Fermi National Accelerator Laboratory
P.O. Box 500 - Batavia, Illinois - 60510

Functional Requirement Specification
PXIE FAST FARADAY CUP, FRS
ED0004200, Rev. -

Prepared by: V. Scarpine,	FNAL PXIE Instrumentation leader	Extension x2571	Date 3 AUG 2015
Approved by: A. Shemyakin	FNAL/AD/MEBT Manager	Extension x4440	Date 14 DEC 2015
Approved by: N. Eddy*	FNAL/AD/Instrumentation Department Head	Extension x6860	Date 10 DEC 2015
Approved by: J. Patrick	FNAL/AD/Controls Department Head	Extension x2626	Date 14 DEC 2015
Approved by: C. Baffes	FNAL/AD/PXIE Front End Lead Mechanical Engineer	Extension x4154	Date 14 DEC 2015

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0	03 AUG 2015	Initial DRAFT	*Vic Scarpine*	*ALL*	
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B					

Introduction and Scope

The specification describes requirements for PXIE Fast Faraday Cup (FFC) intended for measuring the RMS length of bunches in the MEBT. The FFC is an insertion device that consists of a plate with a small hole and a collector of the beamlet cut by the hole. The collector is made as a strip line to provide a large bandwidth.

The FFC is used in the mode of short, infrequent pulses to avoid overheating of the collector and allow analyzing the FFC signal recorded with an oscilloscope. The measurements are done in low-radiation environment so that the oscilloscope can be placed within 3 m from the FFC.

Relevant Beam Parameters

For the purpose of the FFC measurements, the beam is assumed coming in trains (pulses) of 162.5 MHz bunches with parameters indicated in Table 1.

In the Table 1, The FFC is assumed to be moved vertically. Capability of mounting the FFC at other angles is desirable but not required.

Table 1. Relevant beam parameters

Parameter	Unit	Nominal value	Range
Particles type		H^-	
Energy	MeV	2.1	2.0 – 2.2
Velocity	mm/ns	20.01	
Bunch frequency	MHz	162.5	
Bunch length, rms	degrees of 162.5MHz	10	7 -35
Bunch length, rms	ns	0.17	0.12 – 0.60
Nominal pulse repetition rate	Hz	Single Pulse	From single pulse to 0.1 Hz
Nominal pulse length	μs	20	1 - 20
Current averaged over 1 μs	mA	5	1 - 10
Corresponding particles per bunch	10^8	1.9	0.38 - 3.8
rms beam radius	mm	2	1 - 4
Vertical angle of beamlet centroid	mrad	0	0 - 10
Horizontal angle of beamlet centroid	mrad	0	0 - 2
Beamlet angular spread, rms	mrad	1.5	0.5 - 3

FFC Functional Requirements

For the nominal beam parameters listed in Table 1, the FFC should provide an RMS bunch length measurement with accuracy **≤ 5%** averaged over 1 μs of beam. The option to observe the length of

individual bunches should be foreseen as well. The time per measurement should be not more than 20 sec.

The beamlet diameter should be **≤ 1 mm**.

Interfaces

Table 2. Mechanical interfaces for the FFC monitor

Parameter	Unit	Value
Longitudinal space, flange-to-flange	mm	≤ 200
Clear aperture of vacuum chamber	mm	≥ 30
Matching flanges		CF 2 3/4
Vertical range of measurement positions with respect to the beam line axis	mm	± 15
Absolute accuracy of vertical position of the sensor	mm	≤ 1
Reproducibility of vertical position	mm	≤ 0.2
Resolution of vertical position	mm	≤ 0.1
Sensor horizontal alignment with respect to beam line axis	mm	≤ 1
FFC module pitch and yaw adjustment range	mR	± 25
FFC module pitch and yaw adjustment resolution	mR	0.25

The design should allow using the monitor in UHV environment. Vacuum chamber and stand must allow for FFC sensor pitch and yaw adjustment under vacuum.

Recommended Technical Parameters

Table 3. Recommended technical parameters of the FFC, including electronics

Parameter	Unit	Value
FFC sensor bandwidth	GHz	≥ 7
FFC overall system bandwidth	GHz	≥ 5
Amplitude dynamic range	bit	≥ 6

References

1. PXIE Functional Requirements Specification, TC # ED0001223, uncontrolled copy is available at http://projectx-docdb.fnal.gov/cgi-bin/ShowDocument?docid=980
2. MEBT Functional Requirements Specification, TC# ED0001303, uncontrolled copy is available at http://projectx-docdb.fnal.gov/cgi-bin/ShowDocument?docid=938