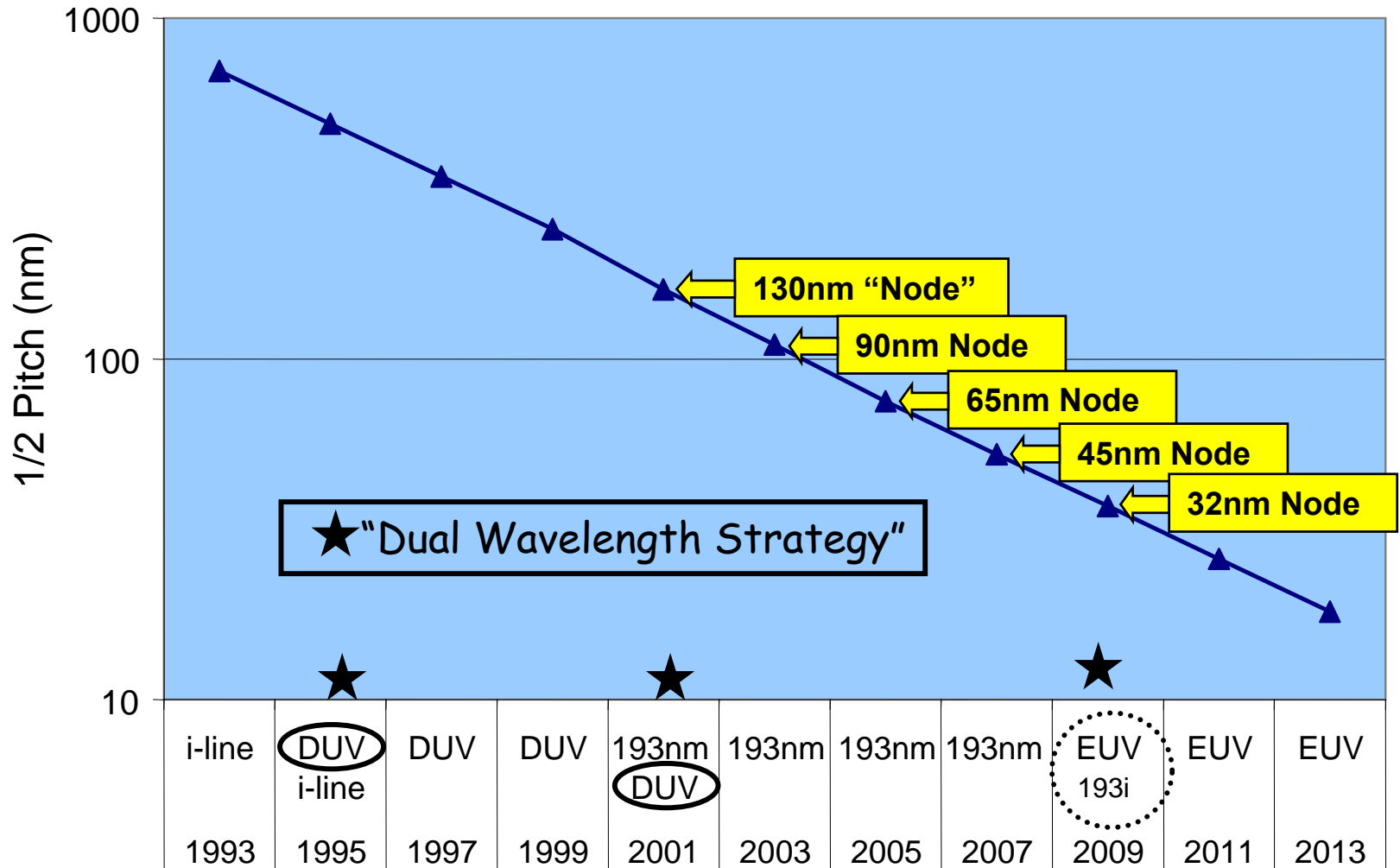


What is needed to enable sources for P1268? An Intel Perspective

Robert Bristol
Components Research
Intel Corp

Intel Lithography Roadmap Targets the 32nm node for EUVL Insertion



β tool timeline

- 2 years needed to develop process on beta tool before HVM ramp
- Q1'09 ramp for P1268: need working β tool Q1'07.
 - Historically, 2+ years to “work out bugs” for β tools at new wavelengths
 - Would like β tool earlier, but **H2'06** at the very latest.
- When are β sources needed?
 - Official answer: Ask integrators/source suppliers – Intel cares about scanner.
 - But if β tool needed at Intel H2'06, hard to imagine a representative source arriving at Integrator later than H2'05.

Source timeline: HVM (γ)

(Ask integrators for real answer, following is Intel opinion)

- Tool delivery Q1'09: sources no later than Q1'08, prototypes much earlier
- HVM-class source demo: expect no later than 2006
 - Demo: ~5x component lifetime, ~2x power on same machine
- When to focus resources on HVM technology path (LPP vs DPP, fuel)?
 - → Don't have time, resources to waste on non-HVM issues
 - » Suppliers may choose different paths, but detracts from industry focus
 - What about Xe for β , metal fuel for γ (or DPP for β , LPP for γ)?
 - » Detracts resources from g problems which must be completely solved
 - » Defeats some of the technology-validation purpose of beta tool
 - Up to each source supplier, but **Q4'04** conservative estimate for HVM focus
 - ≈ β source H2'05, γ demo '06
 - » For this to be possible, need major results in next few quarters

■

Q4'04: feasibility answers needed

“Feasibility”: know enough from focused experiments to have reasonable confidence of HVM solution path (100W, 10,000+ hr collector life, etc)

1. Collector degradation problem:

- Chemical coating/reaction w/ metal fuels: likely a must-have for 100W
- Sputtering: LPP solution not fully demonstrated
- Environmental contamination: C/O, must withstand above

→ Opinion: this is the #1 make-or-brake area for EUV Sources

2. Conversion efficiency: strong lever to other areas, suppliers need numbers they can reasonably achieve in actual HVM configuration

3. Electrode lifetime (DPP): increase plasma-wall >2x, even higher for 100W w/ Xe

4. Drive laser CoO (LPP): Metal fuel (~2% c.e): ~10kW very difficult to meet CoO, uptime. Xe (~1% ce): >20kW with CoO possible at all?

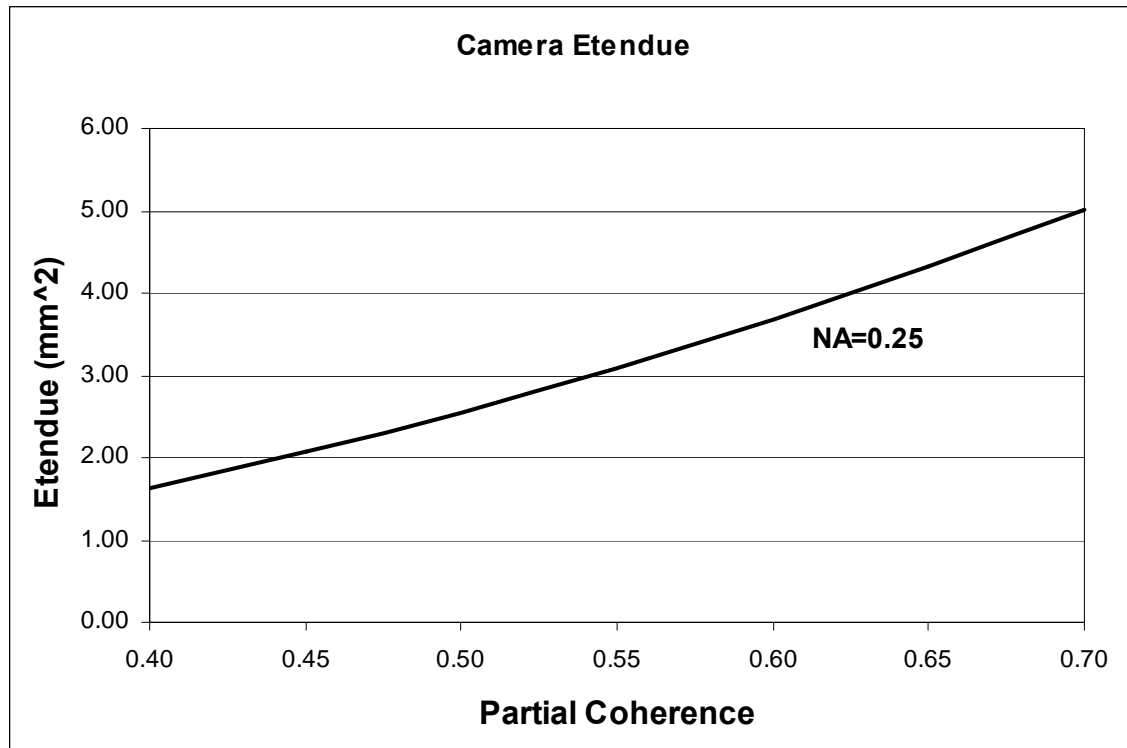
Intel-funded Universities / Nat. Labs

2004 Activities

- Overall philosophy: programs which can focus on key areas needed by source suppliers and deliver results by Q4'04.
 - Preliminary results even earlier (Q2-Q3).
 - More detailed follow-up in '05, depending on industry direction.
- ANL: More detailed plasma/surface modeling + experiments
- UIUC: Sputtering measurements, materials testing, RF mitigation of metal fuels
- LLNL: Further work on low-cost collector fabrication approach
 - Already demonstrated on ETS collector, 10x microstepper
 - Ref: SPIE Proc. Vol. 5193, p.98-104 (2003)
- Jose Sassian: Novel large-angle collector design (Normal, Grazing)

Issue: etendue

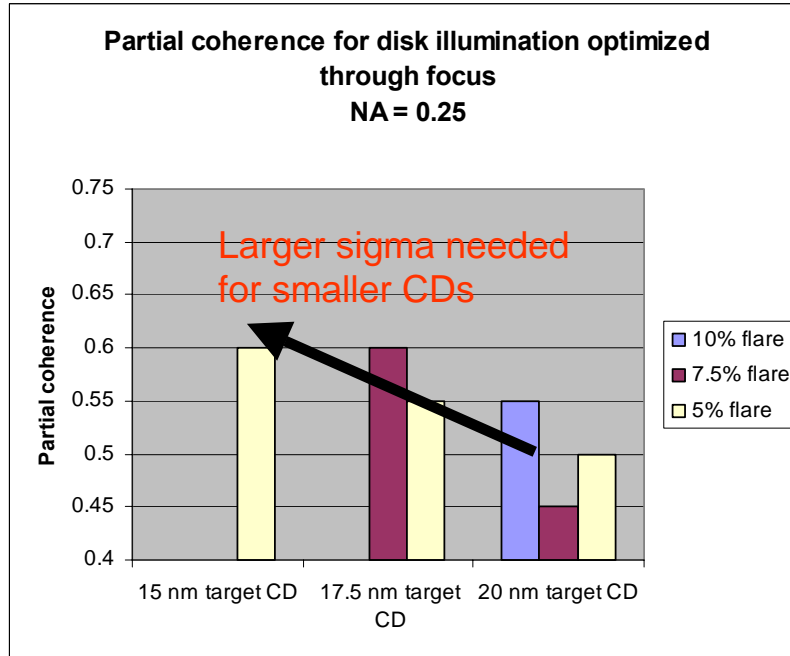
- Ultimately limited to camera etendue: $E_{\text{cam}} = \pi NA^2 A \sigma^2$
 - Etendue practically usable by source somewhat less
- $NA=0.25$, $A=2\text{mm} \times 26\text{mm}$. What about σ ?



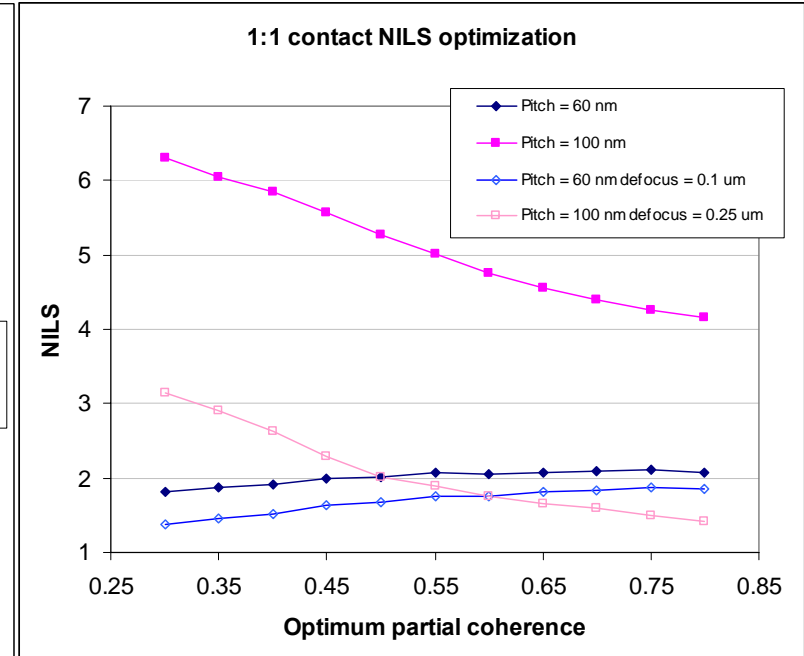
What value for σ ?

Ultimately driven by patterning requirements.

Isolated Line



Nested contacts



- » Isolated line shows $\sigma > 0.5$ is needed (M. Chandhok, Tuesday 1:30pm)
- » Nested contact has optimal aerial image quality at lower σ for 100 nm pitch but σ requirement increases for printing 60 nm pitch.
- Even at $\sigma = 0.5$, NILS for 100 nm pitch contact > 5
- **Bottom line: $\sigma \geq 0.5$ is acceptable (to Intel)**

$$E_{\text{cam}} \geq 2.5 \text{mm}^2$$

Summary

- γ tool need Q1'09, β tool 2H'06.
 - Likely implies γ -class demo '06, β source 2H'05
 - Ask integrators for final word on source timeline
- Above likely implies γ -source technology path decision for each source supplier **Q4'04**
- Key HVM feasibility data needed by Q4'04:
 - Collector degradation problem
 - Conversion efficiency
 - Electrode lifetime
 - Drive laser CoO
 - Many others also important
 - » low cost collector, collection efficiency, out-of-band, stability, etc