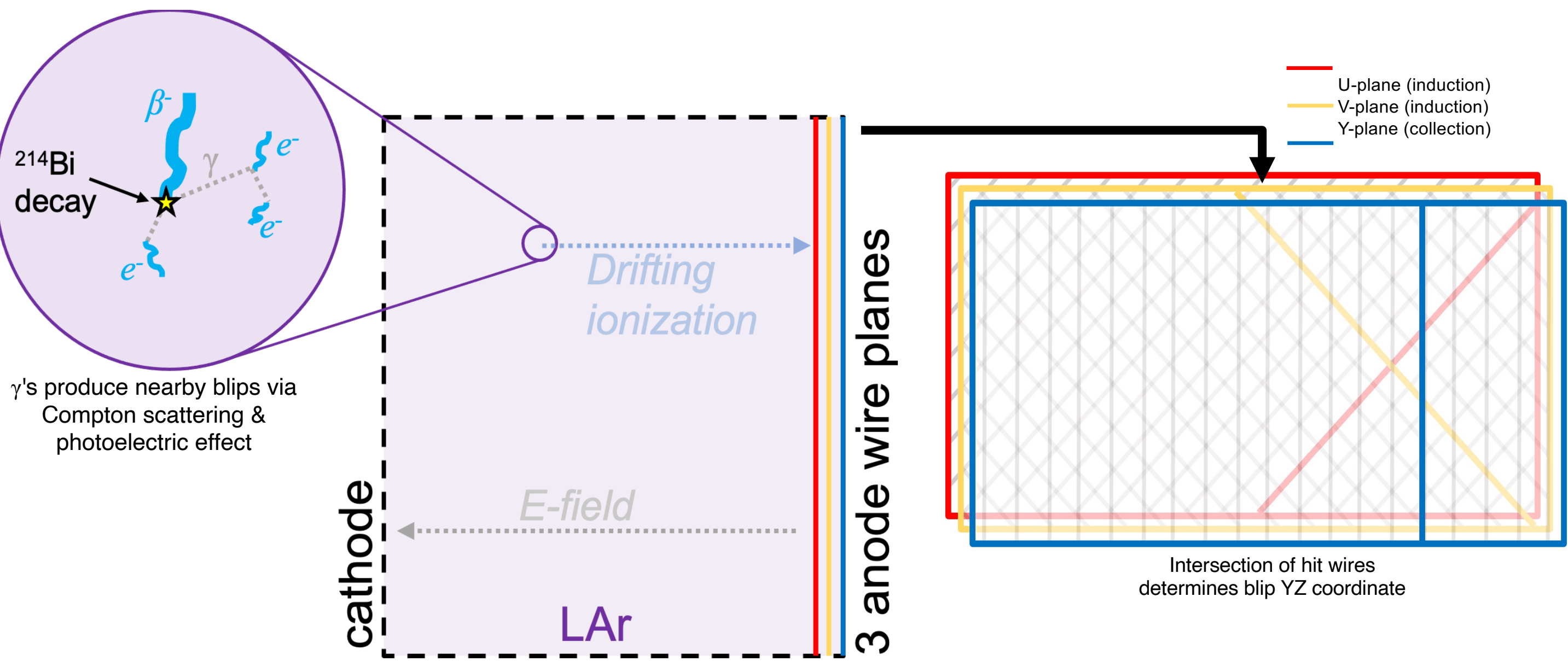
2) The MicroBooNE LArTPC

- Ran from 2015-2021
- Exposed to Booster & NuMI ν beamlines at FNAL ($E_\nu \sim \text{GeV}$)
- E-field: 274 V/cm
- 2.3 ms charge drift time (3.2 ms saved per triggered readout event)
- 3 wire planes
- 3 mm wire spacing
- Sampling: 0.5 μs per time-tick



3) MeV-Scale Reconstruction in MicroBooNE

- Tools adapted from techniques pioneered by the ArgoNeuT [1] and MicroBooNE [2] collaborations, and described in [4].
- Wire signals processed with low-threshold settings to enhance sensitivity at electron energies $\lesssim 1 \text{ MeV}$.
- $\sigma_E \sim 10\%$ at 1 MeV, $< 8\%$ at 5 MeV

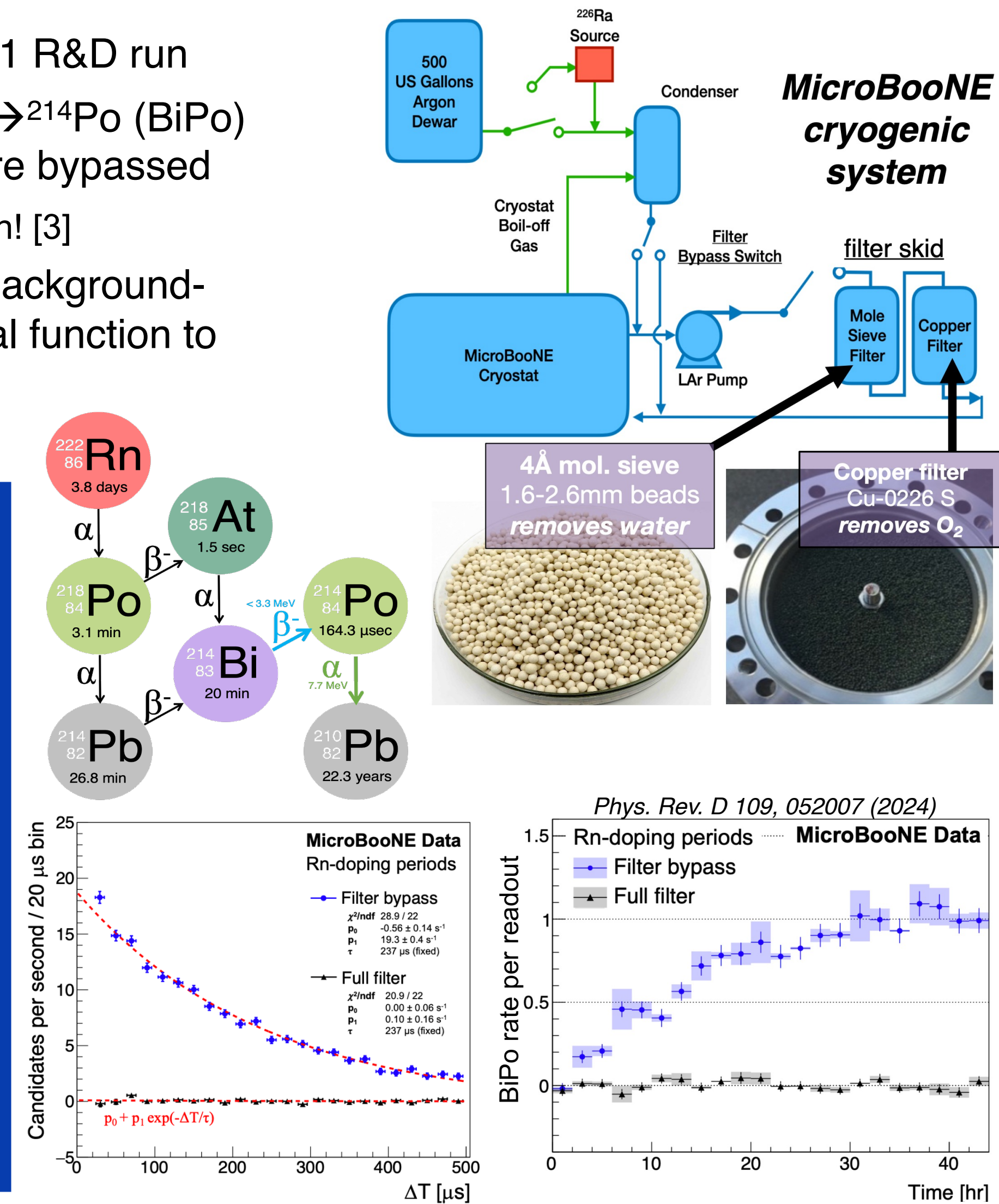
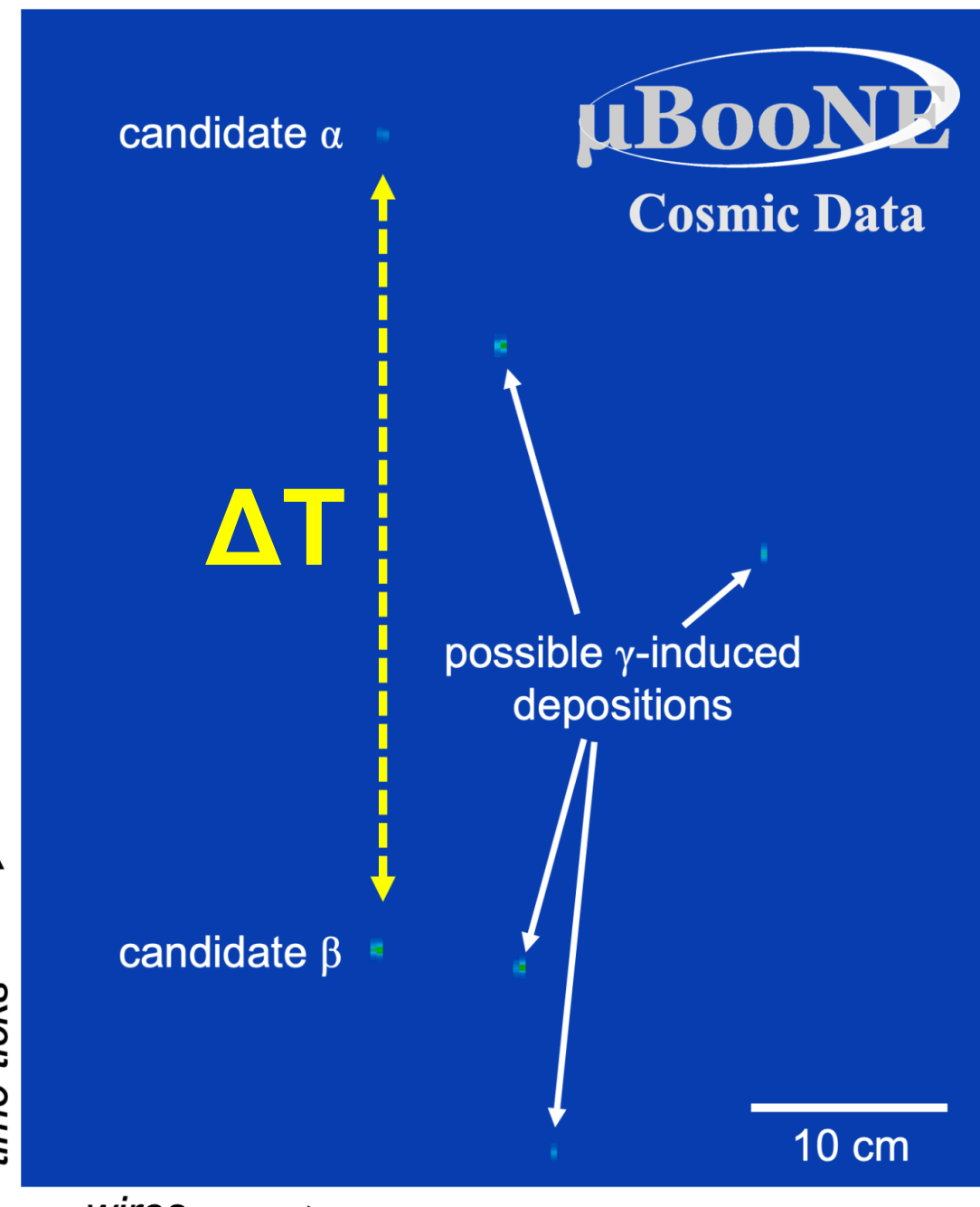


References

- [1] R. Acciarri et al. (ArgoNeuT), *Phys. Rev. D* **99**, 012002 (2019)
- [2] A. Bhat, PhD Thesis, Syracuse Univ., [FERMILAB-THESIS-2021-14](#)
- [3] P. Abratenko et al. (MicroBooNE), *J. Instrum.* **17** 1044 (11), P11022 (2024)
- [4] P. Abratenko et al. (MicroBooNE), *Phys. Rev. D* **109**, 052007 (2024)
- [5] A. Avasthi et al., Snowmass 2022, [arXiv:2203.08821](#)

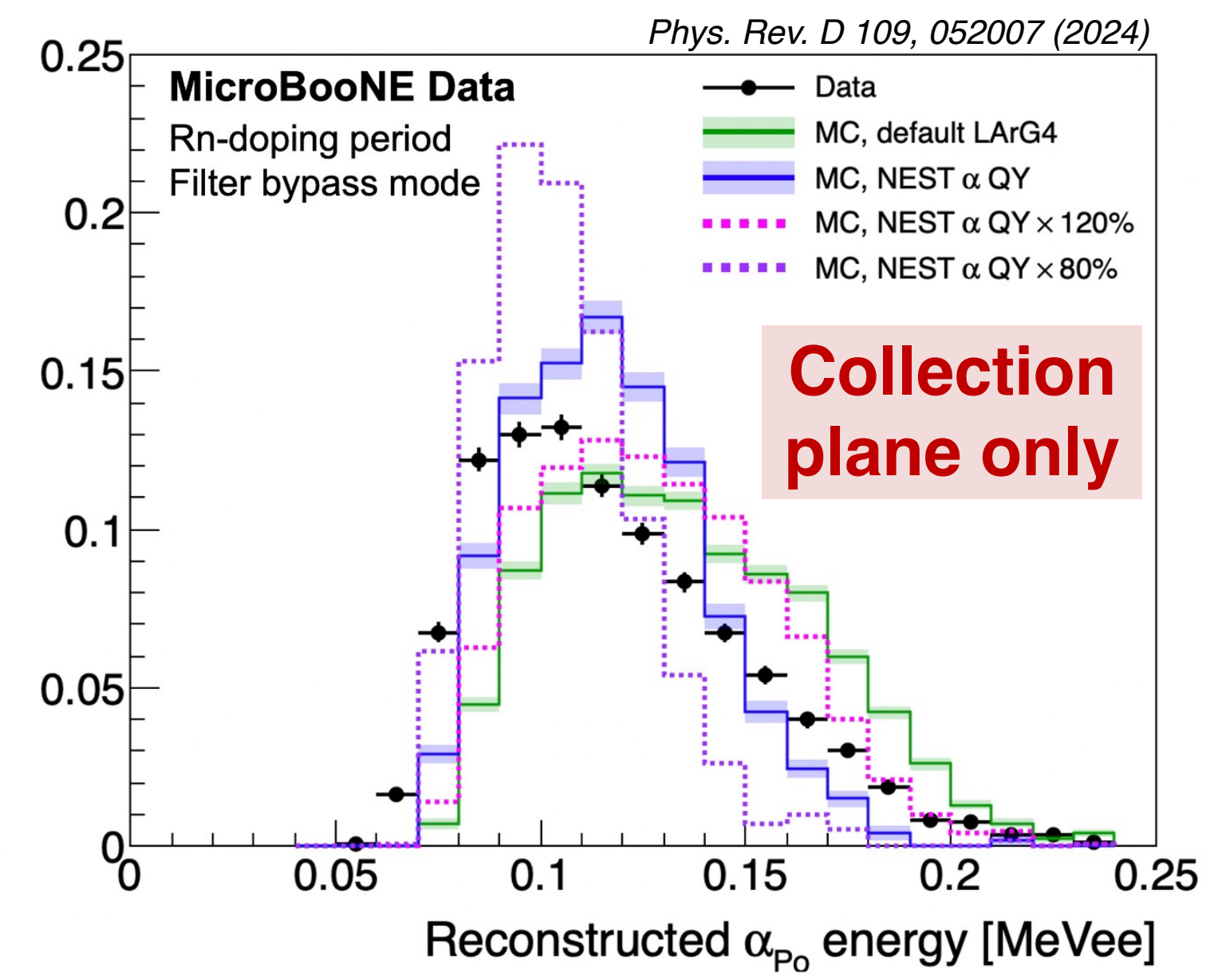
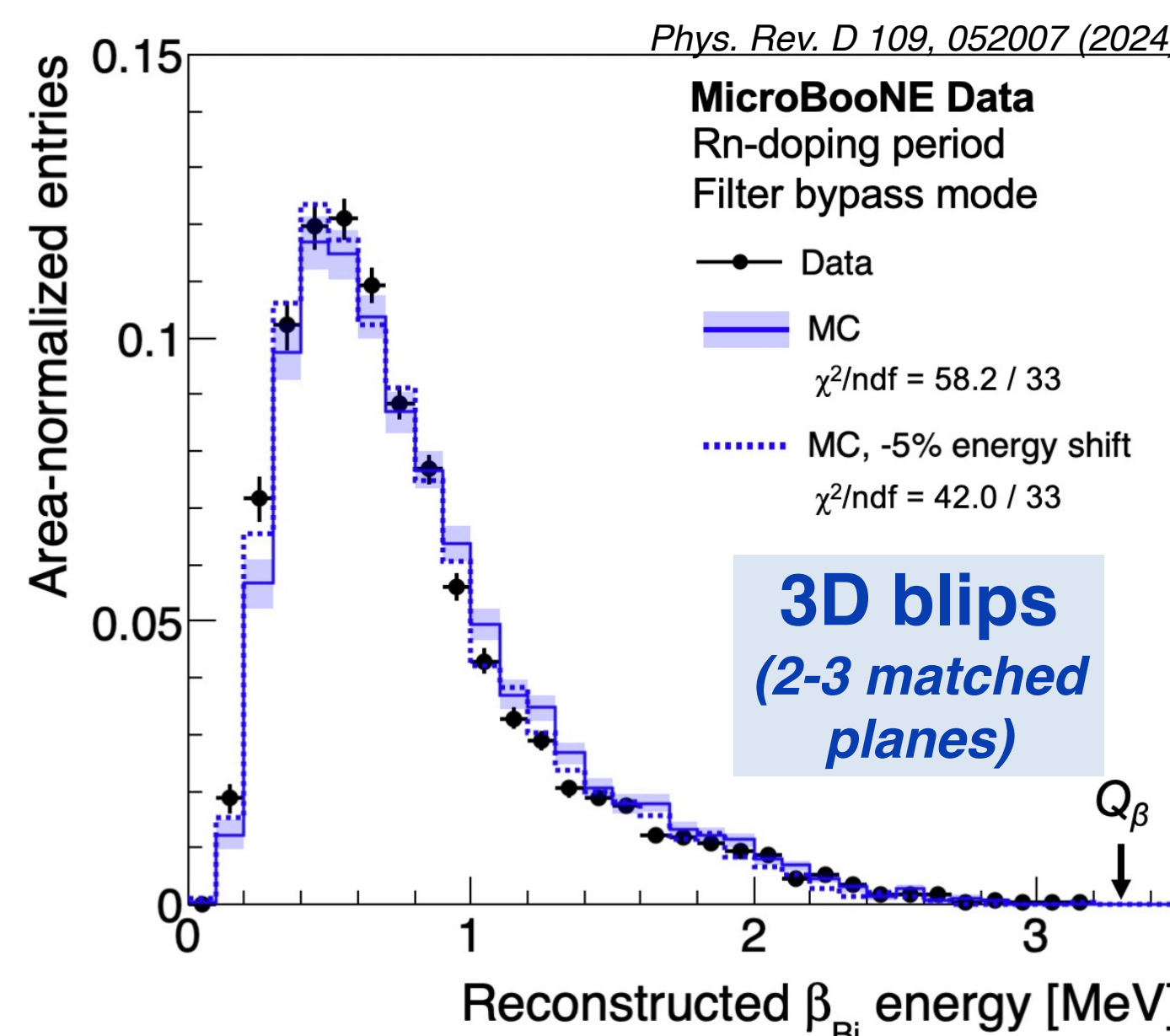
4) Radon-doping R&D Run

- ^{222}Rn doped into LAr for 2021 R&D run
- Measurable number of $^{214}\text{Bi} \rightarrow ^{214}\text{Po}$ (BiPo) seen in data when filters were bypassed
 - Filters remove $> 97\%$ of radon! [3]
- ΔT 'decay time' distribution background-subtracted & fit to exponential function to measure BiPo rate [4]

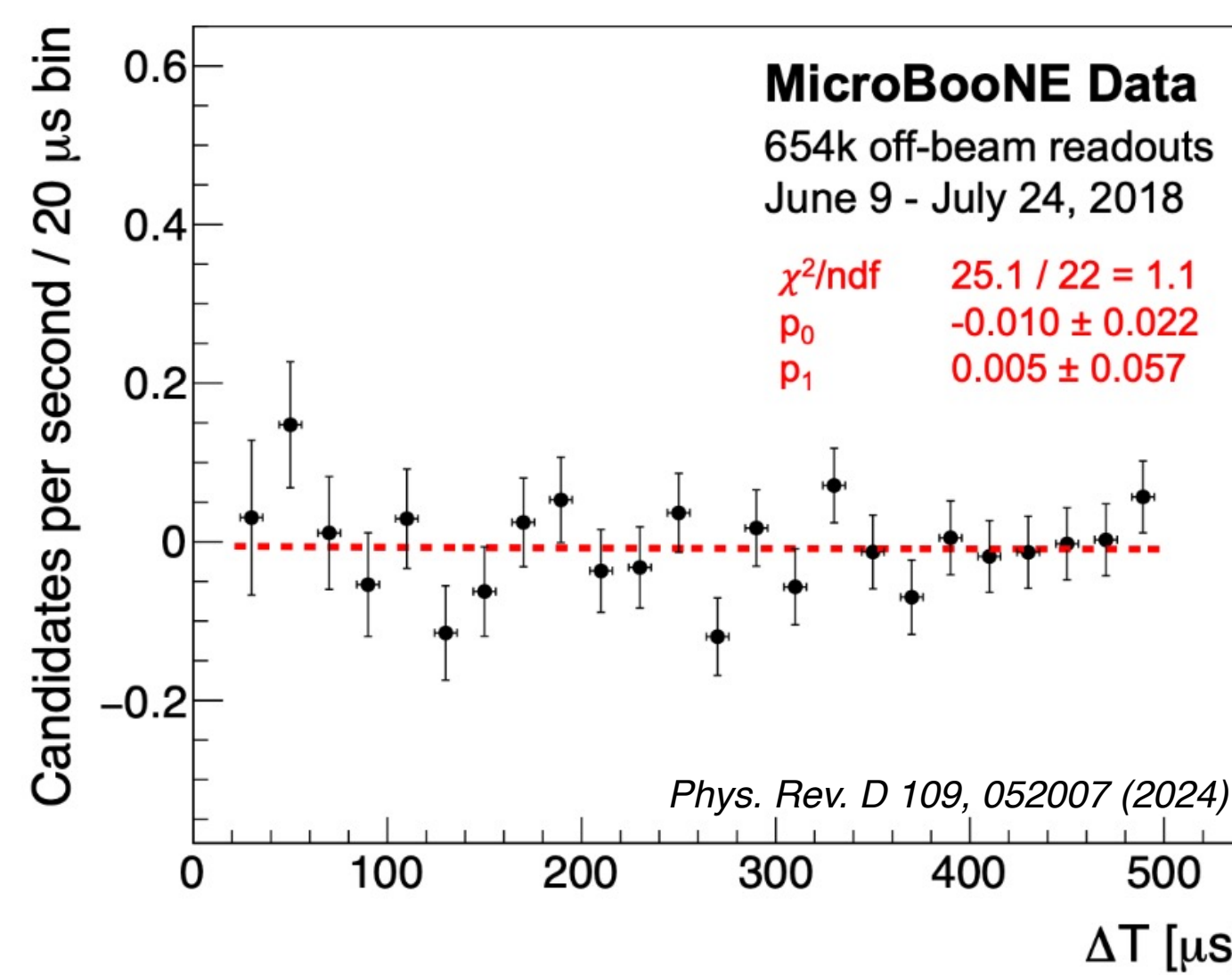


5) Calorimetric Data/MC Validation

- R&D data used to validate the MC at the MeV-scale by reconstructing background-subtracted energy spectra of β_{Bi} and α_{Po}
- BiPo rate efficiency from MC: $\epsilon_{\text{nom}} = (8.3 \pm 4.2)\%$, with uncertainties in α_{Po} charge-quenching dominating the error



6) Ambient Rn Results & Conclusions



- No measurable BiPo rate in standard physics data-taking conditions:
 - $R_{\text{Bi}214} = (0.01 \pm 0.17) \text{ mBq/kg}$
 - $R_{\text{Bi}214} < 0.35 \text{ mBq/kg at } 2\sigma \text{ C.L.}$
- Isotope plate-out effects estimated with toy MC: $R_{\text{Rn}222}/R_{\text{Bi}214} \sim 2.3 \pm 0.4$
- Estimated ^{222}Rn level below DUNE's target of $\lesssim 1 \text{ mBq/kg}$ [5]

This in-situ radiopurity measurement is the first of its kind for a large single-phase LArTPC!

- ✓ calorimetric capabilities to sub-MeV levels
- ✓ achievement of DUNE-required ^{222}Rn levels through standard LAr liquid filtration system

7) Ongoing MeV-scale Work in MicroBooNE

- Calibrations with γ -rays from radioactive ^{208}Tl in support struts
- Electron/proton PID for blips
- Proton/neutron-like content in cosmic flux

Stay tuned!

