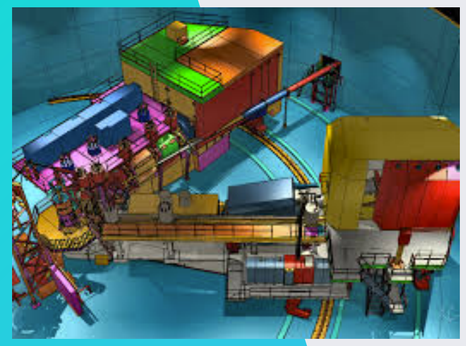
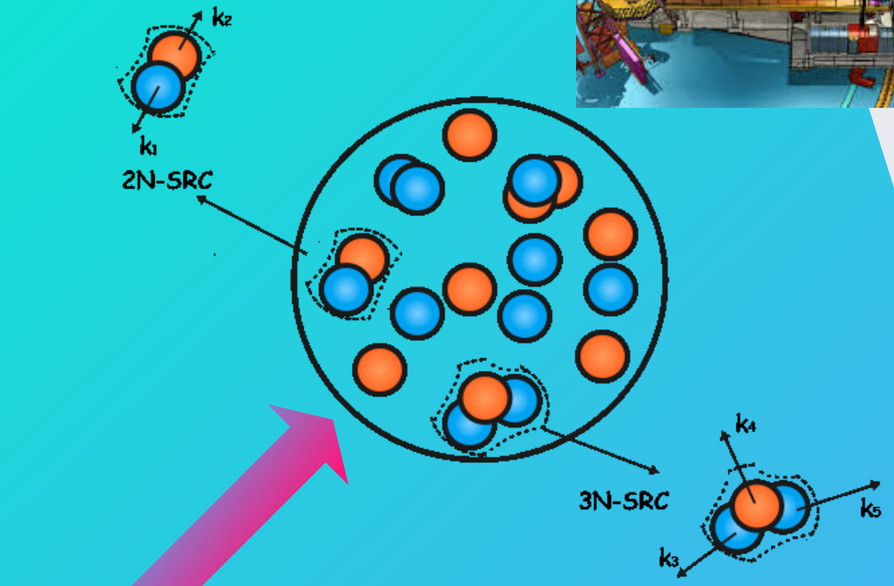




Precision Measurement of the Isospin Dependence in the 2N and 3N Short Range Correlation Region

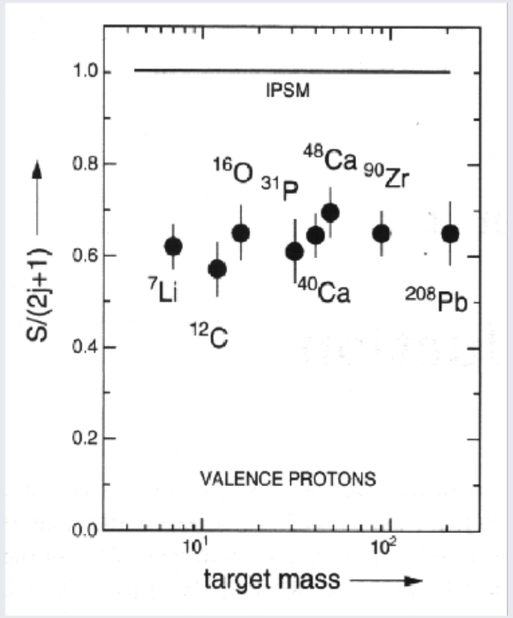
E12-11-112
2N/3N SRC

Nathaly Santiesteban

Hall A Collaboration Meeting
06/22/2018

University of New Hampshire

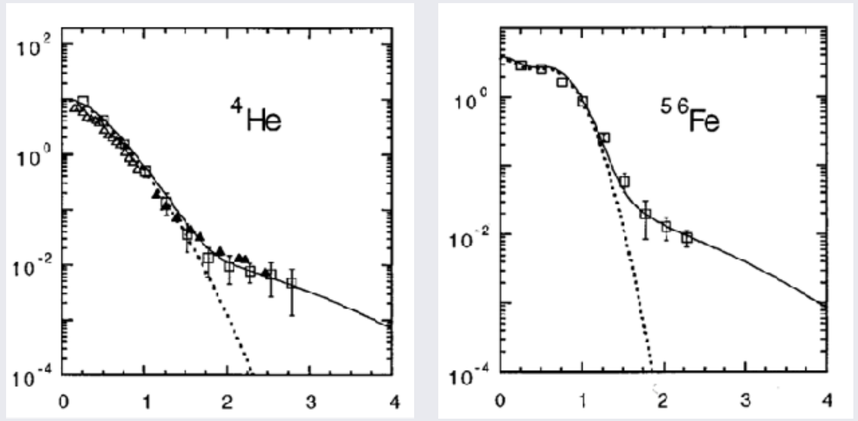
Motivation



Fractional spectroscopic factors for valence nucleon knockout is just about 60-70% of the expected value from the Mean Field theory.

Lapikas, L (1993), Nuclear Physics A 553, 297 – 308

Mean Field Theory results Moment distributions n(k)



..... Mean Field Calculations

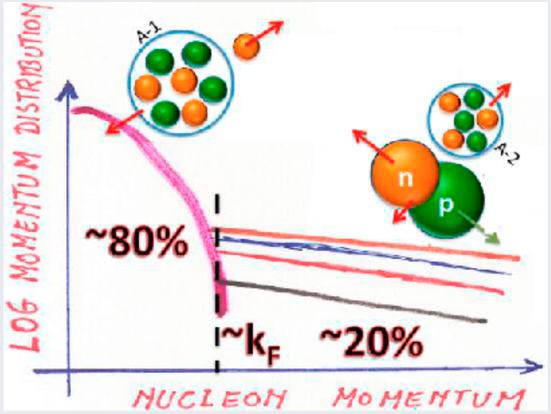
——— Including SRC

ΦΦΔΔ Experimental Data

C. Cio degli Atti and S. Simula, Phys. Rev. C 53. 1689 (1996).

In the mean field theory all the nucleons have momentum k, smaller or equal to the Fermi momentum kf.

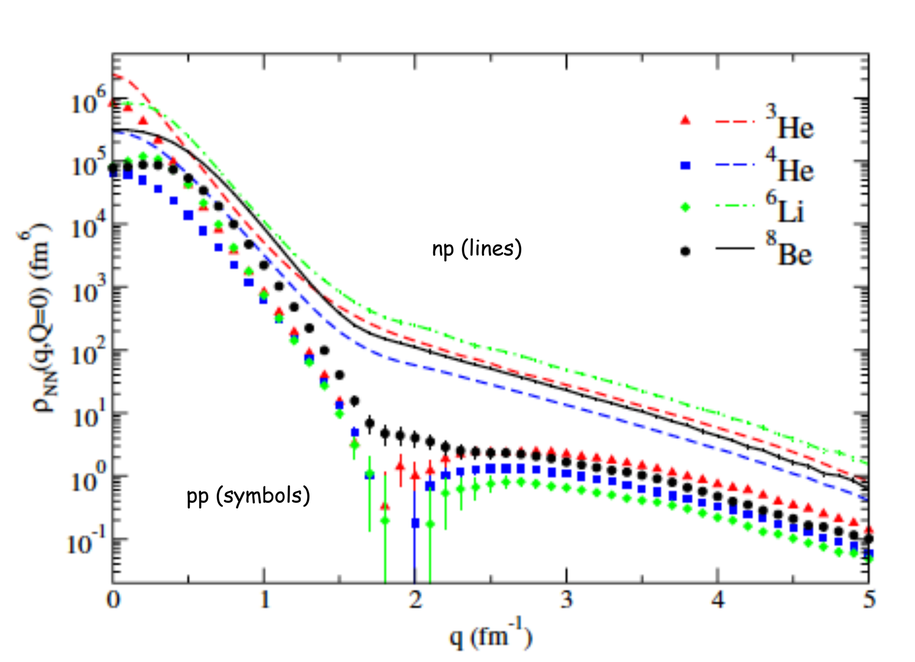
Experimentally nucleons with momentum higher than the Fermi momentum are found.



Hen, O. Miller, G.A. Piasetzky, E. Weinstein, L.B. arXiv:1611.09748

Isospin Dependence

Momentum Distributions
from Monte Carlo Simulations



R. Schiavilla, et al, PRL 98 132501 (2007)

Isospin T (0,1) for the nucleon-nucleon system.

Isospin singlet: T=0

n-p pairs

Isospin Triple: T=1

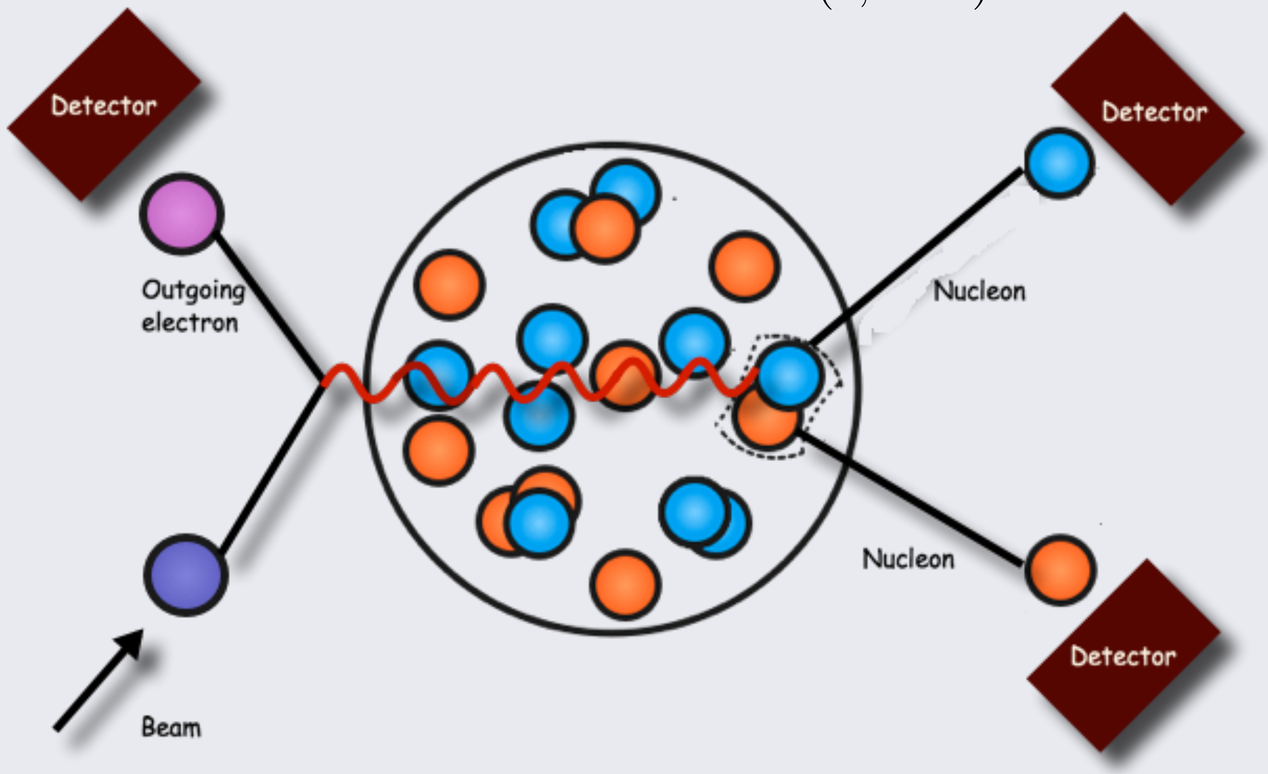
p-p (Tz=1), n-p (Tz=0) and (Tz=-1)

The nucleon-nucleon interaction strongly depends on the isospin channels.

SRC Measurements

a) Exclusive Measurements

$$A(e, e'pp)$$
$$A(e, e'pn)$$
$$A(e, e'nn)$$



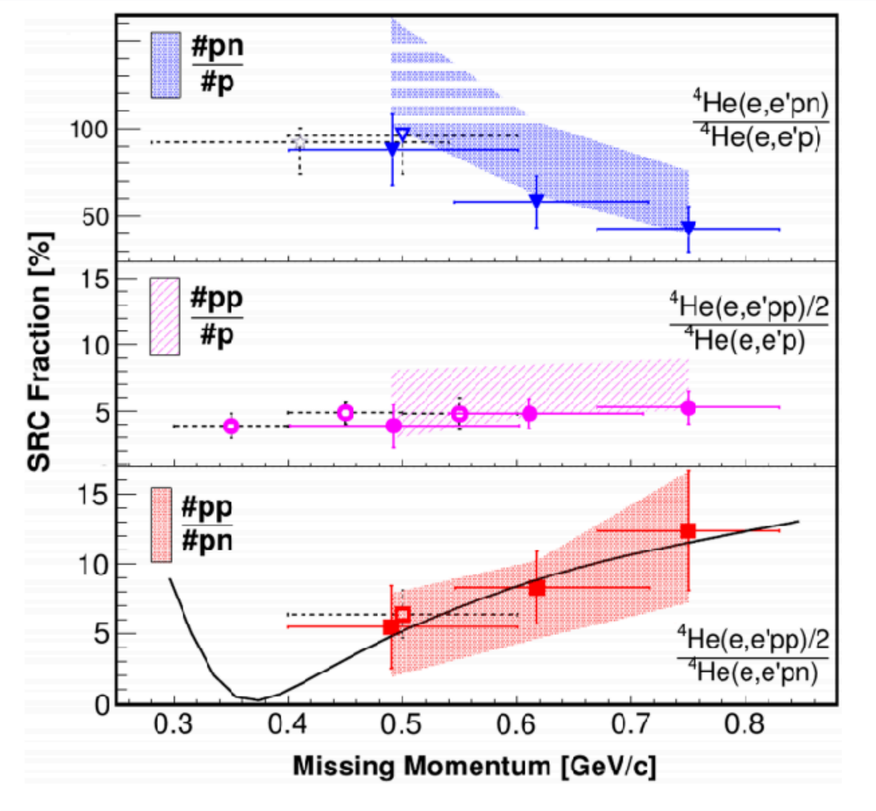
Pros:

Studies of the isospin dependence of the nucleon-pairs.

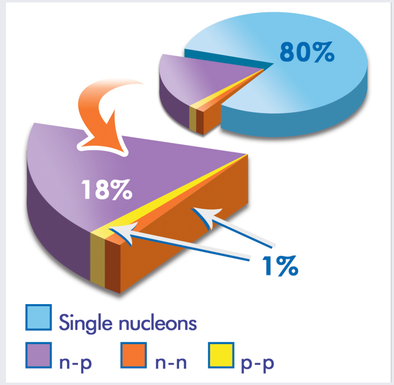
Cons:

Very sensitive to the Final State Interactions FSI.

What did we learn from exclusive measurements?



I. Korover, et al., Phys. Rev. Lett. 113 (2014) 022501.



Structure of 12C:

80% mean field nucleons

20% SRC pairs

90% np -SRC pairs

5% pp and nn SRC pairs each.

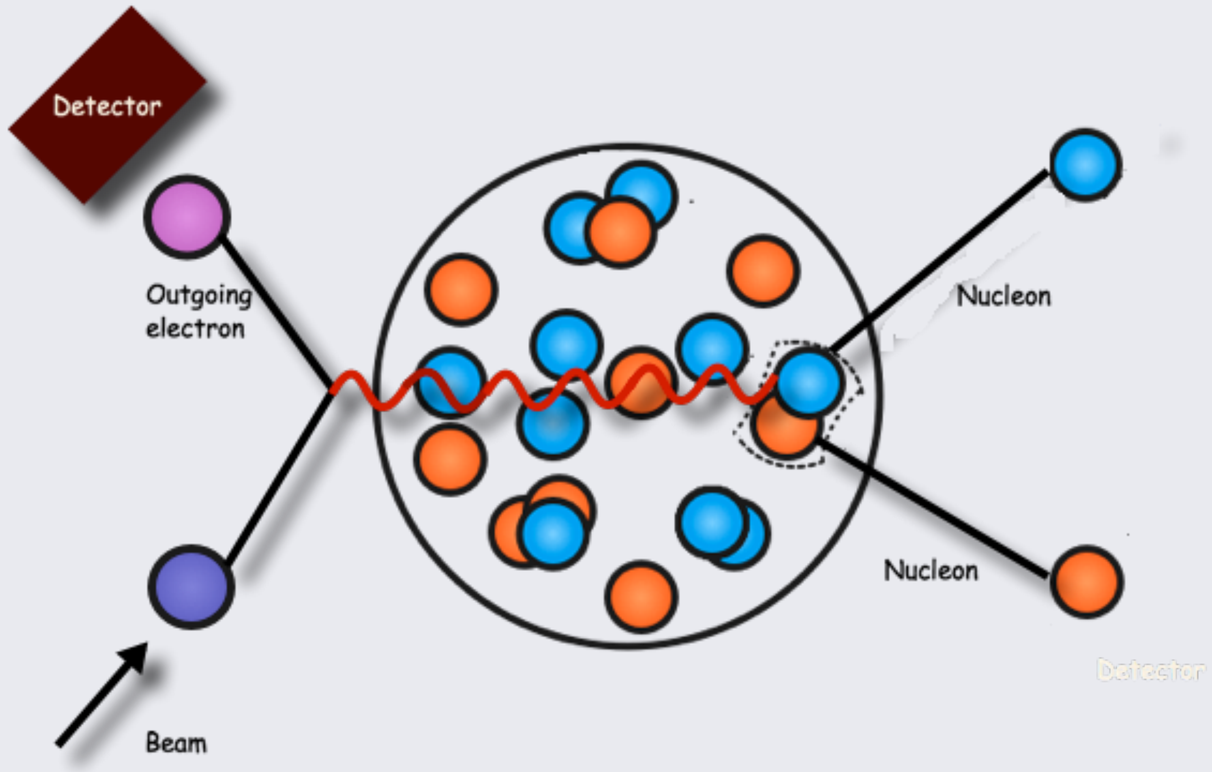
Subedi et al. , 2008

n-p pairs are dominant in the 2N-SRC, in agreement with the theoretical predictions.

n-p pairs form the 90% of the 2N-SRC.

Can we confirm the measurements with other type of setup?

b) Inclusive Measurements



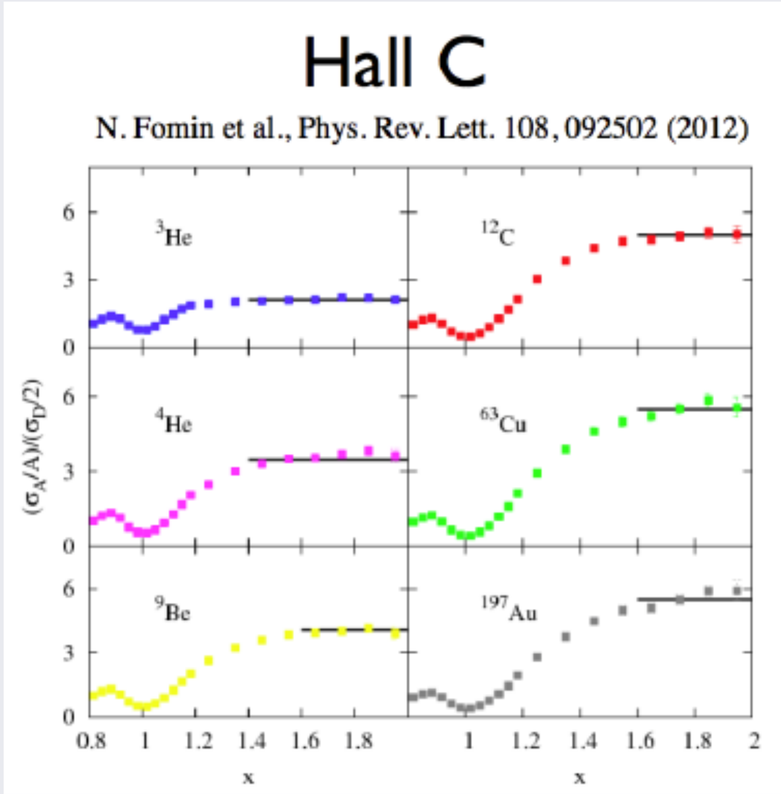
Pro:

Not sensitive to FSI.

Cons:

Not direct access to the final states of the nucleons.

What did we have learn from inelastic measurements?



Plateaus!

Confirmed for 2N-SRC.

And Plateaus means…

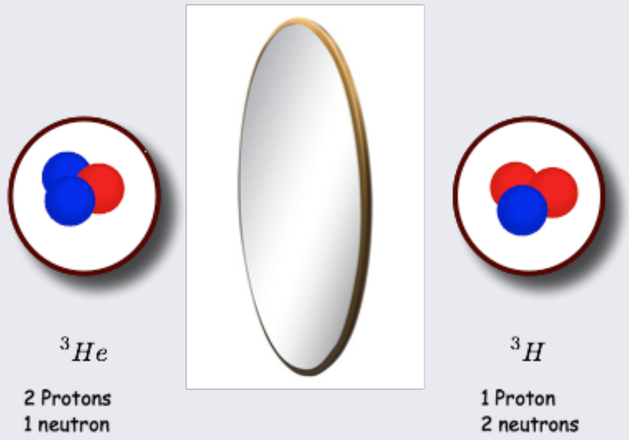
$1 < x < 2$ → 2N-SRC: the momentum distributions of the different nuclei should be similar to the momentum distribution of the deuteron → $(\sigma/A)/(\sigma_D/2)$

The $x > 1$ $(^3He/^3H)$ experiment: Measurement of the isospin dependence of 2 and 3 nucleons short range correlations.

E12-11-112

Spokesperson: **P. Solvignon**, J. Arrington, D. B. Day, D. Higinbotham

Inclusive Measurement



Belongs to the tritium collaboration group.

Inclusive measurements to study isospin dependence using the targets isospin structure.

Experiment Goals (1)

Measure the 2N-SRC Isospin dependence

$$1 < x < 2$$

↓

using the cross-sections ratios

↓

Expectation values

2N-SRC
Isospin independent

$$\frac{\sigma_{^3He}}{\sigma_{^3H}} = \frac{2\sigma_p + 1\sigma_n}{1\sigma_p + 2\sigma_n} \xrightarrow{\sigma_p \approx 3\sigma_n} 1.4$$

2N-SRC
n-p pairs dominance

$$\frac{\sigma_{^3He}}{\sigma_{^3H}} = \frac{2\sigma_{pn} + 1\cancel{\sigma_{nn}}}{2\sigma_{pn} + 1\cancel{\sigma_{pp}}} \approx 1.0$$

✦ Measure 3He/3H ratio in 2N-SRC region with 1.5% precision
. Extract R(T=1/T=0) with uncertainty of 3.8%

Planned for fall 2018.

Experiment Goals (2)

$$2 < x < 3$$

3N-SRC Measurements

↓

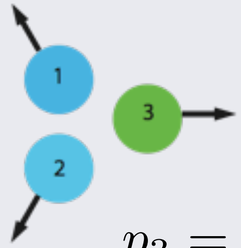
using the cross-sections ratios

Momentum Configurations

Linear Configuration

$$p_3 = p_1 + p_2$$

Star Configuration



$$p_3 = p_2 = p_1$$

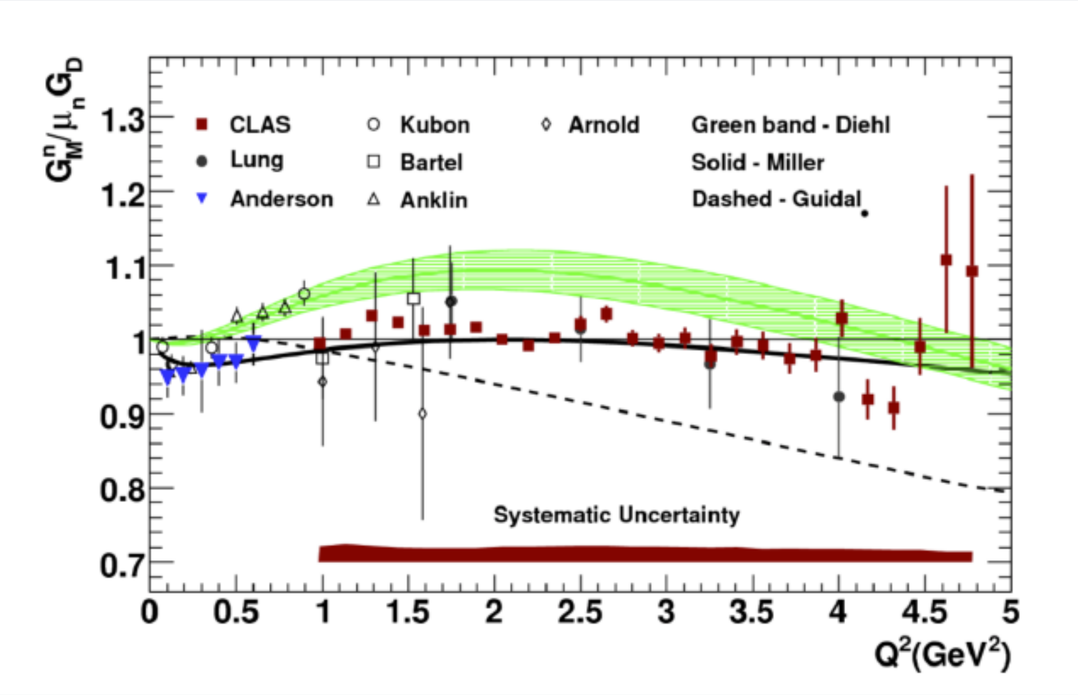
$$\frac{\sigma_{^3He}}{\sigma_{^3H}} = \frac{2\sigma_p + 1\sigma_n}{1\sigma_p + 2\sigma_n} \xrightarrow{\sigma_p \approx 3\sigma_n} 1.4$$

3N-SRC Isospin independent

Planned for fall 2018.

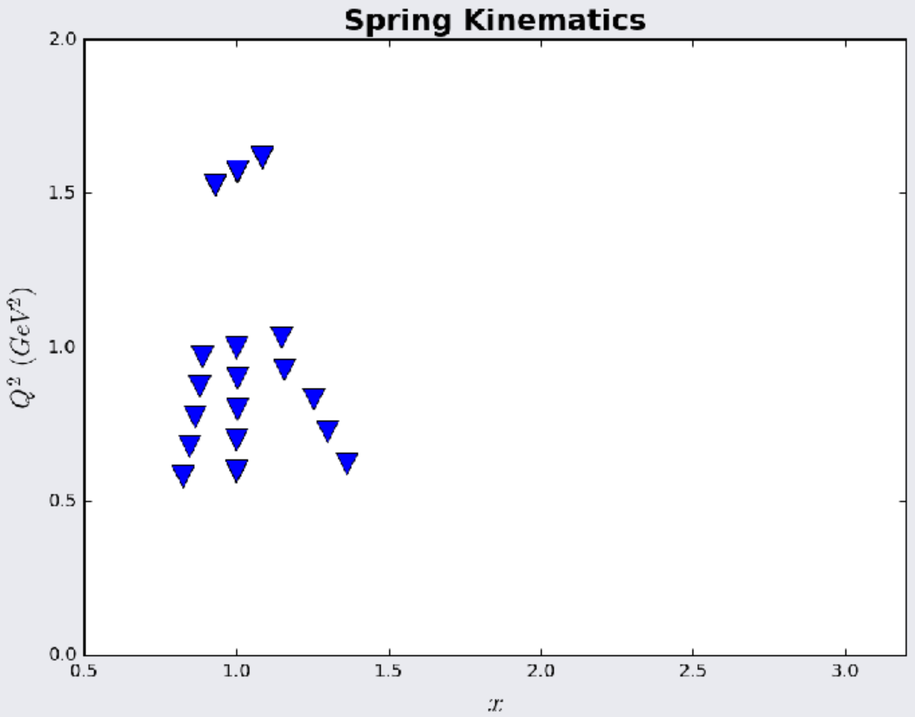
Experiment Goals (3)

Quasielastic Data



J. Lachniet et al. (CLAS), Phys. Rev. Lett. 102, 192001 (2009).

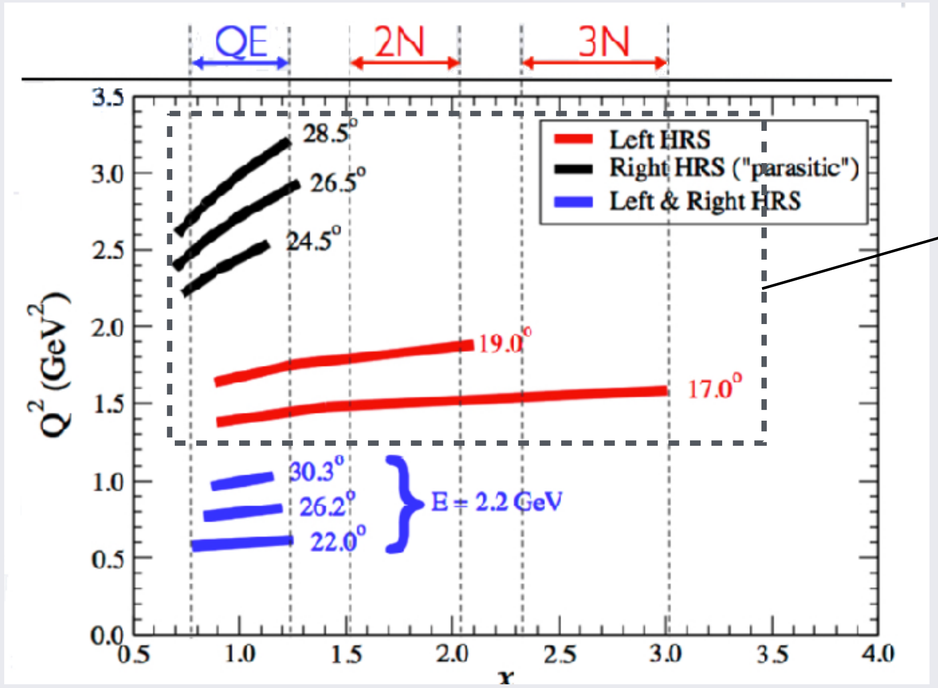
G_M^n extraction at low Q^2



Data already taken!

Projected Kinematics (Proposal)

Kinematic coverage of the E12-11-112 experiment



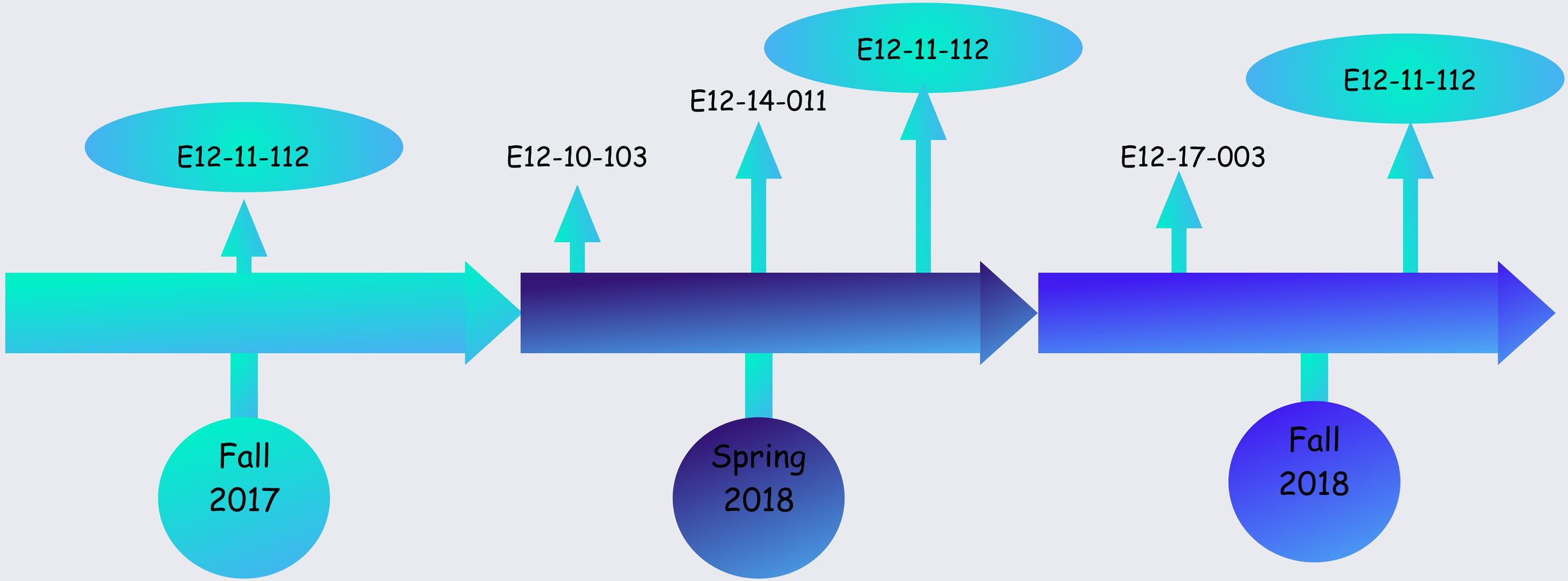
P. Solvignon, J. Arrington, D. Day, D. Higinbotham, JLab Experiment Proposal E12-11-112.

Main physics of the experiment will be taken in fall 2018

*2N/3N-SRC Measurements with the **(left arm)**.

* Projected QE cross section at 3H, 3He from Q2=2 to 3 GeV2 **(right arm)**.

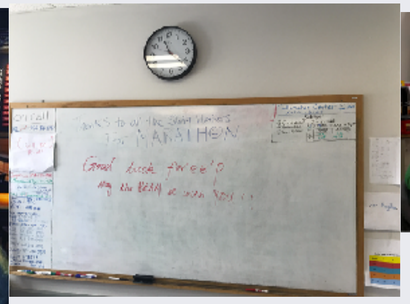
Tritium Experiments



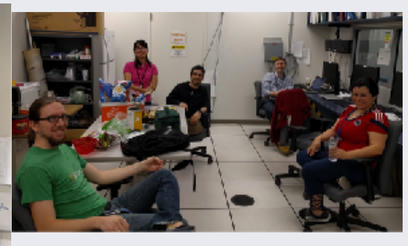
Tritium Experiments

E12-11-112

E12-10-103



E12-14-011



E12-11-112

?

E12-11-112

?

E12-17-003

Fall 2017

Spring 2018

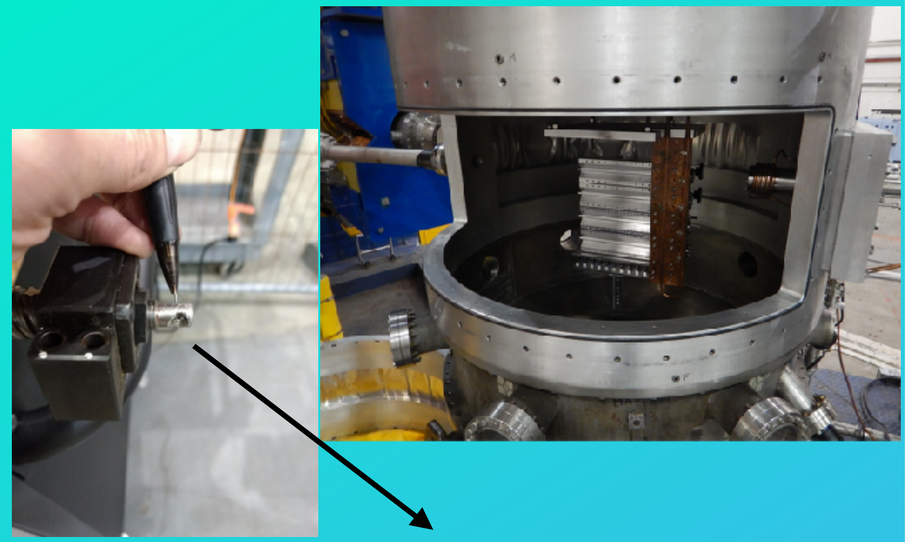
End of the Run?
Not for us yet…

Fall 2018

Little Issues …

Commissioning 2017

Target alignment issue



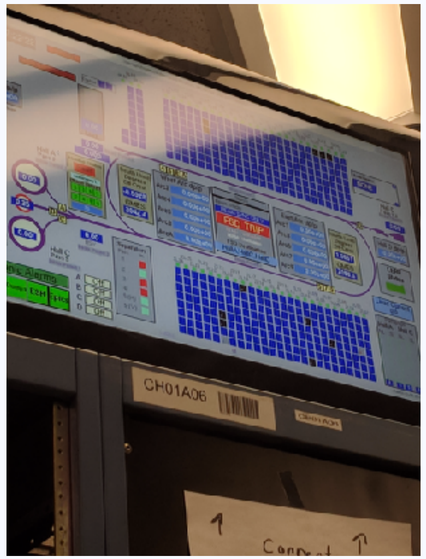
Target failure due to a spun shaft coupler.

Permission to run on the Tritium target:
12/15/17 at 17:06 pm
Lost beam center:
12/16/17 at 10:33 am

4 days on the floor!

Spring 2018

IOC network failure.



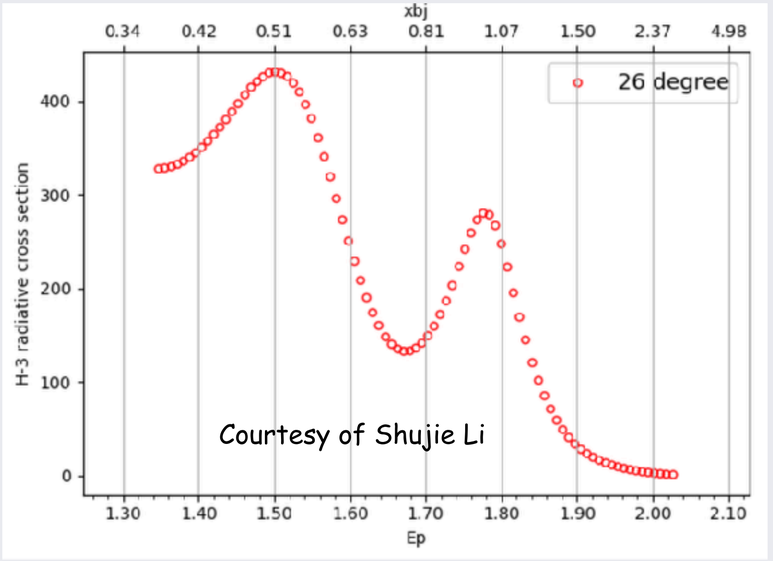
Failure:
05/02/2018 at 16:45 pm
Recovery and moving back to tritium:
05/03/2018 at 23:30 pm

Fall 2018

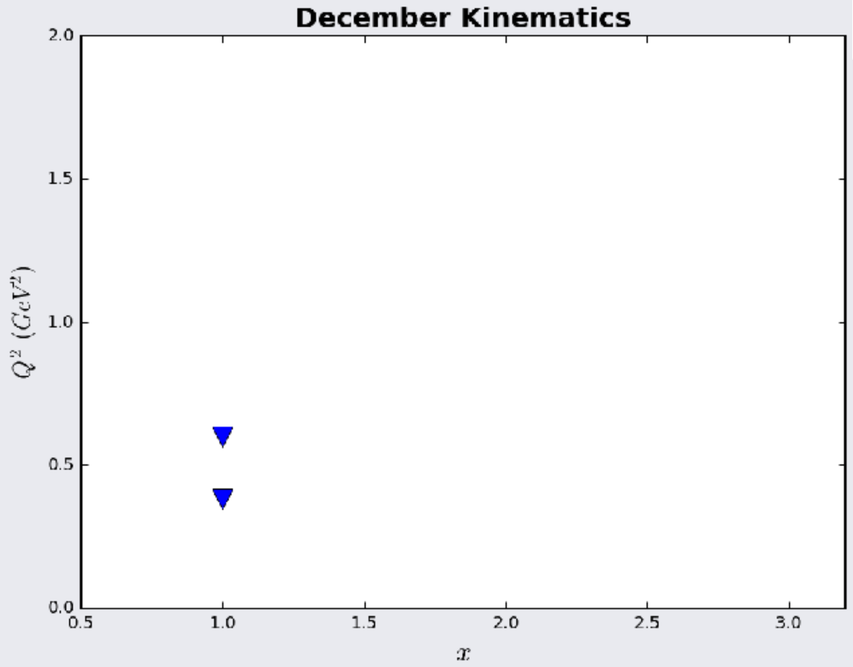
!?

30 days.

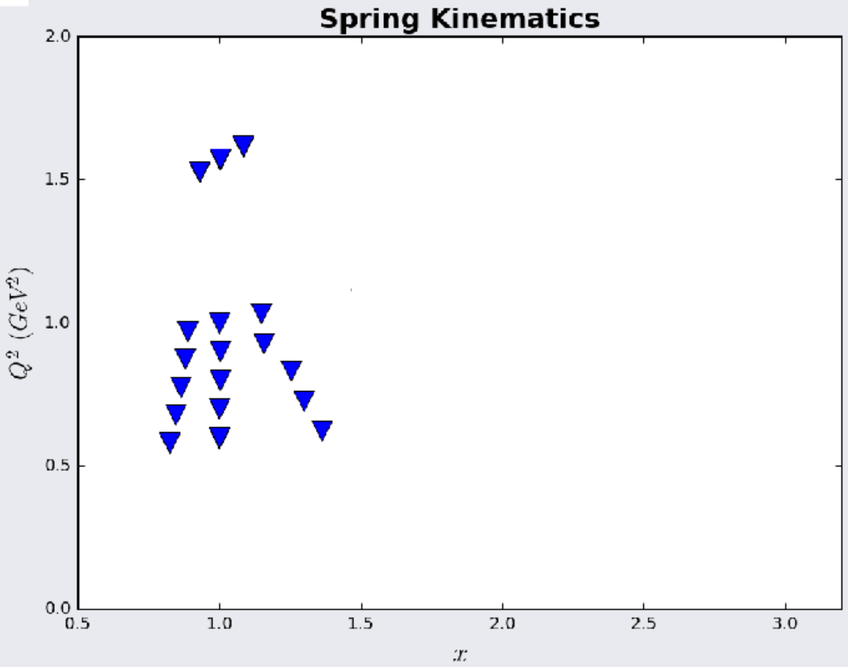
Commissioning 2017



Courtesy of Shujie Li



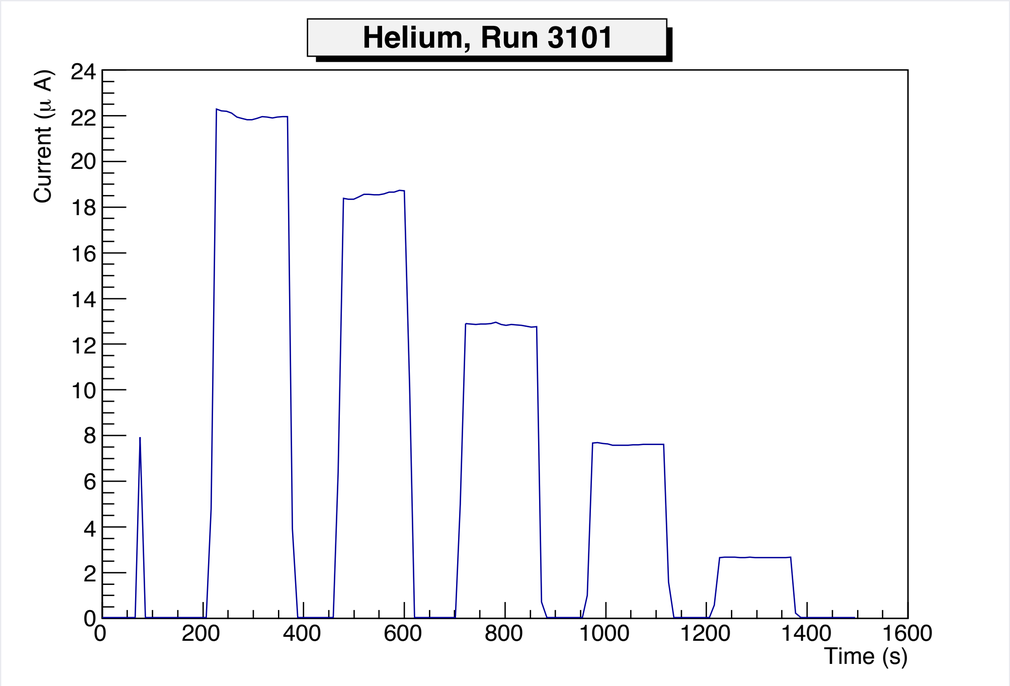
Spring Data:



Target Density Study

All targets!

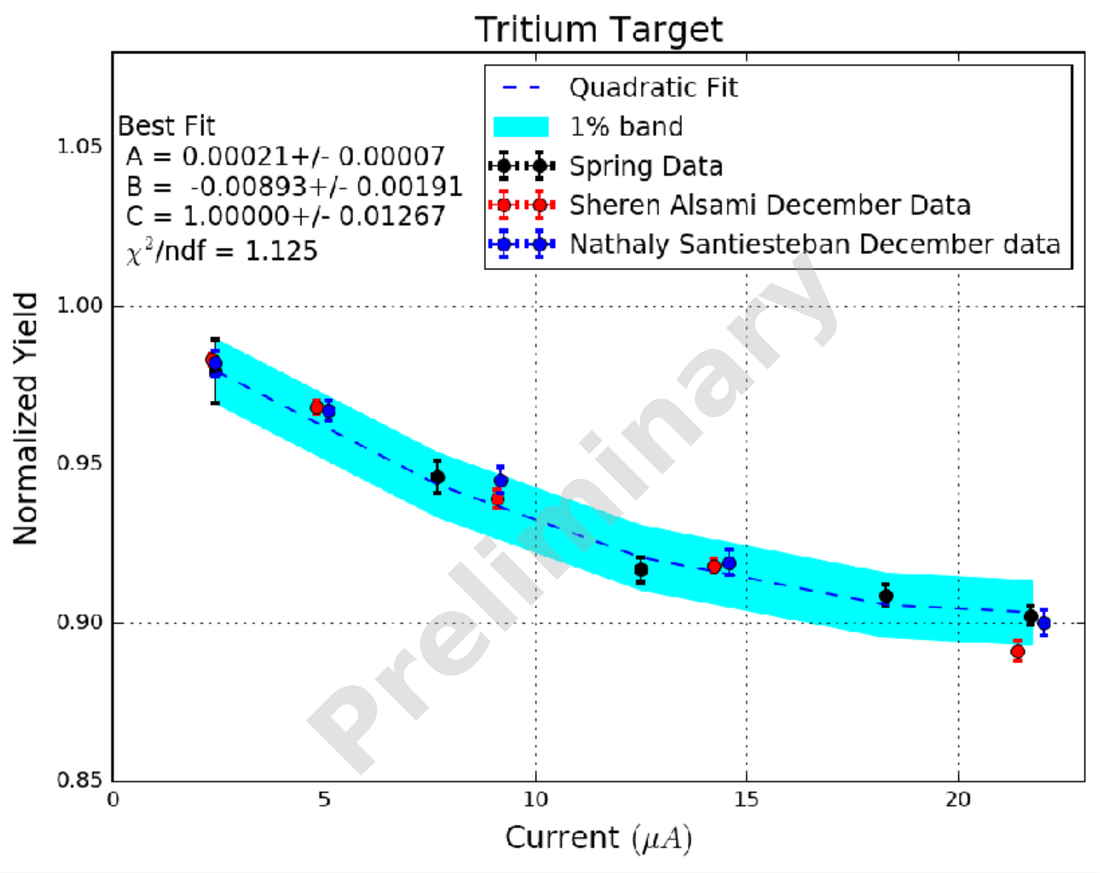
Commissioning 2017:
LHRS at 17.005 degrees
First pass beam
p0 = 1.999 GeV

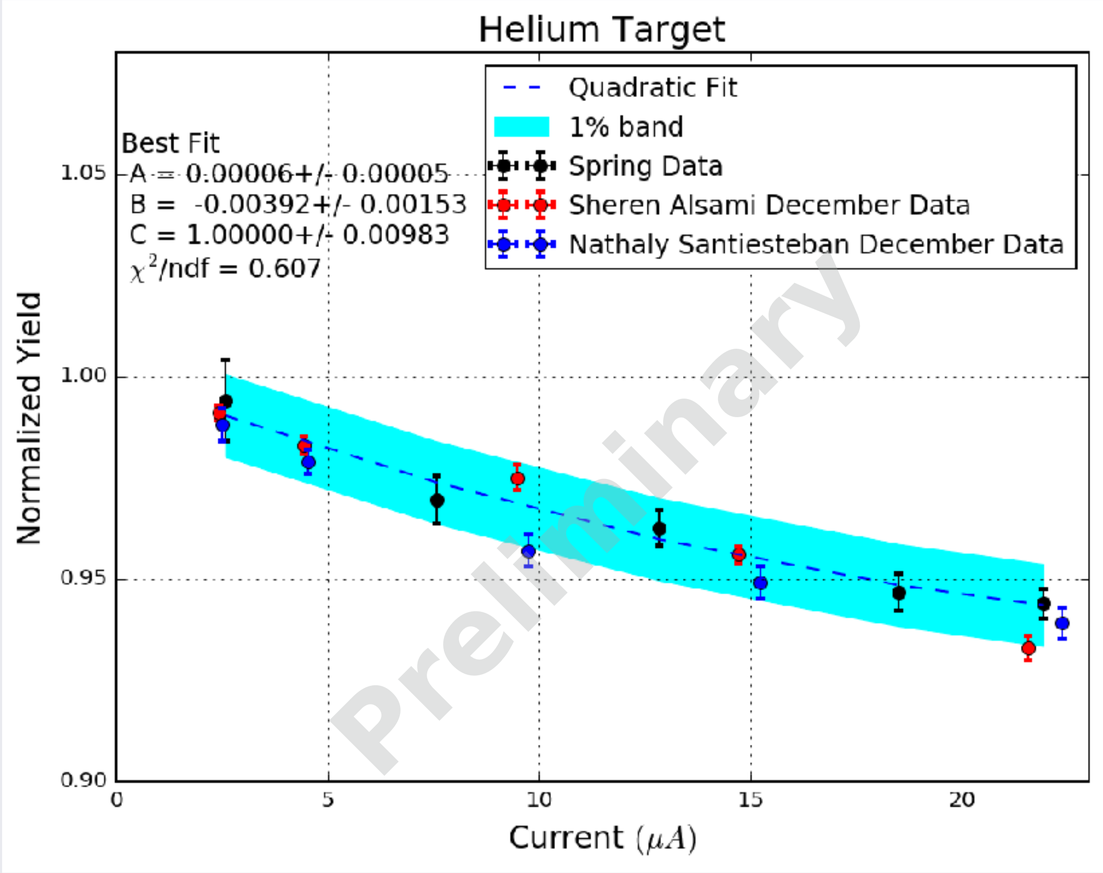


Helium and tritium checks

Spring Data:
LHRS at 21.778 degrees
First pass beam
p0 = 1.896 GeV

Target Density Study

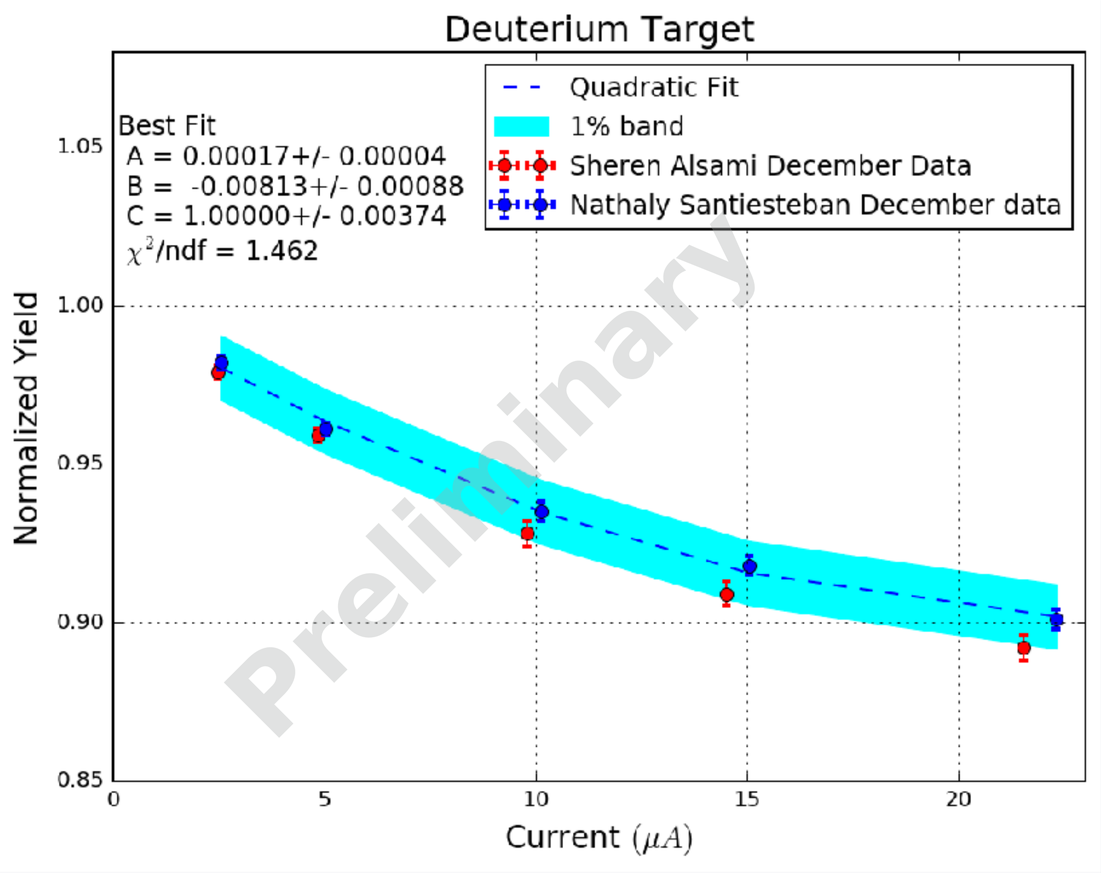




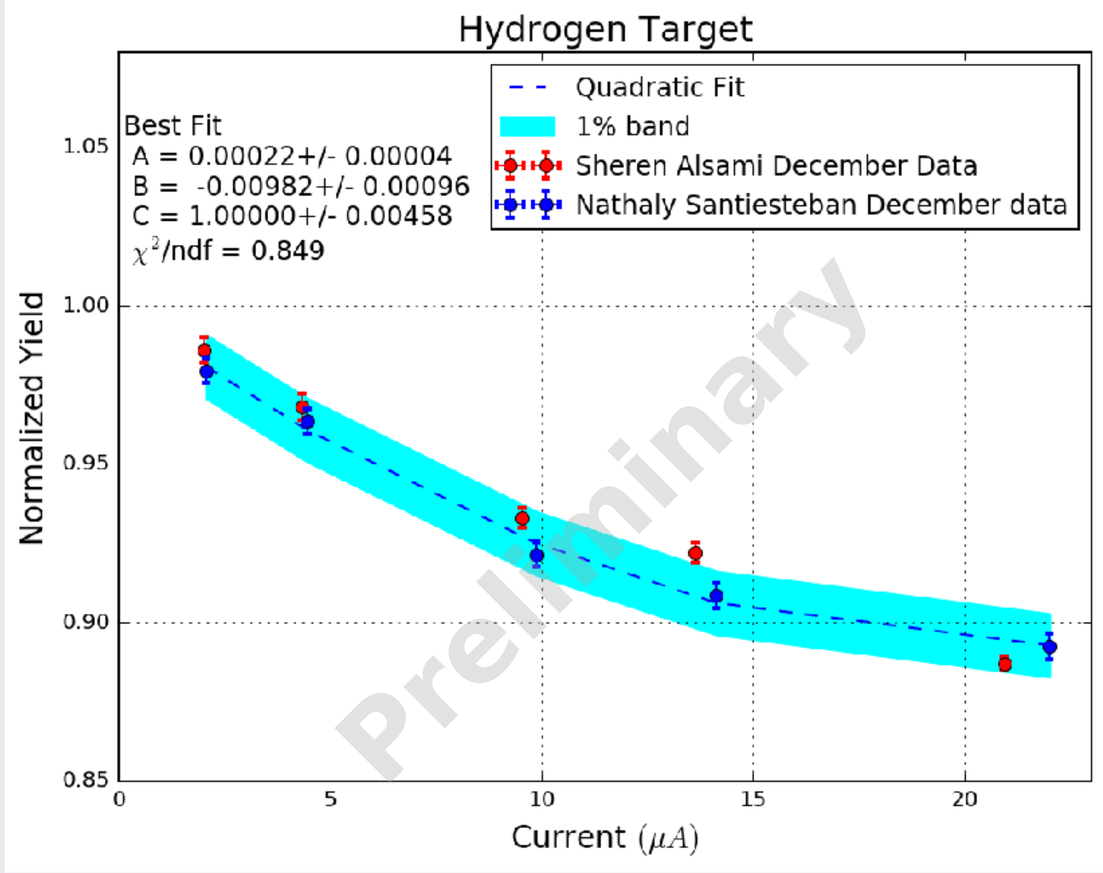
At 22.5 μA ~ 10 %

At 22.5 μA ~ 6 %

Target Density Study

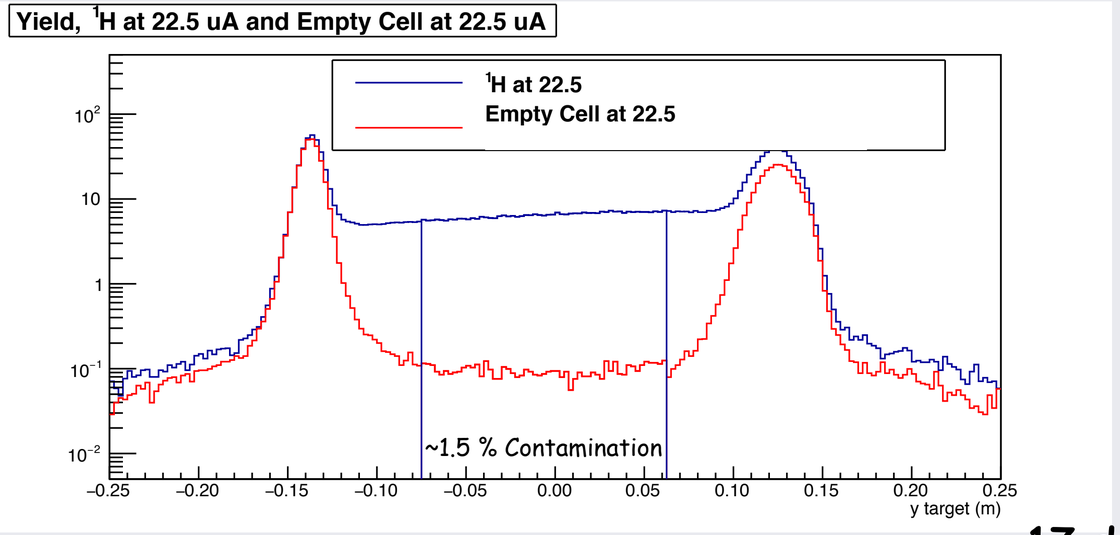


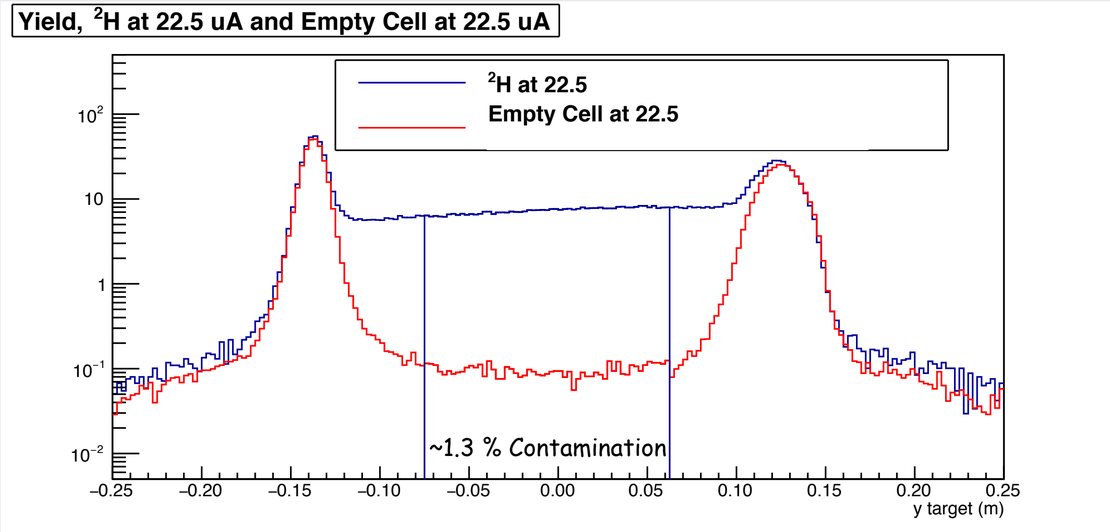
At 22.5 μA ~ 9.5 %



At 22.5 μA ~ 11%

Commissioning 2017



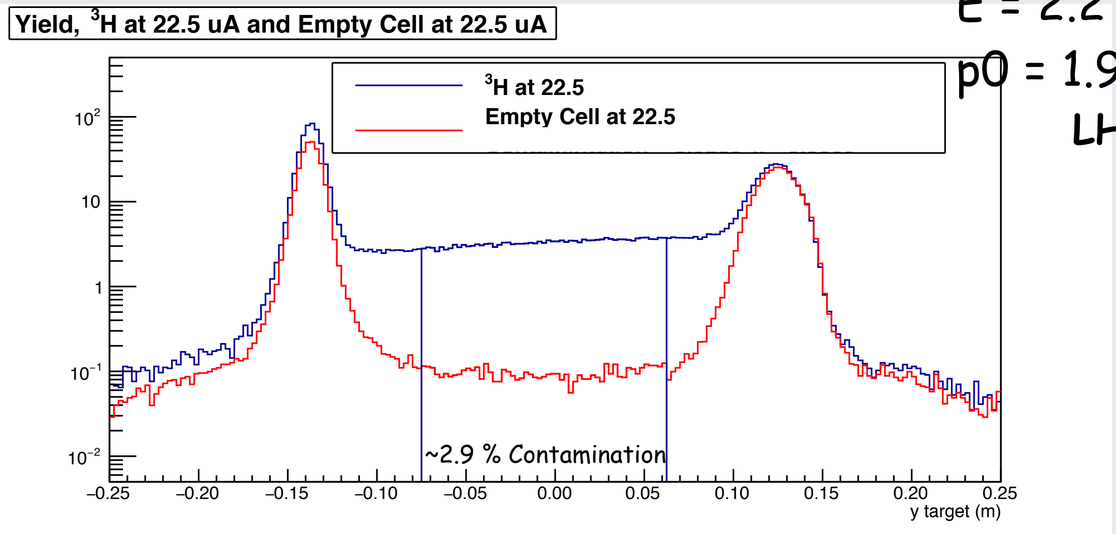


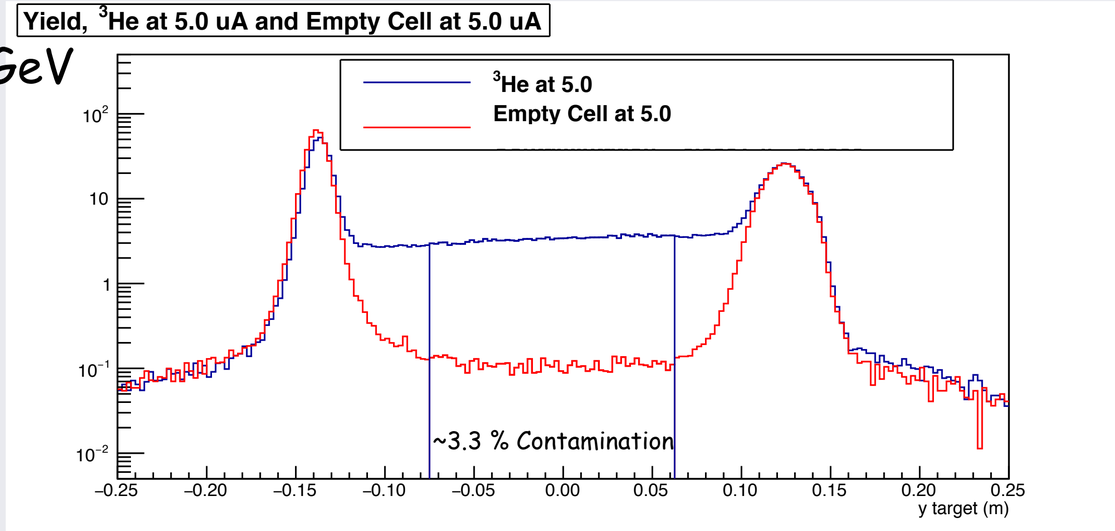
17 degrees

E = 2.2 GeV

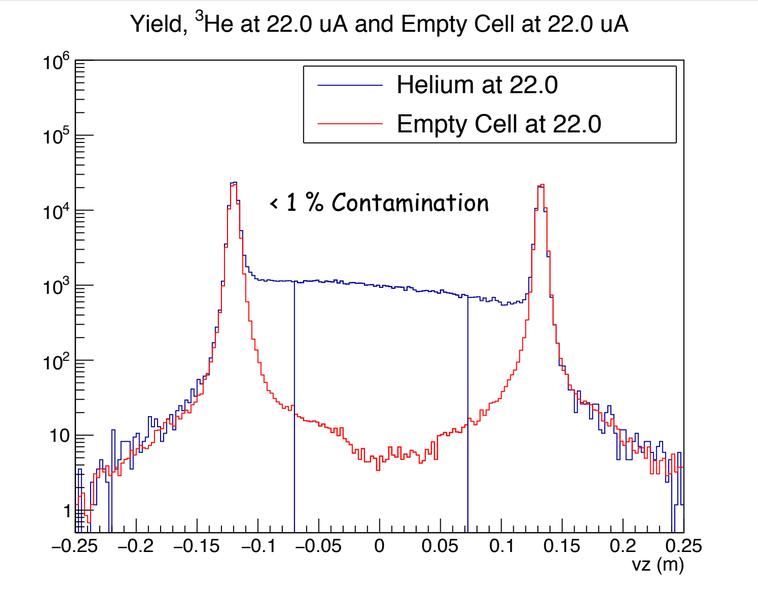
p0 = 1.999 GeV

LHRS

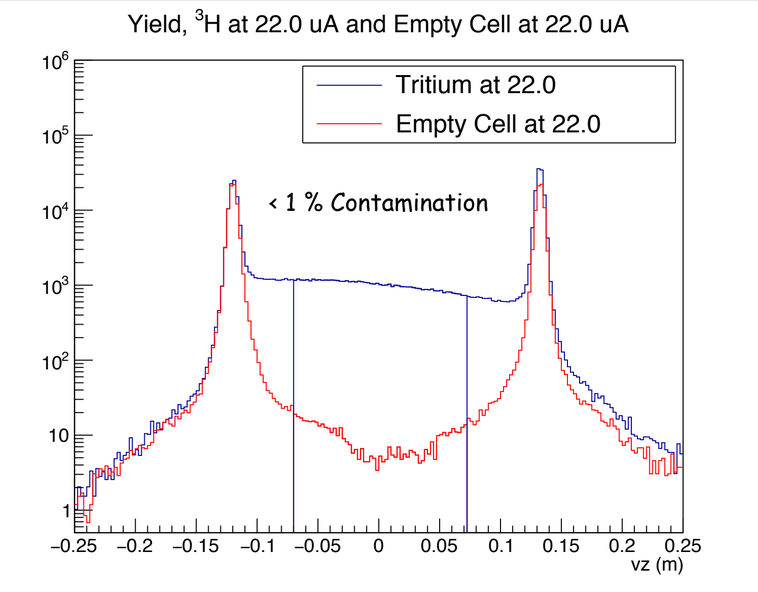


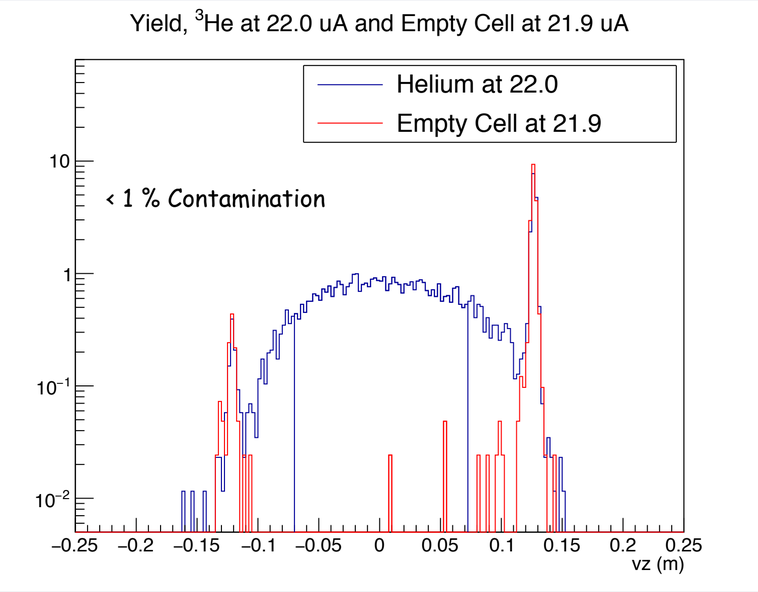


Spring Data

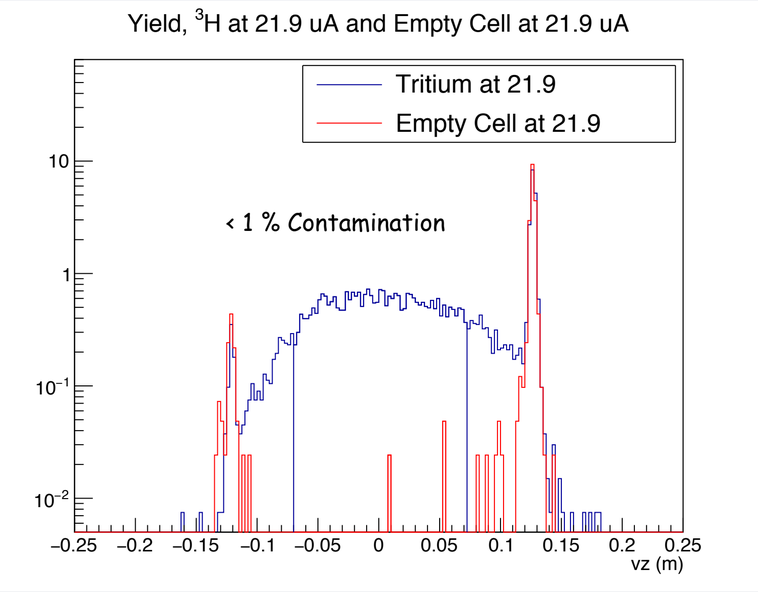


21.778 degrees
E = 2.2 GeV
p0 = 1.896 GeV
LHRS



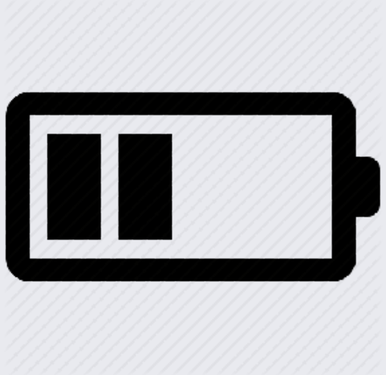


42.025 degrees
E = 2.2 GeV
p0 = 1.420 GeV
LHRS



Analysis in Progress!

Quasielastic Data…



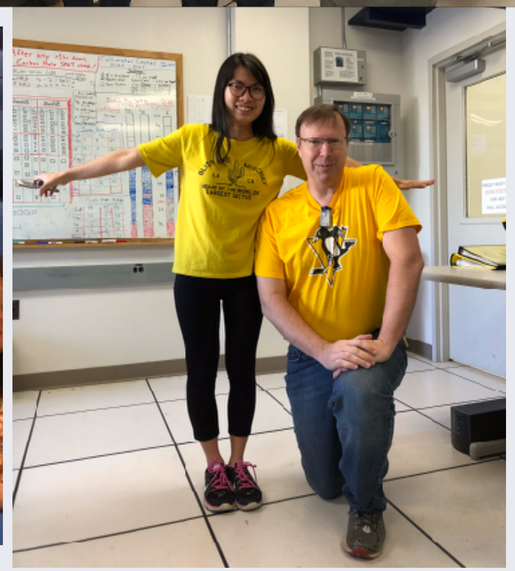
Planned for the fall

2N/3N SRC

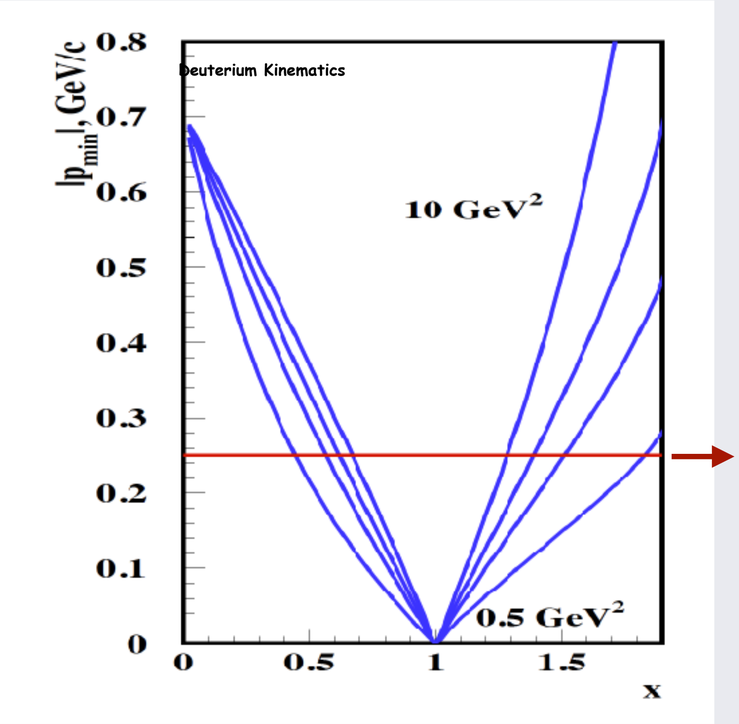
In the mean time…

Let’s enjoy to be part of the tritium family!

In the mean time…



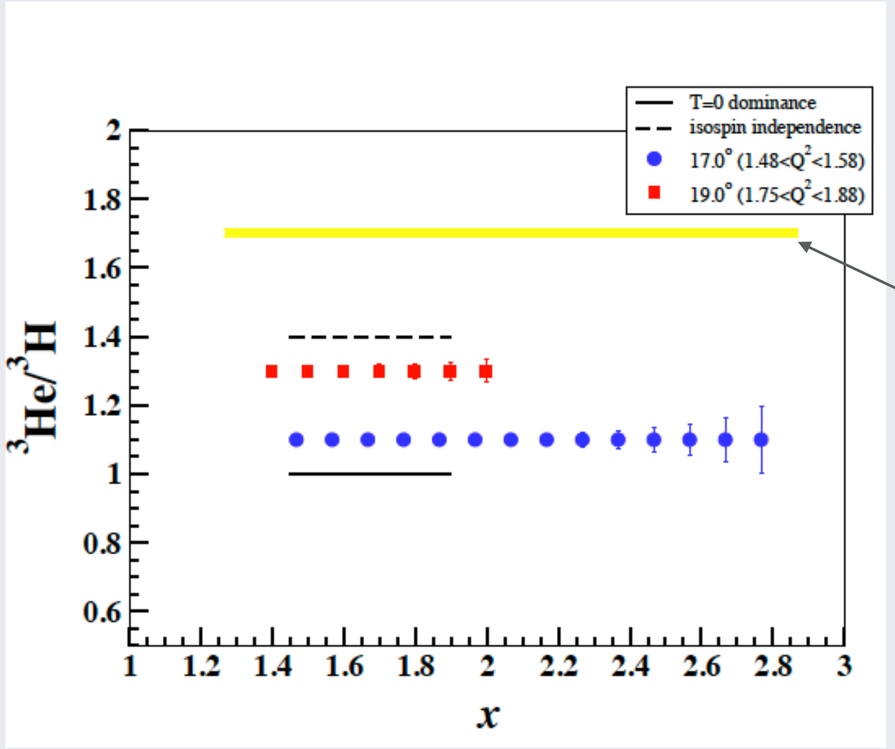
Requirements for the SRC experiments



Fermi Momentum

L. Frankfurt, M. Sargsian, M. Strikman, Int. J. Mod. Phys. A23 (2008) 29913055.

2N-SRC Projected results



Projected systematic uncertainties.

P. Solvignon, J. Arrington, D. Day, D. Higinbotham, JLab Experiment Proposal E12-11-112.