



# This Review

- This is a technical design review, not a requirements review
- You will review a preliminary and, in some aspects, a conceptual design; not a final design
- Review will provide us technical feedback and perhaps demonstrate that:
  - All technical buy-no-buy issues have been resolved (i.e. we detail “a way” to make each required measurement with this hardware)
  - Remaining technical difficulties have at least been identified
  - We have a technical understanding of shortcomings in the present RR BPM system and a plan to avoid or overcome those in any new system
  - The system scope has been addressed on a broad basis and that a plan and an organization to implement this or another design has been identified
- The review comes at this stage so as to initiate either:
  - Approval of long-lead procurements or
  - Redirection of design efforts with revised guidelines



## **RR BPM Requirements Overview**

**Bob Webber**

*Recycler BPM Preliminary Technical Design Review*

2/17/03



# Big Picture

- Beam position measurements required at 104 horizontal and 107 vertical locations in Recycler ring and 26 locations in transfer lines.
- An integrated calibration system for each location is required
- Attachments to the pick-ups must accommodate application of ion clearing voltages to the electrodes
- Recent accelerator planning decisions have removed requirement to measure beams with 7.5MHz bunch structure; requirements will be revised



# Beam Structures Required to Be Measured

- Four bunches in consecutive 2.5MHz buckets
  - Bunch width sigma of 25 nsec to 50 nsec
  - Total charge 2E10 to 30E10
- Un-bunched (barrier bucket contained) beam
  - Total charge 20E10 to 400E10
  - Distribution width 1.8 usec to 11.2 usec
  - Distribution “rise/fall time” 340 nsec to 566 nsec
- 2.5MHz beam partition and one or two un-bunched beam partitions may be circulating at any time
  - Required to be measured separately but not simultaneously
  - Minimum partition separation is 680 nsec
- Must measure protons or antiprotons in each structure (signal polarity)
- No requirement to measure 53MHz beam
- No requirement for any measurement during simultaneous circulation of protons and antiprotons



## Required for Each Structure

- Both position and intensity (sum signal) data required for all measurements
- Single turn “flash” at all locations simultaneously
- Closed orbit at all locations simultaneously
- Turn-by-turn for up to 1024 turns at all locations simultaneously
- Background “flash” at all locations simultaneously at >200 Hz (e.g. for time plots )



# Measurements Required for Individual Structures

- Four-bunch 2.5 MHz beam
  - Each bunch independently; only one at any time
  - “Average” or “center of mass” of entire 4-bunch ensemble
- Un-bunched (barrier bucket contained) beam
  - Head (leading end) of bunch
  - Trail (trailing end) of bunch
  - “Average” or “center of mass” of un-bunched charge distribution



# Accuracy Requirements

- For single “flash” measurements
  - Absolute Position ---  $\pm 1 \text{ mm} \pm 5\%$  of actual position (3 sigma)
  - Relative Position ---  $\pm 0.4 \text{ mm} \pm 5\%$  of actual position (3 sigma)  
measurement to measurement
  - Intensity (sum signal) --- Ability to calibrate sum signal to stable  $\pm 5\%$  relative accuracy for a defined beam structure
- Calibration system
  - Adequate to assure position accuracy of  $\pm 0.25 \text{ mm} \pm 1.25\%$  and sum signal accuracy of  $\sim 2\%$
- For reference
  - Vertical pick-up sensitivity  $\sim 0.6 \text{ db/mm} \Rightarrow A-B/A+B \sim 3.4\%$   
 $\text{@ } 1 \text{ mm}$
  - Horizontal pick-up sensitivity  $\sim 0.3 \text{ db/mm} \Rightarrow A-B/A+B \sim 1.7\%$   
 $\text{@ } 1 \text{ mm}$

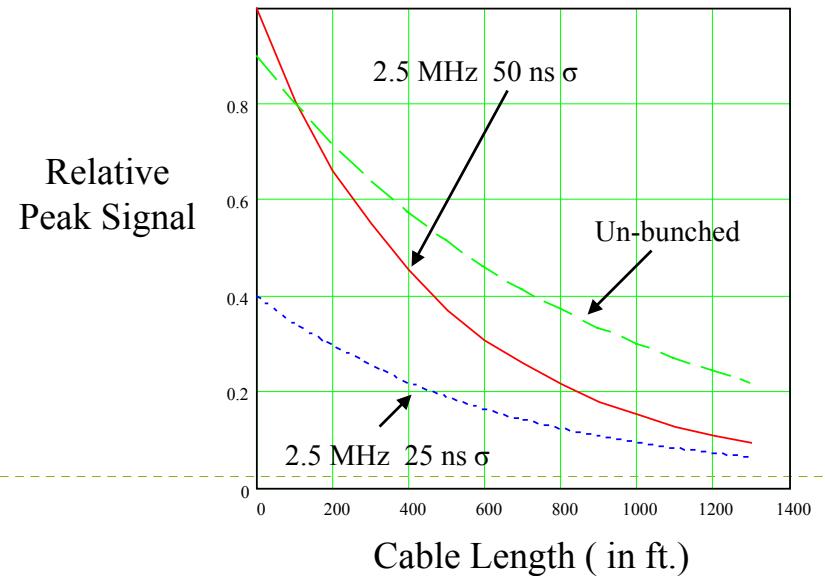
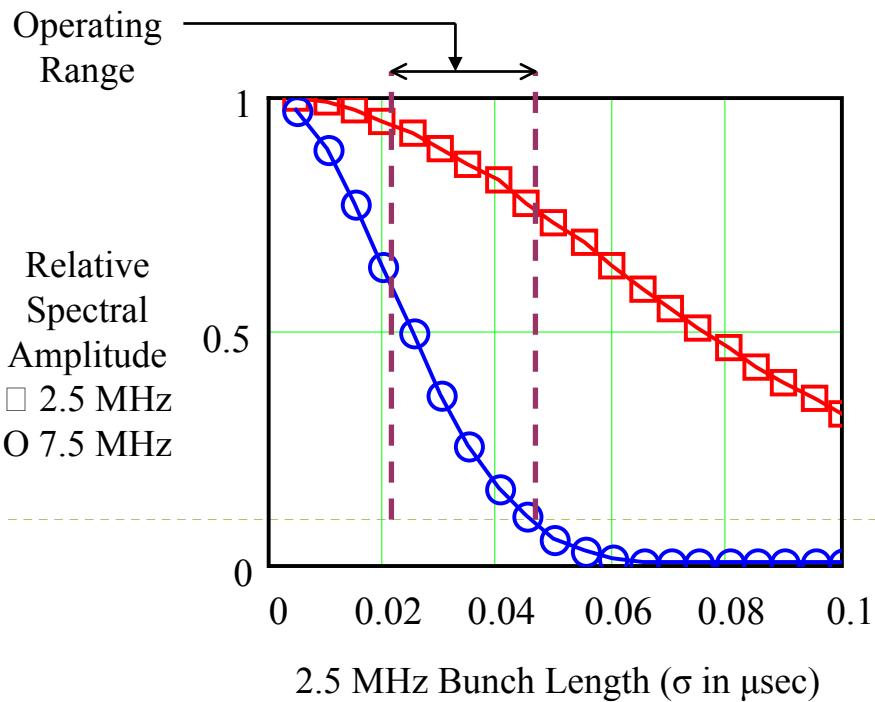


# System Philosophy, Plan, Design Overview

Bob Webber

*Recycler BPM Preliminary Technical Design Review*

2/17/03





# Design Philosophy and Initial Assumptions

- Philosophy
  - System design considerations aim to meet the spirit and scope, if not letter, of MI/RR Department requirement specifications
  - Nothing short of a well planned, documented, and organized effort with sufficient resources will produce results in a timely manner
  - No specific consideration for applicability to MI or Tev BPM upgrades during design development (due to RR schedule)
  - Software concerns represented in the detailed design planning at the earliest stages
- Initial Assumptions
  - Delivery of the system on a short, well-understood, schedule is high priority
  - Existing major cabling systems shall not be replaced
  - EchoTek receiver is the “shortest path” to functional system



# Known Shortcomings at This Time

- Actual beam measurements have been demonstrated for 2.5MHz beam structure, but not for un-bunched beam
- EchoTek board utilization details
  - Comprehensive and definitive list of each measurement mode and EchoTek set-up is not completed (Warren offers “a way”)
  - EchoTek output data for each measurement mode is not yet defined in detail
- Quantitative interpretation of sum signal is not offered
- Calibration system
  - Quantitative performance is not determined
  - Design does not fully comply with specified requirements
- The schedule data is incomplete, though structure is made
- No detailed installation/integration plan is provided



## Recycler BPM Project Organization

### Requesting Organization - MI/RR Department

S. Mishra, Dept. Head  
B. Choudhary, Project Manager

### Technical Organization - BD Instrumentation Dept. et al.

R. Webber, Dept. Head & Technical Project Manager  
J. Crisp, Technical Advisor

Scheduling  
S. Zimmermann/CD

Software  
D. Voy/BDI

Hardware  
P. Prieto/BDI

Front-End  
D. Voy/BDI

Console Apps  
TBD

Preamp  
P. Prieto/BDI

Key:  
BDI –  
Beams Div.  
Instrumentation

BDC –  
Beams Div.  
Controls

BDMI –  
Beam Div.  
Main Injector

CD –  
Computing Div.

Control/DAQ  
D. Voy/BDI

DDC Interface  
C. Briegel/BDC

Calibration  
D. Nicklaus/BDC

Timing  
D. Voy/BDI

Diagnostic Interface  
D. Voy/BDI

Development/TestLab Set-up  
D. Voy/BDI

Libraries  
B. Hendricks/BDC

Closed Orbit/Flash  
L. Winterowd/BDC

Turn-by-Turn  
Ming-Jen/BDMI

Calibration  
TBD/CD

Diagnostics  
TBD/CD

Engineering Interface  
TBD

Calibration  
S. Zimmermann/CD

Transition Module/Crates  
M. Bowden/CD

Calibration Driver Module  
M. Bowden/CD

DDC Module/Crates  
P. Prieto/BDI

Test Set-up  
P. Prieto/BDI

Cabling  
N. Wilcer/CD

Timing Hardware  
C. McClure/BDC



# Cost

| ITEM   | Quantity                 | Unit Cost \$ | Item Cost K\$ |                      |
|--|--------------------------|--------------|---------------|----------------------|
| VME Cpus                                     | 12                       | 4000         | 48            | req prepared 1/28/03 |
| VME Crates & PS                              | 10                       | 5000         | 50            | req prepared 2/5/03  |
| Digital IO cards                             | 8                        | 1000         | 8             | req prepared 1/28/03 |
| EchoTek DDCs (67)                            | 67                       | 7500         | 502.5         | req prepared 1/28/03 |
| DDC Clock Generators & Distribution          | 8                        | 3000         | 24            |                      |
| Tunnel Cable Extensions                      | 500                      | 25           | 12.5          |                      |
| Transistion Crate (w/backplane & connectors) | 10                       | 3000         | 30            |                      |
| Transistion Module PS                        | 10                       | 1500         | 15            |                      |
| Transistion Modules                          | 70                       | 1000         | 70            |                      |
| Transition Module to DDC cables              | 500                      | 25           | 12.5          |                      |
| Calibration switch boards (preamp)           | 250                      | 50           | 12.5          |                      |
| Calibration Signal Genenerators              | 10                       | 2000         | 20            |                      |
| Calibration Signal Drivers                   | 10                       | 1500         | 15            |                      |
| Test Setup costs                             | 1                        | 25000        | 25            |                      |
| Contingency                                  |                          |              | 75            |                      |
| Total  |                          |              | 920           |                      |
| % Contingency (excluding EchoTek and CPUs)   | RR BPM Review<br>2/17/03 |              | 20%           |                      |