COMPACT INTER-UNDULATOR DIAGNOSTIC ASSEMBLY FOR TESSA-515

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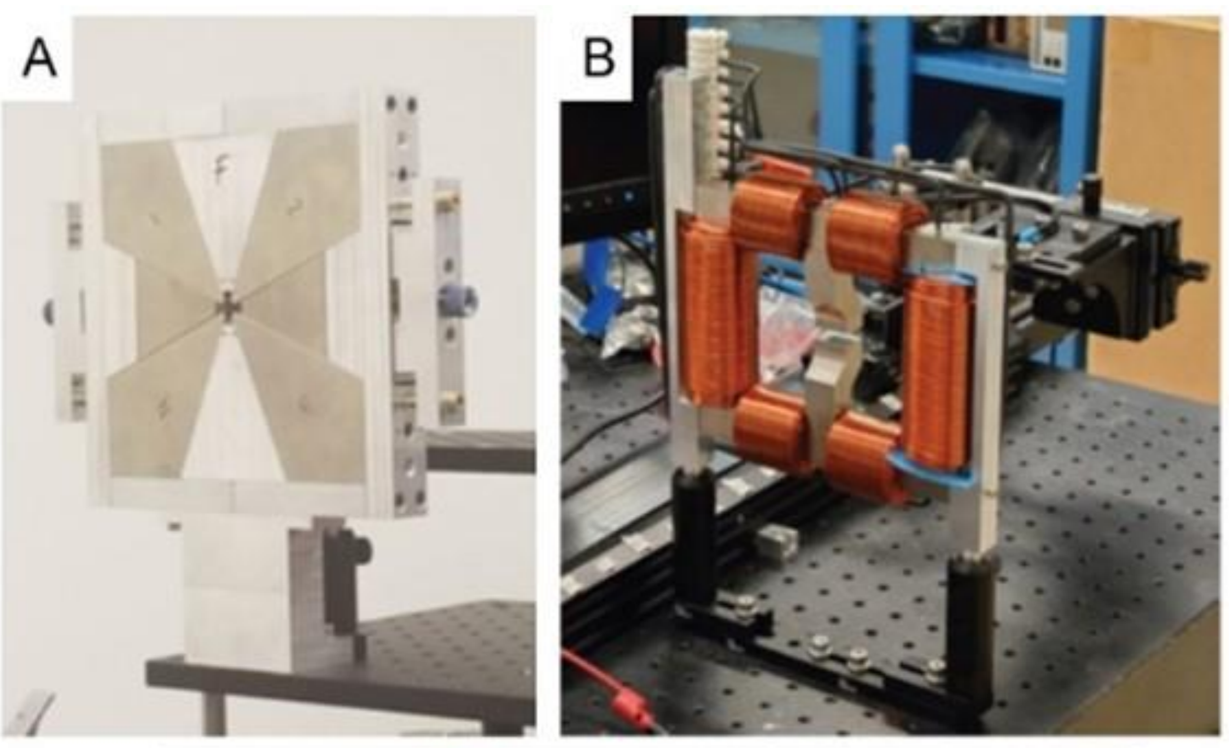
Abstract

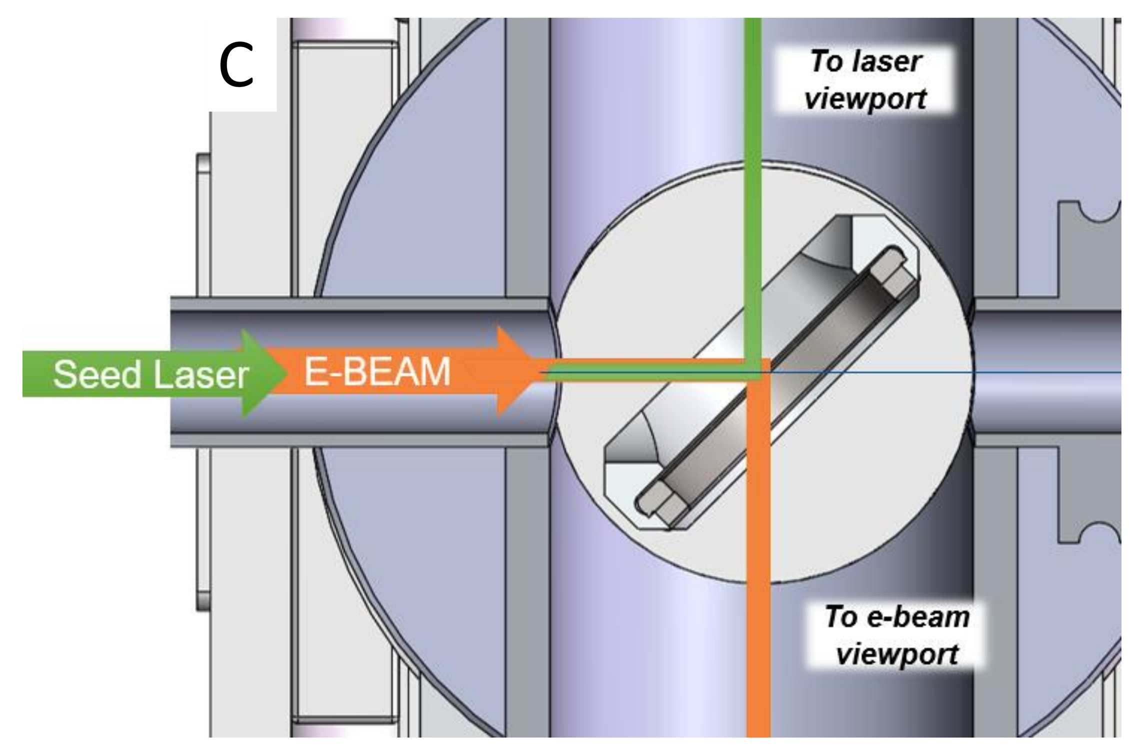
Beamline space is a very expensive and highly sought-after commodity, which makes the creation of compact integrated optics and diagnostics extremely valuable. The FAST- GREENS experimental program aims at demonstrating 10 % extraction efficiency from a relativistic electron beam using four helical undulators operating in the high gain TESSA regime. The inter-undulator gap needs to be as short as possible (17 cm in the current plans) to maximize the output power. Within this short distance, we needed to fit two focusing quadrupoles, a variable strength phase shifter, a transverse profile monitor consisting of a YAG-OTR combination for co-aligning the electron beam and laser, and an ion pump. By making the quadrupoles tuneable with a variable gradient, in combination with vertical displacement, we can meet the optics requirements of matching the beam transversely to the natural focusing of the undulators. The two quadrupoles in conjunction with the electromagnetic dipole also serve as a phase shifter to realign the radiation and the bunching before each undulator section. This paper will discuss the mechanical design of this inter-undulator break section and its components.



TUNABLE PMQ HYBRID (A)

Depending on the gap between the poles of the yoke the target strength of the quadrupole can be adjusted to the needs of the experiment. Matching the 220 MeV beam to the focusing channel set up by the helical undulators and the quadrupole doublet requires a gradient of 112 T/m assuming a magnetic effective length of 30.4 mm and physical length of only 26.2 mm.

Label	Identification	Eff. Mag. Length	Field
A	PMQ Hybrid	30.4 mm	112 T/m
B	EMD	26.3 mm	0.3 T
C	Profile Monitor	-	-
A	PMQ Hybrid	30.4 mm	112 T/m

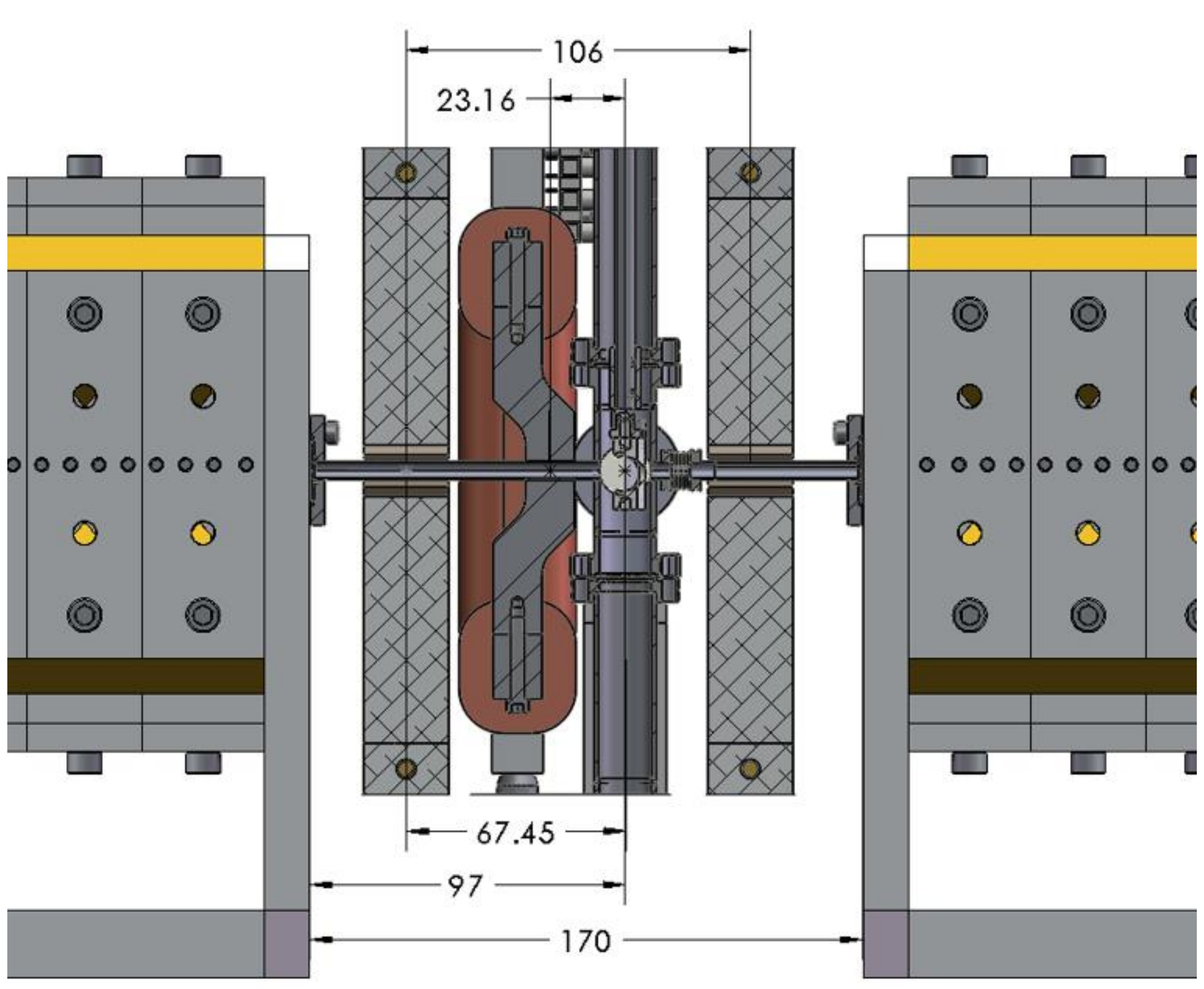


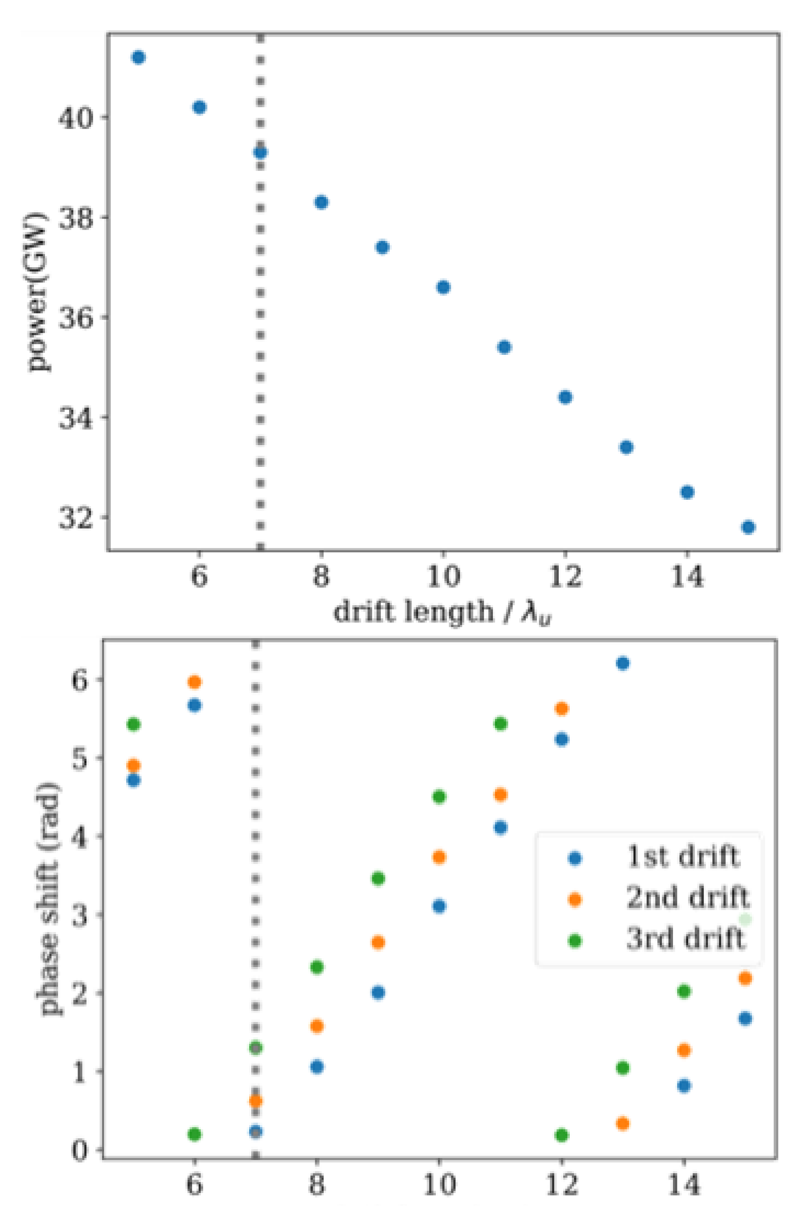
BEAM PROFILE MONITOR (C)

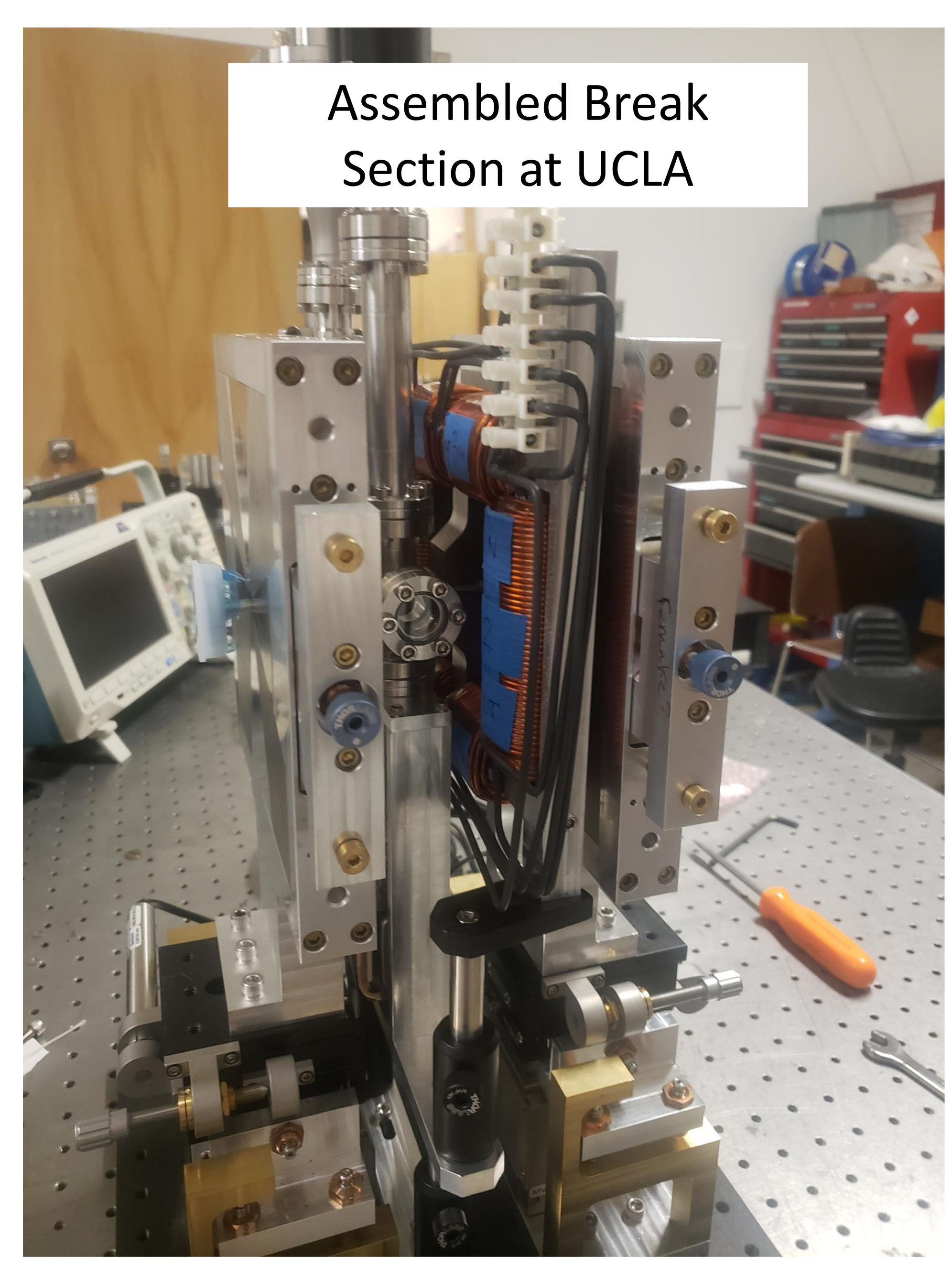
A custom Aluminized YAG was used with 100nm of Aluminum deposition on the upstream side. By viewing this aluminized YAG, placed at a 45-degree angle, from both sides we can get the electron beam profile from the YAG side and the seed laser profile from the aluminized side.

PHASE SHIFTER (A & B)

A phase shifter is required to compensate for the dephasing between the microbunching and the FEL signal due to the diffraction of radiation. Rather than adding a dedicated section, the idea was to combine the function of the quadrupoles and use them as part of a compact phase shifter design. By displacing them horizontally it is possible, adding an electromagnetic dipole (EMD) to compensate the kicks, to create a small adjustable horizontal orbit bump that can be tuned online to realign the microbunches at the right phase and maximize the extraction efficiency. Remotely controllable XY translation stages were incorporated in the design to shift the position of each PMQ to provide horizontal trajectory kicks resulting in a tunable phase shifter. A full phase shift of 2π can be obtained by energizing the dipole at 0.3 T and shifting the quadrupoles by 650 um and 450 um respectively resulting in an orbit kick of 140 um.







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This work is supported by DOE Grants DE-SC0009914, DE-SC0018559, and DE-SC0017102.

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