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黄光制程简介

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- 黄光制程简介
- 涂胶系统
- 曝光系统
- 显影系统
- 检测系统
- 总结黄光制程

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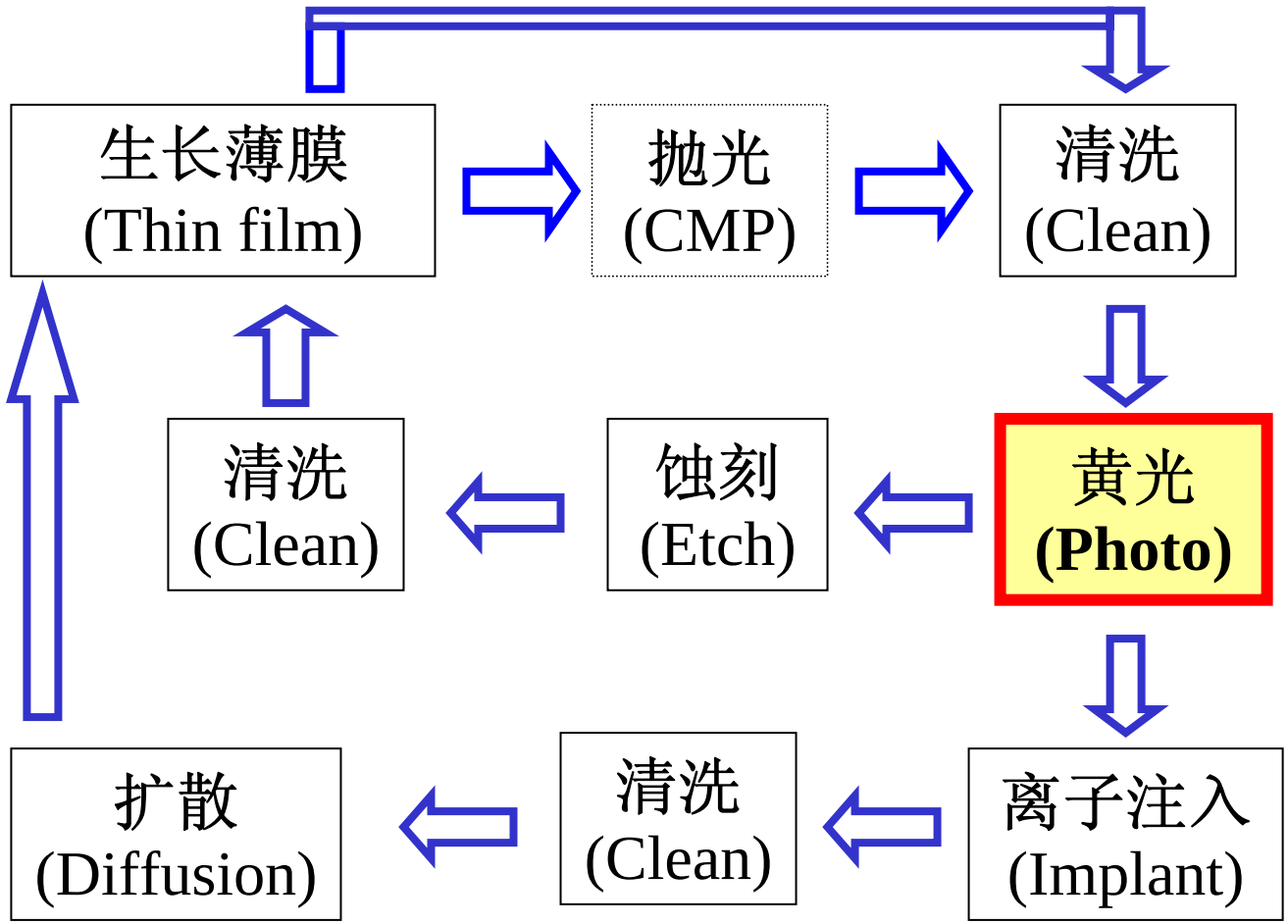
半导体制程简介



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什么是黄光区?

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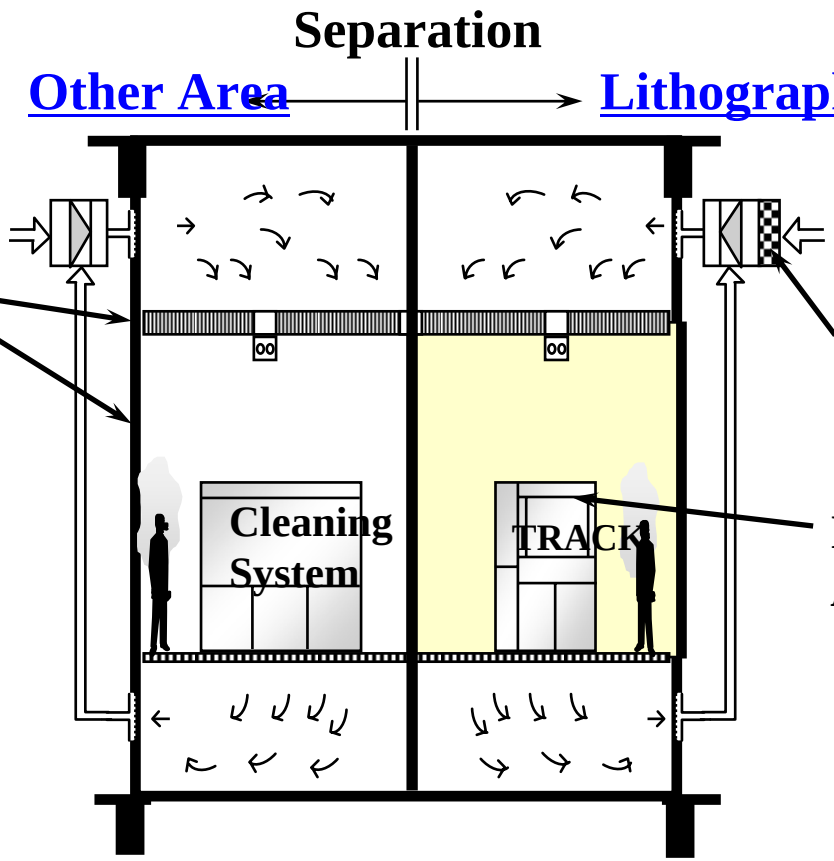
- Clean Room -



† Clean

† Wave Length Control

“Class100”

within100(0.5umUP)/f3(0.028m3)

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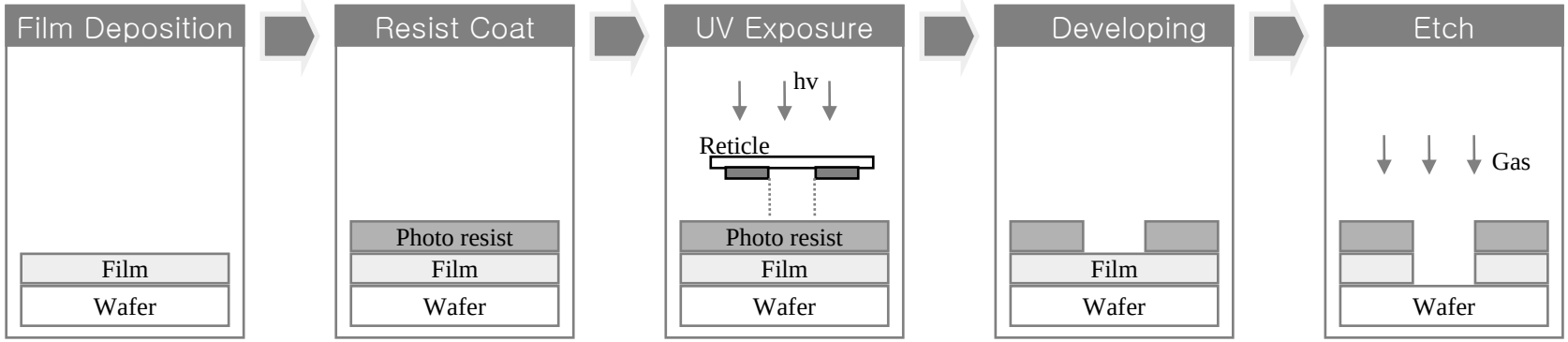
Photo in-line process flow overview

[1] General Flow

Definition:
Photolithography

It's pattern printing process on the resist coated wafer
by UV exposure and pattern designed mask(Reticle).



Photo

JOB

Pattern Size Control
Pattern Profile Control
Align Control between layer

FACTOR

EE / FO
OL Base Line / FB
Mix & Match(System)

- Process condition depends on which layer : Substrate condition,CD,Topology,OL target,Etch target etc
- Key process factor : Tpr(A),Use BARC or not,SB,TARC or not,WEE,EE,FO,OL offset,PEB, Dev. Dipping time and so on.
- Key machine factor : Cup exhaust pressure,Water jacket control temp,Chamber pressure,Temp,focus, Plate exhaust,PEB temp Accuracy.

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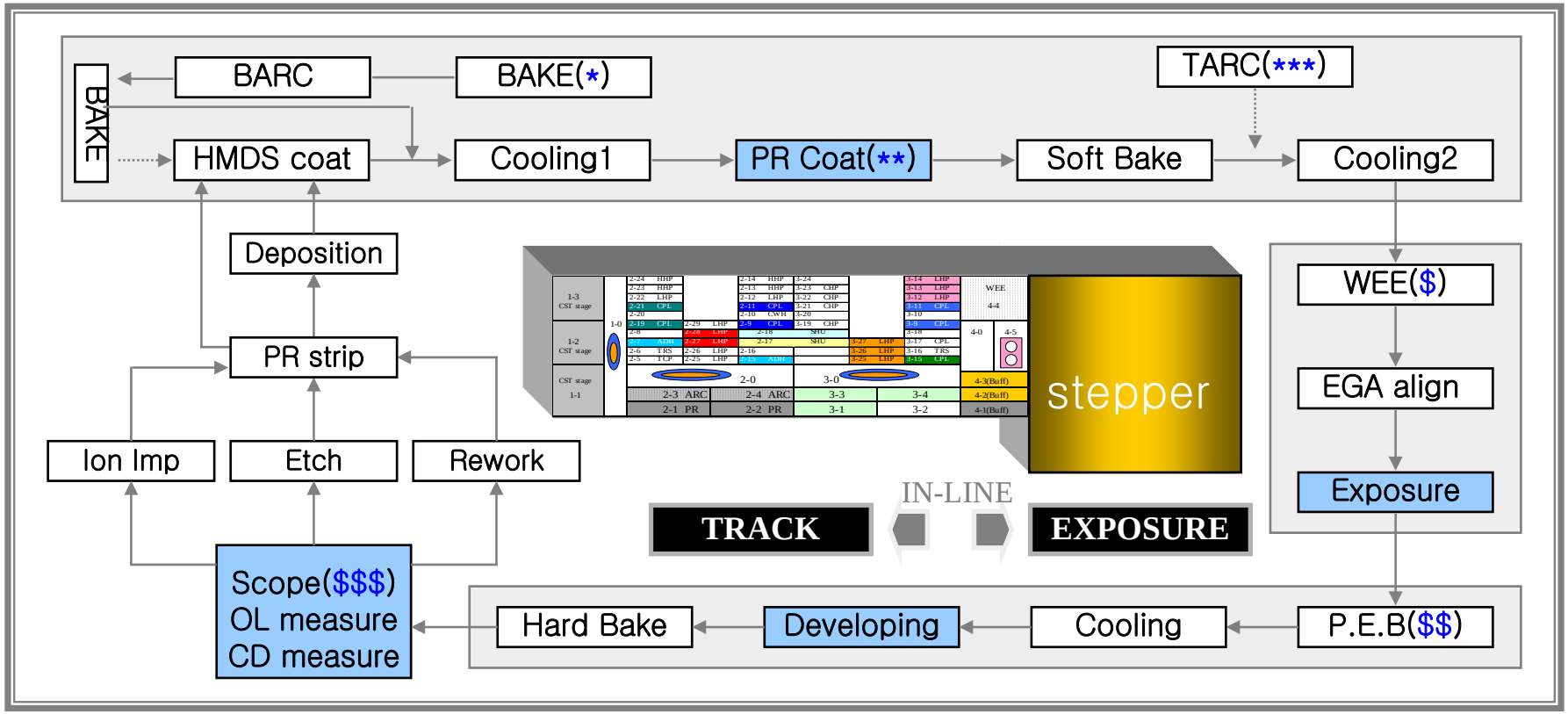
Photo in-line process flow overview



(*) Absolutely we remove moisture on the wafer before BARC coating : Secondary reaction
(**) EBR is not absolute process : We can use WEE instead of EBR ==> Need recipe tuning
(***) TARC should be coated after PR bake(Soft bake) : Do not TARC bake(Secondary reaction)
($) We can change from before exposure to after exposure for I-line,but DUV cannot.
($$) PED control is very important to maintain process performance for DUV,but I-line isn't.
($$$) ADI procedure is important to reduce ADI loss : Scope ==> OL ==> CD

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黄光制程简介

简单的来说, 黄光制程分为四大部分:

- 涂胶
- 曝光
- 显影
- 检测

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涂胶显影机的外形

1. 什么是光阻 (Photoresist)

光阻是一种化学材料，在**PHOTO process** 中经过曝光和显影两个步骤将光罩**(Mask)**上的图形转移到光阻上， 在下一站**etch**或**implant**时作为保护层将不需要**etch**或**implant**的地方保护起来，再次将图案转移到**wafer**上。

2. 光阻的分类

光阻分正光阻 **(Positive photoresist)** 和负光阻 **(Negative photoresist)**。感光的部分溶于显影剂**(Developer)**的叫正光阻，感光的部分不溶于显影剂的叫负光阻。

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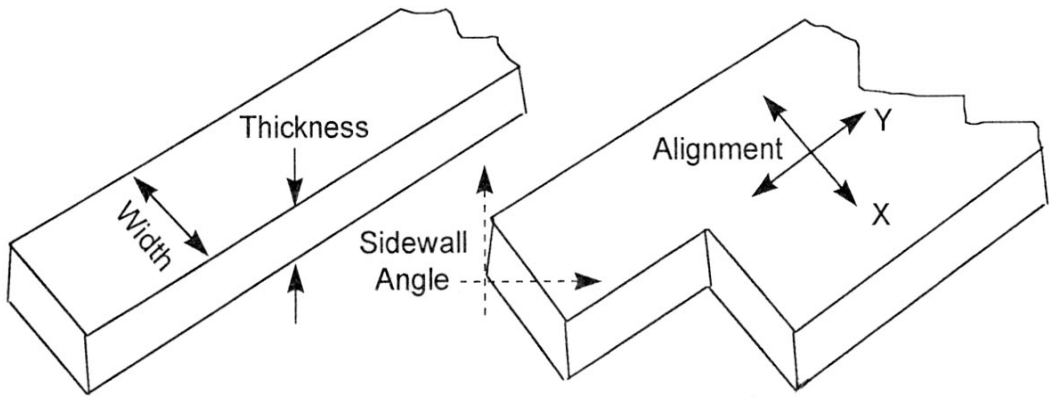
光阻在图形中的作用:

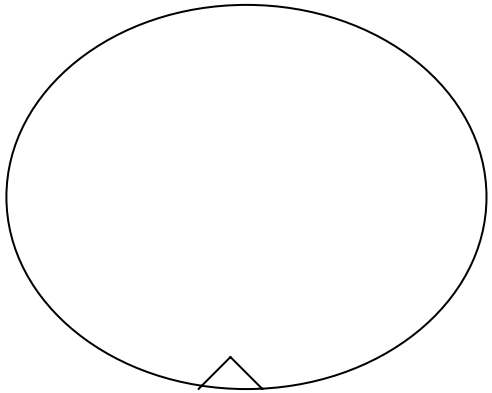
- Used to “resist” etch.
- Used to “resist” ion implantation.
- Accurately “aligned” to other patterns.
- Critically sized.



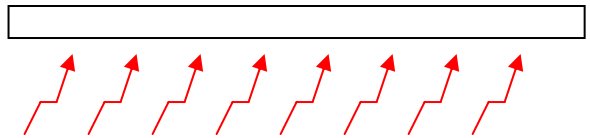
涂胶的步骤

在晶圆上面涂上一层光阻. 共分成 **6** 大部步骤

第一步: 脱水 (DEHYDRATION),用加热法去掉晶圆的水分.



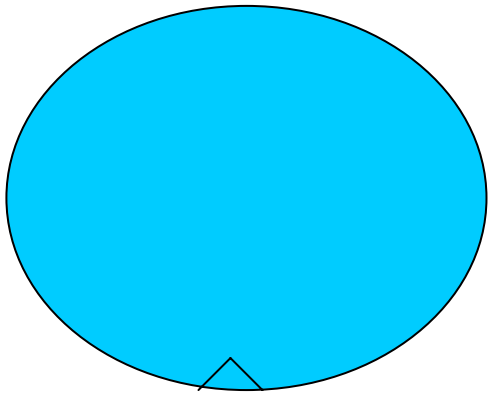
俯视图



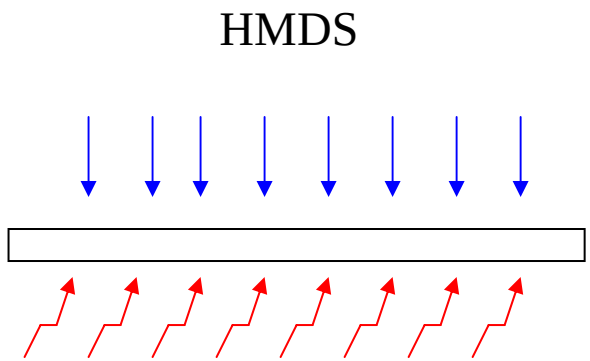
侧面图

涂胶的步骤

第 2 步: 粘附 (ADHERSION),用粘附济(HMDS)涂在晶圆表面以增加粘附性.



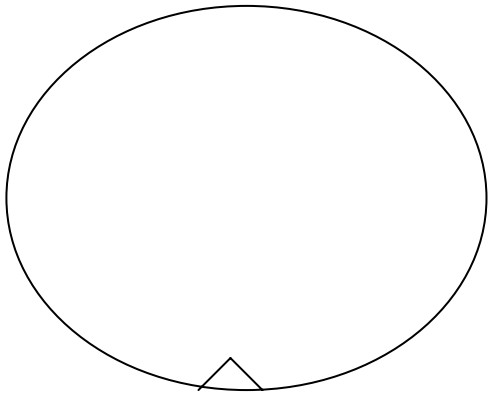
俯视图



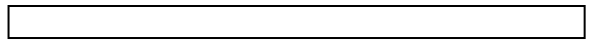
侧面图

涂胶的步骤

第 3 步: 冷却(COOLING), 把晶圆冷却到室温.



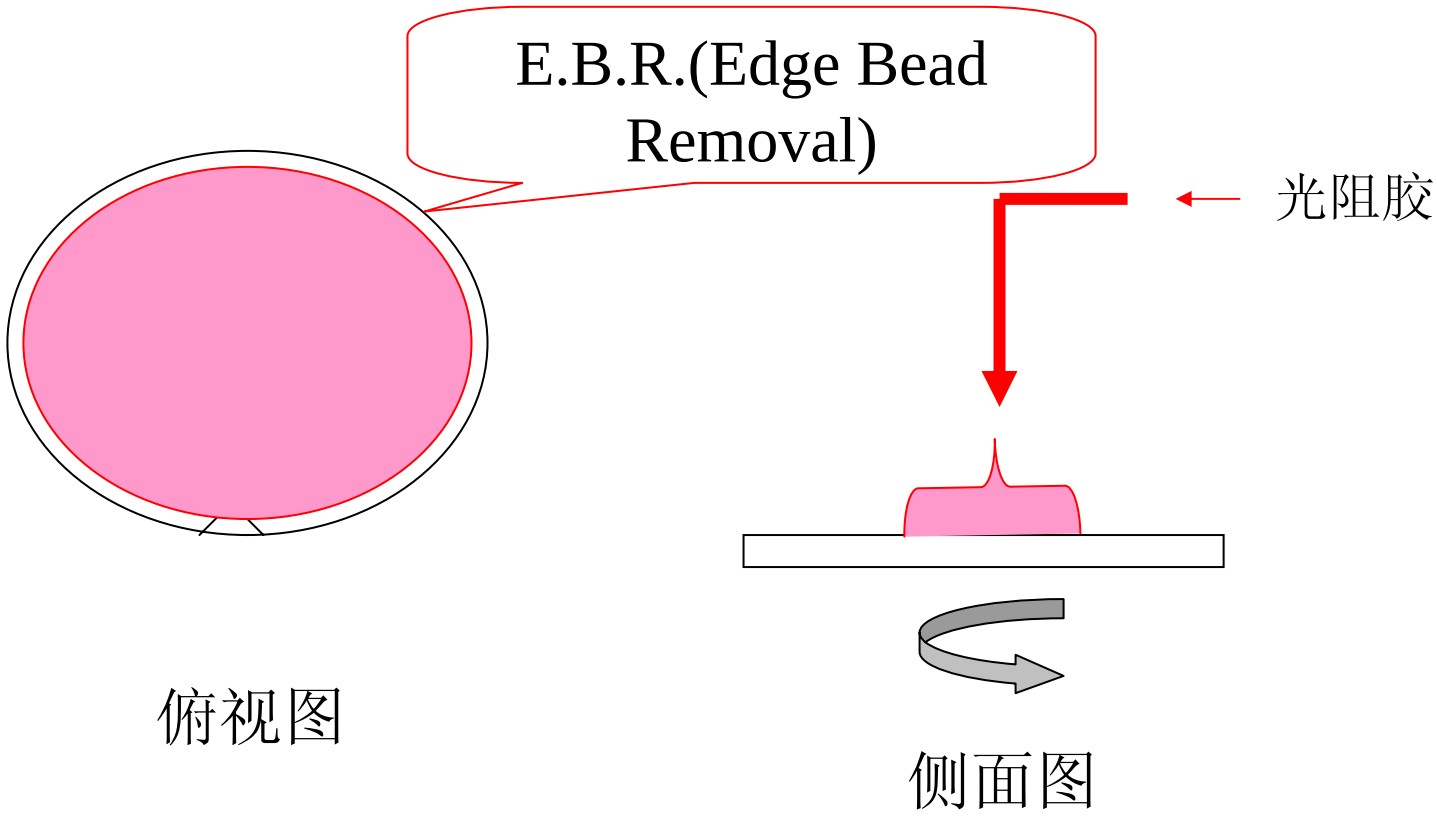
俯视图



侧面图

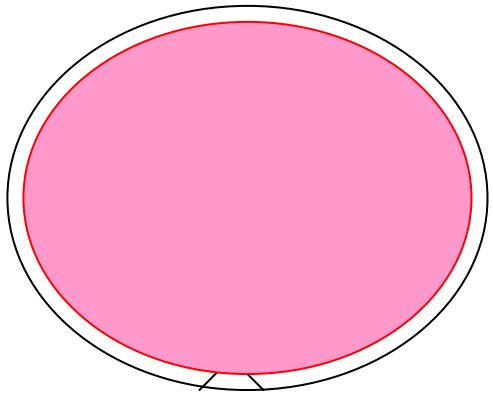
涂胶的步骤

第 4 步:涂胶(COATING), 把晶圆涂上一层光阻胶.

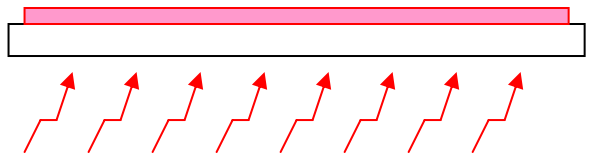


涂胶的步骤

第5步: 预烘 (SOFTBAKE),用加热法把光阻中的溶剂蒸发掉.



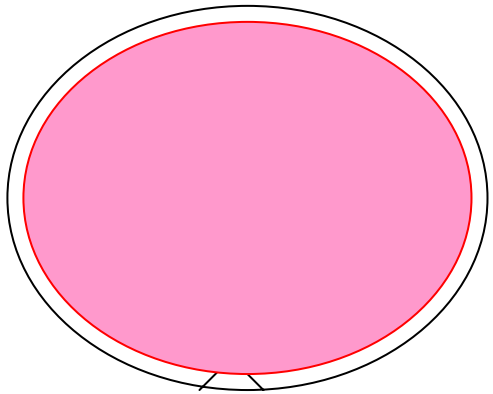
俯视图



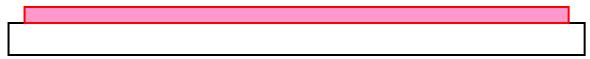
侧面图

涂胶的步骤

第 6 步: 冷却(COOLING), 把晶圆冷却到室温.



俯视图



侧面图

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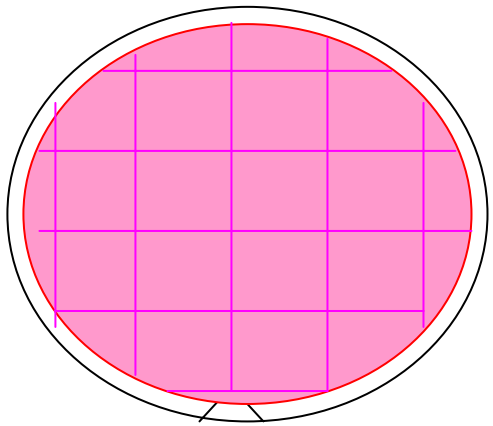
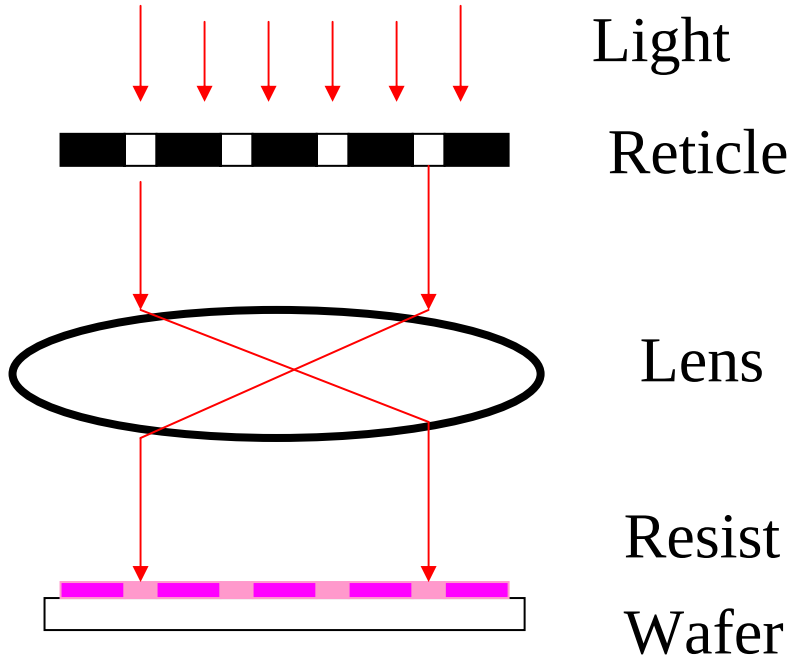
曝光机的外形

曝光的作用



俯视图



侧面图

曝光机的分类

- 按光源分类:

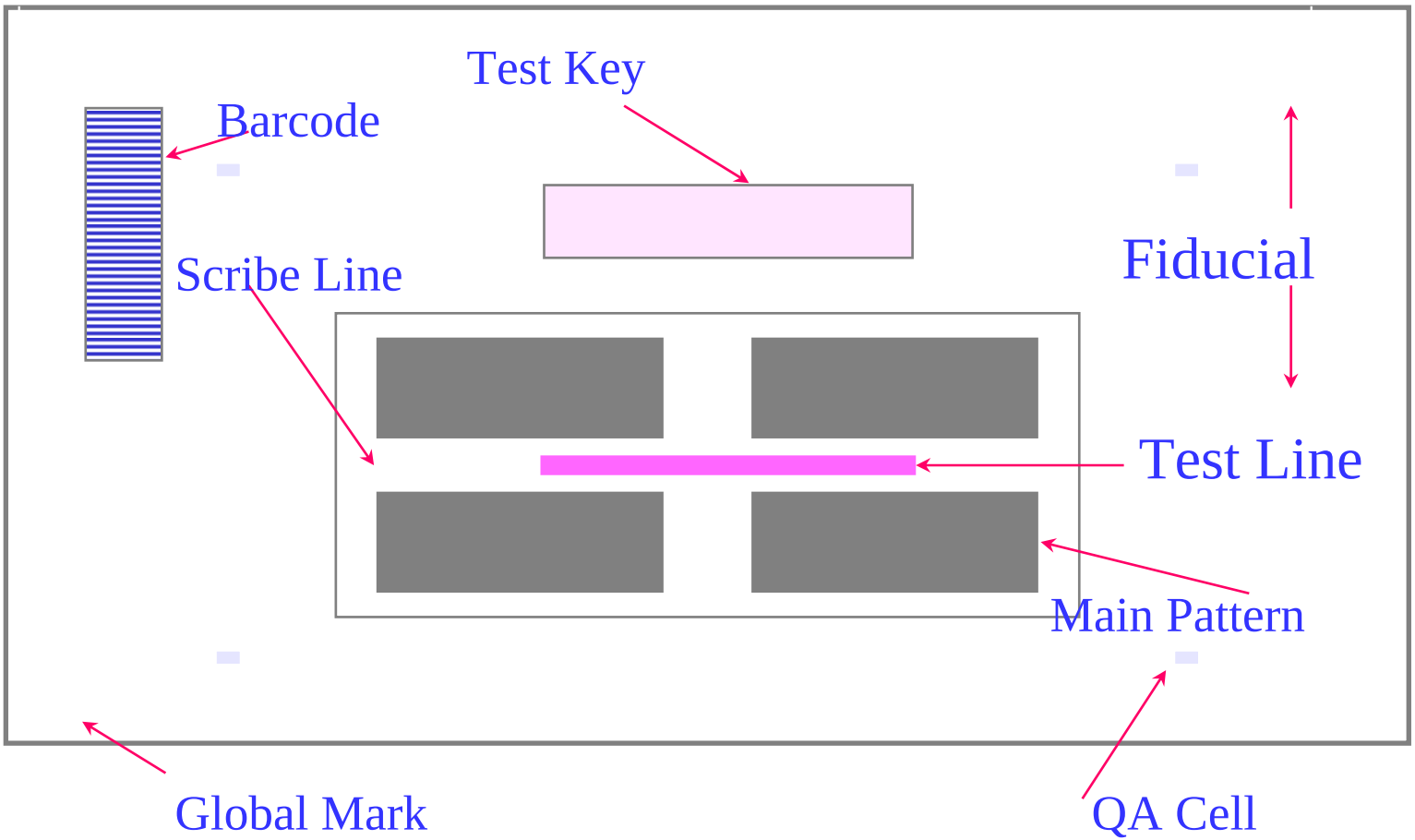
  DUV (波长=248) ; I-line (波长=365nm)

- 按运作分类:

  扫描机**(SCANNER);** 步进机**(STEPPER)**

什么是光罩?

光罩是有很多图形(**Pattern**）的模板设计图形

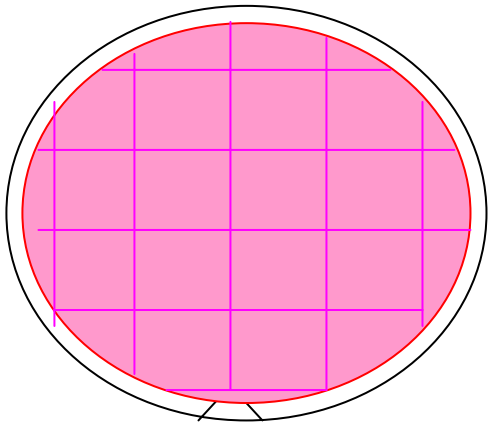


什么是显影液:

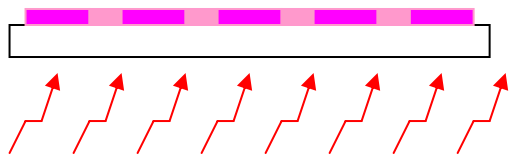
- Developer is used to chemically develop the photoresist pattern on exposed wafers. The basic developer reacts with the exposure-induce carboxylic acid resist.

显影的步骤:

第1步,曝光后之烘烤(PEB), 目的是减少驻波.



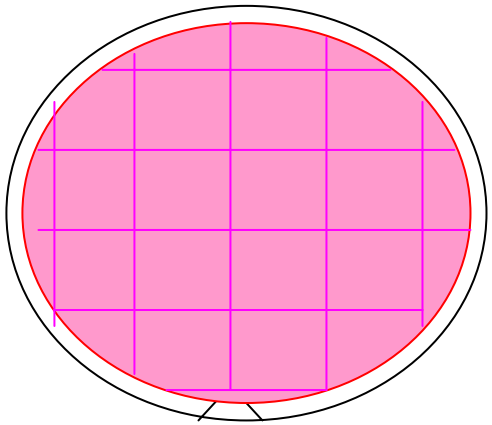
俯视图



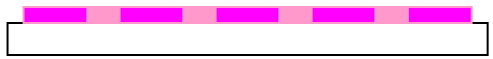
侧面图

显影的步骤:

第2步,冷却(COOLING), 把晶圆冷却到室温



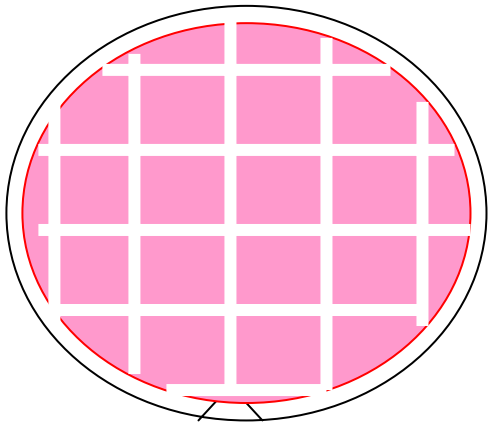
俯视图



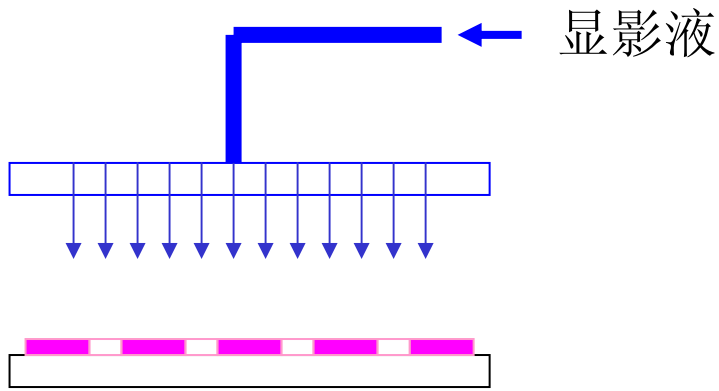
侧面图

显影的步骤:

第3步,显影(DEVELOPING). 显现图形.



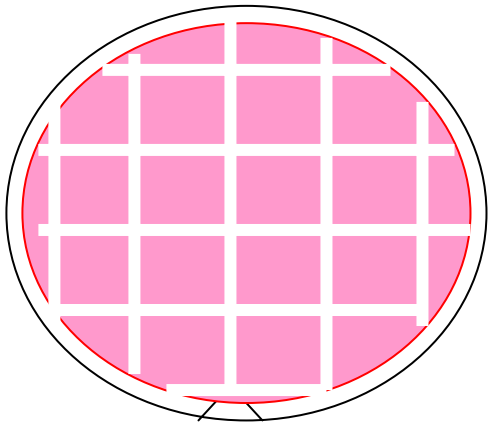
俯视图



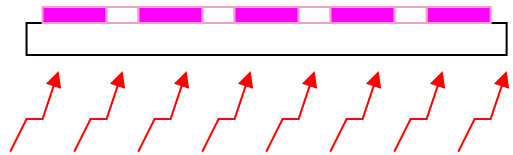
侧面图

显影的步骤:

第4步,后烘(HARDBAKE). 使光阻硬化.



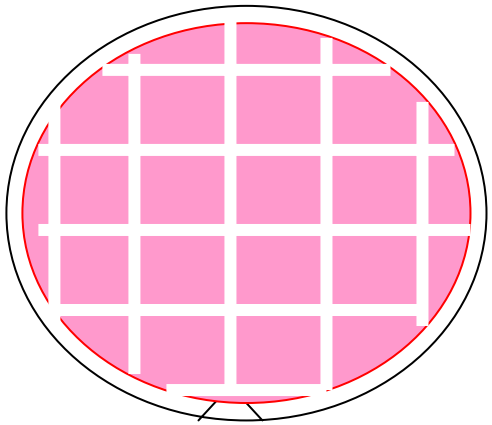
俯视图



侧面图

显影的步骤:

第5步,冷却(COOLING), 把晶圆冷却到室温



俯视图

侧面图

检测系统

检测共分**4**个部份**,** 其中首**3**个用在产品**.**

- **OVERLAY**
- **CD SEM**
- **ADI INSPECTION**
- **RESIST THICKNESS MEASUREMENT**

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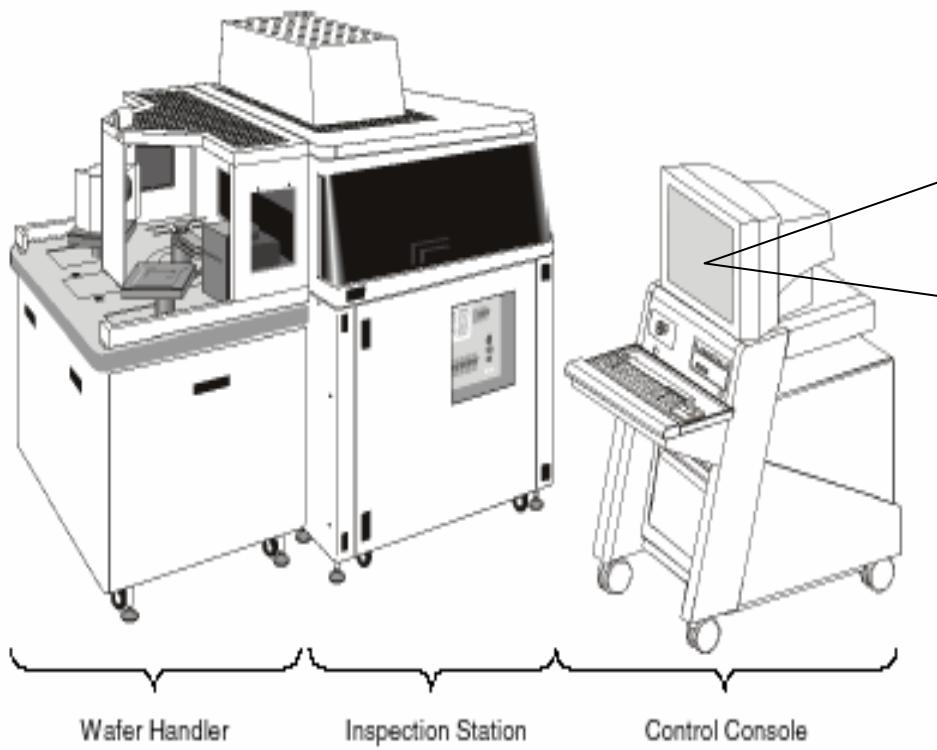
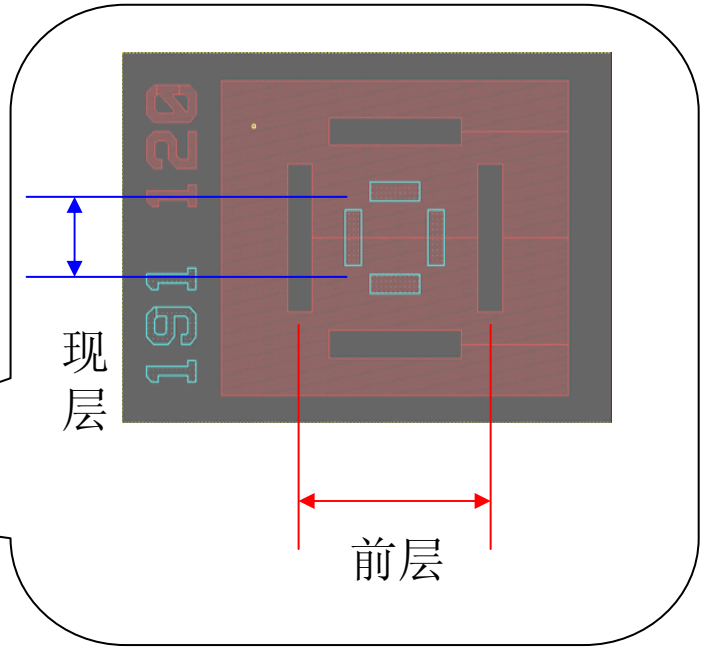
OVERLAY 的作用

------测量图形的对准状况.

机台外观:





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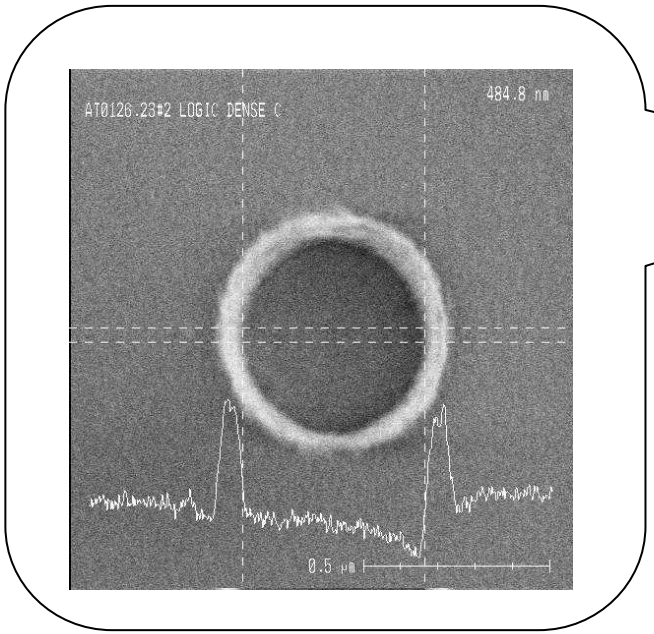
CD-SEM 的作用

-----测量图形的大小.

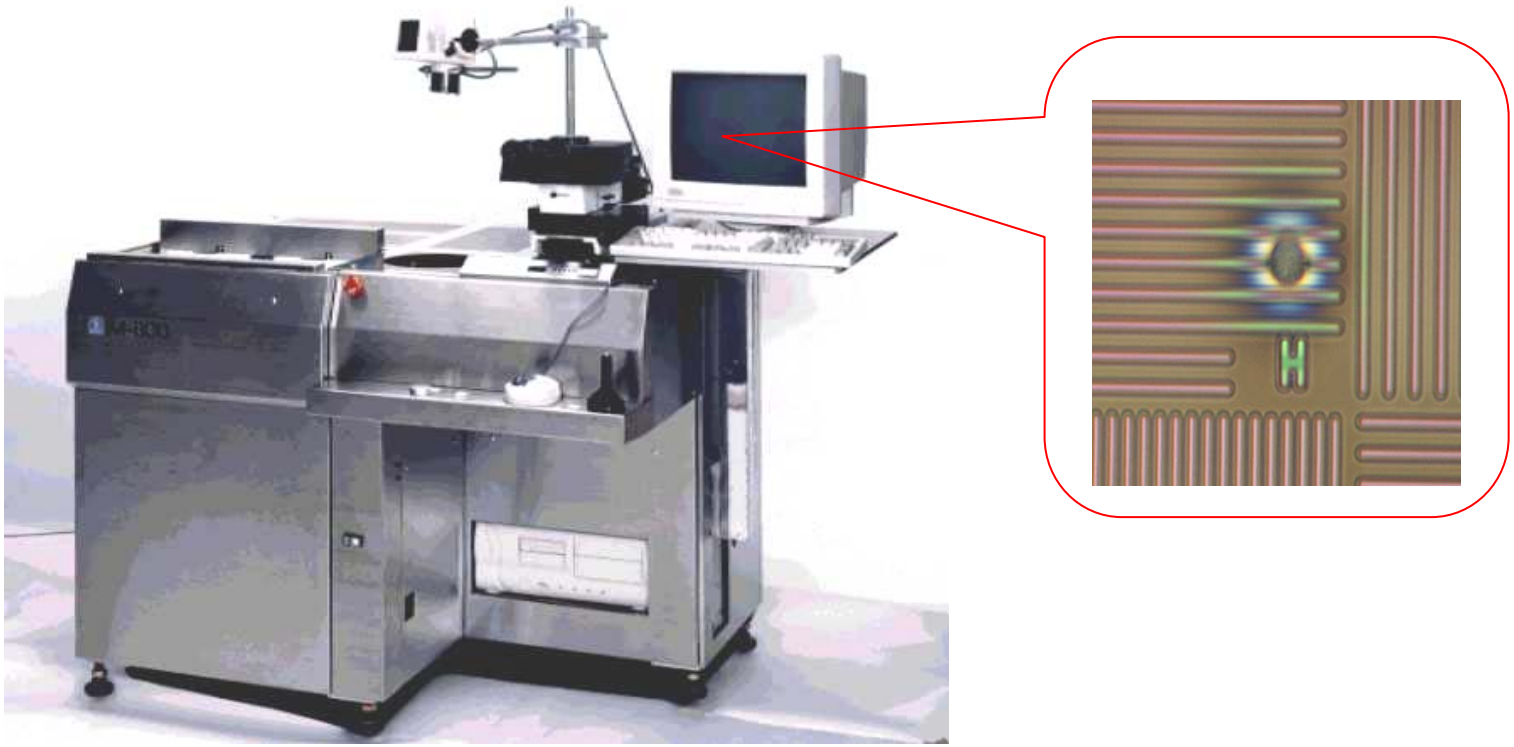
机台外观:



ADI INSPECTION 的作用

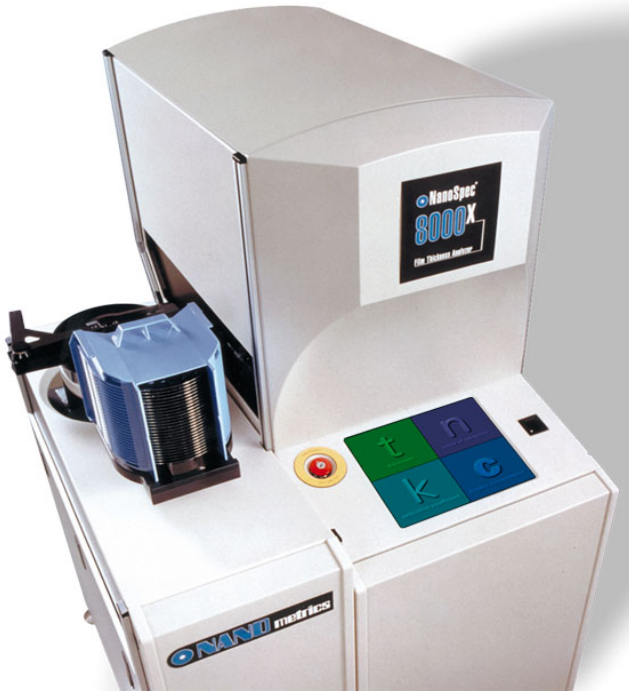
-----显影后, 检测晶圆上有没有瑕次.

机台外观:

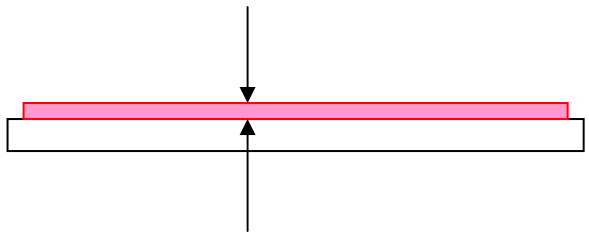


厚度测量仪的作用

-----用来测量光阻的厚度



光阻的厚度



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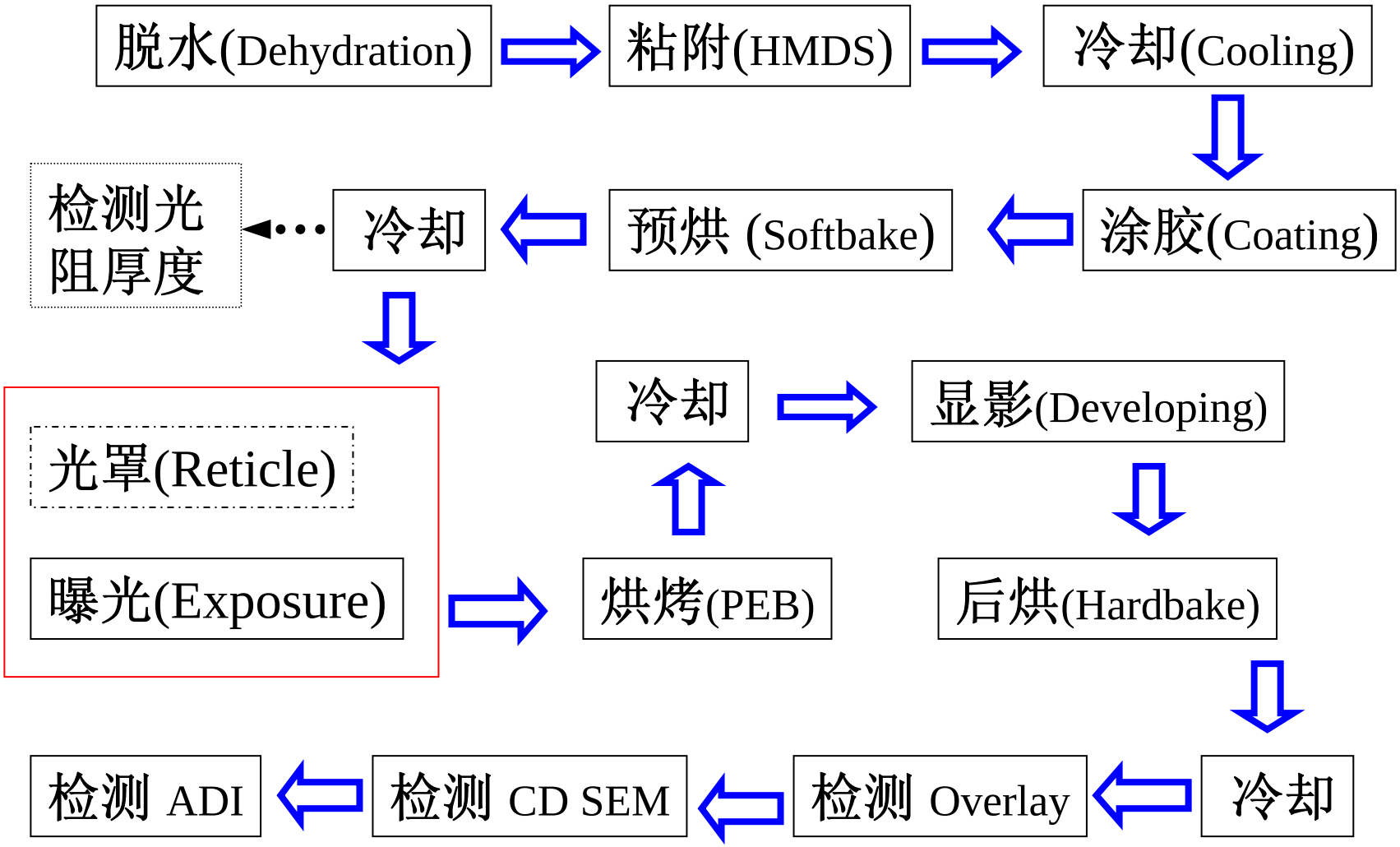
总结黄光制程



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1. 曝光机(Duv,I-line,g-line)

- ASML的Scanner:

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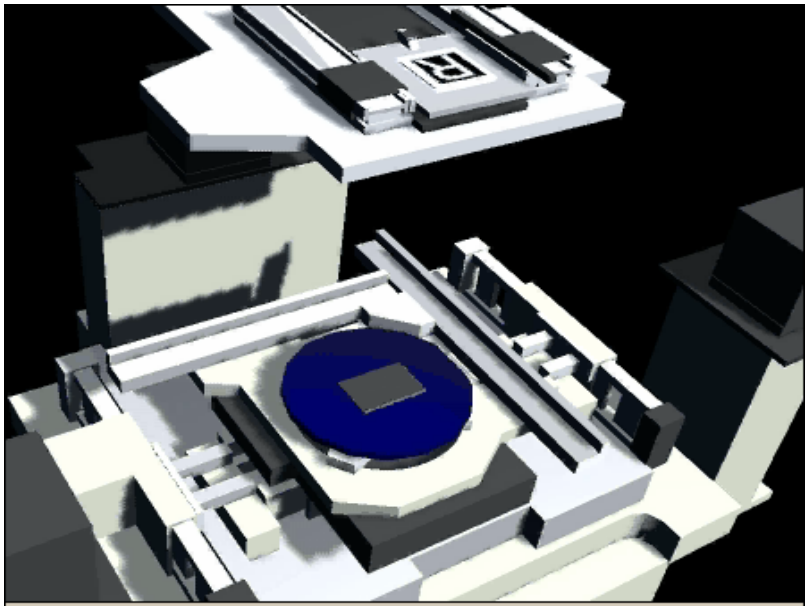
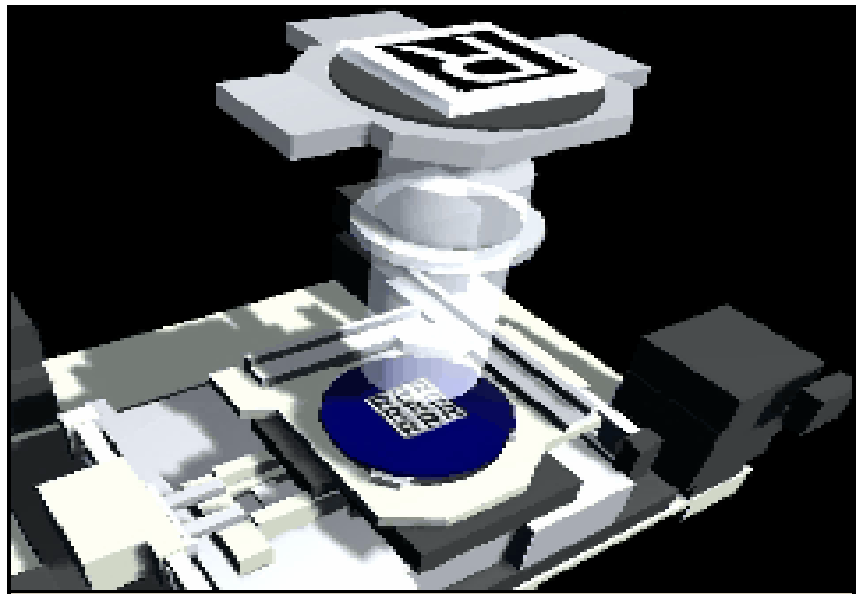
Scanner



扫描式曝光机

Stepper



步进式曝光机

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曝光机的种类**(Scanner ,Stepper)**

工作方式区分：

1 .步进式曝光机：**Stepper**

主要机台： **Cannon iZ01**

2 .扫描式曝光机：**Scanner**

主要机台： **Cannon ES3 ,ASML /400 ,/750, /850,/1100**

工作光源区分：

1 .I-Line 曝光机：**365nm (Hg-Arc)**

主要机台： **Cannon iZ01 ,ASML /400,**

2 . DUV 曝光机： **248nm ,193nm (Laser)**

主要机台： **Cannon ES3 ,ASML /750, /850,/1100**

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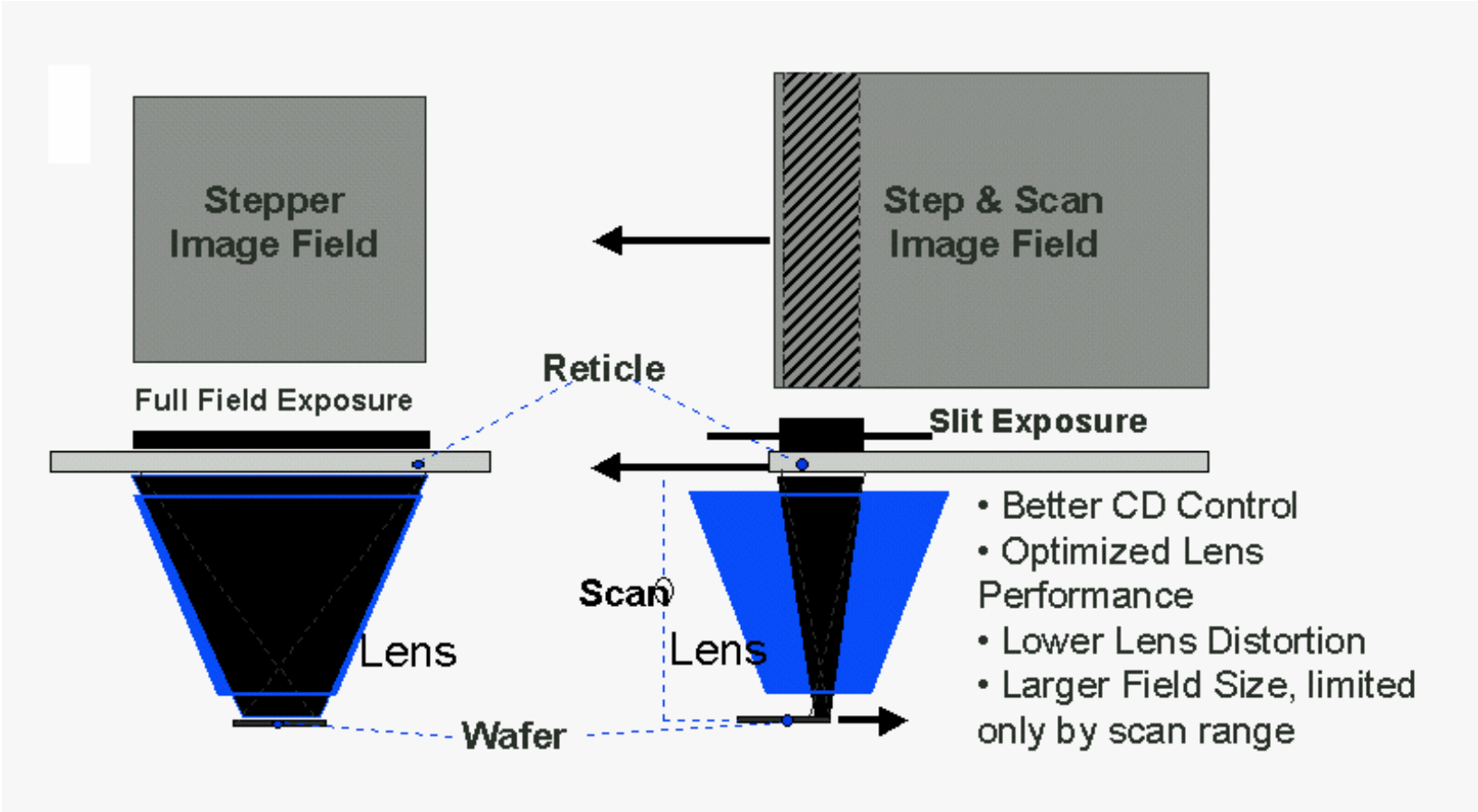
为什么要用Scanner



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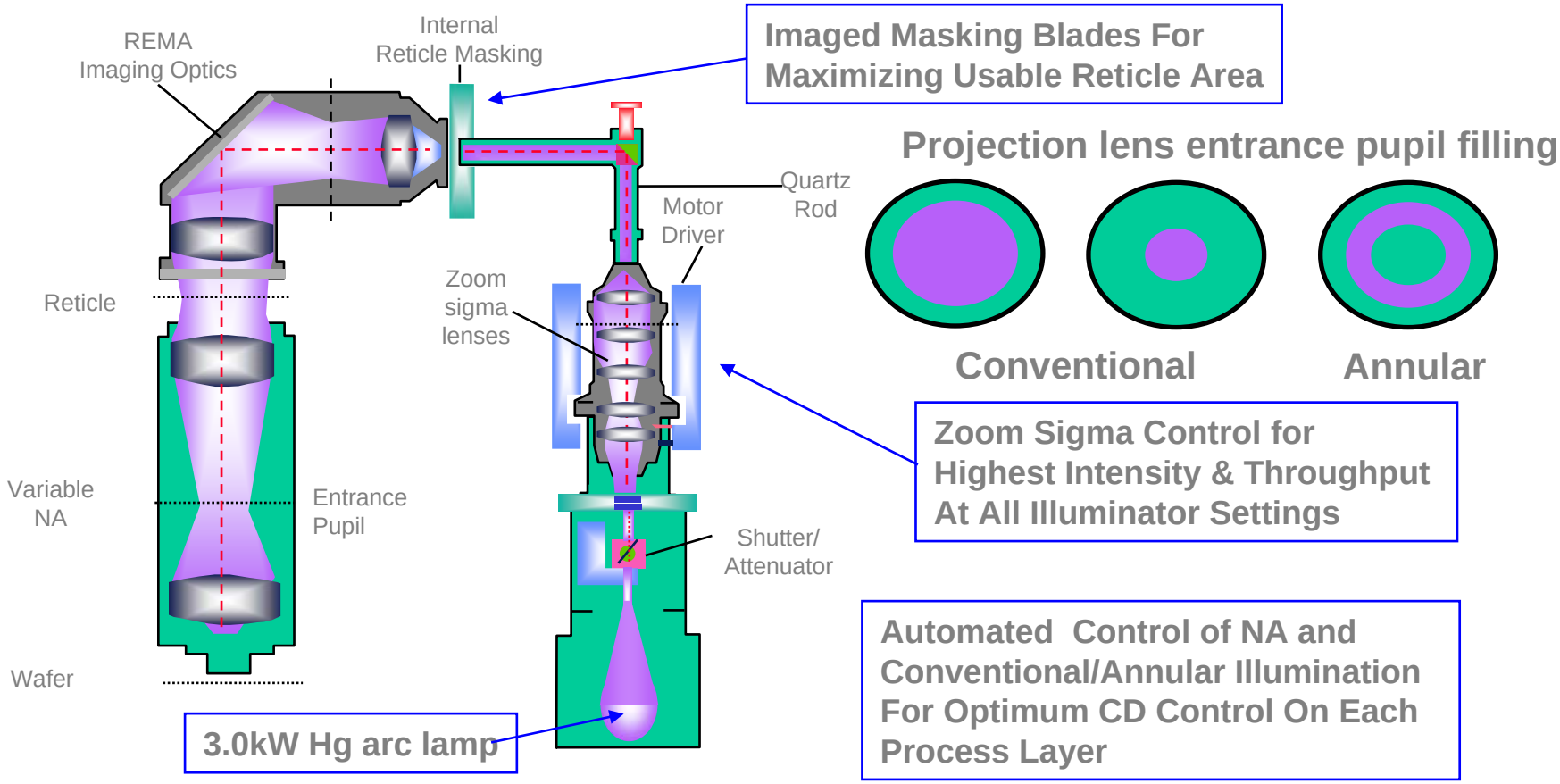
Scanner 工作原理图 1



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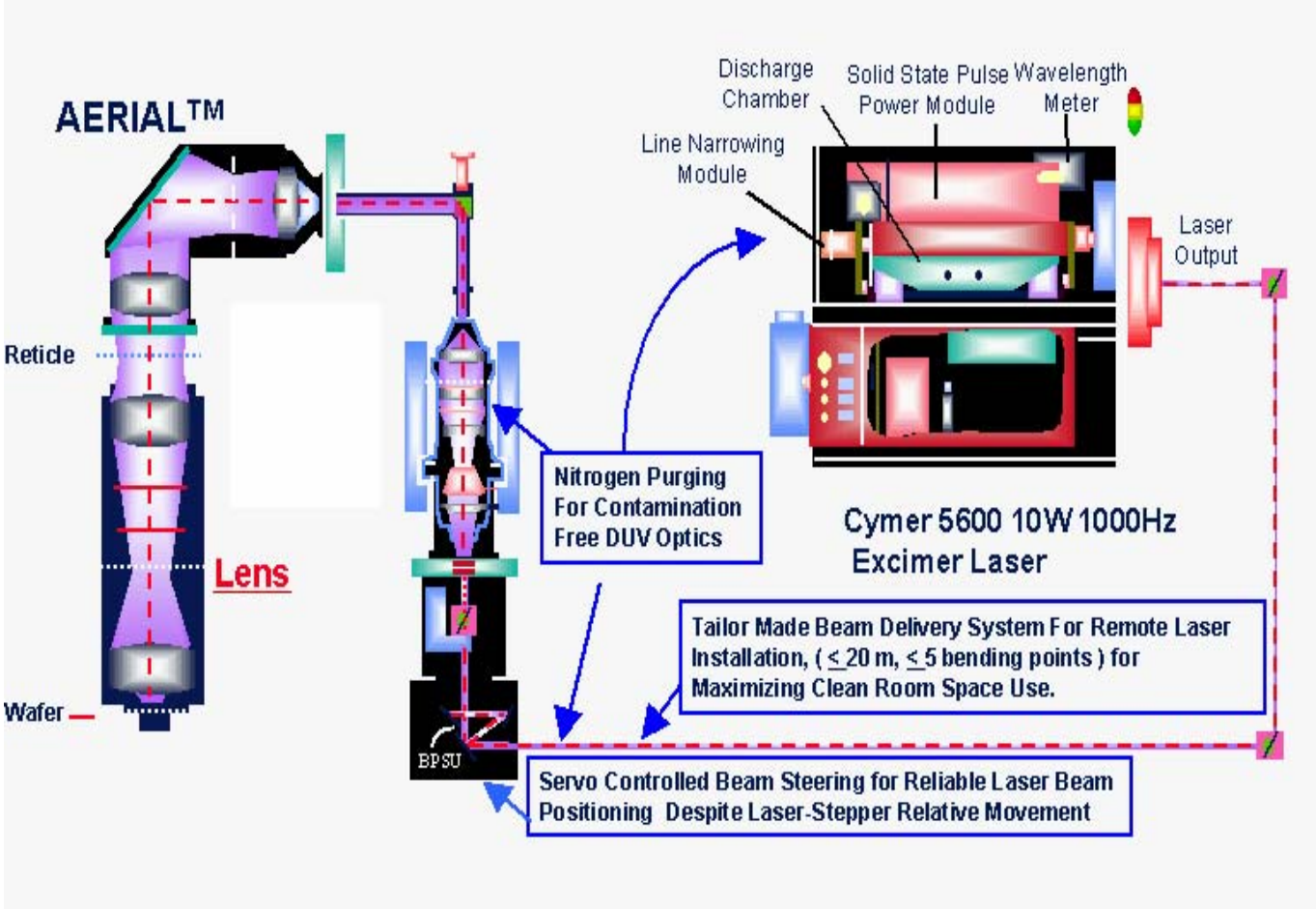
Scanner 工作原理图 **2**



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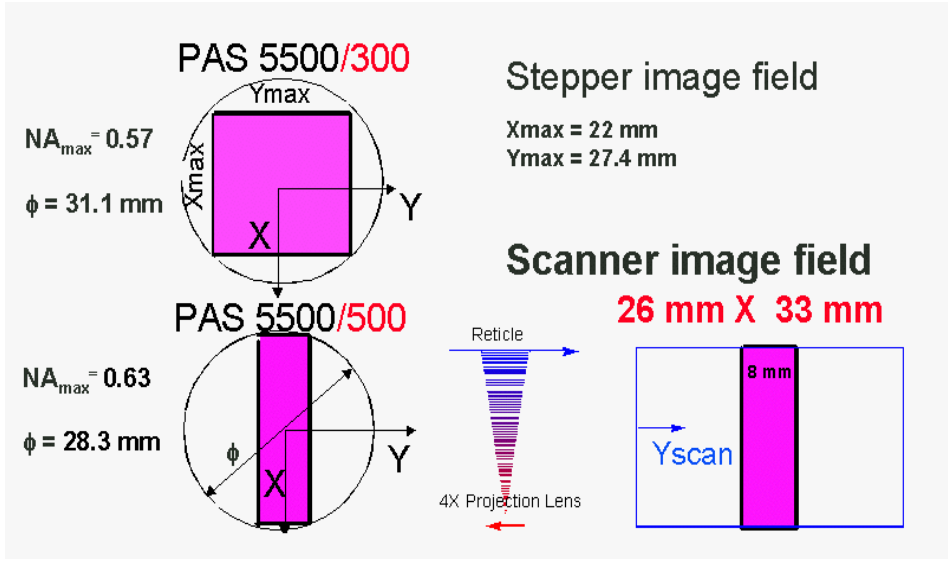
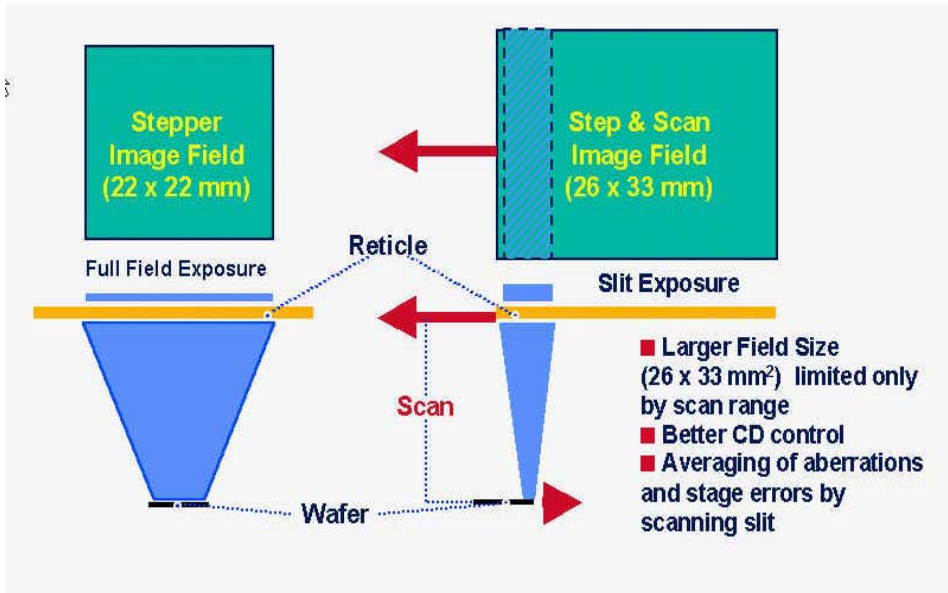
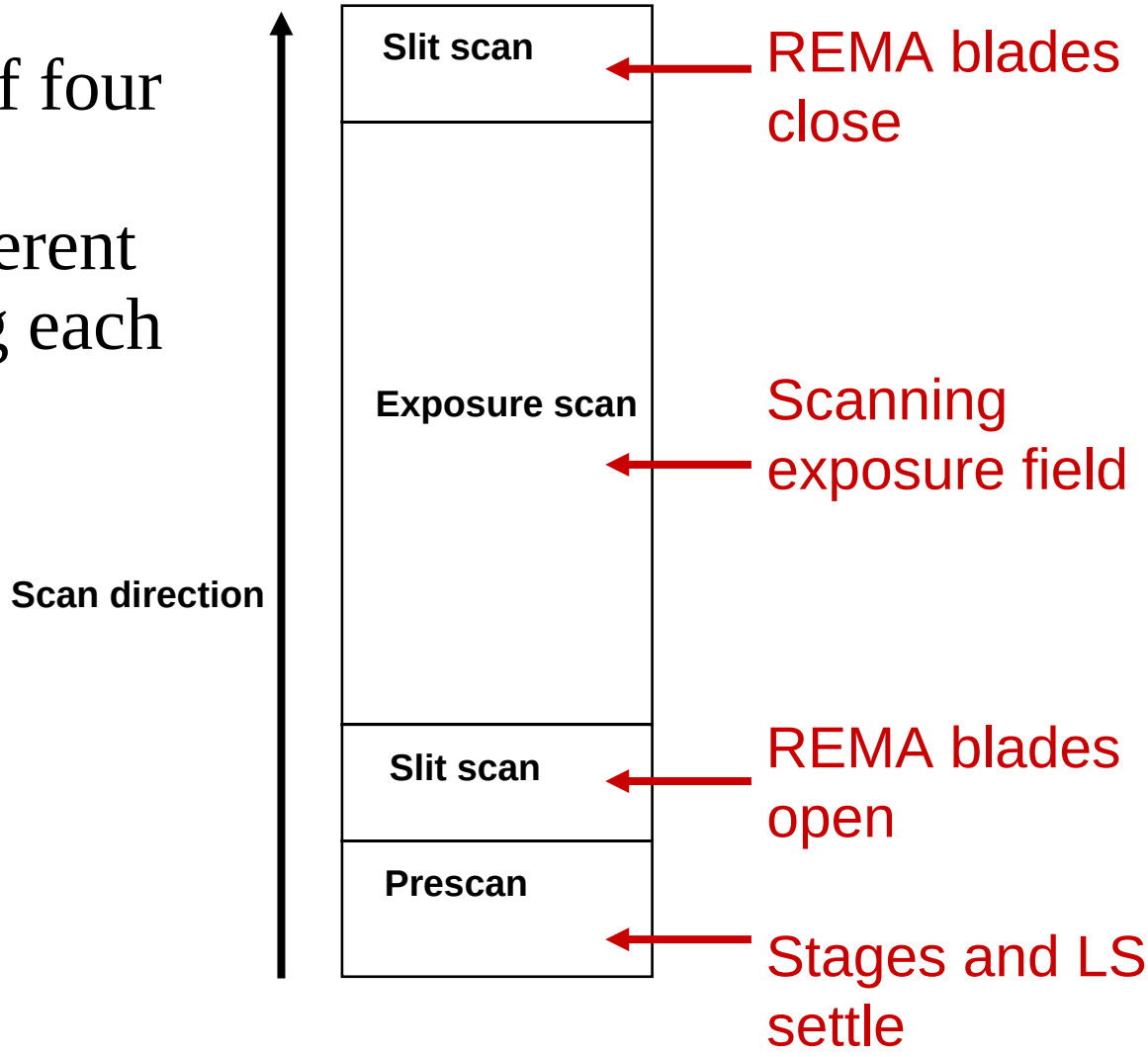
Scanner 和Stepper 的异同 1



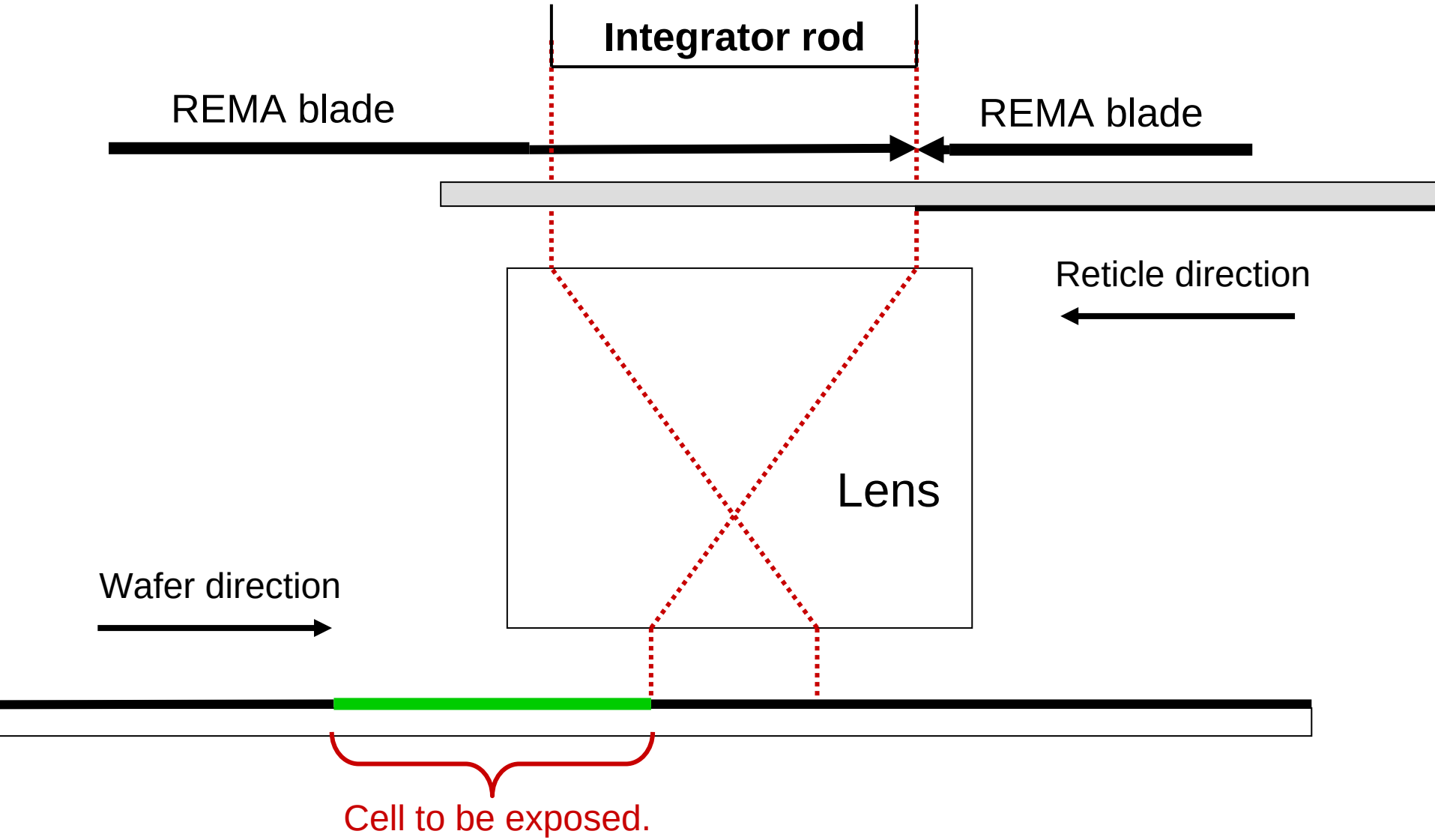


What is a Scan?

A scan consists of four sections and something different happens during each part.



Start of the Slit Scan



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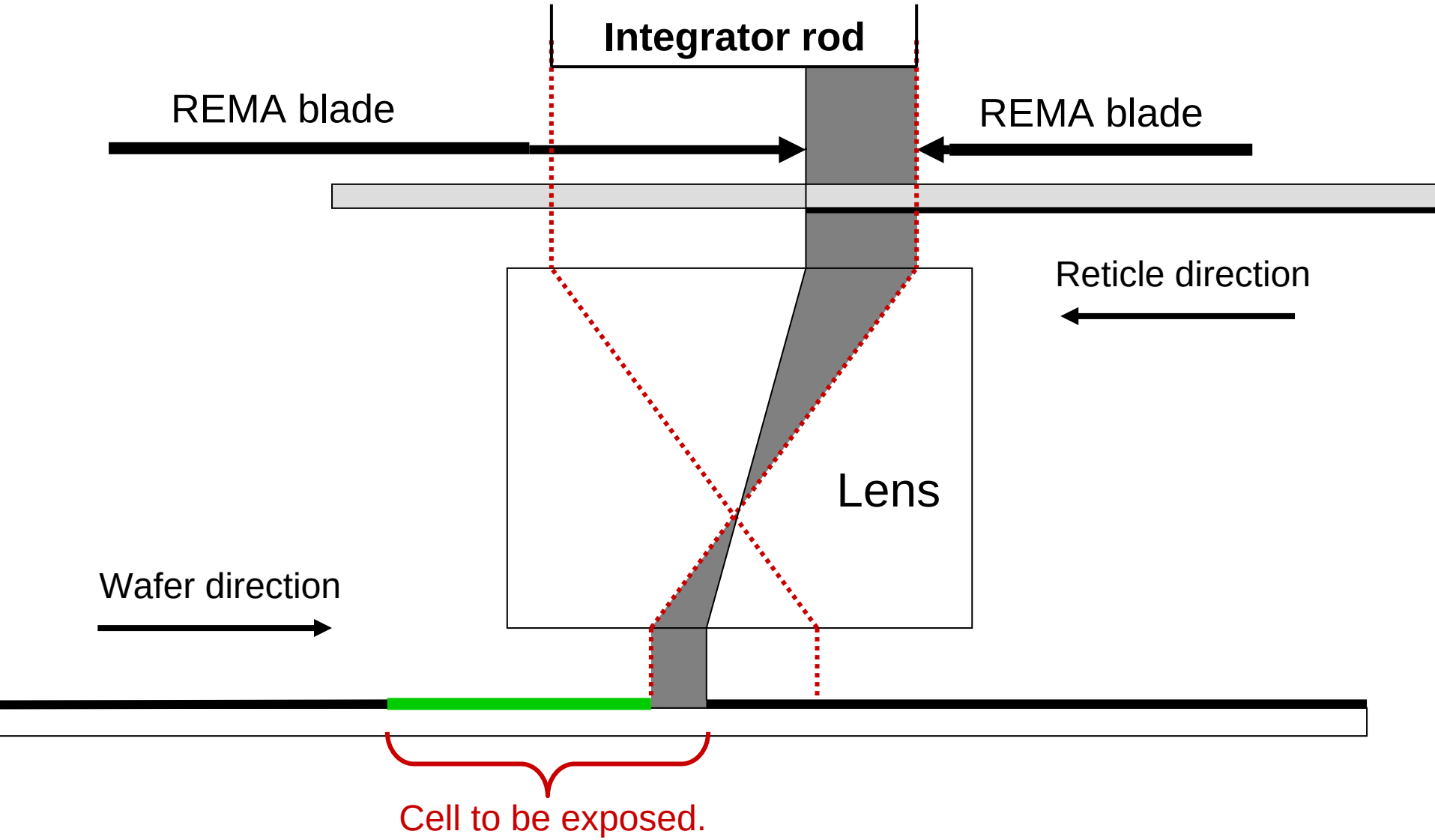
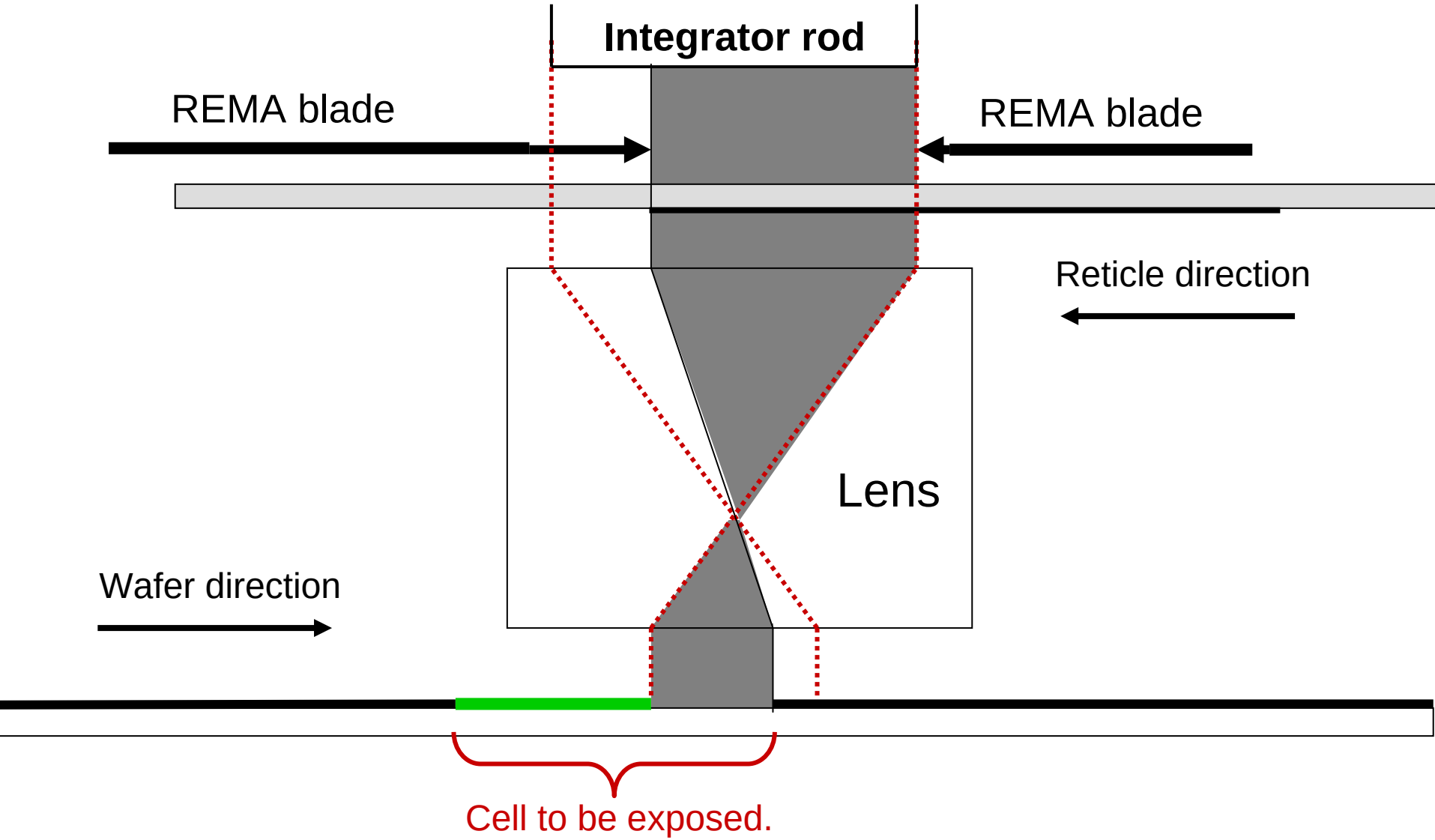
During the Slit Scan

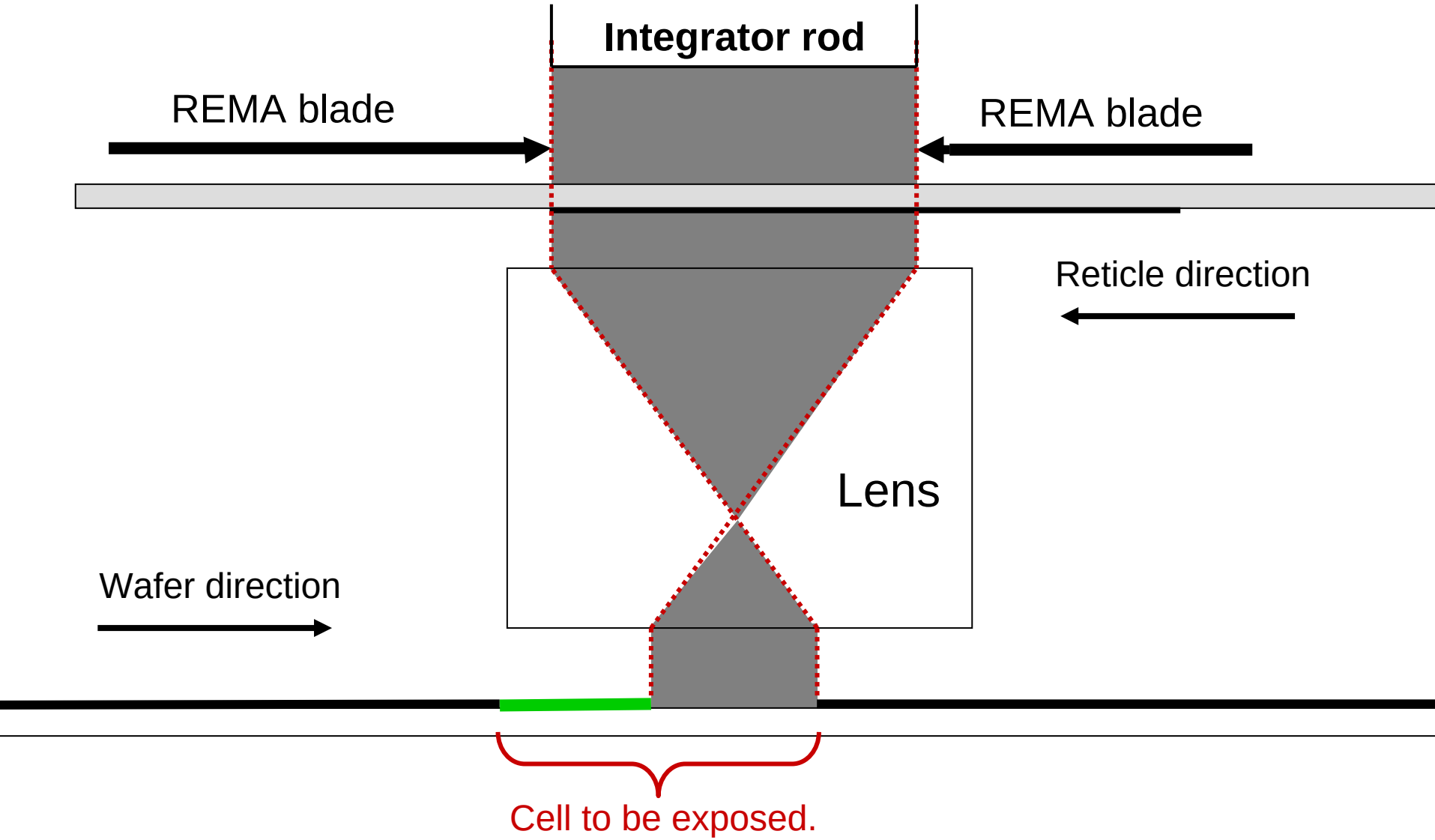


Litho

During the Slit Scan (2)

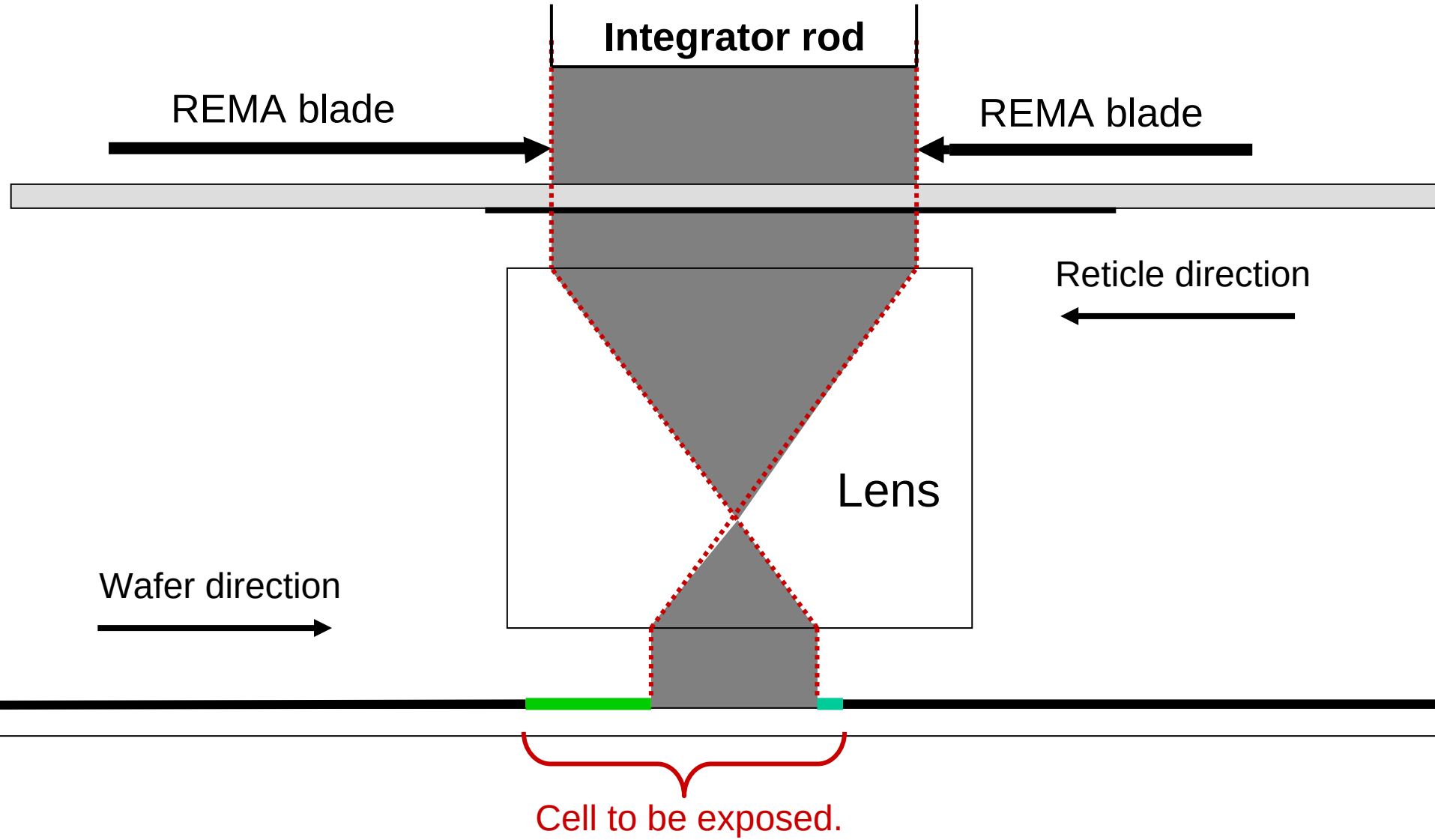


Litho End of the Slit Scan, Start of Exposure Scan

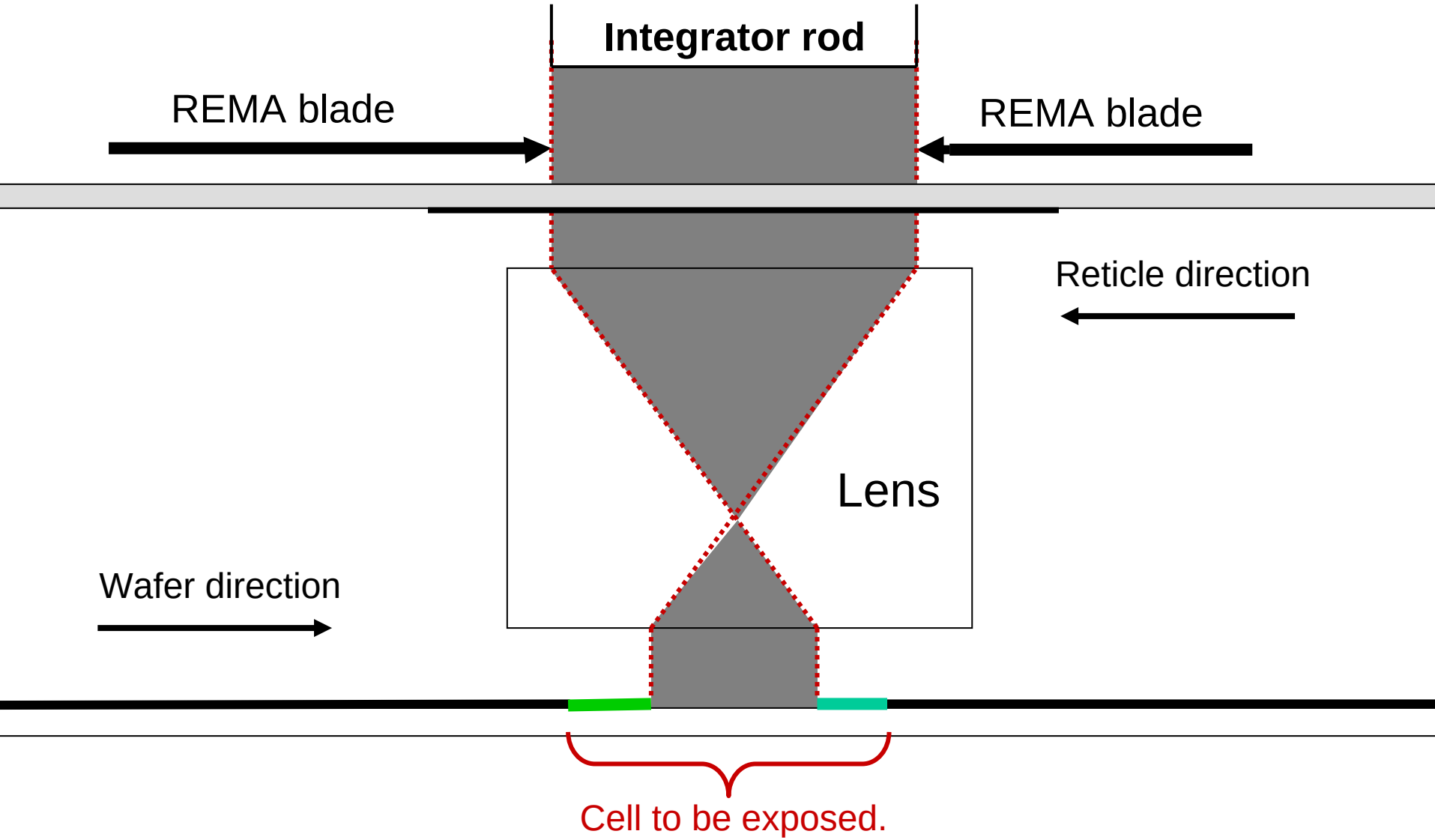


Litho

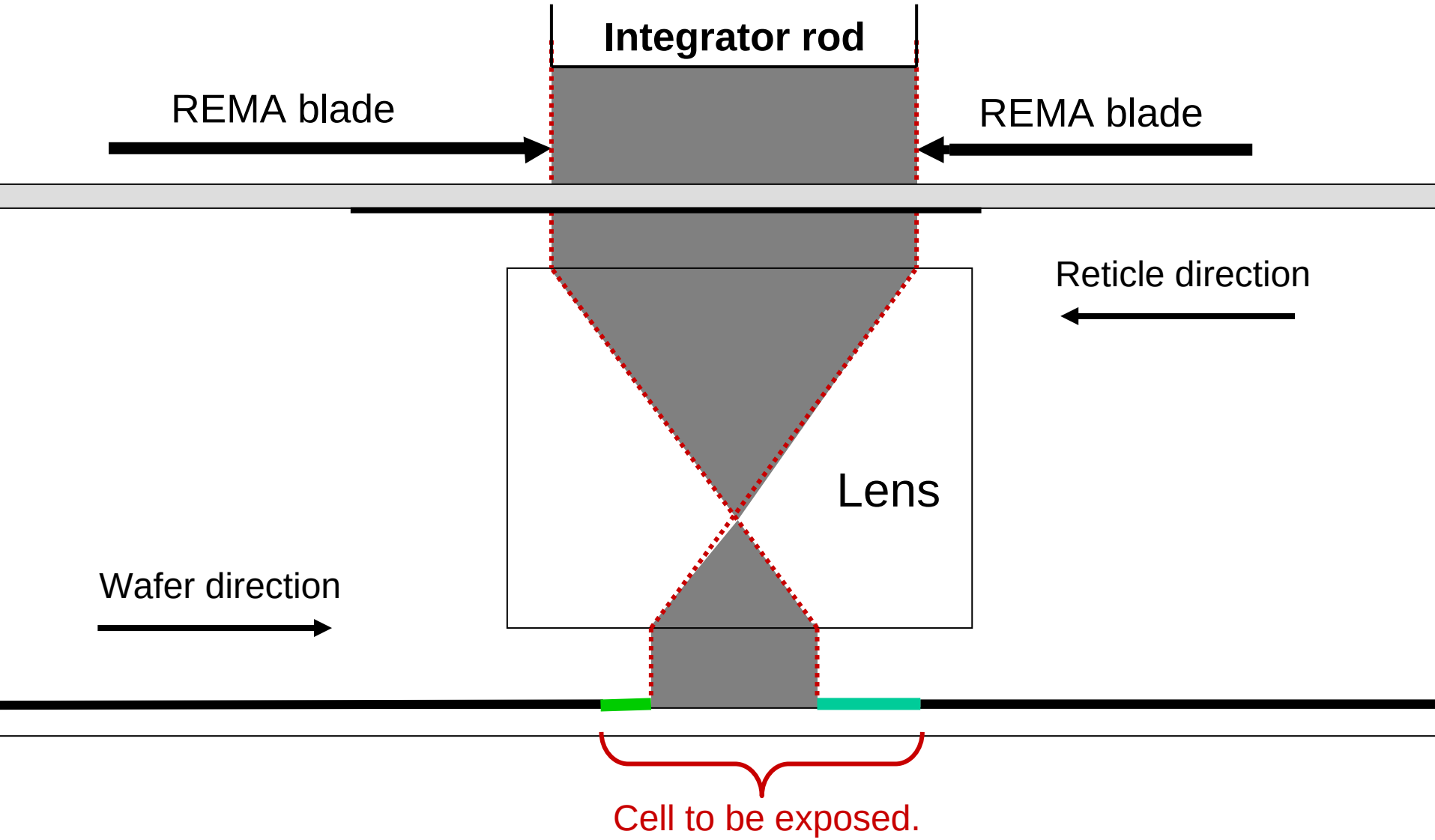
During Exposure Scan



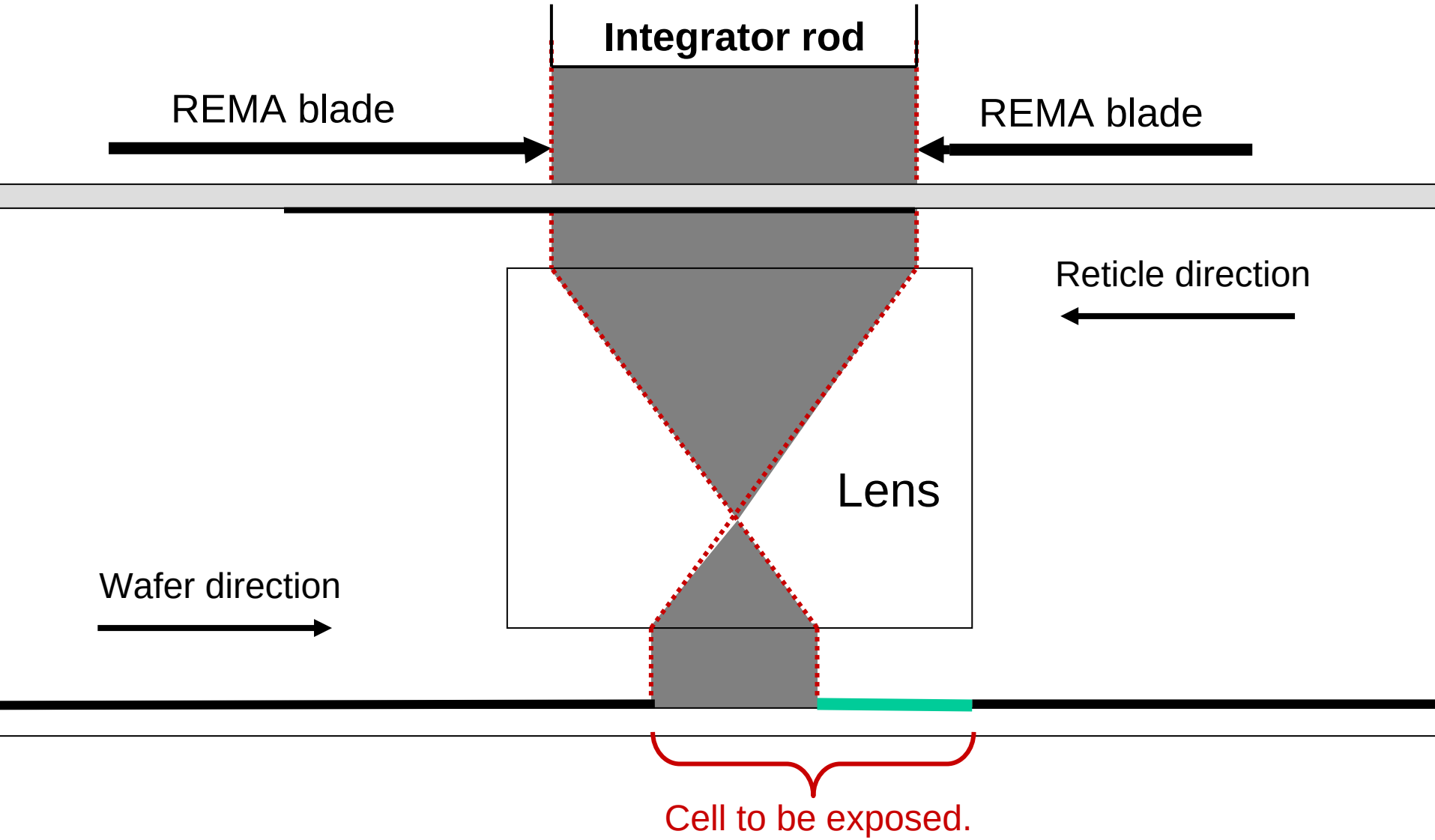
During Exposure Scan (2)



During Exposure Scan (3)

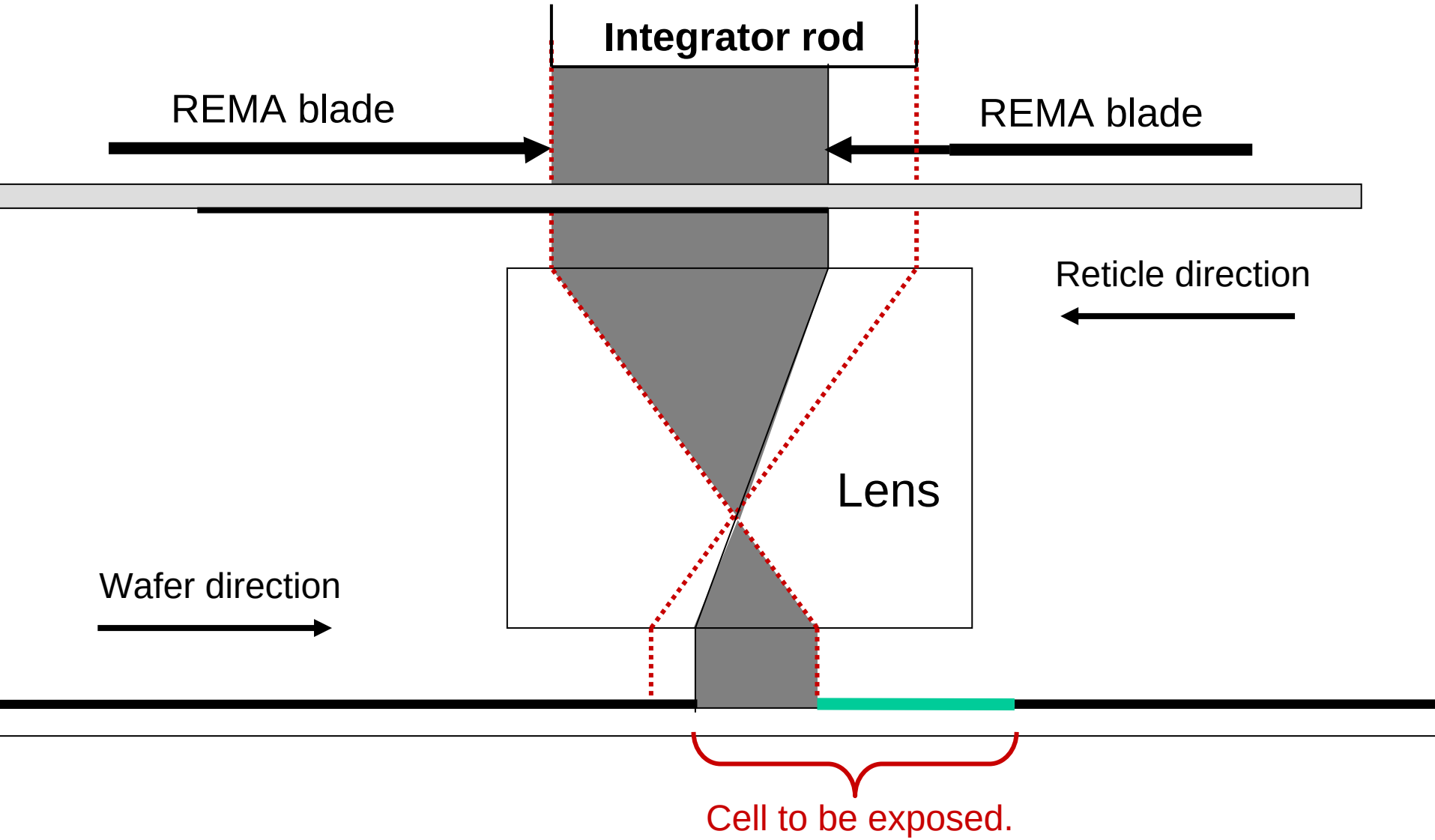


Litho End of Exposure Scan, Start of Final Slit Scan

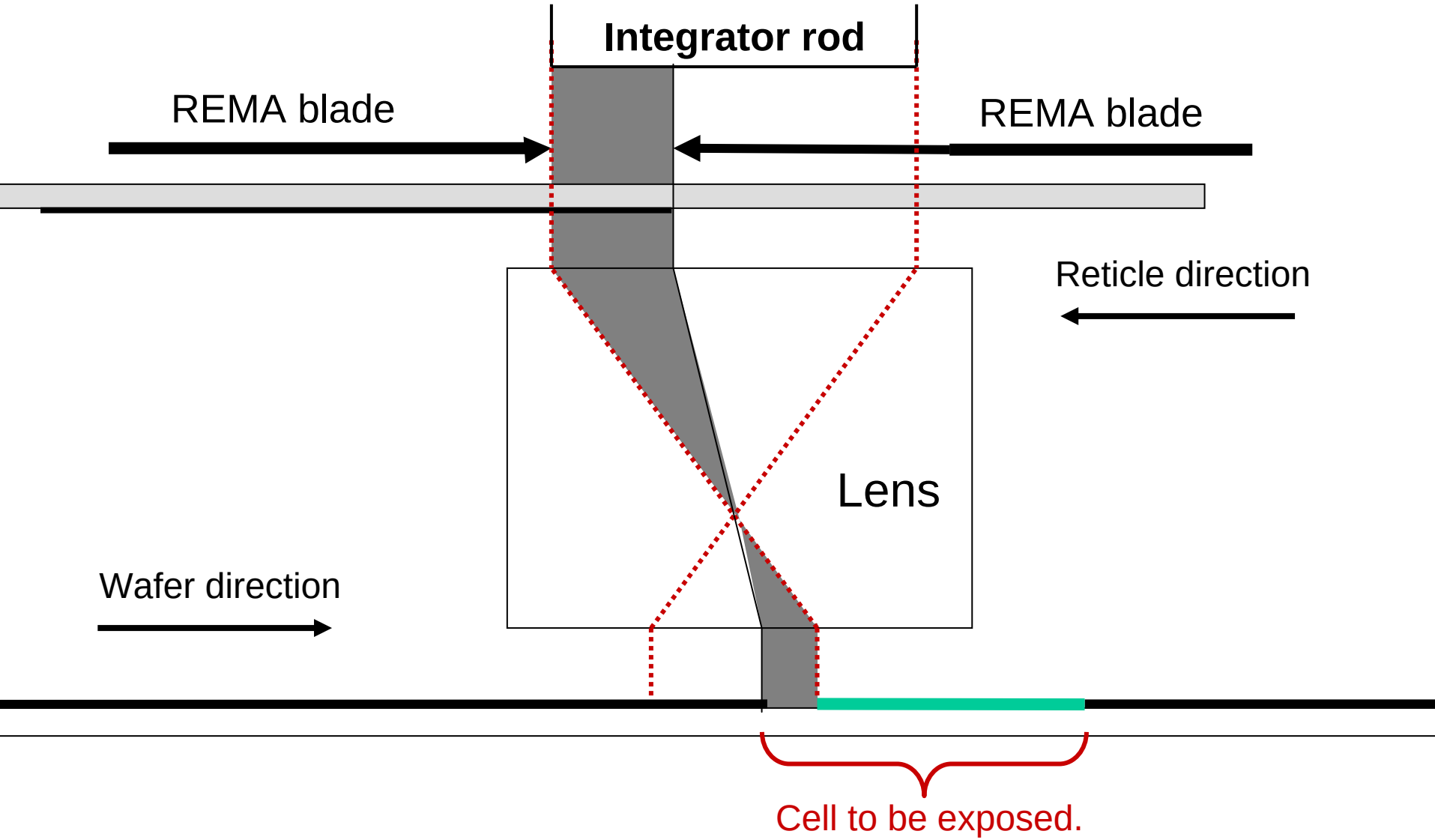


Litho

Final Slit Scan

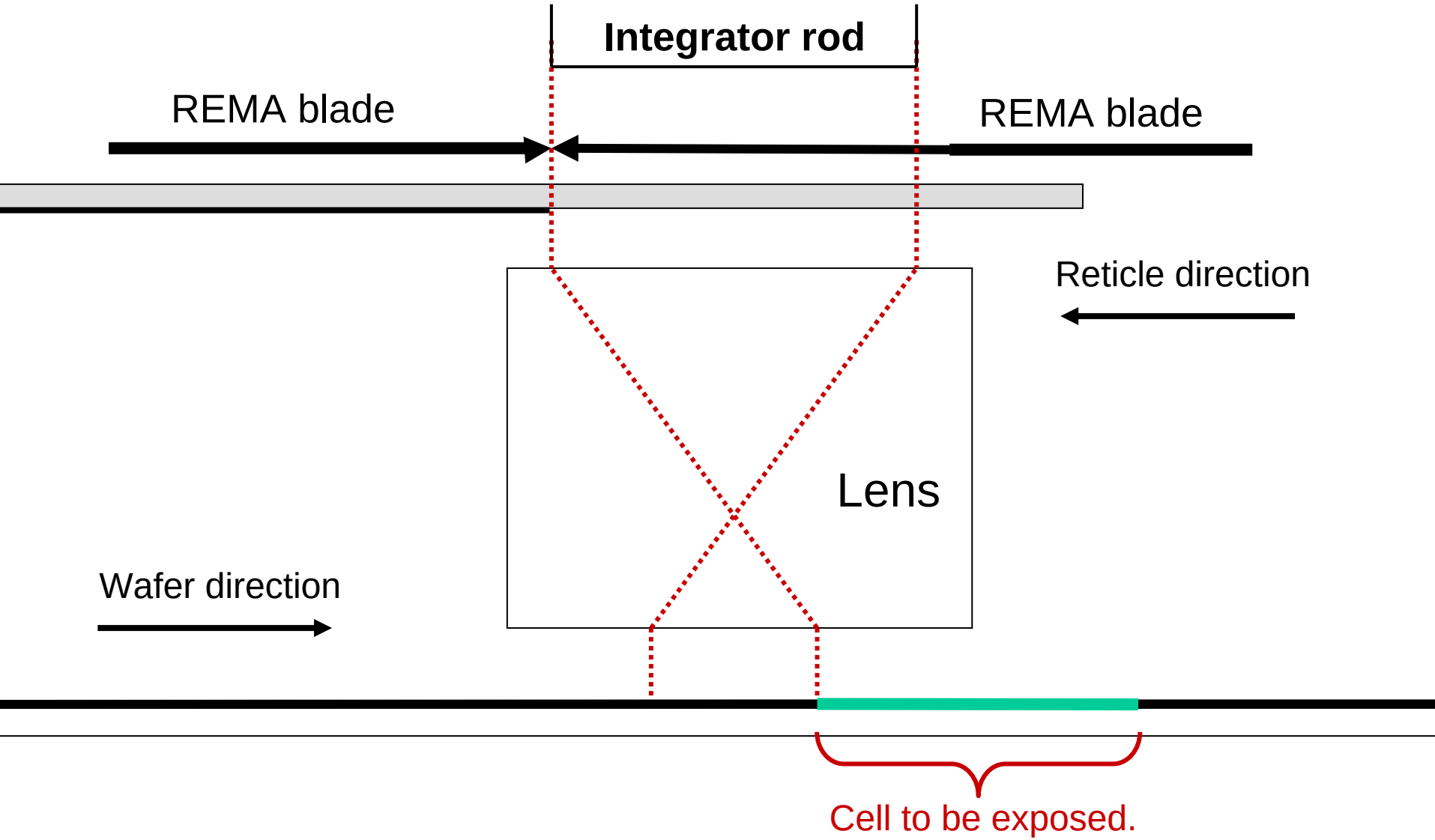


Final Slit Scan (2)



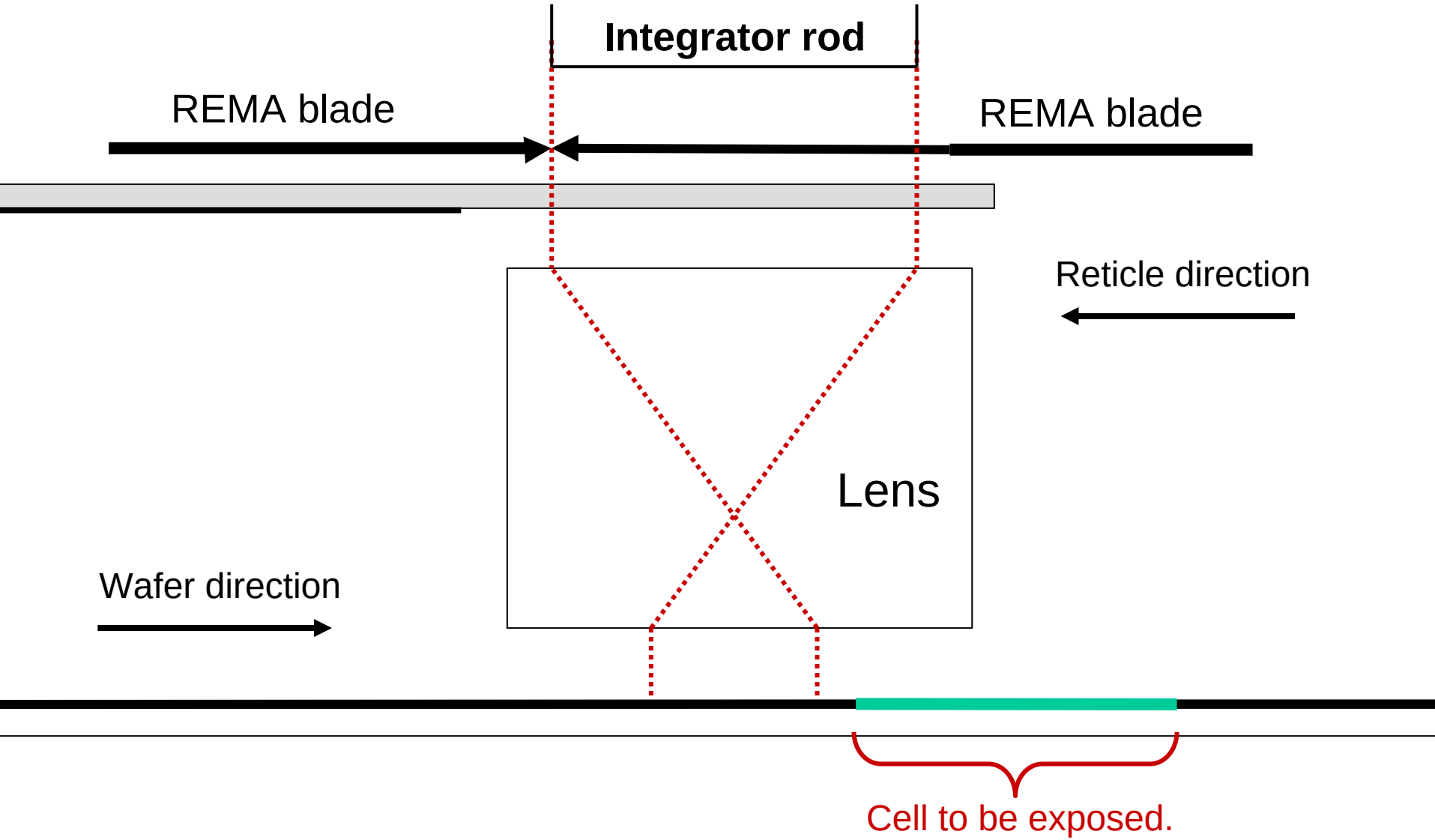
Litho

End of Slit Scan



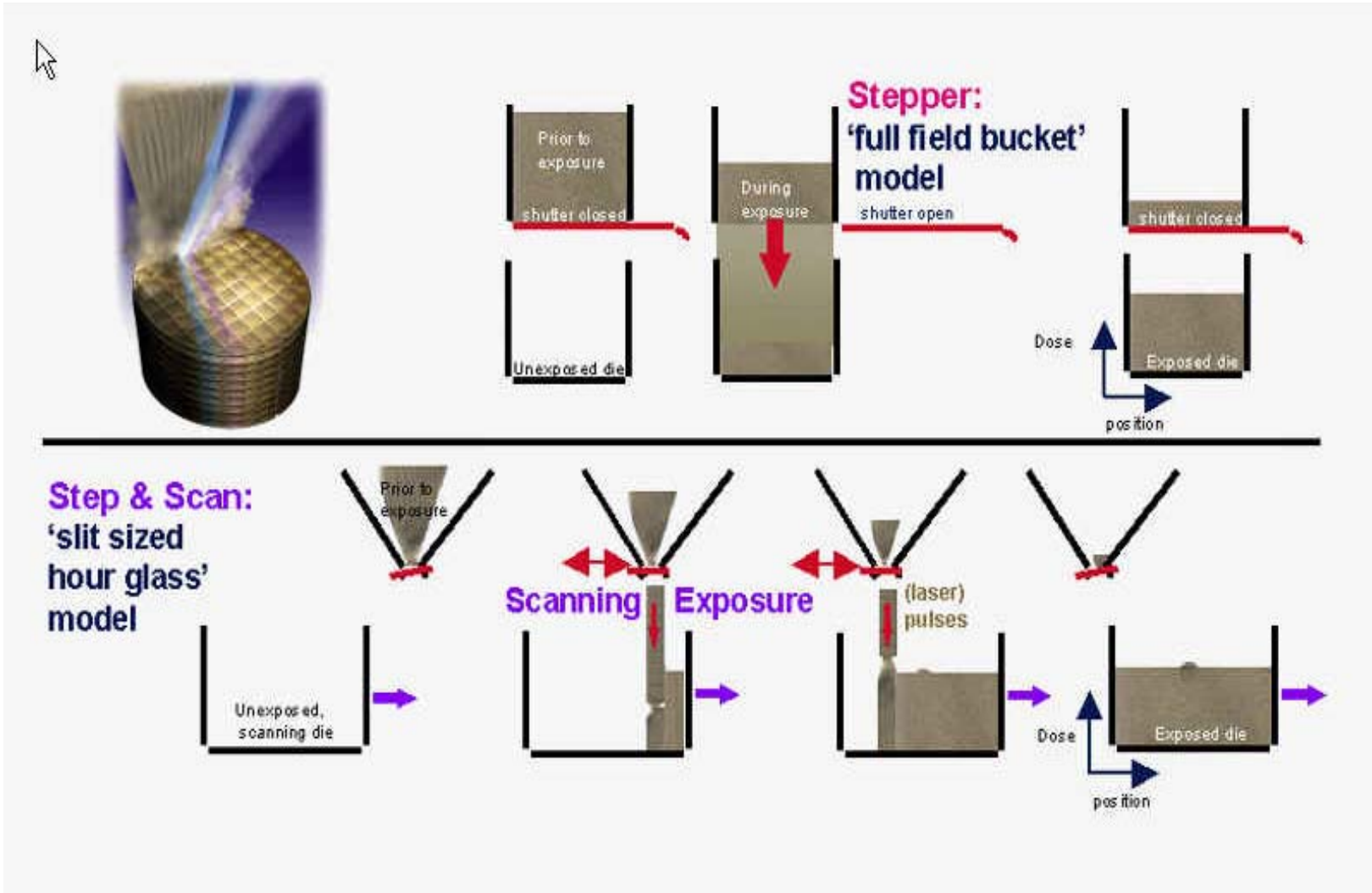
Litho

Scan Finished



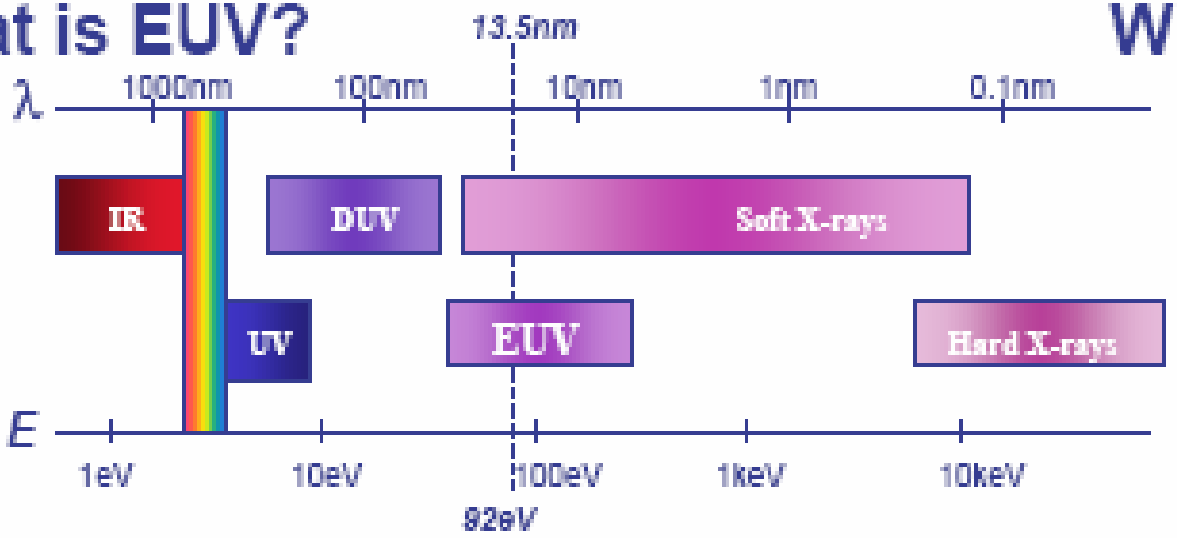
Litho

Scanner 和Stepper 的异同 2



What is EUV?

Why EUV ?



- Extreme UltraViolet (EUV) is Electro Magnetic radiation at ~13.5 nm, which falls into the X-ray band. EUV was the 'marketing name' to separate the program from hard X-ray lithography.
- EUV radiation is absorbed by almost all materials and gases, so all optics (incl. reticle) must be reflective and fully in vacuum.

$$\text{Res} = k_1 \frac{\lambda}{NA}$$

193 nm: 32 nm = 0.30 x 193 / 1.8 (NA must be 1.8)

13.5 nm: 32 nm = 0.60 x 13.5 / 0.25 (NA = 0.25)

- EUV is currently the only viable solution for 32 nm and below (but see next slide)