

The DP&F Changed My Life:

*Ten Years of Accelerator Physics, the Future of Mexico, and a
Nuclear Fusion Reactor in London*

04/19/2026

Gabriel Palacios Serrano

gabriel.g.palacios.serrano@gmail.com

Outline

- My Career Path
- Introduction
 - Photogun
 - Wien-type Spin Rotator
- Challenges
- Solutions
- Side Missions
- New Projects
- Acknowledgments
- End

My Career Path



Azcapotzalco

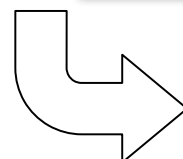
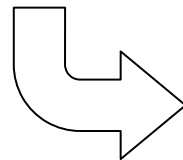


SMF

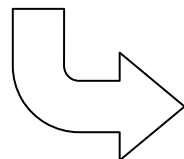
Sociedad Mexicana de Física



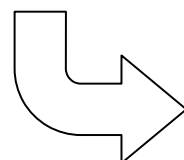
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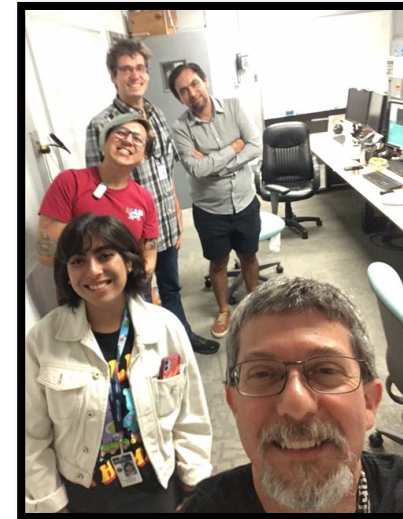
OLD DOMINION
UNIVERSITY



Brookhaven
National Laboratory



Jefferson Lab
Exploring the Nature of Matter



Carlos Hernández García
Former Senior JLab Scientist,
Currently X-Light

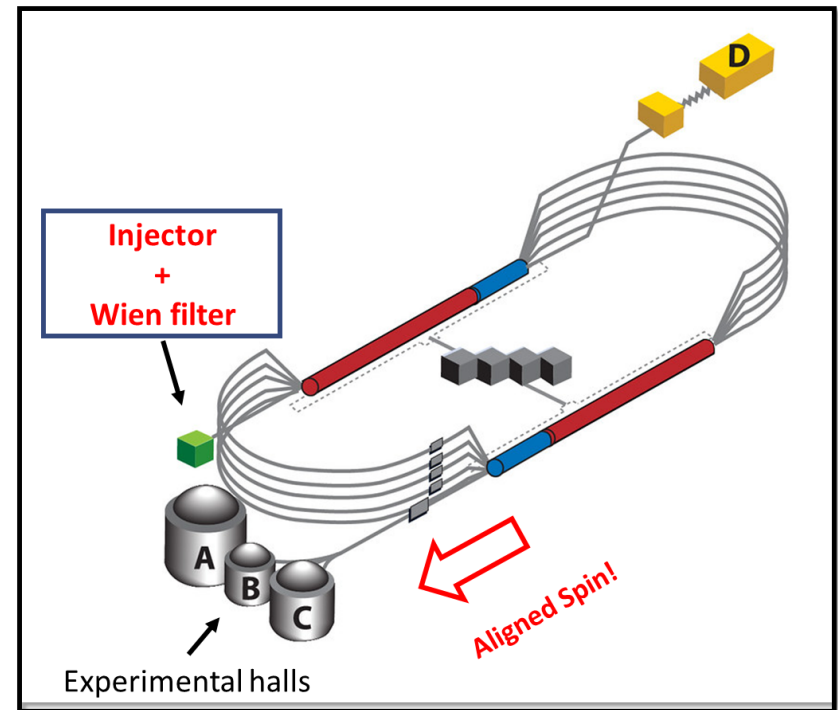


Introduction

- **Objective:**
 - Upgrade the polarized photoelectron source of the main accelerator
 - From 130 keV to 200 keV,
 - along with its spin rotators (Wien filter).
- **What for?***
 - Parity violation experiments
 - Quark structure of nuclei
 - Spin and flavor dependence of valence parton distributions
 - Three-dimensional structure of nuclei
- **Challenges:**
 - Higher voltage
 - Field emission
 - Electrical arc
 - Insulator failure
 - Vacuum degradation
 - Beam quality
 - Unwanted photoemission
 - Photocathode damage
 - Catastrophic device failure!

* P. A. Adderley, et al. **The Continuous Electron Beam Accelerator Facility at 12 GeV.** Phys. Rev. Accel. Beams 27, 084802 – Published 15 August, 2024

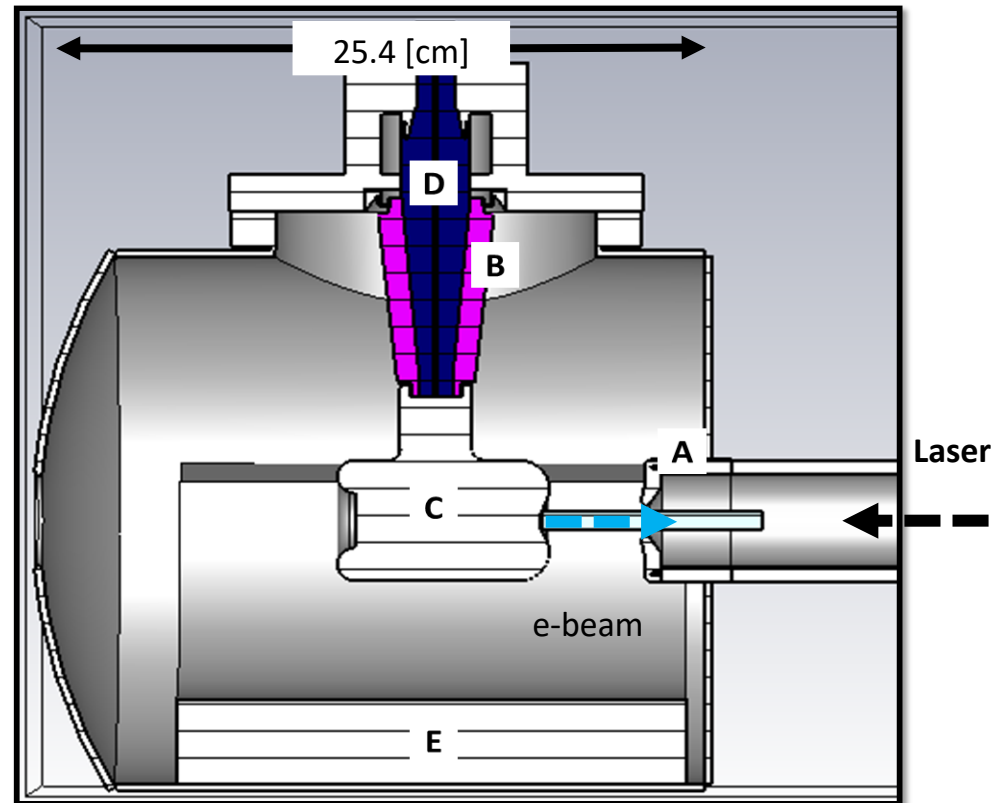
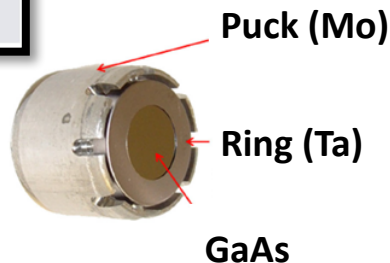
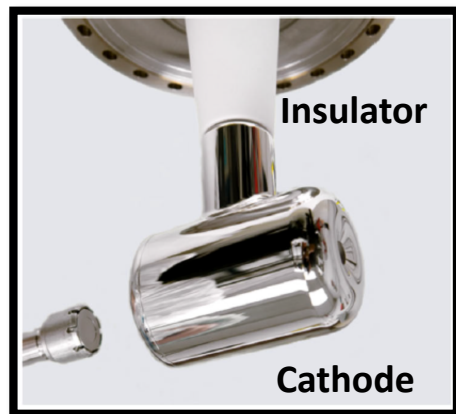
Thomas Jefferson National Accelerator Facility (2019)



- 5.5 passes, 12 GeV, 90% polarization
- 2X 7/8 mi (1.4 km) Linacs plus recirculating arcs

Introduction

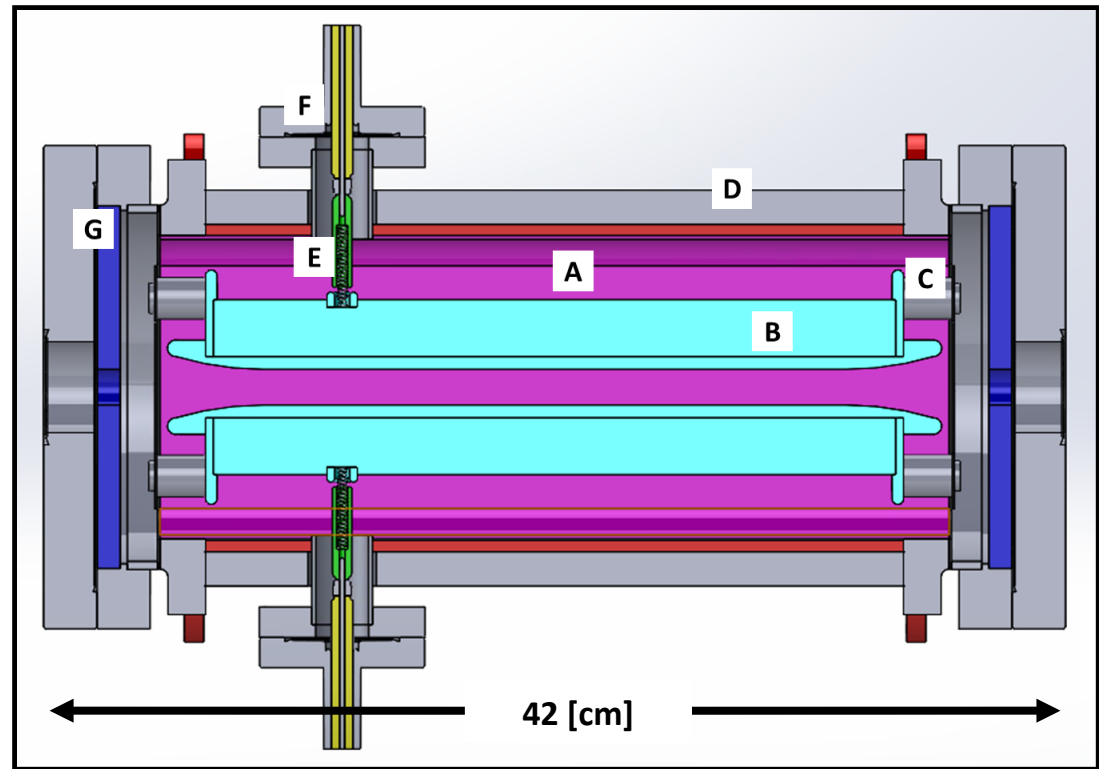
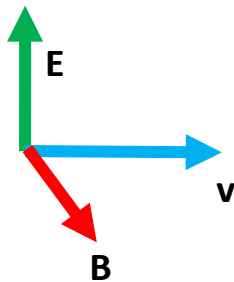
- The polarized electron beam is produced by illuminating a GaAs photocathode mounted on the HV electrode in UHV conditions.
- Higher voltage can lead to field emission → flashover/arcs → catastrophic device failure.
- To address this: an electrostatic shield is implemented.



Longitudinal cross-section of the CEBAF photogun. Vacuum chamber with (A) anode, (B) conical ceramic insulator with (C) connected cathode. High-voltage conductor surrounded by (D) vulcanized rubber, (E) non-evaporable "getter" vacuum pumps connected to ground.

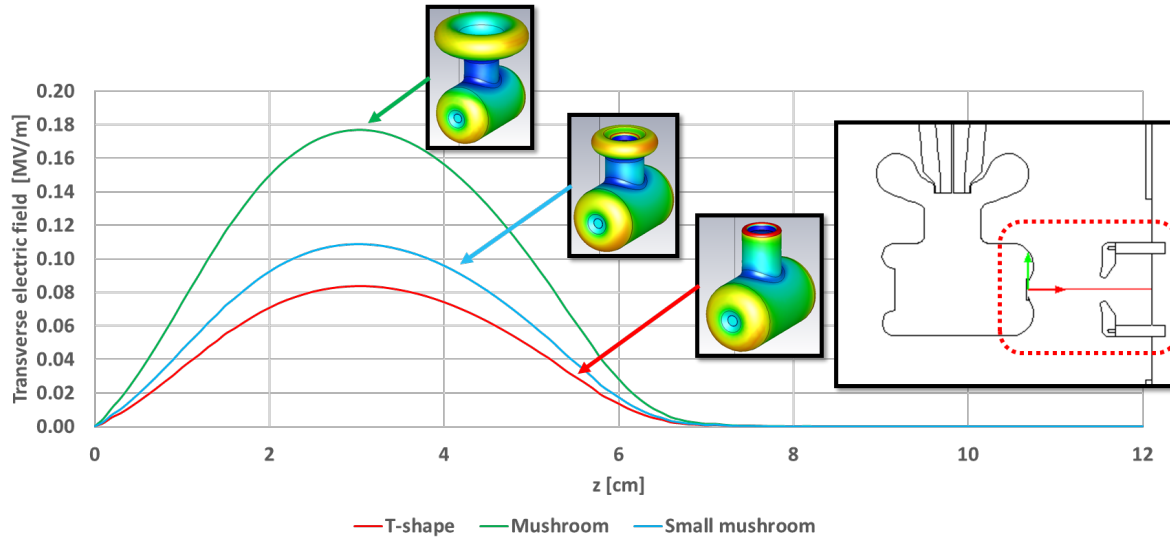
Introduction

- In the Wien filter, homogeneous, mutually orthogonal electric and magnetic fields rotate the spin polarization angle of electrons (with velocity orthogonal to the applied fields) traveling longitudinally along the device axis.
- The existing Wien filter spin rotator must be modified to ensure compatibility with higher-energy beams, increasing its operating voltage while avoiding field emission and any modification of the beam trajectory.



Longitudinal cross-section of the 130 keV Wien-type spin rotator with (A) vacuum chamber, (B) electrode plates, (C) mounting insulators, (D) magnetic shielding, (E) high-voltage contact, (F) high-voltage feedthrough, and (G) magnetic mirrors.

Challenges: Photogun



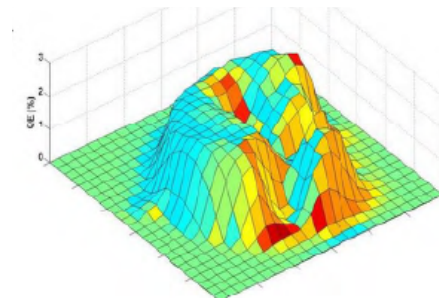
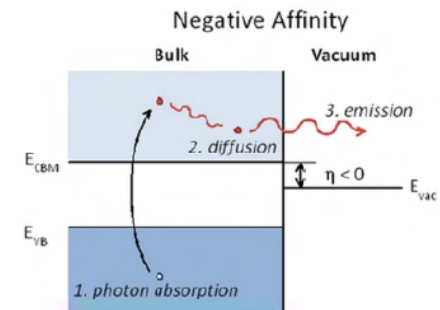
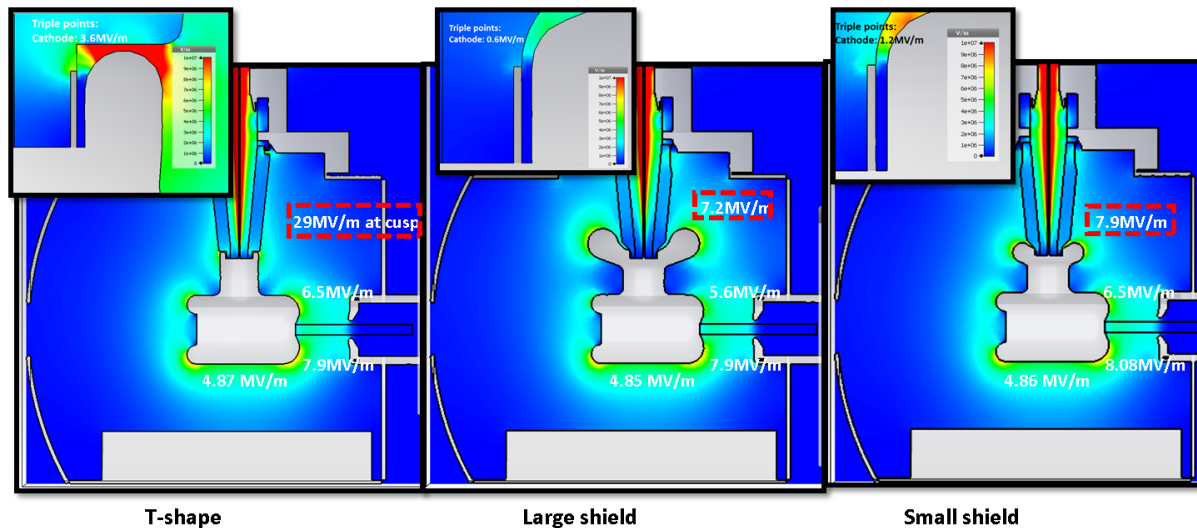
Field emission, Fowler-Nordheim:

$$J = (A\beta^2 E^2 / \Phi) \exp \left[-B\Phi^3 (\beta E)^{-1} \right]$$

Space charge:

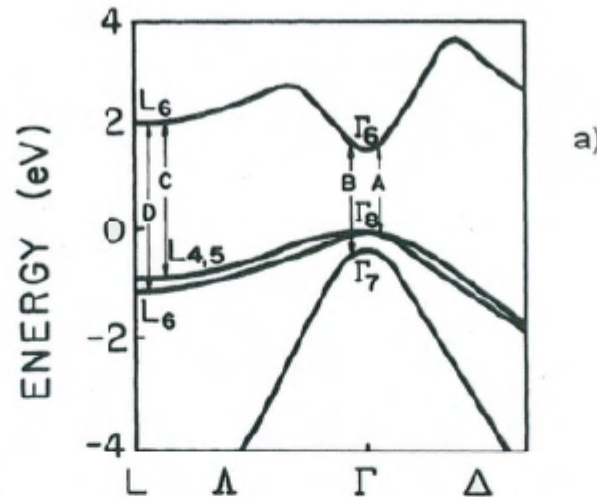
$$F_r(r) = \frac{e\lambda_0 r}{2\pi\epsilon_0 a^2 \gamma^2}$$

Negative affinity and back-bombardment:



Challenges: Photogun

And the spin!



An Engineering
Guide To
Photoinjectors

Triveni Rao, David H. Dowell

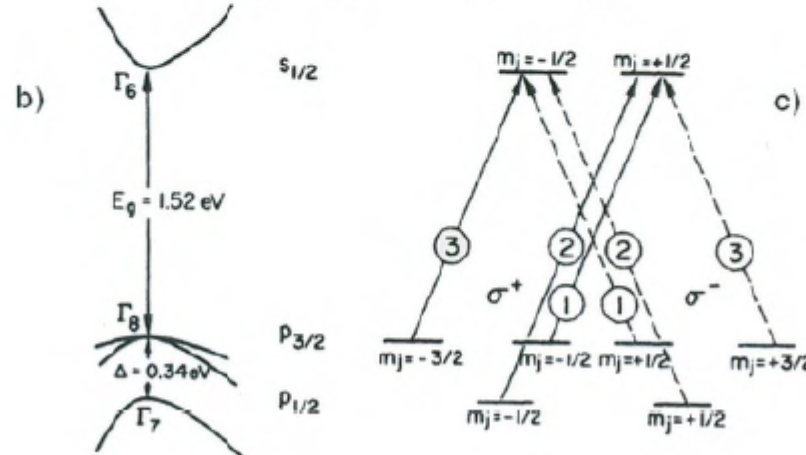
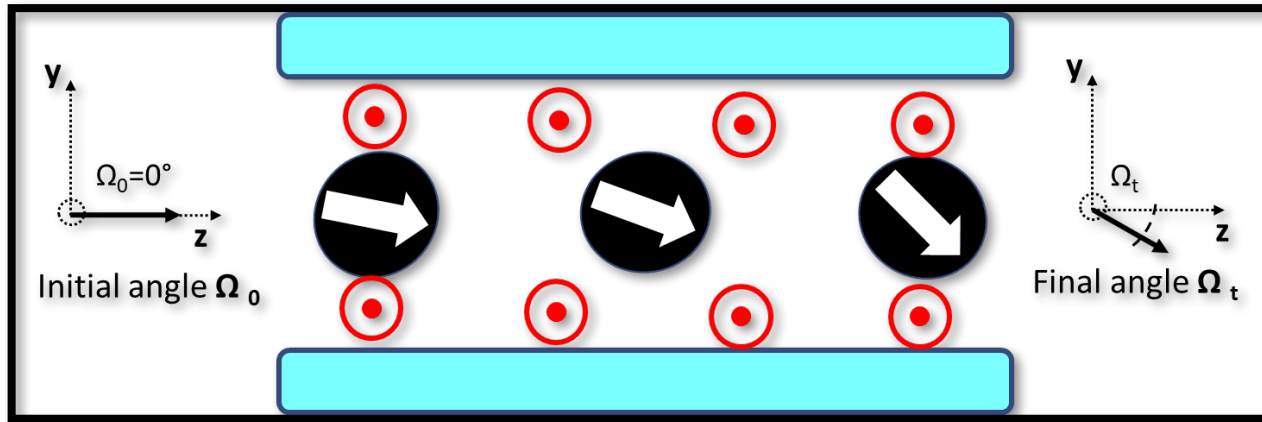


Figure 8.1. Energy level diagrams of GaAs: (a) Detailed band structure of GaAs; (b) “close-up” view near valence band maxima/conduction band minima; and, (c) simplified view showing individual spin-angular momentum states and transition probabilities, circled. [Reprinted figures with permission from [8.20]. Copyright 1976 by the American Physical Society]

Challenges: Wien-type Spin Rotator



Thomas-BMT is the equation of motion for the spin vector (in the particle's rest frame):

$$\frac{ds}{dt} = \mathbf{s} \times \mathbf{\Omega}$$

Then, the rotation angle:

$$\mathbf{\Omega} = -\frac{e}{mc} \left[\left(a + \frac{1}{\gamma} \right) \mathbf{B}_\perp + \frac{1+a}{\gamma} \mathbf{B}_\parallel - \left(a + \frac{1}{\gamma+1} \right) \boldsymbol{\beta} \times \mathbf{E} \right]$$

What?!

In our case

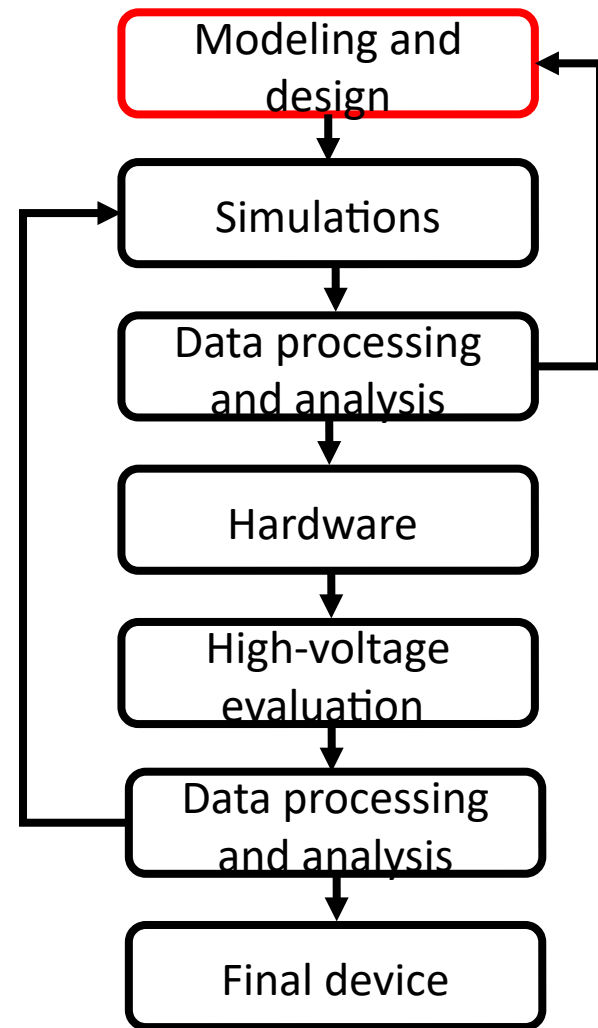
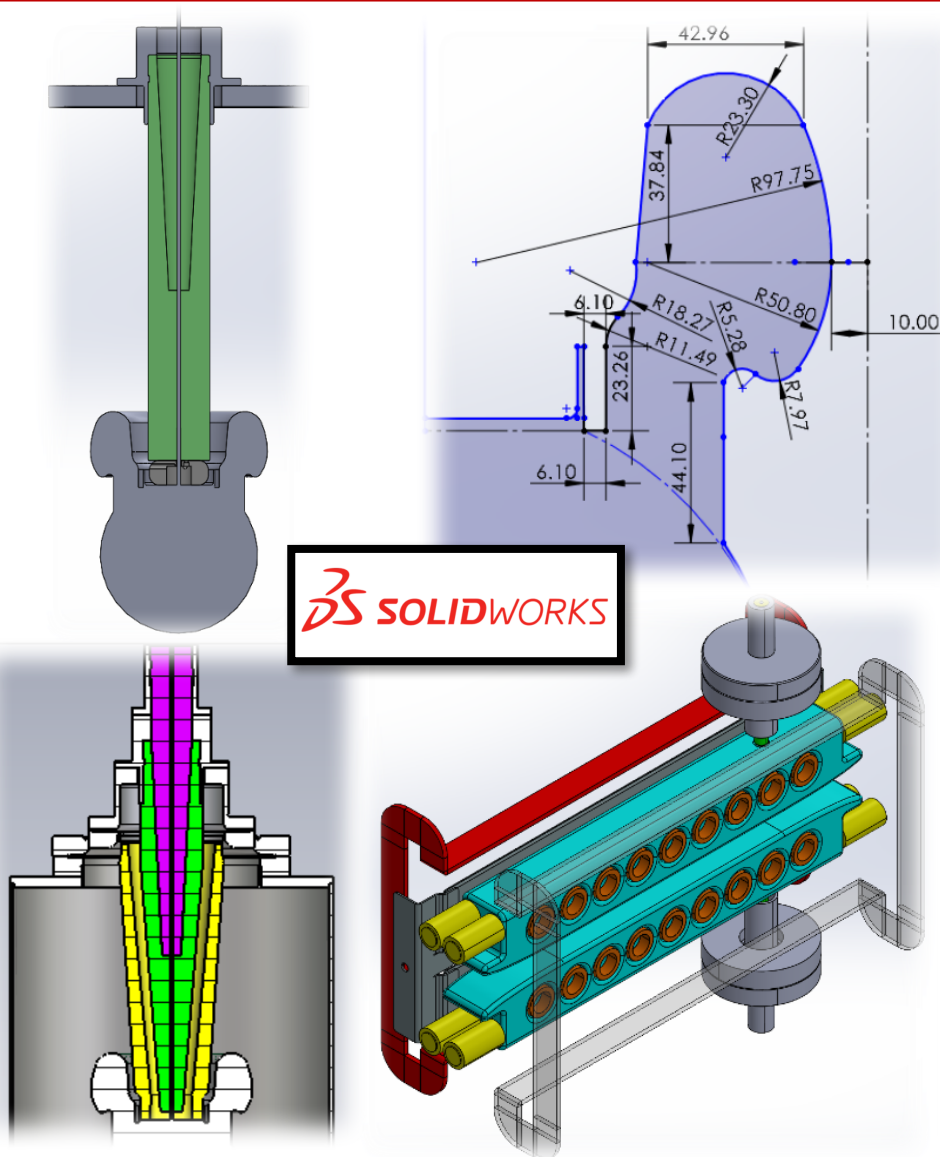
$$B_x = \frac{mc\beta\gamma^2\theta}{eL}$$

where $\Omega = \frac{d\theta}{dt}$

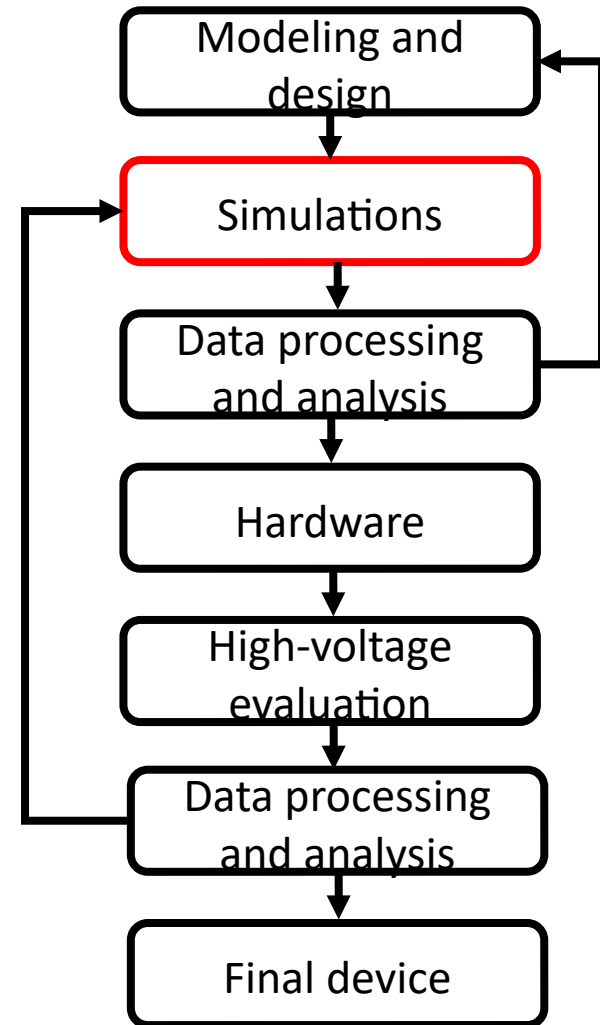
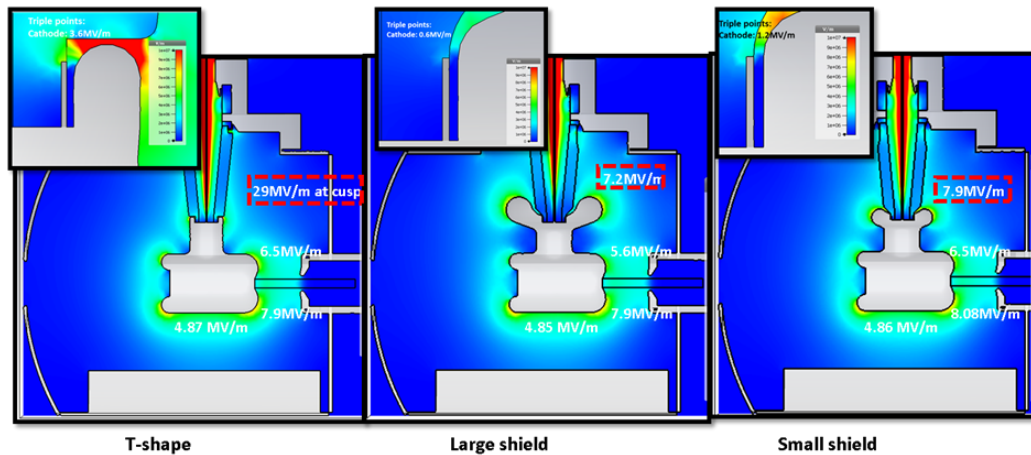
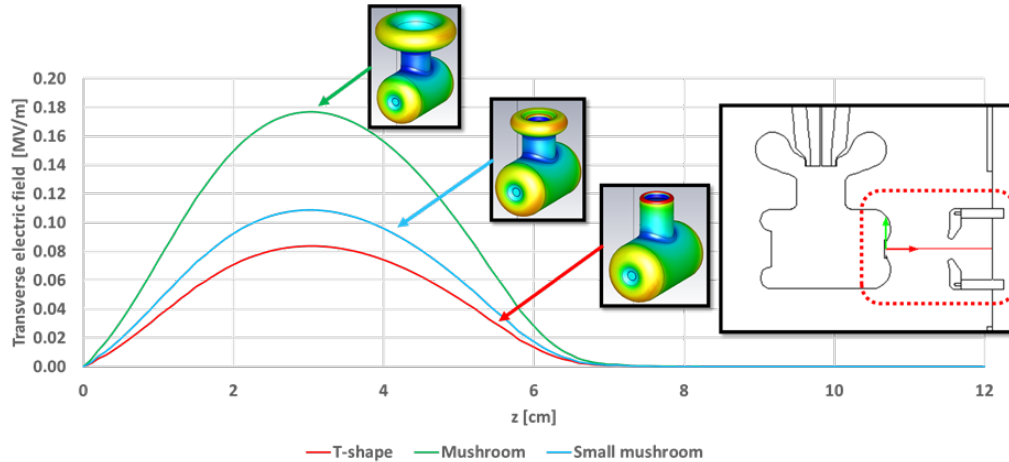
Plus the equilibrium condition: $q(\mathbf{E} + \mathbf{v} \times \mathbf{B}) = 0$

which in turn preserves: $E_y = -v_z B_x$

Methodology



Methodology



Methodology

```
# importing pandas module
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

print ("Give me the left side filename (In CSV format)")
file_name_left=input()

print ("Give me the right side filename (In CSV format)")
file_name_right=input()
|

def reader(file_name, column_tag):
    global data
    global means
    global column_max

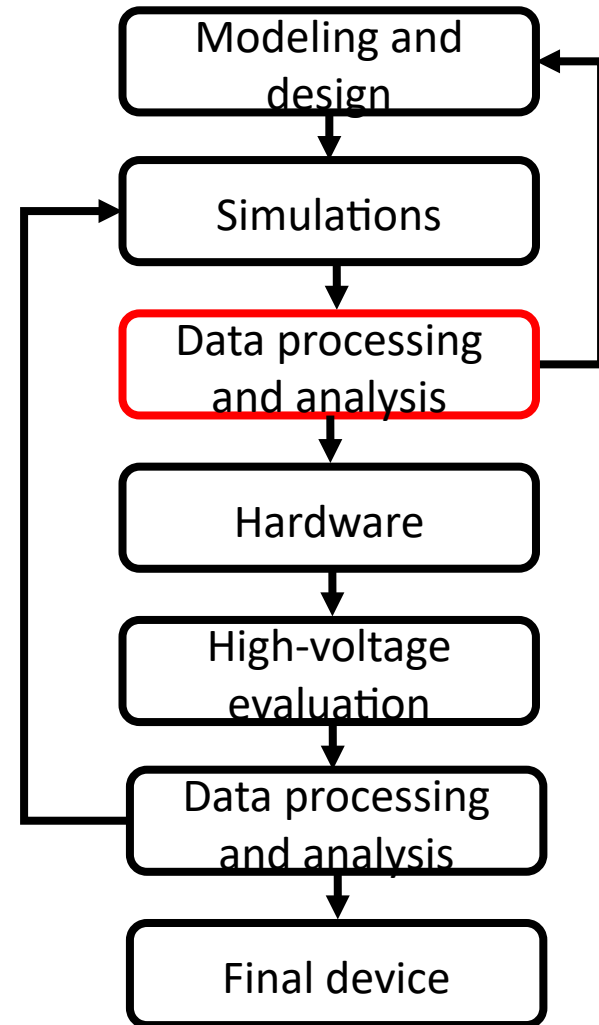
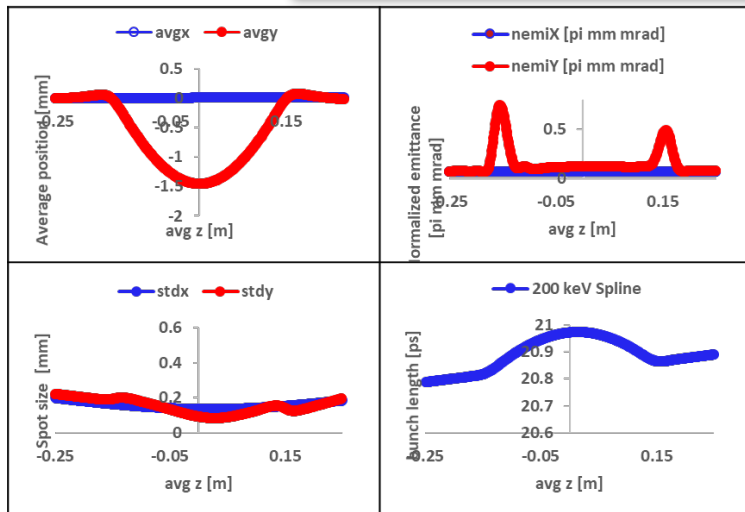
    # making data frame from csv file
    data = pd.read_csv(file_name + '.csv')

    # dropping passed columns
    data.drop(["time", "Unix time"], axis = 1, inplace = True)

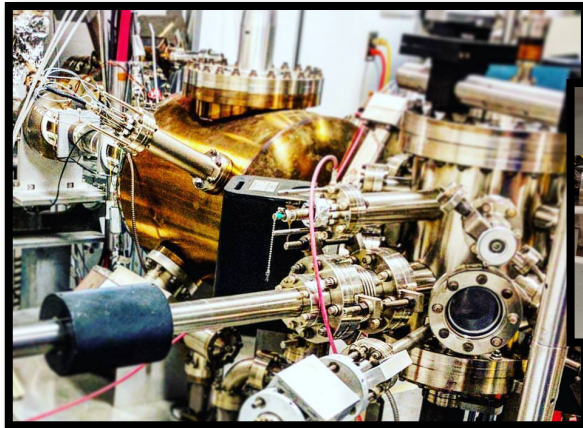
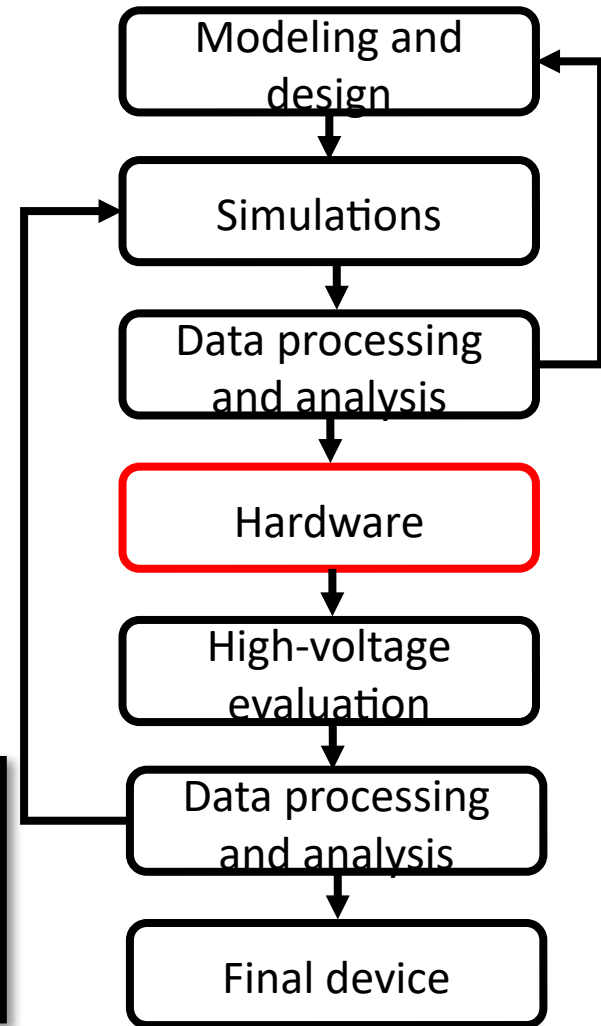
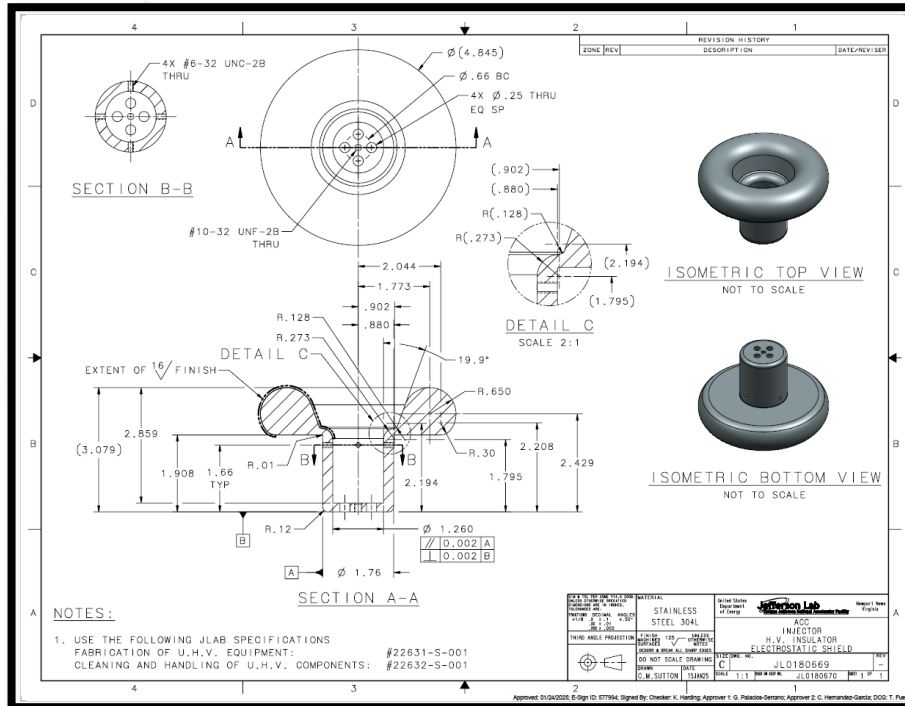
    # dropping the row when HWienNeg:readVolt=0
    data.drop(data[data['HWien' + column_tag + ':readVolt'] ==

    # mean calculation and file appending
    means = data.groupby('HWien' + column_tag + ':setVolt').mean

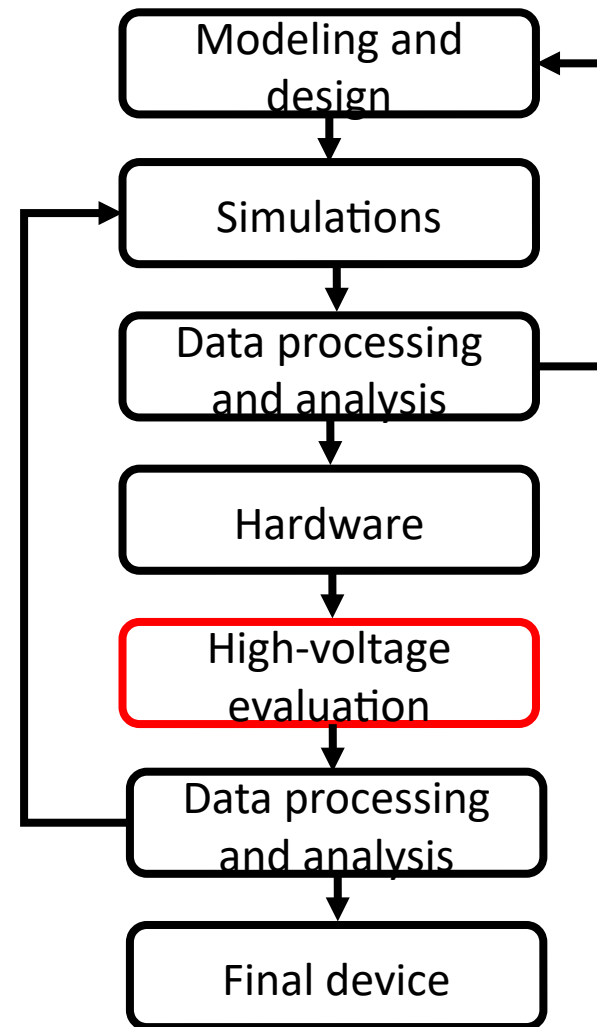
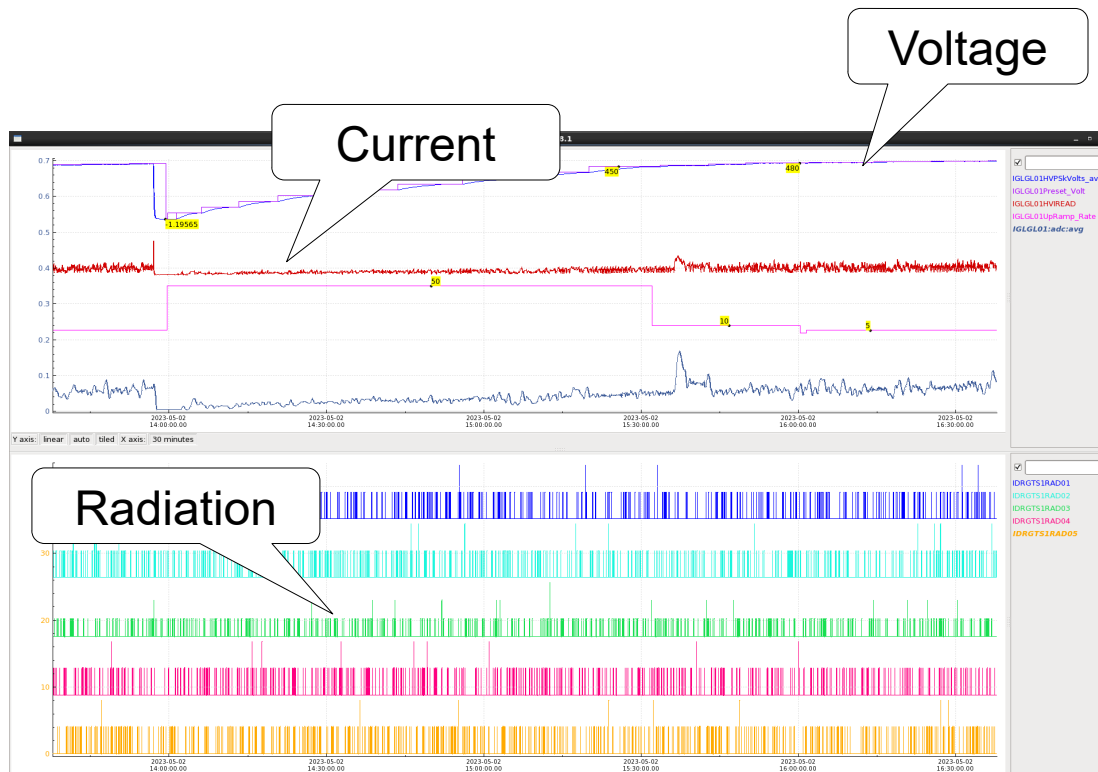
    column_max = data['VIPK202cur'].max() # Gets the max of the
```



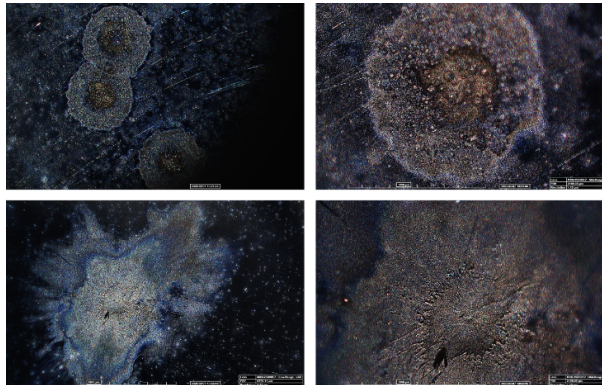
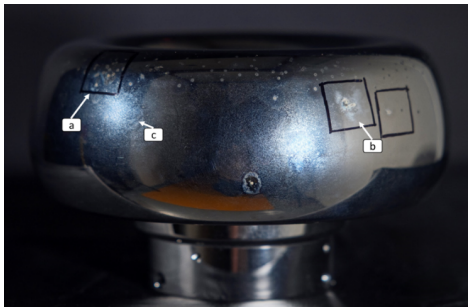
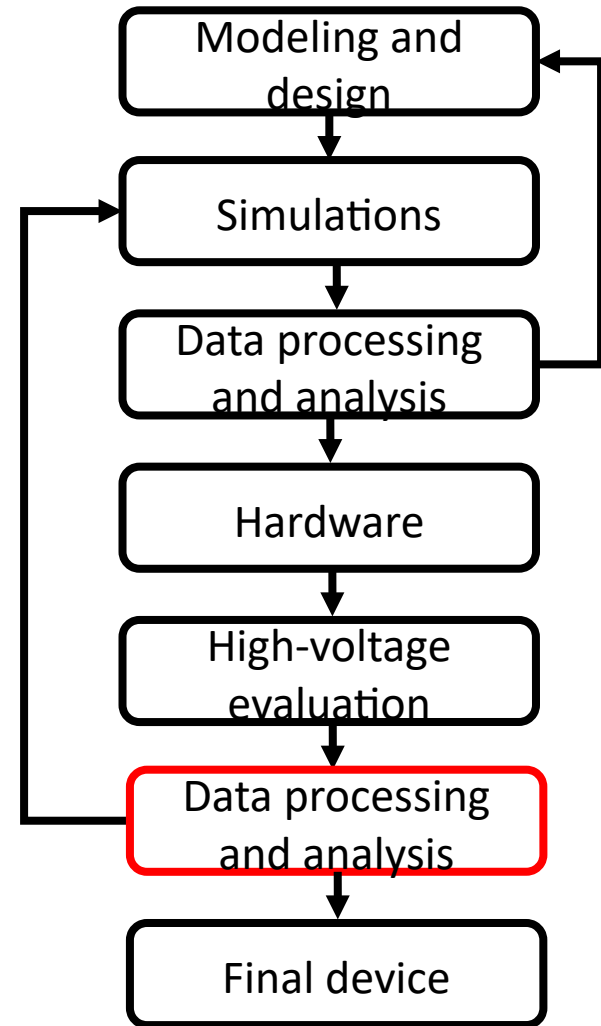
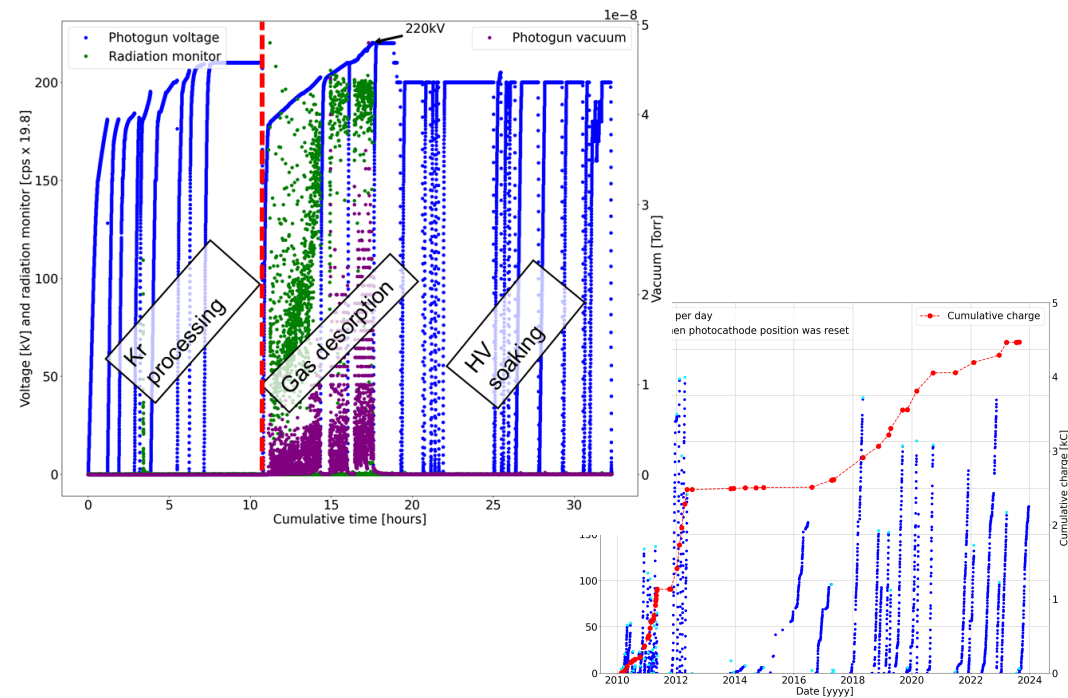
Methodology



Methodology

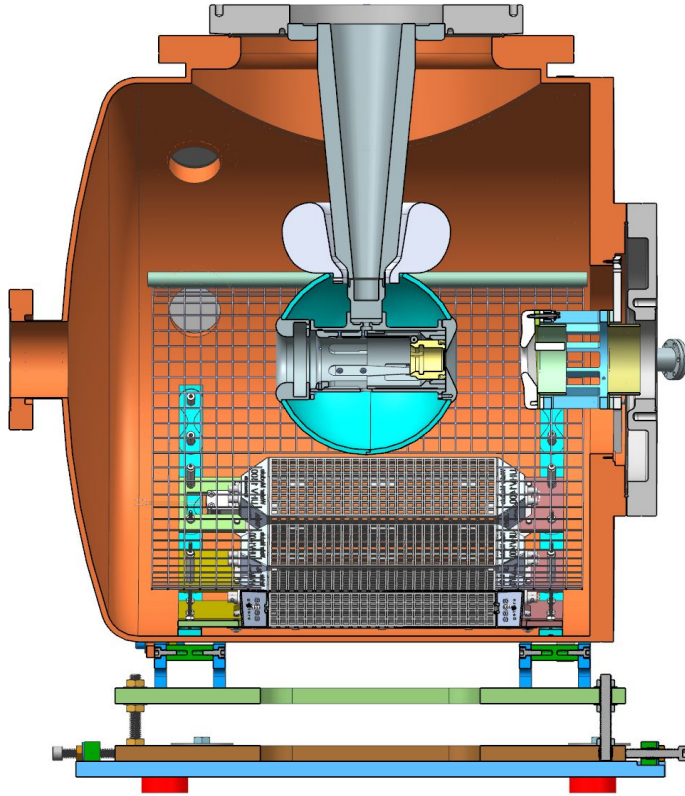


Methodology



Solutions: 200 keV R30-4 Photogun & Wien-type Spin Rotator

Model by the Mechanical Engineering group



Cross-section of the 3D model of the current CEBAF 200 keV photogun

Final device(s)



200 keV U-Wien on the JLab test stand

Solutions: 200 keV Photogun

R28 gun



16° focusing angle
de enfoque de 25°

130 keV Beam May-26-2021

R30-3 gun



16° focusing angle
de enfoque de 25°

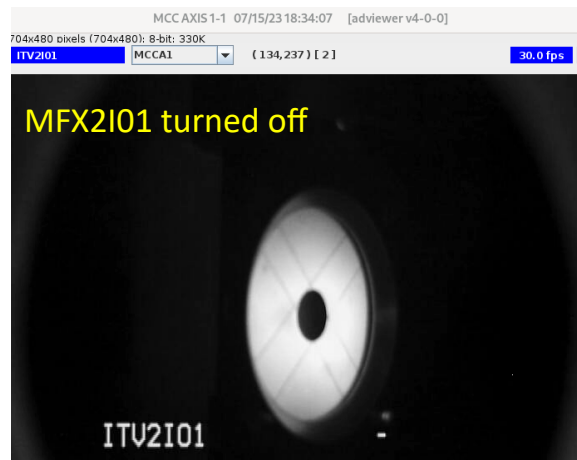
200 keV Beam Jul-15-2023

R30-4 gun

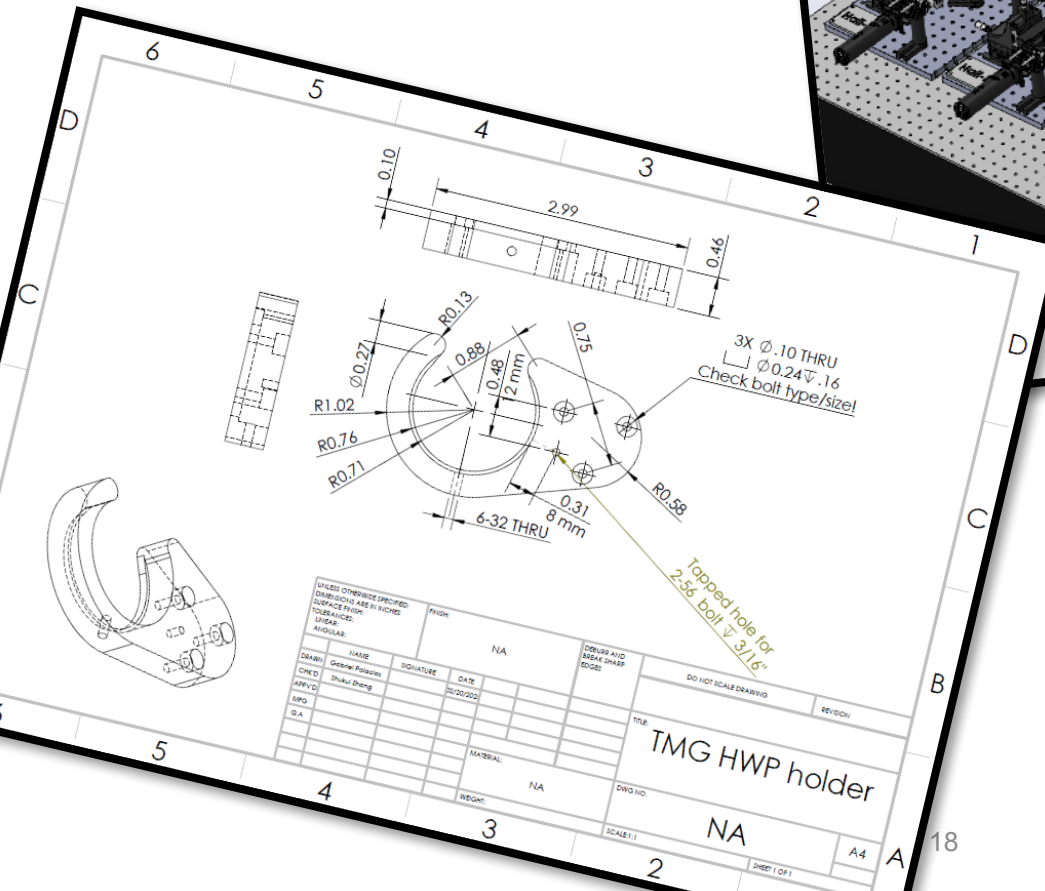
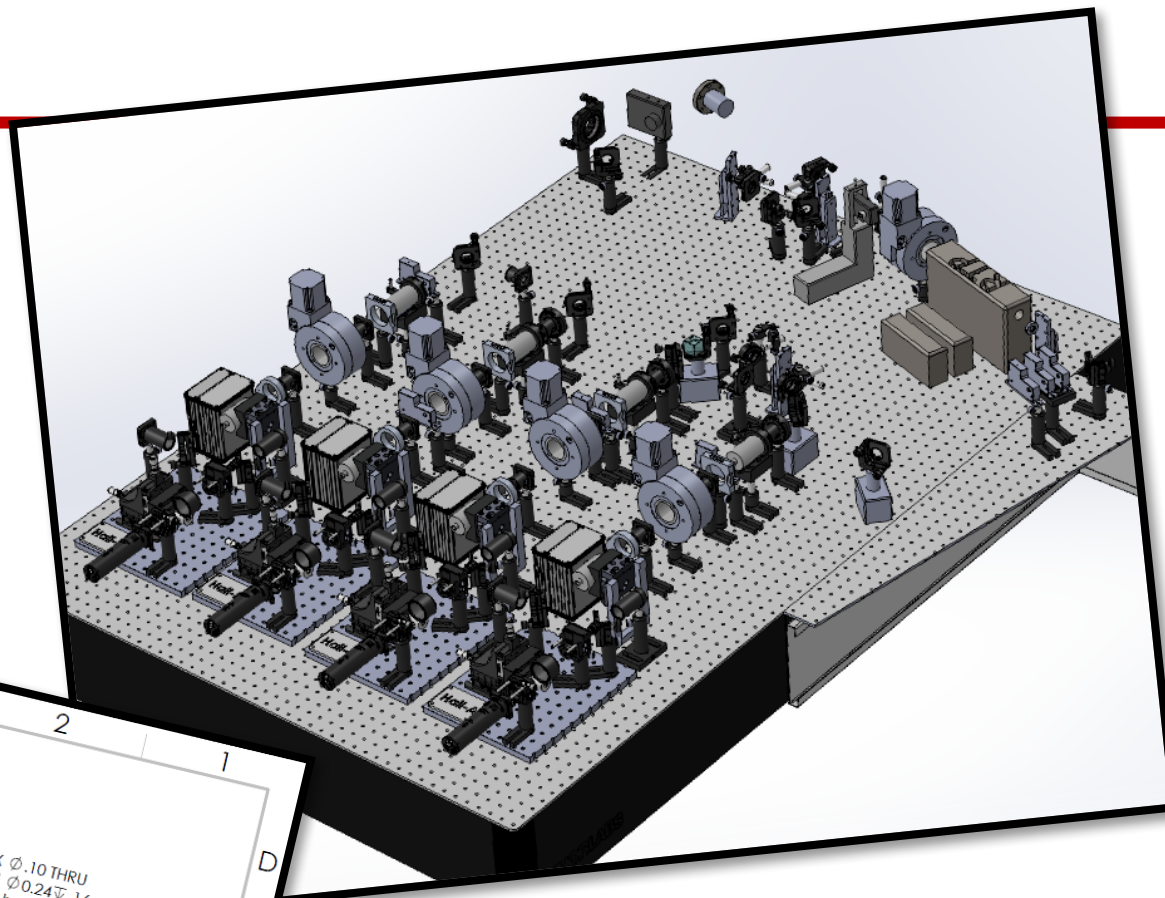


16° focusing angle
de enfoque de 16°

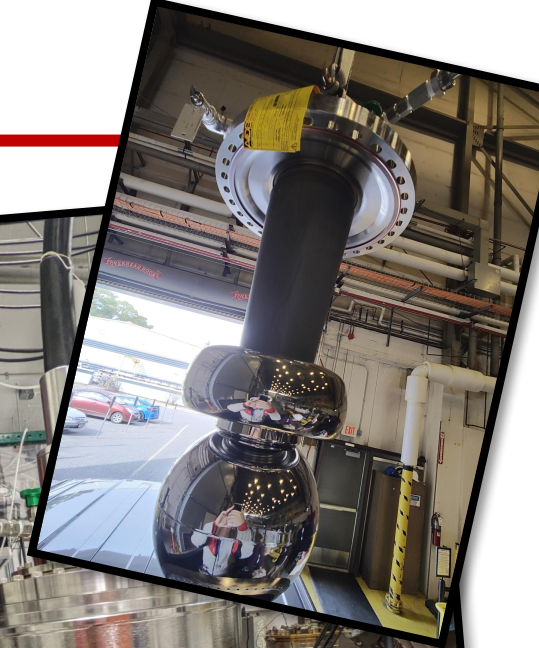
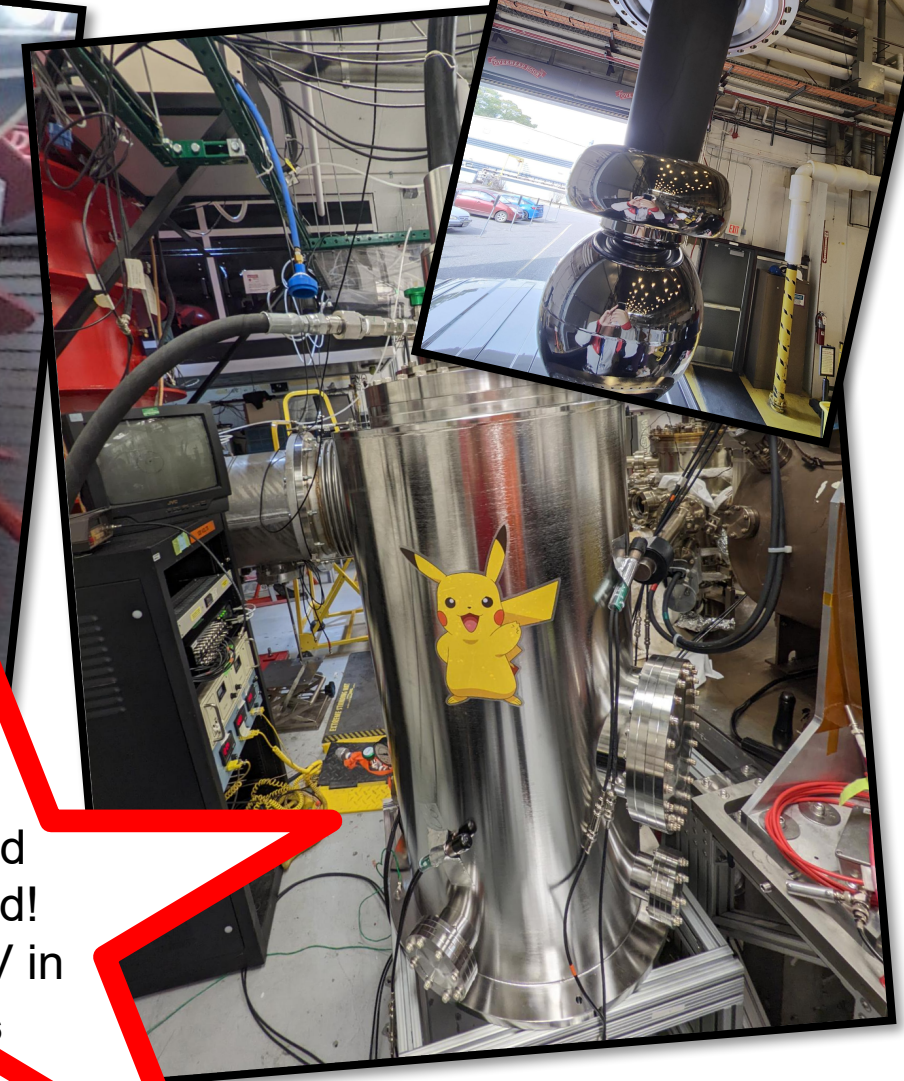
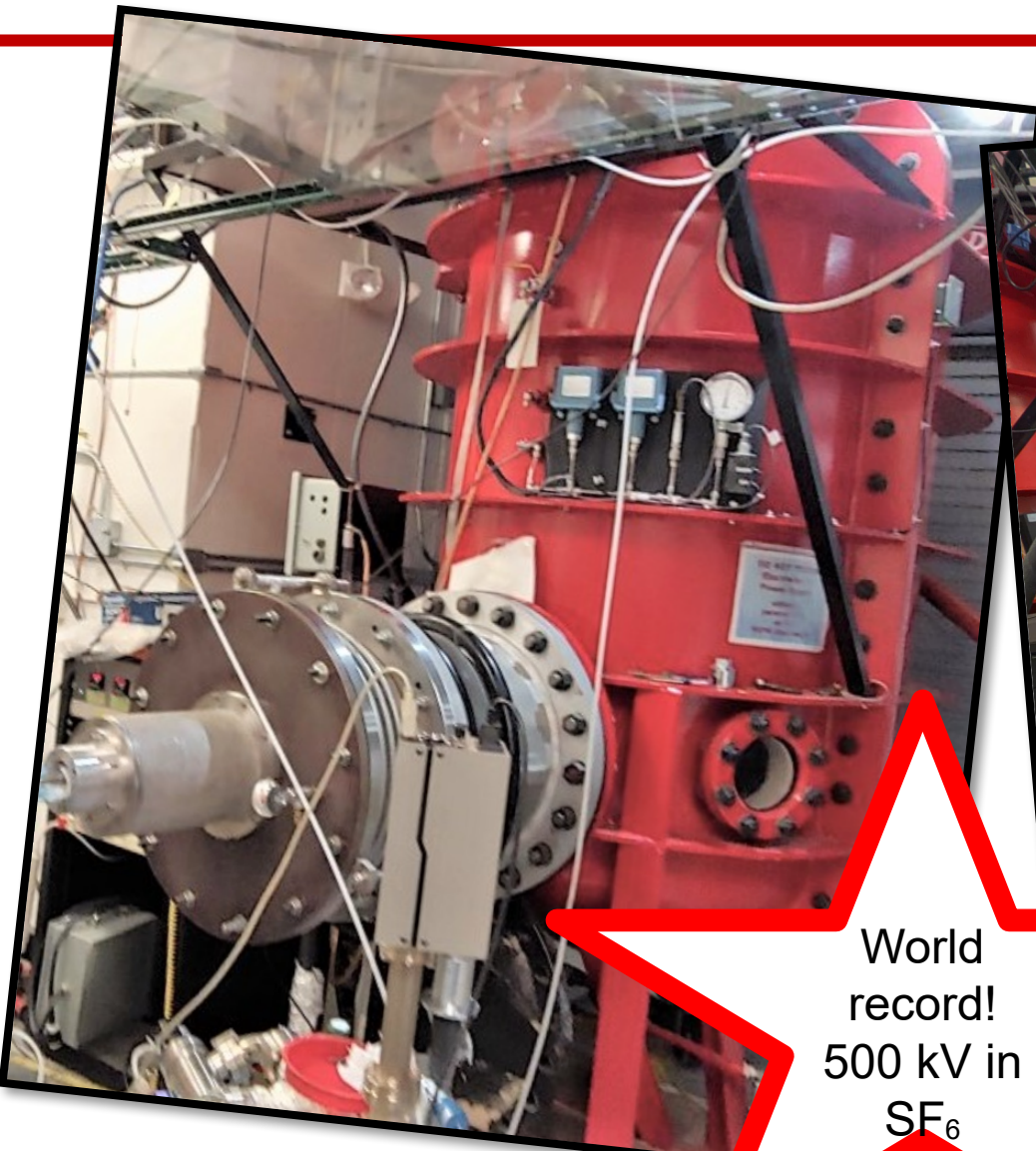
200 keV Beam Aug-30-2024



Side Missions



Side Missions



World
record!
500 kV in
 SF_6

3.68 m^3 , 500 kV, 3 mA

Good Results



Gabriel Gerardo Palacios Serrano

Thomas Jefferson National Accelerator Facility
Verified email at odu.edu

Physics accelerator science electron guns computational physics

TITLE

An SF 6 Gas-insulated 500 kV DC Conical Insulator Vacuum Feedthrough
G Palacios-Serrano, C Hernández-García, M Poelker
Author's Preprints

Polarized Positrons at CE* BAF
A Ushakov, J Benesch, M Bruker, L Cardman, J Conway, S Covrig Dusa, ...

Charge lifetime improvement of the Continuous Electron Beam Accelerator Facility photogun with a biased anode
JT Yoskowitz, GA Krafft, G Palacios-Serrano, SAK Wijethunga, J Grames, ...
Physical Review Accelerators and Beams 27 (12), 123401

The continuous electron beam accelerator facility at 12 GeV
PA Adderley, S Ahmed, T Allison, R Bachimanchi, K Baggett, ...
Physical Review Accelerators and Beams 27 (8), 084802

Toward a long-lifetime polarized photoelectron gun for the Ce+ BAF positron source
M Bruker, A Hoffer, C Hernández-García, G Palacios Serrano, J Grames
Thomas Jefferson National Accelerator Facility (TJNAF), Newport News, VA ...

Polarized electron injector for positron production at CEBAF
R Kazimi, J Grames, A Hoffer, C Hernández-García, G Palacios Serrano
Thomas Jefferson National Accelerator Facility (TJNAF), Newport News, VA ...

Generation and characterization of magnetized electron beam from a DC high volt photogun for electron beam cooling application
SAK Wijethunga, MA Mamun, R Suleiman, P Adderley, B Bullard, ...
Nuclear Instruments and Methods in Physics Research Section A: Accelerators ...

A 500 kV INVERTED GEOMETRY FEEDTHROUGH FOR A HIGH VOLT-AGE DC ELECTRON GUN
C Hernandez-Garcia, DB Bullard, JM Grames, GG Palacios Serrano, ...
Thomas Jefferson National Accelerator Facility (TJNAF), Newport News, VA ...

WIEN-FILTER WITH INTEGRATED ION PUMP
G Palacios-Serrano

High-gradie
GG Palacios
Thomas Jefferson

Inverted Geometry Ceramic Insulators in High Voltage DC
C Hernandez-Garcia, G Palacios-Serrano, P Adderley, D Bullard, ...
2021 IEEE Conference on Electrical Insulation and Dielectric Phenomena

Improving the operational lifetime of the CEBAF photo-gun
JT Yoskowitz, GA Krafft, G Palacios-Serrano, S Wijethunga, J Grames
Proc. IPAC'21, 2840-2842

Wien filter with integrated vacuum pump
BM Poelker, GGP Serrano, CH Garcia
Thomas Jefferson National Accelerator Facility (TJNAF), Newport News

Wien filter with integrated vacuum pump
BM Poelker, GGP Serrano, CH Garcia
US Patent 11,056,313

High voltage design and evaluation of wien filters for the CE
G Palacios-Serrano, H Baumgart, C Hernández-García, P Adderley, ...

Redesign of the Jefferson Lab-300 kV DC Photo-Gun for High
SAK Wijethunga, J Benesch, JR Delaney, C Hernandez-Garcia, GA Krafft

Electrostatic design and characterization of a 200 keV photo
GGP Serrano
Old Dominion University

Electrostatic Design and Characterization of a 200 keV Photo
GG Palacios Serrano

Thermal emittance and lifetime of alkali-antimonide photocathode
molybdenum substrates evaluated in a -300 kV dc photogun
Y Wang, MA Mamun, P Adderley, B Bullard, J Grames, J Hansknecht, ...
Physical Review Accelerators and Beams 23 (10), 103401

Compact -300 kV dc inverted insulator photogun with biased
photocathode
C Hernandez-Garcia, P Adderley, B Bullard, J Benesch, J Grames, ...
Physical Review Accelerators and Beams 22 (11), 113401



US011056313B1

(12) United States Patent Poelker et al.

(10) Patent No.: US 11,056,313 B1
(45) Date of Patent: Jul. 6, 2021

(54) WIEN FILTER WITH INTEGRATED VACUUM PUMP

(56) References Cited

U.S. PATENT DOCUMENTS

- (71) Applicant: JEFFERSON SCIENCE ASSOCIATES, LLC, Newport News, VA (US)
- (72) Inventors: Bernard Matthew Poelker, Yorktown, VA (US); Gabriel Gerardo Palacios Serrano, Yorktown, VA (US); Carlos Hernandez Garcia, Yorktown, VA (US)

2,450,602 A	10/1948	Levaldi
5,871,336 A	2/1999	Young
8,421,029 B1	4/2013	Ren et al.
8,835,866 B2	9/2014	McGinn
9,960,026 B1 *	5/2018	Hughes

* cited by examiner

Primary Examiner — Michael Maskell

- (73) Assignee: jefferson science associates, llc, Newport News, VA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 16/904,910

(22) Filed: Jun. 18, 2020

(51) Int. Cl.
H01J 37/18 (2006.01)
H01J 37/05 (2006.01)

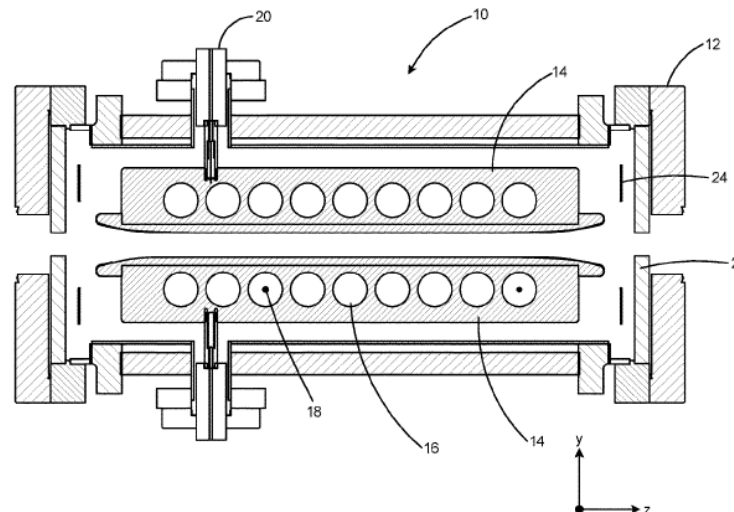
(52) U.S. Cl.
CPC H01J 37/18 (2013.01); H01J 37/05 (2013.01); H01J 2237/057 (2013.01)

(58) Field of Classification Search
CPC H01J 37/18; H01J 37/05; H01J 2237/057
USPC 250/305, 396 R, 396 ML
See application file for complete search history.

(57) ABSTRACT

An integral Wien filter and vacuum pump for separating charged particles or for orienting their spin direction while maintaining optimal beamline vacuum. The vacuum pump is an ion pump including one or more cylindrical Penning cells to trap and expel electrons. The Wien filter includes orthogonal electric and magnetic fields to direct particles with the desired speed through the device while deflecting particles at undesired speeds. The Wien filter includes two electrodes, one biased positive and one biased negative, a dipole magnet, and means for reversing polarity of the electrodes to flip the spin of the charged particles. Metal plates on either side of the Penning cells embed gas that is ionized by trapped electrons in the Penning cell thus creating vacuum by turning gas into solid. The two metal plates can be configured to obtain vacuum pumping via chemical gettering and for removal of noble gases.

6 Claims, 3 Drawing Sheets



A breather

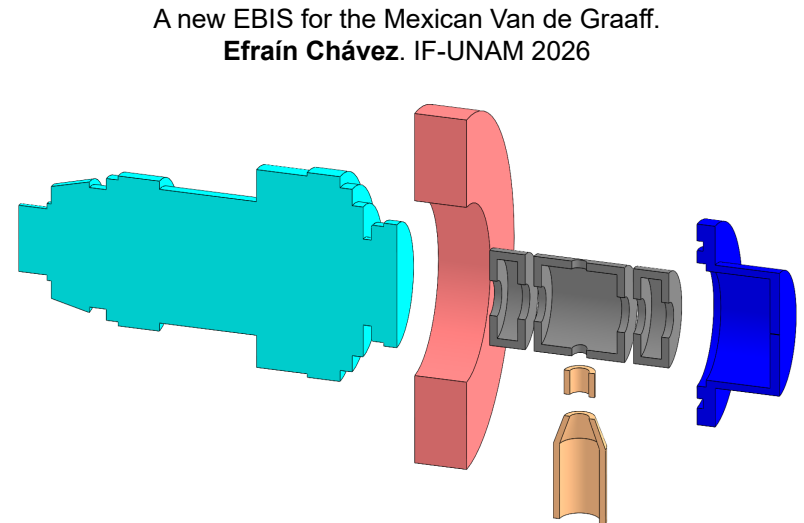
Almost done. 3 more slides 😊

New Projects: IF-UNAM, Mexico

Relevance of Particle Accelerators in Mexico

Accelerators are a cross-cutting technology with direct impact on health, industry, food safety, sustainability, and human capital development.

- Medicine: Radiotherapy and nuclear medicine to fight cancer.
- Industry: Innovation in automotive manufacturing, telecommunications, and medical devices.
- Agri-food: Irradiation that ensures safety and facilitates exports.
- Environment: Emission and water treatment
- Talent: Training scientists and engineers in high-specialization strategic areas.

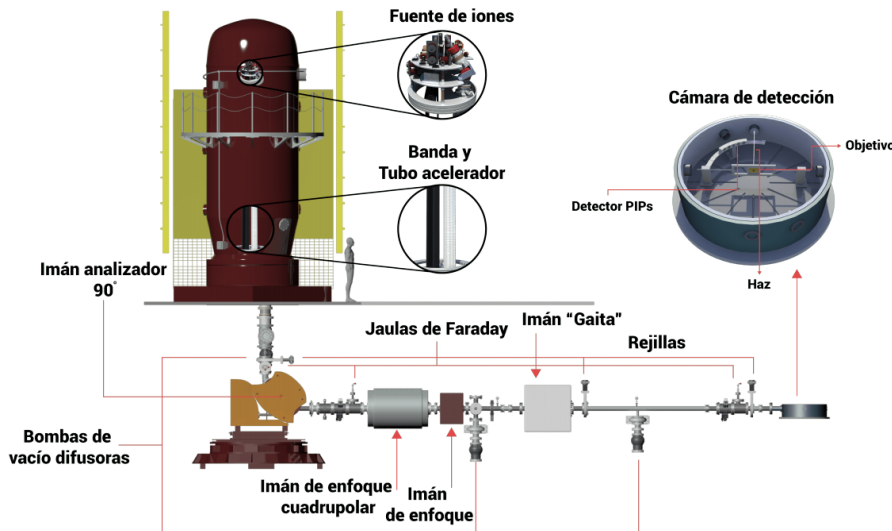


New EBIS system for the Mexican Van de Graaff accelerator:

- Commercial thermionic electron gun

Integrated electrostatic ion trap optimized for the production of highly charged ions.
The design must comply with the geometric and operational constraints of the high-voltage terminal.

Bachelor's thesis of physicist
Alan O. Valdez Guerrero

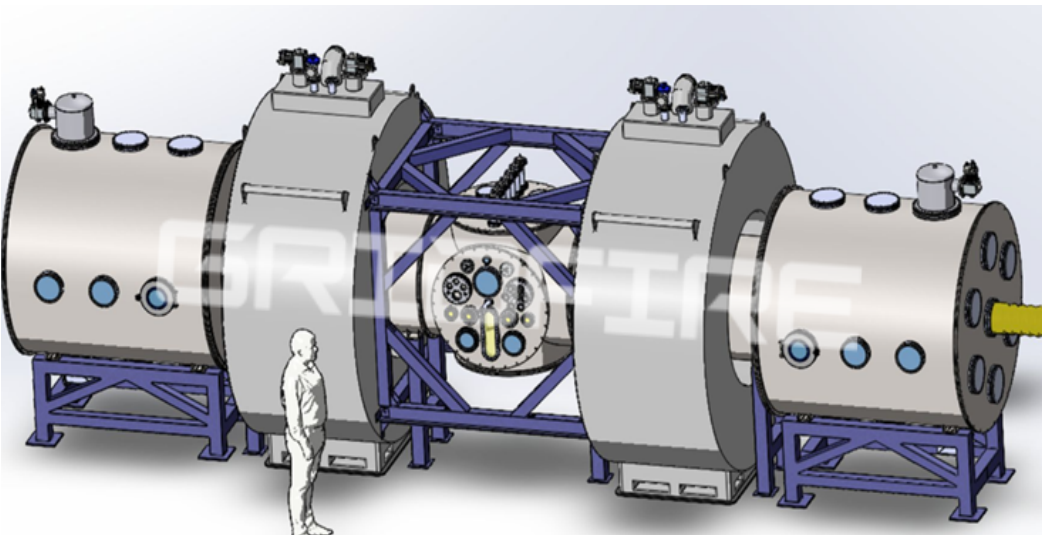
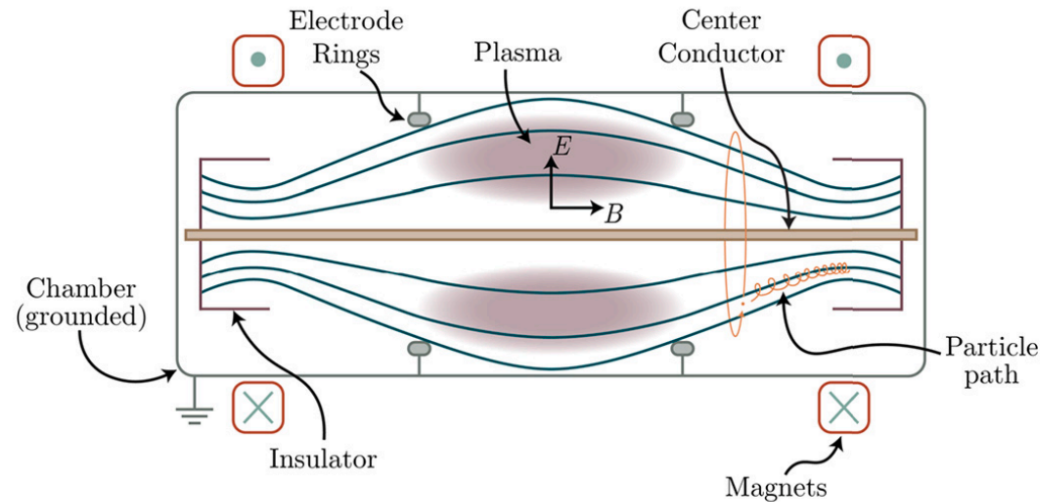


New Projects: Gridfire, London

N.R. Schwartz, et al.

Electrically insulating materials for centrifugal mirrors, Journal of Nuclear Materials, Volume 615, 2025.

<https://doi.org/10.1016/j.jnucmat.2025.155957>



Nathan Eschbach. Gridfire, 2026

JOIN US

Gridfire is building a practical path to fusion energy. We welcome engagement from partners, investors, and collaborators who share our ambition to deliver clean, reliable power at global scale.

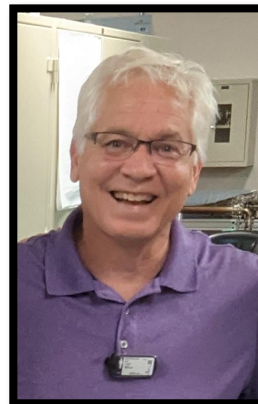
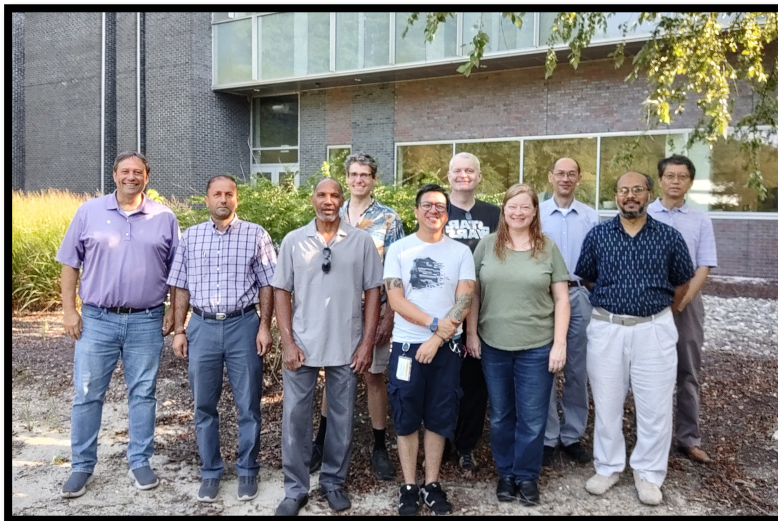
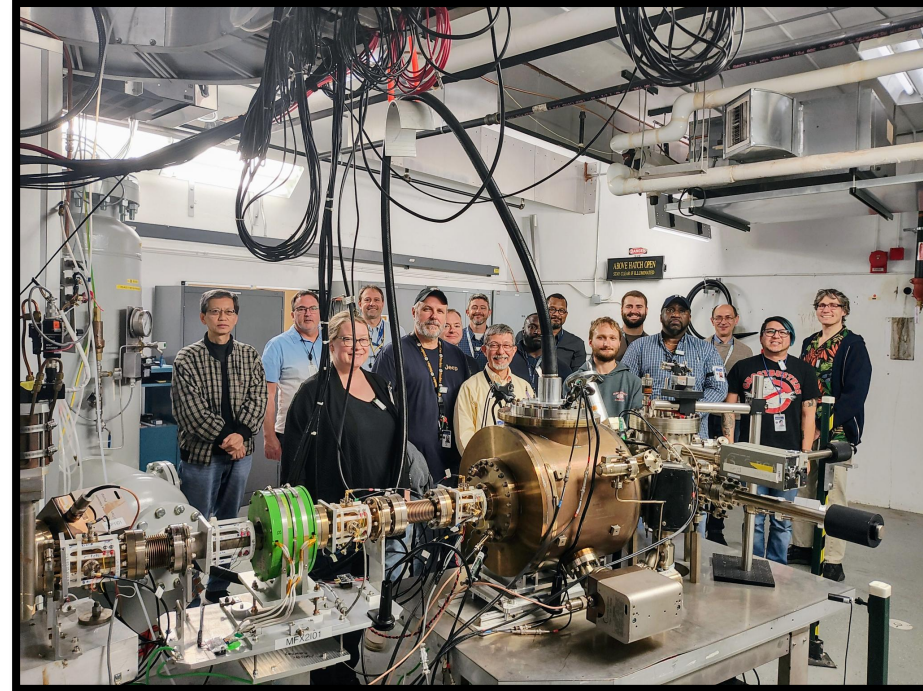
Take part →

<https://gridfire.co/>

Acknowledgments

To SMF DPyC!

- To the Injector and Sources group and all Jefferson Lab staff.
 - Specially to **Carlos Hernández García, Matthew Poelker, & Marcy Stutzman**
- Also to **Arturo Robledo, Jaime Grabinsky, Salvador Arellano, y Jaime Cruz Sampedro.**
- **Efraín Chavez, Eduardo Andrade, and Alan Valdez @ IF-UNAM**
- **Dave Peto, Ian Abel, Kathreen Thome, and Nathan Eschbach @Gridfire**
- and to all of you for your attention!



Fin.



<https://www.cmapmx.org/>



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