Scope and Limit of Lithography to the End of Moore’s Law

Burn J. Lin

tsmc, Inc.
What dictate the end of Moore’s Law

- Economy
- Device limits
- Lithography limits
Litho Requirement of Critical Layers

<table>
<thead>
<tr>
<th>Logic Node (nm)</th>
<th>32</th>
<th>22</th>
<th>16</th>
<th>11</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poly Half Pitch (nm)</td>
<td>45</td>
<td>32</td>
<td>22</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>CD Uniformity (nm)</td>
<td>3.2</td>
<td>2.2</td>
<td>1.6</td>
<td>1.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Overlay Accuracy (nm)</td>
<td>9.6</td>
<td>6.6</td>
<td>4.8</td>
<td>3.3</td>
<td>2.4</td>
</tr>
</tbody>
</table>

These are generic technology nodes that have no correlation to TSMC nodes
Pushing the Limits of Lithography

- Pitch splitting with ArF water immersion
- Further wavelength reduction to EUV
- Multiple E-Beam Maskless lithography
Resolution of Tools from ArF to MEB

\[ MFS = k_1 \frac{\lambda}{NA} \]

\[ DOF = k_3 \frac{n\lambda}{NHA^2} \]

- **ArF**: 193 nm
- **EUV**: 13.5 nm
- **MEB**: 5 or 50 keV

Resolution in Half Pitch (nm)
Multiple Patterning

- Double patterning $\Rightarrow L + E + L + E = 2L2E$
- Triple patterning $\Rightarrow 3L3E$

- Multiple patterning can be used for
  - Pitch splitting
  - Pattern trimming
  - Spacers
Split Pitch with Line-End Cutting

Mask A

Mask B

Mask C

Active

Cut
Contact Pitch Splitting

Watch out for G-rule violation

Mask 1  Mask 2
## Multiple Patterning in ArF Immersion

<table>
<thead>
<tr>
<th>Logic Node</th>
<th>32nm</th>
<th>22nm</th>
<th>16nm</th>
<th>11nm</th>
<th>8nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poly Half Pitch (nm)</td>
<td>45</td>
<td>32</td>
<td>22</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>Contact Half Pitch (nm)</td>
<td>50</td>
<td>35</td>
<td>25</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>Metal Half Pitch (nm)</td>
<td>45</td>
<td>32</td>
<td>22</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>Immersion $k_1$ for Poly</td>
<td>0.31</td>
<td>0.22</td>
<td>0.15</td>
<td>0.11</td>
<td>0.08</td>
</tr>
<tr>
<td>Immersion $k_1$ for Contact</td>
<td>0.35</td>
<td>0.24</td>
<td>0.17</td>
<td>0.12</td>
<td>0.08</td>
</tr>
<tr>
<td>Immersion $k_1$ for Metal</td>
<td>0.31</td>
<td>0.22</td>
<td>0.15</td>
<td>0.11</td>
<td>0.08</td>
</tr>
<tr>
<td>Multiple Patterning</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Immersion $k_1$ for Poly</td>
<td>0.31</td>
<td>0.45</td>
<td>0.31</td>
<td>0.34</td>
<td>0.31</td>
</tr>
<tr>
<td>Immersion $k_1$ for Contact</td>
<td>0.35</td>
<td>0.49</td>
<td>0.35</td>
<td>0.36</td>
<td>0.34</td>
</tr>
<tr>
<td>Immersion $k_1$ for Metal</td>
<td>0.31</td>
<td>0.45</td>
<td>0.31</td>
<td>0.34</td>
<td>0.31</td>
</tr>
</tbody>
</table>
Pushing the Limits of Lithography

- Pitch splitting
  - Cost
  - Design rule restriction
  - Processing complexity
  - Requirement of overlay accuracy
- Further wavelength reduction – EUV
- Multiple E-Beam Maskless lithography
EUV Lithography
### $k_1$ of EUVL

<table>
<thead>
<tr>
<th>Node</th>
<th>22nm</th>
<th>16nm</th>
<th>11nm</th>
<th>8nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>0.25</td>
<td>0.32</td>
<td>0.32</td>
<td>0.45</td>
</tr>
<tr>
<td>EUV $k_1$ for Poly</td>
<td>0.59</td>
<td>0.52</td>
<td>0.38</td>
<td>0.37</td>
</tr>
<tr>
<td>EUV $k_1$ for Contact</td>
<td>0.65</td>
<td>0.59</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>EUV $k_1$ for Metal</td>
<td>0.59</td>
<td>0.52</td>
<td>0.38</td>
<td>0.37</td>
</tr>
</tbody>
</table>
EUV Lithography

APPEALS

- Wavelength=13.5 nm
  7% of 193 nm
  10% of 134 nm
- For 22-nm half pitch at 1.35NA and 193-nm wavelength, $k_1=0.15$.
- Same half pitch at 0.25NA and 13.5-nm wavelength, $k_1=0.52$.
- Ample DOF
- Simpler OPC intuitively
- Evolutional mask writing

CHALLENGES

- Laser power/resist sensitivity/LWR impasse
- Stringent mask spec.
- Absence of pellicle
- Mask inspection and repair
- Atomic-precision optics
- Stray light(Lens flare)
- Contamination and life time of optical elements
- Cost
Comparison of LPP and DPP Sources

Need >400W for HVM

LPP
- No hardware close to plasma
- No moving part in vacuum
- Good point source
- Two-stage energy conversion (low efficiency)
- Need IR filter
- Large footprint in subfab
- Difficult debris mitigation
- Difficult to achieve 100% duty cycle
- High $H_2$ consumption

DPP
- One-stage energy conversion
- Smaller footprint in subfab
- Easy 100% duty cycle
- Does not need IR filter
- Needs little $H_2$ for debris mitigation
- Difficult thermal management at hardware close to plasma
- Source shape not as good
Positioning Errors due to Mask Rotation and Translation

From M1 to M6:

- Off-center tilt
- Mask surface misposition

\[ \delta Z_{\text{tran}} = 2 \delta Z_{\text{tran}} \tan \theta \]

\[ \delta x' = 2 m \alpha \]

\[ \delta z' = \tan \theta \]

[Diagram showing mask rotation and translation errors]
# EUV Mask Flatness Requirement

<table>
<thead>
<tr>
<th>Node</th>
<th>22nm</th>
<th>16nm</th>
<th>11nm</th>
<th>8nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>θ (deg)</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>8.0</td>
</tr>
<tr>
<td>tan(θ)</td>
<td>0.105</td>
<td>0.105</td>
<td>0.105</td>
<td>0.141</td>
</tr>
<tr>
<td>Mask flatness required (nm)</td>
<td>46.5</td>
<td>33.8</td>
<td>23.3</td>
<td>12.6</td>
</tr>
</tbody>
</table>
**OPC Considerations**

- Uneven flare and shadowing effect require field-dependent OPC.

- Inter-field flare necessitates dummy exposures at wafer edge.

- Flare signature if inconsistent between scanners, requires dedicated mask.

- Flare stability still unknown.
On Lack of Pellicle

- Developed reticle box for freedom from contamination during storage, transportation, loading/unloading.

- Attraction of particulates by the electrostatic mask chucking has to be minimized.

- Need to block line-of-sight exposure to Sn debris source.

- Maintain high vacuum. Minimize presence of trace Carbon-containing vapor and H₂O vapor.
EUV Extendibility
High-NA EUV Design Solutions

NA | 0.25 | 0.32 | 0.4x | 0.7
---|------|------|------|------
6 mirrors | | | | 
8 mirrors | | | | 

27 nm NXE:3100
16 nm NXE:3300
11 nm
8 nm

schematic designs – for illustration only.

W. Kaiser et al., SPIE 2008
# NA and $k_1$ of Photon Tools

<table>
<thead>
<tr>
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<th>22nm</th>
<th>16nm</th>
<th>11nm</th>
<th>8nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half pitch (nm)</td>
<td>32</td>
<td>22</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>ArF water immersion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$ (nm)</td>
<td>193</td>
<td>193</td>
<td>193</td>
<td>193</td>
</tr>
<tr>
<td>NA</td>
<td>1.35</td>
<td>1.35</td>
<td>1.35</td>
<td>1.35</td>
</tr>
<tr>
<td>$k_1$</td>
<td>0.22</td>
<td>0.15</td>
<td>0.11</td>
<td>0.08</td>
</tr>
<tr>
<td>EUV at constant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$ (nm)</td>
<td>13.5</td>
<td>13.5</td>
<td>13.5</td>
<td>13.5</td>
</tr>
<tr>
<td>NA</td>
<td>0.25</td>
<td>0.36</td>
<td>0.50</td>
<td>0.73</td>
</tr>
<tr>
<td>$k_1$</td>
<td>0.59</td>
<td>0.59</td>
<td>0.59</td>
<td>0.59</td>
</tr>
<tr>
<td>EUV at diminishing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$ (nm)</td>
<td>13.5</td>
<td>13.5</td>
<td>13.5</td>
<td>13.5</td>
</tr>
<tr>
<td>NA</td>
<td>0.25</td>
<td>0.32</td>
<td>0.32</td>
<td>0.45</td>
</tr>
<tr>
<td>$k_1$</td>
<td>0.59</td>
<td>0.52</td>
<td>0.38</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Cannot maintain constant $k_1$ because of

- Diminishing DOF
- Expensive NA
### DOF of EUV

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<thead>
<tr>
<th>Node</th>
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<th>16nm</th>
<th>11nm</th>
<th>8nm</th>
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</thead>
<tbody>
<tr>
<td>EUV at diminishing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>λ (nm)</td>
<td>13.5</td>
<td>13.5</td>
<td>13.5</td>
<td>13.5</td>
</tr>
<tr>
<td>NA</td>
<td>0.25</td>
<td>0.32</td>
<td>0.32</td>
<td>0.45</td>
</tr>
<tr>
<td>k₁</td>
<td>0.593</td>
<td>0.521</td>
<td>0.379</td>
<td>0.367</td>
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<tr>
<td>DOF (k₃)</td>
<td>0.612</td>
<td>0.557</td>
<td>0.242</td>
<td>0.235</td>
</tr>
<tr>
<td>Theoretical (nm)</td>
<td>520</td>
<td>286</td>
<td>124</td>
<td>59</td>
</tr>
<tr>
<td>Experimental (nm)</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DOF determined with common E-D window
- 0.4:0.6 Resist line : space
- Allowance for mixed pitches
13.5nm light may be reaching physical resolution & DOF limits at 11nm Half Pitch or earlier.
It may reach the economic limit much earlier.
Multiple E-Beam

Maskless Lithography
Reflective E-Beam Lithography (REBL)

Key Features

DPG: Dynamic e-beam reflective mask

Rotary wafer stage:
* Eliminates acceleration/deceleration
* Allows multiple columns per stage

Conventional 50keV e-beam reduction optics

Figure provided by KLA-Tencor
REBL Source Current Utilization

- **DPG efficiency >50%**
- **Aperture 2 : > 90%**
- **Aperture 1 : 10%**
- **Aperture 3 : 95%**

**REBL**  ~ 4.4% source current utilization

**EUV**  ~ 0.1% from IF to wafer
Components of DPG Image Placement System

- **Maglev Stage**: Various Sensors And Actuators
- **Differential IFM**: "Master Coordinate System"
- **E beam Position Detection System**
- **E beam Deflectors and Focus**
- **WMS system**
- **GA C**
- **Wafer with Patterns**

**Electronics and Algorithms**:  
- Several complex subsystems with very tight synchronization  
- Sophisticated Controls and Signal Processing  
- High speed Signal Processing (~200MHz)  
- Sensor fusion algorithms to drive beam deflection
Simulation of REBL Imaging

**Graphs and Data**

- **Defocus (um)** range from -2.29 to 2.94
- **Linear Exposure (um)**
- **DOF (um)** range from 0 to 42.3
- **Elliptical Window**

**Table**

<table>
<thead>
<tr>
<th></th>
<th>P15000-20</th>
<th>P60-20</th>
<th>Common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eop</td>
<td>10.14</td>
<td>6.97</td>
<td>1</td>
</tr>
<tr>
<td>EL</td>
<td>39.8</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Fop</td>
<td>-0.094</td>
<td>-0.099</td>
<td>-0.055</td>
</tr>
<tr>
<td>DOF</td>
<td>2.74</td>
<td>2.86</td>
<td>2.68</td>
</tr>
<tr>
<td>E-D Area</td>
<td>1955</td>
<td>1374</td>
<td>1297</td>
</tr>
</tbody>
</table>
MAPPER Technology

- Single electron source split in 13,000 Gaussian beams
- $V_{\text{acc}} = 5$ keV
- Apertures are imaged on substrate through 13,000 micro lenses
- MEMS-stacked static electric lenses.
- Optical-switch, CMOS-MEMS blanker array
- Simple B&W bitmap data through light signal

* Information from MAPPER Lithography.
Direct Write Scheme

300 mm wafer

EO slit
13,000 beams

EO slit
Field

1 field ~
26x33mm²

26 mm

Each beam writes 2 µm stripe

Electron beam

Beam OFF
Beam ON

2.25 nm

150 µm

50 µm

Waffer movement

2 µm

<~ 33 mm (match to scanner field size), then repeat

Each beam writes 2µm width by up to 33mm long stripe.
Multiple E-Beam Maskless Lithography for High Volume Manufacturing

HVM clustered production tool:
- >13,000 beams per chamber (10 WPH)
- 10 WPH x 5 x 2 = 100 WPH
- Footprint ~ArF scanner
PEC Verification Against Immersion Image

ArF immersion

MAPPER
- Raster scan exposure @ 15μC/cm²
- P-CAR 45 nm thickness
- Pixel size 2.25 nm
- EPC by Double Gaussian model
Multiple-E-Beam Results

- 110 beams working
- Each beam covers a 2x2µm² block
- Met CD mean-to-target & CDU spec

<table>
<thead>
<tr>
<th>pattern</th>
<th>CD [nm]</th>
<th>CD Mean-to-target [nm]</th>
<th>CDu [nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Measured</td>
<td>Required</td>
<td>Measured</td>
</tr>
<tr>
<td>Dots dense</td>
<td>43.4</td>
<td>45.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Dots-isolated</td>
<td>46.4</td>
<td>45.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Horizontal dense</td>
<td>42.8</td>
<td>45.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Horlines-isolated</td>
<td>42.1</td>
<td>45.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Verlines-dense</td>
<td>44.9</td>
<td>45.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Vertical iso lines</td>
<td>46.5</td>
<td>45.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

From 11 randomly selected beams. Data from 110 beams are substantially identical.

### EPC for MAPPER Pre-α Tool @ TSMC

<table>
<thead>
<tr>
<th></th>
<th>P72</th>
<th>P81</th>
<th>P90</th>
<th>P122</th>
<th>P180</th>
<th>P360</th>
<th>P1202</th>
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</thead>
<tbody>
<tr>
<td><strong>Before EPC</strong></td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
<td><img src="image7" alt="Image" /></td>
</tr>
<tr>
<td><strong>After EPC</strong></td>
<td><img src="image8" alt="Image" /></td>
<td><img src="image9" alt="Image" /></td>
<td><img src="image10" alt="Image" /></td>
<td><img src="image11" alt="Image" /></td>
<td><img src="image12" alt="Image" /></td>
<td><img src="image13" alt="Image" /></td>
<td><img src="image14" alt="Image" /></td>
</tr>
</tbody>
</table>

#### Proximity error:

- 12.3 nm before EPC,
- 8.7 nm after EPC (not yet optimized)

#### 45-nm CAR-P1@ 30 μC/cm²

![Proximity Graph]

**Proximity**

- **Before Correction**
- **After Correction**

---

*Figures and graphs depict various patterns and measurements before and after EPC, showing improvements in proximity and pitch optimization.*
Challenge in Data Rate and Volume

- Total pixels in a field (0 & 1 bitmap)
  \[ \text{Total pixels} = \frac{(33\text{mm} \times 26\text{mm})}{(2.25\text{nm} \times 2.25\text{nm})} \times 1.1 \times (10\% \text{ over scan}) \]
  \[ = 190 \text{ T-bits} \]
  \[ = 21.2 \text{ T-Bytes} \]

- A 300-mm wafer has ~ 90 fields

- 20 WPH \( \Rightarrow \) < 1.8 sec / field

- 13,000 beams
  \( \Rightarrow \) data rate > 7.5 Gbps / beam!

- In addition to data rate, also challenge in data storage and cost
11-nm Node Dithering Raster Results

16-nm HP L/S with 0.1-nm EPC layout grid

50% NDV improvement by dithering raster
**Data Path Challenges**

- **System size and cost** with large amount of memory, processors, and transmitters.
- Main driver is high *total raw data bandwidth* (e.g. 45 Tbit/s).
- I/O “Bandwidth Wall” may limit scaling.
- **Power**
Related Presentations
Wednesday

- Influence of Massively Parallel E-Beam Direct Write Pixel Size on Electron Proximity Correction 7970-34
- Data path development for multiple electron beam maskless lithography 7930-35
Comparison of EUVL and MEB ML2
## CD Tolerance Considerations

<table>
<thead>
<tr>
<th>Node</th>
<th>22nm</th>
<th>16nm</th>
<th>11nm</th>
<th>8nm</th>
<th>CD tol budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half Pitch (nm)</td>
<td>32</td>
<td>22</td>
<td>16</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>CD (nm)</td>
<td>22</td>
<td>16</td>
<td>11</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Mask CD tol at 1X (nm) 60% of wafer, MEEF=1.5</td>
<td>1.39</td>
<td>1.01</td>
<td>0.69</td>
<td>0.50</td>
<td>6.3%</td>
</tr>
<tr>
<td>Wafer litho CD tol (nm)</td>
<td>1.54</td>
<td>1.12</td>
<td>0.77</td>
<td>0.56</td>
<td>7.0%</td>
</tr>
<tr>
<td>Wafer non-litho CD tol (nm)</td>
<td>0.74</td>
<td>0.54</td>
<td>0.37</td>
<td>0.27</td>
<td>3.4%</td>
</tr>
<tr>
<td>Total EUV CD tol (nm)</td>
<td>2.20</td>
<td>1.60</td>
<td>1.10</td>
<td>0.80</td>
<td>10%</td>
</tr>
<tr>
<td>Total maskless CD tol (nm)</td>
<td>1.71</td>
<td>1.24</td>
<td>0.85</td>
<td>0.62</td>
<td>7.8%</td>
</tr>
</tbody>
</table>
## Overlay Considerations

<table>
<thead>
<tr>
<th>Node</th>
<th>22nm</th>
<th>16nm</th>
<th>11nm</th>
<th>8nm</th>
<th>Overlay budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD (nm)</td>
<td>22</td>
<td>16</td>
<td>11</td>
<td>8</td>
<td>100%</td>
</tr>
<tr>
<td>Overlay requirement (nm) CD/3</td>
<td>7.3</td>
<td>5.3</td>
<td>3.7</td>
<td>2.7</td>
<td>33.3%</td>
</tr>
<tr>
<td>Wafer overlay (nm) single tool</td>
<td>6.0</td>
<td>4.2</td>
<td>2.9</td>
<td>2.1</td>
<td>27.3%</td>
</tr>
<tr>
<td>Mask edge placement budget (nm) 60% wafer overlay residue</td>
<td>3.6</td>
<td>2.5</td>
<td>1.8</td>
<td>1.2</td>
<td>16.4%</td>
</tr>
<tr>
<td>Mask flatness contribution allowed (nm) 1/3 of overlay requirement</td>
<td>2.4</td>
<td>1.8</td>
<td>1.2</td>
<td>0.9</td>
<td>11.1%</td>
</tr>
<tr>
<td>EUV CD contribution to overlay (nm) $[CD \text{ Tol}] / \sqrt{2}$</td>
<td>1.6</td>
<td>1.1</td>
<td>0.8</td>
<td>0.6</td>
<td>7.1%</td>
</tr>
<tr>
<td>Maskless CD contribution to overlay (nm) $[CD \text{ Tol}] / \sqrt{2}$</td>
<td>1.2</td>
<td>0.9</td>
<td>0.6</td>
<td>0.4</td>
<td>5.5%</td>
</tr>
<tr>
<td>EUV total overlay accuracy (nm)</td>
<td>7.6</td>
<td>5.3</td>
<td>3.7</td>
<td>2.6</td>
<td>34.4%</td>
</tr>
<tr>
<td>Maskless total overlay accuracy (nm)</td>
<td>6.1</td>
<td>4.3</td>
<td>3.0</td>
<td>2.1</td>
<td>27.8%</td>
</tr>
</tbody>
</table>
Defect Considerations

MEB
- Electrostatic chuck if a proprietary non-static chuck is not used
- Contamination
- Wafer processing

EUV
- Electrostatic chuck
- Contamination
- Source debris
- Mask defects
- Wafer processing
Throughput Loss at Node Advances

**MEB**

- 2X due to data volume
  - Use next-node datapath

- 2X due to shot noise
  - Increase parallelism or source brightness

- 2X due to lower current for higher resolution
  - Increase parallelism or source brightness

**EUV**

- 2X due to shot noise
  - Increase source power

- 2X due to more mirrors for higher NA
  - Increase source power

1. **1st method**
2. **2nd method**
3. **3rd method**
Cost Considerations

MEB
- Strong function of tool price and throughput
- Datapath
- High power consumption

EUV
- Strong function of tool price and throughput
- Atomic-precision optics
- High power, water, hydrogen consumptions
- Laser pulse, hydrogen, and collector mirror expenses


**Summary on the Comparison**

- Economy drives 16nm node to EUVL or MEB ML2.
- EUVL has limited Resolution/MEEF/DOF/Overlay margin for 8nm node.
- MEB has potential for better CDU and overlay accuracy because of elimination of mask contribution.
- EUVL needs more source power to compensate for throughput loss per node.
- MEB needs more parallelism or source brightness to compensate for throughput loss per node.
- EUVL has higher capital cost and expense.
- MEB is less developed.
Litho Decision Tree

- **MEBML2**
- **MEBML2 + CR-DPT**
- **CT**
- **EUVL**
- **Poly**
- **CR-DPT**
- **M0**
- **M1**
- **CT**
- **Feasible**
- **End**
- **Cost**
- **Absolute cost**
- **Insignificant difference**
- **Design restriction**
- **Lowest**
- **Acceptable**
- **Not acceptable**

- **HVM**
End of Presentation