CREX Run Plan

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CREX Run: Dec 2 – 19; Jan 10 – March 23

- 1 pass, 2.2 GeV
- Target z (-10 cm) offset ➔ 4.865° central ray
- $<Q^2> \sim 0.031\ GeV^2$
- $<A_{PV}> \sim 2.45$ ppm
- Expected rates: 23.6 MHz per arm ➔ 804 ppm per arm at 120 Hz quartet
- dA ~ 85 ppb
- From Seamus' HAPLOG 3753
  - --dA/A(stat) = 0.0431242
  - --dA/A(sys) = 0.0125
  - --dA/A(total)=0.0448993
  - --dR/R = 0.00731914 (proposed FOM ~recovered)

CREX Run: Comments and points to think about for CREX

- Aperture scraping in the injector; other halls running; Yves new CREX tune
- IHWP IN/OUT polarization difference
- FFB on, or off? We'll see…
- Changes in plans due to higher beam current (150 uA)
- Spot size on target smaller for CREX? (better for Compton bkgds)
- Target/cavity locks (correctors used)
- Warm target ladder problem (leak); will this be robustly fixed for CREX?
- Cold target ladder drive shaft problem; tungsten grease contamination; y-position offset
- Septum current near limit: 805 Z (nominal) for CREX
- Collimator temperatures and flow should not be an issue (chiller, flow meters)
- Pedestal and electronics noise in HRS during counting mode (beam on); espectially Rarm
- s0/s3 issues. What is the plan for CREX? (Devi's talk)
- Given proximity of 1^{st} excited state for calcium (3.84 MeV with 0.94% strength), and jitter level in beam enegry, we may choose to put all these events through the quartz, but not the 4.51 MeV (0.18%) 2^{nd} excited state.
- Need to carefully map-out the inelastic spectrum for CREX (Bob's PREX-I study)
- A_T detectors will be more important for CREX. Need a plan?
- Want new SAMs. Need to be installed before mid November (beam in hall on 18^{th})
- Slow computers, prompting problems
- …

CREX Run Plan

- Run plan will follow closely the PREX plan in the wiki
- These are the following major activities for December:
  - Beam restoration
  - Low current checkout
  - Beam monitor calibration
  - Spectrometer commissioning
  - High current checkout
  - Establish and start production
  - Important activities after first few days
  - Polarimetry studies
  - Important activities during run

Beam Restoration

1. Basic beam setup 1 shift: Yves Roblin
    1. establish tune beam and low current CW beam in the hall.
    2. Establish beam to dump, through Compton chicane
    3. Design match to hall expected as part of original configuration, if additional beam time is required will be necessary to coordinate with optics/production runplan
    4. ion chamber calibration will be skipped until we can get targets in (MASK ION CHAMBERS); CG will coordinate

2. Source and Parity Quality Beam 0 shift (complete before 6/17): Caryn Palatchi, Amali Premathilake, Kent Paschke
    1. Source laser optics configuration and initial setpoints
    2. Wein left/ Wein Right injector optics configuration
    3. Characterize injector optics configuration

Low Current Commissioning

Basic beamline commissioning (may be 3 shifts total) Establish low-current beam with spectrometer magnets on. Establish centering on collimator. BPM offset calibration. Commission target ladders.

Preparations:

Stripchart on ion chambers, with bpm4e and bpm4a positions
stripchart on collimator and beamline temps with bpm 4a and 4e positions
stripchart on compton rates (with beam current) no more 2x what is present in HACOMPTONLOG

1. **Verify Beamline setup 1 shift**: Yves Roblin, Bob
   - Tune mode. No target. Raster off. Ion chambers masked. ATLis 19326
     - beam transport through Compton chicane up to 5uA CW
       - Rates in finger scintillators no more than 2x what is present in HACOMPTONLOG
       - ComptonUS1 ~ 30 Hz, ComptonDSbg1 ~ 870 Hz, ComptonDCbg2 ~ 1010 Hz
     - spot size at target (harps) (nominal spec is 150 um x 150 um. Larger is better)
       - Use 5uA CW, but keep eye on compton rate, ion chambers, temps.)
     - Tune beam. Turn on septum and verify still on dump. Clean transport to dump for PREX set points
     - one arm running (Q1 on) test to verify no beam motion.
     - Turn on both Q1 spectrometers.

Low Current Commissioning

2. Hall bullseye scan 0.5 shift: Bob

- harp scans at each of 5 points around nominal center, (0,0), (2,2), (2,-2), (-2,-2), (-2,2).
  - Set prescale for high rate of clock triggers
  - Watch beam on viewer, ion chamber and temperature stripcharts.
  - Use 2-5uA CW to find each corner position. 4A, 4E harp scan for one of the corner positions and verify EPICS readback of BPMs, check spectrometer BPM calibrations.
    - If PREX expert is available, parasitically collect data for low current beam monitoring (cavities). If during day have RC inform J Musson before taking this data.

3. Collimator checkout 0.5 shift: Yves, Ciprian G, Kent P

- Verify that we are cleanly going through the collimator and cross check power deposition calculations
  - Target ion chamber setpoints can be set high to allow this test.
  - setup ion chamber strip chart
  - Establish 2-5uA tune mode, with empty target. Use 4x4 raster.
  - move beam in 2mm steps as much as +/- 1 cm in both horizontal and vertical. Watch for rise the ion chamber signal. Record positions where edges of the collimator bore are found.
  - set beam to center on collimator based on those edges.
  - compare to position of carbon hole on warm and cold ladders. Do we need to recheck target frames for targets? Do we need to change encoder positions?

Low Current Commissioning

4. Warm target position 0.25 shift: Kent (Silviu, present or on call?)

- Verify target alignment.
  - Insert warm ladder, carbon hole.
  - Set raster for 8mmx8mm
  - Establish 2uA CW. Run spot++ to find carbon hole. log it.
  - Adjust raster setting to establish 4x5 raster size. Log it.
  - If carbon hole not in 4x4 raster view, need to reconsider. (move beam, or use off center?)

5. Cold target position 0.25 shift: Kent (Silviu, present or on call?)

- Verify target alignment.
- Target and dump ion chamber set points will need to be raised to perform this commissioning
  - Insert cold ladder, carbon hole.
  - Set raster nominal 8x8 (or what could be used.)
  - establish 5uA CW. Run spot++ to find carbon hole. Log it.
  - Set raster to 2x2 set point from before. Use spot++ to verify it.
  - if carbon hole not in 2x2 raster view, need to reconsider. (move beam, or use off center?)
  - Move to calcium-40 target, location same as for PREX-II (?)
  - Establish 5uA CW, 2x2 raster. Run spot++ to verify raster size, not hitting edges. Log it.
  - Move to calcium-48 target, location (PREX-II halo target cell)
  - Following calibrations, perform current scans on calcium tgts from 0 – 150 uA and look at detector widths,…

Low Current Commissioning

6. Ion Chamber calibration - thick Target 0.25 shift: Ciprian G

- Procedure discussed with Eric Forman: thick target calibration procedure (ramp 2-10uA) for Al ion chambers (including the dump)
- Must keep rates in compton finger scintillators; no more 2x what is present in [https://logbooks.jlab.org/entry/3687977
    - Establish beam, 5uA beam, 2x2 raster, on calcium target.
    - move beam to x=+1mm (relative to collimator center)
    - target and dump ion chamber setpoints can be set high this configuration
    - Execute thick target Ion Chamber calibration, From Atlis 19326. This calibration will be u to set ion chamber setpoints.
    - Dump and Near-target ICs: set for 45 degree targets by projecting ion chamber setpoints fo 20uA current or 90 degree targets by projecting to 70uA current.
    - parasitic: first check of SAMs at low current (call Devi? or Dustin? before starting)

7. Very low current commissioning 0.25 shift: Yves. Ye Tian. Caryn.

- Commission low current cavities relative to stripline calibration. Commission cavity bpm lock.
- Note: position scan and lock setup are separate pieces, can happen at different times.
- Either/ both can happen later (during optics running). Needed before sieve-out Q2 studies.
    - Cavity lock [Yves is required for step]
        - Setup cavity stripchart. Establish 2uA CW.
        - Setup cavity slow lock. Verify that in operation this lock holds the position in the cavi epics readback.
        - Lower current to 100 nA. Verify that the lock still holds the cavity epics readback.

Low Current Commissioning

7. (continued) Very low current commissioning 0.25 shift: Yves. Ye Tian. Caryn

- Cavity Position scan.
  - Setup cavity stripchart. Establish 1uA CW.
  - Find corrector positions for +/-2mm in X, Y.
  - Reduce current to 50nA.
  - Set to each corrector position, verify position measurements with epics readback
    - Turn on both parity DAQ and counting DAQs. For the counting DAQ, the trigger is set to T1=1, and make sure that S0 HV is on.
      - For changing the trigger prescale factor: for the LHRS, please go to adaq@adaq3, type prescaleL, and you will see a gui, and set T1=1 and press the save button and exit it.
      - For the RHRS, please go to the adaq@adaq2, typle prescaleR, and you will see the same gui, just set T1=1 too and press the save button and exit it.
    - Start/and stop the parity DAQ and counting DAQs at same time for the each position point.
    - Look at the strip chart of IPM1H04BX, IPM1H04CX, IPM1H04DX and IPM1H04BY, IPM1H04CY, (current signal) IPM1H04DY, IPM1H04B, IPM1H04C, IPM1H04D, if the signal is saturate or too small to present. Then we need to change the gain of the cavity BPMs
      - Change the gain, please call Ye Tian (803-553-3570)

Beam Monitor Calibration

- Establish 50 uA in hall
- Run current scan, local around 50uA, using Unser to calibrate beam charge monitor readout in parity DAQ.
  - Run the Compton DAQ concurrently, for calibration
  - Go to FixedGain when at 50 uA on bpms (list of crates???) and repeat local current scan to set bpm pedestals.

Spectrometer Commissioning

1. **Tracking checkout 1 shift**: Bob M, Ryan R, Chandan G
    - Sieve In, raster off. Tune B. 45 deg C target. 1 uA.
    - Septum 805 A
    - Check rates with scalars.
    - Set prescales for S0 triggers.
    - VDC checkout; look at tracks, VDC spectra
    - Some short run for GEM: noise, pulse-heights, tracks, etc. After this GEMS out of DAQ to improve efficiency.

2. **Sieve reconstruction verification 0.25 shift**: Bob, Ryan
    - Sieve In, raster off. Tune B. 45 deg C target. 1 uA.
    - Septum 805 A
    - Collect 500k events

Spectrometer Commissioning

3. Tune septum to central ray 1 shift: Seamus, Ryan

- Sieve In, raster off. Tune B. 45 deg C target. 1 uA.
- Beam centered on axis
- Start septum at 805 A
- 500k events per run
- Adjust Q1 fields by 10% low (one run) and high (one run)
  - Identify the invariant position in the phitarg-thetaTarg space and adjust septum to move the central ray to expected location
- Repeat 10% low (one run) and high (one run) to verify central hole in correct location
- Verify for Q2 and Q3 that central hole does not move under field changes (1 run each, 10% low). (optional)
  - Expected: the hole will be invariant under all quad changes. This location is about 2mm toward beam from central hole.
- Last step: CYCLE QUADS to get back to precise Tune B optics

Spectrometer Commissioning

4. Inner Edge Identification 0.5 shift: Seamus, Ryan

- Sieve In, raster off. Tune B. 45 deg C target. 1 uA.
- Beam centered on axis
- Start septum at central tune
- 500 k events per run
- Take 9 points over septum current from +10% to -10%
  - The expected inner edge of the acceptance should match simulation
  - If there is a small-angle obstruction for currents at or above the central tune current, identify the lower septum current where there is no inner obstruction for both arms. Use this as new production septum current.
- Last step: Cycle Septum

5. Q1 acceptance scan 0.25 shift: Ye T

- Sieve In, raster off. Tune B. 45 deg C target. 1 uA.
- Beam centered on axis
- Optics at central tune
- 500 k events per run
- Take a run for Q1 filed +/-10% over 5 points (cycle, then scan top to bottom)
  - Expected: later analysis should show out of place acceptance compares to simulation.

Spectrometer Commissioning

6. Quartz spot width minimization 0.5 shift: Ryan, Seamus, Bob

- Sieve IN (If this is last step of optics configuration, take an access to pull sieve OUT)
- raster ON (4x6 raster)
- Start with central tune
- 45 deg C target. 1 uA.
- Beam centered on axis
- Optics at central tune
- 500 k events per run
- Take a run along eigenvector quads +/-10% for Q1 filed +/-10% over 5 points (cycle, then scan top to bottom)
  - Expected: width should be minimized
  - Tune that minimizes width at detectors is new central tune.

7. Quartz detector checkout 1 shift: Dustin M, Devi A., VDC expert

- Sieve OUT
- raster ON (4x6 raster)
- Start with central tune
- thin C target. 0.5uA - 1 uA (want quartz scaler rates below 1MHz but need beam position monitoring)
- Beam centered on axis
- Optics at (new) central tune
- verify small spot at quartz (thin C, low current, sieve out, raster on?)
- thin C, low current, raster on, Sieve OUT: positions Plan
- PMT spectra: Examine pulse height distributions to get RMS/mean and Peyields
- rates: These will come from scalers. We can't do a rate "check" without going to integrate mode. This will be done during Width study

Spectrometer Commissioning

8. Optics calibration data 0.5 shift: Nilanga, Siyu
- Sieve In, raster off. Tune B. 1 uA.
- 45deg Tungsten target
- Beam centered on axis
- Optics at central tune
- 500 k events per run
- spectrometer momentum scan (details in run plan still)

9. Water cell pointing 1 shift: Nilanga, Siyu
- Sieve IN: pointing measurement
- Sieve OUT: pointing measurement
- (details in run plan)

10. Y target reconstruction on warm and cold ladders
- Raster off.
- 45 deg carbon
- 90 deg carbon

11. Q2 measurement 0.5 shift:
- Production target

1**2. Quartz detector rate estimate 0.5 shift**: KK, Dustin, Devi, Tao
- controlled access to change UpStream quartz detector (in each arm) to integrating mode
- draft plan

13. Position At detectors: Dustin, Ryan, Devi

High Current Checkout

detailed plan

1. Basic setup 0.5 shift: Yves R, Ciprian G:

- No target.
- 50uA beam current, through Compton (backgrounds on fingers and Compton photon detector).

2. High current with target 0.5 shift: Ciprian G, Dustin, Devi

- Establish 2x2 raster. Insert calcium target.
- Detector and SAM voltages (Dustin, Devi)

3. Beamline instrumentation calibration 0.5 shift: Caryn P,

- Current ramp for BPM/BCM calibrations and detector pedestals detailed plan

4. Initial production condition test 0.25 shift: Caryn P, detailed plan

- detector and SAM widths
- regression sensitivities
- beam noise and asymmetry check
- collimator water and thermocouple temperatures,
- radiation monitors and ion chamber stability

5. Width studies 0.5 shift: KK, Tao, Dustin, Devi

- detector and SAM widths, targets, shutters, etc
- deinstall shutters at conclusion of test

Establish Production Conditions

1. Beam modulation 0.5 shift: Victoria O., Ye T,: (Detectors needed here)

- turn on
  - In integrating mode
  - check HV of Main Detector
  - SAMs on
- set Amplitudes
  - start with .100 A set amplitude. Run (at least) 2 supercycles. Check online gui plots for response.
  - increase amplitudes by .50 A, to see response (if needed).
- test orthogonality
  - after minimum 2 good supercycles (more is better) ready to examine sensitivities
  - if orthogonality is bad, need additional time to discuss with experts about retuning beam.
- turn off
  - restore conditions for Moller commissioning

2. Detector checkout 1 shift: Dustin, Devi

- quartz detector position: verify no inelastic event acceptance
- width study (plan needed)
- raster sync (plan needed)

Establish Production Conditions

3. Spin Dance 1 shift: Simona, Sanghwa
- Moller polarimeter commissioning (establish beam) (plan needed)
- Short spin dance (run plan needed, established optimal spin angle for this Wien state) (plan needed)

4. Hall PQB 1 shift: Caryn P
- Check asymmetries in the hall
- Adiabatic dampening / Matching (plan needed)
  - Use helicity magnets to tune phase trombone
- Establish feedback (if Hall C is not on schedule their feedback for later)

5. Production: 0.5-3 shift? All

6. AT measurement 1.5 shift? All (plan needed)
- Do we need to verify zero longitudinal using Moller polarimeter?
- Carbon
- Calcium targets
- Lead

7. Initial Moller commissioning 1 shift: Simona, Sanghwa
- minimal set for first absolute measurements

8. Initial Compton commissioning 1 shift: Dave G, Juan Carlos
- minimal set for measurement conditions

Important Activities after first few days of Production

- Linearity Studies –
- Background Studies --
  - Scans of Septum Magnet and HRS Dipole
  - Thin Lead Target to check for inelastics at high-resolution
  - Thin C12 to measure diamond background
- Possible scan of Q1 to optimize acceptance and verify that collimator defines acceptance. (old idea, still relevant?)
- We will start with the Wein in Spin-Right. Once we switch to Spin-Left we need to do another spin-dance.

Important Activities during the run

- Linearity Studies --
- Background Studies --
- Repeat Q2 and pointing measurements
- Arc Energy Measurement

Polarimetry Studies

1. Compton Commissioning -- Gaskell, et.al.

- Beam Tune, Background reduction -- Bteam,
- Compton Cavity Checkout --
- Photon Detector Checkout -- CMU group

2. Moller Commissioning -- Simona Malace, Don Jones, et.al.

- Magnet Alignment -- 1 shift (swing)
- Raster size and pulse-mode -- 1 shift (day)
- Target commissioning - 3 shifts
- Pulse-mode target commissioning - 2 shifts
- DAQ checkout -- 1 shift

Summary

- Nearly all tasks addressed during PREX-II commissioning are also needed for CREX–some are not needed and some additional tasks
- Many items may be ”quicker” to complete for CREX due to readiness and experience, but do not underestimate the effort needed in December to get to production
- Folks that are responsible for ”low-level” detailed run plans for their subsystems need to re-visit their run plans and make any adjustments needed for CREX
- I plan to copy the PREX-II wiki run plan, modify it as needed, and repost it in the wiki as the CREX run plan; we may need new names to drive some tasks due to available man-power; expected durations of several tasks could change,...
-