

Longitudinal Emittance Monitoring in the Main Injector using Sampled Bunch Data

Speaker: Lola Ogunmefun

Supervisors: Chandra M. Bhat
Brian S. Hendricks

Beams Division, Main Injector

Main Injector, MI

- Proton/Antiproton synchrotron
- Final accelerator in the Fermi chain before injection into the superconducting Tevatron
- Multifunctional with regards to accelerator operations

Proton/Antiproton Collider Operations

- Protons from Booster, antiprotons from pbar source
- Ramped to 150 GeV in the MI and then transferred to the Tevatron
- 36x36 bunches for TeV. collisions

Longitudinal Emittance (ε_l)

- Total phase-space area occupied by the particles in a bucket
- Affects collision luminosity

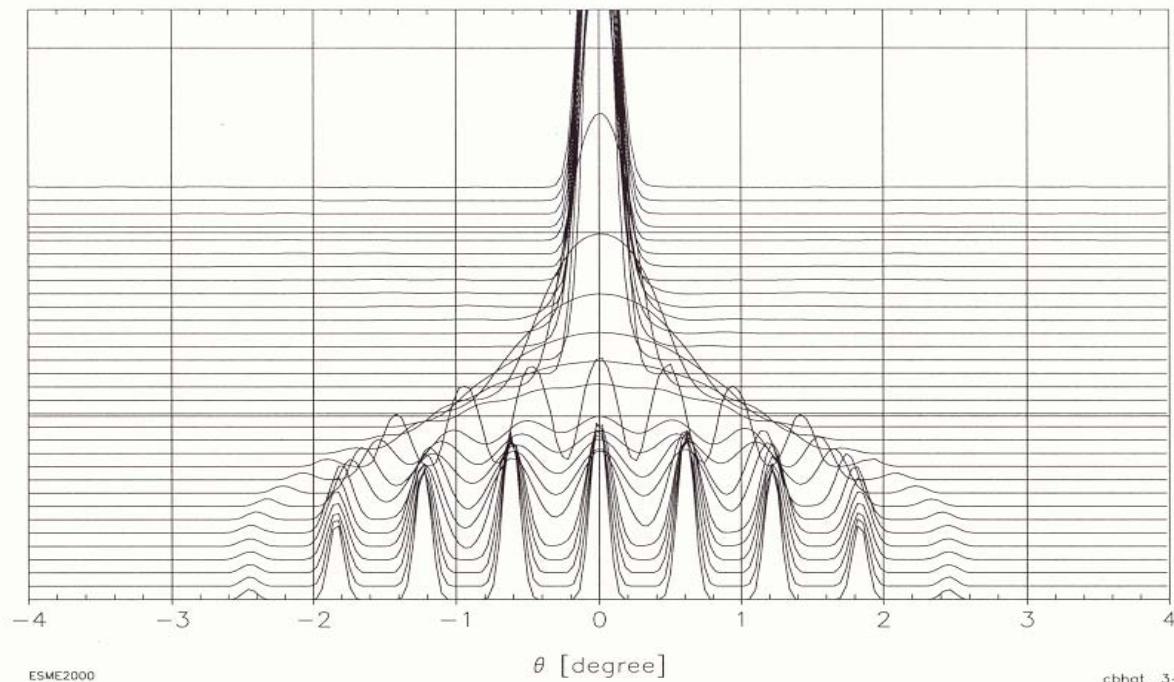
Longitudinal Emittance Growth in the MI

- Phase mismatch / Injection oscillation
- Bunch Coalescing

Bunch Coalescing

End of Rotation in 2.5 MHz Buckets
every 330 turns, from turn 410520

Beam Current Profiles



Sampled Bunch Display (SBD)

- Displays bunch-by-bunch data on the current beam
- Intensity, RMS bunch length, and momentum values used by program for emittance calculation

PA 1896 (version 1.0)

- Devised to monitor longitudinal emittance in the MI
- For proton(2B) and antiproton(2A) ramping cycles
- Sampled bunch data acquired at three time points on the beam in the accelerator
- Written in C

PA1896 (version 2.0)

- Acquire sampled bunch data from seven time points on the beam
- Read momentum values from sampled bunch device
- Emittance calculation for 5 central bunches in each bucket
- Devise a delay method to eliminate premature data acquisition
- Improve user interface

Program Modules

- General operations
- Live Capture
- Graphing
- Data Retrieval

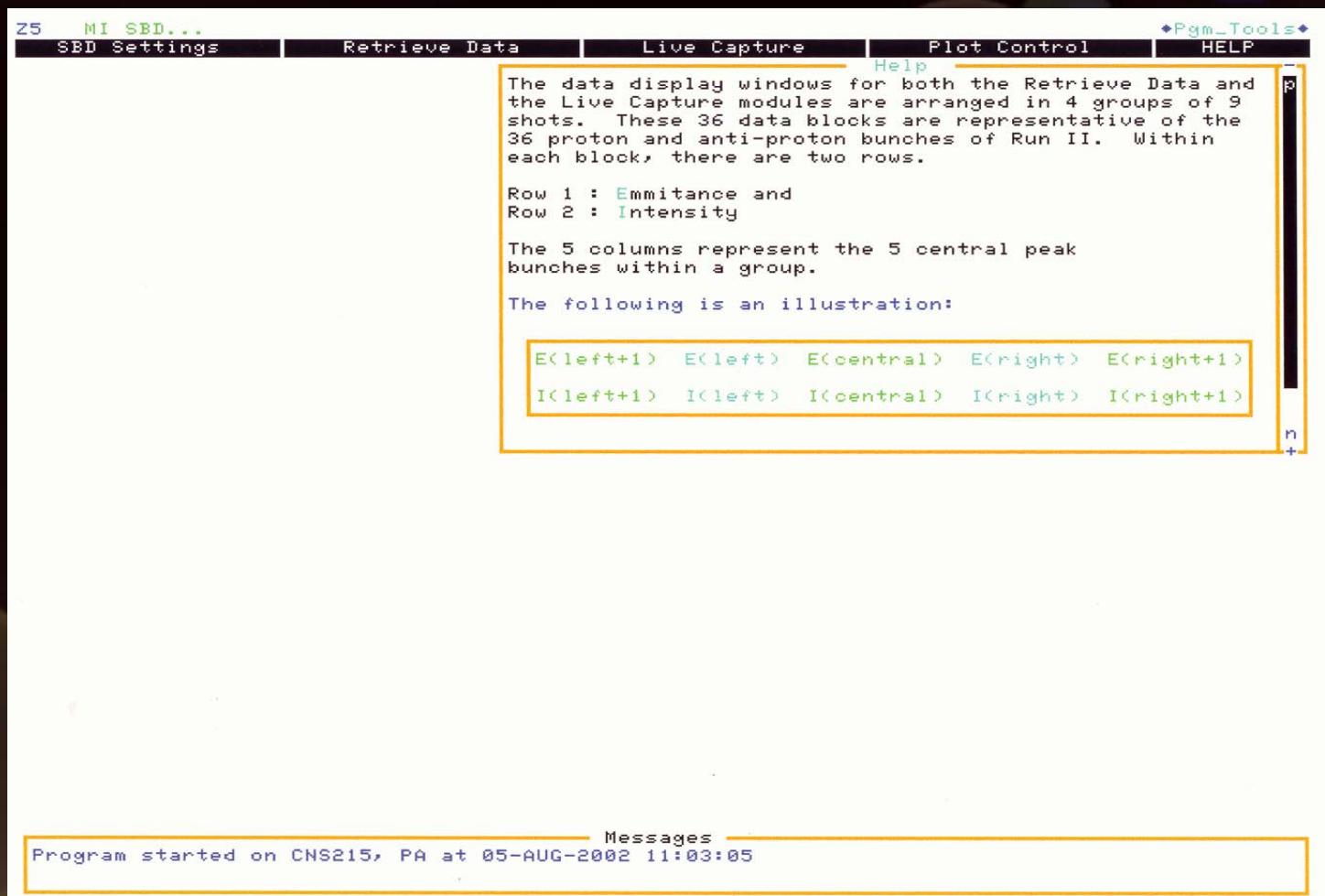
General operation Modules



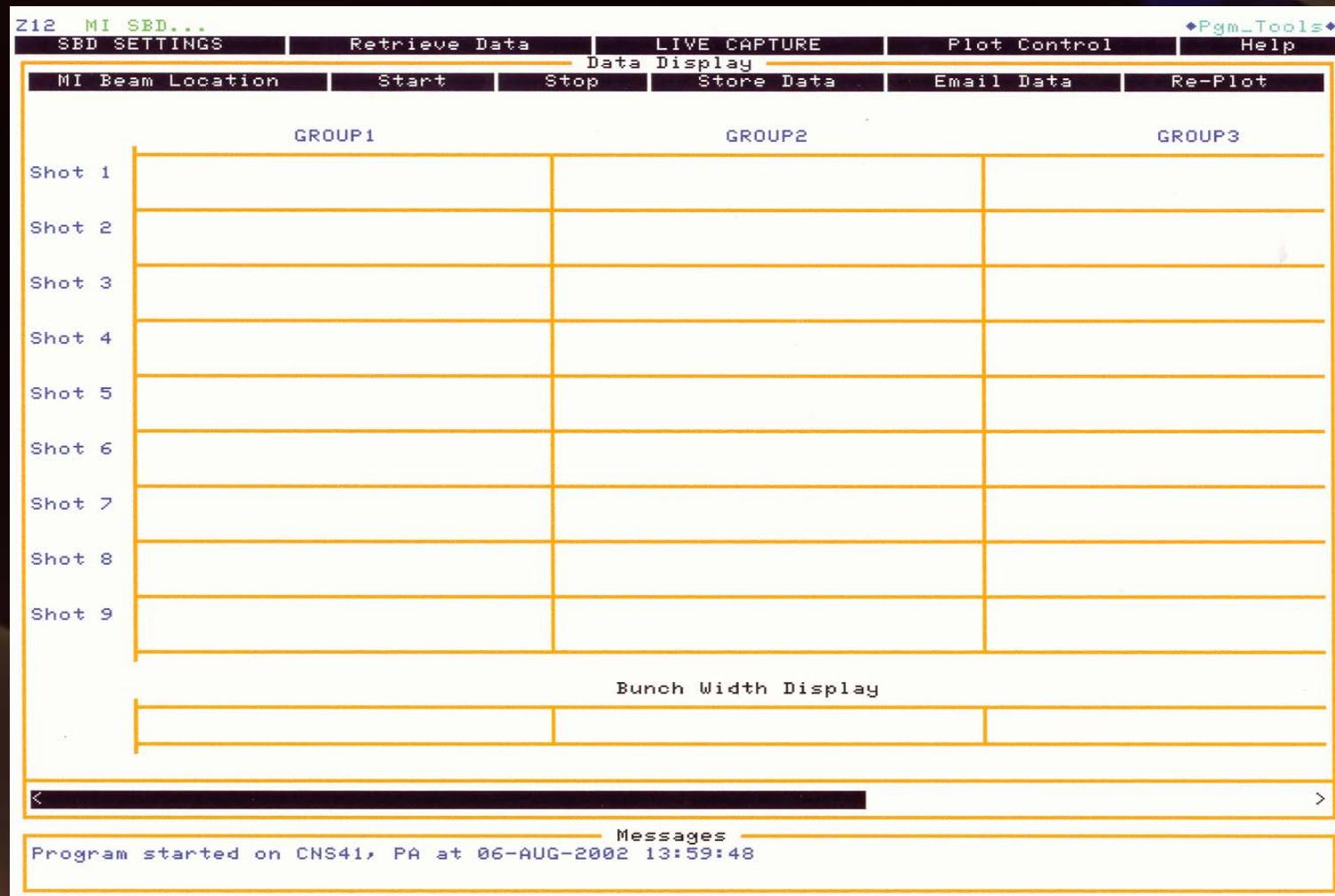
General Operation modules (contd.)



General Operation modules (contd.)



Live Capture module



Live Capture module (contd.)

Graphing module



Data Retrieval module (contd.)

Z5 MI SBD...

SBD Settings | RETRIEVE DATA | Live Capture | Plot Control | Help | ♦Pgm_Tools♦

MI Beam Location MI Injection at 8 GeV Data Display Open Voltage/Momentum

Type:2A

	GROUP1					GROUP2					GROUP3			
Shot	.11	.15	.15	.24	.2	.11	.15	.2	.15	.15	.11	.15	.11	.2
1	.11	.15	.15	.24	.2	.11	.15	.2	.15	.15	.11	.15	.11	.2
2	1.3	1.9	2	2.4	2.2	1.4	1.9	2.2	2.1	2	1.4	1.8	2.1	2.4
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0

< [REDACTED] >

Messages

Program started on CNS215, PA at 05-AUG-2002 11:03:05

Data Retrieval module (contd.)

Data Retrieval module (contd.)

MI Beam Location										Voltage/Momentum				
MI Injection at 8 GeV														
Type:	GROUP1					GROUP2					GROUP3			
Shot 1	.05 15	.08 14	.08 18	.08 17	.05 19	.05 15	.05 17	.08 16	.08 20	.05 17	0 1.8	0 1.1	.11 2.1	.2 2.4
Shot 2	.05 13	.08 16	.11 16	.08 16	.05 13	.08 16	.05 15	.08 15	.08 16	.08 16	0 -.14	0 .22	.11 2.1	.2 2.4
Shot 3	.05 19	.08 17	.08 18	.08 17	.11 19	.05 17	.08 19	.08 18	.11 20	.08 18	0 .75	0 -1.8	0 0	0 0
Shot 4	.08 14	.08 15	.08 15	.05 15	.08 15	.08 15	.08 13	.11 16	.08 15	.05 14	0 -.26	0 -.26	0 0	0 0
Shot 5	.08 17	.08 19	.05 14	.08 19	.11 20	.08 17	.05 16	.05 16	.15 19	.08 16	0 .17	0 1.5	0 0	0 0
Shot 6	.05 15	.05 16	.08 19	.05 16	.08 18	.08 16	.05 13	0 .39	0 -.84	0 2	0 .14	0 1.3	0 0	0 0
Shot 7	.05 15	.05 15	.05 16	.11 15	.05 14	.08 16	.05 15	.05 14	.11 13	0 2	0 2.7	0 -2.2	0 0	0 0
Shot 8	.08 17	.05 14	.05 15	.08 14	.08 17	.11 17	.08 14	.08 16	.05 13	0 .92	0 .49	0 .05	0 0	0 0
Shot 9	.08 16	.05 15	.08 16	.08 15	.05 15	.05 16	.08 16	.11 16	.08 15	.05 12	0 1.5	0 .18	0 0	0 0

Results

- Above-transition raw data problems corrected with a new scaling scheme
- Data acquisition delay time (ACUP clean up time + 3 sec default)
- Bunch peak search, emittance calculations, data storage still functional after adjustments

Recommendations

- I:SBDxxD “ghost” data should be investigated with a front-end check
- Data acquisition could be further expanded to include more peak bunches and time points on the beam

Questions?