CLAIMS

1. An electron optical column apparatus, comprising:

a set of electron-optical elements configured to direct a primary electron beam of an electron beam source to a sample, the set of electron-optical elements comprising:

an objective lens; and

a deflection sub-system comprising:

one or more pre-lens deflectors positioned between the electron beam source and the objective lens,

wherein the one or more pre-lens deflectors include one or more upper pre-lens deflectors and one or more lower pre-lens deflectors;

wherein the one or more upper pre-lens deflectors are configured to operate in conjunction with the one or more lower pre-lens deflectors to split a full scan field of the primary electron beam into a plurality of sub-fields; and

wherein correction signals are applied on top of deflection signals from the one or more pre-lens deflectors to counteract aberrations of the primary electron beam;

a post-lens deflector positioned between the objective lens and the sample; and

a post-lens optical element positioned between the objective lens and the sample.

2. The electron optical column apparatus of Claim 1, wherein the post-lens deflector is configured to augment deflection of the one or more pre-lens deflectors positioned between the electron beam source and the objective lens.

3. The electron optical column apparatus of Claim 1, wherein the post-lens deflector is configured to apply one or more corrections to the primary electron beam.

4. The electron optical column apparatus of Claim 3, wherein the one or more corrections are configured to correct for at least one of:

astigmatism, field curvature, or offsets.

5. The electron optical column apparatus of Claim 1, wherein the post-lens deflector is configured to apply one or more dynamic focus corrections to the primary electron beam.

6. The electron optical column apparatus of Claim 1, wherein the post-lens deflector is configured for scanning.

7. The electron optical column apparatus of Claim 1, wherein the post-lens deflector includes a silicon post-lens deflector.

8. The electron optical column apparatus of Claim 1, wherein the post-lens optical element is configured to apply one or more corrections to the primary electron beam.

9. The electron optical column apparatus of Claim 8, wherein the one or more corrections are configured to correct for at least one of:

astigmatism, field curvature, or offsets.

10. The electron optical column apparatus of Claim 1, wherein the post-lens optical element is configured to apply one or more dynamic focus corrections to the primary electron beam.

11. The electron optical column apparatus of Claim 1, wherein the post-lens optical element is configured for scanning.

12. The electron optical column apparatus of Claim 1, wherein the post-lens optical element is configured to vary an extraction field from the sample.

13. The electron optical column apparatus of Claim 1, wherein the post-lens optical element is configured to vary a termination field.

14. The electron optical column apparatus of Claim 1, wherein the post-lens optical element is configured to vary a focusing element.

15. The electron optical column apparatus of Claim 1, wherein the post-lens optical element is formed of silicon.

16. The electron optical column apparatus of Claim 1, wherein the post-lens optical element includes a post-lens detector.

17. The electron optical column apparatus of Claim 1, wherein the post-lens optical element includes an extraction control electrode.

18. The electron optical column apparatus of Claim 1, wherein the post-lens optical element includes a shield electrode.

19. The electron optical column apparatus of Claim 1, wherein the post-lens optical element includes an additional post-lens deflector.

20. The electron optical column apparatus of Claim 1, wherein the post-lens optical element includes an electrostatic lens.

21. The electron optical column apparatus of Claim 1, wherein the one or more pre-lens deflectors are configured to apply one or more corrections to the primary electron beam.

22. The electron optical column apparatus of Claim 21, wherein the one or more corrections are configured to correct for at least one of:

astigmatism or offsets.

23. The electron optical column apparatus of Claim 1, wherein the one or more pre-lens deflectors are configured for scanning.

24. The electron optical column apparatus of Claim 1, wherein the one or more pre-lens deflectors include one or more silicon pre-lens deflectors.

25. The electron optical column apparatus of Claim 1, wherein the objective lens has a bore diameter less than 4 mm.

26. The electron optical column apparatus of Claim 25, wherein the objective lens has a bore diameter less than 2 mm.

27. The electron optical column apparatus of Claim 26, wherein the objective lens has a bore diameter less than 1 mm.

28. A multi-column characterization system, comprising:

one or more electron beam sources configured to generate an array of primary electron beams;

a plurality of electron optical columns, each electron optical column of the plurality of electron optical columns comprising:

a set of electron-optical elements configured to direct a primary electron beam to a sample, the set of electron-optical elements comprising:

an objective lens; and

a deflection sub-system comprising:

one or more pre-lens deflectors positioned between an electron beam source and the objective lens,

wherein the one or more pre-lens deflectors include one or more upper pre-lens deflectors and one or more lower pre-lens deflectors,

wherein the one or more upper pre-lens deflectors are configured to operate in conjunction with the one or more lower pre-lens deflectors to split a full scan field of the primary electron beam into a plurality of sub-fields,

wherein correction signals are applied on top of deflection signals from the one or more pre-lens deflectors to counteract aberrations of the primary electron beam;

a post-lens deflector positioned between the objective lens and the sample; and

a post-lens optical element positioned between the objective lens and the sample.

29. The multi-column characterization system of Claim 28, wherein the post-lens deflector is configured to augment deflection of the one or more pre-lens deflectors positioned between the electron beam source and the objective lens.

30. The multi-column characterization system of Claim 28, wherein the post-lens deflector is configured to apply one or more corrections to the primary electron beam.

31. The multi-column characterization system of Claim 30, wherein the one or more corrections are configured to correct for at least one of:

astigmatism, field curvature, or offsets.

32. The multi-column characterization system of Claim 28, wherein the post-lens deflector is configured to apply one or more dynamic focus corrections to the primary electron beam.

33. The multi-column characterization system of Claim 28, wherein the post-lens deflector is configured for scanning.

34. The multi-column characterization system of Claim 28, wherein the post-lens deflector includes a silicon post-lens deflector.

35. The multi-column characterization system of Claim 28, wherein the post-lens optical element is configured to apply one or more corrections to the primary electron beam.

36. The multi-column characterization system of Claim 35, wherein the one or more corrections are configured to correct for at least one of:

astigmatism, field curvature, or offsets.

37. The multi-column characterization system of Claim 28, wherein the post-lens optical element is configured to apply one or more dynamic focus corrections to the primary electron beam.

38. The multi-column characterization system of Claim 28, wherein the post-lens optical element is configured for scanning.

39. The multi-column characterization system of Claim 28, wherein the post-lens optical element is configured to vary an extraction field from the sample.

40. The multi-column characterization system of Claim 28, wherein the post-lens optical element is configured to vary a termination field.

41. The multi-column characterization system of Claim 28, wherein the post-lens optical element is configured to vary a focusing element.

42. The multi-column characterization system of Claim 28, wherein the post-lens optical element is formed of silicon.

43. The multi-column characterization system of Claim 28, wherein the post-lens optical element includes a post-lens detector.

44. The multi-column characterization system of Claim 28, wherein the post-lens optical element includes an extraction control electrode.

45. The multi-column characterization system of Claim 28, wherein the post-lens optical element includes a shield electrode.

46. The multi-column characterization system of Claim 28, wherein the post-lens optical element includes an additional post-lens deflector.

47. The multi-column characterization system of Claim 28, wherein the post-lens optical element includes an electrostatic lens.

48. The multi-column characterization system of Claim 28, wherein the one or more pre-lens deflectors are configured to apply one or more corrections to the primary electron beam.

49. The multi-column characterization system of Claim 48, wherein the one or more corrections are configured to correct for at least one of:

astigmatism or offsets.

50. The multi-column characterization system of Claim 28, wherein the one or more pre-lens deflectors are configured for scanning.

51. The multi-column characterization system of Claim 28, wherein the one or more pre-lens deflectors include one or more silicon pre-lens deflectors.

52. The multi-column characterization system of Claim 28, wherein the objective lens has a bore diameter less than 4 mm.

53. The multi-column characterization system of Claim 52, wherein the objective lens has a bore diameter less than 2 mm.

54. The multi-column characterization system of Claim 53, wherein the objective lens has a bore diameter less than 1 mm.

55. A method, comprising:

generating a primary electron beam with an electron beam source;

directing the primary electron beam to a sample with a electron optical column;

adjusting one or more characteristics of the primary electron beam using one or more pre-lens deflectors positioned between the electron beam source and an objective lens of the electron optical column,

wherein the one or more pre-lens deflectors include one or more upper pre-lens deflectors and one or more lower pre-lens deflectors;

wherein the one or more upper pre-lens deflectors are configured to operate in conjunction with the one or more lower pre-lens deflectors to split a full scan field of the primary electron beam into a plurality of sub-fields; and

wherein correction signals are applied on top of deflection signals from the one or more pre-lens deflectors to counteract aberrations of the primary electron beam;

adjusting one or more characteristics of the primary electron beam using a post-lens deflector positioned below the objective lens of the electron optical column; and

adjusting one or more characteristics of the primary electron beam using a post-lens optical element positioned below the objective lens of the electron optical column.

56. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens deflector positioned below an objective lens of the electron optical column comprises:

augmenting deflection of the one or more pre-lens deflectors positioned between the electron beam source and the objective lens.

57. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens deflector positioned below an objective lens of the electron optical column comprises:

applying one or more corrections to the primary electron beam.

58. The method of Claim 57, wherein the one or more corrections are configured to correct for at least one of:

astigmatism, field curvature, or offsets.

59. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens deflector positioned below an objective lens of the electron optical column comprises:

applying one or more dynamic focus corrections to the primary electron beam.

60. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens deflector positioned below an objective lens of the electron optical column comprises scanning.

61. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens optical element positioned below the objective lens of the electron optical column comprises:

applying one or more corrections to the primary electron beam.

62. The method of Claim 61, wherein the one or more corrections are configured to correct for at least one of:

astigmatism, field curvature, or offsets.

63. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens optical element positioned below the objective lens of the electron optical column comprises:

applying one or more dynamic focus corrections to the primary electron beam.

64. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens optical element positioned below the objective lens of the electron optical column comprises scanning.

65. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens optical element positioned below the objective lens of the electron optical column comprises:

varying an extraction field from the sample.

66. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens optical element positioned below the objective lens of the electron optical column comprises:

varying a termination field.

67. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using a post-lens optical element positioned below the objective lens of the electron optical column comprises:

varying a focusing element.

68. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using one or more pre-lens deflectors positioned above an objective lens of the electron optical column comprises:

applying one or more corrections to the primary electron beam.

69. The method of Claim 68, wherein the one or more corrections are configured to correct for at least one of:

astigmatism or offsets.

70. The method of Claim 55, wherein the adjusting one or more characteristics of the primary electron beam using one or more pre-lens deflectors positioned above an objective lens of the electron optical column comprises scanning.