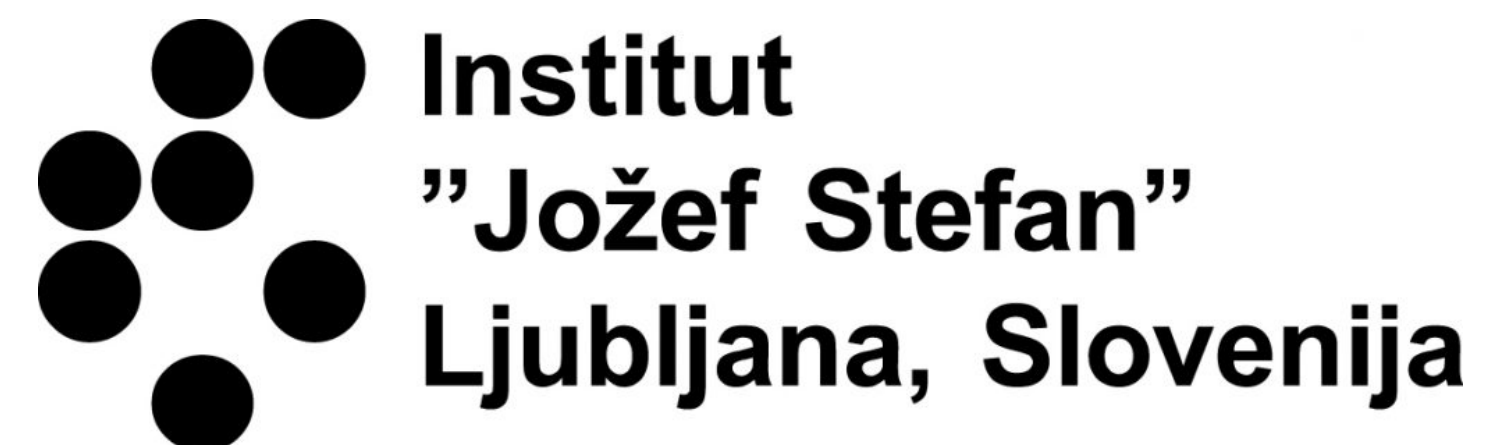


LAPPD studies for the Belle II ARICH upgrade

Connor Pecar-Yannotta
IJS F9 Department Strategic Meeting 2026



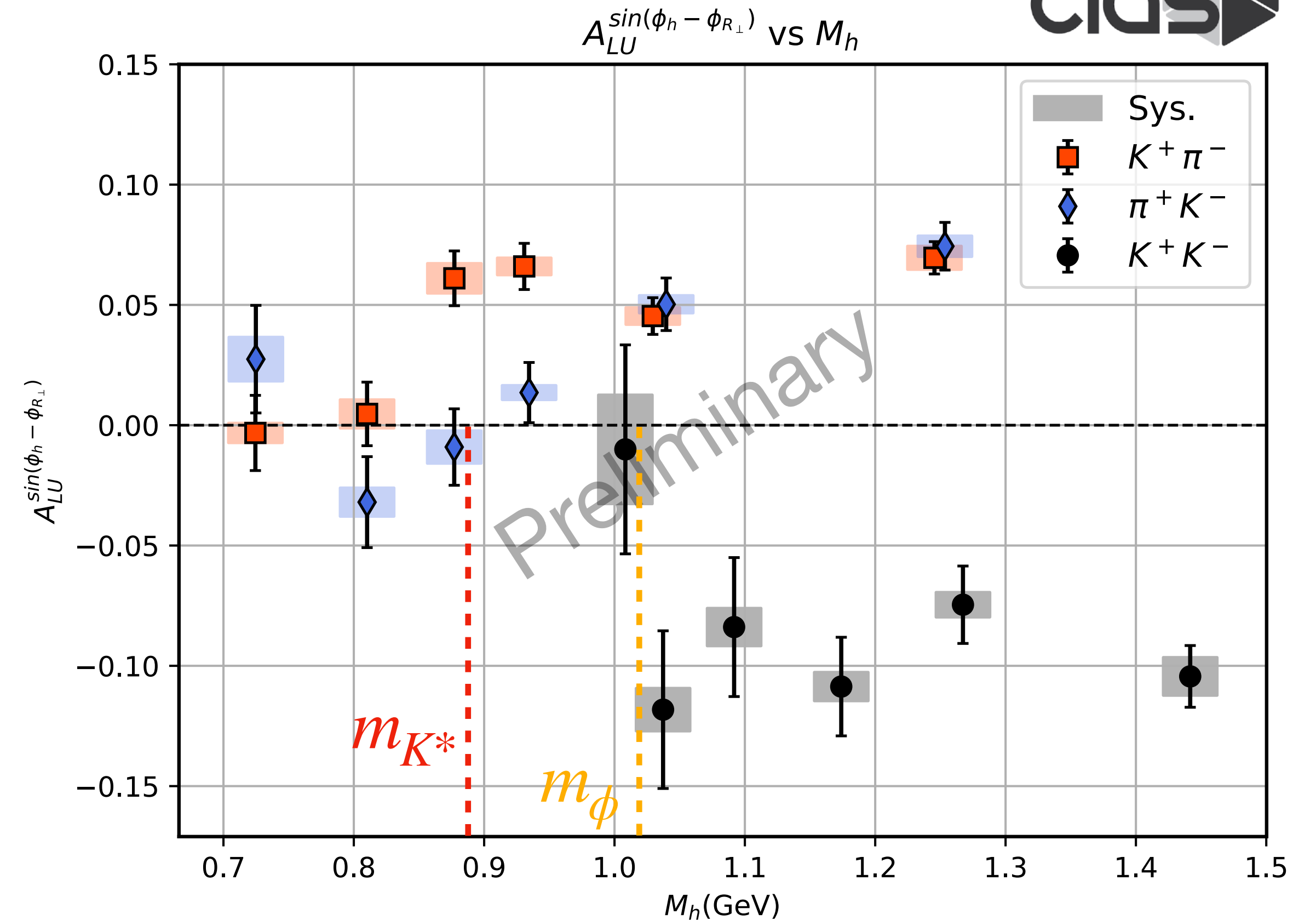
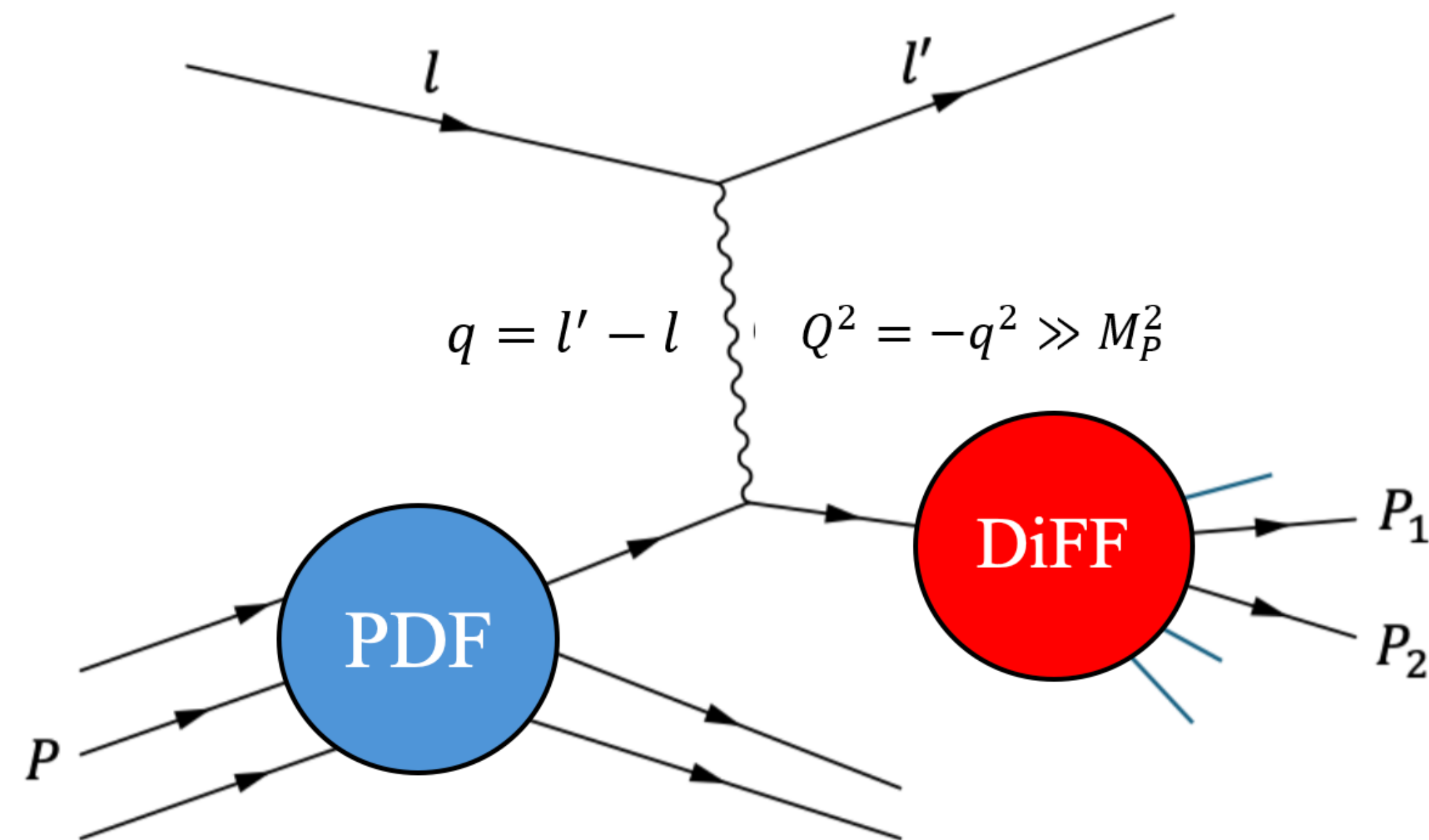
Introducing myself



- New postdoc in the F9 Photosensor group, officially joined in August
- Received PhD in Physics from Duke University in May 2026

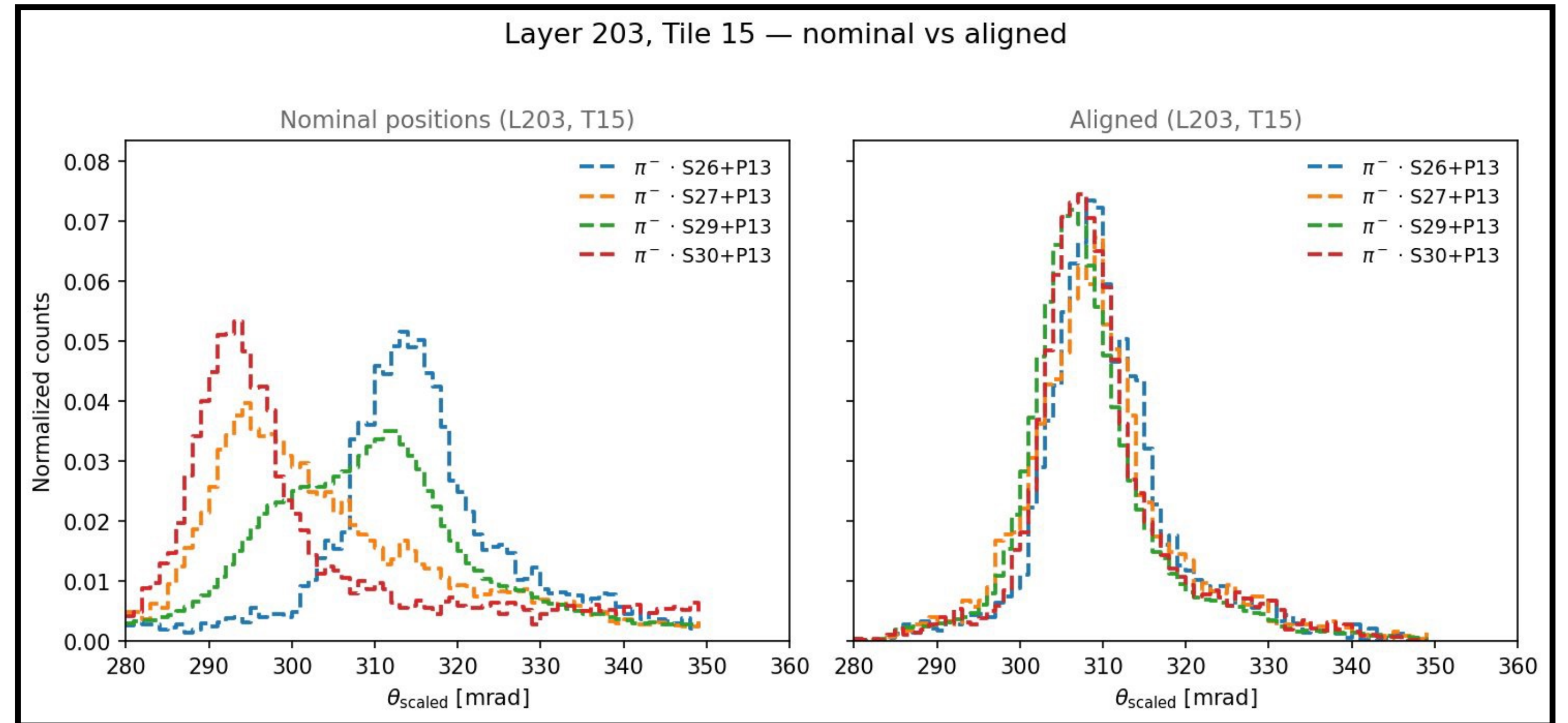
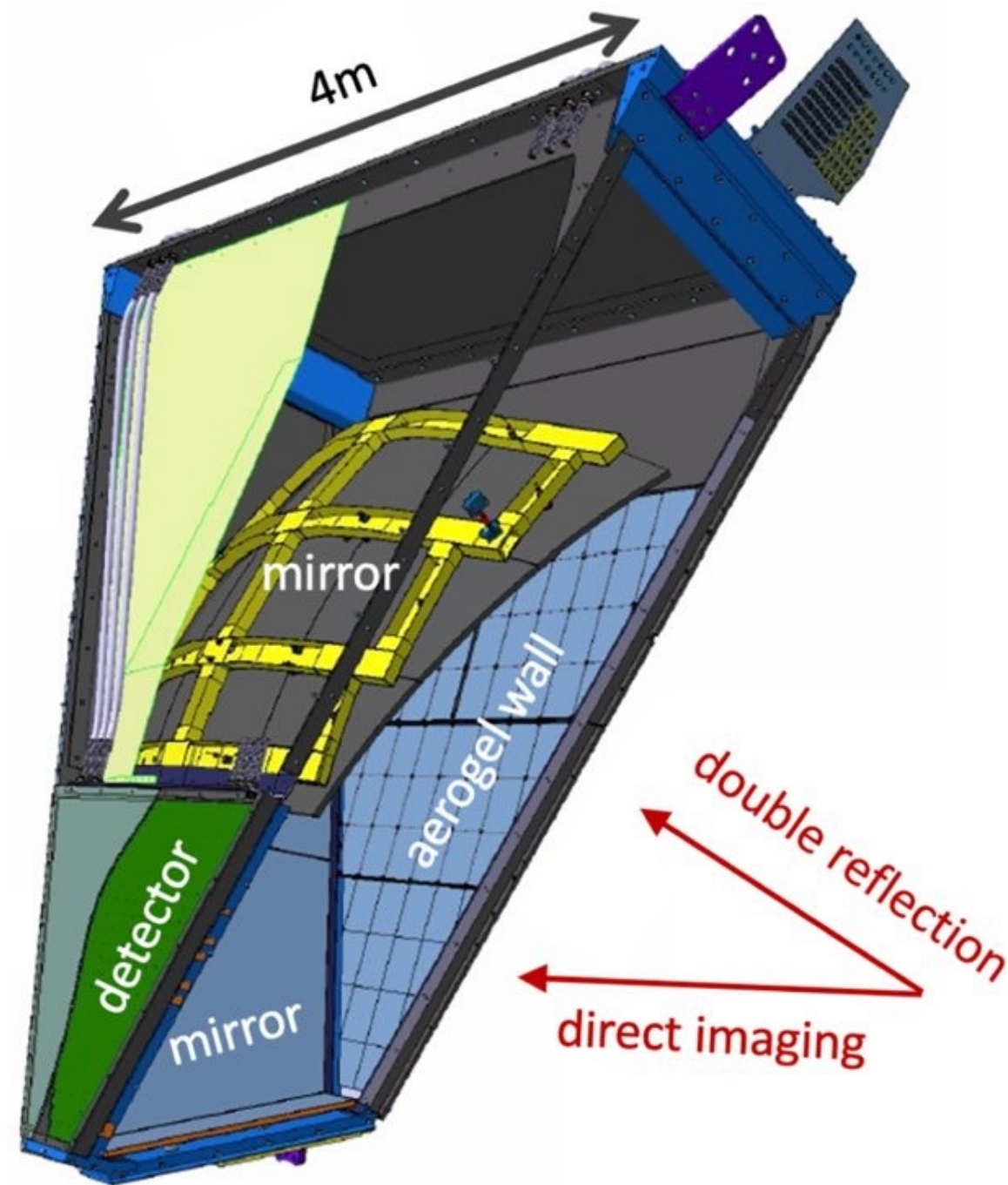
Duke
UNIVERSITY

Previous work: physics analysis



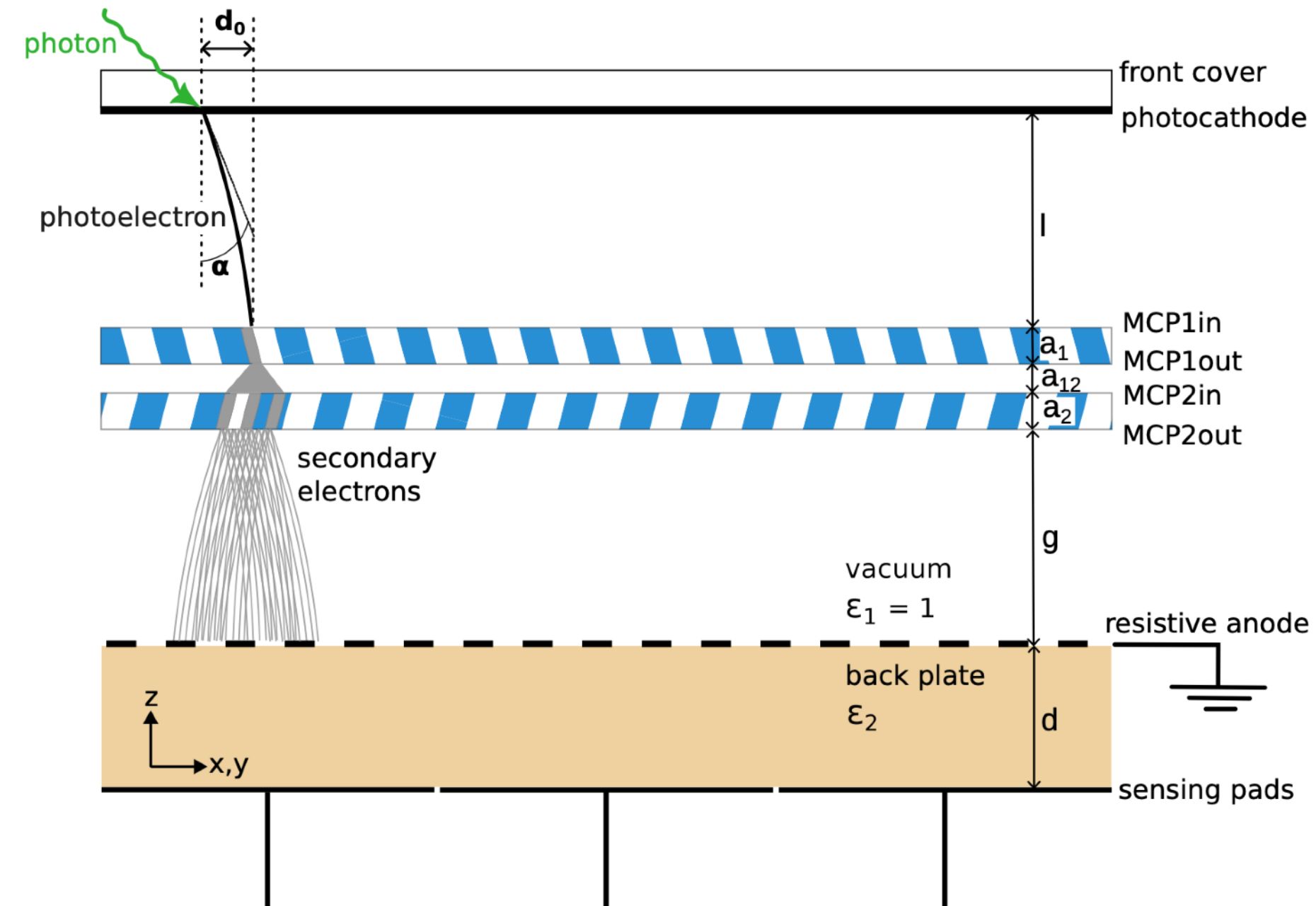
- Semi-inclusive deep inelastic scattering measurements at CLAS12 (Jefferson Lab)
- Sensitive to momentum distributions of quark in nucleons and hadronization dynamics

Previous work: RICH detectors



- Developed first full alignment method for the CLAS12 RICH detector
 - Employed high-dimensional (>50D) Bayesian optimization
- Other: dual-radiator RICH simulation and design optimization for the EIC, detector simulation at CLAS12, EIC physics projections...

LAPPDs



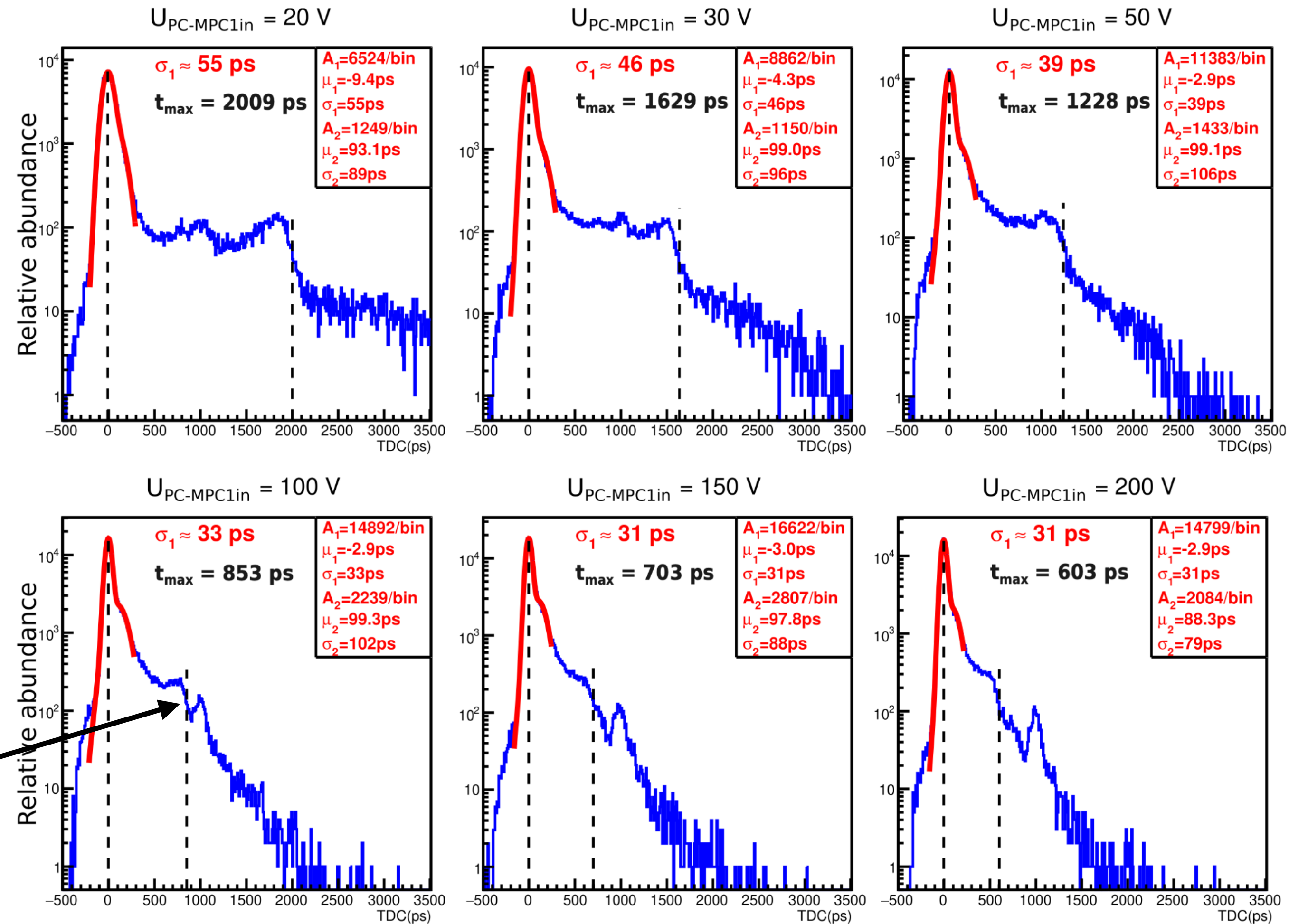
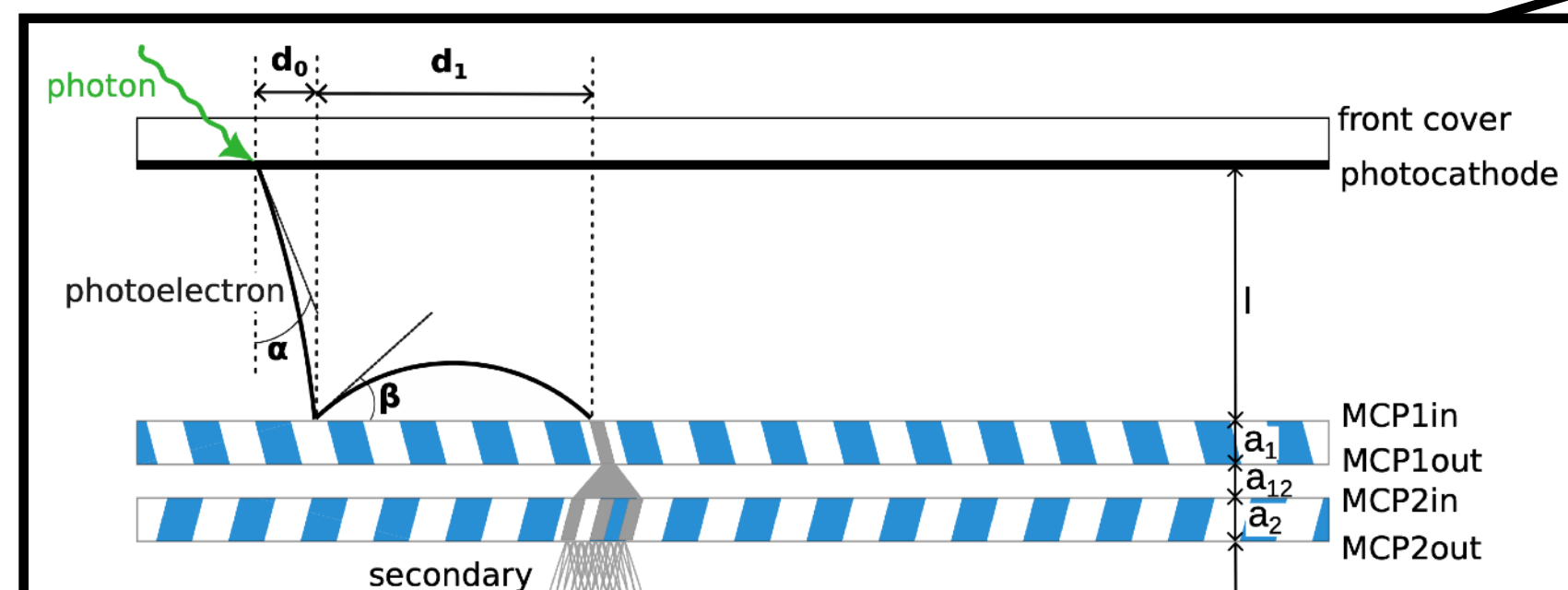
- Large Area Picosecond Photodetectors (LAPPDs)
 - MCP-PMT with excellent intrinsic timing resolution, 20cm x 20cm active area
 - Capacitively coupled readout → flexibility in backplate design
 - Candidate photosensor for Belle II (arXiv:2203.11349) and LHCb (doi.org/10.1016/j.nima.2026.171487) RICH upgrades
- **Further characterization, simulation, and readout studies planned with the sensors targeting their use in an upgrade of the Belle II ARICH**

Previous characterization results

- Most recent results: extensive characterization of LAPPD timing and charge-sharing response with laser stand (2512.02990)

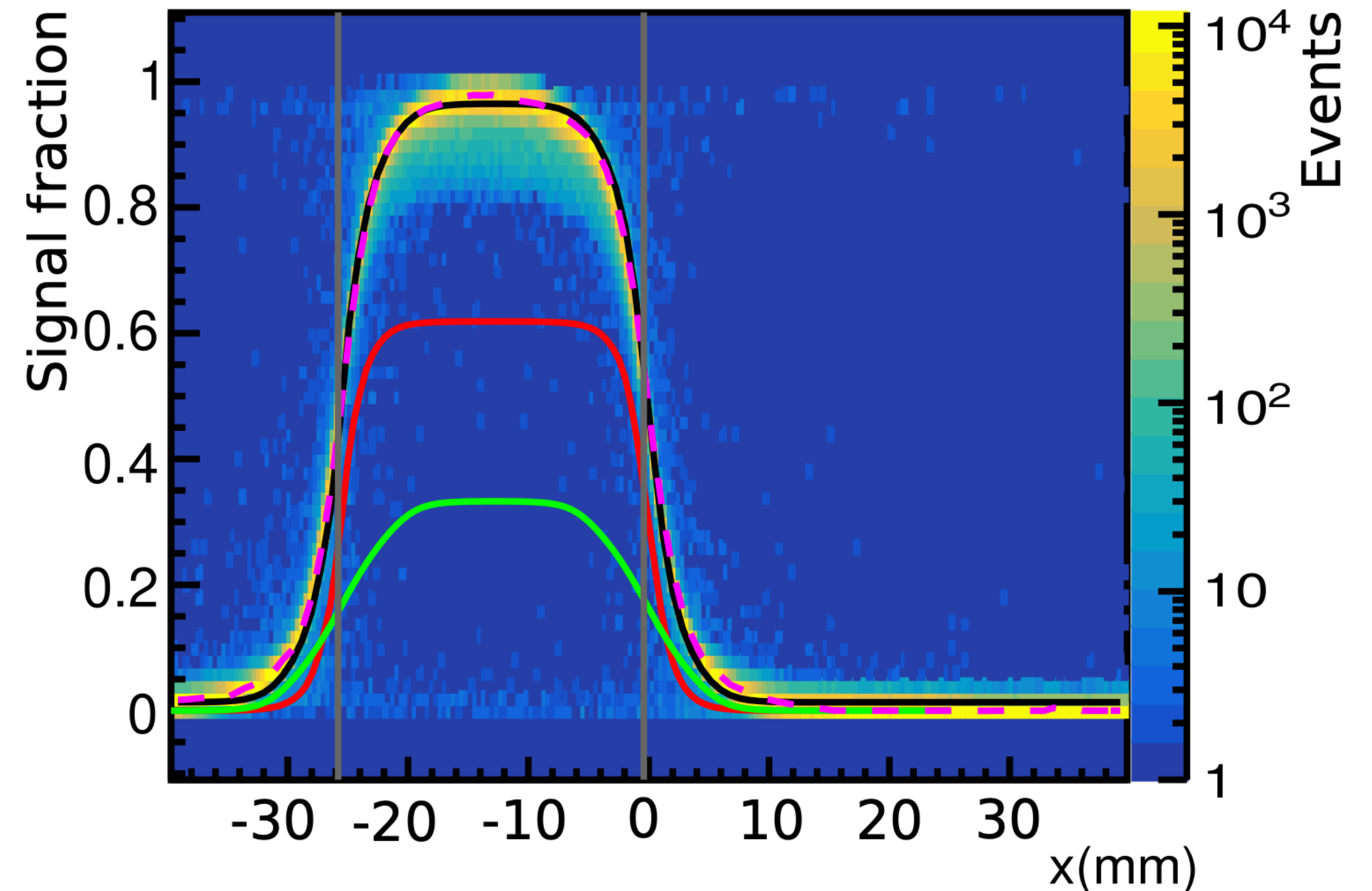
- Prompt timing peak $\sigma \sim 35\text{ps}$

- Ballistic modeling of photo-electron back-scattering at first MCP layer, impact on timing distribution



Previous characterization results

- Also investigated distribution of charge on adjacent readout pads
- Developed successful model of fractional charge distribution with capacitively coupled sensor
- Good agreement with data and varied internal and readout pad geometries



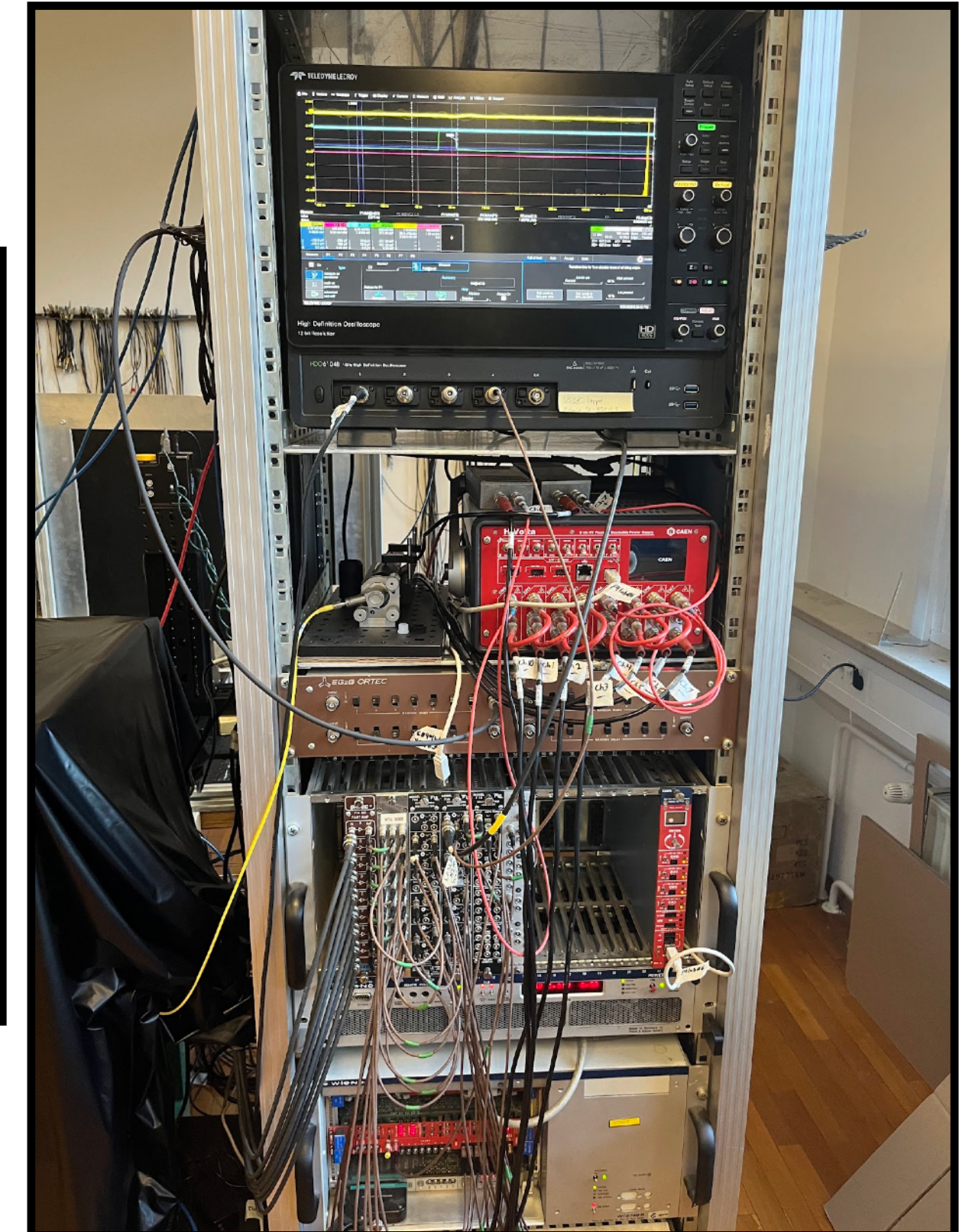
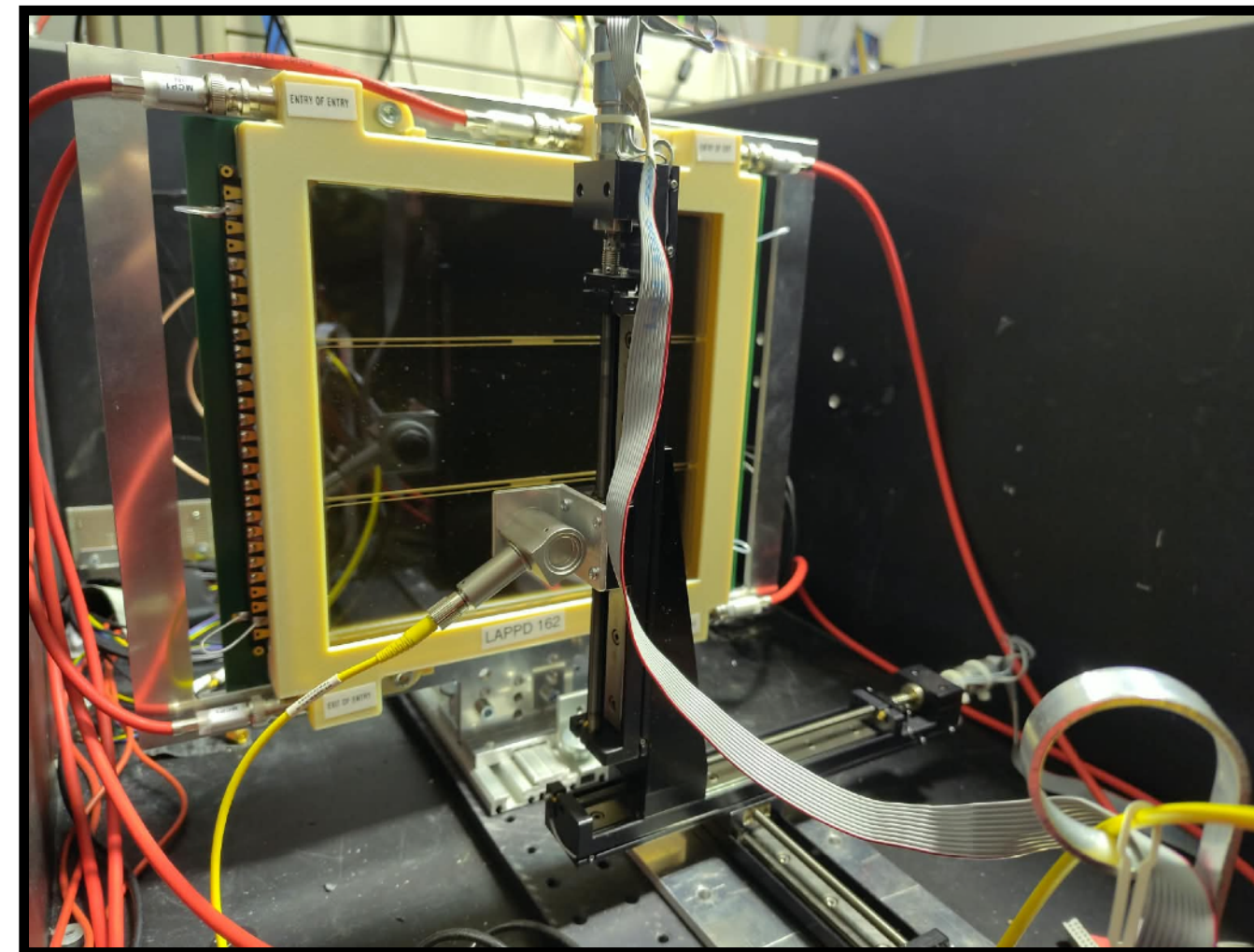
S. Korpar et al. NIM A1088 (2026) 171466

Next steps: sensor characterization

- Plan to acquire and test additional LAPPD/MCP-PMT variants (smaller active areas, directly coupled readout pads)
- Second laser test stand under construction

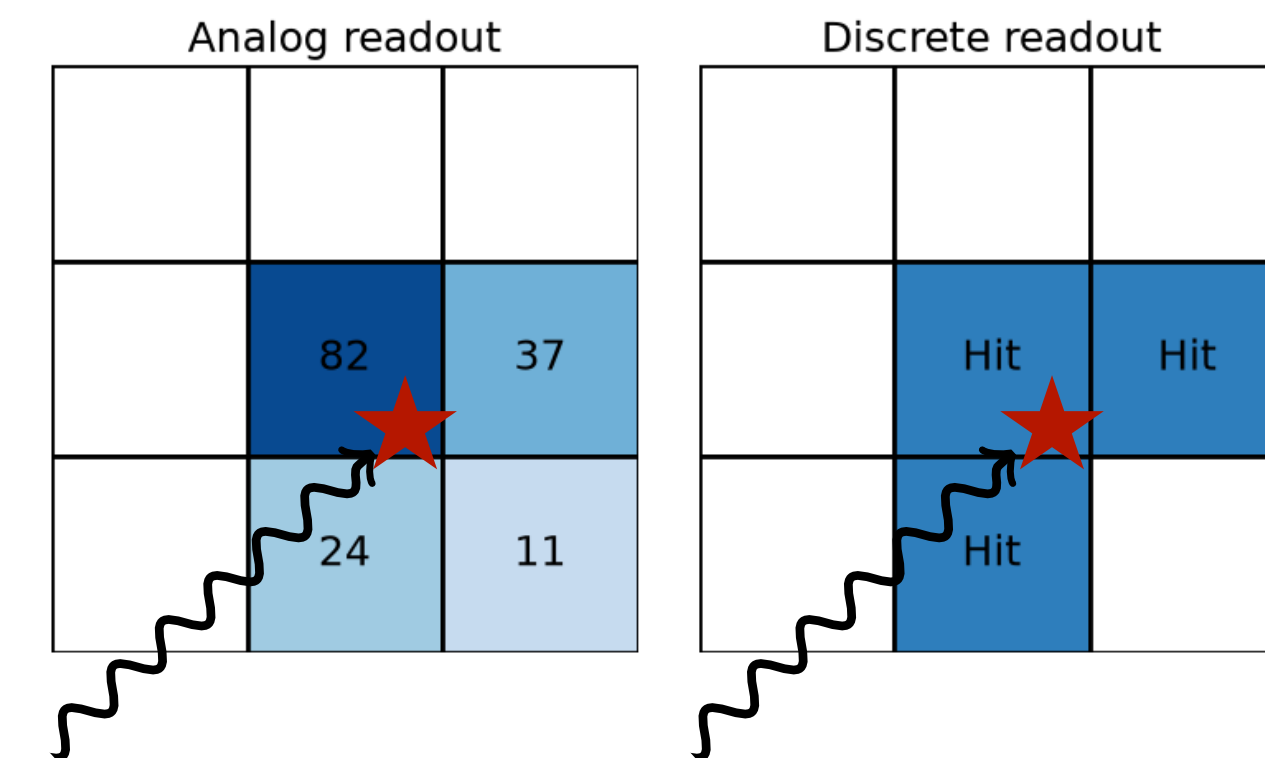
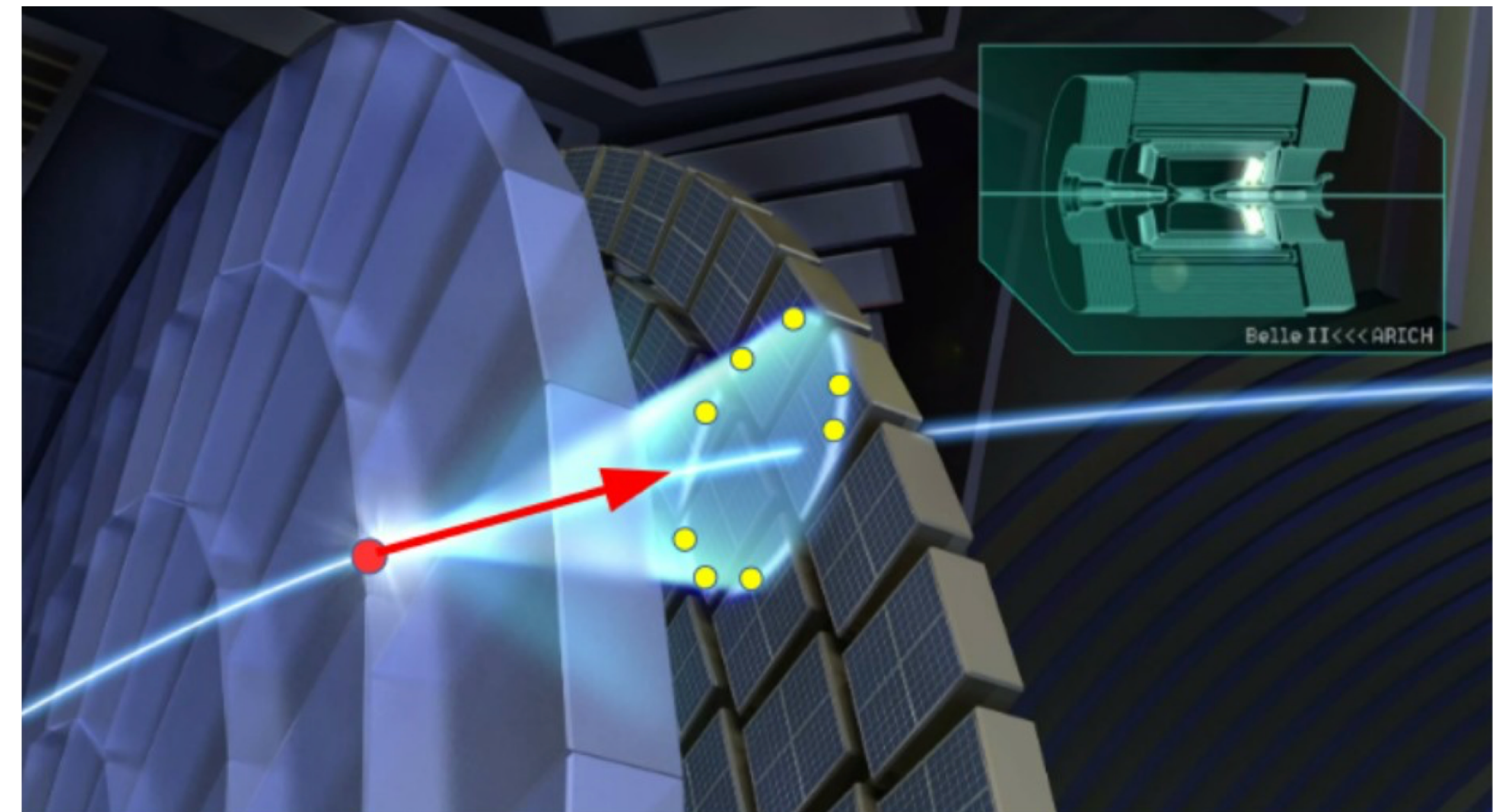
Planned measurements:

- Timing and gain vs position, hit rate, pad size
- Direct vs capacitive readout
- Inter-channel timing response/calibration
- Response in magnetic field



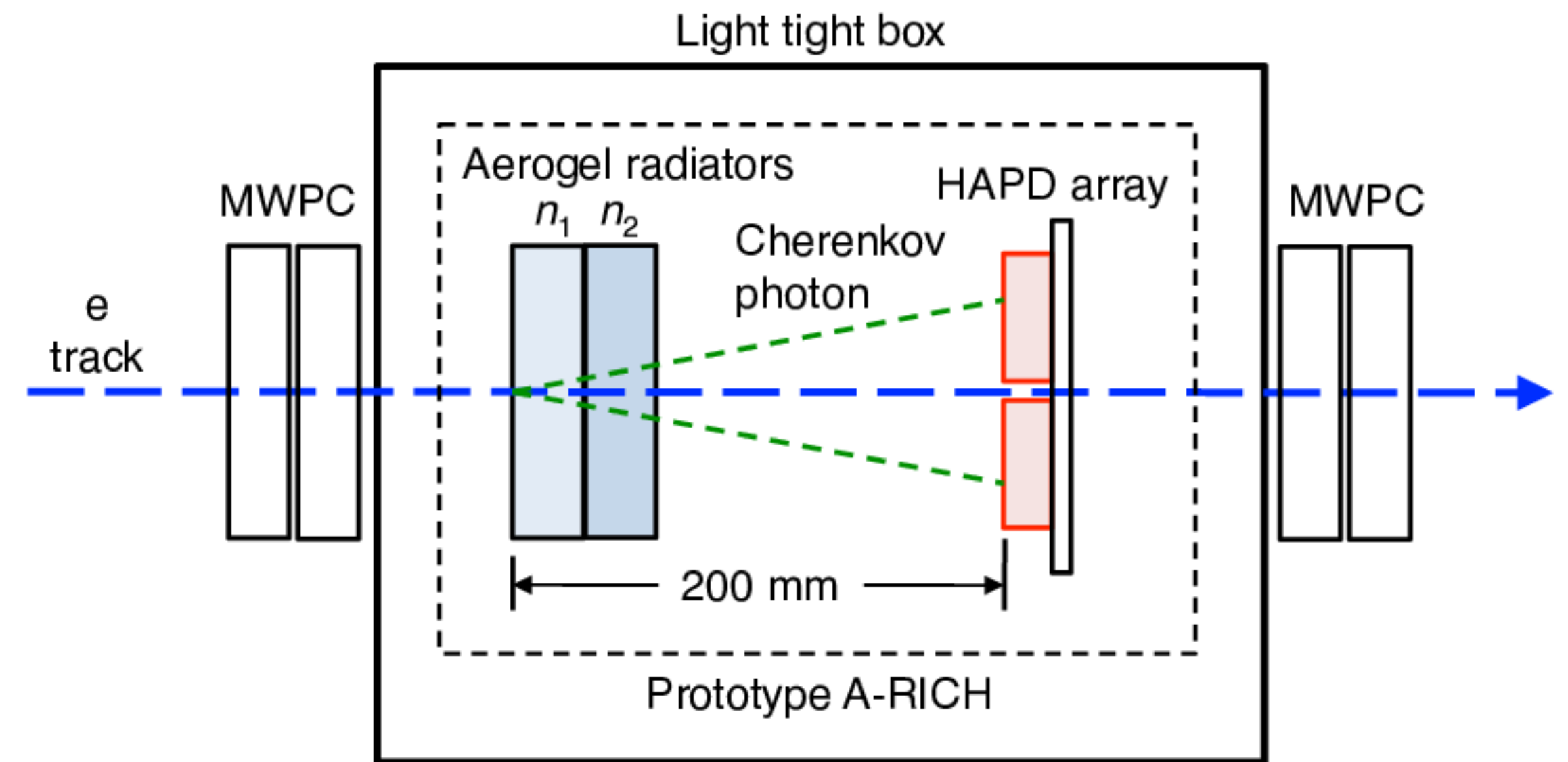
Next steps: simulation & reconstruction

- Implement model of LAPPD photon response in Belle II simulation
- Optimize PID likelihood reconstruction with non-pixelized sensor response
 - Compare use of analog and discrete multi-pad information
- Quantify impact on ARICH PID performance



Next steps: test beam

- Further develop and validate multi-channel DAQ with ASICs available
 - PETsys-TOFPET2, FastIC
 - First results on multi-channel DAQ with ASIC in R. Dolonec et al., <https://doi.org/10.1016/j.nima.2024.169864>
- Test beam run with LAPPDs inside a test aerogel RICH planned for 2027
- To be conducted at KEK



2016 ARICH test beam apparatus (1603.02503)

Conclusion

- Next year's activities with LAPPDs planned to demonstrate performance for Belle II ARICH and possible LHCb RICH upgrades
 - Belle II ARICH upgrade ~2032-2034
- Lab studies → characterize possible LAPPD/MCP-PMT options, optimize position reconstruction
- Simulation → extend RICH PID likelihood reconstruction for LAPPDs and quantify impact at Belle II
- Test beam → validate multichannel readout and performance in an aerogel RICH with high rates

