$^{19}F(\gamma,\alpha)^{15}N$ Measurement at JLab Injector

March 9, 2016

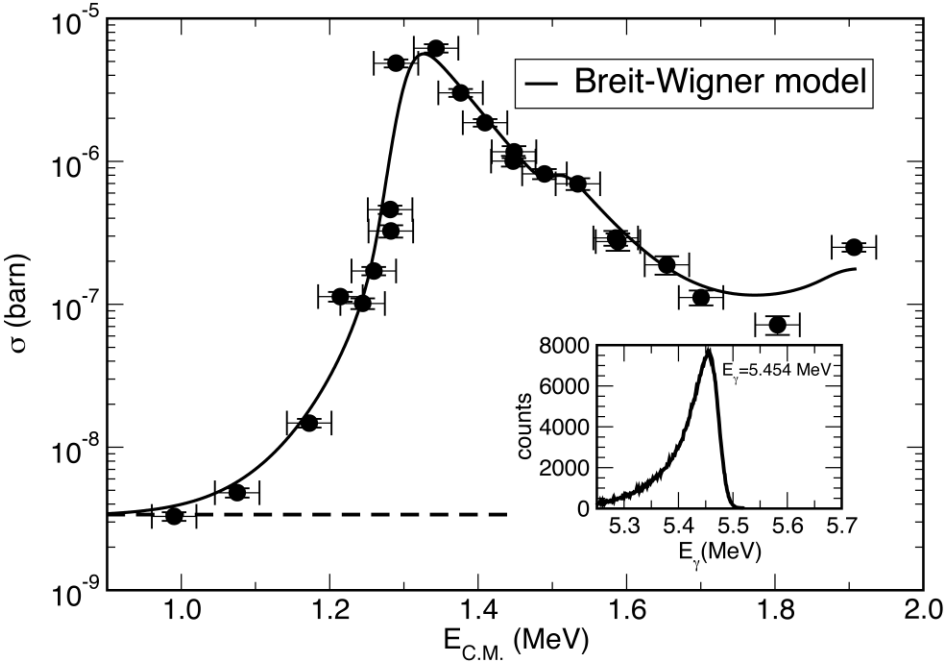
OUTLINE

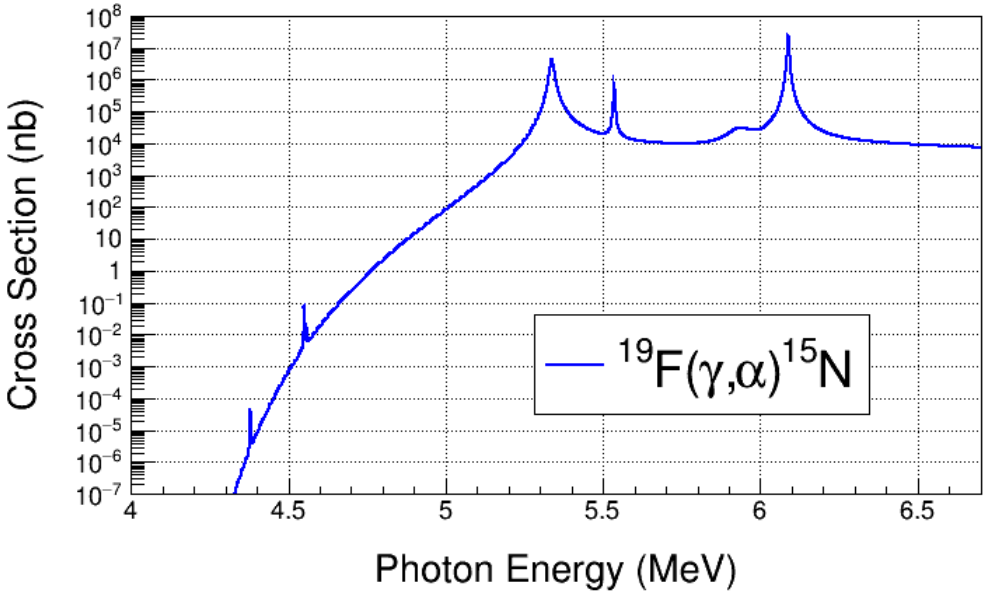
- Measuring $^{19}F(\gamma,\alpha)^{15}N$ at HIGS
- GEANT4 Model
- Gamma Flux
- Expected Rate with C_2F_6
- Expected Number of Bubbles
- Penfold-Leiss Unfolding
- Expected Cross Section Measurement
- Remarks

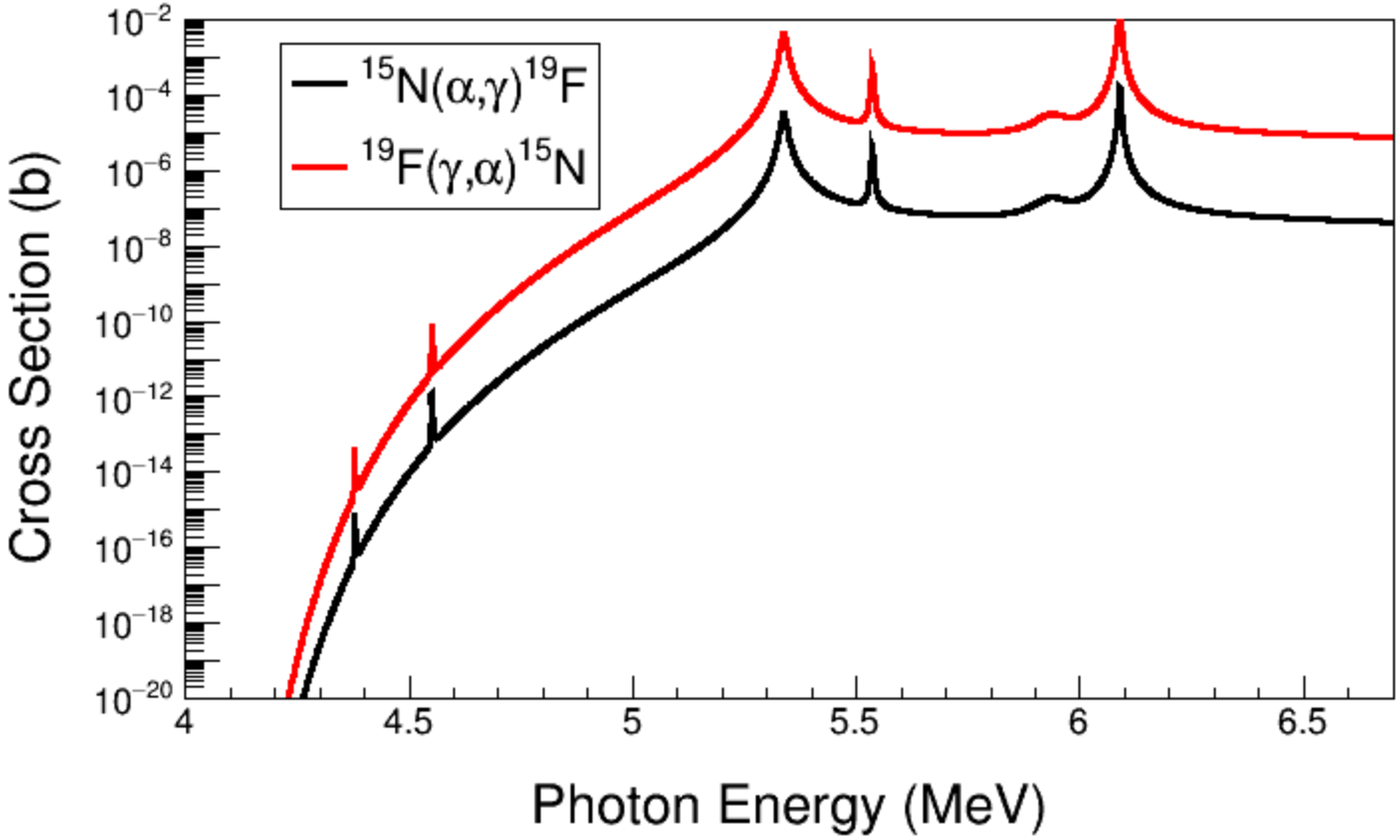
MEASURING $^{19}F(\gamma,\alpha)^{15}N$ AT HIGS

$$E_\gamma \cong E_{C.M.} + Q$$

$$Q = +4.013 \text{ MeV}$$

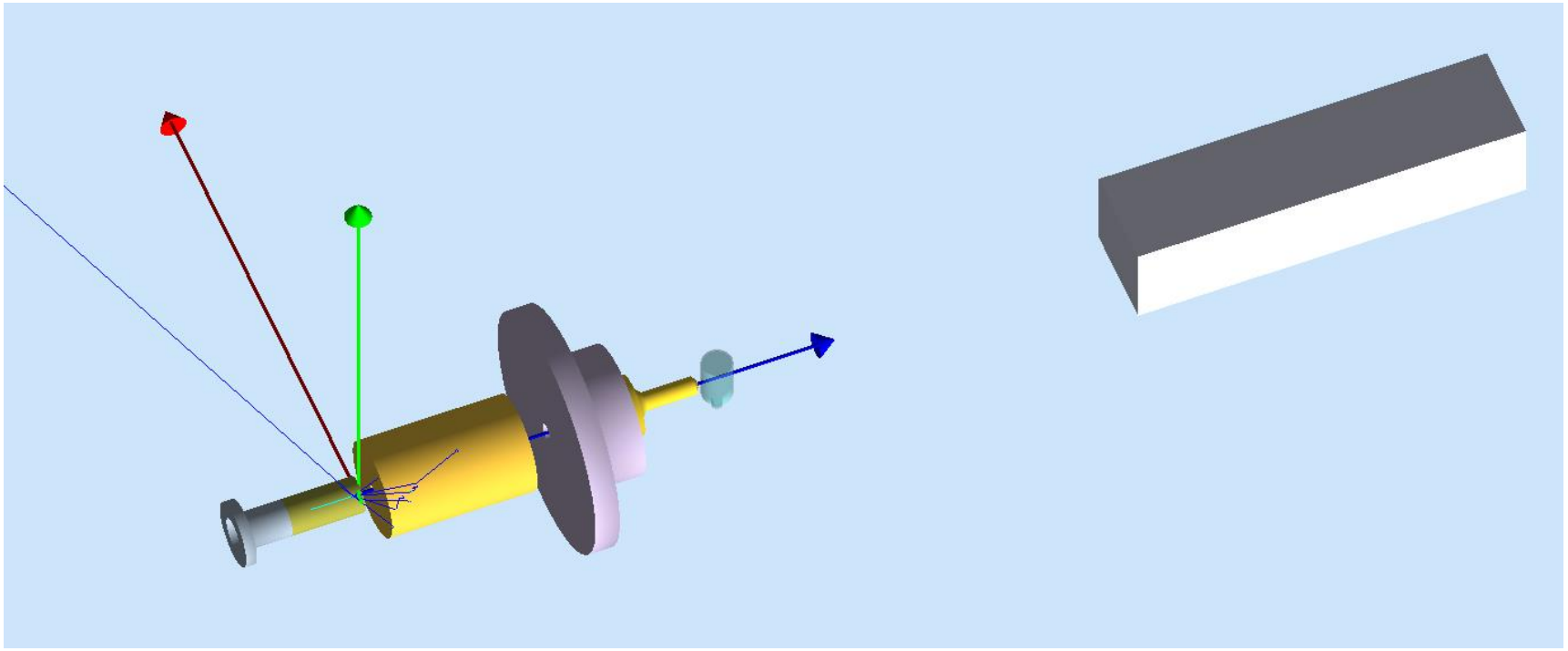




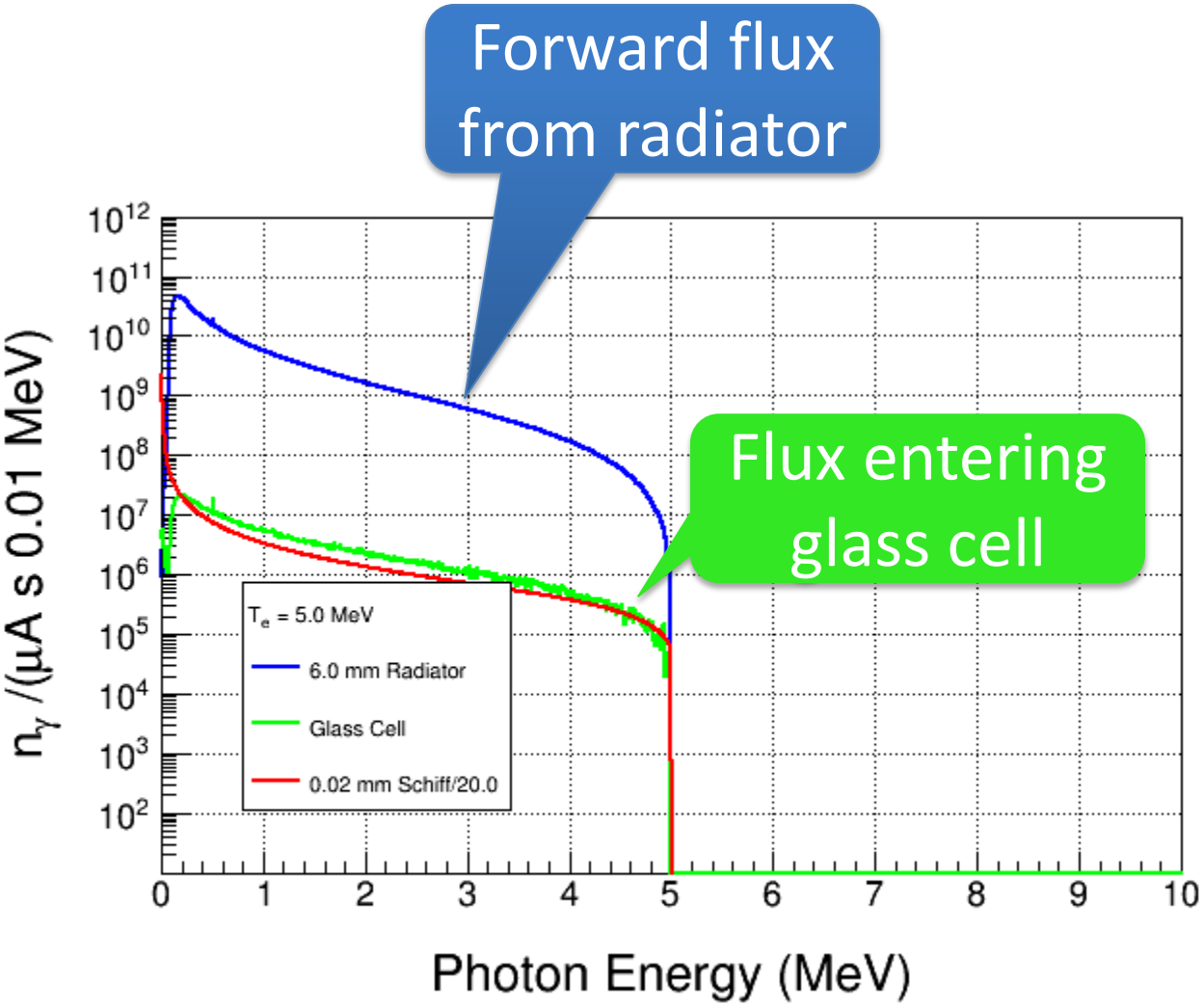

$^{15}N(\alpha,\gamma)^{19}F$
$^{19}F(\gamma,\alpha)^{15}N$
Cross Section (b)
Photon Energy (MeV)
10^{-2}
10^{-4}
10^{-6}
10^{-8}
10^{-10}
10^{-12}
10^{-14}
10^{-16}
10^{-18}
10^{-20}
4
4.5
5
5.5
6
6.5

GEANT4 MODEL

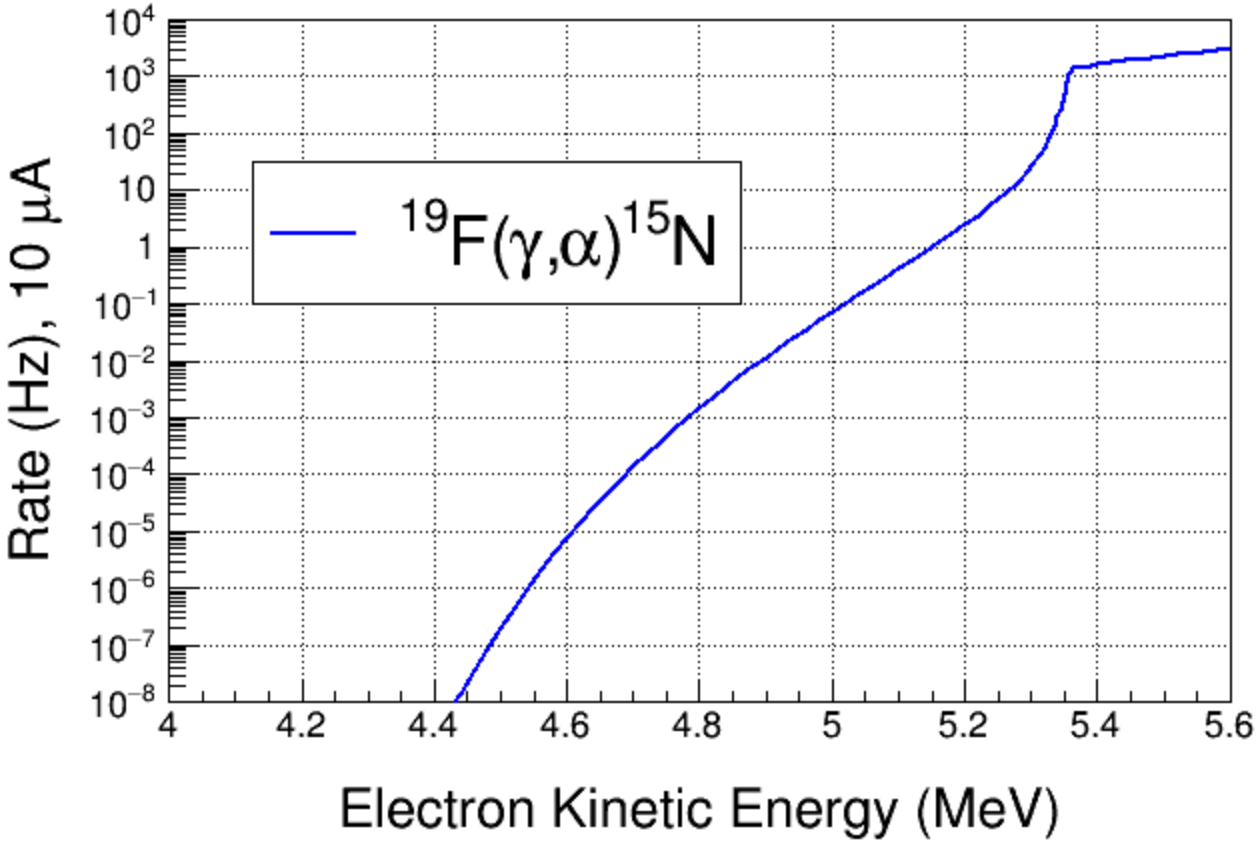
- Gap between radiator and collimator = 0.6 inches
- Distance between radiator and center of glass cell = 14.0 inches



GAMMA FLUX


Forward flux from radiator
Flux entering glass cell
n_γ /(μA s 0.01 MeV)
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
T_e = 5.0 MeV
6.0 mm Radiator
Glass Cell
0.02 mm Schiff/20.0
0
1
2
3
4
5
6
7
8
9
10
Photon Energy (MeV)

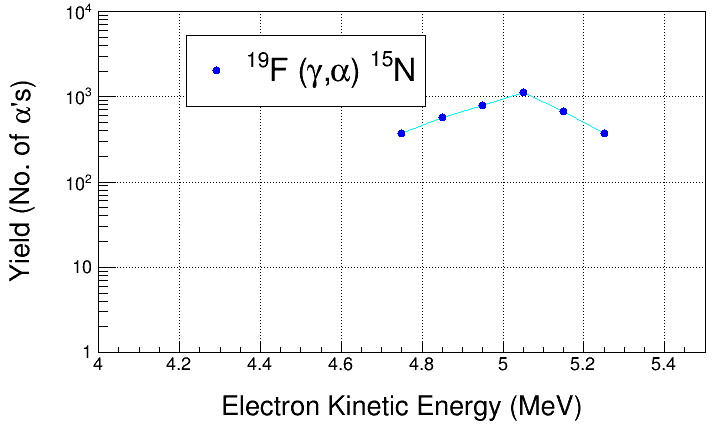
Expected Rate for C_2F_6



Expected Number of Bubbles

- Cosmic background rate in chamber fiducial volume at JLab Injector is about 10^{-3} Hz (or 1 event every 15 minutes)

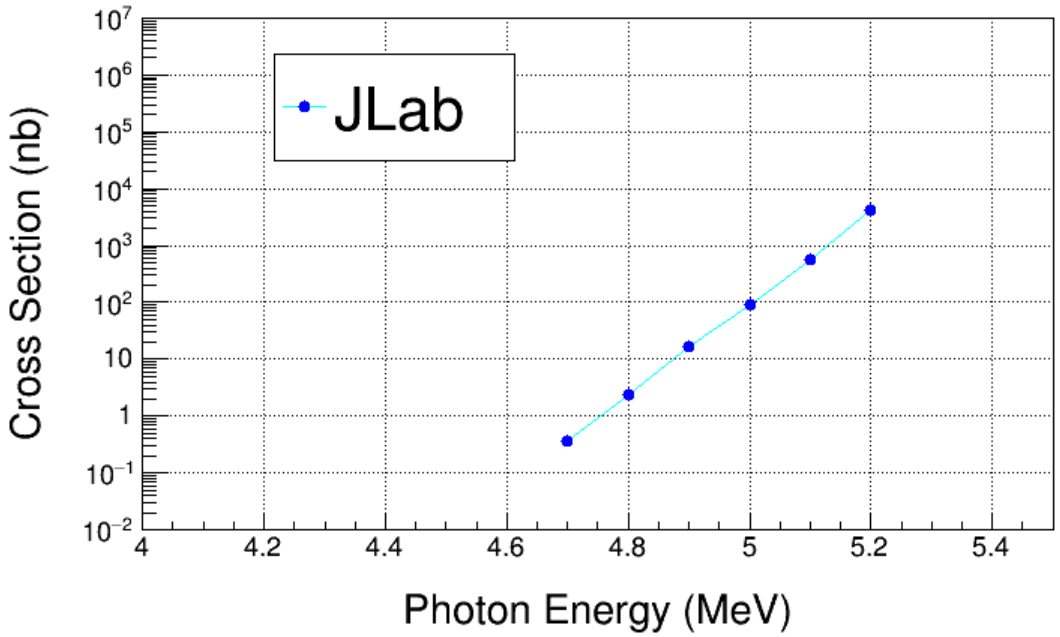
$$dy_i = \sqrt{y_i + 2y_i^{bg}}$$

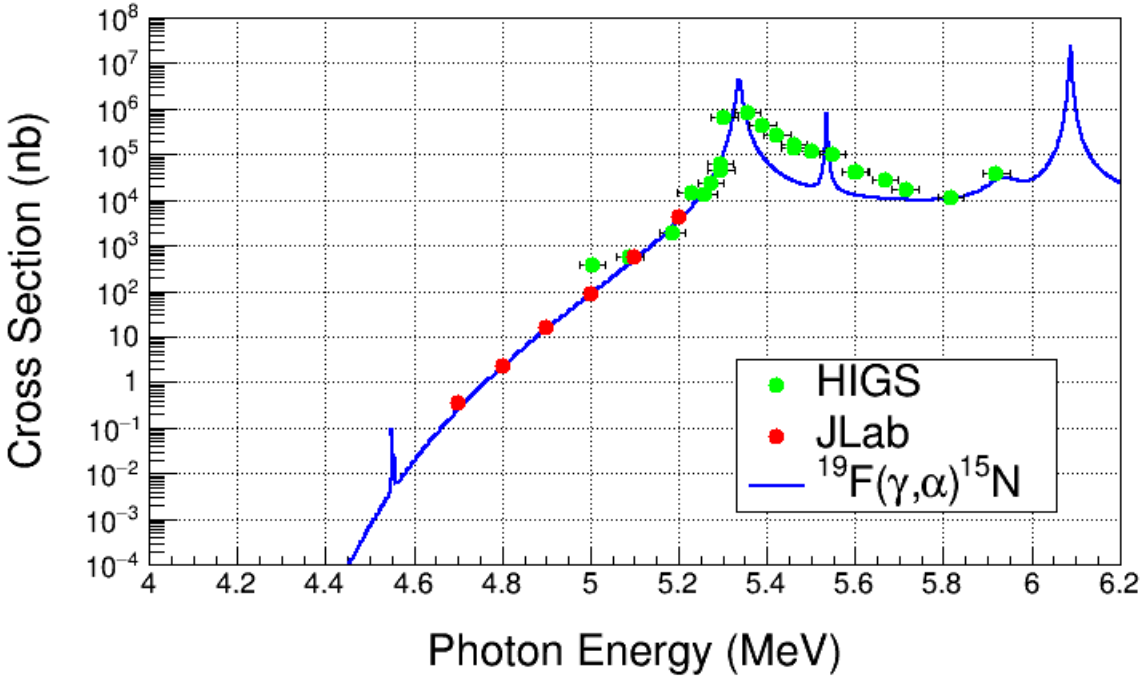


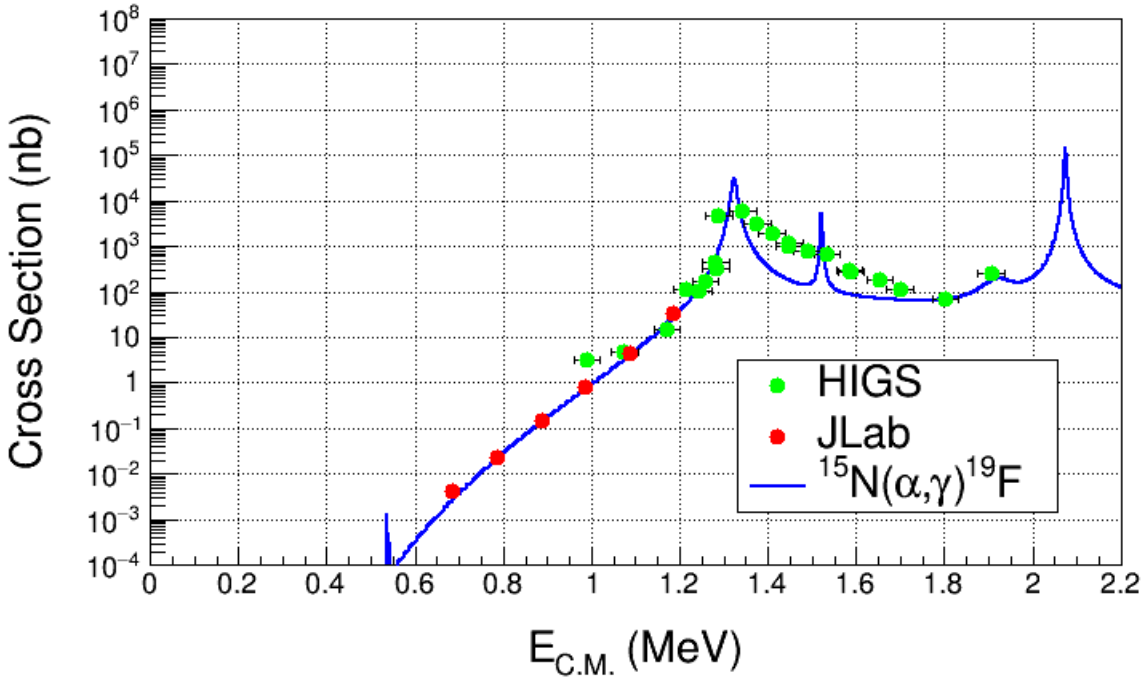
Electron Beam K. E.	Eγ (MeV)	Beam Current (μA)	Time (hour)	y_i	y_i (bg)	dy_i/y_i (with bg, %)
4.75	4.70	50	100	371	400	8.9
4.85	4.80	20	50	568	200	5.4
4.95	4.90	10	20	795	80	3.9
5.05	5.00	5	10	1124	40	3.1
5.15	5.10	1	5	662	20	4.0
5.25	5.20	0.2	2	374	8	5.3

PENFOLD-LEISS UNFOLDING

Eγ (MeV)	Cross Section (nb)	Stat Error (with bg, %)
4.7	0.37	8.9
4.8	2.35	6.3
4.9	16.6	4.6
5.0	91	3.9
5.1	555	5.1
5.2	4217	6.5




Cross Section (nb)
Photon Energy (MeV)
HIGS
JLab
$^{19}F(\gamma,\alpha)^{15}N$


Cross Section (nb)
$E_{C.M.}$ (MeV)
HIGS
JLab
$^{15}N(\alpha,\gamma)^{19}F$

Remarks

- Calculate systematic error: energy, …

Beam Current, $\delta I/I$	3%
Photon Flux, $\delta\varphi/\varphi$	5%
Radiator Thickness, $\delta R/R$	3%
Bubble Chamber Thickness, $\delta T/T$	3%
Bubble Chamber Efficiency, ε	5%

- We are only approved to 10 μA, we will need 50 μA.