

FACET-II Electron Gun Cathode Laser Cleaning Procedure

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Assumptions (1/3)

- All spot size definitions are quoted **FWHM**
- factor 2 safety margin in energy quoted everywhere, expect operational values to be lower
- From ATF experience: 20 uJ needed to clean 60 x 200 um spot
- Clean a circular area on cathode, Radius = 1.5 mm
 - Smaller than assumed in simulations so far
 - Looks to give about the same emittance, start with this and maybe increase later
 - This is with a mind to optimize the clean area to be close to the operational emission area to minimize dark current (and cleaning time).
- Use 3 shots per step, 0.2 x FWHM step size (90% of Gaussian peak, 0.46σ)
 - Actually: issue continuous motion command for each “line” of circular area to minimize motor commands.
 - i.e. take $3/\text{rep_rate}$ sec to traverse $0.2 * \text{FWHM}$ spot size

- Cleaning takes place when there is a 10% increase above the laser energy which raises the gun vacuum by $3\text{E-}11$ above observed background level.
- Cleaning re-deposits contamination over previously cleaned areas. Multiple cleaning passes required.
- Laser parameters for cleaning:
 - 200um x 200um @ 130 μJ
- Time for single cleaning of 1.5mm radius circle
 - $3 \times (\pi \times 1.5^2) / (\pi \times 0.04^2) / 30\text{Hz} = 7.4$ mins (say 15 mins with mover control end effects)
 - ~1 hour if increase to original 3mm circle

- Parameters to observe:
(controls shutdown of cleaning procedure)
Both Matlab & EPICS DB watchdogs for this
 - Laser in laser room, uv position and energy
 - VCC expected motion, energy & size
 - Joulemeter laser energy
 - Gun vacuum gauge (and secondary vacuum gauge?)
 - Readback from motion controller
- To also monitor for interest:
 - Reflection camera position and energy

Pre-Cleaning Steps

- Start by checking laser energy level over circumference of cleaning area and across diagonals.
 - Laser set to non-cleaning strength.
 - Checkout of motion, read back of spot size and stability of energy using all diagnostics (joule meter, VCC & reflection camera).
- Set 200x200 um spot size on cathode with laser
- Set laser position outside of clean area to determine laser energy.

Cleaning Procedure

- 1) Gun RF power OFF
- 2) Laser off - get CCD background image
- 3) Close gun vacuum
- 4) Reconfigure laser optics for cleaning
 - open shaping iris
 - reduce laser spot size = 200 um FWHM
 - Tune iris to optimize laser image quality
 - Check laser pointing stability, should be <10% FWHM spot size
- 5) Note starting vacuum level
 - Must < 9E-10
- 6) Laser ON
 - Initial energy = 30 uJ
 - Rep. Rate = 30 Hz
- 7) Select cleaning area using GUI
 - Use illuminated cathode image or past QE map as guide
- 8) Set cleaning laser energy
 - Move laser spot outside "clean" area
 - Increase laser energy slowly until vacuum rise 10% above initial noted in (5)
 - Return laser spot to center of cleaning area
 - Close laser shutter
- 9) Set laser energy operating range = +/- 10% from set point (used in watchdog)
- 10) Set # pulses per cleaning step = 3
- 11) Set step size = $0.2 * \text{FWHM laser pulse width (90\% of Gaussian peak)}$
- 12) Mover laser spot position to start (x,y coordinates)
 - This should alternate between top and bottom of cleaning area (enforced by GUI)
- 13) Start watchdog (EPICS) (GUI sends laser energy and vacuum watch limits)
- 14) Open laser shutter
- 15) Set motor velocity [step size * (rep.rate / pulse per step)]
- 16) Start moving across line (set dx absolute motor move)
- 17) Monitor conditions during move
 - Laser energy in range?
 - Gun vacuum within limits?
 - Laser spot at anticipated location?
 - Is EPICS watchdog program still running?
 - If any of above false => insert shutter, issue GUI warning dialog, stop autoclean program (remember progress for user commanded restart)
 - Write to EPICS watchdog userProc PV to inform watchdog that Matlab software still alive and running
- 18) Check if still moving across current line
 - if yes, loop to (18)
 - if no, line finished
 - close shutter
 - move to start of next line
 - all lines finished?
 - if yes, stop
 - if no
 - check background vacuum level (shutter closed)
 - loop to (14)
- 19) Set laser to operating spot size and energy, check QE.
- 20) Ave QE < 5e-5
 - Yes, then increase laser energy by 10%, loop to (9)
 - No, repeat cleaning process X3
 - Optionally measure QE map, then done. Make log entry (history kept by cleaning GUI).