Timeline

2018

* Jun – Started learning about ionization, plan to get feet wet over ~6 months
* Jul – Analyzed Gun2 lifetime data w/ V-Wien ON/OFF
* Aug – Got his PC, started learning how to run GPT
* Sep – Started weekly meetings, w/ Geoff; began calculations for collective ion effects
* Oct – Developed GPT expertise, to demonstrate longer-term trapping
* Oct – Got IBSimu installed at JLab, met w/ Erdong discuss collab on GPT
* Nov – Started observing ghost beam, modelling ion collection, ~week of beam studies
* Dec – Worked to get image analyzer statistic live at GTS

2019

* Jan – Learned how to run GPT on farm, analytic trapping conditions, USPAS
* Feb – Oral qualifier scheduled late Feb: discuss a physics topic, present thesis outline…

Thesis Outline

Introduction

* Gas in accelerator vacuum channels is rapidly ionized by leading to ‘bad’ effects:
  + bombardment of photocathodes => degradation of QE
  + bombardment of surfaces => further secondaries and gas load
  + charge neutralization => limits cw operation for high current (no clearing time)
  + bremsstrahlung => generation of x-rays
* Examples
  + Storage rings and high current linacs require clearing gaps
  + DC high voltage guns require precipitators
  + Polarized GaAs photocathodes require ion mitigation to extend QE/uniformity
* Stated Goal
  + Improve the charge lifetime of polarized GaAs photocathodes producing high current from DC high voltage photogun

Theory & Simulation

* Quantify the effects of ion impact (sputtering, implantation) that lead to reduction of quantum efficiency. Use analytic calculations and code like SRIM to characterize and calibrate the simulated dose (intensity, energy) that leads to these effects,
* Quantify the dynamics of ionization (electron impact, of residual gas, secondaries, and x-rays, retroreflections) that leads to generation of ions. Use analytic calculations and codes like IBSimu and GPT to model the dynamics (how these depend upon imposed and self fields) in order to quantify the pathways that result in ion impact at the photocathode.

Experiments & Analysis Goals

* #1 - Design and implement a diagnostic you can use to test and calibrate your model and simulation of production of ions that may affect the photocathode; these diagnostics might be a new ion trap or precipitator, x-ray monitors for beam loss/secondaries, or for recombination or retroreflected laser light; install the diagnostic(s) on a beam line to perform these studies, and to improve the tool as an ion monitor for next stages…
* #2 - Consider measurements of photocathode damage, where your knowledge of ion production and transport to photocathode is demonstrated, well-understood, measurable; perform measurements to characterize the reduction in QE vs. conditions that are as well controlled as possible; use your data to compare and calibrate against model and simulations of photocathode damage; you are now developing calibrate cause “ions” and effects “damage” relationship, which can be used for final leap
* # 3 - Motivated by your simulations modify the design of a dc high voltage photogun to test the ability to suppress/mitigate the ill-effects of photocathode ion bombardment; consider redesign of cathode/anode geometry e.g. to allow larger beam size, limiting total number of ions that may reach the photocathode, and secondary effects (recombination light, x-rays, gas load); in particular use your work to estimate the ability to operate with charge lifetime exceeding 1kC at milliampere current; the solutions should disentangle effects in cathode/anode gap, downstream of gap, and related to beam rep rate/peak current, etc