New combined function wire scanner & screen station for the high resolution transverse profile measurements at FERMI

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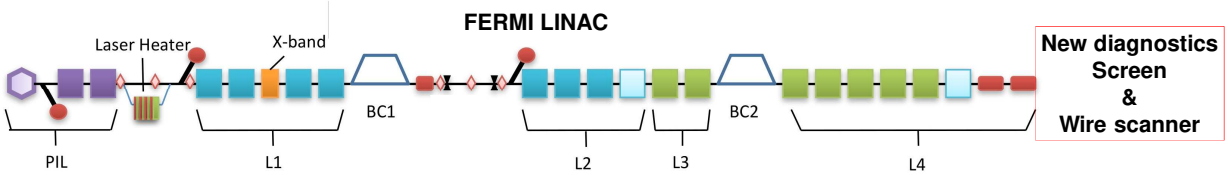
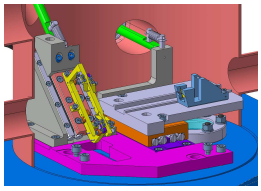
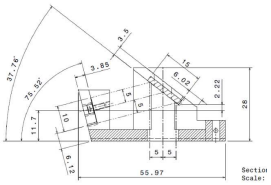
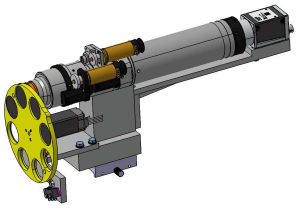
Abstract: We present the upgrade of the transverse profile diagnostics at the end of the FERMI Linac with a new high resolution instrumentation with the aim of improving the accuracy of the measurement of the twiss parameters and of the emittance. A scintillating screen, has been adopted instead of OTR screen due to known COTR issues. We used the same COTR suppression geometry that we had already implemented on our intra undulator screens and YAG:Ce as scintillating material. Screen based transverse profile diagnostics provide single shot measurements with a typical resolution in order of tens of microns mainly due to refraction effects, geometry and other physical material properties. To extend the resolution to the micron level needed in case of low charge operation, we have equipped the same vacuum chamber with a wire scanner housing 10 micron tungsten wires. This paper describes the design and the first operational experience with the new device and discusses strong points as well as limitations.

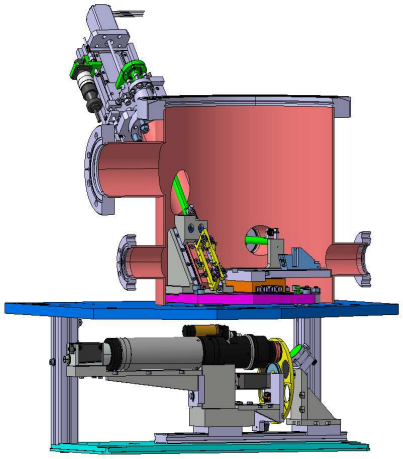


FERMI is a seeded FEL based on the high gain harmonic generation (HGHG) scheme. Two FEL lines, FEL-1 and FEL-2, are presently installed at the facility. FEL-1 is a single stage seeded FEL generating coherent light in the 65-20 nm wavelength range. FEL-2 is a double stage seeded FEL based on the fresh bunch injection technique where the additional stage extends the spectral range to 20-4 nm. At FERMI the electron bunch is generated at 50 Hz by a photo-injector GUN delivering 700pC with energy of 5 MeV. The electrons are accelerated by an S-band linac. The bunch length can be manipulated by means of a magnetic bunch compressor chicane (BC1). The final energy is up to 1.5 GeV in FEL operative conditions.









Chamber:

1 axis at 45 deg for wire scanner + 1 axis at 90deg for view screen
Vacuum translators: vacuum slits + compact motorized actuators
Wires frame and scintillator mounts installed on vacuum slits driven platforms

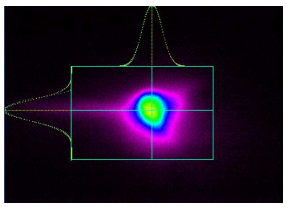
Screen:

Screen mount with COTR suppressing geometry
Incidence angle 15 deg. View angle normal to the scintillator surface
Scintillator YAG:Ce 0.5% doped optical ceramic. Thickness 100 µm
Imaging system installed below vacuum chamber
Imaging system has two installation options: horizontal and vertical
Working distance: Horizontal 175mm. Vertical 113mm
Resolving Power: Horizontal 9.5 µm. Vertical → 6.6 µm
Magnification: from 0,35 to 2.2.
Lens/ Camera: Navitar 6000 motorized focus and zoom / Basler AcA1300-75gm CMOS camera

Wire Scanner:

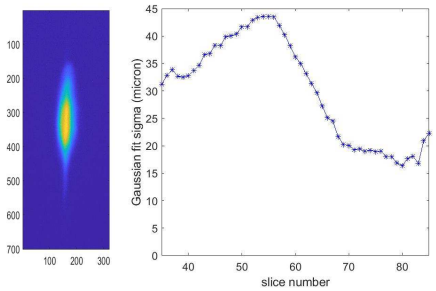
Tungsten wires with 10 microns diameter
Two wires x each direction at 10mm distance
Digital encoder with 0.1 micron accuracy
Acquisition of encoder shot by shot at 50Hz with bunch number
Dose measurement:
Cherenkov + scintillator fibers + PMT + Caen VX1720 digitizer *(SWISSFEL WS prototype tests)*

FEL optimized beam



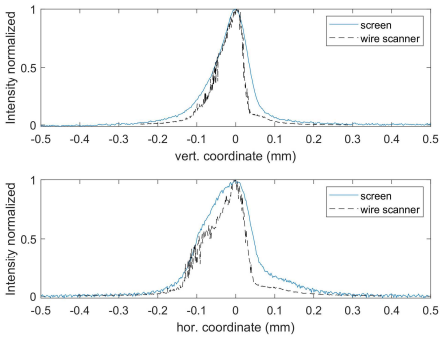
$\sigma_{x,y}$=32 x 34 µm

Stretched beam + slice analysis



Minimum slice width →18 µm

View screen vs wire scanner



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