

# Run plan, conditions, and configuration

(Charges 1,3 &5)

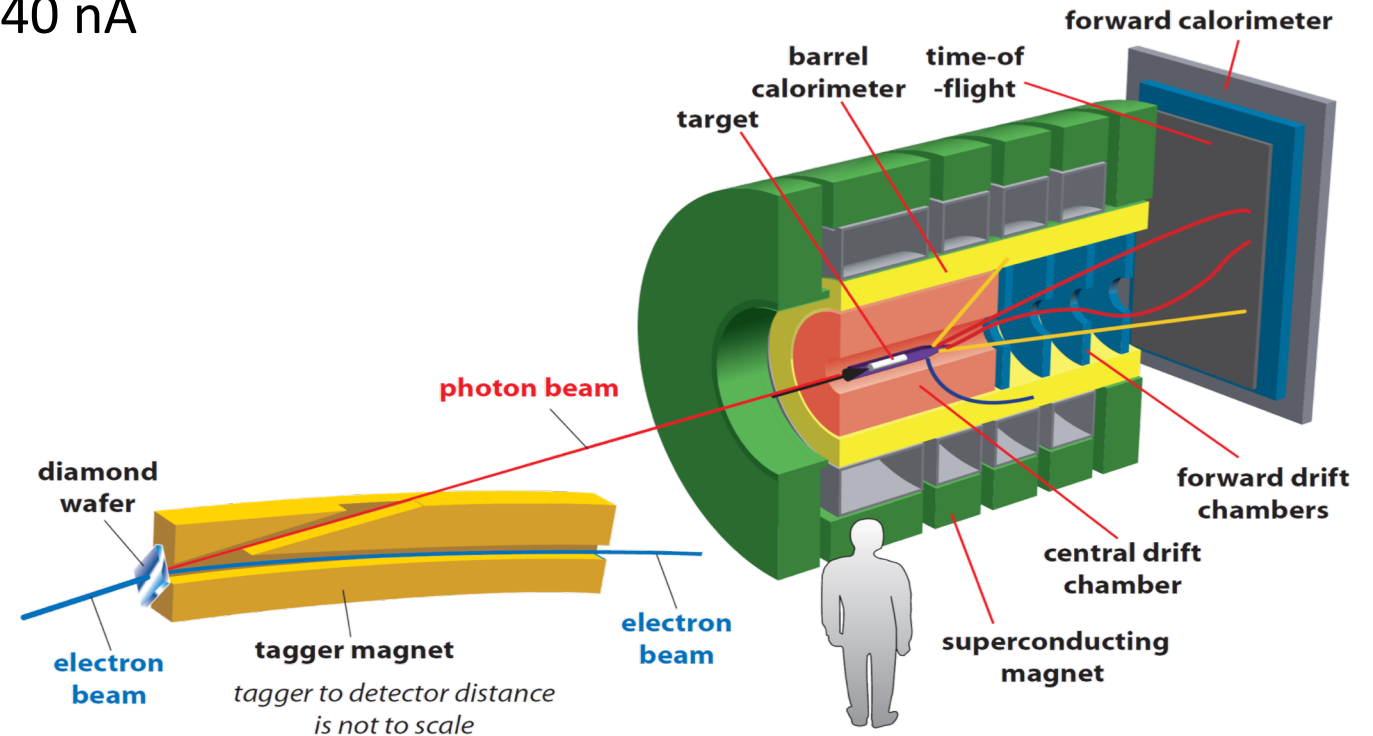
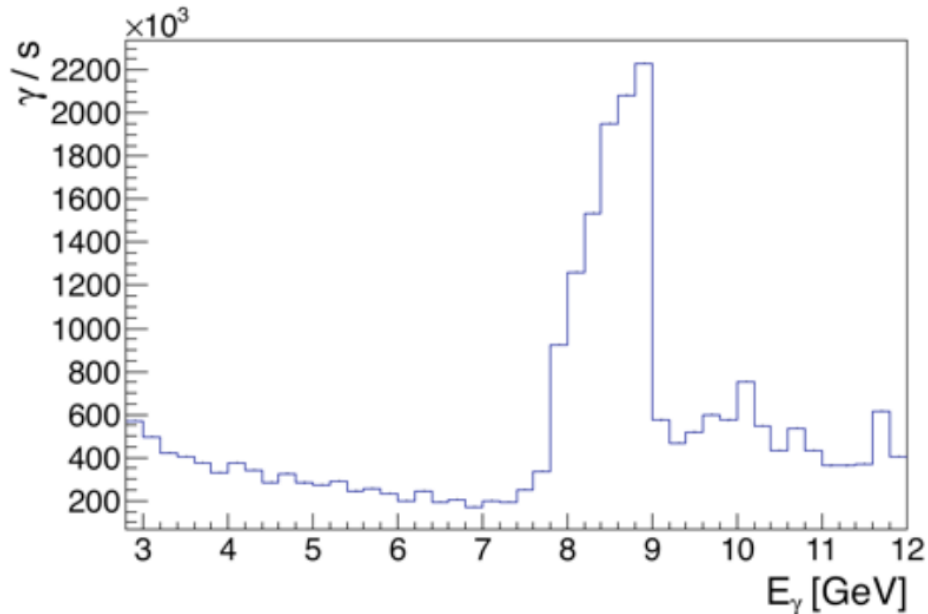
ERR

May 7, 2020

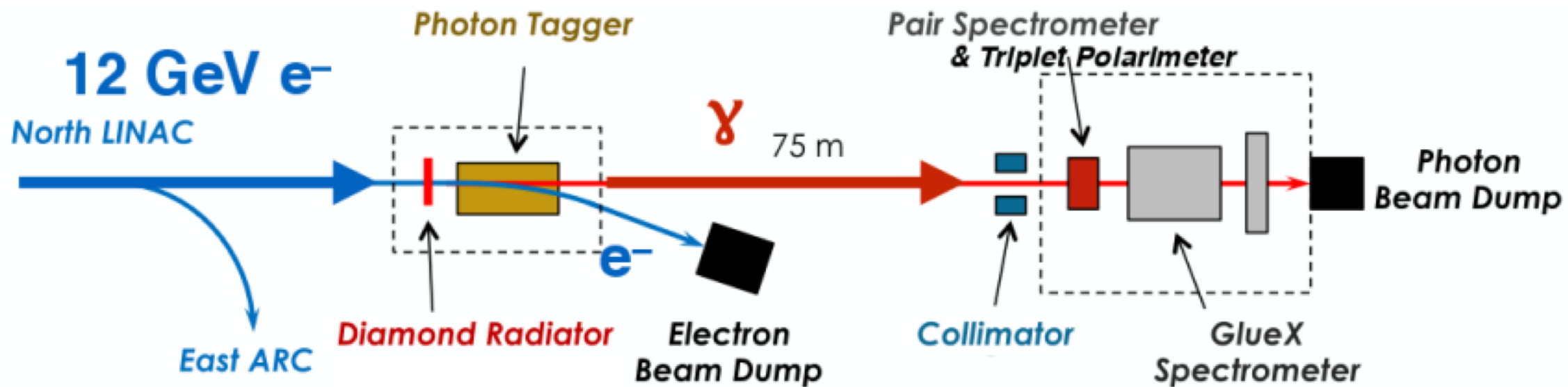
Holly Szumila-Vance

Charge 1: What are the running conditions for the experiment? Please state clearly the target and beamline configurations and operation.

- GlueX in standard configuration
- diamond radiator (standard  $2 \times 10^{-4} X_0$ )
- coherent peak at approximately 9 GeV (energy range 8.4 - 9.1 GeV)
- $2 \times 10^7$  photons/s flux, beam current 140 nA



Standard Hall D photon beam line:





## Run Plan Summary:

13 beam days data-taking  
+ 9.5 shifts overhead

Targets:  $^{12}\text{C}$  foil, D, and  $^4\text{He}$

Target	Thickness [cm] / % $X_0$	Atoms	Run Time (days)
LH	30 / 3.4	$1.28 \cdot 10^{24}$	GlueX
D	30 / 4.1	$1.51 \cdot 10^{24}$	4.5
$^4\text{He}$	30 / 4.0	$5.68 \cdot 10^{23}$	1
$^{12}\text{C}$	1.9 / 7	$1.45 \cdot 10^{23}$	7

## Run Plan:

Condition	Scheduled Work (Activities)	Total Time	Beam Conditions
<b>Pre-experiment</b>	Install C target	3 shifts	no beam
	Disassemble beam pipe. Retract target. Remove Start Counter (ST). Remove vacuum snout. Remove GlueX cell. Mount carbon foils (survey). Attach vacuum snout. Attach ST. Target in place. Assemble beam pipe. Pump vacuum.* Ramp magnet*	1 shift assembly 1 shift for survey & align 1 shift for pumping vacuum*	
<b>Detector checkout</b>		2.5 shifts	140 nA
	Establish typical tagged photon beam, check/calibrate sub-detectors, Trigger, and DAQ (some tests can be done during pumping vacuum)		
<b>Run with C target</b>		<b>7 days</b>	<b>140 nA</b>

\*Hall in Beam Permit

## Run Plan (cont.):

Condition	Scheduled Work (Activities)	Total Time	Beam Conditions
<b>Target change</b>	Install liquid D target	5 shifts	no beam
	Ramp magnet down	1 shift	
	Disassemble beam pipe. Retract target. Remove ST. Remove vacuum snout. Remove carbon foils. Mount GlueX cell. Survey. Mount heat shield (needed for helium). Attach vacuum snout. Attach ST. Target in place. Assemble beam pipe.	1 shift assembly 1 shift for survey & alignment	
	Ramp magnet.* Pump vacuum.*	1.5 shifts	
<b>Run with empty target</b>		<b>0.5 days</b>	<b>140 nA</b>
<b>Target preparation</b>	Cool target*.	1 shift	

\*Hall in Beam Permit

## Run Plan (cont.):

Condition	Scheduled Work (Activities)	Total Time	Beam Conditions
Run with D target		4.5 days	140 nA
Target change	Switch to liquid He target	1.5 shifts	
	Boil LD <sub>2</sub> *. Pump D <sub>2</sub> from tanks. Replace with helium. Cool target*.		
Run with He target		1 day	140 nA

\*Hall in Beam Permit

13 beam days data-taking  
+ 9.5 shifts overhead



Charge 3: Has the spectrometer, detector configuration been defined, including ownership, maintenance and control during beam operations?

- GlueX in standard configuration
- Detector support will come from Hall D staff members and have confirmed:

FDC	L. Pentchev (Jlab)
CDC	B. Zihlmann (Jlab)
BCAL/FCAL	M. Dalton (Jlab) / Z. Papandreou (Regina)
ST	M. Itoh (Jlab)
TOF	B. Zihlman (Jlab) / P. Eugenio (FSU)
Beamline	A. Deur/A. Somov (Jlab)
Slow Control	H. Eigian (Jlab)
DAQ	S. Furletov (Jlab)
Trigger	A. Somov (Jlab)
Tracking	S. Taylor (Jlab)
Detector Calibration	S. Dobbs (FSU)
Data processing	A. Austregesilo (Jlab/CMU)
Target	Target Group (Jlab)

<https://halldweb.jlab.org/level-1/manpower.pdf>

## Charge 5: What is the expected data rate for the experiments?

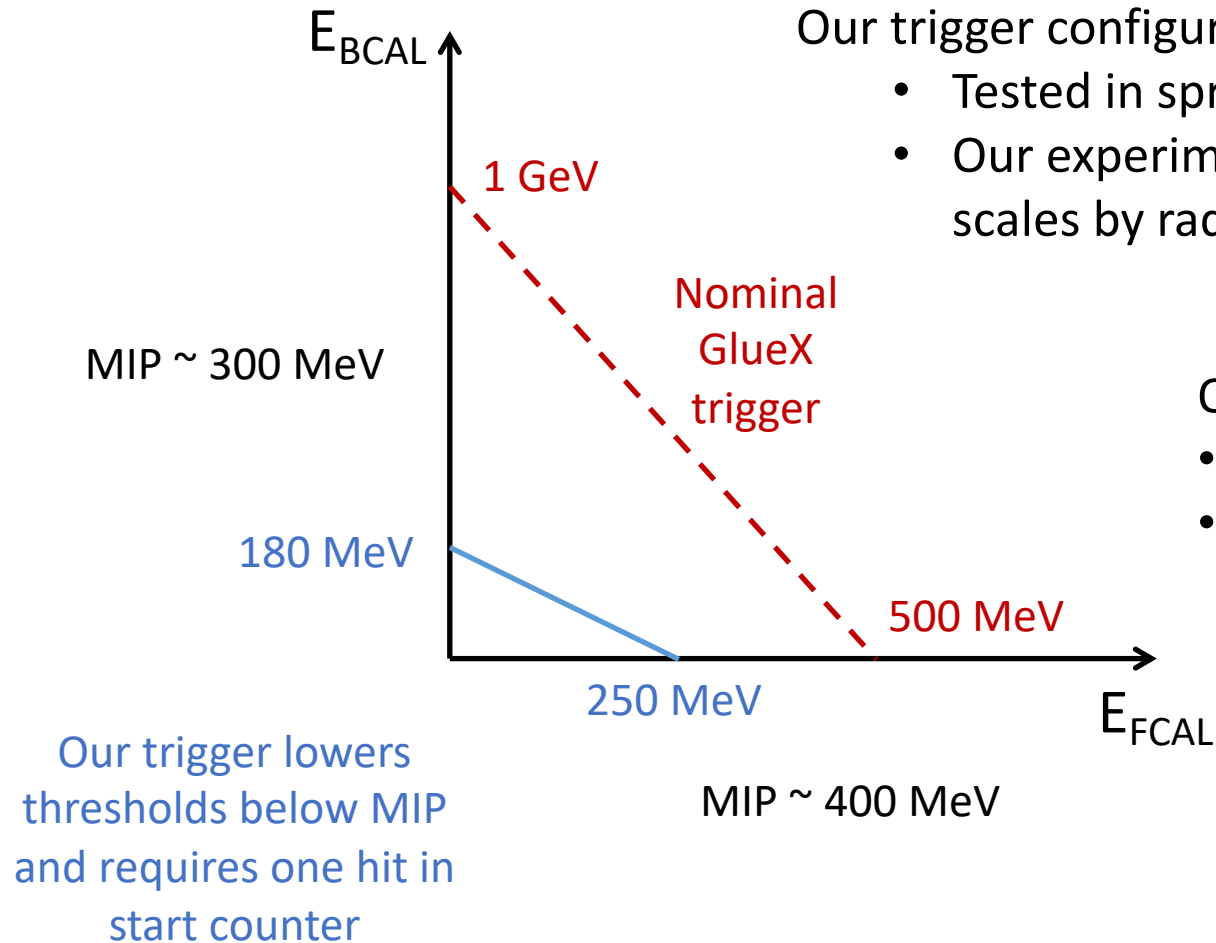
Nominal GlueX trigger: 80 kHz, 90% livetime, 1.1 Gb/s

Our trigger configuration: 78 kHz, 90% livetime, 1 Gb/s ( $5 \times 10^7 \gamma/s$ )

- Tested in spring 2020, see <https://halldweb.jlab.org/level-1/src>
- Our experiment  $\sim x0.5 \gamma/s$ , but C target has  $x2$  rad length (EM bg scales by rad length and hadronic bg scales by attenuation)

Our trigger requirements:

- Proton, pion final state  $\rightarrow$  MIP
- Already accept multiparticle final states by default



Control Sessions Configurations Options Expert User Help

Start Time: 02/23/20 19:27:13 End Time: 0

Run Parameters: Expid: hdops Session: hdops Configuration: hd\_all.tsg\_DIRC\_CC\_HL

Output File: /gluondaqfs/hdops/CDAQ/daq\_dev\_v0.31/DATA/hd\_rawdata\_071932\_022.evio

User RTV %(config): /gluondaqfs/hdops/CDAQ/daq\_dev\_v0.31/daq/config/hd\_all/FCAL\_BCAL\_PS\_SRC\_m9.conf

User RTV %(dir): unset

Run Status: Run Number: 71932 Run State: active Event Limit: 0

Watch Component: ERsoftROC Data Limit: 0

Total Events: 34,611,477 Time Limit (min.): 0

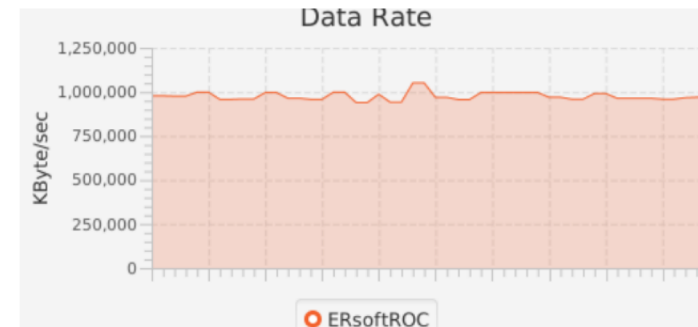
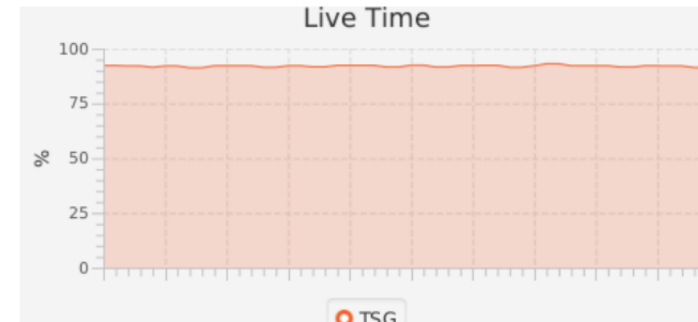
Name	State	EvtRate	DataRate	IntEvtRate	IntDataRate
ERsoftROC	active	70980.5	986821.2	13551.5	188255.2
SEB0	active	71580.0	995707.2	13555.4	188311.0
ROCBAL3	active	1765.5	18546.4	339.4	-3104.7
DCFDC	active	69020.0	314038.2	13572.9	61655.7
DCFAL	active	70380.0	30816.5	13558.5	5948.1
ROCFAL7	active	1771.5	2211.0	339.1	418.7
ROCCDC4	active	1764.5	19973.0	339.4	-2961.2
ROCCDC1	active	1751.5	20149.8	340.0	-2923.1
ROCP52	active	1749.0	50331.2	339.8	3159.4
DCTAG	active	71624.2	250738.7	13568.2	47379.5
ROCFAL9	active	1750.0	2246.8	339.7	441.9
ROCFDC7	active	1751.5	25562.6	340.0	-1712.7
ROCBAL14	active	0.0	0.0	0.0	0.0
ROCFAL4	active	1766.0	2263.3	339.4	428.4
ROCBAL10	active	1771.5	6981.5	339.0	1366.2
ROCTOF3	active	0.0	0.0	0.0	0.0
ROCFAL11	active	1752.5	7324.9	340.1	1390.5

Client Data Live Time LDRs InB OutB

Event Rate

Data Rate

Name	Message	Time	Severity
SEB0	Emu SEB0 go: waiting for PRESTART event in module EbModule (client msg)	19:27:04 02/23	INFO
DCFDC	Emu DCFDC go: waiting for PRESTART event in module EbModule (client msg)	19:27:06 02/23	INFO
DCTAG	Emu DCTAG go: waiting for PRESTART event in module EbModule (client msg)	19:27:06 02/23	INFO
DCBCAL	Emu DCBCAL go: waiting for PRESTART event in module EbModule (client msg)	19:27:06 02/23	INFO
DCCDCSTPS	Emu DCCDCSTPS go: waiting for PRESTART event in module EbModule (client msg)	19:27:06 02/23	INFO
DCFAL	Emu DCFAL go: waiting for PRESTART event in module EbModule (client msg)	19:27:06 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Done process = hd_all.tsg_DOWNLND	19:27:12 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Done process = hd_all.tsg_PRE	19:27:12 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Starting process = hd_all.tsg_RCDB	19:27:12 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Periodic script (/gluondaqfs/hdops/CDAQ/daq_dev_v0.31/daq/scripts/run_update_rcdb %(m) cMsg//...	19:27:12 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Done process = hd_all.tsg_RCDB	19:27:12 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Done process = hd_all.tsg_END	19:27:12 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Starting process = hd_all.tsg_GO	19:27:12 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Script (/gluondaqfs/hdops/CDAQ/daq_dev_v0.31/daq/scripts/run_go 71932 cMsg//gluon41.jlab.org:...	19:27:12 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Done process = hd_all.tsg_GO	19:27:13 02/23	INFO
sms_hd_all.tsg_DIRC_CC_HL	Go succeeded.	19:27:13 02/23	INFO



Trigger rate: 78 kHz    GlueX rate: 80 kHz

## Summary

**Charge 1: What are the running conditions for the experiment? Please state clearly the target and beamline configurations and operation.**

- GlueX in standard configuration, standard diamond radiator
- coherent peak at 9 GeV (energy range 8.4 - 9.1 GeV)
- x2 lower flux than standard GlueX at  $2 \times 10^7$  photons/s flux (140 nA)
- Run plan for 15 days with  $^{12}\text{C}$ , D,  $^4\text{He}$  targets presented

**Charge 3: Has the spectrometer, detector configuration been defined, including ownership, maintenance and control during beam operations?**

- Spectrometer and detectors in standard GlueX configuration
- Detector and beamline support from Hall D staff
- Target support from JLab Target Group

**Charge 5: What is the expected data rate for the experiments?**

- 78 kHz, 90% live time, data rate of approximately 1 GB/s (tested at  $5 \times 10^7$  photons/s)
- $^4\text{He}$  and D comparable,  $^{12}\text{C}$  double radiation length (and attenuation effects)
- Trigger has lower ECAL and BCAL thresholds, hit in start counter

Back-up slides

## Reminder: Physics observables

Exclusive Proton Reactions	Exclusive Neutron Reactions
$\gamma + p \rightarrow \pi^0 + p$	$\gamma + n \rightarrow \pi^- + p$
$\gamma + p \rightarrow \pi^- + \Delta^{++}$	$\gamma + n \rightarrow \pi^- + \Delta^+$
$\gamma + p \rightarrow \rho^0 + p$	$\gamma + n \rightarrow \rho^- + p$
$\gamma + p \rightarrow K^+ + \Lambda^0$	$\gamma + n \rightarrow K^0 + \Lambda^0$
$\gamma + p \rightarrow K^+ + \Sigma^0$	$\gamma + n \rightarrow K^0 + \Sigma^0$
$\gamma + p \rightarrow \omega + p$	x
$\gamma + p \rightarrow \phi + p$	x
...	...

Target	Low XS $\gamma + n \rightarrow \pi^- + p$		High XS $\gamma + n \rightarrow \rho^- + p$		PAC days
	MF	SRC	MF	SRC	
<b>D</b>	12240	675	51300	2700	4.5
<b>4He</b>	1600	84	6800	350	1
<b>12C</b>	5192	1633	21583	6417	7

**MF** = mean field  
**SRC** = short-range pairs

## Option B: Consideration if neutron rates are too high when running deuterium

### 1. Lower intensity

photon flux	Low XS $\gamma + n \rightarrow \pi^- + p$		High XS $\gamma + n \rightarrow \rho^- + p$	
	MF	SRC	MF	SRC
$2 \times 10^7$	13600	750	57000	3000
$1 \times 10^7$	6800	375	28500	1500

**MF** = mean field

**SRC** = short-range pairs

### 2. Change to 4He sooner than planned (all physics goals still attainable)

## Consideration for $^4\text{He}$ target density

- We anticipate that  $^4\text{He}$  target density is known to approximately 5% (or better), and this is acceptable.
- PrimEx will measure the absolute density prior to our experiment, and we expect this to be similar. Compare PrimEx densities between 2019 and 2021 to determine if Option B needed.
- Option B: Measuring the  $^4\text{He}$  absolute density (use remaining 2.5 shifts overhead)
  - At the start of our D2 target running, before ramping field, take 2h run (1/3 photon flux) with Compton calorimeter. Then, proceed to ramp magnet.
  - At the end of our  $^4\text{He}$  run, ramp magnet to 0, take 2h run with Compton calorimeter.



### Energy loss in Carbon foil targets:

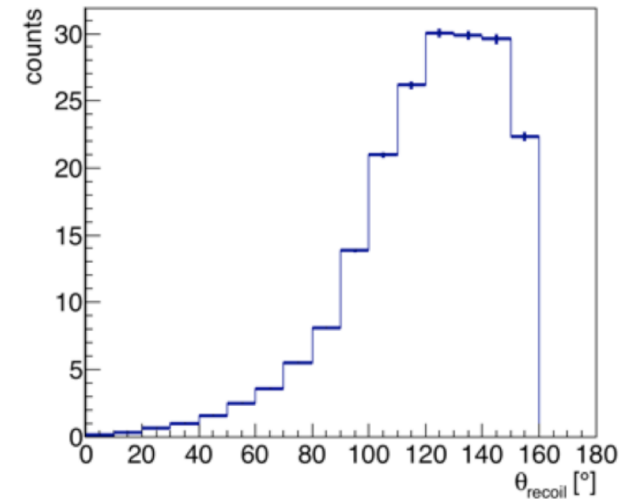
- 3 cm vertex resolution
- 8 foil targets (total is 7% rad length, 1.9 cm total), each is 0.24 cm thick
- 100MeV- $\rightarrow$  6.488 MeV cm<sup>2</sup>/g, 2 g/cm<sup>3</sup>- $\rightarrow$  E loss of 13 MeV/cm
- For 100 MeV proton (p=430 MeV/c):
  - At thickness, 3 MeV loss per C foil
  - At 150 deg, 3.6 MeV loss per C foil

### Effects of Al shielding around cryo target cell:

- Thickness is 0.5mm
- 100 MeV - $\rightarrow$  5.678 MeV cm<sup>2</sup>/g , 2.71 g/cm<sup>3</sup>- $\rightarrow$ E loss of 15.4 MeV/cm
- For 100 MeV proton (p=430 MeV/c):
  - At thickness, 0.77 MeV loss
  - At 150 deg, 0.89 MeV loss

**Al shielding not a problem for recoiling proton!**

### Angular distribution of recoil nucleon



# Acceptance and Efficiency for recoil protons in GlueX at different vertex locations

