Advances in Multi-Beam SEM Technology for High-Throughput Defect Inspection

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Why multi-beam SEM technology?

Defect inspection of a 300mm wafer with a single beam SEM:

~700cm² @ 10nm Pixel Size ➔ 700 terapixel

➔ ~ 13 months @ 20MHz

Advantages of multi-beam systems:

- Low data rate per beam
- Low Coulomb effects
- Total data rate

Advantages of multi-beam, *single column* systems:

- Small & variable beam pitch
- Established technology
- Superb scalability

How does it work?

Multi-Beam Source

Beam Splitter

Projector

Multi-Detector

Objective

Sample

llumination

Detection

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High throughput data acquisition with a multi-beam SEM

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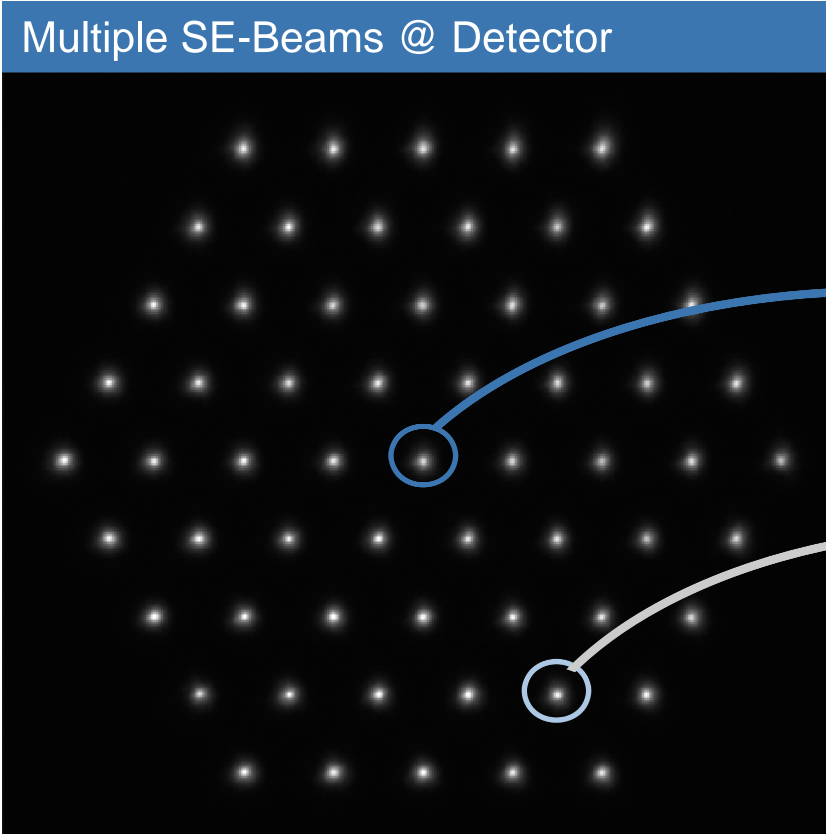
ABSTRACT

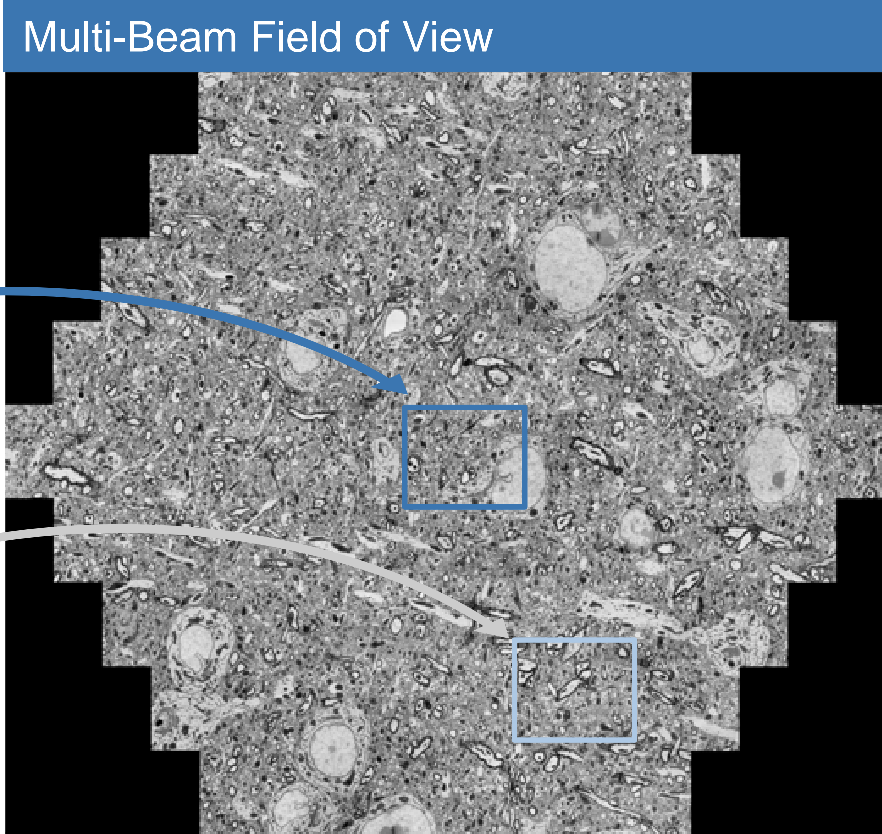
Conventional scanning electron microscopes are limited in their ultimate data acquisition rate at a given resolution t statistical electron-electron interaction (so-called Coulomb interaction) as well as band width of detectors and deflectic systems. We increased imaging speed dramatically by using multiple electron beams in a single column and parall detection of the secondary electrons. The multi-beam SEM generates multiple overlapping images during a single sc pass, thereby covering a larger area in shorter time as compared to a single-beam SEM at the same pixel size. Th addresses the upcoming need for high speed imaging at electron microscopic resolution to investigate larger and larg areas and volumes.

Keywords: Multi-beam, SEM, high speed imaging, beam splitter

1. INTRODUCTION

How does it work?





61 beams: up to 1.22GPix/s

> 30,000 pix > 100µm

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How well does it work?
Key specifications

Speed
Fastest SEM in the world

- Imaging 61 beams in parallel
- Top speed 1.220 MPixel/s

Resolution
4 nm in current configuration

Beam current
570 pA per beam
35 nA total

Automation
Continuous high-throughput imaging

Applications
Ultra-high-throughput electron microscopy,
initially tailored to academia market - brain mapping

Mouse brain section (Jeff Lichtman, Harvard)

Single hexagon imaged on MultiSEM

10 µm

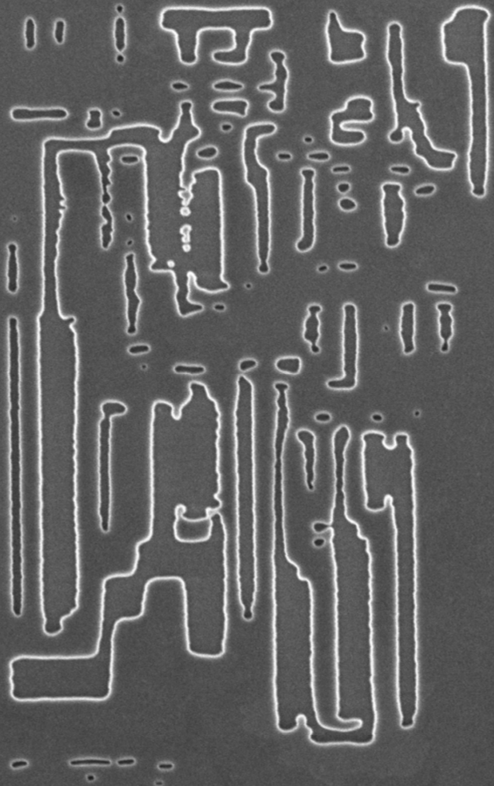
Semiconductor wafer sample: AMAG6L

Single hexagon imaged on multi-beam SEM

10 µm

Semiconductor wafer sample: AMAG6L

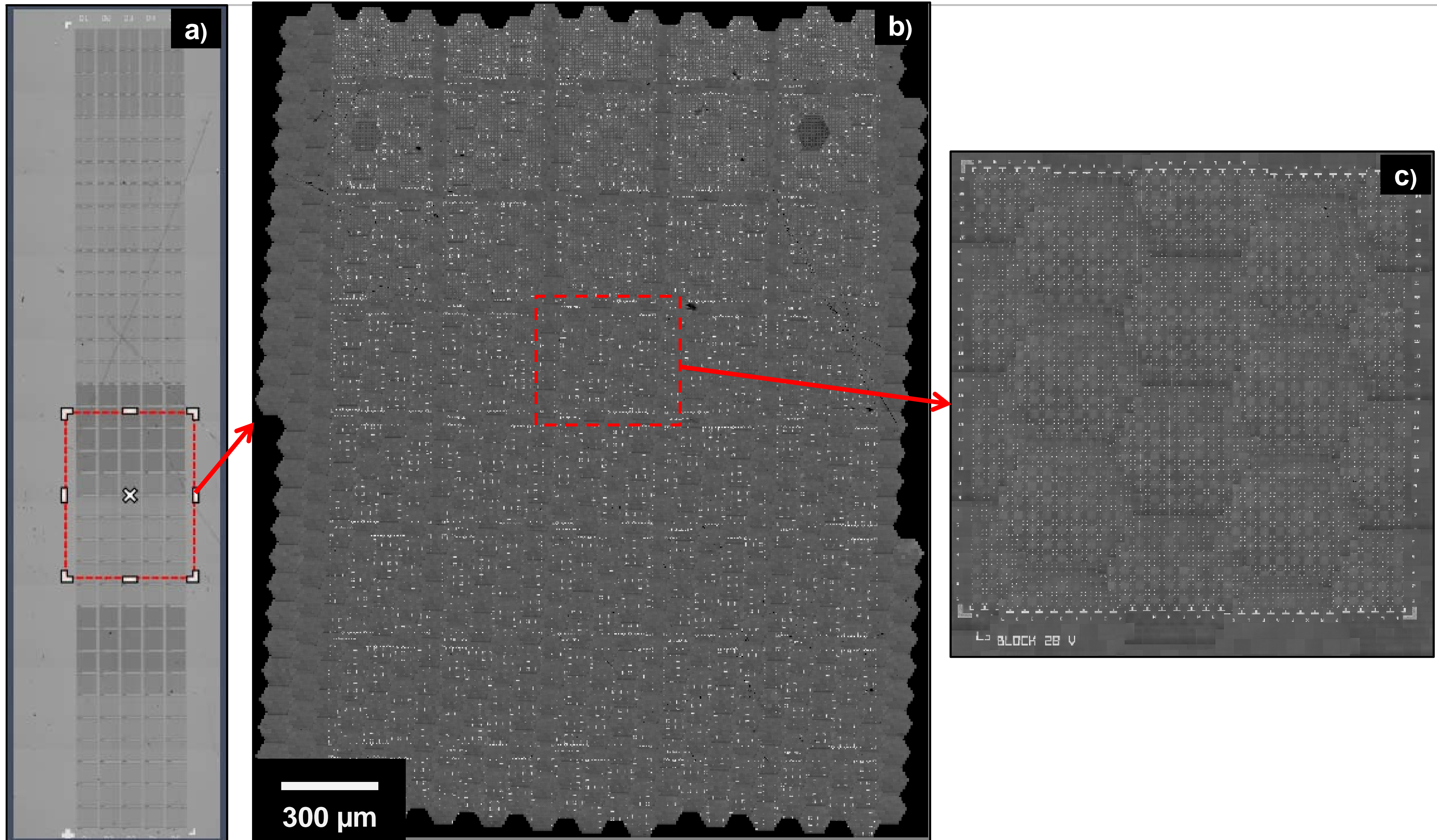
Single-beam image



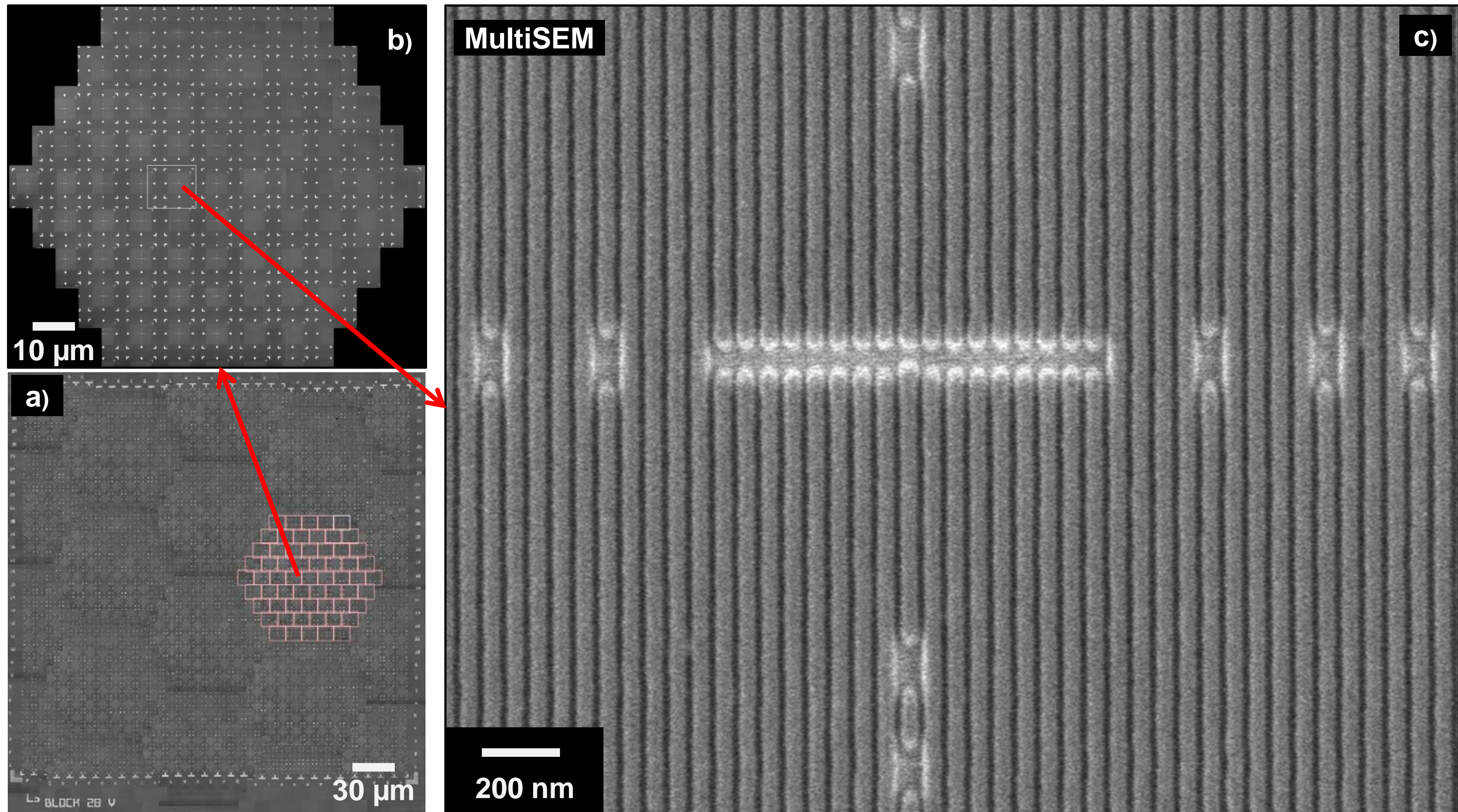
60 nm

1 µm

Intentional Defect Array Imaging I (1/2)



Intenional Defect Array Imaging I (2/2)



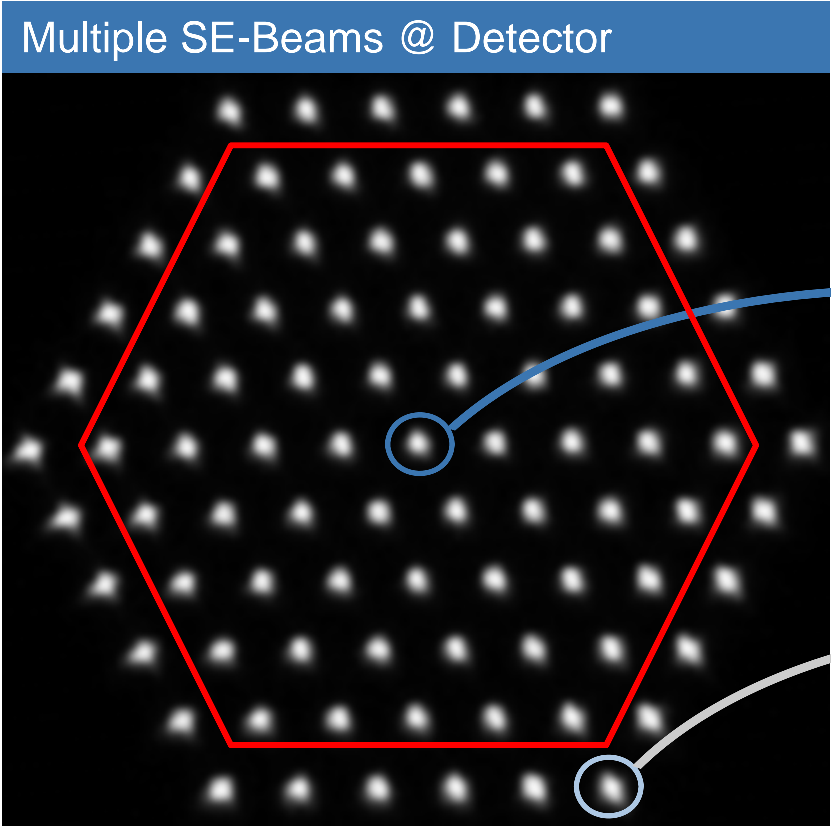
What if 61 beams is still too slow?

Scaling up a single column, multi beam system in 3 easy steps:

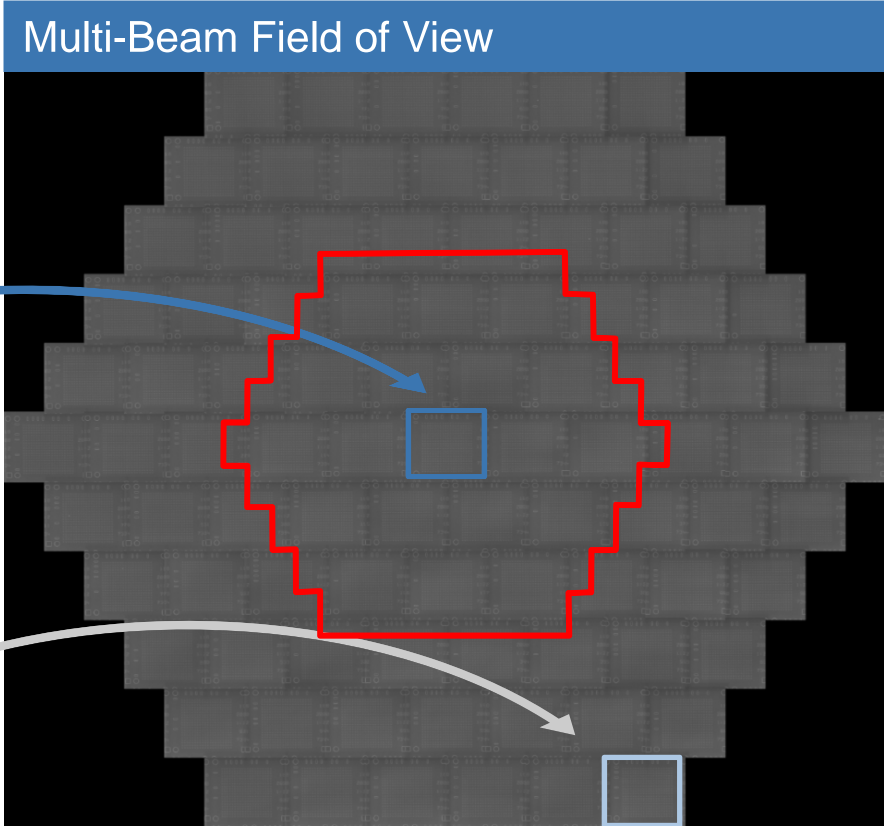
1. Add more electron beams
2. Add more detectors
3. Add *much* more storage capacity and/or post processing power

First 91-beam imaging results @ 10 nm resolution

Multiple SE-Beams @ Detector



Multi-Beam Field of View



91 beams: up to 1.82GPix/s

> 35,000 pix **> 200µm**

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Test chip

18 µm

3 µm

In summary …

- Multi-beam electron microscopy has arrived –
  61 and 91 beam SEMs are working and available today
- Relevant defect structures can be imaged
- Technology is scalabe to higher beam counts

http://www.zeiss.com/multisem

We make it visible.