MARATHON Rate Estimations

John Arrington, Zhihong Ye
ANL

November 9, 2015

1 Introduction

In this reports, we redo the calculation of rates and beam times of the MARATHON experiment with its default settings given in the updated proposal. We also presents the estimation with the optimized settings which pushes the W^2 down to lower values. The detail conditions used in the calculation are indicated in the captions, and also are summarized in the next section.

Table 1 and Table 2 give the ^3H and ^3He cross-sections and rates comparison between Makis's calculation and our calculations with conditions given below. x_b^{avg} and σ_{avg} are the average values of x_b and cross sections for all Monte-Carlo events within one bin. For BigBite, we list two rates, one of which is the total rate with the momentum acceptance from 1 GeV to 11 GeV. The other number, given after the "/" sign, is the rate with the momentum cut, $|\Delta\delta P| < 4.5\%$, which selects the best physics events. The window rate are also given as a reference and it has no $|\Delta\delta P| < 4.5\%$ cut as we are interested in the total rates. Doug told me that the BigBite acceptance is not uniform but decreases when the momentum increasing. Hence, this rate is over-estimated by not considering the acceptance effect.

Table 3 summarizes the rates and beam-times for ^2H, ^3H and ^3He with the default settings and the new experimental conditions.The $|\Delta\delta P| < 4.5\%$ cut is applied on BigBite. If we take out BigBite and use only one HRS, the rates and beam-times are given in Table 4 with the same conditions.

Table 5 has the same settings as Table 4 but takes into account the 10% acceptance reduction because of using SOS and the 15 cm effective target length that the HRS can only cover at moderate large angles. On top of the settings applied in Table 5, Table 6 gives the rates and beam-time after including the 20% radiative effect and 20% overall detector efficiencies and dead-time.

Table 7 lists the optimized settings, by fixing the HRS central momentum at 4 GeV/c, and changing the angles to obtain the desire x_b values. The highest x_b point remains as the same. The values of W^2 are smaller than ones used in the default settings. Table 7 is the same as Table 8 but replacing the cross section model from F2ALLM97 to F1F2IN09.

2 Experimental conditions

The experimental conditions for this rate estimation are listed here:

- The acceptance range of the HRS is:

  $$|\delta P| < 0.045,\ |\theta_{tg}| < 0.045\ rad,\ and\ |\phi_{tg}| < 0.032\ rad.$$

  Hence, the total phase-space is $P_0(2 \cdot 0.045) \times (2 \cdot 0.045) \times (2 \cdot 0.032)\ GeV \cdot sr$.

- The acceptance range of the BigBite is:

  $$1 < E' < 11\ GeV/c,\ |\theta_{tg}| < 0.17\ rad,\ and\ |\phi_{tg}| < 0.08\ rad.$$

  Hence, the total phase-space is $(11-1) \times (2 \cdot 0.17) \times (2 \cdot 0.08)\ GeV \cdot sr$. When calculating physics rate, I applied a $|\Delta\delta P| < 4.5\%$ cut.

- The full target length length of 25 cm is used in Table 1 to Table 4. An effective target length (15 cm) for the HRS is used from Table 5 to to Table 8.

- The beam current for ^{2}H is 20 uA, and its density is 0.00496 g/cm^3. The target luminosity of ^{2}H is $2.80 \times 10^{36}\ cm^{-2}s^{-1}$.

- The beam current for ^{3}H is 20 uA, and its density is 0.00324 g/cm^3. The target luminosity of ^{3}H is $1.22 \times 10^{36}\ cm^{-2}s^{-1}$.

- The beam current for ^{3}He is 25 uA, and its density is 0.00372 g/cm^2. The target luminosity of ^{3}He is 1.75×10^{36} $cm^{-2}s^{-1}$.
- A DIS cut, $W^2 > 4.0$ GeV^2, is used to select events when estimating rates. For $x > 0.75$, the cut is reduced to $W^2 > 3.0$ GeV^2.
- The beam-time is estimated by assuming we need at lease 25K events for each x point.
- The cross section model is calculated with F2. Three models are available now: Eric Christy and Peter Bosted's F1F2IN09 fit, F2ALLM97 and CTEQ-JLab. Current I only use F2ALLM97 here.
  - F1F2IN09 provides F_2^p, F_2^n and F_2^d. It works well at low Q^2. When $Q^2 >\sim 10$ GeV^2, F_2^d becomes negative.
  - F2ALLM97 only provides F_2^p. I used John's R_{np} curve to get F_2^n. It agrees very well with the world data at high Q^2. It doesn't agree with the CLAS6 data at 0.8 GeV^2.
  - CTEQ-JLab (CJ) only provides PDFs. I simply obtained F2 from u, d and s with their charges. There is not any corrections included. I used it to cross check with other models.

3 Conclusions

The following table summarizes the total beam-time in days for different settings given in Table 3 through Table 7. The first row gives the original values in the proposal, while rest of numbers are based on new calculation. New experimental conditions are given in the previous section. The numbers in the brackets are the beam-time after removing the highest x_b point.

Experimental Settings	Total Beam-Time (Days)	Total Beam-Time w/o $x_b = 0.87$ (Days)
HRS+BB with default Setting (from the proposal)	43	35
HRS+BB with default Setting and no Corrections (Table 3)	20	16
two HRS with default Setting and no Corrections (Table 4)	132	96
two HRSs with default Setting(Table 5) and SOS+Target-Length Corrections	244	177
two HRS with default Setting and all corrections (Table 6)	381	276
two HRS with low W^2 Settings (Table 7)	116	11

4 Rate Tables

Table 1: ^3H Cross Section and Rates for d/u Extraction BB and HRS. Makis's calculations are also given here for comparing. F2ALLM97 model is used. A $W^2 > 4$ cut is applied when calculating the rate ($W^2 > 3$ when x>0.75). $|\Delta\delta P| < 4.5\%$ cut is applied on BigBite. 25 cm Target Length is used for both BB and HRS. Set the minimum hour to be 1. The window rate has no momentum cut.

	x_{bj} ($x_{bj^{avg}}$)	W^2 (GeV)	E' (GeV)	θ (Deg)	σ_{old} (nb/sr /GeV)	σ_{new} (nb/sr /GeV)	σ_{avg} (nb/sr /GeV)	old rate Hz(Hour)	new rate &Hour Hz(Hour) (δP+/-4.5%)	window rate Hz
BB	0.87(0.80)	3.10	2.07	47.10	0.0050	0.0031	0.0151	0.09(80.39)	17.01(1.00)/ 0.15(45.27)	33.38
BB	0.83(0.80)	3.87	1.48	57.10	0.0055	0.0035	0.0084	0.07(95.06)	2.07(3.35)/ 0.08(82.44)	4.18
BB	0.79(0.78)	4.71	1.41	57.10	0.0093	0.0072	0.0116	0.12(56.95)	2.08(3.34)/ 0.14(48.72)	4.20
BB	0.75(0.75)	5.25	1.58	51.90	0.0188	0.0147	0.0211	0.28(24.51)	6.65(1.04)/ 0.31(22.22)	13.22
BB	0.71(0.72)	6.07	1.50	51.90	0.0285	0.0249	0.0311	0.43(16.22)	6.64(1.05)/ 0.46(14.98)	13.21
BB	0.67(0.68)	6.66	1.67	47.10	0.0537	0.0482	0.0583	0.92(7.54)	17.19(1.00)/ 0.97(7.17)	33.74
BB	0.63(0.64)	7.22	1.90	42.00	0.1030	0.0970	0.1154	2.04(3.40)	45.93(1.00)/ 2.18(3.18)	89.03
BB	0.59(0.60)	7.97	1.80	42.00	0.1430	0.1355	0.1553	2.83(2.46)	44.55(1.00)/ 2.78(2.50)	86.40
HRS	0.55(0.55)	6.78	4.00	23.40	1.2700	1.2185	1.3131	5.72(1.21)	5.53(1.26)	10.97
HRS	0.51(0.51)	7.32	4.00	22.50	1.8500	1.8048	1.9230	8.58(1.00)	8.10(1.00)	15.94
HRS	0.47(0.47)	7.84	4.00	21.60	2.6700	2.6077	2.7504	12.77(1.00)	11.59(1.00)	22.63
HRS	0.43(0.43)	8.39	4.00	20.60	3.8300	3.8353	4.0305	18.90(1.00)	16.98(1.00)	32.89
HRS	0.39(0.39)	8.92	4.00	19.60	5.4800	5.5348	5.7825	27.92(1.00)	24.36(1.00)	46.84
HRS	0.35(0.35)	9.42	4.00	18.60	7.8500	7.8730	8.2055	41.31(1.00)	34.57(1.00)	65.98
HRS	0.31(0.31)	9.94	4.00	17.50	11.3000	11.4629	11.8926	61.39(1.00)	50.10(1.00)	94.93
HRS	0.27(0.27)	10.48	4.00	16.30	16.6000	17.1169	17.7857	93.03(1.00)	74.93(1.00)	140.87
HRS	0.23(0.23)	10.98	4.00	15.10	24.8000	25.4656	26.4487	143.31(1.00)	111.43(1.00)	207.97
HRS	0.23(0.23)	10.98	4.00	15.10	24.8000	25.4656	26.3886	143.31(1.00)	111.18(1.00)	207.50
								12 Days	10 Days	

Table 2: ^3He Cross Section and Rates for d/u Extraction BB and HRS. Makis's calculations are also given here for comparing. F2ALLM97 model is used. A $W^2 > 4$ cut is applied when calculating the rate ($W^2 > 3$ when x>0.75). $|\Delta\delta P| < 4.5\%$ cut is applied on BigBite. 25 cm Target Length is used for both BB and HRS. Set the minimum hour to be 1. The window rate has no momentum cut.

	x_{bj} ($x_{bj^{avg}}$)	W^2 (GeV)	E' (GeV)	θ (Deg)	σ_{old} (nb/sr /GeV)	σ_{new} (nb/sr /GeV)	σ_{avg} (nb/sr /GeV)	old rate Hz(Hour)	new rate &Hour Hz(Hour) (δP+/-4.5%)	window rate Hz
BB	0.87(0.80)	3.10	2.07	47.10	0.0058	0.0047	0.0214	0.13(54.47)	30.11(1.00)/ 0.31(22.35)	41.73
BB	0.83(0.80)	3.87	1.48	57.10	0.0067	0.0052	0.0119	0.11(61.12)	3.88(1.79)/ 0.17(40.71)	5.23
BB	0.79(0.78)	4.71	1.41	57.10	0.0117	0.0103	0.0160	0.20(35.06)	3.90(1.78)/ 0.28(24.46)	5.25
BB	0.75(0.75)	5.25	1.58	51.90	0.0242	0.0207	0.0288	0.47(14.87)	12.08(1.00)/ 0.61(11.35)	16.52
BB	0.71(0.72)	6.07	1.50	51.90	0.0370	0.0341	0.0417	0.71(9.76)	12.07(1.00)/ 0.89(7.78)	16.51
BB	0.67(0.68)	6.66	1.67	47.10	0.0698	0.0649	0.0768	1.53(4.53)	30.45(1.00)/ 1.83(3.79)	42.18
BB	0.63(0.64)	7.22	1.90	42.00	0.1340	0.1279	0.1492	3.40(2.04)	79.32(1.00)/ 4.05(1.72)	111.29
BB	0.59(0.60)	7.97	1.80	42.00	0.1830	0.1755	0.1978	4.63(1.50)	77.01(1.00)/ 5.08(1.37)	108.00
HRS	0.55(0.55)	6.78	4.00	23.40	1.6000	1.5484	1.6545	9.22(1.00)	10.00(1.00)	13.71
HRS	0.51(0.51)	7.32	4.00	22.50	2.3100	2.2542	2.3844	13.71(1.00)	14.42(1.00)	19.92
HRS	0.47(0.47)	7.84	4.00	21.60	3.2800	3.2048	3.3589	20.08(1.00)	20.31(1.00)	28.28
HRS	0.43(0.43)	8.39	4.00	20.60	4.6400	4.6342	4.8426	29.31(1.00)	29.28(1.00)	41.11
HRS	0.39(0.39)	8.92	4.00	19.60	6.5200	6.5811	6.8416	42.50(1.00)	41.37(1.00)	58.54
HRS	0.35(0.35)	9.42	4.00	18.60	9.1800	9.2193	9.5655	61.83(1.00)	57.84(1.00)	82.48
HRS	0.31(0.31)	9.94	4.00	17.50	13.0000	13.2101	13.6513	90.39(1.00)	82.54(1.00)	118.66
HRS	0.27(0.27)	10.48	4.00	16.30	18.7000	19.4021	20.0869	134.14(1.00)	121.46(1.00)	176.09
HRS	0.23(0.23)	10.98	4.00	15.10	27.5000	28.4160	29.4152	203.39(1.00)	177.86(1.00)	259.96
HRS	0.23(0.23)	10.98	4.00	15.10	27.5000	28.4160	29.3496	203.39(1.00)	177.46(1.00)	259.38
								8 Days	5 Days	

Table 3: ^2H, ^3H and ^3He Cross Section and Rates for d/u Extraction with BigBite and HRS. F2ALLM97 model is used. A $W^2 > 4$ cut is applied when calculating the rate ($W^2 > 3$ when x>0.75). 25 cm target length is used. A $|\Delta\delta P| < 4.5\%$ cut is applied on BigBite. No other corrections.

	x_{bj} ($x_{bj^{avg}}$)	W^2 (GeV^2)	Q^2 (GeV^2)	E' (GeV)	θ (Deg)	σ_{H2} (nb/s /GeV)	σ_{H3} (nb/sr /GeV)	σ_{He3} (nb/sr /GeV)	H2 Rate &Hour Hz(Hour)	H3 Rate &Hour Hz(Hour)	He3 Rate &Hour Hz(Hour)	Total Hour
BB	0.87(0.80)	3.10	14.54	2.07	47.10	0.0122	0.0152	0.0215	0.284(24.42)	0.154(45.07)	0.312(22.25)	91.74
BB	0.83(0.80)	3.87	14.87	1.48	57.10	0.0068	0.0085	0.0119	0.157(44.19)	0.085(81.54)	0.172(40.28)	166.01
BB	0.79(0.78)	4.71	14.17	1.41	57.10	0.0092	0.0116	0.0160	0.261(26.63)	0.143(48.67)	0.284(24.43)	99.73
BB	0.75(0.75)	5.25	13.31	1.58	51.90	0.0166	0.0211	0.0288	0.566(12.26)	0.313(22.19)	0.613(11.33)	45.78
BB	0.71(0.72)	6.07	12.64	1.50	51.90	0.0241	0.0309	0.0415	0.827(8.39)	0.462(15.05)	0.889(7.81)	31.26
BB	0.67(0.68)	6.66	11.73	1.67	47.10	0.0452	0.0585	0.0771	1.724(4.03)	0.972(7.14)	1.838(3.78)	14.95
BB	0.63(0.64)	7.22	10.74	1.90	42.00	0.0883	0.1156	0.1494	3.834(1.81)	2.185(3.18)	4.053(1.71)	6.70
BB	0.59(0.60)	7.97	10.17	1.80	42.00	0.1175	0.1550	0.1975	4.831(1.44)	2.775(2.50)	5.075(1.37)	5.31
HRS	0.55(0.55)	6.78	7.24	4.00	23.40	0.9892	1.3132	1.6545	9.570(0.73)	5.533(1.26)	10.004(0.69)	2.68
HRS	0.51(0.51)	7.32	6.70	4.00	22.50	1.4381	1.9261	2.3880	13.912(0.50)	8.115(0.86)	14.439(0.48)	1.84
HRS	0.47(0.47)	7.84	6.18	4.00	21.60	2.0461	2.7637	3.3745	19.795(0.35)	11.644(0.60)	20.404(0.34)	1.29
HRS	0.43(0.43)	8.39	5.63	4.00	20.60	2.9643	4.0396	4.8532	28.677(0.24)	17.019(0.41)	29.345(0.24)	0.89
HRS	0.39(0.39)	8.92	5.10	4.00	19.60	4.2087	5.7835	6.8427	40.717(0.17)	24.366(0.29)	41.374(0.17)	0.62
HRS	0.35(0.35)	9.42	4.60	4.00	18.60	5.9148	8.1928	9.5517	57.222(0.12)	34.516(0.20)	57.754(0.12)	0.44
HRS	0.31(0.31)	9.94	4.07	4.00	17.50	8.5343	11.9206	13.6823	82.564(0.08)	50.222(0.14)	82.730(0.08)	0.31
HRS	0.27(0.27)	10.48	3.54	4.00	16.30	12.5903	17.7371	20.0337	121.803(0.06)	74.727(0.09)	121.134(0.06)	0.21
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	18.6173	26.4431	29.4087	180.110(0.04)	111.406(0.06)	177.819(0.04)	0.14
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	18.5719	26.3774	29.3383	179.672(0.04)	111.129(0.06)	177.394(0.04)	0.14
											Total Days	20 (16)

Table 4: ^2H, ^3H and ^3He Cross Section and Rates for d/u Extraction with **only one HRS**. F2ALLM97 model is used. A $W^2 > 4$ cut is applied when calculating the rate ($W^2 > 3$ when x>0.75). 25 cm target length is used. No other corrections.

	x_{bj} ($x_{bj^{avg}}$)	W^2 (GeV^2)	Q^2 (GeV^2)	E' (GeV)	θ (Deg)	σ_{H2} (nb/s /GeV)	σ_{H3} (nb/sr /GeV)	σ_{He3} (nb/sr /GeV)	H2 Rate &Hour Hz(Hour)	H3 Rate &Hour Hz(Hour)	He3 Rate &Hour Hz(Hour)	Total Hour
HRS	0.87(0.83)	3.10	14.54	2.07	47.10	0.0055	0.0067	0.0098	0.015(466.06)	0.008(876.86)	0.017(419.05)	1761.97
HRS	0.83(0.82)	3.87	14.87	1.48	57.10	0.0037	0.0046	0.0066	0.012(590.68)	0.006(1106.78)	0.013(532.59)	2230.05
HRS	0.79(0.79)	4.71	14.17	1.41	57.10	0.0065	0.0080	0.0114	0.022(315.43)	0.012(583.66)	0.024(286.91)	1186.00
HRS	0.75(0.75)	5.25	13.31	1.58	51.90	0.0128	0.0161	0.0224	0.049(141.63)	0.027(259.27)	0.053(129.82)	530.71
HRS	0.71(0.71)	6.07	12.64	1.50	51.90	0.0208	0.0264	0.0360	0.076(91.91)	0.042(166.23)	0.082(84.99)	343.13
HRS	0.67(0.67)	6.66	11.73	1.67	47.10	0.0397	0.0509	0.0681	0.160(43.35)	0.090(77.54)	0.172(40.41)	161.30
HRS	0.63(0.63)	7.22	10.74	1.90	42.00	0.0784	0.1018	0.1335	0.360(19.27)	0.204(34.10)	0.383(18.12)	71.49
HRS	0.59(0.59)	7.97	10.17	1.80	42.00	0.1074	0.1407	0.1814	0.467(14.85)	0.267(26.03)	0.494(14.07)	54.95
HRS	0.55(0.55)	6.78	7.24	4.00	23.40	0.9874	1.3107	1.6514	9.552(0.73)	5.522(1.26)	9.985(0.70)	2.68
HRS	0.51(0.51)	7.32	6.70	4.00	22.50	1.4341	1.9207	2.3817	13.874(0.50)	8.092(0.86)	14.401(0.48)	1.84
HRS	0.47(0.47)	7.84	6.18	4.00	21.60	2.0441	2.7611	3.3714	19.776(0.35)	11.633(0.60)	20.385(0.34)	1.29
HRS	0.43(0.43)	8.39	5.63	4.00	20.60	2.9578	4.0307	4.8427	28.615(0.24)	16.981(0.41)	29.281(0.24)	0.89
HRS	0.39(0.39)	8.92	5.10	4.00	19.60	4.2103	5.7857	6.8452	40.732(0.17)	24.375(0.28)	41.389(0.17)	0.62
HRS	0.35(0.35)	9.42	4.60	4.00	18.60	5.9258	8.2085	9.5688	57.328(0.12)	34.583(0.20)	57.858(0.12)	0.44
HRS	0.31(0.31)	9.94	4.07	4.00	17.50	8.5483	11.9406	13.7043	82.699(0.08)	50.306(0.14)	82.863(0.08)	0.31
HRS	0.27(0.27)	10.48	3.54	4.00	16.30	12.6292	17.7931	20.0945	122.180(0.06)	74.963(0.09)	121.501(0.06)	0.21
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	18.6281	26.4587	29.4257	180.216(0.04)	111.472(0.06)	177.922(0.04)	0.14
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	18.6296	26.4610	29.4277	180.230(0.04)	111.481(0.06)	177.934(0.04)	0.14
											Total Days	264 (191)

Table 5: ^2H, ^3H and ^3He Cross Section and Rates for d/u Extraction with **only one HRS**. F2ALLM97 model is used. A $W^2 > 4$ cut is applied when calculating the rate ($W^2 > 3$ when x>0.75). 15cm Target Length is used and 10% reduction with SOS is applied.

	x_{bj} ($x_{bj^{avg}}$)	W^2 (GeV^2)	Q^2 (GeV^2)	E' (GeV)	θ (Deg)	σ_{H2} (nb/s /GeV)	σ_{H3} (nb/sr /GeV)	σ_{He3} (nb/sr /GeV)	H2 Rate &Hour Hz(Hour)	H3 Rate &Hour Hz(Hour)	He3 Rate &Hour Hz(Hour)	Total Hour
HRS	0.87(0.83)	3.10	14.54	2.07	47.10	0.0055	0.0067	0.0098	0.008(848.96)	0.004(1597.11)	0.009(763.38)	3209.46
HRS	0.83(0.82)	3.87	14.87	1.48	57.10	0.0037	0.0046	0.0066	0.006(1089.73)	0.003(2041.87)	0.007(982.58)	4114.18
HRS	0.79(0.79)	4.71	14.17	1.41	57.10	0.0064	0.0080	0.0113	0.012(585.25)	0.006(1082.98)	0.013(532.33)	2200.56
HRS	0.75(0.75)	5.25	13.31	1.58	51.90	0.0128	0.0161	0.0224	0.026(262.79)	0.014(481.10)	0.029(240.86)	984.75
HRS	0.71(0.71)	6.07	12.64	1.50	51.90	0.0208	0.0264	0.0360	0.041(170.19)	0.023(307.80)	0.044(157.37)	635.36
HRS	0.67(0.67)	6.66	11.73	1.67	47.10	0.0397	0.0510	0.0682	0.087(80.17)	0.048(143.42)	0.093(74.74)	298.33
HRS	0.63(0.63)	7.22	10.74	1.90	42.00	0.0782	0.1015	0.1332	0.194(35.77)	0.110(63.30)	0.207(33.63)	132.70
HRS	0.59(0.59)	7.97	10.17	1.80	42.00	0.1075	0.1408	0.1816	0.253(27.49)	0.144(48.18)	0.267(26.03)	101.70
HRS	0.55(0.55)	6.78	7.24	4.00	23.40	0.9880	1.3114	1.6524	5.161(1.35)	2.984(2.33)	5.395(1.29)	4.96
HRS	0.51(0.51)	7.32	6.70	4.00	22.50	1.4363	1.9237	2.3851	7.503(0.93)	4.376(1.59)	7.788(0.89)	3.40
HRS	0.47(0.47)	7.84	6.18	4.00	21.60	2.0365	2.7504	3.3590	10.639(0.65)	6.257(1.11)	10.967(0.63)	2.40
HRS	0.43(0.43)	8.39	5.63	4.00	20.60	2.9607	4.0346	4.8474	15.467(0.45)	9.179(0.76)	15.827(0.44)	1.64
HRS	0.39(0.39)	8.92	5.10	4.00	19.60	4.2096	5.7847	6.8442	21.992(0.32)	13.160(0.53)	22.347(0.31)	1.15
HRS	0.35(0.35)	9.42	4.60	4.00	18.60	5.9260	8.2087	9.5693	30.958(0.22)	18.675(0.37)	31.245(0.22)	0.82
HRS	0.31(0.31)	9.94	4.07	4.00	17.50	8.5251	11.9074	13.6678	44.536(0.16)	27.090(0.26)	44.627(0.16)	0.57
HRS	0.27(0.27)	10.48	3.54	4.00	16.30	12.6402	17.8088	20.1118	66.035(0.11)	40.516(0.17)	65.667(0.11)	0.38
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	18.5838	26.3948	29.3567	97.085(0.07)	60.049(0.12)	95.853(0.07)	0.26
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	18.6097	26.4320	29.3971	97.220(0.07)	60.134(0.12)	95.985(0.07)	0.26
											Today Days	487 (353)

Table 6: ^2H, ^3H and ^3He Cross Section and Rates for d/u Extraction with **only one HRS**. A $W^2 > 4$ cut is applied when calculating the rate ($W^2 > 3$ when x>0.75). 15 cm Target Length is used and 10% reduction with SOS is applied. 20% RC effect and 20% total efficiencies are considered. F2ALLM97 model is used.

	x_{bj} ($x_{bj^{avg}}$)	W^2 (GeV^2)	Q^2 (GeV^2)	E' (GeV)	θ (Deg)	σ_{H2} (nb/s /GeV)	σ_{H3} (nb/sr /GeV)	σ_{He3} (nb/sr /GeV)	H2 Rate &Hour Hz(Hour)	H3 Rate &Hour Hz(Hour)	He3 Rate &Hour Hz(Hour)	Total Hour
HRS	0.87(0.83)	3.10	14.54	2.07	47.10	0.0055	0.0067	0.0098	0.005(1336.37)	0.003(2513.97)	0.006(1201.68)	5052.02
HRS	0.83(0.82)	3.87	14.87	1.48	57.10	0.0037	0.0046	0.0066	0.004(1703.08)	0.002(3191.20)	0.005(1535.60)	6429.88
HRS	0.79(0.79)	4.71	14.17	1.41	57.10	0.0065	0.0080	0.0114	0.008(910.67)	0.004(1685.07)	0.008(828.36)	3424.10
HRS	0.75(0.75)	5.25	13.31	1.58	51.90	0.0128	0.0161	0.0224	0.017(409.97)	0.009(750.50)	0.018(375.76)	1536.23
HRS	0.71(0.71)	6.07	12.64	1.50	51.90	0.0208	0.0265	0.0361	0.026(265.75)	0.014(480.64)	0.028(245.74)	992.13
HRS	0.67(0.67)	6.66	11.73	1.67	47.10	0.0396	0.0509	0.0681	0.055(125.47)	0.031(224.48)	0.059(116.96)	466.91
HRS	0.63(0.63)	7.22	10.74	1.90	42.00	0.0785	0.1018	0.1335	0.125(55.73)	0.070(98.61)	0.133(52.39)	206.73
HRS	0.59(0.59)	7.97	10.17	1.80	42.00	0.1075	0.1409	0.1817	0.162(42.92)	0.092(75.22)	0.171(40.64)	158.78
HRS	0.55(0.55)	6.78	7.24	4.00	23.40	0.9902	1.3145	1.6560	3.311(2.10)	1.914(3.63)	3.460(2.01)	7.73
HRS	0.51(0.51)	7.32	6.70	4.00	22.50	1.4411	1.9303	2.3930	4.818(1.44)	2.811(2.47)	5.001(1.39)	5.30
HRS	0.47(0.47)	7.84	6.18	4.00	21.60	2.0394	2.7545	3.3637	6.819(1.02)	4.011(1.73)	7.029(0.99)	3.74
HRS	0.43(0.43)	8.39	5.63	4.00	20.60	2.9613	4.0356	4.8484	9.901(0.70)	5.876(1.18)	10.132(0.69)	2.57
HRS	0.39(0.39)	8.92	5.10	4.00	19.60	4.2110	5.7866	6.8463	14.079(0.49)	8.425(0.82)	14.306(0.49)	1.80
HRS	0.35(0.35)	9.42	4.60	4.00	18.60	5.9278	8.2114	9.5722	19.820(0.35)	11.956(0.58)	20.003(0.35)	1.28
HRS	0.31(0.31)	9.94	4.07	4.00	17.50	8.5294	11.9136	13.6745	28.518(0.24)	17.346(0.40)	28.575(0.24)	0.89
HRS	0.27(0.27)	10.48	3.54	4.00	16.30	12.5998	17.7506	20.0486	42.127(0.16)	25.845(0.27)	41.895(0.17)	0.60
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	18.6111	26.4340	29.3993	62.226(0.11)	38.489(0.18)	61.435(0.11)	0.41
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	18.6398	26.4754	29.4439	62.321(0.11)	38.549(0.18)	61.528(0.11)	0.40
											Total Days	762 (552)

Table 7: ^2H, ^3H and ^3He Cross Section and Rates for d/u Extraction with **only one HRS and optimized kinematic settings**. F2ALLM97 model is used. A $W^2 > 4$ cut is applied when calculating the rate ($W^2 > 3$ when x>0.75). 15cm Target Length is used and 10% reduction with SOS is applied. 20% RC effect and 20% total efficiencies are considered.

	x_{bj} ($x_{bj^{avg}}$)	W^2 (GeV^2)	Q^2 (GeV^2)	E' (GeV)	θ (Deg)	σ_{H2} (nb/s /GeV)	σ_{H3} (nb/sr /GeV)	σ_{He3} (nb/sr /GeV)	H2 Rate &Hour Hz(Hour)	H3 Rate &Hour Hz(Hour)	He3 Rate &Hour Hz(Hour)	Total Hour
HRS	0.87(0.83)	3.10	14.54	2.07	47.10	0.0055	0.0067	0.0098	0.005(1341.22)	0.003(2523.41)	0.006(1205.94)	5070.57
HRS	0.83(0.78)	3.06	10.96	4.00	28.90	0.0709	0.0885	0.1243	0.122(56.87)	0.066(104.69)	0.134(51.91)	213.48
HRS	0.79(0.76)	3.64	10.37	4.00	28.10	0.0995	0.1251	0.1732	0.243(28.57)	0.133(52.14)	0.265(26.24)	106.95
HRS	0.75(0.74)	4.14	9.87	4.00	27.40	0.1377	0.1746	0.2384	0.405(17.14)	0.224(31.04)	0.438(15.84)	64.02
HRS	0.71(0.71)	4.63	9.38	4.00	26.70	0.1957	0.2503	0.3368	0.635(10.94)	0.354(19.64)	0.683(10.17)	40.76
HRS	0.67(0.68)	5.18	8.84	4.00	25.90	0.2990	0.3861	0.5110	1.000(6.95)	0.562(12.35)	1.068(6.50)	25.80
HRS	0.63(0.63)	5.77	8.24	4.00	25.00	0.4752	0.6201	0.8055	1.589(4.37)	0.903(7.69)	1.683(4.13)	16.19
HRS	0.59(0.59)	6.28	7.73	4.00	24.20	0.6937	0.9131	1.1678	2.319(2.99)	1.330(5.22)	2.440(2.85)	11.06
HRS	0.55(0.55)	6.78	7.24	4.00	23.40	0.9882	1.3118	1.6528	3.304(2.10)	1.910(3.64)	3.454(2.01)	7.75
HRS	0.51(0.51)	7.32	6.70	4.00	22.50	1.4408	1.9299	2.3926	4.817(1.44)	2.810(2.47)	5.000(1.39)	5.30
HRS	0.47(0.47)	7.84	6.18	4.00	21.60	2.0411	2.7568	3.3664	6.824(1.02)	4.014(1.73)	7.035(0.99)	3.73
HRS	0.43(0.43)	8.39	5.63	4.00	20.60	2.9564	4.0286	4.8405	9.884(0.70)	5.866(1.18)	10.115(0.69)	2.57
HRS	0.39(0.39)	8.92	5.10	4.00	19.60	4.2046	5.7776	6.8362	14.058(0.49)	8.412(0.83)	14.285(0.49)	1.81
HRS	0.35(0.35)	9.42	4.60	4.00	18.60	5.9170	8.1958	9.5552	19.783(0.35)	11.933(0.58)	19.967(0.35)	1.28
HRS	0.31(0.31)	9.94	4.07	4.00	17.50	8.5229	11.9042	13.6644	28.496(0.24)	17.333(0.40)	28.554(0.24)	0.89
HRS	0.27(0.27)	10.48	3.54	4.00	16.30	12.6176	17.7762	20.0766	42.187(0.16)	25.883(0.27)	41.953(0.17)	0.60
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	18.6214	26.4490	29.4152	62.260(0.11)	38.510(0.18)	61.468(0.11)	0.40
											Total Days	232 (21)

Table 8: ^2H, ^3H and ^3He Cross Section and Rates for d/u Extraction with **only one HRS and optimized kinematic settings**. **F1F2IN09** model is used. A $W^2 > 4$ cut is applied when calculating the rate ($W^2 > 3$ when x>0.75). 15cm Target Length is used and 10% reduction with SOS is applied. 20% RC effect and 20% total efficiencies are considered.

	x_{bj} ($x_{bj^{avg}}$)	W^2 (GeV^2)	Q^2 (GeV^2)	E' (GeV)	θ (Deg)	σ_{H2} (nb/s /GeV)	σ_{H3} (nb/sr /GeV)	σ_{He3} (nb/sr /GeV)	H2 Rate &Hour Hz(Hour)	H3 Rate &Hour Hz(Hour)	He3 Rate &Hour Hz(Hour)	Total Hour
HRS	0.87(0.83)	3.10	14.54	2.07	47.10	0.0000	0.0000	0.0047	0.000(0.00)	0.000(0.00)	0.003(2511.77)	2511.77
HRS	0.83(0.78)	3.06	10.96	4.00	28.90	0.0776	0.1047	0.1287	0.133(52.19)	0.078(88.78)	0.138(50.32)	191.30
HRS	0.79(0.76)	3.64	10.37	4.00	28.10	0.1076	0.1464	0.1782	0.263(26.40)	0.156(44.57)	0.272(25.52)	96.49
HRS	0.75(0.74)	4.14	9.87	4.00	27.40	0.1478	0.2018	0.2441	0.434(15.99)	0.258(26.88)	0.448(15.48)	58.36
HRS	0.71(0.71)	4.63	9.38	4.00	26.70	0.2054	0.2810	0.3403	0.666(10.43)	0.397(17.50)	0.689(10.07)	38.00
HRS	0.67(0.68)	5.18	8.84	4.00	25.90	0.3101	0.4247	0.5157	1.037(6.70)	0.618(11.23)	1.078(6.44)	24.37
HRS	0.63(0.63)	5.77	8.24	4.00	25.00	0.4856	0.6649	0.8099	1.624(4.28)	0.968(7.17)	1.692(4.10)	15.55
HRS	0.59(0.59)	6.28	7.73	4.00	24.20	0.7061	0.9664	1.1789	2.361(2.94)	1.407(4.94)	2.464(2.82)	10.70
HRS	0.55(0.55)	6.78	7.24	4.00	23.40	1.0030	1.3737	1.6737	3.353(2.07)	2.000(3.47)	3.498(1.99)	7.53
HRS	0.51(0.51)	7.32	6.70	4.00	22.50	1.4556	1.9983	2.4227	4.867(1.43)	2.910(2.39)	5.063(1.37)	5.19
HRS	0.47(0.47)	7.84	6.18	4.00	21.60	2.0656	2.8473	3.4227	6.906(1.01)	4.146(1.68)	7.152(0.97)	3.65
HRS	0.43(0.43)	8.39	5.63	4.00	20.60	2.9806	4.1342	4.9057	9.966(0.70)	6.020(1.15)	10.251(0.68)	2.53
HRS	0.39(0.39)	8.92	5.10	4.00	19.60	4.2301	5.9125	6.9060	14.143(0.49)	8.609(0.81)	14.431(0.48)	1.78
HRS	0.35(0.35)	9.42	4.60	4.00	18.60	5.8947	8.3092	9.5381	19.709(0.35)	12.098(0.57)	19.931(0.35)	1.27
HRS	0.31(0.31)	9.94	4.07	4.00	17.50	8.3598	11.8981	13.3890	27.951(0.25)	17.324(0.40)	27.979(0.25)	0.90
HRS	0.27(0.27)	10.48	3.54	4.00	16.30	12.1314	17.4472	19.2124	40.561(0.17)	25.404(0.27)	40.147(0.17)	0.62
HRS	0.23(0.23)	10.98	3.04	4.00	15.10	17.3490	25.1893	27.1898	58.006(0.12)	36.676(0.19)	56.818(0.12)	0.43
											Total Days	124 (19)