



## Brookhaven 200 MeV H- Linac Beam Instrumentation Upgrade

O. Gould, B. Briscoe, D. Gassner, V. Lo Destro, R. Michnoff, J. Morris, D. Raparia, W. Shaffer,  
C. Theisen, M. Wilinski, Brookhaven National Laboratory, Upton, NY 11973, USA,  
D. Persaud, The City College of New York, New York, NY 10031, USA,  
K. Sanders, Saint Joseph's College, Patchogue, NY 11772 USA

### Abstract

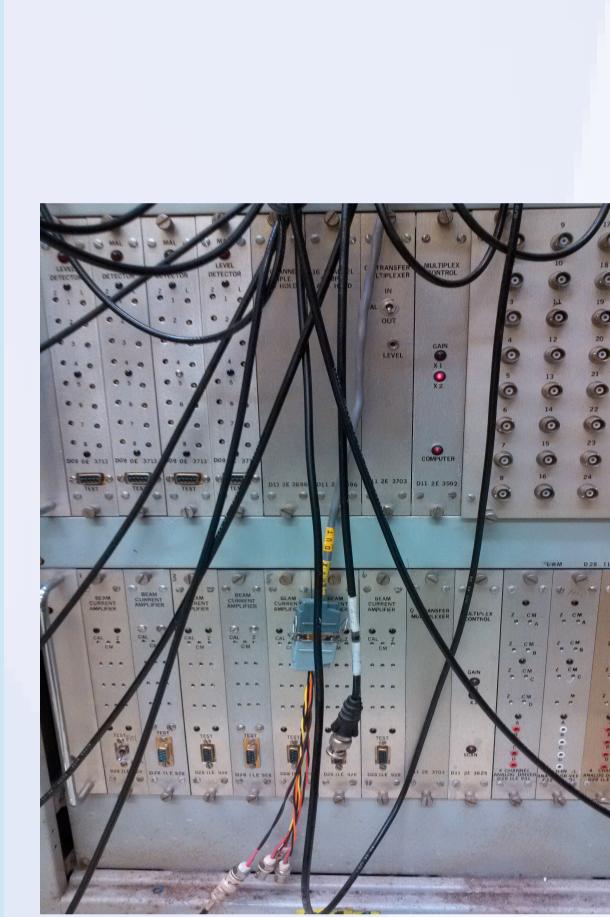
The Brookhaven National Laboratory 200 MeV H- Linac beam instrumentation has been in operation for four decades with various changes implemented over this period. There is a need to upgrade the beam instrumentation systems of the Linac to improve the diagnostics of the beam from the Low Energy Beam Transport Line through the Linac and into the Linac Booster Transfer Line and BLIP Line. Profile Monitors, Current Monitors, Beam Position Monitors, Long Radiation Monitors, and Emittance Measurement devices are to be designed and implemented over the next three years. This upgrade will improve the operation reliability, beam quality; and reduce beam losses. Additional improvements will be obtained by designing the beam instrumentation systems to integrate with other proposed diagnostics and malfunction detection and display upgrades in the Linac Control Room to improve the overall performance of the Linac.

### List of Upgrade Devices and Quantities

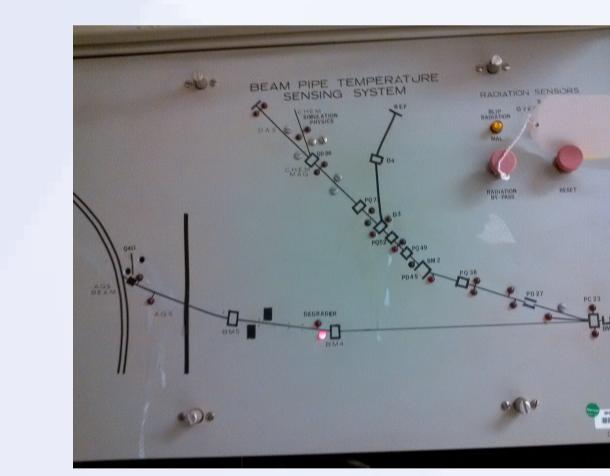
Devices	Present	Upgrade
Current Transformer (CT)	25	27
Secondary Emission Monitor (SEM)	14	14
Slit Aperture Insertion Device (SAID)	1	1
Energy Measurement Absorber Insertion Device (EMAIID)	1	1
Harp Multi-wire Profile Monitor (Harp)	4	6
Long Radiation Monitor (LRM) + Neutron Detector (ND)	33	55
Beam Position Monitor (BPM)	20	21
Laser Profile Monitor (LPM)	1	2

December 2013 – specifications  
February 2014 – Controls assessment  
November 2016 – upgrade completion

### A Snapshot of Some Electronics to be Upgraded

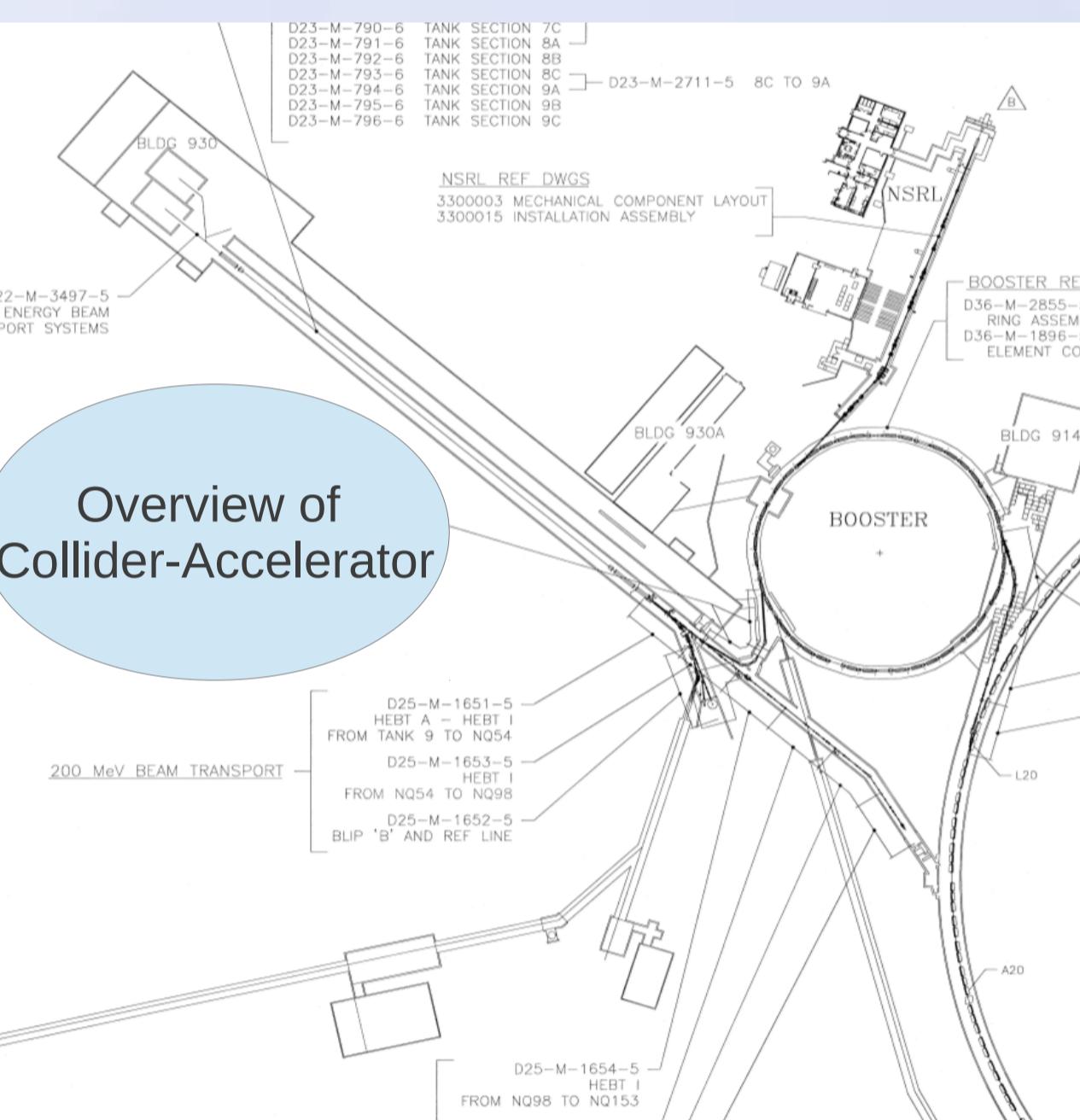
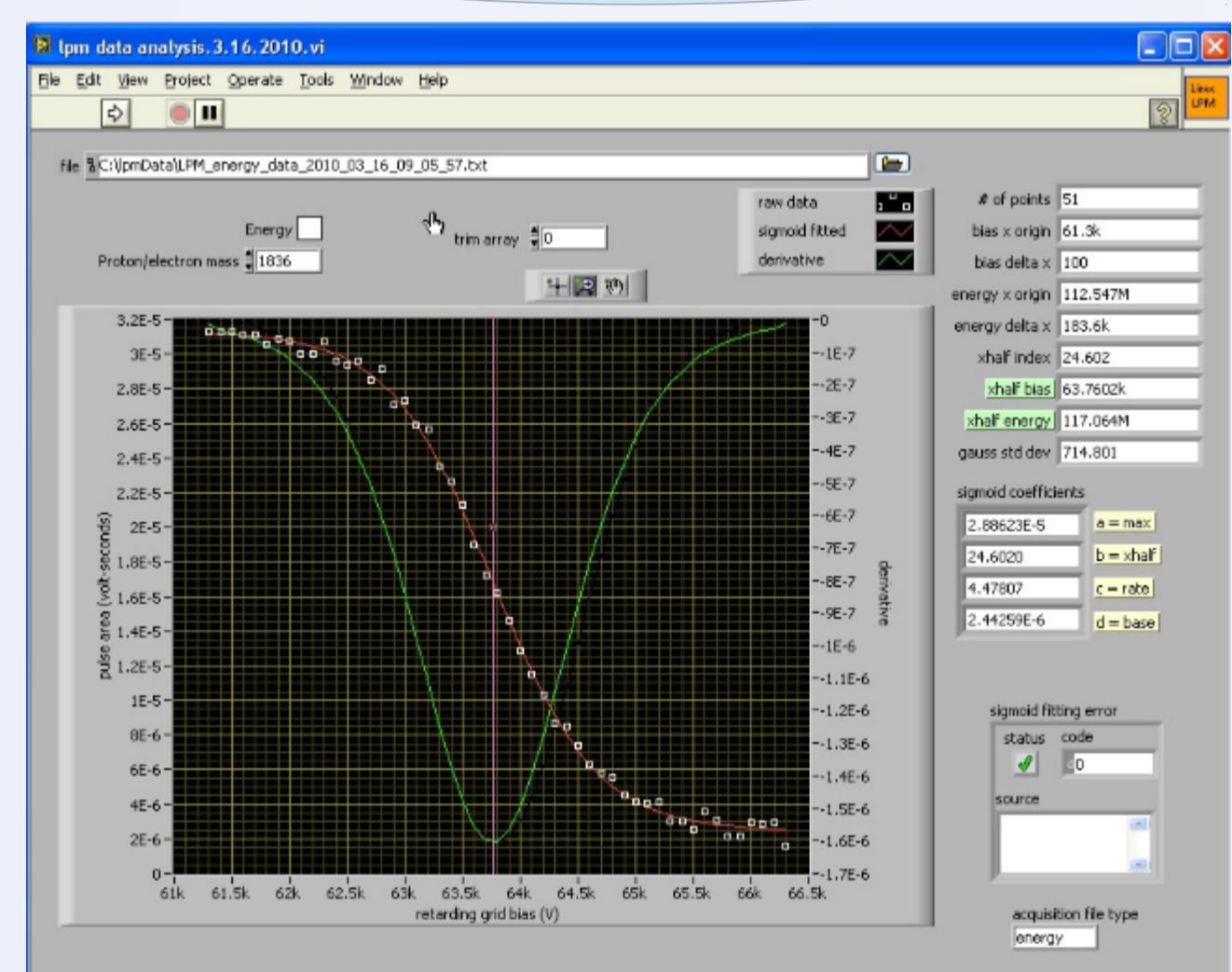


Portions of the Electronics for the LRM and CTs



Beam Pipe Temperature Indicator

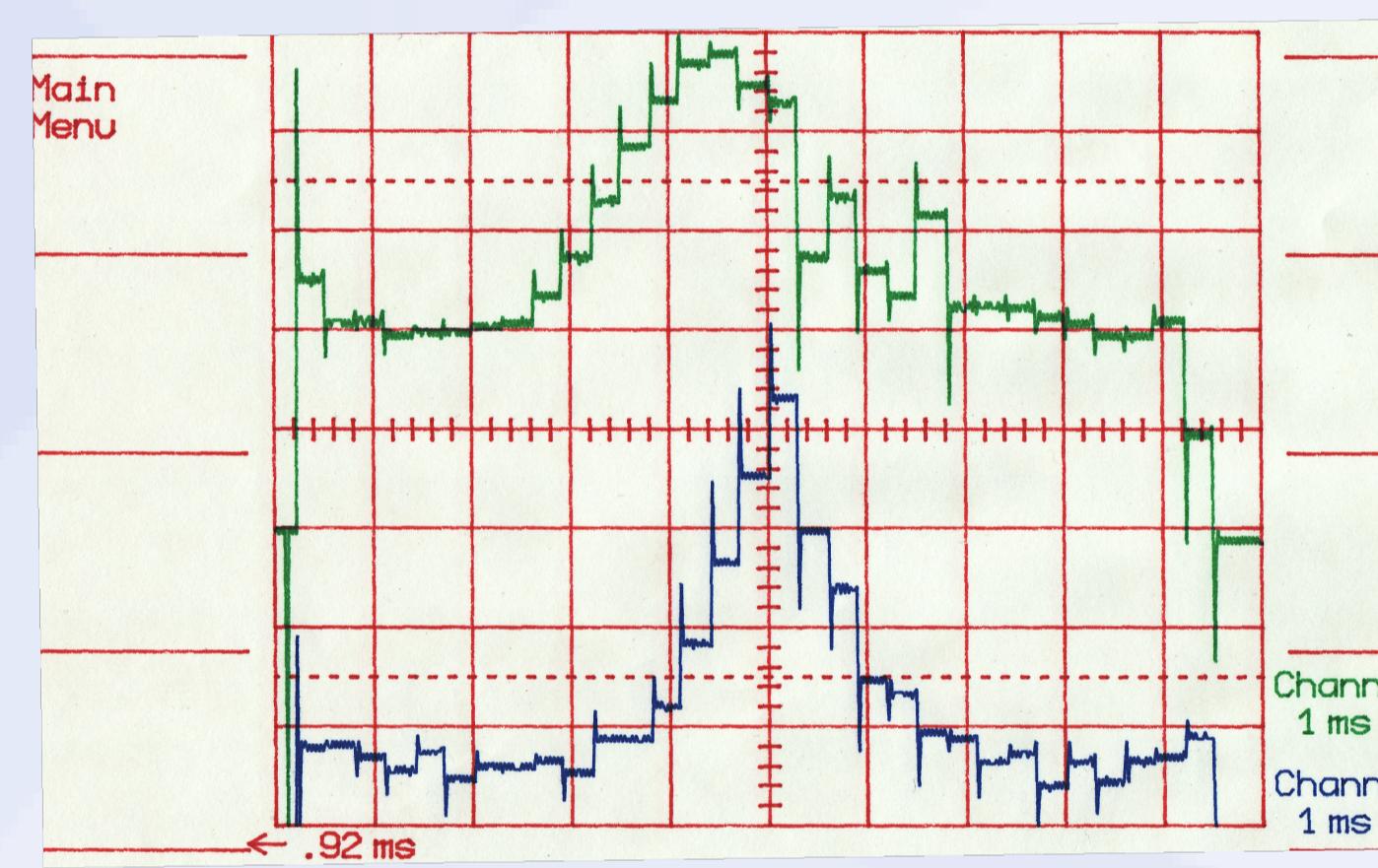
### RF Cavity 9 Downstream Laser Energy-Profile Monitor energy measurement of H- beam.



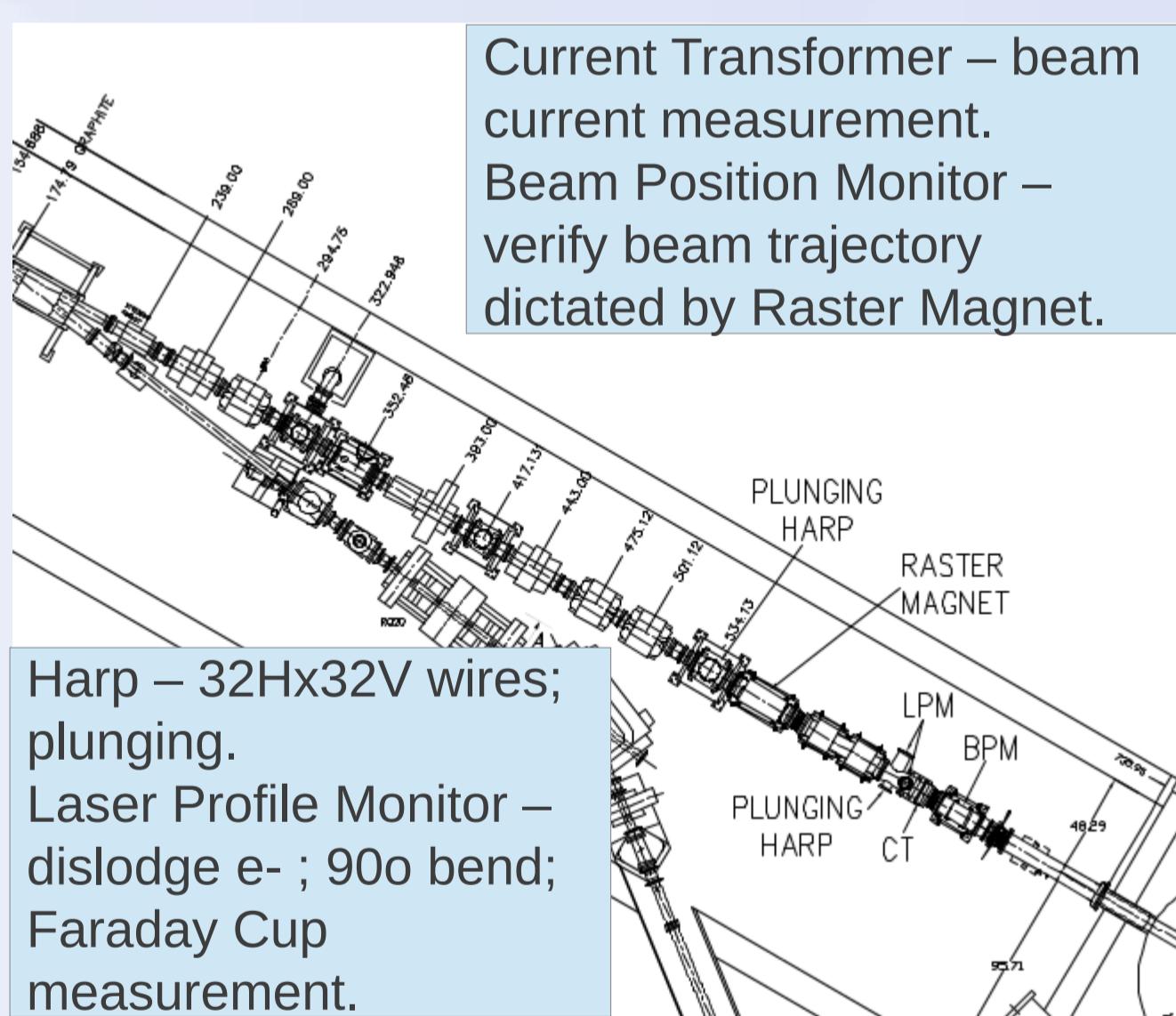
Overview of Collider-Accelerator

- Overview of Upgrade
- Instrumentation hardware upgrade.
- Signal cables replacement with shorter distances.
- Upgraded data acquisition and data storage.
- Universal access and systems integration.
- Additional and upgraded software.

### Harp 32 Channel H/V Beam Profile Measurement.



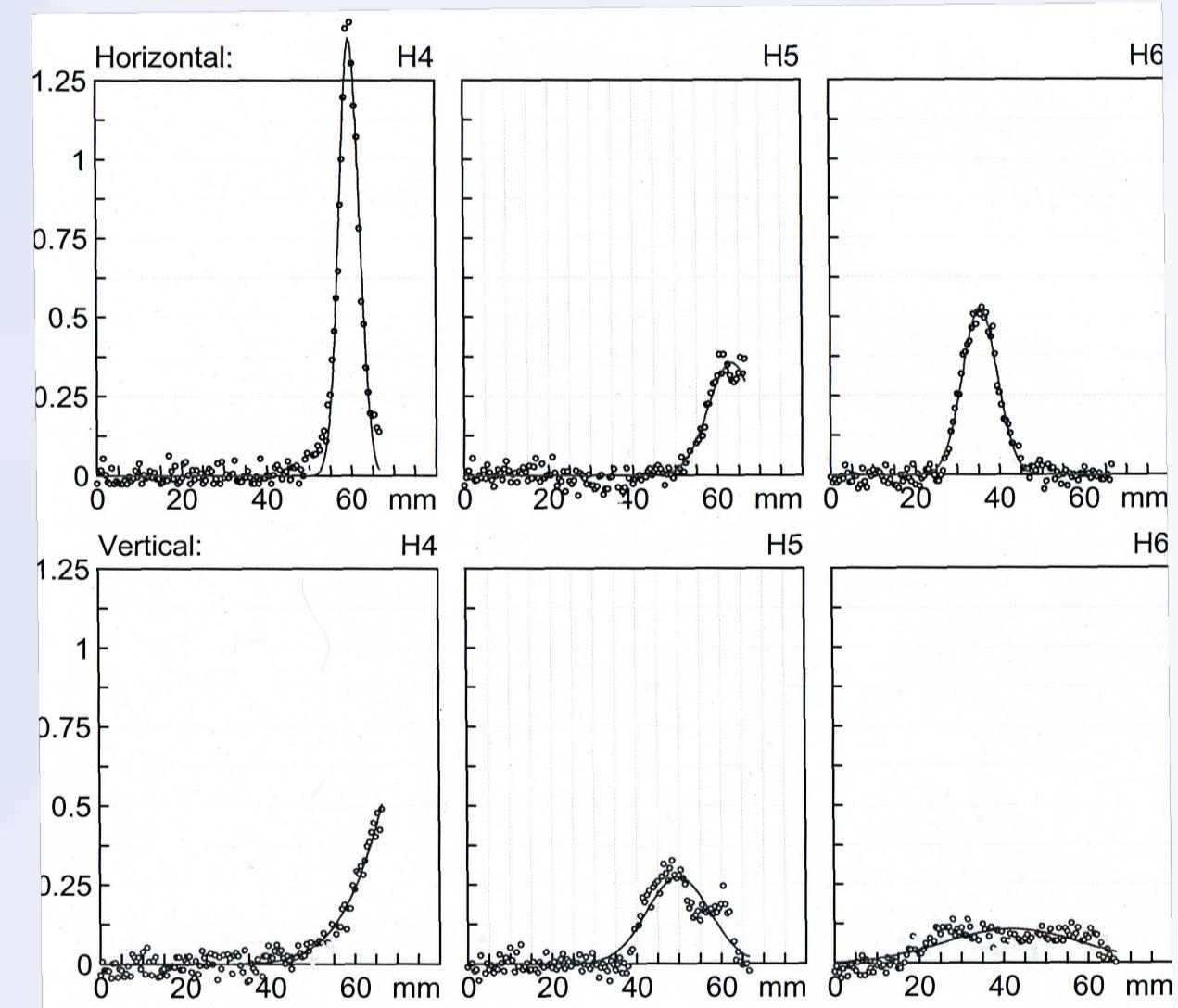
LPM is capable of obtaining Profile and Energy Spread Measurements.



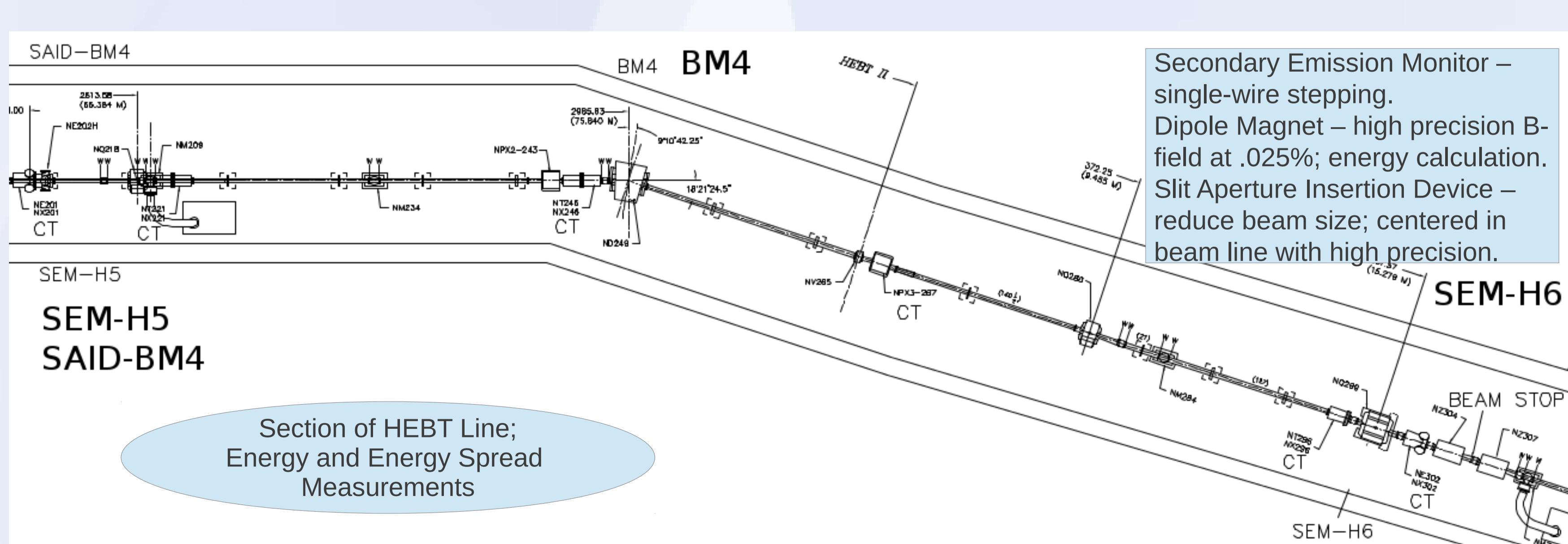
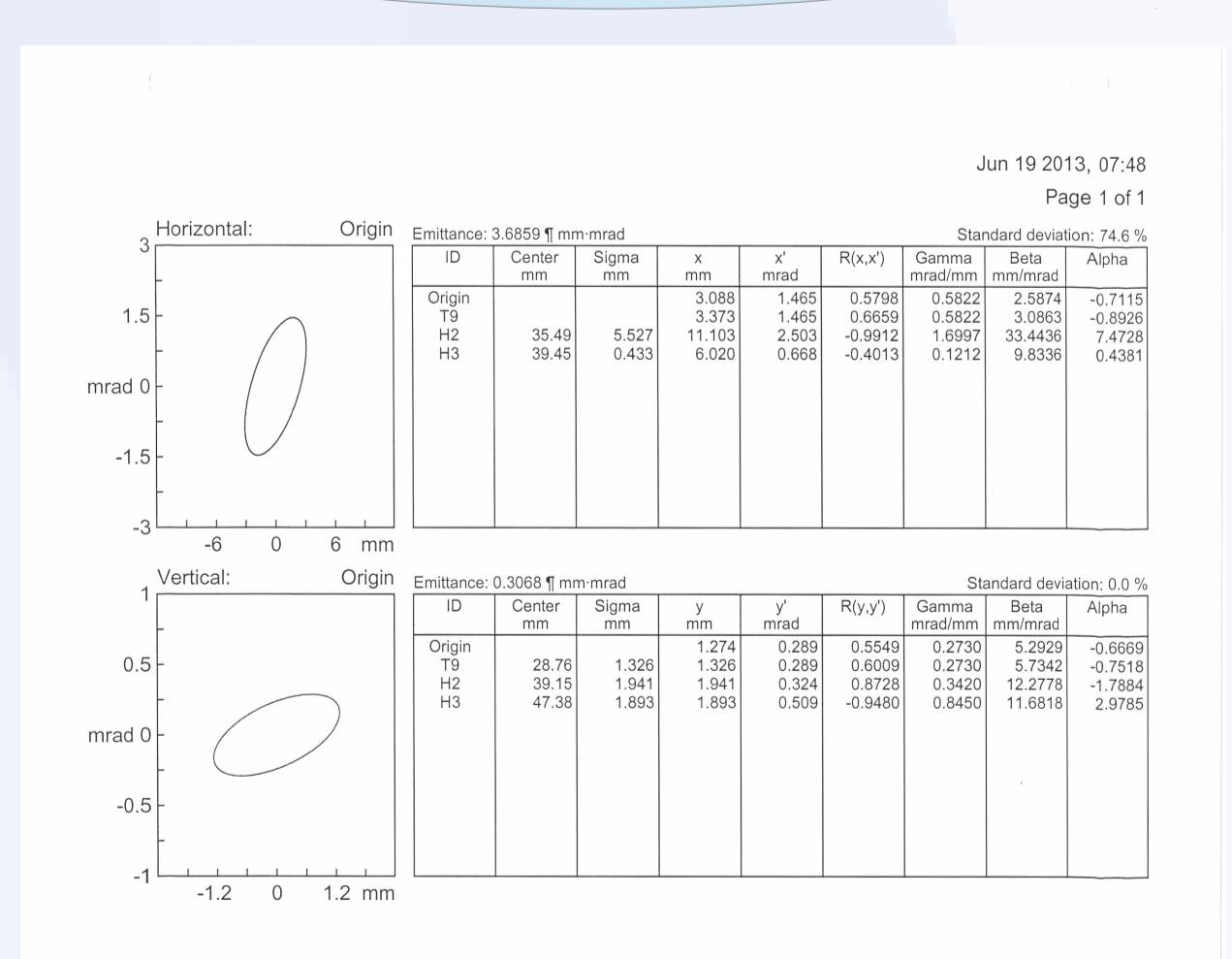
Current Transformer – beam current measurement.  
Beam Position Monitor – verify beam trajectory dictated by Raster Magnet.

BLIP Line Upgrade

### SAID/SEM energy spread measurement.



### SEMs emittance measurement; vertical and horizontal.



Section of HEBT Line; Energy and Energy Spread Measurements

Secondary Emission Monitor – single-wire stepping.  
Dipole Magnet – high precision B-field at .025%; energy calculation.  
Slit Aperture Insertion Device – reduce beam size; centered in beam line with high precision.

**ACKNOWLEDGMENT**  
The many knowledgeable individuals in the Linac Group, Instrumentation Group, Controls Group, and Design Room Group of the Collider-Accelerator Department that are not listed as co-authors are to be recognized for their contributions and support.