Exposure

Motivation

This talk will explain

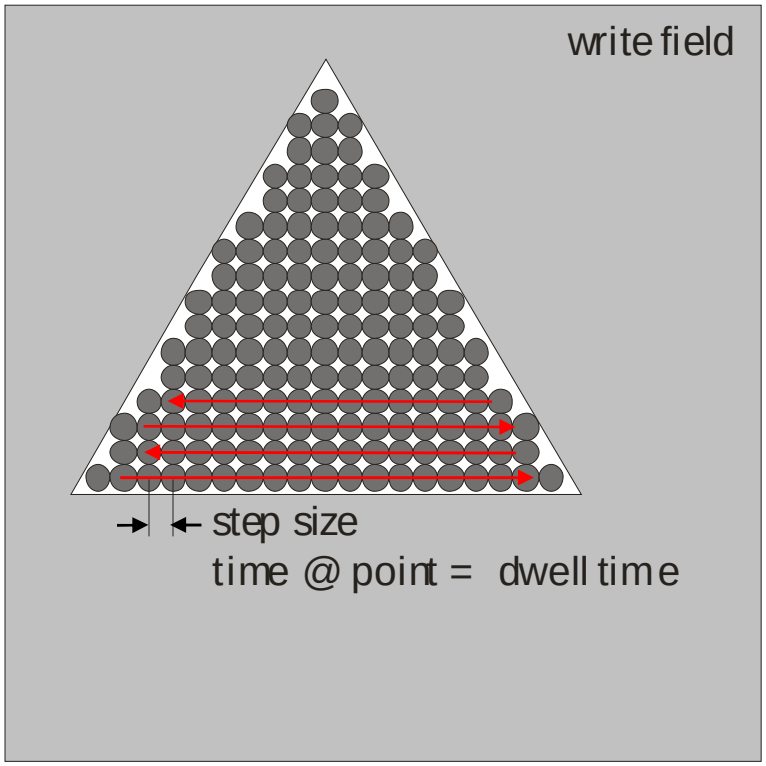
- **definition of exposure parameters**
- **setting up an exposure**
- **details on exposure parameters**

Writing strategy

Exposure

Raith uses

- Round beam with Gaussian-shaped profile
- moved along line = name vector scan

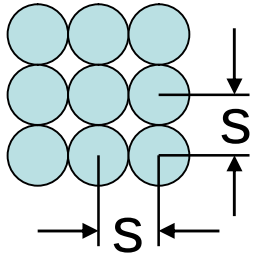


Dose Definition for Area Exposure

Exposure

Rule: To clear an area, a certain **number of electrons** have to hit the sample within that **area**
= clearing area dose

number of electrons
$\propto$ beam current $\times$ dwell time
$= T_{dwell} \times I_{beam}$



area
$\propto$ step size^2
$= s^2$

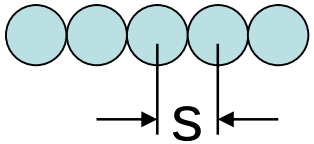
$$\text{Area Dose} = \frac{I_{beam} \cdot T_{dwell}}{s^2} \quad \text{Unit is } \mu As/cm^2$$

Dose Definition for Single Pixel Lines

Exposure

Rule: To clear a line, a certain **number of electrons** have to hit the sample within a certain **length**
= clearing line dose

number of electrons
$\propto$ beam current $\times$ dwell time
$= T_{dwell} \times I_{beam}$



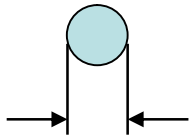
line
$\propto$ step size
$= s$

$$\text{Line Dose} = \frac{I_{beam} \cdot T_{dwell}}{s} \qquad \text{Unit is pAs/cm}$$

Dose Definition for Dots

Rule: To clear a dot, a certain **number of electrons** have to hit the sample within a certain **point**
= clearing dot dose

number of electrons
$\propto$ beam current $\times$ dwell time
$= T_{dwell} \times I_{beam}$



$$\text{Dot Dose} = I_{beam} \cdot T_{dwell}$$ Unit is pAs

Quantities defined by ...

Exposure

beam current
defined by column, i.e. filament, aperture, voltage, ...

dose
defined by process, i.e. resist, developer, temperature, voltage ...

dwell time and step size
exposure parameters defined by your needs, e.g. accuracy, GDSII, throughput, ...

Quantities are used ...

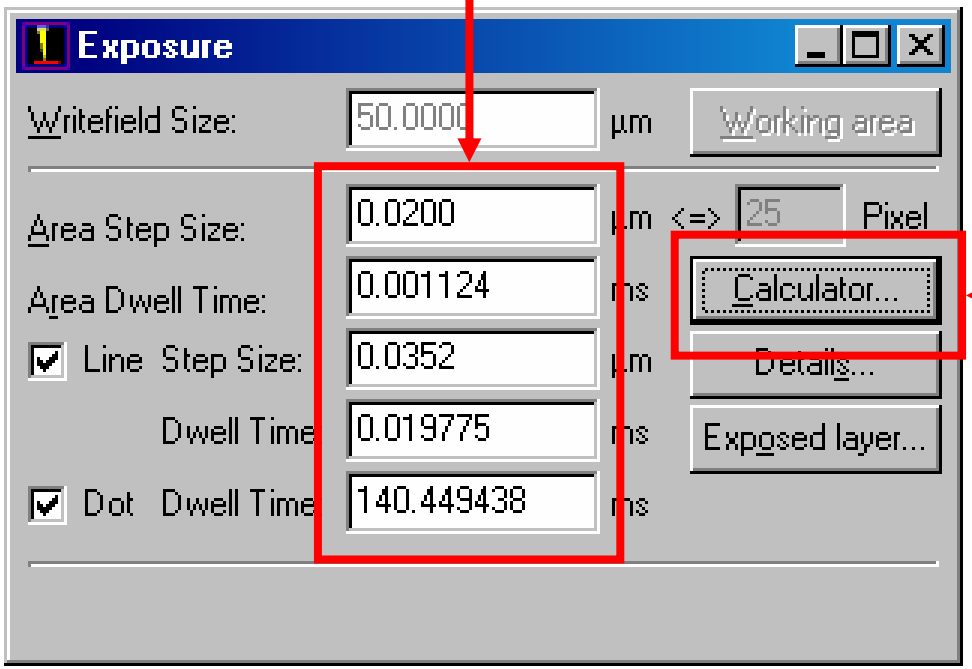
Exposure

Paramter	Area	Line	Dot
beam current	yes	yes	yes
dose	yes	yes	yes
dwell time	yes	yes	yes
step size	yes	yes	no
selectable	3	3	2
determined	1	1	1

under the condition to clear or equivalently fulfill the dose equation.

Exposure Window

Main window to set up
all exposure parameters



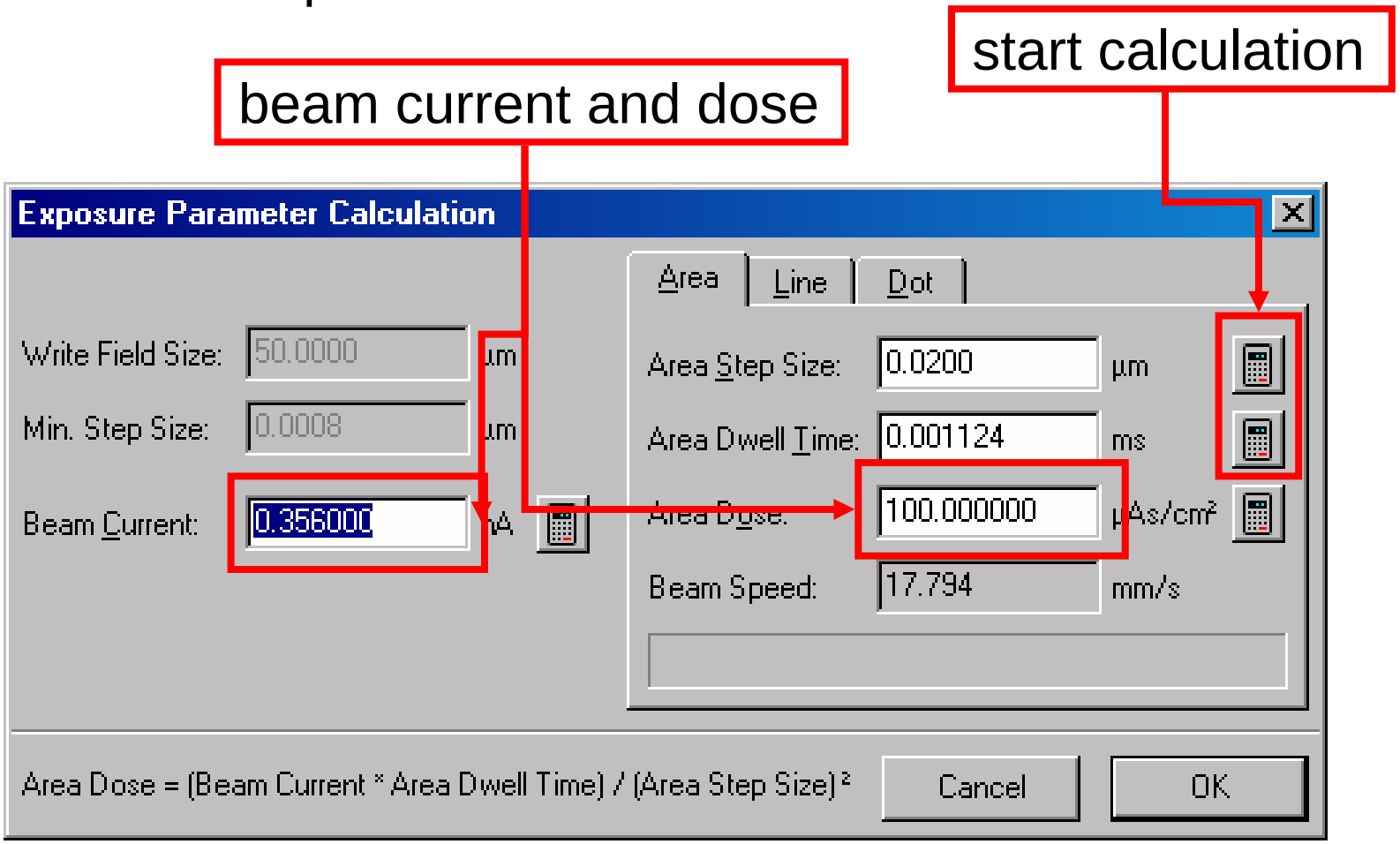
calculated
step size and
dwell time

Calculator using
clearing dose and
beam current

Calculator Window

Exposure

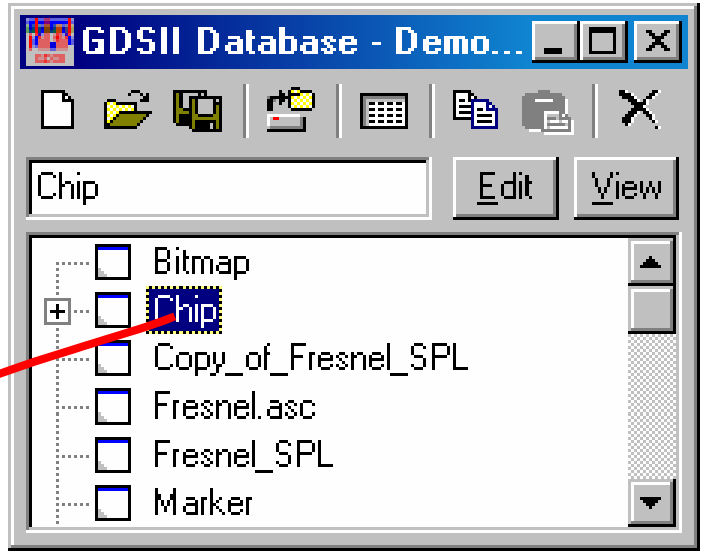
Window to perform calculation

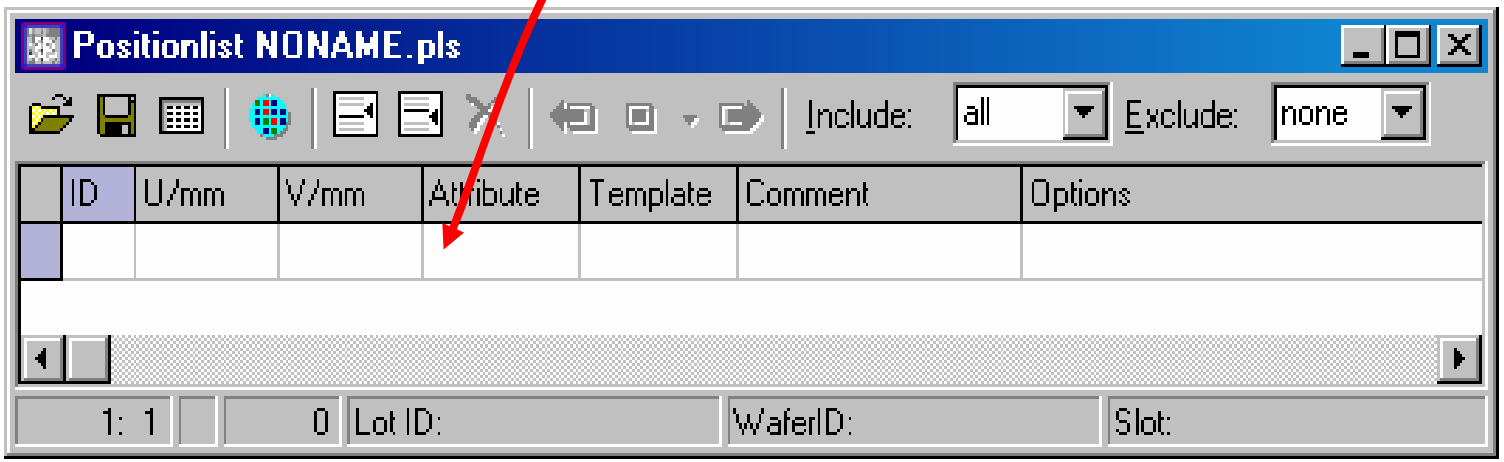


Exposure Setup

Exposure

Pull design into positionlist by „Drag and Drop“





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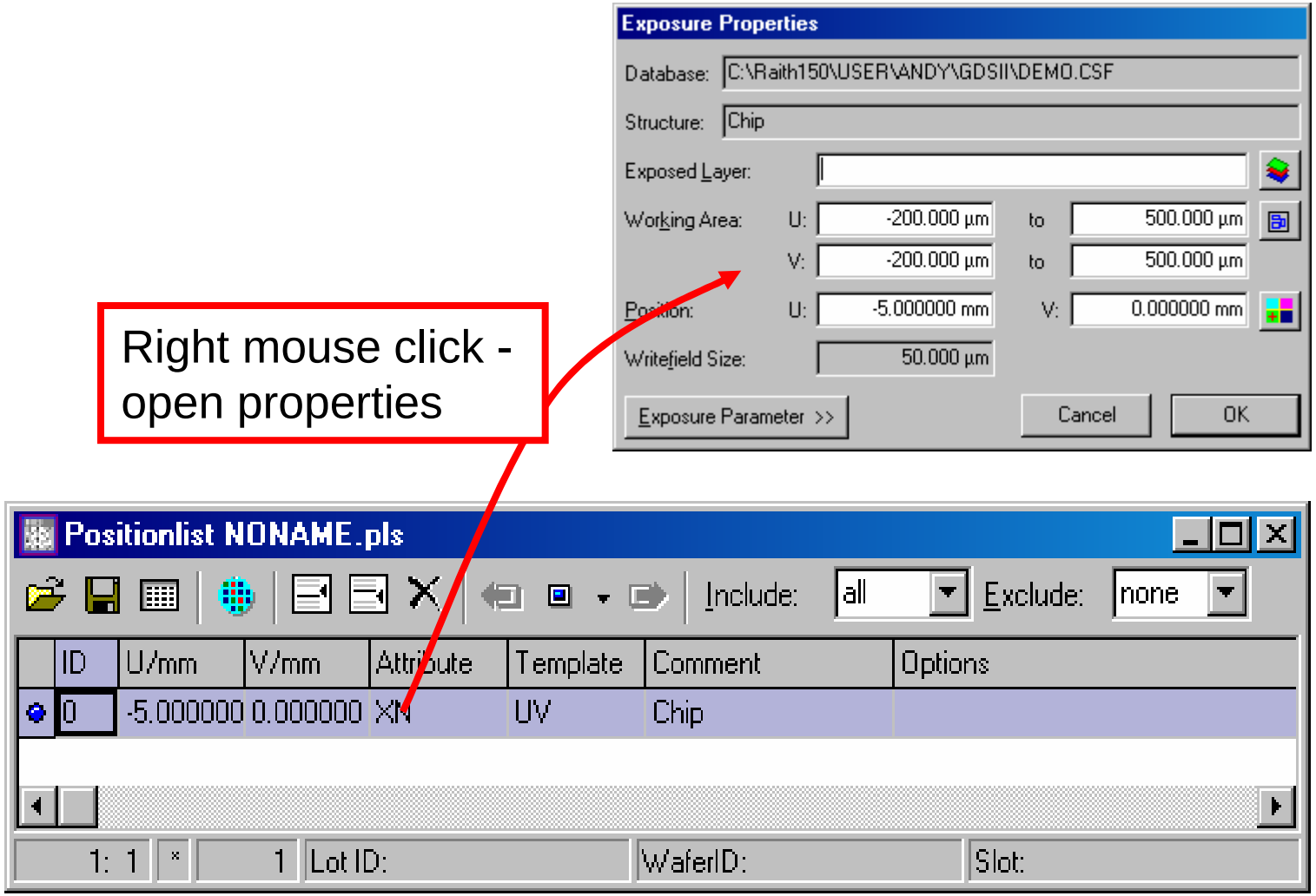
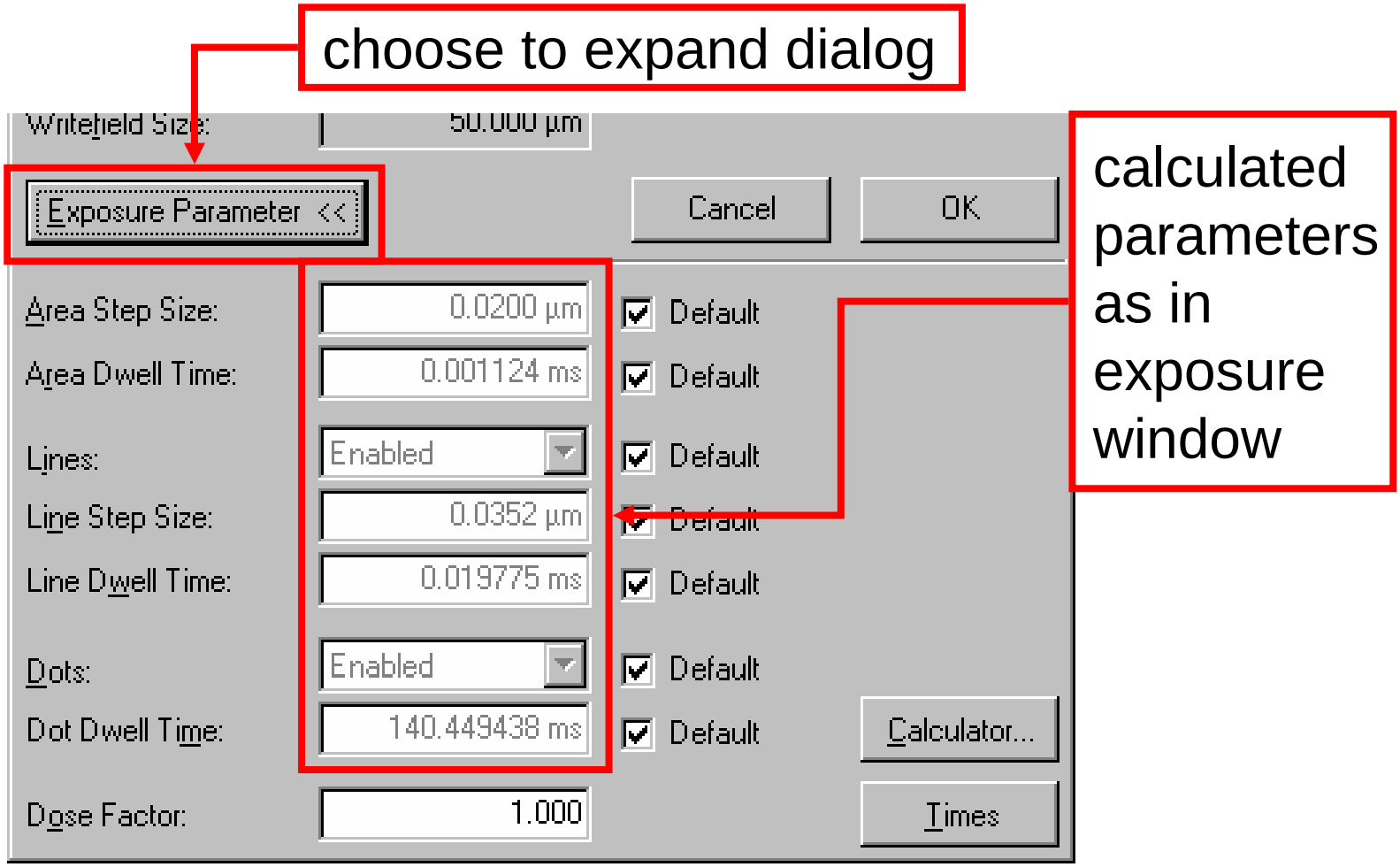
PLS Exposure Properties 1

Exposure

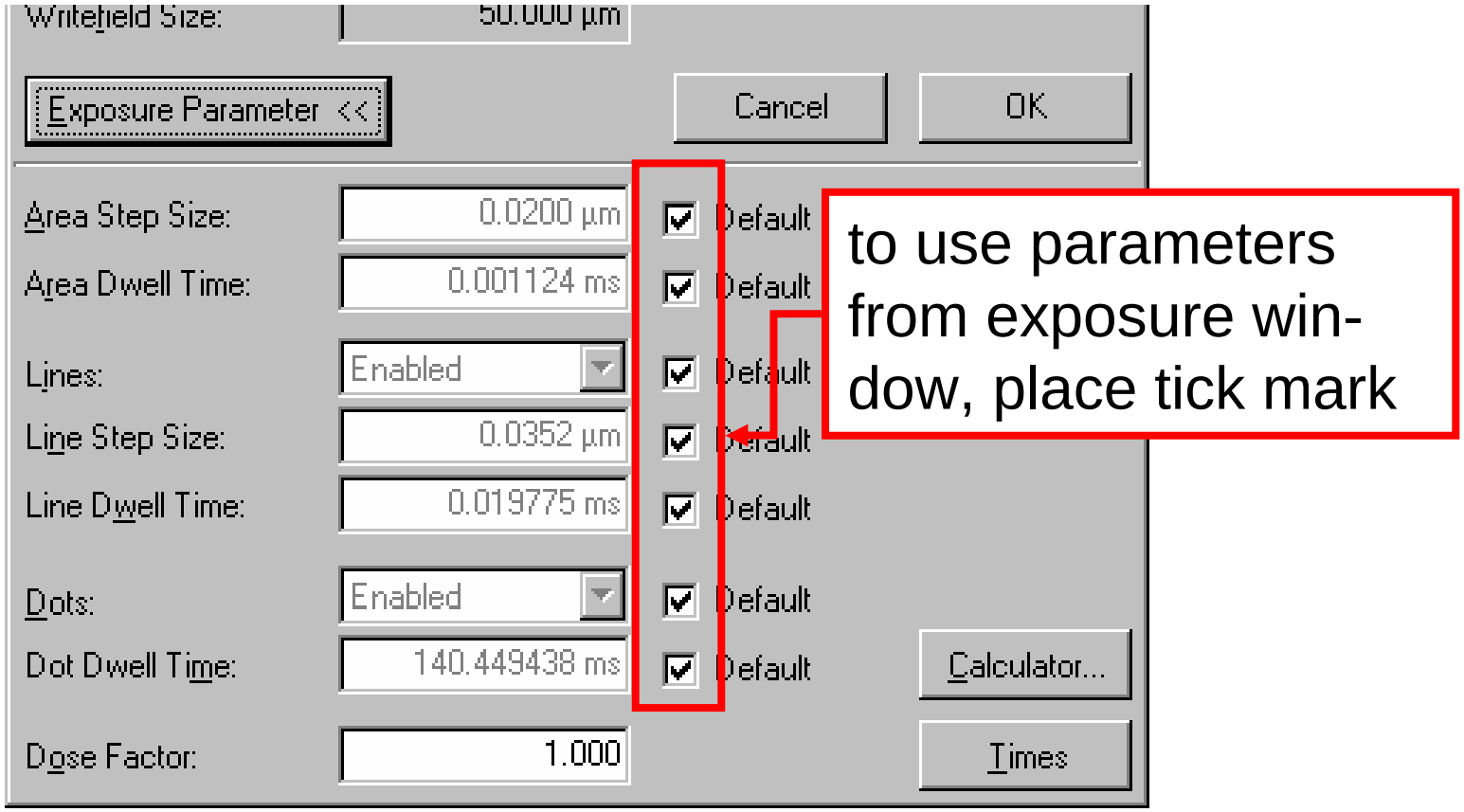


PLS Exposure Properties 2



PLS Exposure Properties 3

Exposure



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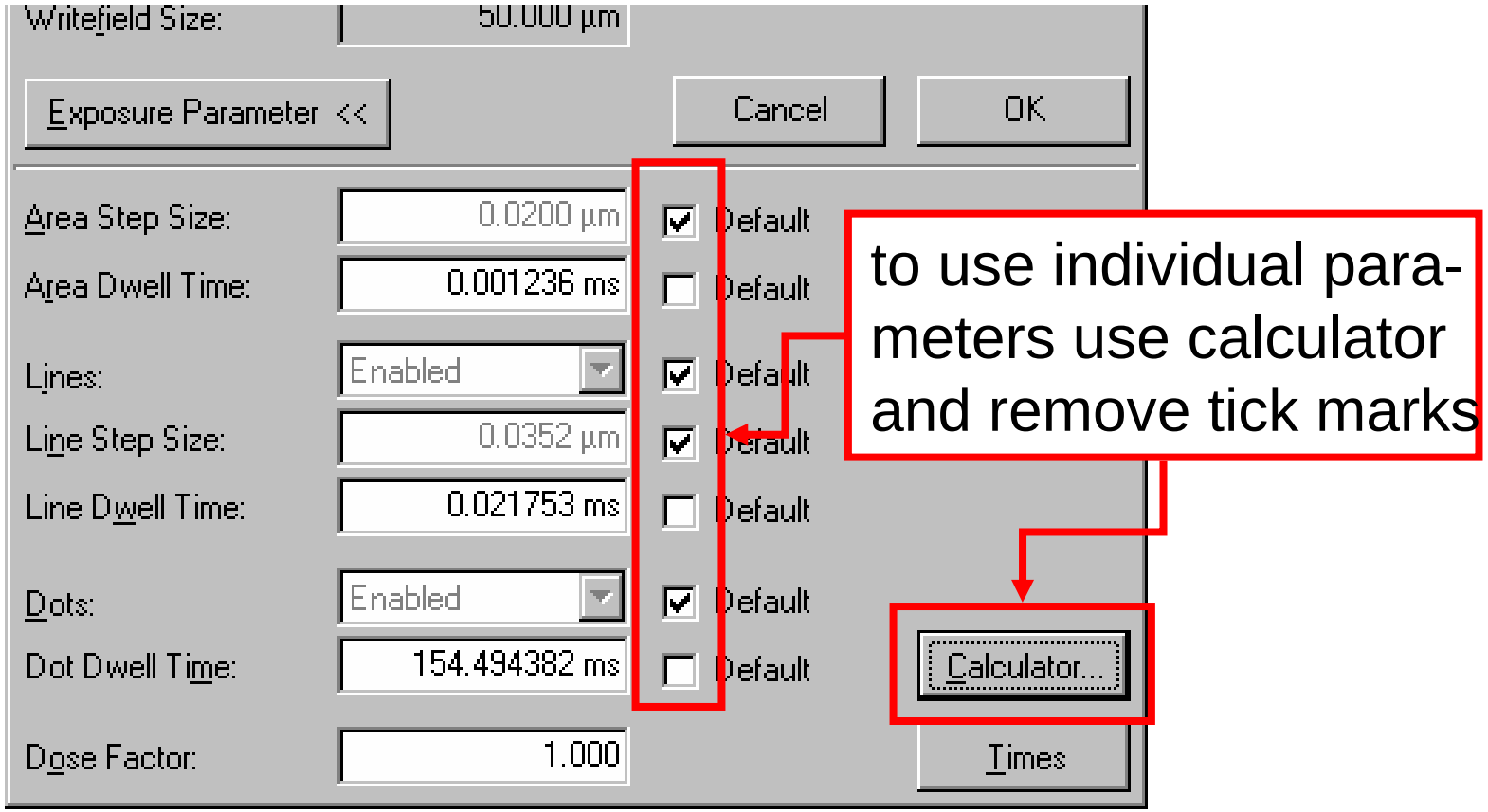
PLS Exposure Properties 4

Exposure



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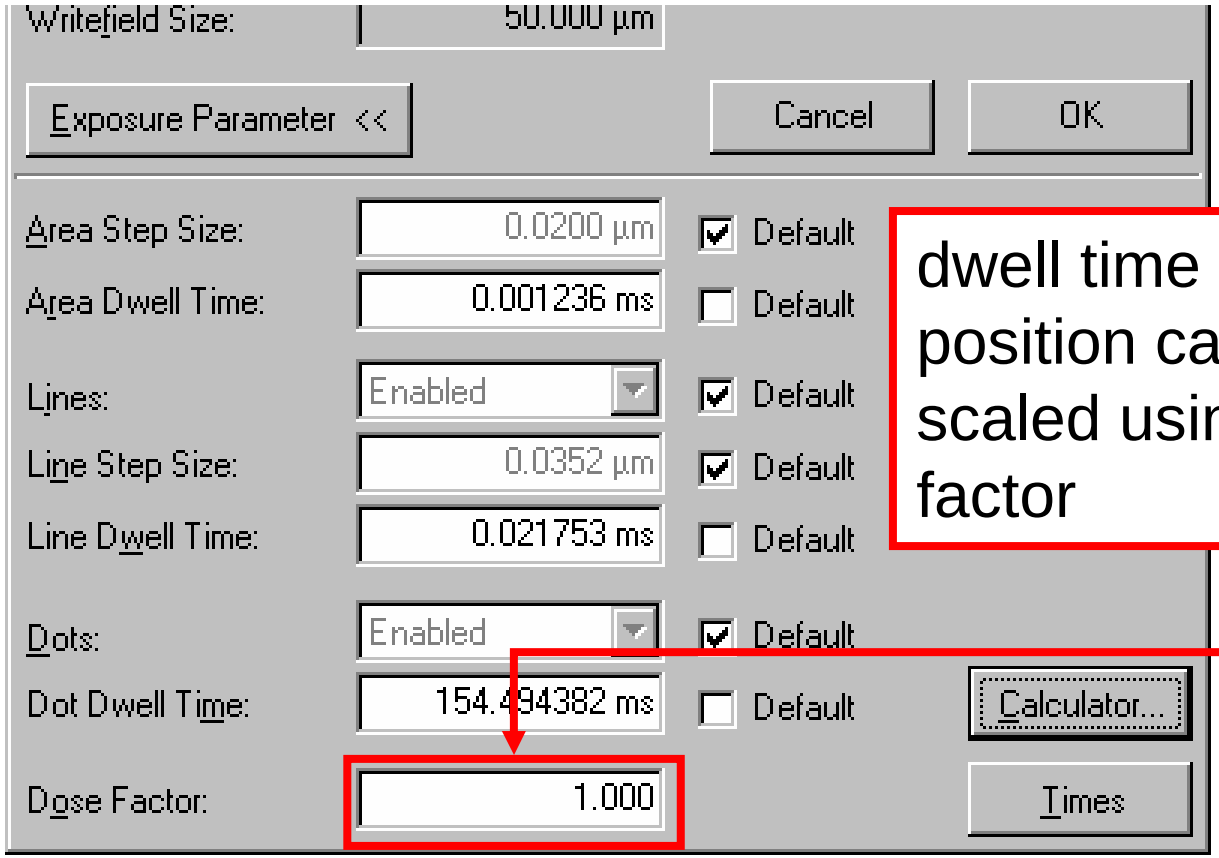
PLS Exposure Properties 5

Exposure



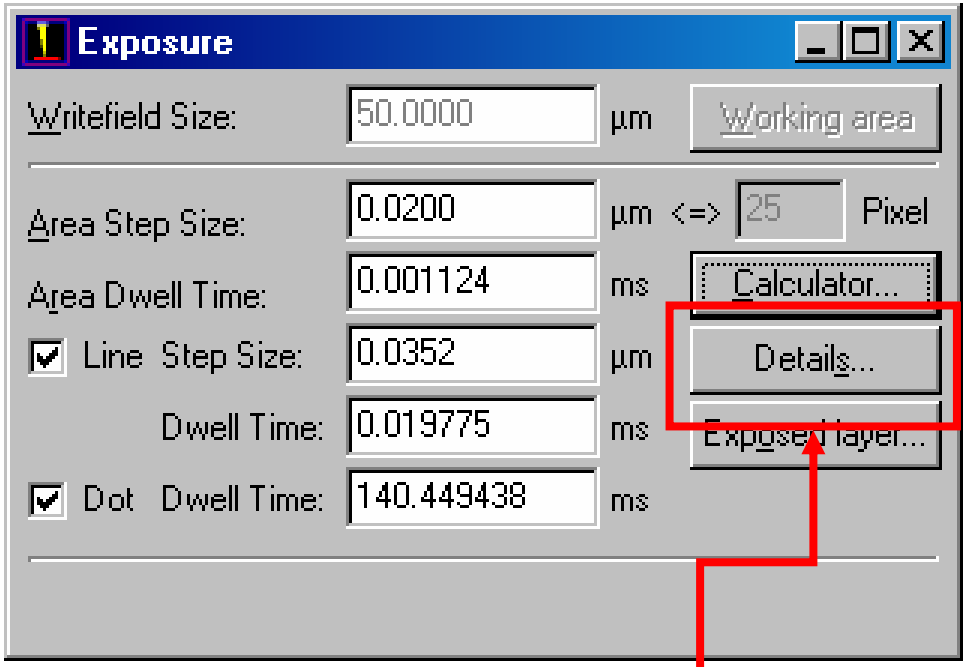
dwell time at each position can be re-scaled using dose factor

Raith

Additional Parameters 1 - Details

Exposure

- Loops
- Line mode
- Meander mode
- Settling time
- Flyback time
- Circular mode



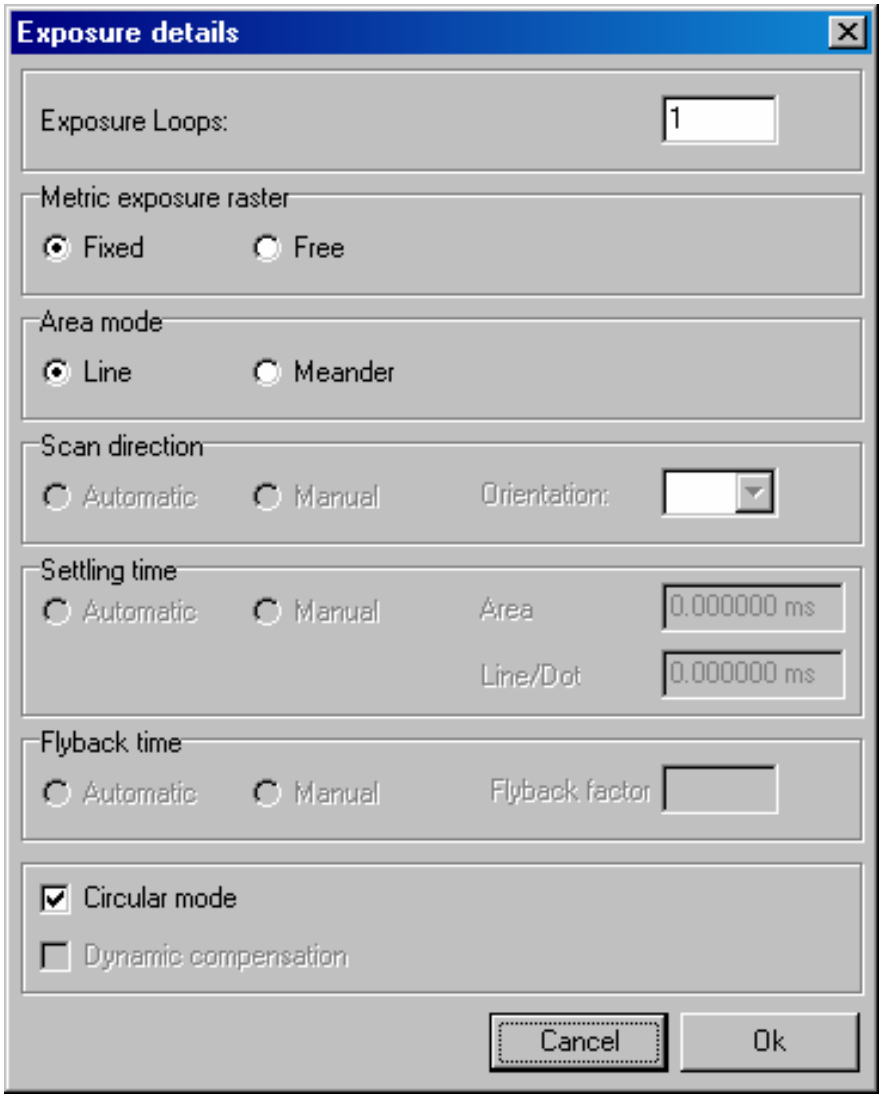
opens dialog to set additional parameters

Raith

Additional Parameters 2 - Details

Exposure

- Loops
- Line mode
- Meander mode
- Settling time
- Flyback time
- Circular mode

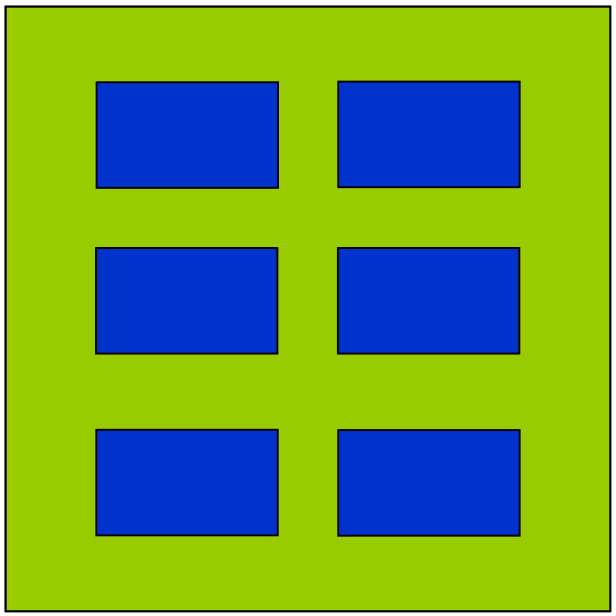


Loops

Exposure

Each write field is repeated n times.

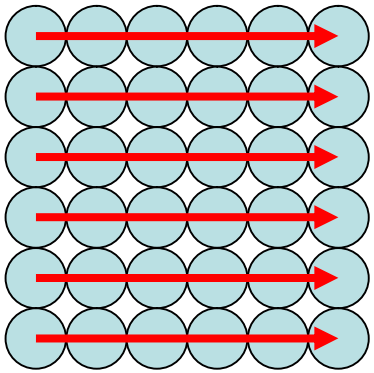
(0 means infinite number of loops)

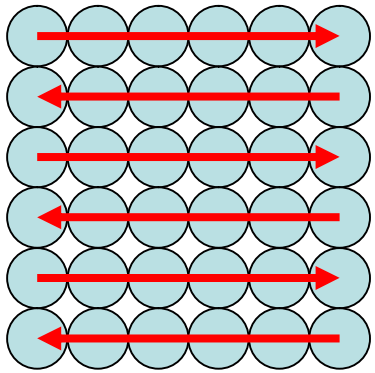


Line mode versus meander mode

Line mode = element is filled with each line from the **same** direction.

Meander mode = element is filled with each line from the **opposite** direction.



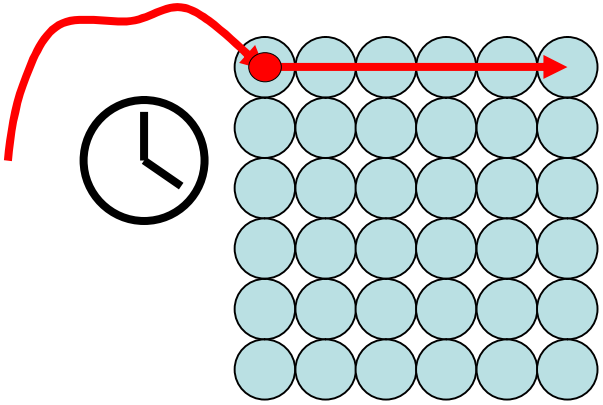


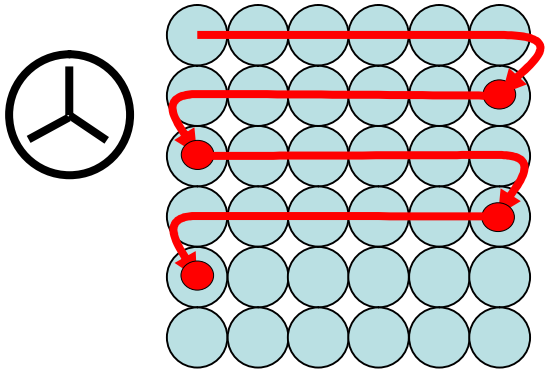
See talk “Exposure parameters” for hints which mode to use.

Settling and Flyback Time

Settling time = waiting period at beginning of each element

Flyback time = waiting period between lines.





Please note, in our software
Flyback time = settling time × flyback factor

Circular Mode

Circular mode =

- round elements are decomposed into dots
- dots are exposed in concentric rings
- vertices are not used

Version 3.0

- area step size, dwell time
- line settling time

Version 4.0

- only area parameters