Update to Preliminary HMS Run Plans

(M. Commisso Dolph & O. Rondon)

- For parallel field configuration:
  - improved estimate of target effective thickness for pair conversion
  - added 9 mm plastic forward tracker to effective radiator for pair production
    - updated effective radiator for SANE: 0.05 X0 (0.03 X0 without tracker)
  - included reduction of pairs background with pair veto factor:
    - run plan estimates for veto efficiency of **1/3**
  - HMS momentum settings for non-overlapping *hsdelta* intervals
  - previous version: http://hallcweb.jlab.org/experiments/sane/rondon/snbkgd3-sdd.pdf
- For 80° field configuration:
  - estimate of run times to measure low ***x*** pair background asymmetry at HMS angle of 23° for 5% (relative) pair background systematic error.
  - errors for measuring $P_{beam} P_{target}$ using coincidence elastic asymmetry

Effective Radiator for Pair Conversion

- Use eg1b parameterization of pair rates
- eg1b effective radiator:
  - $0.014\,X_0 = z_{CLAS}\,(7/9)\,X_0$ + ½ Dalitz
- Hall C effective radiator (**HMS**):
  - $0.050\,X_0 = z_{HMS}\,(7/9)\,X_0$ + ½ Dalitz
- Solve backgrnd. dilution $f_{CLAS}(E')$ for e^+_{CLAS}
  - $R_{HMS/CLAS}$=0.050/0.014
  - v = 1 - veto efficiency factor
  - $\boldsymbol{f_{HMS}(E') = R_{H/C} f_C / [1 + f_C(R_{H/C} - 1)]}$
  - $\boldsymbol{f_{SANE}(E') = 2vR_{H/C} f_C / [1 + f_C(2vR_{H/C} - 1)]}$

Material before Cherenkov	g/cm²	X0
½ Target cell (0.6 p.f.)	0.781	0.021
Target windows**	0.195	0.008
Cherenkov windows	0.076	0.002
Cherenkov gas	0.156	0.004
Forward tracker (9 mm)	0.929	0.021
Sub Total	1.207	0.057

Trigger: Cherenkov*BigCal

** For 80˚ run

Preliminary HMS Parallel Run Plan

- Measure background ***f*** during parallel run
- HMS DIS rates from *RSS*'s montecarlo: 1 GeV ≤ *E*' ≤ 2.2 GeV and 32°, 40°, 48°
  - rates for |*hsdelta*| ≤ 8%
  - momentum settings for non-overlaping *hsdelta* intervals
- Convert to pair rates using Vipuli D.'s eg1b parameterization
- Compute run times for 5% pair background systematic error
- Reduce pair background by a 1/3 pair veto efficiency factor

E = 5.7 GeV θ = 40° **Goal dA / A = 5%**

E' GeV	fCLAS	fSANE	fHMS	e- rate Hz	e+ rate Hz	de+/e+ (dfS/fS)	time e+ [h]	de-/e-	time e- [h]	dA_bg /A	dfS / fS
1.0	0.20	0.54	0.47	0.860	0.769	2%	0.9	4%	0.2	4%	2%
1.2	0.13	0.41	0.34	0.852	0.437	3%	0.7	5%	0.1	7%	3%
1.4	0.08	0.29	0.23	0.705	0.215	5%	0.6	6%	0.1	11%	5%
1.7	0.04	0.16	0.13	0.460	0.067	9%	0.5	11%	0.1	23%	12%
1.9	0.02	0.11	0.08	0.279	0.025	14%	0.5	16%	0.04	37%	19%

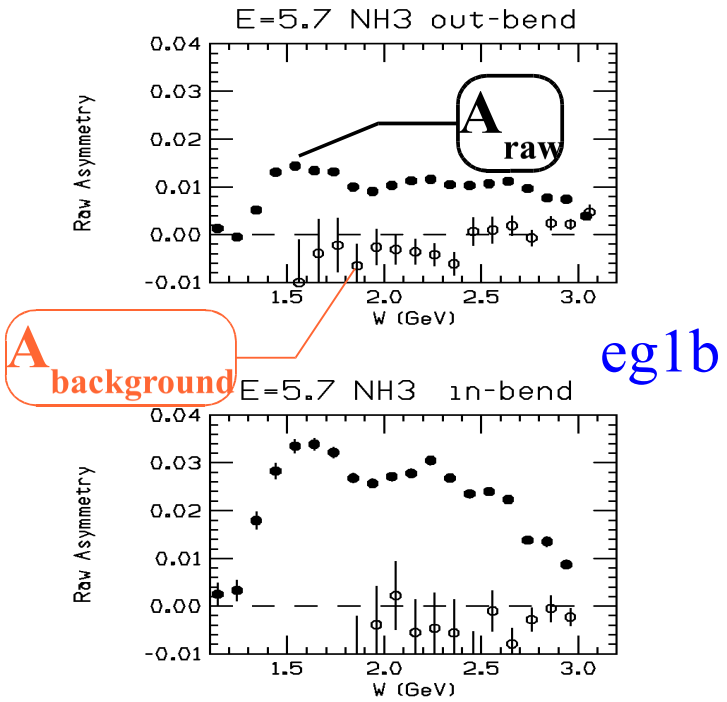
Preliminary HMS Parallel Run Plans

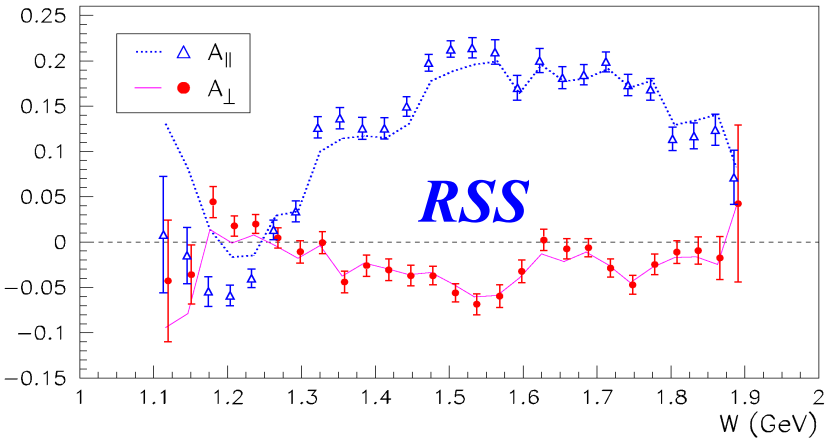
- Proposal for ***f*** during ***parallel*** run:
  - measure three angles during 4.6 GeV run: 34 h including overhead
  - measure three angles during 5.7 GeV run: 70 h including overhead
- Measure pair asymmetry at 40° at each energy: plan TBD
- Measure packing fractions: plan TBD

Summary of times		(FWD. TRCKR.)	
E	θ	**e+ h**	**e- h**
4.6 GeV	32˚	0.4	0.1
	40˚	2	0.4
	48˚	19	3
Total data time 4.6 GeV		22	4
Overhead		4	4
Momentum changes		15	
Time in main run plan [PAC h]		72	
5.7 GeV	32˚	1	0.1
	40˚	3	1
	48˚	51	7
Total data time 5.7 GeV		55	7
Overhead		4	4
Momentum changes		15	
Time in main run plan [PAC h]		120	
Time/ mom. change[h]		0.20	
Angle changes		3	
Time/ angle change[h]		0.25	

Background Asymmetry at 80°

- Parallel pair asymmetry A_b measured in eg1b < ~20% of DIS **A**
- Uncertainty in asymmetry < ~ 100%
- SANE asymmetry
  - $\mathbf{A_m \approx A_{DIS} f P_{beam} P_{target} = A}$
    - $\mathbf{A = (A_m - A_b f_b) / (1 - f_b)}$
  - Parallel SANE $\mathbf{A_m}$ ~ eg1b $\mathbf{A_m}$
  - 80° $\mathbf{A_m}$ < ~ 1/3 parallel $\mathbf{A_m}$
- Background 80° A_b ≤ parallel A_b
  - conservative assumption: equal
  - A_b/80° $\mathbf{A_m}$ **>** A_b/parallel $\mathbf{A_m}$





Preliminary HMS 80° Run Plan

- Measure A_b during 80° run: model expected DIS **$A(80°) \sim -0.12$; ($A_{||} \sim 0.4$)**
- DIS HMS rates from *RSS*'s montecarlo; ***E'***$(0.25 \le x \le 0.35, 23°)$
- Convert to pair rates using eg1b parameterization
  - assume 1/3 pair veto efficiency
- Compute run times for 5% pair background systematic error; $A_b \approx A_m/3$

E = 5.7 GeV θ = 23° **Goal dA /A = 5%** f=0.176 Pb=Pt=0.75 **<A DIS 80°> = -0.12**

E' GeV	x	fCLAS	fSANE	fHMS	e- rate Hz	e+ rate HMS	dAb /A (5% dA/A)	Ab	Am = ADIS f Pb Pt	t(Ab) [h]	Fixed t [h]	Smallest Ab
1.95	0.25	0.02	0.10	0.07	10.7	0.9	42%	0.004	0.012	117	50	0.006
2.20	0.30	0.01	0.06	0.04	11.8	0.5	76%	0.004	0.012	58	50	0.004
2.40	0.35	0.01	0.04	0.03	12.1	0.3	122%	0.004	0.012	36	50	0.003
										211	150	
E = 5.96 GeV												
1.95	0.25	0.02	0.10	0.07	9.75	0.78	0.42	0.004	0.012	128	50	0.006
2.40	0.34	0.01	0.04	0.03	10.73	0.30	1.22	0.004	0.012	40	50	0.004
										227	150	
E = 4.7 GeV												
1.80	0.25	0.03	0.13	0.10	14.8	1.7	29%	0.004	0.012	121	40	0.007
2.20	0.35	0.01	0.06	0.04	18.9	0.8	76%	0.004	0.012	37	40	0.004
										157	80	

Preliminary 80° HMS Run Plans

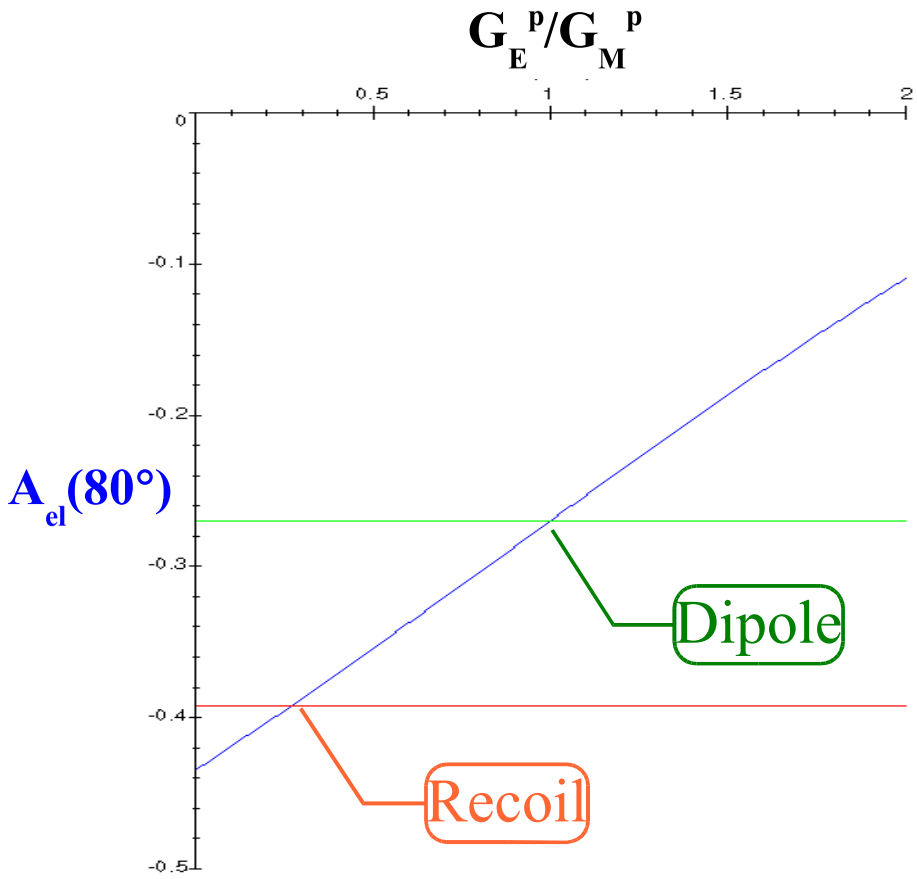
- Proposal for **80°** run:
  - measure pair asymmetry A_b at each energy at 23°, maximum usable HMS angle with field at 80°
  - 2 or 3 values of $E'(x)$
  - required time depends on pair veto efficiency
- Measure packing fractions: plan TBD

Summary of times field at 80˚

E	θ HMS	*v*	Abkgd h
4.6 GeV	23˚	0	354
		1/3	157
		½	89
Time in main run plan [PAC h]			144
5.96 GeV	23˚	0	510
		1/3	227
		½	128
Time in main run plan [PAC h]			252

$P_{beam} P_{target}$ from Elastic Asymmetry

- Coincidence *e-p* elastic asymmetry related to $P_b P_t = A_m/(A_{el} f)$
- $f \approx 1$ for coincidence events
- BigCal - HMS rates at 23°, 5.7 GeV calculated with *simc* in table 3 of SANE update (G. Huber)
- Include 0.087 (stat) and 0.028 (syst.) errors on ratio $G_E^p/G_M^p(5.5\ GeV^2)$
- Errors on $P_b P_t$ for $P_b = P_t = 75\%$, $f = 0.9$



GE/GM	Ael	Am	dAm/Am 50h	dAm/Am 200h	d(PbPt)/PbPt 200h
Dipole	-0.270	-0.137	21%	10%	11%
Recoil	-0.392	-0.198	14%	7%	8%

Preliminary HMS Parallel Run Plan

- Measure ***f*** during parallel run
- Estimate DIS electron rates in HMS with *RSS*'s montecarlo for 1 GeV ≤ *E'* ≤ 2 GeV and 32°, 40°, 48°; rates for |*hsdelta*| ≤ 8%
- Convert to pair rates using Vipuli D.'s eg1b parameterization
- Compute run times for 5% pair background systematic error

E = 5.7 GeV θ = 40° **Goal dA / A = 5%** **(NO FORWARD TRACKER)**

E' GeV	fCLAS	fSANE	fHMS	e- rate Hz	e+ rate HMS	de+/e+HMS (dfS/fS)	time e+ [h]	de-/e-HMS	time e- [h]	dA_bg /A	dfS / fS
1.0	0.20	0.52	0.35	0.109	0.058	2%	12	3%	3	4%	2%
1.1	0.16	0.45	0.29	0.129	0.052	3%	8	4%	2	6%	3%
1.2	0.13	0.38	0.24	0.131	0.040	3%	7	4%	1	7%	4%
1.3	0.10	0.32	0.19	0.120	0.028	4%	6	5%	1	9%	5%
1.4	0.08	0.27	0.15	0.099	0.018	5%	6	6%	1	12%	6%
1.5	0.06	0.22	0.12	0.073	0.010	6%	7	7%	1	16%	8%
1.6	0.05	0.18	0.10	0.049	0.005	8%	8	9%	1	20%	10%
1.7	0.04	0.15	0.08	0.028	0.002	10%	12	11%	1	26%	13%
1.8	0.03	0.12	0.06	0.014	0.001	12%	20	13%	1	33%	16%
1.9	0.02	0.10	0.05	0.006	0.000	15%	39	16%	2	41%	21%

Preliminary HMS Run Plans

- Proposal for ***f*** during ***parallel*** run:
  - measure central and large angle during 4.6 GeV run: 75 h including overhead
  - measure small and central angle during 5.7 GeV run: 24 h including overhead
  - measure pair asymmetry at 40° at each energy: plan TBD
- Proposal for **80°** run:
  - measure pair asymmetry at each energy at 24°: plan TBD
- Measure packing fractions: plan TBD

Summary of times **(NO FWD. TRCKR.)**

E	θ	e+ h	e- h
4.6 GeV	32˚	1	0
	40˚	7	1
	48˚	50	7
Total data time 4.6 GeV		59	8
Overhead		7	7
Momentum changes		32	
Time in main run plan [PAC h		72	
5.7 GeV	32˚	2	0
	40˚	11	1
	48˚	126	13
Total data time 5.7 GeV		139	15
Overhead		8	8
Momentum changes		34	
Time in main run plan [PAC h		120	
Time/ mom. change[h]		0.20	
Angle changes		3	
Time/ angle change[h]		0.25	

Pairs Systematic Errors

- SANE's 80° DIS asymmetry expected **statistical errors ~ 8%**
- Need to keep **systematic errors** due to pair background to **~5%** or less
- Choose $f \sim 1/3$ as reference, corresponding to a ½ magnification
  - < ~7% source errors needed
- Develop run plan to measure dilution to keep DIS asymmetry error at 5% level
- Get background asymmetry from γ, $\gamma\gamma$ and e^+e^- asymmetries in BETA
  - compare with eg1b for parallel
  - also measure with HMS

$$\left(\frac{\delta A}{A}\right)_{max} \le \frac{f_b}{1-f_b}\left[\left(\frac{\delta A_b}{A}\right)^2 + \left(\frac{\delta f_b}{f_b}\right)^2\right]^{1/2}$$

$$\left(\frac{\delta f_b}{f_b}\right) = \frac{1}{\sqrt{1+c^2}}\frac{1-f_b}{f_b}\left(\frac{\delta A}{A}\right)_{max}$$

$$\left(\frac{\delta A_b}{A}\right) = c\left(\frac{\delta f_b}{f_b}\right), \qquad c \ge 1$$