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Design Validation of a Chopping and Deflecting System for the High Current Injector at IUAC

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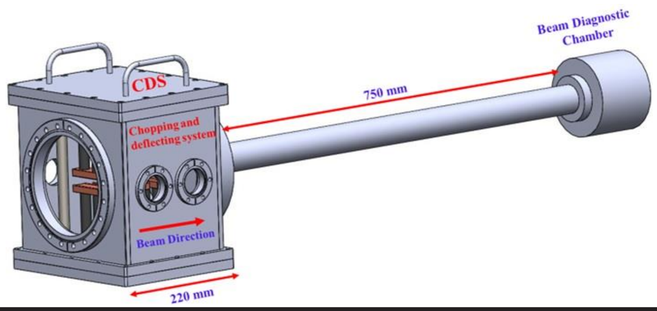
- **The Low Energy Beam Transport (LEBT) section of the High Current Injector (HCI) incorporates a Chopping and Deflecting System (CDS).**
- **The CDS has been designed in such a way that it can produce the maximum transmission within the same voltage conditions.**
- **The semi-circular contour has been incorporated to increase the linearity in the transient region and to maximize the effective electric field.**
- **The distinguishing feature of the CDS structure is the multiplate deflecting structure with low capacitance to optimize the electric field.**
- **A Python code has been has been developed to validate the design parameters of CDS. The design parameters match well with simulations.**
- **The CDS has been fabricated, assembled, and tested. The design, development and test are discussed as below.**

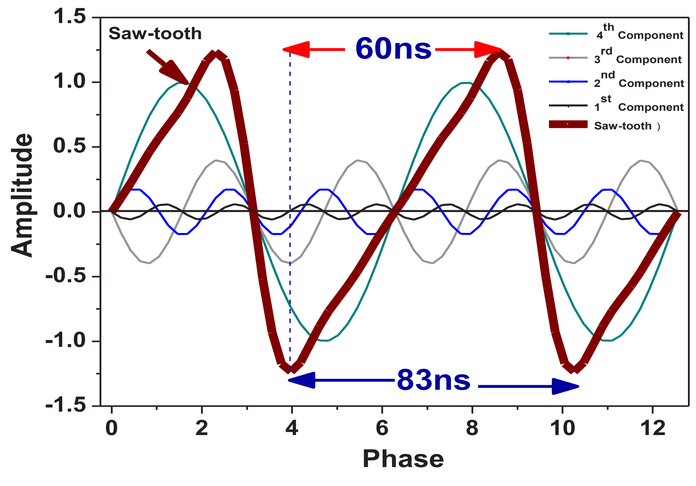


Motivation

- **Experimentalists in IUAC require pulsed beam with various repetition rates 250 ns, 500 ns, 1 µs, 2 µs, 4 µs, and 8 µs.**
- **A compact chopper and deflector is required, to provide the pulsed beam with various repetition rates at target locations.**
- **Due to the space constraint, both the device has to combined together.**

Generation of Saw-tooth @ 12 MHz wave after optimization of coefficient

V(t) = sin(wt)-0.40sin(2wt)+0.18sin(3wt)-0.06sin(4wt)



Salient Features of the Design

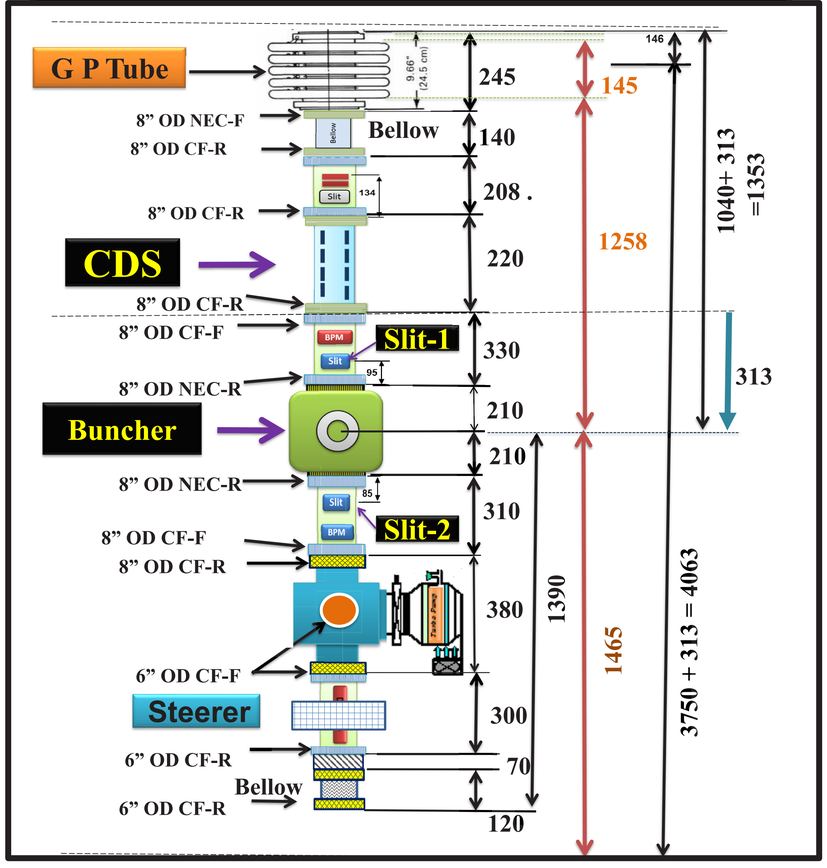
Physical Geometry

- **No of deflecting plates: 4 pairs**
- **Plate separation: 15 mm**
- **Plate Length: 24 mm**
- **Centre distance pair n-pair n+1 39 mm**
- **Gap between plates Variable (15, 18, 21, 24mm)**
- **Slit Location 750 mm**
- **Slit / Aperture size Variable**

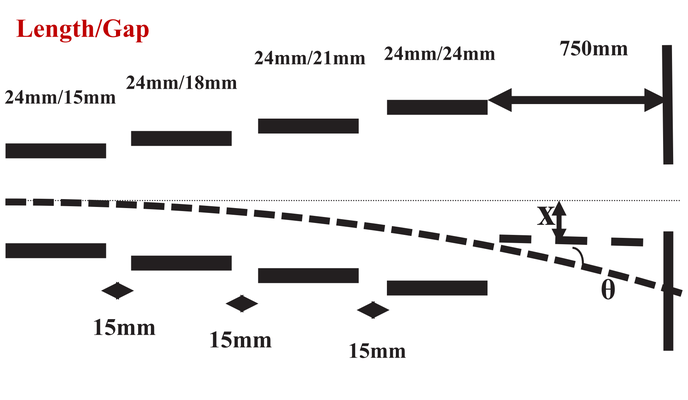
Electronic Requirement

- **Required Repetition Rate: 250, 500ns, 1,2,4,8 µs**
- **Delay b/w pair of plates: 32 ns**
- **Width of deflecting pulses (On time): 50-70 ns**
- **Width of deflecting pulses (Off time): 180-200 ns**
- **Requirement of deflecting voltage: ± 350 V**

Layout of LEBT Section of the High Current Injector



Physical design of Chopping cum Deflecting System



CST Simulations

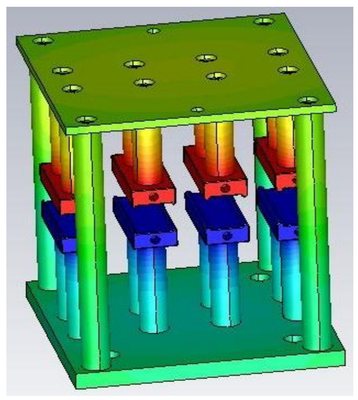
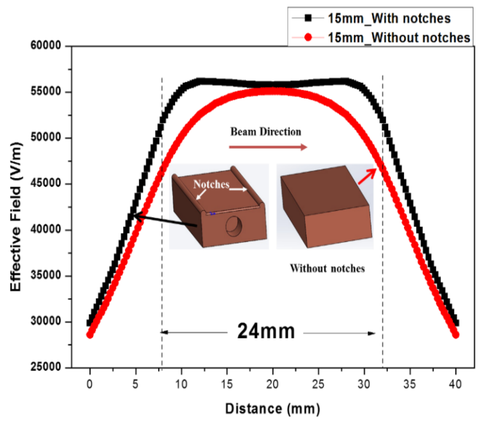
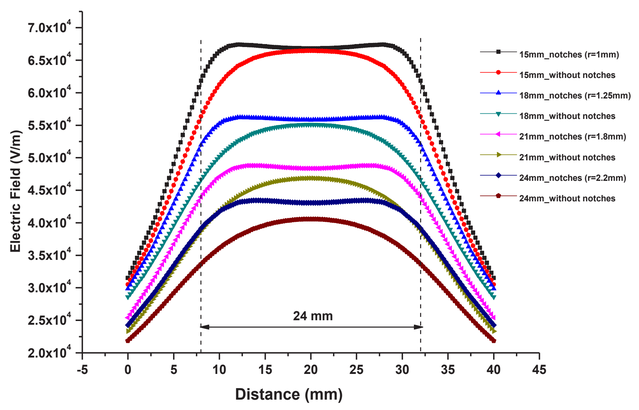


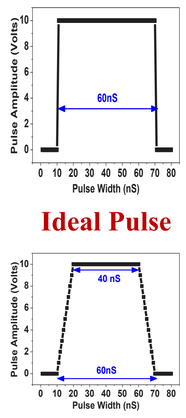
Plate Design Modification (CST)



Incorporation of Contours (CST)

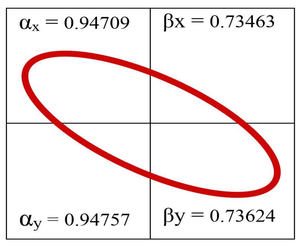


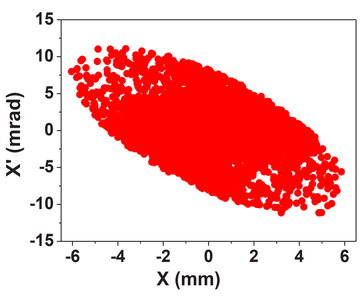
Ideal Pulse



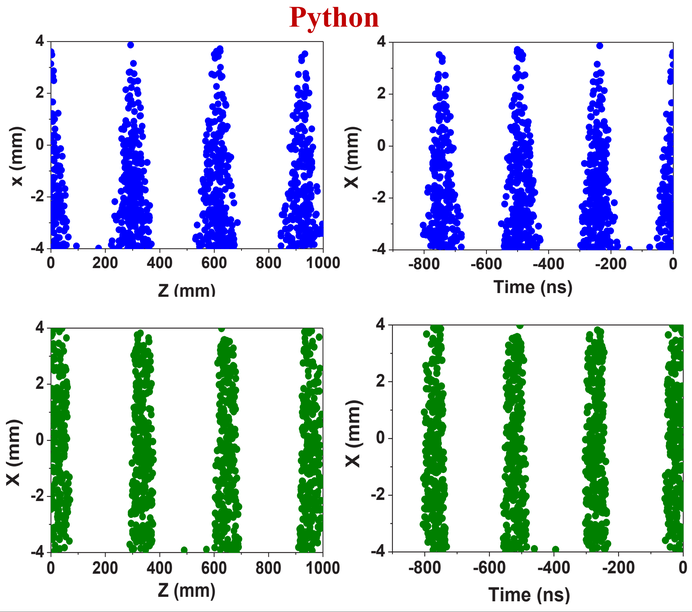
Theoretically Calculated

Compared output of TRACE 3D and Python



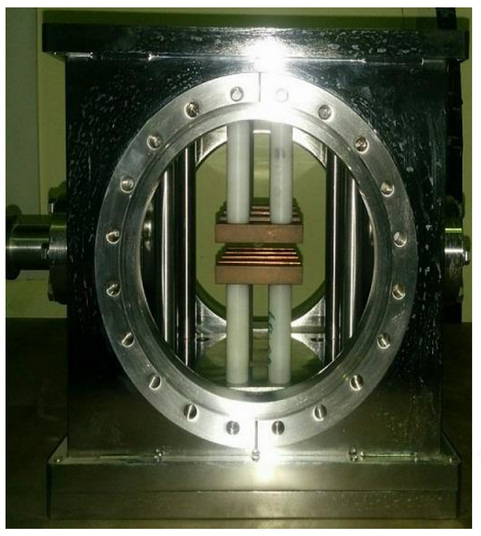


Comparison b/w single pair plate chopper and CDS Python

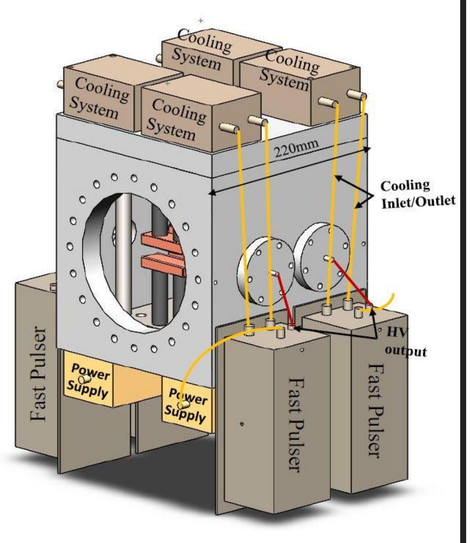


Mechanical Inner Assembly

Complete Assembly



Planned Electronics



CDS ready for beam test in the LEIBF

Results

Increment	Input	Output		
	No of Charged particles traced	Theoretically calculated @ 4 MHz (24%)	Python	% Increment in current
Single Pair Plate Chopper	5000	1200	850 (17%)	35%
CDS	5000	1200	1150 (23%)	

Conclusion

The CDS has been designed and developed to provide the pulsed beam with various repetition rates (250 ns, 500 ns, 1 µs, 2 µs, 4 µs, 8 µs) to IUAC experimental facilities. The Design and Mechanical development has been completed; the development and procurement of electronics is under way

References

[1] WEI K Y. Transport of Charged particle Beams, Science , 1986.
[2] Huachang Liu et al., Nucl. Instr. and Meth. A 654 (2011) 2.
[3] T.K. Fowler et al., Nucl. Instr. and Meth. 7 (1960) 245.
[4] S K Kedia, Rajeev Mehhta, Nucl. Instr. and Meth. A 889 (2018) 22.