Electron Detectors for Diagnostics of Electron Cloud Effects

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Acknowledgements

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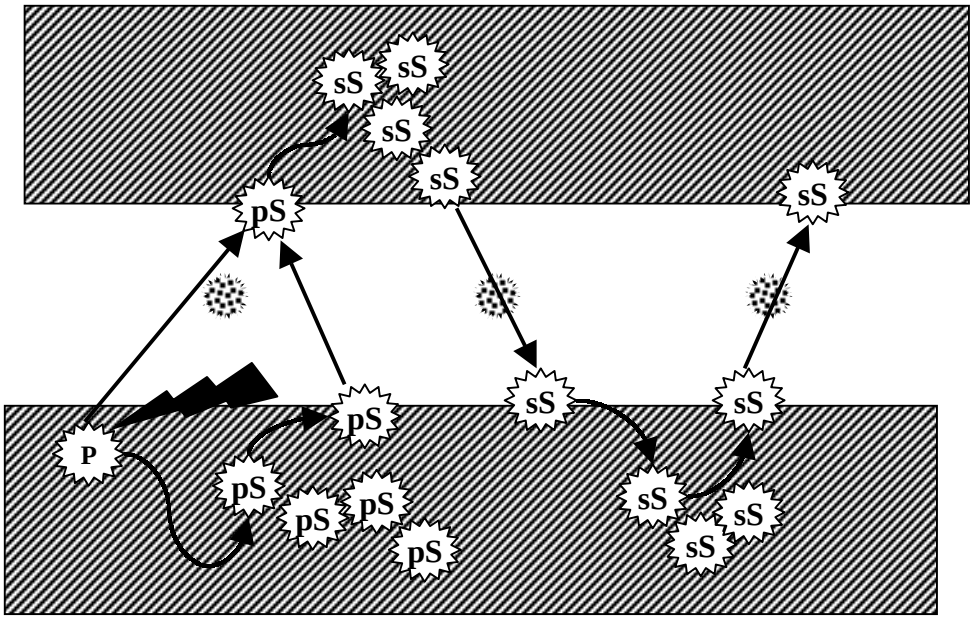
Outline

1. Introduction
2. Detector Design/Simulation
3. Bench Measurements
4. Accelerator Measurements
5. Improvements
6. Conclusions

Background

- A great deal of experimental and theoretical effort has been devoted towards understanding Electron Clouds (EC) and the Electron Cloud Instability (ECI).
- The energy and intensity of the electrons in the EC are predicted to be very sensitive to the bunch structure of the particle beam.
- There have been no previous studies that have examined the energy and intensity of the electrons directly.
- Energy and intensity analysis using available beam-position monitors (BPMs) is fraught with difficulties.

Mechanism for beam-induced electron cloud production



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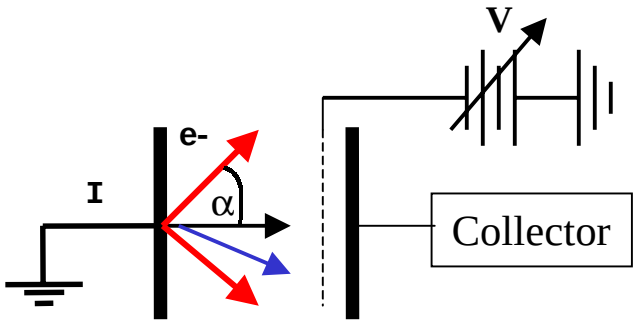
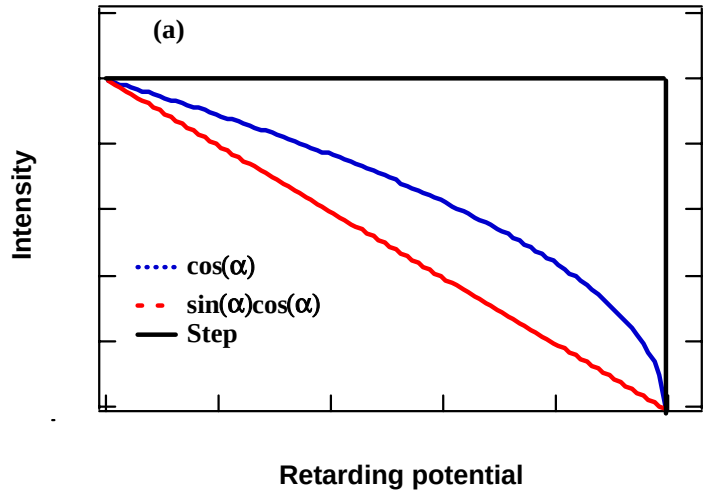
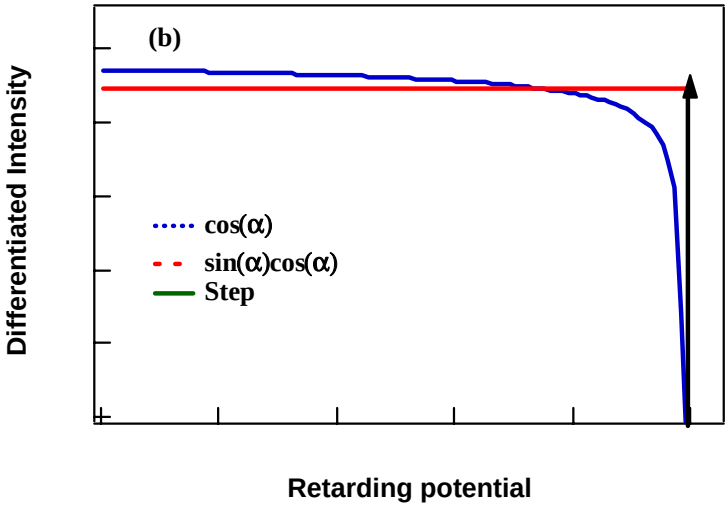
BPM Problems

- Most BPMs are made of stainless steel whose surface has an uncharacterized oxide layer.
- If the BPM surface is used as a collector the intensity of the signal will be very sensitive to the secondary electron yield (SEY) coefficient of the surface which, in turn, depends on the energy of the incident electrons.
- In addition, if one tries to use the BPM for energy analysis, by applying a retarding potential to it, the energy of the electrons will change, thereby influencing the SEY coefficient.
- Furthermore, if one tries to collect the electrons, by applying a positive potential to the BPM, the resulting field's collection length will be voltage dependent. The field will also perturb other electrons in the vicinity of the BPM.
- A detector is needed that decouples the energy analysis and collection.







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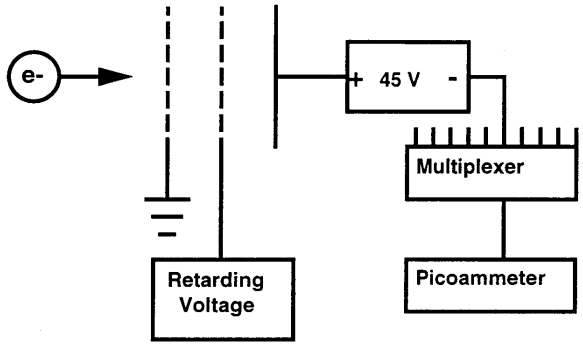
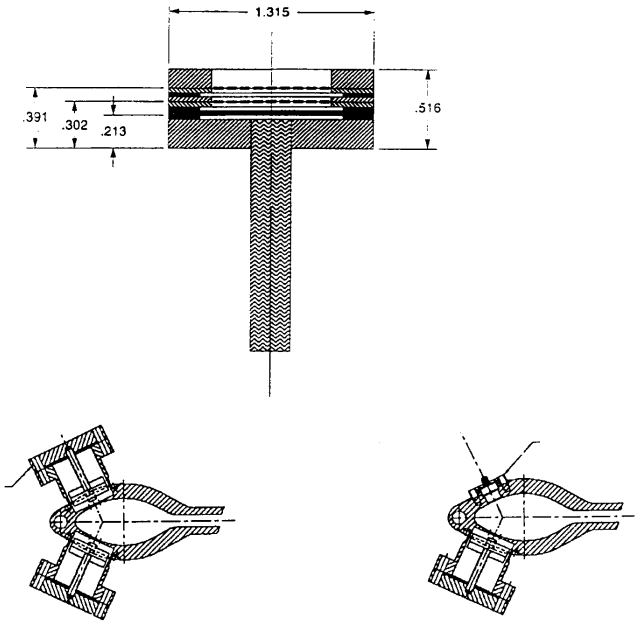
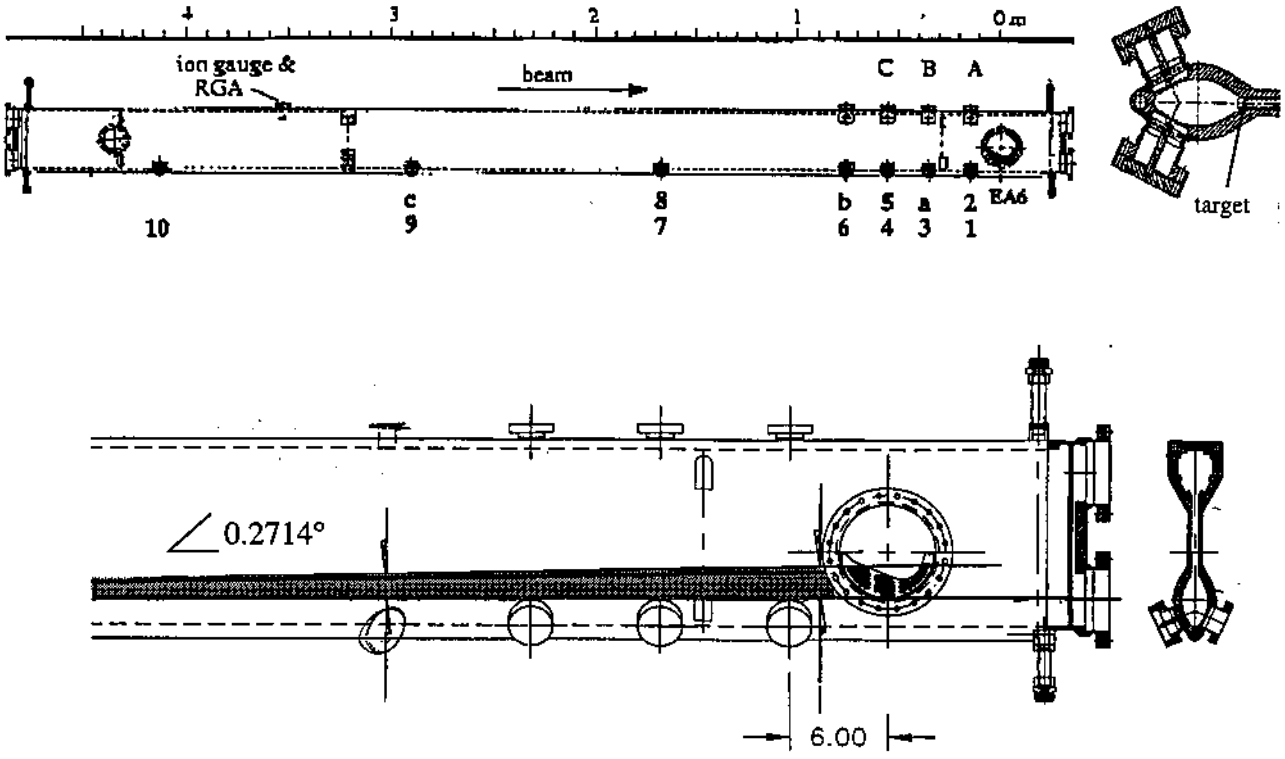
Electron-cloud energy analyzer





Schematic showing mounting of two detectors (left) or a bpm opposite a detector (right) on vacuum chamber

Modified Chamber



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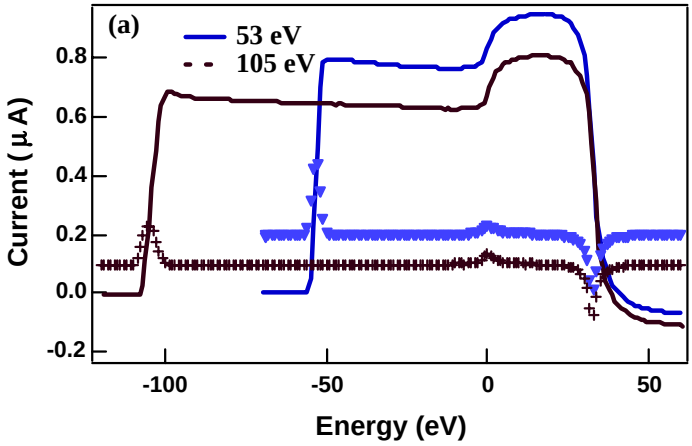

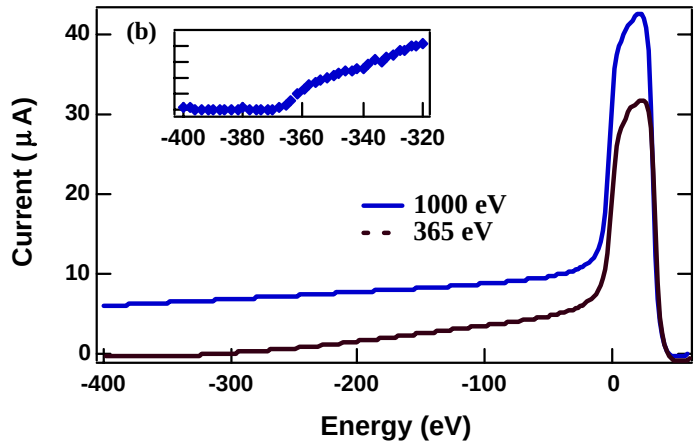

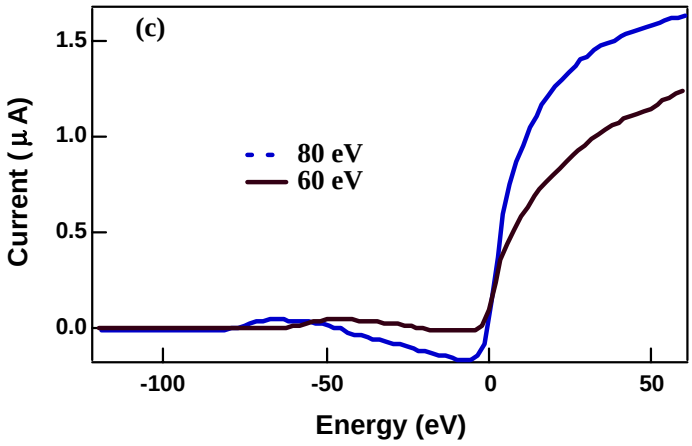

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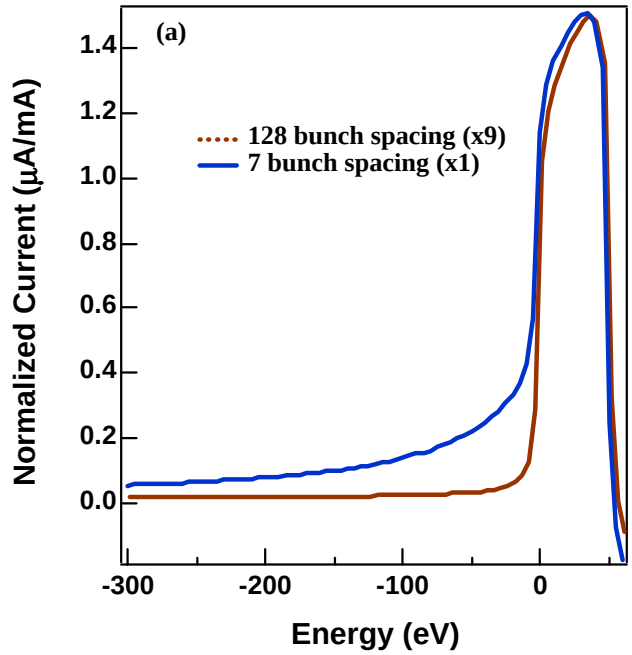

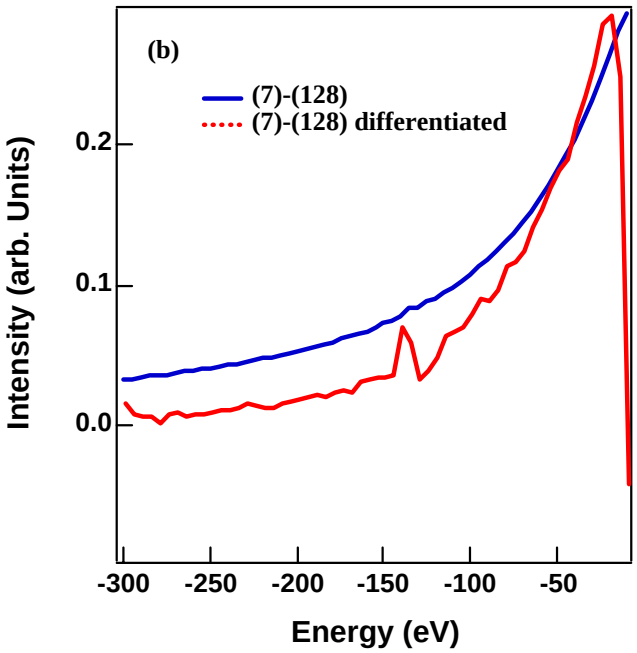

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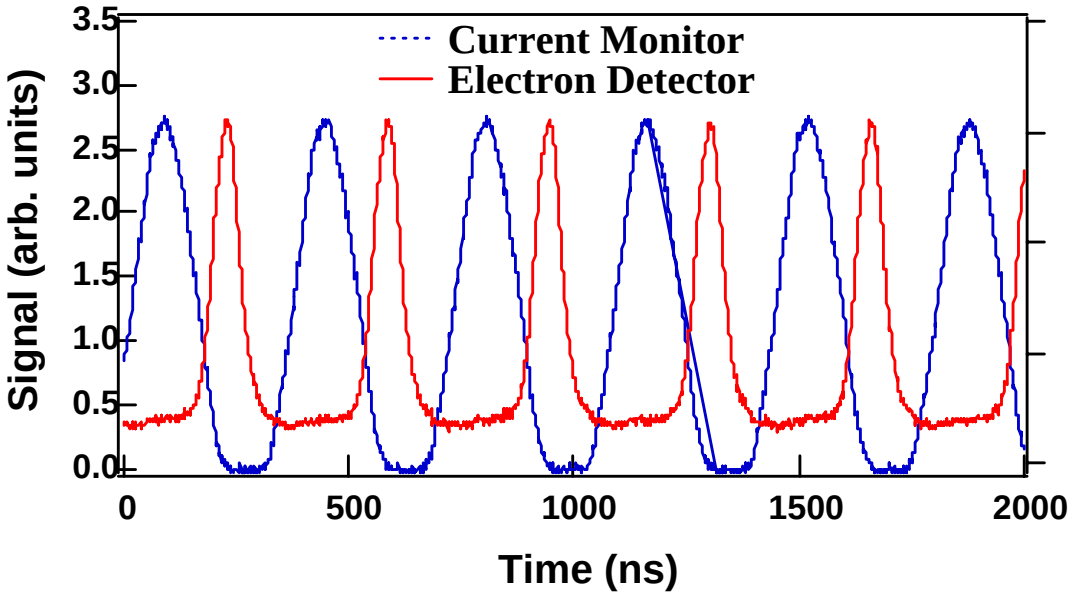
Time-Resolved Data from the PSR at LANL



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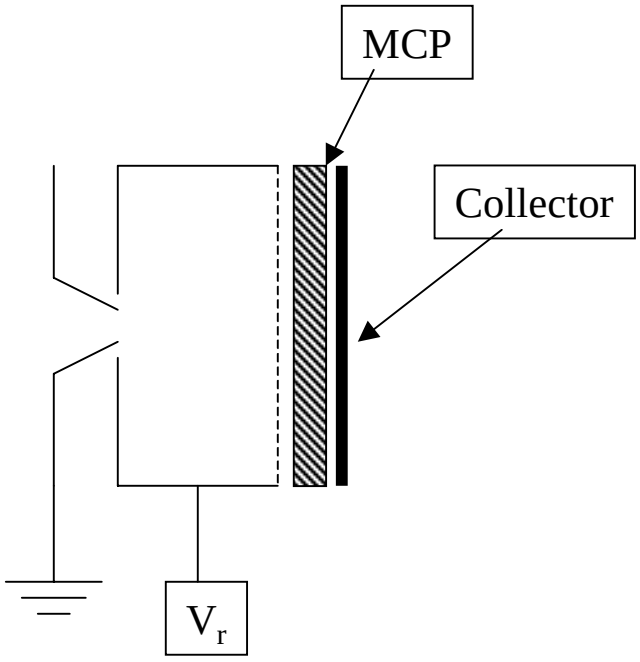
Improvements
Add beam defining apertures and/or electron amplifier



C.L. Enloe, Rev. Sci. Instrum. **62**, 507 (1994).

SUMMARY

•To quantitatively characterize the energy and intensity of electrons in an accelerator environment requires an analyzer that decouples the energy analysis from the collection. A BPM is inadequate.
•The planar retarding field analyzer accomplishes this, although the energy analysis is compromised by the instrumental response.
•Bench measurements of the analyzer agree reasonably well with expectations based on theory.
•Experience in accelerator environments has demonstrated the utility of the analyzer for energy, intensity, and time-structure measurements.
•Possible improvements include the addition of beam-defining apertures and electron amplification.

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