Physics Careers in a National Lab (or National Accelerator Facility) Environment

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HUGS Careers mini-Workshop

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Outline

1. How did I get here?
   → *Grad school experience*
   → *Post-doc*

2. Working as a Staff Scientist at JLab
   → *General description of "Staff Scientist" position*
   → *My experiences over the last 13 years*

Education Background (briefly)

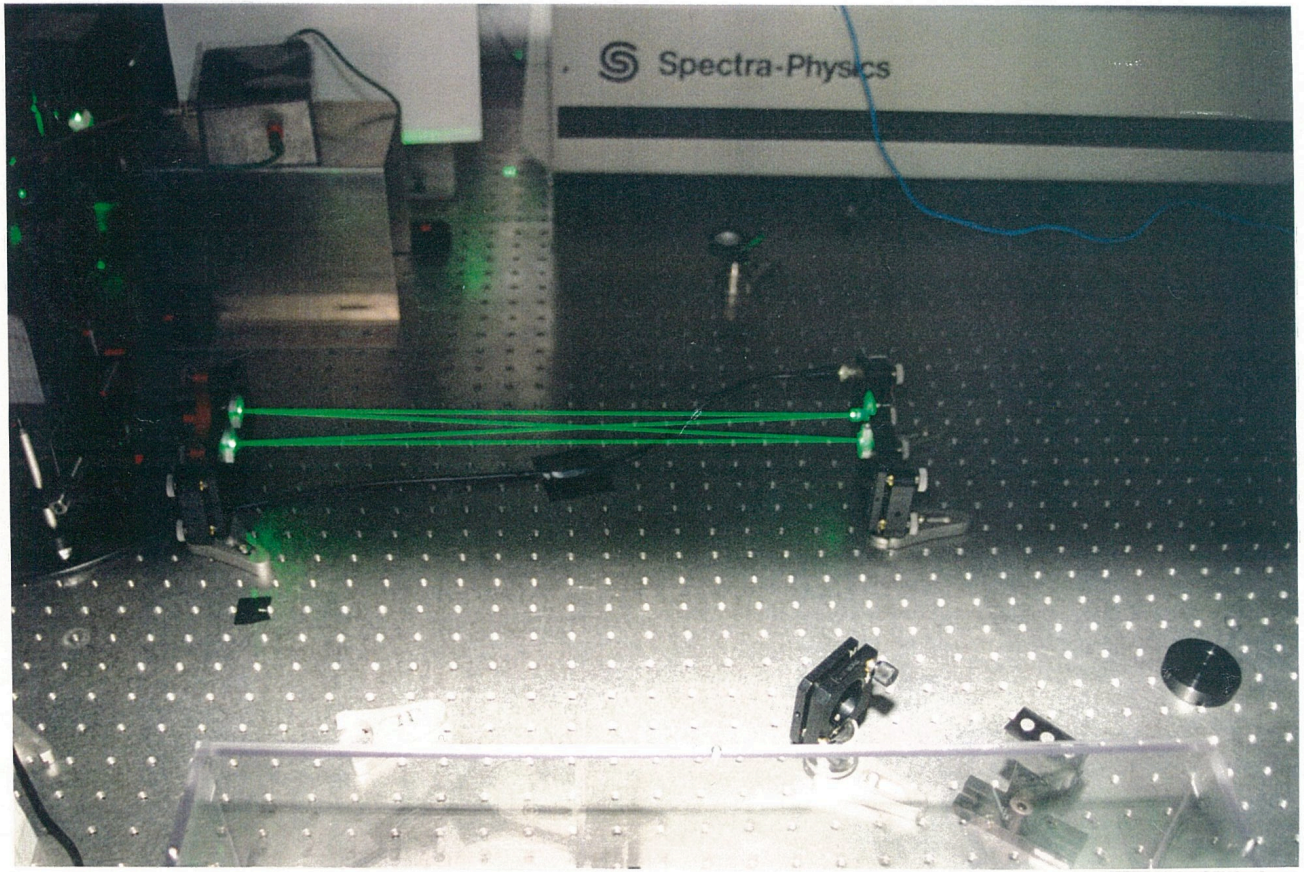
- Undergrad: B.A. (I'm an artistic physicist) in Physics from a tiny college in Indiana (Earlham College – home of the "Hustlin' Quakers")
- Grad school: Ph.D. from Oregon State University (Corvallis, OR)
  - Initially, I wanted to do some kind of laser physics, or trapping → "something cool with lasers"
  - All the laser physics groups were full – then I got interested in nuclear and particle physics
  - In the end, my adviser had an interesting nuclear physics-related project that used lasers

Time at JLab as a student: Lasers!

- After 2 years of courses, passing qualifier, etc., came to JLab with a loosely defined (not at all defined?) thesis project → "Look for Rolf Ent and do what he tells you."
- Initial projects:
  - Construct high-gain Fabry-Perot cavity (make kW of laser power out of 1 W) → this was potentially to be used as a backscattered photon source or for a Compton polarimeter
  - Use high power CO2 laser to measure beam energy via Compton scattering
  - Take shifts on running experiments

Time at JLab as a student: Lasers!

1.5 years later ….



(this is more impressive than it might look)

JLab → ANL → Colorado

- Thesis experiment ran in Hall C
  - Pion electroproduction from H,D, and ^{3}He → L-T separation
- Initial analysis at JLab → moved to Argonne National Lab to complete analysis, finish thesis
- ANL had big involvement with HERMES experiment
  - Learning about what was going on at HERMES influenced by decision to take a post-doc at Colorado (Boulder)
- As part of HERMES, got involved in analysis of DVCS and semi-inclusive data

Coming Back to JLab

- Came back to JLab in 2002 as Staff Scientist
- Graduate student and post-doc experience I think was important in helping get this job
  - Hall C was planning on building a new Compton polarimeter for Q-Weak. Experience with lasers and thinking about Compton polarimetry certainly helped here
  - Deep exclusive and SIDIS physics was really becoming a hot topic at JLab → HERMES experience was helpful
  - Familiar with how to make challenging measurements in Hall C (L-T separations)

Staff Scientist: job description

- Support the physics program at Jefferson Lab
- Research
- If you are clever – you can work things out so that your “support” function closely overlaps your research interests*

*I am not that clever

Staff Scientist: job description

- Support the physics program at Jefferson Lab → this support can take several forms
  - Hardware: build, maintain, or improve a particular piece of equipment
  - Software: develop, maintain, or improve an analysis package, simulation framework, etc.
  - DAQ – this is kind of hardware and software rolled together
  - Organizational: Serve a liaison to experiment(s) running in your hall

Supporting the Physics Program

- Over the years, I've had several different roles in support of the JLab (Hall C) physics program
  - Maintain the Hall C Møller polarimeter
  - Coordinate construction of a new Compton Polarimeter in Hall C
  - Physics Division Liaison/Installation Project Coordinater for large installation experiments
    - G0 Back-angle
    - Q-Weak
  - Manage upgrade of Hall C beamline for 12 GeV

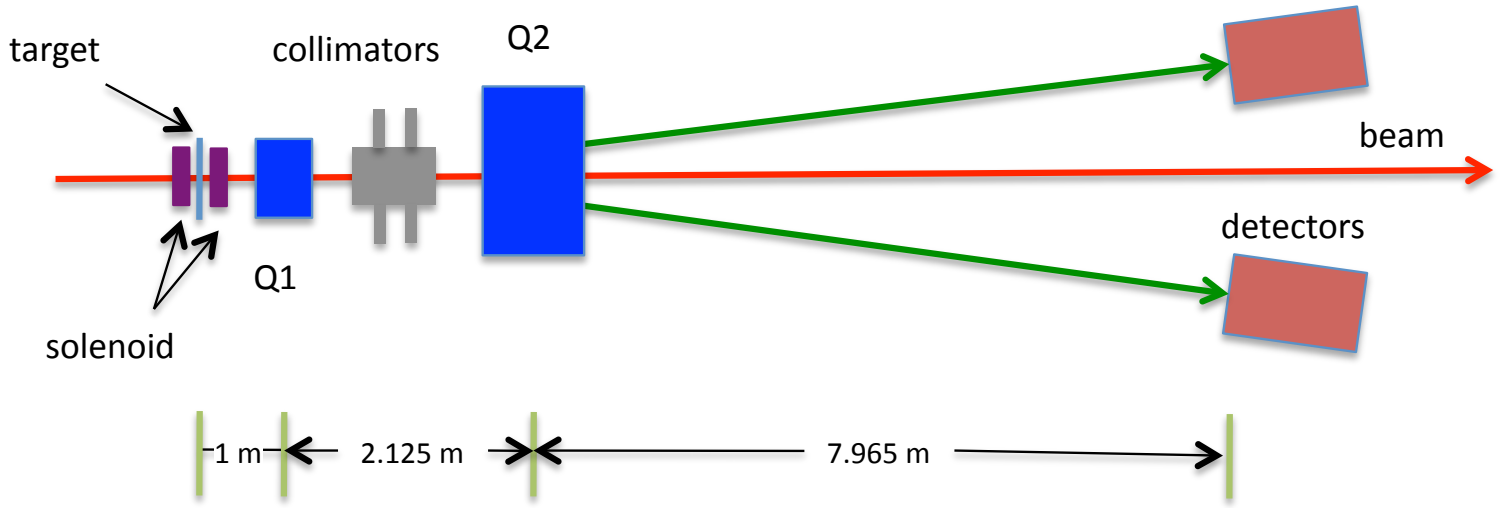
Møller Polarimeter

Hall C Møller polarimeter measures beam polarization via (polarized) electron-electron scattering

→ Like a stand-alone “mini-experiment”

→ System includes detectors, magnets (one superconducting), targets, DAQ, analysis software

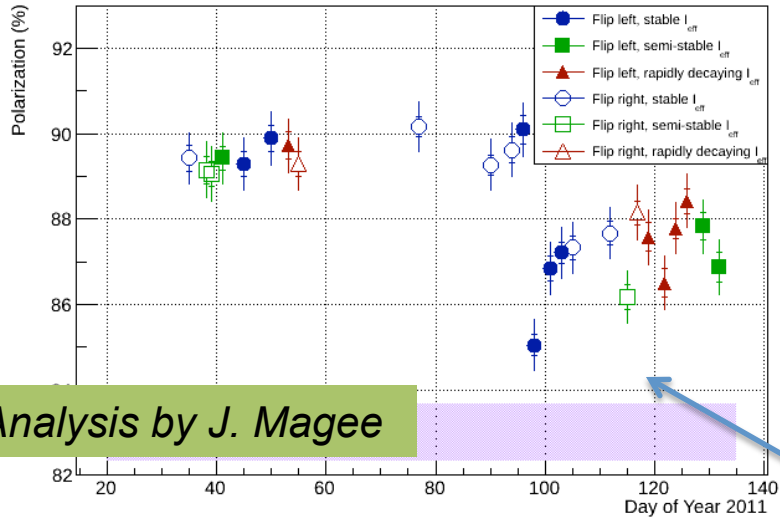
→ I’m responsible for making sure the whole thing works, helping Users make measurements and analyze the data



Møller Polarimeter

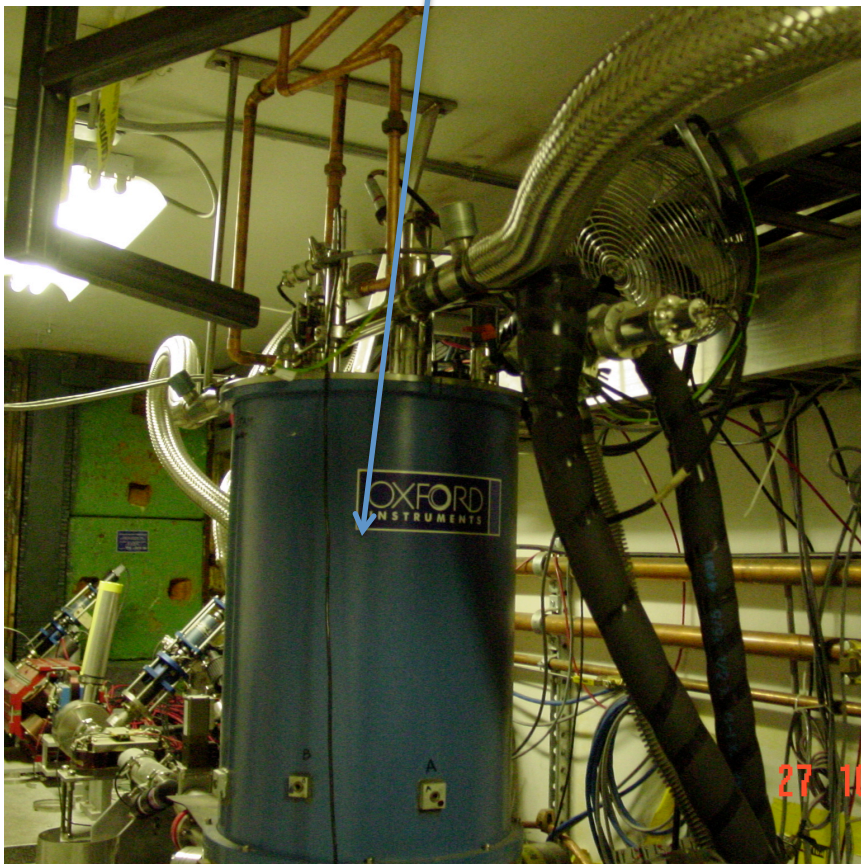
Fix these

Møller Polarization by Day (Run 1)



Analysis by J. Magee

Cool this with 4K He

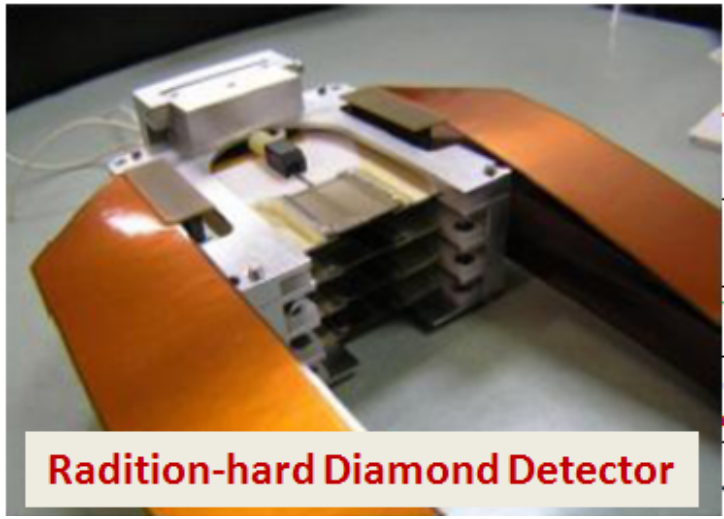


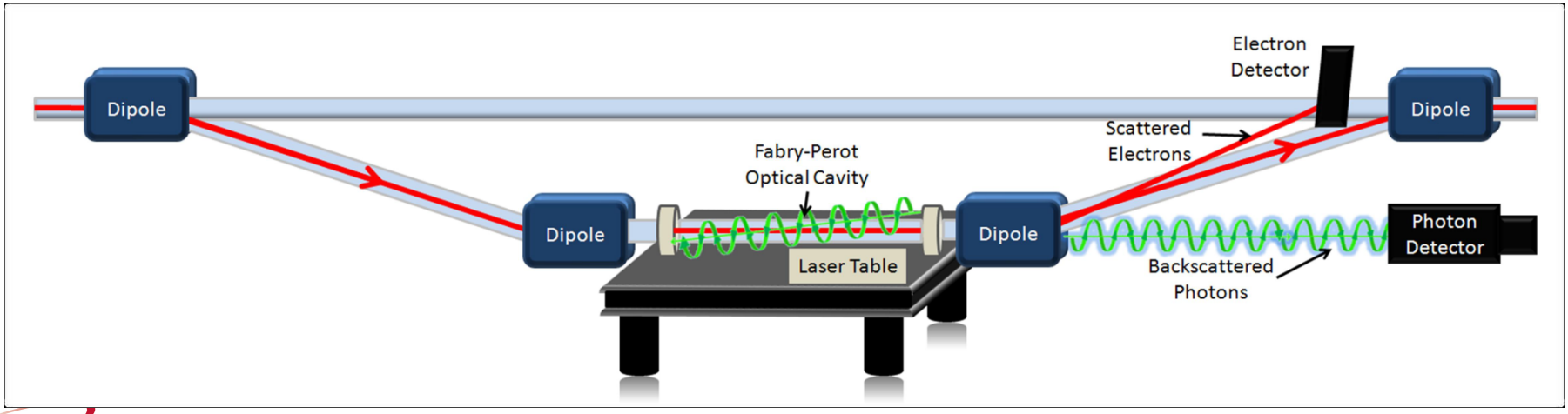
Analyze data to get these results

Compton Polarimeter

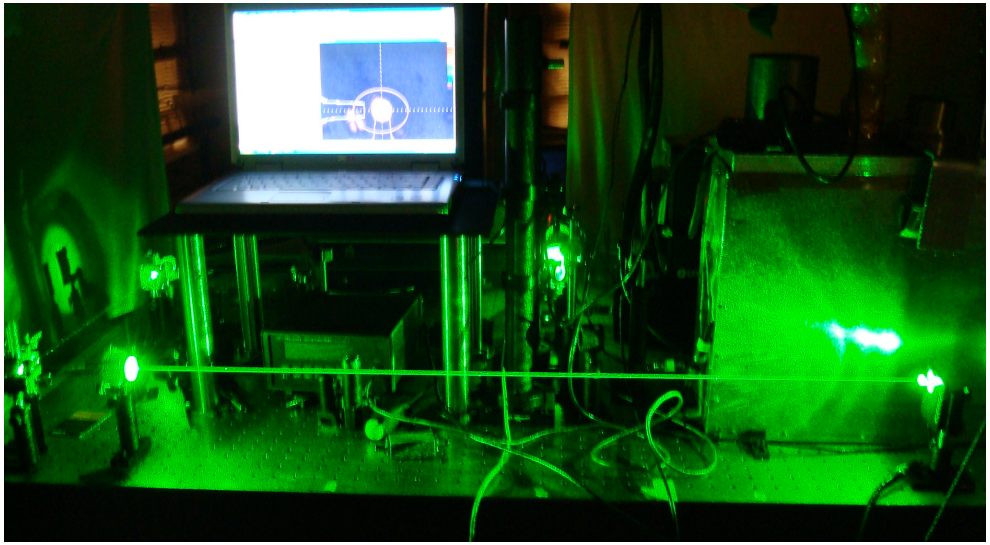
Coordinated construction and installation of new Compton polarimeter

1. 4 dipole chicane → MIT-Bates
2. Photon detector → Yerevan Physics Institute, William and Mary
3. Diamond strip electron detector → Mississippi State, Winnipeg, Manitoba
4. Laser system → University of Virginia, JLab

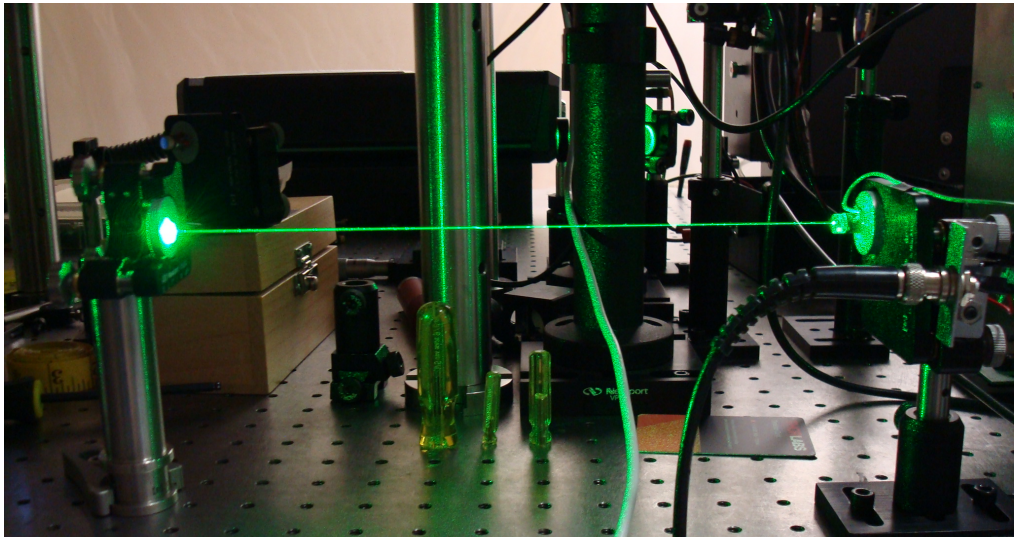




Compton Polarimeter



In addition to general coordination, design decisions etc., I helped with the initial proof-of-principle and implementation of the laser system

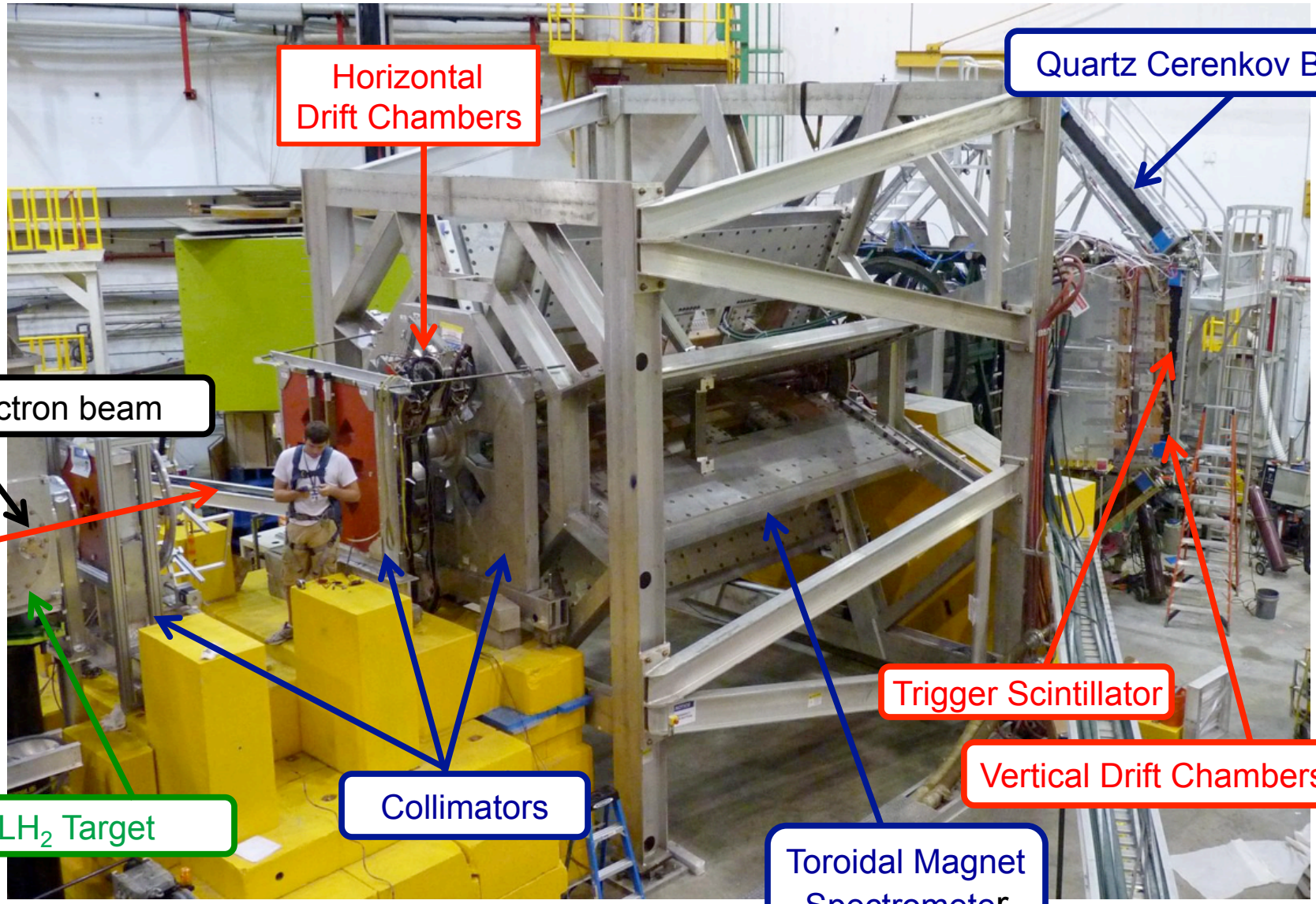


Experiment Installation and Coordination

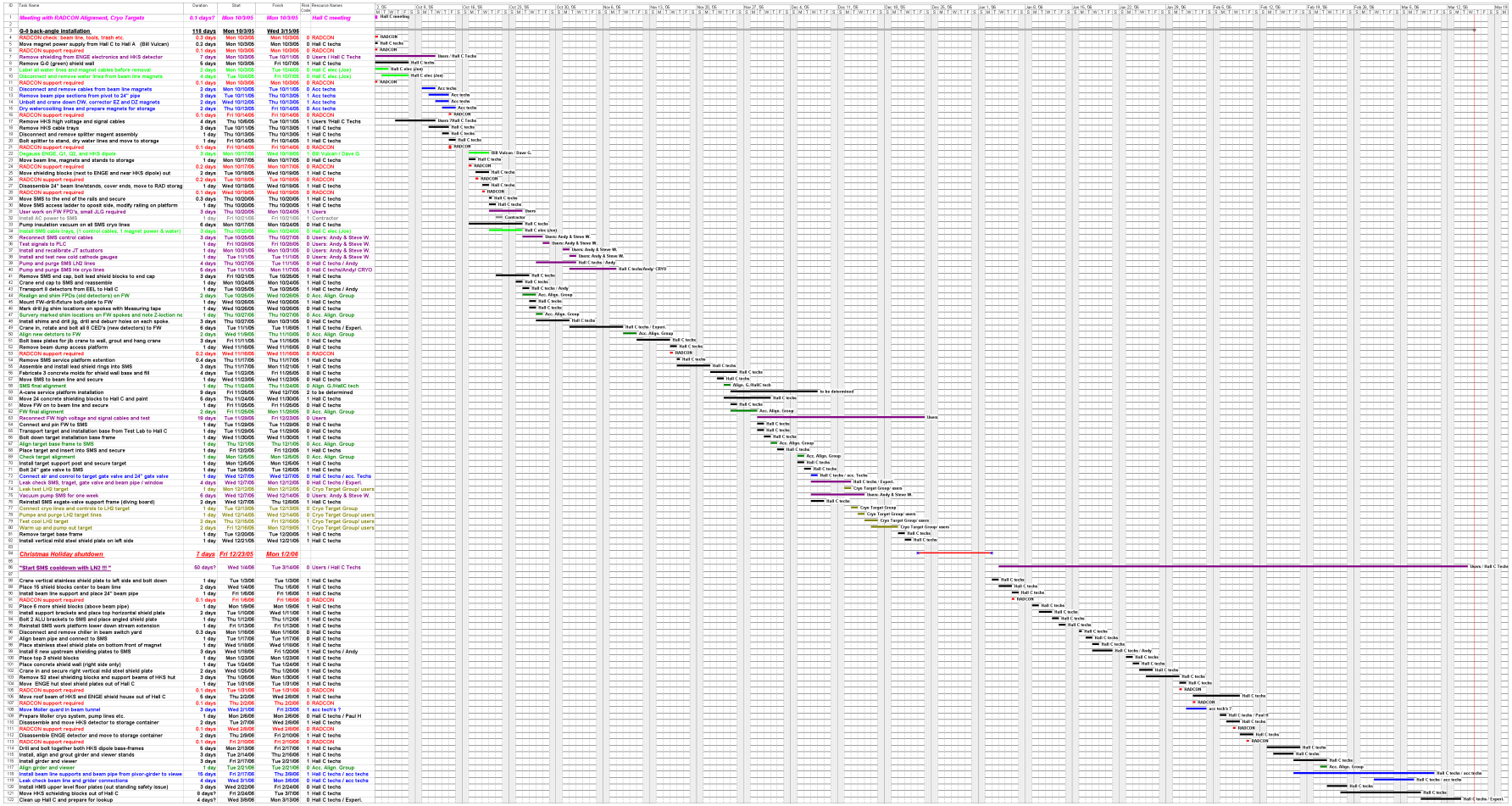
- All experiments at JLab need some level of coordination between the hall staff (physics and technical) and Users
- “Large installation” experiments need a lot of coordination – in cases like this, there is often an “Installation Project Coordinator” – I did this for Q-Weak
- Fun aspects of this job:
  - Get to see experiment built from the ground up
  - Work with hall work coordinator and Users to make sure installation is executed in properly (ordering, schedule, etc.)
  - Work with Accelerator and Engineering groups → really get a new perspective on how the machine works on a daily basis, at a pretty detailed level

Q-Weak Apparatus

Constructed over several years – installed in ~8-9 months



Experiment Installation and Coordination



Less-fun aspects of being “Installation Project Coordinator” …
→ at least I didn’t have to make this schedule

Staff Scientist: job description

- Research → here you can pursue most anything that interests you, within certain limits
  - Experiments: Most typically, a staff scientist's "research" efforts are taken up in proposing, running, and analyzing data from experiments done at JLab
  - Detectors: Staff also pursue new directions in detector technology. However, this often needs to be driven by the needs of an approved experiment (see above).
  - Talks and publishing: Publicizing (your) new results also counts as "research" → this includes presentations at conferences as well as writing articles

Research

- My physics interests:
  - Pion electroproduction (see my thesis) → in particular, using pion production to access the electromagnetic form factor of the charged pion
  - Semi-inclusive DIS → exploring the limits of factorization in SIDIS, trying to access charge symmetry violating quark distributions using SIDIS
  - Nuclear effects in DIS → the nuclear EMC effect, flavor dependence of the EMC effect, nuclear dependence of R_A-R_D

Nuclear Effects in Deep Inelastic Scattering

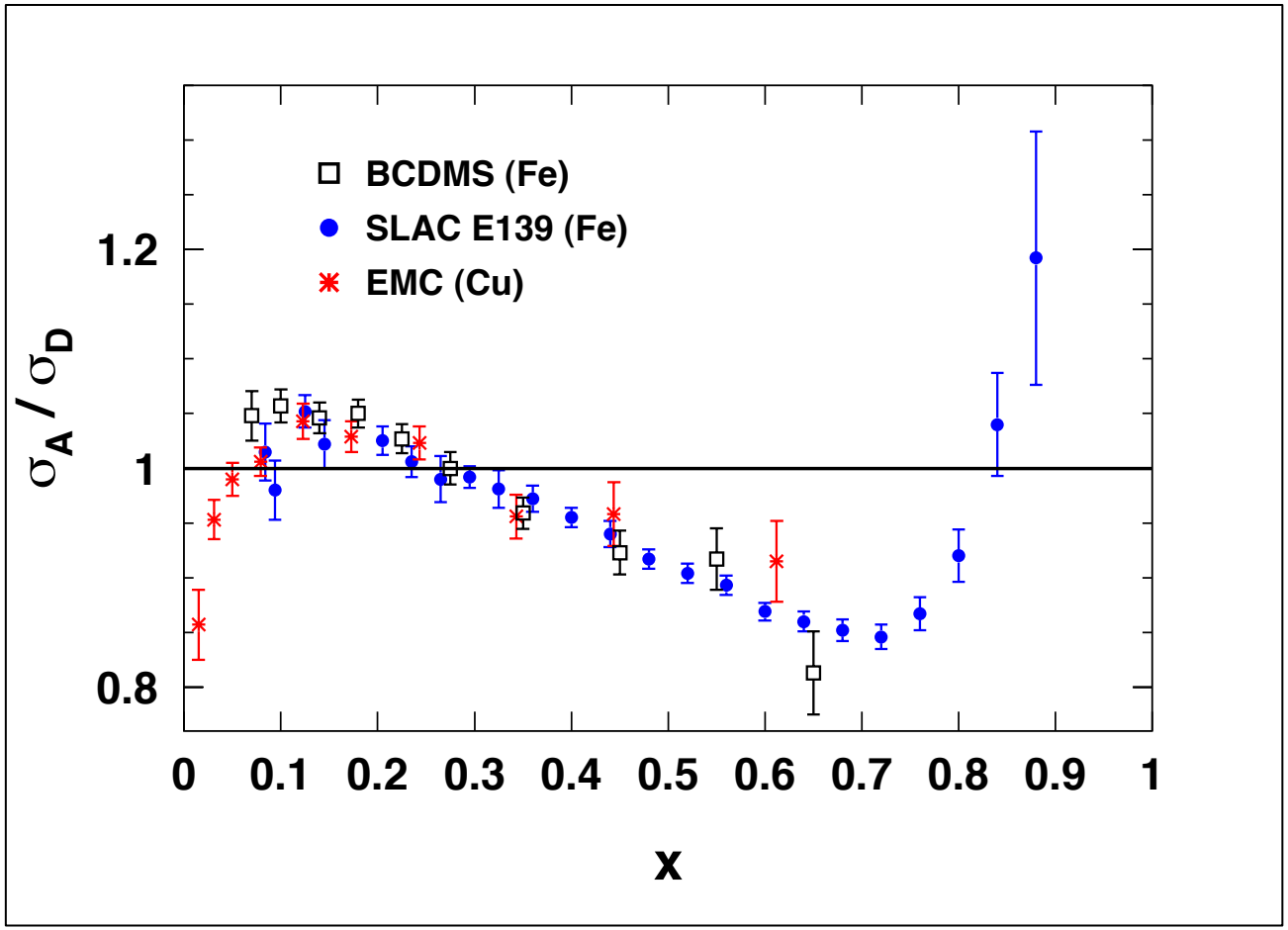
For more than 30 years, we have known that quark distributions are modified in nuclei compared to the free nucleon

"EMC Effect"

Measured via cross section ratios

Before JLab, well measured for medium and large A nuclei

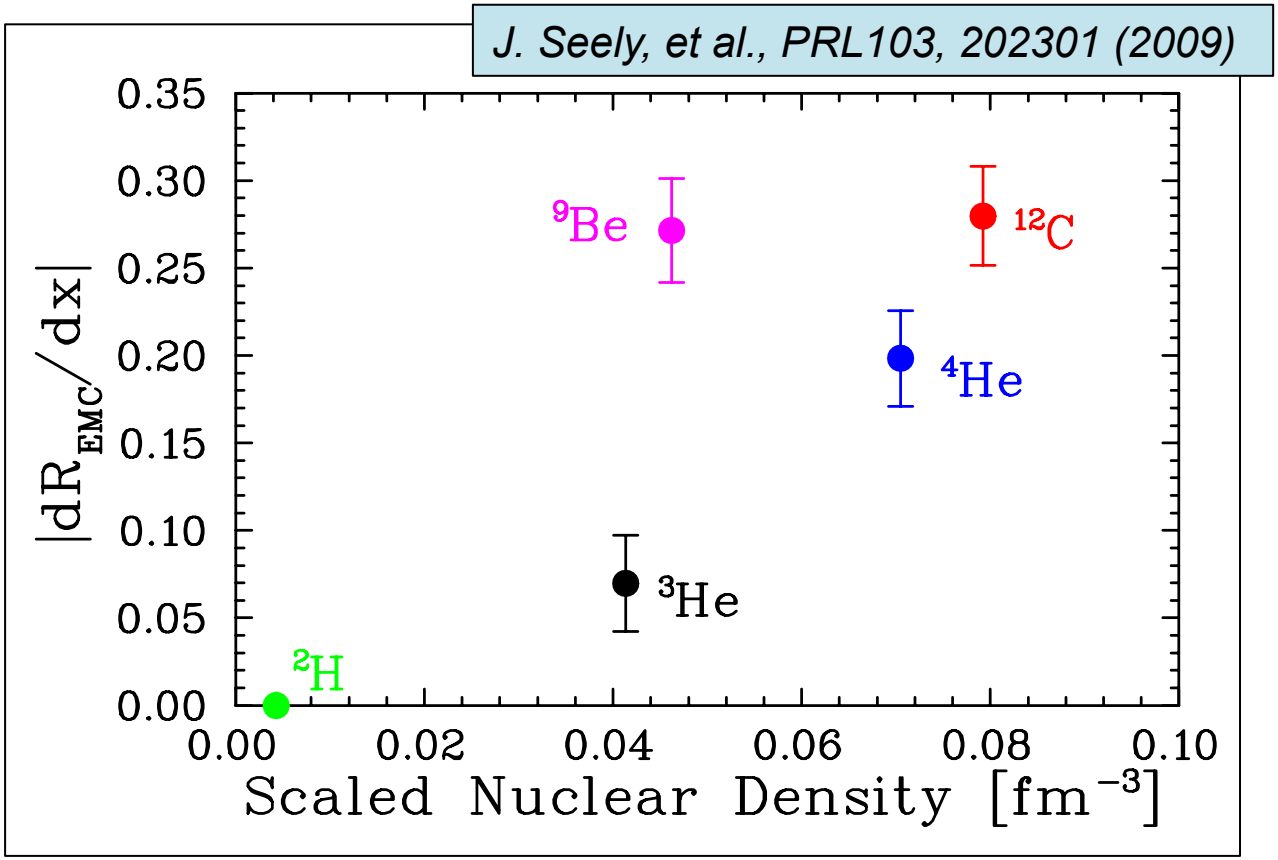
→ JLab added light nuclei



JLab E03103 Results

E03103 measured s_A/s_D for ^{3}He, ^{4}He, Be, C

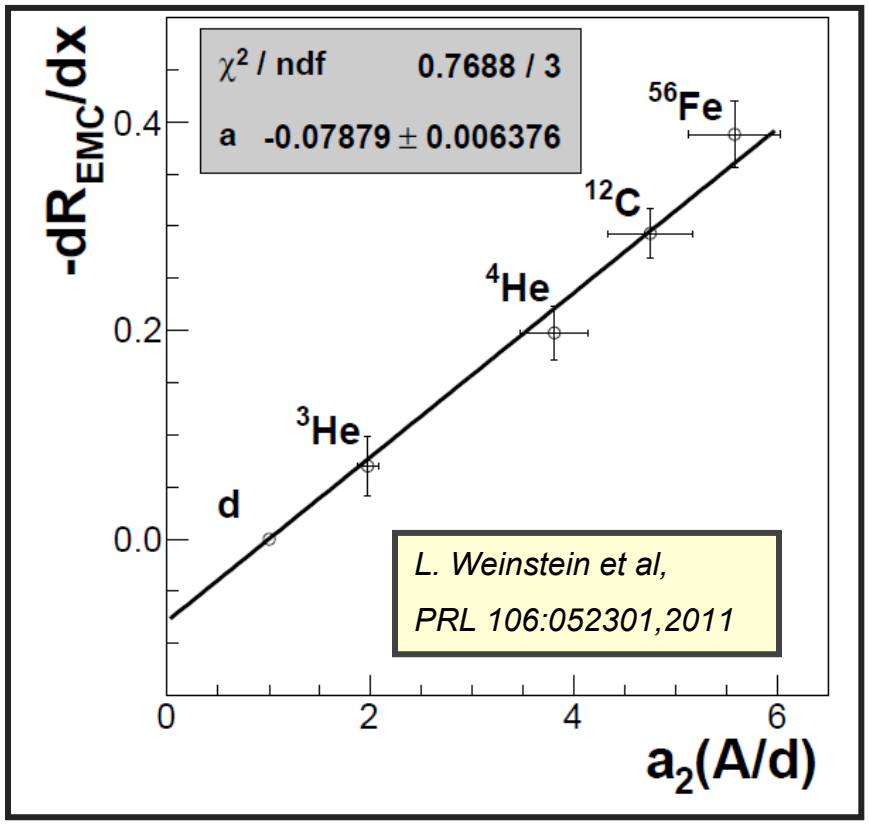
→ ^{3}He, ^{4}He, C, EMC effect scales well with density
→ Be does not fit the trend



Scaled nuclear density = $(A-1)/A \langle\rho\rangle$
→ remove contribution from struck nucleon

$\langle\rho\rangle$ from ab initio few-body calculations
→ *[**S.C. Pieper and R.B. Wiringa**, Ann. Rev. Nucl. Part. Sci 51, 53 (2001)]*

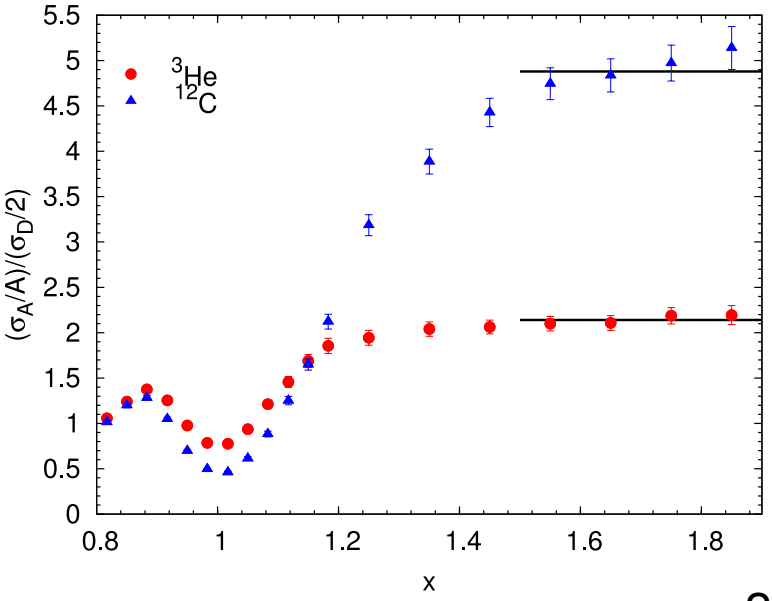
EMC Effect and Short Range Correlations



Weinstein et al observed linear correlation between size of EMC effect and Short Range Correlation "plateau"

→Observing Short Range Correlations requires measurements at *x>1*
→ Reaction dynamics very different – DIS vs. QE scattering, why the same nuclear dependence?

$$\frac{2}{A}\frac{\sigma_A}{\sigma_D} = a_2(A)$$



Future Experiments

- There are several experiments targeting better understanding of the nuclear dependence of quark distributions
- Experiments I'm involved in:
  - Measurements aimed at expanding the database of EMC-SRC correlation measurements
  - Measurements of the nuclear dependence of R_A-R_D
- Other experiments
  - MARATHON – measuring the EMC effect in mirror nuclei (^{3}He and ^{3}H)
  - Tagging high momentum nucleons in the deuteron
  - EMC effect for polarized quark distributions
- Not (yet) approved
  - Flavor dependence of EMC effect via parity violating DIS
  - Flavor dependence using SIDIS

Research Considerations at JLab

- In general (not always true) JLab staff do not have their "own" funds to support their research
  - Travel, equipment, etc. funds (if needed) come directly from lab
  - Lab funds our research time
  - We can apply for lab LDRD funds and "Early Career" awards
- In some ways, this places certain limits on experiments in which we can participate
  - Must make a very strong case if you want to participate in an experiment at a different lab (FNAL, RHIC, etc.)
- Applying for grants and funding can consume a lot of time – this is not something I have to worry about

Students

- Many opportunities to work with students in different capacities
- Summer students
  - SULI and REU programs allow us to work with undergrads on a research project for the summer
  - Sometimes these students come back to JLab in grad school
  - Also – some opportunties to work with high school students
- Graduate students
  - I have worked with many graduate students over the years
  - Some projects have been rather limited in scope (Møller measurements, etc.)
  - I have worked with students on the data-taking and analysis of their thesis data (and served on their thesis committees)
  - Staff scientists generally rely on Users and collaborators to send their students to JLab – if I would like a student for a particular project, I need to talk to collaborators and ask if they have a student who might be interested
  - Also possible (not hard) to become (unpaid) adjunct at local university → easier to serve as “official” adviser for students, etc.