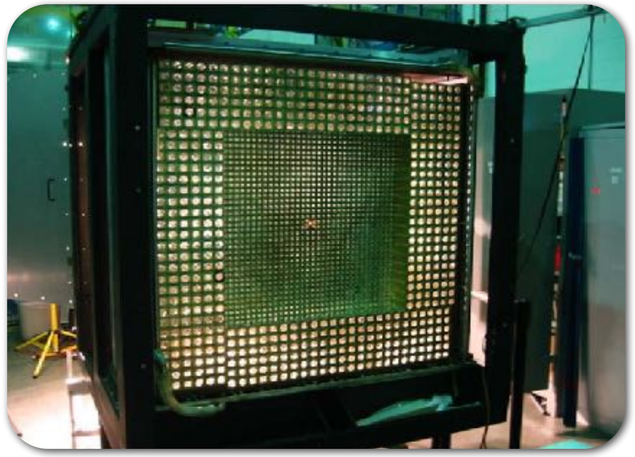
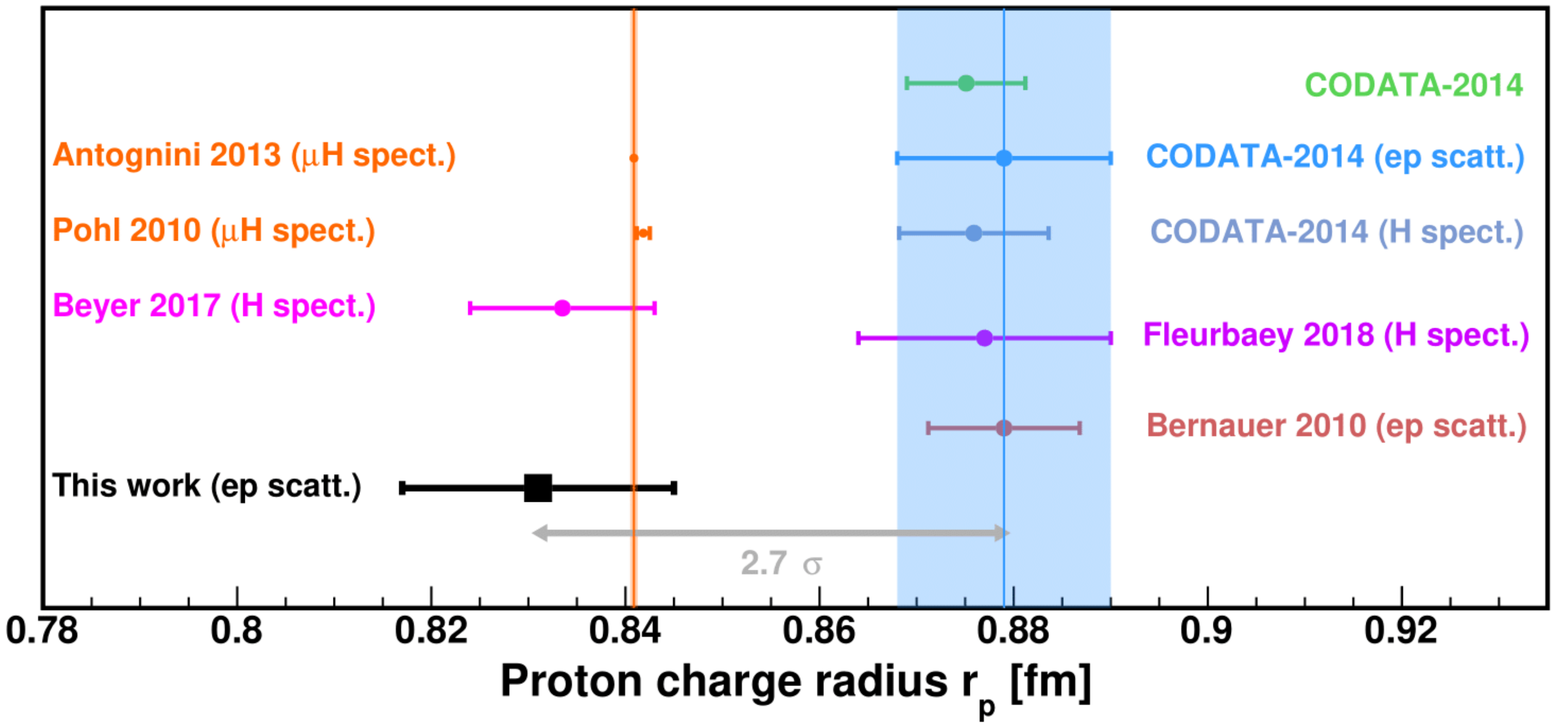
PRad experiment demonstrates the power of the calorimetric technique in measuring the proton charge radius.

A Novel calorimeter based electron scattering experiment carried out at JLab in 2016.



Q^2 range of 10^{-4} – 6×10^{-2} GeV^2 covered in a single setting
(lowest Q^2 for *ep* experiments)

W. Xiong et al., Nature, 575, 147 (2019)



Critical input to the recent revision of the CODATA recommendation for the proton charge radius.

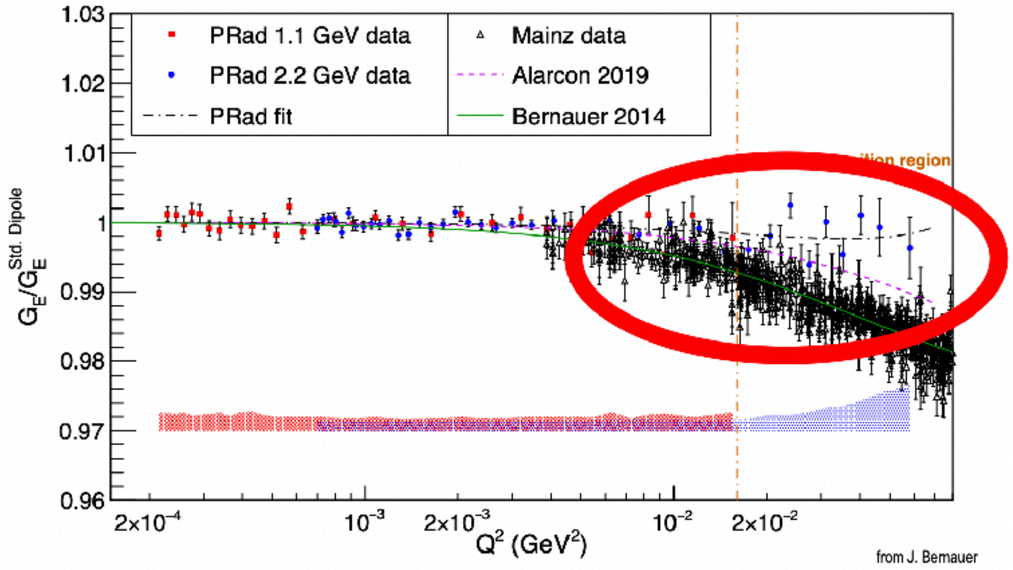
In direct conflict with all modern electron scattering data: ~3σ smaller than the 2010 Mainz result.

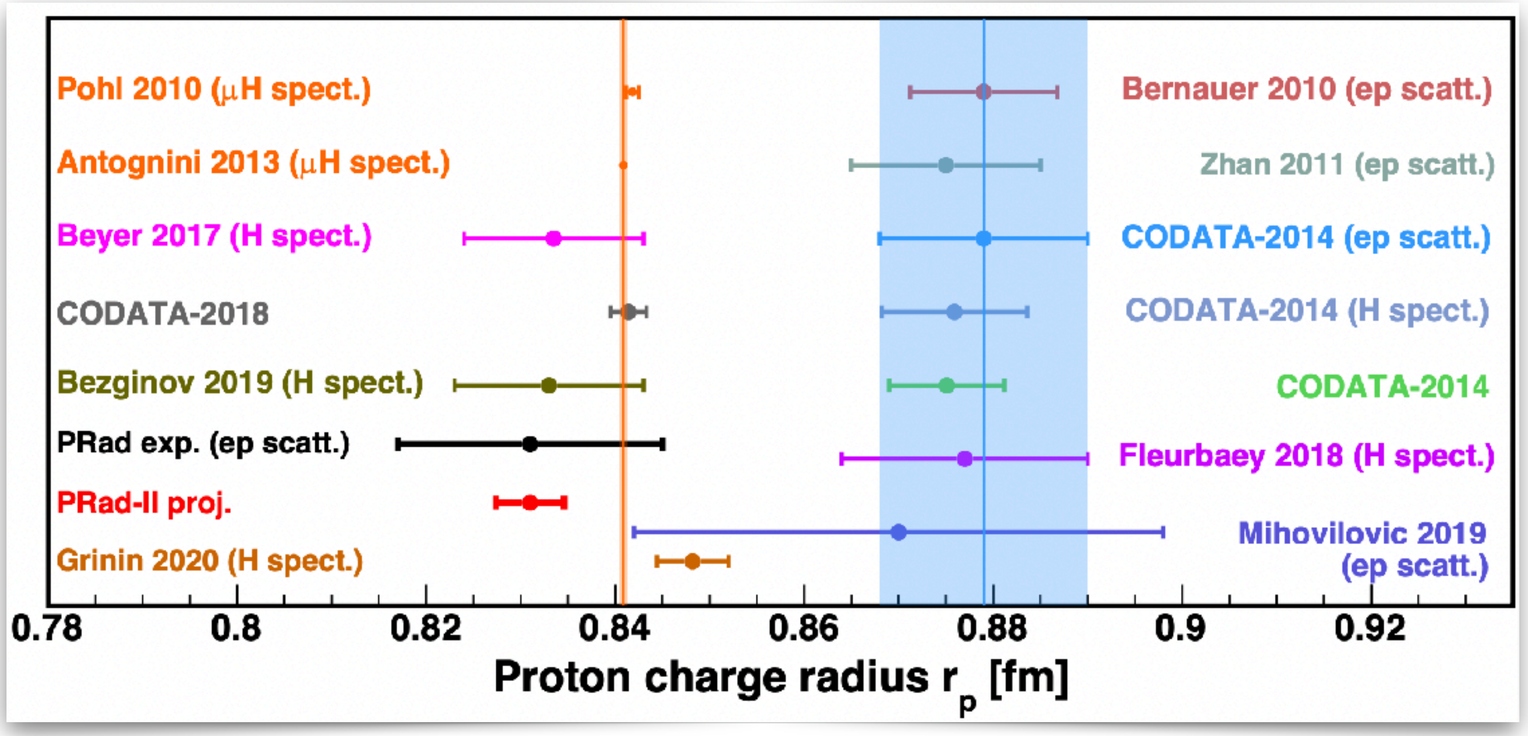
An as yet unresolved controversy in hadronic physics.

PRad-II — push the precision frontier in electron scattering experiments

Will use upgraded PRad apparatus

Precision better than the most precise hydrogen spectroscopy measurement





Address the direct conflict with modern electron scattering data

Explore possible difference between muonic hydrogen and *ep* scattering and evaluate the consistency of systematic uncertainties of muonic hydrogen spectroscopy.

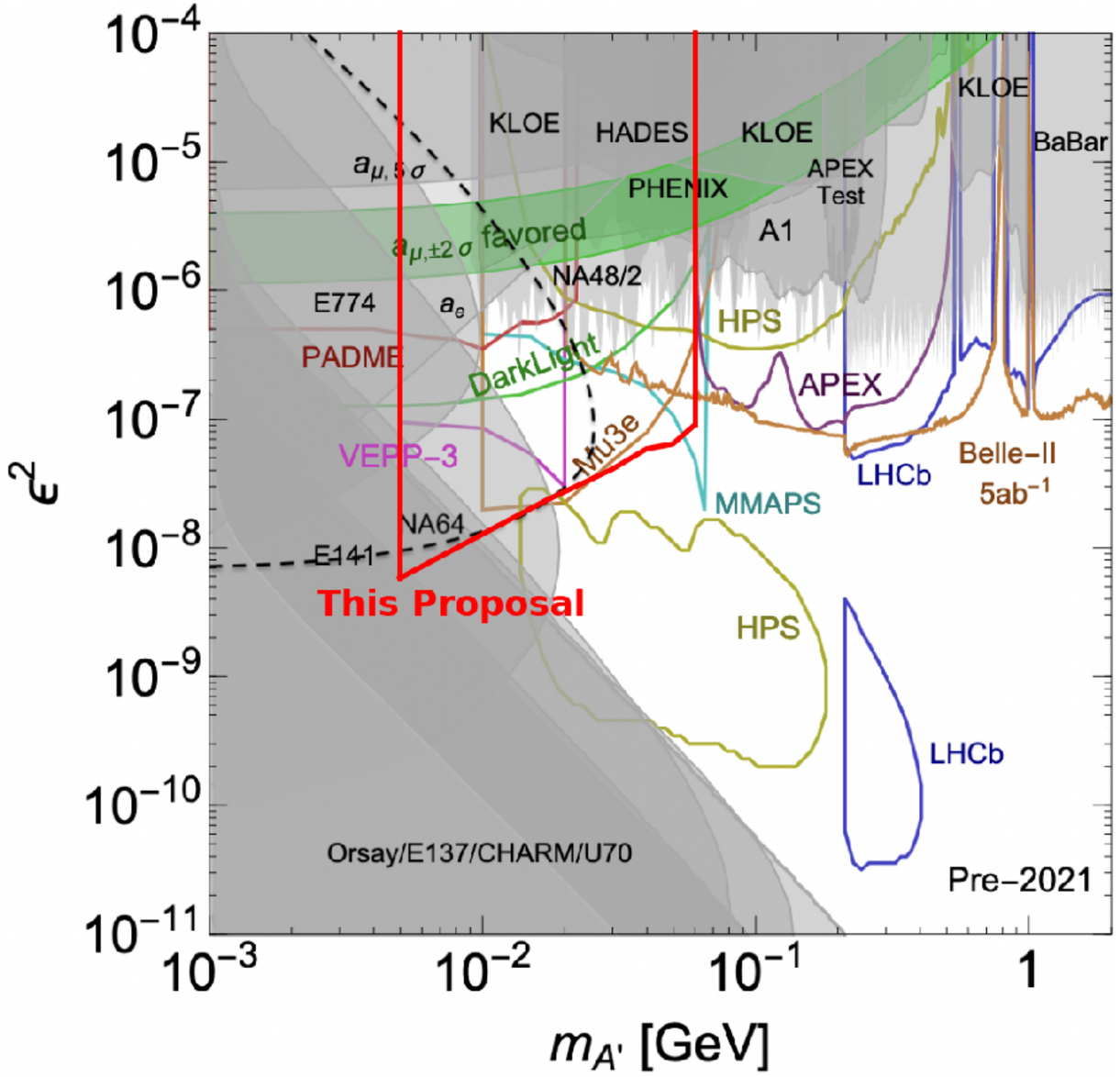
Will enable a new program of high precision measurements using the PRad method

Search for X17 and 3 - 60 MeV hidden sector particles with the PRad setup.

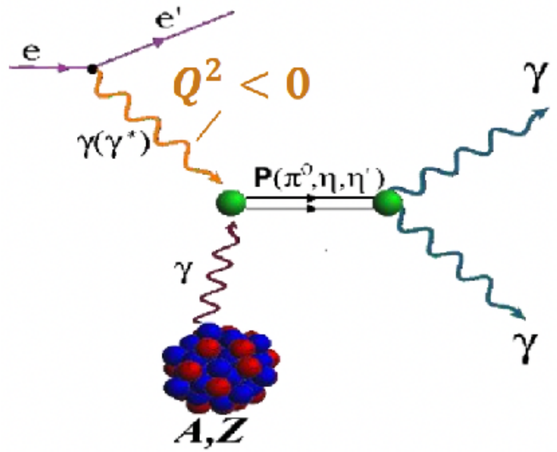
Motivated by new hidden sector models that account for recent anomalous observations such as:

Excess e^+e^- pairs in ^{8}Be and ^{4}He nuclear transitions reported by the ATOMKI group.
+
4.2σ discrepancy in muon g-2 measurement vs SM prediction.
+
small scale structure puzzle in cosmological simulations.

A unique magnet free experiment which detects all final states in e^+e^- / $\gamma\gamma$ decay



The PRad appratus will be used to measure the neutral pion space-like transition form factor.

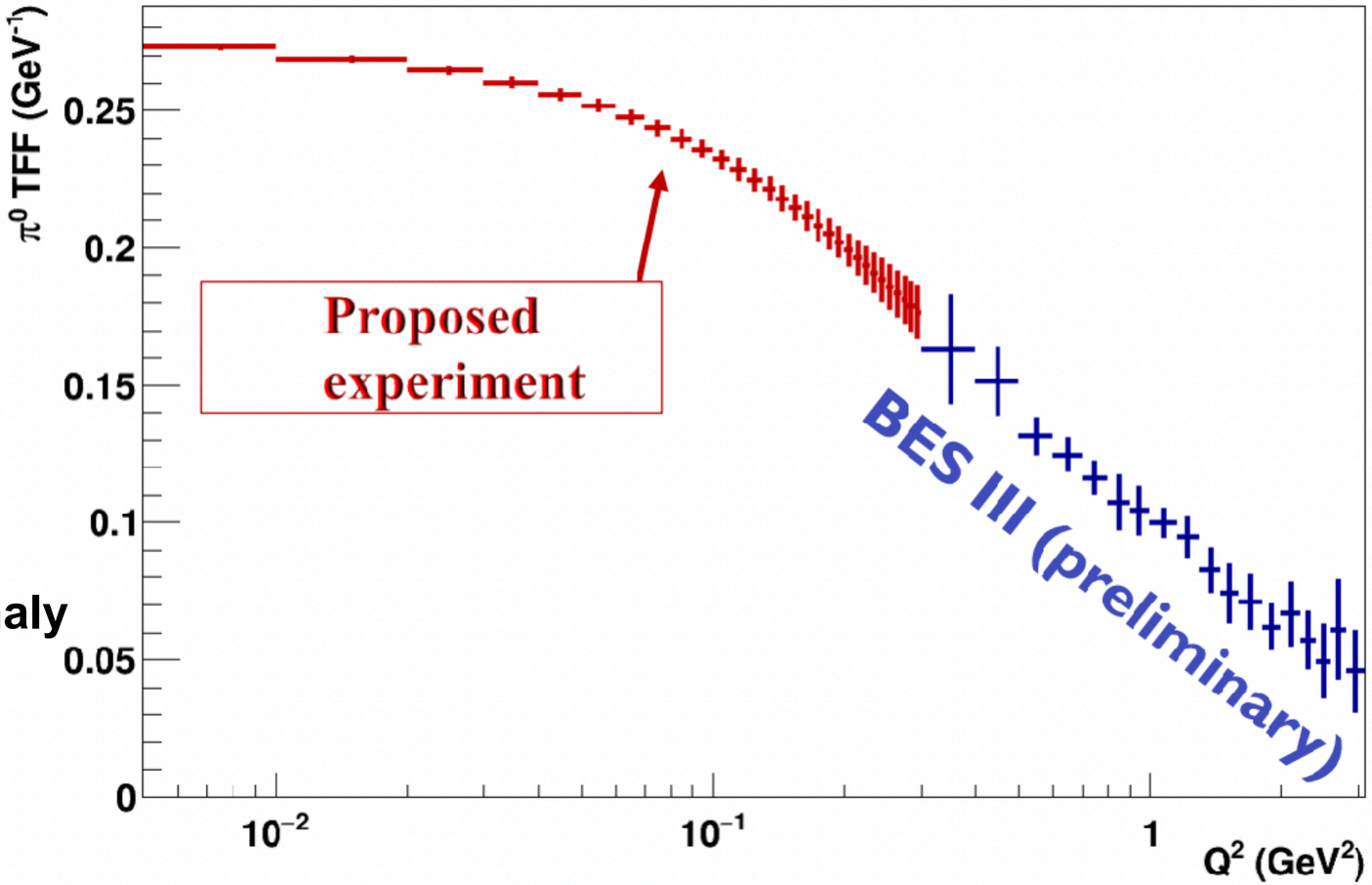


Two fundamental observables of low-energy QCD:

π^0 radiative decay width due to the chiral anomaly

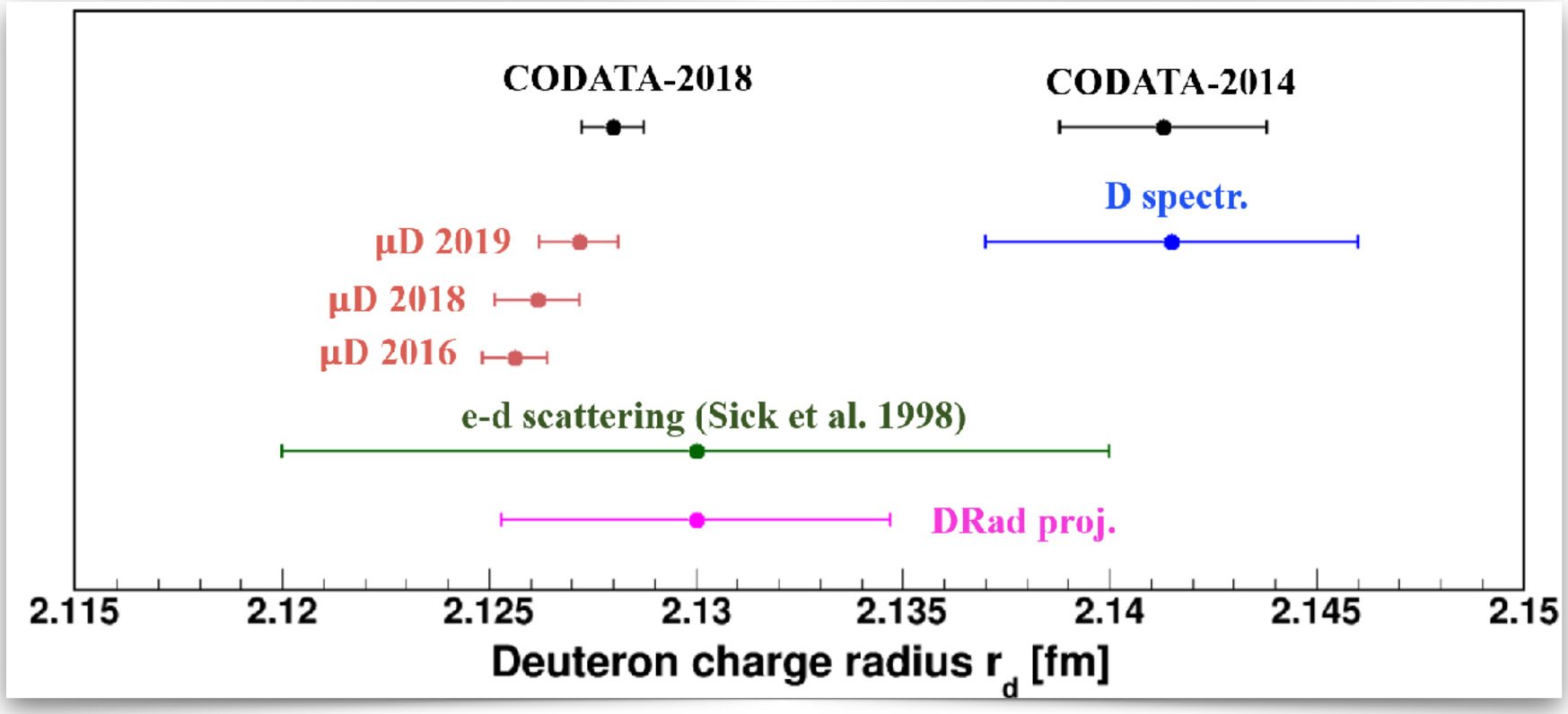
&

π^0 electromagnetic transition radius



Will provide first experimental constrain on hadronic light-by-light scattering — the largest uncertainty in the SM prediction for muon g-2

A deuteron radius (DRad) program using the PRad method is being developed.



Will address the "deuteron radius puzzle" — the large discrepancy between results from muonic deuterium and regular deuterium spectroscopy.








Excellent, training and future opportunities for a number of early career scientists.

This extensive, high precision & high scientific impact program — such as, proton charge radius, X17 search, contribution of light-by-light scattering on muon g-2 — based on an existing high resolution calorimeter should be an integral part of the long range plan.