IBIC 2023, Saskatoon, Canada

FERMILAB-POSTER-23-302-AD

IBIC2023

WEP033

A Schottky Tune Meter for the Fermilab Mu2E Delivery Ring*

V. Scarpine†, B. Fellenz, A. Semenov, D. Slimmer, Fermi National Accelerator Laboratory, Batavia, IL 60510 USA

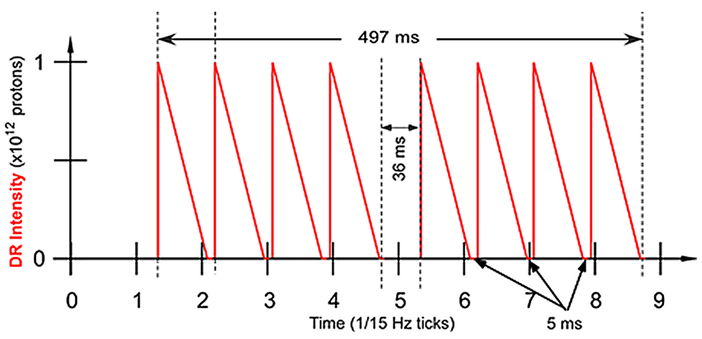
Introduction

As part of the Mu2E experiment, a proton storage ring, called the Delivery Ring (DR), will utilize resonant extraction to slow-spill protons to the experiment. To regulate and optimize the Delivery Ring resonant extraction process, a fast tune measurement scheme will be required. This Mu2E tune meter will measure the average tune and the tune spectrum, in multiple time slices, through the entire resonant extraction cycle. The Mu2E tune meter system utilizes vertical and horizontal 21.4 MHz Schottky detector resonant pickups, high-gain amplifiers and digital down-conversion FPGA logic for its signal processing.

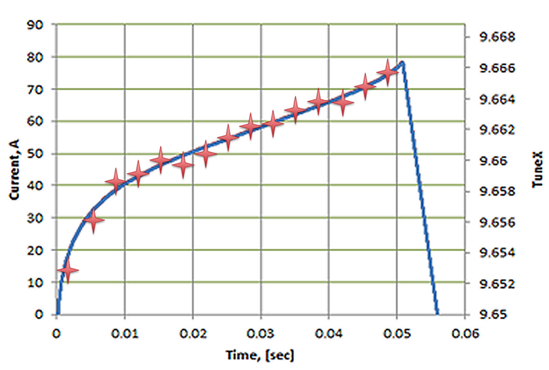
Beam Parameters

Parameter	Value	Units
MI Cycle time	1.333	sec
Number of spills per MI cycle	8	
Duration of each spill	34-54	msec
Number of protons per micro-pulse	$(3.0\text{-}5.0)\times10^{7}$	protons
Maximum DR Beam Intensity	1.0×10^{12}	protons
Reset Time Gap between spills	5	msec
Operation point (Qx/Qy)	9.650/9.735	
DR revolution frequency	590.018	kHz

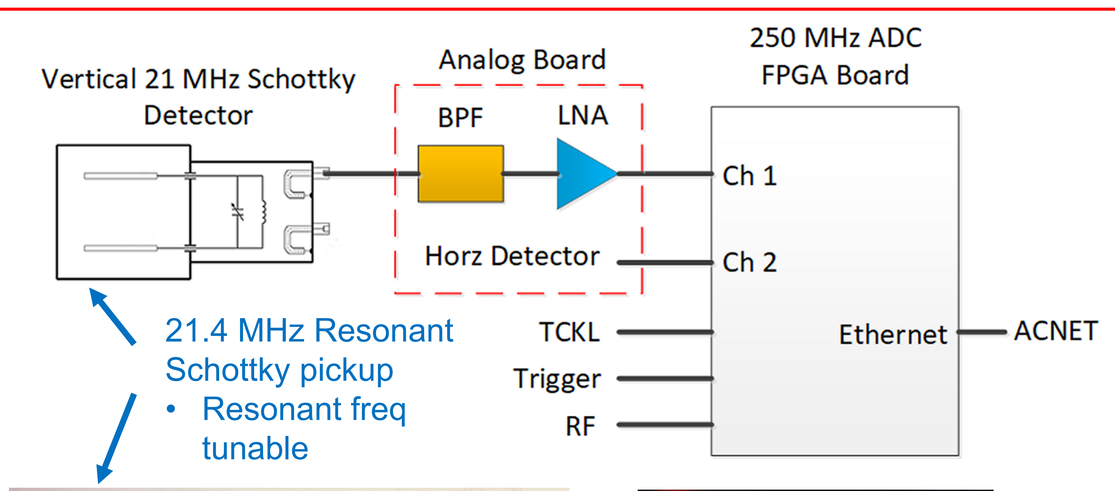
- Eight slow spills from delivery ring
- Ring intensity goes from 1e12 to ~1e8 protons during spill

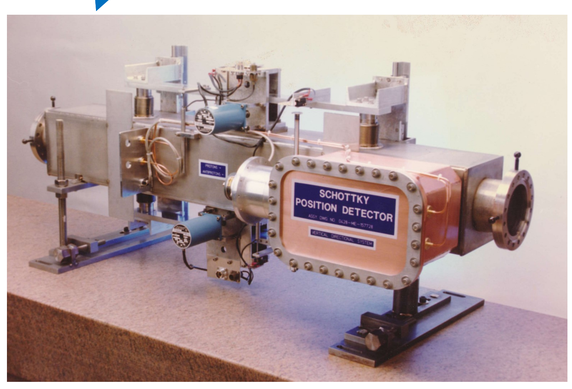


- Beam tune spectrum through slow spill
- Total tune shift ~0.01
- Red cross indicate Schottky tune meter potential measurements

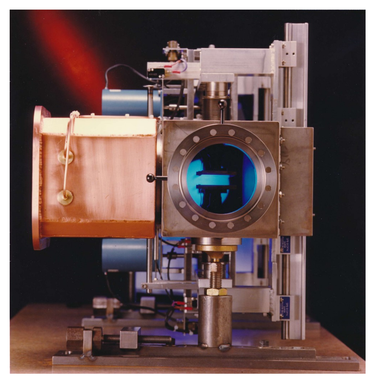


Tune Meter System





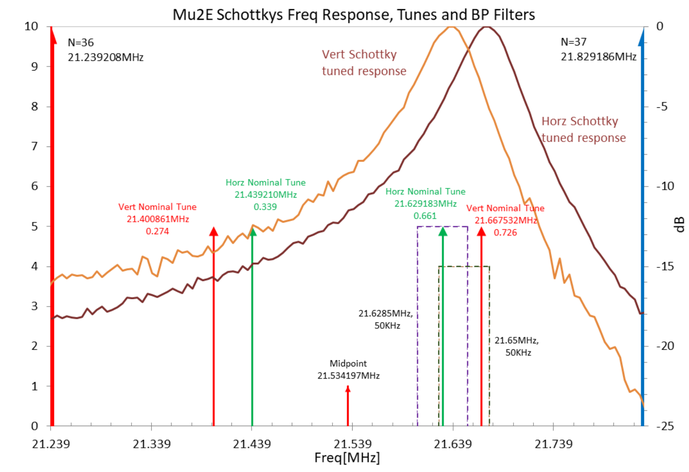
Vertical Pickup with Resonator

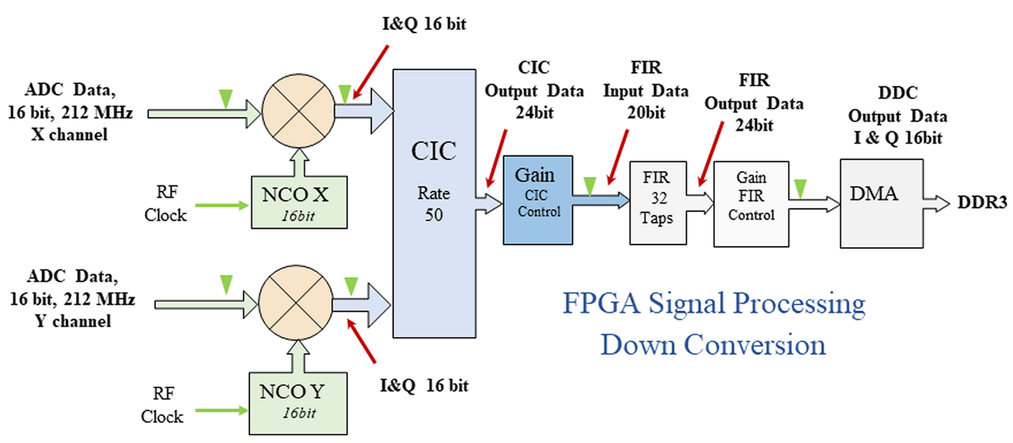


Beamline View

Schottky tune spectrum and pickup frequency response

- Operate between 36th and 37th revolution harmonics
- Vertical and horizontal pickups adjusted to their respective tunes



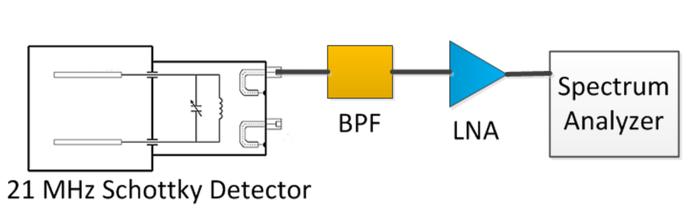


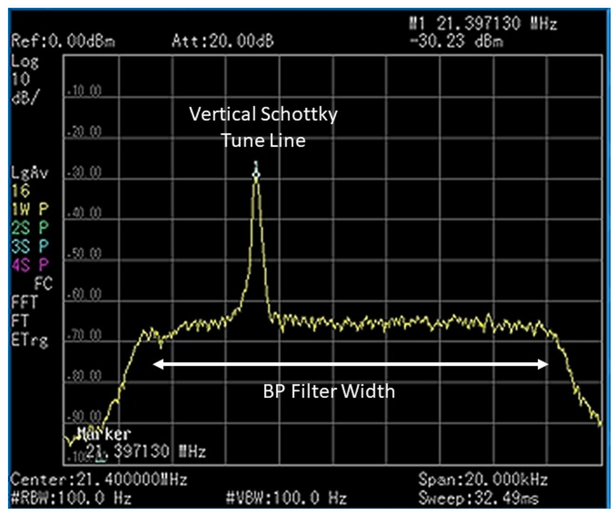
FPGA Signal Processing Down Conversion

Test Setup with Spectrum Analyzer

Preliminary vertical Schottky tune measurements with spectrum analyzer

- ~5e10 coasting beam in DR
- Averaging set to 16

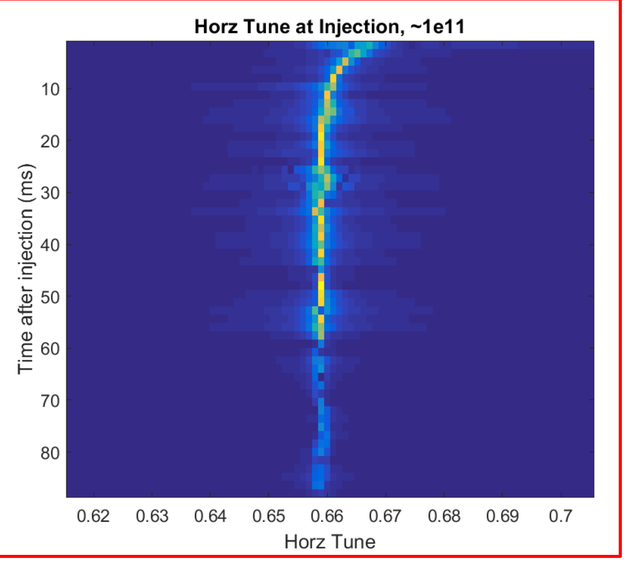




Initial Tune Meter Measurements

DR horizontal Tune measurements at injection

- ~1e11 protons at Injection
- Down convert signal to baseband
- ~80 db analog gain



* This work was supported by the U.S. Department of Energy under contract No. DE-AC02-07CH11359.

†scarpine@fnal.gov