Exp't E97-111: Study of SRC and $(e, e'p)$ Reaction Mechanism *via* $^{4}\mathrm{He}(e, e'p)^{3}\mathrm{H}$

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The Hall A Collaboration
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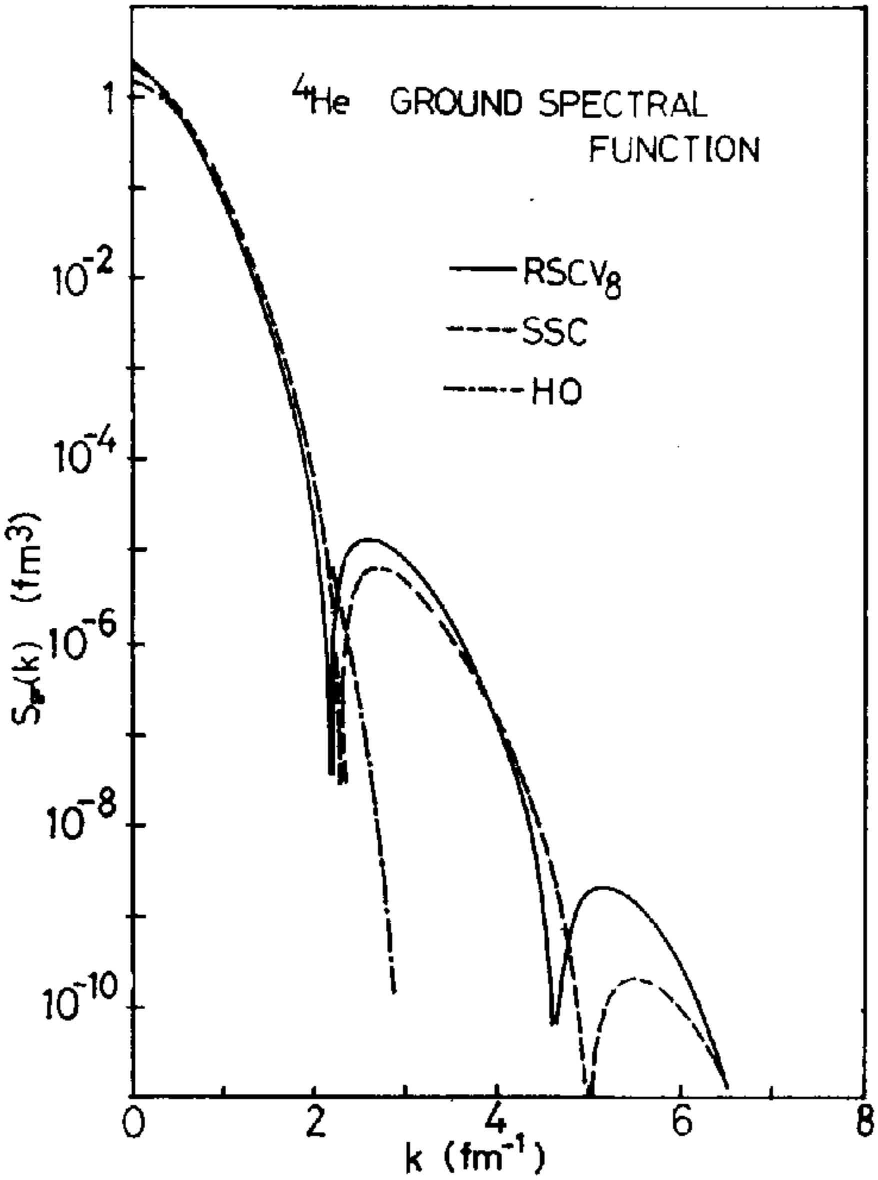
Basic Goal of Experiment

Test prediction for $^4\mathrm{He} \to tp$ momentum distribution

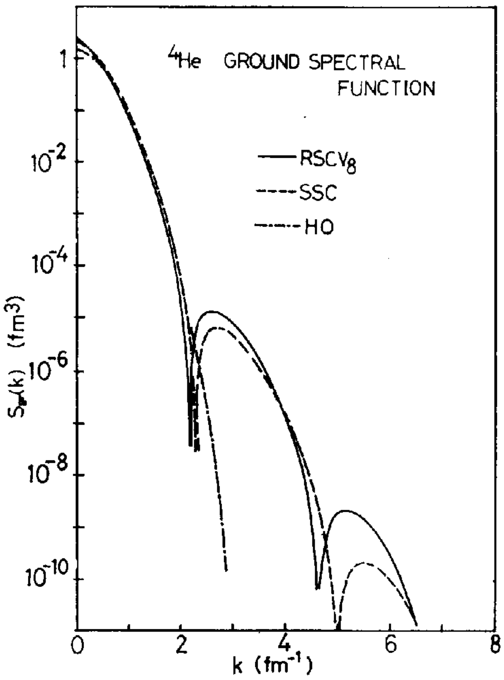


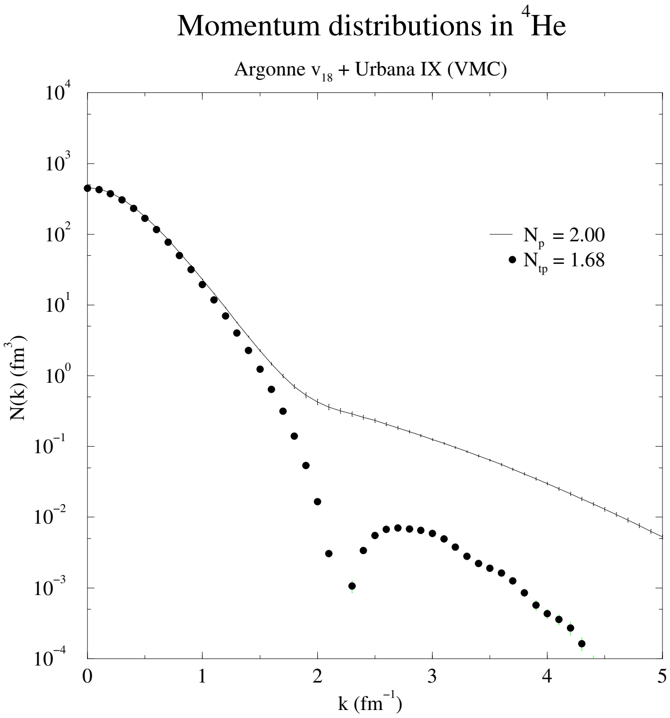
What Could Such A Test Accomplish?

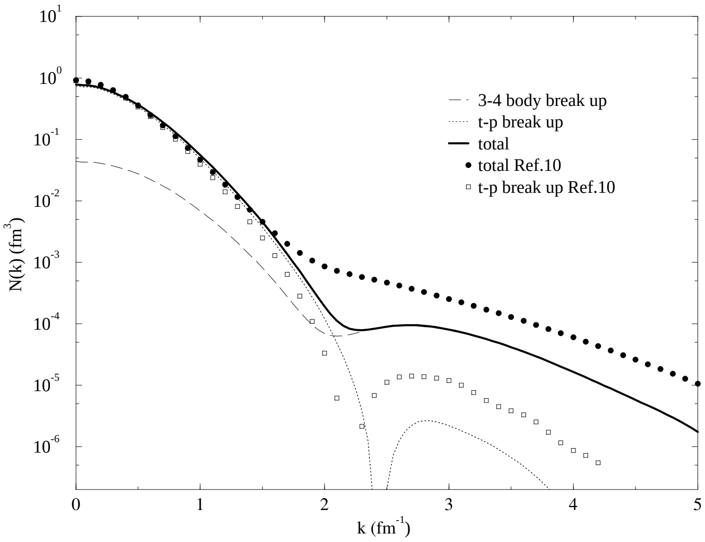
- test "universal" prediction of "complete" 4N calculations
- make a measurement sensitive to short-range particulars of both the nuclear wavefunction and the NN force
- test theoretical understanding of mechanism for $(e,e'p)$ at JLab energies

Test Universal 4N Prediction

calcs predict a minimum in $^4\mathrm{He} \to tp$ mom. dist.

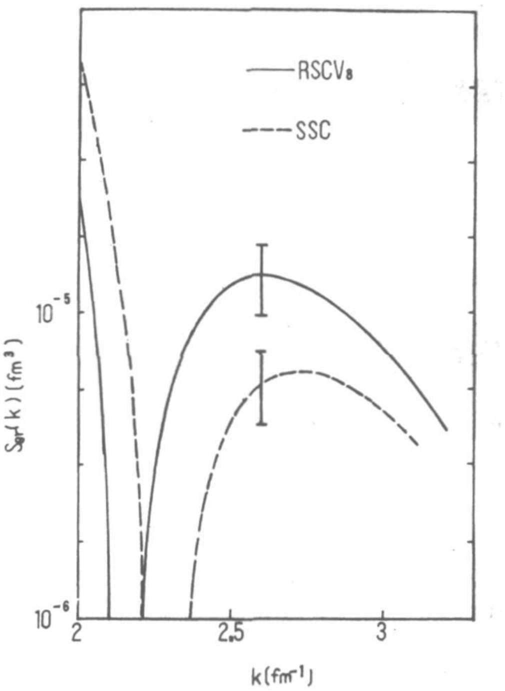


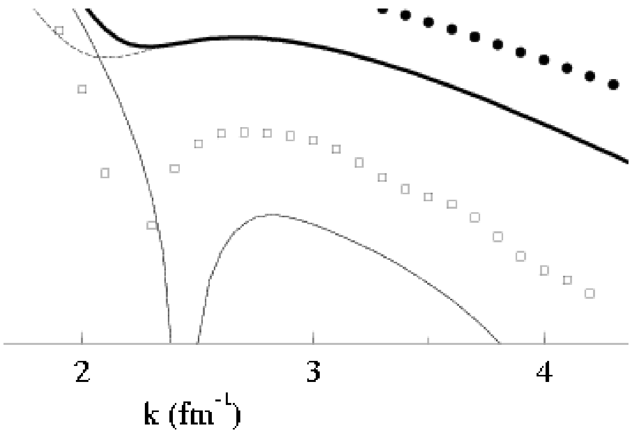




Measurement Sensitive to SR Details

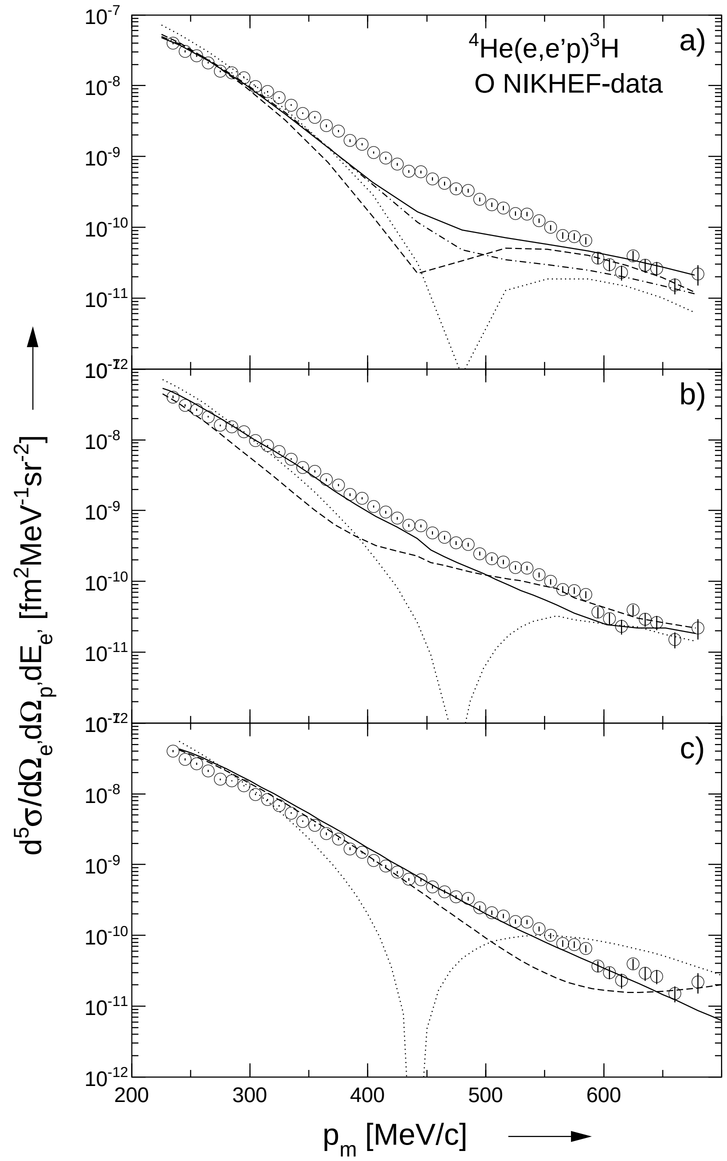
All realistic calcs agree at low momenta, but large disagreements at high momenta





Test $(e,e'p)$ Reaction Mechanism

Nothing is less than zero!



J. J. van Leeuwe *et al.*, Phys. Rev. Lett. **80** (1998) 2543

Expt. 97-111

- calculations indicate that MEC, FSI "filled in" minimum for NIKHEF exp't.

- 97-111 incorporates "best practice" in suppressing these effects:
  - parallel kinematics
  - large $|y|$ values
  - multiple Q^2 settings

- constant $q\omega$ kinematics (CQΩ) retained for comparison

CQΩ electron kinematics			
Parameter	NIKHEF Data	CQΩ I	CQΩ II
Beam Energy	525	3963	3963
Scattering Angle (deg)	49.6	14.17	20.88
Energy Transfer (MeV)	215	395	520
$\lvert\vec{q}\rvert$(MeV/c)	401	1008	1436
Q^2 (GeV/c)^2	0.11	0.86	1.79
y (MeV/c)	220	-91	-380
θ_q (deg)	36.07	60.04	58.70

CQΩ Kinematics Detail

Here, variation of proton angle with respect to $\vec{q}$ is used to vary recoil momentum

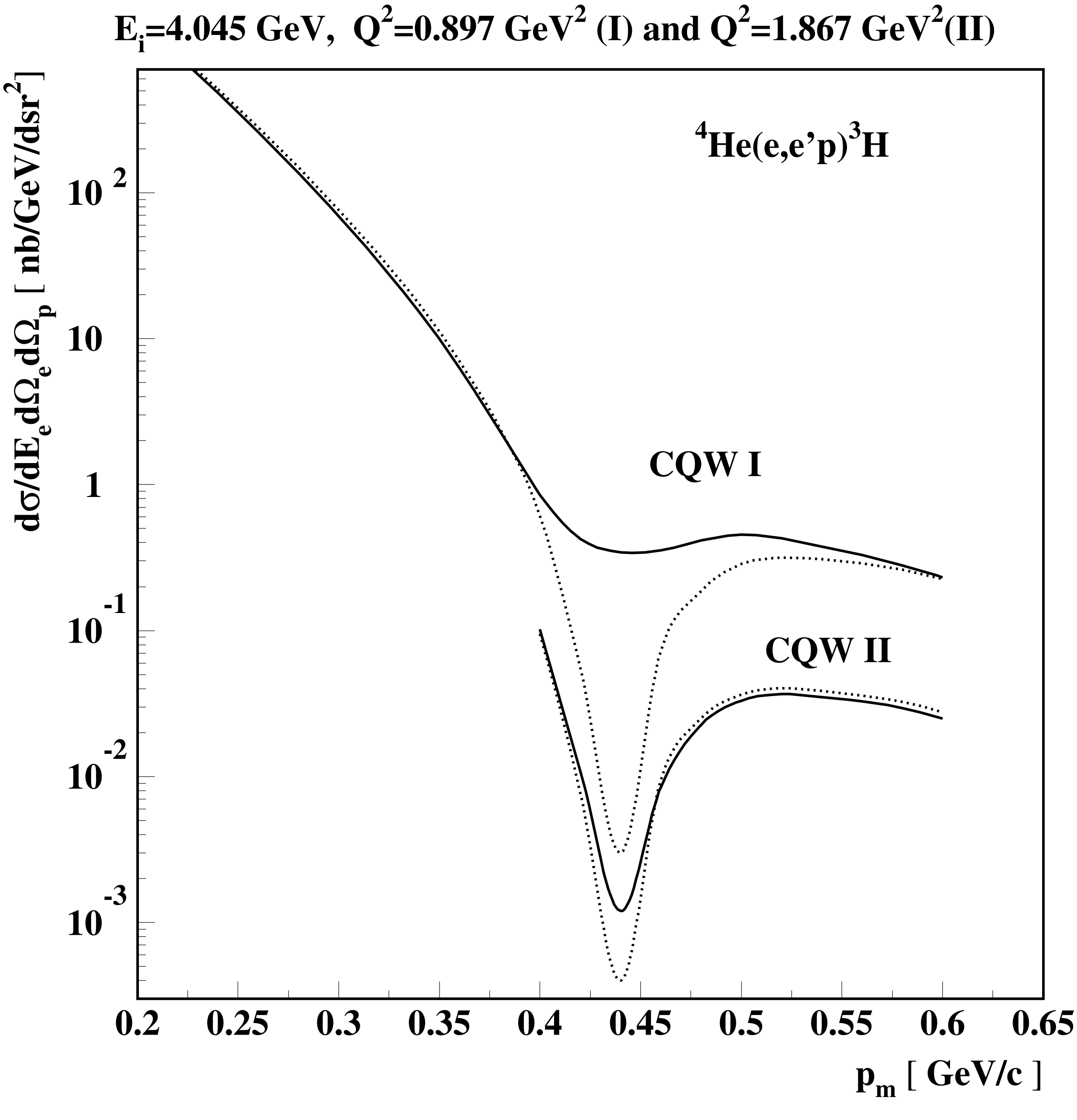
CQΩ Kinematics I			
$E_0 = 3963$ MeV	$\theta_e = 14.17$ deg	$\omega = 395$ MeV	$\lvert\vec{q}\rvert = 1008$ MeV/c
$Q^2 = 0.860\ (\mathrm{GeV}/c)^2$		$y = -91.17$ MeV/c	
θ_p (deg)	p_p (MeV/c)	p_m (MeV/c)	θ_{pq} (deg)
61.29	916.91 (909.60)	93.67	1.25
74.14	902.30 (909.60)	256.96	14.1
83.14	878.47 (866.10)	398.56	23.1
90.04	853.69 (866.10)	504.47	30.0

CQΩ Kinematics II			
$E_0 = 3963$ MeV	$\theta_e = 20.88$ deg	$\omega = 520$ MeV	$\lvert\vec{q}\rvert = 1436$ MeV/c
$Q^2 = 1.792\ (\mathrm{GeV}/c)^2$		$y = -379.84$ MeV/c	
θ_p (deg)	p_p (MeV/c)	p_m (MeV/c)	θ_{pq} (deg)
59.95	1056.16 (1043.80)	380.99	1.25
66.30	1048.74 (1043.80)	420.23	7.60
69.71	1040.46 (1043.80)	460.03	11.01
72.55	1031.37 (1043.80)	500.03	13.85

Parallel Kinematics Measurements

PY Kinematics Summary					
pe	$\lvert\vec{q}\rvert$	pm	θp	pp	Q^2
(MeV/c)	(MeV/c)	(MeV/c)	(deg)	(MeV/c)	$(\mathrm{GeV}/c)^2$
PY Kinematics I Beam Energy 2384 MeV, $\theta_e = 16.88$ deg					
280	714.58	30.77	58.76	745.3	0.432
365	740.26	130.99	52.37	871.3	0.415
475	786.00	231.33	44.85	1017.3	0.392
630	870.19	336.31	35.82	1206.5	0.360
830	1004.06	432.03	26.71	1436.1	0.319
1030	1157.17	499.05	19.86	1657.1	0.278
PY Kinematics II Beam Energy 3164 MeV, $\theta_e = 18.78$ deg					
538	1083.57	30.18	51.28	1113.8	0.885
655	1128.84	130.48	45.69	1259.3	0.845
800	1198.50	229.97	39.42	1428.5	0.796
990	1308.63	330.91	32.33	1639.5	0.732
1245	1482.07	430.82	24.64	1912.9	0.646
1490	1668.55	501.35	18.84	2169.9	0.564

Eikonal Calcs Say FSI Should be subdued



Experimental Configuration

Standard Hall A Setup with two exceptions

- high-power helium cryotarget
- swapped detector packages (electron$\leftrightarrow$hadron)
- Gas Cerenkov detector added on hadron package (for *electron* PID!)
  - Eric Brown (UGA) summer project

Schedule

- requested 14.36 days
- allocated 20 days (assumes 71% eff.)
- distribution not optimal: can we change?
- We lost a factor of two when a) target materialized and b) beam energies were lower than we asked. Not clear how much of this is reflected in BTR.
- How much of facility/commissioning time can we get?
- include time and plan for complete p_m distributions in $+y$ kinematics

Task List

- PID

  pi-e Report on the pi to e ratio in all kinematics —JHM

  1. Cerenkov Pump Bogdan for info. – -JT
  2. Make commissioning plan for Cerenkov — JT, JHM
  3. Analysis kumacs —JT
  4. Look at some shower counter data, low priority.

- Singles

  electron ties into pi to e studies —JHM
  hadron calculate rates—JHM

- Kinematics

  redo all kinematics for the web values of the energy, send results out– -JT

  1. rates in "final" kinematics Aeexp —JT
  2. rates in "final" kinematics MCEEP —JHM
  3. Both must compute pm resolution and accuracy (JHM)

- Target

  Heat exchanger tracking — JHM will coordinate with Seely

  1. Commissioning Plan — JHM
  2. Boiling from scalers —JHM
  3. Hydrogen - Helium changeover (ties back to main run plan)
  4. Survey info—JHM

- Optics

  Detector switch over optics run-plan

  1. run-plan —JT will pump Nilanga
  2. survey of detector stacks—JT
  3. optics databases—what energies have been measured, what do we need—JT
  4. pointing—how is it determined from carbon foil measurements and the pointing gizmos ? What measurements do we need—JHM ?
  5. Acceptance—to collimate or not to collimate ? Lerose six apertures ? — Student ?

task list cont'd

- Trigger

  1. Timing calibrations — How is it done ? JHM
  2. Computer Dead-time—-How is it done ? How are pre-scales handled ? Do we like it? JHM
  3. Electronics Dead-time—-How is it done ? JHM
  4. reaction losses in scintillators (lose S2 due to (p, n) in S1) – Meekins

- Tracking

  1. Chamber efficiencies . How do we know them—JT
  2. Large multiplicity events. How are they handled. How many are there ? Are they getting worse ? Rate dependence ? —JT
  3. Tracking efficiencies—How do we know it ? JT

task list cont'd

- Absolute Normalization JHM, Epstein
  1. charge normalization
  2. target densities (pressure/temp)
  3. target acceptance (ties back into optics/tracking)
  4. absolute beam energy (ties back into ep measurements and target switch over issues)

- Collaboration
  1. **Thesis student?**
  2. Mailing List—JT , Ask Hall C —JT
  3. Shift schedules
  4. COO-ESAD-RSAD—JHM

- Run Plan!!

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