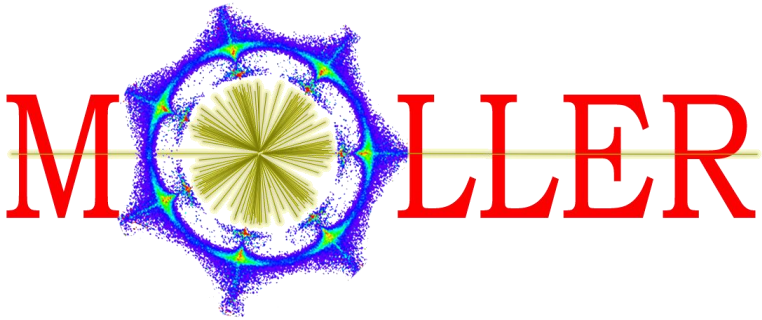
MOLLER Accelerator Jobs

Operations StayTreat

June 6, 2023



Riad Suleiman

Introduction

- **MOLLER: M**easurement **O**f **L**epton **L**epton **E**lastic **R**eactions

- **Physics Outcome:** an ultra-precise measurement of the weak-mixing angle using Møller scattering
  https://moller.jlab.org/cgi-bin/DocDB/public/DocumentDatabase

- **Organization:**
  - **Accelerator Parity-Quality-Beam Liaison:** Riad Suleiman
  - **APEL:** Yves Roblin
  - **Ops Hall A Liaison:** Daniel Moser and Adam Schoene
  - **Hall A Liaison:** Ciprian Gal
  - **MOLLER Liaison:** Caryn Palatchi and Kent Paschke

Parity-Violating Experiments at CEBAF

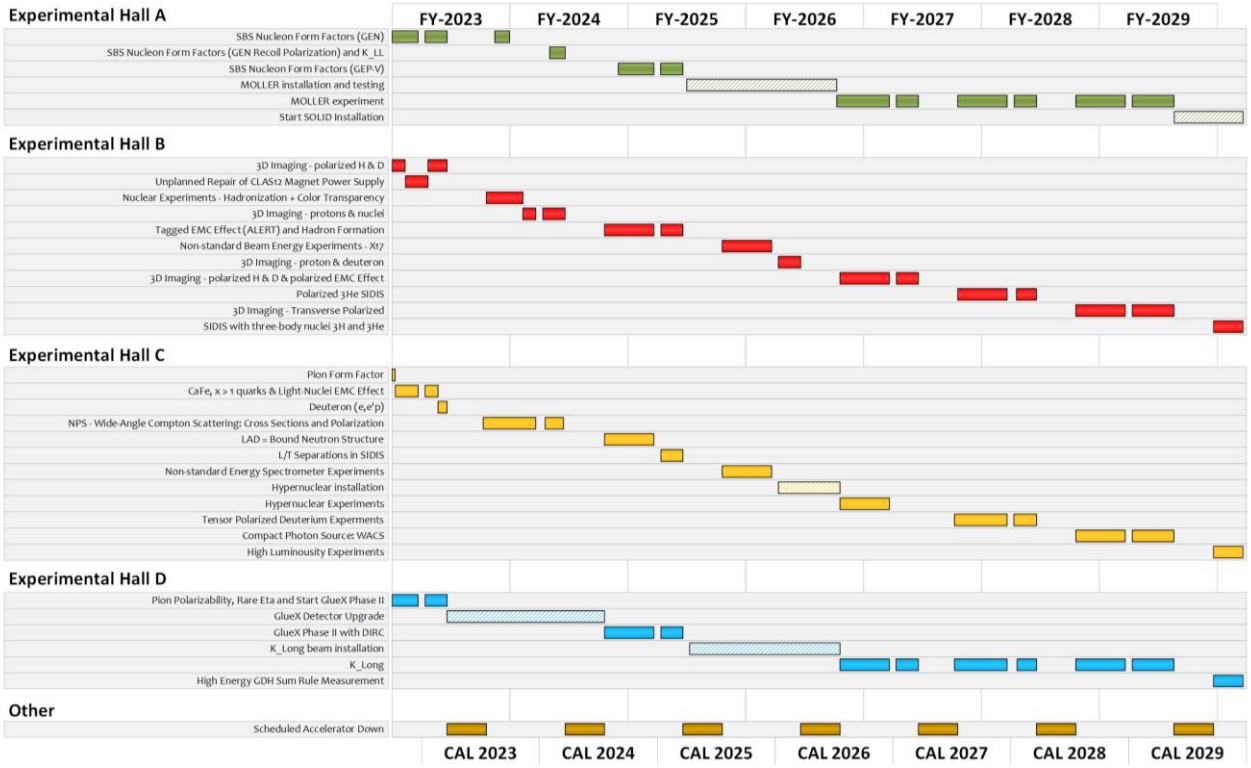
PV Experiment	Energy (GeV)	Pol (%)	I (μA)	Target	A_{pv} (ppb)	Charge Asym (ppb)	Position Diff (nm)	Angle Diff (nrad)	Size Asym(δσ/σ)
HAPPEx-I 1998 – 1999	3.3	38.8 68.8	100 40	^{1}H (15 cm)	15,050	200	12	3	$<10^{-3}$
G0-Forward 2003 – 2004	3.0	73.7	40	^{1}H (20 cm)	3,000-40,000	300±300	7±4	3±1	$<10^{-3}$
HAPPEx-II 2004 – 2005	3.03	87.1	55	^{1}H, ^{4}He (20 cm)	1,580	400	2	0.25	$<10^{-3}$
G0-Backward 2006 – 2007	0.359, 0.688	85.8	60	^{1}H, ^{2}H (20 cm)	9,700-37,400	-30±300	47±9	1.2±0.5	$<10^{-3}$
HAPPEx-III 2009	3.484	89.4	100	^{1}H (25 cm)	23,800	200±10	3	0.5±0.1	$<10^{-3}$
PVDIS 2009	6.067	89.0	105	^{2}H (20 cm)	60,000-160,000	100	100	40	$<10^{-3}$
PREx-I 2010	1.056	89.2	70	^{208}Pb (0.5 mm)	657±60	85±1	4	1	$<10^{-4}$
QWeak 2010 – 2012	1.162	88.7	180	^{1}H (34 cm)	226.5±9.3	20.5±1.7	-4.6±0.2	-0.07±0.01	$<10^{-4}$
PREx-II 2019	0.953	89.7	70	^{208}Pb (0.5 mm)	550±18	20.7±0.2	2.2±4	0.3±0.3	$<6\times10^{-5}$
CREx 2019-2020	2.18	87.1	150	^{48}Ca (5 mm)	2668±113	-88±26	-5.2±3.6	-0.13±0.08	$<6\times10^{-5}$
MOLLER 2026-2028	**10.8**	**90**	**65**	**^{1}H (125 cm)**	**35.6±0.74**	**<10**	**<0.6**	**<0.12**	**$<10^{-5}$**

MOLLER Quick Summary – Notable Things for MOLLER

1. MOLLER Apparatus is designed for nominal beam energy: 10.8 ± 0.2 GeV with low RF trip rate (<6/hr)
2. 65 μA with 90% polarization (max 70 μA for target studies)
3. Fast helicity reversal:
   I. 1920 Hz, 10 μsec settle time, 64-window pattern, 128-window delay
4. Slow helicity reversals:
   I. Insertable half-wave plate (IHWP)
   II. Wien Filters (using new 200 keV injector)
   III. g_e-2 ($\Delta E \sim 0.10$ GeV)
5. Feedbacks on:
   I. Helicity-correlated beam charge
   II. Helicity-correlated position and angle
   III. Polarization orientation
6. Small helicity-correlated beam asymmetries
7. Adequate adiabatic damping of transverse phase-space (for both xx' and yy') – a factor of 100 is desired, a factor of 10 is required. Ideally, $\sqrt{P_f/P_{gun}} = \sqrt{10800/0.494} = 148$
8. Acceptable beam halo (MOLLER Halo Monitor: to be specified, Compton Polarimeter: <100 Hz/μA)

CEBAF Long Term Schedule – potential conflicts

MOLLER experiment in Hall A: installation starts in Jan 2025 and physics run starts in Jan 2026 for three years



- **Hall A (MOLLER)**

0.26 pC @ 249.5 MHz (4 ns, 65 μA average beam current)

- **Hall B**

0.002 pC @ 249.5 MHz (4 ns, 50 nA average beam current)

- **Hall C**

0.12 pC @ 249.5 MHz (4 ns, 35 μA average beam current)

- **Hall D (K_L)**

0.32 pC @ 15.6 MHz (64 ns, 5 μA average beam current)

  - **One task aims to study co-operation of MOLLER with K-long experiment in Hall D**

MOLLER Requirements

- Details about MOLLER action items can be found here: https://wiki.jlab.org/ciswiki/images/2/2b/MOLLER_Accelerator_MainJobs_details_June2023.docx

- MOLLER has other requirements that can be found here: https://wiki.jlab.org/ciswiki/images/7/7b/MOLLER_beam_requirements_22March2023.pdf

- Accelerator jobs are summarized in next four slides (**listed are Deliverable Dates**)

Abbreviation	Staff/People	Group
CIS	Accelerator	Center for Injectors and Sources
CASA	Accelerator	Center for Advanced Studies of Accelerators
Ops-SW	Accelerator	Accelerator software Group
Ops-Inj	Accelerator	Injector group
Ops-MCC	Accelerator	MCC Operations Group
I&C	Engineering	Instrumentation and Controls Group (EESICS)
RF	Engineering	Radio-Frequency Group
SSG	Engineering	Safety Systems Group
Fast Electronics	Physics	Fast Electronics Group
Hall A	Physics	Hall A group
RCG	EH&S	Radiological Control Group
MOLLER	Users	MOLLER Collaboration

MOLLER Accelerator Jobs

1. **Helicity Generator boards (SAD 2024)**
   - Groups (CIS, MOLLER, Fast Electronics, Ops-SW)
2. **Helicity Decoder boards (SAD 2024)**
   - Groups (CIS, MOLLER, Fast Electronics)
3. **New RTP High Voltage (HV) Driver (SAD 2024)**
   - Groups (CIS, MOLLER, I&C, Ops-SW)
4. **Upgrade laser Intensity-Attenuator (IA) system (SAD 2024)**
   - Groups (CIS, MOLLER, I&C, Ops-SW)
5. **Upgrade Helicity Magnets control (SAD 2024)**
   - Groups (CIS, CASA, MOLLER, I&C)
6. **Feedback on polarization orientation (December 2024)**
   - Groups (CIS, Ops-Inj, MOLLER, CASA)
7. **Wien filters slow reversal – Wien Flip (December 2023)**
   - Groups (Ops-Inj, CIS, MOLLER)

MOLLER Accelerator Jobs … continued

8. **Injector transmission and parity-quality beam (December 2023)**
   - Groups (Ops-Inj, MOLLER)
9. **Matching and adiabatic damping from 200 keV to Hall A (December 2024)**
   - Groups (CASA, CIS, Ops-Inj, MOLLER)
10. **Fast Feedback (FFB) system resurrection (December 2024)**
    - Groups (CASA, Ops-SW, I&C)
11. **Compton Polarimeter setup (December 2024)**
    - Groups (CASA, Hall A)
12. **Beam Modulation (December 2024)**
    - Groups (Hall A, CASA, Ops-SW, I&C, MOLLER)
13. **Phase Advance (December 2024)**:
    - Groups (CASA, MOLLER)

MOLLER Accelerator Jobs … continued

14. **Study co-operation of MOLLER with K-long experiment in Hall D (SAD 2024)**
    - Groups (CIS, Ops-Inj, CASA, MOLLER, Hall A)
15. **Control of charge asymmetry on Halls B, C, and D beams (December 2024)**
    - Groups (MOLLER, CIS, Ops-SW)
16. **Parity-Quality Beam (PQB) studies in Injector and Hall (December 2024)**
    - Groups (MOLLER, CIS, Ops-INJ, CASA)
17. **Halo Monitors in Hall A (March 2025)**
    - Groups (Hall A, MOLLER, I&C, Ops-SW, SSG)
18. **Robust beam mis-steer protection / fast shutdown detectors in MOLLER apparatus (March 2025)**
    - Groups (Hall A, MOLLER, RadCon, Ops-MCC)

MOLLER Accelerator Jobs … continued

19. **New BPM Digital Receivers in Hall A line – instead of Sample/Hold cards (March 2025)**
    - Groups (Hall A, MOLLER, I&C, Ops-SW)
20. **New BCMs electronics in Hall A line (March 2025)**
    - Groups (Hall A, MOLLER, I&C, Ops-SW)

Accelerator Beam Tests (June – July 2023)

- **200 kV Gun Optics and Gun-Exit Steering:** measure beam angle and displacement from new gun as a function of laser spot position
- **Beam studies of New Booster:** measure beam emittance upstream and downstream of Booster, beam kicks, energy spread, and x/y coupling caused by Booster
- **Injector Optics:** study gun kick, MFX2I01 auto-centering, 200 keV Wien, and 15 degree dipole
- **200 keV Wien Filter Optics:** optimize Wien filter operation at any angle with no significant impact on transmission (>95%) or downstream optics
- **200 keV E/B Calibrations of V-Wien and H-Wien:** determine E and B field settings which do not deflect electron beam at 200 keV energy
- **200 keV Spin Dance Calibrations of V-Wien, H-Wien, and Spin Solenoids:** Calibrate spin rotators using Mott polarimeter

PQB Beam Tests (June – July 2023)

- Measure beam properties (e.g. widths of beam asymmetries, position differences along injector) from new gun and Booster and compare to before

1. DAQ and Channel Access Setup
2. RHWP Scan – Vacuum Window Assessment
3. Wein-Flip Symmetry Measurement
4. 200 keV Transmission and Noise
5. Post Upgrade 200 keV RTP Position Difference Sensitivity and Feedback Convergence FC2
6. Post Upgrade Chopper Scan at 200 keV

Summary

- MOLLER installation starts in Jan 2025 and physics run starts in Jan 2026 for three years

- Very demanding experiment – preparations must start now

- Managers: please use MOLLER Accelerator Jobs document to plan resources: https://wiki.jlab.org/ciswiki/images/2/2b/MOLLER_Accelerator_MainJobs_details_June2023.docx

- More info about parity-violating experiments can be found at CIS Wiki: https://wiki.jlab.org/ciswiki/index.php/Parity_Quality_Beam