Terahertz and Optical Measurement Apparatus for the Fermilab ASTA Injector*

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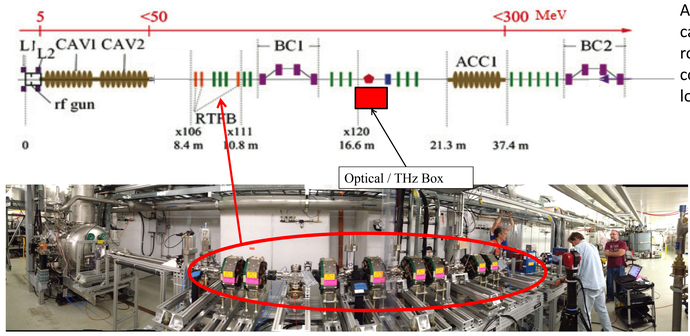
Abstract

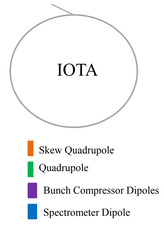
ASTA is a facility at Fermilab that, once completed, will consist of a photoinjector with two superconducting capture cavities, at least one superconducting ILC-style cryomodule, and a small ring for studying non-linear, integrable beam optics. This paper discusses the layout for the optical transport system that will provide THz radiation to a Martin-Puplett interferometer for bunch length measurements as well as optical radiation to an externally located streak camera, also for bunch length measurements. It will be able to accept radiation from two synchrotron radiation ports in the bunch compressor, a diffraction/transition radiation screen downstream of the compressor, and a transition radiation screen after the spectrometer magnet for measurements of energy-time correlations.

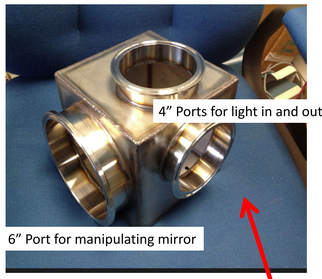
Expected Beam Parameters

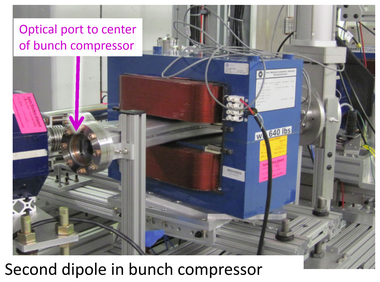
Parameter	Value
Energy	50 – 300 MeV
Bunch Charge	0.02 – 5 nC
Bunch Frequency	3 MHz
Macropulse Duration	≤ 1 ms
Macropulse Frequency	0.5, 1, 5 Hz
Transverse Emittance	0.1 – 100 mm
Longitudinal Emittance	5 – 500 mm
Peak Current	3 – 10 kA



ASTA beamline layout. L1 and L2 are the gun solenoids. CAV1 and CAV2 are the capture cavities. Presently only CAV2 is installed. The section titled RTFB is the round-to-flat beam transform section which is followed by the magnetic bunch compressor BC1. The next section contains space for user experiments and is the location of the optical / THz system. ACC1 is the ILC-type cryomodule.

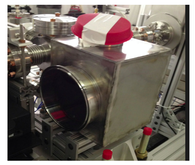


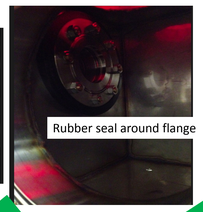


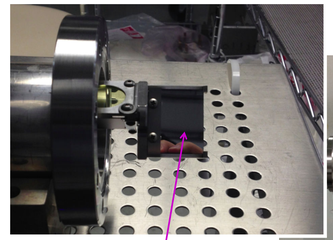


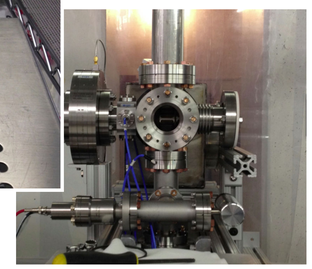
Second dipole in bunch compressor showing the optical entrance port to the center leg of the chicane. The beamline through the dipole is X shaped.

Stainless steel mirror box mounted over flange on X121. Box is sealed around flange with a Uniseal gasket.





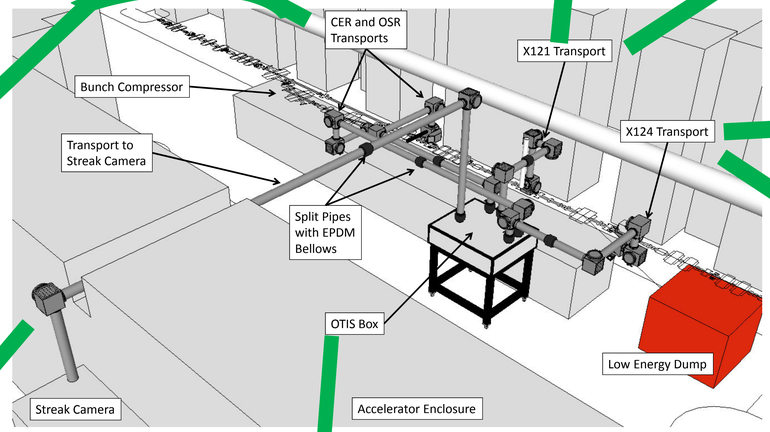




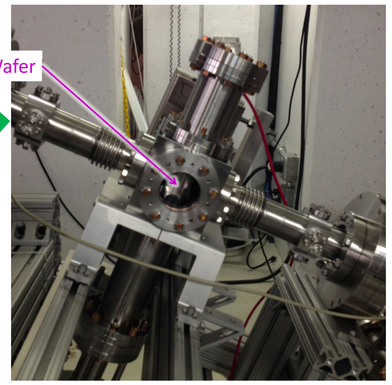
Left) X121 actuator retracted; OTR wafer is visible. Right) X121 cross with actuator installed.

CER / OSR Source

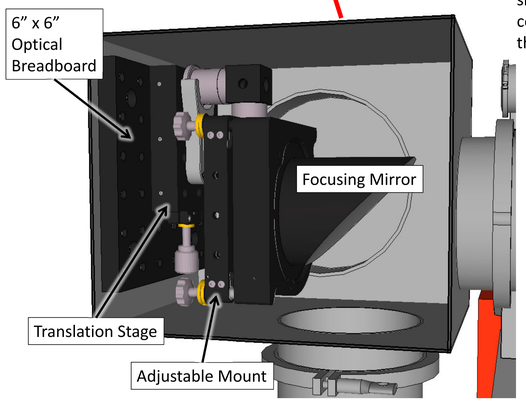
CTR / CDR / OTR Source



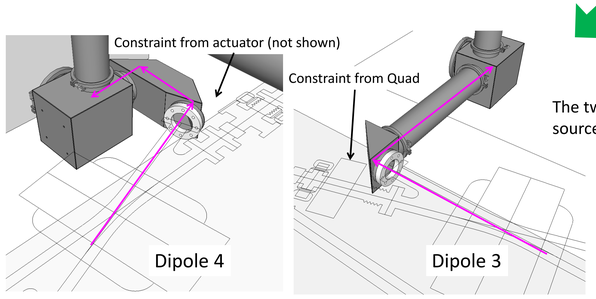
OTR ΔE vs. Δt Source



X124 cross in downward beamline to dump. There will be an optics system attached to this side of the cross.

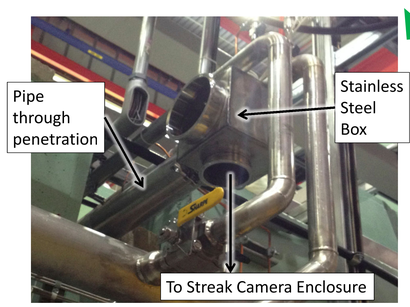


Off-axis parabolic optics in stainless steel mirror box. The box has one 6” flange for access to adjust the mirror, and two 4” flanges for light input and output.

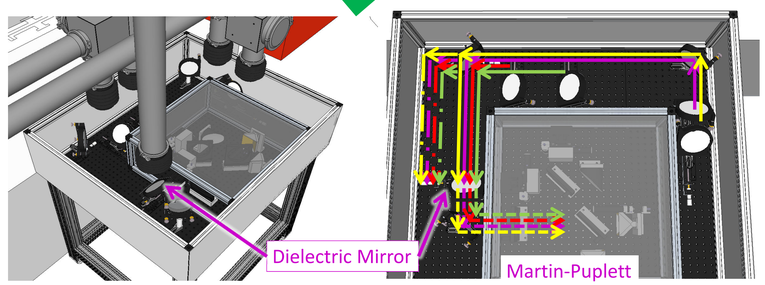


The two compressor source port boxes.

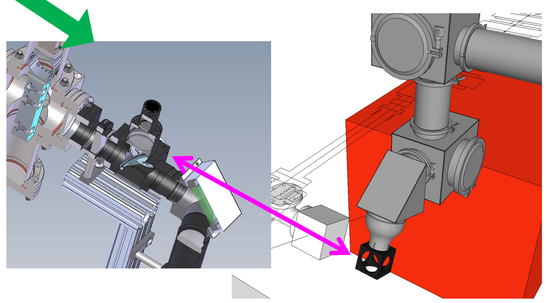
Streak Camera



Penetration pipe and mirror box before streak camera.



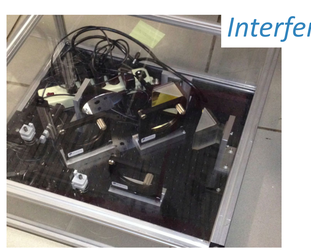
Left) 3-D model of OTIS box. Right) The colors indicate source, Yellow – X124, Purple and Red – Compressor, Green – X121. Solid lines go to the streak camera. Dashed lines go to the interferometer, Dot-Dash lines go the the user are in the box.



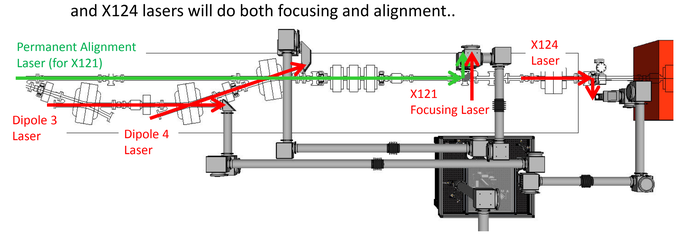
OTIS extraction from X124. Left) Normal camera optics cross section. Right) Attachment point of OTIS transport line.

Two endpoints for light from the beamline are the streak camera and the interferometer. The streak camera is a Hamamatsu C5680 mainframe with S20 PC streak tube that can accommodate a vertical sweep plugin unit and a horizontal sweep unit or blanking unit. It is also equipped with the M5675 synchroscan unit. The interferometer is a polarizing type interferometer that uses the spectrum of THz radiation to measure the bunch length.

Interferometer



Laser paths for alignment purposes. Dipole 3 and 4 and X124 lasers will do both focusing and alignment..



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