ASO-2 Qualification Workbook

Operator Supervisor: PSM 7/28/17

EOIC Supervisor: R. A. Erickson 28 July 2017

AD Safety Office: Paul Miller 1 August 2017

Accelerator Operations and Safety Division: R. A. Erickson 28 July 2017

Preface

This workbook lists the requirements for obtaining the Accelerator Systems Operator 2 (ASO-2) qualification level. Use this workbook to track your progress.

You may be trained by any control room operator who is qualified as an ASO-2 or higher. Ask your trainer or supervisor for clarification of anything you don't understand about this training process or about the training material.

Give your completed workbook to your supervisor as part of your ASO-2 qualification assessment. You will be notified when you are qualified as an ASO-2 and your training record will be updated.

Instructions

Trainee: For all items, review the available documentation that pertains to the subject matter. Next, ask your trainer any questions about the items listed.

Trainer: After the trainee has demonstrated an understanding of the items at the ASO-2 level, initial the corresponding underlined space.

Supervisor: After the trainee has accomplished all required objectives in this section, complete the corresponding signature block in each section.

Trainee (Print Name):________________________________

Certification Started (Date):________________________________

Certification Completed (Date):________________________________

Accelerator Operations Section Final Approvals (Signature/Date):

Operator Supervisor:________________________________

EOIC Supervisor:________________________________

Table of Contents

1. Safety Training

1.1 PPS Certification

___ Complete at least 7 PPS Qualification workbooks.

1.2 Required Classes

___ Complete the *Limited Radiological Assistant (LRCA)* class.

Class Date/Time: ___________ Completed: ___________

1.3 BAS Training

___ Complete the *SPEAR BAS and Safety Training Workbook.*(SLAC-I-040-504-007-00).

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2. Operating Fundamentals

The devices, systems, concepts, and other topics listed in this section are fundamental to the operation of the SLAC accelerator systems. You must thoroughly understand these fundamentals at the ASO-2 level as specified in the Accelerator System Operator II job specifications before proceeding to the operating techniques provided in the next section.

2.1 Beam Transport System

____ Types of magnets
- ____ Solenoid magnets
  - ____ Solenoids
  - ____ Lenses
  - ____ Bucking coil
- ____ Dipole magnets
  - ____ Trim winding magnets (quads and dipoles)
  - ____ Corrector magnets
  - ____ Bend magnets
  - ____ Wiggler magnets
  - ____ Undulator magnets
  - ____ Pulsed magnets
    - ____ BYKICK
- ____ Quadrupole magnets
  - ____ Focusing quadrupoles
  - ____ Defocusing quadrupoles

____ Stepping motor devices
- ____ Movers
- ____ Collimators
- ____ Wire scanners

____ Laser transport optics
- ____ Pockels cells

______ Beam transport lines
- ____ LCLS injector
- ____ Linac
  - ____ L1
  - ____ L2
- ____ BSY
- ____ LTU
- ____ Undulator
- ____ Dump
- ____ A-Line
- ____ GTL
- ____ SPEAR3 Linac
- ____ LTB
- ____ Booster
- ____ BTS
- ____ SPEAR3 Ring

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2.2 Beam Dynamics and Parameters

____ Transverse dynamics

- ____ Coordinate system
- ____ Single particle model
  - ____ Equation of motion
    - ____ Motion in a bend
    - ____ Motion in a quad
    - ____ Motion in a drift space
- ____ Mathematical description of ensemble of particles (bunch)
  - ____ Twiss and other important parameters
    - ____ β (beta)
    - ____ η (eta)
      - ____ What does the dispersion parameter describe? What are the units of dispersion?
      - ____ Where might it be desirable to minimize dispersion? Why?
      - ____ How would you measure dispersion at a specific location?
      - ____ How do we control dispersion?
      - ____ Use the model to determine dispersion at DL2 BPM 250.
    - ____ α (alpha)
    - ____ γ (gamma)
    - ____ ψ (psi) / μ (mu)
      - ____What is phase advance? How are the phase advance and beta function related?
    - ____ δ (delta)
    - ____ ε (epsilon)
    - ____ σ (sigma)
      - ____ Give 2 examples of techniques for making beam size measurements at SLAC. What are the strengths and weaknesses of these techniques?
- ____ Phase space ellipses
  - ____ Machine ellipse
  - ____ Beam ellipse
- ____ Betatron tune
  - ____ What is the betatron tune? What affects it?
  - ____ Tune resonances
- ____ Emittance
  - ____ What does the emittance parameter describe? What are the units of emittance?
  - ____ Why do we measure and try to control emittance? What information is needed to measure emittance?
- ____ Transport (R) matrices
- ____ Synchrotron damping
  - ____ Flat vs. round beams
- ____ Beta and eta matching
  - ____ What is matching?
  - ____ What is Bmag?

____ Longitudinal dynamics
- ____ Acceleration
- ____ RF bucket
  - ____ What is the synchrotron tune? What affects it?
  - ____ Why do we measure and control the tune?
  - ____ What are the units of tune?

- ____ Bunch compression
  - ____ In chicanes
  - ____ In the gun
- ____ BNS damping
- ____ What is chromaticity? What are its units?
  - ____ How do we measure chromaticity? Why do we measure and control it?
  - ____ How do we control chromaticity?

____ Special topics
- ____ Wakefields
  - ____ Longitudinal wakefields
  - ____ Transverse wakefields
  - ____ Wake loss measurement
- ____ Space charge effect
- ____ Bremstrahlung
- ____ Beam tails
- ____ Cathode quantum efficiency
- ____ Typical SLAC DLWG gradient
- ____ Production of coherent light from electron motion in undulators
- ____ FEL saturation

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2.3 Instrumentation and Diagnostics System

____ Explain which devices(s) we use to measure beam current and/or charge in the LINAC and SPEAR3, and how each device works. Which of these devices can act to shut off the beam?

- ____ Toroids
- ____ Direct Current Current Transformers (DCCTs)
- ____ Stripline Beam Position Monitors (BPMs)
- ____ Cavity (microwave) position monitors
- ____ Toroid comparators
- ____ ACMs

____ Explain which devices we use to measure electron bunch length in the LINAC, and how each device works.

- ____ BC1 and BC2 bunch length monitors
- ____ Transverse RF deflector

____ How does a photomultiplier tube (PMT) work? Where do we use PMTs in LCLS? How does a scintillator work?

- ____ PMT
- ____ Scintillator

____ What devices do we use to measure the transverse beam size and/or emittance in the LINAC? What are the problems and benefits associated with each device?

- ____ Profile monitors
- ____ Wire scanners

____ What devices do we use to monitor beam losses? How do these devices work? Do any of these devices shut off the beam?

- ____ Ion chambers
- ____ BSOICs
- ____ BTMs
- ____ PMTs

____ How do the FEE gas detectors work? How are they calibrated? How do we attenuate the x-ray beam in the FEE?

- ____ Differences for hard and soft x-rays
- ____ PMTs

____ How do we measure the beam energy at various points along the linear accelerator? How do we establish and calibrate the energy gain from injector stations when we turn on the machine after a shutdown?

____ Explain different ways to use the system we have for acquiring data that is synchronized from shot-to-shot (BSA). Explain how you would use the BSA system manually.

- ____ Real time BSA
- ____ Matlab BSA

____ Manually from an EDEF

____ Explain where each physical beam stopper is in LCLS and SPEAR3. Which stoppers are interlocked by the PPS system?

- ____ LCLS
  - ____ Mechanical shutter
  - ____ RST1
  - ____ TD11
  - ____ ST950/960
  - ____ D2
  - ____ BYKICK
  - ____ TDUND
- ____ SPEAR3
  - ____ Chopper
  - ____ LTB B1
  - ____ Tungsten target
  - ____ BTS stoppers
  - ____ PR2
  - ____ SPEAR3 ring stoppers

____ Remote scopes

- ____ ACR van scope

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2.4 Feedback System

- ____ LCLS
  - ____ Laser power set
  - ____ Bunch charge
  - ____ Gun launch
  - ____ Injector launch (to spectrometer)
  - ____ Injector launch
  - ____ X cavity launch
  - ____ L2 launch
  - ____ BSY launch
  - ____ DL2 launch
  - ____ LTU launch
  - ____ UND launch
  - ____ DL1 energy (to spectrometer)
  - ____ DL1 and BC1 energies
  - ____ DL1, BC1 energies + BC1 BL
  - ____ DL1, BC1, BC2 energies
  - ____ Energies to BC2 & BC1 BL
  - ____ Energies & BLs to BC2 (new)
  - ____ Energies to BSY
  - ____ 6x6 Feedback

- ____ SPEAR3
  - ____ Gun heater
  - ____ K2/K3 phase and amplitude
  - ____ Cable length
  - ____ FOFB
  - ____ RFFB
  - ____ BLDS

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2.5 RF System

____ RF function
- ____ Bunching
- ____ RF acceleration
  - ____ Linac RF

____ Hardware devices
- ____ Master oscillator
- ____ Master amplifier
- ____ MDL
- ____ VVSs
  - ____ Analog readbacks
  - ____ Reference voltage power supply
- ____ Modulators
  - ____ Modulator Klystron Support Unit (MKSU)
  - ____ Modulator PFN
  - ____ Thyratron
- ____ Linac klystrons
  - ____ Phase and Amplitude Detector (PAD)
  - ____ Programmable Input Output Processors (PIOPs)
- ____ Sub boosters
  - ____ Glassman power supply
  - ____ Solid state subboosters
- ____ Sub Drive Line (SDL)
- ____ Cavities
  - ____ Waveguides
  - ____ Disk loaded waveguide for the linac
  - ____ SLED cavities
- ____ Frequency dividers
  - ____
- ____ Isolation, Phase, and Attenuation (IØA) unit

____ RF controls and operation
- ____ Phase control
  - ____ Fox phase shifters
  - ____ Solid state phase shifters
- ____ Amplitude Control
  - ____ RF drive
- ____ RF feedbacks
  - ____ L0B
  - ____ L1S
  - ____ 24-1/2/3
  - ____ SBs 29 and 30

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2.6 Timing System

____ Linac system overview
- ____ Linac fiducials
- ____ Master Oscillator (MO)
- ____ Main Drive Line (MDL)
- ____ FIDOs
- ____ Linac PDUs
- ____ Simple Timing Buffer (STB)

____ LCLS system overview
- ____ EVG
- ____ EVRs
- ____ Event codes
- ____ Laser/RF synchronization/locking

____ Diagnostics
- ____ Master oscillator analog / digital status

____ Beamcodes, modifiers, and database
- ____ TRIGs/TRBRs

____ Comprehensive questions
- ____ A klystron is triggered through its CAMAC PIOP module. Draw a diagram and describe how the input pulse to the PIOP is generated. This diagram should include all of the modules and chassis between the master oscillator and PDU, as well as all of the modules and chassis between the MPG and PDU.
- ____ In the above example, describe what happens when this trigger is deactivated. Start by tracing the path between LCLS home and the PDU.

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2.7 Control System Hardware

____ Power supply control and interface
  ____ Computer Automated Measurement and Control (CAMAC) system
    ____ Power Supply Controllers (PSCs)
    ____ Digital to Analog Converters (DACs)
    ____ Smart Analog Modules (SAMs)
  ____ Nuclear Instrumentation Methods (NIM) system

____ Flow switches
____ Temperature (Klixon)
____ RTDs
____ Thermocouples

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2.8 Beam Containment System

- ____ Instrumentation (cards/modules/chassis)
  - ____ Ion chamber chassis
  - ____ Average current monitor
  - ____ Dual trip comparator
  - ____ Flow switches (DC detectors)
- ____ Beamline components
  - ____ Ion chamber
  - ____ LION
  - ____ PPS stopper cooling
  - ____ Protection collimator (PC)
  - ____ Beam shut-off ion chamber (BSOIC)
- ____ Machine modes
  - ____ D2 mode
- ____ BCS trip
  - ____ Beam permissive
  - ____ EVG broadcast
  - ____ TIU
  - ____ SBI
  - ____ Laser safety stopper
- ____ General
  - ____ Calculate maximum allowable charge sent to ESA using power limit set in BAS.
  - ____ How do we actively monitor and limit the power that can reach/be dissipated in an area?
  - ____ Under what circumstances are beamline BCS devices automatically bypassed?

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2.9 Machine Protection System

General

____ When are the Linac slow valves automatically inserted? The fast valves?

Link Node MPS

Architecture

____ Link processor
____ Link nodes
____ Shut-off Mechanisms
____ How is it fail-safe? Why no watchdog?
____ Stopper masking (ignore logic)
____ How can you tell which devices will fault the beam when an stopper is removed?
____ How are devices bypassed?
____ What approvals are required to bypass a device?

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2.10 Utilities

____ Electrical system
- ____ Electrical power distribution
  - ____ Master substation
  - ____ Distributed substation
- ____ Variable Voltage Substations (VVSs)
- ____ Power glitches
- ____ Brown out
  - ____ Site power meter
- ____ Power supply types
  - ____ AC to DC converters
  - ____ Large Power Supplies (LGPSs)
    - ____ Individually powered magnets
    - ____ String power supplies
      - ____ Shunts
      - ____ Backlegs / Trim windings
      - ____ Boosters
  - ____ Small Power Supplies (SMPSs)
  - ____ Pulsed high voltage systems

____ Water system
- ____ Cooling towers
- ____ Low Conductivity Water (LCW) pumps
- ____ Heat exchangers
- ____ Demineralizers
- ____ MAKO still
- ____ Deaerators
- ____ Sand filters
- ____ Containment sumps
- ____ Hydrogen recombiners
- ____ Chilled water Systems

____ Compressed air

____ Gas systems
- ____ Dry nitrogen
- ____ PLIC gas
- ____ Helium gas
- ____ Argon

____ DCS

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2.11 Vacuum System

____ What is the pressure range spanned by SLAC's vacuum systems? Go down the machine and give an estimate of the nominal pressure in each area.

____ What types of vacuum pumps and gauges are used on site? What are their operating principles? Over what pressure range do they function?

____ How are vacuum pumps connected to the beamline?

____ What types of vacuum valves are used on site? What purpose does each type of valve serve?

____ What are the potential consequences of sudden increases in pressure?

____ How does the machine respond when pressure spikes are detected? How should we as operators respond?

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3. Operating Techniques

The lists in this section present operating techniques. You must have the ability to perform the techniques at the ASO-2 level as specified in the Accelerator System Operator II job specifications before proceeding to the area-specific details provided in the next section.

3.1 Turning on Systems

____ Review the cold checkout checklists in the area-specific turn-on checklist documents.
____ Review hot checkout checklists in the area-specific turn-on checklist documents.
____ Review the area-specific turn on procedures.

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3.2 Steering Beams

____ Manually steer beams using BPMs and correctors
____ Power steer beams
____ Feedback setpoint steer
____ Make a bump (find FJ Decker program)
____ Remove questionable or faulty BPMs
____ Steer to a reference

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3.3 Operating Feedbacks

____ Enable and disable feedbacks
____ Start and stop feedbacks
____ Re-gold feedbacks
____ View and interpret feedback logs
____ Update feedback act refs, restore feedback acts
____ Config/Ref. Orbit
- ____ Configure
  - ____ Measurements
  - ____ Actuators
  - ____ States and gains
  - ____ Matrices
  - ____ Timer parameters
  - ____ Other feedback parameters
- ____ Reference orbit
  - ____ Collect reference orbit
  - ____ Edit reference orbit
  - ____ Load reference orbit

____ Configure 6x6 feedback
____ Configure Fast Longitudinal feedback

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3.4 Operating Klystrons

____ Phase klystrons/sub-boosters
____ Gold klystrons
____ Understand klystron CUD and 3-letter codes for faults
____ Interpret fast time plots
____ Assign and deassign klystron triggers
____ Measure and adjust sub-booster and klystron timing
____ Understand the use of LEM and use the LEM algorithm
____ Turn the modulator on/off
____ Reset the modulator
____ Adjust klystron amplitude
____ Verify/alter auto trim control
____ Understand klystron auto-trim
____ IPL individual klystron
____ Set klystron rate using mask bits
____ Home Fox phase shifter
____ Decode DSTA and klystron status
____ Set and tune klystrons for SLEDed and unSLEDed modes

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3.5 Operating the Timing System

- ____ Set up and modify beam codes
- ____ Monitor and adjust kicker timing
- ____ Monitor and troubleshoot fiducials timing
- ____ Assign and deassign triggers
- ____ Assign/deassign/modify TMVAs
- ____ Reinit PDUs
- ____ Describe loss of LCLS RF/laser synchronization and run resync GUI
- ____ LCLS Event/Trigger displays

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3.6 Operating Magnets

____ Trim magnets
____ Calibrate magnets
____ Standardize magnets
____ Degauss magnets
____ Decode Hardware Status
____ Decode Software Status
____ Decode secondaries
____ Decode CAMAC Status (CSTA)
____ Load correct configuration
____ Set magnets to on/off line
____ Setup multi-knob
____ Calibrate enable
____ Standardize enable
____ DAC Zero
____ Act to DES

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3.7 Operating BPMs

____ How are BPMs calibrated in the linac? In the undulator hall?
____ Calibrate toroids
____ Scale TMIT values
____ Take buffered data acquisition
____ Use LCLS BSA system to acquire data
____ Save reference orbits
____ Diagnose bad BPMs
____ Set to on/off line
____ Check/adjust BPM timing
____ Create measurement definitions

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3.8 Using Wire Scanners

____ Measure emittance
____ Interpret data (BMAG and ellipses and individual wire profiles)
____ Measure energy spread
____ Measure tails with single wire scan displays
____ Change and re-init scan ranges
____ Run wire loop macro

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3.9 Using Profile Monitors

____ Select cable video channels
____ Operate video distribution
____ Operate hardwired video
____ Digitize a profile monitor
____ Operate profile monitor mechanical controls (iris, lamp, and so forth)

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3.10 Using the Control System

____ LCLS home

- ____ Be able to launch and use the archive viewer
- ____ How do you add a channel to the archiver?
- ____ Demonstrate how to use CVS to edit an EPICS panel.
- ____ Demonstrate how to reset an offline IOC.
- ____ How do you determine the alarm limits of a PV?
- ____ Be able to launch LCLS home from your office
- ____ Use CMLOG

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3.11 Using the ACR Hardware and Software Displays and Controls

____ For the hardware displays and controls, know the location of and how to read the:

- ____ Annunciator panel
- ____ Fire alarm panel
- ____ Master beam control panel

____ For the software displays and controls, know the location of and how to read the

- ____ SDS CUD
- ____ MPS CUD
- ____ Klystron CUD
- ____ CUD control
- ____ Special display

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3.12 Using the Machine Protection System

____ For the LCLS link node MPS, know how to:
- ____ Identify a fault
- ____ Bypass an input
- ____ Reset a fault

____ In the MPS GUI, know how to
- ____ Show fault history
- ____ Find inputs
- ____ Find recent faults

____ For the guardian, know how to
- ____ Reset a fault
- ____ Find inputs
- ____ Find recent faults

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3.13 Using the Beam Containment System

____ Clear faults on all required BCS devices
____ Check dual trip comparator trip points
____ Check average current monitor trip points
____ Perform BAS checks for all active BCS devices

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4. Area-Specific Operating Techniques

The operating procedures for each accelerator area are organized as follows:

Setup: These procedures are used to set beam and system parameters to values specified in the operating and reference manuals. These procedures are typically implemented at the beginning of a run or after a down time. However, they may also be used during running if beam conditions fall outside the specified values.

Tuning: These procedures are used to maintain and make incremental improvements to beam conditions and machine operation. These procedures are used during running.

Diagnostics: These procedures are used to set up diagnostics and interpret and quantify running conditions for a particular region. These procedures are used continuously during normal running to monitor beam conditions and to isolate problems when they arise.

4.1 A-Line Operating Techniques

____ Set up

- ____ Turn on and standardize magnets
- ____ Set up injector beam
- ____ Set up linac beam
- ____ Deliver beam to BSY
- ____ Deliver beam to A-Line
- ____ Turn on and gold launch feedbacks

____ Diagnostics

- ____ Monitor injector beam utilizing PMTs, toroids, and BPMs
- ____ Monitor linac beam utilizing BPMs, feedbacks, and PLIC
- ____ Monitor BSY energy utilizing the flip coil and energy feedback.
- ____ Describe A-line beam losses utilizing profile monitors, ion chambers, and A-line PLIC.
- ____ Minimize losses
- ____ Optimize energy spread
- ____ Optimize spot size at the ESA target
- ____ Find the energy of an unknown energy beam

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4.2 LCLS Injector Operating Techniques

____ Turn on and calibrate the LCLS gun
____ Turn on and calibrate L0a
____ Turn on and calibrate L0b
____ Turn on and calibrate L1s
____ Turn on and calibrate L1x
____ Set up laser/cathode for switch between low and high current running
____ Save/load partial and full configurations
____ Set up beam to gun spectrometer
____ Set up beam to SAB
____ Set up beam to TD11
____ Perform Schottky scan and interpret results
____ Perform L0a, L0b, L1s phase scans and interpret results
____ Set gun solenoid strength
____ Recover from a bucket jump
____ Perform laser maintenance
____ Set DL1 energy
____ Set BC1 energy
____ Set bunch length/peak current in BC1
____ Complete the updated list provided by your supervisor for this section

Supervisor (Signature/Date):____

4.3 LCLS Linac and LTU Operating Techniques

- ____ Take bunch length measurements using TCAVs
- ____ Perform individual klystron phase scans in L1, L2, and L3
- ____ Perform L2 and L3 phase scans and interpret results
- ____ Perform slice emittance measurement and interpret results
- ____ Set BC2 energy
- ____ Change between overcompressed and undercompressed setup
- ____ Measure and identify sources of jitter in the linac and LTU
- ____ Complete the updated list provided by your supervisor for this section

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4.4 LCLS Undulator, Dump, and FEE Operating Techniques

____ Insert and remove undulators
____ Perform undulator beam finder wire scan
____ Insert and remove undulators
____ Perform undulator K measurement
____ Adjust taper for maximum FEL power
____ Steer beam in undulator
____ Calibrate undulator RF BPMs
____ Perform BBA
____ Perform energy loss measurement
____ Control foil attenuators in dump
____ Set solid attenuators in FEE
____ Set gas attenuators in FEE
____ View beam on direct imager

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4.5 SPEAR3 Injector

4.5.1 Establish Beam in the Linac

___ Verify that the Gun Heater is on

___ Describe the Gun Heater power supply location

___ Open vacuum valves in the linac, booster and LTB

  ___ Vacuum valve controller location, software and hardware

  ___ Ion gauge indications, software and hardware location

___ Ensure the CEBAF power supplies are on (quads and correctors)

  ___ Identify location of PSs

  ___ Load and save lattice

  ___ Describe software control for CEBAF PSs

___ Turn on Alpha PS

  ___ Describe location of PS

  ___ Load and save lattice (web based)

  ___ Describe software control for Alpha PS

  ___ Set the scraper correctly

___ Ensure availability of triggers (10Hz and RF)

___ Turn on the Modulators

  ___ Describe location of HVPS breakers and PSs for K2 and K3

  ___ Identify the sections of the linac powered by K2 and by K3

  ___ Reset modulators (needed when first turned on) to get triggers

___ Describe software controls for the linac RF, K2 and K3 and gun

___ Look at the gun and linac temperature in the history buffer to verify they are correct

  ___ Know the location of the TCW and gun chiller

___ Monitor the GT1 signal and turn on the feedback

  ___ Define operational value for the GT1 FB

  ___ Use Pulse Signal Monitor (PSM) diagnostics to ensure correct values

___ Describe how to turn on and set:

  ___ Phase feedback for K2, K3 and Gun

  ___ K2 and K3 power feedback

  ___ Controls for the feedbacks

___ Check GT2 to ensure the beam propagates beyond the Alpha magnet

___ Enable chopper trigger control

___ Monitor linac beam on the ACMs

- ___ Set alpha scraper position to keep beam intensity below the BAS limit

___ Turn on the LTB-B1 magnet PS

- ___ Describe the location of hardware and software controls
- ___ Monitor beam on the LTB B1 screen

___ Adjust beam to the correct energy and phase

___ Describe how to Save/Restore values for any parameter/control panel

4.5.2 Interlocks

___ Linac interlocks:

- ___ PPS fault
- ___ BCS
  - ___ Chopper HV
  - ___ ACMs
  - ___ BSOICs
  - ___ Top-off interlock (lasts for ~2 seconds)
  - ___ Frequent fill module
- ___ MPS
  - ___ Alpha magnet
  - ___ Vacuum
  - ___ RF VSWR
  - ___ Modulator interlocks chassis
  - ___ LCW
  - ___ SPEAR orbit software interlock

Supervisor (Signature/Date):____

4.6 SPEAR3 Ring

____ DC Power Supplies
- ____ Dipoles
  - ____ How does the power supply for a SPEAR3 dipole magnet differ from that of another type of magnet (e.g., a quad)?
- ____ Quadrupoles
- ____ Sextupoles
- ____ On/off procedure
  - ____ How do you turn off an individual DC power supply? All of them?
  - ____ How are the individual set point values for each magnet determined?
  - ____ What is meant by LATVAL? IMONSP? IMON?
  - ____ What are the MCORS?
  - ____ How do you turn the MCORS off and on?

____SPEAR RF
- ____ Main RF panel
  - ____ How do you get to the main RF EPICS panel?
  - ____ How do you adjust the gap voltage?
  - ____ How do you turn off the RF?
  - ____ How do you reset faults and turn the RF station on?
- ____ How do you bring up the ring after an access or a downtime?

____ DCCT
  - ____ What is the DCCT?
  - ____ Where is the DCCT device physically located?
  - ____ What is the DCCT used for?
  - ____ What is the NPCT and how does it relate to the DCCT?

____ FOFB/RFFB/BLDS
  - ____ What do the FOFB. RFFB, and BLDS acronyms stand for?
  - ____ How does the FOFB work?
  - ____ How does the RFFB work? What's its relationship to FOFB?
  - ____ How does BLDS work?

____ Topoff
- ____ Interlocks
  - ____ What are the topoff interlocks intended to protect against?
  - ____ If a topoff interlock is tripped, what action does it take?
- ____ Master Key
  - ____ What function does the Topoff Master Key serve?
  - ____ Where is it normally kept?

____Bucket Selection
- ____ Buck-o-Mat
  - ____ What is Buck-o-Mat?
  - ____ What is the primary function of Buck-o-Mat?

- ____ What other tasks can be performed from the Buck-o-Mat panel?
- ____ Bucket Timing Chasses

____ Orbit Interlock

- ____ What is the Orbit Interlock intended to protect against?
- ____ How does it work?
- ____ What action is taken if the Orbit Interlock is faulted?

- ____ BSOICs
- ____ Kickers
- ____ Insertion Devices/Control
- ____ Beam Lines

Supervisor (Signature/Date):____

Revision Record

Revision Number	Revision Date	Section(s) Affected	Description of Change
R001	July 26, 2017	All	Updated signature blocks on page 1. General updates.
R000	April 26, 2010	All	General updates. New document number. *(old document says R004 but should be R000.)*