Updates on PAC51/LOI12+23-015 and extension to RIB

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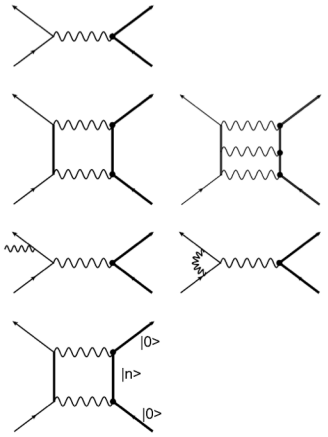
Outline

- LOI12-23-015 (PAC51)
  - Energy Dependence of Dispersive effects in Unpolarized Inclusive Elastic Electron/Positron-Nucleus Scattering
- Extension to Rare Isotope Beams

LOI12-23-015 - Background



Born Approximation

+ ... Coulomb Corrections

partial-wave analysis

static analysis

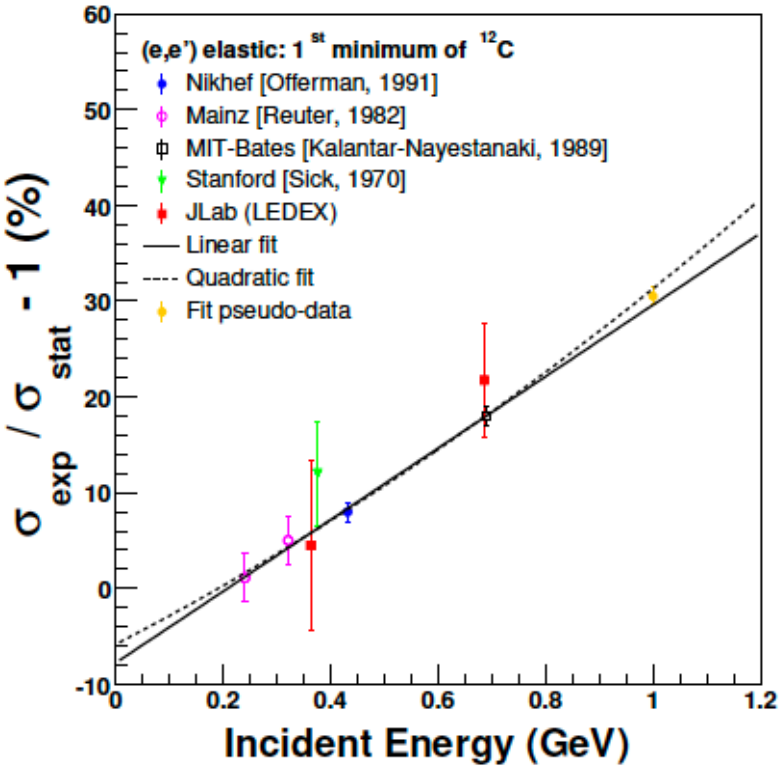
+ ... Radiative Corrections

+ ... Dispersive Corrections

dynamic corrections

$$|\mathcal{M}_{elast+disp}|^2 = (\alpha Z)^2 [F(q^2)]^2 + 2(\alpha Z)^3 [F(q^2)\mathcal{R}e\{G(q^2)\}] + (\alpha Z)^4 [|\mathcal{R}e\{G(q^2)\}|^2 + |\mathcal{I}m\{G(q^2)\}|^2]$$

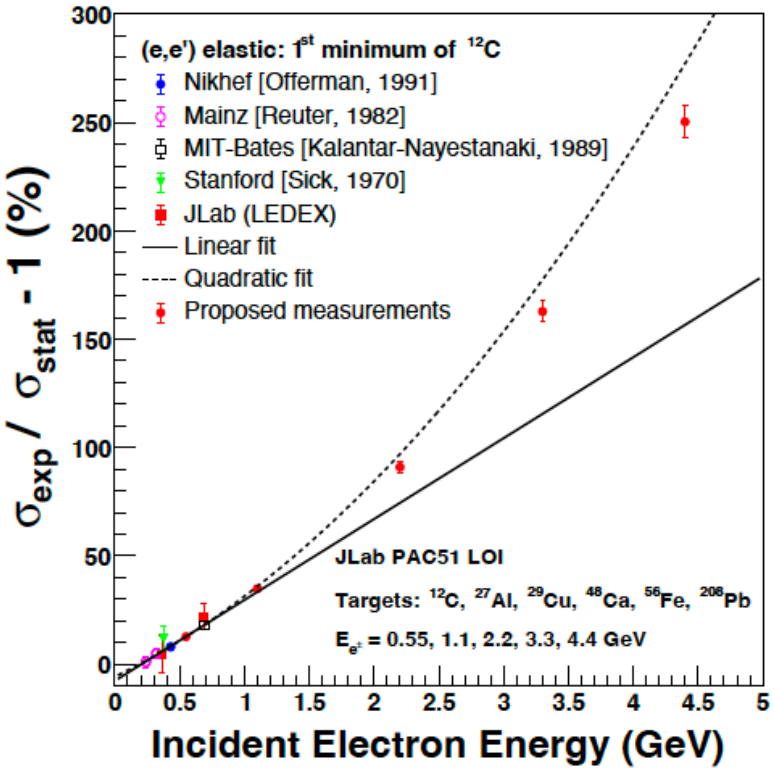
$$\sigma_{disp} = \sigma_{stat}[1 + \delta_{disp}(E_e)]$$



P. Guèye et al., EPJ **A56**(5) 2020
10.1140/epja/s10050-020-00135-7.

LOI12-23-015 - Goals

- Elastic scattering A(e,e')
  - Measure energy dependence of dispersive effects
  - Around first diffraction minimum
- Setup
  - Hall A or C
  - Beam: electrons* & positrons
  - Targets: ^{12}C, ^{13}Al, ^{29}Cu, ^{48}Ca, ^{56}Fe, and ^{208}Pb
  - Beam energies: 0.55, 1.1, 2.2, 3.3 and 4.4 GeV
- Combined run with SuperRosenbluth (J. Arrington)
  - PR12+23-012 in Hall C



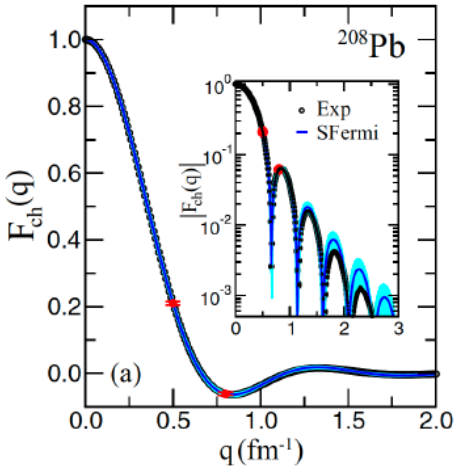
LOI12-23-015 – PAC Report

- Polarization?
  - Now: no
  - Future: yes (no such measurements exist!)
- Use of e±?
  - Required to extract interference term
  - Observable?
    - » σ(Θ)
    - » Difference between e^+ and e^-
    - » Correct for Coulomb effect
  - Impact on parity-violating experiments?
    - » Occurred near diffraction minima
- Theoretical calculation?
- Monte Carlo simulation?

$$|\mathcal{M}_{elast+disp}|^2 = (\alpha Z)^2 [F(q^2)]^2 + \boxed{2(\alpha Z)^3 [F(q^2)\mathcal{R}e\{G(q^2)\}]} + (\alpha Z)^4 [|\mathcal{R}e\{G(q^2)\}|^2 + |\mathcal{I}m\{G(q^2)\}|^2]$$

$$\left(\frac{\sigma_{exp}}{\sigma_{stat}}\right)_{e^-} - \left(\frac{\sigma_{exp}}{\sigma_{stat}}\right)_{e^+}$$

$$q \to q_{eff} = q\left(1 \pm \frac{V_C}{E_{inc}}\right)$$

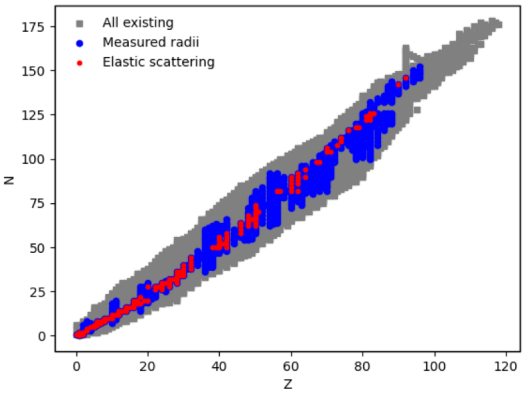


LOI12-23-015 to PAC52 Proposal – Status/Plan

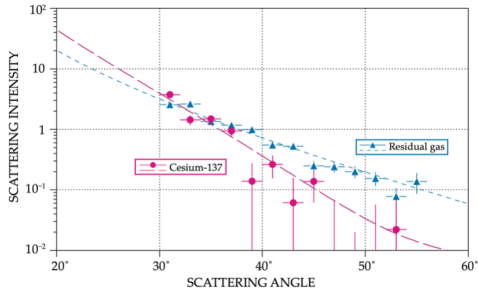
- Monte Carlo simulation
  - Most likely Hall C
- Theory
  - Andrei Afanasev
  - Pablo Giuliani
  - Other?
- Manpower
  - Postdoc: J. Arrington (discussion with D. Higinbotham at APS/DNP2023)
  - Graduate student: Jeseleth Benavides (U. Houston [BS, Fall 2023] & MSU)
  - Undergraduate student: Faith Cherop (MSU)
- Projected timeline
  - December 2023-March 2024: simulation, theory and draft proposal
  - April 2024: submission to PWG
  - May 2024: PAC52

Compact Linac @ FRIB

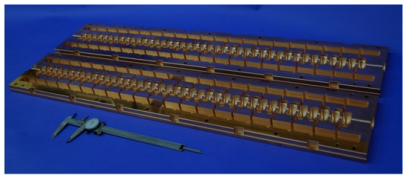
- Nuclear charge radii
  - Most measurements done up to the 80s
  - Current technique: laser spectroscopy
    - » Hyperfine splitting shift from reference nuclei
  - Need comprehensive program
    - » $e^{\pm}$-Rare Isotopes projects (SCRIT …)
  - Relevant for LOI12-23-015
    - » A-dependence for large range of isotopes

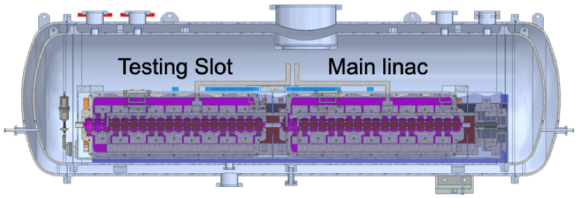


K. Tsukada et al., *Phys. Rev. Lett.* **131**, 092502 (2023)



- Proposal with Cornell
  - ICARUS
    - » Instrument for Cryogenic Accelerator Research and Ultrafast Scattering
  - Test bed for Cool Copper Cavity (C^3): 150 MeV/m
  - Submitted: November 15, 2023





Thanks