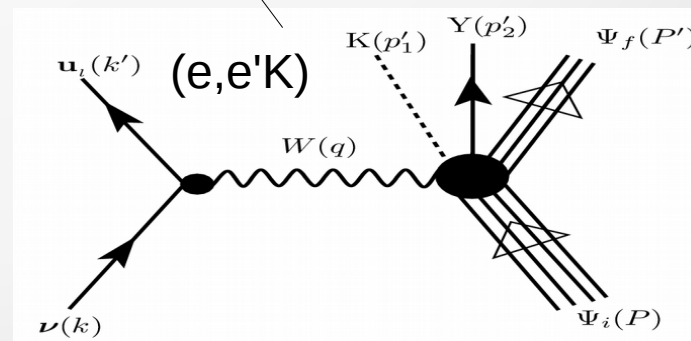
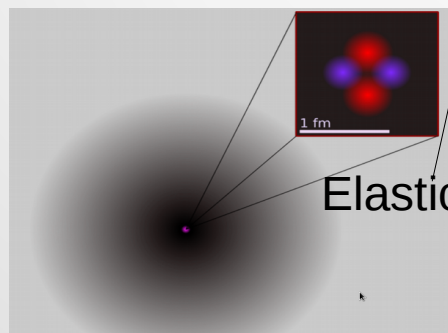
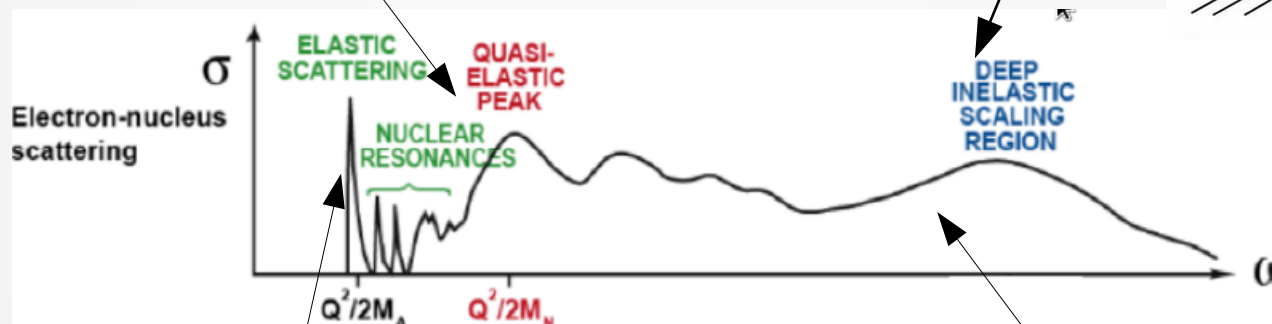
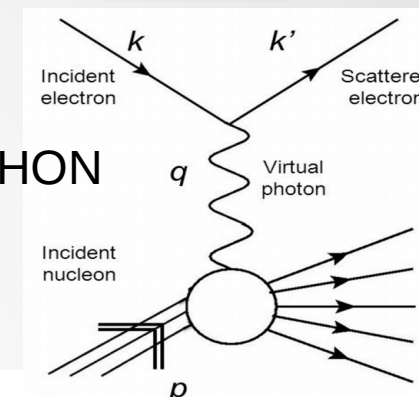
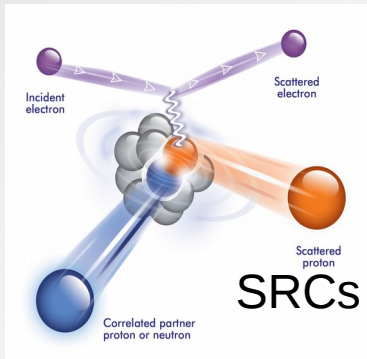
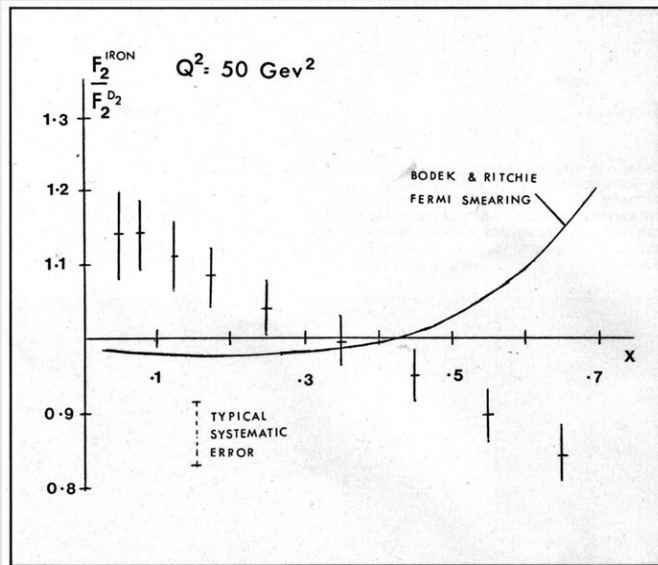


EMC Effect in Light Mirror Nuclei from MARATHON

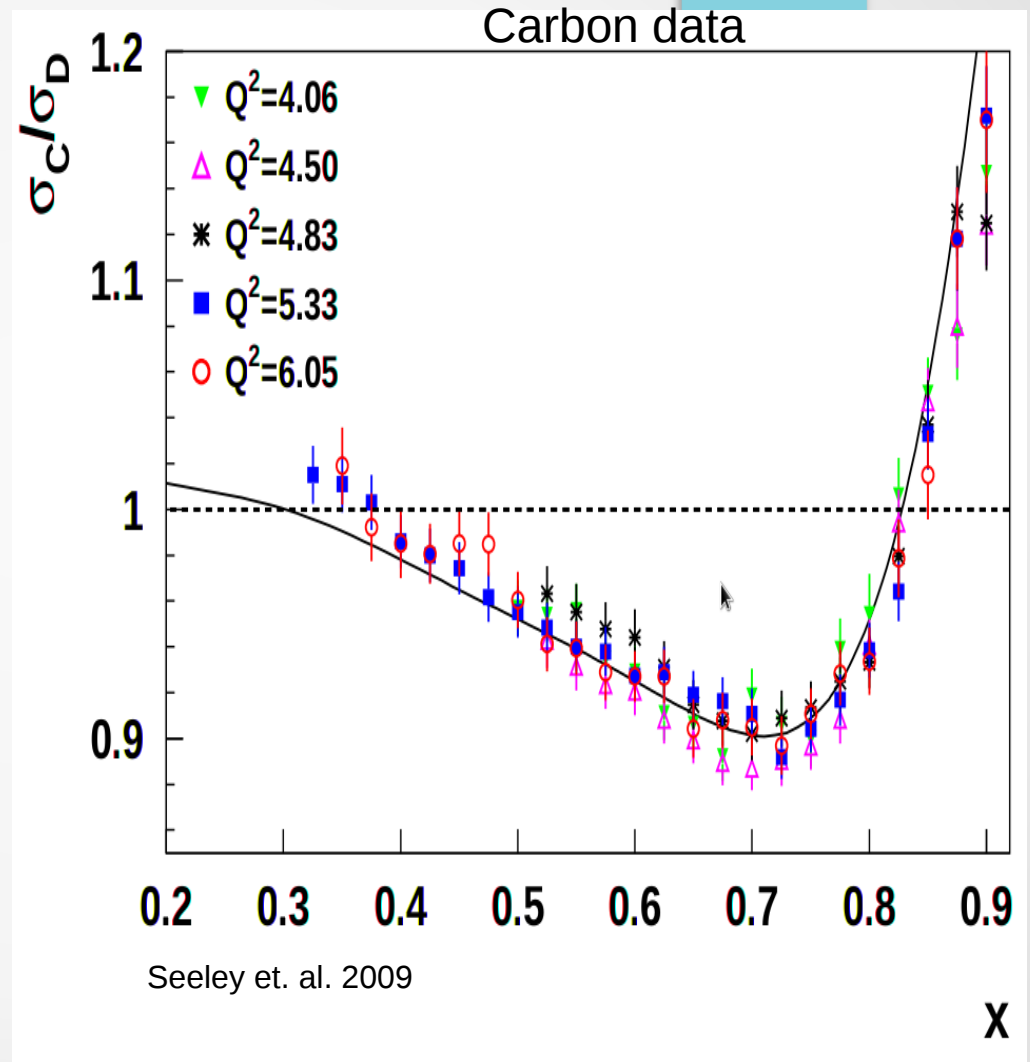


The EMC effect

- European Muon Collaboration
- EMC effect (.3 -.7 X_B)



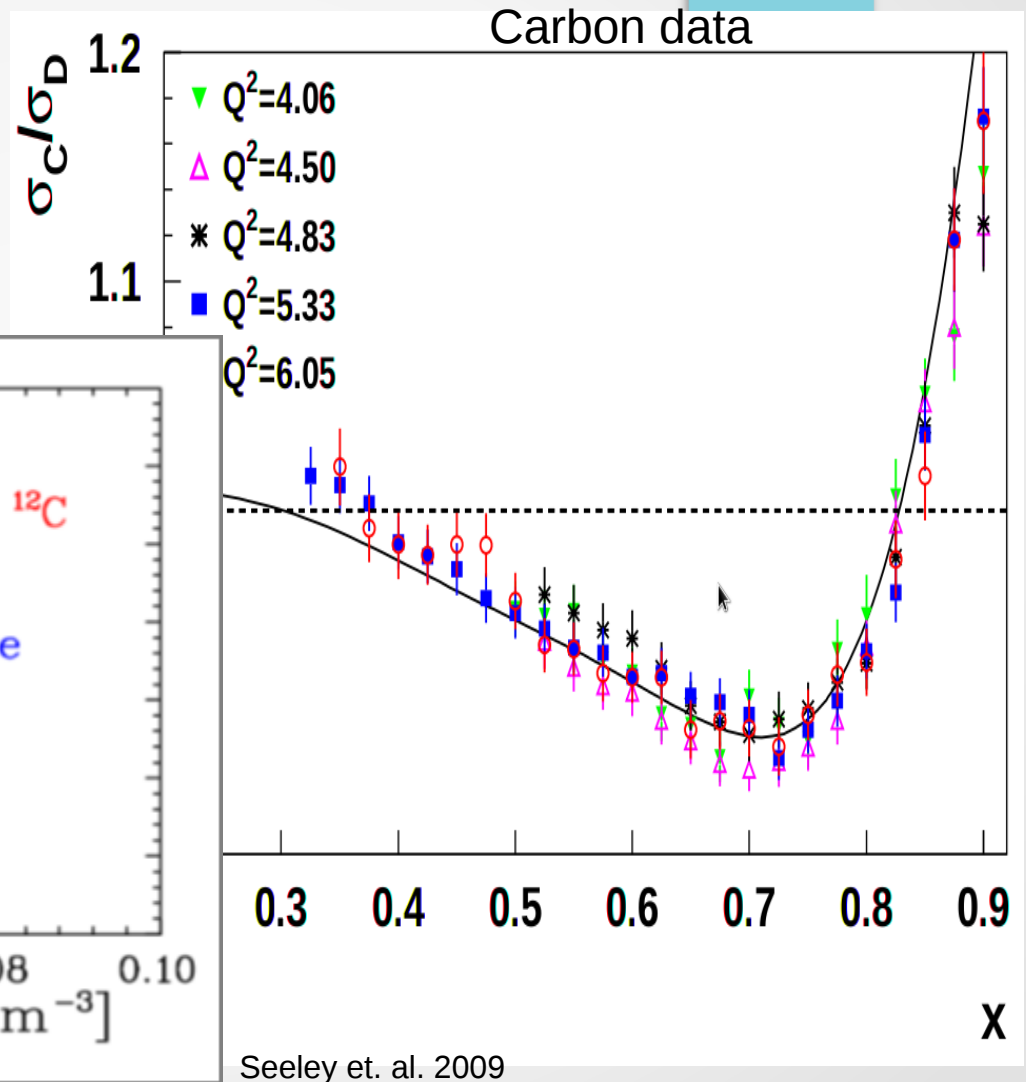
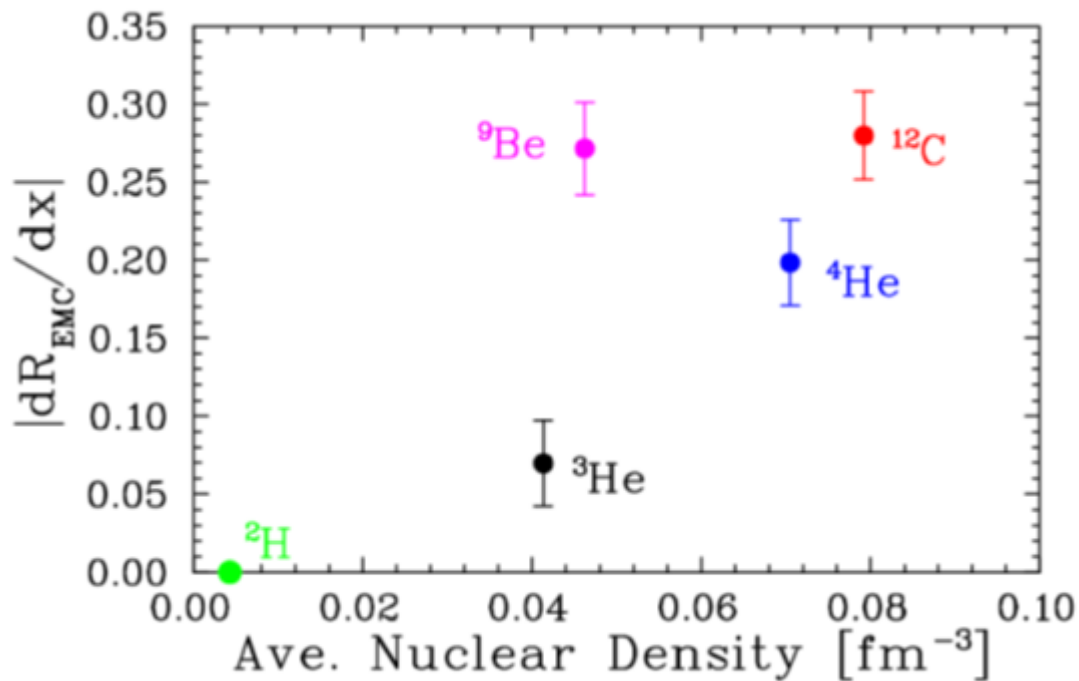
Aubert et al. 1983



Seeley et. al. 2009

The EMC effect

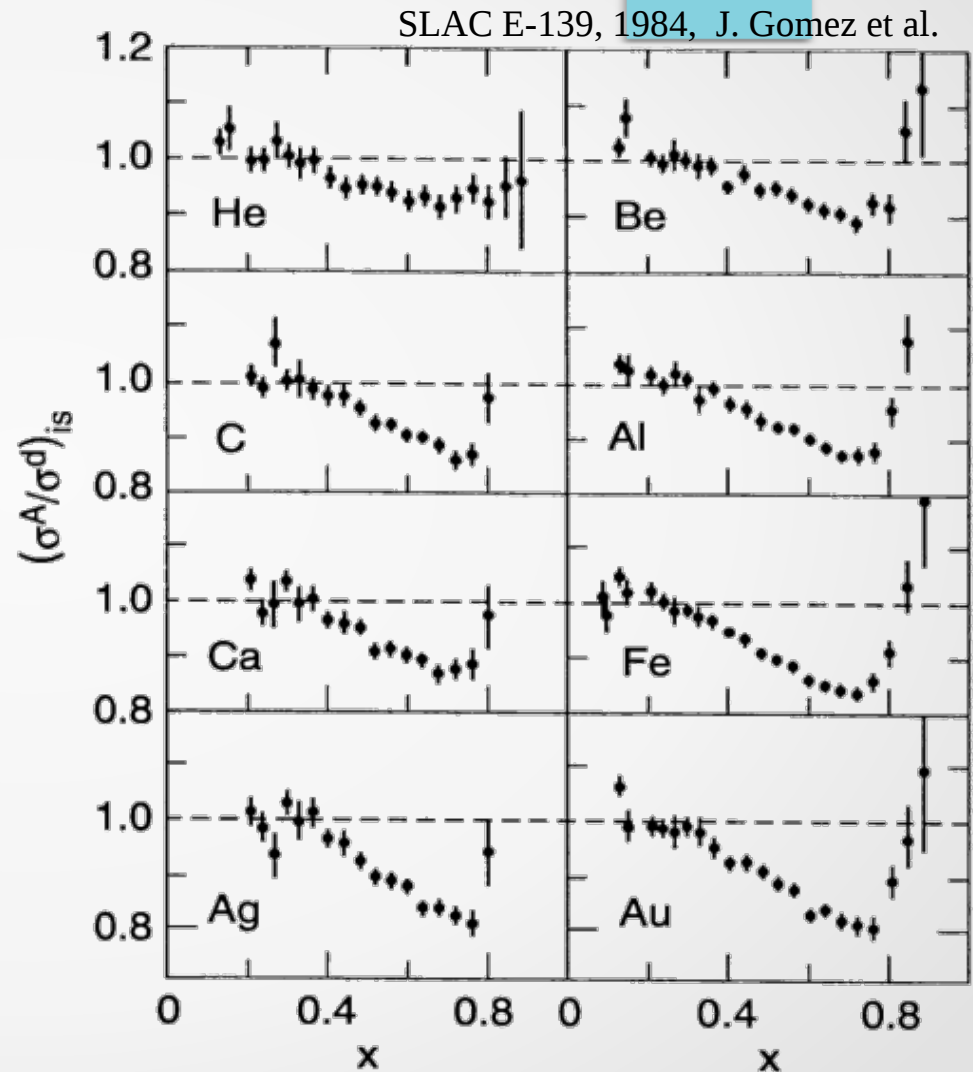
- European Muon Collaboration
- EMC effect ($.3 - .7 X_B$)



MARATHON (E12-10-103)

Use Tritium and ^3He , two mirror nuclei:

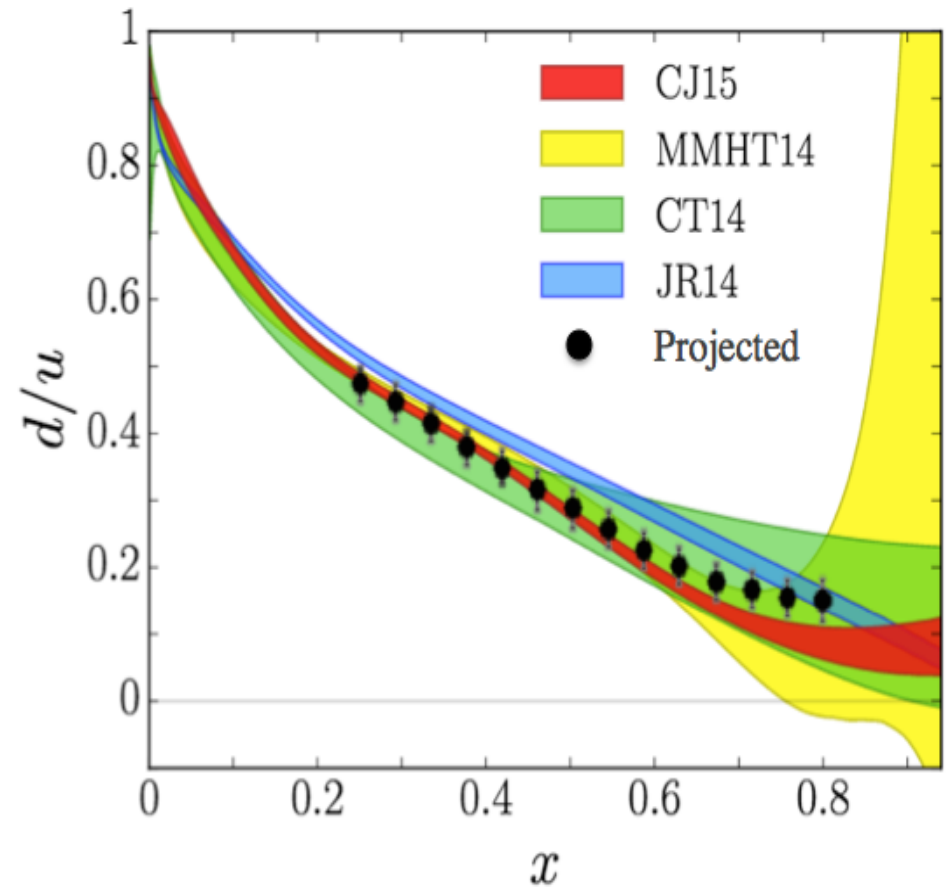
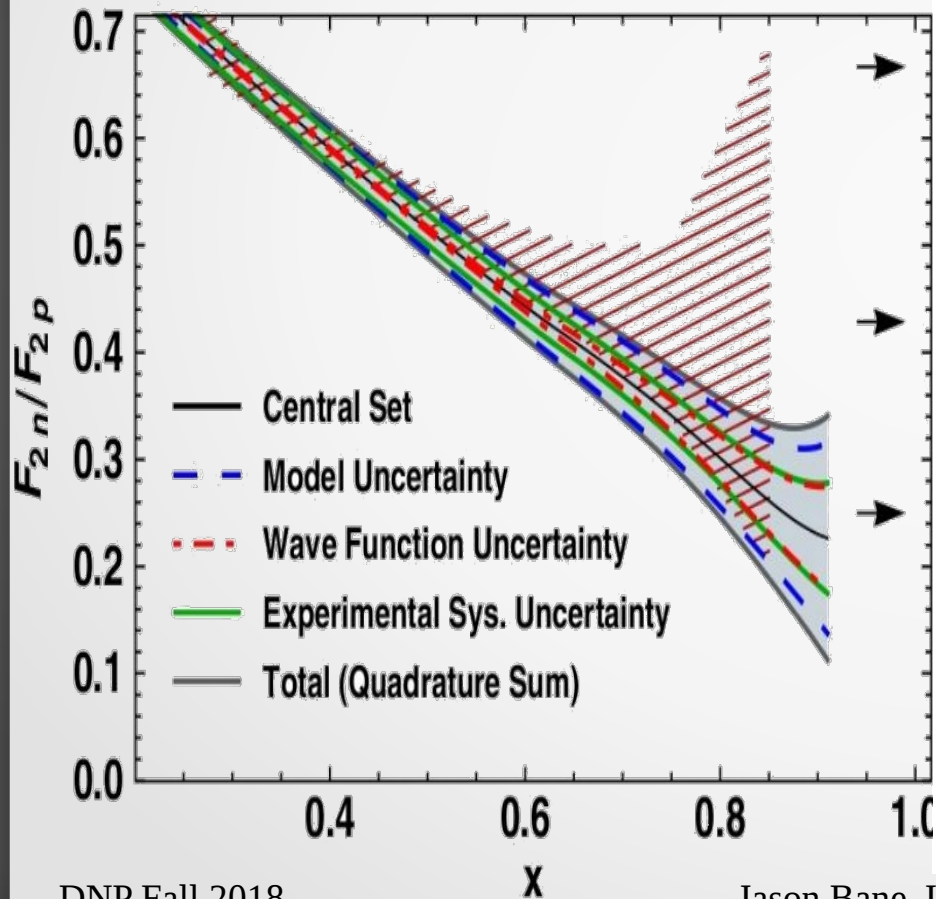
- EMC effect for $A=3$
 - Isospin dependence
- F_{2N}/F_{2P} ratio
- d/u quark distribution ratio.



MARATHON (E12-10-103)

$$\sigma \propto F_2(x, Q^2) \xrightarrow{\text{Parton Model}} F_2(x) = x \sum e_i^2 (q_i(x) + \bar{q}_i(x)) \quad \frac{F_2^n}{F_2^p} = \frac{1 + 4(d/u)}{4 + (d/u)}$$

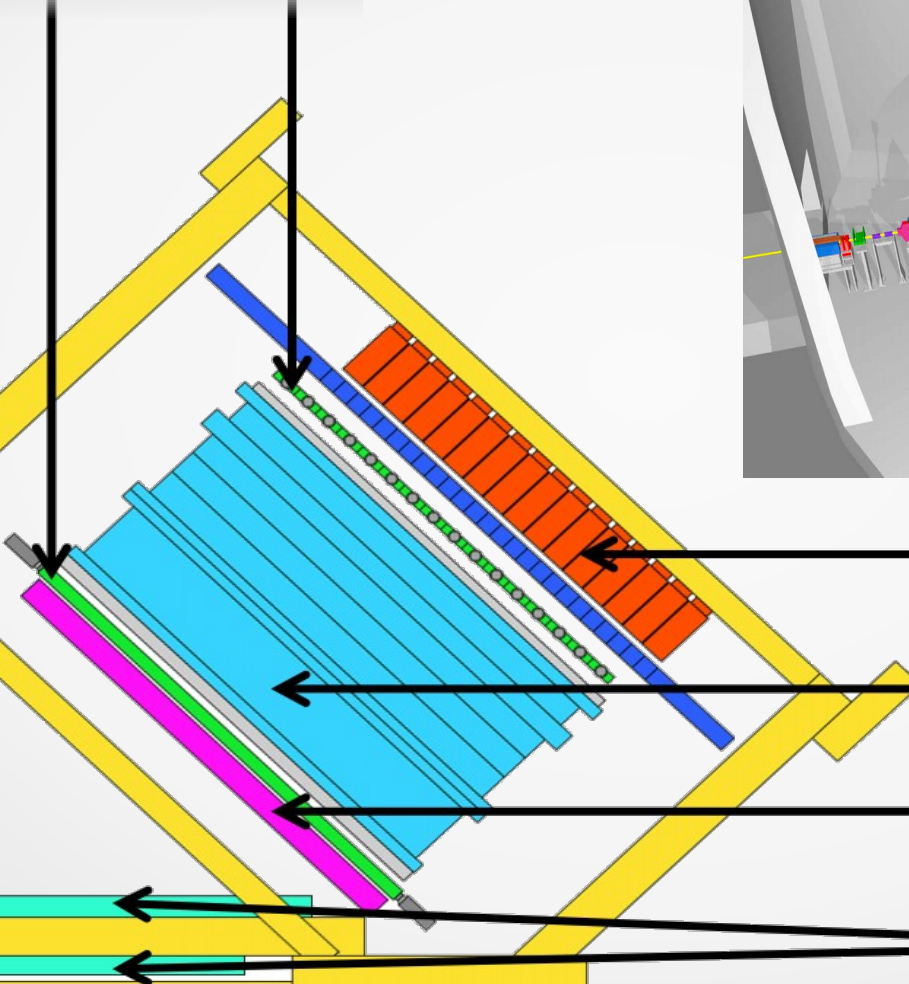
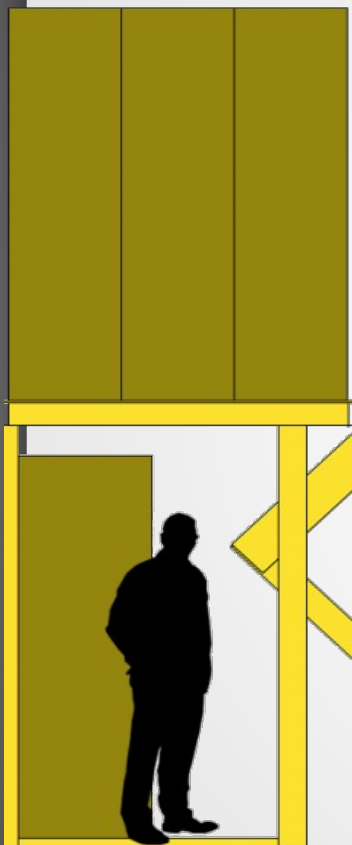
Arrington et al. PRL 108, 252001 (2012)



Mike Nycz, 2017

Hall A HRSs

Scintillator

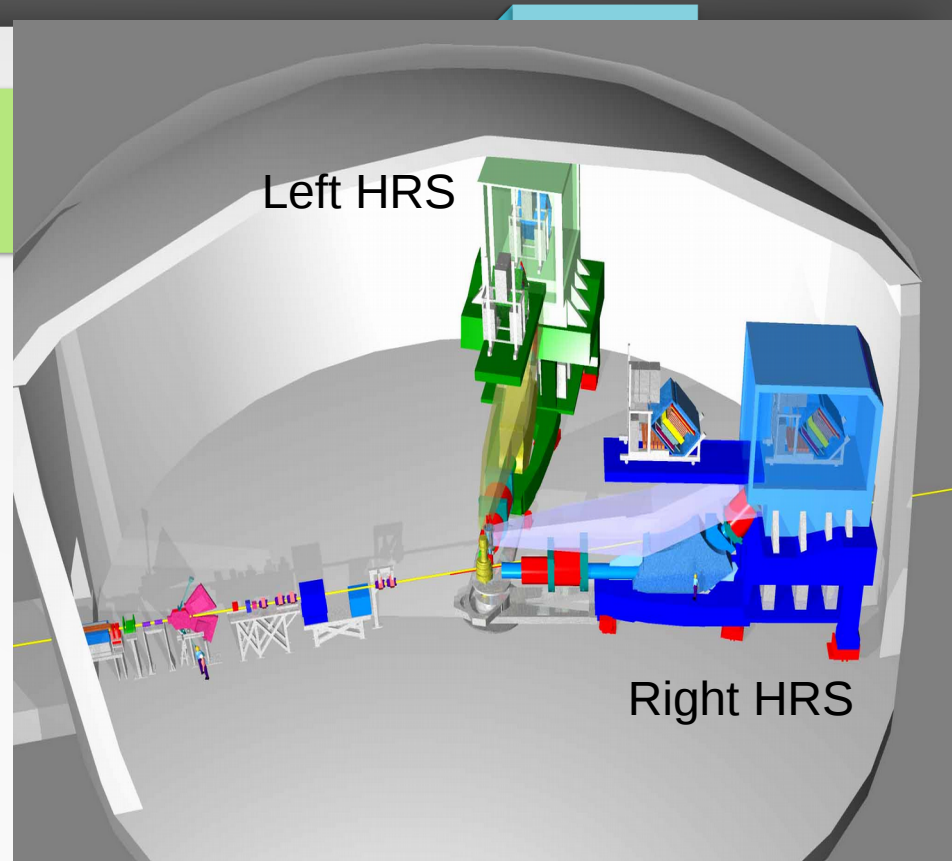


Lead-Glass Calorimeter

Gas Cherenkov

Straw Chamber

VDC

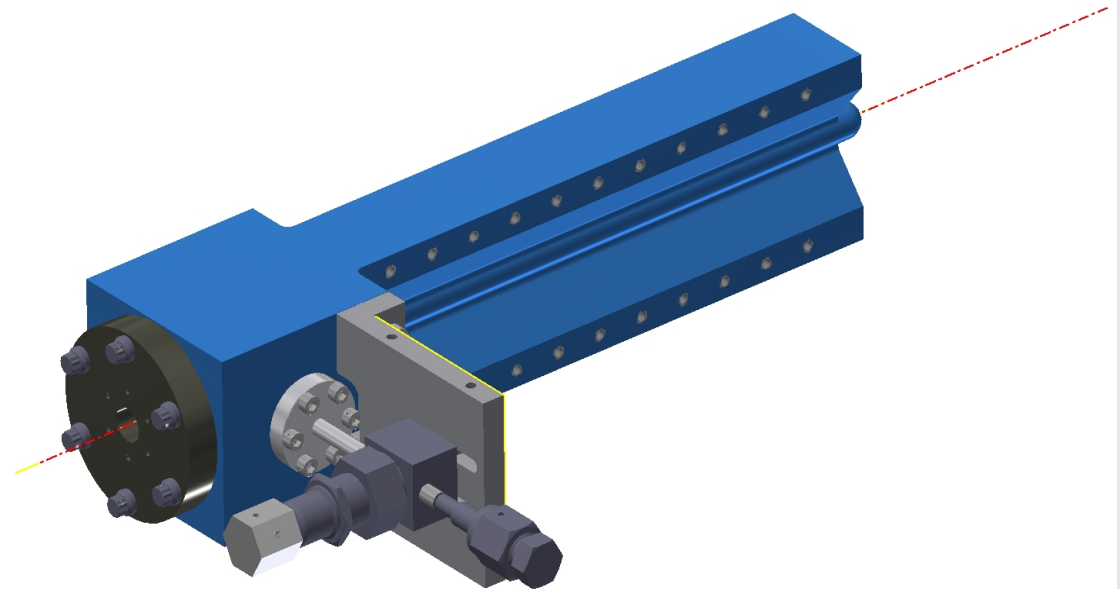


Left HRS

Right HRS

Tritium Target

- Tritium Target specs
 - 1090 Ci of T₂ (0.1 g)
 - ~200 psi at 295K
 - 25 cm long
 - ID of 12.7mm
 - Volume = 34 cc
 - Aluminum CF seals
 - Cell is “sealed”
 - No re-circulation
 - JLAB does not “handle” the T₂ gas



MARATHON Kinematic Table

Kinematic name	Scatter Momentum	Scatter Angle	X-bjorken	W (GeV)	Q2 (Gev ² /c ²)	Beam on Tritium (Charge uC)*
1	3.10	17.58	0.21	3.57	3.07	1.47E+07
2	3.10	19.12	0.24	3.49	3.62	2.22E+07
3	3.10	20.58	0.28	3.41	4.19	2.78E+07
4	3.10	21.93	0.32	3.33	4.76	2.66E+07
5	3.10	23.21	0.36	3.24	5.32	2.47E+07
7	3.10	25.29	0.42	3.08	6.30	3.06E+07
9	3.10	27.78	0.51	2.87	7.57	7.02E+07
11	3.10	29.82	0.59	2.67	8.70	1.11E+08
13	3.10	31.73	0.66	2.45	9.82	2.87E+08
15	3.10	33.56	0.74	2.20	10.96	7.24E+08
16	3.10	36.12	0.85	1.78	12.63	1.10E+09

* This only includes first pass of a kinematic.

Good Electron Count

Before Transformer Failure

kinematic	^3H	^3He	^2D
0	-	-	-
1	235k	206k	178k
2	228k	207k	206k
3	192k	130k	227k
4	-	-	-
5	74k	74k	47k
7	42k	48k	45k
9	44k	44k	43k
11	35k	36k	38k
13	34k	34k	34k
15	38k	38k	33k
16	17k	18k	17k

After Transformer Replacement

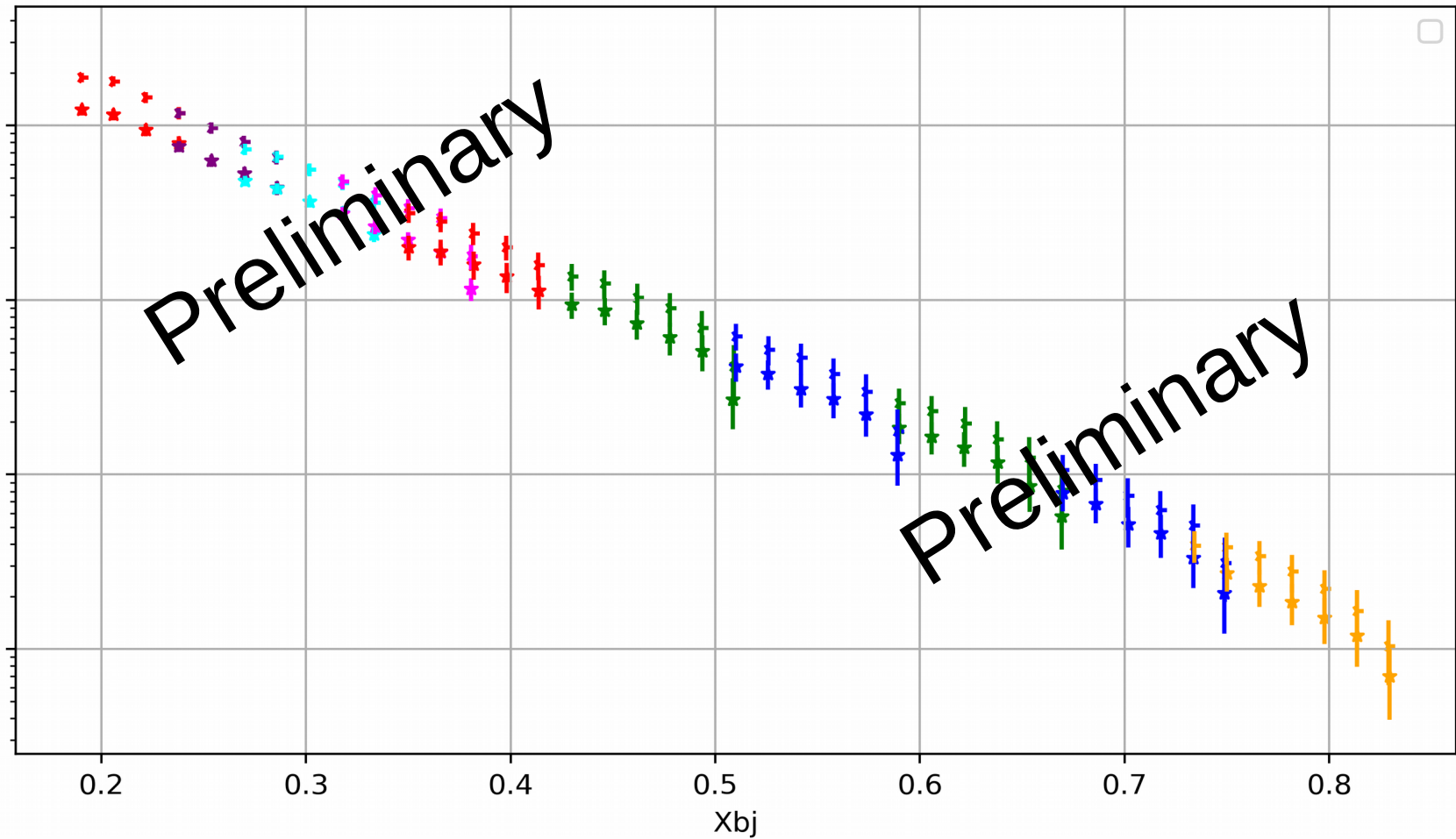
kinematic	^3H	^3He	^2D
0	>200k	>200k	>200k
1	-	-	-
2	-	-	-
3	-	-	-
4	>100k	>100k	>100k
5	-	-	-
7	>29k	>22k	>24k
9	>18k	>19k	>21k
11	-	-	-
13	-	-	-
15	-	-	-
16	>2k	>2k	>1.8k

Error Budget!

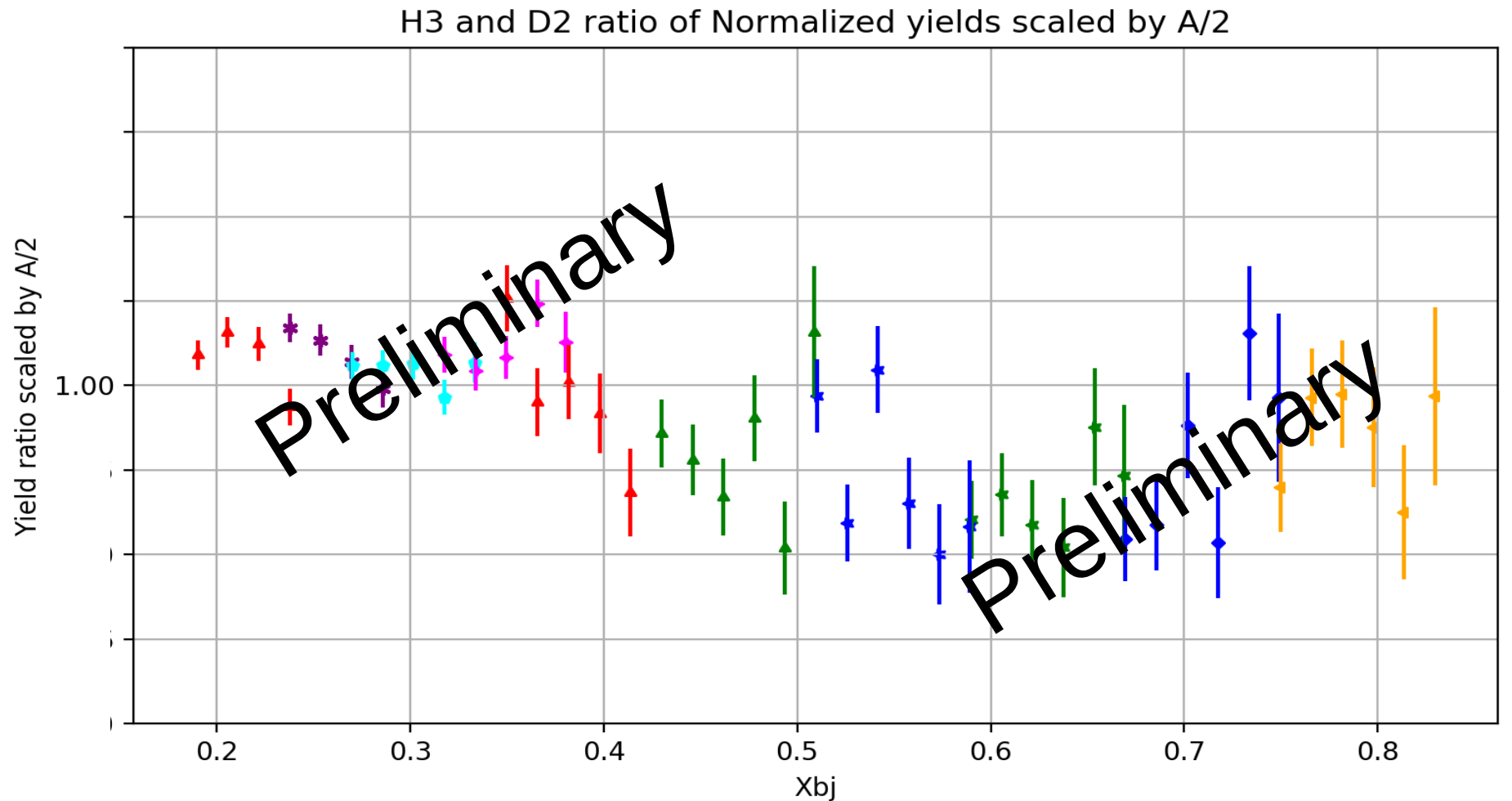
- Dominant source of error
- Statistical: for the larger angle it is possible to drop to less than 1000 events per bin increasing the error to greater than 1%
- Systematic
 - Target Thickness: The tritium target cell was filled off site, with 1% uncertainty.
 - Beam Current measurement: Estimated 1% error at lower current.

Normalized Yields

H3 and D2 Luminosity Normalized yields



Normalized Yield Ratios!



Applied Corrections

- DAQ Deadtime
- Charge symmetric Back ground *
- EndCap contamination from Aluminum end cap *
- Density Correction for modification of target density due to beam heating. *
- Radiative corrections using Bodek fits

* Thanks to the other students of the Tritium Collaboration

Still to work on

- Things that still need to be looked at.
 - Correction error contribution:
 - End cap contamination
 - Charge symmetric back ground
 - Monte carlo studies
 - Acceptance corrections
 - Bin centering corrections
 - Radiative effects error contributions