

Run Group-M Update

Justin Estee



Run Group-M Proposals

- RGM is made up of two proposals will investigate two important physics processes:
- Short Range Correlations E12-17-006A
- Electrons for Neutrinos E12-17-006

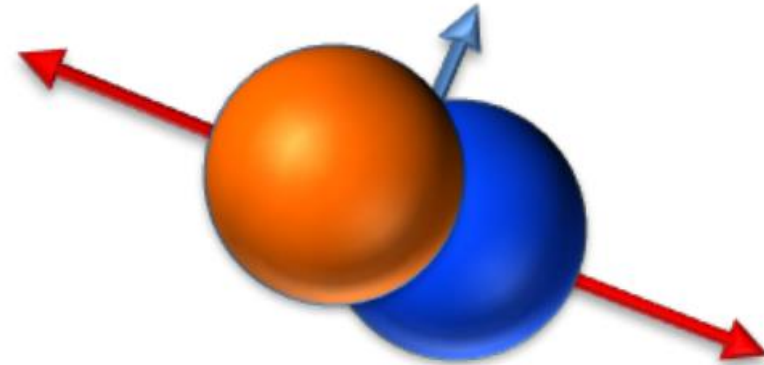
Short Range Correlations (SRCs)

Short range, short lived,
highly correlated pairs

r-space

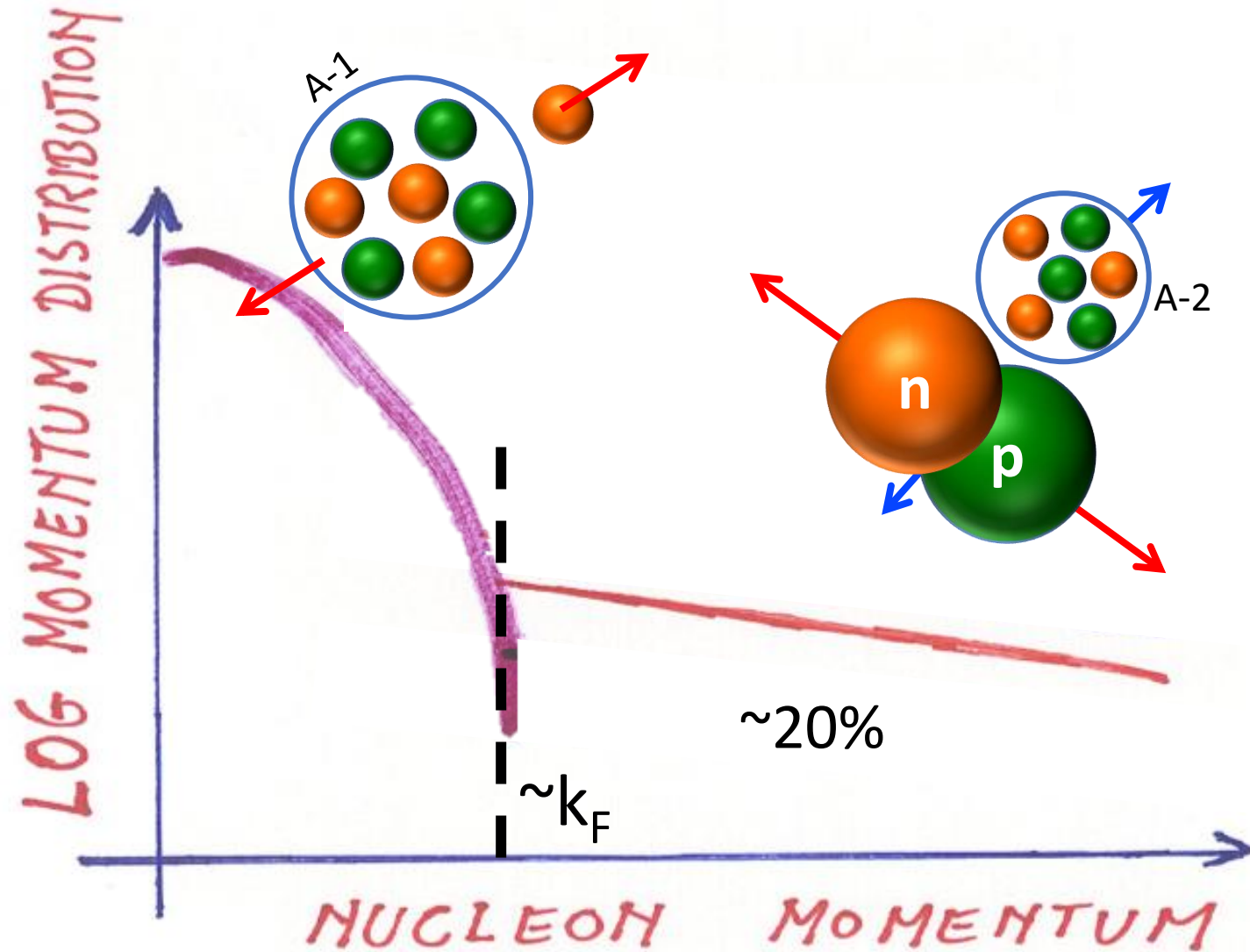


High **relative** momentum
Low **center of mass** momentum

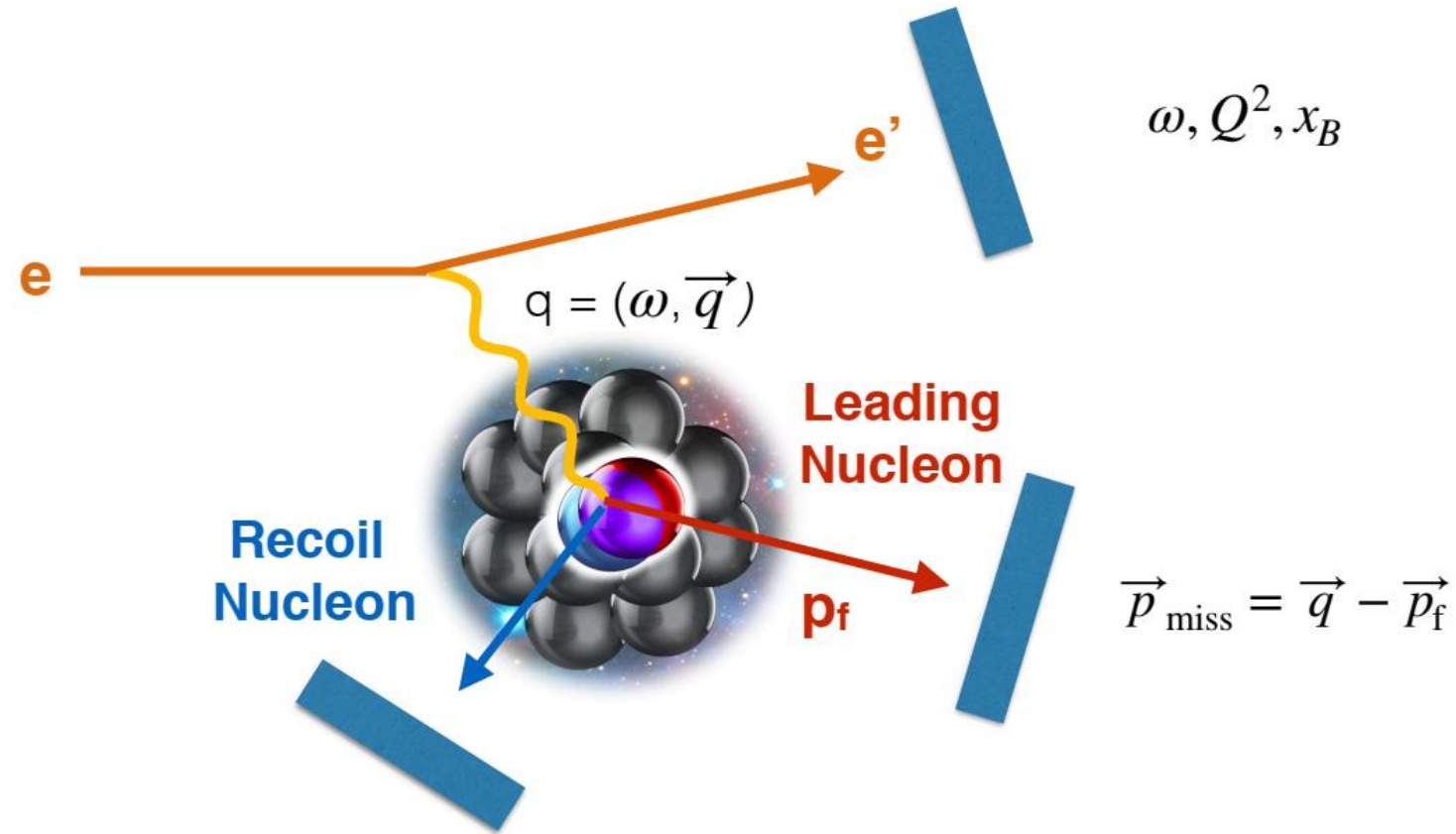


k-space

High momentum tail

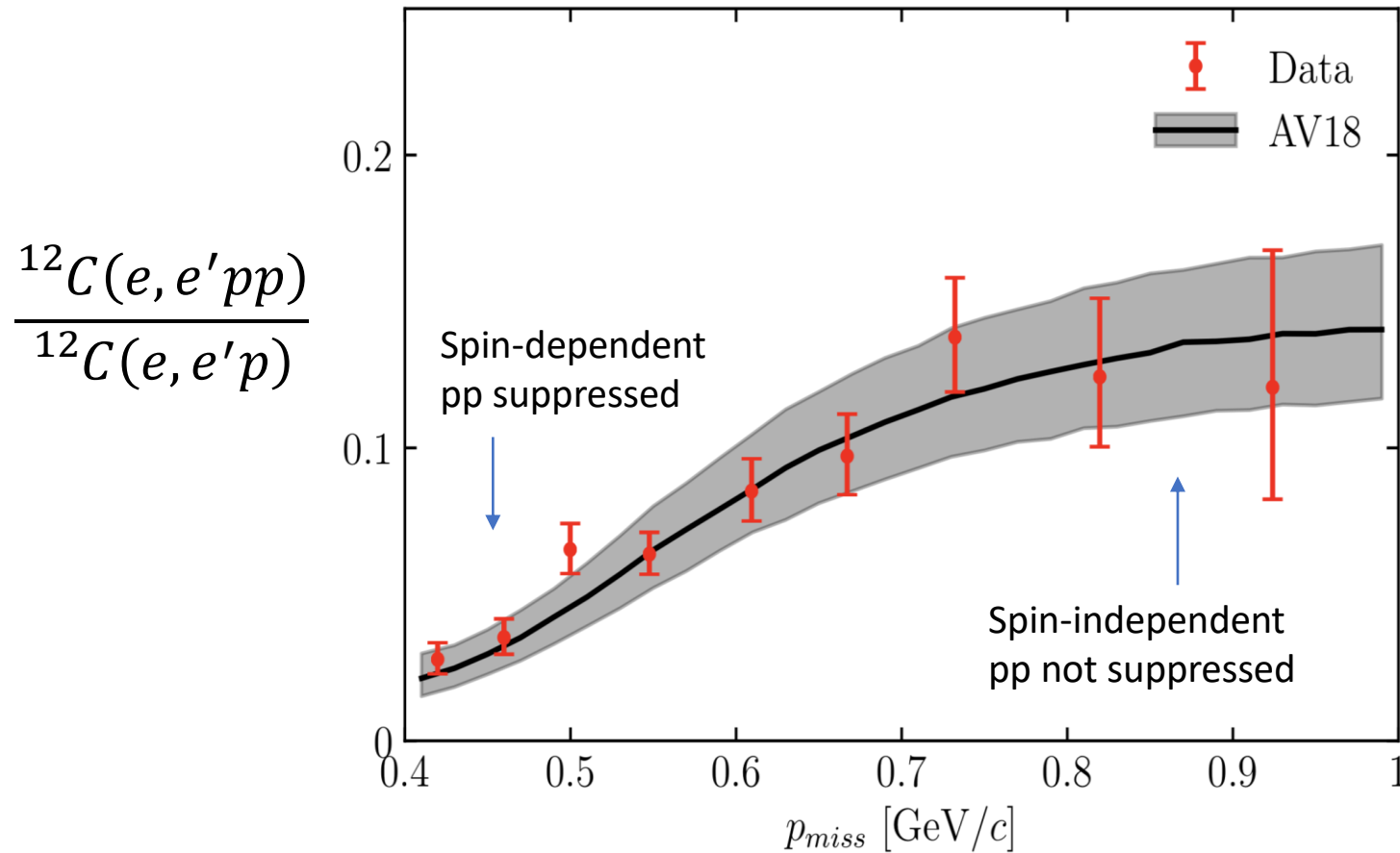


Electron scattering off an SRC pair

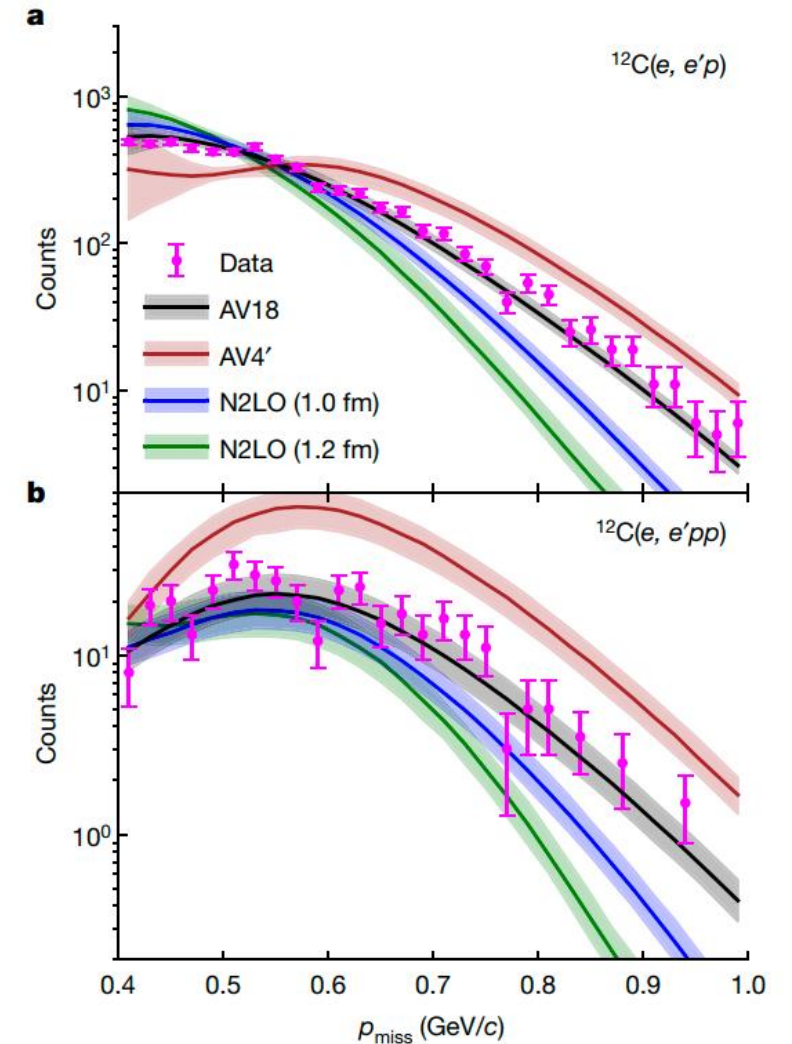


- (e,e') inclusive
- (e,e'N)
- (e,e'NN)

SRC Program Previous Success



A. Schmidt et al. Nature 578, 540(2020)



SRC Program

- Tremendous success of the CLAS6 data mining SRC program with few signal counts (Science, Nature, etc.)
- With increased luminosity and CLAS12 we are expecting 10 -40x more data
- Over a wider range of nuclei
- Explore more observables and mass and isospin scaling

2018-20 SRC CLAS Publications:

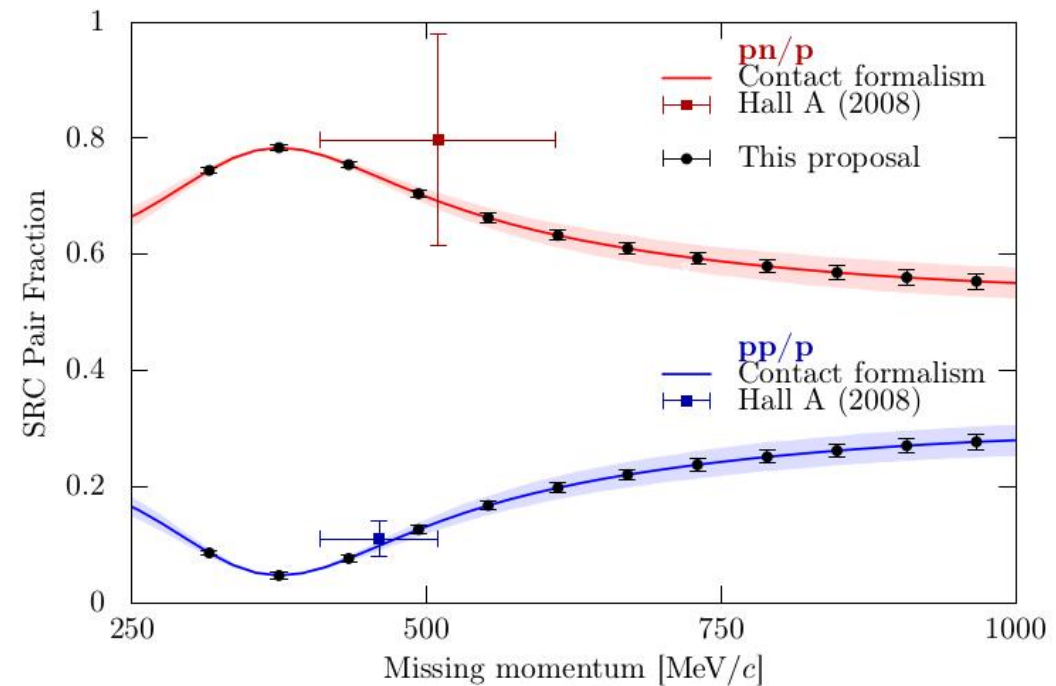
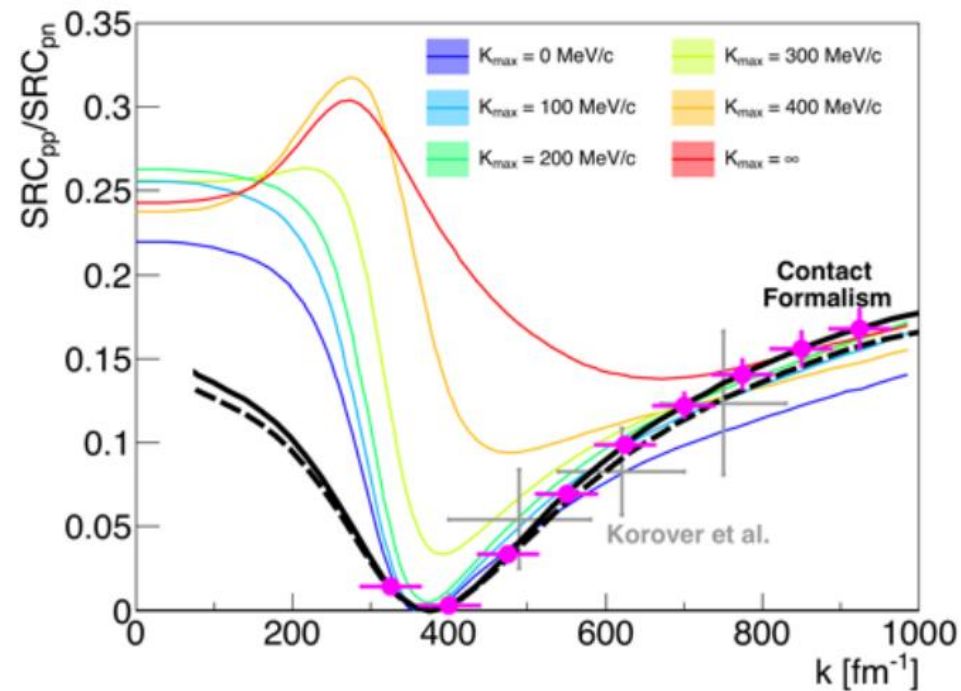
- Nature 578, 540 (2020)
- Nature 566, 354 (2019)
- Nature 560, 617 (2018)
- PRL 122, 172502 (2019)
- PRL 121, 092501 (2018)
- Phys. Lett. B 797, 134792 (2019)

Follow up Theory Publications

- Phys. Lett. B 805, 135429 (2020)
- Phys. Lett. B 791, 242 (2019)
- Phys. Lett. B 785, 304 (2018)
- Phys. Lett. B 780, 211 (2018)

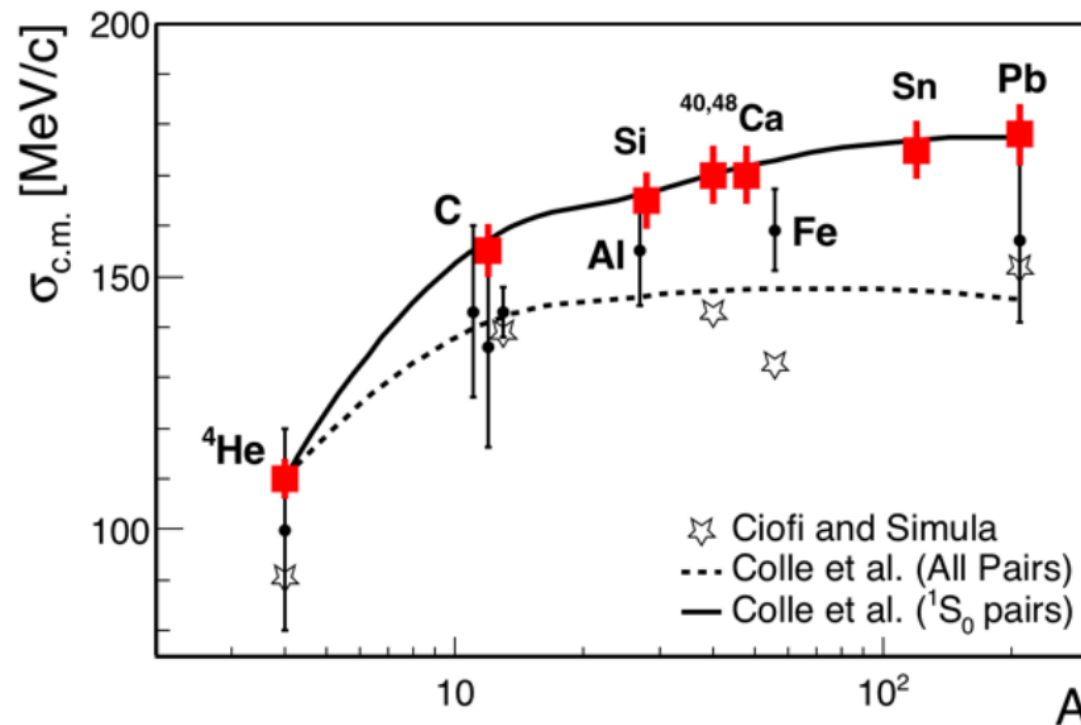
Goals of RGM

- NN interaction and nuclear wave function



Goals of RGM

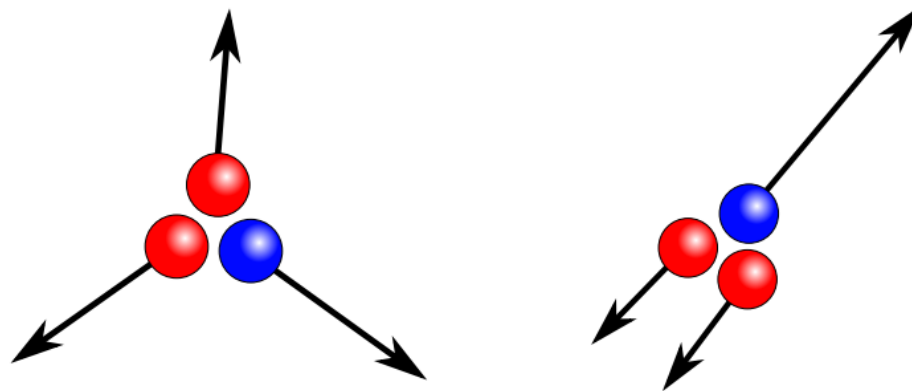
- NN interaction and nuclear wave function
- SRC formation processes



Goals of RGM

- NN interaction and nuclear wave function
- SRC formation processes
- 3N SRC pair observation

1st Observation & A-dependence

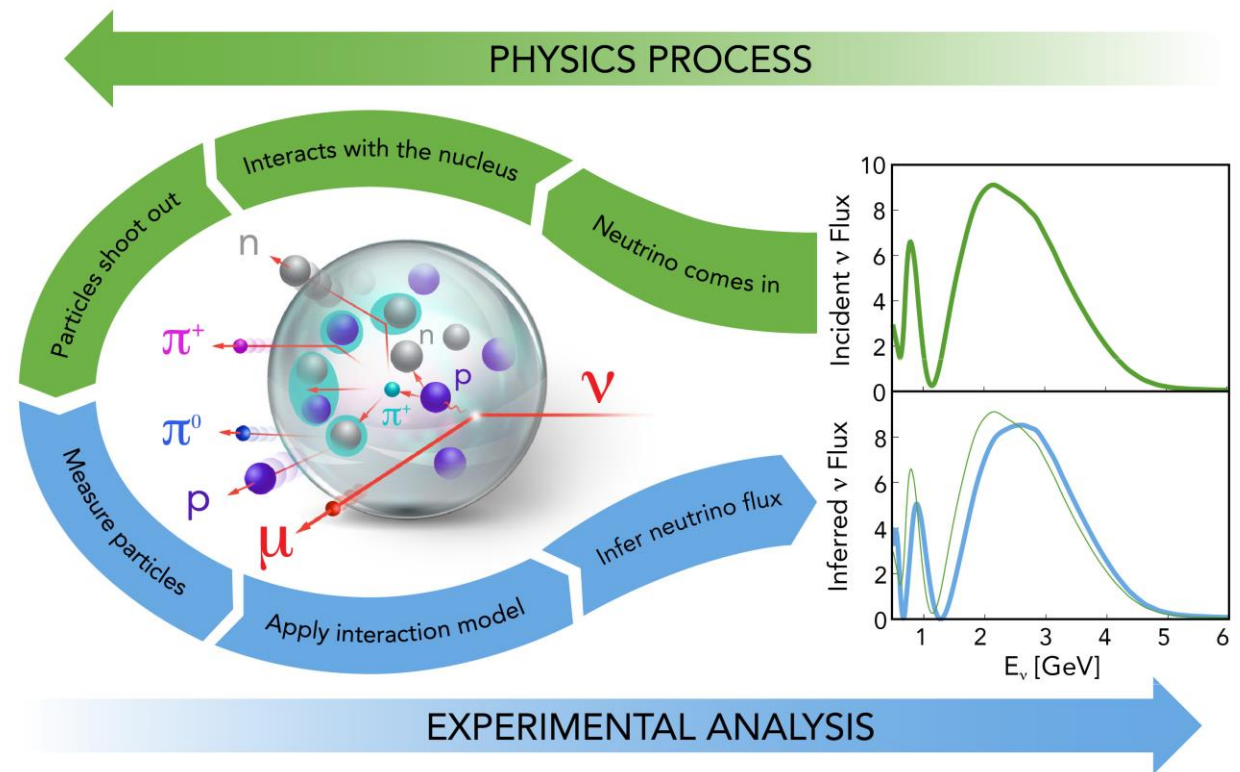


Goals of RGM

- NN interaction and nuclear wave function
- SRC formation processes
- 3N SRC pair observation
- Reaction mechanisms

Electrons for Neutrinos - $e4\nu$

- Neutrino oscillation experiments requires reconstruction of incident neutrino energy
- Requires well understood models for neutrino interaction
- Electrons and neutrinos interact with nuclei in similar ways
- Test energy reconstruction over wide range of nuclei relevant to these experiments



RGM Status

- 45 PAC days approved at 1, 2, 4, 6 GeV
- 30 PAC days scheduled Late 2021
- Standard CLAS12 configuration
 - Forward Tagger off (extra shielding)
 - LTCC empty
 - vacuum pipe downstream of target to reduce backgrounds
 - BAND (Backward Angle Neutron Detector)
- Detailed run plan draft
 - <https://bit.ly/3gZXpmE>

Run Plan			
	Beam Energy	Target	PAC Days
outbending	2	C	1
	2	Ar	1
inbending	4	H	1
	4	C	1
	4	Ar	1
inbending	6	H	1
	6	<i>d</i>	4
	6	⁴ He	4
	6	Sn	2.5
	6	Ar	1.5
	6	⁴⁰ Ca	3
	6	⁴⁸ Ca	3
	6	C	3
Overhead + empty			3
Total			30

RGM Targets

Liquid Targets	Target Thickness (cm)
D	5
He	5
H	5
Ar	0.5

Nuclear Targets	Areal Density (mg cm ⁻²)	Target Thickness (mm)
⁴⁰ Ca		
⁴⁸ Ca		
C	400	1.8
¹²⁰ Sn	200	0.3
C (multi-foil)	100	0.5
¹²⁰ Sn (multi-foil)	50	0.07

[illegible]

Current preparations of RGM

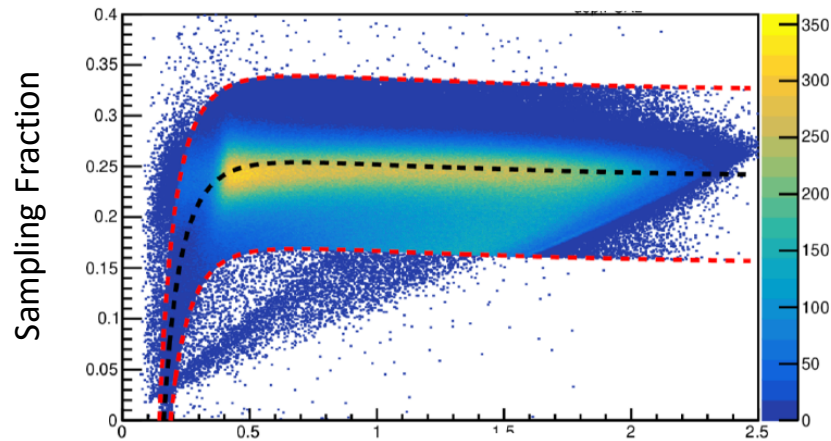
- Data analysis of Deuterium data from RGB
- Developing online monitoring scripts
- Practicing calibration and cooking procedures
- Ongoing simulations in GEMC (different torus field strengths)
 - Lower torus field or not?

Analysis of Data for RGM

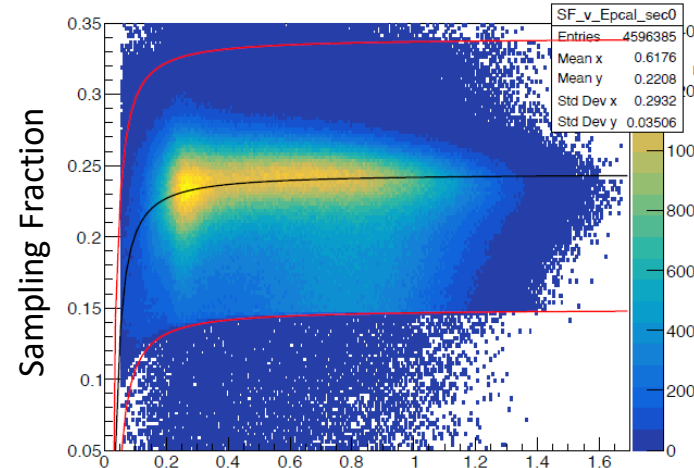
- Analyzing previous data sets to prepare for RGM and CLAS12 analysis
- RG-B data sets 4 GeV and 10.6 GeV looking
 - Ongoing analysis to understand CLAS12
 - Fiducial cuts on detectors, particle ID, etc.
 - Resolution of missing mass
- Sets of Engineering Runs
 - Lower magnetic field settings (torus, solenoid)
 - Lower beam energies
 - Learn the cooking and calibration process

Training Personnel in CLAS12 Analysis

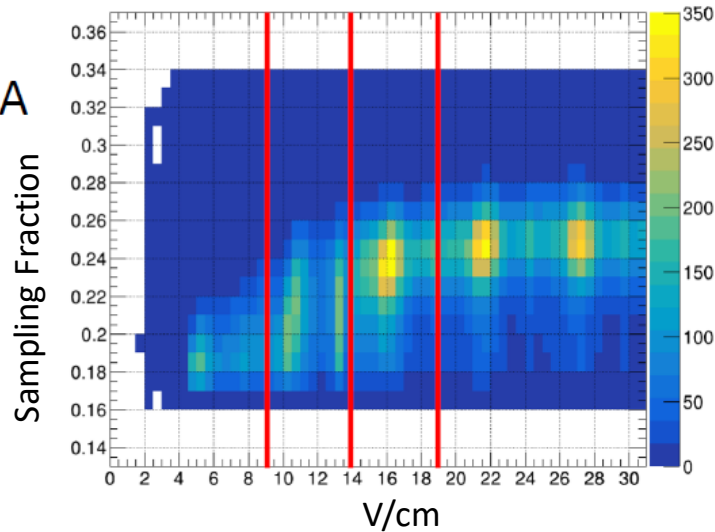
RGA



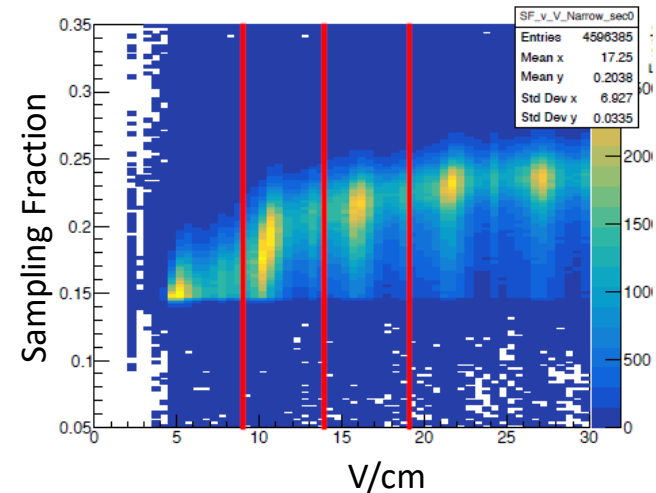
RGB



RGA

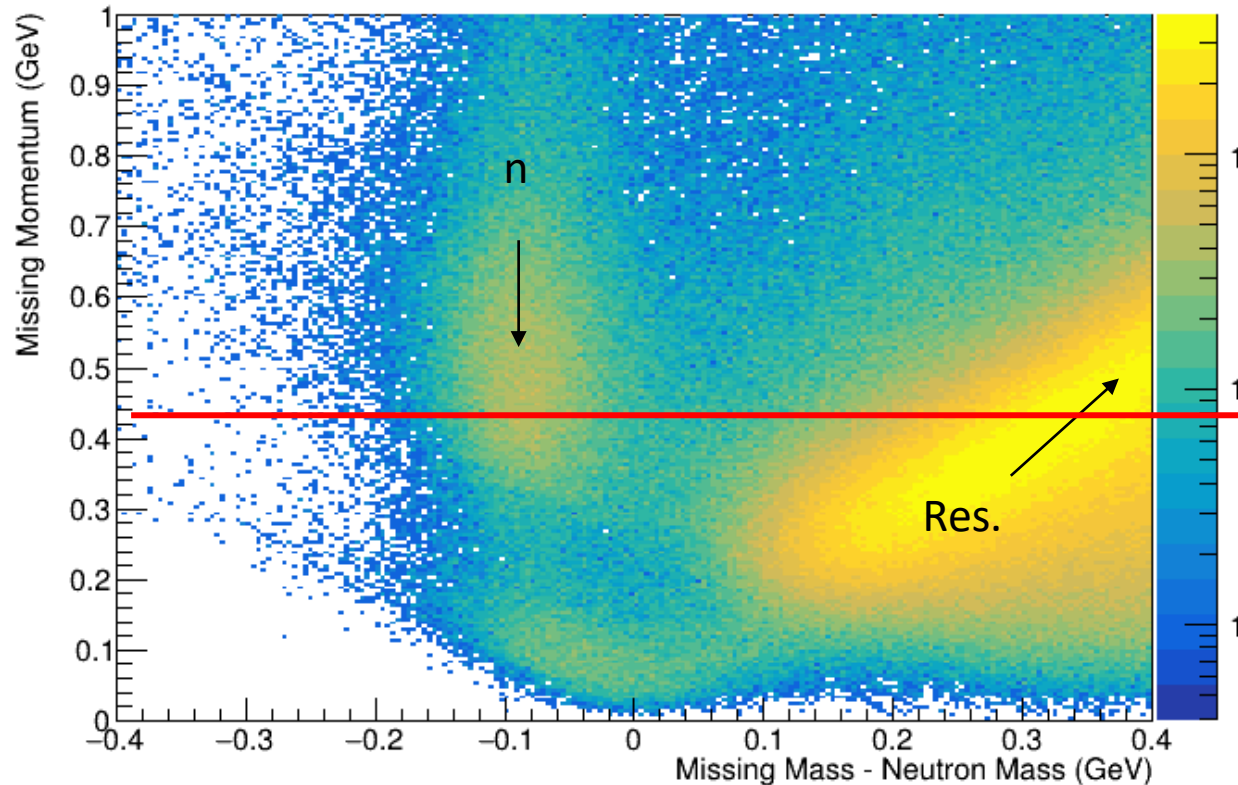


RGB

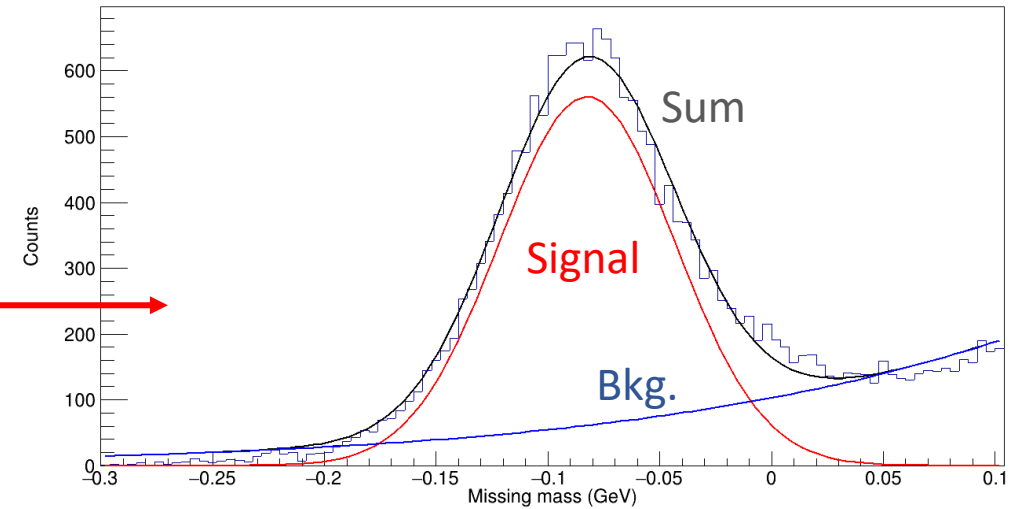


4-GeV Deuterium RGB (e,e'p)n

Protons going in Forward Detector

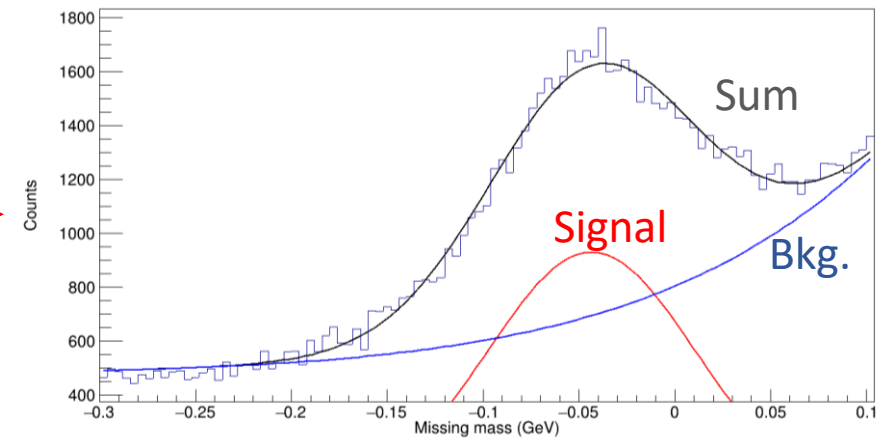
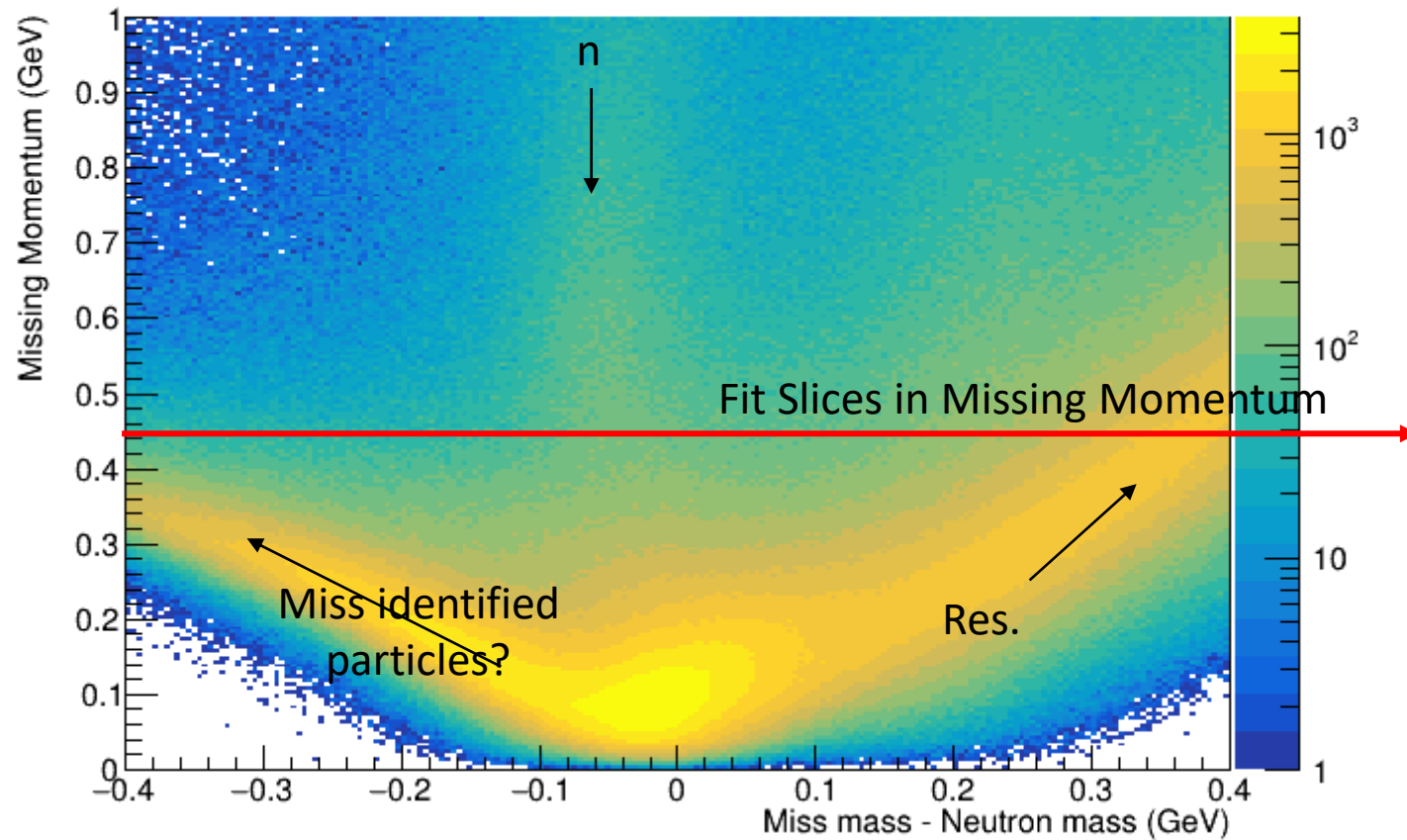


Fit Slices in Missing Momentum



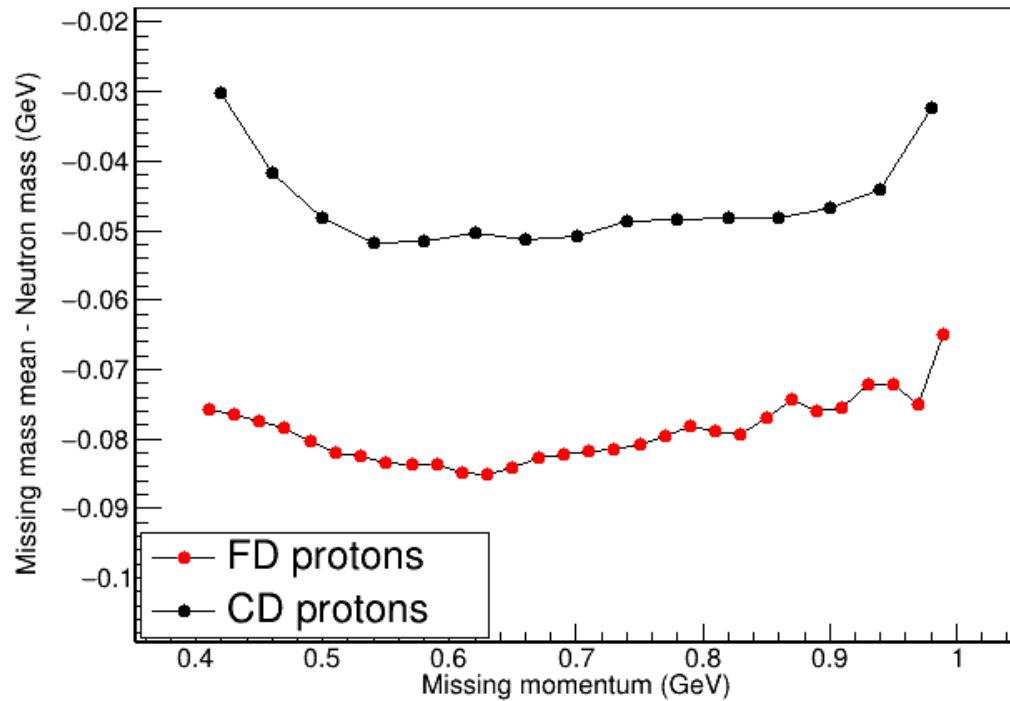
4-GeV Deuterium RGB (e,e'p)n

Protons going in Central Detector

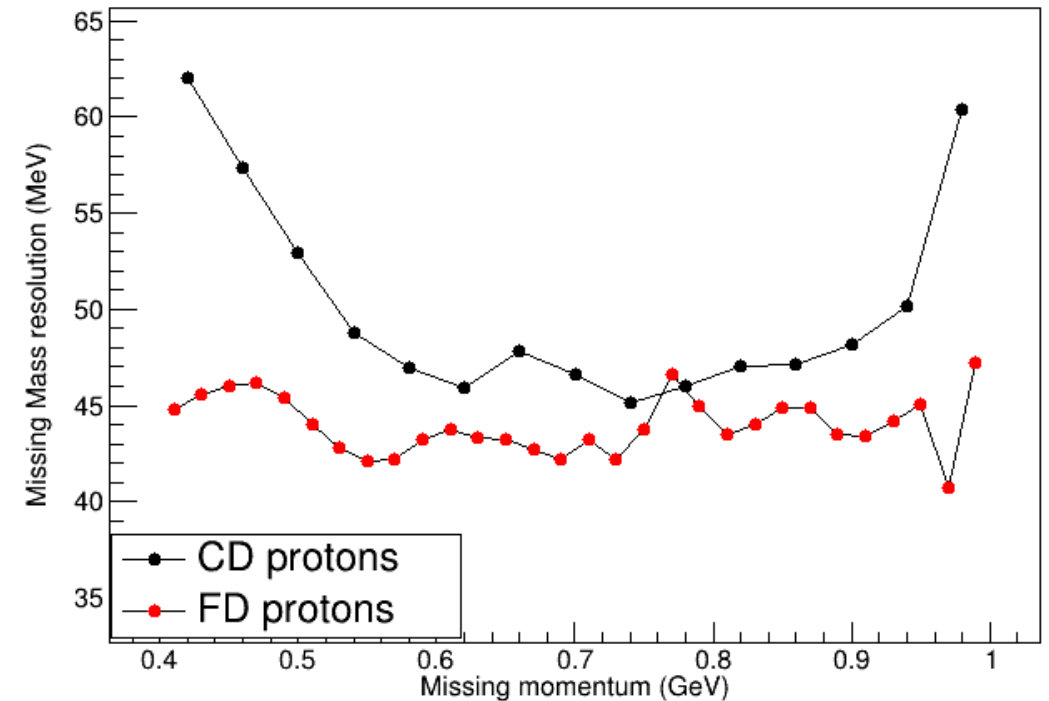


Missing Mass Resolution

Missing Mass Mean



Missing Mass Resolution (1σ)



RGM calibration goals

- Chef and Analysis coordinator involved in CALCOM
- Goal is to be ready for pass-1 cooking in 6 months after data taken
- RGM plans to be first test for this new initiative
- Practicing calibrating and cooking sets of Engineering data
 - Also relevant to RGM pre-analysis

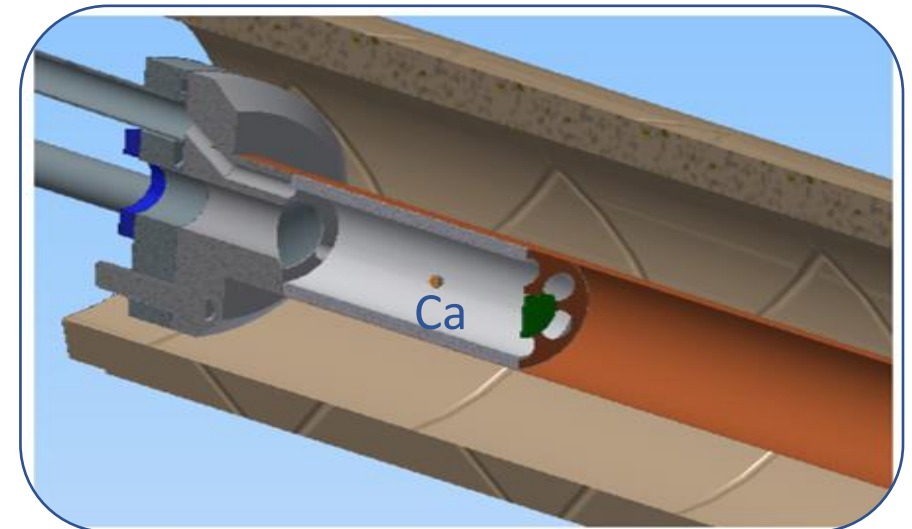
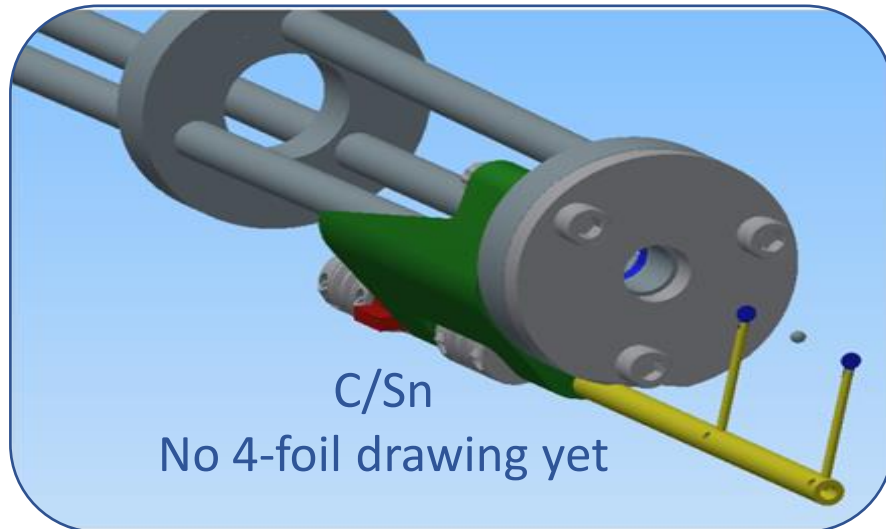
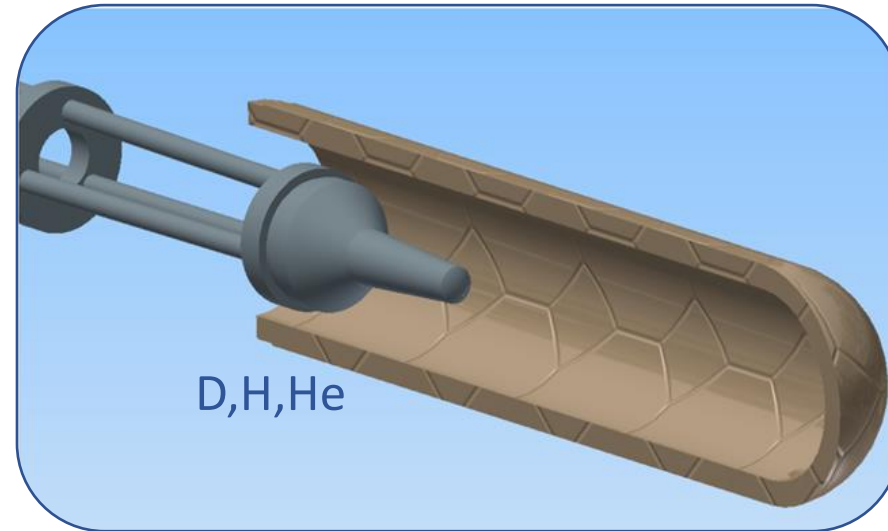
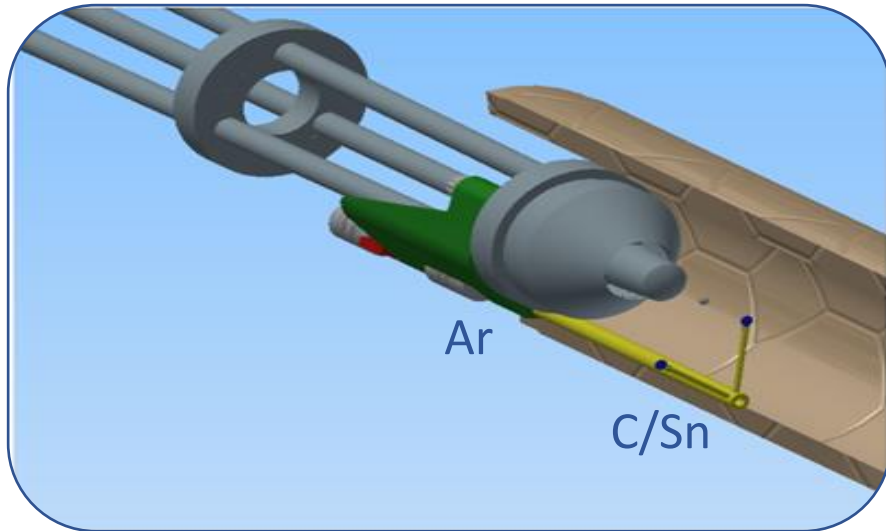
Looking ahead

- Near term (2-3 months)
 - Target preparation and any target measurements
 - Finalize magnetic field settings and generate DC road maps
 - Online monitoring analysis
- Long term
 - CLAS12 monitoring analysis (and training)
 - Preparation for setup
 - Training of more personnel in monitoring

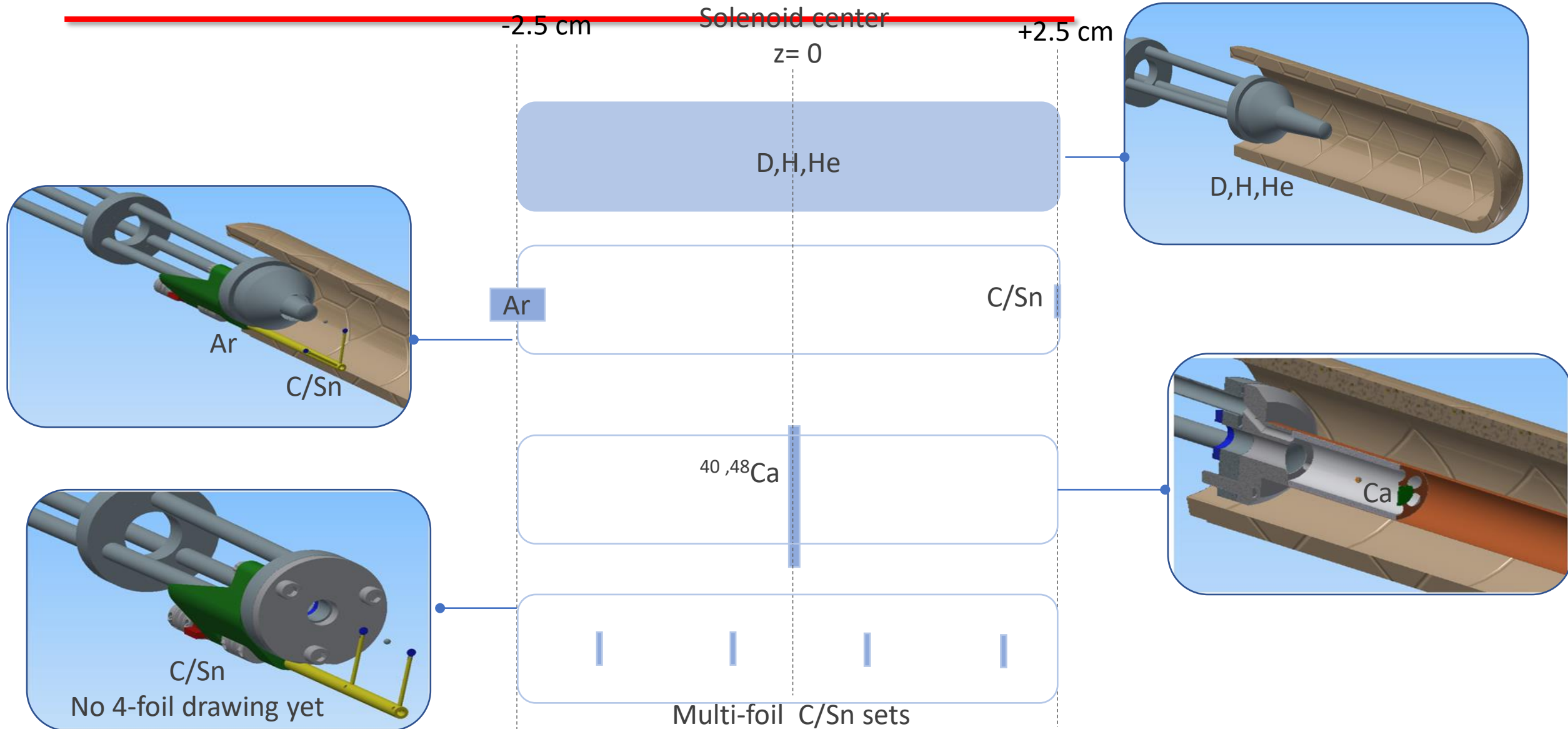
RGM related links

- RGM Weekly meeting
 - https://clasweb.jlab.org/wiki/index.php/Run_Group_M
- RGM Wiki
 - https://wiki.jlab.org/clas12-run/index.php/Run_Group_M
- RGM Task Force (Monthly)
 - [https://clasweb.jlab.org/wiki/index.php/Template:Hall-B_Run_Group_Task_Forces : RG-M](https://clasweb.jlab.org/wiki/index.php/Template:Hall-B_Run_Group_Task_Forces:_RG-M)

RGM Targets



RGM Targets



RGM Targets

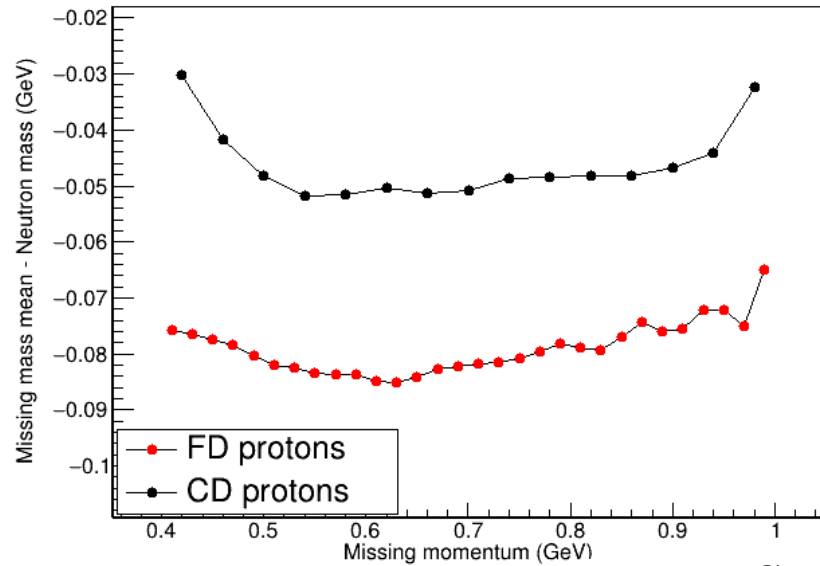
- Carbon and Sn targets will have a multi-foil construction
 - approximates the liquid target acceptance
- Target change estimates
 - Empty to Liquid ~ 8 hrs.
 - Liquid $\leftrightarrow$ solid target ~ 22 hours
 - Solid $\rightarrow$ solid target ~ 12 hours

Isotopic Tin Target

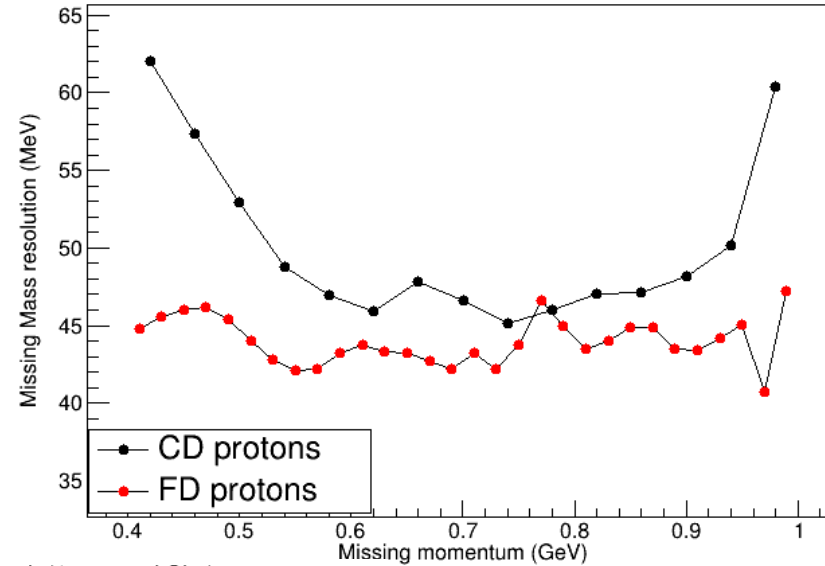
- Naturally occurring Tin has many isotopes
- Procured isotopically pure ^{120}Sn at >99%
- Need to roll to desired thicknesses
 - Target group at Argonne National Lab has agreed to roll the target
- Confirm thickness and uniformity
 - Plan A: ANL capability to measure
 - Plan B: Micrometer, Gamma ray attenuation, X-ray...

Missing Mass Resolution

Missing Mass Mean



Missing Mass Resolution (1σ)



Signal/Background (1σ around Sig.)

