



# Main Injector Beam Position Monitor System Upgrade Overview

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# MI BPM Design

- **Objective**
  - To deliver a useable and maintainable BPM system that will provide the beam position measurements necessary and useful for effective and efficient high-performance operation of the Main Injector
- **Approach**
  - Use the same EchoTek digital signal processing hardware as in the Tevatron (already procured for MI BPM system)
  - Use the same VME/VXWORKS data acquisition environment as in the Tevatron, Recycler, NuMI, etc.
  - Combine the experience and methods developed in creating those systems to produce a system meeting the MI requirements in an effective and timely manner



## Requirements-Driven Differences from Tevatron BPM (1)

- Four-electrode pick-up and two-cable system  
→ **combiner box in tunnel**
- Wide range of beam intensities and bunch structure  
→ **large signal level dynamic range**
- Desired signals (2.5 MHz and 53 MHz) appear in two different Nyquist bands of the 80 MHz EchoTek board digitizer  
→ **parallel, switchable analog signal channels**
- First-turn/last-turn/turn-by-turn measurements of protons and antiprotons to/from multiple injection/extraction points  
→ **timing and data sorting complexity**

## Requirements-Driven Differences from Tevatron BPM (2)

- Selectable batch-by-batch / bunch-by-bunch measurements in turn-by-turn and flash modes  
→ **added timing controls and data tagging**
- Separately configurable measurement setups for different machine states (cycles)  
→ **VME front-end 'state awareness' and added dimension in setup configuration at all levels**
- Separate data buffers for different machine states (cycles)  
→ **VME front-end memory requirements and 'state awareness' for nearly all applications**

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## Requirements-Driven Differences from Tevatron BPM (3)

- Numerous different, relatively short, and dynamically interwoven machine cycles  
→ optimization of mode configuration and switching speed and data readout time



## The Project Path

- New signal combiner boards for the tunnel are designed and in production for early installation
- Utilize larger subset of EchoTek board features
  - Configure Graychip so that all four channels play a role
  - Take advantage of the segmentation and random access features of the EchoTek data memory
- Develop front-end software in sensible stages so that system implementation can proceed at an accelerated pace
- Emphasize console applications to make it possible for system engineers, commissioners, and end-users to cope with the system flexibility in a natural, comprehensible, and manageable way