



## Improved Adhesion by Surfscan for 30nm HSQ Column Arrays on a InGaAs / GaAs Multilayer System

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X 3,500 2.00kV LEI 1µm MPI 3/22/2012  
SEM WD 8.0mm 2:50:16





# ~~Weinberg~~ Campus of the University in Halle Vineyard Germany

MPI of MSP

## Scientific Profile:

Solid state phenomena of small dimensions and surfaces and interfaces.  
Relations between the magnetic, electronic, optical, and mechanical properties of solids and their microstructure. Information for creating new and improved functional or structural materials in application areas such as sensorics, opto- and microelectronics.

**Staff: ~ 100 ( 41 scientists), ~80 graduate students and postdocs**







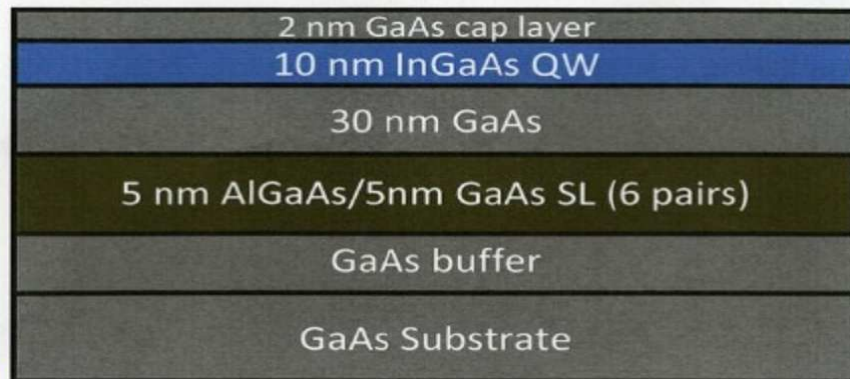
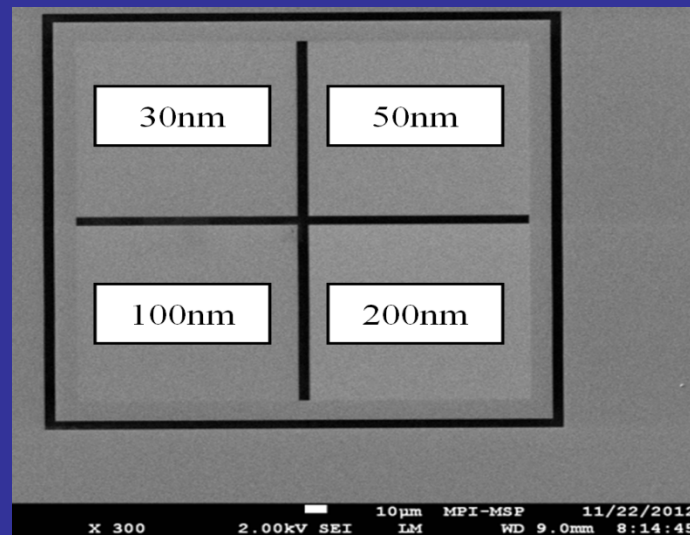
# JEOL Electron Beam Lithography System JBX6300FS

Acceleration Voltage: 100keV  
Dataprep: BEAMER with PEC



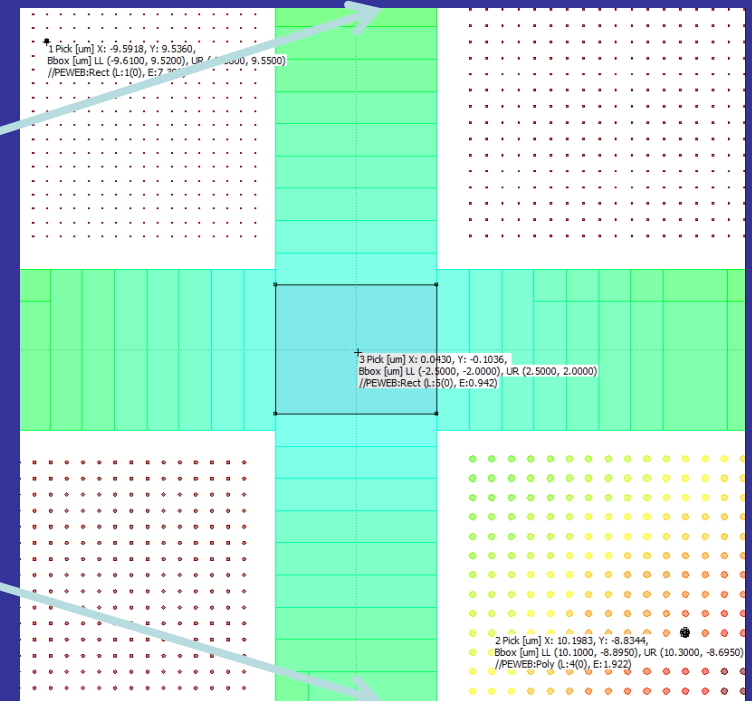
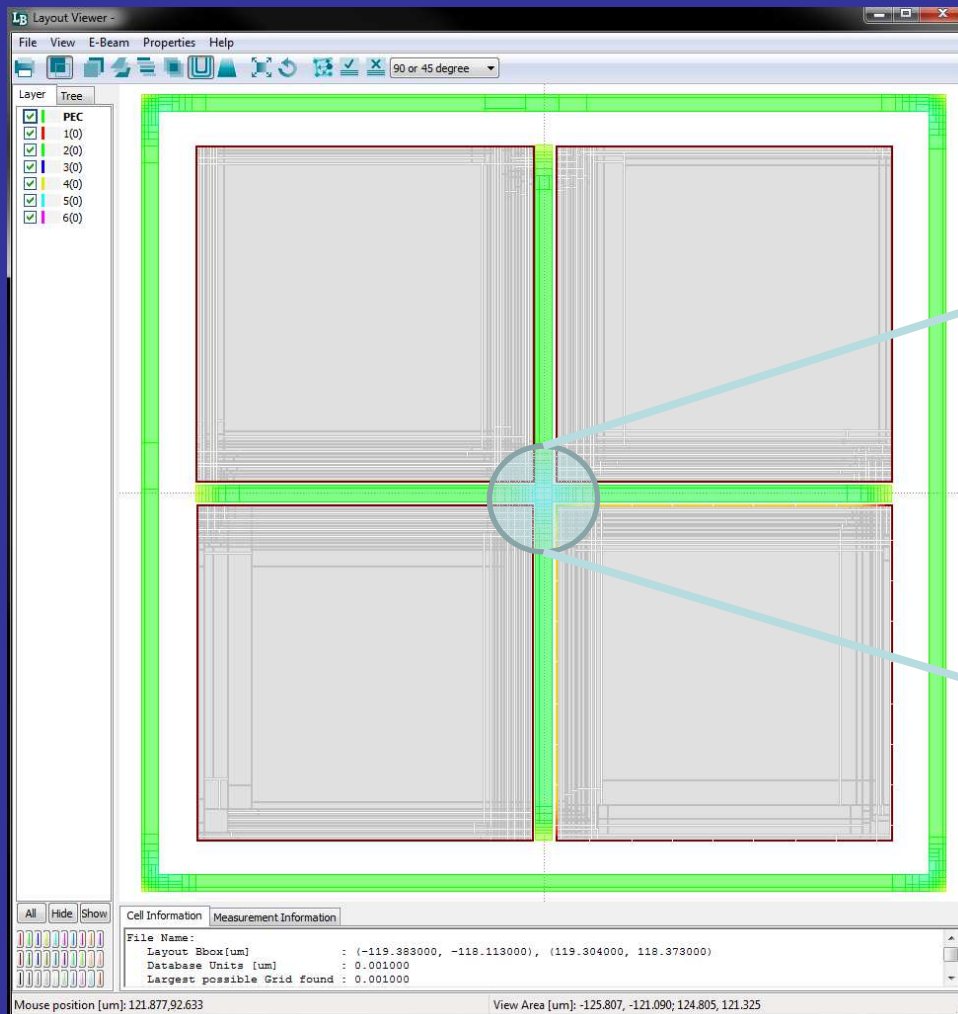


The aim was the creation of arrays consisting of columns with diameters of 30nm, 50nm, 100nm and 200nm. The space between the single columns should be every 400nm.





Data preparation with BEAMER including PEC with Monte Carlo (Skeleton) simulated PSF + beam blur + typical HSQ process blur (C. Chapin – Georgia Tech, BEAMeeting EIPBN 2012).

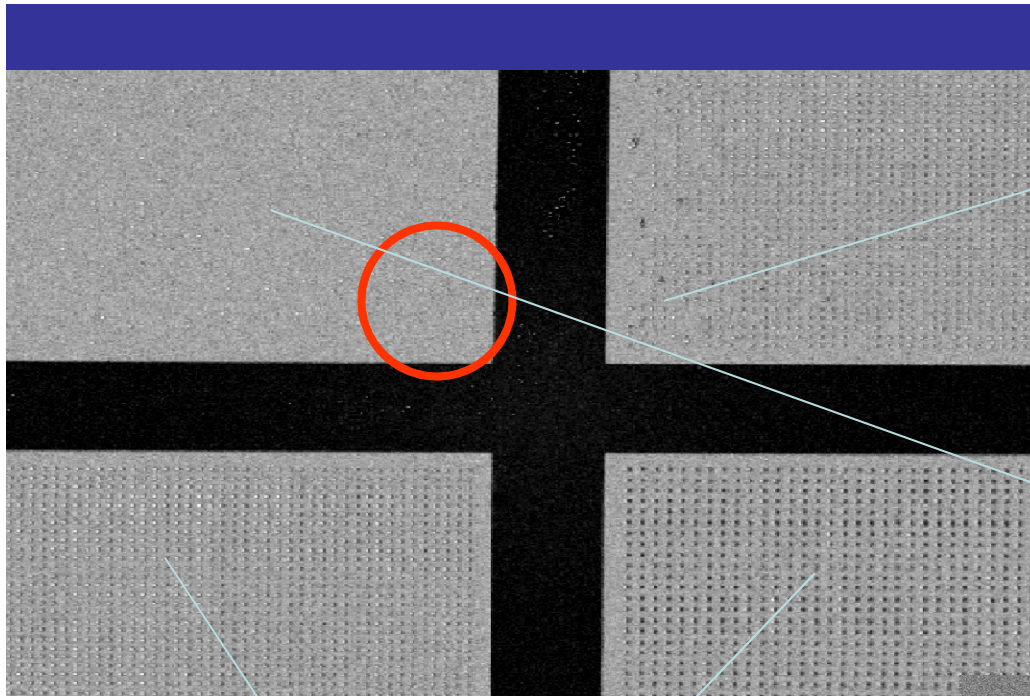


Expectation: At the right base dose all columns will be exposed as designed



... but at the beginning the reality looked different!

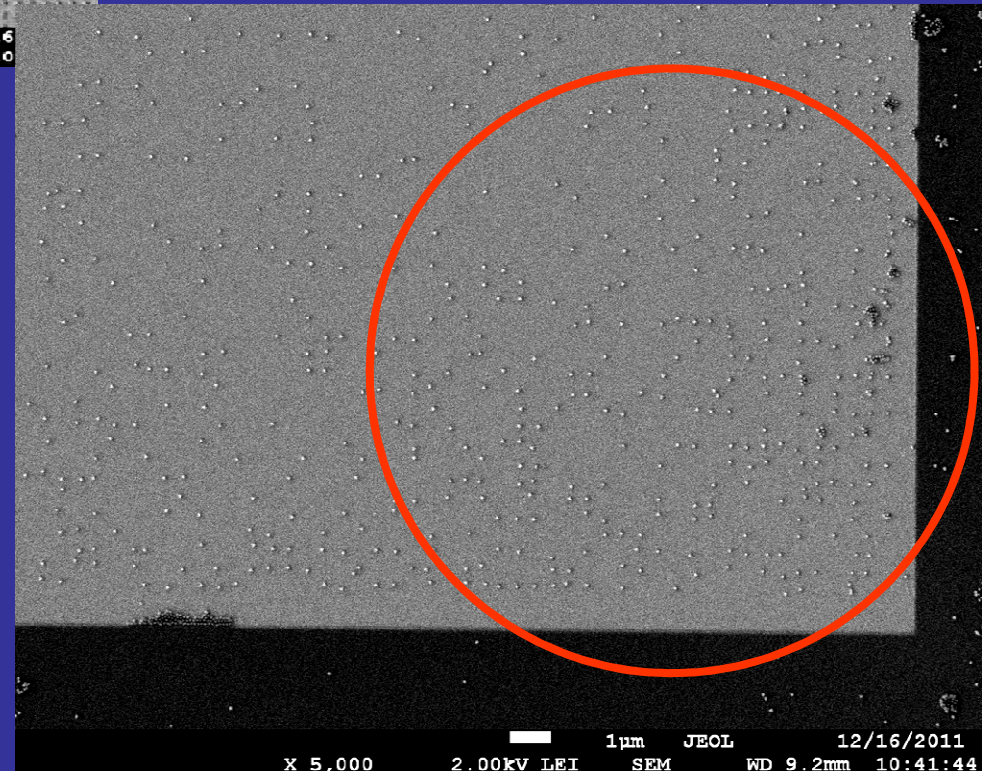




50nm columns are partly missing

30nm columns are mostly missing

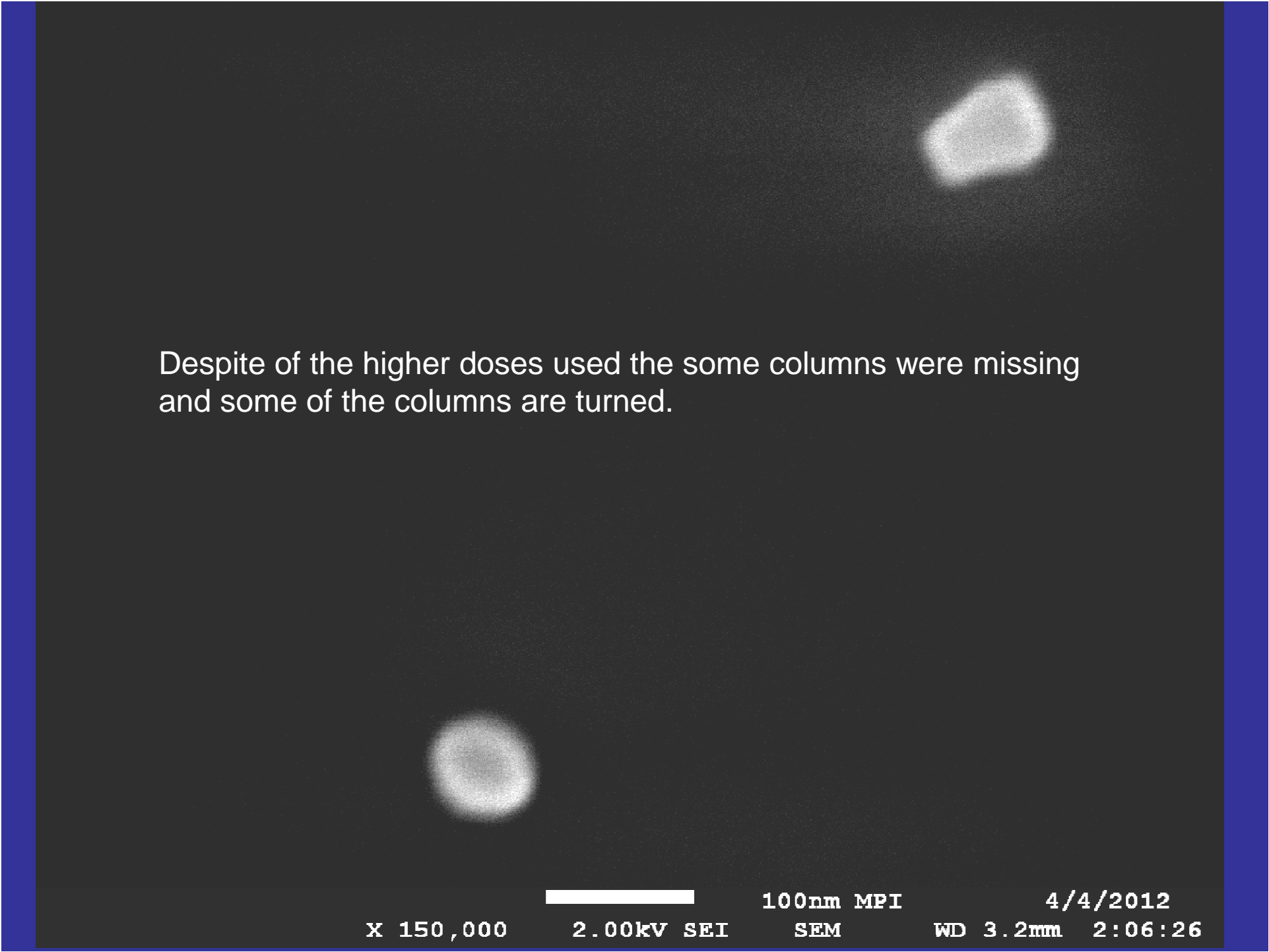
100 and 200nm columns are on size





It seemed that the 50nm and 30nm columns are under-dosed...





Despite of the higher doses used the some columns were missing  
and some of the columns are turned.

X 150,000

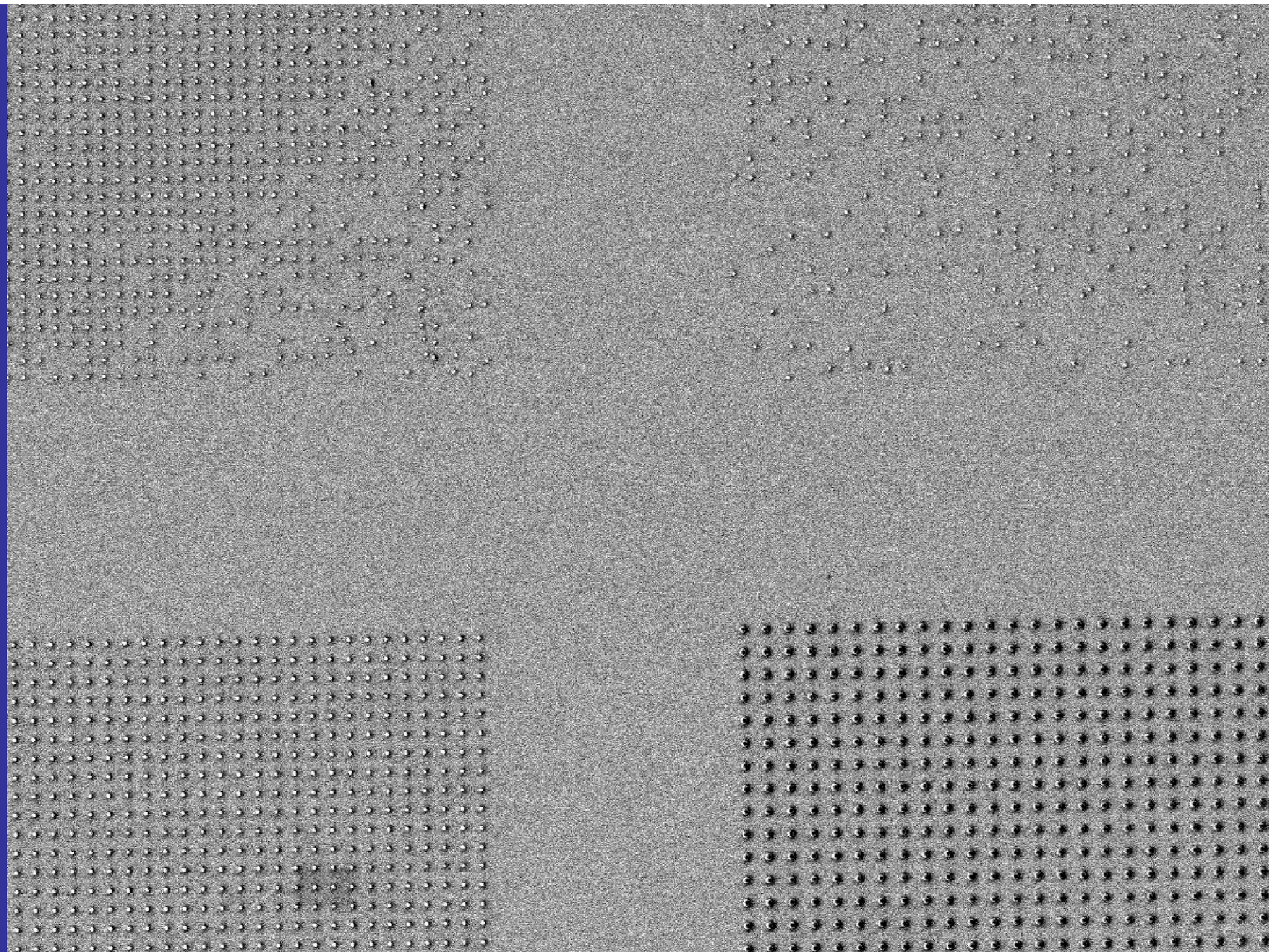
2.00kV SEI

100nm MPI

SEM

4/4/2012  
WD 3.2mm 2:06:26





1 $\mu$ m

MPI

3/30/2012

X 3,500

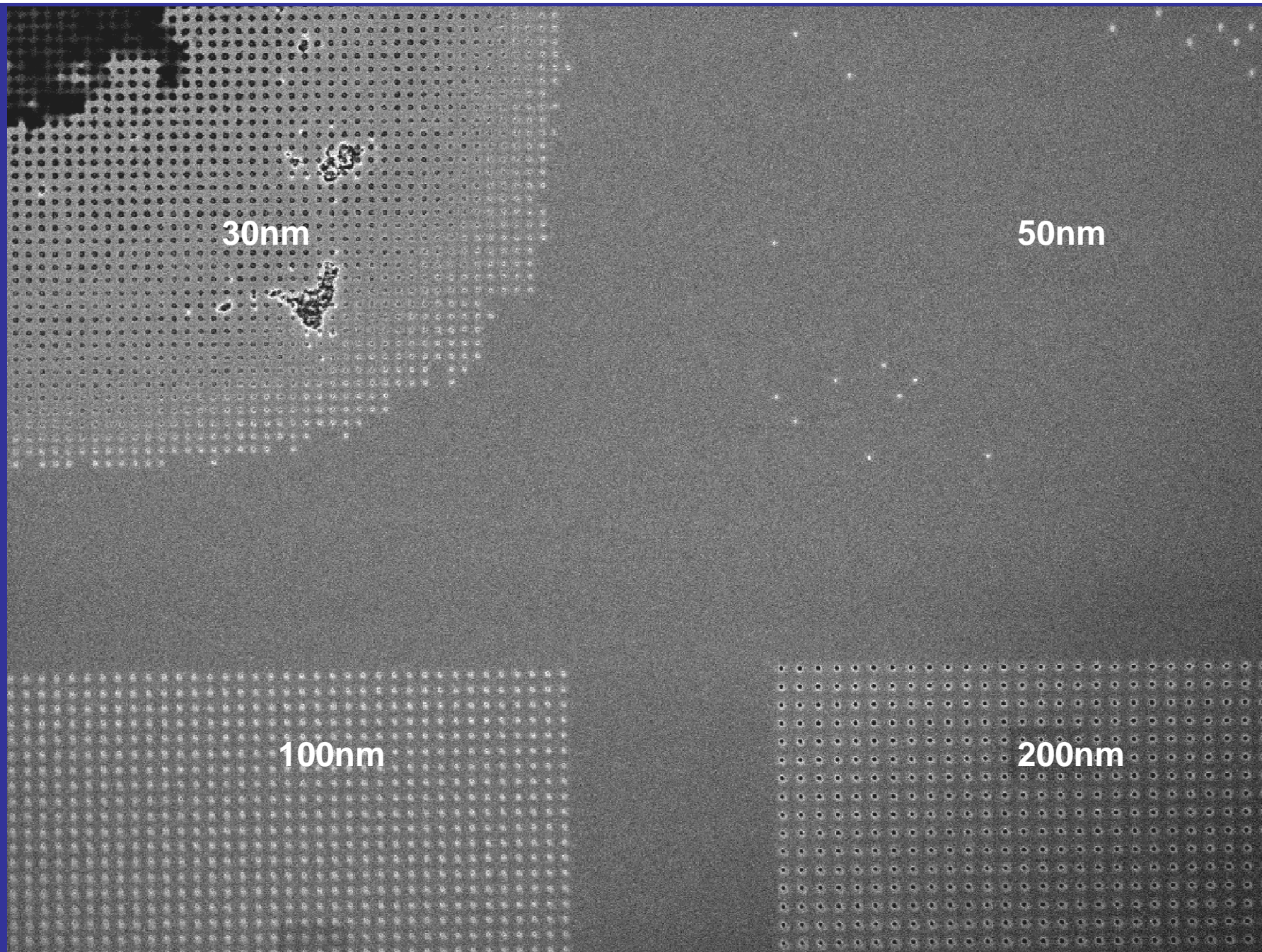
2.00kV LEI

SEM

WD 8.1mm

10:09:38





X 3,000

2.00kV SEI

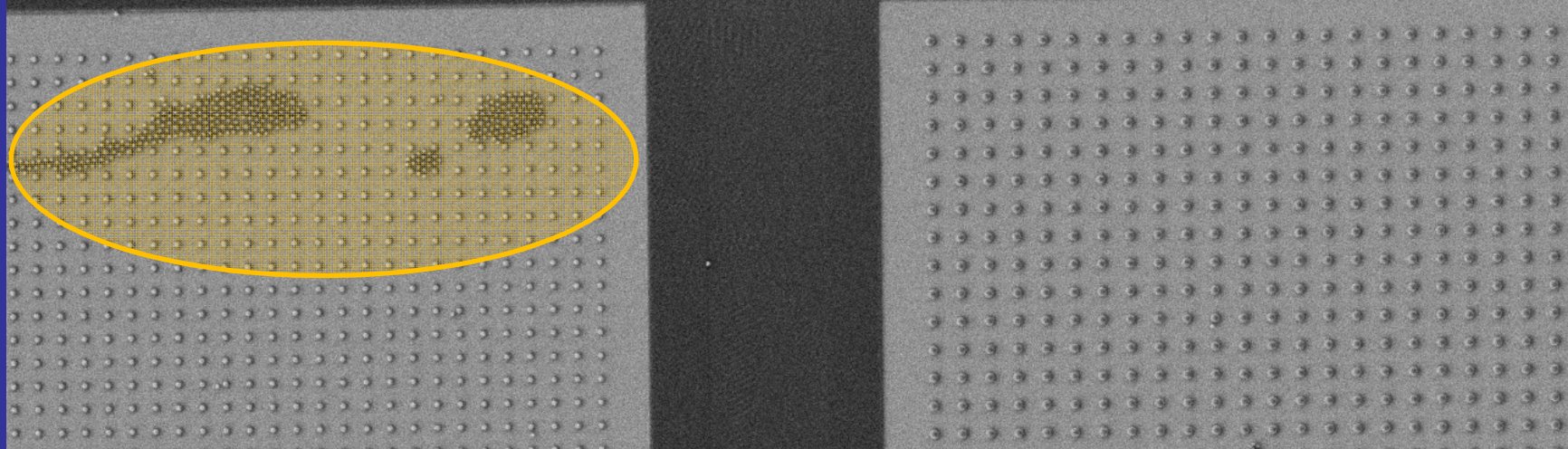
1µm MPI  
SEM

5/7/2012  
WD 4.4mm 1:51:50



Careful SEM inspection after resist development did show that the 30nm and 50nm columns had been formed properly at lower doses, but “washed away”.

Some of them could be found spread over the sample.



X 3,500

2.00kV LEI

1μm MPI

SEM

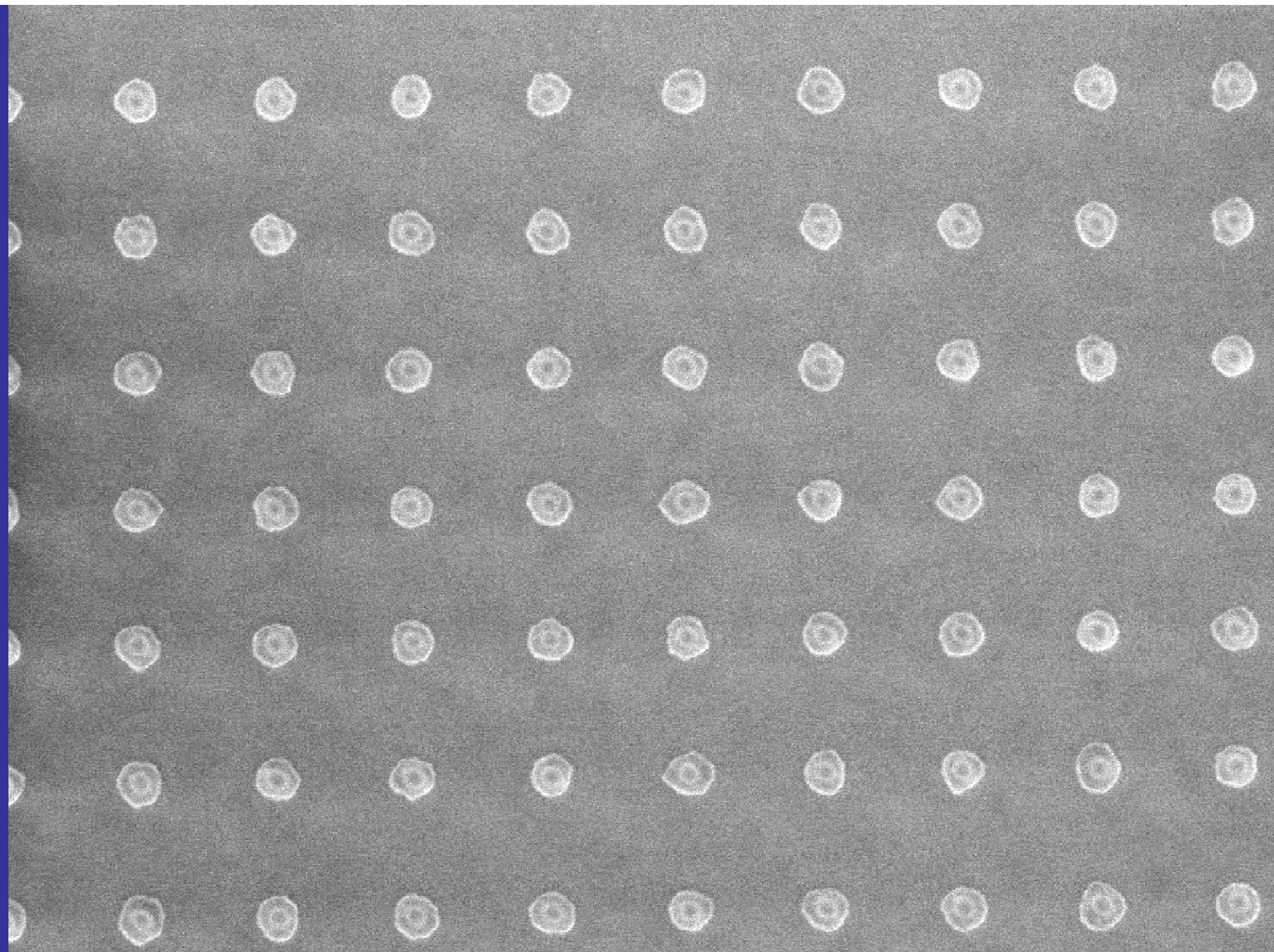
3/22/2012  
WD 8.0mm 1:59:20



For the creation of the fields with 30nm and 50nm columns extremely high dose values up to  $30,000\mu\text{C}/\text{cm}^2$  were necessary.

With these high doses the adhesion of the resist columns could be improved.

But the pattern were oversized and showed strong footing.



X 30,000

2.00kV SEI

100nm MPI

SEM

4/25/2012

WD 5.2mm 2:42:15



The effects could not be explained with the spread of energy (proximity or process effect) alone. The adjustment of PEC parameter for increasing the exposure dose for small columns did not lead to the desired result (dimensions as designed).

Consequence:

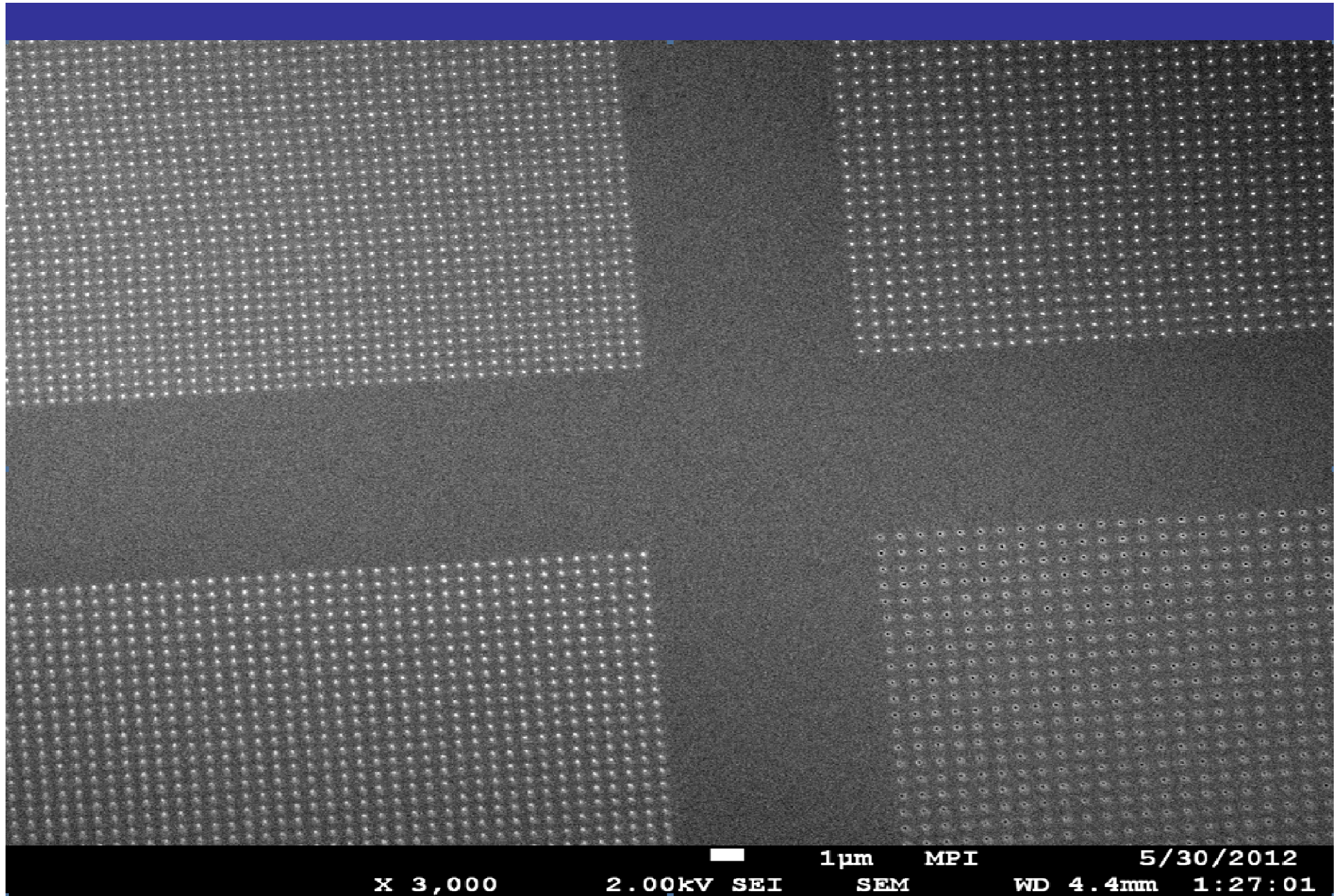
Need to fix the adhesion issue of the small columns at low doses!

## Introduction of SurPass:

- What it is
- Why it works
- How it works (how it is processed)

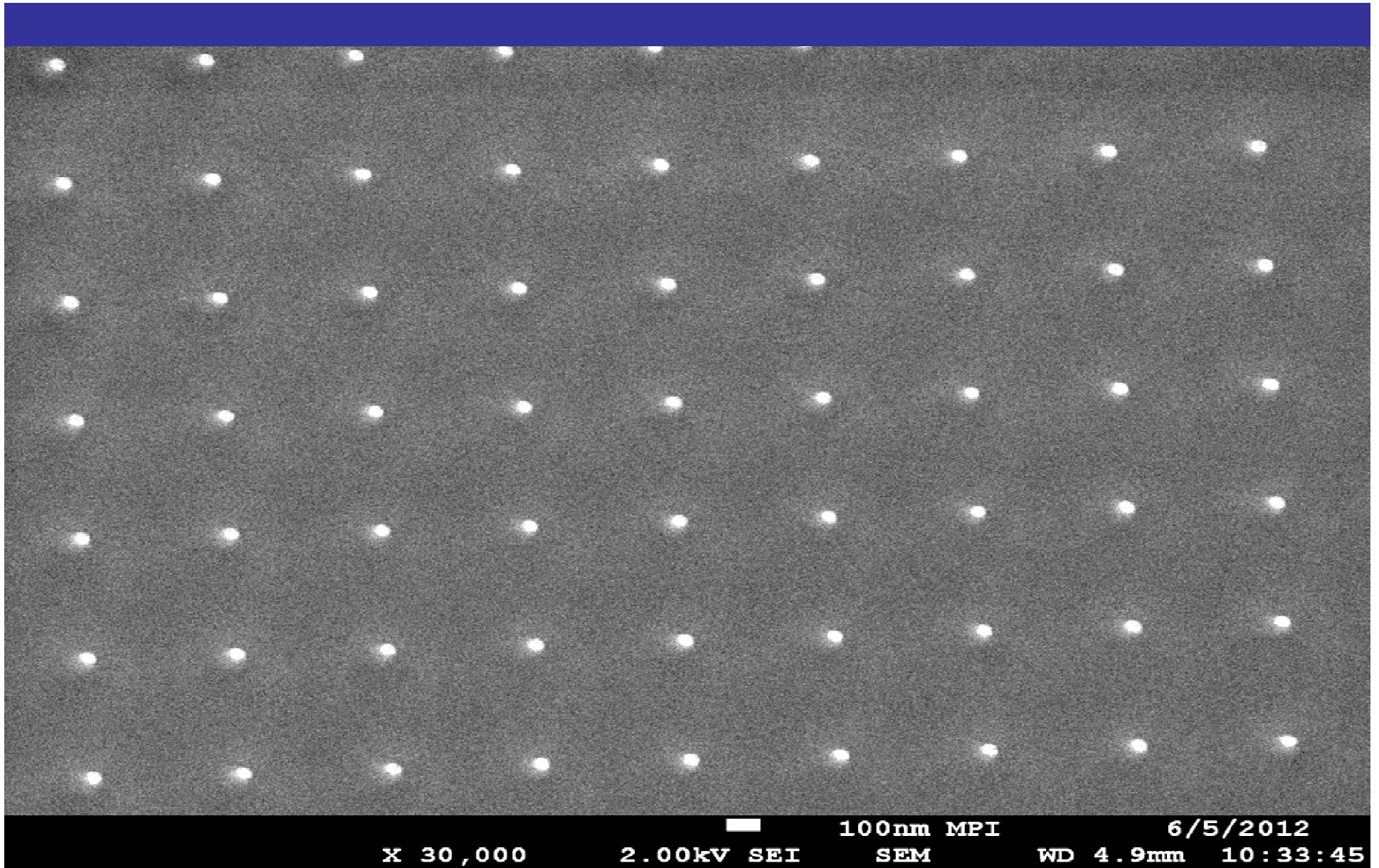


After applying SurfScan.....



All fields are created with dimension as designed!





The 30nm !

## Summary:

The combination of the PEC with **Beamer** of **GenISys** and by improvement of the adhesion with **SurPass 3000** of **Dischem Inc.** we could fabricate the device needed.

Following dose values (center of the fields) exposed successfully



30nm arrays:	8000 $\mu\text{C}/\text{cm}^2$
50nm arrays:	3000 $\mu\text{C}/\text{cm}^2$
100nm arrays:	1500 $\mu\text{C}/\text{cm}^2$
200nm arrays:	1000 $\mu\text{C}/\text{cm}^2$

Without adhesion promoter a dose of 30,000 $\mu\text{C}/\text{cm}^2$  is needed and the columns diameter was over sized.