Run Group M Update

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Run Group-M (RGM) Experiment

- Two important physics processes:
  - Short Range Correlations E12-17-006A
  - Electrons for Neutrinos E12-17-006
- Completed November 2021 - February 2022 at Jefferson Lab
- Electron scattering off of nuclear targets over several energies,
- 10x luminosity CLAS6

RG-M Proposal

NN Interaction & Nuclear wave-function
[^{2}H , ^{4}He]

Many-body systems & nuclear asymmetry
[^{40}Ca,^{48}Ca,^{120}Sn]

Decouple N/Z vs A
nn vs pp

3N - SRC Observation
[^{4}He, ^{12}C, ^{40}Ca]

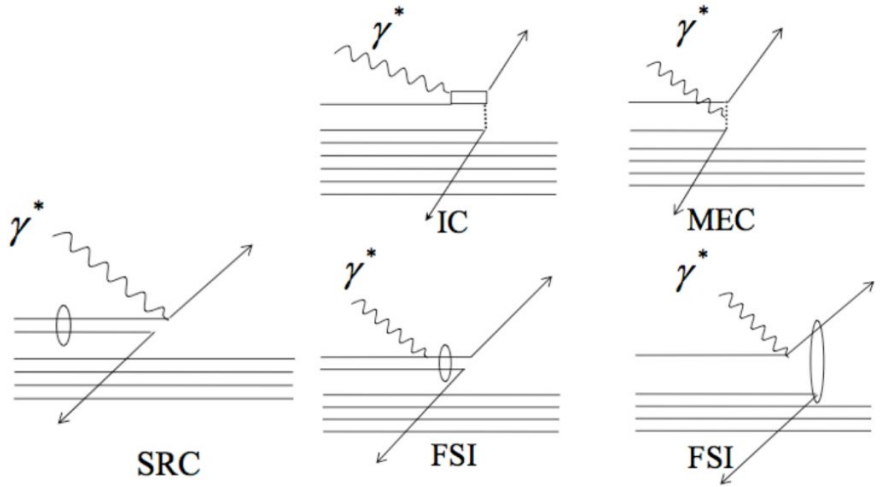
First observation
A dependence

Reaction Mechanisms
[^{4}He, ^{12}C, ^{40}Ca,^{48}Ca,^{120}Sn]

Q^2 independence
A dependence

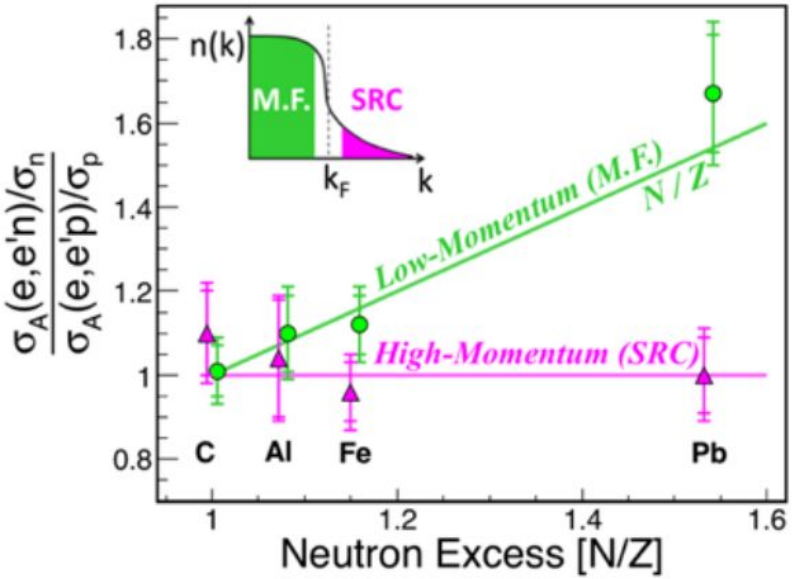
Understanding Scale and Probes

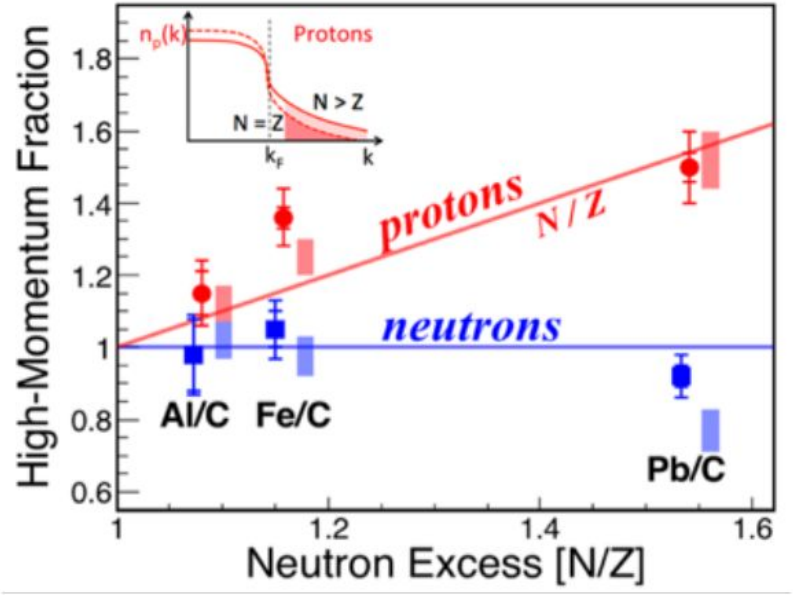
- Later you will here about other probes (Photons, hadrons)
- Final State Interactions minimized by going to high-Q^2 high x_B
- FSI should depend on Q^2
- Q^2 independence study of SRC observables
- A independence



Many Body Problem

M. Duer et al. Nature 560 617–621 (2018)





- Decouple N/Z and A
- Adding 40,48Ca and 120Sn

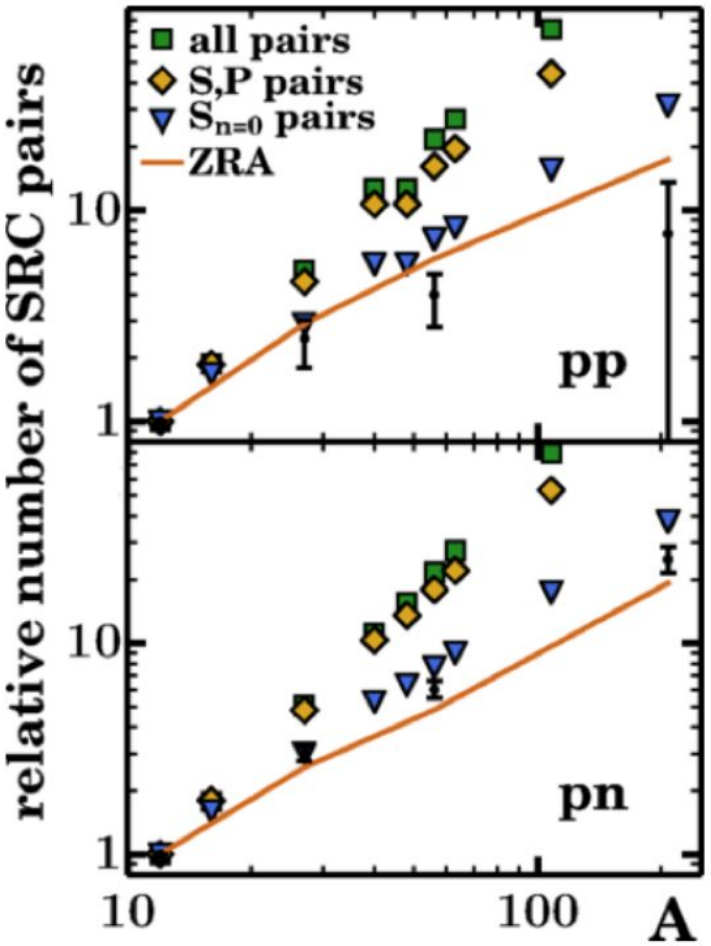
Many Body Problem

- short-range behavior is universal
  - (i.e. relative momentum is nucleus-independent)
- long-range behavior -> e.g. total momentum
  - Depends on which nucleons form the pairs

Which nucleons combine to form the pairs?

- Any two nucleons, only relative s- or p-state, s-state, s-state with n=0, or two nucleons at zero range

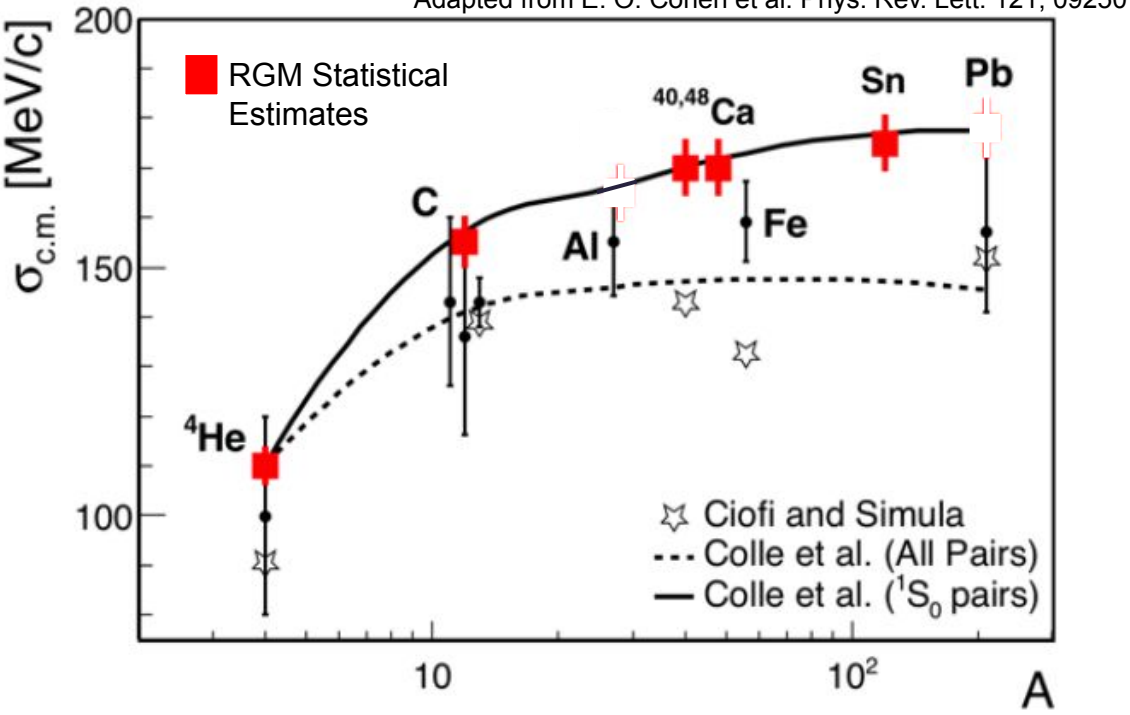
C. Colle et al. Phys. Rev. C92, 024604 (2015)



Many Body Problem

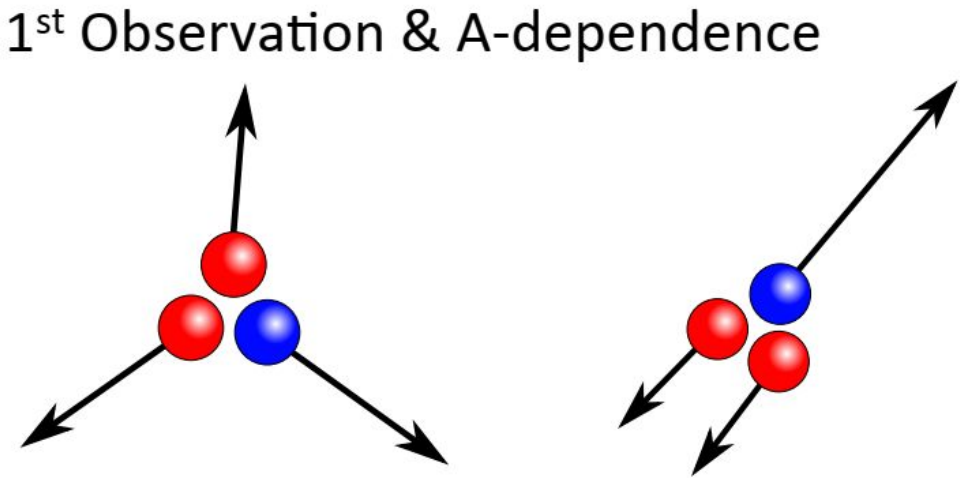
Which nucleons combine to form the SRC pairs?

Adapted from E. O. Cohen et al. Phys. Rev. Lett. 121, 09250



3-N SRC Observation

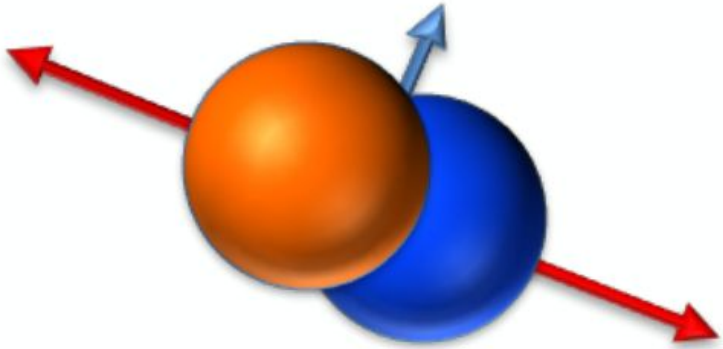
- Effort has been put into looking at very limited statistics of C (Andrew)
- Developing generator (even a primitive one would be helpful)
- Looking forward to discussions at this meeting…



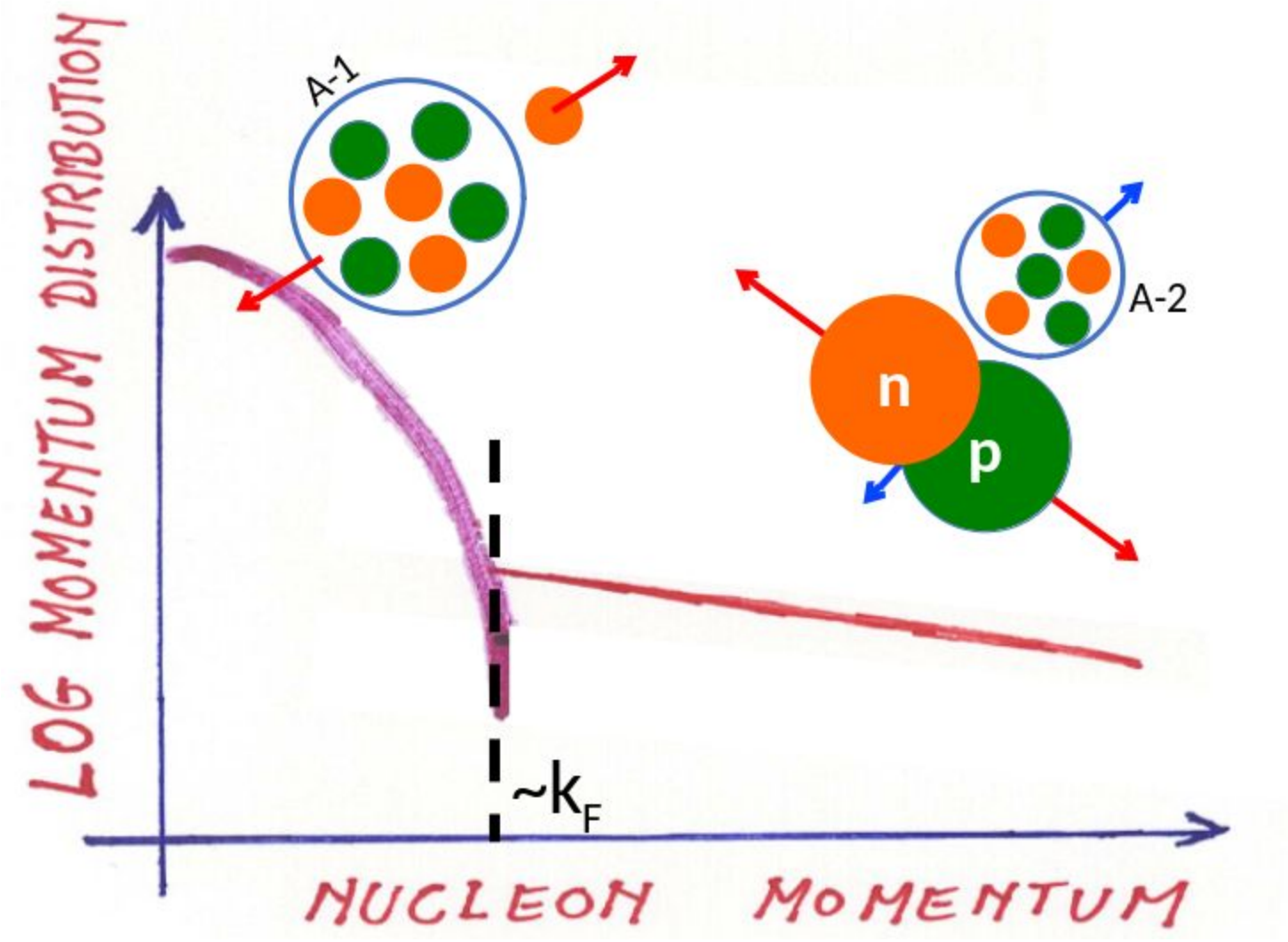
Short range, short lived,
highly correlated pairs

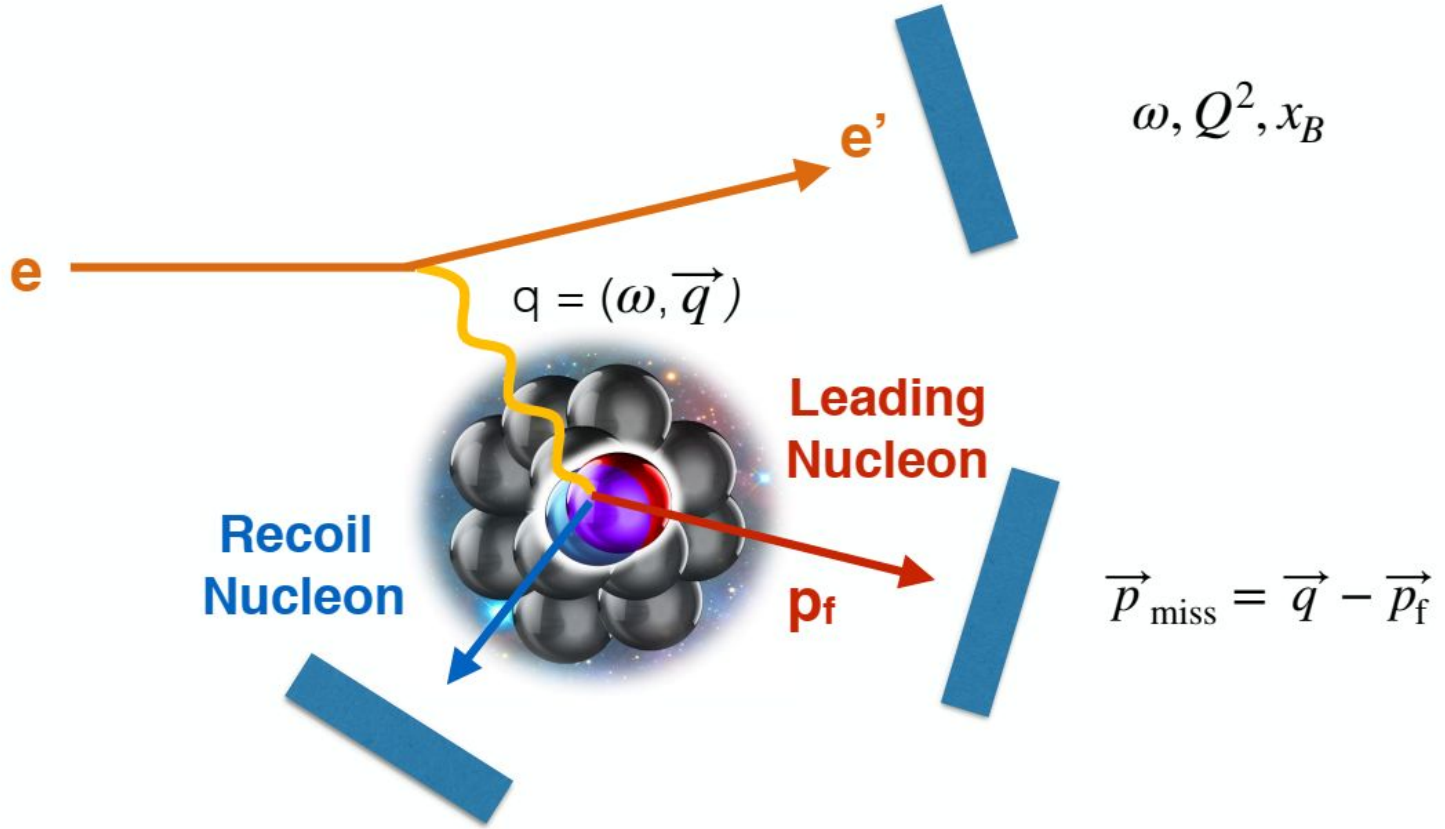
r-space

High relative momentum
Low center of mass momentum



k-space

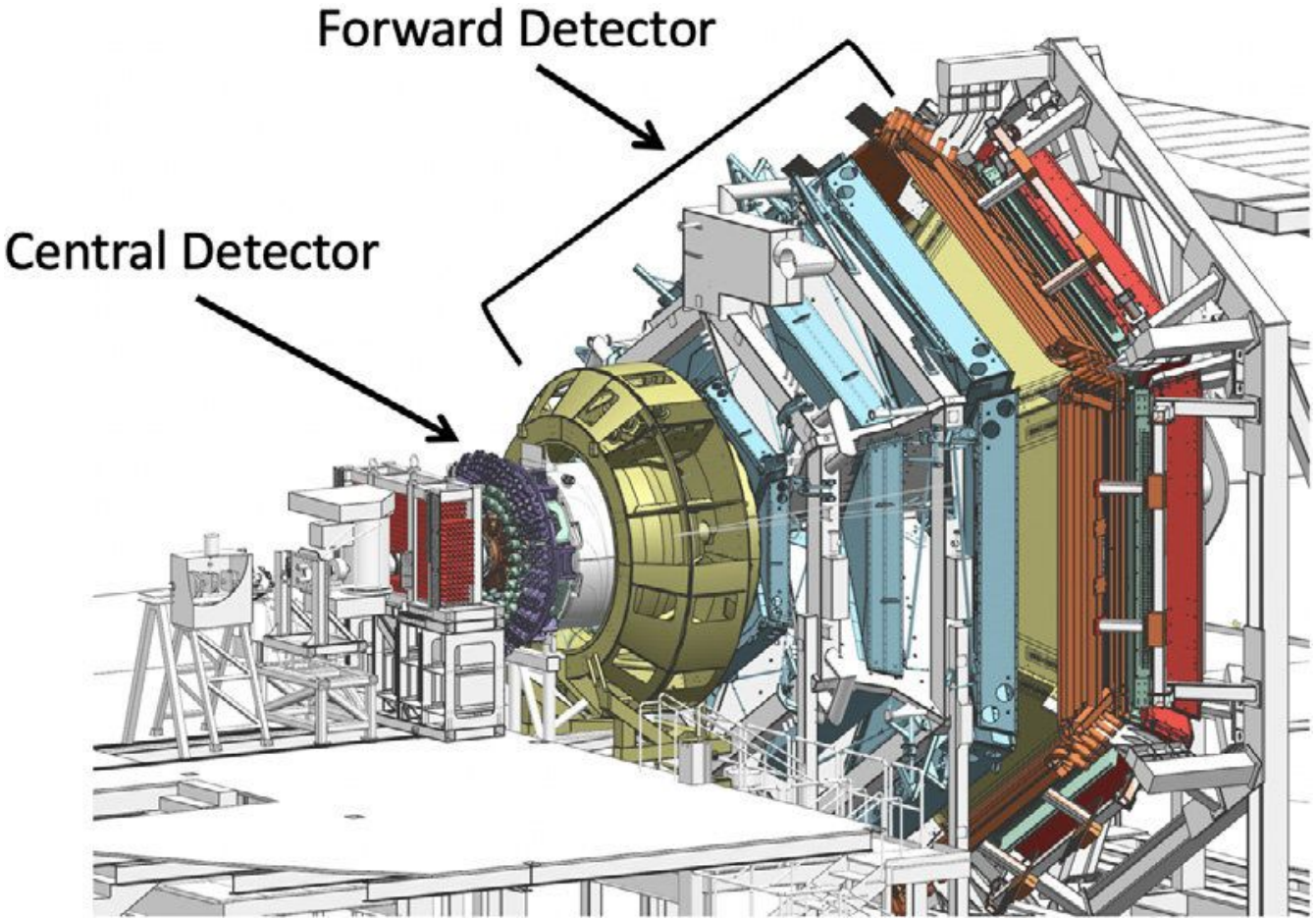

LOG MOMENTUM DISTRIBUTION
A-1
A-2
n
p
~k_F
NUCLEON MOMENTUM



- (e,e') inclusive
- (e,e'N)
- (e,e'NN)

CLAS12 Detector

CEBAF Large Acceptance Spectrometer for operation at 12 GeV @ JLAB

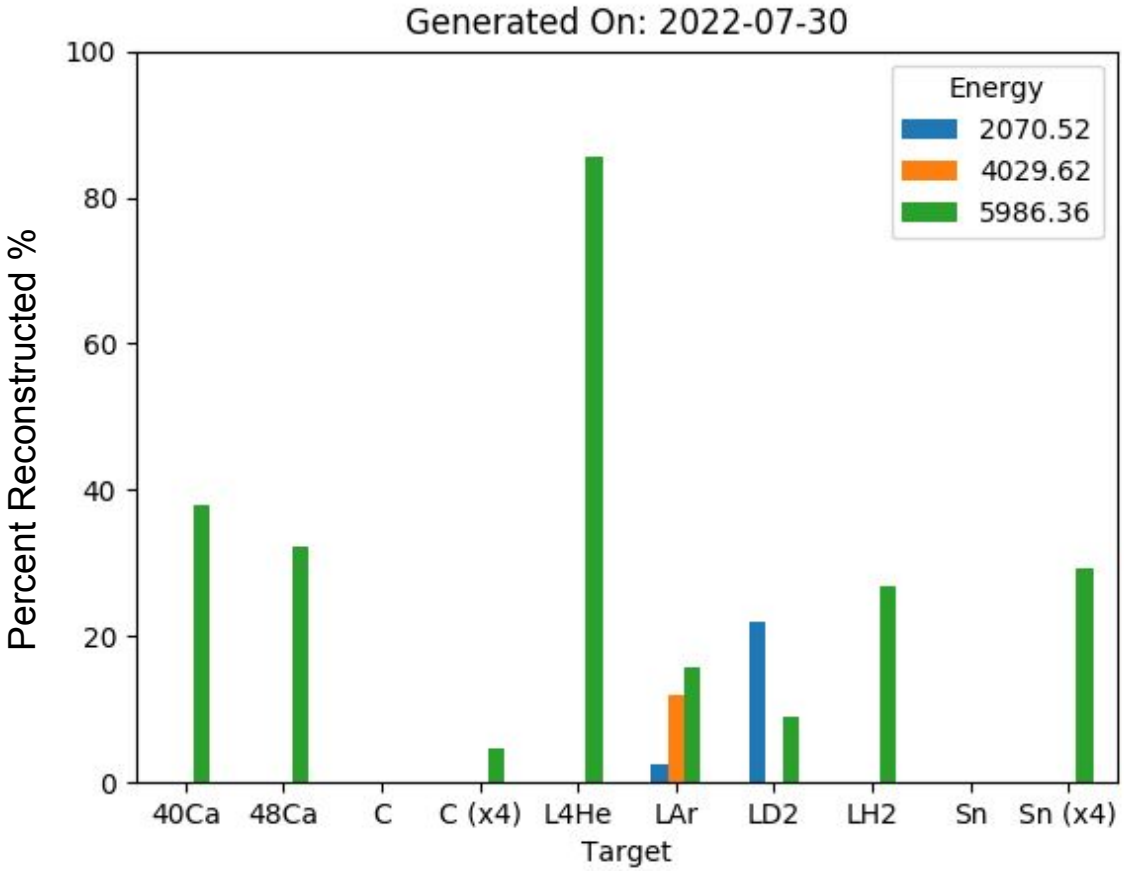


Experimental Data Collected

	Targets	Total Triggers (B)	Reconstruction (Days)**	Data Storage (Tb)
6 GeV				
	H	1.1	2	26
	D	4.2	8	105
	He	3.9	8	98
	C	4.1	8	103
	40Ca	3.0	6	75
	48Ca	1.50	3	38
	Ar	0.55	1	14
	Sn	0.40	1	10
Totals	6 GeV	19	37	468

*Beam energies 2 & 4 GeV shown in backup slides
**Reconstruction days assumes full Hall B priority ~500M events/day

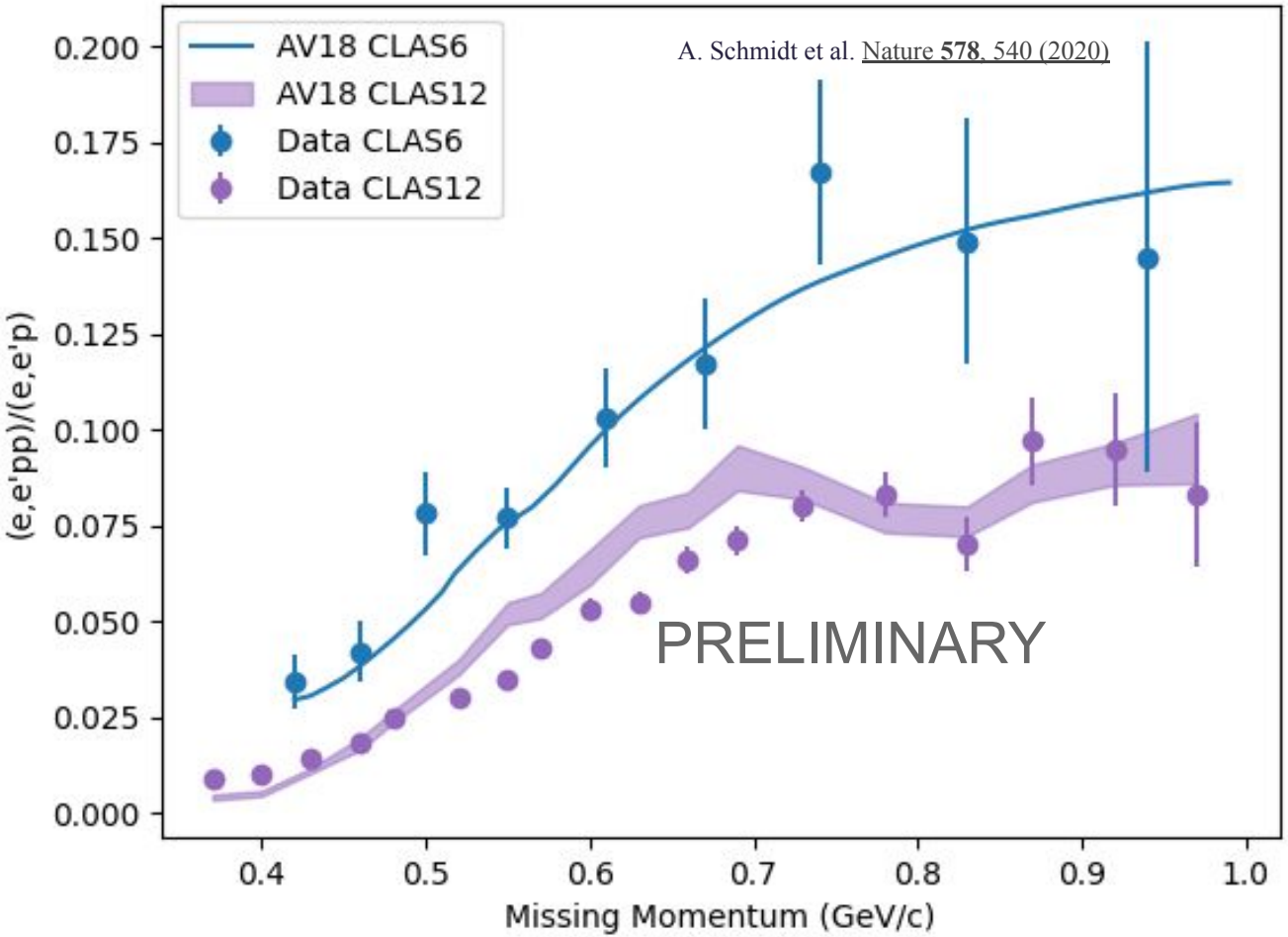
Data Currently Reconstructed



2-N SRC Estimates

Target	Channel	Event Estimate
LD2	e'p	47,000
LHe	e'p	130,000
	e'pp	5,500
Cx4	e'p	161,000
	e'pp	5,600
Snx4	e'p	9,900
	e'pp	430
40Ca	e'p	67,000
	e'pp	3,600

*Extrapolated counts based on small % of data reconstructed online

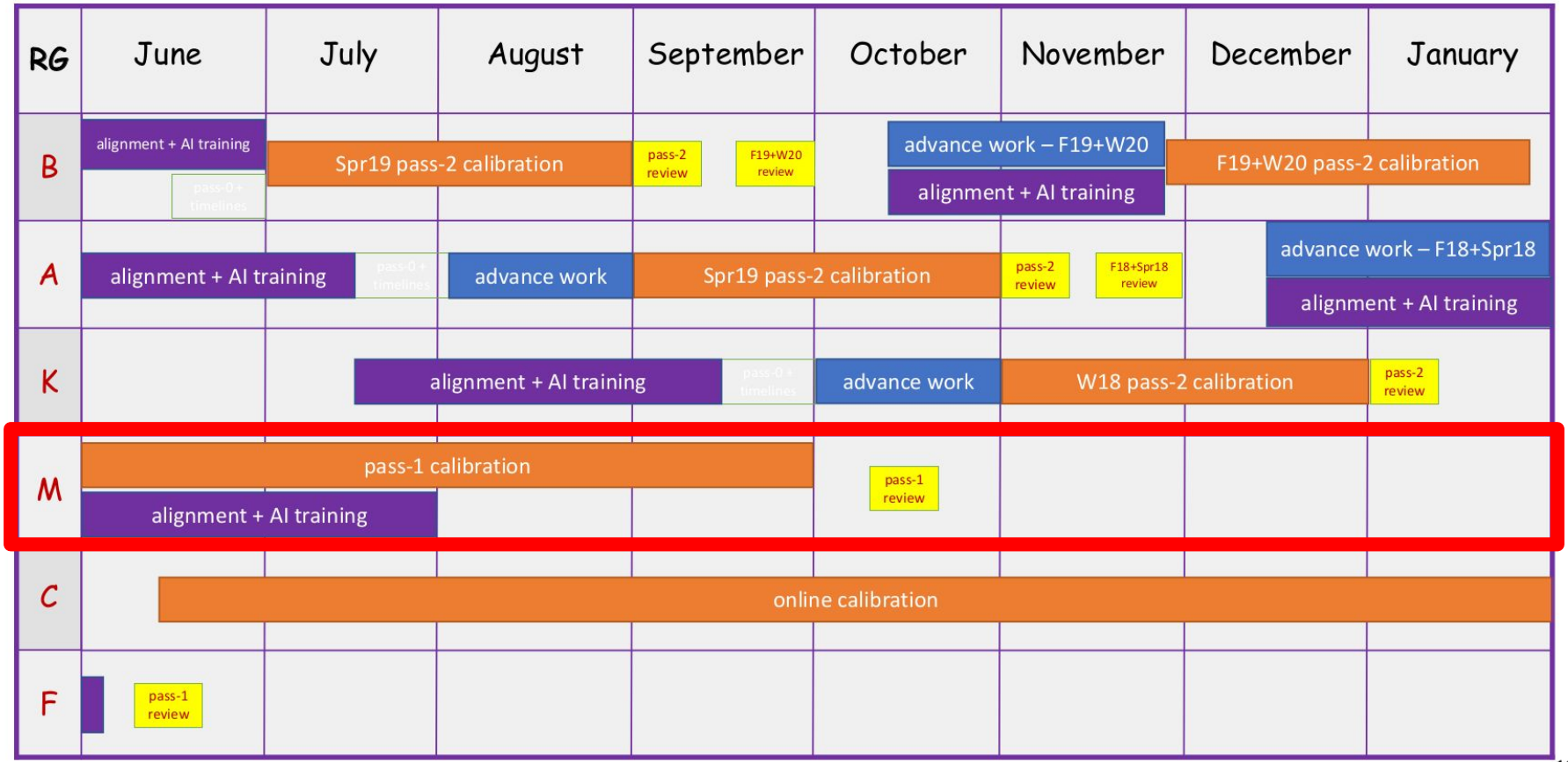


Analysis by Andrew Denniston (MIT)

Calibration Timeline: June 2022 – January 2023

RG	June	July	August	September	October	November	December	January
M	pass-1 calibration				pass-1 review			
	alignment + AI training							

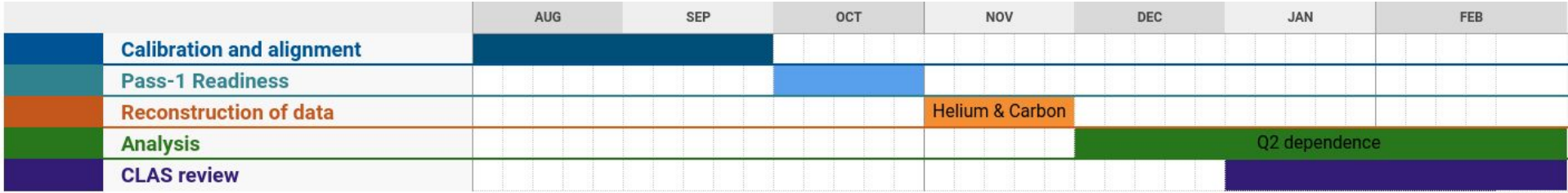
Calibration Timeline: June 2022 – January 2023



Status of Alignment and Calibration

- Final calibrations follows final alignment (large portion finished)
- Drift Chamber alignment (waiting on software)
- Central detector alignment (alignment produced; validating/fixing bugs)
- Finish within the month depending on software/expert availability

Path to first publication

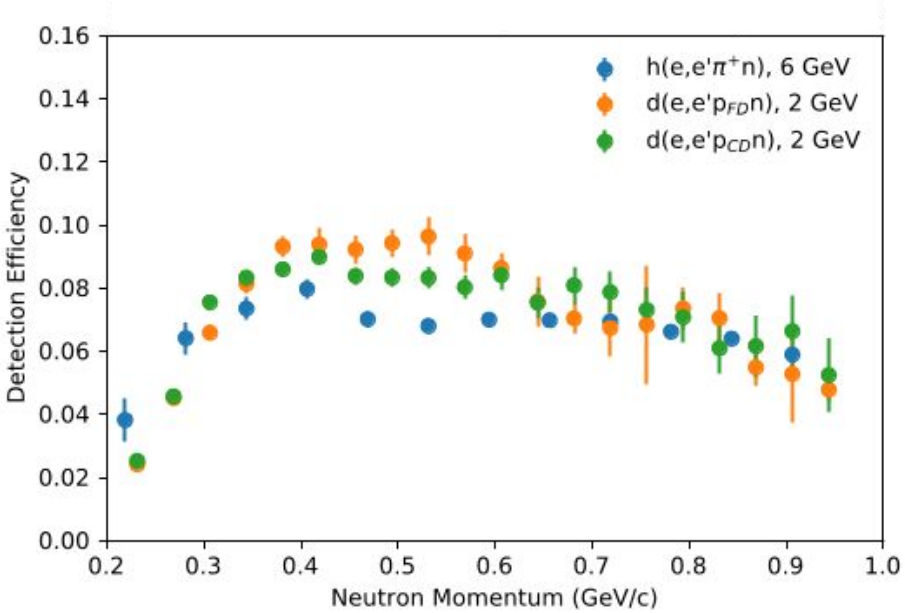


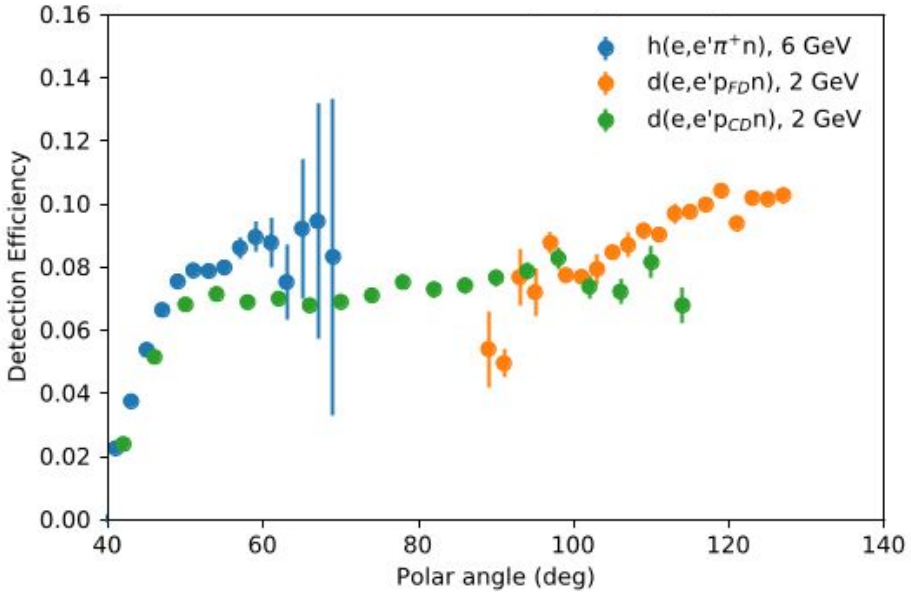
- First publication using pp pairs
- Q^2 independence of (e,e'pp)/(e,e'p) and C.M. momentum distributions
- Rough timeline of earliest of when that may occur

Status of neutrons

- Forward calorimeter (0.5 - 3 GeV/c poor resolution; higher efficiency)
  - Can get neutrons without much further work
- Central detector (0.2 - 1 GeV/c good resolution; ~10% efficiency)
  - Need to develop veto, large background
- Forward detector (0.2 - 1 GeV/c good resolution; ~10% efficiency)
  - Need veto, least explored, not counting on including in first analysis

Neutron Efficiency Analysis (Central Det.)





Analysis by Erin Seroka (GW)

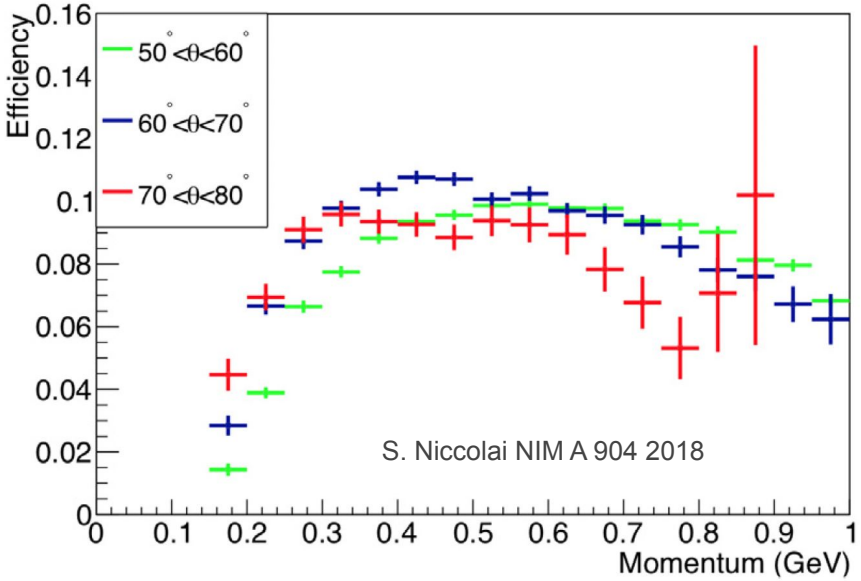
Critical path items

- Develop neutron veto (CD); list of information we need to output (~2 months)
  - Can’t store neutron hit information -> 30% increase to data size
  - Distill critical information need to make a good veto and write to data
- Reconstruction scheduling
  - I’m not aware of any strategy for reconstruction scheduling after calibration efforts
  - Do we go in parallel? Which run groups go first? How much of data will be reconstructed?
  - Need to determine which targets we want first and also get a clear schedule from CLAS Coordinating Committee (CCC)
  - **As a group we need to pick which targets we are interested in first**

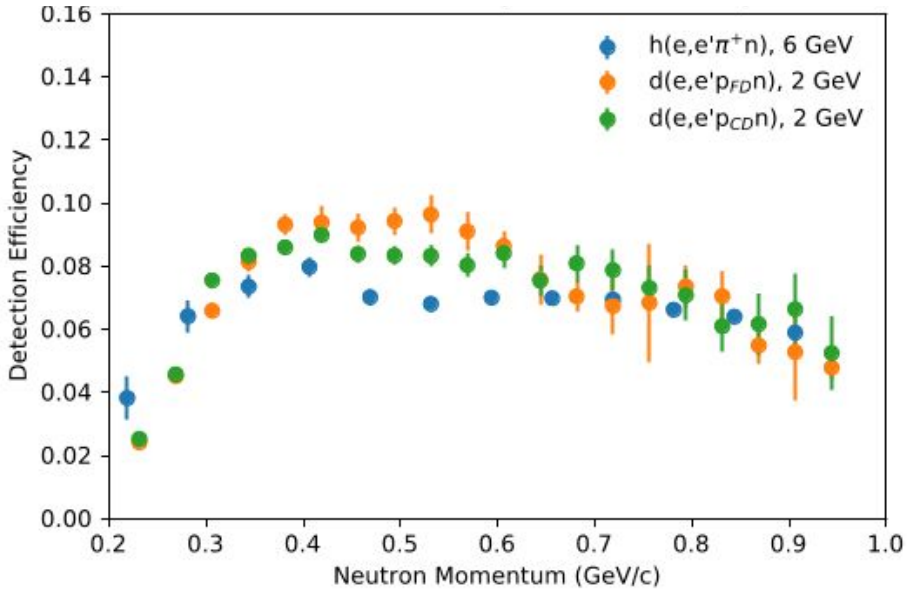
Thank You!

Backup slides

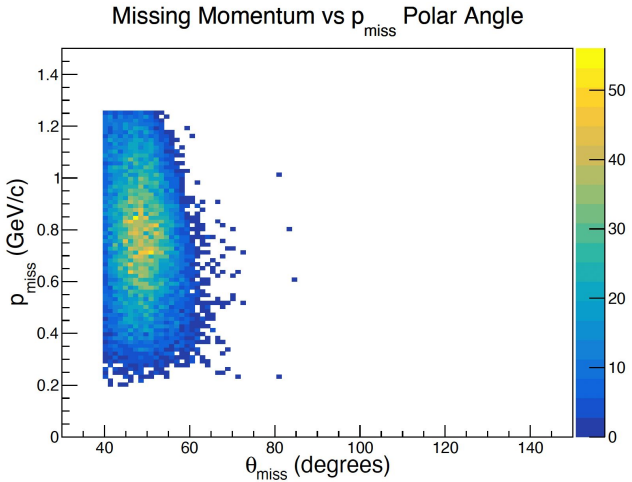
CND NIM Paper



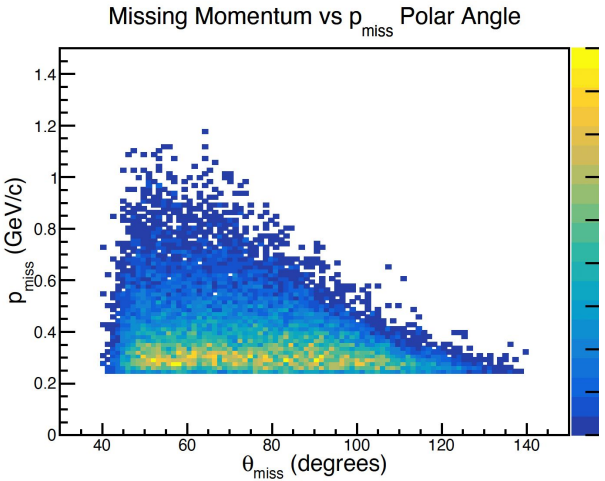
RGM Analysis



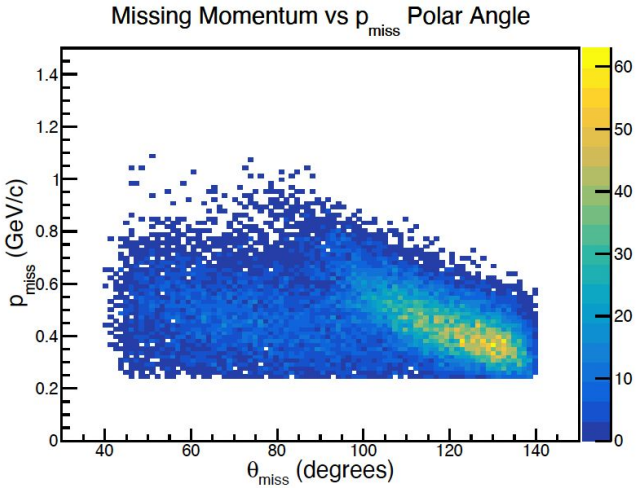
Event Selection
Well-reconstructed pion in FD
Missing momentum points to CD
Neutron momentum agrees with pmiss
0.85 GeV/c2 < Mmiss < 1.05 GeV/c2



Event Selection
Well-reconstructed proton in CD
Missing momentum points to CD
Neutron momentum agrees with pmiss
0.85 GeV/c2 < Mmiss < 1.05 GeV/c2
Background eliminated with



Event Selection
Well-reconstructed proton in FD
Missing momentum points to CD
Neutron momentum agrees with pmiss
0.85 GeV/c2 < Mmiss < 1.05 GeV/c2
Background subtraction



	Targets	Total Triggers (B)	Reconstruction (Days)	Data Storage (Tb)
2.1 GeV				
	LH2	0.9	2	23
	LD2	4.0	8	100
	C	2.0	4	50
	LAr	4.1	8	103
4 GeV	LAr	0.9	2	23
	C	0.80	2	20
Totals	2.1 GeV	11	22	275
	4 GeV	2	3	43
	All	31	63	785